Programmable Multipipette Puller **PMP - 107 USER'S GUIDE**

MicroData Instrument, Inc.

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PMP107 V7.0A

The Puller's Features

Automatic 4-Barrel or 7-Barrel Pipette Puller

With just pressing one key, a 4 or 7-barrel pipette can be successfully pulled by the PMP-107 Programmable Multipipette puller. Equipped with a microcomputer, pneumatic pulling arm, pneumatic rotator and opticaldigital ruler, the PMP-107 can automatically heat, twist and pull a multibarrel pipette. There is no need for any manual rotation or any inconsistent timing interrupt control. The whole pulling processing is programmable and under control of a preset sequence. The PMP-107 is a new generation of sophisticated multipipette puller.

Exclusive Optical-Digital Ruler Measurement

There is an exclusive optical-digital ruler in the PMP-107 to perform precise taper length setting, real-time measurement and tip sensing. With this feature, a user can easily handle taper and tip pulling.

Computerize Real-Time Feedback Heater Control

In the PMP-107, there is an advanced microcontroller to perform real-time heater monitoring and controlling. If a heating level is selected and preset, the microcontroller will measure the actual heating power during heating power on. The measurement will be real-time displayed and feedback to the control unit to match the set point dynamically. As a result, the PMP-107 always provides precise heating power, despite of many times of pipette pulling or thermal/electrical characteristic changing. Under a microcomputer controlling, the heater is smart and reliable.

Programmable and Savable Sequences for Creation and Reproduction

There are 25 user programmable and savable pulling sequences with 18 steps in each sequence. Users can easily program different taper length, tip shape for 4 or 7-barrel pipette. Time number, heat level, heat control and action parameters can be individually set in each step. After a special sequence setting up, a multibarrel micropipette will be automatically produced by just pressing the Start button.

Manufacture Preset Pulling Programs for 4 and 7-Barrel Micropipettes

Every PMP-100 will be well tested and installed sample pulling programs for 4 and 7-barrel. A new user will easily select the right program or just change a few step parameters to fit their special need. The preset programs are convenient and important, not only because they can pull the 4 and 7-barrel pipettes which are supplied by the manufacture, but also as templets to make other programs with only minor parameter change for other applications.

Pneumatic Pulling Force and Very Compact Size

Comparing with other pipette puller using gravity or magnetic field as pulling force, the PMP-107 applies precise controlled pneumatic pressure as the pulling force, which gives more controllable, even and consistent dragging characteristics. Within a very compact size, the PMP-107 can precisely and automatically perform twisting and multiparameter multi-pulling without inconsistent manual interrupt. A precision micro-linear ball bearing rail and advanced pneumatic components are used to provide no fault pulling movement. A simple 4x4 keypad and full information display LCD let users control easily and read all pulling parameters directly, which include sequences, steps, time, timing, heater level, heater control, tip length and actions. With an intelligent PMP-107, pulling a multipipette is no longer an uncertainty of hand skill, but a reproducible automatic processing.

Setting Up the Puller

1. Unpacking and connections

Unpack the puller from the shipping package and check that the following items are included with the puller:

- . Power cord
- . Pressure gas input tubing with connectors
- . User's Guide

Connect the power cord to the puller and then plug into a grounding power supply with the same voltage as specified on the puller's back panel. Connect the gas input tubing to the gas input port of the puller and then connect the tubing to a pressure air source. If the pressure air source is a compressor, there should be an on/off valve, a tank and a coarse regulator for a 30-60 psi output pressure. **An input pressure higher than 100psi will damage the puller.**

Turn on the power first and then turn on the pressure.



2. For First Time Using

The first time user can follow the following steps to quickly use the PMP-107. Please refer to other chapters for details instructions such as the Key Pad Functions and Display, Programming the Pulling Sequences, Installing a Multipipette, Troubleshooting etc.

Two examples of pulling program are already installed in the PMP-107, sequence 1 for 4-barrel micropipette, sequence 2 for 7-barrel micropipette. These example sequences only give users some directions for how to pull the basic 4 or 7-barrel micropipette. They are all changeable. A new user can test these programs, and then copy to a new sequence which some steps will be modified to set a customizes program to suit the specific conditions or requirements.

A. Using a Stored Program:

1) Ensure input gas pressure is less than 100 psi (7000 millibar), 30-50 psi is the requirement.

2) Switch on power, READY status will be displayed.

3) To select required stored program (up to 25 programs can be stored):

Press PROG keyPROGRAM status is displayed and cursor flashes on the program sequence numberPress ^or v keyTo select stored program (SEQ01)

Press READY key To go back to READY status

4) Adjust the PRESSURE 1 and 2 (displayed as pxx.x and Pxx.x) for first and second pulling force to match the required values in the stored program memory (display as mxx.x and Mxx.x), that means pxx.x = mxx.x and Pxx.x = Mxx.x.

5) Move the pipette holder toward the heater and press RETURN key to turn the rotator clamp to start position. Press the ROTA and RETURN keys to make sure the rotator is turnable from initial sticky condition. Adjust the COOL PRESSURE for suitable rotation speed. The last pressing key must be RETURN key.

