

RAININ

Pipetting 360°

RP-1 Peristaltic Pump

User Guide

9920-179 Rev E



METTLER TOLEDO

EC Declaration of Conformity

according to ISO/IEC Guide 22 and EN45014

Manufacturer's Name: Rainin Instrument Co.

Manufacturer's Address: 5400 Hollis St.
Emeryville CA 94608
U.S.A.

declares that the following product:

Product Name: RP-1 Peristaltic Pump

Model Number: RP-1

Product Options: 1 channel liquid head
2 channel liquid head
3 channel liquid head
4 channel liquid head

conforms to the following Product Specifications:

Safety: EN61010-1:1993
IEC1010:1990 + A1,A2

EMC: EN55011:1988 Class A
(Electromagnetic Interference)
EN50082-1
pr EN55024-2:1992(Electrostatic Discharge)
pr EN55024-3:1991(Electromagnetic Immunity)
pr EN55024-4:1993(Electrical Fast Transient)

Supplementary Information:

Responsible Signatory: Haak Magnussen, VP of R&D
Date: March 1, 1996



The Model RP-1 Peristaltic Pump is classified as Portable
Equipment of Installation Category II.

WARNINGS

The following warnings and signs appear in this manual:



WARNING: Keep hands and foreign objects away from the rollers while the machine is in operation.



WARNING: If using the Model RP-1 at high pressure (>25 psi) ensure that the operating pressure does not exceed the maximum rated pressure of the tubing.



WARNING: When cleaning the Model RP-1 tubing head, make sure that the power is turned off.



WARNING: Switch off the pump power before replacing the pump head.

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1: Introduction

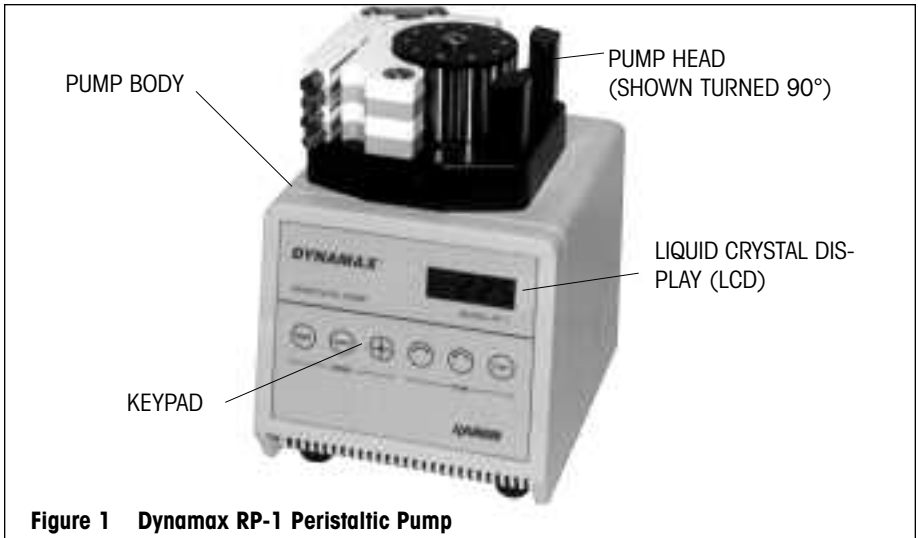


Figure 1 Dynamax RP-1 Peristaltic Pump

General Description

The Dynamax RP-1 Peristaltic Pump is specifically designed for fluid transfer. The rotating head has ten stainless-steel rollers. As the head rotates, five of the rollers press the tubing up against the compression arm, producing flow by peristaltic action. Five rollers constantly in contact with the tubing ensures low pulsation, smooth flow, and high pressure. Model RP-1 is ideal for critical liquid chromatography, gradient generation, and flow analyzer applications.

The RP-1 incorporates a unique cam design: the adjustment screw does not press the compression arm directly. Instead, turning the adjustment screw in the RP-1 moves a cam which applies gradual force to the compression arm. This results in more precise flow control and reduced tubing wear.

RP-1 is powered by a high torque stepper motor, controlled by a microprocessor with unique feedback circuitry for good speed stability, even at very low flow rates. Speed stability is maintained between 0° – 40°C and against back-pressures of up to 5 bars. Pump speed is shown in revolutions per minute (rpm) on a liquid crystal display (LCD) on the pump front panel. Pump speed and direction of rotation are controlled by a membrane keypad next to the display.

Several pump heads are available: a single-channel model and three multi-channel versions: 2-, 4-, and 8-channel. Individual tubing compression settings on the multi-channel pump heads allow different diameter tubing to be used for each channel. Independent compression settings for each channel ensure optimum flow rate and long tubing life.

Fixed collars bonded to the tubing allow easy tube installation at the proper tension, in turn ensuring that the tubing diameter is optimized and not altered from day to day. Precise and accurate motor speed setting, correct tubing tension, and reproducible tubing diameter all contribute to ensuring reproducible flow rates.

The shipping container should hold the following:

