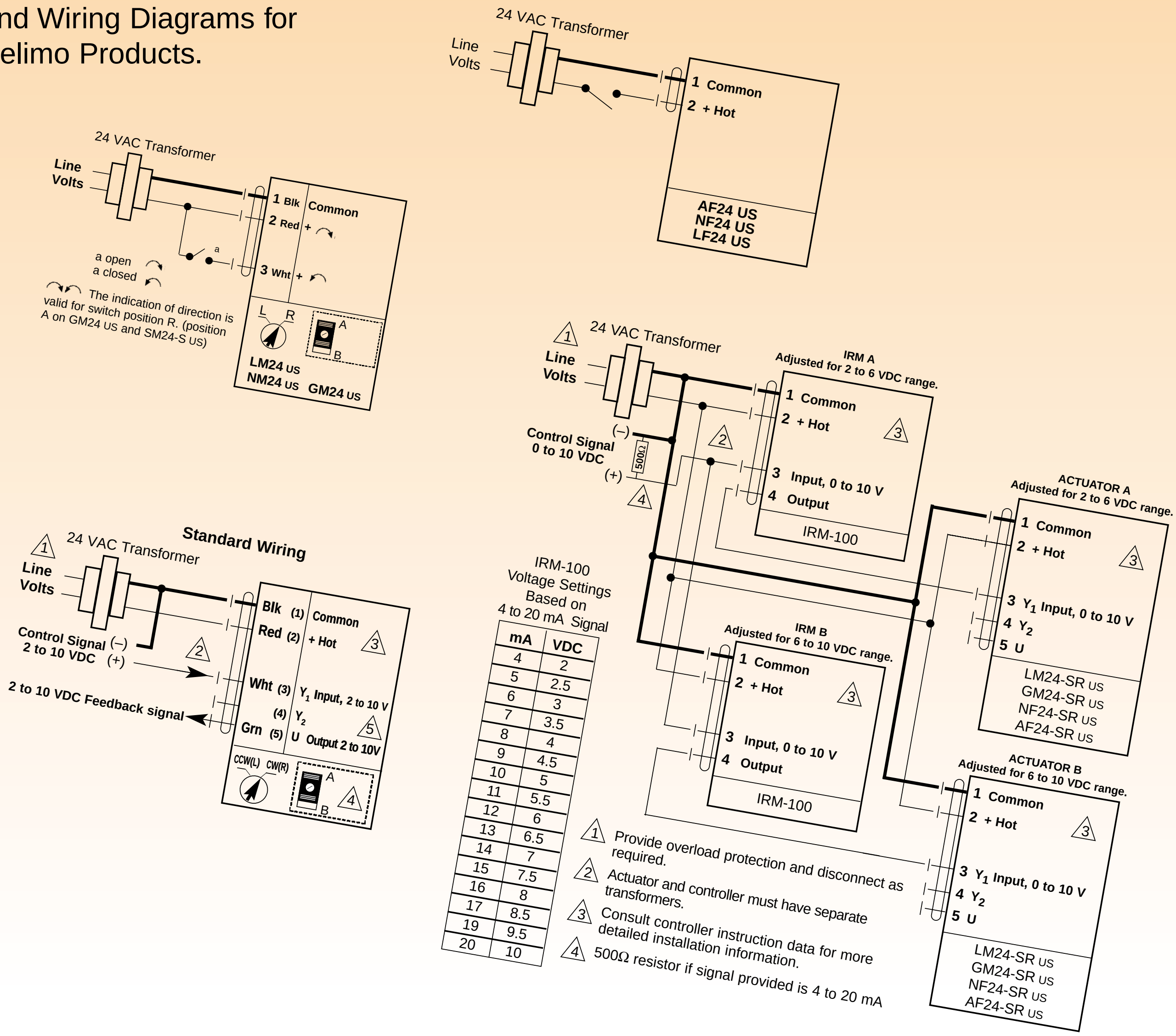
A CLOSER LOOK…

Application Information and Wiring Diagrams for Belimo Products.



mA	VDC
4	2
5	2.5
6	3
7	3.5
8	4
9	4.5
10	5
11	5.5
12	6
13	6.5
14	7
15	7.5
16	8
17	8.5
19	9.5
20	10

The Belimo Difference

- *Basic Electricity*
- *Understanding Wiring Diagrams*
- *Analog Outputs*
- *Wiring Diagrams for Belimo Products*
- *Applications*

BELIMO

INDEX

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 = Megohm = 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

$W = R \times I^2$ *Example 1:* R = 100Ω, I = 3A
$W = 100 \times 3^2 = 100 \times 3 \times 3 = 900W$
Example 2: R = 500Ω, I = 20mA = .020A
$W = 500 \times .020^2 = 500 \times .020 \times .020 = 500 \times .0004 = .2W$ or 200mW.

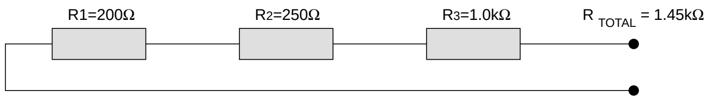
$W = E^2/R$ *Example:* V = 24V, R = 100, Therefore, $W = 24^2/100 = 24 \times 24/100 = 5.76W$

*** 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.

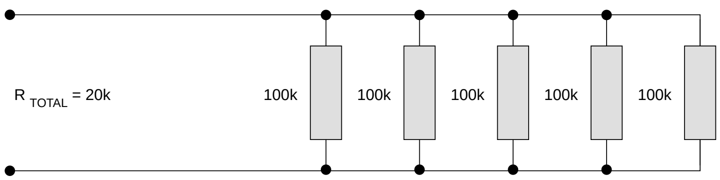
Example: $R_1 = 200\Omega$ $R_2 = 250\Omega$ $R_3 = 1.0k\Omega$ $R_{Total} = R_1 + R_2 + R_3 = 200\Omega + 250\Omega + 1.0K\Omega = 1.45k\Omega$



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

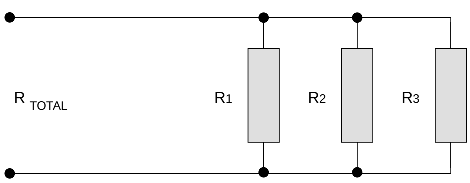
I-I. Parallel Connection of Resistors

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 $R_{Total} = R/5 = 100/5 = 20k$

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



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

Example: R1 = 200 R2 = 250 R3 = 1.0k

$$\frac{1}{R_{TOTAL}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{TOTAL}} = \frac{1}{200} + \frac{1}{250} + \frac{1}{1000} = .005 + .004 + .001 = .01$$

$$R_{TOTAL} = \frac{1}{.01} = 100\Omega$$

$$\mathbf{R_{TOTAL} = 100\Omega}$$

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 x 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 15VA 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.

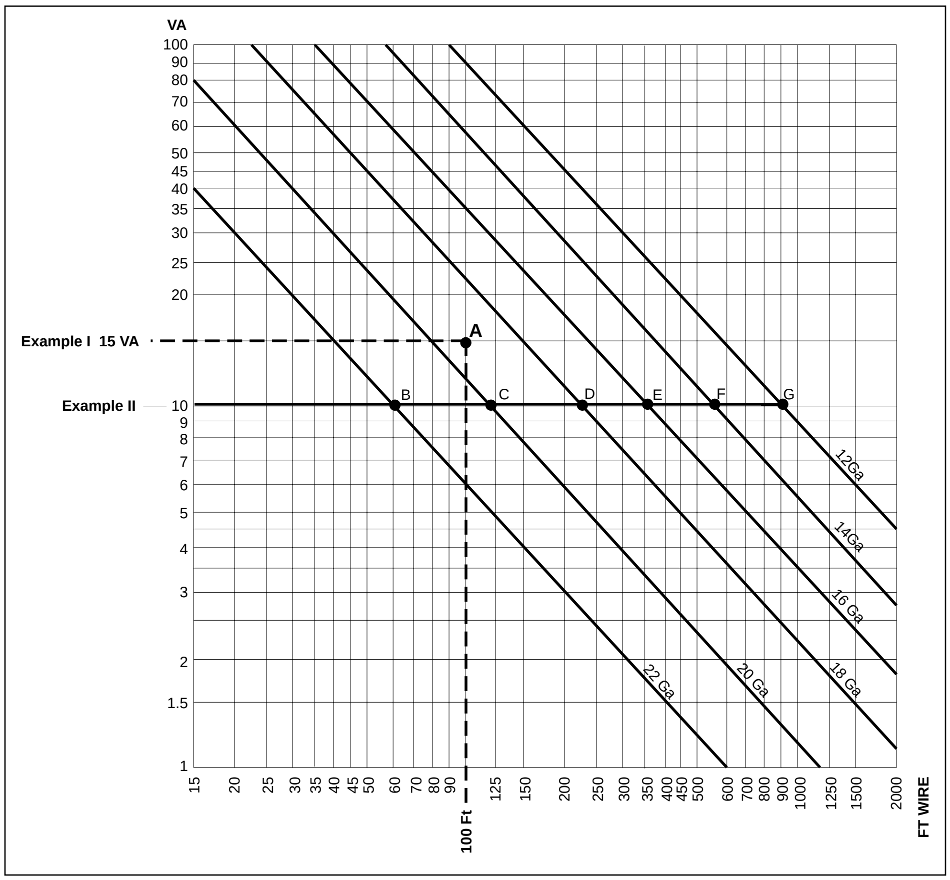


Chart 1

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

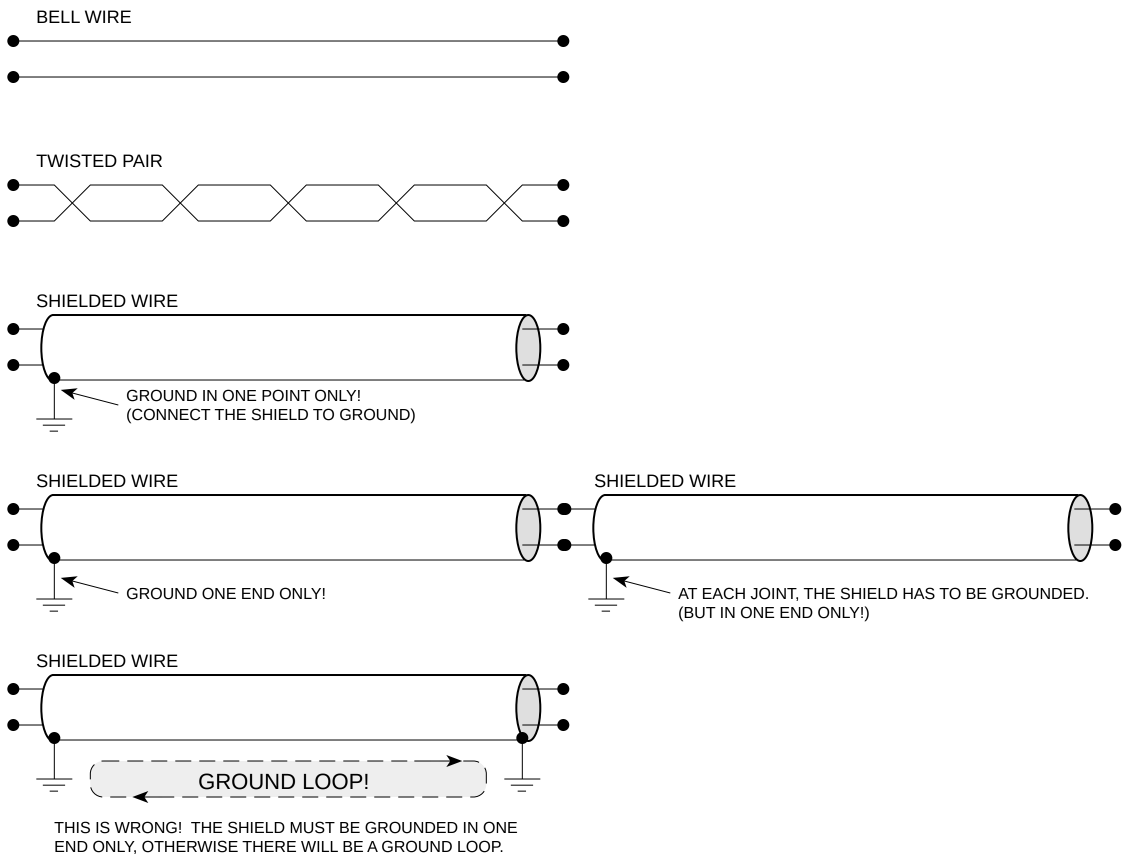
***Example II:* The maximum wire length for a 10 VA power consumption using different wire gauges.**

Point “B”	22 Ga	Max. 60 FT
Point “C”	20 Ga	Max. 120 FT
Point “D”	18 Ga	Max. 220 FT
Point “E”	16 Ga	Max. 350 FT
Point “F”	14 Ga	Max. 550 FT
Point “G”	12 Ga	Max. 900 FT

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.

