# Special Model '11'
# Syringe Pump Series
# User's Manual

*Model '11' Syringe Pump Series*
*with Serial Communication*


HARVARD
APPARATUS

# WEEE/RoHS Compliance Statement

**EU Directives WEEE and RoHS**

To Our Valued Customers:

We are committed to being a good corporate citizen. As part of that commitment, we strive to maintain an environmentally conscious manufacturing operation. The European Union (EU) has enacted two Directives, the first on product recycling (Waste Electrical and Electronic Equipment, WEEE) and the second limiting the use of certain substances (Restriction on the use of Hazardous Substances, RoHS). Over time, these Directives will be implemented in the national laws of each EU Member State.

Once the final national regulations have been put into place, recycling will be offered for our products which are within the scope of the WEEE Directive. Products falling under the scope of the WEEE Directive available for sale after August 13, 2005 will be identified with a "wheelie bin" symbol.

Two Categories of products covered by the WEEE Directive are currently exempt from the RoHS Directive – Category 8, medical devices (with the exception of implanted or infected products) and Category 9, monitoring and control instruments. Most of our products fall into either Category 8 or 9 and are currently exempt from the RoHS Directive. We will continue to monitor the application of the RoHS Directive to its products and will comply with any changes as they apply.

- **Do Not Dispose Product with Municipal Waste.**
- **Special Collection/Disposal Required.**

# Table of Contents

### Serial Numbers
All inquires concerning our product should refer to the serial number of the unit. Serial numbers are located on the rear of the chassis.

### Calibrations
All electrical apparatus is calibrated at rated voltage and frequency. While the flow will stay calibrated, the peak will vary.

### Warranty
Harvard Apparatus warranties this instrument for a period of two years from date of purchase. At its option, Harvard Apparatus will repair or replace the unit if it is found to be defective as to workmanship or material.

This warranty does not extend to damage resulting from misuse, neglect or abuse, normal wear and tear, or accident.

This warranty extends only to the original customer purchaser.

**IN NO EVENT SHALL HARVARD APPARATUS BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES**. Some states do not allow exclusion or limitation of incidental or consequential damages so the above limitation or exclusion may not apply to you. **THERE ARE NO IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR USE, OR OF ANY OTHER NATURE**. Some states do not allow this limitation on an implied warranty, so the above limitation may not apply to you.

If a defect arises within the two-year warranty period, promptly contact ***Harvard Apparatus, Inc. 84 October Hill Road, Building 7, Holliston, Massachusetts 01746-1388*** using our toll free number 1-800-272-2775. Goods will not be accepted for return unless an RMA (returned materials authorization) number has been issued by our customer service department. The customer is responsible for shipping charges. Please allow a reasonable period of time for completion of repairs, replacement and return. If the unit is replaced, the replacement unit is covered only for the remainder of the original warranty period dating from the purchase of the original device.

This warranty gives you specific rights, and you may also have other rights which vary from state to state.

### Repair Facilities and Parts
Harvard Apparatus stocks replacement and repair parts. When ordering, please describe parts as completely as possible, preferably using our part numbers. If practical, enclose a sample or drawing. We offer a complete reconditioning service.

### CAUTION
This pump is not registered with the FDA and is not for clinical use on human patients.

**CAUTION**
**FOR RESEARCH USE ONLY**
**NOT FOR CLINICAL USE**
**ON HUMAN OR**
**VETERINARY PATIENTS**

**Theory of Operation:**

The new Pump 11 is designed as a low cost, highly precise, single syringe infusion pump capable of low to moderate back pressures.

The pump comes in two versions; one to hold one syringe of any make from 0.5 µl to 60ml and a second to hold two syringes of any make from 0.5 µl to 10 ml. The diameter of the syringe(s) is entered via the keyboard and the internal microprocessor drives a precision stepper motor to produce accurate fluid flow.

Non-volatile memory stores the last syringe diameter and flow rate along with other configuration data.

The "Power Failure Mode" can be set to either turn the pump off in the event of power failure or to resume pumping when power resumes.

