Operating Manual
for EV Fluid Processors

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I. INTRODUCTION

A. Description

1. The EV Fluid Processors are compact, automated valves. They are compatible with virtually all remote instruments and laboratory computer systems.

B. Customer Service

1. If you need assistance in sales, technical information, applications or repair please contact your vendor.

II. UNPACKING

A. General

1. Inspect for damage and/or shortage.

2. Keep the original packaging in case the unit must be returned to the factory.

B. Terminology Appendix

1. All terms appearing in *italics* can be found in Appendix A: “Electronic Definitions in Non-Electronic Terms.”

III. IMPORTANT OPERATING NOTICES

A. Cautions

1. For connections from your instrument to the EV Fluid Processors use only a *contact closure* or a *TTL switch*. Do not supply more than 24 volts to the EV Fluid Processor or
it will be damaged.

2. Rinse the valve after using buffer solutions to prevent the formation of crystals that can scratch the sealing surfaces.

3. Use only the supplied Power Supply for connection to the EV Fluid Processor.

4. Operate within temperature range, 4°- 40° C only.

5. When using a PEEK valve use only plastic ferrules in the stator ports. Metal ferrules can cause irreparable damage to the plastic stator.

B. Warnings

1. Do not submerge the EV Fluid Processor in liquids.

2. Confirm there is adequate ground between your instrument and the EV Fluid Processor. This is especially important with electrospray mass spectroscopy.

3. Plug the Power Supply into the EV Fluid Processor first, then plug the Power Supply into AC power source. When disconnecting, unplug at AC power source first.

IV. SPECIFICATIONS 

A. Unit:

1. Temperature range: 4°- 40° C, non-condensing.

2. Weight: 2.1 kg (4.5 lb.).

3. CE Mark represents compliance with EN61326-1.

B. Valve:

1. Contact your vendor for specifications.

C. Electrical Connections: 

1. See Figure 4 for an illustration of the electrical connections.

2. Barrel connector for power input to the Fluid Processor (attached to power supply).

3. *Universal power supply* input is 100-240VAC, 50-60 Hz, output is 24VDC, 1.7A.

4. *Input/output* from the EV Fluid Processor is through a terminal block.

D. Control and Communications

1. *Line Control*

   a) *Input:* 1-line *level logic* or 4-line BCD depending on model

      (*TTL, or contact closure*).

   b) *Output:* 2 line TTL

      (*Done feedback and Error feedback*)

V. INSTALLATION

A. General Description

1. The EV Fluid Processors are compact automated valves that are capable of both remote and manual control.

2. Various schematic flow diagrams are shown below (Figures 1-3). The circles represent the ports in the valve stator. The slots are the connecting passages in the rotor seal. Refer to Figures 8 and 9 for schematic flow diagrams of the three and six column selectors.

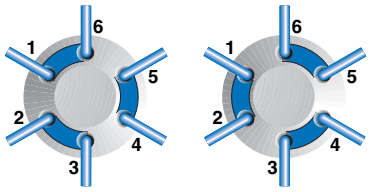


Fig. 1. Two-Position, Six-Port.

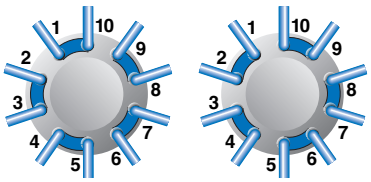


Fig. 2. Two-Position, Ten-Port.

Fig. 3. Ten-Position Selector.

B. Electrical and Communications Connections

1. All electrical and communications connections to the EV Fluid Processor are made in the rear of the unit (see Figure 4):

2. Electrical Connections:

   a) Plug the Power Supply (1) male-barrel terminal (2) into the EV Fluid Processor female port (3).

   b) Plug the IEC 320 connector (4) of the Power Line Cord into the Power Supply (1).

   c) Plug the opposite end of the Power Line Cord into a properly grounded power source (5). The *Universal Power Supply* can be operated from *inputs* of a 100 240 VAC, 50-60 Hz. The *output* is 24VDC, 1.7A.

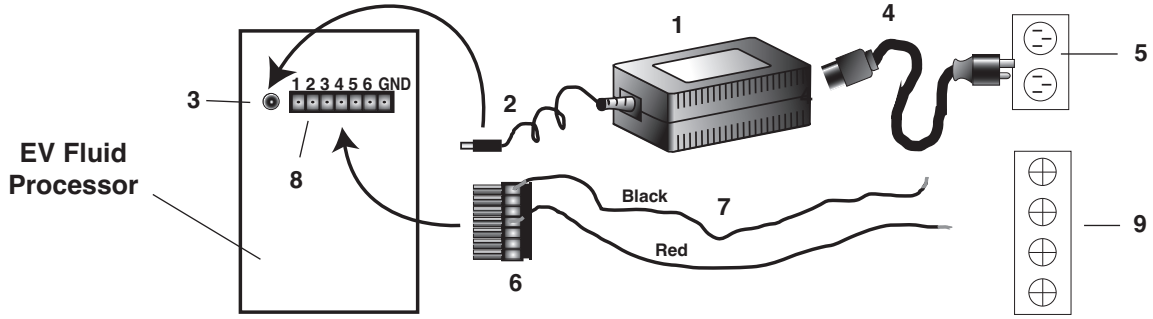


Fig. 4. Electrical and communications connections to EV Fluid Processors. Drawing shows wiring for 1-line control.

3. Remote Communication Cable Connections:

a) A EV Fluid Processor can be controlled remotely via line control using the connecting wires with *contact closures* or *TTL*. Two-position models are controlled using 1-line control. Models with more than two positions are controlled using 4-line control *(BCD)*.

