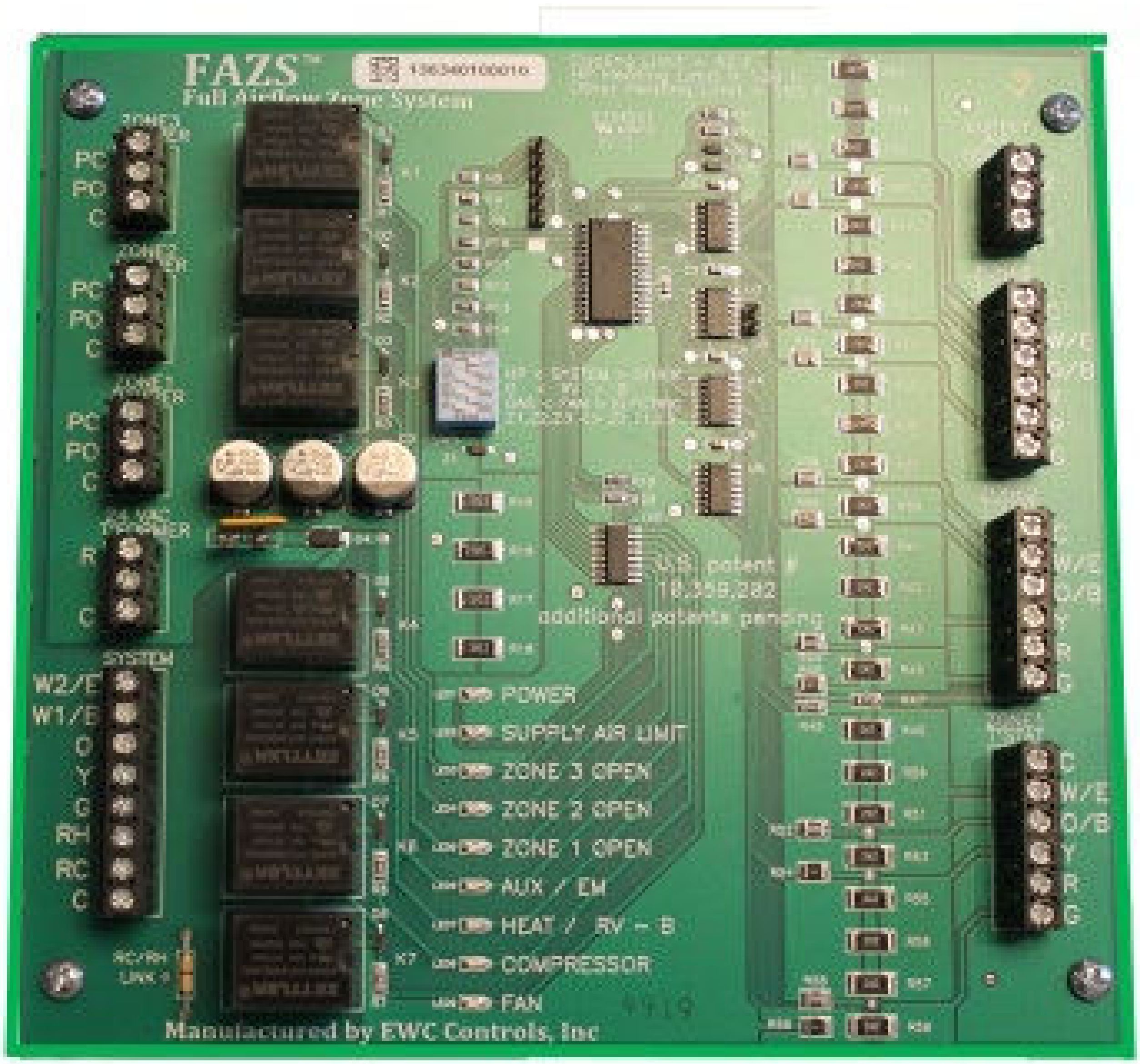
Full Airflow Zone System™
Installation Instructions



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FAZS™

A Technician's Guide For Installing the Full Airflow Zone System™

"Capacity Deployment System"

Version 1.0
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To comment on the content of this document, or for information pertaining to its technical content, please contact:

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Introduction to Full Airflow Zone System (FAZS™)

Background

The Air Conditioning Contractors of America (ACCA) had a committee working on Manual LLH *HVAC System Design for Low Load Homes.* The manual provides guidance on methods of providing code compliant heating and cooling systems for energy efficient low load homes. After studying the current design practices, it was clear that there were no good options available for the use of traditional single speed heating, ventilation and air conditioning (HVAC) equipment. In energy efficient homes the installation of additional insulation, energy efficient windows and doors lowered the heating and cooling loads. A direct result was the equipment size required to condition the space decreased. That sizing decrease provided savings in original equipment cost and on calculated energy savings. However, when the smaller equipment was installed, it caused comfort issues due to the low total airflows available to heat and cool rooms. Further there were comfort complaints related to the daily changes in internal and external heating and cooling loads. To resolve these issues Donald Prather introduced a new control concept that was accepted and added to the LLH Manual named "Capacity Deployment System". However, no zone controls were available on the market that would operate with all zones closed except for one on a priority basis.

The full airflow zone system (FAZS™) control board was developed specifically for use in "Capacity Deployment Systems". In the field it was found that it also is an excellent control scheme for two-and-three story home applications. HVAC contractors can now easily upgrade their builder grade HVAC systems and take advantage of the additional comfort provided by zoned systems. For new home builders this addition is a relatively inexpensive upgrade that is a strong market differentiator. Note: LLH are defined as homes that require 1 ton of cooling per 1500 ft^2. The control will work well in new or retrofit homes with requirements of 1 ton per 1000 ft^2.

In traditional single HVAC system homes, there have been many design challenges that will cause comfort issues in properly designed and installed systems. Those challenges can be resolved by installing a Full Airflow Zone System™. Unfortunately, many designers increase the equipment size in an attempt to resolve comfort issues. That approach increases installation and operational costs, and often multiplies the comfort related temperature differences within homes. The logic used for increasing the whole home's design load has been defended with questions like:

- What about areas like kitchens or bonus rooms above garages?
- What happens when east-west or north-south external loads are vastly different at different times of the day.
- How do you design airflow in a two-or-three-floor home where the loads swap seasonally?
- How do you cool the master bedroom on the east side when the thermostat is in the center of the house by the return?

Additionally, there are always varying internal load related questions such as:

- "What if there is a party and a lot of people are in the great room, and the design load will not keep up?"
- What happens when you want grandma's room warmer at night?
- What about making it cool in the master bedroom at night without freezing the home.
- What happens when you need more cooling due to heat generating medical equipment in a bedroom?

Traditional zone systems can resolve many of the comfort issues in existing homes. However, zone systems bring design challenges as well:

- What to do with excess air when one small zone is calling and how do you design and set up a bypass damper or dump zone?
- How do you compensate for the equipment's decreased humidity removal capacity when variable speed equipment operates at ramped down air speeds and capacity.

Code compliant single speed HVAC system designs are based on the proportional distribution of airflow that warms or heats the spaces. Unfortunately, as internal and external loads change, they are not always proportionally the same as they are during the designs peak time of day, external design temperatures and the estimated design internal loads. A better designed system would allow the proportional amount of airflow to change when the peak and/or internal loads change. The easiest and best way to accomplish that, is by allowing a single zone to have all of the system's airflow when the zone needs to be cooled or heated. That way a single zone gets more than it's required airflow. The entire system is still sized and designed to meet all existing code requirements. The duct design is modified so each zone can easily move all of the system's airflow. The advantage over variable speed zone systems is, the basic cooling and heating system is always on high speed (full airflow) for each zone. Thus, there is no problem with the heat exchanger overheating in heating mode, plus in cooling mode the humidity removal is always at the equipment's full design capacity.

Once the relationship between the required airflow and the zone's load is fully understood, the advantages of a FAZS™ controller becomes obvious. The home's rooms can be divided into two or three separate zones based on time-of-day load variances. Since each of the zones receives all of the airflow when the thermostat calls for heating or cooling the <u>zones cannot be very small</u>. For example, you would not design a system with a small closet as a zone because the airflow would turn it into a wind tunnel. Plus, it would heat or cool down in seconds. Thus, to make sure a zone will operate properly each of the two or three zones for a FAZS™ needs to be fairly large. Based on zone load calculations done for the LLH Manual, zones that are smaller than 25% of the heating/cooling load will cool down or heat up too quickly under full airflow conditions and would cause the system to short cycle. Thus, the concept is limited to three zones per HVAC unit.

This is possibly the simplest zone system to understand and install on the market. Zone priorities are selected. Duct is sized for the systems full airflow to go to each zone one at a time based on the priorities. Thermostats and their corresponding zone dampers connect directly to the board. The board dip switches are set for the type of equipment. The HVAC equipment is connected directly to the board. The board is powered by a separate 40KVA transformer that also operates the motor open motor close type of dampers.

