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& Cell Biology
Research**

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Perfusion/Microfluidics

Oocyte Clamps

Patch Clamps

Microinjectors

Microincubators

Micromanipulators

Ussing/Diffusion Systems

Live Cell Imaging Chambers

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Warner Instruments is proud to introduce our new Electrophysiology & Cell Biology Catalog. This catalog contains many new products for cell imaging, biosensing, microinjection, and electrophysiology.

NEW Products Featured Include:

- **PLI-100A Picoliter Microinjector** - With three positive and two negative pressure capabilities, the versatile PLI-100A is capable of large injections into capillaries or small injections into mammalian nuclei.
- **BioStat Multi-channel Potentiostat** - The BioStat is a software-driven, multi-mode potentiostat that can be used for measurement of pH, reactive oxygen species, and nitric oxide.
- **Compact Motorized Micromanipulator** - Linear amplifiers, used to drive the stepper motors, eliminate stray electromagnetic radiation; reducing noise and resulting in improved patch clamp and electrophysiology performance.
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- **CL-200 Dual Channel Bipolar Temperature Controller** - Single control temperature adjustment, built-in protection for Peltier devices, open thermistor fault protection.
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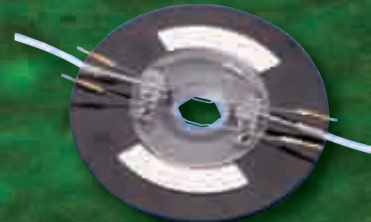
Ralph Abate
Business Manager, **Warner Instruments**



Cell Biology Research Catalog



NEW CL-200 Dual Channel Bipolar Temperature Controller, p. 111



NEW RC-49FS Perfusion Chamber with Field Stimulation, p. 54



NEW PFC-1 Proflow Chamber, p. 57



NEW BioStat Multi-channel Potentiostat, p. 372



NEW Compact Motorized Micromanipulator, p. 297



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Temperature Control	Temperature Control
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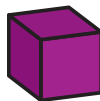
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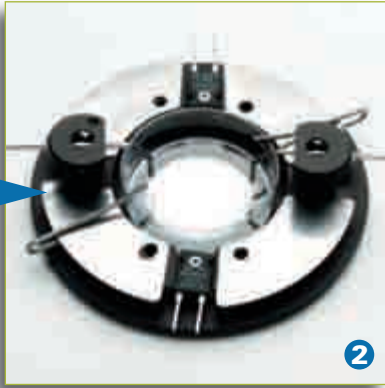
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Chambers, Perfusion and Temperature Control for Live Cell Imaging

Chambers

an integrated systems approach



Imaging and Recording Chambers



Series 40 imaging and recording chambers
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Stage Adapters
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Inline solution heater and coolers
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Temperature Controller Cables
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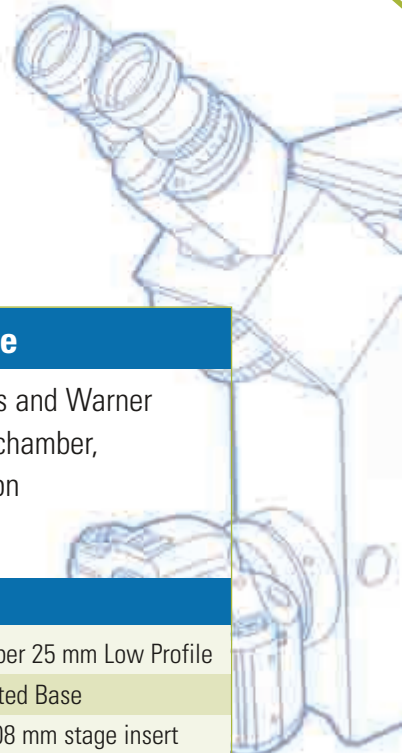


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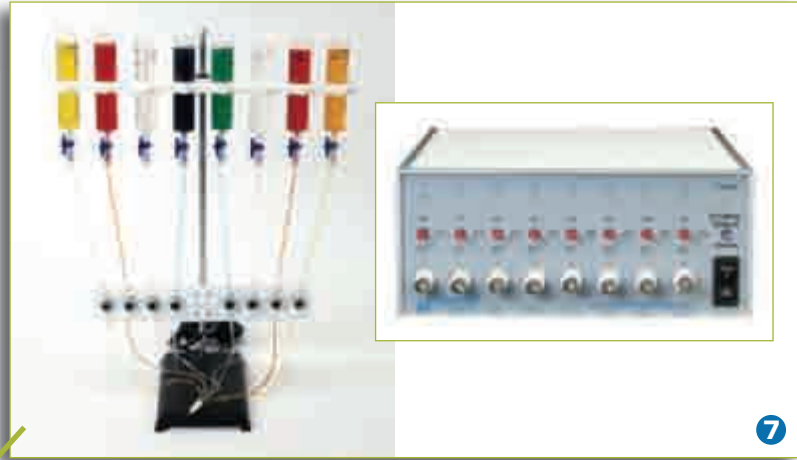
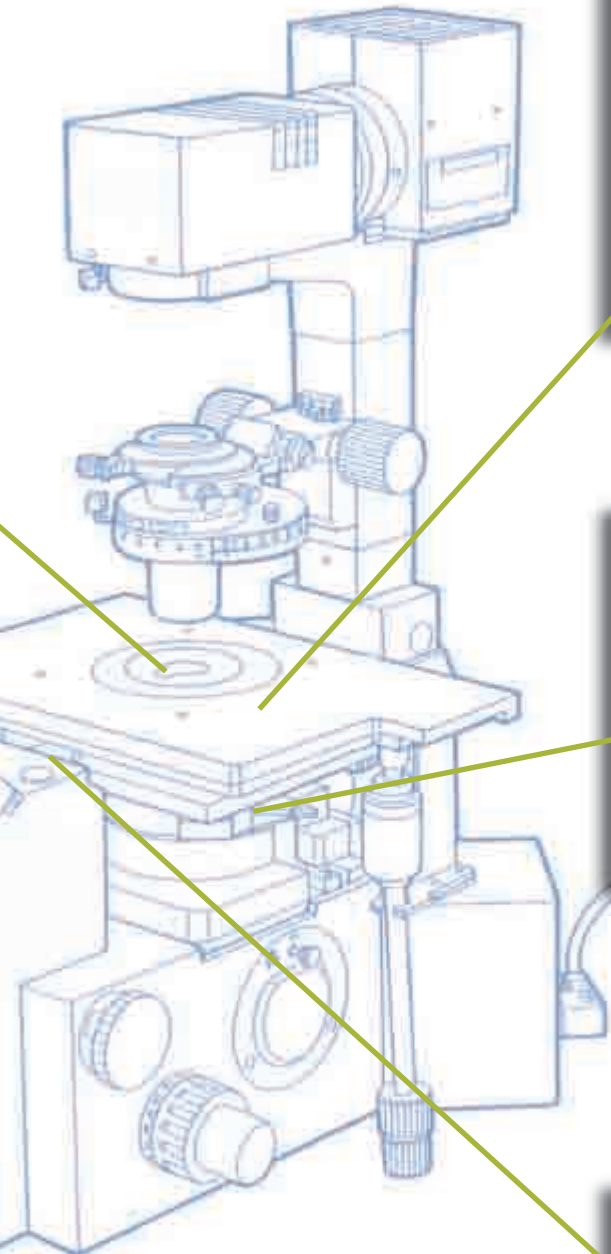
Typical, complete package

for use with 35 mm culture dishes and Warner quick change chambers includes chamber, temperature control, Inline solution heater and stage adapter

Model	Product
1 RC-40LP	Quick Change Chamber 25 mm Low Profile
2 QE-1	Quick Exchange Heated Base
3 SA-NIK	Stage Adapter for 108 mm stage insert
4 SH-27B	Solution Heater
5 CC-28	Cable Assembly for Heater Platforms
6 TC-344B	Dual Channel Heater Controller
7 VC-8	Eight Channel Perfusion Valve Controller
8 OW Series	Objective Warmer
TC-124	Temperature Controller
9 Spill Sensor	Solution Leak Detector



systems approach



Perfusion Systems, page 89



Objective Warmers, page 122



Spill Sensors, page 105

	open bath	closed bath	small volume (< 100 µl)	medium volume	large volume (> 300 µl)	patch studies	tissue or slice studies	oocyte studies	epithelial or ussing studies	special design	micro-incubation chamber system	35 mm culture dish	50 mm culture dish	field stimulation	upright microscopy	platforms
Series 20 Chambers	RC-20	●	●													P-5, PM-5
	RC-20H	●	●													P-5, PM-5
	RC-21B	●		●											●	P-2, PM-2
	RC-21BR	●		●											●	P-2, PM-2
	RC-21BRFS	●			●									●	●	P-2, PM-2
	RC-21BDW				●										●	P-2, PM-2
	RC-21BRW	●			●										●	P-2, PM-2
	RC-22	●			●		●									P-1, PM-1
	RC-22C	●			●		●									P-1, PM-1
	RC-24	●		●			●									P-1, PM-1
	RC-24E	●		●			●									P-1, PM-1
	RC-24N	●		●			●									P-1, PM-1
	RC-25	●		●			●									P-3, PM-3
	RC-25F	●			●		●									P-4, PM-4
	RC-26	●			●		●									P-1, PM-1
	RC-26G	●			●		●									P-1, PM-1
	RC-26GLP	●			●		●									P-1, PM-1
	RC-26GS	●			●		●			●						PM-8
	RC-26Z	●			●			●								P-1, PM-1
RC-27	●				●		●								P-6, PM-6	
RC-27L	●				●		●								P-6D, PM-6D	
RC-27N	●				●		●								P-6, PM-6	
RC-27NE	●				●		●						●		P-6, PM-6	
RC-28	●			●		●									P-6, PM-6	
RC-29	●				●		●				●				P-6D, PM-6D	
RC-30	●	●	●	●	●					●					●	
RC-30HV	●	●	●	●	●					●					●	
RC-30WA	●	●	●	●	●					●					●	
RC-31A	●	●	●	●	●					●						
PFC-1	●	●	●	●	●				●							
RC-50	●	●	●						●	●					●	
RC-50-R3	●	●	●						●	●					●	
RC-50-R15	●	●	basal	apical					●	●					●	
JG-23N/HP	●			●						●						P-1, PM-1
JG-23W/HP	●			●						●						P-1, PM-1
JG-23W/LP	●			●						●						P-1, PM-1
RC-27D	●				●		●			●					●	PM-7
RC-27LD	●				●		●			●					●	PM-7D
YC-1		●	●							●						

Series 30 Chambers

Series 50 Chambers

Ultra Quiet Imaging Chambers

	open bath	closed bath	small volume (< 100 µl)	medium volume	large volume (> 300 µl)	patch studies	tissue or slice studies	oocyte studies	epithelial or ussing studies	special design	micro-incubation chamber system	35 mm culture dish	50 mm culture dish	field stimulation	upright microscopy	platforms
Oocyte Chambers	RC-1Z	●	●					●							●	
	RC-3Z	●	●	●				●							●	
RC Series Chambers	RC-10	●		●	●	●		●							●	
	RC-16	●		●	●	●		●							●	
Quick Coverslip Exchange Chambers	RC-40LP	●			●	●	●	●			●				●	OE-1
	RC-40HP	●		●	●	●	●	●			●				●	OE-1
	RC-41LP	●		●		●	●	●			●				●	OE-1
	RC-42LP	●			●	●	●	●			●				●	OE-1
	RC-43C	●			●	●	●	●			●				●	OE-1
	RC-46SLP	●			●	●	●	●			●				●	OE-1
	RC-46SNLP	●		●		●	●	●			●				●	OE-1
	RC-47FSLP	●			●	●	●	●			●			●	●	OE-1
RC-48LP	●		●		●	●	●			●					●	OE-1
Culture Dish Inserts 35 mm dishes	RC-33DM	●		●								●				
	RC-33DL	●		●								●				
	RC-33SN	●			●							●				
	RC-33SL	●			●							●				
	RC-37W	●			●							●				
	RC-37WC	●			●							●				
	RC-37WS	●			●							●				
	RC-37F	●			●							●				
	RC-37FC	●			●							●		●		
	RC-37FS	●			●							●		●		
	RC-61T-01	●			●							●				
	RC-61T-02	●			●							●				
RC-61T-03	●			●							●					
RC-61T-04	●		●								●					
RC-61T-05	●			●							●					
RC-61T-06	●				●						●					
Culture Dish Platforms	OE-1	●									●					
	OE-2	●									●		●			
Micro-incubation	DH-35	●									●					
	DH-35iL	●									●					
	DH-40iL	●									●					
	DH-50	●									●		●			

Heating of Warner Imaging and Recording Chambers

Application Fundamentals

Why Heat?

Researchers have long understood the importance of temperature regulation in the study of cellular function. For example, a recent PubMed search using the keywords “temperature” and “cell” produced over 29,000 references since 1995, most addressing the effect of temperature on the biophysical and metabolic function of cells. In addition, the performance of imaging system optics is exquisitely sensitive to variations in temperature as revealed by a shifting focal plane as the temperature of the objective changes. Therefore, for the scientist studying cellular function in an imaging and recording environment, the importance of tight thermal control cannot be overstated.

A number of issues confront the researcher attempting to control cellular temperature. These include maintaining a constant and uniform bath temperature under various flow rates and controlling for changes in the ambient temperature of the environment. In addition, effects resulting from the introduction of cold drugs or solution to the perfusion path, and heat sinks due to microscope optics and stage adapters must be addressed.

General Issues

Sources of Heat Flux

Heat flux pathways can be generally characterized as either conductive, convective, or radiative. Traditionally, the greatest effort is directed towards controlling conductive pathways, followed by convective pathways. We define a conduction heat pathway as one wherein heat energy is transmitted through a continuous intervening material. These include the microscope stage or objective, the perfusion solution, the chamber platform and other physical elements of the working environment. Heat flux through convective pathways are generally less significant but include evaporation or condensation and heat transfer due to the movement of air across the imaging chamber. Radiative pathways are, in general, easily controlled and will only be briefly considered here.

Space and Time Considerations in Uneven Heat Conduction

We first consider sources of uneven heat distribution in the spatial regime. These include poor heat conduction across the chamber bath or from the platform to the chamber. Poor heat conduction across the bath is manifest as a temperature gradient within the bathing solution. A gradient of this type is often induced by an immersion objective placed in direct apposition (either above or below) to the sample. Heat flux through this pathway can be significant, resulting in as much as a 10°C temperature change within 3-5 mm. Another, less dramatic, temperature gradient can be generated in the bath by restricting the application of heat to just the chamber platform. Since the platform applies heat only along the edge of a chamber, a temperature gradient will be established due to the heat capacity of water coupled with flow of relatively cold solution into the chamber.

Uneven heating in the temporal regime can be generated by varying the rate at which cool perfusion solution is introduced into a heated platform, or by introducing drugs or solution (into the perfusion path) at a temperature different than that currently being perfused. These considerations will be addressed in greater detail below.

Outgassing

Another significant issue related to the application of heat to perfusion solutions is termed outgassing. Under standard conditions, atmospheric gas in contact with a liquid solubilizes into solution and tends towards an

equilibrium determined in part by the gasses partial pressure and the temperature of the liquid. Generally speaking, cold liquids are capable of solubilizing a greater volume of gas than a warm liquid. Therefore, as the temperature of a liquid increases, dissolved gasses come out of solution resulting in the appearance of bubbles.

Heating Methods

A number of approaches are used by investigators to regulate the temperature of a sample under study. These include warming the chamber platform and/or microscope objective using resistive, Peltier, or liquid based application devices, channeling warm air across the imaging chamber and/or optical components, and regulating the temperature of the perfusing solution. Techniques for regulating the temperature of perfusates include preheating the solution reservoir and/or using an inline solution heater in the perfusion pathway. Each strategy has its strengths and weaknesses and are discussed below.

How Temperature is Sensed

In general, temperature is measured using a thermistor or similar device and fed back into a temperature controller which adjusts power to the heating element. When regulating temperature it is important to account for the response time of the feedback loop since this can cause the system to oscillate.

Control and Regulation

Warner Instruments temperature controllers utilizes two thermistors per channel to provide monitoring and feedback information to the controller. One thermistor is placed within the heated element (e.g., chamber platform, in-line heater, etc.) to measure the temperature of the heater block. Information from this thermistor is fed back to the control mechanism which applies sufficient power to the heater to maintain the controller set point.

The second thermistor is usually placed in the solution path close to the sample and measures the temperature at the sample. Information from this thermistor is used by the researcher to adjust the set point of the controller and to monitor the performance of the system.

This approach is very effective in providing tight thermal control (± 0.1 C) of the heating element, and consequently the perfusion solution, as long as the feedback loop is sufficiently optimized. Warner Instrument temperature controllers are provided with user selectable feedback

Heating of Warner Imaging and Recording Chambers

Application Fundamentals (continued)

response time constants allowing the instrument to accommodate different operating conditions

Methodology

In-line Solution Heating

The simplest and most direct approach for the application of heat to a sample is to preheat the solution immediately prior to its delivery to the chamber. The warmed perfusate washes over the sample and maintains a uniform temperature at the sample, even with variable flow rates. This method works well as long as solution continues to flow through the heater into the chamber.

A number of considerations are important when using this approach. First, it is important to minimize the distance between the heater and chamber. If too much heat is lost en route, the user can attempt to raise the heater controller set point above the boiling point of the solution. In addition, variations in the flow rate can change the quantity of heat lost as the solution moves from heater to chamber.

Chamber Platform Heating

Another strategy is to heat the chamber platform. This is usually achieved by using a resistive element and this approach is provided for in Warner chambers. A slightly more sophisticated tactic would be to supply heat to the platform using either a Peltier or liquid based heating element. Regardless of the method employed, this strategy is best suited for conditions where the solution flow rate is extremely slow or nonexistent.

A number of considerations are important when using this approach. First, the perfusing solution receives heat energy only after entering the chamber, possibly generating a temperature gradient within the bath. Second, since the platform applies heat only to the edges of the chamber, the rate of transfer to the solution is slow. However, this approach excels for conditions where solution flow is nonexistent, such as maintaining a constant temperature while loading cells with indicator dyes.

In all cases, it is recommended that the chamber platform be thermally isolated from the microscope stage as this can be a significant heat sink, second only to the microscope objective. This is most readily achieved by the use of a plastic stage adapter. While the primary purpose of a stage adapter is to mate a platform to the specific microscope stage, the plastic material used can also provide the desired thermal isolation.

Solution Reservoir Heating

Heating the solution reservoir is not generally considered a successful strategy for maintaining temperature in the bath since most, if not all, of the heat energy is lost en route to the chamber. However, this technique is important if outgassing of solutions is a problem. Since the gas load of a solution is dependent on partial pressure and temperature, preheating the solution at atmospheric pressure before delivery to the final heater will minimize the occurrence of bubbles in the bath, even if the solution cools en route. Therefore, solution reservoir heating is best used in combination with other heating techniques as described below.

Microscope Objective Heating

While necessary, the use of immersion objectives in imaging presents a difficult problem for the researcher attempting to maintain temperature at the sample. Since the objective is in direct contact with the solution or the chamber, and is placed immediately above or below the sample, it presents a significant conduction pathway within the system.

Heated objective collars are commercially available and are designed to minimize heat flux through the optics. However, many researchers indicate that small variations in temperature, as the collar cycles off and on, induces an oscillating shift in the focus plane. Warner Instruments has an objective warmer which specifically addresses this issue. The heated collar does not come into direct contact with the objective but instead relies on a slower radiative heat transfer between the heater and the objective. The capacitive thermal properties of the intervening air, coupled with tight heating control by the temperature controller, removes any abrupt changes in the temperature of the objective and stabilizes the system against shifts in the focal plane.

As a final note, many researchers have expressed concerns about deep thermal cycling an objective between uses. Some investigators have addressed this issue by maintaining the objective warmer, and hence the objective, at a constant temperature, even when not in use.

Heated Enclosures

Another strategy currently in use is to encase the imaging chamber and microscope optics within a heated enclosure. The main advantage of this approach is that both the chamber and objective are maintained at a stable and uniform temperature. Heat is usually applied to the environment by the introduction of warmed air to the enclosure. Some disadvantages are slow responses to changes in the thermal set point, possible introduction of airborne contaminants from the blower system, and the requirement for bulky equipment on or about the imaging system.

Discussion

Each heating strategy discussed above has strengths and weaknesses making it an incomplete solution for issues encountered with heating. However, most experimental difficulties can be solved by using these strategies in combination.

For example, platform heating alone is not sufficient to stably heat a perfusing solution, but is necessary if solution flow is to be interrupted for any reason. In addition, the most effective method of heating a perfusion solution is via an in-line heater. Therefore, an optimal combination for experiments where tight thermal control is desired under variable, very slow, or interrupted flow conditions would be a combination of in-line and platform heating.

If solutions are stored cold and used before reaching operating temperature, or if the temperature is changed during an experiment, then outgassing at the sample can be a problem. This is addressed by including reservoir preheating in the experimental setup. However, reservoir heating is unable to supply heated solutions to the chamber and is best used in combination with an in-line solution heater.

Finally, recall that an objective warmer reduces the thermal gradient between the microscope and sample. This, in turn, increases the efficiency of any heating method employed. Of course, all described approaches can be used in combination to provide efficient thermal regulation under virtually any condition.

Warner Instruments provides high quality single and dual channel temperature controllers, solution reservoir heaters, chamber platform heaters, in-line solution heaters, stage adapters, and the aforementioned objective warmer. We invite you to call our technical support staff and we will be glad to aid you in determining the best application of these heating strategies to your experimental setup.

oocyte chambers

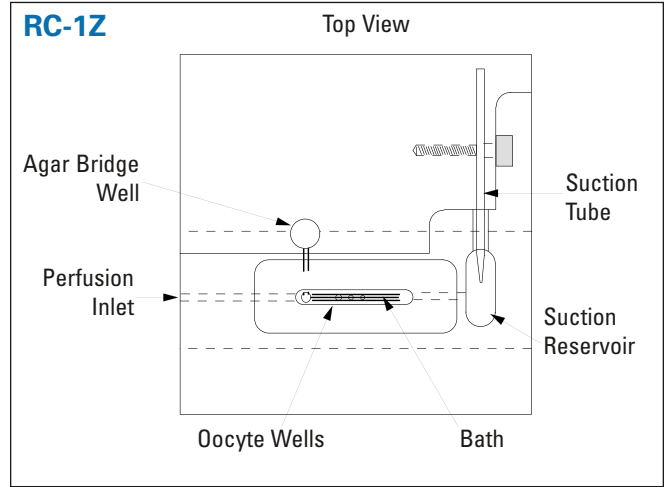
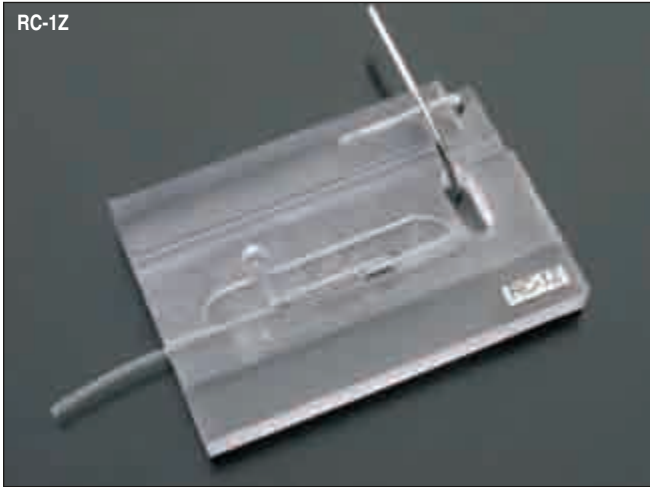
RC-1Z

Oocyte Recording Chamber

Chambers

oocyte chambers

A simple, low cost oocyte perfusion chamber



- Specially designed for oocyte studies
- Unique slotted bath
- Dimpled bottom aids oocyte impalement

The RC-1Z chamber features a unique slot-shaped bath for applications requiring rapid perfusion.

The chamber is constructed using a two-piece design. The top piece forms the chamber body and contains a solution aspiration reservoir. An agar bridge well with connecting channel to the input side of the bath is also provided. An isolated well is provided on the downstream side of the bath, however, most users place the sense electrode directly into the suction well.

The bottom piece forms the floor of the chamber and houses the oocyte work area. To aid in securing the oocyte into position during impalement, the chamber bottom has three dimples with dimple diameters: 0.8, 1.0, and 1.2 mm. Three grooves milled into the chamber bottom (parallel to the direction of solution flow) aid in bathing the bottom side of the oocyte during perfusion.

Solutions are removed from the suction well via an adjustable suction tube and bath solution height is adjusted by raising or lowering the suction tube. The perfusion input accepts standard 1/16" OD (PE-160) polyethylene tubing.

Each chamber includes 10 feet of polyethylene (PE-160) tubing.

Specifications

Material	Polycarbonate
Footprint (L x W)	7.7 x 5.1 cm
Bath Dimensions (L x W x H)	25 x 3.5 x 2.5 mm
Volume, by Depth	85 µl/mm
Chamber Floor Insert	25 x 75 x 3 mm, polycarbonate
Input Tubing (ID x OD)	1.14 x 1.57 mm (PE-160)
Aspirator Coupling	1.67 mm OD

Order # Model Product

W4 64-0318 RC-1Z Oocyte Chamber

Optional Accessories

W4 64-1586 BPM-1 Base Plate Magnetic Steel

W4 64-0206 MP-2 Perfusion Manifold, 2 Inputs

W4 64-0207 MP-3 Perfusion Manifold, 3 Inputs

W4 64-0208 MP-4 Perfusion Manifold, 4 Inputs

W4 64-0209 MP-5 Perfusion Manifold, 5 Inputs

W4 64-0210 MP-6 Perfusion Manifold, 6 Inputs

W4 64-0211 MP-8 Perfusion Manifold, 8 Inputs

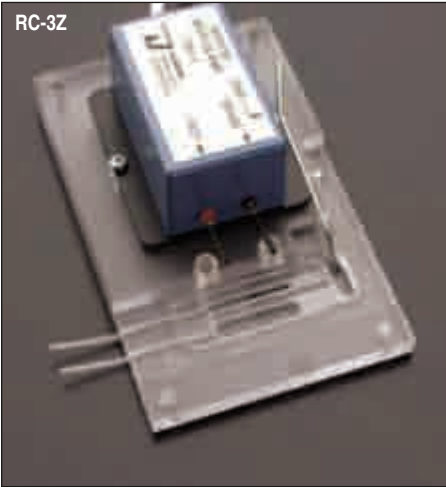
W4 64-0755 PE-160/10 Polyethylene Tubing

oocyte chambers

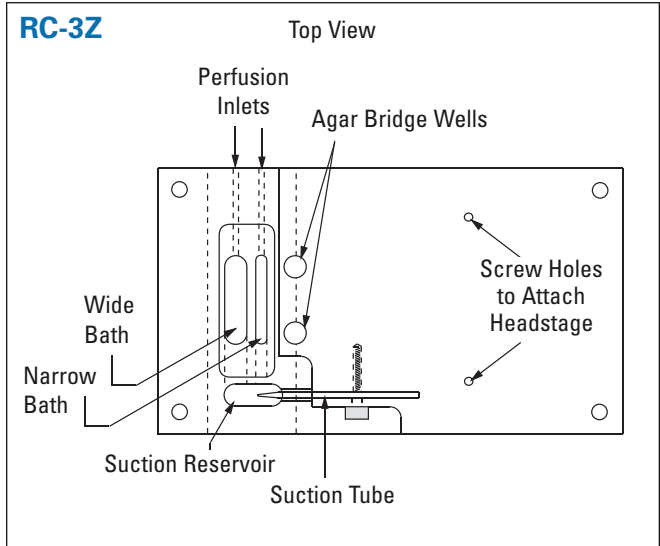
RC-3Z

Oocyte Recording Chamber

A simple, low-cost chamber for studies of oocytes and other large cell structures



RC-3Z Chamber shown with the Warner 7251 I Bath Clamp Headstage



- Specially designed for oocyte studies
- Features two slot-shaped bath wells
- Allows fast solution exchange and easy cell access
- Adjustable solution height

The RC-3Z features two slotted bath wells; a narrow bath for applications requiring rapid solution exchange, and a wider bath allowing good electrode access. The chamber is constructed using a two-piece design. The top piece forms the chamber body and contains a solution aspiration reservoir. The bottom piece forms the floor of the chamber and houses the oocyte work area. An agar bridge well with connecting channel to the input side of the bath is also provided. An isolated well is provided on the downstream side of the bath, however, most users place the sense electrode directly into the suction well.

The perfusion inputs accept standard polyethylene tubing (PE-160). Solutions are removed from the suction well via an adjustable suction tube and solution height is set by raising or lowering this suction tube. The suction tube out-port connects to 1.67 mm ID tubing. Threaded holes are incorporated in the chamber body for mounting of the OC-725C bath headstage.

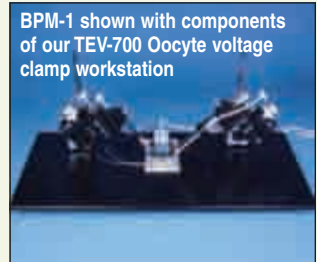
Each chamber includes 10 feet of polyethylene (PE-160) tubing.

Specifications

Chamber material	Polycarbonate
Footprint (L x W)	13 x 7.7 cm (5.1 x 3 in)
Chamber floor insert (L x W x H)	75 x 25 x 1 mm, polycarbonate
Narrow bath dimension (L x W x H)	27 x 3.2 x 3.2 mm
Narrow bath volume, by depth	85 µl/mm
Wide bath dimension (L x W x H)	27 x 6.3 x 3.2 mm
Wide bath volume, by depth	170 µl/mm
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)
Aspirator coupling	1.67 mm (OD)

BPM-1

Steel Base Plate



BPM-1 shown with components of our TEV-700 Oocyte voltage clamp workstation

This solid steel plate provides a stable platform for mounting micromanipulators mounted on magnetic bases. A highly durable powder coating applied to the surface makes it impervious to most common spills in the lab.

Specifications

Dimensions	30.5 x 61.0 x 0.95 cm (12 x 24 x 3/8 inch)
Weight:	14.06 kg (31 lb)

Order #	Model	Product
W4 64-0319	RC-3Z	Oocyte Chamber
Optional Accessories		
W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-1586	BPM-1	Base Plate Magnetic Steel
W4 64-0206	MP-2	Perfusion Manifold, 2 Inputs
W4 64-0207	MP-3	Perfusion Manifold, 3 Inputs
W4 64-0208	MP-4	Perfusion Manifold, 4 Inputs
W4 64-0209	MP-5	Perfusion Manifold, 5 Inputs
W4 64-0210	MP-6	Perfusion Manifold, 6 Inputs
W4 64-0211	MP-8	Perfusion Manifold, 8 Inputs

RC series-legacy design

RC-10, RC-11, RC-13 and RC-16

RC Series Recording Chambers

Legacy, large bath chambers suitable for oocyte studies

Chambers

RC series chambers- legacy design



These chambers are open bath chambers suitable for physiological experiments performed with inverted or dissecting microscopes, including patch and oocyte recording, isolated perfused tubule, and cell impalement studies. RC chambers have also been used with fluorescence microscopy.

RC Series chambers are made from polycarbonate. A #2 thickness coverslip (24 x 60 mm, user attached) becomes the floor of the bath. The coverslip can be attached with vacuum grease or more permanently with Sylgard or RTV cement. Models vary in bath diameter.

Solution can be introduced via gravity-feed and removed via suction, or alternatively, input and output can be pump-controlled. Flow rates can exceed 10 ml/min with gravity feed. The perfusion input accepts standard 1.57 mm OD polyethylene tubing (PE-160). Solutions are removed from a separate suction reservoir to minimize noise in the recording chamber. The suction tube height is adjustable to control the bath solution level.

Multiple perfusion lines can be connected using an MP series manifold, see page 101, in place of the single-line connector supplied with the chamber. An isolated reservoir is provided for an agar bridge in the recording ground circuit.

RC-10

This small chamber with 10 mm diameter bath is recommended where small volumes and fast solution exchange is important. Bath volume is 160 μ l at 2 mm solution height. A single agar bridge well is supplied.

RC-11, RC-13 and RC-16

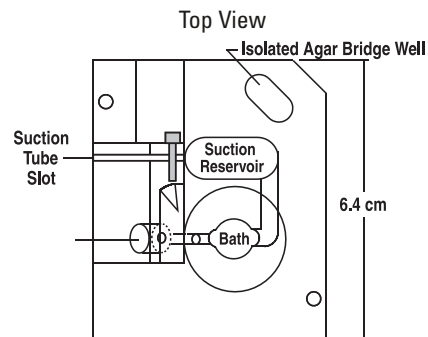
These larger bath chambers are used for studies of slices, oocytes, or other large preparations. Models RC-13 and RC-16 may also be used in patch clamp experiments where cultured coverslips are placed in the chamber.* The RC-13 accepts 12 mm diameter coverslips and the RC-16 accepts 15 mm diameter coverslips. A groove is milled in the chamber underside to hold the coverslip in place.

* Note: The double thickness of glass (bottom + sample coverslips) may not be compatible with some short working distance microscope objectives.

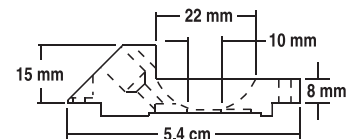
Mounting the Chamber

RC Series chambers are mounted onto a microscope using one of the stage adapters on the following page. Each chamber is supplied with one single input perfusion connector, one suction tube and one package of #2 coverslips (24 x 60 mm). See page 70 for additional coverslips.

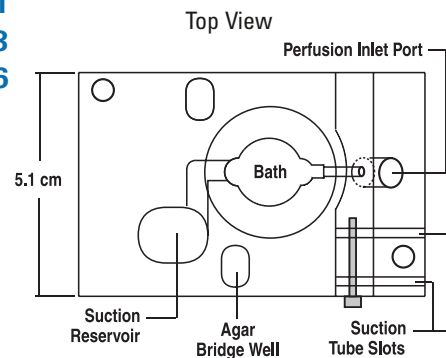
RC-10



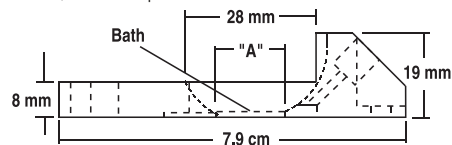
Side View



RC-11 RC-13 RC-16



Side View

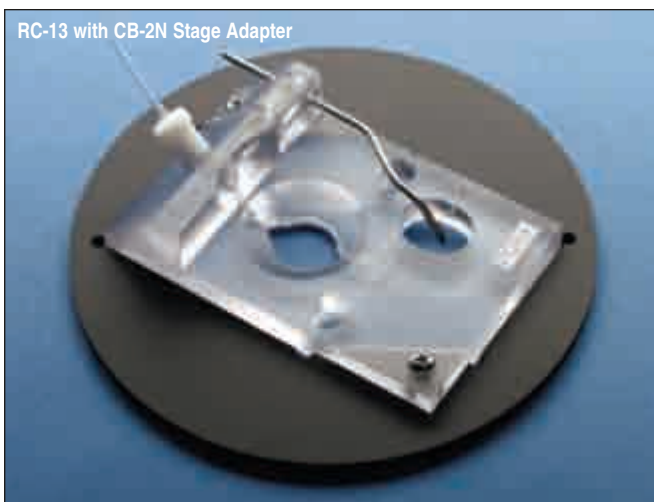


RC-11: A=11 mm, Vol.= 190 μ l
RC-13: A=13 mm, Vol.= 260 μ l
RC-16: A=16 mm, Vol.= 400 μ l

Order #	Model	Product
W4 64-0306	RC-10	Open Bath Chamber/10 mm Bath
W4 64-0307	RC-11	Open Bath Chamber/11 mm Bath
W4 64-0308	RC-13	Open Bath Chamber/13 mm Bath
W4 64-0309	RC-16	Open Bath Chamber/16 mm Bath

RC series-legacy design

RC Series Stage Adapters



RC Series stage adapter bases are made for a variety of microscopes. Standard models fit the most commonly used stage on the microscope model cited. However, microscopes are often fitted with optional or special purpose stages. Refer to the outline drawings to determine the correct adapter for your microscope. Modified or special size adapters can be ordered, call our technical support department for details. Material is polycarbonate.

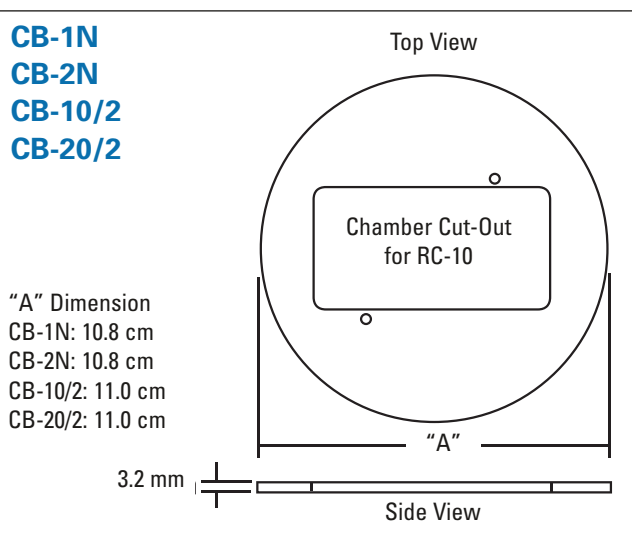
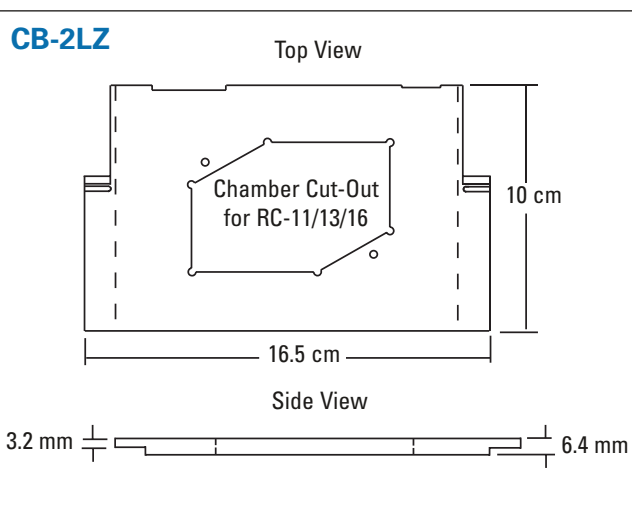
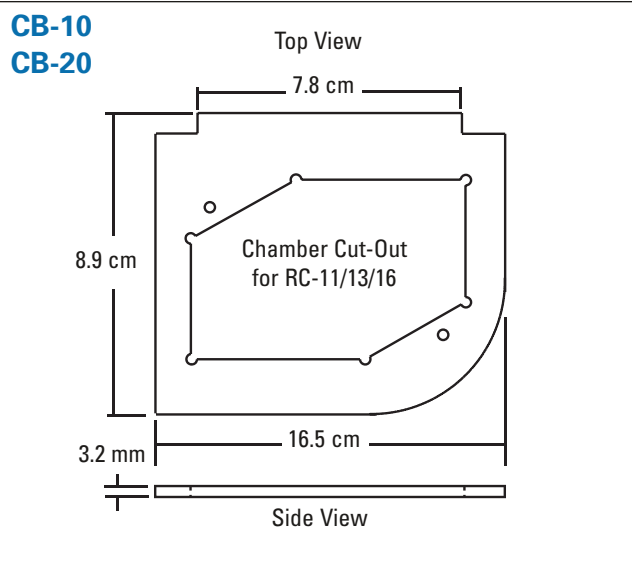
Order #	Model	Product
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RC-10 Adapters

W4 64-0311	CB-1N	Nikon for Diaphot/TE200/TE300
W4 64-0312	CB-10	Olympus for IMT
W4 64-0313	CB-10/2	Olympus for IMT-2/IX-50/IX-70

RC-11/13/16 Adapters

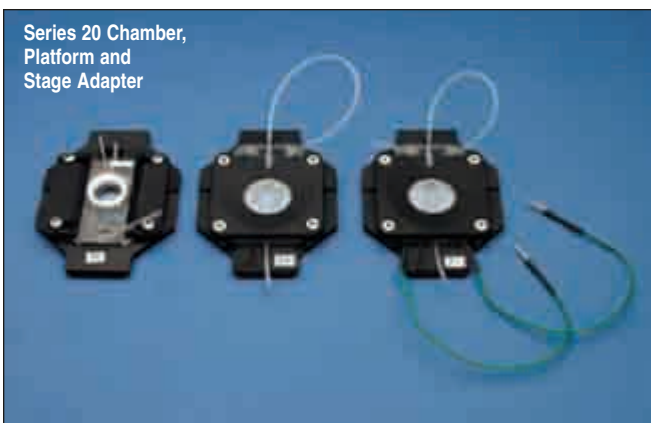
W4 64-0314	CB-2N	Nikon for Diaphot/TE200/TE300
W4 64-0315	CB-20	Olympus for IMT
W4 64-0316	CB-20/2	Olympus for IMT-2/IX-50/IX-70
W4 64-0317	CB-2LZ	Zeiss for Axiovert



Series 20 Chambers

Series 20 Perfusion Chambers for Imaging and Recording

General Information



Modular Design

Series 20 chambers are a family of models designed to fill a large number of imaging and recording needs. The modular design of Series 20 chambers consists of two parts; a polycarbonate chamber (insert) and an aluminum platform (holder). The platform clamps onto the chamber providing a seal between the chamber and coverslip. Platforms come in both heater and non-heater styles and heater platforms are used where chamber warming is required. The platform design allows quick removal of the chamber for exchange of the coverslip. A variety of bath sizes and shapes are offered to provide a ready solution to many research requirements. Most models are stocked in depth for fast delivery.

Single Coverslip Design

A common feature of Series 20 chambers is the use of a disposable coverslip as the bottom or floor of the chamber. In many cases, this same coverslip will contain the cells to be studied. Thus, when used with an inverted microscope, the image is viewed through a single coverslip (#1 thickness, nominally 0.15 mm).

Laminar Flow-Fast Exchange

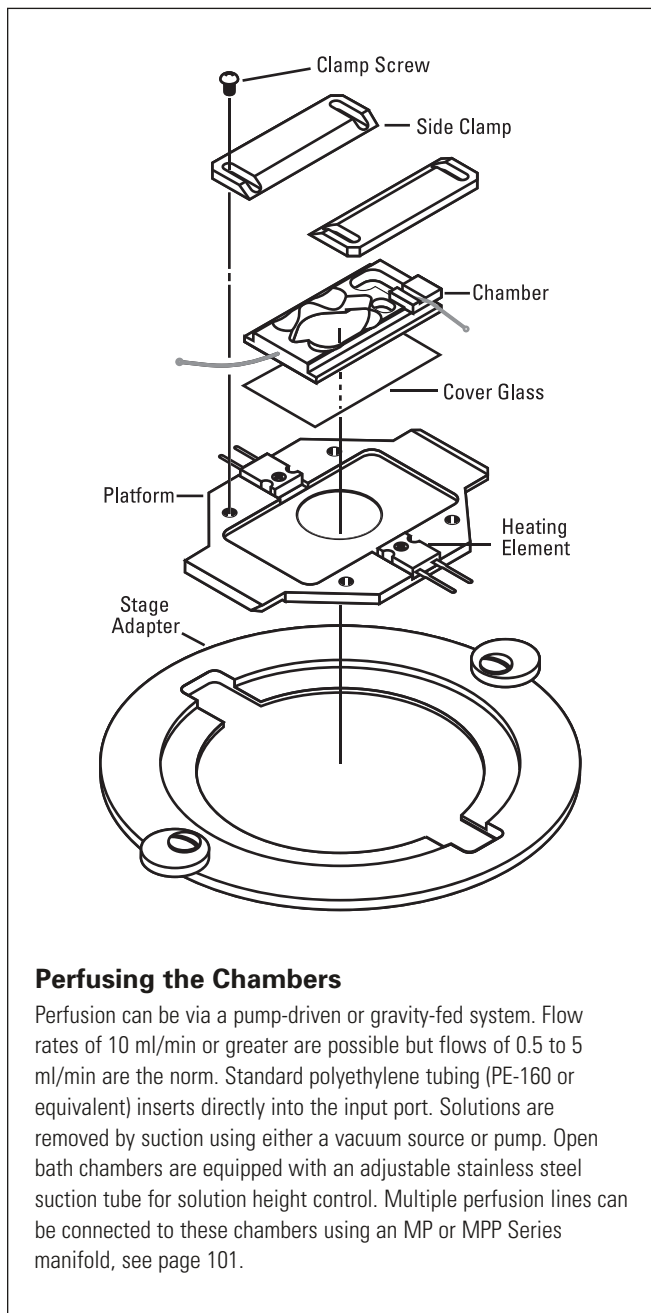
A diamond-shaped bath is incorporated into many Series 20 chambers (models thru RC-26) to provide linear solution flow. Studies performed at both Yale and Stanford Universities have shown that this shape produces a laminar flow across the bath. The general shape is shown on p. x and specific dimensions are provided in each chamber specification. In general, the lower the ratio of bath width (W) to bath length (L), the better the flow characteristics. Models with small bath volumes can have exchange times measured in seconds even with flow rates less than 1 ml/min. Larger models, starting with the RC-27, use a slotted bath shape. These chambers are designed for slice studies and other applications requiring a larger volume bath.

Chamber Materials

In addition to the traditional polycarbonate construction of Series 20 chambers, Warner now provides select chambers fabricated in polysulfone and silicone. This polysulfone has the same high-quality machining characteristics as polycarbonate but is more resistant to solvents, and more importantly, is autoclavable.

Assembly of Chamber

The chamber is prepared by applying a thin layer of vacuum grease to the chamber bottom. The sample coverslip (sample side up) is then attached to the chamber. This assembly is then placed in the platform and clamped to provide a seal between coverslip and chamber. Mounting on the microscope is done with the appropriate stage adapter. The installation is completed by connecting the perfusion lines and any heater cabling required. Assembly of the closed type chambers includes installation of the top coverslip which precedes the steps outlined above.



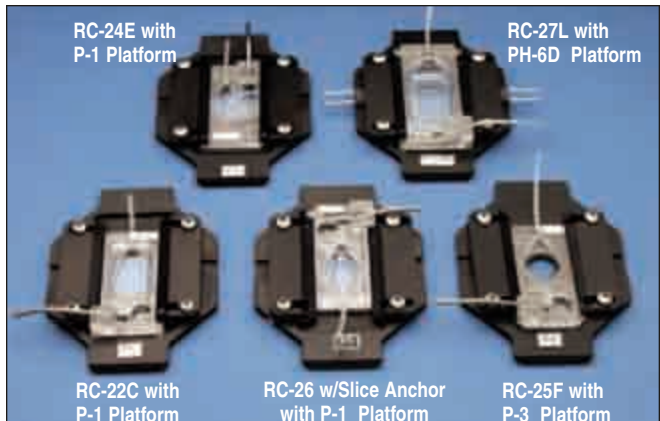
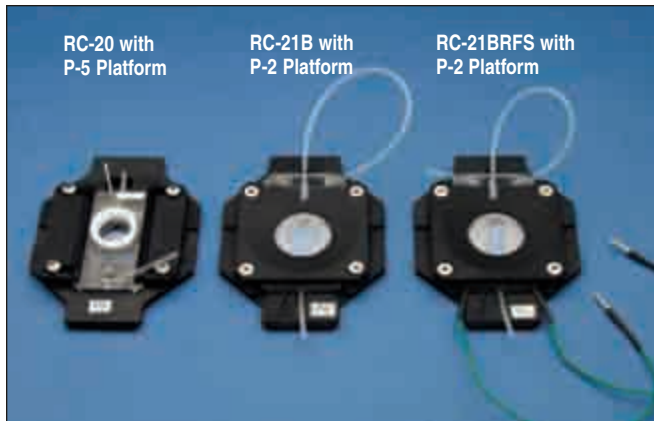
Perfusing the Chambers

Perfusion can be via a pump-driven or gravity-fed system. Flow rates of 10 ml/min or greater are possible but flows of 0.5 to 5 ml/min are the norm. Standard polyethylene tubing (PE-160 or equivalent) inserts directly into the input port. Solutions are removed by suction using either a vacuum source or pump. Open bath chambers are equipped with an adjustable stainless steel suction tube for solution height control. Multiple perfusion lines can be connected to these chambers using an MP or MPP Series manifold, see page 101.

series 20 chambers

Series 20 Perfusion Chambers for Imaging and Recording

General Information (continued)



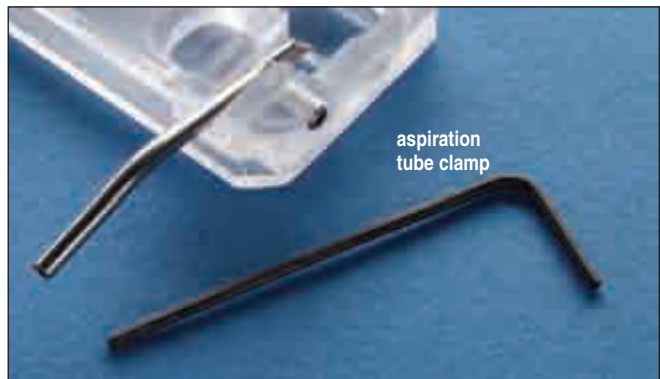
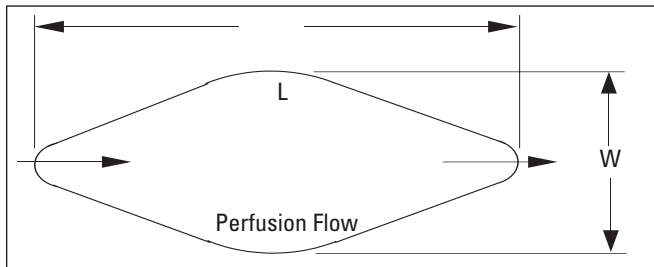
Closed Bath Design

Series 20 Closed Bath Chambers use coverslips at both the top and bottom to enclose the bath area. The closed bath promotes a uniform solution exchange and eliminates changes in focus due to alterations in bath height. In addition, studies involving physiological bicarbonate buffers can be performed with no gas loss at the chamber interface. Closed chambers have been used in fluorescent, calcium and time-lapse imaging studies.

Open Bath Design

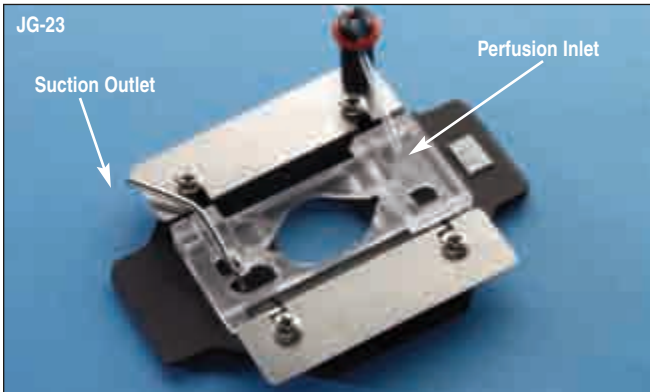
Open bath models are designed for electrophysiological recording and/or optical imaging, and are used in applications including patch clamp, oocyte clamp, and physiological measurements on cell cultures and tissue preparations. The low profile design permits good electrode access to the bath. Agar bridge wells for reference electrodes are provided.

Laminar Flow Geometry



All Series 20 chambers equipped with a stainless steel suction tube now include a suction tube clamp. This insures the adjustable tube will not move once the solution height is set.

Sloped inflow allows for a smooth delivery of solution to the chamber



Using the JG-23 chamber this image of an isolated colonic crypt was acquired on a Zeiss spinning disk confocal. The crypt was loaded with BCECF to measure intracellular pH. Image courtesy of John Geibel.

- Eliminates vibration associated with solution exchange
- Incorporates Warner's diamond fluidics
- Multiplexes solution delivery without switching artifacts

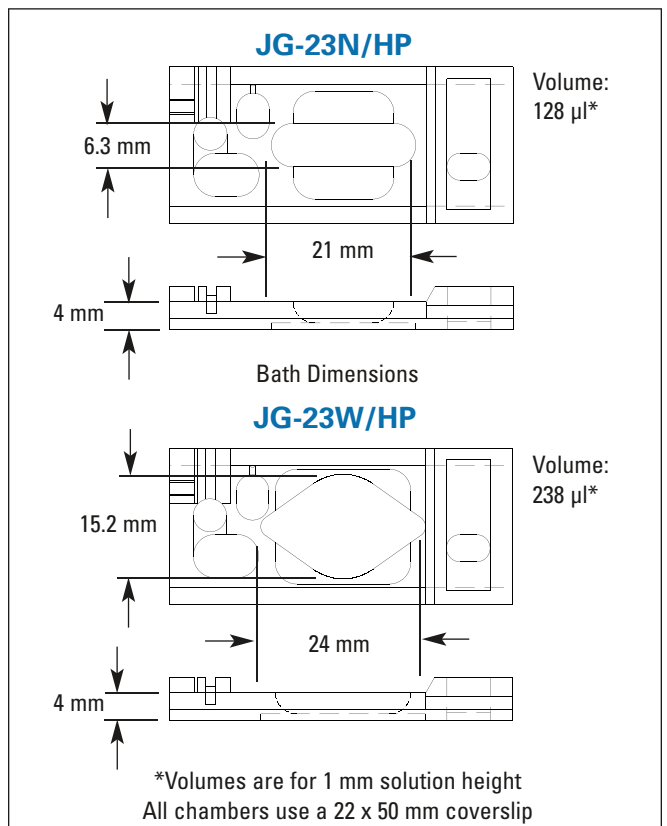
The JG-23 has been designed especially for researchers planning multiple solution changes while attempting to maintain a tight optical focus on the specimen during an experiment. The design of this chamber eliminates vibrations associated with solution delivery that could cause specimens or optical fields to fluctuate during recordings.

The JG-23 Series chambers incorporate the same advanced design as the Series 20 diamond shaped chambers. A large imaging field allows for maximal observation of biological specimens with the addition of a sloped input. The advantage of this system over other chambers is the addition of a sloped inflow which allows for a smooth and "ultra-quiet" delivery of solution to the chamber.

The sloped input allows I-V type infusion lines to be used that can deliver fixed drops per sec to the chamber without the introduction of noise to the specimen field. In addition, multiplexed solution delivery is possible without solution switching artifacts.

Each chamber includes two magnetic plates, a magnetic perfusion tube holder, one pack of #1 thickness coverslips (CS-22/50, 22x50 mm, 85/pkg), and 10 ft of polyethylene (PE-160) tubing.

Slice anchors are available for both the JG-23W/HP and JG-23W/LP. See page 71 for details.



Order #	Model	Product
W4 64-1486	JG-23N/HP	Ultra-quiet Chamber High Profile, Narrow Bath
W4 64-1487	JG-23W/HP	Ultra-quiet Chamber High Profile, Wide Bath
W4 64-1488	JG-23W/LP	Ultra-quiet Chamber Low Profile, Wide Bath

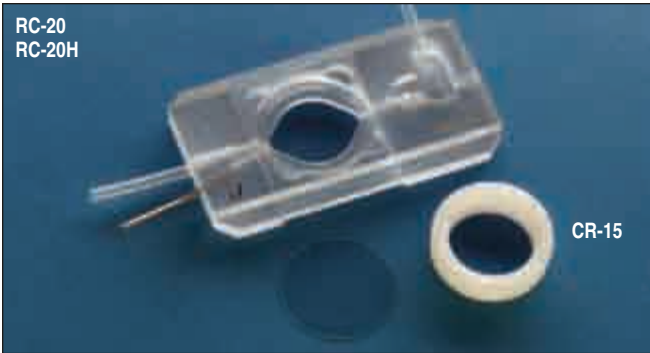
Order #	Model	Product
Accessories and Replacement Parts		
W4 64-0277	P-1	Platform, non-heated
W4 64-0284	PH-1	Platform, heated
W4 64-1526	PM-1	Platform, heated magnetic
W4 64-0253	SHD-26GH/10	Slice Anchor for RC-26G (1.0 mm)
W4 64-0254	SHD-26GH/15	Slice Anchor for RC-26G (1.5 mm)
W4 64-0255	SHD-26GH/20	Slice Anchor for RC-26G (2 mm)
W4 64-0708	CS-22/50	Coverslips, 22 x 50 mm
W4 64-0755	PE-160/10	Polyethylene Tubing

series 20 chambers

RC-20 and RC-20H

Small Volume Closed Bath Imaging Chambers

Polycarbonate chambers featuring fast solution exchange and linear solution flow



- Closed bath design
- Our smallest volume, closed bath chambers
- Ideal for fluorescent, calcium, and time-lapse imaging studies

The RC-20 and RC-20H are very small volume imaging chambers featuring fast perfusion exchange and short working distance. The smaller and narrower RC-20 insures linear solution flow and fast exchange while the RC-20H features a larger viewing area. An access port (Hamilton syringe compatible)* at the bath input may be used to inject substances into the solution flow or to remove gas bubbles.

Two 15 mm round coverslips enclose the bath. The distance between the top and bottom coverslips is 1 mm. The top coverslip is secured into place with a retainer ring.

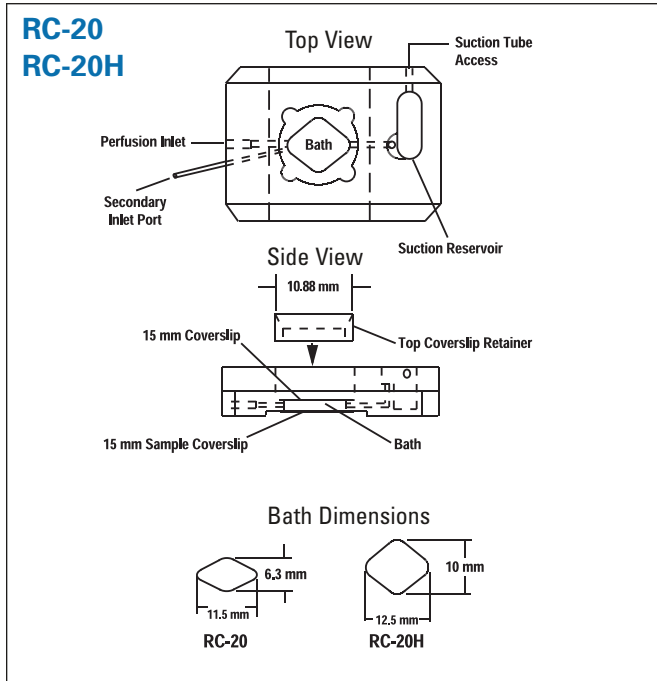
Studies involving physiological bicarbonate buffers can be performed with these chambers with no gas loss at the chamber interface. In addition, the closed design allows the use of permeable supports. With laminar flow, minimal distortion of the sample will occur during perfusion.

RC-20 and RC-20H chambers require a platform (P-5, PH-5, or PM-5) and stage adapter to complete the assembly for mounting onto a microscope.

Each chamber is supplied with a package of #1 thickness glass coverslips (CS-15R, 15 mm diameter, 100/pkg), 10 feet of PE-160 tubing, and a CR-15 top coverslip retaining ring.

* 25 gauge (0.45 mm OD) needle

Specifications	RC-20	RC-20H
Material	Polycarbonate	Polycarbonate
Bath dimensions (L x W)	11.5 x 6.3 mm	12.5 x 10 mm
Volume, by depth	48 μ l	90 μ l
Top coverglass	15 mm round	15 mm round
Bottom coverglass	15 mm round	15 mm round
Injection port (ID x OD)	0.56 x 0.91 mm, stainless steel	0.56 x 0.91 mm, stainless steel
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)	1.14 x 1.57 mm (PE-160)
Output tubing (ID x OD)	1.14 x 1.57 mm (PE-160)	1.14 x 1.57 mm (PE-160)



Order #	Model	Product
W4 64-0222	RC-20	Small Volume Imaging Chamber
W4 64-0223	RC-20H	Small Volume Imaging Chamber
W4 64-0281	P-5	Platform, non-heated
W4 64-0288	PH-5	Platform, heated
W4 64-1564	PM-5	Platform, heated magnetic
Accessories and Replacement Parts		
W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0703	CS-15R	Coverslips, 15 mm
W4 64-0276	CR-15	Replacement Coverslip Retainer
W4 64-0274	RH-2	Heater Elements (2) for PH (Heater) Platforms with Mounting Pads and Screws
W4 64-0273	SS-3	Slice Support for RC-27L and RC-29
W4 64-0271	TS-30G	Glass Thermistor (Alternate to TS-70B)
W4 64-0269	TS-60P	Probe Thermistor for CC-28 Cable
W4 64-0270	TS-70B	Bead Thermistor for CC-28 Cable

RC-21B and RC-21BR series 20 chambers

Large Closed Diamond Bath

Large viewing area and good access for microscope objectives

Chambers

series 20 chambers



- Closed bath design
- Diamond fluidics
- Ideal for fluorescent, calcium, and time-lapse imaging studies
- Uses 22 mm square or 25 mm round coverslips
- Large optical imaging area
- Good access for upright or inverted microscopes

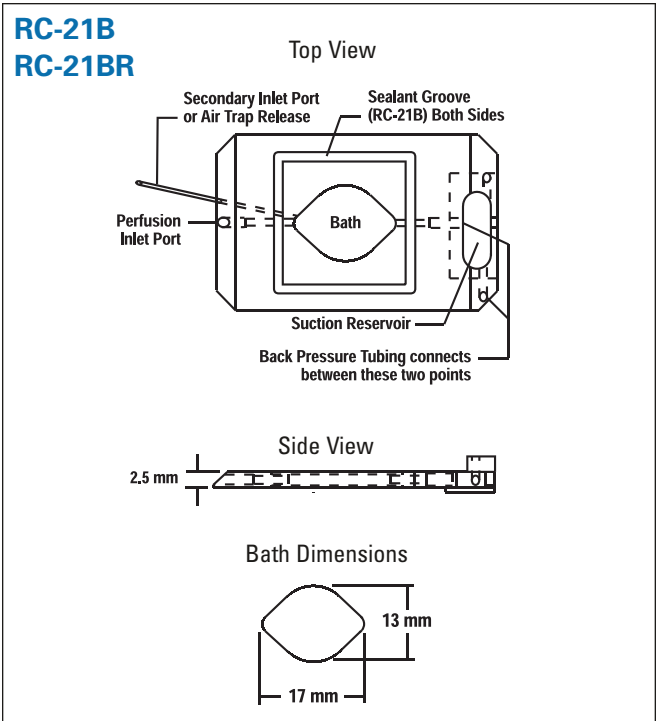
The RC-21B and RC-21BR chambers feature a closed bath, short working distance, and linear solution flow. Separation between the top and bottom coverslip is 2.5 mm and total bath volume is 358 μ l. At the bath output, a length of tubing is used as a back pressure control to insure smooth flow. An additional stainless steel port at the bath input fits a standard Hamilton microliter syringe.* This port is useful for injecting substances or for removing air bubbles from the sealed chamber.

Studies involving physiological bicarbonate buffers can be performed with these chambers with no gas loss at the chamber interface. With laminar flow, minimal distortion of the sample occurs during perfusion.

RC-21B and RC-21BR chambers require a platform (P-2, PH-2, or PM-2) and stage adapter to complete the assembly for mounting onto a microscope.

Each chamber is supplied with a package of #1 thickness glass coverslips (CS-22S and CS-25R, respectively, 100/pkg) and 10 feet of PE-160 polyethylene tubing.

* 25 gauge (0.45 mm OD) needle



Specifications	RC-21B	RC-21BR
Material	Polycarbonate or polysulfone*	Polycarbonate or polysulfone*
Bath dimensions (L x W x H)	17 x 13 x 2.5 mm	17 x 13 x 2.5 mm
Volume	358 μ l	358 μ l
Top coverglass	22 mm square	25 mm round
Bottom coverglass	22 mm square	25 mm round
Injection port (ID x OD)	0.56 x 0.91 mm, stainless steel	0.56 x 0.91 mm, stainless steel
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)	1.14 x 1.57 mm (PE-160)
Output tubing (ID x OD)	1.14 x 1.57 mm (PE-160)	1.14 x 1.57 mm (PE-160)

* Please call for price and availability of polysulfone chambers.

Order #	Model	Product
W4 64-0224	RC-21B	Large Bath Imaging Chamber
W4 64-0225	RC-21BR	Large Bath Imaging Chamber
W4 64-0278	P-2	Platform, non-heated
W4 64-0285	PH-2	Platform, heated
W4 64-1561	PM-2	Platform, heated magnetic

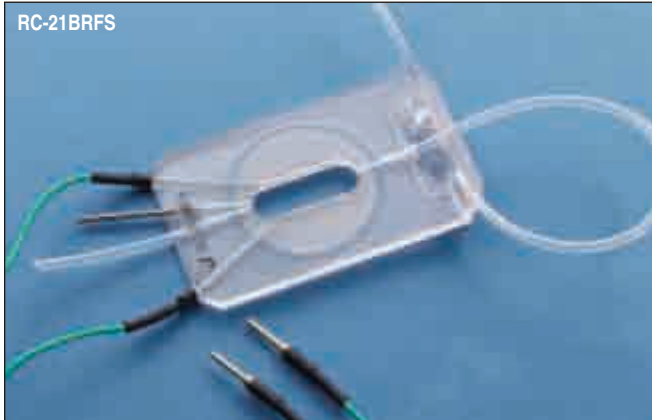
Accessories and Replacement Parts

W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0704	CS-22S	Coverslips, 22 mm, square
W4 64-0705	CS-25R	Coverslips, 25 mm, round

RC-21BRFS series 20 chambers

Chamber with Slotted Bath for Field Stimulation

Imaging chamber designed for field stimulation studies



- Designed for field stimulation studies involving cardiac myocytes
- Closed bath design
- Small volume with slotted bath
- Ideal for fluorescent, calcium, and time-lapse imaging studies

The RC-21BRFS is a small volume, closed bath imaging chamber designed for field stimulation studies. It uses a pair of 25 mm round coverslips to form the top and bottom of the chamber, and the total bath volume is 263 μ l. Separation between top and bottom coverslips is 2.3 mm. Two platinum wire electrodes are attached to the parallel sides of the oval-shaped bath. The connecting wires are 15 cm long and are terminated in 1 mm pins.

An additional stainless steel port at the bath input fits a standard Hamilton microliter syringe.* This port may be used to inject substances into the flow path or to remove air bubbles from the sealed chamber. At the bath output, a length of tubing is used as a back pressure control to insure smooth flow.

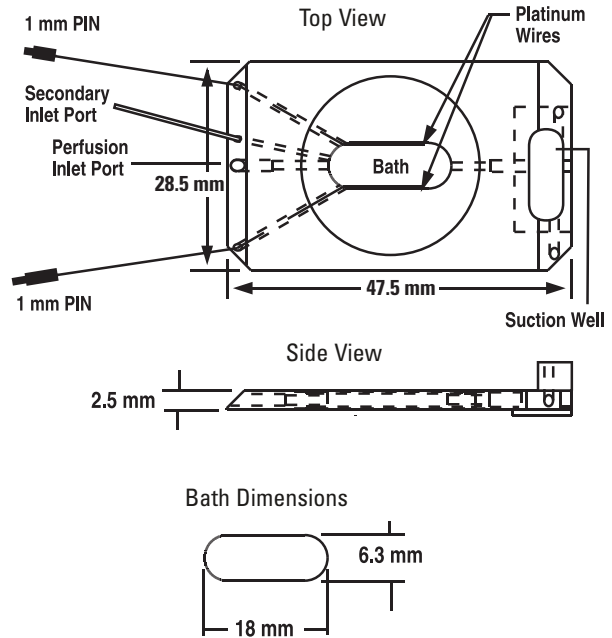
The RC-21BRFS chamber requires a platform (P-2, PH-2, or PM-2) and stage adapter to complete the assembly for mounting onto a microscope.

Each RC-21BRFS chamber is supplied with a package of CS-25R glass coverslips (#1 thickness, 25 mm diameter, 100/pkg) and 10 feet of PE-160 polyethylene tubing.

* 25 gauge (0.45 mm OD) needle

The SIU-102 is a bipolar stimulator designed for use with field stimulation chambers. This instrument features constant current and constant voltage modes, as well as bipolar, pulse, and DC modes. Optical coupling is used to electronically isolate the stimulator from the pulse source. Currents up to 100 mA and voltages up to 100 V are also supported. See page 247 for details.

RC-21BRFS



Specifications

Material	Polycarbonate or polysulfone
Bath dimensions (L x W x H)	18.0 x 6.3 x 2.3 mm
Volume	263 μ l
Electrodes	Platinum wire, 15 cm leads with 1 mm pins
Top coverglass	25 mm round
Bottom coverglass	25 mm round
Injection port (ID x OD)	0.56 x 0.91 mm, stainless steel
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)
Output tubing (ID x OD)	1.14 x 1.57 mm (PE-160)

Order #	Model	Product
W4 64-0226	RC-21BRFS	Imaging Chamber with Field Stimulation
W4 64-0278	P-2	Platform, non-heated
W4 64-0285	PH-2	Platform, heated
W4 64-1561	PM-2	Platform, heated magnetic

Accessories and Replacement Parts

W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0705	CS-25R	Coverslips, 25 mm round #1 thick, Box of 100

series 20 chambers

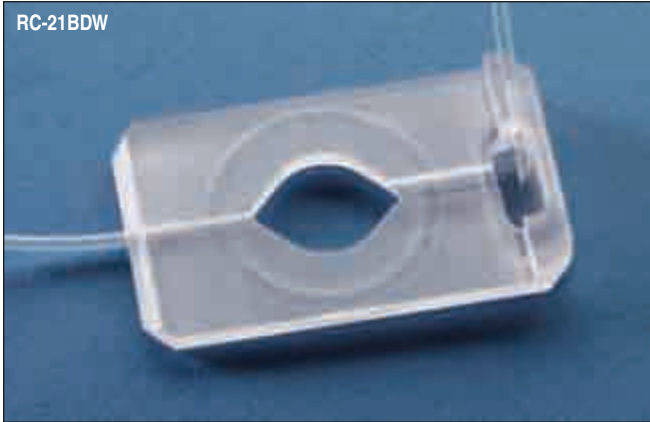
RC-21BDW

Open Diamond Bath

Chambers

series 20 chambers

Open, diamond shaped bath with wicked solution removal



RC-21BDW shown in a P-2 platform

- Designed for physiological measurements on cell cultured coverslips
- Identical to the RC-21BRW except for a diamond shaped bath
- Uses a 25 mm round coverslip as the chamber floor
- Diamond shaped bath provides laminar solution flow
- Quiet operation
- Wicked solution removal from bath
- Can be used with upright or inverted microscopes

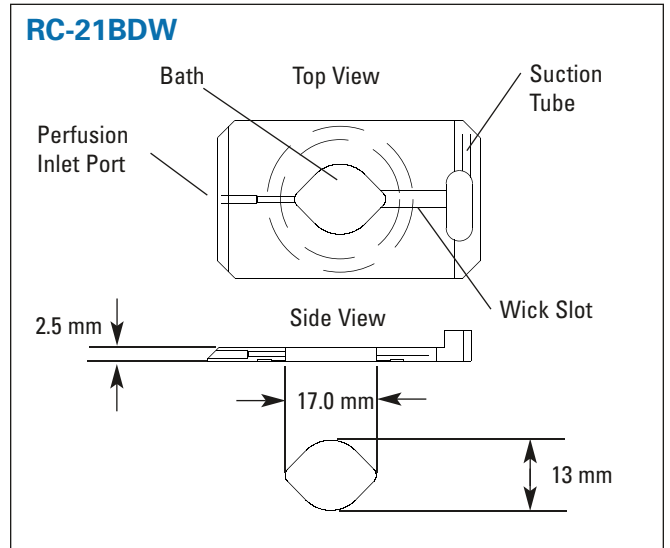
The low profile design of the RC-21BDW permits good electrode access to the chamber bath. Constant solution level and quiet operation are assured with the use of a wick between the chamber bath and suction well. With laminar flow, the sample is minimally distorted during perfusion. Bath volume is 143 μ l for each mm of solution height.

The RC-21BDW chamber requires a platform (P-2, PH-2, or PM-2) and stage adapter to complete the assembly for mounting onto a microscope.

Each RC-21BDW chamber is supplied with a package of #1 thickness glass coverslips (CS-25R, 25 mm diameter, pkg. of 100) and 10 feet of PE-160 polyethylene tubing.

Specifications

Material	Polycarbonate
Bath dimensions (L x W x H)	17 x 13 x 2.5 mm
Volume, by depth	143 μ l/mm
Bottom coverglass	25 mm round
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)
Output tubing (ID x OD)	1.14 x 1.57 mm (PE-160)



Order #	Model	Product
W4 64-0362	RC-21BDW	Open Chamber for 25 mm Round Coverslips
W4 64-0278	P-2	Platform, non-heated
W4 64-0285	PH-2	Platform, heated
W4 64-1561	PM-2	Platform, heated magnetic

Accessories and Replacement Parts

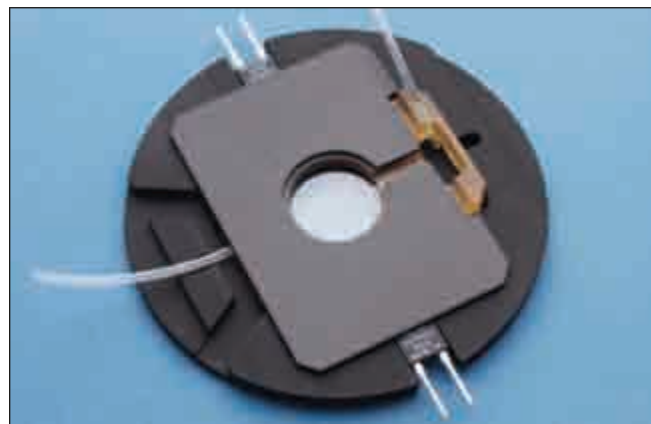
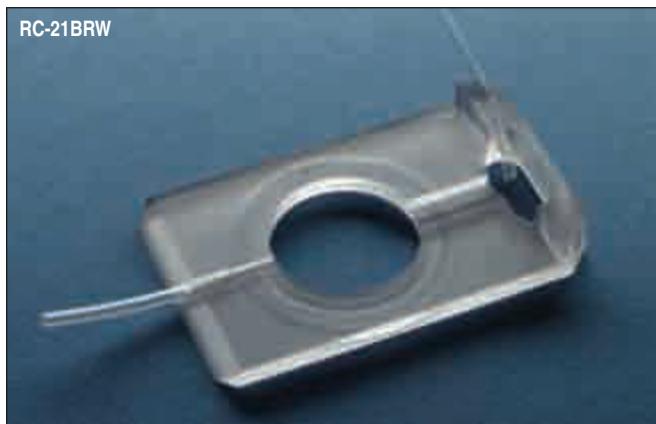
W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0705	CS-25R	Coverslips, 25 mm round, #1 thick, Box of 100

RC-21BRW

Open Round Bath

series 20 chambers

Large round, open bath for maximum imaging area



RC-21BRW shown in a PM-2 platform

- Designed for physiological measurements on cell cultured coverslips
- Uses a 25 mm round coverslip as the chamber floor
- Quiet operation
- Broad imaging area
- Wicked solution removal from bath
- Can be used with upright or inverted microscopes

The RC-21BRW is an open bath recording chamber using a 25 mm round coverslip as the chamber bottom. The wide, round aperture of the RC-21BRW maximizes the viewing area on the coverslip and enables excellent access for electrodes. Constant solution level and quiet operation are assured with the use of a wick between the chamber bath and suction well. Bath volume is 240 μ l for 1 mm solution height.

The low profile design of the RC-21BRW and its platform are useful for use with large objectives and will accommodate either upright or inverted microscopes. The large imaging area (17 mm diameter) increases the likelihood of viewing cell features located along the periphery of the chamber.

The RC-21BRW chamber requires a platform (P-2, PH-2 or PM-2) and stage adapter to complete the assembly for mounting on a microscope.

Each chamber includes a pack of #1 thickness glass coverslips (CS-25R, 25 mm diameter, 100/pkg) and 10 feet of PE-160 tubing.

RC-21BRW

Dimensions of the RC-21BRW are the same as the RC-21BDW (see facing page) except bath is 17.4 mm round.

Specifications

Material	Polycarbonate
Bath dimension (D x H)	17.4 x 2.5 mm
Volume, by depth	240 μ l/mm
Bottom coverglass	25 mm round
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)
Output tubing (ID x OD)	1.14 x 1.57 mm (PE-160)

Order #	Model	Product
W4 64-0227	RC-21BRW	Open Chamber for 25 mm Round Coverslip
W4 64-0278	P-2	Platform, non-heated
W4 64-0285	PH-2	Platform, heated
W4 64-1561	PM-2	Platform, heated magnetic

Accessories and Replacement Parts

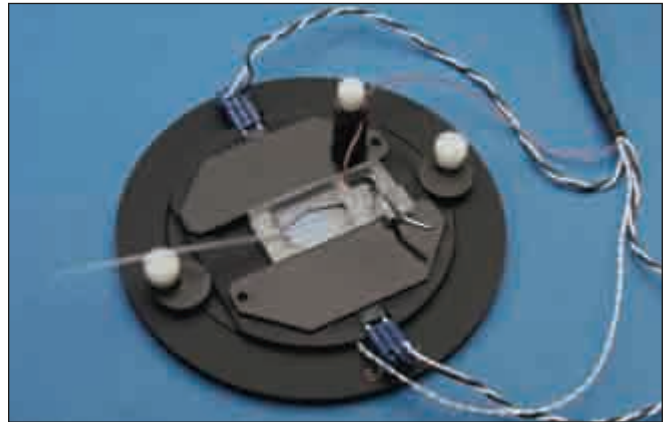
W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0705	CS-25R	Coverslips, 25 mm round, #1 thick, Box of 100

series 20 chambers

RC-22 and RC-22C

Open Diamond Bath for Tissue Slice Studies

Small volume, open bath recording chambers designed for tissue and brain slice studies



RC-22 shown in a PM-1 heated platform

- Designed for tissue slice or cultured cell studies
- Applications include patch clamp, intracellular/extracellular recordings, and imaging
- Diamond shaped bath provides laminar solution flow
- Small bath volume facilitates rapid solution exchange
- Slice anchor included

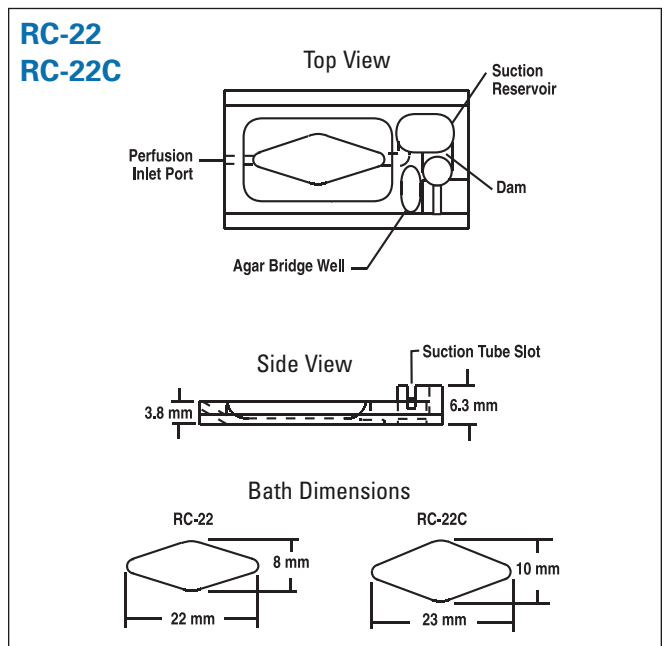
The RC-22 and RC-22C are small volume, open bath recording chambers designed for tissue and brain slice studies. The diamond shaped chamber bath facilitates laminar solution flow.

Slices are secured via a supplied stainless steel anchor (or harp). The RC-22 comes with an SHD-22L/15 anchor, and the RC-22C comes with an SHD-22CL/15 anchor harp. Threads are made of Lycra and have a spacing of 1.5 mm. While anchor mass (typically 300 milligrams) is sufficient to secure a slice into place, Warner anchors rely on a close fit between the anchor body and the chamber sidewall. This feature can reduce stress on the anchored slice.

Solution aspiration is via a stainless steel suction tube which is secured by a clamp insuring the adjustable-height suction tube will not move once set by the user. Each chamber has an agar bridge well for reference electrodes and the working volume of the RC-22 and RC-22C is 115 μ l and 138 μ l, respectively. Chamber sidewalls have a height of 1.2 mm to assist with electrode access and placement.

The RC-22 and RC-22C chambers require a platform (P-1, PH-1, or PM-1) and stage adapter to complete the assembly for mounting onto a microscope. The bottom-forming coverslip is 22 x 40 mm.

Each chamber is supplied with a slice anchor, a swatch of nylon mesh, a pack of #1 thickness glass coverslips (CS-22/40, 22 x 40 mm, 50/pkg) and 10 feet of PE-160 tubing.



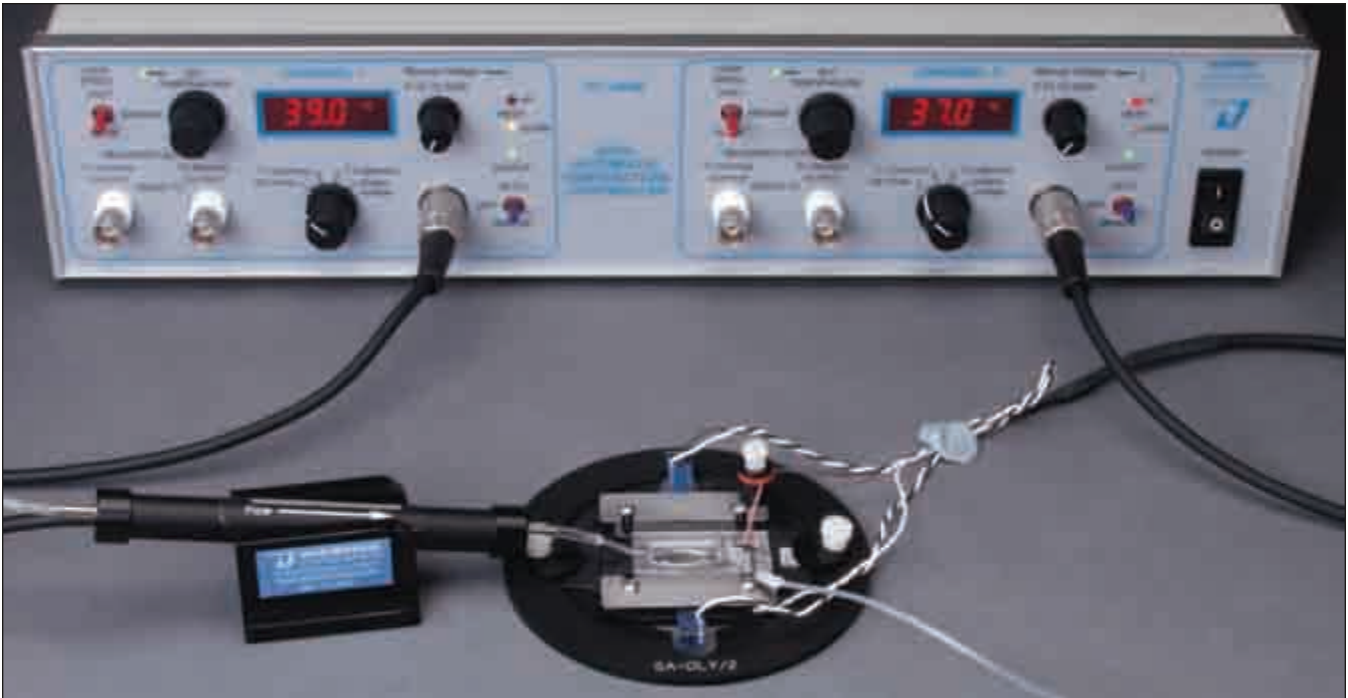
Specifications	RC-22	RC-22C
Material	Polycarbonate or polysulfone*	Polycarbonate or polysulfone*
Bath dimensions (L x W x H)	22 x 8 x 3.8 mm	23 x 10 x 3.8 mm
Volume, by depth	115 μ l/mm	138 μ l/mm
Bottom coverglass	22 x 40 mm	22 x 40 mm
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)	1.14 x 1.57 mm (PE-160)
Aspirator coupling	1.67 mm (OD)	1.67 mm (OD)

* Please call for price and availability of polysulfone chambers.

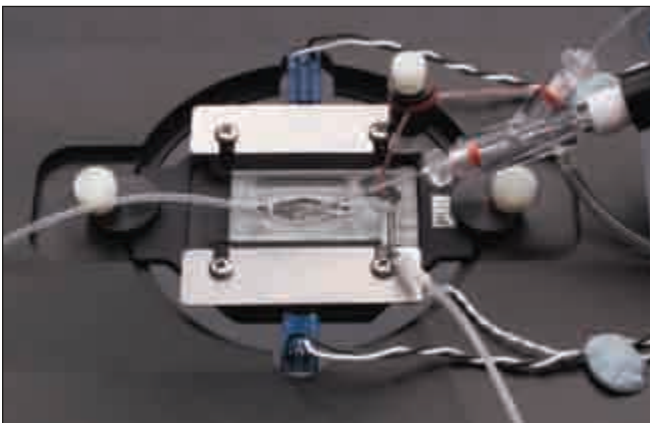
series 20 chambers

RC-22 and RC-22C

Open Diamond Bath for Tissue Slice Studies (continued)



Shown above is a typical complete system, which includes an RC-22 chamber, heated platform, dual channel temperature controller, in-line solution heater, connecting cable and a stage adapter.



RC-22 chamber with slice anchor and patch electrode

Order #	Model	Product
W4 64-0228	RC-22	Recording Chamber for Tissue Slice with SHD-22L/15 Anchor
W4 64-0229	RC-22C	Recording Chamber for Tissue Slice with SHD-22CL/15 Anchor
W4 64-0277	P-1	Platform, non-heated
W4 64-0284	PH-1	Platform, heated
W4 64-1526	PM-1	Platform, heated magnetic
Accessories and Replacement Parts		
W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0707	CS-22/40	Coverslips, 22 x 40 mm #1, 50/box
W4 64-0246	SHD-22L/15	Slice Anchor, 1.5 mm
W4 64-0247	SHD-22CL/15	Slice Anchor, 1.5 mm
W4 64-0198		Nylon mesh, 12 pieces, 7 x 7 cm
Slice Anchor Kits		
W4 64-0263	SHD-22Kit	Slice Anchor Kit
W4 64-0264	SHD-22CKit	Slice Anchor Kit

series 20 chambers

RC-24 and RC-24E

Fast Exchange Open Diamond Bath Chambers

Our smallest, open bath chambers for very fast solution times



- Designed for physiological measurements of cell cultured coverslips
- Applications include patch clamp, imaging and intracellular/extracellular recordings
- Diamond shaped bath provides laminar solution flow
- Both perfusion and aspiration ports on same side of chamber
- Very small bath volume facilitates very fast solution exchange

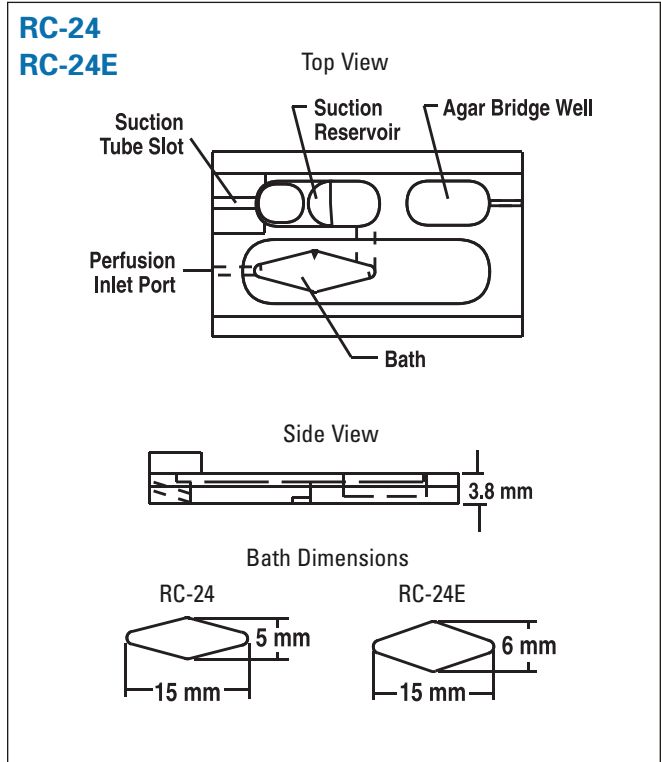
The bath volume in these models is among the smallest of the open style chambers. This enables very fast solution exchange for a variety of applications, including patch clamp and electrophysiology studies. The small bath volumes are especially useful when using drugs in small quantities.

The RC-24 and RC-24E have an unusual characteristic in that both the perfusion inlet and aspiration outlet is on the same side of the chamber. This allows the associated perfusion lines to be conveniently placed on only one side and facilitates electrode placement.

An agar bridge well for reference electrodes is provided, as is an aspiration well. The aspiration well is equipped with a stainless steel aspiration tube (1.67 mm OD) together with a tube clamp. The clamp insures that the adjustable suction tube will not move once the height is set by the user.

The floor of each chamber can be formed from either a 22 mm square coverslip or from a 22 x 40 mm rectangular coverslip. Each chamber requires a platform (P-1, PH-1, or PM-1) and a stage adapter to complete the assembly for mounting on a microscope.

Each chamber is supplied with a package of #1 thickness glass coverslips (CS-22/40, 22 x 40 mm, 50/pkg) and 10 feet of PE-160 tubing.



Specifications	RC-24	RC-24E
Material	Polycarbonate	Polycarbonate
Bath dimensions (L x W x H)	15 x 5 x 3.8 mm	15 x 6 x 3.8 mm
Volume, by depth	40 μ l/mm	50 μ l/mm
Bottom coverglass	22 x 40 mm	22 x 40 mm
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)	1.14 x 1.57 mm (PE-160)
Aspirator coupling	1.67 mm (OD)	1.67 mm (OD)

Order #	Model	Product
W4 64-0230	RC-24	Fast Exchange Recording Chamber
W4 64-0231	RC-24E	Fast Exchange Recording Chamber
W4 64-0277	P-1	Platform, non-heated
W4 64-0284	PH-1	Platform, heated
W4 64-1526	PM-1	Platform, heated magnetic

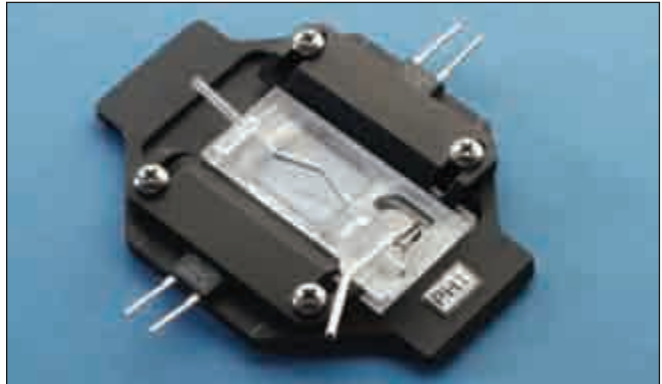
Accessories and Replacement Parts		
W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0707	CS-22/40	Coverslips, 22 x 40 mm #1, Box of 50
W4 64-0704	CS-22S	Coverslips, 22 x 22 mm

RC-24N

series 20 chambers

Open Diamond Bath for Fast Fluid Exchange

A small, open bath chamber with diamond shaped fluidics



RC-24N shown in a PH-1 heated platform

- Designed for physiological measurements of cell cultured coverslips
- Applications include patch clamp, intracellular/extracellular recordings, and imaging
- Diamond shaped bath provides laminar solution flow
- Very small bath volume facilitates very fast solution exchange

The RC-24N chamber design is taken from the RC-24 and improves the flow characteristics by providing a linear path. The bath volume in this model is among the smallest of the open style chambers. This enables very fast solution exchange for a variety of applications, including patch clamp and electrophysiology studies. The small bath volume is especially useful when using drugs in small quantities.

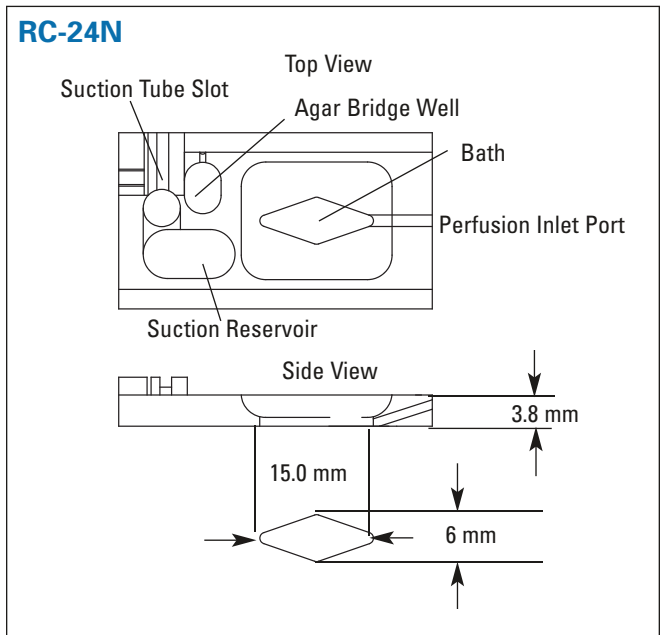
An agar bridge well for reference electrodes is provided, as is an aspiration well. The aspiration well is equipped with a stainless steel aspiration tube (1.67 mm OD) together with a tube clamp. The clamp insures that the adjustable suction tube will not move once the height is set by the user. The chamber floor is formed from a 22 x 40 mm rectangular coverslip.

The RC-24N requires a platform (P-1, PH-1, or PM-1) and stage adapter to complete the assembly for mounting on a microscope.

Each chamber is supplied with a package of #1 thickness glass coverslips (CS-22/40, 22 x 40 mm, 50/pkg) and 10 feet of PE-160 tubing.

Specifications

Material	Polycarbonate
Bath dimensions (L x W x H)	15 x 6 x 3.8 mm
Volume, by depth	54 µl/mm
Bottom coverglass	22 x 40 mm
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)
Aspirator coupling	1.67 mm (OD)



Order #	Model	Product
W4 64-0381	RC-24N	Fast Exchange Recording Chamber
W4 64-0277	P-1	Platform, non-heated
W4 64-0284	PH-1	Platform, heated
W4 64-1526	PM-1	Platform, heated magnetic

Accessories and Replacement Parts

W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0707	CS-22/40	Coverslips, 22 x 40 mm #1, Box of 50

series 20 chambers

RC-25 and RC-25F

Round Coverslip Chambers

Open diamond bath polycarbonate recording chambers designed for round coverslips

Chambers

series 20 chambers



- Designed for physiological measurements of cell cultured coverslips
- Applications include patch clamp, intracellular/extracellular recordings and imaging
- Uses 12 or 15 mm round coverslips as the chamber floor
- Diamond shaped bath provides laminar solution flow
- Small bath volume facilitates fast solution exchange

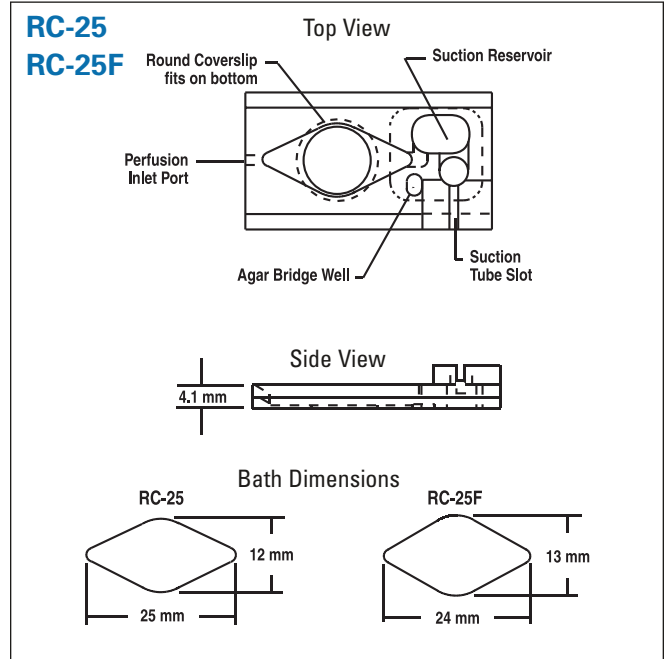
The design of the RC-25 and RC-25F chambers incorporates a diamond-shaped bath which has been shown to produce a laminar flow. Since the bath volumes of these chambers is small (90 $\mu\text{l}/\text{mm}$ and 133 $\mu\text{l}/\text{mm}$ for the RC-25 and RC-25F, respectively), fluid exchange times are measured in seconds even when flow rates are less than 1 ml/min.

The RC-25 works equally well with either 12 or 13 mm diameter coverslips while the RC-25F uses 15 mm coverslips. In general, these coverslips are used to form the bottom of the chamber bath.

NOTE: These chambers are not designed for insertion of coverslips from the top.

The RC-25 requires a platform (P-3, PH-3, or PM-3) and the RC-25F requires a platform (P-4, PH-4, or PM-4). Both chambers require a stage adapter to complete the assembly for mounting onto a microscope.

Each chamber is supplied with a package of #1 thickness glass coverslips (CS-12R; 12 mm round for the RC-25, CS-15R; 15 mm round for the RC-25F; 100/pkg) and 10 feet of polyethylene (PE-160) tubing.



Specifications	RC-25	RC-25F
Material	Polycarbonate or polysulfone*	Polycarbonate or polysulfone*
Bath dimensions (L x W x H)	25 x 12 x 4.1 mm	24 x 13 x 4.1 mm
Volume, by depth	90 $\mu\text{l}/\text{mm}$	133 $\mu\text{l}/\text{mm}$
Bottom coverglass	12 or 13 mm round	15 mm round
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)	1.14 x 1.57 mm (PE-160)
Aspirator coupling	1.67 mm (OD)	1.67 mm (OD)

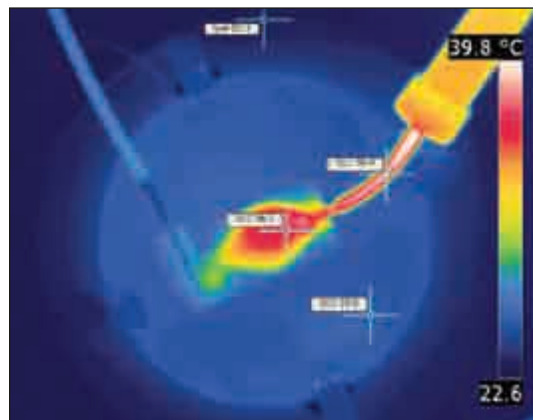
* Please call for price and availability of polysulfone chambers.

Order #	Model	Product
W4 64-0232	RC-25	Round Coverslip Recording Chamber
W4 64-0233	RC-25F	Round Coverslip Recording Chamber
W4 64-0279	P-3	Platform, non-heated, for RC-25
W4 64-0286	PH-3	Platform, heated, for RC-25
W4 64-1562	PM-3	Platform, heated magnetic, for RC-25
W4 64-0280	P-4	Platform, non-heated, for RC-25F
W4 64-0287	PH-4	Platform, heated, for RC-25F
W4 64-1563	PM-4	Platform, heated magnetic, for RC-25F

Accessories and Replacement Parts

W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0702	CS-12R	Coverslips, 12 mm
W4 64-0703	CS-15R	Coverslips, 15 mm

Designed for studies of cell cultured coverslips on upright microscopes



Thermograph demonstrating bath temperature of RC-26GLP with in-line heater. Platform heaters turned off, and the flow rate set to 2 ml/min.

- Applications include patch clamp, intracellular/extracellular recordings and imaging
- Extra-low profile facilitates electrode access
- Diamond shaped bath provides laminar solution flow
- Broad optical imaging area
- Can be used with either upright or inverted microscopes

The RC-26GLP is a low profile version of the RC-26G recording chamber. The sides of this chamber have been milled to a height of only 2 mm and the lower profile provides extra clearance for upright microscopes, water immersion objectives and permits good electrode access to the chamber bath.

The chamber floor is comprised of a 22 x 40 mm coverslip. The working volume is 234 µl per 1.0 mm of solution height. The chamber is equipped with a stainless steel suction tube together with clamp. The clamp insures that the adjustable aspirator tube will not move once the height is set by the user.

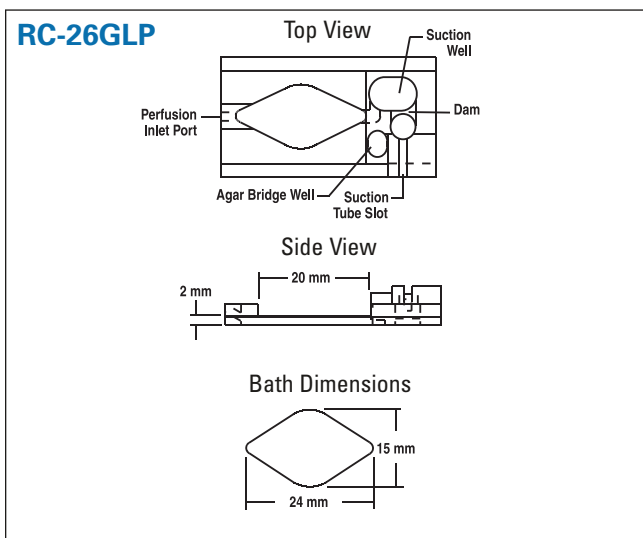
The RC-26GLP chamber requires a platform (P-1, PH-1 or PM-1) and stage adapter to complete the assembly for mounting onto a microscope.

Each RC-26GLP chamber is supplied with a package of CS-22/40 glass coverslips (#1 thickness, 22 x 40 mm, 100/pkg) and 10 feet of PE-160 tubing.

Specifications

Material	Polycarbonate or polysulfone*
Bath dimensions (L x W x H)	24 x 15 x 2 mm
Volume, by depth	234 µl/mm
Bottom coverglass	22 x 40 mm
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)
Aspirator coupling	1.67 mm (OD)

* Please call for price and availability of polysulfone chambers.



Order #	Model	Product
W4 64-0236	RC-26GLP	Low Profile Large Bath Recording Chamber
W4 64-0277	P-1	Platform, non-heated
W4 64-0284	PH-1	Platform, heated
W4 64-1526	PM-1	Platform, heated magnetic

Accessories and Replacement Parts

W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0707	CS-22/40	Coverslips, 22 x 40 mm

Optional Slice Anchors

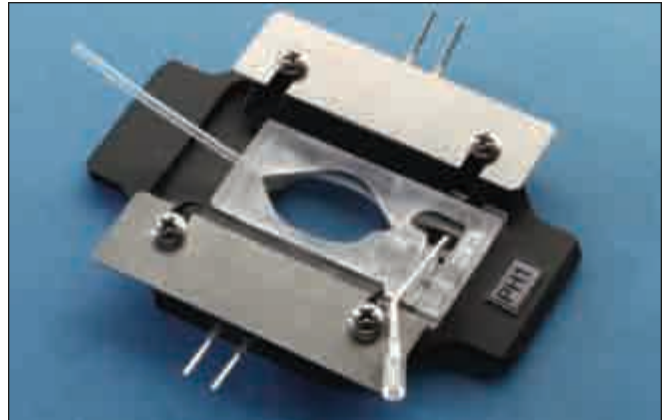
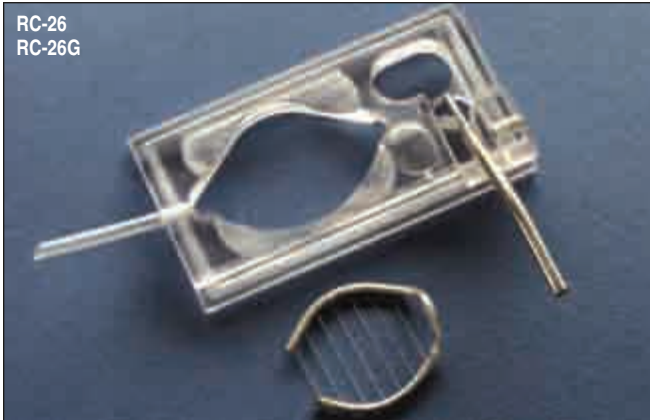
W4 64-0253	SHD-26H/10	Slice anchor for RC-26G (1.0 mm)
W4 64-0254	SHD-26H/15	Slice anchor for RC-26G (1.5 mm)
W4 64-0255	SHD-26GH2	Slice anchor for RC-26G and RC-26GLP (2 mm)

series 20 chambers

RC-26 and RC-26G

Chambers with Coverslip Insertion Option

Supports greater bath depth than the RC-26GLP



RC-26 shown in a PH-1 heated platform

- Designed for patch clamp studies
- Can be used with tissue slice samples or cell cultured coverslips
- Tissue slice anchors available
- Applications include patch clamp, intracellular/extracellular recordings and imaging
- Diamond shaped bath provides laminar solution flow
- Large imaging area
- Can be used with upright or inverted microscopes

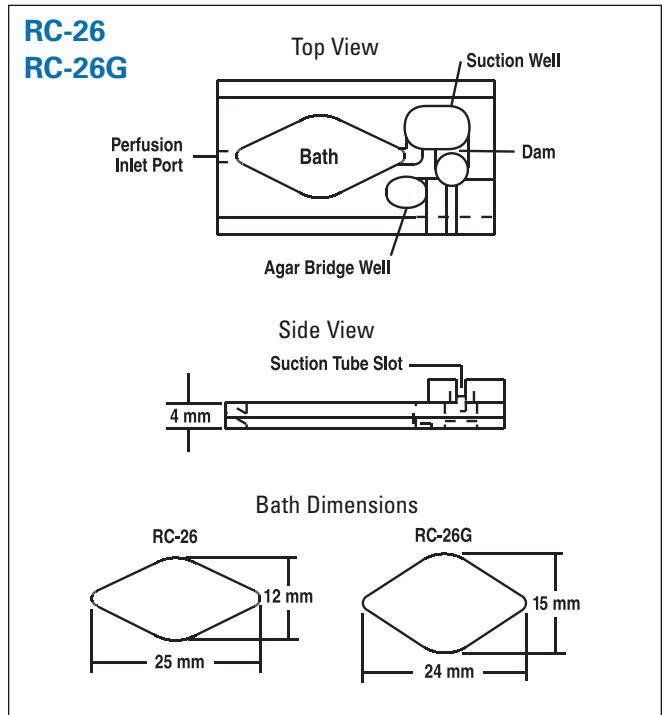
The RC-26 and RC-26G chambers are designed to be used with cells cultured onto glass coverslips or with tissue and brain slice samples. The broad imaging area of these chambers (12 x 25 mm and 15 x 24 mm for the RC-26 and RC-26G, respectively) provides excellent access for both electrodes and water-immersion objectives. The diamond shaped geometry facilitates laminar solution flow throughout the bath area.

The large bath of these chambers allows coverslips to be inserted into the top opening and removed at the end of the experiment. The RC-26 and RC-26G chambers can accept a 12 or 15 mm diameter coverslip, respectively. The working volumes, for 1 mm solution height, of the RC-26 and RC-26G model chambers are 170 and 234 μ l, respectively.

Large tissue samples can also be placed directly into the chamber. Slice anchor hold downs are available for tissue slice studies. Anchors are available with Lycra thread spacing at 1.0, 1.5, and 2.0 mm.

Both chambers require a platform (P-1, PH-1, or PM-1) and stage adapter to complete the assembly for mounting on a microscope. The chamber floor consists of a 22 x 40 mm coverslip.

Each chamber is supplied with a package of #1 thickness glass coverslips (CS-22/40, 22 x 40 mm, 50/pkg) and 10 feet of PE-160 tubing.



Specifications	RC-26	RC-26G
Material	Polycarbonate or polysulfone*	Polycarbonate or polysulfone*
Bath dimensions (L x W x H)	25 x 12 x 4 mm	24 x 15 x 4 mm
Volume, by depth	170 μ l/mm	234 μ l/mm
Bottom coverglass	22 x 40 mm	22 x 40 mm
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)	1.14 x 1.57 mm (PE-160)
Aspirator coupling	1.67 mm (OD)	1.67 mm (OD)

* Please call for price and availability of polysulfone chambers.

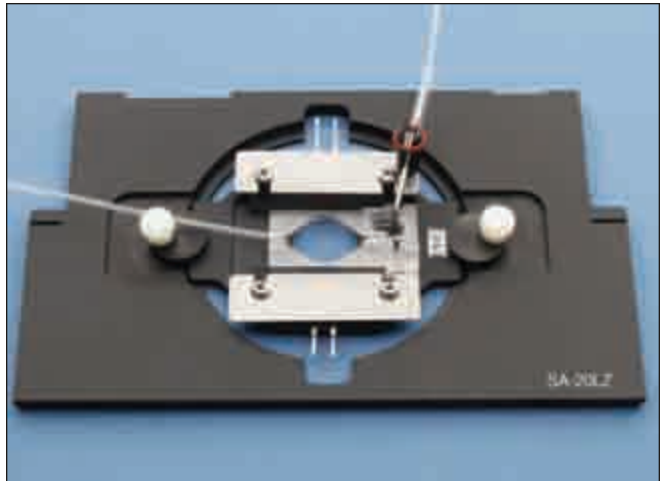
series 20 chambers

RC-26 and RC-26G

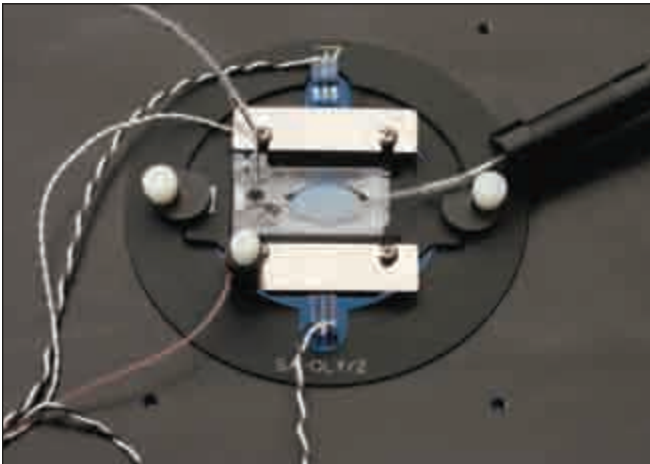
Chambers with Coverslip Insertion Option (continued)



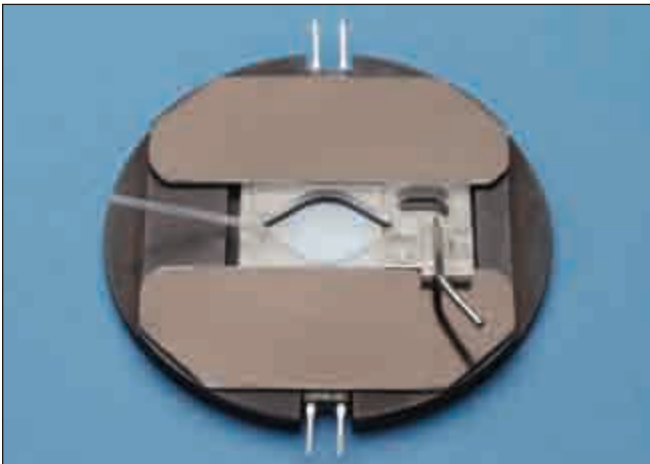
Model RC-26G chamber shown in a PH-1 heated platform on a stage adapter for a Nikon inverted microscope.



Model RC-26G chamber shown in a PH-1 heated platform with optional magnetic platform clamps on a stage adapter for a Zeiss inverted microscope.



Model RC-26G chamber on a microscope stage with in-line heater and CC-28 cable with thermistor feedback, (a typical set-up).



New PM-1 Heated platform with magnetic clamps, no screws needed to secure chamber to platform.

Modular Design

The modular design of all Warner Series 20 chambers permit them to be mounted on just about any microscope stage, including those with a weight restriction.

Order #	Model	Product
W4 64-0234	RC-26	Large Bath Recording Chamber
W4 64-0235	RC-26G	Large Bath Recording Chamber
W4 64-0277	P-1	Platform, non-heated
W4 64-0284	PH-1	Platform, heated
W4 64-1526	PM-1	Platform, heated magnetic

Accessories and Replacement Parts

W4 64-0250	SHD-26H/10	Slice Anchor for RC-26 (1.0 mm)
W4 64-0251	SHD-26H/15	Slice Anchor for RC-26 (1.5 mm)
W4 64-0252	SHD-26H/20	Slice Anchor for RC-26 (2.0 mm)
W4 64-0253	SHD-26GH/10	Slice Anchor for RC-26G (1.0 mm)
W4 64-0254	SHD-26GH/15	Slice Anchor for RC-26G (1.5 mm)
W4 64-0255	SHD-26GH/20	Slice Anchor for RC-26G (2.0 mm)
W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0707	CS-22/40	Coverslips, 22 x 40 mm

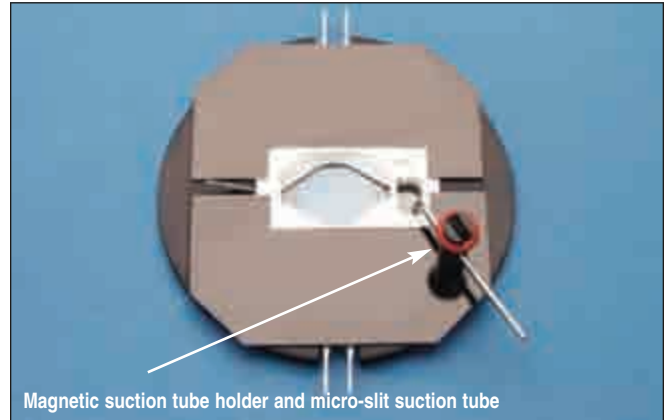
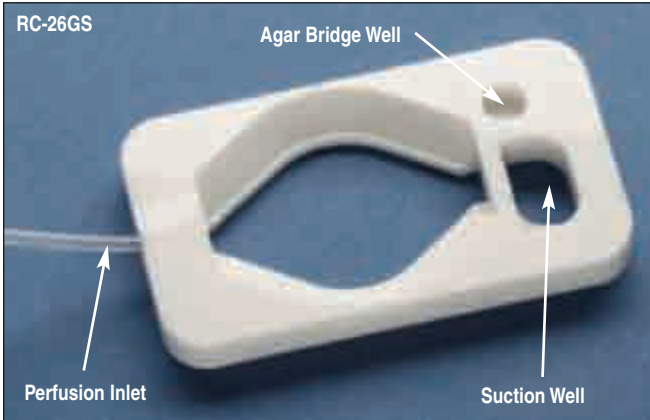
RC-26GS series 20 chambers

Silicone Imaging Chamber

Chambers

series 20 chambers

The classic RC-26G chamber offered in a disposable silicone format



RC-26GS shown in a PM-8 platform

- Eliminates the need for a grease seal
- Incorporates Warner's diamond fluidics
- Low cost for disposable applications

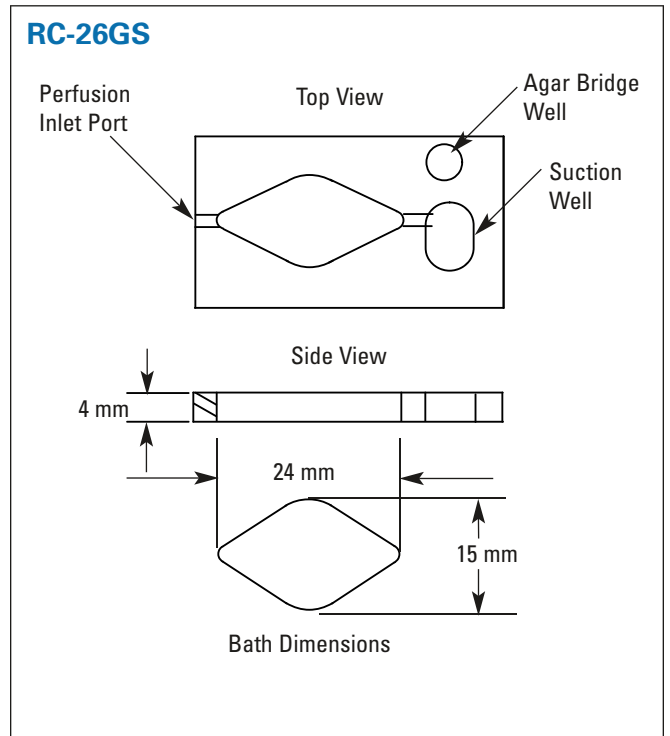
The RC-26G chamber has been one of Warner Instruments most popular recording and imaging chambers. We now offer this classic chamber in a disposable silicone-based format. While disposable, the RC-26GS can be cleaned and reused until it becomes contaminated or the material fails. This feature minimizes the cost-per-use of this chamber. The format of this new chamber carries with it all of the features of the classic RC-26G design, including the use of a 22 x 40 mm coverslip for the chamber floor.

A special PM-8 magnetic platform is required to secure the RC-26GS silicone chamber and coverslip together. The new platform also features several new innovations. See pages 59 and 60 for details.

The RC-26GS silicone chamber enables excellent access for both water-immersion objectives and for electrodes when used with an upright microscope. The bath volume of the RC-26GS is 234 $\mu\text{l}/\text{mm}$. The large diamond-shaped bath area (15 x 24 mm) allows for the insertion and removal 15 mm round coverslips. Large samples can also be directly placed into this chamber.

The RC-26GS silicone chamber and platform requires a stage adapter to complete the assembly for mounting onto a microscope.

Chambers are packaged in lots of two and are supplied with an ST-3 suction tube, a MAG-2 magnetic clamp (for suction tubes), a pack of #1 thickness glass coverslips (CS-22/40, 22x40 mm, 50/pkg.), and 10 feet of PE-160 tubing.



Specifications

Material	Medical grade silicone
Bath dimensions (L x W x H)	24 x 15 x 4 mm
Volume, by depth	234 $\mu\text{l}/\text{mm}$
Bottom coverglass	22 x 40 mm
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)
Aspirator coupling	1.67 mm (OD)

Order #	Model	Product
W4 64-1534	RC-26GS	Chamber Large Bath Silicone pack of 2
W4 64-1531	PM-8	Chamber Platform Magnetic

Accessories and Replacement Parts

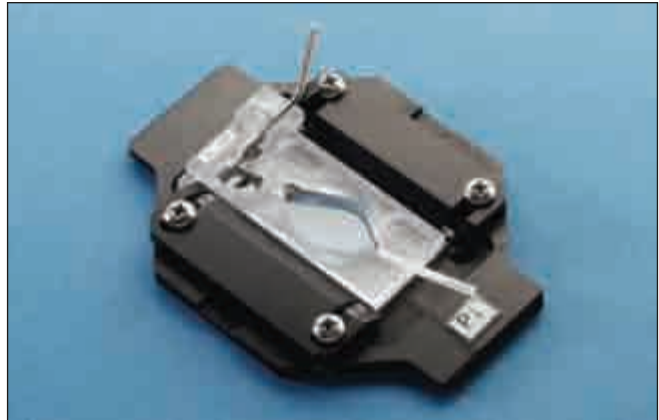
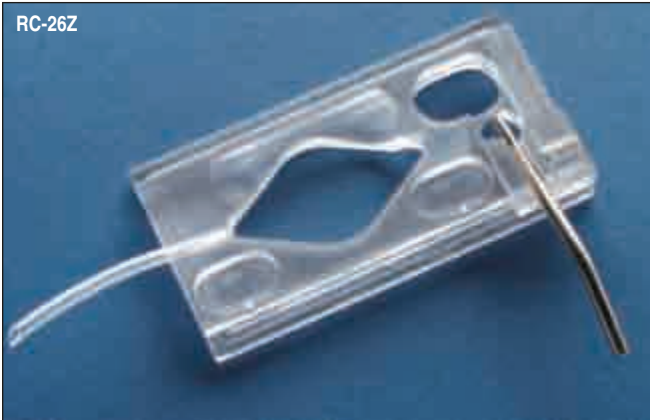
W4 64-0359	MAG-2	Magnetic Clamp for suction tubes
W4 64-1406	ST-3	Suction Tube micro slit design
W4 64-0707	CS-22/40	Coverslips #1 thickness 22 x 40 mm
W4 64-0755	PE-160/10	Polyethylene Tubing

RC-26Z

series 20 chambers

Open Diamond Bath for Oocyte Studies

The RC-26 with the addition of two agar bridge wells for oocyte work



RC-26Z shown in a P-1 platform

- Designed for TEV oocyte recording
- Diamond shaped bath provides laminar solution flow
- Large optical imaging area
- Can be used with either upright or inverted microscopes
- Tissue slice anchors available

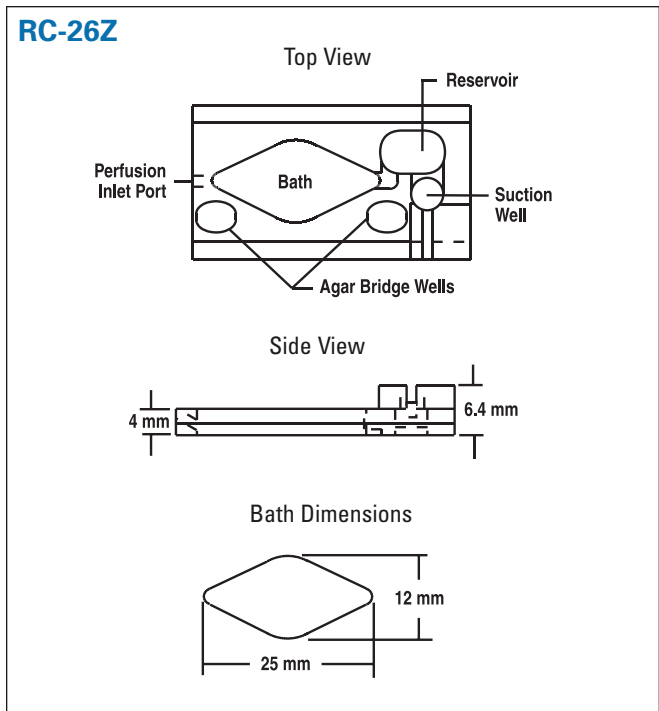
The RC-26Z is a polycarbonate chamber, similar in design to the RC-26, having two additional features specific for two-electrode oocyte recording: Namely, the dam height in the suction well is increased to 2.5 mm to provide an adequate solution level in the bath, and a second agar bridge well has been added to accommodate bath clamp electrodes.

The RC-26Z can also accommodate larger tissue slices and preparations, and permits excellent access for electrodes. The working volume is 170 µl/mm. The chamber floor consists of a 22 x 50 mm coverslip.

The chamber is equipped with a stainless steel suction tube (1.67 mm OD) together with a suction tube clamp. This insures the adjustable height suction tube will not move once the height is set by the user.

The RC-26Z chamber requires a platform (P-1, PH-1, or PM-1) and stage adapter to complete the assembly for mounting onto a microscope.

Each RC-26Z is supplied with a package of #1 thickness glass coverslips (CS-22/50, 22 x 50 mm, 50/pkg) and 10 feet of PE-160 tubing.



Specifications

Material	Polycarbonate
Bath dimensions (L x W x H)	25 x 12 x 4 mm
Volume, by depth	170 µl/mm
Bottom coverglass	22 x 50 mm
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)
Aspirator coupling	1.67 mm (OD)

Order #	Model	Product
W4 64-0237	RC-26Z	Large Bath Oocyte Recording Chamber
W4 64-0277	P-1	Platform, non-heated
W4 64-0284	PH-1	Platform, heated
W4 64-1526	PM-1	Platform, heated magnetic
Accessories and Replacement Parts		
W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0708	CS-22/50	Coverslips, 22 x 50 mm

RC-27

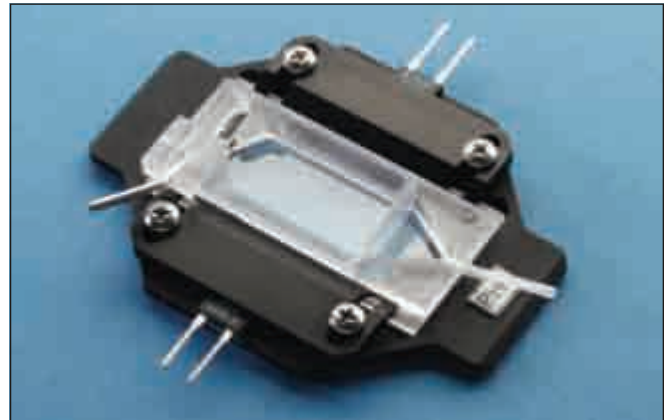
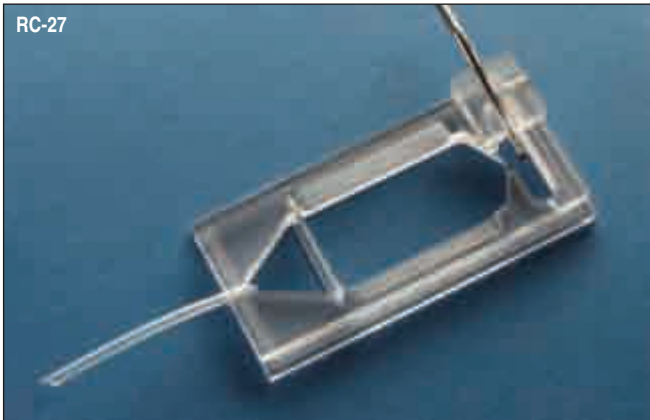
series 20 chambers

Large Rectangular Open Bath Chamber

A large bath chamber with a large viewing area designed for tissue sections

Chambers

series 20 chambers



RC-27 shown in a PH-6 platform

- Designed for large tissue sections or brain slice studies
- Large rectangular bath area accommodates insertion of coverslips up to 12 x 24 mm
- Large optical imaging area
- Can be used with either upright or inverted microscopes
- Slice anchors available

The RC-27 is a large bath chamber ideal for large tissue or brain slice studies. The large imaging area increases the likelihood of viewing desired features and the angled sides of the chamber facilitate electrode placement.

The chamber floor consists of a 24 x 50 mm rectangular coverslip and the bath area is 12 x 24 mm. These dimensions are useful for organotypic slice culture studies. An adjustable spreader plate at the bath input facilitates uniform solution flow. The working volume of the RC-27 is 413 μ l per mm of solution height. The chamber is equipped with a stainless steel aspiration tube together with a clamp.

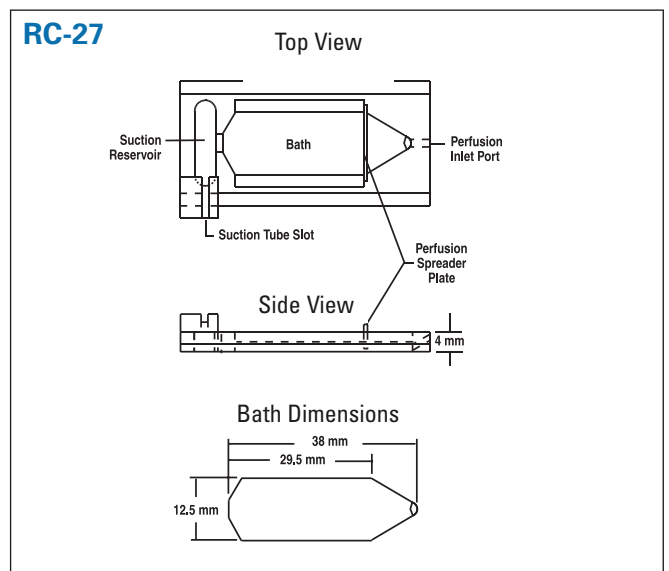
Designed for brain or tissue slice studies, several optional slice anchors are offered with Lycra thread spacing of 1.0, 1.5, and 2.0 mm. An anchor kit is also available containing slice anchors (1 each) in each available thread spacing.

The RC-27 requires a platform (P-6, PH-6, or PM-6) and stage adapter to complete the assembly for mounting onto a microscope.

Each chamber is supplied with a package of #1 thickness glass coverslips (CS-24/50, 24 x 50 mm, 50/pkg) and 10 feet of PE-160 tubing. Slice anchors sold separately, see page 71.

Specifications

Material	Polycarbonate
Bath dimensions (L x W x H)	38 x 12.5 x 4 mm
Volume, by depth	413 μ l/mm
Bottom coverglass	24 x 50 mm
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)
Aspirator coupling	1.67 mm (OD)



Order #	Model	Product
W4 64-0238	RC-27	Very Large Bath Recording Chamber
W4 64-0282	P-6	Platform, non-heated
W4 64-0289	PH-6	Platform, heated
W4 64-1527	PM-6	Platform, heated magnetic

Accessories and Replacement Parts

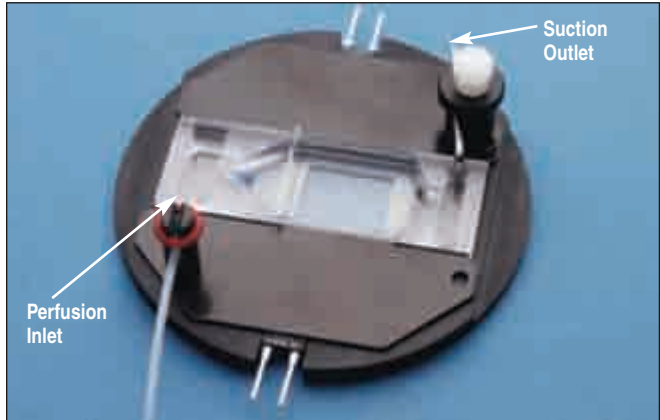
W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0709	CS-24/50	Coverslips, 24 x 50 mm
W4 64-0267	SHD-27KIT	Slice Anchor Kit
W4 64-0194	SHD-27H/10	Slice Anchor, 1.0 mm
W4 64-0193	SHD-27H/15	Slice Anchor, 1.5 mm
W4 64-0192	SHD-27H/20	Slice Anchor, 2.0 mm
W4 64-1451	CPS-27	Perfusion Spreader Plate

series 20 chambers

RC-27D and RC-27LD

Ultra-quiet Imaging Chamber for Slice Studies

The RC-27L with a special input for applications requiring ultra quiet solution delivery



RC-27LD shown in a PM-7D heated platform

- Designed for tissue slice studies
- RC-27LD includes slice support
- Eliminates vibration associated with solution exchange
- Allows multiplexed solution delivery without solution switching artifacts

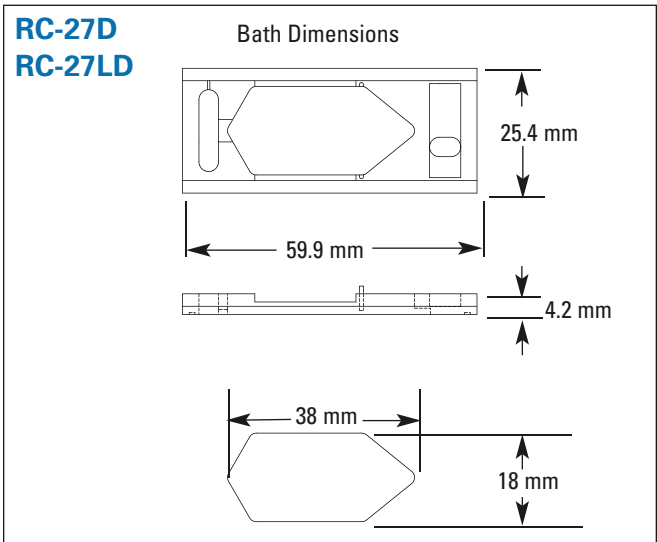
The RC-27D and RC-27LD chambers are designed with tissue slice studies in mind. A large imaging field allows for maximal observation of biological specimens. Advantages of this system over other chambers includes the presence of a sloped inflow channel which allows for smooth and "ultra-quiet" solution delivery.

The sloped input of these chamber allows I-V type infusion lines to deliver drops at a fixed rate without the transfer of noise to the specimen field. In addition, multiplexed solution delivery is now possible without the potential for solution switching artifacts. This new technology provides the capability of ultra-quiet solution exchange without transferring noise to either the system or to the image.

Measurement from tissue slices is provided for by the inclusion of slice support in the RC-27LD chamber. Slices are supported 0.5 mm above the chamber floor. Support threads are made of Lycra and thread spacing is 0.5 mm.

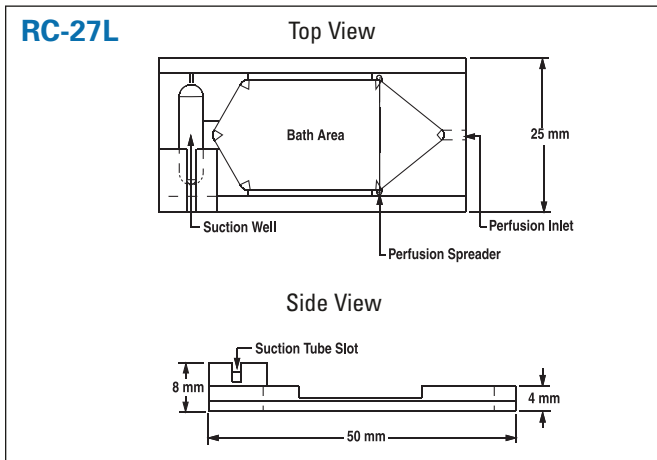
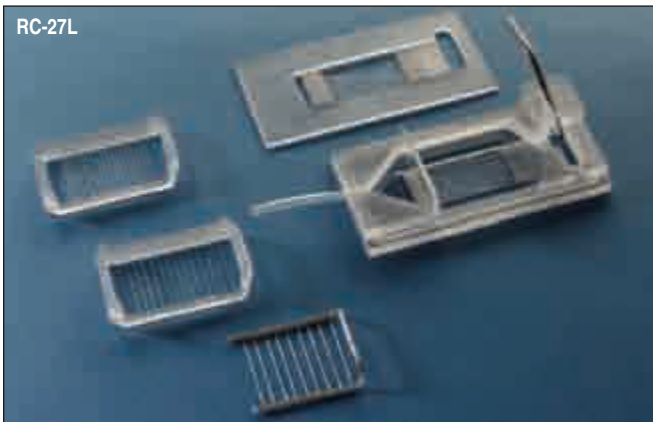
The RC-27D requires a PM-7 platform and the RC-27LD requires a PM-7D platform. Both chambers also require a stage adapter to complete the assembly for mounting onto a microscope

Each chamber is supplied with a MAG-2 magnetic clamp for suction tubes, a magnetic perfusion tube holder, a package of #2 thickness glass coverslips (CS-24/60), 40/pkg, and 10 feet of PE-160 polyethylene tubing. The RC-27LD also includes a slice support. Slice anchors are sold separately, see page 71.



Order #	Model	Product
W4 64-1548	RC-27D	Slice Chamber, Ultra-quiet
W4 64-1532	RC-27LD	Slice Chamber, Ultra-quiet with tissue slice support
W4 64-1529	PM-7	Chamber Platform for RC-27D
W4 64-1530	PM-7D	Chamber Platform for RC-27LD
Accessories and Replacement Parts		
W4 64-1550	SS-4-500V	Slice Support 500 Micron
W4 64-1551	SS-4-500H	Slice Support 500 Micron
W4 64-0256	SHD-27LH/10	Metal Slice Hold Down, 1 mm
W4 64-0257	SHD-27LH/15	Metal Slice Hold Down, 1.5 mm
W4 64-0258	SHD-27LH/20	Metal Slice Hold Down, 2 mm
W4 64-0259	SHD-27LP/10	Plastic Slice Hold Down, 1 mm
W4 64-0260	SHD-27LP/15	Plastic Slice Hold Down, 1.5 mm
W4 64-0261	SHD-27LP/20	Plastic Slice Hold Down, 2 mm
W4 64-0710	CS-24/60	Coverslips, 24 x 60 mm

A large bath chamber specifically designed for tissue slice studies



- Designed for tissue slice studies
- Permits solution flow both above and below a tissue slice
- Provides good access for immersion optics and electrodes
- Can be used with either upright or inverted microscopes
- Slice anchors available

The RC-27L is designed with tissue slice studies in mind. The slice rests on a plastic support and is held in place by an anchor (also known as a harp). The slice support rests 0.5 mm above the coverslip floor. This design allows the tissue slice to be perfused from both above and below, which can increase the sample's viability. Slice supports are included and anchors are sold separately.

The slice support is fabricated in polycarbonate. Slice anchors are available in polycarbonate or stainless steel. Both slice supports and slice anchors use fine Lycra threads to secure the slice in place, allowing maximum access to the preparation. Thread spacing on the slice support is 1 mm and available thread spacing on slice anchors are 1.0, 1.5, and 2.0 mm. Polycarbonate or stainless steel anchor kits containing slice anchors (1 each) in each available thread spacing are also available.

While the weight of the metal harp is sufficient to hold a slice in place, the plastic harp relies on a close apposition between itself and the chamber side walls to secure it into position. This approach can reduce pressure on the slice from the supports.

The RC-27L requires a platform (P-6D, PH-6D, PM-6D)*; Also fits P-6 platform without slice support) and stage adapter to complete the assembly for mounting onto a microscope.

Each chamber is supplied with an SS-3 slice support, 10 feet of PE-160 polyethylene tubing, and a package of #1 thickness glass coverslips (CS-24/50, 24 x 50 mm, pkg. of 50).

* Slice anchors sold separately, see page 71.

* Also fits P-6 Platform without slice support.

Specifications

Material	Polycarbonate or polysulfone*
Bath dimensions (L x W x H)	38 x 18 x 3 mm
Volume, by depth	560 µl/mm
Bottom coverglass	24 x 50 mm
Slice support	24 x 50 x 0.5 mm thick, polycarbonate, Lycra threads at 1 mm
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)
Aspirator coupling	1.67 mm (OD)

* Please call for price and availability of polysulfone chambers.

Order #	Model	Product
W4 64-0241	RC-27L	Large Bath Chamber
W4 64-0283	P-6D	Platform, non-heated
W4 64-0290	PH-6D	Platform, heated
W4 64-1528	PM-6D	Platform, heated magnetic
Accessories and Replacement Parts		
W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0709	CS-24/50	Coverslips, 24 x 50 mm
W4 64-0273	SS-3	Slice Support
W4 64-1533	SS-3G	Grid
W4 64-0190	SHD-27LPKIT	Plastic Slice Anchor Kit
W4 64-0259	SHD-27LP/10	Plastic Slice Hold-Down, 1.0 mm
W4 64-0260	SHD-27LP/15	Plastic Slice Hold-Down, 1.5 mm
W4 64-0261	SHD-27LP/20	Plastic Slice Hold-Down, 2.0 mm
W4 64-0268	SHD-27LKIT	Stainless Steel Slice Anchor Kit
W4 64-0256	SHD-27LH/10	Stainless Steel Slice Hold-Down, 1 mm
W4 64-0257	SHD-27LH/15	Stainless Steel Slice Hold-Down, 1.5 mm
W4 64-0258	SHD-27LH/20	Stainless Steel Slice Hold-Down, 2 mm
W4 64-1450	CPS-27L	Perfusion Spreader Plate

RC-27N

series 20 chambers

Narrow Rectangular Bath Chamber

The RC-27 design in a narrow bath configuration



RC-27N shown in a PM-6 platform

- Rectangular, open bath chamber
- Narrow bath
- Accommodates tissue or brain slice specimens
- Applications include patch clamp, and measurements on cultured cells and tissue preparations
- Slice anchors available

The RC-27N recording chamber is a modified version of the RC-27 with a narrower bath and smaller volume. The narrow bath can stabilize solution flow at high flow rates and the smaller volume improves exchange times.

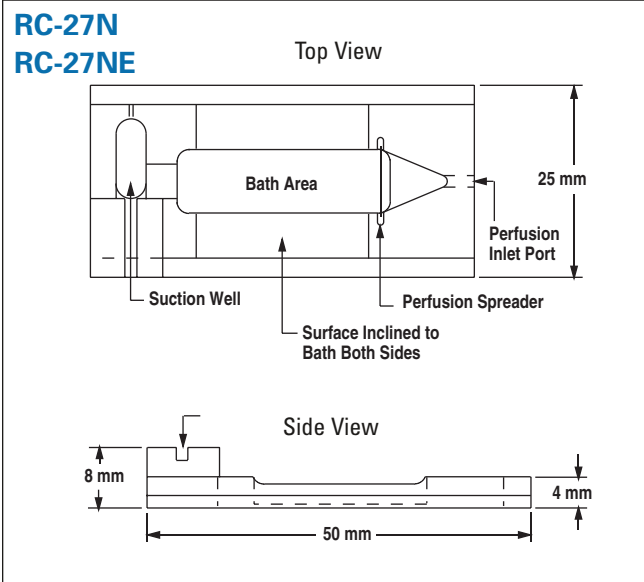
The specimen area is 28 x 8 mm. The height of the bath area side walls is 2 mm, and the sides of the chamber slope away from the bath at an angle of 15° from the horizontal. The low profile design and inclined surfaces permit good electrode access to the specimen area.

The RC-27N chamber requires a platform (P-6, PH-6, or PM-6) and stage adapter to complete the assembly for mounting onto a microscope. The chamber body is manufactured from polycarbonate and the chamber floor is formed from a 24 x 50 mm coverslip.

Each chamber is supplied with a package of #1 thickness glass coverslips (CS-24/50, 24 x 50 mm, pkg. of 50) and 10 feet of PE-160 polyethylene tubing.

Specifications

Material	Polycarbonate
Bath dimensions (L x W x H)	37 x 8 x 2 mm
Volume, by depth	305 µl/mm
Bottom coverglass	24 x 50 mm
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)
Aspirator coupling	1.67 mm (OD)

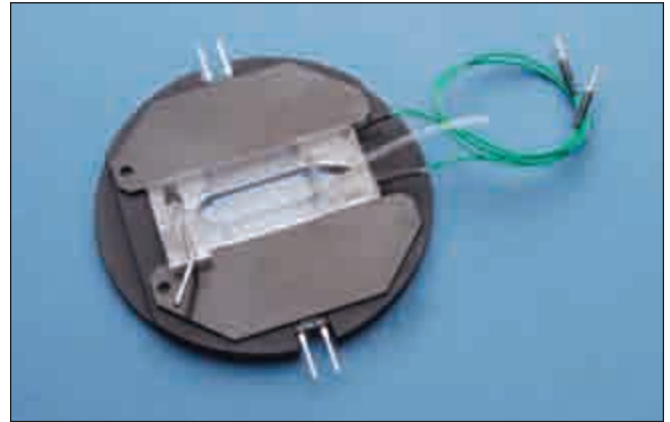
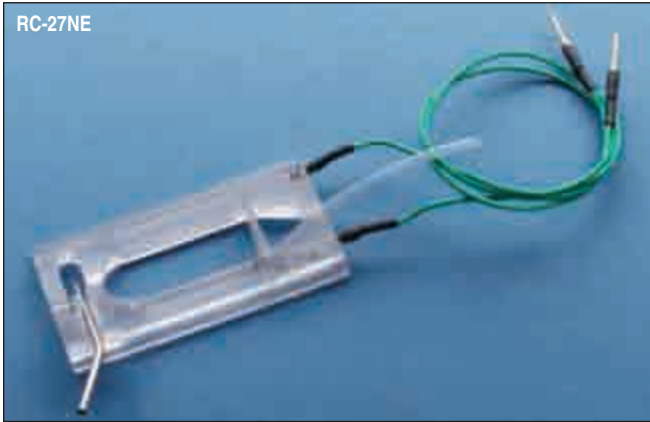


Order #	Model	Product
W4 64-0239	RC-27N	Narrow Bath Recording Chamber
W4 64-0282	P-6	Platform, non-heated
W4 64-0289	PH-6	Platform, heated
W4 64-1527	PM-6	Platform, heated magnetic
Accessories and Replacement Parts		
W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0709	CS-24/50	Coverslips, 24 x 50 mm
W4 64-0191	SHD-27NKIT	Slice Anchor Kit
W4 64-0197	SHD-27N/10	Metal Slice Anchor, 1.0 mm
W4 64-0196	SHD-27N/15	Metal Slice Anchor, 1.5 mm
W4 64-0195	SHD-27N/20	Metal Slice Anchor, 2.0 mm
W4 64-1452	CPS-27N	Perfusion Spreader Plate

RC-27NE series 20 chambers

Narrow Bath Chamber with Field Stimulation

A narrow-bath RC-27 with platinum field stimulation electrodes



RC-27NE shown in a PM-6 heated platform

- Designed for field stimulation studies
- Rectangular open-bath chamber
- Narrow bath
- Accommodates tissue or brain slice specimens
- Applications include patch clamp and physiological measurements on cultured cells and tissue preparations

The RC-27NE recording chamber is a modified version of the RC-27 with a narrower bath and smaller volume designed for applications requiring electric field stimulation. Laminar solution flow is more stable in this chamber than in the wider RC-27 chamber.

The working specimen area is 28 x 8 mm and there are inclined surfaces on both sides (from 2.0 mm to 3.1 mm height). The low profile design and inclined surfaces permits good electrode access to the specimen area.

The chamber is supplied with a pair of platinum wire electrodes installed along the long parallel sides of the bath. Electrode leads are approximately 16 cm long and terminate with 1 mm diameter pins.

The RC-27N chamber requires a platform (P-6, PH-6, or PM-6) and stage adapter to complete the assembly for mounting onto a microscope. The chamber body is manufactured from polycarbonate and the chamber floor is formed from a 24 x 50 mm coverslip.

Each chamber is supplied with a package of #1 thickness glass coverslips (CS-24/50, 24 x 50 mm, pkg. of 50) and 10 feet of PE-160 polyethylene tubing.

The SIU-102 is a bipolar stimulator designed for use with field stimulation chambers. This instrument features constant current and constant voltage modes, as well as bipolar, pulse, and DC modes. Optical coupling is used to electronically isolate the stimulator from the pulse source. Currents up to 100 mA and voltages up to 100 V are also supported. See page 247 for details.

Specifications

Material	Polycarbonate
Bath dimensions (L x W x H)	37 x 8 x 2 mm
Volume, by depth	305 µl/mm
Electrodes	Platinum wire, 15 cm cables with 1 mm pins
Bottom coverglass	24 x 50 mm
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)
Aspirator coupling	1.67 mm (OD)

Order #	Model	Product
W4 64-0240	RC-27NE	Narrow Bath Recording Chamber with Field Stimulation
W4 64-0282	P-6	Platform, non-heated
W4 64-0289	PH-6	Platform, heated
W4 64-1527	PM-6	Platform, heated magnetic

Accessories and Replacement Parts

W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0709	CS-24/50	Coverslips, 24 x 50 mm

Excised Patch Chamber with Two Slotted Open Baths

Permits solution exchange around a membrane patch without contaminating the associated cell population



- Designed for excised patch studies
- Open chamber design
- Dual slotted baths in two sizes
- Baths separated by a controllable dam

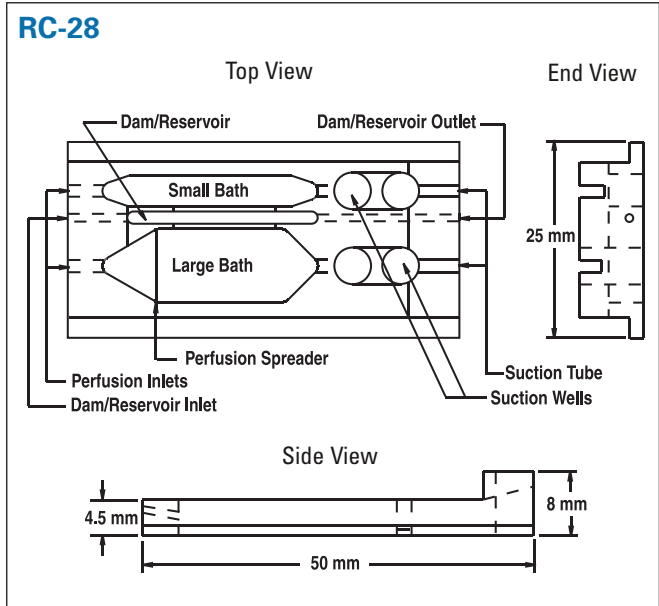
The RC-28 is a special chamber containing two bath compartments separated by an adjustable dam. The dam functions both as a gate and barrier between the two main baths. The composition and flow rate of each bath can be independently controlled, and each bath has a separate stainless steel suction tube for perfusion.

The dual slotted, open bath design allows for the exchange of solution surrounding an isolated membrane patch without contaminating or modifying the rest of the cell population. Raising the solution level in the dam area joins the two baths, while lowering the solution level isolates the two baths. After patching onto a cell in the large bath compartment, the dam is flooded, enabling secure transfer of the electrode attached cell to the smaller compartment. The dam is then drained, isolating the relocated cell.

For the larger chamber, the bath area is 21 x 9.5 mm and the working volume is 243 µl per mm of solution height. For the smaller chamber, the area is 28 x 3.8 mm and the volume is 111 µl.

A platform (P-6, PH-6, or PM-6) and stage adapter are required to complete the assembly for mounting onto a microscope. The chamber bottom is formed by a 24 x 50 mm coverslip.

The RC-28 is supplied with a pack of #1 thickness glass coverslips (CS-24/50, 24 x 50 mm, 50/pkg) and 10 feet of PE-160 polyethylene tubing.



Specifications

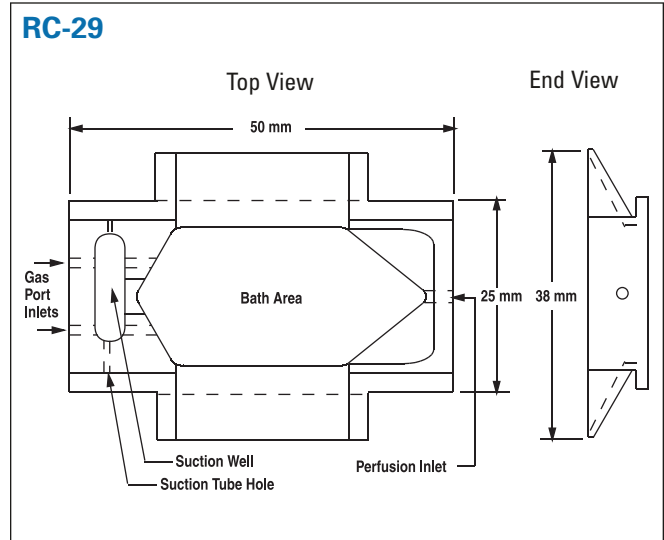
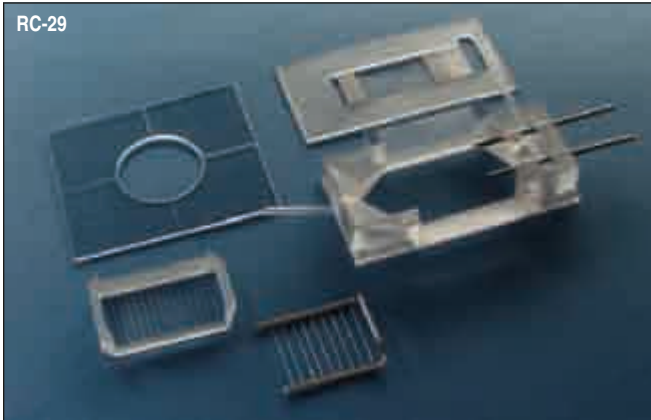
Material	Polycarbonate
Small Bath Dimensions (L x W x H)	28.0 x 3.8 x 4.5mm
Large Bath Dimensions (L x W x H)	28.0 x 9.5 x 4.5 mm
Small Bath Volume, by depth	111 µl
Large Bath Volume, by depth	243 µl
Small Bath Specimen Area (L x W)	28 x 3.8 mm
Large Bath Specimen Area (L x W)	21 x 9.5 mm
Bottom coverglass	24 x 50 mm
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)
Aspirator coupling	1.67 mm (OD)

Order #	Model	Product
W4 64-0243	RC-28	Excised Patch Recording Chamber
W4 64-0282	P-6	Platform, non-heated
W4 64-0289	PH-6	Platform, heated
W4 64-1527	PM-6	Platform, heated magnetic

Accessories and Replacement Parts

W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0709	CS-24/50	Coverslips, 24 x 50 mm

Designed for slice studies requiring controlled atmospheric conditions



- Designed for tissue slice studies
- Gas perfusion ports allow for controlled atmospheric conditions
- Provides for perfusate flow both above and below a tissue slice
- Provides good access for immersion optics and electrodes
- Used with either upright or inverted microscopes
- Large imaging area
- Slice anchors available

The RC-29 chamber is modeled after the RC-27L (in that it enables solution flow both above and below the tissue slice) with the added feature of atmospheric control.

Similar to the RC-27L, the tissue slice rests on a plastic slice support 0.5 mm above the coverslip floor and is held in place by an optional slice anchor. Slice supports and slice anchors use fine Lycra threads to secure the slice into place allowing maximum access to the preparation. Thread spacing is 1 mm on the slice support and are 1.0, 1.5, and 2.0 mm for the slice anchors. Anchors are purchased separately and are available in polycarbonate and stainless steel. Warner also offers anchor kits containing slice anchors (1 each) in each available thread spacing.

The RC-29 has tall sides with sloping surfaces to allow for an atmospheric space. Gas input ports are constructed into the chamber walls and a chamber top (with access port) is also provided. Continuous gas flow into the chamber establishes positive pressure within the chamber maintaining the atmospheric environment.

This chamber requires a platform (P-6D, PH-6D, or PM-6D) and stage adapter to complete the assembly for mounting on a microscope. The chamber bottom is formed by a 24 x 50 mm coverslip.

The chamber is supplied with a plastic SS-3 slice support, 10 feet of PE-160 polyethylene tubing, a chamber cover, and one pack of #1 thickness coverslips (CS-24/50, 24 x 50 mm, pkg. of 50).

Specifications

Material	Polycarbonate
Bath dimensions (L x W x H)	38 x 18 x 6 mm
Volume, by depth	629 µl/mm
Bottom coverglass	24 x 50 mm
Slice support	24 x 50 mm, polycarbonate, Lycra threads at 1 mm
Input tubing (ID x OD)	1.14 x 1.57 mm (PE-160)
Aspirator coupling	1.67 mm (OD)
Gas perfusion ports	Stainless steel, 1.67 mm (OD)

Order #	Model	Product
W4 64-0244	RC-29	Chamber with Slice Support
W4 64-0283	P-6D	Platform, non-heated
W4 64-0290	PH-6D	Platform, heated
W4 64-1528	PM-6D	Platform, heated magnetic

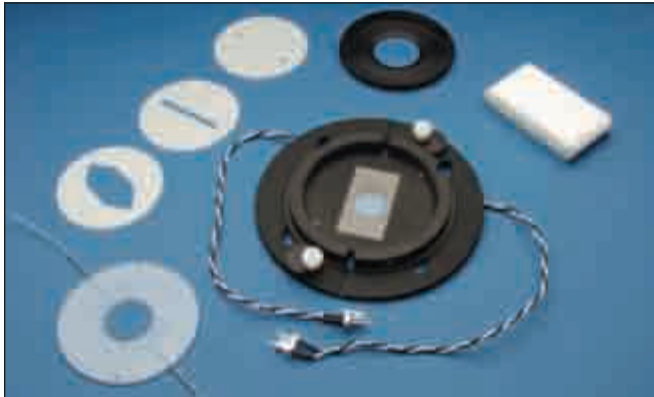
Accessories and Replacement Parts		
W4 64-0755	PE-160/10	Polyethylene tubing
W4 64-0709	CS-24/50	Coverslips, 24 x 50 mm
W4 64-0273	SS-3	Slice Support
W4 64-0256	SHD-27LH/10	Metal Slice Hold Down, 1.0 mm
W4 64-0257	SHD-27LH/15	Metal Slice Hold Down, 1.5 mm
W4 64-0258	SHD-27LH/20	Metal Slice Hold Down, 2.0 mm
W4 64-0259	SHD-27LP/10	Plastic Slice Hold Down, 1.0 mm
W4 64-0260	SHD-27LP/15	Plastic Slice Hold Down, 1.5 mm
W4 64-0261	SHD-27LP/20	Plastic Slice Hold Down, 2.0 mm

series 30 chambers

RC-30, RC-30HV and RC-30WA

Confocal Imaging Chambers

Low profile, closed bath chambers designed for confocal imaging on upright and inverted microscopes



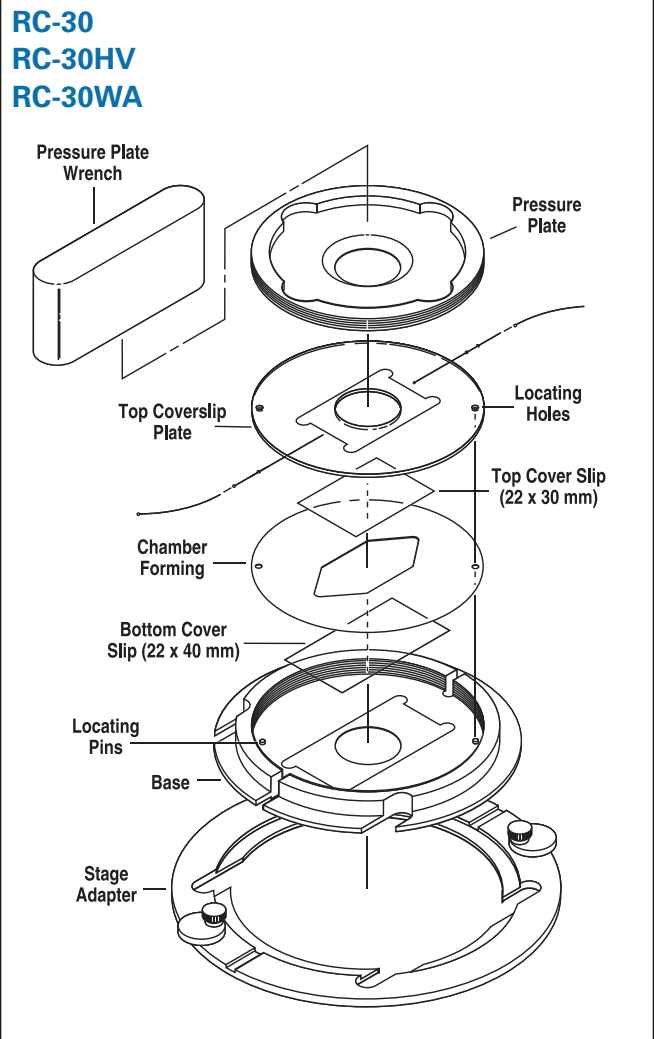
- Option of confocal imaging with continuous perfusion
- Accommodates both upright and inverted microscopes
- 17.7 mm diameter viewing aperture (RC-30, RC-30HV)
- 25.0 mm diameter viewing aperture (RC-30WA)
- User-defined cross-sectional viewing area
- User-defined bath volume with fast fluid exchange
- Three available gasket thicknesses
- Resistive heating option on chamber base

The RC-30 and RC-30HV are closed bath, low profile chambers incorporating special features for confocal imaging. These features include user defined bath geometry and total volume, and a large viewing area. A 22 x 30 mm (#1 thickness) glass coverslip forms the top of the chamber, while a 22 x 40 mm coverslip (also #1 thickness) forms the chamber bottom, creating a closed bath. This design enables the chamber to be inverted in the mounting platform allowing it to be used with both inverted or upright microscopes. The final viewing aperture is 17.7 mm.

The RC-30WA is a wide aperture version of the RC-30HV. It uses a 40 mm diameter coverslip for its bottom surface and a 30 mm diameter coverslip for its top. The final viewing aperture is 25 mm. The chamber bottom is beveled to permit maximum access to the bottom coverslip.

Variable Bath Volume/Fast Perfusate Exchange

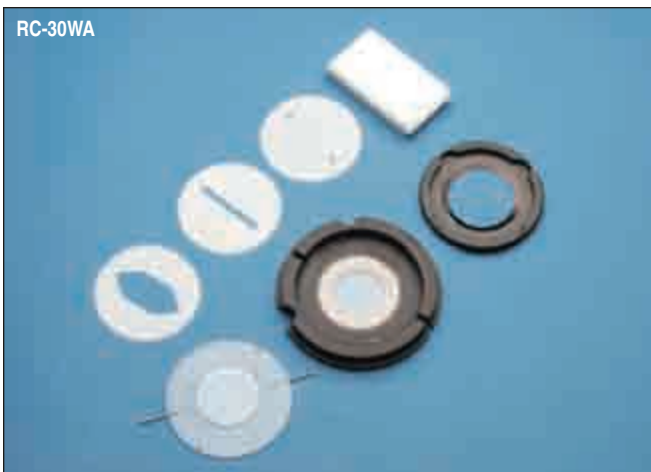
The side walls of the bath are formed by silicone gaskets sandwiched between the top and bottom coverslips. Wall height (i.e., spacing between the two coverslips) can range from 150-1000 μm and is defined by the total thickness of the gaskets used. Blank gaskets are supplied with the chamber allowing the development of the customized bath geometry required for unique applications.



series 30 chambers

RC-30, RC-30HV and RC-30WA

Confocal Imaging Chambers (continued)



Pre-cut gaskets are supplied with the chamber; one cut wide to allow full use of the aperture window and a narrow, slotted version for fast solution exchange. The bath volumes for these two pre-cut, 250 μ m thick gaskets are 26 μ l for the slotted style and 133 μ l for the wide style.

Heater Version

The RC-30HV and RC-30WA include a pair of resistive heater elements mounted onto the chamber base. These resistors are compatible with Warner TC-324B and TC-344B Temperature Controllers which can be ordered separately along with a CC-28 cable.

All versions of the confocal imaging chambers require special microscope stage adapters which must be ordered separately.

Confocal imaging chambers are supplied with six pre-cut 250 μ m thick gaskets: two large area bath gaskets (GS-30L/10, 133 μ l volume), two slotted bath gaskets (GS-30S/10, 25.6 μ l volume), and two blank gaskets (GS-30B/10) for user customized chamber areas. Also included is a special tool used for mounting the top plate, polyethylene tubing (PE-90/10, 10 feet.), and 22 x 30 mm and 22 x 40 mm #1 glass coverslips (CS-22/30 and CS-22/40, pkg. of 50). The RC-30WA includes one box each of 30 mm round coverslips (CS-30R) and 40 mm round coverslips (CS-40R).

Warner Instruments offers 150, 250, 375 μ m thick gaskets which are listed on the facing page.



Viewing Aperture	Top	Bottom
RC-30/30 HV	25.4 mm	17.8 mm
RC-30 WA	34.5 mm	25.4 mm

Specifications

Physical Dimensions (H x D)	9.5 x 82 mm
Weight	< 90 g, assembled with optional heaters
Base and Pressure Plate	Aluminum, black anodized
Top Coverslip Plate	Polycarbonate
Gaskets	Silicone rubber
Input/Output Tubing	PE-90
Coverslips for RC-30, RC-30HV	Top: 22 x 30 mm; Bottom: 22 x 40 mm
Coverslips for RC-30WA	Top: 30 mm round; Bottom: 40 mm round

series 30 chambers

RC-30, RC-30HV and RC-30WA

Confocal Imaging Chambers (continued)



Order #	Model	Product
W4 64-0320	RC-30	Confocal Imaging Chamber
W4 64-0321	RC-30HV	Confocal Imaging Chamber
W4 64-0321WA	RC-30WA	Confocal Imaging Chamber
Series 30 Stage Adapters		
W4 64-0322	SA-30NIK	Nikon Diaphot/TE200/TE300/TE2000
W4 64-0324	SA-30TMS/9	Nikon TMS with 9 x 13 cm Cut-Out
W4 64-0325	SA-30/OLY2	Olympus IMT-2/IX-50/IX-70/BX-50WI
W4 64-0326	SA-30LZ	Zeiss Axiovert 211 x 230 Specimen Stage
W4 64-0327	SA-30KZ	Zeiss Axiovert 85 x 130 Mechanical (K) Stage
W4 64-0328	SA-30L3P	Leica Dmirb/E with 3-Plate Mechanical Stage
W4 64-0329	SA-30PLI	Prior & Ludl Motorized Stage
W4 64-0377	SA-30GALVOZ	Leica Galvo Z Upright Stage
W4 64-0379	SA-30UUZ	Zeiss LSM510
W4 64-0380	SA-30UU	Nikon E400/E600/E800
W4 64-1456	SA-30GALVZi	Leica Galvo Z Inverted Stage
Accessories and Replacement Parts		
W4 64-0330	GS-30L/10	Replacement Gaskets, Large Bath, 250 μ m thickness, pkg. of 10
W4 64-0331	GS-30L/15	Replacement Gaskets, Large Bath, 375 μ m thickness, pkg. of 10
W4 64-0332	GS-30S/10	Replacement Gaskets, Slotted Bath, 250 μ m thickness, pkg. of 10
W4 64-0333	GS-30S/15	Replacement Gaskets, Slotted Bath, 375 μ m thickness, pkg. of 10
W4 64-0334	GS-30B/10	Replacement Gaskets, Blank, 250 μ m thickness, pkg. of 10
W4 64-0335	GS-30B/15	Replacement Gaskets, Blank, 375 μ m thickness, pkg. of 10
W4 64-0341	GS-30B/4	Replacement Gaskets, Blank, 150 μ m thickness, pkg. of 10
W4 64-0342	GS-30L/4	Replacement Gaskets, Large Bath, 150 μ m thickness, pkg. of 10
W4 64-0343	GS-30S/4	Replacement Gaskets, Slotted Bath, 150 μ m thickness, pkg. of 10
W4 64-1464	RC30TCP	Replacement Top Coverslip Plate
W4 64-1464WA	RC30TCPWA	Replacement Top Coverslip Plate for RC-30 WA
W4 64-0706	CS-22/30	Coverslips #1 Thickness (50)
W4 64-0707	CS-22/40	Coverslips #1 Thickness (50)
W4 64-1499	CS-30R	Coverslips #1.5 Thickness (90)
W4 64-1500	CS-40R	Coverslips #1 Thickness (60)
W4 64-1559	RH-3	Replacement Heating Elements, 2/pkg.

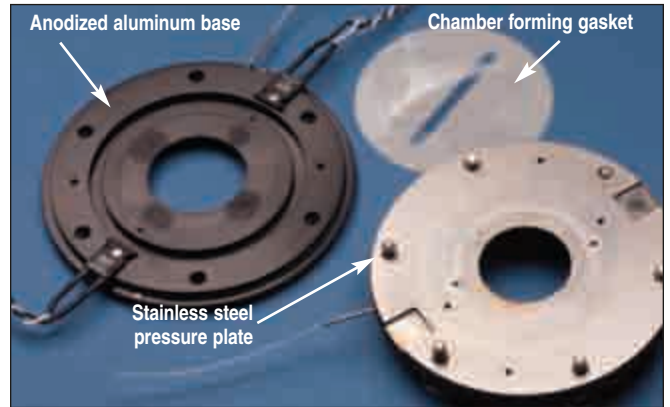
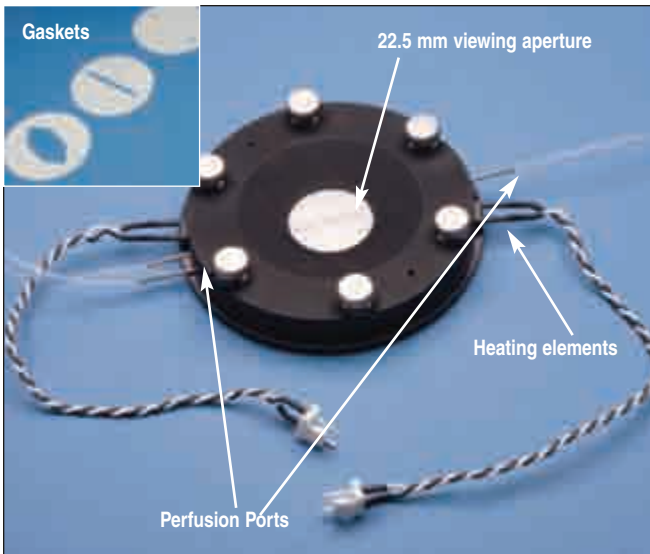
series 30 chambers

NEW Model RC-31

A Low Profile, Parallel Plate Flow Chamber

Chambers

series 30 chambers



Pre-cut gaskets are supplied with the chamber; one cut wide to allow full use of the aperture window (17.7 mm diameter) and a narrow, slotted version (4 x 7 mm) for fast solution exchange and blank gaskets for customized bath shapes.

The bath volumes for these pre-cut, 250 μm thick gaskets are 26 μl for the slotted cut and 133 μl for the wide cut.

- Adjustable distance between upper and lower coverslips, 50 μm to 350 μm
- Optimal control of culture conditions and cellular environment
- Compatible with both upright and inverted microscopes
- Amenable for long term studies using live cells

The RC-31 is closed bath low profile chamber incorporating special features for microscopic confocal imaging.

These features include user defined bath geometry and a large viewing area. A 30 mm, #1.5 glass coverslip forms the top of the chamber, while a 40 mm, #1 coverslip forms the bottom, respectively, creating a closed bath. The closed design allows the chamber to be inverted in the mounting platform enabling its use with both inverted or upright microscopes. The final viewing aperture is 25 mm diameter.

Variable Bath Volume/Fast Perfusate Exchange:

The side walls of the RC-31 bath is formed by a silicone gasket sandwiched between the top and bottom coverslips. Wall height (i.e. spacing between the two coverslips) can range from 50-350 μm and is defined by the thickness and number of gaskets used. Blank gaskets are supplied with the chamber permitting the development of the customized bath geometry required for individual applications.

Order #	Model	Product
W4 64-1685	RC-31	Confocal Imaging Chamber
W4 64-0330	GS-30L/10	Replacement Gaskets, Large Bath, 250 μm thickness, pkg. of 10
W4 64-0331	GS-30L/15	Replacement Gaskets, Large Bath, 375 μm thickness, pkg. of 10
W4 64-0332	GS-30S/10	Replacement Gaskets, Slotted Bath, 250 μm thickness, pkg. of 10
W4 64-0333	GS-30S/15	Replacement Gaskets, Slotted Bath, 375 μm thickness, pkg. of 10
W4 64-0334	GS-30B/10	Replacement Gaskets, Blank, 250 μm thickness, pkg. of 10
W4 64-0335	GS-30B/15	Replacement Gaskets, Blank, 375 μm thickness, pkg. of 10
W4 64-0341	GS-30B/4	Replacement Gaskets, Blank, 125 μm thickness, pkg. of 10
W4 64-0342	GS-30L/4	Replacement Gaskets, Large Bath, 125 μm thickness, pkg. of 10
W4 64-0343	GS-30S/4	Replacement Gaskets, Slotted Bath, 125 μm thickness, pkg. of 10
W4 64-1499	CS-30R	Coverslips #1.5 Thickness (90)
W4 64-1500	CS-40R	Coverslips #1 Thickness (60)

CV-30 CytoViva™ Environment Chamber

Confocal Imaging Chambers

The RC-30 specifically adapted for the CytoViva Imaging System



- Designed for the CytoViva™ high resolution imaging system
- Allows long-term studies of live cells
- Supports oil immersion contact with the CytoViva high resolution illumination system
- Simultaneous observation of fluorescent and non-fluorescent samples

The CV-30 Live Cell Imaging Chamber is a low profile chamber designed specifically for the CytoViva™ Imaging System. This closed-bath chamber incorporates special features for imaging and is compatible with any microscope stage capable of accepting a multi-well plate. The CV-30 also can attach to microscope stages having a standard microscope slide adapter.

The CV-30 Live Cell Imaging Chamber features a user defined bath geometry, volume, and large viewing area. A #1.5 thickness glass coverslip, (0.17 mm) forms the top of the chamber while a 1 mm thick round coverslip forms the bottom. This allows the CV-30 to be used with CytoViva™'s high resolution adapter.

The side wall of the bath is formed by use of silicone gaskets sandwiched between the upper and lower coverslips. Wall height (or spacing between the coverslips) can range from 250 to 1000 µm and is defined by the thickness and number of gaskets used.

Blank gaskets are supplied permitting the development of customized bath geometries as required by your application. Pre-cut gaskets are also supplied with the chamber; one cut wide to allow full use of the large diameter aperture window and a narrow, slotted version targeted towards fast solution exchange.

Included components

The CV-30 comes complete with the following components: CV-30 chamber with universal slide holder connector, a pressure plate wrench, a lift-out tool, one package of #1.5 thickness, 30 mm round coverslips, one package of 1 mm thick, 40 mm round coverslips, one 10 pack, each, of blank, narrow slotted, and wide slotted gaskets in both 250 and 375 µm thicknesses, and 10 feet of PE-90 tubing.

CV-30 Specifications

Physical Dimensions (H x W x D)	9.4 x 85.6 x 128 mm
Weight	240 g
Base and Pressure Plate	Aluminum, black anodized
Top Coverslip Plate	Polycarbonate
Gaskets	Silicone rubber
Input/Output Tubing	PE-90 (0.86 x 1.27 mm)
Coverslips	Top 30 mm dia. x #1.5 Bottom 40 mm dia. x 1.1 mm

Order # Model Product

W4 64-1637	CV-30	Imaging Chamber for CytoViva™
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Accessories/Replacement Parts

W4 64-1499	Coverslips 30 mm Dia. #1.5 90/ pk
W4 64-1638	Coverslips 40 mm Dia. x 1.1 mm 10/ pk
W4 64-0330	Large bath gasket, 250µm thick
W4 64-0331	Large bath gasket, 375µm thick
W4 64-0332	Slotted bath gasket, 250µm thick
W4 64-0333	Slotted bath gasket, 375µm thick
W4 64-0334	Blank bath gasket, 250µm thick
W4 64-0335	Blank bath gasket, 375µm thick

The CV-30 chamber is compatible with Warner TC-324B and TC-344B Temperature Controllers which can be ordered separately along with a CC-28 cable.

culture dish inserts

RC-33DL, RC-33DM, RC-33SM, RC-33SN, RC-33/KIT

Disposable Perfusion Inserts for 35 mm Dishes

Chambers

culture dish inserts

Chamber inserts for 35 mm culture dishes



- Low cost disposable chamber inserts for 35 mm dishes
- Slot-shaped bath for applications requiring rapid perfusion
- Warner's diamond-shaped bath in the large bath versions
- Both temperature and perfusion control are possible when used with QE-1 Quick Exchange Platform

The RC-33DL, RC-33DM, RC-33SM, and RC-33SN chambers are designed to drop into a 35 mm dish to create a low cost perfusion chamber. A thin coating of silicone grease forms a seal between the insert and dish.