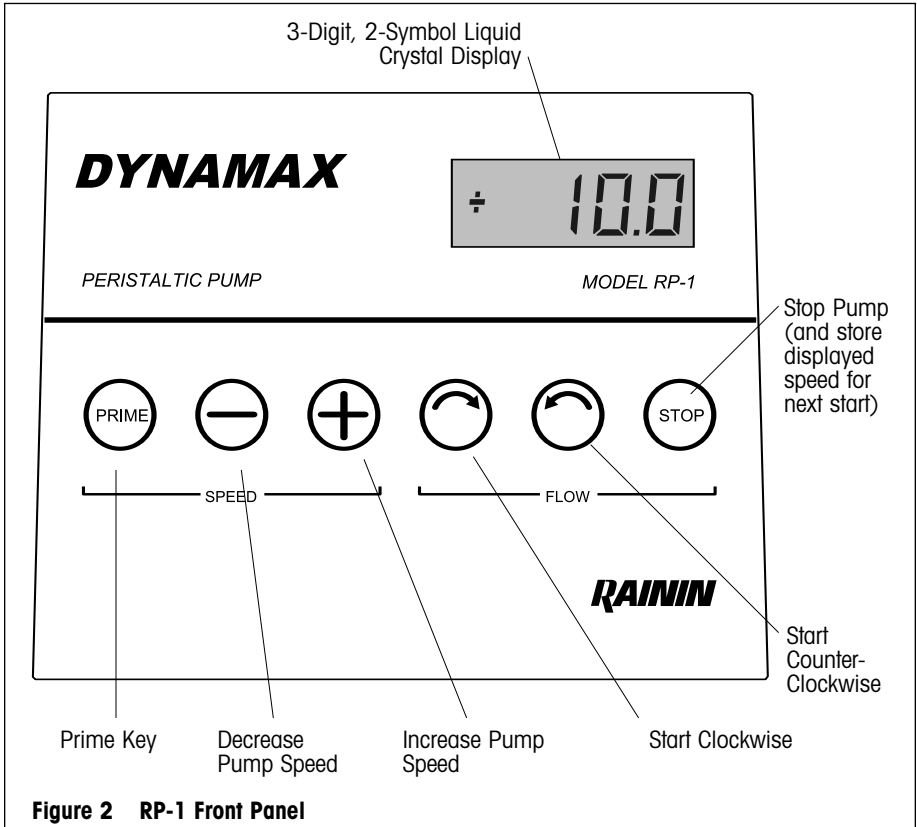
Description	Qty
Pump Body	1
Pump Head	1 (as ordered)
Accessory Pack containing:	
Power Cord	1
Fuses	4
Mounting Screws	2
Tubing	
0.38 mm ID	1
1.52 mm ID	1
3.16 mm ID	1
Drain tubing	2
Instruction Manual	1

Unpacking

If any item from the above list is missing, please call Customer Service at 800-472-4646.

The Dynamax Model RP-1 Peristaltic Pump was shipped in excellent working condition. Inspect the pump on receipt for possible shipping damage. In case of damage, file a claim immediately with the shipping carrier — damage sustained in transit is the responsibility of the carrier. Save the shipping container and packing materials until any damage claim is resolved and the pump is functioning properly. The container and packing materials also afford excellent protection during future storage or transportation.

2: Controls and Indicators



LCD: The 3-digit, 2-symbol liquid crystal display shows motor speed in rpm. When the pump is running, a plus or minus sign is also displayed to indicate clockwise (+) or counterclockwise (−) rotation of the pump head.



PRIME key: High-speed override, for priming the tubing lines. Pressing this key when the pump is running speeds the pump to its maximum rate of 48 rpm. (Pressing the key has no effect when the pump is not running.) The pump remains at the high flow rate until the PRIME key is pressed again, or until either of the two START keys is pressed. Then the pump reverts to its previous speed.



MINUS key: Decreases motor speed. Pressing and holding this key while the pump is running decreases the pumping speed continually as long as the key is held. Pressing and holding the key while the pump is not running sets the speed at which the pump will operate when it starts.



PLUS key: Increases motor speed; use is similar to MINUS key.



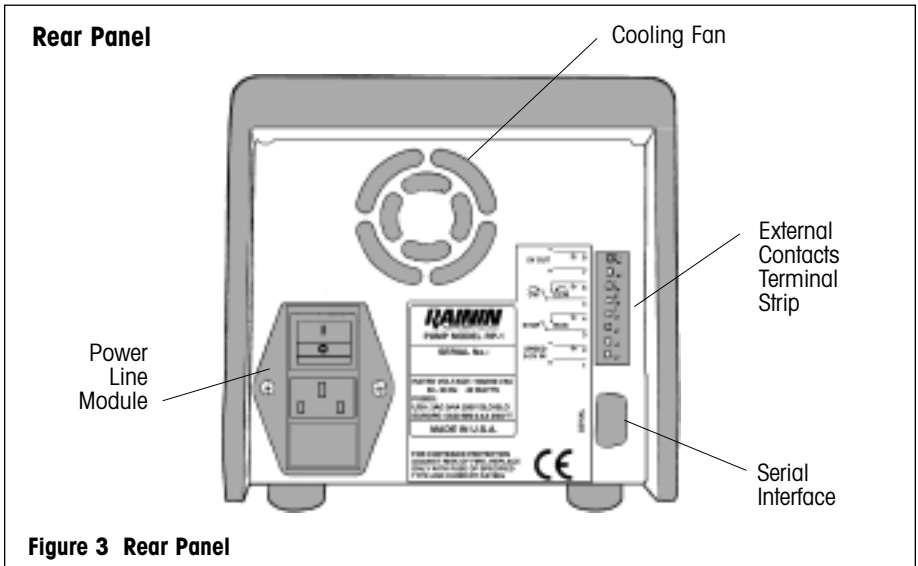
START Clockwise key: Pressing this key when the pump is stopped starts the roller barrel rotating clockwise at the speed displayed on the LCD. Pressing it while the pump head is at maximum speed (after the PRIME key has been pressed) causes the pump to revert to its previous speed. Pressing the key while the pump is running counterclockwise stops the roller barrel and immediately starts it rotating clockwise at the same speed.



START Counterclockwise key: Used in a similar way to the START Clockwise Key.



STOP key: Stops the pump and stores the value displayed on the LCD. This value is used when the pump is started with either of the START keys.



Rear Panel

Power Line Module: Power is supplied to the RP-1 pump via a power line module containing:

1. Power On/Off Switch — Two-position rocker switch that supplies AC power. I is ON, O is OFF.
2. Power Cord Receptacle — Grounded three-pin receptacle. Accepts the power cord supplied in the accessory kit.
3. Fuse/Line Voltage Selector — Two-position 110V/220V line voltage selector containing two fuses.

Note: The RP-1 Pump is shipped from the factory ready for operation at the line voltage of the destination country. Refer to Appendix A for fuse information before operating the pump.

External Contact Terminal Strip: Terminal strip for contact-closure remote control. Inputs control: Speed, Stop/Run, and Rotation Direction. There is also a +5V DC output on the terminal strip, used as an auxiliary voltage. Please refer to Section 5 for more information regarding remote control.

Serial: Serial interface socket for computer remote control. Please refer to Section 5 for more information regarding serial interface remote control.

3: Tubing

Tubing Selection

The Model RP-1 uses special tubing with bonded collars. Choose the tubing most suitable for your application, from:

Polyvinyl Chloride (PVC) - for most aqueous solutions.

Silicone - for aqueous and polar solutions.

Viton® - for gases, oils, strong acids, temperatures to 200°C.