This instruction guide is divided into three sections. The 1st section covers the airflow and load proportional concepts needed to fully understand the full airflow design system. Section 2 contains FAZS™ control board installation instructions for technicians. It also covers the basic air balancing concepts for all of the three zone's individual room settings (quick proportional air balance review). Section 3 covers the duct design process for designers using their existing code compliant calculation method.

The FAZS™ Control board would not exist without the-invaluable comments and helpful input from numerous knowledgeable experts. Chief among these were:

Mike Reilly President (EWC Controls)

Mike Bailey Chief Engineer (AppliCAD Inc.)

John Brown, Chief Engineer (EWC Controls Inc.)

Glenn Hourahan, P.E.

Hank Rutkowski, PE

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SECTION I: PROPORTIONAL MATH FOR AIRFLOW AND HEATING/COOLING LOADS

Proportional Load and Airflow Calculation Basics

Many homes in the U.S. have heating ventilation and air conditioning (HVAC) systems that are larger than required. Unfortunately, that sizing mistake is very often compounded by under sizing the duct work. Those two wrongs result in the HVAC system operating at about 60% of design capacity. Thus, many homes work inefficiently to provide the correct heating and cooling. Contractors that fail to do proper load and duct design calculations should not attempt to install a FAZS™ control board. They will be frustrated when it does not hide their bad load guesses and their duct sizing flaws like a standard zone control can do when combined with a variable speed fan motor. So if you know the heating and cooling load by looking at the size of a home in square feet and let your installers size duct based on a simple installer chart, you can quit reading now: The FAZS™ zone control is not the best product for you to use.

Professional contractors know that Manual J load calculations are universally required by code for sizing residential heating ventilation and air conditioning (HVAC) equipment. The Manual J spread sheet provides the designer with generic supply airflows for each room. Manual D is then used to develop duct sizing utilizing the Manual J airflow numbers. The duct sizing calculation is based on the total external static pressure the system will experience for the longest duct supply and return combination. Since Manual J airflow numbers are simply a calculated value, once the HVAC equipment is selected, the Manual J airflows should be proportionally corrected for the actual airflow the selected equipment is capable of providing. This correction is easily done using proportional calculations.

Example 1: Proportional Correction for Manual J Airflow Numbers

Master bedroom J CFM = 100 cooling 180 heating

Master Bath J CFM = 40 cooling 35 heating

Master Closet J CFM = 30 cooling 25 heating

Great Room Kitchen and Dining J CFM = 200 cooling 100 heating

Bed Room 2 J CFM = 80 cooling 70 heating

Bed Room 3 J CFM = 80 cooling 60 heating

Bath Room 2 J CFM = 50 cooling 25 heating

Manual D requires us to select the larger of the two airflows and to total them up for the duct design: 180+40+30+200+80+80+50= 660 CFM. Manual J requires a system that provides 580 CFM or about a 1.5 ton system for cooling and 495 CFM for heating at about 15,000 BTU.

As you can see the resulting duct design will be larger than needed in rooms for either heating or cooling. So, when the airflow is balanced, good technicians set the airflow somewhere in the middle and hope for the best. Poorly trained technicians never think about airflow until they get a complaint.

Once the HVAC equipment is selected, the manufacturer's maximum airflow is based on the equipment design and will generally be different than the Manual J and/or Manual D CFM requirements. For our example we will used an OEM maximum CFM value of 600 CFM. That value is what we have to work with since it is what the equipment can provide. Now we need to translate that total to the Manual J corrected for Manual D numbers. This is done by using a proportional factor. The proportional factor is found by dividing the airflow that the equipment can provide by the manual D airflow design totals: 600÷660 = 0.91(rounded up).

We can take the Manual D design airflow values and multiply them by 0.91 and they should add up to 600. Thus, they become the new design CFM numbers for the rooms.

180 × 0.91 = 164
40 × 0.91 = 36
30 × 0.91 = 27
200 × 0.91 = 182
80 × 0.91 = 73
80 × 0.91 = 73
50 × 0.91 = 46
Total = 601 Note: New room airflow values are rounded up/down to the nearest whole number so the total should be plus or minus 1 CFM)

That is all there is to proportional calculations. These CFM values will be used to design the duct diffuser sizes for a standard HVAC system. *Note: Most computer programs will automatically calculate the proportional values for you when the actual equipment CFM is entered into the program.*

For our simplified example 3 bedroom, 2 bath home above, the three zones could be divided as follows:

Zone 1: Master bed room and bath = 164 + 36 +27 = 227 CFM

Zone 2: Great room dinning and kitchen =182 CFM

Zone 3: Bed rooms 2&3 and 2nd bathroom= 73 +73 +46 = 192 CFM

Note: The total CFM should add up to our 601 from above: 164+182+192 =601

WARNING: In the full airflow design, the zones will cool/heat faster than is possible in a standard HVAC system. Thus, for the FAZS™ design to work properly with the HVAC equipment, a single zone cannot be smaller than 25% of the Manual J load: In other words receive less than 25% of the airflow in a Manual D duct design. For the FAZS™ system the Manual D duct design is sized for full airflow to each of the zones thus, each zone needs to be large enough to handle the total design airflow.

Always double check the proportional size for each zone. This is done by dividing the zone's CFM total by the total airflow that the equipment can provide. In our example that would be 600 CFM. That total is then multiplied by 100 to get the percentage of the system's total airflow required by the zone:

Zone 1: 227÷600×100 = 38%
Zone 2: 182÷600×100 = 30%
Zone 3: 192÷600×100 = 32%

Note for a recommended double check, the zones should add up to 100%: 38+ 30+ 32 ~~+~~= 100%

The zone size double check is to make sure the zone area/load is large enough for a full airflow system to operate properly. Since the zone that is calling for heating or cooling will receive 100% of the airflow when the system is operating each of the three zones needs to be large enough to avoid short cycling of the system when full airflow is provided to the zone. All three zones in this example are over our minimum value of 25% of the design load. Thus, the zones selected will work well with a FAZS™ control system. *Note: If one zone is below 25% the zone design needs to be modified.*

Thanks for hanging in there, and slogging through the math this far. Many technicians and designers have never been shown the basic proportional relationships between design BTUH and airflow. Proportional airflow design calculations are interchangeable, and proportional airflow/BTUH is the basis for comfort cooling and heating. Those who have no understanding and start making adjustments to satisfy a comfort control issue caused by an unusual event, usually end up creating another comfort issue elsewhere (or in another season of the year). The author of this manual spent over 15 years chasing comfort related airflow issues before learning the basic airflow principles that will be shared in the remainder of this section. Once the basics are mastered, a technician can predict how an HVAC system will operate under all conditions. It is important to note that every mechanical system has design limits and no amount of adjusting airflow will overcome design deficiencies or equipment limits.

Proportional Airflow Zone Calculations

Once the designer has divided the home into the two or three zones, the airflow to each room is then calculated based on the proportional method and the Manual J load requirements.

Example from the sample home used earlier let's look at the airflow for Zone 3.

Zone 3: BR2 = 73 CFM; BR 3 = 73 CFM and the Bathroom = 46 CFM

First, let's keep in mind that we have an exhaust fan in the bathroom and putting more air into a bathroom than the exhaust fan can exhaust, causes bathroom odors to exit through the door as well as through the exhaust. For this example let's say the exhaust fan is designed to remove 50 CFM. The duct design for the bathroom should only allow it to provide 50 CFM of supply air. So, in the example the bathroom duct will be sized for 50 CFM. However, there needs to be a proportional calculation to get the CFM for the duct design for bedrooms 2 and 3. In this basic example they will have the same final CFM.

First the 50 CFM is subtracted from the system's total CFM: 600-50 = 550 CFM

BR2 = 73 CFM

BR3 = 73 CFM

Total = 146 CFM

550 ÷146 = 3.77

BR2 = 73 × 3.77 = 275 CFM

BR3 = 73 × 3.77 = 275 CFM

Total 275+ 275 + 50 = 600 CFM

Thus, for each bedroom the duct and diffuser are designed for a 275 CFM airflow and the bathroom duct and diffuser are sized to provide 50 CFM of airflow. Note: making sure the airflow exits the bathroom is as simple as turning on the exhaust fan and cracking the door. Hold a piece of tissue paper in the cracked door and if it is pulled into the bathroom, you are good to go aroma free elsewhere.

Duct Design Considerations for a FAZS^{TM} Controlled Home

It is an interesting fact that even though Manual D duct design is generally required by code, it was not required in the ACCA/ANSI Quality Installation Specification. Thus, most contractors need to use the Manual D spread sheet when pulling permits. The consensus among equipment manufacturers is a correct duct design can be proven when the equipment is operating. They all have a requirement for checking the external static pressure (ESP) in inches of water column (IWC). In truth, Manual D is a basic duct design based on proportional airflow and Manual J load calculations. However, it does not equate to the actual airflow the HVAC system can provide or how that airflow will pass through ducts that are not balanced for airflow.

