Model 33

Twin Syringe Pump

User's Manual

Syringe Pump Model 33 *MA1-55-3333*

HARVARD

APPARATUS

Publication 5390-001 Revision B

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Warranty and Repair Information

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 one year 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 01746-1371*** using our toll free number 1-800-272-2775, or outside the U.S. 508-893-8999. Goods will not be accepted fir 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: Not for clinical use on human patients.

Specifications

Harvard Pump 33 Specifications

Accuracy	±0.35%
Reproducibility	±0.1%
Type	Dual Syringe Infusion/Withdrawal Parallel/Reciprocal
Size, L x W x H	(286 x 311 x 152 mm) 11.25 x 12.25 x 6 in
Weight	(6.8 kg) 15 lbs
Power	115/230 VAC, 50-60 Hz via selector switch, 45 W
Fuse	1 A (115 V), 0.5 A (220 V)
Leakage to Ground	Typically < 10 µA
Ground Resistance	Typically < 0.06 Ω
Voltage Operating Range	95-130 VAC, 220-260 VAC
Drive Motors	2 motors, each 0.9 degree steppers
Motor Drive Circuitry	Microprocessor controlled from 1/2 to 1/4 microstepping
Timing Belt Drive	2:1
Lead Screw Pitch	24 threads/inch
Motor Steps per One Revolution of Lead Screw	1600 at 1/2 stepping or 3200 at 1/4 stepping
Step Rate:	
Minimum	27.3 sec/step
Maximum	416.7 µsec/step
Pusher Advance per Step:	
Minimum	0.330729 µm
Pusher Travel Rate:	
Minimum	0.726699 µm/min
Maximum	95.25 mm/min
Dynamic Speed Range	131,072 to 1
Force	40 lbs max.
Pressure	99.5 PSI max. with 20 ml stainless steel syringe
Calibration	Enter syringe diameter, any size, any make, up to 50 mm diameter
Syringe Size	10 µl (min.), 50 ml (max.)
Flow Rate Range:	
Minimum	0.0073 µl/hr (10 µl syringe)
Maximum	53.346 ml/min (50 ml syringe)
Display	5 digits plus 14 indicator LEDs
RS-232 Interface	Chained dual bidirectional ports
Non-Volatile Memory	Storage of all settings

Pressure and Speed

Pump 33 can deliver up to 53.346 ml/min with a 50 ml syringe, and is capable of pressures of up to 99.5 PSI with a 20 ml syringe.

Independent Syringe Diameters and Rates

In the Proportional Mode, separate syringe types and rates may be set.

Variable Syringes

Enter the inside diameter of the syringes being used.

Modes of Operation

Auto Stop

Both syringes will operate at same rate and stop when either syringe reaches a limit stop.

Continuous Run

With both syringes operating at same rate, when end of travel is reached, the pump automatically reverses the direction of travel for both syringes. The external valves, optionally attached to the syringes, will be automatically activated or deactivated.

Proportional

Pump operates as in Auto Stop, but independent rates and diameters are set for each syringe.

Parallel/Reciprocal Operation

Syringes may pump in the same direction (parallel) or opposite directions (reciprocal).

External Connections

TTL

Allows pump operations to be synchronized with external devices or by a person at a distance from the pump. Direction of pump travel can be set via a TTL pin. Also, TTL pins are used to control an external valve for refilling and provide an output to indicate whether or not the pump is running. Additional TTL pins are available for general use.

RS-232

Multiple pumps can be chained together and remotely controlled from a computer or any device communicating via RS-232.

Valves

Models MA1-55-3334 and MA1-55-3335 include a valve assembly which allows automatic selection of infusion and refill lines.

Non-Volatile Memory

All operational data entered into the pump from the keypad or requested to be saved via RS-232, will be stored. On power up, all ettings from when it was powered down will be recalled and the display will blink until the pump receives its first command.

Stall Detection

An optical detector on each motor is used to verify expected movement of the motors. If motor is prevented from turning due to jamming or kinking of the tubing, the pump stops and the display indicates a stall condition by blinking the run light and the syringe direction light of the stalled syringe. Pump 33 employs a microcontroller which controls a small step angle stepping motor that drives a lead screw and half nut. Microstepping techniques are used to further reduce the step angle making flow pulsation negligible. A keypad is used for entry of operating data to the pump or data can be entered via RS-232. The microcontroller calculates the cross-sectional area of the syringe selected and calibrates the flow rate.

1. Read the manual.

2. Locate the voltage selector switch on the rear panel of the pump and set it to the voltage being used. If other than 115VAC, 60 Hz is being used, the plug must be cut off and an appropriate plug installed, observing the polarity of the international line cord used:

   Brown – high
   Blue – neutral
   Green – ground

3. Turn on main power switch located directly above the line cord on the rear panel.The display will illuminate indicating that the power connections are correct.The flashing display indicates that power has just been applied.

