A CLOSER LOOK...

Application Information and Wiring Diagrams for Belimo Products.

The Belimo Difference

- **Basic Electricity**
- **Understanding Wiring Diagrams**
- **Analog Outputs**
- **Wiring Diagrams for Belimo Products**
- **Applications**
- **Specifications**
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I. BASIC ELECTRICITY

I-A. Abbreviations

DC = Direct Current
AC = Alternating Current
VDC = Direct Current Voltage
VAC = Alternating Current Voltage

I-B. Current

A = Ampere
mA = Milliampere = Thousandths of an ampere.  (Example: 12mA = 12/1000 = .012A)
I = The symbol for current in mathematical formulas.

I-C. Voltage

V = Volt*
mV = Millivolt = Thousandths of a volt.  (Example: 5mV = 5/1000 = .005V)
E = The symbol for voltage in mathematical formulas.

I-D. Resistance

Ω = Ohm = Resistance
kΩ = Kilo ohm = Thousands of ohms.  1kΩ = 1,000Ω
MΩ = Mega ohm = Millions of ohms.  1MΩ = 1,000kΩ = 1,000,000Ω
R = The symbol for resistance in mathematical formulas.

I-E. OHM’s Law

E = Voltage       I = Current       R = Resistance

E = I x R       Example: I = 20mA,  R = 500Ω  Therefore, E = .020 x 500 = 10V
R = E/I       Example: E = 1.35V,  I = 10mA  Therefore, R = 1.35/.010 = 135Ω
I = E/R       Example: E = 120V,  R = 50Ω  Therefore, 120/50 = 2.4A

I-F. Power

W = Watt*
mW = Milliwatt = Thousandths of a watt  (Example: 7mW = 7/1000 = .007W)
kW = Kilowatt = Thousands of watts  (Example: 1kW = 1,000W)

I-G. Power Calculations

W = E x I       Example: V = 24V,  I = 260mA  Therefore, W = 24 x .260 = 6.24W
W = R x I^2       Example 1: R = 100Ω,  I = 3A
W = 100 x 3^2 = 100 x 3 x 3 = 900W
Example 2: R = 500Ω,  I = 20mA = .020A
W = 500 x .020^2 = 500 x .020 x .020 = 500 x .0004 = .2W or 200mW.

W = E^2/R       Example: V = 24V,  R = 100,  Therefore, W = 24^2/100 = 24 x 24/100 = 5.76W

* I.S.O. standard indicates “U” be used for voltage and “P” for power.
I-H. Series Connection of Resistors

Resistors that are connected in series have a total resistance value that is equal to the sum of all the resistance values of the resistors.

Example: \( R_1 = 200\,\Omega \quad R_2 = 250\,\Omega \quad R_3 = 1.0k\,\Omega \quad R_{\text{Total}} = R_1 + R_2 + R_3 = 200\,\Omega + 250\,\Omega + 1.0k\,\Omega = 1.45k\,\Omega \)

The total resistance is always larger than the largest single resistor!

I-I. Parallel Connection of Resistors

If all the resistors have the same resistance value, the total resistance will be equal to the resistance value of one resistor divided by the number of resistors.

Example: Five equal resistors \( R = 100k \) are connected in parallel. The total resistance \( R_{\text{Total}} = R/5 = 100/5 = 20k \)

If the resistors that are connected in parallel have different values, the following formula must be used:

\[
\frac{1}{R_{\text{Total}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}
\]

\[
R_{\text{Total}} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} = \frac{1}{\frac{1}{200} + \frac{1}{250} + \frac{1}{1000}} = .005 + .004 + .001 = .01
\]

The total resistance is always smaller than the smallest single resistor!

I-J. Impedance

The expression “impedance” is used in the BELIMO literature in the following way:

- **Input impedance:** The input circuit of a control device, based on its circuitry, has a certain electrical resistance. The value of this resistance determines how much current the device will draw from the controller. This value must be taken into consideration when connecting any device to a controller output. Example: “Input impedance 100 kΩ.” This means that the DC resistance between the input (Y or Y1) and common (COM) is 100 kΩ (100,000 ohm). When the signal is 10 VDC, using Ohm’s Law (I=E/R), the current draw on the output of the controller will be (10V/100,000 Ω) = .0001A = .1 mA for each actuator that is connected to the signal. The combined input impedance must be higher than the controller output impedance.

