

# MagnaValve Shot Flow Controller



**Electronics Inc.**  
*Shot Peening Control*

## Electronics Inc.

56790 Magnetic Drive

Mishawaka, Indiana 46545

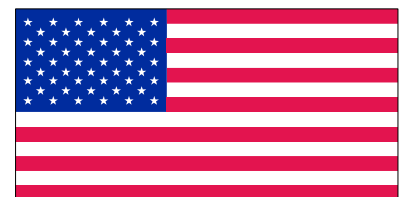
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Made in the USA

**Model FC-24 Control**

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## 1.PRODUCT DESCRIPTION

The Model FC-24 Shot Flow Controller will measure and control the rate of flow of steel shot passing through a special normally closed magnetic valve called a MagnaValve. A digital display is provided for indications of shot flow rate. A 0-10 Volt dc output signal representing flow rate is available for remote indication or strip-chart recording. High and low alarms are set to bracket the requested shot flow rate. The alarm bandwidth, for either percent of full scale or percent of setpoint, is adjustable from the front panel. Either local (front panel) or remote (0-10Vdc) set point commands may be used.

## 2.THEORY OF OPERATION

The MagnaValve uses permanent magnets to hold the shot and electro-magnets to cancel the magnetic field. When power is applied to electro-magnets the shot is free to flow. The desired flow rate command or setpoint is compared to the actual flow rate and a control signal is sent to the MagnaValve to achieve desired flow rate. If the desired flow rate is not achieved within an adjustable time period, then a high/low alarm relay will be triggered. This output signal may be used to inhibit further machine operations and signal the operator. The FC Controller can be used with any MagnaValve with built-in flow rate sensors, which have a 0- 10 Vdc output signal.

## 3.LOCATION OF ADJUSTMENTS

For location of adjustments see Figures 1 and 2. Numbers in parenthesis (figure-balloon) represent figure number and balloon call-out number. For example, digital display is (1-3), meaning figure 1 and balloon number 3. Notice that the yellow buttons also require the use of the ▲ or ▼ buttons to change the display readings. The black buttons act alone to change the status of a function.

## 4.PRELIMINARY ADJUSTMENTS

- A. Apply 24Vdc power.
- B. Zero: The display (1-1) should read 0.0 during no-flow condition. If the digital display does not show zero then push the “Zero” button (2-26).
- C. Calibration of the display range may be required. Use the arrow buttons to adjust the display to read 0.0 Other full-scale values may be used with different MagnaValves. Push the “Display Coarse” button (2-28) to show the current value of full scale range. To change the range use the ▲ or ▼ buttons. The following table shows available scaled settings.

MagnaValve	Flow Range	
576-24	2 Lbs/min	1 Kg/min
577-24	10 Lbs/min	5 Kg/min
578-24	20 or 30 Lbs/min	10 or 15 Kg/min
579-24	100 Lbs/min	50 Kg/min
580-24	200 Lbs/min	100 Kg/min
590-24	300 Lbs/min	150 Kg/min
500-24	700-1200 Lbs/min	300-600 Kg/min

*Note: MagnaValves are calibrated to give a 0-10 Vdc output signal at rated flow. Because of calibration differences caused by shot type and size, custom factory calibration is recommended .Please state type of shot, size of shot and desired flow range from the table above.*

*Multiple shot sizes may be used with one valve with slight degradation of accuracy. Adjustments for different flow ranges can be made by adjusting the “Span” at the MagnaValve or at the FC-24 control.*

- D. For automatic machine cycle, push the “Mode” button (2-22) until the “Ready” LED (1-6) is on. When a 24Vdc "Enable" signal is received the "On" LED indicator (1-7) will come on and activate the valve output. The bar graph display (2-13) will indicate the relative signal strength sent to the MagnaValve. Adjust the flow rate setpoint with button (1-8) and ▲ or ▼ buttons to the desired flow rate. The display is usually scaled in pounds/minute, but may be scaled in Kg/minute.
- E. Display the alarm bandwidth by pushing button (1-4) and using ▲ or ▼ to change the settings. A typical setting is 5% of full scale.
- F. Select either percent of point (PT) or percent of full scale (FS) for the alarm band by pushing button (2-16). Typical setting is percent of full scale (FS). The alarm bandwidth is +/- this value and follows the set point command.
- G. Adjust the alarm delay time (2-17) from 0-10 seconds. A typical setting is 5 seconds.