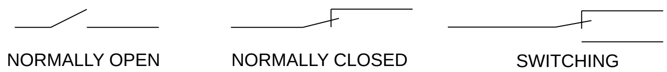
A ground loop acts as an antenna and will pick up electrical noise. This should be avoided, by using the correct wiring practice.

II. UNDERSTANDING WIRING DIAGRAMS

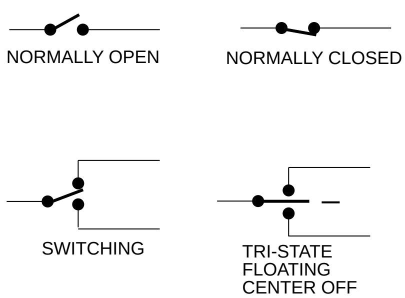
II-A. Electrical Symbols

U.S. Electrical Symbols for Contacts

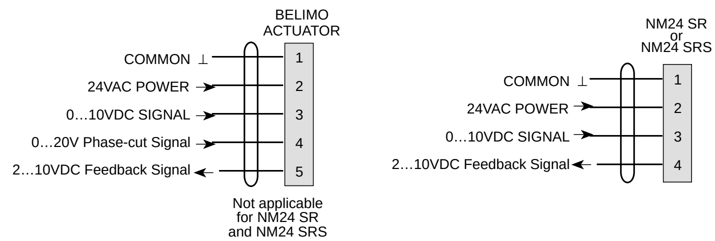
International Symbols for Contacts



Traditional Electronic Symbols for Contacts



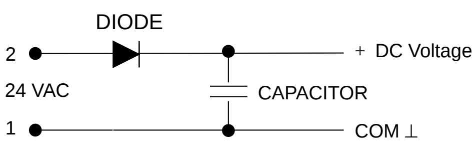
Belimo Proportional Actuators- Wire Symbols and Numbers



If a feedback is available at the actuator, we recommend that this signal be brought back to the control panel. Even if it is not required for the control sequence, it is a useful signal to have available for possible troubleshooting in the future.

II-B. Compatibility of Different Power Supplies

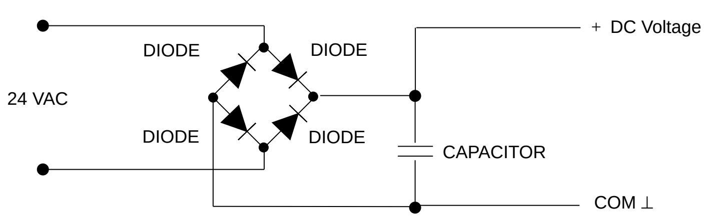
Power Supply with Half-Wave Rectifier



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.

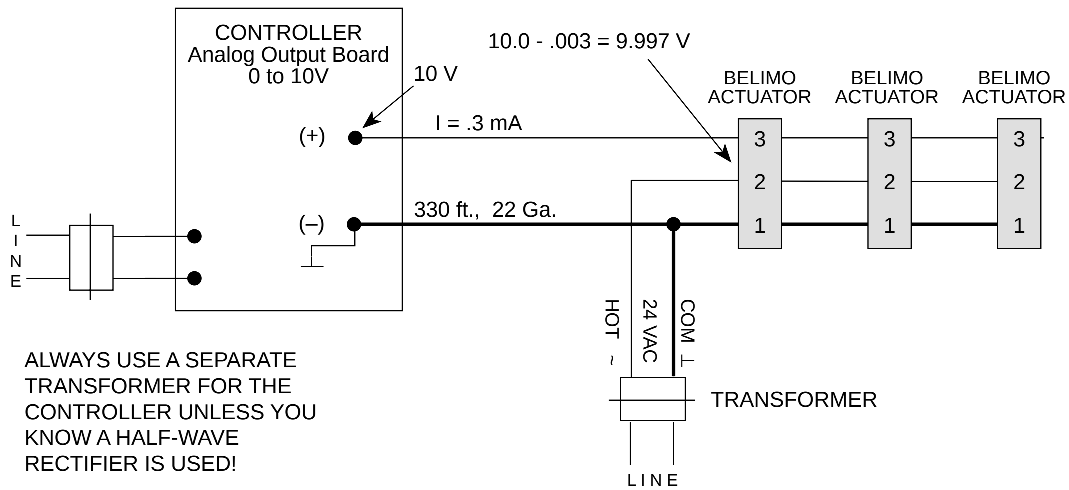
The Belimo products use half-wave rectifiers. Therefore, they may be connected to the same transformer as long as all commons (COM ⊥) are connected to the same leg of the transformer. However, anytime actuators are connected to a controller a separate transformer should be used for the controller power 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

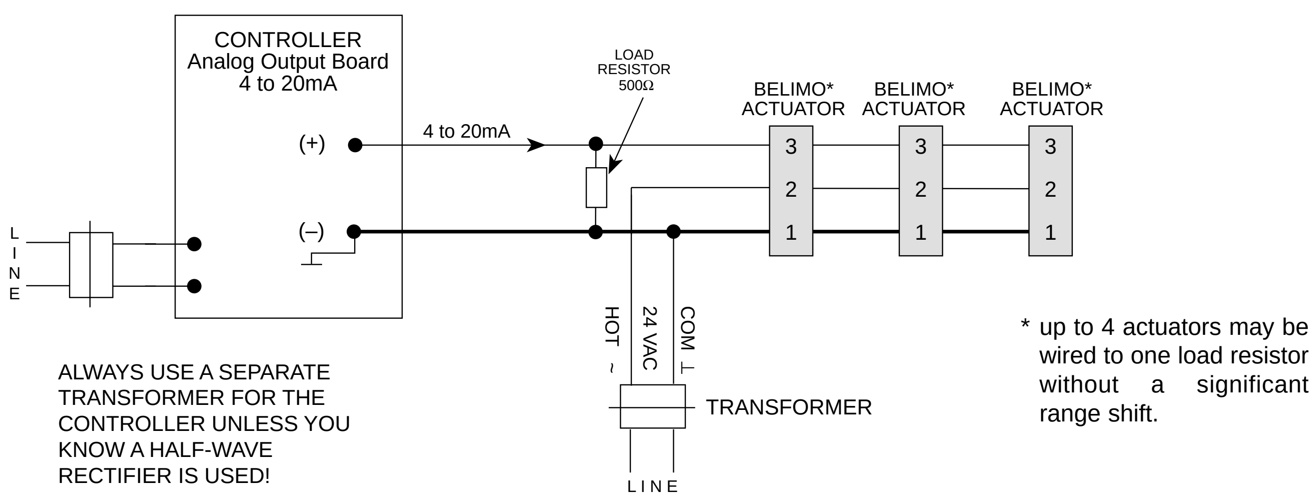
Due to the high input impedance (100kΩ) of the actuators, the current through the signal wire is very low. Therefore, the loss of signal will be negligible, even if with long wire runs.
Example: Three actuators are connected via a 330 ft. (100 meters) long pair of 22 Ga. wires. Each wire has a resistance of 5Ω.
The current draw from each actuator is (I = E/R) 10/100,000 = 0.1 mA, when the signal is 10 VDC.
The current in the wire will be 3 x 0.1 = 0.3 mA. Because 2 wires, the Common and the Source, go to the actuator, the resistance in the wires is 2 x 5Ω = 10Ω. The loss of signal will be (E = R x I) 10 x 0.3 = 3 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.

Modulating Control Signal Wiring

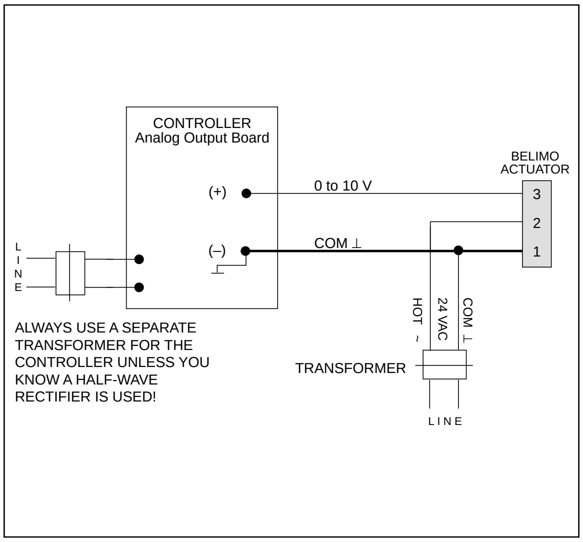


Fig. II-1 Single Output to Single Actuator

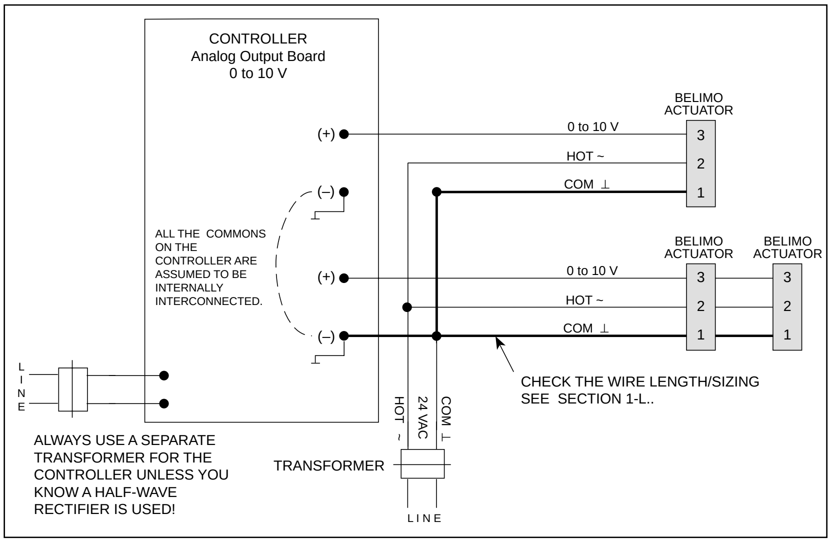


Fig. II-2 Multiple Outputs to Multiple Actuators Using 1 Transformer for Actuators