4. Load syringes.

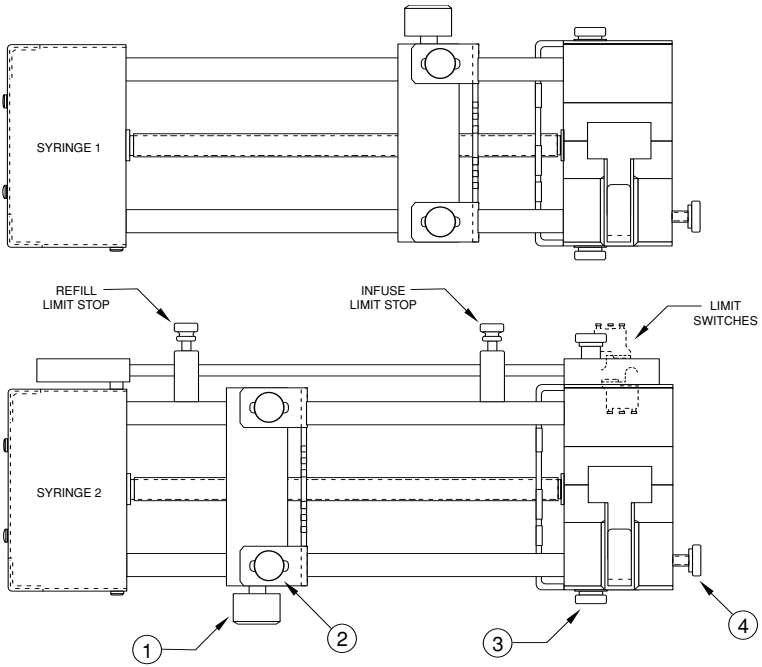


Figure 1. Syringe Loading

1. The syringe holder and pusher block are fitted with movable retaining brackets which hold the syringe barrel and plunger when refilling. When loading the syringe into the pump, it is necessary to adjust these brackets. The pusher block is fitted with a mechanism to release the drive nut from the leadscrew. This allows the block to move freely so the syringe to be loaded.
2. Loosen the screws on the syringe block and pusher block to free the retaining brackets (2 and 3, Figure 1)
3. To free the pusher block from the leadscrew, turn the knob on the front of the block (1) until the pin in the knob slips into the hole in the block.
4. The syringe clamp locking screw on the right side of the syringe block (4) should be loosened and the clamp rotated to the side.
5. Place the syringe barrel on the syringe holder block and move the pusher block to accommodate the plunger.
6. Make sure the syringe barrel flange and the plunger flange are held by the retaining clamps. Press the retaining brackets firmly against the flanges and tighten the retaining screws.
7. Rotate the syringe clamp and press down firmly on the syringe barrel. Secure in place by tightening the locking screw (4).

Setting Limit Stops

To set the limit stops, loosen thumbscrews on limit stops and slide stops to desired travel limits (infuse limit & refill), tighten thumbscrews.

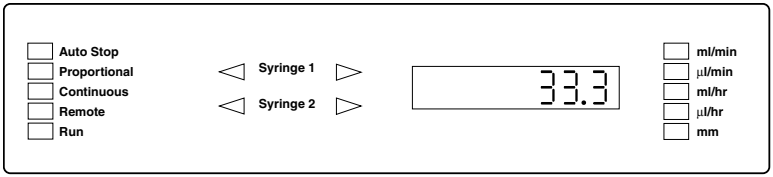


Figure 2. User Interface

The user interface consists of a display area and a keypad. The display consists of a 5 digit LED display and 14 LED indicators. The display will be showing either the default display or an informational message. The two syringes are referred to as Syringe 1 and Syringe 2. Syringe 1 is located towards the front and Syringe 2 is located towards the rear. Rate 1 refers to the set flow rate of Syringe 1 and Rate 2 refers to Syringe 2.

By default, the display will be showing Rate 1. Informational messages are shown when the user queries another data value by pressing the corresponding key, or when the pump is alerting the user to a problem. Such problems are a value out of range (oor) or the pump stalling (StALL).

The 14 LED indicators are divided into three sections: *Pump mode and state, syringe directions, and units of value being displayed.* See Figure 2. The LED indicators are as follows:

Pumping Mode and State LEDs	**Meaning**
Auto Stop	Pump is in Auto Stop mode
Proportional	Pump is in Proportional mode
Continuous	Pump is in Continuous mode
Remote	Pump Chain communication
Run	At least one motor is operating

Syringe Directions LEDs

Comprising of 4 indicators, these LED's indicate the direction of the syringes when illuminated. When blinking, indicates the corresponding motor is stalled, or data pertaining to that syringe is being entered.

Unit LEDs	**Meaning**
ml/mn	milliliters per minute
µl/mn	microliters per minute
ml/hr	milliliters per hour
µl/hr	microliters per hour
mm	millimeters

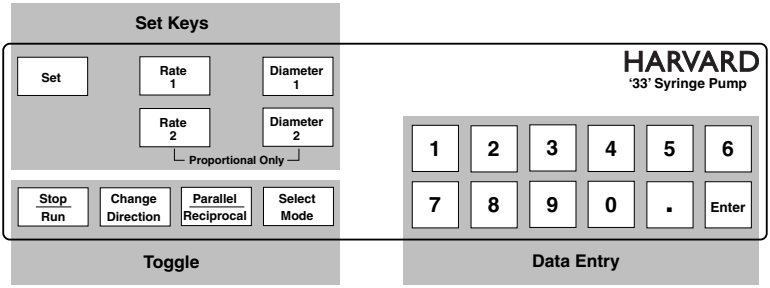


Figure 3. Keypad Interface

The keypad consists of 21 keys used for entering control information and data into the pump. These keys are grouped into 3 sections (see Figure 3 above): *Set keys, toggle keys, and data entry keys.*

Set Keys

Set	Allows modification of a data item in this group of keys. To modify a data item, press the relevant key after pressing the SET key.
Rate 1	Displays/sets current rate of syringe 1. Also syringe 2 rate if current mode is not Proportional. Scrolls through rate units when setting.
Rate 2	Displays/sets current rate of syringe 2. Scrolls through rate units when setting. Key only valid in Proportional mode.
Diameter 1	Displays/sets current diameter of syringe 1. Also diameter of syringe 2 if current mode is not Proportional.
Diameter 2	Displays/sets current diameter of syringe 2. Key valid in Proportional mode.
"1"	Used to display and set current Pump Chain address and to scroll through supported baud rates while setting.

