



R-100EC/R-100EC-S SYRINGE PUMP OPERATOR'S MANUAL



DOC-094
Rev. 2.4

Copyright © 2016
All Rights Reserved

Razel Scientific Instruments
P.O. Box 111
St. Albans, VT 05478
www.razelscientific.com

notes

Table of Contents

Chapter 1 Overview	1
Specifications	1
Chapter 2 Hardware	2
Pump Interface	3
RUN/STOP Switch	4
SYRINGE BRAND / SIZE and INFUSION RATE Switches	4
FORWARD/REVERSE Switch.....	4
LOCAL/REMOTE Switch	4
Automatic Shut-Off Switch	5
OPERATE Light	6
OUT OF RANGE Light.....	6
Chapter 3 Syringe Placement	7
Chapter 4 Specialty Syringes	10
Glass Syringes	10
Small Syringes	10
Chapter 5 Operating Instructions	11
Setting the Pump ID.....	11
LOCAL Operation.....	11
Pre-Programmed Syringe Brands	12
Other Syringe Brands	13
REMOTE Operation.....	16
TTL Operation (R-100EC-S Only)	17
Chapter 6 Driver And Software Installation	18
Chapter 7 Running USB Syringe Pump Test Program	21
Setting the Pump Number	21
Pump Commands	22
Chapter 8 Audible Alarm SETting	24
View Current Settings	24
Set Alarm Defaults	25
Chapter 9 Sample Med-PC® Program	27
Definitions of R-100EC Commands	31

Page intentionally left blank

CHAPTER 1 OVERVIEW

The Razel R-100EC and R-100EC-S (see **TTL Operation**) USB Pumps ensures safe, accurate infusion using several unique features. The R-100EC and R-100EC-S allow the user to specify a syringe brand and capacity, as well as the desired infusion rate. The pump settings are clearly displayed on an LCD for easy viewing. The pumps may be operated remotely via a USB interface. The pumps are supplied with Razel Scientific Instruments' USB Syringe Pump Test Program™ Software for testing functionality and API software for interfacing the pump with third party or custom software. Razel also offers a stand-alone software application, Razel IPC™, as an option for users desiring a fully stand-alone USB controlled pump. For added safety the R-100EC and R-100EC-S utilize an automatic shut-off when the end of the syringe is reached. Razel strongly encourages the user to thoroughly read this manual prior to operating the pump.

Specifications

Pressure Limits

The Razel R-100EC USB pump provides accurate flow when operated below the following pressures:

PSI	mmHg	Syringe Size (cc)
5	259	50-60
7	362	30-35
10	517	20
20	1034	10

CHAPTER 2 HARDWARE

The R-100EC Pump consists of a pump mechanism attached to the pump interface (see Figure 2.1); the syringe (supplied by end user) is mounted onto the pump mechanism.

Figure 2.1 - R-100EC 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 (see Chapter 5).

Figure 2.2 - R-100EC Control Panel

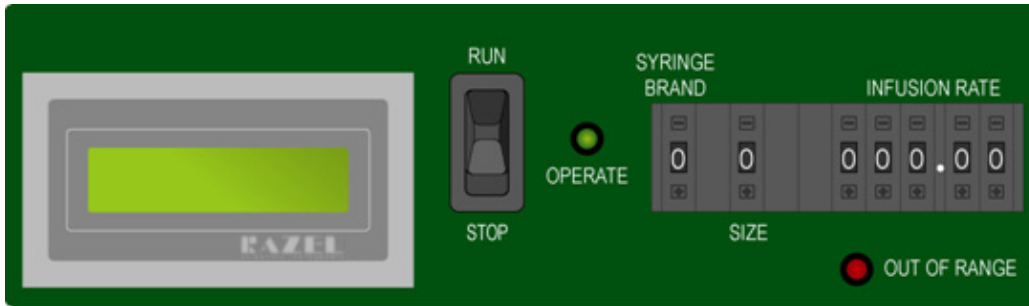


Figure 2.3 - R-100EC Front Panel

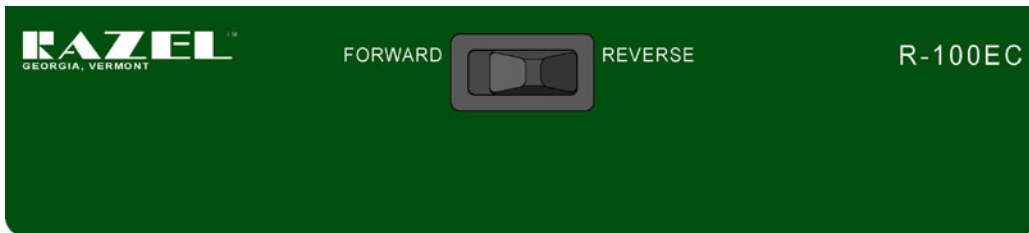
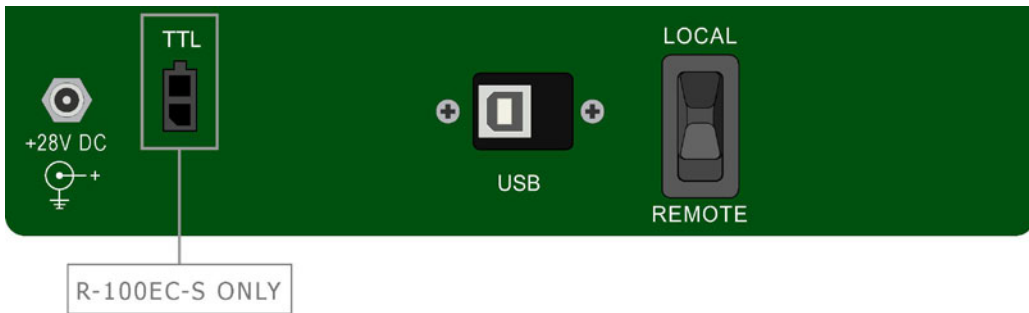