For low load homes, the Manual D duct designs will result in very small duct sizes and very low airflow to rooms and zones. Since calculations in Manual D are based on engineering numbers for standard duct fittings and duct lengths. When they are added together for the individual duct runs they become the effective length. The additional components in the duct system's airflow path are then included in the calculation. The final total result is used to establish a friction rate (FR) in IWC/100 ft. That friction rate is then plugged into the Manual D spread sheet to calculate duct sizing. For the full airflow zone system, a contractor should continue to use the friction method. The only change to that for a FAZS™ is, each zone needs to be designed for the HVAC system's full airflow. Within the individual zone runs the duct sizing decrease remains proportional.

The OEM for a 1.5 ton system states the operating CFM for the system is 610 in the literature at 0.5" ESP. Based on years of measuring airflow and comparing duct sizing to fan operation and system ESP, for residential duct systems (that have supply and return runs 100ft or less) many designers have utilized a shortcut, and always use the Friction Rate of 0.1"wc or 0.08"wc. Using a duct calculator wheel (see Figure 1 next page), once the duct size is rounded up, 0.1 friction rate specifies a 12" round steel duct for 610 CFM. If 0.08 friction rate is used, the duct wheel still specifies a 12" round steel duct. However, what about the return duct? If the OEM filter has been replaced with a "high efficiency" filter from the hardware store, the additional airflow pressure drop must be accounted for. Since the return airflow is passive and not forced, many designers use half of the friction rate to design the return ducting. Thus, 0.1 would become 0.05 and 0.08 friction rate would become 0.04. So, the corresponding return duct size for 0.05 would be a little over 13" that should then be rounded up to 14". The return value of 0.04 would also fall in the 14" round duct range when using the duct calculator. This author strongly recommends that 0.08 friction loss for supply duct and 0.04 friction loss for return duct (or preferably a lower value) be used to do the duct sizing calculations. Furthermore, in systems with duct runs 100 feet or less, if the opening size of the supply and return in the OEM equipment is utilized to calculate the duct size, along with the unit's output CFM, the duct will always be larger than needed and the resulting system ESP will be low. This will result in lower amperage on the blower fan motor and lower the operating cost while maximizing the airflow.

A final note on duct design: In addition to the duct being 100 ft long or less, the duct calculations when using most friction charts are for metal ducts. If one plans to use flex duct, a duct calculator like the Air Conditioning Contractors of America (ACCA) calculator should be used. Based on this author's field measurements and use of the ACCA calculator for flex, correcting the standard friction wheel or chart by increasing the airflow value by 20% will provide an equivalent duct size for flex. For example, when you want to increase 610 CFM by 20% the following formula works: $610 \times 1.2 = 732$ CFM. Using the metal duct wheel 710 CFM at 0.08 and you will find that you need a flex duct sized to just under 13". Designers should always round up in duct size to be safe.

Warning: Design the duct-work so the final ESP for the equipment (when each individual Zone is operating) is 0.5 IWC or less. The use of variable speed fans to force the airflow through smaller ducting to meet system minimum airflow designs is discouraged in full airflow zone systems. It is less efficient and makes more noise than a properly designed duct system.

Note: There is a misconception out there that you need the duct sized small so you will get more velocity. However, cubic feet per minute (CFM) of airflow in, equals CFM out unless the duct *leaks. Therefore, properly sizing the diffusers and return grills for the room's airflow, will determine the air velocity created as the airflow passes through the grill or diffuser. Much like a hose nozzle size will determine a hose's water velocity. For HVAC systems, smaller duct size equals a higher static pressure (SP) and a decreased CFM.*

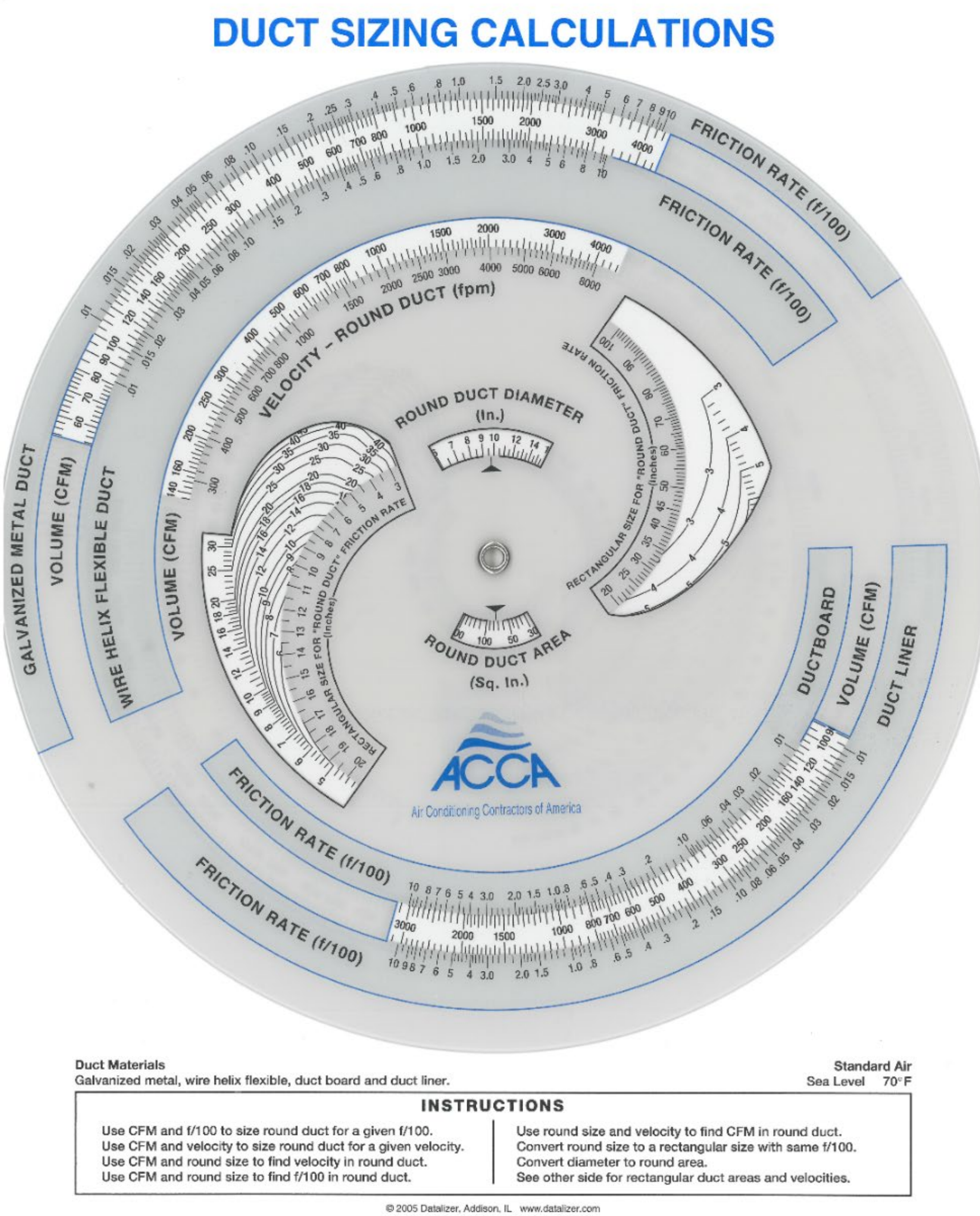


Figure 1: ACCA Duct Wheel

SECTION II
FAZS™ CONTROL BOARD INSTALLATION

The **Full Airflow Zone System™** installation instructions are a written and illustrated step by step connection explanation designed to answer all of the questions a technician may have. After a technician installs a few of the control boards they should be able to do so from memory. However, since there are differing combinations of HVAC systems and thermostats the technician may want to keep this section as a field reference guide. Each subsection contains the information for connections to the control board.