## 5.CALIBRATION

- A. The MagnaValve has been factory calibrated to provide a 10 Vdc signal output at its rated flow. If a different type or size of shot is used it may be necessary to re-calibrate the system. The span setting can be changed at the MagnaValve or at the FC 24 controller. The calibration change should be made at the FC 24 controller for convenience, since replacement MagnaValves will have the same calibration as the original and the span setting at the FC-24 controller can easily be displayed as described below.
- B. Push the “Span” button (2-19) to display the current span setting. The factory standard setting is 1.000 for unity gain. The range of the span function is between .750 and 1.500.
- C. To check the flow accuracy, perform a catch and weigh test. Run shot through the MagnaValve for 1 minute and catch it in a container. Weigh the shot. Use the ▲ or ▼ buttons to increase or decrease the flow rate. Repeat the trial to confirm calibration. Keep a record of the span setting to be used in case the FC-24 controller is replaced.

## 6.OPERATION

- A. Operation consists of controlling the shot flow rate through the MagnaValve and transmitting an alarm signal when the flow rate is above or below the desired flow range. The shot flow rate for the MagnaValve is controlled by a servo loop that compares the setpoint command to the actual shot flow rate.
- B. SETPOINT - To read the current setpoint push the “Setpoint” button (1-8). To change the value use the ▲ or ▼ buttons.
- C. MODE - The FC controller has three mode settings: “Off”, “Ready” and “On” as indicated by LEDs (1-5, 6, 7). The “Off” mode prevents any shot flow. The “On” mode will activate the MagnaValve manually. The “Ready” mode will only activate the MagnaValve upon receipt of a 24 Vdc “Enable” signal. The “On” LED will come on upon receipt of the enable signal and will get brighter upon expiration of the “Enable Delay”.
- D. ENABLE DELAY – The “Enable Delay” feature is set by button (2-21) and is used to allow the air pressure to stabilize prior to activating the MagnaValve output. A typical setting is 3 seconds. Without this delay the air blast system may exhibit unstable flow conditions for 15 or more seconds.
- E. ALARM BANDWIDTH - The alarm bandwidth is adjustable from 0 to 50% of full scale or of setpoint and is factory set at 5% of full scale (FS). The alarm circuit is available only when the servo is "on" and the control is enabled. The flow set point is also the alarm mid-point. The alarm bandwidth, usually set at 5%, will track the flow set point setting.
- F. If the Alarm Mode is set for percent of full scale (FS) as indicated by LED (2-14) then, with 5% of full scale and a full scale of 20 lb/min, the alarm band is  $\pm 1$  lb/min. For a setpoint of 12 pounds/minute the alarms would be active below 11 and above 13 pounds/minute.

Changing the set point to 15 would change the alarm trigger points to 14 and 16 pounds/minute automatically. The alarm bandwidth of  $\pm 1$  stays fixed until the alarm bandwidth is changed.

