Honeywell

Direct Coupled Actuator (DCA) Wiring

BASIC WIRING INFORMATION

Basic Electricity

Current

Current is the flow of electricity in a circuit. It is measured in Amperes (A).

Flow of electricity can be:
— Direct Current (DC), or
— Alternating Current (AC).

Direct Current flows in one direction and is typically supplied from batteries or from controllers with battery back-up. The power that comes from a power plant is called Alternating Current (AC). The direction of the current reverses, or alternates, 60 times per second (in the U.S.) or 50 times per second (in Europe, for example). Alternating Current is the standard for electricity supplied in a HVAC system as is it generally supplied from the AC supply to the building.

Symbol	Represents
A	Ampere
mA	Milliampere (1/1000th of an ampere)
DC	Direct Current
AC	Alternating Current
I	Symbol for Current in equations

Voltage

Voltage is the force that causes current to flow. It is measured in Volts (V). Voltage should be referred to as either Alternating Current Voltage (Vac) or as Direct Current Voltage (Vdc) as the power in each case is not equal.

Symbol	Represents
V	Volt
Vac	Alternating Current Volt
Vdc	Direct Current Volt
E	Symbol for Voltage in equations (Electromotive Force)

Resistance

Resistance is the opposition to the flow of current. It is measured in Ohms (Ω).

Every part of a circuit has resistance, that is, opposes the flow of current. Resistance causes voltage drops in a circuit when the load uses the energy to do work.

Symbol	Represents
Ω	Ohm
kΩ	Kilo Ohm (1K Ω [1,000Ω])
R	Symbol for Resistance in equations

Impedance

The input impedance or load impedance of an electronic circuit is the resistance to current flow experienced by a signal connected to it. The input impedance is a load on the signal circuit; therefore, determines the amount of current the actuator will draw from the controller on the control signal circuit. Input Impedance is usually expressed as a resistance in ohms (Ω).

Example:

A modulating (2-10 VDC) actuator has an input impedance of 100 kΩ.

Calculate the current draw at 10 VDC using Ohm’s Law (I=E/R):

I = 10 VDC / 100,000Ω = 0.0001A or 0.1mA

Therefore, current draw for each actuator is 0.1 mA.

The control signal circuit of a modulating controller has a maximum output current, usually expressed in milliamperes (mA).

Example: A modulating (2-10VDC) controller has maximum current draw output of 1.0 mA

It is important to ensure that the sum of the actuators current draw does not exceed the controller’s maximum output current.

Exercise: What is the maximum number of 2-10Vdc modulating actuators with an input impedance of 100 kΩ that can be driven from a controller with a maximum output current of 0.5 mA?

63-2622-01

1. Calculate the current draw of one actuator:
   I = 10 Vdc / 100,000ΩI = 0.0001A or 0.1 mA
2. Divide the current draw of one actuator into the maximum output current of the controller:
   0.5 mA ÷ 0.1 mA = 5
   Number of Actuators = 5

Ohm's Law

Ohm's Law states the relationship between Current, Voltage and Resistance in a circuit. Ohm's Law is an algebraic equation, which allows us to understand what happens in a circuit:

E=I*R	Voltage is equal to Current multiplied by Resistance
I=E/R	Current is equal to Voltage divided by Resistance
R=E/I	Resistance is equal to Voltage divide by Current

Power

Power is the rate at which energy can be supplied or used. Electrical power is measured in Watts (W).

W	Watt
KW	Kilo Watt (1 kW = 1,000 W)
P	Symbol for Power in equations
P=E*I	Power is equal to Voltage multiplied by Current
$P=I^2*R$	Power is equal to Current squared multiplied by Resistance
$P=E^2/R$	Power is equal to Voltage squared divided by resistance

Power Consumption (Watts vs. VA)

Watts (W)

For purely resistive loads, such as heating elements, powered from either direct current or alternating current, power consumption can be calculated using the following equation and is rated in Watts (W).

P=I*E (Wattage is equal to Current multiplied by Voltage)

Volt-Amperes (VA)

Actuators are not purely resistive loads. The electric motor and actuator control circuits have inductive and capacitive loads as well. When powering actuators from alternating current, the inductive and capacitive loads force the current and voltage out of phase. This results in a current change and apparent power consumption (P_A). Apparent power can be calculated using the same equation. However, as the current may be different the rating is in VA.

P_A=I*E (where Current is that which is out-of-phase)

NOTE: Typically, it is not necessary to calculate actuator VA as it is rated in the actuator's specification.

Transformer Sizing

Transformers used to supply alternating current are rated in volt-amperes (VA). To ensure a properly sized transformer, add the power consumption of all loads in volt-amperes (VA). Ensure that the transformer's VA rating exceeds the sum of the power consumption of all loads connected to that transformer.

Electric Circuits

Electric circuits consist of a power source, connecting wires or conductors, and a device that uses the electrical energy. The device that uses the energy is called the load. For current to flow in an electric circuit, there must be a complete path from the common or negative terminal of the power source, through the connecting wires and load, back to the hot or positive terminal of the power source.

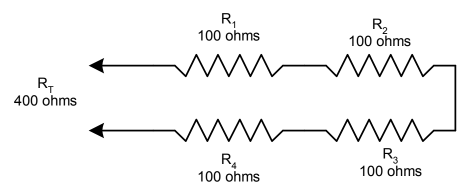
Types of Circuits

There are two basic electrical circuits, Series and Parallel.

Series Circuits

— The current is the same everywhere in the circuit
— The total resistance is equal to the sum of the resistances in the circuit:

$$R_T = R_1 + R_2 + \dots R_n$$



$R_T = R_1 + R_2 + R_3 + R_4$

Or

R_T = 100 ohms + 100 ohms + 100 ohms + 100 ohms

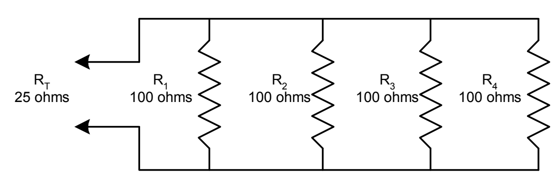
Parallel Circuits

— The voltages across each branch are equal.
— The total circuit current is the sum of the branch circuits.

$$I_T = I_1 + I_2 + \dots I_n$$

— The total resistance is less than the resistance of any branch.

$$1/R_T = 1/R_1 + 1/R_2 + \dots 1/R_n$$

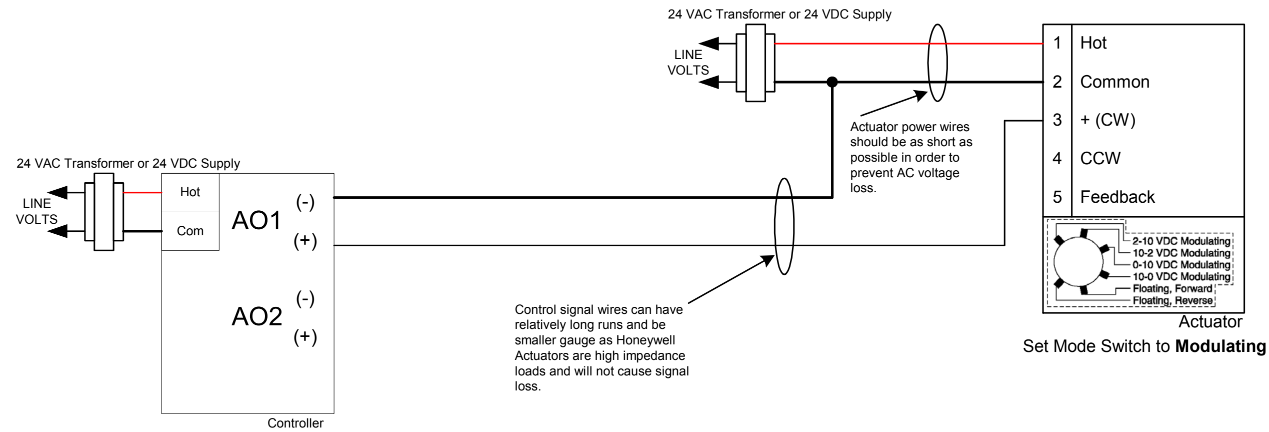


$1/R_T = 1/R_1 + 1/R_2 + 1/R_3 + 1/R_4$

Or

R_T = 1/100 ohms + 1/100 ohms + 1/100 ohms + 1/100 ohms

Wire Length Guidelines



Ground Loops

Ground loops are created when an unintentional circuit is connected using ground as a conductor. Ground loops can introduce electronic “noise” into the control circuit, potentially causing erratic response from the actuators. See the below diagrams for an example of ground loop and the proper wiring to eliminate ground loops.