Figure 2.4 - R-100EC Back Panel



NOTE: The Razel R-100EC can be operated using 24 – 28 VDC.

RUN/STOP Switch

When the switch (see Figure 2.2) is in the **STOP** (or “down”) position:

1. The **SYRINGE BRAND**, **SIZE** and **INFUSION RATE** pushbutton switches are enabled. These settings may be adjusted 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 Run/Stop switch is in the **RUN** (or “up”) position:

1. The Pump operates at the set rate, and in the set direction;
2. The **SYRINGE BRAND**, **SIZE** and **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 will be steady 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 Chapter 5.

FORWARD/REVERSE Switch

When the **FORWARD/REVERSE** 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**.

LOCAL/REMOTE Switch

When the **LOCAL/REMOTE** switch is in the **LOCAL** (or “up”) position:

1. The **RUN/STOP** switch is enabled;
2. The **FORWARD/REVERSE** switch is enabled;
3. The **SYRINGE BRAND**, **SIZE** and **INFUSION RATE** pushbutton switches control the function of the pump;
4. The USB connector is disabled.

When the **LOCAL/REMOTE** switch is in the **REMOTE** (or “down”) position:

1. All switches but the **LOCAL/REMOTE** switch are disabled;
2. The USB connector is enabled;
3. The pump is now completely controlled by commands being received via the USB port.

4. The green **OPERATE** Light is on if operating in **FORWARD** mode and flashing if operating in **REVERSE**.

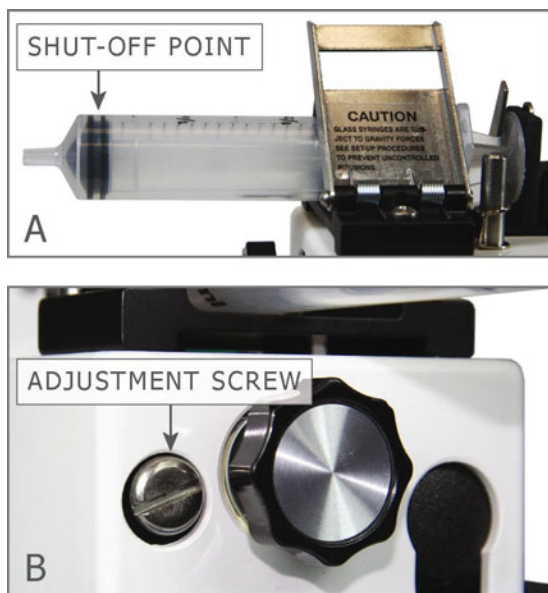
Automatic Shut-Off Switch

When the pump is operating in **FORWARD** mode the 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 the audible alarm will sound (if enabled; See Chapter 8).

The slide assembly houses a micro-switch which closes when the syringe slide reaches the user-adjusted position, stopping pump operation.

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 (see Figure 2.5A). With the pump turned on, rotate the adjustment screw (see Figure 2.5B) until the **OUT OF RANGE** light comes on and the audible alarm beeps. 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 (see Figure 3.3) and move it back until the switch is deactivated.

Figure 2.5 - Automatic Shut-Off Switch Adjustment



NOTE: There will not be any indication that the end of the syringe has been reached when operating in REVERSE mode.

OPERATE Light

- If the pump is operating in **FORWARD** mode, the **OPERATE** Light is on.
- If the pump is operating in **REVERSE** mode, the **OPERATE** Light is flashing.
- The **OPERATE** Light is off when the infusion is complete and when the pump is off.

OUT OF RANGE Light

- If the selected **INFUSION RATE** is out of range, the **OUT OF RANGE** Light is on.
- If the Automatic Shut-Off Switch has been activated, the **OUT OF RANGE** Light is flashing.
- If the **INFUSION RATE** switches are set to "000.00", the **OUT OF RANGE** Light is on.
- The **OUT OF RANGE** Light is off when the pump is operating.

CHAPTER 3 SYRINGE PLACEMENT

Care should be exercised to ensure that the syringe is positioned correctly when loading it into the infusion pump. Accurate flow rates cannot be assured if the syringe is not properly loaded. It is important that the slide makes contact with the syringe plunger.