(1) The terminal block (6) is separate from the EV Fluid Processor. The pin numbers for the terminal block are labeled on the back of the EV Fluid Processor. To ensure that the wiring is done correctly, orient the terminal block with the screws on the top. For wiring connections place one end of the connecting wires (7) into the correct square holes as indicated below. To secure the wires tighten the screws down completely.

One Line Control							
Pin #	1	2	3	4	5	6	GND
Wire	-	-	-	RED	-	-	Black
Event Relay	-	-	-	R1	-	-	Black

Four Line Control							
Pin #	1	2	3	4	5	6	GND
Wire	Green	Blue	Yellow	Red	-	-	Black
Event Relay	-	-	-	R1	-	-	Black

(2) Connect the terminal block (6), with the wires facing up, to the mating connector (8) in the back of the EV Fluid Processor. Check to make sure that the correct color of wire is connected to the corresponding pin.

(3) Connect the opposite end of the wires (7) to the instrument controller *contact closures* or *TTL* relay (9), as described in more detail in the next section "Input Line Control."

(4) Pin 5 is for the Done feedback line. Pin 6 is for the Error feedback line.

4. *Input Line Control* (controlling with a *contact closure* or *TTL* relay).

a) 1-line *control* (for models with two positions). The instrument used to control this model must have one [1] *TTL* or *contact closure output*. You can control the EV Fluid Processor with one *event relay*.

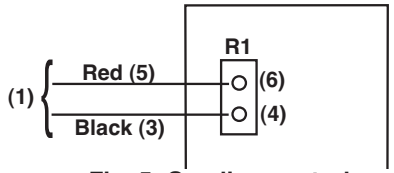


Fig. 5. One line control.

(1) Figure 5 shows wiring the *connecting wires* (1) to the instrument (2) with 1-line *control*.

(a) Connect the black wire (3) to the *ground terminal* (4) of the instrument event relay R1.

(b) Connect the red wire (5) to the control line (6) *terminal* of the instrument event relay R1.

(2) See the Operation section (VI.) for typical commands and examples of programming with this type of control.

b) 4-line *BCD* control (for models with more than two positions). The control instrument used must have four (4) *TTL* or *contact closure outputs*. The relays must be capable of simultaneous operation. The position of the valve is dictated by the *states* of the four *event relays*. This method of control allows direct access to any chosen valve position.

(1) Wiring the loose wires (1) to the instrument (2) with 4-line *BCD* control (see Figure 6):

(a) Connect the black wire (3) to the *ground terminal* (4) of the instrument event relay R1.

(b) Connect the jumper wires (supplied) from the *ground terminal* (4) of the instrument event relay R1 to the *ground terminals* (5, 6, and 7) of the instrument event relays R2, R3, and R4.

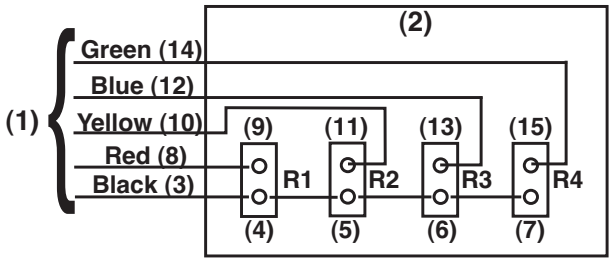


Fig. 6. Four line control.

(c) Connect the red wire (8) to the control line *terminal* (9) of the instrument event relay R1.

(d) Connect the yellow wire (10) to the control line *terminal* (11) of the instrument event relay R2.

(e) Connect the blue wire (12) to the control line *terminal* (13) of the instrument event relay R3.

(f) Connect the green wire (14) to the control line *terminal* (15) of the instrument event relay R4.

(2) See the Operation section (VI.) for typical commands and examples of programming with this type of control.

C. Valve Plumbing

1. Plumb the six-port valve, used as an injection valve, as diagramed in Figure 7. Connect a sample loop (not supplied) between Ports 1 and 4. Before connecting the column to the valve, flush mobile phase through the valve in both positions. After flushing the valve, turn back to Position 1 (LOAD) and connect the column.

2. If the valve is a 3 or 6 column selector, plumb the valve as showed in Figure 8 or 9 respectively. The pump (1) and sample injector (2) [usually an autosampler] are hooked up to the common valve inlet (3), through the columns (labeled as 1-3 or 1-6) to the common valve outlet (4) to the detector (5).

   a) One pair of ports (e.g. 6 and 6') can be dedicated for a flush-out line. In place of a column, a piece of tubing is connected between the two ports. A flush-out line is especially useful when the various columns and solvents are not compatible.

3. For other models refer to the various applications shown in Appendix B "Typical Applications."

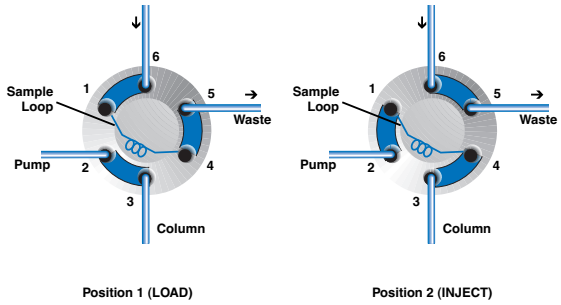


Fig. 7. Two-Position Six-Port sample injection valve.