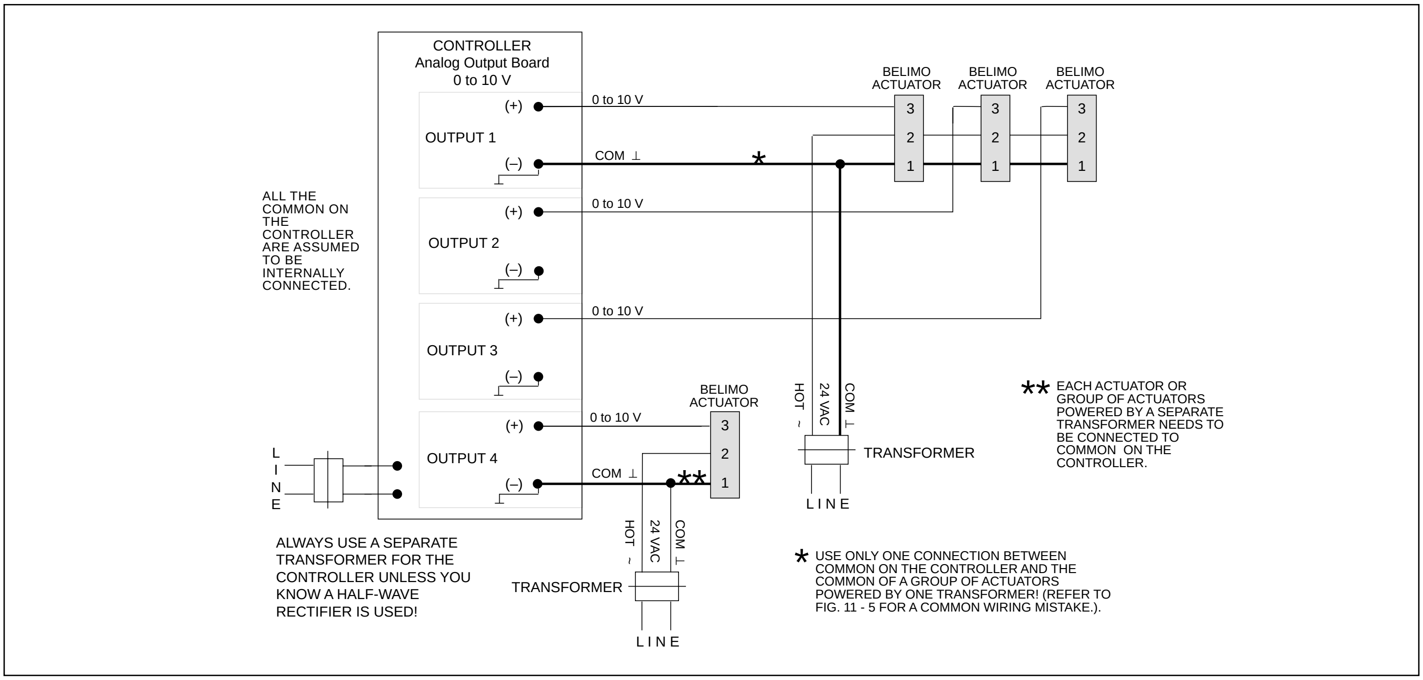
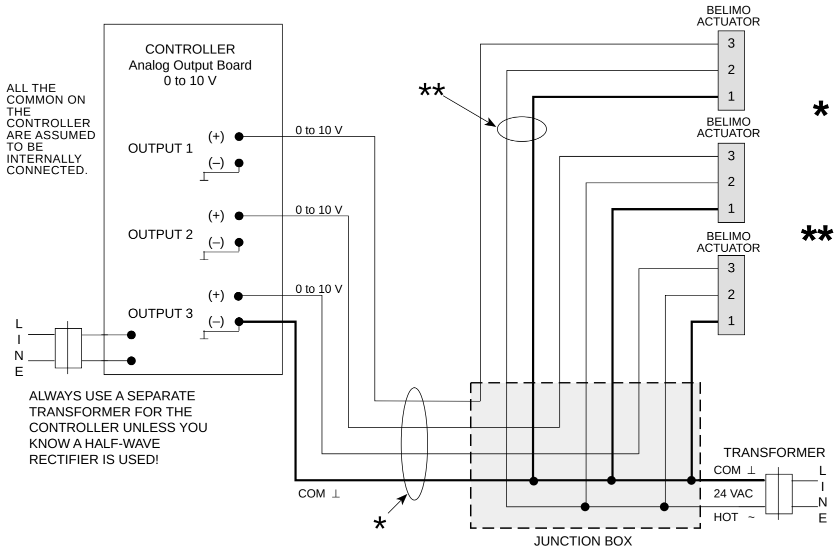


Fig. II-3 Multiple Outputs to Multiple Actuators Using 2 Transformers for Actuators

II-D. Long Distance Wiring



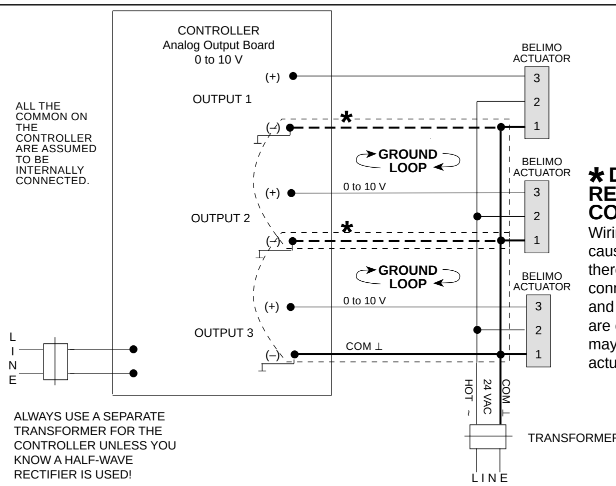
* THESE WIRES CAN BE LONG BECAUSE THE WIRES BETWEEN THE CONTROLLER AND THE JUNCTION BOX CARRY A VERY LOW LOAD (SEE SECTION IIC "SIGNAL LOSS". THEREFORE, THE WIRE LENGTH AND SIZE IS OF NO CONCERN.

** THESE WIRES SHOULD BE RELATIVELY SHORT, BECAUSE THE WIRES BETWEEN THE JUNCTION BOX AND THE ACTUATORS CARRY AC POWER. **SEE SECTION I-L FOR WIRE SIZING.**

(MAKE CERTAIN THAT A SUFFICIENT NUMBER OF WIRES ARE AVAILABLE. ESPECIALLY IN THE CABLE BETWEEN THE CONTROLLER AND THE JUNCTION BOX. IT IS PRUDENT TO HAVE A FEW EXTRA WIRES, JUST IN CASE.)

Fig. II-4

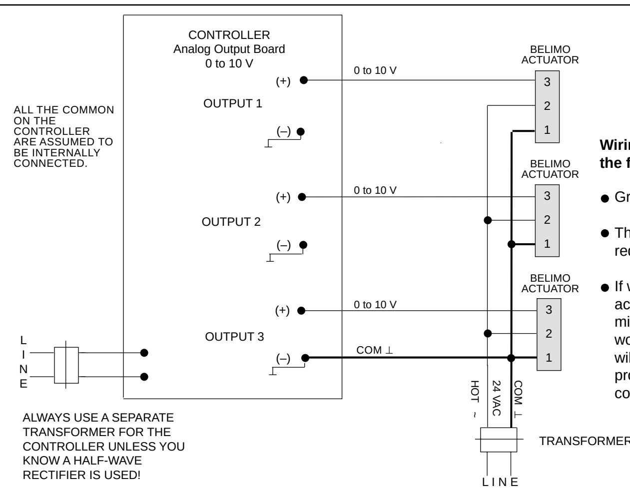
II-E. Wiring Mistakes



*** 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 20mA 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.

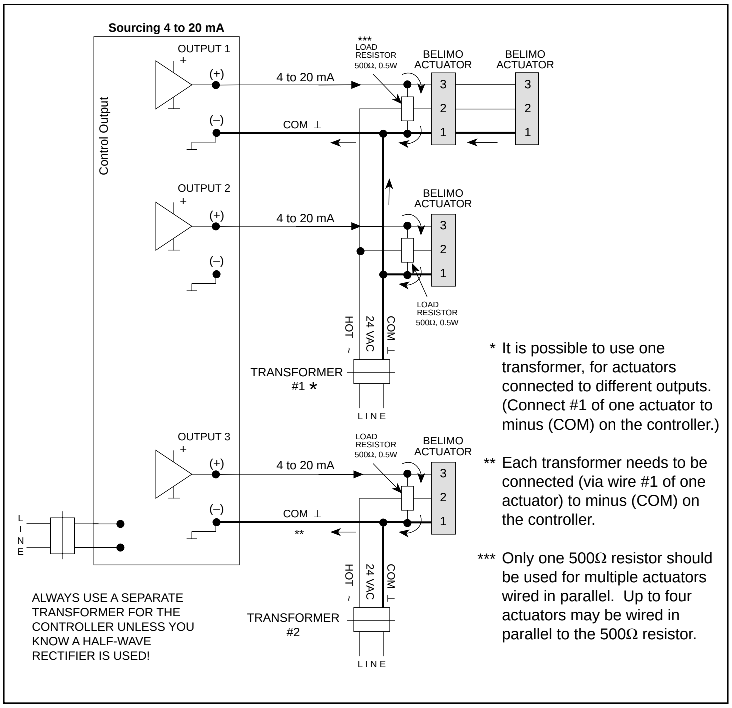


Fig III-1

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 the device being controlled and common. For this reason, the term "Output" in a sinking application is sometimes confusing.

The controller has one terminal that supplies a constant DC voltage (often +24V). The input of the actuators (wire #3) are connected to the constant voltage. A 500Ω resistor is connected 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 500 Ω 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)

