MRA™

Operating Manual

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Introduction to the MRA™

Your MRA™ now allows you to select from among fifty-nine discreet LC/MS split ratios ranging from 100:1 to 100,000:1 — all from a single, high-quality device.

Your ability to select from a wide range of split ratios will add convenience, productivity, and timesavings to your analytical applications and laboratory procedures.

Unlike ordinary passive splitters, your MRA provides flexibility of use for different applications and allows methods to be changed or adjusted without changing to a different splitter or adjusting tubing.

The MRA's split ratios remain accurate and consistent over time since its split ratios will remain unaffected by mobile phase viscosity, tubing length, and temperature changes.

The device can be used in analytical scale to prep scale flow rate applications with little or no observable post-column analyte band broadening.

Unpacking the MRA

Inspect contents for damage and/or shortage. Keep the original packaging in case the device must be returned to the factory.

MRA Maintenance Kit, RheFlex® Fittings, Connecting Wires, Universal Power Supply and Power Cord (most models), Split Factor Table, and Operating Manual are supplied with the MRA.

Mass Rate Attenuation

In the Aliquot Fill position, HPLC effluent enters Port 1 where a portion of the stream is directed into one of the MRA's mass transfer chambers. The LC stream exits from Port 2 and may be directed to a second detector or a fraction collector. An auxiliary pump (not provided) connects to Port 3 and, in the Aliquot Transfer position, the mass captured is transferred through Port 4 into the analytical stream of the MS.

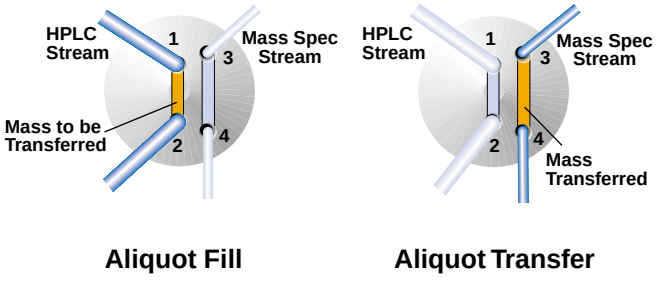


Fig.1. Schematic flow path and transfer action of the MRA.

Specifications of the MRA™

Device Specifications

- Temperature Range: 0°- 40°C, non-condensing.
- Storage and Shipment Temperature: -40° to 75°C.
- Maximum Relative Humidity: 80% up to 31°C decreasing to 50% at 40°C.
- Maximum Operating Pressure: 6.9 MPa (69 bar, 1000 psi).
- Wetted Surfaces: Stainless steel and RPC-8™.
- Connections: Accepts 10-32 male threaded fittings.
- Weight: 2.1 kg (4.6 lb).
- Dimensions: 19.1 cm (7.5 in) x 14.1 cm (5.6 in) x 7.8 cm (3.1 in).
- CE Mark represents compliance with EN61326-1.

Cautions

- For connections from your instrument to the MRA use only a contact closure or a TTL relay.
- Do not supply more than 24 VDC to the MRA or it will be damaged.
- Rinse the valve after using buffer solutions to prevent the formation of crystals that can scratch the sealing surfaces.
- Use only the supplied Universal Power Supply for connection to the MRA.
- Operate within temperature range of 0°- 40°C only.

Warnings

- Do not submerge the MRA in liquids.
- Confirm that there is adequate ground between your controlling instrument and the MRA. Adequate grounding is especially important with electrospray mass spectroscopy.
- Plug the Universal Power Supply into the MRA first, then plug the Universal Power Supply into an AC power source.
- When disconnecting, unplug at the AC power source first.
- Do not remove the cover immediately after use – there are high temperature components in the enclosure.

Installation

General Description

The MRA™ is a compact, active splitting device capable of both automated and manual control.

A schematic of the flow diagram is shown on page 1. The circles represent the ports in the valve Stator. The grooves represent the connecting passages in the Rotor Seal.

All electrical and communication connections to the MRA are made in the rear of the device (see Figure 2).

Electrical Connections

- Plug the Universal Power Supply (1) male barrel connector (2) into the MRA female port (3).
- Plug the IEC 320 connector (4) of the Power Cord into the Universal Power Supply (1).
- Plug the opposite end of the Power Cord into a properly grounded power source (5). The Universal Power Supply can be operated from inputs of 100-240 VAC, 50-60 Hz. The output is 24 VDC, 1.7A.

