Application Note #651
Revision C
August 2020

Controlling 0–10 V⎓ Fan / Valve Actuators with a Palladiom HVAC Controller

Overview

This document describes how to wire the myRoom and HomeWorks FCU controllers to 0–10 V⎓ controlled valve actuators and fans. Actuators and fan control boards powered by alternating current must use a separate power supply from the HVAC controller's power supply to avoid equipment damage and performance issues.

Note that if the devices requiring 0–10 V⎓ control are also powered by a direct current power supply, a single power supply can power both the HVAC controller and valve actuator. The recommendations described in this app note primarily pertain to devices requiring AC power and a DC control signal.

For an explanation on rectification fundamentals and problems associated with incorrect AC power supply implementation, see the appendices at the end of the document.

Affected Models

This application note pertains to the following Palladiom HVAC controllers when they are controlling fan / valve actuators using 0–10V⎓:

- myRoom Fan Coil Unit (FCU) controller (SMC55-HOSP, SMC53-HOSP, SMC55-MYRM, SMC53-MYRM)
- HomeWorks QS Palladiom HVAC controller (SMC55-RESI, SMC55-HWQS, SMC55-RESI-2)

Recommendations

Actuators powered by alternating current must use a separate power supply from the Palladiom HVAC controller power supply. This will prevent any possibility of equipment damage and will ensure that a working system is provided to the customer. Always ensure that the transformers are sized properly to power the connected VA load.

Connecting multiple actuators to the same 0–10 V⎓ signal is allowed, as long as the minimum load resistance and maximum current is followed. Actuators used in conjunction with the Palladiom HVAC controller must have a minimum 360 Ω internal resistance. For actuators without internal burden resistance, an external resistor is required. Also, the maximum current that can be sourced by each 0–10 V⎓ output of the Palladiom HVAC controller is 28 mA.

Recommended Wiring Diagrams

The diagrams in this section outline how to wire various FCU applications with 0–10 V⎓ controlled valve actuators and/or fans. Refer to the table below for the correct diagram to observe. The DC power supply in the diagrams can be a Lutron power supply, such as the MQSPS-DH-1-30. Note that the FCU controller requires 5 PDUs, or 4 W/6 VA. For each 33 mA of current required by the valve actuators, that translates to 1 PDU required of the power supply.

System Configuration	Valve/Element Control	Fan Control	Basic Configuration Number[1]	Power Configuration	Wiring Diagram
4-Pipe FCU or 2-pipe Cooling with Resistive Heat	24 V~ Relay	0–10 V⎓	Configuration #2	Valves: AC Transformer or DC Power Supply Fan: AC Transformer	Diagram #1
	0–10 V⎓	24 V~ Relay	Configuration #3	Valves: AC Transformer or DC Power Supply Fan: AC Transformer	Diagram #2
				Cold Valve: AC Transformer or DC Power Supply Fan and Heat Element: AC Transformer	Diagram #3
		0–10 V⎓	Configuration #4	Valves: AC Transformer Fan: AC Transformer	Diagram #4
				Valves: DC Power Supply Fan: AC Transformer	Diagram #5
2-Pipe FCU	24 V~ Relay	0–10 V⎓	Configuration #8, #9, #10	Valve: AC Transformer or DC Power Supply Fan: AC Transformer	Diagram #6
	0–10 V⎓	24 V~ Relay	Configuration #11, #12, #13	Valves: AC Transformer Fan: AC Transformer	Diagram #7
				Valves: DC Power Supply Fan: AC Transformer	Diagram #8
		0–10 V⎓	Configuration #14, #15, #16	Valves: AC Transformer Fan: AC Transformer	Diagram #9
				Valves: DC Power Supply Fan: AC Transformer	Diagram #10

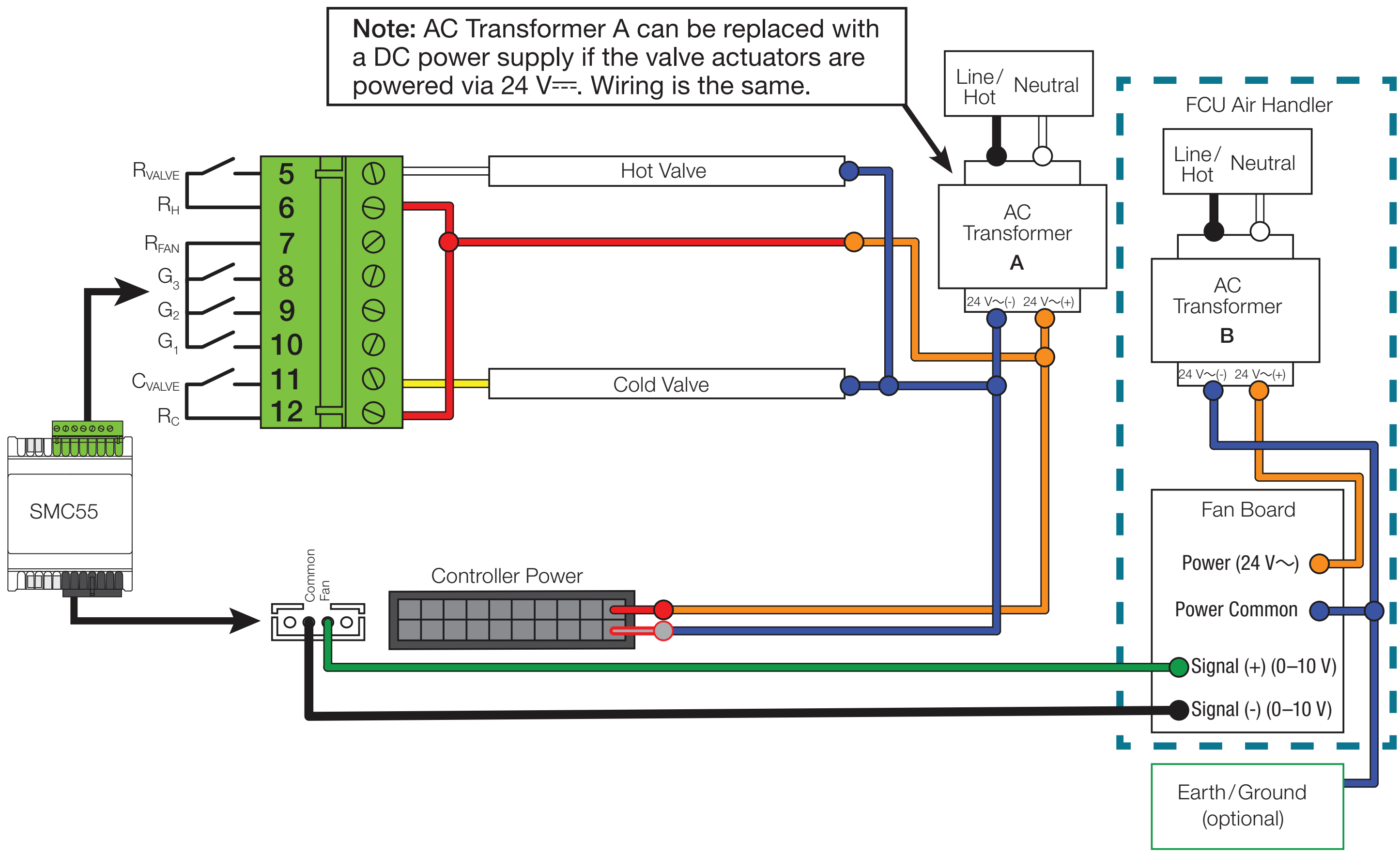
[1] "Basic Configuration Number" refers to the configurations listed in the myRoom Fan Coil Unit Controller Spec Submittal, part number 3691082.

