

IEM

model 660
solvent programmer
operating manual



Waters, The Liquid Chromatography People

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Figure 1-1. Model 660 Solvent Programmer

SECTION 1.
GENERAL INFORMATION

1.1 INTRODUCTION

1.1.1 PURPOSE OF MANUAL

This manual provides the user with the instructions necessary to understand and operate the Model 660 Solvent Programmer (Figure 1-1) referred to as the M660. For specific information about the other instruments that make up the system (not contained in this manual), refer to the appropriate Waters Associates instruction manual.

1.2 FEATURES OF THE M660

The M660 is a special-purpose electronic analog computer designed to control the flow rate of one or two Series 6000 Solvent Delivery Systems (referred to as the Series 6000 pumps). The following are the standard features of the M660.

- ELEVEN PROGRAMS Consisting of two STEP Programs for instantaneously changing the solvent composition at the beginning or end of the program, 1 LINEAR Program, 4 CONCAVE Programs, and 4 CONVEX Programs.
- THREE OPERATIONAL MODES Gradient Elution (solvent programming) - Uses two Series 6000 pumps.
- Flow Programming - Uses one Series 6000 pump.
- Dial-A-Mix Solvent Composition (for Scouting) - Uses two Series 6000 pumps.
- DIRECT PROGRAM TRACE ON CHROMATOGRAM Superimposes a permanent record of solvent composition or flow rate on the chromatogram for convenient interpretation and data retrieval.
- CONTINUOUS DISPLAY OF CHROMATOGRAM Meter displays solvent composition or flow rate during course of program.
- CONTINUOUS ELAPSED TIME DISPLAY Meter indicates extent of program completed continuously.

INITIAL AND FINAL CONDITION

INDICATOR LIGHTS Immediate indication of program status provided by pre-program or post-program lights or absence of lights during a program.

CONVENIENT CONTROL LOCATIONS All operator controls are located on the front panel.

SEAMLESS HOUSING The M660 is housed in a fluoro-carbon polymer-coated seamless aluminum casting.

FOUR DIGITAL INPUT CONTROLS Programs the M660 for Initial Conditions, Final Conditions, Length of Gradient Run, and Total Flow Rate of the Pump(s).

1.3 FUNCTIONAL DESCRIPTION

Figures 1-2 and 1-3 illustrate the two types of programming the M660 can perform. When the M660 is operated as a solvent programmer (Figure 1-2) two Series 6000 pumps are used as follows: Pump 'A' operates at a flow rate which is the difference between the total flow setting and the flow rate of pump 'B'. The solvents from pump 'A' and pump 'B' are combined in the manifold and then mixed in the flow-through high-pressure filter. The result is a solvent mixture having a constant flow rate and variable composition. The flow from