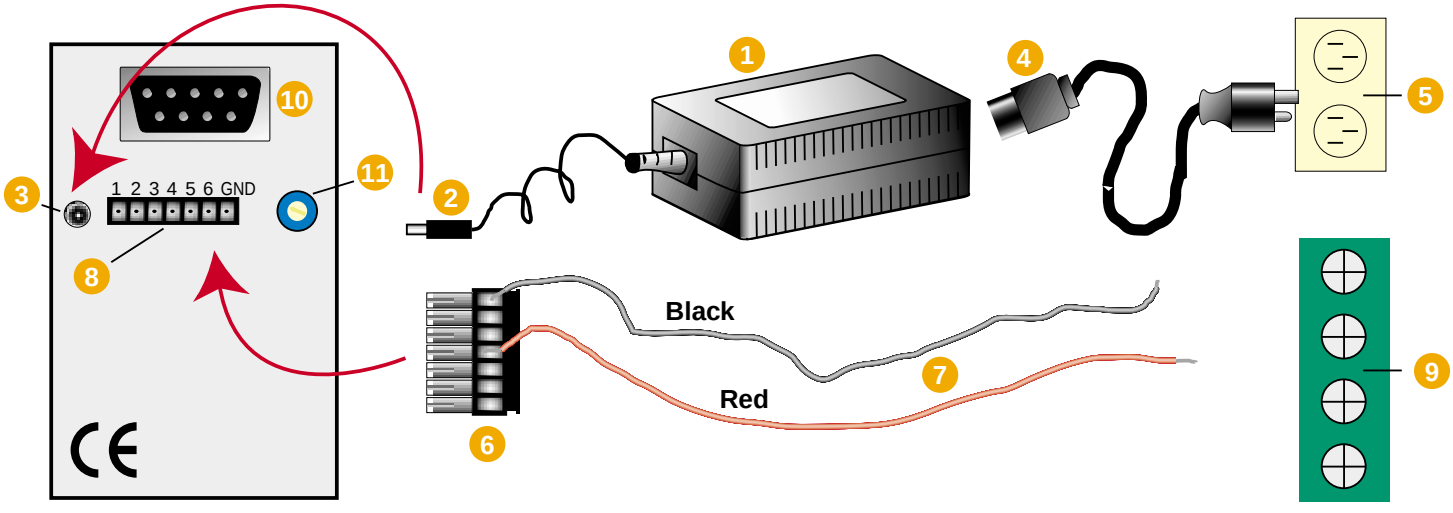
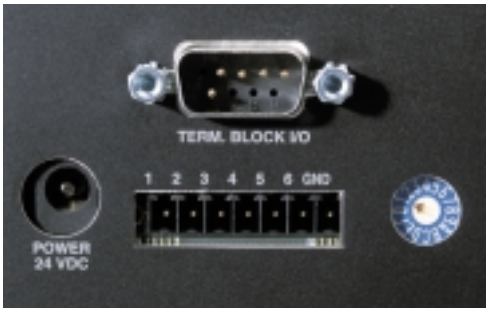


Fig. 2. Electrical and communications connections to MRA. Drawing shows wiring for Input Line Control.

Installation (Cont.)



Terminal block connections for Input Line Control of MRA.

Communication Cable Connections

There are two ways to automate control of the MRA. The first is Input Line Control with level logic using the supplied connecting wires and contact closures or TTL relays of the controlling instrument. The second is Serial Communication using a RS-232 cable (not provided) and software (not provided).

Terminal Block Wire Connections for Input Line Control

Input Line Control							
Pin #	1	2	3	4	5	6	GND
Wire	-	-	-	Red	-	-	Black

Automated Operation - Input Line Control

- The terminal block (6) is separate from the MRA (see Figure 2). The pin numbers for the terminal block are labeled on the back of the MRA. To ensure that the wiring is done correctly, orient the terminal block with the square holes up. For wiring connections, place one end of each of the connecting wires (7) into the correct square holes as shown in the photo above. To secure the wires tighten the screws down completely.
- Connect the terminal block (6), with the wires facing up, to the mating connector (8) in the back of the device. Check to make sure that the correct color of wire is connected to the corresponding pin as shown in Figure 2.
- Connect the opposite end of the wires (7) to the controlling instrument contact closure or TTL relay (9).
- The instrument used to control the MRA must have one TTL or contact closure output (one event relay). Figure 3 shows wiring the connecting wires (1) from the MRA to the controlling instrument (2) for Input Line Control.
- Connect the black wire (3) from the MRA to the ground terminal (4) of the controlling instrument event relay R1.
- Connect the red wire (5) from the MRA to the control line (6) terminal of the controlling instrument event relay R1.
- See example on page 8 of generic time programming commands for this type of control.