FAZS™ DEDICATED TRANSFORMER CONNECTIONS

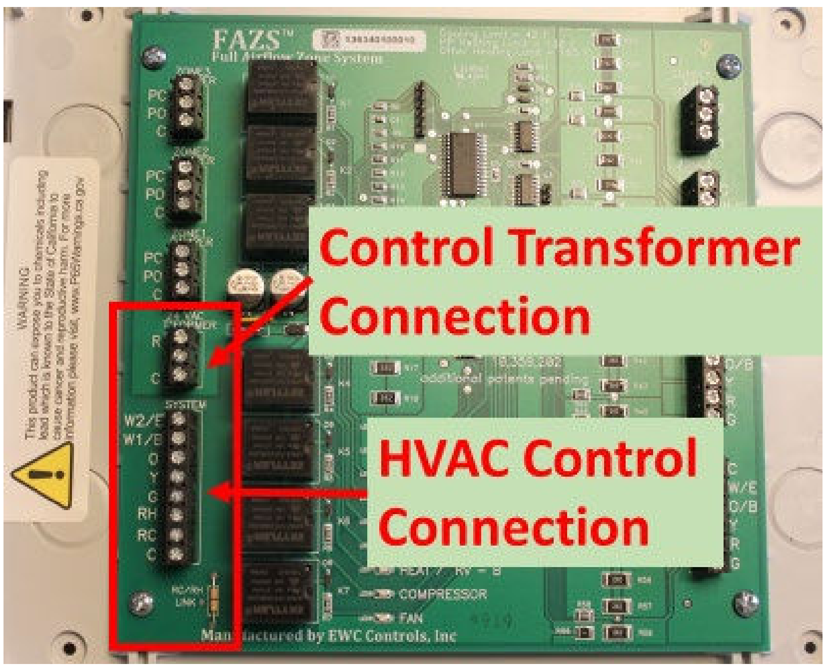


Figure 2: Location of HVAC Equipment Control Connections on Control Board

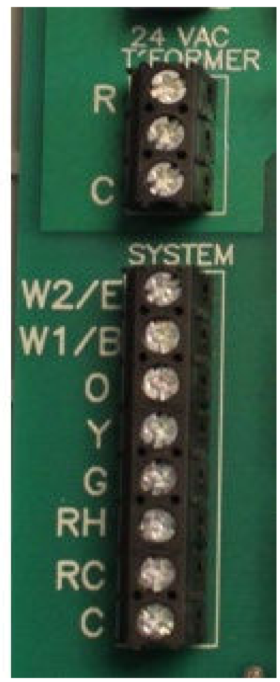


Figure 3: Control Connection

Warning: Before connections are made all power should be off.

Control connections that carry the control signals to the HVAC system from the control board are located on the bottom left side of the control board as shown in Figure 2. Figure 3 shows a close up of the control connections. Note: The HVAC system 24V transformer must not be used as the FAZS™ power source.

The top two connections (R & C) shown in Figure 3 are for the control power connection. The dedicated 24VAC Transformer (see Figure 4 next page) connection are on the left-hand side of the control board in the center, located above the "system" terminal block. The FAZS™ must be connected to a 40VA transformer due to the power required to open/close the zone dampers, and to power the zone thermostats. It is recommended that a separate wire set be run to the control board from the transformer connection. Additionally, it is a good practice to use 120V for the transformer power source to decrease the possibility of damaging controls if there is the loss of one leg of power on the equipment's 220V line power during a power outage.

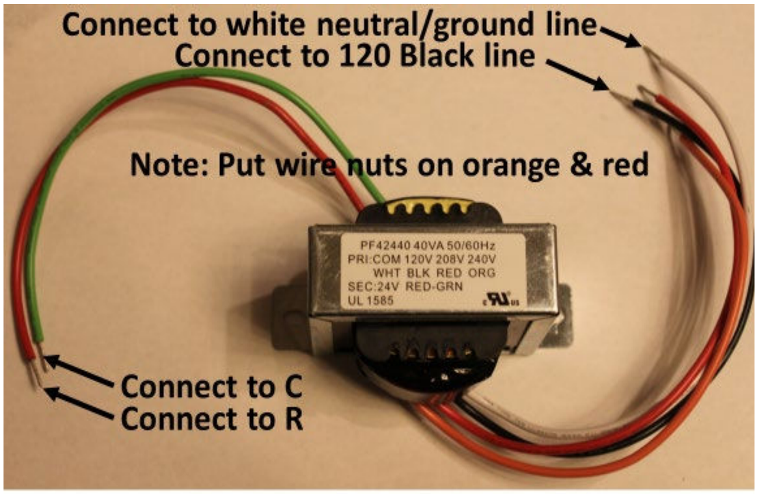


Figure 4: Typical 40VA Transformer

The connections are made simply by skinning the thermostat wire end and placing it into the proper connecting lug. The screw on top is then tightened down gently so there is a snug fit and the wire will not pull out when gently pulled. The screw on top is then tightened to connect and hold the wire in place. Warning: do not over tighten the screws and never use an electric drill or screwdriver for making these connections. Additionally, care should be taken to make sure only the copper is inserted (if plastic coating on the wire is inserted there will not be a metal to metal connection and it will not work).

HVAC EQUIPMENT CONTROL BOARD CONNECTIONS

Typical HVAC Equipment control connections:
W1/B: Connection on the "system" terminal block is connected to the W/W1 (heat) connection on the Furnace. The white wire is generally used for this connection. This terminal also serves as the "B" reversing valve connection, on outdoor Heat Pumps with "B" reversing valve logic, if the FAZS™ is programmed to control a "B" type heat pump.

W2/E: Connection on the "system" terminal block is connected to the W1/W2/W3 (heat) connection on the Furnace or Air Handler. The white wire is generally used for this connection. Exact equipment connections depend on the OEM equipment type.

O: Connection on the "system" terminal block is connected to the O terminal on outdoor Heat Pumps with "O" reversing valve logic. The wire color is generally orange or blue.

Y: Connection on the "system" terminal block is connected to the Y/Y1 ~~(condenser)~~ connection on the Furnace or Air Handler and also the Outdoor AC or HP unit. This connection is for condenser activation and informs the Indoor unit to produce the proper airflow for condenser operation. Generally, a yellow wire will be used for this connection.

G: Connection on the "system" terminal block is connected to the G (Fan) connection on the Furnace or Air Handler. This connection is for Indoor Fan activation and the wire color is generally green. Note: In a FAZS™ system, the "Fan On" function in the zone thermostats, will not bring on the fan (by itself) during heat/cool operations. The system is designed to only circulate air when the system is not calling for a change of temperature. In other words, Heat calls or Cool calls are more important than Fan Only calls.

RC: Connection on the "system" terminal block is connected to the R (24vac power) connection on the Furnace or Air Handler. The RC connections is generally made using a Red wire. For single transformer systems, a factory jumper (Rc/Rh link) is provided to the RH terminal. The link can be cut for two transformer systems such as an Oil fired furnace or Boiler with AC.

C: Connection on the "system" terminal block is connected to the C (24vac common) connection on the Furnace or Air Handler. Note: The "system" C terminal is electrically isolated from the 24vac Transformer C terminal. A blue or black thermostat wire is often used to make this connection.

Figure 5 shows the typical equipment control board plug in connection for the thermostat. The wires from the thermostat to the control board are generally connected by wire nuts to a plug in connector supplied by the equipment manufacturer.

Figure 5: HVAC Equipment Control Board Connection Plug Field connections wire nut to wires (not shown)

CONNECTING THERMOSTATS TO THE FAZS™ BOARD

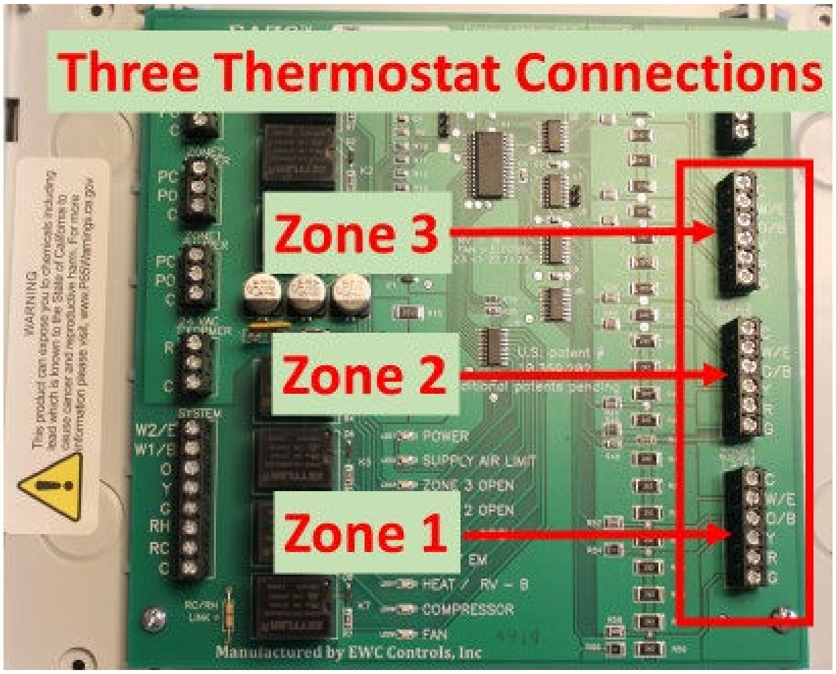


Figure 6: Location of Thermostat Connection

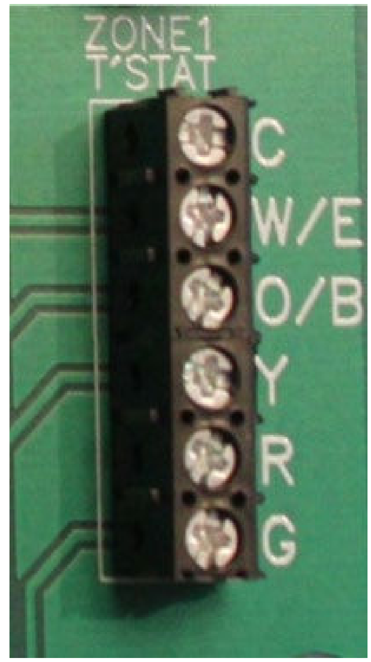


Figure 7: Board Thermostat Connection

Warning: Before connections are made all power should be off.