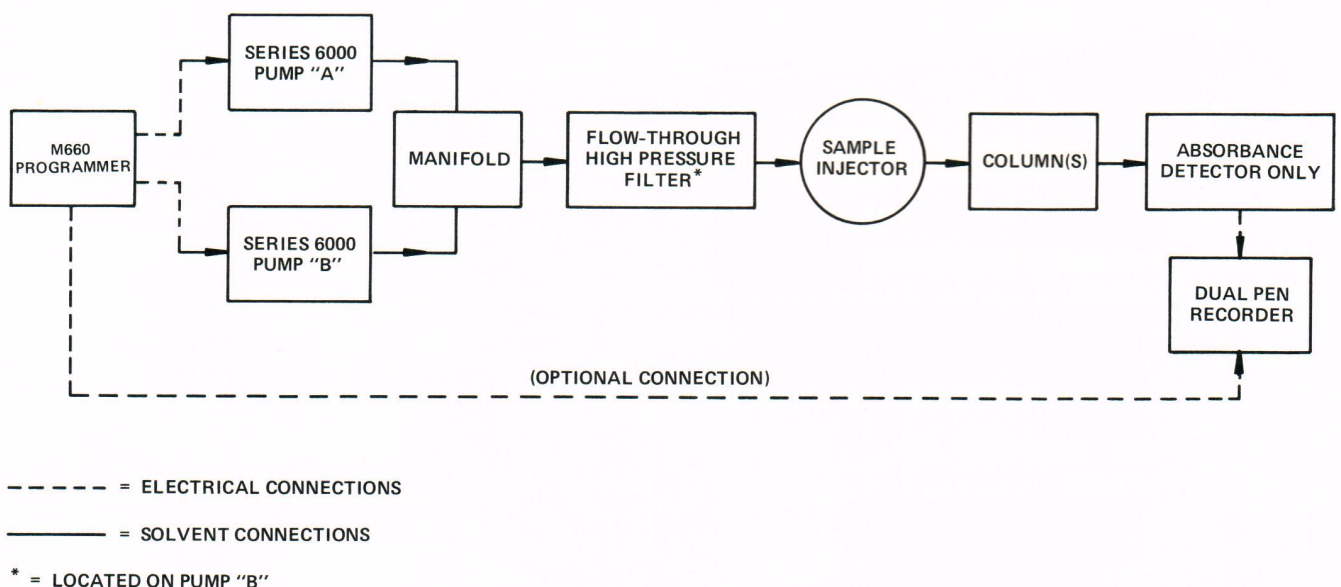


Figure 1-2. Solvent Programming Block Diagram

the high-pressure filter passes through the injector, column(s), and absorbance detector. A chart recorder is used to record the output of the detector, as well as to record the solvent composition curve from the M660.

When operated as a flow programmer (Figure 1-3) the flow of a single Series 6000 pump can be started from any flow value and made to follow any of the eleven programmed curves to a preselected final flow value. The total time for the program can be set from one minute to nine hours and fifty-nine minutes. The flow from the Series 6000 pump passes through the injector, column(s), and absorbance detector and/or refractive index detector. A chart recorder is used to record the output(s) of the detector(s) as well as to record the curve selected on the M660.

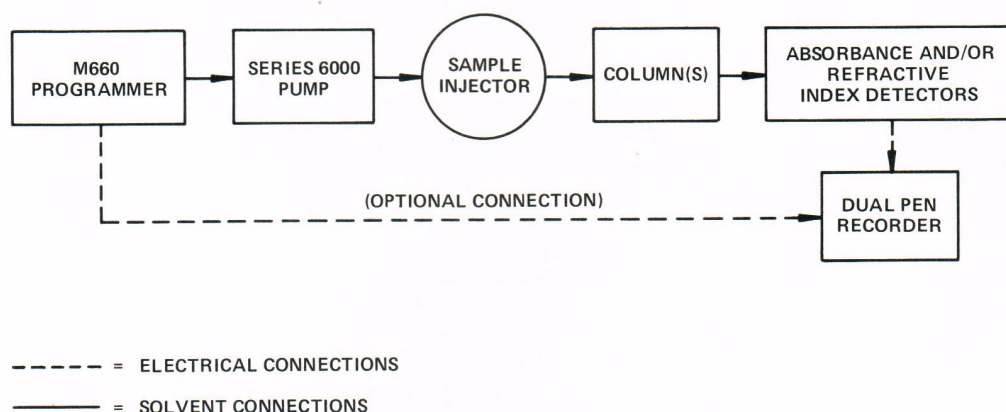


Figure 1-3. Flow Programming Block Diagram

SECTION 3.
OPERATION

3.1 CONTROLS AND INDICATORS

Figure 3-1 illustrates the controls and indicators for the M660 and Table 3-1 outlines their functions.