Figure 3.1 - Syringe Components

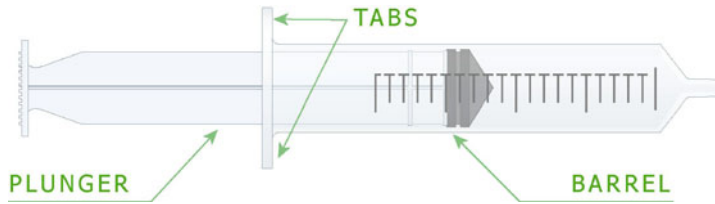
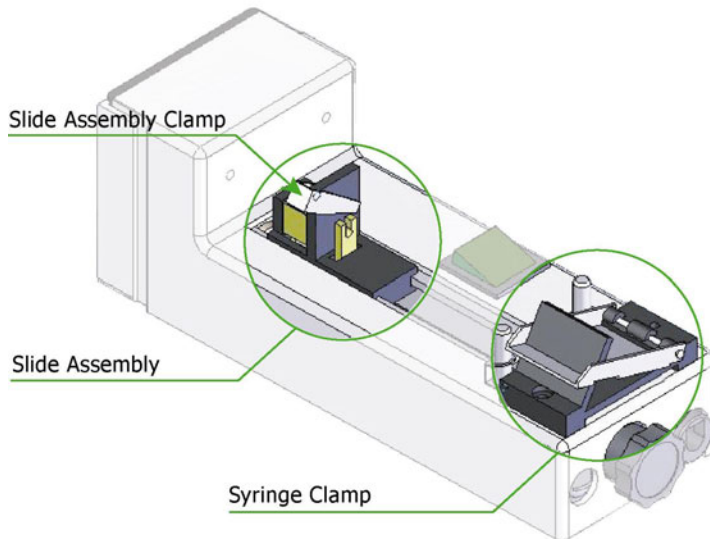


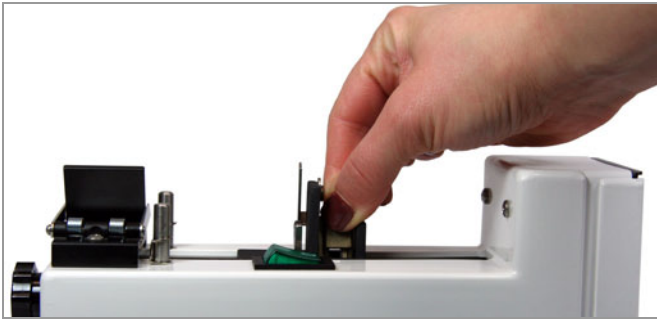
Figure 3.2 - Pump Mechanism Components



Complete the following steps to properly load the syringe:

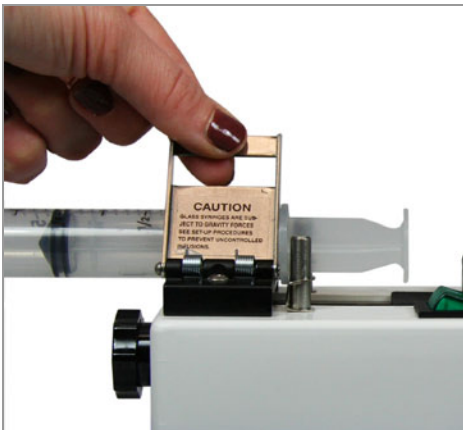
- A. Move the slide assembly to the rear of the pump (toward motor section) by squeezing the jaws and pulling back.

Figure 3.3 - Moving the Slide Assembly to the Rear of the Pump



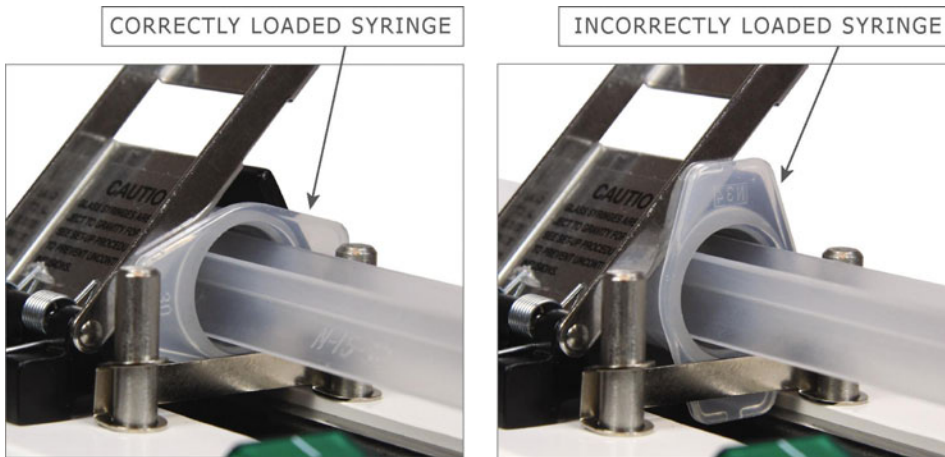
- B. Insert syringe by lifting clamp cover and placing the syringe barrel into the clamp.