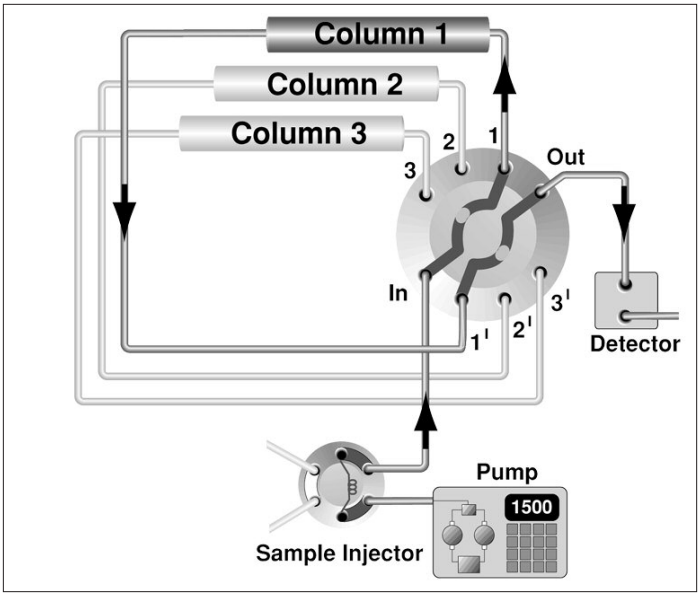


Fig. 8. 3-Column plumbing schematic.

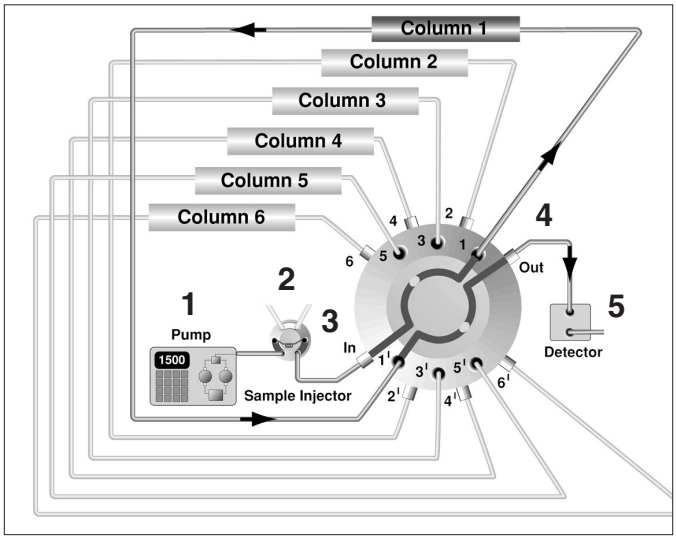


Fig. 9. 6-Column plumbing schematic.

VI. OPERATION

A. Control Panel Overview

1. The EV Fluid Processor and control panel is shown in Figure 10. Display and operations are:

   a) Local-Remote button (1)

   b) Remote indicator light (2)

   c) Local indicator light (3)

   d) Valve/column position [LED] (4)

   e) Manual forward position selector button (5)

   f) Manual reverse position selector button (6)

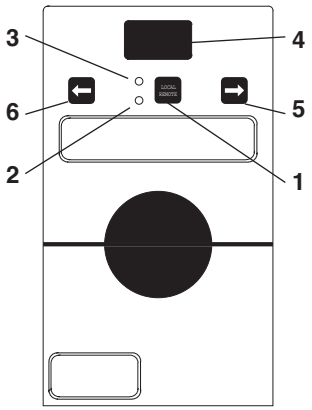


Fig. 10. EV Fluid Processor displays and manual selectors.

B. Manual Operation

1. To operate the EV Fluid Processor manually, connect the Power Supply to it as described in the Installation section (V.), Figure 4.

2. Pressing the Local-Remote button (1) selects either Local (manual) or Remote (automatic) operation.

   a) The EV Fluid Processor must be in Local (manual) mode to use the manual (forward or backward) position selection buttons. Manual mode can be confirmed by observing that the Local indicator light (3) is illuminated.

3. The LED display (4) indicates the active valve/column position.

4. Pressing the forward position selector button (5) moves the valve one position in the clockwise (or numerically higher) direction each time that the button is depressed.

> **NOTE:** (For two- and three-position valves only) If the valve is in highest position pressing the forward button will not move the valve to position #1. The reverse button must be used to relocate to position #1.

5. Pressing the reverse position selector button (6) moves the valve one position in the counterclockwise (or numerically lower) direction each time that the button is depressed.

> **NOTE:** (For two- and three-position valves only) If the valve is in lowest position (position #1), pressing the reverse button will not move the valve to the highest position. The forward button must be moved to relocate to the highest position.

C. The Electronic Self Test

1. To confirm proper operation, the EV Fluid Processor can be put through a "self test." This test is a valuable diagnostic tool to help determine potential problems for remote and automatic operational control.

2. To perform a "self test," put the EV Fluid Processor in Local mode and simultaneously press the two "arrow" buttons located near the Local-Remote button for one second.

3. The EV Fluid Processor will move *slowly* to the number 1 (home) position then rapidly cycle through all available positions and *slowly* return to the number 1 position.

4. If "EE" (ERROR) appears in the numeric display, refer to Troubleshooting section under Operation section (VI.F.).

D. Remote or Automatic Operation

1. *Input Line Control* (controlling with a *contact closure* or *TTL* relay)

   a) 1-line *control* (for models with two positions). The instrument used to control this model must have one [1] *TTL* or *contact closure output*. You can control the EV Fluid Processor with one *event relay*.

      (1) When the logic state is changed to HIGH, (OPEN, or OFF), the valve will rotate to position #1. When the logic state is changed to LO, (CLOSED, ON, or GROUND), the valve will rotate to position #2.

(2) Wiring the *connecting wires* to the instrument with 1-line *control* (see Figure 5).