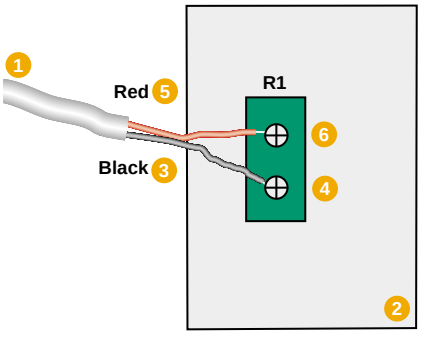


Fig. 3. Wire connections for Input Line Control of controlling instrument.

Automated Operation - Serial Communications

- Plug a RS-232 cable (not furnished) into the 9-pin connector (10) located on the rear of the MRA (see Figure 2).
- Connect the other end of the RS-232 cable to the instrument controller computer port. The board address switch (11) is used to configure the MRA for a given address when used on a serial programmable multidrop bus.
- Contact vendor for RS-232 protocol details.

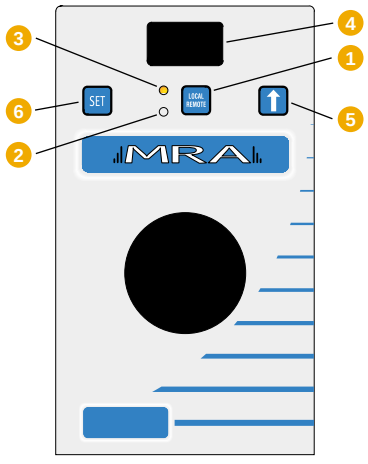


Fig. 4. MRA control panel.

Control Panel Overview

The MRA™ control panel is shown in Figure 4.

- Local-Remote button (1)
- Remote indicator light (2)
- Local indicator light (3)
- Split Factor LED (4)
- Manual Forward Position Selector button (5)
- Manual SET button (6)

Key Parameters for MRA Operation

The MRA operates using the following parameters:

- HPLC flow rate.
- Rotor Seal groove size (aliquot volume) - 22 nL, 100 nL, 300 nL.
- Frequency of valve actuation.

These parameters are related to each other in the equation:

$$\text{Split Ratio} = \frac{\text{HPLC Flow Rate (µL/min) / Rotor Seal Groove Size (µL)}}{\text{Frequency (Cycles/min)}}$$

Setting Split Ratios

The MRA must have a number programmed into it to establish the split ratio relative to a chosen HPLC Flow Rate. To obtain this number, referred to as a Split Factor, use Table I.

From Table I select the HPLC flow rate to be used and the desired split ratio. Where the two parameters intersect is the Split Factor to be set into the MRA.

(Continued on next page.)

Table I. Split Factors.

HPLC Flow Rate (mL/min.)	Split Ratio						
	100:1	500:1	1,000:1	4,000:1	10,000:1	20,000:1	100,000:1
1	1	4	12				
2	2	5	13	22			
4	3	6	14	23	34		
6		7	15	24	35	45	
8		8	16	25	36	46	
10		9	17	26	37	47	
15		10	18	27	38	48	
20		11	19	28	39	49	
30			20	29	40	50	55
40			21	30	41	51	56
60				31	42	52	57
80				32	43	53	58
100				33	44	54	59

Setting Split Ratios (Cont.)

To Set the Split Factor:

- Connect the Universal Power Supply to the MRA™ then the Power Source as described in **Electrical Connections**, Figure 2.
- The Local-Remote button (1) selects either Local (manual) or Remote (automatic) operation. The MRA must be in Local (manual) mode to use the SET and Forward Position Selector buttons. Manual mode can be confirmed by observing that the Local indicator light (3) is illuminated.
- Press the SET button (6) to enter the Split Factor. The display (4) will flash the current Split Factor indicating the MRA is in the programmable mode.
- Pressing the Forward Position Selector button (5) changes the Split Factor numerically higher each time that the button is depressed.
- Once the Split Factor is entered into the MRA press the SET button again to lock in the Split Factor. Two horizontal lines will appear on the LED display indicating the Split Factor is locked in.

