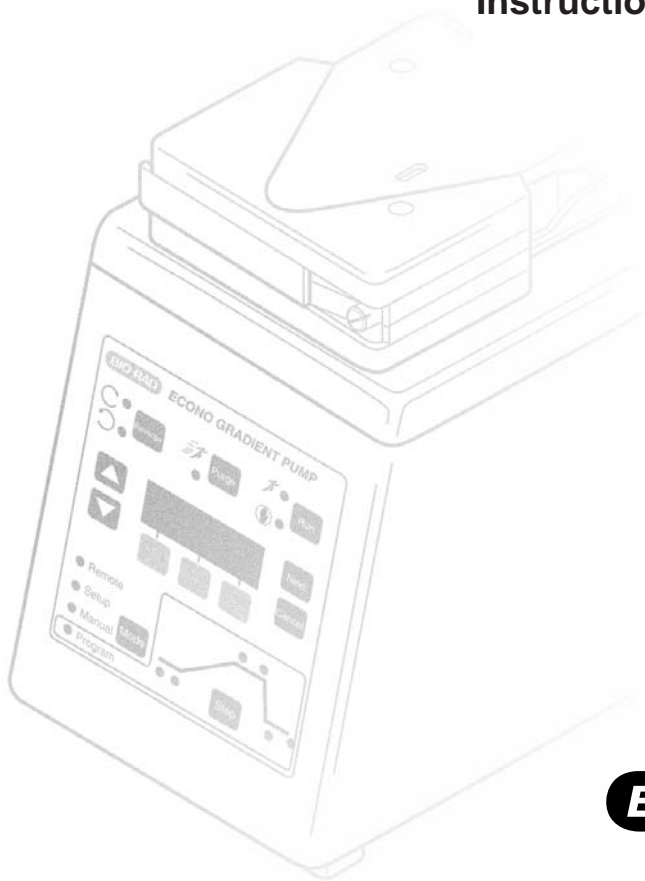




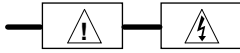
Gradient Monitor • UV Monitor • Fraction Collector • Chart Recorder • Splitter Valve Kit

Econo Gradient Pump Instruction Manual



BIO-RAD

SAFETY



Caution/Warning

Disconnect power to the Econo Gradient Pump before servicing. No user-serviceable parts are inside the unit. Refer servicing to Bio-Rad service personnel.

The Bio-Rad Econo Gradient Pump is certified to meet the I.E.C. 1010-1* standard for safety of laboratory equipment. Certified products are safe to use when operated in accordance with the instruction manual. This safety certification does not extend to other chromatography equipment or accessories not I.E.C. 1010 certified, even when connected to this Bio-Rad Econo Gradient Pump.

This instrument is intended for laboratory use only.

The Bio-Rad Econo Gradient Pump conforms to the “Class A” standards for Electromagnetic Emissions, intended for laboratory equipment applications. It is possible that emissions from this product may interfere with some sensitive appliances when placed nearby or on the same circuit as those appliances. The user should be aware of this potential and take appropriate measures to avoid interference.

This instrument should not be modified or altered in any way. Alteration of this instrument will void the manufacturer’s warranty, void the I.E.C. 1010 certification, and create a potential safety hazard for the user.

Bio-Rad is not responsible for any injury or damage caused by the use of this instrument for purposes other than for which it is intended or by modifications of the instrument not performed by Bio-Rad or an authorized agent.

*I.E.C. 1010 is an internationally accepted electrical safety standard for laboratory instruments.

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1.0 INTRODUCTION

The Econo Gradient Pump (EGP) is a two-channel, bi-directional, variable speed peristaltic pump for low-pressure chromatography and general laboratory use. It offers a full range of features to facilitate ease of use as a stand-alone pump or as a part of the BioLogic Duo-Flow System running software version 3.0 or later..

As a stand-alone pump, the EGP delivers flow rates from 2 $\mu\text{l}/\text{min}$ to 40 ml/min using a single channel of 0.51 mm or dual channels of 3.2 mm ID tubing respectively. The EGP has the ability to self-calibrate the flow rate for 0.51, 0.8, 1.6, and 3.2 mm ID tubing, displaying pump output in ml/min . The pump can be programmed to start or stop Bio-Rad fraction collectors and chart recorders.

A membrane key panel with graphic icon displays allows easy user interface. The EGP will store one program in its non-volatile memory.

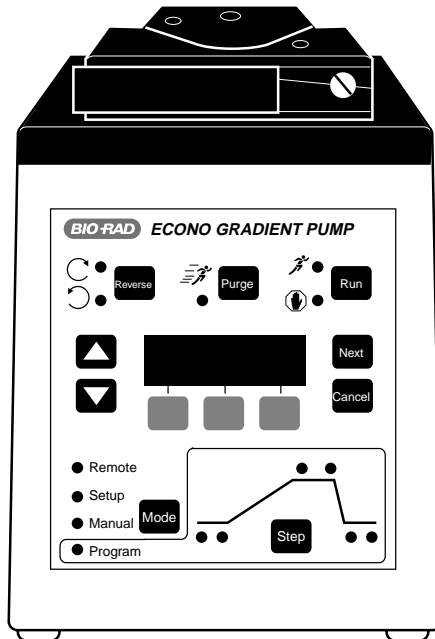


Figure 1-1. Econo Gradient Pump.

2.0 UNPACKING AND SETTING UP

2.1 UNPACKING INSTRUCTIONS

Carefully remove the unit from the shipping box, lifting from the handle on the back of the pump or from the bottom of the instrument. Remove the plastic bag and inspect the instrument for any external damage. Figure 2-1 shows the contents of the box.

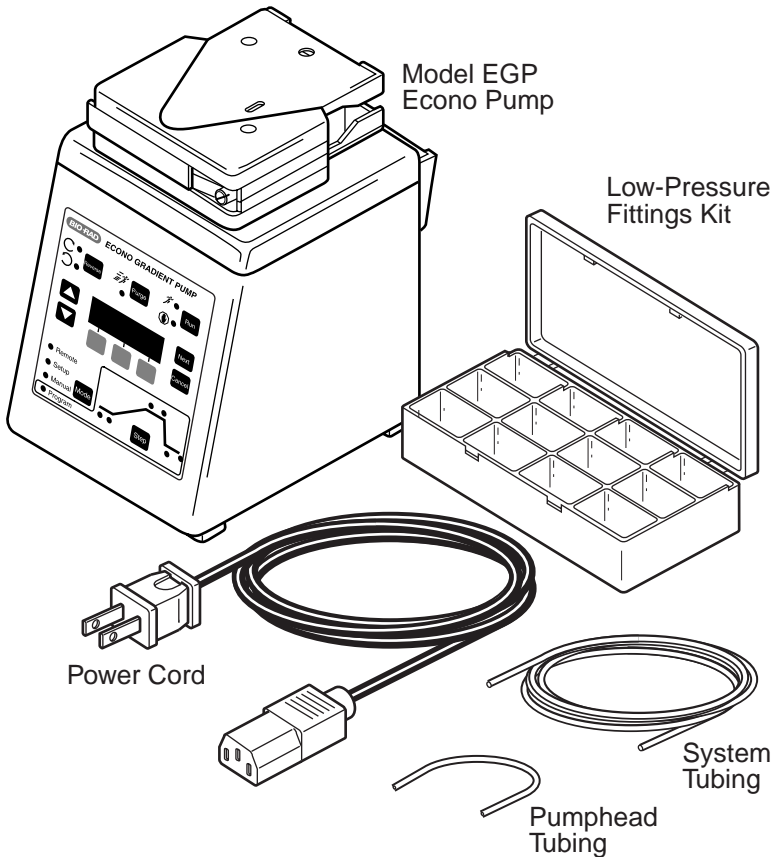


Figure 2-1. Parts supplied with the Econo Gradient Pump.

