med associates inc

instrumentation and software for research

ADVANCED SYRINGE PUMP

PHM-111-EC

USER'S MANUAL

DOC-032
Rev. 1.9

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notes

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CHAPTER 1 | INTRODUCTION

The Med Associates PHM-111-EC Advanced Syringe Pumps ensure safe, accurate infusion using several unique features. The PHM-111-EC pump allows the user to specify a syringe brand and capacity, as well as the desired infusion rate. These settings are clearly displayed on an LCD for easy viewing. For added safety the PHM-111-EC Advanced Syringe Pump utilizes an automatic shut-off when the end of the syringe is reached. Med Associates strongly encourages that this manual be read thoroughly prior to operating the pump.

The PHM-111-EC Advanced Syringe Pumps offer the ability to control the operation of the pump either locally, using the easy-to-use pushbutton switches, or remotely using MED-PC.

The PHM-111-EC may also be operated remotely via a computer USB port. The PHM-111-EC Pump comes standard with USB Syringe Pump Test Program Software for testing functionality and interfacing the pump with third party or custom software. The PHM-111-EC is also compatible with Razel IPC™ software, which is an option for users desiring a fully stand-alone USB controlled pump.

Specifications

Pressure Limits

The PHM-111-EC USB pump provides accurate flow up to:

5 psi or 270 mm Hg with a 50–60 cc syringe

7 psi or 400 mm Hg with a 30-35 cc syringe

10 psi or 500 mm Hg with a 20 cc syringe

20 psi or 1000 mm Hg with a 10 cc syringe

CHAPTER 2 | HARDWARE

The PHM-111-EC pump consists of a pump mechanism attached to the pump interface; the syringe (supplied by end user) is mounted on the pump mechanism.

Figure 2.1 – PHM-111-EC Pump Mechanism and Control Panel with Syringe

Pump Interface

Use the pump interface control panel to enter the syringe brand, dimensions, and desired infusion rate. Prior to powering the device, the pump ID may also be entered using the control panel.

Figure 2.2 - Top of the PHM-111-EC Pump

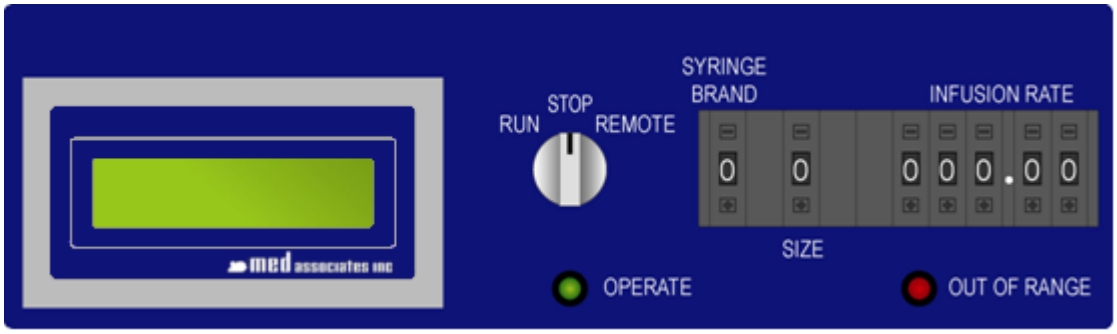
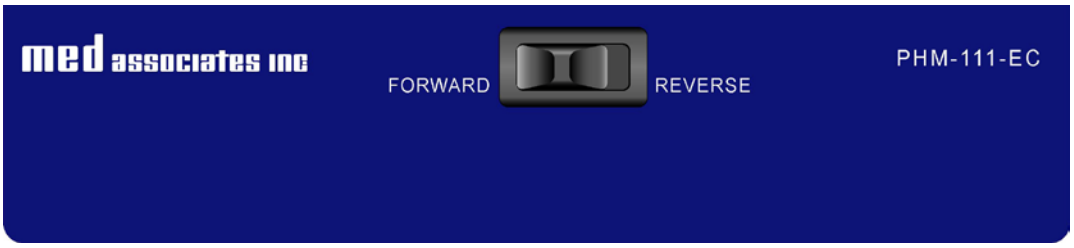


Figure 2.3 - Front of the PHM-111-EC Pump



RUN / STOP / REMOTE Switch

When the switch is in the **STOP** position:

1. The **SYRINGE BRAND**, **SIZE** and **INFUSION RATE** pushbutton switches are enabled. These settings may be adjusted as desired when in **STOP** mode;
2. The direction of the pump can be selected using the **FORWARD/REVERSE** switch;
3. The green **OPERATE** light is off.

When the switch is in the **RUN** position:

1. The pump operates at the set rate, and in the set direction;
2. The **SYRINGE BRAND**, **SIZE** or **INFUSION RATE** pushbutton switches are disabled. Changes made to these settings while the pump is in **RUN** mode will not be recognized;
3. The direction of the pump can be changed using the **FORWARD/REVERSE** switch;
4. The green **OPERATE** light is on if operating in **FORWARD** mode and flashing if operating in **REVERSE** mode.

When the switch is in the **REMOTE** position and Controlled Using a 28V Operate Signal from MED-PC:

1. The pump operates at the set rate, and in the set direction as long as the output from a MED-PC interface is on;
2. The **SYRINGE BRAND**, **SIZE** or **INFUSION RATE** pushbutton switches are disabled;
3. The green **OPERATE** light is on if operating in **FORWARD** mode and flashing if operating in **REVERSE**.

When the switch is in the **REMOTE** position and **USB** controlled **(PHM-111-EC)**:

1. All switches but the **RUN/STOP/REMOTE** switch are disabled;
2. The USB connector is enabled;
3. The pump is completely controlled by commands received via the USB port.
4. The green **OPERATE** light is on if operating in **FORWARD** mode and flashing if operating in **REVERSE**.

SYRINGE BRAND / SIZE and INFUSION RATE Switches

The switches for **SYRINGE BRAND** and **INFUSION RATE** are used to select the desired syringe type and infusion rate. The function of these switches is described in detail in **Error! Reference source not found.**.

FORWARD / REVERSE Switch

When the switch is in the **FORWARD** position:

1. The pump pushes fluid from the syringe;
2. The green **OPERATE** light is on when the pump is switched to **RUN**.

When the switch is in the **REVERSE** position:

1. The pump draws fluid into the syringe;
2. The green **OPERATE** light is flashing when the pump is switched to **RUN**.

Automatic Shut-Off Switch

When the pump is operating in **FORWARD** mode an internal automatic shut-off switch stops the infusion when the pump reaches the end of the syringe. In addition, the red **OUT OF RANGE** light will flash and if the Audible Alarm is enabled, it will sound (if enabled; see Chapter 10).

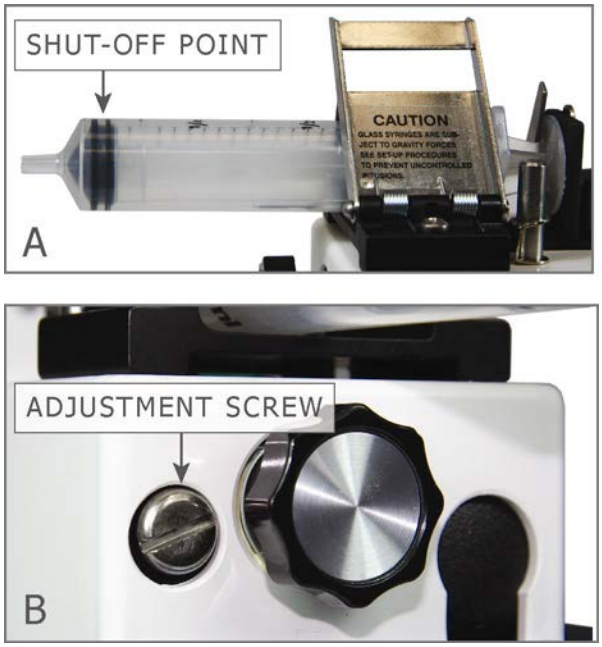
The automatic shut-off switch uses an internal micro-switch that detects when the slide assembly reaches a certain point. This point is adjustable so that the pump can accommodate various sizes and brands of syringes.