- **Output impedance:** The output of a controller has a limited amount of current capacity to supply to the devices it is controlling. The capacity can be given in one of 2 ways. One way is by stating it as “Maximum output current .2 mA.” The other is by giving its output impedance. The output impedance must always be lower than the combined input impedance of the devices being controlled. Example I: “Output impedance 1000Ω minimum.” This means that the combined input impedance of the devices being controlled must be greater than 1000Ω. Example II: “Maximum output current .2 mA.” Based on a 0 to 10 VDC control signal, the output impedance would be equal to R=E/I or (10V)/(.0002A) = 50kΩ

In general, the higher the input impedance, the lower the current draw, therefore less strain on the controller output. The lower the output impedance, the more current available; the more current available, the more devices can be controlled.

I-K. Power Consumption (W) / Volt Amperes (VA)

When a device is powered with direct current (DC), or alternating current (AC) into a pure resistive load (bulb, heater, etc.), the rated power consumption is watts (W) and is the product of the current (I) and voltage (E), \( W = E \times I \).
When an actuator is powered with alternating current (AC), the actual power consumption in watts (W) inside the actuator will remain the same. However, due to the inductive and capacitive character of the load, a shift between current and voltage occurs (phase shift). This results in an “apparent” power consumption, which is higher than the actual power consumption. The “apparent” power consumption is expressed in volt-amperes (VA), which is the product of AC volts and the current (VA = V x I x efficiency.)

The size of a transformer is expressed in volt-amperes (VA) and not in watts (W). **The VA rating of a transformer must be at least as large as the combined VA rating of all the actuators connected to the transformer.**

**Example:** Actuator AM24 US.
Power consumption: 2.5 W. Transformer sizing: 4.5 VA

If five (5) AM24 US are connected to one transformer, the VA rating of the transformer must be 5 x 4.5 VA = 22.5 VA, or larger.

It is better to use a number of small transformers than one large one.

The Belimo products are designed to be powered from Class II transformers for UL applications. These transformers have internal power limitation. A Class II transformer must not provide more than 30 V and no more than 100 VA output. **Do not use a Class I transformer and fuse, because it does not constitute a Class II power source!**

**I-L . Wire Sizing**
Using the correct wire size is important when long wire runs are used. Using too small of a wire increases the resistive losses of the run. The result of this may be too low of a voltage at the actuator to operate correctly. The above chart can be used to determine the correct wire size to use for an application.

**Example I:** Three AM24-SR US actuators are powered from the same wire. The wire run is 100 feet.

Step #1. Calculate the total power required. The AM24-SR US requires 5 VA, 3 actuators are being used. 3 x 5 = 15 VA Total.

Step #2. Locate 15 VA on the vertical axis of the chart and 100 feet on the horizontal axis.

Step #3. Find the intersection of 15 VA and 100 Ft (Point “A”)

Step #4. Read the diagonal line to the **right** of point “A”. It is the 18 ga. wire gauge line. Use 18 ga. or larger wire.

**Note: A low gauge number = a thicker wire; A high gauge number = a thinner wire.**

**Example II:** The maximum wire length for a 10 VA power consumption using different wire gauges.

<table>
<thead>
<tr>
<th>Point</th>
<th>Gauge</th>
<th>Max. Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>“B”</td>
<td>22 Ga</td>
<td>Max. 60 FT</td>
</tr>
<tr>
<td>“C”</td>
<td>20 Ga</td>
<td>Max. 120 FT</td>
</tr>
<tr>
<td>“D”</td>
<td>18 Ga</td>
<td>Max. 220 FT</td>
</tr>
<tr>
<td>“E”</td>
<td>16 Ga</td>
<td>Max. 350 FT</td>
</tr>
<tr>
<td>“F”</td>
<td>14 Ga</td>
<td>Max. 550 FT</td>
</tr>
<tr>
<td>“G”</td>
<td>12 Ga</td>
<td>Max. 900 FT</td>
</tr>
</tbody>
</table>
I-M. Multi-Conductor Wire Types

- “BELL WIRE” has parallel wires, which may act as an antenna and is therefore sensitive to electrical noise. This type of wire should not be used for control circuits.