Thermostat Connections are located on the right side of the control board as shown in Figure 6. There are three identical thermostat connections, the bottom connection on the control board shown in the close-up is for Zone 1. The connections are made simply by skinning the thermostat wire end and placing it into the proper connecting lug. The screw on top is then tightened down gently so there is a snug fit and the wire will not pull out when gently pulled. The screw on top is then tightened to connect and hold the wire in place. Warning: do not leave skinned wire outside of the terminal block, this may cause shorting.

A wide variety of thermostats are available on the market. The thermostats selected must be compatible with the equipment being installed. It is recommended that the installer use thermostats that they are familiar with. There will be one thermostat placed in each zone. The thermostat block connections for Zones 1, 2 and 3 are identical. Figure 7 shows a close up of the Zone 1 connection block that is located on the bottom right side of the board. Warning: Most thermostats have a time delay automatically programmed in when the mode is changed from heating to cooling. For the most efficient operation of this control board, that function should be disabled. Almost all thermostat manufacturers have a way to disable the mode delay function, please contact them if their instruction set does not cover this.

Typical Thermostat connections:
C: Connect the 24v common "C" terminal on each zone thermostat wall plate, to each ZONE T'STAT "C" terminal for all HVAC system types. **Note:** Some thermostats do not require a 24v common wire.-The blue or black thermostat wire is often used to make this connection.

W/E: Connect the "W or W1" terminal on each zone thermostat wall plate, to each ZONE T'STAT "W/E" terminal for standard Gas/Electric systems. Connect the "W2 and E" or "Aux and E" terminals on each zone thermostat wall plate, to each ZONE T'STAT "W/E" terminal for Heat Pump systems. The white wire is generally used for this connection.

O/B: This connection is only used for Heat Pump systems. Connect the "O/B" terminal on each zone thermostat wall plate, to each ZONE T'STAT "O/B" terminal. Program each zone thermostat for the correct O or B reversing valve logic of your OEM Heat Pump. Program the FAZS™ control for the correct O or B reversing valve logic as well. Thermostat O/B setting must match the FAZS™ O/B setting. The wire color is generally orange or blue.

Y: Connect the "Y or Y1" terminal on each zone thermostat wall plate, to each ZONE T'STAT "Y" terminal for all HVAC system types. This connection is for condenser activation. Generally a yellow wire will be used for this connection.

R: Connect the "R or Rc/Rh" terminal on each zone thermostat wall plate, to each ZONE T'STAT "R" terminal for most HVAC system types. The R connections are generally made using the red wire. -**Note:** A jumper between Rc & Rh on each zone thermostat, is not required for baseboard or radiant "in-floor" heating systems. If this is the case, connect the "Rc" terminal only, on each zone thermostat wall plate, to each ZONE T'STAT "R" terminal. Do not jump to Rh.

G: Connect the "G" terminal on each zone thermostat wall plate, to each ZONE T'STAT "G" terminal for all HVAC system types. This connection is for Indoor Fan activation. Note: In a FAZS™ system, the "Fan On" function in the zone thermostats, will not bring on the fan (by itself) during heat/cool operations. The system is designed to only circulate air when the system is not calling for a change of temperature. In other words, Heat calls or Cool calls are more important than Fan Only calls.

<u>Note: Zone damper connections and Zone thermostat connections are a paired set designed to work together. For example when Zone 1 calls for cooling, the Zone 1 damper remains open so all of the airflow goes to Zone 1</u>

Figure 8 shows a typical wall mount plate with thermostat wires out to the control board connected.

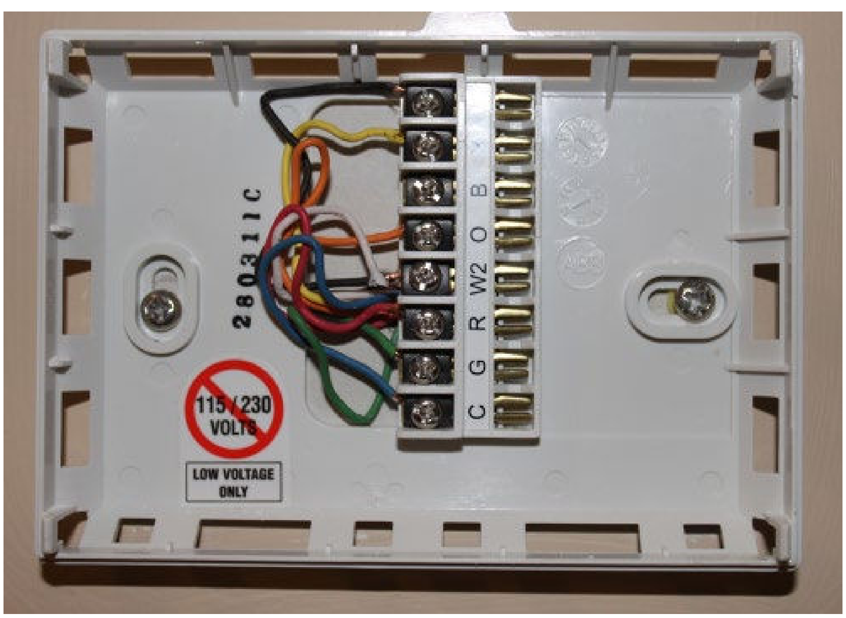
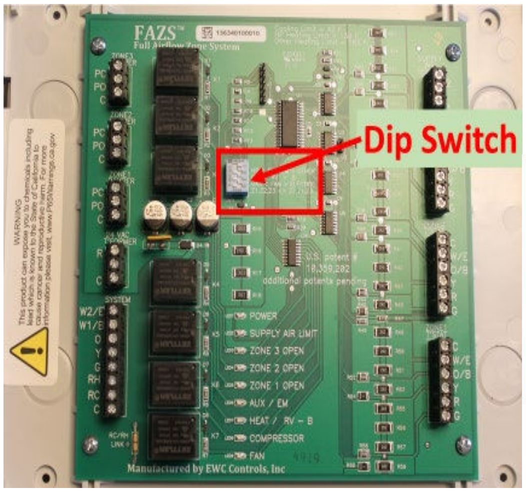


Figure 8: Wall Plate Connections for a typical heat pump thermostat

DIP SWITCH SETTING DIRECTIONS



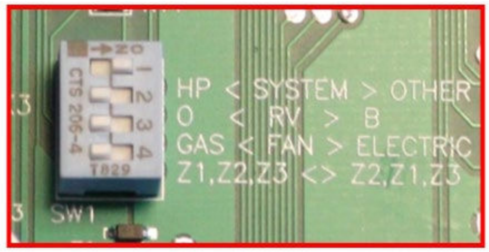


Figure 9: Location of Dip Switch on Control Board **Figure 10:** Factory Dip Switch Setting Closeup

Dip switches are located in the top left center of the control board as shown in Figure 9. The Dip switches are numbered 1 through 4 on the board. A legend describing the function of each switch and the choice Left or Right, is printed next to the DS box, as shown in Figure 10. Detailed instructions for dip switch settings are provided below:

1. Top dip switch: ***Factory setting to the right side*** is good for all units except heat pumps. If the unit is a heat pump the dip switch should be moved to the left-hand position, Factory setting positions for all dip switches shown in Figure 10.
2. Second dip switch: ***Factory setting to the left side*** applies to Heat Pumps only. If “Other” was selected on dip switch #1 leave this switch in the factory setting (O to the left). If “HP” was selected on dip switch #1, set dip switch #2 to the correct reversing valve logic for the installed Heat Pump. If the heat pump has a factory reversing valve energized in heating mode, dip switch #2 should be moved to the right-hand “B” position. If the heat pump has a factory reversing valve energized in cooling mode, dip switch #2 should remain in the left-hand “O” position.
3. Third dip switch: ***Factory setting to the left side*** applies to all fossil fuel furnaces, and dip switch #3 should remain in the left-hand “Gas” position. If the indoor unit is an Air Handler with electric heat or a hydronic (Hot Water) coil, the dip switch should be moved to the right-hand “Electric” position.
4. Fourth dip switch: ***Factory setting to the left side*** prioritizes the zones in sequential order: *First: zone-1; Second zone-2; and Third Zone-3*. Moving the dip switch to the right-hand position will change the zone priority to: *First: zone-2; Second zone-1; and Third Zone-3.*

   Warning: Zone control order cannot be changed by simply switching thermostat connections, because the controller will not automatically switch (realign) the damper connections. Thus, to change the order, both the thermostat and damper connections need to be on the same board zone designation, or the thermostat will not be in the area that is being controlled.