To adjust the automatic shut-off switch, insert an empty syringe with the plunger at the desired shut-off position. Move the slide assembly to the rear of the plunger (Figure 2.4A). With the pump turned on, rotate the adjustment screw (Figure 2.4B) until the **OUT OF RANGE** light comes

on. Each full clockwise turn of the adjustment screw will cause the switch to activate 0.05 inches further, and each full counterclockwise turn of the adjustment screw will cause the switch to activate 0.05 inches sooner. Half turns can be made for 0.025" adjustments. When the automatic shut-off switch is activated the LCD display will read **LIMIT Switch ON Pump OFF**. In order to clear this message and resume pump operation, squeeze the tabs on the slide assembly (Figure 3.3) and move it back until the switch is deactivated.

NOTE: It is important to note that there will not be any indication that the end of the syringe has been reached when operating in REVERSE mode.

Figure 2.4 - Automatic Shut-Off Switch Adjustment



Operate Light

Figure 2.5 - Green OPERATE Light

The OPERATE Light will be:

- On if the pump is operating in **FORWARD** mode;
- Flashing if the pump is operating in **REVERSE** mode;
- Off if the infusion is complete or the pump is off.

Out Of Range Light

Figure 2.6 - Red OUT OF RANGE Light

The **OUT OF RANGE** Light will be:

- On if the selected **INFUSION RATE** is out of range;
- On if the **INFUSION RATE** switches are set to “000.00”;
- Flashing if the Automatic Shut-Off Switch has been activated;
- Off if the pump is operating correctly or the pump is powered off.

Lighted ON/OFF Switch

Figure 2.7 - Lighted ON/OFF Switch

The Lighted ON/OFF Switch will be:

- On if the pump is plugged in and switched on.
- Off if the pump is switched off and/or unplugged.
- Off if the automatic shut-off switch is activated or the safety timer is activated.

CHAPTER 3 | SYRINGE PLACEMENT

Care should be exercised that the syringe is positioned correctly when loading the infusion pump. Accurate flow rates cannot be assured if the syringe is not properly loaded. It is also important that the slide assembly be making contact with the syringe plunger.

Figure 3.1 – Syringe Components

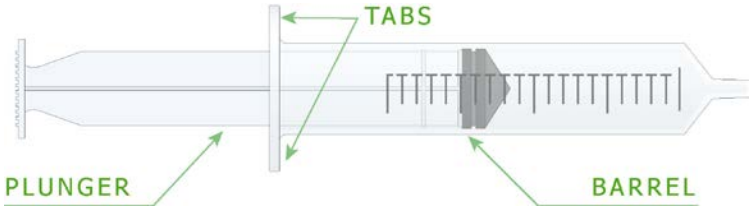
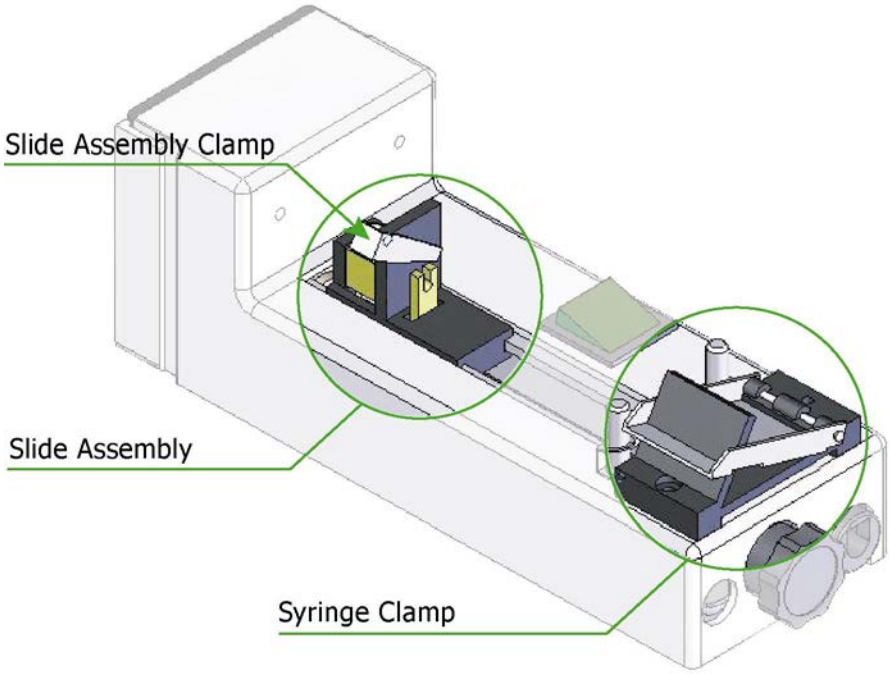


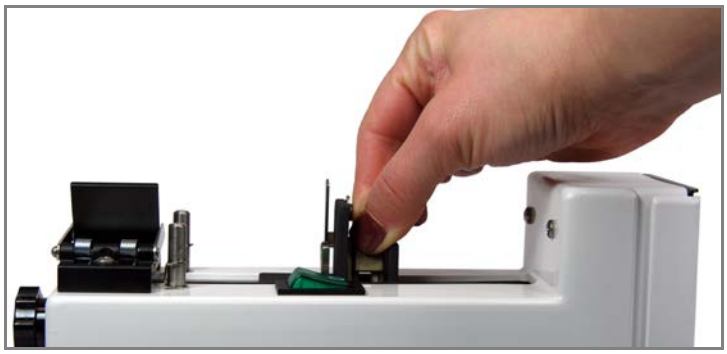
Figure 3.2 – Pump Mechanism Components



Complete the following steps to properly load the syringe:

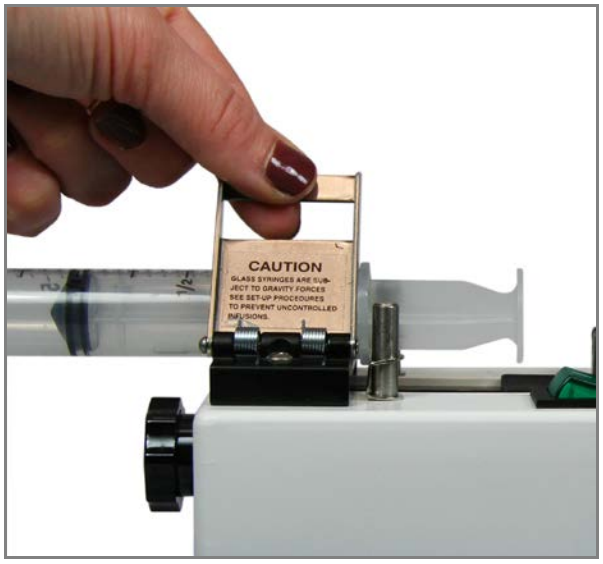
A. Move the slide assembly to the rear (toward motor section) by squeezing the tabs as shown in Figure 3.3.

Figure 3.3 - Moving the Slide Assembly



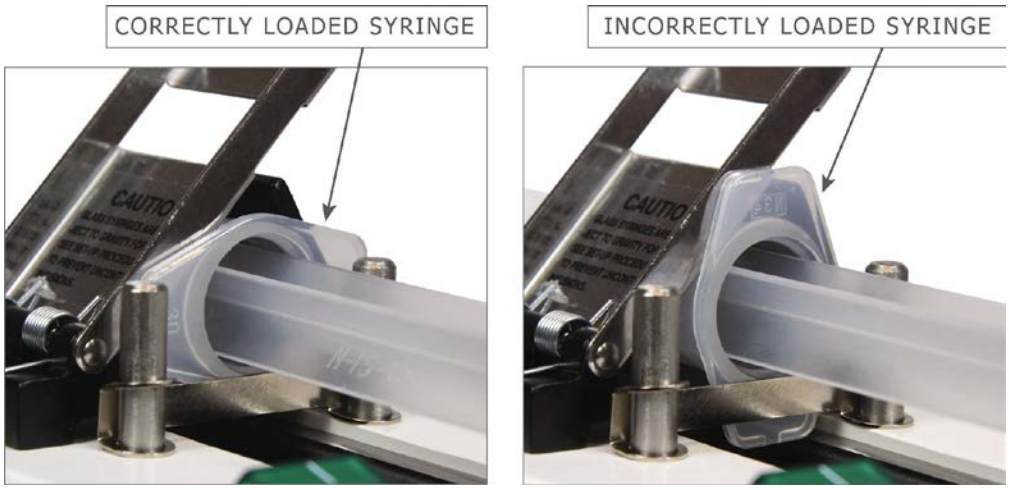
B. Open the syringe clamp and place the syringe barrel into the clamp as shown in Figure 3.4.

