Static pressure Control

ESquared Underfloor Sequence of Operations

The ESquared controller has the capability to control the underfloor static pressure by inclusion of a static pressure sensor or by the BMS commanding the fan speeds directly.

What must be considered is that the static pressure is the square of the fan speed. This means a small change in fan speed has a large effect on the underfloor pressure. If a fan speed of 40% yields an underfloor pressure of 0.64 iwg, a 25% increase in fan speed (40% to 50%) does not increase the pressure by 25% (0.64 to 0.80 iwg). The new value of 1.00 iwg is the result of the ratio of the two fan speeds squared and works out to an increase of 56.25%.

There are several parameters available to fine tune the static underfloor pressure. The inclusion of the underfloor sensor is done at the Config level. Once the sensor is enabled, screens at the Factory and Service levels become visible. The Factory level, Blower section is where you can select Proportional or Proportional/Integral control (default is P+I), the proportional band (default of 10), the integration time (default 100 seconds), and actually enable the underfloor control function. It is recommended to leave the defaults as they are and just enable the control function. The pressure set point and starting fan value are set at the Factory or the Service level under the Blower section.

The starting fan speed is used during startup only. The system uses this speed during fan startup to allow the underfloor pressure to stabilize. The time that this speed is active is a function of the number of fans plus the regular fan start time. The pressure set point is compared to the current pressure sensor reading and the square root of the PI control is added to the starting fan speed to either increase or decrease the actual fan speed. It is not necessary for the starting fan speed to be exactly the right value for the desired pressure, but the overall system will stabilize faster with a good initial start value.

Since the fan is now controlled by the underfloor static pressure sensor, the system will no longer change the fan speed based on cooling demand nor will CW units have their fan speed tied to temperature changes. This includes the CW-fan ratio as well as having the fan speed vary during operation of the CW valve.

If the BMS wants to mimic the underfloor pressure control, it needs to set all three fan speeds (low, run, and dehum) equal to each other and to zero the CW-fan ratio. The controller will still change fan speeds according to its operation but since all fan speeds are the same, no real change in speed will happen. If the CW-fan ratio is non-zero, the fan speed will change slightly during CW operations and thus change the underfloor static pressure as well.

Setting up the static pressure algorithm

Step 1 Adjust the sensor

Each static pressure sensor should be set for 0 to 1" operation (PJ3 at L position, PJ5 at N position). We zero out the sensor by removing any hoses from the two barbs and holding in the Zero button for 4-5 seconds. We also need to slow down the sensor to filter readings every 10 seconds. Move the PJ3 jumper to the F position (top two pins). The display will indicate the number of seconds that the sensor updates (default is 1). Use the Span button to change the display to 10.

Step 2 Get some valid numbers and write them down

The easiest way is to set all 3 fan speeds equal to each other and note what the underfloor static value is for that fan speed. If you have a lot of units, set them all up with the same fan speed and note the static readings. Expect the static readings to vary a little bit even with all fans running at the same speed.

Step 3 Calculate the fan start point

Now we are ready to put some numbers in the controller, but first a little math and explanation.

Static pressure increases by the square of the fan speed and is related by ratios. The actual equation is below where SP1 and SP2 are static pressures and RPM1 and RPM2 are fan speeds.

$$(SP1/SP2) = (RPM1/RPM2) \times (RPM1/RPM2)$$

With all the units running the same fan speed (RPM1), note what the static pressure is (SP1) and ask what static pressure is actually desired (SP2). We can then calculate the new fan speed (RPM2) that will get us to that static pressure. This is easier and faster than changing all the fan speeds at all the units until we arrive at the desired static pressure setpoint and then using that fan speed as the starting value.

$$RPM2 = RPM1 / (SQRT(SP1/SP2))$$

Enter current fan speed (RPM1, 300 = 30.0%)	**300**
Enter current static pressure (SP1, 360 = 360 miwg)	**300**
Enter desired static pressure (SP2) in miwg	**300**
Use this number as your fan start value (RPM2)	**300**

Step 4 Set up the controller

Navigate to the Factory->Blower menu and scroll down to the Static pressure setup screen. Leave the default values of modulation set to P+I, proportional band set to 10 and the integration time set at 100. Enable the underfloor pressure and navigate to the next screen below. Enter the desired static setpoint value (SP2 from above) and the calculated start fan speed (RPM2).