(3) 1-line *level logic* generic time programming example follows. (Note: the actual programming will vary depending on the manufacturer of the instrument used):

Program 1

Time	Relay 1	Comments
Initial	Open	Valve is in position #1
30	Closed	Moves to position #2
40	Open	Moves to position #1

b) 4-line *BCD* control (for models with more than two positions). The instrument must have four (4) *TTL* or *contact closure outputs*. The EV Fluid Processor can be controlled with four event relays. The relays must be capable of simultaneous operation. The position of the valve is dictated by the *states* of the four *event relays*. This method of control allows direct access to any chosen column position.

(1) *BCD* outputs work using binary logic (2^0=1, 2^1=2, 2^2=4, 2^3=8), therefore when activated the relays will produce the following outputs:

	External Event or Relay #			
	1	2	3	4
Number Produced	1	2	4	8

(2) When numerous relays are turned on SIMULTANEOUSLY these numbers become additive, so they can be programmed, as follows:

Desired Valve Position #	External Event or Relay #			
	1	2	3	4
1	Open	Closed	Closed	Closed
2	Closed	Open	Closed	Closed
3	Open	Open	Closed	Closed
4	Closed	Closed	Open	Closed
5	Open	Closed	Open	Closed
6	Closed	Open	Open	Closed
7	Open	Open	Open	Closed
8	Closed	Closed	Closed	Open
9	Open	Closed	Closed	Open
10	Closed	Open	Closed	Open

(3) Wiring the loose wires (1) to the instrument (2) with 4-line *BCD* control is shown in Figure 6.

(4) A 4-line *BCD* generic time programming example follows. (Note: the actual programming will vary depending on the manufacturer of the instrument used):

Program 1

Time	Relay 1	Relay 2	Relay 3	Relay 4	Comments
Initial	Closed	Open	Open	Closed	Valve is in position #6
10	Open	Closed	Closed	Closed	Moves to position #1
20	Closed	Open	Closed	Closed	Moves to position #2
30	Open	Open	Closed	Closed	Moves to position #3
40	Closed	Closed	Open	Closed	Moves to position #4
50	Open	Closed	Open	Closed	Moves to position #5
60	Closed	Open	Open	Closed	Moves to position #6
70	Open	Open	Closed	Closed	Moves to position #3
80	Open	Closed	Closed	Closed	Moves to position #1
90	Open	Closed	Open	Closed	Moves to position #5

E. Maintenance

1. Electrical Maintenance

   a) There is no maintenance required for the electronic components.

   b) If an electrical problem is encountered, please consult the Electrical Connections and Troubleshooting sections of the manual. If the problem persists contact your vendor for assistance.

2. Valve Maintenance

   a) With normal use the valve will give many thousands of actuations without trouble. The main cause of early failure, which is seen as valve leakage, is abrasive particles in the sample and/or mobile phase or crystallization of buffer solutions. Either can cause scratches on the rotor seal and stator face assembly.

b) Valve Disassembly

(1) To disassemble valves that have a Cap Assembly refer to Figure 11 and proceed as follows:

(a) With the Hex Key provided, remove the Stator Screws (1) from the Stator (3).

(b) Remove the Cap Assembly (2) and the Stator (3) from the two pins on the Stator Ring (5).

(c) Remove the three Hex Screws (4) in the Stator Ring (5).

(d) Remove the Stator Ring (5) and the Rotor Seal (6) from the Body (7). The Rotor Seal (6) is mounted on three pins, and can be pulled off.

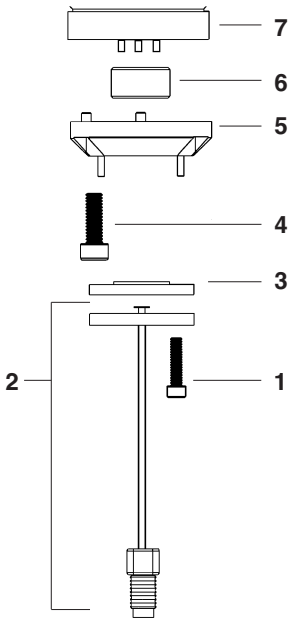


Fig. 11. Exploded view of valves with a Cap Assembly.

(2) To disassemble all other valves refer to Figures 12 and 13 and proceed as as follows:

(a) With the Hex Key provided, remove the Stator Screws (1) from the Stator (2).

(b) Remove the Stator (2) and Stator Face Assembly (3) from the Stator Ring (5). The Stator Face Assembly (3) usually remains on the Stator.

(c) If the Stator Ring (5) has Hex Screws (4), remove them using the Hex Key.

(d) Remove the Stator Ring (5).

(e) Remove the Rotor Seal (6) from the valve Body (7). The Rotor Seal (6) is mounted on three pins, and can be pulled off.

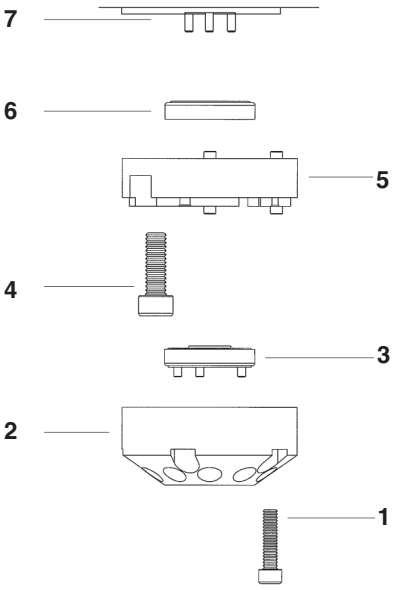


Fig. 12. Exploded view of a typical valve.

