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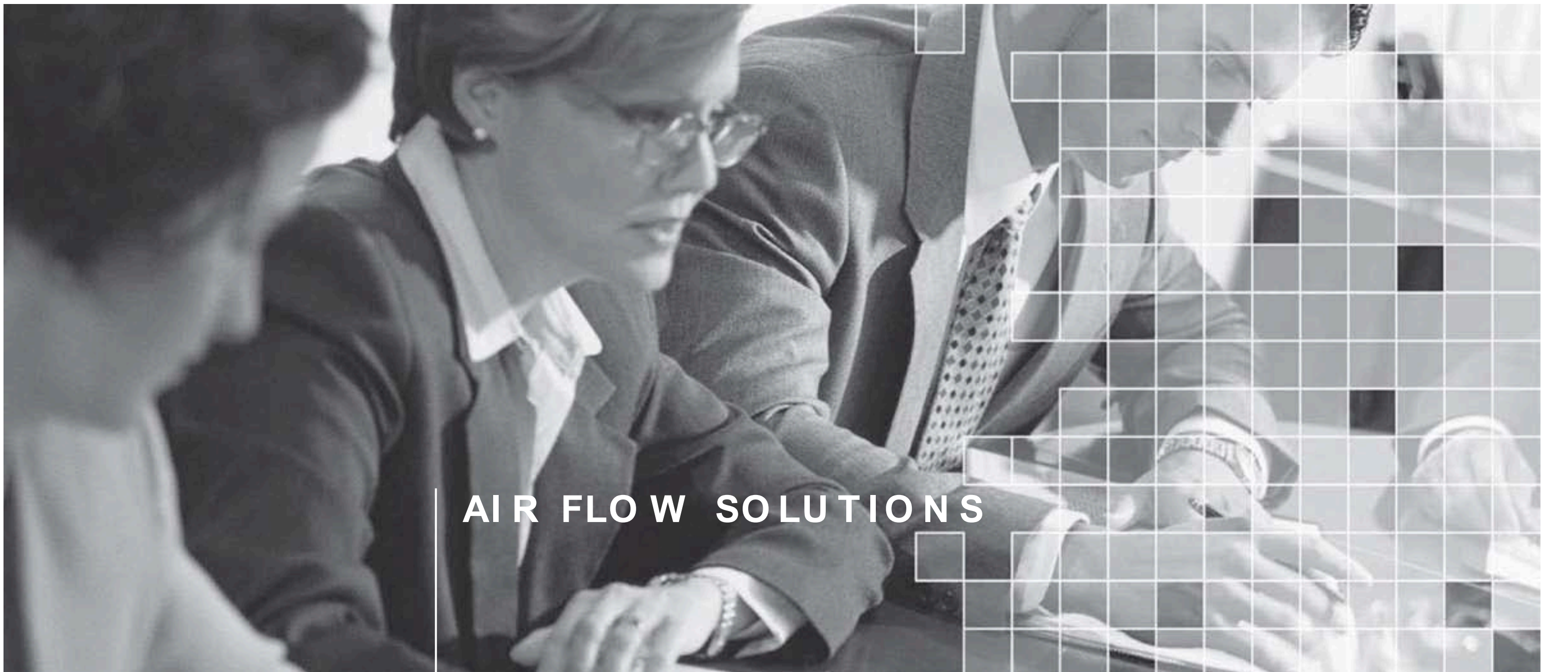
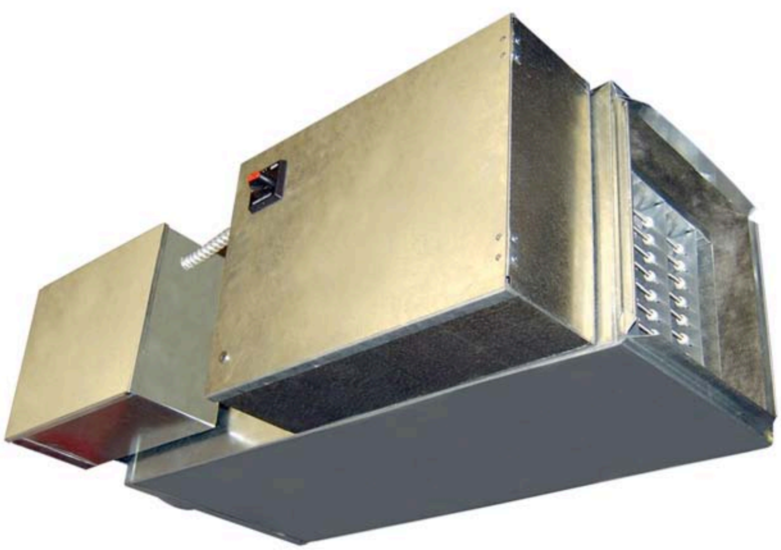


Model EZTE

Troubleshooting Guide

Single Duct w/ Electric Heat
Variable Air Volume Terminal Units



IOM-041
1/24 REV -

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These troubleshooting guidelines are designed to assist the electrician / technician in quickly isolating a problem associated with a non-functioning single duct ***Anemostat Model EZTE*** electric duct heater. These boxes come with an integral electric duct heater installed near the discharge end of the air terminal.

The electrician / technician troubleshooting this type of HVAC equipment should have experience / knowledge of HVAC airflow & pressure, automatic / direct digital controls, and basic electrical circuits and components.

WARNING! You are working around both HIGH and low voltage circuitry. Unless necessary to perform a troubleshooting procedure, disconnect power source and verify using a digital voltmeter. Electrical work gloves shall be worn during all troubleshooting procedures. These procedures should be performed only by a qualified or certified technician / electrician who has documented training working with high and low voltage electrical equipment.

