



Advanced USB Touchscreen Syringe Pump PHM-220

USER MANUAL

DOC- 333

Rev. 1.0



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CHAPTER 1 INTRODUCTION

The [PHM-220 Advanced USB Touchscreen Syringe Pumps](#) offer the ability to control the operation of the pump either locally, using the intuitive [touchscreen interface](#), or remotely via a [USB port](#), or a [Med-Connect port](#). It is designed to interface directly with [Med-PC™](#) or [Razel IPC™](#) (Infusion Pump Control) software. To interface the pump with 3rd party or custom software, the included [USB Syringe Pump Test Program](#) installation will facilitate connection. The touchscreen remote [Dose Control Interface](#) can help you specify a syringe from a list of makes and capacities, as well as set the infusion rate in the desired units of volume and time. You can also save custom syringe size entries for future use. Using Razel IPC or Med-PC you can do more sophisticated control.

The [PHM-220](#) replaces the [PHM-111-EC](#) and is our recommended pump for variable speed and remote operated infusion or siphoning applications.

Med Associates recommends that this manual be read prior to operating the pump.

Figure 1.1 PHM-220 Advanced USB Touchscreen Syringe Pump



Table 1.1 Med Associates Syringe Pumps

	PHM-200	PHM-210	PHM-220
COMPARABLE MODELS	PHM-100, PHM-108	PHM-100VS-2, PHM-107	PHM-1111-EC R100-EC
OPERATION	<ul style="list-style-type: none"> •Standalone •Remote Via Med-PC, using 28 V Output (3pin Microfit Molex) 	<ul style="list-style-type: none"> •Standalone •Remote Via Med-PC, using 28 V Output (3pin Microfit Molex) 	<ul style="list-style-type: none"> •Standalone •Remote Via Med-PC, using 28 V Output (3pin Microfit Molex) OR USB port
TYPE	Single Speed	Variable Speed	Variable Speed
MOTOR SPEED RANGE	3.33 RPM standard (available preset at 0.1, 0.5, 1, 1.5, 2, 3.33, 5, 10, 15, 20, 30 RPM)	Tunable 0.1-30 RPM (in 0.1 RPM increments)	Tunable 0.1-30 RPM (in 0.01 RPM increments)
SPEED SELECTOR	N/A (Factory Set)	1.7" Display with rotary encoder	4.25" Touchscreen Remote Dose Control Interface
INFUSION RATE RANGE	From 0.2 mL/h (0.1 RPM in a 1 mL Syringe) 32.1 mL/min (30 RPM in a 50 mL Syringe)	From 0.2 mL/h (0.1 RPM in a 1 mL Syringe) 32.1 mL/min (30 RPM in a 50 mL Syringe)	From 0.2 mL/h (0.1 RPM in a 1 mL Syringe) 32.1 mL/min (30 RPM in a 50 mL Syringe)
SYRINGE SIZES	1-60 mL Syringes (30mm barrel max) (Small Syringes require R-ACC adapter)	1-60 mL Syringes (30mm barrel max) (Small Syringes require R-ACC adapter)	1-60 mL Syringes (30mm barrel max) (Small Syringes require R-ACC adapter)
SYRINGE TYPE	Plastic or Glass	Plastic or Glass	Plastic or Glass
ELECTRICAL SUPPLY REQUIREMENTS	28 V DC 700 mA 100-240 V AC 50-60 Hz, 25 W	28 V DC 700 mA 100-240 V AC 50-60Hz, 25 W	28 V DC 700 mA 100-240 V AC 50-60Hz, 25 W
ACCURACY	± 1.0% CV	± 1.0% CV	± 1.0% CV
LIMIT SWITCH?	YES	YES	YES
REVERSE?	NO	YES	YES
PURGE/FLUSH SPEED	20 RPM	20 RPM	20 RPM
CONSTRUCTION	Aluminum, Stainless Steel	Aluminum, Stainless Steel	Aluminum, Stainless Steel
ACCESSORIES	R-ACC (Adapter allows use of microsyringes)	R-ACC (Adapter allows use of microsyringes)	R-ACC (Adapter allows use of microsyringes)

CHAPTER 2 GETTING SET-UP

Attaching the touchscreen Dose Control Interface

The [touchscreen dose control interface display](#) is attached via a 4-pin screw-locked I/O [Display connector cable](#) to the [display port](#) next to the [manual rotation knob](#). (See Figure 2.1 Connections and controls). Be sure the plug for the connector cable is aligned correctly with pins in the same orientation as their insertion points on the display port. Insert the connector plug until the threads of the locking collar engage. Then, rotate the threaded collar clockwise until the connection is thumb tight. Do not use tools to perform this operation as they can damage the connection.

The USB Connector

The [USB type B to type A cable](#) included with the pump can be used to connect the [USB type B connection](#) next to the exit of the [display connector cable](#) on the [dose control interface](#) (See Figure 3.7) to any [USB port \(type A\)](#) on the controlling [computer](#). (See p. 18).

Ensuring You Have the Correct Syringe Clamp for Your Application.

Syringes with a barrel or outer diameter of less than 10mm can be held more securely in the [syringe clamp](#) if the (optional) [R-ACC micro syringe adaptor](#) is used (see p.16).

Powering the Pump and Turning the Device On

The PHM-220 requires a power source that provides 700 mA of direct current power at 28 V through a 5 mm jack. The [AC/DC adapter](#) which has been tested for compatibility with this device is included with the pump.

Check to make sure the [FLUSH/ON/OFF](#) switch is in the [OFF](#) position before plugging the power cable into the [AC power source](#).

Connect the [power cable](#) to the [AC/DC adapter](#), and the adapter to the pump through the [power port](#) before plugging in to the [AC power source](#).

To replace the [AC/DC adapter](#), you can order part#: [POW-28 V-0.89A](#), check with sales@med-associates.com for pricing and availability

Accessories

The dose control interface is designed to be conveniently attached to many locations for better access to pump controls when a pump must be kept in less accessible areas. If one wishes to keep the remote very close to the pump, we offer a stand ([PHM-220-stand](#)) designed to do so (See Figure 1.1).

The [R-ACC micro syringe adaptor](#) is designed to enable a better grip on small syringes and enable dispensing from of up to two small barrel diameter syringes at the same time (See Chapter 4: Special Instructions p. 16)