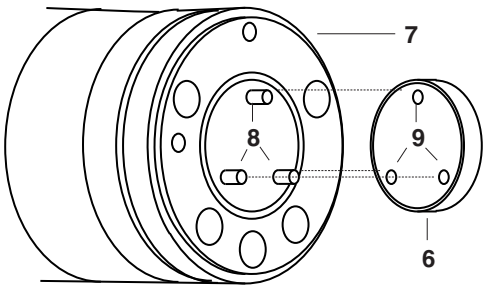


Fig. 13. Mounting a new rotor seal.

c) Valve Reassembly

(1) To reassemble valves that have a Cap Assembly refer to Figure 11 and proceed as follows:

(a) Mount the new Rotor Seal (6) onto the pins with the slot facing the Stator (3). The three pins on the Shaft Assembly fit into the mating holes in the Rotor Seal only one way.

(b) Replace the Stator Ring (5) so the two short pins on the ring enter the mating holes in the Body (7).

(c) Replace and tighten the three Hex Screws (4) into the Stator Ring (5). Tighten each an equal amount until the Screws are fingertight, then turn another half turn.

(d) Mount the new Stator (3) onto the two pins on the Stator Ring (5). The three holes in the Stator must line up with the three holes in the Stator Ring.

(e) Mount the new Cap Assembly (2) onto the two pins coming through the Stator (3). The three holes in the Cap Assembly must line up with the three holes in the Stator.

(f) Replace the three small Hex Screws (1) into the Cap Assembly (2). Tighten each an equal amount until the screws are fingertight, then turn another half turn.

(2) To reassemble all other valves refer to Figures 12 and 13 and proceed as follows:

(a) Mount the new Rotor Seal (6) with the slots facing the Stator (2). The three pins (8) on the Shaft Assembly fit into the mating holes (9) in the Rotor Seal only one way.

(b) Replace the Stator Ring (5) so the two short pins on the ring enter the mating holes in the Body (7).

(c) Replace and tighten the three Stator Ring Screws (4) if applicable. Tighten each an equal amount until the Screws are fingertight, then turn another half turn.

(d) Mount the new Stator Face Assembly (3) onto the Stator (2). Procedures vary depending on the model of the valve. See the instructions for various models below.

(i) For the 3-Column Selector, Two-Channel Selector with By-Pass, and 6-Position, 7-Port Selector, the assembly is symmetrical and has only two pins. It can be mounted on to the stator either of two ways.

(ii) For the 6-Column Selector, the assembly is not symmetrical. The two pins on the assembly have different diameters, and can only mount on the Stator one way.

(iii) The Micro Switching valve does not have a Stator Face Assembly. Skip this step for this model.

(iv) For all other models, the three pins on the assembly fit into the mating holes in the Stator only one way.

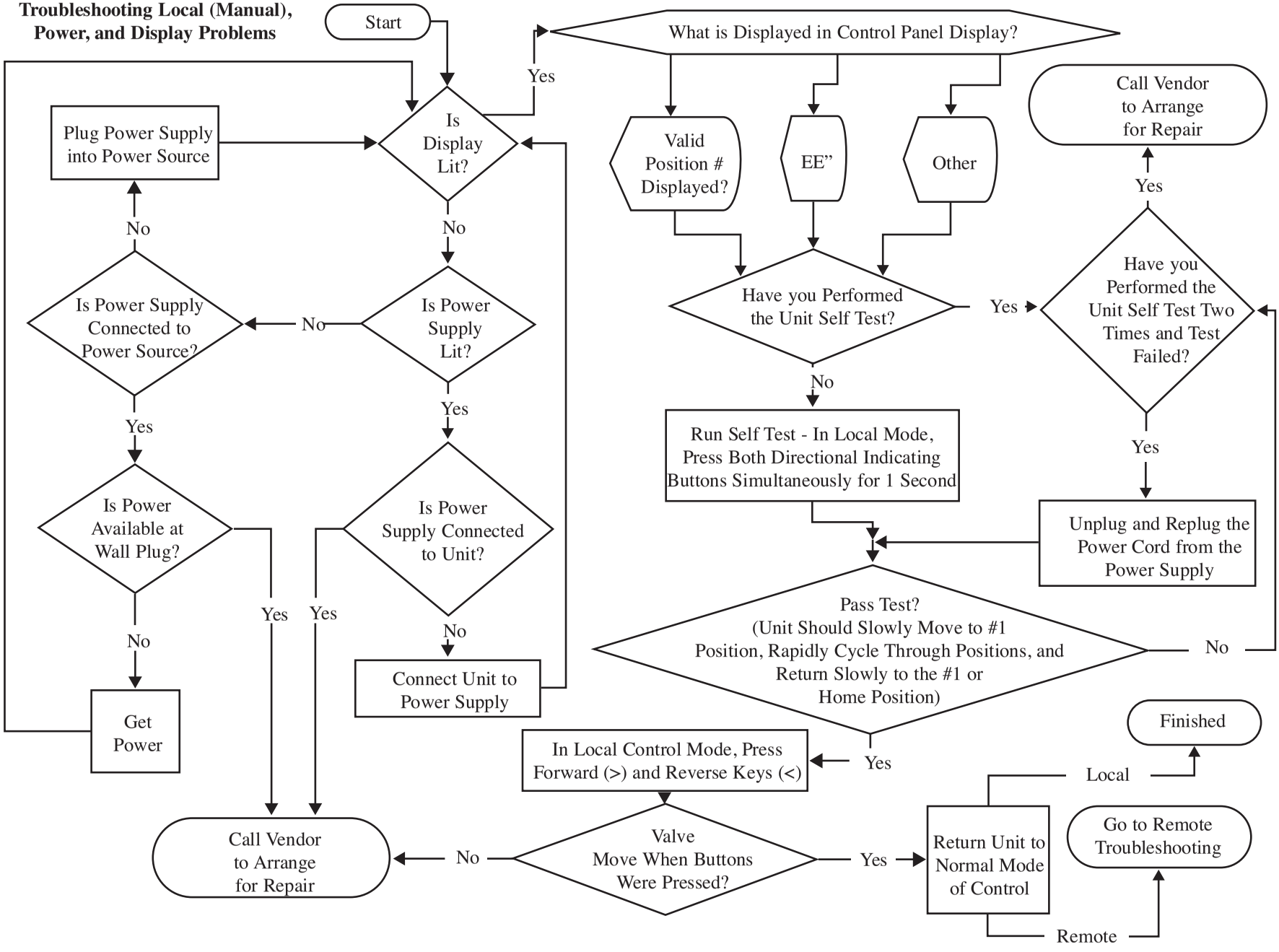
(e) Replace the Stator (2) and Stator Face Assembly (3) on the valve so that the pin in the Stator Ring (5) enters the mating hole in the Stator.