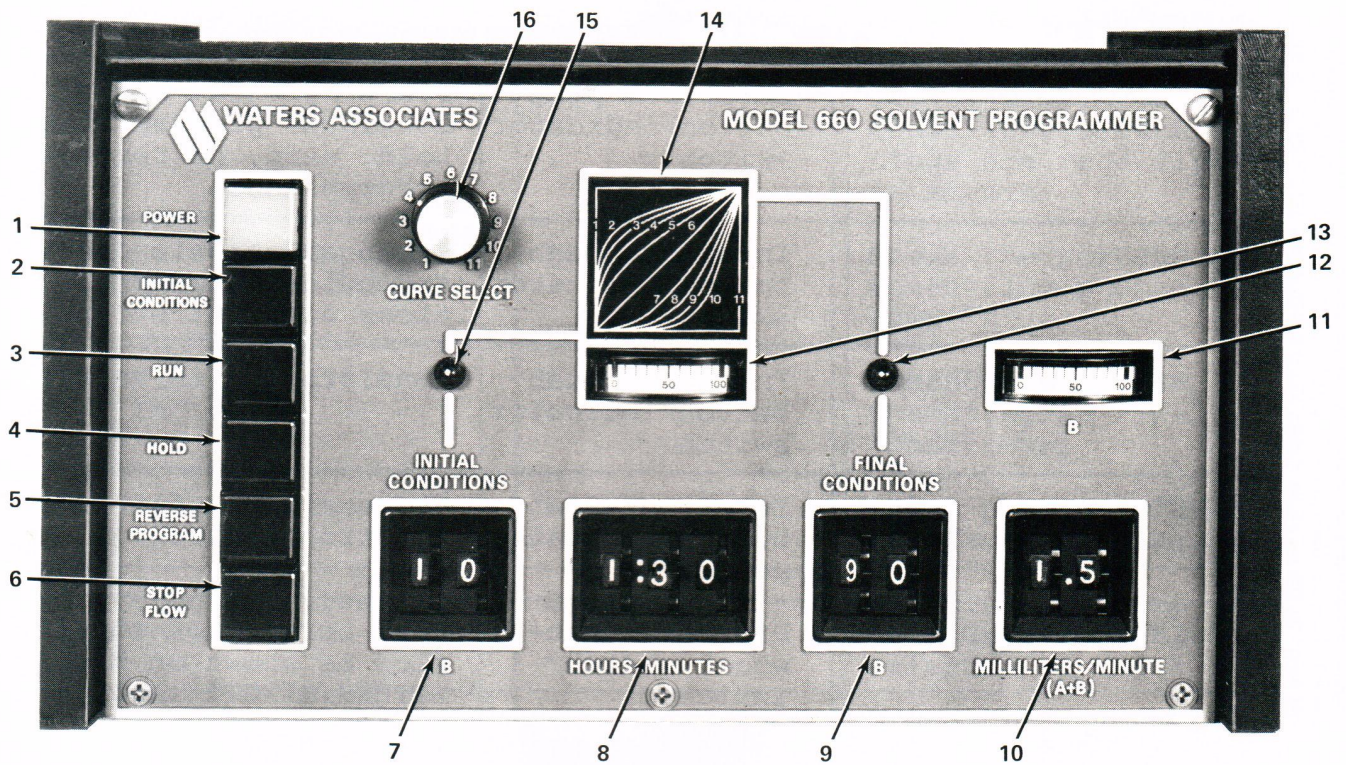


Figure 3-1. M660 Controls and Indicators

Table 3-1.
Operating Controls and Indicators

Item No.	Control/Indicator	Type	Function
1	POWER (on/off)	Alternate-action pushbutton/indicator switch	Applies power to M660.
2	INITIAL CONDITIONS	Interlock pushbutton/indicator switch	Returns program to initial conditions.
3	RUN	Interlock pushbutton/indicator switch	Starts program and/or continues program after hold, stop, or reverse program mode.
4	HOLD	Interlock pushbutton/indicator switch	Stops electronic clock and holds flow conditions at point stopped.
5	REVERSE PROGRAM	Interlock pushbutton/indicator switch	Runs program in reverse.
6	STOP FLOW	Interlock pushbutton/indicator switch	Stops solvent flow and electronic clock.
7	INITIAL CONDITIONS (PUMP B)	Digital thumb-wheel switch/indicator	Sets percent of total flow as shown on MILLILITERS/MINUTE (A&B) switch, that will be pumped by pump 'B' at the start of the program.
8	HOURS:MINUTES	Digital thumb-wheel switch/indicator	Sets time of program run.
9	FINAL CONDITIONS (PUMP B)	Digital thumb-wheel switch/indicator	Sets percent of total flow, as shown on MILLILITERS/MINUTE (A&B) switch that will be pumped by pump 'B' at the end of the program.