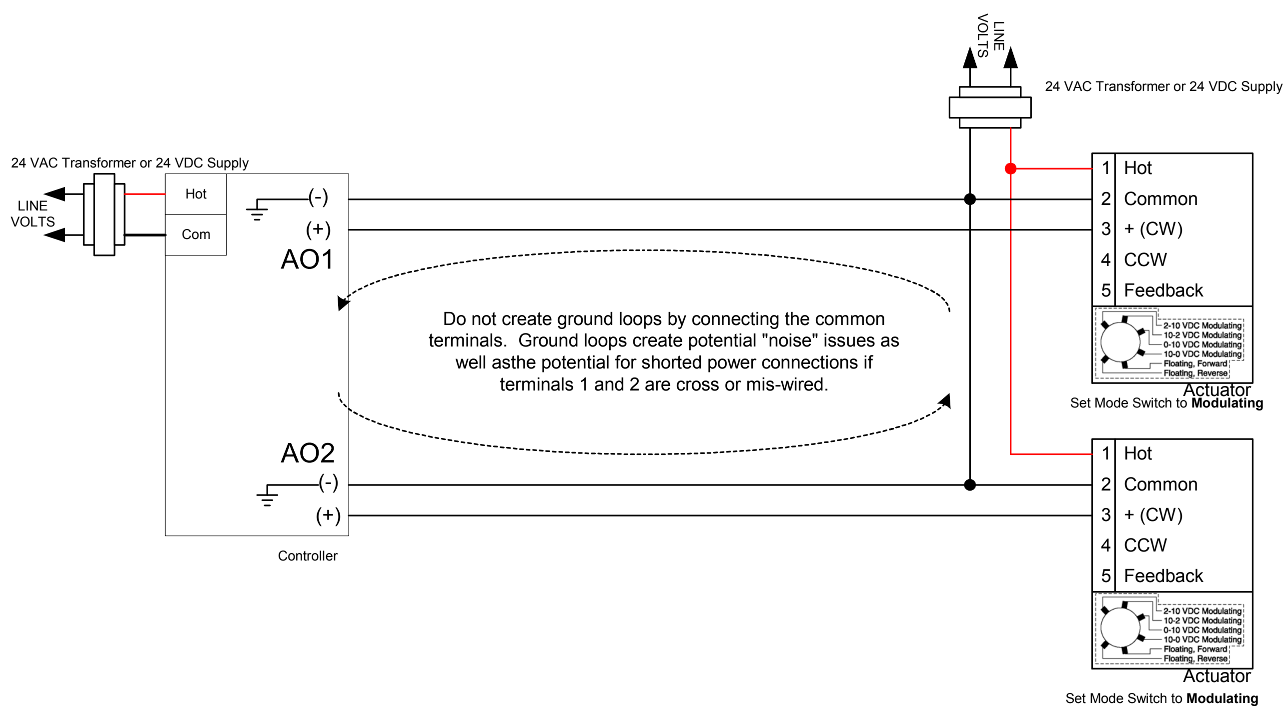


Fig. 1. Wiring with ground loop.

IMPORTANT

See Fig. 2 for correct wiring.

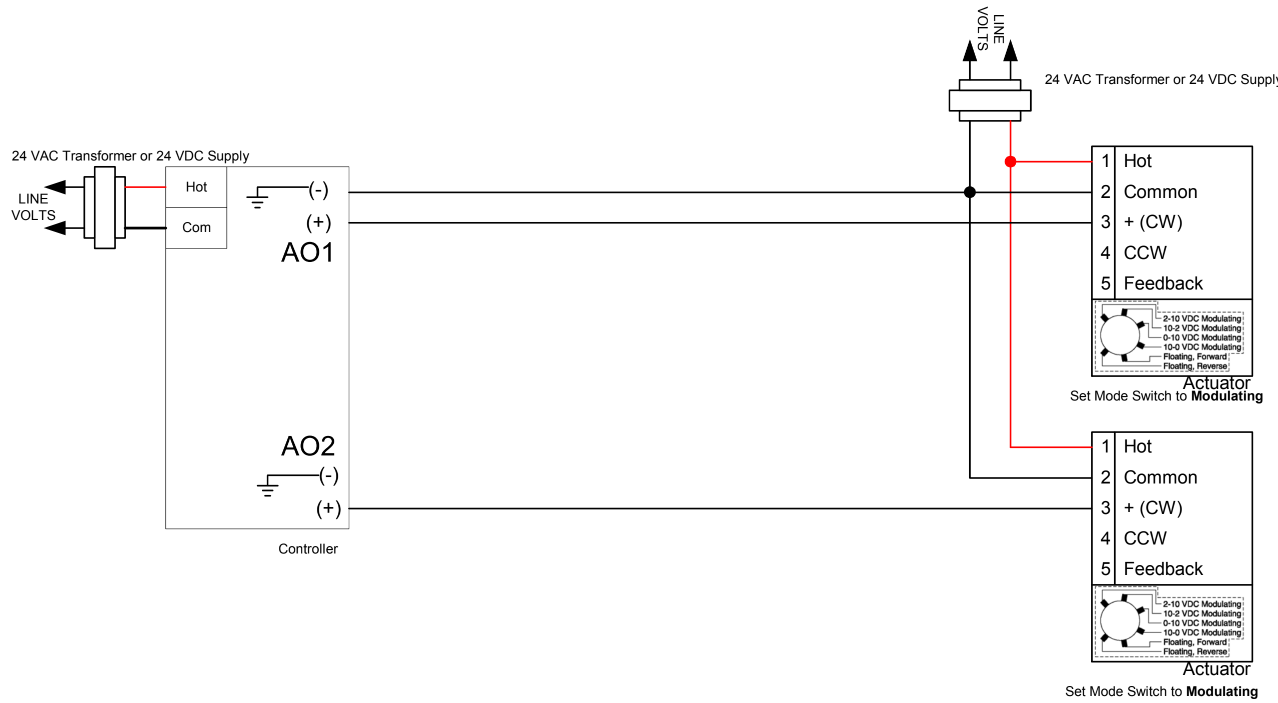


Fig. 2. Corrected wiring without ground loop.

CONTROL WIRING

Table 1. Control Circuits used with DCA

Honeywell Control Series	Type
40	Line Voltage. Two-position Spring Return Actuator
60	Low Voltage. SPDT or Floating. Either Spring Return or Non-Spring Return Actuators.
70	Low Voltage. Proportional (usually analog voltage or current). Either Spring Return or Non-Spring Return Actuators.
80	Low Voltage. Two-position Spring Return Actuator

Actuators should match the type of controller from which they are controlled. Control circuits, especially direct digital, vary from product to product and from company to company. Control signal and supply voltage factors must be taken into account when selecting a DCA for an application. Honeywell has historically classified control circuits into groups and referred to them as Series 40, 60, 70, and 80. Knowing the series group provides much useful information. In most Honeywell part numbers the series designation is in the first number. A MS4120 is Series 40 and therefore is a line voltage, two-position actuator.

Table 2. Wiring Standard for MS and MN Actuators.

Terminal	Floating	Modulating	Two-Position 24 Vac	Two-Position 120 Vac 240 Vac
1	power	power	power	power
2	common	common	common	neutral
3	cw	input	—	—
4	ccw	—	—	—
5	feedback	feedback	—	—

Two-Position

The most fundamental of control series is two-position. This indicates that the final control element is either full open or full closed with no intermediate positions. Most of these will use thermostats or controllers with single-pole-single-throw (SPST) or single-pole-double-throw (SPDT) switching. While this may appear to be a limited form of control it is adequate for many slow changing environments such as an make-up air damper. Series 40, 80 and sometimes Series 60 are two-position. Series 40, 80 use a SPST controller to provide two-position control. Series 60 uses a SPDT controller to provide two-position control.