6) Load a multibarrel glass capillary (See page 15 for Installing a Multibarrel Micropipette).

7) Pull down the cover, then press the START key. The programmed pulling sequence now takes place.

B. Setting a New or Modified Program Sequence: (Modification of a copy sequence from an existing sequence is easier than programming every step of a new sequence.)

1) Ensure input gas pressure is the less than 100 psi (7000 millibar), 30-50 psi is the requirement.

2) Switch on power, READY status will be displayed.

3) Select a program which works for 4 or 7 barrel multipipette as a modification sample if modified sequence is needed. Select a new sequence

Press PROG key: PROGRAM status is displayed and cursor flashes on program sequence number. **Press ^ or v key:** To select an existent sequence number as a copy source file which will be a backbone of a new or modified sequence.

Press and hold PROG key for about 2 seconds until the LCD displays:

COPY SEQXX TO SEQXX? START->YES EXIT ->NO

Press < or > key: To select source or destination sequence.

Press ^ or v key: To select sequence number.

Press START key: Confirm copy action.

Press STEP / EXIT key: No copy action and back to PROG status.

4) See page 12-14 to understand programming a pulling sequence. For programming the first step of preheat: **Press STEP or > key:** Move the cursor to the first step T1 position.

Press STOP key:Except only modify the step, always clear all values before programming a new stepPress > or < key:</th>Move the cursor to next setting position: time digits--heat level digits--actions.Press ^ and v keys:Select time and heat level digital values. No action on the first step, only heat to soften the multipipette.

5) To set the rotation (twist) step, continue press > key until the cursor reach the second step. Or, back the cursor to T1 position by pressing the STEP key, then press v key to move the cursor down to next step.

Press > key or < then v key: Move the cursor to next step T2 position.

Press STOP key: Except only modify the step, always clear all values before programming a new step. **Press > or < key:** Move the cursor to next setting position: time digits--heat level digits--actions. **Press ^ and v keys:** Select time and heat level digital values.

Press ROTA key: Set twist (rotation and pull, R&P) step. Set 2-3 seconds for continue rotation after pulling distance. Set R&P: 02-03 for pulling distance. Pulling too long while rotating will cause multipipette separated. No pull while rotating will cause twist concentrated on small section. Without adding time (2-3 seconds), the rotation may not turn to the end while finishing the pulling distance.

6) To set cool down pause between first and second pull:

Press > key: Move the cursor to next step T4 position.

Press STOP key: Except only modify the step, always clear all values before programming a new step.

Press > key: Move the cursor to time position.

Press ^ and v keys: Select time digit values only, no heat or action setting.

7) To set the pulling step:

Press > key or press STEP key then press v key: Move the cursor to the next step T3 position or, back cursor to T2 position and move down to the next step.

Press STOP key: Always reset all values before programming the step.

 $\label{eq:PressPULL1 key: Set first pull and replace timer control with pulling length control: display as <-L for time and PU1:xx for action.$

Press^ and v keys: Select PULL1 length digit values (Every number represent 0.5mm, maximum setting=40x0.5mm=20mm). More than 40 setting will turn the length control to time control, and then the time number must be set.

Press < **key:** Move the cursor to heat level digit position.

Press > key (or < key): Select heat level digit values

or press AUTOHEAT: set automatic heating level, select a starting heat level (hxx^) for automatic heat rise.

8) To set second or third pull, just repeat step 6) and 7) above.

9) before setting the final pull, a preheating step is recommended:

Press > key: Move the cursor to next step Tx position.

Press STOP key: Always reset all values before programming the step.

Press > key: Move the cursor to time and heat level positions.

Press ^ and v keys: Select time and heat digit values, no action setting. Time value is critical for the final pull. **Press PULL2 key:** Set second pull functions. If the heat level was set for 'Hxx^', the heater will automatically turn off as soon as the tip pulled and if the tip is not pulled to finish the heater will automatically turn on again until finishing the tip pulling. **Press COOL key (optional):** If press COOL key, the 'PULL2C' will be set. That means an air jet will cool down the heater immediately as soon as the tip pulled, also, if the tip is not pulled to finish the heater will automatically turn on again until finishing the tip pulling. This option will produce a very sharp tip, but the heat level and Pull2 pressure settings are critical (See page 9).

10) To set the final pulling step:

Press > key or press STEP key then press v key: Move the cursor to the next step position or, back cursor to Tx position and move down to the next step.

Press STOP key: Always reset all values before programming the step.

 $\label{eq:PressPULL2key: Set last pull and replace timer control with pulling length control: display as <-L for time and PU2:xx for action.$

Press^ and v keys then COOL key : If the final pull no need for air cool, just press the length digit higher than 40 setting, and then set enough time for the final pull (5-10 sec). If air cool is needed, select PU2:xx length digit values, for example :03 (Every number represent 0.5mm, maximum setting=40x0.5mm=20mm), and then press COOL key which is displayed as 'PU2:03c'. That means the air will be injected to the heat coil after pulling 1.5mm long and the pipette is continually pulled to beak. No heat setting on this step.

11) To set recover cooling step:

Press > key: Move the cursor to next step position.

