LUTRON

Application Note #651

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

Overview

HVAC controllers and actuators are typically designed to operate with either Alternating Current (AC/∼) or Direct Current (DC/⎓) to provide maximum installation flexibility. Depending on the application in which the HVAC controller or actuator is used, it may be more convenient to use one power supply over another. Actuators powered by alternating current must use a separate power supply from the Palladiom HVAC controller power supply.

Even though these products can accept AC power, the components within them require DC power. 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.

This application note will explain foundational knowledge required, the root cause and symptoms of the issue, and recommendations to prevent this from occurring.

Affected Models

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

- myRoom FCU controller (SMC5500050407)
- HomeWorks QS Palladiom HVAC controller (SMC55-RESI)

*Isolation in this context refers to the input side being electrically disconnected from the output. This is typically accomplished by means of an internal 1:1 transformer housed within the HVAC controller or actuator.

Fundamentals

There are two typical means of implementing AC to DC conversion: Half-Wave Rectification and Full-Wave Rectification.

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 requirements of the product.

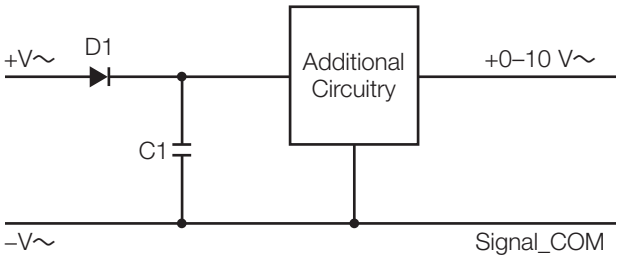

Figure 1 - Basic half-wave rectifier

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.

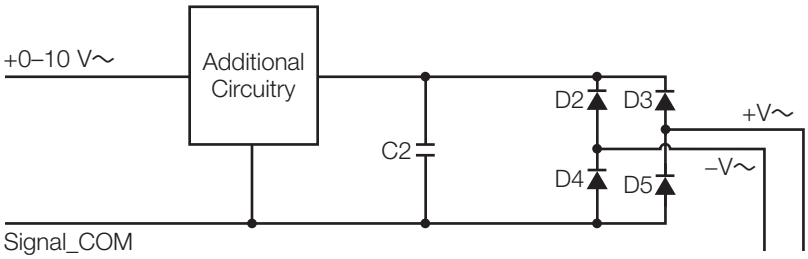

Figure 2 - Basic full-wave rectifier

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.

Problem

A significant problem can exist if the following occurs:

- The same 24 V~ transformer is used to supply power to 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 Palladiom HVAC 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.

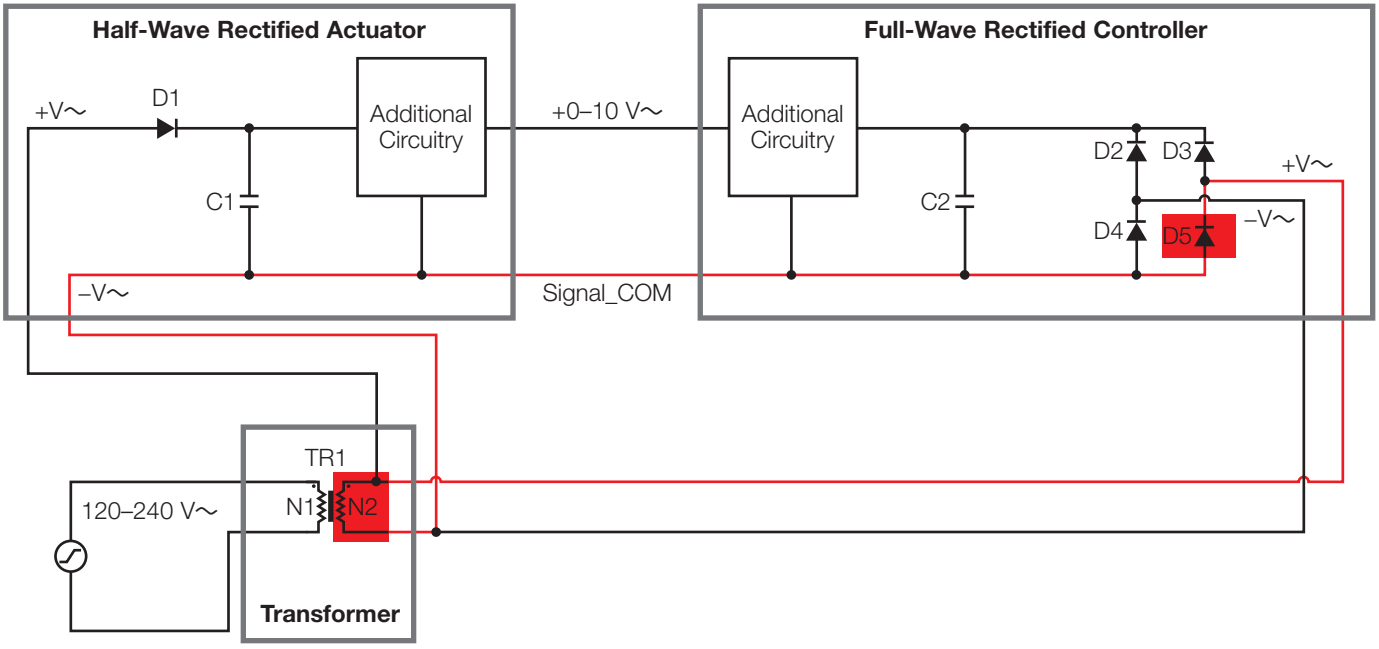

Figure 3 - Full-wave rectified controller incorrectly connected to half-wave rectified actuator

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 Palladiom HVAC controller to power down.
- Failure of the transformer connected to the Palladiom HVAC 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 Palladiom HVAC controller.
- Controller will not turn on. This will cause “E1” to be displayed on any Lutron Palladiom thermostat connected to the 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.

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. Ensure that the transformers are sized properly to power the connected VA load.

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 (output to GND) is required. Also, the maximum current for each proportional signal is 28 mA. Connecting multiple actuators to the same proportional signal is allowed, as long as the minimum load resistance and maximum current is followed.

For more information regarding Lutron temperature control products, visit www.lutron.com. For assistance regarding Palladiom thermostats, contact Lutron Customer Assistance at support@lutron.com or the HVAC Support team at HVACsupport@lutron.com

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