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⚠ WARNING

HAZARDOUS VOLTAGE!
RISK OF ELECTRIC SHOCK
CAN CAUSE INJURY OR DEATH
DISCONNECT ALL REMOTE POWER
SUPPLIES BEFORE SERVICING

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A. Control Enclosures

There are (2) separate steel enclosures on the VAV box (Fig. 1). The VAV controls enclosure is located next to the supply air inlet & houses the low voltage VAV controls and damper shaft / actuator. The Electric Duct Heater (EDH) controls enclosure is located downstream from the controls enclosure and houses both HIGH and low voltage controls and circuitry. Building electric power is brought into the EDH enclosure using one of the electrical knockouts as a single point electrical connection for the entire assembly. There is a metallic conduit that connects these enclosures together for interconnected wiring. Note that there are 2 separate wiring diagrams for the assembly. The primary air flow controls diagram is located on the outside of the VAV controls enclosure & the EDH diagram is located inside the hinged cover.

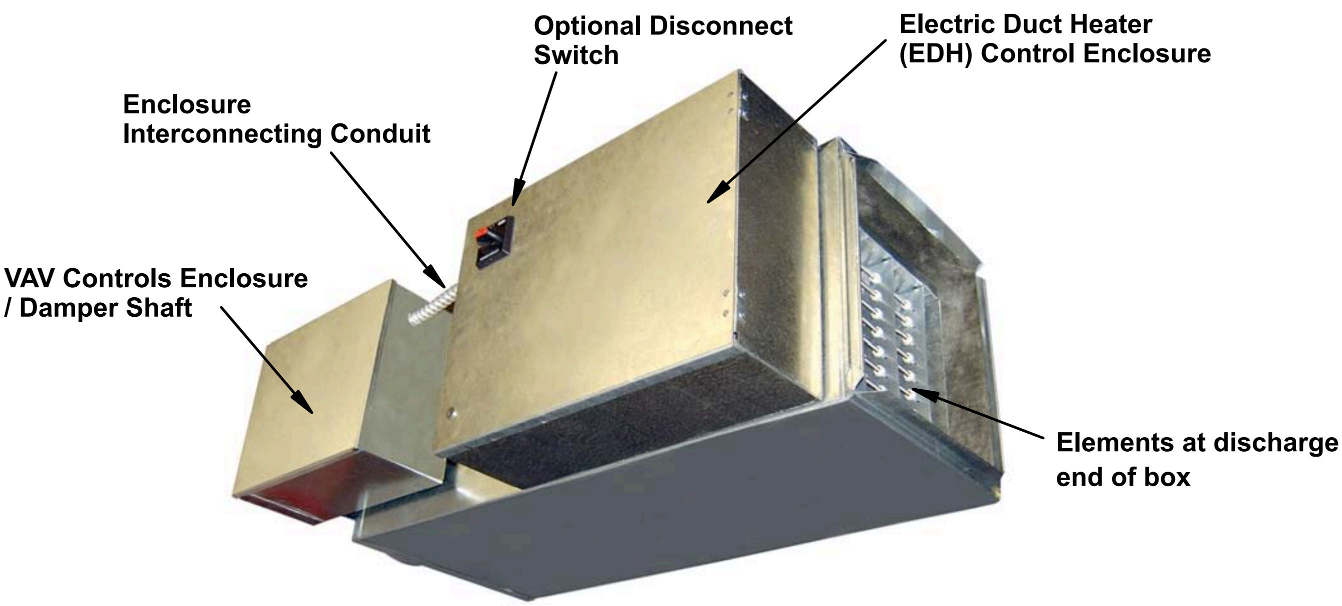

Figure 1. Control Enclosures (Right Hand (RH) controls shown)

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B. Wiring Circuits - Step / Stage Heat

A single duct VAV box with an Electric Duct Heater (EDH) consist of 2 parallel circuits. See figure 2 for a generic, simplified wiring diagram for a basic understanding of the heater controls arrangement. Actual heater wiring diagram is located on the inside of the hinged electric duct heater cover.

- A low voltage, 24vac control circuit consisting of a controller (DDC), 24vac transformer, air flow switch, and an automatic reset thermal cutout switch, and 24vac staging contactors (step heat). IMPORTANT: NEC codes require one leg of the 24vac secondary to be grounded AND the ground cannot be in the leg with the safety devices (air switch, thermal cutout). So for step heat, the controller output to energize each contactor stage of heat must be the grounded 24vac leg (24vac COM). See controller output in Figure 2 below.

- A high voltage circuit to energize the coil elements, 120 vac to 480 vac, 1 or 3 phase, consisting of incoming power terminal block, optional door-interlocking disconnect switch, optional fuses / fuse blocks, secondary manual reset thermal cutout, and staging contactors.