- “TWISTED PAIR” cancels out most of the electrical noise because the wires alternate their positions. This is the type of wire that is used for most control circuits.

- “SHIELDED WIRE” is a twisted pair that is surrounded by a metal foil or wire mesh which acts as a shield and prevents electrical noise from reaching the wires inside.

Shielded wires are used for the BELIMO actuators only if the electrical noise is very severe. Normally twisted pairs are sufficient. Remember! The shield must be grounded in one point only!

I-N. Ground Loops

If a shield is grounded at both ends of a shielded wire, a ground loop is created. Ground loops will defeat the purpose of shielding, and aggravate the electrical noise problem.

Ground loops can also be created by using more than one wire for signal common (COM \(⊥\)). The (-) signal common terminals on the controller are usually interconnected. Therefore, a ground loop is formed when two or more signal common terminals of the controller are wired to the same transformer. (See Fig. 11-5 and 11-6, page 175.)

Signal common (COM \(⊥\)) is necessary, as a reference, but only one connection should be used.

Redundant signal common terminals should not be connected.

A ground loop acts as an antenna and will pick up electrical noise. This should be avoided, by using the correct wiring practice.
II. UNDERSTANDING WIRING DIAGRAMS

II-A. Electrical Symbols

<table>
<thead>
<tr>
<th>U.S. Electrical Symbols for Contacts</th>
<th>International Symbols for Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.O. (NORMALLY OPEN)</td>
<td>N.O. SWITCHING</td>
</tr>
<tr>
<td>N.C. (NORMALLY CLOSED)</td>
<td>N.C.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Traditional Electronic Symbols for Contacts</th>
<th>Belimo Proportional Actuators- Wire Symbols and Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORMALLY OPEN</td>
<td>COMMON ↓</td>
</tr>
<tr>
<td>NORMALLY CLOSED</td>
<td>24VAC POWER</td>
</tr>
<tr>
<td>SWITCHING</td>
<td>0...10VDC SIGNAL</td>
</tr>
<tr>
<td>TRI-STATE FLOATING CENTER OFF</td>
<td>0...20V Phase-cut Signal</td>
</tr>
<tr>
<td></td>
<td>2...10VDC Feedback Signal</td>
</tr>
<tr>
<td></td>
<td>Not applicable for NM24 SR and NM24 SRS</td>
</tr>
</tbody>
</table>

II-B. Compatibility of Different Power Supplies

Power Supply with Half-Wave Rectifier

Half-wave rectifiers offer the advantage of using the same connection for the AC common and DC common. Therefore, the common of different devices using half-wave rectifiers can be interconnected and use the same power source.

Some devices, typically DDC controllers, have full-wave rectifiers. In this case, always use a separate transformer for the controller.

Power Supply with Full-Wave Rectifier

Full-wave rectifiers provide more current capacity. Their disadvantage is that the AC and DC sides cannot be interconnected.

Every device which has a full-wave rectifier must be powered from its own separate transformer, if the COM ↓ wire is connected to the Common of other devices.

**Note:** If a device with a full-wave rectifier is powered from the same transformer as a device with a half-wave rectifier, a short circuit will result if the commons (COM ↓) are interconnected.

The Belimo products use half-wave rectifiers. Therefore, they may be connected to the same transformer as long as all commons (COM ↓) are connected to the same leg of the transformer. However, anytime actuators are connected to a controller a separate transformer should be used for the controller power supply unless you know that the controller also uses a half-wave rectifier.
II-C. Connection of Actuators

0 to 10 V Control Signals

**Signal Loss**

Due to the high input impedance (100kΩ) of the actuators, the current through the signal wire is very low. Therefore, the loss of signal will be negligible, even if with long wire runs.

Example: Three actuators are connected via a 330 ft. (100 meters) long pair of 22 Ga. wires. Each wire has a resistance of 5Ω.

The current draw from each actuator is \( I = \frac{E}{R} = \frac{10}{100,000} = 0.1 \text{ mA} \), when the signal is 10 VDC.

The current in the wire will be \( 3 \times 0.1 = 0.3 \text{ mA} \). Because 2 wires, the Common and the Source, go to the actuator, the resistance in the wires is \( 2 \times 5\Omega = 10\Omega \). The loss of signal will be \( E = R \times I = 10 \times 0.3 = 3 \text{ mV} = -.003V \).