Different diameter tubing can be installed on adjacent channels to give a variety of flow rates for a given pumping speed.

Tubing Installation

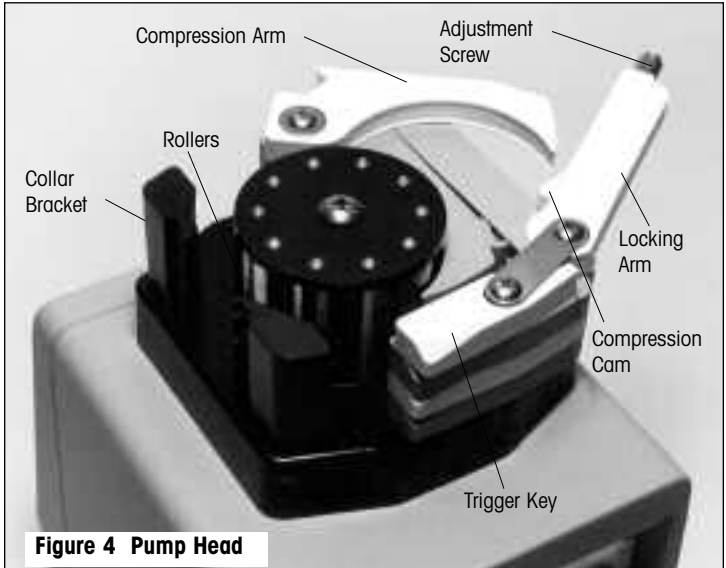


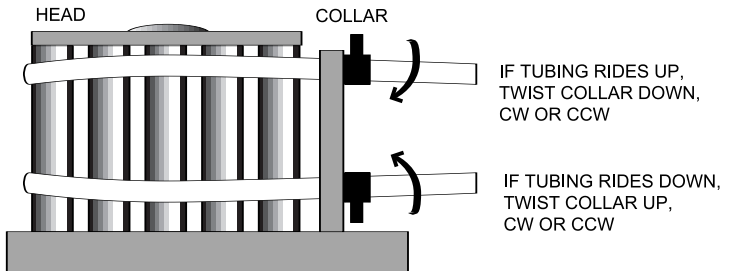
Figure 4 Pump Head

1. Referring to Figure 4, open the compression arm by pressing the beveled trigger key toward the rollers. This allows the locking arm to be pulled out, in turn allowing the compression arm to be pulled clear of the rollers.
2. Select a length of tubing of the desired diameter and insert one of its fixed collars into one of the grooves on the collar bracket.
3. Thread the tubing around the rollers so it fits into the groove in the compression arm (the groove prevents the tubing from snaking during operation). Stretch the tubing slightly and insert the other fixed collar into the groove on the opposite collar bracket. See Figure 5.
4. Close the compression arm on the tubing and close the locking arm. (This action also "sets" the trigger key.)
5. Repeat steps 1 to 4 for each channel and loosen all the adjustment screws for now.



Figure 5 Installing Tubing

Because of tubing inconsistencies, the tubing may ride up or down on the rollers. If this happens, twist the collar on the affected end of the tubing up to 180° in the opposite direction to the movement of the tubing. See the diagram below.



EXPERIMENT FOR BEST RESULTS. OR CALL TECH SERVICES AT 800-543-4030.



WARNING: If using the Model RP-1 at high pressure (>25 psi) ensure that the operating pressure does not exceed the maximum rated pressure of the tubing.

Drain Tubing

Attach a drain tube from the accessory kit to the stub at the back of the pump head by pushing it firmly over the stub. This will help prevent any liquid spill (due to a flow tubing break) from leaking under the rollers and into the pump electronics.

4: Set-up and Operation

Set-up

1. Connect the RP-1 to a GROUNDED AC power source.
2. Switch the pump ON using the power switch on the rear panel. The LCD will display the speed set when the pump was last used. (The speed is set to 10.0 rpm at delivery.) The pump will not operate until you press either of the START keys.
3. Select the type of tubing to be used (see Section 3). Determine your maximum desired flow rate, then refer to the table below to select the specific diameter tubing and speed setting to produce that maximum flow rate.

Cat. No.	Description	Max. Flow
39-628	PVC, 3.16 mm ID	28.2 mL/min
39-627	PVC, 2.80 mm ID	24.6 mL/min
39-626	PVC, 2.29 mm ID	17.2 mL/min
39-625	PVC, 1.52 mm ID	8.3 mL/min
39-624	PVC, 0.76 mm ID	2.2 mL/min
39-623	PVC, 0.63 mm ID	1.6 mL/min
39-622	PVC, 0.50 mm ID	1.13 mL/min
39-621	PVC, 0.38 mm ID	0.66 mL/min
39-620	PVC, 0.25 mm ID	0.33 mL/min

Figure 6 Pump Speed/Flow Rate Maxima

4. Set the pump speed using the plus or minus speed control key. (Pressing either key once changes the rightmost digit in the display; pressing and holding the key changes the speed continually at an increasing rate). Do not start the pump yet.
5. Install flow tubing for each channel that you wish to use, as described in the previous section. Attach connectors, couplings, and additional tubing (see Section 9 — Accessories) as necessary to complete a fluid path from reservoir to collection vessel.



WARNING: If using the Model RP-1 at high pressure (>25 psi) ensure that the operating pressure does not exceed the maximum rated pressure of the tubing.



WARNING: Keep hands and foreign objects away from the rollers while the machine is in operation.

Operation

1. Start the pump in the desired direction by pressing either START key (clockwise or counterclockwise).
2. Adjust the cam pressure for each channel by slowly tightening the adjustment screw until flow just starts, then tighten the screw $\frac{1}{4}$ turn further. (Tighten only to the minimum necessary for pumping to assure long tubing life.)
3. When using new or dry tubing, press the PRIME key to prime the tubing. After the tubing is primed, press the PRIME key again or the START key to revert to the previously set flow rate.
4. Allow the flow to stabilize for 15 minutes then check the flow rate and cam tension. Adjust as necessary.

Autostart

The RP-1 pump has an Autostart feature which operates as follows: If the pump is running and the electrical power is interrupted, the pump will restart automatically at the same speed when the power supply resumes. When this happens, the display flashes on and off (indicating Autostart) until either of the START keys or the STOP key is pressed.