- G. If the Alarm Mode is set for percent of point (PT) as indicated by LED (2-15) then, with 5% of point mode the alarm band diminishes as the flow setpoint is reduced. For a full scale range of 20 lb/min and a setpoint setting of 20 lb/min the alarms will activate at  $\pm 1.0$  lb/min. If the setpoint is reduced to 5.0 lb/min, then the alarm band automatically changes to  $\pm 5\%$  of that value or  $\pm 0.25$  lb/min.
- H. ALARM TIMER - When the control is "Enabled" and in automatic servo mode, the "High" (1-2) or "Low" (1-3) alarm light will come on if the flow rate goes above or below the alarm limits. An adjustable timer, labeled "ALARM DELAY" (2-17), which is adjustable from 0 - 10 seconds, will start each time the "High" or "Low" light comes on. If the fault lasts longer than the timer setting the high (or low) light will get brighter and the high (or low) alarm relay contact will transfer and latch. The alarm will stay on after the "Enable" signal is removed until the alarm is reset, either by a remote "Alarm Reset" 24Vdc signal or application of the next "Enable" signal.
- I. ALARM RESET - Activating the alarm-reset circuit (24Vdc applied to Terminal #12) will cancel the alarm relay and the alarm "high" or "low" LED's will go off. Continuous application of the reset signal will disable or inhibit the alarm output signal. The alarms are automatically reset upon receipt of each new "Enable" command.
- J. REMOTE SETPOINT - A remote set point command may be used by pushing button (2-27) until the "Remote" LED (1-9) is on. Apply a 0 - 10 Vdc analog remote set point command signal to the remote input, Terminal #2. A Zero Volt dc signal will correspond to a 0% flow rate command and a 10 Vdc signal will correspond to a 100% flow rate. To verify the remote set point command, push button (1-8). The remote command may come from a remote potentiometer or any 0 - 10 Vdc signal source.
- K. RECORDER OUTPUT- An analog voltage recorder output signal, Terminal #18 with a 0 - 10 Vdc range is available to operate a strip-chart recorder or analog input card in data loggers. The minimum load on this output is 10K Ohms. Shielded cable (20 AWG or larger gage) should be used and the shield should be connected to rear chassis of the FC control. This analog output signal is heavily filtered with a capacitor to provide noise immunity. Additional electrical noise filtering may be necessary at the input terminals of an analog input card to prevent erroneous readings.
- L. MAGNAVALVE OUTPUT- During operation of the MagnaValve a bar graph display (2-13) will indicate the servo command output signal sent to the MagnaValve. The MagnaValve also has an LED on its valve driver junction box to show this function. This LED will pulse at approximately 10 Hertz with the duty cycle (on time to off time ratio) proportional to flow rate. A low duty cycle will provide a low flow rate and the Valve LED will be relatively dim. A long, or continuously on, duty cycle will provide a high flow rate. At 100% duty cycle the Valve LED is constantly on and the permanent magnet field is completely canceled. Shot will fall freely through the valve.

## **7. STABILITY ADJUSTMENTS - (SERVO STABILITY)**

- A. The servo adjustments have been factory set to typical settings and the customer may fine-tune to optimize the speed of response if desired. Since there are many factors that determine system stability, these adjustments should be made slowly. Use the "Servo Gain" (2-23) and "Servo Speed" (2-24) buttons along with ▲ or ▼ to change the servo response.
- B. If the shot flow rate cannot be stabilized, it will be necessary to perform a simple test. Turn the servo "Off" using button (2-20). Enable the control by pressing the "Mode" button (2-22) until the "on" LED is activated and slowly increase the set point from 0% until the flow

display reads the desired value. Since the control is in manual mode, an unstable flow rate indicates that the machine itself is causing the problem, not the servo adjustments (the servo is off).

## 8.SPARE PARTS LIST

There are no spare parts for the FC-24 controller. It is recommended that a spare controller be purchased or the controller be sent to Electronics Inc. for repair service.