**Features:**

***Bright Display and Easy-To-Use Interface***
A new, two-line 16 character vacuum fluorescent display along with six membrane keys make this a most attractive but powerful, easy-to-use syringe pump. Only two entries required to start pumping; syringe Inside Diameter (mm) and pumping flow rates. The Flow rate can be changed while the Pump is running.

***Two Modes of Operation, Constant Flow Rate and Volume Dispense***
The new Pump 11 will operate continuously in RATE mode or accurately dispense a specific amount of fluid in VOLUME mode.

***Smooth Flow***
New micro-stepping pump profiles deliver very smooth and consistent flow.

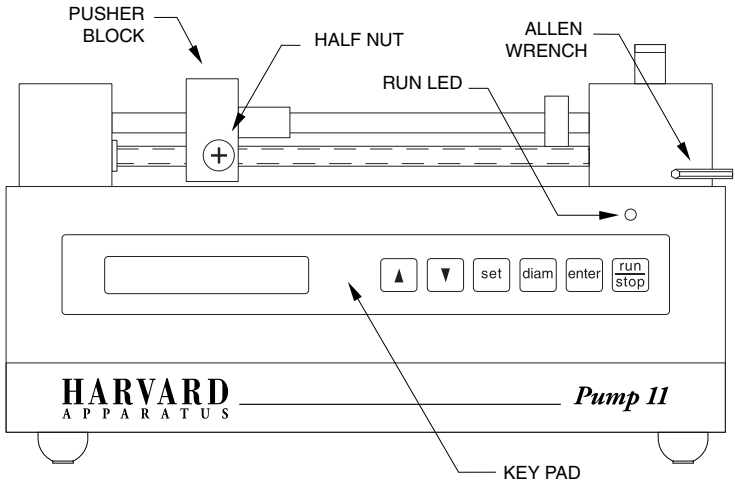
***Nonvolatile Memory***
The pump remembers its last syringe size, flow rate used and configuration settings.

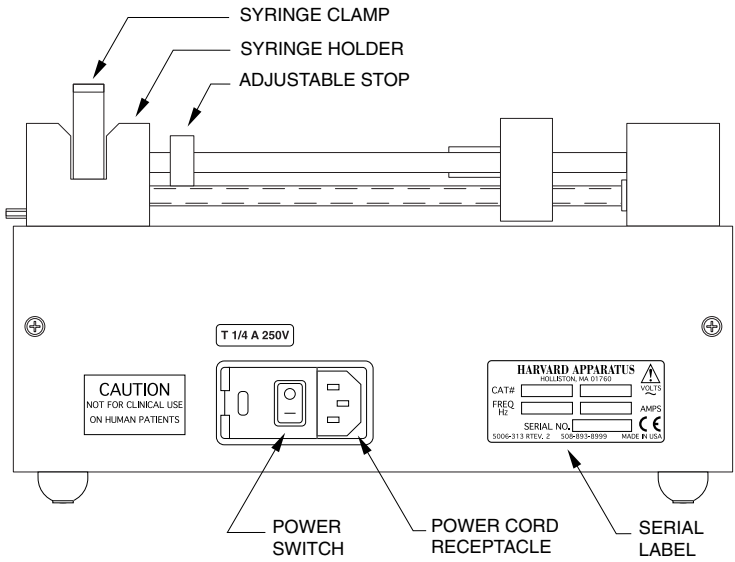
***Universal Power Supply***
No need to change AC line switches, fuses or wires, the new Pump 11 will operate on any AC line voltage from 90 VAC to 240VAC, either 50 or 60 Hz.

***Power Fail Mode***
In a power failure the Pump can either RESUME or STOP pumping when power is returned.

***CE Mark Approved***
The new Pump 11 meets all relevant European EMC and Safety requirements for laboratory equipment.

# Pump '11' Front and Rear Views



### Initial Set-up

1. Read the manual to become familiar with all features and functions of the new Pump 11.
2. Pumps are shipped from the factory with an American line cord with a U.S three wire molded power plug on one end and a IEC 320/C13 connector on the other. Use only an approved AC line cord with a molded IEC 320/C13 connector.
3. Turn on main power switch located directly above the line cord on the rear panel. The display will now illuminate indicating that the power connections are correct. The display will indicate POWER FAIL. (this is normal as the pump indicates on the display if power was disrupted since last use.)