The low volume of the RC-33SM and RC-33SN slotted bath chambers and the natural laminar flow allows rapid exchange of solution, facilitating drug application studies.

The diamond shaped baths of the RC-33DL and RC-33DM provide a larger working area while maintaining good flow characteristics. A suction well is incorporated into all inserts to insure quiet operation.

Chambers are sold six to a package. A twelve pack is also available containing three of each chamber type.

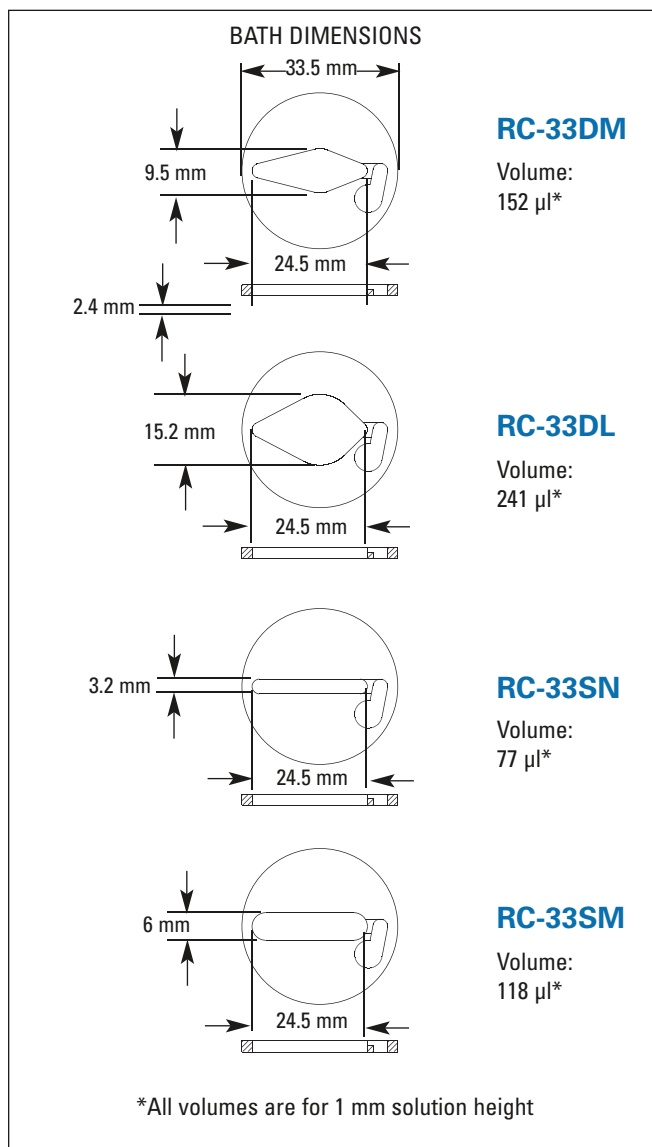
NOTE: Verify the inner diameter of your culture dish before ordering.

Disposable Perfusion Insert Fit:

Nunc

Corning

MatTek (Corning glass bottom)



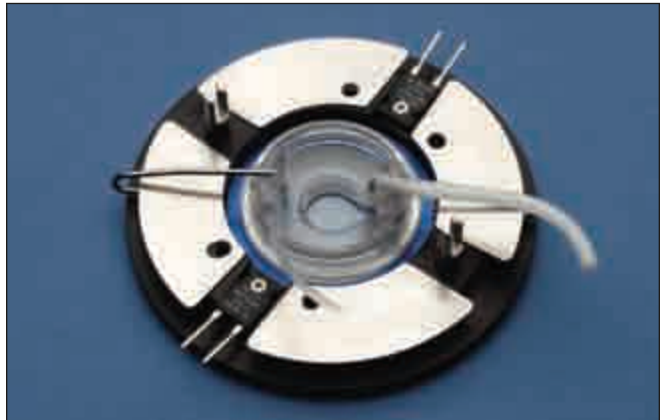
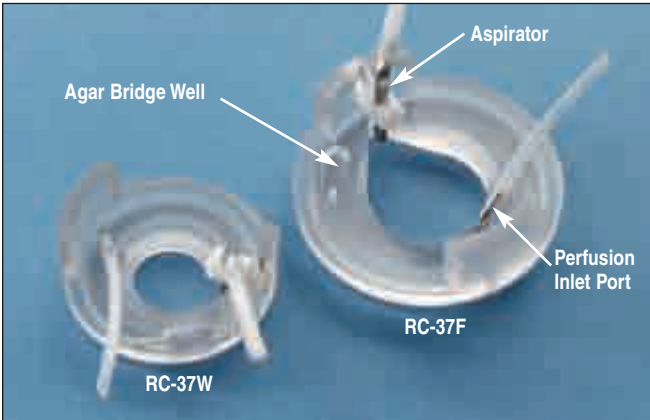
Order #	Model	Product
W4 64-1482	RC-33DL	Chamber Insert Diamond Large Bath, 6 Pack
W4 64-1481	RC-33DM	Chamber Insert Diamond Medium Bath, 6 Pack
W4 64-1484	RC-33SM	Chamber Insert Slotted Large Bath, 6 Pack
W4 64-1483	RC-33SN	Chamber Insert Slotted Narrow Bath, 6 Pack
W4 64-1485	RC-33Kit	Chamber Inserts Assortment 12 Pack, 3 of each type

culture dish inserts

RC-37F and RC-37W

Cell Culture Dish Perfusion Chamber Insert

Chamber inserts with perfusion for 35 mm culture dishes



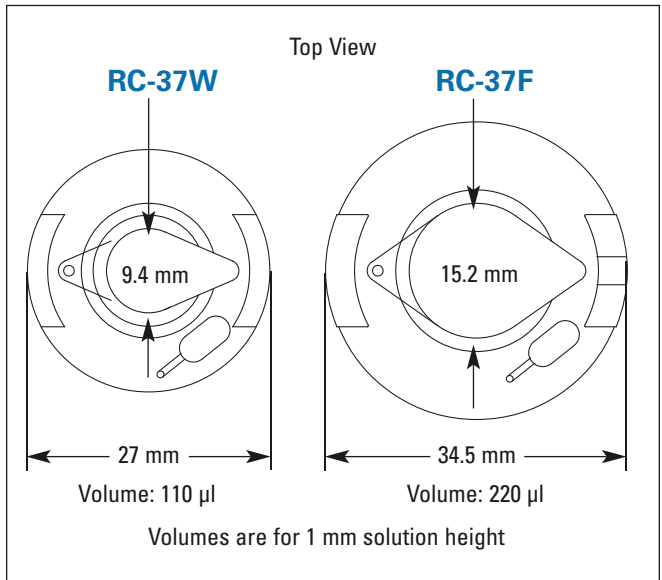
- Designed for glass bottom 35 mm culture dishes
- Permits imaging, recording, and perfusion in the culture dish
- Open and closed bath designs
- Incorporates Warner's diamond fluidics
- Ideal for rapid screening assays

The introduction of thin glass bottom culture dishes has expanded the use of these popular tools dramatically. Applications such as live cell imaging, confocal microscopy and time-lapsed photography are now possible. The ability to exchange the extracellular environment by perfusion 35 mm dishes has been difficult at best, until now.

The RC-37 Perfusion Chamber Inserts for cell culture dishes makes perfusion within these dishes a simple matter. Fluid is delivered to a perfusion inlet port and removed from the chamber by means of a height adjustable aspirator. A thin coating of silicone grease forms a seal between the insert and dish.

Inserts are available to fit the Willco Wells, Corning, MatTek, Nunc and Falcon 35 mm dishes. The chamber is compatible with the DH-35i and DH40i Culture Dish Incubators and the QE-1 Quick Exchange Platform.

Each chamber is supplied with 1 foot of C-Flex tubing and 10 feet of PE-160 tubing.

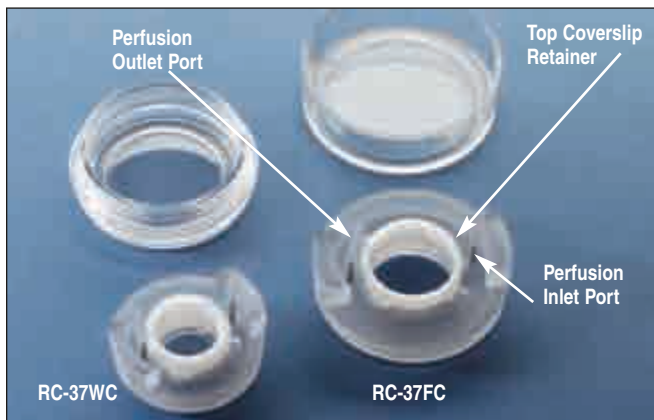


Order #	Model	Product
W4 64-0348	RC-37F	Chamber Insert for Corning, MatTek, Nunc, and Falcon 35 mm Dishes
W4 64-0347	RC-37W	Chamber Insert for Willco 35 mm Dishes

RC-37FC and RC-37WC culture dish inserts

Closed Bath Chambers

Closed bath chamber inserts with perfusion for 35 mm culture dishes



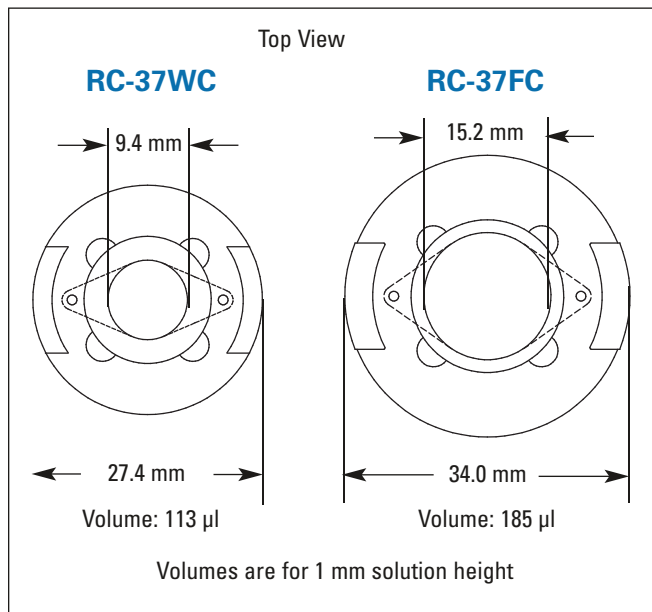
- Designed for glass bottom 35 mm dishes
- Permits imaging and perfusion in the cell culture dish
- Incorporates Warner's diamond fluidics
- Ideal for rapid screening assays

The RC-37 family of perfusion chamber inserts makes perfusion of cell culture dishes a simple matter. The closed bath promotes an even solution exchange and eliminates changes in focus due to alterations in bath height. In addition, studies involving physiological bicarbonate buffers can be performed with no gas loss at the chamber interface.

Fluid is delivered to a 18 gauge perfusion inlet port and removed from the chamber by means of an outlet port of the same gauge. The top coverslip is held in place with a retainer and the dish becomes the chamber bottom. A thin coating of silicone grease forms the seal between chamber and dish. The distance between top and bottom coverslips is 1 mm. The RC-37WC uses 15 mm top coverslips and the RC-37FC works with 18 mm coverslips.

The RC-37WC fits in the Willco Wells dishes while the RC-37FC fits Nunc, Falcon, MatTek or Corning 35 mm dishes. Warner's DH-35 Culture Dish Heater may be used to heat the Corning, MatTek and Willco Wells 35 mm culture dishes. Warner's DH-35i and DH-40i Culture Dish Incubators and the QE-1 Quick Change Heated Base are compatible with all 35 mm culture dishes.

The RC-37WC is supplied with one box of #1 thickness coverslips (CS15R, 15 mm round, 100/pkg) and the RC-37FC is supplied with one box of #1 thickness coverslips (CS18R, 18 mm round, 100/pkg). Both chambers are supplied with 10 feet of PE-160 polyethylene tubing and tools to remove the top coverslip retainer.



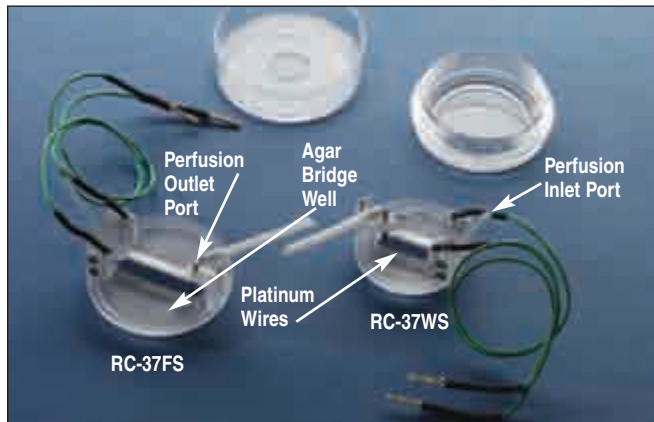
Order #	Model	Product
W4 64-0364	RC-37FC	Chamber Insert Closed for Corning, MatTek, Nunc or Falcon 35 mm Dishes
W4 64-0363	RC-37WC	Chamber Insert Closed for Willco 35 mm Dishes
Accessories and Replacement Parts		
W4 64-0703	CS-15R	Coverslips 15 mm diameter #1 Thickness – Box of 100
W4 64-0384	CS-18R	Coverslips 18 mm diameter #1 Thickness – Box of 100
W4 64-0758	D3522P	Glass Bottom Cell Culture Dishes – 20/Pouch
W4 64-0762	D3522B	Glass Bottom Cell Culture Dishes – Pkg of 120
W4 64-0378	111-KIT	Silicone Grease Kit with Brushes and Pallets
W4 64-0110	DH-35	35 mm Culture Dish Heater
W4 64-0349	DH-35i	Culture Dish Incubation System
W4 64-0388	DH-40i	Culture Dish Incubation System
W4 64-0375	QE-1	Quick Exchange Heated Base w/Perfusion and Adapter Ring Kit

culture dish inserts

RC-37FS and RC-37WS

Perfusion Chamber Inserts with Field Stimulation

Chamber inserts with perfusion for 35 mm culture dishes allowing field stimulation



- Designed for glass bottom 35 mm dishes
- Permits imaging and perfusion in the cell culture dish
- Platinum field stimulation electrodes
- Ideal for rapid screening assays

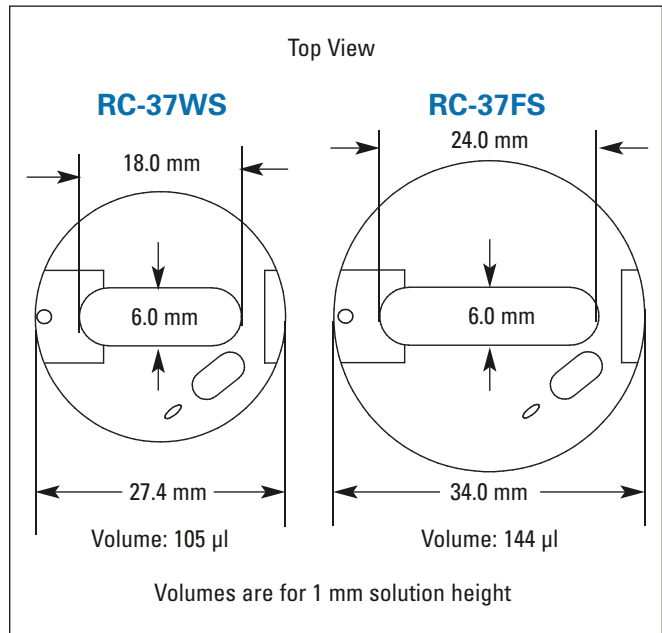
The latest member of the RC-37 family of perfusion chamber inserts is designed for applications requiring field stimulation and includes a pair of platinum electrodes. Both versions feature a slotted bath to promote a laminar solution flow and to ensure an even electrical field.

These models include a perfusion inlet port and a 16 gauge, height adjustable aspirator. An agar bridge well has been added to accommodate a bath ground electrode. A thin coating of silicone grease forms the seal between dish and chamber.

The RC-37WS fits in the Willco Wells dishes; the RC-37FS fits the Nunc, Corning, MatTek and Falcon 35 mm dishes. Warner's DH-35 Culture Dish Heater may be used to heat the Corning, MatTek and Willco Wells 35 mm culture dishes. All 35 mm dishes, including Falcon 35 mm dishes, are compatible with Warner's DH-35i and DH-40i Culture Dish Incubators and the QE-1 Quick Change Heated Base.

Chambers are supplied with 10 feet of PE-160 polyethylene tubing.

The SIU-102 is a bipolar stimulator designed for use with field stimulation chambers. This instrument features constant current and constant voltage modes, as well as bipolar, pulse, and DC modes. Optical coupling is used to electronically isolate the stimulator from the pulse source. Currents up to 100 mA and voltages up to 100 V are also supported. See page 247 for details.



Order #	Model	Product
W4 64-0366	RC-37FS	Chamber Insert Closed for Corning, MatTek, Nunc or Falcon 35 mm Dishes
W4 64-0365	RC-37WS	Chamber Insert Closed for Willco 35 mm Dishes
Accessories and Replacement Parts		
W4 64-0758	D3522P	Willco Wells Glass Bottom Cell Culture Dishes – 20/Pouch
W4 64-0762	D3522B	Willco Wells Glass Bottom Cell Culture Dishes – Pkg of 120
W4 64-0378	111-KIT	Silicone Grease Kit with Brushes and Pallets
W4 64-1424	SIU-102	Stimulus Isolation Unit
W4 64-1425	CC-102	Cable, Male Banana to 1 mm jacks (for use with Warner Field Stimulation Chambers)
W4 64-0110	DH-35	35 mm Culture Dish Heater
W4 64-0349	DH-35i	Culture Dish Incubation System
W4 64-0388	DH-40i	Culture Dish Incubation System
W4 64-0375	QE-1	Quick Exchange Heated Base w/Perfusion and Adapter Ring Kit

series 40 chambers

RC-40 Series Chambers

Quick Change Coverslip Bottom Imaging Chambers

Imaging chambers designed to fit the QE-1 and DH Series heated platforms

Chambers

series 40 chambers



- O-ring seals permit quick exchange of coverslips
- Anodized aluminum base ensures good heat transfer
- Open and closed bath designs
- Use standard #1 or #1.5 thickness coverslips
- Ideal for rapid screening assays

Warner Instruments recognized the need for chambers designed for rapid screening of cells grown on coverslips. The innovative design of RC-40 chambers uses O-rings to seal the coverslip to the polycarbonate chamber. Therefore little or no silicone grease is needed and mechanical fasteners are not required for coverslip mounting.

Chambers are available for use with 12, 15, 18, and 25 mm round coverslips. Round, low profile chambers maximize the viewing area and provide optimal access for electrodes. Slotted bath chambers allow rapid solution exchange. A version which includes platinum wires may be used to study cardiac myocytes and other applications requiring field stimulation. The RC-40HP High Profile Chamber allows for a deep bath.

The Series 40 chambers are designed to be compatible with the Warner QE-1 Quick Exchange Platform and the DH-35i and DH-40i Culture Dish Incubators.

QE-1 Quick Exchange Platform

The Warner QE-1 Quick Exchange Platform is a versatile base for the RC-40 Series chambers, as well as many popular 35 mm glass bottom dishes. Removable perfusion and suction tubes allow solution exchange in any of the RC-40 Series open bath chambers or 35 mm dishes. The platform may be heated using any of the Warner temperature controllers. The QE-1 can be mounted on most microscopes by using the Warner Series 20 stage adapters. See page 172 for more information on the QE-1.

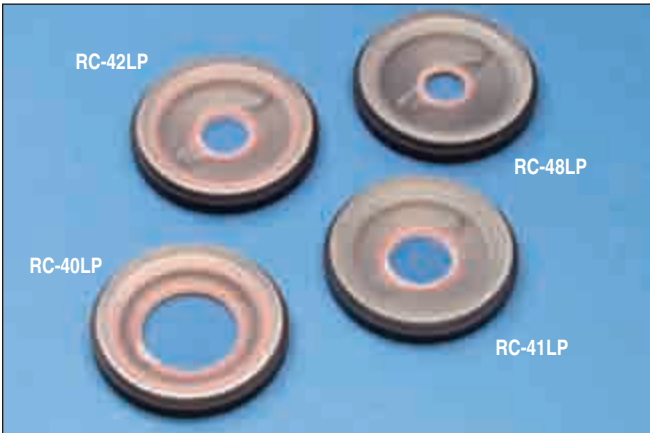


series 40 chambers

RC-40LP, RC-41LP, RC-42LP, RC-48LP

Low Profile Chambers for 12, 15, 18 and 25 mm Coverslips

Open bath chambers for round coverslips



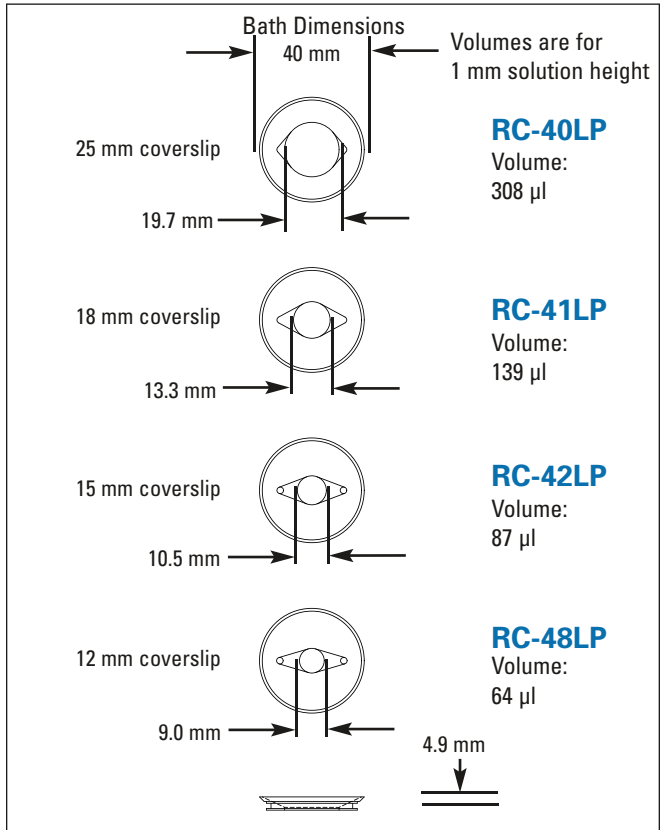
- Low profile design permits low entry angle of electrodes
- Excellent optical and mechanical access to cells and tissue
- When used with QE-1 Quick Exchange Platform, both temperature and perfusion control are possible

The Series 40 family of chambers was designed for research requiring fast exchange of coverslips. The chamber design consists of two parts: a polycarbonate chamber and a 40 mm diameter aluminum base. O-rings are used to seal the coverslip to the polycarbonate chamber and to hold the chamber securely in the aluminum base.

Open bath models are designed for electrophysiological recording and/or optical imaging, and are used in applications including patch clamp, oocyte clamp, and physiological measurements on cell cultures and tissue preparations. The low profile design permits good electrode access to the bath.

The RC-40LP, 41LP, 42LP and 48LP chambers use 25, 18, 15 and 12 mm round coverslips, respectively, in a round bath design to provide maximum viewing area. These chambers work equally well with both water and oil immersion objectives.

The RC-40LP, 41LP, 42LP and 48LP Chambers are supplied with one package of #1.5 coverslips each (25, 18, 15 and 12 mm round, respectively) and spare O-rings. Slice anchors available for RC-40, RC-41 and RC-42, see page 71.



Order #	Model	Product
W4 64-0367	RC-40LP	Quick Change Chamber 25 mm Low Profile
W4 64-0368	RC-41LP	Quick Change Chamber 18 mm Low Profile
W4 64-0369	RC-42LP	Quick Change Chamber 15 mm Low Profile
W4 64-0387	RC-48LP	Quick Change Chamber 12 mm Low Profile

Accessories and Replacement Parts

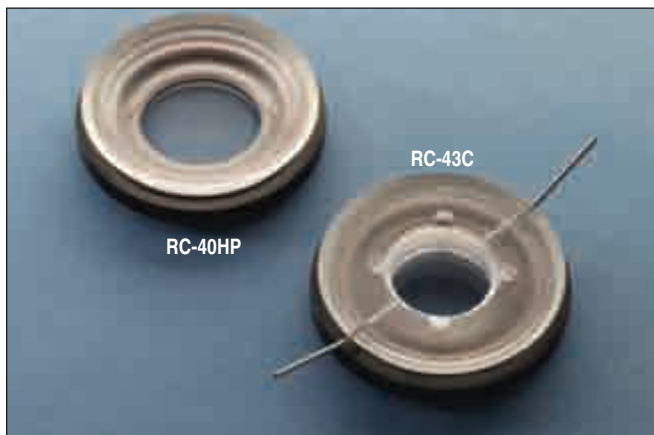
W4 64-0375	QE-1	Quick Exchange Heated Base for RC-40 Series
W4 64-0702	CS-12R	Coverslips 12 mm dia. #1, Box /100
W4 64-0703	CS-15R	Coverslips 15 mm dia. #1, Box /100
W4 64-0384	CS-18R	Coverslips 18 mm dia. #1, Box /100
W4 64-0705	CS-25R	Coverslips 25 mm dia. #1, Box /100
W4 64-0712	CS-12R15	Coverslips 12 mm dia. #1.5, Box /100
W4 64-0713	CS-15R15	Coverslips 15 mm dia. #1.5, Box /100
W4 64-0714	CS-18R15	Coverslips 18 mm dia. #1.5, Box /100
W4 64-0715	CS-25R15	Coverslips 25 mm dia. #1.5, Box /100

series 40 chambers

RC-40HP and RC-43C

High Profile and Closed Bath Chambers

Closed bath chamber for round coverslips



- O-ring seals permit quick exchange of coverslips
- Anodized aluminum base ensures good heat transfer
- Open and closed bath designs
- Use standard #1 or #1.5 thickness coverslips
- Ideal for rapid screening assays

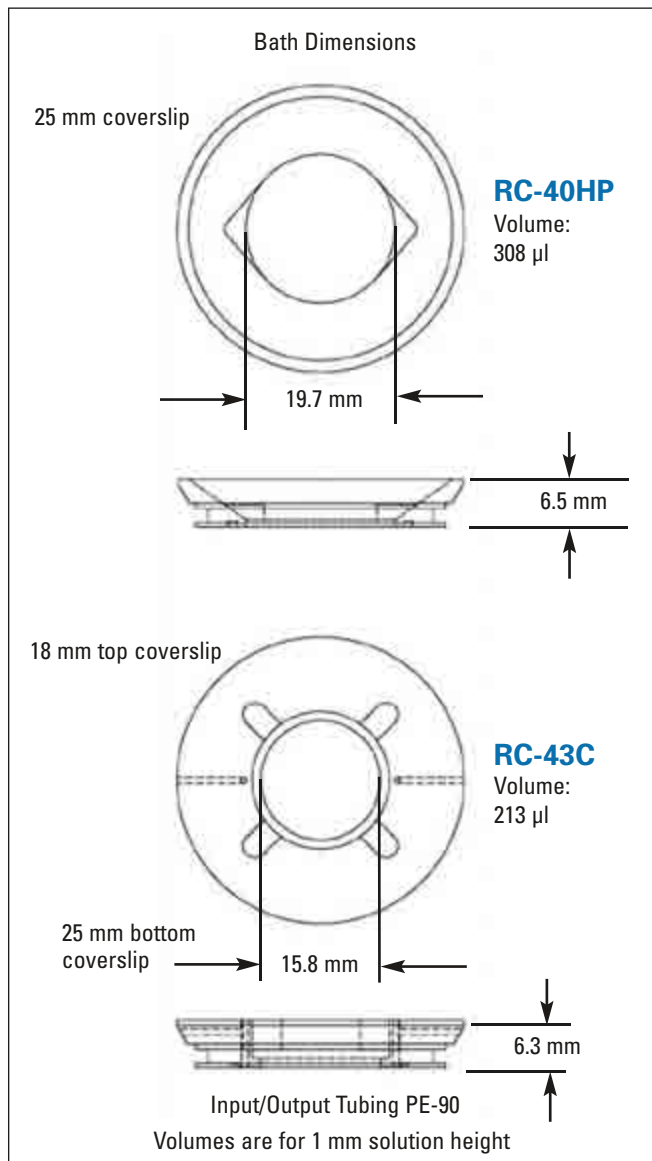
The RC-40HP uses a 25 mm coverslip to form the chamber bottom. The 6.5 mm tapered interior sides provide clearance for pipettes, injectors, etc. and allow for a greater bath depth than the 40LP Series.

The RC-40HP Chamber is supplied with one package of 25 mm diameter #1.5 coverslips.

The RC-43C is the closed bath member of the Series 40 family. The closed bath design promotes an even solution exchange and eliminates changes in focus due to alterations in bath height. Studies involving physiological bicarbonate buffers can be performed with no gas loss at the chamber interface.

Fluid is delivered to a 20 gauge stainless steel perfusion inlet port and removed from the chamber by means of a similar outlet port. The top coverslip is held in place with a retainer. A thin coating of silicone grease forms the seal between chamber and coverglass. The distance between top and bottom coverslips is 1 mm.

The RC-43C Chamber is supplied with one package each of #1.5 coverslips (25 and 18 mm round, respectively) and spare O-rings. Additionally, the RC-43C is supplied with 10 feet of PE-160 and PE-90 polyethylene tubing. Slice anchors available for RC-40, see page 71.



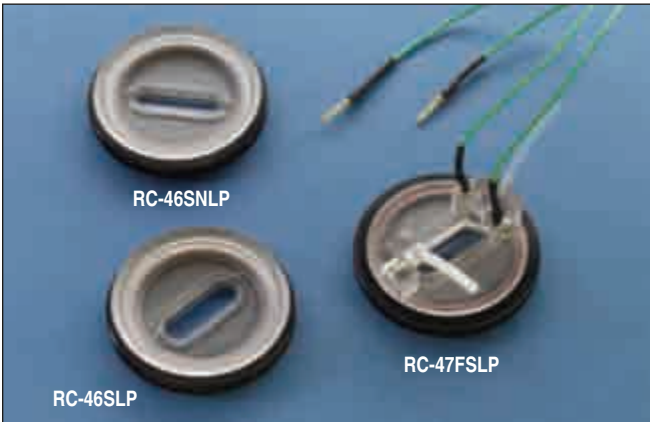
Order #	Model	Product
W4 64-0370	RC-40HP	Quick Change Chamber, High Profile
W4 64-0371	RC-43C	Quick Change Chamber, Closed Bath
Accessories and Replacement Parts		
W4 64-0375	QE-1	Quick Exchange Heated Base
W4 64-0384	CS-18R	Coverslips 18 mm Dia. #1, Box /100
W4 64-0705	CS-25R	Coverslips 25 mm Dia. #1, Box /100
W4 64-0714	CS-18R15	Coverslips 18 mm Dia. #1.5, Box /100
W4 64-0715	CS-25R15	Coverslips 25 mm Dia. #1.5, Box /100
W4 64-0754	PE-90/10	Polyethylene Tubing
W4 64-0755	PE-160/10	Polyethylene Tubing

series 40 chambers

RC-46SLP, RC-46SNLP and RC-47FSLP

Slotted Bath Low Profile Chambers

Slotted bath with and without field stimulation



- Low profile design permits low entry angle for electrodes
- Slotted bath for applications requiring rapid perfusion
- Platinum electrodes for applications requiring field stimulation
- When used with QE-1 Quick Exchange Platform, both temperature control and perfusion are possible

The RC-46SLP, RC-46SNLP, and RC-47FSLP chambers use a 25 mm round coverslip in a slotted bath design to provide rapid solution exchange. O-rings seal the coverslip to the polycarbonate chamber and hold the chamber securely in the aluminum base.

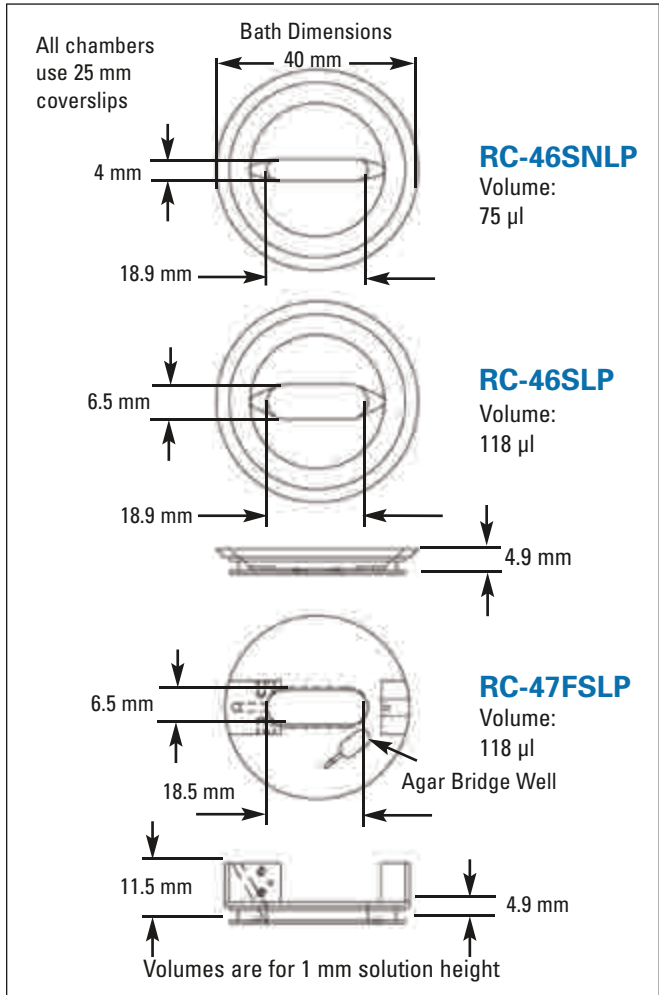
The low volume of these slotted bath chambers and the natural laminar flow allows rapid exchange of solution, facilitating drug application studies.

The RC-47FSLP includes a pair of platinum wires placed onto the parallel sides of the oval shaped bath. The 15 cm long connecting wires are terminated in 1 mm pins. This model includes a perfusion inlet port and a 16 gauge adjustable suction tube. An agar bridge well has been added to accommodate a bath ground electrode.

All chambers mount into the QE-1 Quick Exchange and DH Series Platforms and feature a 19.7 mm diameter aperture in the aluminum base.

Chambers are supplied with one box of #1.5 thickness, 25 mm coverslips and spare O-rings. Additionally, RC-47FSLP is supplied with 10 feet of PE-160 polyethylene tubing.

The SIU-102 is a bipolar stimulator designed for use with field stimulation chambers. This instrument features constant current and constant voltage modes, as well as bipolar, pulse, and DC modes. Optical coupling is used to electronically isolate the stimulator from the pulse source. Currents up to 100 mA and voltages up to 100 V are also supported. See page 247 for details.



Order #	Model	Product
W4 64-0372	RC-46SLP	Quick Change Chamber Slotted Bath
W4 64-0373	RC-46SNLP	Quick Change Chamber Narrow Slotted Bath
W4 64-0374	RC-47FSLP	Quick Change Chamber w/ Field Stimulation

Accessories and Replacement Parts

W4 64-0375	QE-1	Quick Exchange Heated Base
W4 64-0705	CS-25R	Coverslips 25 mm Dia. #1 Box/100
W4 64-0715	CS-25R15	Coverslips 25 mm Dia. #1.5 Box/100
W4 64-1424	SIU-102	Stimulus Isolation Unit
W4 64-1425	CC-102	Cable, male banana to 1 mm jacks (for use with Warner field stimulation chambers)
W4 64-0755	PE-160/10	Polyethylene Tubing

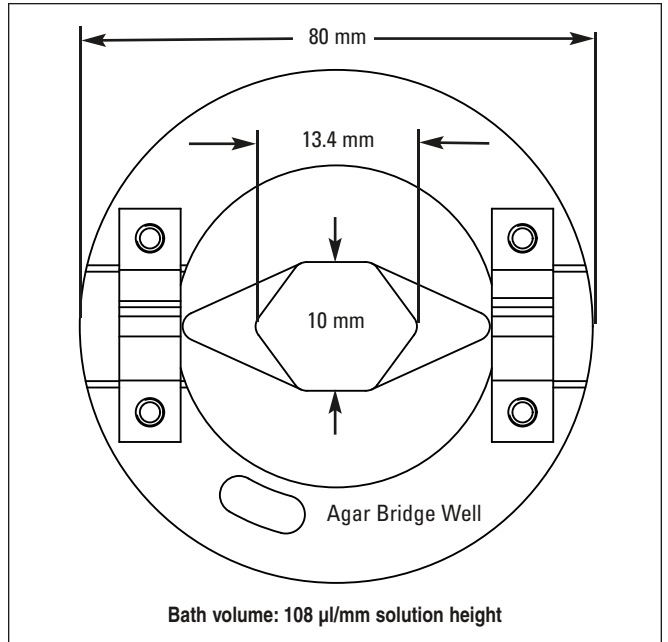
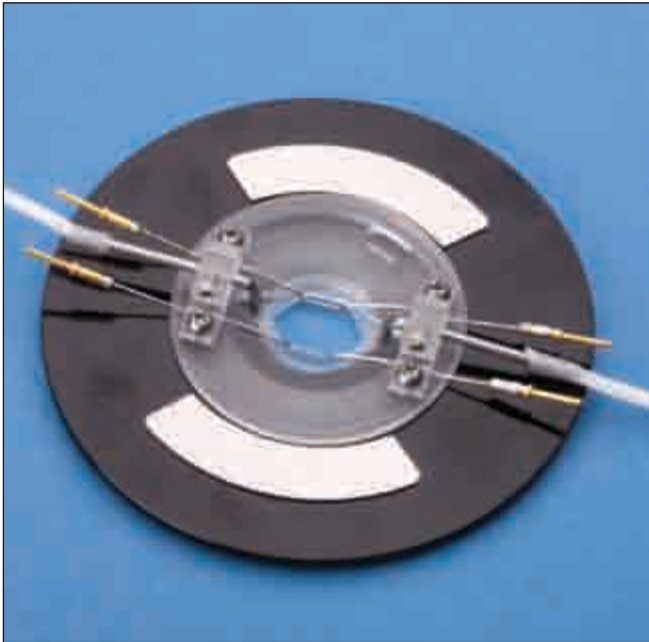
series 40 chambers

NEW RC-49FS

Perfusion Chamber with Field Stimulation for 18mm Coverslips

Chambers

series 40 chambers



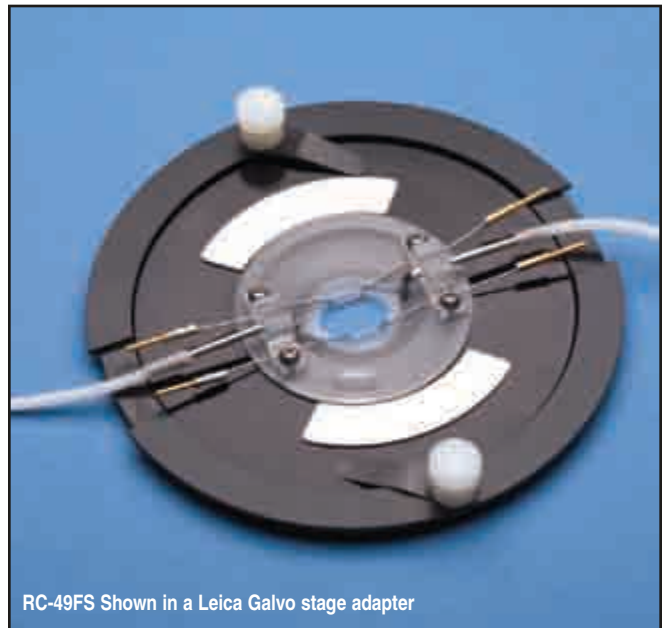
- O-Ring seal permits quick exchange of coverslips
- Low profile design allows low entry angle electrodes
- Platinum field stimulation electrodes
- Uses popular 18 mm round coverslips

The latest member of our family of field stimulation chambers is designed to maximize electrode access. The RC-49FS features a diamond shaped bath to promote laminar solution flow and a pair of easy to remove platinum field stimulation electrodes.

The low volume and natural laminar flow allows rapid exchange of solution, facilitating drug application studies. O-rings on the chamber base form a quick seal on a standard 18 mm, #1.5 thickness coverslip.

A replaceable pair of platinum wires are terminated in 1 mm gold pins on both ends for easy connection to a field stimulator. The RC-49FS uses Warner's Series 20 Stage Adapters for mounting onto a microscope.

The RC-49FS includes suction and perfusion tubes, a package of #1.5 thickness coverslips (CS-18R15), 10 feet of PE-160 polyethylene tubing, and spare o-rings.



Order #	Model	Product
W4 64-1709	RC-49FS	Imaging / recording chamber with removable electrodes
W4 64-1710	SE-49	Replacement stimulation electrodes
W4 64-0714	CS-18R15	Coverslips, 18 mm dia. #1.5, Box/100
W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-1424	SIU-102	Stimulus Isolation Unit
W4 64-1425	CC-102	Cable, male banana to 1 mm jacks (for use with Warner field stimulation chambers)

A low profile, horizontally mounted Ussing chamber for imaging



- Custom round or slotted apertures to accommodate a variety of tissues sizes
- Excellent optical access
- Accommodates both upright and inverted microscopes

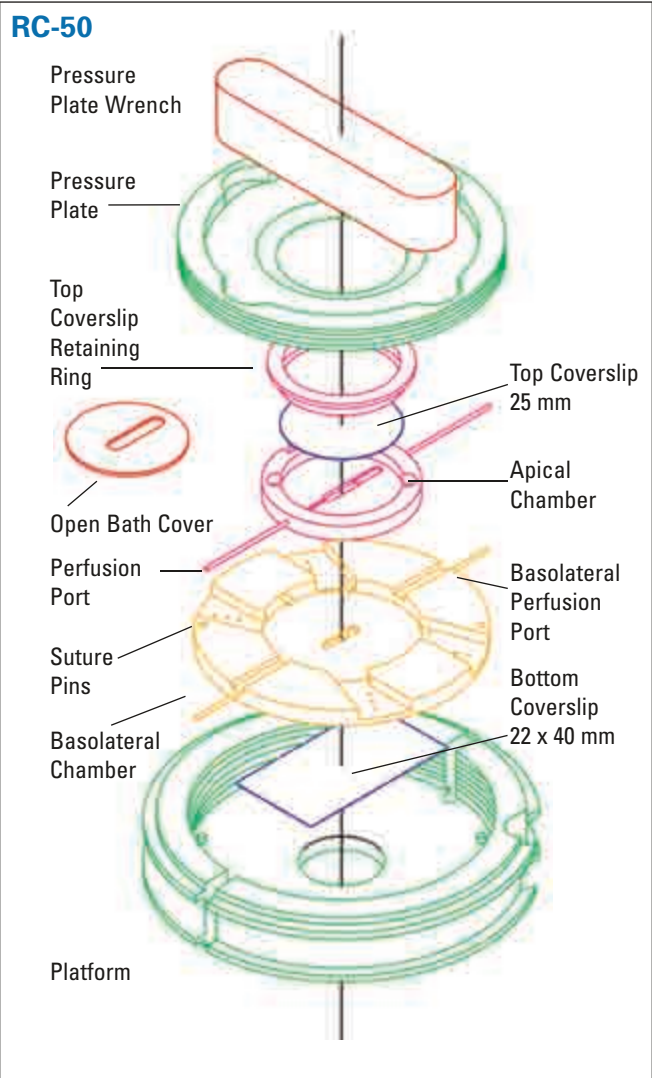
The RC-50 is a low profile, horizontally mounted Ussing chamber incorporating special features for confocal imaging. In particular, the chamber can be configured to use either gravity or pump driven perfusion. In addition, the apical (upper) chamber can be assembled in either an open or closed configuration. The basolateral chamber has been designed to facilitate placement and stretching of hard to handle tissue such as trachea. Suture pins are provided to act as anchor points for suture lines.

A #1 glass coverslip forms both the top and bottom of the chamber, allowing it to be used with both inverted and upright microscopes. While the chamber bottom is beveled to permit maximum access to the bottom coverslip, the chamber body can also be inverted to allow access to the other side. The viewing aperture in the chamber basolateral section is 17.7 mm in diameter and the viewing aperture in the chamber apical section is 22.8 mm.

The RC-50 includes a pair of resistive heater elements mounted to the chamber base. Heater elements are compatible with Warner TC-324B and TC-344B Heater Controllers.

The RC-50 requires the use of a Series 30 Stage Adapter for mounting onto a microscope, see next page.

The RC-50 is supplied with a package of #1 thickness bottom coverslips (CS-22/40, 22 x 40 mm, 100/pkg), a package of #1 thickness top coverslips (CS-25R, 25 mm round, 100/pkg), a suction tube with magnetic clamp, and 10 feet each of PE-90 and PE-160 polyethylene tubing.



Specifications

Physical Dimensions	12.4 mm H x 82 mm D
Weight	<110 g, assembled with heaters
Platform and Pressure Plate	Aluminum, black anodized
Coverslip Plates	Polycarbonate
Input/Output Tubing	PE-90
Coverslips (#1) Top: 25 mm; Bottom: 22 x 40 mm	
Aperture (basolateral)	17.7 mm
Aperture (apical)	22.8 mm
Working Distance (basolateral)	0.375 mm
Working Distance (apical) includes coverslip	1.15 mm

Imaging Chambers for Transepithelial Studies (continued)

Order #	Model	Product
W4 64-0605	RC-50	Imaging Chamber for Transepithelial Studies, custom aperture
W4 64-0606	RC-50-R3	Imaging Chamber for Transepithelial Studies, 3 mm round
W4 64-0607	RC-50-R15	Imaging Chamber for Transepithelial Studies, 15 mm round
W4 64-0608	RC-50-S3X7	Imaging Chamber for Transepithelial Studies, 3 x 7 mm slot
W4 64-0609	RC-50-S2.5X10	Imaging Chamber for Transepithelial Studies, 2.5 x 10 mm slot
W4 64-0610	RC-50-D15X10	Imaging Chamber for Transepithelial Studies, 15 x 10 mm diamond

Replacement Imaging Chamber Inserts

W4 64-0611	BA-R3	RC-50 Imaging Chamber Round Insert, 3 mm diameter
W4 64-0612	BA-R15	RC-50 Imaging Chamber Round Insert, 15 mm diameter
W4 64-0613	BA-S3X7	RC-50 Imaging Chamber Slotted Insert, 3 x 7 mm slot
W4 64-0614	BA-S2.5X10	RC-50 Imaging Chamber Slotted Insert, 2.5 x 10 mm slot
W4 64-0615	BA-D15X10	RC-50 Imaging Chamber Diamond Insert, 15 x 10 mm diamond

Accessories and Replacement Parts

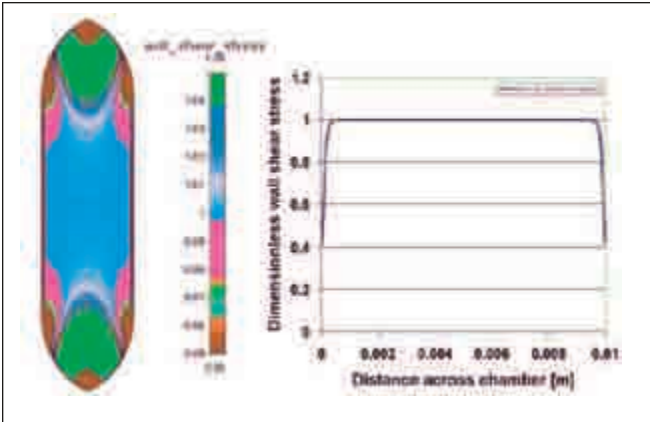
W4 64-0754	PE-90/10	Polyethylene Tubing
W4 64-0755	PE-160/10	Polyethylene Tubing
W4 64-0707	CS-22/40	Coverslips, 22 x 40 mm #1, 50/box
W4 64-0705	CS-25R	Coverslips, 25 mm, round

Series 30 Stage Adapters

W4 64-0322	SA-30NIK	Stage Adapter for Nikon Diaphot / TE200 / TE300
W4 64-0324	SA-30TMS9	Stage Adapter for Nikon TMS with 9 x 13 cm cutout
W4 64-0325	SA-30/OLY2	Stage Adapter for Olympus IMT-2 / IX-50 / IX-70 / BX-50WI
W4 64-0326	SA-30LZ	Stage Adapter for use with Zeiss Axiovert 211 x 230 Specimen Stage
W4 64-0327	SA-30KZ	Stage Adapter for Zeiss Axiovert 85 x 130 Mechanical (K) Stage
W4 64-0328	SA-30L3P	Stage Adapter for Leica Dmirbe/E with 3-Plate Mechanical Stage
W4 64-0329	SA-30PLI	Stage Adapter for Prior & Ludl Motorized Stage
W4 64-0377	SA-30GALVO Z	Stage Adapter for Leica Galvo Z Stage
W4 64-0379	SA-30UUZ	Stage Adapter for Zeiss LSM510
W4 64-0380	SA-30UU	Stage Adapter for use with Nikon E400/E600/E800
W4 64-1456	SA-30GALZi	Stage Adapter for Leica Galvo Z Inverted Stage

shear flow chamber

NEW PFC-1 Proflow Shear Flow Chamber



- Computer designed gaskets optimized for well-defined, well-controlled shear-flow
- Based on technology developed at Case Western Reserve University
- Single- and dual-flow capable chamber
- Made from polycarbonate for easy cleanup

Warner's new PFC-1 ProFlow chamber is based on the designs of Dr. Melissa Knothe Tate, currently of the Case Western Reserve University.

The chamber uses silicone gaskets, similar in approach to our popular RC-30 chamber, to form a closed-bath area sandwiched between two opposing glass coverslips. However, the ProFlow chamber uses specially designed gaskets that optimize the shear-flow dynamics within the bath. This optimized design results in a nearly uniform shear flow across the entire width of the bath. This allows the shear force to be more easily calculated when these gaskets are used.

Precut gaskets are manufactured from medical-grade silicone, are 0.250 mm thick, and can be stacked to achieve bath heights in multiples of a single gasket. Gaskets are supplied in packs of 10 and can be purchased separately.

The system consists of a top plate and two bottom plates. One bottom plate allows the formation of a single-sided flow chamber for use with cultured cells, and the other bottom plate allows the formation of a double-sided flow chamber for use with isolated sections or for conditions where controlled flow is desired on both sides of a structure.

The PFC-1 is designed to fit into our Series 30 stage adapters.

The PFC-1 comes complete with chamber top, two chamber bases, precut gaskets (10 pk), 15 mm round coverslips (# 1.5 thickness, 100 pk, CS-15R15), 25 mm round coverslips (#2 thickness, 50 pk, CS-25R20) and PE-90 tubing (10 ft).

Order #	Model	Product
W4 64-1860	PFC-1	ProFlow Chamber, fit Series 30 stage adapters
W4 64-1861	-	ProFlow Gaskets, 0.250 mm thick, 10 pk
W4 64-0713	CS-15R15	15 mm round coverslip, glass, #1.5 thickness
W4 64-0722	CS-25R20	25 mm round coverslip, glass, #2 thickness
W4 64-0754	PE-90/10	PE-90 tubing, 10 ft

YC-1

Flow Chamber for Yeast Cells

yeast cell chamber

Chambers

yeast cell chamber



- Monitor yeast cell growth using time-lapse microscopy, while changing media
- Cells grow two dimensionally over multiple cell cycles
- Change media in seconds without washing cells out
- Resistive heating or Peltier temperature control options

Research in cell biology often requires scientists to microscopically study individual live cells under various conditions, such as at different temperatures or in the presents of different growth media.

One particular interest is to monitor individual cell growth using time-lapse microscopy while seamlessly and rapidly changing the liquid environment. The YC-1 flow chamber has been developed to allow observation of yeast cells proliferating in a bi-dimensional manner over multiple cell cycles.

The YC-1 overcomes a common problem encountered in standard time-lapse technology: Regular time lapse setups (using agar gel pads) do not allow media to be changed during the experiment. Standard flow chambers do not allow for monitoring multiple cell cycles assay since the progeny is eventually washed out by the flow.

The principle components of the YC-1 microfluidic system include:

1. PDMS flow chamber
2. PDMS coated coverslips
3. Cellulose membranes
4. Temperature controlled platform

Additional components required to complete the system are a temperature controller, fluid delivery system, and a series 20 microscope stage adapter.

The YC-1 is designed for use on an inverted microscope.

The YC-1 is supplied with four PDMS microfluidic chambers, fifty PDMS coated coverslips, fifty cellulose membranes, one chamber platform with resistive heaters, ten feet of PE-50 tubing, and two 23 gauge blunt end syringe needles.

Specifications

Material	PDMS Flow cell (dimensions 50 L x 23 W x 4.5 H mm)
	Platform aluminum black anodized, polycarbonate cover
Bath dimensions (L x W x H)	40 x 0.6 x 0.1 mm
Bath volume	2.4 μ l
Coverslips	24 x 50 mm #1 thickness with 40 μ m PDMS coating
Cellulose membranes	24 x 50 mm x 30 μ m thick
Perfusion ports	0.63 mm OD

Order # Model Product

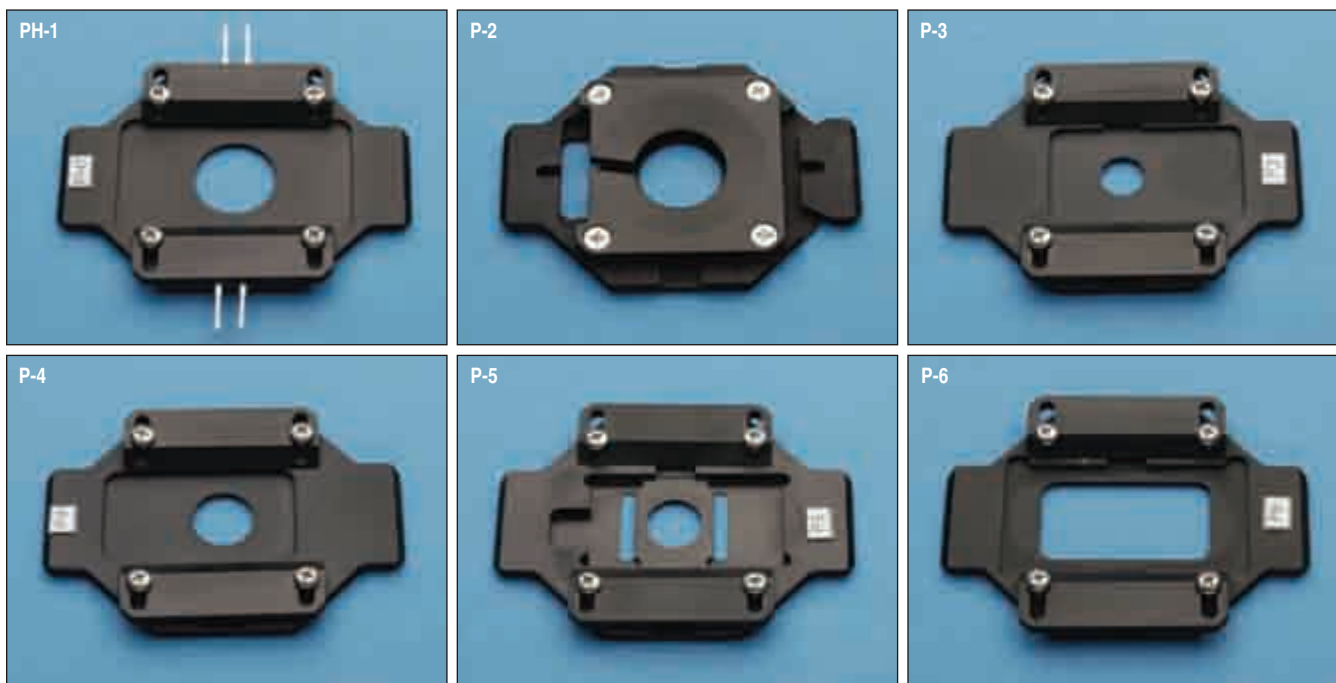
W4 64-1678	YC-1	Flow Chamber for Yeast Cells, Resistive Heaters
W4 64-1679	YC-2	Flow Chamber for Yeast Cells, Peltier Version
W4 64-1680	PH-10	Heated Platform (Resistive)
W4 64-1682	SIC-4	PDMS Chambers (4)
W4 64-1683	SCS-50	PDMS Coated Coverslips (50)
W4 64-1684	CME-50	Cellulose Membranes (50)

Series 20

Classic Series 20 Platforms

culture dish platforms

Anodized aluminum platforms provide clamping between Series 20 chambers and the coverslips



The Warner Series 20 platforms function as a base for Series 20 chambers and provide clamping to make a seal between the chamber and coverslip. Platforms are machined from aluminum and finished with a black anodize. This provides excellent heat conductivity and minimizes stray light reflectance. Platform designs are optimized to provide maximum heat transfer to the coverslip and still afford excellent access for objectives.

Sliding clamps used on most models permit removal of the chamber to change its coverslip. The P-2 Platform uses a one piece clamp secured with 4 screws, while all other models use two clamps each with 2 screws each (i.e. 4 total).

Platforms can be ordered plain or with resistive heaters. Control of platform heating is provided by our TC-324B/TC-344B temperature controllers and a CC-28 cable interface. Heating of perfusate is achieved using our SH-27B or SF-28 In-line Solution Heaters.

Stage adapters are available for all major microscopes; see pages 64 to 65. Custom or modified stage adapters are also available. Call our Technical Support Department for details.

Chamber Model	Aperture	Order #	Plain Platform	Order #	Heater
RC-22/22C/24/24E/24N/ RC-26/26G/26GLP/26Z JG-23N/HP,WHP,WLP	17.8 mm	W4 64-0277	P-1	W4 64-0284	PH-1
RC-21B/21BR/21BDW/21BRFS	17.5 mm	W4 64-0278	P-2	W4 64-0285	PH-2
RC-25	9.5 mm	W4 64-0279	P-3	W4 64-0286	PH-3
RC-25F	13.0 mm	W4 64-0280	P-4	W4 64-0287	PH-4
RC-20/20H	12.0 mm	W4 64-0281	P-5	W4 64-0288	PH-5
RC-27/27N/27NE/RC-28	19 x 35.6 mm	W4 64-0282	P-6	W4 64-0289	PH-6
RC-27L/RC-29	19 x 35.6 mm	W4 64-0283	P-6D	W4 64-0290	PH-6D

culture dish platforms

PM Series

Heated Platforms with Magnetic Clamps

Heated platforms provide a base for Series 20 chambers and allow easy clamping of coverslip and chamber

Chambers

culture dish platforms



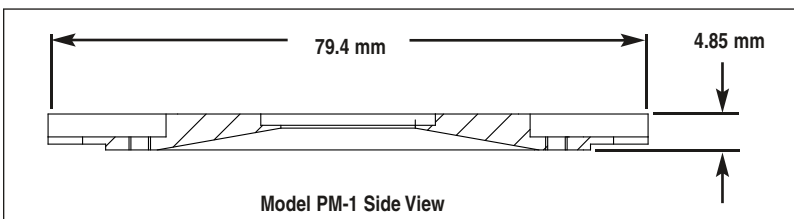
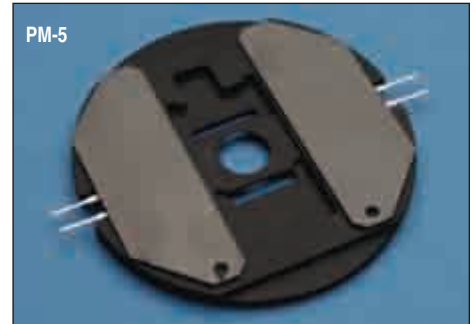
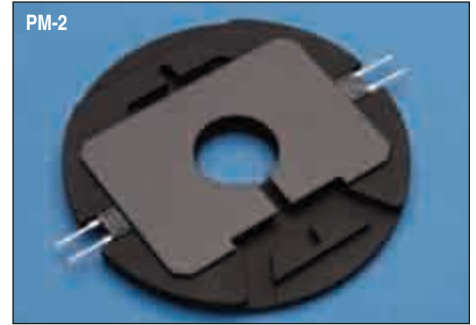
- Permits the small entry angles ideal for patch recording
- No screws needed to secure chamber to platform
- Available for all Series 20 chambers
- Magnetic stainless steel allows use of magnetic holders
- Compatible with all Series 20 stage adapters

The Warner PM Series magnetic platforms function as bases for Series 20 chambers and provide clamping to make a seal between chamber and coverslip. Platforms are machined from aluminum and finished with a black anodize. This provides excellent heat conductivity and minimizes stray light reflectance. Platform designs are optimized to provide maximum heat transfer to the coverslip and still afford excellent access for objectives.

Four nickel-plated magnets on each side of the platform are used to secure the clamps. Magnets are sealed in a corrosion resistant coating. Clamps consist of ferromagnetic stainless steel plates that allow the use of magnetic devices. No screws are needed for assembly, permitting rapid replacement of the chamber even in a darkened room.

Resistive heating of the platforms is provided by our TC-324B/TC-344B temperature controllers and a CC-28 cable interface. Heating of perfusate is achieved using our SH-27B or SF-28 In-line Solution Heaters. All models include resistive heating elements.

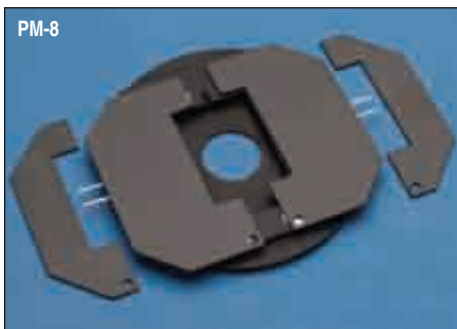
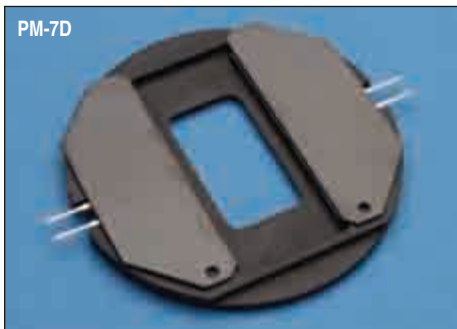
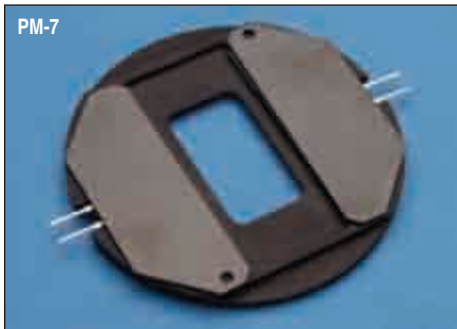
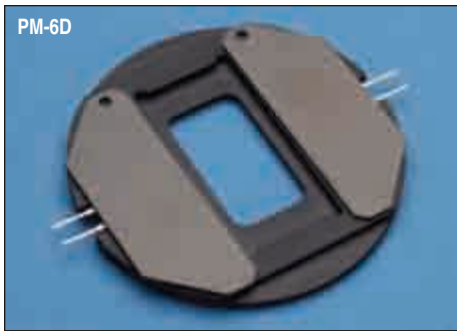
Stage adapters are available for all major microscopes, see pages 64 to 65. Custom or modified stage adapters are also available. Call our Technical Support Department for details.



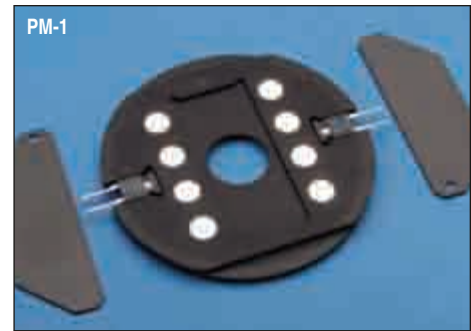
PM Series

Heated Platforms with Magnetic Clamps (continued)

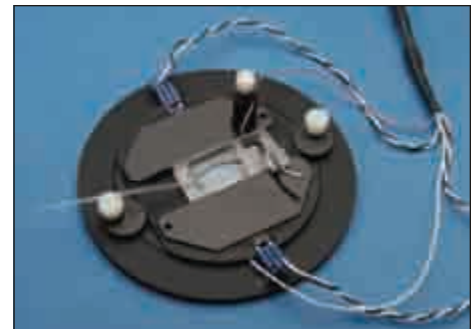
culture dish platforms



Extra clamps with small footprint.



Eight powerful magnets in each platform provide plenty of clamping pressure, ensuring a good seal between chamber and coverslip.



PM-1 w/ RC-22, Nikon stage adapter and CC-28 interface cable

Order #	Model	Aperture Size	For Chamber Model
W4 64-1526	PM-1	17.8 mm	RC-22/22C/24/24E/24N/ RC-26/26G/26GLP/26Z, JG-23N/HP,W/HP,W/LP
W4 64-1561	PM-2	17.5 mm	RC-21B/BR/BDW/BRW/BRFS
W4 64-1562	PM-3	9.5 mm	RC-25
W4 64-1563	PM-4	13.0 mm	RC-25F
W4 64-1564	PM-5	12.0 mm	RC-20/20H
W4 64-1527	PM-6	19.0 x 35.6 mm	RC-27/27N/27NE/28
W4 64-1528	PM-6D	19.0 x 35.6 mm	RC-27L/29
W4 64-1529	PM-7	19.0 x 35.6 mm	RC-27D
W4 64-1530	PM-7D	19.0 x 35.6 mm	RC-27LD
W4 64-1531	PM-8	17.8 mm	RC-26GS

culture dish platforms

Accessories

Chambers

culture dish platforms

Heated platforms provide a base for Series 20 chambers and allow easy clamping of coverslip and chamber

Series 20 Interface Cables and Thermistors



CC-15



CC-28



CC-35



TA-29

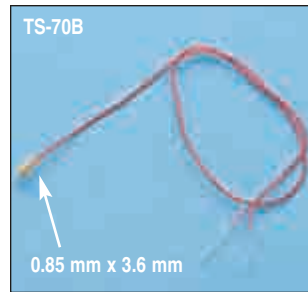


TA-30



TS-60P

1.95 mm x 9 mm



TS-70B

0.85 mm x 3.6 mm



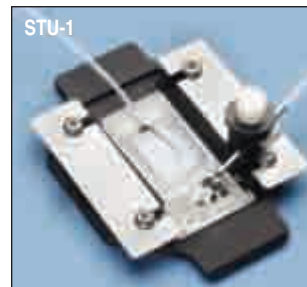
RH-2

Order #	Model	Product
W4 64-0303	CC-15	Interface Cable with connector with tinned leads
W4 64-0106	CC-28	Interface Cable with connector for TC-324B/344B
W4 64-0109	CC-35	Cable with with 8 pin DIN connector for TC-324B/344B
W4 64-0107	TA-29	Cable with Bead Thermistor

Order #	Model	Product
W4 64-0108	TA-30	Cable with Glass Bead Thermistor
W4 64-0269	TS-60P	Replacement Probe Thermistor for CC-28 and CC-15 Cables
W4 64-0270	TS-70B	Replacement Bead Thermistor for CC-28 and TA-29 Cables
W4 64-0274	RH-2	Replacement Heater Elements for PH and PM Platforms

Platform and Chamber Parts

Order #	Model	Product
W4 64-1429	STU-1	Suction Tube Upgrade Kit with Mag-7
W4 64-1506	RPC-1	Replacement Platform Clamps
W4 64-1507	RPC-2	Replacement Clamps for DH35i, DH-40i and QE-1
W4 64-0276	CR-15	Coverslip Retainer for RC-20 and RC-20H



STU-1



RPC-1 Clamps & Screws



RPC-2



CR-15

culture dish platforms

Accessories (continued)

MCK-1 Magnetic Clamp Kit for Series 20 Chambers

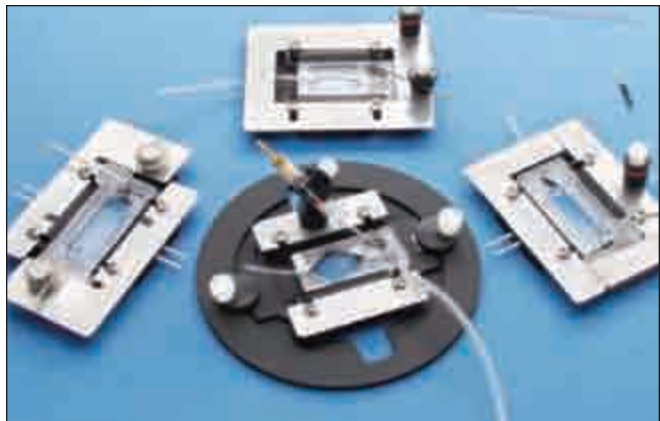


- Useful for simple positioning needs
- Complete kits available for all Series 20 platforms
- Includes a variety of holding tools

The MCK-1 Magnetic Clamp Kit provides our classic Series 20 chamber users with a convenient method of mounting or clamping accessories to the perfusion chamber. Typical items that may be attached are additional suction or perfusion tubes, ground electrodes, hold down needles, thermistor probes or gas jets.

Each kit comes with 4 sets of magnetic stainless steel mounting plates that fit on all P and PH platforms and 6 magnetic supports. A clamp for mounting 1/4 inch (6.3 mm) diameter devices has a rotating joint with locking knob. This clamp is useful for turning a standard electrode holder into an agar bridge for solution bath grounding. Two included low profile twin magnets with silicone rubber pads can be used for mounting needle holddowns. The kit also includes a mechanical clamp with two slits that can clamp onto small diameter tubing such as a suction tube. The remaining two clamps are designed for securing ground wires or thermistors.

Order #	Model	Product
W4 64-0357	MCK-1	Magnetic Clamp Kit
W4 64-0358	MAG-1	Magnetic Clamp for 1/4 inch (6.3 mm) devices
W4 64-0359	MAG-2	Magnetic Clamp 16 g for suction tubes
W4 64-0360	MAG-3	Magnetic Clamp for wires
W4 64-0361	MAG-4	Magnetic Clamp with twin magnetics



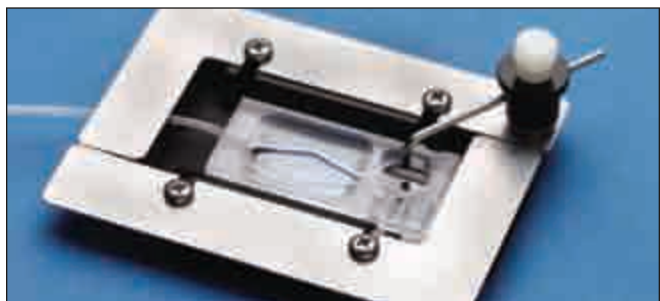
Made from magnetic stainless steel and delrin this kit is easily added to your set-up



Each kit comes with four complete base plate designs, offering considerable versatility.



Magnets with just the right amount of force are used in the clamp kit



Suction tube holder

Series 20 & Series 30 stage adapters

Black Delrin® stage adapters connect Series 20/Series 30 platforms and components with all major brand microscope stages.



Series 20 and Series 30 Stage Adapters each perform exactly the same role with the difference between the two being the size of the internal cutout. Specifically, the Series 30 stage adapter has a larger ID to accommodate the larger diameter Series 30 components. The OD of similarly named stage adapters remains the same.

Design of Stage Adapters

Stage Adapters are designed to allow the mounting of Warner imaging and recording products onto a microscope. We have a wide variety of stage adapters to fit most commonly used microscope stages including stock stages from Nikon, Olympus, Zeiss, and Leica. We also have stage adapters compatible with 3rd party stages from Burleigh, Prior & Ludl, and Marzhauser to name a few. Adapters are machined from high quality Delrin which provides good thermal isolation from the microscope stage. All platforms (e.g., Series 20, Series 30), the QE-1 and the DH-35, DH-35i, and DH-40i microincubators rest upon a 38 mm lip which surrounds the central aperture. Platforms and bases are secured using two plastic button clamps.

Note to Zeiss Axiovert users: Series 20 Platforms fit directly into the Zeiss slide frame (Zeiss p/n 471719) which mounts on the Zeiss 211 x 230 Specimen Stage. However, if a heater platform is used, the metal slide frame is not recommended since it will act as a thermal heat sink. Use stage adapter SA-20LZ for this heating application.

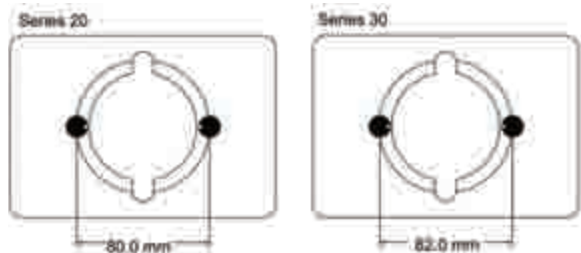
Selecting a Stage Adapter

Consult the table below to identify stage adapters compatible with your microscope stage. Generally speaking, the table lists dimensions that should match the cutout in your microscope stage. Illustrations for the most common stage adapters, along with their dimensions, are also presented below and also in the Product Specs window above.

If your stage is not listed, or if you have questions on adapter compatibility, please contact our technical staff. Custom or modified versions are available.

Stage Adapter Lookup Table

The table (on facing page) lists stage adapter known to be compatible with most common microscope stages. However, since each microscope can support many stages, you should compare the adapter dimensions to the stage cutout before ordering.



Series 20 & Series 30 (continued)

stage adapters

Stage Manufacturer	Adapter Dimensions	Series 20 Stage Adapters	Order Number		Series 30 Stage Adapters	Order Number	
Nikon	10.8 cm Diameter	SA-NIK	W4 64-0291		SA-30NIK	W4 64-0322	
	8 cm x 12 cm	-	-		SA-30TMS/9	W4 64-0324	
	9 cm x 13 cm	SA-TMS/9	W4 64-0293		-	-	
	12.7 cm x 11 cm	SA-TS100	W4 64-0340		-	-	
	23.75 cm x 15.65 cm	SA-20UU	W4 64-0298		SA-30UU	W4 64-0380	
	23.75 cm x 15.65 cm	SA-20Ti	W4 64-1744		SA-30Ti	W4 64-1747	
Olympus	10.3 cm x 8.89 cm	SA-OLY	W4 64-0294		-	-	
	12.7 cm x 11 cm	SA-20UU	W4 64-0298		-	-	
	11 cm diameter	SA-OLY/2	W4 64-0295		SA-30/OLY2	W4 64-0325	
Leica	16.5 cm x 10 cm	SA-20LZ	W4 64-0296		SA-30GALVZi	W4 64-1456	
	14.99 cm x 14.99 cm	SA-20L3P	W4 64-0301		SA-30L3P	W4 64-0328	
	9.66 cm diameter	SA-20GALVO Z	W4 64-0376		SA-30GALVOZ	W4 64-0377	
Zeiss	10.97 cm x 15.98 cm	SA-20KZ	W4 64-0297		SA-30KZ	W4 64-0327	
	16.5 cm x 10 cm	SA-20LZ	W4 64-0296		SA-30LZ	W4 64-0326	
	12.7 cm x 13 cm	SA-20UUZ	W4 64-0336		SA-30UUZ	W4 64-0379	
	14.99 cm x 14.99 cm	SA-20L3P	W4 64-0301		-	-	
Prior & Ludi	16 cm x 11 cm	SA-20PL	W4 64-0299		-	-	
	16 cm x 11 cm	SA-20PLI	W4 64-0300		SA-30PLI	W4 64-0329	
	17.78 cm x 11.76 cm	SA-20PP	W4 64-1746		SA-30PP	W4 64-1745	
Burleigh Gibraltar	11 cm diameter	SA-OLY/2	W4 64-0295		-	-	
	10.96 cm diameter	SA-OLY/3	W4 64-0386		-	-	
Marzhauser	10.97 cm x 15.98 cm	SA-20KZ	W4 64-0297		-	-	
Universal	12.8 cm x 8.6 cm	SA-20MW	W4 64-1645		-	-	

Chambers

stage adapters

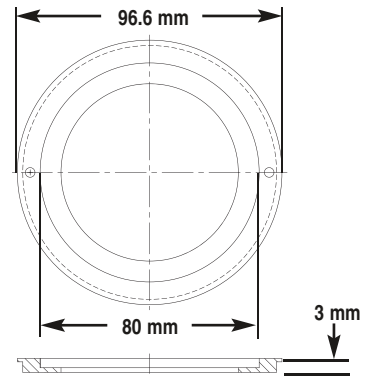
stage adapters

Series 20 & Series 30 (continued)

Chambers

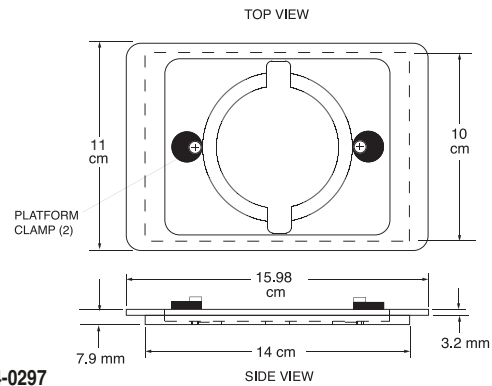
stage adapters

SA-20GALVO Z



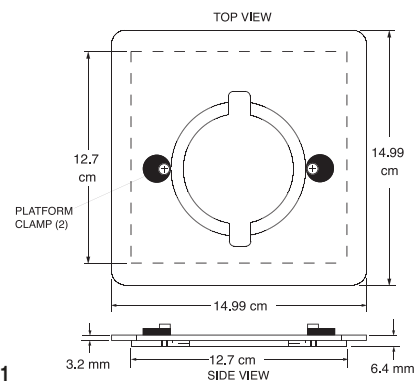
W4 64-0376

SA-20KZ



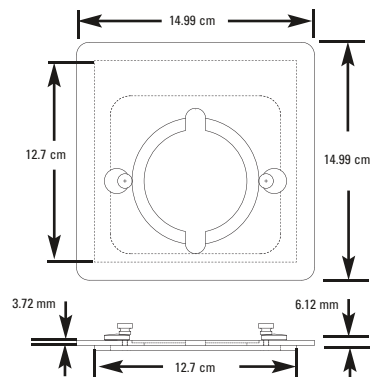
W4 64-0297

SA-20L3P



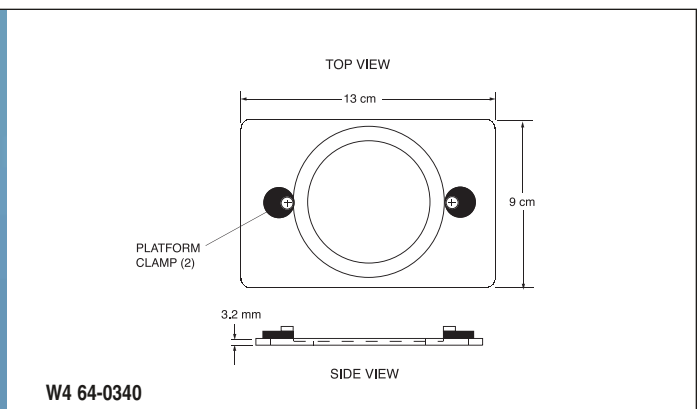
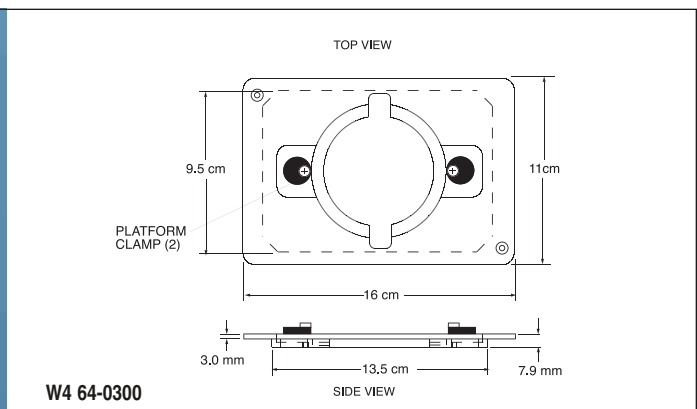
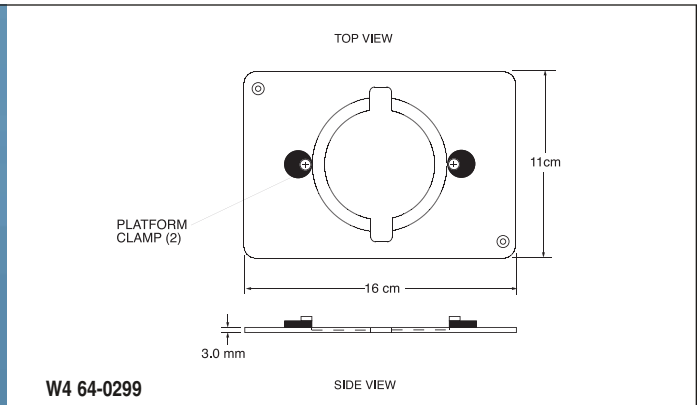
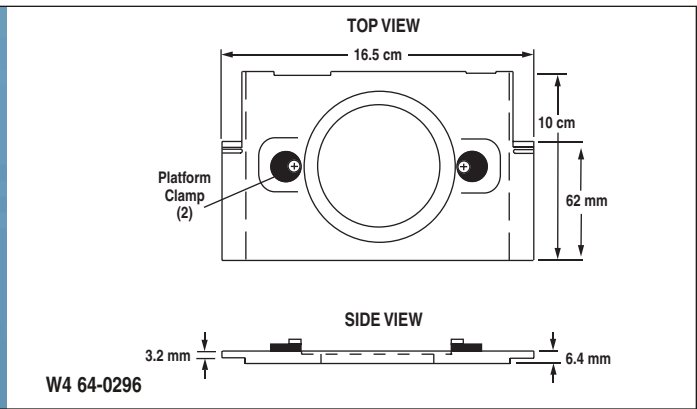
W4 64-0301

SA-20L3P2



W4 64-0389

Series 20 & Series 30 (continued) stage adapters



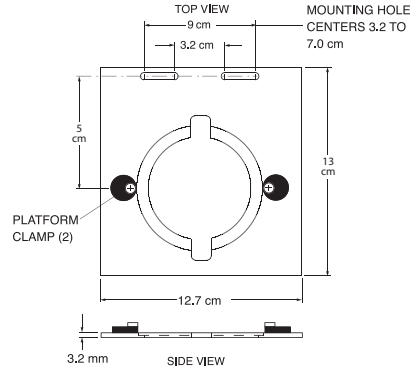
stage adapters

Series 20 & Series 30 (continued)

Chambers

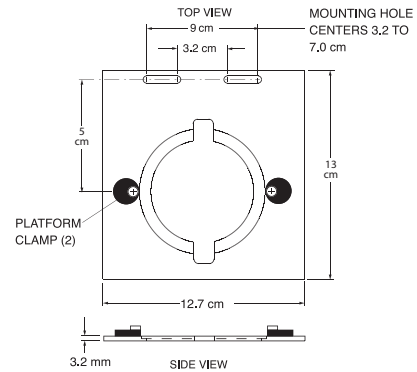
stage adapters

SA-20UU



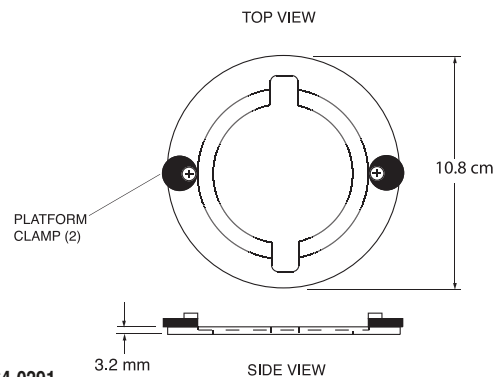
W4 64-0298

SA-20UUZ



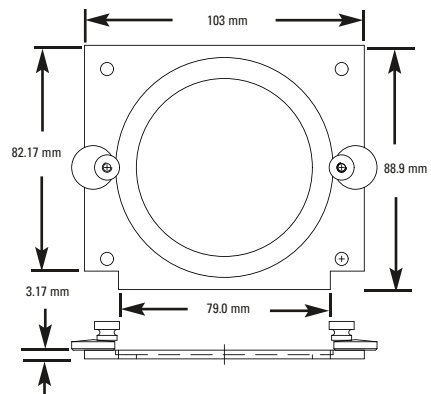
W4 64-0336

SA-NIK



W4 64-0291


SA-OLY



W4 64-0294

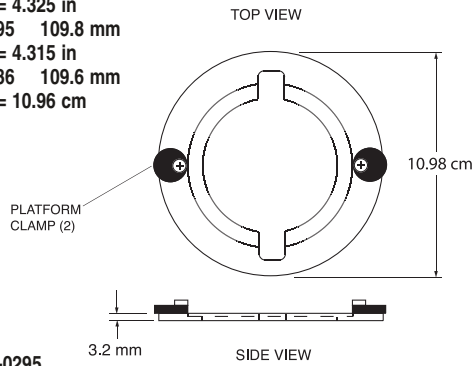
Series 20 & Series 30 (continued) stage adapters

SA-OLY/2



SAOLY/2 = 4.325 in
 W4 64-0295 109.8 mm
 SAOLY/2 = 4.315 in
 W4 64-0386 109.6 mm
 SAOLY/3 = 10.96 cm

TOP VIEW



PLATFORM CLAMP (2)


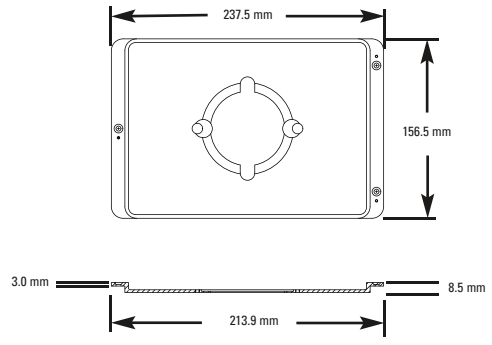
10.98 cm

3.2 mm

SIDE VIEW

W4 64-0295

SA-20TI

237.5 mm

156.5 mm

3.0 mm

213.9 mm

8.5 mm

W4 64-1744

SA-20MW




128 mm

86 mm

3.1 mm

W4 64-1645

SA-20PP




177.8 mm

80 mm

117.6 mm

23.9 mm

23.9 mm

W4 64-1746

Coverslips chamber accessories

Large selection of high quality coverslips stocked for immediate delivery



Now Available in #1.5 Thickness!

High quality Coverslips are essential for microscopy imaging. At high resolutions (40X, 60X or 100X), choosing the correct coverslip is critical for good performance. Warner has recently expanded its line of coverslips to include German borosilicate glass at #1.5 thickness. Except CS-40R, CS-30R and CS-24/60.

Stocked in depth in the sizes used with RC Series, Series 20 and the new Series 40 chambers. Consult the chart to select the correct cover glass for your chamber.

Order #	Model	Quantity	Dimension	Chamber Used With
Coverslip Thickness #1: 0.15 mm (0.006 in.)				
W4 64-0720	CS-3R	100	3 mm D	
W4 64-0700	CS-5R	100	5 mm D	Fits inside 96-well culture plate
W4 64-0701	CS-8R	100	8 mm D	Fits inside 24-well culture plate
W4 64-0702	CS-12R	100	12 mm D	RC-25, RC-48LP
W4 64-0703	CS-15R	100	15 mm D	RC-20, RC-20H, RC-25F, RC-37WC, RC-37FC
W4 64-0384	CS-18R	100	18 mm D	RC-37WC, RC-41LP, RC-43C
W4 64-0704	CS-22S	100	22 x 22 mm	RC-21B
W4 64-0705	CS-25R	100	25 mm D	RC-21BR, RC-21BRFS, RC-21BRW, RC-21BDW, RC-40LP, RC-40HP, RC-43C, RC-46SNLP, RC-46SLP, RC-47FSLP, RC-50
W4 64-1500	CS-40R	60	40 mm D	RC-30WA
W4 64-0706	CS-22/30	50	22 x 30 mm	RC-30, RC-30HV
W4 64-0707	CS-22/40	50	22 x 40 mm	RC-22, RC-22C, RC-24, RC-24E, RC-24N, RC-26, RC-26G, RC-26GLP, RC-26GS, RC-30, RC-50
W4 64-0708	CS-22/50	50	22 x 50 mm	RC-26Z, JG-23N/HP, JG-23W/HP, JG-23W/LP
W4 64-0709	CS-24/50	50	24 x 50 mm	RC-27, RC-27L, RC-27N, RC-27NE, RC-28, RC-29
Coverslip Thickness #1.5: 0.17 mm (0.0067 in.)				
W4 64-0718	CS-10R15	100	10 mm D	
W4 64-0712	CS-12R15	100	12 mm D	RC-25, RC-48LP
W4 64-0713	CS-15R15	100	15 mm D	RC-20, RC-20H, RC-25F, RC-42LP, RC-37WC
W4 64-0714	CS-18R15	100	18 mm D	RC-37FC, RC-41LP, RC-43C
W4 64-0719	CS-22R	100	22 mm D (Round)	
W4 64-0721	CS-22S15	100	22 mm D (Square)	
W4 64-0715	CS-25R15	100	25 mm D	RC-21BR, RC-21BRFS, RC-21BRW, RC-21BDW, RC-40LP, RC-40HP, RC-43C, RC-46SNLP, RC-46SLP, RC-47FSLP, RC-50
W4 64-1499	CS-30R	90	30 mm D	RC-30WA
W4 64-0716	CS-22/3015	50	22 x 30 mm	
W4 64-0717	CS-22/4015	50	22 x 40 mm	RC-22, RC-22C, RC-24, RC-24E, RC-24N, RC-26, RC-26G, RC-26GLP
Coverslip Thickness #2: 0.22 mm (0.0086 in.)				
W4 64-0710	CS-24/60	40	24 x 60 mm	RC-10, RC-11, RC-13, RC-16, RC-27D, RC-27LD

chamber accessories

Slice Anchors for Series 20 and 40 Chambers

Provides ability to use tissue sections in most RC Series chambers



Slice anchors are available for most open bath chambers in the 20 and 40 Series family except for field stimulation chambers. Anchors are constructed for an easy push-in fit into the chamber's bath area. This allows the user to control the anchor pressure applied to slice. Most anchors are made from type 316 stainless steel and Lycra® and finished with a plastic coating. Plastic anchors are available for the RC-27L Chamber.

Order #	Model	Product
W4 64-0246	SHD-22L/15	For RC-22 Chamber, 1.5 mm
W4 64-0247	SHD-22CL/15	For RC-22C Chamber, 1.5 mm
W4 64-0248	SHD-22L/10	For RC-22 Chamber, 1.0 mm
W4 64-0249	SHD-22CL/10	For RC-22C Chamber, 1.0 mm
W4 64-0250	SHD-26H/10	For RC-26 Chamber, 1.0 mm
W4 64-0251	SHD-26H/15	For RC-26 Chamber, 1.5 mm
W4 64-0252	SHD-26H/2	For RC-26 Chamber, 2.0 mm
W4 64-0253	SHD-26GH/10	For RC-26G Chamber, 1.0 mm
W4 64-0254	SHD-26GH/15	For RC-26G Chamber, 1.5 mm
W4 64-0255	SHD-26GH/2	For RC-26G Chamber, 2.0 mm
W4 64-0256	SHD-27LH/10	For RC-27L & RC-29, 1.0 mm
W4 64-0257	SHD-27LH/15	For RC-27L & RC-29, 1.5 mm
W4 64-0258	SHD-27LH/2	For RC-27L & RC-29, 2.0 mm
W4 64-0194	SHD-27H/10	For RC-27 Chamber, 1.0 mm
W4 64-0193	SHD-27H/15	For RC-27 Chamber, 1.5 mm
W4 64-0192	SHD-27H/2	For RC-27 Chamber, 2.0 mm
W4 64-0197	SHD-27N/10	For RC-27N Chamber, 1.0 mm

Order #	Model	Product
W4 64-0196	SHD-27N/15	For RC-27N Chamber, 1.5 mm
W4 64-0195	SHD-27N/20	For RC-27N Chamber, 2.0 mm
W4 64-1411	3SHD-22F/15	Flat for RC-22 Chamber, 1.5 mm
W4 64-1412	SHD-22F/10	Flat for RC-22 Chamber, 1.0 mm
W4 64-1413	SHD-22CF/15	Flat for RC-22C Chamber, 1.5 mm
W4 64-1414	SHD-22CF/10	Flat for RC-22C Chamber, 1.0 mm
W4 64-1415	SHD-40/2	Flat for RC-40 Chamber, 2.0 mm
W4 64-1416	SHD-40/15	Flat for RC-40 Chamber, 1.5 mm
W4 64-1417	SHD-40/10	Flat for RC-40 Chamber, 1.0 mm
W4 64-1418	SHD-41/15	Flat for RC-41 Chamber, 1.5 mm
W4 64-1419	SHD-41/10	Flat for RC-41 Chamber, 1.0 mm
W4 64-1420	SHD-42/15	Flat for RC-42 Chamber, 1.5 mm
W4 64-1421	SHD-42/10	Flat for RC-42 Chamber, 1.0 mm
W4 64-0259	SHD-27LP/10	Plastic for RC-27L, RC-27LD & RC-29, 1.0 mm
W4 64-0260	SHD-27LP/15	Plastic for RC-27L, RC-27LD & RC-29, 1.5 mm
W4 64-0261	SHD-27LP/2	Plastic for RC-27L, RC-27LD & RC-29, 2.0 mm

chamber accessories

Slice Anchor Kits and Supports for Series 20 Chambers

Provides ability to use tissue sections in most RC Series chambers

Slice Anchor Kits

Slice Anchor Kits are available for all Series 20 tissue slice recording chambers. Kits for RC-26, RC-26G, RC-27, and RC-27L, (large bath chambers) contain three anchors with 0.1 mm thick Lycra® threads at 1.0, 1.5, and 2.0 mm spacing. Kits are available with plastic anchors or stainless steel.

Kits for the RC-22 and RC-22C (smaller slice chambers) contain two stainless steel anchors with Lycra® threads at 1.0 mm and 1.5 mm spacing. The stainless steel material allows the anchors to be adjusted for a closer or looser fit in chamber.

All kits come with nylon mesh in two sizes (112 micron and 160 micron) that may be cut and used in conjunction with the slice anchor.



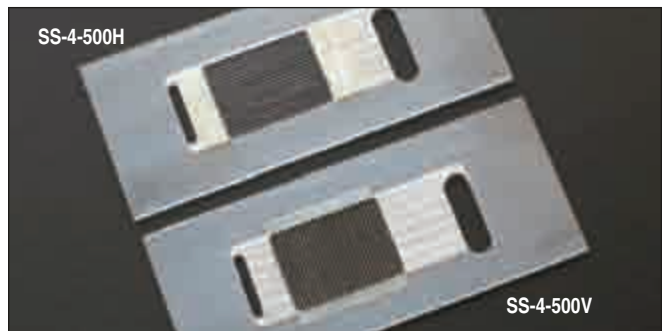
Order #	Model	Product
W4 64-0263	SHD-22KIT	Slice Anchor Kit for RC-22
W4 64-0264	SHD-22CKIT	Slice Anchor Kit for RC-22C
W4 64-0265	SHD-26KIT	Slice Anchor Kit for RC-26
W4 64-0266	SHD-26GKIT	Slice Anchor Kit for RC-26G
W4 64-0267	SHD-27KIT	Slice Anchor Kit for RC-27
W4 64-0268	SHD-27LKIT	Slice Anchor Kit for RC-27L and RC-29
W4 64-0190	SHD-27LPKIT	Plastic Slice Anchor Kit for RC-27L and RC-29 Chambers
W4 64-0191	SHD-27NKIT	Slice Anchor Kit for RC-27N

Slice Support with Nylon Grid

The SS-3G is a version of our standard SS-3 providing additional support by replacing the Lycra strands with a nylon mesh. The support is machined from 0.5 mm polycarbonate and the mesh is 112 micron x 0.1 micron thick.

The SS-4, SS-4-500V and SS-4-500H with Lycra thread provide additional slice support by using strands on a narrower 500 micron spacing. The support is machined from 0.5 mm polycarbonate and the Lycra strands are available in either horizontal or vertical configurations.

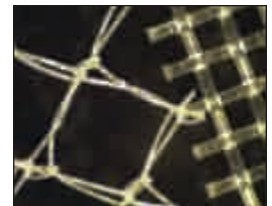
Order #	Model	Product
W4 64-1533	SS-3G	Slice Support for RC-27L Chamber with grid
W4 64-1550	SS-4-500V	Vertical Slice Support for RC-27D and RC-27LD Drip Chambers
W4 64-1551	SS-4-500H	Horizontal Slice Support for RC-27D and RC-27LD Drip Chambers



Nylon Mesh Kit

Ideal for supporting and holding slices in recording and imaging chambers, this nylon mesh can be used in conjunction with Warner slice anchors or other holders. Each kit comes with nylon mesh in two sizes 0.3 mm and 1.13 mm mesh opening and are 0.2 and 0.12 mm thick respectively. Five 7 x 7 cm squares of each size are supplied.

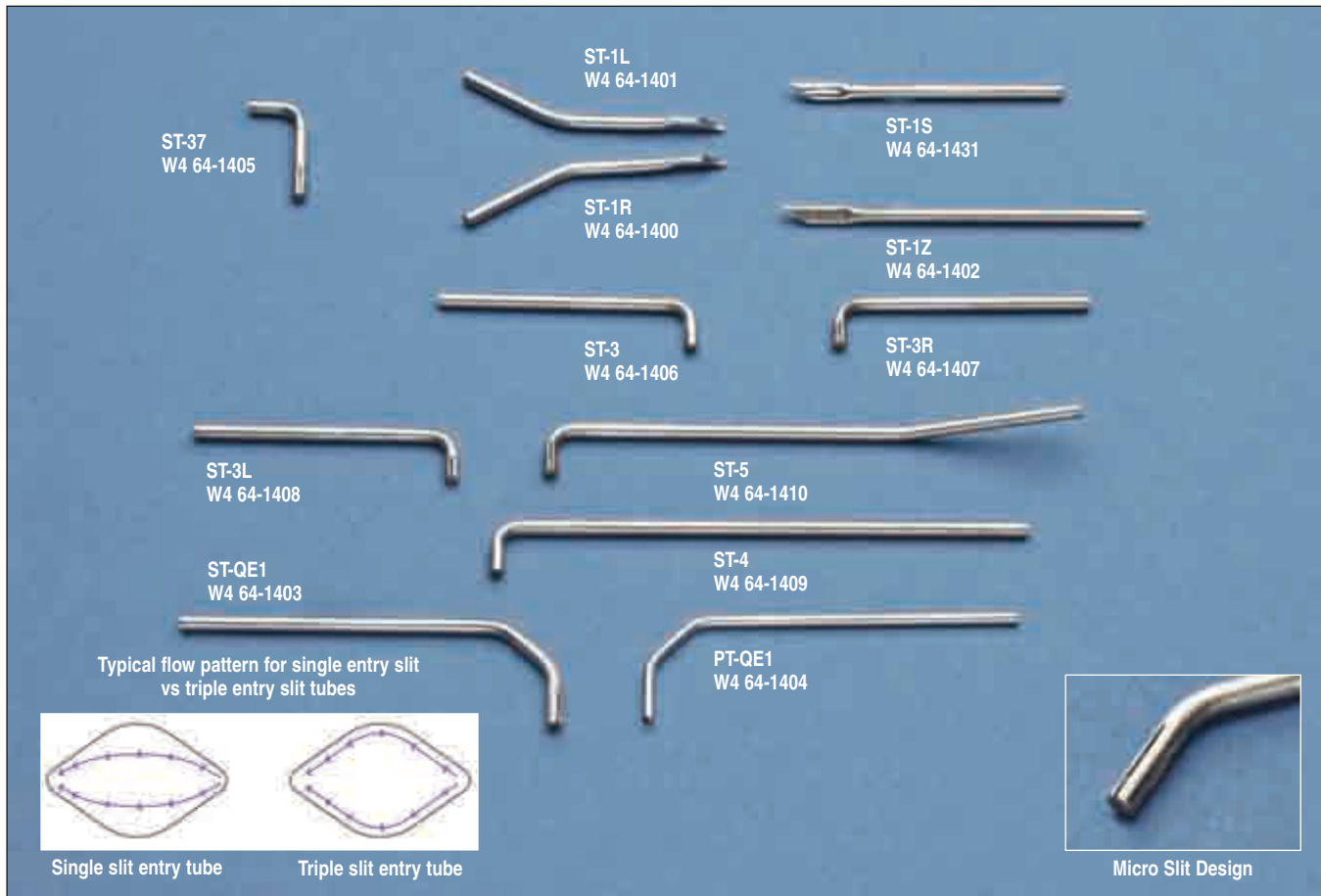
Order #	Model	Product
W4 64-0198	NYL/MESH	Nylon Mesh Kit – 10 pieces



chamber accessories

Replacement Suction and Perfusion Tubes

Replacement parts and accessories for Series 20 chambers



Warner Instruments produces suction tubes designed to make it easier to set and maintain the bath solution height. The innovative tube design has three equally spaced micro-slits at the front entry face and one micro-slit on the rear side of the sipper for air entry. This design helps eliminate tidal action in the bath and works equally well in all chambers, but excels in the larger bath chambers. All suction tubes are manufactured with 16 gauge type 316 stainless steel (1.65 mm OD x 1.19 mm ID). The PT-QE1 perfusion tube is 18 gauge type 316 stainless steel (1.27 mm OD x 0.83 mm ID).

Order #	Model	Product	For Chamber Model
W4 64-1431	ST-1S	Suction Tube, Series 20 Classic Design, Straight	RC-24, RC-24E, RC-28
W4 64-1400	ST-1R	Suction Tube, Series 20 Classic Design, Right Hand	RC-22/22C, RC-25/25F, RC-26/26G/26GLP/26Z
W4 64-1401	ST-1L	Suction Tube, Series 20 Classic Design, Left Hand	RC-27, RC-27L, RC-27N, RC-27NE
W4 64-1402	ST-1Z	Suction Tube, Classic Design, Straight	RC-1Z Chamber
W4 64-1403	ST-QE1	Suction Tube, Micro Slit Design	QE-1, DH-40i
W4 64-1404	PT-QE1	Perfusion Tube	QE-1, DH-40i
W4 64-1405	ST-37	Suction Tube, Micro Slit Design	RC-37W/37F, RC-37WS/37FS, RC-47FS
W4 64-1406	ST-3	Suction Tube, Micro Slit Design, Straight Front & Back Slits	RC-10, RC-24/24E, RC-28, RC-29
W4 64-1407	ST-3R	Suction Tube, Micro Slit Design, Right Hand Side Slits	RC-22/22C, RC-25/25F, RC-26/26G/26GLP/26Z*
W4 64-1408	ST-3L	Suction Tube, Micro Slit Design, Left Hand Side Slits	RC-27, RC-27L, RC-27N, RC-27NE*
W4 64-1409	ST-4	Suction Tube, Micro Slit Design, Front & Back Slits	RC-1Z, RC-11, RC-13, RC-16
W4 64-1410	ST-5	Suction Tube, Micro Slit Design, Side Slits	RC-3Z Chamber

* For upgrade of existing Series 20 chambers to micro slit design, see page 75.

chamber accessories

Electrode Kits and Magnetic Clamps

Chambers

chamber accessories

Replacement parts and accessories for Series 20 chambers

Agar Bridge Reference Electrode Kit

Developed for use in low volume recording chambers. The ABR-1 Agar Bridge Reference Electrode Kit consists of a 1 mm diameter silver wire electrode mounted in a modified pipette tip that can be filled with a 3 M KCl agar mixture. An included magnetic clamp with flexible holder for the pipette tip is perfect for positioning the electrode at any angle in the chamber. In addition, the pipette tips can be cut to length or shaped using a heat gun. The silver wire electrode comes with 1 meter of flexible wire terminated in a 2 mm pin. Includes a 2 mm to 1 mm pin adapter for use with 1 mm jacks.



ABR-1 Kit Components



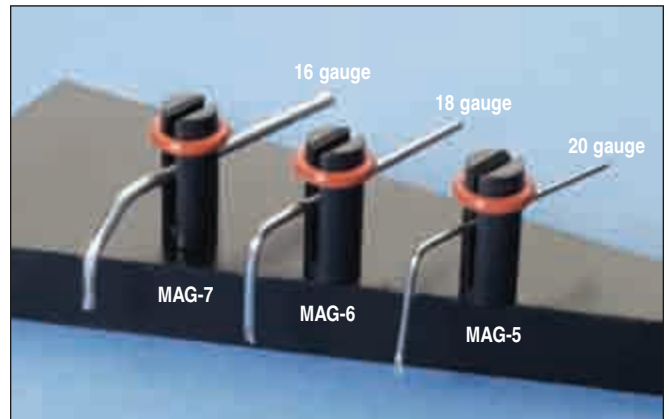
ABR-1 Shown mounted to a QE-1 Heated Base

Order #	Model	Product
W4 64-1426	ABR-1	Agar Bridge Reference Electrode Kit
W4 64-1428	LPE-10	Replacement Pipette Tips, pkg. of 10
W4 64-1323	PJ2-5	2 mm jack (5 pack)
W4 64-0360	MAG-3	Magnetic Clamp

Mini Magnetic Clamps

These miniature magnetic clamps offer a quick and easy method of positioning perfusion and suction tubes in chambers equipped with a magnetic platform. Sized to fit 20, 18, and 16 gauge tubes, they can also be used to hold PE tubing for applications requiring metal free solution delivery. Height: 16.6 mm, Ø: 6.4 mm.

Order #	Model	Product
W4 64-1552	MAG-5	Mini Mag for 20 gauge tubing
W4 64-1553	MAG-6	Mini Mag for 18 gauge tubing
W4 64-1554	MAG-7	Mini Mag for 16 gauge tubing



MAG-7 is for Suction, MAG-6 is for Perfusion, MAG-5 is for Skinny Suction Tubes

Suction/Perfusion Tubes

	A	
	A	B
ST-3	28.5 mm	6.5 mm
ST-3R	28.5 mm	6.5 mm
ST-QE1	40.0 mm ±	13.0 mm ±
PT-QE1	39.5 mm ±	12.7 mm ±

Tubing, Silicone Grease Kit and Suction Tube Upgrade Kit

Replacement parts and accessories for Series 20 chambers

PE (Polyethylene) Tubing

PE tubing is the most commonly used tubing in perfusion systems.

We stock the sizes compatible with our chambers and other perfusion devices. Consult the chart below to select the proper size tubing for your perfusion device.



Order #	Model	Product	length (m)	O.D. (mm)	I.D. (mm)	Where Used (examples)
W4 64-0750	PE-10/10	Polyethylene Tubing	3	0.61	0.28	MM Series Manifolds
W4 64-0751	PE-10/100	Polyethylene Tubing	30	0.61	0.28	MM Series Manifolds
W4 64-0752	PE-50/10	Polyethylene Tubing	3	0.97	0.58	MM & ML Series Manifolds
W4 64-0753	PE-50/100	Polyethylene Tubing	30	0.97	0.58	MM & ML Series Manifolds
W4 64-0754	PE-90/10	Polyethylene Tubing	3	1.27	0.86	RC-30, 30HV, 30VA, RC50
W4 64-0755	PE-160/10	Polyethylene Tubing	3	1.57	1.14	Series 20 Chambers
W4 64-0756	PE-160/100	Polyethylene Tubing	30	1.57	1.14	MP & MPP Manifolds, Most Solution Heaters, FR-50, FR-55S

Silicone Grease Kit

We have determined that an effective tool for applying silicone lubricant (used to form a seal between the coverslip and chamber) is an artist's acrylic brush. With that in mind, we have put together a convenient package that includes #2 and #4 brushes, several pallets to aid in applying the grease, and a tube of Dow Corning® 111 Valve Lubricant & Sealant.

Order #	Model	Product
W4 64-0378	111-Kit	Silicone Grease Kit with Brushes and Pallets
W4 64-0275	111	Replacement Grease



Recommended for all Warner Chambers

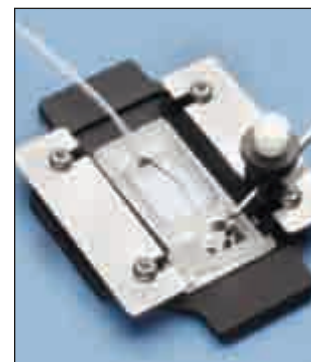
Suction Tube Upgrade Kit for Series 20

An economical version of our popular MCK-1 Magnetic Clamp Kit, the STU-1 upgrade kit includes a MAG-7 Magnetic Clamp for suction tubes and two magnetic strips that fit perfectly on top of Series 20 Platform Clamps. This kit makes upgrading to the new micro-slit suction tubes possible. Kit works with all models of Series 20 Platforms except P-2 and PH-2.

Order #	Model	Product
W4 64-1429	STU-1	Suction Tube Upgrade Kit for Series 20 Platforms



STU-1 Kit Components



Kit mounted to P-1 Platform

Petri Dish Adapter with Clamps & Spring Clamp Set

Replacement parts and accessories for Series 20 chambers

Chambers

chamber accessories



Shown with a 35 mm Petri dish in Nikon stage adapter



Model MSC-1 Magnet Spring Clamp Set

The MSC-1 presents a selection of clamp pairs, each pair has a different bend angle. Magnetic stainless steel plates supplied with the clamp set can be fastened to a chamber or to a stage using double sided tape. This allows the use of light duty clamps for perfusion tubes or ground wires in addition to clamping cell culture plastic ware.

You'll find dozens of uses in your lab for these light and easy-to-use clamps.

Model MDA-1 Petri Dish Adapter with Clamps

This Petri dish adapter is ideal for holding 35 mm dishes, as well as Warner's series 40 chambers, on your microscope stage. Designed for non heated imaging applications. Supplied with 2 sets of adjustable clamps for mounting dishes or chambers. A magnetic stainless steel perimeter allows use of magnetic holders. The addition of a Series 20 stage adapter allows mounting on any microscope stage.

Specifications

Physical Dimensions:	
MDA-1 (D x L)	79.4 x 3.2 mm
Aperture Size (D)	30 mm
Maximum Dish Diameter	40 mm

Order #	Model	Product
W4 64-1675	MDA-1	Miniture dish adapter with clamps

Specifications

Physical Dimensions (Distance from magnet to bottom edge):	
Red	2.5 mm
Green	5.0 mm
Yellow	7.8 mm
Blue	9.0 mm
Magnetic Stainless	16 x 40 mm

Order #	Model	Product
W4 64-1653	MSC-1	Magnetic spring clamp set

perfusion/microfluidics

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syringe pumps

Pump 11 Elite Advanced Syringe Pumps



Applications

- Controlled Flow
- Cellular Injections
- Oocyte Applications
- Microfluidics
- Drug/Nutritional Delivery
- Microdialysis
- Emulsification

Features

- Small Footprint
- Easy to use touch screen and icon interface
- Outstanding flow performance
- Easily run simple to complex methods without a PC
- Alphanumeric keypad for easy Method naming and recall
- Adjustable linear force up to 35 lbs
- Upgrade new versions of software remotely
- Legendary reliability – 2 year warranty

The Pump 11 Elite Series of syringe pumps expands its capabilities to satisfy your experimental requirements. These compact syringe pumps carry on the tradition as the premier workhorse infusion pump, offering unparalleled ease of use with a high resolution color touch screen with intuitive icon interface. The Pump 11 Elite Series allows you to create, save and run simple to complex methods without a PC.

Superior Performance

These syringe pumps have a new mechanism that includes a tight gripping, more secure syringe clamp for syringes ranging from 0.5ul to 60ml (single syringe) and 0.5ul to 10 ml (dual syringe). The Pump 11 Elite Series offers enhanced flow performance with high accuracy and smooth flow from 1.28 pl/min to 88.28 ml/min (25.99 ml/min for dual syringe rack).

The Pump 11 Elite Series is available in Infusion Only or Infusion/Withdrawal Programmable Models with single or dual syringe racks. All Pump 11 Elite syringe pumps have a footswitch input and USB serial port for computer control. The Infusion/Withdrawal Programmable models also have RS-485 (or optional RJ-11) ports for daisy chaining pumps and Digital I/O for external control via an independent computer or device (see facing page for more information on connectivity).

Since 1901 Harvard Apparatus has been supporting bio research fluidics requirements with a key milestone being the introduction of the first commercial syringe pump for bio research in 1956. Since 1956, over 70,000 satisfied syringe pump users around the world have made Harvard Apparatus syringe pumps the worlds #1 choice.

The Pump 11 Elite Series is a family of accurate, low flow syringe pumps designed for use in applications including: controlled flow, cellular injections, oocyte applications and more.

Program Description

To operate the Pump 11 Elite, the user defines all the required parameters for infusing or withdrawing liquids through a Method.

This may be a Quick Start Method, Pre-Programmed or User-Defined Method. The basic operation is a simple 3-step procedure:

1. **Select a method**
2. **Enter operating parameters**
3. **Preview or Run your method**

Quick Start Methods are simple infusions, withdrawals or a combination (depending upon the model). Custom user-defined Methods can be created when more advanced programming is required. The setup for a custom Method is easy using the standard profiles found on all Infusion/Withdrawal Programmable Elite Models. The list of available profiles is:

Constant Rate	Gradient (binary)
Ramp	Autofill

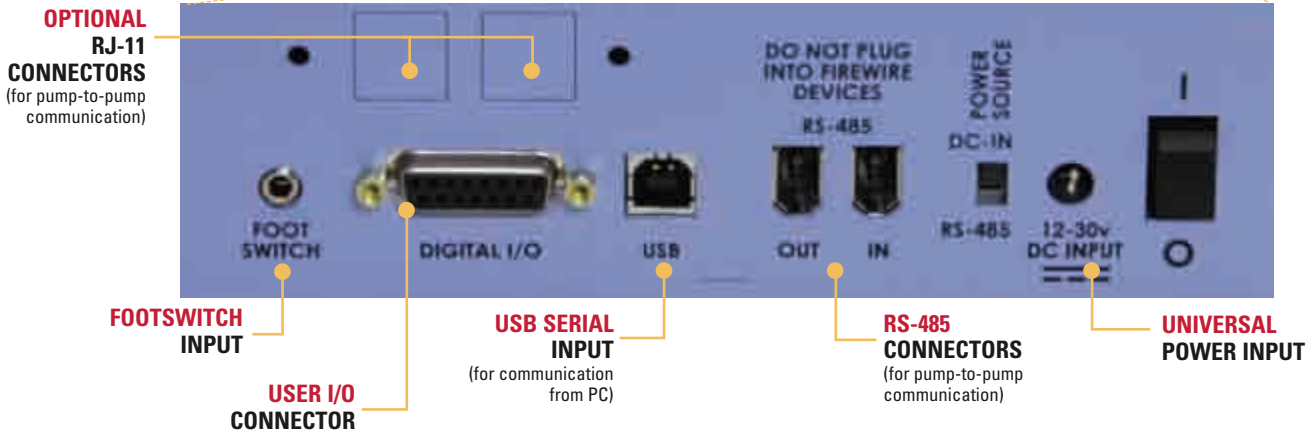
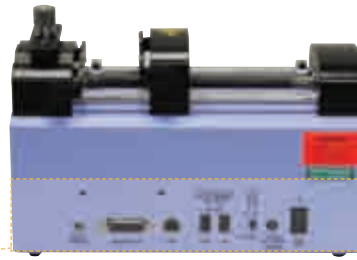
By programming custom (user-defined) Methods into the pump, multi-user errors are reduced. Easily transfer Methods to other pumps and/or download Methods from a PC. Forget having to duplicate Method-development efforts for each new pump added to your system.

Pump 11 Elite

Advanced Syringe Pumps (continued)

Advanced Connectivity

The infusion only Pump 11 Elite Syringe Pumps come standard with a Footswitch input and USB connector. The infusion/withdrawal programmable Pump 11 Elite Syringe Pumps include a Footswitch input, USB, RS-485 and I/O connectors. There is also an option for RJ-11 connectors on the programmable pumps. This option has to be ordered at the time the pump is ordered.



Pump 11 Elite Specifications

Type	Microprocessor single or dual syringe, infusion only or infusion/withdrawal programmable
Accuracy	±0.5%
Reproducibility	±0.05%
Syringe:	
Type	Plastic or glass
Size (single syringe)	0.5 µl to 50/60 ml
Size (dual syringe)	0.5 µl to 10 ml
Flow Rate:	
Single Syringe	1.28 pl/min to 88.28 ml/min
Dual Syringe	1.28 pl/min to 25.99 ml/min
Display	4.3" WQVGA TFT color display with touch screen
Connectors:	
RS-485	IEEE-1394, 6 position
USB	Type B
I/O & TTL	15 pin D-Sub connector
Footswitch	mini phono jack
Average linear force	16 kg (35 lbs) @ 100% Force Selection
Step Resolution	0.069 µm/µstep
Input Power	12-30 VDC
Input Power Connection	2.5 mm ID x 5.5 mm OD male plug
Power Supply	100-240 VAC, 50/60 Hz, 8 Watts Universal Power Supply, Use Only a Harvard Apparatus Approved Power Supply and Line Cord
Dimensions, H x W x D	22.6 x 17.78 x 15 cm (9 x 7 x 6 in)
Weight	2.1 kg (4.6 lbs)
Regulatory Certifications	CE, ETL (UL, CSA), WEEE, EU RoHS & CB Scheme

FOOTSWITCH INPUT	Start and stop a pump
USB SERIAL INPUT	Control your pump with a computer
RS-485 CONNECTORS	Connect multiple pumps together (daisy chain up to 99 pumps) Connect satellite pumps to the Master pump for binary gradient system (% composition)
RJ-11 CONNECTORS (OPTION)	Connect multiple pumps together (daisy chain)
USER I/O CONNECTOR	
Direction Control Input	Set pump to infuse or withdraw
Trigger Input	Connect an external device to start and stop a pump or Method
Trigger 1 Output	Signal another device to start and stop a pump or Method
Run indicator	Connect an external LED or monitoring device to a pump

Order # Product

W4 70-4500	Pump 11 Elite Infusion Only Single Syringe
W4 70-4501	Pump 11 Elite Infusion Only Dual Syringe
W4 70-4504	Pump 11 Elite Infusion/Withdrawal Programmable Single Syringe
W4 70-4505	Pump 11 Elite Infusion/Withdrawal Programmable Dual Syringe

syringe pumps

PHD ULTRA™

Advanced Syringe Pumps

PHD ULTRA™
Infusion/Withdrawal
Programmable



PHD ULTRA™
Push/Pull
Infusion/Withdrawal



Applications

- Shear Stress Studies
- Long-term time lapse
- Continuous Flow
- Oocyte Applications
- Patch Clamping
- Microfluidics
- Feeding Cells
- Flow Programming

Features

- New patent pending drive mechanism for unmatched smooth flow, accuracy and precision
- For operation at $\mu\text{l}/\text{min}$ to ml/min flow rates
- Easily program simple to complex methods without a PC
- Alphanumeric keypad for easy Method naming and recall
- Real and relative time clocks
- Intuitive touch screen and icon interface
- Vertical or horizontal orientation
- Adjustable linear force up to 75 lbs
- Multi-syringe racks for multi-channel operation or large capacity reservoir
- Legendary reliability— 2 year warranty

PHD ULTRA™

The PHD ULTRA™ syringe pump family has a new patent pending fluidics drive mechanism which assures ease of use and high performance, for the smoothest, most accurate flow rates of any syringe pump. Flow rates of 1.56 $\mu\text{l}/\text{min}$ to 215.8 ml/min are accurate within 0.25% and reproducible within 0.05%. A microprocessor-controlled, small step angle stepper motor drives a lead screw and pusher block. Advanced micro-stepping techniques are employed to further reduce the step angle to eliminate flow pulsation.

The PHD ULTRA™ is the solution for your most demanding fluidics applications. This pump represents the latest technology in syringe pumps and was developed utilizing the feedback of the world's largest population of syringe pump users.

The PHD ULTRA™ will change the way you think about syringe pumps. There are three major reasons the PHD ULTRA™ is the new standard for syringe pumps:

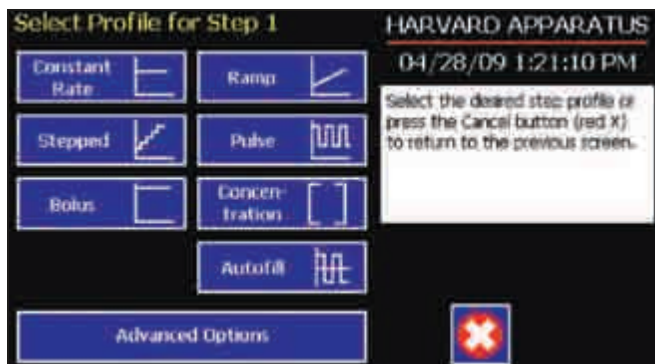
1. **NEW Patent pending mechanical drive mechanism and syringe holding mechanics to achieve the highest performance of any syringe pump.**
2. **NEW EZ PRO Software and user interface allow easy programming of Methods from simple to complex, all without the use of a PC.**
 - Preprogrammed Methods for simple to complex operations that allow you to be up and running with the touch of a button.
 - LCD, high resolution color touch screen for powerful functionality, yet very easy to use.
3. **NEW Levels of Versatility**
 - a. **Configurations:** Standard, push-pull, remote, high pressure, multi-racks.
 - b. **Connectivity:** For USB or RS-232 computer control; RS-485 or optional RJ-11 for daisy chain (control multiple pumps).
 - c. **Orientation:** Horizontal or vertical orientation to optimize bench space or to minimize tubing.

Since 1901 Harvard Apparatus has been supporting bio research fluidics requirements beginning with the introduction of the first commercial syringe pump for bio research in 1956. Since 1956, over 70,000 satisfied syringe pump users around the world have made Harvard Apparatus syringe pumps the world's #1 choice.

syringe pumps

PHD ULTRA™

Advanced Syringe Pumps (continued)



Program Description

To operate the PHD ULTRA™, the user defines all the required parameters for infusing and/or withdrawing liquids through a Method. This may be a Quick Start, Pre-Programmed or User-Defined Method. The basic operation is a simple 3-step procedure:

1. **Select a Method**
2. **Enter operating parameters**
3. **Preview or Run your Method**

Quick Start Methods are for simple infusions, withdrawals or a combination (depending on the pump model). Custom user-defined Methods can be created when a more advanced Method is required. The setup for a custom Method is easy using the standard profiles found on all Infusion/Withdrawal and Infusion/Withdrawal Programmable PHD ULTRA's. The list of available profiles are:

Constant Rate	Bolus	Pulse
Ramp	Concentration	Autofill
Stepped	Gradient	

By programming and saving custom Methods in the pump, multi-user errors are reduced. Easily transfer complex methods to other pumps and/or download methods from a PC. Forget having to duplicate method-development efforts for each new pump added to your system.

In addition to the advanced pumping profiles listed above, the PHD ULTRA™ contains a variety of advanced options allowing the user to repeat steps, link methods, control valves, external triggers etc.

Advanced Programming Features

Flow Programming: Change the flow with time, volume or a triggered event as many times as you like.

Bolus: Inject a large volume of drug (or drugs) at once. The bolus injection can be made in time or volume.

Concentration Delivery: Calibrate flow in concentration units of mg/kg easily so flow is calibrated to concentration of drug and animal weight.

Gradients: EZ PRO software allows you to easily program gradients, continuous or stepped.

% Ratio: Up to three solvents.

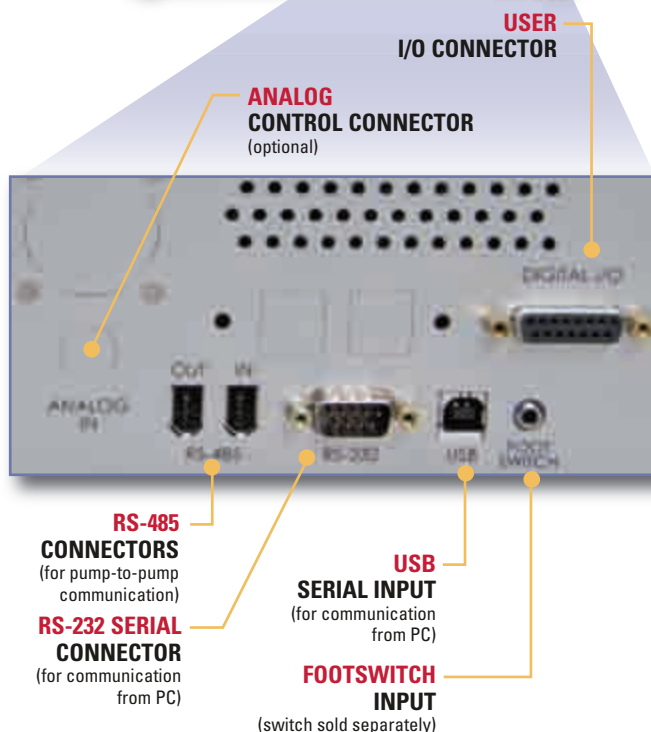
I/O: Dedicated and user defined I/O.

Pulsed Flow: So you can program the pulse easily.

Advanced Connectivity

All PHD ULTRA™ Syringe Pumps come standard with a footswitch, USB, RS-232, RS-485 and I/O connectors. There is also an option for RJ-11 connectors and analog control. These options have to be ordered at the time the pump is ordered.

FOOTSWITCH INPUT	Start and stop a pump
USB AND RS-232 SERIAL INPUTS	Control your pump with a computer
RS-485 CONNECTORS	Connect multiple pumps together (up to 99) Connect remote mechanism Connect satellite pumps to the Master pump for binary or ternary gradient system (% composition)
RJ-11 CONNECTORS (OPTION)	Connect multiple pumps together (daisy chain)
USER I/O CONNECTOR	
Direction Control input	Set pump to infuse or withdraw
Trigger Input	Connect an external device to start or stop a pump or Method
Footswitch Input	Start and stop a pump
Trigger 1 Output	Signal another device to start and stop a pump or Method
Trigger 2 Output	Signal another device to start and stop a pump or Method
Sync Output	Synchronize other devices
Valve Output	External valve control
Run Indicator	Connect an external LED or monitoring device to a pump
ANALOG CONTROL (OPTIONAL)	Analog control of the motor speed (0 to 10 v). This option must be ordered at the same time the pump is ordered.



Perfusion/
Microfluidics

syringe pumps

syringe pumps

PHD ULTRA™

Advanced Syringe Pumps (continued)

PHD ULTRA™ Specifications

Type	Microprocessor multiple syringe, infusion only, infusion/withdrawal or infusion/withdrawal programmable
Accuracy	±0.25%
Reproducibility	±0.05%
Syringes:	
Type	Plastic, glass or stainless steel
Size Minimum	0.5 µl
Size Maximum	140 ml
Flow Rate:	
Minimum	1.56 pl/min
Maximum	215.8 ml/min
Display	4.3" WQVGA TFT color display with touchscreen
Connectors:	
RS-232	9 pin D-Sub Connector
RS-485	6-position IEEE-1394
USB	Type B
I/O & TTL	15 pin D-Sub connector
Footswitch	Phono jack
Linear Force	34 kg (75 lbs) @ 100% force selection
Step Resolution	0.082 µm/step
Voltage Range	Universal input 100/240 VAC, 50/60 Hz
Dimensions, H x W x D	10.16 x 30.48 x 21.59 cm (4 x 12 x 8.5 in)
Weight	4.5 kg (10 lbs)
Regulatory Certifications	CE, ETL (UL, CSA), WEEE, EU RoHS & CB Scheme

Product	Order #	Order #	Order #	Order #
PHD ULTRA™ Standard	Stand Alone	Remote	Satellite*	Syringe Pump Module
PHD ULTRA™ Infusion Only	W4 70-3005	W4 70-3305	-	-
PHD ULTRA™ Infusion/Withdrawal	W4 70-3006	W4 70-3306	W4 70-3406	W4 70-3506
PHD ULTRA™ Infusion/Withdrawal Programmable	W4 70-3007	W4 70-3307	-	-
PHD ULTRA™ Push/Pull	Stand Alone	Remote	Satellite*	Syringe Pump Module
PHD ULTRA™ Push/Pull Infusion/Withdrawal	W4 70-3008	W4 70-3308	W4 70-3408	W4 70-3508
PHD ULTRA™ Push/Pull Infusion/Withdrawal Programmable	W4 70-3009	W4 70-3309	W4 70-3410	-
PHD ULTRA™ High Pressure	Stand Alone	Remote	Satellite*	Syringe Pump Module
PHD ULTRA™ 4400 Pump I/W Programmable	W4 70-3010	W4 70-3110	W4 70-3410	W4 70-3510
PHD ULTRA™ Hpsi Remote Pump I/W Programmable	-	W4 70-3111	-	-
PHD ULTRA™ Hpsi Remote Pump I/W Programmable with 10 x 140 Rack	-	W4 70-3112	-	-

*Note: Gradient Systems are available. Contact technical support for more details.

Order # Product

PHD ULTRA™ Options

W4 70-3030	RS-232 RJ-11 Connectors Option (daisy chain)
W4 70-3033	Analog Control Input Option (0-10V) ³
W4 70-3031	Internal Pinch Valve Option ²
W4 70-3032	Internal 3-Way Isolation Valve Option ²
W4 70-3034	Internal Fan Option ⁴

PHD ULTRA™ Upgrades

W4 70-3020	6/10 Multi-Syringe Rack for PHD ULTRA™
W4 70-3021	4 x 140 Multi-Syringe Rack for PHD ULTRA™
W4 70-3022	Microliter Rack, for PHD ULTRA™ holds 4 syringes
W4 70-3023	Anti-Siphon Kit for PHD ULTRA™
W4 70-4010	Upgrade Infusion Only to I/W ¹
W4 70-4011	Upgrade Infusion Only to Programmable ¹
W4 70-4012	Upgrade I/W to Programmable ¹

¹ Note: Requires Return to Factory

² Note: Only for available for Infusion/Withdrawal or Programmable Models

³ Note: Only for Programmable Models. Not available on Satellite Boxes.

⁴ Note: Fan option is required if external operating ambient is expected to be >35°C

Accessories

W4 70-4000	RS-485 Cable for Pump-to-Pump Communication, 0.5 m (1.6 ft)
W4 70-4001	RS-485 Cable for Pump-to-Pump Communication, 2 m (6.6 ft)
W4 70-4020	RS-485 Extension Cable, 9.1 m (30 ft)
W4 70-4002	USB Cable for PC-to-Pump Communication, 2 m (6.6 ft)
W4 70-4003	USB Cable for PC-to-Pump Communication, 5 m (16.4 ft)
W4 70-4004	RS-232 Cable for PC-to-Pump Communication, 9 pin D-sub, 2 m (6.6 ft)
W4 70-4005	Adapter, PHD Digital I/O
W4 70-4006	Adapter, D-sub 15 to Term. Blk
W4 72-8340	Adapter, USB to Serial
W4 70-2215	Footswitch (with Phono Plug)
W4 55-7002	Auto Fill Valve Box, Normal Pressure, 30 psi
W4 55-7004	Auto Fill Valve Box, High Pressure, 200 psi
W4 55-7760	Cable Assy, Daisy-chain, Legacy RS-232 RJ-11, 0.6 m (2 ft)
W4 72-2478	Cable Assy, Daisy-chain, Legacy RS-232 RJ-11, 2.1 m (7 ft)
W4 55-8000	Adapter for 25 ml, 50 ml, 100 ml Hamilton GasTight™ Syringes



Applications

- Cellular Injections
- Drug Delivery
- Microinjections
- Hand-Held Automated Delivery
- Chamber Dosing
- Regenerative Medicine

Features

- Light weight makes it ideal for hand-held or stereotaxic injection
- Easy-to-use LCD color touch screen with GUI interface
- Create and store >50 programs for
- High performance in a small package
- 1000 times better than manual syringes

The PHD ULTRA™ Nanomite is a single syringe infusion/withdrawal programmable syringe pump. This pump allows you to create, save and run simple to complex Methods without a PC. The flow rate range is 3.66 pl/min to 3.818 ml/min with 11 lbs of adjustable force across the entire flow rate range.

The PHD ULTRA™ Nanomite has a footswitch input, RS-232 and USB serial ports for computer control, RS-485 ports for daisy chaining pumps and Digital I/O for external control via an independent computer or device. There is also an option for daisy chaining pumps through the RS-232 (RJ-11) ports. This option must be ordered at the time the pump is ordered. See page 81 for more information on connectivity.

This pump consists of a control unit, an injection unit, a 6 foot cable to connect the two units and a footswitch.

For more information on the PHD ULTRA™ Nanomite including features and programming see the PHD ULTRA™ on page 80.

PHD ULTRA™ Nanomite Specifications

Type	Microprocessor single syringe Infusion/Withdrawal Programmable
Accuracy	±0.5%
Reproducibility	±0.05%
Syringes:	
Type	Glass or plastic
Size Minimum	0.5 µl
Size Maximum	1 ml
Flow Rate:	
Minimum	3.66 pl/min
Maximum	3.818 ml/min
Display	4.3" WQVGA TFT color display with touchscreen
Connectors:	
RS-232	9 pin D-Sub connector
RS-485	IEEE-1394, 6 position
USB	Type B
I/O & TTL	15 pin D-Sub connector
Footswitch	Mini phono jack
Average Linear Force	5 kg (11 lbs) @ 100% force selection
Step Resolution	0.198 µm/µstep
Voltage Range	100-240 VAC, 50/60 Hz, 75 W, 0.5 A fuse
Dimensions H x W x D:	
Control Box	30.5 x 21.6 x 11.1 cm (12.0 x 8.5 x 4.38 in)
Injector Unit	6.35 x 5.08 x 19.05 cm (2.5 x 2.0 x 7.5 in)
Weight:	
Control Box	2.06 kg (4.55 lbs)
Injector Unit	0.458 kg (1.01 lbs)
Regulatory Certifications	CE, EU RoHS

Order # Product

W4 70-3601	PHD ULTRA™ Nanomite Infusion/Withdrawal Programmable Single Syringe
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syringe pumps

Physio 22

Low RFI Syringe Pump for Physiological Experiments

Large volume, low noise pump for sensitive applications



Applications

- Patch Clamping
- Oocyte Applications
- Cellular Injections

Features

- Low electrical noise
- Pulse less flow
- High accuracy

The PHYSIO 22 Pump delivers high accuracy, pulseless flow with no electrical noise to interfere with the sensor signal while performing physiological analyses. This specialty pump is based on our legendary Syringe Pump 22, but with a special toroidal transformer designed for minimum RFI (Radio Frequency Interference). This new transformer cuts electrical noise so that it is almost non-existent.

The electrical noise difference between our standard PUMP 22 and this new model is quite dramatic. Standard pumps generate a Magnetic field which will induce a current into the conductive media coming out of the syringe. This will create noise in the biological reading/recordings. With the new PHYSIO 22, even the most sensitive sensors will not show a noise spike. With the new toroidal transformer the noise disappears completely.

This pump features an LED display and numerical keypad for easy entry of syringe diameter data and flow rates. Flow rate units can be set in $\mu\text{l/hr}$, $\mu\text{l/min}$, ml/hr and ml/min . An optical encoder monitors leadscrew rotation to accurately maintain any flow rate. The run LED flashes when syringe plunger movement stops unexpectedly. A complete line of accessories for the PHYSIO 22 are available including a footswitch, audible alarm, reversing switch and serial cables, visit our website at www.harvardapparatus.com.

The PHYSIO 22 can be controlled using RS-232 (serial) commands. Multiple syringe pumps can be interconnected by daisy chaining pumps. Up to 100 pumps can be addressed independently using internal reference addresses from 0 to 99. A set of sample programs, using the Basic programming language, is included with each pump.

These types of applications are particularly sensitive to electrical noise and therefore would benefit tremendously by using our new PHYSIO 22 Syringe Pump.

This pump is currently available as infusion only with standard 2-syringe rack or infusion only with 6/10 syringe rack. An infuse/withdraw model is available by special order. Please call for details.

A spurious electromagnetic signal was recently found within the design of the PHYSIO 22 which allowed the introduction of a small 50/60 Hz signal into a shielded environment. In particular, a small transformer within the PHYSIO 22 generated an electromagnetic field which was sensed by an adjacent perfusion line. The problem was corrected by replacing the offending transformer with one incorporating toroidal architecture. This change in design successfully contains the stray electromagnetic field and renders the device electrically silent.

Specifications

Type	Microprocessor multiple syringe, infusion only
Accuracy	$\pm 0.35\%$
Reproducibility	$\pm 0.05\%$
Syringe:	
Type	Plastic, glass or stainless steel
Size Minimum	0.5 μl
Size Maximum	140 ml
Flow Rate:	
Minimum	0.002 $\mu\text{l/hr}$
Maximum	55.1 ml/min
Non Volatile Memory	Storage of all settings
RS-232	25-pin connector
TTL	Shared port with RS-232
Average Linear Force	47 lbs
Drive Motor	0.9° step angle motor
Motor Drive Control	1/4 microstepping
Motor Step per One Rev. of Leadscrew	3,200 steps
Step Resolution	0.33 $\mu\text{m/step}$
Step Rate:	
Minimum	6.8 sec/step
Maximum	416.7 $\mu\text{sec/step}$
Pusher Travel Rate:	
Minimum	2.9068 $\mu\text{m/min}$
Maximum	47.6 mm/min
Power	30 W, 0.5 A fuse
Voltage Range	95 to 130 VAC, 60 Hz; 220 to 260 VAC, 50 Hz, selectable
Dimensions, H x W x D	28 x 22.2 x 14 cm (11 x 8.75 x 5.5 in)
Weight	4.5 kg (10 lb)

Order # Product

W4 70-2222	PHYSIO 22 Syringe Pump with Standard 2-Syringe Holder
W4 70-2223	PHYSIO 22 Syringe Pump with 6/10 Multi-Syringe Rack

Peristaltic Pump 66 and 77

Peristaltic Pumps
66 and 77



Features

- Highly accurate peristaltic pumps $\pm 1\%$
- Unique ramped deceleration and 'slurp back'
- Continuous volume or batch mode operation
- Easy to use

Harvard Apparatus' 66 and 77 Peristaltic Pumps provide highly accurate and repeatable flow rates and are extremely easy to use.

High Accuracy

These pumps have the same high quality micro-stepping motor that creates the legendary accuracy of Harvard Apparatus' Syringe Pumps. Other peristaltic pumps have less accurate DC motors. No other peristaltic pump offers this quality of basic motor control. Additional accuracy features include ramped deceleration as the end-point is approached and a 'slurping' feature to prevent end of dispense dripping. As the end-point approaches, the pump slows to drop-by-drop delivery. As the last drop required is delivered, the pump immediately reverses one step and slurps back preventing unintended fluid delivery. Only these Harvard Apparatus innovations enable accuracy approaching that of a syringe pump from a peristaltic pump.

Fast and Easy

Routine work is made fast, easy and convenient with the 66 and 77 peristaltic pumps. Just enter the calibration factor of the tubing and the flow rate desired. The pump takes care of the rest. All settings are stored in non-volatile memory.

Flexibility

The 66 and 77 peristaltic pumps offer three pumping protocols for outstanding flexibility:

- **Continuous Flow** – set the flow rate desired and the pump will run continuously until you stop it.
- **Volume Mode** – enter the volume to be delivered and the pump will run until that volume is delivered.
- **Batch Mode** – simply enter the time interval between dispenses and the number of dispenses you want and the pump will take it from there. It couldn't be more simple.

Two Sizes Available

Harvard Apparatus' peristaltic pump is offered in two sizes. The only difference between the two pumps is the flow rates provided. The 66 accepts smaller diameter tubing and provides flow rates from 0.01 to 210 ml/minute. The larger size 77 pump accepts larger diameter tubing to provide flow rates from 0.01 to 750 ml/minute.

Calibration by Volume or Weight

For precise volumetric calibration, measure the actual volume pumped compared to what the pump thinks it has delivered. Enter the exact amount actually delivered into the pump and the pump will automatically recalibrate itself in microliters per pump head revolution. For precise gravimetric calibration, connect the pump to a Mettler, Ohaus or Sartorius scale with a feedback connector. The pump now operates by weight and will recalibrate itself in grams per pump head revolution.

RS-232C Interface and TTL Input/Output

This pump can be controlled remotely by any personal computer via an RS-232C interface. Up to 99 pumps can be daisy-chained using the daisy-chain connector and cables offered as accessories. A connector for TTL input/output permits remote control of all functions.

Peristaltic Pump 66 and 77 Specifications

Type	3 roller rotary peristaltic, single channel	
Accuracy	$\pm 1\%$	
Reproducibility	$\pm 1\%$	
RS-232C Interface	Chained dual bi-directional ports	
TTL Connector	9-pin connector	
Display	5 digits and 10 LED indicators	
Selectable Baud Rates	300, 600, 1200, 2400	
Step Rate:		
Minimum	27.3 sec/step	
Maximum	416.7 μ sec/step	
Back Pressure	30 p.s.i. maximum	
Power	115/230 VAC, 50/60 Hz	
Voltage Range	95/130 VAC; 220/260 VAC	
Pump:	Small 66 Pump Large 77 Pump	
Tubing ID*	1.6 and 3.2 mm (0.0625 and 0.125 in)	3.2 and 6.4 mm (0.125 and 0.25 in)
Flow Rates	0.01 to 210 ml/min	0.01 to 750 ml/min
Dimensions, H x W x D	22.9 x 20.6 x 8.9 cm (9 x 8.125 x 3.5 in)	24.1 x 20.6 x 12.7 cm (9.5 x 8.125 x 5 in)
Weight	3.53 kg (7.85 lb)	5.1 kg (11.25 lb)

Order # Product

W4 55-7766	Peristaltic Pump 66
W4 55-7777	Peristaltic Pump 77
W4 70-2022	RS-232 Connection Cable; Computer to Pump
W4 72-2478	Daisy Chain Cable; Pump to Pump, 1.8 m (7 ft)
W4 55-7760	Daisy Chain Cable; Pump to Pump, 0.6 m (2 ft)
W4 55-7757	Feedback Loop Connector for Mettler Scale
W4 55-7758	Feedback Loop Connector for Ohaus Scale
W4 55-7759	Feedback Loop Connector for Sartorius Scale

*Note: Tygon R-1000 or comparable tubing recommended, see page 87.

Harvard MPII Mini-Peristaltic Pump

peristaltic pumps

Small, low cost 2-channel peristaltic pump for basic applications

W4 70-2027 Harvard MPII
Mini-Peristaltic Pump



MPII Flow Rates in ml/min

Switch Setting	With One Tube		With Two Tubes	
	Min.	Max.	Min.	Max.
x1	0.8 ml/min	7.00 ml/min	1.6 ml/min	14.00 ml/min
x2	1.5 ml/min	12.25 ml/min	3.0 ml/min	24.50 ml/min

Specifications

Output Pressure	In excess of 20 p.s.i.
Power	12 VDC 800 mA, 2.5 mm Connector, 115/230 VAC, 50/60 Hz, Universal power supply, 10 W
Dimensions, H x W x D	189 x 114 x 105 cm (3.5 x 4.5 x 4 in)
Weight	0.96 kg (2.1 lb)
Tubing ID	1/16 in

Order # Product

W4 70-2027	MPII, 115/230 VAC, 50/60 Hz*
W4 55-4148	Pump Head Tubing Pieces. These Silicone Pump Head Tubing Pieces Have Connectors on Each End for 1/16 in ID Tubing 2.5 in, pkg. of 10

* Pump Head Tubing Pieces are necessary in order to use the Pump. They are not included, so they must be ordered separately.

- Continuous low flow rates ideal for:
 - Slow perfusion studies
 - Controlled animal feeding
- Pump can take one or two tubes simultaneously, 1/16 in. ID
- Control knob for pumping speed
- Toggle switches for direction and x1 or x2 speed range selection
- Low electrical and mechanical noise
- Small size

The Harvard MPII Mini-Peristaltic Pump takes only one size of tubing, 1.6 mm ID x 3.2 mm OD (1/16 x 1/8 in). It can be used with either a single tube or two tubes simultaneously. Two of the W4 55-4148 Pump Head Tubing Pieces are included with the pump. Additional Pump Head Tubing Pieces (W4 55-4148) may be purchased separately.

Two front panel controls provide flow rates from approximately 0.8 to 24.5 ml/min. The control knob provides variable adjustment from 0 to 100% of the selected flow rate range. The second control is a two position toggle switch marked x1, x2 which selects low or high flow rates, see table to right.

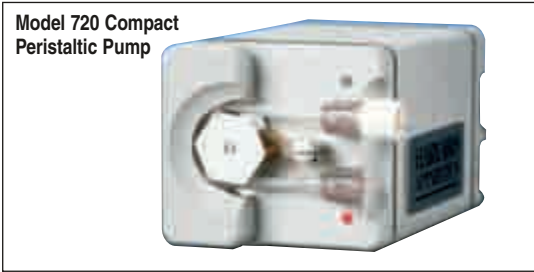
The easy-loading four-roller pump head is on top of the stout metal box. The back of the pump head effortlessly rotates into an 'open' position and either one or two tubes can be dropped into slots. The loaded section simply rotates back against spring loaded jaws and locks into place. The tubing is automatically in proper wiping contact with the pump head rollers. Each Pump is provided with a 12.5 mm (0.5 in) rod clamp on the back so that multiple pumps can be mounted vertically on a lattice rod.

peristaltic pumps

Model 720

Compact Peristaltic Pump

Small, low cost 1-channel peristaltic pump for basic applications



- Continuous infusion
- Battery back-up (30 hrs)
- Compact pump
- Minimal electromagnetic radiation
- Choose from low mid, or high flow

The Model 720 Compact Peristaltic pump is a stand-alone pump series with flow rates of 0.02 to 12 ml/hr (Low Flow), 0.2 to 145 ml/hr (Mid-Flow) and 2 to 1100 ml/hr (High Flow). It is an ideal pump for applications which require limited size or weight, low EMI interference, the versatility of single and dual tubes sets (see table below) and/or external analog control.

An internal 9V lithium battery (supplied with W4 61-0098 and W4 72-0002) will run the pump for up to 30 hours, protecting your experiments in the event of a power failure. Due to its power requirements, the high flow version is not available with battery backup.

The pump is typically powered by a 1.25 V internal reference voltage. An external reference voltage can be used to regulate flow rate and direction (pump direction can only be reversed by analog control). Under external control the speed dials serve as voltage attenuators to limit the external voltage to ± 1.25 volts.

Tube sets must be purchased separately. Frequently ordered tube sets are listed below. Other tube sets are available, please see our website or contact technical support. For use with saline and most drugs, use silicone tubing. For use with solutions containing fats, such as IV diets, use C-FLEX® tubing. For use with petroleum-based fluids, use VITON® tubing.

Universal power supply is included with each pump. Tube sets are not supplied and must be ordered separately. See below.

Specifications

Repeatability	$\pm 3\%$		
Flow Control Range	20:1		
Power Source	Wall-mounted 9 VDC adapter		
Dimensions, H x W x D	6.4 x 5.7 x 10.2 cm (2.5 x 2.3 x 4 in)		
Weight	375 g (1 lb)		
Voltage Range	Universal input 100/240 VAC; 50/60 Hz		
Flow Rate:	High	Mid	Low
Min. (0.015 in. tube)	2 ml/hr	0.2 ml/hr	0.02 ml/hr
Max. (0.093 in. tube)	1100 ml/hr	145 ml/hr	12 ml/hr
	W4 72-0001	W4 61-0098	W4 72-0002



Tube Sets

A wide variety of tube sizes, tube materials and connector types allows you to tailor your peristaltic pump to your particular application.

Tube sets typically last about one month under continuous operation. Dual channel tube sets place more stress on the pump than do single channel tube sets, which may shorten the life of your pump's motor.

Order # Product

	Silicone Tubing Set, pkg. of 5
W4 61-0241	Silicone Tubing Set, 1-Ch, Female Luer to 22 ga, pkg. of 5
W4 61-0242	Silicone Tubing Set, 1-Ch, Female Luer to 20 ga, pkg. of 5
W4 61-0243	Silicone Tubing Set, 1-Ch, 0.062" ID Barbs, 0.8ml/hr, pkg. of 5
W4 61-0244	Silicone Tubing Set, 1-Ch, 0.062" ID Barbs, 5ml/hr, pkg. of 5
W4 61-0245	Silicone Tubing Set, 2-Ch, 0.062" ID Barbs, 3ml/hr, pkg. of 5

Frequently Ordered Tube Sets

Order #	Flow Rates with W4 72-0002*	Flow Rates with W4 61-0098*	Flow Rates with W4 72-0001*	Typical Application
W4 61-0241	0.02 to 0.45 ml/hr	0.2 to 5 ml/hr	2 to 43 ml/hr	IV infusion with 22 ga swivels (lab animals only)
W4 61-0242	0.04 to 0.95 ml/hr	0.3 to 11 ml/hr	4 to 90 ml/hr	IV infusion with 20 ga swivels (lab animals only)
W4 61-0243	0.08 to 1.8 ml/hr	0.8 to 21 ml/hr	9 to 170 ml/hr	General laboratory applications
W4 61-0244	0.9 to 12 ml/hr	7 to 145 ml/hr	90 to 1100 ml/hr	General laboratory applications
W4 61-0245	0.3 to 6.3 ml/hr	3 to 75 ml/hr	33 to 550 ml/hr	Dual channel laboratory applications

*Tube sets are no longer supplied with the pump. They must be purchased separately.

valve control systems

NEW Pressurized Perfusion Kits

Six and Eight Channel

Perfusion/
Microfluidics

valve control systems



Shown with optional syringe holder and stand.

- Upgrades any gravity-feed perfusion system to a pressurized system
- Universal reservoir plug fits 5, 10, and 20 ml syringes
- Dual regulators insure uniform fluid delivery

The latest accessory for Warner perfusion valve control systems is a simple, yet effective pressurization kit. The clever design of the universal reservoir plug allows for easy insertion into 5, 10, or 20 ml BD syringes.

Precise and accurate flow, even at low flow rates, is insured using dual regulator controls. House air or nitrogen is kept at constant 20 PSI using the first regulator and the second regulator is used to set the flow pressure at 0.1 PSI accuracy. Regulators include 5 µm filters and a large, easy to read pressure gauge on the output side. Universal reservoir plugs are designed to fit directly into a 60 cc syringe holder (SH6/60 or SH8/60).

The perfusion pressure kit for 8 channel valve controllers includes; 8- universal reservoir plugs pre-connected with tubing harness, dual pressure regulator/filter/gauges with rod mounting clamp, eight 10 ml BD syringes, eight stopcocks, and 25 feet of polyurethane tubing 4 mm I.D. x 6 mm O.D.

The kit for 6 channel valves includes everything listed above less two of the universal reservoir plugs, two 10 ml syringes, and two stopcocks.

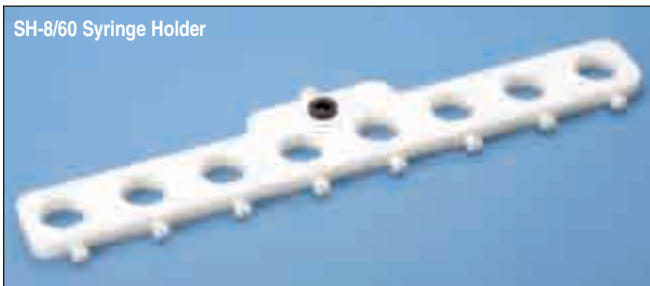
VPP-1 Universal Reservoir Plug



SH-6/60 Syringe Holder



SH-8/60 Syringe Holder



Order #	Model	Product
W4 64-1711	VPP-6	Perfusion Pressure Kit Six Channel
W4 64-1712	VPP-8	Perfusion Pressure Kit Eight Channel
W4 64-1713	VPP-1	Universal Reservoir Plug
W4 64-1714	PPT-25	Tubing Polyurethane 4 mm I.D. x 6 mm O.D.
W4 64-0163	SH-6/60	Syringe Holder, 6 x 60 cc syringes
W4 64-0385	SH-8/60	Syringe Holder, 8 x 60 cc syringes
W4 64-1720	VPP-6-6	Perfusion Pressure Kit, 6 x 60 cc syringes
W4 64-1721	VPP-8-6	Perfusion Pressure Kit, 8 x 60 cc syringes

valve control systems

VC-8M, VC-8MLT, VC-8P, VC-8T

Valve Control Systems

An 8-channel multi-valve perfusion system for diverse applications

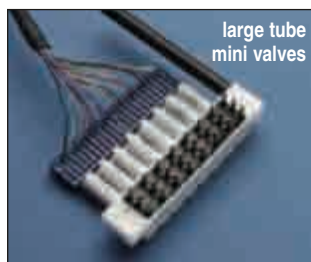


- Integrated spill sensor
- Choice of 3 valve types
- 8 channel system
- Manual and computer controllable

The VC-8 Valve Control System lies at the heart of a multi-valve perfusion system designed to automate and control the delivery of solutions to imaging and recording chambers. The flexible design of this system allows it to be used in diverse applications.

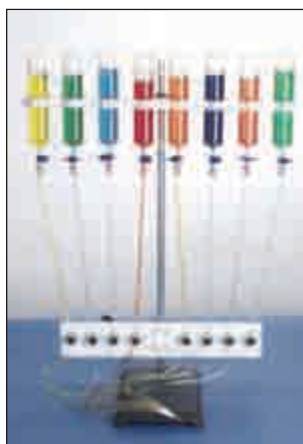
An exciting feature of the VC-8 system is the Spill Sensor Probe. This probe is used to detect the presence of an overflow condition on the microscope and, when activated, will automatically shut off all valves – protecting your valuable equipment.

The controller can independently regulate the function of up to eight valves. Individual valves are manipulated via a manual switch, an external analog signal or an external digital (TTL) signal. An event marker pulse, generated each time a valve is switched on, is provided at the rear of the instrument for recording into your acquisition system. Valve transitions (opened or closed) occur at full power to insure rapid response times and are then held in place at less than half power to prevent heat transfer to solutions.



While pinch valves are standard equipment, additional valve options include Teflon and Lee miniature types. The VC-8M is designed for slow flow perfusion systems where smaller diameter tubing is used. The VC-8MLT uses larger ports on a mini-valve platform to accommodate the PE-160 tubing used on most Warner chambers, this version will permit flow rates of up to 10 ml/min.

A complete VC-8 system includes a powered valve controller, a valve bracket with valves, connecting cable, C-Flex™ tubing, an MP Series manifold, support stand, eight 60 cc syringes, 25 feet of Tygon tubing and an assortment of tubing connectors.



Pinch Valve System



Mini-Valve System

Specifications

VC-8 Standard	12 V, 3-way pinch valves
VC-8 Teflon®	12 V, 2-way Teflon®
VC-8M Mini	12 V, 3-way solenoid valves
VC-8MLT Mini	12 V, 3-way solenoid valves
Typical Max. Flow Rates (with 60 cm head):	
VC-8P, VC-8T Systems	10 ml/min
VC-8M Systems	1 ml/min
VC-8MLT Systems	10 ml/min
VC-8 Valve Controller:	
Switching	Manual, TTL logic or Analog Signal
Event Marker	Logic level pulse
Spill Sensor	BNC Input for detecting an overflow
Power	100-130 or 200-250 VAC, 50/60 Hz, 50 VA
Size	8.9 x 20 x 25.4 cm (H x W x D)
Warranty	All systems carry 2-year warranty

Order #	Model	Product
W4 64-0186	VC-8M	Valve Control System 8 mini valves
W4 64-0186LT	VC-8MLT	Valve Control System 8 mini valves Large tubes for higher flow
W4 64-0185	VC-8P	VC-8P Valve Control System 8 pinch valves
W4 64-0187	VC-8T	Valve Control System 8 Teflon valves
W4 64-1523	MAT-2	Overflow Sensor Mats and Cable (4 Mats)

valve control systems

VC-6 and VC-6M

Valve Control Systems

4- or 6-channel multi-valve perfusion systems for diverse applications



Valve Controller

- Manual and computer control
- Basic or Complete systems
- Pinch valves, standard
- Teflon valves, optional

Perfusion Valve Control

Warner perfusion valve control systems are uncomplicated and easy to operate. The VC-6 Valve Controller is configured to control up to 6 valves. Each valve is individually manipulated by a manual switch or an external digital (TTL) signal. An event marker pulse, generated each time a valve is switched on, is provided for tape or chart recordings.

VC-6 Standard Pinch Valve Systems

Standard systems are supplied with tube pinch valves. They are the simplest to maintain as the solution never comes in contact with the valve and tubings are easily replaced. Valves are dual acting (3-way) with both normally open and closed sides. A "Y" connector at the valve input permits solution flow-to-waste with the valve off.

VC-6 Teflon® Valve Systems

Teflon® valves are also available and are for applications where resistance to chemicals is needed. The valves are 2-way (either on or off).

VC-6M Mini-Valve Systems

The VC-6M is designed for slow flow perfusion systems using smaller diameter tubing. Up to six valves mount directly to a compact Teflon® manifold. The 3-way valves allow for solution flow to waste if desired. The VC-6M system is ideally suited for use with the SF-77B perfusion stepper systems.

System Choices: Basic or Complete

The VC-6 Valve Perfusion Control System is available in two configurations with a choice of either a standard pinch valve or Teflon® valve.

The Basic System includes the VC-6 Controller, valves, valve bracket with 8 ft cable and MP Series Manifold. Systems employing standard pinch valves are also supplied with C-Flex™ valve tubing.

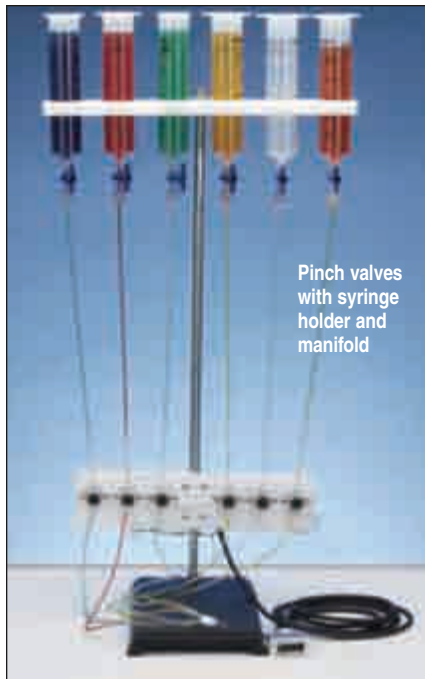
The Complete VC-6 Systems includes all of the components in the Basic Systems plus six 60 cc reservoirs, reservoir holder, support stand, stopcocks and tubing connectors. In addition, the systems employing standard pinch valves are supplied with Tygon™ tubing. Systems employing Teflon® valves include Teflon® tubing.

The VC-6M Mini-Valve Perfusion Control System is also available in two configurations. The Basic System includes the VC-6 controller, valves, valve manifold, 8 ft cable and ML Series manifold. The Complete System includes all of the components in the Basic Systems plus eight 10 cc reservoirs, reservoir holder, support stand, stopcocks, tubing connectors and two packages of PE-50 tubing (10 ft long).

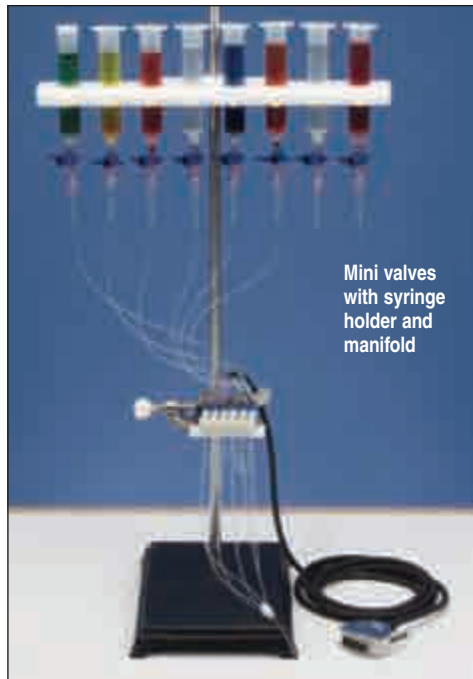
valve control systems

VC-6 and VC-6M

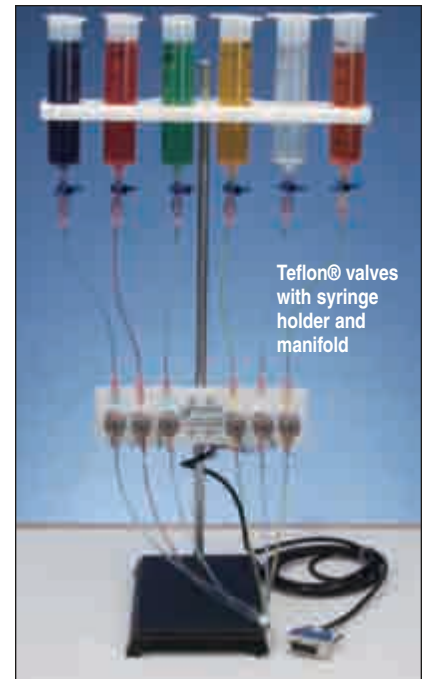
Valve Control Systems (continued)



Pinch valves with syringe holder and manifold



Mini valves with syringe holder and manifold



Teflon® valves with syringe holder and manifold

Comp - 6 channel system with larger tubes for higher flow

Specifications

Valves:	
VC-6 Standard	12 V, 3-way pinch valves
VC-6 Teflon®	12 V, 2-way Teflon®
VC-6M Mini	12 V, 3-way solenoid valves
Typical Max. Flow Rates (with 60 cm head):	
VC-6 Systems	10 ml/min
VC-6M Systems	1 ml/min
VC-6 Valve Controller:	
Switching	Manual or TTL logic
Event Marker	Logic level pulse
Power	110-130 or 200-250 VAC, 50/60 Hz, 50 VA
Size	8.9 x 20 x 25 cm (H x W x D)
Warranty	Two year

Order # Model Product

Basic Perfusion Systems

W4 64-0171	VC-66MBB	Mini-Valve Controller System, 6 Valves
W4 64-0129	VC-66BB	Pinch Valve Controller System, 6 Valves
W4 64-0132	VC-66BBT	Teflon® Valve Controller System, 6 Valves

Complete Perfusion Systems

W4 64-0174	VC-66MCS	Mini-Valve Controller System, 6 Valves
W4 64-0134	VC-64CS	Pinch Valve Controller System, 4 Valves
W4 64-0135	VC-66CS	Pinch Valve Controller System, 6 Valves
W4 64-0138	VC-66CST	Teflon® Valve Controller System, 6 Valves
W4 64-0174LT	VC-66MLTCS	Mini-Valve Controller System, 6 Valves for Large Tubes

Model VT-8 Valve Timer

perfusion control



- Add computer control to any Warner Instruments valve controller
- Low cost
- Easy to use
- Eight channel computer-controlled timer
- Plug and play connectivity via USB 2.0
- Two external trigger inputs
- Eight digital outputs
- Two analog outputs

The VT-8 Valve Timer is a microcontroller unit that communicates with Windows-based computers via the high speed USB 2.0 port. Designed with Warner's perfusion valve controllers in mind, the instrument also makes an excellent general purpose lab timer.

The VT-8 front panel has eight digital TTL outputs, two analog outputs, and two digital inputs. The two digital inputs can be used to trigger the VT-8. The VT-8 can drive TTL standard loads with 250ms time resolution, and can accept two TTL external trigger signals.

A user friendly, software-driven computer interface makes it easy to generate an automated protocol for valve opening and closing during any experiment.

The timer continuously communicates with the computer which facilitates instantaneous response to user-directed commands of the output TTL.

Programming is straightforward and is accomplished using a graphical interface and keyboard. A 'syringe configuration' feature ensures there is adequate solution volume to complete the experiment. An emergency cut-off feature is included and can be used to automatically close all valves simultaneously.

The VT-8 includes the control unit, USB cable (2 m), and software.

Specifications

Digital Data Output	+5V TTL output, 20mA source, 20mA sink, 100Ω impedance.
Digital Data Input	+5V TTL input, 47KΩ impedance.
Analog Data Output	+10V buffered output.
Communication	USB 1.1, USB 2.0, 12Mbps
Firmware Update	Via supplied software
Data Generation	Via 54008 dedicated communication software included
Power Requirement	+5V, 300mA, supplied from USB bus
Operating Temperature	10° to 40° C
Physical Dimensions:	
Case Size	6.0 x 10.0 x 13.5 cm (H x W x D)
Shipping Weight	1 kg
Warranty	One year, parts & labor

Order # Model Product

W4 64-1660	VT-8	Valve Timer
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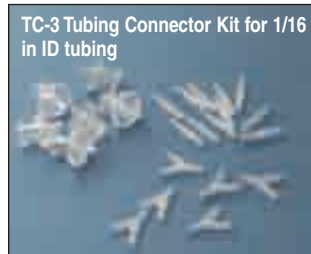
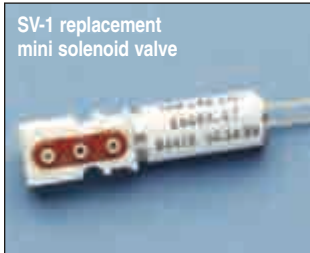
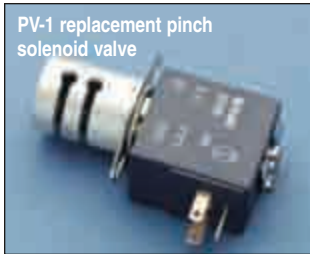
Accessories and Replacement Parts

W4 64-1661	VT-ST	Set of 8 BNC Cables, (2 ft)
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W4 64-0186	VC-8M	Valve Control System 8 Mini Valves
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W4 64-0185	VC-8P	Valve Control System 8 Pinch Valves
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Parts and Accessories



Order # Model Product

Replacement Valves for VC-6 Systems

W4 64-0139	PV-1	Pinch Valve
W4 64-0140	TV-2	Teflon® Valve
W4 64-0175	SV-1	Mini Solenoid Valve

Accessories for VC-6 Systems

W4 64-1428	LPE-10	Replacement Pipette Tips, pkg. of 10
W4 64-0162	RS-1	Support Stand
W4 64-0163	SH-6/60	Syringe Holder, six 60 cc syringes
W4 64-0144	SH-6/140	Syringe Holder, six 140 cc syringes
W4 64-0143	SH-8/10	Syringe Holder, eight 10 cc syringes
W4 64-0385	SH-8/60	Syringe Holder, eight 60 cc syringes
W4 64-0164	TC-3	Tubing Connectors (1/16 in ID), pkg. of 12 straight, 6 Y and 6 Luer Connectors
W4 64-0165	SL-6	Stopcock with Luer Connector, pkg. of 6
W4 64-1489	SN-18	Blunt End Needles 18 AWG, pkg. of 12
W4 64-1490	SN-23	Blunt End Needles 23 AWG, pkg. of 12

Tubing for VC-6 Systems

W4 64-0166	CFL-6	C-Flex (1/32 in x 6 ft, ID x L)
W4 64-0168	TT-25	Teflon® (1/16 in x 25 ft, ID x L)
W4 64-0167	TY-50	Tygon (1/16 in x 50 ft, ID x L)

Tubing for VC-6M Mini Systems

W4 64-0752	PE-50/10	PE-50 Polyethylene Tubing, 10 ft
W4 64-0753	PE-50/100	PE-50 Polyethylene Tubing, 100 ft

Additional PE Tubing

W4 64-0754	PE-90/10	PE-90 Polyethylene Tubing, 10 ft
W4 64-0755	PE-160/10	PE-160 Polyethylene Tubing, 10 ft
W4 64-0756	PE-160/100	PE-160 Polyethylene Tubing, 100 ft
W4 64-0142	DC-6	Drip chamber, 6 pack



SF-77B, SF-77BLT and SF-77BST

Perfusion Fast-Step

A fast stepper combined with a mini-valve perfusion system



- Solution delivery for patch clamp and other electrophysiology studies
- Solution changes in milliseconds
- Minimal flow turbulence
- No switching through intervening solutions
- Manual or automatic step control (digital or analog)
- Modest cost and easy maintenance

The SF-77B is a fast solution delivery device for use in patch clamp and electrophysiology studies. Control and test solutions flow continuously through adjacent delivery tubes and a stepper mechanism selects which tube is directed at the preparation. The rapid response and nominal hysteresis of the stepper allows for very short switching times. Complete solution changes are typically achieved within 20 msec for a large, 700 μm step and times are significantly shortened as the step size is decreased.

Multiple Solution Studies

In the standard configuration, up to six different solutions are connected to a single input manifold, which in turn is connected to one of three square glass stimulus tubes. The three tube design is superior to a two-tube design in that complex solution exchange protocols can be brought to bear on the sample under study. Since the complete system is designed to accommodate three manifolds (one for each tube), and since each manifold can accommodate up to 6 feed lines, it is possible to immediately select between 18 different input solutions.

Manual or External Control

The stepper mechanism can be manually controlled via the front panel or externally directed from your data acquisition program. Manually, the system can be stepped to 8 positions in 7 equally spaced steps. These same 8 positions can also be directly selected by applying an analog signal to the external analog input BNC or by passing a 3 byte word to the TTL input on the instrument rear panel.

Square Glass Ports

The square glass tubes used for solution delivery significantly reduces mixing turbulence, allowing the SF-77B to be used for studies with both membrane patches and whole cells, even when the cells are not fixed to a substrate.

System Versatility

The design of the SF-77B permits the use of various size glass tubing for perfusion delivery.

SF-77B: Standard System (0.7 mm ID tubes)

The standard system is shipped with 3SG700-5 single-walled 3-barrel glass tubing which eliminates the need to glue individual barrels together. Spacing between barrels is 0.7 mm and step speed between adjacent barrels is typically 20 msec. Single barrel SG800-5 tubes (up to 5) can be used with the same holder.

SF-77BLT: Large Tube System (1.0 mm ID tubes)

Larger ports are required when using the SF-77B with larger cell structures such as the *Xenopus* oocyte. Solutions are delivered through 1.0 mm ID square tubes (SG1000-5) with barrel-to-barrel spacing of 1.4 mm.

SF-77B/5M: Standard System with Five Manifolds

The SF-77B/5M is the same system as the SF-77B except that it is provided with five perfusion manifolds.

SF-77BST: Fast Stepping with Theta Tubing

Very fast perfusion stepping is possible using 2-barrel Theta tubing. The technique requires close attention to detail with careful placing of the pipes and the excised patch. The tubing is pulled on a standard puller for a tip diameter of approximately 300 μm and a barrel spacing of approximately 100 μm . When using 100 μm steps, it is important to minimize any vibration produced by the stepper motor. This is accomplished by reducing the motor voltage via the control located on the instrument rear panel. The voltage is lowered until the vibration artifact is minimized. Any residual artifact may be removed by subtracting averaged null traces.*

Easy Set-Up

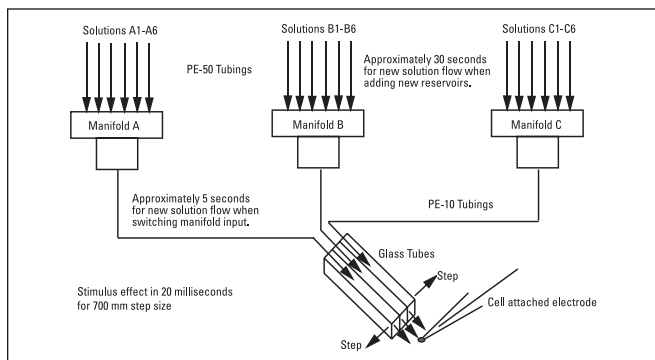
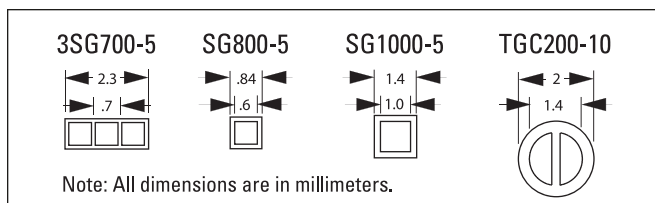
The stepper mechanism is compact, lightweight, and free of either mechanical or electrical noise. The mechanism connects to the control box with a 2 meter shielded cable and is provided with a mounting rod for attachment to a manipulator. Manifolds can support 2, 4 or 6 inputs depending on the experiment. Solutions flow from reservoirs to the manifold through PE-50 tubing and PE-10 tubing is used to connect the manifold outputs to the glass tubes.

- Solution changes between tubes occur within milliseconds.
- Changes between solutions connected to individual ports occur within 5 seconds.
- Entirely new solutions can be added into any port with a waiting time of no more than 30 seconds.
- The cell is never required to pass through an intervening solution to get from control to test solution.