Series 40 and 80 are identical except for the voltage of the control circuit. Series 40 is line, typically 120 volts AC, while Series 80 is low, typically 24 volts. A controller with SPST switching is used. The actuator is energized and repositioned fully to its other position. When the control point is attained the controller switch is opened, the actuator is de-energized and it is spring returned to its normal position. Applications for this type of actuator are:

- Outside air dampers on 100% outside air or make-up air handlers,
- Exhaust dampers controlled from a room thermostat to prevent overheating in a mechanical room,
- Barometric dampers that are opened to exhaust return air if the static pressure exceeds a setpoint,
- Combustion air inlet dampers for equipment rooms with boilers and furnaces.

Floating

Floating control is a simple means to provide a modulated control without using analog signals. Floating controllers are similar to two-position Series 60 in that there are two separate control circuits. There is, however, an additional position in the center at which neither circuit is made. This has the effect of stopping the actuator regardless of its position. The actuator remains there till either of the two circuits, open or close, is made again. Floating control such as this approximates modulation. Series 60 floating control actuators are typically selected for VAV box damper blade control or inlet vane control of VAV airhandlers.

Modulating

Modulation, also referred to as proportional, has many more output positions for the actuator other than just open or closed. The total number of output positions is dependent upon the resolution of the control equipment. Typically the actuator is half open if the control point matches the setpoint of the controller. Modulation is preferable for most applications since it is feasible to more closely match the output of the controlled equipment with the requirements in the controlled area. This reduces cycling of the mechanical equipment while providing better control. Series 70 is modulating.

Series 70 devices use 0 to 10 volts dc (Vdc), 2 to 10 Vdc or 4 to 20 milliampere (mA) control circuits. These control circuit voltages are very prevalent today, making replacement of other company's actuators with Honeywell DCA economically feasible. Series 70 is intrinsically modulating with actuator feedback either built into the signal voltage or from a feedback signal. Series 70 actuators are supplied with 24 volts.

ON-OFF DIRECT COUPLED ACTUATORS

Non-Spring Return Models

ML6161, ML6174

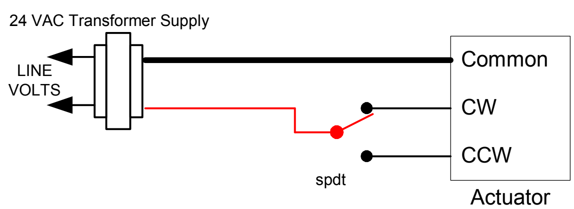


Fig. 3. SPDT controller, two-position actuation.

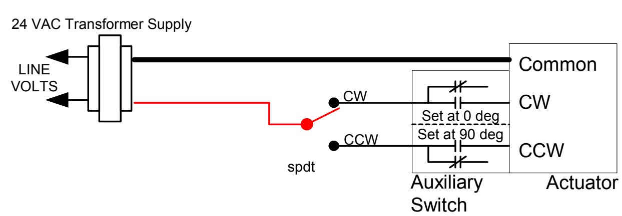


Fig. 4. SPDT controller, two-position actuation using end switch to shut down motor at end of stroke.

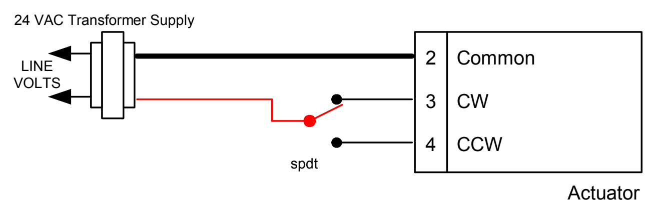


Fig. 5. SPDT controller, two-position actuation.

Spring Return Models

Two-Position Control

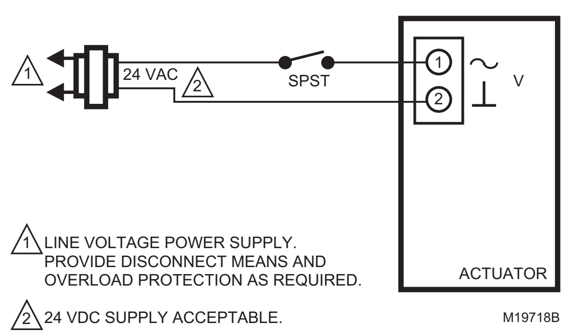


Fig. 6. MS81XX, two-position actuation.

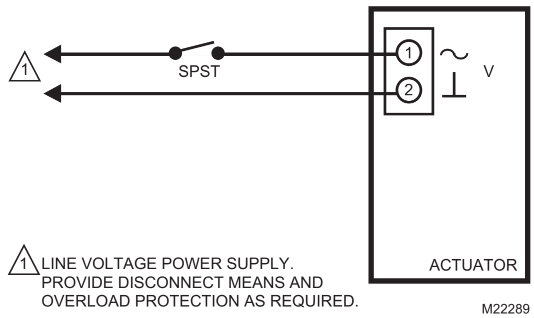


Fig. 7. MS41xx, two-position actuation.

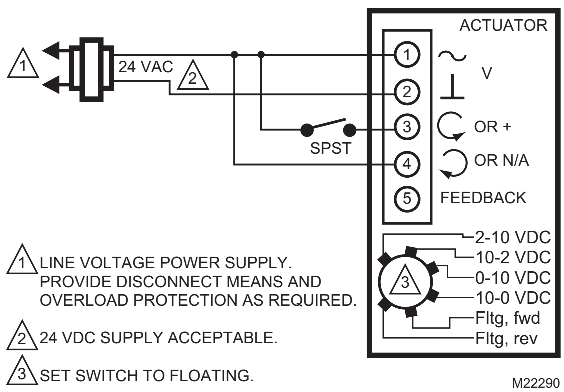


Fig. 8. MS75XX using spst, 3 wires from the controller.

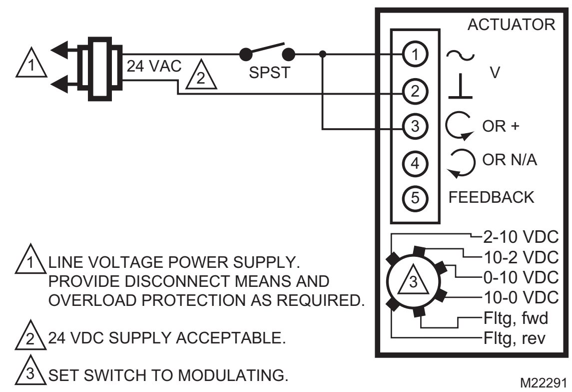


Fig. 9. MS75XX using SPST, two controller wires.

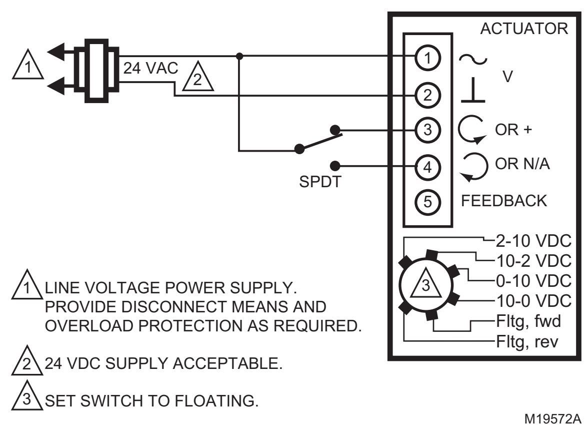


Fig. 10. MS75XX using spdt, 3 wires from the controller.