## 9.TROUBLE-SHOOTING GUIDE

- A. SYMPTOM: Unstable operation. If the display indicates flow rate variations of more than 5%, check for the following:
1. Air Blast Systems: Air leaks - nozzle, hose, valve, etc.
  2. Pressure regulator malfunction (may be pulsing).
  3. Contaminated shot (dust, oil, water, and broken shot).
  4. Blast hose restricted during nozzle movement.
- B. SYMPTOM: Display reads high value and doesn't change.
1. Wiring defect in the cable to the MagnaValve. Check voltages at Terminals #17 and #18 for proper connection to the MagnaValve.
  2. Be sure the MagnaValve is installed right side up (see flow arrow).
  3. Check to see if the lower portion of the MagnaValve is full of shot due to hose blockage etc.
  4. SYMPTOM: Setpoint does not control flow rate.
  5. Control must be in "Ready" mode, the "Enable" signal must be present (Terminal #4) and the "On" LED must be lighted (1-7).
  6. MagnaValves operate using a magnetic field and have no moving parts. High differential air pressure in air peening applications or suction in wheel peening applications, may force shot through the valve. This symptom is characterized by having shot flowing when the valve is off (red valve LED=off). For direct pressure air-peening systems, be sure the air pressure in the pressure pot is equal to boost the air supply. This will eliminate the differential air pressure that can force shot through the MagnaValve.
- C. SYMPTOM: No alarm output.
1. "On" LED must be on (1-7).
  2. "Servo" must be on (2-19).
  3. High (1-2) or low (1-3) Alarm LED must be on (bright) for alarm relay contact to transfer.
  4. Check  $\pm$  alarm bandwidth; it may be too large.
  5. "Alarm Reset" signal, (24Vdc) should be absent from terminal #12
- D. SYMPTOM: Cannot achieve any flow, or flow rate is very low.
1. "On" light must be on (1 -7).
  2. Setpoint command must be present, push (1-8).
  3. Bar graph display must have one or more elements on.
  4. Check the red LED (2-13) at the MagnaValve. If it is not "on", check for a wiring problem. Check for contamination in or above the MagnaValve, especially check for water, oil, or dust mixture in the shot, or other obstructions. To check, remove the MagnaValve from the machine (keep wires attached). Enable the output and get the red LED valve "on" at 100% duty cycle. When the Valve LED is on, the magnetic field inside the MagnaValve should be completely canceled. No shot should stick inside the MagnaValve. If any shot sticks to the valve, then the MagnaValve is defective.
- E. SYMPTOM: High flow alarm or flow continues when set point is reduced or Enable is turned off.

The MagnaValve is leaking shot. This is usually caused by a pressure difference above and below the valve. Direct pressure air blast systems: The boost air pressure must be equal to the pressure vessel pressure. Gravity fed (suction) air blast systems: The suction induced by some venturi nozzles is quite large. Be sure there is a large (1/2") aspiration air inlet near the bottom of the MagnaValve. The shot needs air to convey it to the nozzle. Older practice was to "choke" the shot like a carburetor to get richer flow rate. Since the MagnaValve acts more like a fuel injector, this choking is not required.

F. SYMPTOM: Shot flow rate is unstable.

1. New installations - refer to servo adjustments.
2. Old installations - machine worked fine until recently.
3. Check shot for cleanliness.
4. Check shot for cleanliness.
5. Check shot for cleanliness.
6. Do not make any servo adjustments.
7. Call the factory for advice.
8. NOTE: This category is the most challenging to troubleshoot. Shot cleanliness and foreign objects are usually the problem. Items such as: wire, welding rod, nuts and bolts from the machine or screen separators, masking tape, razor blades, milk cartons, cigarette butts, etc., seem to find their way to the valve. Remove the MagnaValve and inspect it for contamination. Be sure the shot hopper does not have contamination.

## **10. MAINTENANCE**

There is no maintenance required for the FC-24 controller.