Figure 3.4 – Open Syringe Clamp



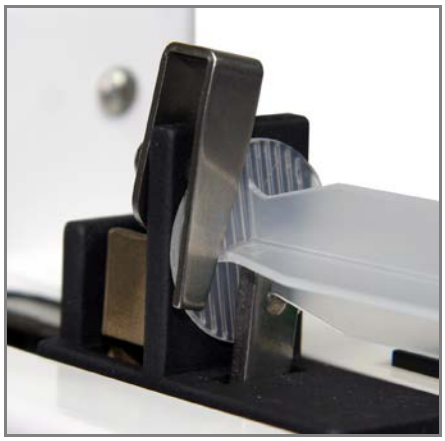
C. Be sure that the syringe tabs are properly inserted between the syringe clamp and the retaining posts, and ensure that the syringe is loaded with the syringe tabs positioned horizontally, so that they do not impede the travel of the slide assembly, as shown in Figure 3.5.

Figure 3.5 – Alignment of Syringe Tabs



D. Move the slide assembly to the end of the syringe and insert the plunger into the slide assembly clamp as shown. When the pump is operating in **REVERSE** mode it is especially important that the syringe be loaded into the slide assembly clamp correctly.

Figure 3.6 - Plunger Positioned in the Slide Assembly Clamp



E. Run the pump in **FORWARD** mode (see Operating Instructions) until the slide assembly makes contact with the plunger and the syringe tabs are in contact with the syringe clamp

CHAPTER 4 | SPECIALTY SYRINGES

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 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.

Small Syringes

Syringes of less than 5 ml capacity can be held more securely in the syringe clamp if the (optional) R-ACC Micro Syringe Adapter is used. The R-ACC adapter slides into the standard syringe clamp. The R-ACC-6 is a permanent attachment and can hold up to 6 micro syringes. The reverse option will not work with the R-ACC-6 adapter.

Figure 4.1 – R-ACC and R-ACC-6 Microsyringe Adapters

Images are not to scale

CHAPTER 5 | OPERATING INSTRUCTIONS

Setting the Pump ID

In **REMOTE** mode, the first 2 pushbutton switches set the pump ID. The pump IDs allow Med Associates or other 3rd party software programs to uniquely identify a pump. If more than one pump is being used, each requires a unique ID. Before turning the pump on, set switch 1 (labeled "**SYRINGE BRAND**") and switch 2 (labeled "**SIZE**") to the desired pump number. Valid pump IDs are from 00-99 (01-24 for Med-PC IV). 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. Be sure to switch each pump to **REMOTE** mode when setting the ID. With the pump in **LOCAL** mode, the **SYRINGE BRAND** and **SIZE** fields are used as labeled. Now the pump may be turned on.

Figure 5.1 - Pushbutton Switches

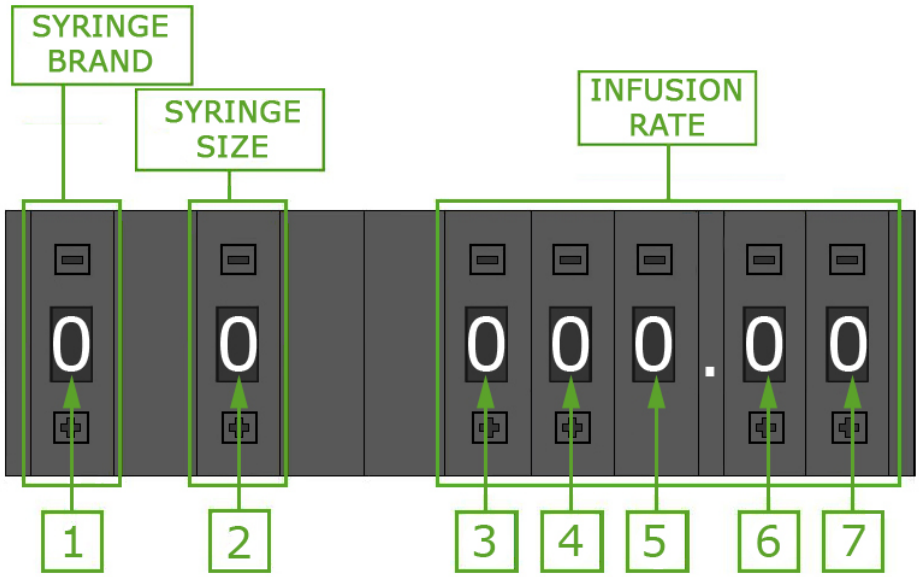
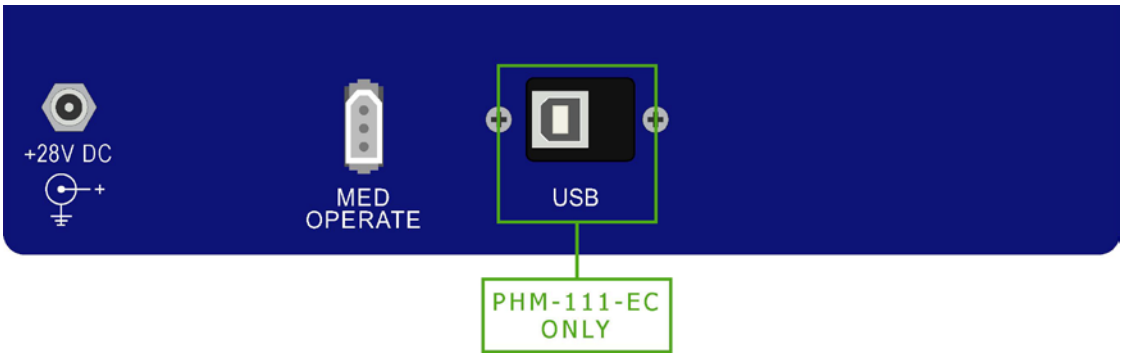


Figure 5.2 - Back of the PHM-111-EC Pump



NOTE: The PHM-111-EC can be operated using 24 – 28 VDC.

LOCAL Operation

1. Apply power to the pump by plugging the A/C power adapter into the "+28 VDC" Connector (Figure 5.2). Be sure that the **RUN/STOP/REMOTE** switch is in the **STOP** position. Using the green **ON/OFF** switch (Figure 2.7), turn the pump on. Changes to the pushbutton settings will not be recognized if the **RUN/STOP/REMOTE** switch is in the **RUN** position.
2. Turn the pump on.
3. **a. Pre-Programmed Syringe Brands**

   The PHM-111-EC pump is pre-programmed with syringe settings for several common syringe brands and sizes (Refer to Table 5.1. To use one of these syringe types, set the **SYRINGE BRAND** pushbutton switch by selecting the number that corresponds to the brand. Refer to Table 5.1.

Figure 5.3 - SYRINGE BRAND Pushbutton Switch

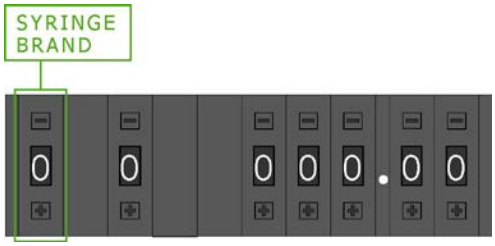


Table 5.1 - Syringe Brand Key

SYRINGE BRAND Pushbutton Setting	Corresponding Syringe Brand	Upper Left of LCD Display will read:
0	Unknown Brand	Select Units
1	BD Plastipak	BD PLASTIC
2	Monoject	MONOJECT
3	Terumo	TERUMO
4	BD Glass	BD GLASS
5	Unimetrics	UNIMET
6	Hamilton (µl)	HAMLTON µl
7	Hamilton (ml)	HAMLTON ml
8	Popper & Sons	P & S
9	Alarm Setting	ALARM

The Brand Name selected is displayed in the upper left corner of the LCD display. Proceed to Step 4.

b. Other Syringe Brands

If the brand of syringe being used is not included in Table 5.1, set the SYRINGE BRAND pushbutton to zero. With the SYRINGE BRAND pushbutton set to zero, the SIZE pushbutton switch may be used to select the distance/time that the pump travels; see Table 5.2. The LCD display will read "Select Units" with the units being some measure of distance/time (Refer to Figure 5.4).