TEMPERATURE SAFETY PROBE BOARD CONNECTION

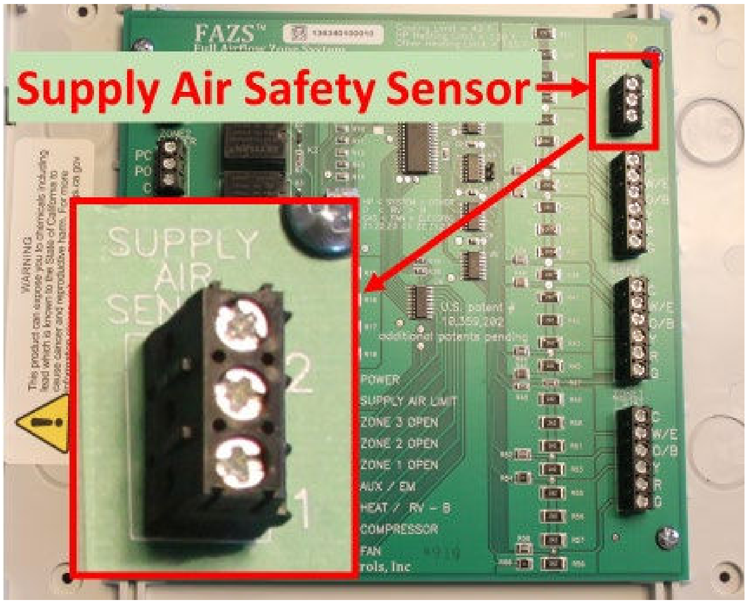


Figure 11: Supply Air Temperature Safety Connections Location

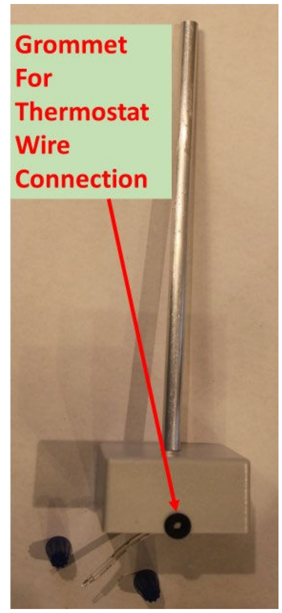


Figure 12: Supply Air Temperature Probe

Warning: Before connections are made all power should be off.

The supply air safety temperature connection is located on the top right side of the control board as shown in Figure 11. Figure 12 shows the temperature probe that comes with the control board. The connections are made simply by skinning the thermostat wire end and placing it into the connecting proper lug. The screw on top is then tightened down gently so there is a snug fit and the wire will not pull out when gently pulled. The connections are not polarity sensitive, so either wire can connect to terminal 1 or terminal 2.

A wide variety of temperature probes are available on the market. The probe that comes with the board will provide the proper temperature reading over the total operating range of the HVAC system. To ensure proper temperature safety protection, the probe supplied should be the only one used with the FAZS™ control panel.

Safety control probe connections: A thermostat wire with two wires inside will easily slide through the, grommet shown in Figure 12. Wire nuts are provided with the probe for connecting to the two wires in the probe. The other end of the thermostat wire is then connected to the control board temperature safety connections 1 and 2 as shown in Figure 1.

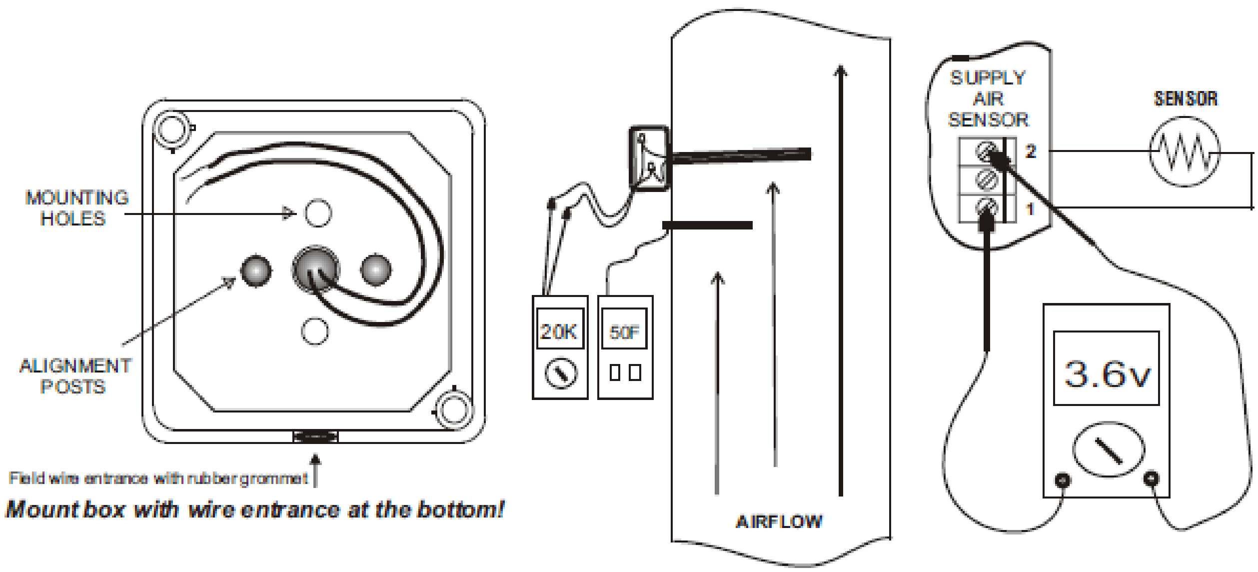
To measure the supply air temperature correctly the supply probe must be located in the main supply air duct that feeds airflow to all of the zones. The probe can also be located inside the Air Handler for certain Heat Pump applications. Figure 13 is the submittal sheet for the temperature probe.
Warning: the probe must be place downstream from backup heat elements and gas furnace heat exchangers far enough to prevent it from reaching the set point cut out temperature when emergency heat comes on.

- Heat Pump Heating Limit – 130ºF
- Cooling limit – 42ºF
- Other Gas/Auxiliary Heating limit – 165ºF

ULTRA-ZONE®
Forced Air Zone Controls

SUBMITTAL SHEET
Model SAS
(Supply/Return Air Sensor)

Choose a suitable location to mount the SAS. Make sure there are no critical components behind the duct and drill a 5/16" hole into the duct. Remove the front cover on the SAS to expose the box interior. Insert the SAS probe into the 5/16" hole you drilled into the duct. Now fasten the box to the duct using two 1/4" hex head screws. Route 2x18AWG field wire through the grommet and into the box. Use the provided wire nuts to connect to the SAS sensor wires. Place the cover back on and secure it. Connect both #18AWG field wires to the correct terminals on your Ultra-Zone control panel, to achieve real time monitoring of the Supply or Return Air temperature.



TEMPERATURE (F)	OHMS k	VOLTSdc	TEMPERATURE (F)	OHMS k	VOLTS dc	TEMPERATURE (F)	OHMS k	VOLTS dc
30	34.36	4.10	85	8.40	2.64	140	2.48	1.24
35	29.49	3.98	90	7.40	2.48	145	2.23	1.14
40	26.68	3.90	95	6.53	2.32	150	2.01	1.05
45	23.01	3.77	100	5.77	2.21	155	1.87	1.0
50	19.90	3.63	105	5.11	2.02	160	1.69	0.92
55	17.25	3.48	110	4.72	1.93	165	1.53	0.84
60	15.00	3.33	115	4.20	1.79	170	1.38	0.77
65	13.68	3.23	120	3.74	1.66	175	1.29	0.73
70	11.94	3.07	125	3.34	1.54	180	1.17	0.68
75	10.44	2.91	130	3.09	1.46	185	1.07	0.62
80	9.16	2.75	135	2.77	1.35	190	0.97	0.57