Toggle Keys

Parallel/ Reciprocal	Chooses between Parallel and Reciprocal pumping operation.
Select Mode	Chooses between Proportional, Continuous Run, or Auto Stop. LED indicators display current mode. Pump must be stopped to change modes.
Change Direction	Reverses direction of both syringes and sets the valve control output as appropriate.
Run/Stop	Starts or stops the pump.

Data Entry Keys

1 through 0, .	Used to facilitate the entering of numeric data values.
Enter	Stores displayed data value when entering data.

Set Keys

The keys in this group are used to modify or review settings of the pumps control data. *To review* the current setting of a control data item, simply hold down the relevant key and the data setting will appear in the display.

To modify a data setting, first press then release the green SET key. The display will then read "SET". Press the key in the SET key group of the data item that is to be modified. The display will show the current setting. Data is entered into the pump by either entering a numerical value or, in the case of entering a baud rate, by scrolling through a menu of choices. Always press ENTER to terminate each data request by the pump.

When entering a numerical value, the LEDs corresponding to the data being entered will blink. Using the yellow data entry keys on the right side of the keypad (see Figure 3) enter the new data value. Up to five digit numbers are accepted for rates and diameters, including up to four decimal places. Entering more than five digits will clear the previous five digits in the display. Press the green ENTER key when the desired data value is displayed.

If the data value entered is outside the pump's operating parameters, the display will read "oor" meaning "Out of Range". Pressing any key will restore the display with the original data value. Enter another data value within the pump's parameters or just press ENTER to reuse the original data value.

The data value entered can be reviewed as described above. *Note: Certain data items have multiple settings.* For these, after the ENTER key is pressed, the display will prompt you for the additional information. Various rules apply to when, what and how data can be set at various times. See the relevant section for further details.

Toggle Keys

The keys in this group, when pressed successively, select different states. Each state change is accompanied by a corresponding change in status LED display.

To operate, Pump 33 needs to know the diameter(s) of the syringes, the rate(s) of pumping, pumping directions, and the mode of operation. Except for Proportional mode, syringe 2 is assumed to be the same diameter as syringe 1 and will pump at same rate as syringe 1.

Diameters

The pump must be stopped when entering a diameter. Diameter 1 is the diameter of both syringes, except in Proportional mode. In Proportional mode, enter the diameter of each syringe separately; Diameter 1 for syringe 1 and Diameter 2 for syringe 2. When entering a diameter, the 2 direction LEDs corresponding to the syringe and the "mm" LED will blink. Enter the inside diameter of the syringe in millimeters. After a new diameter is entered the corresponding rate is set to 0. This is done for reasons of safety. The maximum diameter is 50 mm. See Appendix A for a list of syringe diameters.

Pumping Rates

Rate 1 is the rate of pumping of both syringes, except in Proportional mode. In Proportional mode, enter the rate of each syringe separately, Rate 1 for syringe 1 and Rate 2 for syringe 2. When entering a rate, the directional LEDs corresponding to the syringe and the current units LED will blink. Use the corresponding rate key (RATE 1 or RATE 2) to scroll through the rate units: ml/mn, ml/hr, µl/mn and µl/hr. The minimum and maximum rates permitted vary depending on the diameter of the syringe. If an "OOR" message, meaning "Out of Range" is displayed when entering a rate, try using a different syringe for your application.

Selecting the Run Mode

To select the run mode, press the SELECT MODE key to advance the run mode LED indicator. Advance the run mode indicator to the desired mode, either *Auto Stop, Proportional, or Continuous* mode.

Auto Stop	Both syringes pump according to DIAMETER 1 and RATE 1 until syringe 1 reaches the limit switch when pump will stop.
Proportional	Each syringe pumps independently; syringe 1 according to DIAMETER 1 and RATE 1, syringe 2 according to DIAMETER 2 and RATE 2. When syringe 1 reaches limit switch, pump stops.
Continuous	Both syringes pump according to DIAMETER 1 and RATE 1. When syringe 1 reaches limit switch, the direction of pumping for both syringes is reversed and pumping continues. The valves, if applicable, are set accordingly.

Selecting the Pumping Directions

Parallel or Reciprocal Operation	Pressing the PARALLEL/ RECIPROCAL key reverses pumping direction of syringe 2.
Change Direction	Pressing the CHANGE DIRECTION key reverses the pumping directions of both syringes. When valves are used in the system then the valve(s) setting(s) will be changed simultaneously with the change in direction.

Running the Pump

Pressing RUN/STOP key starts pump and illuminates Run LED on display. Pressing RUN/STOP key again stops pump. While running, a new rate can be set. The new rate, for relevant syringe(s), takes effect when ENTER key is pressed. Pump will operate according to selected run mode. Pump can also be started and stopped via external controls. If operation of one of the motors is impeded, both motors will stop and display will read "StALL", with the "run" LED and the direction LED of stalled syringe blinking. Investigate cause of stalling and then press RUN/STOP key to resume pumping.

Single Syringe Operation

To operate only one syringe, select the Proportional mode and set the rate of the syringe not in use to 0.