In this case, the infusion rate in volume/time must be calculated by multiplying the syringe pump speed (distance/time) by the cross-sectional area of the syringe being used (see Table 9.1). For example:

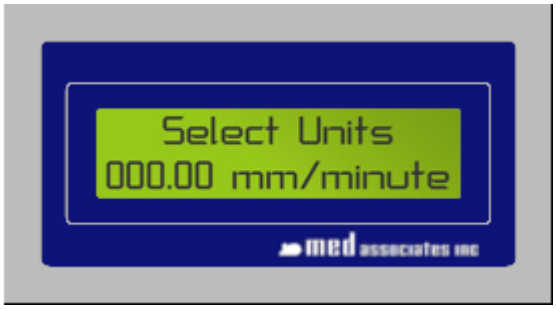
Rate (cc/min) = (Distance/Time (cm/min)) x Syringe Cross-Sectional Area (cm^2)

It is important to note that the Distance and Syringe Cross-Sectional Area must be in the same units, and the time units must also agree. Proceed to Step 4.

Table 5.2 – Distance / Time Selection

SYRINGE BRAND Pushbutton Setting	SIZE Pushbutton Setting									
	0	1	2	3	4	5	6	7	8	9
0	mm/min	mm/hr	cm/hr	in/hr	R-99EJM	RPM/100	Hz	Hz	Hz	Hz

Figure 5.4- LCD Display with SYRINGE BRAND and SIZE Pushbutton Settings of 0



4. Once a selection has been made for **SYRINGE BRAND**, set the **SIZE** pushbutton switch using Table 5.3.

   In Table 5.3, the sizes displayed in **black** will be infused in cc/hour, the sizes displayed in red will be infused in µl/minute and the sizes displayed in blue will be infused in µl/hour. The SIZE is displayed in the upper right corner of the LCD display and the infusion units are displayed in the lower right corner of the LCD display (see Figure 5.7).

Figure 5.5 - SIZE Pushbutton Switch

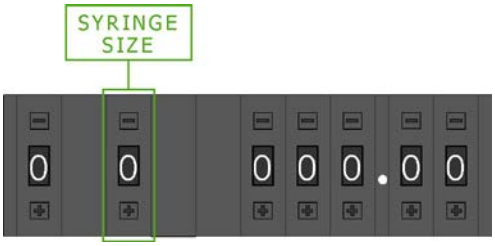


Table 5.3 - Syringe Size Chart

SYRINGE SIZE CHART											
SYRINGE BRAND	**SYRINGE BRAND Pushbutton Setting**	**SIZE Pushbutton Setting***									
		0	1	2	3	4	5	6	7	8	9
BD Plastipak	1	1 ml[2]	1 ml[1]	2.5 ml[2]	2.5 ml[1]	5 ml[1]	10 ml[1]	20 ml[1]	30 ml[1]	50 ml[1]	60 ml[1]
Monoject	2	1 ml[2]	1 ml[1]	3 ml[2]	3 ml[1]	6 ml[1]	12 ml[1]	20 ml[1]	35 ml[1]	60 ml[1]	60 ml[1]
Terumo	3	3 ml[2]	3 ml[1]	5 ml[1]	10 ml[1]	20 ml[1]	30 ml[1]	60 ml[1]	60 ml[1]	60 ml[1]	60 ml[1]
BD Glass	4	1 ml[2]	1 ml[1]	2 ml[2]	2 ml[1]	5 ml[1]	10 ml[1]	20 ml[1]	30 ml[1]	50ml[1]	50 ml[1]
Unimetrics	5	50 µl[2]	50 µl[3]	100 µl[2]	100 µl[1]	250 µl[2]	250 µl[1]	500 µl[2]	500 µl[1]	1 ml[2]	1 ml[1]
Hamilton (µl)	6	10 µl[3]	25 µl[3]	50 µl[2]	50 µl[3]	100 µl[2]	100 µl[1]	250µl[2]	250 µl[1]	500 µl[2]	500 µl[1]
Hamilton (ml)	7	1 ml[2]	1 ml[1]	2.5 ml[2]	2.5 ml[1]	5 ml[2]	5 ml[1]	10 ml[1]	25 ml[1]	25 ml[1]	25 m[1]l
Popper & Sons	8	1 ml[2]	1 ml[1]	2 ml[2]	2 ml[1]	3 ml[1]	5 ml[1]	10 ml[1]	20 ml[1]	30 ml[1]	50 ml[1]

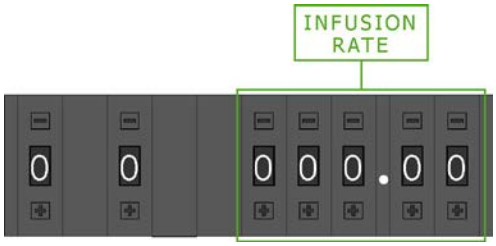
[1] Infused in cc/hour.

[2] Infused in µl/minute.

[3] Infused in µl/hour.

5. Set the desired **INFUSION RATE** using the pushbutton switches (Figure 5.6). The **INFUSION RATE** is displayed on the bottom left corner of the LCD display. The unit of the **INFUSION RATE** is also displayed on the lower right of the LCD display.

Figure 5.6 - INFUSION RATE Pushbutton Switches

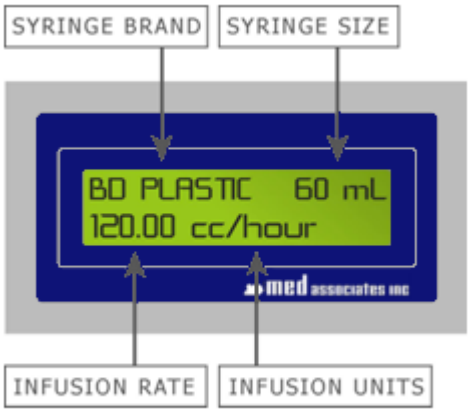


6. Select **FORWARD** or **REVERSE** mode using the **FORWARD/REVERSE** switch on the front of the pump (Figure 2.3). In **FORWARD** mode fluid is pumped out of the syringe and in **REVERSE** mode fluid is drawn into the syringe. It is important to note that the **FORWARD/REVERSE** switch remains active when the pump is switched to **RUN** so that the direction can be changed during an infusion.

NOTE: The automatic shutoff switch is active only when the pump is operating in **FORWARD** mode.

7. Verify that the desired pump settings are correct using the LCD display and make any necessary changes.

Figure 5.7 - Viewing the LCD Display



8. Switch **RUN/STOP/REMOTE** switch to **RUN**. The pump will infuse at the set rate, in the selected direction (**FORWARD** or **REVERSE**) and the green **OPERATE** light will come on (solid green in **FORWARD**, flashing green in **REVERSE**).

9. If the **INFUSION RATE** selected is out of range, the red **OUT OF RANGE** light will come on and the pump will not operate. If "000.00" is selected on the **INFUSION RATE** pushbutton switch the Pump will not operate.

10. Changes made to any of the pushbutton switches while the pump is in **RUN** mode will not be recognized until the pump is switched to **STOP**. If the **OUT OF RANGE** light is on and the pump settings cannot be changed, be sure that the **RUN/STOP/REMOTE** switch is set to **STOP**.

11. When the end of the syringe is reached in **FORWARD** mode the automatic shut off switch will stop the infusion, the red **OUT OF RANGE** light will flash and if the Audible Alarm is enabled it will sound (see Chapter 10).