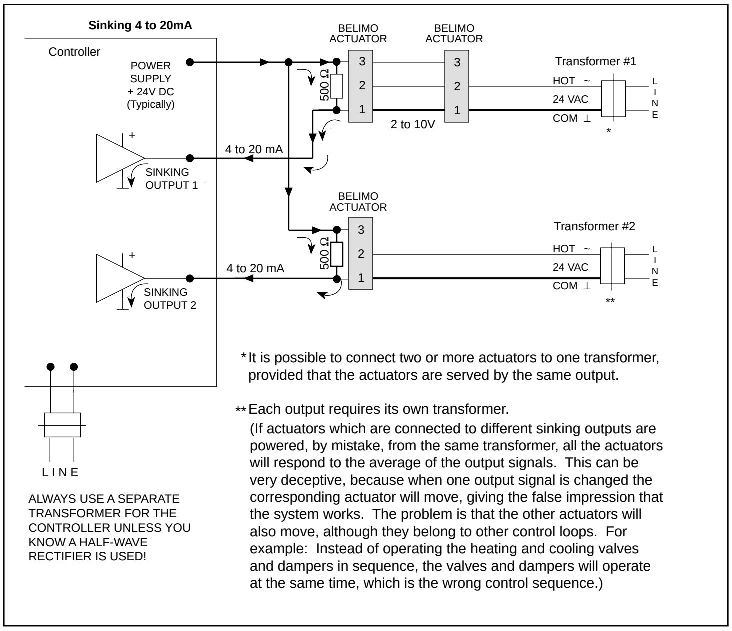


Fig. III-2 Sinking 4 to 20 mA

BELIMO

III-D. Parallel Operation

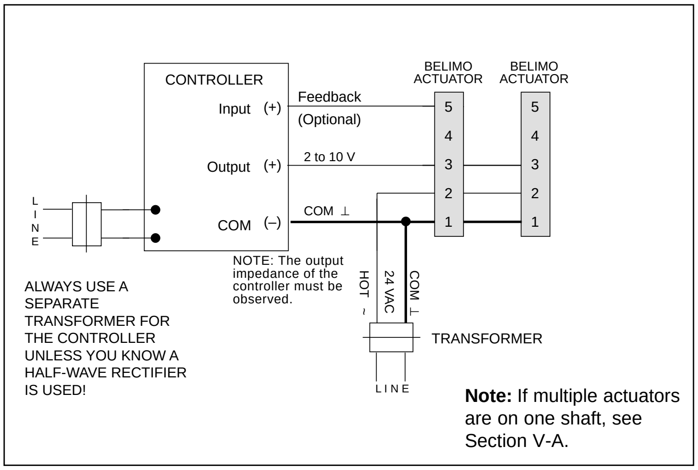


Fig III-3

III-E. Master-Slave operation

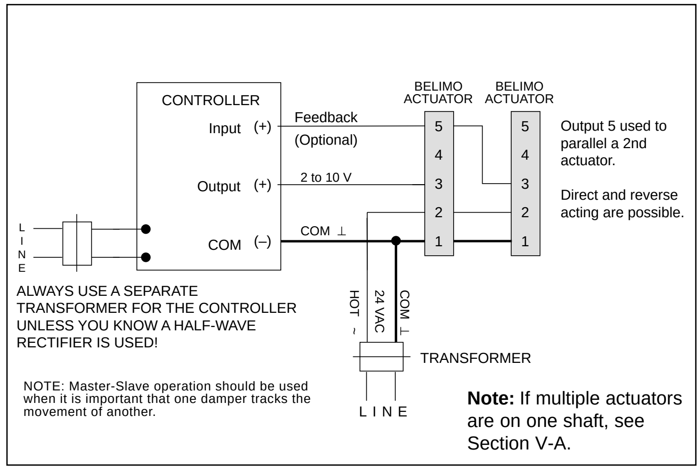


Fig III-4

III-F. Monitoring feedback with a remote indicator

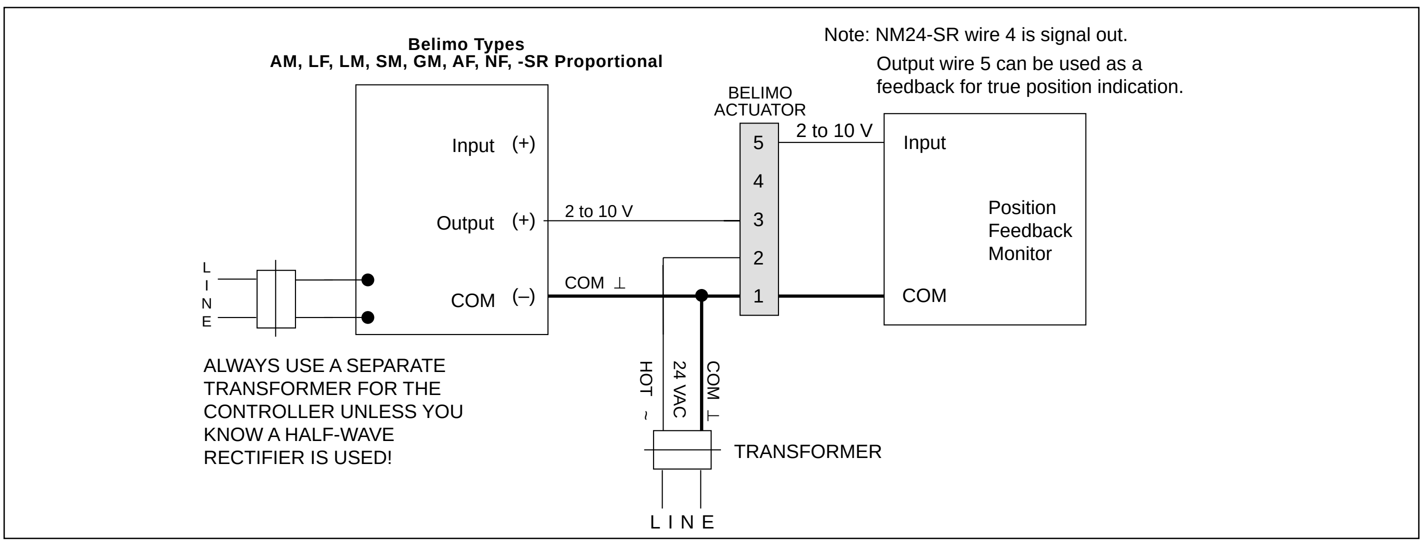


Fig. III-5

III-G. One Output/Multiple Transformers

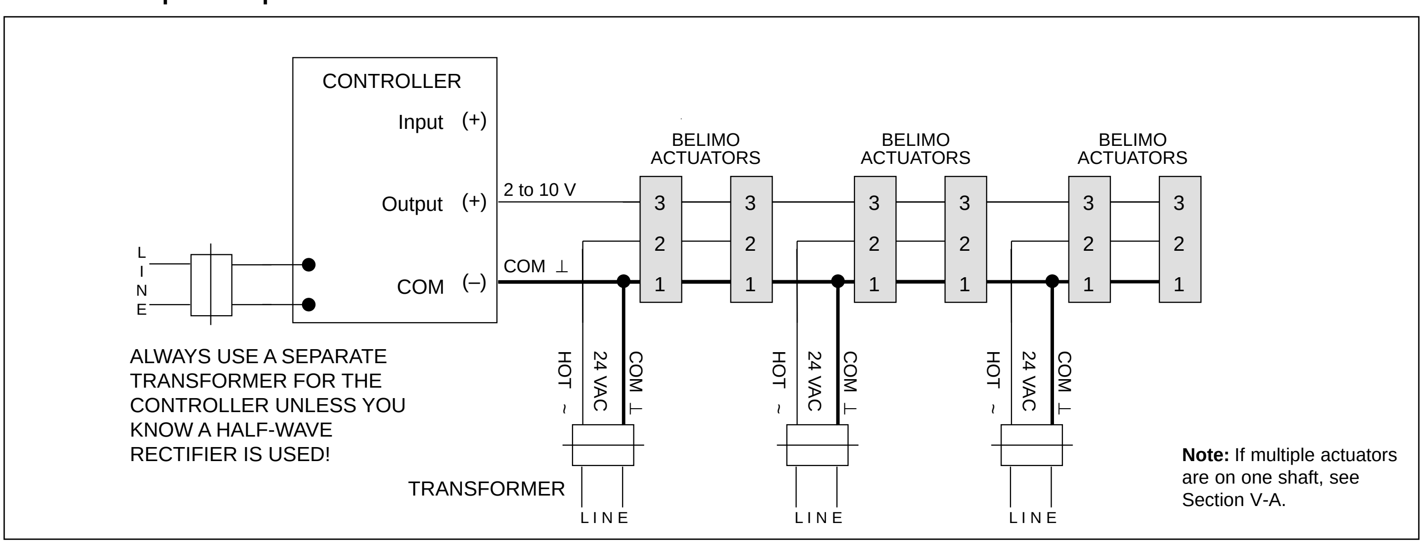
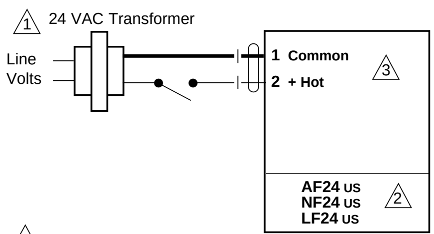


Fig. III-6

IV. WIRING DIAGRAMS FOR BELIMO PRODUCTS

IV-A. Spring Return On/Off Control

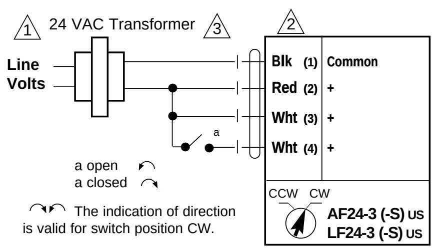
24 V



1 Provide overload protection and disconnect as required.

2 Actuators may be connected in parallel. Power consumption must be observed.

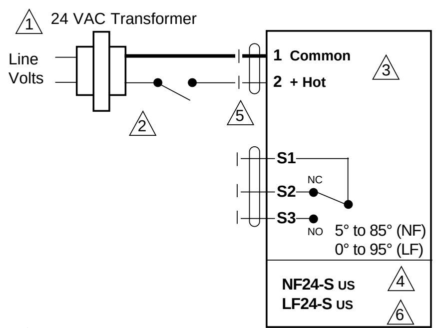
3 Actuator may also be powered by 24 VDC.



1 Provide overload protection and disconnect as required.

2 Actuators may be connected in parallel. Power consumption must be observed.

3 Actuator may also be powered by 24 VDC.



1 Provide overload protection and disconnect as required.

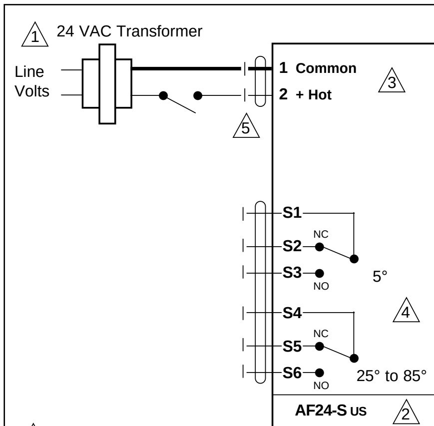
2 Actuators may be connected in parallel. Power consumption must be observed.

3 Actuator may also be powered by 24 VDC.

4 For end position indication, interlock control, fan startup, etc., NF24-SUS incorporates a built-in auxiliary switch: 1 x SPDT, 7A (2.5A) @250 VAC, UL listed, adjustable 5° to 85°.

5 Meets UL and CSA requirements without the need of an electrical ground connection.

6 For end position indication, interlock control, fan startup, etc., LF24-SUS incorporates a built-in auxiliary switch: 1 x SPDT, 6A (1.5A) @250 VAC, UL listed, adjustable 0° to 85°.



1 Provide overload protection and disconnect as required.

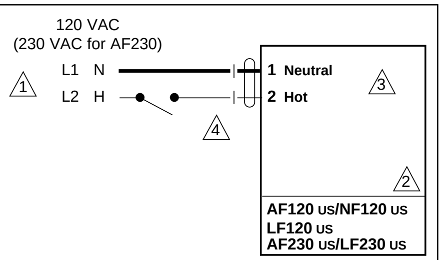
2 Actuators may be connected in parallel. Power consumption must be observed.

3 Actuator may also be powered by 24 VDC.

4 For end position indication, interlock control, fan startup, etc., AF24-S incorporates two built-in auxiliary switches: 2 x SPDT, 7A (2.5A) @250 VAC, UL listed, one switch is fixed at +5°, one is adjustable 25° to 85°.

5 Meets UL and CSA requirements without the need of an electrical ground connection.

120/230 V

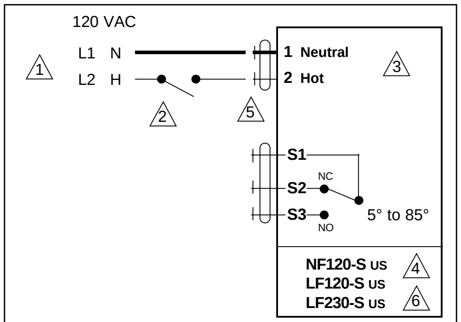


1 Provide overload protection and disconnect as required.

2 Actuators may be connected in parallel. Power consumption must be observed.

3 No ground connection is required.

4 Meets UL and CSA requirements without the need of an electrical ground connection.



1 Provide overload protection and disconnect as required.

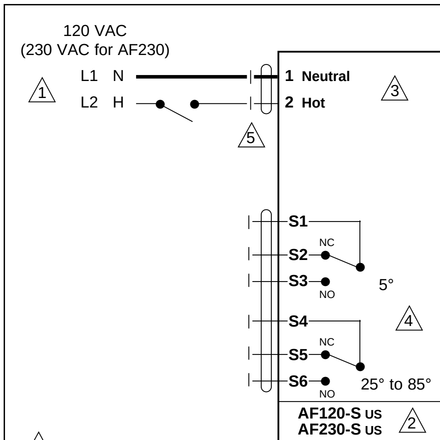
2 Actuators may be connected in parallel. Power consumption must be observed.

3 No ground connection is required.

4 For end position indication, interlock control, fan startup, etc., NF120-SUS incorporates a built-in auxiliary switch: 1 x SPDT, 7A (2.5A) @250 VAC, UL listed, adjustable 5° to 85°.

5 Meets UL and CSA requirements without the need of an electrical ground connection.

6 For end position indication, interlock control, fan startup, etc., LF120/230-SUS incorporates a built-in auxiliary switch: 1 x SPDT, 6A (1.5A) @250 VAC, UL listed, adjustable 0° to 85°.



1 Provide overload protection and disconnect as required.

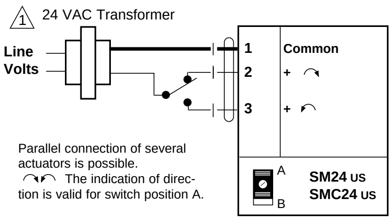
2 Actuators may be connected in parallel. Power consumption must be observed.

3 No ground connection is required.

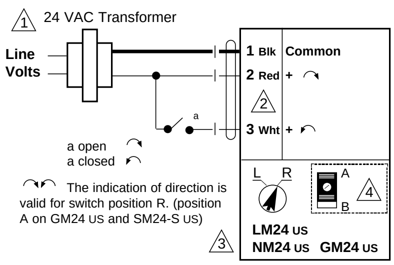
4 For end position indication, interlock control, fan startup, etc., AF120/230-S incorporates two built-in auxiliary switches: 2 x SPDT, 7A (2.5A) @250 VAC, UL listed, one switch is fixed at +5°, one is adjustable 25° to 85°.

5 Meets UL and CSA requirements without the need of an electrical ground connection.

IV-B. Non-Spring-Return On/Off Control



1 Provide overload protection and disconnect as required.



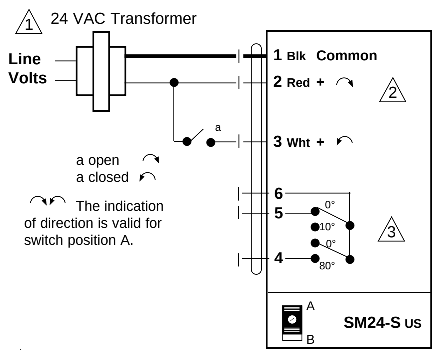
1 Provide overload protection and disconnect as required.

