FläktGroup

SEMCO

# HEALTH & SAFETY MONITOR

## OWNER'S MANUAL

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# 1: PRINCIPLE OF OPERATION

## Introduction:

The Health and Safety Monitor (HSM) has been developed to control, monitor, and trend important performance parameters of the SEMCO total energy recovery wheel. This system is especially beneficial for critical applications where the concern for cross-contamination is high.

The purge monitor and seal pressure function of this technology are important for variable volume or variable pressure systems. In some cases the effectiveness of the purge section may be compromised when purge pressure is reduced as the system airflow is lowered in response to exhaust operation or space load.

The HSM also includes enthalpy based wheel control to optimize performance, frost prevention algorithms, rotation and reverse rotation sensors, and real time airflow estimates for both the supply and return air streams. All of these control features are integrated within the purge monitor function.

Integrated temperature and humidity sensors are used to calculate and provide absolute humidity content (grains) and enthalpy values. Combined with the airflows, this provides an estimate of real time energy recovery as well as cooling and heating/humidification savings. User inputted energy costs allow the HSM to accumulate energy savings over time to document the economic benefit provided by the system.

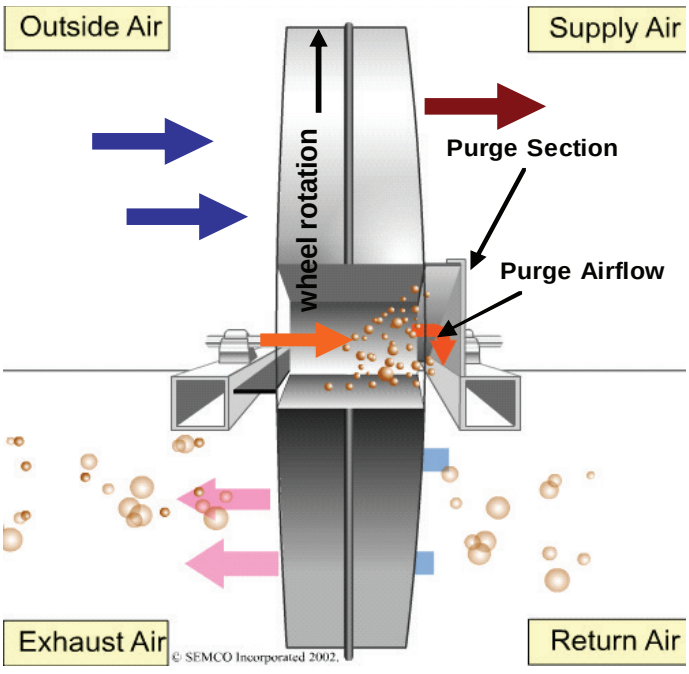
## The energy wheel "purge section" and how it works:

The purge section of an energy recovery wheel is a strategically placed sheet metal baffle, which uses the pressure differential between the outdoor and the return airstreams, to force high velocity, unconditioned, clean outdoor air through the wheel media as it rotates from the dirty exhaust air stream into the clean outdoor air stream (See **Figure 1**). Because of this, essentially all of the exhaust air contaminants that would otherwise be trapped within the volume of the wheel media are forced into the return air steam and subsequently exhausted outdoors. As a result, the air that is contained within the transfer media as it passes into the outdoor air stream is essentially uncontaminated clean air.

Provided that the system pressurization is set appropriately, the purge angle is correctly selected and that the appropriate purge pressure is maintained, any cross-contamination associated with air trapped within the media can be limited at or below .045% of the exhaust air concentration. This carry-over percentage is well below the .1% level of short circuiting frequently observed as a result of normal re-entrainment between the exhaust outlet and outdoor air intake of well designed laboratory facilities.

Without an effective purge section, the cross-contamination associated with exhaust air trapped within the recovery wheel media would typically range from about 3% to 7% although it could be even higher. For applications such as research laboratories, hospitals, smoking areas and toilet exhaust, it is easily recognized that this level of cross-contamination is unacceptable and therefore effective purge operation is essential.

**FIGURE 1.** Purge section and energy recovery wheel



## The purge monitor and seal pressure function

By measuring the pressure differential across the purge section, air volume through the recovery wheel or both, the rotational speed of the SEMCO wheel is modulated to ensure optimum purge efficiency as the airflow and thereby pressures through the system change. This is accomplished by using an integrated DDC module, high precision pressure transducers and specialized control algorithms.

In a variable volume/variable pressure installation, the purge air volume changes considerably. If not addressed, the carry-over percentage can be as high as 20% of the exhaust air volume in a typical VAV application. The HSM accommodates this variable purge air flow using a preset, fixed purge angle by addressing each pressure condition with an optimized wheel rotational speed to limit carryover of contaminants from the exhaust to the supply air stream while simultaneously maintaining a high level of sensible and total recovery.

Prior to the introduction of the HSM, the only way to accommodate a variable volume/variable pressure application incorporating an energy wheel was to select the purge angle for the minimum flow/pressure condition then accept the excessive purge volume that exists at the higher flow/pressure conditions. Research has shown that the purge excess is often as high as 250% of that actually needed at the high flow condition. Significant savings in energy, fan motor sizing (supply and exhaust) and electrical wiring result from the use of the HSM.

By monitoring the pressure driving force across the seals between the supply and return airstreams, the HSM can also alarm if a condition exists where leakage could occur from the dirty (return) to the clean (supply) airstream. Should these conditions exist, due to a loss of fan or inadvertent change in system operating conditions, an alarm is activated and the recovery wheels can either be turned off or operated at a predetermined minimum speed (user input) to protect space occupants.

## Advanced wheel control function

The HSM also allows for seamless integration of supply air temperature control to avoid over recovery and enthalpy based summer/winter change over and economizer control. Advanced frost formation control is offered as well (when needed) by calculating the exhaust air dew point temperature and modulating wheel performance to maintain the average exhaust air temperature above that condition plus the appropriate safety factor. All of these functions are accomplished while simultaneously performing the purge optimization control as described previously.