* Reference: Jie Zheng and Fred Sigworth, Selecting Changes during Activation of Mutant *Shaker* Potassium Channels, *J. General Physiology*, vol. 10 August 1997, 101-117, Rockefeller Univ. Press

SF-77B, SF-77BLT and SF-77BST

Perfusion Fast-Step (continued)



Specifications

Number of Steps	1 to 7 selectable
Step Size	Adjustable from 100 μm to 1.5 mm steps in 100 μm increments
Step Speed	Typically 20 msec for 700 μm step
Step Control:	
Manual	8 positions with POSITION selector
Analog Signal	8 positions with voltage levels 0-7 V, 1V/step
Digital Signal	8 positions with 3 byte TTL signal
Max. Stepper Range	12.0 mm
Mounting Handle	6.3 mm X 10 cm (D x L)
Stepper Weight	110.5 g (including handle)
Solution Manifolds:	Three manifolds supplied with each system; MM series for SF-77B and SF-77BST and ML series with SF-77 BLT
MM Series	Manifolds use PE-50 tubing at input and PE-10 tubing at output
ML Series	Manifolds use PE-50 tubing at both input and output
Solution Flow Rates:	Rates measured with solution reservoir height of approx. 60 cm (24 in)
With MM Series	100 μl/min
With ML Series	1 ml/min
Control Box:	
Size (H x W x D)	6.3 x 14 x 23 cm
Power Requirements	100 – 130 or 220 – 250 VAC, 50/60 Hz, 10 VA
System Shipping Wt.	2.7 kg
Warranty	Two years, parts and labor

Order #	Model	Product
W4 64-0114	SF-77B	Standard System with MM Series Manifolds, 1 pkg. 3SG700-5 Glass, GH-1 Glass Holder, and 1 pkg. each PE-10 and PE-50 Tubing, 115 VAC
W4 64-1515	SF-77B	Standard System with MM Series Manifolds, 1 pkg. 3SG700-5 Glass, GH-1 Glass Holder, and 1 pkg. each PE-10 and PE-50 Tubing, 220/240 VAC
W4 64-0117	SF-77B/5M	Perfusion System with 5 manifolds, 115 VAC
W4 64-1518	SF-77B/5M	Perfusion System with 5 manifolds, 220/240 VAC
W4 64-0116	SF-77BLT	Large Tube System with ML Series Manifolds, 1 pkg. SG1000-5 Glass, GH-10 Glass Holder, and 2 pkg. of PE-50 Tubing, 115 VAC
W4 64-1517	SF-77BLT	Large Tube System with ML Series Manifolds, 1 pkg. SG1000-5 Glass, GH-10 Glass Holder, and 2 pkg. of PE-50 Tubing, 220/240 VAC
W4 64-0115	SF-77BST	Theta Glass System with MM Series Manifolds, 1 pkg. TGC-200-10 Glass, GH-2T Glass Holder, and 1 pkg. each PE-10 and PE-50 Tubing, 115 VAC
W4 64-1516	SF-77BST	Theta Glass System with MM Series Manifolds, 1 pkg. TGC-200-10 Glass, GH-2T Glass Holder, and 1 pkg. each PE-10 and PE-50 Tubing, 220/240 VAC

Accessories and replacement parts

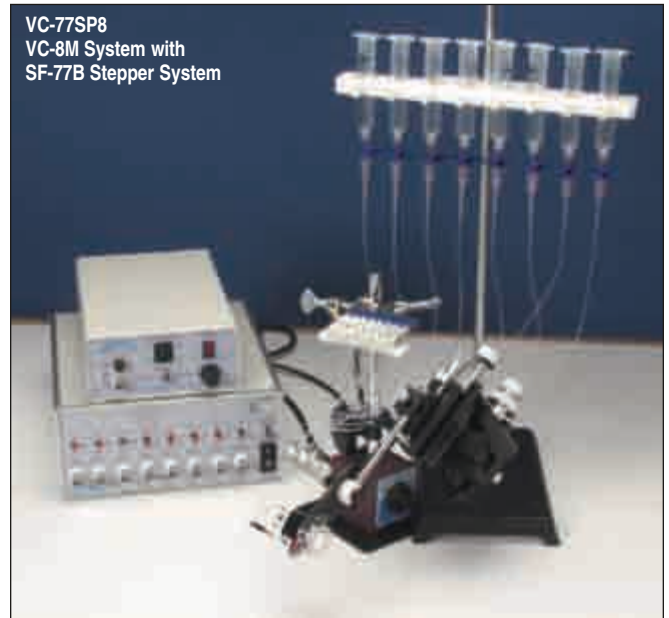
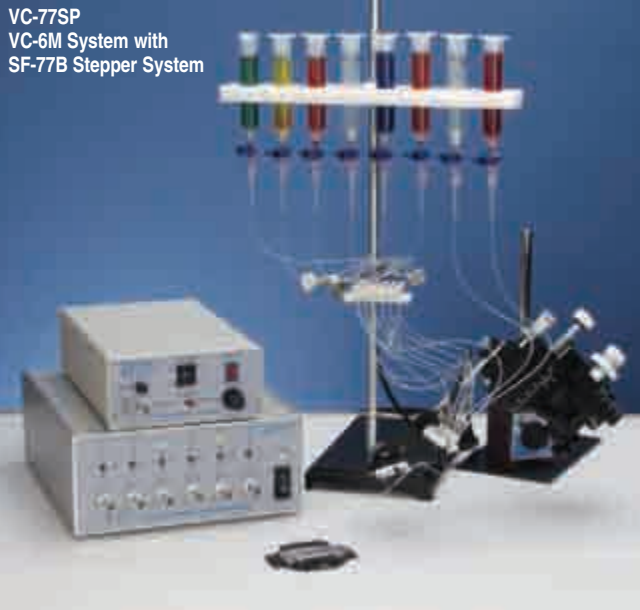
W4 64-0119	3SG700-5	3-Barrel Square Glass Tubes, 0.6 mm x 5 cm (ID x L), pkg. of 10
W4 64-0120	3SG700-10	3-Barrel Square Glass Tubes, 0.6 mm x 10 cm (ID x L), pkg. of 10
W4 64-0121	SG-800-5	Single Barrel Square Glass Tubes, 0.6 mm x 5 cm (ID x L), pkg. of 25
W4 64-0122	SG-1000-5	Single Barrel Square Glass Tubes, 1 mm x 5 cm (ID x L), pkg. of 25
W4 64-0124	GH-1	Glass Holder for 3SG700-5, 3SG700-10 and SG800-5 Glass
W4 64-0125	GH-2T	Glass Holder for Theta Glass
W4 64-0126	GH-10	Glass Holder for SG1000-5 Glass
W4 64-0750	PE-10/10	Polyethylene Tubing 10 ft.
W4 64-0752	PE-50/10	Polyethylene Tubing 10 ft.
W4 64-0811	TG200-4	Theta Glass Tubes, 2.0 mm x 10 cm (OD x L), pkg. of 100

fast-step systems

VC-77SP and VC-77SP8

Perfusion Fast-Step

A fast stepper combined with a mini-valve perfusion system



- Allows computer control of multiple perfusion lines
- Six and eight channel systems available
- Solution changes in milliseconds

The VC-77SP perfusion system combines the VC-6M Perfusion Valve Control System and the SF-77B Fast Step Perfusion System into a single package. It allows computer control of multiple perfusion setups, saving time and effort.

The VC-77SP system includes:

W4 64-0174	VC-66MCS	Complete Mini-Valve System, 6-Channels
W4 64-0114	SF-77B	Perfusion Fast-Step System
W4 64-0056	MM-33R	Micromanipulator, Right Handed
W4 69-0225	MB-B	Magnetic Base

The VC-77SP8 perfusion system combines the VC-8M Perfusion Valve Control Systems and the SF-77B Fast Step Perfusion System.

The VC-77SP8 system includes:

W4 64-0186	VC-8M	Complete Mini-Valve System, 8-Channels
W4 64-0114	SF-77B	Perfusion Fast-Step System
W4 64-0056	MM-33R	Micromanipulator, Right Handed
W4 69-0225	MB-B	Magnetic Base

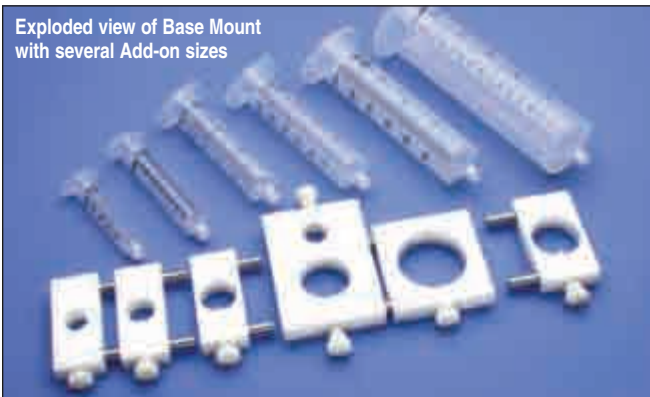
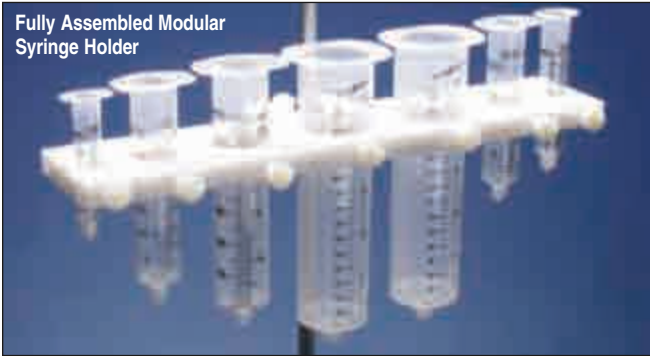
For complete details of the VC-6 and VC-8 Complete Mini-Valve Perfusion Systems, see pages 90 to 91. For complete details on other Perfusion Fast-Step System, see pages 94 and 95.

Order #	Model	Product
W4 64-0177	VC-77SP	Complete VC-6 Fast-Step Perfusion System with right-handed micromanipulator, 115 VAC
W4 64-1519	VC-77SP	Complete VC-6 Fast-Step Perfusion System with right-handed micromanipulator, 220/240 VAC
W4 64-0177L	VC-77SPL	Complete VC-6 Fast-Step Perfusion System with left-handed micromanipulator, 115 VAC
W4 64-0177LE	VC-77SPLE	Complete VC-6 Fast-Step Perfusion System with left-handed micromanipulator, 220 VAC
W4 64-1590	VC-77SP8	Complete VC-8 Fast-Step Perfusion System with right-handed micromanipulation, 115 VAC
W4 64-1590E	VC-77SP8E	Complete VC-8 Fast-Step Perfusion System with right-handed micromanipulation, 220 VAC
W4 64-1590L	VC-77SP8L	Complete VC-8 Fast Step Perfusion System with left-handed micromanipulator, 115 VAC
W4 64-1590EL	VC-77SP8EL	Complete VC-8 Fast Step Perfusion System with left-handed micromanipulator, 220/240 VAC

MSH and SH Series

Modular and Fixed Syringe Holders Series

A modular system designed to accept 5, 10, 20, 30, 60, and 1400 cc syringes



Syringe Holder Size Chart

Syringe Holder	Maximum O.D. of syringe accepted	
	Inches	mm
5 cc	0.57	14.4
10 cc	0.655	16.6
20 cc	0.85	21.5
30 cc	0.95	24.1
60 cc	1.117	29.7
140 cc	1.63	41.4

Order # Model Product

Base Mounts

W4 64-0145	MSH/5M	Syringe Base Mount, 5 cc
W4 64-0146	MSH/10M	Syringe Base Mount, 10 cc
W4 64-0147	MSH/20M	Syringe Base Mount, 20 cc
W4 64-0148	MSH/30M	Syringe Base Mount, 30 cc
W4 64-0149	MSH/60M	Syringe Base Mount, 60 cc
W4 64-0150	MSH/140M	Syringe Base Mount, 140 cc

Add-on Units

W4 64-0151	MSH/5	Syringe Add-On, 5 cc
W4 64-0152	MSH/10	Syringe Add-On, 10 cc
W4 64-0153	MSH/20	Syringe Add-On, 20 cc
W4 64-0154	MSH/30	Syringe Add-On, 30 cc
W4 64-0155	MSH/60	Syringe Add-On, 60 cc
W4 64-0156	MSH/140	Syringe Add-On, 140 cc

Fixed Syringe Holders

W4 64-0143	SH-8/10	Syringe Holder, 8 x 10 cc Syringes
W4 64-0163	SH-6/60	Syringe Holder, 6 x 60 cc Syringes
W4 64-0385	SH-8/60	Syringe Holder, 8 x 60 cc Syringes
W4 64-0144	SH-6/140	Syringe Holder, 6 x 140 cc Syringes

Accessories and Replacement Parts

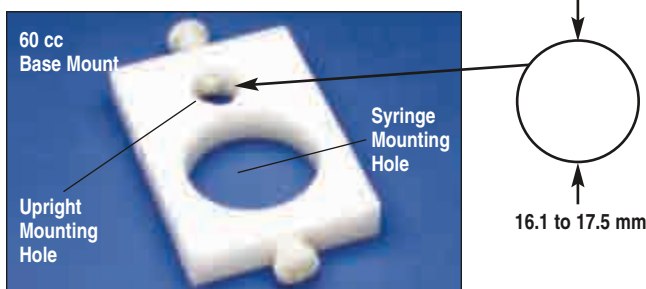
W4 64-0165	SL-6	Stopcock with Luer Connector, pkg. of 6
W4 64-0162	RS-1	Support Stand

MSH Series Holder System

The Modular Syringe Holder System offers users the ability to assemble a family of differently sized syringes into a single apparatus. Warner Instruments offers a full range of add-on holders to fit every application. Made from high quality Delrin and 316 stainless steel, this system assures excellent protection from most harmful chemicals.

The modular syringe holder system consists of a single syringe base mount that is coupled with add-on syringe holders. The base mount has a primary hole that holds the first syringe. A secondary hole permits the unit to mount onto an upright rod or support stand ranging in size from 3/8 to 5/8 inch. Both holes have thumbscrews that tighten so that the rod or syringe is securely held.

Additional add-on syringe holders can then mount on either side of the base mount by simply snapping the add-on onto the side of the base mount. Multiple add-on holders can be used and sizes may be intermixed.



DN Series

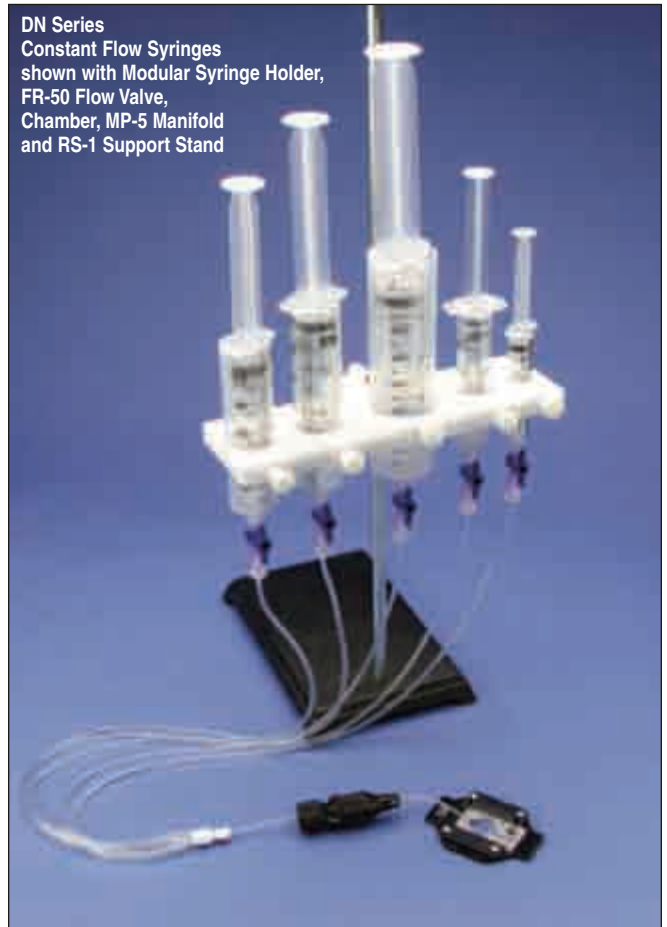
Constant Flow Syringes

Eliminates changes in flow rate as the reservoir empties

DN Series
Constant
Flow Syringes



DN Series
Constant Flow Syringes
shown with Modular Syringe Holder,
FR-50 Flow Valve,
Chamber, MP-5 Manifold
and RS-1 Support Stand



When using a gravity-feed perfusion system, a common difficulty facing researchers is maintaining a constant flow as the reservoir empties. In general, since head pressure is a linear function of column height, the change in height of a 60 cc syringe as the solution reservoir drains can result in as much as a 20% decrease in flow rate.

Warner Instruments provides a simple and unique solution to this common problem. The DN Series Constant Flow Syringes eliminates changes in flow rate, normally to less than 1%. These reservoirs are designed to maintain a constant pressure on the syringe contents without resorting to complex or bulky apparatus (such as a pressure system or regulator).

When used in conjunction with Warner Instruments' FR-55S Solution Flow Valve, precise, sub-maximal flow control is easily achieved. Syringe reservoirs may be refilled without interrupting solution flow. They are available in 5 to 60 cc volumes and can be used with Warner's MSH Series Modular Syringe Holder System, see page 97.

If you want to use the DN Series Constant Flow Syringe with the MSH Modular Syringe Holder Series, you must order the next size up in the series. See the reference chart below for proper ordering information.

DN Series Constant Flow Syringes

syringe size	mount/holder size	base mount	add-on holder
5 cc	10 cc	W4 64-0146	W4 64-0152
10 cc	20 cc	W4 64-0147	W4 64-0153
20 cc	60 cc	W4 64-0149	W4 64-0155
30 cc	60 cc	W4 64-0149	W4 64-0155
60 cc	140 cc	W4 64-0150	W4 64-0156

Order #	Model	Product
W4 64-0157	DN/5	Constant Flow Syringe, 5 cc, pkg. of 6
W4 64-0158	DN/10	Constant Flow Syringe, 10 cc, pkg. of 6
W4 64-0159	DN/20M	Constant Flow Syringe, 20 cc, pkg. of 6
W4 64-0160	DN/30M	Constant Flow Syringe, 30 cc, pkg. of 6
W4 64-0161	DN/60M	Constant Flow Syringe, 60 cc, pkg. of 6

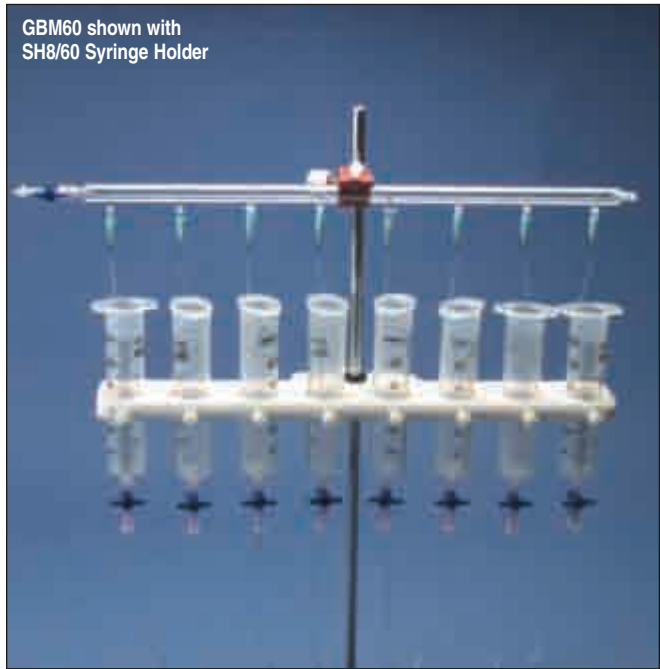
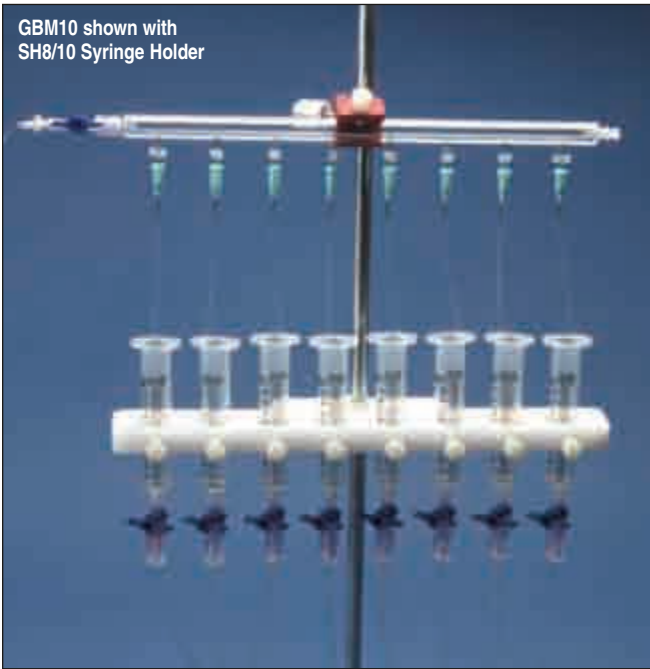
Accessories and Replacement Parts

W4 64-0220	FR-50	Flow Valve
W4 64-0221	FR-55S	Flow Valve with On-Off Switch
W4 64-0165	SL-6	Stopcock w/Luer Connector, pkg. of 6
W4 64-0162	RS-1	Support Stand
W4 64-0209	MP-5	5 to 1 Perfusion Manifold
W4 64-0755	PE-160/10	PE-160 Polyethylene Tubing, 10 ft
W4 64-0756	PE-160/100	PE-160 Polyethylene Tubing, 100 ft

GBM10 and GBM60

Gas Bubbler Manifold

Maintain gas tension in solution



These gas bubbler manifolds for 10 and 60 cc syringes are useful for delivering water soluble gases to syringe reservoirs mounted in Warner syringe holders. Luer fittings on all the inlet and outlet ports make these manifolds very easy to assemble. Constructed from clear polycarbonate for durability and easy cleaning.

Supplied with support stand clamp, Tygon tubing (1/16 x 1/8", ID x OD, 50 ft), PE-50 tubing (10 ft), 1 stopcock on the gas inlet port, and 9 luer plugs to block off any unused outlet ports.

Specifications

Physical Dimensions

Body	(10 cc) 13 mm diameter x 267 mm long
Port Spacing	(10 cc) 33 mm center to center
Body	(60 cc) 13 mm diameter x 419 mm long
Port Spacing	(60 cc) 54 mm center to center

Order #	Model	Product
W4 64-1587	GBM10	Gas Bubbler Manifold for 10 cc syringes
W4 64-1588	GBM60	Gas Bubbler Manifold for 60 cc syringes
W4 64-0752	PE-50/10	PE-50 Polyethylene Tubing, 10 ft
W4 64-0753	PE-50/100	PE-50 Polyethylene Tubing, 100 ft

Tubing and Connector Kit, Syringe Needles

accessories

Parts and accessories

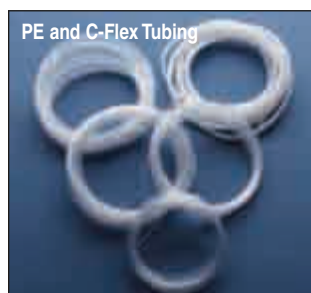


Warner Instruments offers a complete tubing and connector kit. This kit is ideal for use with Warner's Imaging and Recording Chambers. The kit is comprised of barbed and Luer fittings, blunt end needles, and an assortment of PE and C-Flex tubing. All barbed and Luer fittings are made from polypropylene and include tube to tube, reducing, Y-, T-, Luer-to-Luer, and Luer-to-barb adapters.

Comes in a convenient plastic storage box.

Order #	Model	Product
W4 64-1565	KIT-1	Fitting and Tubing Kit

Components listed at right are included in the tubing and connector kit. Components also sold separately.



Order #	Product
W4 64-1566	Tube Fitting Barb 1/8" to 1/8", pkg. of 10
W4 64-1567	Tube Fitting Barb 1/8" to 1/8", pkg. of 10
W4 64-1568	Tube Fitting Barb 1/8" to 1/8" in, pkg. of 10
W4 64-1569	Tube Fitting Tee Barb 1/8", pkg. of 10
W4 64-1570	Tube Fitting Tee Barb 1/8", pkg. of 10
W4 64-1571	Tube Fitting Y Barb 1/8", pkg. of 10
W4 64-1572	Tube Fitting Y Barb 1/8", pkg. of 10
W4 64-1573	Tube Fitting Barb 1/8" to Luer Male, pkg. of 10
W4 64-1574	Tube Fitting Barb 1/8" to Luer Male, pkg. of 10
W4 64-1575	Tube Fitting Barb 1/8" to Luer Female, pkg. of 10
W4 64-1576	Tube Fitting Barb 1/8" to Luer Female, pkg. of 10
W4 64-1577	Tube Fitting Luer Male to Luer Female, pkg. of 10
W4 64-1578	Tube Fitting Luer Tee Female, pkg. of 10
W4 64-1579	Tube Fitting Luer Male to Luer Male, pkg. of 10
W4 64-1580	Tube Fitting Luer Female to Luer Female, pkg. of 10
W4 64-1581	Tube Fitting Luer Female Plug, pkg. of 10
W4 64-1582	Tube Fitting Luer Male Plug, pkg. of 10
W4 64-0141	LPE-50, Luer to PE-50 tubing adapter, pkg. of 8
W4 64-0166	CFL-6, C-Flex tubing (1/32" ID x 6 ft) 3/32 OD mm, 6 ft

Blunt Needle Plastic Hub

W4 64-1489	SN-18, 18G, 0.5", pkg. of 12
W4 64-1490	SN-23, 23G, 0.5", pkg. of 12
W4 64-1583	SN-30, 30G, 0.5", pkg. of 12

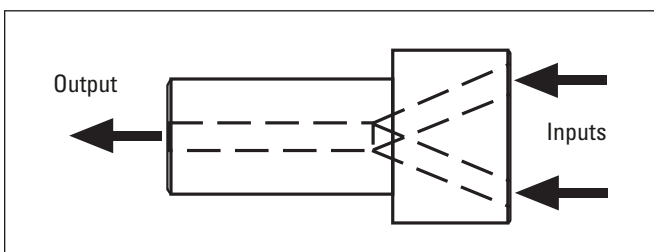
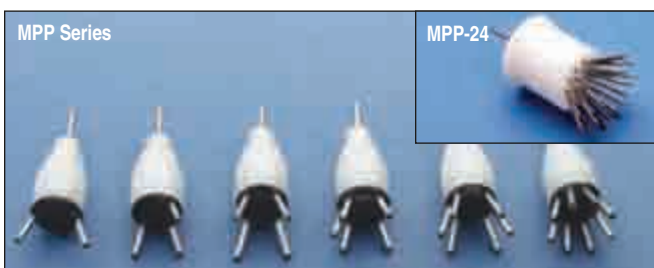
Polyethylene Tubing

W4 64-0750	PE-10/10, 0.28 ID x 0.61 OD mm, 10 ft
W4 64-0752	PE-50/10, 0.58 ID x 0.97 OD mm, 10 ft
W4 64-0754	PE-90/10, 0.86 ID x 1.27 OD mm, 10 ft
W4 64-0755	PE-160/10, 1.14 ID x 1.57 OD mm, 10 ft

ML, MM, MP and MPP Series

Manifolds and Flow Control Hardware

Multi-in or multi-out manifolds for fluid management



	ML Series	MM Series	MP Series	MPP Series
Material	Delrin™	Delrin™	Teflon®	Delrin™
Large Diameter	8.0 mm	8.0 mm	9.4 mm	9.4 mm
Small Diameter	4.7 mm	4.7 mm	6.3 mm	4.7 mm
Body Length	18 mm	18 mm	22 mm	21 mm
Input Tubing	PE-50	PE-50	PE-160	PE-160
Output Tubing	PE-50	PE-10	PE-160	PE-160

Warner perfusion manifolds can be used in any application where from 2 to 8 perfusion lines are required to be connected to a chamber or other device. Manifold inputs converge to the common output with minimum dead space. Designed for use with polyethylene (PE) tubing, manifolds can be used with any other tubing of similar dimensions. When connected to a chamber via a short length of tubing, very rapid solution changes are possible.

ML and MM Series

Designed to be part of the SF-77 Perfusion Fast-Step systems, these miniature manifolds are useful for applications involving small volumes or slow flow rates. Small diameter tubing is used with these models; PE-50 tubing for the input ports, and PE-10 or PE-50 tubing for the MM or ML series output ports, respectively.

MP Series

MP series manifolds are recommended for gravity fed perfusion systems. Input and output tubing are inserted with a friction fit. Manifolds should be ordered with inputs to match the number of solutions to be connected. Pin plugs to block unused inputs are also supplied. MP series manifolds are used with PE-160 tubing.

MPP Series

These manifolds are suitable for systems in which solutions are pumped or at pressures greater than those generated in gravity fed systems. Input and output ports are 18 gauge stainless steel hypodermic tubing. PE-160 tubing slides over these ports to make a snug fit.

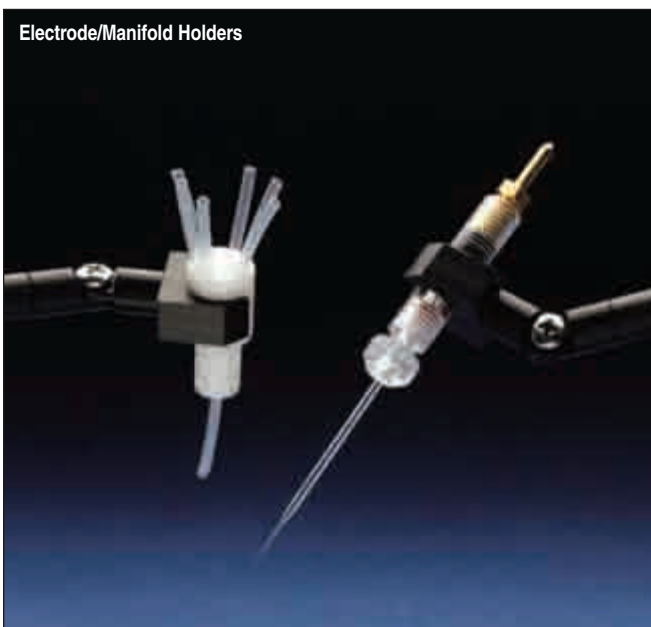
Order #	Model	Product
W4 64-0200	ML-2	Miniature Manifold, 2 ports
W4 64-0201	ML-4	Miniature Manifold, 4 ports
W4 64-0202	ML-6	Miniature Manifold, 6 ports
W4 64-0199	ML-8	Miniature Manifold, 8 ports
W4 64-0203	MM-2	Miniature Manifold, 2 ports
W4 64-0204	MM-4	Miniature Manifold, 4 ports
W4 64-0205	MM-6	Miniature Manifold, 6 ports
W4 64-0206	MP-2	MP Manifold, 2 ports
W4 64-0207	MP-3	MP Manifold, 3 ports
W4 64-0208	MP-4	MP Manifold, 4 ports
W4 64-0209	MP-5	MP Manifold, 5 ports
W4 64-0210	MP-6	MP Manifold, 6 ports
W4 64-0211	MP-8	MP Manifold, 8 ports
W4 64-0212	MPP-2	MPP Manifold, 2 ports
W4 64-0213	MPP-3	MPP Manifold, 3 ports
W4 64-0214	MPP-4	MPP Manifold, 4 ports
W4 64-0215	MPP-5	MPP Manifold, 5 ports
W4 64-0216	MPP-6	MPP Manifold, 6 ports
W4 64-0217	MPP-8	MPP Manifold, 8 ports
W4 64-0339	MPP-24	MPP Manifold, 24 ports

MHH-25/MHH-38 and FR-50/FR-55S

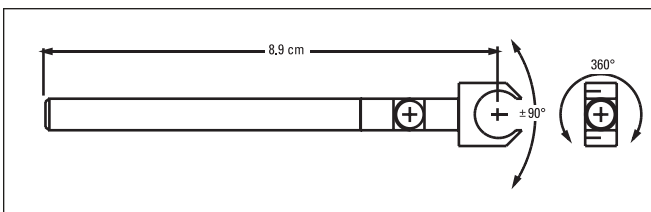
Manifolds and Flow Valves

Tools for fluid management

Electrode/Manifold Holders



Vacuum/Solution Flow Valve



Electrode/Manifold Holders

The MHH-25 and MHH-38 Holders permit convenient mounting of manifolds and electrode holders or other devices with 6.3 or 9.5 mm diameters. The holder head can be pivoted $\pm 90^\circ$ from the axial position and rotated 360° about the axis. Friction holds the head firmly in the set position. Holder head and coupler are made from Delrin®. The anodized aluminum handle is 6.3 mm diameter x 6.3 cm long and will fit most positioners. The MHH-25 electrode/manifold holder is compatible with E and Q Series Electrode Holders, and the MHH-38 with PE Series and Theta Electrode Holders, as well as the MP and MPP Series Manifold.

Order #	Model	Product
W4 64-0218	MHH-25	Holder for 6.3 mm (1/4 in) Devices
W4 64-0219	MHH-38	Holder for 9.5 mm (3/8 in) Devices

Vacuum/Solution Flow Valves

FR-50 and FR-55S flow valves are used for fine control of solutions in a gravity fed perfusion system or for vacuum used to evacuate a chamber. When used for chamber evacuation, the FR-50 provides the fine control critical to a properly operating system. Solution flow rate is adjustable from zero to a maximum of 10 ml/min., (measured with a solution head of 30 cm). Model FR-55S includes a convenient on-off switch for interrupting the flow without disturbing the flow rate setting.

Specifications

Materials	Teflon® and Delrin® plastics
Input/Output	Stainless steel tubing compatible with PE-160 tubing

Order #	Model	Product
W4 64-0220	FR-50	Flow Valve
W4 64-0221	FR-55S	Flow Valve with On-Off Switch

Harvard CO₂ Gas/pH Controller

gas controllers

Precise solution pH control using CO₂ gas



- CO₂ flow regulation from 0 to 2 liters per minute
- Microminiature combination pH glass electrode included with system
- Easy setup
- Analog recorder output
- 12 V DC powered

This compact, stand-alone controller is designed to precisely regulate the pH of biological solutions. It can be used in a number of experiments requiring regulated pH, such as isolated organs (heart, lung, kidney, etc.) or isolated tissues.

Maintaining pH is accomplished by either “bubbling” CO₂ through the solution or flowing gas over the surface of the medium. CO₂ is supplied via an external source, such as a bottle.

To maintain pH, the “set-point” of the controller is adjusted to the desired level. When the pH exceeds the programmed set point, the flow of acidifying CO₂ is started. Adjusting the controller’s flow rate regulator determines the rate of pH drop; the higher the flow rate the faster the drop in pH. The controller’s flow regulator allows the user to adjust the CO₂ flow between 0 to 2.0 liters per minute. Once the pH reaches the set point, gas flow automatically stops.

A three-position (manual override) switch on the front panel provides several ways to control CO₂ gas delivery.

By-Pass Mode: the flow of CO₂ is continuous and the flow rate is controlled by adjustment of the regulator.

Momentary Mode: CO₂ flows as long as the switch is depressed. The switch is spring loaded and the regulator will return to the Auto Mode when released.

Auto Mode: the controller uses the set-point to regulate the flow of CO₂ automatically.

When used with the Harvard Apparatus series of heating/cooling micro-incubators, this controller provides a complete pH/temperature controlled environment ideal for long term cell or tissue studies. The pH controller has a 4-digit LCD display capable of displaying the full pH range from 0 to 14 pH. The supplied microminiature combination pH electrode is ideal for applications involving placement of the pH electrode in a small area. The system is also compatible with any standard combination pH electrode.

A BNC connector on the rear of the unit provides an output (0 to 5 V) signal proportional to the pH. This connection can be used to continuously log the pH values to a chart recorder, data acquisition system, or other recording device. The unit is powered by 12 VDC universal power supply for benchtop use. The pH controller is shipped with a controller, power supply, AC/DC adaptor, combination pH electrode and quick disconnect fittings matching front panel connectors for input and output hoses.

Specifications

Range	0 to 14 pH
Resolution	0.01 pH
Accuracy	±0.02 pH
Input Resistance	10 ⁹ Ω
Calibration:	
Offset	±2 pH units through offset trimmer
Slope	80 to 110% through slope trimmer
CO ₂ Flowmeter	2 L per min
Gas Input/Output	Quick disconnect fittings
pH Analog Output	BNC connector 4-20 mA, isolated
Electrode Response Time	~0 sec
Electrode Slope	55 mV/pH in pH range of 1 to 14
Electrode Impedance	200 MΩ
Electrode Stability	0.05 pH/day
Electrode Dimensions	1.5 x 0.03 in (38.1 x 0.75 mm), L x D
System Power 50/60 Hz adapter)	12 VDC (Universal 90/240 VAC,
Dimensions (H x W x D)	12.2 x 15.2 x 12.7 cm (4.8 x 6 x 5 in)
Weight	0.8 kg (1.75 lb)

Order #	Model	Product
W4 70-2116		Harvard CO ₂ Gas/pH Controller

Accessories and Replacement Parts

W4 69-0494		Replacement pH Electrode
W4 65-0105		Input/Output Connector Fitting, pkg. of 5
W4 72-1015	R-3603	Tygon Tubing, 1/8 x 1/16 in (OD x ID x 50 ft)

Perfusion/
Microfluidics

gas controllers

gas controllers

Oxystreamer®

Dual Stream O₂ and CO₂ Controller

Simultaneous control of both gas and liquid phases, useful for live cell microscopy



- Provides two identical streams of any mix of O₂ and CO₂ gas
- Full range, real-time control of both gases
- Easily switch from one gas concentration to another
- Eliminates the inflexibility and high cost of premixed gas, and inaccuracies due to gas stratification in premixed gas tanks
- Vertical footprint saves bench space

The Oxystreamer® has two output streams that can be used to simultaneously condition (1) the atmosphere in a microscope stage mount cell culture incubator/chamber and (2) the dissolved oxygen and carbon dioxide levels in a media or perfusate. The following is a list of the major benefits derived from replacing pre-mixed gas cylinders:

- Precise, variable, selection of oxygen and carbon dioxide gas concentrations (ratios)
- Substantial cost savings by using standard, low cost cylinders of oxygen, carbon dioxide and nitrogen gas
- Eliminates the stratification induced concentration errors that are inherent in premixed gas cylinders
- By independently monitoring and controlling oxygen and carbon dioxide concentrations of the streams, the OxyStream® can monitor and proportionally mix (blend) oxygen, carbon dioxide and nitrogen gases into any concentration combination in real time

The OxyStream® is easy to use. After calibrating the oxygen and carbon dioxide sensors, the desired concentrations are simply entered into their respective controllers using the digital display and up/down control

buttons. The closed-loop dynamic gas control system then automatically monitors and adjusts the output gas stream to the pre-programmed ratios in the controllers. This technique maintains the output (mixed) gas concentration to within 0.2% of the selected set-point levels.

The flow rate for each stream is independently controlled for efficiency and provides a method for setting a reproducible rate at which the gas is delivered to the cell culture chamber and/or diffused into the cell culture media or perfusate. Inlet ports on the back of the unit are 1/4 inch hose barb fittings and will take standard 1/4 inch ID tubing. Output ports are quick-disconnect fittings using 1/16 inch or 1/8 inch ID tubing.

Options include a Windows® based software package that provides trend plotting, data logging, and remote operation via RS-232 connection to your PC. Multiple Oxystreamer® models can be daisy-chained via an optional RS-485 interface.

Specifications

O ₂ /CO ₂ /N ₂ Inlet Gas Supply Connectors	1/4 in hose barb
Outlet Gas Stream Connectors	Plastic quick disconnects for 1/16 in and 1/8 in ID tubing
Independent Channel Flow Control	0 to 100 ml/min, 0 to 50 ml/min
O ₂ Range	0.1% to 99.9%
CO ₂ Range	0.1% to 20.0%
Accuracy	±5% of reading; 2% full scale
O ₂ Sensor	Fuel Cell
CO ₂ Sensor	Infrared
Serial Comm.	RS-232/RS-485
O ₂ Analog Output	0 to 100 mV DC linear
CO ₂ Analog Output	0 to 1 V DC linear
Dimensions (H x W x D)	36.1 x 23.6 x 33.0 cm (14.2 x 9.3 x 13.0 in)
Power	12 V DC Universal Wall Adapter
Weight	4.54 kg (10 lbs)

Order #	Model	Product
W4 64-0383	SL ₂ CO	Oxystreamer – 0 to 10 ml/min max

OS-250 spill sensor systems

Overflow Sensor System

Because microscopes and liquids don't mix

Control Unit



JC-1
Jumper cable used to
connect two overflow
sensor mats



As little as 3 drops of liquid will cause the OS-250 to respond

Specifications

Power Requirements	92-240 VAC, 50/60 Hz, 0.5 VA
Operating Humidity	10% to 75%
Switched Outlet Current	8 A
Enclosure Dimensions	4.6 x 8.2 x 18 cm (H x W x D)
Shipping Weight	1.4 kg
Warranty	one year

Order #	Model	Product
W4 64-1520	OS-250	Overflow Sensor System

Accessories and Replacement Parts

W4 64-1522	MAT-1	Overflow Sensor Replacement Mats, set of 4
W4 64-1523	MAT-2	Overflow Sensor Mats and Cable (4 Mats)
W4 64-1589	JC-1	Jumper Cable Used to Connect Two Overflow Sensor Mats

- Prevent costly downtime
- Easy to install
- Compatible with upright and inverted microscopes
- Visible and audible alarms
- Switched power output on alarm

Warner Instruments is pleased to provide a product designed to detect solution leaks on your microscope before they cause a problem. As little as 3 drops of liquid will cause the OS-250 to react.

The system consists of a fluid sensing mat, a material specifically developed for detecting liquid spills, which simply connects to the OS-250. Once assembled, an alarm condition sounds an audible alert, flashes an LED, and turns the power off to any device plugged into the internal single outlet, solid-state power controller. The switched power outlet can control up to 8 amps and will easily handle syringe pumps or valve controllers.

The OS-250 is supplied with four reusable 30 x 30 cm mats that can be cut to any size with sharp scissors or knife. Additionally, the OS-250 is supplied with a mat connecting cable (1.5 m) and an IEC 60320 detachable power connector system.

Battery Powered Spill Sensor System

Because microscopes and liquids don't mix

Control Unit



Spill Sensor Mats with Connecting Cable



Perfusion/
Microfluidics

spill sensor systems

- Protect your microscope
- Audible alarm
- TTL cutoff circuitry
- Compatible with upright and inverted microscopes
- Easy set up and installation
- Complete system

Warner Instruments is pleased to provide a system to detect solution leaks before they cause a problem. This system is ideal for all environments where leak detection is critical such as on a microscope or in a chemical cabinet.

The heart of the system is comprised of a special moisture sensitive mat that has been specifically developed for detecting the presence of fluids. As little 3 drops of liquid are sufficient to trigger the system.

A simple connection between the moisture sensitive mats and the spill sensor controller arms the system. When as little as three drops of liquid come in contact with the moisture sensitive mat an audible alarm is sounded. In addition, an alarm condition switches the state of a regulated TTL output on the Spill Sensor allowing you to dynamically control attached devices.

The Spill Sensor System is supplied with four 30 x 30 cm mats that can be cut to any size or shape using sharp scissors or a straight edge.

Specifications

Power Requirements	9 V (internal battery)
Operating Humidity	10 to 75%
TTL Output	User settable; alarm = TTL high or TTL low
Enclosure	6.6 x 12.1 x 2.1 cm (W x H x D)

Order #	Model	Product
W4 64-1546		Spill Sensor System, Battery Powered

Accessories and Replacement Parts

W4 64-1522	MAT-1	Overflow Sensor Replacement Mats, set of 4
W4 64-1523	MAT-2	Overflow Sensor Mats and Cable (4 Mats)
W4 64-1589	JC-1	Jumper Cable Used to Connect Two Overflow Sensor Mats

temperature control

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TC-324B and TC-344B

Chamber System Temperature Controllers – Single and Dual Channel

Quiet operation optimized for patch clamp electrophysiology!



TC-324B – Single Channel

- Ramped DC power for quiet operation
- Single control temperature adjustment
- Manual DC setpoint
- Ambient to 50°C operation
- High temperature models available

The TC-324B and TC-344B heater controllers have been designed to provide quiet power to a variety of perfusion heating devices including Warner Series 20 heater platforms, solution in-line heaters, and culture dish heaters.

Each channel can supply up to 18 watts into an 8 Ω load. Maintenance of temperature setpoint is controlled automatically via thermistor feedback. A loop-speed selector allows for selection of three feedback speeds to optimize the stability of the thermal response of the device being heated. Temperature setpoint may also be manually set in MANUAL mode.

Ease of Use

In AUTO mode, the desired temperature is set with a single SET TEMPERATURE control. The connected platform, solution heater, or other device is automatically driven to the set temperature. Accuracy is typically better than $\pm 1^\circ\text{C}$, and under ideal conditions will approach $\pm 0.1^\circ\text{C}$.

In MANUAL mode, the controller provides DC output to the heater blocks, adjustable from zero to +12 volts.

Set temperatures range from ambient to 50°C, or from ambient to 65°C for high temperature models.

Quiet Operation in Recording Setups

Highly filtered DC supplies and slow-ramped analog switching circuitry deliver power without adding noise to the system. As such, the TC-324B and TC-344B have been optimized for electrophysiology applications.



TC-344B – Dual Channel temperature controller shown with in-line solution heater and heated platform with connecting cable.

Thermistor Readouts

Each channel reads two thermistors simultaneously: T1 for feedback control of the system, and T2 for any point of interest. Temperatures are displayed on the meter and are also available at front panel outputs for recording devices. Unical thermistors are used throughout and can be replaced without the need for recalibration.

Temperature controllers require the use of an adapter cable (CC-28) to connect to Series 20, Series 30 and QE Series platforms. In-line solution heaters do not require an additional connecting cable.

TC-324B and TC-344B

Chamber System Temperature Controllers – Single and Dual Channel (continued)



Specifications (per channel)

Max. Output Voltage	12 V DC
Max. Output Current	1.5 Amps
Max. Output Power	18 W (8 Ω load)
Manual Voltage Range	0 to 12 V
Temperature Range	Ambient to 50°C or ambient to 65°C
Recorder Outputs	T1 (Control Thermistor) 100 mV/°C T2 (Monitor Thermistor) 100 mV/°C
Inputs	Rear Panel BNC for T2 (TA-29 Thermistor Cable assembly)
Meter	3 1/2 digit LED display of: Set Temperature, 50°C maximum T1 (Control Thermistor) temperature T2 (Monitor Thermistor) temperature Heater Voltage, 12 V maximum
Power Requirements	100-130/220-240 VAC, 50/60 Hz, 70 VA
Enclosure Dimensions (H x W x D):	
TC-324B	8.9 x 20 x 25.4 cm; Shipping weight 3.6 kg
TC-344B	8.9 x 43 x 25.4 cm; Rack Mount hardware included; Shipping weight 6.8 kg
Warranty	Two years, parts & labor

Order # Model Product

W4 64-0100	TC-324B	Heater Controller, Single Channel
W4 64-0101	TC-344B	Heater Controller, Dual Channel
W4 64-1453	TC-324BHT	Perfusion Heater Controller Single Channel with High Temp Modification, 65°C
W4 64-1454	TC-344BHT	Perfusion Heater Controller Dual Channel with High Temp Modification, 65°C

Accessories and Replacement Parts

W4 64-0106	CC-28	Cable Assembly for Series 20 Heater Platforms
W4 64-0109	CC-35	Cable Assembly with Unterminated Outboard End

CL-100

Bipolar Temperature Controller

Optimized for the SC-20 In-line Solution Heater/Cooler



ACC-1 – Adapter cable for 8 pin Din heaters

- Quiet operation
- Built-in protection for Peltier devices
- Single control temperature adjustment
- Freeze alert
- External inputs for computer control

The CL-100 Temperature Controller is an automatic single channel controller capable of accurately maintaining a Peltier device between 0° and 50°C. The CL-100 will also maintain a resistive heater from ambient to +65°C.

While the instrument has several uses, it is specifically designed to control the Warner SC-20 Dual In-line Solution Heater/Cooler. When coupled with the SC-20, the CL-100 provides efficient control of perfusion solution temperatures.

The unit is simple to use with a single control for temperature adjustment and a loop speed switch to optimize the response of the system. Power for the instrument is provided by an ultra low noise power supply making it suitable for use in sensitive electrophysiology applications.

Built-in circuitry limits the maximum temperature of the Peltier to prevent damage and a freeze alert indicates when the cold side of the Peltier reaches 0°C.

Specifications

Max. Output Voltage	±15 V DC
Max. Output Current	2.4 A
Max. Output Power	36 W (8 Ω load)
Manual Voltage Range	0 to ±15 V
Temperature Range	0 to 50°C Peltier, ambient to +65°C resistive
Recorder Outputs:	
Control Temp Out	100 mV/°C
Monitor Temp Out	100 mV/°C
Inputs:	
Front Panel BNC	for external thermistor
Rear Panel BNC	for external set temperature
Rear Panel BNC	for external voltage set
Rear Panel	15 pin female "D"
Meter (3-1/2 digit LED display of):	
Peltier Set Temperature	0 to 50°C maximum
Control Temperature	
Monitor Temperature	
Output	Voltage, ±15 V maximum
Power Requirements	100-130/220-240 VAC, 50/60 Hz, 80 VA, user selectable
Enclosure Dimensions	8.9 x 20.0 x 25.4 cm (H x W x D)
Shipping weight	5.6 kg
Warranty	Two years, parts & labor

Order #	Model	Product
W4 64-0352	CL-100	Bipolar Temperature Controller

Accessories and Replacement Parts

W4 64-0353	SC-20	Solution Heater/Cooler Two Line
W4 64-1430	SHM-828	Solution Heater Eight Line No Manifold
W4 64-1427	ACC-1	Adapter Cable for 8 pin Din Heaters
W4 64-0107	TA-29	Cable with Bead Thermistor for Heater Controllers

NEW CL-200

Dual Channel Bipolar Temperature Controller



- Single control temperature adjustment
- Built-in protection for Peltier devices
- Open thermistor fault protection
- Heat loss compensation mode
- Quiet operation

The CL-200 Dual Temperature Controller is an automatic two channel controller capable of accurately maintaining two Peltier devices between -6° and 65°C. Power for the instrument is provided by a low noise power supply making it suitable for use in sensitive electrophysiology applications.

While the instrument has broad compatibility, it is specifically designed to control the SC-20 Dual In-line Solution Heater/Cooler in combination with any of our heated and cooled stage chambers.

The CL-200 is simple to use with a single control for temperature adjustment. While total automatic control is provided in the automatic mode, a manual control mode is also available. A loop-speed selector is available to optimize the feedback response of the system to the intrinsic thermal delay characteristics of the setup.

In addition, the CL-200 has a new heat-loss compensation control that allows the instrument to control the temperature at a location downstream from the temperature source.

A feedback thermistor switch allows the user to select which thermistor is used for feedback control. Choosing T1 (control thermistor) uses the built-in thermistor attached to the peripheral device. Selecting T2 (monitor thermistor) allows control at the user selected location of the monitor thermistor (T2).

Built-in circuitry limits the maximum temperature of the Peltier to prevent thermal damage, and a freeze alert/alarm indicates when the cold side of the Peltier reaches 0°C.

Specifications

Max. Output Voltage	±15V Heat/Cool, 0-15V Heat-Only
Max. Output Current	5.0 Amps DC each channel
Max. Output Power	75 Watts @ 3Ω load each channel
Set-Temperature Range	-6 °C to 65 °C Heat/Cool ambient to 65 °C resistive
Recorder Outputs, each channel	Control Temperature, 100mV/°C Monitor Temperature, 100mV/°C
Inputs, each channel	Monitor Thermistor, 10KΩ @25 °C 100KΩ @25 °C (switchable) External Temp Set (auto mode) External Voltage Set (manual mode)
I/O Connector, each channel	15-pin "D" connector
Panel Meter, each channel	3-digit LED display of: Heat Loss Compensation Temp Set Temperature Control Temperature Monitor Temperature Output Voltage Output Current
Panel Meter Resolution	0.1 °C / 0.01 V / 0.01 A
Power Requirement	97-265 VAC / 200VA Max
Weight	4.54 kg
Dimensions (HxWxD)	8.9 x 42.6 x 29.2 cm (H x W x D)
Warranty	One year, parts & labor

Order #	Model	Product
W4 64-1708	CL-200	Dual Channel Bipolar Temperature Controller

Accessories and Replacement Parts

W4 64-0353	SC-20	Solution Heater/Cooler Two Line
W4 64-1659	QE-1HC	Quick Exchange Stage Incubator
W4 64-1632	TB-3 CS	Thermal Insert for Prior NanoScanZ and chamber slides
W4 64-1636	TB-3 CCD	Thermal Insert for Prior NanoScanZ and 35 mm Petri dishes

Model LCS-1 Liquid Cooling System



- Complete self contained liquid cooling system
- Designed for use with all Peltier driven devices from Warner Instruments
- Electrically and mechanically quiet

The LCS-1 Liquid Cooling System from Warner Instruments is a versatile and simple to use thermal control accessory. This apparatus circulates water through a fan/radiator housing and is designed to easily and quietly remove excess heat from the Peltier portion of all Warner devices employing this technology.

This heat exchanger can also be used with any apparatus, allowing the quiet removal of heat energy via the movement of circulating water. A great deal of effort has been dedicated towards making this system both mechanically and electrically quiet.

The LCS-1 is supplied with 20 feet of 1/8" ID x 1/4" OD Tygon tubing, one bottle of antifreeze, and a desktop power supply with line cord.

Specifications

Pump rate	4201/hr (111 gal/hr)
Power Input	Universal Input 100-240 VAC 50/60Hz
Power Output	12 VDC 540 mA
Power Connector Type	15 pin Male "D"
Physical Dimensions:	
Chassis Size (D x W x H)	49.5 x 21.3 x 9.5 cm
Weight	3.63 kg (81 lbs)
Chassis material	Aluminum
Water Jacket Ports	Male thread to 1/8" Barb Fittings
Warranty	One Year

Order # Model Product

W4 64-1922	LCS-1	Liquid Cooling System
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Replacement Parts

W4 64-1704	ANT-1	Replacement antifreeze Propylene Glycol non-toxic 2oz
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Compatible with these items

W4 64-0353	SC-20	Solution Heater/Cooler
W4 64-0450	BLM-TC	Bilayer Thermocycler System
W4 64-1632	TB-3 CS	Thermal Insert for Chambered Slides
W4 64-1636	TB-3 CCD	Thermal Insert for 35 mm Dishes
W4 65-0043	PDMI-2	Open Perfusion Micro-Incubator
W4 65-0044	PSMI	Patch Slice Micro-Incubator
W4 65-0101	CSMI	Chambered Slide Micro-Incubator

TC-202A

Bipolar Temperature Controller

Works with all Harvard Apparatus Micro-Incubation and Tissue Slice Chambers



- Low Noise
- Bipolar or monopolar operation
- Temperature control from 0° to 50°C
- Digital display
- Excellent stability

The TC-202A Bipolar Temperature Controller is the next generation of the TC-102 Monopolar Temperature Controller. This instrument operates with all Harvard Apparatus micro-incubators to provide both heating and cooling functions for life science research purposes.

Because the TC-202A is bipolar, it is ideally suited for use with Peltier devices such as those built into our PDMI-2 Open Perfusion Micro-incubator, PSMI Patch Slice Micro-incubator, and CSMI Chambered Slide Micro-incubator.

While the unit has multiple uses, it has been designed as an ideal companion for Harvard Apparatus/Medical Systems Peltier-based micro-incubators. In its monopolar mode, the TC-202A efficiently controls microincubators that use resistive heaters such as the Leiden Micro-incubator Systems and the BSC-BU Brain/Tissue Slice Chamber units.

Specifications

Temperature Setting Range	0 to 50°C
Temperature Regulation	±0.2°C
Temperature Display	0.1°C resolution
Chamber Temperature Sensor	Thermoliner type, 36 KΩ nominal at 25°C
Voltage Range	0 to ±5 V
Current Range	0 to ±6 A DC
Case Size (W x H x D)	48.3 x 8.9 x 33.7 cm (19 x 3.5 x 13.25 in), 19 in. rack mountable
Weight	5.7 kg (12.5 lb)
Power	150 W, 120/230 VAC, 50/60 Hz, user selectable

Flexible

The TC-202A allows the researcher to control the command temperature from alternative locations. In the case of the PDMI-2, PSMI, and CSMI micro-incubators, temperature is controlled either from a thermistor placed in the bath, or from a second thermistor permanently positioned on the plate containing the regulated surface of the Peltier devices.

Accurate

Accurate thermal control (±0.2°C) is achieved by sensing temperature with a miniature thermistor, digitizing the thermistor signals, and then proportionally regulating a low noise DC current output. Current output is also regulated to match the thermal time constants of small systems (such as micro-incubators), thus minimizing initial overshoot and oscillations about the set point.

Other Features

- Low electrical noise for sensitive electrophysiology recordings
- Stable long term operation
- Excellent temperature stability at user selectable set points
- Easy to use, digitally set command temperatures
- Versatile monopolar or bipolar operation (heat only or heat and cool)
- Temperature profile monitoring capability
- Over-temperature shut down

Order #	Model	Product
W4 65-0045	TC-202A	Bipolar Temperature Controller for use with PDMI-2, PSMI, CSMI, LU-CB-1, LU-CPC-CEH, and BSC-BU. Includes BSC-T3 Thermistor

Accessories and Replacement Parts

W4 65-0057	BSC-T3	Bath Thermistor for use with PDMI-2, PSMI, LU-CB1, and TC-202A (36 KW total)
W4 65-0056	BSC-T3A	Bath Thermistor for use with LU-CPC-CEH
W4 65-0098	BSC-T2	Old Style Bath Thermistor for Obsolete TC-102
W4 65-0016	BSC-T2A	Old Style Bath Thermistor for use with LU-CPC-CEH and TC-102

TC-124A Temperature Controller

Designed for use with Warner OW Series Objective Warmers and SWS Series Syringe Warmers



TC-124A shown with warmed platforms for 35 mm Petri dishes



BAC-1 – Battery adapter cable

- Easy to use
- Command temperatures digitally set
- Ambient to 65°C temperature range
- Can be powered from 12 volt battery for sensitive electrophysiology applications

The TC-124A Temperature Controller from Warner Instruments is a simple, low cost device designed for use with our microscope objective warmers and the SWS Series syringe warmers.

This unit is a basic on-off controller with slowly ramped switching speeds making it ideal for large mass devices where the temperature changes slowly.

The LED display reports the actual temperature of the connected device. Adjustment of the set temperature using either the heat up or heat down buttons causes the display to momentarily report the set temperature.

This compact instrument takes up very little space and may be powered from the 12 VDC wall power supply (included), or a 12 volt battery for low noise applications.

Specifications

Input Voltage Range	9 to 16 VDC
Max. Output Current	1.2 A
Max. Output Power	13 W
Temperature Ranges (4)	Set by DIP Switch: Ambient to +65°C
Meter	3-Digit LED display
Meter Resolution	0.1°C
Panel Indicators	Red: Heat-up Condition Green: Heat-down Condition Yellow: Displaying Set-Temperature
Features	Pushbutton entry of Set-Temperature Set-Temperature displayed for 3 seconds after adjustment
Enclosure Dimensions	2.1 x 6.6 x 11.1 cm (H x W x D)
Weight	92 grams
Warranty	One year, parts & labor

Order #	Model	Product
W4 64-1545	TC-124A	Temperature Controller, 120 VAC US
W4 64-1545E	TC-124AE	Temperature Controller, 240 VAC Europe
W4 64-1606	BAC-1	Battery Adapter Cable

Model TC-144 Dual Temperature Controller



- Ambient to 65°C temperature range
- Compatible with Warner's objective warmer, syringe warmers, and warmed stage insert
- Can be powered from 12 volt battery for sensitive electrophysiology applications
- Large, easy to read LED display

The TC-144 Dual Temperature Controller from Warner Instruments is a simple, low cost device designed for use with our microscope objective warmer or the SWS Series syringe warmers. This device is capable of driving two objective warmers simultaneously.

This compact instrument is a basic on-off controller with a slowly ramped switching speed, making it ideal for large mass devices where the temperature changes slowly.

The LED display reports the actual or set temperature of either channel. Front panel LED's indicate the currently displayed information.

Supplied with universal input voltage power supply and plug kit for major countries.



Specifications

Input Voltage Range	9 to 16 VDC
Maximum Output Current	1.2 A (per channel)
Maximum Output Power	13 W (per channel)
Temperature Ranges (4)	Set by DIP switch: ambient to +65C
Meter Resolution	0.1 °C
Display	LED, 3 digit, 10 mm (0.4 in) high
Panel Indicators:	
Red	Heat-up condition
Green	Heat-down condition
Yellow	Displaying set-temperature or view temperature
Features	Pushbutton entry of modes, dust-proof, splash-proof case
Physical Dimensions:	
Case Size	2.1 x 6.6 x 11.1 cm (H x W x D)
Shipping Weight	0.5 kg
Warranty	One year, parts & labor

Order #	Model	Product
W4 64-1655	TC-144	Temperature Controller Dual

Accessories/Replacement Parts

W4 64-1606	BAC-1	Battery Adapter Cable
W4 64-1665	OW-1	Objective Warmer for 23-28 mm Objectives
W4 64-1662	WP-10	Warmed Platform 10 mm Aperture
W4 64-1663	WP-16	Warmed Platform 16 mm Aperture
W4 64-1584	SWS-10	Syringe Heater for 10 cc Syringes
W4 64-1560	SWS-60	Syringe Heater for 60 cc Syringes
W4 64-1585	SWS-140	Syringe Heater for 140 cc Syringes

Model WP-10 and WP-16 Warmed Platforms for 35 mm Petri Dishes



- Temperature control from 25 to 65 C
- Stage adapters for all major brand microscopes
- Low Cost Systems available

Warner Instruments warmed platforms are designed to maintain the temperature of 35 or 50 mm Petri dishes and glass or chambered slides.

Available with aperture sizes of 10 and 16 mm, these aluminum platforms provide excellent mechanical access from below and very good heat conductivity. Platforms are finished in black anodize for corrosion protection and to minimize stray light reflectance. A groove in the top surface of the platform allows Petri dishes with a raised bottom to achieve full contact with the platform heated surface.

Control of platform heating is provided by our TC-124A and TC-144 temperature controllers. Complete systems are available for Nikon microscopes using a 108 mm stage insert and for Olympus microscopes using a 110 mm insert.

Complete systems include a warmed platform (choice of aperture), a TC-124A temperature controller (select line voltage), and a SA-NIK stage adapter for the Nikon systems or a SA-OLY/2 stage adapter for the Olympus systems.

Stage adapters are available for all major microscopes; the warmed platforms use Warner's series 20 stage adapters. Please see page 64 for detailed information regarding the stage adapters.

Specifications

Temperature Range	25° to 65°C
Accuracy	±0.1°C
Feedback Thermistor	Built in Unical 10kΩ at 25°C
Controller	TC-124A / TC-144 Single and Dual Channel Controllers

Specifications (continued)

Physical Dimensions:	
Warmed Platforms (D x L)	79.4 x 3.2 mm
Aperture Size (D)	10 mm- WP-10, 16 mm- WP-16
Weight	50 g
Cable Length	2.4 m
Connector Type	4 pin Male RJ-22
Warranty	One Year

Order #	Model	Product
W4 64-1662	WP-10	Warmed Platform 10 mm Aperture
W4 64-1662D	WP-10D	Warmed Platform 10 mm Aperture for use with TC-324B/TC-344B Temperature Controllers
W4 64-1663	WP-16	Warmed Platform 16 mm Aperture
W4 64-1663D	WP-16D	Warmed Platform 16 mm Aperture for use with TC-324B/TC-344B Temperature Controllers

Systems Below Include TC-124A Temperature Controller, Warmed Platform, and Stage Adapter

W4 64-1666	WPN-10	Warmed Platform for Nikon 10 mm Aperture
W4 64-1667	WPN-16	Warmed Platform for Nikon 16 mm Aperture
W4 64-1668	WPN-10E	Warmed Platform for Nikon 10 mm Aperture (for 240 VAC)
W4 64-1669	WPN-16E	Warmed Platform for Nikon 16 mm Aperture (for 240 VAC)
W4 64-1670	WPO-10	Warmed Platform for Olympus 10 mm Aperture
W4 64-1671	WPO-16	Warmed Platform for Olympus 16 mm Aperture
W4 64-1672	WPO-10E	Warmed Platform for Olympus 10 mm Aperture (for 240 VAC)
W4 64-1673	WPO-16E	Warmed Platform for Olympus 16 mm Aperture (for 240 VAC)

SH-27B, SH-27G and SF-28

In-line Solution Heaters

Quiet Temperature Control for Flowing Solutions



- Quiet operation
- Ambient to 50°C
- Fast or slow flow
- Designed to work with the TC-324B and TC-344B Temperature Controllers

In-line solution heating is the simplest and most effective method of warming perfusion solutions. The heater is connected to the chamber with a short length of tubing such that the warmed perfusate flows directly into the chamber bath. Depending on bath volume and other factors, in-line solution heating by itself may be sufficient for many applications.

The model SH-27B will accommodate flow rates up to 10 ml/min while the model SF-28 is designed for slower flow rates of 2 ml/min or less.

Both models feature a straight flow path for easy cleaning. The stainless steel flow channel in both models may be lined with polyethylene tubing (PE-50) when exposing compounds to metal is a problem.

These In-line Solution Heaters require either the TC-324B single or the TC-344B dual channel temperature controller. See pages 108 and 109.

Each heater is supplied with a thermistor cable assembly (p/n TA-29) which allows for monitoring the actual bath temperature during use (T2 output on heater controllers TC-324B/TC-344B).

Specifications

Heater Resistance	10 Ω
Voltage Requirement	Variable to 12 V max.
Maximum Temperature	50°C
Internal Dead Volume	262 μl
Perfusion Lines	Type 316 Stainless Steel 0.083 in OD x 0.067 in ID, 2.1 mm x 1.70 mm
Maximum Flow Rate at 37°C:	
SF-28	2 ml/min
SH-27B/SH-27G	10 ml/min
Temperature of 37°C can be maintained at ±1°C under following conditions: a) Solution temperature at input (nominally 21°C) varies no more than ±10%; b) Solution flow rate varies no more than 25%	
Physical Dimensions:	
Body (D x L)	12.5 mm x 12.5 cm
Cable Length	1.9 m
Warranty	One year

Order #	Model	Product
W4 64-0103	SF-28	Slow Flow Solution Heater
W4 64-0102	SH-27B	Solution Heater
W4 64-1503	SH-27G	Solution Heater with Banana Connectors

Accessories and Replacement Parts

W4 64-0107	TA-29	Replacement Cable with Bead Thermistor
W4 64-0108	TA-30	Replacement Cable with Glass Thermistor
W4 64-0100	TC-324B	Heater Controller, Single
W4 64-0101	TC-344B	Heater Controller, Dual

solution heaters

SC-20

Dual In-line Solution Heater/Cooler

Bipolar Temperature Control for Flowing Solutions



- Heats and cools from 0° to 50°C
- Compatible with Warner Series 20 Chambers
- Optimized for use with the CL-100 Bipolar Temperature Controller

In-line solution heating has proven to be one of the most effective methods of maintaining the temperature of perfusion solutions. The SC-20 Dual In-line Solution Heater/Cooler utilizes Peltier thermoelectric devices to regulate temperature both above and below ambient levels.

The SC-20 is designed to thermally regulate one or two solutions at the same temperature. Solution temperature can be maintained at 0°C at flow rates of 2 ml/min., 5°C at 5 ml/min., or as high as 50°C at 5 ml/min.

An integral water jacket is used to remove excess heat from the SC-20 peltier device. Running water either from a tap or a large reservoir can be used. Flow rates as low as 4 liters per hour are sufficient to maintain cooling efficiency.

The SC-20 can be used with either one or two discrete perfusate solutions, or with a solution/gas combination. When coupled with a PHC Series Imaging Chamber Heater/Cooler Jacket, the SC-20 provides an effective means of temperature control in a Warner chamber, even in the absence of solution flow.

Each SC-20 is supplied with a TA-29 Thermistor Cable Assembly for monitoring the bath temperature during use, 10 feet of PE-160 tubing and 10 feet of 1/8" I.D. x 1/4" O.D. Tygon tubing.

Specifications

Minimum Temperature	0°C (2 ml/min. max flow)
Maximum Temperature	50°C
Maximum Flow Rate at 5°C	5 ml/min.
Accuracy	±0.1°C
Internal Dead Volume	330 µl
Perfusion Lines	Type 316 Stainless Steel 0.032 in ID x 0.062 in OD
Water Jacket Ports	Type 316 Stainless Steel 0.12 in ID x 0.147 in OD
Controller	Model CL-100 Bipolar Controller
Physical Dimensions:	
Body (D x L)	21 x 165 mm
Weight	109 g
Cable Length	1.9 m
Connector Type	15 pin Male "D"
Warranty	One year

Order # Model Product

W4 64-0353 SC-20 Solution Heater/Cooler Two Line

W4 64-0352 CL-100 Bipolar Temperature Controller

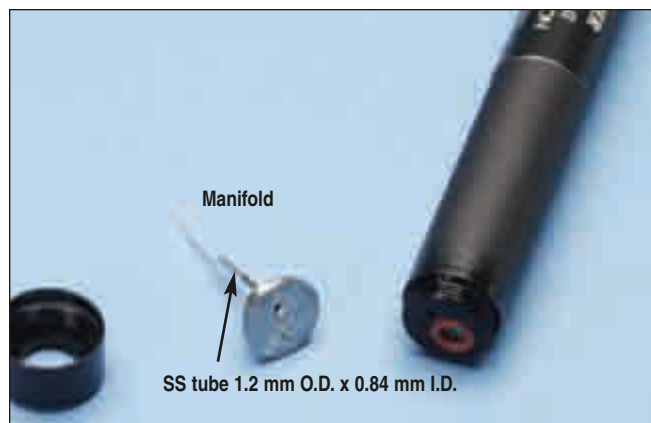
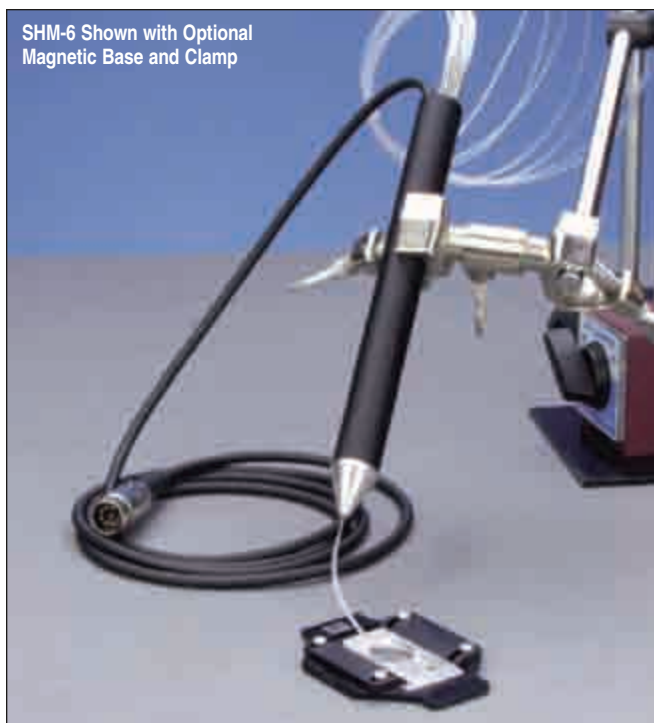
Replacement part

W4 64-0107 TA-29 Cable with Bead Thermistor for Heater Controllers

SHM-6 and SHM-8

solution heaters

Multi-Line In-Line Solution Heaters



- Six-line and eight-line models
- Single outflow line
- Plugs into TC-324B and TC-344B Heater Controllers
- Removable manifold for easy cleaning
- Low dead volume

In-line solution heating is the simplest and most effective method of warming perfusion solutions. The minimal dead space manifold (see right image) at the output allows this heater to be used in any application where from 2 to 8 perfusion lines are connected to a chamber or other device. The manifold dead volume is 30 μ l.

The heater is connected to the chamber using a short length of tubing such that the warmed perfusate flows directly into the chamber bath. Connections are made by press fitting (PE-160) tubing onto the 18 gauge stainless steel hypodermic tubes. Cap plugs are supplied to block any unused inputs.

Depending on bath volume and other factors, in-line solution heating itself may be sufficient for many applications. The heaters will accommodate flow rates up to 5 ml/min. Solution reservoir heaters from Warner are recommended if outgassing of solutions is a problem.

These solution heaters require either a single or dual channel temperature controller. See pages 108 to 116.

Each heater is supplied with a TA-29 thermistor cable assembly which allows for monitoring the actual bath temperature (T2 output on heater controllers TC-324B/TC-344B), and 3 meters of PE-160 tubing, a three way valve and replacement O-rings.

Specifications

Heater Resistance	10 Ω
Voltage Requirement	Variable to 12 V max
Maximum Temperature	50°C
Internal Heater Volume	94 μ l/line
Manifold Dead Volume	30 μ l (input of manifold to output tip)
Maximum Flow Rate at 37°C	5 ml/min

Temperature of 37°C can be maintained at $\pm 2^\circ\text{C}$ under following conditions:
a) Solution temperature at input (nominally 21°C) varies no more than $\pm 10\%$;
b) Solution flow rate varies no more than 25% with 3 ml/min max flow rate

Physical Dimensions:

Body (D x L)	16.5 x 165 mm
Weight	104 g
Cable Length	1.9 m
Warranty	One year

Order # Model Product

W4 64-0104	SHM-6	Six-Line Solution Heater
W4 64-0105	SHM-8	Eight-Line Solution Heater

Accessories and Replacement Parts

W4 64-0107	TA-29	Replacement Cable with Bead Thermistor
W4 64-0108	TA-30	Replacement Cable with Glass Thermistor
W4 64-0755	PE-160/10	Polyethylene Tubing, 3 m (10 ft.)
W4 64-0060	MB/B	Magnetic Base
W4 64-0564	U9404	3-Prong Clamp
W4 64-0100	TC-324B	Heater Controller Single
W4 64-0101	TC-344B	Heater Controller Dual

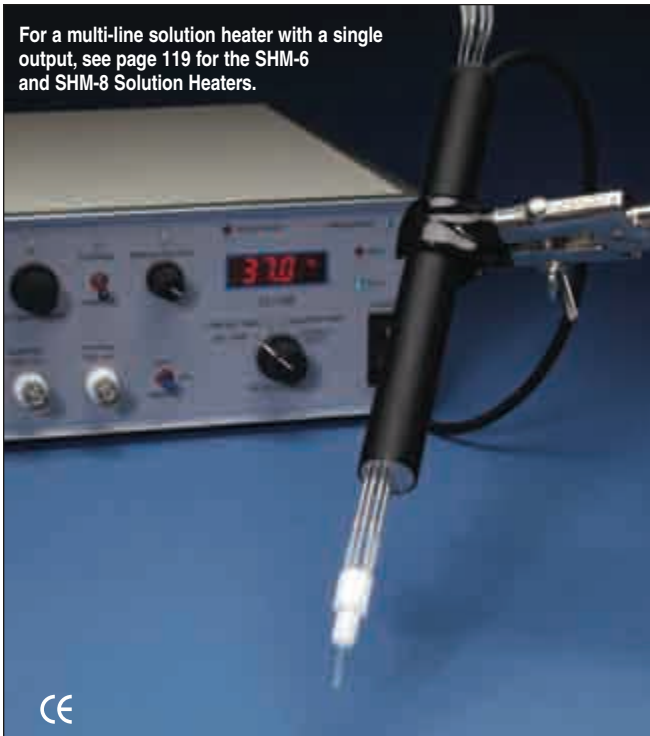
solution heaters

SHM-828

Eight Line In-Line Solution Heater

Warms up to eight independent perfusion lines to the same temperature

For a multi-line solution heater with a single output, see page 119 for the SHM-6 and SHM-8 Solution Heaters.



- Straight flow path for all eight lines
- Connects to the CL-100 Bipolar Temperature Controller
- Easily cleaned
- Perfusion lines remain independent

The SHM-828 is an eight line solution heater designed for superfusion. Construction is such that all eight lines can be used simultaneously. The solution is heated as it flows through 21.5 cm of 18 gauge type 316 stainless steel tubing. The straight flow path allows for easy cleaning.

If contact with stainless steel tubing is undesirable, polyethylene tubing (PE-50) can be drawn through the heater tubes. This eliminates metal contact and reduces the dead volume of the tubes.

For single output applications an MP-8 Perfusion Manifold can be connected directly to the 18 gauge tubes. An ML-8 Miniature Manifold may be used if PE-50 polyethylene tubing is pulled inside the heater tubes.

Solution temperatures can be maintained at 37°C for flow rates up to 5 ml/min., or 50°C at 3 ml/min., per line. Higher flow rates at any given temperature can be achieved if fewer lines are used.

Each heater is supplied with a TA-29 Thermistor Cable Assembly which allows for monitoring the actual bath temperature and 3 meters of PE-160 Tubing. This heater requires the CL-100 Bipolar Temperature Controller; see page 110.

Specifications

Heater Resistance	6.7 Ω
Voltage Requirement	Variable to 15 V max
Maximum Temperature	50°C
Internal Dead Volume	157 μ l / line
Perfusion Lines Type	316 Stainless steel 1.2 mm OD x 0.84 mm ID
Maximum Flow Rate at 37°C	5 ml/min (with all eight lines flowing)
Temperature	37°C can be maintained at $\pm 0.2^\circ\text{C}$
Physical Dimensions:	
Body (D x L)	18 x 168 mm
Tube Length	215 mm
Weight	98 g
Cable Length	1.9 m
Warranty	One year

Order #	Model	Product
W4 64-1430	SHM-828	Solution Heater Eight Line, No Manifold
W4 64-1430L	SHM-828LP	Solution Heater Eight Line Low Power, No Manifold
W4 64-0352	CL-100	Bipolar Temperature Controller

Accessories and Replacement Parts

W4 64-0755	PE-160/10	Polyethylene Tubing PE-160, 10 ft.
W4 64-0752	PE-50/10	Polyethylene Tubing PE-50, 10 ft.
W4 64-0107	TA-29	Replacement Cable with Bead Thermistor
W4 64-0108	TA-30	Replacement Cable with Glass Thermistor
W4 64-0211	MP-8	Perfusion Manifold MP Series 8 to 1
W4 64-0199	ML-8	Perfusion Manifold ML Series 8 to 1

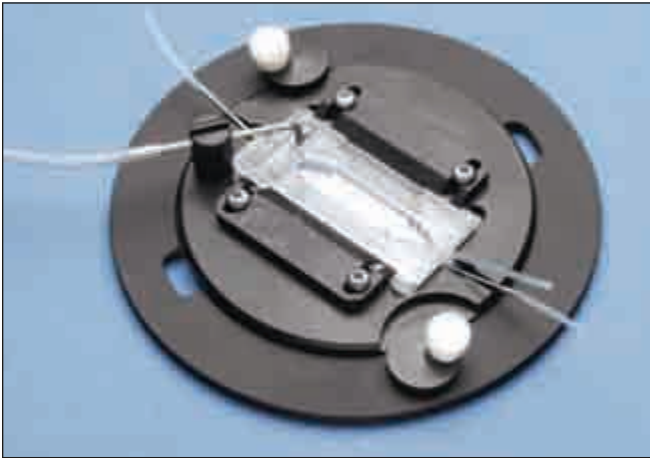


other coolers/warmers

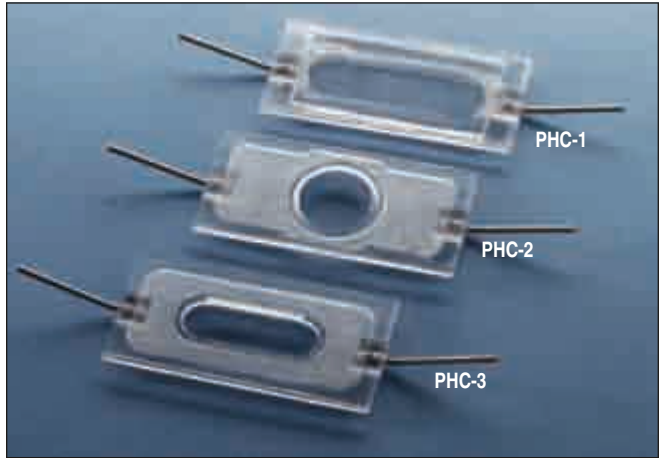
PHC Series

Heater/Cooler Jackets

Maintains temperature in both perfused and static baths



Model PHC-3 shown with mounting platform and mounted in a Nikon stage adapter



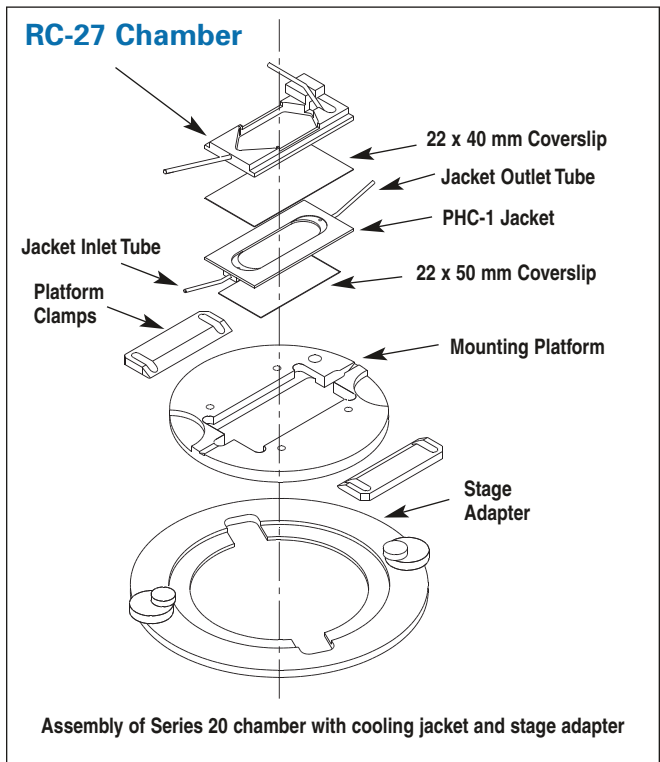
Individual heater/cooler jackets shown without mounting platform

- Designed for Series 20 chambers
- Optimized for the SC-20 In-line Solution Heater/Cooler
- Jackets available for both upright and inverted microscopes
- Includes Series 20 platform

The Warner PHC Heater/Cooler Jackets are designed to bring heating and cooling to our classic Series 20 Imaging and Recording Chambers. Accurate temperature control from 5° to 50°C can be achieved using the PHC jackets in concert with the SC-20 Dual In-line Solution Heater/Cooler. Heated or chilled water flows from the SC-20 into a PHC jacket which is in direct thermal contact with the chamber bottom coverslip.

The PHC-1 is used for upright microscopes and provides a thermal barrier between the chamber-forming coverslip and the local environment. The PHC-2 and PHC-3 are designed for inverted microscopes and provide either rectangular or round openings.

Heater/Cooler Jackets are provided with a mounting platform, which replaces the standard platforms used with Series 20 chambers. The platform functions as a base for the jacket/chamber sandwich and provides the clamping pressure to make a tight seal. Mounting platforms are machined from black Delrin and are compatible with all Series 20 stage adapters, see pages 64 to 69.



Model	Aperture Size	For Chamber Model
PHC-1	17.0 x 37 mm	RC-22/22C/24N/26/26G/26GLP/26Z RC-27/27N/27NE/28/RC-27L/RC-29
PHC-2	15 mm diameter	RC-22/22C/24N/26/26G/26Z/26GLP
PHC-3	8.0 x 25 mm	RC-27/27N/27NE

Order #	Model	Product
W4 64-0354	PHC-1	Heater/Cooler Jacket, Upright
W4 64-0355	PHC-2	Heater/Cooler Jacket, Inverted
W4 64-0356	PHC-3	Heater/Cooler Jacket, Inverted

Other coolers/warmers

OW Series Objective Warmers

Reduces the thermal gradient between objective and specimen



Systems include heated collar and temperature controller

- Reduces thermal gradient between objective and sample
- No direct contact between warmer and objective
- Heated collar warms the surrounding air which then gently warms the objective
- Fits microscope objectives from most manufactures
- Can be powered from Warner's low noise TC-324B/TC344B temperature controller or a 12 volt battery for sensitive electrophysiology applications

A common problem with immersion optics is the loss of thermal control of the solution directly adjacent to the microscope objective. The need to keep a sample at a temperature different from ambient during observation is directly compromised by the heat-sink character of the microscope objective.

The OWS Series Objective Warmer from Warner Instruments provides a simple and effective method for maintaining a stable temperature within a microscope objective. This in turn reduces the thermal gradient between the lens and sample.

A thermally controlled collar attaches to the microscope objective via soft silicone rings. The collar incorporates a resistive heater and thermistor which allows the included electronic controls to maintain the objective warmer at a constant and well maintained temperature.

Heat generated by the isolated collar is not directly communicated to the objective but is instead distributed around the objective via a conducting sleeve.

The conducting sleeve warms the surrounding air, which in turn gently warms the objective. This approach allows the apparatus to take full advantage of the thermal characteristics of the surrounding air. The warmer achieves its task without directly contacting or exposing the objective to significant stresses associated with temperature gradients.

Collars are available to fit objectives from most microscope manufacturers and custom designs are available.

Order #	Model	Product
W4 64-1664	OWS-1	Objective Warmer System for 23-30 mm Lens Includes TC-124A Controller
W4 64-1676	OWS-2	Objective Warmer System for 30-35 mm Lens Includes TC-124A Controller
W4 64-1664E	OWS-1E	Objective Warmer System for 23-30 mm Lens Includes TC-124A Controller (240VAC)
W4 64-1676E	OWS-2E	Objective Warmer System for 30-35 mm Lens Includes TC-124A Controller (240VAC)
Accessories / Replacement Parts		
W4 64-1665	OW-1	Objective Warmer Collar for 23-30 mm Lens; Requires a TC-124A Controller
W4 64-1674	OW-2	Objective Warmer Collar for 30-35 mm Lens; Requires a TC-124A Controller
W4 64-1665D	OW-1D	Objective Warmer Collar for 23-30 mm Lens; Requires a TC-324B/344B Controller
W4 64-1674D	OW-2D	Objective Warmer Collar for 30-35 mm Lens; Requires a TC-324B/344B Controller
Temperature Controllers		
W4 64-1545	TC-124A	Temperature Controller 100-120 VAC
W4 64-1545E	TC-124AE	Temperature Controller 240 VAC
W4 64-1655	TC-144	Temperature Controller Dual Channel Universal Input Voltage

syringe warmers

SW-10/6 Syringe Warmers

Eliminates the need for a large heated water bath



- Accommodates 6 x 10 cc syringes
- Compact design
- Quiet operation in recording setups
- Compatible with TC-324B and TC-344B Heater Controllers

Solution reservoir heating is an important technique used to eliminate outgassing of solutions in a heated perfusion chamber. Since the gas load of a solution has dependence on pressure and temperature, preheating a solution at the final pressure before delivery to the chamber will minimize the occurrence of bubbles in the bath, even if the solution is allowed to cool en route. Solution reservoir heaters from Warner Instruments are designed for applications where the use of a large heated water bath is inconvenient.

Designed to accommodate six 10 cc syringes, the SW-10/6 heater housing is made of anodized aluminum which is both corrosion resistant and serves as an excellent conductor. These heaters may be mounted on any 3/8" or 1/2" diameter lab rod. Solutions will reach set temperature approximately 15 minutes after the application of power.

Each unit is supplied with a cable assembly for connection to Warner's TC-324B or TC-344B heater controllers, see pages 108 and 109. Also supplied is a TA-29 thermistor for monitoring the temperature within any syringe.

Specifications

Syringe Size	10 cc
Heater Resistance	10 Ω
Voltage Requirement	Variable to 12 V maximum
Temperature Range	Ambient to 50°C
Temperature Accuracy	$\pm 1^\circ\text{C}$
Physical Dimensions:	
Body (H x W x D)	7.5 x 17.8 x 2.5 cm
Cable Length	1.9 m
Weight	680 g
Warranty	One year

Order # Model Product

W4 64-0111 SW-10/6 Six 10 cc Syringe Heater

Accessories and Replacement Parts

W4 64-0165 SL-6 Stopcock with Luer Connector, pkg. of 6

W4 64-0162 RS-1 Support Stand

W4 64-0220 FR-50 Flow Valve

W4 64-0221 FR-55S Flow Valve with On-Off Switch

W4 64-0210 MP-6 6 to 1 Perfusion Manifold

W4 64-0755 PE-160/10 Polyethylene Tubing

syringe warmers

SW-61

Syringe Warmers

Eliminates the need for separate water bath

SW-61 Syringe Warmer



- Compatible with TC-324B and TC-344B Heater Controllers
- Accommodates a single 60 cc syringe
- Particularly useful for applications where use of a water bath is undesirable (e.g. a shared facility)

Solution reservoir heating is an important technique used to eliminate outgassing of solutions in a heated perfusion chamber. Since the gas load of a solution has dependence on pressure and temperature, preheating a solution at the final pressure before delivery to the chamber can minimize the occurrence of bubbles in the bath, even if the solution is allowed to cool en route.

Solution reservoir heaters from Warner Instruments are designed for applications where the use of a large heated water bath is inconvenient.

Designed to accommodate one 60 cc syringe, the SW-61 Heater housing is made of anodized aluminum which is both corrosion resistant and serves as an excellent conductor. These heaters may be mounted on any 3/8" or 1/2" diameter lab rod, and each unit is supplied with a cable assembly for connection to Warner's TC-324B or TC-344B heater controllers, see pages 108 and 109.

Also supplied is a TA-29 thermistor for monitoring the temperature within any syringe. Solutions will reach set temperature approximately 15 minutes after the application of power.

Specifications

Syringe Size	60 cc
Heater Resistance	10 Ω
Voltage Requirement	Variable to 12 V maximum
Temperature Range	Ambient to 50°C
Temperature Accuracy	$\pm 1^\circ\text{C}$
Physical Dimensions:	
Body (H x W x D)	14.8 x 8.1 x 6.4 cm
Cable Length	1.9 m
Weight	900 g
Warranty	One year

Order # Model Product

W4 64-0112 SW-61 60 cc Syringe Heater

Accessories and Replacement Parts

W4 64-0165 SL-6 Stopcock with Luer Connector, pkg. of 6

W4 64-0162 RS-1 Support Stand

W4 64-0182 PS-560 Syringe Heater Stand*

*see page 129.

TC-324B & TC-344B Heater Controllers

One or two heater blocks may be powered from the single channel **TC-324B** or dual channel **TC-344B** heater controller, respectively. See pages 108 and 109 for details on these models.

Dual Channel TC-344B Heater Controller, see page 108



Single Channel TC-324B Heater Controller, see page 109



syringe warmers

SW-60 and SW-707 Syringe Heating System

Independent temperature control for multiple syringes



Specifications

Syringe Heater	SW-60	
Syringe Size	60 cc	
Heater Resistance	6.67 Ω	
Temperature Range	Ambient to 50°C	
Input Voltage	12 V nominal, 16 V max	
Physical Dimensions	14.8 x 8.1 x 6.4 cm (H x W x D)	
Weight	900 g	
Warranty	One year	
Syringe Heater Stand	PS-560	
Dimensions:		
Base, H x W x D	2.5 x 30.4 x 30.4 cm	
Main Pole, D x H	1.9 x 91.4 cm	
Sub Poles, D x L	1.2 x 30.4 cm	
Weight	3.7 kg	
Order #	Model	Product
W4 64-0179	SW-60	Syringe Heater for 60 cc Syringe
W4 64-0182	PS-560	Syringe Heater Stand
W4 64-0181	SW-707	Power Controller

Solution reservoir heating is an important technique used to eliminate outgassing of solutions in a heated perfusion chamber. Since the gas load of a solution is dependent on partial pressure and temperature, preheating the solution at atmospheric pressure before delivery to the final heater will minimize the occurrence of bubbles in the bath, even if the solution is allowed to cool en route.



The ability to independently control each heater block allows the researcher to control the initial temperature of each solution without influencing other nearby solutions. This system is available to fit 60 cc syringes. The heater housing is made of anodized aluminum which is both corrosion resistant and serves as

an excellent conductor of heat. Heater blocks can be mounted on any 9.5 mm (3/8 inch) diameter metal rod with an insulating bushing supplied with each SW-60. If multiple SW-60 heaters are to be mounted, the stand must have a heavy base for stability.

PS-560 Syringe Heater Stand

Having a large base for stability, the syringe heater stand will accommodate up to eight syringe heaters. Mounting rods are thermally non-conducting plastic. The 90 cm long vertical rod permits a wide range of height adjustment.

SW-707

Syringe Power Controller



As many as six SW-60's can be controlled with the model **SW-707** Power Controller. When used in the local mode, the SW-707 allows the temperature of each

syringe block to be independently set. A master mode allows all syringe blocks to be set to the same temperature. Both the set temperature and the actual temperature of each syringe block can be displayed on the LED meter.

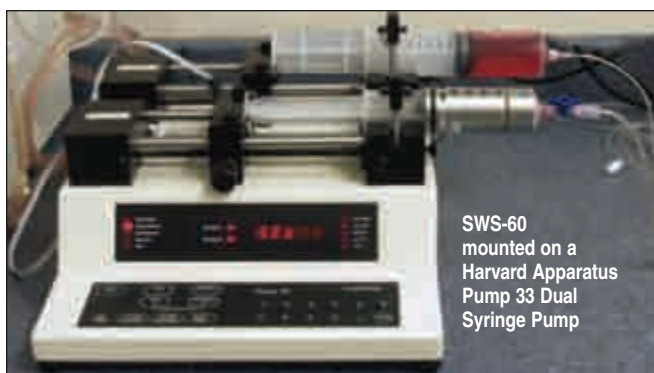
Specifications

Temperature Range	Ambient to 50°C
Max. Output	12 VCD, 144 W
LED Display	Monitor to set and read temperatures
Power Requirements	100-130 or 220-250 VAC, 50/60Hz
Physical Size	9 x 22 x 26 cm (H x W x D)
Warranty	2 years

SWS-10, SWS-60 and SWS-140

Syringe Warmers

Independent temperature control for individual syringes



- Designed for use on a syringe pump or support stand
- Accommodates 10, 60 and 140 cc syringes
- Scale marking ports permit volume monitoring during use
- Can be powered from 12 volt battery for sensitive electrophysiology applications

The SWS-Series Syringe Warmers provide a simple and effective method for maintaining a stable temperature within a syringe. The compact design of this warmer allows it to be used either with a syringe pump or mounted on a support stand.

The thermally controlled heater housing slides onto a 10, 60, or 140 cc syringe and is held in place with a self adjusting friction band. The housing incorporates a resistive element and thermistor, which when connected to a TC-124 temperature controller, allows the syringe warmer to be maintained at a constant temperature.

The heater housing is made of anodized aluminum which is both corrosion resistant and serves as an excellent thermal conductor. Solutions usually reach the set temperature approximately 15 minutes after application of power.

Be sure to order the TC-124 temperature controller with your syringe warmer.

Specifications

Heater Resistance	18 Ω
Voltage Requirement	Variable to 12 V maximum
Temperature Range	Ambient to 65°C
Temperature Accuracy	±1°C
Cable Length	2.4 m
Warranty	One year

Model	Weight	Length	OD	ID	Syringe Type
SWS-10	32.7 g	38.2 mm	22.2 mm	16.2 mm	Becton Dickinson
SWS-60	76 g	83.7 mm	35.0 mm	29.1 mm	Becton Dickinson
SWS-140	192 g	109.5 mm	51.0 mm	41.4 mm	Monoject

Order #	Model	Product
W4 64-1584	SWS-10	Syringe Heater for 10 cc Syringes
W4 64-1560	SWS-60	Syringe Heater for 60 cc Syringes
W4 64-1585	SWS-140	Syringe Heater for 140 cc Syringes
W4 64-1545	TC-124A	Temperature Controller, 120 VAC US
W4 64-1545E	TC-124AE	Temperature Controller, 240 VAC Europe
W4 64-1655	TC-144	Temperature Controller
W4 64-1606	BAC-1	Battery Adapter Cable

Temperature Control Accessories and Cables

SHH-1, SHH-2, SHH-3 and SHH-4 Holders for In-line Solution Heaters



An ideal tool for holding Warner In-line Solution Heaters close to the chamber. Machined from a solid Delrin block, these sturdy holders can be secured to your microscope stage using gaffer or duct tape.

- The SHH-1 works with both our SH-27B and SF-28 Solution Heaters.
- The SHH-2 mounts our SC-20 In-line Solution Heater/Cooler.
- The SHH-3 is used for the SHM-6, SHM-8, and SHM-828 Multiline In-line Heaters.
- The SHH-4 works with our FR-50 and FR-55S flow valves.

Order #	Model	Product
W4 64-1555	SHH-1	Holder for Solution Heaters Models SH-27B & SF-28
W4 64-1556	SHH-2	Holder for Solution Heaters Model SC-20
W4 64-1557	SHH-3	Holder for Solution Heaters Models SHM-6, SHM-8, SHM-828
W4 64-1558	SHH-4	Holder for Flow Valves Models FR-50 and FR-55S

Cables and Thermistors



Order #	Model	Product
W4 64-0303	CC-15	Cable Assembly with Connector with Tinned Leads
W4 64-0106	CC-28	Cable Assembly for Series 20 Heater Platforms
W4 64-0109	CC-35	Cable Assembly with Unterminated Outboard End
W4 64-1425	CC-102	Cable Assembly, Male Banana to 1 mm Jacks (for use with Warner Field Stimulation Chambers)
W4 64-0107	TA-29	Replacement Cable with Bead Thermistor
W4 64-0108	TA-30	Replacement Cable with Glass Thermistor

Additional replacement parts are shown on page 62 (Platforms).

Model TM-3 Three-Scale Thermistor Temperature Monitor

Fahrenheit, celsius, Kelvin

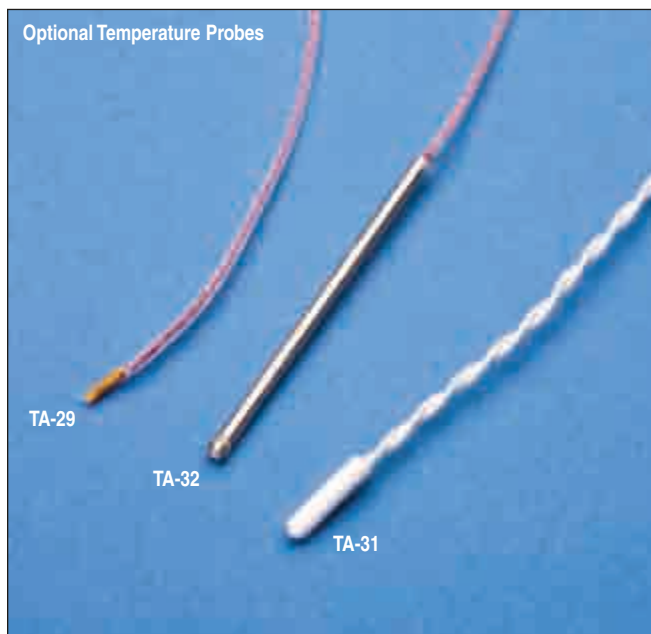


- Celsius, Fahrenheit, or Absolute (Kelvin) scales
- Analog output for data acquisition systems or pen recorders
- Dust-proof, splash-proof and battery powered for use in the field
- Compatible with any 10kΩ unical thermistor
- Large easy to read LCD display

The TM-3 is a portable thermistor thermometer built for lab accurate temperature measurement. Designed to use any 10 KΩ unical thermistor, no recalibration is required when changing probes. The meter features three scales, Celsius, Fahrenheit, and Absolute (Kelvin), pushbutton selectable from the dust-proof and splash-proof front panel interface.

Meter will operate for approximately 100 hours with a single 9 volt alkaline battery or may be powered from the supplied AC wall adapter. A front panel LED indicates low battery condition.

Probe (thermistor) not included. Select from Thermistor Options to the right.



Specifications

Temperature Range:	
Celsius	0 °C to 104 °C
Fahrenheit	2 °F to 220 °F
Absolute (Kelvin)	256 K to 378 K
Accuracy	0.3°C ± 1 digit between 20° to 60°C
Meter Resolution	0.1 degrees
Display	LCD, 4 digit, 10 mm (0.4in) high
Sensor	10kΩ Unical Thermistor
Input & Output Connectors	BNC female
Analog Output	10 mV/°C
Power Requirements	9 Volt transistor alkaline battery or supplied AC wall adapter
Physical Dimensions:	
Case Size	2.4 x 7.9 x 12.8 cm (H x W x D)
Shipping Weight	0.5 kg
Warranty	Two years, parts & labor

Order #	Model	Product
W4 64-1654	TM-3	Three-Scale Temperature Monitor
W4 64-1654E	TM-3	Three-Scale Temperature Monitor 230 VAC

Thermistor Options

W4 64-0107	TA-29	Bead Thermistor 1 mm Diameter
W4 64-1657	TA-31	Probe Thermistor 2 mm Diameter 10 mm Long Plastic Housing
W4 64-1656	TA-32	Probe Thermistor 1.63 mm Diameter 32 mm Long Stainless Steel Housing

Temperature Control Accessories and Cables

PI-1 Power Interface

The PI-1 Power Interface Module will allow a single syringe warmer to run from a 12 volt battery or power supply. Voltage outputs at 100 mV/°C are provided to monitor both the set and actual temperatures. Fuse protected.

Specifications

Input DC Voltage	12 V nominal 16 V maximum
Connectors	1 mm jacks
Physical Size	2.8 x 5.7 x 2.2 cm (H x W x D)
Warranty	One year
Fuse	1.5A - 3AG

PI-1 Power Interface



Order #	Model	Product
W4 64-0180	PI-1	Power Interface

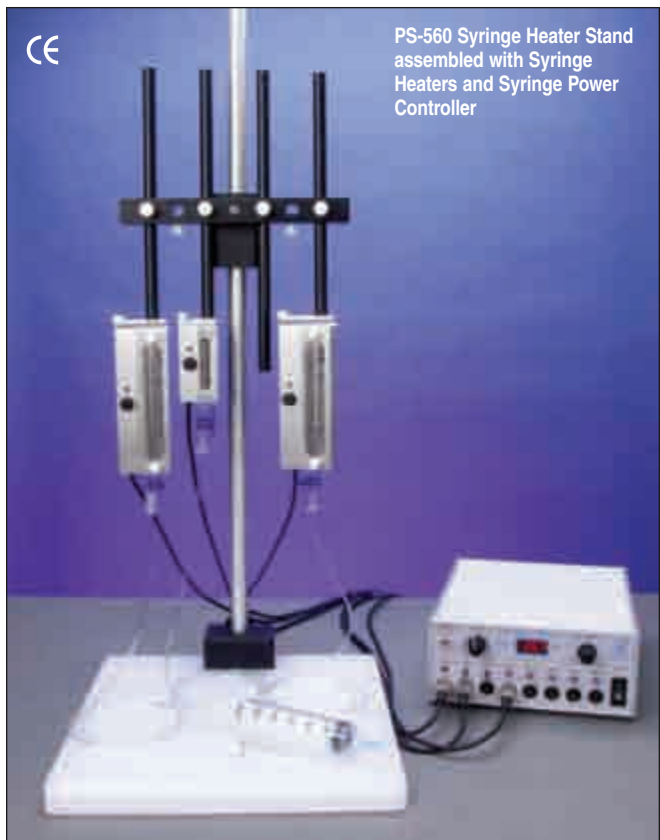
PS-560 Syringe Heater Stand

The PS-560 syringe heater stand will accommodate up to eight syringe heaters. The stand has a large base for stability. Mounting rods are thermally non-conducting plastic. The 90 cm long vertical rod permits a wide range of height adjustment.

Specifications

Dimensions:	
Base, H x W x D	2.5 x 30.4 x 30.4 cm
Main Pole, D x H	1.9 x 91.4 cm
Sub Poles, D x L	1.2 x 30.4 cm
Weight	3.7 kg

Order #	Model	Product
W4 64-0182	PS-560	Syringe Heater Stand



PS-560 Syringe Heater Stand assembled with Syringe Heaters and Syringe Power Controller

controller

Notes:

Temperature
Control

notes

micro-incubation

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Brain/Tissue Slice Chamber System, see page 176

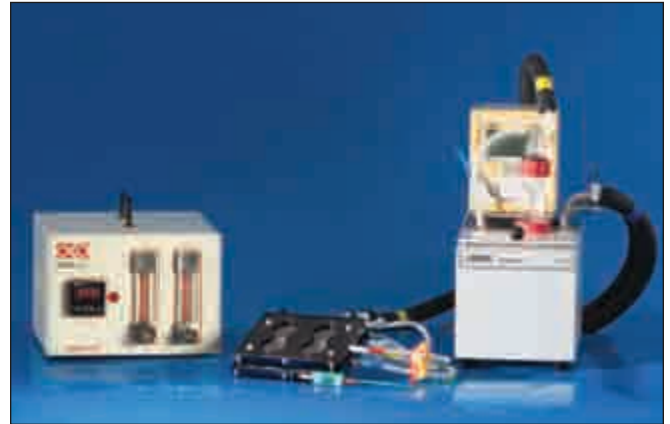


micro-incubators

NEW Okolab Microscope Incubators

Okolab and Warner Instruments-Superior Products for Live Cell Imaging

Superior Products for Live Cell Imaging



Available in USA Only

Okolab microscope incubators provide your cells with an ideal environmental condition for Live Cell Imaging.

The CO₂ Microscope Cage Incubator is designed to completely enclose your microscope and works to maintain the required conditions for cell culture within your microscopy workstation. This enables prolonged observations on biological specimens and allows sufficient space for other equipment.

The CO₂ Microscope Stage Incubators offer excellent incubation stability combined with ease of movement on and off the microscope; a real plus for shared facilities.

Tests of both products in comparison with a CO₂ Benchtop Incubator show how these systems set the standard in Live Cell Microscopy.

Overview of technologies

Okolab Microscope Cage Incubator

The Cage Incubator is sold as a complete system and includes the enclosure, a temperature control module, CO₂ and humidity modules, and a stage chamber.

The cage features full accessibility to the microscope via access doors on the front and side. If your application requires, we can place

additional panels in strategic locations. The cage also features easy turn-to-open hinges allowing the incubator to be assembled and disassembled in less than five minutes.

Typically, cage Incubators are custom designed to meet the needs of your imaging workstation.

Okolab Microscope Stage Incubators

The CO₂ Microscope Stage Incubator is a compact solution designed to create a suitable environment for cell culturing directly on the microscope stage, again allowing prolonged observations of living cells.

Cells cultured within the microscope stage incubator have been shown to proliferate as well as in a regular bench-top incubator. Operating temperatures are from 10°C to 50°C and thermal cycles are possible.

- **ELECTRIC:** Temperature range: Ambient + 3°C to 50°C. Electrically heated.
- **BASIC Water Jacket:** Temperature range: Ambient + 3°C to 50°C. Water Jacket.
- **CRYO Water Jacket:** Capable of heating and cooling in the temperature range: 10°C to 50°C. Temperature cycle capable.

A wide choice of chambers and interchangeable inserts adds flexibility to the equipment and allows use of any cell culture support (Petri-dishes, chamber slides, multiwell plates, and others).

NEW Electric CO₂ Microscope Stage Incubator

Superior Products for Live Cell Imaging



- Low cost solution for long term experiments
- One model fits all XY stages
- Suitable for high magnification microscopy
- Temperature control from Ambient + 3°C to 50°C
- Wide selection of cell culture support adapters

The Electric CO₂ Microscope Stage Incubator is the latest release in the family of Stage Top Incubators. It represents a one-button solution for long term experiments. The same model fits all the XY stages on the market, and it is suitable at the same time for high magnification microscopy and multipoint experiments. A wide choice of interchangeable inserts adds flexibility to the equipment and accepts any cell culture support (Petri-dishes, glass slides, multiwell plates, etc.).

Temperature Regulation

In the Electric Microscope Stage Incubator, specimen temperature is regulated by the combined action of two controllers acting on the power dissipated by the electric resistances, embedded both in the base and in the lid of the incubating chamber. Two temperature feedback mechanisms are available:

- Chamber temperature feedback
- Specimen temperature feedback

In the Chamber temperature feedback mode a thermocouple reads the temperature of the incubating chamber. A careful calibration performed in our laboratories guarantees that specimen temperature is maintained at the desired value. The advantage of this solution is that the thermocouple is not visible since it is embedded into the chamber.

In the Specimen temperature feedback mode a thermocouple wire reads the temperature of a reference well placed in the incubating chamber very close to the specimen. The advantage of this configuration is in the accuracy of the temperature control.

CO₂ Regulation

CO₂ is mixed with air in the supplied control unit and this mixture is continuously fed into the incubating chamber to control medium pH. An optional third gas line can also be fed into the controller.

Humidity Regulation

A humidifying and a pre-heating module (optional) prevent evaporation of medium and avoids water condensation within the chamber.

Software (optional)

Read Temperature Software is available to read the incubator temperature and to store the data in computer memory.

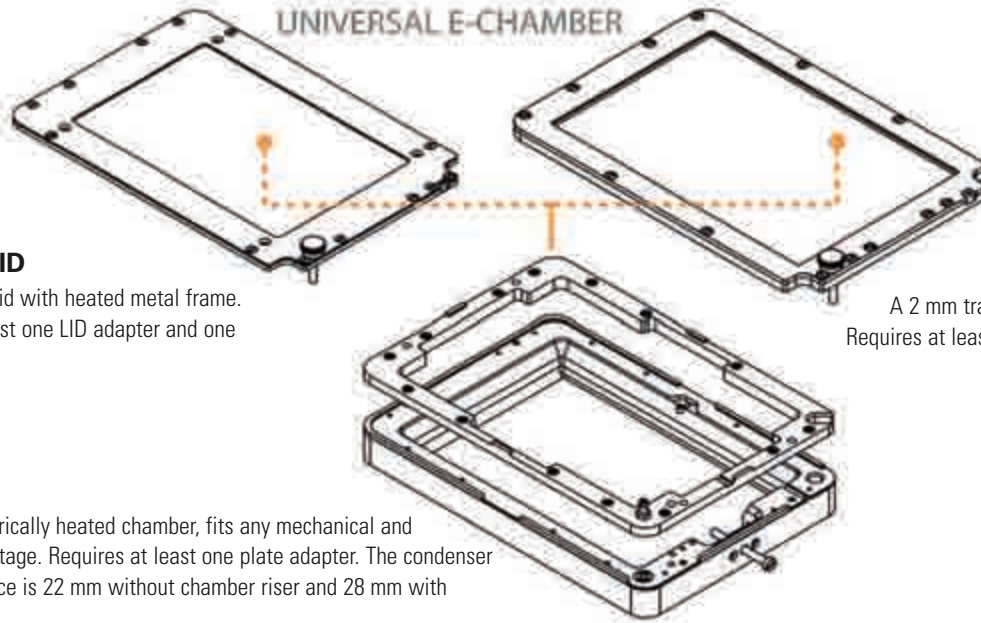
Specifications

Temperature Range	Ambient + 3°C to 50°C
Accuracy	±0.3°C (Chamber temperature feedback) ±0.2°C (Specimen temperature feedback)
Heating Technology	Electric
Type of Controller	Hardware
Temperature Feedback	Chamber temperature feedback Specimen temperature feedback (optional)
Humidification Module	Not heated (optional heated version)
CO ₂ Range	0 to 100%
Physical Dimensions:	
(L x W x H)	159 x 110 x 18 mm
Weight	405 g



Available in USA Only

NEW Electric CO₂ Microscope Stage Incubator Accessories



H301-EC-LID

A 1 mm glass lid with heated metal frame. Requires at least one LID adapter and one BASE adapter.

H301-EC-HG

A 2 mm transparent heated lid. Requires at least one BASE adapter.

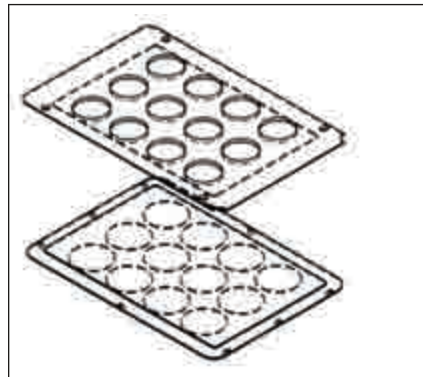
H301-EC

Universal electrically heated chamber, fits any mechanical and motorized XY stage. Requires at least one plate adapter. The condenser working distance is 22 mm without chamber riser and 28 mm with chamber riser.



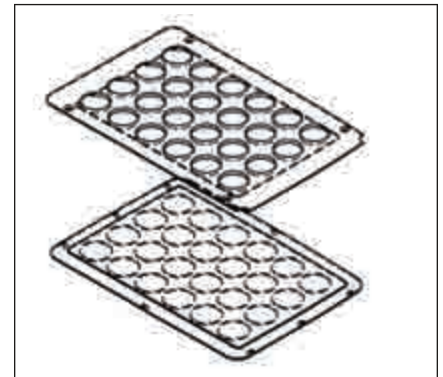
H301-EC-6MWLID

6-well plate Lid adapter.



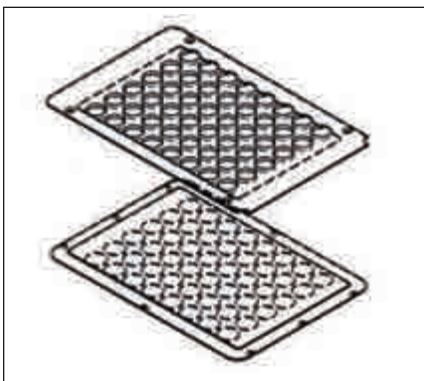
H301-EC-12MWLID

12-well plate Lid adapter.



H301-EC-24MWLID

24-well plate Lid adapter.



H301-EC-48MWLID

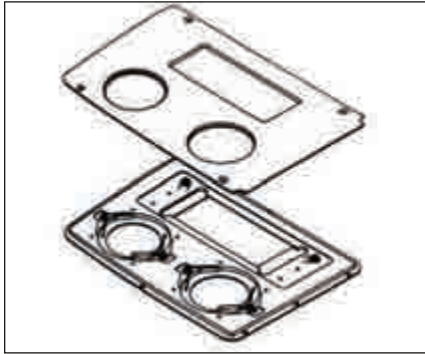
48-well plate Lid adapter.



H301-EC-96MWLID

96-well plate Lid adapter.

NEW Electric CO₂ Microscope Stage Incubator Accessories (continued)

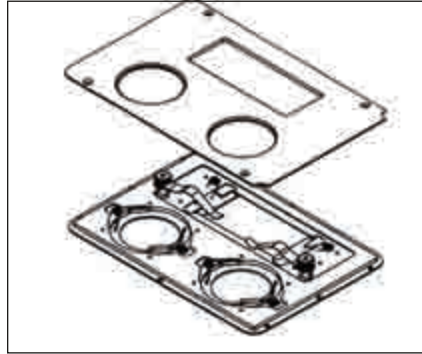


H301-EC-GS35LID

One standard chamber slide and two 35 mm Petri dish LID adapter.

H301-EC-GS35BASE

One standard chamber slide and two 35 mm Petri dish BASE adapter.



H301-EC-GS35LID

One standard chamber slide and two 35 mm Petri dish LID adapter.

H301-EC-[57mm]GS35BASE

One 57 chambered coverglass and two 35 mm Petri dish BASE adapter.

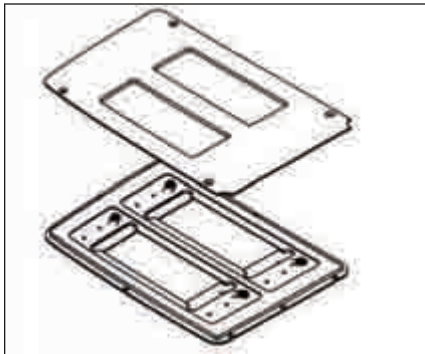


H301-EC-35LID

Four 35 mm Petri dish LID adapter.

H301-EC-35BASE

Four 35 mm Petri dish BASE adapter.

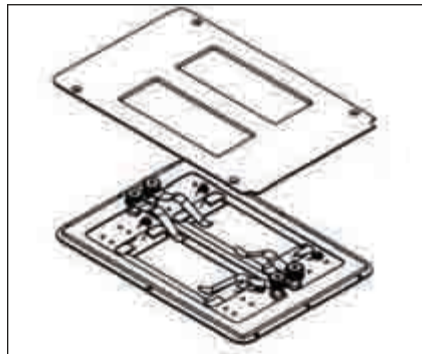


H301-EC-GSLID

Two standard chamber slides LID adapter.

H301-EC-GSBASE

Two standard chamber slides BASE adapter.

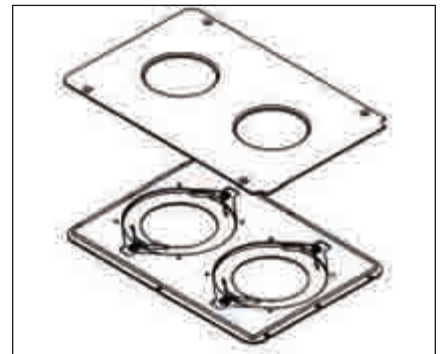


H301-EC-GSLID

Two standard chamber slides LID adapter.

H301-EC-[57 mm]GSBASE

Two 57 mm chamber coverglass BASE adapter.

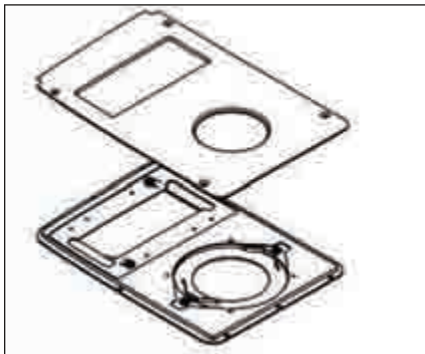


H301-EC-60LID

Two 60 mm Petri dish LID adapter.

H301-EC-60BASE

Two 60 mm Petri dish BASE adapter.

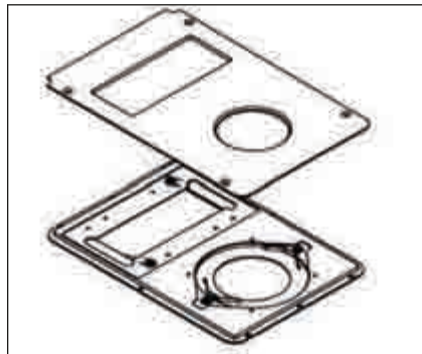


H301-EC-GS60LID

One standard chamber slide and one 60 mm Petri dish LID adapter.

H301-EC-GS60BASE

One standard chamber slide and one 60 mm Petri dish BASE adapter.



H301-EC-GS60LID

One standard chamber slide and one 60 mm Petri dish LID adapter.

H301-EC-GS60BASE

One standard chamber slide and one 60 mm Petri dish BASE adapter.



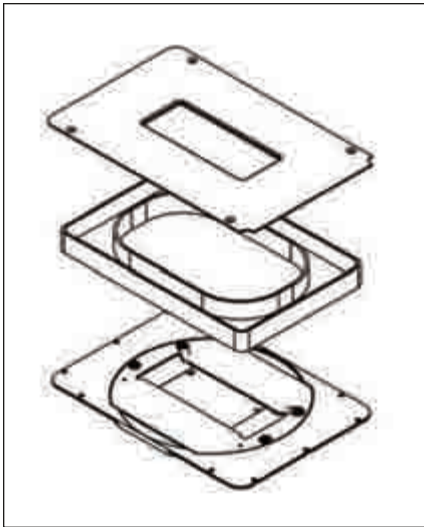
H301-EC-GS3560LID

Two 35 mm and one 60 mm Petri dish LID adapter.

H301-EC-GS3560BASE

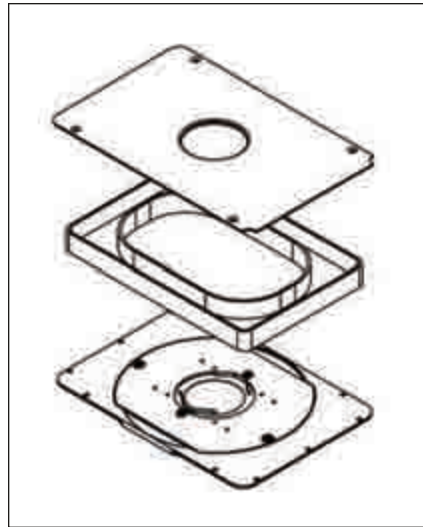
Two 35 mm and one 60 mm Petri dish BASE adapter.

NEW Electric CO₂ Microscope Stage Incubator Accessories (continued)



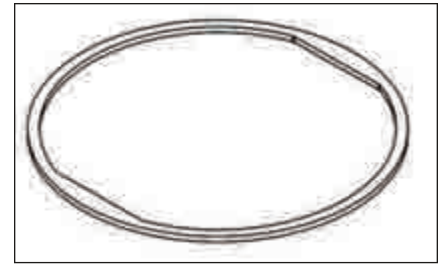
H301-EC-GSPA-FST

Plate adapters for flat stages with circular insert. Fits stage with round 108 mm insert (Nikon), add H-FST-R108-RING, for stages with R110 mm insert (Olympus), add H-FST-R110-RING.



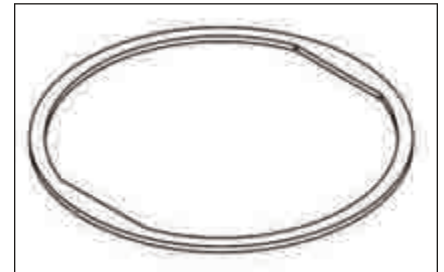
H301-EC-35PA-FST

Plate adapters for two 35 mm Petri dishes for flat stages with circular insert. Fits stage with round 108 mm insert (Nikon), add H-FST-R108-RING, for stages with R110 mm insert (Olympus), add H-FST-R110-RING.



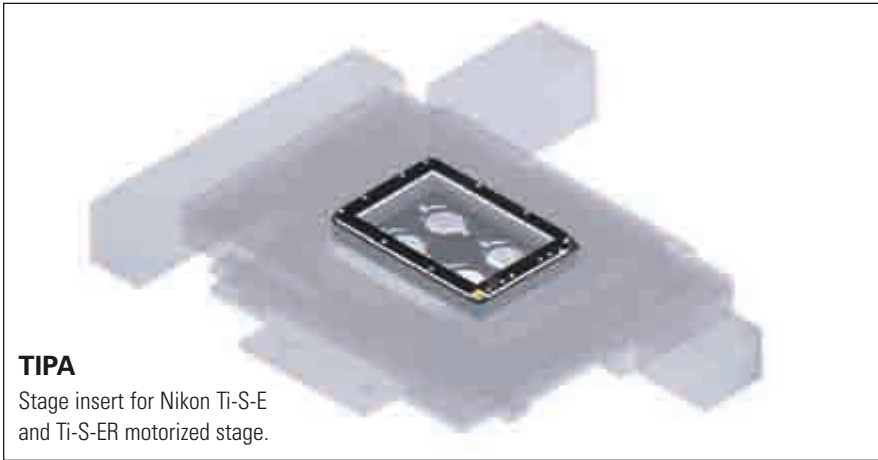
H-FST-R108-RING

108 mm Ring Adapter for all Flat Stage Plate Adapters (Nikon).



H-FST-R108-RING

110 mm Ring Adapter for all Flat Stage Plate Adapters (Olympus).



TIPA

Stage insert for Nikon Ti-S-E and Ti-S-ER motorized stage.



IC-VICE-TI-SR

Tool to fix incubating chambers on Nikon T/Ti-SR XY stage.



SAMPA

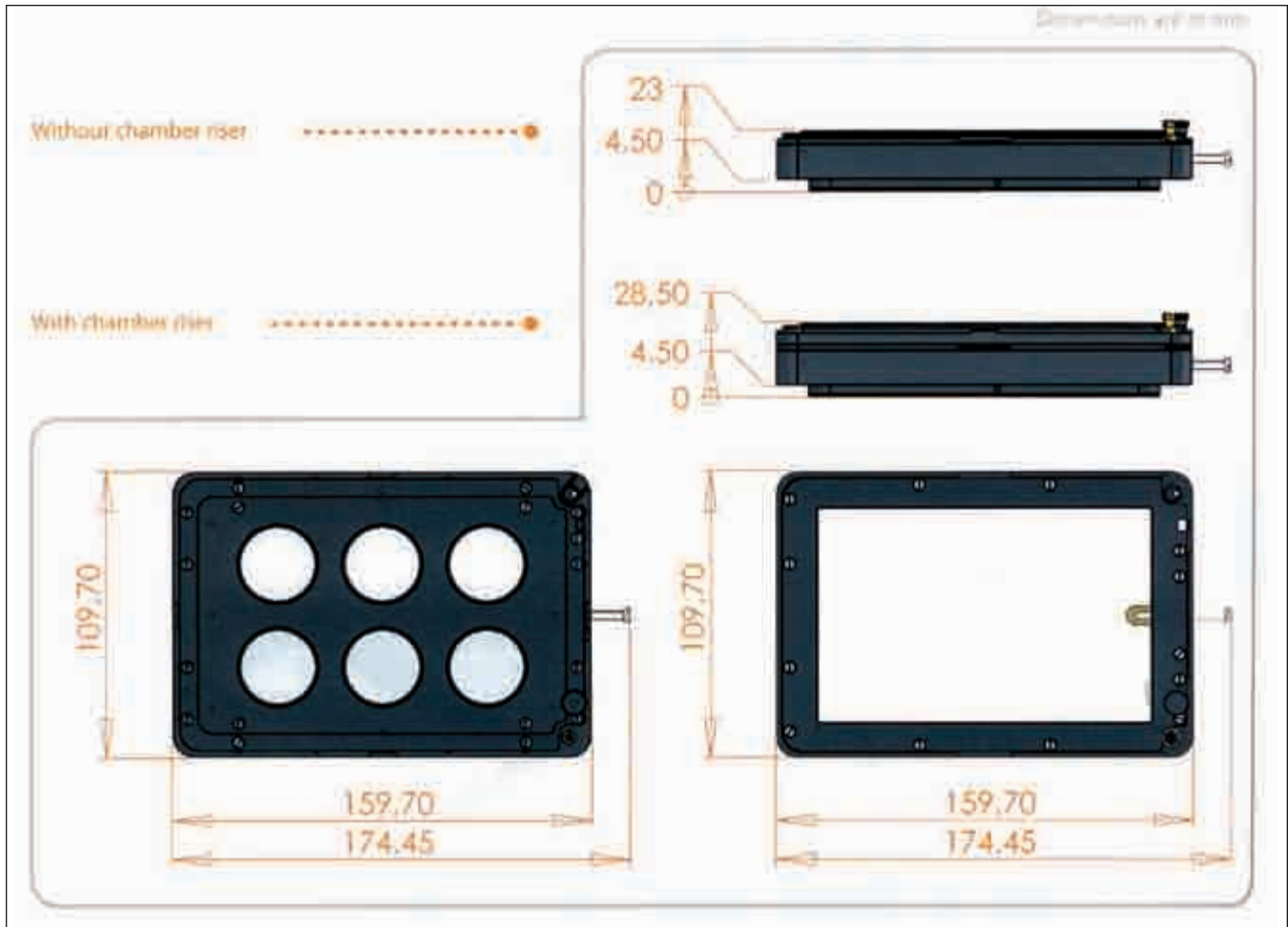
Stage adapter for mounting Okolab chambers with bottom rectangular shape 95 x 135 mm on T/Ti-SP plain stage equipped with T/Ti-SAM attachable mechanical stage, replaces the Nikon plate adapter.



MVR-SA

Adapts the H301-EC electric stage incubator to the Olympus CK40-MVR and IX-MVR mechanical stages.

NEW Electric CO₂ Microscope Stage Incubator Accessories (continued)



NEW Electric CO₂ Microscope Stage Incubator Accessories (continued)

Order #	Model	Product
Stage Chambers		
W4 99-0717	H301-TC1	Chamber Temperature Controller, controls the temperature of the base and lid of the stage incubator. With this controller specimen temperature accuracy is $\pm 0.3^{\circ}\text{C}$.
W4 99-0718	H301-TC2	Specimen Temperature Controller, controls the temperature of the specimen and the lid of the stage incubator, improves temperature accuracy to $\pm 0.2^{\circ}\text{C}$
W4 99-0719	H301-TM	Temperature Meter, an external temperature probe, measure ambient temperature or specimen temperature
W4 99-0720	H301-TS	Read Temperature Software - Acquire temperature data measured during the experiment, H301-TM required
Humidifying Module		
W4 99-0730	H301-BC	Bubbling column - humidifies the gas stream before it enters chamber
W4 99-0731	H301-HMTC	Humidifying Module Temperature Controller, controls bubbling column temperature
W4 99-0670	H301-HM-FRAME	Humidifying Module Frame-humifies gas stream before it enters chamber, substitutes H301-BC and H301-HMTC, Suitable for flat stages
W4 99-0732	H301-EC	Universal electrically heated chamber- Fits on Prior, Ludl, Marzhauser, ASI XY Stages Choose between H301-EC-LID and H301-EC-HG-LID- requires at least one BASE plate adapter Condenser working distance: 22 mm without the chamber riser and 28 mm with the chamber riser
W4 99-0679	H301-EC-LID	1 mm lid with heated metal frame - requires at least one LID adapter
W4 99-0932	H301-EC-HG-LID	2 mm Transparent Glass Heated LID
W4 99-0681	H301-EC-MCLTi	Electrically heated chamber for Mad City Labs Nano-Z100-N Piezo stage on Nikon TI-S-E XY stage. Includes Transparent Heated LID H301-EC-HG-LID, requires at least one BASE plate adapter. Condenser working distance: 21 mm without the chamber riser and 28 mm with the chamber riser
LID and BASE adapters for motorized stages, compatible with H301-EC and H301-EC-MCLTi		
W4 99-0682	H301-EC-6MWLID	6-well plates - Lid adapter for H301-EC-LID
W4 99-0683	H301-EC-6MWBASE	6-well plates - Base adapter
W4 99-0684	H301-EC-12MWLID	12-well plates - Lid adapter for H301-EC-LID
W4 99-0685	H301-EC-12MWBASE	12-well plates - Base adapter
W4 99-0686	H301-EC-24MWLID	24-well plates - Lid adapter for H301-EC-LID
W4 99-0687	H301-EC-24MWBASE	24-well plates - Base adapter
W4 99-0688	H301-EC-24MWLID-NUNC	24-well NUNC plates - Lid adapter for H301-EC-LID
W4 99-0689	H301-EC-24MWBASE-NUNC	24-well NUNC plates - Base adapter
W4 99-0690	H301-EC-48MWLID	48-well plates - Lid adapter for H301-EC-LID
W4 99-0709	H301-EC-48MWBASE	48-well plates - Base adapter
W4 99-0934	H301-EC-96MWLID	96-well plates - Lid adapter for H301-EC-LID
W4 99-0693	H301-EC-96MWBASE	96-well plates - Base adapter
W4 99-0694	H301-EC-GSLID	Two standard chamber slides - Lid adapter for H301-EC-LID (common to H301-EC-GSBASE and H301-EC-[57 mm]GSBASE)
W4 99-0695	H301-EC-GSBASE	Two standard chamber slides - Base adapter
W4 99-0696	H301-EC-[57 mm]GSBASE	Two 57 mm chambered coverglass - Base adapter
W4 99-0697	H301-EC-GS35LID	One standard chamber slide and Two 35 mm Petri-dish - Lid adapter for H301-EC-LID (common to H301-EC-GS35BASE and H301-EC-[57 mm]GS35BASE)
W4 99-0698	H301-EC-GS35BASE	One standard chamber slide and Two 35 mm Petri-dish - Base adapter
W4 99-0699	H301-EC-[57 mm]GS35BASE	One 57 mm chambered coverglass and Two 35 mm Petri-dish - base adapter
W4 99-0700	H301-EC-GS60LID	One standard chamber slide and One 60 mm Petri-dish - Lid adapter for H301-EC-LID (common to H301-EC-GS60BASE and H301-EC-[57 mm]GS60BASE)
W4 99-0701	H301-EC-GS60BASE	One standard chamber slide and One 60 mm Petri-dish - Base adapter
W4 99-0702	H301-EC-[57 mm]GS60BASE	One 57 mm chambered coverglass and One 60 mm Petri-dish - Base adapter

NEW Electric CO₂ Microscope Stage Incubator Accessories (continued)

Order #	Model	Product
W4 99-0703	H301-EC-35LID	Four 35 mm Petri-dish - Lid adapter for H301-EC-LID
W4 99-0704	H301-EC-35BASE	Four 35 mm Petri-dish - Base adapter
W4 99-0705	H301-EC-60LID	Two 60 mm Petri-dish - Lid adapter for H301-EC-LID
W4 99-0706	H301-EC-60BASE	Two 60 mm Petri-dish - Base adapter
W4 99-0707	H301-EC-3560LID	One 35 mm and One 60 mm Petri-dish - Lid adapter for H301-EC-LID
W4 99-0708	H301-EC-3560BASE	One 35 mm and One 60 mm Petri-dish - Base adapter
Plate adapters for manual Flat Stages, compatible with H301-EC and H301-EC-MCLTi. They require H-FST-R[...]RING		
W4 99-0991	H301-EC-GSPA-FSTLID	One standard chamber slide - Lid adapter for H301-EC-LID Suitable for flat stages with circular insert
W4 99-0992	H301-EC-GSPA-FSTBASE	One standard chamber slide - Base adapter. Suitable for flat stages with circular insert For stages with R108 mm insert (Nikon), add H-FST-R108-RING; for stages with R110mm insert (Olympus), add H-FST-R110-RING
W4 99-0993	H301-EC-GS35PA-FSTLID	One standard chamber slide and One 35 mm Petri-dish. Lid adapter for H301-EC-LID Suitable for flat stages with circular insert
W4 99-0994	H301-EC-GS35PA-FSTBASE	One standard chamber slide and One 35 mm Petri-dish - Base adapter Suitable for flat stages with circular insert For stages with R108 mm insert (Nikon), add H-FST-R108-RING; for stages with R110 mm insert (Olympus), add H-FST-R110-RING
W4 99-0995	H301-EC-35PA-FSTLID	One 35 mm Petri-dish. Lid adapter for H301-EC-LID. Suitable for flat stages with circular insert
W4 99-0996	H301-EC-35PA-FSTBASE	One 35 mm Petri-dish - Base adapter. Suitable for flat stages with circular insert For stages with R108 mm insert (Nikon), add H-FST-R108-RING; for stages with R110 mm insert (Olympus), add H-FST-R110-RING
W4 99-0997	H-FST-R108-RING	108 mm Ring Adapter for all Flat Stage Plate Adapters (Nikon)
W4 99-0998	H-FST-R110-RING	110 mm Ring Adapter for all Flat Stage Plate Adapters (Olympus)
Fixing tools		
W4 99-0825	TIPA	Stage insert for Nikon Ti-S-E and Ti-S-ER Motorized XY stage
W4 99-0744	IC-VICE-TI-SR	Tool to fix incubating chambers on Nikon T/Ti-SR XY stage
W4 99-0742	SAMPA	Stage Adapter that allows to use Okolab Chambers with bottom rectangular shape 95 x 135 x 5 mm on T/Ti-SP Plain Stage equipped with T/Ti-SAM Attachable Mechanical Stage replaces the Nikon plate adapter
W4 99-0909	H301-EC-ASI-PA	Stage insert for ASI XY Stage
W4 99-0910	MVR-SA	Allows use of H301-EC(-MCLTi) electric stage incubator on the Olympus CK40-MVR and IX-MVR Mechanical Stages
W4 99-0911	H301-EC-AB	Electrically heated chamber for Applied Biophysics. Fits on Prior, Ludl, Marzhauser XY Stages
W4 99-0912	H301-EC-PZ100	Electrically heated chamber for Prior PZ100 Nanoscan Z-stage NZ100 and NZ200 It hosts One 35 mm pertri or One chamber slide
W4 99-0913	H301-EC-LG	Electrically heated chamber for Leica Galvo Stage, requires at least one base plate adapter. Condenser working distance: 20 mm
W4 99-0914	H301-EC-LG-GSBASE	One standard chamber slide - Base adapter
W4 99-0915	H301-EC-LG-[57 mm]GSBAS	One 57 mm chambered coverglass - Base adapter
W4 99-0916	H301-EC-LG-35BASE	One 35 mm Petri-dish - Base adapter
W4 99-0917	H301-EC-LG-60BASE	One 60 mm Petri-dish - Base adapter
W4 99-0918	H301-ECS-FST	SINGLE HOLDER - Electrically heated chamber for mechanical flat XY stage with circular opening (i.e. Nikon T/Ti-SR and T/Ti-SSR & Olympus IX2-SFR and IX2-SLV2). Transparent Heated LID Integrated humidifying module with active temperature control, requires at least one plate adapter. Condenser working distance: 22 mm without the chamber riser and 27 mm with the chamber riser
W4 99-0919	H301-ECS-FST-S35PABASE	One 35 mm Petri-dish - Base adapter
W4 99-0920	H301-ECS-FST-S60PABASE	One 60 mm Petri-dish - Base adapter
W4 99-0921	H301-ECS-FST-GSPABASE	One standard chamber slides - Base adapter
W4 99-0922	H301-ECS-FST-[57 mm]GSPABASE	One 57 mm chambered coverglass - Base adapter
W4 99-0923	H301-ECS-IX2SFR-TIS-SI	External rectangular frame required to lock the H301-ECS-FST chamber on the XY stage

NEW Basic-Water-Jacket CO₂ Microscope Stage Incubator

Superior Products for Live Cell Imaging



- Superior incubation stability for long term experiments
- Models to fit all XY stages on the market
- Suitable for high magnification microscopy
- Temperature control from Ambient+3°C to 50°C
- Wide selection of cell culture support adapters

The Basic-Water-Jacket CO₂ Microscope Stage Incubator provides superior incubation stability. Water is pumped from a water bath into the base plate and into the lid, which are both water jackets. Models fitting all XY stages on the market are available.

Chambers suitable for high magnification microscopy and multipoint experiments are available. A wide choice of inserts adds flexibility to the equipment and allows the use of any cell culture support (Petri-dishes, chamber slides, multiwell plates, etc.).

Specimen Temperature Regulation

Temperature is directly measured inside a reference Petri dish and temperature is controlled by software from a water bath into the water jacket. The software controller reads the temperature in the reference well and updates the set point temperature of the water bath, ensuring a specimen temperature stability of $\pm 0.1^\circ\text{C}$.

CO₂ Regulation

CO₂ is mixed with air in the control unit and is continuously fed into the incubating chamber to control medium pH. An optional third gas can also be fed into the incubating chamber.

Humidity Regulation

A humidifying and a pre-heating module prevents evaporation of medium and avoids water condensation on glass and plastic surfaces.

The gas stream is warmed up by flowing into a copper coil immersed into the water bath and then is humidified by bubbling into a glass column filled with distilled water and immersed into the water bath.

To reach a nearly saturated atmosphere in the incubation chamber, without causing water condensation, the humid gas is equilibrated with the chamber by flowing into a tube embedded into the water jacket.

Software: Temperature Control Basic

Temperature Control Software communicates with both the water bath and the temperature meter, ensuring a temperature stability of $\pm 0.1^\circ\text{C}$. Temperature Control Software reads the sample temperature every minute and stores it in computer memory. Intelligent software tools avoid thermal shock to the specimen when the CO₂ Microscope Stage Incubator is opened (thermal shock prevention). A software temperature offset compensates the heat sink caused by oil immersion objectives (oil immersion compensation).

Software Features

Specimen temperature display	Yes
Specimen temperature storage	Yes
Thermal shock prevention	Yes
Oil immersion compensation	Yes
Temperature cycles	No

Specifications

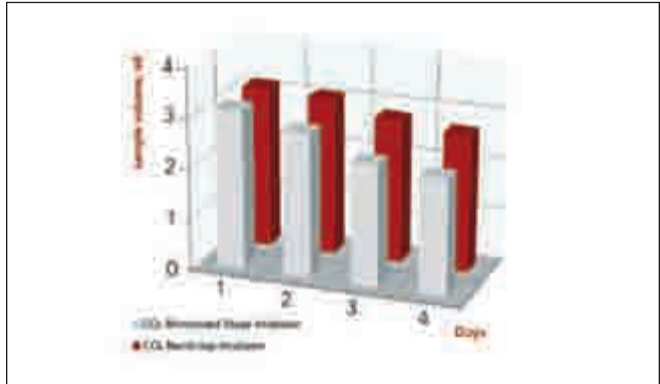
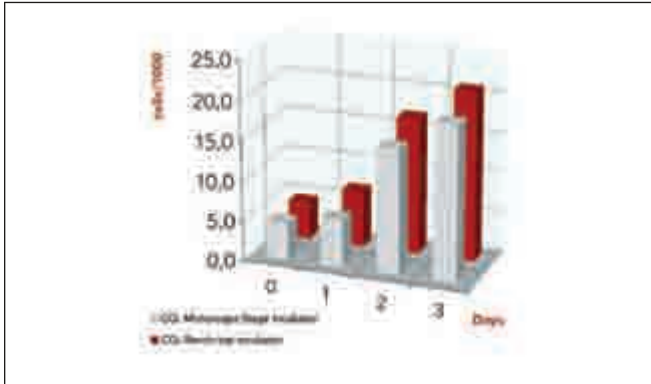
Temperature Range	Ambient+ 3°C to 50°C
Accuracy	$\pm 0.1^\circ\text{C}$
Heating Technology	Water jacket
Type of Controller	Software / PC required
Temperature feedback	Specimen temperature feedback
Humidification module	Heated
CO ₂ range	0 to 100%
Physical Dimensions:	
(L x W x H)	159 x 142 x 31 mm
Weight	450 g



Available in USA Only

NEW Basic-Water-Jacket CO₂ Microscope Stage Incubator (continued)

Superior Products for Live Cell Imaging

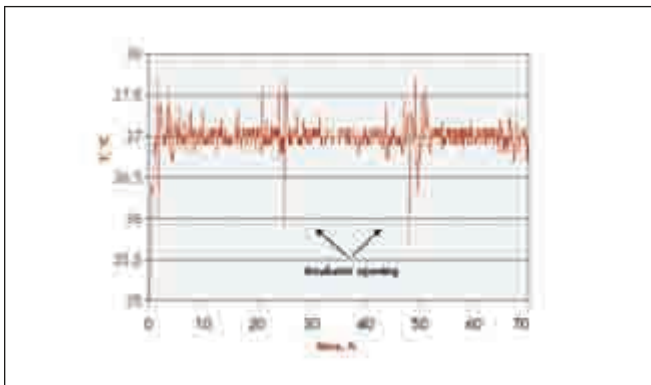


Cell Proliferation

- Overall system performance can be assessed by measuring cell proliferation in time
- Data of cell proliferation in the CO₂ Microscope Stage Incubator and in a CO₂ bench-top incubator are compared for a period of three days. Cell line: Panc-1
- As shown in the graph, cells proliferate as well as in the CO₂ bench-top incubator

Reduced Evaporation

- A combined action of the humidifying module and of the water reservoirs in the incubating chamber minimizes medium evaporation
- System design guarantees similar evaporation in all the wells
- Low evaporation rate allows long term experiments



Temperature Stability Within $\pm 0.1^\circ\text{C}$

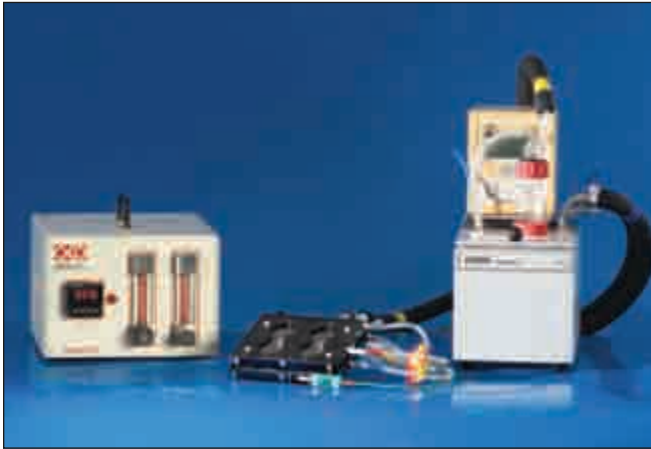
- Water jacket design of the incubating chamber and PID software insure a thermal stability and uniformity within $\pm 0.1^\circ\text{C}$
- Thermal stability is very important to reduce focus drift, while thermal uniformity in the chamber is essential to prevent water condensation



Available in USA Only

NEW Cryo-Water-Jacket CO₂ Microscope Stage Incubator

Superior Products for Live Cell Imaging



- Superior incubation stability for long term experiments
- Models to fit all XY stages on the market
- Suitable for high magnification microscopy
- Temperature control from 10°C to 50°C
- Wide selection of cell culture support adapters

The Cryo-Water-Jacket CO₂ Microscope Stage Incubator provides superior incubation stability above and below room temperature. Water is pumped from a water bath into the base plate and into the lid, which are both Water Jackets. Models fitting all XY stages on the market are available.

Chambers suitable for high magnification microscopy and multipoint experiments are available. Wide varieties of inserts are available and accept any cell culture support (petri-dishes, chamber slides, multiwell plates, etc.). The Cryo water bath allows thermal cycling.

Specimen Temperature Regulation

Temperature is directly measured inside a reference Petri-dish and is controlled by a software PID controller by circulating water from a cryostatic water bath into the Water Jacket. The software controller reads the temperature in the reference well and updates the set point temperature of the water bath, ensuring a specimen temperature stability of $\pm 0.1^\circ\text{C}$.

CO₂ Regulation

CO₂ is mixed with air in the control unit and is continuously fed into the incubating chamber to control medium pH. An optional third gas line can also be fed into the controller.

Humidity Regulation

A humidifying and a pre-heating module prevents evaporation of medium and avoids water condensation on glass and plastic surfaces.

The gas stream is warmed up by flowing into a copper coil immersed into the water bath and then is humidified by bubbling into a glass column filled with distilled water and immersed into the water bath.

To reach a nearly saturated atmosphere in the incubation chamber, without causing water condensation, the humid gas is equilibrated with the chamber by flowing into a tube embedded into the water jacket.

Software: Temperature Control Cryo

Temperature Control Software communicates with the water bath and the temperature meter ensuring a temperature stability of $\pm 0.1^\circ\text{C}$. Temperature Control Software reads sample temperature every minute and stores it in computer memory. Intelligent software tools avoid thermal shock to the specimen when the CO₂ Microscope Stage Incubator is opened (thermal shock prevention). A software temperature offset compensates the heat sink caused by oil immersion objectives (oil immersion compensation). Thermal cycle module allows thermal cycles (ramps, waves, etc).

Software Features

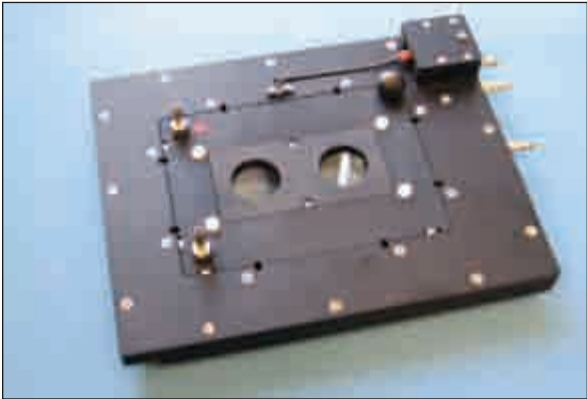
Specimen temperature display	Yes	Oil immersion compensation	Yes
Specimen temperature storage	Yes	Temperature cycles	Yes
Thermal shock prevention	Yes		

Specifications

Temperature Range	5°C to 50°C
Accuracy	$\pm 0.1^\circ\text{C}$
Heating Technology	Water jacket
Type of Controller	Software / PC required
Temperature feedback	Specimen temperature feedback
Humidification module	Heated
CO ₂ range	0 to 100%
Physical Dimensions:	
(L x W x H)	159 x 142 x 31 mm
Weight	450 g

NEW Basic and Cryo Water-Jacket CO₂ Microscope Stage Incubator & Accessories

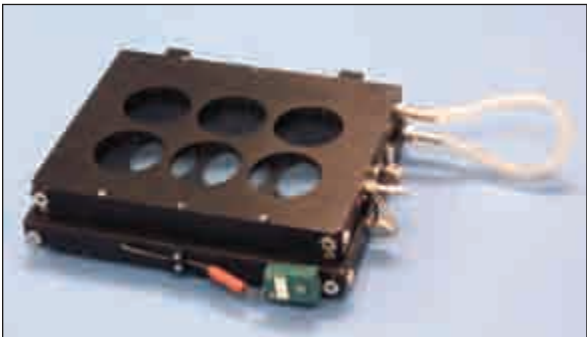
Superior Products for Live Cell Imaging



Slim Water Jacket CO₂ Microscope Stage Incubator



Interchangeable plate adapters for multiwell plates



Universal WJ CO₂ Microscope Stage Incubator



Plate adapter for Petri dishes and chamber slide



Adapters for round 25 mm #1.5 thickness coverslips

Slim 2-Well Model

This model is especially designed to be used with high NA objectives, such as 63x and 100x. Its slim profile design allows it to be used with high NA condensers as well. It can host two 35 mm Petri dishes or one chamber slide. The temperature probe can be inserted in a second 35 mm Petri dish or into a rectangular well filled with water inside the chamber.

Typical applications are time-lapse observations of a single field of view. Access ports allow insertion of perfusion tubes. Tubes are placed on the top of the chamber to pre-heat the perfusion medium before it enters into the sample.

Usually mounted on a manual XY stage. This chamber fits any Ludl/Marzhauer/Prior motorized stage, any rectangular 160 x 110 mm mechanical stage (i.e. Ludl BioPrecision and BioPoint, Marzhauer SCAN IM 120 x 100, Prior H107 and H117) and all mechanical flat stages.

A dedicated stage insert for the Nikon TI-S-E motorized XY stage is also available. For A.S.I. stages, please see the model "Universal for A.S.I. stage".

Dimensions: 207 x 155 x 22 mm.

Universal Model

This chamber can accommodate any cell culture support. Interchangeable adapters allow use of multiwell plates (6-12-24-48-96), 35 mm Petri-dishes, and chambered slides.

Designed to increase reproducibility and versatility this chamber improves experimental efficiency, and can be used both with long working distance and oil-immersion objectives. Two holes on the chamber body allow the insertion of perfusion tubing.

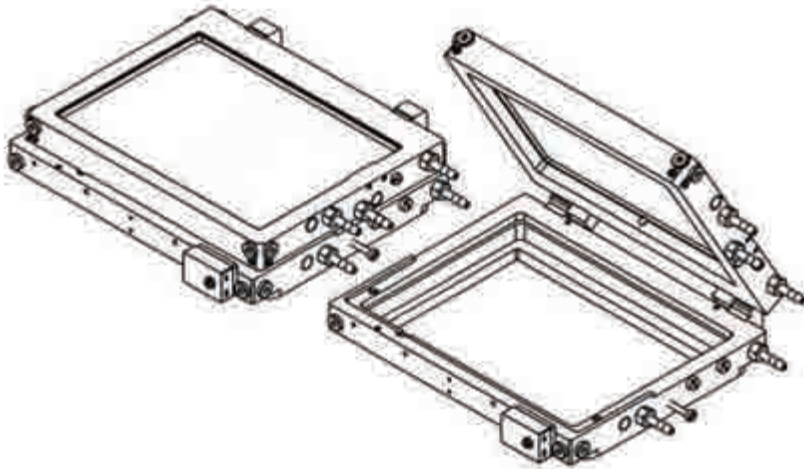
Typical applications are time-lapse observations of more than one field of view. To fully benefit from the multi-accommodation design, this chamber should be mounted on a microscope equipped with motorized focus and motorized XY stage. It fits any 160x110mm sized stage (i.e. Ludl BioPrecision and BioPoint, Marzhauer SCAN IM 120x100, Prior H107 and H117) and all mechanical flat stages.

A dedicated stage insert for the Nikon TI-S-E motorized XY stage is also available, For A.S.I. stages, please see the model "Universal for A.S.I. stage".

Dimensions: 159 x 142 x 31 mm.

NEW Basic and Cryo Water-Jacket CO₂ Microscope Stage Incubator & Accessories (continued)

Universal WJ CO₂ Microscope Stage Incubator



H101-WJC

Universal water jacket chamber, fits on 160 x 110 mm stage insert (i.e. Ludl BioPoint and BioPrecision, Marzhauser SCAN IM 120 X 100, PRIOR H107 AND H117 stages. It also fits Nikon motorized XY stages with insert TIPA. Requires at least one plate adapter. The condenser working distance is 35 mm.



H101-WJC-6035PA

Plate adapters for two 35 mm Petri dishes and one 60 mm Petri dish.



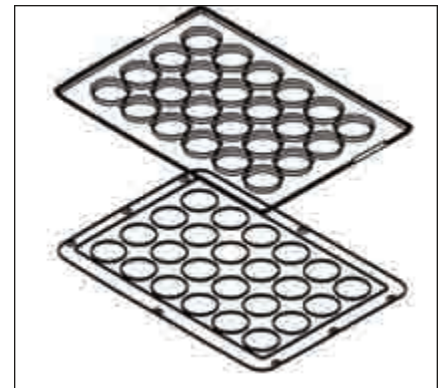
H101-WJC-6MWPA

Plate adapters for 6-well plates.



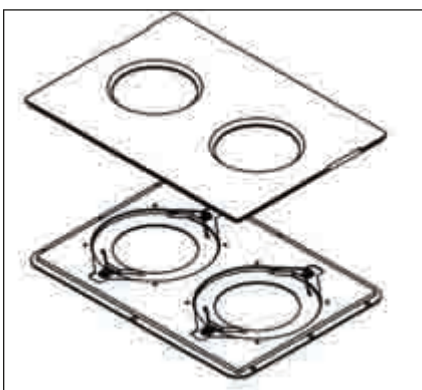
H101-WJC-12MWPA

Plate adapters for 12-well plates.



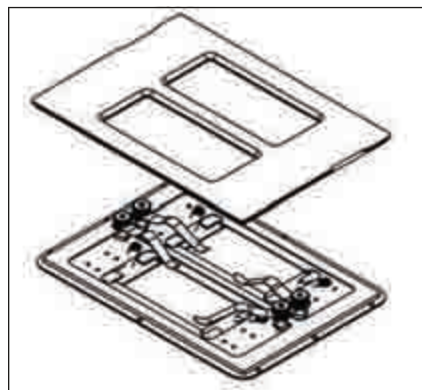
H101-WJC-24MWPA

Plate adapters for 24-well plates.



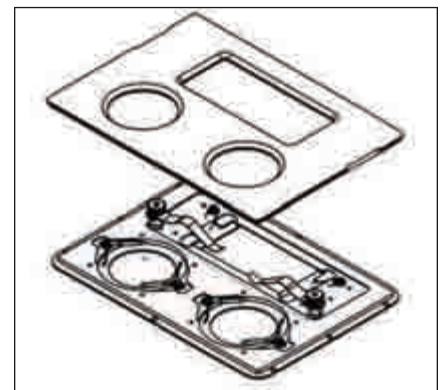
H101-WJC-60PA

Plate adapters for two 60 mm Petri dishes.



H101-WJC-[57 mm]GSPA

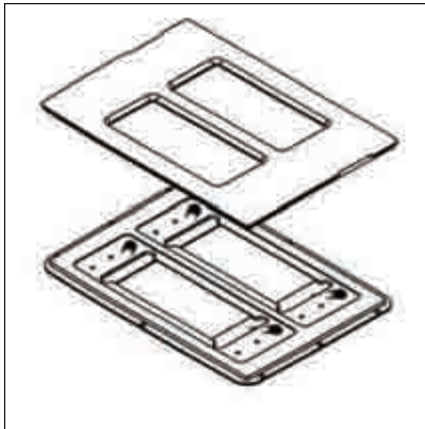
Plate adapters for two 57 mm chambered coverglass.



H101-WJC-[57 mm]GS35PA

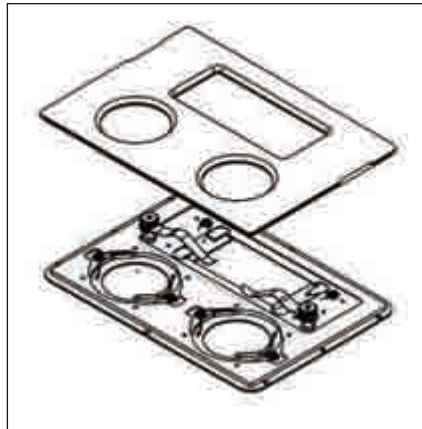
Plate adapters for one 57 mm chambered coverglass and two 35 mm Petri dishes.

NEW Basic and Cryo Water-Jacket CO₂ Microscope Stage Incubator & Accessories (continued)



H101-WJC-GSPA

Plate adapters for two standard chamber slides.



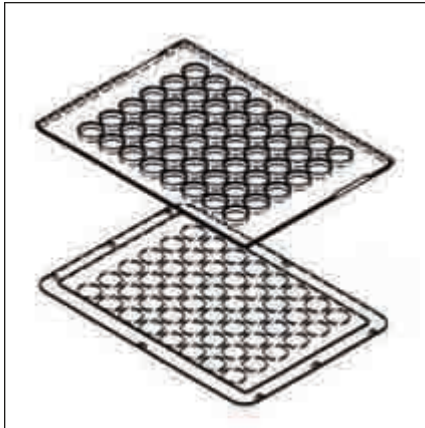
H101-WJC-GS35PA

Plate adapters for two 35 mm Petri dishes and one standard chamber slide.



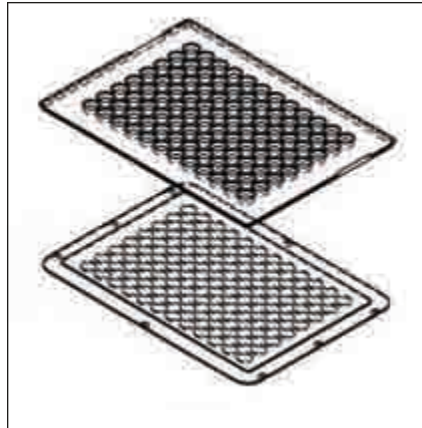
H101-WJC-35PA

Plate adapters for four 35 mm Petri dishes.



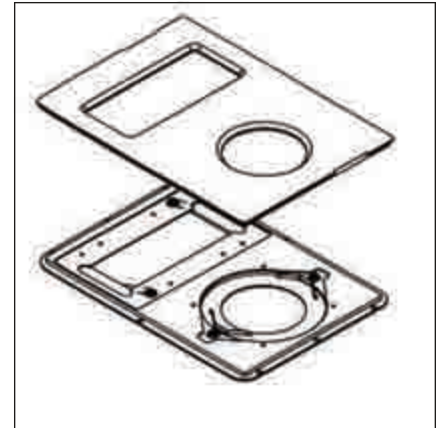
H101-WJC-48MWPA

Plate adapters for 48-well plates.



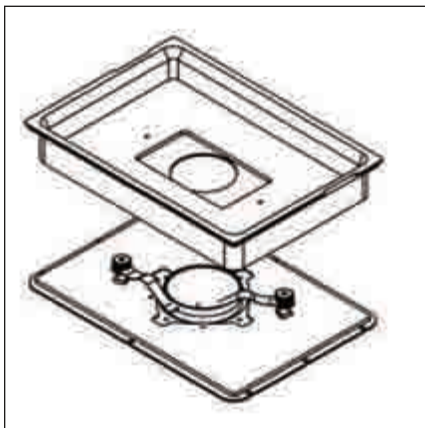
H101-WJC-96MWPA

Plate adapters for 96-well plates.



H101-WJC-GS60PA

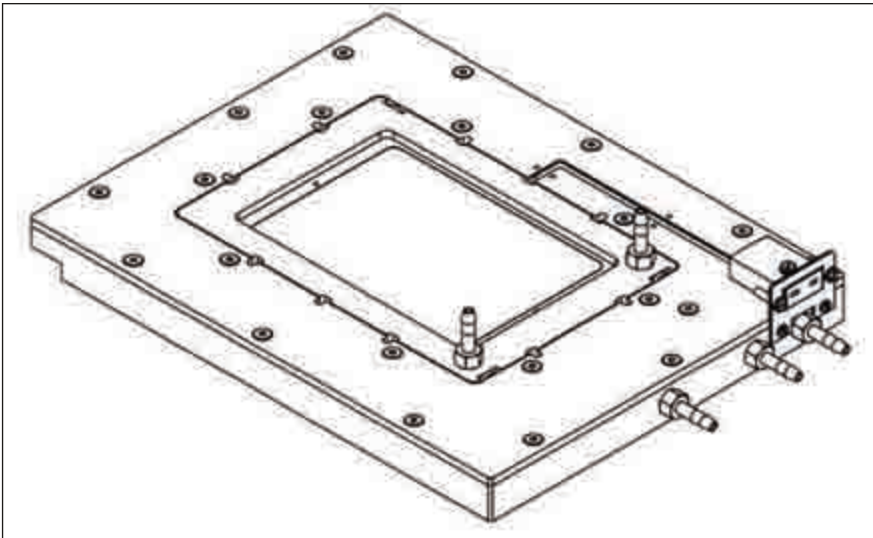
Plate adapters for one standard chamber slide and one 60 mm Petri dish.



H101-WJC-GS35PA

Deep set kit for high N.A. condensers (working distance 21 mm). Accommodates one standard chamber slide or one 35 mm Petri dishes.

NEW Basic and Cryo Water-Jacket CO₂ Microscope Stage Incubator & Accessories (continued)



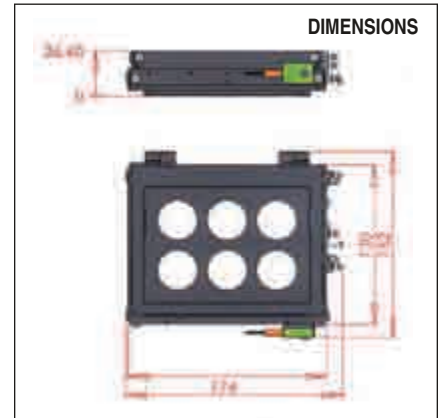
H101-WJC-SLIM

Slim water jacket chamber, suitable for high N.A. condensers. Requires at least one plate adapter. Condenser working distance 24 mm.

H101-WJC with H101-WJCMWPA

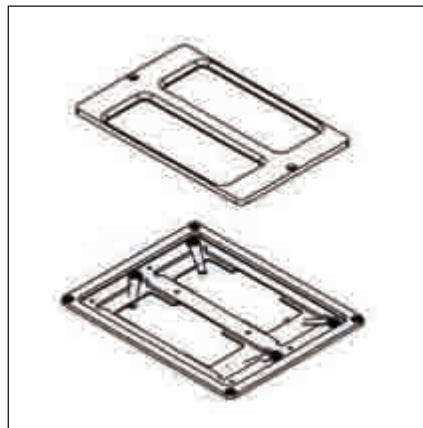


DIMENSIONS



H101-WJC-SLIM-35PA

Plate adapters for two 35 mm Petri-dishes.



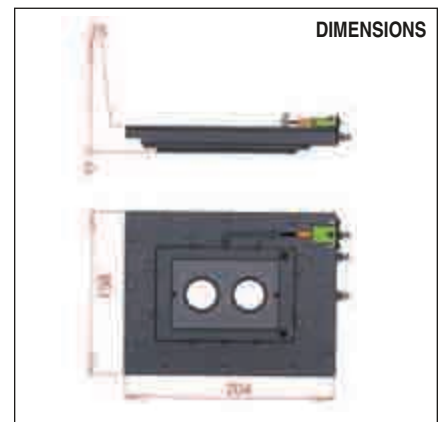
H101-WJC-SLIM-GSPA

Plate adapters for two standard chamber slides.

H101-WJC-SLIM with H101-WJC-SLIM-35PA



DIMENSIONS

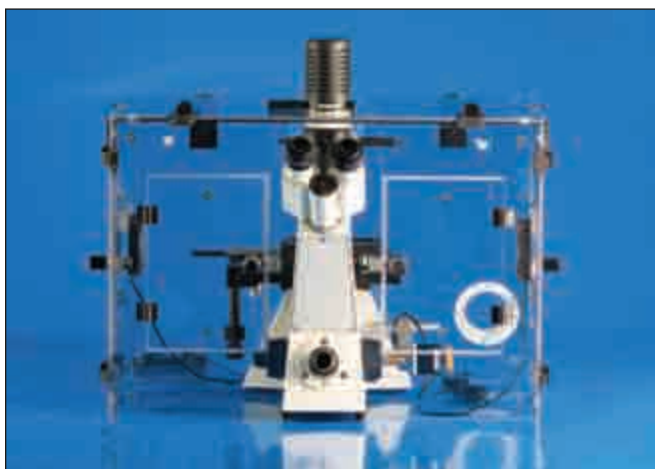
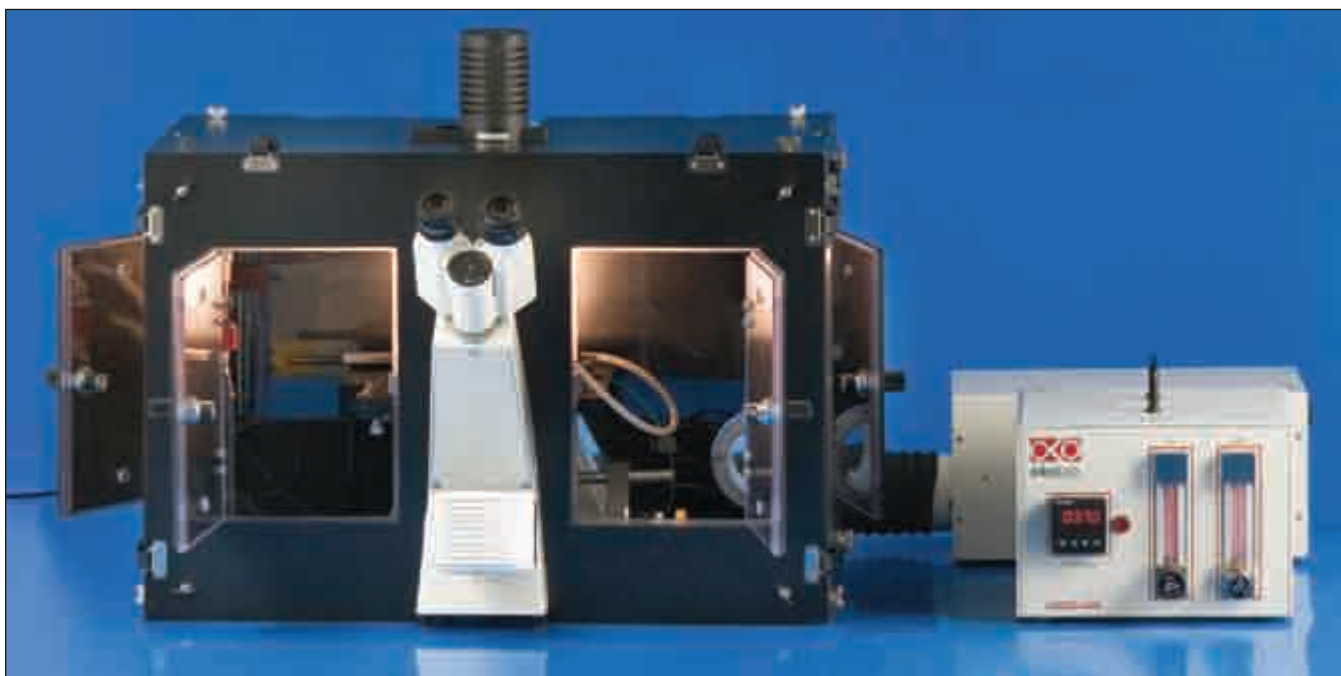


NEW Basic and Cryo Water-Jacket CO₂ Microscope Stage Incubator & Accessories (continued)

Order #	Model	Product
W4 99-0800	H101-BASIC	Heating unit- Includes water bath, temperature sensor, temperature meter, control temperature software
W4 99-0801	H101-CRYO	Heating / Cooling unit- Includes cryostatic water bath, temperature sensor, temperature meter, cryo-control temperature software
W4 99-0802	H101-CRYO-S	Temperature cycles software -enables temperature cycles and ramps
W4 99-0810	H101-HM	Humidity module- Includes gas preheating system and bubbling column
W4 99-0811	H101-BC	Bubbling column Included in item H101-HM
W4 99-0812	H101-WJC	Universal water jacket chamber for 160x110 mm stage insert (i.e Ludl BioPoint and BioPrecision, Marzhauser SCAN IM120x100, Prior H107 and H117) Requires at least one plate adapter (Condenser working distance: 35mm)
W4 99-0813	H101-WJC-6MWPA	Plate adapters for 6-well plates
W4 99-0814	H101-WJC-12MWPA	Plate adapters for 12-well plates
W4 99-0815	H101-WJC-24MWPA	Plate adapters for 24-well plates
W4 99-0816	H101-WJC-24MWPA-NUNC	Plate adapters for 24-well Nunc plates
W4 99-0817	H101-WJC-48MWPA	Plate adapters for 48-well plates
W4 99-0818	H101-WJC-96MWPA	Plate adapters for 96-well plates
W4 99-0824	H101-WJC-GSPA	Plate adapters for #2 standard chamber slides
W4 99-0927	H101-WJC-[57mm]GSPA	Plate adapter for #2 57 mm chambered coverglass
W4 99-0820	H101-WJC-GS35PA	Plate adapters for #2 35mm Petri-dish and #1 standard chamber slide
W4 99-0928	H101-WJC-[57mm]GS35PA	Plate adapters for #1 57 mm chambered coverglass and #2 35mm Petri-dish
W4 99-0929	H101-WJC-GS60PA	Plate adapters for #1 standard chamber slide and #1 60mm Petri-dish
W4 99-0821	H101-WJC-35PA	Plate adapters for #4 35mm Petri-dish
W4 99-0822	H101-WJC-6035PA	Plate adapter for #2 35mm Petri-dish and #1 60mm Petri-dish
W4 99-0823	H101-WJC-60PA	Plate adapters for #2 60mm Petri-dish
W4 99-0933	H101-WJC-DS-GS35PA	Deep set kit for high N.A. condensers (working distance 21 mm) hosts one standard chamber slide or one 35mm Petri-dish
W4 99-0930	H101-WJC-PA-CUSTOM	Custom water jacket plate adapter
W4 99-0825	TIPA	Stage insert for Nikon Ti-S-E and Ti-S-ER Motorized XY stage
W4 99-0744	IC-VICE-TI-SR	Tool to fix incubating chambers on Nikon T/Ti-SR XY stage
W4 99-0742	SAMPA	Stage Adapter allows to use Okolab Chambers with bottom rectangular shape 95x135x5mm on T/Ti-SP Plain Stage equipped with T/Ti-SAM Attachable Mechanical Stage. It replaces the Nikon plate adapter
W4 99-0826	H101-WJC-SLIM	Slim water jacket chamber Suitable for high N.A. condensers Requires at least one plate adapter Condenser working distance: 24mm
W4 99-0827	H101-WJC-SLIM-35PA	Plate adapter for #2 35mm Petri-dish
W4 99-0828	H101-WJC-SLIM-GSPA	Plate adapter for #2 chamber slides
W4 99-0832	H101-WJC-ASI Maximum plate height 17mm	Water jacket chamber for ASI XY stage. Requires at least one plate adapter
W4 99-0813	H101-WJC-6MWPA	Plate adapters for 6-well plates
W4 99-0814	H101-WJC-12MWPA	Plate adapters for 12-well plates
W4 99-0815	H101-WJC-24MWPA	Plate adapters for 24-well plates
W4 99-0816	H101-WJC-24MWPA-NUNC	Plate adapters for 24-well Nunc plates
W4 99-0817	H101-WJC-48MWPA	Plate adapters for 48-well plates
W4 99-0818	H101-WJC-96MWPA	Plate adapters for 96-well plates
W4 99-0824	H101-WJC-GSPA	Plate adapters for #2 standard chamber slides
W4 99-0927	H101-WJC-[57mm]GSPA	Plate adapter for #2 57 mm chambered coverglass
W4 99-0820	H101-WJC-GS35PA	Plate adapters for #2 35mm Petri-dish and #1 standard chamber slide
W4 99-0928	H101-WJC-[57mm]GS35PA	Plate adapters for #1 57 mm chambered coverglass and #2 35mm Petri-dish
W4 99-0665	H101-WJC-GS60PA	Plate adapters for #1 standard chamber slide and #1 60mm Petri-dish
W4 99-0821	H101-WJC-35PA	Plate adapters for #4 35mm Petri-dish
W4 99-0822	H101-WJC-6035PA	Plate adapter for #2 35mm Petri-dish and #1 60mm Petri-dish
W4 99-0823	H101-WJC-60PA	Plate adapters for #2 60mm Petri-dish
W4 99-0840	H101-WJC-AB	Water jacket chamber for Applied Biophysics. (Fits on 160x110 mm stage insert: i.e Ludl BioPoint and BioPrecision, Marzhauser SCAN IM120x100, Prior H107 and H117)

NEW CO₂ Microscope Cage Incubator

Superior Products for Live Cell Imaging



- Stable temperature control for upright and inverted microscopes
- Temperature is controlled by blowing warm air into the cage
- Built from removable panels for fast assembly
- Temperature control from ambient +3°C to 50°C
- Obscuring panels available for fluorescence applications

The CO₂ Microscope Cage Incubator is designed to maintain the required environmental conditions for cell culture around your microscopy workstation, thus enabling prolonged observations on biological specimens and allowing space for other equipment.

Cells cultured within the microscope cage incubator have been shown to proliferate as well as in a regular bench-top incubator.

Temperature is controlled by gentle stream of warm air. A small thermocouple is inserted into a reference well to control the temperature as close as possible to the sample, ensuring a specimen temperature stability of $\pm 0.1^\circ\text{C}$.

Models for virtually any inverted and upright microscope are available. A wide choice of chambers and interchangeable plate adapters allow the use of any cell culture support (petri, glass slides, multiwell plates, etc.). Compatible with manual and digital CO₂ / O₂ gas controllers.

Specifications

Temperature Range	Ambient + 3°C to 50°C
Accuracy	$\pm 0.1^\circ\text{C}$
Heating Technology	Warm air
Type of Controller	Software / PC required
Temperature feedback	Specimen temperature feedback
Humidification module	Heated
CO ₂ range	0 to 100%
Physical Dimensions:	Custom enclosures depend on microscope brand and options installed



Available in USA Only

NEW CO₂ Microscope Cage Incubator (continued)

Superior Products for Live Cell Imaging

Specimen Temperature Regulation

Temperature is directly measured inside the Petri-dish and controlled by blowing warm air from a fan heater into the plastic box around the microscope. A PID controller reads the temperature in the reference well and updates the temperature of the fan heater, ensuring a specimen temperature stability of $\pm 0.1^{\circ}\text{C}$.

Micro-Environmental Chamber

The Micro Environmental Chamber fits into the microscope stage and hosts the sample. Pre-mixed and pre-humidified air / CO₂ is continuously fed into the chamber. Interchangeable adapters for all cell culture supports are available.

CO₂ and Humidity Regulation

Medium pH is controlled by mixing CO₂ and air in the control unit and continuously feeding this mixture into the micro-environmental chamber.

An optional third gas line can be fed into the controller. A heated humidifying module prevents evaporation of culture medium and prevents water condensation on glass and plastic surfaces.

Features

Several doors on the front and side panels allow full and easy access to the microscope. In particular, two openings on the bottom of the front panel give unrestricted access to the focus knob. Additional doors can be added upon request.

Turn-to-open hinges permit direct removal of both the front and upper panel. Once these panels have been removed, the rest of the cage incubator can be easily moved backwards. When needed, the cage incubator can be reassembled around the microscope in five minutes.

Obscuring panels for fluorescence microscopy can be attached to the outside of cage incubator by means of turn-to-open hinges.