Press STOP key: Always reset all values before programming the step.

Press > key: Move the cursor to time digit positions.

Press ^ and v keys: Select timer digit values. No heating setting.

Press COOL key: Set cool air injection to thoroughly cool down the heater to recover the original heater condition.

12) To set last step for completion of program:

Press > key:Move the cursor to last step position.Press STOP key:Clear all values for the termination.

IMPORTANT: If the total of steps in the programmed sequence is less than 18, it is essential to program STOP on the last step to enable the program to finish. If all 18 steps have been set, the sequence will automatically stop after 18 steps.

13) It is now necessary to set the gas pressure values for the force of Pull 1 and Pull 2: Within the READY or PROG status, pressure 1, 2 (p and P as displayed) can be adjusted to match the requirement. But only in PROG status, the pressure readings can be saved to the memory:

Press P MEMO SAVE? key: Move the cursor to Pressure Memory position.

Press P SAVE? key again: Display real Pressure 1, 2 measurements.

(Press P SAVE? key third time): (Cursor will back to Pressure Memory position, no memory change.) Adjust knobs of Pressure 1, 2: To get required pressures.

Press SAVE DOWN (v) key: To save the pressure measurements and up date the pressure memory and back to Pressure Memory position,

Press READY key: Back to READY status. The instrument is now ready to operate the programmed sequence.

Understanding the Puller's Control and Functions 1. Parts and Fuctions on the Front Panel



1. Top Cover. Open up for installing and picking the multipipette. Cover down for pulling actions.

2. Pulling Cylinder. Pneumatic pulling actuator.

3. Precision Linear Balling Rail for precision linear pulling movement.

4. Pipette Rotating Clamp clamps head side of a multibarrel pipette first.

5. Pipette Pulling Clamp clamps tail side of a multibarrel pipette for pulling.

6. Heater Fixture. Turning two screws to rep-place the heating coil.

7. Heater Coil. There are different turns of heat- ing coils for different pipette pulling.

8. Air Jet Tube can inject air to cool down the heater coil from Pressure 2 (P).

9. Rotation Cylinder. Pneumatic rotation (twisting) actuator.

10. Optical/Digital Ruler for measuring Pull 1 and Pull 2 length. The resolution is 0.5mm.

11. Pressure 1 (p) Control Regulator

supplies regulated pressure for Pull 1 action.

12. Pressure 2 (P) Control Regulator

supplies regulated pressure for Pull 2 action.

13. LCD Display Window displays all pulling parameters and programs.

14. Action Indicators will light for corresponding actions.

15. Control Key Pad is used for program- ming and action controlling.

16. Power Switch On/off power supply.

17. Power Indicator lights when power is on.

18. Cool Pressure Rotation speed adjustment.

2. Key Pad Functions and Display



The PMP-107 Key Pad



The PMP-107 Display Window

READY, PROGRAM and **ACTION** are three kinds of status in the PMP-107. The READY status is ready for manual action and automatic programming pull according to the displayed action sequence. The PROGRAM status is for selecting programs (sequences) stored in the memory and programming a new sequence. The ACTION status indicates an action is taking place. By pressing one of four Program Command Keys (PROG, TIMER, AUTO HEAT, P-SAVE?), the PMP-100 will go to PROGRAM status from READY status. By pressing READY key, the PMP-100 will back to READY status from PROGRAM status.

Within the READY status: Pressing one of five action keys (ROTA, PULL1, PULL2, COOL, RETURN), the action will take place as long as the finger press on the key, except the PULL1 function which the pulling will stop at the optical ruler set point. Pressing the START key will trigger the displaying sequence action. Pressing the STOP key will interrupt the sequencing action. Before pressing the START key, check and adjust the actual pressure 1(p) and pressure 2(P) to match the required values in the program memory (i.e. p=m and P=M). See page 15 for how to install a micropipette.

Within the PROGRAM status: The cursor blinks to indicate the program parameter that can be changed. Press the '<' and '>' keys to move cursor to different parameters or digits. (Sequence #--> Time step #--> Time setting digits --> Heat level setting digits --> Action setting or length of Pull). Press the '^' or 'v' key to select value.

There are a total of 25 sequences that can be programmed and saved, with maximum 18 steps in each sequence. For each timer step, a user can set time (from 0.0 to 999.9 second), heat level (from 26-99) or AUTO HEAT levels (from 50-98) and action (Pull 1, Pull 2, Pull2+Cool or Cool Air). To select a program (sequence), press the PROG key then press '^' or 'v' key.

If a new program is setting, press the < or > key to select a step. Before setting any new parameter in a step, press the STOP key to clear and reset the step first.

Pressing the TIMER key, the cursor will blink on the 'Txxx.x' position. Pressing the AUTO HEAT key, the cursor will blink on 'Hxx' position. Press AUTO HEAT key second time will change the heat setting to 'H50^' automatic heat rising initial number. Press <or> to select a digit and press ^or v key to select value (the optical ruler setting value=digit # x 0.5mm). Pressing the same action key second time will cancel that action setting.