Figure 2.1 Connections and controls

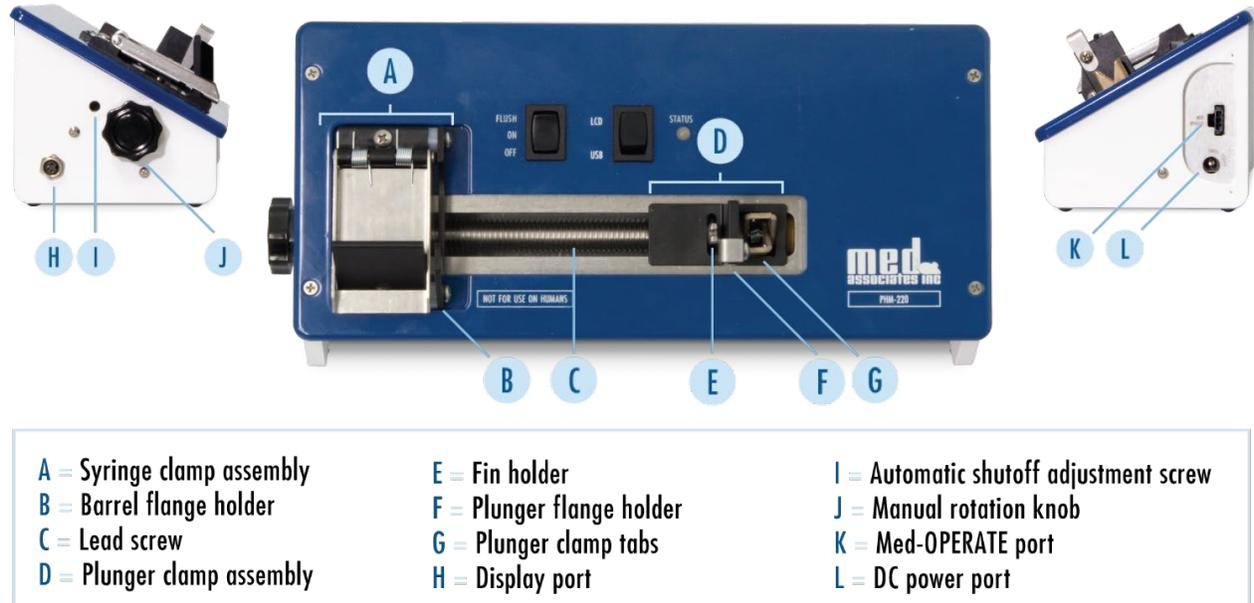


Figure 2.2 Parts of a Syringe

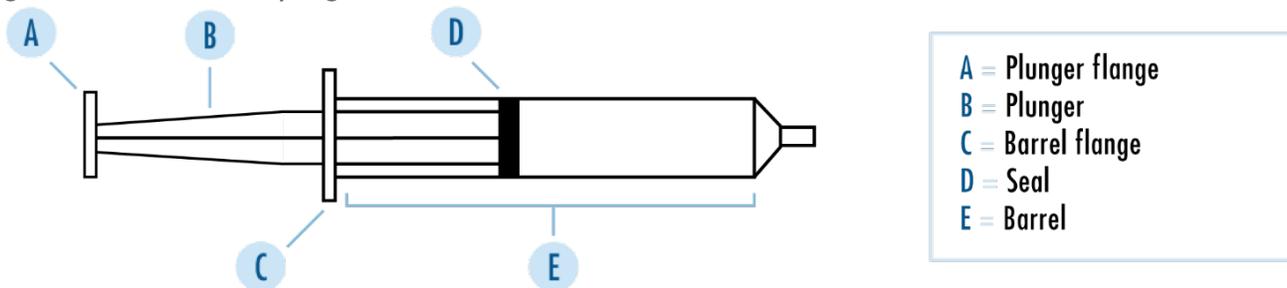


Figure 2.3 The pinout of the 3-pin Med OPERATE Molex connector

Med Control connector

To operate the PHM-220 from a standard Med Associates Connection panel connect the [Med OPERATE](#) port to any available [Med OUTPUT](#) using the included [SG-222 cable](#).

Med-PC sends active-low [Operate](#) signals. Meaning that the signal is active when the voltage drops to ground on the [Operate](#) line.

The pump will begin the infusion until the [Operate](#) signal stops, meaning power returns to the [Operate](#) pin. This reduces latency in operation, and helps confirm connection integrity, but care must be taken if damage is done to the [Operate](#) pin line as a short between this line and the [Voltage](#) pin (3) will trigger the pump to dispense.

FUNCTION	
1	GROUND 28 Volt Ground
2	OPERATE (+28 Volts) Active low
3	VOLTAGE +28 Volts DC



CHAPTER 3 GETTING STARTED

To turn on the pump look to the switch on the top left of the face of the device marked FLUSH/ON/OFF and move the switch to the ON position.



Figure 3.1 PHM-220 switches set to ON-USB (left) and ON-LCD (right)

When the pump LCD/USB switch is set to USB mode (as in the first half of Figure 3.1), the touchscreen interface is used to set the pump ID. This is explained in the next section.



Figure 3.2 USB Operation view (left) and LCD Operation view (right)

The Active Settings view

The Active Settings view can be accessed from either operation view by pressing the * button in the lower left corner. This view is a pathway to a number of options which will be covered in greater detail later in this manual. From this screen one can access the Set Pump ID view (See p.9), the Alarm Settings view (See p.25), and the Pump Info view (See p.8). The Rotate Display button will rotate the view 180 degrees so that the screen may be viewed when hung inverted. Clear All Settings is a seldom used button that will reset the pump back to factory presets. It is important that the user is aware that once this option is chosen and confirmed that the preferences and saved syringe settings will be deleted and cannot be recovered.



Figure 3.3 Active (*) Settings view



Figure 3.4 Pump Info view

Setting the Pump ID

If no [Pump ID](#) has been set, when the pump is turned on in [USB](#) mode (or switched to [USB](#) mode) the pump will open the [Set Pump ID](#) view (See Figure 3.6). The [pump ID](#) allows Med-Associates or other third-party software programs to uniquely identify a pump. If more than one pump is being used, each requires a unique [pump ID](#). Valid [Pump ID](#) numbers are from 01-99 (01-24 for [Med-PC](#)). The pump number will appear on the [select pump](#) pulldown menu of the [USB Syringe Pump Test Program](#) and is used to identify which pump is being programmed (See Chapter 4 Special Instructions and Running USB Syringe Pump Test Program pp. 16 & 19).



Figure 3.5 Syringe Selection view

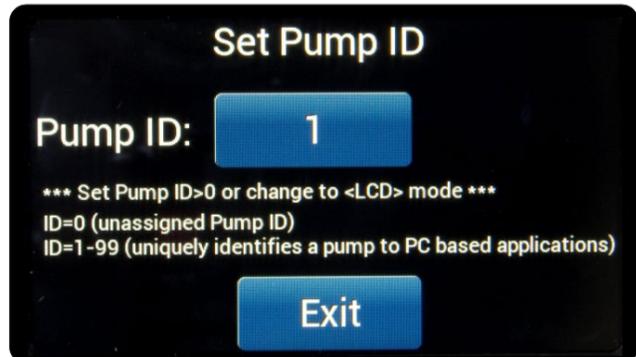


Figure 3.6 Set Pump ID view



Figure 3.7 The Dose Control Interface

Pre-programmed Syringe Settings

For user convenience, the [PHM-220](#) pump is pre-loaded with syringe settings for common commercially available syringe makes and sizes. The device can operate in both [direction modes](#) with most commercially made syringes. The inner barrel diameter ([ID](#)) and subsequent [flow rate](#) ranges of many commercial makes are available in Table 3.1. Common glass syringes and Table 3.2 Common plastic syringes. Flow rates from these tables are integrated into the pump interface and can be selected to reference a calculated flow rate estimate. The rates listed in the table are approximated based on the formula in Equation 3.1 (See p. 11).

To select a syringe for calculation, from the LCD operation view (see Figure 3.1) press the [Syringe](#) touchscreen button. This will bring up the [syringe selection view](#). (See Figure 3.5).