Available in USA Only



NEW CO₂ Microscope Cage Incubator (continued)

Assessing System Performance

Microscope Enclosure System Components

The Okolab microscope enclosures are made up from modular components giving the user tremendous flexibility in building a system to best match their experimental requirements. All major components may be ordered as individual items, a complete system will consist of the following items:

Custom design Lexan microscope enclosure

A few photos of your microscope are generally all that are needed to design your enclosure. Obscuring panels can be added to the Lexan enclosure to create a dark environment.

Temperature Controller

Temperature accuracy of +/- 0.1 C is maintained with in a reference well by controlling the power to a warm air blower connected to a port at the rear of enclosure. Temperature uniformity with in the enclosure is insured by the action of two strategically placed vents, reducing temperature induced focus drift.

Available Read Temperature Software allows storage of the temperature profile during the experiment. The temperature graph can be visualized in real time, recording temperature fluctuation and the set point. Data can be reloaded off line, or exported to a file. The software also features a water consumption window which predicts when the bubbler will need refilling. Software also allows real time temperature monitoring through UDP transfer protocol for third part software synchronization.

O₂ / CO₂ Controller

A two gas manual mixer is the most economical solution to gas control, typically used to mix air with CO₂ regulated to a 95% / 5% mixture.

A three gas manual mixer can be used to mix N₂/CO₂/O₂ using floating ball flowmeters. Digital CO₂ and O₂ controllers offer sensor and PID closed loop feedback control for greater accuracy.



Micro Environmental Chamber

The micro environmental chamber fits into the microscope stage and hosts the sample. The stage chamber allows the humidified stream of premixed gas to be continuously streamed around the cells. Plate adapters for the chamber allow the use of a variety of cell culture supports from Petri dishes to multiwell plates. Chambers can be used with both long working distance and oil-immersion objectives.

The chamber will fit into any 160 x 110 mm stage, i.e. Ludl BioPrecision and BioPoint, Marzhauser SCAN IM 120 x 100, Prior H107 and H117, and all mechanical flat stages. It also fits into the Nikon TI-S-E, motorized XY stage with insert TIPA. Models fitting piezo stages are also available.

Humidity Module

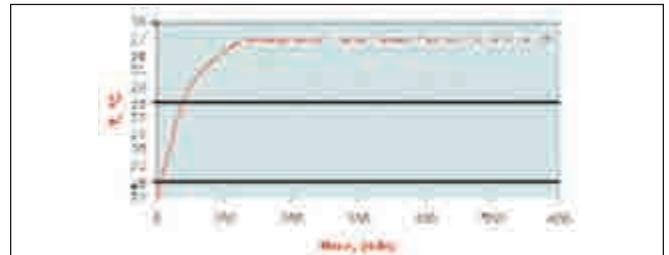
A bubbling column placed into the microscope enclosure is used to humidify the air and CO₂ stream before entering into the microenvironment chamber.



NEW CO₂ Microscope Cage Incubator (continued)

Assessing System Performance

Superior Products for Live Cell Imaging

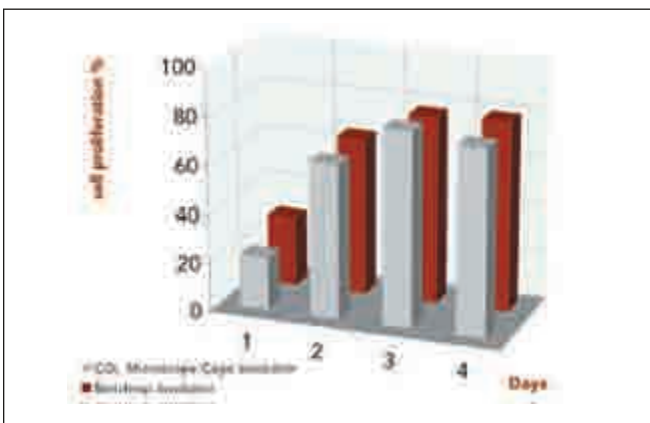


Temperature Stability Within $\pm 0.1^{\circ}\text{C}$

- Temperature stability and uniformity is guaranteed by forced ventilation into the cage incubator
- Temperature accuracy is obtained by controlling the temperature very close to the sample
- Initial warm up requires two hours

Medium evaporation below 2% per day

- A combined action of the humidifying module and of the water reservoirs in the micro-environmental chamber minimize medium evaporation
- System design guarantees similar evaporation in all the wells
- Low evaporation allows long lasting experiments



Cell proliferation

- Overall system performance can be assessed by measuring cell proliferation in time.
- Data of cell proliferation in the CO₂ microscope cage incubator and in a CO₂ bench-top incubator are compared for a period of four days. Cell line: lymphocytes (jurkat)
- As shown in the graph, cells proliferate as well as in in the CO₂ bench-top incubator.



Available in USA Only

NEW CO₂ Microscope Cage Incubator Accessories

Universal Stage Chamber Slim

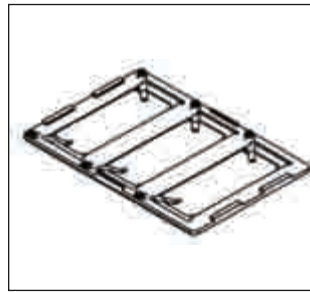
H201-MEC-SLIM

Universal Micro environmental chamber for 160 x 110 mm stage inserts (i.e. Ludl BioPoint and BioPrecision, Marzhauser SCAN IM 120 x 100, Prior H107 and H117). Chamber will accommodate 6, 12, 24, 48, and 96 multiwell plates.

For other supports, add the corresponding plate adapter. Condenser working distance is 22 mm without chamber riser and 27 mm with chamber riser.



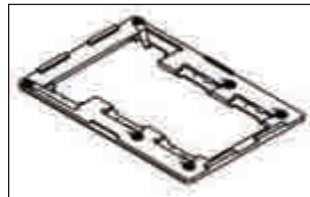
H-210-MEC-35PA
Plate adapter for 4 Petri dishes



H-210-MEC-3GSPA
Plate adapter for three standard chambered slides



H-210-MEC-GS60PA
Plate adapter for one chamber slide and one 60 mm Petri dishes



H-210-MEC-3 (57mm)GSPA
Plate adapter for three 57 mm chambered coverglass



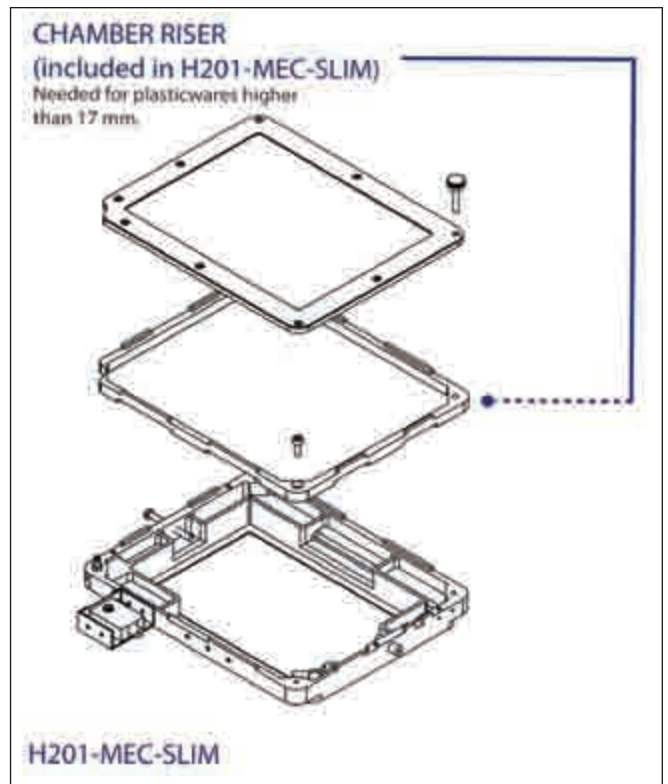
H-210-MEC-60PA
Plate adapter for two 60 mm Petri dishes



H-210-MEC-6035PA
Plate adapter for one 60 mm Petri dish and two 35 mm

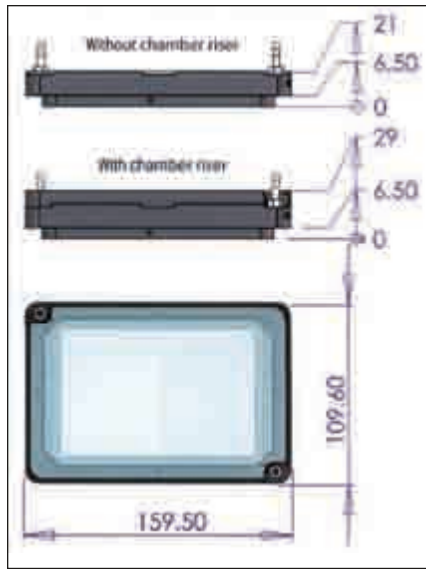


H-210-MEC-G35PA
Plate adapter for two standard chamber slides and two 35 mm Petri dishes



NEW CO₂ Microscope Cage Incubator Accessories

Universal Stage Chamber Slim (continued)



H-210-MEC-SLIM

Without chamber riser

H-210-MEC-SLIM

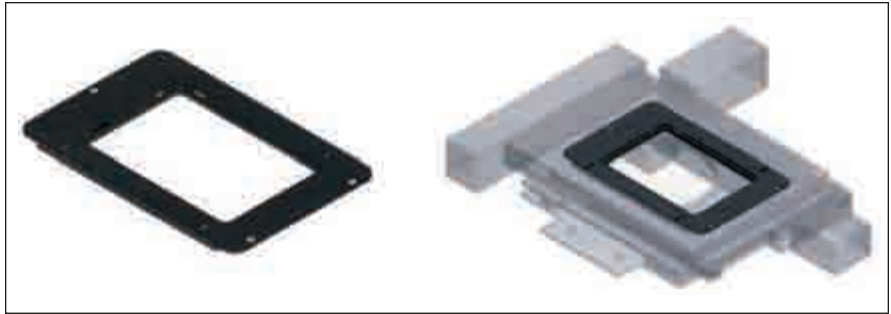
With chamber riser



H-210-MEC-SLIM

With chamber riser

CO₂ Microscope Cage Incubator Universal Stage Chamber Slim Fixing Tools



TIP

Stage insert for Nikon Ti-S-E and TiS-ER motorized XY stage



IC-VICE-TI-SR

Tool to fix incubating chambers on Nikon T/Ti-SR XY stage



SMPA

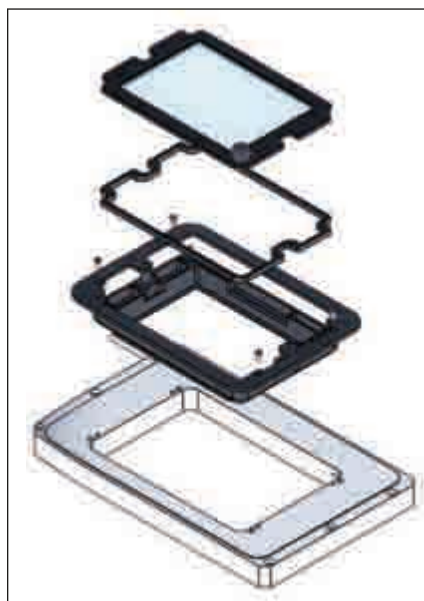
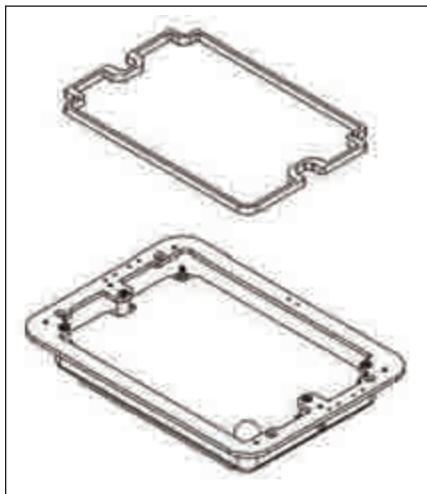
Stage adapter for mounting Oko chambers with bottom rectangular shape 95 x 135 mm on T/Ti-SP plain stage equipped with T/Ti-SAM attachable mechanical stage, Replaces Nikon plate adapter.

NEW CO₂ Microscope Cage Incubator Accessories (continued)

CO₂ Microscope Cage Incubator Stage Chamber For Piezo Prior NZ250 and NZ500

Chamber Riser

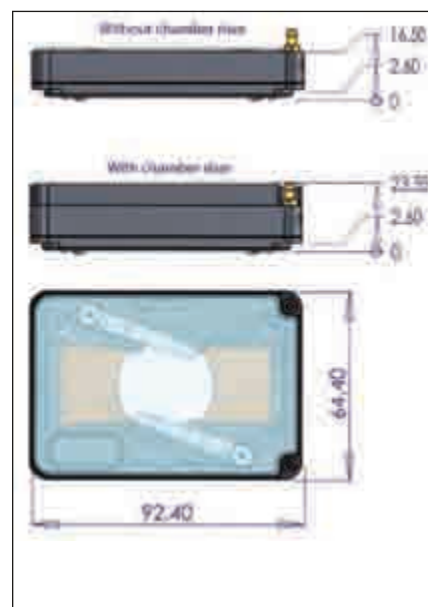
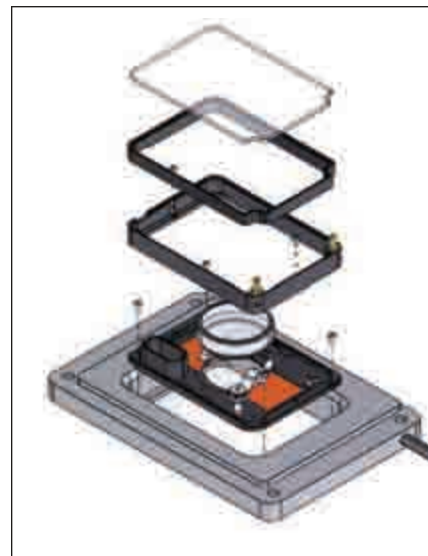
Included in the H201-MEC-NZ500. Needed for multiwell plates higher than 17 mm



H201-MEC-NZ500

Micro environmental chamber for Prior NanoScan Z- stage NZ250 and NZ500. Accommodates 6, 12, 24, 48, and 96 multiwell plates. For other supports add the corresponding plate adapter. Condenser working distance: 22 mm without chamber riser and 26 mm with chamber riser.

CO₂ Microscope Cage Incubator Stage Chamber for Prior NZ100 and NZ200



H201-MEC-PZ100

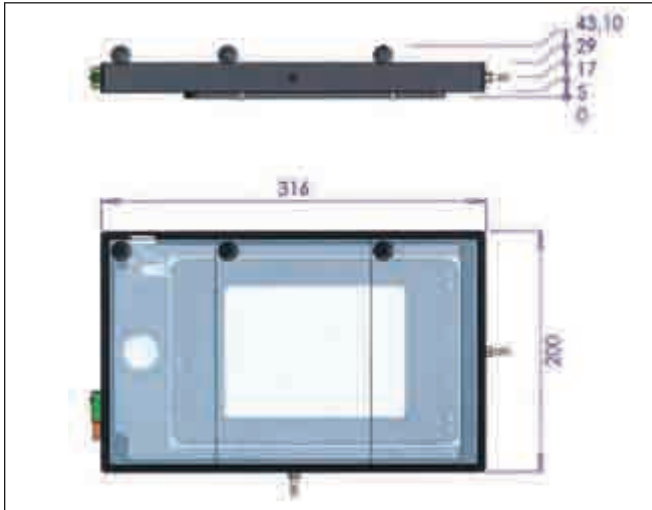
Micro environmental chamber for Prior NanoScan Z- stage NZ100 and NZ200. Accommodates one 35 mm Petri dish or one chamber slide.

NEW CO₂ Microscope Cage Incubator Accessories (continued)

CO₂ Microscope Cage Incubator Stage Chamber for Mad City Labs Piezo Stage

H201-MEC-MCLTi

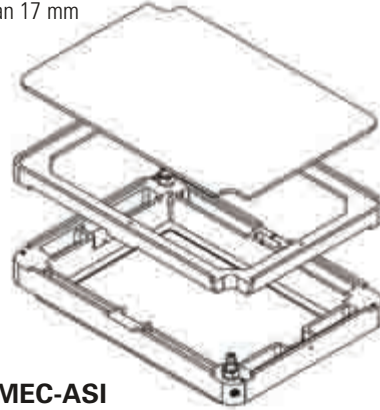
Micro environmental chamber for Mad City Labs Nano Z100 piezo stage.



CO₂ Microscope Cage Incubator Stage Chamber for ASI Stage H201-MEC-ASI

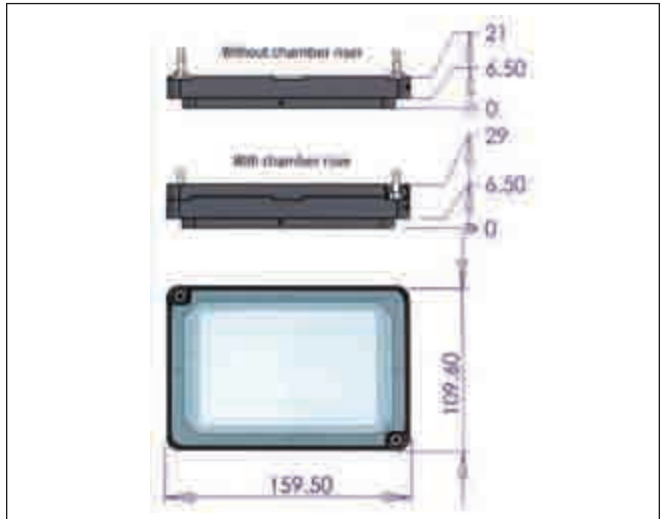
Chamber Riser

Included in the H201-MEC-ASI. Needed for multiwell plates higher than 17 mm



H-210-MEC-ASI

Micro environmental chamber for ASI stage, accomodates 6,12, 24, 48, and 96 multiwell plates. For other supports add the corresponding plate adapter.



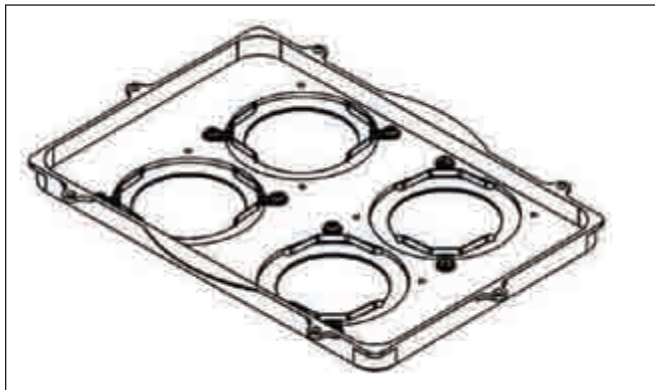
H-210-MEC-ASI

Micro environmental chamber for ASI stage



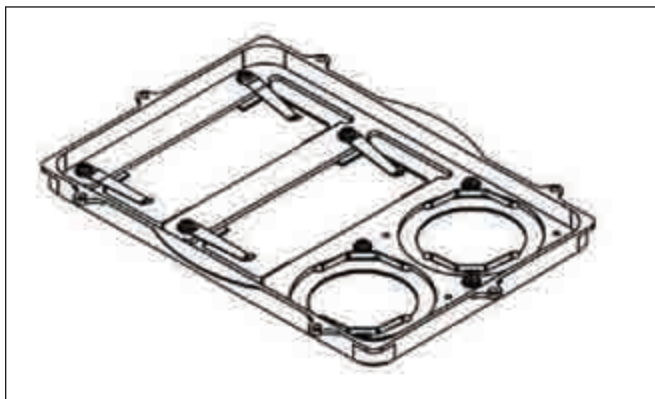
NEW CO₂ Microscope Cage Incubator Accessories (continued)

CO₂ Microscope Cage Incubator Stage Chamber for Leica SP5 Galvo Stage H201-MEC-LG



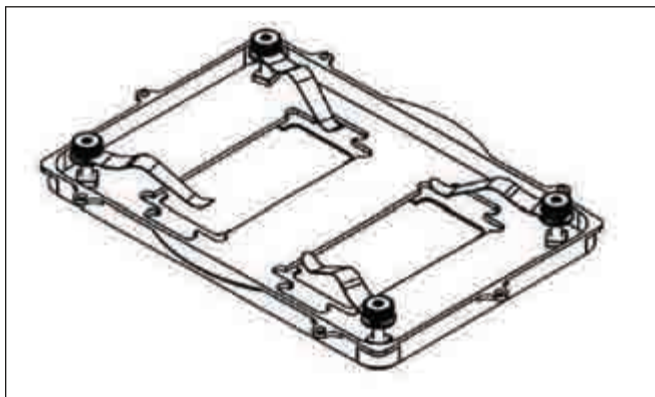
H-210-MEC-LG35PA

Plate adapter for four 35 mm Petri dishes



H-210-MEC-LG-GS35PA

Plate adapter for two #2 chamber slides and two mm Petri dishes

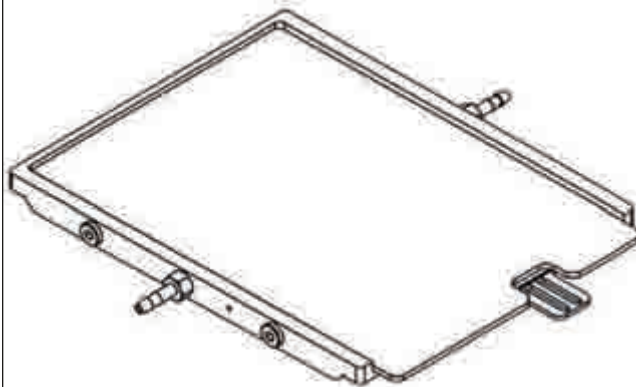


H-210-MEC-LG-(57 mm)GSPA

Plate adapter for two 57 mm chambered coverglass

ME-CHAMBER

Plate adapter for two 60 mm Petri dishes



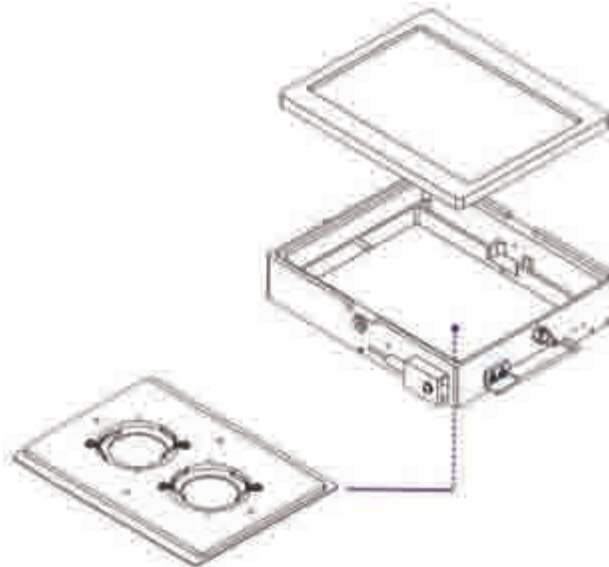
H-210-MEC-LG

Micro environmental chamber for Leica SP5 Galvo Stage

CO₂ Microscope Cage Incubator Stage Chamber for Manual Stage H201-MEC-MAN

H-210-MEC-MAN

Micro environmental chamber for mechanical flat XY stages. Accommodates 6, 12, 24, 48, and 96 multiwell plates. For other supports, add the corresponding plate adapter.



H-210-MEC-MAN-35PA

Plate adapter for two 35 mm Petri dishes

NEW CO₂ Microscope Cage Incubator Accessories (continued)

Order #	Model	Product
W4 99-0650	H201	Microscope lexan enclosure
W4 99-0652	H201-OP	Obscuring panels can be added to the lexan enclosure to create a dark environment
W4 99-0654	H201-T1	Temperature control unit Includes: PID Temperature control unit; air heater; auxiliary fans, temperature sensor
W4 99-0655	H201-T2	Temperature control unit with two heaters Includes PID Temperature control unit; 2 air heaters; auxiliary fans, temperature sensor. Required if room temperature is less than 21°C
W4 99-0674	H201-TS	ReadTemperature Software records the temperature profile during the experiment
W4 99-0677	H201-BC	Bubbling column - humidifies the gas stream before the inlet into the chamber
Chambers		
W4 99-0658	H201-MEC-SLIM	Universal Micro environmental chamber for 160 x 110 mm stage insert (i.e Ludl BioPoint and BioPrecision, Marzhauser SCAN IM120 x 100, Prior H107 and H117) accommodates 6, 12, 24, 48, 96 multiwell plates. Condenser working distance: 22 mm without the chamber riser and 27 mm with the chamber riser
W4 99-0294	H201-MEC-NZ500	Micro environmental chamber for Prior NanoScan Z-stage NZ250 and NZ500 accommodates 6-12-24-48-96 multiwell plates. Condenser working distance: 21 mm without the chamber riser and 26mm with the chamber riser
W4 99-0931	H201-MEC-ASI	Micro environmental chamber for ASI stage accommodates 6, 12, 24, 48, 96 multiwell plates. Condenser working distance: 20 mm without the chamber riser and 28 mm with the chamber riser
Plate Adapters		
W4 99-0295	H201-MEC-3GSPA	Plate adapter for #3 standard chamber slides.
W4 99-0660	H201-MEC-1S2[57mm]GSPA	Plate adapter for #1 standard chamber slide and #2 57 mm chambered coverglass
W4 99-0680	H201-MEC-GS35PA	Plate adapter for #2 standard chamber slides and #2 35 mm Petri-dish
W4 99-0692	H201-MEC-GS60PA	Plate adapter for #1 standard chamber slide and #1 60 mm Petri-dish
W4 99-0926	H201-MEC-35PA	Plate adapter for #4 35 mm Petri-dish
W4 99-0710	H201-MEC-60PA	Plate adapter for #2 60 mm Petri-dish
W4 99-0691	H201-MEC-6035PA	Plate adapter for #1 60 mm Petri-dish and #2 35 mm Petri-dish
W4 99-0661	H201-MEC-PA-CUSTOM	Customized plate adapter

NEW CO₂ Microscope Cage Incubator Accessories (continued)

Order #	Model	Product
Fixing Tools		
W4 99-0825	TIPA	Stage insert for Nikon Ti-S-E and Ti-S-ER Motorized XY stage
W4 99-0744	IC-VICE-TI-SR	Tool to fix incubating chambers on Nikon T/Ti-SR XY stage
W4 99-0742	SAMPA	Stage Adapter that allows to use Okolab Chambers with bottom rectangular shape 95 x 135 x 5 mm on T/Ti-SP Plain Stage equipped with T/Ti-SAM Attachable Mechanical Stage
W4 99-0878	H201-MEC-PZ100	Micro environmental chamber for Prior NanoScan Z-stage NZ100 and NZ200 accommodates one 35 mm Petri-dish or one chamber slide
W4 99-0879	H201-MEC-MCLTi	Micro environmental chamber for Mad City Labs Nano-Z100-N Piezo stage on Nikon TI-S-E XY stage
W4 99-0880	H201-MEC-LG	Micro environmental chamber Leica SP5 Galvo Stage
W4 99-0881	H201-MEC-LG-3GSPA	Plate adapter for #3 standard chamber slides
W4 99-0882	H201-MEC-LG-35PA	Plate adapter for #4 35mm Petri-dish
W4 99-0883	H201-MEC-LG-GS35PA	Plate adapter for #2 standard chamber slides and #2 35 mm Petri-dish
W4 99-0884	H201-MEC-LG-[57mm]GSPA	Plate adapter for #2 57 mm chambered coverglass
W4 99-0885	H201-MEC-LG-S35PA	Plate adapter for #1 35 mm Petri-dish
W4 99-0886	H201-MEC-LG-S60PA	Plate adapter for #1 60 mm Petri-dish
W4 99-0887	H201-MEC-FST	Micro Environmental chamber for mechanical flat XY stage with circular opening (i.e. Nikon T/Ti-SR and T/Ti-SSR & Olympus IX2-SFR and IX2-SLV2) accomodates 6-12-24-48-96 multiwell plates. Condenser working distance: 22 mm without the chamber riser and 27 mm with the chamber riser
W4 99-0888	H201-MEC-FST-35PA	Plate adapter for #2 35 mm Petri-dish. Circular bottom shape
W4 99-0889	H201-MEC-FST-GSPA	Plate adapter for #2 Standard Chamber Slides. Circular bottom shape
W4 99-0890	H201-MEC-FST-[57MM]GSPA	Plate adapter for #2 57 mm Chambered Coverglass, Circular bottom shape
W4 99-0891	H201-MEC-FST-S60PA	Plate adapter for #1 60 mm Petri-dish. Circular bottom shape
W4 99-0892	H201-MEC-FST-SI	External rectangular frame required to lock H201-MEC-FST on Nikon T/Ti-SR and Ti-SSR and Olympus IX2-SFR and IX2-SLV2 XY stages
W4 99-0893	H201-MEC-MAN	Micro environmental chamber for Zeiss mechanical flat XY stages with Object Guide 130 x 85 and ObjectTraverser M. accomodates 6, 12, 24, 48, 96 multiwell plates
W4 99-0894	H201-MEC-MAN-35PA	Plate adapter for #2 35 mm Petri-dish
W4 99-0895	H201-MEC-UPRIGHT	Micro environmental chamber for upright microscopes. It allows to work both with LD and immersion objectives, requires a plate adapter
W4 99-0896	H201-MEC-UPRIGHT-LID-F	Flat lid for long distance objectives
W4 99-0897	H201-MEC-UPRIGHT-LID-WIMM	Lid for immersion objectives, two parts: one part rests on the main body, the top one has an hole allowing objective insertion. The top part can slide on the fixed part, allowing to move the H201-MEC-UPRIGHT
W4 99-0898	H201-MEC-UPRIGHT-LID-MM	Flat sliding lid Suitable to use H201-MEC-UPRIGHT along with MicroManipulators
W4 99-0899	H201-MEC-UPRIGHT-35PA	Plate adapter for #1 35 mm Petri-dish
W4 99-0900	H201-MEC-UPRIGHT-60PA	Plate adapter for #1 60 mm Petri-dish

Two Gas Mixer 2GF_Mixer



- Works with any brand microscope incubator
- CO₂ concentrations in the 0-15% range
- Reusable PTFE membrane filter
- Accessories:
 - gas filter
 - pressure gauge for CO₂ with regulator
 - two white rigid tubes of 6mm O.D. 3m long
 - one blue rigid tube of 6mm O.D. 2 m long

Two Gas Mixer

2GF_Mixer is a two gas mixer, it is generally used to generate CO₂- Air mixtures with an adjustable CO₂ concentration in the range 0-15%. 2GF_Mixer can be used as a stand-alone device as well as in combination with any kind of microscope incubator.

Air and CO₂ flows are regulated by two floating ball flow meters in the range 0.2 – 1.7 NI/min and 0.013 – 0.13 NI/min, respectively. As an example, Table 1 reports a set of flow rates to obtain a concentration of CO₂ equal to 5%.

A more Comprehensive table is reported in the manual.

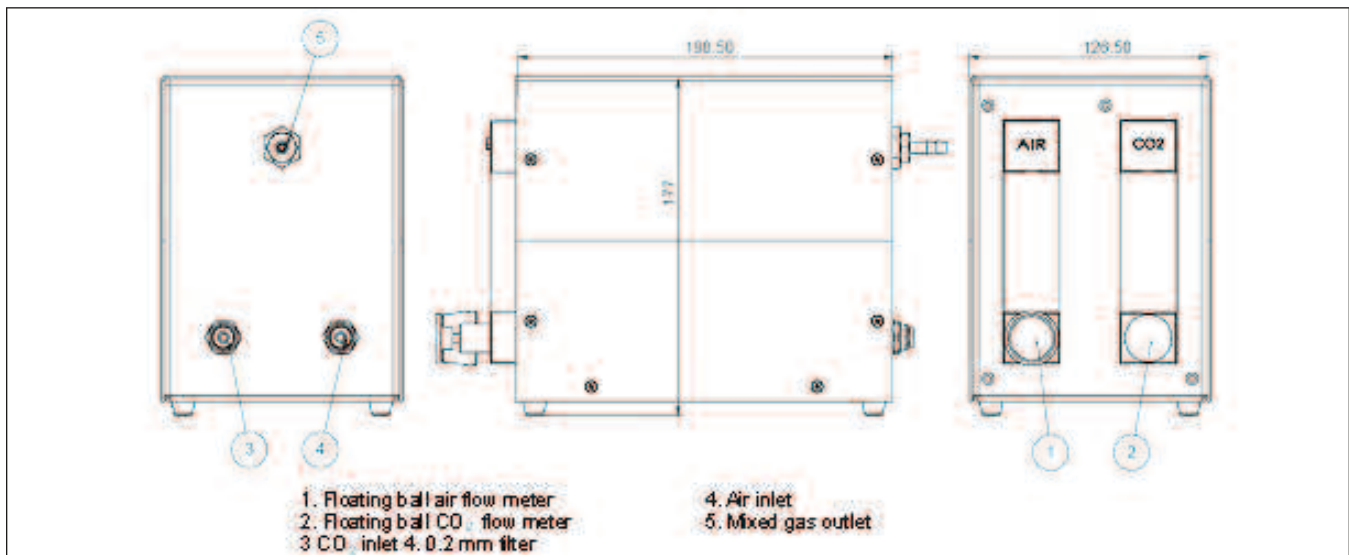
Specifications

Second gas set point range	0-15%
Accuracy of second gas concentration	±0.1%
Filtering device	Reusable PTFE membrane with 0.2 mm pores
Compatibility	Any microscope incubator
Physical Dimensions:	
(L x W x H)	220 x 128 x 178 mm
Weight	1.9 kg

Air / CO₂ flow rates to obtain a 5% CO₂ mixture

Target Gas %		Gas flow rate values to set (NI/min)		
Air	CO ₂ (%)	Air	CO ₂ (%)	Total
95.0	5.0	0.8	0.04	0.84

Order #	Model	Product
W4 99-0484	2GF_Mixer	Two Gas Mixer



Digital Gas Mixer DGTCO2BX (-D-RS232)



- Works with any brand microscope incubator
- CO₂ concentrations in the 0-20% range
- Stand alone or Software driven
- Accessories:
 - gas filter
 - pressure gauge for CO₂ with regulator
 - two white rigid tubes of 6mm O.D. 3 m long
 - one blue rigid tube of 6mm O.D. 2 m long
 - RS232 serial cable (-D-RS232 version only)
 - CD with control software (-D- RS232 version only)

Digital Gas Mixer

The DGTCO2BX is a Digital Control Unit that generates a CO₂-Air mixture with an adjustable CO₂ concentration in the range 0-20%, with an accuracy of $\pm 5\%$ of CO₂ concentration, for example, if CO₂ set point is

5%, accuracy is $\pm 0.25\%$. DGTCO2BX can be used as a stand-alone device as well as in combination with any kind of microscope incubator. The air flow is regulated by a floating ball air flow meter in the range 0.2 to 0.8 NI/min.

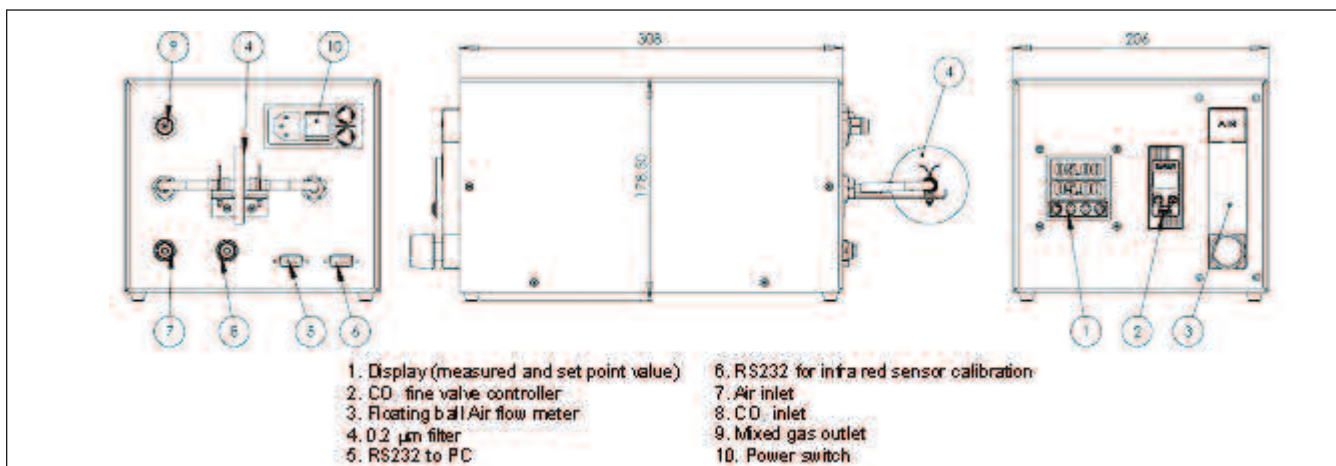
Sensing Technology

A CO₂ infrared sensor continuously measures CO₂ concentration in the mixed gas stream and a PID closed loop controller gives feedback to a fine valve regulating CO₂ flow. The measured value of CO₂ concentration is displayed in real time in green. An alarm can be set on CO₂ concentration so that if CO₂ concentration goes below set value, the display color turns red and a buzzer turns on.

Specifications

Sensing technology	Non dispersive infrared (NDIR) dual wave length decator
CO ₂ Set Point value range	0-20%
Accuracy	$\pm 5\%$ of CO ₂ concentration, i.e. $\pm 0.25\%$ if CO ₂ is 5%
Repeatability of CO ₂ Concentration	Below 0.1%
Air flow rate	From 0.2-1.8 NI/min
Filtering device	Reusable PTFE membrane with 0.2 mm pores
Digital interface (-D-RS232)	RS232 to PC
Communication Software (-D- RS232)	Stand alone version and Plug-in Version for all Okolab software
Compatibility	Any microscope incubator
Voltage/frequency	110-230 VAC 50-60 Hz
Physical Dimensions:	
(L x W x H)	206 x 178 x 310 mm
Weight	3.5 kg

Order #	Model	Product
W4 99-0486	DGT-CO2BX	Digital Gas Mixer (stand alone)
W4 99-0487	DGT-CO2BX (-D-RS232)	Digital Gas Mixer (stand alone with serial cable and software)



Digital Gas Mixer (Continued)

Performance Assessment

Figure 2 and 3 report CO₂ concentration as a function of time in a fixed set point value experiment (Figure 2) and in a step change experiment.

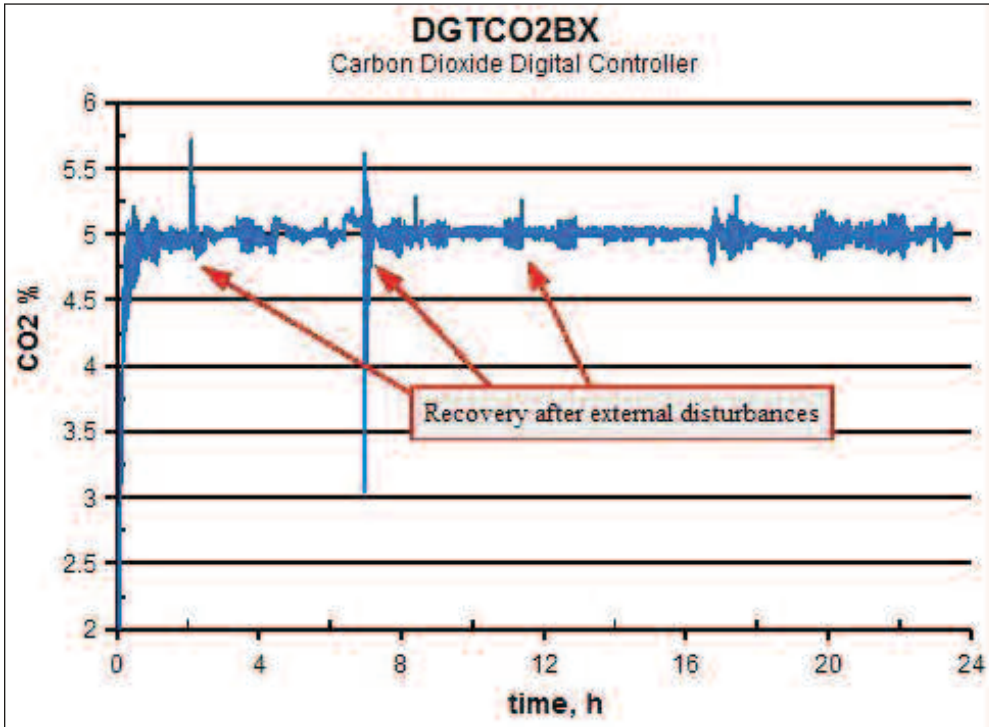


Fig. 2 CO₂ concentration during 2-days experiments

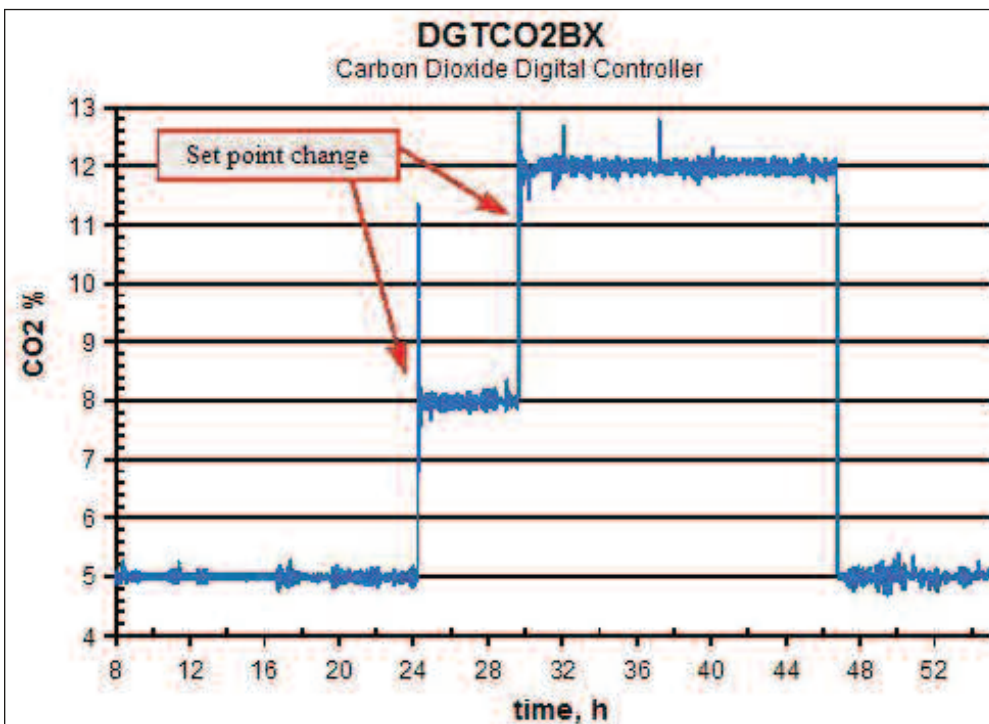


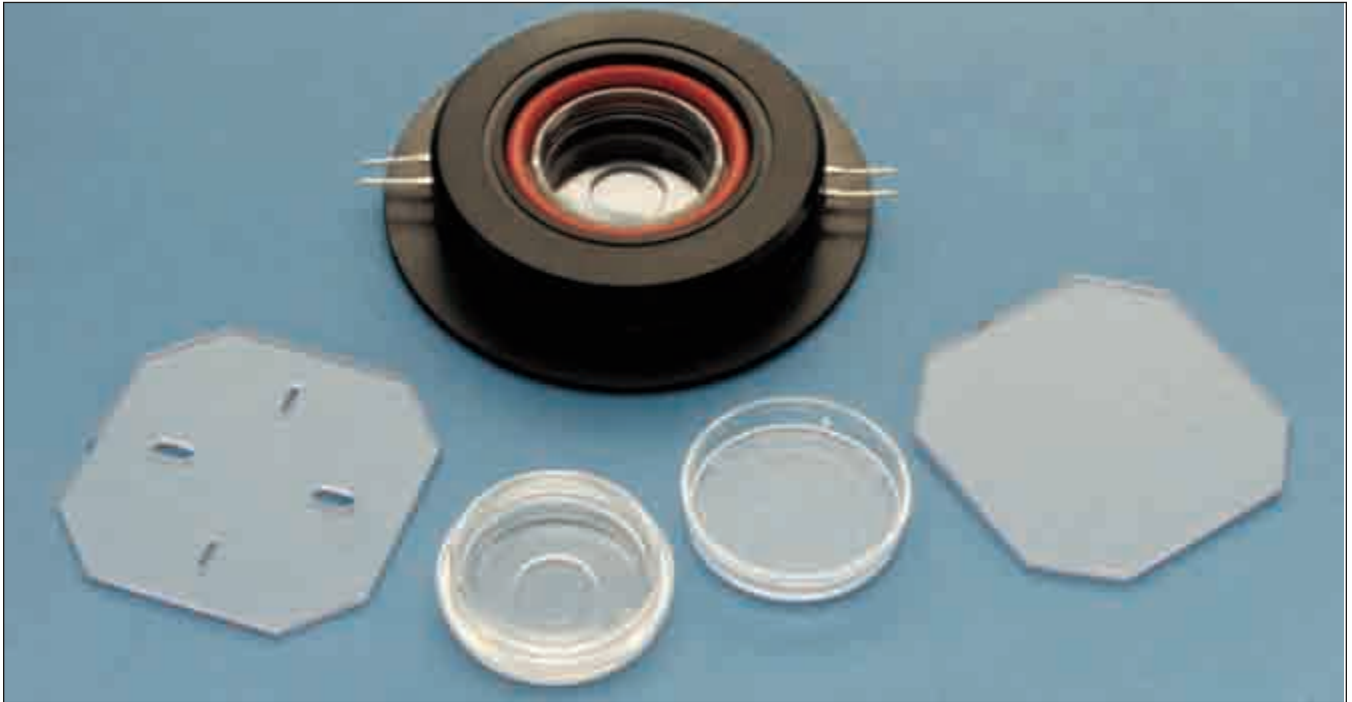
Fig. 3 CO₂ concentration in step up and step down experiments

micro-incubators

DH-35

Culture Dish Heater

Deep heating for 35 mm culture dishes



DH-35 Culture Dish Heater work with Corning 35 mm tissue culture dishes (Corning p/n 25000) and are designed for mounting on most microscopes. The holder is machined in two pieces. The top half is easily removed for replacement of dishes.

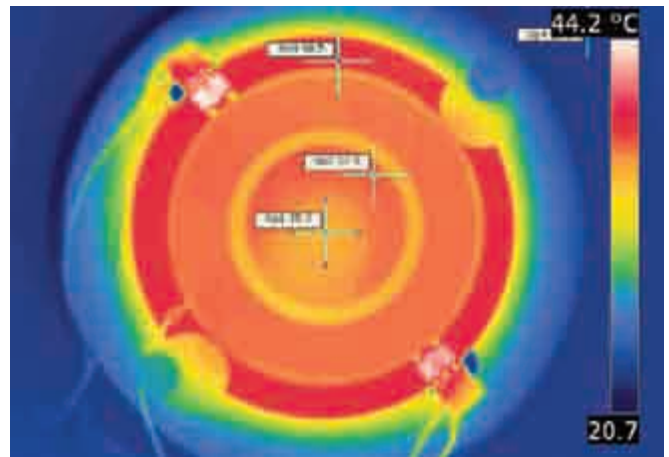
Dishes can be placed in the holder with or without dish covers. The holder is supplied with two additional holder covers, one of which has openings to allow for perfusion or insertion of probes or electrodes.

The base of the DH-35 has a 19 mm diameter aperture. Stage adapters are available for many microscopes, see pages 64 to 69. The DH-35 is used with the CC-28 Cable Assembly.

Corning P/h 2500 W4 65-0054 LU-PD Sleeve of plastic 35 mm dishes, pkg of 20, see page 175.

Specifications

Height	14.7 mm
Base ø	79.3 mm
Well	4 mm depth
Base Height	6.3 mm overall



Thermograph DH-35 with a Corning 35 mm Petri dish.

Order #	Model	Product
W4 64-0110	DH-35	Culture Dish Heater, 35 mm
W4 64-0106	CC-28	Cable Assembly for Heater Platforms
W4 64-0350	AR-1	Adapter Ring for Willco Dish

Popular Stage Adapter Microscopes

W4 64-0291	SA-NIK	Nikon Diaphot, TE200 & TE300
W4 64-0295	SA-OLY/2	Olympus IMT-2, IX & BX50WI
W4 64-0296	SA-20LZ	Zeiss Axiovert , Leica DMIRB & DMIL

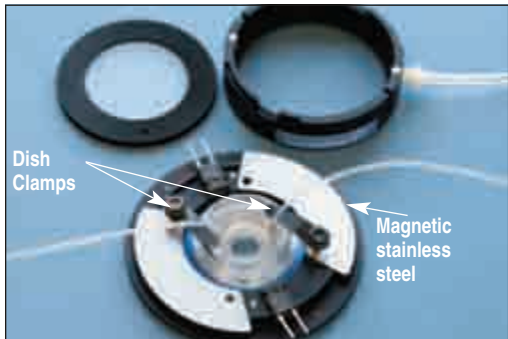
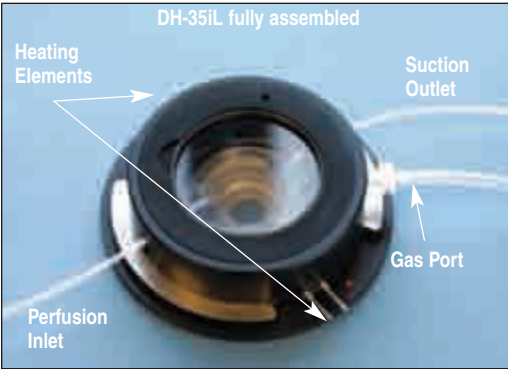
For other microscopes, please consult our technical support department.

micro-incubators

DH-35iL

Micro-incubation System for 35mm Cell Culture Dishes

Complete environment on the microscope - New light weight for use in Z stages 105 grams



- Designed for glass bottom 35 mm dishes
- Permits imaging, temperature and gas environment control
- Compatible with Corning, Falcon, MatTek, Nunc, Willco Wells and WPI Dishes
- Unique dish clamps permit easy cell access
- Compatible with Warner's RC-37 Cell Culture Dish Perfusion Chamber Inserts

The introduction of glass bottomed 35 mm culture dishes extended their use into areas such as confocal microscopy, fluorescence microscopy, and high resolution image analysis. The DH-35iL Culture Dish Incubator is a system designed for imaging live cells in an open culture dish (for easy access) or in a closed dish (for gas atmosphere control).

DH-35iL Incubators work well with 35 mm culture dishes from all suppliers. Adapter rings are supplied to ensure a close fit for the supported dish. Dishes can be placed in the holder with or without dish covers.

The holder is machined in three pieces. The midsection and top are easily removed for dish replacement and enables the positioning of electrodes at low angles. Resistive heating of the DH-35iL is provided via the optional Warner TC-324B/TC-344B Temperature Controllers and a CC-28 cable. Clamps are provided to ensure good contact between the dish and the heated surface and to prevent unwanted movement. The removable midsection is magnetically secured and has several ports to allow multi-channel perfusion, atmospheric maintenance, and aspiration of the dish.

The base of the holder has a 25 mm aperture and the removable cover features a 36 mm glass aperture.* Included with the system are an MP-2 Perfusion Manifold and a set of 6 culture dish adapter rings.

When combined with the Warner RC-37 Cell Culture Perfusion Chamber Insert, a complete micro-environmental system is achieved, and this system is compatible with Warner's SH-27B and SF-28 In-line Solution Heaters.

Series 20 Stage adapters are available for all major microscopes. Custom or modified stage adapters are also available; call our technical support department for details. See pages 64 to 69 for Stage Adapters.

* Distance between bottom and top cover glass is 18.3 mm.

Order #	Model	Product
W4 64-0349	DH-35iL	Culture Dish Incubation System, Includes Set of 6 Adapter Rings

Accessories and Replacement Parts

W4 64-0351	AR-4	Retaining Clips, Magnetic Holders MAG-1 and MAG-3, Wire Probe Support, Lift Tool, PE-160/10 CFlex Tubing
W4 64-0100	TC-324B	Heater Controller, Single Channel
W4 64-0101	TC-344B	Heater Controller, Dual Channel
W4 64-0106	CC-28	Cable Assembly for Heater Platforms
W4 64-0102	SH-27B	In-line Solution Heater
W4 64-0103	SF-28	In-line Solution Heater
W4 64-1543	HSC-1	Heated Top Coverslip
W4 64-1544	HSC-RPL	Replacement ITO Coverslip

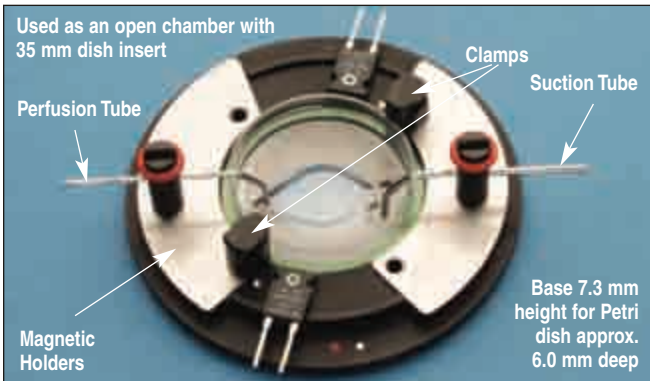
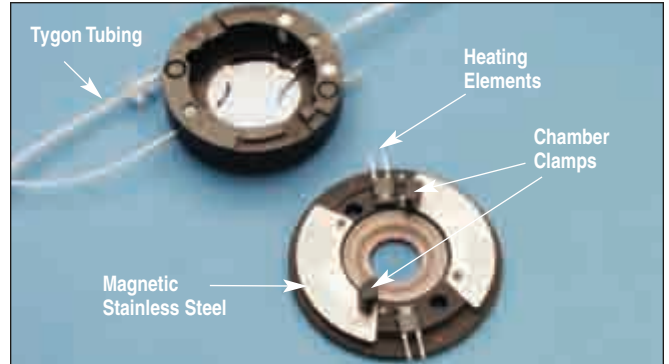
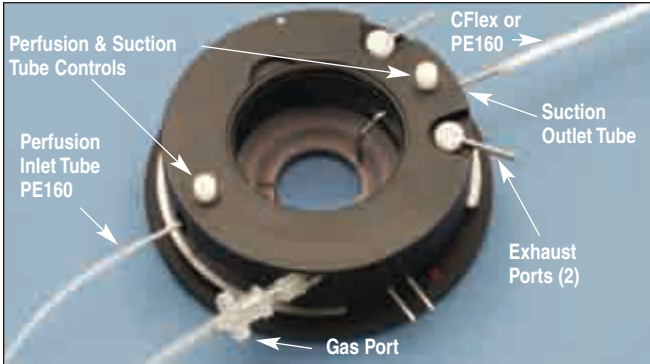
micro-incubators

DH-40i

Micro-Incubation System

Complete environment on the microscope

Permits imaging with perfusion, temperature and gas control



- Designed for RC-40 Quick Change Imaging Chambers and 35 mm culture dishes
- Adapters for Willco Wells, Corning, Nunc, WPI, MatTek and Falcon dishes
- Heated top coverslip (optional) eliminates condensation when used as a closed chamber
- Accommodates upright and inverted microscopes

The DH-40i Micro-Incubator is a system designed for imaging live cells at the required temperature and atmospheric conditions. This versatile chamber is designed for high resolution image analysis, fluorescence microscopy and time-lapse imaging studies.

DH-40i incubators work with Warner RC-40 Quick Change Imaging Chambers and 35 mm culture dishes. The removable top section of the incubator is magnetically held in place and has several sealed ports to allow perfusion, aspiration, and gas atmosphere maintenance. Perfusion and suction tubes can be easily adjusted without disturbing the cell environment. When used as an open bath chamber, magnetic holders are supplied to allow entry of perfusion and suction tubes into Series 40 chambers and 35 mm dishes. Clamps are provided to insure good contact between the chamber and the heated surface, and to prevent movement. Adapter rings are supplied to insure a close fit for 35 mm culture dishes.

The base of the holder has a 25 mm diameter aperture and the removable top section features a 40 mm glass aperture.* An optional heated top coverslip eliminates condensation when used as a closed chamber.

Resistive heating of the DH-40i is provided by means of our TC-324B/TC-344B Temperature Controllers and a CC-28 cable. Heating of perfusate is achieved by our SH-27B or SF-28 In-line Solution Heaters.

The DH-40i chamber includes a set of 6 adapter rings, suction and perfusion tubes, magnetic holders, clamps for RC-40 series chambers and 35 mm dishes, PE-160 tubing (10 ft.), 1/16" ID Tygon tubing (25 ft.), and 5 replacement 40 mm coverslips. See page 175 for replacement parts, weighs 238.7 grams without ring and dish.

Series 20 Stage adapters are available for all major microscopes, see pages 64 to 69. Custom or modified stage adapters are also available, call our technical support department for details.

Order #	Model	Product
W4 64-0388	DH-40i	Culture Dish Incubation System
Accessories and Replacement Parts		
W4 64-0351	AR-4	Replacement Adapter Ring Kit set of 6
W4 64-0100	TC-324B	Heater Controller, Single Channel
W4 64-0101	TC-344B	Heater Controller, Dual Channel
W4 64-0106	CC-28	Cable Assembly for Heater Platforms
W4 64-0102	SH-27B	In-line Solution Heater
W4 64-0103	SF-28	In-line Solution Heater
W4 64-1543	HSC-1	Heated Top Coverslip
W4 64-1544	HSC-RPL	Replacement ITO Coverslips

* Distance between bottom and top cover glass is 18.3 mm.

Model TB-3 CCD

Thermal Insert for Prior Nano Z Stage

micro-incubators

Precise temperature control from 5° to 50° C in a compact design



- Designed for use with Prior Scientific NZ200CE NanoScanZ Piezo Z stage
- Optimized for 35 mm culture dishes and Warner RC-40 quick change imaging chambers
- Adapters for all major brand 35 mm dishes
- Temperature control from 5° to 50°C
- Magnetic stainless steel allows use of magnetic holders
- Additional stage adapters available

The Warner TB-3 CCD Thermal Insert is a versatile platform for cell culture and tissue work on the NanoScanZ stage from Prior Scientific. It is designed to work with Warner RC-40 quick change imaging chambers and all 35 mm cell culture dishes. Precise temperature control of the media is possible when used with our low noise CL-100 temperature controller and heat exchanger (TCM-1, Thermal Cooling Module).

An integral water jacket is used to remove excess heat from the internal Peltier device. Running water either from a tap or from Warner's TCM-1 may be used.

Magnetic clamps hold cell culture dishes and quick change imaging chambers securely in place. Magnetic stainless steel along the perimeter of the platform allows for the use of included magnetic suction and perfusion tube holders.

The TB-3 CCD is supplied with a 35 mm adapter ring kit, set of six, three sets of magnetic clamps for holding Petri dishes, one humidifying cover, one TA-29 bead thermistor, one MAG-3 magnetic holder for wires, one perfusion tube with magnetic holder, one suction tube with magnetic holder, four M-2 x 10 mm mounting screws for the Prior stage, 10 feet of PE-160 tubing, 20 feet of 1/8" ID x 1/4" OD soft tubing, 50 feet of 1/16" Tygon tubing, an allen wrench, and a lift tool.

While designed to fit the NanoScanZ stage, adapters are available for other major microscope stages.

Specifications

Temperature Range	5° to 50°C
Accuracy	±0.1°C
Feedback Thermistor	Built in Unical 10kΩ at 25°C
Controller	CL-100 Bipolar Controller
Physical Dimensions:	
Aperture Size (D x L)	25.4 mm
Thermal Insert Size(D x L x H)	64.0 x 92.2 x 10.5 mm
Weight	105 g
Cable Length	2.4 m
Connector Type	15 pin Male "D"
Water Jacket Ports	1/8" Barb Fittings
Warranty	One Year

Order #	Model	Product
W4 64-1636	TB-3 CCD	Thermal Insert for 35 mm Dishes

Accessories / Replacement Parts

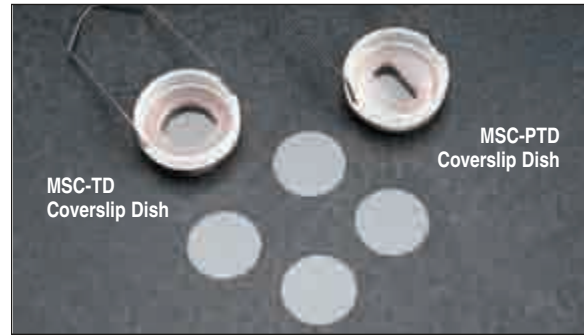
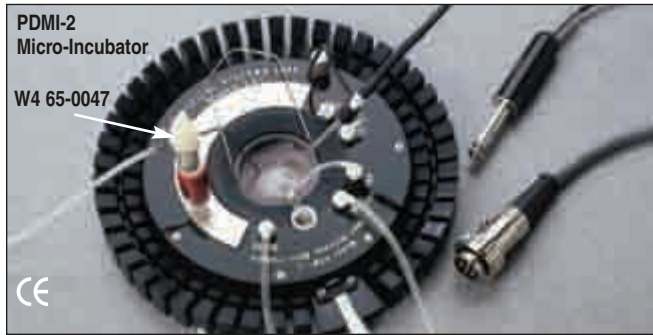
W4 64-0352	CL-100	Bipolar Temperature Controller
W4 64-1922	LCS-1	Liquid Cooling System
W4 64-0107	TA-29	Cable with Bead Thermistor
W4 64-1404	PT-QE1	Perfusion Tube
W4 64-1553	MAG-6	Mini Magnetic Clamp for 18 gauge tube
W4 64-1403	ST-QE1	Suction Tube
W4 64-1554	MAG-7	Mini Magnetic Clamp for 16 gauge tube
W4 64-0297NZ	SA-20KZnano	Stage Adapter for the (K) stage
W4 64-0296NZ	SA-20LZnano	Stage Adapter for the Zeiss
W4 64-0291NZ	SA-NIKnano	Stage Adapter for the Nikon 108 Dia.
W4 64-0295NZ	SA-OLY/2nano	Stage Adapter for the Olympus 110 Dia.

micro-incubators

PDMI-2

Open Perfusion Micro-Incubator

Complete environment on the microscope



- Heats and cools from ~5° below ambient to 50°C
- Maintains pH, O₂ and temperature using Peltier technology
- Flexible chamber option

The PDMI-2 operates equally well under static or perfused conditions. When operated with perfusion, the Micro-Incubator's unique design places flexible tubes carrying inflowing perfusate in contact with a temperature regulated Peltier driven plate, thus heating or cooling the incoming fluid to a command temperature. This eliminates the need for auxiliary preheating or cooling. The Peltier plate heats or cools the cell carrying central chamber uniformly when no perfusate is flowing.

Flexible Temperature Range

The operating temperature range of the PDMI-2 Open Perfusion Micro-Incubator is nominally ~5° below ambient to 50°C when used with the TC-202A Temperature Controller; see page 113. Lower temperatures can be achieved (approximately 10°C below ambient) by using an optional cool water-carrying coil which attaches to the perimeter of the PDMI-2. Temperatures stabilize quickly throughout the operating range and temperature uniformity across the chamber is excellent.

Optimal and Flexible Perfusion

Two temperature controlled perfusion lines deliver perfusates through the Micro-Incubator into the chamber at a nominal rate of 3 ml per minute each. Fluid level is maintained by placing an aspirator (model LU-ASP) in the chamber. Fluid height is easily adjusted via a simple screw mechanism; a cleverly designed suction port eliminates fluid flutter making aspiration quiet; a magnetic base secures the aspirator to the Micro-Incubator at a user selectable convenient location.

Excellent pH Control

The PDMI-2 also provides gas flow over the top of the chamber for pH control and improved temperature uniformity. The open design provides excellent mechanical and optical access to the media.

Specifications

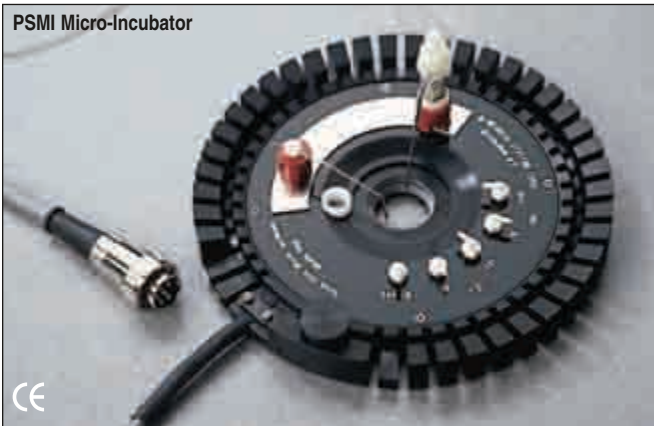
Chamber Options	Corning 35 mm Petri dishes, LU-CSD, MSC-TD or MSC-PTD, LU-CSD Special
Recommended Gas Flow	0.5 to 2.0 L/min
Temperature Range	~5° to 10°C below ambient to 50°C
Temperature Stability	±0.2°C with TC-202A, at 37°C with 1 ml/min perfusion
Temperature Gradient Across Chamber	2°C with 1.5 ml media volume, 1 ml/min perfusion
Built-In Temperature Sensor	Thermistor, 100 kΩ at 25°C
Peltier Device Current Rating	6 A maximum
Media Perfusion Rates	Up to 3.0 ml/min
Overall Dimensions	17 x 152 mm (0.67 x 6.0 in), H x D
Weight	0.5 kg (17.9 oz)
Microscope Stage Mounting	Call for options
Chambers:	
Cover Slips	25 mm D thickness #1 or 2
Overall Dimensions	LU-CSD/MSC-TD: 19 mm D round optical window MSC-PTD: 9.5 x 19 mm (WxL) slotted optical window
Weight	17 g (0.6 oz)
Dish Materials	Teflon® and stainless steel

Order #	Model	Product
W4 65-0043	PDMI-2	Open Perfusion Micro-Incubator, comes with LU-PD and LU-ASP (Stage Adapter not included, see page 175)
W4 65-0058		Copper Cooling Tube for PDMI-2

Micro-incubator Chambers

W4 65-0049	LU-CSD-S	Leiden Multi Well Cover Slip Dish; Special 35 mm D Teflon Dish with two (2) kidney-shaped inner optical window wells, approx. 15 x 8 mm (L x W) (max.) and one (1) 31.50 mm D surrounding well
W4 65-0050	MSC-PTDS	Teflon Glass Cover Slip Dish; 35 mm D, 9.5 x 19 mm (W x L) rectangular optical window, rounded at each end; low volume (less than 1 ml), fast fluid transfer and maximum mixing
W4 65-0051	MSC-TD	Teflon Glass Cover Slip Dish; 35 mm D with Removable Handle, 19 mm D optical window, 31.50 mm D working area, 1 ml approx. fluid volume

Complete micro-environment for patch clamp on the microscope



- Small entry angles ideal for patch slice recordings
- Shallow fluid level minimizes pipette capacitance
- Heats and cools from ~5° below ambient to 50°C
- Peltier heat pump maintains cell conditions for hours

The Patch Slice Micro-Incubator System provides a complete solution to the challenge of electrophysiological study of synaptic connections at physiological temperatures. Low noise whole cell patch recording, with or without water immersion of the microscope objective in the recording medium, are possible with the PSMI.

This Micro-Incubator is a shallow, annular assembly which surrounds the central slice holding dish. Room temperature perfusant is delivered to the incubator which in turn delivers it to the dish at a precisely controlled temperature you select. The perfusant is removed (via user supplied suction) by an included, height adjustable aspirator (LU-ASP). Two independent perfusant channels flow through the PSMI into the chamber via replaceable plastic tubing (of low volumes <100 µl) to allow rapid switching of media via an upstream valve for pharmacological studies. A separate inlet provides temperature controlled gas delivery across the dish.

The TC-202A provides temperature control (~5° below ambient to 50°C) using the Micro-Incubator warming/cooling plate as the control point. Lower temperatures (approximately 10°C below ambient) may be obtained by using an optional cooling tube. The cover slip dish (PS-CSD) consists of two 22 mm diameter cover slips held in a circular frame. The slice sits on the top cover slip with the immersion objective reaching the fluid surface. The bottom cover slip prevents condensation for optimal illumination and viewing. To enable placement of the patch electrode, entry angles as small as 15° can be achieved for slice access.

Specifications

Chamber Type	PS-CSD Cover Slip Dish
Temperature Stability	±0.2°C with TC-202A, at 37°C with 1 ml/min perfusion
Temperature Gradient	Across chamber: 2°C with 1.5 ml media volume, 1 ml/min
Temperature Range	5-10°C below ambient to 50°C
Built In Temp. Sensor	Thermistor type: 100 kΩ at 25°C
Peltier Device	Current rating: 6 A max
Media Perfusion Rates	Up to 3.0 ml/min
Dimensions, H x Dia	17 x 152 mm (0.67 x 6.0 in), overall
Weight	0.5 kg (17.9 oz)

Order #	Model	Product
W4 65-0044	PSMI	Patch Slice Micro-Incubator with PS-CSD
W4 65-0109		Copper Cooling Tube for PSMI
W4 65-0053	PS-CSD	Patch Slice Cover Slip Dish for PSMI
W4 65-0052	MI-M	Mini Magnets for Top Surface of Micro-Incubators (LU-CB-1, PDMI-2 or PSMI), set of 4

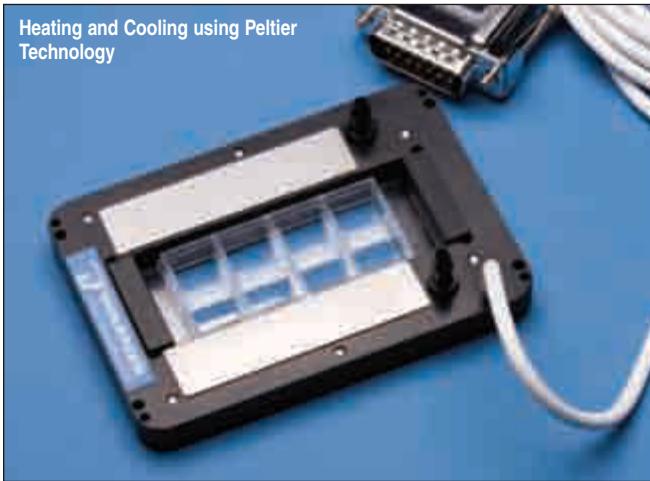
micro-incubators

Model TB-3 CS

Thermal Insert for Prior Nano Z Stage

Temperature control from 5° to 50° C in a compact design

Heating and Cooling using Peltier Technology



Complete system with CL-100 Temperature Controller and TCM-1 Thermal Cooling Module

- Designed for use with Prior Scientific NZ200CE NanoScanZ Piezo Z stage
- Optimized for rectangular chambered slides and chambered coverglass
- Can accept up to 1 x 3" slides
- Temperature control from 5° to 50°C
- Magnetic stainless steel allows use of magnetic holders
- Additional stage adapters available

Thermal Insert for Prior Nano Z Stage

The Warner TB-3 CS Thermal Insert is a versatile platform for cell/tissue culture work on the NanoScanZ stage from Prior Scientific. It is designed to accommodate rectangular chambered slides and coverglass from several manufactures. Slides up to 1x3" can be used.

Precise temperature control of the media is possible when used with our low noise CL-100 temperature controller and heat exchanger (TCM-1, Thermal Cooling Module).

An integral water jacket is used to remove excess heat from the internal Peltier device. Running water either from a tap or from Warner's TCM-1 may be used.

Magnetic clamps hold slides and chambered coverglasses securely in place. Magnetic stainless steel along the perimeter of the platform allow the use of magnetic tools.

The TC-3CS is supplied with two "L" shaped chambered slide holding brackets, two chambered slide hold-down clamps, one TA-29 bead thermistor, one MAG-3 magnetic holder for wires, four M-2 x 10 mm mounting screws for the Prior stage, 20 feet of 1/8" ID x 1/4" OD soft tubing, an allen wrench, and lift tool.

Optional magnetic holders for perfusion and suction tubes allow perfusion in the wells. Stage adapters are available for several major microscopes in addition to the NanoScanZ stage.

Specifications

Temperature Range	5° to 50°C
Accuracy	±0.1°C
Feedback Thermistor	Built in Unical 10kΩ at 25°C
Controller	CL-100 Bipolar Controller
Physical Dimensions:	
Aperture Size (D x L)	21.5 x 52.3 mm
Thermal Insert Size (D x L x H)	64.0 x 92.2 x 10.5 mm
Weight	105 g
Cable Length	2.4 m
Connector Type	15 pin Male "D"
Water Jacket Ports	1/8" Barb Fittings
Warranty	One Year

Order #	Model	Product
W4 64-1632	TB-3 CS	Thermal Insert

Accessories/Replacement Parts

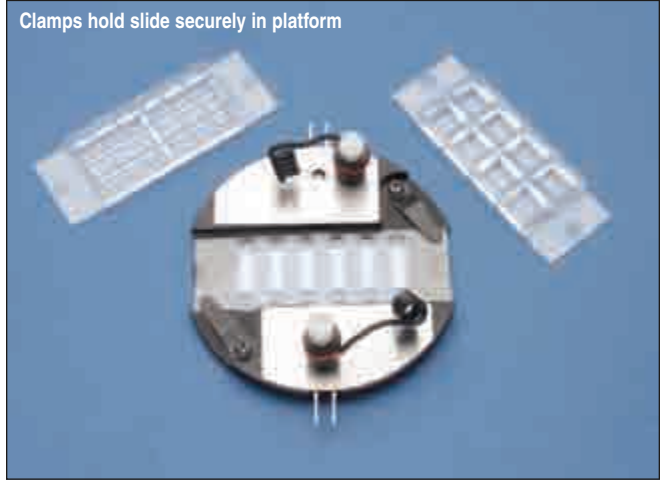
W4 64-0352	CL-100	Bipolar Temperature Controller
W4 64-1922	LCS-1	Liquid Cooling Sytem
W4 64-0107	TA-29	Cable with Bead Thermistor
W4 64-1404	PT-QE1	Perfusion Tube
W4 64-1553	MAG-6	Mini Magnetic Clamp for 18 Gauge Tube
W4 64-1403	ST-QE1	Suction Tube
W4 64-1554	MAG-7	Mini Magnetic Clamp for 16 Gauge Tube
W4 64-0297NZ	SA-20KZnano	Stage Adapter for the (K) Stage
W4 64-0296NZ	SA-20LZnano	Stage Adapter for the Zeiss
W4 64-0291NZ	SA-NIKnano	Stage Adapter for the Nikon 108 Dia.
W4 64-0295NZ	SA-OLY2nano	Stage Adapter for the Olympus 110 Dia.

CSH-1

micro-incubators

Heated Platform for Chambered Slides and 1" x 3" Slides

A specially designed, heated chamber for 1x3 inch slides



- Open design for easy cell access
- Ideal for use with chambered coverglass
- Magnetic stainless steel platforms allow use of magnetic holders
- Stage Adapters permit mounting on all major microscopes

Rectangular Slide Heated Platform

The Warner CHS-1 heated platform is a versatile base for many popular disposable glass slides and chambered coverglasses.

The platform is at home on both upright and inverted microscopes and includes resistive heating elements. Magnetic stainless steel along the perimeter of the CHS-1 permits the use of Warner's MAG-3 magnetic clamps. The base has a 21.5 x 52.3 mm viewing aperture.

The MAG-3 clamps are equipped with an adjustable arm that can be used to bring perfusion and aspiration lines into the chamber.

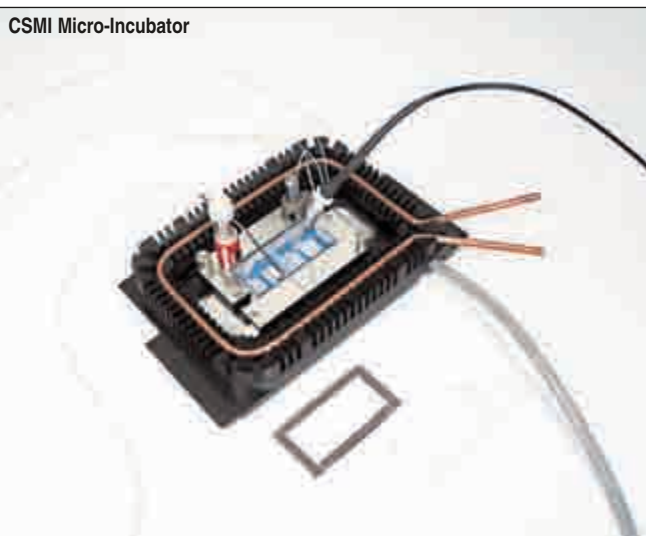
Control of CSH-1 resistive heating is provided via our TC-324B/TC-344B Temperature Controllers and a CC-28 cable. Heating of perfusate is achieved using our SH-27B or SF-28 In-line Solution Heaters.

Stage adapters are available, see page 64 for all major microscopes. The CSH-1 uses the Series 30 stage adapters. Custom or modified stage adapters are also available. Call our Technical Support Department for details.

Each chamber includes 2 special version MAG-3 magnetic clamps with adjustable wire arms.

Order #	Model	Product
W4 64-1592	CSH-1	Heated base for chamber slides
W4 64-0100	TC-324B	Single Channel Heater Controller
W4 64-0101	TC-344B	Dual Channel Heater Controller
W4 64-0106	CC-28	Cable Assembly for Heater Platforms
W4 64-0102	SH-27B	In-line Solution Heater
W4 64-0103	SF-28	In-line Solution Heater
W4 64-0360	MAG-3	Magnetic Clamp

A versatile microscope-stage incubator for cell/tissue culture work on chambered glass slides



- Ideal for use with rectangular chambered slides and chambered coverglass
- Controls pH, temperature, perfusion and gas atmosphere
- Uses Peltier heat pump; heats and cools from ~5° below ambient to 50°C
- Accommodates up to 4 perfusion lines
- Unique aspirator for perfusate removal

The CSMI is a versatile microscope stage-incubator for cell/tissue culture work. It is designed to accommodate disposable rectangular Chamber Slides™ and Chambered Coverglass from the Nunc Lab-Tek® series, and the Falcon® Culture slide series from Beckton Dickinson.

The CSMI, in combination with a matching low noise TC-202A temperature controller, facilitates long term maintenance of tissue or cell cultures on a microscope stage. This allows optical monitoring of dyes, micro-injection, electrical recording, and micro-manipulation for many hours or even days.

The CSMI not only facilitates the precise regulation and manipulation of bath temperature, but also supports multi-channel perfusion (up to 4 lines), gas atmosphere maintenance, and CO₂ superfusion for pH control.

The CSMI is based on a successful design of the Medical Systems PDMI-2 Micro-Incubator for 35 mm Petri dishes. The CSMI utilizes Peltier technology to regulate temperature over a wide range of temperatures, both above and below ambient levels. Lower temperatures (approximately 10°C below ambient) may be obtained by using an optional cooling tube.

The CSMI fits on the stage of inverted microscopes from major microscope manufacturers including Zeiss, Nikon, Olympus and Leica. Harvard Apparatus offers custom-made rectangular adapters for these microscopes.

Specifications

Temperature Range	~5° to 10°C below ambient to 50°C
Disposable Chambers Accommodated	<ul style="list-style-type: none"> • Nalge Nunc chambered slides & cover slips • Becton Dickinson Falcon chambered slides
Microscopes Accommodated	<ul style="list-style-type: none"> • Zeiss Axiovert with attachable mechanical stage • Leica DAS Microscope DMIL and DMIRB/E with attached mechanical stage • Nikon Diaphot • Olympus IX50/70 or IMT-2 fixed stage
Peltier TED Current Rating	6 A DC max
Built In Plate Thermistor	100 kΩ at 25°C
Perfusion Inlet Lines	26 AWG Teflon capillary up to 4 lines can be installed simultaneously
Perfusion Rate	3 ml/min nominal total
Perfusate Outlet	LU-ASP aspirator
Gas Port	1/16 in. barb
Gas Superfusion Rate	0.5 to 2.0 L/min
Weight	17.9 oz (0.5 kg)
Overall Dimensions	6.5 x 4 x 1 in (16.5 x 10.2 x 2.5 cm)

Order #	Model	Product
W4 65-0101	CSMI	Chambered Slide Micro-Incubator
W4 65-0102	CSMI	Chambered Slide Micro-Incubator Special Design Version for 3 Plate Mechanical Stages
W4 65-0045	TC-202A	Bipolar Temperature Controller
W4 65-0103	–	Copper Cooling Tube for CSMI
W4 65-0052	MI-M	Mini Magnets for Top Surface of Micro-Incubators (LU-CB-1, PDMI-2 or PSMI), set of 4

micro-incubators

Accessories

for PDMI-2, PSMI, CSMI and Leiden Chambers



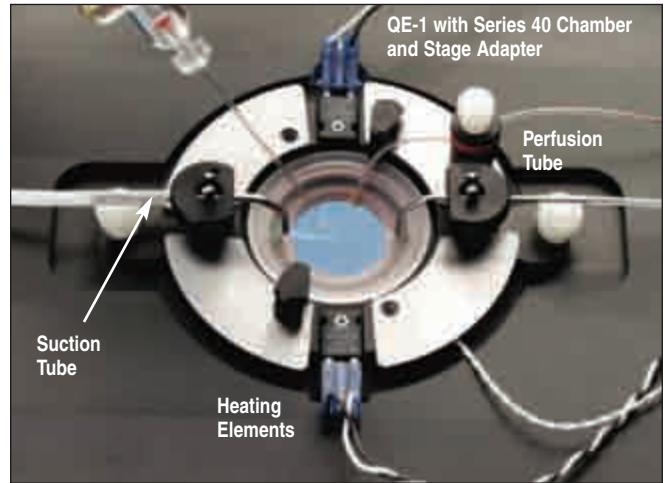
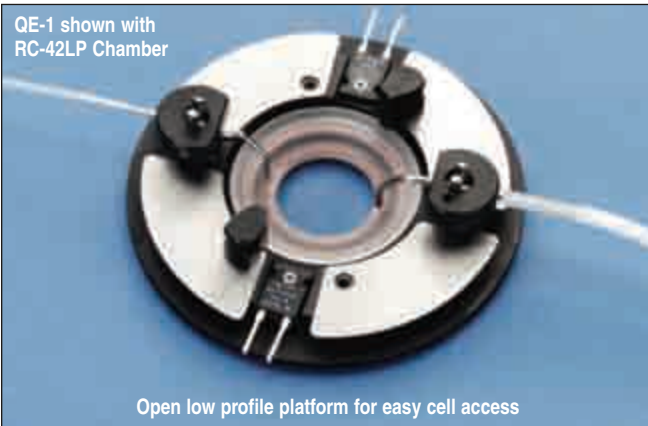
Order #	Model	Product
Alignment Rings and Fixing Platforms		
W4 65-0093	PDMI-ARL	Alignment Ring for Leica Microscope, 88 x 1.8 mm (OD x Thickness)
W4 65-0059	PDMI-ARN	PDMI-2/PSMI Alignment Ring for Nikon Diaphot (Old or 300/200) TMD Stage, 4.242 x .071 in (D x Thickness)
W4 65-0060	PDMI-ARO	PDMI-2/PSMI Alignment Ring for Olympus IX50/70 or IMT-2 Fixed Stage, 4.320 x .071 in (D x Thickness)
W4 65-0061	PDMI-ARZ	PDMI-2/PSMI Alignment Ring for Zeiss Axiovert Gliding or Rotary Stages, 4.046 x .071 in (D x Thickness)
W4 65-0062	PDMI-FPL	PDMI-2/PSMI Fixing Platform for Leica DAS Mikroskop DMIL and DMIRB/E w/Attachable Mechanical Stage
W4 65-0063	PDMI-FPZ	PDMI-2/PSMI Fixing Platform for Zeiss Axiovert with Attachable Mechanical Stage, M-Type Stage
W4 65-0058	PDMI-TUBE	PDMI-2 Copper Cooling Tube Coil (Shaped to Conform to Fin Channel) with Open Ends
W4 65-0064	LU-FPL	LU-CB-1 Fixing Platform for Leica DAS Mikroskop DMIL and DMIRB/E with Attachable Mechanical Stage
W4 65-0065	LU-FPZ	LU-CB-1 Fixing Platform for Zeiss Axiovert with Attachable Mechanical Stage, M-Type Stage
Miscellaneous		
W4 65-0047	LU-ASP	Leiden Aspirator, Cover Slip Dish Fluid Level Setting Device, 38 mm H
W4 65-0052	MI-M	Mini Magnets for Top Surface of Micro-Incubators (LU-CB-1, PDMI-2 or PSMI), set of 4
W4 65-0053	PS-CSD	Patch Slice Cover Slip Dish for PSMI
W4 65-0054	LU-PD	Sleeve of Plastic 35 mm Petri Dishes, pkg. of 20
W4 65-0055	BSC-TH	Magnetic Thermistor Holder for LU-CB-1
Thermistors		
W4 65-0057	BSC-T3	Bath Thermistor for Use with PDMI-2, PSMI, LU-CB1, and TC-202A
W4 65-0056	BSC-T3A	Bath Thermistor for Use with LU-CPC-CEH and TC-202A
W4 65-0098	BSC-T2	Replacement-Bath Thermistor for Obsolete TC-102
W4 65-0016	BSC-T2A	Replacement-Bath Thermistor for Use with LU-CPC-CEH and TC-102
Micro-Incubator Replacement Parts		
W4 65-0066	D-ORING-1	Cover Slip Dish O-Rings Replacement for LU-CSD or MSC-TD, 1 Small (approx. 23.80 mm OD) and 1 Large (approx. 29.80 mm OD), set of 2
W4 65-0067	D-ORING-2	Cover Slip Dish O-Rings, Replacement for MSC-PTD, 1 Small (approx. 20.80 mm OD) and 1 Large (approx. 29.80 mm OD), set of 2
W4 64-0705	CS-25R	Cover Glass 25 mm round thickness #1, pkg. of 100
W4 65-0069	CS-GLASS-2	Glass Cover Slips (#2) for LU-CSD or MSC-PTD, 0.18 to 0.25 x 25 mm (Thickness x D), pkg. of 100
W4 65-0070	MI-T	Perfusion/Aspiration Teflon Tubing Replacements for PDMI-2/PSMI, 2 ft L x 26 AWG, pkg. of 8
W4 65-0071	LU-CPC-P	Silicone Rubber Plugs for LU-CPC or LU-CPC-CEH, set of 4
W4 65-0072	TC-CA	Replacement Output Cable to Connect TC-102 Temperature Controller to LU-CB-1 or LU-CPC-CEH

micro-incubators

QE-1

Quick Exchange Heated Platform with Perfusion for 35 mm dish format

Ideal for imaging and electrophysiology applications



- Open design for easy cell access
- Removable perfusion and suction tube holders
- Designed for 35 mm dishes and Series 40 chambers
- Quick exchange of chamber or 35 mm dish
- Magnetic stainless steel allows for the use of magnetic holders

The QE-1 Quick Exchange Platform is a versatile base for the RC-40 Series chambers, as well as many popular 35 mm glass bottom dishes. The platform is at home on both upright and inverted microscopes and includes resistive heating elements. The base has a 25 mm diameter aperture. Magnetic stainless steel along the perimeter of the QE-1 permits the use of Warner's MC-1 Magnetic Clamp Kit, which includes a variety of holding tools.

Removable perfusion and suction tubes allow perfusion in any of the RC-40 Imaging Chambers or 35 mm dishes. Suction and perfusion tubes also feature set-screw locks for the horizontal location, and adjustable presets on the vertical for setting the bath height. These adjustments permit easy and exact positioning/repositioning of the suction and perfusion tubes. A redesigned suction tube eliminates tidal action and fluid flutter, making aspiration very quiet.

Resistive heating of the QE-1 is provided by means of our TC-324B/TC-344B Temperature Controllers and a CC-28 Cable. Heating of perfusate is achieved using our SH-27B or SF-28 In-line Solution Heaters.

Adapter rings are supplied for Corning, Falcon, Nunc, WPI, MatTek and Willco 35 mm dishes to ensure a close fit within the QE-1.

Series 20 stage adapters are available for all major microscopes. Custom or modified stage adapters are also available; call our Technical Support Department for details or see pages 64 to 69.

The QE-1 includes 10 ft. of PE-160 polyethylene tubing and adapter rings for a variety of 35 mm culture dishes.

Order #	Model	Product
W4 64-0375	QE-1	Quick Exchange Heated Base with Perfusion and Adapter Ring Kit
Accessories and Replacement Parts		
W4 64-1404	PT-QE1	Perfusion Tube for QE-1
W4 64-1403	ST-QE1	Tube Suction Micro-Slit Design for QE-1
W4 64-0103	SF-28	Slow Flow Solution Heater
W4 64-0351	AR-4	Replacement Adapter Ring Kit for 35 mm Dishes
W4 64-0100	TC-324B	Single Channel Heater Controller
W4 64-0101	TC-344B	Dual Channel Heater Controller
W4 64-0106	CC-28	Cable Assembly for Heater Platforms
W4 64-0102	SH-27B	Solution Heater
W4 64-0357	MCK-1	Magnetic Clamp Kit

* QE-1 weight without stage adapter 134 g.

QE-1HC

culture dish platforms

Quick Exchange Heated / Cooled Platform for 35 mm Petri Dishes

Temperature control from 5° to 50° C for the Leica Galvo Z stages



- Designed for use with 35 mm Petri dishes and Series 40 quick change imaging chambers
- Open design for easy cell access
- Dish adapters for all major brand 35 mm dishes
- Temperature control from 5° to 50°C
- Magnetic suction and perfusion tube holders
- Magnetic dish clamps
- Available stage adapters for all microscopes

The Warner QE-1HC is designed to work with Warner RC-40 quick change imaging chambers and all 35 mm cell culture dishes. Precise temperature control of the media is possible when combined with our low noise CL-100 temperature controller and TCM-1 Thermal Cooling Module (heat exchanger). An integral water jacket is used to remove excess heat from the internal Peltier device.

Magnetic clamps hold cell culture dishes and quick change imaging chambers securely in place. Magnetic stainless steel along the perimeter of the platform allows for the use of included magnetic suction and perfusion tube holders (included).

Fits Series 20 stage adapters. All major microscope stages are accommodated. Custom or modified stage adapters are also available; call our Technical Support Department for details or see visit our website.

The QE-1HC is supplied with a 35 mm adapter ring kit, set of six, three sets of magnetic clamps for holding Petri dishes, one humidifying cover, one TA-29 bead thermistor, one MAG-3 magnetic holder for wires, one perfusion tube with magnetic holder, one suction tube with magnetic holder, 10 feet of PE-160 tubing, 20 feet of 1/8" ID x 1/4" OD soft tubing, 50 feet of 1/16" Tygon tubing, and a lift tool.

Specifications

Temperature Range	5° to 50°C
Accuracy	±0.1°C
Feedback Thermistor	Built in Unical 10kΩ at 25°C
Controller	CL-100 Bipolar Controller
Physical Dimensions:	
Aperture Size (D x L)	25.4 mm
Thermal Insert Size (D x L x H)	64.0 x 92.2 x 10.5 mm
Weight	105 g
Cable Length	2.4 m
Connector Type	15 pin Male "D"
Water Jacket Ports	1/8" Barb Fittings
Warranty	One Year

Order # Model Product

W4 64-1659	QE-1HC	Quick Exchange Stage Incubator
W4 64-0352	CL-100	Bipolar Temperature Controller
W4 64-1922	LCS-1	Liquid Cooling System

Accessories/Replacement Parts

W4 64-0297	SA-20KZ	Stage Adapter for the (K) sSage
W4 64-0296	SA-20LZ	Stage Adapter for the Zeiss
W4 64-0291	SA-NIK	Stage Adapter for the Nikon 108 Dia.
W4 64-0295	SA-OLY/2	Stage Adapter for the Olympus 110 Dia.
W4 64-0107	TA-29	Cable with Bead Thermistor
W4 64-1404	PT-QE1	Perfusion Tube
W4 64-1553	MAG-6	Mini Magnetic Clamp for 18 Gauge Tube
W4 64-1403	ST-QE1	Suction Tube
W4 64-1554	MAG-7	Mini Magnetic Clamp for 16 Gauge Tube

Micro-
Incubation

culture dish platforms

QE-2 culture dish platforms

Quick Exchange Heated Platform with Perfusion for 50 mm dish format

The QE-1 in a 50 mm culture dish format



- Designed for 50 and 60 mm culture dishes
- Removable perfusion and suction tube holders
- Open design for easy cell access
- Adapters for Willco Wells, Corning, Nunc, and Falcon dishes
- Magnetic stainless steel perimeter allows use of magnetic holders

The Warner QE-2 Quick Exchange Platform is a versatile base for many popular 50 and 60 mm glass bottom and plastic dishes. The platform is at home on both upright and inverted microscopes and includes resistive heating elements. The base has a 36 mm diameter aperture. Magnetic stainless steel along the perimeter of the QE-2 facilitates use of Warner's MC-1 Magnetic Clamp Kit, which includes a variety of holding tools.

Suction and perfusion tube holders are slotted and allow easy adjustment of the vertical position for setting the bath height. A specially designed suction tube eliminates tidal action and fluid flutter, making aspiration very quiet and even. Drop in one of Warner's RC-61 Series of 50 mm disposable chamber inserts and turn your dish into a low cost perfusion chamber.

Resistive heating of the QE-2 is provided by means of our TC-324B/TC-344B temperature controllers and a CC-28 cable. Heating of perfusate is achieved using our SH-27B or SF-28 In-line Solution Heaters.

Adapter rings for Corning, Falcon, Nunc and Willco 50 mm dishes are supplied. The following tissue culture dishes are supported: Corning (p/n 25060, 60 x 15 mm), Falcon (p/n 351006, 50 x 9 mm), Nunc (p/n 150326, 60 x 15 mm), and Willco (D5030 and D5040).

Stage adapters are available for all major microscopes. The QE-2 uses the Series 30 stage adapters, see page 64. Custom or modified stage adapters are also available. Call our Technical Support Department for details.

Order #	Model	Product
W4 64-1542	QE-2	Quick Exchange Heated Base with Perfusion and Adapter Ring Kit
Accessories and Replacement Parts		
W4 64-1403	ST-QE1	Tube Suction Micro-Slit Design for QE-1
W4 64-0100	TC-324B	Single Channel Heater Controller
W4 64-0101	TC-344B	Dual Channel Heater Controller
W4 64-0106	CC-28	Cable Assembly for Heater Platforms
W4 64-0102	SH-27B	Solution Heater
W4 64-0357	MCK-1	Magnetic Clamp Kit
W4 64-0760	D5040P	Glass Bottom Willco 50 mm Dishes, pack of 20

Adapter Rings, Coverslips and Culture Dishes

Accessories and Replacement Parts for Warner Micro-incubation Chambers



Order #	Model	Product
W4 64-0350	AR-1	Adapter Ring for DH-35 and Willco Dish
W4 64-1455	AR-2	Adapter Ring for AttoFluor® cell chamber in DH-35i/QE-1
W4 64-0351	AR-4	Adapter Ring Kit, set of 6, for Willco, Corning, Nunc, WPI, MatTek and Falcon Dishes
W4 64-1507	RPC-2	Replacement Clamps for DH-35i/DH-40i/QE-1
W4 64-1500	CS-40R	Cover Glass, 40 mm round, #1.0 thickness, 60 pc.

Heated Top Coverslip for DH-35i and DH-40i Chambers



Developed for use in our DH-35i and DH-40i Micro-incubation chambers, this heated coverslip assembly replaces the 40 mm coverslip normally supplied with these chambers. Once installed, the HCS-1 eliminates condensation which occurs when these chambers are used in the closed mode.

The heated coverslip derives its power from the heated base of the DH-35i or DH-40i chamber and does not require an additional temperature controller.

Order #	Model	Product
W4 64-1543	HCS-1	Heated Top Coverslip
W4 64-1544	HCS-RPL	Replacement ITO Coverslip

Glass Bottom Cell Culture Dishes (35 and 50 mm), #1.5 Thickness (0.17 mm)



- Highest quality construction, sterilized
- #1.5 Cover glass for microscope imaging
- Glass fully covers bottom
- Compatible with all Warner Dish Heaters

Glass Bottom Cell Culture Dishes

High quality polystyrene dishes with No. 1.5 cover glass bottoms are available in 35 mm and 50 mm diameters, available both in pouch packs (20/pouch) and individual blister packs (120/case). All dishes are sterilized before packaging.

50 mm dishes are 7 mm in height.

Order #	Model	Product
Pouch-Pack Dishes, 20 sterilized dishes/pouch		
W4 64-0757	D3512P	35 x 9.9 mm, 12 mm Well Diameter
W4 64-0758	D3522P	35 x 9.9 mm, 22 mm Well Diameter
W4 64-0759	D5030P	50 x 7.2 mm, 30 mm Well Diameter
W4 64-0760	D5040P	50 x 7.2 mm, 40 mm Well Diameter
Blister-Pack Dishes, individual packaged sterile dishes, case of 120		
W4 64-0762	D3522B	35 x 9.9 mm, 22 mm Well Diameter
W4 64-0763	D5030B	50 x 7.2 mm, 30 mm Well Diameter

Note: 35 mm dishes supplied with triple vented lids for optimum ventilation. 50 mm dishes have low side walls to facilitate microinjection.

Brain/Tissue Slice Chamber System

Sensitive recordings without electrical interference

Submerged or interfacial chambers for the in vitro study of tissue slices



- Maintains brain slices for 10 hours or more on the bench-top
- Modular design accommodates submersible or interface chambers
- Over 20 years of use in leading labs

submerged slices. Each top allows rapid solution replacement, and both provide excellent access to slices for electrophysiological recording or other observations.

Designed by Experts

Over twenty years ago, Drs. Haas and Zbicz, two leading electrophysiologists, designed these chambers for use in their own research.

No Electrical Interference

Low noise temperature controllers (TC-324B, TC-344B, TC-202A) ensure even the most sensitive electrophysiologic recordings (such as single channel patch clamping) can be made from slices without electrical interference.

Convenient

Temperature regulated perfusion lines are built in for rapid changeover of superfusing fluids without the need for an external temperature regulated perfusate supply tank.

Components

All components must be purchased individually. See ordering information on the following pages.

This unique and versatile Brain/Tissue Slice Chamber System offers the investigator two in vitro methods of studying a thin tissue slice bathed by perfusates of interest.

The BSC-HT (Haas Top) is an interface-type chamber in which one surface of the slice is wet by a perfusing solution while the other surface is kept moist by a humidified gas mixture. The BSC-ZT (Zbicz Top) is a submersion-type chamber in which solution flow is transverse to fully



BSC-BU Base Unit

The function of the Base Unit is to warm the superfusing solution. The BSC-BU consists of a double walled cylinder which is filled with distilled water and encloses a nichrome

heating element. The cavity also contains two separate sets of PVC tubing which can transport one or two superfusing solutions to the slice chamber. The base unit holds an aerator to humidify vapor when the Haas Top is employed.

The BSC-BU is mounted on legs which suspend the heating cylinder. This prevents the thermal expansion of the heating cylinder from moving the top unit and slice during temperature changes. The BSC-BU is specifically designed to accept both the BSC-HT and the BSC-ZT top units, providing economy and versatility. Includes connecting cable six pin DIN to Banana.

Specifications

Dimensions, L x W x H	114.6 x 139.4 x 111.1 mm (4.5 x 5.4 x 4.3 in)
Weight	618 g (1 lb 5.8 oz)

Order #	Model	Product
W4 65-0073	BSC-BU	Base Unit
W4 65-0088	BSC-ACC-KIT	Base Unit, Haas & Zbicz Tops Accessory Kit (Replacement Screws, Fittings and Mesh)



BSC-PC Prechamber

The BSC-PC chamber allows several (10 to 12) brain slices to be stored in vitro for several hours while maintaining excellent viability. A mixture of 95:5% O₂:CO₂ is bubbled through physiological saline. This initiates a circular flow, and oxygen enriched saline

continuously permeates the slices. Slices remain viable for hours while awaiting transfer to an examining chamber. Gas flow pressure should not exceed 5 p.s.i. 1 insert included with prechamber.

Specifications

Dimensions, L x W x H	112.6 x 48.9 x 95.4 mm (4.4 x 1.9 x 3.7 in)		
Weight	362 g (12.8 oz)		
Internal Dimensions	OD	ID	L
	1.5 in	1.25 in	1.13 in
	38.1 mm	31.75 mm	28.7 mm

Order #	Model	Product
W4 65-0076	BSC-PC	Prechamber (for holding slices)
W4 65-0608		Insert for BSC-PC Prechamber

Brain/Tissue Slice Chamber System (continued)



BSC-HT Haas Top

The BSC-HT Haas Top is an interface-type chamber utilizing semi-submersion principles. It provides for rapid exchange of superfusing fluids and excellent stability for intracellular recording. Slices rest on a nylon mesh below which a thin sheet of the perfusate

of interest flows. The bottom side of the slice is wet by capillary action as solution saturates the mesh. Slices are oxygenated by a warmed, humidified mixture of 95% O₂/5% CO₂ which flows across the top surface of the slice. The BSC-HT has been designed such that, if desired, one can study the effects of two drugs simultaneously. One drug flows down the left portion of the chamber and the second down the right.

Laboratory results confirm a good performance history for the semi-submersion top design:

Advantages

- Maintains a stable intracellular membrane potential of more than -60 mV.
- Facilitates action potentials with overshoots close to 100 mV in amplitude, duration of less than 2 msec at 32°C, when used with hippocampal pyramidal and granular cells.
- Maintenance of the membrane resting potential is possible for more than 1 hour, undisturbed by changes in perfusion fluids.
- Preparation slices remain viable for up to 12 hours.
- Flow rates of 1 ml/min will completely exchange the chamber fluid in less than 1 minute.

Specifications

BSC-HT:	
Dimensions, L x W x H	111.1 x 85.4 x 23.8 mm (4.3 x 3.3 x 0.9 in)
Weight	130 g (4.6 oz)
BSC-ZT:	
Dimensions, L x W x H	98.5 x 101.6 x 28.1 mm (3.8 x 4.0 x 1.1 in)
Weight	124 g (4.4 oz)

Order #	Model	Product
W4 65-0075	BSC-HT	Haas Top including 2 slice holds
W4 65-0074	BSC-ZT	Zbicz Top including nylon mesh



BSC-ZT Zbicz Top

The BSC-ZT Zbicz Top is a submersion type chamber in which tissue slices are supported on a stiff nylon mesh. The perfusate flows transversely across both cut surfaces. The steady flow of warmed media across the cut surfaces of the slice is sufficient to

keep many tissues alive and responsive for 10 hours or more. The fluid level is set to 1 mm above the mesh by a dam at the end of the chamber. The chamber is 6 mm wide and the trough is 24 mm long; this provides adequate room for slices and instrumentation, yet minimizes the well volume to optimize drug exchange times. Fluid overflowing the dam is drained to waste via vacuum.

Advantages

- Slices remain viable for 10 hours or more.
- The slices are mechanically stable. They are placed on a special ribbed nylon mesh and may be held in place by 3 to 4 stimulating electrodes or a plastic insert. This stability is attributed to the stiff nylon mesh which does not rise or sag with changes in fluid flow, therefore, moderate changes in the transverse laminar flow can be well tolerated during intracellular and extracellular recordings. These features allow for switching of solutions with minimal risk of tissue movement and loss of neurons while recording.
- The low volume of the chamber cavity and the relatively fast flow rate allows rapid exchange of solution (1 to 2 minutes) which facilitates drug application studies.
- Slices remain moist and viable because they are wetted on both sides and do not dry out due to surrounding air currents.
- The mesh surface holding the slice is semipermanent and can be cleaned easily. The BSC-ZT comes with extra mesh which can be easily installed when necessary.
- Because the fluid depth is shallow (400 to 600 microns), the electrode capacitance remains low; an important consideration in single microelectrode voltage and patch clamping.
- Bubble formation is minimal. Bubbles, which form in the heating unit, escape by the path formed at the entrance of the trough. Movement of the slice will not result should bubbles inadvertently form under the mesh. The flow of solution over the slice's top surface will maintain tissue viability.
- The solution temperature at the slice can be precisely regulated due to the close proximity of an optional thermistor to the slice.
- Slices can be transilluminated.

Brain/Tissue Slice Chamber System (continued)



Choice of Temperature Controllers

The BSC-BU Base unit is offered in two versions, the original unit for use with the model TC-202A, and a new version, the BSC-BUW, designed to work with Warner's TC-324B and TC-344B temperature controllers.

Order #	Model	Product
W4 64-0100	TC-324B	Temperature Controller, Single Channel
W4 64-0101	TC-344B	Temperature Controller, Dual Channel
W4 65-0045	TC-202A	Biopolar Temperature Controller



Ordering Information

All components are ordered individually. Most researchers order the BSC-BU Base unit with either the Haas or Zbicz top, depending on individual research. The pre-chamber is an effective accessory for slice preservation, but is not necessary for system operation. We recommend ordering the BSC-ACC-Kit since it contains valuable replacement parts such as screws, fittings, and mesh.

References:

- Zbicz, K.L. & Weight, F.F. "Transient Voltage and Calcium Dependent Current..." J. Neurophys 53,1038-1058 (1985).
- Haas, H.L. et al "A Simple Perfusion Chamber for the Study of Nervous Tissue Slices in Vitro" J. Neurosci Meth 1, 323-325 (1979).

Order #	Model	Product
W4 65-0073	BSC-BU	Base Unit Including Tubing, Heating Element and Electrical Terminals
W4 64-1525	BSC-BUW	Base Unit Slice Heater for Warner Temperature Controllers includes W4 64-1591 Cable
W4 65-0074	BSC-ZT	Zbicz Top Including Nylon Mesh
W4 65-0075	BSC-HT	Haas Top Including 2 Slice Holders
W4 65-0076	BSC-PC	Prechamber for Holding Slices

Accessories and replacement parts

W4 65-0098	BSC-T2	Replacement T2 Thermistor for TC-102
W4 65-0057	BSC-T3	Thermistor (Bath) for Use with Brain Slice Chamber
W4 65-0078	BSC-AIR	Aeration Element Replacement, set of 2
W4 65-0079	BSC-ORING	Base Unit (BSC-BU) Replacement Gasket Set
W4 65-0080	BSC-HE	Base Unit Heating Element Replacement
W4 64-1697	-	Replacement Heating Element for BSC-BUW
W4 65-0081	BSC-TUBE	Base Unit (BSC-BU) Tubing Set Replacement, Tygon .031 x .093 (ID x OD)
W4 65-0082	BSC-G10	Haas Top (BSC-HT) Tissue Insert Replacement, set of 2
W4 65-0083	BSC-HTC	Haas Top (BSC-HT) Plastic Cover Replacement
W4 65-0084	BSC-HT-AG	Haas Top (BSC-HT) Ground Wire Replacement
W4 65-0086	BSC-ZTC	Zbicz Top (BSC-ZT) Plastic Insert Replacement
W4 65-0087	BSC-PC-VAL	Prechamber (BSC-PC) Valve Replacement
W4 65-0088	BSC-ACC-KIT	Base Unit, Haas & Zbicz Tops Accessory Kit (Replacement Screws, Fittings and Mesh)
W4 65-0091	BSC-CABLE	BSC-BU/TC-102 Replacement Power Cable
W4 65-0090	BSC-MESH	Haas Top (BSC-HT) Zbicz Top (BSC-ZT) Replacement Mesh 300 µm grid, 5 x 5 in, pkg. of 4
W4 65-0104	-	Output Cable, 6-Pin to Banana for TC-202A or BSC-BU
W4 65-0100	-	Output Cable, 6-Pin to 1 mm for BS4 TC-202A, BS4 LU-CB1 and BS4 LU-CPC-CEH
W4 64-1591	-	Output Cable, 8-Pin to Banana for temperature controller to BSC-BUW base, includes thermistor (Warner Temperature Controllers) Comes with BSC-BUW

electrophysiology

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PC-505B

Patch Clamp

patch clamp

The lowest noise, switchable, resistive-feedback patch clamp amplifier currently available



- Lowest noise — approaching theoretical limit
- Calibrated Cap Comp and Series R circuitry
- % Compensation circuitry
- Independent V hold and I hold controls
- Zap safety switch
- LED meter
- 3 year warranty

The PC-505B is the lowest noise, switchable, resistive-feedback patch clamp amplifier available. This model also has features of particular interest to those doing whole cell studies. The slow capacitance compensation circuitry has been combined into a single control and allows direct measurement of membrane capacitance. The companion Series R control displays the access resistance and the new % correction circuit compensates up to 90% of the access resistance. These and other features make the PC-505B an extremely capable amplifier.

Switching Headstages

Two selectable feedback resistors in the headstages permit single channel and whole cell recording on the same cell. A 50 G Ω resistor is used in both switching models for low noise single channel recording with currents to 200 pA.

LC-201B Headstage (50 G Ω /500 M Ω)

This headstage with 500 M Ω feedback resistor will handle whole cell currents up to 20 nA.

HC-202B Headstage (50 G Ω /50 M Ω)

For larger whole cell currents, the 50 M Ω resistor in this headstage permits currents up to 200 nA.

Bilayer Headstage

W4-205B Bilayer Headstage (50 G Ω /500 M Ω modified)

The 50 G Ω resistor headstage is modified for artificial bilayer capacitances up to 250 pF.

Headstage Resistor Selection

Headstage feedback resistance is dynamically switched at the amplifier front panel. LED's indicate resistor selection and the corresponding multiplying factor applied to the current gain [Im] switch setting.

Operating Modes

The PC-505B has three modes of operation: voltage clamp, zero current clamp, and current clamp.

V Clamp

In voltage clamp mode, the input range is ± 1 V. Active commands (V hold, junction and auto zero, test pulse, zap) and external inputs are scaled and summed at the headstage input. Capacity compensation and speed test are also active.

I_o

Zero current is essentially a standby mode used to preset voltage hold or current hold levels before switching to voltage or current clamp. All commands are inactive with the exception of junction zero which, in this case, functions as an offset control for the electrode and tip potentials associated with the pipette.

I Clamp

Current clamp mode clamps the cell to a current level determined by the current hold setting and any external commands. Capacitance compensation is inactive in this mode.

Commands

Voltage and current commands applied to the cell include: voltage and current hold, junction and auto zero, test pulse, speed test, and zap.

V & I Hold

Holding potentials and currents are set with separate controls eliminating the need to reset levels when switching between voltage and current clamp modes.

Junction & Auto Zero

Adjusting for offset potentials is performed with either the manual junction zero control or with auto zero. The offset potential is read on the meter or at the V_c x10 output.

Test Pulse & Speed Test

Test Pulse and Speed Test are internally generated 50/60 Hz signals. Test pulse is attenuated by the command sensitivity and is useful for monitoring the formation of a gigaseal. The speed test signal is applied to the headstage input to allow for tuning the headstage response. A rear panel speed test switch allows for an external signal to be used.

PC-505B

Patch Clamp (continued)

Zap

Variable duration pulse used to rupture the cell membrane for whole cell recording.

Signals applied to the command input are attenuated at one of three levels with the command sensitivity selector.

Capacitance & Resistance Compensation: Fast Compensation

Stray capacitance between the input and electrode resistance is compensated with two pair of controls, C-Fast 1 and C-Fast 2. Amplitude and time constant of each pair is independently adjustable. Whole cell capacitance compensation is adjusted with the single control, C-Slow. Membrane capacitance is read from the C-Slow calibrated dial. The companion Series R control is used in conjunction with the C-Slow and its calibrated dial provides a reading of the access resistance. C-Slow may be disabled to view the uncompensated signal. The % Correction control is used to increase the command signal to compensate for the voltage drop across the access (Series R) resistance. Correction is adjustable up to 90%.

Outputs

Signals at the Im output are filtered at the selected cutoff frequency set with the 4-pole Bessel filter. Selecting Bypass presents the full bandwidth signal to the Im output. Filtered and unfiltered Im output is also available at the instrument rear panel. Additional outputs are the membrane voltage Vm x10 and the sum of the voltage commands Vc x10, both at x10 gain.

Voltammetry with PC-505B

PC-505B functions as an excellent low-noise potentiostat for voltammetric and other electrochemical measurements. In this mode, the V hold (electrode potential) is increased to a maximum of ± 1 volt and the maximum external command signal to ± 2 volts at electrode or sensor.

Specifications

Headstages:

LC-201B Headstage (50 G Ω /500 M Ω)

Single channel currents to 200 pA, whole cell currents to 20 nA.

HC-202B Headstage (50 G Ω /50 M Ω)

Single channel currents to 200 pA, whole cell currents to 200 nA.

W6-205B Bilayer Headstage (50 G Ω /500 M Ω modified)

For artificial bilayer capacitances up to 250 pF, currents to 20 nA.

Noise (referred to input)

Measured with an 8-pole Bessel filter, input open, 50 G Ω resistor:

DC to 1 kHz	0.035 pA RMS
DC to 5 kHz	0.150 pA RMS

Bandwidth	25 kHz
-----------	--------

Voltage Clamp Commands:

Command In BNC	± 10 V Max, AC or DC, applied to input
Voltage Hold	± 200 mV Max with 10-turn control
Junction Zero	± 100 mV Max with 10-turn control
Internal Test Pulse	1 V 50/60 Hz (line freq.) square wave attenuated by Command Sensitivity
Command Sensitivity	x0.1, x0.01, and x0.001
Zap	1.0 V Pulse, adjustable duration from 0.1 to 10 msec

Current Clamp Commands:

Command In	± 1000 pA max with Command Sensitivity @ x0.1 ± 100 pA max with Command Sensitivity @ x0.01 ± 10 pA max with Command Sensitivity @ x0.001
Current Hold	± 1 nA with 10-turn control
Internal Test Pulse	1 nA 100 Hz square wave through Command Sensitivity
Command Sensitivity	x 0.1, x 0.01, and x 0.001

Specifications (continued)

Fast Capacitance Compensation (Voltage Mode):	
C Fast 1	0.1 to 1.75 μ sec, 0 to 5 pF
C Fast 2	0.33 to 8.5 μ sec, 0 to 15 pF
Whole Cell Compensation:	
C Slow	0-100 pF with 10 turn control
Series R	0-10 M Ω with 10 turn control
% Correction	0-90% of Series R
Leak Subtraction	50 G Ω Headstage Resistor ∞ to 50 G Ω 500 M Ω Headstage Resistor ∞ to 500 M Ω 50 M Ω Headstage Resistor ∞ to 50 M Ω
Front Panel Outputs: Im (membrane current), selected in the range of: Gains of 0.05 to 10 mV/pA with 50 M Ω headstage resistor Gains of 0.5 to 100 mV/pA with 500 M Ω headstage resistor Gains of 5 to 1000 mV/pA with 50 G Ω headstage resistor	
Vc x10	Summation of all commands amplified by 10
Vm x10	Membrane voltage amplified by 10
Im Low-Pass Filter	0.05, 0.1, 0.2, 0.5, 1, 2, 5, 10, 20 kHz and Bypass (4-Pole Bessel)
Panel Meter: 3 $\frac{1}{2}$ Digit LED reads (full scale):	
Junction Zero	± 199.9 mV
Vc + h In	Sum of all commands and V Hold, ± 199.9 mV
Vc	Sum of all commands, ± 199.9 mV
Vm	Membrane voltage (current clamp mode) ± 199.9 mV
Im	Membrane current, ± 1999 pA
RMS Noise	1.999 pA
Rear Panel Outputs:	
Gain Telegraph	From 0.5 to 7.0 V in 0.5 V steps.*
Filter Telegraphs	From 0.2 to 2.0 V in 0.2 V steps.*
Im/Vm Telegraph	Logic levels, V-Clamp=1, I-Clamp=0
Sync Out	Signal for synchronizing an oscilloscope to internal test
Power Requirements	110 to 130 or 220 to 250 VAC, 50/60 Hz, 15 VA
Physical Dimensions:	
Main Unit	8.9 x 43.2 x 30.5 cm, H x W x D
Headstage	1.9 x 3.5 x 5.7 cm, H x W x L, with 1.8 m cable
Mounting Rod	6.3 mm D x 6.3 cm cm L
Shipping Weight	11.4 kg
Warranty	Three years, parts and labor

* Compatible with Axon pClamp and Heka PatchMaster.

Order # Model Product

Line operating voltage if other than 100-130 VAC.

W4 64-0000	PC-505BLC	Patch Clamp PC-505B with LC-201B Headstage*
W4 64-0001	PC-505BHC	Patch Clamp PC-505B with HC-202B Headstage*
W4 64-0002	PC-505BHB	Patch Clamp PC-505B with HB-205B Bilayer Headstage*

* Supplied with model cell and rack mount hardware.

Additional/Replacement Headstages

W4 64-0004	LC-201B	50 G Ω /500 M Ω Headstage
W4 64-0005	HC-202B	50 G Ω /50 M Ω Headstage
W4 64-0006	HB-205B	50 G Ω Headstage for Bilayer

Electrode Holders for PC-501A and PC-505B

W4 64-0821	QSW-A10P	Straight Holder 1.0 mm glass OD
W4 64-0822	QSW-A12P	Straight Holder 1.2 mm glass OD
W4 64-0823	QSW-A15P	Straight Holder 1.5 mm glass OD
W4 64-0978	QSW-A17P	Straight Holder 1.7 mm glass OD
W4 64-0824	QSW-A20P	Straight Holder 2.0 mm glass OD

PC-501A

Patch Clamp

patch clamp

A workhorse patch clamp amplifier equally at home in research and teaching labs



- Independent V Hold and I Hold
- Stability in Current Clamp with selection of three I Clamp response speeds
- 4-Pole low-pass Bessel filter
- Internally generated test signals
- Zap circuit with variable duration

The PC-501A Patch Clamp is a “workhorse” equally at home in research and teaching labs. Most single channel and whole cell studies are easily handled with this modestly priced instrument.

With a choice of four headstages, a wide range of patch, whole cell and bilayer applications are covered.

Headstage Choices

Four resistive-feedback headstages are available for the PC-501A:

- 5101-10G (10 G Ω) headstage for recording single channel currents up to ± 1 nA. Noise level measured at 1 kHz is 60 fA.
- 5101-01G (1 G Ω) headstage for whole cell studies with currents to ± 10 nA.
- 5101-100M (100 M Ω) headstage for whole cell studies with currents to ± 100 nA.
- 5101-10GB (10 G Ω) headstage modified for bilayer capacitances up to 250 pF. Maximum current is ± 1 nA.

Operating Modes

- V Clamp Mode: Input is clamped to a maximum of ± 1 V. Commands are the sum of the holding voltage and any external input signals.
- Zero Current Mode: Bridges the voltage and current clamp modes. All commands are inactive except the junction zero, which functions in this case as an offset control for the electrode and tip potentials associated with the pipette.

- I Clamp Mode: In current clamp mode, active commands are the current hold and any external command input signals, summed. Clamp stability is enhanced with the selection of three clamp speeds.

Compensation Controls

- Voltage Offsets (including junction potentials): are automatically compensated with the auto zero or manually with the junction zero.
- Capacity Compensation: Paired controls; fast (0-5 μ sec), medium (0-2 msec) and slow (0-20 msec) compensate the current transient caused by a step command signal. Each pair has a separate control for amplitude and time constant.
- Series Resistance: Signal errors contributed by the electrode (access) resistance in whole cell recording are subtracted from the output with the series R comp control. The compensated resistance (0-100 M Ω) is read from a 10-turn dial.
- Leak Subtraction: Used to compensate leakage current due to the voltage drop across the seal (shunt) resistance.

Outputs/Signal Conditioning

The I_m signal is bandwidth limited by a 4-pole Bessel filter with six frequency cut-offs and can be bypassed to obtain the full 10 kHz bandwidth. Gain is selected with a 7 position switch and scaled to the headstage resistor.

Additional outputs are $V_m \times 10$ (membrane voltage at x10 gain) active in current clamp mode and $\sum V_c \times 10$ (the sum of all commands at x10 gain). Rear panel outputs include; gain telegraph and sync output.

Voltammetry with PC-501A/V

A simple modification to the PC-501A makes it suitable for voltammetric measurements. This includes increasing the holding voltage potential to ± 1 V and the external voltage signal level to ± 2 V maximum. Internal switches can be installed to allow switching between normal [patch] and voltammetry operation. Contact our technical support department for details.

PC-501A

Patch Clamp (continued)

Specifications

Headstages:	
5101-10G Headstage	With 10 GΩ resistor for single channel recording, maximum current ±0.8 nA*
5101-01G Headstage	With 1 GΩ resistor for whole cell currents to ±8 nA*
5101-100M Headstage	With 100 MΩ resistor for whole cell currents to ±80 nA*
5101-10GB Headstage	With 10 GΩ modified for bilayer capacitances up to 250 pF Maximum current is ±1 nA
Noise:	
Measured with an 8-pole Bessel filter and 10 GΩ headstage, input open.	
DC to 1 kHz	0.06 pA RMS
DC to 5 kHz	0.20 pA RMS
DC to 10 kHz	0.40 pA RMS
High Frequency Boost	Increases bandwidth to 10 kHz. Front panel adjustable with Speed Test for 1 GΩ and 10 GΩ headstages
Voltage Clamp Commands:	
Command Input	Applied voltage attenuated by Command Sensitivity, Max input ±10 V
Command Sensitivity	Attenuates CMD IN by x0.1, x0.01 or x0.001.
V Hold	Adjustable from zero to ±200 mV with 10 turn control.
Junction Zero	Adjustable between ±100 mV with 10 turn control.
Test Pulse	100 Hz square wave, amplitude at the electrode dependent on Command Sensitivity;
	100 mV @ x0.1
	10 mV @ x0.01
	1.0 mV @ x0.001
Zap	1.5 V pulse with duration adjustable from 0.1 to 10 msec
Current Clamp Commands:	
Command Input	±1.0 nA max. with Command Sensitivity @ x0.1 ±100 pA max. with Command Sensitivity @ x0.01 ±10 pA max. with Command Sensitivity @ x0.001
Series Resistance	Zero to 100 MΩ, read from 10 turn digital dial
Compensation Capacity	Three ranges with amplitude and time constant
Compensation	Fast (0-5 μsec), Medium (0-2 msec), Slow (0-20 msec)
Leak Subtract	Adjustable from ∞ to 10 GΩ for 10 GΩ headstage, ∞ to 1 GΩ for 1 GΩ headstage, ∞ to 100 MΩ for 100 MΩ headstage
Im Output Low Pass Filter	4 pole Bessel with -3 dB frequencies at 0.1, 0.2, 0.5, 1, 2, and 5kHz. Bypass allows full 10 kHz bandwidth
Outputs:	
Im (membrane current)	Gain is adjustable, in the range of: 10 to 1000 mV/pA with 10 GΩ headstage 1 to 100 mV/pA with 1 GΩ headstage 0.1 to 10 mV/pA with 100 MΩ headstage
V c x10	Sum of all commands (Vc +h, Junction Zero, Auto Zero and Series R) x 10
Vm x10	Membrane Voltage x 10
Gain Telegraph	DC voltage scaled to Im:
Output (rear panel)	From 3.0 to 4.2 Volts for 10 GΩ headstage, 0.2 V steps From 1.6 to 2.8 Volts for 1 GΩ headstage, 0.2 V steps From 0.2 to 1.4 Volts for 100 MΩ headstage, 0.2 V steps Compatible with acquisition software.*
Panel Meter	3½ digit LCD provides DC or average readout of:
Vc + h In	Sum of all commands and V Hold, ±199.9 mV
∑ Vc	Sum of all Commands, ±199.9 mV
Vm	Membrane voltage (current clamp mode) ±199.9 mV
Im	Membrane Current, ±1999 pA
Power Requirements	100 -130 VAC or 220-240 VAC, 50/60 Hz, 10 VA

Specifications (continued)

Physical Dimensions:	
Control Unit	13.3 x 43.2 x 25.4 cm, H x W x D
Headstage	5.7 x 2.9 x 2.5 cm, H x W x L, with 1.8 m long cable
Detachable Mounting Rod	6.2 mm dia x 6.3 cm L
Shipping Weight	11.4 kg (25.1 lbs)
Warranty	Three years, parts & labor

* Output volt maximum 8V/Rf

** Molecular Devices pClamp and Heka PatchMaster.

Order #	Model	Product
W4 64-0007	PC-501A/10	Patch Clamp PC-501A with 5101-10G Headstage (10 GΩ)
W4 64-0008	PC-501A/9	Patch Clamp PC-501A with 5101-01G Headstage (1 GΩ)
W4 64-0009	PC-501A/8	Patch Clamp PC-501A with 5101-100M Headstage (100 MΩ)
W4 64-0010	PC-501A/10B	Patch Clamp PC-501A with 5101-10GB Bilayer Headstage
W4 64-0012	PC-501AV/9	Patch Clamp PC-501A for Voltammetry with 5101-01G Headstage (1 GΩ)
W4 64-0013	PC-501AV/8	Patch Clamp PC-501A for Voltammetry with 5101-100M Headstage (100 MΩ)

Supplied with rack mount hardware. Electrode Holder must be purchased separately based on your glass outer diameter.

Also, specify line operating voltage if other than 100-130 VAC.

Electrode Holders for PC-501A and PC-505B

W4 64-0821	QSW-A10P	Straight Holder 1.0 mm glass OD
W4 64-0822	QSW-A12P	Straight Holder 1.2 mm glass OD
W4 64-0823	QSW-A15P	Straight Holder 1.5 mm glass OD
W4 64-0978	QSW-A17P	Straight Holder 1.7 mm glass OD
W4 64-0824	QSW-A20P	Straight Holder 2.0 mm glass OD

Additional/Replacement Headstages

W4 64-0014	5101-10G	Headstage with 10 GΩ Resistor
W4 64-0015	5101-01G	Headstage with 1 GΩ Resistor
W4 64-0016	5101-100M	Headstage with 100 MΩ Resistor
W4 64-0017	5101-10GB	Headstage with 10 GΩ Resistor for Bilayer

Optional Accessories

W4 64-0018	MC-10G	Model Cell for 5101-10G (10 GΩ) Headstage
W4 64-0019	MC-01G	Model Cell for 5101-01G (1 GΩ) Headstage
W4 64-0020	MC-100M	Model Cell for 5101-100M (100 MΩ) Headstage
W4 64-0021	MC-10GB	Model Cell for 5101-10GB (10 GΩ) Bilayer Headstage

bilayer workstation

Bilayer Workstation

The Planar Lipid Bilayer Workstation

The tool for measuring pico- to nano-scale charge currents across a lipid membrane

The **Planar Lipid Bilayer (BLM) Workstation** from Warner Instruments integrates every significant component required for the use of a working BLM rig. This unique device allows the user to quickly get up to speed in performing research using this powerful technology.



- Integrated instrumentation for Planar Lipid Bilayer recording
- Simple and integrated design
- Complete System
- Optional power line conditioning
- Popular data acquisition packages
- Available on-site setup and training

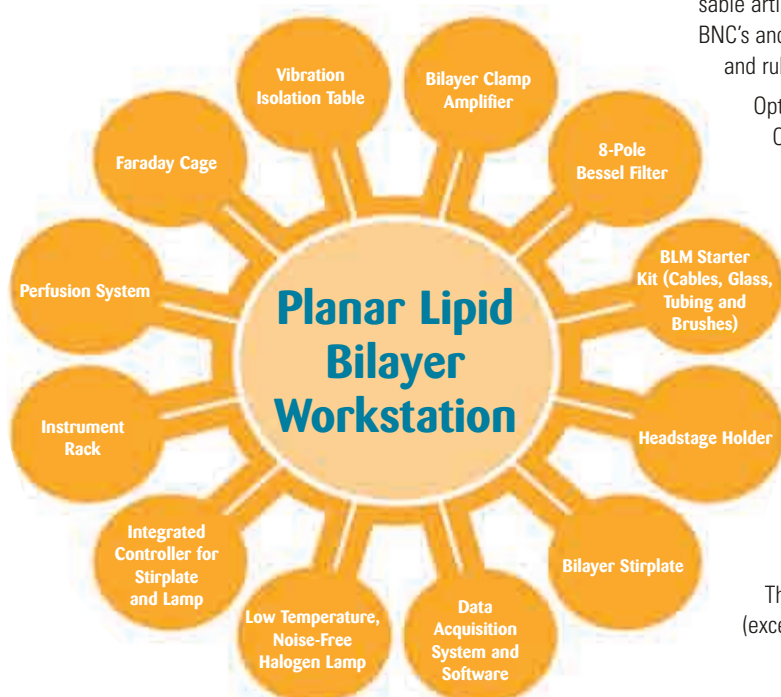
The BLM Workstation is comprised of an FC Series Faraday cage, a BenchMate vibration isolation table from Kinetic Systems, our BC-535 bilayer clamp amplifier and LPF-8 8-pole Bessel filter, a SUN-1 halogen lamp, a SPIN-2 bilayer stirplate, the SUNStir integrated controller (for the stirrer and lamp), and the BPS-2 perfusion system. The HST-1 headstage holder with magnetic base rounds out the package. Also included is a RAC-14 table top rack and the BLM-ST starter kit which includes a red sable artist dotting brush, glass capillary tubing for lipid application, BNC's and grounding cables, spare stirbars for bilayer cups and chambers, and rubber matting for traction control of the bilayer chamber.

Optional components include the BLM-TC Bilayer Thermocycler, the ON-750 power line conditioner and a stereo zoom microscope for viewing the membrane. We also supply accessories useful for bilayer work. These include the CM-3 (variable) and CM-1 (fixed value) single channel simulators.

Additional items required for a complete Workstation include our popular BCH-13A or BCH-22A bilayer cups and chambers, acquisition hardware/software and a computer.

The BLM workstation supports the use of either pClamp (Molecular Devices, Union City, CA) or PatchMaster (HEKA Instruments, Bellmore NY) for data acquisition. You may purchase your acquisition system directly from the vendor or from us at no additional charge (Technical support and warranty are through the manufacturer).

The complete system from Warner includes everything you need (except the computer) to begin collecting data.



Bilayer Workstation

bilayer workstation

The Planar Lipid Bilayer Workstation (continued)

Ordering Information

Order #	Model	Product
W4 64-0452P	BLM-WS-P	Bilayer Workstation Passive Table
W4 64-0452A	BLM-WS-A	Bilayer Workstation Active Table

System Includes

FC-Series Cage	Faraday Cage with Vibration Isolation Table
BC-535	Bilayer Clamp Amplifier
LPF-8	Bessel Filter, 8 Pole, Low Pass
SUNStir-3	Dual Function Rack Mountable Controller with SUN-1 Lamp and SPIN-2 Stirrer
BPS-2	Bilayer Perfusion System
RAC-14	Instrument Rack
HST-1	Headstage Holder with Magnetic Base
BLM-ST	Bilayer Starter Kit

Purchase of a bilayer cup and chamber, and a data acquisition system are needed to complete the Workstation

All components available separately. Please contact our Sales Department.

Add on Acquisition System (to complete the system)

Order #	Model	Product
W4 64-0436	DIGI	Molecular Devices – Digidata 1440 + pClamp 10

Accessories

Order #	Model	Product
W4 64-0083	OST-1*	On-site Setup and Training 2 Day Minimum. Price Per Day*
W4 64-0450	BLM-TC	Bilayer Thermocycler
W4 64-0026	CM-3	Single Channel Simulator, Adjustable Characteristics
W4 64-0024	CM-1	Single Channel Simulator, Fixed Characteristics
W4 64-0069	ON-750A	6.5 A Power line conditioner
W4 64-1803	Z850	Stereo Zoom Horizontally Mounted Microscope with Boom Stand
W4 64-0420	MAG-13	2 x 5 mm Stirbars for 13 mm Chambers and Cuvettes (pkg. of 5)
W4 64-0421	MAG-22	2 x 7 mm Stirbars for 22 mm Chambers and Cuvettes (pkg. of 5)

Note: Price is per day with a 2 day minimum. Travel expenses are additional.

Cup Chamber Set A

Order #	Model	Product
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Classic 13 mm Chamber (1 ml volume)

W4 64-0451	BCH-M13	Bilayer Chamber (Includes Two 2 x 5 mm Stirbar Magnets)
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Classic 13 mm Cuvettes

W4 64-0404	CP13A-150	Polystyrene with 150 µm Aperture
W4 64-0403	CP13A-200	Polystyrene with 200 µm Aperture
W4 64-0402	CP13A-250	Polystyrene with 250 µm Aperture
W4 64-0410	CD13A-150	Delrin with 150 µm Aperture
W4 64-0409	CD13A-200	Delrin with 200 µm Aperture
W4 64-0408	CD13A-250	Delrin with 250 µm Aperture
W4 64-0416	CF13A-150	Polysulfone with 150 µm Aperture
W4 64-0415	CF13A-200	Polysulfone with 200 µm Aperture
W4 64-0414	CF13A-250	Polysulfone with 250 µm Aperture

Cup Chamber Set B

Order #	Model	Product
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Classic 22 mm Chamber (3 ml volume)

W4 64-0453	BCH-M22	Bilayer Chamber (Includes Two 2 x 7 mm Stirbar Magnets)
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Classic 22 mm Cuvettes

W4 64-0407	CP22A-150	Polystyrene with 150 µm Aperture
W4 64-0406	CP22A-200	Polystyrene with 200 µm Aperture
W4 64-0405	CP22A-250	Polystyrene with 250 µm Aperture
W4 64-0413	CD22A-150	Delrin with 150 µm Aperture
W4 64-0412	CD22A-200	Delrin with 200 µm Aperture
W4 64-0411	CD22A-250	Delrin with 250 µm Aperture
W4 64-0419	CF22A-150	Polysulfone with 150 µm Aperture
W4 64-0418	CF22A-200	Polysulfone with 200 µm Aperture
W4 64-0417	CF22A-250	Polysulfone with 250 µm Aperture

Cup Chamber Set C

Order #	Model	Product
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Perfusion Bilayer Chamber (1 ml volume)

W4 64-0423	BCH-P	Perfusion Bilayer Chamber (Includes Two 2 x 5 mm Stirbar Magnets)
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Perfusion Bilayer Cups

W4 64-0424	CP-P-150	Polystyrene Perfusion Cup with 150 µm Aperture
W4 64-0425	CP-P-200	Polystyrene Perfusion Cup with 200 µm Aperture
W4 64-0426	CP-P-250	Polystyrene Perfusion Cup with 250 µm Aperture
W4 64-0427	CD-P-150	Delrin Perfusion Cup with 150 µm Aperture
W4 64-0428	CD-P-200	Delrin Perfusion Cup with 200 µm Aperture
W4 64-0429	CD-P-250	Delrin Perfusion Cup with 250 µm Aperture

BC-535**Bilayer Clamp Amplifier**

bilayer workstation

The only amplifier specifically dedicated to research using the planar lipid bilayer

The **BC-535** is the newest version of our popular bilayer clamp amplifier. Warner Instruments is the only company to supply an instrument specifically designed for research using planar lipid bilayer technology and this device forms an integral component of the BLM Workstation.



Major improvements in this model include:

- Reduced noise and wider bandwidth
- Improved stability with gains to 1000 mV/pA
- Digital hold potential
- AutoZero function
- Digital readout of membrane capacitance
- Multi-step 4-pole Bessel filter
- Hold potentials to 1400 mV; currents to 20 nA

Resistive Feedback Headstage

The BC-535 sports an advanced, resistive feedback headstage which provides high bandwidth and low noise recording. The switchable headstage resistance is automatically selected based on the gain selection. The low current mode provides up to 100 pA of current carrying capability, while the high current mode provides up to 20 nA of current capacity!

Hold Control

The hold control for the BC-535 has been redesigned to function entirely within the digital domain. This unique approach allows the user to make holding potential adjustments in highly reproducible and discrete steps of 1, 10, and 100 mV, up to ± 400 mV. Hold potentials up to ± 1000 mV or step sizes greater than 100 mV can be applied at the Command Input BNC's located on the front and rear panels of the instrument. Internal and external hold potentials sum for a possible total of 1400 mV.

AutoZero

The large currents flowing through the low resistance aperture prior to bilayer formation saturates the amplifier input. Under these conditions, junction potential offsets can be easily nullified by using the AutoZero function. Once armed, the AutoZero measures and compensates for any offset potentials within the conducting pathway. Traditional manual controls remain for making small corrections or for resetting the offset potential without re-activating the AutoZero cycle.

Audio Output

The BC-535 sports a VCO circuit providing auditory feedback during membrane formation. This feature is selectable from the front panel and an internal speaker is included. An external speaker output is provided on the instrument rear panel.

Capacitance Test

This test circuit has been completely redesigned and is used to monitor the formation of the bilayer membrane. A calibrated triangular waveform is applied to the command input and the amplitude of the resulting square wave is proportional to the membrane capacitance. When selected, the membrane capacitance is read directly from the meter.

4-Pole Bessel Filter

The filtering capacity of the instrument has been expanded to include a low pass, 4-pole Bessel filter ranging from 0.05 to 20 kHz in 1-2-5 steps. The internal filter can be bypassed allowing realization of the instrument's full 75 kHz bandwidth.

Capacitance Compensation

Large capacitance transients are cancelled using both fast (0-10 μ s) and slow (0-2 ms) controls. Each control provides separate adjustment of both amplitude and time constant. Maximum capacitance compensation is 500 pF.

I/O

Input and output BNC's have been duplicated or moved to the instrument rear panel except for those requiring user interaction. Front panel BNC's include Command Input, $V_c \times 10$ and I_m Output. Rear panel BNC's include the headstage connector, I_m Output, Cap Sync, Command In, and Gain and Filter telegraphs. A speaker output is also available on the rear panel.

BC-535

bilayer workstation

Bilayer Clamp Amplifier (continued)

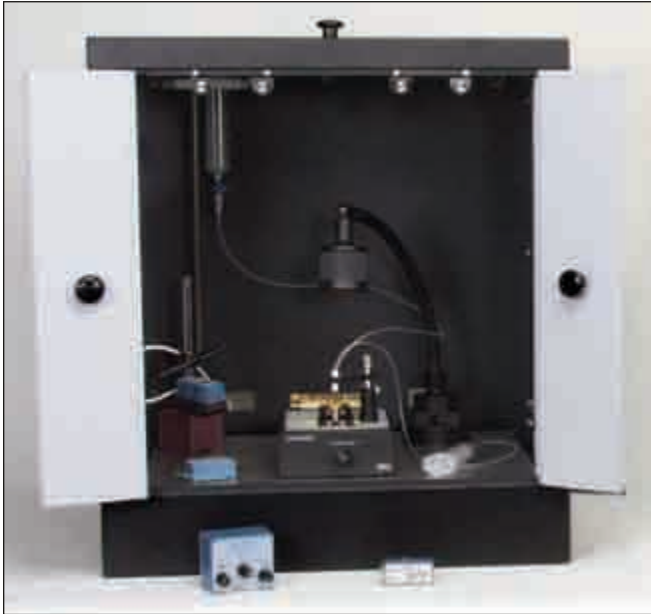
Specifications

Noise frequency	Measured with 8-pole Bessel filter at specified cutoff		
	Frequency Range	Open Input	100 pF at Input
	DC to 1 kHz	0.060 pA RMS	0.82 pA RMS
	DC to 100 Hz	0.009 pA RMS	0.28 pA RMS
Bandwidth	75 kHz		
Input Commands:			
Internal Hold	Digital; 1, 10 or 100 mV steps to ± 400 mV maximum		
Command In	Front and rear external input, 10 V/V (applied voltage is attenuated by 10/100/1000 at the command electrode)		
Junction zero	AutoZero or manual adjust. AutoZero lockout feature. Cycle time 1.5 s. Correction to ± 120 mV		
Audio	VCO with off switch and volume control. Internal speaker and external speaker output		
Capacitance Test	Triangle wave applied to command electrode. Derived membrane capacitance read from meter up to 1000 pF. Calibrated (1 mV/pF) square wave available at Im output. Cap Sync (rear panel) synchronized with input triangle wave		
Gain	Membrane current gain selectable from 0.5 to 1000 mV/pA in 1-2-5 steps		
Filter	4-pole Bessel selectable from 0.05 to 20 kHz in 1-2-5 steps, or bypassed for full amplifier bandwidth		
Capacity Compensation	Fast (0-10 μ s) and slow (0-2 ms) with adjustment of amplitude and time constant for each range. Maximum compensation 500 pF		
Headstage:			
<i>Switching:</i>			
Low Current Mode	50 gigohm feedback, 100 pA maximum current		
High Current Mode	500 megohm feedback, 20 nA maximum current		
I/O:			
<i>Front Panel:</i>			
Command Input	BNC input up to ± 10 V. Attenuated by 10, 100 or 1000		
Im Output	Membrane current scaled by amplifier gain setting		
Vc x 10 Output	Applied command voltage x 10		
<i>Rear Panel:</i>			
Im Output	Membrane current scaled by amplifier gain setting		
Cap Sync	TTL compatible		
Cap Out	Reports calculated membrane capacitance scaled to 1 mV/pF		
Command Input	BNC input up to ± 10 V. Attenuated by 10, 100 or 1000		
Gain Telegraph	Stepped DC voltage 0.5 to 5.5 V in 0.5 V steps for gain settings of 0.5 to 1000 mV/pA. Telegraphed value of 0.0 V for bypass		
Filter Telegraph	Stepped DC voltage 0.5 to 4.5 V in 0.5 V steps for filter settings of 0.05 to 20 kHz. Telegraph value of 5.0 V for full bypass		
External Speaker	Standard RCA jack		
Digital Meter:			
3.5 digit LED	± 1999 mV full scale		
Junction offset	± 120 mV full scale		
Cap Test	0 to 1999 pF		
Vc	± 1999 mV full scale		
Im	± 1999 pA full scale		
Power	100-125 or 220-240 VAC, 50/60 Hz		
Dimensions (H x W x D):			
Case	9 x 42 x 25 cm (3.5 x 16.5 x 10 in.)		
Headstage	2.3 x 2.8 x 5.8 cm (0.9 x 1.1 x 2.25 in.) 1.8 m connecting cable		

Order #	Model	Product
W4 64-0432	BC-535	Bilayer Clamp Amplifier

A self-contained, tabletop Faraday cage with vibration isolation

The **Faraday cage** provides critical shielding of electromagnetic interference from outside sources and is an integral component of the Bilayer Workstation. FC Series Faraday cages from Warner include the vibration isolation table and are designed to optimize the user's experience.



- Convenient benchtop design
- Enclosed vibration isolation table
- Passive or active support mechanisms
- Large access doors
- Magnetic closures
- Solid brass grounding block
- Durable powder coat finish

The Cage

The Faraday cage is a critical component in the Bilayer Workstation since it functions to shield the sensitive electronics contained therein from externally generated electrical interference. Without such, the ability to make single channel measurements would be mitigated.

FC Series cages from Warner are designed to be conveniently placed on a sturdy workbench and are supplied with a choice of automatic or manual vibration isolation table. A version of the cage without a table is also available.

Large access doors allow entry into the cage from all sides and the fan-fold front doors are designed to be placed out of the way when open. Doors along the base of each side allow access to table controls. There are also ports on the rear panel for entry of electronic cabling into the cage enclosure.

The Table

The cage is shipped with a custom 16" x 19" table manufactured for Warner Instruments by Kinetic Systems, Inc. When installed, the table is entirely contained within the cage enclosure and this design successfully isolates the tabletop from external acoustic and mechanical noise sources. The table has a steel top allowing the attachment of magnetically coupled devices to its surface.

Specifications

Dimensions (H x W x D)	25 x 22 x 18 in.
Materials	Aluminum with durable powder coat finish. Solid brass grounding block
Design	Electrically continuous cage with solid wall construction. Cage base accommodates 16" x 19" vibration isolation table (either automatic or manual support) manufactured by Kinetic Systems, Inc. Table top forms cage floor. Large panel doors with magnetic closures. Dual fan-fold front doors. Large panel doors on top and sides. Cage base has wing doors for access to vibration isolation table controls. Access ports on back panel for electrical connection to cage contents
Table	Specifications are supplied by Kinetic Systems, Inc. Contact our offices or Kinetic Systems for a copy of the table specifications
Model:	
FC-2	Faraday cage with automatic pneumatic vibration isolation table
FC-1	Faraday cage with manual pneumatic vibration isolation table, includes hand pump
FC-0	Faraday cage without vibration isolation table. This model has a shallow (1.5"), weighted base for improved access and stability in the absence of the enclosed table

Order #	Model	Product
W4 64-0062	FC-0	Faraday Cage without Vibration Isolation Table
W4 64-0063	FC-1	Faraday Cage with Manual Vibration Isolation Table (Includes Hand Pump)
W4 64-0064	FC-2	Faraday Cage with Automatic Vibration Isolation Table (Requires Pressurized Air)
W4 64-0081	KS-1	Vibration-Free Platform, 16 x 19 in, Manual Air, (Includes Hand Pump)
W4 64-0082	KS-2	Vibration-Free Platform, 16 x 19 in, Automatic Air

BCH-M13 and BCH-M22

Classic Bilayer Chambers and Cuvettes

bilayer workstation

The standard membrane support system

Since the pioneering work on black lipid membranes by Paul Mueller and co-workers in the early '60s, several generations of membrane biologists have exploited this model membrane for biophysical and reconstitution studies. The planar bilayer formed by painting lipids across a small aperture in a partition is one of the simplest techniques available to the novice and expert alike, and the cup/chamber system has been used to reconstitute and record the single-channel behavior of a wide variety of ion channel proteins from diverse tissues.



- Polystyrene, polysulfone or Delrin cuvettes
- Precision machined apertures of 150, 200 or 250 μm
- *cis* and *trans* stirbar wells
- Stirbar included with each cup and chamber
- Viewing window
- Shipments from stock

The Basics

Classic design cups and chambers from Warner Instruments are designed such that addition of equal volumes to the *cis* and *trans* sides results in a balanced solution height, thus minimizing mechanical gradients across the bilayer membrane.

All cuvettes have a 0.5 mm well milled into their base to confine the motion of stirbars and to reduce mechanical noise artifacts. A 2 x 5 mm or 2 x 7 mm Teflon-coated stirbar is supplied with each cuvette. Standard available aperture diameters are 150, 200 or 250 μm . **Contact our offices for custom aperture sizes.** The wall thickness at the aperture is 250 μm .

Bilayer Chambers

Chambers are made from black Delrin and have a 0.5 mm recessed well milled into the floor of the non-cup side to confine the motion of stirbars and to reduce mechanical noise artifacts. A 2 x 5 mm or 2 x 7 mm Teflon-coated stirbar is supplied with each chamber.

Polyethylene centrifuge tubes (supplied) serve as intermediate wells for electrical connections between the headstage electrodes and the cup or chamber. Chambers include a nylon screw and rubber plug to secure the cups during use. The classic model has a window for viewing the aperture during membrane formation.

Classic Models BCH-M13 and BCH-M22

Two classic models are offered: The BCH-M13 is a small volume chamber (1.0 ml) with a 13 mm ($\frac{1}{2}$ " diameter) cuvette. The BCH-M22 is a larger volume chamber with (3.0 ml) chamber with a 22 mm ($\frac{7}{8}$ " diameter) cuvette.

Bilayer Cuvettes

Polystyrene has been a favored material for cuvettes for several years. The physical properties of this material make for a high quality membrane support. However, its poor resistance to organic solvents can lead to degradation of the aperture.

Cuvettes have also been made from Delrin (acetyl resin) and many users report good membrane formation as well as easier maintenance. It should be noted, however, that Delrin cuvettes do not work equally well in all applications and with all users.

Warner Instruments now offers bilayer cups made from polysulfone. This material has many of the mechanical properties of polystyrene coupled with enhanced solvent resistance. The choice of material will depend on your application.

Order #	Model	Product
Classic 13 mm Chamber (1 ml volume)		
W4 64-0451	BCH-M13	Bilayer Chamber (Includes Two 2 x 5 mm Stirbar Magnets)
Classic 13 mm Cuvettes		
W4 64-0404	CP13A-150	Polystyrene with 150 μm Aperture
W4 64-0403	CP13A-200	Polystyrene with 200 μm Aperture
W4 64-0402	CP13A-250	Polystyrene with 250 μm Aperture
W4 64-0410	CD13A-150	Delrin with 150 μm Aperture
W4 64-0409	CD13A-200	Delrin with 200 μm Aperture
W4 64-0408	CD13A-250	Delrin with 250 μm Aperture
W4 64-0416	CF13A-150	Polysulfone with 150 μm Aperture
W4 64-0415	CF13A-200	Polysulfone with 200 μm Aperture
W4 64-0414	CF13A-250	Polysulfone with 250 μm Aperture
Classic 22 mm Chamber (3 ml volume)		
W4 64-0453	BCH-M22	Bilayer Chamber (Includes Two 2 x 7 mm Stirbar Magnets)
Classic 22 mm Cuvettes		
W4 64-0407	CP22A-150	Polystyrene with 150 μm Aperture
W4 64-0406	CP22A-200	Polystyrene with 200 μm Aperture
W4 64-0405	CP22A-250	Polystyrene with 250 μm Aperture
W4 64-0413	CD22A-150	Delrin with 150 μm Aperture
W4 64-0412	CD22A-200	Delrin with 200 μm Aperture
W4 64-0411	CD22A-250	Delrin with 250 μm Aperture
W4 64-0419	CF22A-150	Polysulfone with 150 μm Aperture
W4 64-0418	CF22A-200	Polysulfone with 200 μm Aperture
W4 64-0417	CF22A-250	Polysulfone with 250 μm Aperture

Helps minimize membrane breakage and maintains solution volume



Order #	Model	Product
W4 64-0423	BCH-P	Perfusion Bilayer Chamber
Perfusion Bilayer Cups		
W4 64-0424	CP-P150	1 ml Polystyrene Perfusion Cup, 150 μ m Aperture
W4 64-0425	CP-P200	1 ml Polystyrene Perfusion Cup, 200 μ m Aperture
W4 64-0426	CP-P250	1 ml Polystyrene Perfusion Cup, 250 μ m Aperture
W4 64-0427	CD-P150	1 ml Delrin Perfusion Cup, 150 μ m Aperture
W4 64-0428	CD-P200	1 ml Delrin Perfusion Cup, 200 μ m Aperture
W4 64-0429	CD-P250	1 ml Delrin Perfusion Cup, 250 μ m Aperture

Perfusion Design

- Polystyrene or Delrin cuvettes
- Precision machined apertures of 150, 200 or 250 μ m
- *cis* and *trans* stirbar wells
- Stirbar included with each cup and chamber
- Maintains fixed volume
- Dedicated perfusion line ports
- Unique aspiration shelf

The Perfusion Bilayer Chamber is designed to simplify the exchange of solutions in both the cup and chamber. The BCH-P incorporates unique features which can improve your perfusion success rate.

The design of the BCH-P has two features not found in our classic cup and chamber. First, ports have been permanently milled into both the chamber and cup body for attachment of perfusion lines. The input port is routed to the bottom of the cup (or chamber) while the output port collects solution from the top of the cup (or chamber).

A second improvement is the incorporation of an aspiration shelf in both the cup and chamber. This shelf provides two advantages. First, the aspiration line can remain attached to the chamber without introducing noise artifacts into the bath. Second, the fixed height of the shelf, coupled with rapid aspiration of overflow solutions, helps maintain the working volume.

Connection between your PE perfusion lines and the perfusion ports is conveniently made via standard 200 μ l pipette tips. Alternatively, PE-90 tubing can be attached directly to the cup (or chamber) to minimize dead volume.

The BCH-P chamber is machined from black Delrin and has a working volume of 1 ml. Cups are available in either white Delrin or polystyrene and have a working volume of 1 ml.

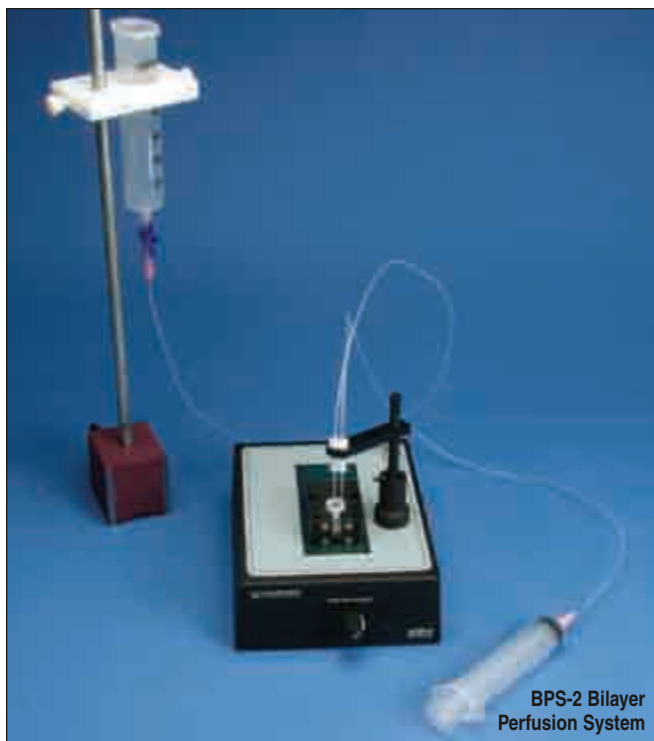
Not compatible with BLM-TC Thermocycler.

bilayer workstation

BPS-2 and LPF-8

Bilayer Perfusion System and 8-Pole Bessel Filter

An easy to use perfusion system that helps reduce membrane breakage



BPS-2 Bilayer Perfusion System

Bilayer Perfusion System

- Complete gravity-feed system
- Quiet operation
- High volume flow rates possible
- Includes everything shown (except for the cup, chamber, and stirplate)

The BPS-2 Bilayer Perfusion System from Warner Instruments provides a simple and straightforward way to exchange solutions in either the bilayer cup or the chamber. The magnetic base holds the perfusion head ready for quick insertion into your solution when expedited solution exchange is necessary.

The gravity-feed mechanism allows the device to support flow rates of up to 10 ml/min without breaking the bilayer membrane. The commonly available syringe reservoirs are easily replaced to reduce cross-contamination between different reservoir solutions.

A perfusion system is a critical component of a Bilayer Workstation. The ability to exchange solutions on both sides of the bilayer membrane is important if complicated experimental protocols are to be performed. Warner Instruments recommends the use of a gravity-driven system as this is the best way to remove biological and chemical materials with a minimum of noise.

Order #	Model	Product
W4 64-0431	BPS-2	Basic Bilayer Perfusion System
W4 64-0774	G200-3	Capillary glass, 2 mm OD

One of the best



8-Pole Bessel Filter

- 8-Pole low-pass Bessel filter with cutoff frequencies from 0.1 Hz to 20 kHz.
- Differential amplifier gains to x200
- Frequency selection with single control
- Input offset adjustment
- Digital frequency readout
- Rack mountable

The LPF-8 is the premier low-pass Bessel filter from Warner Instruments and provides superior control of analog signal filtering. This instrument incorporates both low-pass signal filtering and output gains from 1 to 200. Selectable dual signal inputs allow the instrument to be configured to operate in normal, inverted or differential modes.

This instrument features optically encoded circuitry which permits frequency selection with a single control. Since the set frequency control is not a physical part of the filtering circuit, adjustments to the instrument do not introduce noise artifacts into the output signal. This unique design uses no mechanical switching and ensures long term instrument reliability.

The LPF-8 is a signal conditioner combining an 8-pole low-pass Bessel filter and DC amplifier. Special features include digital frequency readout, visual input offset indicator, clipping indicator, and gain telegraph outputs.

Specifications

Input	DC differential
Input impedance	1 M Ω each channel
Input range	± 10 V
Input offset control	2 Ranges, ± 100 mV and ± 1 V, variable from 0 with 10-turn control
Offset indicator	20 LED display
Low frequency range	0.1 to 199.9 Hz
Low range resolution	0.1 Hz
High frequency range	10 to 19.99 kHz
High range resolution	10 Hz
Gains	x1, x2, x5, x10, x20, x50, x100 and x200
Output impedance	50 Ω
Power requirements	100-130 VAC or 200-250 VAC, 50/60 Hz

Order #	Model	Product
W4 64-0050	LPF-8	LPF-8 Bessel Filter, Low Pass Filter/DC Amplifier. Specify Line Operating Voltage if Other Than 100-130 VAC

SUNStir-3 System

Lamp, Stirplate and Dual Function Controller

bilayer workstation

An integrated system for stirring and illumination

The **SUNStir-3 System** is comprised of the **SUNStir controller**, a **SUN-1 lamp** and a **SPIN-2 stirplate**. This convenient, rack-mountable system is designed to provide simultaneous control for both the SUN-1 lamp and the SPIN-2 stirplate.



Lamp

- Dichroic reflector
- Noise-free electronics
- Halogen bulb
- Adjustable spotlight intensity with external control device
- Magnetic base with gooseneck and swivel-head lamp

SPIN-2 Stirrer

- Very low noise!
- Stir while recording
- Independent cis/trans dipoles
- Minimized magnetic flux through bilayer membrane
- Magnetic steel side panels

Controller

The SUNStir controller is a rack-mountable instrument designed to provide quiet and efficient control of the SUN-1 Lamp and SPIN-2 Stirrer.

Lamp

The SUN-1 is an externally controlled, noise-free halogen light source suitable for inclusion in a shielded enclosure. The magnetic base attaches securely to any steel tabletop and the lamp swivel-head allows projection of the beam in virtually any direction. Modifications to the design of the reflector result in significant improvements in the lamp's performance.

The lamp is comprised of a magnetic base with 12" gooseneck for accurate positioning of the illumination spot. A jointed swivel-head at the end of the gooseneck allows the beam to easily subtend a solid angle of 2π steradians (half of a sphere).

Beam intensity is adjustable to one of eight levels via the rack-mount controller. The lamp electronics are well isolated to prevent the introduction of external EMF into the Faraday cage enclosure and allows recording of data even while the lamp is on.

A dichroic reflector reduces much of the projected heat from the lamp and allows longer illumination times without significantly warming the object under study.

SUNStir-3 System

Lamp, Stirplate and Dual Function Controller (continued)

Stirrer

Bilayer work often requires stirring of contents on both sides of a bilayer membrane. The SPIN-2 Bilayer Stirplate achieves this task by providing two spinning dipoles in a mechanically quiet apparatus.

Stirring of solutions in a bilayer cup and chamber has traditionally been achieved using a commercial stirplate. Unfortunately, these devices are not designed for use in a bilayer rig and present a single rotating magnetic dipole to the bilayer chamber.

A result of these characteristics is that it is impossible to simultaneously stir both wells since the stirbars will be drawn to a common rotational axis defined by the stirplate magnet. The resulting collisions between the stirbars and the bilayer cup introduces a noise artifact into the acquired data. Many researchers avoid this problem by not stirring while recording, which is an undesirable state of affairs.

The SPIN-2 stirplate from Warner Instruments is designed to specifically address these problems experienced by researchers in the field.

First, it has two separate spinning dipoles, one each for the cis and trans wells. This design allows the stirbars within each well to be independently controlled which virtually abolishes cup/stirbar collisions. The relative separation between the two dipoles is adjustable allowing the apparatus to be used with bilayer cups and chambers of different sizes.

Second, the rotation characteristics (speed and phase) of the two spinning dipoles is digitally controlled. This allows the device to present the minimum magnetic flux to the bilayer membrane. A liquid crystal display allows the researcher to view the rotating dipoles in real-time.

Third, the apparatus is both electrically isolated and mechanically quiet. In addition, steel strips are provided on each side of the liquid crystal window for attachment of magnetic holders and the like. This provides a convenient method of positioning a perfusion head.

Taken together, these features allow the SPIN-2 to be used while acquiring data.

SUNStir Controller Specifications

SUNStir	Master power switch, Power on LED
Lamp control Power on LED	Eight position intensity selection with on/off switch, Power on LED
Stirrer control switch, Power on LED	Continuously variable speed control with on/off switch, Power on LED
Power requirements	20 W-12 V internal, 100-125 VAC, 60 Hz external
Dimensions	1.75 x 16.5 x 8 in (H x W x D)

SUN-1 Lamp Specifications

Lamp	High impact polyamide housing; swivel head; spot reflector; clear lens Halogen bulb, dichroic reflector; 20 W-12 V
Gooseneck	1.4 cm diameter x 30.5 cm length; with PVC sleeve

Spin-2 Stirplate Specifications

Controls:	
Controller	Power on/off switch, Speed rotary control
Stirplate	Position adjust (rotary)
Display:	
Controller	LED; flashes once per complete rotation
Stirplate	Magnetic field display; passive LCD
Speed Range	300 to 600 RPM
Rotor:	
Synchronization	Counter-rotating with magnets repelling
Position Adjustment Range (center-to-center)	0.4 to 2.5 inches
Dimensions (W x D x H)	
Stirplate	5.5 x 8.0 x 2.3 in
Weight	
Stirplate	3.0 lb

Order #	Model	Product
W4 64-0076	SUNSTIR-3	Complete SunStir-3 System, Includes Sun-1 Lamp, Spin-2 Stirrer and SunStir Controller

System Components

W4 64-0061	SUN-1	Halogen Lamp with Tabletop Controller
W4 64-0074	SPIN-2	Dual Channel Spin Plate with Tabletop Controller
W4 64-0075	SUNSTIR	Dual Function Controller (Lamp plus Stirplate)
W4 64-0065	SUN-DCH	Replacement 12W-12V Dichroic Bulb for Sun-1 Lamp

bilayer workstation

Additional Components

RAC-14



RAC-14 Instrument Rack

An instrument rack provides an organizing influence on the electronics and facilitates the tabletop design of the Workstation.

The RAC-14 is a 14" tabletop rack and comes with all the hardware needed to mount your amplifier, filter, stirring-illumination controller and A/D board into one integrated unit. A ground point is provided for attachment to a Power Line Conditioner. Powder black finish.

Order #	Model	Product
W4 64-0070	RAC-14	Instrument Rack

BLM Starter Kit

Warner Instruments has put together a Starter Kit to aid you in completing your Bilayer Workstation. The kit includes 3 BNC cables, grounding cables, a Red Sable artist's dotting brush, glass capillary tubing, PE tubing (for your perfusion system), and one replacement pack of stirbars (2 x 5 mm).

Order #	Model	Product
W4 64-0067	BLM-ST	Bilayer Starter Kit

HST-1 Headstage Holder Kit



HST-1 Headstage Holder Kit

- Shock mounting for headstage
- Non-conducting surface
- Flexible headstage attachment
- Magnetic base with on/off switch

The HST-1 is designed as a shock mount positioning device for the bilayer headstage. The non-conducting neoprene pad, mounted onto a polycarbonate base, serves as a stable platform for the headstage. Two medium elasticity rubber bands are used to fix the headstage to the pad and provides a secure but flexible attachment.

Convenient positioning of the HST-1 Headstage Holder is provided by an MB/B magnetic base. The base contains a magnet with on/off switch for easy re-positioning of the assembly within your application.

Specifications

Platform, H x W x D	5.7 x 4.4 x 1.3 cm (2.24 x 11.2 x 0.5 in)
Material	Polycarbonate base; non-conducting neoprene pad
Shaft, Dia x L	0.6 x 6.4 cm; anodized aluminum

Order #	Model	Product
W4 64-0435	HST-1	Headstage Holder System

Replacement parts

W4 64-0422	HH-1	Headstage Holder
W4 64-0060	MB/B	Magnetic Base

BLM-TC

Planar Lipid Bilayer Thermocycler

bilayer workstation



- Peltier driven
- Cools to 5°C
- Heats to 50°C
- Heats and cools at 3°C/minute
- Stable to 0.2°C

The new BLM-TC from Warner uses Peltier technology to cool, heat, or thermocycle a planar lipid bilayer membrane.

The tight and reproducible temperature control provided by this unique device can facilitate the measurement of single channel events at physiologic temperatures, or at any temperature between 5 °C and 50 °C.

The device heats and cools at an average rate of 3 °C/min when transitioning between 40 °C to 10 °C. More importantly, the BLM-TC can maintain a temperature to within 0.2 °C of the set temperature.

The BLM-TC system is comprised of a Peltier-driven bilayer platform (compatible with Warner's SPIN 2 bilayer stirplate), a CL-100 bipolar temperature controller, and a an LCS-1 (for the water jacket, see page 142).

The purchase of a standard bilayer cup and chamber completes the package.

Note: If you will be primarily working at temperatures above ambient, then we recommend using the larger BCH-M22 chamber to reduce the impact of evaporative losses in the system during use.

Order #	Model	Product
W4 64-0450	BLM-TC	Planar Lipid Bilayer Thermocycler System
W4 64-0400	BCH-M13	1 ml Bilayer Chamber (Cup Purchased Separately)
W4 64-0401	BCH-M22	3 ml Bilayer Chamber (Cup Purchased Separately)
W4 64-1922	LCS-1	Liquid Cooling System
W4 64-0352	CL-100	Bipolar Temperature Controller

On-Site Setup and Training

Investigators first entering the arena of research using the planar lipid bilayer can be overwhelmed by the wealth of design and application issues surrounding the proper assembly and use of a Bilayer Workstation. While tractable, this state of affairs can result in an investigator choosing a less effective means to achieve his or her research goals.

Warner Instruments recognizes the need to make this technology more accessible and is the only company to establish on-site assembly and training in the proper care and use of the Bilayer Workstation. Our senior scientist, Dr. Edmond Buck, has over 18 years experience using this powerful technology and is committed to providing extensive support for this important technique.

Dr. Buck will visit your site, assemble the Workstation and instruct you in how to use and maintain the equipment. If desired, he will also provide guidance and insight in the best way to use your acquisition and analysis software.*

It is our committed goal to quickly and efficiently optimize your equipment and skill set allowing you to focus your efforts on data acquisition.

**Support and warranty rights are retained by the manufacturer of the acquisition software package.*

We invite you to contact Dr. Buck to discuss your needs and application.

References available.

CM-3 and CM-1 Channel Model Simulator

Ideal for testing and training

CM-3 Variable Single-Channel Model



CM-3 Variable Channel Model

- Independent selection of open and close time constants via calibrated rotary dial
- Selection of unitary channel conductance via calibrated rotary dial
- Available in 10 and 100 pF membranes
- Small dimensions allow easy attachment to the amplifier headstage within the Faraday cage enclosure
- Battery operated

The CM-3 is a continuously variable single channel simulator which models an actively gating ion channel. Gating transitions from the closed to the open, or from the open to the closed state are randomly induced within the constraints imposed by the mean open and mean close time settings. This unique device provides the researcher with a means to generate well-defined ion channel gating kinetics allowing critical analysis of data acquisition hardware and software and data analysis software. The instrument is also an ideal teaching aid.

Specifications

Mean time constants	Individually adjustable from 1-200 ms
Conductance	Continuously variable from 0-750 pS
Battery	9 V, 3 years of continuous operation
Dimensions (H x W x D)	6.6 x 7.6 x 4.2 cm

Order #	Model	Product
W4 64-0026	CM-3/10	Variable Simulator with 10 pF Membrane
W4 64-0027	CM-3/100	Variable Simulator with 100 pF Membrane
W4 64-1618	–	CM Cable for Non-Warner Amps

CM-1 Fixed Channel Model

The CM-1 is a fixed variable single channel model which simulates an actively gating ion channel. Gating transitions from the closed to the open, and from the open to the closed state, are randomly induced within the constraints imposed by the mean open and mean close time settings. Attaches directly to the headstage.

Specifications

Mean time constants	Open and closed factory set to 10 ms
Conductance	20 and 200 pS for patch and bilayer models, respectively
Battery	3 V lithium, 3 years of continuous operation
Dimensions (H x W x D)	2.8 x 5.7 x 2.2 cm

Order #	Model	Product
W4 64-0024	CM-1/10	Simulator with 10 pF Membrane
W4 64-0025	CM-1/100	Simulator with 100 pF Membrane
W4 64-1618	–	CM Cable for Non-Warner Amps



Stereo Zoom Microscope

The Z850 Stereo Zoom Microscope, when used in conjunction with the Planar Lipid Bilayer Workstation, is an ideal instrument for viewing the formation of bilayer membranes. The included boom stand permits the device to be positioned within the cage during use and then swung out of the way after the membrane has stabilized. The microscope can be mounted both vertically or horizontally for diverse applications. A binocular version lacking the camera c-mount is also available.

The rugged boom stand features a 14.3" chrome steel vertical post and a 20.4" horizontal bar. The 42 lb, 10" x 10" rectangle metal base assures positive stability. The locking collars prevent accidental slippage on the horizontal and vertical poles.

The Z850 has a drift free focusing range of 11.5 cm. See pages 338-341 for more details.

Stirbars

Replacement **stirbars** (magnetic fleas) are available for the BCH Series bilayer chambers. Stirbars are Teflon coated and are available in two sizes. Stirbars are sold in packages of 5 each and come in 2 x 7 mm and the more difficult to find 2 x 5 mm sizes.

Glass Capillary Tubing

Glass capillary tubing has gained favor among bilayerologists as the preferred tool for applying lipids to the aperture in the bilayer cup. The advantages of this approach (as compared to Sable hair brushes) are durability and the ability to sterilize the applicator between uses. Glass tubing from Warner Instruments has been chosen with dimensions that facilitate this use. The 1.5 mm OD and 15 cm length of this thick-walled tubing make for good quality glass applicators.



Power Line Conditioning

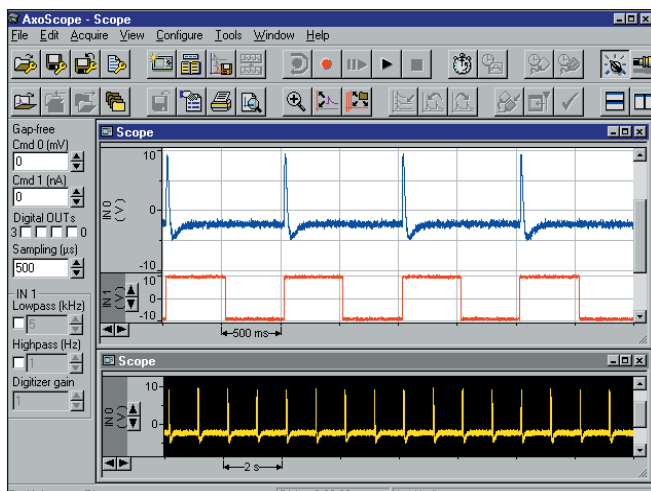
An often overlooked source of noise in electrophysiological recording is that introduced by fluctuations in the power circuit supplying the apparatus. Many labs are placed on upper floors in large research facilities where the power circuit is shared by many other labs. While most instrumentation used in BLM work are designed to compensate for variances in the power circuit, these effects cannot be completely abolished in a distributed network of components.

An elegant solution to this problem is provided by the use of an isolation transformer to supply power to the entire Workstation. The ON-750 Power Line Conditioner is a two-sided device wherein one side connects to the institutionally supplied power and the other, isolated, side connects to the BLM Workstation. This configuration results in the presentation of a stable power source to the Workstation which abolishes noise artifacts introduced from varying loads on the "house circuit".

Order #	Model	Product
W4 64-0067	BLM-ST	Bilayer Starter Kit
W3 64-1803	Z850	Stereo Zoom Microscope with Boom Stand without Camera C-Mount
W4 64-1805	Z850	Stereo Zoom Microscope with Boom Stand and Camera C-Mount
W4 64-0069	ON-750A-US	Power Line Conditioner for 120 VAC/60 Hz
W4 64-0073	ON-750A-EU	Power Line Conditioner for 220 VAC/60 Hz
W4 64-0772	G150-4	Capillary glass 1.5 mm OD
W4 64-1327	WA10-5	Silver wire, 10 cm long, 0.25 mm dia, with 1 mm pin, 2 pack
W4 64-0420	MAG-13	2 x 5 mm Stirbars for 13 mm Chambers and Cuvettes (pkg. of 5)
W4 64-0421	MAG-22	2 x 7 mm Stirbars for 22 mm Chambers and Cuvettes (pkg. of 5)

Acquisition Hardware and Software

PClamp Package from Molecular Devices



Digidata 1440A Low-noise Data Acquisition System with pClamp Software

Molecular Devices presents the latest Digidata 1440A digitizer for low-noise experiments. This high-resolution 16-bit data acquisition system is self-contained and communicates with the host computer via a USB 2.0 interface, which means extremely easy installation and setup. Designed for ease-of-use and fast results, the Digidata 1440A comes with versatile AxoScope for Windows software and is ready to take data immediately after installation. Absolutely no programming is necessary.

The Digidata 1440A has a maximum sampling rate of 250 kHz per channel, with an outstanding total data throughput rate of 4 megasamples per second. Both the inherent digitizer noise and channel crosstalk noise are rated at less than ± 1 mV average p-p at 10 kHz, within a ± 10 V input range. The front panel is well laid out with sixteen analog input channels and four analog output channels, eight general digital outputs, one dedicated digital output to trigger devices such as oscilloscopes, trigger inputs to start acquisition and to tag data. The back panel has four additional analog instrument telegraph inputs, as well as a DB-25 connector for the digital outputs.

Designed to support continuous data acquisition within a multitasking operating system, the Digidata 1440A digitizer is fully supported by our AxoScope 10 for Windows and pCLAMP 10 for Windows electrophysiology software.

With its USB 2.0 interface, you can easily connect the Digidata 1440A to a laptop computer without the need for a peripheral PC card.

A data acquisition system is an integral component of the Planar Lipid Bilayer Workstation. To facilitate a convenient purchasing experience for our customers, Warner Instruments can include these products as part of a Workstation purchase. We can also install and configure the acquisition system if you desire. Contact our Sales Department for details. (*Axon system not available in Japan.)*

The pCLAMP 10 software suite fulfills many different experimental needs, such as synchronized stimulation, event detection, and online analysis. It is the most widely-used data acquisition and analysis program for the control and recording of voltage-clamp, current-clamp, and patch-clamp experiments. Three separate programs are included: Clampex 10, AxoScope 10, Clampfit 10.

Clampex 10 expands the range and quality of your data acquisition experiments. These improvements should prove useful for a wide variety of applications, allowing more flexibility in your experimental protocols.

AxoScope 10 provides a convenient way to produce background recordings with the included MiniDigi 2-channel digitizer. You can monitor cells during intra-sweep periods, or create an overview of the entire day's activities including voice tags.

Clampfit 10 is a powerful solution for analyzing, graphing and layout of all of your Clampex and AxoScope data. Clampfit includes an extensive array of filtering and fitting routines. Functionality includes I-V graphs, power spectrums, and special "linked data views" for threshold (AP), template (minis) and single-channel modes of event detection and analysis.