The pressure 1 and 2 real-time measurements are displayed as 'pxx.x' and 'Pxx.x'. The previous pressure values which were saved in the memory are displayed as 'mxx.x' and 'Mxx.x'. In the READY status, both real-time measurements and memory are displayed and the pressure 1 and 2 can be adjusted. Pressing the 'P-MEMO/ SAVE?' key second time, the two real-time pressure measurements are displayed only and a 'SAVE?' is asked and the regulated pressure values can also be changed by turning the regulator knobs. By pressing the 'SAVE DOWN(V)' key and the new pressures will be saved and updated in the memory. If the update is not required, pressing the 'P-MEMO/SAVE?' again will back to previous PROGRAM status.

Please refer following pages for detail function of each key.

Display Window:

PROGRAM: SEQ01 TTST11 MEMO:M 20.0 m03.0			
T3: <-L	H78	PU1:03	
T4: 010.0	H00		

COPY SEQ01 TO SEQ01 ? START -> YES EXIT -> NO

PROG COPY	
Step Exit	
$P^{\texttt{MEMO}}_{\texttt{SAVE?}}$	

HEAT

Pressing Keys:

The status will change to PROGRAM and the cursor will be turned on by pressing one of these keys. When pressing the 'PROG' key, the cursor will blink on sequence # position. Pressing the 'STEP' key, the cursor will blink on sequence step position. Pressing the 'P-MEMO/SAVE?' key the cursor will blink on pressure memory position. Press and hold PROG/ COPY key about 2 seconds the LCD will display COPY status.

PROGRAM: SEQ01 TTST11			
MEMO:M	20.0	m03.0	
T3: <-L	H50^	PU1:03	
T4: 010.0	H00		

Pressing the 'HEAT' key, the cursor will blink on the heat level position. There are useful features in the AUTOHEAT function. If pressing the HEAT key second time, the heat level becomes initial '50^' setting of Automatic Rising Heat. There is a'^' which indicates that the heater will automatically rise heat level from 50 to what ever to heat the pipette until the length of PU1(2):xx setting being pulled. If pulls are controlled by timer, the heater will automatically rise heat level until 0.5mm length being pulled. To get initial heat level closer to actual pulled heat point, the ^key and v key can be used to select the 'Hxx^' digit setting up and down. The 'Hxx^' can be set from 'H45^' to 'H97^'. An excess of this range will back to fixed heat setting of 'Hxx', which can be set from 'H26' to 'H99'. After actual execution of a sequence with a 'Hxx^' setting, the heat level had risen to a point which was capable of pulling the pipette. That point already had been stored. Pressing the AUTO HEAT key again, the stored heat point digit (yy) will replace the beginning setting of 'Hxx^' to 'Hyy'. But if press the AUTO HEAT key again, the 'Hyy' will go back to 'H50^' again.

PROGRAM: SEQ01 TTST11			
MEMO:M	20.0	m03.0	
T3: <-L	H50^	PU1:03	
T4: 010.0	H00		



Pressing the < key will move cursor to one setting position left and pressing the > key will move cursor to one setting position right.

PROGRAM: SEQ01 TTST11	▲
MEMO:M 20.0 m03.0	+/UP
T3: <-L H50^ PU1:03 T⊈: 010.0 H00	

When the cursor is on timer step number position, pressing ^ key or v key will move timer step up or down. When the cursor is on sequence digits, timer digits or heat level digits positions, press ^ or v key will add or reduce the digit number. When an underline cursor is on 'Pressure SAVE?' position, adjust the pressure regulator and see the change on real pressure display. Press the v key will save the real pressure measurements to the memory (update the pressure memory). Pressing the 'P-MEMO/SAVE?' key only, the display will back to pressure MEMO without update the pressure memory.

Display Window:

PROGRAM: SEQ01 TTST03			[
MEMO:M 2	0.0	m03.0	
T2: 003.0	H85	ROTA	
T4: <-L	H80	P U1:01	

Pressing Keys:

PULL1 PULL1 Pressing the 'PULL1' key within PROGRAM status will set 'PU1:xx' on the cursor flashing step action position. Set the pull 1 length 'xx' for optical ruler measuring. The maximum setting is 40 (40x0.5mm=20mm). Setting more than 40 will change the pull1 control from optical ruler to a timer. Pressing the 'pull1' again will erase that PULL1 setting. During READY status, pressing the 'PULL1'key will trigger Pull 1 action which will pull distance as the setting of 'PU1L:xx', if the finger pressing the key long enough.

PROGRA	M: SEQ01 TTST03	Γ.
MEMO:M	20.0 m03.0	ľ
T9: 010.0	H90	
T10: <-L	H00 PU2:03c	

PULL2 PULL2 Pressing the 'PULL2' key within PROGRAM status will set 'PU2:xx' on the cursor flashing step action position. Set the pull 2 length 'xx' for optical ruler measuring. The PULL2 optical ruler control is different with the PULL1 optical control. When the pulling reaches the length set point, the PULL1 optical