Figure 13: Supply Air Temperature Safety

ZONE DAMPER CONNECTION

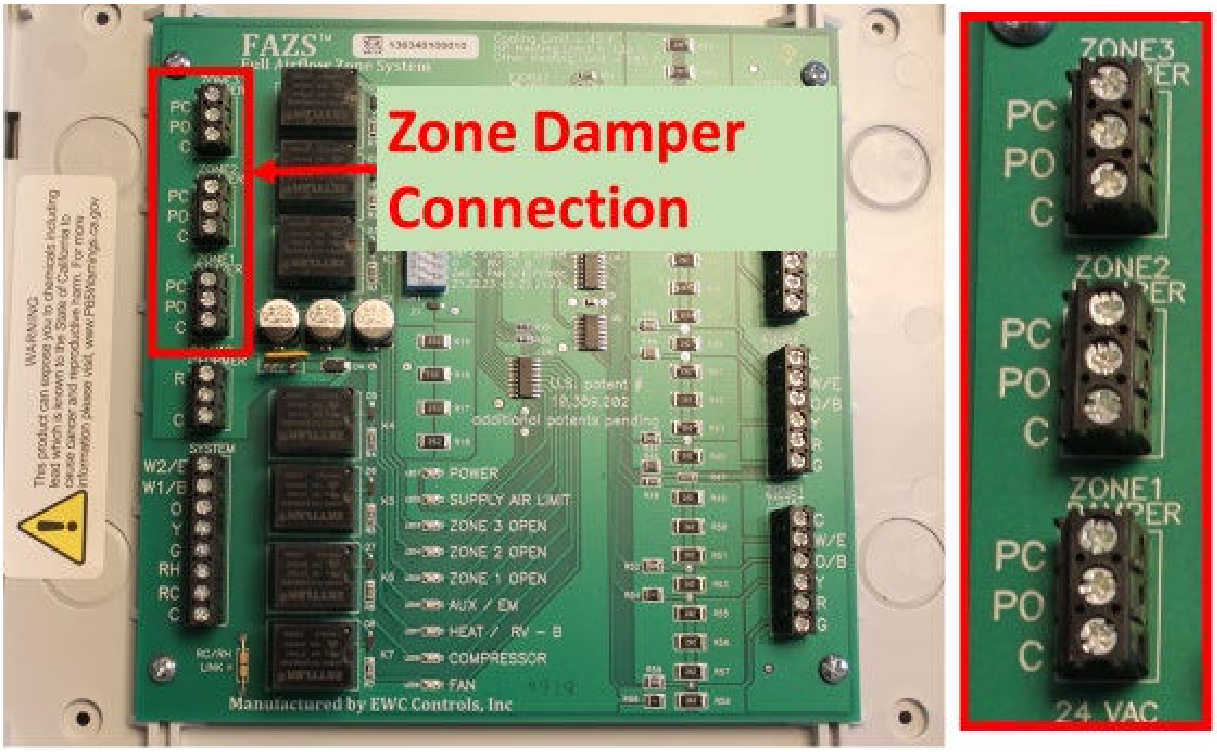
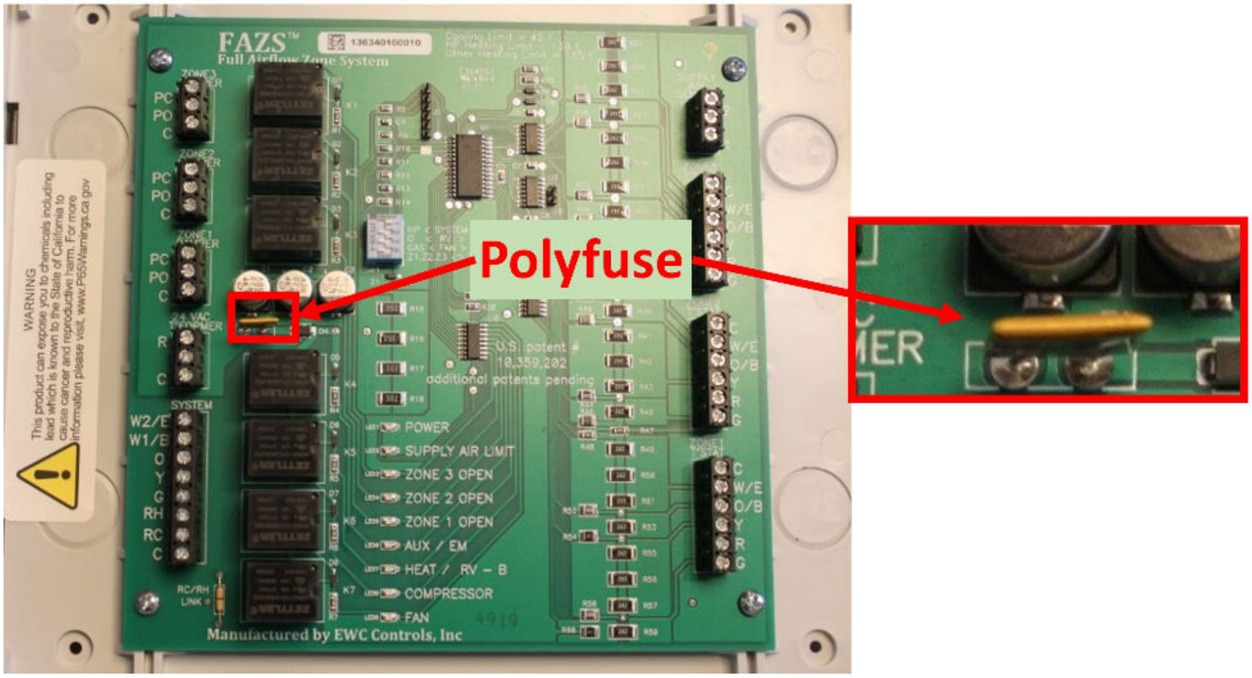


Figure 14: Zone Damper Connections

Zone Damper connections are located in the top left of the control board as shown in Figure 15. The zones are marked on the board with Zone 3 on the top, Zone 2 in the middle and Zone 1 at the bottom.

- The "C" terminal on the FAZS™ Connects to PC/6 on the MA-ND5 damper motor (three wire motor open motor close damper) and is the common terminal for all dampers.
- The PC Terminal on the board connects with the PC/6 on the MA-ND5 damper motor (or the normally closed position on any motor open motor closed damper). For two wire (spring type) it is also the connection used for normally open dampers.
- The "PO" terminal on the control board connects to PO/4 on the MA-ND5 damper motor (or the normally open position on any motor open motor closed damper). For two wire (spring type) it is also the connection used for normally closed (spring type) dampers.

POLYSWITCH SAFETY AUTOMATIC RESET



BOARD LIGHTS OUT AFTER INSTALLATION

If there is a short on one of the circuits the board will automatically shut down to save itself. The Polyswitch will be warm to the touch when the power is on and when there is a short in the control wiring. Before attempting to reset the board the electrical problem must be corrected.

- First, Turn the power off
- With the power on remove the thermostat and damper control wires one at a time leaving them unconnected and in a position where they will not touch each other. When the board light comes on you have identified the wire that is shorted (repair or replace)
- Reconnect the wires one at a time and if the board light goes out again you have found another shorted wire. (repair or replace and continue reconnecting the wires.

  Note: Yon will probably want to turn the power off while repairing the short. After the short fixed turn the power back on and continue reconnicting the remaining control wires. After turning off the power there will be a 3 minute time delay before the startup (see sequence of operations in this instruction set).

SECTION III

FAZS™ CONTROL LOGIC and SEQUENCE OF OPERATION

INTRODUCTION

EWC controls manufactures the FAZS™ control boards. Parts of the control sequence are patented and unique to the Full Airflow Zone System™. The Chief Engineer at EWC controls John Brown wrote this section. John was instrumental in the development of the control board and the early operational and endurance testing of the final product.

CONTROL LOGIC AND SEQUENCE OF OPERATION OVERVIEW

The patented FAZS™ controller is a "Zone Priority" architecture that is designed to condition the home "One Zone" at a time.

The default Zone Priority is as follows:
Zone 1 = Highest Priority
Zone 2 = Medium Priority
Zone 3 = Lowest Priority

Available Zone Priority options are as follows:
Zone 2 = Highest Priority
Zone 1 = Medium Priority
Zone 3 = Lowest Priority

CONTROL LOGIC

- During idle mode (zero heat/cool/fan demands and during changeover delay), the FAZS™ controller will default/energize ALL zone dampers to the open position. This allows ancillary HVAC devices such as ERV's, Humidifiers and De-Humidifiers to operate as needed. At no time, will all zones be energized to the closed position. There will always be at least one zone energized to the open position.
- During idle mode, the FAZS™ controller is monitoring all zone thermostat inputs for Heat, Cool or Fan only demands.
- The highest priority demand will always be honored first. Lower priority zone demands will be honored in the absence of a higher priority zone demand.
- In addition, Heat and Cool zone demands take priority over Fan only zone demands.
- In a condition where a high priority zone is demanding Fan only, and a lower priority zone demands Heating or Cooling, the lower priority zone demand for Heating or Cooling wins. *Low priority Heat and Cool zone demands interrupt high priority Fan only zone demands.*

In a condition where 2 or more zones are actively demanding Heat at the same time, the highest priority zone wins and the FAZS™ controller will energize the highest priority

- zone to the open position and lower priority zone(s) will be energized to the closed position, after a 1 minute delay expires.
    - Assuming the highest priority zone then satisfies, the next priority zone (medium or low) will be energized to the open position, while the highest priority zone remains open for I minute. After a 1 minute delay expires, the highest priority zone (now satisfied) will be energized to the close position.