If the pump is not running when the power is interrupted, operation is normal. The pump will not automatically restart when power resumes, but will idle until either START key is pressed.

Note: The Model RP-1 must be running for at least ten seconds before power is interrupted for the Autostart feature to work.

Autostart is set "ON" when the pump is delivered. You can turn Autostart off as follows:

1. With the power off, press and hold the STOP key while you switch the power on. When the display appears, release the STOP key. The display should read A30, where A indicates Autostart enabled, and 30 indicates the unit ID number for remote operation (see Section 5.)
2. If you wish, change the Autostart status by pressing the PRIME key. The A changes to a dash (-) to show Autostart disabled. Pressing the PRIME key again enables Autostart and changes the dash to an A. Set the Autostart status as desired.
3. Press the STOP key again to store the Autostart status and revert to normal display (rpm).

Operating Requirements

The Model RP-1 is designed to operate in a laboratory or similar setting at temperatures between 4°C and 40°C. The pump should be placed on a clean flat surface and should be operated in an area with adequate ventilation, free of volatile fumes. All air holes on the pump should remain unobstructed during operation.

If the equipment is used in a manner not specified by the manufacturer the protection provided by the equipment may be impaired.

Ensure that the fan is not obstructed during operation.

Operating Suggestions

- For accurate slow flow rates, use small diameter tubing at a fast speed, not large diameter tubing at slow speed.
- For maximum tubing life, use slow or medium speed with appropriate diameter tubing for desired flow rates.
- Install the drain tube supplied in the accessory kit to the stub on the back of the pump head (see Section 3).
- Change flow tubing as soon as any signs of cracking, wear, or stiffness are seen. Replacing worn tubing before it leaks will help avoid spillage into the pump electronics compartment, and possible costly repairs.
- Place the RP-1 higher than the liquid reservoir or collection vessel to prevent gravitational flow into the pump in the event of a tubing break.
- When the pump is not in use, press the trigger key to release the compression arm. Relax the tubing by unhooking one of the tubing collars. This will improve start-up performance by eliminating flat spots in the flow tubing caused by the pressure of the cam against the rollers. Flat spots will eventually work out of the tubing, but initially can cause excessive pulsation and irregular flow rates.
- Clean any spills promptly, especially near the pump head and on the front panel membrane and display.
- Turn the power off when cleaning the Model RP-1. Use a cloth dampened with water only to clean the pump; do not use harsh detergents or any solvents for cleaning.



WARNING: When cleaning the Model RP-1 tubing head, make sure that the power is turned off.

5: Remote Control

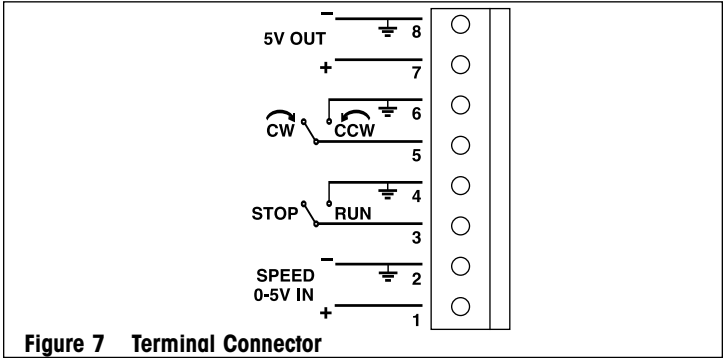
Contact-Closure Remote Control

The RP-1 Peristaltic Pump can be remotely controlled by contact closures from a suitable device through the terminal connector on the rear panel, when:

- 1) the pump STOP key has been pressed, and
- 2) the pump is not under computer remote control.

Flow must be stopped to switch between keyboard control and contact closure remote control and vice versa.

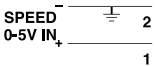
Inputs in the terminal connector control: Pump Speed (pin 1), Stop/Run (pin 3), and Rotation Direction (pin 5). Ground connections are available on pins 2, 4, 6, and 8. Pin 7 supplies a +5V output. The voltage range for pin 1 is from 0V (stopped) to +5V (100% of speed set on keyboard). Electrical levels for pins 3 and 5 are +5V open, 0V closed. The terminal connector is shown in Figure 6, with pinouts for the inputs shown below.



Contact	Input	Electrical level	Input state
Pin 1	Speed	0 to +5V	0-100% of speed set on keyboard
Pin 3	Stop/Run	+5V (open) 0V (closed)	Stop Run
Pin 5	Rotation Direction	+5V (open) 0V (closed)	Clockwise Counterclockwise
Pin 7, 8	(+5 V Output)	+5V out	—
Pin 2,4,6	Ground	0V	Ground

Terminal Connector Pinouts

SPEED: Pump speed is controlled by supplying up to +5V analog DC voltage between pin 1 and GROUND (pins 2, 4, 6). When controlled in this way, actual speed of the pump head is:



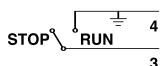
$$\text{Actual Speed} = \frac{(\text{Nominal Speed} \times \text{Voltage})}{5 \text{ volts}}$$

where: actual speed is the speed of the pump head, and nominal speed is the speed selected with Plus or Minus keys.

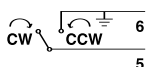
e.g.: If the nominal speed is 20 rpm and the analog DC voltage is 4V, actual speed is 16 rpm.

When STOP/RUN is closed (pump running), the actual pump head speed is displayed. When STOP/RUN is open (pump stopped), the nominal speed is displayed.

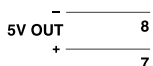
Notes: 1) The SPEED input operates only when STOP/RUN is closed.
2) The SPEED input is internally pulled up to +5V to make actual speed equal to nominal speed when this input is open.



STOP/RUN: The pump runs when pin 3 is closed (shorted to GROUND: pins 2, 4, 6 or 8). When the input is open, the pump does not run.



ROTATION DIRECTION: With this input open, rotation will be clockwise. When closed (shorted to GROUND: pins 2, 4, 6 or 8), rotation will be counterclockwise.



+5V OUTPUT: Supplies +5V DC voltage for external uses. Internally limited to 70 mA.

Computer Remote Control

The RP-1 Peristaltic Pump can be remotely controlled by an external computer through the serial interface socket on the rear panel. Up to 64 devices with unique unit ID numbers (0 through 63) can be controlled one at a time via the same serial interface on the computer.