(f) Replace the Stator Screws (1) into the Stator (2). Tighten each an equal amount until the screws are fingertight, then turn another half turn.

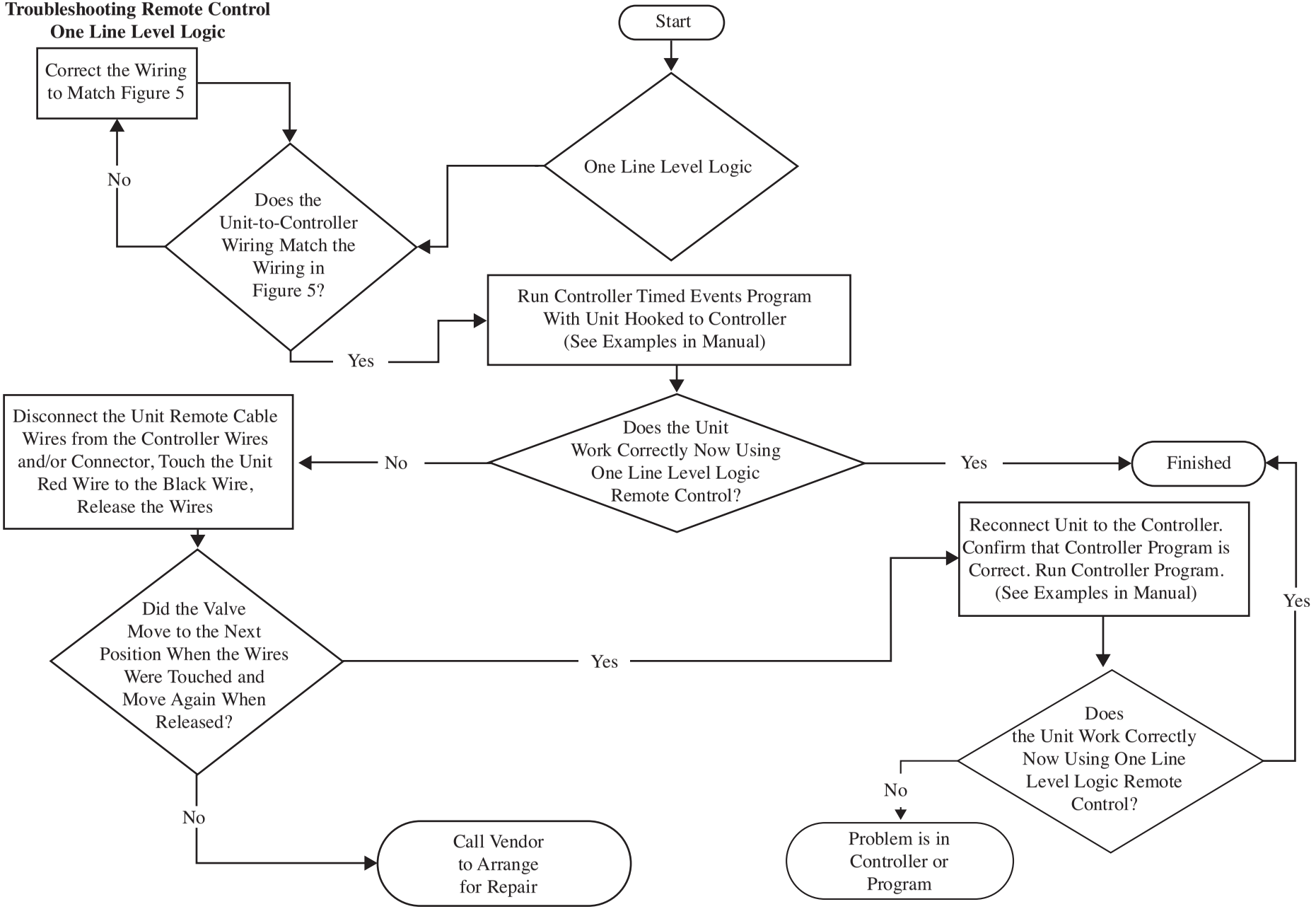
F. Troubleshooting

Symptom	Cause	Solution
1: Valve leaks between the stator and stator ring or from a port.	**A:** The Rotor Seal and Stator Face Assembly have been damaged by abrasive particles in the sample and/or mobile phase or crystallization of buffer solutions.	Replace the Rotor Seal and Stator Face Assembly. Filter sample and mobile phase. Flush the valve frequently to prevent crystallization of buffer solutions.
	B: The pressure rating of the valve has been exceeded.	Confirm that the pressure increase is not caused by a blockage in the flow path. If no blockage, lower the flow rate or change the column to decrease the pressure.
	C: The port is damaged and a nut and ferrule cannot seal correctly.	Replace the Stator.
2: Valve is not rotating.	**A:** There is no power to the EV Fluid Processor.	Confirm there is power at the source, and all electrical connections are secure.
	B: The program and/or wiring to control the EV Fluid Processor is incorrect.	Check the program used to control the EV Fluid Processor. Review the wiring as detailed in the installation section.
	C: Attempting to rotate the valve using the control panel positional selector keys - nothing happens.	Set the control panel control mode to Local (manual) mode and press the appropriate positional selector key.