Table 3-1. (Continued)
Operating Controls and Indicators

Item No.	Control/Indicator	Type	Function
10	MILLILITERS/MINUTE (A&B)	Digital thumb-wheel switch/indicator	Sets total flow of pump 'A' and 'B' together when operating in solvent programming mode. When operating in flow programming mode (one pump) it can be set to 9.9 so INITIAL and FINAL CONDITIONS switch settings are read directly in ml/min.
11	Solvent Composition Indicator (Pump B)	Meter	Shows the percent of total flow pumped by pump 'B'.
12	Final Conditions Indicator	Light	Indicates program is operating at final conditions.
13	Program Time Indicator	Meter	Shows percent of total program time elapsed.
14	Program Curves Indicator	Graph	Graphically shows the (11) curves that can be selected.
15	Initial Conditions	Light	Indicates program is at initial conditions.
16	CURVE SELECT	Rotary Switch	Selects program curve.

3.2 OPERATING PROCEDURES

Any M660 control may be operated at any time during a run. When the CURVE SELECT, INITIAL CONDITION, or FINAL CONDITION switch is changed during the running of a program, the operating point will be changed instantaneously to the flow conditions that would exist if those settings had been made initially. When the HOURS:MINUTES setting is changed during a program, the remainder of the program will proceed at a new rate. When the MILLILITERS/MINUTE switch is changed, the HOLD, STOP FLOW, or REVERSE PROGRAM pushbutton is depressed, the following occurs:

a. HOLD Pushbutton/Indicator

When the HOLD pushbutton/indicator switch is depressed, the following occurs:

1. HOLD pushbutton/indicator lights.
2. Any other pushbutton/indicator switch lit (except POWER) turns off.
3. The recorder pen draws a straight line on the time axis (see Figure 3-2).
4. The total time for the run will be the time set by the HOURS:MINUTES thumbwheel switch (Figure 3-1, Item 8) plus the time the HOLD function is actuated.

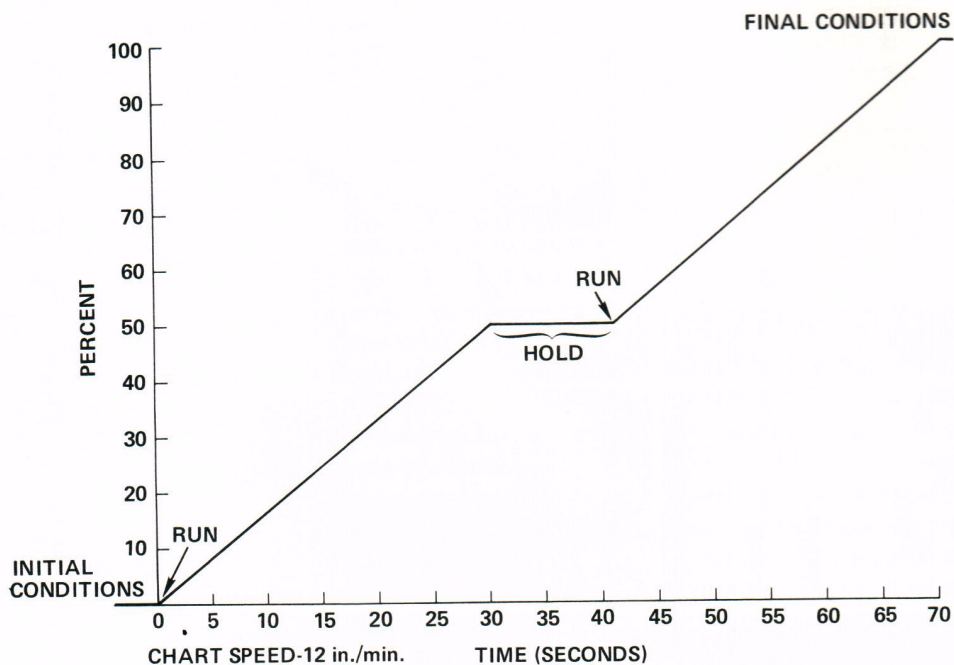


Figure 3-2. Curve '6' Profile with HOLD Pushbutton Depressed for 10 Seconds

b. STOP FLOW Pushbutton/Indicator

When the STOP FLOW pushbutton/indicator switch is depressed, the following occurs:

1. STOP FLOW pushbutton/indicator switch lights.
2. Any other pushbutton/indicator switch lit (except POWER) turns off.
3. The recorder pen goes to ZERO (see Figure 3-3).
4. The pumps are stopped.
5. The total time for the run will be the time set by the HOURS:MINUTES thumbwheel switch (Figure 3-1, Item 8) plus the time the STOP FLOW function is activated.