Each RP-1 pump has a unit ID number, set at the factory to 30.

To change the ID number, switch the pump off, press the STOP key and switch the pump on again. The display should read A30, indicating that the Autostart feature is enabled (see section 4) and that the pump's unit ID is 30.

Press the PLUS or MINUS key to change the ID number. Store the new ID number by pressing the STOP key again.

Software for controlling the Model RP-1 from an external computer must use specific command protocols, described in Appendix B.

6: Pump Head Replacement

The RP-1 Peristaltic Pump is shipped fully assembled, with the pump head that you ordered already installed. Follow the instructions below if you have purchased an additional head and wish to replace the pump head, or if you wish to reposition the pump head.



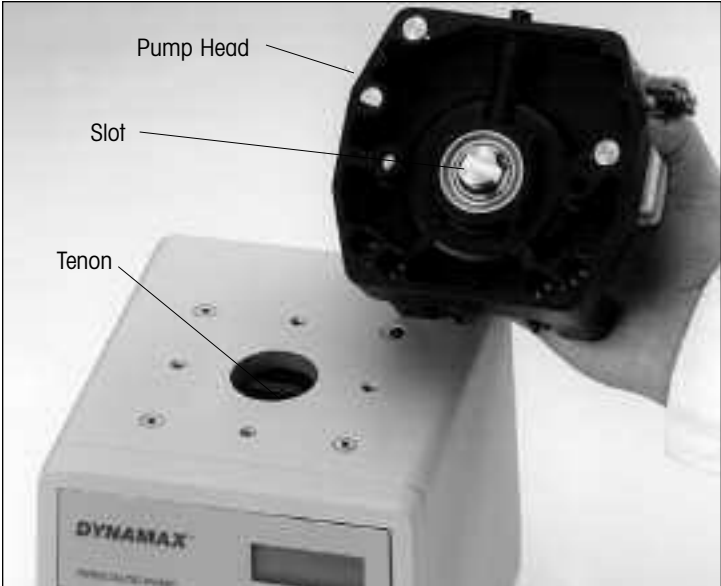
WARNING: Switch off the pump power before replacing the pump head.

1. Open the compression arm for each channel by pressing the trigger keys toward the rollers. This allows the locking arms to be pulled out and frees each compression arm. Rotate each compression arm away from the rollers.
2. The pump head is attached to the pump body with two hex-head machine screws. With a 5 mm hexdriver, loosen both screws so you can lift the head from the pump body.
3. With the head removed, lightly coat the top of the pump around the opening with silicone grease. This will help prevent any spillage from seeping into the pump body.
4. If you are changing heads, remove the mounting screws from the head and insert them into the holes in the replacement head.

Note: Four screw holes in the pump cover give you four positions to install the pump head. The recommended position is as shown in Figure 1 of this manual, with the tubing collar brackets to the right. To avoid any possibility of liquid from the drain tube dripping on the keypad, do not position the head with the tubing collar brackets to the back.

5. Refer to Figures 8A and 8B and position the pump head on the pump cover. Turn the roller barrel until the slot at the base of the pump head is aligned with the black plastic tenon in the opening on top of the pump body.
6. Engage the slot at the base of the pump head with the tenon, gently turning the roller barrel back and forth to assist engaging the slot and tenon.
7. When the slot and tenon are matched (when the pump head is flush with the pump body) gently lower the head until the mounting screws locate their threaded holes. Tighten the mounting screws to secure the pump head in place. Do not overtighten the screws. The procedure is now complete.

Replacing the Pump Head



Figures 8A and 8B Pump Head Replacement

7: Maintenance and Troubleshooting

Maintenance

The RP-1 pump is ruggedly designed and should require little maintenance and few operating precautions:

- operate the RP-1 only at the recommended line voltage
- operate the pump within a laboratory or similar setting
- use only recommended tubing
- do not place anything on top of the pump head
- avoid mechanical shock to the RP-1
- keep the instrument clean and mop up any spills promptly
- use a soft cloth moistened with water to clean the pump
- do not use harsh detergents or any solvents to clean the pump

Trouble-shooting Table

Excessive or premature wear on flow tubing	Check that pressure is not too high on compression arm. Tighten tension screw only enough to produce flow.
Pump will not run. Display blank	Check that the pump is plugged in, switched on, and that power is supplied to the wall socket.
	Check that the fuses are intact and replace if necessary. (See Appendix A.)
Pump will not run in contact-closure Remote Control	Check that the STOP button is pressed.
	Check that the SPEED input is not shorted to GROUND.
Other problems	Contact Rainin Technical Support at 800-543-4030.

8: Specifications

Pump Options

Model	Cat No.	Approx Size	Approx Weight
1-channel	7103-051	160 W x 190 D x 210 H (mm) 6.3 W x 7.5 D x 8.27 H (in)	4 kg 8.75 lbs
2-channel	7103-052	160 W x 190 D x 215 H (mm) 6.3 W x 7.5 D x 8.46 H (in)	4.2 kg 9.25 lbs
4-channel	7103-054	160 W x 190 D x 235 H (mm) 6.3 W x 7.5 D x 9.25 H (in)	4.4 kg 9.75 lbs
8-channel	7103-058	160 W x 190 D x 275 H (mm) 6.3 W x 7.5 D x 10.83 H (in)	5.3 kg 11.75 lbs
Pump body	7103-050	160 W x 190 D x 165 H (mm) 6.3 W x 7.5 D x 6.5 H (in)	3.7 kg 8.25 lbs

Specifications

Head speed:	0 to 48 rpm
Torque:	greater than 3 N-m across full operating range at 115VAC
Speed stability:	0.5%
Speed adjustment:	0.00 to 9.99 rpm in 0.01 rpm increments 10.0 to 48.0 rpm in 0.1 rpm increments
Flow rate:	0-37 mL/min max at 0 backpressure (depending on tubing diameter)
Max back-pressure:	70 psi
Wetted surfaces:	PVC, Silicon, Viton (tubing only)
Flow tubing diameter:	0.25 mm ID - 4 mm ID
Line voltage:	110V (nominal): 90V to 130V 220V (nominal): 180V to 260V (The rated voltage implies a $\pm 10\%$ fluctuation of 100-240VAC in mains power output; the RP-1 will operate between 90 and 260 volts.)
Line frequency:	50 - 60 Hz
Power consumption	40 watts max, 20 watts typical
Temperature:	4° to 40°C
Humidity:	up to 95% non-condensing
Operating position:	vertical $\pm 5^\circ$
Prices and specifications are subject to change without notice.	