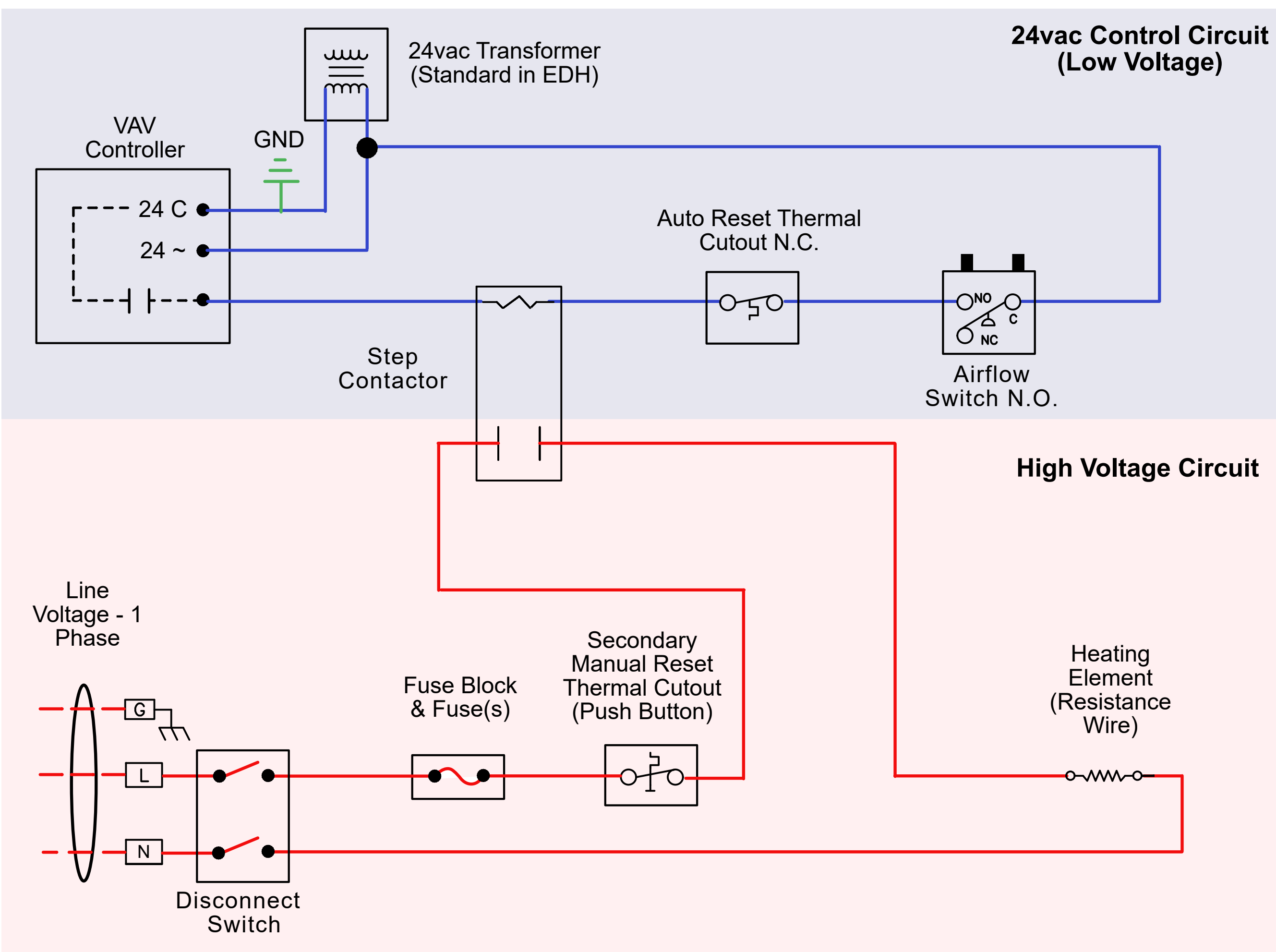

Figure 2. Simplified Wiring Diagram - Step / Staged Heat

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C. Step - Staged Heaters (with Direct Digital Controllers (DDC))

Figure 3. shows a typical wiring diagram for a three phase heater with 3 steps of heat controlled by a Direct Digital VAV flow controller. Heater elements may be connected in a WYE or DELTA configuration but does not change the troubleshooting procedure. EDH's typically have 2 circuits - a 24vac control circuit and a high voltage circuit that energizes the heating elements in the air stream. Note that there are many options and configurations for a specific project, so the VAV box you are troubleshooting may have different components. While performing the troubleshooting steps, refer to the appropriate wiring diagram and numbered black circles. ❶

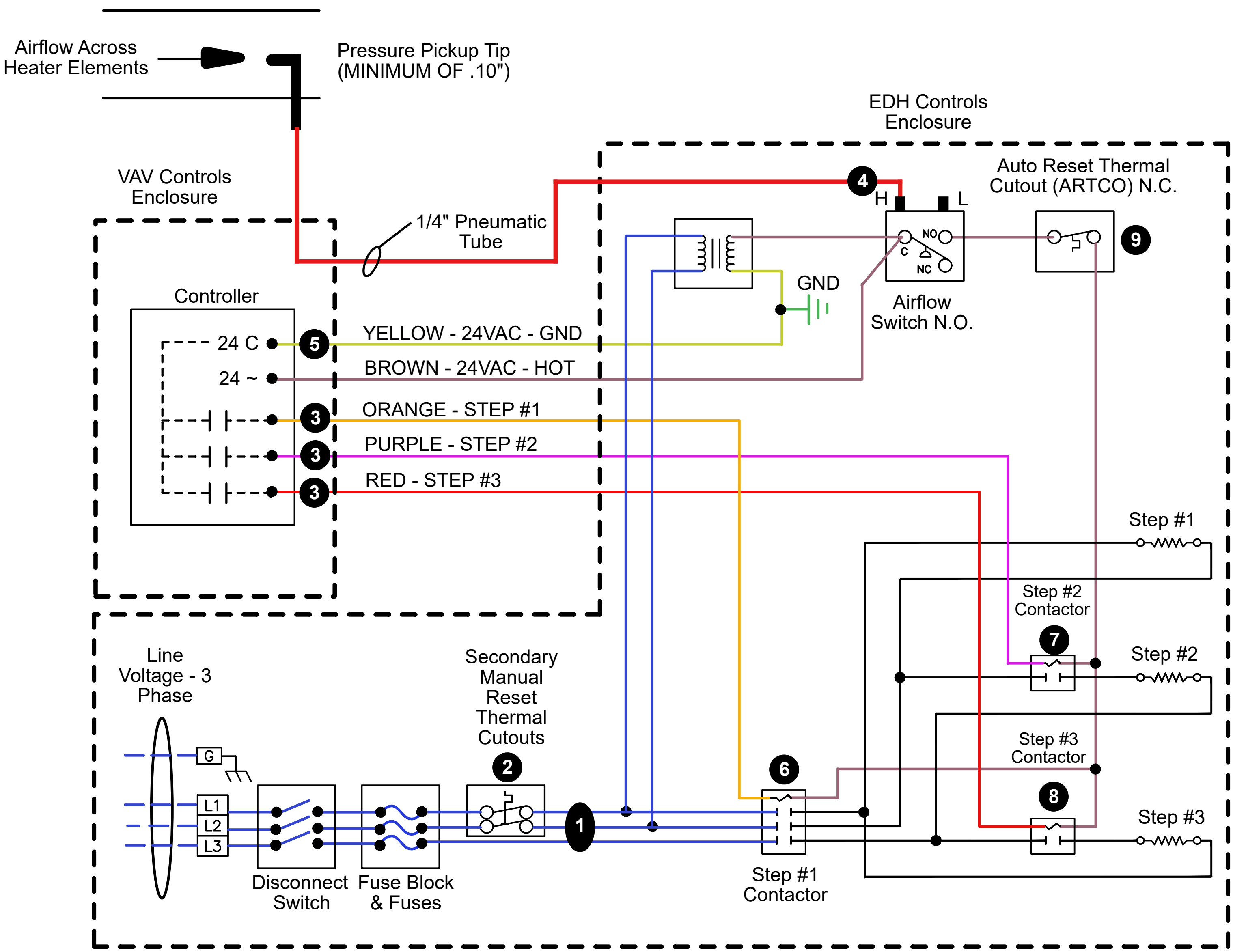

Figure 3. Typical 3 Step Heater Control Circuit - 3 Phase Power

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D. Step / Staged Heat Troubleshooting - Quick Method