Syringes in the [syringe selection view](#) are organized by make and then by fluid capacity. The [syringe](#) selected for calculation is displayed in the upper right white box of the [LCD operation view](#) right of the [syringe](#) touchscreen button (See Figure 3.2)

Table 3.1. Common glass syringes

	BRAND/ MAKE	INNER-DIAMETER (mm)	OUTER-DIAMETER (mm)	CROSS-SECTIONAL AREA (cm ²)	FLOW RATE ***	MIN *** = 0.1 RPM	MAX*** = 30 RPM
5 µL	Hamilton 700 series*	0.34	6.60	0.000924	0.181 µL/rev	18.1 nL/min	5.4 µL/min
10 µL	Hamilton 700 series*	0.49	6.60	0.001847	0.361 µL/rev	36.1 nL/min	10.8 µL/min
25 µL	Hamilton 700 series*	0.73	7.75	0.004174	0.816 µL/rev	81.6 nL/min	24.5 µL/min
50 µL	Hamilton 700 series*	1.03	7.75	0.008332	1.628 µL/rev	162 nL/min	48.8 µL/min
100 µL	Hamilton 700 series*	1.46	7.75	0.016742	3.271 µL/rev	327 nL/min	98.1 µL/min
250 µL	Hamilton 700 series*	2.30	7.75	0.041548	8.118 µL/rev	812 nL/min	243.5 µL/min
500 µL	Hamilton 700 series*	3.26	7.75	0.083469	16.31 µL/rev	1.63 µL/min	489.2 µL/min
1 mL	Hamilton 1000 series*	4.61	9.02	0.166914	32.61 µL/rev	3.26 µL/min	978.4 µL/min
1 mL	B-D Multifit *	4.74	no data	0.176460	34.45 µL/rev	3.45 µL/min	1.034 mL/min
2.5 mL	Hamilton 1000 series*	7.29	9.60	0.417393	81.55 µL/rev	8.16 µL/min	2.447 mL/min
2 mL	B-D Multifit *	8.93	no data	0.626315	122.4 µL/rev	12.2 µL/min	3.671 mL/min
5 mL	Hamilton 1000 series	10.30	13.50	0.833229	162.8 µL/rev	16.3 µL/min	4.884 mL/min
5 mL	B-D Multifit	11.75	no data	1.084340	211.9 µL/rev	21.2 µL/min	6.356 mL/min
10 mL	Hamilton 1000 series	14.57	17.65	1.667282	325.8 µL/rev	32.6 µL/min	9.773 mL/min
10 mL	B-D Multifit	14.68	no data	1.692552	330.7 µL/rev	33.1 µL/min	9.921 mL/min
20 mL	B-D Multifit	19.60	no data	3.017186	589.5 µL/rev	58.9 µL/min	17.685 mL/min
30 mL	B-D Multifit	22.70	no data	4.047078	790.7 µL/rev	79.1 µL/min	23.722 mL/min
25 mL	Hamilton 1000 series	23.04	27.10	4.168424	814.4 µL/rev	81.4 µL/min	24.433 mL/min
50 mL	B-D Multifit	28.03	no data	6.170723	1.206 mL/rev	121 µL/min	36.169 mL/min

Table 3.2 Common plastic syringes

	BRAND/ MAKE	INNER-DIAMETER (mm)**	OUTER-DIAMETER (mm)**	CROSS-SECTIONAL AREA (cm ²) **	FLOW RATE (/REV) ***	MIN= 0.1 RPM	MAX*** = 30 RPM
1 mL	Monoject*	4.69	no data	0.172757	33.7 μ L/rev	3.37 μ L/min	1.01 mL/min
1 mL	B-D Plastipak*	4.69	no data	0.173000	33.8 μ L/rev	3.38 μ L/min	1.01 mL/min
1 mL	Terumo*	4.70	6.69	0.173494	33.9 μ L/rev	3.39 μ L/min	1.02 mL/min
2.5 mL	B-D Plastipak*	8.58	no data	0.578000	113 μ L/rev	11.3 μ L/min	3.38 mL/min
3 mL	Monoject*	8.90	no data	0.622114	121 μ L/rev	12.2 μ L/min	3.64 mL/min
3 mL	Terumo*	8.95	10.26	0.629000	123 μ L/rev	12.3 μ L/min	3.69 mL/min
3 mL	McKesson*	9.00	10.55	0.636173	124 μ L/rev	12.4 μ L/min	3.73 mL/min
5 mL	B-D Plastipak	11.99	no data	1.129001	220.6 μ L/rev	22.06 μ L/min	6.617 mL/min
5 mL	McKesson	12.40	13.75	1.207628	236.0 μ L/rev	23.60 μ L/min	7.078 mL/min
5 mL	Terumo	13.00	14.35	1.327000	259.3 μ L/rev	25.93 μ L/min	7.778 mL/min
6 mL	Monoject	12.68	no data	1.262782	246.7 μ L/rev	24.67 μ L/min	7.402 mL/min
10 mL	B-D Plastipak	14.43	no data	1.635000	319.5 μ L/rev	31.95 μ L/min	9.583 mL/min
10 mL	McKesson	14.95	16.50	1.755385	343.0 μ L/rev	34.30 μ L/min	10.29 mL/min
10 mL	Terumo	15.80	17.40	1.961001	383.1 μ L/rev	38.31 μ L/min	11.49 mL/min
12 mL	Monoject	15.87	no data	1.978079	386.5 μ L/rev	38.65 μ L/min	11.59 mL/min
20 mL	B-D Plastipak	19.05	no data	2.849999	556.8 μ L/rev	55.68 μ L/min	16.70 mL/min
20 mL	McKesson	19.15	20.80	2.880232	562.7 μ L/rev	56.27 μ L/min	16.88 mL/min
20 mL	Terumo	20.15	18.79	3.189001	623.1 μ L/rev	62.31 μ L/min	18.69 mL/min
20 mL	Monoject	20.52	no data	3.307079	646.1 μ L/rev	64.61 μ L/min	19.38 mL/min
30 mL	B-D Plastipak	21.59	no data	3.661999	715.5 μ L/rev	71.55 μ L/min	21.46 mL/min
30 mL	Terumo	23.10	25.58	4.190999	818.8 μ L/rev	81.88 μ L/min	24.56 mL/min
35 mL	Monoject	23.87	no data	4.475017	874.3 μ L/rev	87.43 μ L/min	26.23 mL/min
50 mL	B-D Plastipak	26.60	29.97	5.556002	1.086 mL/rev	108.6 μ L/min	32.57 mL/min
60 mL	Monoject	26.57	no data	5.544635	1.083 mL/rev	108.3 μ L/min	32.50 mL/min

*Med Associates recommends syringes with a barrel outer diameter of less than 10mm are used with the accessory microsyringe holder R-ACC

**Cross-sectional Area and diameter values were obtained from the manufacturer and are subject to variability and accuracy parameters associated with that manufacturer.

***Flow Rates are calculated based on the listed dimensions using the formula in "Equation 3.1". Min and Max values are based on a minimum and maximum speed settings of the pump. Actual dispensed volumes will vary most at the extremes of pump operation parameters.