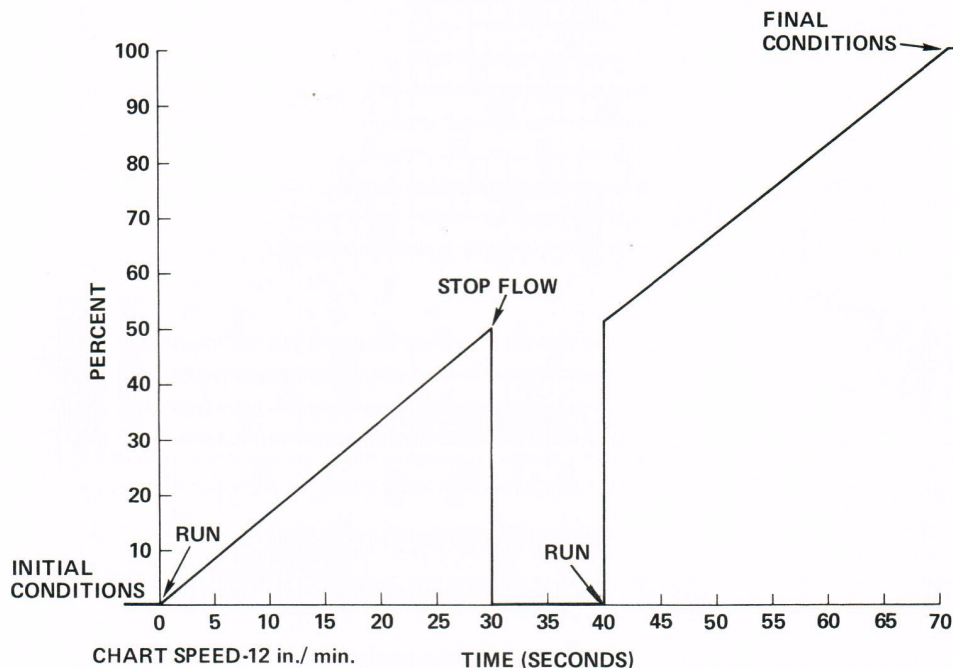


Figure 3-3. Curve '6' Profile with STOP FLOW Pushbutton Depressed for 10 Seconds

c. REVERSE PROGRAM Pushbutton/Indicator

When the REVERSE PROGRAM pushbutton/indicator is depressed, the following occurs:

1. REVERSE PROGRAM pushbutton/indicator lights.

2. Any other pushbutton/indicator switch lit (except POWER) turns off.
3. The program will run backward toward initial conditions retracting the curve at the same rate that it has been going forward (see Figure 3-4).