FAST-ACTING, TWO-POSITION ACTUATORS

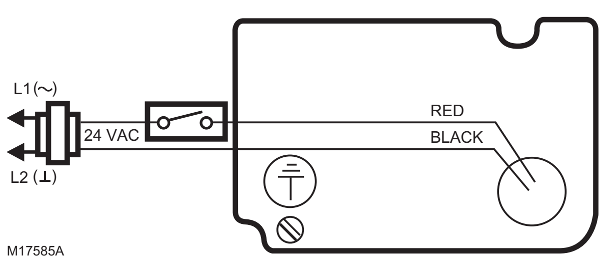


Fig. 11. ML8X02F, ML8115A,B, MS8X09F.

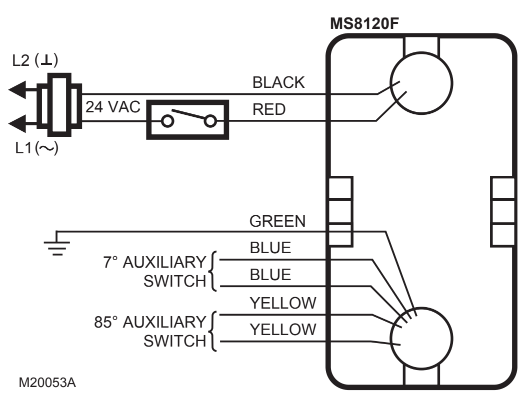


Fig. 12. MS8120F.

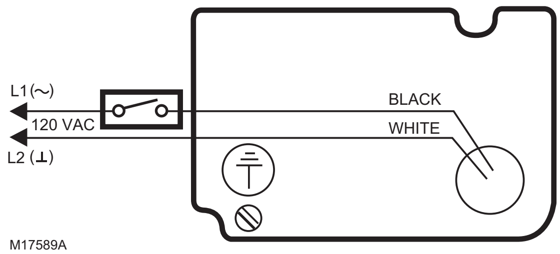


Fig. 13. ML4X02F, ML4115A-D, ML4X09F (120 Vac).

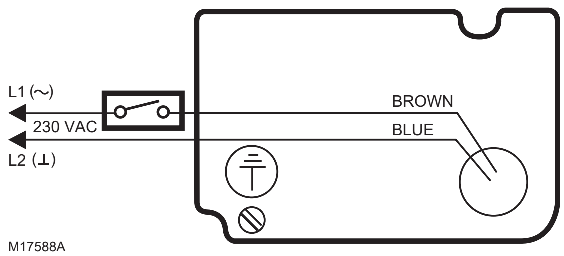


Fig. 14. ML4X02F, ML4115A-D, ML4X09F (230 Vac).

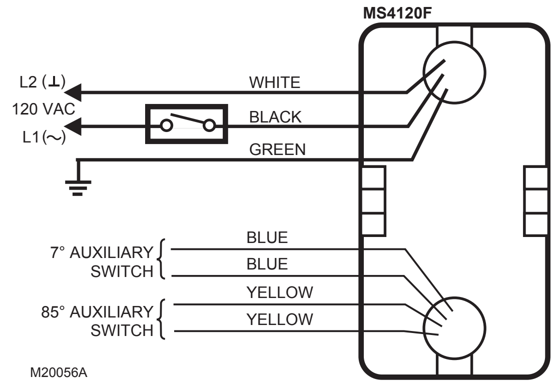


Fig. 15. MS4120F.

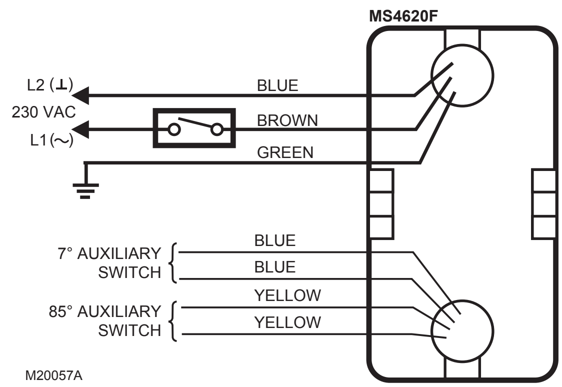


Fig. 16. MS4620F.

FLOATING DIRECT COUPLED ACTUATORS

Non-Spring Return Models

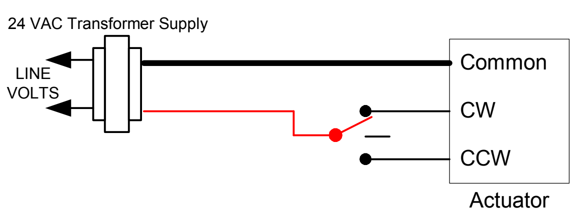


Fig. 17. Floating ML6161/ML6174.

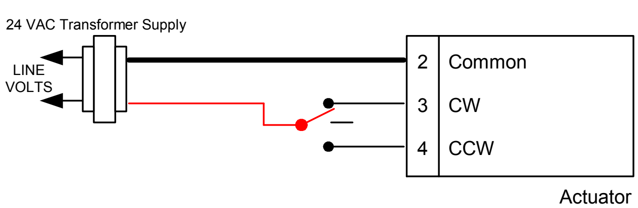


Fig. 18. Floating N20, N34 Series (MN61XX, MN72XX).

Spring Return Models

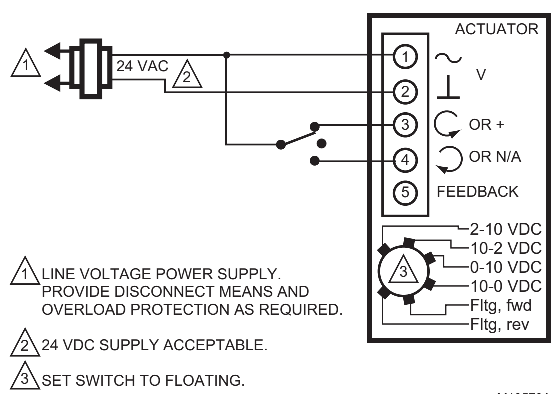


Fig. 19. Standard floating S03, S05, S10, S20 Series (MS81XX, MS41XX, MS75XX).

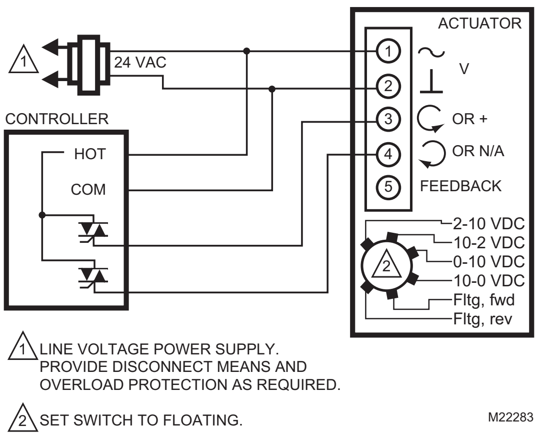


Fig. 20. High-side triac floating S03, S05, S10, S20 Series (MS81XX, MS41XX, MS75XX).

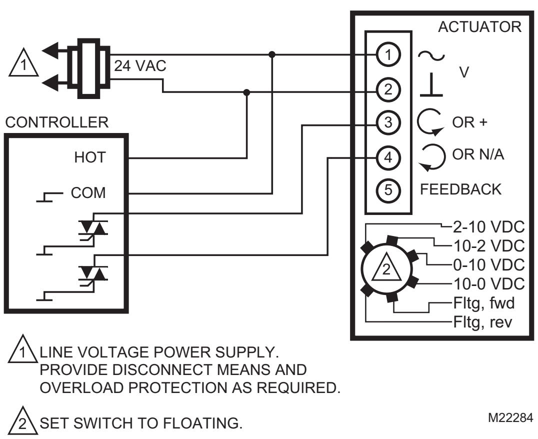


Fig. 21. Low-side triac floating S03, S05, S10, S20 Series (MS81XX, MS41XX, MS75XX).