Equation 3.1

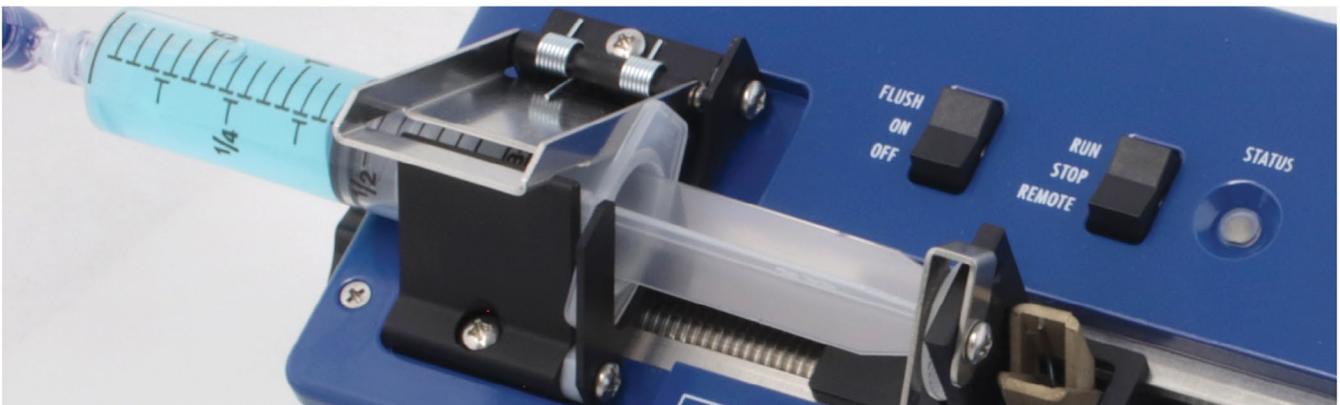
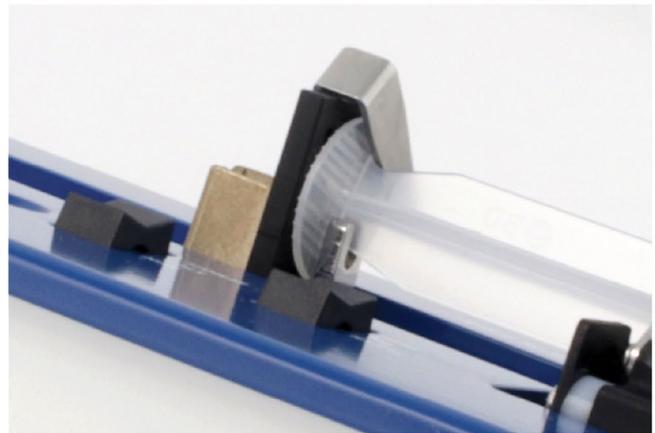
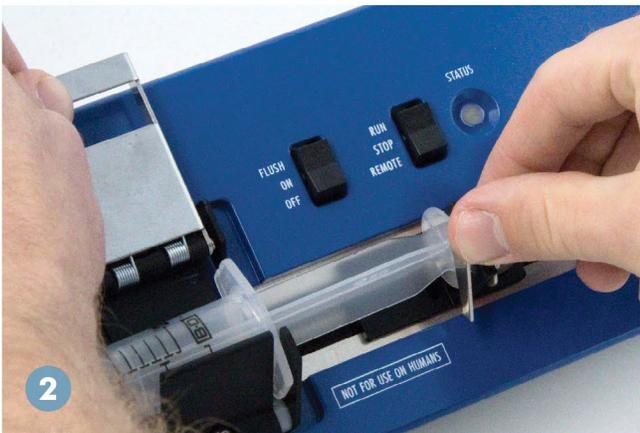
$$\text{Flow Rate (mL/min)} = 0.19538 \times \text{Motor-RPM} \times \text{Syringe Cross Sectional Area (cm}^2\text{)}$$

Note: For the most precise infusion rates, plot a curve of infusion amounts over time at set RPM and adjust the speed of the pump relative to the difference between expected and measured dispensed amount.

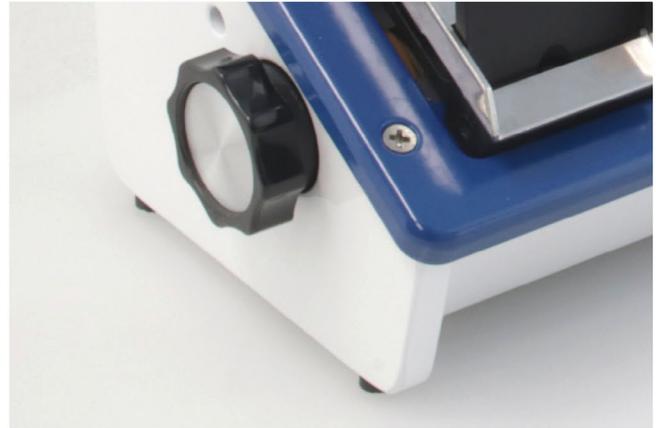
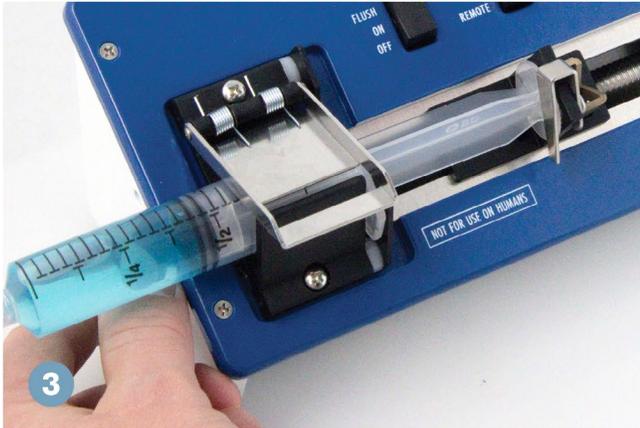
Loading the syringe



- 1) Squeeze the plunger clamp tabs and clear the slide assembly by sliding it along the lead screw to give enough room for the syringe plunger.



- 2) Open the syringe clamp and place the syringe inside. Be sure that the syringe barrel flange tabs are properly inserted between the flange holder and rest of the syringe clamp so that they do not impede the travel of the slide assembly. Close the syringe clamp around the syringe barrel.



- 3) Squeezing the plunger clamp tabs to free the slide assembly from the lead screw return the slide assembly close to the plunger. Run the pump in Forward (infuse) mode (see Chapter 3 GETTING STARTED Setting Direction Modes p.13) or use the flush function or manual rotation knob to progress the slide assembly until it is in solid contact with the end of the plunger. Insert the support struts for the plunger into the notched metal guide and close the clamp around the plunger flange. Because the clamp is designed to work with many syringe designs, some syringes will be a tight fit. Securing the plunger flange into the slide assembly clamp is especially important when the pump is operating in Reverse (siphon) mode.



- 4) The syringe should be secure. Check for leakage or displacement, and double check the security of the hold before beginning the infusion.

Setting Direction Modes

The [direction mode](#) of the pump ([Forward \(infuse\)](#) or [Reverse \(siphon\)](#)) mode setting is displayed below the [Syringe](#) setting on the [LCD operation screen](#) of the [touchscreen](#) display (See Figure 3.2). In [Forward \(infuse\)](#) mode, fluid is pumped out of the syringe, and in [Reverse \(siphon\)](#) mode, fluid is drawn into the syringe. The user can toggle between these direction modes by pressing the touchscreen button on the [LCD operation screen](#) of the touchscreen display.

The [Forward \(infuse\) / Reverse \(siphon\)](#) touchscreen button remains active when the pump is running so the direction can be changed quickly during an infusion. If the [direction button](#) is touched while running, a confirmation screen prompts the user to confirm that the direction change is intended. The [automatic shut-off switch](#) will activate when the [slide assembly](#) reaches its extreme travel point in either direction mode (See p.25).



Figure 3.8 Set infusion rate view



Figure 3.9 Select Infusion Units view

Setting the Infusion Rate

The [infusion rate](#) touchscreen button on the LCD operation view prompts the [Set Infusion rate](#) view of the pump (See Figure 3.8). From the Set Infusion rate view, the user can choose to change the rate within the valid infusion rate range listed at the bottom of this view in units set in the Select Infusion Units view.