The pClamp package (comprised of Molecular Devices' Digidata 1440 computer interface and pClamp 10 software) represents a state-of-the-art acquisition system from Molecular Devices Corporation.

Warner Instruments is pleased to include the following information detailing a compatible acquisition systems from Axon Instruments. We provide this information and product as a service to our customers and make it available as an optional component of the Warner Instruments Planar Lipid Bilayer Workstation. All product warranty and support rights for this acquisition package are retained by Axon Instruments.

Please contact the vendor directly if you require additional information.

Order # Product

W4 64-0436 Molecular Devices - Digidata 1440 + pClamp 10

voltage clamps

TEV700

Oocyte Two-Electrode Voltage Clamp Workstation

The most common components in a single package



- **NEW** Automated Two-Electrode Voltage Clamp System, see page 200
- Oocyte Clamp OC-725C, see pages 201-202
- RC-3Z Oocyte Chamber, see page 13
- MM-33L Manipulator, see page 295
- MM-33R Manipulator, see page 295
- MB/B Magnetic Base, see page 304

The **TEV700 Workstation** provides many of the necessary components typically used with the OC-725C voltage clamp. When these components are purchased with the OC-725 Oocyte Clamp, the complete package is discounted as shown. The individual components of the system are listed below.

Order #	Model	Product
W4 64-0034	TEV700	Complete Oocyte Two-Electrode Voltage Clamp Work Station

System Components (included in TEV700)

W4 64-0028	OC-725C	Oocyte Clamp
W4 64-0319	RC-3Z	Oocyte Chamber
W4 64-0055	MM-33L	Left Manipulator
W4 64-0056	MM-33R	Right Manipulator
W4 64-0060	MB/B	Magnetic Base, must purchase 2 for complete system

Accessories

W4 64-1586	BPM-1	Base Plate Magnetic Steel
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BPM-1

Steel Base Plate

This solid steel plate provides a stable platform for mounting micromanipulators mounted on magnetic bases. A highly durable powder coating applied to the surface makes it impervious to most common spills in the lab.

BPM-1 shown with components of our TEV-700 Oocyte voltage clamp workstation



Specifications

Dimensions	30.5 x 61.0 x 0.95 cm (12 x 24 x 3/8 in)
Weight	14.06 kg (31 lb)

NEW Automated Two-Electrode Voltage Clamp Systems



- Single and dual channel systems available
- Eliminates microscope
- Manipulators may be used for both patch and oocyte voltage clamp experiments
- High efficiency design

Warner Instruments in collaboration with NeoBiosystems, Inc., is pleased to introduce an automated workstation for oocyte two-electrode voltage clamp experiments.

This complete workstation is built on a strong foundation of the NeoBiosystems ChannelMAX 100A Mini computer controlled manipulators, the Warner Instruments OC-725C oocyte voltage clamp, a VC-8P eight channel valve control system, and a custom perfusion chamber.

Save time, money, and increase throughput using a system featuring the world's most widely used two electrode whole-cell voltage clamp for *Xenopus* oocytes. The unique design of the OC-725C bath clamp eliminates the need for series resistance compensation. It also provides an accurate measurement of bath current by creating a virtual bath ground while simultaneously clamping the bath potential at zero.

The high compliance of ± 180 volts, and the AC clamp gain of 2×10^3 in addition to the DC gain of 1×10^6 , ensures accurate clamp voltage is maintained even when working with high conductance (leaky) oocytes.

Order #	Model	Product
W4 64-1740	TEV-S12	Automated two-electrode voltage clamp - single channel for 1.2 mm electrodes: Includes one OC-725C, one ChannelMAX 100A Mini, one VC-8P pinch valve controller, one perfusion chamber, and two electrodes holders for 1.2 mm O.D. glass
W4 64-1741	TEV-S15	Automated two-electrode voltage clamp - single channel for 1.5 mm electrodes: Includes one OC-725C, one ChannelMAX 100A Mini, one VC-8P pinch valve controller, one perfusion chamber, and two electrodes holders for 1.5 mm O.D. glass
W4 64-1742	TEV-D12	Automated two-electrode voltage clamp - dual channel for 1.2 mm electrodes: Includes two OC-725C, one ChannelMAX 100A Twin, one VC-8P pinch valve controller, two perfusion chambers, and four electrodes holders for 1.2 mm O.D. glass
W4 64-1743	TEV-D15	Automated two-electrode voltage clamp - dual channel for 1.5 mm electrodes: Includes two OC-725C, one ChannelMAX 100A Twin, one VC-8P pinch valve controller, two perfusion chambers, and four electrodes holders for 1.5 mm O.D. glass

OC-725C Oocyte Clamp

voltage clamps

Designed for two-electrode whole-cell voltage clamping of *Xenopus* oocytes



The **OC-725C** Oocyte Clamp is designed for two-electrode, whole-cell voltage clamping of *Xenopus* oocytes. The dedicated design of the OC-725C includes such features as high compliance voltage (± 180 V) and unique bath clamp circuitry. These same features also make the OC-725C ideal for clamping other large cells and cell structures such as squid axons. Improvements to this version include an extended current measuring range, decreased noise level and a 4-pole Bessel filter.

Fast Stable Voltage Clamping

The OC-725C combines high AC and DC gains and a voltage compliance of ± 180 volts to insure fast, nonsaturating clamp performance under nearly any condition. The AC clamp gain is variable up to 2000. An additional DC gain of 1×10^6 may be employed for high conductance cells (leaky oocytes).

Two clamp speeds are available: The Slow mode is used for screening oocytes or for applications not requiring fast response times. The Fast mode is used for accurate voltage clamp of fast whole cell currents. Clamp response time in the Fast mode is 350 μ sec (10-90% rise time) when applying a 100 mV step to a model cell.

Improved Bath Clamp Headstage

The current measuring range of the OC-725C bath clamp headstage has been extended at both ends by the addition of a 3 position range multiplier. Smaller currents are amplified to usable levels and larger currents up to 1 mA can be recorded without output saturation. The unique design of the bath clamp eliminates the need for series resistance compensation. It provides an accurate measurement of bath current by creating a virtual ground in the bath while simultaneously clamping the bath potential at zero.

Voltage Headstage Probe

The voltage measuring headstage is a single-ended, high-impedance probe. Its small size, convenient mounting rod and 2 meter cable make for easy attachment to a micropositioner. The headstage input is a 2 mm diameter pin. An electrode holder with a 2 mm jack (supplied) mounts directly on the headstage.

Voltage & Current Meters

Independent meters provide simultaneous displays of membrane voltage V_m and membrane current I_m . To assure proper impalement of the current electrode, the current meter displays membrane potential V_e from the current electrode before the clamp circuit is turned on.

Clamp Commands

The internal Hold control is a digital push button control with two ranges; ± 1 to 99 mV (x1) and ± 2 to 198 mV (x2). Hold can be incremented in steps of 1, 2, 10 and 20 mV for I-V studies. External command signals applied to Command IN ± 10 are attenuated to reduce noise from the command source. Hold and external commands are summed.

Additional Features

- Buzz controls (1 kHz square wave) for each electrode aid in penetration of cell membranes with a minimum of leakage.
- Overload alarm (audible and visual) indicate when the compliance voltage is exceeded safeguarding the oocyte and indicating that current records are subject to saturation.
- DC Offsets for both voltage and current electrodes.
- Electrode Test for both electrodes.
- Capacity Compensation for the V_m voltage input.

Electrode Holders

Two vented electrode holders with silver wires are typically required with the clamp; a straight type for use with the voltage headstage and a 45° type with mounting handle for use with current electrodes. Vents have been added to the electrodes to prevent pressure build-up inside the electrode which can damage oocytes. A two meter length cable assembly is provided to connect the current electrode holder to the clamp.

voltage clamps

OC-725C

Oocyte Clamp (continued)



RC-3Z chamber shown with the Warner OC-725 bath clamp headstage.

Dual Oocyte Studies

Some studies, such as voltage control across gap junctions, require the clamping of two oocytes in a common bath using two voltage clamps. The combined currents from the two oocytes cause problems since the bath clamp headstage cannot separate the individual currents and therefore cannot provide effective clamping.

OC-725C has two features to address these problems:

- An internal switch permits measurements of the current in series with the current electrode instead of in the bath.
- Optional differential voltage headstages (7255 DI): The differential measurement subtracts the voltage drop across the series resistance in the bath, which is normally eliminated by the bath clamp.

Specifications

Test Conditions	
1. Model cell used to obtain specifications: model membrane, 1 MΩ in parallel with 220 nF, 1 MΩ current and voltage electrodes.	
2. Noise measurements made with an 8-pole Bessel filter.	
Voltage Recording Channel (Vm):	
V Probe Input Impedance	0.5 x 10 ¹² Ω, 1 pF
Output Resistance	100 Ω
DC Offset	±200 mV at input, var. from zero with 10 turn control, (20 mV/turn)
Noise (0-10 kHz)	3 μV RMS with input grounded 20 μV RMS with model cell
Electrode Test	10 mV/MΩ read on meter 100 mV/MΩ at Vm x10 output
Meter Range	±199.9 mV full scale
Capacity Compensation	0 - 90 pF
Current Sensing (Bath Clamp) Channel (Im):	
Noise (0-1 kHz)	4.5 nA RMS with bath clamp 10 nA RMS in output leg
I Monitor Output	1 nA/mV to 1 mA/10V in 7 steps and 3 ranges, x0.1, x1, and x10
Gain Telegraph Output	0.2 to 2.6 V in 7 steps (200 mV/step) and 3 ranges, x0.1, x1, and x10. Compatible with data acquisition software*
Meter Range, Full Scale	Clamp Current: ±199.9 μA

Specifications (continued)

Electrode Voltage Ve	±199.9 mV (Current meter reads Ve when clamp mode switch is off)
Current Electrode Channel:	
Compliance Voltage	±180 V
Clamp Speed	350 μsec. (10-90%) with 100 mV square wave command applied to model cell
Gain	Variable AC/DC: 0 to 2000
Fixed DC Gain	Switch selected: 1 x 10 ⁶
Ve DC Offset	±200 mV at input (20 mV/turn)
Electrode Test	10 mV/MΩ read on current meter 100 mV/MΩ at Ve x10 output, rear panel
Commands:	
Hold	Manually set with digital potentiometer, 2 digit resolution and 2 ranges: x1 range: ±1 to 99 mV in 1 mV steps x2 range: ±2 to 198 mV in 2 mV steps
External	Signals applied to COMMAND IN=10 are attenuated by a factor of 10, 1 V applied = 100 mV command
Power Requirements	100-130 V or 220-240 VAC, 50/60 Hz, 20 VA
Physical Dimensions:	
Case	8.9 cm H x 43.2 cm W x 30.5 cm D
Voltage Headstage	12.5 mm D x 5 cm L with 1.8 m cable
Mounting Handle	4.8 mm D x 6.3 cm L
Bath Headstage	2.3 cm H x 3.5 cm W x 4.2 cm L with 1.8 m cable
Shipping Weight	6.8 kg
Warranty	Three years, parts & labor

*Molecular Devices pClamp and Heka PatchMaster

Order #	Model	Product
W4 64-0028	OC-725C	Oocyte Clamp supplied with 7250V Voltage Headstage, 7251I Bath Clamp Headstage, 7259C Current Cable, Model Membrane and Rack Mount Hardware. Specify line operating voltage if other than 100-130 VAC. <i>One straight holder and one 45° holder purchased separately.</i>

Optional/Replacement Headstages

W4 64-0030	7255DI	Optional Differential Headstage
W4 64-0031	7250V	Replacement Voltage Headstage
W4 64-0032	7251I	Replacement Bath Clamp Headstage
W4 64-0033	7259C	Replacement Current Electrode Cable
W4 64-0029	725MC	Model Cell

For Use with OC-725C Voltage Probe

W4 64-1008	ESW-F12V	Straight Holder 1.2 mm glass OD
W4 64-1009	ESW-F15V	Straight Holder 1.5 mm glass OD
W4 64-1010	ESW-F20V	Straight Holder 2.0 mm glass OD
W4 64-1007	ESW-F10V	Straight Holder 1.0 mm glass OD

For Use with OC-725C Current Electrode

W4 64-1051	E45W-F10VH	45° Style Holder 1.0 mm glass OD
W4 64-1052	E45W-F12VH	45° Style Holder 1.2 mm glass OD
W4 64-1053	E45W-F15VH	45° Style Holder 1.5 mm glass OD
W4 64-1054	E45W-F20VH	45° Style Holder 2.0 mm glass OD

HAI 118

Data Acquisition System

A fast, high-resolution data acquisition system suitable for most physiological recording studies



- 100kHz 16 bit A/D converter
- Easy to install USB connection
- Built-in stimulator and digital outputs
- Low noise
- Full gain telegraph support for Warner Instruments clamp amplifiers

The **HAI 118** is a fast high-resolution data acquisition system suitable for most data recording studies in the research laboratory. It offers 8 analog input channels, 8 digital outputs, 4 digital inputs and 2 DACs. The Hardware connects to PC compatible computers via the popular USB interface, so setup is plug-and-play easy.

Hardware Features

DAC

The HAI 118 offers two $\pm 10V$ DACs. Each DAC is independently programmable and can be synchronized with one another. Basic stimulus parameters for each DAC, such as pulse width, frequency and amplitude can be changed on the fly using handy controls located in the LabScribe® software tool bar. Standard protocols include pulse, train, and step waveform. Each standard protocol allows the quiescent state to be a holding voltage thereby making it ideal for voltage clamping applications.

Resolution and Noise

The HAI 118 employs a 16 bit A/D converter to sample data over its $\pm 10 V$ input range. Typical noise on any input is less than 1 V. This allows the recording of signals from 10 mV to 10V without the need for additional external gain.

Digital Input/Output

8 digital output lines are available. The digital output connectors are industry standard BNC, eliminating the need for custom cables. Programming the output lines is point-and-click easy as well - no complicated scripting language is required. Four digital input lines are also provided, with one configured as an external trigger.

Speed

The HAI 118 is a fast recorder. At top speed it can collect 100,000, 16 bit samples per second on a single channel. With 8 channels enabled it can collect data at 10,000 samples per second on each of the open channels.

USB Connection

Connection to the computer is accomplished over the popular USB port. This eliminates the need to install special interface cards and makes the HAI 118 compatible with notebook computers. The HAI 118 has a small footprint and in combination with a notebook requires very little bench space.

Software Included

Powerful LabScribe® software is included with each HAI 118. LabScribe is provided with a site license at no additional charge and upgrades are free forever. The program will actually upgrade itself on any Internet connected machine.

LabScribe Software Features:

Real Units

LabScribe software allows you to calibrate the displayed data in any units that you choose. Reading your data in mm Hg, g, or mA is a snap.

Display Controls

LabScribe uses an AutoScale feature that automatically ensures the optimal scaling of displayed data. A simple click centers and expands the data in the display window to fill the available space. Time base or y axis scaling can be zoomed in or out with a single click.

Realtime Notations

Keyboard input from the user may be time locked to the data to indicate drug delivery or stimulus points. Annotations can be positioned in the data much as you would write on chart paper.

Thirteen Realtime Functions

LabScribe currently supports 13 functions that are calculated and displayed in realtime, each called from a single click in the main window. These include Rate, Frequency, Period, Max, Min, Mean, Integral, dV/dt and Filter. Functions can be applied to raw data in real time or they can be called after the data has been recorded. No matter how data may be permuted, raw data is always preserved.

Twenty-Six Off Line Calculations

Twenty-six off line calculations are also supported. These operate on a selection of data and return a value. The list includes Area Under the Curve, Max-Min, Slope at a Point, Slope of the Line of Best Fit, and the mean.

Data Exported to .txt or .png Files

Any view of the data can be exported to the disk as a text file or a graphic. This is ideal for post calculation in programs like Excel or MACLAB. Picture formats make reports or poster presentations easy. Of course you can always print data from any window in the program.

HAI 118

Data Acquisition System (continued)

Software Features (continued):

Gain Telegraph

LabScribe will automatically calibrate and display the output of Warner Voltage/Patch clamp amplifiers. This feature takes into account the changes in gain that may be applied from the voltage clamp.

Fast Scrolling

LabScribe display can smoothly scroll data at any speed. This is particularly useful when high resolution data is compressed on the time axis to create a data overview.

Settings

Settings or templates for various experiments are stored in the programs settings menu. This makes changing program settings to accommodate different experiments point-and-click easy.

Applications Supported:

Oocyte clamp

LabScribe's gain telegraph feature automatically calibrates the software to any Warner Oocyte Clamp so that the main display reads in current and voltage. The on-board stimulator includes a flexible voltage clamp protocol so an external stimulator is not required. Finally, the digital output capability of the HAI 118 also adds the ability to automate your oocyte rig.

Epithelial Clamp

Output from Warner Instruments or other epithelial voltage clamps can be fed directly into the HAI 118. The voltage clamp protocol in the LabScribe program's stimulator section makes recordings of four to six channels of epithelial data possible.

Blood Flow and Blood pressure

Blood flow data from doppler devices and blood pressure signals from available transducer amplifiers can be fed directly into the HAI 118. Analytical features in the LabScribe software can give beat-to-beat rate, systolic, diastolic, and mean pressures, as well as dP/dt.

Hemodynamic Studies

Blood pressure signals from available transducer amplifiers can be fed directly into the HAI 118. Analytical features in the LabScribe software can display beat-to-beat rate, systolic, diastolic, and mean pressures as well as dP/dt. Up to 8 channels of pressure data can be recorded and the high speed nature of the hardware makes it ideal for use with rapid heart rate animals such as mice.

Electrophysiology.

The high speed nature of the HAI 118 make it perfect for studies involving blood pressure and sympathetic nerve activity as well as all types of cardiac electrophysiology, even in rapid heart rate animals such as mice where extra speed is required.

Specifications

Input:	
Number of Inputs	8 single ended BNC
Input Impedance	1 M Ω
Input Range	± 10 V
Noise	1 mV typical
Gain Telegraph	Software or hardware 8 bit
Output:	
Number of DACs	2
DAC Resolution	12 bit
DAC Speed	100 kHz independent of sample speed
DAC Output Range	± 10 V
Digital Output Lines	8 TTL
Digital Output Connector	BNC
A/D Converter:	
Sample Speed	1 Hz - 100 kHz
Resolution	16 bit
Interface	USB
Trigger/Digital Input Lines	4, TTL
Enclosure	Aluminum
Power	120/220 VAC, 60/50 Hz, CE compliant
Trigger Modes	External trigger, Threshold trigger from data, User trigger
Display	Real time, User definable screen time independent of sample rate. User definable units, AutoScale, Full Scale or User defined scale
DAC Modes	Pulse, Train, Step, DC, Custom
DAC Performance:	
Pulse Width	0.01 msec to 6500 msec (Pulse mode)
Frequency	0.2 Hz to 50 kHz (Pulse Mode)

Order # Product

W4 69-3130 HAI 118 Data Acquisition System

IE-210

Intracellular Electrometer

A high impedance electrometer designed specifically for intracellular studies



- High impedance microelectrode amplifier for intracellular studies
- Simultaneous stimulation and recording

The **IE-210** is an intracellular microelectrode amplifier with low noise, low drift, and fast response time for recording from high impedance fluid-filled glass electrodes. Current injection (bridge) circuitry permits simultaneous stimulation and recording through a single electrode. These features, in combination with a small lightweight headstage, a 4-pole Bessel low pass filter, and optional probe breakaway make it an ideal instrument for easy, accurate and reliable intracellular recording and current injection.

The Headstage

Fluid-filled microelectrodes can have resistances of over 100 m Ω . To faithfully record potentials with such high resistances, the amplifier input resistance must be at least 100 times greater. The input resistance of the IE-210 is 5000 times greater ($5 \times 10^{11} \Omega$) to assure accurate measurements with high resistance electrodes.

To maximize the bandwidth of voltage recording with high resistance electrodes, care must be taken to limit the input capacitance of the amplifier and minimize stray capacitance associated with the electrode and the cable which connects it to the amplifier. The IE-210 headstage is designed to minimize both. The headstage utilizes bootstrap circuitry and a driven shield to limit input capacitance to 0.5 pF. Stray input capacitance is reduced with two design features of the headstage: 1) the pencil-sized headstage mounts directly on the micromanipulator, therefore the electrode holder can connect directly to the headstage input and requires no connecting cable; 2) the headstage driven shield is available at the probe input to permit attachment of additional shielding. This allows the driven shield to be extended to surround the electrode holder and further reduce the stray input capacitance. This method of capacitance neutralization is preferable to the common method of capacitance neutralization since capacitance compensation circuitry can increase noise levels.

Electrometer Features

The probe/electrometer output is available at a gain of one. Amplifier gain is increased to x10 at the current injection Bridge Output. Input junction potentials can be compensated with the Input Offset control. If desired,

remaining stray input capacitance, up to 50 pF, can be neutralized with Cap Comp (capacity compensation). Convenient electrode resistance measurement is available using Electrode Test which produces a voltage proportional to the electrode resistance. Cell impalement is facilitated with a Buzz voltage (variable in both frequency and amplitude) applied to the electrode. An overload condition at the input (blocked electrode or oscillations caused by excessive capacity compensation) is indicated by the Input Overload light.

Current Injection

Simultaneous stimulation and recording with a single electrode is made possible with an active bridge circuit. Stimulus currents are generated either internally with the DC Current source or by a voltage applied to the external Stimulus Input. The internal source supplies currents up to ± 100 nA in the Low range and up to ± 1000 nA in the High range. The current injection feature is often used for iontophoretic injection of dyes or drugs. External signals can be of any waveform or DC level. Internal and external stimulus currents are summed when applied simultaneously.

Voltage drops across the electrode are subtracted from the Bridge Output using the DC Balance and AC Balance controls. The remaining output represents the cell's response to the applied current. Electrode resistance can be read directly from the DC Balance dial. Gain of the Bridge Output signal is x10 at the front panel and can be switch-selected to x20 or x50 at the rear panel. The output signal is available at either the full amplifier bandwidth (30 kHz) or filtered with the internal 4-pole Bessel low pass filter.

Additional Features

- Meter: The $3\frac{1}{2}$ digit LED meter provides readouts of the x1 Amplifier Output voltage and the stimulus DC Current, and is easily viewed in a darkened room.
- Probe Test: Checks of amplifier operation are quick and convenient with the front panel Probe Test facility, a real time-saver when troubleshooting set-up problems.
- Differential Amplifier: Signals from another amplifier can be applied to the Differential Input and are then summed with the IE-210 x1 output.
- Filter Telegraph: The filter frequency is encoded by a stepped DC voltage for input to a data acquisition system.

IE-210

Intracellular Electrometer (continued)

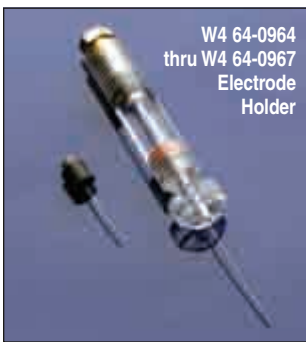
Electrode Holder

An electrode holder is not included with the IE-210. Please purchase the holder separately based on your glass outer diameter. Electrical coupling between the electrode and headstage can be either a Ag wire or Ag-AgCl pellet and is easily replaceable. The holder is supplied with the silver wire installed and a pellet is included for conversion to a pellet type holder.

Optional Accessories

The Remote Buzz (RB-1) control provides convenient remote operation of the Buzz voltage. It is supplied with a 3 m length cable.

The Breakaway Box (BB-15) permits the application of large voltages to the electrode for iontophoretic injection of dyes or drugs. Voltages up to ± 200 V may be applied to the Breakaway input without damage to the probe input. Breakaway Current = applied voltage \div (electrode resistance + 2 M Ω).



Specifications

Electrometer Section:

Input Impedance	5 x 10 ¹¹ Ω shunted By 0.5 pF
Output Resistance	100 Ω
Gain	x1 $\pm 0.1\%$
Probe Input Range	± 10 V
Risetime (10-90%)	25 μ sec, measured through 20 M Ω
Noise Level	25 μ V p-p input shorted
(0.1 Hz – 10 kHz)*	250 μ V p-p, 20 M Ω at input
Capacitance Compensation	0 to 50 pF
Leakage Current	1 pA typical, adjustable to zero

Specifications (continued)

Input Offset	± 200 mV, referred to input
Electrode Resist. Test	1 mV/M Ω (Low Range) 10 mV/M Ω (High Range)
Buzz	Amplitude variable 0 to 6 V, frequency variable 100 Hz to 10 kHz
Current Injection Bridge: Bridge operates in Low and High current ranges. Specifications shown for each range where applicable.	
Bridge Resist.	0 to 100 M Ω and 0 to 1000 M Ω (Low Range)
Ranges	0 to 10 M Ω and 0 to 100 M Ω (High Range)
Internal DC	0 to ± 100 nA (Low Range)
Current Source	0 to ± 1000 nA (High Range)
External Stimulus	Current is limited by electrode resistance up to maximums shown: ± 10 V \div electrode R or 0.5 μ A (Low Range) ± 10 V \div electrode R or 5 μ A (High Range)
Max. Stimulus Input	± 15 V
Stimulus Input Resist.	10 K Ω
I Monitor Output	100 mV/nA (Low Range), 10 mV/nA (High Range)
Bridge Output Gain	x10 at front panel, x20 or x50 at rear panel
Bridge Output Filter	4-pole low pass Bessel with cut-offs at 0.05, 0.1, 0.2, 0.5, 1, 2, 5, 10 and 20 kHz
Bridge Output Resist.	100 Ω
Meter	3 $\frac{1}{2}$ digit LED, Full Scale Ranges: Amplifier Output: 200 mV, 2 V and 20 V Current: 200 nA and 2 μ A
Power Requirements	100 to 130 or 220 to 240 VAC, 50/60 Hz, 10 VA
Physical Dimensions:	
Probe	12.5 mm D x 6.2 cm L with 1.8 m L cable
Case	8.9 x 43.2 x 30.5 cm (H x W x D)
Shipping Weight	5.5 kg
Warranty	Three years, parts and labor

* At x1 output

Order # Model Product

W4 64-0039	IE-210	Intracellular Electrometer; Supplied with Probe and Rack Mount Hardware. Specify Line Operating Voltage if Other Than 100 to 130 VAC.
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W4 64-0042	2100	Replacement Headstage
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Optional Accessories

W4 64-0040	BB-15	Breakaway Box
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W4 64-0041	RB-1	Remote Buzz Control
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W4 64-0964	ESP/W-F10N	Electrode Holder, Straight 1.0mm for IE-210/251A
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W4 64-0965	ESP/W-F12N	Electrode Holder, Straight 1.2mm for IE-210/251A
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W4 64-0966	ESP/W-F15N	Electrode Holder, Straight 1.5mm for IE-210/251A
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W4 64-0967	ESP/W-F20N	Electrode Holder, Straight 2.0mm for IE-210/251A
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IE-251A

Intracellular Electrometer

A moderately priced intracellular electrometer complete with current passing capability



The **IE-251A** is a moderately priced intracellular electrometer, complete with current passing capability, incorporating the same basic design as the more costly IE-210. The important features required for low noise, drift free recording from glass microelectrodes have been retained in this lower cost model. The IE-251A is easy to use and an excellent choice for the budget-conscious researcher or student teaching lab.

The IE-251A features a very small active headstage, essentially the same as used with the more costly IE-210. Epoxy-sealed construction affords maximum resistance to saline corrosion. Its small size and low mass permit easy mounting in a micro-positioner. The electrode holder supplied connects directly to the probe input.

The amplifier features include:

- Fixed gains are at x1 and x10.
- Capacity Compensation neutralizes input capacitance up to 50 pF.
- Junction potentials up to ± 200 millivolts are nulled with the DC Position control.
- Electrode Test provides convenient electrode resistance check.
- Push button operated Buzz produces oscillations at pipette tip to facilitate cell impalement.
- Convenient Probe Test port permits fast check of amplifier performance.

Current Injection

The injection circuitry of the IE-251A allows simultaneous stimulation and recording through microelectrode resistances up to 1 G Ω in two ranges. Voltages at the Stimulus Input are converted to constant currents applied to the electrode. The steady state and transient components of the current injection artifact are nulled with the DC and transient balance controls. The corrected signal is viewed at the single-ended bridge output. Electrode resistance is read from the DC balance ten-turn dial.

Overdrive Indicators

Two visual indicators call attention to overload conditions:

- Input Overdrive is illuminated whenever the probe input voltage exceeds ± 1 V, caused by either excessive current through the microelectrode or an open circuit (open or blocked electrode).
- Current Overdrive warns of excessive voltage (>50 V) applied to the Stimulus Input.

This Intracellular Electrometer is supplied with a probe. An Electrode Holder must be purchased separately based on your glass outer diameter. Also, specify line operating voltage if other than 100-130 VAC.

Specifications

Amplifier:	
Input Impedance	$>10^{10}\Omega$ shunted by 0.5 pF
Noise Level	(0.1 Hz to 10 kHz)* 25 μ V p-p input shorted 250 μ V p-p, 20 M Ω at input
Output Resistance	100 Ω
Gains	x1 and x10
Rise Time (10 to 90%)	10 μ sec measured with 20 M Ω resistor
Capacity Compensation	0 to 50 pF
Probe Input Voltage Range	± 1 V
DC Positioning Range	± 200 mV referred to input
Leakage Current	Adjustable to zero
Electrode Test	1 mV/M Ω
Buzz:	
Amplitude variable	0 to 15 V
Frequency variable	100 Hz to 10 kHz
Current Injection:	
Balance Ranges	0 to 100 M Ω and 0 to 1000 M Ω
Current Injection Limit	± 1 V divided by electrode R or 0.5 μ A, whichever occurs first
Stimulus Input Resistance	3.3 k Ω
Maximum Stimulus Input	± 50 V
Bridge Bal. Output Resist.	100 Ω
I Monitor Output Resist.	1 k Ω
I Monitor Output Scale Factor	1V = 50 nA
Power Requirements	100 to 130 or 220 to 240 V, 50/60 Hz, 10 VA
Physical Dimensions:	
Case Size	12.5 x 20.3 x 25.4 cm (H x W x D)
Probe	9.5 mm x 6.5 cm (D x L) with 1.8 m L cable
Probe Handle	6.5 mm x 6.5 cm (D x L)
Shipping Weight	4.5 kg
Warranty	Two years, parts & labor

* At x1 output.

Order #	Model	Product
W4 64-0090	IE-251A	Intracellular Electrometer Electrode Holders for IE-210/251A, 110 VAC
W4 64-1514	IE-251A	Intracellular Electrometer Electrode Holders for IE-210/251A, 200/240 VAC
W4 64-0964	ESP/W-F10N	Electrode Holder, Straight 1.0mm glass OD for IE-210/251A
W4 64-0965	ESP/W-F12N	Electrode Holder, Straight 1.2mm glass OD for IE-210/251A
W4 64-0966	ESP/W-F15N	Electrode Holder, Straight 1.5mm glass OD for IE-210/251A
W4 64-0967	ESP/W-F20N	Electrode Holder, Straight 2.0mm glass OD for IE-210/251A
Optional Accessories		
W4 64-0043	2510	Replacement Headstage

DP-301 & DP-304

Differential Amplifier: Single Channel and 4-Channel

Single and four channel AC/DC differential pre-amplifiers suited for EEG, EKG and extracellular recording



The DP-300 Series are AC/DC differential amplifiers highly suited for EEG, EKG and extracellular recording. Features include high input impedance, high common mode rejection [100 dB @ 60 Hz], low noise, high gain, high tolerance to DC, and bandwidth filtering.

High Input Z, High CMR

High common mode rejection (CMR) is very important in minimizing electrical interference. The high input resistance of the DP-300 Series ($10^{12} \Omega$ typical) ensures that the instrument's high CMR will not be degraded by differences in source impedance at the input. This is important in extracellular recording, where the difference in resistance of the recording and indifferent electrode is often large.

High DC Tolerance

Extracellular action potentials are typically measured in microvolts but are usually accompanied by much larger DC electrode voltages. DP-300 Series are designed to amplify these microvolt level events with as much as ± 3 V DC at the input.

High Gain, Low Noise & Bandwidth Limiting

With gain selections at x100, x1000 and x10,000, even microvolt signals are sufficiently amplified for computer and recorder inputs. Noise is very low, typically $10 \mu\text{V}$ p-p at 1 Hz to 10 kHz bandwidth. Reducing the bandwidth with the low pass and high pass filters further lowers noise.

Calibration Signal

The internal Cal signal provides a convenient check of amplifier gain and operation.

Battery Powered/Portable DP-301

The single channel DP-301 is powered with 4 standard 9 V transistor batteries yielding approximately 500 hours of normal operation.

The small size of the DP-301 makes it possible to be placed at the measurement site or inside a Faraday cage. End of battery life is indicated by the Low Bat light.

Rack Mounted DP-304

The DP-304 is housed in a rack mounting cabinet and is line powered.

Input Cables

The standard IC-2S input cables (2/channel) are BNC and unterminated at the outboard end. Optionally available are BNC cables with 2 mm pin and alligator clip, (p/n IC-4M). There is no additional cost if specified at time of order.

Specifications

Voltage Gain, AC & DC	x100, x1,000 & x10,000
Input Resistance	$10^{12} \Omega$ typical
Leakage Current	50 pA typical at the input has 100 m
Common Mode Rejection	100 dB min (100,000:1) at 60 Hz
Noise, Input Shorted	$10 \mu\text{V}$ p-p, 1 Hz to 10 kHz, $\approx 14 \text{ nV}/\sqrt{\text{Hz}}$ @ 10 KHz Maximum
Low Frequency (high pass) Filter Settings	0.1, 1.0, 10 & 300 Hz
High Frequency (low pass) Filter Settings	0.1, 1.0, 3.0 & 10 kHz
Calibration Signal	1 mV p-p at 10 Hz
Max. Common Mode Signal	± 3 V
Output Voltage Swing	± 10 V
Output Resistance	220
Input & Output Connectors	BNC
Power Requirements:	
DP-301	4 x 9 V alkaline batteries
DP-304	110 to 130 or 220 to 240 VAC, 50/60 Hz, 10 VA
Physical Size, H x W x D:	
DP-301	8.8 x 20 x 17.5 cm
DP-304	17.8 x 43.2 x 25 cm
Shipping Weight	DP-301: 2.3 kg; DP-304: 6.8 kg
Warranty:	
DP-301	Two years, parts and labor (excluding batteries)
DP-304	Three years, parts and labor

Order #	Model	Product
W4 64-0044	DP-301	Differential Amplifier, Single Channel Bench Top
W4 64-0045	DP-304	Differential Amplifier, 4-Channel Rack Mount Case. Each Channel Supplied with IC-2S Input Cables, qty. of 2
W4 64-0046	IC-2S	Replacement Input Cable Set, qty. of 2
W4 64-0047	IC-4M	Replacement Input Cable Set, qty. of 2

DP-311

Differential Amplifier with Active Headstage

The DP-311 AC/DC differential pre-amplifier is highly suited for EEG, EKG and extracellular recording



- Excellent common mode rejection: 120 dB at 60 Hz
- Small active headstage which can be mounted in micromanipulators
- Suitable for use with high impedance glass or metal microelectrodes

The **DP-311 AC/DC Differential Amplifier** is highly suited for EEG, EKG and extracellular recording using glass or metal microelectrodes. Features include high input impedance, high common mode rejection [120 dB at 60 Hz], low noise, high gain, high DC tolerance, bandwidth filtering and an active headstage.

High Input Z, High CMR

High common mode rejection is very important in minimizing electrical interference. The high input resistance of the DP-311 Series ($10^{12} \Omega$ typical) ensures that the instrument's high CMR will not be degraded by differences in source impedance at the input. This is important in extracellular recording, where the difference in resistance of the recording and indifferent electrode is often large.

High DC Tolerance

Extracellular action potentials are typically measured in microvolts but are usually accompanied by much larger DC electrode voltages. The DP-311 is designed to amplify these microvolt level events with as much as ± 2 Volts DC at the input.

High Gain, Low Noise & Bandwidth Limiting

With gain selections at x10, x100, x1000 and x10,000, even microvolt signals are sufficiently amplified for computer and recorder inputs. Noise is very low, typically 8 μV p-p at 1 Hz to 10 kHz bandwidth. Reducing the bandwidth with the low pass and high pass filters further lowers noise.

Calibration Signal

An internal Cal signal provides a convenient check of amplifier gain and operation.

Specifications

Voltage Gain, AC & DC	x10, x100, x1,000 & x10,000
Input Resistance	$10^{12} \Omega$ typical
Leakage Current	1.0 pA typical
Common Mode Rejection	120 dB min (1,000,000 :1) at 60 Hz
Noise, Input Shorted	8 μV p-p, 1 Hz to 10 kHz typical, $\approx 14 \text{ nV}/\sqrt{\text{Hz}}$ @ 10 KHz Maximum
Low Frequency (high pass) Filter Settings	DC, 0.1, 1.0, 10 & 300 Hz
High Frequency (low pass) Filter Settings	0.1, 0.3, 1.0, 3.0 & 10, 50 kHz
Offset Control Range	± 600 mV min at output, any gain set
Calibration Signal	1 mV p-p at 100 Hz
Max. Common Mode Signal	± 2 V
Output Voltage Swing	± 10 V (± 5 V in gain of 10)
Output Resistance	50 Ω
Input Connectors	2 mm male pins, 0.5" in (12.7 mm) spacing
Output Connector	BNC
Power Requirements	90 to 270 VAC, 50/60 Hz, 10 VA
Physical Size, H x W x D	5.1 x 21.25 x 18 cm
Shipping Weight	2.3 kg
Warranty	Two years, parts and labor

Order #	Model	Product
W4 64-1422	DP-311	Differential Amplifier
W4 64-1423	3110	Replacement Headstage
W4 64-1323	PJ2-5	2 mm Jack uninsulated, pkg. of 5

Model HiZ-223

Dual Channel Differential Electrometer

The HiZ-223 is a very high input impedance, dual channel electrometer designed for measurements with high resistance ion-selective microelectrodes



- $10^{15}\Omega$ Input Resistance
- Designed for measurements with ion-selective microelectrodes
- Probe Test Port
- Standby mode protects input amplifiers
- Driven Guard Shield reduces stray capacity and noise

The HiZ-223 is a very high input impedance, dual channel electrometer designed for measurements with high resistance ion-selective microelectrodes. The amplifier features two small active headstages, allowing the first stage of amplification to take place at the electrode site. Shunt capacity is reduced and electrical interference, such as electrostatic noise and motion artifact, common with this type of recording, are greatly minimized.

To further reduce the noise and stray capacity, the probe housing includes a signal driven guard. A portion of this inner driven shell is exposed at the probe tip allowing a spring shield to be extended over the electrode holder and microelectrode.

The amplifier features a probe test port that permits testing of the electrode test feature and setting of the probe leakage current, (IG).

A standby mode is included and should be used when attaching glass microelectrode or electrode holders to the probe input. While in the standby mode the voltage at the probe input is clamped near zero volts thus protecting the input.

Specifications

Input Resistance	$10^{15}\Omega$
Input Capacitance	1.0 pF nominal
Input Leakage Current	75 fA max
Voltage Gain	$1.000 \pm 0.1\%$
Output Resistance	50 Ω
Input Voltage Swing	± 10 V
Risetime	5 μ s (10 -90%, small signal)
Output Noise (input shorted)	100 μ V peak-to-peak
Baseline Stability	± 0.1 mV/day
Position Control Range	± 600 mV
Power Requirements	90 to 265 VAC, 50/60 Hz, 10 VA
Physical Dimensions:	
Case Size	8.8 x 21 x 17.5 cm (H x W x D)
Probe	12.7 mm x 6.5 cm (D x W) with 1.8 m cable length
Shipping Weight	2.5 kg
Warranty	Two years, parts & labor

Order # Model Product

W4 64-1650 HiZ-223 Dual Differential Electrometer

Accessories/Replacement Parts

W4 64-1651 HiZP Replacement Probe

W4 64-1658 DG-1 Driven Guard Shield Pkg. 2

W4 64-0980 ESP-F10N E Series Holder for 1.0 mm glass OD

W4 64-0981 ESP-F12N E Series Holder for 1.2 mm glass OD

W4 64-0982 ESP-F15N E Series Holder for 1.5 mm glass OD

W4 64-0983 ESP-F20N E Series Holder for 2.0 mm glass OD

low pass filters

LPF-8

8-Pole Bessel Filter with DC Differential Amplifier—Single Channel

A signal conditioner combining an 8-pole Bessel filter with a DC amplifier



- Provides greater frequency control for Bilayer, Patch, and Oocyte Clamps
- High quality 8-pole Bessel filter
- 8-Pole low pass Bessel filter with cutoff frequencies from 0.1 Hz to 20 kHz.
- Differential amplifier gains to x200
- Frequency selection with single control
- Input offset adjustment
- Digital frequency readout
- Rack mountable

Specifications

Input	DC Differential
Input Impedance	1 M Ω each channel
Input Range	± 10 V
Input Offset	2 Ranges, ± 100 mV and ± 1.0 V variable from zero with 10-turn control; Max offset compensation
Offset Indicator	20 LED Display
Frequency Ranges:	
Low	0.1 to 199.9 Hz
High	10 Hz to 19.99 kHz
Low Range Resolution	0.1 Hz
High Range Resolution	10 Hz
Gains	x1, x2, x5, x10, x20, x50, x100 and x200
Gain Telegraph Output	2.5 V to 6.0 V in 0.5 V steps, x1 Gain = 2.5 V
Output Impedance	50 Ω
Power Requirements	100-130 VAC or 200-250 VAC 50/60 Hz, 15 VA
Enclosure	Rack Mount Cabinet, H x W x D, 4.4 x 43.2 x 20 cm rack hardware included
Shipping Weight	4.6 kg
Warranty	2 years

The **LPF-8** is a signal conditioner combining an 8-pole low pass Bessel filter and DC amplifier. Special features include a digital frequency readout, visual input offset indicator, clipping indicator, and gain telegraph outputs.

The LPF-8 is the premier low-pass Bessel filter from Warner Instruments and provides superior control of analog signal filtering from 0.1 Hz to 20 kHz. The instrument incorporates low-pass signal filtering and output gains from 1 to 200. Dual selectable signal inputs allow the instrument to be configured to operate in normal, inverted or differential modes.

This instrument features an optically encoded circuit which permits frequency selection in two ranges with a single control. Since the set frequency control is not a physical part of the filtering circuit, adjustments to the instrument do not introduce noise artifacts into the output signal.

The unique circuit design uses no mechanical switching which insures long-term instrument reliability.

User Conveniences

- Frequency is dialed up with a single rotary control in 2 ranges. Resolution is 0.1 Hz or 10 Hz, depending on range selected.
- BYPASS switch selects full amplifier bandwidth for comparison of filtered and unfiltered signal.
- The DC OFFSET/CLIPPING indicator is a zero center display serving two functions; it is used as a null meter with the offset control and it indicates overload (clipping) conditions.
- Gain telegraph signals are provided for data acquisition systems.

Order #	Model	Product
W4 64-0050	LPF-8	Low Pass Filter/DC Amplifier, Single Channel Rack Mount 100-130 VAC
W4 64-1524	LPF-8	Low Pass Filter/DC Amplifier, 200-240 VAC 50/60 HZ

low pass filters

LPF-100B and LPF-202A

Low Pass Filters, Single and Dual Channel

These DC amplifier and signal conditioners are used to filter noise and boost signals to levels compatible with computers, chart recorders, and DAT recorders



LPF-100B (inset) and LPF-202A

- Useful with Epithelial and Oocyte Clamps

4-Pole low pass Bessel filters with DC Amplifier Gains from 1 to 100

LPF DC Amplifier/Filter signal conditioners are used to filter noise and boost signals to levels compatible with computers, chart recorders and tape recorders. Built with analog circuitry, these instruments exhibit very low noise and excellent stability.

The 4-pole low pass Bessel filter frequencies are selected in six steps, from 100 Hz to 5 kHz and gains are selectable from 1 to 100 in seven steps, both in 1, 2, 5 sequence. The full 10 kHz bandwidth is also available. DC signals at the input can be nulled with the Input Offset control. If the gain is set too high for the signal being processed, the Overload indicator will light.

Single & Dual Channel Models

The LPF-100B is a single channel bench top instrument. The LPF-202A is a dual-channel model packaged in a low profile rack mounting cabinet (hardware supplied). Both models have input shorting switches that are handy for quickly establishing a zero level at the input. The LPF-202A also has a digital meter for reading DC or average voltage levels. Both models are line powered and covered by a 2-year warranty.

Specifications

Input Impedance	1 M Ω
Input Offset	± 200 mV @ input
Gains	x1, x2, x5, x10, x20, x50, & x100
Input Range	± 10 V
Noise (referred to input)	12 μ V RMS DC-5 kHz, 20 μ V RMS wideband
Max. Output	± 10 V
Bandwidth	10 kHz @ x100 gain
Filter	4-Pole Bessel low pass
-3 dB Frequencies	0.1, 0.2, 0.5, 1, 2 & 5 kHz
Digital Meter (LPF-202A):	
Low Range	± 1.999 V
High Range	± 19.999 V
Overload Indicator:	Lights when output exceeds ± 10 V
Power Requirements	100-130 VAC or 220-240 VAC, 50/60 Hz, 3 VA
Physical Size, H x W x D:	
LPF-100B	6.3 x 14 x 23 cm, shipping weight 2.3 kg
LPF-202A	4.4 x 43.2 x 20 cm, shipping weight 4.6 kg
Warranty	Two years, parts and labor

Order #	Model	Product
W4 64-0048	LPF-100B	Low Pass Filter/DC Amplifier, Single Channel
W4 64-0049	LPF-202A	Low Pass Filter/DC Amplifier, Dual Channel Rack Mount
W4 64-1510	LPF-100B	Low Pass Filter/DC Amplifier, Single Channel, for 200 to 240 VAC
W4 64-1511	LPF-202A	Low Pass Filter/DC Amplifier, Dual Channel Rack Mount, for 200 to 240 VAC

Rack mount hardware supplied with LPF-202A.

Introduction to Ussing Chamber Systems

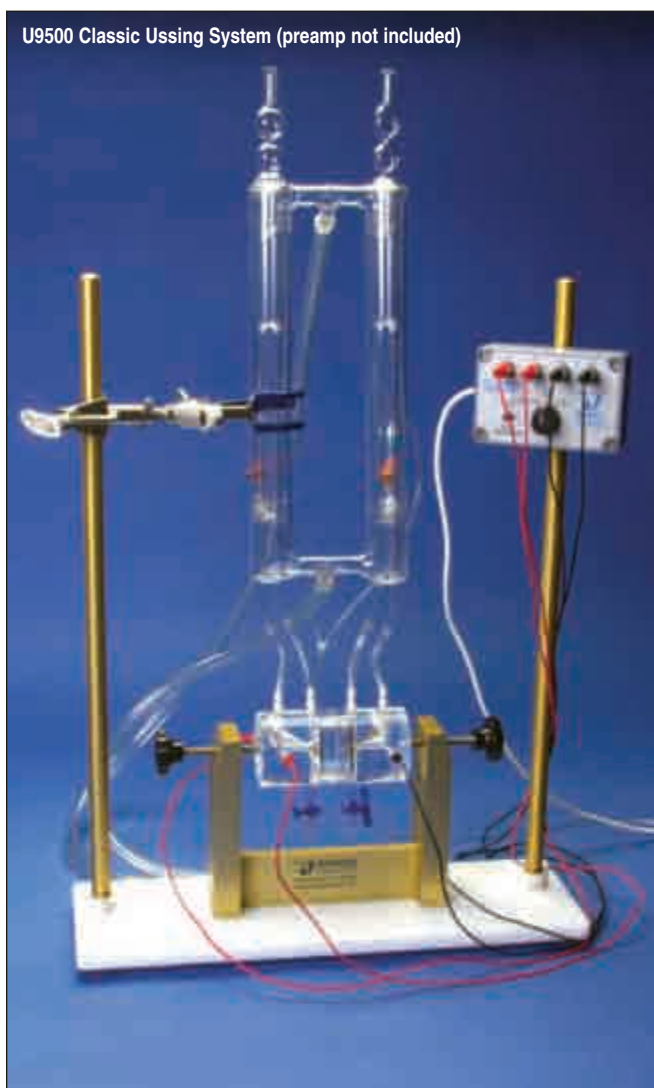
Ussing/diffusion

For the investigation of ionic transport across epithelial cells, whether by diffusion or active transport

An Ussing System, used to measure transport across epithelial membranes, is generally comprised of a chamber and perfusion system, and, if needed, an amplifier and data acquisition system. The heart of the system lies in the chamber with the other components performing supporting roles. The 'Classic' chamber design, first introduced by the Danish physiologist Hans Ussing in the early 1950's, is still in wide use today. However, several newer designs are now available that optimize for convenience and for diffusion- or electrophysiology-based measurements. Epithelia are polar structures possessing an apical (or mucosal) and basolateral (or serosal) side. It is the movement of electrolytes, non-electrolytes, and H₂O

across this membrane that is of interest to the researcher. Ussing systems have been used to make measurements from native tissue including stomach, large and small intestine, gall and urinary bladder, skin, and trachea, as well as from tissue derived cell monolayers from various sources including renal tubes, pancreas, and salivary and sweat glands.

A well designed Ussing chamber supports an epithelia membrane or cell monolayer in such a way that each side of the membrane is isolated and faces a separate chamber-half. This configuration allows the researcher to make unique chemical and electrical adjustments to either side of the membrane with complete control.



U9500 Classic Ussing System (preamp not included)

Study Types

Ussing systems can be used for either electrophysiology- or diffusion-based studies, or for a combination of both. They can also be used for radiotracer studies wherein the ionic species under transport is radiolabeled. For convenience, we will consider radiotracer studies to operate within the context of a diffusion- or electrophysiology-based system.

While each approach described above makes use of a chamber and fluid handling system, an electrophysiology-based setup has the added dimension of a current and/or voltage clamp amplifier and data acquisition system. Relevant components include:

Diffusion-based system

- A chamber with perfusion system and tissue holding apparatus
- Temperature and gas control, if needed
- The ability to acquire data

Electrophysiology-based system

- A chamber with perfusion system and tissue holding apparatus
- Temperature and gas control, if needed
- Amplifier
- Data acquisition system and software

A Systems Approach

Warner instruments offers many Ussing system components embodying several different design philosophies. Fortunately, the various components are generally interchangeable with each other (i.e., all the amps are compatible with all the chambers). While this presents the potential for a great degree of flexibility and customization, it can also increase the complexity of selecting the optimum combination of Ussing system components for your needs.

The goal of this article is to outline the advantages and disadvantages associated with each Ussing chamber design with an eye towards guiding you in selecting the best components for your application.

Introduction to Ussing Chamber Systems (continued)

Ussing Measurements

A basic understanding of different Ussing measurements commonly made can guide you in determining which components best fit your needs when building a system. As stated earlier, Ussing systems can be defined as being either diffusion- or electrophysiology-based.

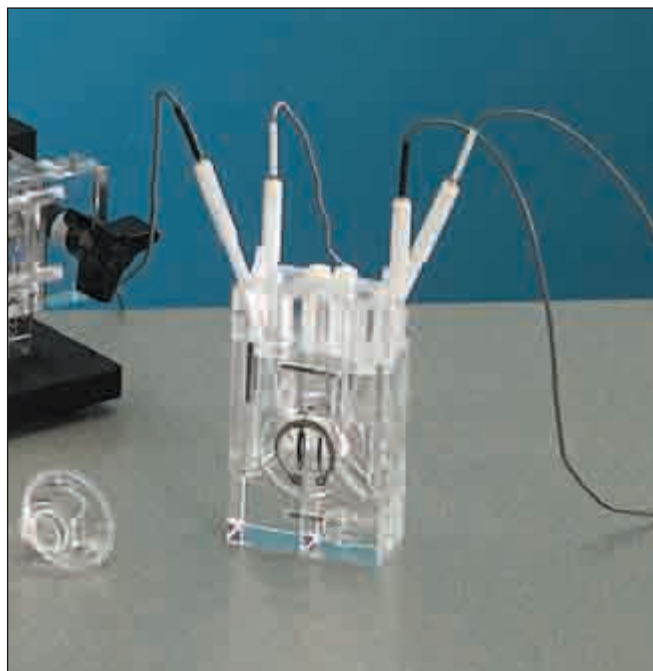
A diffusion-based system is generally focused on measuring transepithelial fluid transport and is used to follow net movement of H_2O or solute across the membrane. By itself, diffusion-based systems do not provide specific information regarding the underlying transport mechanism and are best suited towards measurements of leaky epithelia characterized by electroneutral transport.

While fluid transport can result in a volume change in the recording chamber, it is usually quantitated by measuring a corresponding change in a volume marker. Volume markers include changes in salt or dye concentration, or changes in physical characteristics such as fluid capacitance or resistance. Advantages of fluid transport measurements using a volume marker include good temporal resolution and sensitivity to small fluxes (volume changes as low as ± 1 nl/min have been reported). A disadvantage is the requirement for small volume chambers.

An electrophysiology-based system focuses on measuring transepithelial electrical responses to experimental perturbations. These systems are used to quantitate the operation of electrogenic pathways in the membrane (e.g., ion pumps, channels, etc). As such, an electrophysiology-based system carries the additional hardware requirement of a voltage and/or current clamp amplifier, a data acquisition system, and collection/analysis software.

Basic measurement parameters in electrophysiology-based Ussing systems include transmembrane voltage (V_t), epithelial membrane resistance (R_t), and short circuit current (ISC; the current required to bring V_t to 0 mV). A limitation with these systems is that non-electrogenic ion transport mechanisms such as fluid transport and electroneutral ion transport cannot be directly monitored. This limitation, however, can be addressed by employing indirect or secondary measurements such as ion replacement, transport inhibition, and the use of hormones and second messengers.

The use of radioisotope tracers is one measurement technique deserving special mention. This technique can be applied equally well to both diffusion- and electrophysiology-based measurements and is usually employed to provide information regarding ion-specific transport mechanisms. For example, a diffusion-based model cannot identify the fluid being transported or if the measured volume change is the result of a hydrostatic or osmotic process. Finally, if an osmotic-driven volume change is mediated by an ionic mechanism, then the responsible ion is not identified. By comparison, a limitation with the electrophysiology-based model is that while ionic transport can be measured, the specific ion crossing the membrane is not specifically determined. This is especially true for multi-ionic salt conditions. For both cases, the use of a radiolabeled ionic species allows for directly monitoring ion-specific translocation for the two measurement systems described above.



The Components

An Ussing system is comprised of a chamber and perfusion system, and if needed, an amplifier and data acquisition package. If working at defined temperatures, then a circulating water bath is also needed for the heat jackets.

The Chamber System

While decisions need to be made for each step in assembling a complete Ussing system, the greatest complexity is associated with choosing the chamber and its associated tissue support. Once these elements have been addressed, then the task of selecting the other components (amplification, data acquisition, etc) is more or less direct.

All Ussing chamber systems have the following features in common: a means to hold the membrane while minimizing tissue damage, a means for holding and exchanging solutions, a means to facilitate precise electrode placement, and a means to control solution temperature and gas load.

Ussing chamber systems from Warner include the Classic, introduced by Ussing in the 50's, Self-Contained, incorporating the full classic setup within a small housing, and Multi-Channel systems, allowing simultaneous measurement from many epithelia in parallel. Most chamber systems, except the Classic and NaviCyte Vertical make use of inserts allowing them to accommodate various tissues as well as cultured cells on permeable supports (e.g., Snapwell, Millicell, Falcon, and Transwell) without having to purchase a separate chamber for each support.

Introduction to Ussing Chamber Systems (continued)

The Classic is the fundamental chamber system as designed by Ussing. It is comprised of a cylindrical tissue holder to which the electrodes and plumbing attach. Tissues are mounted directly onto and are compressed between the two chamber-halves. A variety of tissue chambers are available with both round and slotted openings. The enclosed baths (apical, basolateral) are perfused via a glass circulation reservoir that mounts above the chamber. The reservoir uses a 'gas-lift' mechanism to drive circulation and to provide gas tension. Reservoirs are available in 4, 10, and 20 ml volumes.

The Classic with Insert chamber system is the same as the Classic system except that the tissues are supported via inserts. This system also supports cultured cells on Snapwell, Millicell, Falcon, or Transwell culture cups.

The Self-contained chamber systems provide all of the features of the Classic system but houses the full apparatus (chamber, electrodes, and perfusion system) within a single Lucite block. Tissues or cultured cells mount into a two piece assembly (an insert) that is easily placed into the chamber from the top. Temperature control is provided via an external circulating water bath. Self-contained chambers are available in both single and dual channel models.

The Multi-channel chamber systems include the Navicyte and EasyMount designs. Both designs make use of a support assembly to hold anywhere from 2 to 24 independent chambers (depending on design) and to couple the perfusion and electronic components to the chambers. Navicyte chambers are available in both horizontal and vertical configurations and the EasyMount chambers are only available in the vertical configuration.

- The **Navicyte Horizontal** configuration accommodates from 1 to 6 chambers and is ideal for studying mucosal layers at an air/liquid interface. Navicyte Horizontal chambers make use of a mounting ring or Snapwell insert to support the tissue of interest.
- The **Navicyte Vertical** configuration is well designed for diffusion-based studies and accommodates from 1 to 24 chambers. Tissues are supported directly in the chamber block and no insert is required. However, a chamber block supporting a Snapwell insert is also available.
- The **EasyMount** configuration accommodates from 2 to 8 chambers and are well designed for electrophysiology-based measurements. EasyMount chambers are visually similar to the Navicyte Vertical chambers but differ in that they require the use of an insert to secure and place the tissue into the chamber.

The Amplifier

An amplifier is required if making electrophysiology-based measurement. Warner offers a large selection of amplifiers, all compatible with the chamber systems described above. Available options include the EC-800 and VCC-600 single channel amplifiers, the EC-825A and VCC-MC2 dual channel amplifiers, and finally, the VCC-MC6 and VCC-MC8 six and eight channel amplifiers, respectively.

Data Acquisition Packages

Data acquisition is necessary for collecting data from the Ussing system (usually from the amplifier when making electrophysiological recordings) and processing it into a digital form for later analysis on a computer. The basic system offered for this purpose by Warner is the Acquire and Analyze acquisition system.

A second acquisition system offered is the HAI-118. Output from Warner's EC-800 and EC-825A, as well the VCC Series epithelial voltage clamps, can be fed directly into the HAI-118. The voltage clamp protocol in the LabScribe program's stimulator section makes recording of data of four to six epithelial channels possible.

There is another option, however, that bears special mention. This is the Computer Controlled Multi-clamp with Software. This is a unique package that houses several amplifiers (2, 4, or 6), a computer, and the software all in a single box. As such, a separate amplifier and data acquisition system are not needed when using the Multi-clamp with Software.

U9500 & U2520 Classic Ussing Systems

Ussing/diffusion

The Classic system as designed by H.H. Ussing

The investigation of ionic transport across epithelial cells was greatly facilitated by the development of a chamber system designed by Dr. H. H. Ussing more than 40 years ago. Today this equipment bears his name. The U9500 'Classic' design presented here varies little from Dr. Ussing's original equipment which remains in wide use for the study of electrophysiological properties of epithelial tissues.

A newer design, the U9520 'Classic with Inserts' allows for insertion of cell culture or tissue supports and greatly increases the functionality of the classic Ussing chamber. The low initial cost of the Classic design, coupled with the modest cost of add-on components, makes this system an ideal option for classroom instruction and in-the-field research.

U9500 Classic Ussing System (preamp not included)



The Classic Ussing Chamber Systems

The U9500 and U9520 are complete chamber systems consisting of an Ussing chamber, chamber support stand, circulation reservoir, 3-prong clamp, air/gas fitting kit, and electrode set. Both systems are virtually identical with the difference embodied in the actual chamber.

U9500 'Classic' Ussing Chambers

The U9500 'Classic' chambers are machined from solid acrylic into two halves and have vertical and horizontal ports in each half for connection to the circulation system and for making electrical connections.

The face of one chamber-half is imbedded with sharp stainless-steel pins which mate with corresponding holes in the other chamber-half face. These pins allow for puncturing and positioning of an epithelium membrane within the chamber. Chambers are available in a variety of sizes and pin configurations. In the 'Classic' design, a separate chamber must be purchased for each different desired pin configuration. This is a good choice if you intend to study a single tissue type as the assembly is direct and simple.

U9520 'Classic with Inserts' Ussing Chambers

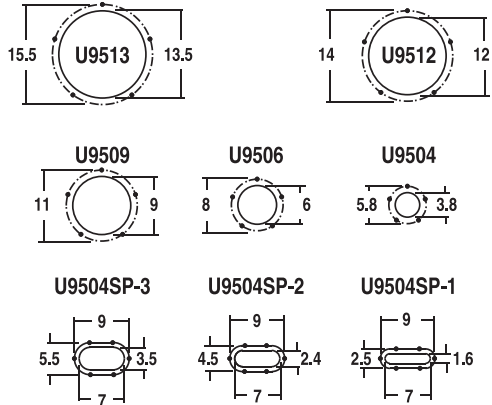
The U9520 'Classic with Inserts' chamber is functionally similar to the U9500 except that it makes use of low-cost adapters (inserts) to position and support tissues or cultured cells within the chamber body. Inserts are interchangeable and permit the researcher to investigate a variety of tissues without having to purchase a separate chamber for each different tissue. The U9520 'Classic with Inserts' chamber is mounted in the standard support stand and procedures for experimentation are the same as with the 'Classic' system.

U9500 & U2520

Classic Ussing Systems (continued)

Ussing/diffusion

Tissue Insert Sizes, Openings and Pin Layouts



*All dimensions in millimeters



Chamber configurations

U9500 chambers are available with pinned openings in diameters from 3.8 to 13.5 mm and in slot widths from 1.6 to 3.5 mm to accommodate a variety of tissue dimensions. The choice of pin configuration depends on the epithelia under study. The specified diameter designates the main opening to which the buffer makes contact with the membrane.

U9520 chamber inserts are available with openings in diameters from 3.8 to 13.5 mm. Inserts are also available for culture cups from Falcon, Millicell, Snapwell, and Transwell.

Both U9500 and U9520 chambers are available with and without drains.

Circulation Reservoirs, 3 Volumes

Available in 4, 10, and 20 ml capacities (per side), circulation reservoirs are two sided, hand-blown apparatus made from borosilicate glass. Each side has two outlets at the base for connection to the perfusion fittings on the associated Ussing chamber-half. Each side also has a separate air/gas inlet to drive the circulation system. Gas, commonly a 95% O₂/5% CO₂ mixture, is forced under low pressure into these inlets and allowed to come into contact with the buffer solution. The rising bubbles drive circulation and oxygenate the buffer. This method is commonly referred to as a 'gas-lift' perfusion system.

Each horizontal reservoir arm has either an inlet or outlet port for access to the water jacket. Water at the desired temperature is pumped through the jacket and allowing thermoregulation of the perfusion solutions. Glass condensers are provided to minimize evaporative solution losses from the top. Reservoirs are.

Electrode Sets and Agar Bridge Fittings

Each chamber is supplied with a U9975A Electrode Set comprised of 4 electrodes, 2 Ag-AgCl pellet electrodes (for voltage) and 2 Ag wire electrodes (for current). Electrodes include 1 meter (3 feet) of wire and a connector to plug into the amplifier headstage.

Also supplied are Luer taper fittings that screw onto the electrodes to provide an agar salt bridge connection into the chamber. Fittings can be filled with agar either before or after assembly onto the electrodes.

U9500 & U2520

ussing/diffusion

Classic Ussing Systems (continued)

How To Order:

- **Select Base Assembly with desired reservoir size.** Systems include support stand with rods, circulation reservoir, 3-prong clamp, U9303 Air/Gas Fitting Kit, U9975A Electrode Set, and U9965EP Electrode Bridge Fitting Kit.
- **Select chamber.** Choices are 'Classic' or 'Classic with Insert'. Both available with or without drains.
- Finally, if using 'Classic with Insert', **select desired insert.**

Order #	Model	Product
Base Assembly		
W4 64-0500R4	U95004R	Classic Ussing Base Assembly with 4 ml circulation reservoir
W4 64-0500R10	U950010R	Classic Ussing Base Assembly with 10 ml circulation reservoir
W4 64-0500R20	U950020R	Classic Ussing Base Assembly with 20 ml circulation reservoir

'Classic' Chambers

Without Drains	With Drains			w/o	with
W4 64-0504	W4 64-0512	U9504	'Classic' Chamber with 3.8 mm D round opening		
W4 64-0505	W4 64-0513	U9506	'Classic' Chamber with 6.0 mm D round opening		
W4 64-0506	W4 64-0514	U9509	'Classic' Chamber with 9.0 mm D round opening		
W4 64-0507	W4 64-0515	U9512	'Classic' Chamber with 12.0 mm D round opening		
W4 64-0508	W4 64-0516	U9513	'Classic' Chamber with 13.5 mm D round opening		
W4 64-0509	W4 64-0517	U9504SP-1	'Classic' Chamber with 1.5 x 7.0 mm slotted opening		
W4 64-0510	W4 64-0518	U9504SP-2	'Classic' Chamber with 2.5 x 7.0 mm slotted opening		
W4 64-0511	W4 64-0519	U9504SP-3	'Classic' Chamber with 3.5 x 7.0 mm slotted opening		

'Classic with Insert' Chamber

Without Drains	With Drains		
W4 64-0532	W4-64-0533	U9521	'Classic with Insert' Chamber, no insert

Order #	Model	Product
Chamber Inserts		
Inserts with pins		
W4 64-0539	U9524B-04	3.8 mm Round Insert with 5 Pins
W4 64-0540	U9524B-06	6.0 mm Round Insert with 5 Pins
W4 64-0541	U9524B-09	9.0 mm Round Insert with 5 Pins
W4 64-0542	U9524B-12	12.0 mm Round Insert with 5 Pins
W4 64-0543	U9524B-13	13.5 mm Round Insert with 5 Pins
Inserts with o-rings		
W4 64-0534	U9524A-04	3.8 mm Round Insert with O-Ring
W4 64-0535	U9524A-06	6.0 mm Round Insert with O-Ring
W4 64-0536	U9524A-09	9.0 mm Round Insert with O-Ring
W4 64-0537	U9524A-12	12.0 mm Round Insert with O-Ring
W4 64-0538	U9524A-12	13.5 mm Round Insert with O-Ring
Inserts for culture cups		
W4 64-0549	U9524S	Snapwell™ Adapter
W4 64-0544	U9524F-09	Falcon® Adapter, 9 mm
W4 64-0545	U9524F-12	Falcon® Adapter, 12 mm
W4 64-0546	U9524F-25	Falcon® Adapter, 25 mm
W4 64-0547	U9524M-12	Millicell® Adapter, 12 mm
W4 64-0548	U9524M-30	Millicell® Adapter, 30 mm
W4 64-0550	U9524T-06	Transwell® Adapter, 6.5 mm
W4 64-0551	U9524T-12	Transwell® Adapter, 12 mm
W4 64-0552	U9524T-24	Transwell® Adapter 24 mm

Order #	Model	Product
Accessories and replacement parts		
W4 64-0553	U9565EP	Electrode Bridge Fittings, pkg. of 12, and Adapters, pkg. of 6
W4 64-0554	U9975A	Electrode Set, 2 Ag/AgCl Pellet, 2 Ag Wire
W4 64-0555	U9985	Bridge Fitting Adapters, pkg. of 6
W3 64-0556	U9304	Circulation reservoir, 4 ml total volume
W3 64-0557	U9310	Circulation reservoir, 10 ml total volume
W3 64-0558	U9320	Circulation reservoir, 20 ml total volume
W4 64-0560-4ml	U9302-4	Condenser Set for 4 ml Circulation Reservoir, Set of 2
W4 64-0560-10ml	U9302-10	Condenser Set for 10 ml Circulation Reservoir, Set of 2
W4 64-0560-20ml	U9302-20	Condenser Set for 20 ml Circulation Reservoir, Set of 2
W4 64-0561	U9303	Air/Gas Connection Kit
W4 64-0562	U9403	Support Stand with One Ring Stand Rod
W4 64-0563	U9403R	Ring Stand Rod
W4 64-0564	U9404	3-Prong Clamp
W4 64-0567	SL-6U	Stopcocks with Luer Connectors for U9926 and U2500
W4 64-0165	SL-6	Stopcocks, pkg. of 6

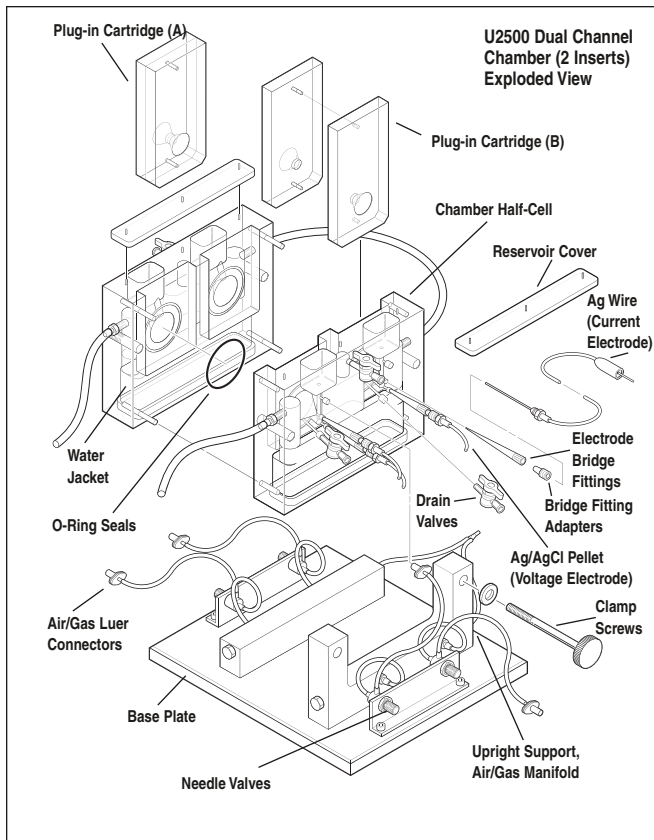
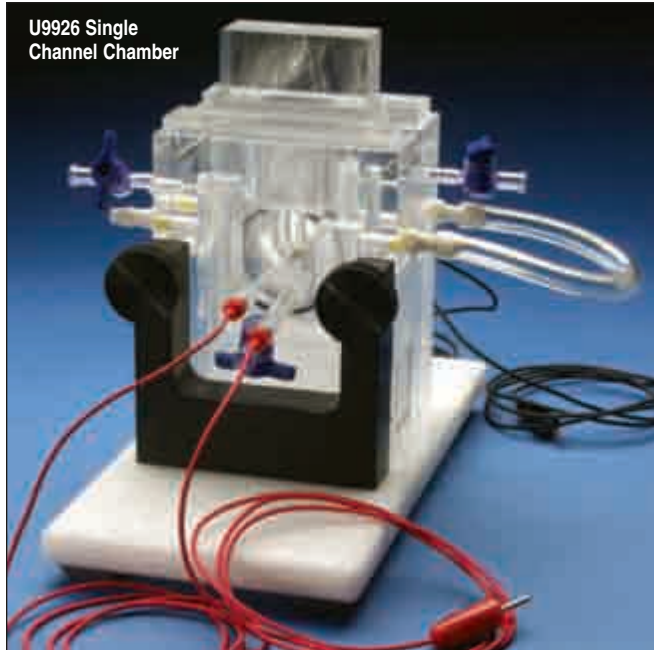
U9926 & U2500

Self-Contained Ussing Chambers

Ussing/diffusion

The Classic system in a small package. Inserts available for excised tissue and cultured cells

The U9926 and U2500 Self-Contained Ussing chambers improve on the Classic design by bringing the solution reservoir into the chamber housing. This dramatically reduces the size of the apparatus and increases the ease-of-use of the system.



The Self-Contained Ussing Chamber Systems

The Self-Contained Ussing Chambers systems come in single- and dual-channel models and offer many advantages over the Classic design. The single-channel **U9926** and dual-channel **U2500** are shown above. Both systems make use of inserts to secure and position the tissue or culture cup within the chamber body.

Chamber bodies (single- and dual-chamber models) consist of chamber-halves which clamp around the insert(s). Each chamber-half has four ports that enter into its respective bath compartment: a voltage electrode port, a current electrode port, an air/gas port, and a solution drain port. Solution warming is provided by pumping heated water through each chamber-half and there are no delicate glass heat exchangers to be broken. The dual-chamber U2500 has the additional feature of including four needle valves for adjusting the air/gas mixture into each individual chamber-half.

Inserts can be easily exchanged between experiments. Solutions are removed from the chambers through the drain valves and the halves unclamped from each other. The insert is then simply replaced. Inserts are available to support a variety of tissue sizes and culture cups.

Standard Accessories Supplied with U9926 and U2500

The U9926 (single-channel chamber) is supplied with 1 electrode set (consisting of 2 voltage and 2 current electrodes), 12 bridge fittings with adapters; and a tubing/ fitting kit. The U2500 (dual channel) chamber is supplied with two each of the above described accessories. Chamber inserts are ordered separately.

U9926 & U2500

ussing/diffusion

Self-Contained Ussing Chambers (continued)

How to Order:

- **Select Base Assembly.** Each system includes one or two U9975A Electrode Set(s) and U9965EP Electrode Bridge Fitting Kit(s)
- **Select Insert.** Order 1 if using the U9926 and order 2 if using the U2500

Order #	Model	Product
Base Assembly		
W4 64-0568S	U9926	Single-channel Ussing Chamber Base Assembly, does not include insert
W4 64-0575S	U2500	Dual-channel Ussing Chamber Base Assembly, does not include inserts
Inserts for U9926 and U2500 Base Assembly		
Inserts for tissue, with o-ring		
W4 64-0582	U9924A-04	Round Insert, 3.8 mm, with O-Ring
W4 64-0583	U9924A-06	Round Insert, 6.0 mm, with O-Ring
W4 64-0584	U9924A-09	Round Insert, 9.0 mm, with O-Ring
W4 64-0585	U9924A-12	Round Insert, 12.0 mm, with O-Ring
W4 64-0586	U9924A-13	Round Insert, 13.5 mm, with O-Ring
Inserts for tissue, with pins		
W4 64-0587	U9924B-04	Round Insert, 3.8 mm, with 5 Pins
W4 64-0588	U9924B-06	Round Insert, 6.0 mm, with 5 Pins
W4 64-0589	U9924B-09	Round Insert, 9.0 mm, with 5 Pins
W4 64-0590	U9924B-12	Round Insert, 12.0 mm, with 5 Pins
W4 64-0591	U9924B-13	Round Insert, 13.5 mm, with 5 Pins
W4 64-0592	U9924C-03	Slotted Insert, 1.6 x 7.0 mm, with 6 Pins
W4 64-0593	U9924C-04	Slotted Insert, 2.4 x 7.0 mm, with 6 Pins
W4 64-0594	U9924C-05	Slotted Insert, 3.5 x 7.0 mm, with 6 Pins

Order #	Model	Product
Inserts for Culture Cup		
W4 64-0595	U9924F-09	Falcon® Adapter, 9 mm
W4 64-0596	U9924F-12	Falcon® Adapter, 12 mm
W4 64-0597	U9924F-25	Falcon® Adapter, 25 mm
W4 64-0598	1U9924M-12	Millicell® Adapter, 12 mm
W4 64-0599	U9924M-30	Millicell® Adapter, 30 mm
W4 64-0600	U9924S	Snapwell™ Adapter, 12mm
W4 64-0601	U9924T-06	Transwell® Adapter, 6.5 mm
W4 64-0602	U9924T-12	Transwell® Adapter, 12 mm
W4 64-0603	U9924T-24	Transwell® Adapter, 24 mm
Replacement Parts		
W4 64-0565	U9406	Tubing/Fitting Kit; Includes 3/16 in x 10 ft (ID x L) Tygon Tubing, 1/16 in x 10 ft (ID x L) Tygon Tubing, Eighteen 1/16 in Fittings (six each of straight, Y and Luer Fittings)
W4 64-0553	U9565EP	Electrode Bridge Fitting Kit; Includes twelve Bridge Fittings, six Bridge Fitting Adapters
W4 64-0554	U9975A	Electrode Set; Includes two Ag-AgCl Pellet Voltage Electrode, two Ag Wire Current Electrode
W4 64-0555	U9985	Bridge Fitting Adapters, pkg. of 6

Multichannel Ussing Chamber Systems NaviCyte and EasyMount Systems

Designed for parallel studies on epithelial membranes

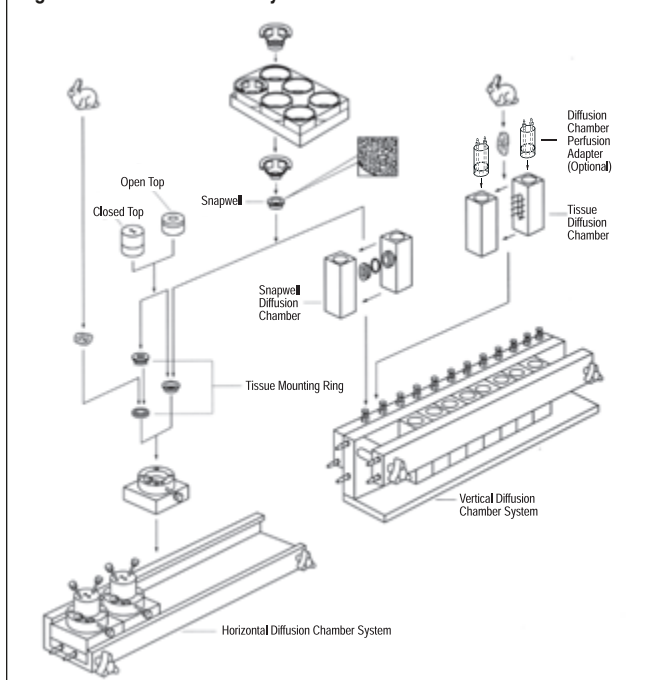


NAVICYTE™

EasyMount

Warner Instruments offers three multichannel Ussing chamber systems capable of supporting up to 24 independent chambers, all operating in parallel. Two systems position the membrane vertically and the one positions the membrane horizontally. All three multichannel chamber systems embody the self-contained design and are fully capable of supporting either membranes or cell culture cups. Differences between these systems exist, however, and are explained below.

Figure 1: Diffusion Chamber Systems



The **NaviCyte Horizontal** chamber system is designed for transport and toxicology studies using cells or tissue exposed to an air interface such as occurs in the in vivo environment (e.g., nasal, pulmonary, corneal, or dermal cells). The chambers create an environment wherein the apical surface can be exposed to liquids, semi-solid compounds, or to gases while the basolateral surface remains perfused with medium. NaviCyte Horizontal chambers accept either tissue mounting rings or Snapwell™ cell culture cups and can be used in either open or closed configurations. In the closed configuration, electrodes can be brought to bear to make electrophysiological membrane resistance measurements. Accepts from 1 to 6 chambers.

Similar to the NaviCyte Horizontal, the **NaviCyte Vertical** chamber system is designed for transport studies on filter grown cell monolayers or excised tissue sections. This system differs, however, in that membranes are mounted vertically and the chamber blocks do not use inserts to secure tissues. Instead, tissue is affixed between the opposing faces of the chamber-halves using a series of pins surrounding the opening. Chambers are available with both circular and oblong openings, depending on the tissue type under study, and can also accommodate Snapwell™ culture cups. Several low volume chambers that reduce the amount of compound required to conduct permeability studies are also available. Accepts from 1 to 24 chambers.

NaviCyte Electrodes

The NaviCyte electrodes can be used with either the NaviCyte horizontal or vertical chamber systems and provide the ability to make electrophysiological recordings. Electrodes are terminated with a 2 mm pin connector and are compatible with the NaviCyte electric manifolds (used to connect chambers to our current/voltage clamps). The Ag/AgCl reference electrode is contained in a glass barrel that terminates in a micro-porous ceramic tip. The barrel is filled with a suitable electrolyte solution, usually the buffer used for the external media or 3M KCl, and is refillable.

EasyMount Vertical Chamber Systems

The **EasyMount Vertical** chamber systems are ideal for studies requiring electrophysiological measurement of transmembrane resistance. While visually similar to the NaviCyte Vertical chambers, EasyMount chambers are different in that they use inserts to position and secure tissues or culture cups within the chamber body. Inserts can be easily exchanged without removing the chamber from its support assembly or disturbing the electrodes. Chambers come in standard and low volume designs with a variety of inserts available for each. All chambers, however, mount into the same support assembly. Accepts from 2 to 8 chambers.

The EasyMount chamber systems consist of 2 to 8 vertical Ussing chambers, a heater block/support stand, needle valves for adjustment of gas flow (for oxygenation and gas lift stirring), and Ag/AgCl voltage/current electrodes for measuring transepithelial voltage and for passing current. Tissue specific inserts are ordered separately.

NaviCyte Horizontal and Vertical Chamber Systems

The Harvard/NaviCyte patented line of horizontal and vertical diffusion chambers is designed for the study of transport across cultured cell monolayers or excised tissue under dynamic conditions. The basic system architecture shown here demonstrates the fundamental design of both the horizontal and vertical diffusion chamber systems.

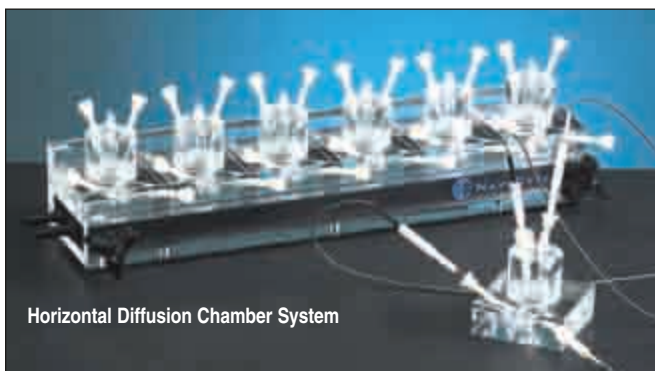
These systems are extremely well suited for non-electrical applications, however, the introduction of electrodes can provide the ability to make electrophysiological measurements. For larger applications, electrical manifolds can be employed to organize and simplify the connections to our various voltage/current clamps.

NaviCyte chamber systems are manufactured from acrylic and can be temperature controlled.

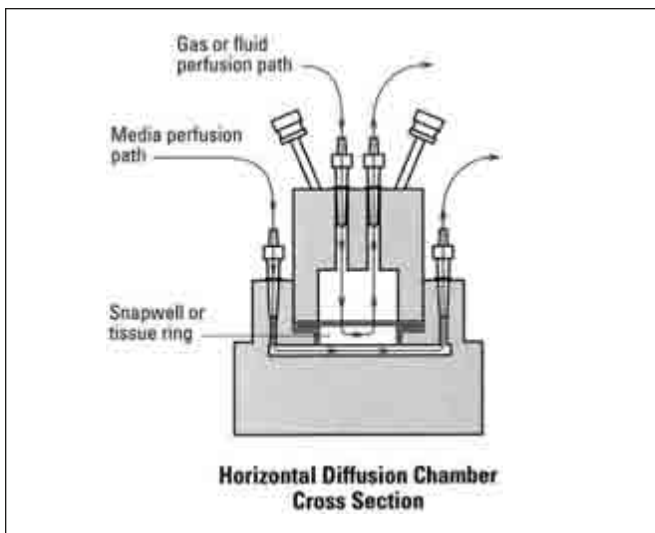
NaviCyte Horizontal Multichannel Ussing Chamber Systems

Optimized for diffusion studies on membranes at an air interface

The NaviCyte Horizontal system features the ability to run up to six chambers simultaneously and is optimized for transport studies on cells and tissues exposed to an air interface. The included heater block permits temperature control, with the use of a circulating water bath, for these chambers in both open and closed configurations. While optimized for diffusion-based studies, the use of optional electrodes permits electrophysiological membrane resistance measurements.



Horizontal Diffusion Chamber System

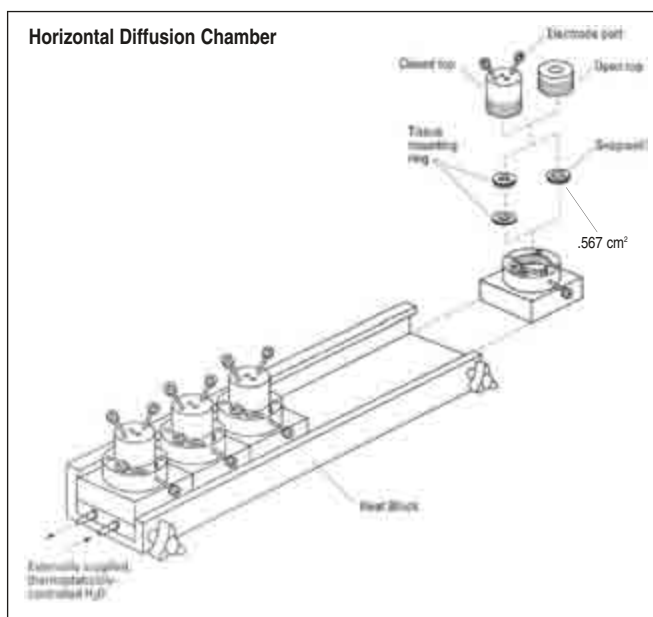


The **NaviCyte Horizontal** chamber system consists of a heater/support block and up to six horizontal chambers. Chambers require the use of a supplied open or closed chamber cap into which either a Snapwell™ culture cup or a tissue mounting ring may be fitted. Culture cups or tissues are mounted on a horizontal plane. Chambers have basolateral and apical inputs for attachment to perfusion lines, and in the closed configuration chambers can accept electrodes.

Single or multichannel setups

Chambers can be used singly as a stand-alone entity, or can be mounted into the heater/support block in sets of up to six chambers per block. The heater/support block provides chamber heating and is recommended even if using a single chamber. Inserts are easily exchanged in mounted chambers. The compact footprint (38.1 x 8.9 x 10.2 cm) of the heater/support block conserves lab bench space.

Horizontal Diffusion Chamber



Open and Closed Configurations

Open and closed chamber configurations are defined by the use of an open or closed chamber cap. Either cap completes the chamber and holds the culture cup or tissue ring into place. Both an open and closed cap is supplied with each chamber.

In the open configuration, the upper surface (usually the apical side) of the membrane is directly accessible, making the system suitable for drug transport studies or cytotoxicity testing of liquids or semi-solid materials. In the closed configuration, the membrane can be exposed to solutions, exposed to gases, perfused with gas, or perfused with liquid.

NaviCyte Electrodes and Electrical Manifolds

While optimized for diffusion-based assays, NaviCyte electrodes are available for making electrophysiology-based measurements from NaviCyte chambers. Electrodes can only be used with the NaviCyte Horizontal chamber in its closed configuration.

Electrical manifolds are available to organize the multiple connections between the amplifiers and the electrodes when making electrophysiology-based measurements using multiple chambers. Two manifolds are available, one compatible with the VCC amplifiers and the other compatible with the 'Computer Controlled Multi-Clamp with Software' package. See the associated amplifiers for these components.

NaviCyte Horizontal Multichannel Ussing Chamber Systems (continued)

How to order:

- **Select Base Assembly.** This is the heater block and is needed only if using more than one chamber or if heating.
- **Select Chambers.** Order from 1 to 6 per heater block. Each chamber includes both open and closed caps, and electrode port screws (for perfusion-only applications).
- **Order a tissue mounting ring** if not using Snapwell. Order one per chamber.
- **Order electrodes, glass barrels, and open screws** if making electrophysiological recordings.

Order #	Product
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Base Assembly

W4 66-0017	Heater Block for Horizontal Chambers
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NaviCyte Horizontal Chambers

W4 66-0016	Single NaviCyte Horizontal Diffusion Chamber
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W4 66-0022	Tissue mounting ring, 9 mm Round Aperture
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Electrode Components

W4 66-0023	Ag/AgCl electrodes with KCl, pkg. of 4
------------	--

W4 66-0024	Glass barrel for Electrode, with Ceramic Tip, pkg. of 8
------------	---

W4 66-0058	Open screw (straight hole) and O-rings, Serves as an Electrode Holder, pkg. of 24
------------	---

Replacement Parts

W4 66-0054	Closed Caps for Horizontal Chambers
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W4 66-0055	Open Caps for Horizontal Chambers
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W4 66-0053	Closed Screws, Used when perfusion is not needed, pkg. of 24
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W4 66-0056	Male Luer Fitting - 3/32 Bar, pkg. of 24
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W4 66-0057	Small O-rings for Electrodes, pkg. of 24
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The Package System

W4 66-0005	NaviCyte Horizontal Chamber System – Includes Base Assembly and Six Horizontal Chambers only
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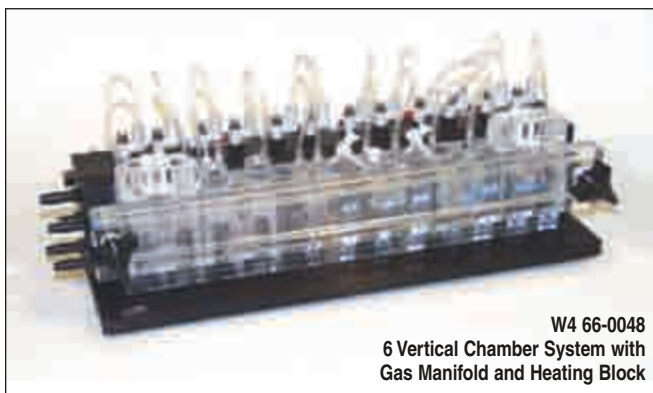
NaviCyte Vertical Multichannel Ussing Chamber Systems

Ussing/diffusion

Optimized for simultaneous diffusion studies on up to 24 membranes

This system features the capacity of running up to 24 chambers simultaneously and is optimized for transport studies on both filter grown cell monolayers and surgically excised tissue sections. 14 different chamber types are currently available. The standard support assembly holds 6 chambers and the included 12 channel gas manifold provides

air regulation to both sides of each chamber. An included heater block allows for temperature control with the use of a circulating water bath. While optimized for diffusion-based studies, the use of optional electrodes allows for electrophysiological membrane resistance measurements.

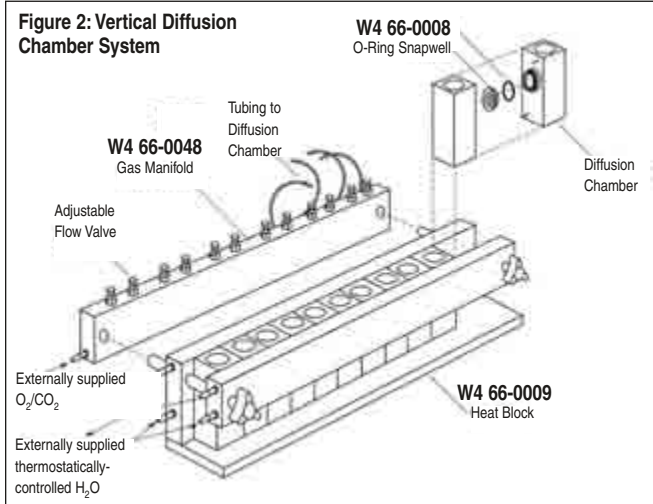


W4 66-0048
6 Vertical Chamber System with
Gas Manifold and Heating Block



W4 66-0021
24 Chamber Heating Block
for Vertical System

Figure 2: Vertical Diffusion Chamber System



The **NaviCyte Vertical** chamber system consists of up to six vertical chambers, a gas manifold, and a heater block. The system can be extended to 24 channels by the use of an available 24 channel heater block. NaviCyte Vertical chambers do not use inserts, except for the Snapwell chamber, and 14 different chambers are currently available. Chambers are described in detail below.

Single or Multichannel Setups

Chambers can be used singly as a stand-alone entity, or can be mounted in quantity into the heater/support blocks. The heater/support blocks provide chamber heating. The standard heater block and associated gas manifold allows up to six experiments to be run in parallel. The compact design (38.1 x 10.2 x 12.7 cm) of this setup conserves valuable bench space.

Heater Blocks

The standard heater block of the NaviCyte Vertical chamber system provides efficient and precise temperature control of chambers. Temperature is regulated by use of an external, user supplied circulating water bath. An optional 24 channel heat block (shown above) allows a greater number of simultaneous measurements to be made.

Gas Manifold

The 6-chamber (12-channel) gas manifold distributes gas to the chambers where media circulation is generated by the previously described gas-lift process. Gas manifolds can be ganged to accommodate the 24 chamber heater block.

NaviCyte Vertical Chambers

NaviCyte Vertical chambers are primarily designed for work with excised tissue segments. Chambers are two piece assemblies held together by a high spring-tension retaining ring to insure leak free operation. Tissue is affixed between the opposing faces of two half-chambers using a series of pins that surround the opening. Chambers are available with both circular and oblong openings of various sizes.

The optimal choice of opening will depend on the size and type of tissue under study. For example, an oblong opening can increase the effective sample surface area for an intestinal tissue.

Low Volume Chambers

Several low volume tissue chambers are offered and are designed to reduce the amount of compound required for permeability studies.

Snapwell™ Chamber

The Snapwell™ chamber is specifically designed for use with Snapwell™ culture inserts from Corning Costar. This chamber accepts the lower section of the insert, which contains the cultured cell monolayer.

NaviCyte Vertical

Ussing/diffusion

Multichannel Ussing Chamber Systems (continued)

Perfusion Caps

Perfusion caps provide perfusion capability to the standard volume Snapwell™, 8 x 24 mm oblong, and 9 mm round chambers. They are not needed for, and cannot be used with, the other standard volume or any of the low volume chambers. The use of a perfusion cap places a chamber into its 'closed' configuration.

Electrode Caps

Electrode caps provide electrode placement, if making electrophysiological measurements, within the standard volume Snapwell™, 8 x 24 mm oblong, and 9 mm round chambers. They are not needed for, and cannot be used with, the other standard volume or any of the low volume chambers. The use of an electrode cap places a chamber into its 'closed' configuration. You do not need to use a perfusion cap if using an electrode cap.

NaviCyte Electrodes and Manifold

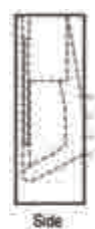
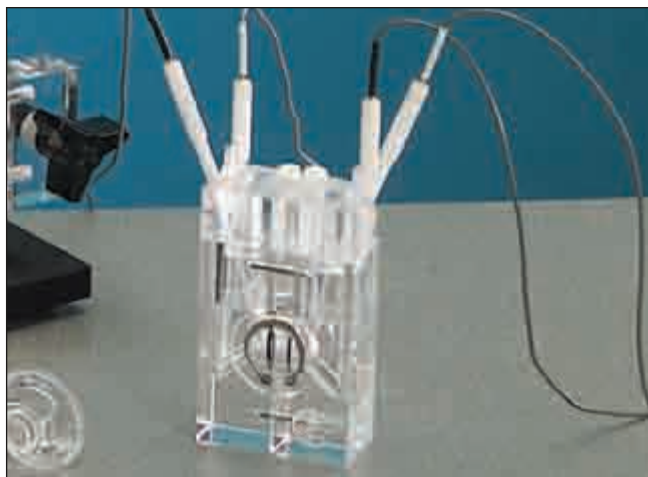
While optimized for diffusion-based assays, NaviCyte electrodes are available for making electrophysiology-based measurements with NaviCyte chambers. Electrodes can be used with NaviCyte Horizontal chambers in both their open and closed configurations. Snapwell™, 8 x 24 mm oblong, and 9 mm round chambers (standard volume) require the use of electrode caps for proper electrode placement.

Electrical manifolds are available to organize the multiple connections between the amplifiers and the electrodes when making electrophysiology-based measurements using multiple chambers. Two manifolds are available, one compatible with the VCC amplifiers and the other compatible with the 'Computer Controlled Multi-Clamp with Software' package. See the associated amplifiers for these components.

References

- 1) Grass, G.M. and Sweetana, S.A., "In vitro measurement of gastrointestinal tissue permeability using a new diffusion cell", *Pharm. Res.* 5:372-76 (1988)
- 2) Hidalgo, I.J., Hilgren, K.M., Grass, G.M., and Borchardt, R.T., "Characterization of the unstirred water layer in Caco-2 cell monolayers using a novel diffusion apparatus", *Pharm. Res.* 8:222-227 (1991)

For additional references, please visit our website.



Side



Front

Standard Diffusion Chamber
W4 66-0013,0032,0038,0046



Side



Front

Standard Diffusion Chamber
W4 66-0014, 0036



Side



Front

Low Volume Diffusion Chamber
W4 66-0027



Side



Front

Low Volume Diffusion Chamber
W4 66-0034, 0042



Side



Front

Low Volume Diffusion Chamber
W4 66-0026, 0040



Side



Front

Low Volume Diffusion Chamber
W4 66-0015



Side



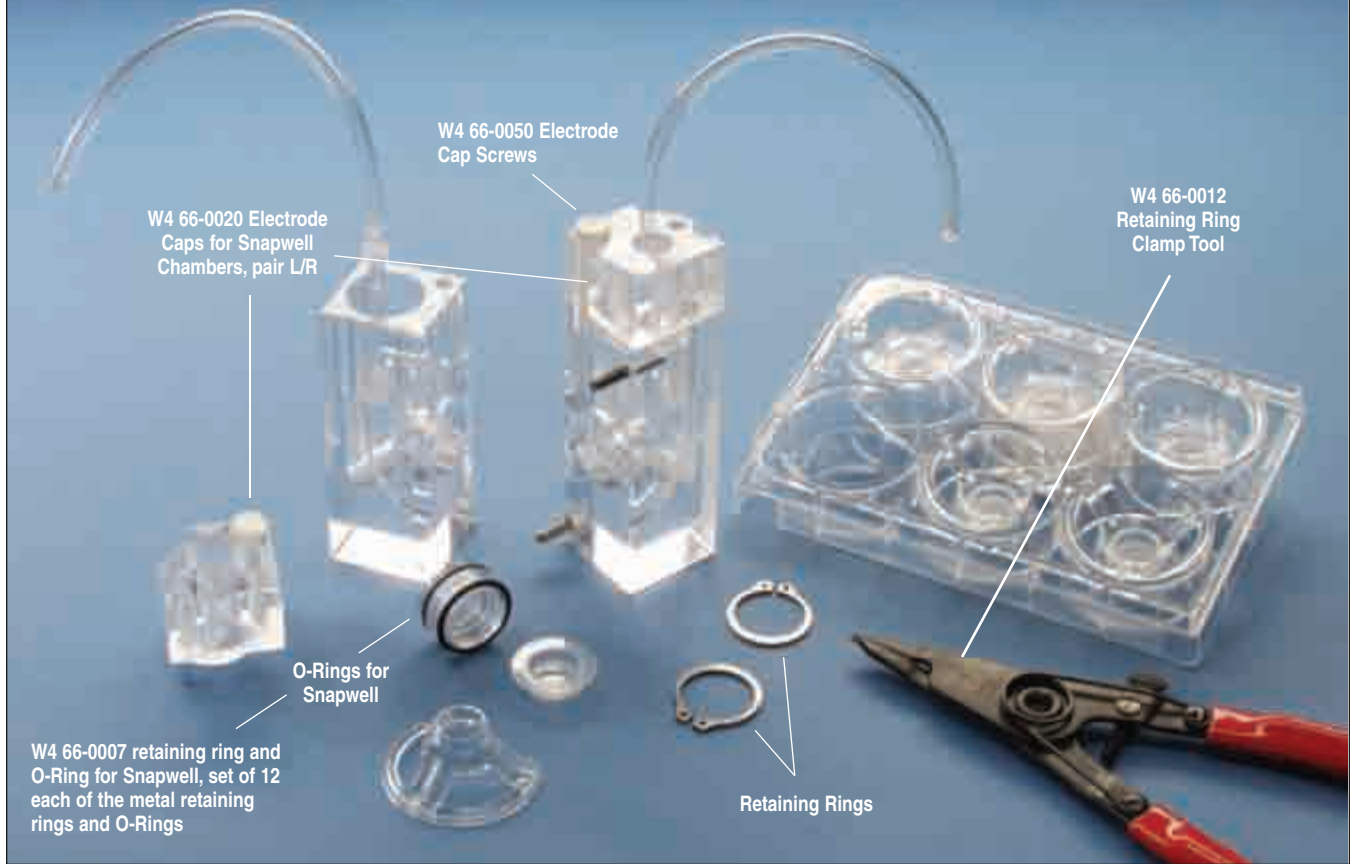
Front

Snapwell™ Diffusion Chamber
W4 66-0008

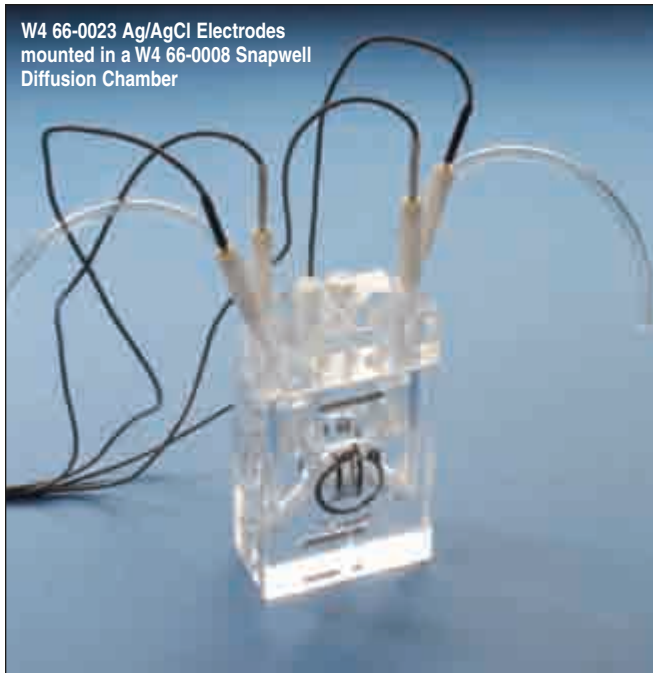
NaviCyte Vertical **ussing/diffusion**

Multichannel Ussing Chamber Systems (continued)

W4 66-0008 Snapwell Diffusion Chamber with Electrode Caps



W4 66-0023 Ag/AgCl Electrodes mounted in a W4 66-0008 Snapwell Diffusion Chamber



W4 66-0019 Perfusion Caps mounted in a Snapwell Diffusion Chamber



NaviCyte Vertical

Multichannel Ussing Chamber Systems (continued)

Ussing/diffusion

How to order:

- **Select Base Assembly.** Only needed if using more than one chamber or if heating.
- **Select Chambers.** Order from 1 to 6.
- **Order Perfusion Caps.** Only needed if perfusing in the standard volume Snapwell, 8 x 24 mm oblong, and 9 mm round chambers. Not needed if using electrode cap. One set per chamber.
- **Order electrodes and glass barrels** if making electrophysiological recordings. One set per chamber.
- **Order electrode caps and electrode cap screws** if making electrophysiological recordings in the standard volume Snapwell, 8 x 24 mm oblong, and 9 mm round chambers. One set per chamber.

Order # Product

Base Assembly

W4 66-0075 6-Chamber Heater Block Assembly – System includes 6-Chamber Heating Block, 6-Chamber Air/Gas Manifold, Clear Front Panel, and Retaining Ring Clamp Tool

NaviCyte Vertical Chambers

Order #	Chamber Type	Exposed Tissue Area	Working Reservoir Volume
Standard Volume (working volume 5-7 ml per chamber half)			
W4 66-0014*	9 mm Round	0.64 cm ²	5 to 7 ml
W4 66-0036	4 mm Round	0.12 cm ²	5 to 7 ml
W4 66-0013*	8 x 24 mm Oblong	1.78 cm ²	5 to 7 ml
W4 66-0032	4 x 8 mm Oblong	0.29 cm ²	5 to 7 ml
W4 66-0038	6 x 9 mm Oblong	0.46 cm ²	5 to 7 ml
W4 66-0046	5 x 24 mm Oblong	1.15 cm ²	5 to 7 ml
Low Volume (working volume 1-4 ml per chamber half)			
W4 66-0026	5 mm Round	0.20 cm ²	0.2 to 0.4 ml
W4 66-0015	9 mm Round	0.64 cm ²	1 to 2 ml
W4 66-0027	12 mm Round	1.13 cm ²	2 to 4 ml
W4 66-0040	3 mm Round	0.07 cm ²	1 to 2 ml
W4 66-0034	2 x 10 mm Oblong	0.10 cm ²	2 to 4 ml
W4 66-0042	4 x 8 mm Oblong	0.28 cm ²	2 to 4 ml
Specialty			
W4 66-0008*	Snapwell™	1.13 cm ²	4 to 6 ml

*May require perfusion or electrode caps, available separatel.

Order # Product

Accessories

W4 66-0019 Tissue Chamber Perfusion Cap, pkg. of 2

W4 66-0021 24-Chamber Heating Block

Electrodes

W4 66-0018 Electrode Cap for Chambers, pair L/R

W4 66-0020 Electrode Cap for Snapwell Chambers, pair L/R

W4 66-0050 Electrode Cap Screws, pkg. of 12

W4 66-0023 Ag/AgCl Electrodes with KCl, pkg. of 4, with O-rings

W4 66-0024 Glass Barrel for Electrode with Ceramic Tip, pkg. of 8

Order # Product

W4 66-0049 Open Screws (with step) and O-rings, pkg. of 12. Serves as Electrode Holders for Low Volume Chambers

W4 66-0057 Small O-rings for Electrodes, pkg. of 24

Replacement parts

W4 66-0009 6-Chamber Heating Block

W4 66-0048 12 Channel (6 chamber) Air Manifold

W4 66-0010 Clear Front Panel

W4 66-0007 Retaining Ring and O-Ring, pkg. of 12

W4 66-0012 Retaining Ring Clamp Tool

W4 66-0006 Replacement Air Line for Air\Gas Manifold, 6 inch long, pkg. of 12

The Package Systems

Standard Volume Systems (does not include electrodes)

W4 66-0003 NaviCyte Vertical Chamber System – Includes base assembly and six **9 mm round** (W4 66-0014) chambers (does not include perfusion or electrode caps)

W4 66-0037 NaviCyte Vertical Chamber System – Includes base assembly and six **4 mm round** (W4 66-0036) chambers

W4 66-0002 NaviCyte Vertical Chamber System – Includes Base Assembly and six **8 x 24 mm oblong** (W4 66-0013) Chambers (does not include perfusion or electrode caps)

W4 66-0033 NaviCyte Vertical Chamber System – Includes base assembly and six **4 x 8 mm oblong** (W4 66-0032) chambers

W4 66-0039 NaviCyte Vertical Chamber System – Includes base assembly and six **6 x 9 mm oblong** (W4 66-0038) chambers

W4 66-0047 NaviCyte Vertical Chamber System – Includes base assembly and six **5 x 24 mm oblong** (W4 66-0046) chambers

Low Volume Systems (does not include electrodes)

W4 66-0028 Low Volume NaviCyte Vertical Chamber System – Includes base assembly and six **5 mm round** (W4 66-0026) chambers

W4 66-0004 Low Volume NaviCyte Vertical Chamber System – Includes base assembly and six **9 mm round** (W4 66-0015) chambers

W4 66-0029 Low Volume NaviCyte Vertical Chamber System – Includes base assembly and six **12 mm round** (W4 66-0027) chambers

W4 66-0041 Low Volume NaviCyte Vertical Chamber System – Includes base assembly and six **3 mm round** (W4 66-0040) chambers

W4 66-0035 Low Volume NaviCyte Vertical Chamber System – Includes base assembly and six **2 x 10 mm oblong** (W4 66-0034) chambers

W4 66-0043 Low Volume NaviCyte Vertical Chamber System – Includes base assembly and six **4 x 8 mm oblong** (W4 66-0042) chambers

Specialty Systems

W4 66-0009 NaviCyte Vertical Chamber System – Includes base assembly and six **Snapwell** (W4 66-0008) chambers (does not include perfusion or electrode caps)

EasyMount Multichannel Ussing Chamber Systems

Optimized for simultaneous electrophysiological studies on up to 8 membrane

The EasyMount chamber systems are ideal for studies requiring electrophysiological measurement of transmembrane resistance. While visually similar to the NaviCyte Vertical chambers, EasyMount chambers are different in that they use inserts to position and secure tissues or culture cups within the chamber body.



The EasyMount chamber systems consist of 2 to 8 vertical Ussing chambers, a heater block/support stand, needle valves for adjustment of gas flow (for oxygenation and gas lift stirring), and Ag/AgCl voltage/current electrodes for measuring transepithelial voltage and for passing current. Tissue specific inserts are ordered separately.

Multichannel setups

All EasyMount chambers (P2300 and P2400,) use the same stands and electrodes. Stands are available to support 2, 4, 6, or 8 chambers and can be readily ganged to allow for higher count applications. Stands have an incorporated heater block that warms all chambers to the same temperature. A needle valve assembly (one set per chamber) is mounted on the rear of the heater block for regulation of the gas flow.

EasyMount Chambers

EasyMount chambers are a two piece assembly using an insert to secure and position tissues or culture cups. Tissues are placed in the chamber by loosening a thumbscrew, sliding the tissue holding insert into the space between the chamber halves, and retightening the thumbscrew. Chambers do not need to be removed from the heater block, nor are the electrodes disturbed, when placing an insert. This easy and rapid replacement process makes the EasyMount system an excellent choice for high-throughput applications.

Chambers are available in two styles; the P2300 is the standard chamber and accommodates a large variety of inserts and the P2400 is designed for low-volume applications. The P2300 has chamber caps available for sealing the chamber when radioligands or toxic chemicals are used.

EasyMount Inserts

EasyMount inserts are available to mount a variety of tissues and can also accommodate cell culture cups. Each chamber type has its own supporting family of inserts.

The P2300 Series inserts are available to accommodate Snapwell, Millicell, Nunc, and Transwell culture cups. Inserts are also available with pins or o-rings in both oblong and round formats.

P2400 Series inserts do not support culture cups but are available with pins or o-rings in both oblong and round formats.

Electrodes and Accessories

Electrodes are available in sets comprised of two sintered Ag/AgCl pellet electrodes for voltage sensing (black), two Ag wire electrodes for current passing (white), and eight electrode tips. The number of sets provided is dependent on the system purchased, however, one electrode set is required for each chamber.

Replacement current and voltage electrodes are available, as are electrode tips. Additional accessories include electrode lead sets and chamber filling needles.

How to order:

- **Select Chamber Assembly.** Each assembly includes heater block/stand, chambers, needle valves, and electrodes.
- **Select Chamber Inserts.** Select from P2300 or P2400 Series depending on the volume of the system assembly chosen. Order at least 1 insert per chamber.
- **Select FN15 filling needles** and extra electrode tips.
- **Select P2300 Chamber Caps** if using radioligands or toxic chemicals with P2300 chambers.

Order #	Model	Product
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EasyMount Chamber Assembly

P2300 Chamber Systems (Standard Volume)

W4 69-1070	CSYS-2-HA	P2300 EasyMount Assembly, 2 Chambers, No Inserts
W4 69-1071	CSYS-4-HA	P2300 EasyMount Assembly, 4 Chambers, No inserts
W4 69-1072	CSYS-6-HA	P2300 EasyMount Assembly, 6 Chambers, No Inserts
W4 69-1073	CSYS-8-HA	P2300 EasyMount Assembly, 8 Chambers, No Inserts

P2400 Chamber Systems (Low Volume)

W4 69-1074	LVSYS-2-HA	P2400 EasyMount Assembly, 2 Chambers, No Inserts
W4 69-1075	LVSYS-4-HA	P2400 EasyMount Assembly, 4 Chambers, No Inserts
W4 69-1076	LVSYS-6-HA	P2400 EasyMount Assembly, 6 Chambers, No Inserts
W4 69-1077	LVSYS-8-HA	P2400 EasyMount Assembly, 8 Chambers, No Inserts

Order #	Model	Aperture	Working Area	Description
Chamber Inserts (Fits P2300 Chamber Systems)				
W4 69-0956	P2302	12 mm Round	1.12 cm ²	For Snapwell cell culture cups
W4 69-1081	P2302M	8.75 mm Round	0.60 cm ²	For Millicell cell culture cups
W4 69-1082	P2302N	8.0 mm Round	0.50 cm ²	For Nunc/Anopore cell culture cups
W4 69-1083	P2302T	6.5 mm Round	0.33 cm ²	For Costar Transwell cell culture cups
W4 69-1084	P2303	2.8 x 4.5 mm	0.10 cm ²	For juvenile mouse intestine
W4 69-1085	P2303A	2.8 x 4.5 mm	0.10 cm ²	For juvenile mouse intestine or bladder, with pins
W4 69-0957	P2304	2.8 x 11.0 mm	0.30 cm ²	For mouse intestine, with pins
W4 69-0958	P2305	4.5 x 11.2 mm	0.50 cm ²	For rat and larger animal intestine, with pins
W4 69-0959	P2306	2.8 x 1.5 mm	0.036 cm ²	For mouse trachea and similar tissue
W4 69-0960	P2307	2.0 mm Round	0.031 cm ²	For small tissues (e.g., biopsies)
W4 69-1086	P2308	1.0 mm Round	0.008 cm ²	For very small, thin tissues (e.g., lower mouse trachea)
W4 69-0961	P2310	5.0 mm Round	0.20 cm ²	With pins
W4 69-0962	P2311	6.2 mm Round	0.30 cm ²	With pins
W4 69-1087	P2311A	5.7 mm Round	0.26 cm ²	With pins
W4 69-0963	P2312	8.0 mm Round	0.50 cm ²	With pins
W4 69-0964	P2313	9.5 mm Round	0.71 cm ²	With pins
W4 69-0965	P2314	11.3 mm Round	1.00 cm ²	With pins
W4 69-0966	P2315	12.7 mm Round	1.26 cm ²	With pins
W4 69-1088	P2316	5.0 mm Round	0.20 cm ²	for Skin, with o-ring
W4 69-1089	P2317	10.8 mm Round	0.93 cm ²	For synthetic membranes, with o-ring
W4 69-1090	P2318	11.3 mm Round	1.00 cm ²	For Frog Skin, with o-ring
W4 69-1091	P2319	12.7 mm Round	1.26 cm ²	For studying mucus layer, with spacer ring
Chamber Inserts Fits (P2400 Chamber Systems)				
W4 69-1092	P2403	2.8 x 4.5 mm	0.10 cm ²	For small Tissue Specimens
W4 69-0969	P2404	2.8 x 9.2 mm	0.25 cm ²	For mouse intestine
W4 69-0970	P2405	4.5 x 9.2 mm	0.40 cm ²	For rat and larger animal intestine
W4 69-0971	P2406	2.8 x 1.5 mm	0.04 cm ²	For mouse trachea
W4 69-0972	P2407	2.0 mm round	0.031 cm ²	For biopsies
W4 69-1093	P2408	0.8 mm round	0.005 cm ²	For biopsies
W4 69-1094	P2408A	0.5 mm round	0.002 cm ²	For biopsies
W4 69-1095	P2408B	1.0 mm round	0.008 cm ²	For biopsies
W4 69-0973	P2410	5.0 mm round	0.20 cm ²	With pins
W4 69-0975	P2412	8.0 mm round	0.50 cm ²	With pins
W4 69-0976	P2413	9.5 mm round	0.71 cm ²	With pins
Order #	Model	Product		
Accessories				
W4 69-1096	P2300-CAP	Chamber Caps for P2300 Chamber – set of 2		
W4 69-1097	FNS15-2	Two Syringes with Filling Needles		
W4 69-1098	FN15	Replacement Filling Needle		
W4 69-0990	P2023-20	Electrode Tips – 20 Pack		
W4 69-0991	P2023-50	Electrode Tips – 50 Pack		
W4 69-0992	P2023-100	Electrode Tips – 100 Pack		
Replacement Parts				
W4 69-0993	P2300	EasyMount Chamber – Standard Volume (Chamber Only)		
W4 69-0995	P2400	EasyMount Chamber – Low Volume (Chamber Only)		
W4 69-0987	P2020-S	Electrode Set (2 current, 2 voltage, 8 tips)		
W4 69-0988	P2020-IS	Electrode Set (4 current, 8 tips)		
W4 69-0989	P2020-VS	Electrode Set (4 voltage, 8 tips)		
W4 69-3147	P2024-36	Electrode Lead Set (36 in, 4 pk)		
W4 69-1099	P2060	Air Control Valve Assembly, Mounts on Stand, Fits One Chamber		

EC-800 and EC-825A

Single and Dual Channel Epithelial Voltage Clamps

Our single and dual channel epithelial voltage clamps

EC-825A



CE

- For studies of epithelial transport and the electrical properties of tissue
- High common mode rejection
- Clamp Speed Selection
- Membrane Resistance Measurement Circuit
- Watertight Headstage with Model Membrane

Single Channel EC-800 and Dual Channel EC-825A

Epithelial voltage clamps from Warner provide accurate measurements of transepithelial voltage, short circuit current, and membrane resistance. Important features include fluid resistance compensation, membrane resistance readout, choice of voltage compliance, and small water-tight preamp headstages. Operating modes include voltage clamp, current clamp, voltmeter, and resistance. The dual channel model includes an internal timer.

The **EC-800** and **EC-825A** are state-of-the-art instruments with several unique and important design features offering more reliable recording and operator convenience.

High CMR

Differential voltage recordings are made with very high common mode rejection providing accurate measurements free from the effects of common mode potential changes of a noisy environment.

Membrane Resistance Measurement

Accurate resistance measurements are made with the membrane mounted in the chamber. This measurement is made using a low frequency 2 Hz bipolar signal to avoid polarization of the membrane (ideal for monolayers). Resistances up to 200 k Ω are displayed on the meter with push-button convenience.

Clamp Speed Selection

Three clamp speeds provide optimum recording conditions for a variety of applications. In Fast mode, preparations with low access resistance (small tissues or monolayers) can be clamped with speeds as fast as 10 μ sec. Typical Ussing chambers with larger tissues will use Medium or Slow modes for stable, oscillation free clamping.

Commands

Internal DC Command (Hold) control for both Voltage clamp and Current clamp modes.

Watertight Headstage with Model Membrane

The small compact headstage can be located close to the measurement site to keep input leads short for reduced noise pick-up. The model membrane circuit simulates a preparation to provide convenient operational checks of the clamp. Internal circuits are protected against the invasion of corrosive saline solutions by a watertight seal.

Choice of Voltage Compliance

The EC-800 has a voltage compliance of ± 120 V and the EC-825A has a voltage compliance of ± 50 V.

The high voltage compliance of these instruments are important for studies of low resistance (leaky) epithelial cells and in applications in which long agar leads in the current passing circuit produce large voltage drops (which must be compensated). Additionally, the high compliance helps in charging large membrane capacitances typical of epithelial tissues, resulting in faster settling times and improved overall clamp performance.

EC-800 and EC-825A

Single Channel and Dual Channel Epithelial Voltage Clamps (continued)



External Control

The clamp can be operated by an external programmer, lab timer or computer. Logic control of clamp mode and clamp command levels is possible as well as simultaneous mixing of external linear commands.

Onboard Timer Controller

The dual channel EC-825A includes event timers (2) to provide cycle times and clamp durations up to 2000 seconds. Times are set with 2 digit thumbwheel switches and 4 position range switches. Once set, the timer will free run, eliminating the need for a computer or other external device to control the experiment.

Model EC-800LV ± 15 Volt Compliance

Studies with small tissue samples or monolayers in set-ups with low access resistance may not require high compliance. For these applications, models EC-800LV offers both a lower cost and a safer environment for the membrane.

Specifications

EC-800, EC-800LV, EC-825A

Headstage:

Input Impedance	$1 \times 10^{10} \Omega$ shunted by 6 pF
Input Voltage	± 1.5 V maximum
Common Mode Voltage	± 13 V maximum
Common Mode Rejection	100 dB at 60 Hz
Leakage Current	20 pA maximum
Offset Voltage Range	± 120 mV

Voltage Clamp Ranges:

Int. Clamp Potentiometer	± 100 mV with 10-turn control
Ext. Command	± 1 V
Ext. Command Factor	1 mV/10 mV applied

Current Clamp Ranges:

Clamp Potentiometer	± 1 mA
External Command	± 10 mA
Command Factor	1 μ A/10 mV applied
Speed	10 μ sec measured with model membrane

Resistance:

Fluid Resistance	0-100 Ω standard
Compensation Range	0-1 k Ω optional
Membrane Resistance Measurement	(made with 2 Hz bipolar constant current square wave)
Ranges	0-2 k Ω , injected current = 10 nA 0-200 k Ω , injected current = 1 nA

Specifications (continued)

Membrane Resistance	0-2 k Ω , 1mV/ Ω
Output (EC-825A)	0-200 k Ω , 10mV/ Ω
Panel Meter EC-800	3-1/2 digit LCD; Voltage Range: 200 mV max; Current Range: 2000 μ A max
Panel Meter EC-825A	3-1/2 digit LED; Voltage Range: 200 mV max; Current Range: 2000 μ A max

Outputs:

Voltage Monitor	x10
Current Monitor	10 mV/ μ A

Compliance:

EC-800	± 120 V
EC-800LV	± 15 V
EC-825A	± 50 V

Timers (A & B) EC-825A:

Range	10 ms to 1000 secs, set with 2 digit resolution and 4 ranges (each channel)
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Power Requirements

Power Requirements	100-130 VAC or 220-240 VAC, 50/60 Hz, 15 VA
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Physical Dimensions, H x W x D:

EC-800, EC-800LV & EC-825A	8.9 x 43.2 x 30.5 cm
Headstage	7.7 x 7.7 x 5 cm

Shipping Weight:

EC-800 & EC-800LV	6.4 kg
EC-825A	9.1 kg

Warranty

Warranty	Two years, parts & labor
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Order # Model Product

W4 64-0035	EC-800	Single Channel Voltage Clamp with ± 120 V Compliance* for Leaky Tissue
W4 64-1508	EC-800	Single Channel Voltage Clamp with ± 120 V Compliance* for Leaky Tissue, 200 - 240 VAC
W4 64-0036	EC-800LV	Single Channel Voltage Clamp with ± 15 V Compliance* for Tight Tissue and Culture Type Monolayers
W4 64-1509	EC-800LV	Single Channel Voltage Clamp with ± 15 V Compliance* for Tight Tissue and Culture Type Monolayers, 200 - 240 VAC
W4 64-1605	EC-825A	Dual Channel Voltage Clamp with ± 50 V Compliance*

*Supplied with rack mount hardware.

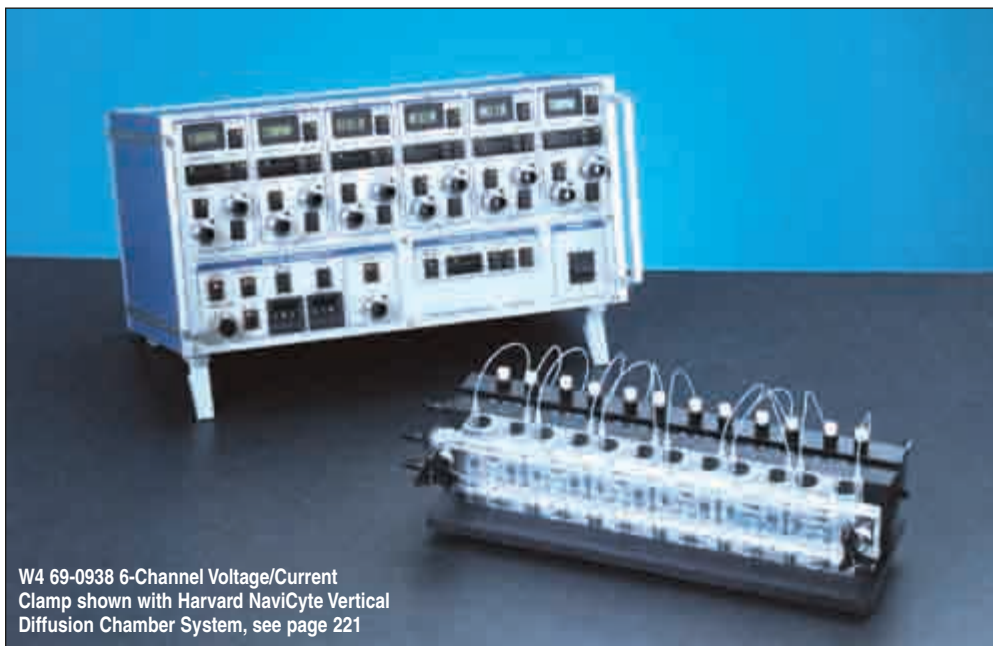
VCC-MC

Multichannel Epithelial Voltage Clamps

ussing/diffusion

Supports from 2 to 8 amplifiers in a single package

The VCC-MC family of epithelial voltage/current clamps are ideal instruments for use with the multichannel chamber systems described earlier. Configurations range from 2 to 8 amplifiers and these systems integrate fully with the Acquire and Analyze software package.



W4 69-0938 6-Channel Voltage/Current Clamp shown with Harvard NaviCyte Vertical Diffusion Chamber System, see page 221

The **VCC-MC** family of voltage/current clamps and accessories have been designed to be flexible tools for studying ion transport across epithelial tissue.

The VCC-MC family is of particular benefit in high throughput, multi-channel applications and where laboratory bench space is limited. All models in this family provide similar capabilities and specifications as the VCC-600 single channel clamp to control the voltage or the current across the epithelium. However, unlike the VCC-600, these clamps are modular in design.

The **VCC-MC2** contains two voltage/current clamp modules, a pulse generator, and a computer interface in a compact 9.5 inch chassis.

The VCC-MC2 is best suited for small scale applications and for student laboratories. The VCC-MC2 is compatible with all chamber systems offered by Warner. Each VCC-MC2 comes complete with two single channel input modules (DM MC6) for connection to electrodes.

The **VCC-MC6** and **VCC-MC8** are multichannel chassis that can be configured with 2 to 8 voltage/current clamp channels, depending on model. These instruments are ideally suited for experiments where multiple specimens are sampled in parallel. They offer the distinct advantage of expandability within the same instrument chassis.

A useful feature built into the VCC-MC6 and VCC-MC8 instruments is a master control section. This section enables the investigator to quickly change the function, mode, and meter settings on each clamp module from a single switch bank. This markedly simplifies the use of the instrument and removes some of the tedium associated with continually having to change multiple, identically placed switches (e.g., changing the meter switch to display current instead of voltage on eight channels).

The VCC-MC Multichannel clamps are well suited for the NaviCyte and EasyMount systems. For use with the NaviCyte systems, a special 24-lead input module (EP-MC6) replaces the individual DM-MC6 input modules for making electrode connections. The EP-MC6 mounts between the heat block and air manifold on the NaviCyte system and must be ordered separately.

Specifications

Input Resistance	≥ 10 ⁹ Ω, differential
Common Mode Rejection	≥ 100 dB
Frequency Response	4-stage adjustment via internal switch
Display:	3.5 digit, 3/8 in LCD with green backlight for each channel
Transepithelial Voltage	±199.9 mV
Transepithelial Current	±19.90, ±199.9, ±1999 μA, jumper selectable
Switches	Push button, digital switching with LED indicators
Power	100/125 VAC, 60 Hz or 200/250 VAC, 50 Hz, user selectable
Meter	Selects current or voltage to be displayed on panel meter
Function:	Three position switch with LED indicator of state
Zero	Standby mode, voltage inputs are internally grounded
Open	Open circuit, voltage inputs are connected to sensing electrodes
Clamp	Feedback loop is closed to control either current or voltage
Mode:	Two switches select operating modes
Voltage/Current (I/V)	Selects transepithelial voltage or current to be controlled when Function is on Clamp
Remote (REM)	Selects control to be from front panel switches or from remote interface
Offset Potential	±10 or ±100 mV, set via precision 10-turn dial, jumper selectable ranges and lighted polarity switch
Fluid Resistance	Push-button current injection, compensation set by precision 10-turn dial, jumper selectable ranges
On/Off	'On' sends pulse output to clamp, red indicator light
Polarity	Selects +, - or bipolar pulses to be generated
Single Pulse	Injects single pulse during interval between pulses
Reset	Initializes interval timer and injects pulse
Amplitude	0 to 10 mV in 1 mV steps at X1 gain; 0 to 100 mV in 10 mV steps at X10 gain
Period	0.1 to 99.9 sec time period between pulses; set by 3-decade thumbwheel switch
Duration	0.01 to 9.99 sec duration of each pulse; set by 3-decade thumbwheel switch
DC Clamp Level:	Sets DC holding voltage or current
Voltage Clamp	±100 mV via 10-turn dial, lighted polarity switch
Current Clamp	Current gain dependent, 50% of max. displayed current
Master Override	Permits control of function, mode, and meter features on all installed clamp channels

I/O Connection Specifications

Electrode Inputs	2 mm pin tip via DM-MC6 single channel input module, 1 per channel (VCC-MC6 and VCC-MC8) 2 mm pin tip via electrode panel (EP-MC6) for Harvard/Navicyte chamber system (VCC-MC6)
Recorder Output Voltage	10 mV/mV, x10 transepithelial voltage
Recorder Output Current	Jumper selectable, 1, 10 or 100 mV/μA
Pulse Generator	0 to ±100 mV and 0 to ±1 V
External Input	Allows arbitrary analog input signal to be clamped
Remote Interface	9-pin DB connector, 1 per channel (VCC-MC2) 25-pin DB connector (all others)

VCC Amplifiers

VCC Series Amplifier	w/DM-MC6 Input Module (for EasyMount)	w/EP-MC6 Input Module (for NaviCyte)	w/DM-MC6-HV Input Module (High Voltage) (for EasyMount)	w/EP-MC6-HV Input Module (High Voltage) (for NaviCyte)
VCC-MC2	W4 69-0933	---	W4 69-0934	---
VCC-MC6				
2-Channel	W4 69-0946	W4 69-0944	W4 69-0947	W4 69-0945
4-Channel	W4 69-0942	W4 69-0940	W4 69-0943	W4 69-0941
6-Channel	W4 69-0938	W4 69-0936	W4 69-0939	W4 69-0937
VCC-MC8				
8-Channel	W4 69-1003	---	W4 69-1001	---

VCC Amplifiers (CE Version)

VCC Series Amplifier	w/DM-MC6 Input Module (for EasyMount)	w/EP-MC6 Input Module (for NaviCyte) (for EasyMount)	w/DM-MC6-HV Input Module (High Voltage) (for NaviCyte)	w/EP-MC6-HV Input Module (High Voltage)
VCC-MC2	W4 69-0933CE	---	W4 69-0934CE	---
VCC-MC6				
2-Channel	W4 69-0946CE	W4 69-0944CE	W4 69-0947CE	W4 69-0945CE
4-Channel	W4 69-0942CE	W4 69-0940CE	W4 69-0943CE	W4 69-0941CE
6-Channel	W4 69-0938CE	W4 69-0936CE	W4 69-0939CE	W4 69-0937CE
VCC-MC8				
8-Channel	W4 69-1003CE	---	W4 69-1001CE	---

Order # Model Product

Accessories and replacement parts

W4 66-0025		6-Channel Electrical Manifold for NaviCyte Chamber Systems
W4 69-1004	MC601	Add-on/replacement amplifiers for VCC amplifier case for NaviCyte Chamber Systems

VCC-600

Single Channel Epithelial Voltage Clamp

ussing/diffusion

A single channel epithelial voltage clamp

The VCC-600 is a single channel voltage/current clamp for epithelial tissue. It is the most versatile instrument in the VCC series. Basic features include 10-turn dials for electrode offset and fluid (series) resistance compensation, user selectable current gain and response frequency.

W4 69-0930 Single Channel Voltage/Current Clamp



The VCC-600 epithelial clamp amplifier is a versatile single channel instrument. In addition to its basic features, a clamp level control allows the holding voltage or current to be set while a built-in pulse generator provides unipolar or bipolar step changes from the holding level for tissue conductance/resistance measurements.

Voltages and currents can be monitored via recorder outputs on the front panel and by a bright 3.5 digit LED digital panel meter. An interface connector, for remote instrument control and data acquisition, is provided on the rear panel. A high voltage option is also available to increase the output compliance voltage to ± 35 V DC for certain types of experiments.

The VCC-600 also has special features making it a popular instrument for electrophysiological studies of epithelia. These features include an active headstage that incorporates a virtual grounding amplifier for current measurement and an extra level of current gain to measure currents in the nA range. This allows the instrument to be used for studies on very small tissues such as isolated renal tubules and single isolated colonic crypts. A switch and buffer amplifier in the headstage allows selection and continuous measurement of the potential on either side of the epithelium. The output on the rear of the instrument can be used as a reference for microelectrode experiments so that the intracellular voltage can be directly measured across either apical or basolateral membranes regardless of side of impalement. Similarly, it can be used as the reference voltage in pH stat experiments, thereby eliminating a problem with some combination electrodes and pH meters in which a fraction of the transepithelial current may be shunted to ground.

Specifications

Input Resistance	10^9 W, differential, $\geq 10^{12}$ W available as option
Common Mode Rejection	≥ 100 dB
Frequency Response	4-stage adjustment via internal switch
Clamp Output	± 13 V standard, ± 35 V optional high voltage
Display:	3.5 digit, 1/2 in red LED
Transepithelial Voltage	± 199.9 mV
Transepithelial Current	$\pm 1.990, \pm 19.90, \pm 199.9, \pm 1999$ μ A, jumper-selectable
Switches	Subminiature toggle
Grounding	Signal (circuit) ground is isolated from chassis and power grounds; binding posts on rear panel allow connection of circuit to chassis ground

Specifications (cont'd)

Power	100/125 VAC, 60 Hz or 200/250 VAC, 50 Hz, user selectable
Meter	Selects current or voltage to be displayed on panel meter
Function:	Three position rotary switch
Zero	Standby mode, voltage inputs are internally grounded
Open	Open circuit, voltage inputs are connected to sensing electrodes
Clamp	Feedback loop is closed to control either current or voltage
Mode:	Two switches select operating modes
Voltage/Current (I/V)	Selects transepithelial voltage or current to be controlled when Function is on Clamp
Local/Remote	Selects control to be from front panel switches or from remote interface
Offset Potential	± 10 mV, set via precision 10-turn dial
Fluid Resistance	Push-button current injection, compensation set by precision 10-turn dial, jumper selectable ranges
On/Off	'On' sends pulse output to clamp, red indicator light
Polarity	Selects +, - or bipolar pulses to be generated
Single Pulse	Injects single pulse during interval between pulses
Reset	Initializes interval timer and injects pulse
Amplitude	0 to 10 mV in 1 mV steps at X1 gain; 0 to 100 mV in 10 mV steps at X10 gain
Period	0.1 to 99.9 sec time period between pulses; set by 3-decade thumbwheel switch
Duration	0.01 to 9.99 sec duration of each pulse; set by 3-decade thumbwheel switch
DC Clamp Level:	Sets DC holding voltage or current
Voltage Clamp	± 100 mV and ± 300 mV via 10-turn dial
Current Clamp	Current gain dependent, 50% and 150% of max. displayed current
Headstage	Active input stage for sensing voltage and current near preparation, cable length 6 ft
Reference Buffer	Switch selectable to send V1 or V2 inputs to buffer amplifier in headstage; allows monitoring of bath potential on either side of epithelium; output via rear panel permits micro-electrode impalements or pH electrodes to be referenced to either V1 or V2

I/O Connection Specifications

Electrode Inputs	Banana jacks on headstage
Recorder Output Voltage	10 mV/mV, x10 transepithelial voltage
Recorder Output Current	Jumper selectable, 1, 10, 100 or 1000 mV/ μ A
Pulse Generator	0 to ± 100 mV and 0 to ± 1 V
External Input	Allows arbitrary analog input signal to be clamped
Remote Interface	9 pin DB connector

Order #	Model	Product
W4 69-0930	VCC600	Single Channel Voltage/Current Clamp
W4 69-0931	VCC600HV	Single Channel Voltage/Current Clamp with High Voltage Option

DM MC6, EP MC6, DM660 and DM6 Input Manifolds and Dummy Membranes

W4 69-0950 DM MC6 Single Chamber
Input Module and Dummy Membrane



The VCC MC family of instruments utilizes standard 2 mm pintip jacks for connection to the electrode leads. The **DM MC6** is a single channel input module that can be mounted close to individual Ussing chambers and is compatible with all of the VCC MC series of voltage/current clamps. It connects to modular plugs on the rear of the VCC MC instruments via shielded cable. The DM MC6 contains an integral dummy membrane, see below, that is activated by a slide switch on the module. One DM MC6 is required for each clamp channel/Ussing chamber and is compatible with both EasyMount and Harvard/Navicyte chamber systems.

The **EP MC6** is 6-channel (24 pintip jacks) electrode input manifold is designed specifically for use with the Harvard/Navicyte vertical diffusion chamber system. The EP MC6 mounts directly behind the heat block and in the front of the air valve manifold to provide clean, organized connection to the electrode leads (W4 69-0998 not included). Connection between the EP MC6 and VCC MC6 is by means of a flat cable assembly (included).

Dummy membranes are useful both for quickly verifying the operating status of the instrument during an experiment and as a learning aid for students.

The **DM660** is a single channel dummy membrane for use with the VCC600. A similar dummy membrane is built into the DM MC6 input module for the multi-channel clamps.

Finally, the **DM6** is a 6-channel dummy membrane for VCC MC6 in which each dummy membrane may be individually manipulated. The DM6 connects to the VCC MC6 by way of the EP MC6 flat cable assembly.

W4 69-0932 DM660
Single Channel Dummy



W4 69-0952
DM6 Six Channel Dummy

Order #	Model	Product
W4 69-0950	DM MC6	Single Channel Electrode Input Module and Dummy Membrane
W4 69-0951	EP MC6	Electrode Input Panel for VCC MC6 Vertical Diffusion
W4 69-0932	DM660	Single Channel Dummy Membrane
W4 69-0952	DM6	6-Channel Dummy Membrane for VCC MC6

Computer Controlled Multi-Clamp with Software Data Acquisition and Analysis System with integrated amplifiers

Acquire data, analyze data, and control up to 8 amplifiers from a single integrated software/hardware package!

The system provides individual data acquisition and control for 2, 4 or 6 chambers and is fully compatible with the NaviCyte horizontal/vertical Ussing chamber systems. Windows 95/98/2000/XP compatible.



Figure 1

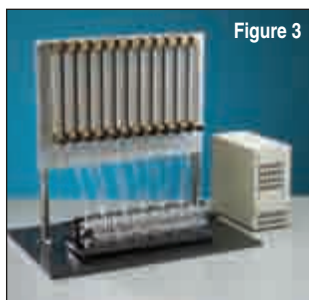


Figure 3

**W4 69-0300, W4 69-0301 or
W4 69-0302 2-, 4- or 6- Channel
Microcomputer Current/Voltage
Clamp System**

- Individual voltage clamp, current clamp or open circuit control for each chamber
- Overlay of uni/bipolar current pulses with variable parameters for dynamic definition of Gt/Rt
- I/V and V/I curves with freely adjustable parameters
- Minimum pulse duration 200 ms, max. amplitude $\pm 250 \mu\text{A}$ for dynamic definition of Gt/Rt
- Alphanumeric display of measured parameters
- Ability to input marker and comments and save with data file
- Printout of parameters in variable timetable
- Data format compatible to Excel
- Continuous graphics display
- Experimental time up to 8 hours

The Computer Controlled Multi-Clamp with Software is a combined voltage/current clamp and data acquisition system in one compact microcomputer controlled unit. The amplifiers are entirely controlled by the associated acquisition and analysis software running on a Windows PC computer. This makes for a clean, elegant, and simple to operate system. In its full configuration the multi-clamp can be used to control and collect electrophysiological data from up to six NaviCyte horizontal or vertical diffusion chambers.

The system provides independent chamber control in three different modes: voltage clamp, current clamp, and open circuit. A change between these modes is possible during the experiment at each time point.

The Multi-Clamp is available in 2-, 4- or 6-channel configurations and is fully compatible with both NaviCyte Ussing chamber systems. The clamp provides a separate A/D converter and isolated current source for each chamber, and current and voltage electrodes from each half-cell are connected to the Multi-Clamp via an electrode manifold. Data exchange between the PC and the Multi-Clamp is via standard COM ports, and depending on the number of ports available, a single PC can handle several clamps.

An interesting option consists of the incorporation of a gas delivery system into a NaviCyte/Multi-Clamp system. This gas delivery system consists of 12 precision gas flow meters mounted to a stabilizing base and connect to a 6-channel NaviCyte vertical or horizontal chamber systems. The 600 x 400 mm stabilizing base also houses an electrode manifold for connecting each Ag/AgCl electrodes to their respective half-cells.

Software

The Multi-Clamp system comes complete with an easy to use Windows 95/98/2000/XP based control and data acquisition software package that allows for the individual control and monitoring of each chamber.

Some features of the software include:

- Automatic compensation of fluid resistance and electrode potential during the experiment

Specifications

Channels	2, 4 or 6
A/D Subsystem for Analog Data Acquisition	13 Bit
Current Source by D/A	12 Bit, isolated
Serial Connection to PC	COM1 / COM2 for bi-directional data transfer
Case Dimensions	24.5 x 11.4 x 19.7 cm (9.6 x 4.5 x 7.8 in)
Power	100/230 VAC, 50/60 Hz
System Parameters	
Input Resistance	$> 10^9 \Omega$ differential
Input Current	$< 100 \mu\text{A}$
Input Voltage	$\pm 400 \text{ mV}$, 0.1 mV step
Current Output	$\pm 2000 \mu\text{A}$, 1 μA step
Product of Current and External Resistance Max	13 V

Order # Product

W4 69-0300	2-Channel Voltage/Current Clamp System with Software
W4 69-0301	4-Channel Voltage/Current Clamp System with Software
W4 69-0302	6-Channel Voltage/Current Clamp System with Software

Perfusion and Electrical Accessories

W4 69-0303	12-Channel Precision Flowmeter and Electrode Manifold
W4 66-0025	6-Channel Electrical Manifold for NaviCyte Chamber Systems

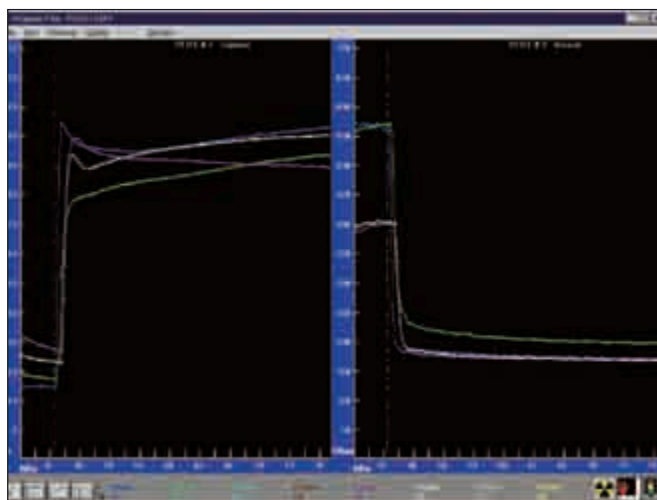
ussing/diffusion

Data Acquisition & Analysis System

Acquire & Analyze

Acquisition and analysis system to accompany our epithelial voltage clamps

Acquire & Analyze is a comprehensive data acquisition and analysis package designed specifically for recording transepithelial electrophysiological data from epithelia mounted in Ussing chambers. The system consists of a data acquisition hardware and software to record current, voltage and conductance/resistance from up to 8 tissues as well as analysis software that enables one to quickly extract selected data and output it to summary spreadsheets.



Unlike general-purpose data acquisition packages, Acquire & Analyze is written specifically for the study of epithelial tissues.

For example, say you want to measure the dose/response curve of an agent on the I_{sc} and G_t by progressive additions in eight tissue samples. To do this you monitor the I_{sc} and G_t on the computer until stable basal readings are attained. You then place an event mark in the file and make the first addition to all 8 tissues. When the current reaches a new stable level (or a specified time has passed) you place another event mark and make the second addition. This process is repeated until all additions have been made.

To summarize the effect of the additions, use Analyze to graph the data for all 8 tissues. Begin by displaying the movable data bar and positioning it over the basal currents just to the left of the first event mark. Right-click the mouse to save the mean values of current, conductance and voltage to a spreadsheet. Simply repeat the mouse movements and clicks to obtain the data for each subsequent addition. The spreadsheet thus created can be saved and imported directly into Excel for further analysis.

Data Acquisition and Analysis Capabilities

Acquire & Analyze runs under Windows and includes a data acquisition card, input/output cables, and software. The system can measure currents and voltages from up to 8 voltage-current clamp channels.

- Activate/deactivate acquisition on individual clamp units
- Setup and toggle between fast and slow acquisition speeds to capture transient events; speeds can be set by user and can be changed at any time during experiment
- Place time marks into file to indicate when experimental manipulations (e.g., drug additions) have been made; marks can be predefined and selected from menu or be entered from keyboard
- Graphically display current, voltage, conductance, resistance, calculated open circuit voltage and calculated I_{sc} during data acquisition in multiple formats
- Graphical/digital readout of current, voltage or conductance vs. time
- Plot raw or area corrected data
- User definable x, y scaling; zoom all, in, out, or previous; pan left, right, up or down
- Extract data under movable, adjustable width time bar in file format compatible with spreadsheet files.
- Extracted data may be individual points or mean values.
- Extracted data may be imported into commercial graphics packages to produce publication quality graphs.
- Linear regression analysis of conductance vs. current can be performed on data within time bar to estimate pericellular pathway conductance.

Order #	Model	Product
W4 69-3145	—	Acquire & Analyze Data Acquisition and Analysis Software
W4 69-0954	MOD 08/A	Interface Module for VCC 600, VCC MC2, EC-800 and EC-825A amps
W4 64-1705	DB9EC800	Interface Cable for EC-800
W4 64-1706	DB15EC825A	Interface Cable for EC-825A

Data Acquisition & Analysis System

HAI-118

The HAI-118 is a fast, high-resolution data acquisition system suitable for most data recording needs in the research laboratory, including studies of epithelial tissue. The system consists of data acquisition hardware and a programmable software package used to record current, voltage, and conductance/resistance from 4 to 6 tissues.



The HAI-118 includes hardware from iWorx and the popular LabScribe® software package. This system offers 8 analog input channels, 8 digital outputs, 4 digital inputs and 2 DACs. The hardware connects to PC compatible computers via USB, so setup is plug-and-play easy.

DACs

The HAI-118 offers two $\pm 0V$ DACs. Each DAC is independently programmable and can be synchronized with one another. Basic stimulus parameters for each DAC, such as pulse width, frequency, and amplitude can be changed on the fly using handy controls located in the LabScribe software tool bar. Standard protocols include pulse, train, and step waveform. Each standard protocol allows the quiescent state to be a holding voltage thereby making it ideal for voltage clamping applications.

Resolution

A 16 bit A/D converter is used to sample data over the full input range. Typical noise on any input is less than 1 mV. This allows the recording of signals from 10 mV to 10 V without the need for additional external gain.

Digital Input/Output

Eight digital output lines are available and the digital output connectors are industry standard BNC, eliminating the need for custom cables. Programming output lines is point-and-click and no complicated scripting language is required. Four digital input lines are also provided. One digital input line can be configured as an external trigger.

Speed

The HAI-118 can collect 16 bit samples at 10kHz bandwidth on a single or up to eight channels simultaneously.

USB Connection

Connection to the computer is accomplished over the popular USB port. This eliminates the need to install special interface cards and makes the HAI 118 compatible with notebook computers. The HAI 118 has a small footprint and in combination with a notebook requires very little bench space.

Software Included

Powerful LabScribe® software is included with each HAI 118. LabScribe is provided with a site license at no additional charge and upgrades are free forever. The program will actually upgrade itself on any Internet connected machine.

Data Acquisition & Analysis System

HAI-118 (continued)

Supported Applications

Epithelial Studies - Output from Warner's EC-800 and EC-825A, as well the VCC Series epithelial voltage clamps can be fed directly into the HAI-118. The voltage clamp protocol in the LabScribe program's stimulator section makes recording of data of four to six epithelial channels possible.

Oocyte Studies - LabScribe's gain telegraph feature automatically calibrates the software to Warner's Oocyte Clamp so that the main display reads in current and voltage. The on-board stimulator includes a flexible voltage clamp protocol so an external stimulator is not required. Finally, the digital output capability of the HAI-118 also adds the ability to automate your oocyte rig. Organ and Tissue Bath Studies - LabScribe's smooth data recording interface and available 8 channels area perfect fit for tissue and organ bath studies. Real-time displays of force in grams as well as real-time annotations are ideal for these types of studies. In addition, the on board stimulator and digital outputs make automation of tasks like filling and draining baths or delivering drugs very straightforward. An available 8 channel high voltage field stimulator is directly controlled by the HAI-118 and LabScribe software.

Electrophysiology Studies - The high speed nature of the HAI-118 make it perfect for studies involving blood pressure and sympathetic nerve activity as well as all types of cardiac electrophysiology, even in rapid heartrate animals such as mice where extra speed is required.

LabScribe Data Acquisition Software The cornerstone of the HAI-118 data acquisition system is the LabScribe software. A single program, LabScribe detects what hardware it is connected to and self-configures. LabScribe is, by far, the easiest to use data recording and analysis solution available. It strikes the ideal balance between flexibility and simplicity. Just push the "Start" button, then use the AutoScale feature to center and expand your data; and you're recording! The 'click and play' approach of the software extends to a useful assortment of analyses, such as rate, integral, and conversion to real units. And, of course, built-in online help is always available.

LabScribe Software Features:

Simplified User Interface

- Only two mouse-clicks are required to record most data
- Only one mouse-click is required for most online functions
- Use of screen-time makes time calculations quick and simple

AutoScale

- Automatically ensures the optimal scaling of displayed data
- A simple click centers and expands the data in the display window to fill the available space
- You can toggle between Best View and a preset viewing range or you can zoom the time base or y axis scaling with a single click

Fast Scrolling

- LabScribe's display can smoothly scroll data at any speed
- Useful when high resolution data is compressed on the time axis to create a data overview.

Real Units

- LabScribe software allows you to calibrate the displayed data in any units that you choose
- Reading your data in mm Hg or grams or A takes the guesswork out of analysis

Real-time Annotation

- Keyboard input from the user may be time locked to the data to indicate drug delivery or stimulus points
- You can search and "Go To Annotations" anywhere in the data

Real-time Functions

- LabScribe currently supports 17 functions that are calculated and displayed in real-time, each is called from a single click in the Main window
- These include Periodic (rate, freq., period, max, min, mean), dV/dt, integral, Channel Math, Cardiac, EEG and Spirometry
- Functions can be applied to raw data in real-time or they can be called after the data has been recorded

Volt Meter Panel

- LabScribe can display a voltmeter status panel
- Values recorded on each channel are displayed in large type, easily visible from across the room
- Display DAC output on any channel
- Ability to revert back to Raw Data at any time
- LabScribe reports can

Journal

- LabScribe reports can be prepared and edited, all within the program's own Journal.
- No need to export to word processor or spreadsheet programs.
- The onboard journal also serves as a collecting place for the various measurements made in the Analysis window.
- The journal saves automatically with the file in .rtf format, which can be opened by any word processor.

Offline Functions

- Twenty-six offline calculations are also supported. These operate on a selection of data and return a value. While more are being added all the time, the current list includes area under the curve, max-min, slope at a point, slope of the line of best fit and the mean.

XY Plot

- In the Analysis window you can choose to overlay selected portions of your data or you can plot different channels against one another in an XY style plot.
- In XY mode, the available measurement functions adjust to the xy mode.

Data Acquisition & Analysis System

HAI-118 (continued)

LabScribe Software Features: (continued)

Export

- Recorded data may be exported in text (.txt), pictures (.png) or MatLab (.mat) format.
- This is ideal for post analysis in programs like Excel or MatLab and export picture formats make reports or poster presentations easy to create.
- Of course, you can always print data from any window in the program.

The Stimulator

- LabScribe has full support for the analog outputs on HAI hardware.
- The user can specify simple pulses or complex protocols involving trains and stepped voltage patterns.
- When used with HAI 118 hardware, LabScribe supports two simultaneous outputs.

Digital I/O

- When used with the HAI 118 the LabScribe software allows the user to configure eight digital inputs or outputs.
- Digital inputs can show frequency, period, duty cycle, time on or raw data
- Digital outputs can be assembled into control protocols for external devices

Settings

- Settings or templates for various experiments are stored in the program's settings menu
- This makes changing program settings to accommodate different experiments point-and-click easy

Broadcast

- A version (LS/16MC) of LabScribe is available that transmits recorded data in real-time over your local area network!
- Ideal for teaching or student labs where everyone can not get data first hand, this feature allows the network to share what the broadcast version sees

Gain Telegraph

- LabScribe will automatically calibrate and display the out put of Warner Instrument Voltage/Patch Clamp amplifiers
- This feature takes into account the changes in gain that may be applied from the voltage clamp

Software license allows copying on all departmental and student computers.

Specifications

Input:	
Number of Analog Inputs	8 single ended BNC
Input Impedance	1 MΩ
Input Range	±10 V
Noise	1 mV typical
Gain Telegraph	Software or hardware 8 bit
A/D Converter:	
Sample Speed	1 sample/sec - 100k sample/sec
Resolution	16 bit
Interface	USB
Trigger or Digital Input Lines	4, TTL
Output:	
Digital Output Lines	8 TTL
Digital Output Connector	BNC
DAC Performance:	
Number of DACs	2
DAC Resolution	12 bit
DAC Speed	100k sample/sec, Independent of sample speed
DAC Output Range	±10V
DAC Modes	Pulse, Train, Step, DC, Custom
Pulse Width	0.01 ms to 6500 ms (pulse mode)
Frequency	0.2 Hz to 50kHz (pulse Mode)
Trigger Modes	
	External Trigger, Data Threshold Trigger, User Trigger
Display	
	Real time user definable screen independent of sample rate. User definable scale units: Auto Scale, Full Scale or User Scale
Enclosure	
	Aluminum
Power	
	120/220 VAC, 60/50 HZ, CE compliant

Order #	Model	Product
W4 69-3130	IX118	Data acquisition system with hardware and Labscribe® software

vibration isolation

2200 Series

BenchMate Vibration-Free Platforms



- Unmatched price / performance
- Low profile Manual-Air or Automatic-Air designs
- VibraDamped construction
- Low natural frequency
- Excellent horizontal isolation
- SPILLPRUF spill management
- Class 10 Cleanroom Compatible - Class 10 available

These 2200 Series BenchMate Vibration-Free Platforms enhance the performance of precision tabletop equipment.

The 2210 Series is a Manual-Air design using an included hand pump (good for situations where an air source is not available). It requires periodic manual leveling.

The 2212 Series is an Automatic-Air design that requires an external air source for use (not included). It is a self-leveling unit and is recommended for regular use.

These tables are not compatible with the Planar Lipid Bilayer workstation.

Applications (Partial List)

- Atomic Force Microscopes
- Microhardness Testers
- Profimeters
- Balances
- Audio Equipment
- Precision Measuring and Testing Equipment

Specifications

Min. Load @ 20 psi

Vertical Natural Frequency:	2.3 Hz
Isolation Efficiency @ 5 Hz	52%
Isolation Efficiency @ 10 Hz	83%
Horizontal Natural Frequency:	2.9 Hz
Isolation Efficiency @ 5 Hz	40%
Isolation Efficiency @ 10 Hz	92%

Max. Load @ 80 psi

Vertical Natural Frequency:	2.1 Hz
Isolation Efficiency @ 5 Hz	70%
Isolation Efficiency @ 10 Hz	91%
Horizontal Natural Frequency:	1.8 Hz
Isolation Efficiency @ 5 Hz	81%
Isolation Efficiency @ 10 Hz	95%

Gross Load Capacity @ 80 psi:

W4 72-4728 to W4 72-4733	90.8 kg (200 lbs)
All Others	204 kg (450 lbs)

Finish	Ferromagnetic stainless steel, Ferromagnetic stainless steel with ¼-20 x 1" centers or Ferromagnetic stainless steel with M6 x 25mm on center
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Catalog No.	Depth x Width	Max. Capacity	Air Movement	Platform Top
W4 72-4755	16 x 19 in	up to 200 lbs	Manual Air	Ferromagnetic SS
W4 72-4756	16 x 19 in	up to 200 lbs	Automatic Air	Ferromagnetic SS
W4 64-0081	16 x 19 in	up to 200 lbs	Manual Air	Custom table for Bilayer Workstation, includes hand pump
W4 64-0082	16 x 19 in	up to 200 lbs	Automatic Air	Custom table for Bilayer Workstation
W4 72-4728	20 x 24 in	up to 200 lbs	Manual Air	Ferromagnetic SS
W4 72-4729	20 x 24 in	up to 200 lbs	Manual Air	Ferromagnetic SS SPILLPRUF with ¼-20 x 1" centers
W4 72-4730	20 x 24 in	up to 200 lbs	Manual Air	Ferromagnetic SS SPILLPRUF with M6 x 25mm centers
W4 72-4731	20 x 24 in	up to 200 lbs	Automatic Air	Ferromagnetic SS
W4 72-4732	20 x 24 in	up to 200 lbs	Automatic Air	Ferromagnetic SS SPILLPRUF with ¼-20 x 1" centers
W4 72-4733	20 x 24 in	up to 200 lbs	Automatic Air	Ferromagnetic SS SPILLPRUF with M6 x 25mm centers
W4 72-4734	24 x 30 in	up to 450 lbs	Automatic Air	Ferromagnetic SS
W4 72-4735	24 x 30 in	up to 450 lbs	Automatic Air	Ferromagnetic SS SPILLPRUF with ¼-20 x 1" centers
W4 72-4736	24 x 30 in	up to 450 lbs	Automatic Air	Ferromagnetic SS SPILLPRUF with M6 x 25mm center

5600 Series **vibration isolation**

Lightweight VIBRALITE Breadboards



- Nominal broadband damping
- High natural frequency
- Magnetic
- Thickness: 1 inch or 2 inch nominal
- 1/8 inch Ferromagnetic stainless steel top and bottom skin
- Extruded structural aluminum core
- Flatness: ± 0.004 inch over 24 x 24 inch
- SPILLPRUF mounting holes English 1/4-20 x 1 inch or Metric M6 x 25 mm grid

These economical 5600 Series VIBRALITE breadboards feature a lightweight construction with 1/8 inch ferromagnetic stainless steel top and bottom skins with an aluminum core to reduce weight. They are an excellent economical choice. VIBRALITE breadboards are thinner and smaller than full-size optical tables, these "mini-tables" are built with the same precision tooling and high quality materials. Furnished with SPILLPRUF tapped mounting holes.

Optional, Level-Lok™ tie-downs fasten your breadboard to another surface, enabling you to level your work surface and lock it down. They are available in packages of 4 or 5 tie-downs.

Order #	W x D	Top
W4 72-4741	18 x 24 in	English SPILLPRUF 1/4-20 x 1 in
W4 72-4742	18 x 24 in	Metric (45 x 60 cm) SPILLPRUF M6 x 25 mm
W4 72-4743	24 x 48 in	English SPILLPRUF 1/4-20 x 1 in
W4 72-4744	24 x 48 in	Metric (45 x 120 cm) SPILLPRUF M6 x 25 mm
W4 72-4745	24 x 24 in.	English SPILLPRUF 1/4-20 x 1 in
W4 72-4746	24 x 24 in	Metric (60 x 60 cm) SPILLPRUF M6 x 25 mm
W4 72-4747	24 x 36 in	English SPILLPRUF 1/4-20 x 1 in
W4 72-4748	24 x 36 in	Metric (60 x 90 cm) SPILLPRUF M6 x 25 mm
W4 72-4749	24 x 48 in	English SPILLPRUF 1/4-20 x 1 in
W4 72-4750	24 x 48 in	Metric (60 x 120 cm) SPILLPRUF M6 x 25 mm
W4 72-4751	36 x 48 in	English SPILLPRUF 1/4-20 x 1 in
W4 72-4752	36 x 48 in	Metric (90 x 120 cm) SPILLPRUF M6 x 25 mm

Accessories

W4 72-4753	Level-Lok Tie-downs, qty. of 4
W4 72-4754	Level-Lok Tie-downs, qty. of 5

9100 Series

LabMate VIBRAPLANE Workstations

vibration isolation

The 9100 Series VIBRAPLANE Workstations are available for two load capacities, and is field convertible to the desired capacity. Faraday Cages are offered as accessories.



- Vertical vibration isolation
- Horizontal vibration isolation
- VibraDamped steel frame
- High performance automatic-air suspension
- Maintains a preset zero deflection level (regardless of load addition or removal)
- Choice of tabletops
- Choose from 12 sizes
- Ergonomic styling
- Class 10 Cleanroom Compatible - Class 10 available

Applications (Partial List)

- Analytical Balances
- Cell Injection
- Confocal Microscopes
- Patch Clamping
- Optical Microscopes
- Wafer Probing
- Mask Aligning
- Atomic Force Microscopes

**Guard rails and side rails must be purchased separately.
Supplied in packages of 2.
Warranty 1 year.*

Specifications

Minimum Load @ 20 psi

Vertical Natural Frequency:	1.9 Hz
Isolation Efficiency @ 5 Hz	70%
Isolation Efficiency @ 10 Hz	90%
Horizontal Natural Frequency:	2.2 Hz
Isolation Efficiency @ 5 Hz	64%
Isolation Efficiency @ 10 Hz	90%

Max. Load @ 80 psi

Vertical Natural Frequency:	1.5 Hz
Isolation Efficiency @ 5 Hz	85%
Isolation Efficiency @ 10 Hz	97%
Horizontal Natural Frequency:	1.2 Hz
Isolation Efficiency @ 5 Hz	91%
Isolation Efficiency @ 10 Hz	97%

Gross Load Capacity @ 80 psi:

9101	363 kg (800 lbs)
9102	590 kg (1300 lbs)

Finish:

Standard	Linear White Polyurethane
Class 10	White Epoxy Powder Coat

Note: Typical performance efficiencies are for microdisturbances

Labmate vibraplane workstations do not include any accessories; all must be purchased separately.

- Sliding shelf
- Padded Arm Rests
- Castors
- Guard Rails
- Side Rails
- Power Outlet Strip

LMVW Require a fork lift for transport when delivered, Aprox. 500 lbs.

Guard and side rails ship together (wooden pkg), Aprox 45 lbs (43 x 15 x 8 in)

9100 Series **vibration isolation**

LabMate VIBRAPLANE Workstations (continued)

Order #	Load Capacity	Depth x Width	Tabletop
W4 72-4701	648 lbs	30 x 36 in	2" White Composite w/White Plastic Laminate
W4 72-4702	648 lbs	30 x 36 in	2" White Composite w/Stainless Steel Laminate
W4 72-4703	627 lbs	30 x 36 in	4" SPILLPRUF Honeycomb ¼-20 x1 in. centers
W4 72-4704	627 lbs	30 x 36 in	4" SPILLPRUF Honeycomb M6 x 25 mm centers
W4 72-4706	598 lbs	30 x 48 in	2" White Composite w/White Plastic Laminate
W4 72-4707	598 lbs	30 x 48 in	2" White Composite w/Stainless Steel Laminate
W4 72-4708	569 lbs	30 x 48 in	4" SPILLPRUF Honeycomb ¼-20 x1 in. centers
W4 72-4709	569 lbs	30 x 48 in	4" SPILLPRUF Honeycomb M6 x 25 mm centers
W4 72-4711	548 lbs	30 x 60 in	2" White Composite w/White Plastic Laminate
W4 72-4712	548 lbs	30 x 60 in	2" White Composite w/Stainless Steel Laminate
W4 72-4713	512 lbs	30 x 60 in	4" SPILLPRUF Honeycomb ¼-20 x 1 in. centers
W4 72-4714	512 lbs	30 x 60 in	4" SPILLPRUF Honeycomb M6 x 25 mm centers
W4 72-4716	679 lbs	24 x 36 in	2" White Composite w/White Plastic Laminate
W4 72-4717	679 lbs	24 x 36 in	2" White Composite w/Stainless Steel Laminate
W4 72-4719	558 lbs	36 x 48 in	2" White Composite w/White Plastic Laminate
W4 72-4720	558 lbs	36 x 48 in	2" White Composite w/Stainless Steel Laminate
W4 72-4721	523 lbs	36 x 48 in	4" SPILLPRUF Honeycomb ¼-20 x 1 in. centers
W4 72-4722	523 lbs	36 x 48 in	4" SPILLPRUF Honeycomb M6 x 25 mm centers
W4 72-4724	562 lbs	36 x 60 in	2" White Composite w/White Plastic Laminate
W4 72-4725	562 lbs	36 x 60 in	2" White Composite w/Stainless Steel Laminate
W4 72-4726	954 lbs	36 x 60 in	4" SPILLPRUF Honeycomb ¼-20 x 1 in. centers
W4 72-4727	954 lbs	36 x 60 in	4" SPILLPRUF Honeycomb M6 x 25 mm centers

Order #	Model	Product
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Accessories

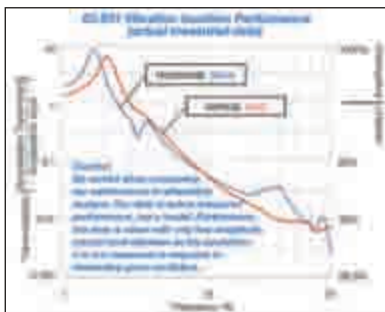
W4 64-1458	RC-4	Retractable Casters, set of 4
W4 64-1459-36	GR-36	Guard Rails, 36 inch length, front and rear
W4 64-1459-48	GR-48	Guard Rails, 48 inch length, front and rear
W4 64-1459-60	GR-60	Guard Rails, 60 inch length, front and rear
W4 64-1459-72	GR-72	Guard Rails, 72 inch length, front and rear
W4 64-1460	PA2	Padded Arm Rests, pkg. of two
W4 64-1461-10	SS-10	Sliding Shelf, 10 inch width, 31 inch length
W4 64-1461-12	SS-12	Sliding Shelf, 12 inch width, 31 inch length
W4 64-1461-14	SS-14	Sliding Shelf, 14 inch width, 31 inch length
W4 64-1462	PAC	Portable Air Compressor
W4 64-1463	EOS	Electrical Outlet Strip
W4 64-1607	SDR	Side Rails
W4 72-4737		24 x 36 in Kinetic Systems Faraday Cage*, Height 48 in
W4 72-4738		30 x 36 in Kinetic Systems Faraday Cage*, Height 48 in
W4 72-4739		30 x 48 in Kinetic Systems Faraday Cage*, Height 48 in
W4 72-7733		30 x 60 in Kinetic Systems Faraday Cage*, Height 48 in
W4 72-4740		36 x 48 in Kinetic Systems Faraday Cage*, Height 48 in
W4 72-7734		36 x 60 in Kinetic Systems Faraday Cage*, Height 48 in
W4 72-6021		36 in Side Rails for Kinetic Systems Faraday Cage
W4 72-6023		24 in Side Rails for Kinetic Systems Faraday Cage

*Requires Side and Guard Rails

vibration isolation

63-500 Series High-Performance Lab Tables

- Vertical and horizontal isolation
- Gimbal piston™ isolators
- Aluminum height control valves
- Internal piston travel restraint
- Rugged built-in leveling feet
- Choice of tabletops



The 63-500 Series High-Performance Lab Table provides an excellent vibration-free working surface for loads up to 350 lb (160 kg). Now with modular construction, these tables are recommended for use in such diverse applications as electrophysiology, cell injection, ultramicrotomy, photomicroscopy, scanning tunnel microscopy, and confocal laser scanning microscopy.

Table Tops

Stainless Steel Laminate

Recommended for applications that require a strong magnetic attachment and will not involve repeated exposure of the top to corrosive liquids. This top does not have the precision flatness of our CleanTop II honeycomb top. Flatness is 0.030 in. (0.8 mm).

Plastic Laminate on Stainless Steel

An easy-to-clean alternative to stainless steel without sacrificing structural performance. A plastic laminate is added to the top surface, which reduces ferromagnetic attachment strength.

CleanTop II

Features a spill-proof, drilled and tapped mounting hole array. Tops are 4 in. (100 mm) thick and have 1/4–20 holes on 1 in. spacing or M6 holes on 25 mm spacing. The small cell-size steel honeycomb design provides stiffer damping than the stainless steel laminate. Guaranteed flat to 0.005 in. (0.13 mm).

Accessories

Front and Rear Support Bars

These adjustable steel rails mount on the table's front and rear legs. They may be cantilevered and have slots in which shelves can be mounted. A front support bar is required for use with 60-4555 armrest pads. A front and rear support bar is required for use with sliding shelves. Support bars cannot be used in conjunction with the Faraday cage.

Armrest Pads

Available for both Faraday cage and non-Faraday cage applications. Adjustable leather forearm rests fasten to the Front



Support Bar or Perimeter Enclosure and can slide from side to side for added comfort. Sold in sets of two pads.

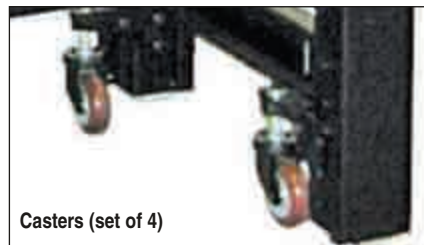


Sliding Shelves for Non-Faraday Cage Applications

Sliding shelves are made of wood with white plastic laminate covering all sides. Available in 6, 10, 14 and 20" widths. A metal bracket on the front edge of the shelf fits into the slot in the front support bar. Shelves slide freely from side to side and are easily lifted from the support bars. Built-in stops prevent shelves from sliding out of slots.

Casters

A set of four retractable casters with a total weight capacity of 1,000 lb (450 kg) can be mounted to the base of the table legs. Fits all tables.



Casters (set of 4)

Fixed Full-Perimeter Enclosures

A fixed, welded-steel structure that completely surrounds the table top to provide non-isolated support for the Faraday Cage and the sliding side shelf. Only accepts 8" wide Sliding Side Shelf.

Type II Faraday Cage

The Type II Faraday Cage offers improved access and simplified assembly. The "window-shade" type retracting front panel is easy to operate and causes reduced disturbance when adjusted. The front panel may be positioned anywhere between fully opened and fully closed, and stays in position without a fastener. The Type II Faraday cage requires the full-perimeter enclosure to mount to the 63-500 Series table.



Type II Faraday Cage

Sliding Shelf for Faraday Cage Applications

An 8" wide shelf that slides freely from side to side within the Faraday cage enclosure.

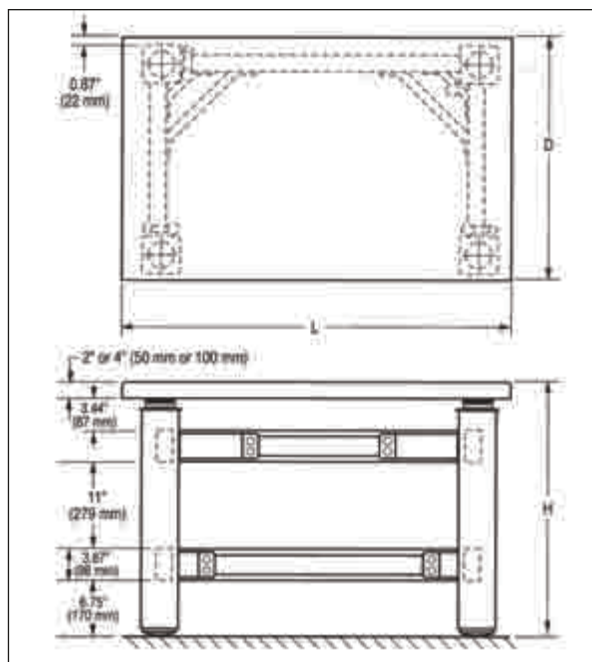
vibration isolation

63-500 Series

High-Performance Lab Tables

Specifications

Vertical natural frequency:		
High Input		1.2 Hz
Low Input		1.5-2.0 Hz
Isolation efficiency @ 5Hz		70-85%
Isolation efficiency @ 10Hz		90-97%
Horizontal natural frequency:		
High Input		1.0 Hz
Low Input		1.2-1.7 Hz
Isolation efficiency @ 5Hz		75-90%
Isolation efficiency @ 10Hz		90-97%
Gross load capacity	1400 lb (640 kg)	
Net load capacity	350 lb (160 kg)	
Finish	Black powder coat frame Stainless steel top	
Facilities required	80 PSI	



Tables

Description	25" x 36"	30" x 30"	30" x 36"	30" x 48"	36" x 48"
Stainless steel top	W4 60-4750	W4 60-4751	W4 60-4752	W4 60-4753	W4 60-4754
Plastic laminate top	W4 60-4755	W4 60-4756	W4 60-4757	W4 60-4758	W4 60-4759
Cleantop II, 1/4-20 thread	---	---	---	W4 60-4760	W4 60-4761
Cleantop II, M6 thread	---	---	---	W4 60-4763	W4 60-4764

Accessories for Non-Faraday Cage Applications

Description	25" x 36"	30" x 30"	30" x 36"	30" x 48"	36" x 48"
Front support bar	W4 60-4536	W4 60-4535	W4 60-4536	W4 60-4537	W4 60-4537
Rear support bar	W4 60-4540	W4 60-4539	W4 60-4540	W4 60-4541	W4 60-4541
Armrest pads (set of 2)	W4 60-4567	W4 60-4567	W4 60-4567	W4 60-4567	W4 60-4567
Sliding shelf, 6" wide	W4 60-4543	W4 60-4547	W4 60-4547	W4 60-4547	W4 60-4551
Sliding shelf, 10" wide	W4 60-4544	W4 60-4548	W4 60-4548	W4 60-4548	W4 60-4552
Sliding shelf, 14" wide	W4 60-4545	W4 60-4549	W4 60-4549	W4 60-4549	W4 60-4553
Sliding shelf, 20" wide	W4 60-4546	W4 60-4550	W4 60-4550	W4 60-4550	W4 60-4554
Casters (set of 4)	W4 60-4798	W4 60-4798	W4 60-4798	W4 60-4798	W4 60-4798

Accessories for Faraday Cage Applications

Description	30" x 36"	30" x 48"	36" x 48"
Faraday Cage	W4 60-4799	W4 60-4800	W4 60-4801
Perimeter enclosure for stainless steel and laminated tops (required for cage)	W4 60-4804	W4 60-4806	W4 60-4808
Perimeter enclosure for Cleantop tops (required for cage)	W4 60-4805	W4 60-4807	W4 60-4809
Armrest pads (set of 2)	W4 60-4568	W4 60-4568	W4 60-4568
Hanging shelf	W4 60-4571	W4 60-4572	W4 60-4572
Sliding side shelf, 8" wide	W4 60-4811	W4 60-4811	W4 60-4815
Casters (set of 4)	W4 60-4798	W4 60-4798	W4 60-4798

SIU-102

Stimulus Isolation Unit – Bipolar High Current

Designed for use with Warner's imaging chambers and dish inserts with field stimulation electrodes



- Constant current and constant voltage modes
- Bipolar, pulse and DC modes
- Optical coupling is used to isolate the stimulator from pulse source
- Current up to 100 mA, voltage up to 100 V
- **For imaging applications only**

Designed for use with Warner imaging chambers having field stimulation electrodes, the SIU-102 features optical isolation at the input and transformer isolation at the output. Timing pulses can be controlled by any device capable of generating a TTL level positive pulse – a computer with data acquisition, for example.