4 to 20 mA Control Signals

The controller will regulate the output current (signal) to the desired value, regardless of the resistance (up to a specified value) in the wires and the load resistor.

The resistance in the wires will only cause the output voltage of the controller to be slightly higher than the input of the actuators. The advantage with a 4 to 20 mA output signal to the actuators is that wire resistance does not cause any error to the control signal, and that electrical interference is rejected.

The input impedance of the actuators will reduce the resulting resistance of the load resistor. However, the error is so small that there is no need to compensate for this by using a slightly higher resistance value. A 500Ω load resistor will give an adequate accuracy. Use a 499Ω, 1%, 1/2w resistor or two 1kΩ, 1%, 1/4 w resistors in parallel.
Understanding Wiring Diagrams

Modulating Control Signal Wiring

Fig. II-1  Single Output to Single Actuator

Fig. II-2  Multiple Outputs to Multiple Actuators Using 1 Transformer for Actuators

Fig. II-3  Multiple Outputs to Multiple Actuators Using 2 Transformers for Actuators
II-D. Long Distance Wiring

![Diagram of long distance wiring](image)

All the common on the controller are assumed to be internally connected.

**These wires can be long because the wires between the controller and the junction box carry a very low load. (See Section IC. "Signal Loss".) Therefore, the wire length and size is of no concern.**

**These wires should be relatively short, because the wires between the junction box and the actuators carry AC power. See Section II.D for wire sizing.**

Always use a separate transformer for the controller unless you know a half-wave rectifier is used!

Fig. II-4

II-E. Wiring Mistakes

![Diagram of wiring mistakes](image)

All the common on the controller are assumed to be internally connected.

**Do not connect redundant common wires!**

Wiring in this manner will cause ground loops. Also, there will be a short if the connections to terminals #1 and #2 on one of the actuators are crossed by mistake. This may damage the controller, actuator or transformer.

Fig. II-5 A common wiring problem

Wiring in this manner gives the following advantages:

- Ground loops are eliminated.
- The number of wires is reduced.
- If wires #1 and #2 of an actuator are crossed by mistake, the actuator will not work properly but no damage will occur. Resolve the problem by rewiring in the correct manner.

Fig. II-6 Correct Wiring
III. ANALOG OUTPUTS

III-A. 2 to 10 Volt Analog Output

The controller produces a variable voltage between signal common and the analog output.

The signal common (wire #1) of the actuator must be connected to the signal common of the controller, and the output of the controller is connected to actuator signal input (wire #3).

III-B. Sourcing 4 to 20 mA Analog Output

A sourcing 4 to 20 mA analog output sends out a current to the actuator, and receives it at the signal common terminal.

It is similar to a 0 to 10 V output. The only difference is that one 500Ω resistor has to be installed between wires #3 and #1 at the actuator. The resistor converts the current (4 to 20 mA) to a 2 to 10 V signal. The resistor should be located at the actuator.

III-C. Sinking 4 to 20 mA Analog Output

A sinking 4 to 20 mA output uses a different logic to create a control signal. In both a 0 to 10 VDC and sourcing 4 to 20 mA application, the signal is regulated at the positive (+) source of the signal. In a sinking application the signal is regulated between wires #1 and #3 on one actuator connected to each output. (One resistor for each output.) Terminal #1 on the actuator is connected to the output of the controller.

The current will run from the constant voltage on the controller, to wire #3 on the actuator, through the 500Ω resistor, to wire #1, and back to the input of the controller.

From the controllers point of view, all the #3 terminals of the actuators are at a “common” constant +24VDC. The signal common, wire #1, of the actuators will vary with the control signal.

Because the signal common of the actuators is variable, each output requires a separate transformer. The signal common of actuators connected to different outputs must never be interconnected. (See note ** in the wiring diagram)
III-D. Parallel Operation

![Diagram of Parallel Operation]

III-E. Master-Slave operation

![Diagram of Master-Slave Operation]

III-F. Monitoring feedback with a remote indicator

![Diagram of Feedback Monitoring]

III-G. One Output/Multiple Transformers

![Diagram of One Output/Multiple Transformers]

Note: If multiple actuators are on one shaft, see Section V-A.
IV. WIRING DIAGRAMS FOR BELIMO PRODUCTS

IV-A. On/Off Control, 24V

- 24 VAC Transformer
  - 1 Common: Blk
  - 2 Hot: Red
  - 3 Ground: Wht

- 24 VAC Transformer
  - 1 Common: Blk
  - 2 Hot: Red
  - 3 Ground: Wht

- 24 VAC Transformer
  - 1 Common: Blk
  - 2 Hot: Red
  - 3 Ground: Wht

Notes:
- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel.
- Power consumption and input impedance must be observed.
- Actuators may also be powered by 24 VDC.
- Meets cULus or UL and CSA requirements without the need of an electrical ground connection.
- Actuators with plenum rated cable do not have numbers on wires; use color codes instead.
- Actuators with appliance cables are numbered.
- Ground connection required only for Fire and Smoke actuators.

IV-B. On/Off Control, 120/230V

- 120 VAC
  - 1 Neutral: Blk
  - 2 Hot: Red
  - 3 Ground: Wht

- 100 to 240 VAC
  - 1 L1: GM
  - 2 L2: H1

Notes:
- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel.
- Power consumption and input impedance must be observed.
- TF, GM, AM, NM, and LM can be supplied with both 120 VAC and 230 VAC.
- Meets cULus or UL and CSA requirements without the need of an electrical ground connection.
- Actuators with plenum rated cable do not have numbers on wires; use color codes instead.
- Actuators with appliance cables are numbered.
- Ground connection required only for Fire Smoke actuators.
**Wiring Diagrams for Belimo Products**

**IV-C. Floating Point Control, 24V**

**Notes:**
- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel. Power consumption and input impedance must be observed.
- Actuators may also be powered by 24 VDC.
- Meets cULus, or UL or CSA requirements without the need of an electrical ground connection.
- Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance rated cable use numbers.
- For triac sink the Common connection from the actuator must be connected to the Hot connection of the controller. The actuator must be connected to the control board common.

**IV-D. Floating Point Control, 120/230V**

**Notes:**
- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel. Power consumption and input impedance must be observed.
- LM, NM, AM, GM, LP, and AR can be supplied with both 120 VAC and 230 VAC.
- Meets cULus requirements without the need of an electrical ground connection.
- Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables are numbered.
IV-E. Proportional Control, 24V

Notes:
- Provide overload protection and disconnect as required.
- Up to Four Actuators may be connected in parallel.
- Power consumption and input impedance must be observed.
- Actuator may also be powered by 24 VDC.
- Meets cULus or UL and CSA requirements without the need of electrical ground connection.
- Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables are numbered.
- Only connect common to neg. (—) leg of control circuits.
- A 500 Ω resistor converts the 4 to 20mA control signal to 2 to 10 VDC.

IV-F. Proportional Control, 120/230V

Notes:
- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel. Power consumption and input impedance must be observed.
- LM, NM, and AM can be supplied with both 120 VAC and 230 VAC.
- Meets cULus requirements without the need of an electrical ground connection.
- Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables are numbered.
- Only connect common to neg. (—) leg of control circuits.
- A 500 Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC.
- 24 VAC power supply output.
### IV-G. Multi-Function Control

#### Spring Return

**VDC/4-20 mA**

- **24 VAC Transformer**
  - Line Volts
  - Control Signal: 2 to 10 mA (4-20 mA)
  - Feedback Signal: 2 to 10 VDC

**Two Position**

- **24 VAC/DC Transformer**
  - Line Volts
  - Control Signal: 2-10 VDC or 4 to 20 mA
  - Feedback Signal: + Hot or Feedback VDC

**PWM**

- **24 VAC Transformer (AC only)**
  - Line Volts
  - Position Feedback VDC

#### Floating Point

- **24 VAC Transformer**
  - Line Volts
  - Control Signal: 2 to 10 VDC
  - Feedback Signal: 2 to 10 VDC

**Override control to min, mid, max positions**

- **24 VAC Transformer**
  - Line Volts
  - Control Signal: 2-10 VDC or 4 to 20 mA

#### Non-Spring Return

**VDC/4-20 mA**

- **24 VAC Transformer**
  - Line Volts
  - Control Signal: 2 to 10 mA (4-20 mA)
  - Feedback Signal: 2 to 10 VDC

**Two Position**

- **24 VAC/DC Transformer**
  - Line Volts
  - Control Signal: 2-10 VDC or 4 to 20 mA
  - Feedback Signal: + Hot or Feedback VDC

**PWM**

- **24 VAC Transformer (AC only)**
  - Line Volts
  - Position Feedback VDC

#### Notes:

- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel if not mechanically mounted to the same shaft. Power consumption and input impedance must be observed.
- Actuators may also be powered by 24 VDC.
- Meets UL and CSA requirements without the need of an electrical ground connection.
- Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables are numbered.
- A 500 Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC.
- Control signal may be pulsed from either the Hot (Source) or Common (Sink) 24 VAC line.
- Contact closures A & B also can be triacs. A & B should both be closed for triac source and open for triac sink.
- For triac sink the Common connection from the actuator must be connected to the Hot connection of the controller.
- Position feedback cannot be used with a Triac sink controller. The actuator internal common reference is not compatible.
- IN4004 or IN4007 diode. (IN4007 supplied, Belimo part number 40155)

- Actuators may be connected in parallel if not mechanically mounted to the same shaft. Power consumption and input impedance must be observed.
- Actuators may also be powered by 24 VDC.
- Meets UL and CSA requirements without the need of an electrical ground connection.
- Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables are numbered.
- A 500 Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC.
- Control signal may be pulsed from either the Hot (Source) or Common (Sink) 24 VAC line.
- Contact closures A & B also can be triacs. A & B should both be closed for triac source and open for triac sink.
- For triac sink the Common connection from the actuator must be connected to the Hot connection of the controller.
- Position feedback cannot be used with a Triac sink controller. The actuator internal common reference is not compatible.
Wiring Diagrams for Belimo Products

IV-H. 0 to 135Ω Control

Override

Low Limit Control

High Limit Control

Wiring multiple actuators to a Series 90 controller.

Wiring multiple actuators to a Series 90 controller using a minimum position potentiometer.

Used with the W973 and W7100 controllers.

Typical wiring diagrams for multiple actuators used with the W973, W7100 and T775 controllers.

Special Wiring
IV-I. Auxiliary Switch Wiring

Auxiliary switch wiring for AF...S US

Auxiliary switch wiring for NF...S US

Auxiliary switch wiring for LF...S US, TF...S, LxB24-3-S, and AxB24-3-S

Add on Auxiliary Switches
S1A/S2A for GM, AM, NM and LM

Auxiliary Switch Ratings

<table>
<thead>
<tr>
<th>Product</th>
<th>Voltage</th>
<th>Resistive Load</th>
<th>Inductive Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF...S US</td>
<td>250</td>
<td>7.0 A</td>
<td>2.5 A</td>
</tr>
<tr>
<td>NF...S US</td>
<td>250</td>
<td>7.0 A</td>
<td>2.5 A</td>
</tr>
<tr>
<td>LF...S US</td>
<td>250</td>
<td>6.0 A</td>
<td>1.5 A</td>
</tr>
<tr>
<td>TF...S US</td>
<td>250</td>
<td>3.0 A</td>
<td>0.5 A</td>
</tr>
<tr>
<td>AM...S</td>
<td>250</td>
<td>3.0 A</td>
<td>0.5 A</td>
</tr>
<tr>
<td>LM...S</td>
<td>250</td>
<td>3.0 A</td>
<td>0.5 A</td>
</tr>
<tr>
<td>S1A, S2A</td>
<td>250</td>
<td>3.0 A</td>
<td>0.5 A</td>
</tr>
</tbody>
</table>

Notes:
Two built-in auxiliary switches (2xSPDT), for end position indication, interlock control, fan startup, etc.
One built-in auxiliary switch (1xSPDT), for end position indication, interlock control, fan startup, etc.
Meets cULus or UL and CSA requirements without the need of an electrical ground connection.
IV-J. Accessories

Feedback Potentiometer
P...A used with GM / AM / NM / LM

Provide overload protection and disconnect as required.
The controller should be powered from a separate transformer.
The actuator and IRM-100 may be powered from the same transformer.
Consult controller instruction data for more detailed installation information.
To reverse control rotation, use the reversing switch.

IRM-100 Input Rescaling Module

Remote Control

24 VAC Transformer

Line Volts

1 Common 2 + Hot 3 Y 4 Y 2 5 U

Override control

A

A

B

1 Common 2 + Y 3 Y 4 Z

SGA24 SGF24

Provide overload protection and disconnect as required.
Override switches are optional.

SGA, SGF Positioners

Minimum Position Setting

24 VAC Transformer

Line Volts

1 Common 2 + Hot 3 Y 4 Z

0 to 10 VDC Control Signal

1 Common 2 + Y 3 Y 4 Z

SGA24 SGF24

Provide overload protection and disconnect as required.
Override switches are optional.

SBG 24 Range Controller

24 VAC Transformer

Line Volts

1 Common 2 + Hot 3 Y 1 4 Y 2 5 U

SBG24

Provide overload protection and disconnect as required.
Actuators may be connected in parallel. Power consumption and input impedance must be observed.
The actuator and SBG-24 may be powered from the same transformer.
The controller should be powered from a separate transformer.
Wire No. 4 on the NM24-SR US is used for feedback.

ADS-100 Analog to Digital Switch

24 VAC Transformer

Line Volts

1 Common 2 + Hot 3 Y 1 4 Y 2 5 U

ADS-100

5.7.9 = Switch point reference signal for manual adjustment of stages 1,2, & 3 respectively.
Actuator and controller must have separate transformers.
IV-J. Accessories (continued)

2 3 10 9
1 11

NSV 24

max
4A (T)

AM24 US

PTA-250 Pulse Width Modulation Interface

PTA-250

2 3 1 10 9
1 11

NSV 24

max
4A (T)

AM24 US

NSV 24 Battery Back-up Module

ZAD24 Digital Position Indicator

ZG-R01, ZG-R02 Resistor Kits

The impedance of the device attached must be 100kΩ.
V. APPLICATION INFORMATION

V-A. Wiring for Multiple Actuators on One Shaft (AF/GM, for other actuators use next higher torque actuator)

**Notes:**
- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel. Power consumption must be observed.
- May also be powered by 24 VDC.
- Set reversing switch (CCW-CW)(A-B) as required by control logic and control range.

<table>
<thead>
<tr>
<th>Actuators which may be used on one shaft:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>AF24(-S) US</td>
</tr>
<tr>
<td>AF120(-S) US</td>
</tr>
<tr>
<td>AF230(-S) US</td>
</tr>
<tr>
<td>AF24-SR US</td>
</tr>
<tr>
<td>GM24 US</td>
</tr>
<tr>
<td>GM24-SR US</td>
</tr>
<tr>
<td>AM24(-S) US</td>
</tr>
<tr>
<td>AM24-SR US</td>
</tr>
</tbody>
</table>
V-A. (continued) Wiring for Multiple Actuators on One Shaft (AF/GM, for other actuators use next higher torque actuator)

**All actuators except AF24-SR US**

**AF24-SR US**

**Typical wiring of multiple dampers with more than one AF24-SR US mounted on a single shaft.**
V-E. Floating Control Using a 2-wire DC Control Signal

Explanation: The diode allows the positive (+) signal to pass through it and does not allow a higher level positive signal to back feed to the other controller. Only the highest controller signal is seen by the actuator. There is a .7 VDC voltage loss across the diode. This makes the actual voltage range 2.7 to 10.7 VDC.

IN4001, IN4003 diode or equivalent, observe polarity.

V-F. Operating two 0 to 10 VDC Controllers with the Higher of Two Control Signals

IN4001, IN4003 diode or equivalent, observe polarity.

V-G. Minimum Position with 0 to 10 VDC Actuators

Minimum Position Setting

Provide overload protection and disconnect as required.
Override switches are optional.

V-H Wiring to Johnson Controls A350P Controller

Step 3

Power polarity must be correct
V-I. Wiring to Honeywell T775 Controller

Note: The T775 Controllers have an adjustable control range of 0 to 18 VDC. Use the T775 Calibration instructions to calibrate a 2 to 10 VDC range.

Use separate transformer for T775 if powering from 24 VAC.

Resistor 500 Ω 1/2 W (ZG-R01)