For user convenience, conversions are pre-programmed into the pump to convert the rate units using either the manually entered or pre-programmed syringes on the [syringe selection](#) view (See Figure 3.5)

Starting the Pump

The touchscreen [Start](#) button activates the pump at the set rate in the selected direction. The red [IDLE](#) banner will change to a green [Active](#) banner (solid green in [Forward](#) direction mode, flashing green in [Reverse](#) direction mode). The STATUS light will flash green.

When the slide assembly has reached the extreme end of its travel distance, the [automatic shut off switch](#) will stop the motion, the STATUS light will change from flashing green to solid orange, the appropriate red ([LEFT or RIGHT](#)) [LIMIT EXCEEDED](#) banner will flash at the top of the touchscreen (see The Automatic Shut-off Switch p.25), and if the [audible alarm](#) is enabled it will sound (see Alarm Settings p. 25 and Figure 3.10 Example operation view banner messages).

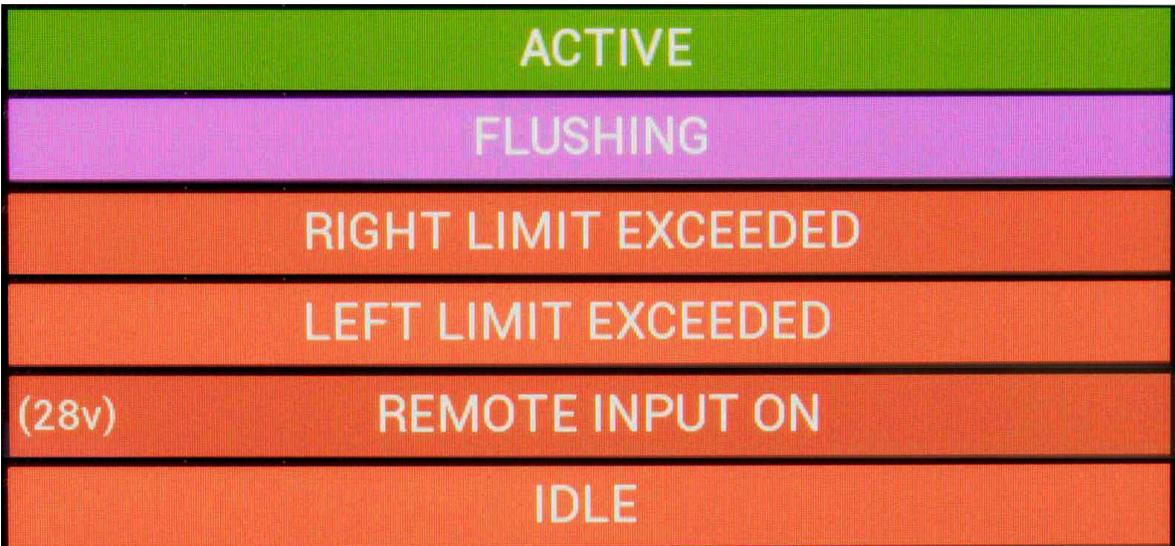


Figure 3.10 Example operation view banner messages

CHAPTER 4 SPECIAL INSTRUCTIONS

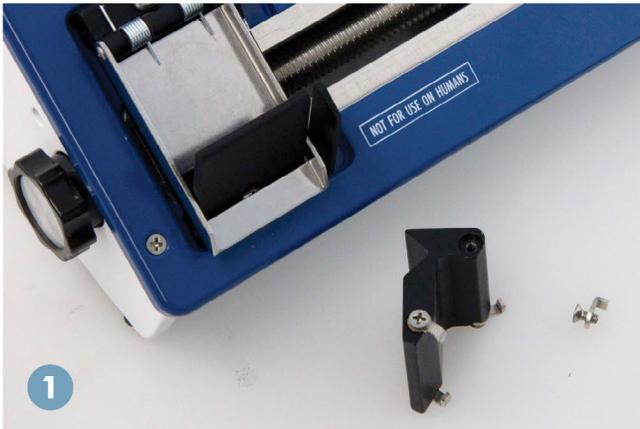


R-ACC adapter

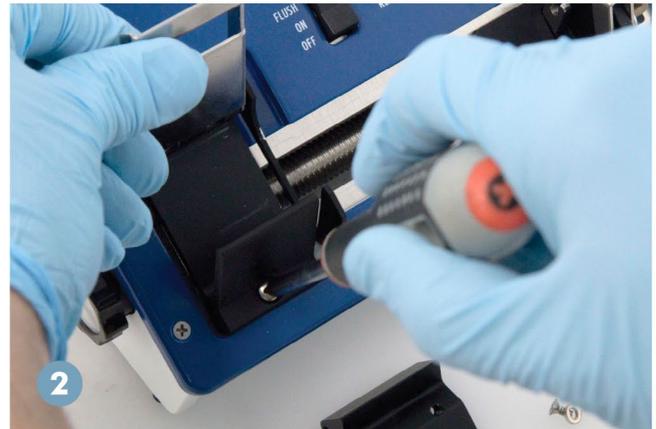
The R-ACC adapter slides into the standard syringe clamp. It is used for small syringes, with less than 5 mL capacity or a barrel diameter less than 10mm.



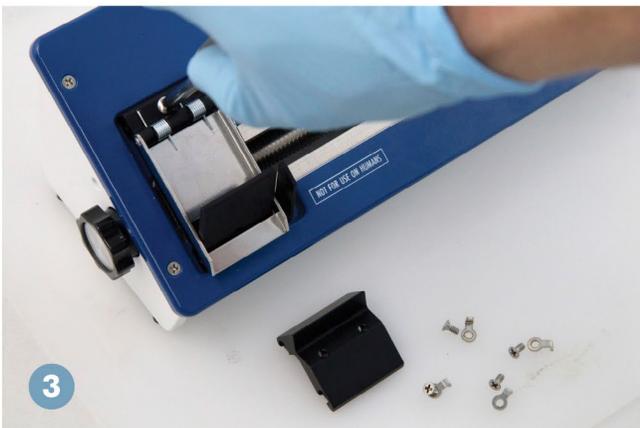
Installation Instructions



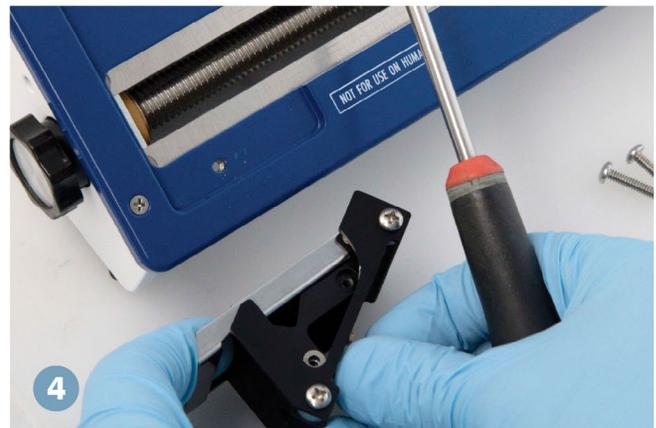
1) Using a small Phillips screwdriver, remove the screws and bent tabbed key washers from the R-ACC adapter.