Positive or negative pulses, positive or negative DC, and bipolar pulses are possible in constant current or constant voltage delivery modes. For bipolar delivery, a positive pulse during the input pulse is followed immediately by a negative pulse of equal duration and amplitude. Bipolar pulse widths from 100 μ s to 100 seconds per each polarity are possible.

Output amplitude is set using a range mode switch in conjunction with a ten-turn potentiometer to set a percentage of the selected range.

Indicator lights keep the user apprised of the following:

High voltage:	Lights red when output voltage above 30 volts
Compliance:	Lights when impedance across output is too high for current setting
T>100 Sec:	Lights when pulse width input is longer than 100 seconds in Bipolar mode
Ext. Trigger:	Lights when a valid input is applied to the Pulse In BNC

Specifications

Output Waveform	DC, Current Pulse or Voltage Pulse
Output Current Ranges	1, 10, and 100 mA
Output Voltage Ranges	10 and 100 V
Output Impedance	10 V Range: 1 k Ω
Voltage Mode	100 V Range: 10 k Ω
Output Compliance	100 V
Output Polarity	Selected by Mode Switch Red connector is positive in any positive mode; Red connector is negative in any negative mode
Amplitude Control	Multi-turn dial
Input Pulse Requirements	TTL level, positive pulse 3 V, 1 mA minimum Minimum
Pulse Width	100 μ s Maximum Pulse Width: 100 s (Bipolar Mode Only)
Input Connector	BNC
Output Connector	Banana Jacks
Power Requirements	90 to 270 VAC, 50/60 Hz, 10 VA
Physical Size, H x W x D	8.9 x 20 x 25.4 cm
Shipping Weight	3 kg
Warranty	Two years, parts and labor

Order #	Model	Product
W4 64-1424	SIU-102	Stimulus Isolation Unit
W4 64-1425	CC-102	Cable, male banana to 1 mm jacks (for use with Warner field stimulation chambers)

DS4**Bipolar Isolated Stimulator***Compatible with electrophysiology recording*

- No interference with recordings
- No ground loops
- Bi-phasic constant current
- Gated operation allows multiple units
- Battery powered energy saver circuitry

The DS4 provides an isolated biphasic constant current stimulus in response to an external command voltage signal. Generally speaking, the command signal is a computer generated DAC signal via software.

The DS4 accepts a variety of voltage input ranges from $\pm 1V$ to $\pm 10V$ and produces a constant current output in 4 overlapping ranges from $\pm 10_{\mu}A$ to $\pm 10mA$. The compliance voltage is $\pm 48V$.

In addition, the DS4's GATE input allows multiple DS4's to be connected to a single analog voltage source, with each DS4 capable of being independently enabled.

One problem with stimulators that use an external voltage source to define the stimulus waveform is that small offsets or noisy baseline signals from the DAC's can result in battery drain or low amplitude stimulation. The DS4 uses a special "inactivity sensor" to monitor the input voltage and disable the output if this voltage falls within 0.2% of the full scale value for a user selectable time period. This "inactivity sensor" reduces battery usage and damaging "leak currents" during infrequent stimulation, while at the same time maintaining low zero crossing distortion for repetitive waveforms.

The DS4 uses an external power supply to power the input control circuitry and inexpensive batteries to provide an opto-isolated voltage source.

Specifications

Output	Biphasic constant current proportional to the input voltage	
Output Ranges	$\pm 10_{\mu}A$; $\pm 100_{\mu}A$; $\pm 1mA$; $\pm 10mA$ for a full scale input	
Output Duration	$>2_s$	
Compliance	$\pm 48V$ from 8x GP23A batteries	
Linearity	$\pm 3\%$ of full scale output for each output range	
Output Impedance	$>900M\Omega$	
Output Rise Time	$<5_s$ (1k Ω load), $<40_s$ (1M Ω load)	
Frequency Response	Expected DS4 output is maintained for frequencies up to 5kHz.	
Inputs		
IN Ranges	± 1 ; ± 2.5 ; ± 5 ; $\pm 10 V$ full scale (selected by an internal jumper) with a limit of $\pm 12V$ max without damage	
Input Impedance	1M Ω	
GATE	Range: TTL; Gate OFF if Low; Gate ON if High or open circuit. Limit of $\pm 15V$ max. Input Impedance: 10k Ω	
Inactivity Sensor	The output is disabled if the voltage input remains within $0\pm 0.2\%$ of the full scale value for a user selectable period of 100ms, 200ms, 1s or 2s. This time period can be adjusted with an internal jumper.	
Connections	Output - 2mm shrouded, touch-proof sockets (red and black) spaced at 0.75" Input - Front panel BNC socket Gate - Front panel BNC socket Battery Test - Six 2mm sockets Power - Socket for external power supply	
Controls:	Gate - On/Off toggle (off overrides BNC input) Output Range - 4 position rotary switch Power - On/Off toggle switch	
Indicators	Power ON - LED Green (lit when the power supply is connected and DS4 is switched On) Gate Enabled - LED Amber (lit when Gate is On and the Gate Input is held TTL high) Phase+ve - LED Amber (lit when input exceeds +0.2% of full scale voltage) Phase-ve - LED Amber (lit when input exceeds -0.2% of full scale voltage)	
Power	Included external power supply (input voltage 110V - 220V) providing $\pm 15V$ DC output 10 x 12V GP23A Batteries.	
Mounting	One or two stimulators may be mounted in a 19" rack using a specially fabricated frame (D121-11)	
Dimensions (w x h x d)	190 x 110 x 80 mm (7.5 x 4.3 x 3.1 in)	
Weight (approx.)	500g (1.1 lbs)	
Order #	Model	Product
W4 65-0364	DS4	Biphasic Stimulus Isolator

DS2A and DS3

Constant Voltage and Constant Current Isolated Stimulators

A bettery operated stimulator useful for electrophysiology experiments



Specifications

Maximum Output	99 V (High), 9 V (Low) selected by front panel switch; square wave pulse shape, typical rise
Voltage (DS2A)	Time < 1 μ sec fall time < 3 μ sec into resistive load
Output Ranges (DS3)	2 to 32 μ A, 20 to 320 μ A, 0.2 to 3.2 mA and 2 to 32 mA
Output Compliance (DS3)	90 V
Output Impedance (DS2A)	Dependent on position of amplitude control, 1.25 K max. at center position, 200 Ω at ends of travel
Pulse Width Controls*:	Two dials providing continuous adjustments over range 20 μ sec to 2 sec, as well as selection of input pulse width
1)	6-Position Switch for pulse widths 10 μ sec, 100 μ sec, 1 msec, 10 msec, 100 msec with \pm 10% accuracy or equal to input pulse width
2)	Multiplier continuously variable over range x2 to x20; pulse width is product of two dial settings
Trigger Isolation*	Optical coupling is employed between trigger source and stimulator circuitry; capacity coupling less than 3 pF
Single Shot*	Single shot push button provided
Batteries	Self contained batteries are used to provide isolated source of power; current is drawn only when delivering output pulse; max. current drain is 30 mA plus load current
Battery Type	11 x PP3 - (IEC-6R61) style 9V batteries
Dimensions:	
Panel Size	190 x 110 mm (7.5 x 4.3 in)
Depth	80 mm (3.15 in) over knobs
Weight	800 g (28.2 oz) with batteries installed

Order #	Model	Product
W4 65-0329	DS2A	Isolated Stimulator, Constant Voltage
W4 65-0550	DS3	Isolated Stimulator, Constant Current Output
W4 65-0337	D121-11	19 Inch Rack Mounting Frame, holds two DS2A/ DS3/DG2

*Note: Fulfilled by both DS2A and DS3.

- Minimal interference with recordings
- No ground loops
- DS2A: 100 V maximum at up to 50 mA
- DS3: 2 μ A - 32 mA from 90 Volts
- Battery powered energy saver circuitry

Many experiments in electrophysiology use a brief pulse of current as a stimulus to excite nerve or muscle fibers. It is desirable that the source of this E.M.F. should be isolated both from ground and from the timing generator used to release the stimulus. The DS2A and DS3 fulfill these requirements by using self contained batteries as the source of power and optical coupling is employed to isolate the stimulator from the trigger source. Precise timing of stimulus application can be controlled by a PC or other stimulus generating device such as the DG2 Trigger Generator. The duration of the stimulator output is adjustable over the range of 20 microseconds to two seconds by controls on the stimulators or can be the same as the applied trigger pulse.

Current is drawn from the batteries only and instruments have non-conductive enclosure. A single shot button is provided, which operates at all times irrespective of the trigger input.

DG2A**Train/Delay Generator**

Designed for control of normal repetitive stimulation as well as for defining the Effective Refractory Period using a second, delayed pulse



- Trigger timing generator
- Ideal for electrophysiology
- Perfect match for DS2A and DS3
- Internal battery

The DG2A is a compact, free-standing, battery powered instrument which can be used to generate trigger pulses required for repetitive stimulation. Also featuring DELAY controls, it is useful for determining nerve or axonal Effective Refractory Period (ERP) through the production of a delayed second pulse.

Various modes allow output pulses to be produced singularly (SINGLE), continuously (FREE-RUN & GATED) or in a burst (TRAIN), with the burst/train duration and pulse frequency determined by the front panel controls. In each of the modes (except FREE-RUN), outputs can be initiated either by the front panel push button, a TTL compatible trigger/gating pulse or a suitable foot switch.

The unit has control of train duration over three full decades, pulse repetition rate (or frequency) within that train over five decades and control of the delayed pulse over three decades. It has two BNC output sockets (i) the SYNC output produces a pulse to trigger recording devices or synchronize other equipment and (ii) the OUT output produces either a delayed version of the same or by toggle switch selection, pairs of delayed and non-delayed pulses (as would be necessary for ERP studies).

The unit is especially suitable for use with our DS2A Isolated Constant Voltage and DS3 Isolated Current Isolated Stimulators which have their own Pulse Duration controls.

The instrument is powered by an internal 9V battery (PP3 - 6R61 style) and replaces our DG2 Trigger Generator.

A mounting frame (part number W4 65-0337) is available so that two units of either DG2A, DS2A or DS3 can be mounted in 19" rack.

Specifications

The unit always produces a pulse to synchronize other equipment at SYNC and a pulse delayed from SYNC by DELAY controls.

Modes:

Modes:	Control Functions	Four position rotary switch
SINGLE	Input signal triggers a single Output pulse	
FREE-RUN	Continuous Output pulses as set by REPETITION controls	
GATED	Input signal enables unit to produce pulses as set by REPETITION controls	
TRAIN	Input signal Triggers unit to produce pulses as set by REPETITION controls for the time as set by the DURATION controls	

Specifications (continued)**Input:**

Connector	BNC socket
Levels	TTL high (>1.5 V), TTL low (<0.8 V)
Polarity	Active High (GATE/TRAIN) and Positive edge (SINGLE) or Active Low and Negative edge by Internal Jumper
Internal Jumper	Enable "Active Low" - allowing for an Input that is Low during its active phase
Push-button	Has same function as a valid input signal
Indicator	"TOO FAST" Red LED that flashes if a Trigger is received while the unit is busy

Duration:

Total range	10 msec - 12 sec in three overlapping ranges
Control	Single turn control marked 1 - 12 sec with intermediate integer panel marks
Accuracy	±1% at '1' and '12' marks, ±5% at intermediate marks
Multiplier	x0.01 ; x0.1 ; x1
Internal Jumper	Enable "x10" - giving a 100 msec - 120 sec total range

Repetition (Frequency):

Total Range	0.01 - 1200 Hz in five overlapping ranges
Control	Single turn control marked 1 - 12 Hz with intermediate integer panel marks
Accuracy	±1% at '1' and '12' marks, ±5% at intermediate marks
Multiplier	x0.01 ; x0.1 ; x1 ; x10 ; x100

Delay:

Total Range	1 - 1200 msec in three overlapping ranges
Control	Single turn control marked 1 - 12 msec with intermediate integer panel marks
Accuracy	±1% at '1' and '12' marks, ±5% at intermediate marks
Multiplier:	x1 ; x10 ; x100
Internal Jumper	Enable "x10" - giving a 10 msec - 12 s total range
Indicator	"TOO LONG" Red LED that flashes if DELAY longer than can be produced for each pulse

Internal Jumper	Enable "x10" - giving a 10 msec - 12 s total range
Indicator	"TOO LONG" Red LED that flashes if DELAY longer than can be produced for each pulse

Outputs – SYNC:

Connector	BNC socket
Signal	Positive going, 200µs pulse, TTL compatible pulse (5 V amplitude)

Outputs – OUT:

Connector	BNC socket
Signal	Positive going, 200µs pulse, TTL compatible pulse (5 V amplitude)
Control	Selection of only the Delayed pulse (upwards) or both the Sync and Delayed pulses
Indicator	Amber LED that flashes for each OUT output pulse
Internal Jumper	Enable "Active Low" - giving an Output that is Low during its active phase

Power:

Control	ON/OFF toggle: OFF is down
Consumption	<2 mA
Internal	PP3 - (IEC-6LR61) style, alkaline preferred
Battery Life	250 Hours with EverReady 6LF22 or Duracell MN1604
Dimensions, H x W x D	110 x 188 x 60 mm (4.3 x 7.4 x 2.4 in)
Weight	490 g (17.3 oz) with battery installed

Order # Product

W4 65-0641 Train Delay Generator DG2A

W4 65-0337 19 in Rack Mounting Frame, Holds 2 DG2 generators

Note: No other accessories, other than a battery, are supplied.

NL900D and NL905 Rack (Case) with Power Supply

neurolog™ system

The NeuroLog™ System

The NeuroLog™ System is now widely accepted throughout the world by scientists who demand high quality, dependability and innovation in their research instrumentation.

Because the NeuroLog™ System is fully modular, it has the following well-recognized advantages over non-modular "multi-purpose" instruments.

- It is more flexible. Complex systems can be quickly assembled or modified.
- It is more efficient. Modules can be shared among several set-ups, expanding capabilities without duplication. Only those modules required for a particular task are tied up and occupy rack space.
- Fewer interface problems. Input and output levels, impedances, connectors, etc., of different modules in the system are compatible, minimizing the problems encountered in interconnecting pieces of equipment of diverse origin.
- It is less costly. Only those modules actually required are purchased. You do not pay for all those functions added to an instrument to make it "general purpose".
- Individual modules can be added to the system at any time, as the scope and orientation of your application changes.



- Intracellular Recording
- Extracellular Recording
- Spike Detection
- Electrical Stimulation
- Pulse & Train Generation
- Multi-channel EMG or EEG Recording
- Pressure or other Transducer Recordings
- High quality, dependable and efficient
- Modular — easy to install modules as you need them
- Fewer interface problems
- Less costly than general purpose instruments
- Built in logic circuit indicates excessive loading

The NeuroLog™ module frame and power supply are housed in a fully finished, enclosed case. The case has handles and integral rack mounting hardware so that it can be shifted directly between rack and bench top. The case contains 13 module bays plus power supply panel.

The NeuroLog™ case has an integral module retention system, consisting of a simple, slide action lever on the power supply panel. Therefore, fittings such as retained screws, D-locks, etc., on individual module front panels are unnecessary. This simple design enables easy, rapid, changes in module arrangements, and ultimately reduces the cost of the modules.

The NeuroLog™ power supply produces three voltages (+15 V, +5 V, and -15 V), stabilized against line and load variations. The voltage outputs are rated at 650 mA, 3.0A, and 650 mA, respectively. All three supplies have internal 'fold-over' current limiting; the 15V supplies, in addition, are protected with series fuses. Each supply has less than 15 mV line ripple at maximum load. The power supply transformer employs a sectionalized winding former for additional safety and complies with the requirements of IEC601 part 1 and BS5724. The power supply provides sufficient power for almost any mix of NeuroLog™ modules.

A unique feature of the NeuroLog™ power supply is a built-in logic circuit which indicates (by extinguishing the power supply indicator on the front panel) excessive loading of one or more of the three supply outputs. While it is expected that a power supply failure will never occur using NeuroLog™ modules, the fault indication is invaluable when testing custom circuits built in the NL50 Blank Module.

The NL905 Compact Case and Power unit is an enclosed case which will accept up to 4 single width NeuroLog System modules. This case is designed as a more compact counterpart to the full width NL900D.

Specifications

Model	NL900D
Dimensions, H x W x D	133 x 483 x 317 mm (5.25 x 19 x 12.5 in), without feet
Weight	5.5 kg (12.1 lb), without modules

Order #	Model	Product
W4 65-0283	NL900D	Rack (Case) with Power Supply
W4 65-0283S	NL905	Small Rack (Case) with Power Supply

NL50

Blank Module

neurolog™ system

Each module has a split ring handle attached to its front panel. This handle serves as a cable run and as a handle for withdrawing or inserting the module into the case. All module outputs are short circuit proof. The extensive use of standard transistor-transistor logic (TTL, the standard logic in small computers) and standard linear integrated circuits ensures the lowest possible cost and highest possible compatibility with

other instruments. The output levels and impedances of the linear inputs and outputs are appropriate for general purpose oscilloscopes and low gain chart recorders, etc. The NeuroLog™ System is also compatible with the components most frequently used in special circuitry built by individual investigators to meet their own particular needs.

Module Interconnection

The general problem of module interconnection has been minimized in the NeuroLog™ System by a unique method of automatic connection of outputs and inputs of neighboring modules through the case edge connectors. Thus, for many linear arrangements of modules, only the input and output cables connecting the system to the preparation and to output devices such as oscilloscopes, recorders, etc., are required. Front panel controls are therefore not obscured by cables which merely connect each module to the next. More complex module arrangements will, however, require some front panel cable interconnection; between 5 and 10 cables of various lengths will be required for a typical 13-module system. No cables are supplied with the case, see NeuroLog™ accessories on page 206.

Cables

Only microminiature coaxial connectors with a 'snap-on' action are used in the NeuroLog™ System, eliminating the nuisances caused by connectors such as the BNC and UHF types which have a 'twist-on' or 'screw-on' action. All external connections between modules are made through miniature, screened coaxial cable, which reduce cross-talk and transient pick-up, as well as eliminating the tangling of fine, unscreened wires and 1 mm (or 2 mm or 4 mm) plugs frequently used for patching in other modular systems.

A variety of assembled cables, plugs, sockets, BNC to NeuroLog™ adaptors and 'T' connectors are available from Harvard Apparatus, see NeuroLog™ accessories list page 206.

NeuroLog™ Module Dimensions

Dimensions, H x W:

Front Panel (All modules)	122 x 30 mm (4.8 x 1.2 in)
Attached Printed Circuit Board	102 x 152 mm (4.0 x 6.0 in)



NL50 Blank Module

The **NL50** Blank Module consists of an undrilled, finished front panel and an unassembled printed circuit board. The printed circuit board has a 76 mm (3 inch) by 102 mm (4 inch) area of drilled soldering pads on 2.54 mm (0.1 inch) centers, for mounting components and supporting solder connections. The gold-plated edge connector has pads labeled for the appropriate power supply voltages and back connections. Input and output jumpers and pin sockets are supplied with the same configuration used in factory constructed modules. The front panel can be labeled with white letraset and lacquered, to give an appearance very similar to other NeuroLog™ modules. The NL50 can be used to construct modules of your own design, compatible with the NL900 Case and power supply.

Order #	Model	Product
W4 65-0219	NL50	Blank Module

NL102G

DC Pre-Amplifier

- Electrode impedance check
- Calibrator
- Four current injection ranges (± 100 nA, ± 50 nA, ± 20 nA, ± 10 nA) with four corresponding bridge balance ranges (100 M Ω , 200 M Ω , 500 M Ω , and 1000 M Ω)
- External gating of above facilities
- Bridge balance
- Back-off (DC Level) control
- Constant current capacitance compensation (neg. cap.) which largely eliminates readjustment, due to changes in input source resistance, common with voltage feedback circuits. The NL102G is now supplied with the hand held NL412 Pulse Box providing remote, push button overcompensation (ZAP!) control in order to assist membrane penetration
- Dye/clean (+ OFF -) toggle switch can be used for clearing blocked microelectrodes or depositing dyes through extracellular pipettes (max. current ± 1.0 μ A)
- x1 output amplifier has ± 10 V dynamic input signal range



The **NL102G** is a direct-coupled preamplifier is designed specifically for intracellular recording. With features such as capacity neutralization, current injection, low leakage current and low DC drift, it is particularly suitable for intracellular measurements through high impedance fluid-filled electrodes. The input stage is conveniently located at the end of a 2 meter cable for direct attachment to a micro electrode stepper.

The high impedance headstage of the NL102G is fitted in a metal tube at the end of a 2 meter cable. The Headstage is matched with the main amplifier module supplied with it. It is not interchangeable with other NL102G DC Preamplifier modules without recalibration (the serial numbers on the headstage and module match). The central 2 mm input socket (IN) is the capacity-compensated signal input through which current can be injected. The shield socket is the X1 output and may be used as a capacitance ground or shield at the electrode and preparation. The third socket is the system earth (ground) and connection should be made to the indifferent electrode only.

Specifications

Input Resistance	10 ¹¹ Ω
Voltage Gains	x1, x10 fixed
Input Voltage Range	±10 V, absolute max. of ±14 V
Gate Leakage Current	Adjustable to zero
Risetime	Zero Source Resistance: 1 μsec (20 MΩ source resistance); 15 μsec
Injection Current/ Bridge Balance	Selectable ranges: 100 nA/100 MΩ, 50 nA/200 MΩ, 20 nA/500 MΩ, and 10 nA/1000 MΩ
Zero Stability (Referred to Input)	±100 μV/day
Output Impedance	600 Ω
Capacity Neutralization	0 to 30 pF
Max. Noise Level	At 10 kHz bandwidth, referred to input (zero source resistance): 20 μV peak-to-peak (4 μV RMS); (10 MΩ source resistance): 180 μV peak-to-peak (36 μV RMS)
DC Level Range	±2 V (referred to input)
Output Voltage Range	±11 V
Electrode Impedance Check	x1 out 1 mV/MΩ x10 out 10 mV/MΩ
Calibrator	10 mV or 100 μV 150 Hz square wave
External Stimulus Input Range	±10 V corresponds to ±full scale current, depends on range selected
Amplification:	2 outputs available:
x1 Out	Voltage present at '+' input referred to GND including any potential dropped across electrode resistance by injection stimulus current applied. Max. voltage range of amplifier ±10 V
x10 Out	x10 signal present at '+' input referred to GND less voltage generated across electrode resistance R _e when bridge balance control is correctly set for value of R _e
Bridge Balance	Range ±10 V corresponds to 100 MΩ at 100 nA, 200 MΩ at 50 nA, 500 MΩ at 20 nA, and 1000 MΩ at 10 nA depending on setting of inject current selector (printed circuit board mounted)
DC Level Control	Enables x10 amplifier to back off up to ±2 V at input
Current Injection:	Stimulus currents can be injected into electrode system in either direction under following conditions:
1	Set by current inject control in magnitude, direction by front panel HYPER/DEP switch and gated ON or OFF by TTL gate pulses at front panel socket
2	Set in magnitude and direction by analog voltage applied at front panel socket signal range ±10 V; current injection can be combination of both control systems; full scale current injection conditions are printed circuit board selector at 100 nA, 50 nA, 20 nA or 10 nA
Monitor Out Socket	Allows connection of oscilloscope to monitor injection current (±10 V full scale injection current)
Other Injection Current Possibilities:	
1	Max. non-controlled current for dye injection to preparations or clearing of blocked electrodes; current is dependent on electrode resistance and can be up to ±1 μA max.; repeated reversal of selector switch usually cleans blocked electrodes
2	Impedance check measurement selected by front panel switch injects current (1 nA) through electrode giving signal at x1 output which is pulse wave of amplitude 1mV/MΩ or 10 mV/MΩ at x10 output

Specifications (continued)

Capacity Compensation	NL102G has front panel control to adjust amplifier section to compensate for capacity to ground at electrode; adjustment is easily made by switching on impedance check signal and setting NEG CAP control for fast rise time square wave without excessive overshoot at output; range is sufficient to compensate for capacities up to 30pF; amplifier can be deliberately put into oscillatory mode by push button adjacent to NEG CAP control and is of use when penetrating cell membrane during electrode manipulation
Calibration	Square wave calibration signal built into NL102G for calibration through complete system; select it through front panel switch as one of two magnitudes: 10 mV or 100 μV. Can be gate controlled by TTL signal applied to front panel sockets; signal (approx. 150 Hz) is summed with bridge balance signal at input of x10 amplifier section

Order #	Model	Product
W4 65-0222	NL102G	DC Pre-Amplifier includes Headstage and NL412 Pulse Generator
W4 65-0223	NL102GH	Replacement Headset (Including Fitting)

NL100AK and NL104A

neurolog™ system



NL100AK Headstage

The **NL100AK** Headstage is a differential input, low noise, high impedance buffer amplifier contained in a metal tube and supplied with a 2 meter long flexible cable. The NL100AK is supplied as standard with a removable 6.4 mm (0.25 inch) diameter stainless steel mounting rod. Power is supplied by the NL104A AC preamplifier via a 4 way lemo plug and socket. This headstage can also be used in conjunction with other NeuroLog™ amplifiers (NL103, NL104, NL107), please specify with order.

Specifications

Input Resistance	100 MΩ
Gain	±1.0
Input Noise	< 2 μV (peak to peak) with inputs shorted; < 25 μV for a typical tungsten microelectrode in saline; < 30 μV with a MΩ resistor between inputs (bandwidth in all three cases, 10 Hz to 10 kHz)
Dimensions, L x OD	35.6 x 9.5 mm (1.4 x 0.375 in) diameter
Connections:	
+ IN	2 mm socket for non-inverting input accepts plugs supplied, as well as (optional) NL101 electrode chambers or NL08 micro-electrode adapters
- IN	1 mm socket for inverting input connection to reference electrode or via U connector (supplied) to ground socket (GND)
GND	Screen connected to mains earth

Order #	Model	Product
W4 65-0220	NL100AK	Headstage
W4 65-0396	NL08	Metal Microelectrode Adapter pin, 2 mm to 0.8 mm

NL104A AC Pre-amplifier

The NL104A AC Pre-amplifier is a low noise, high input impedance, differential, pre-amplifier. It can be used alone for making recordings from low resistance (gross) electrodes, or with the NL100AK Headstage for microelectrode recordings. The NL104A features a wide dynamic balance adjustment for asymmetrical inputs (useful for balancing out interference and shock artifacts), a choice of two input time constants, 8 gain ranges and 3 high frequency filter settings. An internal 50Hz oscillator is provided for precisely balancing the input (input switch in the CM position).

Specifications

Gain	100, 200, 500, 1 k, 2 k, 5 k, 10 k or 20 k
Input Resistance	10 MΩ
High Frequency Cutoff	Selectable for 100 Hz, 700 Hz, 6 kHz or W.B. (> 40 kHz)
Low Frequency Cutoff	0.1 Hz or 10 Hz
Common Mode Rejection Ratio	10,000:1 at 50 Hz
Input Noise	< 10 μV (peak to peak) with inputs shorted to ground and bandwidth of 0.1 Hz to 10 kHz
Dynamic Balance Adjustment	Gain for one input can be varied ±50% with respect to other
Output Voltage Range	±12 V max.

Order #	Model	Product
W4 65-0224	NL104A	AC Pre-Amplifier

NL100RK, NL101 and NL04 **neurolog™ system**

- Allows stimulation and recording through the same electrode
- Stimulus can be controlled manually or from external device

NL100RK Pre-Amplifier and Stimulus Relay

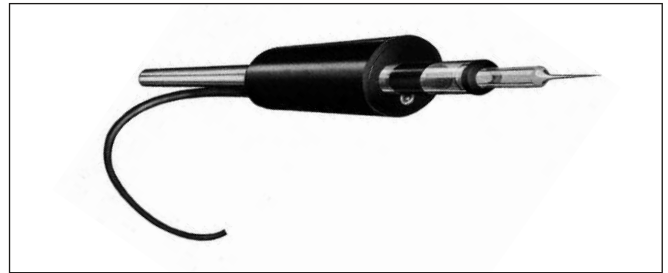
The **NL100RK** consists of an NL100AKS head-stage and the NL100C Stimulus Control module designed for use with the NL104A AC Pre-amplifier and allowing stimulation and recording through the same electrode. The NL100C allows a voltage of up to 100V to pass through the NL100AKS head-stage and recording electrode under the control of a three position switch on the NL100C front panel. The switch has "On", "Off" and "Ext" positions, allowing presentation of the stimulus to be controlled manually or via a gating pulse from an external device.



Order #	Model	Product
W4 65-0642	NL100RK	Pre-Amplifier and Stimulus Relay

NL101 Electrode Chambers

NL101 Electrode Chambers are compatible with all NeuroLog™ system headstages. They are available with two different plug sizes; Both of these are available in four sizes to fit glass capillaries. For example, NL101B3 will plug into a NL100AK or NL102G and hold a glass capillary with an outside diameter of 1.5 mm.



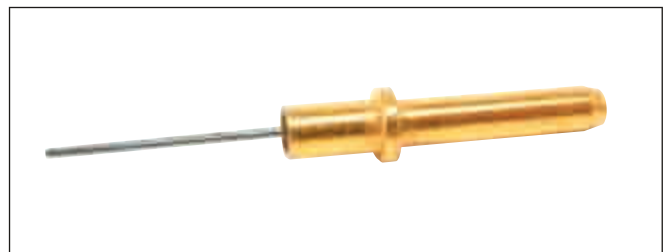
Order #	Model	Electrode Chamber OD	Plug Size	Color
W4 65-0221	NL101A	1 mm	1 mm	Yellow
W4 65-0389	NL101A	1.2 mm	1 mm	Green
W4 65-0390	NL101A	1.5 mm	1 mm	Blue
W4 65-0391	NL101A	2 mm	1 mm	Red
W4 65-0392	NL101B*	1 mm	2 mm	Yellow
W4 65-0393	NL101B*	1.2 mm	2 mm	Green
W4 65-0394	NL101B*	1.5 mm	2 mm	Blue
W4 65-0395	NL101B*	2 mm	2 mm	Red

*Fits NL100AK and NL102G headstages.

Tungsten Micro-Electrode Holder

The **NL04** Micro-Electrode Holder is a 26 gauge hypodermic needle tube soldered into a drilled out 2 mm pin. This holder is for use with NL100AK and NL100AKS headstages.

Order #	Model	Product
W4 65-0638	NL04	Tungsten Micro-Electrode Holder





NL106 AC-DC Amplifier

The NL106 AC-DC Amplifier features attenuation or amplification which is continuously adjustable, using a locking ten-turn potentiometer, from 0 to x10, or 0 to x100. Its input controls are similar to those of conventional oscilloscope vertical amplifiers, allowing operation in AC or DC coupled, single-ended (inverting or non inverting) or differential modes. Up to ± 2 VDC at either input can be zeroed using the ten-turn DC OFFSET adjustment. The output voltage is shown by 4 light-emitting diodes: two red LED's show outputs in excess of 50 mV and 1.0 V; two green LED's show corresponding negative outputs. Thus, adjustment of gain and DC offset can be accomplished without an oscilloscope monitor. Low drift, low noise, and moderate input impedance make the NL106 suitable either as an amplifier for low impedance sources, or as variable gain stage following a preamplifier.

Specifications

Input Voltage Range	± 15 V
Input Impedance	1 M Ω
Gain	0 to X10 or 0 to X100 continuously variable by 10-turn potentiometer
Small Signal	± 1 V out >30 kHz Frequency Response
Low Frequency Cutoff	In AC Mode 2 Hz
Output Voltage Range	± 12 V
Output Impedance	600 Ω
DC Offset Range	± 2 V at either input, 10-turn potentiometer adjustment
CMRR	> 2500; 1 at 50 Hz

Order #	Model	Product
W4 65-0225	NL106	AC-DC Amplifier

NL108A Pressure Amplifier

The NL108A Pressure Amplifier module provides two gain settings, one appropriate for blood pressure measurement (1.0 V at the output corresponds to 100 mmHg pressure at the transducer) and the other for low pressure measurement such as intratracheal pressure (100 mV at the output equals 1 cm H₂O at the transducer port). An internal voltage calibrate signal provides the appropriate deflection (1.0 V or 100 mV) for these two ranges. Other features include excellent DC stability, a push button switch for setting the zero pressure baseline on the recording instrument, and a sensitive zero offset control. Although the NL108A is designed to mate perfectly with our own pressure transducer, due to its internally adjustable gain and bridge excitation voltage, it can be used with a variety of other standard pressure transducers. Call Harvard Apparatus for additional information.

Specifications

Input Voltage Range	± 10 V
Input Impedance	10 ⁹ , typical
Gain	1 V/100 mmHg or 100 mV/cmH ₂ O, for pressure transducer having out put of 50 μ V/mmHg
DC Offset	± 80 cmH ₂ O, ± 60 mmHg, when switched to appropriate range
Bandwidth	DC to 150 Hz
O/P Voltage Range	± 12 V
O/P Impedance	600 Ω (nom) except 'zero out', where O/P is - S/C direct to ground
Bridge Supply	0 to 24 V DC (25 mA)

Order #	Model	Product
W4 65-0227	NL108A	Pressure Amplifier

NL108T4 Pressure Transducer



Order #	Model	Product
W4 72-4222	NL108T4	Pressure Transducer, pkg. of 1
W4 72-4223	–	Replacement Dome for W4 72-4222, pkg. of 1
W4 72-4224	–	Replacement Dome for W4 72-4222, pkg. of 10
W4 65-0631	NL108L4	Lead for NL108T4 to NL108A

Suitable for both arterial and venous blood pressure monitoring, the NL108T4 can be attached via a lead (NL108L4) to the NL108A pressure amplifier, allowing continuous pressure monitoring. The NL108T4 is a highly accurate and rugged re-useable transducer, which is used in conjunction with disposable domes (NL108D4). These disposable domes are easy to fill and attach to the transducer body and are available in packs of 10 or individually (one dome is included with each transducer). The components of the transducer are electrically isolated from the transducer housing, which is in turn isolated from the saline solution by the silicone membrane of the dome. The transducer is gold plated, making it easier to clean.

The transducer is designed primarily for use during blood pressure monitoring, but equally well operates as a monitor for intracranial, gastrologic or intrauterine pressures, as well as urodynamic measurements.

Specifications

Pressure range	20 to 300 mmHg
Max. Overpressure	10000 mmHg
Sensitivity	50 $\mu\text{V/V/cmHg}$
Resonance Frequency	300 Hz typical (transducer and dome)
Max Electrical Excitation	15 V DC or AC
Input Resistance	700 Ω (or equipment specified)
Output Resistance	1000 Ω (or equipment specified)
Non-Linearity and Hysteresis	max. 0.5% of full scale
Zero Balance	max. ± 30 mmHg
Thermal Sensitivity	0.15%/°C
Thermal Zero Shift	max. 0.25 mmHg/°C
Operating/Storage Temperature Range	+10 to +50°C/-20 to +70°C
Insulation Resistance	min. 10 Ω
Leakage Current	max. 1.5 μA at 250 V, 50 Hz
High Voltage Resistance	10000 V between saline in dome and transducer leads
Weight	26 g (without cable)
Length of Cable	0.3 m



- Low cost alternative to isolated NL108TA
- Can be reused several times
- Available individually or in a package of 10

NL108T2 Disposable Pressure Transducer

The **NL108T2** Pressure Transducer is a low cost alternative to the isolated unit NL108T1 which can be used with the NL108A Pressure Amplifier. Although the transducers are classed as 'disposable', it has been found that they can be used several times. The NL108T2 is connected by the NL108L2 lead, which is reusable. These transducers are for animal use only. Supplied individually or in a package of ten.

Specifications

Pressure Range	-50 mmHg to +300 mmHg
Over-Pressure Tolerance	10000 mmHg
Bridge Resistance	
Input Resistance	1000 W nominal
Output Resistance	350 W nominal
Excitation Voltage	Up to 10 V DC or AC max. up to 5kHz
Zero Offset	±40 mmHg, max.
Maximum Inaccuracy	±2% of reading or 1 mmHg, whichever is greater
Thermal Coefficient of Sensitivity	±0.3 mmHg/°C
Thermal Coefficient of Zero	2 µA at 120 VAC, 60 Hz
Electrical Leakage	400 Ws, maximum across 50 W lead
Resonant Frequency	145 Hz with 30 cm pressure tubing, 43 Hz with 150 cm pressure tubing

Order #	Model	Product
W4 65-0229	NL108T2	Disposable Pressure Transducer, pkg. of 1
W4 65-0230	NL108T2/10	Disposable Pressure Transducer, pkg. of 10
W4 65-0231	NL108L2	Lead for NL108T2 to NL108A



(NL120 pictured)

NL120S Audio Amplifier

The **NL120S** Audio Amplifier is a power amplifier for driving a 4 or 8 ohm loudspeaker. It has sufficient power amplification to raise a ±20 mV signal to moderate sound level. The module features an input selector for switching between two input signals, and the options of amplifying only positive or negative peaks, useful when baseline noise masks the sounds of nerve spikes of interest. The output is shaped to improve the low frequency response of small loudspeakers, and is power limited to minimize the nuisance caused by large transients such as shock artifacts.

Specifications

Input Impedance	10 kΩ
Bandwidth	20 Hz to >15 kHz
Output Voltage Range	±1.5 V
Min. Load Resistance Across Output	3 Ω
Recommended Loud Speaker	W4 65-0323 (NL985)

Order #	Model	Product
W4 65-0236	NL120S	Audio Amplifier
W4 65-0323	NL985	Loudspeaker

neurolog™ system

NL125/6, NL134, NL135, NL136 and NL144



NL125/6 Filter (High & Low Pass, 50/60Hz Notch)

The **NL125/6** filter module employs two active sections to control the high and low pass characteristics. The low frequency cutoff point can be set continuously from 0.5Hz to 5kHz with a single turn potentiometer, in four switched ranges. Similarly the high frequency cutoff can be set continuously from 5Hz to 50kHz in four switched ranges. DC and WB (wide band) switch positions bypass the lower and upper filter sections, respectively. An active notch filter is provided for the rejection of line frequency interference; this can be operator set at 50Hz or 60Hz, with a 20Hz notch width (-3dB points).

Specifications

Input Voltage Range	±10 V
Input Impedance	56 kΩ
Low Frequency Cutoff Range	DC, 0.5 Hz to 5 kHz continuously adjustable
High Frequency Cutoff Range	Wide band (> 50 kHz) and 5 Hz to 50 kHz, continuously adjustable
Gain Within Passband	x1
Attenuation Beyond Cutoff	40 dB/decade
Notch Attenuation	> 50 dB
Notch Width	20 Hz
Output Voltage Range	±10 V
Output Impedance	600 Ω

Order #	Model	Product
W4 65-0237	NL125/6	Filter (Low Cut, High Cut and 50 Hz Notch)

- NL134, NL135 and NL136 – Low Pass
- NL144 – High Pass

4-Channel Filters

The **NL134**, **NL135** and **NL136** are 4-channel, 2-pole (second order) low pass filters. Both the NL135 and NL136 have an AC power rejection notch filter module that is an ideal partner for the NL820A Isolated Amplifier System with its 2/4 channel AC or DC pre-amplifiers. The filter settings have been selected for most electrophysiological and clinical protocols but special frequencies can be factory set. Call Harvard Apparatus for details. The NL144* is a high-pass version of this filter and does not have a notch filter.

*Note: Has frequency settings of 0.1, 0.2, 0.3, 0.5, 1, 2, 3, 5, 10, 20, 30, 50, 100, 200 Hz and DC.

Specifications

Input Voltage Range	±15 V max, ±10 V operating
Input Impedance	120 kΩ
Filter Settings (-6 dB)	10, 20, 30, 50, 100, 200, 300, 500, 1k, 2k, 3k, 5k, 10k, 20k and WB
Cut-Off Accuracy	(±2% ±1.25 Hz < 630 Hz) or (±2% ±62.5 Hz > 630 Hz)
Gain Before Cut-Off	+1.0
Attn. Beyond Cut-Off	40 dB/decade, 12 dB/octave
Notch Attn/Width (-3 dB)	> 50 dB/20 Hz
Crosstalk // Noise	Better than -60 dB // < 100 μVrms

Order #	Model	Product
W4 65-0239	NL134	4-Channel Low-Pass Filter without Notch Filter
W4 65-0240	NL135	4-Channel Low-Pass Filter with 50 Hz Notch Filter
W4 65-0241	NL136	4-Channel Low-Pass Filter with 60 Hz Notch Filter
W4 65-0242	NL144	4-Channel High-Pass Filter* without Notch Filter



NL143 Three Channel Difference Amplifier

The **NL143** Difference Amplifier allows the difference between two signals to be continuously monitored during the course of an experiment. The module has four inputs and three outputs, allowing three alternative “differences” to be recorded simultaneously from each module. Internal settings define the channels to be subtracted. The module also features a post-subtraction offset control which allows the output to be offset to a desired level e.g. for zeroing at the start of an experiment. While this module was originally designed to allow the differences between two biological parameters to be continuously monitored, it could also be used to remove unwanted offsets introduced into analogue signals originating from computer DAC interface cards.

Order #	Model	Product
W4 65-0643	NL143	Three Channel Difference Amplifier



NL201 Spike Trigger

The **NL201** Spike Trigger is an amplitude discriminator for nerve spikes and other events, with an output that shows the levels superimposed on the signal. It produces separate output pulse trains for spikes which: (a) cross the Upper voltage threshold; (b) cross the Lower voltage threshold; (c) cross the Lower but not the Upper threshold. The window height potentiometer sets the DC level of the ‘window’ and the aperture potentiometer sets the separation between the two voltage thresholds of this window. Thus, slight changes in signal amplitude require adjustments of only one setting, and it is impossible to set the upper voltage threshold lower than the lower voltage threshold. The monitor output socket provides a display of the input signal with the lower and upper levels superimposed on it to enable easy setting of the discrimination levels. There is a choice of two internally selected input voltage ranges and a front panel switch selects either positive or negative slope and level triggering. This module is essential for converting spike trains (which are analogue signals) into trains of digital pulses; these can be analyzed using other modules (such as the NL700 Log Display) or used to synchronize displays, trigger averaging, etc. An internal jumper allows the input to be AC or DC coupled.

Specifications

Input Voltage	±10 V max.
Input Impedance	1 MΩ
Input Time Constant	0.2 sec or DC
Lower Range (Height)	0 to 5 V
Aperture Range	0.2 to 5 V
Gain	x1 or x10 (internally)
Triggering	+ve or -ve slope
Threshold Calibration	±10%
Output - Upper	TTL, 230 μsec (±10%) pulse
Output - Lower	TTL, 200 μsec (±10%) pulse
Gate	TTL, 15 μsec (±10%) pulse
Monitor	Input plus upper and lower levels

Order #	Model	Product
W4 65-0243	NL201	Spike Trigger



- Monitors the difference between two signals continuously
- Monitor up to three pairs of signals

NL301 Pulse Generator

The **NL301 Pulse Generator**, replaces the NL300, is a low cost module for producing trains of uniform TTL pulses. It can be operated continuously, switched off, or a single pulse can be triggered manually. A Gate input socket allows synchronous trains of pulses to be gated-on by an externally applied TTL high logic level. An internal jumper either excludes (as with the NL300) or produces an output pulse coincident with the start of the Gate signal.

Pulse frequency is continuously variable over more than three decades using a single 12:1 control and a three-position decade switch. Three fixed output pulse widths are available. The frequency range and pulse widths were chosen to make this module suitable as a timing source for electrical stimulation of the nervous system, without the necessity of additional modules for determining pulse widths.

The NL301 is also useful for a variety of other timing purposes where a widely variable rate is desirable, and precision is important but not critical. It has an on-board jumper that allows the user to select a frequency range 1/10 of that shown on the front panel. This allows a frequency range of < 0.1 to > 120 Hz.

Specifications

Frequency	< 1 to > 1200 Hz
Control Marked	1 to 12 (0.5 to 12 possible)
Accuracy	±1% at '1' and '12' marks, ±5% at other scale marks
Multiplier	x1, x10, x100
Output Pulse Widths	50, 150 or 500 μsec (±10%)
Output Fan-Out	10 TTL inputs

Order #	Model	Product
W4 65-0247	NL301	Pulse Generator

NL304 Period Generator

The **NL304 Period Generator** (replaces the NL303) contains a crystal oscillator and frequency dividers for producing a precise, stable frequency standard. It can be externally gated (Gate In) and synchronized with an external source (Reset input). The pulse train can be switched off and a single output pulse can be triggered manually. Eight decades of pulse rate are available. The NL304 is the basic 'clock' of the NeuroLog™ System: it provides the 'fine grain' (1 μsec increments) necessary for digital control of pulse width, cycle duration, delay, etc., using the NL603 Counters.

Specifications

Output	TTL pulses
Period Accuracy	0.01%
Period Range	1 μsec to 10 min by 1 μsec, 10 μsec, 100 μsec, 1 msec, 10 msec, 100 msec, 1 sec, 10 sec, 30 sec and 60 sec Period switch and x1, x2, x5, and x10 MULT switch
Output Pulse Width	0.5 μsec

Order #	Model	Product
W4 65-0248	NL304	Period Generator



NL410 Calibration Module

The **NL410** Calibration Module can be used for the precise calibration of the gain of an amplifier system or for adding a pulse of accurate amplitude and duration to a recording trace. The output of the Calibrator is isolated allowing for the user to choose the best method of preparation grounding to optimize recordings. Switches allow selection of 1 of 3 calibrated output levels with 1 of 2 calibrated triggered pulse widths of either polarity. The calibration level at the preset amplitude and polarity may also be enabled or pulsed manually from a front panel switch.

Specifications

Trigger Level	+2 V on positive edge with 200 mV hysteresis
Trigger Input Limit	±15 V max.
Trigger Input Impedance	> 1 MΩ
Output Level	0.1 mV, 1 mV, 10 mV switch selectable
Output Level Accur.	±2%
Output Pulse Duration	1 or 10 msec (triggered) or under manual control
Pulse Duration Accur.	±2% (triggered)
Polarity	Positive or negative switch selectable
Output Impedance	2 Ω, 20 Ω, 200 Ω for output levels of 0.1 V, 1 V, 10 mV respectively
Output Isolation	> 50 V

Order #	Model	Product
W4 65-0252	NL410	Calibration Module

NL510 Logic Gate

The **NL501** Logic Gate module contains two logic gates each with two inputs and complementary outputs. Both of these gates can be independently configured by PCB mounted switches as either 2-input AND gates or 2-input OR gates. The open circuited inputs are automatically held low for the OR function or high for the AND function and a further switch allows expansion of the second gate to take the output of the first as a third input. This enables a 4-input AND gate or a 4-input OR gate to be realized. A further possibility is a 3-input AND or OR gate where one of those inputs is a 2-input OR or AND function from the other gate. Provision is made for input 1 of gate 1 to be connected to the output of the module to the left and all 4 outputs are available for selection as the output to the module to the right. This is done by jumper plugs at the rear of the PCB.

Specifications

Input	TTL
Outputs	TTL
Output Fan-Out	10 TTL inputs

Order #	Model	Product
W4 65-0253	NL501	Logic Gate

NL405 Width Delay



The **NL405** Width Delay is a digitally controlled pulse duration generator and is used to produce precise pulses of adjustable duration with high accuracy and repeatability. The NL405 produces TTL logic output pulses (of both polarities) that have a duration set using three decades of thumbwheels and a seven (7) position range switch. It also features a press to start button, LED indication of an output and a separate logic output signal at the end of the defined WIDTH time. It was designed as a replacement for the NL401 and in most places where the NL403 would have been used.

The NL405 can be triggered off either positive or negative-going edges of the input pulses and the NL405 is capable of 100% duty cycles. An external push to make switch can be used when -ve edge triggering is selected. In the "FIXED WIDTH" mode, the NL405 produces an Output pulse as specified by the front panel controls; In the "RE-TRIGGER" mode, any valid Input trigger arriving whilst the Output is active will restart the timing and therefore extending the Output pulse duration. As long time periods can be generated (999 seconds is over 16 minutes) any change in position of the rotary range switch will stop the current Output and inhibit further input triggers for 450 ms.

The "DELAYED" Output socket provides a short duration pulse (set internally) that is produced at the end of the timed WIDTH pulse. This provides a trigger-out after the set Delay time.

The NL405 can be used for digital control of pulse duration or for introduction of a delay to a trigger pulse. The logarithmic or exponential nature of the many biological responses make the very wide continuous adjustment (from μ s to minutes) particularly beneficial.

Rear connections to the motherboard allow Input and Output interconnections between this and other logic modules without the need of front panel cables.

Specifications

Input:	TTL pulse, 1 TTL load
Trigger Edge	Positive or Negative, selected from front panel
Manual	Push-button, operation on push
Output (Width):	TTL, Output will drive 10 loads
Polarity	Both active-high and active-low sockets
Range	1 μ s - 999 s
Control	001 - 999
Multiplier	1 μ s, 10 μ s, 100 μ s, 1 ms, 10 ms, 100 ms, 1 s
Accuracy	$\pm 0.5\%$
Delay from Trigger In	<200 ns
Indicator	Amber LED on for approximately 100 ms for each pulse
Output (Delay):	TTL, Output will drive 10 loads
Polarity	Active-high
Duration	0.5 μ s, 1.5 μ s, 5 μ s $\pm 20\%$ 50 μ s, 150 μ s, 500 μ s $\pm 10\%$, by on-board jumpers
Output:	
Mode	Fixed Width or Re-Triggered, selected from front panel
Reset/Inhibit	450 ms $\pm 20\%$, after change of rotary range control

Order #	Model	Product
W4 65-0630	NL405	Width Delay

NL412 Pulse Generator



The **NL412 PULSE** is a small, handheld, general purpose pulse generator which can be used to “start” experiments, command the “gate” of a train of pulses or be used with an NL102G to “Buzz” electrodes. The NL412 is self-powered by a standard internal 9 V battery and is fitted with a 2 m lead terminating in the standard Lemo connector.

Start

On pressing the button the NL412 generates an active high pulse which will trigger remote modules.

Gating

The front panel control on the NL412 provides control for output pulse durations over the range of 1 to 10 ms. Setting this control allows different durations of trains of pulses when the NL412 is combined with a Pulse Generator such as the NL301.

Use with NL102G

When used with a NL102G (that incorporates external “Buzz” control circuitry) the duration of the “Buzz” is set by the front panel control.

Technical Note - NL102G use

During intracellular micro-electrode recording, cell penetration is often facilitated by use of a Buzz button, a feature included on the front panel of the NL102G DC pre-amplifier. Pressing the Buzz button fully activates the capacitance compensation circuitry, causing the amplifier voltage to oscillate. This oscillation often aids passage of the electrode into the intracellular milieu. In certain situations, it may be necessary to operate the Buzz button in combination with microelectrode manipulation, making the front panel location of the Buzz button less convenient for the user. To make the Buzz feature more accessible, a remote NL412 Pulse box has been developed by Digitimer Ltd. This small handheld unit provides control over Buzz duration (1-10ms) and has a single push button for Buzz pulse delivery.

The NL412 is connected via its own 2m long Lemo cable to a modified version of the NL102G, incorporating an external Buzz control input socket. Existing users of NL102G modules can have the modification made at Digitimer Ltd.

Specifications

Button LED (not release)	Only produces an output pulse on “Press” (not release) Amber - illuminates for approximately 250 ms after each press
Pulse Duration:	
Range	1 to 10 ms
Accuracy	Better than 20% at all scale markings
Output:	
Level	9 V, with new battery.
Rise and Fall Times	< 100 μ s
Battery	Standard 9 V, 6LR61 style. (Non-alkaline supplied) - we recommend the Duracell Ultra MN1604 alkaline battery
Power Consumption	< 5 μ A (static)
Cable	2 m (nom) with standard Lemo connector fitted
Dimensions, H x W x D	105 x 61 x x 28 mm plus 15 mm on “d” for knob
Weight	< 170 g including battery

Order #	Model	Product
W4 72-4220	NL412	Pulse Generator



NL505 Flip-Flop

The **NL505** Flip-Flop can be operated either as a “set-reset” flip-flop or as a “toggled” complementing flip-flop. This makes it useful in setting up conditional and “single-shot” stimuli, and testing logic outputs for the presence of pulses, logic levels etc.

It has three inputs, Set, Complement and Clear, and two outputs (Q and Q') all of which drive or are driven from TTL logic (ie +5V and 0V).

A LED indicator is illuminated when the Q output is at a high level.

The table below shows the relationship between inputs and outputs.

Complement	Set	Clear	Q	Q'	Function
0	0	0	Q0	Q'0	Static Condition
X	0	1	0	1	Clear Output
X	1	0	1	0	Set Output
X	1	1	1	1	*see below
^	0	0	Q0	Q'0	Complement

Where a 1 is a logic high (+5V)

0 is a logic low (0V) or unconnected inputs

X is irrelevant

Q0 is the previous output

^ is a positive going pulse

* This is a non-stable situation, it will only remain whilst Set and Clear are both held high.

N.B. The Set and Clear inputs override the Complement input, that is why the output is only affected by the complement input when both of these are low.

Order #	Model	Product
W4 65-0254	NL505	Flip Flop

NL506 Analog Switch

The **NL506** Analog Switch contains a single pole change-over switch, the state of which is controlled by a logic signal. This signal can be generated externally or by the internal Flip-Flop that can be toggled by a logic input. A front panel switch allows direct selection of the switch state which is indicated by an LED. The switch is bi-directional allowing it to be used as a 1-input 2-output or a 2-input 1-output device. Also, as the switch is analog; it can handle signals up to ±15 volts as well as being of low enough impedance to handle TTL signals.

Note: The analog switch is robust but has a current limit, especially when the NeuroLog™ power supply is off. Only signals originating from within the same NL900 should be coupled to the NL506.

Specifications

Analog Switch:	
Range	±15 V
Impedance Per Socket	1 MΩ
ON Resistance	< 35 Ω
OFF Leakage	< 50 nA
Switching Time	< 200 nsec
Break-Before-Make Delay	< 10 nsec
Indicator	Amber LED indicates switch position
Switches	SET/-RESET toggle forces selection of analog switch; also presets internal Flip-Flop; in mid position, IN/FF switch selects control signal for analog switch
Flip-Flop	Is preset by SET/-RESET toggle switch and toggled by negative (-ve) going edge of logic input signal
Input Allowed Signal	±15 V max.
Input Logic Threshold	+1.4 V approx. (suits TTL)
Input Impedance	10 kΩ approx.

Order #	Model	Product
W4 65-0255	NL506	Analog Switch



NL510A Pulse Buffer

The **NL510A** Pulse Buffer converts TTL logic pulses into 0 to 10V pulses, which can be used to drive the NL800A STIMULUS ISOLATOR. The output pulses in the ISOLATOR DRIVE mode are offset to match the input characteristics of the NL800A. Output amplitude is adjusted with a precision 10-turn potentiometer and turns counting dial. The mode switch has an OFF position, a useful feature when more than one stimulator is used. The NL510A can be used as a voltage stimulator, relay driver, solenoid drive, oscilloscope beam brightener, etc.

Specifications

Output Voltage Range	0 to 10.0 V
Output Resistance	< 10 Ω
Output Current	50 mA
Output Rise & Fall Times	< 1 μsec

Order #	Model	Product
W4 65-0256	NL510A	Pulse Buffer

NL530 4-Channel Conditioner

The **NL530** Conditioner module is designed to give Gain and Offset setup controls when interfacing signals to the Analog-to-Digital Converters (ADCs) of PCs.

The module contains four channels. Each has independently adjustable filter settings and front panel Gain and Offset presets. There is also a master ADC offset control to allow unipolar ADCs to be used with bipolar signals. ADC boards have precise input ranges (outside of which damage may occur) and this module features on-board preset controls to set all channels to 'CLIP' or limit at independently set positive and negative (or zero) levels.

Specifications

Each Independent Channel

Input:

Absolute Max.	±100 V
Impedance	20 kΩ
Gain	x0.1, x0.2, x0.5, x1, x2, x5, x10
Variable Gain	x1 (CAL) to x2.5 (nominal)
Offset Control	±1 V or ±5 V
Filters	100 Hz, 1 kHz, 10 kHz, none
Bandwidth	DC to 100 kHz
Crosstalk	< -56 dB between channels

Output:

Range	±11 V min.
Impedance	< 5 Ω (for up to 10 mA load)

Common To All Channels

Clip Limits:

Positive	+4 V to +11 V min
Negative	-11 V to 0 V
ADC Offset	Zero (0 volts) or +2.5 V

Output	[Input x Gain] + [(ADC + variable) offsets]
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Order #	Model	Product
W4 65-0259	NL530	4-Channel Conditioner

NL512

Biphasic Pulse Buffer



The **NL512** Biphasic-Pulse Buffer is the interface between any bipolar signal and two of the NeuroLog™ NL800A ISOLATORS so that bipolar, isolated, constant current signals can be used for stimulation. This is “current out for voltage in”.

The NL512 features a high input impedance and four input ranges to allow a number of different modules, or an external signal (such as from the ADC in a PC), to be used for the input signal. A GATE input allows multiple units to be connected to a single analogue source with each channel being digitally enabled separately. The switch, in the OFF position, disables the module.

The NL800A ISOLATOR features no battery usage except for when a stimulus is being presented which is achieved by using an input opto-coupler. This does suffer from having a low impedance and a DC offset which is different for each unit but the NL512 removes these problems.

The NL512 provides easily adjustable internal finger controls for the DC offset of each of the NL800A's.

An on-board jumper allows the unit to be driven by one of four different ranges for Full Scale current output from the NL800's. These are $\pm 10V$, $\pm 5V$, $\pm 2.5V$ and $\pm 1V$. The 1 mm jumper system on the board allows the unit to be driven from the unit on its immediate left, if required, via the Motherboard in the NL900 Rack and Power Supply.

Specifications

IN

Input Voltage Range:	$\pm 15V$ max
For Full Scale Output	$\pm 10V$; $\pm 5V$; $\pm 2.5V$ or $\pm 1V$ by on-board jumper selection
Input Impedance	1 MW
Frequency Response	> 1 MHz; this will usually be limited to less than this by the NL800

Gate:

Logic Levels	TTL compatible
Function	ON (unit working) - TTL high (> 2.8 V or no connection) OFF (unit disabled) - TTL low (< 0.8 V)

Input Voltage Range:	$\pm 15V$ max
Input Impedance	$\sim 85k\Omega$
Response Time	< 5 μs

ON/OFF Switch	This overrides the GATE input to disable the module when set to OFF
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OUT

Output DC Offset for NL800	< 0.7 to > 2.3 V - Separately set for each phase
Output Voltage Range	0 to +10 V
Output Current for NL800	Up to 20 mA
Output Impedance	< 10 W
Rear connections	To the NL900 motherboard allow an input interconnection for IN or GATE and the module to the immediate left without the need of a front panel cable

Order #	Model	Product
W4 72-4221	NL512	Biphasic Pulse Buffer



NL601 Pulse Integrator

The **NL601** Pulse Integrator has a digital counter which produces an analog output proportional to the count. A pulse at the input socket increments the counter towards a full scale count of 255, 2550 or 25500 which is pre-selectable by the front panel scale switch. The counter will continue to increment on input pulses until the unit is reset. This can be done manually (with the on, off/reset switch) or by applying a pulse to the reset socket. Alternatively, with the unit set to internal-reset, when the counter reaches full scale the unit will automatically reset. There is one other reset function, the external reset/latch function. On a reset pulse the output will be held at the previous count level until the next reset pulse. In effect the counter is reset but the output is held at its value at the time of the pulse. The NL601 has two outputs, the first is a simple pulse out when the counter reaches full scale count the output goes high until the counters are reset. The second is the analog output. Adjustable between 1 volt and 11 volts for full scale count (using the front panel output adjuster pot) the output will increase by 1/255 (for a full scale count of 255) for every pulse in and will stay at maximum voltage for every pulse after 255 until the unit is reset.

Specifications

Inputs	TTL pulses
Pulse Out	TTL
Analog Out	Adjustable between 1 V and 11 V for full scale via front panel pot
Output Steps	255
Pre-Scaler	None, 10, or 100

Order #	Model	Product
W4 65-0260	NL601	Pulse Integrator

NL603 Counter

The **NL603** Counter is a 2-digit preset decade counter with a 2-digit light emitting diode decimal readout. The counters can be externally reset and gated; they can be operated in one of three modes: Preset-Reset in which the counters are reset to zero when the count equals the preset switch settings; Preset-Stop in which the count is stopped when the preset number is reached; and FREE RUN, in which the preset number does not affect the count. A pulse occurs at the output when the count equals the preset number (Free Run and Preset-Reset modes); a high logic level appears at the output during counting in the Preset-Stop mode. Up to 3 NL603 Counters can be cascaded to give arbitrarily large counts. Carry, reset and preset logic signals are automatically relayed to adjacent Counters through rack edge connectors when the Counters are cascaded. NL603 modules can be used for digital control of pulse width, cycle duration, pulse delay (phase), number of pulses in trains, etc. Precision obtainable when used with the NL304 Period Generator is better than 0.01% in minimum steps of 1 µsec. The LED display of the NL603 enables it to be used to count responses, number of stimuli delivered, etc., in addition to controlling pulse trains.

Specifications

Inputs	TTL pulses
Output Fan-Out	10 TTL inputs
Output Pulse Width	(Free Run and Preset-Reset modes) 0.5 µsec (nominal)
Max. Counting Rate	5 MHz

Order #	Model	Product
W4 65-0261	NL603	Counter

NL703 and NL800A **neurolog™ system**



NL703 EMG Integrator

The **NL703** EMG Integrator module was designed to produce an analogue signal to represent muscle activity. The unit will accept signals up to ± 1 V which it full-wave rectifies and applies to a 'leaky integrator'. The output of the integrator is buffered and the overall gain is set at unity. The time constant of the integrator is set by a 6-position rotary switch. A toggle switch is also provided so that the direct signal can be viewed.

Specifications

Input	Max. signal that can be processed without distortion is ± 1 V
Input Overload	Input is protected up to ± 75 V
Time Constants	Setable to 20, 50, 100, 200, 500 and 1000 msec; accuracy better than 10%
Integrate/Direct	Either Integrated signal or input signal is selectable by this switch; if Direct is selected, Integrator is reset to zero
Output	Output produces signal which has gain of unity from input but integrated with respect to time at time constant selected
Output Impedance	600 Ω in integrate; connected to INPUT socket in Direct

Order #	Model	Product
W4 65-0266	NL703	EMG Integrator



NL800A Stimulus Isolator-Constant Current

The **NL800A** Stimulus Isolator is a battery powered, light-coupled isolated stimulator. It has a constant current output, with very high output impedance, making it suitable for stimulation through microelectrodes as well as with gross electrodes. Can be driven by the NL510A Pulse Buffer or NL512 Biphasic Buffer. When used with the NL510A, output current is set by the 10-turn AMPLITUDE control on the NL510A itself. Alternatively, the NL512 allows biphasic analogue waveforms (e.g. from a PC) to be converted into a biphasic stimulus when used in conjunction with two NL800A units. In both cases, output pulses have the same timing as input pulses. Features of the NL800A are its very small physical size (for mounting close to the preparation), low battery consumption, excellent isolation (< 1 pF output to input or ground coupling), and fast rise time.

Specifications

Input Requirements	10 V at 30 mA (nominal) for full scale output
Output Current Range	0 to 10 mA in 4 overlapping decade ranges
Output Risetime	< 5 μ sec (1 k Ω load); < 20 μ sec (typical tungsten micro-electrode load); < 40 μ sec for 1 M Ω resistor across output
Output Resistance	> 900 M Ω
Input-Output Capacitive Coupling	< 1 pF
Accuracy and Linearity	$\pm 3\%$ of full scale output for each output range
Dimensions	38 x 54 x 98 mm (1.50 x 2.13 x 3.5 in) excluding knob

Order #	Model	Product
W4 65-0276	NL800A	Stimulus Isolator, Constant Current
W4 65-0363	NL800BATT	Set of Five Batteries for NL800A



NL844 4-Channel Pre-Amplifier

The **NL844** pre-amplifier is specifically designed to operate in conjunction with the NL820A Isolator. Its low noise and high impedance differential inputs make it particularly suitable for use as a headstage pre-amplifier close to the preparation, ideal for isolated EMG, EEG or ECG applications. It features 4 pairs of colour coded 1.5mm DIN “touch proof” sockets for electrode connection as well as a COM input. The unit can be operated in 1, 2, 3 or 4 channel modes with unused channels switched off using the rear panel toggle switches. This unit is particularly suited for use where there are very large stimulus artefacts, for example when used close to a magnetic stimulator coil. The input circuit automatically adjusts to the DC input conditions plus a non-linear filter modifies its time constant if the differential input signal exceeds its normal $\pm 0\text{mV}$ working range. Therefore, fast, short artefacts do not block the subsequent stages. This results in an amplifier with a very fast recovery time from stimulus artefact pulses.

Specifications




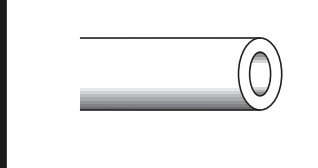

Gain	x100, x1,000, x10,000 (operated in channel pairs)
Low Frequency Cut	3, 10, 30 Hz (operated in channel pairs)
High Frequency Cut	With NL820A > 35 kHz -3dB
Input Impedance	100 M Ω
Input Channels	4
Common Mode	10,000:1 (-80 dB) (with NL820A -120 dB)
Noise	5 μV RMS full bandwidth
Lead Length	2.5 m

Order #	Model	Product
W4 65-0362	NL844	4-Channel Pre-Amplifier

Order #	Model	Product
Cables		
W4 65-0386	NL951-15cm	Cable With Male Connectors (Lemo Type F00250) on Both Ends, 15 cm L
W4 65-0387	NL951-30cm	Cable With Male Connectors (Lemo Type F00250) on Both Ends, 30 cm L
W4 65-0388	NL951-45cm	Cable With Male Connectors (Lemo Type F00250) on Both Ends, 45 cm L
W4 65-0284	NL951-1m	Cable With Male Connectors (Lemo Type F00250) on Both Ends, 1 m L
W4 65-0385	NL951-2m	Cable With Male Connectors (Lemo Type F00250) on Both Ends, 2 m L
W4 65-0285	NL952	Cable With Male Connector at One End and Tinned Leads at Other End, 2 m L
W4 65-0286	NL953	4-Way Cable With One Plug (Mates with NL103/NL107), 2 m L
W4 65-0287	NL953K	4-Way Cable With One Plug (Mates with NL104A/NL108A), 2 m L
W4 65-0288	NL975	Two-Way With 2 x 4 mm Plugs (for NL120), 1 m L
Extension Cables		
W4 65-0289	NL950	One-Way With Plug (Standard NeuroLog™ Style), 10 cm L
W4 65-0290	NL954	4-Way Extension Cable for NL100A/NL103/NL107, 2 m L
W4 65-0291	NL954K	4-Way Extension Cable for NL100AK/ NL104A/NL108A/NL850A, 2 m L
W4 65-0292	NL955	6-Way Extension Cable for NL102 (With Split Socket), 2 m L
W4 65-0293	NL955K	6-Way Extension Cable for NL102 (Standard Keyway), 2 m L
W4 65-0294	NL956K	6-Way Extension Cable for NL102G, 2 m L
Plugs		
W4 65-0295	NL962	Lemo 1-Pole (Standard NeuroLog™ Plug)
W4 65-0296	NL963	Lemo 4-Pole for NL103/NL107
W4 65-0297	NL963K	Lemo 4-Pole for NL104A/NL108A
W4 65-0298	NL967K	Lemo 6-Pole for NL102G
W4 65-0299	NL968K	Lemo 2-Pole for NL410
W4 65-0300	NL969P	Lemo 9-Pole Insulated for NL820A

Order #	Model	Product
Panel-Mounted Sockets		
W4 65-0301	NL944	Lemo 4-Pole, as on NL103 and NL107
W4 65-0302	NL944K	Lemo 4-Pole, as on NL104A, NL108A
W4 65-0303	NL964	Lemo RA00250 (Standard NeuroLog™ Socket)
W4 65-0304	NL969S	Lemo 9-Pole Insulated, as on NL820A
Cable Mounted Sockets		
W4 65-0305	NL965	4-Pole (Matches NL100A)
W4 65-0306	NL965K	4-Pole (Matches NL100AK/NL850A)
W4 65-0307	NL966K	6-Pole (Matches NL102GH)
Adapters		
W4 65-0308	NL957	4-Way for NL100AK to NL103, 2 m L
W4 65-0309	NL957K	4-Way Adapter for NL100A to NL104A, 2 m L
W4 65-0310	NL960	BNC Plug to Lemo Socket
W4 65-0311	NL961	Lemo One-Pole 'T' Connector
W4 65-0312	NL969T	'T' Connector for Two NL822/832
Accessory Kit		
W4 65-0313	NL973A	NL100AK Headstage Accessory Kit
W4 65-0314	NL976	NL102G Headstage Accessory Kit
Blank NeuroLog™ Front Panels for Current Royal Blue NL900D's		
W4 65-0632	NL910D-1	Single Width Panel
W4 65-0633	NL910D-2	Double Width Panel
W4 65-0634	NL910D-4	Quad Width Panel
W4 65-0635	NL910D-6	Hex Width Panel
W4 65-0636	NL910D-8	Octal Width Panel
W4 65-0637	NL911D-1	Single Width Panel with Handle and Panel Screws, No PCB Mounts
<i>Blank Panels for older NL900™ Models are available. Please contact Customer Service for availability.</i>		
Other Items		
W4 65-0320	NL970/10	Stacking Plugs, 1 mm D, pkg. of 10
W4 65-0321	NL972/10	Gold Plugs, 2 mm D, pkg. of 10
W4 65-0322	NL980	Edge Connector Extender Cable; Allows Access to Both Sides of Working Module for Trimmer Adjustments, Calibration and Servicing
W4 65-0323	NL985	Loudspeaker for NL120S
W4 65-0325	NL1MAN	NeuroLog™ Operators Manual (Supplied with NL900 but also Sold Separately)

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microinjection

Introduction to Microinjection

The use of Glass Needle (Fine Glass Microcapillary Pipette) based techniques for intracellular/extracellular microinjection and perfusion has become a popular procedure in numerous areas of experimental biology research (e.g. In vitro fertilization, transgenics, etc.). These techniques can best be described as micro surgical procedures that are conducted on a single cell using either a single or multiple barrel glass micropipette a precision positioning device (micromanipulator) and a microinjector or microperfuser. The micropipettes used in these procedures are formed using a Pipette Puller. The capillary glass tubing is heated to its softening point and 'pulled' to create the proper size tip diameter and taper for the desired application. The small tip diameters (as low as 0.2 μm) of these micropipettes combined with the high precision of the Micromanipulator and Microinjection/Perfusion Apparatus, allows for precise and accurate delivery. This precision allows for accurate and repeatable injections down to the sub-picoliter liter range into or around various types and sizes of cells with accuracy to 0.1 micron. The process of extruding substances through these micropipettes is accomplished through the use of either direct hydrostatic pressure (Pressure Injection) or by moving charged ions that are the result of an applied electric field (Iontophoresis) without the use of hydraulic flow.

Applications of microinjection range from assisted (In vitro) cell fertilization techniques to the transport of molecular and cellular elements. These substances are typically injected into the cell to manipulate and/or monitor the fundamental biochemistry of a specific living cell. Substance that can be injected include, cellular organelles, kinases, histochemical markers (such as horseradish peroxidase or lucifer yellow), proteins, metabolites, microbeads, ions, antibodies, genes, molecular biology mRNA and DNA, etc. The precise delivery (microperfusion) of small volumes (picoliter to milliliter) of various agents and drugs to a cell or group of cells for applications such as pharmacological drug testing can also be accomplished using these techniques.

In order for the researcher to conduct any of the above experiments and get meaningful results, the tools (equipment) used in these experiments must provide not only the specific functionality, but they also need to be of the highest quality and provide the necessary reliability, accuracy and repeatability to insure proper results. Harvard Apparatus, Inc. manufactures and sells the complete range of product that are needed to successfully microinject and/or microperfuse.



Warner and Harvard Apparatus Clark Capillary Glass, pages 324-330



Harvard Apparatus/Medical Systems Picoliter Injectors, pages 275 to 282



Harvard Apparatus Medical Systems NeuroPhore, see pages 284 to 292



Pressure Injection Systems, pages 291 and 292



Pipette Pullers, pages 331 to 334



Micromanipulators, pages 295 to 304

NEW Model PLI-10 Low Cost Pico Injector



- Femtoliter to microliter injections
- Digital readouts for injection pressure, time, and count
- Reliable optically encoded circuit for injection time set
- Easy to use

The PLI-10 Pico-Injector reliably delivers ejections from femtoliters to nanoliters through micropipettes by applying a regulated pressure for a digitally set period of time.

Pressure to the pipette is controlled precisely through a multi-turn regulator, and is reported digitally for reproducibility. Injection time is set using an optically encoded circuit which permits fine and coarse settings from a single knob.

The system timer can be controlled in three ways, front panel push button, foot switch, and external trigger input BNC.

Typical applications are large volume injections, (large volume is considered to be in the 10-100 Pico liter range), extracellular sample delivery, and

Xenopus Oocyte injection because of their large size (1.0 mm).

Specifications

Input Gas Pressure	75 PSI Recommended, 105 PSI Maximum
Injection Pressure	0.2 to 60 PSI (413 KPa) regulated
Injection Time	0.01 to 99.99 Seconds
Injection Time Accuracy	±0.01% (Crystal Time Base)
Pressure Display	3½ Digits, 0.1 PSI or 1 KPa Resolution
Injection Count Display	0 to 9999 Injections
Trigger Mode	Front Panel, Footswitch, TTL (Gate In)
Pressure Monitor Output	BNC, Rear Panel, 10 mV/PSI or 1 mV/KPa
Power Input	External 9VDC @ 400mA (min) Power Supply universal input voltage 90 to 264 VAC
Weight	2.3 kg
Dimensions (HxWxD)	89 x 215 x 175 mm (3.5 x 8.5 x 6.9 in)
Warranty	One year, parts & labor

Order #	Model	Product
W4 64-1707	PLI-10	Pico-liter includes input hose, output hose, and foot switch
W4 64-1626	A0161.0	Acrylic pipette holder for 1.0 mm pipettes
W4 64-1627	A0161.2	Acrylic pipette holder for 1.2 mm pipettes
W4 64-1628	LPLI-PPH	Acrylic pipette holder for 1.5 mm pipettes
W4 64-1629	A0162.0	Acrylic pipette holder for 2.0 mm pipettes

microinjection

PLI-100

Medical Systems Pico-Injector

A full featured workhorse microinjector



W4 65-0001 PLI-100 Pico-Injector



- 5 pressures: inject, balance, clear, fill and hold
- Reliable
- Femtoliter to microliter injections
- Reproducible performance
- Easy to use
- Popular applications:
 - Injection of mouse, frog, zebrafish and other oocytes
 - Extracellular brain injections
 - Injection of DNA, mRNA, microbeads, neurotransmitters, kinases and other proteins
- Most Published Injector

The PLI-100 Pico-Injector reliably delivers a wide range of volumes through micropipettes by applying a regulated pressure for a digitally set period of time. Compressed gas allows the user to deliver desired volumes from femtoliters to microliters while simultaneously holding a cell. Whether you need to do large injections into capillaries or very small injections into mammalian nuclei, the PLI-100 is well suited for your experiment.

The PLI-100 has become a favorite of prestigious national microinjection workshops like Cold Spring Harbor Laboratories and other researchers worldwide. Other companies have tried to design similar systems, but the PLI-100 remains unparalleled in terms of ease of use, durability, precision, and cost.

Researchers Say:

"The PLI-100 is very robust, in constant use in our lab."

"Most importantly, the PLI-100 valves prevent cytosol and yolk backflow into my pipette after oocyte injection."

"It's very easy to control."

"The PLI-100 is heavily used on a daily basis, and works great."

"I like the fact that I can use the PLI-100 with TTL pulses."

"It works great in conjunction with my imaging system."

"The balance pressure is a good option."

"My injection pipettes rarely clog."

Easy to Use

Inject with the touch of a button or a tap of the foot switch — it's as easy as that!

Reproducible

Pressure to the pipette is controlled precisely through a multi-turn regulator, and is reported digitally for easy repeat. Injection time is digitally controlled in 10 msec steps between 0.01 to 0.99 seconds (and in 1 second steps between 1 to 99 seconds). Pipette tip diameter, and hence delivered volume, are easy determinations once the timing and pressure are known.

Versatile

Deliver volumes from femtoliters to microliters with the same instrument, resulting in a wide range of applications.

Pressure Capabilities

The PLI-100 features two negative and three positive pressure pneumatic capabilities.

The negative, or vacuum functions allow the user to:

1. Fill micropipettes from their tips, reducing wastage of valuable injectables.
2. Provide a means to secure and manipulate a cell using a holding pipette.

PLI-100

Medical Systems Pico-Injector (continued)

The positive pressures allow the user to:

1. Eject precise amounts of fluids.
2. Create a balance pressure which prevents backflow into the micropipette following an injection.
3. Clear a micropipette of material in it.

Unique Features

The PLI-100's important 'Balance', 'Hold' and 'Clear' functions are not found on other microinjection units.

Balance

In addition to the ejection pressure, the Pico-Injector offers a secondary balance pressure. This secondary balance maintains a positive pressure on the injection pipette before and after injections. This eliminates dilution caused by capillary action and aids in the prevention of clogging. Wasteful continuous injection, which often occurs when no separate balance pressure is offered by an injection device, is avoided.

Fill/Hold

There are two built-in vacuum generators to fill a micropipette from the tip and to hold suspended cells. Filling the pipette from the tip is easier than back filling. Suspended cells can be held with a second (holding) pipette. The holding vacuum's range accommodates most cell types.

Clear

A high-pressure pulse can be used for clearing a pipette, should it happen to clog. This is particularly useful when working with pipettes sized for smaller volumes.

Electrical Connectors

BNC type connectors are available at the front panel to ease integrating the Pico-Injector with other equipment. Synchronization of injections to other stimulations or recordings is therefore possible.

Selection Guidelines

The PLI-100 is available in three packages: Plus, Basic and Deluxe. The basic unit is supplied with an input hose, output hose, holding hose, power cord and instruction manual. The plus unit also includes a foot switch, pipette holder and input hose adapter. The deluxe unit includes all the previously mentioned accessories plus an additional foot switch and one pipette holder.

Accessories

Available accessories for the PLI-100 Injection Systems are located on page 281.

Specifications

Input Gas Pressure	70 to 105 p.s.i. (480 to 720 kPa)
Injection Pressure	0.2 to 60 p.s.i. (413 kPa), regulated, multi-turn control
Balance Pressure	0.1 to 3.5 p.s.i. (68.9 kPa), regulated, multi-turn control, other ranges available upon request
Fill Vacuum	Internally produced, -12.0 p.s.i. (-82 kPa), unregulated
Holding Vacuum	Internally produced, 0 to 3 in H ₂ O (0 to 0.75 kPa or 0 to 0.1 p.s.i.), regulated
Clearing Pressure	Input gas pressure, unregulated
Injection Timer Pulse Width	0.01 to 0.99 sec in 10 msec steps; 1 to 99 sec in 1 sec steps
Injection Count Display	Digital, 0 through 9999
Duration Mode	Internally timed or externally gated
Time Trigger	Front panel, foot switch, or external TTL pulse (BNC)
Pressure Units	p.s.i./kPa; switch selectable
Pressure Monitor	BNC connector, 10 mV/p.s.i.
Pressure Readout	Inject, balance, clear, output port
Line Voltage	100/110/220/240 VAC
Power Usage	220 W
Meter Accuracy	0.1% full scale
Foot Switches	Inject, fill, hold, and gated; provided in plus and deluxe pkgs.
Weight	6.8 kg (15 lb)
Dimensions, H x W x D	11 x 38 x 25.5 cm (5 x 15 x 10 in)
Accessories Supplied	Input, output and holding hoses

Order #	Model	Product
W4 65-0001	PLI-100	PLI-100 Basic Pico Injector with Injection, Balance, Clear, Filling and Holding Pressures; Comes with Input Hose, Output Hose, Holding Hose, Power Cord and Instruction Manual
W4 65-0002	PLI-100 Plus	PLI-100 Plus Pico Injector with Injection, Balance, Clear, Filling and Holding Pressures; Comes with Input Hose, Output Hose, Holding Hose, Power Cord, Instruction Manual, Foot Switch (W4 65-0029), Pipette Holder (W4 65-0013) and Input Hose Adapter
W4 65-0003	PLI-100 Deluxe	PLI-100 Deluxe Pico-Injector with Injection, Balance, Clear, Filling and Holding Pressures, Comes with Input Hose, Output Hose, Holding Hose, Power Cord, Instruction Manual, Two Foot Switches, Two Pipette Holders and Input Hose Adapter

microinjection

PLI-100A

Pico-Injector



- Femtoliter to microliter injections
- Digital readouts for injection pressure, time, and count
- Reliable optically encoded circuit for injection time set
- 5 pressures: inject, balance, clear, fill and hold

The PLI-100A Pico-Injector reliably delivers ejections from femtoliters to nanoliters through micropipettes by applying a regulated pressure for a digitally set period of time.

Pressure to the pipette is controlled precisely through a multi-turn regulator, and is reported digitally for reproducibility. Injection time is set using an optically encoded circuit which permits fine and coarse settings from a single knob.

The system timer can be controlled in three ways, front panel push button, foot switch, and external trigger input BNC.

Whether you need to do large injections into capillaries or very small injections into mammalian nuclei, the PLI-100A is up for the task.

Pressure Capabilities

The PLI-100A features two negative and three positive pressure pneumatic capabilities. The negative or vacuum functions allow the user to:

1. Fill micropipettes from their tips, reducing waste of pipettes.
2. Provide a means to secure and manipulate a cell using holding pipette.

The positive pressures allow the user to:

- **Eject precise amounts of fluids**
- **Create a balance pressure which prevents backflow into the micropipette following an injection**
- **Clear a micropipette of material in it**

Unique Features

The PLI-100A's important 'Balance', 'Hold' and 'Clear' functions are features not found on other microinjection units.

Balance

In addition to the ejection pressure, the Pico-Injector offers a secondary balance pressure. This adjustable pressure keeps a positive pressure on the injection pipette before and after injections. This eliminates dilution caused by capillary action and aids in the prevention of clogging. Wasteful continuous injection, which often occurs when no separate balance pressure is offered by an injection device, is avoided.

Fill/Hold

There are two built-in vacuum generators to fill a micropipette from the tip and to hold suspended cells. Filling the pipette from the tip is easier than back filling. The PLI-100A features a Fill Vacuum adjustment on the front panel. Suspended cells can be held with a second (holding) pipette. The holding vacuum's range accommodates most cell types.

Clear

A high-pressure pulse can be used for clearing a pipette, should it happen to clog. This is particularly useful when working with pipettes sized for smaller volumes.

Electrical Connectors

BNC type connectors are available at the front panel to ease integrating the Pico-Injector with other equipment. Synchronization of injections to other stimulations or recordings is therefore possible.

Selection Guideline

The PLI-100A is available in three packages: **Basic, Plus, and Deluxe**. The **Basic** unit is supplied with an input hose, output hose, holding hose, and input hose adapter.

The **Plus** unit also includes a foot switch, pipette holder, and input hose adapter.

The **Deluxe** unit includes all the accessories included with the Plus and an additional foot switch and pipette holder.

PLI-100A

Pico-Injector (Continued)



Rear Panel



Output Hose



Holding hose with cell release bulb



Pipette Holder (W4 65-0013)

Specifications

Input Gas Pressure	75 PSI Recommended, 105 PSI Maximum
Injection Pressure	0.2 to 60 PSI (413 KPa), regulated
Balance Pressure	0.1 to 9.9 PSI (68.9 KPa) regulated, multi-turn control, other ranges available on request
Fill Vacuum	Internally produced 0 to -12 PSI (0 to -82 KPa), regulated
Holding Vacuum	Internally produced 0 to -0.1 PSI (0 to -0.75 KPa), regulated
Clearing Pressure	Input gas pressure, unregulated
Injection Time	0.01 to 99.99 Seconds
Injection Time Accuracy	±0.01% (Crystal Time Base)
Duration Mode	Internally timed or externally gated
Time Trigger	Front panel, foot switch, or external TTL pulse (BNC)
Pressure Units	PSI /KPa switch selectable
Pressure Monitor Output	BNC, Rear Panel, 10 mV/PSI or 1 mV/KPa
Pressure Readout	Inject, balance, clear, output port
Pressure Display Resolution	3½ Digits, 0.1 PSI or 1 KPa
Injection Count Display	0 to 9999 Injections
Power Input	External 9VDC @ 400mA (min) Power Supply universal input 90 to 264 VAC
Weight	5.44 kg (12 lb)
Dimensions (HxWxD)	89 x 432 x 250 mm (3.5 x 17 x 9.8 in) (H x W x D)
Warranty	One year, parts & labor

Order #	Model	Product
W4 64-1735	PLI-100A	PLI-100A Basic Pico Injector with Injection, Balance, Clear, Filling and Holding Pressures; Comes with Input Hose, Output Hose, Holding Hose, and Input Hose Adapter
W4 64-1736	PLI-100A Plus	PLI-100A Plus Pico Injector with Injection, Balance, Clear, Filling and Holding Pressures; Comes with Input Hose, Output Hose, Holding Hose, Foot Switch (65-0029), Pipette Holder (65-0013), and Input Hose Adapter
W4 64-1737	PLI-100ADeluxe	PLI-100A Deluxe Pico-Injector with Injection, Balance, Clear, Filling and Holding Pressures, Comes with Input Hose, Output Hose, Holding Hose, Two Foot Switches, Two Pipette Holders, and Input Hose Adapter

PLI-90

Medical Systems Pico-Injector

Precise and reproducible injection



W4 65-0004 PLI-90 Pico-Injector

- 3 pressures — inject, balance, and clearing
- Eliminates backflow into pipette after injection
- Reproducibly delivers femtoliters to microliters
- Easy to use
- Economical
- Precise

The PLI-90 Pico-Injector, like the reliable PLI-100 Pico-Injector, controls the precise and reproducible regulation of injection pressure and time.

Simplicity

Because the PLI-90 features only the injection, balance, and clearing pressures, it is a lower cost alternative to the PLI-100. This simplicity makes it even easier to use than the PLI-100.

Selection Guidelines

The PLI-90 is ideal for the user who does not require vacuum for filling pipette barrels or if using a holding pipette for holding cells is not essential to your application.

The PLI-90 is available in two packages: Basic and Plus. The basic model includes an input and output hose, handle, power cord and instruction manual. The plus model is supplied with all of the same parts as the basic model but also includes a Footswitch, Pipette Holder, and Input Hose Adapter.

Specifications

Input Gas Pressure	70 to 105 p.s.i. (480 to 720 kPa)
Injection Pressure	0.2 to 60 p.s.i. (413 kPa), regulated, multi-turn control
Balance Pressure	0.1 to 9.9 p.s.i. (68.9 kPa), regulated, multi-turn control, other ranges available upon request
Clearing Pressure	Input gas pressure, unregulated
Injection Time	0.01 to 0.99 sec in 10 msec steps; 1 to 99 sec in 1 sec steps
Pressure Display	Digital, three and a half digits
Duration Mode	Internally timed or externally triggered
Trigger Mode	Foot or panel switch
Pressure Readout	Inject, balance, clear, output port
Line Voltage	100/110/220/240 VAC
Power Usage	220 W
Foot Switch(es)	Optional inject and gating
Accessories Supplied	Input hose, output hose and power cord
Weight	6.8 kg (15 lb)
Dimensions, H x W x D	11 x 38 x 25.5 x cm (5 x 15 x 10 in)

Order #	Model	Product
W4 65-0004	PLI-90 BASIC	Pico-Injector with Injection, Balance and Clear Pressures; Includes Input Hose (PLI-IHN) and Output Hose (PLI-OHN), Handle, Power Cord and Instruction Manual. Applications: Basic setups that do not need suction.
W4 65-0005	PLI-90 PLUS	Pico-Injector Basic Model and Accessories (Shown Above), Plus One Each PLI-FS Foot Switch, PLI-PH1 Pipette Holder and PLI-IHA Input Hose Adapter

PLI-100 and PLI-90

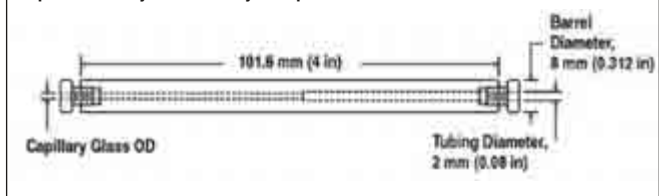
PLI-100 and PLI-90 Accessories



Order #	Model	Product
Accessories		
W4 65-0029	PLI-FS	Footswitch for Inject, Hold, Fill or Gate (Order more than one if frequent use of footswitch is needed for more than one of these functions.)
W4 65-0030	PLI-RM	Frame to Mount PLI-90 or PLI-100 in 19-in. Wide Instrument Rack
Hosing		
W4 65-0006	PLI-IHA	Input Hose Adapter (¼ in Male W4T Pipe Thread) Gas Bottle Regulator Fitting; Connects with PLI-IHO/N
W4 65-0007	PLI-IHO	Gas Input Hose (Tygon Tubing), 9 ft x 0.250 in (6.35 mm) x 0.125 in (3.18 mm) x 0.062 in (1.57 mm) (L x OD x ID x Wall Thickness); Connects to PLI-IHA and PLI 90/100 Gas Input, Brass Screw Fitting Type - Old
W4 65-0008	PLI-IHN	Gas Input Hose (Tygon Tubing) 9 ft L x 0.250 in (6.35 mm) OD x 0.125 in (3.18 mm) ID x 0.062 in (1.57 mm) Wall Thickness; Connects to PLI-IHA and PLI 90/100 Gas Input, Quick Connect/Disconnect Type - New
W4 65-0009	PLI-OHO	Output Hose (Tygon Tubing) 9 ft L x 0.071 in (1.80 mm) OD x 0.039 in (1 mm) ID x 0.016 in (0.41 mm) Wall Thickness; Connects to MSC Pipette Holders, Brass Screw Fitting Type - Old
W4 65-0010	PLI-OHN	Output Hose (Tygon Tubing) 9 ft L x 0.071 in (1.80 mm) OD x 0.039 in (1 mm) ID x 0.016 in (0.41 mm) Wall Thickness; Connects to MSC Pipette Holders and PLI 90/100 Gas Output, Quick Connect/Disconnect Type - New
W4 65-0011	PLI-HHO	Holding Hose with Cell Release Bulb; 9 ft L x 0.071 in (1.80 mm) OD x 0.039 in (1 mm) ID x 0.016 in (0.41 mm) Wall Thickness; Connects to MSC Pipette Holders and PLI-100 Hold Output, Brass Screw Fitting Type - Old
W4 65-0012	PLI-HHN	Holding Hose with Cell Release Bulb; 9 ft L x 0.071 in (1.80 mm) OD x 0.039 in (1 mm) ID x 0.016 in (0.41 mm) Wall Thickness. Connects to MSC Pipette Holders and PLI-100 Hold Output, Quick Connect/Disconnect Type - New

Order #	Model	Product
Pipette Holder/Adapter/Parts		
W4 65-0013	PLI-PH1	Stainless Steel Pipette Holder, 130 mm L for 1 to 1.5 mm OD Glass Pipettes
W4 65-0014	PLI-PH1A	Stainless Steel Pipette Holder, 80 mm L for 1 to 1.5 mm OD Glass Pipettes
W4 65-0017	PLI-SRG	Silicone Rubber Gasket Replacement for use with PLI-PH1 and PLI-PH1A, 10.2 cm (12 in)
W4 65-0015	PLI-SRG1.5	Silicone Rubber Gasket Replacement for use with 1.5 mm Glass Pipettes
W4 65-0018	PLI-SSB	Stainless Steel Bushing Replacement for use with PLI-PH1 and PLI-PH1A Pipette Holders
W4 65-0019	PLI-PC	Stainless Steel Pipette Cap Replacement for use with PLI-PH1 and PLI-PH1A Pipette Holders
W4 65-0020	PLI-HN	Stainless Steel Hose Nut Replacement for use with PLI-PH1 and PLI-PH1A Pipette Holders
W4 65-0021	PLI-PH-KIT	Pipette Holder Hardware Replacement Kit for use with PLI-PH1 and PLI-PH1A Pipette Holders, Includes 1 each PLI-SSB, PLI-PC, PLI-HN and PLI-SRG
W4 65-0022	PLI-PHA	Stainless Steel Pipette Holder (PLI-PH series) Adapter for Eppendorf ECET FEMTOTIP

Optional "Easy Insert" Acrylic Pipette Holder



W4 64-1626	A016 1.0	Acrylic Pipette Holder for 1.0 mm Pipettes
W4 64-1627	A016 1.2	Acrylic Pipette Holder for 1.2 mm Pipettes
W4 64-1628	PLI-PPH	Acrylic Pipette Holder for 1.5 mm Pipettes
W4 64-1629	A016 1.2	Acrylic Pipette Holder for 2 mm Pipettes

microinjection

PLS-1

Pico Injection/Micromanipulator System



The PLS-1 Pico Injection/Micromanipulator System combines our popular PLI-100 pico injector, a motorized micromanipulator, and magnetic base in a single package.

The PLI-100 Pico-Injector delivers a wide range of volumes through micropipettes by applying a regulated pressure for a set period of time. The system features 5 pressures: inject, balance, clear, fill, and hold. The injector comes complete with input and output hoses, foot switch and pipette holder.

For precise and convenient movement of the electrode our three axes motorized micromanipulator and push button controller are included. This micromanipulator features hands free spatial resolution of 0.5 μm which enables positioning in the sub-micro range. Flexible motor coupling ensures no vibration of probe during movement.

The MB/B magnetic base provides a convenient position device for the micromanipulator.

Order #	Model	Product
W4 64-1608	PLS-1	Pico-Injector Micromanipulator System
W4 65-0002	PLI-100 Plus	Pico Injector
W4 60-0571		Right-handed motorized micromanipulator
W4 60-0577		Push button controller
W4 64-0060		MB/B Magnetic base

Model Air-1 Ultra Low Noise Air Compressor



Specifications

Input Voltage Range	120 or 230 VAC specify at time or order
Maximum Current	6.2A@ 120 VAC 2.9A@ 230 VAC
Motor	0.54 HP / 0.40kW
Displacement	60 l/min or 2.12 CFM
FAD @ 8 bar	32 l/min or 1.13 CFM
Max. Pressure	8 bar / 120 psi
Tank Size	4 liters / 1.1 gallon
Noise Level	45 dB(A)
Physical Dimensions:	
Size, H x W x D	382 x 300 x 334 mm (15 x 11.8 x 13.2 in)
Weight	23 kg (50.6 lb)
Warranty	One year, parts & labor

Order #	Model	Product
W4 64-1701	AIR-1 U	Ultra low noise 120VAC
W4 64-1702	AIR-2	Ultra low noise 230VAC

- Suitable for installation directly at point of use
- Lowest noise and vibration level in the market 45dB(A) you won't even know it's on
- Complete compressed air package
- Ideal for use with our microinjection systems

When a reliable supply of clean and quiet compressed air is required, this oil-lubricated compressor is the perfect choice. The noise level is 45 dB(A) - far below the level of normal conversation. Quiet, vibration-free and reliable this compressors compact design easily allows mounting at the place of use.

The oil-lubricated piston compressor is supplied ready for use. The unique synthetic SJ-27 oil designed especially for AIR-1 optimizes the lubrication of the compressor.

Furthermore, the internal motor is mounted in a closed motor house, reducing the noise level even further. Due to the design of the motor, the oil is also used for cooling the motor.

The motor is mounted on springs inside the motor housing, which means that hardly any vibrations are imparted to the surroundings. Two noise reduction chambers on the intake side and two noise reduction chambers on the pressure side ensure absorption of the noise. The compressor is also supplied with rubber feet, preventing vibrations from imparting to the mounting bolts and foundation. The noise level of the oil-lubricated compressor is 45 dB (A) – below the noise level of a refrigerator.

The oil minimizes the wear and tear of the vital parts in the compressor, prolonging the lifetime and at the same time ensuring low maintenance costs.

Harvard Neuro Phore BH-2 System

Micro-Iontophoresis and Micro Injection

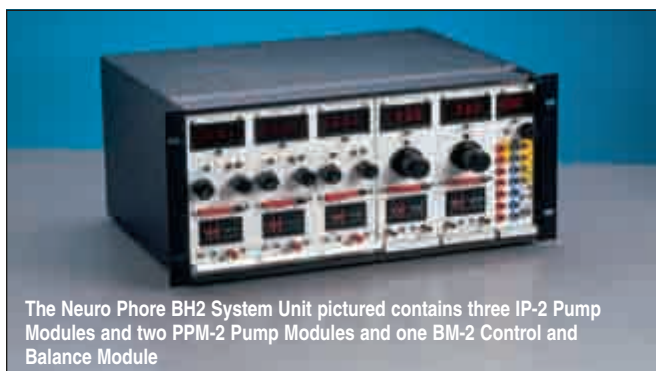
Harvard Neuro Phore BH-2 System

In the past few decades, the application of drugs and other dissolved agents from multibarrel electrodes/pipettes has evolved into a practical method of testing their effects on cells or cellular systems. The versatile Neuro Phore BH-2 System is designed to facilitate controlled ejection of fluids from multibarrel micropipettes.

Extracellular ejections of minute volumes can be delivered using up to five pumps in serial or parallel. The ejection schedule for each pump can be independently programmed for sequential or simultaneous output. Ejection cycles can be internally timed, triggered manually, or synchronized to external events.

This flexible system allows the use of iontophoretic pump modules, pneumatic pump modules, or a combination of both. By interchanging the IP-2 Iontophoresis Pump Module with a PPM-2 pneumatic pressure pump, the overall system capability can be expanded for simultaneous pressure and iontophoretic injection of drugs from a multibarrel pipette.

The Neuro Phore BH-2 System was developed under the guidance of active researchers with extensive experience in iontophoresis techniques. These researchers needed a system to provide precise stimulation and quantitative control for ejection of drugs in their pharmacological studies of drug evoked responses such as neurosynaptic discharges, contraction, and changes in chemical concentration. What emerged was a reliable, accurate, easy to use, Neuro Phore BH-2 system that is capable of accommodating high impedance multi-barreled micro-electrode pipettes.



The Neuro Phore BH2 System Unit pictured contains three IP-2 Pump Modules and two PPM-2 Pump Modules and one BM-2 Control and Balance Module

- Used by leading researchers for over 20 years
- Modular
- Minimal noise
- Up to 6 channels
- Digitally controlled eject and pause timing
- Mix and match pump types

Features

- Successfully utilized in key laboratories around the world for over 20 years, with many journal articles published as a result
- Modular design; buy what you need now and add additional modules later as your protocol evolves
- Accommodates 7 barrel micropipettes, supports the most complex and demanding injection and recording protocols
- Extremely low noise, ± 105 volts compliance, allows rapid iontophoretic injection with even the smallest micropipette tips
- Automatic current neutralization for minimal electrical artifacts

- Digitally controlled eject and pause timing utilizes easy to read and set digital panel switches on each iontophoretic or pressure module/channel
- Unbalance and out of compliance indicators are a great aid in troubleshooting clogged pipettes and other problems
- External analog input control allows external programming of complex, or closed loop injection protocols
- Current and electrode resistance readout with large bright easy to read digital displays

System Configuration

The Neuro Phore BH-2 System is modular and is comprised of the following components (all ordered separately):

- One BH-2 Mainframe Chassis, W4 65-0600 that can accommodate 1 to 5 Iontophoretic Pump and/or Pressure Pump Modules; Mainframe Chassis can be rack mounted or set on table
- One BM-2 Control and Balance Module, W4 65-0602
- IP-2 Iontophoretic Pump Modules, W4 65-0603 and/or
- PPM-2 Pressure Pump Modules, W4 65-0604
- One low noise MS-2 Power Supply, W4 65-0601
- Blank Panel DP-1 Dummy Module, W4 65-0605 used to maintain timing if less than 5 Pump Modules are installed
- One Model OC-01 output cable, W4 65-0215
- One Model NL-952 lemo cable, W4 65-0285

Harvard Neuro Phore BH-2 System

Micro-Iontophoresis and Micro Injection (continued)

BH-2 Mainframe Chassis

The BH-2 Mainframe Chassis is pre-wired to accept one Control and Balance module and five Iontophoretic Pump Modules and/or Pneumatic Pump Modules. The selected modules are specified by the researcher and depend on applications. Although all components are ordered separately, the unit is assembled, calibrated, and balanced by Harvard Apparatus before shipping.

BM-2 Balance Module: Balance and More

In addition to providing current neutralization (automatic feedback and control of inverse sum of all pump currents), the balance module has independent capability of current pump settings with a working range of 0 to 500 nanoamperes. The Balance Module includes a digital display, time clock, provisions for electrical and manual cycle start/stop and single cycle/recycle switch, trigger, and gate input terminals to initiate externally controlled eject pumping action of respective modules. Analog input for balance or drive with override capability. Analog output for monitoring of unbalance currents.

**Brain Slice Chambers are available in a variety of formats. Please visit our website for more information.*

Order #	Product
W4 65-0600	BH-2 Mainframe Chassis (Does Not Include BM-2 Balance Module, see Below)
W4 65-0602	BM-2 Control and Balance Module with OC-01 and NL-952

Specifications

Neutralization (balance) Pump Range	Max. ± 2500 nA automatically controlled
Current Pump	Compliance ± 105 V linear constant current source; manually adjustable 0 to 500 nA by pump control; polarity selected +/- switch
Digital Meter Display	3 digits and sign
Unbalance Current/Current	Pump Switch:
Unbalance	Digital display reads unbalance (ground going) current in nA
Current Mode	In this mode, automatic current neutralization is provided
Current Pump Mode	Automatic balance feature is switched off; display reads amount of current in nanoamperes passed through balance barrel as adjusted by pump control
Single Cycle Mode	In single cycle mode, start switch or external trigger initiates each cycle
Recycle Mode	In recycle mode, once start switch or external trigger is actuated, repetitive cycles commence automatically
Time Unit Switch	Two basic time units can be selected, 10 msec or 1 sec. In 10 msec position, Eject and Pause time switches of IP-2 Modules can be set to cover time range from 10 to 990 msec with 10 msec resolution. In 1 sec position, time scale is expanded from 1 to 99 sec with 1 sec resolution.
Inputs	Cycle start, stop, trigger/gate #1 through #5; banana jacks terminals, floating input, optically coupled; input voltage ± 5 to ± 15 V TTL compatible
Analog Input	Lemo miniature receptacle, ground referenced 5 mV/nA; input impedance 100 k Ω
Analog Output	Lemo miniature receptacle, 5 mV/nA ground referenced
Sync Output	Lemo miniature receptacle, TTL pulse
Output Connector	7-pin miniature connector, mates with ultra flexible cable leading to micro-electrode holder
Dimensions, H x W x D	21 x 47 x 35 cm (8.75 x 19 x 14 in)
Weight	8.2 kg (18 lb)

Application Note: Working Unit:

One (1) each of BH-2 Main-Frame, MS-2 power supply, BM-2 Control & Balance module and any combination of one (1) to five (5) modules selected from IP-2 and/or PPM-2. If less than five (5), DP-1 module is required to fill the spaces.

MS-2 Power Supply

The AC power supply is self contained in a rack-mounted cabinet and provides all voltages required to operate the Neuro Phore System. The power supply interconnects with the mainframe via flexible cable. The supply works with 115 or 220 VAC, 50/60 Hz mains source.

Specifications

Outputs	± 125 V at 0.1 A ± 15 V at 0.5 A -5 V at 3 A Line operated 115 to 220 VAC, 50/60 Hz
Dimensions, H x W x D	13 x 47 x 35 cm (5-1/4 x 19 x 14 in)
Weight	11 kg (24 lb)

Order #	Product
W4 65-0601	MS-2 Power Supply with Power Cord

Harvard Neuro Phore BH-2 System

Micro-Iontophoresis and Micro Injection (continued)



PPS-2 Mini-Frame

The rack mountable PPS-2 Mini-Frame was designed as a less expensive alternative to the BH-2 for those applications that require pressure injections only. The PPS-2 is a multichannel pneumatic pumping system, designed especially for short-term pressure ejection of small quantities of fluids through micropipettes. The system can operate with up to four PPM-2 Pump Modules. Each module can be programmed to its own schedule of ejection and pause times, coordinated with the other modules. Ejection and pause times cover a range of 10 to 990 milliseconds with 10 millisecond resolution and 1 to 99 seconds with 1 second resolution. Continuous and cyclical modes of operation are also available.

System Configuration

The PPS-2 system (Order # W4 65-0606) includes a Control Module and a power supply. It is pre-wired to accept up to four PPM-2 Pneumatic Pressure Modules (Order # W4 65-0604) which are ordered separately.

The Control Module CM-1 includes a time clock. Panel mounted push-buttons as well as TTL electrical inputs are provided to control the following functions: Cycle Start/Cycle Stop, Trigger (each PPM-2), and Gate (each PPM-2). In essence, the CM-1 Control Module provides all necessary signals to operate the sequential and single shot timing for the installed PPM-2 Pneumatic Pump Modules.

A Self Cycle mode control switch controls independent self timing action of each of the pneumatic pump modules. The self-timing action permits each PPM-2 Pump Module to eject and pause for a predetermined period. Actuating any of the self cycle control switches causes the respective PPM-2 Module to be engaged into the self timing mode. The push buttons at the corresponding trigger/gate terminals initiate the self cycle timing action.

Specifications

Cycle Start, Cycle Stop, Trigger/Gate Inputs	Push-button, and banana jack terminals; floating input, optically coupled
Input Voltage	±5 to ±15 V
Minimum Trigger Pulse Width	5 µsec at 5 V
Sync Out	Lemo miniature connector TTL pulse
Single Cycle Mode	In single cycle mode, start switch or external trigger initiates each cycle
Recycle Mode	In recycle mode, once start switch or and external trigger is actuated, repetitive cycles will continue until stopped
Time Unit Switch	Two basic time units can be selected: 10 msec or 1 sec. In 10 msec position, Eject and Pause time switches of PPM-2 Modules can be set to cover time range from 10 to 990 msec with 10 msec resolution. In 1 sec position, time scale is expanded to 1 to 99 sec with 1 sec resolution
Power	115 VAC, 50/60 Hz (100 or 220 VAC optional)
Dimensions, H x W x D	21 x 47 x 35 cm (8.75 x 19 x 14 in)
Weight	5.5 kg (12 lb) PPS-2 Mini-Frame System: mainframe, power supply and CM-1 Control Panel. PPM-2 Modules not included.

Application Note:

Working Unit

Mini-Frame, Power Supply, and Control Panel plus four (4) modules selected from PPM-2 and DP-1

Order #	Product
W4 65-0606	PPS-2 Mini-Frame with Power Supply, Control Module and NL-952 Power Cord and Manual
W4 65-0604	PPM-2 Pneumatic Pump Module with OH-01 and IH-01, PPS-2 System Can Support 1 to 4 Modules
W4 65-0605	DP-1 Dummy Module (to Maintain Timing) PPS-2 System Can Support 1 to 4 Modules
W4 65-0210	Model SC-01, Tygon Flexible Hose Micropipette Interface Coupling for Pneumatic (PPM-2) Use
W4 65-0211	Model SC-02, Tygon Flexible Hose Micropipette Interface Coupling for Current (IP-2)/Pneumatic (PPM-2) Use
W4 65-0212	Model IH-01, Input Hose 2.7 m (9 ft) Coupling to PPM-2
W4 65-0213	Model OH-01, Output Hose 2.7 m (9 ft) Including SC-01 Coupling
W4 65-0214	Model OH-02, Output Hose 2.7 m (9 ft) Including SC-02 Coupling
W4 65-0215	Model OC-01, Output Cable 2.7 m (9 ft) with (7) Seven-Pin Lemo Connector
W4 65-0285	Model NL-952, Cable 2 m (6.5 ft) with Lemo Miniature Connector at One End and Tinned Leads at Other (Sync. Output or Analog Input/Output Cable)

Harvard Neuro Phore BH-2 System

Micro-Iontophoresis and Micro Injection (continued)

IP-2 Iontophoresis Pump Module

Each IP-2 Module includes controls for precise settings of current magnitude and polarity (retention 0 to 50 nanoamperes, ejection 0 to 500 nanoamperes). The actual current and polarity is continuously displayed digitally and can be externally monitored at the analog output terminal.

Operating Modes

Ejection Timing and Mode Switch

The mode switch provides five push-button controls which include operations such as cycle, trigger, gate, continuous, and termination.

Cycle Mode

In the cycle mode by virtue of selecting single or recycle operation on the BM-2 Module an incoming trigger or cycle start push-button will initiate the current ejection pumping action. In this mode each succeeding Pump Module is automatically triggered after the pause time of the preceding event has been completed. Both eject and pause times can be preset to cover a range from 10 to 990 milliseconds with a 10 millisecond resolution and 1 to 99 seconds with a 1 second resolution.

Trigger Mode

When the TRIG. switch is energized the eject time interval will be started by virtue of the incoming trigger pulse applied to the respective inputs on the BM-2 Balance Module. Eject timing interval can be preset covering a range from 10 to 990 milliseconds with a 10 millisecond resolution and 1 to 99 seconds with a 1 second resolution.

Gate Mode

When the GATE switch is energized the eject current will be started by virtue of a gate input signal applied to the respective trigger/gate terminals on the BM-2 Balance Module. The eject and pause time settings are not operative in this mode, since the eject time function is slaved to the duration of the gate input.

Continuous Mode

When the CONT. switch is energized the ejection pump current is continuously maintained.

Termination Mode

When the TERM. switch is energized the output is automatically diverted from the preparation into an internal 'dummy load' (100 M Ω). This function is particularly useful for testing of possible instability in the preparation pipette.

Analog Input

The analog input terminal is available to facilitate externally controlled current pumping action. An external voltage applied to the input will generate a pumping current at a ratio of 5 millivolts/nanoamperes. This current will be summated with any preset pump current governed by both the retention and ejection controls. The combined magnitude and sign of the summated pumping current is displayed on the digital display of each corresponding Pump Module. This input can be connected to a computer D/A converter when external programming is desired.

Analog Output

The analog output terminal provides a buffered voltage which is proportional in magnitude and polarity to the actual current passed from the current pump into the pipette. The conversion ratio is 5 mV/nA. This output can be polygraphically recorded to monitor progress of the experiment.

Sync Output

The sync output provides a TTL pulse that coincides with the eject time. This output is provided to trigger external devices such as a computer, event counter, etc.

Specifications

Current Pump	Compliance ± 105 V, linear constant current source
Ejection Current	Pulsing controlled by Ejection Timing Mode Switch; amplitude adjustable by 10-turn ejection control and range switch from 0 to 50 or 0 to 500 nA; polarity is selected by polarity switch; accuracy of ± 1 nA
Ejection Indicator	Red LED lamp indicates Eject time period; green LED lamp indicates pause time period
Retention Current	Amplitude adjustable by front panel dial from 0 to 50 nA; polarity automatically set opposite to ejection current polarity, socket (x3)
Analog Input	Lemo miniature receptacle, ground referenced 5 mV/nA; input impedance 100 k Ω , socket (x3)
Analog Output	Lemo miniature receptacle, ground referenced 5 mV/nA, socket (x3)
Sync Output	Lemo miniature receptacle, TTL pulse time incident with eject pulse
Current and Resistance	Digital Meter Display 3 digits and sign Metering System
Resistance/Current Switch:	
Current Mode	Switch in center 'nA' position, digital display reads total current in nA passed through micro-electrode pipette (sum of retention and ejection current)
Resistance Mode	Switch in either (pos) or (neg) M Ω position, digital display reads actual electrode barrel resistance in M Ω derived by passing positive or negative constant current (50 nA) through electrode pipette
Compliance Exceeded	Digital display will flash whenever electrode barrel resistance
Indicator	exceeds working range of current pump (i.e., when electrode resistance times current exceeds compliance of ± 105 V)
Voltage Readout Switch	Depressing switch will cause digital display to read voltage across pipette

Order # Product

W4 65-0603 IP-2 Iontophoresis Pump Module

Harvard Neuro Phore BH-2 System

Micro-Iontophoresis and Micro Injection (continued)

PPM-2 Pneumatic Pump Module

Designed specifically for pressure injection of drugs in pharmacological studies of drug evoked responses (i.e. synaptic discharges, contraction, etc.) Emphasis has been given to pressure control and regulation (0 to 30 p.s.i.; optional 0 to 10 or 0 to 90 p.s.i.) as well as precise timing. The PPM-2 Module is comprised of a precise pressure regulator, digital display, transducer, and a timing mode switch. It connects to an external pressure source (such as a compressed bottle of N₂) which can be set to provide continuous or periodic pressure pulses ranging from 0 to 30 p.s.i. Outputs include (0 to 1 volt) proportional to output pressure as well as a sync pulse coincident with pressure cycle.

Operating Modes

Ejection Timing and Mode Switch

The mode switch provides five push-button controls which include operations such as cycle, trigger, gate, continuous, and termination.

Cycle Mode

In the cycle mode, after selecting single or recycle operation, the start push-button will initiate the ejection pumping action. In this mode each succeeding pump module is automatically triggered after the pause time of the preceding event has been completed. Both eject and pause times can be preset to cover a range from 30 to 990 milliseconds with a 10 millisecond resolution and 1 to 99 seconds with a 1 second resolution.

Trigger Mode

When the TRIG. switch is energized the eject time interval will be started by virtue of an externally applied trigger pulse fed to the respective inputs on the CM-I control panel. Eject timing intervals can be preset to cover a range from 30 to 990 milliseconds with a 10 millisecond resolution and 1 to 99 seconds with a 1 second resolution.

Gate Mode

When the GATE switch is energized pumping action will be started by virtue of a gate input signal applied to the respective trigger/gate terminals on the CM-I control panel. The eject and pause time settings are

not operative in this mode, since the eject time function is slaved to the duration of the gate input.

Continuous Mode

Eject pump action is continuously maintained when CONT. switch is energized.

Termination Mode

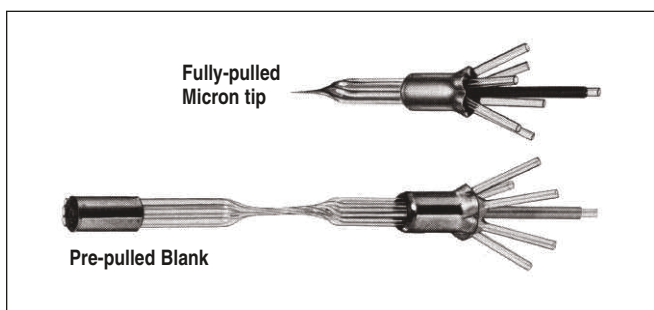
When the TERM. switch is energized, the output pressure is automatically diverted from the preparation. This function is particularly useful for setting up the desired pressure range and timing while preventing ejection of any drug from the pipette.

Specifications

Source Gas	Air or Nitrogen recommended (no explosive or combustible gases)
Input Pressure	125 p.s.i.g. (7.8 kg/cm ²) maximum
Input Filter	5 μm element
Output Pressure	0 to 99.9 p.s.i.g. (0 to 7 kg/cm ²), 30 p.s.i. standard
Output Pressure Display	Three decimal digits
Pressure Pulse Width:	
Minimum	30 msec
Maximum	99 sec (990 sec optional)
Gas Input and Output Couplings	Quick disconnect type
Analog Output	Lemo miniature connector, voltage proportional to output pressure, 0 to -999 mV full scale in p.s.i.g. setting; 0 to -700 mV full scale in kg/cm ² setting
Sync Output	Lemo miniature connector TTL pulse, time incident with output pressure pulse
Eject Time Indicator	Red LED
Pause Time Indicator	Green LED

Order # Product

W4 65-0604	PPM-2 Pneumatic Pump Module with Input/Output Hose
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- Easy filling
- Minimal tip resistance
- Minimal leakage
- Available pre-pulled or fully-pulled

7-Barrel Iontophoresis Micropipette

The MS-7P Micropipette has been designed for iontophoretic use as well as pneumatic ejection of drugs. The standard blank consists of seven barrels, Pyrex Omegadot tubing, 1.5 mm outer diameter and 1.2 mm inner diameter, pre-pulled to 2 mm formation as shown. For complete details, see our Warner Instruments Cell Biology Catalog.

Order #	Model	Micropipettes
W4 65-0207	MS-7PB	Micropipette 7-Barrel, 1.5 mm OD Borosilicate Glass, Pre-Pulled Blank, 20 per box
W4 65-0208	MS-7MT	Micropipette 7-Barrel, 1.5 mm OD Borosilicate Glass, Fully-Pulled Approx. 20 μm Tip, 10 per box

microinjection

Nanoject II Auto Nanoliter Injector

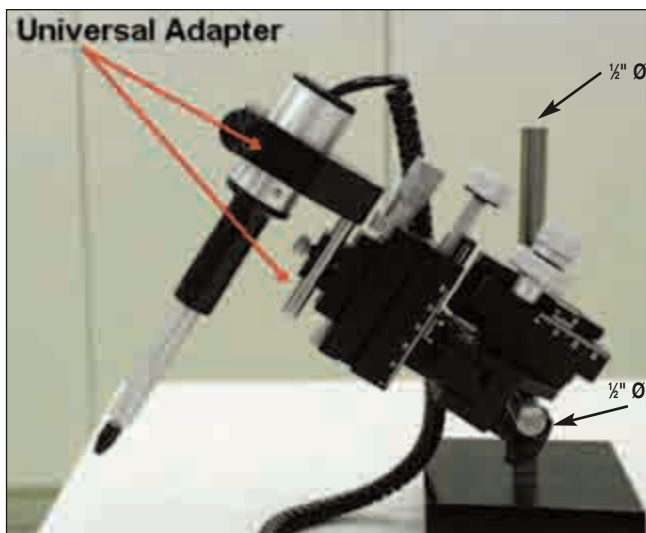


- Lower volume (2.3 nl) capability
- Positive displacement technology
- 2.3 to 69.0 nl range of volumes
- Minimal vibration
- New improved high torque motor
- Membrane key pad
- Improved micropipette holder
- Two speed injection/fill rates
- Auto 'Home' capability

The Nanoject II is the latest development in the Nanoject family of microinjectors. One unique feature of the Nanoject II is the use of a high torque motor to provide smooth operation resulting in substantially reduced tip movement. A new collect configuration holds the micropipette more securely thereby reducing air infiltration and oil leakage. The two-speed fill/inject mode allows the user to fill and inject at half speed, facilitating the use of smaller micropipettes. The handling of more viscous samples is also improved. All of the above factors enhance the precise delivery of sample.

Volumes for the Nanoject II range from 2.3 nl to 69 nl. The smaller tips and smaller injection volumes of the Nanoject II allow users to perform injections into other specimens/applications that previously could not be performed.

Positive displacement technology and the use of precision micropipettes, eliminate the need for tedious calibration when the viscosity of the sample changes. Contaminants in the sample do not hinder or change the injection volume as with some other injectors. An optional universal mounting adapter provides easy mounting of the Nanoject II to a variety of micromanipulators and stereotaxic frames.



Needs Micromanipulator to attach to Support Stand. Universal adapter now included for all NJ2's.

Specifications

Operation	Automatic
Glass Properties	Softening point 780°C
Glass Dimensions	1.14 x 0.053 mm (0.045 x 0.021 in) (OD x ID)
Injection Speed:	Fast: 46 nl/sec; Slow: 23 nl/sec
Fill Speed:	Fast: 46 nl/sec; Slow: 23 nl/sec
Empty Speed	92 nl/sec
Volume Range	2.3 nl to 69.0 nl
Change Volume	Dip switches #1 to #4
Change Inject Speed	Dip switch #5
Weight	99.2 g (3.5 oz)

Order # Product

W4 69-0130*	Nanoject II Nanoliter Injector, 115 V, 60 Hz, US Plug
W4 69-0131*	Nanoject II Nanoliter Injector, 230 V, 50 Hz, European Plug
W4 69-0132*	Nanoject II Nanoliter Injector, 230 V, 50 Hz, UK Plug

Replacement Parts

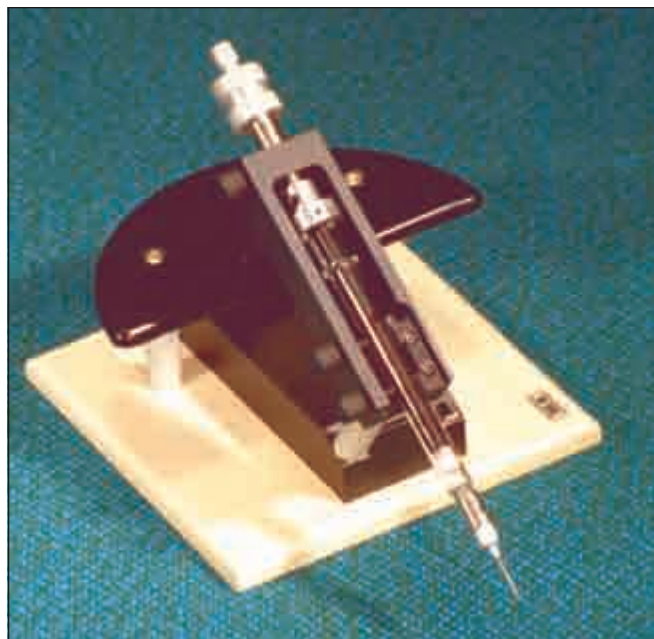
W4 69-0133	Replacement Glass, 88.9 x 1.14 x 0.053 mm (3.5 x 0.045 x 0.021 in) (L x OD x ID), Vial of 100
W4 69-0134	Replacement Glass, 177.8 x 1.14 x 0.053 mm (7 x 0.045 x 0.021 in) (L x OD x ID), Vial of 100
W4 69-0135	Flared Glass, 90 mm (3.5 in), Vial of 100
W4 69-0136	Standard O-Ring
W4 69-0137	Special Flared O-Ring
W4 69-0138	Replacement Wire Plunger
W4 69-0139	Needle, 30 ga x 51 mm (2 in)
W4 69-0142	Universal Mounting Adapter, see above photo

Accessories (Must be ordered separately)

W4 69-0140	Footswitch
W4 69-0141	Support Base

*Universal adapter now included for all NJ2's

Screw-Actuated Syringes



Screw-Actuated Air Syringes

- For air-assisted microinjection and microaspiration
- Uncomplicated and easy to use
- Accurate
- Sensitive control
- High suction/pressure

These air-assisted microinjection/microaspiration syringes provide the user with sensitive control and an extremely low dead-air volume. The capacity of the syringe is 10 ml. When required, the syringes can be used to generate high pressure or suction.

The Screw-Actuated Syringe is a small compact unit incorporated into a heavy circular base. Its convenient dimensions enable it to be ergonomically positioned next to the control lever of a micromanipulator to facilitate single-handed operation of both instruments.

The syringe is connected by hard polyethylene tubing to a micropipette, which in turn, may be fitted to a micromanipulator or positioning device. Suction/injection is obtained by turning the metal colored actuator screw-control on the top of the syringe. The syringe provides a solution to the problem of capillary action when working with small micropipettes. A small balance (equilibrating) pressure can be maintained to offset the effects of capillary action. A conveniently situated release-button on-top of the screw-control is provided to achieve equilibration.

Order #	Product
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W4 69-0105	Screw-Actuated Air Syringe
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Screw-Actuated Micrometer Driven Hamilton Syringe

- Ideal for oil-filled injection/aspiration
- Easy to use
- Hamilton syringe incorporated
- Accurate
- Sensitive control
- Low dead-air volume
- High suction/pressure
- Easy to exchange or replace the syringe

This screw actuated syringe is a micrometer-actuated syringe mechanism mounted on a small base. This syringe is for oil/air-assisted micro-injections and micro-aspirations. Its compact dimensions enable it to be ergonomically positioned next to the control lever of a micromanipulator to facilitate single-handed operation of both instruments.

Suction/injection is achieved by using the rotary-actuator with a fine micrometer-thread, which has a 15 mm movement range. A 1 ml gastight Hamilton glass syringe with a Luer-taper is incorporated. A Luer-taper hypodermic needle is mounted on the taper of the Hamilton syringe. The syringe is connected by hard polyethylene tubing to a micropipette, which in turn, may be fitted to a micromanipulator or similar instrument. The 1 ml Hamilton syringe can be easily exchanged for any other Hamilton 1700 syringe series including the 1000, 500, 200, 100 and 50 μ l sizes, visit www.harvardapparatus.com for complete details.

Order #	Product
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W4 69-0107	Screw-Actuated Micrometer Driven Hamilton Syringe
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microinjection

PM-8 and PM-4

8- and 4-Channel Pressure Injection Systems

W4 69-0153 8-Channel Pressure Injection System



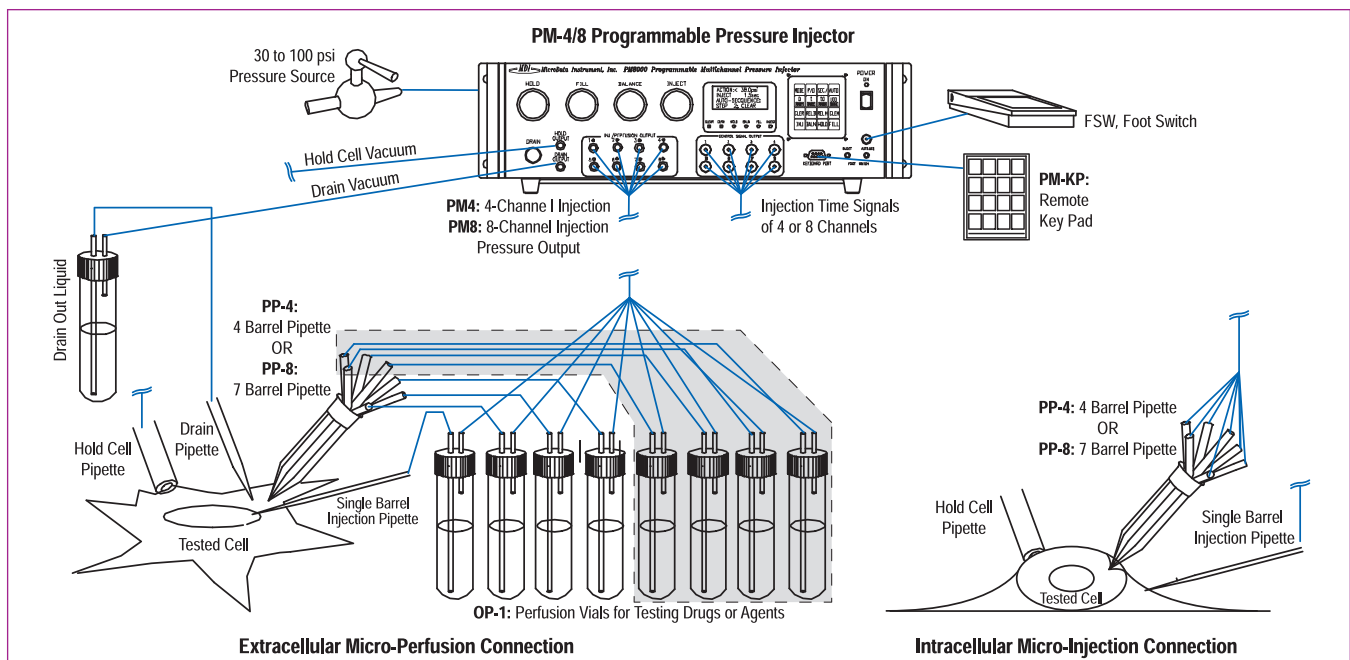
Combining an advanced micro-controller with precision pneumatic components, these systems can simultaneously control up to eight injection micropipettes or eight perfusion vials, one cell holding pipette, and one drain pipette. The four (PM-4) or eight (PM-8) injection/perfusion output ports can be controlled separately or combined together to perform actions such as injection, capillary action balancing, suction or clear up. The cell holding output port can produce an adjusted gentle suction to hold a cell, eject a pressure to push a cell, or completely clear the holding pipette. Another drain output port can simultaneously produce an adjusted suction to drain and clear out liquid before the next channel micro-perfusion. The PM-4/8 can deliver different quantity agents and drugs from picoliters to continuous perfusion. All output pressures and vacuums can be regulated and can be displayed real-time on the front panel display. Previous pressure readings can also be recovered on the display for setting comparison.

- Multiple function system for micro-injection and perfusion
- Up to 8 injection/perfusion outputs, one hold cell output, and one synchronized drain out channel
- Programmable timers, counters, and step sequences which can be stored for reuse
- Manual control or automatic sequential step cycle operation
- Front panel display for pressures and programming information

Besides programmable timers and counters, there are 16 programmable and savable injection/perfusion sequences with 32 programmable steps in each sequence. Each sequence can be repeated continuously or triggered manually. The interval time between steps can be programmed for automatic sequential cycle or manual trigger. There are two foot switch connectors for sequential step trigger and injection trigger. A digital remote port can be connected to an optional remote key pad or be controlled by a computer. With exceptional versatility and extremely precise control, either the PM-4 or 8 is an ideal multi-channel injection/perfusion engine.

The PM-4 and PM-8 programmable 4 and 8-Channel Pressure Injector Systems are designed for one to eight channel intracellular injection and extracellular perfusion. These microinjection and perfusion engines are especially designed for pharmacological drug testing, molecular biological DNA, RNA transferring, intracytoplasmic sperm injection and cell electrophysiological applications.

Connection Diagram for Extracellular Micro-Perfusion and Intracellular Micro-Injection Systems



PM-8 and PM-4

8- and 4-Channel Pressure Injection Systems (continued)

W4 69-0152 4-Channel Pressure Injection System



Below are the components supplied with each of the **Pressure Injection Systems**.

Pressure Injection System	PM-4	PM-8
Order #	Qty.	Qty.
W4 69-0154	1	1
W4 69-0156	6	10
W4 69-0157	1	1
W4 69-0164	1	-
W4 69-0166	1	-
W4 69-0163	-	1
W4 69-0167	-	1
-	1	1
-	1	1

Specifications

Output Channels	Four (PM-4) or eight (PM-8) injection / perfusion outputs, one synchronized drain out and one cell hold channel
Input Gas Pressure	30 to 100 p.s.i.
Clearing Pressure	Same as input pressure
Clear Hold Pressure	0 to 3 p.s.i. (regulated)
Injection Pressure	0.05 to 60 p.s.i. (regulated)
Balance Pressure	0.05 to 10 p.s.i. (regulated)
Fill Vacuum	0 to 24 in Hg (regulated)
Hold Vacuum	0 to 30 in of water (regulated)
Drain Vacuum	0 to 30 in of water (regulated)
Repeatability	±0.02 p.s.i.
Display Accuracy	±0.05 p.s.i. for pressure, ±0.2 in for vacuum (< 2 in H ₂ O)
Timer Setting Range	10 msec to 327.67 sec (10 msec resolution for whole range)
Counter Setting Range	1 to 255
Savable Sequences	16 sequences
Programmable Steps	32 steps for each sequence
Remote Control Ports	DB9 connector for remote key pad, foot switch jack and BNC for negative TTL trigger, jack connector for injection foot switch
Signal Output Ports	Eight BNCs for injection signal on output port 1 to 4
Power Consumption	100, 120 or 220 VAC, 35 W

Order #	Model	Product
W4 69-0152	PM-4	4-Channel Pressure Injection System
W4 69-0153	PM-8	8-Channel Pressure Injection System
Options and Accessories		
W4 69-0154	IP-1	Input Tubing with Connector
W4 69-0155	OP-1	Output Tubing with Connector and 4.5 ml Vial
W4 69-0156	OP-2	Output Tubing with Connector only
W4 69-0157	FSW	Footswitch
W4 69-0158	PM-KP	Remote Key Pad
W4 69-0160	RK-2	Rack Mounting Kit with Handles for PM 4/8
W4 69-0163	PP-7	Pulled Seven Barrel Pipette (each)
W4 69-0164	PP-4	Pulled Four Barrel Pipette (each)
W4 69-0165	HOLD-1	Holder for Single-Barrel Pipette
W4 69-0166	HOLD-4	Holder for Four-Barrel Pipette
W4 69-0167	HOLD-7	Holder for Seven-Barrel Pipette



W4 69-0156 Output Tubing with Connector for use with:
W4 69-0152, see above
W4 69-0153, see above
W4 69-0150, see pages 332-333
W4 69-0151, see pages 332-333



W4 69-0154 Input Tubing with Connector for use with:
W4 69-0152, see above
W4 69-0153, see above
W4 69-0150, see pages 332-333
W4 69-0151, see pages 332-333



W4 69-0164 and W4 69-0163 Pulled Pipettes for use with:
W4 69-0152, see above
W4 69-0153, see above








W4 69-0155 Output Tubing with Connector and 4.5 ml Vial for use with:
W4 69-0152, see above
W4 69-0153, see above
W4 69-0150, see pages 332-333
W4 69-0151, see pages 332-333

micromanipulators

Micromanipulator Selection Guide







Manipulator Selection Guide Chart

	Ratio Adjustment	Coarse Movement Travel	Resolution	Fine Movement Travel	Resolution	Mounting	Features/Options	Order #	Page
Mechanical Manipulators									
	–	X: 65 mm Y: 29 mm Z: 65 mm	X, Y, Z: 100 µm	Z fine: 2.2 mm	Z fine: 10 µm	Mounting Base 0.5 in Rod Clamp	Brass Construction Tilttable Arm	W4 72-6030 W4 72-6031 W4 72-6032 W4 72-6033	296 296 296 296
	–	X: 37 mm max, Y, Z: 20 mm max	X, Y, Z: 100 µm	X: 10 mm max	X: 10 µm	10, 12 mm, 0.5 in Rod Clamp	Single Electrode	W4 64-0056 W4 64-0055	295 295
	–	X: 37 mm max, Y, Z: 20 mm max	X, Y, Z: 100 µm	X: 10 mm max	X: 10 µm	10, 12 mm, 0.5 in Rod Clamp Tilting Base	Dual Tool/ Electrode Holder	W4 60-0569 W4 60-0570	295 295
	1:15 to 1:150	X: 37 mm Y: 20 mm Z: 25 mm	–	Z fine: 3 mm	–	Mounting Base 0.5 in Rod Clamp	Joystick	W4 60-0582 W4 60-0583	300 300
	–	–	–	X, Y, Z: 25 mm max	X, Y, Z: 5 µm	Integrated 25° Tilting Base	Large Spindle Knobs, High Mass for Stability	W4 60-0594	301

micromanipulators

Micromanipulator Selection Guide

Manipulator Selection Guide Chart (continued)

	Ratio Adjustment	Coarse Movement Travel	Resolution	Fine Movement Travel	Resolution	Mounting	Features/Options	Order #	Page
Motorized Manipulators									
	-	-	-	10 mm max	0.5 µm	7 mm Clamping Bolt Parallel to Working Axis	DC Motor-Controlled	W4 73-0003	303
	-	-	-	25 mm max	1 µm	12 mm Clamping Fitting, 10 mm Clamping Width	DC Motor-Controlled	W4 73-0011	303
	-	X: 37 mm max, Y, Z: 20 mm max	X, Y, Z: 100 µm	X, Y, Z: 100 µm	X, Y, Z: 0.5 µm	10, 12 mm, 0.5 in Rod Clamp Tilting Base	Can use either Joystick or Push-Button Controller	W4 60-0571 W4 60-0572 W4 60-0574 W4 60-0600 W4 60-0601	298 298 298 298 298
	-	-	-	X, Y: 25 mm max	X, Y: 1 µm*	Integrated 25° Tilting Base	Velocity of ≤36 mm/sec, 40,000 steps/µm revolution	W4 60-0586 W4 60-0588	301 301
	-	-	-	X, Y, Z: 25 mm max	X, Y, Z: 1 µm*	Integrated 25° Tilting Base	Velocity of ≤36 mm/sec, 40,000 steps/µm revolution	W4 60-0590 W4 60-0592	301 301
	-	-	-	X, Y, Z: 25 mm max	25 nm	-	Designed for Electrophysiology Applications	W4 64-1731 W4 64-1732 W4 64-1733	297 297 297

* In conjunction with MCL Controller 0.01 µm Resolution

micromanipulators

Standard Manual Control

Classic design at a reasonable price

Micromanipulators are recognized as classic pieces of research equipment. How they work is precision engineering. How they 'feel' is art. These micromanipulators have set the standard worldwide for decades. They are the most popular and widely used. Selecting the correct micromanipulator for the application is important. If you are buying one instrument for general laboratory use, then select the *Ultraprecise Micromanipulator*, see page 301.

Its rigidity and scope make it ideal for any application. For repetitive work, where a number of stations may be required, the Standard Manual Control Micromanipulator with its numerous options generally meets any requirement. To hold freely mobile cells or manipulate larger cells, the Micromanipulator with Mechanical Joystick, see page 300, is flexible yet stable.



W4 60-0570 Left-Handed Standard Manual Control Micromanipulator with 1 Tool/Electrode Holder, Micropipettes not included



Standard Manual Control Micromanipulator with 2 Tool/Electrode Holders, Micropipette not included

- 20 mm of travel in lateral (Y-axis) and vertical (Z-axis) graduated in 0.1 mm increments
- 37 mm of travel in probe direction (X-axis) graduated in 0.1 mm increments plus 10 mm of travel with fine positioning in 0.01 mm increments
- All three control knobs located in a single plane for one-handed operation and close positioning of several instruments side-by-side
- For use with microscope magnifications up to 250x

These micromanipulators have three stacked, stainless steel roller bearing raceways providing movement in the X, Y and Z axes. Rack and pinion drives minimize backlash and provide fast positioning and long life. The lateral (Y-axis) and vertical (Z-axis) planes each have 20 mm of travel graduated in 0.1 mm increments. The probe direction (X-axis) has 37 mm

of travel. Two adjustments are provided. The coarse adjustment is graduated in 0.1 mm increments while the fine adjustment provides 10 mm of travel with precision positioning graduated in 0.01 mm increments.

A unique and valuable feature of these standard manual control micromanipulators is that the three control knobs are located in a single plane. This positioning permits one-handed control of a single instrument, without taking the operator's eyes from the microscope. It also allows several micromanipulators to be closely positioned side-by-side with all control knobs easily accessible. They are available for both right- and left-handed use.

Tool/Electrode Holder

Each micromanipulator is supplied complete with one or two tool/electrode holders. The second holder has two fine controls that allow movement of 8 mm in both the lateral (Y) and probe (X) direction independent of the micromanipulator. Two additional fine controls allow this second tool/electrode holder to be tilted and swiveled.

Tilt Base or Clamp Mounting

Each micromanipulator is offered with a choice of either a tilt base or a clamp to mount the micromanipulator on a 13 mm (1/2 in) OD vertical rod. Other clamps are available as accessories. For a selection of stands with 13 mm (1/2 in) OD rods, see the Stronghold Clamps, Stands and Lattices on the Harvard Apparatus website: www.harvardapparatus.com. The tilt base permits the micromanipulator to be tilted 80° from the vertical. The manipulators with clamp mount are supplied with a 1/2 in. to 10 mm bushing which permits mounting on a magnetic base, see page 304.

Standard Manual Control Micromanipulator

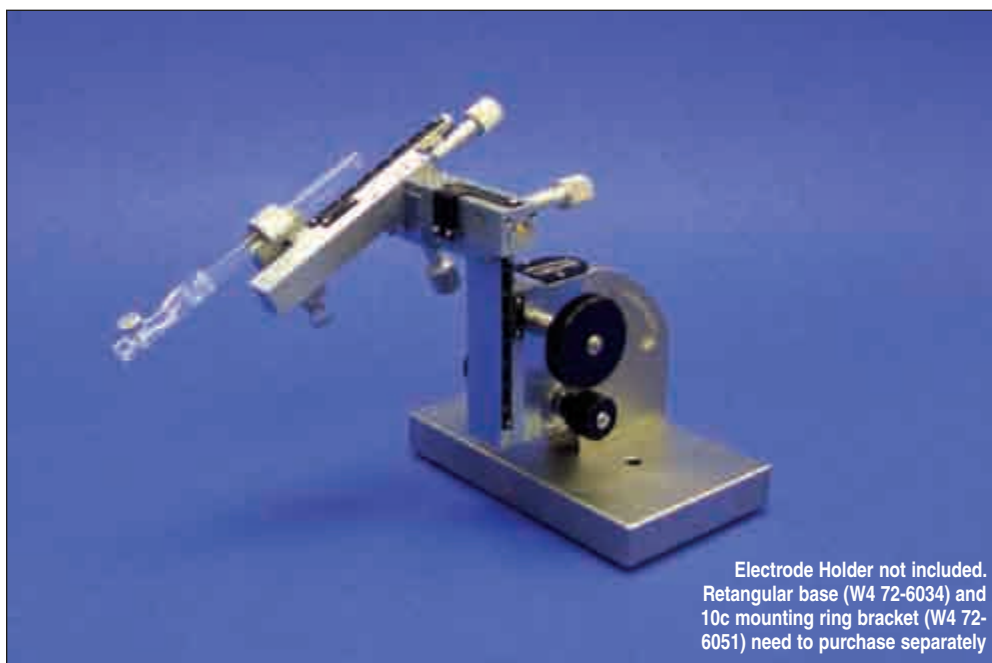
	One Holder	Two Holders
Right-Handed		
Clamp	W4 64-0056	W4 60-0569
Tilt Base	W4 64-0058	—
Left-Handed		
Clamp	W4 64-0055	W4 60-0570
Tilt Base	W4 64-0057	—

Order #	Product
W4 69-1066	10 mm Rod Clamp, for use with Magnetic Bases
W4 69-1067	12 mm Rod Clamp, for use with Magnetic Bases
W4 60-0604	Tool Holder, pkg. of 3
W4 64-1652	Rod Clamp, 1/2 in
W4 64-1652WB	Rod Clamp, 1/2 in with 1/2" to 10 mm bushing

micromanipulators

Dovetail Slide Micromanipulators

For applications requiring a robust holder



Electrode Holder not included. Rectangular base (W4 72-6034) and 10c mounting ring bracket (W4 72-6051) need to purchase separately

- Brass dovetail slide construction – strong and durable
- Available with fixed or tiltable X-axis arm
- Stable probe clamp allows for firm hold of 1/4 to 1/2 inch probe, rod or electrode
- Available for right- or left-handed use

Manufactured from brass, these Dovetail Slide Micromanipulators are significantly more durable, and hold greater weight without slippage or drift, than any ball bearing slide micromanipulator available. Micromanipulators are available with a fixed or a tiltable X axis arm. The fixed arm version has the X axis locked at precisely 90°. The tilt arm version can be rotated to any desired angle and securely locked.

The dovetail slides are driven by rack and pinion mechanisms for rapid positioning to a resolution of 0.1 mm on the coarse vertical (Z) and lateral (Y) drives. The probe direction (X) drive is also graduated in 0.1 mm increments, and has an anti-backlash worm drive for more precise control of movement.

The fine drive, graduated in 0.01 mm increments, is located on the base of the Z axis. This is especially useful where the specimen is in a Petri dish or microtiter tray. The probe holder allows mounting of any rod or pipette, even up to 1/2 inch diameter. These micromanipulators can be mounted directly on several bases via the most secure dovetail slide mount. Alternatively, a mounting ring bracket is available, which allows mounting onto any 1/2 inch rod.

The adjustable probe clamp allows firm hold of the widest range of probe and electrode diameters, providing absolutely steadfast grip of any probe, rod or electrode holder from 1/4 to 1/2 inches.

Rectangular base and mounting ring bracket must be purchased separately.

Specifications

Axis	Range	Resolution
X	65 mm	0.1 mm
Y	29 mm	0.1 mm
Z	65 mm	0.1 mm
Z fine	2.2 mm	0.01 mm
Weight (without base)	1.25 kg	

Order #	Product
W4 72-6030	Right-Handed Fixed Axis
W4 72-6031	Right-Handed Tilt Arm
W4 72-6032	Left-Handed Fixed Axis
W4 72-6033	Left-Handed Tilt Arm
W4 72-6034	Rectangular Base
W4 72-6051	Mounting Bracket*

*Rectangular base not included

NEW SM-3

micromanipulators

High Resolution Motorized Micromanipulator



Magnetic base not included.

The SM-3 is a high-resolution, three axes motorized micromanipulator featuring a compact design, 25 nm resolution, and a low noise controller. Linear amplifiers, used to drive the stepper motors, eliminate stray electromagnetic radiation, a key feature for patch clamp and noise sensitive electrophysiology applications.

The mechanical design of the SM-3 manipulator is compact and is optimized for direct attachment to a microscope stage. The x-slide may be tilted by 90 degrees making precise positioning of the tool assembly simple and direct. Additionally, an integral swivel device allows the tool holder to tilt to one side permitting rapid exchange and easy cleaning of micro tools.

Stepper motors with 40,000 steps per revolution, and single steps of 25 nm, enable vibration-free operation with no backlash. Full travel range is 25 mm in all three axes, eliminating the need for a course manual adjustment.

The included controller features a 4 line display, and includes a front panel switch enabling stand-alone operation via joystick. The controller comes complete with user-friendly WinCommander software, a joystick, an RS-232 interface cable, and motor cables. The software can store up to 999 position coordinates for automated operation. For users wishing to write their own software, a complete set of function commands and a DLL library are included.

Specifications

Resolution	25 nm/step 40,000 steps/revolution
Travel range	25 mm each axis
Control method	Joystick, RS-232/software
Maximum speed	4 mm/sec
Power Input	120 to 260 VAC switch selectable
Weight Micromanipulator	1.400 Kg
Controller	3.1Kg
Dimensions Micromanipulator (H x W x D)	106 x 135 x 135 mm (4.1 x 5.3 x 5.3 in)
Controller (H x W x D)	89.9 x 25.4 x 228.5 mm (3.5 x 1 x 9 in)

Order #	Model	Description
W4 64-1731	SM-3	Compact high resolution three axis motorized micromanipulator with MCL3 controller
W4 64-1732	MCL3	Controller for SM-3 micromanipulator Includes RS-232 interface, cables, software, and joystick
W4 64-1733	SM-3MO	Compact high resolution three axis motorized micromanipulator without controller

micromanipulators

Standard Motorized Control Micromanipulators

Hands-off control for fine positioning



W4 60-0571 Standard Motorized Control Micromanipulator with W4 60-0577 Push Button Control Unit (Tool Holder Included)



Detail of Fine Adjustment Control

- Requires one of two control units offered on the facing page.
- Available with choice of:
 - 1- or 2-tool/electrode holders
 - Tilt base or clamp mounting
 - Right- or left-handed use
- 20 mm of travel in lateral (Y-axis) and vertical (Z-axis) graduated in 0.1 mm increments
- 37 mm of travel in probe direction (x-axis) graduated in 0.1 mm increments
- All three control knobs located in single plane for ease of operation and close positioning of several instruments side-by-side
- For use with microscope magnifications up to 250x
- Positioning in sub-micron range is possible
- Smallest step size is 0.5 μ m
- Micromanipulator does not have to be touched for fine adjustment
- Flexible motor coupling ensures zero vibration of probe during movement

This Standard Motorized Micromanipulator has the same manual coarse adjustment for each of the three axes graduated in 0.1 mm increments: X-axis 37 mm of travel; Y- and Z-axes 20 mm of travel each. On each of the three axes there is installed an additional fine adjustment slide with built-in miniature DC-motors rotating micrometer spindles. This motorized fine adjustment has 10 mm (2-1/2 in) of travel on each axis and the scales read to 0.01 mm. (Note: For operation, these motorized micromanipulators require one of the control units listed on the facing page.)

These micromanipulators provide 'hands off' control for fine adjustments. Each axis has a controller motor with a flexible coupling to the micrometer spindle which ensures that the probe can be moved with zero vibration.

They are available with one or two tool/electrode holders. The micromanipulator with two tool/electrode holders has a swing-in/swing-out platform. This feature permits the entire x-axis platform with tool holder to be swung out to the side for rapid and easy exchange and cleaning of tools, capillaries, electrodes, etc. After exchange/cleaning of tools, the platform swings back to the prior working position without losing time for readjustment. The micromanipulators with this X-axis tilt should always be mounted in the vertical position to make best use of the tilting fine control.

Standard Motorized Control Micromanipulator

	One Electrode Holder	*Two with X-Axis Platform Swing-Out
Right-Handed		
Clamp Base	W4 60-0571	W4 60-0600
Left-Handed		
Clamp Base (20 x 12 x 11 cm)	W4 60-0572	W4 60-0601
Tilt Base	W4 60-0574	—

Note: These Standard Motorized Control Micromanipulators require one of the control units described on page 299.

Control Units for Motorized Manipulators

Hands-off control for fine positioning

Choice of two control units with increasing complexity

- Push button control unit
- 3-direction joystick control unit



Push Button Control Unit

- For either 'step' or continuous motion
- Simple push button control

Movement, forward or back, in each of three axes is controlled by six push buttons. The amount of time the button is depressed determines the type of movement that occurs. By pressing a button for less than 1 second, a 'step' movement is provided. Pressing the button for more than 1 second activates continuous movement until the button is released.

This control unit has two control knobs: one for 'step' size and one for continuous motion speed. The 'Step' size knob ranges from 0.5 to 10 microns graduated in 0.5 micron increments. The continuous motion knob provides speeds up to 0.2 mm/sec. The 'step' size and speed are equal for all three axes. Backlash on reversing directions has been essentially eliminated with this control unit. At each reversal an additional current pulse compensates almost completely for gear/spindle slack. This is particularly important in the step mode as it eliminates 'dead steps' when the motor turns but the micromanipulator does not move. For use on either 115/230 VAC, 50/60 Hz.

Order #	Product
W4 60-0577	Push Button Control Unit



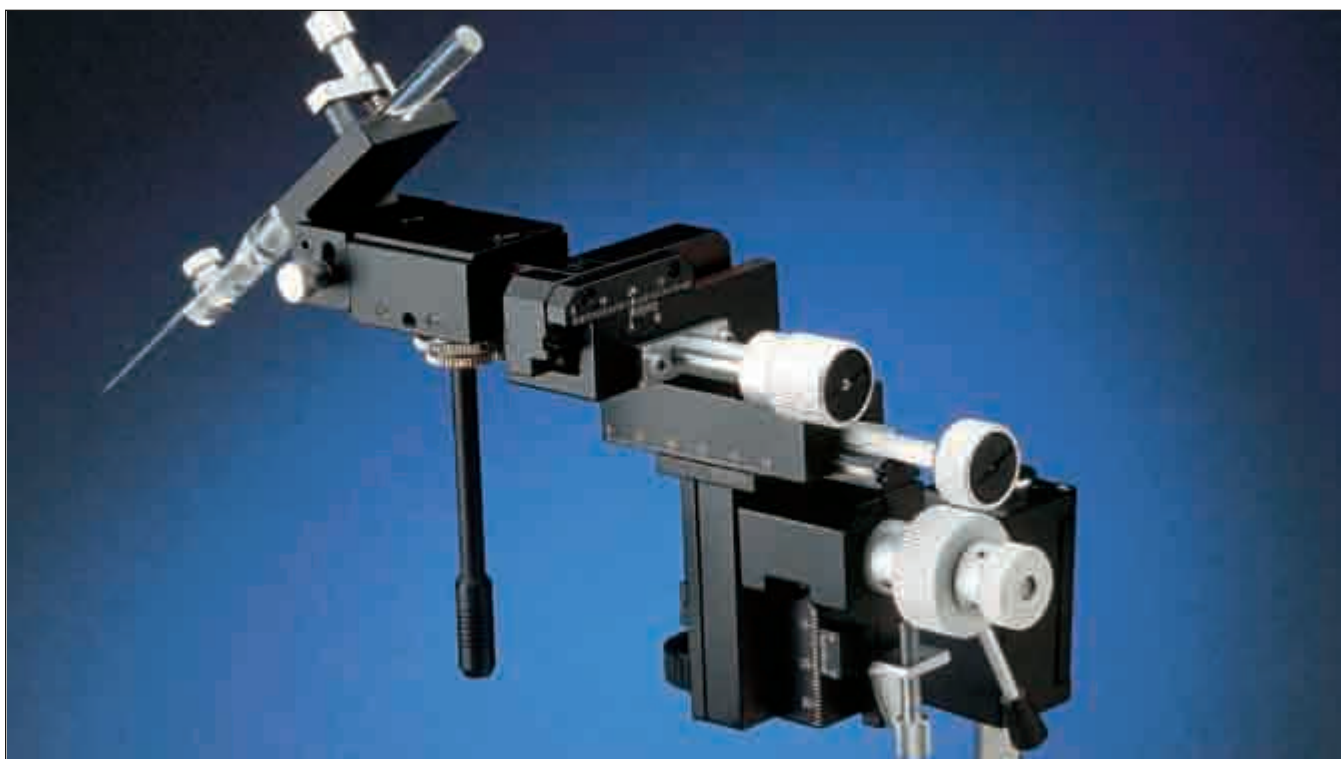
3-Direction Joystick Control Unit

- Provides simultaneous movement in three axes
- Permits easy placement of probe within accuracy of 2 or 3 μm

This control unit permits control of movement in three directions simultaneously. The speed and direction of forward or backward movement is regulated by the degree of displacement of the joystick from the central null position. The third axis of simultaneous movement is obtained by rotating the joystick handle. For use on either 115/230 VAC, 50/60 Hz. Supplied with a screened cable. Joystick requires W4 60-0577 for operation.

Order #	Product
W4 60-0581	3-Direction Joystick Control Unit
W4 60-0580	Replacement Screened Cable
W4 60-0604	Tool Holder, pkg. of 3
W4 69-1066	10 mm Rod Clamp, for use with Magnetic Bases
W4 69-1067	12 mm Rod Clamp, for use with Magnetic Bases

Simple, multi-dimensional control



- Joystick reduction gear ratio from 1:15 to 1:150
- Fine positioning on Z-axis (vertical) gives 3 mm (0.12 in) of movement per revolution
- Lever tips the tool quickly for such actions as hanging a petri dish and the preset stop returns tool tip to focus plane
- Stop screw prevents damaging probe tip
- Probe holder tilts to 90°
- Available for right- or left-handed use

With this very sensitive mechanical joystick micromanipulator, motion, even in the micron range, is possible. This micromanipulator is so stable and strong that it can accommodate even piezo-steppers. Joystick micromanipulators provide movement of probes that are direct reductions of the speed and direction of the hand movement. Under the microscope, the probe appears to move directly with the hand.

Typical applications for the Joystick micromanipulator are positioning of holding pipettes, to grab and hold freely mobile cells, or the manipulation of larger cells. The joystick drives the probe in the X (probe) and Y (horizontal) directions. The reduction of the joystick travel relative to the hand may be adjusted from 1:15 to 1:150. The travel of the joystick ranges from 0.35 to 4 mm (0.014 to 0.16 in) depending on the reduction gear ratio being employed.

The Z-axis also has a fine movement with a reduction gear ratio of 1:10 relative to the coarse movement. This fine movement is operated by a further knob on the Z-axis providing 3 mm (0.12 in) of movement per

revolution. The Z-axis has a lever on the coarse adjust which enables the operator to lift the tool tip quickly for such operations as changing a petri dish. A preset stop ensures that the tool tip will return to the previous focusing plane when again lowered. The stop screw prevents the probe from being inadvertently broken by being driven into the slide or dish. The stop screw also prevents downward drift of the micromanipulator so that the pipette or electrode may be left in a stable position over a long period of time. The probe holder may be tilted up to 90°.

This joystick micromanipulator is offered in right- or left-handed versions. It is also offered with a mounting clamp for a 13 mm (½ in) OD vertical rod or with a wide table clamp, when particularly stable mounting is required.

Joystick Micromanipulator Coarse Positioning

Axis	Travel
X (probe)	37 mm (1.45 in)
Y (horizontal)	20 mm (0.79 in)
Z (vertical)	25 mm (1 in)

Order # Product

W4 60-0582	Right-Handed Joystick Micromanipulator with Mounting Clamp for 13 mm (0.5 in) Rod
W4 60-0583	Left-Handed Joystick Micromanipulator with Mounting Clamp for 13 mm (0.5 in) Rod
W4 60-0604	Tool Holder, pkg. of 3
W4 69-1066	10 mm Rod Clamp, for use with Magnetic Bases
W4 69-1067	12 mm Rod Clamp, for use with Magnetic Bases

micromanipulators

Ultraprecise Micromanipulators

For accurate, reproducible, and precise positioning

These ultraprecise micromanipulators have the mass, 6 kg (13.2 lb), and solid workmanship to support the most precise movement with a minimum of hand-transmitted vibration, backlash or drift.

The instrument can be used alone or can serve as an ideal mount for even more precise microdrives. For ultimate precision the

ultraprecise micromanipulator is available with motorized control on either two or three axes for essentially vibration-free steps as small as 0.01 mm.

- Available with manual control or motorized control

Ultraprecise Motorized Control Micromanipulator

This ultraprecise motorized control micromanipulator is offered either with stepper motors on two axes or on all three axes. These motors are controlled by a precision controller that is supplied with the instrument. The same micrometers are used, as with the manual version, with a travel of 25 mm (1 in). The controller provides fast motor speed of 9 revolutions/sec which allows a maximum velocity of 36 mm/sec. Speed is infinitely variable to a slowest speed of 40,000 steps per revolution which corresponds to 0.01 μ m per step. Only by these extremely small single steps can an operator be assured of essentially vibration-free movement. The controller works in a vector mode, that is, the target coordinates are approached directly in a straight line from the starting point. In all modes there are end stop switches.

The movement can be programmed on a thumb wheel switch and is started by a press button. Alternatively, advance and retraction may be controlled by manual operation of buttons. A return button causes the probe to be retracted to the zero position. The Motorized Controller is available with or without a display. The Controller with Display monitors the location of the probe on a six digit LED counter. A clear button resets the position to zero. Movement may also be made by joystick. These joystick movements are also monitored and may be both displayed on the controller and read via the RS-232 interface. The Controller may be used either alone or computer driven via the RS-232 interface. Power 115/230 VAC, 50/60 Hz.

W4 60-0594 Ultraprecise Manual Control Micromanipulator, Micropipette Not Included



Ultraprecise Motorized Control Micromanipulator

	With Stepper Motors	
Controller	On 2 Axes	On 3 Axes
With Display	W4 60-0586	W4 60-0590
Without Display	W4 60-0588	W4 60-0592

Ultraprecise Manual Control Micromanipulator

The base of the manual micromanipulator is in keeping with the mass and stability of the entire instrument. It is 14 x 14 cm (5-1/2 x 5-1/2 in), has a three point rest and is bored for four M6 bolts. The large diameter micrometer spindles on each axis have fine adjustment only with 25 mm (1 in) of travel that can be read direct to 5 μ m and interpolated to a 1 μ m positioning resolution.

The entire micromanipulator can be tilted forward up to 25° so that cells can be penetrated along the axis of one of the drives. The same locking screw that controls the tilt also provides coarse height adjustment. The probe holder has multiple locking swivels allowing it to be positioned at any angle relative to the X, Y or Z axes.

Order #	Product
W4 60-0594	Ultraprecise Manual Control Micromanipulator
W4 60-0604	Tool Holder, pkg. of 3
W4 69-1066	10 mm Rod Clamp, for use with Magnetic Bases
W4 69-1067	12 mm Rod Clamp, for use with Magnetic Bases

HSE-HA Microdrive Controller 864

Hands-off control for precise positioning



- Single-axis motorized micrometer drive controller
- Alternative to hydraulically-operated micro drive

The HSE-HA Microdrive Controller Type 864 is a single-axis control unit with microprocessor control for operating motorized micrometer drives (vernier controls) with DC motor. It has been specially developed to meet the requirements in physiological and pharmacological research. It is ideally suitable as control unit for the remote operation and vibration-free movement of microelectrodes or capillaries, e.g. in intracellular potential recording, patch clamp experiments or stereotaxic investigations in the brain. When used with either the micrometer drive HSE-HA 864/1 or 864/2, see page 303, the Microdrive Controller thus represents a complete alternative to hydraulic micro drives which have now become very expensive. Apart from its compact size, similar to a remote control for a TV set, a special feature is the combination of continuous and stepping linear operation. In the continuous mode the micrometer drive is operated by the joystick shift in the direction IN or OUT. The drive speed is proportional to the displacement of the joystick. In the switch mode the micrometer drive is moved by the joystick either IN or Out by a preset step. The size of the step can be adjusted continuously with the STEP BS4DTH potentiometer from $\sim 0.5 \mu\text{m}$ to approx. 0.1 mm per step. This operating mode is particularly useful when advancing glass microelectrodes into the cell membrane for intracellular potential recording. In order to reduce interference emission to a minimum, e.g. in the input circuit of a microelectrode amplifier, special attention has been paid in the design of the instrument to good electrical de-coupling and screening. The system consists of the Microdrive Controller 864, mains adapter, ground cable, foil-screened connecting cable for micrometer drive and operating instructions.

Specifications

Operating Mode	Pulse width modulation under microprocessor control
Accuracy	Real information on resolution obtainable, positioning accuracy, compensation of play and min/max displacement speed cannot be provided for controller alone; these are affected largely by drive mechanics, loading, sliding and sticking friction in guides, operating position, and manufacturing tolerances
Motor Voltage	10 to 15 V DC (depending on mains supply unit used)
Motor Current	Nominally 100 mA
Overload Protection	Output current is monitored continuously to protect drive mechanics and motor; switch-off limit can be adapted by trimmer potentiometer to suit individual micrometer drive used
Continuous Operating Mode	Manual displacement proportional to movement of joystick in IN or OUT direction
Stepping Operating Mode	Step-wise displacement by amount set on STEP BS4DTH potentiometer
Fast Mode	Changes displacement speed for fast movement of micrometer drive
Backlash Compensation	Backlash in gearing is compensated by means of additional displacement pulse on change of direction; pulse length can be adjusted to individual mechanism
Monitor LEDs	Brightness-modulated indicating LED for IN and OUT directions to indicate control voltage produced
Beep	Short audible signal when triggering pulse in stepping mode or error message on over-current switch-off
Supply suit	230 V AC (115 V AC) through external mains adapter to local supply, or directly by 12-15 V DC or AC, 150 mA
Dimensions, W x H x L	45 x 130 x 70 mm (1.8 x 5.1 x 2.8 in)
Weight	250 g (8.8 oz)

Note: The motorized micrometer drive required for operation is not included with the controller and has to be ordered additionally, e.g. HSE Type 864/1 or Type 864/2.

Order # Product

W4 73-0000	Microdrive Controller 864, 115 VAC, 60 Hz
W4 73-0001	Microdrive Controller 864, 220 VAC, 50 Hz

Microdrive 864/1 and 864/2

Hands-off control for precise positioning



HSE-HA Microdrive 864/1

- Resolution down to 2 μm

The motorized micrometer drive Type 864/1 is based on the motor X axis of the long-established micromanipulator DC-3K. Together with the HSE-HA Microdrive Controller Type 864 it permits remotely controlled displacement of microelectrodes or capillaries, e.g. in intracellular potential recording, patch clamp experiments or stereotaxic investigations in the brain. It thus represents a complete alternative to hydraulic micro drives which have now become very expensive. The mechanism is based on a conventional micrometer screw with a displacement of 10 mm. The micrometer scale is visible and permits reading to 10 μm . The drive is powered by a flange-mounted DC motor with gearbox. The micrometer drive slider moves on a precision crossed-roller guide.

The excellent rolling properties of the guide ensure absence of sticking and sliding friction, and therefore no stick-slip effect, so that this design is ideally suitable for precision displacement systems. The micrometer drive is mounted at its back through a 7 mm dia. mounting bolt parallel to the working axis. The drive can therefore be mounted e.g. on the non-remote-control micromanipulator MM-3 in place of the microelectrode holder.

Specifications

Spindle	Precision micrometer
Displacement Range	10 mm
Resolution	2 μm
Drive	DC motor (12 V, 100 mA nom. current)
Gearbox	Spur gearing; compensation of gearing backlash is through backlash correction setting of HSE Microdrive Controller Type 864
Connection Cable	Foil-screened cable with moulded Mini-DIN plug suitable for HSE Microdrive Controller Type 864 (approx. 1.60 m long)
Scale	According to displacement, 0 to 10 mm, reading accuracy 10 μm
Case	Rigid aluminium, black anodized
Mounting	On back, offset 7 mm clamping bolt parallel to working axis
Dimensions (H x W x D)	112 x 25 x 32 cm (4.4 x 1 x 1.3 in), sizes without fitted microelectrode holder and mounting bolt
Weight	320 g (11.3 oz)

Order # Product

W4 73-0003 DC Microdrive Type 864/1



•HSE-HA Microdrive 864/2

Perfect for intracellular recording

The motorized micrometer drive Type 864/2 offers excellent displacement characteristics, as required e.g. for inserting glass microelectrodes during intracellular measurement. Together with the control unit (HSE-HA Microdrive Controller Type 864) the Microdrive Type 864/2 represents a complete alternative to previous hydraulic micro controls for the remote operation and vibration-free insertion of the microelectrode into the cell membrane. In addition to the compact construction, a special feature is the backlash-free circulating-ball spindle and the limit switch built into the mechanism. The circulating-ball spindle requires no maintenance and operates virtually without friction, unlike a micrometer spindle with sliding bearing. Freedom from backlash is achieved through the use of factory-selected balls and is maintained through a very long operating life. Absence of sliding friction inside the circulating-ball spindle ensures freedom from the so-called stick-slip effect. As a result the mechanism accurately follows even the slightest displacement settings.

Specifications

Spindle Drive	Hardened and ground circulating-ball spindle, freedom from axial play through use of selected balls
Resolution	~1 μm
Maximum Loading	in both directions 50 N
Displacement Range	25 mm (50 and 75 mm options also available)
Bi-Directional Repeatability	$\pm 2 \mu\text{m}$
Uni-Directional Repeatability	$\pm 0.1 \mu\text{m}$
Drive	DC motor with flanged gearbox (12 V, 170 mA nom. current)
Gearbox	76:1, with backlash (optionally without backlash); backlash compensation normally through backlash correction adjustment of HSE Microdrive Controller Type 864
Connection Cable	Foil-screened cable with moulded Mini-DIN plug suitable for HSE Microdrive Controller Type 864 (approx. 1.60 m L)
Limit Switch	To protect drive unit, wired internally, with evaluation of displacement direction
Scale	To suit displacement, 0 to 25 mm
Case	Rigid aluminium, black anodized
Mounting	Clamping fitting 12 mm D and 10 mm clamping width
Dimensions	Length 196 mm, motor case D. 20 mm
Spindle Connection	M6 x 0.5 mm, 6 mm deep
Weight	360 g (12.7 oz)

Order # Product

W4 73-0011 DC Microdrive Type 864/2

micromanipulators

Magnetic Bases



- Holds with powerful magnetic force
- Perfect for use with micromanipulators
- Easy on-off control lever

Magnetic bases offer a convenient way to mount various tools such as micromanipulators in various positions near to your working site. The easy to use on-off control lever allows for easy placement of the magnetic base in the off position. When the control knob is moved to the on position the magnet is engaged and a powerful magnet field holds the magnetic base (and tool) securely in place.

A wide variety of models are available with varying rod sizes, mounting holes and magnetic base mounts to meet every need. When combined with our line of lightweight breadboards, see page 242, it provides a configurable platform for all of your positioning needs. Other configurations of bases are available, please call our Technical Sales Department for details.



Order # Product

W4 69-0235	Sub Pole, 10 x 165 mm (D x L)
W4 69-0236	Sub Pole, 12 x 165 mm (D x L)
W4 69-1066	10 mm Rod Clamp
W4 69-1067	12 mm Rod Clamp

Magnetic Bases

Order #	Base			Main Pole		1st Sub Pole		2nd Sub Pole		Hold Force
	Width	Length	Height	Diameter	Length	Diameter	Length	Diameter	Length	
W4 69-0225	50 mm	58 mm	55 mm	12 mm	176 mm	10 mm	165 mm	–	–	800 N
W4 69-0226	50 mm	58 mm	55 mm	12 mm	194 mm	10 mm	165 mm	–	–	800 N
W4 69-0227	50 mm	58 mm	55 mm	14 mm	178 mm	12 mm	165 mm	–	–	800 N
W4 69-0229	50 mm	73 mm	55 mm	20 mm	178 mm	14 mm	165 mm	12 mm	130 mm	1000 N
W4 69-0230	50 mm	58 mm	55 mm	16 mm	315 mm, flex with holder for 8 mm rod					800 N

Magnetic Holders

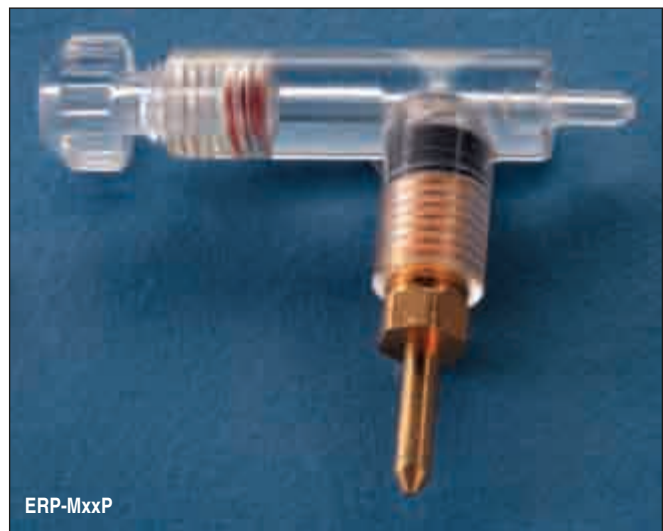
Order #	Holder			Tapped Hole			Mounting Screw Holes				
	Width	Length	Height	Diameter	Thread	Depth	Qty.	Diameter	Depth	Span	Hold Force
W4 69-0231	50 mm	58 mm	55 mm	M8	1.25	7	–	–	–	–	800 N
W4 69-0232	45 mm	45 mm	20 mm	M8	1.25	6	4	M6	6	25	65 N
W4 69-0233	65 mm	65 mm	20 mm	M8	1.25	6	8	M4	6	25	200 N
W4 69-0234	90 mm	90 mm	20 mm	M8	1.25	6	8	M4	6	25	250 N
W4 69-0237	50 mm	73 mm	55 mm	M8	1.25	7	–	–	–	–	1000 N

microelectrode holders

E Series

E-Series Electrode Holders

Microelectrode holders for every application and manufacturer



- Intracellular recording
- Extracellular recording
- Iontophoresis
- Ported or vented versions
- Compatible with MHH-25 holder

E Series

Applications include intracellular and extracellular recording, iontophoresis and ion specific measurements. They are available with choice of body style and electrical coupling and may be specified with or without a port or vent (see accompanying chart). The holders are used with microelectrode amplifiers that have either a 2 mm pin or 2 mm jack headstage connector. Amplifier headstages with the BNC connector will use a Q Series holder.

Specifications

Body Material	Acrylic, 6.3 mm diameter
Body Styles	Straight, 45°, and 90°
Connectors	2 mm Pin or 2 mm Jack
Coupling	Ag Wire or Ag-AgCl Pellet
Port	2 mm diameter Polycarbonate
Vent	0.8 mm diameter Hole
Standard Glass Sizes	1.0, 1.2, 1.5 and 2.0 mm

microelectrode holders

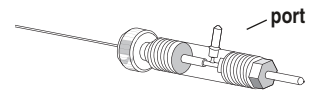
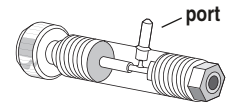
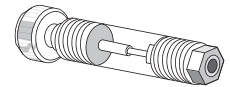
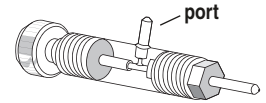
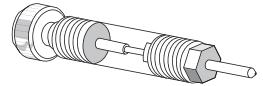
E Series

E Series Straight Body Holders



E-SERIES Straight Body Holders

Order #	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
W4 64-0992	Pellet	2 mm Pin	No	1.0	ESP-M10N
W4 64-0993				1.2	ESP-M12N
W4 64-0994				1.5	ESP-M15N
W4 64-1260				2.0	ESP-M20N
W4 64-0995			Yes	1.0	ESP-M10P
W4 64-0996				1.2	ESP-M12P
W4 64-0997				1.5	ESP-M15P
W4 64-0998				2.0	ESP-M20P
W4 64-0980		2 mm Jack	No	1.0	ESP-F10N
W4 64-0981				1.2	ESP-F12N
W4 64-0982				1.5	ESP-F15N
W4 64-0983				2.0	ESP-F20N
W4 64-0984			Yes	1.0	ESP-F10P
W4 64-0985				1.2	ESP-F12P
W4 64-0986				1.5	ESP-F15P
W4 64-0987				2.0	ESP-F20P
W4 64-1011	Wire	2 mm Pin	No	1.0	ESW-M10N
W4 64-1012				1.2	ESW-M12N
W4 64-1013				1.5	ESW-M15N
W4 64-1014				2.0	ESW-M20N
W4 64-1015			Yes	1.0	ESW-M10P
W4 64-1016				1.2	ESW-M12P
W4 64-1017				1.5	ESW-M15P
W4 64-1018				2.0	ESW-M20P



microelectrode holders

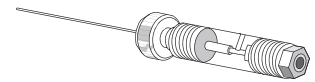
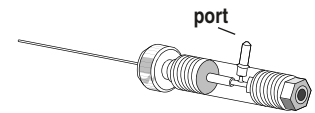
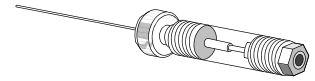
E Series

E Series Straight Body Holders (continued)

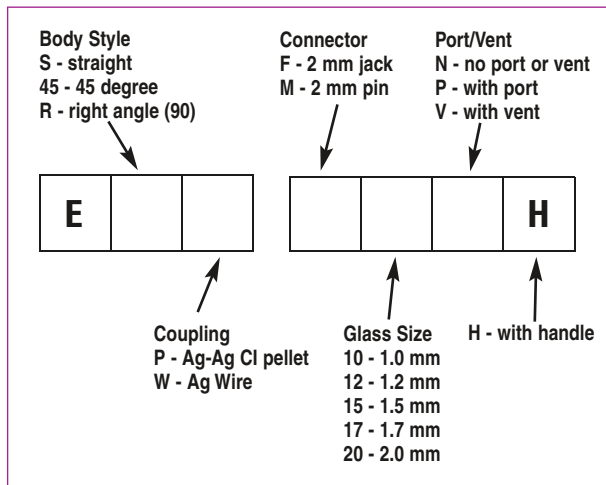
E SERIES-Straight Body Holders (continued)

Order #	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
W4 64-0999	Wire	2 mm Jack	No	1.0	ESW-F10N
W4 64-1000				1.2	ESW-F12N
W4 64-1001				1.5	ESW-F15N
W4 64-1002				2.0	ESW-F20N
W4 64-1003			Yes	1.0	ESW-F10P
W4 64-1004				1.2	ESW-F12P
W4 64-1005				1.5	ESW-F15P
W4 64-1006				2.0	ESW-F20P
W4 64-1007			Vent*	1.0	ESW-F10V
W4 64-1008				1.2	ESW-F12V
W4 64-1009				1.5	ESW-F15V
W4 64-1703				1.7	ESW-F17V
W4 64-1010				2.0	ESW-F20V

*Vented models are standard with the Warner OC-725 Oocyte Clamp.