The procedure for loading syringes is the same for all models of the Pump '11':

### Location Requirements for the Syringe Pump

- A sturdy, level, clean and dry surface
- Minimum of one inch (2cm) clearance around the pump
- Adequate power supply
- Room temperature 4°C to 40°C (40°F to 104°F)
- Relative humidity 20% to 80%
- A well ventilated room

### Loading the Syringe

1. Release the syringe pusher by pressing the bronze button on the side of the pusher.
2. While holding the bronze button 'in', slide the pusher to the left.
3. Raise the spring loaded syringe retainer and swing it out of the way.
4. Lay the loaded syringe in the 'V' shaped holder.
5. Swing the retainer so it holds the syringe in place.
6. Move the pusher so it makes contact with the syringe plunger.

# Fuse Replacement

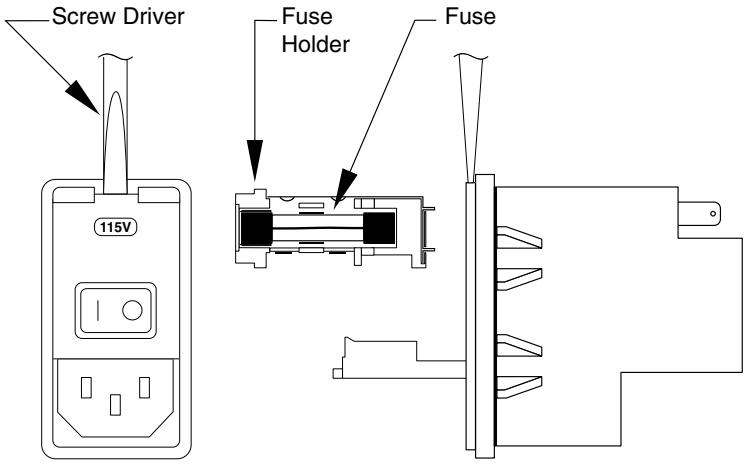
### Fuse Replacement

Make sure the power cord is disconnected from the main supply before servicing the fuse.

### Fuse Replacement Procedure

Turn off power, remove power cord from power module. Use straight blade screw driver, pry open access door. Remove fuse holder, remove fuse(s) from holder. Replace fuse(s) and fuse holder. (Replace holder with correct voltage marking is showing through access door window) For continued fire protection, replace fuse only with 250V fuse of the specified type and rating. (T 1/4 A 250V)

**Fuse not replaceable by the operator is located on the power supply. Fuse F 2.0A 250V.**




**WARNING:** USE IN MANNER NOT SPECIFIED BY THE MANUFACTURER MAY IMPAIR THE PROTECTION PRO VIDED BY THE EQUIPMENT.

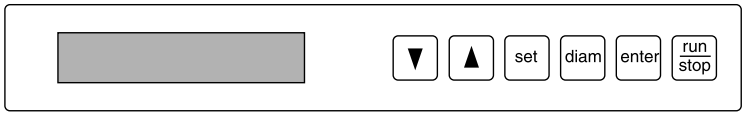
## Getting started

### *1. Turn Pump 'ON'*

Turn on power using the switch on rear of the pump, the display will light, and indicate POWER FAIL. (this is normal as the pump indicates on the display if power was disrupted since last use.)

### *2. Function Keys and Run Indicator*

Refer to the colored keypad at the front of the pump to identify the following functions starting from the right.




**RUN/STOP** – This turns the pump motor on and off.

**ENTER** – This key enters the data that is on the display into the memory of the pump. Also used to query the flow rate.

**DIAM** – Used to enter or query the syringe diameter.

**SET** – This key is used to select which digit of the display is to be changed, to move the decimal point and to move between modes. Each time the set key is pressed the underline cursor below the digit or character on the display moves one step to the right. It is used in conjunction with the ascending and descending keys. When it the display shows the desired the correct value the set key will advance right to the next digit.

△▽ – The ascending and descending keys are used to change the numbers on the display. △ Up key makes numbers increase, ▽ Down Key makes numbers decrease. When the underline cursor is placed below the decimal point, the △▽ keys shift the decimal one place up or down.