Use the following procedure if a chosen HPLC Flow Rate is not listed in Table I:

- From Table I choose the listed HPLC Flow Rate closest to the flow rate to be used and choose the Split Ratio closest to the Split Ratio desired.
- The Split Factor to be entered into the MRA is found at the intersection of the HPLC Flow Rate and the Split Ratio.
- Calculate the actual Split Ratio using the actual flow rate and the HPLC Flow Rate from Table I.

Calculating a Split Ratio

Split Ratios are calculated using the following equation:

Actual Flow Rate ÷ HPLC Flow Rate from Table I x Corresponding Split Ratio from Table I

Example:

Actual flow rate: 50 mL/min
Approximate desired split ratio: 10,000:1

The HPLC Flow Rate of 40 mL/min can be used to obtain the 10,000:1 Split Factor to be entered into the MRA. In this case it would be 41. The actual split ratio at 50 mL/min would be:

50 mL/min ÷ 40 mL/min x 10,000 = 12,500

Split Ratio = 12,500:1.

Operation (Cont.)

MRA in Local (manual) mode. Note indicator light for Local is illuminated. Split Factor of 19 is displayed by Split Factor LED

The Electronic Self Test

- To confirm proper operation, the MRA™ can be put through a Self Test. This test is a valuable diagnostic tool to help determine potential problems.
- Put the MRA in the Local mode.
- To start the Self Test press the Forward Position Selector button.
- The MRA will cycle through all available positions a number of times and then return to the home position if it passes the Self Test.
- If “EE” (ERROR) appears in the numeric display the Self Test has failed, Refer to **Troubleshooting**.

Local or Manual Operation

- Put the MRA in the Local mode.
- Set the Split Factor as described in **Setting Split Ratios** on pages 5-6.
- To start the MRA simultaneously press both the SET button and Forward Position Selector buttons.
- During the MRA actuations the LED display will alternate between the symbols [and ⌷.
- To stop the MRA, simultaneously press both the SET button and Forward Position Selector buttons. Due to the speed of actuation cycles this may need to be repeated for the stop signal to register.

Remote or Automated Operation

Input Line Control (Controlling with a contact closure or TTL relay)

Input Line Control is used to start or stop the MRA™. The instrument used to control the MRA must have one TTL or contact closure output. Only one event relay is needed. Wiring the connecting wires to the controlling instrument with Input Line Control is shown in Figure 3.

- Put the MRA in Local mode.
- Set the Split Factor as described in **Setting Split Ratios** on pages 5-6.
- When the logic state of the output is changed to HIGH, (OPEN, or OFF), the MRA will turn on. When the logic state is changed to LO, (CLOSED, ON, or GROUND), the MRA will turn off.
- See Example: Input Line Control Generic Time Programming. Note that the actual programming will vary depending on the manufacturer of the instrument used.

Example: Input Line Control Generic Time Programming

Program 1

Time	Relay 1	Comments
Initial	Closed	MRA is stopped
30	Open	MRA starts
40	Closed	MRA stops

If the MRA was used in the Local (Manual) or RS-232 mode prior to Input Line Control, the MRA may need to be synchronized to execute Input Line Control.

The MRA needs to be synchronized if:

- The MRA is actuating and the relay is CLOSED.
- The MRA is not actuating and the relay is OPEN.

To synchronize the MRA, toggle the relay twice. For example:

- If the MRA is actuating and the relay is CLOSED, open and close the relay.
- If the MRA is not actuating and the relay is OPEN, close and open the relay.

Once the MRA is synchronized it will resume normal Input Line Control operation.

Output

The MRA has 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).

RS-232 Control

RS-232 control requires a special cable (not supplied). The cable is connected between the MRA and the controller computer port. Contact your instrument vendor for supporting documentation.

Maintenance

Electrical Maintenance

- If an electrical problem is encountered, please consult **Electrical Connections** on page 3 and **Troubleshooting** on pages 11-13. If the problem persists contact your vendor for assistance.
- No maintenance is required for the electronic components.

Valve Maintenance

With normal use the MRA™ will provide one million samplings. 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.