CHAPTER 6 | MED-PC CONTROLLED OPERATION

This section describes the procedure for using a MED-PC 28 Volt output to turn the pump on and off. When controlling the pump using MED-PC, the infusion parameters are set using the pump interface, as described below. The PHM-111-EC pump is also capable of more sophisticated computer control via the USB port. Refer to USB Controlled Operation for more detailed information regarding the USB control of the PHM-111-EC pump.

1. Connect the **MED OPERATE** port (Figure 5.2) on the pump to any available output on the Standard MED Connection Panel (e.g. SG-716D), using the included cable.
2. Apply power to the pump by plugging the A/C power adapter into the "+28 VDC" Connector (Figure 5.2). Be sure that the **RUN/STOP/REMOTE** switch is in the **STOP** position. Using the green **ON/OFF** switch (Figure 2.7), turn the pump on. Changes to the pushbutton settings will not be recognized if the **RUN/STOP/REMOTE** switch is in the **RUN** position.
3. Refer to **LOCAL Operation** steps 2 – 6 (Pages 12 - 15) for detailed instructions regarding the use of the pushbutton switches.
4. Switch **RUN/STOP/REMOTE** switch to **REMOTE**. The pump will infuse at the set rate, in the selected direction (**FORWARD** or **REVERSE**) for as long as the 28 Volt output from MED-PC is on.
5. The green **OPERATE** light will come on (solid green in **FORWARD**, flashing green in **REVERSE**) when infusing.
6. If the **INFUSION RATE** selected is out of range, the red **OUT OF RANGE** light will come on and the pump will not operate. If "000.00" is selected on the **INFUSION RATE** pushbutton switch the Pump will not operate.
7. Changes made to any of the pushbutton switches while the pump is in **REMOTE** mode will not be recognized until the pump is switched to **STOP**. If the **OUT OF RANGE** light is on and the pump settings cannot be changed, be sure that the **RUN/STOP/REMOTE** switch is set to **STOP**.
8. When the end of the syringe is reached in **FORWARD** mode the automatic shut off switch will stop the infusion, the red **OUT OF RANGE** light will flash and if the Audible Alarm is enabled it will sound (see Chapter 10).
9. If the Safety Timer is enabled, the infusion will be stopped if the 28 Volt output from MED-PC is on longer than the Safety Timer duration (see Chapter 10). The lighted **ON/OFF** switch will go out to indicate that the Safety Timer has been activated.

CHAPTER 7 | USB CONTROLLED OPERATION

To control the PHM-111-EC pump via USB, the **USB** port on the pump must be connected to any available USB port on the computer using the included USB cable. The pump may now be controlled via USB using either the USB Syringe Pump Test Program, MED-PC or Razel IPC software. In order to control the pump using software, the necessary drivers must be installed. (See Chapter 8.)

For USB control, the **RUN/STOP/REMOTE** switch must be set to **REMOTE**. When the pump is in **REMOTE** mode and the USB cable is connected, the computer USB port will control the pump, and the **FORWARD/REVERSE** switch and the pushbutton switches will be disabled.

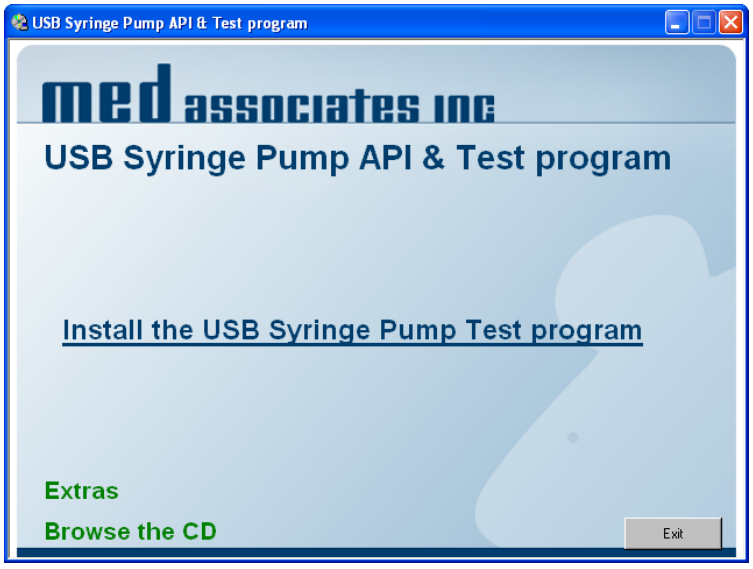
CHAPTER 8 | DRIVER AND SOFTWARE INSTALLATION

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

NOTE: The PHM-111-EC driver is specific to the computer USB port that the pump is connected to during driver installation. For this reason, it will be necessary to complete driver installation again if the pump is connected to a different USB port at a later time.

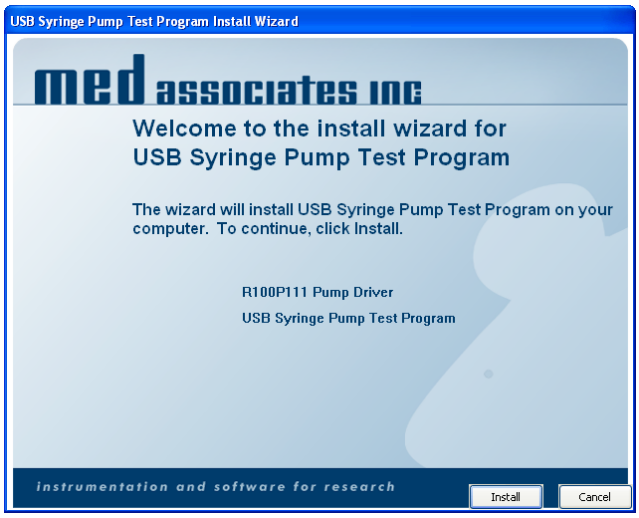
Insert the USB Syringe Pump Test Program CD into the CD-ROM drive. The screen shown in Figure 8.1 will appear. Click **Install the USB Syringe Pump Test Program** and the screen shown in Figure 8.2 will appear.

Figure 8.1 - USB Syringe Pump Test Program CD Menu



To begin driver and software installation, click Install. Follow the steps to complete installation. When the driver and software are installed, the screen will appear as shown in Figure 8.3.

Figure 8.2 – Installation Checklist



Green checkmarks indicate successful installation. If a red X appears next to any item, contact MED Associates Customer Support. The USB driver and software installation is now complete. Click **Finish** to close this screen and proceed to the device driver installation.

Figure 8.3 – Installation Checklist Complete

Using the included AC power adapter, connect the **+28V DC** connector on the pump to a standard wall outlet. Using the included USB cable, connect the **USB** connector on the pump to any available USB port on the computer. Turn the pump on (lighted ON/OFF switch), and the screen shown in Figure 8.4 will appear. Select **Install the software automatically (Recommended)** and then click **Next**.

Figure 8.4 – Found New Hardware Wizard

When the screen shown in Figure 8.5 appears, select **Finish**. The driver installation is now complete.

Figure 8.5 - Driver Installation Complete

CHAPTER 9 | RUNNING USB SYRINGE PUMP TEST PROGRAM

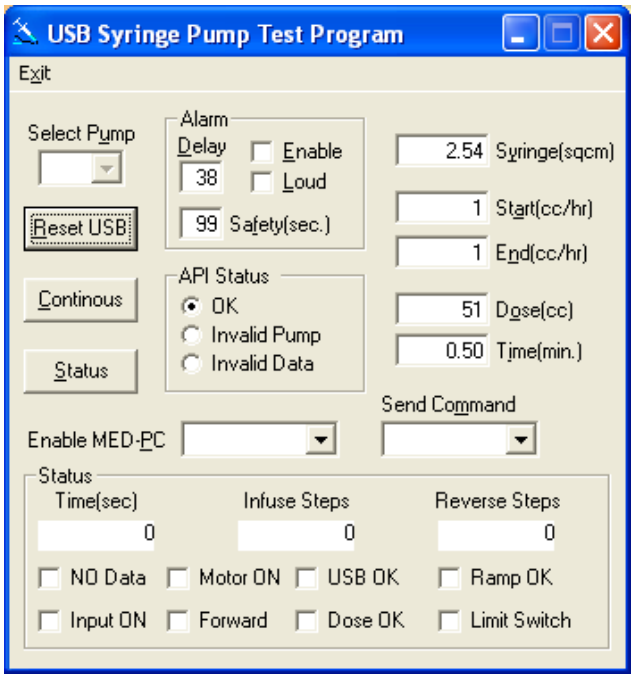
Prior to running the USB Syringe Pump Test Program each pump must be connected to any available USB port on the computer. Next, plug each pump in using the +28V power adapter.