control will stop the heater and pulling, but the PULL2 optical control only stop the heater, pulling is continue. The maximum length setting is also 40 (40x0.5mm=20mm). Setting more than 40 will change the pull1 control from optical ruler to a timer. Pressing the 'PULL2' again will erase that PULL2 setting. During READY status, pressing the 'PULL2' key will trigger Pull 2 action which will pull as long as the finger pressing the key. If pressing COOL key after setting PULL 2 in the same step, the setting becomes powerful function of PULL then AIR JET (PU2:xx c). With the 'PU2:xx c' setting, a air jet will cool the heater immediately as the tip being pulled for setting xx length. The heater is stop but the pulling is continue until a fine and very sharp tip is pulled to finish. There is an exclusive **Tip Sensing Function** for the PULL2 action. With the Tip Sensing Function, if the heater is too cool to finish a tip, the heater will be turned on again to repeat the pulling. However, repeating 'PU2:xx c' pulling may not be the best way to pull a tip. If this is the case, change 'Hxx' setting or preheat time to find out correct heat setting level digit or change the PULL2 pressure or add one more PULL1 step before the final tip pulling. The following table will illustrate the heating, pulling and tip sensing functions for PULL1 and PULL2 different setting:

SETTING	HEATER	PULLING	TIP SENSING FUNCTION
xxx.x Hxx PU1: <t <l hxx="" pu1:xx<br=""><l hxx^="" pu1:xx<="" th=""><th>Heat as long as set time. Heat as long as set length. Heat auto-rising from set point, stop on set length.</th><th>Pull as long as set time. Pull as long as set length. Pull as long as set length.</th><th>No. No. No.</th></l></l></t 	Heat as long as set time. Heat as long as set length. Heat auto-rising from set point, stop on set length.	Pull as long as set time. Pull as long as set length. Pull as long as set length.	No. No. No.
xxx.x Hxx PU2: <t <l hxx="" pu2:xx<br=""><l hxx^="" pu2:xx<br=""><l hxx="" pu2:xxc<br=""><l hxx="" pu2:xxc<br=""><l hxx="" pu2:xxc<="" th=""><th>Heat as long as set time. Heat as long as set length. Heat auto-rising from set point, stop on set length. Heat as long as set length, then air cool. Heat auto-rising from set point, stop on set length, then air cool.</th><th>Pull as long as set time. Pull to the end. Pull to the end. Pull to the end. Pull to the end.</th><th>No. No. Yes. Yes. Yes.</th></l></l></l></l></l></t 	Heat as long as set time. Heat as long as set length. Heat auto-rising from set point, stop on set length. Heat as long as set length, then air cool. Heat auto-rising from set point, stop on set length, then air cool.	Pull as long as set time. Pull to the end. Pull to the end. Pull to the end. Pull to the end.	No. No. Yes. Yes. Yes.

Display Window:

Pressing Keys:

ROTA

PROGRAM: SEQ01 TTST03			
MEMO:M 20.0 m03.0			
T2: 003.0	H85	R&P:03	
T4: <-L	H80	PU1:01	

In the PROGRAM status, pressing the ROTA key will set rotation and pull on the same step. Time setting indicates continue rotating time after pulling specified distance. The R&P:xx indicates the simultaneous pulling distance setting. Press the same key again will erase the rotation setting. However, if the status is READY, pressing the ROTA key will trigger rotation as long as the finger is pressing on the key.

PROGRAM:	SEQ0	1 TTST11	
MEMO:M 20	0.0	m03.0	
T11: 003.0	H00	COOL	
T12: 000.0	H00		

PROGRAM: SEQ01 TTST11 MEMO:M 20.0 m03.0		STOP
T11:003.0 H00 COOL		

READY: SEQ01 TTST11 P20.1 M 20.0 p 03.0 m03.0	READY
T1: 030.0 H90 T2: 003.0 H85 ROTA	L

In the PROGRAM status, pressing the COOL key will set air ejection on the step. The air jet can be used for cool down the heater before next pulling sequence. Press the same key again will erase the setting. However, if the status is READY, pressing the COOL key will trigger air ejecting as long as the finger is pressing on the key.

When all steps of setting are finished, but total number of steps is less than 18, don't forget to press 'STOP' key for next step to terminate the sequence. If the total number of steps is 18, the sequence will automatically stop after step 18. Pressing the 'STOP' key will set timer, heater and action to zero. Always press this key in the beginning of a new step setting. During ACTION status, pressing the 'STOP' key will halt the action and stop executing the sequence.

Press the 'READY' key when finishing the programming of a sequence. Pressing the 'READY' key will turn status to READY from PROGRAM. The READY status is ready for manual control or automatic sequential actions.

Before installing a capillary in the clamps, press the 'RETURN' key until the rotator clamp turn back to the beginning position. If the PMP-100 has not been used for some time, the rotator may be too sticky to turn. Press ROTA and RETURN few times to recover the normal turning condition.

RETURN

See page of Installing a Micropipette for how to install a capillary in the puller clamps. Make sure 'pxx.x' and 'Pxx.x' pressures are adjusted to the same value as the memory setting pressures. Then press PULL1 key only to test the security of clamping of the glass. **Do not press the PULL2 key with higher pulling pressure.** If the clamping is secure, the START key can now be pressed to start an automatic pulling sequence.