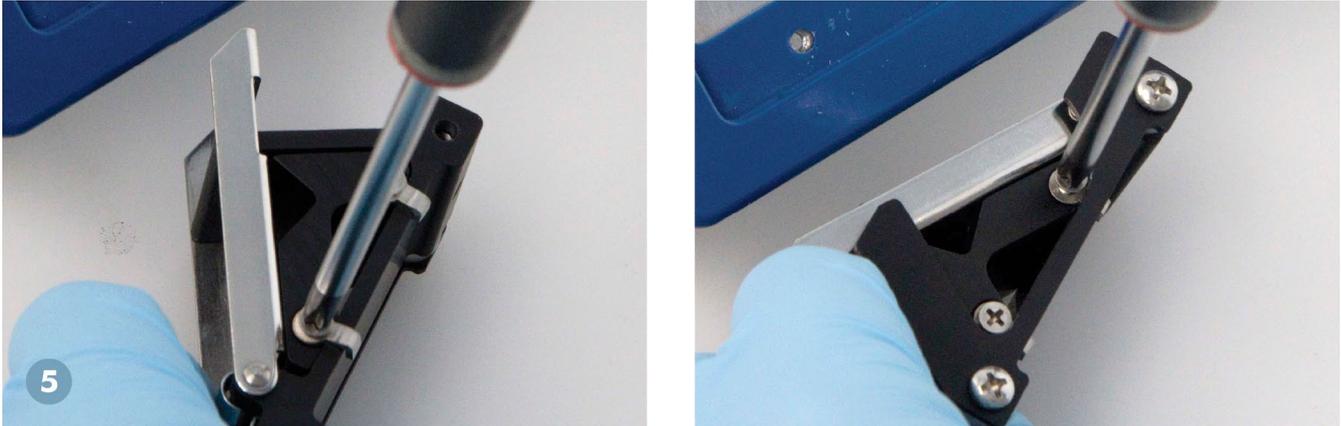
2) Lift clamp and remove bottom clamp assembly screw.



3) Remove the top clamp assembly screw, and remove the clamp assembly from the pump.



4) Insert the R-ACC into the clamp assembly.



5) The R-ACC short side should mate up to the fixed section of the clamp. Attach by reinstalling the bent tabbed key washers that wrap around the bottom of the clamp assembly.



6) Reinstall the syringe clamp assembly using the two screws in parts 2 and 3.

Glass Syringes

Extra caution is needed when using glass syringes with a ground glass plunger. These syringes exhibit almost no sliding friction and thus can cause an uncontrolled infusion in the following two ways:

1. The weight of the plunger may be sufficient to push the fluid out of the syringe if the syringe is held with the plunger above the syringe.
2. The weight of the fluid in the tubing may be sufficient to siphon the fluid out of the syringe if the catheter infusion site is below the height of the syringe.

To test for these two conditions, it is suggested that the syringe be connected to the tubing and held vertically at the height of the pump. If no motion occurs, the syringe can then be placed in the pump.

The following steps may reduce the danger of an uncontrolled infusion:

1. Lower the relative height of the infusion pump in relation to the infusion site. With the pump below the infusion site, the instrument will pump the fluid to the higher elevation.
2. Use a smaller bore catheter, which will reduce the weight of the fluid in the tubing and increase the friction on the flowing fluid.
3. Use a syringe with a rubber seal on the plunger, i.e., an O-ring sealed or plastic syringe.

USB controlled operation

To control the [PHM-220](#) pump via [USB](#), the [USB port](#) on the pump must be connected to any available [USB port](#) on the [computer](#) using the included [USB -type B to type A cable](#). The pump may now be controlled via [computer](#) (enabling a controller of user's choice). [Med-PC](#) software can independently operate the pump via Med Control (See p.22) or via commands in the state notation protocol. Razel IPC can substitute for USB Syringe Test Program as a direct pump controller (See Razel IPC operation manual) and is capable of planning sophisticated infusion protocols that can be saved for re-use. In any case to control the pump using software, the necessary drivers must be installed (See Chapter 5 DRIVER AND SOFTWARE INSTALLATION p.21).

For [USB control](#), the [LCD/USB switch](#) must be set to [USB](#). When the pump is set to [USB mode](#) and the [USB cable](#) is connected, the [computer](#) will control the pump, and the [touchscreen interface](#) will be disabled. Through the dose control interface, you can set an infusion/siphon rate and syringe sizes for directing the pump. These same presets can be referenced in the USB Syringe Pump Test Program as well as any custom sizes that have been saved in the pump.

Open the USB Syringe Pump Test Program alone to send direct pump control commands from a computer. Use Med PC to send commands coordinated as part of a behavioral experiment. Use Razel IPC as a sophisticated infusion control that tracks dispensed volume and syringe progress. One can also use a third-party interface to control pump operations through the library built into the installed software. See the next section on how to use the USB Syringe pump interface.

Running USB Syringe Pump Test Program

Prior to running the [USB Syringe Pump Test Program](#) each pump must be set to a unique [Pump ID](#) (See Chapter 3 GETTING STARTED p. 8).

If the pump is being used with [Med-PC](#) the [Pump ID](#) should correspond to the Med-PC box number. Be sure to switch each pump to [USB](#) mode (See Figure 3.1)

Open the [USB Syringe Pump Test Program](#) and the screen shown in will appear. The cross-sectional area of the syringe being used must be entered (Syringe(sqcm)). Table 3.1 and Table 3.2 each contain the cross-sectional areas of several commonly used syringes.

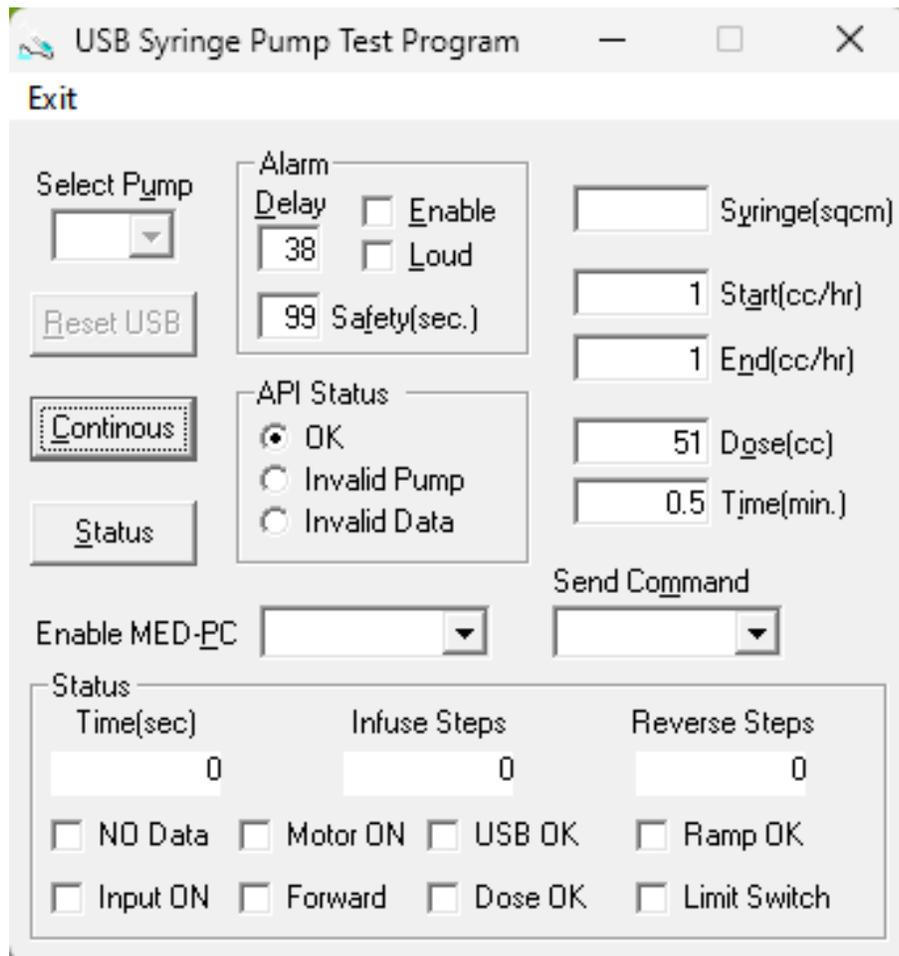


Figure 4.2 USB Syringe Pump Test Program

Pump Commands

The commands below can be directly sent to the pump through the USB syringe pump test program or used in Med state notation code to reference in Med-PC without using the control panel as the signal source. This will allow for more sophisticated actions than simple execution of a predetermined set action on the pump. (See Chapter 7 SAMPLE MED-PC PROGRAMS p.22)

OFF ; stops pump activity and ends any active commands.