Recommended Wiring Diagrams *(continued)*

Diagram 1 – Basic Configuration #2: 4-pipe FCU, 24V Relay-Controlled Valves, 0–10 V⎓ Controlled Fan

Two AC Transformers Application or One AC Transformer and One DC Power Supply Application

Do not connect AC Transformer A's 24 V~ (-) to earth / ground

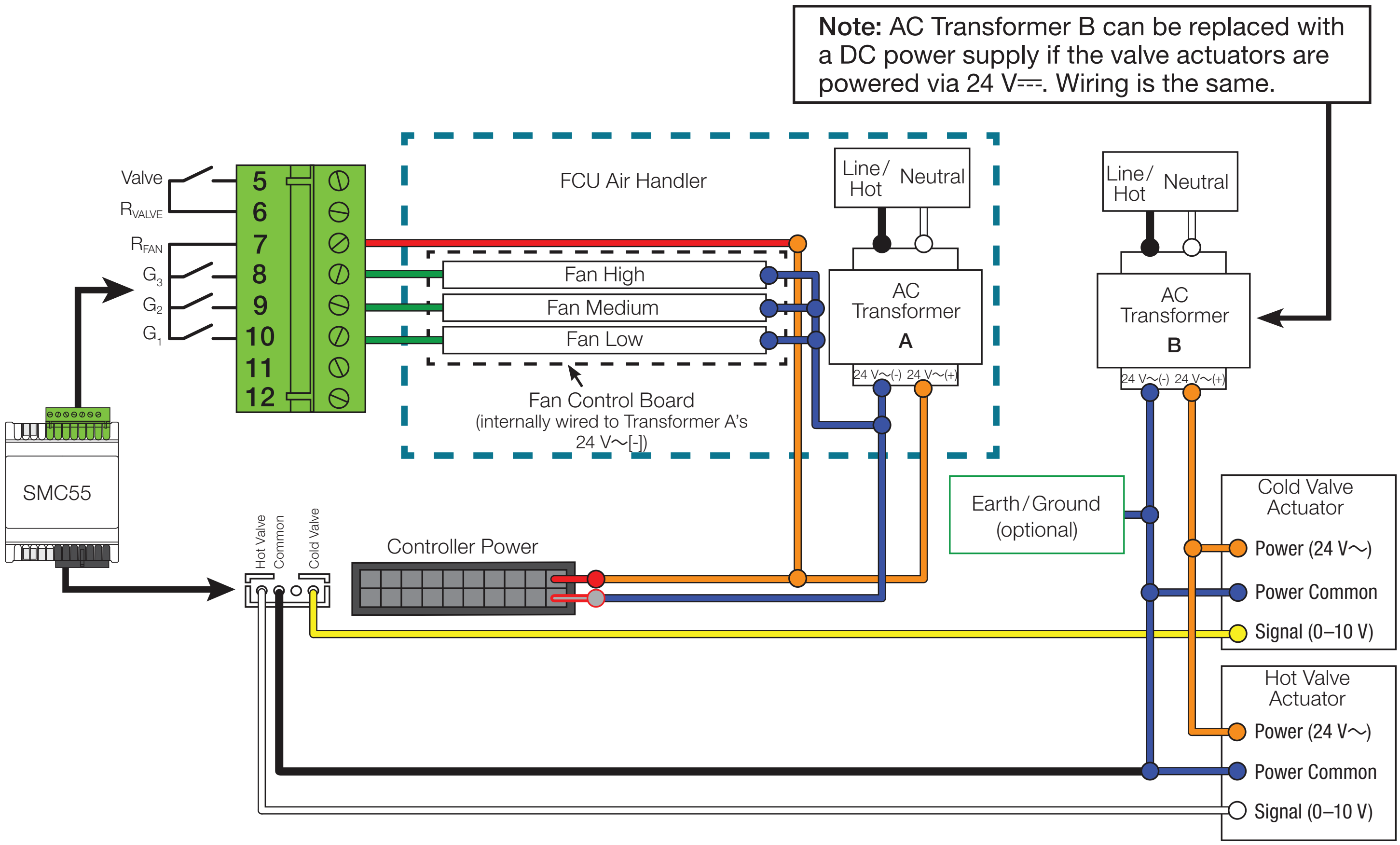


Recommended Wiring Diagrams *(continued)*

Diagram 2 – Basic Configuration #3: 4-pipe FCU, 0–10 V⎓ Controlled Valves, 24 V~ Relay-Controlled Fan