## **11. SPECIFICATIONS**

**FIGURE 1: FRONT PANEL (Operator Controls)**

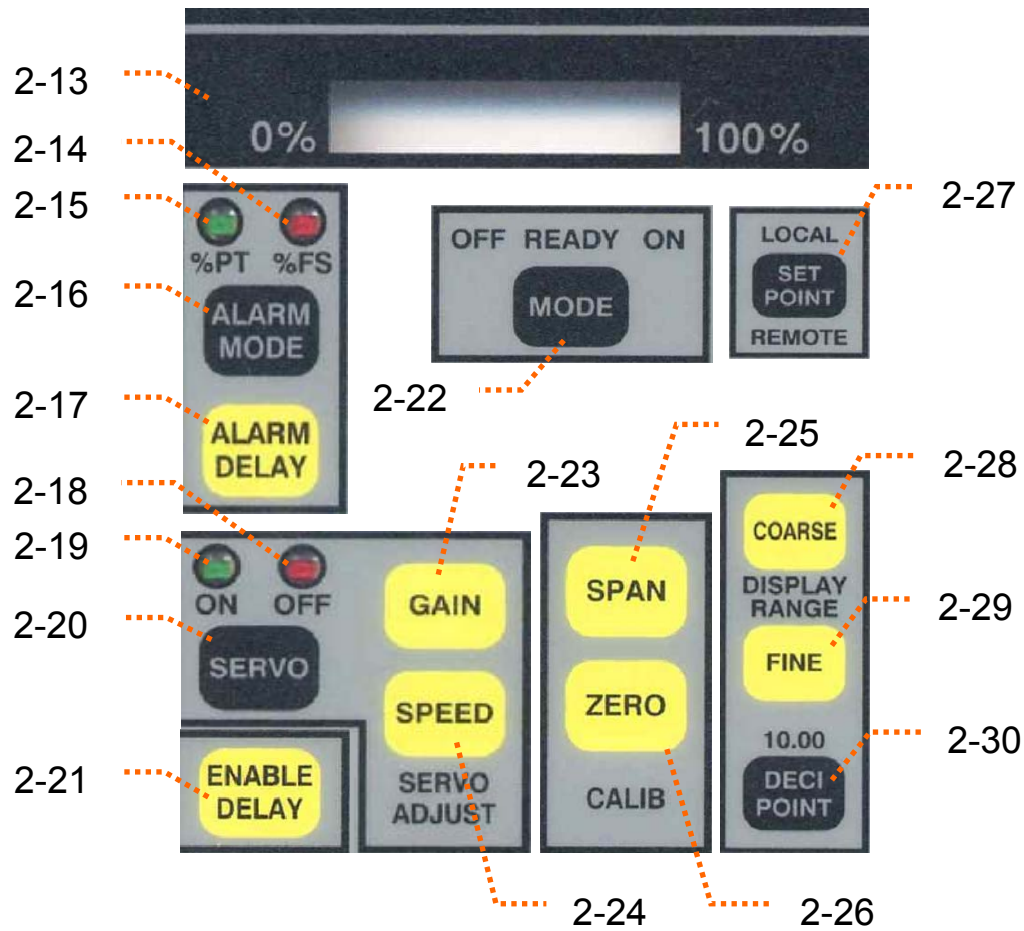


Black switches toggle sequence  
 Yellow switches require up/down ▲ ▼

**FRONT PANEL (upper portion)**

- |                               |                            |
|-------------------------------|----------------------------|
| (1-1) Digital Display         | (1-7) Mode status "On" LED |
| (1-2) High Alarm LED          | (1-8) Setpoint button      |
| (1-3) Low Alarm LED           | (1-9) Remote Setpoint LED  |
| (1-4) Alarm Band button       | (1-10) Local Setpoint LED  |
| (1-5) Mode status "Off" LED   | (1-11) Decrement button ▼  |
| (1-6) Mode status "Ready" LED | (1-12) Increment button ▲  |

**FIGURE 2: FRONT PANEL (Technical Adjustments)**



**FRONT PANEL** (lower portion with plate removed)

2-13	MagnaValve output signal level	2-22	Control Mode button
2-14	Alarm bandwidth % of full scale	2-23	Servo Gain button
2-15	Alarm bandwidth % of setpoint	2-24	Servo Speed button
2-16	Alarm mode button	2-25	Span button for amperage calibrate
2-17	Alarm delay button	2-26	Zero button for zero amperage
2-18	Servo "Off" LED indicator	2-27	Setpoint local/remote button
2-19	Servo "On" LED indicator	2-28	Coarse Display Range
2-20	Servo On-Off button	2-29	Fine Display Range
2-21	Enable Delay button	2-30	Decimal Point