Applicable to Following Models

Model No.	Description
MA1-55-3334	Supplied with 1/8" ID, 1/4" OD silastic tubing and connector to syringe
MA1-55-3335	Supplied with 1/4" OD 304 stainless steel tubing with Swagelok fittings

Setting up Valve

Set up consists of:

1. **Pump to Valve Electrical Connections:**
   The cable fitted with a male 3 pin connector must be connected to the female connector on the rear of the Model 33. The Model 33 should be turned off when making/breaking this connection.
2. **Valve tubing to syringe hook up:**
   The valve(s) are de-energized when the front mechanism (#1) is running in the INFUSE direction. The syringe on the #1 mechanism when infusing should therefore be connected to the lower tubing in the pinch valve (see figures on next page).

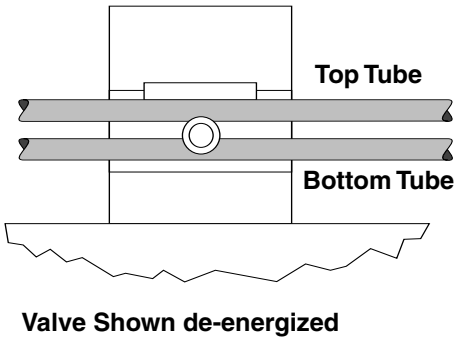


Figure 4. Pinch Valve Connections

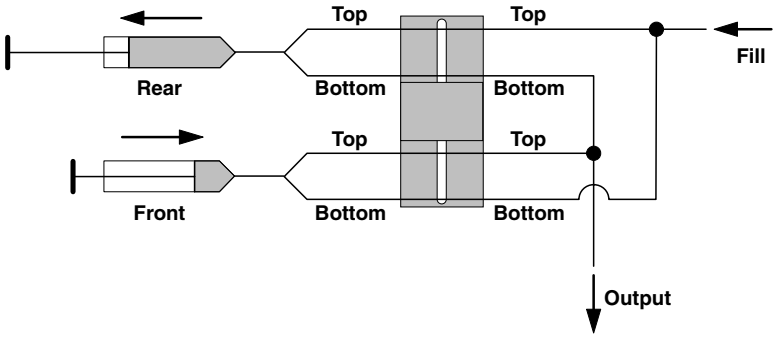


Figure 5. Continuous Delivery. Pump in Reciprocal Mode.

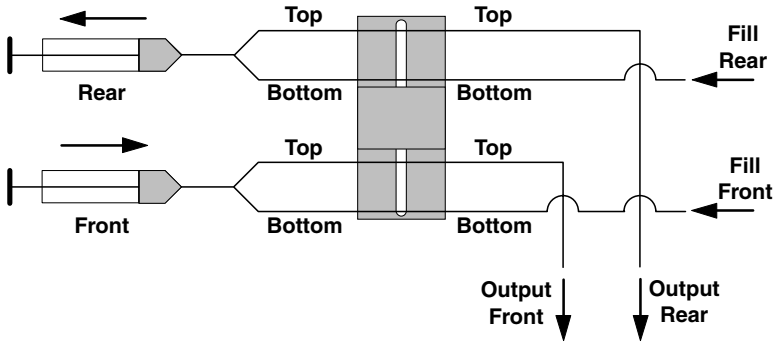


Figure 6. Dual Delivery followed by Refill. Pump in Parallel Mode.

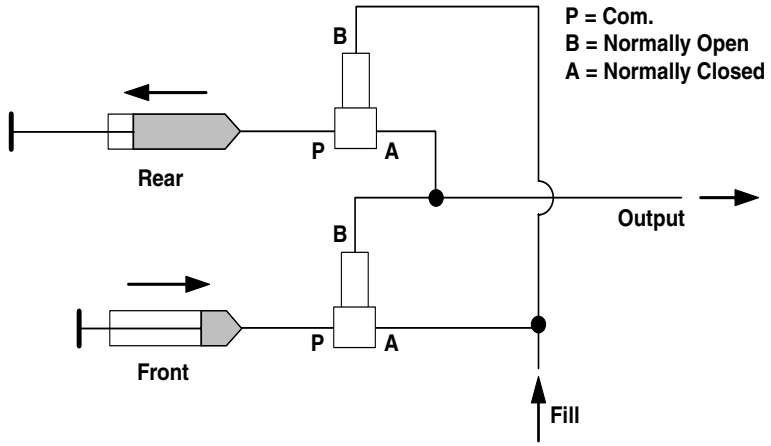


Figure 7. Continuous Delivery. Pump in Reciprocal Mode.

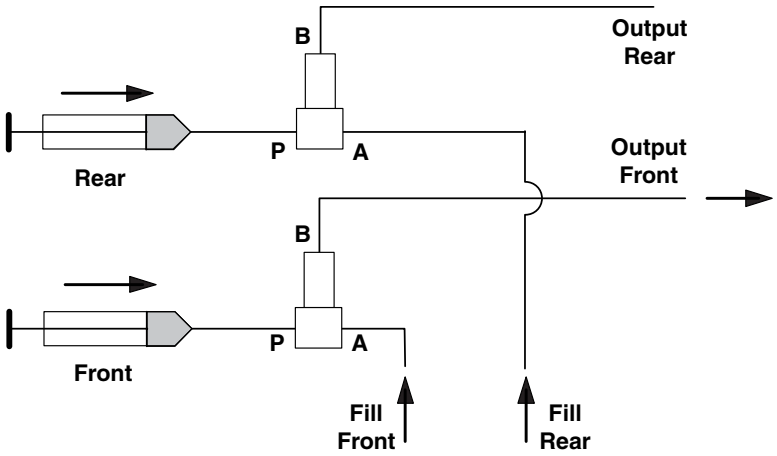


Figure 8. Dual Delivery followed by Refill. Pump in Parallel Mode.