9: Accessories

Tubing

Cat. No.	Tubing Length (in)	ID, mm	Max Flow (48rpm) mL/min	Color
Polyvinyl Chloride. For most aqueous solutions. Low gas permeability. Pkg. of 12.				
39-620	14	0.25	0.33	Orn/Blue
39-621	14	0.38	0.66	Orn/Green
39-622	14	0.50	1.13	Orn/Yel
39-623	14	0.63	1.6	Orn/White
39-624	14	0.76	2.2	Black
39-625	14	1.52	8.3	Yel/Blue
39-626	14	2.29	17.2	Pur/Blk
39-627	14	2.8	24.6	Pur/Wht
39-628	14	3.16	28.2	Blk/White
Silicone. For aqueous and polar solutions. High gas permeability. Cold-room applications. Pkg. of 12.				
39-660	14	0.25	0.26	Orn/Blue
39-661	14	0.38	0.6	Orn/Green
39-662	14	0.50	0.95	Orn/Yel
39-663	14	0.63	1.5	Orn/White
39-664*	14	0.76	2.0	Black
39-665*	14	1.52	7.4	Yel/Blue
39-666*	14	2.29	15.4	Pur/Blk
39-667*	14	2.8	20.6	Pur/White
* Autoclavable				
Viton. For gases, oils, strong acids, bases, organics, up to 200°C. Pkg. of 12.				
39-640	7	0.50	0.6	Orn/Yel
39-641	7	0.63	0.94	Orn/White
39-642	7	0.76	1.2	Black
39-643	7	1.42	4.7	Yellow
39-644	7	2.28	11.8	Pur/Blk
39-645	7	2.79	15.8	Pur/White

Pump Heads

Cat No	Description
7103-061	Single-Channel Head
7103-062	Two-Channel Head
7103-064	Four-Channel Head
7103-068	Eight-Channel Head
all heads have stainless steel rollers	

Connectors and Unions

Cat No	Description
P-757	Peristaltic Tubing Adapter



Connects small-diameter flexible peristaltic tubing to PTFE or other rigid polymeric tubing using standard 1/4-28 flanged or flangeless inert fittings PEEK, fits flexible tubing with ID 1.22–2.79 mm and OD up to 5 mm

Appendix A: Fuse Installation

Note: The Rainin Model RP-1 Peristaltic Pump is shipped from the factory ready for operation the line voltage of the country of destination.

Use this Appendix only for fuse replacement or installation when necessary.

If your line voltage is not 110VAC, or when a blown fuse needs replacing, you will need to install fuses and set the line voltage module in the correct orientation.

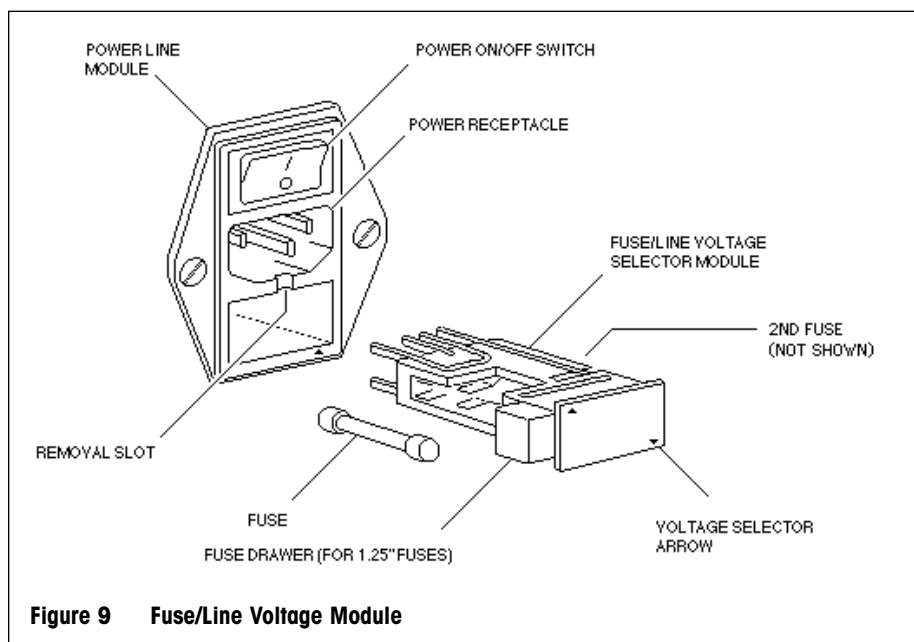


Figure 9 Fuse/Line Voltage Module

Fuse Installation

1. Turn off the power switch and remove the power cord.
2. Insert a small screwdriver blade downward into the removal slot at the top center of the line voltage module. Lever the module out by twisting the screwdriver.
3. Pull the module away from the rear panel.
4. Select fuses according to your line voltage and the following chart. (Fuses are supplied in the accessory pack.)

MODEL RP-1 FUSE TABLE:

USA 3AG 3/4A 250V Slo-Blo

Europe: 5 x 20 mm .4A 250V T

Note: Two fuses are necessary for operation, one each side of the line voltage module. You will need to pull out the fuse drawers on both sides of the line voltage module to install or remove the fuses.

5. Insert the fuse by pushing it into the fuse holder until it is firmly seated. Close the fuse drawer and repeat for the other fuse.
6. Refer to the chart above and install the line voltage module into its socket in the correct orientation. Gently push the line voltage module until it is firmly seated in the socket. (Your line voltage should read right way up at the base of the module with the two arrowheads aligned.)
7. Replace the power cord. The procedure is now complete.