Two AC Transformers or One AC Transformer and One DC Power Supply Application

Do not connect AC Transformer A's 24 V~(-) to earth/ground



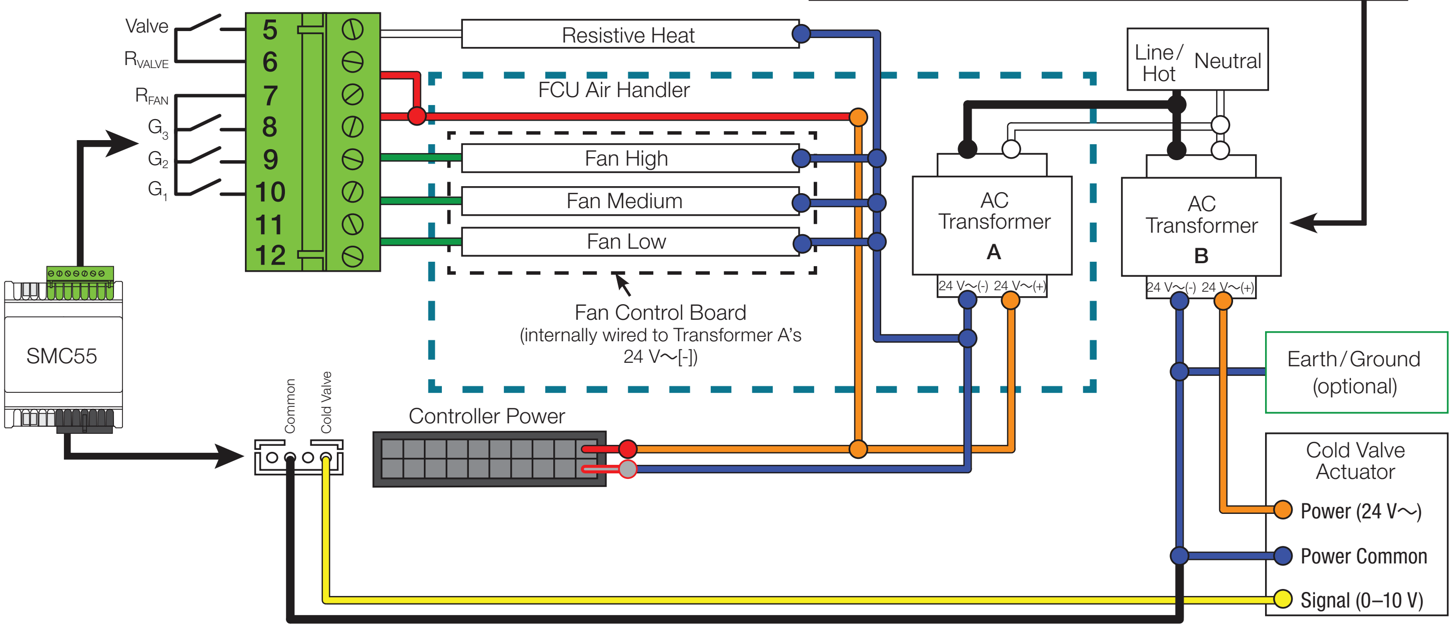
Recommended Wiring Diagrams *(continued)*

Diagram 3 – Basic Configuration #3: 4-pipe FCU, 0–10 V⎓ Controlled Cooling Valve, 24 V~ Relay-Controlled Resistive Heat, 24 V~ Relay-Controlled Fan

Two AC Transformers or One AC Transformer and One DC Power Supply Application

Do not connect AC Transformer A's 24 V~(-) to earth/ground

Note: AC Transformer B can be replaced with a DC power supply if the valve actuators are powered via 24 V⎓. Wiring is the same.

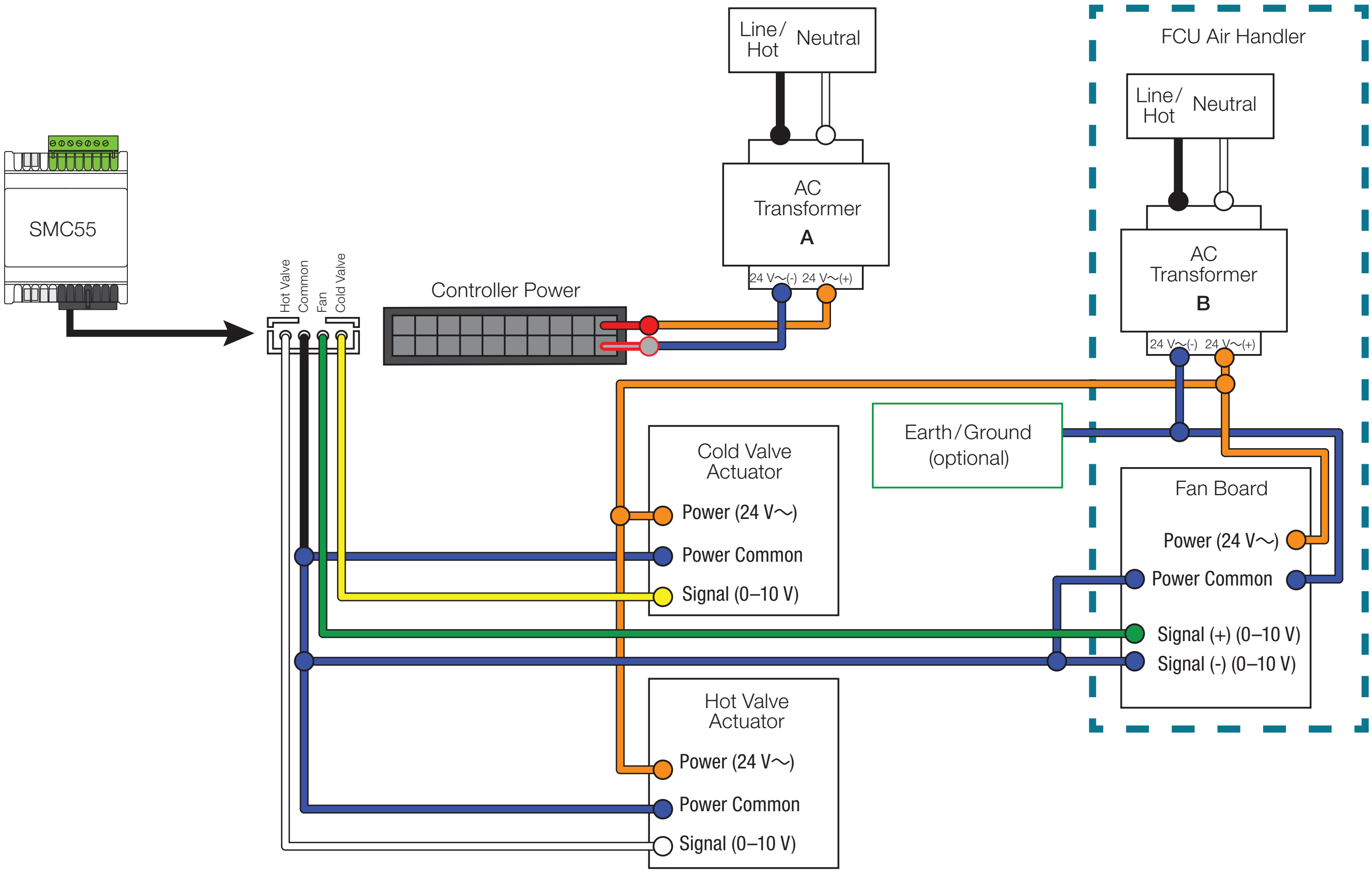


Recommended Wiring Diagrams *(continued)*

Diagram 4 – Basic Configuration #4: 4-pipe FCU, 0–10 V⎓ Controlled Valves, 0–10 V⎓ Controlled Fan