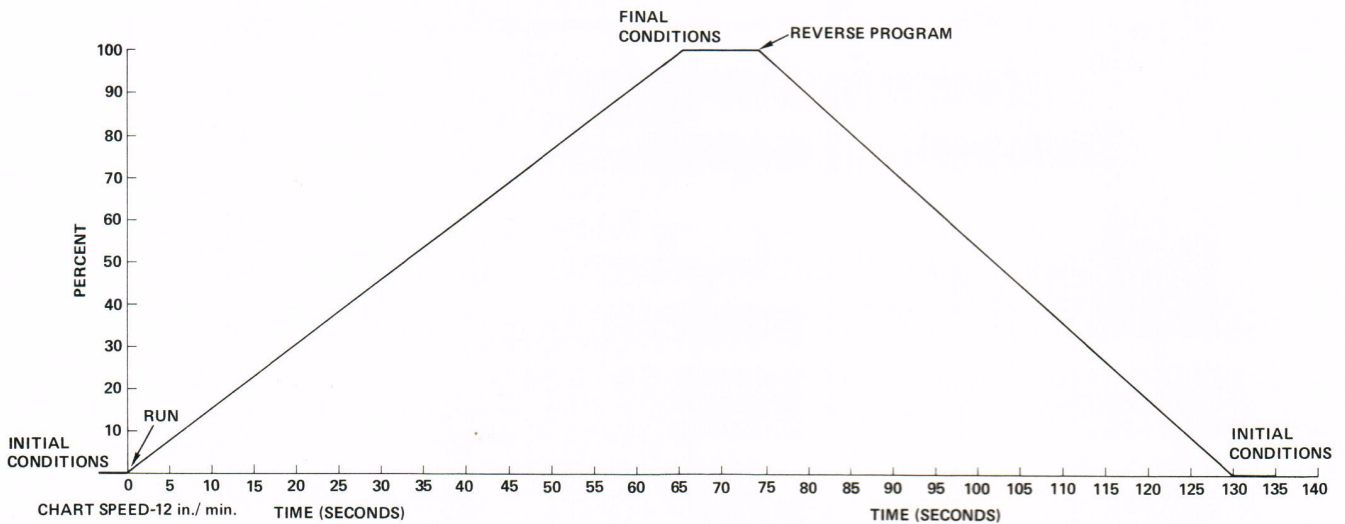


Figure 3-4. Curve '6' Profile for 0% to 100% and Reverse Flow Program from 100% to 0%

3.2.1 FLOW PROGRAMMING

Flow programming is performed with one Series 6000 pump, which is connected to the pump 'B' connector on the rear of the M660.

Flow programming is performed as follows:

- a. Set M660 POWER pushbutton/indicator (Figure 3-1, Item 1) to 'OFF' (out) position.
- b. Set MILLILITERS/MINUTE thumbwheel switch on Series 6000 pump to '0.0'.
- c. Set POWER switch on Series 6000 pump to 'ON' position.
- d. Set the M660 INITIAL CONDITIONS, HOURS:MINUTES, FINAL CONDITIONS, and MILLILITERS/MINUTE (A&B) thumbwheel switches to the desired settings. See Table 3-1 for function of each control.

NOTE

For a valid program, the Final Conditions setting must be higher than the Initial Conditions setting. HOURS: MINUTES setting must not be '0.00'.

- e. Depress the M660 INITIAL CONDITIONS pushbutton/indicator switch (Figure 3-1, Item 2).
- f. Depress the M660 POWER pushbutton/indicator switch (Figure 3-1, Item 1).

NOTE

The Series 6000 pump is now operating at a flow rate equal to the percentage setting on the INITIAL CONDITIONS thumbwheel switch multiplied times the MILLILITERS/MINUTE (A&B) switch setting. In order to read the INITIAL CONDITIONS thumbwheel switch setting directly in milliliters/minute, set the MILLILITERS/MINUTE (A&B) thumbwheel switch to '9.9'. If this setting is left at 9.9, the flow program will begin at approximately the flow setting on the INITIAL CONDITIONS thumbwheel switch and end at the flow setting on the FINAL CONDITIONS thumbwheel switch.

- g. To start the M660 program depress the RUN pushbutton/indicator switch.

3.2.2 SOLVENT COMPOSITION PROGRAMMING AND MANUAL COMPOSITION SCOUTING

NOTE

Become familiar with Section 4, 'Practical Solvent Programming Considerations' prior to performing solvent composition programming.

Solvent composition programming and manual solvent composition scouting is performed with two Series 6000 pumps. The pump located in the instrument is connected to the 'Pump A' connector on the

M660. The Series 6000 pump located outside the instrument is connected to the 'Pump B' connector on the M660. Each Series 6000 pump is prepared for operation as outlined in the Solvent Delivery System Instruction Manual (with accompanied each pump) and then connected as outlined in Section 2, 'Installation', of this manual.

NOTE

The Series 6000 pumps must be disconnected from the M660 should it ever become necessary to operate them independently with their front panel controls.