Valve Disassembly

To disassemble refer to Figure 6 then proceed as follows:

- With the Hex Key provided in the MRA Maintenance Kit, remove the Stator Screws from the Stator.
- Remove the Stator and Stator Face Assembly from the Stator Ring. The Stator Face Assembly usually remains on the Stator.
- Remove the Stator Ring.
- Remove the Rotor Seal from the valve Body. The Rotor Seal is mounted on three pins and can be pulled off.

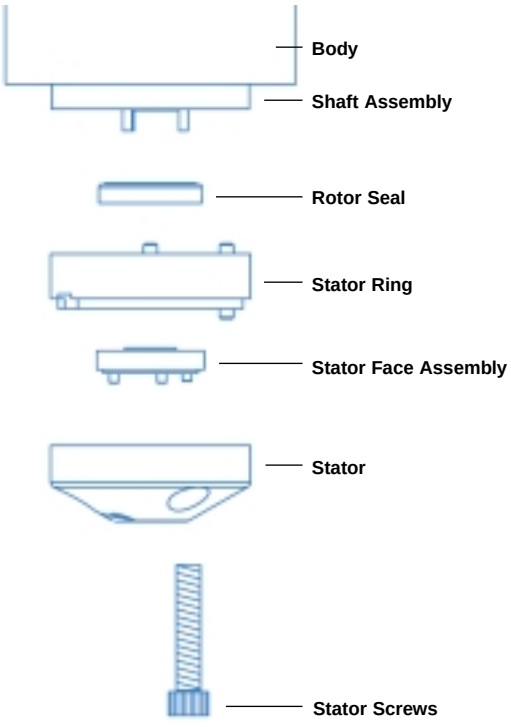


Fig. 6. Exploded view of MRA.

Valve Reassembly

Before reassembly, use clean, filtered compressed gas to blow out the Shaft Assembly area of the valve, then proceed as follows:

- Mount the new Rotor Seal with the slots facing the Stator. The three pins on the Shaft Assembly fit into the mating holes in the Rotor Seal only one way.
- Replace the Stator Ring so the two short pins enter the mating holes in the Body.
- Mount the new Stator Face Assembly onto the Stator. The pins on the assembly fit into the mating holes in the Stator only one way.
- Replace the Stator and Stator Face Assembly on the valve so that the pin in the Stator Ring enters the mating hole in the Stator.
- Replace the Stator Screws into the Stator. Tighten each an equal amount until the screws are fingertight, then turn another half turn.

Additional MRA Maintenance Kits

Please contact your vendor for additional MRA Maintenance Kits. Additional Maintenance Kits include three sets of replacement parts.

Definitions

Contact Closure
Also known as open collector or relay. It simply means there is no connection when the circuit is open. The line is either grounded (CLOSED) or not (OPEN).

Event Relay
See External Event Relay.

External Event Relay
These are the terminals on the controlling instrument where the MRA™ is connected. They are also known as Timed Event Terminals, External Event Terminals or Time Function 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 MRA requires either a TTL or contact closure.

Level Logic
Type of electrical signal. In reference to the MRA, 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 MRA has 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).

Serial Communication
A way of communicating with a computer. The MRA is capable of RS-232 serial communication. Contact your vendor for more information.

State
See Logic State.

Terminal
The position at the event relay where the wire is connected. Each event relay has two terminals.