**Run Indicator** – When the pump is running, the highly visible, green LED above the RUN/STOP key will illuminate.

### *3. Enter Syringe Size*

Enter the inside diameter (ID) of the syringe you wish to use. Units are in millimeters (mm).

If you do not know your syringe diameter, refer to appendix B for nominal inside diameters of most popular syringes. For the greatest accuracy or if your syringe is not listed in appendix B, measure the inside diameter with a vernier caliper or other precision measuring tool. Record this value for future use.

Press SET followed by the DIAM key. The previously used diameter will appear on the display. The underline cursor will appear under the left-most digit or decimal point. The △ and ▽ keys are used to scroll to the desired number and the SET key moves the underline cursor one place to the right. Once the desired diameter is displayed, press the ENTER key to place this value into memory.

### *4. Enter Flow Rate Range*

Choose your flow rate units; either microliters or milliliters, per minute or per hour.

From the initial RATE VOL CONFIG menu, using the △ or ▽ key, move the underline cursor under the CONFIG mode menu prompt. Press the SET key to enter the CONFIG mode. Press the SET key again to move the underline cursor to the flow rate choices. Choose your flow rate units while in the SET:UNITS mode by pressing the △ or ▽ keys to scroll the four flow rate choices; ml/min, µl/min, ml/hr, µl/hr. Once the desired flow rate units are displayed, press the ENTER key to return to the main SET:CONFIG mode. Press SET or ENTER again to put your desired flow rate units into memory and return to the RATE VOL CONFIG menu.

### *5. Enter Flow Rate*

From the initial RATE VOL CONFIG menu, press the SET key to enter the SET:RATE mode. Each time you change the syringe diameter, the previously used flow rate is erased. If the syringe diameter is unchanged, the previously used flow rate will appear on the display. The underline cursor will appear under the left-most digit or decimal point. The △ and ▽ keys are used to scroll to the desired number and the SET key moves the underline cursor one place to the right. Once the desired rate is displayed, press the ENTER key to place this value into memory.

### *6. Press RUN*

Press the RUN/STOP key to start pump and begin pumping. The Run Indicator (Green LED above the RUN/STOP key) will light when the pump is on and pumping.

### *7. Check Syringe Often*

The Pump 11 will not shut itself off when the syringe is empty or is otherwise overloaded. It is prudent to check the syringe from time to time.

## 1. *Volume Mode*

The Pump 11 can be set to dispense a precise volume and then stop. To activate the volume dispense mode a target volume must be set.

To set a target volume, at the RATE VOL CONFIG display, move the underline cursor, using the △ or ▽ key, to VOL. Press the SET key to enter the VOL set mode. Use the △ or ▽ key and the SET key to display a target volume from 00.01 to 99.99. Volume units are either ml (milliliters) or µl (microliters). Target volume units are established in the CONFIG SET:UNITS mode; example: if your pumping units are ml/ min or ml/ hr, then the volume dispense units will be ml's. Press the ENTER key to select the desired target volume. Exit the VOL mode by pressing the ENTER key.

Once you press the RUN key, the pump will run until the target volume is delivered. The display will show the actual volume dispensed along with the target volume. Press the RUN key each time you want to repeat the volume dispense. If you press the STOP key during a volume dispense, you can restart the pump at the place you stopped by pressing the RUN key again.

To exit the volume dispense mode, set the target volume to 00.00 or turn off and on the pump via the main power switch. NOTE: In the event of a power failure, the actual dispensed volume and the target volume are not retained in memory. This means that while in volume dispense mode, if a power failure occurred, the pump would not resume volume dispense pumping even if the POWER ON mode was set to run.

## 2. *Power Failure*

In the event of a momentary or prolonged power failure, the Pump 11 can be set to either;

a) Resume pumping when power is returned, with "POWER FAIL" on the display.

b) Not start pumping when power is returned, with "POWER FAIL" on the display.

To set the power fail mode, at the RATE VOL CONFIG display, move the underline cursor, using the △ or ▽ key, to CONFIG. Press the SET key to enter the CONFIG mode options. Use the △ or ▽ key to scroll the CONFIG options until you reach the SET:POWER ON: display. Press the SET key again moving the underline cursor to the right. Use the △ or ▽ key to scroll the POWER:ON choices; 'stop' or 'run'. Press the ENTER key to select either mode. Exit the CONFIG mode by pressing the ENTER key again and save the POWER:ON setting in memory.