Two AC Transformers Application

Do not connect AC Transformer A's 24 V~ (-) to earth / ground

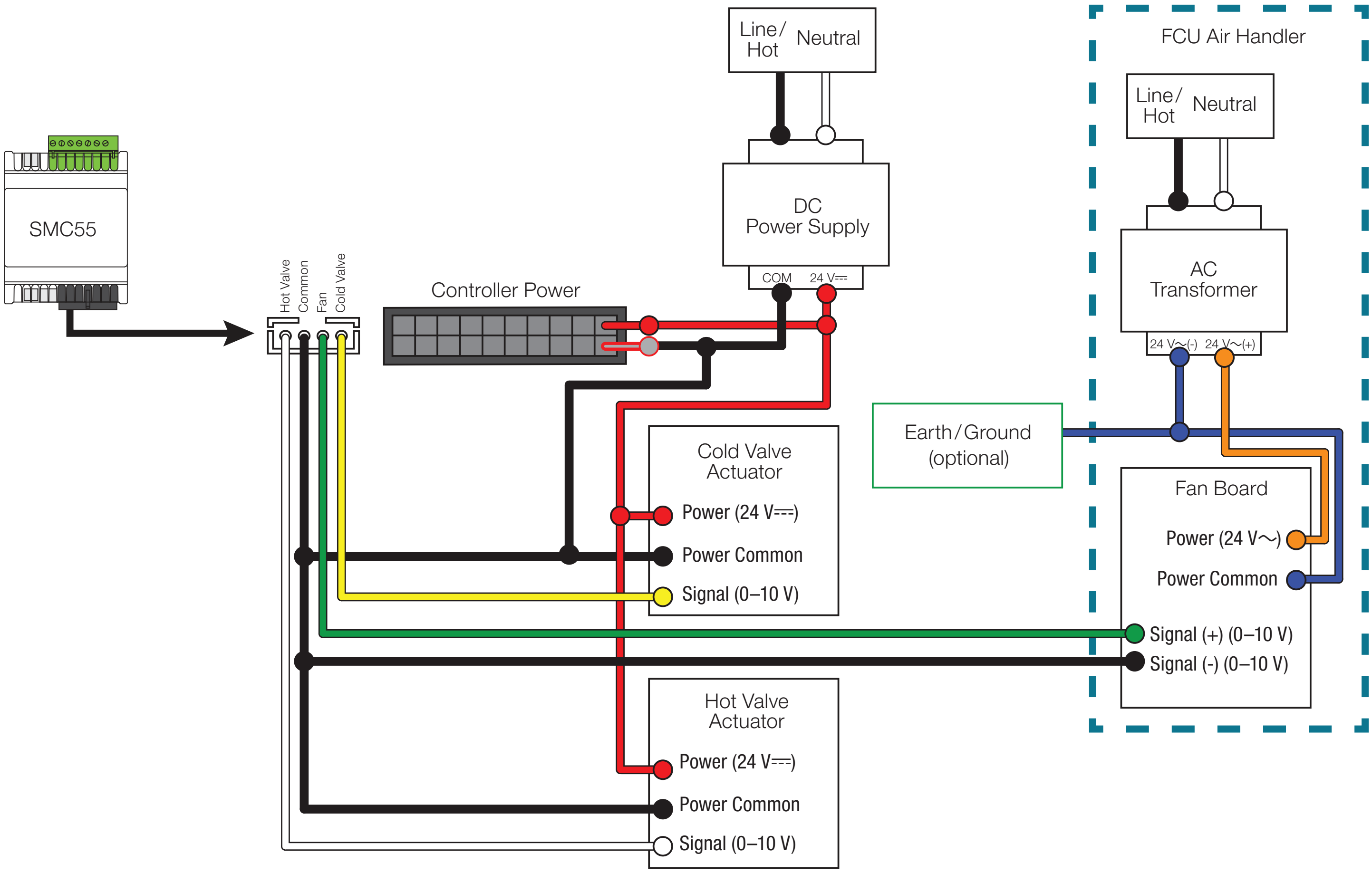


Recommended Wiring Diagrams *(continued)*

Diagram 5 – Basic Configuration #4: 4-pipe FCU, 0–10 V⎓ Controlled Valves, 0–10 V⎓ Controlled Fan