Your Econo Gradient Pump was carefully tested at the factory and was shipped in good working order. If any part is missing or damaged, contact your local Bio-Rad office immediately.

2.2 VOLTAGE CONVERSION

Warning: The Econo Gradient Pump is shipped in its 100/120 V configuration. To operate at 220/240 V, refer to the procedure in section 7, Cleaning and Maintenance, to make the conversion. Failure to follow this procedure may result in damage to the unit and invalidation of the warranty.

Description

3.0 PHYSICAL DESCRIPTION AND CONTROL FEATURES

3.1 FRONT PANEL FUNCTIONS

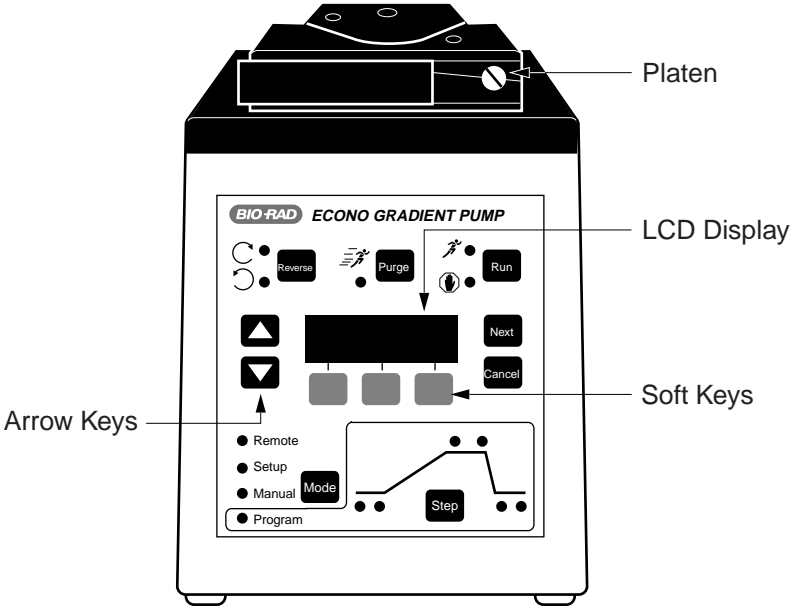






Figure 3-1. Front Panel Controls and Displays.

Front Panel	Function
[LCD; see figure 3-1]	LCD Display <p>This display has two rows of 16 characters. Different windows will appear on this display depending on the requests made by the user. Some windows will display operating parameters, while others will allow entry of variables such as flow rates, valve position and programming steps. Choices are shown in the lower row, above one of the three soft keys. A selection is indicated in uppercase letters.</p>
	Soft Keys <p>These keys are used to select choices displayed on the LCD. A selection is indicated in uppercase letters. Pressing and holding a soft key and an arrow key acts to accelerate the action of the arrow keys.</p>
 	Arrow Keys <p>These keys are used for setting system parameters when programming the system, and for selecting which parameter to display when running the pump. A value input with the arrow key can be erased or accepted with the Cancel and Next keys respectively. Pressing and holding an arrow key will accelerate the action of the arrow keys.</p>
	Next Key <p>Pressing Next will accept any values displayed in the current window and advance to the next window.</p>

Description

Front Panel

Function

Cancel

Cancel Key

Pressing Cancel will clear an entry that has been input with either the arrow or soft keys. If no entry has been made, the previous window will be displayed. This allows passage through the windows in the reverse direction.

Run




Run/Stop Key

This key is used to start or stop the pump in both Manual mode and Program mode operation. The pump will run in the clockwise direction by factory default. The green and red LEDs are illuminated when the Econo Gradient Pump is running or stopped, respectively. The direction can be changed using the Reverse Direction key, when the pump is stopped.

Reverse

Reverse Direction Key

This key changes the direction of pump head rotation. The Econo Gradient Pump must be stopped before the direction can be changed. This key is not operable when the pump is running. The yellow and orange LEDs are illuminated when the pump is running clockwise (CC) and counter-clockwise (CCW), respectively.

Front Panel	Function
	<p>Purge Key</p> <p>This key is used to prime and purge tubing lines without disturbing the primary speed setting of the pump. When Purge is pressed, the pump will run at maximum speed (25 rpm), leaving the connected Gradient Mixer and Aux valve operating and the fraction collector and chart recorder off. The yellow purge LED is illuminated when purging. This key is not operable when the pump is running in Program mode. Purge can be stopped by pressing the Purge or Run keys.</p>
	<p>Mode Key</p> <p>Four different operation modes are available: Remote, Setup, Manual, and Program modes. These modes are described in Section 6, System Operation.</p>
	<p>Step Key and LEDs</p> <p>Up to six program steps can be used. This key selects the active step for programming. The Step LEDs indicate which of the six steps is active.</p>
[Platen; see figure 3-1]	<p>Platen Screw</p> <p>This is the screw on the pumphead assembly. Proper adjustment of the platen pressure increases flow stability, minimizes flow pulsation, and prolongs the life of the tubing. It should be adjusted 3-5 turns, depending on tubing diameter. Refer to section 4.3 for more details.</p>

Description

3.2 REAR PANEL FUNCTIONS

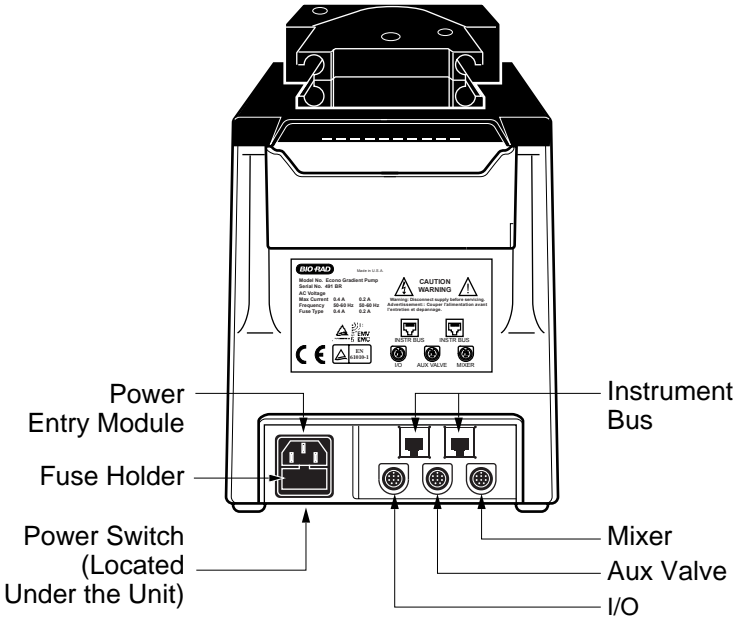


Figure 3-2. Rear panel connectors.

Display

Function



Power Entry Module

Grounded 3-pin receptacle for the power cord. Also contained within is a two-position (100-120 V/220-240 V) fuse holder.



Gradient Mixer Connector

This 8-pin outlet controls the Gradient Mixer used for making binary linear gradients.

Display

Function



Aux Valve Connector

This 8-pin connector controls auxiliary valves such as the optional SV-3 Diverter valve or the optional Splitter valve.



I/O Connector

This 8-pin outlet provides start signals to the Model 1327 Chart Recorder, the Model 2110 Fraction Collector, or the Model 2128 Fraction Collector. Simultaneous control of both the Model 2110 and the Model 1327, or the Model 2128 and the Model 1327, can be accomplished via the 2110-Y cable and the 2128-Y cable respectively. I/O connector pinouts are given in Appendix B. A TTL input is also present which allows the pump to be started remotely.