## Energy recovery performance and airflow monitoring

The temperature and relative humidity sensors are used by the DDC controller to calculate both the absolute humidity levels and enthalpy values required to indicate recovery wheel performance.

Pressure transducers measure the pressure loss across the supply air and return air side of the total energy wheel. Using SEMCO's patented AQflow technology, the pressure loss allows the airflow to be estimated and used alongside the temperature, absolute humidity and enthalpy values to calculate the recovery wheel total effectiveness in real time, as well as, verifying correct purge operation.

## Energy monitor

The measured airflow and recovery effectiveness values are combined with user inputted energy costs to allow for the accumulation of energy savings to be shown in dollars over time. In addition, values are provided to show the amount of cooling and heating/humidification energy saved over time. This feature is an important advantage, especially for buildings pursuing LEED certification which requires post commissioning and energy monitoring.

# 2: DESCRIPTION OF HSM DEVICE, PANELS AND SENSORS PROVIDED

The health and safety monitor is comprised of a NEMA1 rated control panel with all sensors provided loose for field installation. In addition to these components, a wheel motor and frequency inverter drive are provided to receive an output signal from the HSM control panel.

## Control panel

The control panel is designed to be mounted on the exterior of the air handling unit in a location of easy access. This panel has a surface mounted key pad which allows for navigating all user inputs, outputs and alarms for the HSM device (See **Figure 2**).

In addition to the key pad, the panel has a surface mounted start-stop switch which is used to energize the recovery wheels and controls. An alarm/fault light is also mounted on the surface of the main panel, which indicates the unit is in alarm.

The control panel houses the DDC controller, expander board, rotation detector board, transformers, relays, and terminal strips.

## Bypass Dampers

When bypass dampers are placed around the wheel to save fan horsepower during economizer, the HSM determines when bypass are appropriate based on enthalpy differential and wheel demand. A digital output is provided from the expander board in the secondary panel which needs to be field wired to a relay or damper actuator.

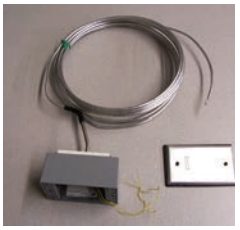

**FIGURE 2.** Main panel with BacView keypad

## Sensors provided

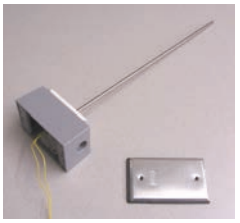
Items that are field installed are listed below:

- Three pressure transducers in addition to pressure tubing and pitot tubes. The location of the pitot tubes is critical and must be installed in accordance with SEMCO recommendations.
- One magnet and two proximity sensors per wheel to detect and report loss of rotation or reverse rotation.

- One averaging temperature sensor to be mounted in the supply air leaving airstream mounted near or at the face of the recovery wheel.



- One point temperature sensor to be mounted in the exhaust airstream. Sensor must be located as per SEMCO recommendations. Locations are covered in the startup/commissioning section of the appendix.



- Three combination temperature and relative humidity sensors to be mounted in the outdoor air, return air, and supply air streams.

- The supply air relative humidity sensor must be located as per SEMCO recommendations. Locations are covered in the startup/commissioning section of the appendix.

# 3: COMPLETING/CHECKING THE INITIAL SETUP – INPUTS REQUIRED

## 3.1: End user provided inputs

Before the HSM can operate correctly, some important end user inputs must be provided along with many more factory entered inputs that are project specific. In addition to the user defined inputs, some control questions need to be answered. This section addresses the user provided information. Note that it is likely that the information covered in this section will be inserted by SEMCO during field commissioning.

The cost inputs shown in **Figure 3** below will likely be changed over time while the supply air temperature setpoint and most other inputs will remain the same over the life of the building.

- **Supply air setpoint** – this is the temperature that is desired after the wheel during the heating season. Typically this temperature will be around 55°F to avoid over-heating the building. Some buildings can benefit from a warmer temperature on very cold days, so the HSM provides the option to have this setpoint adjusted via the keypad or building automation system.
- **Energy cost per million BTUs** – this number is typically the cost of gas corrected for boiler and system efficiency. Further adjustments are required if steam to steam humidifiers are used. A gas cost of $8.50/million BTUs is typical, and when corrected for boiler efficiency and system losses, the cost per million BTUs offset by the wheel becomes $12.00 (78% boiler efficiency, 99% system efficiency).
- **Energy cost per ton of cooling** – this number is typically the cost per KW of electricity since the chiller efficiency is often .7 kw/ton on average while the pumps, cooling tower, etc. add another .3 kw per ton of cooling provided.

**FIGURE 3:** important user provided input data

| Item | Typical Value | Key Pad Screen |
|---|---|---|
| 1 Wheel Supply Air Temp Setpoint | 55°F | Setpoints |
| 2 Energy cost per million BTUS heating | $12.00 | Setup Parameters |
| 3 Energy cost per ton of cooling | $0.10 | Setup Parameters |

**FIGURE 4.** Important user provided control logic decisions

| Item | Typical Answer | Keypad Screen |
|---|---|---|
| 1 Supply setpoint changed via BAS? | No | Setpoints |
| 2 Condensation control enabled | see next page | Setpoints - advanced settings |
| 3 Stop wheels if purge pressure alarms | see next page | Setpoints - advanced settings |
| 4 Stop wheels if seal pressure alarms | see next page | Setpoints - advanced settings |
| 5 Set wheel speed if purge pressure alarms | Yes | Setpoints - advanced settings |
| 6 Set wheel speed if seal pressure alarms | Yes | Setpoints - advanced settings |
| 7 If yes 5 or 6, heating min speed | 8 | Setpoints - advanced settings |
| 8 If yes 5 or 6, cooling min speed | 4 | Setpoints - advanced settings |

**Figure 4** lists key control logic decisions that are made in conjunction with the end user depending upon the critical needs of the installation. These decisions will not likely change over time. An explanation is provided below.