	D: Attempt to rotate the valve forward from last position to 1 or in reverse from 1 to the last position using the control panel positional selector keys - nothing happens.	In Local (manual) mode you cannot rotate forward from the last position to 1 (must rotate in reverse direction) or from 1 to the last position (must rotate in forward direction).
	E: Attempting to rotate the valve using the computer control mode (with either TTL or contact closure) - nothing happens.	Verify that the Remote (automatic) mode is selected on control panel.
	F: Attempting to rotate the valve using the computer control mode (with either TTL or contact closure) and Remote (automatic) mode is selected on control panel - nothing happens.	Verify that you have programmed the computer or instrument control software correctly and that the device is outputting a correct output (either TTL or contacts).
	G: Additional Problems.	See **Troubleshooting Local (Manual), Power, and Display Problems** (page 17) or **Troubleshooting Remote Control Problems** (pages 18 and 19).
3: After running the Self Test (see Section VI. C) "EE" is displayed in the numeric display.	**A:** The electronics are not responding correctly.	See Troubleshooting flowcharts on pages 17-19.
4: Remote Control Problems	**A:** Problems arise when attempting to use 1-line Level Logic control.	See Flow Charts on Troubleshooting Remote Control 1-line Level Logic (page 18).
	B: Problems arise when attempting to use 4-line BCD control.	See Flow Charts on Troubleshooting Remote Control 4-line BCD Logic (page 19).

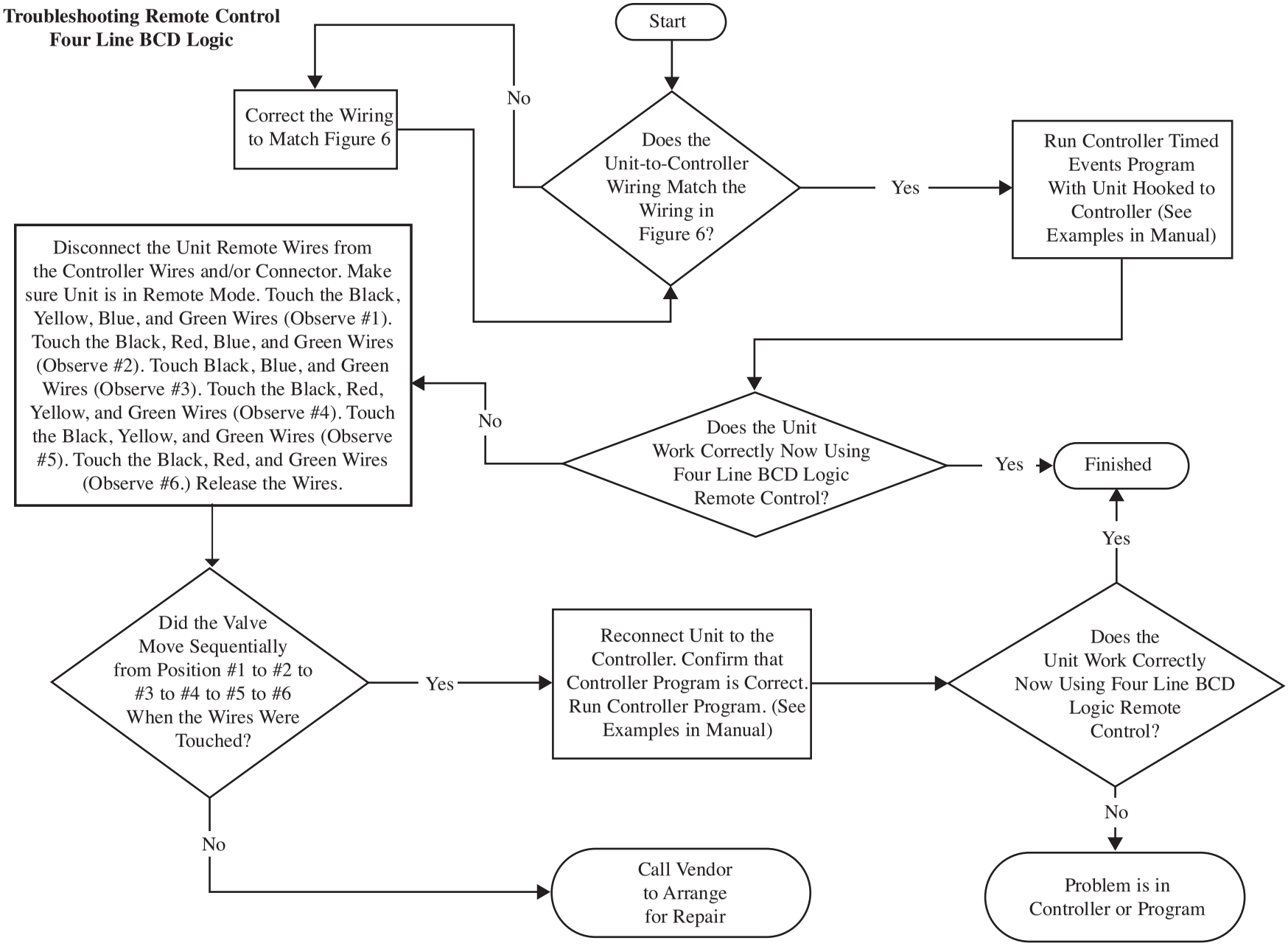
Troubleshooting Local (Manual), Power, and Display Problems