[base; see figure 3-2]

The underside of the Econo Gradient Pump contains the power switch.

4.0 TUBING SELECTION AND INSTALLATION

4.1 TUBING SELECTION

The Econo Gradient Pump may be used with most flexible tubing having an inner diameter less than or equal to 3.2 mm (1/8"), and a wall thickness of 1.0 mm or less, including Silicone, Tygon, and PharMed. Silicone tubing, the most inert of the three, is suitable for aqueous and polar solutions. Tygon is suitable for most aqueous solutions. It will generally have the shortest lifetime of the three and should not be used for the pumphead. PharMed is the longest lasting of the three, and will provide the most consistent flow rate over time. Figure 4-1 shows approximate flow rate ranges with different tubing sizes. Flow rates above 20 ml/min may be obtained by plumbing two channels of 3.2 mm tubing through the pump and joining them at the output.

Very low flow rates can be achieved with tubing having ID as small as 0.51 mm. Tubing this small must be jacketed inside larger tubing and requires an adapter. These items are included in the optional splitter valve kit.

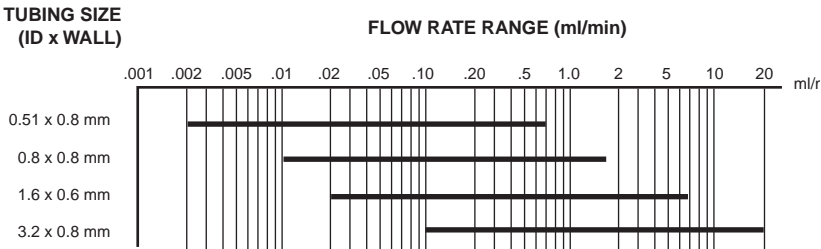


Figure 4-1. Approximate Flow Rate Ranges.

Tubing length and the amount of tubing prestretch have a significant effect on both flow rate calibration and reproducibility of flow. The PharMed tubing supplied with the Econo Gradient Pump has been cut to a predetermined length to accommodate tubing prestretch. (Silicon tubing in precut lengths is also available from Bio-Rad. See ordering information in Appendix D.)

When using tubing other than precut tubing from Bio-Rad, the tubing must be cut to the following lengths to accommodate prestretch:

Tubing	Length
Tygon, PharMed	179 mm +/- 1.5 (7.04" +/- 0.05)
Silicone	171 mm +/- 1.5 (6.75" +/- 0.05)

Install tubing onto the pump head as described in Section 4.2.

Warning: If using tubing other than the type supplied by Bio-Rad, make sure the wall thickness is not greater than 1.0 mm. Using tubing with a greater wall thickness can damage the pump and void your warranty.

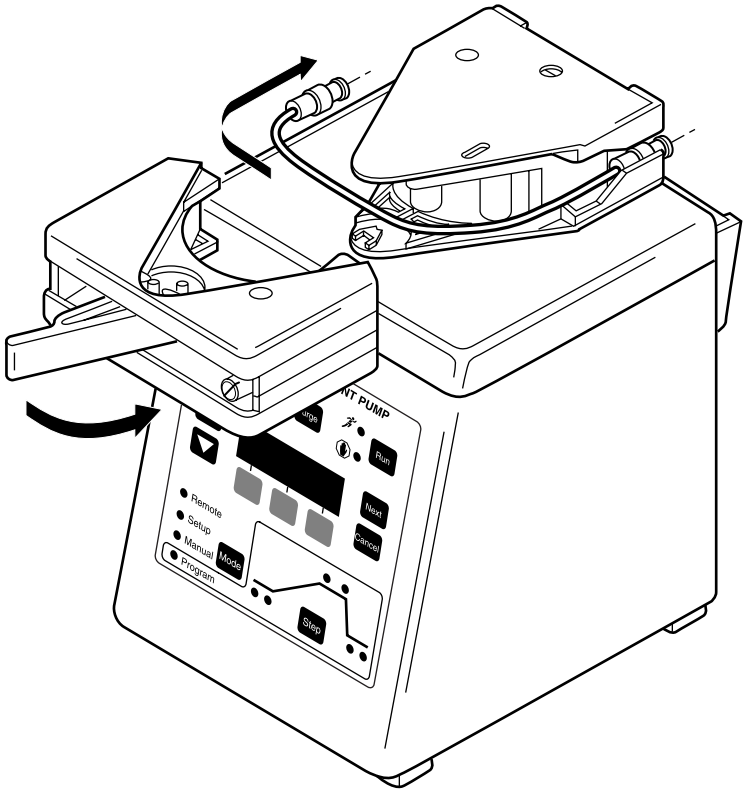


Figure 4-2. Tubing installation.

Tubing Selection

4.2 TUBING INSTALLATION

1. Referring to Figure 4-2, pull the platen cam lever away from the pump head to unlock the platen and slide the platen away from the pump head frame assembly, exposing the rollers.
2. Slip a lock-ring onto one end of the tubing. See below for the size and color of each lock-ring. Insert a barbed female luer fitting into the same end until the tubing reaches the flange of the fitting. Clamp the luer-fitting into place by sliding the lock ring along the tubing over the barbed fitting (see Figure 4-3). Repeat on the other end of tubing.

Note: Use of lock-rings is required only when operating at pressures above 10 psi.

Tubing ID	Lock-Ring Color
0.51 mm (.02")*	None Required
0.8 mm (1/32")	Red
1.6 mm (1/16")	Orange
3.2 mm (1/8")	Yellow

* The 0.51 mm ID tubing is placed inside the 3.2 mm ID tubing, thus no lock-rings are required for the smaller tubing.

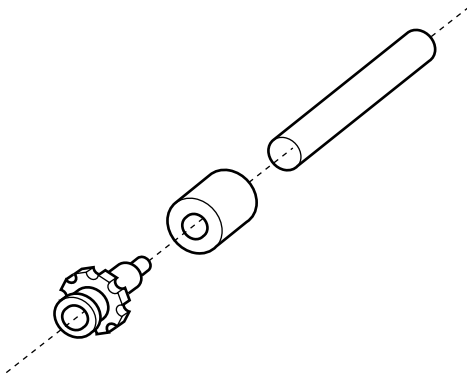


Figure 4-3. Attachment of tubing fittings.

3. Insert one end of the tubing into the tubing retaining bracket of the pump head. Lightly pull the tubing around the rollers to remove slack. Attach the other end of tubing into the tubing retaining bracket on the opposite side of the pump head.
4. Slide the platen back into the pump head frame assembly until it rests up against the tubing. Press the cam lever in toward the pump head, locking the platen up against the tubing and rollers. The platen may be inserted with the cam lever on the left or the right.

4.3 PLATEN ADJUSTMENT

Proper adjustment of the platen pressure increases flow stability, minimizes flow pulsation, and prolongs the life of the tubing.

Once the tubing is installed, completely loosen the platen adjustment screw counterclockwise until the stop is reached. Use the information in the table below to determine the appropriate number of turns that are required.

Overtightening the platen adjustment screw will reduce flow rate and shorten tubing life. If the platen is too loose, flow rate will decrease as backpressure increases. The platen must be adjusted each time pumpehead tubing is replaced.

Tubing ID	Number of Turns from Fully Open
0.8 mm (1/32")	5
1.6 mm (1/16")	4
3.2 mm (1/8")	3

5.0 SYSTEM OPERATION

There are four modes of system operation:

- Remote
- Setup
- Manual
- Program, including running the system

5.1 REMOTE MODE

The Econo Gradient Pump can be connected to the BioLogic Duo-Flow Workstation running software version 3.0 or later with an Instrument bus cable (System cables 17, 18, 19, or 21). When the BioLogic assumes control of the Econo Gradient Pump, the Econo Gradient Pump is automatically set to Remote Mode. In Remote Mode, the Econo Gradient Pump keys provide limited control, allowing only basic observation of Econo Gradient Pump operating parameters.