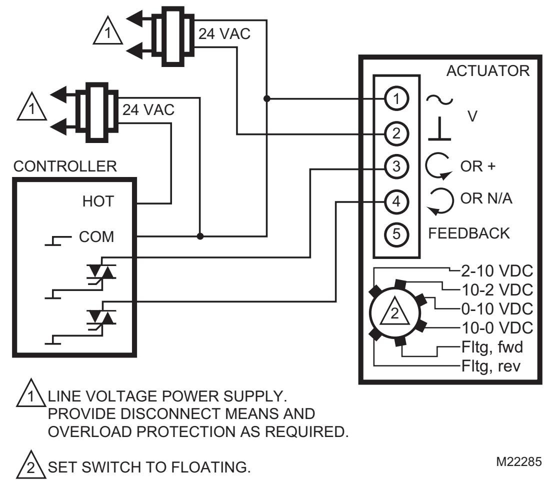


Fig. 22. Low-side triac floating S05, S10, S20 Series (MS81XX, MS41XX, MS75XX) with separate transformers.

MODULATING DIRECT COUPLED ACTUATORS

Non-Spring Return Models

One Controller, One Actuator

0/2 TO 10 VDC CONTROL SIGNAL

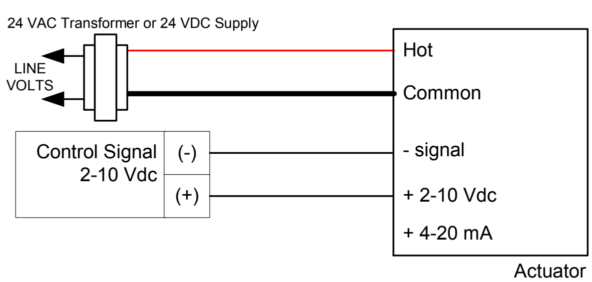


Fig. 23. 2-10 Vdc control of ML7161/ML7174.

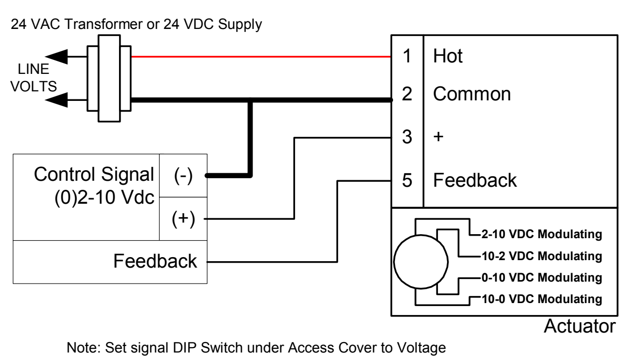


Fig. 24. (0)2-10 Vdc control of N20, N34 Series (MN61XX, MN72XX).

4 TO 20 MA CONTROL SIGNAL

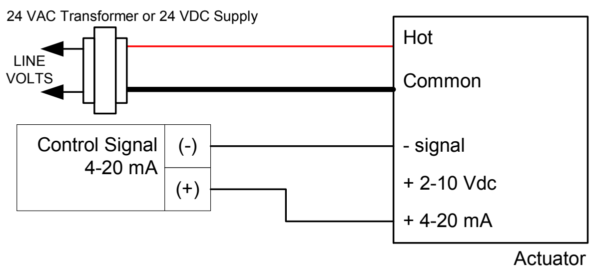
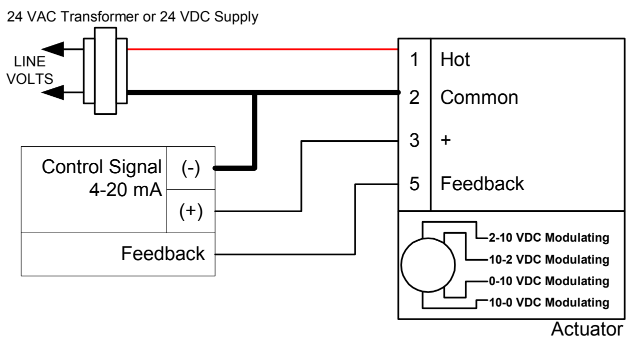


Fig. 25. ML7161/74.



Note: Set signal DIP Switch under Access Cover to Current

Fig. 26. N20, N34 Series (MN61XX, MN72XX).

One Controller, One Actuator with Override

0/2 TO 10 VDC CONTROL SIGNAL

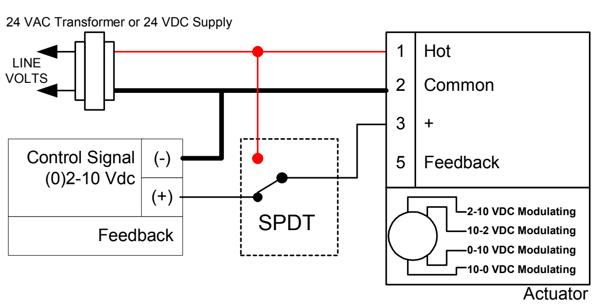


Fig. 27. Override to full open N20, N34 Series (MN61XX, MN72XX).

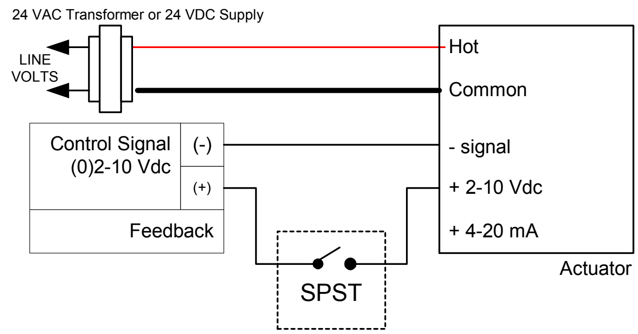


Fig. 28. Override to full closed ML6161/74.

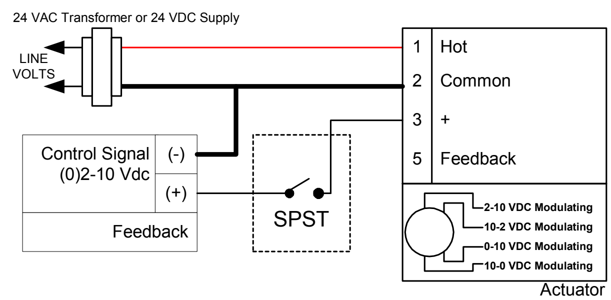


Fig. 29. Override to full closed N20, N34 Series (MN61XX, MN72XX).

One Controller, Multiple Actuators

0/2 TO 10 VDC CONTROL SIGNAL

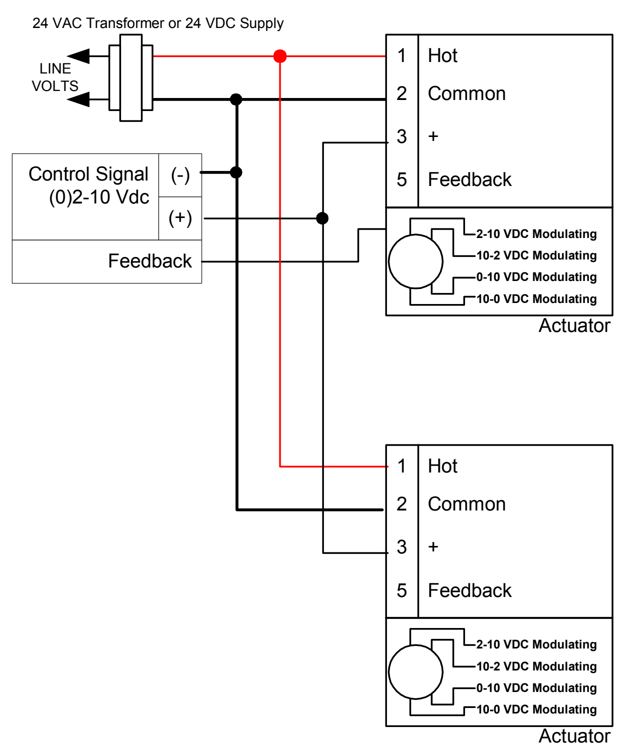


Fig. 30. Single transformer wired in unison.