- **Supply setpoint changed via BAS** – normally this setpoint will not change and, as a result, placing it in the keypad is the right choice. However, some facilities want the ability to modify the supply air temperature limit (usually up) especially as the outdoor air drops below approximately 40°F. If this feature is desired, the building management system can change the setpoint through BAS communications or via a 0-10v signal sent to the HSM and configured to read the desired temperature input.
- **Condensation Control** – When condensation control is enabled the total energy wheel modulates to prevent the exhaust temperature from dropping below the wheel exhaust temperature setpoint. When enabled the exhaust temperature setpoint can be auto calculated based on return humidity or manually entered.
- **Stop wheels if the low purge pressure or seal pressure alarm trips** – in most cases, these alarms are best handled by sending a status alarm and resetting the recovery wheels to a reduced speed that will still provide recovery on very hot or cold days, but enhance purge efficiency (see next bullet item).

  However, for some critical applications (such as laboratories) the wheels should stop to ensure that no carry-over of contaminants is introduced to the space if the purge pressure is lost. Seal leakage in the wrong direction (i.e. carry-over) will still exist if the seal pressure is in the wrong direction even if the wheel is off, but since low seal pressure will always result in low purge pressure, monitoring low seal pressure provides important safety redundancy.

  If it is desirable to have the wheels off to minimize any carry-over risk in the event that low purge pressure or seal pressure is observed (fan failure, loaded filters, etc.) then the "run preset speed with critical alarm" software point should be set to off. This can be done at the keypad in the Advanced Settings section.
- **Set reduced wheel speed if low pressure or seal pressure alarm trips** – this option is the recommended approach for most projects that are well monitored and/or not highly critical. Turning ON the Run at Preset Speed at Critical Alarm in the Advanced Settings section and setting the high temperature preset setting to 4 rpm for the cooling season and the low temperature preset to 8 rpm in the heating season will initiate this option. An adjustable parameter (45°F) for high/low temp changeover determines whether it is cooling or heating season.

  The end user always has the option to allow the wheels to operate normally during a low purge pressure or seal pressure fault while sending a status alarm signal. This is accomplished by setting all three alarm settings (low purge pressure, low seal pressure and run preset speed with critical alarm) to OFF in the Advanced Settings window of the keypad.

## 3.2: Other field set adjustable inputs

If other field adjustable inputs are known prior to visiting the site they should be placed in the controller by the SEMCO service technician. A list of potential inputs is shown in **Figure 5**. If there are questions regarding any of these inputs, contact SEMCO. Some inputs are field adjustable (bracketed in the keypad screen) but not listed in **Figures 3-5**. These inputs should not be changed without first contacting SEMCO.

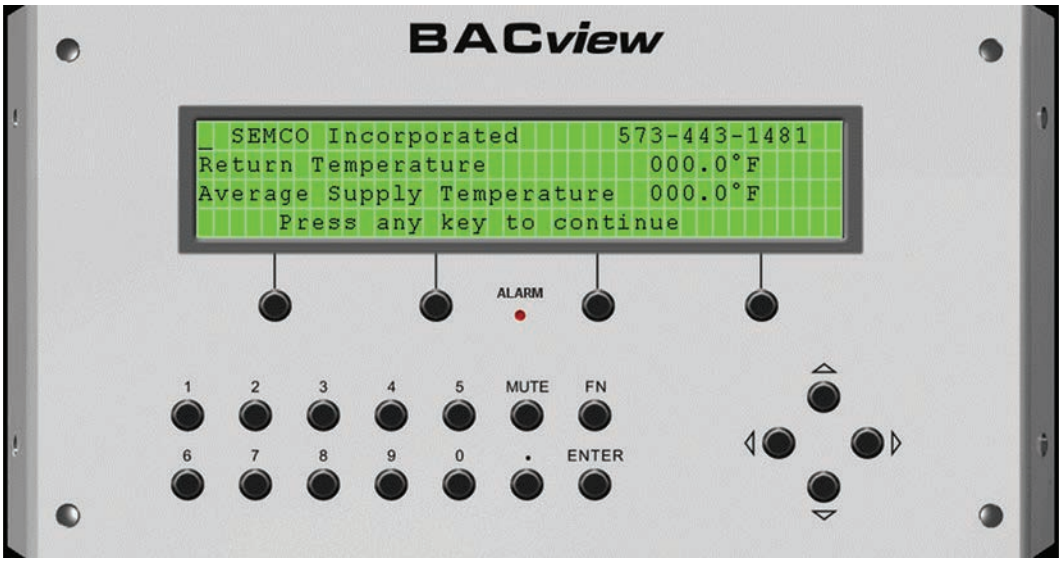
- **Purge cfm at maximum flow condition –** this value is used by the purge monitor algorithms and is provided by the program logic based on actual field data. This is provided during the commissioning process and MUST be obtained with the system operating at its maximum flow condition with all ductwork connected.
- **Clear accumulated cooling and heating values –** if accumulating energy on an annual basis is desired, for example, then after recording a given years values, this allows you to clear the data by turning the clear value to ON then OFF.
- **Beginning cooling and heating energy values –** in cases where a new software download is required, it is important to record the values shown in the program for cooling and heating energy values in case they get lost during the process. If they do, they can simply be placed as these starting values to allow the new energy numbers to be added to the beginning values so that the accumulated totals remain correct.
- **Critical alarms –** as previously mentioned, all critical alarms are best left OFF (status only) except for the low seal and low purge pressure alarms, with the wheel speed lowered in the case of critical alarm, unless the owner/operator wants the wheels to be stopped AND preheat or glycol is provided for winter season coil protection.