This method assumes wiring is correct, disconnect switch is closed, fuses are functional, transformer is putting out 24vac secondary, and the controller is calling for heat:

1. Verify that the ***Secondary Manual Reset Thermal Cutout*** switch(es) are closed by pressing the reset tab / button on the switch (high voltage circuit). ❷
2. Verify that the N.O. ***Airflow Switch*** (low voltage circuit) is closed (C-NO). There must be air flowing thru the VAV box. TIP: This is the MOST common issue with electric duct heaters. ❹
3. Verify that the **controller is calling for heat** (low voltage control) and that the controller output for firing each step / stage of heat is 24vac COM (24C, 24Gnd) at its' output terminals. ❸
4. Verify that the N.C. ***Automatic Reset Thermal Cutouts*** (low voltage circuit) are closed. ❾
5. Manually depress step / stage #1 contactor (high voltage circuit) and verify the heating element energizes (air temp leaving outlets should increase). ❻

If the above steps do not resolve or identify the issue causing the heater not to energize, continue to the detailed troubleshooting section E. below.

E. Step / Staged Heat Troubleshooting - Detailed Method

(Refer to Fig. 3 wiring diagram - set controller to call for heat)

1. Wiring OK?

Make sure that all connections are tight and observe any wiring that may have come loose due to shipping, handling or installation. Connect as shown on the wiring diagrams attached to the box and inside the heater enclosure door. <u>Wiring must be correct to successfully isolate the problem.</u>

2. Power Supply?

The ***Secondary Manual Thermal Cutout*** switch ❷ opens the high voltage circuit when it senses an over-temperature condition while monitoring the heater elements inside the duct. It does NOT automatically reset and close when temperatures decrease. Press the reset tab / button on the cutout to reset it and close the circuit if necessary. Verify the correct line voltage and phase is wired to the EDH and measure voltage at ❶.Using a digital volt meter, read the line voltage of each hot leg to ground. If there is an optional door interlocking disconnect switch, you can close the switch manually with the door open by turning the square extension rod protruding from the switch. Fuses / fuse blocks are an optional accessory. By measuring at this location, we are verifying that the heater is powered and the disconnect switch, fuses, and the secondary manual reset thermal cutouts are functioning and closed. If no voltage is indicated on all hot power legs at location ❶ , measure voltage in succession starting at the building power terminal block, then after the disconnect switch, then after the fuses to isolate the component that has an open circuit condition. Replace defective component or blown fuse(s) as determined by this test.

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Step / Staged Heat Troubleshooting - Detailed Method (cont'd)

3. Identify which circuit (high or low) is causing the issue

It is not common for BOTH the high and low voltage circuits to contain the problem associated with the heater not energizing. The 24vac low voltage control circuit includes the controller and safety devices which are nothing more than switches that complete a 24vac circuit which in turn powers a 24vac contactor coil to close a set of contacts in the high voltage circuit. You can hear an audible "Click" when a contactor closes / pulls in when 24vac is applied to the contactor coil. Each step contactor can be manually closed by constant pressing on the bar on the back of the contactor to close the high voltage contacts. Find step / stage #1 contactor and manually press and hold closed the contactor. If you observe an increase in supply air temperature, that indicates that the problem most likely resides in the 24 vac low voltage control circuit and that high voltage circuit is functioning.

4. Controller wired properly and calling for HEAT?

The VAV box controller is typically powered by the 24vac transformer located in the EDH enclosure with YELLOW (24vac COM) and BROWN (24vac ~) wires from the EDH enclosure fed into the VAV controls enclosure. Verify that the controller is powered up while observing 24vac polarity. Codes require that one leg of the transformer 24vac secondary must be grounded AND the grounded leg cannot be in the heater safety circuit (adjacent to the air flow switch and thermal cutouts). Because of this requirement, the controller must be configured to switch 24vac COM 5 to its' output terminals 3 to fire each step / stage of heat.(Step #1 = Orange 6 , Step #2 = Purple , 7 Step #3 = Red 8).

Note that the controller needs to be put into the heating mode such that one or more steps of heat are being initiated and that the controller step heat output terminals are active. When each step of heat is activated by the controller, you should hear an audible click in the EDH enclosure as each step contactor is pulled in / closed to complete the 24vac low voltage circuit. If you do not hear the contactors energize, verify that the controller is sending the correct polarity (24vac GND/C/COM) as the output 3 to fire each step contactor. You can check if the output polarity of the controller is correct by removing the ORANGE Step #1 wire from the controller output and touching it directly to the YELLOW (24Vac COM) wire. If you hear an audible click when doing this, either the controller is NOT calling for heat OR the polarity of the controller output is reversed. Consult with the Controls Contractor regarding options to remedy this issue with the controller.