2 Actuators with plenum rated cable do not have numbers on wires; use color codes instead.

3 See special wiring diagrams for LM24-T US.

4 LM and NM actuators use a L/R switch to change rotation. SM and GM actuators use a A/B switch to change rotation.

On/Off Control GM, SM, NM, LM

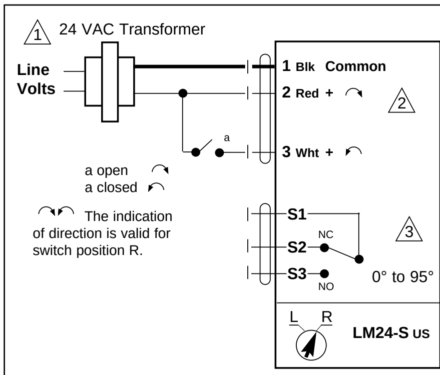


1 Provide overload protection and disconnect as required.

2 Actuators may also be powered by 24 VDC

3 SPDT, 2A @24 VAC

On-Off Control of SM24-S US

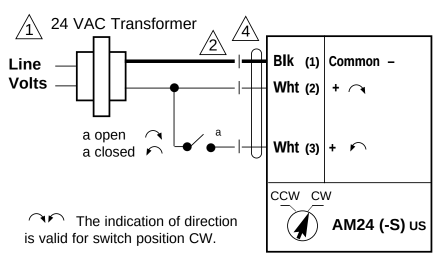


1 Provide overload protection and disconnect as required.

2 Actuators may also be powered by 24 VDC

3 For end position indication, interlock control, fan startup, etc., LM24-S US incorporates a built-in auxiliary switch: 1 x SPDT, 6A (2.5A) @24 VAC, UL listed, adjustable 0° to 95°.

On-Off Control of LM24-S US



1 Provide overload protection and disconnect as required.

2 Actuators may also be powered by 24 VDC

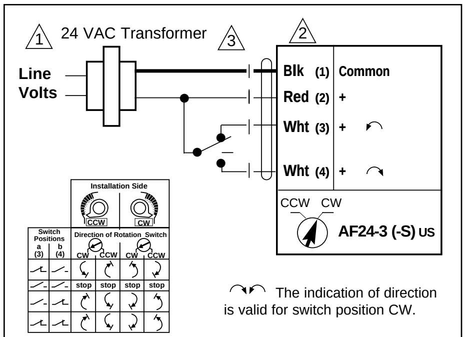
3 For end position indication, interlock control, fan startup, etc., AM24-S US incorporates two built-in auxiliary switches: 2 x SPDT, 6A (1.5A) @250 VAC, UL listed, adjustable between 0° and 95°.

4 Meets UL and CSA requirements without the need of an electrical ground connection.

On-Off Control of AM24 (-S) US

IV-C. Floating Point Control, Spring Return and Non-Spring-Return

Spring Return

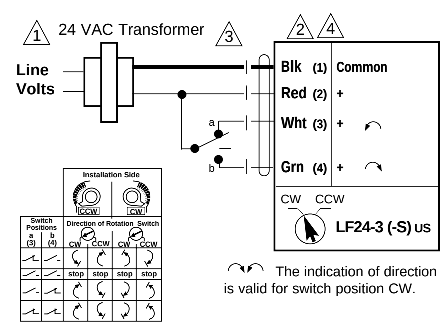


1 Provide overload protection and disconnect as required.

2 Actuators may be connected in parallel. Power consumption must be observed.

3 May also be powered by 24 VDC.

Floating point control of AF24-3 (-S) US



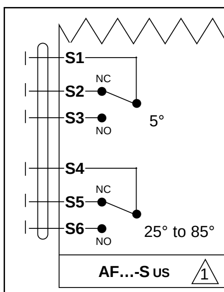
1 Provide overload protection and disconnect as required.

2 Actuators may be connected in parallel. Power consumption must be observed.

3 May also be powered by 24 VDC.

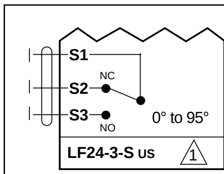
4 Actuators with plenum rated cable do not have numbers on wires; use color codes instead.

Floating point control of LF24-3 (-S) US



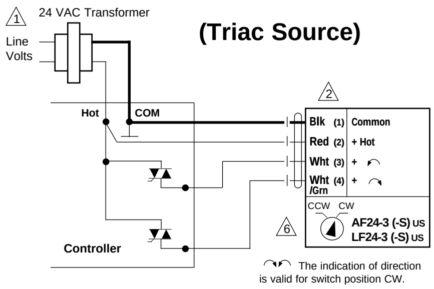
1 For end position indication, interlock control, fan startup, etc., AF24-3-S US incorporates two built-in auxiliary switches: 2 x SPDT, 7A (2.5A) @250 VAC, UL listed, one switch is fixed at +5°, one is adjustable 25° to 85°.

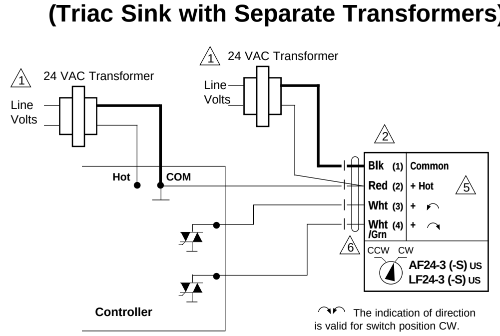
Auxiliary switches of AF24-3-S US

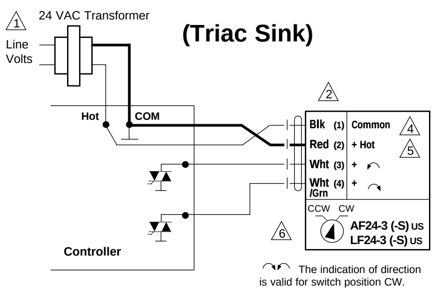


1 For end position indication, interlock control, fan startup, etc., LF24-S US incorporates a built-in auxiliary switch: 1 x SPDT, 6A (1.5A) @250 VAC, UL listed, adjustable 0° to 85°.

Auxiliary switches of LF24-3-S US



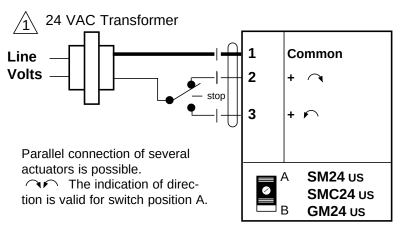




1. Provide overload protection and disconnect as required.
2. Actuators may be connected in parallel. Power consumption must be observed.
3. May also be powered by 24 VDC.
4. The Common connection from the actuator must be connected to the Hot connection of the controller.
5. The actuator Hot must be connected to the control board Common.
6. Actuators with plenum rated cable do not have numbers on wires; use color codes instead. AF… No. 4 wire is white; LF… No. 4 wire is green.

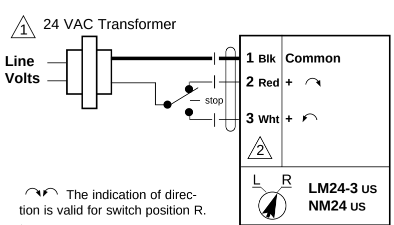
Floating point control of AF24-3(-S) US and LF24-3(-S) US from triac

Non-Spring Return



Parallel connection of several actuators is possible.
The indication of direction is valid for switch position A.

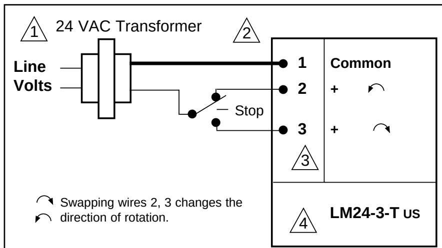
1. Provide overload protection and disconnect as required.



The indication of direction is valid for switch position R.

1. Provide overload protection and disconnect as required.
2. Actuators with plenum rated cable do not have numbers on wires; use color codes instead.

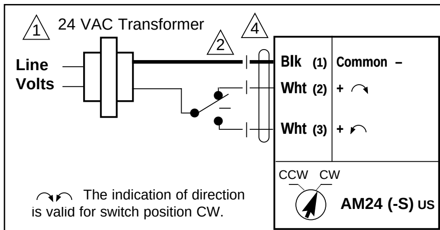
Standard Floating Point Control



Swapping wires 2, 3 changes the direction of rotation.

1. Provide overload protection and disconnect as required.
2. Actuators may also be powered by 24 VDC
3. The LM24-TUS actuator has terminals instead of wires.
4. The LM24-T US actuator does not have a direction of rotation switch.

Floating Point Control of LM24-3-T US



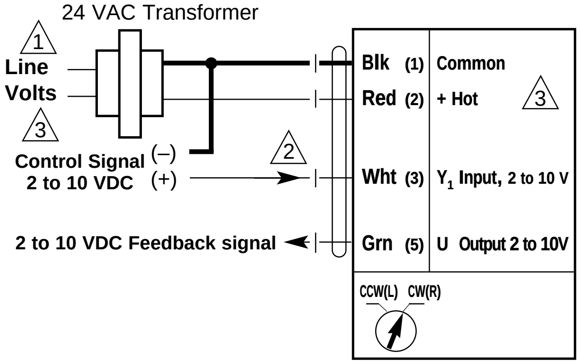
The indication of direction is valid for switch position CW.

1. Provide overload protection and disconnect as required.
2. Actuators may also be powered by 24 VDC
3. For end position indication, interlock control, fan startup, etc., AM24-S US incorporates two built-in auxiliary switches: 2 x SPDT, 6A (1.5A) @250 VAC, UL listed, adjustable between 0° and 95°.
4. Meets UL and CSA requirements without the need of an electrical ground connection.

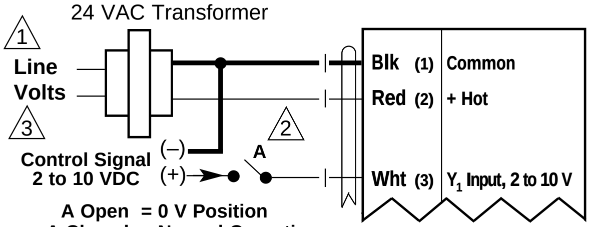
Floating Point Control of AM24 (-S) US

IV-D. Proportional Control

Standard Wiring

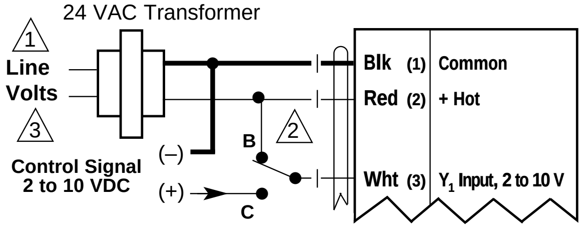


Override to zero position



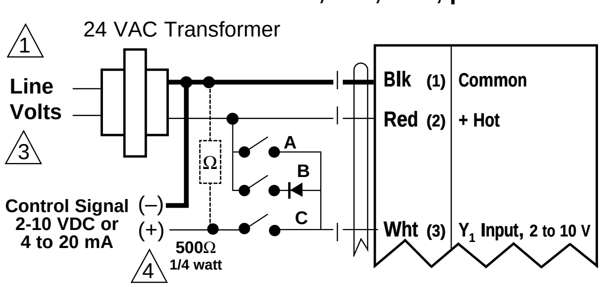
A Open = 0 V Position
A Closed = Normal Operation

Override to 10 V position



B Closed = 10 V Position
C Closed = Normal Operation

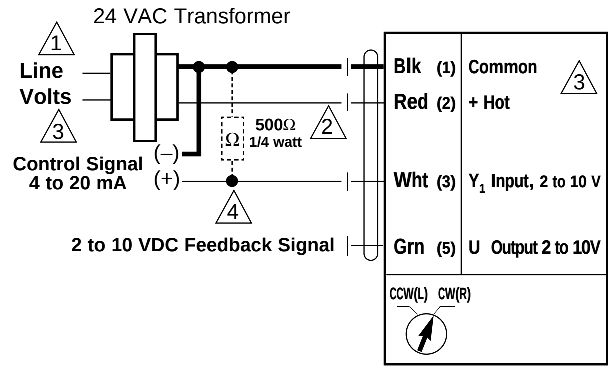
Override control to min, mid, max, positions



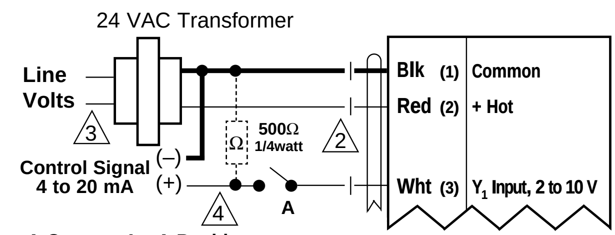
	Functions	a	b	c
Min*	0% ◁	open	open	open
Mid*	50% ◁	open	closed	open
Max*	100% ◁	closed	open	open
Normal**	Control mode acc. to Y	open	open	closed

*** Default selectable 0-100%. See Configuration Data Sheet.**
****Customizable. See Configuration Data Sheet.**

Standard Wiring

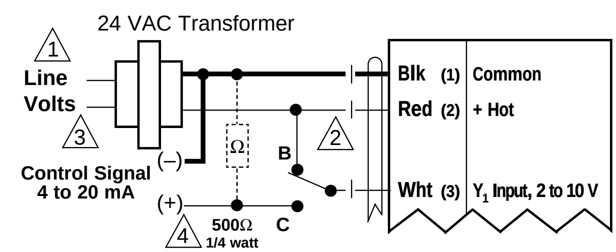


Override to zero position



A Open = 4 mA Position
A Closed = Normal Operation

Override to 20 mA position



B Closed = 20 mA Position
C Closed = Normal Operation

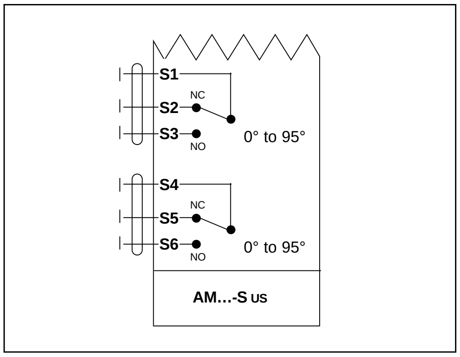
With a 4-20 mA Input, up to 4 actuators may be wired in parallel. A 2% shift in the signal is seen when using a 500Ω resistor. Power consumption must be observed.