5.2 SETUP MODE

Each of the pump's features can be customized in Setup mode. While the pump is stopped, plug in the desired valves (i.e., Gradient Mixer, SV-3 Diverter valve, or Splitter valve) into the connectors on back. (Note, these valves must be plugged in before any run requiring them is started.) Then press the **Mode** key until the Setup LED is illuminated. Each of the Setup windows is discussed on the following pages.

Note: When a selection is made, it will be displayed in capital letters.

Screen 1. Flow Rate Selection.

Use the soft keys to select either RPM (revolutions per minute) or ml/m. This information will be used in writing a protocol from the Program mode and in using the Manual mode.

- If RPM is selected, the user may control the pump speed in revolutions per minute (RPM). Pressing **Next** skips to screen 9.
- If ML/M is selected, the user is required to calibrate the pump. This choice enables the user to control the pump speed in ml/m. Pressing **Next** continues to screen 2.

1	Flow rate
RPM	ml/m

Screen 2. Pump Calibration.

The tubing ID is selected here. Calibration can be accomplished by either entering the tubing ID or actually measuring the flow rate.

- If you select “Tube ID” pressing **Next** continues to screen 3.
- If you select “flow” pressing **Next** skips to screen 4.

2	Calibrate by
TUBE ID	flow

Note: Flow rate depends on condition of tubing, platen adjustment, and back pressure. For maximum flow rate accuracy, calibrate the flow rate as the tubing ages or becomes worn, when the tubing is replaced, if the platen is readjusted, or if back pressure changes significantly.

Screen 3. Pump Calibration by Tubing ID.

The tubing ID can be entered here. Use the arrow keys or the center softkey to scroll through the available tubing ID choices. The pump calibration is estimated from this. Enter the tubing ID and press **Next** to accept the value and advance to screen 6.

3	Enter tube ID
	___ mm

System Operation

Screen 4. Pump Calibration by Measured Flow.

Pressing the left or right soft keys will start the pump for the selected time. Collect the pump effluent in a graduated cylinder. During calibration, the pump runs at half speed (12.5 RPM). Typical volumes collected after a 2-minute run are 20 ml, 6.4 ml, 1.7 ml, and 700 μ l for tubing IDs of 3.2 mm, 1.6 mm, 0.8 mm, and 0.51 mm respectively. The volume collected is entered in screen 5.

```
4 Start cal run
2m           20m
```

The time remaining in the calibration run will be displayed as shown below. It is not necessary to run a calibration to completion.

```
Time = _min:  _s
End           ABORT
```

- **End:** Ends volume collection and continues to screen 5, permitting flow rate calibration, before the timer reaches 0 minutes.
- **Abort:** Ends volume collection and returns to screen 1, disallowing flow rate calibration.

Screen 5. Calibrated Volume.

When the calibration run ends, enter the volume of liquid that was collected.

```
5      Volume ?
      _ ml
```

Press **Next** to accept the entered value and advance to screen 6. Press **Cancel** to return to screen 4 and repeat the calibration.

Screen 6. Selecting Units for Programming.

Programming steps can be described in either units of time (in minutes) or volume (in ml).

6 Program Steps
TIME vol

Pressing the left soft key selects time; the right key selects volume. Pressing **Next** advances to screen 8 if a Splitter valve is present or screen 9 if a Splitter valve is not present.

Screen 7 (not displayed). This is available for future upgrades.

Screen 8. Splitter Valve Period Selection.

The Econo Gradient Pump automatically detects the presence of a splitter valve. The default period is 2 seconds. This parameter, in conjunction with the “%-split” parameter, may be varied for stream splitting, process sampling, or on-line biological activity assays. More information is included in the splitter valve instruction manual. If you are uncertain about this value, accept the default of 2 seconds and adjust it later according to your application needs.

8 Split period
— sec

Enter a new value for the split period and press **Next** to advance to screen 9.

System Operation

Screen 9. Biologic System Address Number.

The Econo Gradient Pump can be connected to the BioLogic HR or BioLogic Duo-Flow workstation via an Instrument bus cable (System cables 17, 18, 19, or 21). When connected, the address of the Econo Gradient Pump must correspond to the address recognized by the BioLogic System. This address is only relevant when the Econo Gradient Pump is connected to the BioLogic System. The default address is 1.

9	Address #
	001

Use the arrow keys to enter a new address, and press **Next** to accept and advance to screen 10.

Screen 10. Revolutions Counter.

The performance of the peristaltic tubing degrades with use. This revolution counter provides a measure of wear experienced by the tubing. The relation between revolutions and tube life must be empirically determined because it is dependent on several factors including load, tubing type and platen pressure.

10	Revolutions=
Reset	_____

Pressing the Reset softkey resets the counter back to 0. Pressing **Next** will accept the displayed value and advance to screen 11.

Screen 11. LCD Contrast.

The LCD display contrast is set here.

11	LCD Contrast
	___%

Use the arrow keys to enter the desired contrast and press **Next** to advance to screen 12.

Screen 12. Beeper.

The beeper can be switched on or off at the user's discretion. The beeper, which beeps on each key press, can be disabled.

```
12      Beeper
ON      off
```

Using the soft keys, select the desired option and press **Next** to accept and advance to screen 13.

Screen 13. Erase Program Option.

The Econo Gradient Pump will store one program in its non-volatile memory. The program stored in the Program mode can be erased by selecting the "yes" option. This is useful for writing a new protocol. Pressing **Next** will erase the program if "yes" has been selected.

```
13 Erase Program
yes      NO
```

Screen 14. Selecting a Fraction Collector.

Three choices are available: NONE, 2110, and 2128 Fraction Collectors. The choices are selected using the arrow keys. These are operated by the pump only when they are connected to the pump's I/O port. Press **Next** to proceed to the last setup screen.

```
14 Fraction
collector: NONE
```

Final Setup Screen.

The final Setup screen allows you to exit setup by pressing the **Mode** key. Alternatively, the **Mode** key may be pressed to exit Setup at any of the preceding screens.

```
Press MODE to
exit Setup
```

System Operation

5.3 MANUAL MODE

The Econo Gradient Pump and attached devices can be controlled using the pump's front panel membrane keys and LCD display while in Manual mode. Press the **Mode** key until the Manual LED is illuminated. Up to three parameters (depending on how many optional devices are connected to the Econo Gradient Pump) can be controlled. Choose a field on the LCD by pressing the corresponding soft key. The selected parameter can be adjusted using the arrow keys. Pressing the Up arrow key will raise the value of the parameter, pressing the Down arrow key will lower the value. Pressing and holding a soft key acts to accelerate the action of the arrow keys.