One AC Transformer and One DC Power Supply Application

Do not connect DC power supply's COM to earth/ground

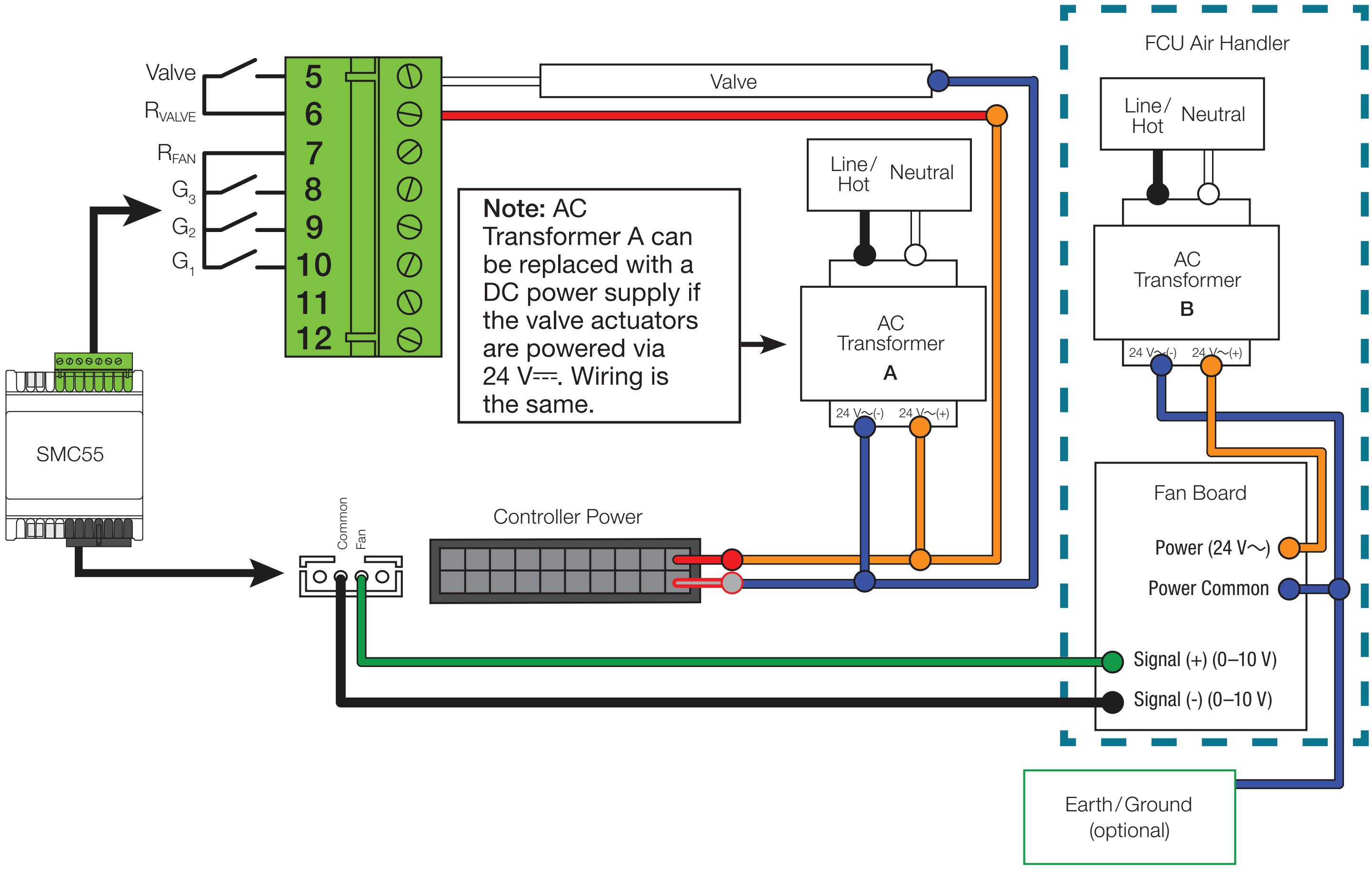


Recommended Wiring Diagrams *(continued)*

Diagram 6 – Basic Configuration #8, #9, and #10: 2-pipe FCU, 24 V~ Relay-Controlled Valve, 0–10 V⎓ Controlled Fan

Two AC Transformers or One AC Transformer and One DC Power Supply Application

Do not connect AC Transformer A's 24 V~ (-) to earth / ground

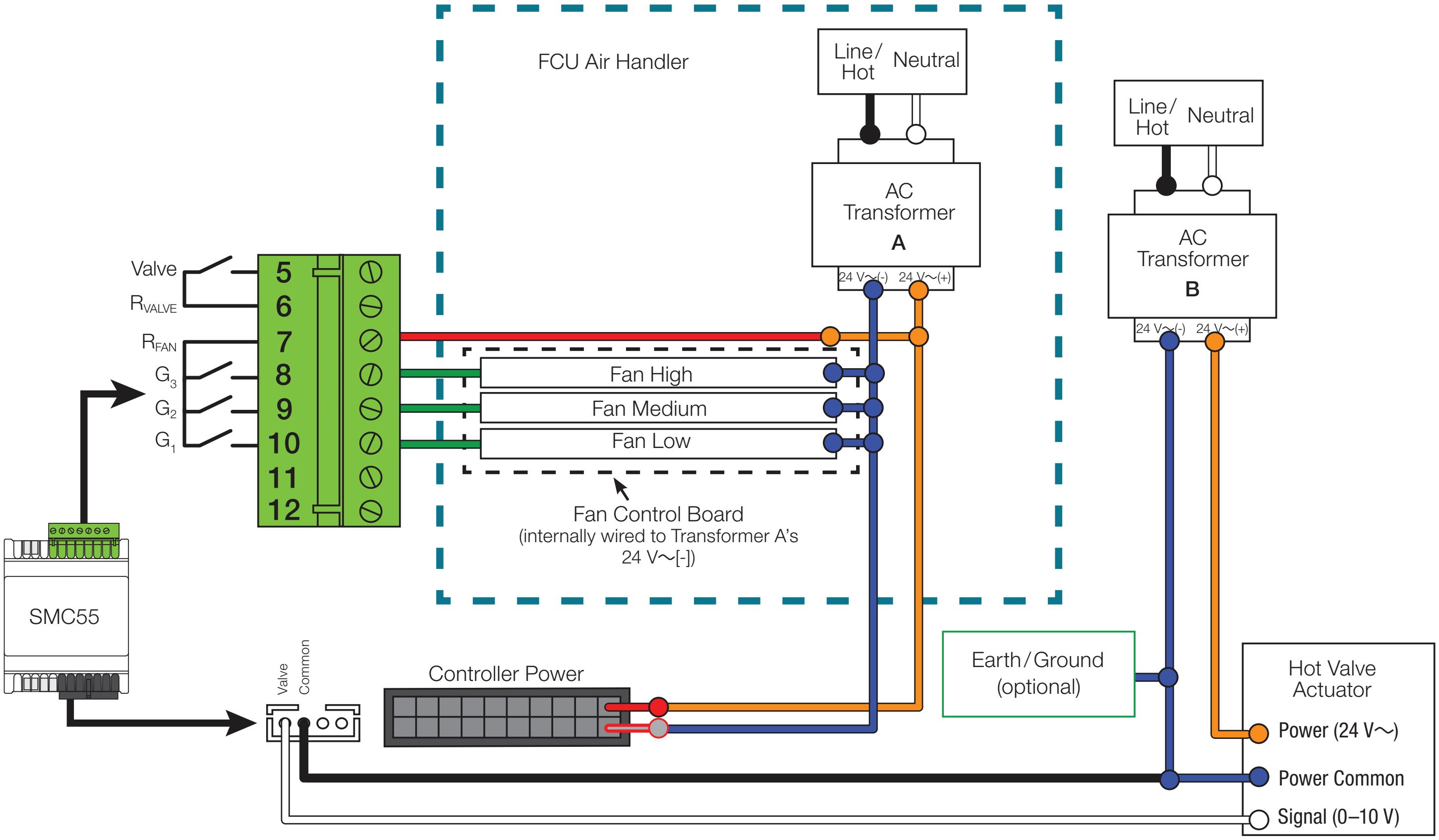


Recommended Wiring Diagrams *(continued)*

Diagram 7 – Basic Configuration #11, #12, and #13: 2-pipe FCU, 0–10 V⎓ Controlled Valve, 24 V~ Relay-Controlled Fan