**FIGURE 5.** Other field set adjustable inputs

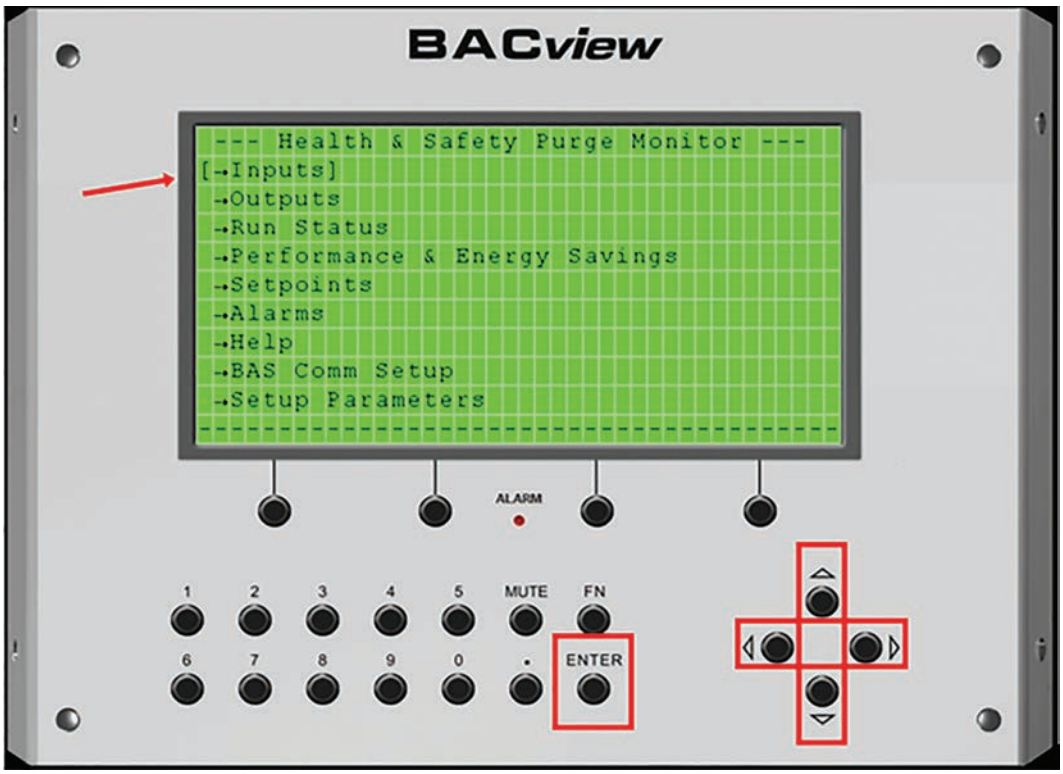
| Item | Typical Answer | Keypad Screen |
|---|---|---|
| 1 Number of wheels per HSM device | 1 to 3 | Setup Parameters |
| 2 Wheel Size | 3 to 70 | Setup Parameters |
| 3 Purge CFM at maximum flow condition | from program logic | Setup Parameters |
| 4 Clear accumulated cooling ton hours | see above | Performance and Energy Savings |
| 5 Clear accumulated heating MMBTU | see above | Performance and Energy Savings |
| 6 Beginning cooling ton hours | see above | Performance and Energy Savings |
| 7 Beginning heating MMBTU | see above | Performance and Energy Savings |
| 8 No wheel rotation alarm | Off | Critical Alarms |
| 9 Reverse wheel rotation alarm | Off | Critical Alarms |
| 10 Low purge pressure alarm | Off | Critical Alarms |
| 11 Low seal pressure alarm | Off | Critical Alarms |
| 12 All others | Do not change | Various |

# 4: INPUTTING VALUES AND NAVIGATING THE KEYPAD

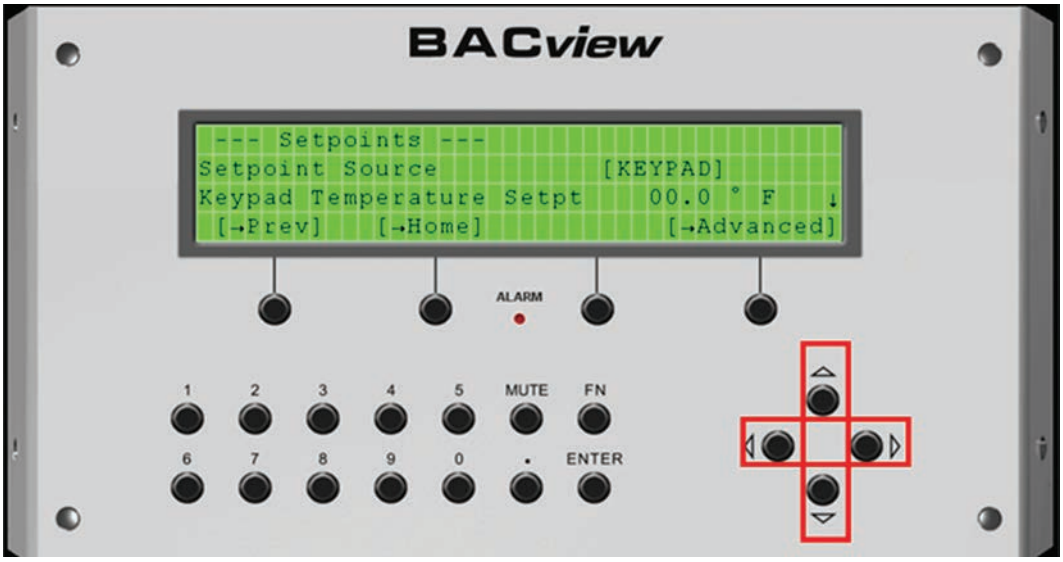
This section provides a short tutorial on how to navigate through the large BACview keypad mounted on the face of the main HSM control panel