5.3.1 Setting Flow Rate or Motor Speed

Either RPM or ml/min will be displayed, depending on the setting in Setup, screen 1. Flow rate or motor speed is selected by pressing the left soft key. The speed is adjusted by depressing the arrow keys. If neither a Gradient Mixer nor an auxiliary valve are connected, the LCD looks like this:

RPM Selected

RPM 3.45

Flow Rate Selected

ml/m 6.40

5.3.2 Setting Buffer Gradient

Buffer gradient (%B) is selected by pressing the center soft key. This option is only available if the Gradient Mixer is connected to the pump's Mixer connector. The percent of the gradient is adjusted using the arrow keys. Pressing and holding a softkey acts to accelerate the action of the arrow keys.

ml/m	%B
3.45	0

5.3.3 Setting Auxiliary (SV-3 or Splitter) Valve Control

Control for an auxiliary valve is selected by pressing the right soft key. This option is available if a valve is connected to the Auxiliary port on back of the Econo Gradient Pump. The valve type is automatically recognized. The SV-3 diverter valve must be connected if you wish to program a collection window with either the model 2110 or 2128 Fraction collector. With an auxiliary valve and Gradient Mixer attached, the LCD display would look like this:

with Mixer and Diverter valve

ml/m	%B	Divert
3.45	100	WASTE

with Mixer and Splitter valve

ml/m	%B	Split
3.45	100	100%

5.4 PROGRAM MODE

The Econo Gradient Pump can be programmed to perform up to six sequential steps automatically. Selections made in the Setup screen will be reflected in the Program screen. The Program screen will display the program step (either time or volume), the %B if a Gradient Mixer is present, and the flow rate/motor speed (RPM.) For the first program step, the time (or volume) parameter is -0- and is not editable. Here is an example of a Program screen where volume and flow rate have been selected in Setup and a Gradient Mixer is connected.

ml	%B	ml/m
-0-	15	5.0

System Operation

Each field may be selected with the corresponding soft key. The arrow keys are then used to increment or decrement the value. Pressing the **Step** key or the **Next** key will accept the displayed values and advance to the next step. The program end occurs when either 6 steps have been entered, or two identical steps (pressing **Step** twice) are entered sequentially.

If an auxiliary valve is present, a screen will appear after programming is completed.

If an SV-3 diverter valve is connected, then a fraction collection window will appear. The units will be either in minutes (m) or volume (ml.)

from COLLECT to
2m 10m

In this example, the valve will be in the DIVERT position from $t = 2\text{min}$ to $t = 10\text{min}$, diverting the eluant stream to the fraction collector. All other times, it will be in the WASTE position, diverting the eluant stream to waste. Fraction collection size is programmed directly at the fraction collector faceplate.

If a splitter valve is connected, then a split per cent window appears

splitter
25%

In this example, 25% of the eluant stream is split into another receptacle such as a microplate or secondary fraction collector.

Pressing the **Step** key scrolls through each step, illuminating the LED for that step and allowing the user to observe and edit the program. At the AUX Valve screen, LEDs for all the programmed steps are illuminated. The program may be deleted using the ERASE function in Setup mode.

5.5 RUNNING A PROGRAM

To start a program (be sure to enter the Program mode by using the **Mode** key), press the **Run** key. This will start the run. By using the right soft key, the Run screen can show time elapsed or time remaining on the run. If program steps are in volume, elapsed or remaining volume will also be displayed.

Time elapsed

__m:	__s
__ml	elapsed

Time remaining

__mm:	__s
__ml	left

Pressing the **Next** key will show the current gradient conditions:

with Mixer and Diverter valve

ml/m	%B	Divert
------	----	--------

with Mixer and Splitter valve

ml/m	%B	Split
------	----	-------

If the program is allowed to finish normally, the Econo Gradient Pump beeps and displays the following screen:

Program Finished

Pressing any key will put the Econo Gradient Pump into Manual mode.

The run may be interrupted by pressing the **Next** key twice. Doing so brings up the following screen:

Hold Pause Abort

System Operation

5.5.1 Holding a Run

Pressing the **Hold** key displays the following screen:

Holding	___%B
CONTINUE	Abort

When holding, the pump runs indefinitely at the current programmed conditions. Selecting **Continue** will continue the run. Selecting **Abort** will stop the run, leaving the pump in Program mode, and indicate, by the Step LED, which step was running at the time Abort was pressed.

5.5.2 Pausing a Run

Pausing a run stops the pump and displays the following screen:

Paused ...
Continue Abort

Selecting **Continue** will continue the run. Selecting **Abort** will stop the run leaving the pump in Program mode and indicating, by the Step LED, which step was running at the time. Press any key to return to the Manual mode.

5.5.3 Aborting a Run

Aborting a run displays the following screen:

Program Aborted

The run is stopped, and the pump remains in Program mode and indicates, by the Step LED, which step was running at the time. Press any key to return to the Manual mode.

5.5.4 Power Failure While in Run Mode

In the event of a power failure while a Program is running, the LCD display will indicate:

Power Failure!
CONTINUE stop

If **Stop** is selected, the program that was running is aborted. Pressing any key on the front panel will display the Manual mode. If Continue is selected, the program that was running is resumed at the point where the power failure occurred.

6.0 OPERATION WITH OTHER BIO-RAD INSTRUMENTS

The Econo Gradient Pump (EGP) may be used with other chromatography components (the Model 2110 or Model 2128 fraction collectors and the Model 1327 Chart recorder), and with the BioLogic Duo-Flow System running software version 3.0 or later, the high resolution liquid chromatography systems. Each of these connections is discussed in the following table. Refer also to Figure 6-1 for system cabling and to Figure 6-2 for system plumbing.

Table 6-1. Connecting the Econo Gradient Pump to other Bio-Rad instruments

Model 2128 Fraction Collector

Cable #23	1. This cable connects the EGP (mini-DIN I/O socket) to the 15-pin D-connector on the fraction collector and transmits “start” and “stop” signals.
Catalog # 731-9009	If the Model 1327 Chart Recorder is present, connect the cable’s remaining end to the chart recorder. If the chart recorder is not present, then place this portion of the cable aside.
	2. Power up the EGP and the fraction collector (and the chart recorder, if present.)
	3. Enter the fraction collector’s Standard mode and set all fraction collector parameters from its faceplate.
	The EGP will automatically start the fraction collector when a programmed run is started. If the SV-3 diverter valve is connected to the EGP, then fraction collection will begin at the point in the program when the diverter valve is in the DIVERT position.

Model 2128 Fraction Collector (continued)

Alternatively, one may use the Model 2128 Diverter Valve; it will respond to the program in the Model 2128 Fraction Collector itself, not from the EGP.

If **HOLD** is selected during the program, then the pump will continue pumping at the current conditions and fraction collection will continue as programmed.

If **PAUSE** is selected during the program, then the pump and fraction collector will stop.

The pump and fraction collector will resume when **CONTINUE** is selected.

Model 2110 Fraction Collector

Cable #22

1. This cable connects the EGP (mini-DIN I/O socket) to the 9-pin D-connector on the Model 2110 Fraction Collector and transmits “start” and “stop” signals.

Catalog #
731-9010

If the Model 1327 Chart Recorder is present, connect the cable’s remaining end to the chart recorder. If the chart recorder is not present, then place this portion of the cable aside.

2. Power up the EGP and the fraction collector (and the chart recorder, if present.)
3. Select collection by time or by drops by pressing the Time/Drop key on the fraction collector’s faceplate.

When the EGP is running in Manual mode, the 2110 fraction collector will not start automatically. It may be started from its own faceplate if fraction collection is required.

Model 2110 Fraction Collector (continued)

When a programmed run is started, the EGP will automatically start the fraction collector. If the SV-3 diverter valve is connected to the EGP, then fraction collection will begin at the point in the program when the diverter valve is in the FRAC position.

If **HOLD** is selected during the program, then the pump will continue pumping at the current conditions and fraction collection will continue as programmed.

If **PAUSE** is selected during the program, then the pump and fraction collector will stop.

The pump and fraction collector will resume when **CONTINUE** is selected.

Model 1327 Chart Recorder

Either
Cable #22
(Catalog #
731-9010)
or
Cable #23
(Catalog #
731-9009)

As described above, these cables connect fraction collectors and the Model 1327 Chart Recorder to the EGP. The fraction collector part of the cable should be put aside if a fraction collector is not present. The EGP will automatically start and stop the chart recorder. The parameters should be set at the chart recorder itself.