START

Programming Pulling Sequences

1. Pulling Factors

It usually takes 5-6 steps to pull a basic multipipette. A multipipette with desired tip shape and size usually needs even more than 10 steps. Besides temperature level and pulling force, the number of pulls, twisting angle, pulling distance, timing, preheat and post-cool are all critical for a multipipette production. The following figure and steps describe basic principle for pulling a multipipette :



STEP 1:

Heating a pre-pulled multibarrel pipette till softening all barrels. Besides heating, no any action is taken.

STEP 2:

After thoroughly softening all pipette barrels, the pipette is twisted 180 degree by the rotator and can be simultaneously pulled for setting distance. If the pulling distance is set too long the multipipette will not be twisted together. Only rotating without simultaneous pull, the twist will concentrate on the small section.

STEP 3:

After twisting, the pipette should be pulled little distance to reduce the size. That is first pull.

STEP4:

To continue reduce the pipette tip to a desirable size, if it is pulled only one time, the tip will be too long and too weak. Therefore, to make a strong and sharp tip, the pipette must be pulled many times, and every time with short pulling distance. After first pull, this step should stop heating to cool down the pipette for a while before next pull.

STEP 5:

Heat the pipette again until pulling another short distance.

STEP 6:

If more pulling are needed, just repeat STEP 4 and STEP 5 again.

STEP 7:

Preheat the pipette before final tip pulling. The preheat temperature and time are very critical factors for the next step final pulling. If temperature is too low, a fine tip can't be pulled in next step. If preheat time is too long, the tip will be pulled to too long and too weak in the final pull. However, if the preheat time is insufficient, the final tip opening will be too big.

STEP 8:

The last pull to form a fine tip. In this step, a higher pulling force is applied but stop the heater. Since the pipette is preheated and softened in previous step, the pipette can be pulled even as the temperature dropping down. The speed of temperature dropping down will decide the sharpness of tip. Rapid drop down temperature and higher pulling force will make a sharper tip. That is why some times an air jet is added to increase the temperature drop down speed. However, if the temperature drops down too fast or too low, the tip can't be pulled or pulled with broken tip.

STEP 9: Cool down the heater to original condition for next pipette pulling.



The above is principle for programming pulling multipipette sequences. An experienced PMP-100 user can create many different pulling sequences to pull a multipipette. The following are two examples of pulling sequences. The first sequence is pulling a 4-barrel pipette. The second sequence is pulling 7-barrel pipette. The pre-pulled 4 and 7-barrel pipettes are supplied by MicroData Instrument. The multipipettes made by other venders need different sequences set up.

2. Pulling a Four-barrel Pipette

SEQ 1:

Total 10 steps. Pressure 1 (p) = 2 psi, Pressure 2 (P) = 15 psi, Pipette: UP-4 Unpulled 4-Barrel Pipette (Made by MDI). Heater coil: #20 Nickel Chromium, 3/16" ID, 5 turns.

STEP	OPERATING TIME (sec)	HEAT LEVEL	ACTION	EXPLAINATION	
T1	25.0	H80		High temperature preheat for twist.	
Т2	03.0	H80	R&P:03	Rotate and pull the simultaneously.	
Т3	07.0	H00		Stop heat and let cool 7 seconds.	
Т4	<-L	H80	PU1:02 Second pull 1 mm.		
Т5	07.0	H00		Wait cool 7 seconds again.	
Т6	<-L	H75	PU1:04 Thirdpull2mm.		
Т7	0.9(0.8- 1.5)	H00		Stop heat 0.9 second and then ready to final pull. Time setting are very critical for the final tip pulling. The final pull will break the tip or even can't pull a tip if time is set too long. But time too short will make a tip too long.	
Т8	<-L	H00	PU2:04c	Final pull 0.5-2mm(PU2:01-04) with heater turning off, and then	
(Т9	03.0	H00	COOL)	eject air to rapid cool the heater for continue pull to the end. Option,- eject air to cool the heater for next operation.	
T10	00.0	H00		Don't forget to clear and reset the last step to stop the sequence.	

SEQ 2:

Total 8 steps. Pressure 1 (p) = 2 psi, Pressure 2 (P) = 15 psi, Pipette: UP-4 Unpulled 4-Barrel Pipette (Made by MDI). Heater coil: #20 Nickel Chromium, 3/16" ID, 5 turns.

STEP	OPERATING TIME (sec)	HEAT LEVEL	ACTION	EXPLAINATION	
T1	25.0	H78		High temperature preheat for twist.	
T2	02.0	H75	R&P:03	Rotate and pull simultaneously.	
Т3	07.0	H00		Stop heat and let cool 7 seconds.	
Т4	<-L	H75	PU1:10	Second pull 5 mm.	
Т5	2.5(0.8- 2.5)	H00		Stop heat 2.5 second and then ready to final pull. Time setting are very critical for the final tip pulling. The final pull will break the tip or even can't pull a tip if time is set too long. But time too short will make a tip too long.	
Т6	<-L	H00	PU2:04c	Final pull 0.5-2mm(PU2:01-04) with heater turning off, and then eject air to rapid cool the heater for continue pull to the end.	
(T7	03.0	H00	COOL)	Option, - eject air to cool the heater for next operation.	
Т8	00.0	H00		Don't forget to clear and reset the last step to stop the sequence.	