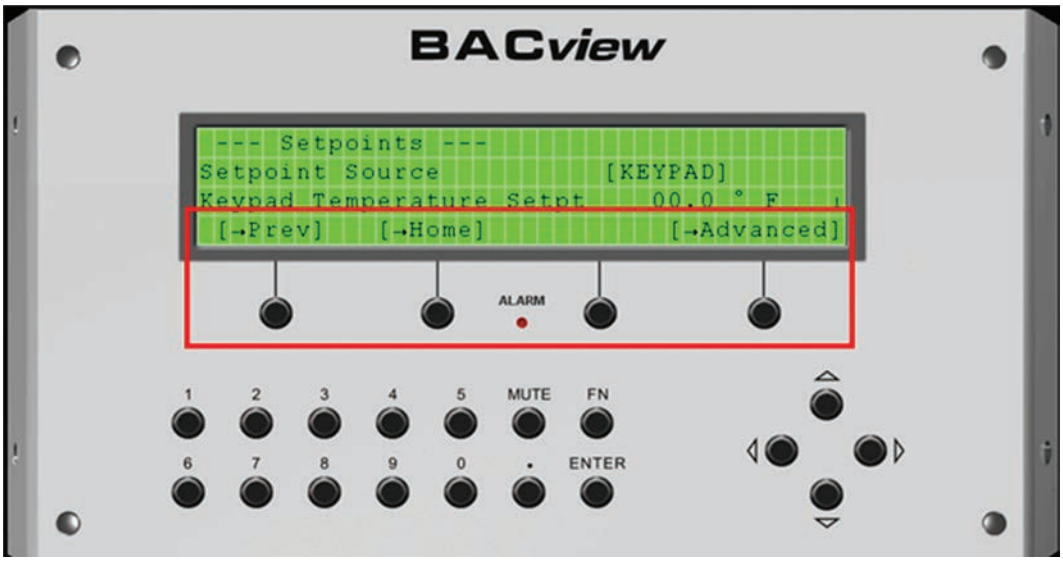

Above is the Standby Screen. As it states on the display, press any key to continue from here. Note that this screen provides the SEMCO phone number if at any time guidance is needed.




Use the up and down or left and right arrow keys to scroll through the menu options. Pressing the enter key will take you to the selected menu option which is indicated by the brackets [ ] around it. In this example, **[Inputs]** is selected.

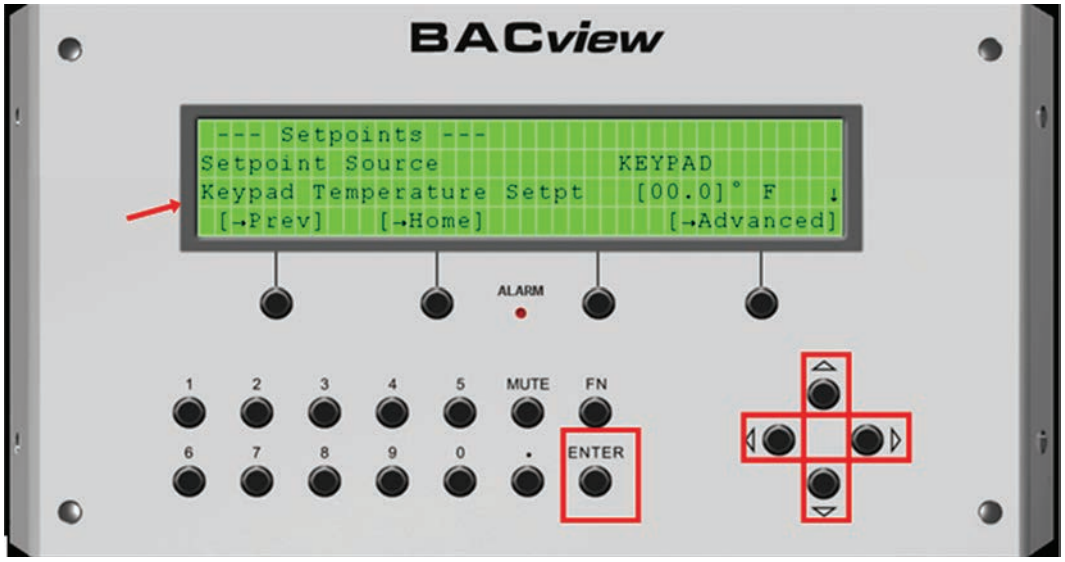



After entering a selected menu option ("**Setpoints**" in this example), use the arrow keys to scroll through the available parameters. **NOTE:** Parameters with settings that can be changed will have brackets [ ] when they are selected. This is very common for Setpoint and Setup parameters.

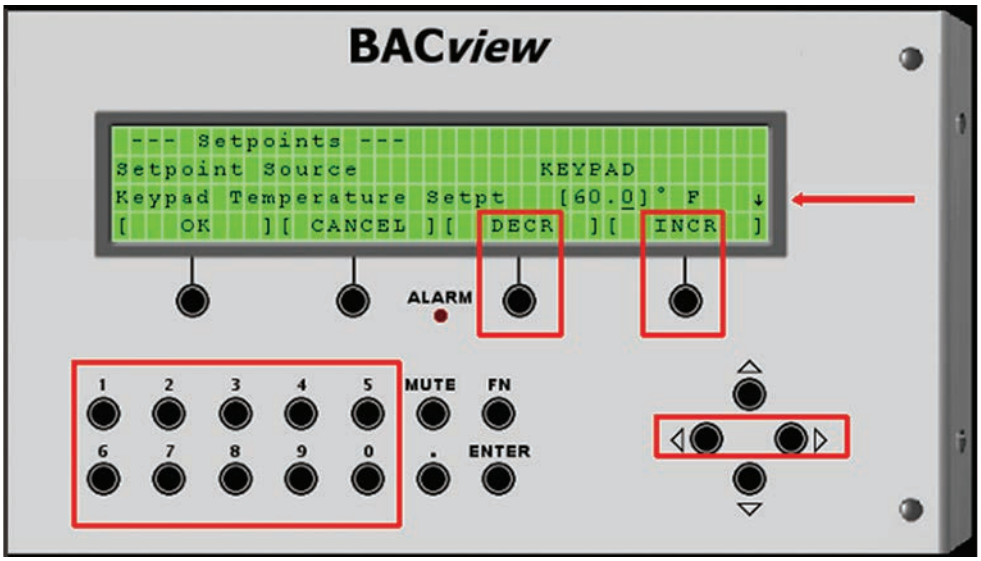



You can also jump to other menu options by pressing one of the four keys directly below the display. Each of these "soft" keys corresponds to a different menu option as shown on the bottom line of the display, directly above each soft key.