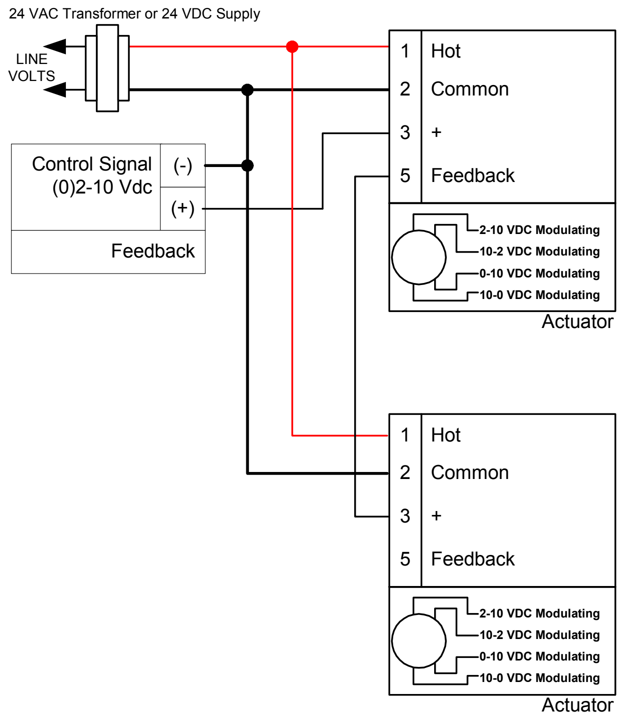


Fig. 31. Single transformer, master drone.

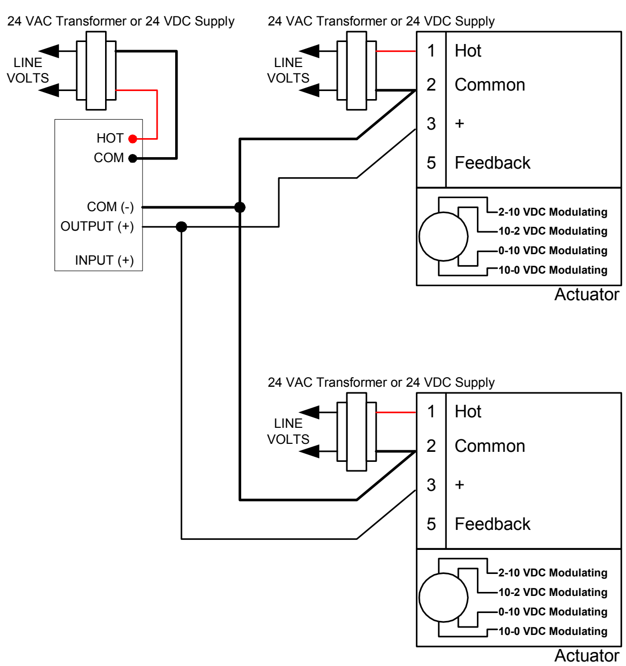


Fig. 32. Separate transformers, wired in unison.

4 TO 20 MA CONTROL SIGNAL

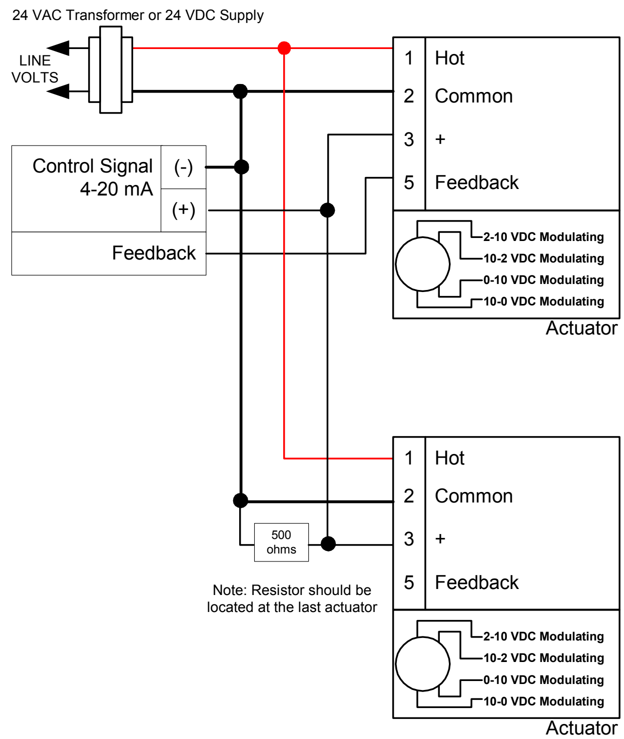


Fig. 33. Single transformer, wired in unison.

MINIMUM POSITION POTENTIOMETER

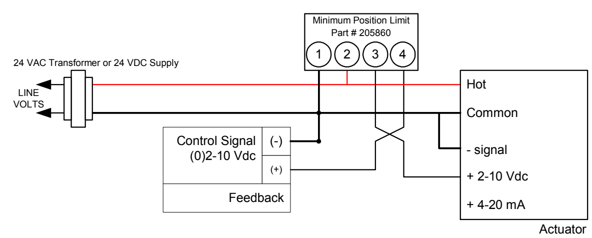


Fig. 34. ML7161/74.

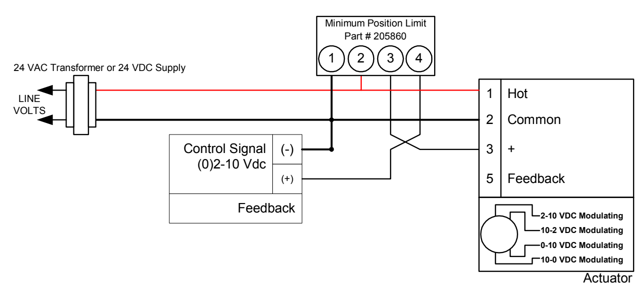


Fig. 35. N20/N34.

Spring Return Models

One Controller, One Actuator

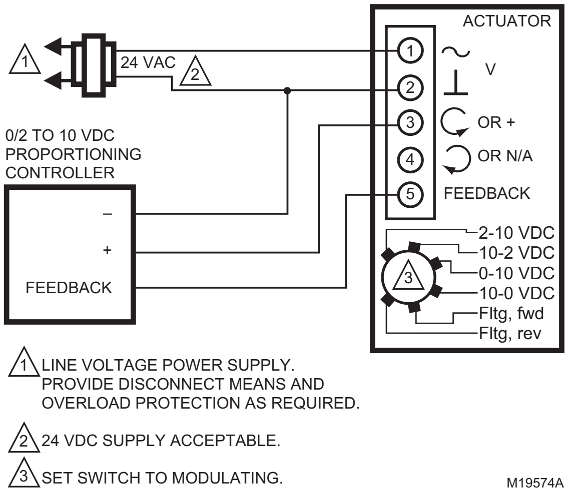


Fig. 36. 0/2 to 10 Vdc.

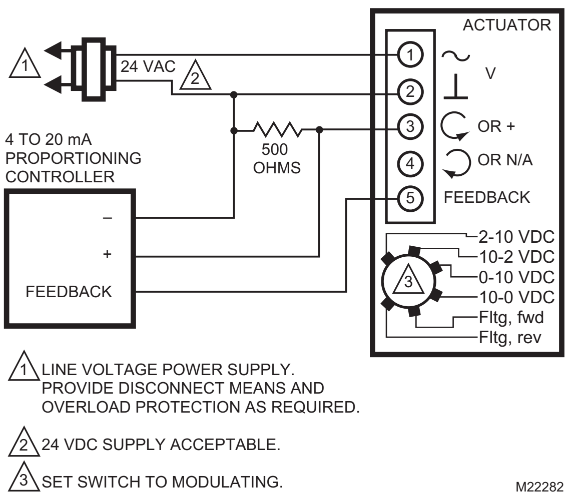


Fig. 37. 4 to 20 mA.

One Controller, One Actuator with Override

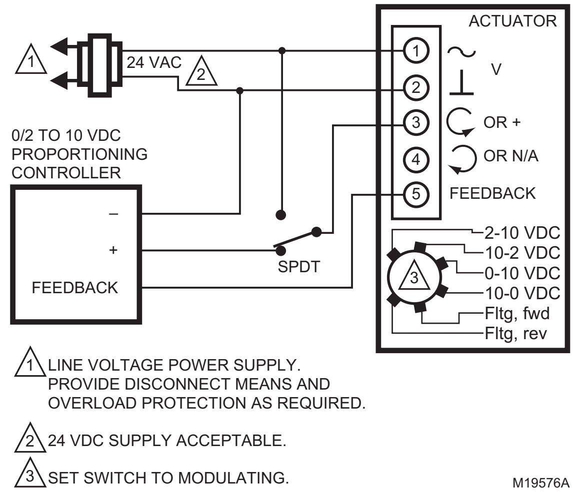


Fig. 38. 0/2 to 10 Vdc, override to full open.

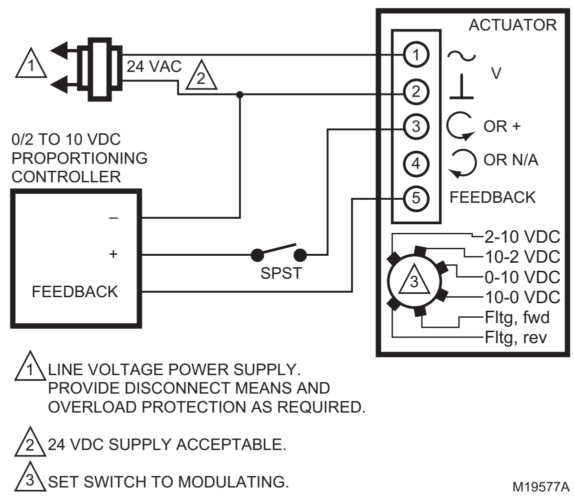


Fig. 39. 0/2 to 10 Vdc override to full closed.

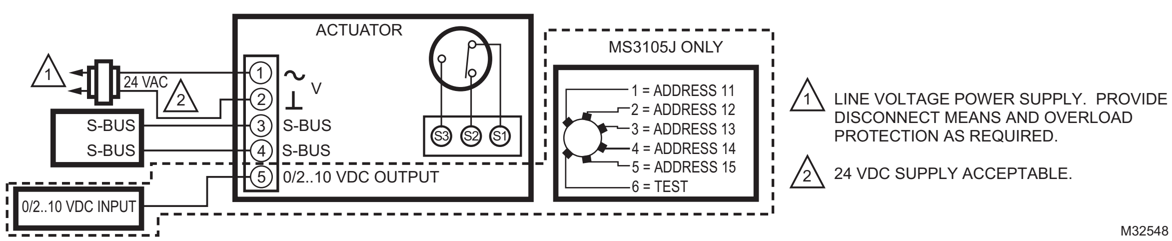


Fig. 40. Wiring for Sylk BUS, MS3103, 05 series.

One Controller, Multiple Actuators

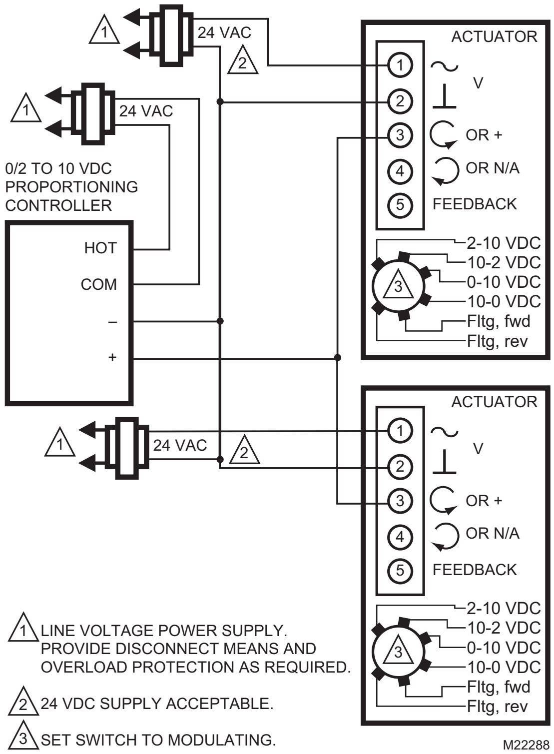


Fig. 41. 0/2 to 10 Vdc, multiple DCA, one transformer.

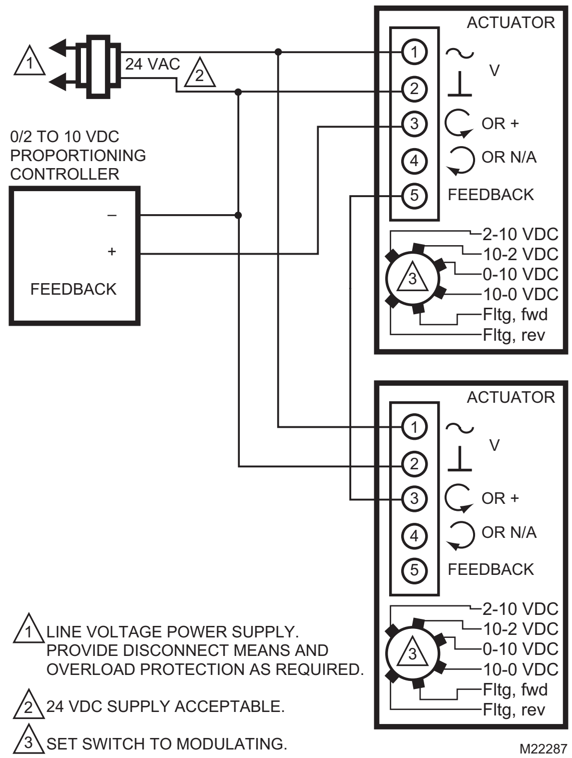


Fig. 43. (0) 2-10 Vdc control as master drone.

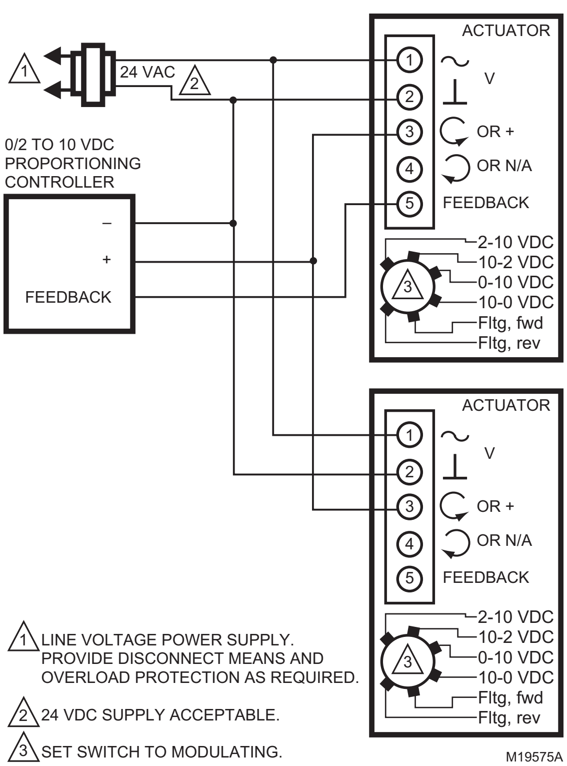


Fig. 42. 0/2 to 10 Vdc.

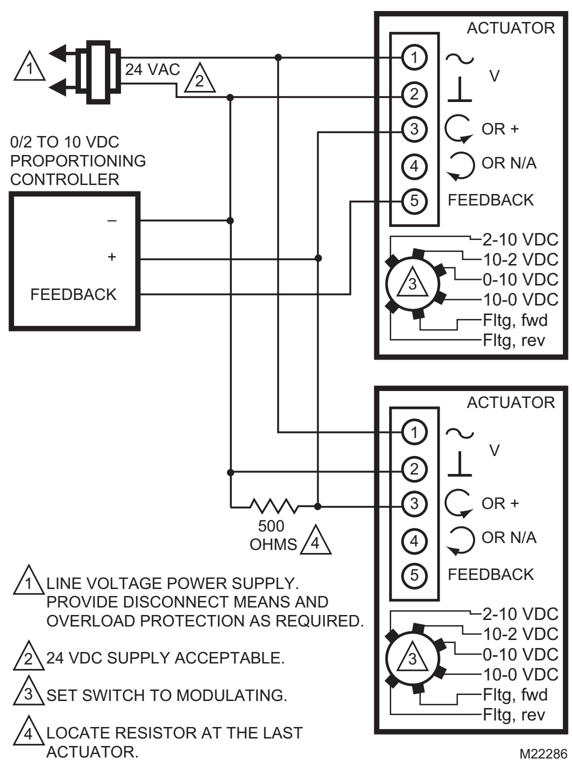


Fig. 44. 4-20 mA control of multiple actuators.