3. Pulling a Seven-barrel Pipette

SEQ 3:

Total 10 steps. Pressure 1 (p) = 2 psi, Pressure 2 (P) = 15 psi, Pipette: UP-7 Unpulled 7-Barrel Pipette (Made by MDI). Heater coil: #20 Nickel Chromium, 3/16" ID, 5 turns.

STEP	OPERATING TIME (sec)	HEAT LEVEL	ACTION	EXPLAINATION	
T1	25.0	H85		High temperature preheat for twist.	
Т2	03.0	H82	R&P:03	Rotate and pull simultaneously.	
Т3	07.0	H00		Stop heat and let cool 7 seconds.	
Т4	<-L	H80	PU1:02	Second pull 1 mm.	
Т5	07.0	H00	Wait cool 7 seconds again.		
Т6	<-L	H75	PU1:04	Third pull 2 mm.	
Τ7	1 (0 . 8 - 1.5)	H00		Stop heat 0.9 second and then ready to final pull. Time setting are very critical for the final tip pulling. The final pull will break the tip or even can't pull a tip if time is set too long. But time too short will make a tip too long.	
Т8	<-L	H00	PU2:04c	Final pull 0.5-2mm(PU2:01-04) with heater turning off, and then	
(Т9	03.0	H00	COOL)	Option, - eject air to cool the heater for next operation.	
T10	00.0	H00		Don't forget to clear and reset the last step to stop the sequence.	

SEQ 4:

Total 8 steps. Pressure 1 (p) = 4.5 psi, Pressure 2 (P) = 11.0 psi, Pipette: UP-7 Unpulled 7-Barrel Pipette (Made by MDI). Heater coil: #20 Nickel Chromium, 3/16" ID, 5 turns.

STEP	OPERATING TIME (sec)	HEAT LEVEL	ACTION	EXPLAINATION	
T1	25.0	H82		High temperature preheat for twist.	
T2	02.0	H80	R&P:03	Rotate and pull simultaneously.	
Т3	07.0	H00		Stop heat and let cool 7 seconds.	
Т4	<-L	H75	PU1:10	Second pull 5 mm.	
Т5	2.5(0.8- 2.5)	H00		Stop heat 2.5 second and then ready to final pull. Time setting are very critical for the final tip pulling. The final pull will break the tip or even can't pull a tip if time is set too long. But time too short will make a tip too long.	
Т6	<-L	H00	PU2:04c	Final pull 0.5-2mm(PU2:01-04) with heater turning off, and then eject air to rapid cool the heater for continue pull to the end.	
(Т7	03.0	H00	COOL)	Option,-eject air to cool the heater for next operation.	
Т8	00.0	H00		Don't forget to clear and reset the last step to stop the sequence.	

Operating the Puller

1. Installing a Multipippette

To install a pre-pulled multi-barrel pipette to the puller, follow steps and illustration below:

(1) Make sure the puller is in READY status and the real pressure measurements (p and P) are what you need (and should be the same as the m and M numbers). Press the ROTA and RETURN keys several times to overcome the stickiness of rotator in the beginning. If the rotator still can not be rotated, increase the Pressure 2. However, the Pressure 2 also is the pulling force of PULL 2. Changing Pressure 2 will change the force of PULL 2 too.

(2) Press the RETURN key finally. Loosen the rotator clamp and clamp screw. Loosen the set screw if clamping different barrel or diameter multipipette (manufactory set for 4-barrel pipette).

(3) Insert the pipette through the filament coil and let the pipette head (small side) go into the rotator clamp. The pipette head should be deep into the rotator clamp but be careful to keep enough plastic clamping area on the tail for the pulling clamp. Tighten the rotator clamp to just hold the plastic head portion of a multibarrel pipette. Don't force too tight.

(4) Adjust the clamp screw to clamp the pipette tail on the sealing plastic portion only (see following figure). If the set screw is loosened for a new type of pipette, push or pull the clamp screw slightly to make sure the tail clamping just in its free position. Then tighten the set screw. For pulling same type of pipettes, just let the set screw stays in the same alignment position as the first adjustment Turn the clamp screw only for next pipette holding.

(5) press the PULL 1 key to pull the pipette manually (without heating) to test pipette tightening security. **Do not** press the PULL2 Key for testing. If the pipette is tighten securely, then go to step (6), Otherwise, tighten the clamps again.

(6) Let the puller cover down to cover the pulling machinery and make sure no powerful light source on the rear of the puller (bright light on the rear will effect the optical ruler). Then, just press the START key to pull the pipette automatically following the displayed sequence.



2. Monitoring A Pulling Sequence Execution

The following information is important for users to create and test a new pulling sequence. Besides sequence setting parameters, there are two real time messages displayed on the display window during apulling sequence execution. One is the Timer Real-Time Counting on the upper right corner of display window. Another is Dynamic Heat Control counting in the second row of display window:



The window always displays the acting step on the third row during action. The Action Time counts up till reach the acting step time set point, and then goes to next step counting. If the acting step is PULL1 controlled by optical ruler, the Time Count will show the optical ruler movement count till reach the PU1:XX set point. If the heater is acting in the current step, the 'HC' will be displayed on the third row of window followed by dynamic heat control counting. The less significant numbers of heat control changing and jumping indicate the computer heat control is working intensely. The computer heat control is base on the filament current. There are different current limits for different diameter and different turns of filament coil. Therefore, the highest heater current setting (H99) may not be reached for some kinds of filament. Checking the dynamic heat setting number, it means the heating current reach the limit. Changing up the heat setting number will not increase the heater current in such condition.