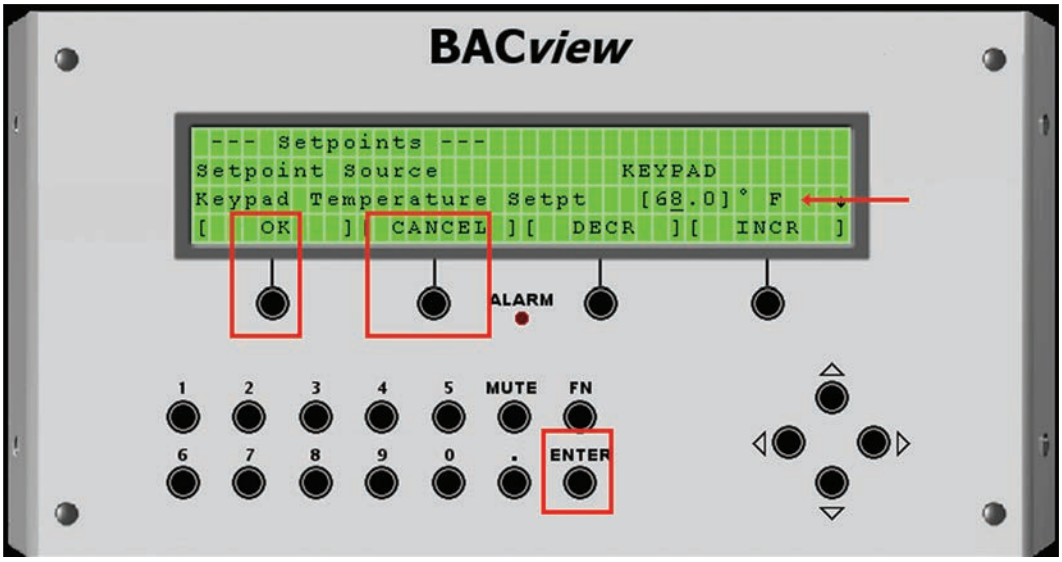
In this example there are three options available: "**Prev**" (previous screen), "**Home**" (home screen), "**Advanced**" (advanced setpoints screen).



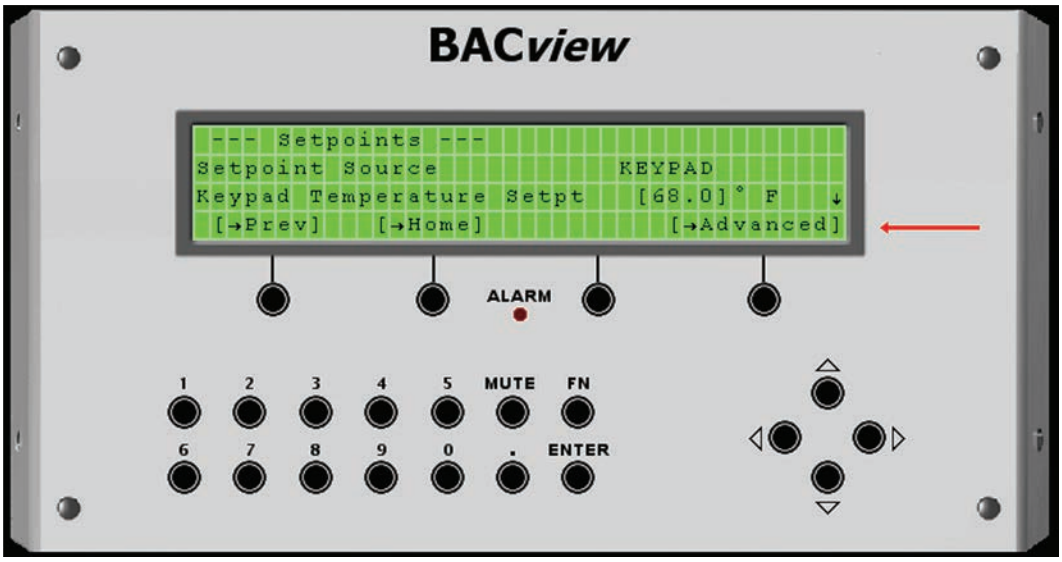

To change a parameter setting, first use the arrow buttons to scroll to the desired parameter, then press the enter key. In this example, the "**Setpoints**" menu is shown, and "**Keypad Temperature Setpoint**" is the parameter selected.