Minimum Position Potentiometer

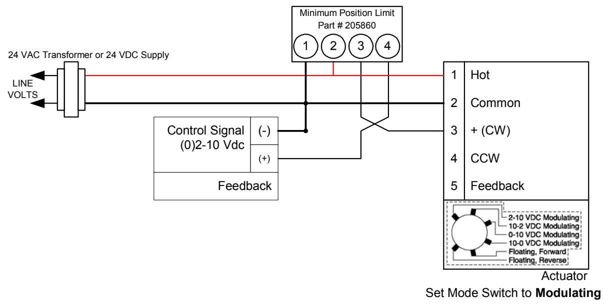


Fig. 45. 0/2 to 10 Vdc control.

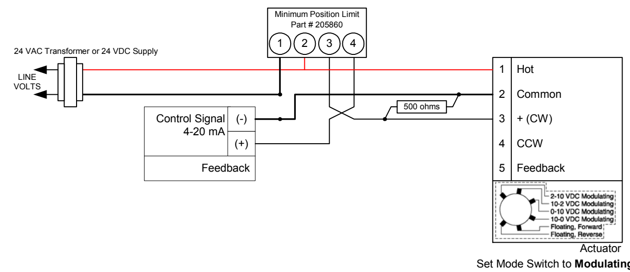


Fig. 46. 4-20mA control.

Spring Return

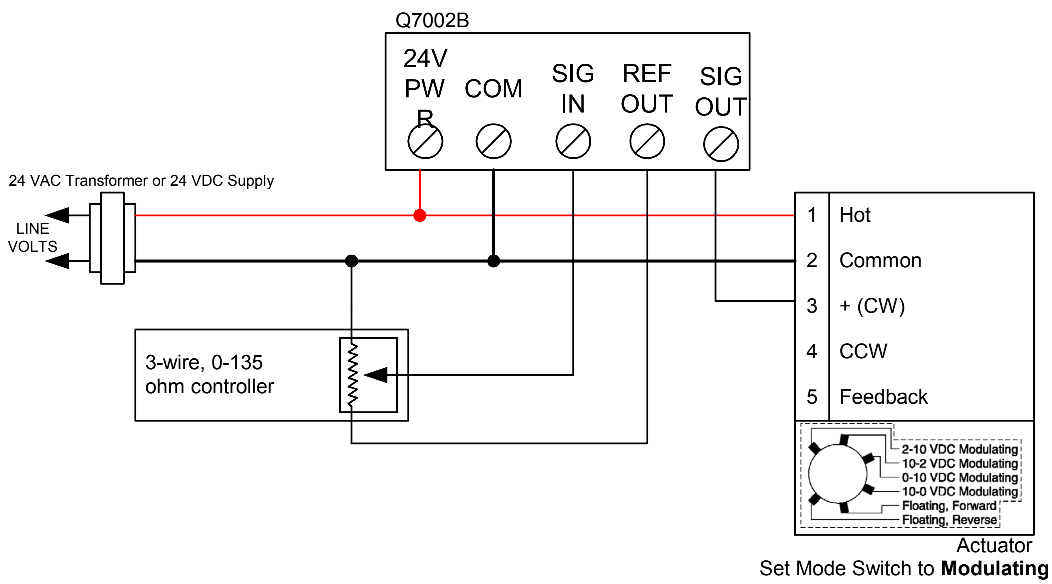
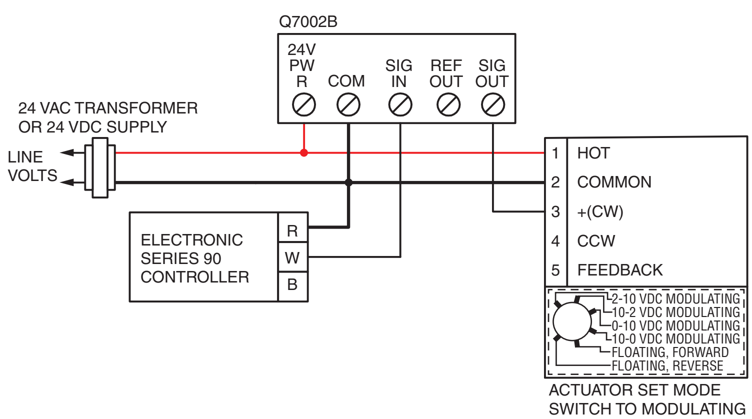


Fig. 47. 135 ohm control of S03, S05, S10, S20 Series (MS75XX).



NOTE: REQUIRES Q7002B “SIG IN” TO BE CALIBRATED FOR 0-1.80 VDC

MCR34485

Fig. 48. Electronic series 90 control of S03, S05, S10, S20 Series (MS75XX).

AUXILIARY SWITCHES

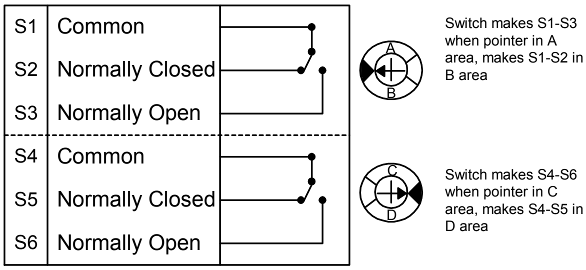


Fig. 49. SW2-US Auxiliary Switch wiring.

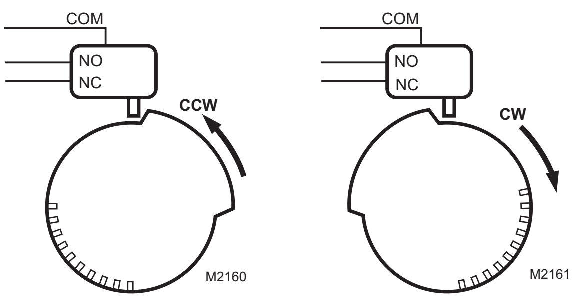


Fig. 50. ML6161/74 switch package.

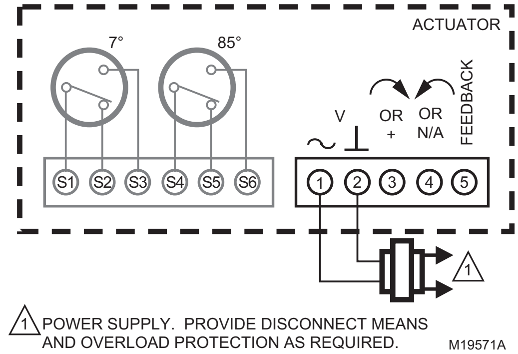


Fig. 51. S10, S20, N20, N34 Series (MS81XX, MS41XX, MS75XX, MN61XX, MN72XX) internal package.

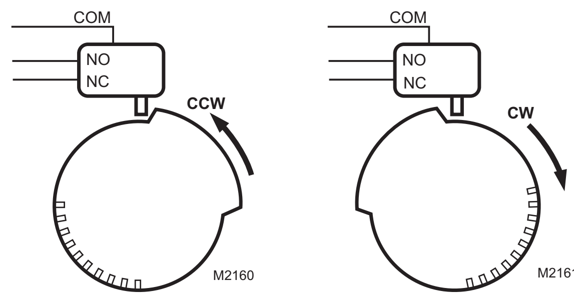


Fig. 52. Fast-acting two position actuator switch package.

NOTES

NOTES

Automation and Control Solutions
Honeywell International Inc.
1985 Douglas Drive North
Golden Valley, MN 55422
customer.honeywell.com

63-2622—01 M.S. Rev. 01-13
Printed in United States

Honeywell