3. Replacing Heating Filament

If a heating filament replacement is needed, loosen two screws in the heater fixture. Take out the old or broken filament and replace a new one. Before tightening the fixture screws, insert an unpulled pipette or a straight metal pin into the filament coil. Use the rotator clamp and pulling clamp to clamp the unpulled pipette or pin. Adjust the filament coil center the pipette or pin inside the coil, then tighten the two screws.

Troubleshooting

Sympton	Cause	Solution
The pipette is broken when press- ing PULL1 to test.	The pulling clamp loosen or clamp- ing position is not correct.	Make sure the pulling clamp is tighten enough and clpamping posi- tion is on the plastic clamping area.
The pipette is pulled out from rota- tor clamp during PULL 1 testing.	The rotator clamp was not tighten enough.	Tighten the rotator clamp again.
When executing a pulling sequence, the pipette is broken during rotat- ing.	The pipette is not heated enough.	Set longer preheat time before ro- tation. Set heating level no less than 78.
The rotator doesn't rotate during a pulling sequence.	Static stickiness or not sufficient pressure 2.	Rotate and return the rotator before installing a pipette and check the pressure 2.
The tips of pipette are separated after pulling sequence.	The rotator doesn't rotate. The R&P:xx number is set too big (pull too long during rotating).	Same as above.
The pipette tip is not pulled to break even the pulling sequence is fin- ished.	Pressure 2 is not high enough or preheat is too long or heat level too high for PULL2.	Adjust regulator 2 for higher pres- sure 2, or set 'PU2xxc' for rapid cool when PULL 2.
The PULL 1 is not controlled by the ruler setting.	The optical ruler is interfered by other light source.	Turn off or shield off the rear or top light source.
The PULL1 step never stop (no pull).	The heating level of PULL1 step is too low.	Press the stop to interrupt the se- quence. Then reprogram the PULL 1 heat level.
The pipette clamped area is broken after sequence pulling.	The clamping is too tight or clamp- ing position is not correct.	Manage the tightening force well and make sure to clamp on the right position.

Specifications

Pulling force Heater Heater control Heating Number of sequences Steps of each sequence Taper length setting Pressure 1 regulator	Pneumatic Nichrome coil Microcontrollor 74 general heat levels (24-99), 64 automatic heat levels (45-98). 25 18 0.5 - 20 mm 0.1 - 10 psi	Pressure 2 regulator Cool Pressure: Pressure gas input Actions Display Power input Power consumption Dimension Weight	0.1 - 60 psi Adjustable rotation speed 30 - 60 psi Pull 1, Pull 2, Pull 2/Cool, Rotation, Rotation and pull, Cool Air and Return. 20x4 LCD 110 / 240 VAC Maximum 150 watts 14"L x 11"W x 7"H 18 lbs.
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Warranty

The following warranty is in place of all other warranties, expressed or implied, and all other warranties, including warranties as to merchantability or fitness, are expressly excluded.

1. SYSTEM, PARTS AND LABOR. MDI (MicroData Instrument, Inc.) warrants purchased equipment to be free of defects in material and workmanship under normal use and maintenance from the date of shipment for a period of one year (90 days in the case of (a) fuses, light emitting diodes, and (b) separately purchased replacement parts). Consumable supplies and cables are warranted to be free of defects in material and workmanship at the time of shipment. Labor invoiced in connection with repairs performed at MDI's facility is warranted for a period of 90 days from the day of shipment of the repaired equipment.

2. LIMITATION OF REMEDY. MDI shall have no liability for any direct, incidental or consequential damages resulting from breach of warranty, from the breach of nonperformance of any term. This limited warranty does not include service to repair damage from improper installation, improper connections with peripherals, external electrical fault, accident, disaster, misuse, abuse or modifications to the equipment not approved in writing by MDI.

3. GEOGRAPHICAL LIMITATION, NONTRANSFERABILITY AND INCONSISTENT LANGUAGE. In the case of equipment located outside of the 50 states, the District of Columbia and the Commonwealth of Puerto Rico which is returned (in whole or in part) to MDI for warranty service, the transportation costs incurred in such return shall be at buyer's expense. This warranty is not transferrable and may not be supplemented or amended except in writing referring specifically hereto and signed by buyer and MDI. Without limiting the generality of the foregoing, any inconsistent language contained in requests for quotation, buyer's purchase orders, shipping instructions or similar documents is specifically rejected by MDI.



MicroData Instrument, Inc. Tel: 908-222-1717 Fax: 908-222-1365

1207 Hogan Drive, South Plainfield, NJ 07080, U.S.A. e-mail: mdi8cai@aol.com http://www.microdataMDI.com