Two AC Transformers Application

Do not connect AC Transformer A's 24 V~ (-) to earth / ground

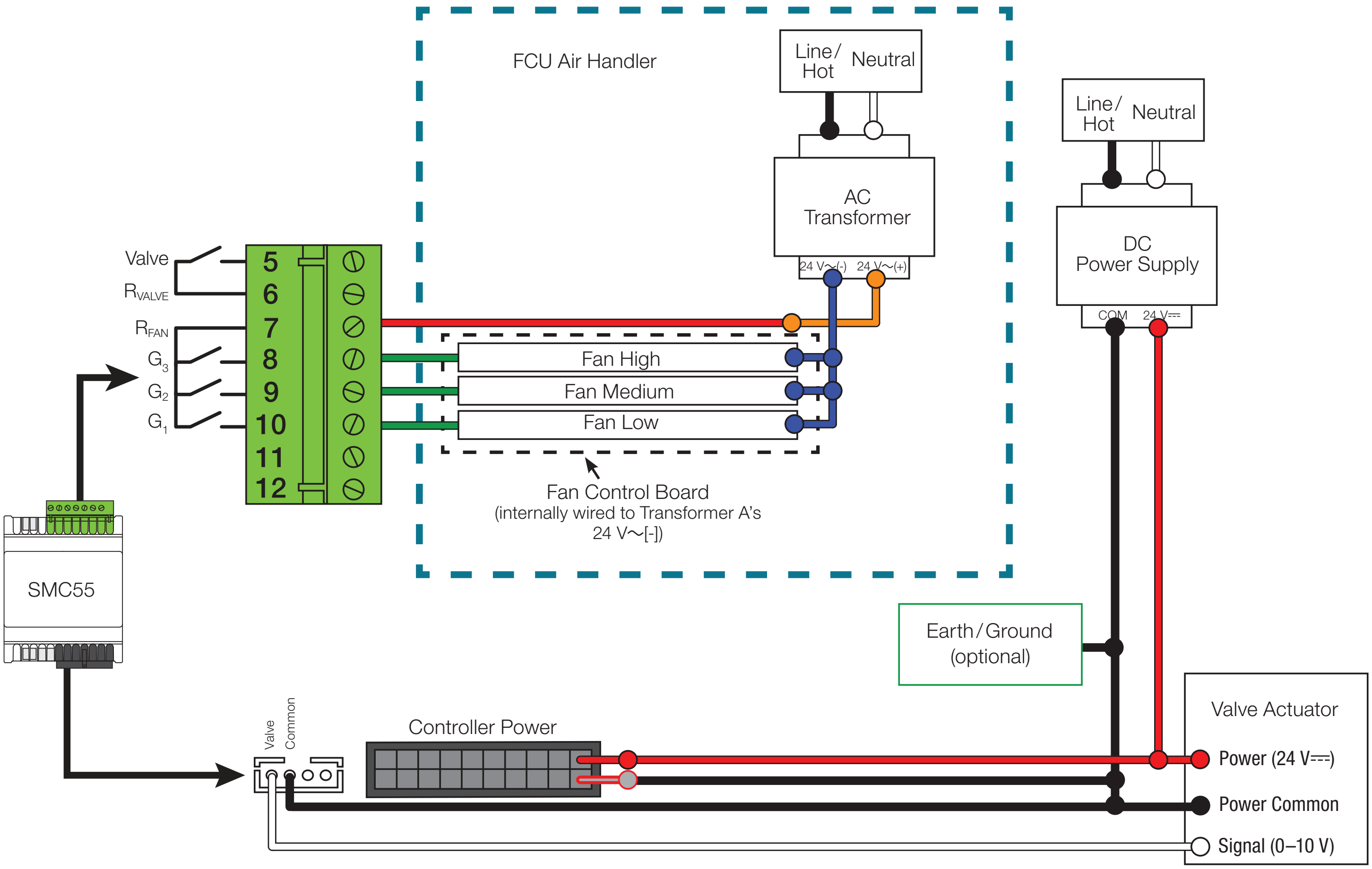


Recommended Wiring Diagrams *(continued)*

Diagram 8 – Basic Configuration #11, #12, and #13: 2-pipe FCU, 0-10 V⎓ Controlled Valve, 24 V~ Relay-Controlled Fan

One AC Transformer and One DC Power Supply Application

Do not connect AC Transformer A's 24 V~ (-) to earth / ground

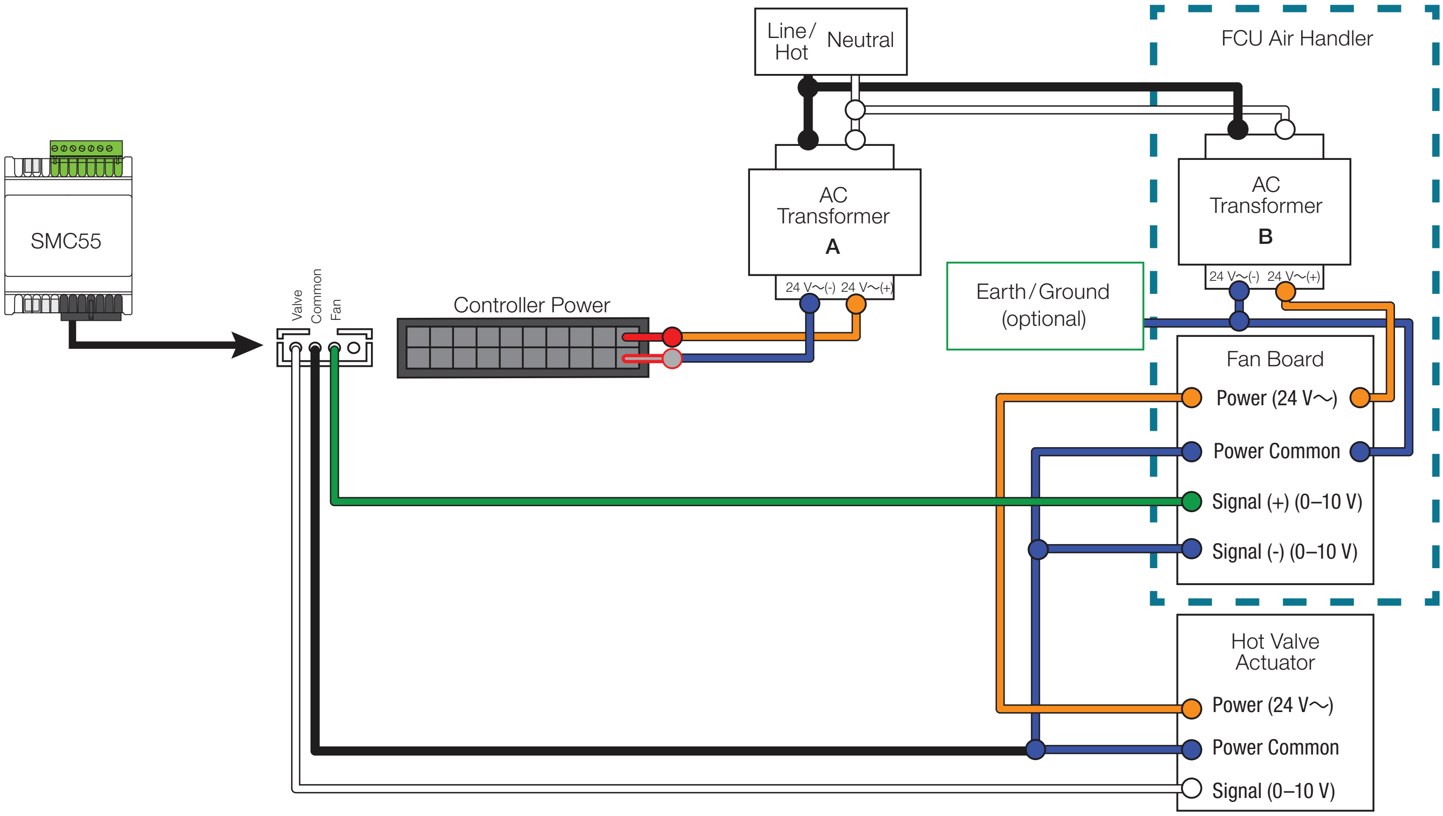


Recommended Wiring Diagrams *(continued)*

Diagram 9 – Basic Configuration #14, #15, and #16: 2-pipe FCU, 0-10 V⎓ Controlled Valve, 0-10 V⎓ Controlled Fan