Appendix B: Computer Remote Command Protocols

Introduction

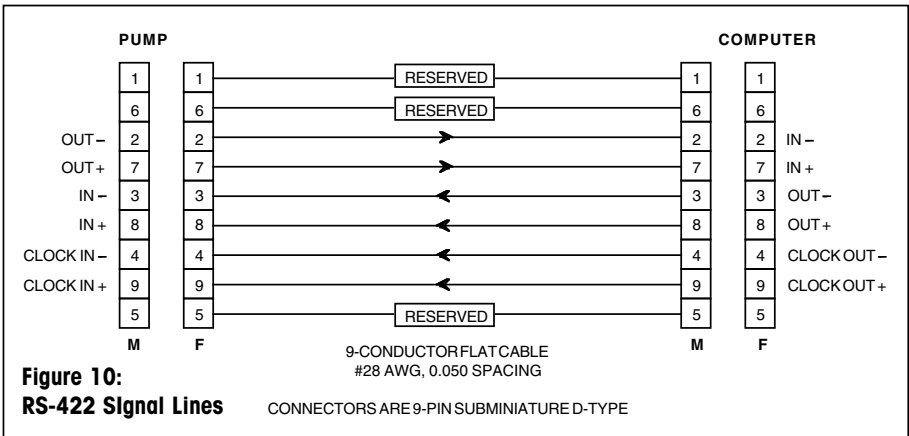
Any computer with an RS-422 serial interface port can be used to control the Rainin RP-1 Peristaltic Pump. Interface adapters are commercially available to convert RS-232 ports to RS-422. Software for controlling the RP-1 from an external computer must use specific RS-422 protocols, described in the following paragraphs.

Description

The RS-422 bidirectional communications channel allows the computer to communicate with up to 64 slave devices with unique unit ID numbers, designated as units 0 through 63. The computer communicates with one pump at a time by transmitting the pump's unit ID. The pump which recognizes the unit ID connects to the channel, and any other selected device disconnects.

Physical Connections

All connections are made with 9-pin sub-miniature D-connectors and cabling as shown in Figure 1.



Data Format

Data communication is asynchronous, eight-bit, even parity, consisting of one start bit, eight data bits, one parity bit and one stop bit. RP-1 pumps check for even parity and use even parity when replying. Parity error causes the pump to disconnect from the RS-422 channel. This can be corrected by reconnecting then restarting the message.

Baud rates

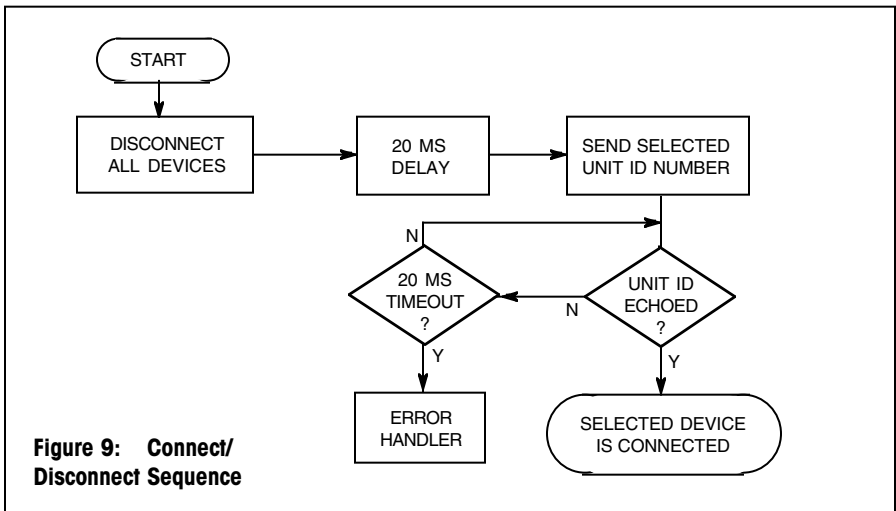
Baud rates are: 600, 1200, 2400, 4800, 9600 and 19200. The clock will run at 16X the baud rate. RP-1 pumps operate at 600 baud with their internal clocks. If no clock signal is supplied, the pump will communicate at 19200 baud.

Connect/ Disconnect Sequence

Before connecting to a particular pump, the computer must first send a disconnect code (255 - FF hexadecimal). The computer waits 20 milliseconds to allow any active device to turn off its driver. Then the computer sends the desired pump's unit ID number as an eight-bit byte with the most significant bit set (add 128 to the unit ID number).

The pump that recognizes the unit ID connects its transmitter to the communications channel and echoes the unit ID. Any device which does not recognize the unit ID will disconnect. The active pump will echo its unit ID within 20 milliseconds after receiving it — if no response is received in that time, the computer may assume the pump is unavailable. The selected pump remains connected until the disconnect code or the unit ID of another device is received.

The connect/disconnect flow chart is shown below.



**Figure 9: Connect/
Disconnect Sequence**

Commands

Two types of commands can be sent via the RS-422 channel; buffered and immediate. Buffered commands are instructions, and are executed as background processes. Immediate commands are status requests, and are given a higher priority. The RP-1 will interrupt a buffered command to respond to an immediate command.

Immediate commands are single-letter status requests with immediate priority. Buffered commands will be interrupted to complete an immediate command. Immediate commands (from the following RP-1 set:) can be any valid data character except the following:

- 1 line-feed (0A hexadecimal)
- 2 carriage return (0D hexadecimal)
- 3 pound sign (23 hexadecimal) or
- 4 NAK (15 hexadecimal)

Immediate commands return messages of one or more characters. Each character must be sent within 20 milliseconds after the command character has been transmitted. The first character is sent as a response to the command. The computer gets additional characters in response by sending an ACK (6 hexadecimal). The last character of an immediate command has its most significant bit set to 1. The host computer will not "ACK" it.

Buffered commands consist of an ASCII string of one or more characters preceded by a line feed <LF> (0A hexadecimal) and followed by a carriage return <CR> (0D hexadecimal). The pump echoes with a line feed <LF> if ready for a command and with a pound sign <#> (23 hexadecimal) if not ready. If not ready, the computer retries sending the line feed until the pump echoes a line feed.

Once the pump echoes the line feed, each subsequent character will be echoed if there is no error. If there is an error, no echo will be made and the pump will disconnect from the channel. If the computer is checking echoes and receives one with an error, it can send a NAK (15 hexadecimal) and the pump will retransmit the character.

The pump can be "locked" (put into "Remote" with the "L" buffered command. When the pump is unlocked, it will ignore all buffered commands except the "L" command.