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Step / Staged Heat Troubleshooting - Detailed Method (cont'd)

5. Air flowing through the box - Airflow switch closing?

Verify that there is air flowing thru the VAV box (AHU ON) and the damper is not closed. The EDH requires a minimum of 70 CFM / kW during heating AND a minimum of .10" of downstream duct static pressure to make the ***Air Flow Switch*** CLOSE. This "proof of air flow" switch is a PE switch and includes pneumatic tubing connection(s) and an electric single pole switch. Functionally, the switch monitors the pressure input from the pressure tip located inside the VAV box. This pressure is an indicator that there is air flow across the heater elements and when the pressure sensed is higher than the pressure set point of the switch (typically fixed at .07" wg), the contacts close C-NO. No airflow or low airflow will keep the switch open and will not allow the heater to turn on (will not hear any audible contactor click). Note that the airflow switch is position sensitive and is installed with the internal diaphragm in a vertical plane. The switch may have only ONE pneumatic barbed fitting or may include both a HIGH (H or +) and LOW (L or -) fitting. A pneumatic sensing tube is connected to the HIGH port only ❹ . If there is a LOW port, it should not have a cap on it and should be left open to atmosphere. You can test to see if the air flow switch is causing the open circuit by using a jumper wire from C to NO on the switch (24vac circuit). If the controller is calling for heat and you hear an audible click from the contactors when the switch is jumpered, that indicates that the air flow switch is not closing. TIP: This is the #1 cause in the HVAC industry regarding EDH's not energizing. This typically indicates a low airflow / low duct static pressure condition. The remedy for this is to either build duct static pressure by closing down air outlet dampers or increasing the airflow rate during heating. In very rare cases, the switch can be non-functional and require replacement.

6. Automatic thermal reset cutout switch closed?

The Automatic reset thermal cutout switch is wired in series in the low voltage control safety circuit. ❾
This switch monitors the heater elements inside the duct and if an over-temperature condition occurs, the switch automatic changes from NC to NO to open the 24vac safety circuit which in turn opens all of the step / staging contactors. Once the duct heater returns to a low temperature condition (below the temperature set point of the switch), the contacts in the switch automatically revert back to a NC condition to allow the heater to energize if commanded by the control system. This switch can be tested to determine its' state by removing wires from one side of the switch and then measuring for continuity between the 2 spade connectors on the switch to determine if the contacts are open or closed. Or if you just jumper the contacts to remove the switch from the circuit, this can indicate / isolate whether the thermal switch is keeping the circuit open. Jumpers should only be used for troubleshooting and removed immediately after testing the component.

7. Open heating element / resistance wire?

On rare occasion, a heating element (resistance wire) in the high voltage circuit might be damaged causing an open circuit or direct short which will not allow the heater to energize or which will trip breakers or blow fuses. 3-phase heaters will have the heating elements wired in either a WYE or Delta configuration. This is determined during the engineering of the heater based on kW, # steps, and accessories installed in the heater. Refer to the EDH wiring diagram on the inside of the EDH enclosure cover to determine what method of wiring was used. Since the heater elements are internal to the box and may not be visible, it will be necessary to remove building supply power from the heater and measure continuity for each separate heating element at the element terminals inside the EDH enclosure. Note that the wire is RESISTANCE wire so will have some measured resistance if measuring ohms with a digital voltmeter.

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Step / Staged Heat Troubleshooting - Detailed Method (cont'd)

8. Cannot determine the issue?

If you have made it to this point after following the previous troubleshooting steps, then it is very likely that you either measured a value incorrectly with your digital voltmeter OR multiple issues are compounding the problem. The following tips are to be used only for troubleshooting and should not be left as a permanent fix to the problem:

Tips:

- Use temporary jumper wires across the Automatic Reset Thermal Cutout Switch and Airflow Switch to remove them from the circuit. This should only be done for a few minutes during troubleshooting.
- Bypass the controller and remove the Orange wire from the controller and connect the ORANGE wire directly to 24VAC COM to see if the contactors energize.
- Manually depress the step contactor which bypasses the low voltage control circuit to verify that the elements energize and the supply air temperature increases.

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F. Wiring Circuits - Proportional Heat (SSR)

A single duct VAV box with an Electric Duct Heater (EDH) consist of 2 parallel circuits. See figure 4 for a generic, simplified wiring diagram for a basic understanding of the heater controls arrangement. Actual heater wiring diagram is located on the inside of the hinged electric duct heater cover.

- A low voltage, 24vac control circuit consisting of a controller (DDC), 24vac transformer, air flow switch, an automatic reset thermal cutout switch, safety contactor, SSR controller, and solid state relay(s).
- A high voltage circuit to energize the coil elements, 120 vac to 480 vac, 1 or 3 phase, consisting of incoming power terminal block, optional door-interlocking disconnect switch, optional fuses / fuse blocks, safety contractor, solid state relay(s), and a secondary manual reset thermal cutout.