4 to 20 mA Control Signal

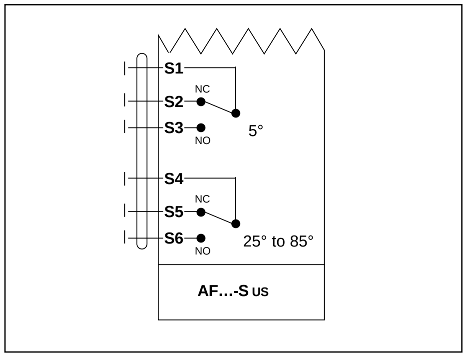
Notes

1. Provide overload protection and disconnect as required.
2. Actuators may be connected in parallel. Power consumption and input impedance must be observed.
3. Actuator may also be powered by 24 VDC.
4. ZG-R01 may be used.

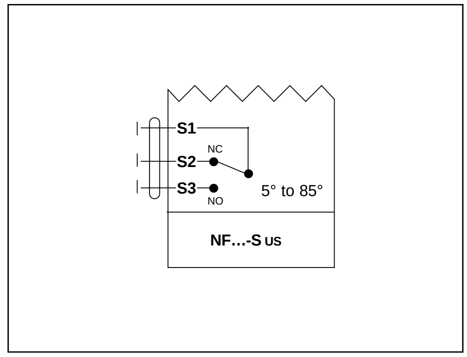
IV-F. Auxiliary Switch Wiring



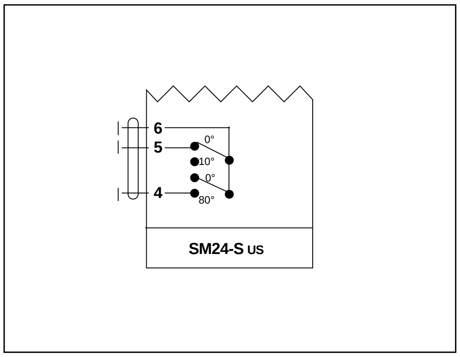
Auxiliary switch wiring for AM…-S US



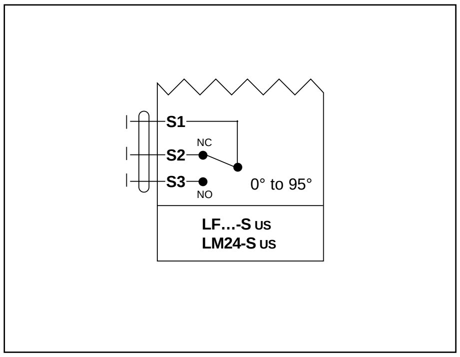
Auxiliary switch wiring for AF…-S US



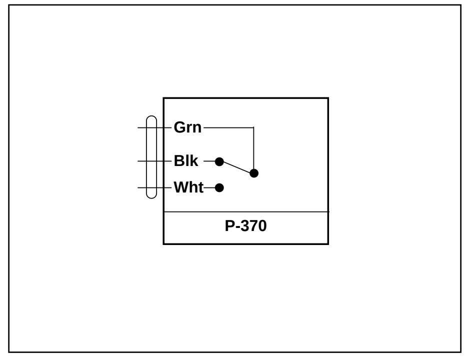
Auxiliary switch wiring for NF…-S US



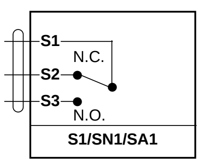
Auxiliary switch wiring for AM…-S US

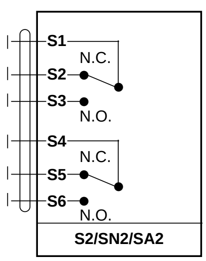


Auxiliary switch wiring for LF…-S US and LM24-S US



Auxiliary switch wiring for P-370 US





Note: S1,S2 are used with the SM and Gm Series actuators.

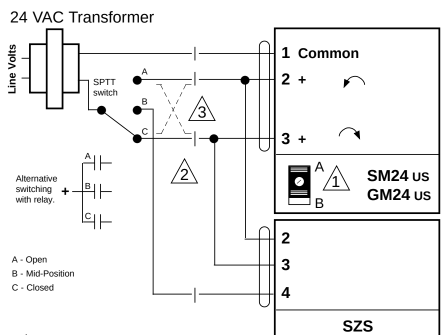
SN1,SN2 are used with NM Series actuators

Auxiliary Switches
S1/S2 for SM, GM; SN1/SN2 for NM
SA1/SA2 for AM

Product	Voltage	Resistive load	Inductive load
S1, S2	250	7.0 A	2.5 A
SA1, SA2	250	6.0 A	2.5 A
SN1, SN2	250	6.0 A	2.5 A
AF…-S US	250	7.0 A	2.5 A
AM…-S US	24	3.0 A	1.5 A
LF…-S US	250	6.0 A	1.5 A
LM24-S US	24	6.0 A	2.5 A
NF…-S US	250	7.0 A	2.5 A
P-370	120	1.0 A	1.0 A
	240	0.7 A	0.7 A

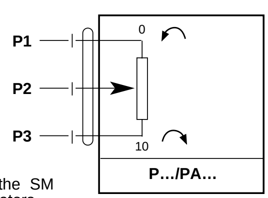
Note:
SA1, SA2, AM…24-S US, AF…24-S US, NF…-S US auxiliary switches are double insulated and meet UL and CSA requirements without an electrical ground.

IV-G. Accessories



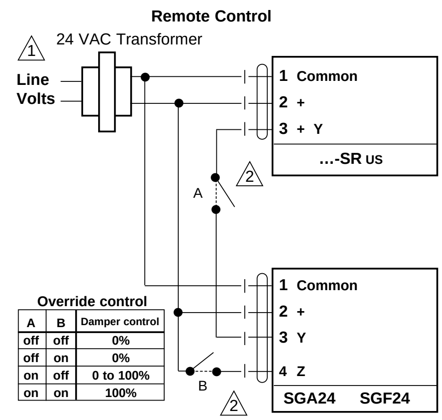
1. The direction of rotation switch on the actuator must be in position "A" for the SZS to function correctly.
2. Parallel connection of further actuators is not possible.
3. Reverse A and C connections to the actuator to change direction of rotation.

SZS Mid Position Switch



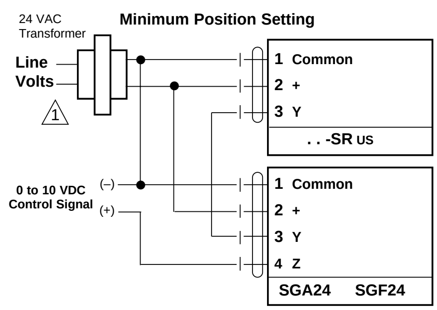
Note: Used with the SM and GM Series actuators

Feedback Potentiometer
P... used with SM/GM
PA... used with AM



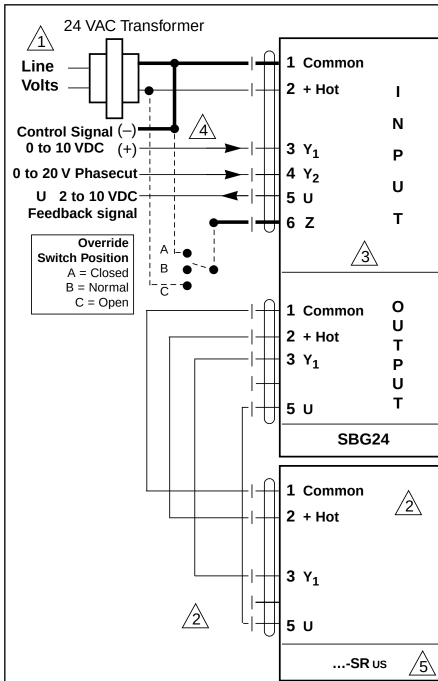
Override control

A	B	Damper control
off	off	0%
off	on	0%
on	off	0 to 100%
on	on	100%



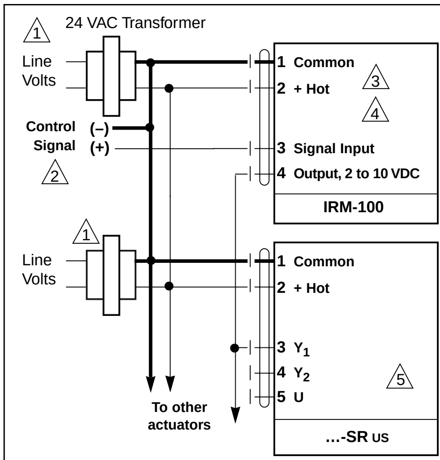
1. Provide overload protection and disconnect as required.
2. Override switches are optional.

SGA, SGF Positioners



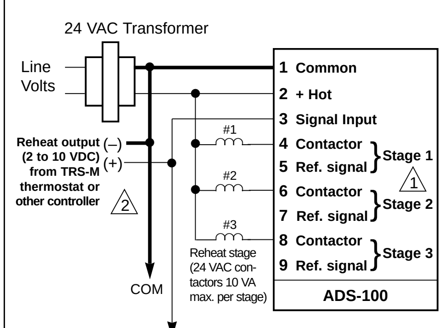
1. Provide overload protection and disconnect as required.
2. Actuators may be connected in parallel. Power consumption and input impedance must be observed.
3. The actuator and SBG-24 may be powered from the same transformer.
4. The controller should be powered from a separate transformer.
5. Wire No.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

SBG 24 Range Controller



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

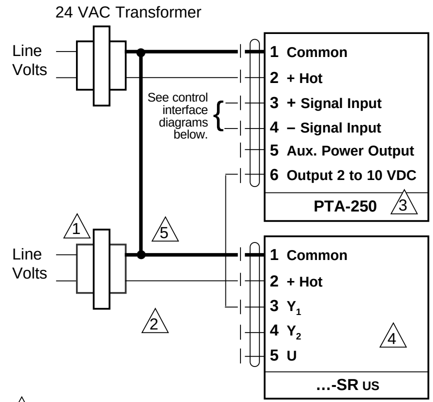
IRM-100 Input Rescaling Module



1. 5,7,9 = Switch point reference signal for manual adjustment of stages 1,2, & 3 respectively.
2. Actuator and controller must have separate transformers.

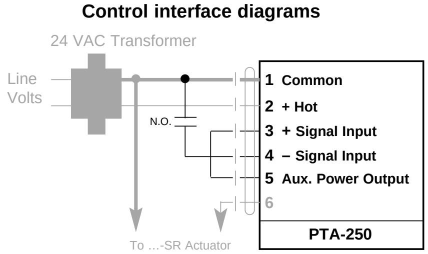
ADS-100 Analog to Digital Switch

IV-F. Accessories (continued)

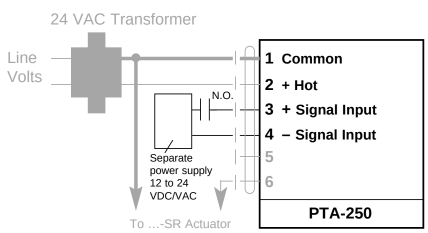


1. Provide overload protection and disconnect as required.
2. Actuator and controller must have separate transformers.
3. Consult controller instruction data for more detailed installation information.
4. To reverse control rotation, use the reversing switch.
5. The PTA-250 and actuator may be powered from the same transformer.

Control interface diagrams

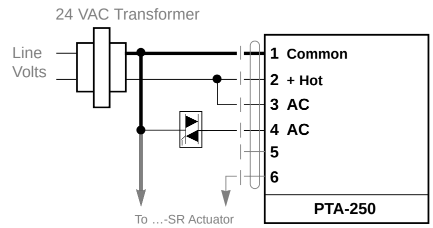


Relay pulsed signal (non-isolated circuit)

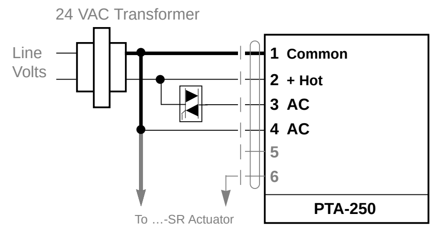


Relay pulsed signal (isolated circuit)

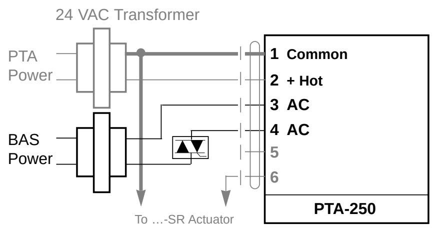
Control interface diagrams



Triac, common pulsed signal (non-isolated circuit)

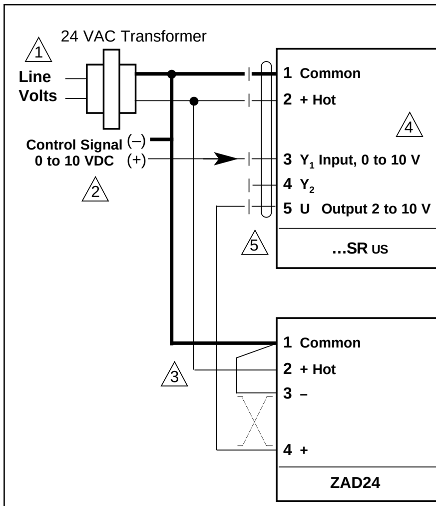


Triac, hot pulsed signal (non-isolated circuit)



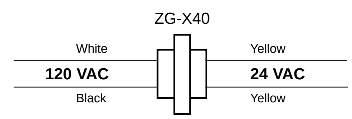
Triac, pulsed signal (isolated circuit)

PTA-250 Pulse Width Modulation Interface

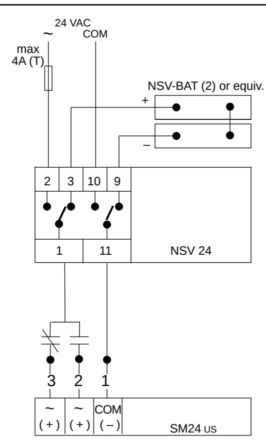


1. Provide overload protection and disconnect as required.
2. Actuator and controller must have separate transformers.
3. Actuators may be connected in parallel. Power consumption must be observed.
4. Actuator may also be powered by 24 VDC.
5. Wire #4 is used for feedback on the NM24-SR US.

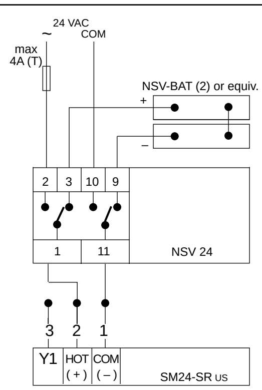
ZAD24 Digital Position Indicator



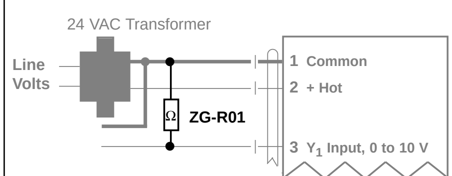
ZG-X40 Transformer

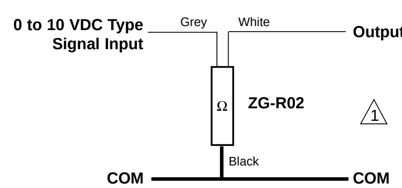


Failsafe direction must have a normally closed contact.



NSV 24 Battery Back-up Module



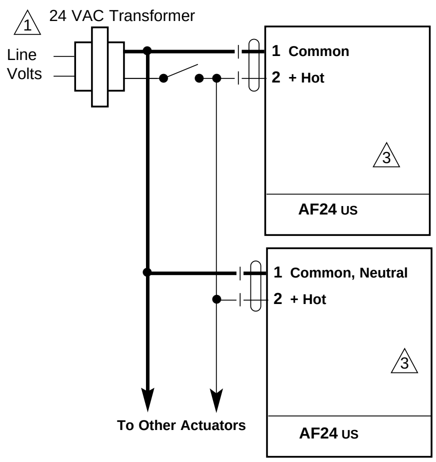


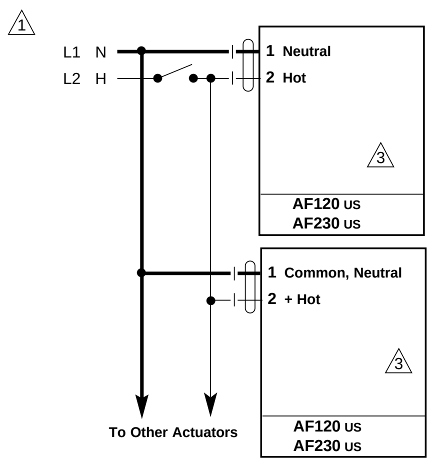
1. The impedance of the device attached must be 100kΩ.

ZG-R01, ZG-R02 Resistor Kits

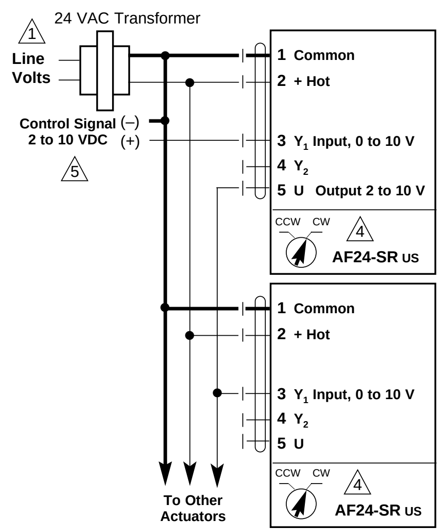
V. APPLICATION INFORMATION

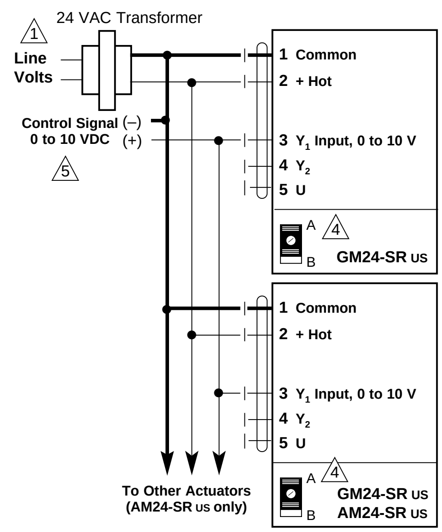
V-A. Wiring for Multiple Actuators on One Shaft (AF/GM, for other actuators use next higher torque actuator)

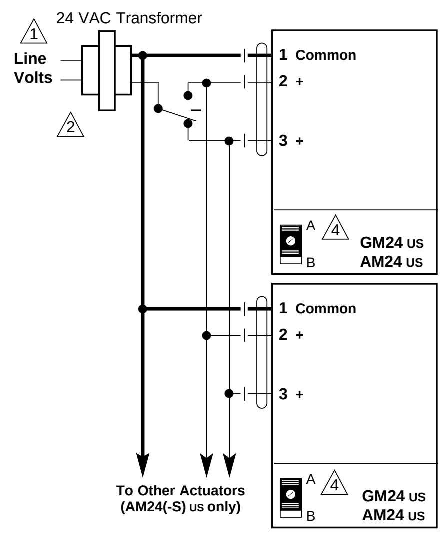


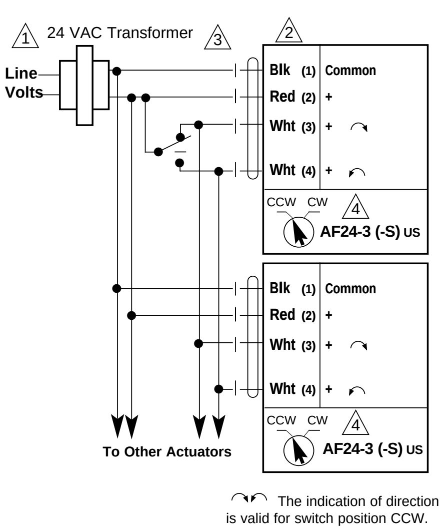


Note:
When using the **AF24-SR95** US and the **SM24-SR94** US consult the actuator data sheet.









Notes:

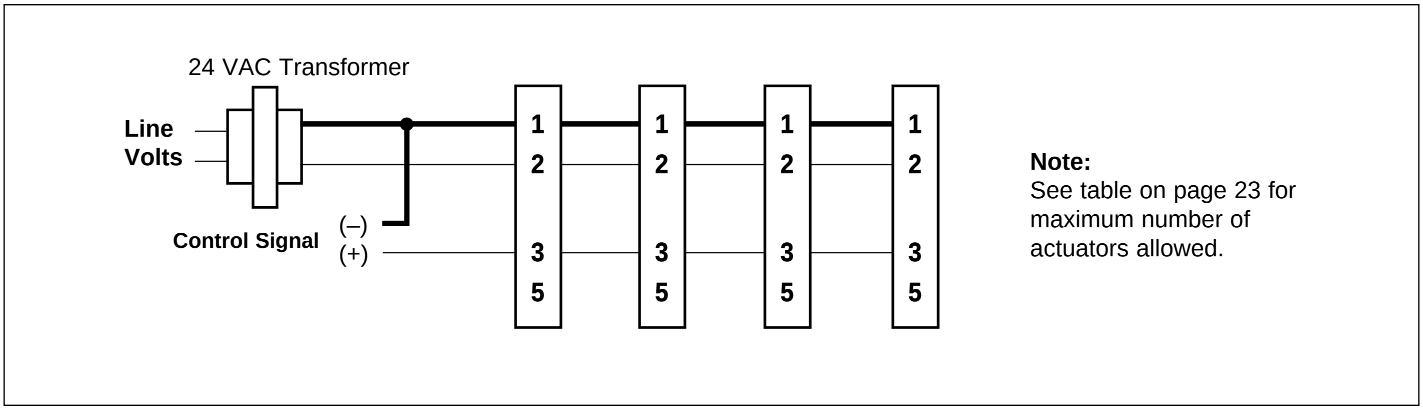
1. Provide overload protection and disconnect as required.
2. Actuators may be connected in parallel. Power consumption must be observed.
3. May also be powered by 24 VDC.
4. Set reversing switch (CCW-CW)(A-B) as required by control logic and control range.
5. Actuator and controller must have separate transformers.

Note:
See page 185 for ladder diagram wiring of 2 to 10 VDC actuators.

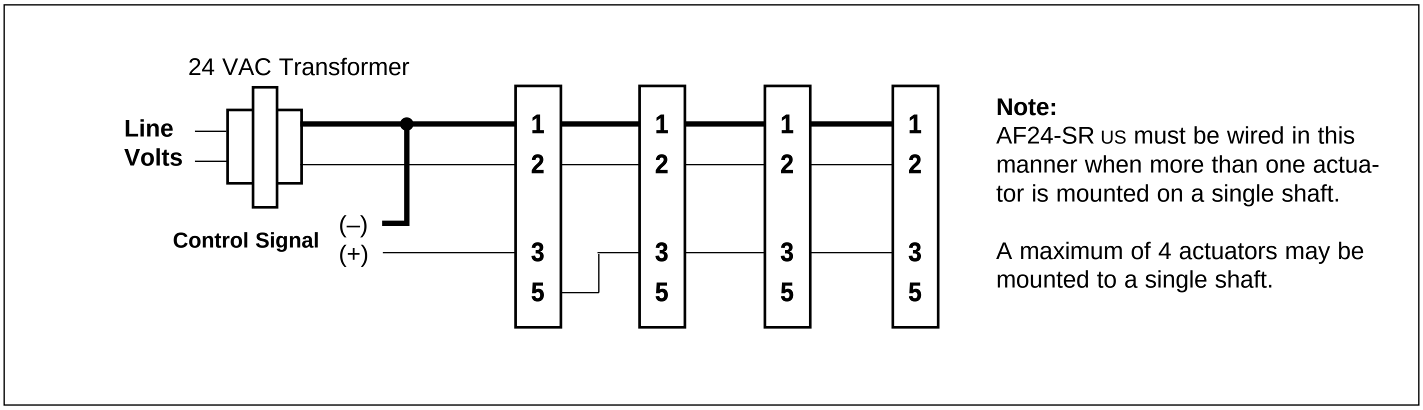
Actuators which may be used on one shaft:

Model	Max Quantity Per Shaft
AF24(-S) US AF120(-S) US AF230(-S) US	4
AF24-SR(-S) US	4
AF24-3(-S) US	4
AF24-SR95 US	1
GM24 US	2
GM24-SR US	2
AM24(-S) US	4
AM24-SR US	4

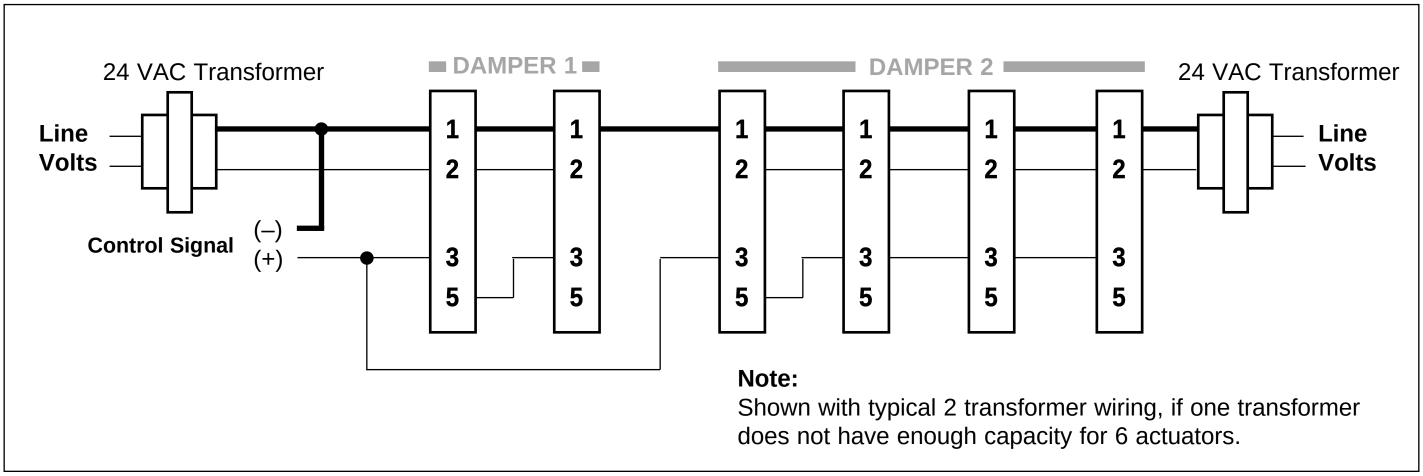
V-A. (continued) Wiring for Multiple Actuators on One Shaft (AF/GM, for other actuators use next higher torque actuator)



All actuators except AF24-SR US



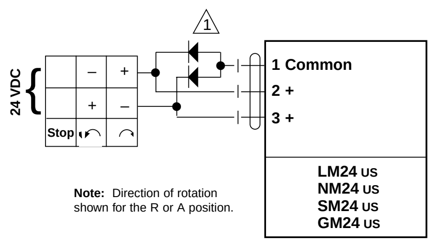
AF24-SR US



Typical wiring of multiple dampers with more than one AF24-SR US mounted on a single shaft.

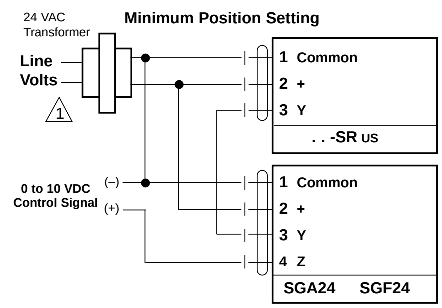
F20358 / 5 4 3 2 1 -01/04-10M-IG-Subject to change.

V-E. Floating Control Using a 2-wire DC Control Signal



1 IN4001, IN4003 diode or equivalent, observe polarity.

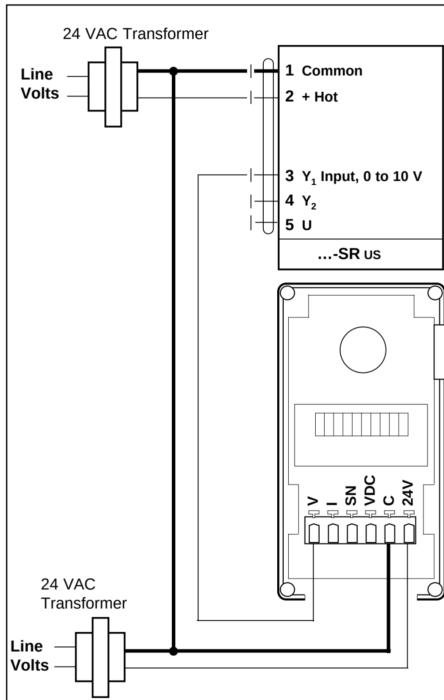
V-G. Minimum Position with 0 to 10 VDC Actuators



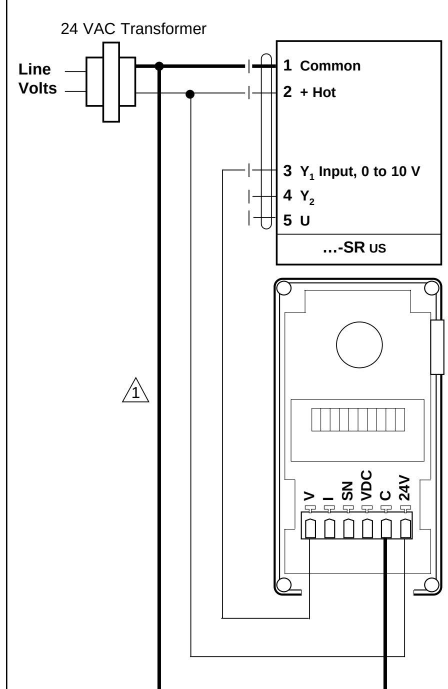
1 Provide overload protection and disconnect as required.

2 Override switches are optional.

V-H Wiring to Johnson Controls A350P Controller



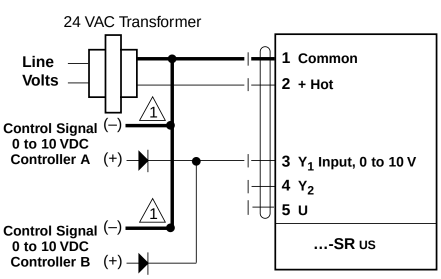
Johnson Controls A350P Controller
Multiple Power Source Wiring



Johnson Controls A350P Controller
Single Transformer Wiring

1 Power polarity must be correct

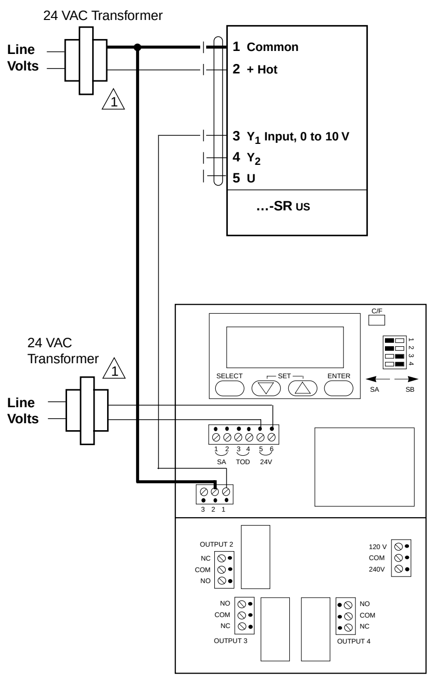
V-F. Operating two 0 to 10 VDC Controllers with the Higher of Two Control Signals



1 IN4001, IN4003 diode or equivalent, observe polarity.

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.

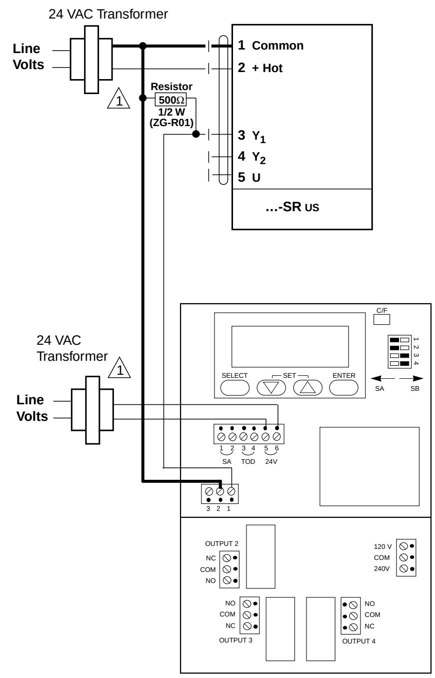
V-I. Wiring to Honeywell T775 Controller



T775E1098 / T775F1089
0 to 18 VDC Output Models

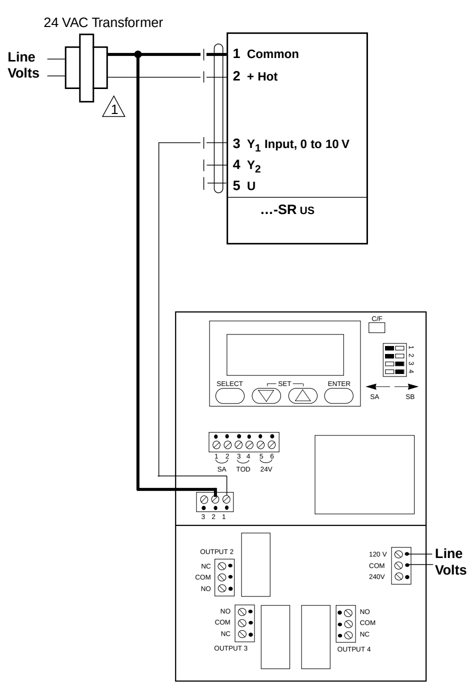
⚠1 Use separate transformer for T775 if powering from 24 VAC.

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.



T775E1056 / T775F1055
4 to 20 mA Output Models

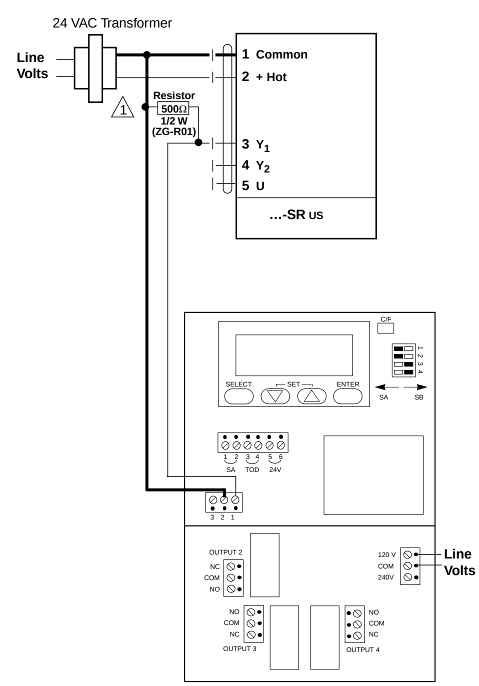
⚠1 Use separate transformer for T775 if powering from 24 VAC.



T775E1098 / T775F1089
0 to 18 VDC Output Models

⚠1 Use separate transformer for T775 if powering from 24 VAC.

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.



T775E1056 / T775F1055
4 to 20 mA Output Models

⚠1 Use separate transformer for T775 if powering from 24 VAC.