### 3. *Display Intensity*

For varying light conditions, four levels of intensity can be set on the vacuum fluorescent display.

To set the desired display intensity, at the RATE VOL CONFIG display, move the underline cursor, using the △ or ▽ key, to CONFIG. Press the SET key to enter the CONFIG mode options. Use the △ or ▽ key to scroll the CONFIG options until you reach the SET:INTENSITY:. Press the SET key again moving the underline cursor to the right. Use the △ or ▽ key to scroll the SET:INTENSITY choices; "1", "2", "3" or "4" (4 is highest intensity, 1 is lowest intensity) Press the ENTER key to select the desired display intensity. Exit the CONFIG mode by pressing the ENTER key again and save the INTENSITY setting in memory.

### 4. *Changing Rates*

If the pump is running at an existing rate it will continue to do so until a new rate is entered. Except for volume mode, the flow rate can be changed while the pump is running. As soon as the ENTER key is pressed the pump will change to the new flow rate. To change rates from the keypad, while in volume mode, the pump must be stopped first.

### 5. *Maintenance*

No special maintenance is required other than keeping the pump 11 clean and dry. Avoid liquid spills that may find their way into the electronics.

A small container of grease is provided for periodic lubrication of the lead screw. A small bottle of oil is provided for periodic lubrication of the two steel guide rods. It is important to keep these guide rods clean and oiled.

### 6. *Protecting Small, Fragile Syringes*

The Pump 11 will hold microliter size syringes down to 0.5µl size. These small syringes have fine wire plungers that may be damaged if allowed to bottom out. The Pump 11 is equipped with an adjustable stop collar on one of the guide rods. Use the provided hex wrench to position and lock the stop collar to prevent damage to small syringes.

# Appendix A





## Pump '11' Specifications

| | |
|---|---|
| **Type** | Microprocessor single or dual syringe, infusion only |
| **Syringe/Size for Pump '11' with Holder For:** | Plastic or glass |
| **1 Syringe** | From 10 µl to 50/60 ml |
| **2 Syringe** | From 0.5 µl to 10 ml |
| **Flow Rate Range:** | |
| **Minimum / Maximum** | 0.0014 µl/hr with 0.5 µl syringe / 26.55 ml/min with 50/60 ml syringe |
| **Calibration** | Automatic, enter syringe size up to 35 mm Inside Diameter |
| **Display** | 2 line, 16 character vacuum, fluorescent display and green run led |
| **Nonvolatile Memory** | Stores diameter, rate and configuration settings |
| **Maximum Force** | 8 kg (17 lb.) |
| **Maximum Pressure** | 8 p.s.i. with 50/60 cc syringe; 100 p.s.i. with 1 ml syringe |
| **Drive Motor** | 0.9° step angle motor |
| **Step Rate:** | |
| **Minimum / Maximum** | 1 pulse in 27.6 sec / 200 steps/sec |
| **Pusher Advance/Step** | 0.8 µm pusher advance per motor step |
| **Pusher Travel Rate:** | |
| **Minimum / Maximum** | 0.7 µm/min / 15 mm/min |
| **Dynamic Range** | 1 to 16,384 |
| **Leakage to Ground** | Typically < 150 µA |
| **Ground Resistance** | Typically < 0.05 ohms |
| **Voltage Range** | 95 – 240 VAC 50/ 60 hz |
| **Power** | 15 W, 0.25 A fuse |
| **Size, H x W x D** | 11.4 x 22.9 x 11.4 cm (4-1/2 x 9 x 4-1/2 in) |
| **Weight** | 2.1 kg (4.6 lb) |

# Appendix B: Syringe Inside Diameter

*Terumo*

| Size | Diameter |
|---|---|
| 3 cc | 8.95 mm |
| 5 | 13.00 |
| 10 | 15.80 |
| 20 | 20.15 |
| 30 | 23.10 |
| 60 | 29.10 |

*Sherwood–Monoject Plastic*

| Size | Diameter |
|---|---|
| 1 cc | 4.65 mm |
| 3 | 8.94 |
| 6 | 12.70 |
| 12 | 15.90 |
| 20 | 20.40 |
| 35 | 23.80 |
| 60 | 26.60 |
| 140 | 38.40 |

*Popper & Sons, Inc. "Perfektum" Glass*

| Size | Diameter |
|---|---|
| 0.25 cc | 3.45 mm |
| 0.5 | 3.45 |
| 1 | 4.50 |
| 2 | 8.92 |
| 3 | 8.99 |
| 5 | 11.70 |
| 10 | 14.70 |
| 20 | 19.58 |
| 30 | 22.70 |
| 50 | 29.00 |
| 100 | 35.70 |

*Stainless Steel*

| Size | Diameter |
|---|---|
| 8 cc | 9.525 mm |
| 20 cc | 19.130 |
| 50 cc | 28.600 |
| 100 cc | 34.900 |

*Becton Dickinson Plastic "Plasticpak"*

| Size | Diameter |
|---|---|
| 1 cc | 4.78 mm |
| 3 | 8.66 |
| 5 | 12.06 |
| 10 | 14.50 |
| 20 | 19.13 |
| 30 | 21.70 |
| 50/60 | 26.70 |

*Air–Tite "All Plastic"*

| Size | Diameter |
|---|---|
| 2.5 cc | 9.60 mm |
| 5.0 | 12.45 |
| 10 | 15.90 |
| 20 | 20.05 |
| 30 | 22.50 |
| 50 | 29.00 |

*Unimetrics Series 4000 & 5000*

| Size | Diameter |
|---|---|
| 10 µl | 0.460 mm |
| 25 | 0.729 |
| 50 | 1.031 |
| 100 | 1.460 |
| 250 | 2.300 |
| 500 | 3.260 |
| 1000 | 4.610 |

*–SGE Scientific Glass Engineering*

| Size | Diameter |
|---|---|
| 25 µl | 0.73 mm |
| 50 | 1.03 |
| 100 | 1.46 |
| 250 | 2.30 |
| 500 | 3.26 |
| 1.0 ml | 4.61 mm |
| 2.5 | 7.28 |
| 5 | 10.30 |
| 10 | 14.57 |

*–Hamilton–Microliter Series Gastight*

| Size | Diameter |
|---|---|
| .5 µl | 0.103 mm |
| 1 | 0.1457 |
| 2 | 0.206 |
| 5 | 0.3257 |
| 10 | 0.460 |
| 25 | 0.729 |
| 50 | 1.031 |
| 100 | 1.46 |
| 250 | 2.3 |
| 500 | 3.26 |
| 1.0 ml | 4.61 mm |
| 2.5 | 7.28 |
| 5 | 10.3 |
| 10 | 14.57 |
| 25 | 23.0 |
| 50 | 32.6 |

# Appendix C: Flow Rates



| nominal syringe size | nominal diameter (mm) | µl/hr | | µl/min | | ml/hr | | ml/min | |
|---|---|---|---|---|---|---|---|---|---|
| | | min | max | min | max | min | max | min | max |
| Min | **0.10** | 0.0014 | 22.35 | 0.0001 | 0.3725 | 0.0001 | 0.0223 | 0.0001 | 0.0003 |
| 2 µl | **0.21** | 0.0061 | 98.58 | 0.0002 | 1.6430 | 0.0001 | 0.0985 | 0.0001 | 0.0016 |
| 10 µl | **0.46** | 0.0289 | 473.0 | 0.0005 | 7.883 | 0.0001 | 0.4730 | 0.0001 | 0.0078 |
| 50 µl | **1.03** | 0.1448 | 2,371 | 0.0025 | 39.52 | 0.0002 | 2.371 | 0.0001 | 0.0395 |
| 250 µl | **2.30** | 0.7218 | 9,999 | 0.0121 | 197.0 | 0.0008 | 11.82 | 0.0001 | 0.1970 |
| 1 ml | **4.61** | 2.900 | 9,999 | 0.0484 | 791.8 | 0.0029 | 47.50 | 0.0001 | 0.7918 |
| 3 ml | **8.66** | 10.24 | 9,999 | 0.1706 | 2,794 | 0.0103 | 167.6 | 0.0002 | 2.794 |
| 10 ml | **14.57** | 28.97 | 9,999 | 0.4828 | 7,909 | 0.0290 | 474.5 | 0.0005 | 7.909 |
| 30 ml | **23.10** | 72.81 | 9,999 | 1.214 | 9,999 | 0.0729 | 1,192 | 0.0013 | 19.88 |
| **Max** | **35.00** | **167.2** | **9,999** | **2.786** | **9,999** | **0.1672** | **2,738** | **0.0028** | **45.64** |

### Commands, Queries and Responses

After each transmission to the pump terminating with a CR character (ASCII 13), the pump enters remote mode and responds with the three character sequence:

CR LF ***prompt***

The prompt character indicates the status of the pump as follows:

| ***prompt*** | meaning | ASCII code |
|---|---|---|
| : | When stopped | (ASCII 58 decimal) |
| > | When running forward | (ASCII 62 decimal) |
| * | When stalled | (ASCII 42 decimal) |
| | | Pump 11 does not include stall detection |

### Serial commands and their meanings:

***Commands:***

| | |
|---|---|
| **KEY** | Return to keyboard control. Exit remote mode |
| **RUN** | Start infuse (forward direction) |
| **STP** | Stop motor |
| **CLV** | Clears volume accumulator to zero |
| **CLT** | Clears target volume to zero, dispense disabled |

***Commands with numbers:***

| | | |
|---|---|---|
| **MMD** | number | Set syringe diameter, units are mm.<br>Rate is set to zero after MMD command. |
| **ULM** | number | Set flow rate and range, units are microliters per minute |
| **MLM** | number | Set flow rate and range, units are milliliters per minute |
| **ULH** | number | Set flow rate and range, units are microliters per hour |
| **MLH** | number | Set flow rate and range, units are milliliters per hour |
| **MLT** | number | Set target infusion volume, units are ml or µl depending on range |

**Numbers can be between 0 and 1999.**
Leading zeros and trailing decimal point are optional. Any number of digits to the right of the decimal point may be transmitted. The number will be rounded.

**Queries:**

| | |
|---|---|
| **DIA** | Returns diameter value units in mm |
| **RAT** | Returns rate value set in current range units |
| **VOL** | Returns current accumulated infused volume, units in ml or µl depending on range |
| **VER** | Returns model and version number of firmware |
| **TAR** | Returns target volume, units in ml or µl depending on range |

value format: nnnn.nnn
The returned value is an 8 character string with leading zeros converted to SP characters (ACSII 32 decimal). The fifth character is a decimal point (ASCII 46 decimal)

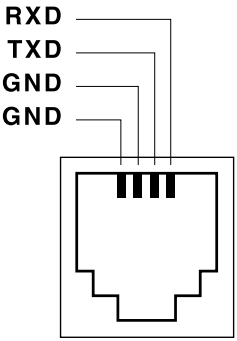
**Queries with string response:**

| | |
|---|---|
| **RNG** | Returns range message (character string either: ML/H ML/M UL/H UL/M) |

**Error responses:**

| | |
|---|---|
| **CR LF ? CR LF prompt** | Unrecognized command |
| **CR LF OOR CR LF prompt** | Entered value in out of range |

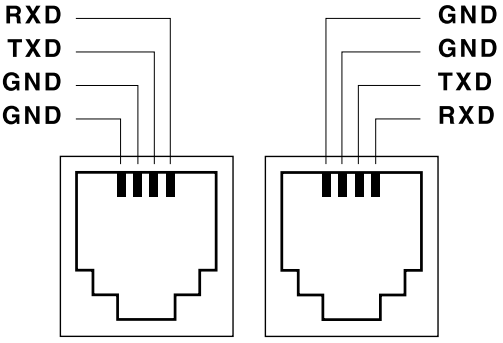
# Appendix E: Single RS-232




**IN**

***Host Computer Connection***

# Appendix F: Dual RS-232




**IN**

***Host Computer Connection***

**OUT**

***Chain Connection to Additional Pump(s)***