Setting the Pump Number

Before turning the pumps on set Switches 1 and 2 (refer to Figure 10.1 for the location of Switches 1 and 2) to the desired pump number. This pump number will appear on the **Select Pump** pulldown menu and can be used to identify which pump is being programmed. If the pump is being used with MED-PC the pump number should correspond to the box number. Be sure to switch each pump to **REMOTE** mode. Now the pumps may be turned on.

Open the USB Syringe Pump Test Program and the screen shown in Figure 9.1 will appear.

Figure 9.1 - USB Syringe Pump Test Program



The cross-sectional area of the syringe being used must be entered (Syringe(sqcm)).

Table 9.1 contains the cross-sectional areas of several commonly used syringes.

Pump Commands

OFF	Turns the pump off and ends the command.
ON	Runs the pump at Start (cc/hr) rate in the forward direction.
REVERSE	Runs the pump at Start (cc/hr) rate in the reverse direction.
DOSE	Enter a Start (cc/hr) rate and either a Dose (cc) **or** Time (min) value. Pump will turn on at the Start (cc/hr) rate and stop after the Dose (cc) or Time (min) has been completed (whichever value has been entered).
RAMP	Enter a Start (cc/hr) rate, End (cc/hr) rate and Time (min). The infusion will begin at the Start (cc/hr) rate, and in the Time(min) duration the rate will gradually ramp up to the End (cc/hr) rate. The pump will continue to run at the End rate.
RAMPDOSE	Enter a Start (cc/hr) rate, End (cc/hr) rate and Dose (cc) **or** Time (min). The infusion will begin at the Start (cc/hr) rate and ramp up to the End (cc/hr) rate until the Dose (cc) has been delivered or the Time (min) is up, depending on which value has been entered. The pump will stop when the RAMPDOSE command is completed.

Table 9.1 - Syringe Cross-Sectional Areas

MULTIFIT, glass	
Syringe Size	Cross-section
1 mL	0.176 sq cm
2 mL	0.626 sq cm
5 mL	1.084 sq cm
10 mL	1.692 sq cm
20 mL	3.017 sq cm
30 mL	4.047 sq cm
50 mL	6.173 sq cm

HAMILTON, glass	
Syringe Size	Cross-section
10 µL	0.00167 sq cm
25 µL	0.00417 sq cm
.05 mL	0.00833 sq cm
.10 mL	0.01667 sq cm
.25 mL	0.04167 sq cm
.50 mL	0.08333 sq cm
1 mL	0.16667 sq cm
2.5 mL	0.41667 sq cm
5 mL	0.83333 sq cm
10 mL	1.6667 sq cm

UNIMETRICS, glass	
Syringe Size	Cross-section
.05 mL	0.00833 sq cm
.10 mL	0.01667 sq cm
.25 mL	0.04167 sq cm
.50 mL	0.08333 sq cm
1 mL	0.16667 sq cm

MONOJECT, plastic	
Syringe Size	Cross-section
1 mL	0.173 sq cm
3 mL	0.622 sq cm
6 mL	1.263 sq cm
12 mL	1.977 sq cm
20 mL	3.308 sq cm
35 mL	4.474 sq cm
60 mL	5.545 sq cm

B-D PLASTIPAK, plastic	
1 mL	0.173 sq cm
2.5 mL	0.578 sq cm
5 mL	1.129 sq cm
10 mL	1.635 sq cm
20 mL	2.850 sq cm
30 mL	3.662 sq cm
60 mL	5.556 sq cm

TERUMO, plastic	
3 mL	0.629 sq cm
5 mL	1.327 sq cm
10 mL	1.961 sq cm
20 mL	3.189 sq cm
30 mL	4.191 sq cm
60 mL	6.651 sq cm

The CD containing the USB Syringe Pump Test Program also contains file folders for the header and library files used with Med-PC.

CHAPTER 10 | ALARM SETTINGS

Audible Alarm

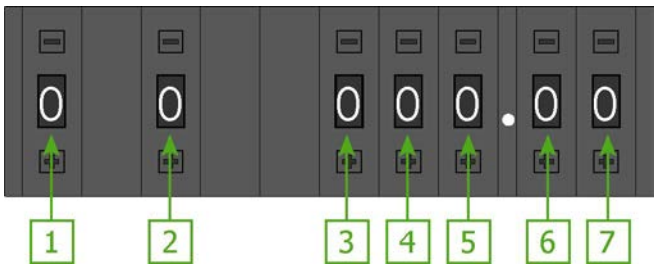
When enabled, the Audible Alarm sounds when the automatic shut-off switch is activated. The volume level (low and high) and interval between alarm beeps (0.5 - 39 seconds) are user-defined. It is important to note that the audible alarm functions only when pump is being operated in FORWARD mode. In order to clear this alarm and resume pump operation squeeze the tabs on the slide assembly and move it back until the automatic shut-off switch is deactivated.

Safety Timer

The Safety Timer can be used to disable the pump if the MED-PC input is on longer than the user-defined Safety Timer duration. The Safety Timer duration can be set to 1 – 99 seconds. The lighted ON/OFF switch (Figure 2.7) will go out to indicate that the Safety Timer has been activated. To clear the Safety Timer once it has been activated the pump must be turned off using the lighted ON/OFF switch.

For the remainder of this section the pushbuttons switches will be referred to as follows:

Figure 10.1 - Switch Numbering for Alarm Setting



View Default Alarm Settings

To view the current alarm settings on the LCD Display, the RUN/STOP/REMOTE switch should be set to STOP, Switch 1 should be set to '**9**' and Switch 3 should be set to '**0**', as shown in Figure 10.2.

Figure 10.2 - Viewing Current Alarm Settings

Change Default Alarm Settings

To make changes to the alarm settings, the following procedure should be followed:

1. Set the RUN/STOP/REMOTE switch to STOP and Set **Switch 1** to '**9**' and **Switch 3** to '**1**', as shown below.

Figure 10.3 - Changing Audible Alarm Settings

2. Use **Switch 2** to select the desired alarm function, as shown in Table 10.1.

Table 10.1 - Switch 2 Settings

Switch 2	Function	LCD Display
0	Safety Timer Off	SET SAFETY OFF
1	Safety Timer On	SET SAFETY ON
2	Audible Alarm Off	SET ALARM OFF
3	Audible Alarm On Low	SET ALARM LOW
4	Audible Alarm On High	SET ALARM HIGH
5	Audible Alarm On High	SET ALARM HIGH
6	Audible Alarm On High	SET ALARM HIGH
7	Audible Alarm On High	SET ALARM HIGH
8	Audible Alarm On High	SET ALARM HIGH
9	Audible Alarm On High	SET ALARM HIGH

3. Use Switches 6 and 7 to set either the interval between Audible Alarm occurrences, or the duration of the Safety Timer.
4. The Audible Alarm interval can be 0.5 – 39 seconds. If it is desired that the Audible Alarm sound every 30 seconds, Switch 6 should be set to 3 and Switch 7 should be set to 0. The LCD will display this value as **DELAY = 30 sec**. Setting Switches 6 and 7 to "00" will produce an interval of 0.5 seconds.

Figure 10.4 - Alarm Display

5. Verify that the settings are correct and set **Switch 3** to '**2**' to save the changes. **ALARM SAVED** will be displayed on the LCD. If changes need to be made to the alarm settings once ALARM SAVED has appeared on the LCD, Switch 1 must be switched from 9 to any other setting, Switch 3 must be set back to 1, then Switch 1 must be set back to 9 again.