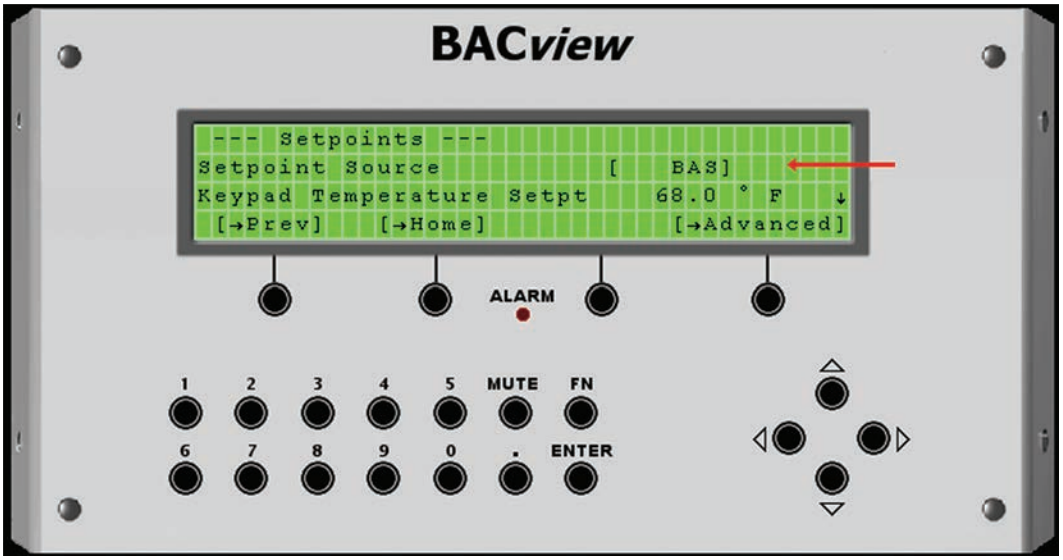

In parameter editing mode, a cursor ( _ ) is displayed below the parameter setting (for numeric settings). For numeric settings, use the left and right arrow keys to move the cursor ( _ ) to the desired digit. Then use the "**Incr**" and "**Decr**" keys to change the number to the desired value.



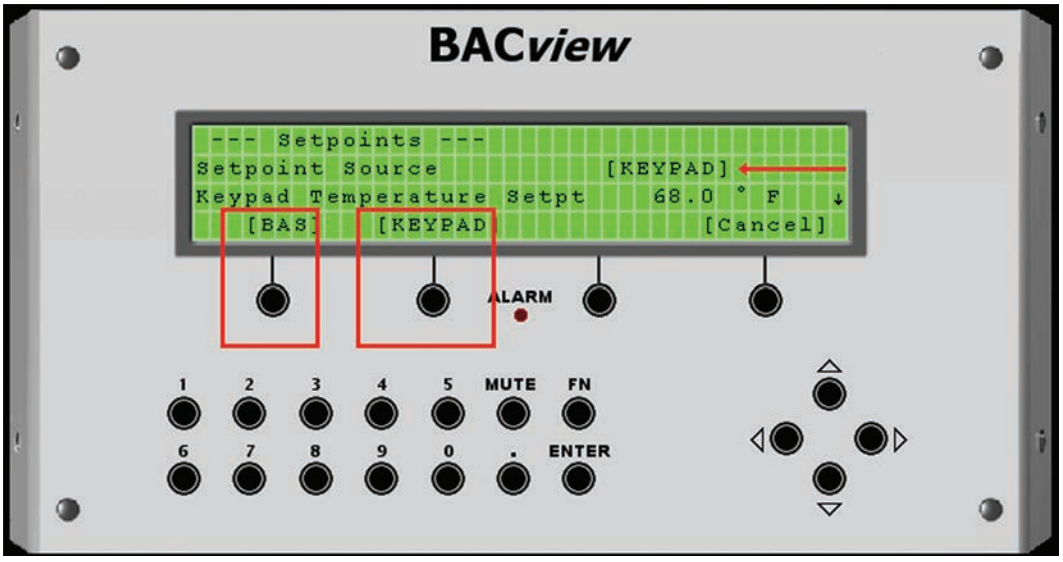

When the parameter setting has been changed to the desired value, press the "**Enter**" or "**OK**" key to apply the new setting. If you do not wish to apply the new setting, press the "**Cancel**" key and it will revert to the previous parameter setting.




After pressing the "**Enter**" or "**Cancel**" keys, parameter editing mode is exited and the cursor is no longer shown. Scroll to the next parameter desired using the up and down arrow keys, or select another menu option.




When some non-numeric setpoints are selected (Setpoint Source has been selected and the ENTER key pressed above), the parameter will flash, and the available options will appear on the bottom row of the display. These options are linked to the soft keys directly below (in this case BAS and KEYPAD). Make your parameter selection simply by pressing the soft key which corresponds to the option you want. If no changes are desired, then press the Cancel soft key.




After making a selection or pressing Cancel (in this case, the BAS option key was pressed), parameter editing mode is exited and the parameter no longer flashes. In addition, the available parameter options are no longer displayed. Scroll to the next parameter desired using the up and down arrow keys, or select another menu option.

Remember, only inputs with brackets [ ] can be changed using the keypad. All other values are either locked or outputs. Knowing how to navigate around the keypad, as shown by the tutorial, will allow all data contained within the device to be managed and viewed using only the BACview keypad.

Inputs are found within the "Alarms", "Critical Alarms", "Setup Parameters", "Setpoints" and "Advanced Settings" windows. There are a few inputs that might be changed by the end user as seen in Figure 6 through 9. Some of the inputs are configured during commissioning and should not be altered. All users should be careful to avoid accidentally changing any of these inputs since they are integral to the proper operation of the system.

## Setpoints

The setpoint and advanced settings section includes some of the parameters that can be adjusted within the HSM. They include the temperature setpoint, wheel condensation control settings, alarm triggering setpoints, and wheel speed control (See **Figures 6 and 7**).