How to Decode E Series Model Numbers



microelectrode holders

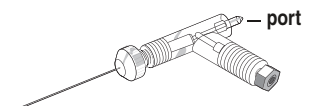
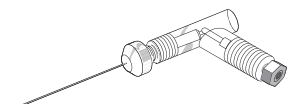
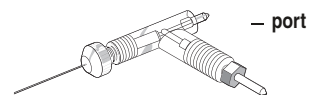
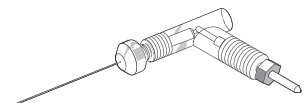
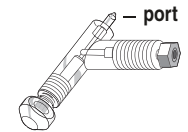
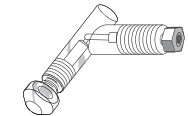
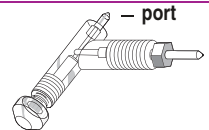
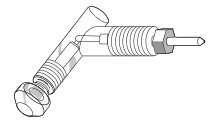
E Series

E Series 45° Body Holders



E SERIES-45° Body Holders

Order #	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
W4 64-0908	Pellet	2 mm Pin	No	1.0	E45P-M10N
W4 64-0909				1.2	E45P-M12N
W4 64-0910				1.5	E45P-M15N
W4 64-0911				2.0	E45P-M20N
W4 64-0912			Yes	1.0	E45P-M10P
W4 64-0913				1.2	E45P-M12P
W4 64-0914				1.5	E45P-M15P
W4 64-0915				2.0	E45P-M20P
W4 64-0900		2 mm Jack	No	1.0	E45P-F10N
W4 64-0901				1.2	E45P-F12N
W4 64-0902				1.5	E45P-F15N
W4 64-0903				2.0	E45P-F20N
W4 64-0904			Yes	1.0	E45P-F10P
W4 64-0905				1.2	E45P-F12P
W4 64-0906				1.5	E45P-F15P
W4 64-0907				2.0	E45P-F20P
W4 64-0924	Wire	2 mm Pin	No	1.0	E45W-M10N
W4 64-0925				1.2	E45W-M12N
W4 64-0926				1.5	E45W-M15N
W4 64-0927				2.0	E45W-M20N
W4 64-0928			Yes	1.0	E45W-M10P
W4 64-0929				1.2	E45W-M12P
W4 64-0930				1.5	E45W-M15P
W4 64-0931				2.0	E45W-M20P
W4 64-0916	Wire	2 mm Jack	No	1.0	E45W-F10N
W4 64-0917				1.2	E45W-F12N
W4 64-0918				1.5	E45W-F15N
W4 64-0919				2.0	E45W-F20N
W4 64-0920			Yes	1.0	E45W-F10P
W4 64-0921				1.2	E45W-F12P
W4 64-0922				1.5	E45W-F15P
W4 64-0923				2.0	E45W-F20P



microelectrode holders

E Series

E Series 45° Body Holders



E SERIES-90° Body Holders

Order #	Wire/Pellet	Connector	Port	Glass OD (mm)	Model	
W4 64-0940	Pellet	2 mm Pin	No	1.0	ERP-M10N	
W4 64-0941				1.2	ERP-M12N	
W4 64-0942				1.5	ERP-M15N	
W4 64-0943				2.0	ERP-M20N	
W4 64-0944			Yes	1.0	ERP-M10P	
W4 64-0945				1.2	ERP-M12P	
W4 64-0946				1.5	ERP-M15P	
W4 64-0947				2.0	ERP-M20P	
W4 64-0932		2 mm Jack	No	1.0	ERP-F10N	
W4 64-0933				1.2	ERP-F12N	
W4 64-0934				1.5	ERP-F15N	
W4 64-0935				2.0	ERP-F20N	
W4 64-0936			Yes	1.0	ERP-F10P	
W4 64-0937				1.2	ERP-F12P	
W4 64-0938				1.5	ERP-F15P	
W4 64-0939				2.0	ERP-F20P	
W4 64-0956	Wire	2 mm Pin	No	1.0	ERW-M10N	
W4 64-0957				1.2	ERW-M12N	
W4 64-0958				1.5	ERW-M15N	
W4 64-0959				2.0	ERW-M20N	
W4 64-0960			Yes	1.0	ERW-M10P	
W4 64-0961				1.2	ERW-M12P	
W4 64-0962				1.5	ERW-M15P	
W4 64-0963				2.0	ERW-M20P	
W4 64-0948		2 mm Jack	No	1.0	ERW-F10N	
W4 64-0949				1.2	ERW-F12N	
W4 64-0950				1.5	ERW-F15N	
W4 64-0951				2.0	ERW-F20N	
W4 64-0952			Yes	1.0	ERW-F10P	
W4 64-0953				1.2	ERW-F12P	
W4 64-0954				1.5	ERW-F15P	
W4 64-0955				2.0	ERW-F20P	

*Vented models are standard with the Warner OC-725 Oocyte Clamp.

microelectrode holders

E Series

E Series Holders with Handle

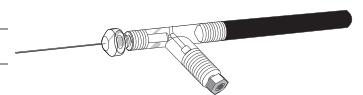
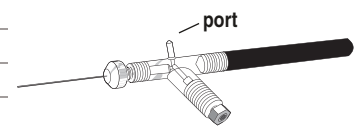
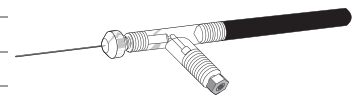
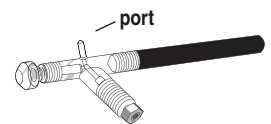
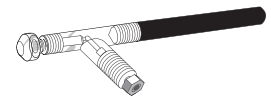
Holders include a 6.3 mm diameter 6.3 cm long handle for mounting in a micropositioner.

Handles are screwed together except for vented models which are joined by a pin and jack for easy removal from the handle.



E-SERIES with Handle

Order #	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
W4 64-1023	Pellet	2 mm Jack	No	1.0	E45P-F10NH
W4 64-1024				1.2	E45P-F12NH
W4 64-1025				1.5	E45P-F15NH
W4 64-1033		2 mm Pin		1.5	E45P-M15NH
W4 64-1026				2.0	E45P-F20NH
W4 64-1039			Yes	1.0	E45P-F10PH
W4 64-1040				1.2	E45P-F12PH
W4 64-1041				1.5	E45P-F15PH
W4 64-1042				2.0	E45P-F20PH
W4 64-1019	Wire	2 mm Jack	No	1.0	E45W-F10NH
W4 64-1020				1.2	E45W-F12NH
W4 64-1021				1.5	E45W-F15NH
W4 64-1022				2.0	E45W-F20NH
W4 64-1035			Yes	1.0	E45W-F10PH
W4 64-1036				1.2	E45W-F12PH
W4 64-1037				1.5	E45W-F15PH
W4 64-1038				2.0	E45W-F20PH
W4 64-1051			Vent*	1.0	E45W-F10VH
W4 64-1052				1.2	E45W-F12VH
W4 64-1053				1.5	E45W-F15VH
W4 64-1372				1.7	E45W-F17VH
W4 64-1054				2.0	E45W-F20VH



*Vented models are standard with the Warner OC-725 Oocyte Clamp.

microelectrode holders

Q Series

Q Series Electrode Holders

Microelectrode holders for every application and manufacturer

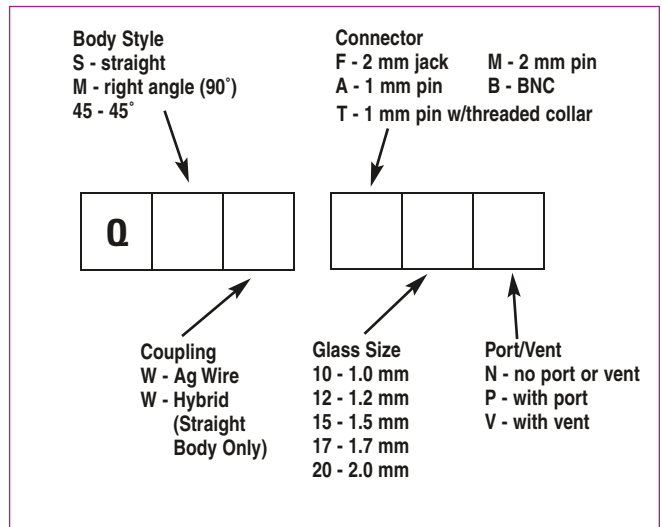


- Patch Clamp Recording
- Intracellular Recording

Specifications

Body Material	Polycarbonate, 6.3 mm diameter
Body Styles	Straight, 45°, and 90°
Connectors	1 mm Pin, 1 mm Pin Threaded and BNC
Coupling	Ag Wire or Ag-AgCl Hybrid
Port	2 mm diameter Polycarbonate
Standard Glass Sizes	1.0, 1.2, 1.5, 1.7 and 2.0 mm

How to Decode Q Series Model Numbers



Connector and Amplifier Headstage Compatibility

Connector	Headstage
A (1 mm pin)	Warner PC-505A/B, PC-501A Axon Patch Clamps prior to 2/1/95
B (BNC)	List and Dagan
F (2 mm jack)	Warner PC-501 & Electrometers
M (2 mm pin)	Axon Axoclamp & Axoprobe prior to 2/1/95
T (1 mm pin/threaded)	All Axon after 2/1/95

microelectrode holders

Q Series

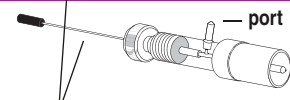
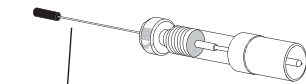
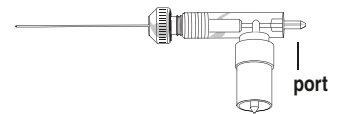
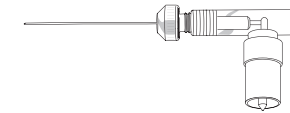
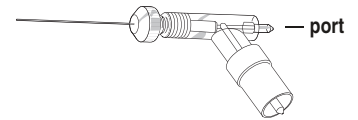
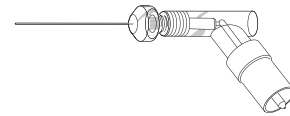
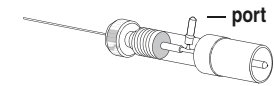
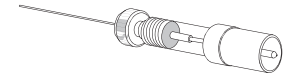
Q Series Electrode Holders with 1 mm Pin

Compatible with Warner PC-501 and PC-505 Patch Clamps, and Axon Patch Clamps (prior to 2/1/95)

NOTE: Holders without ports are not suitable for patch clamp recording.

Q SERIES Holders with 1 mm Pin

Order #	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
W4 64-1105	Wire	Straight	No	1.0	QSW-A10N
W4 64-1106				1.2	QSW-A12N
W4 64-1107				1.5	QSW-A15N
W4 64-0745				1.7	QSW-A17N
W4 64-1108				2.0	QSW-A20N
W4 64-0821			Yes	1.0	QSW-A10P
W4 64-0822				1.2	QSW-A12P
W4 64-0823				1.5	QSW-A15P
W4 64-0978				1.7	QSW-A17P
W4 64-0824				2.0	QSW-A20P
W4 64-0841		45°	No	1.0	Q45W-A10N
W4 64-0842				1.2	Q45W-A12N
W4 64-0843				1.5	Q45W-A15N
W4 64-1098				1.7	Q45W-A17N
W4 64-0844				2.0	Q45W-A20N
W4 64-1055			Yes	1.0	Q45W-A10P
W4 64-1056				1.2	Q45W-A12P
W4 64-1057				1.5	Q45W-A15P
W4 64-0968				1.7	Q45W-A17P
W4 64-1058				2.0	Q45W-A20P
W4 64-0861		90°	No	1.0	QRW-A10N
W4 64-0862				1.2	QRW-A12N
W4 64-0863				1.5	QRW-A15N
W4 64-1103				1.7	QRW-A17N
W4 64-0864				2.0	QRW-A20N
W4 64-1075			Yes	1.0	QRW-A10P
W4 64-1076				1.2	QRW-A12P
W4 64-1077				1.5	QRW-A15P
W4 64-0973				1.7	QRW-A17P
W4 64-1078				2.0	QRW-A20P
W4 64-1351	Hybrid	Straight	No	1.5	QSH-A15N
W4 64-1352				1.7	QSH-A17N
W4 64-1353				2.0	QSH-A20N
W4 64-1354			Yes	1.5	QSH-A15P
W4 64-1355				1.7	QSH-A17P
W4 64-1356				2.0	QSH-A20P



HP-205 (W4 64-1288)
with Teflon™ Sleeve

microelectrode holders

Q Series

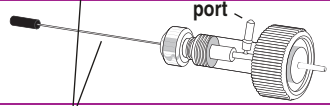
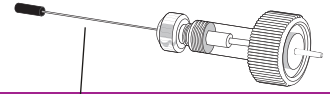
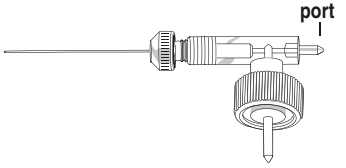
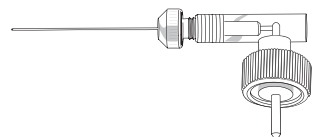
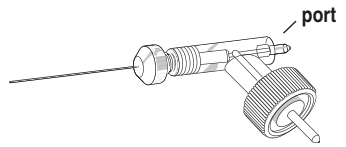
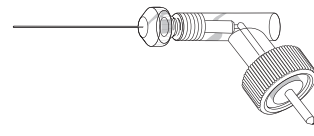
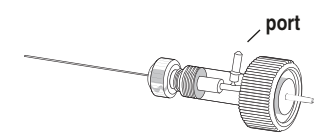
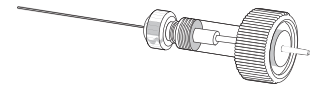
Q Series Holders with 1 mm Pin, Threaded Collar

Compatible with: Axon Patch Clamps and Microelectrode Amps post 2/1/95

NOTE: Holders without ports are not suitable for patch clamp recording.

Q SERIES Holders with 1 mm Pin, Threaded Collar

Order #	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
W4 64-1121	Wire	Straight	No	1.0	QSW-T10N
W4 64-1122				1.2	QSW-T12N
W4 64-1123				1.5	QSW-T15N
W4 64-0749				1.7	QSW-T17N
W4 64-1124				2.0	QSW-T20N
W4 64-0837			Yes	1.0	QSW-T10P
W4 64-0838				1.2	QSW-T12P
W4 64-0839				1.5	QSW-T15P
W4 64-1097				1.7	QSW-T17P
W4 64-0840				2.0	QSW-T20P
W4 64-0857		45°	No	1.0	Q45W-T10N
W4 64-0858				1.2	Q45W-T12N
W4 64-0859				1.5	Q45W-T15N
W4 64-1102				1.7	Q45W-T17N
W4 64-0860				2.0	Q45W-T20N
W4 64-1071			Yes	1.0	Q45W-T10P
W4 64-1072				1.2	Q45W-T12P
W4 64-1073				1.5	Q45W-T15P
W4 64-0972				1.7	Q45W-T17P
W4 64-1074				2.0	Q45W-T20P
W4 64-0877		90°	No	1.0	QRW-T10N
W4 64-0878				1.2	QRW-T12N
W4 64-0879				1.5	QRW-T15N
W4 64-0744				1.7	QRW-T17N
W4 64-0880				2.0	QRW-T20N
W4 64-1091			Yes	1.0	QRW-T10P
W4 64-1092				1.2	QRW-T12P
W4 64-1093				1.5	QRW-T15P
W4 64-0977				1.7	QRW-T17P
W4 64-1094				2.0	QRW-T20P
W4 64-1363	Hybrid	Straight	No	1.5	QSH-T15N
W4 64-1364				1.7	QSH-T17N
W4 64-1365				2.0	QSH-T20N
W4 64-1366			Yes	1.5	QSH-T15P
W4 64-1367				1.7	QSH-T17P
W4 64-1368				2.0	QSH-T20P



HP-205 (W4 64-1288) with Teflon™ Sleeve

microelectrode holders

Q Series

Q Series Holders with BNC Connector

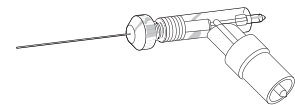
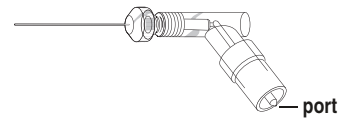
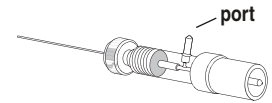
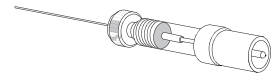


Compatible with: Heka, List and Dagan Patch Clamps

NOTE: Holders without ports are not suitable for patch clamp recording.

Q SERIES Holders with BNC Connector

Order #	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
W4 64-1109	Wire	Straight	No	1.0	QSW-B10N
W4 64-1110				1.2	QSW-B12N
W4 64-1111				1.5	QSW-B15N
W4 64-0746				1.7	QSW-B17N
W4 64-1112				2.0	QSW-B20N
W4 64-0825			Yes	1.0	QSW-B10P
W4 64-0826				1.2	QSW-B12P
W4 64-0827				1.5	QSW-B15P
W4 64-0979				1.7	QSW-B17P
W4 64-0828				2.0	QSW-B20P
W4 64-0845		45°	No	1.0	Q45W-B10N
W4 64-0846				1.2	Q45W-B12N
W4 64-0847				1.5	Q45W-B15N
W4 64-1099				1.7	Q45W-B17N
W4 64-0848				2.0	Q45W-B20N
W4 64-1059			Yes	1.0	Q45W-B10P
W4 64-1060				1.2	Q45W-B12P
W4 64-1061				1.5	Q45W-B15P
W4 64-0969				1.7	Q45W-B17P
W4 64-1062				2.0	Q45W-B20P



microelectrode holders

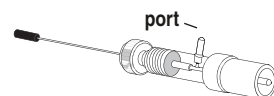
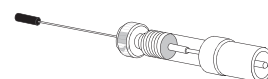
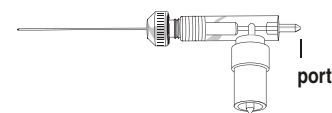
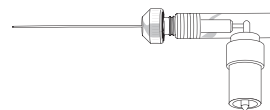
Q Series

Q Series Holders with BNC Connector (continued)

Q SERIES Holders with BNC Connector

Order #	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
W4 64-0865		90°	No	1.0	QRW-B10N
W4 64-0866				1.2	QRW-B12N
W4 64-0867				1.5	QRW-B15N
W4 64-1104				1.7	QRW-B17N
W4 64-0868				2.0	QRW-B20N
W4 64-1079			Yes	1.0	QRW-B10P
W4 64-1080				1.2	QRW-B12P
W4 64-1081				1.5	QRW-B15P
W4 64-0974				1.7	QRW-B17P
W4 64-1082				2.0	QRW-B20P
W4 64-1357	Hybrid	Straight	No	1.5	QSH-B15N
W4 64-1358				1.7	QSH-B17N
W4 64-1359				2.0	QSH-B20N
W4 64-1360			Yes	1.5	QSH-B15P
W4 64-1361				1.7	QSH-B17P
W4 64-1362				2.0	QSH-B20P
W4 64-0833*		Straight	Yes	1.0	QSW-M10P
W4 64-0834*		Straight	Yes	1.2	QSW-M12P
W4 64-0835*		Straight	Yes	1.5	QSW-M15P
W4 64-0836*		Straight	Yes	2.0	QSW-M20P

*Compatible with Axon.



microelectrode holders

ME Series

ME Series Electrode Holders

Microelectrode holders for every application and manufacturer

- Intracellular and Extracellular Recording
- Microiontophoresis

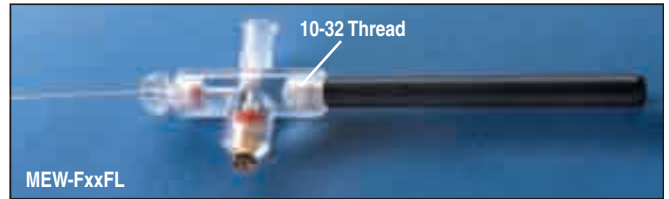
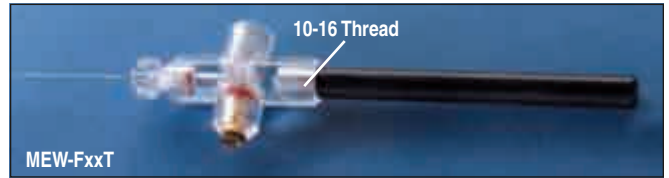
Pressure Ports

A	Accepts 1.5 mm (1/16") tubing
B	Accepts 2.4 mm (3/32") tubing
ML	Accepts female Luer fitting
FL	Accepts male Luer fitting
T*	Accepts 1/8-28 male thread fitting

* Holders with the T port are compatible with the Picospritzer® system made by General Valve Corp.

Specifications

Body Material	9.3 mm diameter acrylic
Body Style	Straight
Connector	2 mm jack
Coupling	Ag/AgCl pellet or Ag Wire
Standard Glass Sizes	1.0, 1.2, 1.5 and 2.0 mm
Handle	6.3 mm diameter x 6.3 cm long, threaded to attach to holder.



ME SERIES Holders

Order #	Wire/Pellet	Body Style	Port	Connector	Glass OD (mm)	Model	
W4 64-1220	Wire	2 mm Straight	Jack	1/16" barb	1.0	MEW-F10A	
W4 64-1221					1.2	MEW-F12A	
W4 64-1222					1.5	MEW-F15A	
W4 64-1223					2.0	MEW-F20A	
W4 64-1224				3/32" barb	1.0	MEW-F10B	
W4 64-1225					1.2	MEW-F12B	
W4 64-1226					1.5	MEW-F15B	
W4 64-1227					2.0	MEW-F20B	
W4 64-1232				male Luer	1.0	MEW-F10ML	
W4 64-1233					1.2	MEW-F12ML	
W4 64-1234					1.5	MEW-F15ML	
W4 64-1235					2.0	MEW-F20ML	
W4 64-1228				female Luer	1.0	MEW-F10FL	
W4 64-1229					1.2	MEW-F12FL	
W4 64-1230					1.5	MEW-F15FL	
W4 64-1231					2.0	MEW-F20FL	
W4 64-1236				threaded	1.0	MEW-F10T	
W4 64-1237				1/8-28	1.2	MEW-F12T	
W4 64-1238					1.5	MEW-F15T	
W4 64-1239					2.0	MEW-F20T	
W4 64-1180	Pellet	2 mm Straight	Jack	1/16" barb	1.0	MEP-F10A	
W4 64-1181					1.2	MEP-F12A	
W4 64-1182					1.5	MEP-F15A	
W4 64-1183					2.0	MEP-F20A	

microelectrode holders

ME Series

ME Series Electrode Holders (continued)

ME SERIES Holders

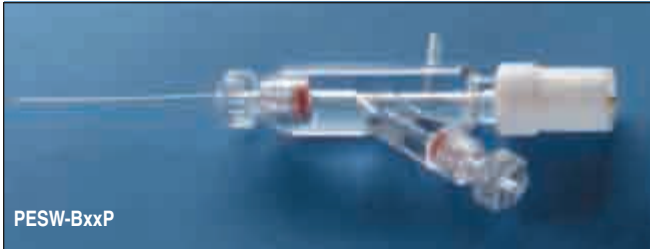
Order #	Wire/Pellet	Body Style	Port	Connector	Glass OD (mm)	Model	
W4 64-1184				1/32" barb	1.0	MEP-F10B	<p>— port (B)</p>
W4 64-1185					1.2	MEP-F12B	
W4 64-1186					1.5	MEP-F15B	
W4 64-1187					2.0	MEP-F20B	
W4 64-1192				male Luer	1.0	MEP-F10ML	<p>— port (ML)</p>
W4 64-1193					1.2	MEP-F12ML	
W4 64-1194					1.5	MEP-F15ML	
W4 64-1195					2.0	MEP-F20ML	
W4 64-1188				female Luer	1.0	MEP-F10FL	<p>— port (FL)</p>
W4 64-1189					1.2	MEP-F12FL	
W4 64-1190					1.5	MEP-F15FL	
W4 64-1191					2.0	MEP-F20FL	
W4 64-1196				threaded	1.0	MEP-F10T	<p>— port (T)</p>
W4 64-1197				1/4-28	1.2	MEP-F12T	
W4 64-1198					1.5	MEP-F15T	
W4 64-1199					2.0	MEP-F20T	

microelectrode holders

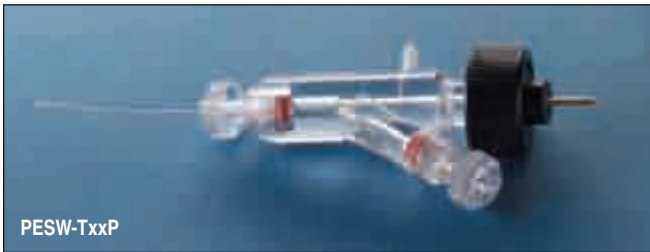
PE Series

PE Series Electrode Holders

Microelectrode holders for every application and manufacturer



PESW-BxxP



PESW-TxxP

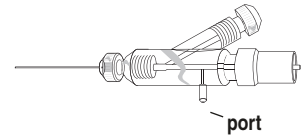
• Microperfusion (perfusion at the pipette tip)*

For microperfusion inside the pipette

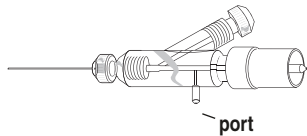
Perfusion at the electrode tip is possible with the **PE Series holders**. They include an additional port at 30° to the glass bore allowing for the insertion of micro-bore tubing into the pipette. This port includes a threaded cap and seal for up to 1 mm diameter tubing. See references below for information on the microperfusion technique.

PE SERIES Holders

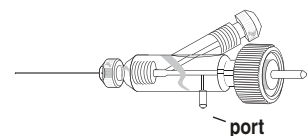
Order #	Wire/Pellet	Body Style	Port	Connector	Glass OD (mm)	Model
W4 64-1144	Wire	Straight	Yes	1 mm Pin	1.0	PESW-A10P
W4 64-1145					1.2	PESW-A12P
W4 64-1146					1.5	PESW-A15P
W4 64-1371					1.7	PESW-A17P
W4 64-1147					2.0	PESW-A20P
W4 64-1148				BNC	1.0	PESW-B10P
W4 64-1149					1.2	PESW-B12P
W4 64-1150					1.5	PESW-B15P
W4 64-1369					1.7	PESW-B17P
W4 64-1151					2.0	PESW-B20P
W4 64-1160				1 mm pin	1.0	PESW-T10P
W4 64-1161				Threaded	1.2	PESW-T12P
W4 64-1162				Collar	1.5	PESW-T15P
W4 64-1373					1.7	PESW-T17P
W4 64-1163					2.0	PESW-T20P



port



port



port

Specifications

Body Material	Polycarbonate
Body Style	Straight
Connectors	1 mm Pin, 1 mm Pin Threaded and BNC
Coupling	Ag Wire
Port	2 mm diameter Polycarbonate
Perfusion Port	30° port accepts tubing up to 1 mm diameter
Standard Glass Sizes	1.0, 1.2, 1.5, 1.7 and 2.0 mm

Ø 9.5 mm, compatible with MHH-38

Patch Clamp Compatibility

Connector	For Use With
1 mm Pin	Warner Patch Clamp Models PC-501 & PC-505 Axon Patch Clamps prior to 2/1/95
BNC	List, Heka and Dagan Patch Clamps
1 mm Pin with threaded collar	Axon Patch Clamps and Microelectrode Amps prior to 2/1/95

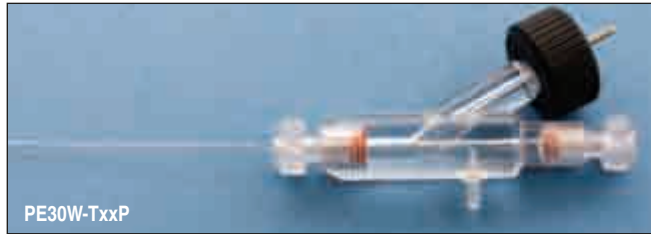
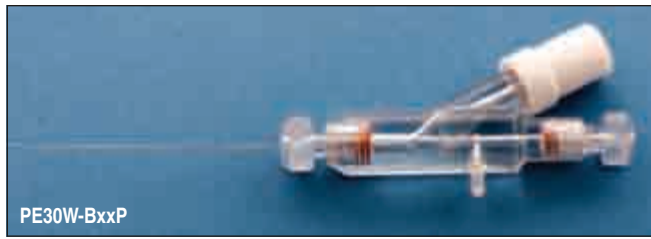
*References:

- 1) Nehr, E. and Eckert, R.: Fast patch-pipette internal perfusion with minimum solution flow. Grinnel, A.D., Armstrong, D. and Jackson, M.B.: Calcium and Ion Channel Modulation, Plenum Press, N.Y.
- 2) Cull-Candy, S.G., Miledi, R. and Parker, I.: Single glutamate-activated channels recorded from locust muscle fibers with perfused patch clamp electrodes. J. Physiology 32-, 195-210.
- 3) Pusch, M. and Nehr, E. (1987) Kinetics of loading small cells with various compounds by use of patch pipettes. Pflugers Archives (Spring Meeting of the Physiol. Ges.).
- 4) Tang, J.M., Wang, J. and Eisenberg, R.S. (1992) Perfusing patch pipettes. Methods in Enzymol. 207, 176-181.

microelectrode holders

NEW PE30W Series

PE30W Series Electrode Holders for Patch Perfusion



Specifications

Body Material: Polycarbonate

Body Style: 30

Connectors: 1 mm Pin, 1 mm Pin

Threaded and BNC

Coupling: Ag Wire

Port: 2 mm diameter

Polycarbonate

Perfusion Port: port accepts

tubing up to 1 mm diameter

Standard Glass Sizes: 1.0, 1.2,

1.5, 1.7 and 2.0 mm

Patch Clamp Compatibility

Connector	For use with
1 mm Pin	Warner Patch Clamp Models PC-501 & PC-505 Axon Patch Clamps prior to 2/1/95
BNC	List, Heka and Dagan Patch Clamps
1 mm Pin with threaded collar	Axon Patch Clamps and Microelectrode Amps prior to 2/1/95

*References:

- 1) Nehr, E. and Eckert, R.: Fast patch-pipette internal perfusion with minimum solution flow. Grinnel, A.D., Armstrong, D. and Jackson, M.B.: Calcium and Ion Channel Modulation, Plenum Press, N.Y. Cull-Candy, S.G., Miledi, R. and Parker, I.: Single glutamate-activated channels recorded from locust muscle fibers with perfused patch clamp electrodes. *J. Physiology* 32-, 195-210.
- 2) Pusch, M. and Nehr, E. (1987) Kinetics of loading small cells with various compounds by use of patch pipettes. *Pflugers Archives (Spring Meeting of the Physiol. Ges.)*. Tang, J.M., Wang, J. and Eisenberg, R.S. (1992) Perfusing patch pipettes. *Methods in Enzymol.* 207, 176-181.

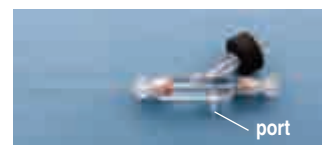
• Microperfusion (perfusion at the pipette tip)*

For microperfusion inside the pipette

Perfusion at the electrode tip is possible with the **PE Series holders**. They include an additional port in-line with the glass bore allowing for the insertion of microbore tubing into the pipette. This port includes a threaded cap and seal for up to 1 mm diameter tubing. See the reports referenced below for information on the microperfusion technique.

PE30W SERIES Holders

Order #	Wire/Pellet	Body Style	Port	Connector	Glass OD (mm)	Model
W4 64-1761	Wire	Straight	Yes	1 mm Pin	1.0	PE30W-A10P
W4 64-1762					1.2	PE30W-A12P
W4 64-1763					1.5	PE30W-A15P
W4 64-1764					1.7	PE30W-A17P
W4 64-1765					2.0	PE30W-A20P
W4 64-1766				BNC	1.0	PE30W-B10P
W4 64-1767					1.2	PE30W-B12P
W4 64-1768					1.5	PE30W-B15P
W4 64-1769					1.7	PE30W-B17P
W4 64-1770					2.0	PE30W-B20P
W4 64-1771				1 mm pin	1.0	PE30W-T10P
W4 64-1772				Threaded	1.2	PE30W-T12P
W4 64-1773				Collar	1.5	PE30W-T15P
W4 64-1774					1.7	PE30W-T17
W4 64-1775					2.0	PE30W-T20P



microelectrode holders

MP Series

MP Series Electrode Holders

Microelectrode holders for every application and manufacturer



- Microinjection

Pressure Ports

A	Accepts 1.5 mm (1/16") tubing
B	Accepts 2.4 mm (3/32") tubing*
ML	Accepts female Luer fitting
FL	Accepts male Luer fitting
T*	Accepts 1/4"-28 male thread fitting

Specifications

Body Material	Acrylic
Body Style	Straight
Port	1/16" barbed (1/16" tubing ID), 3/32" barbed (3/32" tubing ID), male Luer, female Luer and 1/4"-28 female threaded
Glass Sizes	1.0, 1.2, 1.5 and 2.0 mm
Handle	6.3 mm diameter x 6.3 cm long, threaded to attach to holder.

MP SERIES Holders

Order #	Body Style	Port	Glass OD (mm)	Model	
W4 64-1261	Straight	1/16" barb	1.0	MP-S10A	
W4 64-1262			1.2	MP-S12A	
W4 64-1263			1.5	MP-S15A	
W4 64-1264			2.0	MP-S20A	
W4 64-1265		3/32" barb*	1.0	MP-S10B	
W4 64-1266			1.2	MP-S12B	
W4 64-1267			1.5	MP-S15B	
W4 64-1268			2.0	MP-S20B	
W4 64-1273		male Luer	1.0	MP-S10ML	
W4 64-1274			1.2	MP-S12ML	
W4 64-1275			1.5	MP-S15ML	
W4 64-1276			2.0	MP-S20ML	
W4 64-1269		female Luer	1.0	MP-S10FL	
W4 64-1270			1.2	MP-S12FL	
W4 64-1271			1.5	MP-S15FL	
W4 64-1272			2.0	MP-S20FL	
W4 64-1278		threaded	1.0	MP-S10T	
W4 64-1279			1.2	MP-S12T	
W4 64-1280			1.5	MP-S15T	
W4 64-1281			2.0	MP-S20T	

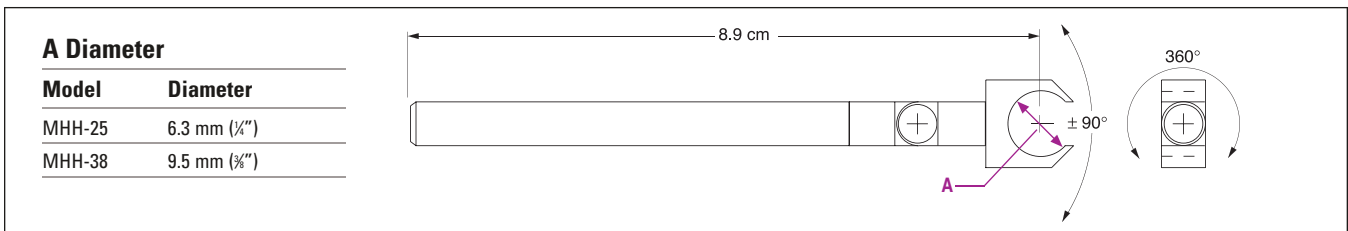
* Shaft Diameter

** Threads/Inch

microelectrode holders

MHH-25, MHH-38 and Theta Glass Holders

Microelectrode holders for every application and manufacturer



Electrode/Manifold Holders MHH-25, MHH-38

Specifications

The MHH-25 and MHH-38 Holders permit convenient mounting of manifolds and electrode holders or other devices with 6.3 or 9.5 mm diameters. The holder head can be pivoted $\pm 90^\circ$ from the axial position and rotated 360° about the axis. Friction holds the head firmly in the set position. Holder head and coupler are made from Delrin®. The anodized aluminum handle is 6.3 cm diameter x 6.3 cm long and will fit most positioners.

Device Compatibility

Order #	Model	Description
W4 64-0218	MHH-25	E and Q Series Electrode Holders
W4 64-0219	MHH-38	PE Series and Theta Electrode Holders MP and MPP Series Manifolds



Specifications

Body Material	Acrylic
Body Style	Straight
Coupling	Ag wire (2)
Connector	2 mm jack
Port	2 mm diameter polycarbonate
Standard Glass Sizes	1.5 and 2.0 mm
Handle	6.3 mm diameter x 6.3 cm long, threaded to attach to holder.

Theta Glass Holders

- Microinjection or microiontophoresis with theta glass

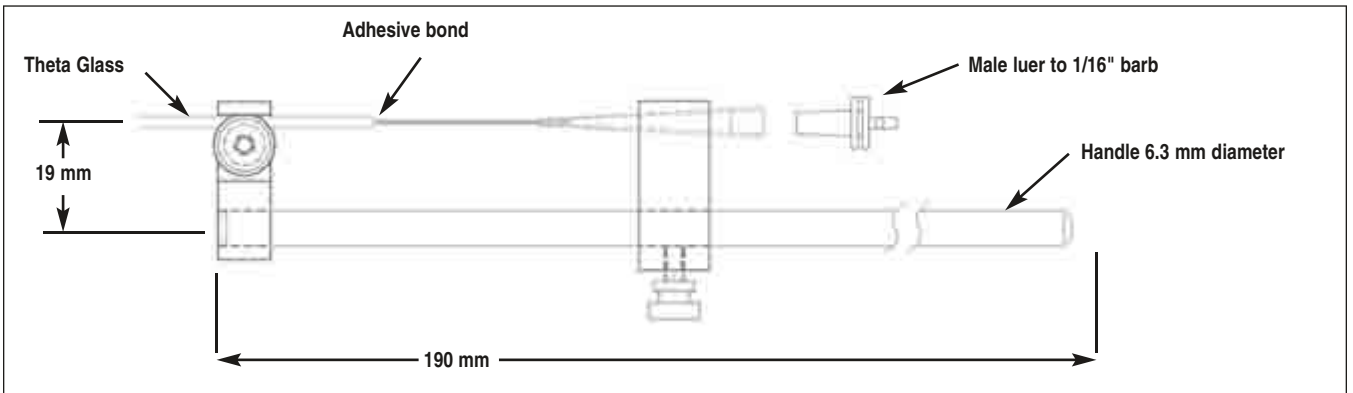
Theta Glass Electrode Holders

Order #	Port	Handle	Glass OD (mm)	Model
W4 64-1164	No	No	1.5	THS-F15
W4 64-1165			2.0	THS-F20
W4 64-1172		Yes	1.5	THS-F15H
W4 64-1173			2.0	THS-F20H
W4 64-1168	Yes	No	1.5	THS-F15P
W4 64-1169			2.0	THS-F20P
W4 64-1176		Yes	1.5	THS-F15PH
W4 64-1177			2.0	THS-F20PH

microelectrode holders

THP Pressurized Holder for Theta Glass

This holder allows quick and easy coupling of theta tubing to a pressurized source



- Allows microinjection using theta glass
- Kit includes everything needed
- Light weight acrylic electrode holder
- Easy coupling to pressure source
- Rated to 100 PSI

The new THP holder from Warner Instruments allows quick and easy coupling of theta tubing to a pressure source.

Complete kits are available for both 1.5 mm and 2.0 mm theta tubing. A drop of included hot glue adhesive bonds the theta to a flexible fill capillary tube. A barb fitting at the output permits coupling to the pressure source with 1/16" I.D. Tygon tubing. The light weight, fully adjustable holder makes assembly a breeze.

Order #	Model	Product
W4 64-1620	THP-15	Pressurized Holder Kit for 1.5 mm Theta Tubing
W4 64-1621	THP-20	Pressurized Holder Kit for 2.0 mm Theta Tubing
W4 64-1624	THP	Pressurized Holder Only
W4 64-1642	FTC-35	Flexible Fill Capillary Tubes 350 μ m
W4 64-1643	FTC-45	Flexible Fill Capillary Tubes 450 μ m
W4 64-0810	TG150-4	Theta Glass 1.5 mm OD
W4 64-0811	TG200-4	Theta Glass 2.0 mm OD
W4 64-1622		Barb Fitting 1/16" Male Luer (25)

Included with the THP-15:

- | | |
|----|--|
| 1 | THP acrylic theta tubing holder with integrated handle |
| 1 | Package of 10 Flexible Fill Capillary Tubes 350 μ O.D. Package of 10 |
| 50 | Feet of 1/16" Tygon tubing |
| 1 | Hot Glue Gun |
| 5 | Hot Glue Sticks |
| 1 | Package of male luer to 1/16" barb fittings, (25 pcs/pkg.) |
| 1 | Package of 1.5 mm O.D. Theta glass, (100 pcs/pkg.) |

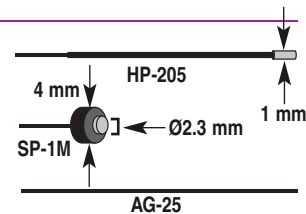
- | | |
|----|--|
| 1 | THP acrylic theta tubing holder with integrated handle |
| 1 | Package of 10 Flexible Fill Capillary Tubes 450 μ O.D. Package of 10 |
| 50 | Feet of 1/16" Tygon tubing |
| 1 | Hot Glue Gun |
| 5 | Hot Glue Sticks |
| 1 | Package of male luer to 1/16" barb fittings, (25 pcs/pkg.) |
| 1 | Package of 2.0 mm O.D. Theta glass, (100 pcs/pkg.) |
| 1 | Package of 10 Flexible Fill Capillary Tubes 350 μ O.D. Package of 10 |

microelectrode holders

Electrode Holder Replacement Parts

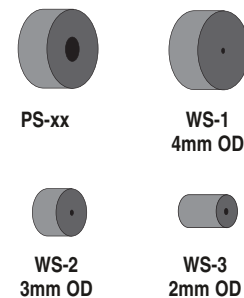
Microelectrode Replacement Parts

Order #	Qty/Pkg	Model	Description
Coupling Elements			
W4 64-1297	3	SP-1M	Molded Ag-AgCl pellet assembly
W4 64-1282	10	AG25-10	Ag wire, 0.25 mm diameter x 70 mm long
W4 64-1319		AG10W	Ag wire, 0.25 mm diameter x 2 m (6'6")
W4 64-1288	1	HP-205	Hybrid Ag-AgCl pellet/Ag wire assembly with 40 mm teflon sleeve sealed at junction of pellet and silver wire



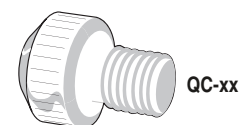
Pipette and Wire Seals

W4 64-1289	10	PS-10	Pipette seal for 1.0 mm diameter glass
W4 64-1290	10	PS-12	Pipette seal for 1.2 mm diameter glass
W4 64-1291	10	PS-15	Pipette seal for 1.5 mm diameter glass
W4 64-1374	10	PS-17	Pipette seal for 1.7 mm diameter glass
W4 64-1292	10	PS-20	Pipette seal for 2.0 mm diameter glass
W4 64-1298	10	WS-1	Wire seal for E, ME, MP and theta holder
W4 64-1299	10	WS-2	Wire seal for Q and PE Series holders
W4 64-1300	10	WS-3	Wire seal for Q and PE Series holders with threaded "T" connector



Glass Seal Compression Caps

W4 64-1293	2	QC-10	Compression cap for 1.0 mm glass holders
W4 64-1294	2	QC-12	Compression cap for 1.2 mm glass holders
W4 64-1295	2	QC-15	Compression cap for 1.5 mm glass holders
W4 64-1375	2	QC-17	Compression cap for 1.7 mm glass holders
W4 64-1296	2	QC-20	Compression cap for 2.0 mm glass holders



Connector Pins and Jacks

W4 64-1283	3	HC-10M	1 mm pin for Q and PE holders with A or T connectors
W4 64-1284	3	HC-13M	1.3 mm pin for Q and PE holders with B (BNC) connector
W4 64-1285	3	HC-20M	2 mm threaded pin for E, ME and theta holders
W4 64-1286	3	HC-21F	2 mm jack assembly for all series holders
W4 64-1287	3	HC-22M	2 mm pin for Q and PE holders with M connector

Warner capillary glass is known worldwide for its consistent high quality

- Ends are fire polished to prevent damage to the rubber gaskets when inserted into electrode holders
- Glass is cleaned with deionized water before being packed in dust-free containers

Warner capillary glass is known worldwide for its consistent high quality. The glass is precision drawn to insure reliability and consistency from batch to batch. The full line of glass capillaries listed here is stocked for fast shipment.

Standard Wall/Thin Wall

Tubing is available in two wall thickness, standard wall and thin wall. Additionally, a variety of diameters is offered to cover most needs of micropipette and microelectrode research.

Capillaries with Filament

A small diameter filament is fused to the glass inside diameter to facilitate rapid solution filling through capillary attraction. This is especially important for the very small diameter of sharp electrodes typically used for intracellular studies and microiontophoresis.

Premium Corning Type 7740 (Pyrex)

Corning 7740 Borosilicate is the most commonly used glass in electrode fabrication because of its mechanical strength, chemical durability, electrical resistivity, and its ability to withstand thermal stress. It is also easy to work with and suitable for a wide range of applications. Corning 7740 glass is offered in a choice of diameters, in standard or thin-walled format, and either with or without inner filament; they are additionally available in Theta style. Single barrel glass is available in 3 lengths: 75, 100 and 150 mm. Theta glass is offered in 100 mm lengths only.

Specifications

Composition	81% SiO ₂ , 13% B ₂ O ₃ , 4% Na ₂ O, 2% Al ₂ O ₃
Softening Temp.	821°C
Dielectric Constant	4.6

Premium Standard Wall Borosilicate



Order #	Model	OD mm	ID mm	Length mm	Qty/Pkg
W4 64-0765	G100-3	1.0	0.58	75	500
W4 64-0766	G100-4	1.0	0.58	100	500
W4 64-0770	G120-6	1.2	0.69	150	350
W4 64-0771	G150-3	1.5	0.86	75	225
W4 64-0772	G150-4	1.5	0.86	100	225
W4 64-0773	G150-6	1.5	0.86	150	225
W4 64-0774	G200-3	2.0	1.16	75	125

Premium Thin Wall Borosilicate



Order #	Model	OD mm	ID mm	Length mm	Qty/Pkg
W4 64-0778	G100T-4	1.0	0.78	100	500
W4 64-0780	G120T-3	1.2	0.94	75	350
W4 64-0781	G120T-4	1.2	0.94	100	350
W4 64-0783	G150T-3	1.5	1.17	75	225
W4 64-0784	G150T-4	1.5	1.17	100	225
W4 64-0785	G150T-6	1.5	1.17	150	225

Premium Standard Wall Borosilicate with Filament



Order #	Model	OD mm	ID mm	Length mm	Qty/Pkg
W4 64-0786	G100F-3	1.0	0.58	75	500
W4 64-0787	G100F-4	1.0	0.58	100	500
W4 64-0788	G100F-6	1.0	0.58	150	500
W4 64-0789	G120F-3	1.2	0.69	75	350
W4 64-0790	G120F-4	1.2	0.69	100	350
W4 64-0791	G120F-6	1.2	0.69	150	350
W4 64-0792	G150F-3	1.5	0.86	75	225
W4 64-0793	G150F-4	1.5	0.86	100	225
W4 64-0794	G150F-6	1.5	0.86	150	225
W4 64-0795	G200F-3	2.0	1.16	75	125
W4 64-0796	G200F-4	2.0	1.16	100	125

Premium Capillary Glass (continued)

Premium Thin Wall Borosilicate with Filament



Order #	Model	OD mm	ID mm	Length mm	Qty/Pkg
W4 64-0798	G100TF-3	1.0	0.78	75	500
W4 64-0799	G100TF-4	1.0	0.78	100	500
W4 64-0800	G100TF-6	1.0	0.78	150	500
W4 64-0801	G120TF-3	1.2	0.94	75	350
W4 64-0802	G120TF-4	1.2	0.94	100	350
W4 64-0804	G150TF-3	1.5	1.17	75	225
W4 64-0805	G150TF-4	1.5	1.17	100	225

Premium Theta Glass (100 pcs/pkg.)



Order #	Model	OD mm	ID mm	Septum mm	Length mm
W4 64-0810	TG150-4	1.5	1.0	0.2	100
W4 64-0811	TG200-4	2.0	1.4	0.2	100

Custom 8520 glass has been shown to be equal in noise performance to the discontinued Corning 7552

Choosing patch clamp glass is generally based on noise performance and the ability to form and maintain a seal. No single type of glass works best in all applications and some trial and error is usually required to find the type yielding optimum results in your experiment. Patch glass is manufactured without an inner filament. This glass is offered in both the standard and premium models. The premium glass has fire polished ends and is cleaned with deionized water before being packed in dust-free containers.

Custom 8520 Patch Glass



Now Available in Premium Line!

The custom patch glass from Clark was introduced in 1997 as a substitute for the Corning 7052 glass, a favorite amongst researchers performing patch clamping. Initial tests showed the 8520 glass to be equal to the 7052 in noise performance. More importantly, seals were formed faster and maintained for longer periods.

Specifications

Composition	>10% SiO ₂ , >10% B ₂ O ₃ , >1% Al ₂ O ₃ , >1% K ₂ O, <1% Na ₂ O, <1% Li ₂ O, <1% ZnO, <1% As ₂ O ₃ , <1% TiO ₂ , <1% ZrO ₂
Softening Temperature	720°C
Dielectric Constant	4.6

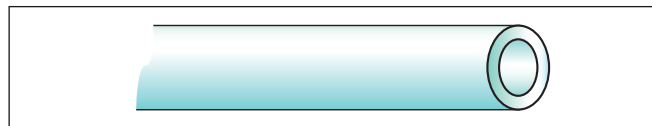
Premium Custom 8520 Patch Glass

Order #	Model	OD mm	ID mm	Length mm	Qty/Pkg
W4 64-0817	G85150T-3	1.50	1.16	75	225
W4 64-0818	G85150T-4	1.50	1.16	100	225
W4 64-0819	G85165T-3	1.65	1.28	75	190
W4 64-0820	G85165T-4	1.65	1.28	100	190

Clark Custom 8520 Patch Glass

Order #	OD mm	ID mm	Length mm	Qty.
W4 30-0091	1.2	0.93	75	350
W4 30-0089	1.2	0.93	100	350
W4 30-0090	1.2	0.93	150	350
W4 30-0094	1.5	1.16	75	225
W4 30-0092	1.5	1.16	100	225
W4 30-0093	1.5	1.16	150	225
W4 30-0097	1.65	1.28	75	190
W4 30-0095	1.65	1.28	100	190
W4 30-0096	1.65	1.28	150	190

Premium Corning 7056 (Alkali Barium Borosilicate) Patch Glass



Now Available in Premium Line!

Corning 7056 glass is now offered in place of the 7052 glass, last melted in 1992 and no longer available. The 7056 formula has also been discontinued by Corning (last melt in 1995) but stocks of this material are still available. The properties of the 7056 glass are similar to the 7052 as is its performance in patch experiments.

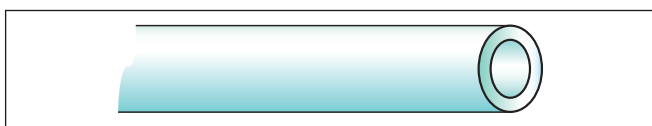
Specifications

Composition	68% SiO ₂ , 18% B ₂ O ₃ , 9% K ₂ O, 3% Al ₂ O ₃ , 1% Li ₂ O, 1% Na ₂ O
Softening Temperature	718°C
Dielectric Constant	5.7

Premium Corning 7056 Patch Glass

Order #	Model	OD mm	ID mm	Length mm	Qty.
W4 64-0813	G75150T-4	1.50	1.10	100	225
W4 64-0814	G75165T-4	1.65	1.20	100	190

Premium Corning 8161 (Potash Rubium Lead) Patch Glass



This glass pulls at a lower temperature and is easily shaped. It is recommended for low noise recordings. However, the lead content should be considered for the intended application.

Specifications

Composition	51% PbO, 39% SiO ₂ , 6% K ₂ O, 2% BaO
Softening Temperature	600°C
Dielectric Constant	8.3

Premium Corning 8161 (Potash Rubium Lead) Patch Glass

Order #	Model	OD mm	ID mm	Length mm	Qty.
W4 64-0815	G86150T-4	1.50	1.10	100	225
W4 64-0816	G86165T-4	1.65	1.20	100	190

An old favorite

Borosilicate Capillaries

The properties of borosilicate glass make it the most popular material among researchers for the fabrication of electrodes and micro-pipettes. Its low softening temperature combined with its mechanical strength, chemical durability, high electrical resistivity, and its ability to withstand thermal stress, make these capillaries the most widely used in the world. Clark borosilicate capillaries are offered in a variety of diameters and wall thickness (standard or thin walled) with or without an inner filament. They are available in fused multi-barrel configurations, as well as in theta style. Single barrel glass is available in 75 mm (3 in), 100 mm (4 in) and 150 mm (6 in) lengths.

- High quality borosilicate glass
- Five outside diameters available
- Available with either thin or standard wall
- Ratio of outside to inside diameters preserved to tip
- Economical

Borosilicate Thin Wall without Filament



Borosilicate Thin Wall without Filament

Order #	OD mm	ID mm	Length mm	Qty.
W4 30-0037	1.0	0.78	75	500
W4 30-0035	1.0	0.78	100	500
W4 30-0036	1.0	0.78	150	500
W4 30-0049	1.2	0.94	75	350
W4 30-0047	1.2	0.94	100	350
W4 30-0048	1.2	0.94	150	350
W4 30-0064	1.5	1.17	50	225
W4 30-0065	1.5	1.17	75	225
W4 30-0062	1.5	1.17	100	225
W4 30-0063	1.5	1.17	150	225

Discounts on Quantity Purchases:

Discount apply to only single part number quantities (no mixing).

1 to 4	none
5 to 9	5%
10+	10%

Specifications

Composition	80.9% SiO ₂ 12.9% B ₂ O ₃ 4.4% Na ₂ O 1.8% Al ₂ O ₃
Softening Temp.	815°C
Dielectric Constant	4.7

Borosilicate Standard Wall without Filament



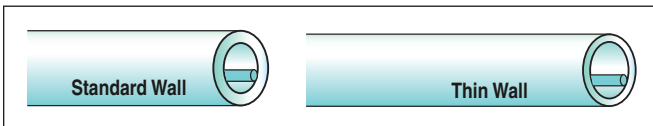
Borosilicate Standard Wall without Filament

Order #	OD mm	ID mm	Length mm	Wall	Qty.
W4 30-0018	1.0	0.58	75	0.21	500
W4 30-0016	1.0	0.58	100	0.21	500
W4 30-0017	1.0	0.58	150	0.21	500
W4 30-0043	1.2	0.69	75	0.25	350
W4 30-0042	1.2	0.69	100	0.25	350
W4 30-0041	1.2	0.69	150	0.25	350
W4 30-0056	1.5	0.86	75	0.32	225
W4 30-0054	1.5	0.86	110	0.32	225
W4 30-0053	1.5	0.86	100	0.32	225
W4 30-0055	1.5	0.86	150	0.32	225
W4 30-0073	2.0	1.16	75	0.42	125
W4 30-0070	2.0	1.16	100	0.42	125
W4 30-0071	2.0	1.16	150	0.42	125
W4 30-0127	3.0	1.62	75	0.69	55
W4 30-0080	3.0	1.62	100	0.69	55
W4 30-0081	3.0	1.62	150	0.69	55

Clark Capillary Glass (continued)

capillary glass

Borosilicate with Filament



- Easy filling
- Available in standard or thin wall configurations with selection of three outside diameters
- Exceptionally low tip impedance (less than 50 MΩ)
- Good for patch clamp pipettes and microinjection needles

Borosilicate with Filament

Order #	OD mm	ID mm	Length mm	Qty.
Borosilicate Standard Wall with Filament				
W4 30-0034	1.0	0.50	75	500
W4 30-0032	1.0	0.50	100	500
W4 30-0033	1.0	0.50	150	500
W4 30-0021	1.0	0.58	75	500
W4 30-0019	1.0	0.58	100	500
W4 30-0020	1.0	0.58	150	500
W4 30-0046	1.2	0.69	75	350
W4 30-0044	1.2	0.69	100	350
W4 30-0045	1.2	0.69	150	350
W4 30-0060	1.5	0.86	75	225
W4 30-0057	1.5	0.86	100	225
W4 30-0058	1.5	0.86	150	225
W4 30-0076	2.0	1.16	75	125
W4 30-0074	2.0	1.16	100	125
W4 30-0075	2.0	1.16	150	125
W4 30-0084	3.0	1.62	75	55
W4 30-0082	3.0	1.62	100	55
W4 30-0083	3.0	1.62	150	55
Borosilicate Thin Wall with Filament				
W4 30-0040	1.0	0.78	75	500
W4 30-0038	1.0	0.78	100	500
W4 30-0039	1.0	0.78	150	500
W4 30-0052	1.2	0.94	75	350
W4 30-0050	1.2	0.94	100	350
W4 30-0051	1.2	0.94	150	350
W4 30-0068	1.5	1.17	75	225
W4 30-0066	1.5	1.17	100	225
W4 30-0067	1.5	1.17	150	225
W4 30-0128	2.0	1.56	75	125
W4 30-0077	2.0	1.56	100	125
W4 30-0078	2.0	1.56	150	125

Borosilicate Double and Triple Barrel Specials



- High quality borosilicate glass
- Special two barrels - one barrel with filament, one without
- Ratio of outside to inside diameter preserved to tip during pull

Borosilicate Double and Triple Barrel Specials

Order #	OD mm	ID mm	Length mm	Qty.
Double Barrel				
W4 30-0004	1.5	0.86	75	100
W4 30-0005	1.5	0.86	100	100
W4 30-0006	1.5	0.86	150	100
Triple Barrel				
W4 30-0011	1.5	0.86	75	100
W4 30-0009	1.5	0.86	100	100
W4 30-0010	1.5	0.86	150	100

Borosilicate Theta Glass



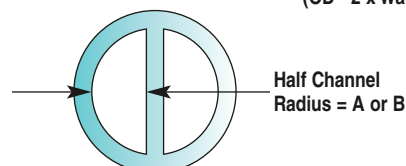
- Easy to fill
- Two channels in a single diameter

Borosilicate Theta Glass

Order #	OD mm	ID mm	Septum mm	Length mm	Qty.
W4 30-0116	1.5	0.23	0.17	75	100
W4 30-0114	1.5	0.23	0.17	100	100
W4 30-0115	1.5	0.23	0.17	150	100
W4 30-0119	2.0	0.30	0.22	75	100
W4 30-0117	2.0	0.30	0.22	100	100
W4 30-0118	2.0	0.30	0.22	150	100

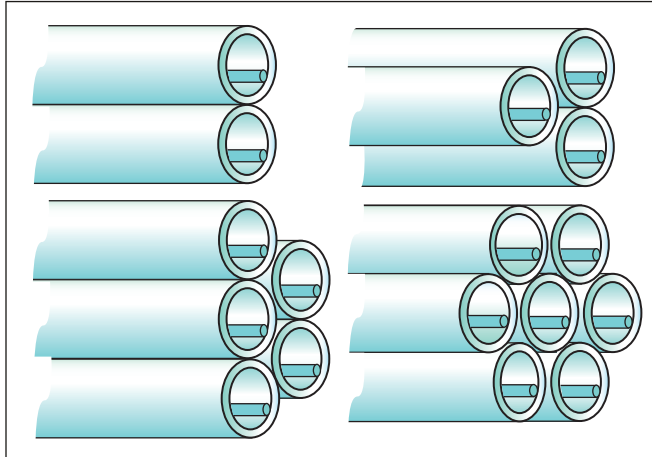
A: 0.435 mm
B: 0.59 mm

HRC = $\frac{1}{2}$
(OD - 2 x Wall Sept)



Clark Capillary Glass (continued)

Borosilicate Multi-Barrel



- High quality borosilicate glass
- Two, three, five and seven barrel configurations with filament
- Capillaries fused along their full length

Borosilicate Multi-Barrel

Order #	OD mm	Wall mm	# of Septum	Barrels	Qty.
W4 30-0003	1.5	0.86	75 mm	2	100
W4 30-0001	1.5	0.86	100 mm	2	100
W4 30-0002	1.5	0.86	150 mm	2	100
W4 30-0007	1.2	0.69	100 mm	3	100
W4 30-0008	1.2	0.69	150 mm	3	100
W4 30-0012	1.2	0.69	100 mm	5	65
W4 30-0013	1.2	0.69	150 mm	5	65
W4 30-0014	1.0	0.58	100 mm	7	60
W4 30-0015	1.0	0.58	150 mm	7	60

Aluminosilicate Capillaries with Filament



Aluminosilicate Capillaries with Filament

Order #	OD mm	ID mm	Length mm	Qty.
W4 30-0110	1.0	0.53	75	500
W4 30-0108	1.0	0.53	100	500
W4 30-0109	1.0	0.53	150	500

Specifications

Composition	51.9% SiO ₂ , 22.0% Al ₂ O ₃ , 7.8% P ₂ O ₅ , 7.7% MgO, 6.9% CaO, 2.1% B ₂ O ₃ , 1.4% BaO and 0.2% As ₂ O ₃
Softening Temperature	950°C
Dielectric Constant	6.2

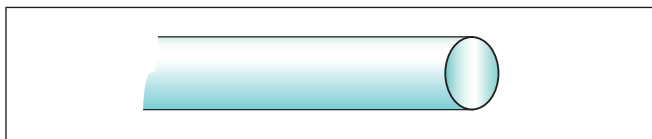
Aluminosilicate Capillaries

In recent years there has been a developing interest in fabricating micropipettes from aluminosilicate glass. Like silicon, aluminum combines with oxygen to form Tetrahedral Networks and the Al-O bonds are very strong. In comparison with borosilicate glass, **aluminosilicate** provides increased hardness, improved chemical durability, reduced electrical conductivity and a lower coefficient of thermal expansion. Also, while the original ratio of a borosilicate capillary's inner to outer diameter will remain unchanged over its total taper length, aluminosilicate glass demonstrates a marked tendency to thin out as it is drawn to a tip. This behavior allows extremely fine tips to be formed.

For more information, see:

1. Na/H Exchange, Vaughan-Jones, R.D.; Grinstein Press, Cb.1 p.8;
2. Effects of intracellular and extracellular pH on contraction in isolated mammalian cardiac muscle, Bountra, C. & Vaughan-Jones, R.D.; Journal of Physiology Volume 418 (1989)

Borosilicate Glass Rod



- High quality borosilicate glass
- Available in two diameters

Borosilicate Glass Rod

Order #	OD mm	Length mm	Qty.
W4 30-0087	1.0	75	500
W4 30-0085	1.0	100	500
W4 30-0086	1.0	150	500

Pipette Sterilization and Micropipette

The Pipette storage container is both convenient and easy to use



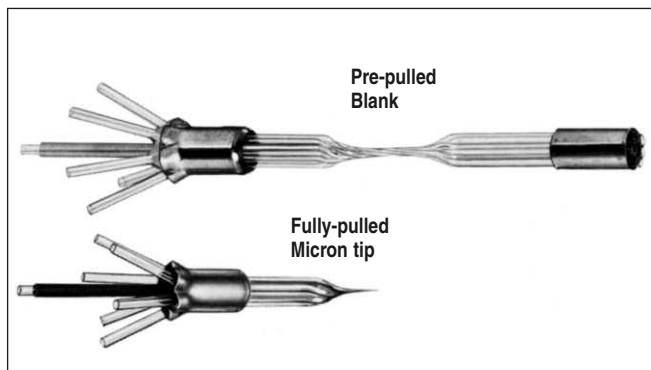
Pipette Sterilization and Storage Container

- Ideal for dry heat sterilization of pipettes
- Pyrex-type glass covers make contents easily visible
- Holds 21 pipettes
- Available for 1.0, 1.2, 1.5 and 2.0 mm diameter pipettes

This container is a convenient and easy to use pipette storage container. It is ideal for both storage and dry heat sterilization of micropipettes. In most application pipettes must be free from contamination at all times. By storing completed pipettes and partially made pipettes (between operations), the cleanliness of the micropipettes can be assured. Because the covers are made of Pyrex glass, the complete container with pipettes in-situ can be dry-heat sterilized, ensuring contamination-free pipettes. The base accepts 21 pipettes. Select from containers holding either 1.0, 1.2, 1.5 or 2.0 mm OD pipettes.

Order #	Product
W4 69-0114	Pipette Sterilization and Storage Container for 1.0 mm Pipettes
W4 69-0316	Pipette Sterilization and Storage Container for 1.2 mm Pipettes
W4 69-0317	Pipette Sterilization and Storage Container for 1.5 mm Pipettes
W4 69-0318	Pipette Sterilization and Storage Container for 2.0 mm Pipettes

Designed for iontophoretic applications and pneumatic ejection of drugs through up to seven barrels



7-Barrel Iontophoresis Micropipette

- Easy filling
- Minimal tip resistance
- Minimal leakage
- Available pre-pulled or fully-pulled

The MS-7P Micropipette has been designed for iontophoretic use as well as for pneumatic ejection of drugs. The standard blank consists of seven barrel, pyrex Omegadot tubing, 1.5 mm outer diameter and 1.2 mm inner diameter, pre-pulled to 2.0 mm formation as shown. The design of the micropipette readily lends itself to electrical connection by inserting Ag wire or to pressure tube attachment for pneumatic use. The overall length of the blank assembly is 10 centimeters. The micropipette is supplied as either pre-pulled blanks or fully-pulled to a micron tip as shown. The micron tip is not bumped and therefore can be finalized prior to use.

Features

- The orifice ratio of each barrel is 0.80 and thus is optimized for minimal tip resistance when pulled to micron size.
- Omegadot tubing permits easy filling.
- Fanned-out outer barrel assembly provides separation thus avoiding leakage due to spills and any cross-coupling between barrels.
- The 22 mm long twisted segment of the blank assembly assures singular tip formation during pulling action thus provides flexibility in a selection of a desired tip configuration.

Order #	Model	Micropipettes
W4 65-0207	MS-7PB	Micropipette 7-Barrel, 1.5 mm OD Borosilicate Glass, Pre-Pulled Blank, pkg. of 20
W4 65-0208	MS-7MT	Micropipette 7-Barrel, 1.5 mm OD Borosilicate Glass, Fully-Pulled, approx. 20 µm Tip, pkg. of 10

A state of the art, microprocessor controlled horizontal pipette puller designed to simultaneously pull two identical, single barrel pipettes

Needle micropipette fabrication devices include instruments intended to pull, bevel, or forge various types and styles of glass micropipette needles for ICSI, IVF, transgenics, patch recording or other similar procedures involving the use of micropipettes in electrophysiological recording, microinjection, and microperfusion techniques.

The first step in the process involves the initial fabrication of the micropipette itself using either single or multibarrel capillary tubing. This tubing typically ranges in size from between 1 and 2 mm OD and is usually made from borosilicate glass although other materials such as aluminosilicate or quartz are also used in some applications. The capillary tubing is then placed in a micropipette puller where a point on the capillary tubing is brought to its softening point through the use of a heating device such as an electrical filament, laser or gas flame. Once the capillary tubing's softening point temperature is reached, a mechanical parallel pulling force is applied to each end of the capillary tube and it is 'pulled' to the desired tip diameter and profile. Depending on a number of preset variables such as capillary material type, temperature, filament type and pulling force, numerous types of tip profiles and tip diameters can be fabricated. Using this technique tip sizes as small as 0.02 μm can be achieved. Pipette pullers can range in complexity from a simplistic spring/counter weight mechanical puller to highly sophisticated programmable microprocessor controlled pullers.

To reshape the pipette or to fuse the tip into a different geometry, a microforge system is used. A microforge uses a heating element, microscope, illumination, micromanipulators and microtools to change the shape of or contact fuse other elements to the micropipette pipette by heating certain sections of the micropipette to either soften (for bending) or melting (fusing) the micropipette. Some types of microforges can also be fabricate metal and glass microtools.

Harvard Apparatus manufactures and sells a complete range of high quality equipment and supplies to fabricate micropipettes.



pipette pullers

Pipette Pullers

Programmable Pipette Pullers

A state of the art, microprocessor controlled horizontal pipette puller for pulling single- or multi-barrel micropipettes

W4 69-0151



- Two models available:
 - Single-barrel
 - Multi-barrel
- Microprocessor controlled system performs programmable multiple step pulling sequences
- Produces micropipettes for patch clamping, intracellular electrodes, injection micropipettes, micro needles, etc.
- Consistent pulling force by utilizing pneumatic pressure instead of gravity or magnetic fields

The PMP-102 is a state of the art microprocessor controlled horizontal pipette puller that has been designed to pull two identical single barrel pipettes at the same time. The pipettes can be used as patch clamp electrodes, intracellular electrodes, injection micropipette or micro-needles.

The PMP-107 is similar to the PMP-102, but is designed to pull a single 4- or 7-barrel pipette. Under program control, the PMP-107 can automatically heat, twist and pull a multi-barrel pipette. There is no need for any manual rotation or any inconsistent timing interrupt control.

Exclusive Optical-Digital Taper Measurement

Instead of a mechanical tip length setting as on other pipette pullers, the PMP-102 and PMP-107 use an exclusive optical-digital ruler to perform precise taper length setting, real-time measuring and controlling. With this feature, a user can handle the taper pulling of pipette tips precisely and very easily. Equipped with a powerful computerized tip sensing function, the PMP-102 and PMP-107 can automatically finish the tip pulling.

Computerized Heater Control

The PMP-102 and PMP-107 use an advanced microcontroller design to perform real-time heater monitoring and pulling control. Thus, they will always provide precise heating power, despite multiple/consecutive pipette pullings or changes in thermal/electrical characteristics.

Programmable Sequences for Creation and Reproduction

There are 25 user programmable pulling sequences with 18 steps in each sequence. Users can start the pulling sequence by just pressing the Start button.

Factory Installed Preset Programs for Major Different Pipette Pulls

Every pipette puller is pre-installed with a number of different pipette pulling programs. With just a few modifications to these steps or parameters new programs can be configured.

Pneumatic Pulling Force

Both pullers use a precise controlled pneumatic pressure as the pulling force rather than gravity or magnetic fields used by other manufacturers. This technique provides more controlled, even, and consistent dragging characteristics allowing the units to pull an ideal injection tip or microelectrode tip. A precision micro-linear ball bearing rail, and advanced pneumatic components are used to provide no fault pulling movement.

Programming

A simple 4x4 keypad and full information display allows the user to easily control and read all pulling parameters. Programming functions include sequences, steps, time, timing, heater level, heater control, and tip length and actions.

These units are supplied with input tubing and connector, spare heater filament, tweezers, power cord and manual.

pipette pullers

Pipette Pullers

Programmable Pipette Pullers (continued)



Specifications

Pulling Force	Pneumatic
Multi-Barrel Pipette	4- or 7-barrel (W4 69-0150 only)
Each Barrel Pipette	1 mm OD
Heater	Nichrome coil
Heater Control	Microcontroller
Heating	74 general heat levels (24 to 99), 54 auto heat levels (45 to 98)
Number of Sequences	25
Steps in Each Sequence	18
Taper Length Setting	0.5 to 20 mm
Pressure 1 Regulator	0.1 to 10 p.s.i.
Pressure 2 Regulator	0.1 to 60 p.s.i.
Pressure Gas Input	30 to 60 p.s.i.
Actions	Pull 1, pull 2, pull 2/cool, rotation (W4 69-0150 only), cool air, return
Display	20 x 4 LCD
Power Input	110/240 VAC
Power Consumption	Max. 150 W
Dimension, H x W x D	17.8 x 27.9 x 35.6 cm
Weight:	
W4 69-0150	6.8 kg (18 lbs)
W4 69-0151	5.9 kg (13 lbs)

Order # Product

W4 69-0150	PMP-107 Programmable Multi-Barrel Pipette Puller
W4 69-0151	PMP-102 Programmable Single-Barrel Micropipette Puller
W4 69-0161	Unpulled 7-Barrel Pipette for W4 69-0150 Only
W4 69-0162	Unpulled 4-Barrel Pipette for W4 69-0150 Only

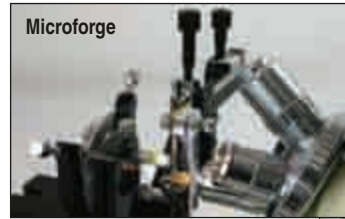
pipette pullers

MF-5 and MG-5 Microforge-Grinding Center

Glass micropipette polishing, shaping, tipping, bending, beveling, and grinding - all in one compact platform



Microforge and
Microgrinder



Microforge



Microgrinder

- Glass micropipette tip polishing, shaping, tipping, bending, beveling, and grinding all in one compact platform.
- Quick changeable platinum heater and microgrinder as center tools.
- Precise, convenient movement controls for heater/grinder, pipette locations, and optical focus.
- Universal pipette holder for one to seven barrel pipette holding and 0-180 degree beveling.
- Up to 40x long working distance objective and 20x eyepiece optics combination, plus scale eyepiece for precision measurement.
- Adjustable precision power supply for variable grinder speed and heating level.
- Pressurized air for pipette tip clearing, expanding and cooling. Foot switch controllable.

The MFG-5 Microforge/Grinding Center is designed for precise and efficient modification of micropipette and multi-pipette tips. This unique apparatus combines a precision microforge with a full-function microgrinder in a compact platform.

The optical system of the MFG-5 is based on a high-power, horizontally mounted, binocular microscope. A precision focusing system, with a dual-axial pipette holder, can conveniently and precisely position single or multi-barrel pipettes. The pipette holder is capable of rotating through 180° to allow a multitude of beveling angles and pipette bending positions.

The MFG-5 uses high quality optical components which include 10x and 20x wide field eyepieces, and 4x, 10x/0.25, and 40x/0.6 long working distance plan achromatic objectives. The 10x wide field scale eyepiece can be used as an independent and accurate measurement tool. Two high intensity LED's provide a powerful light source.

An included foot switch, or a heat/speed adjustment dial, can be used to regulate the attached heater or grinder. In addition to the included heater/grinder foot switch, the MFG-5A has a second foot switch for the regulation of pressurized air. Air from an external source is connected to the Microforge/Grinding Center and, when the foot switch is activated, is directed to an output channel. Pressure air from this source can be used for clearing a pipette of dust after grinding, or for expanding or cooling a pipette during forging.

The MFG-5 can be purchased comprised of the microforge only, the microgrinder only, or comprised of both components. For the latter system, the microgrinder and the microforge mini-heater can be quickly and easily exchanged since both components use the same quick connector and temperature/speed control system. Finally, the MFG-5 can be combined with a PMP-102 or a PMP-107 micropipette/multipipette puller to assemble a complete micropipette production work station.

Specifications

Pipette Movement	Two-axial manipulator and coarse-fine focusing adjustment
Heater Movement	Three-dimensional adjustment
Pipette Holder	180 degree turnable for single or multipipette holding
Body	Horizontal Binocular microscope
Eyepiece	10x, 20x/WF Optional 10x Scaled
Objective Lenses	4x, 10x/0.25, 40x Optional: 25x, 40x/0.6 Long Working Distance
Heater	Platinum wire
Light	Two super bright white LED's
Air In/Output	Optional air jet foot switch, in/output tubing and connector
Microgrinder	Optional changeable microgrinder One foot switch
Accessory	Extra foot switch
Power Supply	20W, 120/240VAC

Order #	Model	Product
W4 64-1610	MF-5	Microforge
W4 64-1611	MG-5	Microgrinder
W4 64-1612	MFG-5	Microforge-Grinding Center
W4 64-1613	MFG-5A	Microforge-Grinding Center w/ Air
W4 64-1614	MF-5E	Microforge 220/240VAC
W4 64-1615	MG-5E	Microgrinder 220/240VAC
W4 64-1616	MFG-5E	Microforge-Grinding Center 220/240VAC
W4 64-1617	MFG-5AE	Microforge-Grinding Center with Air 220/240VAC

NEW Automatic Oscillating Tissue Slicer (OTS 5000)



Updates and Advantages of the OTS 5000 Series:

- Cutting window for automatic sectioning allows for faster and more reliable sectioning.
- Control pad with membrane buttons is now separated from the slicer module for improved ergonomics and protection of electronic components.
- 3-axis adjustable specimen mounting pedestal.
- Easy to release slicer head for safety and ease of specimen mounting.
- Slice thickness is now adjustable from 1-999 microns (in 1 micron increments).
- One touch "home" button to return the blade arm to a predetermined point near the specimen.
- The specimen tray is made from clear polycarbonate for improved viewing of the slice operation.
- The pivot pins which come as a standard on the pedestal as well as the vice holder allow changing of the angle of the pedestal relative to the blade. Easy sample orientation in all directions.
- The tray includes a lock-on feature for a more secure mount to the platform.
- The standard unit comes complete with our unique pivotal tissue pedestal (you can mount the specimen directly on the pedestal without the need for vices or blocks mounted in the sample tray).

Automatic Oscillating Tissue Slicer (OTS 5000)

The OTS-5000 Oscillating Tissue Slicer represents the most thoughtfully designed solution to sectioning either fixed or fresh tissue, and can prepare sections as thin as 5 microns. Embedding or freezing of the sample is not required, thus tissue preparation time is reduced dramatically. The risk of distortion and artifacts normally associated with these procedures are eliminated. The OTS-5000 meets the highest standards for precision

and accuracy and it meets or exceeds the performance of units on the market costing twice as much.

The OTS 5000 now features a new innovative design of the slicer head which minimizes Z-Axis vibration. This improvement dramatically improves slice surface integrity and is especially beneficial in the use of fresh tissue where IR/DIC imaging methods are used. The unique blade holder has the ability to accept sapphire blades as well as razor blades.

To minimize the time between harvesting consecutive slices, the OTS-5000 features a user programmable travel window (cutting window). This allows the section-cutting range of the blade to be customized to the specimen sample. In conjunction with the "home button", the programmable window guarantees rapid sectioning of even the largest of specimens. As well, the OTS-5000 allows the sectioning of samples in two different modes. In the single-slice mode, the unit prepares one section at a time and the blade repositions itself and waits to perform the next slice upon triggering by the user. In the multiple-slice mode, the OTS-5000 will automatically perform multiple uniform slices.

The OTS-5000 control panel has been redesigned to allow for ambidextrous and ergonomic operation. The keypad has been sealed to avoid exposure from buffer spills. The tray is made from molded clear polycarbonate for improved viewing of the slicing operation. The tray is removable to facilitate specimen mounting and cleaning. Two white LED's are installed in the blade head, which provide constant cold-illumination of the specimen during the slicing process.

The OTS-5000 is engineered for maximum stability, allowing even the most delicate of tissue to be cut successfully every time. The knife holder allows the blade to be well-secured and the blade angle set from 10-20 degrees. The specimen mount is adjustable on the x, y, and z axis. Blade oscillation is adjustable from 50-5000 cycles/minute, the knife advance is continuously adjustable with a touch of the keypad from 0-5mm/s, and the section thickness is adjustable in 1 micron increments ranging from 1-999 microns. This precision slicer features automatic touch selection of section thickness, blade speed, advance, and a user-defined travel window so that consecutive sections may be cut easily and rapidly. Other OTS-5000 features include: Touch pad control of the blade height, slice counter / slice thickness, precise bar graph displays of blade oscillation and advance speeds.

The OTS-5000 is designed for easy operation and maintenance. The specimen collecting tray is removable and easy to clean. All controls may be set with one hand with options for multiple slicing modes.

The unit comes complete with gooseneck magnifying lens, media tray (2.5" wide) and pedestal, specimen vice holder, blocks, as well as a foot switch with 6' cable. A large tray (3.5" wide) is available as an option and comes complete with fixed stage and adjustable pedestals.

NEW Automatic Oscillating Tissue Slicer (OTS 5000) (continued)

OTS-5000 Continued

The tissue pedestal with pivotal pin (included with media tray) allows for the mounting of a specimen directly to the pedestal and the ability to change the angle of your specimen relative to the blade, offering maximum flexibility in specimen orientation. The sample vice with pivotal pins (also included in package) allows for the adherence of your specimen directly to a mounting block.

The OTS-4500 Tissue Slicer

The OTS-4500 Tissue Slicer is a scaled down version of the OTS-5000. All of the specifications of the OTS-5000 are the same for the OTS-4500. The only differences between the two units are as follows:

The OTS 4500 does not include:

Functional Features

1. Adjustable window
2. Multi-Slice function
3. Home functionality

Accessories

1. Foot Switch
2. Tissue Blocks
3. Vice Holder

The OTS-5000 Refrigerated Controller and Tray

The OTS-5000 Refrigerated Controller and Tray provide refrigeration capabilities to the OTS-5000 Tissue Slicer. The refrigeration controller's three-digit LED displays the current temperature of the bath medium in degrees C. The temperature is maintained within 0.5°C. The temperature range on the unit is between 0-10°C.

The refrigerated tray is fitted with a Peltier heat exchange unit. A cold water source is circulated through the assembly to transfer heat. The tubing is connected to the tray with quick connect fittings. No tools are necessary for installation. The fittings are self sealing to prevent leaking during installation. The tray fits directly to the mounting platform of the OTS 5000.

Specifications

Vertical Travel:	28 mm
Slice Thickness:	Adjustable from 1 to 999 microns in 1 micron increments
Blade Speed:	Adjustable from 50- 5000 cycles per minute
Blade Angle Adjustment:	Adjustable from 15° to 35°
Blade Travel:	35 mm total
Blade Types:	Sapphire, Razor, Diamond, Glass
Blade Advance Speed:	Continuously adjustable from 100 microns-5 mm per second
Blade Reverse Speed:	2.5 mm per second
Specimen Size:	25 x 25 x 15 mm (1 x 1 x .6 in) (W x D x H) maximum volume
Magnifier:	4 in diameter, X2 lens mounted on 12 in (30 cm) gooseneck, 9 in working distance
Lighted:	White LED's mounted on the knife holder aimed at blade edge.
Dimensions:	
Slicer	27 x 40 x 21.5 cm (10.5 x 16 x 7.5 in)
Keypad	17 x 8.5 x 3.4 cm (6.7 x 3.4 x 1.35 in)
Weight:	13kg (30 lbs)
Power Requirements:	110-240VAC, 50-60Hz universal power input. Available with CE Mark
Display:	3 segment LED display of slice counter and thickness. (Changes with appropriate buttons) 20 segment LED's bar graph display blade oscillation and advance speed.
Specimen Mount:	X, Y, Z axis adjustable pedestal: 1 3/4 x 2 1/2 in
Mounting Blocks	1/2 x 1/2 x 1/2 in (3 each) /1 x 1 x 1 in (3 each)
Working Space Requirements:	30 x 45 x 25 cm (12 x 18 x 10 in) (W x D x H)
5000 Series Refrigeration Controller and Tray	
Temperature Control Range	0°- 10°C
Temperature Indication	3 digit LED display indicates temperature in 0.1°C with a negative sign indicator.
Power Requirements	115/230V AC 50-60 Hz auto ranging fused at 1 amp max current
Dimensions:	
Control Module	20.9 x 15.9 x 13.9 cm (8.25 x 6.25 x 5.5 in)
Cooling Tray	10.8 x 8.9 x 6.7 cm (4.25 x 3.5 x 2.625 in) with a 3 ft cable (91.4cm)

Order # Product

W4 69-0266	OTS 5000 Tissue Slicer
W4 69-0267	OTS 5000 with Refrigeration
W4 69-0265	OTS 4500 Tissue Slicer
W4 69-0264	Sapphire Blade for Tissue Slicers
W4 69-0262	Slicer Kit
W4 69-0257	Specimen Adhesive Pk/5

microscopy

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NEW Model Z850 Stereo Zoom Microscope Series

- High performance optics at an affordable price
- Excellent zoom range 0.8x-5.0x
- 115 mm working distance for easy access to specimens
- Binocular or trinocular viewing heads are inclined 45° and can rotate 360°

The Z850 Series is a versatile, high performance, ergonomically designed zoom stereo microscope ruggedly built to withstand years of heavy use. With a zoom ratio of 6.3:1 the Z850 provides superior optical performance at an affordable price.

These Microscopes are supplied in several complete systems with either Trinocular or Binocular zoom bodies and six different stand options.

Select from the plain focusing stand or the LED illuminator stand. The booms stands do not have illumination, but permit working with large objects.



LED Illuminator Stand

Simultaneous variable reflected and transmitted LED illumination can be utilized on this stand. The compact, thin design of the base allows users to keep sample positions low and maintains easy accessibility to the variable light controls. The reflected LED illuminator is powered by a 12 volt, 2 watt LED system and the transmitted LED illuminator by a 12 volt, 4 watt LED system. Both light sources are variable and controlled by a universal power supply (110–240V).



Plain Focusing Stand

The Plain Focusing Stand's thin design helps keep sample positions low resulting in increased user comfort. The focus mount is easily removable and can be positioned at two different points on the dovetail to offer maximum flexibility when working with small or large size samples.

NEW Model Z850 Stereo Zoom Microscope Series (continued)



Boom Stand

The boom stand features safety tracks on the horizontal arm and Delrin® inserts in the focus block to ensure smooth, precise movements.



Articulating Swing Arm Stand

Designed for maximum freedom and flexibility this stand will deliver the adjustability you need. Ideal for the inspection of specimens that require a lot of movement or to scan a large sample area, the articulating arm can be easily adjusted into hard to reach positions and moved easily out of the way.



Ball Bearing Boom Stand

For users seeking precise, stable movements the ball bearing boomstand is the recommended choice. Sturdy and ruggedly built, the ball bearing boom stand is ideal for observation applications where magnification adjustment and the ability to move across a sample are important considerations.



Diascopic/Embryo Transfer Stand

This cost-effective transmitted illumination stand provides bright, even illumination across the entire magnification range. A tiltable mirror provides direct and oblique illumination for low contrast specimens. This unit can be configured with either a 6V, 20W halogen illuminator or 150W fiber optic illuminator.

NEW Model Z850 Stereo Zoom Microscope Series (continued)

Specifications

Viewing Body

Optical System	Twin zooming objective
Viewing Bodies	Binocular or Trinocular with 50/50 light split
ESD Protection	Viewing body is made from anti-electrostatic materials
Anti-Mold	Anti-mold and airtight design
Magnification	0.8x to 5.0x with click stops at 1x, 2x, 3x, 4x and 5x
Zoom Ratio	6.3:1
Working Distance	115 mm (4.5 in)
Viewing Angle	45 degrees
Interpupillary Distance Adjustment	52-75 mm
Camera Adaptability	0.4x or 0.5x C-mount adapters, photo tube
Eyepieces (with diopter adjustment)	WF 10x/22 mm with reticle holder (Reticle size: 27 mm), WF 15X/16 mm with reticle holder (reticle size: 20 mm), WF 20x/12.5 mm
Auxiliary Objectives	0.5x (211 mm working distance) and 2.0x (43.5 mm working distance)

Stands

Plain Focusing Stand	76 mm focus mount diameter, 100 mm focusing stroke, 240 x 290 x 318 mm (9.4 x 11.4 x 12.5 in) (LxDxH), 125 mm black & white plate
LED Reflected/Transmitted Illuminated Stand	76 mm focus mount diameter, 100 mm focusing stroke, 240 x 292 x 318 mm (9.4 x 11.5 x 12.5 in) (LxDxH), 100 mm clear glass and black & white plate. Variable Transmitted & Reflected LED illumination. Average LED life expectancy - 7,000 hours, Color temperature: 6200-7000° Kelvin
Diascopic Stand with Transmitted Illumination Attachment	76 mm focus mount diameter, 100 mm focusing stroke, 255 x 310 x 382 mm (10 x 12.2 x 15 in) (LxDxH), 280 mm clear glass plate. Tiltable mirror provides direct and oblique illumination. Choice of 6V, 20 W halogen or 150 W fiber optic illuminators
Pole Stand	76 mm focus mount diameter, 305 mm pole height, 193 mm focusing stroke, 240 x 290 x 318 mm (9.4 x 11.4 x 12.5 in) (LxDxH), 125 mm black & white plate
Boom Stand	Base dimensions: 254 x 254 mm (10 x 10 in), Vertical Post - 365 mm, Horizontal Post - 518 mm. Physical weight 37 lbs. (16.8 kg)
Ball Bearing Boom Stand	Base dimensions: 254 x 254 mm (10 x 10 in), Vertical Post - 394 mm, Horizontal Post - 585 mm. Physical weight 42 lbs. (19 kg)
FlexArm/Swing Arm Stand	The Swinging Arm has a 3 ft scanable range and a lockable 14.5 in vertical motion range with an adjustable counterbalanced support. Horizontal or vertical clamp mount

Eyepiece Specifications

Auxiliary Objective	Working Distance (mm)	WF 10x/22		WF 15x/16		WF 20x/12.5	
		Total Magnification	Visual Field Total (mm)	Total Magnification	Visual Field Total (mm)	Total Magnification	Visual Field Total (mm)
-	115x	8-50x	27.5-4.4x	12-75x	20.0-3.2x	6-100x	15.6-2.5x
0.5x	211x	4-25x	55.0-8.8x	6-37.5x	40.0-6.4x	8-50x	31.2-5.0x
2x	43.5x	16-100x	13.8-2.2x	24-150x	10.0-1.6x	32-200x	7.8-1.3x

NEW Model Z850 Stereo Zoom Microscope Series (continued)

Order #	Product
W4 64-1802	Trinocular Zoom Stereo Microscope on LED stand Incident & Transmitted ESD Trinocular viewing head, 50/50 light split, 0.8x to 5.0x zoom range, inclined at 45°, 115 mm W.D., interpupillary distance adj. 52-75 mm, glass lens shield Widefield 10x eyepieces with built-in diopter adjustment (paired), 22 mm field of view Variable LED incident (12v/2w) and transmitted (12v/4w) focusing stand with stageclips, universal power supply Frosted, clear glass, black & white stage plates, dust cover and manual C-mount adapters and cameras sold separately
W4 64-1803	Binocular Zoom Stereo Microscope on Boom Stand Binocular viewing head, 0.8x to 5.0x zoom range, inclined at 45°, 115 mm working distance, interpupillary distance adj. 52-75 mm, glass lens shield Widefield 10x eyepieces with built-in diopter adjustment (paired), 22 mm field of view, Bonder arm focusing mount, boom stand, dust cover and manual
W4 64-1804	Trinocular Zoom Stereo Microscope on Boom Stand Trinocular viewing head, 50/50 light split, 0.8x to 5.0x zoom range, inclined at 45°, 115mm W.D., interpupillary distance adj. 52-75 mm, glass lens shield Widefield 10x eyepieces with built-in diopter adjustment (paired), 22 mm field of view, Bonder arm focusing mount, boom stand, dust cover and manual C-mount adapters and cameras sold separately
W4 64-1805	Trinocular Zoom Stereo Microscope on Ball Bearing Boom Stand Trinocular viewing head, 50/50 light split, 0.8x to 5.0x zoom range, inclined at 45°, 115 mm W.D., interpupillary distance adj. 52-75 mm, glass lens shield Widefield 10x eyepieces with built-in diopter adjustment (paired), 22 mm field of view, Bonder arm focusing mount, ball bearing boom stand, dust cover and manual C-mount adapters and cameras sold separately
W4 64-1806	Trinocular Zoom Stereo Microscope on Flex Arm Stand Trinocular viewing head, 50/50 light split, 0.8x to 5.0x zoom range, inclined at 45°, 115 mm working distance, interpupillary distance adj. 52-75 mm, glass lens shield Widefield 10x eyepieces with built-in diopter adjustment (paired), 22 mm field of view, Bonder arm focusing mount, flexible articulating arm stand with c-clamp mount Dust cover and instruction manual, C-mount adapters and cameras sold separately
W4 64-1807	Viewing Heads ESD safe Binocular viewing head, 0.8x to 5.0x zoom range, inclined at 45°, 115 mm working distance, interpupillary distance adj. 52-75 mm, glass lens shield
W4 64-1808	Viewing Heads ESD safe Trinocular viewing head, 50/50 light split, 0.8x to 5.0x zoom range, inclined at 45°, 115 mm W.D., interpupillary distance adj. 52-75 mm, glass lens shield
W4 64-1809	Camera and Video Adapters 0.5x c-mount adapter
W4 64-1810	Camera and Video Adapters 1.0x video adapter with c-mount (no lens)
W4 64-1811	Eyepieces WF10x eyepiece with built-in diopter adjustment, 22mm field of view. Eyepiece accepts a 26.5 mm reticle
W4 64-1812	Eyepieces WF15x eyepiece with built-in diopter adjustment, 16mm field of view. Eyepiece accepts a 20 mm reticle
W4 64-1813	Eyepieces WF20x eyepiece with built-in diopter adjustment and eyeguard, 12.5 mm field of view, does not accept a reticle.
W4 64-1814	Eyepieces Roll down rubber eyeguards (pair) - small
W4 64-1815	Eyepieces Roll down rubber eyeguards (pair) - large
W4 64-1816	Reticle 26.5 mm eyepiece reticle, 10 mm/100 divisions with crossline
W4 64-1817	Reticle 26.5 mm eyepiece reticle, 10 mm/100 divisions without crossline
W4 64-1818	Reticle 20 mm eyepiece reticle, 10 mm/100 divisions with crossline
W4 64-1819	Reticle 20 mm eyepiece reticle, 10 mm/100 divisions
W4 64-1820	Stage Micrometer, 1 mm/1 - division (each division 0.010 mm)
W4 64-1821	Calibration slide
W4 64-1822	0.5x Auxilliary objective, working distance 211 mm
W4 64-1823	2.0x Auxilliary objective, working distance 43.5 mm
W4 64-1824	Plain focusing stand with ø76 mm pod holder, black and white contrast plate
W4 64-1825	Variable LED incident (12v/2w) and transmitted (12v4w) focusing stand with ø76mm pod holder, stage clips, universal power supply,
W4 64-1826	Diascopic stand for embryo transfer with tiltable mirror reflector and ø76mm pod holder (fiber optic or halogen illuminator sold separately)
W4 64-1827	Pole stand with focus mount, black and white plate - no illumination
W4 64-1828	Variable Halogen incident (12v15w) and variable transmitted (12v15w) focusing stand with ø76 mm pod holder, stage clips, glass and black & white plate Stages and Stage Plate
W4 64-1829	Universal boom stand, horizontal arm with bonder port, base dimensions 10 x 10 in, 14 3/8 in vertical post, 20 3/8 in horizontal post, order with W4 64-1834 Bonder arm
W4 64-1830	Ball bearing boom stand, horizontal arm with bonder port, base dimensions 10 x 10 in, Vertical post 15.5 in, Horizontal arm 23 order with W4 64-1834 Bonder arm
W4 64-1831	Ball bearing boom stand extension post
W4 64-1832	Flexible arm stand, lockable 14.5 in vertical motion range, 3 foot scanable range, adjustable counterbalanced support use with W4 64-1833
W4 64-1833	Horizontal or vertical c-clamp mount for use with W4 64-1832
W4 64-1834	Bonder arm (E-Arm) with ø76 mm pod holder, 5/8 in mounting pin

NEW 3025 Series Compound Microscope

microscopes



- Advanced clinical microscope
- AIS Plan 4x, 10x, 40x, 100xR oil objectives
- Ceramic coated stage with tension adjustment
- 6 volt 30 watt illumination

Designed for research and other clinical applications, the 3025 features AIS infinity optical system renowned for resolution, contrast, and clarity that is among the very best in this class of microscope.

As configured the 3025 is supplied complete with the following components: *ergo binocular microscope, EWF 10 x 22 mm focusing eyepieces, AIS Plan 4x, 10x, 40xR, 100xR oil objectives, ceramic coated stage with tension adjustment, 6 volt 30 watt illumination.* Popular add-ons are listed in the order information section.

Specifications

Optical System	AIS Infinity Corrected
Viewing Body	Ergonomic binocular head angled 0-35°
Eyepieces	EWF 10x focusing eyepieces with eyeguards, 22 mm field of view
Nosepiece	Reversed quintuple nosepiece
Stage	Tension adjustable ceramic stage with low position coaxial controls, right hand control
Condenser	N.A. 1.25 Abbe condenser with built-in aperture iris diaphragm
Focusing Mechanism	Coaxial coarse and fine focusing mechanism with marking on fine focus knobs. Fine focus sensitivity to 0.002 mm
Objectives	Plan Achromat, 4x, 10x, 40xR, 100xR oil
Illumination	Variable Koehler 6 volt 30 watt halogen illumination
Filter	Clear blue standard, optional frosted blue, green and yellow filters are available
Stand	Cast alloy aluminum
Shipping weight	27 lbs (12.25 kg)
Shipping Dimensions	18 x 16 x 24 in (46 x 41 x 61 cm) (H x W x D)

Order # Product

W4 64-1840	3025-BE-CS Ergo binocular microscope, EWF 10x/22mm focusing eyepieces, AIS Plan 4x, 10x, 40xR, 100xR oil objectives, ceramic coated stage with tension adjustment, 6v30w illumination
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Popular Add-ons

W4 64-1841	25-2000-E Photo/video intermediate attachment for use with ergonomic binocular viewing head
W4 64-1842	25-3179-PL AIS 50xR oil plan achromat objective, N.A. 0.90
W4 64-1843	25-3177-PL AIS Planachromat 20x objective, N.A. 0.40, W.D. 5.1 mm
W4 64-1844	25-3178-PL AIS Plan achromat 60xR objective
W4 64-1845	5048 C-Mount adapter sleeve
W4 64-1846	5041 0.67 c-mount adapter for 1/1.8 chip sensors - high resolution
W4 64-1782	(C3) ProgRes® C3 '- 1/1.8" 3.3 mega pixel CCD camera, 2080 x 1542 pixel Includes software
W4 64-1784	(C3 USB) ProgRes® C3 USB (without cooling) '- 1/1.8" 3.3 mega pixel CCD camera, 2080 x 1542 pixel Includes software
W4 64-1785	(C5) ProgRes® C5 '- 2/3" 5.02 mega pixel CCD camera, 2580 x 1944 pixel Includes software
W4 64-1786	(C5-C) ProgRes® C5 - version with cooling '- 2/3" 5.02 mega pixel CCD camera, 2580 x 1944 pixel

NEW 3032PH Inverted Phase Contrast Microscope



- Trinocular inverted phase contrast microscope
- Ideal for tissue culture and cell biology
- Hard coated stage with glass insert
- 6 volt 30 watt illumination

Sharp, high contrast images driven by the AIS infinity optical system make the 3032 inverted microscope an outstanding performer for routine applications in embryology, tissue culture, pharmacology and immunology.

The 3032's ergonomic, modular design allows users to add a fluorescence illuminator with a 2 position filter cube slider. A third position on the filter slider is left open to quickly switch to brightfield or phase contrast. A wide variety of accessories allow the 3032 to be used for examining cell viability in petri dishes, culture flasks and well plates.

As configured the 3032PH is supplied complete with the following components: EW10x22 eyepieces, infinity PL 4x, PLPH 10x, PLPH 20x, plain stage - glass insert, 6 volt 30 watt halogen illumination, dust cover, and power cord.

Specifications

Optical System	AIS Infinity Corrected
Eyepieces	EW10x focusable eyepieces with eyeguards, 22 mm field of view, 48-75 mm interpupillary distance settings, ±5 diopter adjustment
Viewing Head	Siedentopf trinocular viewing head with photo tube, inclined 30°, rotatable 360° (c-mount adapter sold separately)
Light Distribution	Binocular 100% or binocular/trinocular 20%/80%
Nosepiece	Side facing quintuple nosepiece
Objectives	Infinity PL 4x, PLPH 10x, PLPH 20x
Stage	Fixed plain stage 160 mm x 250 mm with glass insert
Condenser	ELWD condenser, N.A. 0.3, working distance 72 mm
Illumination	Variable Koehler 6 volt 30 watt halogen illumination
Filters	Clear blue, green and ground glass filters, Pre-centered phase slider with 10x and 20x annuli and brightfield position
Shipping Dimensions	19 x 16 x 26 in (48 x 41 x 66 cm)
Shipping weight	30 lbs (13.6 kg)

Optional AIS Infinity Phase 40xR objective, Plan Achromat 10x, 20x, and 40xR objectives, attachable mechanical stage, Ø35 mm petri dish holder, teraski holder and Ø54 mm glass slide holder.

Order # Product

W4 64-1847	3032PH Trinocular inverted microscope, EW10x/22 eyepieces, infinity PL 4x, PLPH10x, PLPH 20x, plain stage - glass insert, 6v30w halogen illumination
W4 64-1848	AIS LWD Plan Phase 40x objective, N.A. 0.60, W.D. 2.6 mm
W4 64-1849	Universal attachable mechanical stage, right hand coaxial controls, movement range 120 x 78 mm
W4 64-1850	32-35PD Ø35 mm petri dish holder
W4 64-1851	32-54SGH Ø54 mm Slide Glass Holder
W4 64-1852	32-TH Teraski holder
W4 64-1845	5048 C-mount adapter sleeve
W4 64-1846	5041 0.67 c-mount adapter for 1/1.8 chip sensors - high resolution
W4 64-1782	(C3) ProgRes® C3 ' - 1/1.8" 3.3 mega pixel CCD camera, 2080 x 1542 pixel Includes software
W4 64-1784	(C3 USB) ProgRes® C3 USB (without cooling) ' - 1/1.8" 3.3 mega pixel CCD camera, 2080 x 1542 pixel. Includes software.
W4 64-1785	(C5) ProgRes® C5 ' - 2/3" 5.02 mega pixel CCD camera, 2580 x 1944 pixel Includes software
W4 64-1786	(C5-C) ProgRes® C5 - version with cooling ' - 2/3" 5.02 mega pixel CCD camera, 2580 x 1944 pixel

microscope cameras

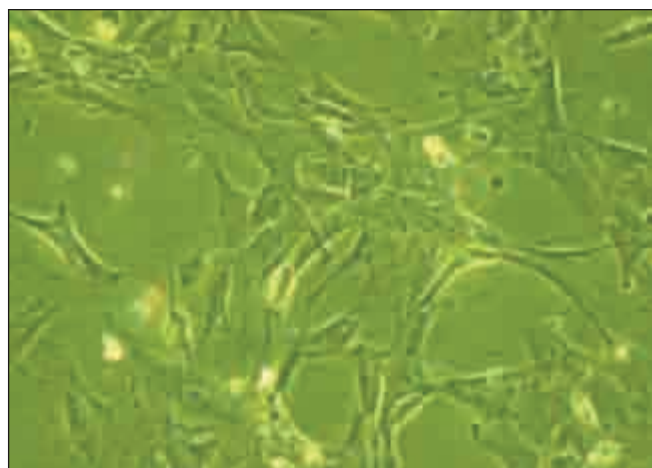
NEW ProgRes® Digital Microscope Cameras



- Large selection of CMOS and CCD cameras
- Powerful ProgRes® CapturePro software included with all cameras
- Works with Microsoft Windows® or Mac® OSX Systems
- Superior image quality at an affordable price

ProgRes® Digital Microscope Cameras

Microscope cameras of the ProgRes® family are based on more than two decades experience in the development and production of high-end solutions for digital imaging. ProgRes® cameras are suitable for all contrast methods in light microscopy and can be easily integrated into each laboratory via C-Mount and USB 2.0/ FireWire interfaces.



ProgRes® cameras provide rapid frame rate capability while keeping power consumption at low levels – all this in support of Green Microscopy and for the sake of our environment. High frame rates provide fast live images and provide easy workflow and convenient use. Furthermore, the high sensitivity of the ProgRes® research grade cameras meet the strict requirements of low-light applications. The exact reproduction of colors, and the display of fine details due to the high resolution capability of these cameras, make them particularly well suited for demanding analysis and reliable documentation.

ProgRes® Image Capture Software

All ProgRes® microscope cameras come with the powerful ProgRes® CapturePro image capture software. This is an intuitive software suite that directly guides the user to an optimal image. The software is suitable for both routine as well as advanced applications and is thoroughly designed for professional use. The ProgRes® software can be operated as a standalone application and as twain plug-in. Of course, the ProgRes® CapturePro software can be operated on Windows as well as the Apple operating system platforms.

ProgRes® Cameras - Software Benefits

Multi-Fluorescence Mode	Measurements	User Preferences
<ul style="list-style-type: none"> • Definition of up to 5 color filters • Guided Workflow for multi-fluorescence images • Auto-fluorescence reduction 	<ul style="list-style-type: none"> • Calibration Options • Various Measurement Tools • Storage with the captured image • Reproducible Data 	<ul style="list-style-type: none"> • Storage of individual user settings • Connection of up to 5 different cameras to one computer
Programmable Resolution	Live Image Functions	Time Lapse
<ul style="list-style-type: none"> • Various Resolutions • ROI and crop functionality • Microscanning 	<ul style="list-style-type: none"> • Rotate/Mirror • Focus tool • Automatic exposure 	<ul style="list-style-type: none"> • Adjustment of delay and duration of capture sequences • Storage as movie file

NEW ProgRes® CMOS Microscope Cameras

ProgRes® Digital Microscope Cameras (Continued)

The ProgRes® CMOS Camera Range:

- ProgRes® CT3
- ProgRes® CT5

Benefits:

- Highest frame rates
- Good color reproduction
- Available in color (CT3, CT5) and monochrome (CT5)

Experience the High Performance

ProgRes® CMOS Cameras

Designed to provide the highest versatility and cost-effectiveness, the digital microscope cameras of the ProgRes® CMOS range allow for quick and precise setting of both specimen and microscope. The fast live images coupled with the outstanding CMOS technology and high resolutions make these cameras the first choice in education institutes and training labs.

Fields of Application

Image analysis, documentation and archiving in micro- and macroscopy in the fields of:

- **Material Science, Geology & Mineralogy**
- **Life Science, Diagnostics**
- **Quality Control**
- **Education and Teaching**

Specifications		
ProgRes® Camera Type	CT3	CT5
Image Sensor	1/2" CMOS Color	1/2.5" CMOS Color / Monochrome
Sensor Resolution [max]	2048 x 1536 pixel [3.15 Mpix]	2592 x 1944 pixel [5 Mpix]
Sensor Size [H x V]	6.55 x 4.92 mm (.26 x .19 in)	5.70 x 4.28 mm (.22 x .17 in)
Pixel Size	3.2 µm ²	2.2 µm ²
A / D Conversion	10 bit	12 bit
Pixel Clock	48 MHz 36 MHz	48 MHz
Dynamic Range	58 dB	68 dB
Exposure Times	50 µs - 3 s	75 µs - 3 s
Analog Gain	1x - 8x	1x - 8x
Max. Frame Rate [image size] typical via USB 2.0)	12 fps [2048 x 1536 pixel] 9 fps [2048 x 1536 pixel]	9 fps [2592 x 1944 pixel] 5 fps [2048 x 1536 pixel]
Image Resolution Binning:	2x, 3x	2x, 4x
Cooling	no	no
Digital Interface	USB 2.0 / FireWire A	USB 2.0
Optical Connection	C-Mount (0.5x TV Pref.)	
Trigger In / Out	Synchronization with external devices; configurable via control software	
Voltage Supply	USB / FireWire A Powered	USB Powered
Power Consumption	Approx. 1.9 W 2.5 W	Approx. 1.8 W
Ambient Conditions	Temperature: +5°C - +55°C / Humidity: 5% - 80%, not condensing	
Stock Conditions	Temperature: -20°C - +70°C	Temperature: -20°C - +70°C
Dimensions (L x W x H)	89 x 84 x 93 mm (3.5 x 3.3 x 3.6 in)	89 x 84 x 93 mm (3.5 x 3.3 x 3.6 in)
Weight	Approx. 700 g (1.5 lbs)	Approx. 700 g (1.5 lbs)
Software	ProgRes® CapturePro PC / MAC (TWAIN for PC only); ProgRes® SDK	
External Camera Driver	Available at: www.progres-camera.com	
Hardware Requirements	PC: MS WIN 2000 / XP / Vista Mac: OS X 10.4 or higher, 3 GHz CPU, 1 GB RAM, 64 MB graphics, FireWire a or USB 2.0	

NEW ProgRes® CCD Routine Microscope Cameras

ProgRes® Digital Microscope Cameras (Continued)

The ProgRes® CCD Routine Camera Range:

- ProgRes® C3
- ProgRes® C5
- ProgRes® C7

Benefits:

- Perfect color reproduction
- Excellent image quality
- High resolution & fast live image

Visualize Exact Colors

ProgRes® CCD Routine Cameras

Excellent color reproduction and high resolution are the distinguishing features of the cameras of the ProgRes® CCD Routine range. With up to 7 megapixel resolution, these cameras are ideal tools for high quality image documentation and elementary image analysis. To facilitate precise focusing and positioning of specimens, a high resolution, fast, live image frame rate (up to 50 fps) is available.

Fields of Application

Image analysis, documentation and archiving in micro- and macroscopy in the fields of:

- **Material Science, Geology & Mineralogy**
- **Life science, Diagnostics**
- **Quality Control**
- **Pathology and Cell Biology**
- **Forensics**

Specifications

ProgRes® Camera Type	C3	C5	C7
Image Sensor	1/2" CCD Color	2/3" CCD Color	1/2.5" CCD Color
Sensor Resolution [max]	2080 x 1542 pixel [3.3 Mpix]	2580 x 1944 pixel [5.0 Mpix]	3072 x 2304 pixel [7.1 Mpix]
Sensor Size [H x V]	8.10 x 6.64 mm	9.74 x 7.96 mm	5.71 x 4.29 mm
Pixel Size	3.45 µm ²	3.4 µm ²	1.86 µm ²
A / D Conversion	12 bit	12 bit	12 bit
Pixel Clock	12 MHz	12 MHz 18 MHz	32 MHz
Dynamic Range	61 dB	61 dB 60 dB	60 dB
Exposure Times	500 µs - 180 s	400 µs - 180 s	200 µs - 5 s
Analog Gain	1x - 8x	1x - 8x	1x - 16x
Max. Frame Rate [image size]	18 fps [1040 x 770 pixel]	9 fps [1290 x 972 pixel]	11 fps [1228 x 920 pixel]
Image Resolution Binning:	2x - 5x	2x - 4x	4x
Program Scan:	346 x 256 692 x 512	644 x 490 1290 x 972	614 x 466 1228 x 932
Cooling	Optional	Optional	No
Digital Interface	FireWire A	FireWire A	FireWire A
Optical Connection	C-Mount (0.5x TV pref.)	C-Mount (0.63x TV pref.)	C-Mount (0.5x TV pref.)
Trigger In / Out	Synchronization with external devices; configurable via control software		
Voltage Supply	USB powered	FireWire Powered	FireWire Powered
Power Consumption	Approx. 4 W	Approx. 6 W	Approx. 6 W
Ambient Conditions	Temperature: 0°C - +35 °C / Humidity: 5% - 80%, not condensing		
Stock Conditions	Temperature: -20°C - +70°C	Temperature: -20°C - +70°C	Temperature: -20°C - +70°C
Dimensions (L x W x H)	89 x 84 x 93 mm (3.5 x 3.3 x 3.6 in)	89 x 84 x 93 mm (3.5 x 3.3 x 3.6 in)	89 x 84 x 93 mm (3.5 x 3.3 x 3.6 in)
Weight	Approx. 700 g (1.5 lbs)	Approx. 700 g (1.5 lbs)	Approx. 700 g (1.5 lbs)
Software	ProgRes® CapturePro PC / MAC (TWAIN for PC only); ProgRes® SDK		
External Camera Driver	Available at: www.progres-camera.com		
Hardware Requirements	PC: MS WIN 2000 / XP / Vista Mac: OS X 10.4 or higher, 3 GHz CPU, 1 GB RAM, 64 MB graphics, FireWire a or USB 2.0		

ProgRes® CCD Research Microscope Cameras

ProgRes® Digital Microscope Cameras (Continued)

The ProgRes® CCD Research Camera Range:

- ProgRes® CF
- ProgRes® CFcool
- ProgRes® CFscan
- ProgRes® C14plus
- ProgRes® M
- ProgRes® MFcool
- ProgRes® MFscan

Benefits:

- Perfect, reproducible color reproduction
- Outstanding image quality
- High sensitivity combined with a broad dynamic range
- Highest resolution & fast live image

Discover Highest Image Quality

ProgRes® CCD Research Cameras

All cameras of the ProgRes® CCD Research range have been optimized for applications requiring exacting capabilities. These cameras are particularly well suited for acquiring brilliant images when working with specimens under low-light conditions. Smooth operation is facilitated by sensitive CCD sensors, optionally available with cooling, that offer high frame rates and a broad dynamic range. Sophisticated Microscanning Technology provided in the scanning ProgRes® cameras allows for capturing images of up to 12.5 megapixels, even in true color.

Fields of Application

Image analysis, documentation and archiving in micro- and macroscopy in the fields of:

- **Fluorescence Microscopy**
- **Phase Contrast Microscopy**
- **Macroscopy**
- **Life Science, Diagnostics**
- **Quality Control**
- **Pathology and Cell Biology**
- **Forensics**

Specifications			
ProgRes® Camera Type	CF / MF	CFcool / MFcool	CFscan / MFscan / C14plus
Image Sensor	2/3" CCD progress. scan	2/3" CCD progress. scan	2/3" CCD progress. scan
Color / Monochrome	Color / Monochrome	Color / Monochrome	Color / Monochrome
Sensor Resolution [max]	1360 x 1024 pixel [1.4 Mpix]	1360 x 1024 pixel [1.4 Mpix]	1360 x 1024 pixel [1.4 - 12.5 Mpix]
Sensor Size [H x V]	8.8 x 6.6 mm	8.8 x 6.6 mm	36.07 x 24.05 mm "35 mm format"
Pixel Size	6.45 µm ²	6.45 µm ²	6.45 µm ²
A / D Conversion	12 bit	14 bit	14 bit
Pixel Clock	12 MHz 24.5 MHz	12 MHz 24.5 MHz	12 MHz 24.5 MHz
Dynamic Range	65 - 67 dB	67 - 69 dB	67 - 69 dB
Exposure Times	200 µs - 180 s	200 µs - 300 s	200 µs - 600 s [C14plus]
Analog Gain	1x - 8x	1x - 8x	1x - 8x
Max. Frame Rate [image size]	15 fps [1360 x 1024 pixel]	13 fps [1360 x 1024 pixel]	13 fps [1360 x 1024 pixel]
Image Resolution Binning:	2x - 8x	2x - 5x	2x - 5x
Microscan	No	No	4080 x 3072, 2740 x 2048
True Color	No	No	Yes [C14plus]
Cooling	No	Yes	Yes
Digital Interface	USB 2.0 / FireWire A	FireWire A	FireWire A
Optical Connection	C-Mount (0.5x TV pref.) C-Mount (0.63x TV pref.)		
Trigger In / Out	Synchronization with external devices; configurable via control software		
Voltage Supply	USB / FireWire Powered	FireWire Powered	FireWire Powered
Power Consumption	2.5 W 5 W [FireWire]	8 W	8 W
Ambient Conditions	Temperature: 0°C - +35°C / Humidity: 5% - 80%, not condensing		
Stock Conditions	Temperature: -20°C - +70°C		
Dimensions [L x W x H]	89 x 84 x 93 mm (3.5 x 3.3 x 3.7 in) [USB], 145 x 93 x 123 mm (5.7 x 3.7 x 4.8 in) [FireWire]		
Weight	Approx. 700 / 800 g (1.5 / 1.8 lbs)	Approx. 800 g (1.8 lbs)	Approx. 800 g (1.8 lbs)
Capture Software	ProgRes® CapturePro PC / MAC (TWIN for PC only); ProgRes® SDK		
External Camera Driver	Available at: www.progres-camera.com		
Hardware Requirements	PC: MS WIN 2000 / XP / Vista Mac: OS X 10.4 or higher, 3 GHz CPU, 1 GB RAM, 64 MB graphics, FireWire a or USB 2.0		

NEW ProgRes® Digital Microscope Cameras (Continued)

Order #	Model	Product
W4 64-1778	CT3 USB	ProgRes® CT3 - USB version - 1/2" 3.15 mega pixel CMOS camera, 2048 x 1536 pixel
W4 64-1779	CT3 FireWire	ProgRes® CT3 - IEEE1394 a version - 1/2" 3.15 mega pixel CMOS camera, 2048 x 1536 pixel FireWire version
W4 64-1780	CT5-C	ProgRes® CT5 - color version - 1/2.5" 5 mega pixel CMOS camera, 2592 x 1944 pixel USB2.0
W4 64-1781	CT5-M	ProgRes® CT5 - monochrome version - 1/2.5" 5 mega pixel CMOS camera, 2592 x 1944 pixel USB2.0
W4 64-1782	C3	ProgRes® C3 - 1/1.8" 3.3 mega pixel CCD camera, 2080 x 1542 pixel
W4 64-1783	C3 cool	ProgRes® C3 - version with cooling - 1/1.8" 3.3 mega pixel CCD camera, 2080 x 1542 pixel
W4 64-1784	C3 USB	ProgRes® C3 USB (without cooling) - 1/1.8" 3.3 mega pixel CCD camera, 2080 x 1542 pixel
W4 64-1785	C5	ProgRes® C5 - 2/3" 5.02 mega pixel CCD camera, 2580 x 1944 pixel
W4 64-1786	C5-C	ProgRes® C5 - version with cooling - 2/3" 5.02 mega pixel CCD camera, 2580 x 1944 pixel
W4 64-1787	C5 USB	ProgRes® C5 USB (without cooling) - 2/3" 5.02 mega pixel CCD camera, 2580 x 1944 pixel
W4 64-1788	C7	ProgRes® C7 - 1/2.5" 7.1 mega pixel CCD camera, 3082 x 2304 pixel
W4 64-1789	CF USB	ProgRes® CF - USB version - 2/3" 1.4 mega pixel color CCD camera, 1360 x 1024 pixel
W4 64-1790	CF FireWire	ProgRes® CF - FireWire version - 2/3" 1.4 mega pixel color CCD camera, 1360 x 1024 pixel
W4 64-1791	CF cool	ProgRes® CFcool - 2/3" 1.4 mega pixel color CCD camera, 1360 x 1024 pixel
W4 64-1792	CF scan	ProgRes® Cfscan - 2/3" 1.4 mega pixel color CCD camera, 1360 x 1024 pixel
W4 64-1793	C14 plus	ProgRes® C14plus - 2/3" 1.4 mega pixel color CCD camera, 1360 x 1024 pixel
W4 64-1795	MF USB	ProgRes® MF - USB version - 2/3" 1.4 mega pixel CCD camera - monochrome, 1360 x 1024 pixel
W4 64-1796	MF FireWire	ProgRes® MF - IEEE1394 a FireWire version - 2/3" 1.4 mega pixel CCD camera - monochrome, 1360 x 1024 pixel
W4 64-1797	MF cool	ProgRes® MFcool - 2/3" 1.4 mega pixel CCD camera - monochrome, 1360 x 1024 pixel
W4 64-1798	MF scan	ProgRes® MFscan - 2/3" 1.4 mega pixel CCD camera - monochrome, 1360 x 1024 pixel
W4 64-1800		OHCI PCI Host Adapter Fireboard blue for PC operation
W4 64-1801		Adapter-Set for Notebook operation (includes 4pin-6pin FireWire cable & power supply)

NEW XYClone Laser System*

laser systems



Applications

- Blastocyst and 8-cell Injections
- Inner Cell Mass Isolation
- Somatic Cell Nuclear Transfer
- Embryo Biopsy
- Laser-Assisted IVF
- Laser-Assisted Hatching
- Developmental Biology
- Cell Culture Maintenance

About the XYClone Laser System

The XYClone delivers a highly focused laser beam to the targeted area permitting non-contact ablation of targeted membranes or structures. The XYClone laser module consists of a high power, Class 1, 1450 nm infrared laser integrated with a specially designed 40x or 20x objective that functions in both visible and near infrared wavelengths. Compatible with most inverted microscopes, the XYClone laser attaches to the turret just like a typical objective and allows full use of all the microscope's standard features, such as fluorescence and Hoffman imaging. In addition, the laser is factory-aligned and locked in place to ensure safe ablation while minimizing service. The XYClone system may be configured for use on either a desktop or laptop computer. Dual systems with both 40x and 20x laser modules are also available.

Why use the XYClone:

- **Increase productivity and efficiency**
- **Easy to learn and use**
- **Mercury-free system**
- **Xenogenic-free process**
- **Eliminates need for sharp micropipettes**
- **No expensive needles or pipettes required**
- **Micromanipulators not needed for operation**
- **May be used with fluorescence**
- **Compatible with Oosight™ imaging system from CRi**
- **Portable between labs - great for field work**



XYClone Software Features:

- **Laser Panel:** Adjustable laser power (mW) and pulse time (μ s). The size of the ablated area is controlled by varying the laser pulse time and the laser power.
- **Target Options:** Isotherm Rings, Circle or Arrow targets. The patented Isotherm Rings are used to preview heat generation based on the selected laser power and pulse times selected.
- **Image Capture Controls:** Images may be stored manually or automatically upon laser firing. You may also choose to save the graphic image overlays within the image.
- **Video Recording:** One touch video recording allows storage of .avi files. Record in real-time or time-lapse mode.
- **Measurement Tool Box and Documentation:** Allows measurements of various cell characteristics with automatic calculation of means and standard deviations.
- **Image Toolbox:** Add freehand text, drawings, and measures to any captured image.
- **Auto-labeling:** Captured images may be labeled automatically with user-defined input. Multiple labels may be stored and enabled.
- **Scale Bar:** Visible on the live image, the scale bar is saved on captured images and videos.
- **Report Generation:** Create comprehensive reports combining general information, measurements, and pre- and post-treatment images.

Options

XYClone RED-i Target Locator

Visible through the microscope eyepieces, the RED-i LED target locator speeds workflow by allowing you to position the cell under the laser beam without looking at the monitor.

XYClone Staccato

Staccato software allows rapid, multi-pulse firing for near-continuous application of laser to the sample.

Laser Control Panel

The XYClone laser control panel optimizes use of the laser with other imaging systems, such as the Oosight™ from CRi. A standalone laser control panel is configured to work side by side with the imaging software and installed camera.

Footswitch

An optional foot switch may be used to fire the laser, to allow hands-free laser control. A double footswitch is also available for working in dual laser mode.

* XYClone is for non-clinical research use only in USA. hESC research using the XYClone should be conducted in accordance with any applicable Federal, State or local laws and regulations.

Please Note: The XYClone™ is for use ONLY with ANIMAL and STEM CELL APPLICATIONS.

NEW XYClone Laser System (continued)

Specifications

Laser:

Type	1480 nm, Infrared Solid State Diode
Power	300 mW @ focus (Class I)
Laser Pulse Length	Adjustable from 1 microsecond to 3000 microseconds, slider resolution - 1, 10, and 100 microsecond intervals
Laser Power	Adjustable from 1% to 100%
Laser Mode	Single mode standard, Double Mode
Firing	By mouse (Optional foot switch firing)
Target Marker	Circle or arrow, adjustable "Blink Time" after firing; Isotherm Rings, showing peak temps and hole size. Select which rings to display;
Optional	RED-i LED target locator
Crosshairs	Activation, size and color set by user (used for positioning embryo)
Laser Alignment	Aligned and locked at factory. No on-site physical laser alignment required
Target	Adjust target alignment on-screen
Safety	Class I Laser: Laser pulse and energy cannot exceed Class I limits.

Objective:

Standard	40x or 20x, 0.60 N.A., I.R. (High transmission in both the visible and near-infrared, long working distance)
Scale Calibration	Performed interactively on-screen; Calibrate and save multiple objectives
Scale Bar	Scale bar graphic overlay automatically adjusts based on calibrated objective; May be saved with images/video.

Video:

Camera	High resolution analog or digital color
Image Area	NTSC: 640 x 480 pixels: Digital: 1280 x 1024 pixels
Zoom	2x, 4x, and 8x with user defined image panning
Illumination	Microscope, image on screen

Double Validation Panel: Set two separate power and pulse length combinations

Image Capture and Storage Utility: Capture and store unlimited images. Images stored in user-selected JPG, BMP, or TIF format. Capture unlimited thumbnail images and select which to save. Automatic image capture on laser fire. Manual or automatic file naming. Images may be saved with graphic overlay.

Image Annotation Tools: Unlimited automatic image labels may be stored and enabled. Freehand text, circles, rectangles, lines, and image measurements may be added to captured images.

Video Capture: Capture and store real time and time lapse video in .avi format. Ability to set maximum recording length. Manual and automatic naming options. Open and play saved videos within program.

Measurement Toolbox: Tools allow measurement of various embryo parameters on captured images. Each measure visible as graphic overlay, including length in micron.
Zona: 5 zona thickness measurements; Mean & Standard Deviation
Embryo: 2 diameter measurements; Mean & Standard Deviation; Blastomere count.
Pronuclei: 2 diameter measurements for two separate pronuclei; Mean for each pronuclei
Drill: 5 hole size measurements; Mean & Standard Deviation
Ruler: 5 user-defined measurements Mean & Standard Deviation

Reports and Output: **Data Input:** Data from keyboard, Data from measurements, ASCII Import critical fields
Report: Ova/embryo information, procedure/protocol information, choice of 2 images plus evaluation data or 4 images
Output: Printout of report, Report stored in JPG format, ASCII output of all numerical and alphanumeric fields in TXT & MER formats

Dimensions H x W x D in. (mm) / lb (kg)

XYClone Module	1.65 (42) x 1.1 (28) x 2.1 (54) / 0.5 (0.22)
XYClone Controller	3.8 (95) x 2.5 (63.5) x 1.8 (46) / 1.0 (0.45)
Desktop Computer	16.1 (408) x 7.4 (187) x 17 (433) / 26.5 (12)
Monitor	16.8 (427) x 17.5 (445) x 7.9 (198) / 12.6 (5.7)
Laptop Compute	1.48 (37.5) x 13.99 (355) x 10.24 (27) / 6.36 (2.89)

Electrical

Input Voltage	Desktop: 100/240 VAC, Monitor: 110-240 VAC, Laptop: 100-240 VAC
Power	Desktop: 300 W, Monitor: 30 W, Laptop: 90W
Line Frequency	Desktop: 50/60 Hz, Monitor: 50/60 Hz, Laptop: 50/60 Hz

XYClone Computer Specifications (subject to change without notice)

Type	Desktop	Laptop
O.S.	Windows XP Pro	Windows XP Pro
CPU	Pentium Dual Core 2.7 GHz	Pentium M or Dual Core 2 GHz
Memory	2 GB	512 RAMI GB
Drives	250 GB HD, 16x DVD-RW	250 GB HD, 16x DVD-RW
Display	20" flat panel, UXGA	5.4" (typical), WXGA
Ports	Serial, Parallel, USB 2.0, PS/2	Serial, Parallel, USB 2.0, VGA
Network	10/100/1000 Mps Ethernet	10/100/1000 Mps Ethernet, Wireless Network (802.11bg)

NEW XYClone Laser System (continued)



Order #	Product
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XYClone Desktop System for laser ablation of oocyte membranes, embryo membranes and ICM excision	
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W4 64-1870	Includes 40x APO II Objective and analog camera
W4 64-1871	Includes 40x APO I Objective and analog camera
W4 64-1872	Includes 40x APO II Objective and digital camera
W4 64-1873	Includes 40x APO I Objective and digital camera

XYClone Laptop System for laser ablation of oocyte membranes, embryo membranes and ICM excision	
--	--

W4 64-1874	Includes 40x APO II Objective and analog camera
W4 64-1875	Includes 40x APO I Objective and analog camera
W4 64-1876	Includes 40x APO II Objective and digital camera
W4 64-1877	Includes 40x APO I Objective and digital camera

XYClone RED-i Desktop System for laser ablation of oocyte membranes, embryo membranes and ICM excision	
---	--

W4 64-1878	Includes 40x APO II Objective and analog camera, and RED-i target locator
W4 64-1879	Includes 40x APO I Objective, analog camera, and RED-i target locator
W4 64-1880	Includes 40x APO II Objective and digital camera, and RED-i target locator
W4 64-1881	Includes 40x APO I Objective and digital camera, and RED-i target locator
W4 64-1882	Includes 40x APO II Objective and analog camera, and RED-i target locator

XYClone Laptop System for laser ablation of oocyte membranes, embryo membranes and ICM excision	
--	--

W4 64-1874	Includes 40x APO II Objective and analog camera
W4 64-1875	Includes 40x APO I Objective and analog camera
W4 64-1876	Includes 40x APO II Objective and digital camera
W4 64-1877	Includes 40x APO I Objective and digital camera

XYClone RED-i Desktop System for laser ablation of oocyte membranes, embryo membranes and ICM excision	
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W4 64-1878	Includes 40x APO II Objective and analog camera, and RED-i target locator
W4 64-1879	Includes 40x APO I Objective, analog camera, and RED-i target locator
W4 64-1880	Includes 40x APO II Objective and digital camera, and RED-i target locator
W4 64-1881	Includes 40x APO I Objective and digital camera, and RED-i target locator

XYClone RED-i Laptop System for laser ablation of oocyte membranes, embryo membranes and ICM excision	
--	--

W4 64-1882	Includes 40x APO II Objective and analog camera, and RED-i target locator
W4 64-1883	Includes 40x APO I Objective and analog camera, and RED-i target locator
W4 64-1884	Includes 40x APO II Objective and digital camera, and RED-i target locator
W4 64-1885	Includes 40x APO I Objective and digital camera, and RED-i target locator

NEW XYClone Laser System (continued)

laser system

Order # Product

XYClone Desktop System for laser ablation of oocyte membranes, embryo membranes and ICM excision

W4 64-1886 Includes 20x Leica Objective and analog camera

W4 64-1887 Includes 20x Leica Objective and digital camera

XYClone Laptop System for laser ablation of oocyte membranes, embryo membranes and ICM excision

W4 64-1888 Includes 20x Leica Objective and analog camera

W4 64-1889 Includes 20x Leica Objective and digital camera

XYClone Desktop System for laser ablation of oocyte membranes, embryo membranes and ICM excision

W4 64-1890 Includes 20x Leica Objective and analog camera, and RED-i target locator

W4 64-1891 Includes 20x Leica Objective and digital camera, and RED-i target locator

XYClone Laptop System for laser ablation of oocyte membranes, embryo membranes and ICM excision

W4 64-1892 Includes 20x Leica Objective and analog camera, and RED-i target locator

W4 64-1893 Includes 20x Leica Objective and digital camera, and RED-i target locator

Accessories

W4 64-1894 Staccato software enables rapid multi-pulse and standard single pulse laser firing. Requires XYClone version 5.2 or higher.

W4 64-1895 20x Laser added onto a 40x XYClone System to create a dual laser system

W4 64-1896 20x Laser added onto a 40x XYClone System to create a dual laser system - for previously installed laser systems

W4 64-1897 40x Laser added onto a 20x XYClone System to create a dual laser system

W4 64-1898 40x Laser added onto a 20x XYClone System to create a dual laser system - for previously installed laser systems

W4 64-1899 20x Laser added onto a 40x XYClone System to create a dual laser system with RED-i target locator

W4 64-1900 20x Laser added onto a 40x XYClone System to create a dual laser system with RED-i target locator -for previously installed laser systems

W4 64-1901 40x Laser added onto a 20x XYClone System to create a dual laser system with RED-i target locator

W4 64-1902 40x Laser added onto a 20x XYClone System to create a dual laser system with RED-i target locator - for previously installed laser systems"

W4 64-1903 CIVA software with color analog camera. Stand alone imaging software based on imaging, video, measurement and reporting functions of the laser software. Includes analog color camera.

W4 64-1904 CIVA software with color analog camera and computer. Stand alone imaging software based on imaging, video, measurement and reporting functions of the laser software. Includes analog color camera and computer.

W4 64-1905 Remote Foot Switch for hands-free laser firing. Includes USB interface #W4 30-1205

W4 64-1906 Remote Foot Switch for hands-free laser firing in Double Validation Mode. Includes USB Port #W4 30-1205

W4 64-1907 Analog color camera includes video capture device and power supply

W4 64-1908 Color digital camera - 1280 x 1024, High resolution, USB 2.0 Replaces standard color analog camera

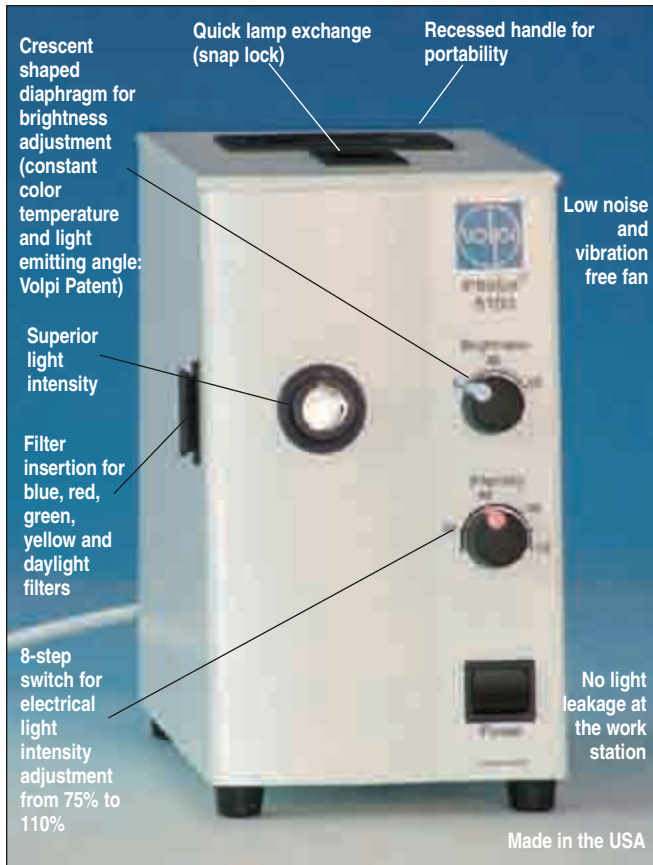
Upgrades

W4 64-1909 40x RED-i target locator upgrade. Upgrade after purchase of a XYClone System. Requires return of original laser prior to upgrade.

W4 64-1910 20x RED-i target locator upgrade. Upgrade after purchase of a XYClone System. Requires return of original laser prior to upgrade.

Intralux® 5100

High Intensity Cold Halogen Light Source



- Compatible with all Volpi Fiber Optic Components
- Ergonomic design with small footprint
- Quick bulb replacement, reducing downtime
- Solid metal housing, designed for industrial use
- Certified for electronic and mechanical safety
- 150 watt cold light source with superior illumination intensity and long lamp life

Intralux® light sources have represented the best in Fiber Optic Cold Light Illumination the world for over 25 years. They provide reliable, dependable, high-intensity cold halogen light for use with all Volpi fiber optic components in microscopy applications.

The Intralux Series is equipped with the most advanced features and highest quality components available. It includes InfraRed Reflecting Filters to ensure the coldest light possible and the unique patented Crescent Shaped Diaphragm, which provides constant color temperature and light emitting angle, and continuous intensity adjustment.

Fiber optic components consist of:

- **Ringlights**
- **Goosenecks (sliding Sleeve: Volpi Patent)**
- **Flexible Light Guides**
- **Backlights**

Specifications

Average Lamp Life (calculated value, in continuous operation at line voltage 230V / 121V / 100V):

110% Intensity	100 hours
100% Intensity	200 hours
90% Intensity	520 hours
80% Intensity	1700 hours
75% Intensity	3600 hours

Color Temperature at 110% Intensity

3433K

Illumination Intensity at 110% Voltage at Lightguide Input (DIN 58141-10)

12.3 M Lux

Maximum Illuminated Light Guide-Ø

13 mm

Mechanical Light Guide Connector Ø

15 mm

Light Adjustment electrical, 8-step switch 75 to 110% Crescent shaped diaphragm (Volpi Patent) 16-steps

Halogen Reflector Lamp EKE 21 V/150 W

Line Voltages ±10% 230 V, 50 Hz or 121 V, 60 Hz or 100 V, 60 Hz

Power Consumption 190 W

Protection Class 1

Weight 4.6 kg (10 lbs)

Housing Metal, powder coated, color RAL 9002

Approvals UL61010-1, CAN/CSA 61010-1, CE/Product Safety : IEC/EN 61010-1:2001 EMC: Emission: IEC/CISPR 11, Class B/Immunity: IEC 61000-4-2 to 6 and 11

Manufactured in U.S.A.

Order # Product

W4 72-6195 Intralux® 5100 Light Source, USA, 121V, 60Hz

W4 72-6196 Intralux® 5100 Light Source, EURO, 230V, 50Hz

W4 72-6198 Intralux® 5100 Light Source, CH, 230V, 50Hz

W4 72-6197 Intralux® 5100 Light Source, JAP, 100V, 60Hz

Accessories and Spares

W4 72-0227 Halogen Spare Lamp EKE 21V/150W

W4 72-0219 Blank Filter Holder for Intralux 5100/NCL-150

W4 72-0220 Blue Filter for Intralux 5100/NCL-150

W4 72-0221 Red Filter for Intralux 5100/NCL-150

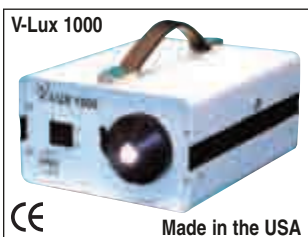
W4 72-0222 Green Filter for Intralux 5100/NCL-150

W4 72-0223 Yellow Filter for Intralux 5100/NCL-150

W4 72-0224 Daylight Filter for Intralux 5100/NCL-150

W4 72-0310 Set of Filters

V-Lux 1000 and NCL-150 Fiber Optic Cold Light Sources



V-Lux 1000 Cold Light Source

- For Microscope Illumination
- Constant color temperature and light emitting angle
- Continuous intensity adjustment

- Low-cost alternative to the Intralux series
- Use with fiber optic ringlights, goosenecks, and flexible light guides

The V-Lux 1000 is a low-cost quality fiber optic cold light source featuring many high-end features such as compact design, constant color temperature, long lamp life and low noise/vibration. It is ideal for any microscopy applications. The V-Lux 1000 will provide reliable, dependable, high-intensity cold halogen light for use with all Volpi fiber optic components in microscopy applications. Although it is factory equipped with DDL Lamps, EKE bulbs may be easily substituted for slightly more light output. Has integrated resettable fuse transformer. This unit has a fixed power cord.

Specifications

Uniformly Illuminated Light Guide Diameter	13 mm
Rated Lamp Life	DDL 800 hrs*, EKE 350 hrs*
Constant Color Temperature	DDL 3120°K, EKE 3190°K
Light Adjustment	Crescent shaped diaphragm
Lamp	DDL-20V/150W or EKE-21V/150W
Dimensions, H x W x D	9.5 x 17.1 x 21.0 cm (3.75 x 6.75 x 8.25 in)
Weight	4.5 kg (9.92 lb)

* Average of continuous operation,
Manufactured in U.S.A.

Order # Product

W4 72-0215	V-Lux 1000, 120 V, USA/Canada
W4 72-0216	V-Lux 1000, 230 V*
W4 72-0217	V-Lux 1000, 230 V**
W4 72-0218	V-Lux 1000, 230 V***
W4 72-0231	V-Lux 1000, 230 V****
W4 72-0232	V-Lux 1000, 230 V*****

Accessories and Spares

W4 72-0227	Halogen Spare Lamp EKE 21V/150W
W4 72-0219	Blank Filter Holder for Intralux 5100/NCL-150
W4 72-0220	Blue Filter for Intralux 5100/NCL-150
W4 72-0221	Red Filter for Intralux 5100/NCL-150
W4 72-0222	Green Filter for Intralux 5100/NCL-150
W4 72-0223	Yellow Filter for Intralux 5100/NCL-150
W4 72-0224	Daylight Filter for Intralux 5100/NCL-150
W4 72-0310	Set of Filters

* Argentina/Austria/Belgium/Brazil/China/Denmark/Finland/France/Germany/
Indonesia/Netherlands/Norway/Sweden/Switzerland/Thailand/Vietnam
** Australia/New Zealand/Fiji
*** UK
**** South Africa
***** Ireland/Italy



NCL 150 Cold Light Source

- 20V/150W
- Constant color temperature
- High/Low settings
- Filter shot

- Use of DDL or EKE bulbs
- Continuous intensity adjustment brightness
- Long lamp life
- Low noise/vibration

Specifications

Rated Lamp Life	DDL 400/1400 hrs*, EKE 100/900 hrs*
Constant Color Temperature	DDL 3280°K/3140°K, EKE 3310°K/3120°K
Light Adjustment	Crescent shaped diaphragm
High/Low Settings	25 dB noise level
Filter Slot	98° F Housing temperature
Lamp	DDL-20V/150W or EKE-21V/150W
Dimensions, H x W x D	10.5 x 21.9 x 21.9 cm (4.125 x 8.625 x 8.625 in)
Weight	4.5 kg (10 lb)

* Average of continuous operation,
Manufactured in U.S.A.

Order # Product

W4 72-0311	NCL 150, 120V USA/Canada
W4 72-0312	NCL 150, 230V Euro

Accessories and Spares

W4 72-0226	DDL Lamp, 20V/150W
W4 72-0227	Halogen Spare Lamp, EKE Lamp, 21V/150W
W4 72-0220	Blue Filter
W4 72-0221	Red Filter
W4 72-0222	Green Filter
W4 72-0223	Yellow Filter
W4 72-0224	Daylight Filter
W4 72-0238	Standard/Compact Ringlight
W4 72-0262	Ringpolarizer Set
W4 72-0264	Diffuser
W4 72-0267	Bifurcated Gooseneck, 4.7 mm Ø
W4 72-0266	Bifurcated Gooseneck, 5.4 mm Ø
W4 72-0329	Incident Gooseneck
W4 72-0269	Focusing Lens
W4 72-0273	Polarizing Cap for p/n W4 72-0270
W4 72-0342	Backlight, 2"x 2"
W4 72-0287	Single Light Guide 10 mm

All volpi light sources are compatible with all volpi fiber optics.

IntraLED 2020 and Filters

Fiber Optic Cold Light Sources



IntraLED 2020

This high power LED light source represents a viable alternative to halogen light sources. It achieves its high light yield of more than 6 MLux at a total power consumption of just 15W. With a color temperature of 6500K, the IntraLED 2020 emits a very white

light that is far superior to halogen lamps. The illumination intensity is controlled manually using keys on the front panel or digitally via an RS 232 interface.

The IntraLED 2020 is suitable for clean room applications and outperforms halogen light sources with respect to bulb life and efficiency.

Specifications

Optical Characteristics:

Light Source	High Power LED White CIE 1931
Illumination Intensity	>6,000,000 Lux
Efficiency	>440,000 Lux/W
Max. Optical Efficiency	65lm/W
Aperture (Viewing Angle a/2)	10°
Color Temperature Typical	6500K
Color Reproduction Index	80
Degradation Period of LEDs	>50,000h1)
Optical Output	<10mm (2/5 inch)
Regulation of emittance on Vs area illuminated1)	Constant @ Vs = 12V ±10% and T = 10°C to 40°C
LED Radiation Class	1M LED Product

Electrical Characteristics:

Supply Voltage Vs	12V DC
Current Consumption	Approximately 1.250mA
Communication	RS 232
Connector	M8 Male; 4 Poles2)

Mechanical Characteristics:

Dimension	89mm x 84mm x 159mm (including connectors)
Enclosure	Aluminum body, anodized
Forced Cooling, Fan Noise	39dB(A)
Enclosure Rating	IP 20
Adapter	15mm standard Volpi ferrule
Weight	Approximately 1.1kg

Ambient Conditions:

Ambient Temperature	Operation: 0°C to 40°C Storage: 0°C to 50°C
Humidity	Maximum 95%, relative not condensing

Order #	Product
W4 72-0322	IntraLED 2020
W4 72-4667	IntraLED 2020 with Schott-Foster Receptacle



Light Source Filters

- **Blue Filters** enhance red and yellow objects and lighten blue and green objects
- **Red Filters** will darken blue and green objects and are useful for black and white applications
- **Green Filters** increase contrast for blue and red objects and brighten yellow and green objects
- **Yellow Filters** of specific band widths may be used as a safe light when working with photosensitive materials
- **Daylight Conversion Filters** increase the Kelvin Temperature of the halogen light to 5500°K, which is daylight. Daylight Filters reduce glare from highly reflective material such as muscle tissue and metals

Light Source Filters provide contrast enhancement. When the composition of an object is made of two or more colors, a filter may be used to darken the color that is most important and, therefore, be able to observe it better. When the composition of an object is pale, a filter of the opposite or complementary color may enhance the detail. Specifically, when the composition of the object is highly dense and color saturated, a filter of the same color will most likely enhance the detail on the object. Custom filters of a specific band width are also available upon request.

Order # Product

W4 72-0219	Blank Filter Holder for Intralux 5100/NCL-150
W4 72-0220	Blue Filter for Intralux 5100/NCL-150
W4 72-0221	Red Filter for Intralux 5100/NCL-150
W4 72-0222	Green Filter for Intralux 5100/NCL-150
W4 72-0223	Yellow Filter for Intralux 5100/NCL-150
W4 72-0224	Daylight Filter for Intralux 5100/NCL-150
W4 72-0310	Set of Filters

Light Source Spare Parts and Accessories

illuminators



Spare Lamps and Power Cords

Order #	Product
W4 72-0227	EKE Spare Lamp for Intralux 5100 /V-Lux 1000/Intralux DC 1100 (21 V/150 W)
W4 72-0226	DDL Spare Lamp for Intralux 5100 /V-Lux 1000 (20 V/150 W)
W4 72-0356	Spare Lamp Socket-Round for Intralux 5100 /V-Lux 1000/Intralux DC 1100/NCL-150
W4 72-0348	Power Cord, United Kingdom
W4 72-0349	Power Cord, France
W4 72-0350	Power Cord, Italy
W4 72-0351	Power Cord, Switzerland
W4 72-0352	Power Cord, Germany
W4 72-0353	Power Cord, The Netherlands
W4 72-0354	Power Cord, Spain/Portugal

Note: All Volpi Light Sources are compatible with all Volpi Fiber Optic Components.

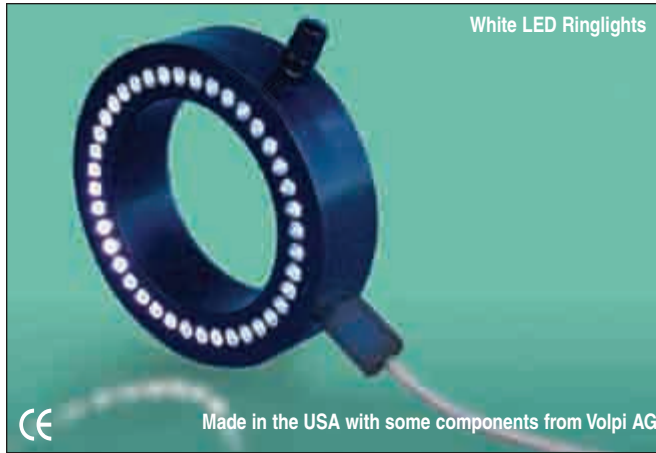
Ringlight Adapters

- Ringlight adapters available for all brand microscopes
- Provide direct and indirect mounting
- Low-Cost

sed with Standard/Compact and 4-Point Standard Ringlights for attachment to all brand microscopes. If your microscope is not listed here, please contact customer service for assistance.

Order #	Product
W4 72-0249	Ringlight Adapter for Leica Classic Stereo Zoom 1-5 without Attachment Lens
W4 72-0250	Ringlight Adapter for Leica New Family SZ4/SZ6/Photo/Plus without Attachment Lens
W4 72-0305	Ringlight Adapter for Leica New Family SZ4/SZ6/Photo/Plus with Attachment Lens
W4 72-0251	Ringlight Adapter for Leica Stereo Zoom 7/GZ7 without Attachment Lens
W4 72-0252	Ringlight Adapter for Leica M3B/C/Z; Leica MZ6 Achromatic 0.32x/0.5x/0.63x/0.8x/1.0x
W4 72-0257	Ringlight Adapter for Olympus SZ/ without Attachment Lens
W4 72-0258	Ringlight Adapter for Olympus SZH9/SZH12 and Nikon SMZ Series without Attachment Lens
W4 72-4666	Ringlight Adapter for SZM 180 Stereo Zoom Microscopes

LED Ringlights



White LED Ringlights

- Compact, Metal Design
- Flicker-Free Light
- 7,000 to 10,000 LED life
- 7800°K Temp
- Working Distance Range of 30 to 150 mm
- Adaptable to all microscopes

White Light Emitting Diodes (LEDs) are now available in a ringlight to produce uniform, shadow-free illumination comparable to that of fiber optic ringlights. This exciting new technology is available in 5500°K Temperature (Daylight) and 7800°K Temperature for working distances of 30-150 mm. Metal housing design produces minimal heat for cool light illumination. Powered with an 8W/24V DC power supply (included), these ringlights offer flicker-free illumination. The most unique feature of these White LEDs is by far their rated life of 7,000-10,000 hours. White LED ringlights have the standard 66 mm inside diameter and are adaptable to all microscopes and lenses through a series of available ringlight adapters. This ringlight is supplied with slim line power supply

Order #	Product
W4 72-4656	Standard White LED Ringlight, 30-70 mm Working Distance
W4 72-4657	Diffuse Standard White LED Ringlight, 30-90 mm Working Distance
W4 72-4658	Spot/Focused White LED Ringlight, 70-160 mm Working Distance
W4 72-4659	Daylight LED Ringlight-5500°K Temp - Short Working Distance, 30-70 mm Working Distance
W4 72-4660	Daylight LED Ringlight-5500°K Temp - Long Working Distance, 70-160 mm Working Distance
W4 72-4661	Rheostat Accessory for use with all LED Ringlights
W4 72-4662	Ring Polarizer Set with Glass Analyzer for all LED Ringlights
W4 72-0321	Slim Line Power Supply, works with all LED Ringlights

Twin Row Spot Focused LED Ringlight

- Twice as bright
- Available with white or yellow LEDs
- Applications:
 - Scratch & Flaw
 - General purpose illumination
 - Inspection (yellow LED)

Uniform shadow-free illumination. LED light source with extremely stable and homogeneous light output. Optimal working distance 3-6 inches. Includes on/off switch and power supply.

Specifications

Illumination Type	White 7800K Yellow 6400K
Expected Life	> 10,000 Hours*
Slim Line Power Supply	110V (included)
Maximum Voltage	24 Volt DC
Cable	1.5M
Wiring	Black = GND White = +

Black Anodized Aluminum Body

* Average of continuous operation

Order #	W4 72-0319	W4 72-0320	W4 72-0321
Product	Twin Row Spot Focused LED Ringlight White	Twin Row Spot Focused LED Ringlight Yellow	Slim Line Power Supply (included)
Number of LEDs	84	84	
Power Consumption	7.2W	7.2W	
Mounting Diameter	66 mm	66 mm	
Working Distance	75-150 mm (3-6 inches)	75-150 mm (3-6 inches)	

Fiber Optic Ringlights

Standard Ringlight

- 25 to 90 mm working distance
- Uniform and shadow-free illumination
- Full-circular
- Adaptable to all microscope brands

Full circular glass fiber ringlight provides homogeneous, shadow-free illumination for working distances of 25 to 90 mm. Inside diameter is 66 mm for mounting on all microscopes through a series of ringlight adapters listed on 360.

Order #	Product
W4 72-0238	Standard Ringlight with 750 mm (30 in) flexible length
W4 72-0239	Standard Ringlight with 1200 mm (48 in) flexible length
W4 72-0240	Standard Ringlight with 2400 mm (96 in) flexible length



Compact Ringlight

- Compact design
- 15 to 70 mm working distances
- Uniform and shadow-free illumination
- Adaptable to all microscope brands

Full circular glass fiber ringlight provides homogenous, shadow-free illumination for working distances of 15 to 70 mm. Inside diameter is 66 mm for mounting on all microscopes through a series of ringlight adapters listed on 360. Standard Flexible length is 750 mm (30 in). Longer lengths available.

Order #	Product
W4 72-0233	M10 Compact Ringlight



4-Point Standard Ringlight

- Depth perception
- 70 to 100 mm working distance
- Adaptable to all microscope brands

Standard ringlight with four fiber points provides illumination with depth perception for working distances of 70 to 100 mm. Inside diameter is 66 mm for mounting on all microscopes through a series of ringlight adapters listed on page 360. Standard Flexible length is 750 mm (30 in). Longer lengths available.

Order #	Product
W4 72-0248	4-Point Standard Ringlight



Fiber Optic Ringlights (continued)

Mini Ringlight

- Small diameter
- Full circular
- 5 to 175 mm working distances
- Shadow-free
- Direct mounting for 20 to 32 mm objectives

Small full circular glass fiber ringlight provides homogeneous, shadow-free illumination for working distances of 5 to 25 mm. Long Working Distance version is available for distances of 25 to 175 mm. Can be used for fiber optic illumination on Compound Microscope objectives. Mounting diameter ranges from 20 to 32 mm with the presence of 3 mounting screws without the need for adapters. Standard Flexible length is 900 mm (40 in). Longer lengths available.

Order #	Product
W4 72-0246	Short Working Distance Mini Ringlight
W4 72-0247	Long Working Distance Mini Ringlight



SMD/MAXI Ringlight

- Large diameter
- Full circular
- 50 to 120 mm working distance
- Diffuse light
- High intensity

Large full circular diameter glass fiber ringlight that provides homogenous, shadow-free illumination for working distances of 50 to 120 mm. Large diameter and shallow fiber angle produces wonderful darkfield effect on large surface areas. Inside diameter is 150 mm and can be adapted to SMD stations and stereomicroscope columns. Standard Flexible length is 480 mm (19 in) with longer lengths available on request.

Order #	Product
W4 72-0245	SMD/MAXI Ringlight



Ringlights and Accessories

Ergo/Olympus SZ/SD Ringlight

- Ergonomic
- Long working distance starting at 100 mm
- Direct mounting to Olympus

Tapered ringlight for direct mounting on Olympus SZ/SD Microscopes with minimum loss of working distance. Flexible length exits at 45° angle allowing maximum work space. Long Working distance starting at 100 mm with long flexible lengths available. Adapter included.



Order #	Product
W4 72-0242	Ergo/Olympus SZ/SD Ringlight

Accessories for Standard/Compact and 4-Point Ringlights

- Reduces or eliminates unwanted reflections
- Extends standard ringlight working distance range
- Used with standard, compact and 4-point standard ringlights

Ring Polarizer Set

Eliminates unwanted reflections of highly reflecting materials such as tissue and metallic objects. Glass analyzer is used with plastic polarizer for the best possible cross-polarization effect. Can be used with Standard, Compact, and 4-Point Standard Ringlights.

Toric Lens

Extends the working distance of Standard and Compact Ringlights from 90 to 150 mm. Longer distance ringlights are also available as an alternative.

Diffuser

Reduces unwanted reflections of highly reflecting materials such as tissue and metallic objects. Can be used with Standard, Compact, and 4-Point Standard Ringlights.



Order #	Product
W4 72-0262	Ring Polarizer Set for Standard/Compact Ringlights
W4 72-0265	Toric Lens for Standard/Compact Ringlights
W4 72-0264	Diffuser for Standard/Compact Ringlights

Note: All Volpi Light Sources are compatible with all Volpi Fiber Optic Components.

Gooseneck Light Guides

Gooseneck Light Guides

Gooseneck light guides provide fiber optic incident illumination using semi-obedient, self-supporting arms with no spring-back action. You can position each arm independently and with the key system in place, there is no rotation. Single Arm and bifurcated Goosenecks are available with 4.7 mm and 5.4 mm diameter.

Special Volpi Patent: Sliding Sleeve allows fiber bundles to move independently of the outer tubing for minimal fiber breakage over time. Gooseneck Arms are repairable. Light sources are sold separately.

Order #	Product
W4 72-0268*	Single Arm Gooseneck Light Guide, 4.7 mm x 500 mm fiber diameter
W4 72-0309	Single Arm Gooseneck Light Guide, 5.4 mm x 500 mm
W4 72-0267	Bifurcated Gooseneck Light Guide, 4.7 mm x 500 mm fiber diameter (each arm)
W4 72-0266*	Bifurcated Gooseneck Light Guide, 5.4 mm x 500 mm fiber diameter (each arm)

* 20" long, Ferrule diameter = 10mm



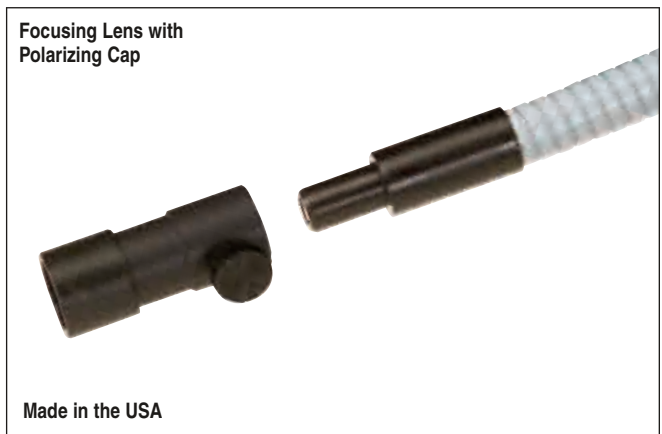
Gooseneck Accessories

Standard Focusing Lens: A spherical lens used to focus light to a concentrated spot.

Polarizing Cap: Fits onto focusing lens.

Order #	Product
W4 72-0269*	Standard Focusing Lens
W4 72-0304	Polarizing Cap for Standard Focusing Lens For Modular Accessory System, see page 363

* Fits on 10mm Ferrule



Gooseneck Light Guides (continued)

illuminators



Incident Gooseneck Light Guides

- Bifurcated Gooseneck and flexible light guide combination
- Attachable to columns of all brand microscopes through available adapters
- Great flexibility in the placement of light source
- Available in different lengths
- Uses standard Gooseneck accessories

This combination of a Semi-Obedient Bifurcated Gooseneck and a Flexible Light Guide provides incident illumination. Fiber Optic Incident Goosenecks attach to the columns of microscopes or other work station columns with specialized adapters. Each arm can be positioned and adjusted independently. The flexible length size can vary to allow the placement of the light source away from the microscope and work station.

Utilizes standard Gooseneck accessories such as Focusing Lens W4 72-0269, Polarizing Caps W4 72-0304 and Modular Accessory System found on pages 361 and 363. Light sources are sold separately.

Order #	Product
W4 72-0329	Incident Gooseneck Light Guide, 4.7 mm fiber diameter (each arm), 75 cm (30 in)
W4 72-0330	Incident Gooseneck Light Guide, 4.7 mm fiber diameter (each arm), 100 cm (40 in)
W4 72-0331	Incident Gooseneck Light Guide, 4.7 mm fiber diameter (each arm), 150 cm (60 in)
W4 72-0333	Incident Gooseneck Light Guide Adapter for 20 to 25 mm Round Columns
W4 72-0334	Incident Gooseneck Light Guide Adapter for 32 mm Round Columns
W4 72-0335	Incident Gooseneck Light Guide Adapter for Nikon SM5/6 and SMZ 6/10
W4 72-0336	Incident Gooseneck Light Guide Adapter for Olympus SZX9/12
W4 72-0308	Incident Gooseneck Articulated Arm Support Adapter for Leica G26, MS5, M26, M28, M212



Flexible Light Guides

- Point illumination
- Highly flexible
- PVC metal tubing provides durability.
- 3 to 13 mm fiber diameters
- Standard and custom lengths available

Highly flexible and durable light guides available in 3 to 13 mm of fiber diameters and various standard and custom lengths. Outer tubing is composed of PVC metal tubing to provide both flexibility and protection. Standard single arm and twin arm versions available. Customized versions are available upon request.

Flexible Light Guides

Fiber Diameter (mm)	3	5	8	10	13
Bushing Diameter	5	10	10*	13*	16*
Single Arm Lengths					
50 cm (20 in)	W4 72-0283	W4 72-0287	W4 72-0291	W4 72-0295	W4 72-0299
100 cm (40 in)	W4 72-0284	W4 72-0288	W4 72-0292	W4 72-0296	W4 72-0300
150 cm (60 in)	W4 72-0285	W4 72-0289	W4 72-0293	W4 72-0297	W4 72-0301
200 cm (80 in)	W4 72-0286	W4 72-0290	W4 72-0294	W4 72-0298	W4 72-0302
* Does not fit standard focusing lense					
Twin Arm Lengths					
100 cm (40 in)	–	W4 72-0313	W4 72-0316	–	–
150 cm (60 in)	–	W4 72-0314	W4 72-0317	–	–
200 cm (80 in)	–	W4 72-0315	W4 72-0318	–	–

Light Guide Accessories

illuminators



Articulating Arm with Heavy Steel Base

- Fixed point illumination
- Accurate adjustment for quick, simple and precise positioning
- Unrestricted movement – 220 mm radius of action
- Very durable

Articulating Support Arm provides unrestricted movement and accurate fine adjustment for fixed point illumination. Adjustment is simple and precise with 220 mm radius of action. Articulating Arms are available with M6/M6 and M6/M8 thread ends. Flexible Light Guides can be attached with small (9 to 12 mm OD) and large (11 to 16 mm OD) holders depending on flexible light guide outer ferrule diameters.

3 Components

W4 72-0324

W4 72-0322

W4 72-0325 or W4 72-0326 depending on light grid brushing \varnothing

Order #	Product
W4 72-0323	Articulated Support Arm, M6/M6 Thread
W4 72-0324	Heavy Steel Base for Articulated Support Arm
W4 72-0325	Holder for Articulated Support Arm, ferrule diameter 9 to 12 mm (0.35 to 0.47 in)
W4 72-0326	Holder for Articulated Support Arm, ferrule diameter 11 to 16 mm (0.43 to 0.63 in)



Modular Accessory System

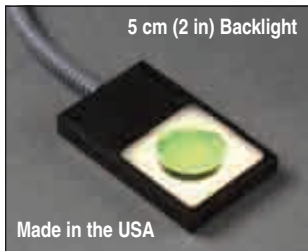
- Use with Goosenecks and up to 8 mm OD Flexible Light Guides
- Allows combination of filters and other accessories
- Very versatile

Modular Holder has a 10 mm mounting diameter and attaches onto ends of goosenecks and up to 8 mm OD flexible light guides. Modular Accessory Holder and each of the Modular Accessories are threaded to accept one another. Modular accessories include the Modular color filters, Modular focusing lens, Modular diffuser, Modular polarizing filter, and Modular iris diaphragm. One or all can be attached at any one time. Custom filters are also available upon request.

Order #	Product
W4 72-0270	Modular Accessory Holder
W4 72-0271	Modular Focusing Lens
W4 72-0272	Modular Iris Diaphragm
W4 72-0273	Modular Polarizing Filter
W4 72-0274	Modular Daylight Filter, plastic
W4 72-0275	Modular Blue Filter, plastic
W4 72-0276	Modular Red Filter, plastic
W4 72-0277	Modular Green Filter, plastic
W4 72-0278	Modular Yellow Filter, plastic
W4 72-0280	Modular Blank Filter, plastic
W4 72-0279	Modular Diffuser, plastic

Note: All Volpi Light Sources are compatible with all Volpi Fiber Optic Components.

Backlights and Base



Glass Light Fiber Backlights

- Homogeneous, diffuse backlight illumination
- Used in the image processing, brightfield illumination on stereo microscopes, pattern recognition of different transparencies, area recognition of different colors, side illumination, dimensional gauging, shape verification, etc.

Glass Fiber Backlights provide homogeneous, diffuse illumination. Glass fiber used is extremely durable and heat tolerant. Can be adapted to most brand microscope bases.

Available in three sizes: 5 x 5 cm (2 x 2 in), 7.6 x 7.6 cm (3 x 3 in), and 12.7 x 12.7 cm (5 x 5 in). Additional specifications listed below.

Specifications

	W4 72-0342	W4 72-0343	W4 72-0344
Product	2 inch Backlight	3 inch Backlight	5 inch Backlight
Homogeneous Illumination Field	5 x 5 cm (2 x 2 in)	7.6 x 7.6 cm (3 x 3 in)	12.7 x 12.7 cm (5 x 5 in)
Dimensions, H x W x D	1.3 x 10.2 x 6.4 cm (0.5 x 4.0 x 2.5 in)	2.3 x 17.2 x 12.1 cm (0.9 x 6.75 x 4.75 in)	2.3 x 22.2 x 17.2 cm (0.9 x 8.75 x 6.75 in)
Uniformity	±10%	±10%	±10%
Fixing Holes (4 each) Diameter	6.3 mm (0.25 in)	6.3 mm (0.25 in)	6.3 mm (0.25 in)
Flexible Light Guide (Met/PVC)	91.4 cm (36 in)	91.4 cm (36 in)	91.4 cm (36 in)
Light Source Adapter	Intralux Series	Intralux Series	Intralux Series

Order # Product

- W4 72-0342** Glass Fiber Backlight, 5 x 5 cm (2 x 2 in)
- W4 72-0343** Glass Fiber Backlight, 7.6 x 7.6 cm (3 x 3 in)
- W4 72-0344** Glass Fiber Backlight, 12.7 x 12.7 cm (5 x 5 in)

Brightfield/Darkfield Base

- Transmitted bright/darkfield illumination
- Uses standard/compact ringlight illumination
- Low cost alternative
- Compact design
- Adapts to all brand name microscopes

This is a low-cost, intense, contrast-rich, transmitted, light Bright/Darkfield Base used with Standard or Compact Fiber Optic Ringlights. It provides transmitted bright/darkfield illumination. Easily accessible knob allows quick and easy change between brightfield and darkfield. Adapts to all brand name microscopes.

Order # Product

- W4 72-0337** Bright/Darkfield Base
- W4 72-0339** Polarizer to Base
- W4 72-0340** Diaphragm to Objective, 0.5/0.63X
- W4 72-0341** Diaphragm to Objective, 1.5/2.0X

Note: All Volpi Light Sources are compatible with all Volpi Fiber Optic Components.

Large selection of high quality coverslips stocked for immediate delivery



Now Available in #1.5 Thickness!

High quality Coverslips are essential for microscopy imaging. At high resolutions (40X, 60X or 100X), choosing the correct coverslip is critical for good performance. Warner has recently expanded its line of coverslips to include German borosilicate glass at #1.5 thickness. Except CS-40R, CS-30R and CS-24/60.

Stocked in depth in the sizes used with RC Series, Series 20 and the new Series 40 chambers. Consult the chart to select the correct cover glass for your chamber.

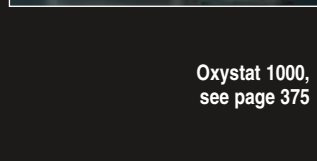
Order #	Model	Quantity	Dimension	Chamber Used With
Coverslip Thickness #1: 0.15 mm (0.006 in.)				
W4 64-0700	CS-5R	100	5 mm D	Fits inside 96-well culture plate
W4 64-0701	CS-8R	100	8 mm D	Fits inside 24-well culture plate
W4 64-0702	CS-12R	100	12 mm D	RC-25, RC-48LP
W4 64-0703	CS-15R	100	15 mm D	RC-20, RC-20H, RC-25F, RC-37WC, RC-37FC
W4 64-0384	CS-18R	100	18 mm D	RC-37WC, RC-41LP, RC-43C
W4 64-0704	CS-22S	100	22 x 22 mm	RC-21B
W4 64-0705	CS-25R	100	25 mm D	RC-21BR, RC-21BRFS, RC-21BRW, RC-21BDW, RC-40LP, RC-40HP, RC-43C, RC-46SNLP, RC-46SLP, RC-47FSLP, RC-50
W4 64-1500	CS-40R	60	40 mm D	RC-30WA
W4 64-0706	CS-22/30	50	22 x 30 mm	RC-30, RC-30HV
W4 64-0707	CS-22/40	50	22 x 40 mm	RC-22, RC-22C, RC-24, RC-24E, RC-24N, RC-26, RC-26G, RC-26GLP, RC-26GS, RC-30, RC-50
W4 64-0708	CS-22/50	50	22 x 50 mm	RC-26Z, JG-23N/HP, JG-23W/HP, JG-23W/LP
W4 64-0709	CS-24/50	50	24 x 50 mm	RC-27, RC-27L, RC-27N, RC-27NE, RC-28, RC-29
Coverslip Thickness #1.5: 0.17 mm (0.0067 in.)				
W4 64-0712	CS-12R15	100	12 mm D	RC-25, RC-48LP
W4 64-0713	CS-15R15	100	15 mm D	RC-20, RC-20H, RC-25F, RC-42LP, RC-37WC
W4 64-0714	CS-18R15	100	18 mm D	RC-37FC, RC-41LP, RC-43C
W4 64-0715	CS-25R15	100	25 mm D	RC-21BR, RC-21BRFS, RC-21BRW, RC-21BDW, RC-40LP, RC-40HP, RC-43C, RC-46SNLP, RC-46SLP, RC-47FSLP, RC-50
W4 64-1499	CS-30R	90	30 mm D	RC-30WA
W4 64-0716	CS-22/3015	50	22 x 30 mm	
W4 64-0717	CS-22/4015	50	22 x 40 mm	RC-22, RC-22C, RC-24, RC-24E, RC-24N, RC-26, RC-26G, RC-26GLP
Coverslip Thickness #2: 0.22 mm (0.0086 in.)				
W4 64-0710	CS-24/60	40	24 x 60 mm	RC-10, RC-11, RC-13, RC-16, RC-27D, RC-27LD

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Nitric Oxide Measurement System, see page 368



Dissolved Oxygen Meter with Electrodes, see page 374



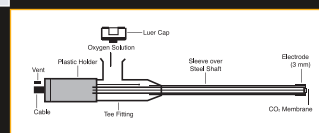
Oxystat 1000, see page 375



6-Channel Oxygen System, see page 378



Micro-CO₂ Electrode, see page 384



Duracal Buffers, see page 389



W4 69-3054 Dual Channel inNO-T System

W4 69-3050
1 Channel inNO-T System

- Dual Channel System
- Uses 'amiNO' sensors which are up to 100 times more sensitive than other sensors
- First available NO system to have temperature compensation
- No base line drift due to temperature changes
- Combination NO meter and data acquisition system
- User friendly recording, playback and analysis software compatible with Windows 95/98, 2000, and XP
- Continuous recordings (over 1 month)
- Battery-powered benchtop/portable system
- 24 bit A/D converter
- System shipped complete with NO meter, software, 2 types of NO sensors, and calibration kit

Nitric Oxide Measurement System

The 'inNO-T' system is the most technologically advanced nitric oxide electrochemical detection system on the market today. It combines a nitric oxide configured potentiostat and a sophisticated software controlled data acquisition system in one compact battery powered unit. When used with the 'amiNO' series of NO sensors, this unit provides an NO detection sensitivity increase of up to 100 times that of any other electrochemical detection system. The battery powered design allows the unit to run continuously for up to 5 years, making it ideal for any electrically isolated and/or portable application.

The 'inNO-T' system is the first available nitric oxide system to include temperature compensation which further enhances the detection limits and data reliability by eliminating temperature dependent baseline drift. A temperature probe is supplied with each system.

The inNO-T system's internal 24 bit analog to digital converter and built in digital notch filtering allows for accurate, noise free, detection of nitric oxide levels of less than 0.01 nM. The 24 bit A/D technology also gives the unit a dynamic range in excess of 16,000,000 to 1. Its sophisticated control and analysis software can be linked to any computer system that utilizes Windows™ 95/98, 2000 or NT via the 'inNO's' internal RS-232 interface.

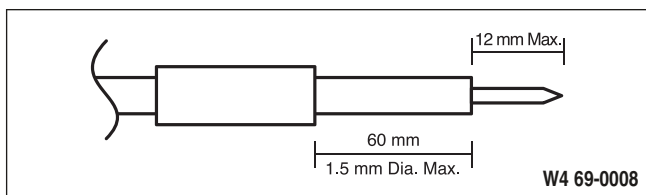
- All amiNO sensors are combination sensors, no external reference electrode is required
- Mechanically rugged membrane
- All sensors covered with proprietary triplecoat gas permeable membrane to guarantee selectivity and very fast response time
- All sensors completely shielded from environmental/electrical noise
- All sensors work the 'inNO-T' meter as well as many other currently available meters
- One calibration procedure, simple, easy, no expensive chemicals

Using state of the art combination NO sensor design, the 'amiNO' Series nitric oxide sensors increase the sensitivity of electrochemical nitric oxide measurement, by up to 100 times that of any existing electrochemical sensor on the market today.

amiNo sensors are the first NO sensors to break the 100 pA/nM barrier. This higher sensitivity greatly reduces measurement errors due to baseline drift associated with temperature changes. Baseline drift has been a particular concern with older technology sensors that not having the enhanced sensitivity characteristics of the 'amiNO' sensors.

Additionally the new 'amiNO' series adds newly designed sensor types for in vivo applications and large surfaces (cultured cells). Customized sensors are available upon request to meet specialized applications, call for details.