Figure 10.5 - Alarm Saved

CHAPTER 11 | SAMPLE MED-PC PROGRAM

Example Med State Notation code for the PHM-111-EC Advanced Syringe Pump Application is shown below for reference purposes. This code is included on the PHM-111-EC CD. The code must be translated and compiled using Trans IV prior to running it in MED-PC. Refer to the MED-PC User's Manual and MED-PC Programmer's Manual for detailed information.

```
\ Copyright (C) 2016 MED Associates, All rights reserved.

\ PHM-111 PUMP.MPC
\
\ This program demonstrates how to properly call the MED-PC commands that Start
\ and Stop the PHM-111 Pump.
\
\ After the START command has been issued the User can then issue different
\ K-pulses (1-13) to send various commands to the pump.  Each K-pulse
\ demonstrates a different way of communicating with the pump and/or responses
\ that might be received from the pump.
\
\ Some commands (K-pulses 2-5) will turn ON the pump and leave it on until an
\ OFF command is sent.
\
\ Some commands (K-pulses 6-13) will turn ON the pump for a certain amount of
\ time or until a specified doseage has been delivered.
\
\ This program has no code to prevent a second ON command being sent to the pump
\ when the pump is already running so care must be taken to make sure that the
\ pump has already been stopped before trying to send another ON command via the
\ K-pulses.
\
\
\ PHM-111 Procedures
\   PHM111_Init       - Initializes the PHM-111 pump and returns the number of
\                       pumps found attached to the system
\
\   PHM111_CheckRate  - Used to check valid Rates and Syringe Sizes.  1 = OK
\
\   PHM111_PumpStart  - Starts the pump at the currently selected values
\
\   PHM111_PumpStop   - Stops the pump
\
\   PHM111_RampUpdate - Sets up pump parameters and/or starts the pump running
\                       at those specified values
\
\   PHM111_PumpDose   - Turns on the pump at the last specified Dose or Time
\
\   PHM111_PumpRamp   - Turns on the pump with the values last specified for the
\                       Ramp Rates and Dose/Time
\
\
\ PHM-111 Commands
\   PUMP_NULL     - Updates Rate values only, no change to PUMP ON/OFF/DIRECTION
\                   pump Rate changed if running
\
\   PUMP_OFF      - Turns pump off.  Leaves pump direction & speed alone
\
\   PUMP_ON       - Turns on pump in last set infuse direction (forward or
\                   reverse)
\
\   PUMP_DOSE     - Turns on pump & stops pump after Dose or Time settings
\
\   PUMP_RESET    - Stops motor, sets direction to infuse, step rate to full,
\                   and clears rate values & pulse & tic counters
\
\   PUMP_REV      - Turns on pump in reverse direction
\
\   PUMP_INPUTOFF - Disables remote INPUT control
\
```

```
\   PUMP_INPUTON  - Enables remote INPUT control
\
\   PUMP_RAMP     - Starts pump ramping @ startRate & ramps to endRate in
\                   specified Time and leaves pump on
\
\   PUMP_RMPDOS   - Starts pump ramping @ startRate & stops @ endRate after Dose
\                   or Time
\
\   PUMP_CALRAMP  - Downloads Rate or Dose values to the pump without turning it
\                   on
\
\
\ MG  - This is the MED-PC Global Pointer.  It allows the PHM-111 to pass
\       back information about any errors that might have occured.
\
\ BOX - This parameter specifies which PHM-111 the command is for.  When this
\       program is running in Box 1, then the BOX parameter will equal 1 and the
\       PHM-111 that is set to Node 1 will receive the command.  When this
\       program is running in Box 2, then the BOX parameter will equal 2 and the
\       PHM-111 that is set to Node 2 will receive the command, etc.  This
\       allows the same program to be run in multiple Boxes and control the
\       different Chambers.


\ List Working Variables Here
\  A = Response from the PHM111_Init, PHM111_PumpStart, PHM111_PumpDose,
\        PHM111_PumpRamp, PHM111_CheckRate, and/or PHM111_PumpStop Commands
\  B = Response from the PHM111_RampUpdate Command


\************************************************
\      PUMP INITIALIZATION/CHECK RATE EXAMPLE
\************************************************
S.S.1,  \ Initialize the Pump
S1,     \ Set a default Rate of 50 RPM and Syringe Size of 2.54cc
  #START: ~A := PHM111_Init(MG);~;
          ~B := PHM111_RampUpdate(MG, BOX, BOX, 50, 2.54, 0, 0, 0, PUMP_NULL);~;
          SHOW 1,Init Resp,A, 2,Update Resp,B ---> S2

S2,     \ Check if the Rate value supplied is valid for the Syringe Size
        \   supplied
  #K1: ~A := PHM111_CheckRate(MG, BOX, 50, 2.54);~;
       CLEAR 2,2; SHOW 1,Rate Resp,A ---> S2


\************************************************
\              PUMP START/STOP EXAMPLE
\************************************************
S.S.2,
S1,
  #START: ---> S2

S2,     \ Turn on the Pump at the Currently Selected Values
  #K2: ~A := PHM111_PumpStart(MG, BOX, BOX);~;
       CLEAR 2,2; SHOW 1,Start Resp,A ---> S3

S3,     \ Turn off the Pump
  #K2: ~A := PHM111_PumpStop(MG, BOX, BOX);~;
       CLEAR 2,2; SHOW 1,Stop Resp,A ---> S2


\************************************************
\     PUMP START/STOP WITH RATE UPDATE EXAMPLE
\************************************************
S.S.3,
S1,
  #START: ---> S2

S2,     \ Turn on the Pump with a Rate of 178 RPM and Syringe Size of 2.54cc
  #K3: ~B := PHM111_RampUpdate(MG, BOX, BOX, 178, 2.54, 0, 0, 0, PUMP_ON);~;
       CLEAR 1,1; SHOW 2,Update Resp,B ---> S3
```

```
S3,     \ Turn off the Pump.  Reset the Rate to 50 RPM and the Syringe Size to
        \   2.54cc
  #K3: ~B := PHM111_RampUpdate(MG, BOX, BOX, 50, 2.54, 0, 0, 0, PUMP_OFF);~;
       CLEAR 1,1; SHOW 2,Update Resp,B ---> S2


\************************************************
\          PUMP REVERSE DIRECTION EXAMPLE
\************************************************
S.S.4,
S1,
  #START: ---> S2

S2,     \ Turn on the Pump in Reverse with a Rate of 178 RPM and Syringe Size of
        \   2.54cc
  #K4: ~B := PHM111_RampUpdate(MG, BOX, BOX, 178, 2.54, 0, 0, 0, PUMP_REV);~;
       CLEAR 1,1; SHOW 2,Update Resp,B ---> S3

S3,     \ Turn off the Pump.  Reset the Rate to 50 RPM and the Syringe Size to
        \   2.54cc.  Reset the Pump to the Forward Direction
  #K4: ~B := PHM111_RampUpdate(MG, BOX, BOX, 50, 2.54, 0, 0, 0, PUMP_RESET);~;
       CLEAR 1,1; SHOW 2,Update Resp,B ---> S2


\************************************************
\                PUMP RAMP EXAMPLE
\************************************************
S.S.5,
S1,
  #START: ---> S2

S2,     \ Turn on the Pump with a Starting Rate of 178 RPM, Syringe Size of
        \   2.54cc, and Ending Rate of 50 RPM.  It will take 0.34s to go from
        \   the Starting Rate to the Ending Rate.  Pump will remain running at
        \   the Ending Rate
  #K5: ~B := PHM111_RampUpdate(MG, BOX, BOX, 178, 2.54, 0, 0.34, 50, PUMP_RAMP);~;
       CLEAR 1,1; SHOW 2,Update Resp,B ---> S3

S3,     \ Turn off the Pump.  Reset the Rate to 50 RPM and the Syringe Size to
        \   2.54cc
  #K5: ~B := PHM111_RampUpdate(MG, BOX, BOX, 50, 2.54, 0, 0, 0, PUMP_OFF);~;
       CLEAR 1,1; SHOW 2,Update Resp,B ---> S2


\************************************************
\    PUMP RAMP DOSE WITH SPECIFIED TIME EXAMPLE
\************************************************
S.S.6,
S1,
  #START: ---> S2

S2,     \ Turn on the Pump with a Starting Rate of 178 RPM, Syringe Size of
        \   2.54cc, and Ending Rate of 50 RPM.  It will take 0.53s to go from
        \   the Starting Rate to the Ending Rate and then the Pump will stop
  #K6: ~B := PHM111_RampUpdate(MG, BOX, BOX, 178, 2.54, 0, 0.53, 50, PUMP_RMPDOS);~;
       CLEAR 1,1; SHOW 2,Update Resp,B ---> S2


\************************************************
\    PUMP RAMP DOSE WITH SPECIFIED DOSE EXAMPLE
\************************************************
S.S.7,
S1,
  #START: ---> S2

S2,     \ Turn on the Pump with a Starting Rate of 178 RPM, Syringe Size of
        \   2.54cc, and Ending Rate of 50 RPM.  The Pump will calculate how long
        \   and fast to Ramp until 1cc is delivered and then the Pump will stop
  #K7: ~B := PHM111_RampUpdate(MG, BOX, BOX, 178, 2.54, 1, 0, 50, PUMP_RMPDOS);~;
       CLEAR 1,1; SHOW 2,Update Resp,B ---> S2
```

```
\************************************************
\       PUMP RATE WITH SPECIFIED DOSE EXAMPLE
\************************************************
S.S.8,
S1,
  #START: ---> S2

S2,     \ Turn on the Pump with a Rate of 178 RPM and Syringe Size of 2.54cc
        \   until 1cc is delivered and then the Pump will stop
  #K8: ~B := PHM111_RampUpdate(MG, BOX, BOX, 178, 2.54, 1, 0, 0, PUMP_DOSE);~;
       CLEAR 1,1; SHOW 2,Update Resp,B ---> S2


\************************************************
\       PUMP RATE WITH SPECIFIED TIME EXAMPLE
\************************************************
S.S.9,
S1,
  #START: ---> S2

S2,     \ Turn on the Pump with a Rate of 178 RPM and Syringe Size of 2.54cc
        \   for 0.34s Infusion Duration Time
  #K9: ~B := PHM111_RampUpdate(MG, BOX, BOX, 178, 2.54, 0, 0.34, 0, PUMP_DOSE);~;
       CLEAR 1,1; SHOW 2,Update Resp,B ---> S2


\************************************************
\      PUMP RATE WITH SPECIFIED DOSE EXAMPLE 2
\************************************************
S.S.10,
S1,
  #START: ---> S2

S2,     \ Sends the Pump a Rate of 178 RPM, Syringe Size of 2.54cc, and a Dose
        \   size of 1cc
  #K10: ~B := PHM111_RampUpdate(MG, BOX, BOX, 178, 2.54, 1, 0, 0, PUMP_NULL);~;

        SHOW 2,Update Resp,B ---> S3

S3,     \ Turns on the until 1cc is delivered and then the Pump will stop
  0.01": ~A := PHM111_PumpDose(MG, BOX, BOX);~;
         SHOW 1,Dose Resp,A ---> S2


\************************************************
\      PUMP RATE WITH SPECIFIED TIME EXAMPLE 2
\************************************************
S.S.11,
S1,
  #START: ---> S2

S2,     \ Sends the Pump a Rate of 178 RPM, Syringe Size of 2.54cc, and a
        \   Infusion Duration Time of 0.34s
  #K11: ~B := PHM111_RampUpdate(MG, BOX, BOX, 178, 2.54, 0, 0.34, 0, PUMP_NULL);~;
        SHOW 2,Update Resp,B ---> S3

S3,     \ Turns on the Pump for the 0.34s Infusion Duration Time
  0.01": ~A := PHM111_PumpDose(MG, BOX, BOX);~;
         SHOW 1,Dose Resp,A ---> S2


\************************************************
\   PUMP RAMP DOSE WITH SPECIFIED DOSE EXAMPLE 2
\************************************************
S.S.12,
S1,
  #START: ---> S2

S2,     \ Sends the Pump a Starting Rate of 178 RPM, Syringe Size of 2.54cc,
```

```
        \   Ending Rate of 50 RPM, and 1cc Dose
  #K12: ~B := PHM111_RampUpdate(MG, BOX, BOX, 178, 2.54, 1, 0, 50, PUMP_CALRAMP);~;
        SHOW 2,Update Resp,B ---> S3

S3,     \ Turns on the Pump with the Ramp Rates provided.  The Pump will
        \   calculate how long and fast to Ramp until 1cc is delivered and then
        \   the Pump will stop
  0.01": ~A := PHM111_PumpRamp(MG, BOX, BOX);~;
         SHOW 1,Ramp Resp,A ---> S2


\***********************************************
\   PUMP RAMP DOSE WITH SPECIFIED TIME EXAMPLE 2
\***********************************************
S.S.13,
S1,
  #START: ---> S2

S2,     \ Sends the Pump a Starting Rate of 178 RPM, Syringe Size of 2.54cc,
        \   Ending Rate of 50 RPM, and a Infusion Duration Time of 0.53s
  #K13: ~B := PHM111_RampUpdate(MG, BOX, BOX, 178, 2.54, 0, 0.53, 50, PUMP_CALRAMP);~;
        SHOW 2,Update Resp,B ---> S3

S3,     \ Turns on the Pump with the Ramp Rates provided.  It will take 0.53s to
        \   go from the Starting Rate to the Ending Rate and then the Pump will
        \   stop
  0.01": ~A := PHM111_PumpRamp(MG, BOX, BOX);~;
         SHOW 1,Ramp Resp,A ---> S2
```