Two AC Transformers Application

Do not connect AC Transformer A's 24 V~ (-) to earth/ground

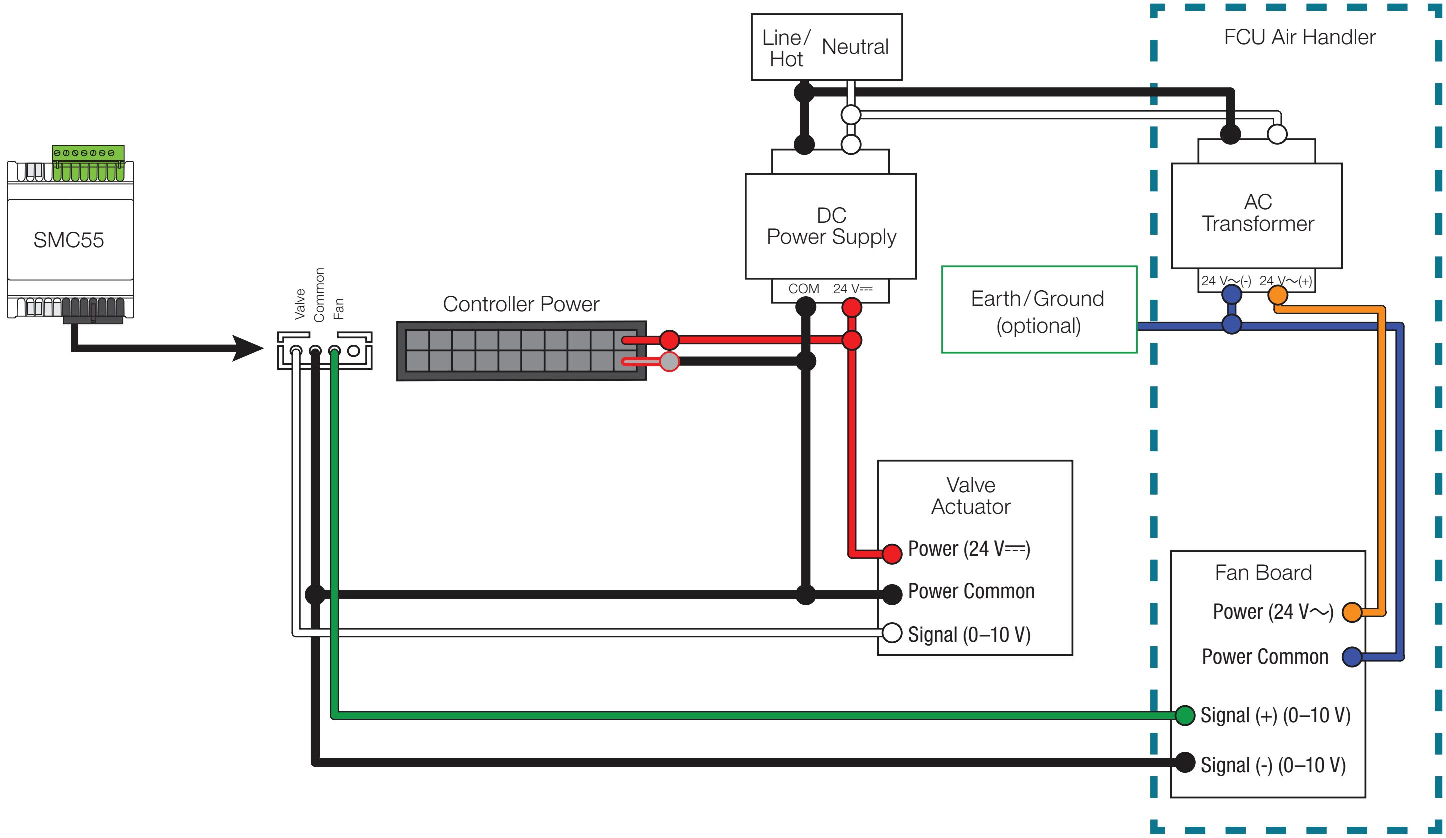


Recommended Wiring Diagrams *(continued)*

Diagram 10 – Basic Configuration #14, #15, and #16: 2-pipe FCU, 0-10 V⎓ Controlled Valve, 0-10 V⎓ Controlled Fan

One AC Transformer and One DC Power Supply Application

Do not connect DC power supply's COM to earth/ground



Appendix A: Rectification Fundamentals

There are two typical means of implementing AC to DC conversion: Half-Wave Rectification and Full-Wave Rectification. Even though actuators and fan control boards can accept AC power, the components within them require DC control signals. This means that each of these products must implement front-end rectification to produce a DC waveform from an AC input. When these two rectification methods are wired together along with analog 0–10 V⎓ control wires that are not isolated from the incoming power connections, this can cause possible equipment damage when both the HVAC controller and actuator are powered from the same AC transformer. Isolation in this context refers to the input side being electrically disconnected from the output. This is typically accomplished by means of an internal transformer housed within the HVAC controller or actuator.

Half-Wave Rectification

Half-wave rectifiers use a single diode to block the flow of current in the negative half-cycle and a filtering capacitor to limit the ripple voltage to an acceptable level. Figure 1 is an example schematic of a half-wave rectified input circuit, filtering capacitor C1, and additional circuitry based on the design of the product.

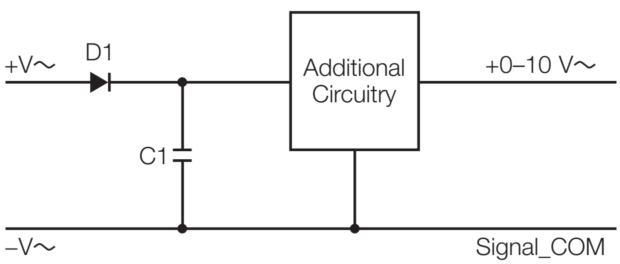


Figure 1 - Basic half-wave rectifier

In the half-wave rectified power supply, the input of the AC transformer (–V∼) and output common (Signal_COM) that would be used on a 0–10 V⎓ signal are directly connected.