3.2.2.1 Solvent Composition Programming Procedure

Solvent composition programming is performed as follows:

- a. Set M660 POWER pushbutton/indicator (Figure 3-1, Item 1) to 'OFF' (out) position.
- b. Set both Series 6000 pumps' MILLILITERS/MINUTE thumbwheel switches to '0.0'.
- c. Set both Series 6000 pumps' POWER switches to the 'ON' position.
- d. Set the PSI PRESSURE LIMIT control (on both the Series 6000 pumps) to the desired maximum pressure limit.

NOTE

If either pump reaches the PSI PRESSURE LIMIT setting, both Series 6000 pumps will stop but the program will continue to run. In addition, both Series 6000 pumps will restart when the illuminated RESET pushbutton is depressed.

- e. Set M660 INITIAL CONDITIONS thumbwheel switch (Figure 3-1, Item 7) to desired value.
- f. Set M660 FINAL CONDITIONS thumbwheel switch (Figure 3-1, Item 9) to desired value.

NOTE

Initial conditions setting must be less than final conditions setting.

- g. Set the CURVE SELECT switch (Figure 3-1, Item 16) to desired curve.

NOTE

For easier interpretation of the chromatogram, the first run should be performed on curve '6'.

- h. Set M660 HOURS:MINUTES thumbwheel switch (Figure 3-1, Item 8) to desired value.
- i. Set MILLILITERS/MINUTE thumbwheel switch (Figure 3-1, Item 10) to desired value.

NOTE

A MILLILITERS/MINUTE setting of 0:00 is invalid.

- j. Depress INITIAL CONDITIONS pushbutton/indicator (Figure 3-1, Item 2).
- k. Depress the M660 POWER pushbutton/indicator (Figure 3-1, Item 1) to 'ON' (down) position.

NOTE

Both pumps are now running so that their total flow rates are equal to the MILLILITERS/MINUTE (A&B) thumbwheel switch setting. Pump 'B' is running at the percentage set on the INITIAL CONDITIONS thumbwheel switch multiplied times the MILLILITERS/MINUTE (A&B) switch setting. The flow rate of pump 'A' is determined by subtracting the flow rate of pump 'C' from the flow rate set on the MILLILITERS/MINUTE (A&B) thumbwheel switch.

- l. Depress RUN pushbutton/indicator (Figure 3-1, Item 3); program will start.
- m. The FINAL CONDITIONS (Figure 3-1, Item 12) indicator will light at the end of the program.

3.2.2.2 Manual Solvent Composition Scouting Procedure

Solvent composition scouting is performed as follows:

- a. Set M660 POWER pushbutton/indicator (Figure 3-1, Item 1) to 'OFF' (out) position.
- b. Set both Series 6000 pumps' MILLILITERS/MINUTE thumbwheel switches to '0.0'.
- c. Set both Series 6000 pumps' POWER switches to 'ON' position.
- d. Set the PSI PRESSURE LIMIT Control on the Series 6000 pumps to the desired maximum pressure.

NOTE

If either Series 6000 pump reaches the PSI PRESSURE LIMIT setting, both pumps will stop but the program will continue to run. In addition, both pumps will restart when the illuminated RESET pushbutton is depressed.

- e. Set the M660 MILLILITERS/MINUTE (A&B) thumbwheel switch (Figure 3-1, Item 10) to the desired total flow rate of the two Series 6000 pumps.
- f. Set the M660 INITIAL CONDITIONS thumbwheel switch (Figure 3-1, Item 7) to the desired percentage of the total flow required from pump 'B'.
- g. Depress the INITIAL CONDITIONS pushbutton/indicator (Figure 3-1, Item 2).
- h. Set the M660 POWER pushbutton/indicator (Figure 3-1, Item 1) to 'ON' (down) position.

NOTE

Both pumps are now running so that their total flow rates are equal to the MILLILITERS/MINUTE (A&B) thumbwheel switch setting. Pump 'B' is running at the percentage set on the INITIAL CONDITIONS thumbwheel switch multiplied times the MILLILITERS/MINUTE (A&B) switch setting. As the INITIAL CONDITIONS thumbwheel switch is changed from '0' to '99', pump 'B' decreases such that the total flow rate is always constant. The M660 may be used in this way to perform solvent composition scouting.