If a fraction collector is present, then the fraction collector marks are superimposed on the UV trace directly.

If **HOLD** is selected during the program, then the pump will continue pumping at the current conditions and the chart recorder will continue recording.

Model 1327 Chart Recorder (continued)

If **PAUSE** is selected during the program, then the pump and chart recorder will stop.

The pump and chart recorder will resume when **CONTINUE** is selected.

Model EM-1 UV Monitor

None	A connection is not required between the pump and the EM-1 UV Monitor. To record UV data onto the Model 1327 Chart Recorder, use cable #4, 8-pin mini-DIN to banana plug cable. It is supplied with the UV Monitor. The banana plugs plug into Channel 1 of the chart recorder. The UV trace will be displayed by the blue pen.
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Model EG-1 Gradient Monitor

None	A connection is not required between the pump and the EG-1 Gradient Monitor. To record the gradient data onto the Model 1327 Chart Recorder, use cable #4, 8-pin mini-DIN to banana plug cable. It is supplied with the Gradient Monitor. The banana plugs plug into Channel 2 of the chart recorder. The gradient trace will be displayed by the red pen.
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Other Instruments

BioLogic Duo-Flow System

One of these four System (bus) Cables: The EGP can be controlled by the BioLogic Duo-Flow System provided that the BioLogic System firmware is version 3.0 or higher.

Cable #17
4-ft (1.2m)
(Catalog #
750-0650) Connect the EGP to the Duo-Flow Workstation using a bus cable of the appropriate length.

The EGP may be used either as a user-defined device or specifically as a sample loading pump.

Cable #18
12-ft (3.7m)
(Catalog #
750-0651)

Cable #19
30-ft (9.2m)
(Catalog #
750-0652)

Cable #21
100-ft (30m)
(Catalog #
750-0655)

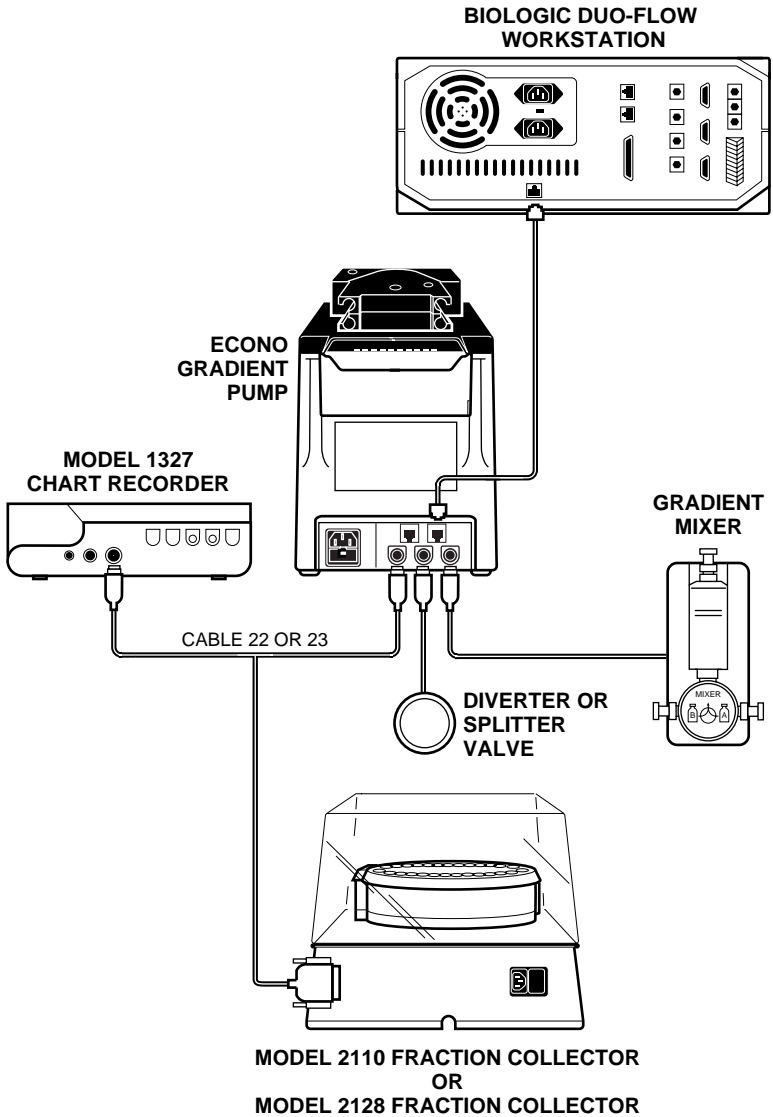


Figure 6-1. System Cabling.

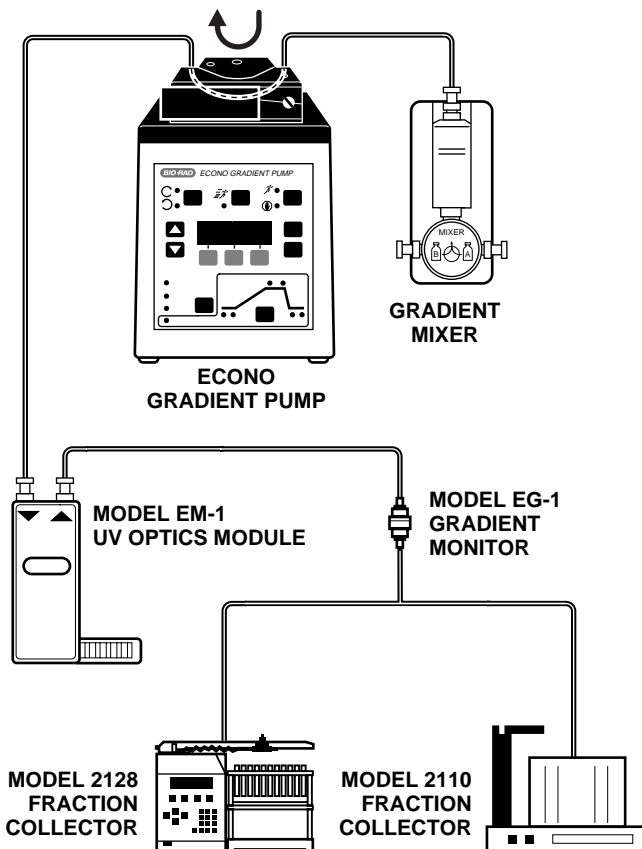


Figure 6-2. System Plumbing.

7.0 CLEANING AND MAINTENANCE

The Econo Gradient Pump requires very little maintenance to assure reliable operation. The procedures outlined below will insure maximum pump life:

- Check tubing regularly for signs of cracking and wear. If any exist, replace the tubing.
- For optimal tubing life, use a slow to medium pump speed. To increase throughput, increase tubing size to obtain the desired output.
- When not in use, tubing should be removed from the pump to prevent deformation of the tubing. Remove the platen and relax the tubing by unhooking one end of the tubing from the tubing bracket.
- To prevent the formation of precipitates around the pump head and on the membrane key panel, promptly remove any spills. Clean with deionized water.
- If an auxiliary valve or the Gradient Mixer is used, rinse it with deionized water after each use. Store them in 20% EtOH for long-term storage. Do not expose the valves to pressures greater than 20psi.
- If using the pump at 4°C, leave the pump on (not necessarily running) to mitigate condensation within the pump.