Definitions of PHM-111 Commands

PHM111_Init initializes the PHM-111 pump and returns the number of pumps attached to the driver.

Syntax: ~PHM111_Init(MG);~;
Where: MG = MED-PC Global Parameter
Example:

```
S.S.1,
S1,
  #START: ~PHM111_Init(MG);~ ---> S2
```

PHM111_PumpStart starts the pump.

Syntax: ~PHM111_PumpStart(MG, Box, P1);~;
Where: MG = MED-PC Global Parameter
Box = MED-PC BOX Parameter
P1 = Pump Number that this command is for (valid values 0 – 24)
Example:

```
S2,
  #R^Lever: ~PHM111_PumpStart(MG, BOX, BOX);~ ---> S3
```

PHM111_PumpStop stops the pump.

Syntax: ~PHM111_PumpStop(MG, Box, P1);~;
Where: MG = MED-PC Global Parameter
Box = MED-PC BOX Parameter
P1 = Pump Number that this command is for (valid values 0 – 24)
Example:

```
S3,
  1": ~PHM111_PumpStop(MG, BOX, BOX);~ ---> S2
```

PHM111_RampUpdate sets up pump parameters.

Syntax: ~PHM111_RampUpdate(MG, Box, P1, Start Rate, Size, Dose, Time, End Rate, Code);~;
Where: MG = MED-PC Global Parameter
Box = MED-PC BOX Parameter
P1 = Pump Number that this command is for (valid values 0 – 24)
Rate = cc/hr
Size = Syringe Cross-Sectional Area (cm^2)
Dose = cc
Time = Infusion Duration (minutes)
Code = Any of the following

Code

PUMP_NULL:	Updates rate values only, no change to PUMP ON/OFF/DIRECTION. Pump rate changed if running.
PUMP_OFF:	Turns pump off and leaves pump direction and speed alone.
PUMP_ON:	Turns the pump on in FORWARD mode.
PUMP_DOSE:	Turns the pump on and stops infusion after dose or time is complete.
PUMP_INPUTON:	Enables remote MED-PC Input control

Example:

```
~B := PHM111_RampUpdate(MG, BOX, BOX, 50, 2.54, 0, 0, 0, PUMP_NULL);~;
```

APPENDIX A | CONTACT INFORMATION

Please contact Med Associates, Inc. for information regarding any of our products.

Visit our website at www.med-associates.com for contact information.

For technical questions, email support@med-associates.com.