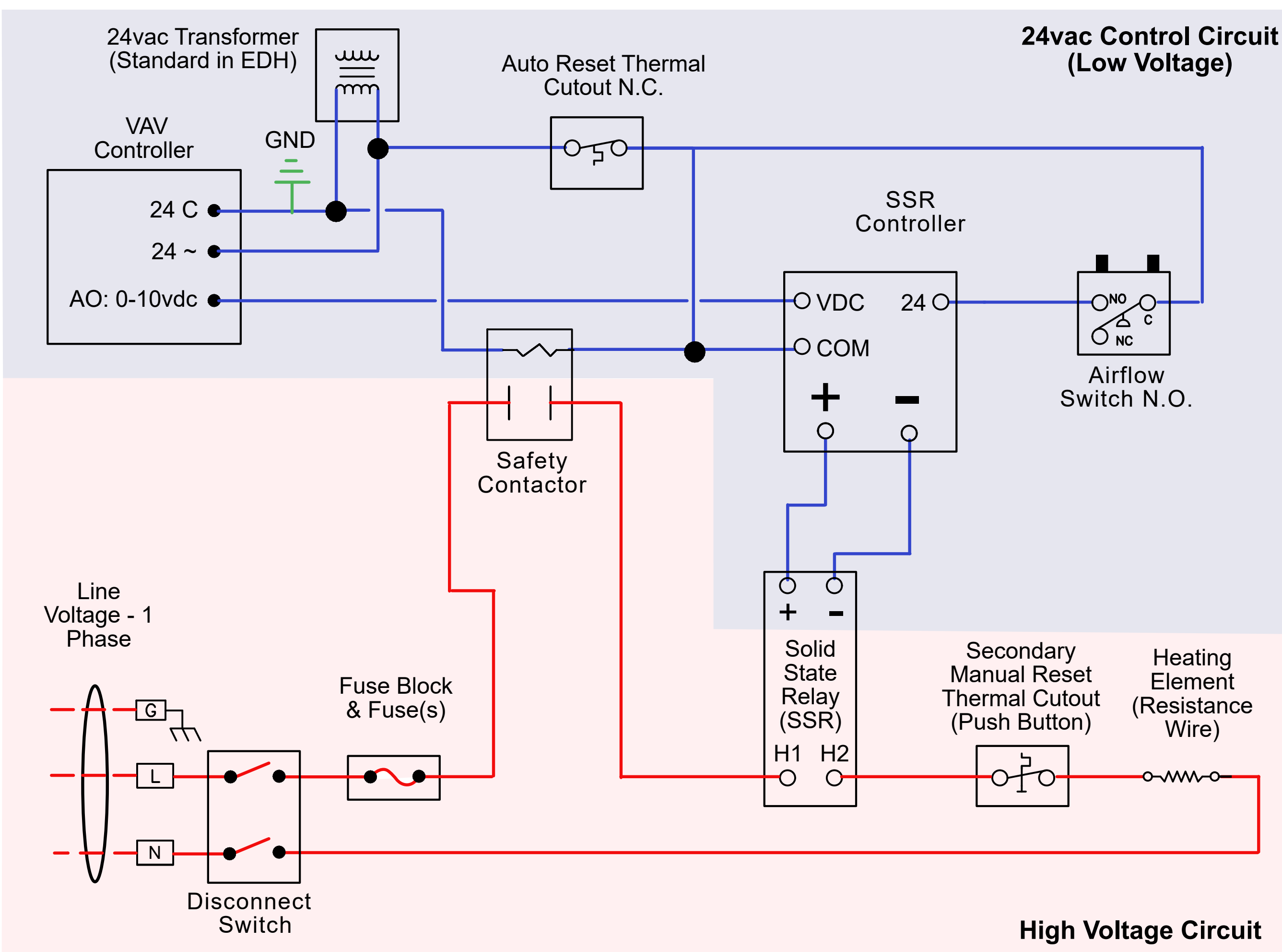

Figure 4. Simplified Wiring Diagram - Proportional Heat

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G. Proportional Heaters (with Direct Digital Controllers (DDC))

Figure 5. shows a typical wiring diagram for a three phase heater with proportional control controlled by a Direct Digital VAV flow controller. Heater elements may be connected in a WYE (shown below) or DELTA configuration but does not change the troubleshooting procedure. EDH's typically have 2 circuits - a 24vac control circuit and a high voltage circuit that energizes the heating elements in the air stream. Note that there are many options and configurations for a specific project, so the VAV box you are troubleshooting may have different components. While performing the troubleshooting steps, refer to the appropriate wiring diagram and numbered black circles. 1

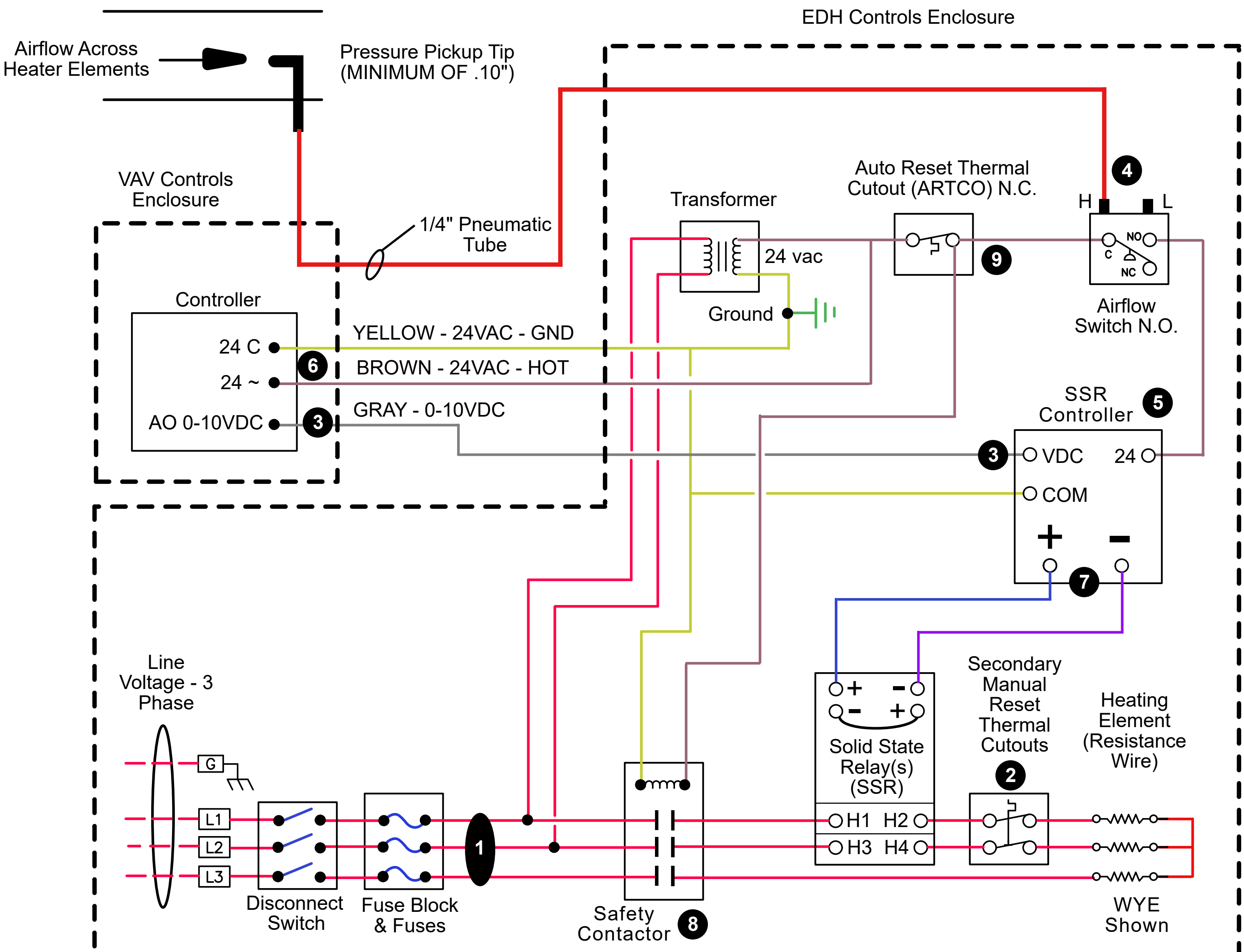

Figure 5. Typical Proportional Heater Control Circuit - 3 Phase Power

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H. Proportional Heat Troubleshooting - Quick Method