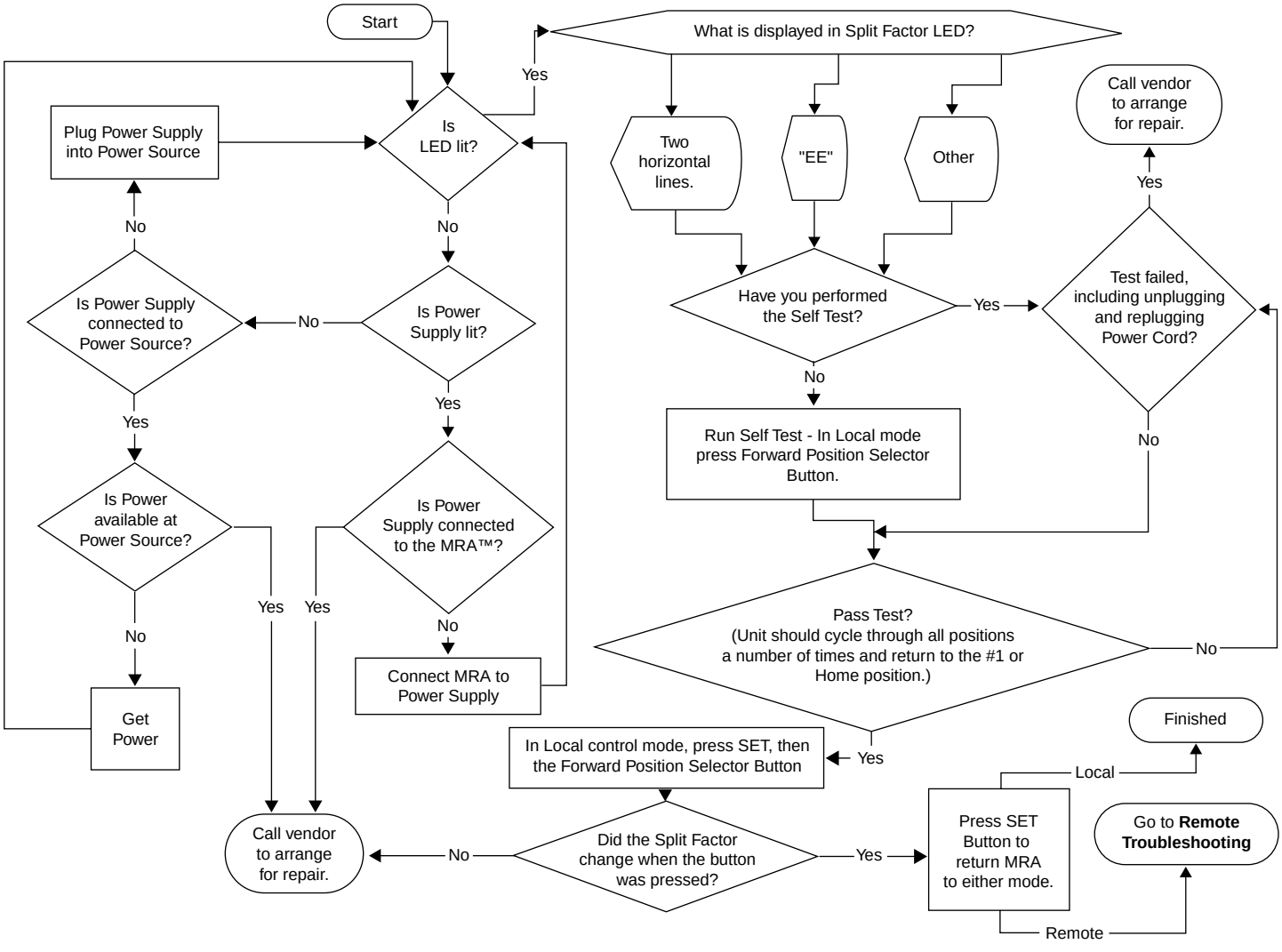
TTL
Abbreviation for Transistor-Transistor-Logic, also called digital logic. A control line is either HI (+5 volts) or LO (0 volts). Typical OFF state of an instrument's TTL switch is HI.

Universal Power Supply
The adapter that converts electrical power from a wall socket to usable power to run the MRA. The input required is 100-240 VAC, 50-60 Hz. The output of the power supply to run is 24 VDC.

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 using the MRA Maintenance Kit available from your vendor. 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 post MRA tubing to decrease the pressure.
	C: The port is damaged and a fitting does not seal correctly.	Replace the Stator.
2: Valve is not rotating.	**A:** There is no power to the MRA™.	Confirm there is power at the source and all electrical connections are secure.
	B: The program and/or wiring to control the MRA is incorrect.	Check the program used to control the MRA. Review the wiring on pages 3-4.
	C: Nothing happens when pressing the Forward Position Selector button while attempting to change the Split Factor.	Set the control mode to local (manual) mode.
	E: Attempting to rotate the valve using the Remote (automated) control mode (with either TTL or contact closure).	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).
	F: Additional problems.	See **Troubleshooting Flow Charts** on pages 12-13.
3: After running the Self Test (see **Electronic Self Test** on page 7) "EE" shows in the LED display.	**A:** The electronics are not responding correctly.	See **Troubleshooting Flow Charts** on pages 12-13.
4: Remote control problems.	**A:** Problems arise when attempting to use Input Line Control.	See Flow Chart on **Troubleshooting Remote Control Input Line Control** on page 13.

Local (Manual), Power, and Display Problems



Remote (Automatic) Input Line Control