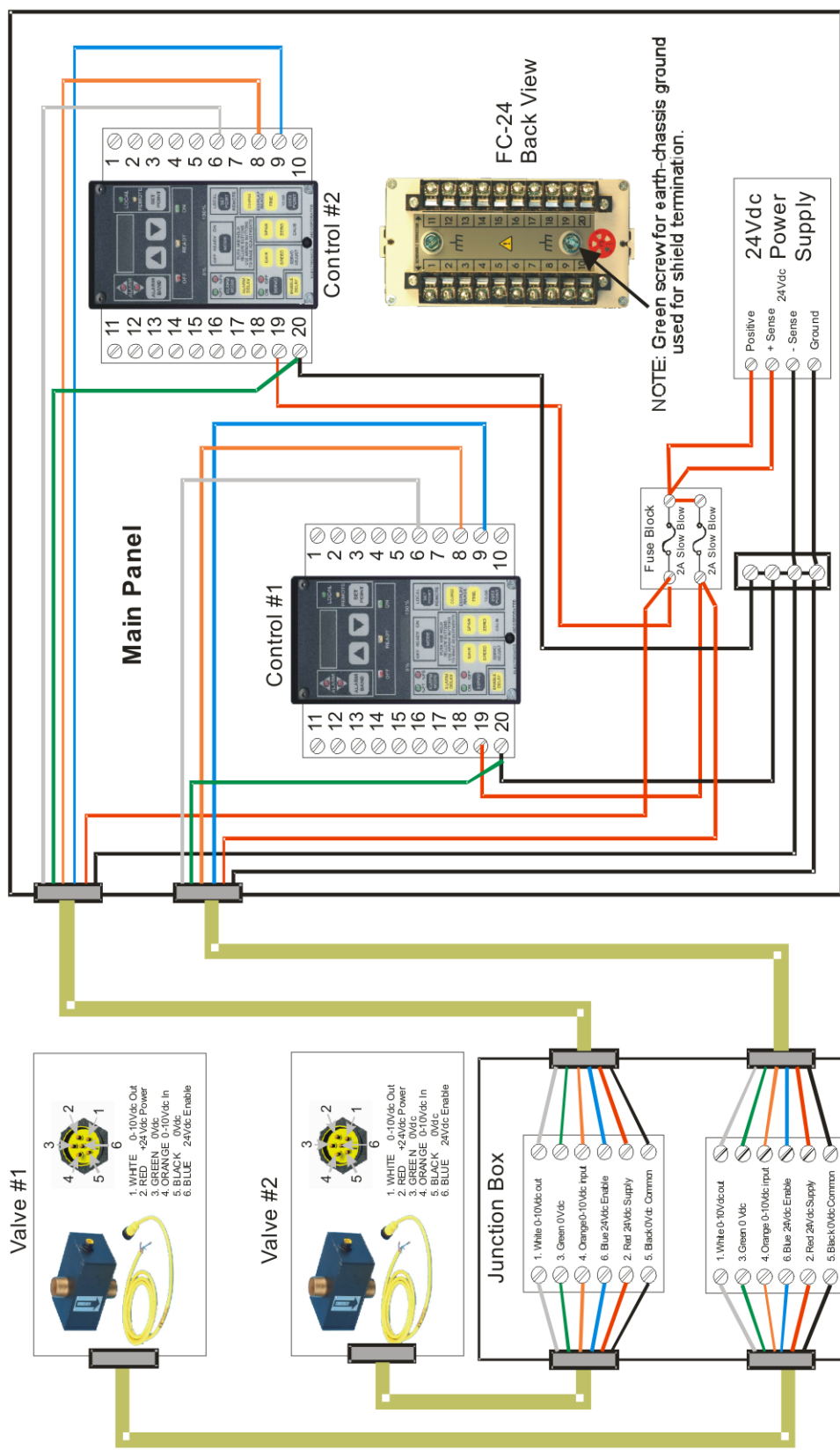
## 12. WIRING CONNECTIONS

Power:	24 Vdc @ 0.5 Amp
Inputs:	0-5 A ac from current transformer loop Remote analog setpoint 0-10 Vdc Enable input 24 Vdc Alarm reset 24 Vdc
Outputs:	Servo output signal 0-10 Vdc Recorder Analog output 0-10 Vdc Alarm relay contacts (rated at 120 Vac @ 0.5 Amp) Enable output signal 24 Vdc
Weight:	2.2 pounds / 1 Kg
Display range:	0-1999
Decimal Points:	1000, 100.0, 10.00
Alarm Bandwidth:	0-50% of full scale or of set point
Alarm Delay:	0-10 seconds
Enable Delay:	0-10 seconds