This method assumes wiring is correct, disconnect switch is closed, fuses are functional, transformer is putting out 24vac secondary, and the controller is calling for heat:

1. Verify that the ***Secondary Manual Reset Thermal Cutout*** switch(es) are closed by pressing the reset tab / button on the switch (high voltage circuit). ❷
2. Verify that the N.O. ***Airflow Switch*** (low voltage circuit) is closed (C-NO). There must be air flowing thru the VAV box. TIP: This is the MOST common issue with electric duct heaters. ❹
3. Verify that the **controller is calling for heat** (low voltage control) and that the controller's analog output is a minimum of 10vdc and by measuring VDC & COM at the SSR Controller terminals. ❸
4. Verify that the N.C. ***Automatic Reset Thermal Cutout*** (low voltage circuit) is closed ❾ and that the Safety Contactor ❽ is energized and closed / pulled in.
5. Verify that the SSR controller ❺ is powered by 24vac (measure terminals 24 & COM on the board..
6. Measure and verify that the SSR controller output ❼ at the + and - terminals is a constant voltage of approximately 24 VDC.
7. Observe that the LED light on the Solid State relays (SSRs)(mounted on a heat sink) are on continuously. The light ON indicates that the relay is closed and should be energizing the heating element(s).

If the above steps do not resolve or identify the issue causing the heater not to energize, continue to the detailed troubleshooting section E. below.

I. Proportional Heat Troubleshooting - Detailed Method

(Refer to Fig. 5 wiring diagram or diagram inside EDH enclosure cover - set controller to call for heat)

1. Wiring OK?

Make sure that all connections are tight and observe any wiring that may have come loose due to shipping, handling or installation. Connect as shown on the wiring diagrams attached to the box and inside the heater enclosure door. <u>Wiring must be correct to successfully isolate the problem.</u>

❶

2. Power Supply?

The ***Secondary Manual Thermal Cutout*** switch ❷ opens the high voltage circuit when it senses an over-temperature condition while monitoring the heater elements inside the duct. It does NOT automatically reset and close when temperatures decrease. Press the reset tab / button on the cutout to reset it and close the circuit if necessary. Verify the correct line voltage and phase is wired to the EDH and measure voltage at ❶.Using a digital volt meter, read the line voltage of each hot leg to ground. If there is an optional door interlocking disconnect switch, you can close the switch manually with the door open by turning the square extension rod protruding from the switch. Fuses / fuse blocks are an optional accessory. By measuring at this location, we are verifying that the heater is powered and the disconnect switch and fuses are functioning and closed. If no voltage is indicated on all hot power legs at location ❶ , measure voltage in succession starting at the building power terminal block, then after the disconnect switch, then after the fuses to isolate the component that has an open circuit condition. Replace defective component or blown fuse(s) as determined by this test.

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Proportional Heat Troubleshooting - Detailed Method (cont'd)

3. Identify which circuit (high or low) is causing the issue

It is not common for BOTH the high and low voltage circuits to contain the problem associated with the heater not energizing. The 24vac low voltage control circuit includes the controller and safety devices which are nothing more than switches that complete a 24vac circuit which in turn powers the SSR controller and closes the safety contactor. You can hear an audible "Click" when the safety contactor closes / pulls in when 24vac is applied to the contactor coil. The safety contactor can be manually closed by constant pressing on the bar on the back of the contactor to close the high voltage contacts.

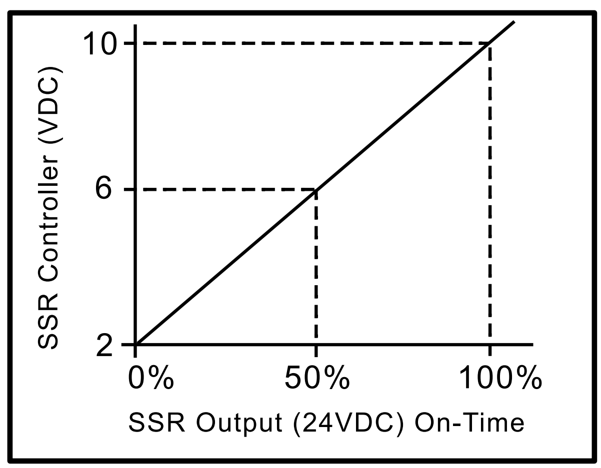
4. Controller wired properly and calling for HEAT?

The VAV box controller is typically powered by the 24vac transformer located in the EDH enclosure with YELLOW (24vac COM) and BROWN (24vac ~) wires from the EDH enclosure fed into the VAV controls enclosure. Verify that the controller is powered up while observing 24vac polarity. 6 Codes require that one leg of the transformer 24vac secondary must be grounded.

Note that the controller should be put into full heating mode during troubleshooting such that the analog output signal from the VAV controller is a constant 10+ vdc 3 which lands on the SSR controller input terminal VDC 3 . Verify that the SSR controller 5 sees this voltage by measuring VDC & COM using a digital voltmeter. The SSR controller is a time proportioning controller and turns the solid state relays (SSRs) on and off based on the VDC input to it from the VAV box controller. Using a 1 second base, a 2-10 vdc input into the controller results in an off vs on time of 0-100% output at the SSR terminals + and -. A red LED light on the SSR controller will illuminate when the SSR output (+ &-) is 24vdc.

Example (see Graph 1): 6 VDC at terminal VDC on the SSR controller = 50% on time. This means that the SSR controller output at terminals + and - will will be 24vdc for .5 seconds and 0 vdc for .5 seconds (on for 50%, off for 50%, on for 50%, off for 50%, etc).

The output of 24vdc from the SSR controller is connected to the solid state relays (N.O.). For 1 phase power, there is only 1 relay. For 3 phase power, there are 2 relays that switch in tandem. The relays only need a minimum of 10vdc to switch closed. The relays have an LED indicator light that illuminates when the switch is closed. Since the time base is only 1 second, it might be difficult to see the light flash on and off when there is only minimal call for cooling (Ex: 3 vdc Signal = 12.5% On time = .125 seconds. Therefore, calling for 100% heat is recommended during troubleshooting.



Graph 1. SSR On-Time vs. VDC input

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Proportional Heat Troubleshooting - Detailed Method (cont'd)

5. Air flowing through the box - Airflow switch closing?

Verify that there is air flowing thru the VAV box (AHU ON) and the damper is not closed. The EDH requires a minimum of 70 CFM / kW during heating AND a minimum of .10" of downstream duct static pressure to make the ***Air Flow Switch*** CLOSE. This "proof of air flow" switch is a PE switch and includes a pneumatic tubing connection and an electric single pole switch. Functionally, the switch monitors the pressure input from the pressure tip located inside the VAV box near the inlet. This pressure is an indicator that there is air flow across the heater elements and when the pressure sensed is higher than the pressure set point of the switch (typically fixed at .07" wg), the contacts close C-NO. No airflow or low airflow will keep the switch open and will not allow the heater to turn on (no power sent to the SSR controller). Note that the airflow switch is position sensitive and is installed with the internal diaphragm in a vertical plane. The switch may have only ONE pneumatic barbed fitting or may include both a HIGH (H or +) and LOW (L or -) fitting. A pneumatic sensing tube is connected to the HIGH port only ❹ . If there is a LOW port, it should not have a cap on it and should be left open to atmosphere. You can test to see if the air flow switch is causing the open circuit by using a jumper wire from C to NO on the switch (24vac circuit) or measure the power to the SSR controller (24v & COM). The airflow switch circuit powers the SSR and must be closed for the SSR controller to fire the solid state relays. TIP: An open airflow switch is the most probable cause for a non-functioning EDH. This typically indicates a low airflow / low duct static pressure condition. The remedy for this is to either build duct static pressure by closing down air outlet dampers or increasing the airflow rate during heating. In very rare cases, the airflow switch might be non-functional and require replacement.

6. Automatic thermal reset cutout switch closed?

The Automatic reset thermal cutout switch ❾ monitors the heater elements inside the duct and if an over-temperature condition occurs, the switch automatic changes from NC to NO to open the 24vac safety circuit which in turn opens the safety contactor and powers down the airflow switch / SSR controller circuit. Once the duct heater returns to a low temperature condition (below the temperature set point of the switch), the contacts in the switch automatically revert back to a NC condition to allow the heater to energize if commanded by the control system. This switch can be tested to determine its' state by removing wires from one side of the switch and then measuring for continuity between the 2 spade connectors on the switch to determine if the contacts are open or closed. Or temporarily jumper the contacts to remove the switch from the circuit, this can indicate / isolate whether the thermal switch is keeping the circuit open. Jumpers should only be used for troubleshooting and removed immediately after testing the component.

7. Open heating element / resistance wire?

On rare occasion, a heating element (resistance wire) in the high voltage circuit might be damaged causing an open circuit or direct short which will not allow the heater to energize or which will trip breakers or blow fuses. 3-phase heaters will have the heating elements wired in either a WYE or Delta configuration. This is determined during the engineering of the heater based on kW, # steps, and accessories installed in the heater. Refer to the EDH wiring diagram on the inside of the EDH enclosure cover to determine what method of wiring was used. Since the heater elements are internal to the box and may not be visible, it will be necessary to remove building supply power from the heater and measure continuity for each separate heating element at the element terminals inside the EDH enclosure. Note that the wire is RESISTANCE wire so will have some measured resistance if measuring ohms with a digital voltmeter.

Proportional Heat Troubleshooting - Detailed Method (cont'd)

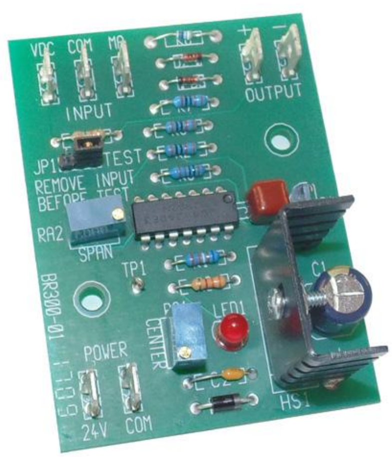
8. Cannot determine the issue?

If you have made it to this point after following the previous troubleshooting steps, then it is very likely that you either measured a value incorrectly with your digital voltmeter OR multiple issues are compounding the problem. The following tips are to be used only for troubleshooting and should not be left as a permanent fix to the problem:

Tips:

- Use temporary jumper wires across the Automatic Reset Thermal Cutout Switch and Airflow Switch to remove them from the circuit. This should only be done for a few minutes during troubleshooting.
- The vav box controller analog output must be vdc and can be verified by measuring the volts at the vav controller output terminal and 24vac COM.

J. Heater Components (may vary from that shown)



SSR Controller


Solid State Relays
on Heatsink


Automatic Reset
Thermal Cutout Switch


Airflow Switch

Door Interlocking
Disconnect Switch


Power Fuses / Fuse
Block

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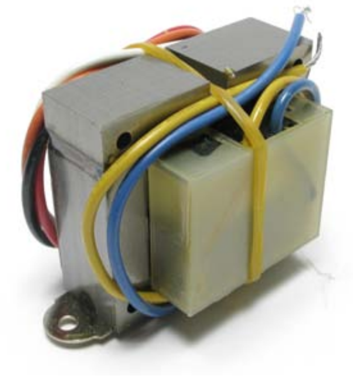
Heater Components (may vary from that shown)



24vac Control Transformer

Magnetic Contactor