ON ; activates the pump at Start rate(mL/h) in the Forward (infuse) direction mode (see p.13).

Dose ; protocol sets a Start rate (mL/h) and either Dose (mL) or Time (min) duration. The pump will activate at the given Start rate (mL/h) and stop after either the set Dose (cm³) or Time (min) has been completed.

RAMP ; user sets a Start rate (mL/h), End rate (mL/h) and Time duration (min). The infusion will begin at the set Start rate (mL/h) and incrementally change speed to the End (mL/h) rate over the set Time (min) duration. The pump will continue to dispense at the set End rate until given the OFF command.

RAMPDOSE ; user sets a start rate (mL/h), end rate (mL/h) and dose (mL) or time (min). The infusion will begin at the start rate (mL/h) and incrementally change speed to the End rate (mL/h) until the set Dose (mL) or set Time (min) is completed. The pump will stop when the RAMPDOSE command is completed.

CHAPTER 5 DRIVER AND SOFTWARE INSTALLATION

Before the pump can be controlled using software, the necessary drivers and software must be installed.

The [installation media](#) containing the [USB syringe pump test program](#) also contains file folders for the header and library files used with [Med-PC](#). It also contains the necessary [drivers](#) needed to operate the pump with the computer USB connection.

To install the necessary software and drivers, open the installation media on the computer you wish to control the pump with and open the installation files. If possible, it is best to do so signed in as an administrator. Run the autoinstall.exe file from each folder by right clicking and running “as administrator” for the best results, otherwise it is often sufficient to simply run the executable normally. After you have installed all the driver and software media, restart the computer so that changes can take effect.

Minimum computer requirements for installation of various software for secondary control of the pump through USB appear in Table 5.1.

Table 5.1 Minimum installation and system requirements

	MED TEST	USB SYRINGE PUMP TEST PROGRAM	RAZEL INFUSION PUMP CONTROLLER	MED-PC	MED DRIVERS
SOFTWARE VERSION	SOF-MED-TEST v.6.03.00	SOF-111 v1.12.00	RAZ-IPC v.2.00.00	SOF-736 v.5.1.0.15	SOF-MED-DRIVERS v.1.07.00
OPERATING SYSTEM	Windows 7 SP1+ 64bit	Windows 7 SP1+ 64bit	Windows 7 SP1+ 64bit	Windows 7 SP1+ 64bit	Windows 7 SP1+ 64bit
PROCESSOR MEMORY	2GB RAM	2GB RAM	2GB RAM	2GB RAM	2GB RAM
PROCESSOR SPEED	1GHz 64bit	1GHz 64bit	1GHz 64bit	1GHz 64bit	1GHz 64bit
INSTALL SIZE	4.5MB	19 MB	19.3 MB	340 MB	641 MB
NEEDED FOR USB OPERATION	YES	YES	NO	NO	YES

CHAPTER 6 MED-PC CONTROLLED OPERATION

This section describes the procedure for using a [Med-PC](#) 28-volt [OUTPUT](#) to activate the pump. When controlling the pump using [Med-PC](#), set the parameters using the pump interface (see 0 GETTING STARTED p.8) up to the point before pressing the [START](#) touchscreen button. The [PHM-220](#) pump is also capable of more sophisticated computer control via the USB port. Refer to Chapter 4 Special Instructions, USB controlled operation p.18 for more details.

1. Connect the [Med-OPERATE port](#) (See) on the pump to any available OUTPUT on the Standard [Med-Connection panel](#) (e.g. SG-716B), using the included cable.
2. When the [LCD/USB](#) switch is set to LCD. The pump will infuse at the [set rate](#), in the set [direction mode](#) (See Chapter 3 GETTING STARTED p.8) for as long as the [OUTPUT](#) from Med-PC is active. This action is the same in USB mode except that the [set rate](#), [direction mode](#), and other pump settings are controlled through the [computer](#) interface.

When the OUTPUT is active the red IDLE banner will change to a green Active banner (solid green in forward (infuse) direction mode, flashing green in reverse (siphon) direction mode.) When the slide assembly has reached the extreme travel point in either direction mode, the automatic shut-off switch will stop the motion(see The Automatic Shut-off Switch p.25), the appropriate red (LEFT or RIGHT) LIMIT EXCEEDED banner will flash at the top of the touch screen and if the audible alarm is enabled, it will sound (See Safety Timer p. 26). An error message on the display will indicate that the [safety timer](#) has been activated and stopped the pump.

CHAPTER 7 SAMPLE MED-PC PROGRAMS

Refer to the Med-PC User's Manual and Med-PC Programmer's Manual for detailed information.

If the installation media that came with the pump has been installed on the computer and .mpc files have been imported into Med-PC through Trans prior to reading this entry, example MedState Notation code for the PHM-220 Advanced USB Touchscreen Syringe Pump Application can be found at the following file address on that computer.

<C:\MED-PC\MPC\PHM-220 PUMP.MPC>

For a brief coding example of some of common pump interactions see Example 7.1.

Procedures and Parameters for Med-PC

Each of the procedures shown in table 7.1 invoke different action on the pump in MedState Notation. Each comes with a set of parameters that need to be defined according to the desired result.

Example 7.1 Common Code interactions

```

1      \ Copyright (C) 2023 MED Associates, All rights reserved.
2      \ PHM-220 PUMP SAMPLE FR1.MPC
3
4      \Inputs
5      ^LeftLever = 1
6      ^RightLever = 2
7
8      \Outputs
9      ^Houselight = 7
10     ^Pump      = 8
11
12     \***** FR1 *****
13 S.S.1,
14 S1, \ Turn levers and house light ON
15     #START: ON ^LeftLever, ^RightLever, ^Houselight ---> S2
16
17 S2, \ Left Lever response to meet Fixed Ratio (1) Turn OFF house light and issue a
18     \ Z1 to trigger pump.
19     1#R^LeftLever: OFF ^Houselight; Z1 ---> S3
20
21 S3, \ 10 second Time Out, Turn house light back ON and return to FR.
22     10": ON ^Houselight ---> S2
23
24     \***** Pump Control *****
25 S.S.2,
26 S1, \ Initialize the Pump.
27     #START: -MPC_Init(MG);-; ---> S2
28
29 S2, \ Z1 trigger Starts the Pump with a Rate of 178cc/hr and Syringe Size of
30     \ 2.865sqcm until 1cc Dosage is delivered and then stop the Pump.
31     #Z1: -MPC_RampUpdate (MG, BOX, BOX, 178, 2.865, 1, 0, 0, CMD_DOSE);-; ---> S2
32