Troubleshooting Remote Control
One Line Level Logic



Troubleshooting Remote Control
Four Line BCD Logic



G. Appendix A. Electronic Definitions in Non-Electronic Terms

BCD
Abbreviation for Binary Coded Decimal. A system of representing numbers in a code using 0 and 1. For example, in a 4 bit code, the number 5 would be 0101.

CCW
Abbreviation for counterclockwise.

Contact Closure
The correct term is open collector or relay. It simply means there is no connection when the circuit is open. The line is either grounded (LO) or not (OPEN).

Cord Set
The electrical power cord to connect the power supply to an electrical wall outlet.

CW
Abbreviation for clockwise.

Event Relay
See External Event Relay.

External Event Relay
These are the terminals on the instrument where the EV Fluid Processor is wired to the instrument. They are also known as Timed Event Terminals, External Event Terminals or Time Functions Switches. Each relay has two terminals. When the relay is a TTL, one is ground, the other is HI/LO (+5 volts/0 volts). When the relay is a contact closure either terminal can be ground, the other is to the control line.

Ground
Common reference point required between two or more devices.

Input
The electrical communication coming into a device. For example, the EV Fluid Processor requires either a TTL or contact closure.

Level Logic
Type of electrical signal. In reference to the EV Fluid Processor, any change in the control signal's logic state will cause the valve to move one position.

Line Control
A remote control scheme employing separate wires. Each wire is used with a common ground to send signals controlling the instrument.

Logic State
The terminal at the Event Relay is in either one or the other state in the following pairs, HI/LO, OPEN/CLOSE, OFF/ON, OPEN/GROUND. For example, in a contact closure switch the relay is either grounded (GROUND) or not (OPEN).

Output
The electrical communication coming out of a device. For example, the EV Fluid Processors have two output lines which are provided via the terminal block. Pin number 5 of the terminal block is the Busy/Done feedback (Lo = busy, Hi = done) and Pin number 6 is the Error feedback (Lo = error detected, Hi = no error detected).

Random Access
The valve can be programmed to move directly to the designated position. For example, from position 1 to position 4 in one step rather than move sequentially requiring three program steps. This is available with 4-line BCD.

State
See Logic State

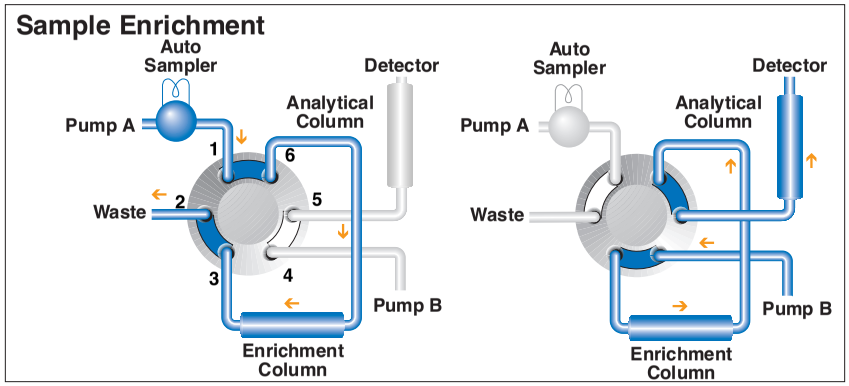
Terminal
The position at the Event Relay where the wire is connected. Each Event Relay has two terminals.

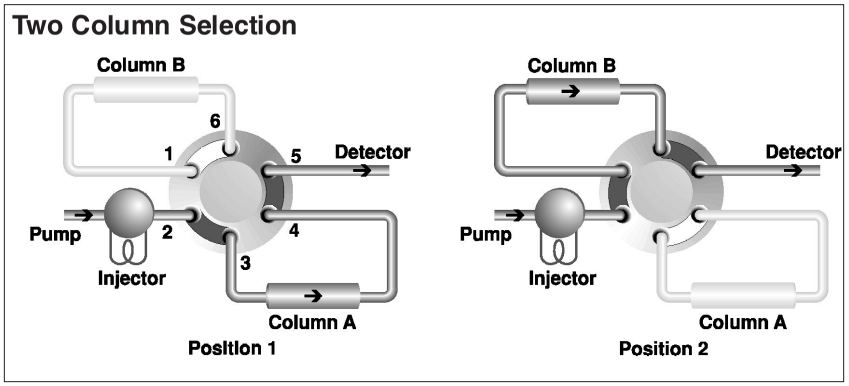
TTL
Abbreviation for Transistor-Transistor-Logic, also called digital logic. A control line is either HI (+5 volts) or LO (0 volts). Typical OFF state of an instrument's TTL switch is HI.

Universal Power Supply
A "black box" or adapter that converts electrical power from a wall socket to usable power to run the EV Fluid Processor. The input required is 100-240 VAC, 50-60 Hz. The output of the power supply to run is 24 VDC.

H. Appendix C.

Typical Two-Position, Six-Port Applications.





Typical Two-Position, Ten-Port Applications.