3.3 PROGRAM MONITOR TERMINAL JACKS

The program monitor terminal jacks (Figure 3-5), makes available a 10-millivolt signal which is used for recording program profiles.

The program profiles can be used for the following:

- a. Becoming familiar with the front panel controls.
- b. Simultaneous recording of the program on chromatograms.
- c. Troubleshooting.

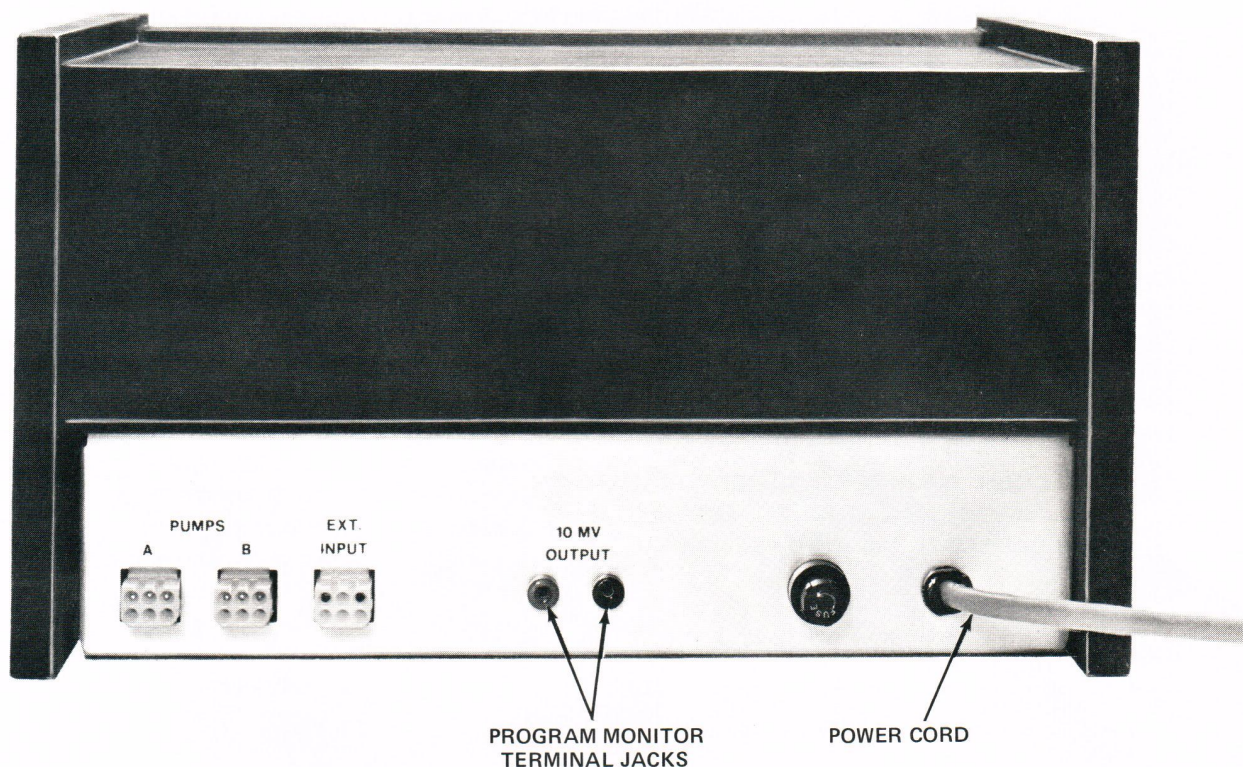


Figure 3-5. Program Monitor Terminal Jacks and Power Cord Locations

3.3.1 PROGRAM PROFILE RECORDING PROCEDURE

To obtain a program profile recording, proceed as follows:

- a. Locate the recording cable assembly (Part No. 25565 supplied in the Series 6000 pump start-up kit) and connect the end with pin jacks to the 10 mV outfit on the back of the M660 (Figure 3-5).

- b. Connect other end to a 10 mV recorder (black lead to ground, red lead to signal).

NOTE

Recorder should be zeroed on the right margin. This enables profile to be read right side up with time axis from left to right.

- c. The M660 program profile will now be recorded.