Swage lock fittings should be finger tight plus 1-1/4 turns. Tubing is 304, stainless 1/4" OD, wall thickness 0.035"

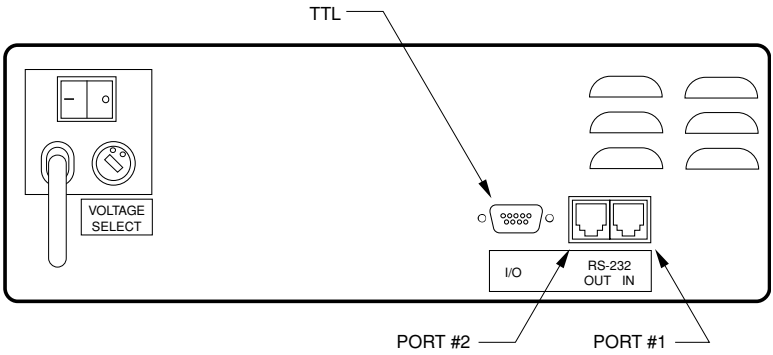


Figure 9. External Interface

External devices that can be attached to the Pump 33 include external valves, pump chain, and TTL devices. See the appropriate appendixes for specification details on attaching devices.

Attaching a Pump Chain

On the back of the pump are two telephone jack type connectors. These are the RS-232 ports. Looking at the back of the pump, the connector on the right is port 1 and the left is port 2. Attach the RS-232 connectors in the appropriate port according to the following chart:

Device	Port Number
Computer	1
Pump Chain	2

Configuring the Pump Chain

After pressing SET and 1, the Remote LED will blink, indicating the pump is requesting its pump chain configuration:

1. First, the display will show "Adr:nn", with the colon blinking, where "nn" is the current pump chain address. Enter the 2 digit address assigned to the pump and press ENTER. Note: Each pump in the chain needs a unique address.
2. Next, the display will show "b:nnnn", with the colon blinking, where "nnnn" is the current baud rate. Use the 1 key to select between the supported baud rates: 300, 1200, 2400 and 9600; then press ENTER. Note: Each pump in the chain must have the same baud rate.

See the section on Pump Chain Commands for pump chain control information.

Attaching a Valve Control Accessory Box

Attach the valve control cable to the pump's accessory valve connection (see Figure 9). Refer to the Valve Control Box section.

TTL Devices

The pump does not need to be configured to attach a TTL device. To attach a TTL device, simply plug the appropriate TTL connector into the 9 pin connector on the rear of the pump. See Appendix E for wiring specifications.

Foot Switch Input

Used to start and stop the pump. Pressing the foot switch performs the same function as pressing the RUN/STOP key on the keypad. The foot switch connector allows remote or automated operation of the pump.

Timer Input

Opening the timer input starts the pump. Closing the timer input stops the pump. The timer input allows for an externally controlled pumping interval.

Pumping Direction Input

Sets the direction of pumping. Opening the directional input sets syringe 1 to infuse. Closing the input sets syringe 1 to refill. The pumping direction input is not recognized when data is being entered from the keypad. Syringe 2 changes direction appropriately. Also, the valve control output is set appropriately.

Directional Indicator Output

The Directional Indicator output is an indicator of the direction of pump travel. When the output is a logical high, syringe 1 is set to infuse. A logical low indicates refill. A valve attached to this output enables automatic selecting of infuse and refill vessels.

Running Indicator Output

Provides a signal to another device indicating whether or not the pump is running.

Pump Chain Commands

The Pump Chain RS-232 interface is used to enhance the control applications of the Pump 33. This interface allows all control information to be entered into the pump from an external source such as a computer. In addition, this interface allows up to 100 Pump 33's or, in certain cases, other RS-232 devices to be controlled from a single RS-232 communication port on a computer. Assign each pump in the pump chain a unique address from 0 to 99. This address is used to identify which pump is to receive a command and which pump is responding. Configure each pump with its assigned address and the baud rate being used (See External Control & Interfaces). When a pump is sent a command, or a request is made for its prompt, the Remote LED on the display will illuminate, indicating that the pump is receiving pump chain commands. The LED remains illuminated until the pump is turned off or SET and 1 is entered on the keypad, indicating a change in the pump chain configuration.

A pump will not respond to pump chain communication while it is in a setting mode (entered when the user presses the SET key). The pump can still be controlled from the keypad while it is in a pump chain. Control data that is changed via RS-232 will NOT be stored in the pump's non-volatile memory unless requested with the "SAV" command or other data is changed from the keypad. Each command sent to the pump chain is a string of ASCII characters, with leading zero's on numbers and all spaces optional. Numbers are a maximum of five digits. The following symbols are used in describing the commands:

Symbol	**Meaning**
[. . .]	optional
{. . . }	select one
|	either–or
f	digits 0-9 or a decimal point
d	digits 0-9
<cr>	carriage return (ASCII 13)
<lf>	line feed (ASCII 10)
<float>	f f f f f f
<integer>	d d d d d
<text>	any string of ASCII characters

Command Formats	**Meaning**
<cr>	Stops all pumps. All pumps on the pump chain interpret this as a stop command, but do not respond with a prompt.
pump address, <cr>	Request for prompt. The pump with the indicated address responds with its prompt.
optional pump address, command, <cr>	Sends a command to a pump. The pump with the indicated address executes the command then responds with its prompt. The optional pump address, if not specified, will default to pump address 0.

After each command is received and executed, the pump acknowledges the command with a prompt. Preceding the prompt will be the text response, if applicable. The text response will be one or more lines of ASCII text, each preceded by a line feed and terminated by a carriage return:

<lf>, <text>, <cr>

A prompt is a string of ASCII characters sent by a pump, indicating the pump's address and its present state:

<lf>, 1 or 2 digit address, prompt character

Prompt Characters	Meaning
:	Pump stopped
>	Syringe 1 infusing
<	Syringe 1 refilling
*	Pump stalled

Pump Commands and Responses

RUN
Starts pumping according to the present setting of the pump. If pump already pumping, a "Not Applicable" error is returned.

STP
Stops pump if it was running. If pump already stopped, a "Not Applicable" error is returned.

RAT [{A|B}] [[<float> [<units>]]
Request *to set or query* infusion rate settings.

Set syringe 1 rate:
RAT rate
RAT rate units
RAT A rate
RAT A rate units

Set syringe 2 rate (only valid in *proportional mode*):
RAT B rate
RAT B rate units

Rate is of the format: f f f f f f

Units are one of	Meaning
UM	µl/mn
UH	µl/hr
MM	ml/mn
MH	ml/hr

Rate 2 is only accepted when mode is *Proportional.* If rate is accepted and valid, rate will become the new rate. If the rate is invalid, an "Out Of Range" error is returned.

Query syringe 1 rate:
RAT
RAT A

Query syringe 2 rate (only valid in p*roportional mode)*:
RAT B

Response is of the following format:
f f f f f f <units>

Where units are one of the following:
ml/mn, ml/hr, µl/mn, µl/hr

DIA [{A|B}] [<float>]
Request to set or query syringe diameter settings.

Set syringe 1 diameter:
DIA diameter
DIA A diameter

Set syringe 2 diameter (only valid in *proportional mode)*:
DIA B diameter

Corresponding syringe's rate will be zeroed.

Diameter is of the format:
f f f f f f

Units are millimeters.

Diameter 2 is only accepted when mode is *proportional*. If diameter is accepted and valid, diameter will become the new diameter. Diameter will not be accepted if the pump is running and a "Not Applicable" error is returned. If the diameter is invalid, an "Out Of Range" error is returned.

Query syringe 1 diameter:
DIA
DIA A

Query syringe 2 diameter (only valid in p*roportional* mode)
DIA B

Response is of the following format:
f f f f f f

Units are millimeters.

MOD [{AUT|PRO|CON}]
Request to set or query pumping mode

SET:	**Command**	**Meaning**
	MOD AUT	Puts pump in Auto Stop mode
	MOD PRO	Puts pump in Proportional mode
	MOD CON	Puts pump in Continuous mode

If pump is running, command will not be accepted and a "Not Applicable" error is returned.

Query:
MOD

Possible Responses	**Meaning**
AUT	Auto Stop mode
PRO	Proportional mode
CON	Continuous mode

DIR [{INF|REF|REV}]
Request to set or query pumping direction of syringe 1.

SET:	**Command**	**Meaning**
	DIR INF	Sets syringe 1 pumping direction *to infusion*
	DIR REF	Sets syringe 1 pumping direction *to refill*
	DIR REV	*Reverses* pumping direction of syringe 1

Direction of syringe 2 is set appropriately.

Query pumping direction of syringe 1:

DIR

Response will be one of:

INFUSE
REFILL

PAR [{ON|OFF}]

Request to set or query Parallel or Reciprocal setting.

SET:	**Command**	**Meaning**
	PAR ON	Sets syringes *to parallel* pumping direction.
	PAR OFF	Sets syringes *to reciprocal* pumping direction.

Direction of syringe 2 changes appropriately, while direction of syringe 1 does not change.

Query:

PAR

Possible Responses	**Meaning**
ON	Parallel
OFF	Reciprocal

IN <d>

Request to read in the TTL logic level at the specified pin, "d", on the external 9 pin D-SUB connector.

Valid pin numbers for input are:

6, 7 and 8

Possible Responses	**Meaning**
ON	TTL level high
OFF	TTL level low

If the pin specified is invalid, a "Not Applicable" error is returned.

OUT <d> = {ON|OFF}

Request *to set the TTL logic level* at the specified pin "d" on the external 9 pin D-SUB connector.

ON – Set pin to a *logic high*
OFF – Set pin to a *logic low*

Valid pin numbers for output are:

4 and 5

If the pin specified is invalid, a "Not Applicable" error is returned.

SAV

Request *to save pump settings* in the pumps non-volatile memory (NOVRAM). Normally, settings changed from a pump chain are not stored in the pump's NOVRAM and are lost after power down.

VER

Request *for version of pumps* embedded software.
Response for the present version will be: 33V2.0

Pump Chain Error Messages

Error messages are in the format:

<lf>, <message>, <cr>,

and are followed by a prompt. <Message> is one of the following:

Possible Responses	Meaning
?	Syntax error in a received command
NA	Command "Not Applicable" at this time.
OOR	"Out Of Range". Control data is out of pump's operating range.

Appendix A: Syringe Diameters in mm

Harvard Stainless Steel

Size	Diameter
8 cc	9.525 mm
20	19.130
50	28.600
100	34.900
200	44.755

Becton Dickinson Plastic 'Plasti-pak'

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	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

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

Renfac

Size	Diameter
2 cc	9.12 mm
5	12.34
10	14.55
20	19.86
30	23.20
50	27.60

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
0.5 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

Becton Dickinson Glass-All Types

Size	Diameter
0.5 µl	4.64 mm
1	4.64
2.5	8.66
5	11.86
10	14.34
20	19.13
30	22.70
50	28.60
100	34.90

Appendix B: Nominal Min/Max Flow Rates

Minimum flow rates are taken from the smallest inside diameters and maximum flow rates are taken from the largest inside diameters of the syringes supplied by the eleven most widely used syringe manufacturers.

Nominal Minimum/Maximum Flow Rates for Various Syringes (Actual Limits will vary depending on manufacturer)

Syringe Size	µl/hr Min.	Max.	µl/min Min.	Max.	ml/hr Min.	Max.	ml/min Min.	Max.
10 µl	0.0073			950.05				
25 µl	0.0183			2386.10				
50 µl	0.0365			4772.50				
100 µl	0.0731			9570.50				
250 µl	0.1813					23.751		
1000 µl	0.7281					95.418		
1 ml	0.7828					102.580		
2 ml	2.8493					373.430		
2.5 ml	1.8156					237.950		
3 ml	2.5691					336.710		
5 ml	4.9824					653.010		
10 ml	7.2024							15.733
20 ml	12.5360							27.384
30 ml	16.1310							35.236
50 ml	24.4201							53.346

Pump Chain Command Summary

All spaces in command are ignored. Maximum 5 digits per integer, or float data.

command	= >	[<adr>] [<cmd>] <CR>	
adr	= >	[d]d	1 or 2 digit address
cmd	=>	RUN	Start pump
		STP	Stop pump
		RAT [A] [<float> [<units>]]	Set/query syringe 1 rate
		RAT B [<float> [<units>]]	Set/query syringe 2 rate
		DIA [A] [<float>]	Set/query syringe diameter 1
		DIA B [<float>]	Set/query syringe diameter 2
		MOD [{AUT|PRO|CON}]	Set/query pumping mode
		DIR [{INF|REF|REV}]	Set/query pumping direction
		PAR [{ON|OFF}]	Set/query Parallel/Reciprocal
		IN <d>	Read TTL pin d
		OUT <d> = {ON|OFF}	Set TTL pin d
		SAV	Save settings in NOVRAM
		VER	Query software version
units	= >	{UM|UH|MM|MH}	µl/mn, µl/hr, ml/mn, ml/hr

Command Response Output Format:

output	= >	[<response>] <prompt>	
response	= >	<response> <response>	
		<lf> <message> <cr>	
prompt	= >	<lf> <adr> :	Stopped
		<lf> <adr> >	Syringe 1 infusing
		<lf> <adr> <	Syringe 1 withdrawing
		<lf> <adr> *	Pump stalled
adr	= >	[d]d	1 or 2 digit pump address
message	= >	?	Unrecognized command
		NA	Command not presently applicable
		OOR	Entered value out of range
		<text>	
		<integer>	
		<float>	

All spaces ignored. Maximum 5 digits per integer or floating point number.

Legend

float	= >	f f f f f f
f	= >	d|.
integer	= >	d d d d d
d	= >	0|1|2|3|4|5|6|7|8|9
b	= >	space
cr	= >	(ASCII 13)
lf	= >	(ASCII 10)
text	= >	(any string of ASCII characters)
< . . . >		non-terminal
upper case		terminals
[. . .]		optional
{ . . . }		select one
|		either-or

Appendix D: RS-232 Specifications

Pump Chain

Pump Port 1:	Computer control side
Pump Port 2:	Connection for remainder of pump chain
Baud Rate:	300, 1200, 2400 or 9600
Word Size:	8
Parity:	none
Stop Bits:	2

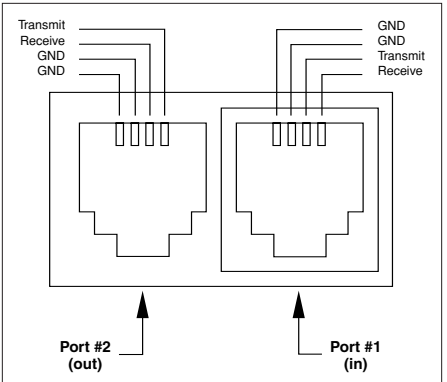


Figure 9. RS-232 Specifications

Appendix E: TTL Connector Specs

TTL Connections are via a 9 pin D-sub type connector. All inputs are internally pulled up to a logic high. All user definable pins are controlled via the IN and OUT pump chain commands. See Pump Chain Commands.