7.1 Fuse Replacement and Voltage Conversion

To replace a fuse, see Figure 7-1 and follow these steps:

1. Disconnect the power cord from the unit.
2. Remove the fuse drawer with a small-blade screwdriver or similar tool.
3. Pull the fuse holder out of the fuse drawer and replace the fuses with ones having the correct current rating. Use 0.40 A slow-blow fuses for 100/120 V operation; 0.20 A slow-blow fuses for 220/240 V operation. The 0.20A fuses are packaged in a plastic bag and taped to the exterior of the pump.

Maintenance

4. The fuse socket in the fuse drawer is removable. Turn the socket such that the correct voltage shows through the window.
5. Reinsert the fuse drawer into the power entry module, with the locking tab to the left. Press gently until it snaps into place.
6. Insert the power cord plug into the power entry module. Plug the power cord into a properly grounded outlet.

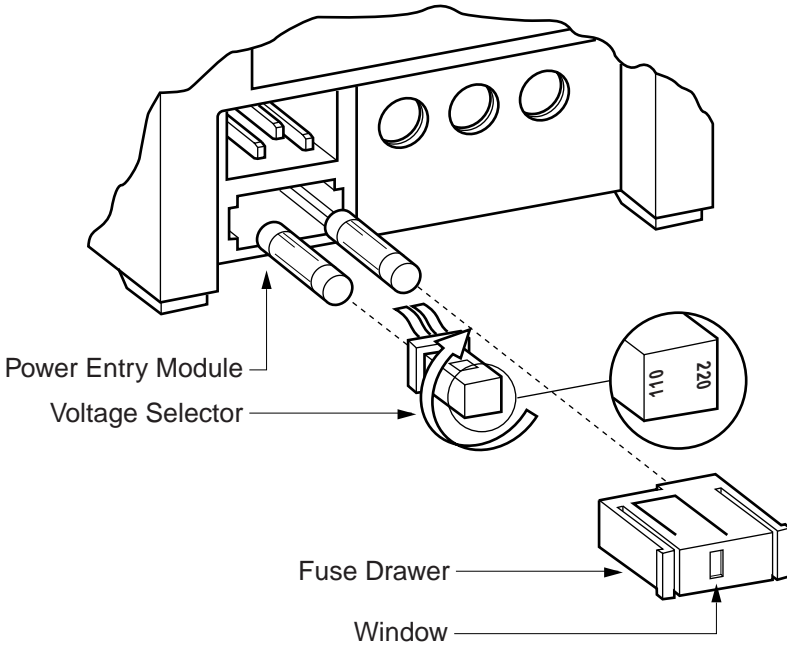


Figure 7-1. Fuse Replacement and Voltage Conversion.

8.0 TROUBLESHOOTING

Problem	Possible Cause	Solution
Pump displays "Power Failure!"	Power outage	If you wish to continue a run in progress, press the Continue soft key. The LCD will display the program at the time of the power failure. Pressing the Stop soft key will display the message "Program Aborted". You may now operate the pump as normal.
Pump will not run	No power (no LEDs lit)	Verify that power cord is plugged in and the power switch is turned on.
	Fuses	Check that proper fuses are installed and intact. Insure that the calibration indicator light is not flashing. For pump to run, this light must either be off or steadily lit.
	Mode	Econo Gradient Pump must be in either Manual or Program mode to start.
Liquid remains stationary in tubing	Platen not adjusted	Adjust the platen by turning it counter clockwise until it is completely loosened, then rotate three to five full turns clockwise. See section 4.3, Platen Adjustment.
	Clogged tubing, valves, or fittings	Check tubing, fittings, and valves for obstructions.
	Damaged tubing	Check pump tubing. Replace damaged tubing.

Troubleshooting

Problem	Possible Cause	Solution
Flow rate not consistent	Pump tubing damaged or worn out	Replace tubing.
	Platen adjustment incorrect	Adjust the platen by turning it counter clockwise until it is completely loosened, then rotate three to five full turns clockwise. See section 4.3, Platen Adjustment.
	Wrong tubing size selected	Refer to Figure 4-1 for selection criteria. Select proper ID tubing within Setup.
	Large change in back pressure or fluid viscosity	Re-calibrate flow within Setup.
	Restriction on inlet side	Detach the inlet tubing and Gradient Mixer. Rinse with deionized water.
Excessive wear on tubing	Platen too tight	Adjust the platen by turning it counter clockwise until it is completely loosened, then rotate three to five full turns clockwise. See section 4.3, Platen Adjustment.

Problem	Possible Cause	Solution
Cannot calibrate pump	Pump must be stopped in order to calibrate pump	Insure that pump is stopped.
	RPM has been selected	Select Flow Rate in screen 1 of Setup.
Valves do not respond or actuate	Pump is off	Turn on the pump.
	Valve cabled to wrong connector	Mixer and/or Aux valve must be plugged in to its correct socket.
Chart recorder or fraction collector does not respond	Pump is off	Turn on the pump.
	Valve cabled to wrong connector	Chart recorder or fraction collector must be plugged in to its correct connector.
	Wrong fraction collector specified in setup	Setup screen 14 allows choice of a Model 2110, 2128 or none. Select the appropriate choice.
The proper valves do not appear on the display	Valves plugged into wrong port.	See section 3.2 to plug valves into the correct port.
EGP program starts unexpectedly	Wrong device plugged into I/O port	Ensure that only the fraction collector or chart recorder is plugged into the I/O port. Ensure that pin #3 is not shorted.

9.0 EMBEDDED FUNCTIONS

During a technical service call, you may be asked to perform tasks which require you to press combinations of keys. These tasks are defined below.

9.1 FIRMWARE CONFIRMATION

To check the version of firmware installed in the Econo Gradient Pump, power up the Econo Gradient Pump. During power up, the firmware version is displayed. The checksum (CS) is also displayed.

9.2 RESET

To initiate a reset, press all three soft keys simultaneously and hold for 3 seconds. This will reset all stored values to the factory defaults.

APPENDIX A TECHNICAL SPECIFICATIONS

Number of channels	2
Flow rate range (per channel)	0.002 - 20 ml/min (depending on tubing diameter)
Pump head speed	0.05 to 25 rpm maximum
Tubing diameter	0.19 mm ID to 3.2 mm ID; maximum 1 mm wall thickness
Speed adjustment increment	0.01 RPM
Speed stability	0.2% at 10 RPM
Speed accuracy	0.1% at 10 RPM
Maximum counterpressure	30 psi (2 kg/cm ² or bars)
Motor	DC speed controlled, 25 watts
Line voltage	90-132 VAC 180-264 VAC 47-63 Hz
Dimensions	143 x 202 x 222 mm (W x D x H) with pumphead
Weight	3.5 kg
Operating temperature	4 to 40 °C
Material of construction	polypropylene and other solvent resistant plastics
Regulatory Compliance	TÜV: EN61010-1:1993 CE: EN55011:1991 Class A EN50082-2:1997 EN50081-2:1994 ENV50204:1995

Specifications

Gradient Mixer

Range 0-100% B

Increment 1% B

Valve control

SV-3 Diverter Valve Waste and divert positions.

Splitter Valve 0-100%

Fraction Collectors

Model 2110 Run, hold, pause, stop

Model 2118 Run, hold, pause, stop

Chart Recorder

Model 1327 Dual pen recorder, paper feed
start/stop, pen up/down

APPENDIX B

CONNECTION TO OTHER INSTRUMENTS

The I/O connector on the rear panel of the pump is for the operation of the fraction collectors and chart recorder (see Figure 3-2). Output signals are TTL compatible. To use these signals for non-Bio-Rad devices, you must insure that the circuit external to the Econo Gradient Pump does not draw more than 15 milliamperes of current. The following table describes the rear panel mini-DIN connector pinouts for this I/O connector.

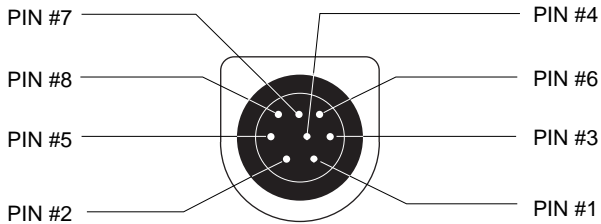


Table B-1. I/O mini-DIN Connector Pinouts

Pin#	Name	Selected Fraction Collector		
		None	2110	2128
1	PS	held HIGH starts 1327	held HIGH starts 1327	held HIGH starts 1327
2	RUN	---	2.5 s LOW PULSE resets 2110	held LOW starts 2128
3	FCNTRL1	held LOW starts EGP program	held LOW starts EGP program	held LOW starts EGP program
4	START	---	120 ms LOW PULSE toggles between start and stop	held LOW starts 2128

Other Instruments

Pin#	Name	Selected Fraction Collector		
		None	2110	2128
5		no contact	no contact	no contact
6	ER/PD	held LOW starts 1327	held LOW starts 1327	held LOW starts 1327
7	Ground	Signal Ground	Signal Ground	Signal Ground
8		no contact	no contact	no contact

APPENDIX C WARRANTY

The Econo Gradient Pump is warranted for one year against defects in materials and workmanship. If any defects should occur during this warranty period, Bio-Rad will replace the defective parts without charge. However, the following defects are specifically excluded:

1. Defects caused by improper operation.
2. Repair or modification done by anyone other than Bio-Rad Laboratories or their authorized agent.
3. Use with tubings or fittings not specified by Bio-Rad Laboratories for use with this pump.
4. Deliberate or accidental misuse.
5. Damage caused by disaster.
6. Damage due to use of improper solvent or sample.

This warranty does not apply to tubing, fittings, and fuses.

For inquiry or request for repair service, contact Bio-Rad Laboratories after confirming the model and serial number of your instrument.

For Technical Service Call Your Local Bio-Rad Office or in the U.S. Call 1-800-4BIORAD (1-800-424-6723).

APPENDIX D ORDERING INFORMATION

Catalog Number	Product Description
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Econo Gradient Pump

731-9001	Econo Gradient Pump 100/120 V
731-9002	Econo Gradient Pump 220/240 V
731-9004	Econo Gradient Pump Rack and Column Clamp Set
731-9005	EGP Column Clamp Set, replacement
731-8322	Model SV-3 Diverter Valve
731-8323	Gradient Mixer
731-8320	Sample Injection Valve
731-9011	Splitter Valve Kit
731-9012	Model SPL3-2 Splitter Valve
731-9013	Splitter Valve Tygon Sleeve Assembly
731-9014	Splitter Valve PEEK Adapter Assembly
731-9015	Splitter Valve Flow Dampner Assembly
731-9008	Econo Gradient Pump Instruction Manual
731-8160	Model EM-1 Econo UV Monitor, 110/120 V, includes control module, optics module, filters for 280 and 254 nm wavelengths, System Cable 4, fittings starter kit.
731-8162	Model EM-1 Econo UV Monitor, 220/240 V.
731-8151	Model EG-1 Econo Gradient Monitor, includes 100/120V (USA) power adaptor, flow cell, System Cable 4.
731-8150	Model EG-1 Econo Gradient Monitor, without power adaptor, includes flow cell, System Cable 4.
100-1908	Fuses for 100Volt operation, quantity 2. Specifications are 0.4A, 250V, 5x20mm, Type T (Time-Lag), I ² T=2.4A ² s.
100-1909	Fuses for 220Volt operation, quantity 2. Specifications are 0.2A, 250V, 5x20mm, Type T (Time-Lag), I ² T=0.3A ² s.

Catalog Number	Product Description
Tubing and Accessories	
731-8210	Silicone Tubing, 0.8 mm ID, 0.8 mm wall, 10 m
731-8211	Silicone Tubing, 1.6 mm ID, 0.8 mm wall, 10 m
731-8212	Silicone Tubing, 3.2 mm ID, 0.8 mm wall, 10 m
731-8213	Tygon tubing, 0.51 mm ID, 0.8 mm wall, 10 m
731-8214	Tygon Tubing, 0.8 mm ID, 0.8 mm wall, 10 m
731-8215	Tygon Tubing, 1.6 mm ID, 0.8 mm wall, 10 m
731-8207	PharMed Tubing, 0.8 mm ID, 1.0 mm wall, 10 m
731-8208	PharMed Tubing, 1.6 mm ID, 1.0 mm wall, 10 m
731-8209	PharMed Tubing, 3.2 mm ID, 1.0 mm wall, 10 m
731-9007	Peristaltic Pumphead Tubing, includes two precut lengths each of PharMed tubing, 0.8, 1.6, and 3.2 mm ID.
731-8240	Silicone Tubing Kit, 0.8 mm ID, 20 precut lengths and 4 sets of fittings.
731-8241	Silicone Tubing Kit, 1.6 mm ID, 20 precut lengths and 4 sets of fittings.
731-8242	Silicone Tubing Kit, 3.2 mm ID, 20 precut lengths and 4 sets of fittings.
731-8247	PharMed Tubing Kit, 0.8 mm ID, 20 precut lengths and 4 sets of fittings.
731-8248	PharMed Tubing Kit, 1.6 mm ID, 20 precut lengths and 4 sets of fittings.
731-8249	PharMed Tubing Kit, 3.2 mm ID, 20 precut lengths and 4 sets of fittings.
731-8220	Low Pressure Fittings Kit, includes over 250 male and female luer connectors, 2- and 3-way stopcocks, and tubing connectors.

PharMed and Tygon are the registered trademarks of the Norton Company.

Ordering Information

Catalog Number	Product Description
731-9006	Low Pressure, Small Fittings Kit. Contains a subset of the fittings found in catalog # 731-8220, including barb-to-female and male luer for 0.8, 1.6, and 3.2 mm tubing, slip fittings, and both female and male luer plugs.

Cables

731-8264	System Cable 4, 8-pin mini-DIN to banana cable. To connect Econo UV Monitor or Econo Gradient Monitor to the Model 1327 Chart Recorder.
731-9009	System Cable 23, Y-cable. To connect both a Model 2128 Fraction Collector and Model 1327 Chart Recorder to the Econo Gradient Pump.
731-9010	System Cable 22, Y-cable. To connect both a Model 2110 Fraction Collector and Model 1327 Chart Recorder to the Econo Gradient Pump.
750-0650	System Cable 17 (bus cable), 4 feet (1.2 m)
750-0651	System Cable 18 (bus cable), 12 feet (3.7 m)
750-0652	System Cable 19 (bus cable), 30 feet (9.2 m)
750-0655	System Cable 21 (bus cable), 100 feet (30 m)

Model 2110 Fraction Collector

731-8122	Model 2110 Fraction Collector, 100/120 V
731-8120	Model 2110 Fraction Collector, 220/240 V

Model 2128 Fraction Collector

731-8123	Model 2128 Fraction Collector, 100/120 V
731-8124	Model 2128 Fraction Collector, 220/240 V

Bio-Rad sells a complete line of integrated chromatography systems for protein purification. For more information on the BioLogic System family of products, contact your local Bio-Rad representative.

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The Netherlands 0318-540666 **New Zealand** 64-9-4152280 **Norway** 47-23-38-41-30
Russia 7 095 979 98 00 **Singapore** 65-2729877 **Spain** 34-91-590-5200
Sweden 46 (0)8-55 51 27 00 **Switzerland** 061-717-9555 **United Kingdom** 0800-181134

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