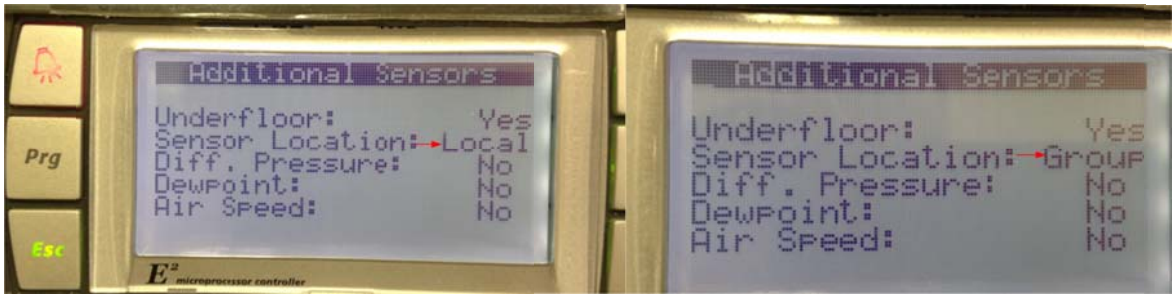
The controller takes the static setpoint and fan start value and uses the actual sensor reading to figure out what fan speed adjustment is needed to move the static pressure towards the setpoint. If the static pressure is too high, the fan slows down and vice versa. The algorithm has been tested in the lab and should be able to maintain the setpoint to within +/- 10 miwg. Remember to use the variance you got in Step 2 with a fixed fan speed as a starting point for discussions if the customer thinks the control should be accurate to something like +/- 1 miwg.

Note 1: Set address on expansion module to #2
Note 2: B1 & VDC wire to the sensor
Note 3: J9 negative to VDC
Note 4: J9 B1 wires to sensor positive terminal

In Factory Configuration>Additional Sensors>Underfloor screen, Underfloor (Static pressure control) should be YES. Choosing YES triggers the controller to add the "Static Pressure Setup" screens that are in the regular Factory menu.

It is also necessary to configure the controller for what sensor it should use.

In Factory> Configuration>Additional Sensors> Sensor Location: Group= the unit will NOT have its own sensor and will rely on the network static sensor input. Local= the unit WILL have its own sensor (If no sensor is actually connected, a sensor failure alarm will occur).



Access the "Static Pressure Setup" screens via Factory>Blower:

The first "Static Pressure Setup" screen: Make sure "Enable underfloor"=YES Default parameters are shown. "Modulation" can be "P"(proportional) or "P+I"(proportional+ Integral)."Proportional Band" and "Integration Time" are adjustable for fine tuning but normally require no adjustment.

The second "Static Pressure Setup Screen: Enter the desired "Static set point". Note that unit of measure is "miwg" (milli inches of water column). Default Static Set point of 200(miwg) =.2"(iwg). Some other common conversion variables: 25 miwg=.025 iwg / 50miwg=.05 iwg / 100miwg=.1iwg / 500miwg=.5iwg / 1000miwg=1iwg Enter the desired "Start fan speed".

Static Pressure Sensor Parameters/Explanation

The Static sensor input can be read or rescaled in Factory>Sensors (Analog Input). The min and max values should only be rescaled if a customer supplied sensor is used.

Note that no sensor is connected (0 ma input) in the screenshot below, thus the sensor input is displaying "-250miwg".

**Note that the default values are shown below. Although the "Maximum" displays as 100.0, the actual value used by the controller (for calculation purposes) is 1000. If a custom sensor is used, this must be taken into consideration. For example: If a custom sensor (0-.1 iwg) is utilized, the "Maximum" value would literally be 100, however; the entered value would have to appear as 10.0 for the sensor to accurately display.