- In a condition where a lower priority zone is actively Heating and a higher priority zone demands Heating as well, the higher priority zone wins and the FAZS™ controller will energize the higher priority zone to the open position and the lower priority zone will be energized to the closed position, after a 1 minute delay expires.
    - The lower priority zone Heat demand will not be honored again, until all higher priority zone Heat demands are satisfied.

- In a condition where a lower priority zone is actively Heating and a higher priority zone demands Cooling instead, the higher priority zone wins and the FAZS™ controller will terminate the heating operation for the lower priority zone.
    - The FAZS™ controller energizes all zone dampers to the open position, purging the last of the warm air into all zones. The FAZS™ controller also starts a 2 minute changeover delay, allowing the HVAC system time to rest. *All zones remain energized to the open position during the changeover delay.*
    - After the 2 minute changeover delay expires, the FAZS™ controller will start the Cooling system. The higher priority zone damper was already energized to the open position, and will remain so. The FAZS™ controller will energize the lower priority zone damper(s) to the closed position, after a 1 minute delay expires. Any lower priority zone H/C demands will not be honored again, until all higher priority zone H/C demands are satisfied.

- In a condition where a lower priority zone is actively Cooling and a higher priority zone demands Heating instead, the higher priority zone wins and the FAZS™ controller will terminate the cooling operation for the lower priority zone.
    - The FAZS™ controller energizes all zone dampers to the open position, purging the last of the cool air into all zones. The FAZS™ controller starts a 2 minute changeover delay, allowing the HVAC system time to rest. *All zones remain energized to the open position during the changeover delay.*
    - After the 2 minute changeover delay expires, the FAZS controller will start the Heating system. The higher priority zone damper was already energized to the open position, and will remain so. The FAZS™ controller will energize the lower priority zone damper(s) to the closed position, after a 1 minute delay expires. Any lower priority zone H/C demands will not be honored again, until all higher priority zone H/C demands are satisfied.

SEQUENCE OF OPERATION

- **OTHER (Gas, Oil, Electric, Hydronic) HEAT MODE:** Upon a drop in temperature in any zone, the zone thermostat will energize the W/E input input of the ™controller.
  - Depending on the priority level of that zone, the FAZS™ controller may honor or ignore that demand.
  - Assuming the demand is the highest priority OR no other higher priority demands are detected, the FAZS™ controller will energize the W1/B (1st stage heat) system output and if applicable (Electric or Hydronic heat) the G (fan) system output to the forced air unit.
  - Assuming the FAZS™ controller was idle, the related zone damper was already energized to the open position, and will remain so. The FAZS™ controller will energize the inactive zone damper(s) to the closed position after a 1 minute delay expires.
  - The FAZS™ controller will continue heating, so long as High, Medium or Low priority zone demands exist.
  - Once all zoned demands are satisfied and no other heat demands are detected, the FAZS™ controller will de-energize the W1/B (1st stage heat) system output and the G (fan) system output if applicable. The FAZS™ controller will then energize all zones to the open position and enter idle mode.

- **HEAT PUMP HEAT MODE:** Upon a drop in temperature in any zone, the zone thermostat will energize the Y (compressor) input, the G (fan) input and/or the W/E (auxiliary/emergency) input of the FAZS™ controller.
  - Depending on the reversing valve logic for that heat pump, the zone thermostat may or may not energize the O/B input of the FAZS™ controller.
  - Depending on the priority level of that zone, the FAZS controller may honor or ignore that demand.
  - Assuming the demand is the highest priority OR no other higher priority demands are detected, the FAZS™ controller will energize the Y (compressor) system output, the W1/B (reversing valve) system output and the G (fan) system output, to the forced air unit and the heat pump.
  - If the zone thermostat energized the W/E input along ***with*** the Y input, the FAZS™ controller will also energize the W2/E (*auxiliary heat*) system output.
  - If the zone thermostat energized the W/E input ***without*** the Y input, the FAZS™ controller will energize the W2/E (*emergency heat*) system output and the G (fan) system output. The Y (compressor) output will be de-energized.
  - Assuming the FAZS™ controller was idle, the related zone damper was already energized to the open position, and will remain so. The FAZS™ controller will energize the inactive zone damper(s) to the closed position after a 1 minute delay expires.
  - The FAZS™ controller will continue heating, so long as High, Medium or Low priority zone demands exist.
  - Once all zoned demands are satisfied and no other heat demands are detected, the FAZS™ controller will de-energize the Y (compressor), the W2/E (*auxiliary/emergency heat*) and the G (fan) system outputs. The W1/B (reversing valve) system output will remain energized. The FAZS™ controller will then energize all zones to the open position and enter idle mode.

- **HEAT PUMP COOL MODE:** Upon a rise in temperature in any zone, the zone thermostat will energize the Y input and the G input of the FAZS™ controller.
  - Depending on the reversing valve logic for that heat pump, the zone thermostat may or may not energize the O/B input of the FAZS™ controller.
  - Depending on the priority level of that zone, the FAZS™ controller may honor or ignore that demand.
  - Assuming the demand is the highest priority OR no other higher priority demands are detected, the FAZS™ controller will energize the Y (compressor) system output, the O (reversing valve) system output and the G (fan) system output, to the forced air unit and the heat pump.
  - Assuming the FAZS™ controller was idle, the related zone damper was already energized to the open position, and will remain so. The FAZS™ controller will energize the inactive zone damper(s) to the closed position after a 1 minute delay expires.
  - The FAZS™ controller will continue cooling, so long as High, Medium or Low priority zone demands exist.
  - Once all zoned demands are satisfied and no other cool demands are detected, the FAZS™ controller will de-energize the Y (compressor) and the G (fan) system outputs. The O (reversing valve) system output will remain energized. The FAZS™ controller will then energize all zones to the open position and enter idle mode.

- **FAN ONLY MODE:** Any zone may demand fan only however, fan only demands are not honored if Heat and Cool zone demands are also detected. Assuming there are zero H/C demands detected, the zone thermostat will energize the G input of the FAZS™ controller.
  - Depending on the priority level of that zone, the FAZS™ controller may honor or ignore that demand.
  - Assuming the demand is the highest priority OR no other higher priority demands are detected, the FAZS™ controller will energize the G (fan) system output, to the forced air unit.
  - Assuming the FAZS™ controller was idle, the related zone damper was already energized to the open position, and will remain so. The FAZS™ controller will energize the inactive zone damper(s) to the closed position after a 1 minute delay expires.
  - The FAZS™ controller will continue running the fan, so long as High, Medium or Low priority zone “fan only” demands exist.
  - Heat or Cool demands from any priority level zone will interrupt “fan only” operations
  - Once no other “fan only” demands are detected, the FAZS™ controller will de-energize the G (fan) system output.
  - The FAZS™ controller will then energize all zones to the open position and enter idle mode.

- **FAZS™ BUILT-IN TIME DELAYS**
  - Start-up Delay – 10 seconds
  - Damper Close Delay – 1 minute
  - Minimum Run Delay – 2 minutes
  - Short Cycle Delay – 2 minutes
  - Changeover Delay – 2 minutes
  - Supply Air Limit Delay – 3 minutes
  - All delays are fixed / non-adjustable

- **SUPPLY AIR LIMIT LOGIC**
- The FAZS™ controller includes a supply air sensor that provides supply air temperature data to the FAZS™ processor, allowing the HVAC system's supply air temperature to be monitored in real time.
- The FAZS™ uses fixed supply air limit values in order to protect the HVAC system from extreme supply air temperatures.
    - Other/Gas/Auxiliary Heating limit – 165ºF
    - Heat Pump Heating Limit – 130ºF
    - Cooling limit – 42ºF
- In the event the FAZS™ controller detects a supply air temperature that exceeds the fixed limit values for Heating or Cooling, the FAZS™ controller will de-energize the W1/B (1st stage heat), the Y (compressor) and/or the W2/E (auxiliary/emergency) system outputs for 3 minutes. The G (fan) system output (if applicable) will remain energized to assist in moderation of the supply air temperature.
- After 3 minutes has expired AND the supply air temperature has moderated, the FAZS™ controller will resume standard H/C operations. Numerous supply air limit cycles do not result in a lock-out condition.
- In the event the active zone thermostat demand for heat or cool satisfies during a supply air limit cycle, and no other zone thermostat demands are detected, the FAZS™ controller will enter idle mode and energize all zone dampers to the open position, after the 3 minute delay has expired.
- In the event the supply air sensor is not connected or fails (opens or shorts), the Supply Air Limit LED on the FAZS™ controller will blink rapidly. This provides a "fail" indication to the User that the supply air sensor cannot be found. The FAZS™ controller will continue/resume standard H/C operations, albeit without the protection that the supply air sensor provides.
- This document describes the control logic and sequence of operation for the patented FAZS™ zone controller. Should you discover a discrepancy and/or the data provided herein does not reflect real time operations in the field, please contact Don Prather at FAZSDP@YAHOO.CO

JOB NOTES: