**Thermostat Project Operational Notes.**

There are (6) main operational modes of heating/cooling/dehumidifying and (2) modes for fan operation. Listed are the operational modes followed by a more detailed sequence of operation for each. Additionally, there are multiple operational characteristics of each mode based on installer setup choices and will be discussed later.

There are (2) main control “Select buttons”.  ***FAN*** and ***SYSTEM***. Following is a breakdown of each.

*Fan* Modes are **AUTO** and **ON**

**Auto** In this position the indoor fan is energized with any call for heat, cool, dehumidify, Humidify, CO2 air change and CO monitoring. (CO High condition will activate an alarm sequence and fan shut down).

**ON** In this position the indoor fan is energized to run continuously. (Except in alarm condition).

*System* Modes are **OFF**, **COOLING**, **HEATING**, **EMERGENCY HEAT**, **DEHUMIDIFY,** and **CRUISE CONTROL**

**OFF** This will command the whole system to shut down. (Fan can still run in the ON position) The detailed sequence will be outlined in more detail.

**COOLING** This will energize the Cooling and Fan contacts based on the actual temp vs. the set temp. There are two stages of cooling, if that option has been selected in the installer setup menu. The detailed sequence will be outlined in more detail.

**HEATING** This will energize the Heating and Fan contacts. There are up to three stages of heating, if that option has been selected in the installer set up menu. The detailed sequence will be outlined in more detail.

**EMERGENCY HEAT** This is only available if the HEAT PUMP option is selected in the installer setup menu. This will energize the fan and only the electric heating system. The detailed sequence will be outlined in more detail.

**DEHUMIDIFY** This will energize the Cooling, Fan and electric heating. This is only available if selected from the installer set up menu. Additional contacts are used for a stand-alone dehumidifier.

**CRUISE CONTROL** This will simply command the system to energize the associated contacts as need for any “out of parameter” condition. This is only available if selected from the installer set up menu.

This Thermostat will have a very broad and flexible application ability to many of the most common heating and cooling systems on the market today. However, it is aimed more toward heat pump and straight cooling systems with electric heat. Following is a detailed sequence of operation assuming that SINGLE STAGE, HEAT PUMP with electric has been chosen in the installer setup menu.

Sequence of operation (1) Main control buttons set to **Fan AUTO/ON** and **System OFF**

If the Fan select button is AUTO and the system select button is OFF, all air monitoring remains active but no action will be initiated regardless of temperature/humidity/CO2. One exception is the CO monitoring.

If the CO rises above \_\_\_\_ ppm, a “HIGH CARBON MONOXIDE WARNING” alarm event will de-energize all contacts and put the system in idle mode including the *G* fan contacts. This should command a “Push Notification” to the user and will present an on-screen alarm warning. Once CO falls below \_\_\_\_\_ ppm, the system may return to the modes required to maintain space comfort as outlined above while indicating an alarm event has taken place. A record of re-settable alarm events should be available in a diagnostic screen.

If the Fan select button is in the ON position and the system select button is in the OFF position, all air monitoring remains active, but no action will be initiated regardless of temperature/humidity. If the CO2 rises above 600ppm the *AUX3* CO2 contacts are energized to allow for an outside air damper to open, introducing fresh air into the space. Once the CO2 reaches 500ppm the *AUX3* CO2 contacts are de-energized. The *G* fan contacts simply remain energized since the Fan control button is in the ON position.

The Following Sequence of operation is used IF 2 stage cooling compressor is selected in the setup menu selections:-

Sequence of operation (2) Main control buttons set to **Fan AUTO/ON** and **System COOL**.

Sequence of operation (2.1) : (This is 1st Stage cooling)

The thermostat monitors the actual temp inside the space and compares it to the set point selected by the user. Should the actual temperature rise above the set point by .5deg F, the 1st Stage Y1 compressor contacts, the *G* fan contacts, and the O/B reversing valve contacts will be energized allowing the system to cool. When the actual temp falls below the set point by .5deg F then 1st Stage Y1 and *G* contacts will be de-energized, and system will go back to idle. (Assuming humidity is in range). O/B reversing valve contacts remain energized anytime the System Select button is set to COOL. This small temp offset from set point prevents the system from short cycling while still maintaining close control of the desired temp. Once the contacts are de-energized a short minimum off timer begins a countdown to prevent mechanical short cycling. (Timer is set in Setup Menu).

Two conditions will cause the system to energize the 2nd Stage Cooling. The first is if the actual Temperature is >1deg F above the set point. The other is if the 1st stage runs >15minutes without reaching set point.

Sequence of operation (2.2): (This is 2nd Stage Cooling)

The thermostat monitors the actual temp inside the space and compares it to the set point selected by the user. Should the actual temperature rise above the set point >1deg F, the 1st Stage Y1 compressor contacts, the O/B reversing valve and the G fan contacts will remain energized. Additionally, the 2nd Stage Y/Y2 contacts energize, allowing the system to cool in 2nd Stage. When the actual temp falls below the set point by .5deg F, only then will the 1st Stage Y1, the 2nd Stage Y/Y2 and G contacts be de-energized, and system will go back to idle. (Assuming humidity is in range). O/B reversing valve contacts remain energized anytime the System Select button is set to COOL. Note. There needs to be a minimum run time (2 Minutes) on Stage 1 before stage 2 can be energized. Even if the temperature is >1deg F. This prevents air mixing in the space from energizing stage 2 prematurely.

If “DEHUMIDIFIER” was chosen from the installer setup menu, humidity is controlled in this mode as well. If the actual humidity rises more than 5% above the humidity set point, The *AUX1 DEHUM* contacts, and the *G* fan contacts will be energized allowing a stand-alone dehumidifier to reduce the space humidity. Once the humidity is 5% below the humidity set point, the *AUX1 DEHUM* contacts and the G fan contacts are de-energized.

 If “ALLOW DE-HUMIDIFICATION WITH ELECTRIC HEAT” was chosen from the installer setup menu, humidity is controlled by the system. If the actual humidity rises more than 5% above the humidity set point, The *Y/Y2* compressor contacts, the *G* fan contacts and the *W1* electric heating contacts will be energized. This will command the system to cool while reheat is introduced by electric heat to allow the space to dehumidify while not over cooling. Temperature must not go out of range while dehumidifying. Therefore, the *W1* electric heat contacts are energized when the actual temp reaches the temp set point -.75deg F and are de-energized when the actual temp reaches the set point +.75deg F. This modulation will continue until the humidity reaches the humidity set point -5% AND the temperature is within .5 deg F of the temperature set point.

Hard parameters need to keep the system from “Running away” in the event of a mechanical failure or lack of heating capacity provided by the electric heat. When/if the actual temp reaches the set point -1deg F, the system will de-energize the *Y/Y2* compressor contacts while maintaining the *W1* electric heat and *G* fan contacts. Once the actual temp reaches the set point temp +.5deg F then the *Y/Y2* compressor contacts can be energized again to commence the modulation.

If the temperature is within .5deg F above or below set point AND the humidity is within 5% above or below set point, the system simply cycles to “idle”. The *Y/Y2* compressor contacts, the *G* fan contacts and the *W1* electric heat contacts are all de-energized.

In all operations listed above, the *G* fan contacts will remain energized if the fan control button is in the ON position.

Carbon Dioxide and Carbon Monoxide detection are always active and operate independently/simultaneously with the above sequence.

If the CO2 rises above 600ppm the *AUX3* CO2 contacts and the *G* fan contacts are energized to allow for an outside air damper to open, introducing fresh air into the space. Once the CO2 reaches 500ppm the *AUX3* CO2 contacts and the G fan contacts are de-energized. The *G* fan contacts simply remain energized if the Fan control button is in the ON position.

If the CO rises above \_\_\_\_ ppm, a HIGH CARBON MONOXIDE WARNING alarm event will de-energize all contacts and put the system in idle mode including the *G* fan contacts. This should command a “Push Notification” to the user and will present an on-screen alarm warning. Once CO falls below \_\_\_\_\_ ppm, the system may return to the modes required to maintain space comfort as outlined above while indicating an alarm event has taken place. A record of alarm events should be available in a diagnostic screen.

The Following Sequence of operation is used IF 2 stage heating compressor is selected in the setup menu selections:-

Sequence of operation (3) Main control buttons set to **Fan AUTO/ON** and **System HEAT**

Sequence of operation (3.1) : (This is 1st Stage Compressor Heating)

The thermostat monitors the actual temp inside the space and compares it to the set point selected by the user. Should the actual temperature fall below the set point by .5deg F, the Y1 compressor contacts and the G fan contacts, will be energized allowing the system to Heat. When the actual temp rises above the set point by .5deg F then both contacts will be de-energized, and system will go back to idle. (Assuming humidity is in range). This small temp offset from set point prevents the system from short cycling while still maintaining close control of the desired temp. Once the contacts are de-energized a short minimum off timer begins a countdown to prevent mechanical short cycling. (Timer set in Setup menu).

Two conditions will cause the system to energize the 2nd Stage Heating. The first is if the actual Temperature is >1deg F below the set point. The other is if the 1st stage runs >10minutes without reaching set point.

Sequence of operation (3.2) : (This is 2nd Stage Compressor Heating)

The thermostat monitors the actual temp inside the space and compares it to the set point selected by the user. Should the actual temperature fall below the set point by >1deg F, the 1st Stage Y1 compressor and the G fan contacts, will remain energized. Additionally, the 2nd Stage Y/Y2 contacts will be energized allowing the system to Heat in Stage 2. When the actual temp rises above the set point by .5deg F, only then will the 1st Stage Y1, the 2nd Stage Y/Y2 and G Fan contacts be de-energized, and system will go back to idle. (Assuming humidity is in range). This small temp offset from set point prevents the system from short cycling while still maintaining close control of the desired temp. Once the contacts are de-energized a short minimum off timer begins a countdown to prevent mechanical short cycling. (Timer set in Setup menu)

There are two conditions that would require the addition of the W1 electric heat while heating with the heat pump. First, if the actual temp is > 1.5 deg below the set point. And the other is extended heating run time. In either case the Y/Y2 Contacts, the G fan Contacts and the W1 electric heat contacts are energized to allow for 2nd Stage heat pump AND supplemental electric heat to operate simultaneously. If the 2nd Stage heating run time duration exceeds 10 minutes, this sequence would be initiated. System would return to idle once the actual temp reached the set point +.5deg F.

The Following Sequence of operation is used IF Dual Fuel System Type is selected in the setup menu selections. (This is for Single Stage Compressor) :-

Sequence of operation (3.3): (Heating with Heat Pump)

The thermostat monitors the actual temp inside the space and compares it to the set point selected by the user. Should the actual temperature fall below the set point by .5deg F, the Y/Y2 compressor contacts and the G fan contacts, will be energized allowing the system to Heat utilizing the Heat Pump. When the actual temp rises above the set point by .5deg F then both contacts will be de-energized, and system will go back to idle. (Assuming humidity is in range). This small temp offset from set point prevents the system from short cycling while still maintaining close control of the desired temp. Once the contacts are de-energized a short minimum off timer begins a countdown to prevent mechanical short cycling. (Timer set in Setup menu)

Two conditions will cause the system to energize the Gas furnace for heating. The first is if the actual Temperature is >2deg F below the set point. The other is if the Heat pump run time >15minutes without reaching set point.

Sequence of operation (3.4): (Heating With Gas Furnace)

The thermostat monitors the actual temp inside the space and compares it to the set point selected by the user. Should the actual temperature fall below the set point by >2deg F, and/or the heat pump run time is >15 minutes, the compressor Y/Y2 contacts and the G fan contacts will be deenergized and the W heating contacts will be energized. This allows the system to Heat with the Gas furnace and turns off compressor heating. (They cannot run simultaneously). When the actual temp rises above the set point by .5deg F, only then will the “W” contacts be de-energized, and system will go back to idle. (Assuming humidity is in range). This small temp offset from set point prevents the system from short cycling while still maintaining close control of the desired temp. Once the contacts are deenergized a short minimum off timer begins a countdown to prevent mechanical short cycling. (Timer set in Setup menu)

If “ALLOW DE-HUMIDIFICATION WHILE HEATING” was chosen from the installer setup menu, the Dual Fuel system Type disallows this operation.

 If “ALLOW DE-HUMIDIFICATION WHILE HEATING” was chosen from the installer setup menu, humidity is controlled in this mode as well. If the actual humidity rises more than 10% above the humidity set point, The *Y/Y2* compressor contacts, the *G* fan contacts, the *O/B* reversing valve contacts, and the *W1* electric heating contacts will be energized. This will command the system to cool while reheat is introduced by electric heat to allow the space to dehumidify. Temperature must not go out of range while dehumidifying. Therefore, the *W1* electric heat contacts are energized when the actual temp reaches the temp set point -.75deg F and are de-energized when the actual temp reaches the set point +.75deg F. This modulation will continue until the humidity reaches the humidity set point -5% AND the temperature is within .5 deg F of the temperature set point.

Hard parameters need to keep the system from “Running away” in the event of a mechanical failure or lack of heating capacity. When/if the actual temp reaches the set point -1deg F, the system will            de-energize the O/B reversing valve contacts while maintaining the *W1* electric heat and *G* fan contacts.  Once the actual temp reaches the set point temp +.75deg F then the *O/B* reversing valve contacts can be energized again to commence the modulation.

If the temperature is within .5deg F above or below set point AND the humidity is within 5% set point, the system simply cycles to “idle”. The *Y/Y2* compressor contacts, the *G* fan contacts, the *O/B* reversing valve contacts and the *W1* electric heat contacts are all de-energized. The *G* fan contacts will remain energized if the fan control button is in the ON position.

If “HUMIDIFIER” was chosen from installer setup menu, a humidifier can be turned on from this mode. If the actual humidity is 8% below the humidity set point, the G fan contacts and the *AUX1* Hum contacts are energized to allow a humidifier to increase space humidity. Once Actual humidity is 5% above humidity set point, the *AUX1* Hum contacts and the G fan contacts are de-energized. The *G* fan contacts will remain energized if the fan control button is in the ON position.

Carbon Dioxide and Carbon Monoxide detection are always active and operate independently/simultaneously with the above sequence.

If the CO2 rises above 600ppm the *AUX1* CO2 contacts and the *G* fan contacts are energized to allow for an outside air damper to open, introducing fresh air into the space. Once the CO2 reaches 500ppm the *AUX1* CO2 contacts and the G fan contacts are de-energized. The *G* fan contacts simply remain energized if one of the above conditions are driving the fan contacts to the energized position.

If the CO rises above \_\_\_\_ ppm, a HIGH CARBON MONOXIDE WARNING alarm event will de-energize all contacts and put the system in idle mode including the *G* fan contacts. This should command a “Push Notification” to the user and will present an on-screen alarm warning. Once CO falls below \_\_\_\_\_ ppm, the system may return to the modes required to maintain space comfort as outlined above.

Sequence of operation (4) Main control buttons set to **Fan AUTO/ON** and **System EMERGENCY HEAT**

The thermostat monitors the actual temp inside the space and compares it to the set point selected by the user. Should the actual temperature fall below the set point by .5deg F, the *W1* electric heat contacts, and the *G* fan contacts, will be energized allowing the system to heat with electric heat only. When the actual temp rises above the set point by .5deg F then both contacts will be de-energized, and system will go back to idle. (Assuming humidity is in range). This small temp offset from set point prevents the system from short cycling while still maintaining close control of the desired temp. Once the contacts are de-energized a short minimum off timer begins a countdown to prevent mechanical short cycling. (90 seconds)

If “HUMIDIFIER” was chosen from installer setup menu, a humidifier can be turned on from this mode. If the actual humidity is 8% below the humidity set point, the G fan contacts and the *AUX1* Hum contacts are energized to allow a humidifier to increase space humidity. Once Actual humidity is 5% above humidity set point, the *AUX1* Hum contacts and the G fan contacts are de-energized. The *G* fan contacts will remain energized if the fan control button is in the ON position.

Carbon Dioxide and Carbon Monoxide detection are always active and operate independently/simultaneously with the above sequence.

If the CO2 rises above 600ppm the *AUX1* CO2 contacts and the *G* fan contacts are energized to allow for an outside air damper to open, introducing fresh air into the space. Once the CO2 reaches 500ppm the *AUX1* CO2 contacts and the G fan contacts are de-energized. The *G* fan contacts simply remain energized if one of the above conditions are driving the fan contacts to the energized position.

If the CO rises above \_\_\_\_ ppm, a HIGH CARBON MONOXIDE WARNING alarm event will de-energize all contacts and put the system in idle mode including the *G* fan contacts. This should command a “Push Notification” to the user and will present an on-screen alarm warning. Once CO falls below \_\_\_\_\_ ppm, the system may return to the modes required to maintain space comfort as outlined above.

Sequence of operation (5) Main control buttons set to **Fan AUTO/ON** and **System CRUISE CONTROL**

The thermostat monitors the actual temp inside the space and compares it to both the Cooling and Heating set points selected by the user. Should the actual temperature rise above the cooling set point by .5deg F, the *Y/Y2* compressor contacts, the *G* fan contacts, and the O/B reversing valve contacts will be energized allowing the system to cool. When the actual temp falls below the cooling set point by .5deg F then the *Y/Y2* and *G* contacts will be de-energized, and system will go back to idle. (Assuming humidity is in range). O/B reversing valve contacts remain energized. This small temp offset from set point prevents the system from short cycling while still maintaining close control of the desired temp. Once the contacts are de-energized a short minimum off timer begins a countdown to prevent mechanical short cycling. (90 seconds)

Additionally, if the actual temp inside the space falls below the heating set point by .5deg F, the *Y/Y2* compressor contacts, the *G* fan contacts, will be energized allowing the system to Heat. When the actual temp rises above the set point by .5deg F then both contacts will be de-energized, and system will go back to idle. (Assuming humidity is in range). This small temp offset from set point prevents the system from short cycling while still maintaining close control of the desired temp. Once the contacts are de-energized a short minimum off timer begins a countdown to prevent mechanical short cycling. (90 seconds)

If “DEHUMIDIFIER” was chosen from the installer setup menu, humidity is controlled in this mode as well. If the actual humidity rises more than 5% above the humidity set point, The *AUX1 DEHUM* contacts, and the *G* fan contacts will be energized allowing a stand-alone dehumidifier to reduce the space humidity. Once the humidity is 5% below the humidity set point, the *AUX1 DEHUM* contacts and the G fan contacts are de-energized.

 If “ALLOW DE-HUMIDIFICATION WITH ELECTRIC HEAT” was chosen from the installer setup menu, humidity is controlled in this mode as well. If the actual humidity rises more than 5% above the humidity set point, The *Y/Y2* compressor contacts, the *G* fan contacts and the *W1* electric heating contacts will be energized. This will command the system to cool while reheat is introduced by electric heat to allow the space to dehumidify while not over cooling. Temperature must not go out of range while dehumidifying. Therefore, the *W1* electric heat contacts are energized when the actual temp reaches the temp set point -.75deg F and are de-energized when the actual temp reaches the set point +.75deg F. This modulation will continue until the humidity reaches the humidity set point -5% AND the temperature is within .5 deg F of the temperature set point.

Hard parameters need to keep the system from “Running away” in the event of a mechanical failure or lack of heating capacity provided by the electric heat. When/if the actual temp reaches the set point       -1deg F, the system will de-energize the *Y/Y2* compressor contacts while maintaining the *W1* electric heat and *G* fan contacts. Once the actual temp reaches the set point temp +.5deg F then the *Y/Y2* compressor contacts can be energized again to commence the modulation.

If the temperature is within .5deg F above or below set point AND the humidity is within 5% above or below set point, the system simply cycles to “idle”. The *Y/Y2* compressor contacts, the *G* fan contacts and the *W1* electric heat contacts are all de-energized.

In all operations listed above, the *G* fan contacts will remain energized if the fan control button is in the ON position.

Carbon Dioxide and Carbon Monoxide detection are always active and operate independently/simultaneously with the above sequence.

If the CO2 rises above 600ppm the *AUX3* CO2 contacts and the *G* fan contacts are energized to allow for an outside air damper to open, introducing fresh air into the space. Once the CO2 reaches 500ppm the *AUX3* CO2 contacts and the G fan contacts are de-energized. The *G* fan contacts simply remain energized if the Fan control button is in the ON position.

If the CO rises above \_\_\_\_ ppm, a HIGH CARBON MONOXIDE WARNING alarm event will de-energize all contacts and put the system in idle mode including the *G* fan contacts. This should command a “Push Notification” to the user and will present an on-screen alarm warning. Once CO falls below \_\_\_\_\_ ppm, the system may return to the modes required to maintain space comfort as outlined above while indicating an alar event has taken place. A record of alarm events should be available in a diagnostic screen.