Pin Assignments

1. Vss (Ground reference, logic low)
2. Directional Indicator:
   Low – Syring 1 Infusing
   High – Syringe 1 Refilling
3. Pump Running Indicator
   Low - Pumped Stopped
   High - Pump Running
4. User Definable Output
5. User Definable Output
6. Foot Switch Input
   Falling edge starts/stops pump
7. Timer Input
   Rising edge starts pump
   Falling edge stops pump
8. Directional control input
   Rising edge sets Syringe 1 to infuse
   Falling edge sets Syringe 1 to refill
9. Vcc (Logic High Reference)

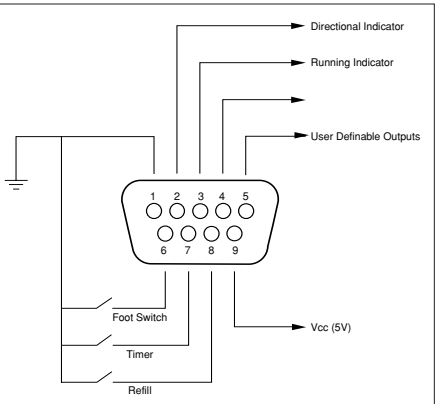
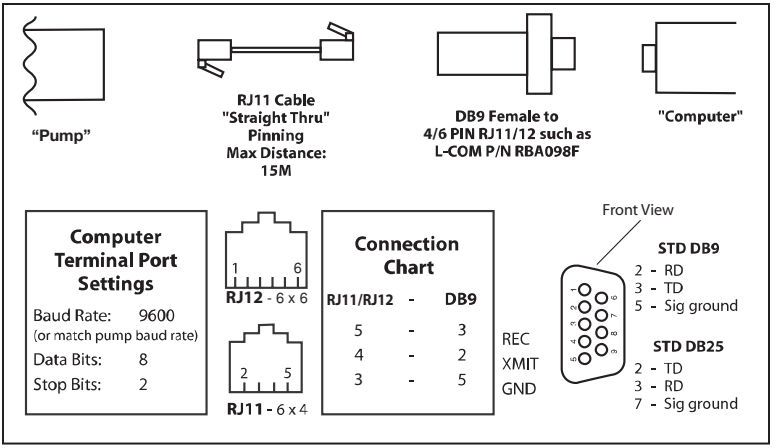


Figure 10. TTL Connector Specifications

Logic Low: 0 V – 0.5 V
Max. 2 mA current sink

Logic High: 2 V – 5 V
Max. 400 mA current source

Appendix F: Pump to PC Connection



Pump 33 requires no special maintenance other than keeping it clean by avoiding accidental spills of pumped material.

The two guide rods and the lead screw should be sparingly lubricated periodically with the Magnalube-G R grease provided with the pump. This Teflon R based grease is available either from Harvard Apparatus or Carleton-Stuart Corp. 13-02 44th Ave., Long Island City, NY 11101.

Solvents of any type should never be used to clean the pump. A mild detergent solution may be used to clean the keypad.

Fuse Replacement

Make sure power cord is disconnected from main supply before replacing fuse. Remove bottom cover on pump by removing four (4) rubber feet and four (4) screws. Locate fuse on power supply module. Remove fuse from fuse clip. Use caution no to break fuse when removing. Replace fuse, bottom cover, screws and rubber feet. For continued fire protection replace fuse only with 250V fuse of the specified type and rating. (3AG 1AMP 250V SLO-BLO)

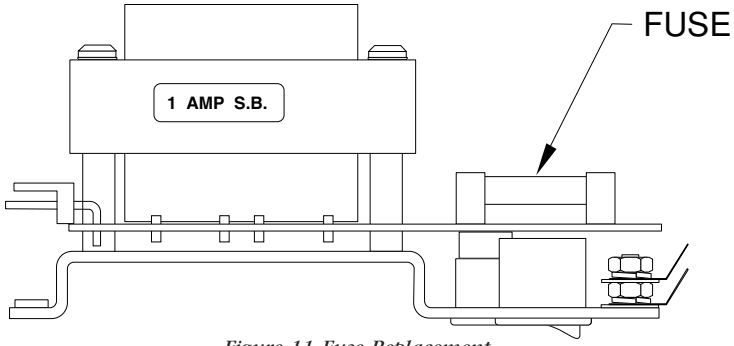


Figure 11. Fuse Replacement

WARNING:
Use in manner not specified by manufacturer may impair protection provided by equipment.

RS-232 Difficulties

Verify that the baud rates and data framing parameters on all devices are the same. With a pump chain, a "Communication timeout" error on a computer is usually caused by the computer errantly handshaking on the RTS, CS and/or DSR lines. Verify pins 4, 5 and 6, on the 25 pin connector, are jumpered on the computer side of the cable.

Display Messages:

All digits flashing
Pump has not received any commands since being powered on.

StALL
Also a syringe LED and Run LED flashing. This indicates that the pusher block travel of the syringe corresponding to the syringe LED blinking has been impeded. This may be caused by the syringe plunger hitting bottom, a kink in the tubing, syringe plunger binding or any situation requiring more force to the head of the syringe than the pump is capable of delivering. To restart the pump, remove the cause of stalling and press RUN. The pump will continue the interrupted procedure where it stopped. Also note, a large increase in the pumping rate while running could also stall the motor.

oor
Out of range. A value was entered or encountered in a pump program that was beyond the pumps limits. Try using a different size syringe. Note that rates must be less than 42950. Express larger rates using different units.

- - - - -
Key pressed is not applicable.

Appendix I: Accessories

Catalog No.	Product
MA1-55-4144	Foot Switch
MA1-55-7760	Pump Chain Cable for connecting two or more pumps
MA1-55-4145	RS-232 Connector Cable for IBM and compatible personal computers
MA1-55-4146	RS-232 Connector Cable for other than IBM and compatible personal computers

Appendix J: Custom Applications

The Harvard 33 Syringe Pump lends itself to a multitude of OEM industrial applications, for all types of custom pumping or pilot plant applications. Please contact the Harvard Development Group if we can be of help.

Harvard Apparatus pumps are distributed
on a non-exclusive basis by:

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