Figure 3.4 - Open Syringe Clamp



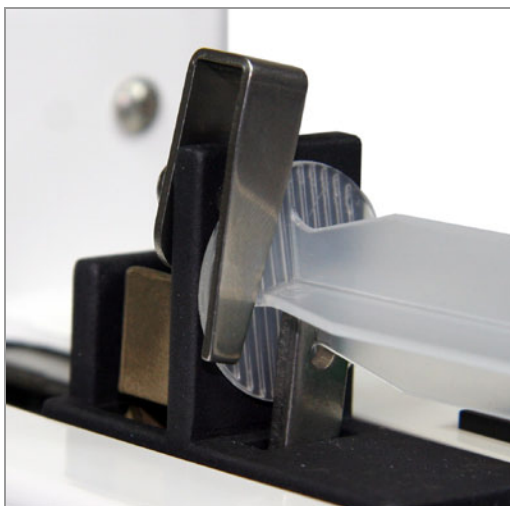
- C. Be sure that the syringe tabs are properly inserted between the syringe clamp and the retaining posts, and ensure that the syringe is loaded with the syringe tabs positioned horizontally so that they do not impede the travel of the slide assembly, as shown in Figure 3.5.

Figure 3.5 - Aligned Syringe Tabs



- D. Move the slide assembly to the end of the syringe and insert the plunger into the slide assembly clamp as shown in Figure 3.6. 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



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

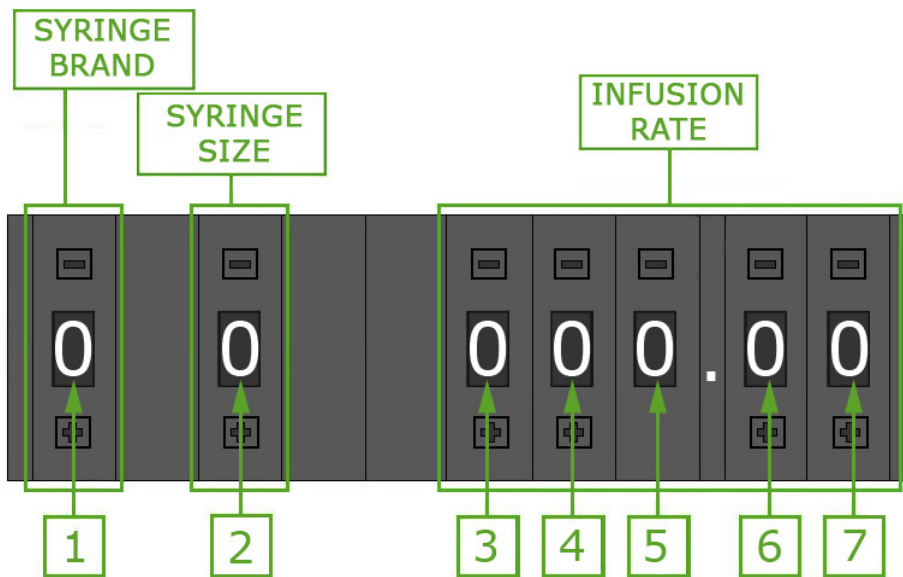
CHAPTER 5 OPERATING INSTRUCTIONS

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®). 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



LOCAL Operation

LOCAL operation enables the syringe pump to operate “standalone” without connection to a PC via the USB interface.

1. Using the included A/C power adapter, connect the **+28 VDC** connector on the pump to a standard wall outlet. Be sure that the **LOCAL/REMOTE** switch is in the **LOCAL** position, and the **RUN/STOP** switch is in the **STOP** position. (Changes to the pushbutton settings will not be recognized if in **RUN** mode.)
2. Using the green **ON/OFF** rocker switch, turn the pump on.

Pre-Programmed Syringe Brands

3a. The R-100 pump is pre-programmed with syringe settings for several common syringe brands and sizes. 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 5.2 - SYRINGE BRAND Pushbutton Switch

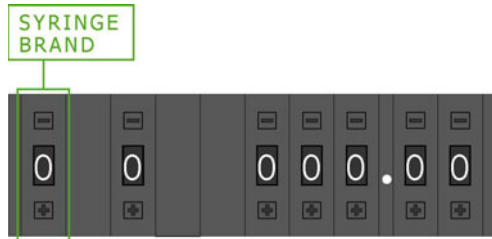


Table 5.1 - Syringe Brand Key

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.

Other Syringe Brands

3b. 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 5.3).

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 7.1). For example:

$$\text{Rate (cc/min)} = (\text{Distance/Time (cm/min)}) \times \text{Syringe Cross-Sectional Area (cm}^2\text{)}$$

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 5.

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



- 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 $\mu\text{l}/\text{minute}$ and the sizes displayed in **blue** will be infused in $\mu\text{l}/\text{hour}$. 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 5.6).

Figure 5.4 - SIZE Pushbutton Switch

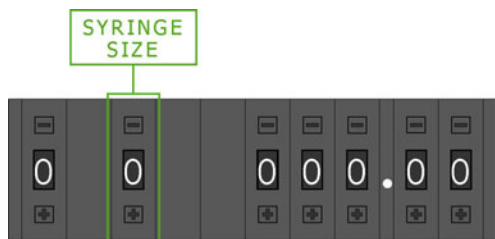


Table 5.3 - Syringe Size Chart

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	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	250 μl 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 ml ¹
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

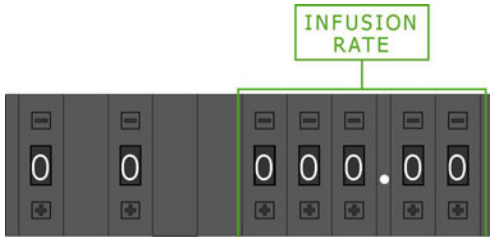
¹ infused in cc/hour.

² infused in $\mu\text{l}/\text{minute}$.

³ infused in $\mu\text{l}/\text{hour}$.

- Set the desired **INFUSION RATE** using the pushbutton switches (see Figure 5.5). 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 5.5 - INFUSION RATE Pushbutton Switches

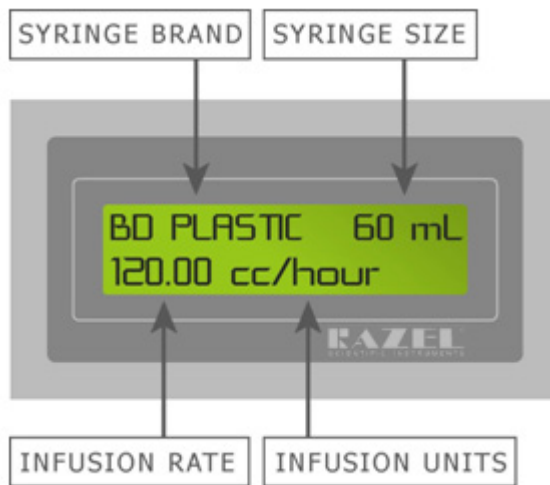


- Select **FORWARD** or **REVERSE** mode using the **FORWARD/REVERSE** switch on the front of the pump (see Figure 2.3). In **FORWARD** mode fluid is pumped out of the syringe and in **REVERSE** mode fluid is drawn into the syringe. It is important to note that the **FORWARD/REVERSE** switch remains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

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

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

Figure 5.6 - Viewing the LCD Display



8. Switch **RUN/STOP** 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** 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 8 "Audible Alarm Setting").

REMOTE Operation

When the pump is in **Remote** mode it can be controlled via USB using either the USB Syringe Pump Test Program or the Razel IPC software. In order to control the pump using either of these methods, the necessary drivers must first be installed (Refer to Chapter 6 "Driver and Software Installation").

NOTE: The R-100EC 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.

Use the included USB cable to connect the USB port on the pump to the USB port on the computer that was used during driver installation. Using the included A/C power adapter connect the **+28 VDC** connector on the pump to a standard wall outlet. Then, with the pump turned on, switch the **LOCAL/REMOTE** switch to **REMOTE**.

When the pump is in **REMOTE** mode and the USB cable is connected all switches besides **LOCAL/REMOTE** are disabled. Changes made to any other switches while in **REMOTE** mode will not affect the operation of the pump.

TTL Operation (R-100EC-S Only)

Follow Steps 1 – 7 above (Local Operation) to select the desired pump settings. The **LOCAL/REMOTE** switch should be set to **LOCAL** and the **RUN/STOP** switch to **STOP** for TTL operation. Once all of the desired pump settings have been completed, connect the TTL cable to the **TTL** port, located on the back of the pump (see Figure 2.4). The wire connections for the TTL cable are as follows:

Table 5.4 - TTL Cable Wire Connections

Red Wire	Black Wire
Operate (+ 5V Inactive, 0V Active)	Ground

When the operate signal is activated, 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**).

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.

Changes made to any of the pushbutton switches while the pump is operating will not be recognized until the pump is stopped. 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 8 “Audible Alarm Setting”).

CHAPTER 6 DRIVER AND SOFTWARE INSTALLATION

Before the pump can be controlled using the USB Syringe Pump Test program, the drivers and software need to be installed.

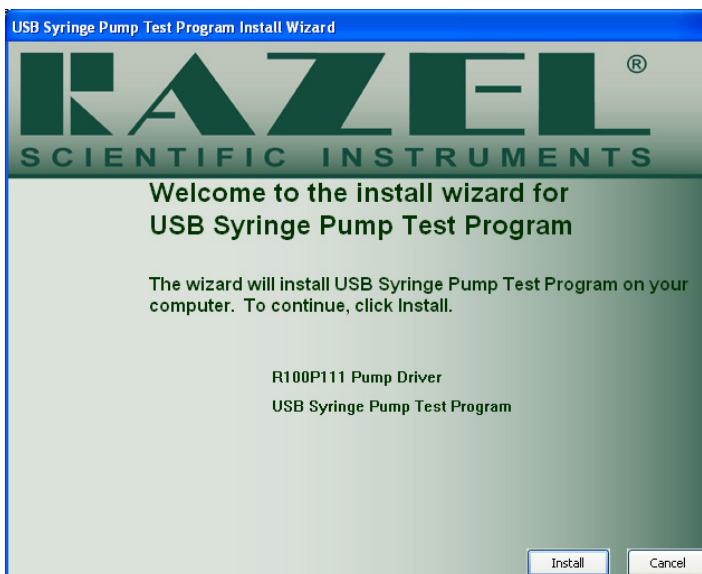
Insert the USB Syringe Pump Test Program CD into the CD-ROM drive. Click **Install the USB Syringe Pump Test Program** (see Figure 6.1)

Figure 6.1 - USB Syringe Pump Test Program CD Menu



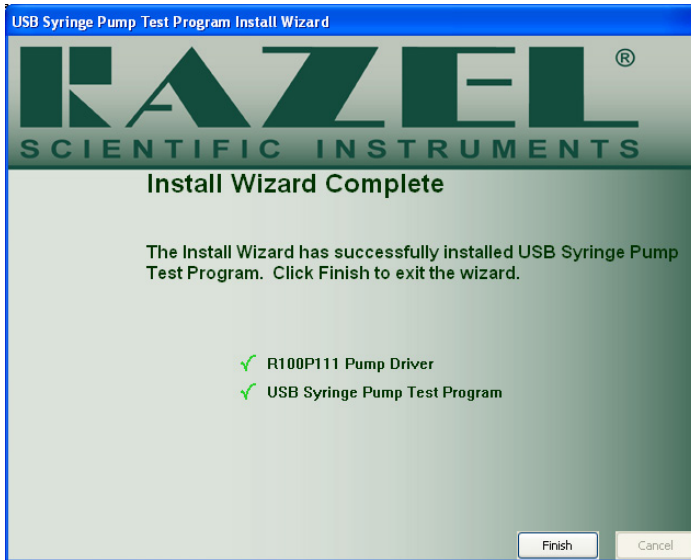
To begin driver and software installation, click Install (see Figure 6.2).

Figure 6.2 – Installation Checklist



Green checkmarks indicate successful installation. If a red X appears next to any item, contact Razel Scientific Support. When the driver and software are installed, the screen will appear as shown in Figure 6.3. The USB driver and software installation is now complete. Click **Finish** to close this screen and proceed to the device driver installation.

Figure 6.3 – Installation Checklist Complete



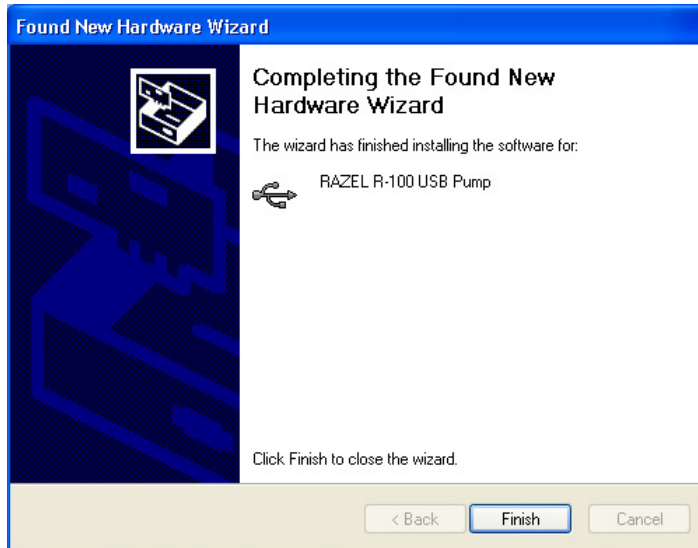
Using the included AC power adapter, connect the **+28V DC** connector on the pump to a standard wall outlet. Using the included USB cable, connect the **USB** connector on the pump to any available USB port on the computer. Turn the pump on (lighted **ON/OFF** switch), and the screen shown in Figure 6.4 will appear. Select **Install the software automatically (Recommended)** and then click **Next**.

Figure 6.4 – Found New Hardware Wizard



When the screen shown in Figure 6.5 appears, select **Finish**. The driver installation is now complete.

Figure 6.5 - Driver Installation Complete



NOTE: The R-100EC 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.

CHAPTER 7 RUNNING USB SYRINGE PUMP TEST PROGRAM

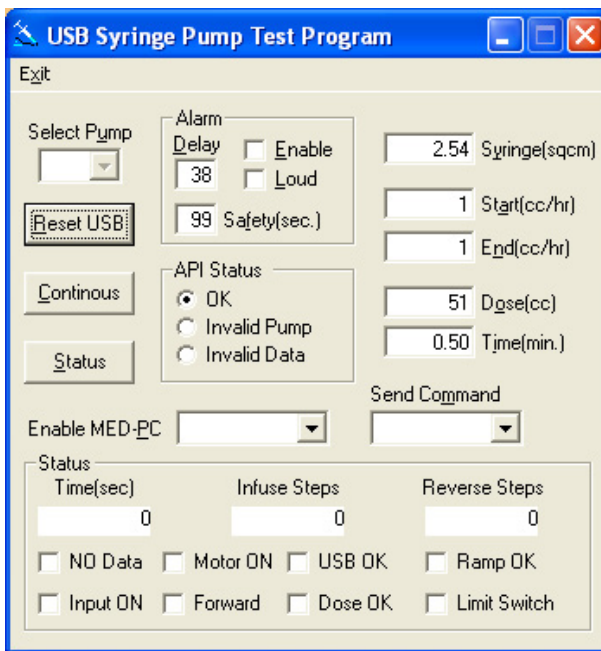
Before running the USB Syringe Pump Test Program, each pump must be connected to the computer via the USB port for which the driver was installed. Next plug each pump in using the included +28V power adapters.

Setting the Pump Number

Before turning the pumps on set Switches 1 and 2 (refer to Figure 8.1 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. Be sure to switch each pump to **REMOTE** mode.

Now the pump may be turned on. Open the USB Syringe Pump Test Program and the screen shown in Figure 7.1 will appear.

Figure 7.1 - USB SYRINGE PUMP TEST PROGRAM Software



The cross-sectional area of the syringe being used must be entered (Syringe(sqcm)). Table 7.1 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 7.1 - Syringe Cross-Sectional Areas (continued on next page)

MULTIFIT, glass		HAMILTON, glass	
Syringe Size	Cross-section	Syringe Size	Cross-section
1 mL	0.176 sq cm	10 µL	0.00167 sq cm
2 mL	0.626 sq cm	25 µL	0.00417 sq cm
5 mL	1.084 sq cm	.05 mL	0.00833 sq cm
10 mL	1.692 sq cm	.10 mL	0.01667 sq cm
20 mL	3.017 sq cm	.25 mL	0.04167 sq cm
30 mL	4.047 sq cm	.50 mL	0.08333 sq cm
50 mL	6.173 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	
Syringe Size	Cross-section
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	
Syringe Size	Cross-section
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 Razel Scientific Instruments R-100 API & Test Program also contains file folders for the header and library files.

CHAPTER 8 AUDIBLE ALARM SETTING

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

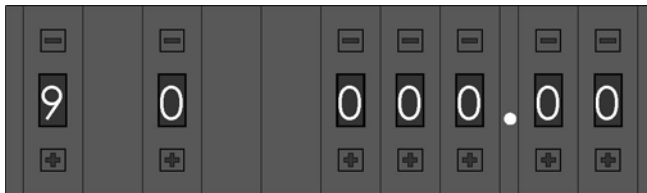
Figure 8.1 - Switch Numbering



View Current Settings

To view the current alarm settings on the LCD Display, Switch 1 should be set to **9** and Switch 3 should be set to **0**.

Figure 8.2 - Viewing Current Alarm Settings



Set Alarm Defaults

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

1. Set **Switch 1** to **9** and **Switch 3** to **1**, as shown below.

Figure 8.3 - Changing Audible Alarm Settings



2. Use Switch 2 to select alarm volume or alarm off. A setting of 0 will turn the alarm off, a setting of 1 will turn the alarm on at the low volume level and a setting of any value above 1 (2 – 9) will turn the alarm on at the high volume level, refer to Table 8.1.

Table 8.1 - Switch 2 Settings

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

- Use Switches 6 and 7 to set the interval between Audible Alarm occurrences. This 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 8.4 - Alarm Display



- Be sure that the Audible Alarm 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, then back to 9 again.

Figure 8.5 - Alarm Saved



CHAPTER 9 SAMPLE MED-PC® PROGRAM

Example Med State Notation code for the Razel R-100EC Syringe Pump Application is shown below for reference purposes. This code is included on the R-100EC CD. The code must be translated and compiled using MED Associates' Trans software application 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.

\ R-100 PUMP.MPC
\
\ This program demonstrates how to properly call the MED-PC commands that Start
\ and Stop the R-100 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.
\
\
\ R-100 Procedures
\ MPC_Init - Initializes the R-100 pump and returns the number of pumps
\ found attached to the system
\
\ MPC_CheckRate - Used to check valid Rates and Syringe Sizes. 1 = OK
\
\ MPC_PumpStart - Starts the pump at the currently selected values
\
\ MPC_PumpStop - Stops the pump
\
\ MPC_RampUpdate - Sets up pump parameters and/or starts the pump running at
\ those specified values
\
\ MPC_PumpDose - Turns on the pump at the last specified Dose or Time
\
\ MPC_PumpRamp - Turns on the pump with the values last specified for the
\ Ramp Rates and Dose/Time
\
\ R-100 Commands
\ CMD_NULL - Updates Rate values only, no change to PUMP ON/OFF/DIRECTION
\ pump Rate changed if running
\
\ CMD_OFF - Turns pump off. Leaves pump direction & speed alone
\
\ CMD_ON - Turns on pump in last set infuse direction (forward or
\ reverse)
\
\ CMD_DOSE - Turns on pump & stops pump after Dose or Time settings
\
\ CMD_RESET - Stops motor, sets direction to infuse, step rate to full, and
\ clears rate values & pulse & tic counters
\
\ CMD_REV - Turns on pump in reverse direction

```

```

\
\  CMD_RAMP      - Starts pump ramping @ startRate & ramps to endRate in
\                  specified Time and leaves pump on
\
\  CMD_RMPDOS    - Starts pump ramping @ startRate & stops @ endRate after Dose
\                  or Time
\
\  CMD_CALRAMP   - Downloads Rate or Dose values to the pump without turning it
\                  on
\
\
\  MG - This is the MED-PC Global Pointer. It allows the R-100 to pass back
\        information about any errors that might have occurred.
\
\  BOX - This parameter specifies which R-100 the command is for. When this
\        program is running in Box 1, then the BOX parameter will equal 1 and the
\        R-100 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 R-100
\        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 MPC_Init, MPC_PumpStart, MPC_PumpDose, MPC_PumpRamp,
\        MPC_CheckRate, and/or MPC_PumpStop Commands
\  B = Response from the MPC_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 := MPC_Init(MG);~;
           ~B := MPC_RampUpdate(MG, BOX, BOX, 50, 2.54, 0, 0, 0, CMD_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 := MPC_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 := MPC_PumpStart(MG, BOX, BOX);~;
           CLEAR 2,2; SHOW 1,Start Resp,A ---> S3

S3,    \ Turn off the Pump
      #K2: ~A := MPC_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 := MPC_RampUpdate(MG, BOX, BOX, 178, 2.54, 0, 0, 0, CMD_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 := MPC_RampUpdate(MG, BOX, BOX, 50, 2.54, 0, 0, 0, CMD_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 := MPC_RampUpdate(MG, BOX, BOX, 178, 2.54, 0, 0, 0, CMD_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 := MPC_RampUpdate(MG, BOX, BOX, 50, 2.54, 0, 0, 0, CMD_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 := MPC_RampUpdate(MG, BOX, BOX, 178, 2.54, 0, 0.34, 50, CMD_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 := MPC_RampUpdate(MG, BOX, BOX, 50, 2.54, 0, 0, 0, CMD_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 := MPC_RampUpdate(MG, BOX, BOX, 178, 2.54, 0, 0.53, 50, CMD_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 := MPC_RampUpdate(MG, BOX, BOX, 178, 2.54, 1, 0, 50, CMD_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 := MPC_RampUpdate(MG, BOX, BOX, 178, 2.54, 1, 0, 0, CMD_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 := MPC_RampUpdate(MG, BOX, BOX, 178, 2.54, 0, 0.34, 0, CMD_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 := MPC_RampUpdate(MG, BOX, BOX, 178, 2.54, 1, 0, 0, CMD_NULL);~;
          SHOW 2,Update Resp,B ---> S3

S3,    \ Turns on the until 1cc is delivered and then the Pump will stop
      0.01": ~A := MPC_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 := MPC_RampUpdate(MG, BOX, BOX, 178, 2.54, 0, 0.34, 0, CMD_NULL);~;
          SHOW 2,Update Resp,B ---> S3

S3,    \ Turns on the Pump for the 0.34s Infusion Duration Time
      0.01": ~A := MPC_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 := MPC_RampUpdate(MG, BOX, BOX, 178, 2.54, 1, 0, 50, CMD_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 lcc is delivered and then
        \ the Pump will stop
0.01": ~A := MPC_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 := MPC_RampUpdate(MG, BOX, BOX, 178, 2.54, 0, 0.53, 50, CMD_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 := MPC_PumpRamp(MG, BOX, BOX);~;
        SHOW 1,Ramp Resp,A ---> S2

```

Definitions of R-100EC Commands

MPC_Init initializes the R-100EC pump and returns the number of pumps attached to the driver.

Syntax: ~MPC_Init(MG);~;

Where: MG = MED-PC Global Parameter

Example:

```

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

```

MPC_PumpStart starts the pump.

Syntax: ~MPC_PumpStart(MG, Box, P1);~;

Where: MG = MED-PC Global Parameter

Box = Box Number

P1 = Pump ID set in **REMOTE** mode using first 2 pushbutton switches (See Figure 5.1; valid values 1 – 24).

Example:

```

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

```

MPC_PumpStop stops the pump.

Syntax: ~MPC_PumpStop(MG, Box, P1);~;

Where: MG = MED-PC Global Parameter

Box = Box Number

P1 = Pump ID set in **REMOTE** mode using first 2 pushbutton switches (See Figure 5.1; valid values 1 – 24).

Example:

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

MPC_RampUpdate sets up pump parameters.

Syntax: ~MPC_RampUpdate(MG, Box, P1, Start Rate, Size, Dose, Time, End Rate, Code);~;

Where: MG = MED-PC Global Parameter

Box = Box Number

P1 = Pump ID set in **REMOTE** mode using first 2 pushbutton switches; valid values 1 – 24.

Start Rate = cc/hr

Size = Syringe Cross-Sectional Area (cm²)

Dose = cc

Time = Infusion Duration (minutes)

End Rate = cc/hr

Code = Any of the following

CMD_NULL Updates rate values only, no change to PUMP ON/OFF/DIRECTION. Pump rate changed if running.

CMD_OFF Turns pump off and leaves pump direction and speed alone.

CMD_ON Turns the pump on in FORWARD mode.

CMD_DOSE Turns the pump on and stops infusion after dose or time is complete.

CMD_INPUTON Enables remote MED-PC Input control.

Example:

```
~B := MPC_RampUpdate(MG, BOX, BOX, 50, 2.54, 0, 0, 0, CMD_NULL);~;
```