```

Table 7.1 Med-PC Procedures

PROCEDURE TEXT (PARAMETERS);	ACTIONS	RETURNS
MPC_Init(MG);	Initializes the PHM-220 pumps	<ul style="list-style-type: none"> The number of pumps found attached to the system
MPC_CheckRateEx(MG, BOX, pumpID, pumpType, rate, syringeSize);	Used to check if the desired Rates and Syringe Sizes are valid for the specified pump	<ul style="list-style-type: none"> 0 = No pump found with specified ID 1 = Values OK for the specified pump 255 = Invalid values for the specified pump
MPC_PumpStop(MG, BOX, pumpID);	Stops the pump	<ul style="list-style-type: none"> 0 = Failed to stop pump 1 = Pump stopped
MPC_RampUpdate(MG, BOX, pumpID, startRate, syringeSize, dose, minutes, endRate, command);	Sets up pump parameters and/or starts the pump running at the values specified	<ul style="list-style-type: none"> 0 = Invalid pump 1 = Pump updated and/or started with values specified 255 = Invalid values for the specified pump

- MG [Med-PC Global Pointer](#) this is a designator for errors to be passed back to Med-PC from the pump.
- BOX This designates the chamber that the pump is connected to and matches the pumpID when set up as recommended.
- pumpID This is the pumpID as set by the dose control device (see Chapter 3 GETTING STARTED Setting the Pump ID p.9).
- pumpType is the model of pump (PHM_220), can be set to 0 if the pumpID specifies a valid pump.
- startRate is reported in cubic centimeters per hour and is the rate the pump delivers at when it starts the infusion.
- syringeSize is the cross-sectional area of syringe plunger seal in square centimeters.
- dose is the volume to dispense in cubic centimeters.
- minutes is the duration in minutes of the infusion.
- endRate is reported in cubic centimeters per hour and is the rate the pump delivers at when it starts the infusion.
- command can be any of the values listed below when used with the MPC_RampUpdate procedure specified in Table 7.1.

- CMD_OFF - Stops pump. Leaves pump direction & speed as is.
- CMD_ON - Starts pump in last set direction (forward or reverse).
- CMD_DOSE - Starts pump & stops pump after Dose or Time settings.
- CMD_RESET - Stops pump and sets pump direction. This command can also set new rate values for the pump.
- CMD_REV - Starts pump in reverse direction (siphon).
- CMD_INPUTOFF - Disables remote INPUT control.
- CMD_INPUTON - Enables remote INPUT control.
- CMD_RAMP - Starts pump at startRate & ramps to endRate in specified Time and leaves pump on.
- CMD_RMPDOS - Starts pump at startRate & stops at endRate after dose or time.

CHAPTER 8 SAFETY AND FAILPROOFS

The Automatic Shut-off Switch

The [automatic shut-off switch](#) is activated when the pump reaches the end of the syringe, which causes the pump to cease operation and the [STATUS](#) indicator light to turn off, providing a visual indication that the infusion is complete. The [automatic shut-off switch](#) uses an internal micro-switch that detects when the slide assembly reaches a set point. This point is adjustable so that the pump can accommodate diverse sizes and makes of syringes. To adjust the [automatic shut-off switch](#), insert an empty syringe with the plunger at the desired shut-off position. With the pump in the ON position, rotate the adjustment screw using the included 9/64" Allen/hex key until the [STATUS](#) light turns off.

Rotating the screw clockwise will allow the pump to operate longer before the automatic shut-off switch activates, while rotating the screw counterclockwise will cause the automatic shut-off switch to activate sooner. To resume pump operation once the [automatic shut-off switch](#) has been activated, the [slide assembly](#) must be moved back until the switch is deactivated ([STATUS](#) indicator light will illuminate green when switch is deactivated).



Figure 8.1 *Automatic Shut-off Switch Adjustment*



Figure 8.2 Alarm Settings view

Alarm Settings

When enabled, the audible alarm sounds when the automatic shut-off switch is activated. The volume level (low or high) and interval between alarm pulses (0.5 - 39 seconds) are user defined in the active settings view (See Figure 3.3). To clear this alarm and resume pump operation, squeeze the [plunger tabs](#) on the [Slide assembly](#) and move it away from the end of the track until the [automatic shut-off switch](#) is deactivated.

To access the [alarm settings](#) view, navigate to the [Active.\(*\)settings.view](#) (See Chapter 3 GETTING STARTED The Active Settings view p.8)

Safety Timer

The [Safety Timer](#) is a failsafe setting that can be used to disable the pump if the [Med-PC OUTPUT](#) is active longer than the user-defined [Safety Timer Duration](#). The [safety timer duration](#) can be set from “Disabled” to 99 seconds. The [STATUS](#) light will flash orange to indicate a problem, and an error message will prompt that the pump was stopped due to the [Safety Timer](#) expiring (See Figure 8.3). When this message is cleared, a red flashing “[REMOTE INPUT ON](#)” banner will appear on the operation screen. The remote activate will not function until the Med Output has been returned to inactive.



Figure 8.3 Safety Timer message

Cleaning

Do not submerge any portion of the pump in liquid. Clean the pump case using a soft cloth that is dampened with water and detergent. The pump case is entirely aluminum. The dose control interface casing is plastic polymer. Should fluids enter the pump internals, disconnect the power and invert the pump to drain. Set the pump in a warm dry area to air dry thoroughly before restoring power.



DO NOT AUTOCLAVE



DO NOT SUBMERGE

Warranty & Repair

This device is protected under a limited manufacturer warranty for two years from the date of purchase.

Med Associates continues to support and repair products outside the warranty period indefinitely, for a fee, if we are logistically able. We are proud to continue to support instruments manufactured in our opening production line from 1972.

If you are interested in further information about this device, its component parts, accessories, or integrating it within your application, please contact Med Associates Support.

Mechanical Maintenance

A few drops of food grade oil lubricant on the lead screw is recommended annually. The maximum pressure the pump can press against is dependent on the strength of the [stepper motor](#) leveraged against the integrity of the [lead screw](#) and its engagement with the [slide assembly](#). This is often greater than the physical integrity of the syringe or plunger seal. If a blockage or downstream fluid resistance creates a large enough pressure block and the syringe does not fail, the [slide assembly](#) may skip along the threads of the [lead screw](#) or the [stepper motor](#) may be unable to turn which can cause damage to the [stepper motor](#). Care should be taken in set up to ensure that the fluid resistance is within the pressure limits of the pump (See Table 8.1 Pressure Limits). If the fluid resistance and line pressure are within limits but the [slide assembly](#) is not capable of pushing the plunger, both the [lead screw](#) and the [slide assembly](#) should be inspected for wear; and any worn part should be replaced by Med Associates (See Contact Med Associates support see p.27).

	PRESSURE LIMITS
50-60 mL syringe	5 psi or 270 mmHg
30-35 mL syringe	7 psi or 400 mmHg
20 mL syringe	20 psi or 1000 mmHg

Table 8.1 Pressure Limits

Contact Information

Please contact Med Associates, Inc. for information regarding any of our products. Med Associates Support is available to answer technical questions weekdays between 8:00am and 4:30pm ET by phone at 802-527-2343, or email at support@med-associates.com. We look forward to collaborating with you. Visit our website at www.med-associates.com For pricing inquiries, email sales@med-associates.com.

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