Warner Instruments offers 4 different Nitric Oxide Measurement Systems. Each system includes either a 1-channel or 2-channel inNO-T Temperature compensated meter, an amiNO-2000 sensor, SensoReady Electrode Polarizer and a temperature probe (for a complete listing of system components see chart on page 371). Each system is offered in either 115 or 230 VAC.



amiNO-7 Sensor

- 7 μm tip diameter
- Ideal for single cell measurements
- Metal alloy fiber
- Tip Volume ~ 500 μl

amiNO-30 Sensor

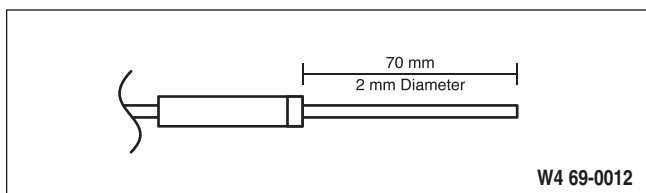
- 30 μm tip diameter
- For space restricted measurements
- Metal alloy fiber
- Tip Volume ~ 10 μl

amiNO-100 Sensor

- 100 μm tip diameter
- Extremely stable background
- Resists breakage
- To be used in restricted area and 'in vivo' measurements
- Very consistent & reproducible
- Tip Volume ~ 100 μl

amiNO-600 Sensor

- 600 μm tip diameter
- Exceptional sensitivity and baseline stability
- Very rugged membrane, flexible body
- Very durable
- Tip Volume ~ 4 μl

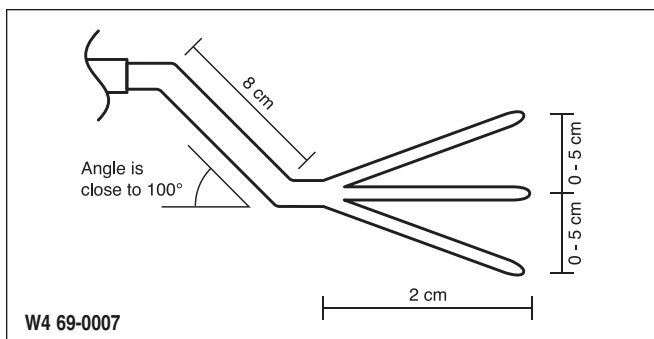


amiNO-2000 Sensor

- Flat 2 mm tip diameter
- Stainless steel/aluminum body
- Longest life NO electrode (user replaceable membranes)
- Tough enough for training new staff and students
- Used to measure high levels of NO as in drug solutions and macrophages
- Tip Volume ~ 250 μl

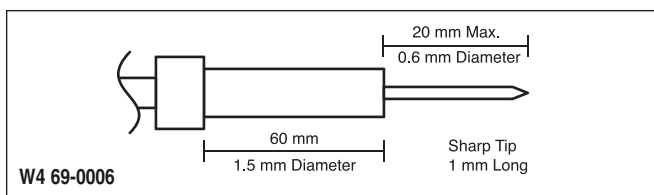
inNO-T

Nitric Oxide Measurement System (continued)



amiNO-FLAT Sensor

- 'Chicken foot' design to increase contact area
- Designed specially for measuring NO released from monolayer cultured cells and large flat tissues
- Rugged membrane
- Highest sensitivity
- Low background



amiNO-IV Sensor

- 600 μm tip diameter
- Very sharp metallic tip for insertion/penetration of tissue, no extra needles or catheters are needed, sensor is the needle
- Higher sensitivity, up to 100 times more sensitive than other commercially available sensors
- Sub nano-molar detection limit
- Special membrane survives numerous insertions
- Very stable, low background current
- Tip Volume $\sim 6\mu\text{l}$

Specifications

Current Scale	$\pm 2,500,000.0$ pA
Concentration Scale	$\pm 1,000,000.0$ nM
Resolution	0.01 nM (0.1 pA)
Screen Meter	7.5 digit meter
Recording Speed	1 to 1000 sec/div
Power	Replaceable battery
Dimensions, H x W x D	76 x 229 x 203 mm (3 x 9 x 8 in)
Temperature Range	0° to 50°C, inNO-T only
Temperature Resolution	0.01°C, inNO-T only
Temperature Sensor	< 0.50 mm tip, 120 mm long, inNO-T only

Please refer to the guide below to help you select the best sensor for your application. For additional assistance, please call Warner Instruments Technical Support*

**The selection guide below is based on design, sensitivity and economy. For example, amiNO-FLAT and amiNO-IV are the most sensitive but are also the most expensive. The amiNO-600 is less sensitive but is more economical.*

amiNO Sensor Selection Guide*

Application	First Choice(s)	Second Choice(s)
Measuring NO released from cells/large flat tissue	amiNO-FLAT	amiNO-600 or amiNO-IV
In vivo measurements and other insertion applications	amiNO-IV	amiNO-600
Measuring NO in small volumes or restricted space	amiNO-100	amiNO-7, amiNO-30 or amiNO-600
Measuring micro-molar levels of NO	amiNO-2000	amiNO-100 or amiNO-30
Following the decomposition of an NO producing compound	amiNO-600 or amiNO-100	amiNO-2000 or amiNO-IV
Measuring very low levels of NO (below 50 nM)	amiNO-600 or amiNO-IV	amiNO-100
Indirect measurement of Nitrate and Nitrite	amiNO-600, depending on expected level	amiNO-100 or amiNO-2000
Training new staff or students	amiNO-2000	amiNO-600

amiNO Sensor Performance Comparison and Ordering Information

Order #	Qty.	Model	Size	Typical Sensitivity	Competitor Typical Sensitivity
W4 69-0008	2	amiNO-7	7 µm	0.5-3 pA/nM (typical 1.5 pA/nM)	n/a
W4 69-0009	2	amiNO-30	30 µm	2-6 pA/nM (typical 4 pA/nM)	n/a
W4 69-0010	2	amiNO-100	100 µm	25 to 50 pA/nM (typical 35 pA/nM)	No Equivalent
W4 69-0011	2	amiNO-600	600 µm	150 to 250 pA/nM (typical 200 pA/nM)	No Equivalent
W4 69-0012	1	amiNO-2000	2 mm	Typical 1 pA/nM	Typical 1 pA/nM
W4 69-0006	2	amiNO-IV	600 µm	150 to 250 pA/nM (typical 200 pA/nM)	No Equivalent
W4 69-0007	1	amiNO-FLAT	See diagram	250 to 700 pA/nM (typical 400 pA/nM)	No Equivalent

inNO-T Nitric Oxide Measurement Systems, Sensors and Accessories

Order #	System Components	Premium System #1		Premium System #2		Premium System #3		Premium System #4	
		115 VAC, 60 Hz	230 VAC, 50 Hz	115 VAC, 60 Hz	230 VAC, 50 Hz	115 VAC, 60 Hz	230 VAC, 50 Hz	115 VAC, 60 Hz	230 VAC, 50 Hz
W4 69-0012	amiNO-2000 Nitric Oxide Sensor, 2 mm Tip	•	•	•	•	•	•	•	•
W4 69-0010	amiNO-100 Nitric Oxide Sensor, 100 µm Tip, pkg. of 2	•	•						
W4 69-0011	amiNO-600 Nitric Oxide Sensor, 600 µm Tip, pkg. of 2			•	•				
W4 69-0006	amiNO-IV Nitric Oxide Sensor, InVivo 600 µm Tip, pkg. of 2					•	•		
W4 69-0007	amiNo-FLAT Nitric Oxide Sensor, Flat 25 x 25 mm, pkg. of 1							•	•
W4 69-0013	Electrolyte for W4 69-0012	•	•	•	•	•	•	•	•
W4 69-0014	Replacement Membranes for W4 69-0012, pkg. of 4	•	•	•	•	•	•	•	•
W4 69-0037	Nitrite Standard, 50 ml	•	•	•	•	•	•	•	•
W4 69-0038	Calibration Vials, pkg. of 5	•	•	•	•	•	•	•	•
W4 69-0016	SensoReady Electrode Polarizer	•	•	•	•	•	•	•	•
W4 69-0029	Adapter, LIMO Connector to amiNO Sensor Connector	•	•	•	•	•	•	•	•
W4 72-0460	Spin Bar Magnetic Stir Bar, 5 x 2 mm, pkg. of 5	•	•	•	•	•	•	•	•
W4 72-1972	Magnetic Stirrer, 115 VAC	•		•		•		•	
W4 72-1973	Magnetic Stirrer, 230 VAC		•		•		•		•
W4 72-1922	Electrode Holder and Stand	•	•	•	•	•	•	•	•
W4 69-0052	Temperature Probe	•	•	•	•	•	•	•	•

Systems

1-Ch inNO System with inNO-T Meter with Temp. Compensation	W4 69-3050	W4 69-3051	W4 69-3052	W4 69-3053	W4 69-0048	W4 69-0049	W4 69-0050	W4 69-0051
2-Ch inNO System with inNO-T Meter with Temp. Compensation	W4 69-3054	W4 69-3055	W4 69-3056	W4 69-3057	W4 69-3058	W4 69-3059	W4 69-3060	W4 69-3061

Note: inNO and inNO-T are battery operated. Voltage selection is for Magnetic Stirrer. Call Harvard Apparatus Customer Service for Nitrate Reduction Products.

NEW Biostat Multi-Channel Potentiostat

nitric oxide



BioStat Multi-Mode Potentiostat

- Four independent optically isolated channels
- Easy to use software Windows® 2000 or later operating system
- Precise amperometric or voltammetric measurements
- Rugged compact design

The BioStat is a software-driven, multi-mode potentiostat that can be used for measurement of pH, reactive oxygen species, and nitric oxide.

The BioStat System is designed to be used with a wide range of electrochemical sensors and electrodes for measurement of reactive oxygen species and biologically significant molecules. This system allows precise amperometric (with two-electrode or three-electrode sensors for measurement of nitric oxide, oxygen, nitrite and nitrate, nitrosothiols, glutamate, etc.) or voltammetric (with sensors for measurement of pH, neurotransmitters, etc.) and temperature measurements to be made independently on up to four channels. Total electrical isolation of each channel ensures independent recording with ultra-low noise. The BioStat System can handle signals of either polarity, employing either two-electrode or three-electrode sensor configurations.

The BioStat System uses a robust high-quality all-metal case that provides exceptional stability and durability. The shielding of the case provides immunity from external interference and surface mount technology ensures reliability. Each system can be used flat on the bench or in a vertical configuration. Its extremely small size (about size of a paper-back book) requires little lab-bench space. The device is powered by an external universal AC power supply that provides 12 volts of DC power to the device.

pH, Oxygen, and Nitric Oxide Measurements

The BioStat is capable of receiving input from the Warner Instruments line of microminiature pH electrodes, oxygen sensors, and nitric oxide sensors. This flexibility is attained through the use of adapting connectors (such as BNC Triad, and Stereo to Triad connectors). The high input impedance of the BioStat is ideal for these sensitive applications.

Data Acquisition Software

The software takes less than 5 minutes to load from the CD onto any computer with the Windows® 2000 or later operating system. On-screen menus and pop-ups make it easy to use. The software provides comprehensive data analysis capability even while data is being collected. Data is easily exported to allow analysis using other software applications.

Although configured for biosensing measurements, the BioStat system is extremely versatile and can be used for any multi-channel, isolated data acquisition, such as multielectrode electrophysiological recordings.

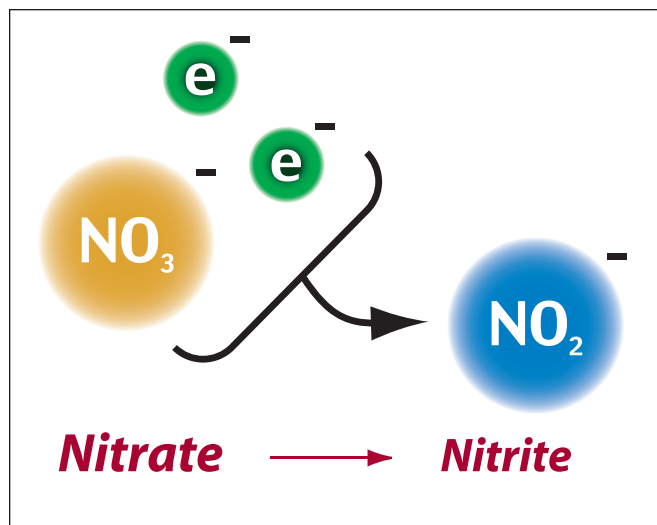
Specifications

Number of Channels	4
Electrode Configuration	2 or 3
Operational Modes	Amperometric, Voltammetric, Temperature
Input Signal Polarity	Bipolar
Input Signal Configuration	Single-ended
Range Settings:	
For Amperometric Mode	± 1 nA to ± 1 mA
For Voltammetric Mode	± 5000 mV
For Temperature Mode	$\pm 100^\circ\text{C}$
Measurement Accuracy:	
For Amperometric/Voltammetric Mode	0.1% x full scale (10 fA in nA range)
For Temperature Mode	$\pm 0.1^\circ\text{C}$
Activation Voltage Range	-2000 mV to +2000 mV
Input Impedance	>1012 Ohm
Baseline Noise	10^{-6} x full scale of selected range [e.g. 1 fA for 1 nA range]
Resolution	10^{-5} x full scale of selected range
Operating System	Host Computer Windows® 2000 or Later
Power Supply	9 to 30 VDC 10 W unregulated
Instrument Dimensions	35 x 166 x 125 mm (1.4 x 6.5 x 5 in)
Weight	1.4 lb (0.65 kg)

Order # Product

W4 64-1750	Biostat Multi-Channel Potentiostat, Cables and Connectors
W4 64-1751	Temperature Electrode for Biostat
W4 64-1752	Triad Bare Connector for Custom Wiring Sensors
W4 64-1753	Adapter Triad to BNC
W4 64-1754	Adapter Triad to stereo phono 3.5 mm

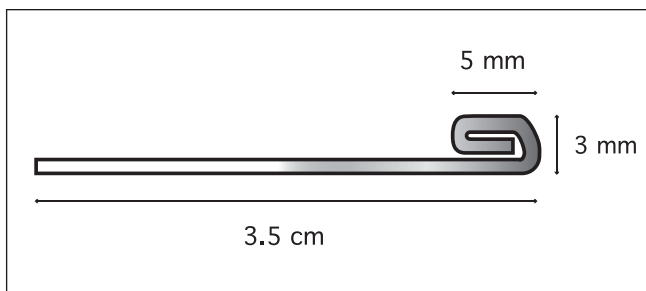
Nitrate Reductor



- Never needs reactivation, even after hundreds of samples!
- No need to bring the sample to the reductor; take the reductor to the sample. This eliminates the need for sample transfer which saves time and eliminates sample loss
- Can be used in any sample container such as a vial, tube, micro-plate well or spectrophotometric cell
- Very small; it can be used in 50 microliters or 5 milliliters
- 100% conversion in minutes
- Economical
- Reusable

The measurements of nitrate and nitrite anions in biological samples have gained more interest due to their association with the nitric oxide (NO) pathway. Since these ions are the oxidation products of NO, their presence can be used as an indicator of NO production activities.

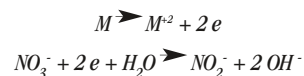
There are many methods available for both direct and indirect measurement of nitrite. Unfortunately, this is not the case for nitrate due to its different chemical reactivity. Therefore, most of the analytical procedures involving nitrate include its conversion to nitrite using either enzymatic reduction or cadmium-based reductors. These conversion procedures are tedious, time consuming, expensive, require multiple sample transfer, and suffer from diminished activity. The Nitrate Reductor is specifically designed to overcome these shortcomings.



Principle of Operation

Conventional bimetallic composition based reductors are based on copper-plated cadmium beads. The presence of copper metal alters the potential energy of the cadmium electrons enhancing the rate of their transfer to nitrate. Even though this design has been used successfully for many years, it has two main drawbacks. The loss of its catalytic activity after using it on a number of samples requires that the reductor be reactivated. The second problem deals with the difficulty in handling and utilizing the beads for use with very small sample volume containers to avoid diluting the sample because these beads are normally packed in a column.

Our nitrate reducing wire is based on a multi-metal alloy structure. This multi-metallic structure preserves the activity of the reductor and enhances the rate of electron transfer in these chemical reactions:



This alloy structure completely eliminates the need to reactivate the nitrate reductor. The design of the reductor in the form of a wire enables it to be used on very small sample volumes and removes the restriction of having to move your sample to a specialized container.

The reductor is available in two kit forms. The manual kit includes 6 reductors that can be used to reduce nitrate in 6 samples simultaneously. The motorized kit is a mixer/reductor combination. The mixer itself is the reductor! This system is ideal for use in sample containers where stirring is difficult and reduces nitrate faster than the manual kit. The motorized kit comes with a removable reductor and micro-sleeve enabling the user to utilize it as a micro-mixer in the lab.

Order #	Product
W4 69-0054	Manual Nitrate Reductor Kit, pkg. of 6

Dissolved Oxygen Meter and Electrodes

dissolved O₂

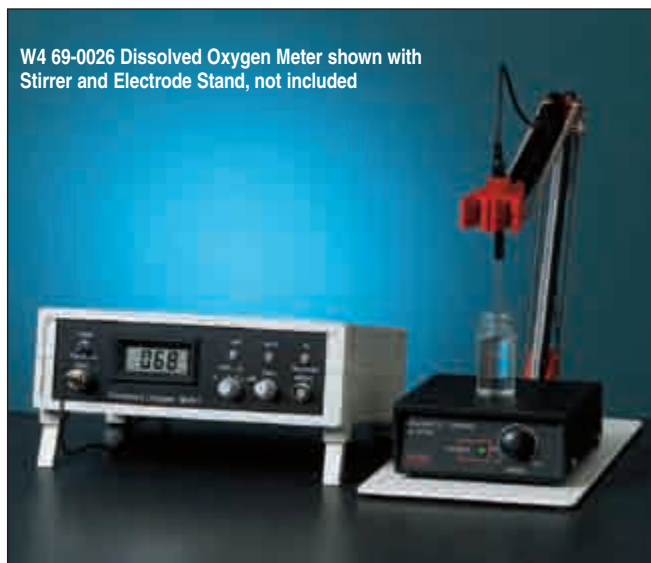
Dissolved Oxygen Meter

- Measures O₂ in liquids or gases
- Meter offers a "clean" function to reactivate the electrode
- Replaceable membranes

This dissolved oxygen measuring system utilized the latest technologies in electronic circuitry and chemical sensors. The 2 mm, stainless steel tipped oxygen electrode allows measurements in both the liquid and gas phases. A W4 69-0027 electrode is supplied with each system with two replacement membranes and electrolyte. The meter can display current, percentage, or PPM oxygen. The meter offers an activation function to restore the activity of the sensor without the need of polishing and conditioning. Stirrer and electrode stand not included.

Specifications

% O ₂	0 to 100%
PPM	0 to 20
Current Range	0 to 2000 nA
Resolution	0.1 PPM, 0.1 %
Accuracy	±1%
Recorder Output	Analog output 0 to 5 V
Electrode Response Time	Under 10 sec, 90% response in stirred solution
Display	3.5 digit LCD
Power	120/240 VAC
Dimensions	20.3 x 22.9 x 76.2 cm (8 x 9 x 3 in)
Shipping Weight	2 lb (1.5 kg)



W4 69-0026 Dissolved Oxygen Meter shown with Stirrer and Electrode Stand, not included

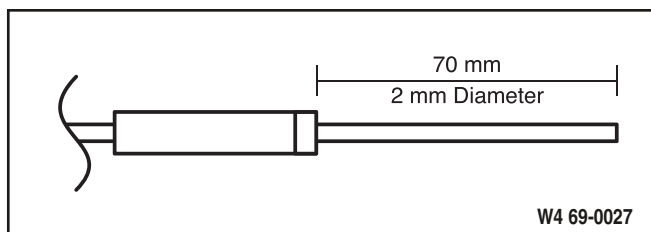
Order # Product

W4 69-0026	Oxygen Meter with Temperature Compensation and 2 mm Oxygen Electrode (W4 69-0027)
W4 69-0028	Replacement O ₂ Membranes, pkg. of 4
W4 72-1972	Magnetic Mini Stirrer, 110/115V - 50/60 Hz Stir Bar
W4 72-1973	Magnetic Mini Stirrer, 220/240V - 50/60 Hz Stir Bar
W4 72-1922	Electrode Holder and Stand

2 mm Oxygen Electrode

Specifications

Cable and Connector	3.5 mm x 6 ft (D x L)
Handle	6.4 x 50 mm (D x L)
Tip	Stainless steel, 2 x 70 mm (D x L) with flat sensing tip



Order # Product

W4 69-0027	Oxygen Electrode, 2 mm
W4 69-0028	Replacement O ₂ Membranes, pkg. of 4

Oxystat 1000

Oxystat System for Oxygen Consumption Measurements



- Unique open system with 'feedback' for measuring oxygen consumption of cardiomyocytes, hepatocytes, and endothelial cells
- Measures as low as 0.1 mmHg
- Two operating modes possible:
 - Closed system oxygen consumption calculated from pO_2 reduction
 - Open system (measurement at constant pO_2) controlled addition of solution with known pO_2
- Electrical stimulation capabilities
- Fitting for fiber optics for easy Ca^{++} concentration or redox potential

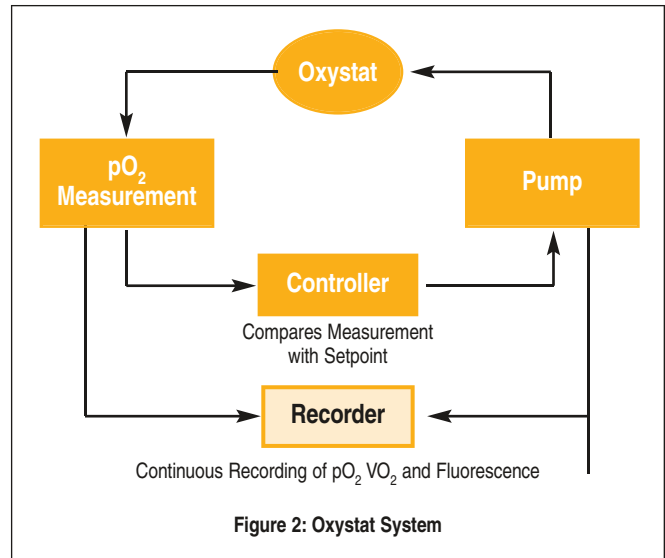
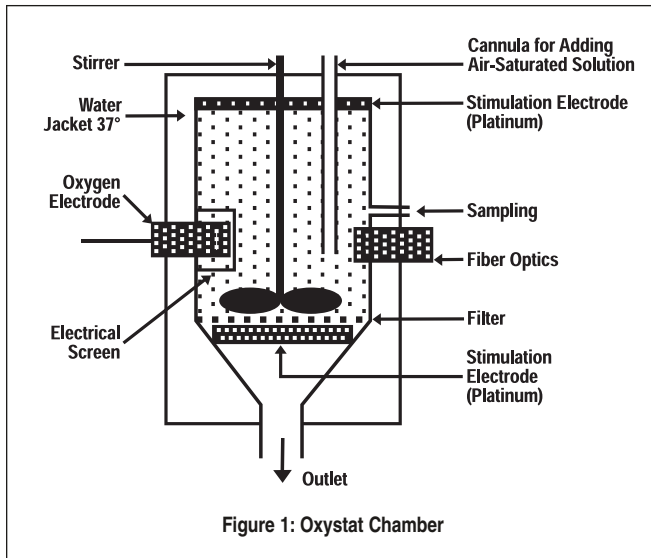
Application

The oxygen consumption VO_2 of small cell assemblies (e.g. papillary muscle) or of isolated cells has usually in the past been calculated from the reduction in the oxygen partial pressure (pO_2) in a 'closed system'. By contrast, the HSE-HA Oxystat operates as an 'open system with feedback'. The pO_2 (as the controlled variable) is maintained constant by the addition of solution with known pO_2 . VO_2 can be calculated from the volume added and the pO_2 . It is an important advantage of the method that the pO_2 is maintained virtually constant during the experiment. In this way the oxygen consumption can be measured under steady-state conditions at accurately defined pO_2 values, while at the same time also measuring metabolic parameters.



Oxystat 1000

Oxystat System for Oxygen Consumption Measurements (continued)



Oxystat System Components

The Oxystat 1000 System includes the following:

- **Oxystat Incubation Chamber with Stirrer**
- **Power Supply for HSE-HA Stirrers**
- **pO₂ Electrode**
- **Model 719 Control Unit with Amplifier and Pump**
- **Stimulator**
- **Thermocirculator**

All components must be purchased separately. In addition, a chart recorder or data acquisition system will permit recording of data for subsequent analysis.

The Oxystat chamber is an incubation chamber with a volume of 10 ml (Figure 1). Mechanical damage to cells during stirring of cell suspensions is an important disadvantage of other systems; as such, special attention has been paid to achieve a very gentle stirring action. Cells are introduced and the chamber filled with medium so as to be free from air bubbles (the venting cannula is used to remove air bubbles from the system). The pO₂ electrode measures the fall in chamber pO₂ due to the oxygen consumed by the cells. Since pO₂ measurement is significantly affected by temperature, the chamber is provided with thermostating.

Operation of the Oxystat

The HSE-HA Oxystat can operate similar to conventional setups as a 'closed system'. The oxygen consumption is calculated from the slope of the recorded pO₂ reduction. Since the chamber is very well screened against oxygen diffusion it is possible to measure pO₂ as low as 0.1 mm Hg. The new application, however, of the Oxystat is however an 'open system' with controlled addition of oxygen through the solution such that O₂ consumption is measured at constant pO₂.

The operation of the Oxystat as an open system is indicated in Fig. 2. The pO₂ signal is examined by the controller; if it differs from the preset value a pump is operated to introduce oxygen-rich solution into the chamber. This raises the pO₂ in the chamber back to the set value and the pump is then stopped again. As a result a flow equilibrium is established through which, despite the oxygen consumption of the incubated cells, the

chamber pO₂ is maintained close to the set value ($\pm 5\%$). The volume in the chamber is maintained constant since the additional volume flows away through an outlet filter. The volume introduced into the Oxystat to maintain the set pO₂ is used to calculate the oxygen consumption of the cells. A cannula permits withdrawal of samples for biochemical analysis without interfering with the measurement of oxygen consumption. As an option there is provision for fitting a fiber optic into the chamber for simultaneous measurement of additional parameters such as intracellular Ca⁺⁺ concentration or redox potential. Two platinum mesh fittings inside the chamber can be used for electrical stimulation of muscle cells to experimentally increase the O₂-consumption. A separate stimulator, see below, is required for this application.

Oxystat Measuring System Model 719

This system includes the Oxystat control unit and the pump. It consists of a titrator connected to the pO₂ meter. The volume is displayed and can be recorded.

Square Wave Stimulator G-270

It has been developed for the stimulation of isolated cardiomyocytes in suspension. The main specifications are:

- Output voltage 50 to 250 V
- Maximum output current 7 A
- Square wave biphasic stimulation pattern
- Stimulation width 10 to 255 μ sec
- Stimulation frequency 0.1 to 20.0 Hz

Oxystat 1000

Oxystat System for Oxygen Consumption Measurements (continued)

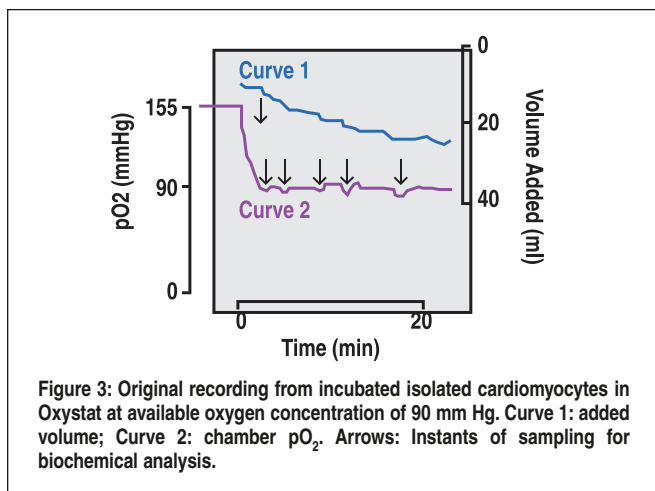


Figure 3: Original recording from incubated isolated cardiomyocytes in Oxystat at available oxygen concentration of 90 mm Hg. Curve 1: added volume; Curve 2: chamber pO₂. Arrows: Instants of sampling for biochemical analysis.

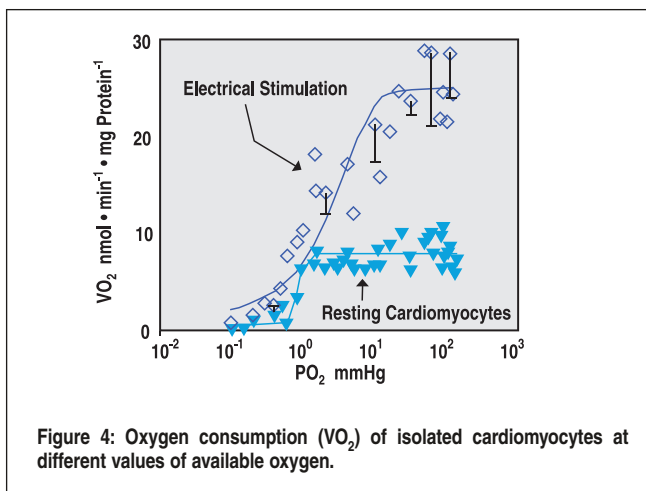


Figure 4: Oxygen consumption (VO₂) of isolated cardiomyocytes at different values of available oxygen.

Typical Recording

Fig. 3 shows an original recording. Isolated cardiomyocytes were incubated at a pO₂ of 90 mm Hg and seven samples were withdrawn consecutively for biochemical analysis. Curve 2 is the record of the pO₂ electrode. The electrode was calibrated with aerated solution (155 mm Hg). After the cells were added, the pO₂ in the chamber drops steeply. When the pO₂ falls below 90 mm Hg the controller starts the pump and aerated solution is added (curve 1) until the pO₂ has returned to its set value. The pump is operated more or less frequently depending on the O₂ consumption of the cells. From the solution volume added in unit time, i.e. the slope of curve 1, it is possible to calculate the oxygen consumption of the isolated cardiomyocytes. After taking the samples (0.8 ml each, arrows) the total quantity of cells in the chamber is reduced and less solution is required in order to maintain the chamber pO₂ at 90 mm Hg. The slope of curve 1 is correspondingly reduced.

Typical Application

The relationship between available oxygen and oxygen consumption of isolated cardiomyocytes has been investigated under different forms of stimulation (Fig. 4). Resting cardiomyocytes (triangles) have a constant oxygen consumption over a wide pO₂ range (1 to 120 mm Hg). It is only below a so-called 'critical pO₂', here at 1 mm Hg, that the oxygen consumption decreases with decreasing available oxygen. Electrical stimulation of the cells at a frequency of 9 Hz produces a 3-fold increase in oxygen consumption (rhombus). Here again the oxygen consumption remains constant over a wide pO₂ range. The critical pO₂ is raised to 10 mm Hg. Below this pO₂ the oxygen consumption decreases with decreasing available oxygen. Using the Oxystat system it could thus be shown that stimulation not only produces an increase in oxygen consumption but also that the critical oxygen value, below which the cells are in oxygen deficit, is displaced towards higher partial O₂ pressures.

References:

1) Stumpe T. and Schrader J.: Phosphorylation potential, adenosine formation, and critical PO₂ in stimulated rat cardiomyocytes, *Am.J.Physiol.* 273, H756-H766, 1997

Oxystat System

For a complete Oxystat System, please order one each of the following:

W4 73-0117, W4 73-0118 or W4 73-0119, W4 73-0120, W4 73-0122, W4 73-0124, W4 50-1932 or W4 50-1940

Order # Product

W4 73-0117	Oxystat Chamber, Thermostated, Volume 10 ml, with Built-In Stirrer, Requires W4 73-0118 or W4 73-0119 Power Supply for Stirrer
W4 73-0118	Power Supply for Stirrer with Adjustable Voltage, 115 VAC, 60 Hz
W4 73-0119	Power Supply for Stirrer with Adjustable Voltage, 230 VAC, 50 Hz
W4 73-0120	PO ₂ Electrode Type 2000-100
W4 73-0122	Oxystat Measuring System Controller Model 719, Includes Controller and to Connect pO ₂ Electrode; with Recording Outputs for pO ₂ , pO ₂ Drift and Volume, 115/230 VAC, 60/50 Hz
W4 73-0124	Square Wave Stimulator G270, for Biphasic Stimulation, 115/230 VAC, 60/50 Hz
W4 50-1932	Harvard Apparatus Thermocirculator, 115 VAC, 60 Hz
W4 50-1940	Harvard Apparatus Thermocirculator, 230 VAC, 50 Hz

Optional Accessories

W4 72-2987	2-Channel Flatbed Recorder, Economy Version, 250 mm Chart Width
W4 73-1523	Plugsys Minicase
W4 73-0210	OPPM Oxygen Partial Pressure Amplifier Module

929 and 782

Dissolved Oxygen Measurement and Respirometry System

Precision Dissolved Oxygen Measurement and Respirometry

Strathkelvin Instruments dissolved oxygen respirometry systems are based on ultra precise microcathode oxygen electrodes. The oxygen meters and interfaces are supplied with dedicated respirometry software. A choice of respirometer cells, with volumes from 50 microlitres to 3 ml, are available to meet most biomedical research applications.



CE



CE

6-Channel Oxygen Meter with Software, Model 929

- For closed chamber respirometry
- Flow respirometry
- Dissolved oxygen monitoring

The 929 is a complete system for replicate measurements of dissolved oxygen, together with data recording and analysis by computer. Use of this system will result in considerable time saving in both respiration experiments and in dissolved oxygen monitoring situations. The system is comprised of a microprocessor-based interface which accepts up to six 1302 microcathode oxygen electrodes, and dedicated Windows software. All operations are controlled from the computer screen, and output of recordings in chart recorder format to a printer is available.

The interface provides the polarizing voltage to the electrodes, amplifies the low-level signals, makes the A/D conversion, and feeds the resulting data stream to the computer. The system is a "virtual instrument" therefore there are no front panel controls. All operations are controlled by the computer. An illuminated front panel display provides information on the activity of the interface and displays readings from the electrodes when they are in use.

The 929 Oxygen System may be used with the Model RC 650 6-electrode Respirometer, see page 381. Details of the software are shown on the facing page. Software included (Not Windows 7 compatible).

Specifications

Resolution with 1302 Electrode	0.1% of air-saturated water
Polarizing Voltage	400-900 mV (anode connected to ground)
Power Requirements	100 to 250 VAC, 50 or 60 Hz
Dimensions	275 x 258 x 117 mm (11 x 11 x 4.5 in)

Order #	Model	Product
W4 69-3002	929	6-Channel Oxygen System

2-Channel Oxygen Meter with Software, Model 782

- Operates with 1 or 2 oxygen electrodes
- Interfaces to respirometry/monitoring software, or use as stand alone meter
- Use any unit of PO₂ or oxygen concentration
- Closed cell, flow-through respirometry and O₂ monitoring software included

This versatile new Oxygen Meter acts as both a stand alone oxygen meter, (displaying and storing oxygen values), or as an interface to respirometry or monitoring software running on a PC. It accepts inputs from either one or two Strathkelvin 1302 microcathode oxygen electrodes, and shows the oxygen values on a large liquid crystal display. The display will show units of either PO₂ (mm Hg; torr; kPa) or concentration (μmol/l; μg/l; mg/l; μl/ml; ml/l; ppm; or % saturation). When connected to the supplied software it can be used for either closed cell respirometry (using the MT200 mitocell; RC300 or RC350 respiration cell) or for flow respirometry (using the FC100 flowcell or MC100 microcell). Alternatively, the software can be used to monitor dissolved oxygen (as in isolated organ preparations). Details of the software are shown on the facing page. Not Windows 7 compatible.

Specifications

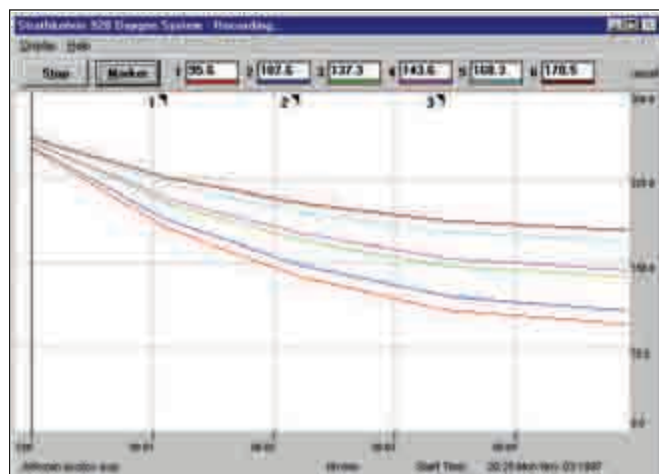
Resolution	0.01% of full scale
Repeatability	0.01%
Logging Capacity	2000 readings
Computer Interface	USB1
Power Requirements	5V, 1A from external plugtop power supply, 100-230 VAC, 47-63 Hz
Dimensions	185 x 135 x 105 mm (7.25 x 5.25 x 4.125 in)

Order #	Model	Product
W4 69-3001	782	2-Channel Oxygen Meter

Respirometry Software

Dissolved Oxygen Measurement and Respirometry System (continued)

respirometry



The screenshot shows a report window titled 'Alfozan Cytotoxicity'. It includes fields for Date (Wed Jul 19 2000), Time (18:21:03), Temp (37.0°C), and Comments (Effects of 1, 2 & 4 ppm Alfozan, added cumulatively, on DOES2502). The file name is C:\bio\res\alfozan.dat. Below this is a table with columns for Biomass (µg) and Vol (µl) for four chambers (A, B, C, D). At the bottom, there is a table with columns for Start (Alfozan (µl)), Length (Alfozan (µl)), Chamber A Norm Rate (µmol/l/hg), Chamber B Norm Rate (µmol/l/hg), and Chamber C Norm Rate (µmol/l/hg).

	Biomass (µg)	Vol (µl)
Chamber A	0.79	2.1
Chamber B	0.93	2.1
Chamber C	0.81	2.1
Chamber D	0.88	2.1

	Start (Alfozan (µl))	Length (Alfozan (µl))	Chamber A Norm Rate (µmol/l/hg)	Chamber B Norm Rate (µmol/l/hg)	Chamber C Norm Rate (µmol/l/hg)
1 No testant	0.0041	0.02.06	27.837	26.251	
2 1ppm Alfozan	0.0212	0.02.02	22.969	21.811	
3 2ppm Alfozan	0.0535	0.02.31	18.181	15.79	

The software used in the 782 meter and the 929 system is functionally similar. The main difference is that the 929 displays up to 6 traces, while the 782 has a maximum of two.

The program has been written so that it is extremely user-friendly and quick to learn. It can be used for closed cell respirometry (with the MT200, RC300, RC350 or RC650), or flow respirometry (using the FC100 or MC100) or for monitoring dissolved oxygen (using the FC 100 or MC100). When used for respirometry experiments, it follows the familiar logical sequences of operations, from electrode calibration to recording and analysis. The program follows a sequence of 3 main stages: Setting up, Recording, and Analysis.

Setup

The setup screen is used for entering all of the details which the computer needs in order to record in the correct units, and to express the respiration rate, normalized to biomass units if required, in the desired units. All experimental details entered here are transferred through to the final calculated results report page. During setup, the cell volumes (for closed cell) and flow rate, electrode positioning (for flow respirometry), temperature of the experiment, scrolling speed of the traces during recording, and the instruction to print the recording screen to printer (if hard copy is required) are all entered. Many of these will not change from one experiment to the next, and it is only necessary to enter changes.

Recording

Clicking the 'Start' button initiates the recording process, and traces then scroll across the screen. If substrates, inhibitors or other solutions require to be added during the run, the position where this occurs can be recorded with a flag, and the nature of the addition is recorded on a drop down menu. At the termination of the experiment, the data are saved to a data file, and may be analyzed straight away if required.

Analysis

The data file, recorded traces, and event marker flags are recalled to the screen. If the recording has exceeded one screen width, it can be contracted to fit the screen, if required. Alternatively it is possible to scroll along long recording traces. Selector lines may be dragged to enclose specific parts of the trace. Thus if the traces show both control respiration

and changed respiration after adding a solution, the selector lines would be dragged to the control rate first and then to the changed rates.

In each case respiration rates (normalized if so designated) are calculated automatically by clicking the 'Calculate' button. The calculated rates are tabulated, together with the experimental details entered during Setup, on the report page. The results may be exported to a spreadsheet, word processing or statistics package. The Analysis screen and the Report page may be printed, if required.

When the software is used for dissolved oxygen monitoring, the Analysis screen which displays the recorded traces and the oxygen values at flagged points or at set times can be transferred to the Results and report page.

The program requires a computer with a minimum specification of: Pentium processor, 1 free serial port, 64 Mb RAM, Windows 95 or later (excluding Windows 7) and 4 MB hard disk space. A comprehensive Instruction Manual is supplied, which will be particularly valuable to anyone who is not familiar with respirometric work.

This software is supplied with the 6-Channel Oxygen System Model 929 and the 1-2 Channel Oxygen Meter. It is not available separately.

1302 and MT200/MT200A

Dissolved Oxygen Measurement and Respirometry System (continued)



Microcathode Oxygen Electrode

- May be used with or without stirring
- High output stability
- Very low rate of oxygen consumption
- Compatible with all Strathkelvin accessories

The 1302 is a Clark-type polarographic electrode with a 22 micron diameter platinum cathode and silver/silver chloride anode connected by a buffered potassium chloride electrolyte solution. In the normal configuration the cathode is covered with a relatively low permeability polypropylene membrane to allow the electrode to be used in unstirred solutions or where minimal stirring is required. This membrane gives a relatively slow response time. For rapidly respiring enzyme preparations, an electrode with a thin FEP membrane (W4 69-3004) is used. Rapid stirring is necessary. Electrodes are not temperature compensated and require thermally controlled environments to within 0.1°C. Electrodes are specifically designed for use in the MT-200 or MT200A. Electrode service kits provide all tools and parts, including membranes, needed to repair the electrodes. We recommend the purchase of an electrode kit with the purchase of the electrode.

Specifications

Response Time at 37°C:	
Polypropylene Membranes	18 sec for 90% change
FEP Membranes	6 sec for 90% change
Oxygen Consumption (Polypropylene Membranes)	0.5 to 3x10 ⁻¹⁰ mg O ₂ /min
Temperature Coefficient	2% per °C

Order #	Model	Product
W4 69-3006	SI130	1302 Oxygen Electrode with Polypropylene membrane
W4 69-3004	SI132	1302 Oxygen Electrode with FEP membrane
W4 69-3007	SI020	Polypropylene electrode service kit
W4 69-3005	SI021	FEP electrode service kit

Accessories and Replacement Parts

W4 69-3008	SI030	Electrolyte
W4 69-3014	SI045	Replacement polypropylene electrode jackets, pk 6
W4 69-3011	SI035	Replacement FEP electrode jacket, no membrane
W4 69-3010	SI025	FEP membranes, pk 15



Mitocell Miniature Respirometer

- Miniature respirometer for mitochondria and cell suspensions
- Integral magnetic stirrer
- Glass chamber with volumes of 50/100 µl (MT200) or 0.3/0.5/1.0 ml (MT200A), and good visibility of contents
- Transparent polycarbonate plunger
- Substrate and inhibitors may be injected directly into chamber

This MT200 and MT200A Mitocell Miniature Respirometer has a chamber volume of only 50 µl and was introduced for measurements on mitochondria isolated from biopsy samples. It can be used in any situation where sample size is limited. The base section contains an integral solid state, fixed speed magnetic stirrer. The 1302 microcathode electrode (W4 69-3006) is inserted from beneath the unit, and its projecting tip forms the base of the respirometer chamber. The glass chamber unit is surrounded by a water jacket through which constant temperature water is circulated. The respiration cell has a polycarbonate plunger with a central capillary through which solutions may be added during the course of a respiration run. Stainless steel magnetic spinbars are supplied together with a special 1 µl syringe supplied with MT200 and a 5 µl syringe with the MT200A for solution additions.

Order #	Model	Product
W4 69-3033	MT200	Mitocell Miniature Respirometer, 50/100 µl
W4 72-6186	MT200A	Mitocell Miniature Respirometer, 0.3/0.5/1.0 ml
W4 72-6187	SK205	Replacement Glass Top with Plunger for MT200
W4 72-6188	SK206	Replacement Glass Top with Plunger for MT200A
W4 98-2200	SK204	Stirbars for MT200, pk 6
W4 64-0421	MAG-22	Stirbars for MT-200A, pk 6

RC 650

Dissolved Oxygen Measurement and Respirometry System (continued)

respirometry



6 Cell Respirometer

- Ability to carry out replicate experiments, utilizing the advanced recording and analysis features of the Strathkelvin 928 system
- Integral unit complete with magnetic stirrer
- Good visibility of cell contents
- Variable cell volume

Designed for use with the Model 928 six channel oxygen meter. This respirometer is ideal for replicate respiration measurements of cell and microbial suspensions, as well as mitochondrial or enzyme preparations.

The respirometer consists of a sealed water bath containing six respirometer cells positioned above a six position magnetic stirrer. Electrode holders, each with a hole in its tip through which the membrane of the 1302 electrode protrudes, makes a sliding fit into the cells. A small slot runs the complete length of the holder and allows respiratory inhibitors or other solutions to be injected directly into the cell using an included fine bore needle.

The volume of individual cells may be set between 1 and 3 ml by rotating the knurled collar of the associated holder. The rear of the bath assembly contains 6 parking cells which are used to hold the electrode holders at a constant temperature while exchanging the contents of respiratory cells. Cells are sealed into the water bath by o-rings for easy removal and cleaning.

Specifications

Diameter of Cells	16 mm
Volume of Cells	1 to 3 ml (adjustable)
Cell	Precision bore glass
Electrode Holder	Black acetal, with peek tip
Bath	Clear and black acrylic
Magnetic Stirrer	6-position; 12 VDC from external plugtop power supply, 100-230 V, 47-63 Hz

Order #	Model	Product
W4 69-3021	RC 650	6 Electrode Respirometer*
W4 69-3006	SI130	1302 Electrode with polypropylene membrane
W4 69-3004	SI134	1302 Electrode with FEP membrane
W4 69-3007	SI020	Polypropylene Electrode Service Kit
W4 69-3005	SI021	FEP Electrode Service Kit

* Oxygen Electrode Service Kit should be ordered with Respirometer

RC 300/350 and MC 100

Dissolved Oxygen Measurement and Respirometry System (continued)

respirometry



Respiration Cells RC 300 and RC 350

- Small sample volume
- Good visibility of cell contents

These respiration cells are for small volume measurements of oxygen uptake rate by microbial suspensions, cell suspensions, mitochondria or enzyme preparations. The electrode holder (supplied with the cell) slides into one of two glass tubes fused into the glass water jacket. The second tube is used to park the electrode holder when changing solutions. A fine slot (1 x 1 mm) in the side of the holder allows air to escape when the holder is inserted into the cell. It may also be used to introduce other solutions during the course of a respiration run and a fine bore needle with luer fitting (included). A PTFE covered magnetic spinbar is provided and the cell should be located on a magnetic stirrer unit (not provided). For fast reactions, it is recommended that electrodes with FEP membranes (W4 69-3004) be used (electrodes sold separately).

Specifications

Model	RC 300	RC 350
Cell Diameter	13 mm	16 mm
Cell Volume	0.3 to 1.0 ml	1.0 to 3.0 ml
Cell	Glass	
Electrode Holder	Black acetal	

Order #	Model	Product
W4 69-3018	RC 300	Respiration Cell
W4 69-3019	RC 350	Respiration Cell
W4 69-3027	SK300	Replacement Glass for W4 69-3018
W4 69-3028	SK350	Replacement Glass for W4 69-3019
W4 69-3032	RC355	Spinal Needles for use with W4 69-3018 & W4 69-3019, pkg. of 3
W4 69-3006	SI130	1302 Oxygen Electrode with Polypropylene membrane
W4 69-3004	SI132	1302 Oxygen Electrode with FEP membrane



MicroCell Model MC 100

- For pO₂ measurement of blood or other fluids, or for micro flowcell use
- Small Sample Volume
- Flow through or spot measurement
- Exceptional visibility
- Easy access for cleaning

The all-glass sample chamber has a capacity of approximately 70µl. Samples are injected into the chamber through a 1mm stainless steel tube fitted with a fine PVC needle-locating collar. Alternatively, the cell can be used as a micro flowcell by connecting the outflow from a respiring preparation. The sample leaves the chamber through a glass Luer fitting to which a small bore flexible drainage tube can be connected. The sample chamber is completely surrounded by water circulated through the glass water jacket from a constant temperature bath. This provides good temperature regulation while providing excellent visibility of the contents of the chamber. The water jacket screws into an acetal base section and can be easily removed for cleaning. The microcathode electrode fits into the central electrode holder and the membrane at its tip forms the floor of the sample chamber. Electrode sold separately.

Specifications

Sample Chamber	70 µl
Overall Height	106 mm
Jacket and Cell	Glass
Base Section	Black acetal

Order #	Model	Product
W4 69-3016	MC 100	MicroCell Model

FC 100 and EH 100

Dissolved Oxygen Measurement and Respirometry System (continued)



Flow Cell FC 100

- For continuous in-line oxygen monitoring or for connection to flow-through respirometer chamber
- Easily disassembled for cleaning
- Good visibility of flowline

The acrylic chamber of the flowcell screws onto the electrode holder. Only the tip of the electrode projects into the water flow. The inlet and outlet tubes are made from stainless steel. The electrode holder is fitted with a collar for attachment to a vertical or horizontal (¼ to ¾ inch) diameter laboratory rod to enable the flowcell to be immersed below the surface of the constant temperature bath containing the respirometer chamber. Electrode sold separately.

Specifications

Material:	
Electrode Holder	Black acetal
Collar	Black acetal
Chamber	Clear acrylic
Inlet/Outlet	6 mm OD and 3 mm ID stainless steel

Order #	Model	Product
W4 69-3023	FC 100	Flow Cell
W4 69-3006	SI130	1302 Oxygen Electrode with Polypropylene membrane
W4 69-3004	SI132	1302 Oxygen Electrode with FEP membrane



General Electrode Holder EH 100

- For use with any of your own custom respiration chamber designs

The 1302 electrode should only be used with an electrode holder to prevent ground-leak damage. The EH100 electrode holder is a black acetal tube designed to allow a user to place the electrode into any self-designed respiration chamber. The holder positions the electrode so that its tip projects slightly from the end. An acrylic collar containing an o-ring on its inside surface is provided and this collar can be cemented over any 13mm hole to facilitate placement of the electrode holder in the respiration chamber.

Specifications

	Electrode Holder	Acrylic Collar
Dimensions	13 x 85 mm (D x L)	26 x 10 mm (D x L)
Holder Material	Black acetal	Clear acetal

Order #	Model	Product
W4 69-3024	EH 100	Electrode Holder
W4 69-3006	SI130	1302 Oxygen Electrode with Polypropylene membrane
W4 69-3004	SI132	1302 Oxygen Electrode with FEP membrane

Microminiature pH Electrodes

Model pHamp pH peramplifier

The pH preamplifier is a compact unity gain preamplifier designed to convert the high impedance mV signal of a pH electrode to a low impedance signal which can travel up to 1,000 feet over coaxial cable. Recommended for all applications using the pH electrodes below.

This rugged preamplifier is encapsulated in an epoxy filled stainless steel enclosure and uses BNC input and output connections. Powered from a lithium battery. Expected life is 5-years minimum.

Order #	Product
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W4 69-1625	pH pre-amplifier, battery powered
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This series of **micro pH, O₂ and CO₂ electrodes** has been specifically designed for use in various area of bioscience research. Their microminiature design and small sensing area allows them to be used for small area measurements. This series of pH electrodes have similar response characteristics to standard size, glass pH electrodes making them compatible with any standard pH meter. The pH series of electrodes come in a variety of configurations to fit every need.

Combination pH Electrode for Micro Wells

This a miniature combination pH/reference electrode has been designed to fit small perfusion chambers without effecting fluid exchange rates. It does not require an external reference electrode and the reference solution can be replaced. The electrode is stored wet.

Specifications IC-501

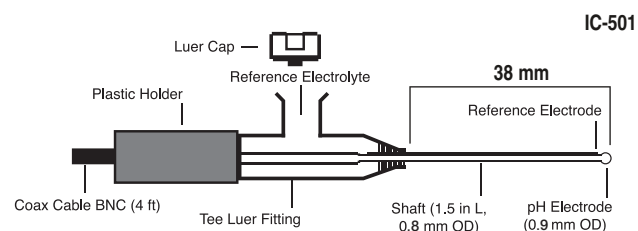
Response Time	~10 sec
Slope	55 mV per pH, range of 1 to 14
Impedance	200 MΩ
Stability	0.05 pH per day
Dimensions, L x D	38.1 x 0.75 mm (1.5 x 0.03 in)

Order #	Product
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W4 69-0494	Combination pH Electrode for Micro Wells, Model IC-501
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W4 69-1625	pH pre-amplifier, battery powered
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Smallest Sample Volume is 10 to 20 µl



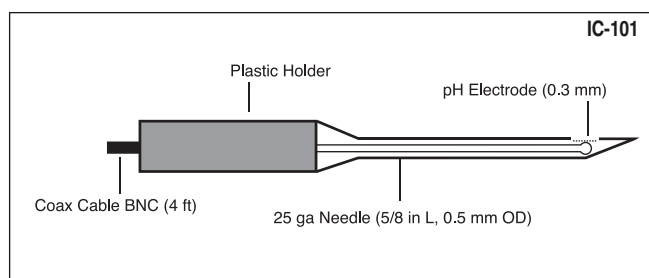
Microminiature pH Electrodes

Single pH Electrode in 25 Gauge Needle

This is a microminiature pH electrode mounted in the lumen of a fine hypodermic needle. This configuration allows for easy penetration and insertion of the electrode into all types of tissue for on-line/real time monitoring of pH. This pH electrode does not contain an external reference and an external reference electrode such as the W4 69-0490 or similar must be used. The electrode is stored dry.

Specifications IC-101

Response Time	~15 sec
Slope	55 mV per pH, range of 1 to 14
Impedance	1,500 MΩ
Stability	0.05 pH per day



Order # Product

W4 69-0491 Single pH Electrode in 25 ga Needle, Model IC-101

W4 69-0490 Flexible Reference Electrode, see page 373

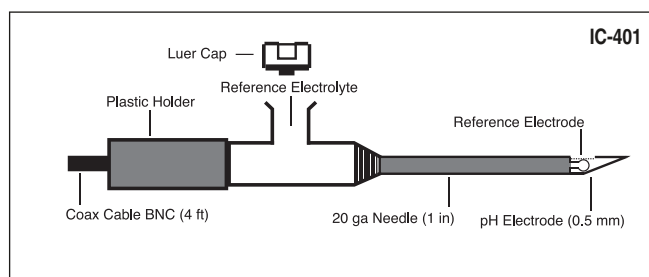
W4 69-1625 pH pre-amplifier, battery powered

Combination pH Electrode in 20 Gauge Needle

This is a miniature combination pH/reference electrode that is mounted in a 20 gauge stainless steel tube. The stainless steel tube provides protection to damage of the internal miniature glass pH sensor. It does not require an external reference electrode. The reference solution can be replaced. The electrode is stored wet. Tip length is 1.8 mm.

Specifications IC-401

Response Time	~10 sec
Slope	55 mV per pH, range of 1 to 14
Impedance	200 MΩ
Stability	0.05 pH per day
Dimensions, L x D	25.4 x 0.9 mm (1 x 0.035 in)



Order # Product

W4 69-0493 Combination pH Electrode in 20 ga Needle, Model IC-401

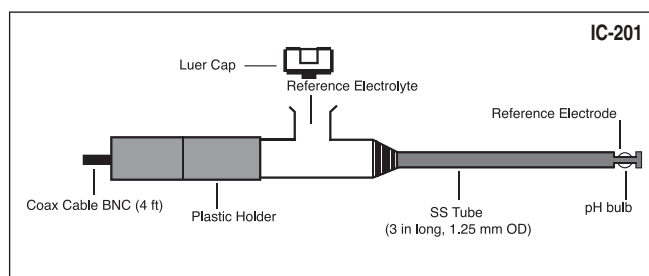
W4 69-1625 pH pre-amplifier, battery powered

Combination pH Electrode in 18 Gauge SS Tube

This miniature combination pH/reference electrode is mounted in an 18 gauge stainless steel tube. The stainless steel tube provides protection to damage of the internal miniature glass pH sensor. It does not require an external reference electrode. The reference solution can be replaced. The electrode is stored wet. Tip length is 1.5 mm.

Specifications IC-201

Response Time	~10 sec
Slope	55 mV per pH, range of 1 to 14
Impedance	200 MΩ
Stability	0.05 pH per day
Dimensions, L x D	76 x 1.25 mm (3 x 0.005 in)



Order # Product

W4 69-0492 Combination pH Electrode in 18 ga SS Tube, Model IC-201

W4 69-1625 pH pre-amplifier, battery powered

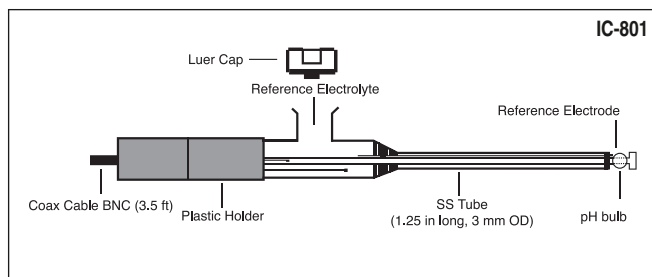
Microminiature pH Electrodes (continued)

Combination pH Electrode in 11 Gauge SS Tube

This miniature combination pH/reference electrode is mounted in an 11 gauge stainless steel tube. The stainless steel tube provides protection to damage of the internal miniature glass pH sensor. It does not require an external reference electrode. The reference solution can be replaced. The electrode is stored wet.

Specifications IC-801

Response Time	~10 sec
Slope	55 mV per pH, range of 1 to 14
Impedance	200 MΩ
Stability	0.05 pH per day
Dimensions, L x D	31.7 cm x 3 mm (1.25 x 0.1 in)



Order # Product

W4 69-0497 Combination pH Electrode in 11 ga SS Tube, Model IC-801

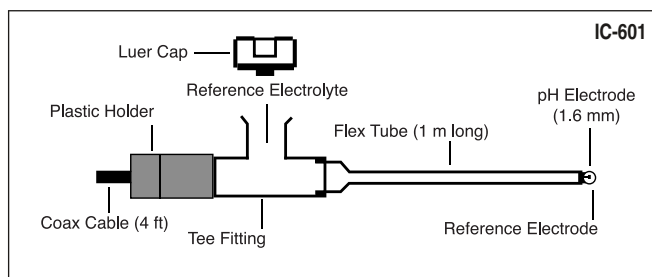
W4 69-1625 pH pre-amplifier, battery powered

Combination Gastroesophageal pH Electrode

This miniature combination pH/reference electrode has a long (3 foot) flexible tube to fit into the esophagus. It does not require an external reference electrode. The reference solution can be replaced. The electrode is stored wet.

Specifications IC-601

Response Time	~10 sec
Slope	55 mV per pH, range of 1 to 14
Impedance	200 MΩ
Stability	0.05 pH per day
Electrode OD	1.6 mm
Dimensions, L x D	91.4 cm x 1.6 mm (3 ft x 0.06 in)



Order # Product

W4 69-0495 Combination Gastroesophageal pH Electrode, Model IC-601

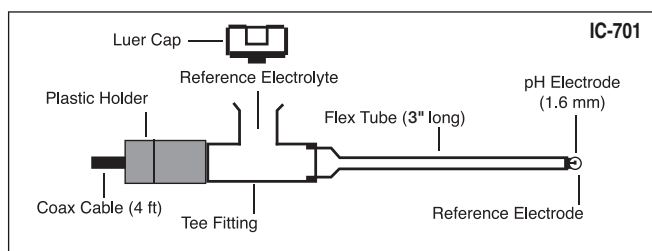
W4 69-1625 pH pre-amplifier, battery powered

Flexible Combination pH Electrode for Free Flap Surgery

This miniature combination pH/reference electrode has been specifically designed to be used in free flap surgery. It does not require an external reference electrode. The reference solution can be replaced. The electrode is stored wet.

Specifications IC-701

Response Time	~10 sec
Slope	55 mV per pH, range of 1 to 14
Impedance	200 MΩ
Stability	0.05 pH per day
Dimensions, L x D	91.4 x 1.6 mm (3 x 0.06 in)



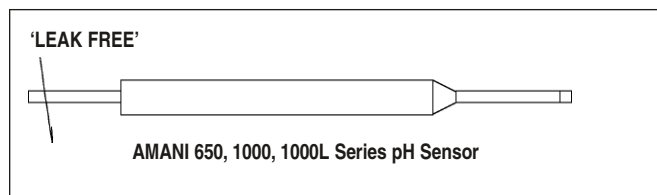
Order # Product

W4 69-0496 Combination pH Electrode for Free Flap Surgery Battery Operated Meter 10⁹Ω Input Impedance, Model IC-701

W4 69-1625 pH pre-amplifier, battery powered

AMANI

AMANI 'LEAK FREE' Microcombination pH Electrodes



The AMANI 'Leak Free' series of non-glass, micro pH electrodes are the latest development in our combination (built in reference) pH electrode line. The new technologies used in these electrodes provide superior sensitivity and stability. The 'Leak Free' non-porous reference junction eliminates the problems of clogged junction and adsorption of proteins and surfactants. They also have high resistance to chemical including hydrofluoric acid solutions.

With tip diameters starting as low as 650 μm , they are one of the smallest combination pH electrodes on the market today. Custom configurations of the AMANI series of pH combination electrodes are also available, please contact Technical Sales for further details.

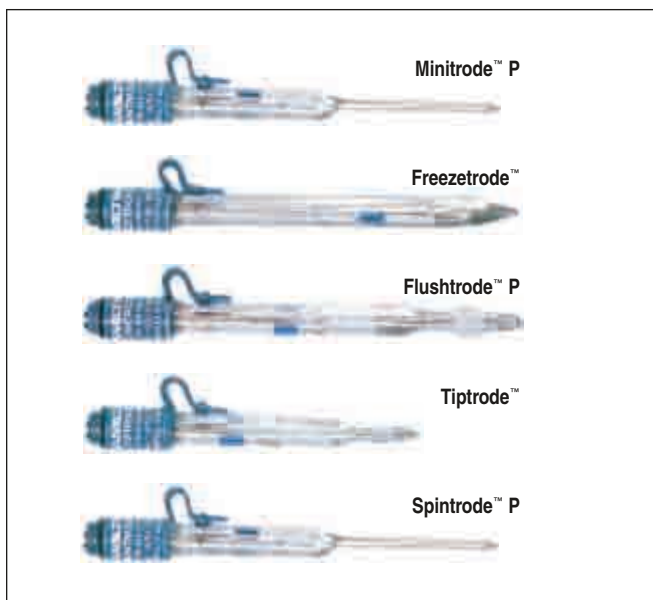
- Integrated 'LEAK-FREE' non-porous reference junction eliminates problems of clogged junction and adsorption of proteins and surfactants
- All plastic construction, unbreakable and tough — no glass!
- Can be used with any pH meter with BNC connector
- 'Zero' depth of immersion, just touch sample to flat tip
- Superior chemical resistant — can even be used in hydrofluoric acid solutions
- Tip diameter as small as 650 μm including reference electrode
- Standard Nernstian behavior
- Flexible version is available for use in restricted areas such as microscope stage
- Long working life
- Low cost
- Maintenance-free, dry or wet storage, no filling solutions needed

Specifications

Model	AMANI-650	AMANI-1000	AMANI-1000L
Tip Diameter	650 μm	1000 μm	1000 μm
Tip Length	20 mm (0.8 in)	20 mm (0.8 in)	75 mm (3 in)
Construction	All Plastic	All Plastic	All Plastic
Depth of Immersion	< 100 μm	< 100 μm	< 100 μm
Min. Sample Volume	250 nL	500 nL	500 nL
Response Time	< 3 sec, 90% response	< 3 sec, 90% response	< 3 sec, 90% response
Temperature Range	0° to 100°C	0° to 100°C	0° to 100°C
Internal Reference	Ag/AgCl	Ag/AgCl	Ag/AgCl
Slope	Nernstian	Nernstian	Nernstian
pH Range	0 to 14	0 to 14	0 to 14
Storage	Wet or dry	Wet or dry	Wet or dry
Connector	BNC	BNC	BNC
Electrode Holder	4.8 x 75 mm	4.8 x 75 mm	4.5 x 50 mm
OD x Length	(0.19 x 2.9 in)	(0.19 x 2.9 in)	(0.18 x 2 in)
Lead Wire	0.9 m (3 ft)	0.9 m (3 ft)	0.9 m (3 ft)
Order #	W4 69-0020	W4 69-0021	W4 69-0022

pH Electrodes

Protein Resistant pH Electrodes



- Ideal for determining pH in samples that contain protein
- Faster response times than traditional pH electrodes
- More accurate than traditional pH electrodes
- Longer electrode life — more economical
- Five styles available to meet most application needs
- pH range from 2 to 11

Measuring the pH of biological samples containing proteins is difficult. Proteins in solution can combine with silver ions from the electrolyte to clog the pH electrode diaphragm. This leads to long response times, inaccurate pH measurements, and eventually discarded electrodes. These protein resistant electrodes are designed for rapid, accurate, and reproducible pH measurements of protein containing solutions.

Unique to these pH electrodes is the specially formulated Protelyte™ reference electrolyte. Protelyte™ electrolyte prevents the precipitation of proteins on the electrode diaphragm. You get faster, more accurate, reproducible pH measurements of your samples. Select from five specialized electrodes. The best electrode for you depends upon your applications, physical size limitations, and temperature range. Each has a pH range of 2 to 11.

Minitrode™ P

The small size of this sensor makes it ideal for pH measurement of sample in microplates and microcentrifuge tubes. The sensor tip is 3 mm diameter with a usable length of 100 mm (3.9 inches).

Freezetrode™

This sensor is ideal for measuring the pH of samples stored in cold rooms. Select this sensor if your sample is between -20° to +80°C. It has a 12 mm diameter tip.

Flushtrode™ P

If your sample contains between 5 to 85% water, this is the ideal sensor for you. It is good for determining pH of buffer solutions. It has a 12 mm diameter tip.

Tiptrode™

This pH sensor was designed for pH measurements in applications requiring penetration of solid and semi-solid materials including: foods, gelatinous materials, and viscous buffers. It has a 6 mm tip.

Spintrode™ P

Use the SPINTRODE™ to determine the pH of samples in NMR tubes. The 3 mm diameter, 180 mm (7 inch) long sensor allows you to determine the pH without transferring the sample from the NMR tube.

These pH Electrodes are supplied individually and have S7 type connectors. To ensure the most accurate pH measurements, calibrate your electrodes with DURACAL™ Buffer Solutions, see facing page for more information.

Specifications

Order #	Electrode	Length	Outer Diameter	Temp. Range
W4 69-0070	Minitrode™ P	100 mm	3 mm	0° to 60°C
W4 69-0071	Spintrode™ P	180 mm	3 mm	0° to 60°C
W4 69-0072	Freezetrode™	120 mm	12 mm	-20°C to 80°C
W4 69-0073	Flushtrode™ P	120 mm	12 mm	10° to 50°C
W4 69-0074	Tiptrode™	25 mm	6 mm	0° to 80°C

Order # Product

Accessories

W4 69-0075	Protelyte™ Reference Electrolyte Solution, 100 ml
W4 69-0076	Electrode Storage Solution, 500 ml
W4 69-0077	Electrode Connecting Cable, BNC to AS7, 1 m (3.3 ft)
W4 69-0078	Electrode Connecting Cable, DIN to AS7, 1 m (3.3 ft)
W4 69-0079	Electrode Connecting Cable, Metrohm (Lemo) to AS7, Type F, 1 m (3.3 ft)
W4 69-0080	Electrode Connecting Cable, Metrohm (Lemo) to AS7, Type H, 1 m (3.3 ft)
W4 69-0081	Electrode Connecting Cable, Radiometer to AS7, 1 m (3.3 ft)
W4 69-0082	Electrode Connecting Cable, Standard US to AS7, 1 m (3.3 ft)

DURACAL™

pH and Redox Buffers

electrodes

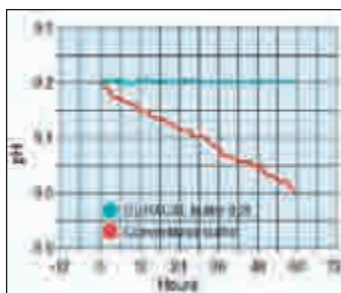


Figure 1

- Stable, guaranteed 5 year buffer lifetime
- Unique time saving CALPAK™ dosing bottle
 - No more searching for suitable containers
 - No more cleaning
 - No more risk of contamination
- No wasted buffer, economical and easy to dispense only the required quantity of buffer for calibration
- Automatic buffer recognition with a majority of pH meters
- Certified, traceable to N.I.S.T.



Step 1. Unscrew cap to access calibration compartment.

Step 2. Squeeze CALPAK™ bottle to force buffer into compartment



Step 3. Insert electrode for calibration.

Step 4. Turn CALPAK™ bottle on its side to dispose of used buffer.

Figure 2: Calibrating Electrodes in the CALPAK™ Dosing Bottle

Accurate, stable buffers are critical for the calibration of pH and redox electrodes to achieve accurate measurements, particularly with modern pH meters incorporating GLP functions for recording electrode performance. DURACAL™ pH and Redox Buffer solutions are the buffers you can trust. They offer you many advantages over traditional buffer solutions: guaranteed five year stability, excellent stability of even pH 9.21 in air, see Figure 1, automatic buffer recognition so you use the correct buffer to calibrate. All of this in a unique time saving, money saving dispensing bottle.

DURACAL Buffers are guaranteed for 5 years from the date of production. During this time they retain a high buffer capacity for fast, stable calibrations. The pH 7.00 buffer is less sensitive to ions while the pH 9.21 buffer provides stability superior to conventional buffers. See Figure 1 for a comparison of DURACAL™ and conventional buffer stability when subjected to prolonged air exposure.

The unique, easy-to-use, CALPAK™ dispensing bottle allow electrode calibration in the buffer bottle without contamination. In 4 easy steps, calibration is complete, see Figure 2. It's that simple! No more searching for a suitable container, no more cleaning, no more risk of contamination, and no more wasted buffer from overfilling a container. The composition of DURACAL™ Buffers has been optimized so the temperature function is similar to that of conventional buffers. This guarantees that the automatic buffer recognition of most pH meters can be used without any problems.

Duracal™ Buffers Specifications

	pH 4.01	pH 7.00	pH 9.21	pH 10.01	Redox +475 mV
pH	±0.02	±0.02	±0.02	±0.02	±5 mV
Solution Color	Red	Green	Blue	Yellow	Yellow
1 Bottle, 500 ml	W4 69-0083	W4 69-0084	W4 69-0085	W4 69-0086	W4 72-7140
Multipack (500 ml x 3)	W4 69-0088	W4 69-0089	W4 69-0090	W4 69-0091	—

Order # Product

W4 69-0092 Buffer Set, One 500 ml Bottle of 4.01, 7.00 and 9.21

W4 72-7141 Buffer Set, One 500 ml Bottle of 4.01, 7.00 and 10.01

Reference Electrodes

Leak-Free Reference Electrodes

The 'LEAK FREE' reference electrodes were developed to eliminate the problems associated with the use of conventional porous junction-based reference electrodes such as clogging, sample contamination, electrolyte loss, changing of ionic strength of the sample, and the difficulties with organic based solvents. They utilize a unique junction that is highly conductive ($< 10 \text{ K } \Omega$) but not porous. There is no solution migrating through the junction in either direction. The reference is totally leak free! The junction is resistant to most commonly used organic solvents. It offers excellent resistance to acetonitrile, DMSO, THF, MEK, acetone, dichloromethane, esters, alcohols, and ketones, hydrofluoric acid or common dilute acids and bases. Unlike conventional reference electrodes, there is no need to store them in concentrated chloride solution. If the electrode is left dry for a long period of time, it should be immersed in water for few hours to recover.

Two sizes of 'leak free' reference electrodes are available, see ordering chart below for details. Other custom configuration of the leak-free reference electrode are available, please consult with Harvard Apparatus Technical Sales Department.

Low-Leakage Reference Electrodes

The low-leakage reference electrodes are for use in applications where contamination would interfere with the application. The electrode junctions are resistant to most commonly used organic solvents. They offer excellent resistance to acetonitrile, DMSO, THF, MEK, acetone, dichloromethane, esters, alcohols, and ketones. Hydrofluoric acid or common dilute acids and bases have no effect on the on these electrodes.

Two low-leakage reference electrodes are available. One is 2 mm (0.08 in) in diameter and the second is 5 mm (0.2 in) in diameter. Other custom configurations of the low-leakage reference electrodes are available, please call the Harvard Apparatus Technical Sales Department.



Specifications

	Low-Leakage Reference Electrodes	Leak-Free Reference Electrodes	
Diameter	5 mm (0.2 in)	1 mm (0.04 in)	2 mm (0.08 in)
Length	130 mm (5.1 in)	100 mm (3.9 in)	65 mm (2.6 in)
Construction	PEEK*	PEEK*	PEEK*
Leakage Rate	5×10^{-12} l/min	0	0
Filling Electrolyte	3 M KCl	3 M KCl	3 M KCl
Electrical Connection	2 mm pin	1 mm gold	1 mm gold plated pin
Junction Resistance	$< 1 \text{ K } \Omega^{\dagger}$	$< 10 \text{ K } \Omega^{\dagger}$	$< 10 \text{ K } \Omega^{\dagger}$
Temperature Range	5° to 80°C	5° to 80°C	5° to 80°C
Storage	3 M KCl	Distilled water	Distilled water
Order #	W4 69-0025	W4 69-0053	W4 69-0023

* Polyether Ketone

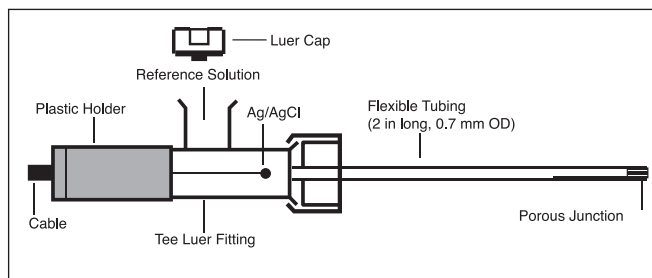
\dagger In 1 M potassium chloride

Flexible Reference Electrode

This miniature flexible reference electrode is 3 inches long and has an outside diameter of 2 mm. It comes complete with a 4 foot long cable and is terminated with an alligator clip connector. Each unit comes pre-filled with the reference solution (3.0 M NaCl in 25% Glycerol) and it is stored dry. If refilling is ever required, reference solution can be injection into the side of the tee fitting and flexible tube portion of the electrode.

Order # Product

W4 69-0490 Flexible Reference Electrode



Model 863 Auto Chloridizer Kit



- Simple means to chloridize Ag/AgCl electrodes
- Environmentally safe

The Auto Chloridizer 863 is an electrolytic chloridation unit which provides a simple means for chloriding Ag/AgCl electrodes. It covers the surface of the silver electrode with an AgCl film insoluble in water. Unlike a purely chemical procedure, electrolytic chloridation does not involve the use of substances endangering the environment. It is normal practice to work with physiological saline solution (NaCl) as the electrolyte.

The electrolytic chloridation method also offers excellent reproducibility of the AgCl film at constant current density and chloridation time. The auto chloridizer operates with an electronically controlled constant-current source with current monitoring and error indication through an LED and error beep. During chloridation of a single Ag/AgCl electrode the unit is operated manually through the start/stop key.

For routine production of several identical electrodes, such as Ag/AgCl wires for glass microelectrodes, the unit offers a simple programming feature for the chloridation period in the repeat mode. First the learning mode is initiated by pressing the repeat key (for longer than 1 second) and then an electrode is produced manually using the start/stop key. All further electrodes are then prepared automatically according to the manual setting by pressing the repeat key. The end of the chloridation process is indicated by a beep and the current source is automatically switched off.

The counter electrode (cathode) used is a carbon-glass ceramic crucible. This material has a very high electrical conductivity, is inert physiologically, and is resistant to oxidation and corrosion. There is thus no contamination of the AgCl film through free metal ions, as is the case when using stainless steel as a cathode for example.

Specifications

Chloridation Current	Electronically controlled constant current source with current monitoring facility, and with low/medium/high selection by switch, corresponding to approx. 5/10/15 mA respectively
Chloridation Voltage approx.	Max. driving voltage of constant current source is 15 V and is therefore completely safe for user
Start/Stop	Manual operating mode start/stop for chloridation of single electrodes
Repeat	Automatic repetition of manually set chloridation procedure
Dimensions, H x W x D	15 x 6 x 12 cm (5.9 x 2.4 x 4.7 in)
Weight	750 g (1.7 lb)

Order # Product

W4 73-0004	HSE Auto Chloridizer Model 863, 115 VAC, 60 Hz
W4 73-0005	HSE Auto Chloridizer Model 863, 230 VAC, 50 Hz
W4 73-0006	Spare Crocodile Clips
W4 73-0007	Maintenance Kit for Silver Electrodes, Emery Paper and Scotch-Brite Cleaning Sponge, for Cleaning Silver Electrode before Chloridation



This microelectrode starter kit makes entry into microelectrode production technology easy for researchers who have not yet produced microelectrodes themselves. It contains all the necessary aids, components and consumables. A puller must be purchased separately, see pages 331 to 334. In addition to manual dexterity, which is always necessary, the system requires a binocular transmitted-light microscope with eyepiece graticule and up to 500X magnification for optical checking of the tip diameter.

The kit is suitable for producing intracellular microelectrodes using borosilicate glass capillaries with an integral filament, see pages 324 to 330. The filament makes microelectrode filling easy. Special filling devices, such as vacuum filling equipment, are therefore not required. In addition to a transport and storage container for completed microelectrodes, the kit also includes a specially developed electrolytic chloridation unit for producing an AgCl film on silver electrodes. Controlled application of the AgCl film through the selection of current density and chloridation period in the case of the electrolytic chloridation method, together with the good reproducibility of the AgCl film, readily justify the increased cost of purchasing the electrical chloridation equipment. By contrast, chemical chloridation involves less equipment but produces poorer chloridation results and has negative effects on the environment.

The kit includes:

Materials: Pack of 1.5 mm OD glass capillaries with filament, 10 m pure silver wire, 0.2 mm dia., fine solder wire, emery paper, Scotch-Brite cleaning sponge, KCl and NaCl powder, connecting pins for the microelectrodes, and sealing wax.

Tools: 18 W, 230 V miniature, curved soldering tweezers, straight soldering tweezers, fixation tweezers, clamping stand as aid for soldering the micro pins, electrolytic chloridation Auto Chloridizer, transport and storage container for micro-electrodes, special microelectrode holder with miniature socket, and illustrated book about the microelectrode technology.

Order #	Product
W4 73-0008	Microelectrode Starter Kit, 115 VAC, 60 Hz
W4 73-0009	Microelectrode Starter Kit, 230 VAC, 50 Hz

Ag-AgCl Electrodes

Why Silver-Silver Chloride (Ag-AgCl)?

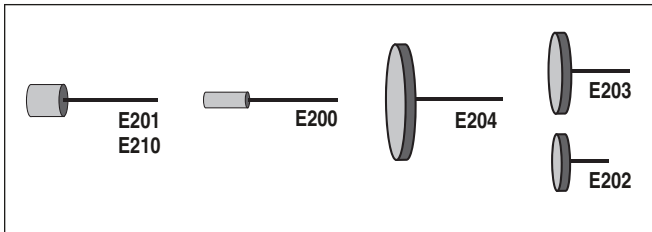
Ag-AgCl electrodes have long been recognized for their superiority in sensing bioelectric signals. The electrochemical properties of Ag-AgCl electrodes are such that biopotential waveforms are faithfully reproduced. Usually any offset potential - and this includes the electrode potential - is compensated (zeroed) before a recording. Long-term changes in the offset potential appear as baseline drift, and short-term changes as noise on the trace.

The quality of a Ag-AgCl electrode depends to a great extent on the formulation of the AgCl pellet. Our electrodes are made from very high purity materials. A careful proprietary process results in a

fine grain, homogeneous mixture of silver and silver chloride. A careful sintering process strengthens and stabilizes the entire electrode assembly.

Typical values of the key parameters, measured in 0.9% saline, between pairs of electrodes the same size are:

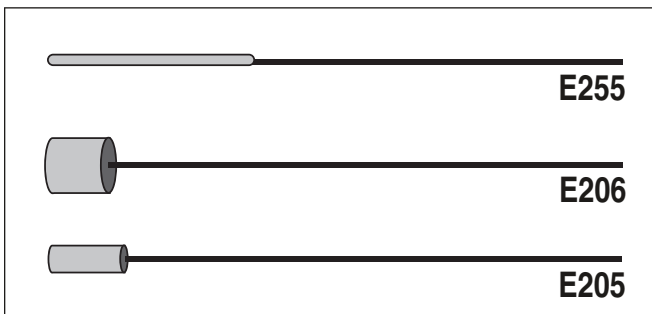
- 1) DC Offset Voltage: 180 μ V
- 2) Drift: 25 μ V/hour
- 3) Noise: 1 μ V peak-to-peak (0.1-1000 Hz with 50/60 Hz eliminated).



Ag-AgCl Pellet and Disc Electrodes

These six electrodes are ideally suited for making custom assemblies of skin electrodes and other bioelectric recording and stimulation apparatus. All have a pure silver wire (.25 mm diameter x 7 mm) embedded in the Ag-AgCl matrix. This wire can be easily soldered or twisted onto other wires.

Order #	Model	Product
W4 64-1304	E200	Pellet 1.5 x 3 mm (D x Thick)
W4 64-1305	E201	Pellet 2.0 x 4 mm (D x Thick)
W4 64-1313	E210	Pellet 2.0 x 2 mm (D x Thick)
W4 64-1306	E202	Disc 4.0 x 1 mm (D x Thick)
W4 64-1307	E203	Disc 8.0 x 1 mm (D x Thick)
W4 64-1308	E204	Disc 12.5 x 1 mm (D x Thick)



Ag-AgCl Pellet and Wire Electrodes

Pellet electrodes have a cylindrical pellet embedded on wire.

Wire electrodes have a uniform coating of Ag-AgCl over the last 10 mm of a 0.25 x 70 mm (D x L) wire. Maximum diameter of the Ag-AgCl matrix is 0.8 mm.

Note: All electrodes suitable for probing tissues.

Order #	Model	Product
W4 64-1309	E205	Pellet Electrode 1.0 mm D
W4 64-1310	E206	Pellet Electrode 2.0 mm D
W4 64-1317	E255	Wire Electrode 0.8 mm D

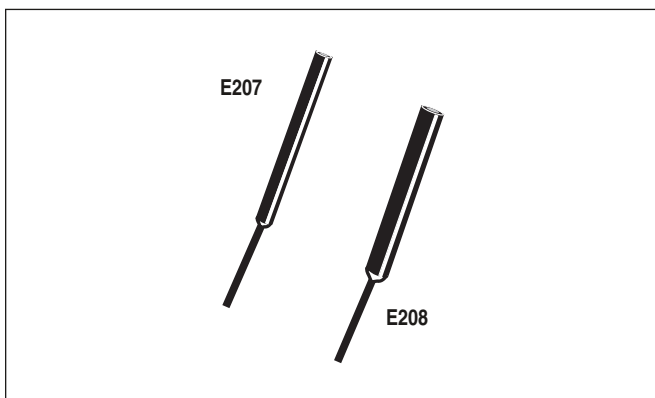
Electrodes, Probes and Reference Cells



Disc Electrodes With Lead Wires

These disc-type electrodes are made with a flexible 20 cm lead wire attached to the back. The connection is encapsulated so that only the surface and edges of the electrode can make electrical contact. These electrodes can be used as direct-contact skin electrodes, or subcutaneously in temporary applications on research animals.

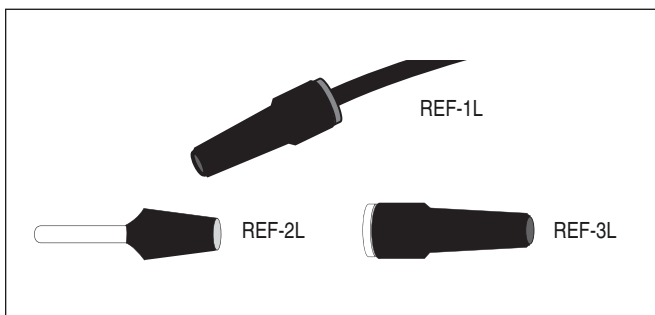
Order #	Model	Product
W4 64-1314	E242	Disc Electrode 4.0 mm D
W4 64-1315	E243	Disc Electrode 8.0 mm D
W4 64-1316	E244	Disc Electrode 12.5 mm D



Flat Tip Probes

Ag-AgCl cylinders, encapsulated in sturdy, insulating epoxy tubes; these probes are ideal for use in ionic solutions. They can be resurfaced frequently with fine sandpaper. Terminated with a 2 mm tinned copper wire for connection to your leads.

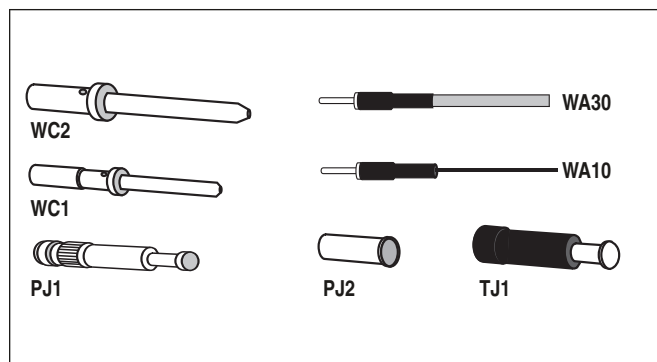
Order #	Model	Product
W4 64-1311	E207	Sensor Tip 2 x 4 mm (D x Thick) Epoxy Tube 3.5 x 25 mm (D x L)
W4 64-1312	E208	Sensor Tip 2 x 4 mm (D x Thick) Epoxy Tube 5 x 50 mm (D x L)



Reference Cells

Ag-AgCl electrodes are epoxy encapsulated in a plastic shell. They can be used as preparation references or as ground electrodes. Approximately 4.5 mm D, they are available with 2 mm pin, 2 mm jack and wire connection. All have a Luer taper for convenient mounting in chambers and other devices.

Order #	Model	Product
W4 64-1301	REF-1L	Reference Cell with 2 m Wire
W4 64-1302	REF-2L	Reference Cell with 2 mm Pin
W4 64-1303	REF-3L	Reference Cell with 2 mm Jack



Plugs and Jacks

An assortment of gold-plated 1 mm plugs and jacks, with or without wires. Useful for grounding, shielding, etc.

Order #	Model	Product
W4 64-1325	WC1-10	1 mm Pin, pkg. of 10
W4 64-1326	WC2-5	2 mm Pin, pkg. of 5
W4 64-1322	PJ1-10	1 mm Jack, Uninsulated, pkg. of 10
W4 64-1323	PJ2-5	2 mm Jack, Uninsulated, pkg. of 5
W4 64-1324	TJ1-3	1 mm Jack, Teflon® Insulated, pkg. of 3
W4 64-1328	WA30-5	1 mm Pin with 30 cm, 26 ga. Insulated Wire, pkg. of 3
W4 64-1327	WA10-5	1 mm Pin with 10 cm, .25 mm D, Bare Silver Wire, pkg. of 2 For Bilayer Headstage

Silver Wire

Made of annealed silver 99.99% pure. Supplied for the convenience of researchers to fashion their own electrodes.

Order #	Model	Product
W4 64-1318	AG8W	Silver Wire, 2 m, 0.20 mm (.008") D, L, No Insulation
W4 64-1319	AG10W	Silver Wire, 2 m, 0.25 mm (.010") D, L, No Insulation
W4 64-1320	AG15W	Silver Wire, 2 m, 0.37 mm (.015") D, L, No Insulation
W4 64-1321	AGT10W	Silver Wire, 2 m, 0.25 mm (.010") D, L, Teflon® Insulation

Notes:

electrodes

notes

Biosensing

electroporation & electrofusion

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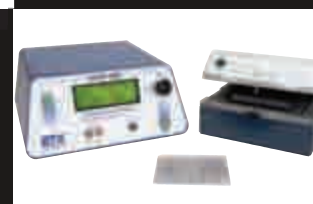
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decision guide

Application	Cell/Tissue	Instrument	Electrode	Field of Study	Comments
Ex Vivo	Brain Tissue or Brain Slice	ECM 830, ECM 2001	Tissue Slice Chamber/Tissue Chamber/L-Shaped Needle	Neurobiology	Transfection of delicate brain tissue and tissues with unique morphologies are more easily transfected with our new tissue slice chamber, L-shaped platinum needles or other BTX electrodes.
	Retina/Cornea	ECM 830, ECM 2001	Tissue Slice Chamber/Tissue Chamber/Genepaddles	Developmental Biology	
	Tumor/Skin	ECM 830, ECM 2001	Tissue Chamber/Tweezerrodes/Genetrodes	Cell Biology Ophthalmology Cancer Research Gene Therapy	
In Utero	Embryos	ECM 830, ECM 2001	Tweezerrodes and Genepaddles	Developmental Biology Neuroscience Neurology Embryology	The new smaller size Platinum Tweezerrodes for use with early stage embryos.
In Vivo	Muscle	ECM 830, ECM 2001	2-Needle Array/Genetrodes/Tweezerrodes	Ophthalmology	The numerous electrodes offered by BTX can be used for multiple tissues type depending on the specific application the researcher is trying to perform. To the left are some of the most common recommendations. For more assistance please contact BTX technical support.
	Brain	ECM 830, ECM 2001	L-Shaped Needle/Tweezerrodes/Genepaddles	Cancer Research	
	Skin	ECM 830, ECM 2001	2-Needle Array/Calipers/Tweezerrodes/Genetrodes	Vaccine Development	
	Retina	ECM 830, ECM 2001	Tweezerrodes/Genepaddles	Gene Therapy	
	Cornea	ECM 830, ECM 2001	Tweezerrodes/Genetrodes	Immunology	
	Tumors	ECM 830, ECM 2001	2-Needle Array/Calipers/Tweezerrodes/Genetrodes	Developmental Biology	
	Other Soft Tissue	ECM 830, ECM 2001	2-Needle Array/Calipers/Tweezerrodes/Genetrodes/Genepaddles/L-Shaped Needles	Cell Biology Neurology Biological Sciences	
In Ovo	Chick Embryo	ECM 830, ECM 2001	L-Shaped Genetrodes/L-Shaped Needle	Neurobiology	The Genetrodes are available in 3 different sizes and the New L-Shaped Needle electrodes provides a finer diameter needle in various length tips to best suit the dimensions of your target tissue.
	Zebra Fish	ECM 830, ECM 2001	L-Shaped Genetrodes/Tissue Chamber/Genepaddles/Tweezerrodes	Developmental Biology	
	Xenopus	ECM 830, ECM 2001	L-Shaped Genetrodes/Tweezerrodes/Genepaddles	Ophthalmology Regenerative medicine Embryology	
In Tact Plant	Plant Fragments	ECM 630	Tissue Chambers/Microslides/Tweezerrodes/Cuvettes	Cellular Physiology	The electrodes can vary for plant applications depending on the target tissue.
	Seeds	ECM 630	Tissue Chambers/Microslides/Tweezerrodes/Cuvettes	Food and Agriculture	
	Anthers	ECM 630	Tissue Chambers/Microslides/Tweezerrodes/Cuvettes	Plant Biology	
	Pollen	ECM 630	Tissue Chambers/Microslides/Tweezerrodes/Cuvettes		

crossover guide



BTX generally recommends a square waveform for mammalian cell work, and an exponential decay waveform for bacteria and yeast applications. However, there are some exceptions, and crossover in the use of our electroporation generators. We highly recommend that you contact BTX regarding your application prior to purchasing a generator system to ensure that you are getting the best possible system for your needs.

For BTX Technical Support go to www.btxonline.com or call **800-272-2775** within the U.S.

ECM® 2001

This square wave pulse electroporator and electrofusion generator is primarily used for cell fusion work and mammalian cell transfection. It can also be used for transforming bacteria, but with lower efficiencies than with an exponential decay waveform, see page 405.

ECM® 830

This square wave unit is engineered mainly for mammalian cell transfection. The 830 is also capable of performing certain cell fusion applications which will require the use of a manual cell alignment method. The basic transformation of bacteria to generate plasmids can be accomplished with 830 but with lower efficiencies compared to our exponential decay wave system (830/107-108 pfu/ug. vs. 630/108-1010 pfu/ug), see page 404.

ECM® 630

This exponential decay wave pulse generator is primarily used for bacteria and yeast transformation applications. The exponential decay wave system is used for efficient transfection of mammalian cells but with much lower cell viabilities compared to square wave pulse system, with the exception of mouse embryonic stem cells. Excellent transfection is achieved with the ECM 630, see page 403.

ECM® 399

This exponential decay wave generator is our most economical unit for a lab doing mainly gram (-) bacteria and yeast applications. This unit is not recommended for mammalian transfection, see page 402.

optimization guide

Electroporation is the application of controlled direct current (DC) electrical pulses which are applied to living cells and tissues for a short duration of time. The pulse induces a transmembrane potential which causes the reversible breakdown of the cellular membrane. This action results in the permeation or “pore formation” of the cell membrane which allows small molecules (such as dye, oligonucleotides or peptides) and large molecules (such as proteins, DNA and RNA) to be introduced into the cell. During this process the cellular uptake of the molecules continue until the pores close which can take milliseconds to minutes.

Electrofusion is an expansion of electroporation using different buffers and one or more proprietary alternating current (AC) pulse(s). Cells are brought together or “aligned” by the use of an AC pulse which causes charges to form on the cellular membrane (dielectrophoresis) resulting in alignment of cells or pearl-chain (dimer) formation. Following the AC cellular alignment the DC pulse is applied to induce permeation of the cell membrane. When cells are brought into contact during electroporation, these cells are induced to fuse. Following this DC pulse the AC pulse is maintained to allow complete cell membrane fusion during the recovery period.

Optimization of the electroporation process involves several factors. Choosing the wave form, determining field strength and adjusting pulse length are just a few critical variables. Other parameters which play a crucial role in optimization include cell diameter, DNA concentrations, temperature and electroporation buffer.

Wave Forms

Pulse shape generally falls into two categories, square wave or exponential decay wave:

Square wave pulse: Square wave pulses rise quickly to a set voltage level, maintains this level during the duration of the set pulse length and quickly turns off. This square wave system yields higher efficiencies and viabilities in mammalian cells. Square wave EP in in vivo and ex vivo tissues, embryo's, cell fusions and plant protoplast applications yield better results in comparison to an exponential decay wave system.

Exponential decay wave pulse: Exponential decay waves generate an electrical pulse by allowing a capacitor to completely discharge. A pulse is discharged into a sample the voltage rises rapidly to the peak voltage set then declines over time. The powerful exponential decay wave pulse is routinely used for transformation of gram-negative and gram-positive, bacterial, yeast, plant tissues, insect cells and some mammalian cells.

Field Strength

The field strength is measured as the voltage delivered across an electrode gap and is expressed as kV/cm. Field strength is critical to surpassing the electrical potential of the cell membrane to allow the temporary reversible permeation or “pore formation” to occur in the cell membrane. Three factors should be considered for optimizing field strength:

1. Cuvette Gap Size
2. Cell Diameter
3. Temperature

Cell Types	Field Strength Ranges
Bacteria/Yeast	3-24 kV/cm
Mammalian	0.25-3 kV/cm
Plant	3-12 kV/cm

1. Cuvette Gap Size

The distance between electrodes, or “gap size” is important when optimizing your electroporation experiment. Field strength is calculated using voltage divided by gap size. For example, using a 4mm gap cuvette with 500V would provide a field strength of 1.25kV/cm. If instead of a 4mm gap cuvette, a 2mm gap cuvette was used, the voltage would have to be reduced by half or 250V in order to maintain the same field strength of 1.25kV/cm. It is possible to derive the voltage needed to accomplish electroporation if the desired field strength and gap size are known. The calculation for this is Field strength (kV) multiplied by gap size (cm) equals voltage. For example, if a user was certain that a 1.25 kV/cm field strength was required in a 1mm gap cuvette the calculation would be: $1.25\text{kV} \times 0.1\text{cm} = 0.125\text{kV}$ or 125volts.

Example: A field strength of 1.25 kV/cm
4mm gap cuvette = 500 volts
2mm gap cuvette = 250 volts
1mm gap cuvette = 125 volts

2. Cell Diameter

Generally, smaller cell sizes require higher voltages while larger cell diameters require lower voltages for successful cell membrane permeation.

Cell Diameter	Cuvette 4mm Room Temp. (Volt)	Cuvette 4mm 4°C
10	500 Volts	1000 V
15	350 Volts	700 V
20	250 Volts	500 V
30	180 Volts	360 V
40	130 Volts	250 V
50	100 Volts	200 V

3. Temperature

The temperature at which cells are maintained during electroporation affects the efficiency of the electroporation for several reasons. For a majority of mammalian cell lines are effectively electroporated at room temperature. Samples which are pulsed at high voltage or exposed to multiple pulses and long pulse durations can cause the sample to heat up. These conditions cause increased cell death and lowers the transfection efficiency. Maintaining the sample at lower temperatures can diminish the heating effects on cell viability and efficiency. Since electroporation causes the transient formation of pores, keeping the cells at lower temperature following the pulse may allow the pores to remain open longer to allow more uptake of the exogenous molecule. Yet lower temperatures on other cell lines can be damaging and cause high cell mortality. This effect is specific to each cell line and should be considered during optimization studies. The standard pulse voltage used for cells at room temperature will need to be approximately doubled for electroporation at 4°C in order to effectively permeate the cell membrane.

Pulse Length

The pulse length is the duration of time the sample is exposed to the pulse. This is measured as time in micro to milliseconds ranges. Adjusting this parameter is dependent on the pulse generator in use square wave or exponential decay wave. The pulse length in a square wave system can be inputted directly. The pulse length in an exponential decay wave system is called the "time constant" which is characterized by the rate at which the pulsed energy (e) or voltage is decayed to 1/3 the original set voltage. This time constant is modified by adjusting the resistance and capacitance (RC) values in an exponential decay. Time constant calculation $T=RC$, where T is time and R is resistance and C is capacitance.

The pulse length works indirectly with the field strength to increase pore formation and therefore the uptake of target molecules. Generally, during optimization of parameters an increase in voltage should be followed by an incremental decrease in pulse length. Decreasing the voltage, the reverse is true. Pulse length is a key variable that works hand in hand along with voltage and needs to be considered when optimizing electrical parameters to maximize the results for a given cell type.

Number of Pulses

Electroporation is typically carried out as a single pulse for most cell types. However, other cell lines may require multiple pulses to achieve maximum transfection efficiencies. Usually lower voltages are used when applying multiple pulses in order to gradually permeate the cell membranes. This allows the transfer of molecules while avoiding damage to delicate or whole tissue samples. This method of multiple pulsing is critical for maximum gene delivery without causing tissue damage to in vivo, in utero and ex-plant tissue environments. The use of multiple pulsing will require the optimization of key electrical parameters including voltage and pulse length. Typically, for in vivo applications the use of lower voltages between 10-100 volts with pulse lengths ranging 30-50msec provides efficient transfection. The optimal voltage, pulse length and number of pulses will vary depending on the cell type and molecule (DNA or RNA) transfected.

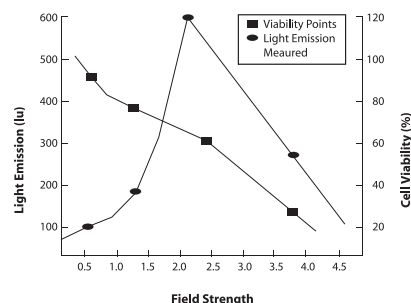
Electroporation Buffer

The buffers used for electroporation can vary depending on the cell type. Many applications use highly conductive buffers such as PBS (Phosphate Buffered Saline <30 ohms) and HBSS (Hepes Buffer <30 ohms) or standard culture media which may contain serum. Other recommended buffers are hypoosmolar buffers in which cells absorb water shortly before pulse. This swelling of the cells results in lowering the optimal permeation voltage while ensuring the membrane is more easily permeable for many cells but can be damaging to others. Prokaryotic cells such as bacteria require the use of high resistance buffers (>3000 ohms) for this reason proper preparation and washing of the cells is essential to remove excess salt ions to reduce the chance of arcing. Ionic strength of an electroporation buffer has a direct affect on the resistance of the sample which in turn will affect the pulse length or time constant of the pulse. The volume of liquid in a cuvette has significant effect on sample resistance for ionic solutions, the resistance of the sample is inversely proportional to the volume of solution and pH. As the volumes are increased resistance decreases which increases the chance of arcing, while lowering the volume will increase the resistance and decrease the arc potential.

BTX now offers BTXpress™ High Performance Electroporation Solution, a low conductance buffer that achieves higher transfection efficiencies with minimal cell toxicity. The BTXpress buffer is a single buffer developed to facilitate high efficiency gene delivery into mammalian cells.

DNA/RNA Concentrations

Electroporation is typically thought of as a nucleic acid (DNA, mRNA, siRNA and miRNA) transfer method into prokaryotic and eukaryotic cells. Electroporation is not limited to just nucleic acid delivery, it can introduce proteins, antibodies, small molecules and fluorescent dyes. The standard range of DNA used for transfections is 5-20µg/ml for most cell types; however in some instances increasing the DNA concentration as high as 50µg/ml improves transfection efficiency without changing other parameters. Determining the optimal DNA concentration through a DNA titration can be beneficial. The size of a molecule will have an effect on the electrical parameters used to transfect the cell. Smaller molecules (siRNA or miRNA) may need higher voltage with microsecond pulse lengths and larger molecules (DNA) may need lower voltages with longer pulse lengths. Buffers such as EDTA or Tris can drastically reduce the transfection efficiency. Therefore, we recommend resuspending DNA in distilled water. Finally, electroporating ligation mixtures into E.coli can cause arcing and reduced transformations. Diluting the ligation mixture a minimum of 1:5 with diH₂O, dialysis, or ethanol precipitation can significantly improve transformation efficiencies and reduce the potential for arcing.



ECM® 399

generator systems

Exponential Decay Wave Electroporation System



The ECM® 399 is an exponential decay wave electroporation system specifically designed to deliver the field strengths and pulse lengths required for the simple transformation of bacteria and yeast cells. In low voltage mode the ECM® 399 has a limited capability for transfecting some mammalian cell lines. The ECM® 399 is ideal for basic transformation in research and academic environments. It is easy to operate, cost effective, compact in size and portable.

Combination System

BTX provides a combination system which has the power of both its exponential decay and square wave technologies for labs involved in multiple applications. These labs need the versatility of the BTX systems to range from prokaryotes to eukaryotes with the ability to transfect delicate in vivo tissues efficiently. This combo system includes the power of the ECM 399 exponential decay wave generator to provide the highest transformation efficiencies of basic bacteria and yeast strains. This package option also includes the gentle strength and versatility of the ECM 830 Square Wave System to provide high transfection efficiencies with equally high cell viabilities in mammalian cells and in vivo tissues. BTX offers the ECM 399/ECM 830 Combo System complete with a PEP and a safety stand for cuvettes. These systems can be used together or separate as independent systems for operation in different labs with no extra components needed.

Specifications

Operational Status	Internal self test upon start-up
Interface	Digital User Interface
Charge Time	5 sec maximum
Voltage Range:	
LV Mode	2 – 500 V HV Mode/ 2 V resolution
HV Mode	10 – 2,500 V HV Mode/10 V resolution
Capacitance:	
LV Mode	1,050 µF Fixed
HV Mode	36 µF Fixed
Resistance:	
LV Mode	150 ohm Fixed
HV Mode	150 ohm Fixed

Item #	Product
W4 45-0000	Electroporation System includes ECM 399 Generator, PEP, Cuvettes 1 mm, 2 mm, 4 mm, pkg. of 30 (10 each) and Cuvette Rack 660
W4 45-0050	ECM 399 Generator Only
W4 45-0060	Combination package includes ECM 830 Generator, ECM 399 Generator, Safety Stand, PEP, 30 Cuvettes, (10 each: 1mm, 2mm and 4mm) and Cuvette Rack



- Transformation of Bacteria and Yeast
- Transfection of Mammalian Cells
- Transfection of Plant Tissue and Plant Protoplast
- High Throughput 96 & 25 Well Electroporation

The ECM 630 is an exponential decay wave electroporation generator providing a broad range of voltage and time constant for full flexibility in varying applications. The ability to select the resistance and capacitance values and adjust the range of voltages is the key to achieving the optimal time constants and field strengths needed for efficient transformation of prokaryotes and eukaryote transfection. This system is an outstanding value for researchers working with bacteria, yeast, stem cell transfection, plant transformation and insect transfection. Flexibility is important to a researcher, so BTX has designed a plug and play system for our ECM 630 system to transition between standard cuvettes and to a 96 well electroporation plate using our High Throughput plate handler.

96-Multi-Well Electroporation

Transition from standard cuvette work using the safety stand to multi-well electroporation is quick and simple with the addition of the High Throughput (HT) plate handler and plates. The HT plate handler accommodates either 96 & 25 well electroporation plates and it operates with an existing ECM 630 generator or is offered as an ECM 630 HT System for easy scale up. The HT System offers the researcher the advantage of multi-well technology. High Throughput electroporation permits for large numbers of samples to be quickly processed or easy optimization of electroporation conditions for the highest possible efficiencies.

Monitoring Option

The ENHANCER 3000 allows the researcher to monitor and track key electrical parameters used in electroporation applications. The electrical pulse data is captured as both a graphic display of the wave form and electrical output values following each experiment. This data can be stored on a memory stick or downloaded to a computer easily by using the USB port for potential analysis, documentation and validation purposes.

Combination System

This combo system includes the power and flexibility of the ECM 630 Exponential Decay Wave Generator to provide the highest transformation efficiencies for a wide range of bacteria and yeast strains. This combo also contains the gentle strength and versatility of the ECM 830 Square Wave System to provide high transfection efficiencies with equally high cell viabilities in mammalian cells and in vivo tissues. BTX offers the ECM 630/ECM 830 Combo System complete with two safety stands and sample cuvettes. These systems may be used together or separate as independent systems for operation in different labs with no extra components needed.

Specifications

Operational Status	Internal self test upon start-up
Interface	Digital User Interface
Input	110 V/220 V Universal
Charge Time	5 sec maximum
Arc Control	Arc Quenching™
Voltage Range	10 – 500 V LV Mode/ 1 V resolution 50 – 2500 V HV Mode/ 5 V resolution
Capacitance Range	1 µF, 25 µF to 3,275 µF LV Mode 25 µF, 50 µF HV Mode
Resistance Range	25 ohm – 1,575 ohm/ 25 ohm resolution HV & LV Modes “None” setting to simulate alternative systems lacking resistance control LV Mode

Item #	Product
W4 45-0001	Electroporation System includes ECM 630 Generator, 630B Safety Stand, Cuvettes 1 mm, 2 mm, 4 mm pkg. of 30 (10 each) and Cuvette Rack 660
W4 45-0051	Generator Only
W4 45-0422	Includes ECM 630 Generator, 2 x 96-Well Plates (2 mm), Plate Seals and HT-100 Plate Handler
W4 45-0412	Includes ECM 630 Generator, 6 x 25-Well Plates (2 mm), Plate Seals, and HT-100 Plate Handler
W4 45-0061	Combination package includes ECM 830 Generator, ECM 630 Generator, 2 x Safety Stands, 30 Cuvettes (10 each: 1mm, 2mm and 4mm) and Cuvette Rack
W4 45-0071	ENHANCER 3000 Probe, ENHANCER Interface Box, Oscilloscope, Communications Module, ECM 630 Generator, Safety Stand, 30 Cuvettes (10 each 1 mm, 2 mm and 4 mm) and Cables

Visit the BTX website for hundreds of protocols and publications

www.btxonline.com



- Transfection of Mammalian Cells
- In Vitro, In Vivo, Ex Vivo & In Ovo Tissue Transfection
- Nuclear Transfer
- Plant Protoplast Transfection
- High Throughput 96 and 25 well Electroporation

The ECM 830 is a square wave pulse generator designed for In Vitro and In Vivo electroporation applications. BTX square wave technology provides the advantage of efficient cell transfer and high cell viability for numerous applications. The versatility of the ECM 830 applications for gene, drug and protein delivery include; mammalian cells, in vivo and ex-vivo tissues, zebra fish tissue and embryos, nuclear transfer, embryo manipulation, plant protoplast and basic bacteria and yeast transformations. The ECM 830 possesses key features including a wide range of voltages from 5 to 3000 volts, fine voltage discrimination, pulse durations from 10µsec to 10sec, user control of pulse intervals, Arc Quenching™, digital display of output of voltage and pulse length for precise optimization of experiments. It is a true laboratory work-horse with a 2-year warranty. The ECM 830 can be used in combination with a wide array of BTX specialty electrodes and accessories to enhance your molecular and drug delivery for In Vivo and Ex Vivo experiments. Flexibility is important to a researcher, so BTX has designed a plug and play system for our ECM 830 system to transition between standard cuvettes and 96 or 25 well electroporation plates using our High Throughput plate handler.

96-Well Electroporation

The High Throughput (HT) 96 & 25 well systems offer the researcher the advantage of multi-well technology. This permits a large number of samples to be quickly processed for routine applications or easy optimization of electrical and biological conditions. Simplify discovering the conditions needed to obtain the best possible efficiencies using the BTX ECM 830 pulse generator and HT plate handler.

Monitoring Option

The ENHANCER 3000 allows the researcher to monitor and track key electrical parameters used in electroporation applications. The electrical pulse data is captured as both a graphic display of the wave form and electrical output values following each experiment. This data can be stored on a memory stick or downloaded to a computer easily by using the USB port for potential analysis, documentation and validation purposes.

Combination System Options

This combo system includes the power and flexibility of the ECM 630 exponential decay wave generator to provide the highest transformation efficiencies for a wide range of bacteria and yeast strains. The gentle strength and versatility of the ECM 830 square wave system provides high transfection efficiencies with equally high cell viabilities in mammalian cells and in vivo tissues. BTX offers the ECM 630/ECM 830 combo system complete with two safety stands and sample cuvettes. These systems may be used together or separate as independent systems for operation in different labs with no extra components needed.

Specifications

Operational Status	Internal self test upon start-up
Interface	Digital User Interface
Input	110 V/220 V Universal
Charge Time	5 sec maximum (without delay)
Pulse Length Range	10 µs – 999 µs LV Mode/ 1 µs resolution 1 msec – 999 msec LV Mode/ 1 msec resolution 1 sec – 10 sec LV Mode/ 0.1 sec resolution 10 µs – 600 µs HV Mode/ 1 µs resolution
Voltage Range	5 – 500 V LV Mode/ 1 V resolution 505 – 3000 V HV Mode/ 5 V resolution
Multiple Pulsing	1 – 99
Pulse Interval	100 msec – 10 sec
Programmability	Storage for 3 protocol setups (V,t,n,interval)
Arc Control	Arc Quenching™
Safety	Generator short circuit proof
Capacitance	4000 µF LV, 111 µF HV
Amperage	500 A limit at 100 µs
Remote Operation	Footswitch available. Please contact BTX Technical Services at 1-800-272-2775 or techsupport.btx@harvardapparatus.com for assistance.

Item #	Product
W4 45-0002	ECM 830 Electroporation System includes, ECM 830 Generator, 630B Safety Stand, Cuvettes 1 mm, 2 mm, 4 mm pkg. of 30 (10 each) and Cuvette Rack 660
W4 45-0052	ECM 830 Generator Only
W4 45-0421	HT 96/200 includes ECM 830 Generator, 2 x 96-Well Plates (4 mm), Plate Seals and HT-200 Plate Handler
W4 45-0411	HT 25/200 includes ECM 830 Generator, 6 x 25-Well Plates (4 mm), Plate Seals and HT-200 Plate Handler
W4 45-0061	ECM 830 / ECM 630 Combination Package includes ECM 830 Generator, ECM 630 Generator, 2 x Safety Stands, Sample Package of Cuvettes and Cuvette Rack
W4 45-0060	ECM 830 / ECM 399 Combination Package includes ECM 830 Generator, ECM 399 Generator, Safety Stand, PEP, Sample Package of Cuvettes and Cuvette Rack
W4 45-0072	ECM 830 / ENHANCER 3000 System: ENHANCER 3000 Probe, ENHANCER Interface Box, Oscilloscope, Communications Module, ECM 830 Generator, Safety Stand, 30 Cuvettes (10 each 1 mm, 2 mm and 4 mm) and Cables

ECM[®] 2001

Electro Cell Fusion & Electroporation System



- Cell Fusion
- Nuclear Transfer
- Embryo Manipulation
- Hybridoma Production
- Mammalian Cell Transfection
- Plant Protoplast Fusion
- Stem Cell Production

The ECM 2001 is a multipurpose pulse generator. This system offers AC/DC pulsing and a variety of pulse lengths with multiple pulsing features. This generator has the capability of performing electrofusion as well as electroporation.

Fusion

Electrofusion is carried out by applying both AC and DC waves. Fusion is achieved by the generation of a proprietary AC wave form for benign dielectrophoretic alignment of cells. Microsecond switchover time from AC to DC creates efficient fusion results. After fusion, the AC pulse reapplication maintains compression of the cells following the DC pulse for the rounding off process, resulting in a higher number of hybrids. The 1 MHz AC pulse aligns cells together in "real time", saving time (seconds vs. hours) in comparison to PEG methods. Blastomeres and Oocytes can also be aligned to the correct position for better fusion accuracy during nuclear transfer and embryo manipulation.

Electroporation

The ECM 2001 can function as a powerful stand alone electroporation system for efficient cell transfection or for in vivo tissue transfection applications. Using the ECM 2001 for standard mammalian cell transfections the AC feature is turned off and the DC mode can now be set as a square wave electroporation device. The range of voltages and

pulse lengths that can be set coupled with the ability to carry out up to 9 pulses per experiment make this an all around flexible system for any lab.

Monitoring Option

The ENHANCER 3000 allows the researcher to monitor and track key electrical parameters used in electroporation and electrofusion applications. The electrical pulse data is captured as both a graphic display of the wave form and electrical output values following each experiment. This data can be stored on a memory stick or downloaded to a computer easily by using the USB port for potential analysis, documentation and validation purposes.

Specifications

AC Parameters (Alignment)

Proprietary nonsinusoidal wave shape

Frequency	1 MHz
Voltage	0 – 75 V RMS (zero to peak)
Duration	0 – 99 sec
Post fusion AC	1/10 of pre fusion amplitude
Post fusion ramp	1 – 9 sec
Pause between AC/DC	50 μ sec

DC Pulse Parameters (Fusion) (Electroporation)

High Voltage Mode

Voltage	10 – 3000 V
Pulse Length	1 – 99 μ sec/ 1 μ sec resolution

Low Voltage Mode:

Voltage	10 – 500 V
Pulse Length	1 – 9 pulses
Number of Pulses	0.01 – 0.99 msec/ 0.01 msec res 1 – 99 msec/ 1 msec res

Item #	Product
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W4 45-0011	Electroporation System includes ECM 2001 Generator, Safety Stand 630B, Cuvettes 1 mm, 2 mm, 4 mm, pkg. of 30 (10 each), Cuvette Rack 660
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W4 45-0012	Embryo Manipulation System includes ECM 2001 Generator Micro-Slides 450, 450-1, 453 and Connection Cable
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W4 45-0010	Electro Cell Fusion System includes ECM 2001 Generator, Micro-Slides 450, 453, Meander Fusion Chamber 454, Flat Electrode/ Divergent Field 484, Electrode Adapter, Connection Cable, Safety Stand 630B Cuvettes 1 mm, 2 mm, 4 mm, pkg. of 30 (10 each), Cuvette Rack 660
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W4 45-0080	ECM 2001 Generator Only
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W4 45-0013	ENHANCER 3000 Probe, ENHANCER Interface Box, Oscilloscope with USB communications, ECM 2001 Generator, Safety Stand, Cuvettes 1 mm, 2 mm, 4 mm, pkg. of 30 (10 each) and Cables
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multi-well plate handlers

ECM[®] 830 High Throughput HT Multi-Well Electroporation System



- Mammalian Cells
- Primary Cells
- Stem Cells
- siRNA Libraries

The BTX High Throughput (HT) System, offers a multi-well electroporation technology for processing multiple samples in seconds. Using the HT Multi-Well plates instead of traditional cuvettes, the researcher can transition from a single cuvette to either a 96 well or 25 well electroporation plate by using one simple plate handler. This increases yields and the number of experiments runs in a single day. Experiments take seconds to run, allowing for quick and efficient optimization of the electrical and biological parameters. Once optimized, samples are rapidly processed increasing yields and saving valuable time and money.

The HT plate handler is compatible with the ECM 830 and some older ECM 830 generators (for more details regarding compatibility of your ECM 830 systems please contact BTX tech support).

The HT System is comprised of 3 components: The HT Multi-Well Plates, an HT Plate Handler and the BTX ECM 830 Generator.

HT Plates

Each HT Plate consists of either 96 or 25 individual wells with integrated electrodes. The 96-well plate assumes a traditional 96 well format i.e., 12 columns of 8 wells each. The 25-well format has 5 columns of 5 well each. Four different Multi-Well Plates are available: 96-well with 4mm gap, 96-well 2mm gap, 25-well 4mm gap and 25-well 2mm gap.

Rapid protocol optimization of transfection parameters can be obtained by loading a plate with unique experimental samples. Optimization of electrical parameters can be achieved by pulsing each column within the plate with variable electrical settings. **The same electrical settings are applied to each well within a column.**

Plate Handler

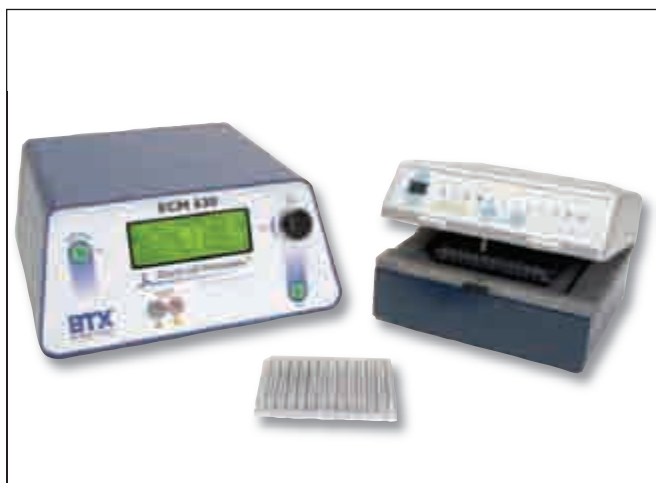
The key to the HT system is the combination of the Plate Handler and Multi-Well Plates. The Plate Handler holds the HT Multi-Well Plates; much like the safety stand holds the cuvettes. It delivers the pulse(s) to the wells using parameters set in the ECM 830 generator. Specifically, the HT 200 plate handler offers the option of the delivery of multiple pulses column by column automatically.

Generator

The final component of the HT System is a BTX ECM 830 Square Wave Electroporation Generator.

Item #	Product
W4 45-0421	Includes ECM 830 Generator, 4 mm gap, 2 x 96-Well Plates, Plate Seals and HT-200 Plate Handler
W4 45-0411	Includes ECM 830 Generator, 4 mm gap, 6 x 25-Well Plates, Plate Seals and HT-200 Plate Handler
W4 45-0452	96-Well Disposable Electroporation Plates, 4 mm gap, 250 μ l, 1 plate
W4 45-0450	96-Well Disposable Electroporation Plate, 2 mm gap, 125 μ l, 1 plate
W4 45-0462	25-Well Disposable Electroporation Plate, 4 mm gap, 250 μ l, 1 plate
W4 45-0466	25-Well Disposable Electroporation Plate, 2 mm gap, 125 μ l, 1 plate
W4 45-0463	25-Well Disposable Electroporation Plate, 4 mm, 250 μ l, pkg. of 6 plates
W4 45-0467	25-Well Disposable Electroporation Plates, 2 mm, 125 μ l, pkg. of 6 plates
W4 45-0401	HT-200 Plate Handler, Automatic Column Switching

ECM[®] 630 High Throughput HT Multi-Well Electroporation System



- Bacteria
- Yeast
- Insect Cells
- cDNA Libraries

The BTX High Throughput (HT) System, offers a multi-well electroporation technology for processing multiple samples in seconds. Using the HT Multi-Well plates instead of traditional cuvettes, the researcher can transition from a single cuvette to either a 96 well or 25 well electroporation by using one simple plate handler. This increases yields and the number of experiments runs in a single day. Experiments take seconds to run, allowing for quick and efficient optimization of the electrical and biological parameters. Once optimized, samples are rapidly processed increasing yields and saving valuable time and money.

The HT plate handler is compatible with the ECM 630 including older ECM 630 generators.

The HT System is comprised of 3 components: The HT Multi-Well Plates, an HT Plate Handler and the BTX ECM 630 Generator.

HT Plates

Each HT plate consists of either 96 or 25 individual wells with integrated electrodes. The 96-well plate assumes a traditional 96 well format i.e., 12 columns of 8 wells each. The 25-well format has 5 columns of 5 well each. Four different Multi-Well Plates are available: 96-well with 4mm gap, 96-well 2mm gap, 25-well 4mm gap and 25-well 2mm gap.

Rapid protocol optimization of transformation and transfection parameters can be obtained by loading a plate with unique experimental samples. Optimization of electrical parameters can be achieved by pulsing each column within the plate with variable electrical settings. **The same electrical settings are applied to each well within a column.**

Plate Handler

The key to the HT system is the combination of the Plate Handler and Multi-Well Plates. The Plate Handler holds the HT Multi-Well Plates; much like the safety stand holds the cuvettes. It delivers a single pulse to the wells using parameters set in the ECM 630 generator. Specifically, the HT 100 plate handler applies a single pulse to each column of a plate while switching through columns is performed manually.

Generator

The final component of the HT System is a BTX ECM 630 Exponential Decay Wave Electroporation Generator.

Item #	Product
W4 45-0423	Includes ECM 630 Generator, 2 mm gap, 2 x 96-Well Plates, Plate Seals and HT-200 Plate Handler
W4 45-0413	Includes ECM 630 Generator, 2 mm gap, 6 x 25-Well Plates, Plate Seals and HT-200 Plate Handler
W4 45-0452	96-Well Disposable Electroporation Plates, 4 mm gap, 250 µl, 1 plate
W4 45-0450	96-Well Disposable Electroporation Plate, 2 mm gap, 125 µl, 1 plate
W4 45-0462	25-Well Disposable Electroporation Plate, 4 mm gap, 250 µl, 1 plate
W4 45-0466	25-Well Disposable Electroporation Plate, 2 mm gap, 125 µl, 1 plate
W4 45-0463	25-Well Disposable Electroporation Plate, 4 mm, 250 µl, pkg. of 6 plates
W4 45-0467	25-Well Disposable Electroporation Plates, 2 mm, 125 µl, pkg. of 6 plates
W4 45-0400	HT-100 Plate Handler, Manual Column Switching
W4 45-0401	HT-200 Plate Handler, Automatic Column Switching

generator specifications

ECM® 830

Mammalian Cell Transfection, Intact Plant Tissue and Protoplast Transformation, In Vivo and In Vitro Protein/Drug/ Gene Delivery, In Ovo Nuclear Transfer and Embryo Manipulation, Limited Bacterial and Yeast Transformations

ECM® 2001

Cell Fusion, Nuclear Transfer, Embryo Manipulation, Mammalian Transfection, Hybridoma Production, In Vivo Protein/Drug/Gene Delivery, Plant Protoplast Fusion, Limited Bacteria and Yeast Transformations

Applications	ECM® 830 Mammalian Cell Transfection, Intact Plant Tissue and Protoplast Transformation, In Vivo and In Vitro Protein/Drug/ Gene Delivery, In Ovo Nuclear Transfer and Embryo Manipulation, Limited Bacterial and Yeast Transformations	ECM® 2001 Cell Fusion, Nuclear Transfer, Embryo Manipulation, Mammalian Transfection, Hybridoma Production, In Vivo Protein/Drug/Gene Delivery, Plant Protoplast Fusion, Limited Bacteria and Yeast Transformations
Waveform	Square	Square
AC Ranges		
<i>Proprietary Non-Sinusoidal Wave Shape:</i>		
Frequency	N/A	1 MHz
Voltage	N/A	0 to 75 V RMS
Duration	N/A	0 to 99 sec
Amplitude Post Fusion	N/A	1/10 of alignment current
Pause Between AC/DC	N/A	50 µsec
DC Pulse Ranges		
<i>Voltage Range:</i>		
LV Mode	5 to 500 V / 1 V resolution	10 to 500 V / 10 V resolution
HV Mode	505 to 3,000 V / 5 V resolution	10 to 3,000 V / 10 V resolution
<i>Pulse Length Range:</i>		
LV Mode	10 µsec to 999 µsec / 1 µsec resolution	0.01 to 0.99 msec / 0.01 msec resolution
LV Mode	1 msec to 999 msec / 1 msec resolution	1 to 99 msec / 1 msec resolution
LV Mode	1 sec to 10 sec / 0.1 sec resolution	N/A
HV Mode	10 to 600 µsec / 1 µsec resolution	1 to 99 µsec / 1 µsec resolution
Voltage Dependent/Internally Controlled		
Multiple Pulsing	1 to 99	1 to 9
Pulse Interval	100 msec to 10 sec	1 sec fixed
No. Cycle Repeats	N/A	0 to 9 cycles
Programmability	Storage for 3 parameters (V, t, n, interval)	N/A
Arc Control	Arc Quenching™	N/A
Safety	Generator is short circuit proof	Generator is short circuit proof
<i>Capacitance in Micro Farads:</i>		
LV	4,000 µF	3,900 µF
HV	111 µF	108 µF
Internal Resistance (in parallel with load) Ω		
LV	56 Ω	50 Ω
HV	56 Ω	50 Ω
Other Specifications		
Operational Status	Internal self test upon start-up	N/A
Interface	Digital User Interface	Digital Display
Input	100 to 240 VAC, 50/60 Hz	100/115 VAC, 230 VAC, 50/60 Hz
Charge Time	5 sec maximum (without delay)	10 sec maximum
Display	4 line x 20 character LCD	4 characters Digital Display LED
Controls	Single rotary knob with push button toggle to set parameters, On/Off Power and Start switches	Thumb wheel potentiometer and push button control
Electroporation Chamber	Safety Stand or Plate Handler	Microslides or Safety Stand
Monitoring	Monitoring and display of V, t, n, interval	Display of set voltage
HT (High Throughput) Multi-Well 96 or 25	Compatible	N/A
Remote Operation	Footswitch available	Automatic or manually controlled / Footswitch available
CE Marking	Yes	N/A
Dimensions (H x W x D)	14 x 31.8 x 31.1 cm (5.5 x 12.5 x 12.25 in)	27.9 x 43.2 x 39.4 cm (11 x 17 x 15.5 in)
Weight	6.8 kg (15 lbs)	21.3 kg (47 lbs)
Warranty	2 Years	2 Years
See Page	Page 404	Page 405

generator specifications

	ECM® 630	ECM® 399
Applications	Bacteria and Yeast Transformations, Plant Protoplast and Intact Plant Tissue Transformation, In Vitro Protein/Drug/ Gene Delivery, Mammalian Transfections	Bacteria and Yeast Transformations, Limited Mammalian Transfections
Waveform	Exponential Decay	Exponential Decay
AC Ranges		
<i>Proprietary Non-Sinusoidal Wave Shape:</i>		
Frequency	N/A	N/A
Voltage	N/A	N/A
Duration	N/A	N/A
Amplitude Post Fusion	N/A	N/A
Pause Between AC/DC	N/A	N/A
DC Pulse Ranges		
<i>Voltage Range:</i>		
LV Mode	10 to 500 V / 1 V resolution	2 to 500 V / 2 V resolution
HV Mode	50 to 2,500 V / 5 V resolution	10 to 2,500 V / 10 V resolution
<i>Pulse Length Range:</i>		
LV Mode	N/A	N/A
LV Mode	N/A	N/A
LV Mode	N/A	N/A
HV Mode	N/A	N/A
Voltage Dependent/Internally Controlled		
Multiple Pulsing	N/A	N/A
Pulse Interval	N/A	N/A
No. Cycle Repeats	N/A	N/A
Programmability	Storage for 2 parameters (V, t, n, interval)	N/A
Arc Control	Arc Quenching™	Arc Quenching™
Safety	Generator is short circuit proof	Generator is short circuit proof
<i>Capacitance in Micro Farads:</i>		
LV	1 µF, 25 µF to 3,275 µF	1,050 µF
HV	25 µF and 50 µF	36 µF
Internal Resistance (in parallel with load) Ω		
LV	25 Ω to 1,575 Ω / 25 Ω resolution "None" setting to simulate alternative systems lacking resistance.	150 Ω
HV	25 Ω to 1,575 Ω / 25 Ω resolution	150 Ω
Other Specifications		
Operational Status	Internal self test upon start-up	Internal self test upon start-up
Interface	Digital User Interface	Digital User Interface
Input	100 to 240 VAC, 50/60 Hz	100 to 240 VAC, 50/60 Hz
Charge Time	5 sec maximum (without delay)	5 sec maximum (without delay)
Display	4 line x 20 character LCD	1 line x 16 character LCD
Controls	Single rotary knob with push button toggle to set parameters, On/Off Power and Start switches	Single rotary knob with push button toggle to set parameters, On/Off Power and Start switches
Electroporation Chamber	Safety Stand	PEP or Safety Stand
Monitoring	Monitoring and display of V, t, n, interval	Monitoring and display of Voltage
HT (High Throughput) Multi-Well 96 or 25	Compatible	N/A
Remote Operation	N/A	N/A
CE Marking	Yes	Yes
Dimensions (H x W x D)	14 x 31.8 x 31.1 cm (5.5 x 12.5 x 12.25 in)	10.9 x 23.1 x 19.6 cm (4.3 x 9.1 x 7.7 in)
Weight	4.5 kg (10 lbs)	3.2 kg (7 lbs)
Warranty	2 Years	2 Years
See Page	Page 403	Page 402

Enhancer 3000 Monitoring System



- Optimize and Troubleshoot Electroporation Settings
- Capture and Print Results for Documentation Purposes
- Track & Download Images to Computer for Analysis

The BTX Enhancer 3000 offers a novel approach to monitoring critical parameters while performing electroporation applications.

The system allows researchers to maintain efficiencies, optimize both electrical and biological parameters, view sample runs, troubleshoot possible problems and easily perform routine quality control. Communications using the USB data port permits storage and documentation of data for further analysis.

The ENHANCER 3000 Monitoring System can monitor all key electroporation parameters including:

- **Wave Form**
- **Peak Amplitude**
- **Field Strength**
- **Pulse Lengths**
- **Pulse Intervals**
- **AC duration**

The electrical pulse data is captured as both a graphic display of the waveform and electrical output values following each electroporation experiment from generators w/ external pulse capability.

The ENHANCER 3000 System is comprised of three components: a Voltage Probe, an Interface Box and a digital Oscilloscope. The Voltage Probe and Interface Box together comprise the voltage monitor, while the Oscilloscope displays waveform images from the actual electrical pulse. This system offers a solution for evaluating critical electroporation settings and USB for storage and input to a computer.

ECM / ENHANCER 3000 Monitoring Systems

These Systems pair electroporation methods with the advanced monitoring capabilities of the ENHANCER 3000 System. They allow complete documentation and storage of data for further review and analysis. This system is available separately for use with your existing electroporation equipment.

Specifications

Input Voltage

Common Mode:

Range	± 7000 V (DC+Peak AC) or 2500 V rms at 1/100 & 1/1000
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Output Voltage:

Maximum Amplitude	± 7 V (into 50 k Ω load)
Offset (typical)	± 5 mV
Power Requirements	4 AA batteries and AC plug adapter
Length of BNC Cable	88.9 cm (35 in)
Length of Input Leads	30.5 cm (12 in)

ENHANCER 3000 High Voltage Interface Box Specifications

Input, Output, Probe Connections:

Type	4 mm Banana Jack
Voltage	2500 V rms, 3500 V pk CAT II
Current	15 A, maximum continuous
Current (Peak)	1000 A for 100 μ sec

Item # Product

W4 45-0059 Interface Box, ENHANCER 3000 Probe, Digital Oscilloscope, Communications Module & Cables

W4 45-0057* Interface Box, ENHANCER 3000 Probe & Cables

** Requires a digital Oscilloscope for readout of waveforms and electrical parameters.*

BTX Cuvette Advantage Electroporation Accessories



Safety Stand



Cuvettes



BTX Footswitch for ECM 830



BTX Footswitch for ECM 2001

- Safety Stand and Cuvettes protect both the user and sample
- Cuvettes are compatible with most commercially available Electroporators
- Sterile Transfer Pipette included with every cuvette Plus package, allowing quick and easy removal of each sample
- Three cuvette sizes: 1 mm, 2 mm and 4 mm, are available to suit all applications
- Round, cuvette caps allow for single-hand removal and are color coded for easy recognition

Visit the BTX website for hundreds of protocols and publications
www.btxonline.com

Safety Stand and Disposable Cuvettes

The BTX Safety Stand is specially designed to connect to any BTX Generator allowing for the safe delivery of HV electrical pulses to cuvettes. Up to two cuvettes may be electroporated in the safety stand simultaneously. Each BTX Cuvette Plus includes a transfer pipette for the fast and easy removal of samples. The cuvette and pipette are packaged together and are gamma irradiated for sterility.

The cuvette caps are round for easy, one-handed removal and are color coded for quick identification.

The BTX Cuvette Rack holds up to 20 cuvettes in numbered positions.

Footswitch

The Footswitch allows for hands free operation of the ECM 830 and ECM 2001 Generators. This accessory is desirable when conducting in vivo / in ovo gene delivery or nuclear transfer/cloning when both hands are needed for sample manipulation.

The footswitch functions as the start button on the front of the generator.

Two types of Footswitches are available, the 1250SF model for the ECM 830 and the 2001FS model for ECM 2001 generator. Please call BTX technical support for information regarding compatibility with older models.

BTX Cuvettes Plus

(Individually packaged cuvettes with sterile transfer pipette)

Item #	Gap	Pkg.	Volume	Color	App.
W4 45-0124	1 mm	50 each	20 – 90 µl	Gray	Bacterial
W4 45-0125	2 mm	50 ea	40 – 400 µl	Blue	Bacterial, Mammalian
W4 45-0126	4 mm	50 ea	80 – 800 µl	Yellow	Mammalian

BTX Safety Stand, Cuvette Rack & Footswitch

Item #	Product
W4 45-0207	Safety Stand for use w/BTX Generator and BTX Cuvette Plus (Model 630B)
W4 45-0208	Cuvette Rack, 20 Position (Model 660)
W4 45-0211	Footswitch for ECM 830 (Model 1250FS)
W4 45-0086	Footswitch for ECM 2001 (Model 2001FS)

BTX Bulk Case Cuvettes

(Case contains 24 packs of 100 Cuvettes each)

Item #	Gap	Pkg.	Volume	Color	App.
W4 45-0140	1 mm	2400 ea	20 – 90 µl	Gray	Bacterial
W4 45-0141	2 mm	2400 ea	40 – 400 µl	Blue	Bacterial, Mammalian
W4 45-0142	4 mm	2400 ea	80 – 800 µl	Yellow	Mammalian

BTXpress™

High Performance Electroporation Solution



- **Efficient Electroporation Transfection:**
High efficiency transfection of the cell lines and previously considered "hard to transfect" cells.
- **High Cell Viability:**
Low toxicity resulting in improved cell viability.
- **Single Buffer for all Cell types:**
One buffer used in place of standard electroporation buffers for all mammalian cell types.
- **Control:**
Versatility of choosing your electroporation optimization settings for the highest transfection efficiency with BTX systems.
- **Affordability:**
Choose your size kit to fit your needs, more samples per kit with lower cost compared to competitor.

BTXpress™ High Performance Electroporation Solution

BTX, the electroporation experts, are introducing the BTXpress™ High Performance Electroporation Solution. The BTXpress™ is THE solution in High Performance Electroporation. A single buffer solution developed to quickly and efficiently deliver genes into mammalian cells

that were previously considered "hard to transfect" by chemical and other non-viral methods. This solution, in combination with the BTX electroporation instruments, provides researchers with the versatility and success desired with a broad range of cell types while maintaining critical cell viability. Transfection using this high performance



electroporation solution is equally effective in delivering DNA as well as siRNA into mammalian cells. BTXpress™ solution is the first electroporation reagent that meets all of your high performance transfection needs without sacrificing control over your experiment or your budget. The BTXpress™ solution offers increased numbers of transfections per kit compared to our competitors providing higher value to the researcher. As a universal solution, the BTXpress™ electroporation solutions can be used in other electroporators including the Amaxa™ to deliver similar results without the typical high cost associated with these buffer kits. The BTXpress™ High Performance Electroporation Solution is offered as a kit including the BTX plus cuvettes with transfer pipettes or as a buffer alone.

BTXpress™

High Performance Electroporation Solution (continued)

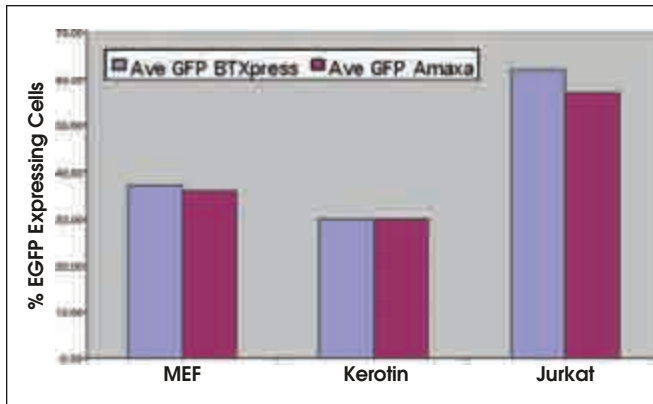
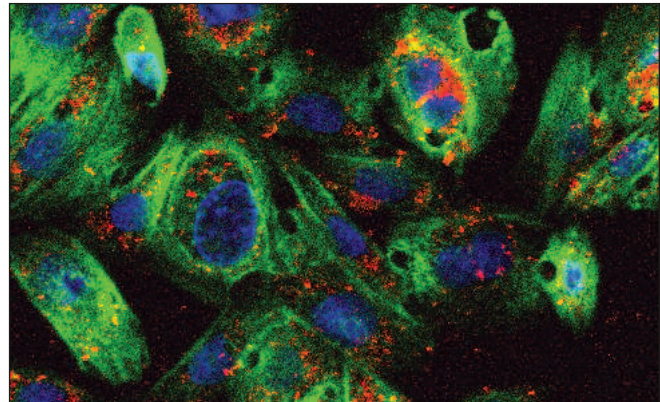


Figure 1: BTXpress™ High Performance Electroporation Solution vs. Amaxa™ Nucleofector™. Cells were electroporated with an EGFP reporter vector in parallel, using the BTX ECM 830 Square Wave Electroporator with the BTXpress™ High Performance Electroporation Solution or using the Amaxa (Lonza) system. EGFP expressing cells were identified 24hrs post-electroporation by flow cytometry and presented as a percentage of the live cell population.



BTXpress™ High Performance Electroporation Solution Efficient siRNA silencing: CHO Cells were transfected by electroporation with BTXpress™ electroporation solution with tracker Cy™ 3 labeled siRNA. Cells were fixed and counterstained to locate the nuclei (blue) and actin (green).

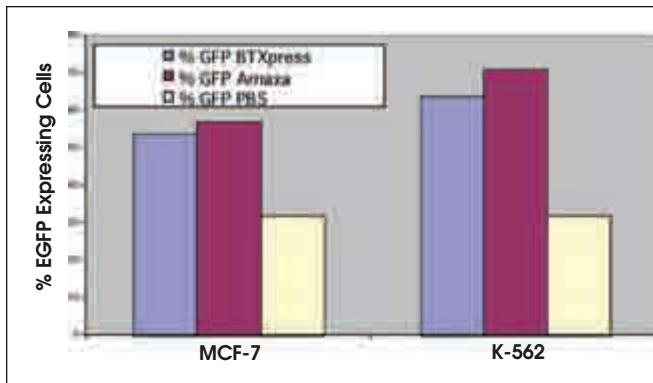


Figure 2: BTXpress™ Solution Transfection Efficiency vs. Amaxa™: Cells were electroporated in parallel with an EGFP reporter vector using either the BTX electroporation system with BTXpress™ High Performance Electroporation Solution or PBS. In comparison to the same cells transfected in the Amaxa™ (Lonza) system using the Amaxa™ kit V solution. The EGFP expressing cells were identified 24 hrs post-electroporation by flow cytometry and presented as a percentage of the live cell population.

Storage Conditions

Store BTXpress™ Electroporation Solution at 4°C. Store all other components at room temperature.

Components: Kits contain BTX plus cuvettes either 2mm gap or 4mm gap with transfer pipette.

Please Note: Amaxa™ Nucleofector™ are a registered trademarks.

BTXpress™ Kits

Item #	Product
W4 45-0803	BTXpress Solution Kit 50 Reactions in 2mm gap Cuvettes: Includes 5.0ml bottle BTXpress Solution and 5 bags of (10 cuvettes per bag), 2mm gap BTXplus cuvettes with transfer pipette.
W4 45-0804	BTXpress Solution Kit 20 Reactions in 4mm gap Cuvettes: Includes 5.0ml bottle BTXpress Solution and 2 bags of (10 cuvettes per bag) 4mm gap BTXplus cuvettes with transfer pipette.
W4 45-0806	BTXpress Solution Kit 100 Reactions in 2mm gap Cuvettes: Includes a 10ml bottle of BTXpress Solution and 2 bags of 50 cuvettes per bag, 2mm gap BTXplus cuvettes with transfer pipette.
W4 45-0807	BTXpress Solution Kit 40 Reactions in 4mm gap Cuvettes: Includes a 10ml bottle of BTXpress solution and 4 bags of (10 cuvettes per bag) 4mm gap BTXplus cuvettes with transfer pipette.

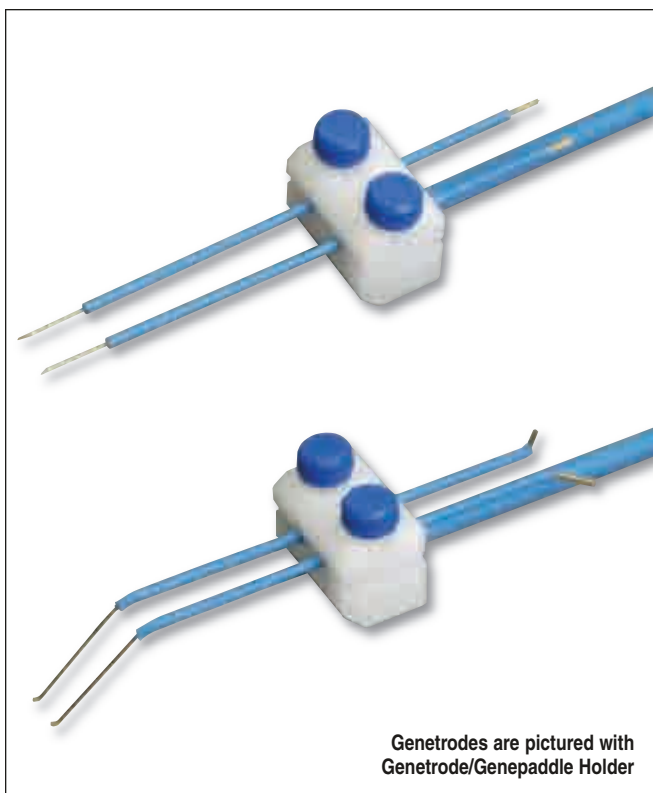
BTXpress™ Solution Only

Item #	Product
W4 45-0802	BTXpress Solution: 5.0 ml Bottle for up to 50 Reactions
W4 45-0805	BTXpress Solution: 10 ml Bottle for up to 100 Reactions

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Genetrodes are pictured with Genetrode/Genepaddle Holder

- In Vivo Gene Delivery
- Ex Vivo Gene Delivery
- In Ovo Gene Delivery

BTX Genetrodes are paired, reusable, needle-style or L-shaped type electrodes that are ideal for in vivo and in ovo electroporation applications, including drug and gene delivery. Genetrodes come in five models to suit the size and shape of the target electroporation area. Each model consists of a pair of electrodes configured as either straight or bent L-shaped electrodes with gold tips.

The Electrodes are placed into target tissue following injection of the molecule of interest. An electroporation pulse is then delivered using a BTX Generator. The electric field introduced by the Genetrodes causes transient pores to form in the cells of the tissue, allowing uptake of the molecules into cells. Genetrodes are positioned in parallel at a predetermined gap in tissue using the Genetrode/Genepaddle Holder.

Specifications

Generator Compatibility	ECM 830, ECM 2001
Voltage Range	0 – 200 V DC
Pulse Length Range	10 µsec – 99 msec
Diameter	Electrode tip 0.5 mm
Genetrode Holder:	
Electrode Gap	1 – 10 mm range
Life Span	Approximately 1500+ pulses

Genetrodes*

Item #	Tip Size	Shape
W4 45-0113*	5 mm	Straight
W4 45-0114*	10 mm	Straight
W4 45-0115*	5 mm	L-Shapped
W4 45-0116*	3 mm	L-Shapped
W4 45-0117*	1 mm	L-Shapped

Genetrode Kits**

Item #	Tip Size	Shape
W4 45-0160**	5 mm	Straight
W4 45-0161**	10 mm	Straight
W4 45-0162**	5 mm	L-Shapped
W4 45-0163**	3 mm	L-Shapped
W4 45-0164**	1 mm	L-Shapped

Genetrode Accessories

Item #	Product
W4 45-0203	Genetrode/Genepaddle Holder (Model 515)
W4 45-0216	Connection Cable, Micrograbber to Banana Plug Cable
W4 45-0217	Banana to Banana Plug, 10ft.
W4 45-0089	Adapter Set Banana to Square Post
W4 45-0087	Adapter Micrograbber for ECM 2001

* Requires 45-0203 Genetrodes/Genepaddle Holder and 45-0216 Connection Cable

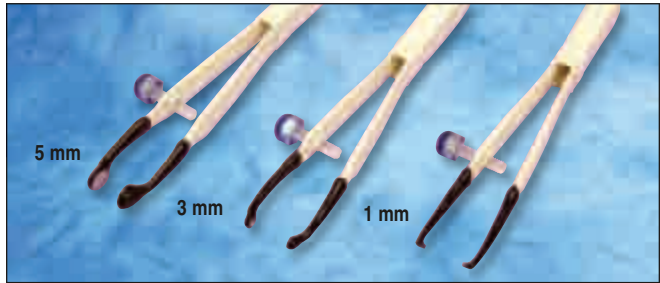
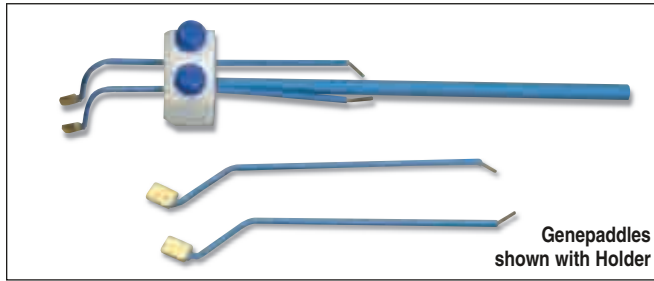
** Kit Includes Genetrode Electrode, 45-0203 Genetrodes/Genepaddle Holder and W4 45-0216 Connection Cable

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Genepaddles™ and Tweezertrodes™

In Vitro Embryo & In Vivo Gene Delivery



Genepaddles™

- In Vivo Gene Delivery
- Ex Vivo Gene Delivery

BTX Genepaddles are designed for in vivo applications such as Gene Delivery in mouse embryo. Genepaddles are non-invasive, paddle-style, reusable electrodes suitable for a variety of applications. These electrodes are gold plated and are available in two models, each model consisting of a pair of electrodes. The electrodes are placed anterior and posterior to the embryo following injection of the molecule of interest, and then an electroporation pulse is delivered using a BTX Generator. The Genepaddles may be positioned in parallel at a predetermined gap in tissue using the Genetrode/Genepaddle Holder.

Specifications

Generator Compatibility	ECM 830, ECM 2001
Voltage Range	0 – 200 V DC (Do not use AC)
Pulse Length Range	10 µsec – 99 msec
Paddle Configuration	Rectangular, 1 mm thick
Gold Plating Thickness	0.04 mm
Genetrode Holder	Electrode gap 1 – 10 mm range, life span (depending on care) approximately 200+ sets of pulses

Genepaddle Electrodes

Item #	Paddle Size
W4 45-0122*	3 x 5 mm
W4 45-0123*	5 x 7 mm

Genepaddle Kits

Item #	Paddle Size
W4 45-0169**	3 x 5 mm
W4 45-0170**	5 x 7 mm

Genetrode Accessories

Item #	Product
W4 45-0203	Genetrode/Genepaddle Holder (Model 515)
W4 45-0216	Connection Cable, Micrograbber to Banana Plug Cable
W4 45-0216	Connection Cable, Micrograbber to Banana Plug Cable
W4 45-0217	Banana to Banana Plug, 10ft.
W4 45-0089	Adapter Set Banana to Square Post
W4 45-0088	Adapter Set F/F Banana to Square Splice
W4 45-0087	Adapter Micrograbber

* Requires W4 45-0203 Genetrodes/Genepaddle Holder and W4 45-0216 Connection Cable

** Kit Includes Genepaddle Electrode, W4 45-0203 Genetrodes/Genepaddle Holder and W4 45-0216 Connection Cable

Tweezertrodes™

- In Vivo Drug or Gene Delivery
- Ex Vivo Drug or Gene Delivery
- In Utero Drug or Gene Delivery

The Tweezertrodes™ are reusable, tweezer style electrodes for in vivo, and in utero drug or gene delivery. Tweezertrodes™ consist of a standard 12 cm tweezer that has been modified with stainless steel or platinum circular electrodes at the tip. The gap between the electrode disks may be adjusted from under 1 mm to over 2 cm. Stainless Steel Tweezertrodes are available in two sizes 10 mm and 7 mm diameters. Our Platinum Tweezertrodes™ are available in 7 mm, 5 mm, 3 mm and 1 mm diameters. These electrodes are connected to an electroporator with the Model 524 Connection Cable, and are compatible with the BTX ECM® 830 and ECM® 2001.

Specifications

Generator Compatibility	ECM 830, ECM 2001
Voltage Range	0 – 200 V
Pulse Length Range	10 µsec – 99 msec
Monitoring	Enhancer 3000 Recommended
Autoclave	No

Platinum & Stainless Steel Tweezertrodes™

Item #	Product
W4 45-0118*	Stainless Steel Tweezertrode Electrode, 7 mm Diameter, no Cables (Model 520)
W4 45-0165	Stainless Steel Tweezertrode Kit, 7mm, Includes Cable (Model 520KIT)
W4 45-0119*	Stainless Steel Tweezertrode Electrode, 10 mm Diameter, no Cables (Model 522)
W4 45-0166	Stainless Steel Tweezertrode Kit, 10 mm, Includes Cable
W4 45-0486	Platinum Tweezertrode, 1 mm Diameter, Includes Cables
W4 45-0487	Platinum Tweezertrode, 3 mm Diameter, Includes Cables
W4 45-0489	Platinum Tweezertrode, 5 mm Diameter, Includes Cables
W4 45-0488	Platinum Tweezertrode, 7 mm Diameter, Includes Cables
W4 45-0204	Tweezertrode Cables (Model 524)

* Needs cable W4 45-0204 to connect to generator

2-Needle Array™ and Caliper Electrodes

In Vivo Muscle Gene Therapy/Transdermal Drug Delivery



2-Needle Array™

- In Vivo Drug or Gene Delivery
- Muscle Gene Therapy

The BTX 2-Needle Array Electrodes are needle-style electrodes designed for in vivo drug or gene delivery applications. The electrode is available in two gap sizes, 5 mm and 10 mm. The 5 mm 2-Needle Array and Handle is recommended for small muscle masses such as mouse tibialis. The 10 mm 2-Needle Array and Handle is recommended for larger muscle masses such as rat gastrocnemius. Among the non-viral techniques for in vivo gene transfer, the direct injection of plasmid DNA into muscle is simple, inexpensive and safe.

These Electrodes are supplied in a convenient kit that includes one 2-Needle Array Handle and six 2-Needle Arrays. Components may also be purchased separately.

Specifications

Generator Compatibility	ECM 830, ECM 2001
Voltage Range	0 – 500 V
Pulse Length Range	10 μ sec – 99 msec
Handle Length	8 cm (3.2 in)
Handle Material	Delrin
Needle Length	20 mm
Needle Material	Stainless Steel

2-Needle Array™ Electrode Kits

Item #	Gap Size	Handle	2-Needle Array
W4 45-0168*	5 mm	1 each	Package 6, 5 mm gap
W4 45-0167*	10 mm	1 each	Package 6, 10 mm gap

2-Needle Array™ Electrodes, pkg. of 6

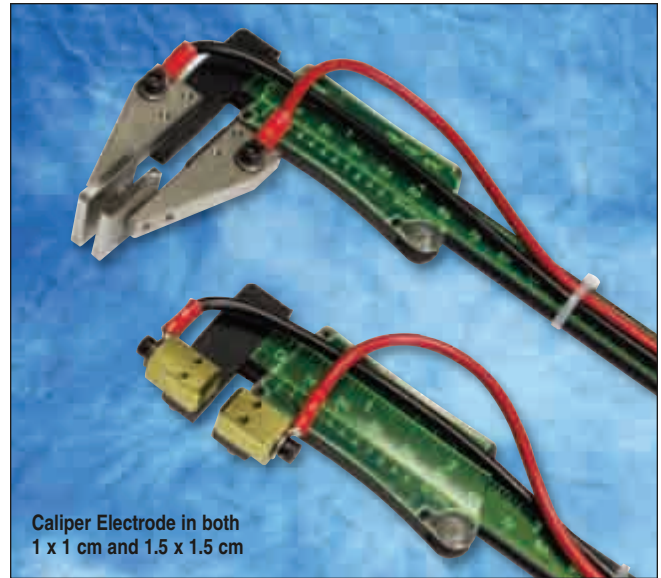
Item #	Gap Size	Pkg	Sterile
W4 45-0121**	5 mm	pkg 6	Yes
W4 45-0120**	10 mm	pkg 6	Yes

2-Needle Array Handles Only

Item #	Gap Size	Qty
W4 45-0206	5 mm	1 each
W4 45-0205	10 mm	1 each

* Kit Includes 2-Needle Array Electrode and Handle with Cable

** Requires 2-Needle Array Handle with Cable



Caliper Electrode in both
1 x 1 cm and 1.5 x 1.5 cm

Caliper Electrodes

- In Vivo Drug or Gene Delivery
- Transdermal Applications
- Intact Plant Applications

BTX Caliper Electrodes are reusable, caliper-style electrodes used for a variety of in vivo applications such as drug or gene delivery into muscle tissue, skin and whole organs. Caliper Electrodes consist of a caliper and a pair of plate electrodes.

Two models are available. The W4 45-0101 Calipers have 1 x 1 cm brass electrode plates and are used for smaller animals. The W4 45-0102 Calipers are supplied with two pairs of stainless steel electrode plates, 1.5 x 1.5 cm and 2 x 2 cm, and are used for larger surface areas. The Electrode plates on the caliper may be adjusted by using the roller mounted on the caliper.

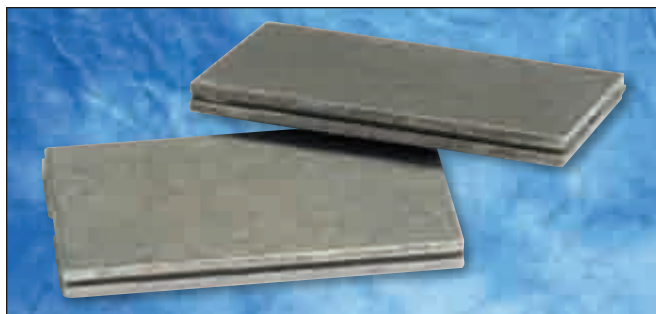
The Electrodes clasp the target tissue area following injection of the molecule of interest. Electroporation pulses are then delivered using a BTX 830 or 2001 Generator. The electric field introduced by the Caliper Electrodes causes transient pores to form in the cells of the tissue, allowing uptake of the molecules into cells.

Specifications

Generator Compatibility	ECM 830, ECM 2001
Voltage Range	0 – 500 V (depending on electrode gap)
Pulse Length Range	10 μ sec – 99 msec (multiple pulsing permitted)
Electrode Gap	0.1 to 13 cm
Electrode Dimensions	1 x 1 cm brass or 1.5 x 1.5 cm and 2 x 2 cm stainless steel

Item #	Plate Dimensions	Material
W4 45-0101	1 x 1 cm	Brass
W4 45-0102	1.5 x 1.5 cm and 2 x 2 cm	Stainless Steel

Flatpack Chambers & Flat Electrode for Cell Fusion



Flatpack Chambers

- Bacterial Transformation
- Yeast Transformation
- Stem Cell Transfection

Flatpack Chambers are primarily used for prokaryotic applications; however they are used often for high efficiency stem cell transfection as well. The one of a kind flow-through construction of the 0.56 mm gap has a volume capacity from 10 to 85 μ l. This design provides the unique combination of small sample volumes with field strengths as high as 40 kV/cm. The Flatpack Chamber 1.83 mm has a three-ply solid sandwich construction of stainless steel and mylar plastic holds a volume of 1.5 ml, ideal for stems cells. Flatpack chambers are gamma sterilized in individual packages. They are provided in sets of 50 and may be used in the Safety Stand.

Specifications

Generator Compatibility ECM 830, ECM 2001 and ECM 630

Item #	Gap Size	Package	Volume
W4 45-0109	1.83 mm	50 each	1.5 ml
W4 45-0110	0.56 mm	50 each	80 μ l

Flat Electrode

- Cell Fusion
- Hybridoma Production
- Plant Protoplast Fusion
- Mammalian Cell Transfection

The Flat Electrode can be used for both electroporation and electro cell fusion. The Flat Electrode generates either a divergent or homogeneous field depending on the orientation of the grooved electrodes.

The Flat Electrode can be oriented with the grooved sides of the electrode facing one another to generate a divergent field for use in electro cell fusion. Alternatively, it can be oriented with the flat sides facing each other providing a homogeneous field for electroporation.

The Electrode is made of two rectangular, parallel plates of high grade stainless steel that are press-fitted into a polysulfone base.

Specifications

Generator Compatibility ECM 830 and ECM 2001

Field Type Divergent or Homogeneous

Autoclavable No

Flat Electrode*

Item #	Gap	Package	Volume
W4 45-0108*	1 mm	1 each	0.5 ml

Cable

Item #	Product
W4 45-0217	Electrode Connection Cable, Banana to Banana, 10ft.

* Requires W4 45-0217 Connection Cable

Petri Pulser™ & Petri Dish Electrode

Adherent Cell Gene Delivery



Petri Pulser™

- Mammalian Cell Transfections, Gene Therapy, Protein or Drug Delivery
- Plant/Yeast Applications

The Petri Pulser is designed for the electroporation of adherent cells in situ or as an alternative to cuvette electroporation for larger cell suspensions volumes. The electroporation of adherent cells avoids the need for chemical dissociation of cells and eliminates the problems associated with low plating efficiencies following electroporation, interruption of cell cycles and intercellular communications.

To perform electroporation, simply add the exogenous molecule of interest into the electroporation buffer. The buffer can range in volume from 1.0 ml to 3.0 ml and is added to the cells grown in the plate. The electrode is lowered into the well plate containing the sample and then pulsed.

The Petri Pulser is designed to be reusable and fits into a single well of a 6-well plate or in an individual 35 mm dish. It consists of 13 gold plated electrodes spaced 2 mm apart. The Petri Pulser can be used with most BTX Generators.

Specifications

Generator Compatibility	ECM 830, ECM 630, ECM 399 and ECM 2001
Pulse Length Range	1 μ sec – 35 msec
Voltage Range	0 – 300 V
Volume Range	0.5 – 3.0 mls
Autoclavable	No
Field Type	Homogeneous
Gap Size	2 mm

Item #	Product	Volume	Electrode Material
W4 45-0130	Petri Pusher, 2 mm gap for 6-well or 35 mm Petri Dish (Model PP35-2P)	0.5 – 3.0 ml	Gold plated

Petri Dish Electrode

- Adherent Mammalian Cell Transfections
- Plant Tissue Cell Transfections

The Petri Dish Electrode is designed to be used with a 100 mm petri dish that functions as the electroporation chamber. The Petri Dish Electrode is used to electroporate adherent cells or tissue grown in a petri dish.

To perform electroporation, simply add the exogenous molecule of interest into the electroporation buffer. The buffer can range in volume from 10 ml to 50 ml and is added to the cells grown in the plate. The electrode is lowered into the petri dish containing the sample and pulsed.

The electrode assembly has a 2 mm gap size. It contains parallel stainless steel electrodes which generate a homogeneous field. The Petri Dish Electrode is compatible with most BTX Generators.

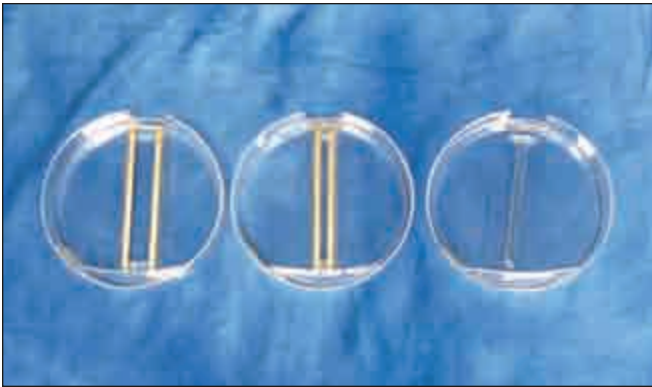
Specifications

Generator Compatibility	ECM 830, ECM 630 and ECM 2001
Voltage Range	0 – 2000 V
Volume Range	10 – 50 ml
Gap Size	2 mm
Autoclavable	No
Field Type	Homogeneous
Pulse Length	10 μ sec – 10 msec

Item # Product

W4 45-0100	Petri Dish Electrode, 2 mm Gap, for 100 mm Petri Dish (Model 366)
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Microslides & Meander Fusion Chamber



Microslides

- Hybridoma Production
- Cell Fusion
- Nuclear Transfer
- Embryo Manipulation
- Plant Protoplast Fusion
- Oocyte Transfections

BTX Microslides are used for cell fusion, plant protoplast fusion and embryo manipulation applications. They are available in 4 gap sizes, 0.5, 1.0, 3.2 and 10 mm. The 0.5 and 1.0 mm microslides produce a divergent field of energy ideal for efficient embryo fusion. While the 3.2 and 10 mm slides provide a homogenous field for high fusion rates of hybridoma cells. The Microslides are designed to easily fit on a microscope stage to allow easy observation of the alignment of cells during electrofusion.

The Microslides are composed of a glass slide and two strips of stainless steel (wire or bar) set in a plastic petri dish.

Specifications

Generator Compatibility	ECM 830 and ECM 2001
Field Type:	
W4 45-0103 & W4 45-0104	Divergent
W4 45-0105 & W4 45-0106	Homogeneous
Max Voltage	500 V
Autoclavable	No

Item #	Product
W4 45-0103*†	Microslide*, 0.5 mm Gap, 20 µl, pkg. of 10* (Model 450)
W4 45-0104*†	Microslide*, 1.0 mm Gap, 40 µl, pkg. of 10* (Model 450-1)
W4 45-0105*†	Microslide*, 3.2 mm Gap, 650 µl, pkg. of 1* (Model 453)
W4 45-0106*†	Microslide*, 10 mm Gap, 2.0 ml, pkg. of 1* (Model 453-10)
W4 45-0216	Connection Cable, Micrograbber to Banana Plug Cable

* Requires W4 45-0216 Micrograbber to Banana Plug Cable for connect on 830

† Requires W4 45-0087 Adapter Set to connect with W4 45-0216 when connecting to EMC 2001



Meander Fusion Chamber

- Cell Fusion
- Plant Protoplast Fusion

The BTX Meander Fusion Chamber is a novel microslide design which is specifically used for electro cell fusion. The Meander Fusion Chamber generates a divergent field and is used for fusion of mammalian cells, plant, yeast, fungi and microorganisms.

This specialty electrode is constructed of a conductive metal alloy. It has two primary bars that are connected by many tiny fingerlike projections. These projections are spaced 0.2 mm apart. This electrode is mounted on a glass slide. It is designed for direct viewing of dimer formation during alignment while under a microscope.

Specifications

Generator Compatibility	ECM 2001
Field Type	Divergent
Max Voltage:	
AC	16 V (0 – peak)
DC	480 V
Gap Size	0.2 mm
Autoclavable	No

Item #	Product
W4 45-0107*†	Meander Fusion Chamber*, 0.2 mm Gap*, pkg. of 4 (Model 454)

* Requires W4 45-0216 Micrograbber to Banana Plug Cable

† Requires W4 45-0087 Adapter Set for Connection to EMC 2001

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Platinum Needle L-Shaped Electrode



- Ex-Vivo Tissues Gene or Drug Delivery
- In Vivo Tissues Gene or Drug Delivery
- Nuclear Transfer

These needle style platinum electrodes are specifically designed for in vivo applications on the most fragile of tissue types, such as brain tissue. In vivo transfection of delicate brain tissue can be difficult to perform without damage to the tissue. The ultra thin electrode enables pinpoint transfection for greater ease and efficiency in fragile or inaccessible tissue. These electrodes are ideal for delivering the electrical pulses directly to oocytes or embryos for nuclear transfer fusion applications. Our L-shaped electrodes are available in 3 mm tip length in order to accommodate the most research needs in small animal models.

Specifications

Generator Compatibility	ECM 830, ECM 2001
Voltage Range	0-100 Volts
Pulse Length Range	10 μ sec to 100 msec
Needle Lengths	3 mm
Electrode Length	3 mm
Electrode Material	Platinum

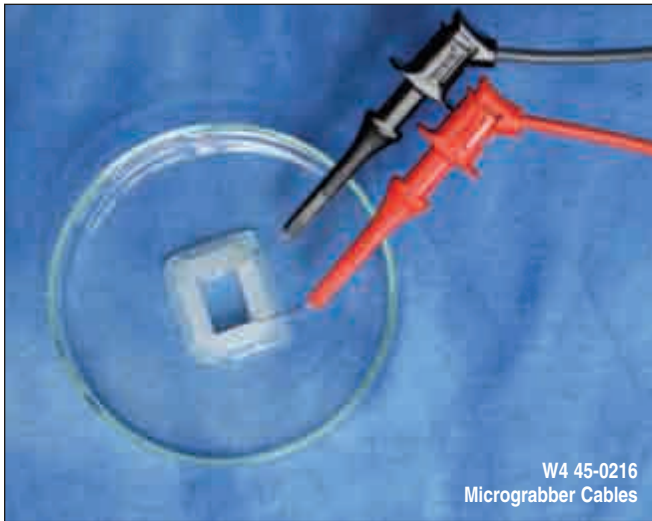
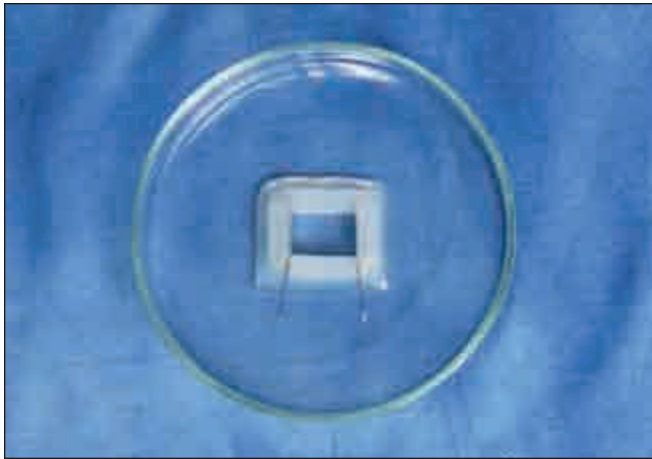
Platinum Needle L-Shaped Electrode

Item #	Product
W4 45-0510*	Platinum Needle L-Shaped Electrode Kit, 3 mm, Includes Cables
W4 45-0509*†	Platinum Needle L-Shaped Electrode, 3 mm, Needle Electrode Only
W4 45-0508	Micrograbber Adapter for Needle Electrode
W4 45-0204	Banana Adapter Cables

* Requires W4 45-0508 and W4 45-0204 to Banana Adapter

† Also requires W4 45-0088 Adapter Set, female to female for ECM 2001

Petri Dish Platinum Electrode for Tissue



W4 45-0216
Micrograbber Cables

• Ex-Vivo Tissues Gene or Drug Delivery

This tissue chamber is specifically designed to handle ex-vivo tissue samples that are either larger than normal or have a unique shape making it difficult to transfect using other standard electrodes. Transfection of ex-vivo tissue samples is an efficient method to deliver genes and drugs to a wide range of tissue types including cornea, muscle and skin. With the use of this chamber, transfection is made simple and easy. The chambers are available in two widths; 15mm and 5mm to accommodate many tissue sample sizes. The reusable chamber is made of a lab grade Pyrex glass petri dish and two platinum electrodes embedded in an inert silicone, creating the rectangular chamber that provides a homogeneous field of energy for high efficiencies.

Specifications

Generator Compatibility	ECM 830, ECM 2001		
Voltage Range	0-200 Volts		
Pulse Length Range	10 μ sec to 100 msec		
Dimensions:			
Chamber 5mm:	Length	8 mm	
	Width	5 mm	
	Depth	3 mm	
Chamber 15mm:	Length	10 mm	
	Width	15 mm	
	Depth	5 mm	

Petri Dish Platinum Electrode for Tissues Kits

Item #	Product
W4 45-0505	Petri Dish Platinum Electrode for Tissue Chamber Kit, 5 mm. Includes Glass Petri Dish with Tissue Chamber 5 mm, Glass Petri Lid and Micrograbber Cables*
W4 45-0507	Petri Dish Platinum Electrode for Tissue Chamber Kit, 15 mm. Includes Glass Petri Dish with Tissue Chamber 15 mm, Glass Petri Lid and Micrograbber Cables*

Petri Dish Platinum Tissue Chamber

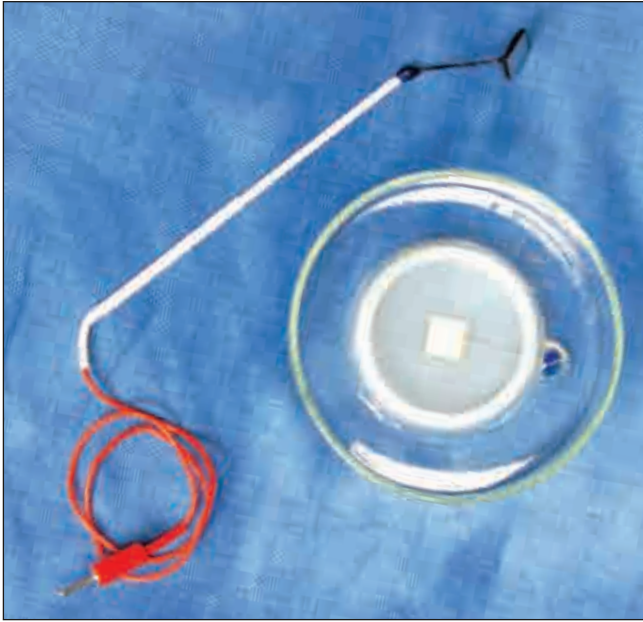
Item #	Product
W4 45-0504*	Petri Dish Platinum Electrode, Chamber Only, 5 mm gap
W4 45-0506*	Petri Dish Platinum Electrode, Chamber Only, 15 mm gap

Cables

Item #	Product
W4 45-0216*	Micrograbber Cables (positive and negative)

* Cables required are not included

Petri Dish Platinum Electrode for Tissue Slices



• Ex-Vivo Tissues Gene or Drug Delivery

This electrode is designed for delicate and/or difficult tissue transfection. Ex vivo electroporation is an efficient, effective method to introduce genes, drugs or any number of molecules into a tissue. A common application is mouse brain slice for studying neuronal development. This specialty electrode makes transfection quick and simple and is compatible with the BTX ECM 830 and ECM 2001 generators.

The electrode is comprised of two parts, the petri dish and wand. The petri dish contains a platinum electrode chamber to secure the tissue. The wand incorporates an identical shaped platinum electrode, which is placed over the chamber to complete electroporation. This sandwich configuration ensures a homogeneous field of energy for optimum transfection.

Specifications

Generator Compatibility	830, ECM 2001	
Voltage Range	0-100 Volts	
Pulse Length Range	10 usec to 100 msec	
Chamber Depth	1mm	
Electrode Material	Platinum	
Wand Material	Platinum	
Dimensions:		
Dish Electrode:	10 mm 7 mm	10 mm x 10 mm x 1 mm 7 mm x 7 mm x 1 mm
Wand Electrode:	10 mm 7 mm	10 mm x 10 mm 7 mm x 7 mm

Petri Dish Platinum Electrode for Tissue Slices Kits

Item #	Product
W4 45-0500*	Petri Dish Platinum Electrode for Tissue Slices Chamber Kit, 10 mm
W4 45-0490*	Petri Dish Platinum Electrode for Tissue Slices Chamber Kit, 7 mm

* Kits include dish chamber, wand and cables

Petri Dish Platinum Electrode Chambers and Wands

Item #	Product
W4 45-0501**	Petri Dish Platinum Electrode Chamber Only, 10 mm, negative
W4 45-0491**	Petri Dish Platinum Electrode Chamber Only, 7 mm, negative
W4 45-0502***	Platinum Electrode Wand Only, 10 mm, positive
W4 45-0492***	Platinum Electrode Wand Only, 7 mm, positive

** Requires, 45-0502, 45-0503, 45-0504

*** Requires, 45-0501, 45-0503, 45-0504

Cables

Item #	Product
W4 45-0503	Micro-Grabber Cable for Chamber, negative
W4 45-0511	Single Adaptor Cable for Wand

contact information

Sales Subsidiaries & Authorized Distributors

Subsidiaries

CANADA



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website **www.harvardapparatus.ca**

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