## 13. HOW TO RETURN CONTROLLERS FOR REPAIR

<b>1</b>	0 Vdc, Common	0 Vdc, Common	<b>11</b>
<b>2</b>	Remote Setpoint (0-10 Vdc)	Alarm Reset (24 Vdc)	<b>12</b>
<b>3</b>	0 Vdc, Common	Alarm High Relay Contact	<b>13</b>
<b>4</b>	Enable Input (24 Vdc)	Alarm Common Relay Contact	<b>14</b>
<b>5</b>	0 Vdc, Common	Alarm Low Relay Contact	<b>15</b>
<b>6</b>	Process Input (0-10 Vdc)	Flow "OK" Relay Contact	<b>16</b>
<b>7</b>	Process Input (0- 0.5 Vac)	0 Vdc, Common	<b>17</b>
<b>8</b>	Servo Output (0-10 Vdc)	Recorder Output (0-10 Vdc)	<b>18</b>
<b>9</b>	Enable Output (24 Vdc)	24 Vdc Power	<b>19</b>
<b>10</b>	0 Vdc, Common	0 Vdc, Common	<b>20</b>

# BASIC WIRING CONNECTIONS 24VOLT SERIES FLOW CONTROL MAGNAVALVES



**Valve #1**

- 1. WHITE 0-10Vdc Out
- 2. RED +24Vdc Power
- 3. GREEN 0Vdc
- 4. ORANGE 0-10Vdc In
- 5. BLACK 0Vdc
- 6. BLUE 24Vdc Enable

**Valve #2**

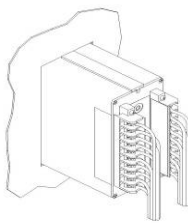
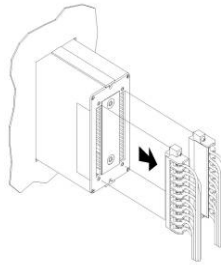
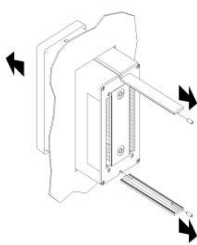
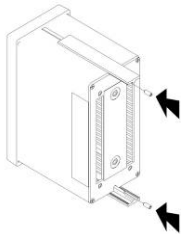
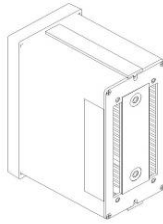
- 1. WHITE 0-10Vdc Out
- 2. RED +24Vdc Power
- 3. GREEN 0Vdc
- 4. ORANGE 0-10Vdc In
- 5. BLACK 0Vdc
- 6. BLUE 24Vdc Enable

**Junction Box**

- 1. White 0-10Vdc out
- 3. Green 0Vdc
- 4. Orange 0-10Vdc input
- 6. Blue 24Vdc Enable
- 2. Red 24Vdc Supply
- 5. Black 0Vdc Common

Note: Cable from Junction box to Main Panel not to exceed 50FT  
Use 16 AWG or larger wire size.

- Wiring Connections FC-24**
- 1. 0Vdc
  - 2. Remote Set Point Input 0-10Vdc
  - 3. 0Vdc
  - 4. Enable Input (24Vdc)
  - 5. 0Vdc
  - 6. Process Input (0-10Vdc)
  - 7. Process Input (0-0.5Vdc)
  - 8. Servo Output (0-10Vdc)
  - 9. Enable Output (24Vdc)
  - 10. 0Vdc
  - 11. 0Vdc
  - 12. Alarm Reset (24Vdc)
  - 13. High Alarm Relay Contact
  - 14. Relay Contact Common
  - 15. Low Alarm Relay Contact
  - 16. Flow OK Relay Contact
  - 17. 0Vdc
  - 18. Recorder Output (0-10Vdc)
  - 19. Power (24Vdc)
  - 20. 0Vdc

<p>1</p>  <p>Installed in panel. Turn "Off" all</p>	<p>2</p>  <p>Remove terminal blocks and leave wires attached.</p>
<p>3</p>  <p>Remove Rails and Rail Mounting Screws.</p>	<p>4</p>  <p>Slide Rails back on and install the Rail Mounting</p>
<p>5</p>  <p>Controller is ready to return.</p>	<p>6</p> <p>Call 1-574-256-5001 ask for a Returns Goods (RG) Number (#)</p> <p>Ship controller with RG # to:</p> <p>Electronics Incorporated 56790 Magnetic Drive Mishawaka, IN 46545</p>