A List of the RP-1 immediate and buffered commands follows:

Command List

Command	Mode	Description
I	I	Request Contact Input Status Return: "ab"

where "a" reflects pin 3 (START/STOP input) and "b" reflects pin 1 (CW/CCW input)

The allowable values are:

"1" for an inactive or high input (open)

"0" for an active or low input (closed)

Default response: "11"

Command	Mode	Description
R	B	Set a new speed "Rn"

where "n" is a 1-4 digit integer interpreted as the value of the new speed in hundredths of a revolution per minute. Example: "R1250" means 12.5 r.p.m. This command changes the speed of the pump if the mode is in Remote control. If the speed given requires an increase in rotation rate, a ramp is calculated and executed. If the new speed is less than the present rotation rate, the effect is almost immediate.

Where direction ('j' command) and speed ('R' command) are to be used, this 'R' command should precede the 'j'.

See note at end of this document on how to set RPM given tubing type, inside diameter, and desired flowrate.

Command	Mode	Description
R	I	Read Display Return: "dXX.XXca"

Where "d" is the direction status

" " a space if stopped

"+" if CW

"-" if CCW

"XX.XX" is the speed status in rpm

"48.00" at full speed

"c" is the control status

"K" if started through the keypad

"R" if started through the contacts

or set to remote mode through GSIOC

"a" is the autostart condition

"*" if in autostart condition (display flashing)

" " a space if not in autostart

Default return: " 12.50K " when the pump is new.

S B Set the mode

"SK" for Keypad control

"SR" for Remote control

Any other letter following the S is ignored. If the pump has been enabled by the Run signal on its back panel, the pump will ignore this command to change mode. The computer should check the results of this command by issuing the '?' command.

Command	Mode	Description
V	I	Request Analog Input Status Return: "vvv"

Where "vvv" is a 3 digit decimal number ranging from 000 to 255. A response of 255 corresponds to 5V or open circuit.

The last character of the returned message has its high bit set.

Command	Mode	Description
!	B	Set Select Code "!nn"

Where "nn" is the new select code for this instrument. The new code can range from 00 through 63. This command instructs the instrument to immediately change its select code because it will be selected through this new code for all future commands. The pump must be locked for this command to have any effect.

Command	Mode	Description
%	I	Module Identification Return: "RP1V1.x" Identifies the pump as a RP1 pump (Note: Should be V1.9 or larger. If not, call Technical Service, 800-543-4030 for newer chips.)

Command	Mode	Description
j	B	Set Direction "jF" for forward (CW), "jB" for Backwards (CCW)

Sets pump's motor direction. Can be read in 'd' field of ? command. This command has the "side effect" of starting the pump - just as the circular arrow keys do from the front panel. If the pump is stopped, this command will start it rotating at the currently defined rate. If the pump is already rotating in the direction specified by this command, this command has no effect. If the pump is rotating, this command will reverse the pump's direction. The 'R' command, used to set the rotation rate, should precede this command.

Command	Mode	Description
L	B	Lock. Enable Remote Control

Only the Stop key remains active. Pushing it once is enough to generate a "Panic Stop" condition.

Command	Mode	Description
U	B	Unlock. Exit Remote Control

Releases the pump from remote control, returning control to the keyboard.

Command	Mode	Description
?	I	Request Status Return: "ceds"

where

"c" is control status: "K" is for keypad mode, "R" is for remote mode, "X" is External Input Mode (from back panel).

"e" is for Error status. This is normally a blank. If the Stop key is hit, this field becomes 'S'. Once read by this command, it returns to being a blank again.

"d" is direction of rotation: "F" for forward (CW when viewed from above) and "B" for backwards (CCW) This definition does not require the pump to be running.

"s" is "S" for stop (no motion), or "F" for flowing (rotating). This is independent of the panic stop error logic.

Because the command buffer is 40 characters long, a buffered command string can be as long as 39 characters, the last character being the CR (carriage return) ASCII code.

Note: Users want to set flowrates in mL/min while the pump must be controlled in RPM. For the conversion, the computer will need to know the tubing material, inside diameter, and flowrate at some specified RPM. This information is contained in the table below. Note that the conversion factor, RPM per unit flowrate, can be obtained by dividing the MaxRPM (always 48 RPM for this pump) by the "Max" flowrate value listed in the user manual column of that name. For Polyvinyl Chloride (PVC) tubing of inside diameter 0.25 mm, the Max flowrate listed is 0.33 mL/min (this value presumes 48 RPM). The computer will need to form a conversion factor of $48 / 0.33$ or 144 (for this user-specified tubing). When the user's method asks for a flowrate of 0.2 mL/min, for example, the computer will have to calculate an RPM value of 0.2×144 , or 28.8 RPM. The corresponding 'R' command would then appear as 'R2880'.

Mat'l	Tubing Length, (In)	Cat. No.	ID, mm	Max flow at 48rpm (mL/min)	Color Code
PVC	14	39-620	0.25	0.33	Orn/Blue
PVC	14	39-621	0.38	0.66	Orn/Green
PVC	14	39-622	0.50	1.13	Orn/Yel
PVC	14	39-623	0.63	1.6	Orn/White
PVC	14	39-624	0.76	2.2	Black
PVC	14	39-625	1.52	8.3	Yel/Blue
PVC	14	39-626	2.29	17.2	Pur/Blk
PVC	14	39-627	2.8	24.6	Pur/Whit
PVC	14	39-628	3.16	28.2	Blk/White
Silicone	14	39-660	0.25	0.26	Orn/Blue
Silicone	14	39-661	0.38	0.6	Orn/Green
Silicone	14	39-662	0.50	0.95	Orn/Yel
Silicone	14	39-663	0.63	1.5	Orn/White
Silicone	14	39-664	0.76	2.0	Black
Silicone	14	39-665	1.52	7.4	Yel/Blue
Silicone	14	39-666	2.29	15.4	Pur/Blk
Silicone	14	39-667	2.8	20.6	Pur/White
Viton	7	39-640	0.50	0.62	Orn/Yel
Viton	7	39-641	0.63	0.94	Orn/White
Viton	7	39-642	0.76	1.2	Black
Viton	7	39-643	1.42	4.7	Yellow
Viton	7	39-644	2.28	11.8	Pur/Blk
Viton	7	39-645	2.79	15.8	Pur/White

Notes:

LIMITED WARRANTY

SEE THE ENCLOSED LIMITED WARRANTY AND LIMITATIONS OF LIABILITY STATEMENT.

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RAININ website: www.rainin.com

From outside North America: T: +1-510-564-1600
global@rainin.com (from outside the U.S.)

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