Half-wave rectified products can be identified in the field either by having only a single terminal for power and signal common (–) or close to zero resistance between one of the input power terminals and signal common.

Full-Wave Rectification

Full-wave rectifiers use 4 diodes in a specific configuration to direct the flow of current in the same direction in both the positive and negative half-cycles. Along with a filtering capacitor to limit the ripple voltage to an acceptable level, this allows a DC supply with higher power output, greater efficiency, and less ripple voltage to be used. Figure 2 is an example schematic of a full-wave rectified input circuit, filtering capacitor C1, and additional circuitry based on the requirements of the product.

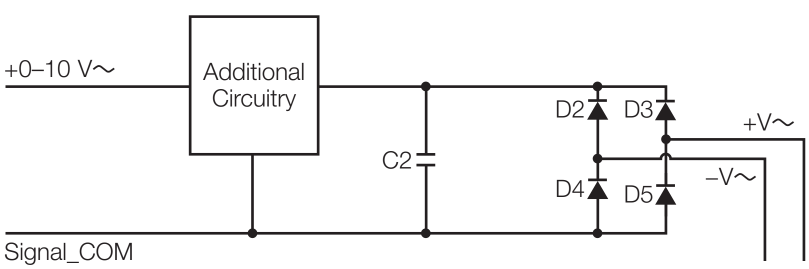


Figure 2 - Basic full-wave rectifier

In the full-wave rectified power supply, the input of the AC transformer (+V∼) and output common (Signal_COM) are separated by diode D5.

Full-wave rectified products can be identified in the field by placing a digital multimeter into diode-check mode and testing from the signal common to the power input (–). A single diode drop of 0.6–0.7 V separating the two connections would confirm that the product is full-wave rectified.

Note: The Palladiom HVAC controller is a full-wave rectified device.

Appendix B: Problems Associated with Incorrect Implementation

A significant problem can exist if the following occurs:

- The same 24 V~ transformer is used to supply power to a full-wave rectified controller (such as a Palladiom HVAC controller) and 0–10 V~ actuator(s).
- The signal output of the actuator is not isolated from the power input connections.
- 0–10 V⎓ or 2–10 V⎓ analog control signals are being used to communicate between the full-wave rectified controller and 0–10 V~ actuator(s).

Figure 3 is a schematic that illustrates the incorrect way to connect these devices via 0–10 V⎓. Do NOT connect products in this manner.

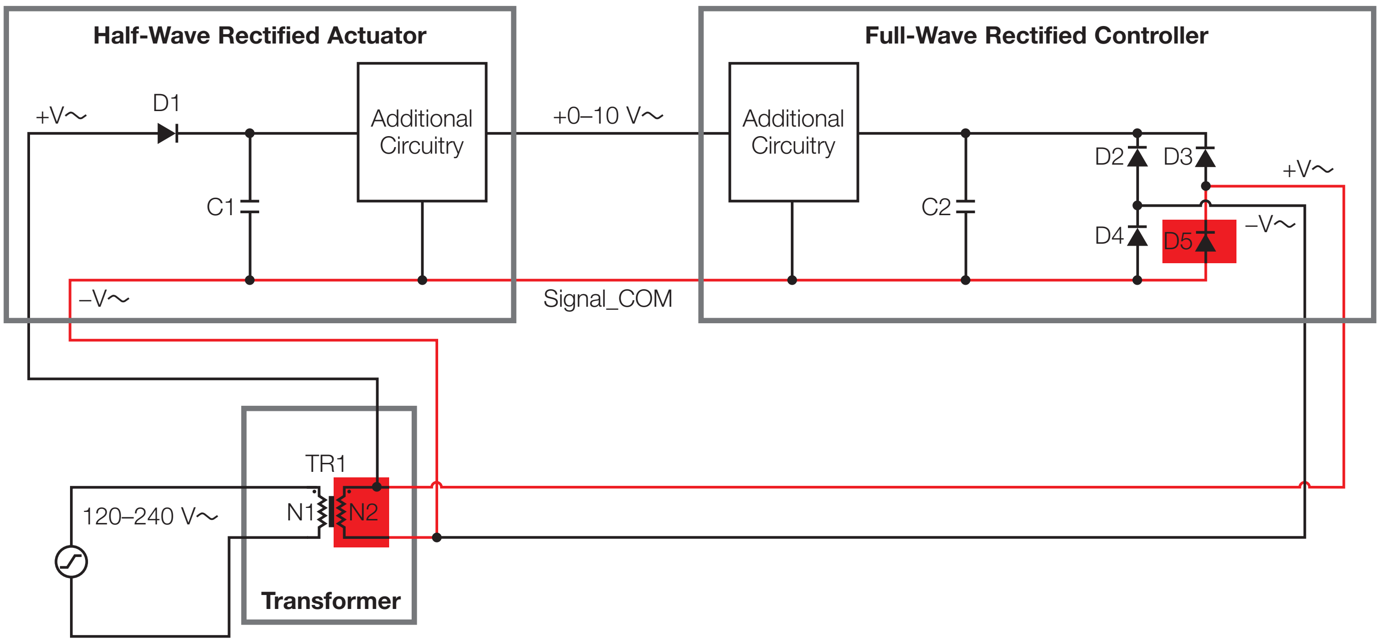


Figure 3 - Full-wave rectified controller incorrectly connected to half-wave rectified actuator

On the negative half-cycle, the red line shows the path of the current from the transformer through the connected devices. D5 is the only component in the path of the current due to the 0–10 V⎓ connection between the devices and the sharing of AC and signal common on the half-wave rectified device.

Once D5 is forward biased, the secondary winding of the transformer is essentially shorted for the duration of the negative half-cycle. This can have any or all of the following consequences:

- Excessive power draw from the transformer resulting in tripped overcurrent protection.
- Failure of the rectifier diode D5, which will cause the full-wave rectified controller to power down.
- Failure of the transformer connected to the full-wave rectified controller and 0–10 V~ actuator(s).

If none of these consequences occur immediately, the added strain of operating in this manner every negative half-cycle can lead to premature failure of the transformer or diode D5. Any of the following results may be seen prior to resolving the wiring issue:

- No control of the actuator from the full-wave rectified controller.
- Controller will not turn on. For example, this will cause “E1” to be displayed on any Lutron Palladiom thermostat connected to a Palladiom HVAC controller.

If controls or actuators are already wired in this manner, Lutron recommends replacing the Palladiom HVAC controller and adding an additional transformer to separate the power of the Palladiom HVAC controller and 0–10V~ actuators.

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