**FIGURE 6.** Setpoints shown within the "Setpoint" section of the keypad

| Parameter | Value | Description |
|---|---|---|
| Setpoint Source | KEYPAD/BAS (KEYPAD) | Determines whether to control the supply temperature to the keypad setpoint or the BAS communication setpoint |
| Keypad Temperature Setpt | °F (55.0) | Keypad supply temperature setpoint, active when Setpoint Source = KEYPAD |
| BAS Temp Setpt Input Type | COMM/WIRED (COMM) | Determines whether the BAS setpoint is via communications or wired to IN-12 (0-10vdc = 45°F-75°F) |
| BAS Comm Temp Setpoint | °F (55.0) | BAS communication supply temperature setpoint, active when Setpoint Source = BAS and BAS Temp Setpt Input Type = COMM |
| BAS Wired Temp Setpoint | °F | BAS wired supply temperature setpoint (IN-12, 0-10vdc analog signal = 45°F-75°F), active when Setpoint Source = BAS and BAS Temp Setpt Input Type = WIRED |

**FIGURE 7.** Setpoints shown within the "Advanced Settings" section of the keypad.

Advanced Setpoints:

Note: These setpoints should only be modified by advanced users. Consult SEMCO engineering for assistance.

| Parameter | Value | Description |
|---|---|---|
| -- Condensation Control Settings -- | | |
| Cond Control Enable | ON/OFF<br>(ON) | Enable enthalpy wheel condensation control. When ON, control program monitors the exhaust temperature and will limit the wheel speed to keep the exhaust temp above the Cond Ctrl Setpt to prevent frosting and condensation on the wheel. |
| Cond Control Mode | AUTO/MANUAL<br>(AUTO) | Condensation Control Mode. When set to AUTO, the control program automatically calculates a minimum exhaust temp setpoint. When set to MANUAL, the control program uses the Manual Cond Ctrl Setpt. |
| Manual Cond Ctrl Setpt | °F<br>(15.0) | Manual condensation control setpoint |
| Auto Cond Ctrl Setpt | °F | Automatic condensation control setpoint. Setpoint is calculated based on outdoor temp & return %rh. |
| -- Alarm Settings -- | | |
| Low Purge P Alarm Setpt | "H2O<br>(1.0) | Low purge pressure alarm setpoint. When the wheel purge pressure falls below this value, the low purge pressure alarm is activated (if the alarm is not disabled). |
| Disable Low Purge P Alarm | ON/OFF<br>(OFF) | If this parameter is set to ON, the low purge pressure alarm is disabled. Under normal operation, this should be OFF. |
| Disable Low Seal P Alarm | ON/OFF<br>(OFF) | If this parameter to set to ON, the low seal pressure alarm is disabled. Under normal operation, this should be OFF. |
| Allowable Speed Mult Diff | (0.3) | If the purge cfm ratio differs from the supply side wheel pressure drop ratio by more than this amount, the Speed Mult Out of Range Alarm is activated. |
| # of Reverse Trips Allowed | (4) | A limited amount of reverse rotation trips are allowed, to prevent nuisance reverse rotation alarms. When the number of trips exceeds this amount, the reverse rotation alarm is activated. |
| Reverse Trips Reset Timer | MIN<br>(15) | Reverse trips counter is reset to zero when there are no reverse trips for this amount of time. |
| -- Critical Alarm Override Settings -- | | |
| Run Preset Spd w/ Crit Alarm | ON/OFF<br>(ON) | If this parameter is set to ON, when there is an active Critical Alarm, the wheel will continue running at a fixed preset speed (see following parameters). When set to OFF, the wheel will stop when there is an active Critical Alarm. |
| Low Temp Preset RPM | 0-20 RPM<br>(8) | Wheel preset speed setting used when the outdoor temp is at or below the High/Low Temp Changeover. |
| High Temp Preset RPM | 0-20 RPM<br>(4) | Wheel preset speed setting used when the outdoor temp is above the High/Low Temp Changeover. |
| High/Low Temp Changeover | °F<br>(45) | Preset speed high/low outdoor temp changeover setting |
| -- Wheel Control Settings -- | | |
| Wheel Speed Control Mode | AUTO/MANUAL<br>(AUTO) | If this parameter is set to AUTO, the enthalpy wheel speed is controlled automatically by the control program. If this parameter is set to MANUAL, the wheel speed is determined by the Manual Wheel RPM parameter. |
| Manual Wheel RPM | 0-20 RPM<br>(20) | Manual wheel speed command in rpm. This value is only active when the Wheel Speed Control Mode is set to MANUAL. |
| Current Wheel Speed | RPM | Current wheel speed command in rpm |
| Wheel Loop Speed | (1.0) | Wheel PID control loop speed. |

## Setup Parameters

This menu, seen in **Figure 8**, contains advanced parameters which are set during startup by a qualified technician. Please contact SEMCO engineering for assistance before modifying any settings. For reference, it is suggested that your particular settings be recorded below where indicated by *.

**FIGURE 8.** Setpoints shown within the "Setup Parameters" section of the keypad.

| Parameter | Value |
|---|---|
| ---Wheel Parameters--- | |
| Number of Wheels | * |
| Wheel Size | * |
| Purge Index Setting | * |
| Supply Area (per wheel) | |
| Return Area (per wheel) | |
| Purge Area (per wheel) | |
| ---Energy & Savings--- | |
| Cooling Cost $/Ton-Hr | * |
| Heating Cost $/MMBTU | * |
| ---Max Condition Settings--- | |
| Current Wheel Purge Pressure | |
| Current Purge CFM | |
| Purge CFM @ Max Conditions | * |
| Current Supply Side Wheel DP | |
| Supply Side Wheel DP @ Max | * |
| ---Override Purge CFM--- | |
| Use Manual Purge CFM Setpt | OFF |
| Manual Purge CFM Setpt | 1000 |
| ---BAS Setpoint Input--- | |
| BAS Temp Setpt Input Type | COMM |
| BAS Comm Temp Setpoint | |
| BAS Wired Temp Setpoint | |
| ---Reported Wheel Performance--- | |
| Max Allowable Effctvns Diff | 3.0 % |

* Indicates place to record your own setting

## Critical alarms status

If at any point in time the end user wishes to change the alarm status from critical to status mode (or visa versa), this can be done within the "Critical Alarms" window, seen in **Figure 9**. If an alarm is set to "critical status", then the wheel is either stopped (if this option is chosen during startup) or operated at a fixed reduced speed (recommended). If this alarm is not set to critical, only status, then a light will be shown on the front of the main panel.

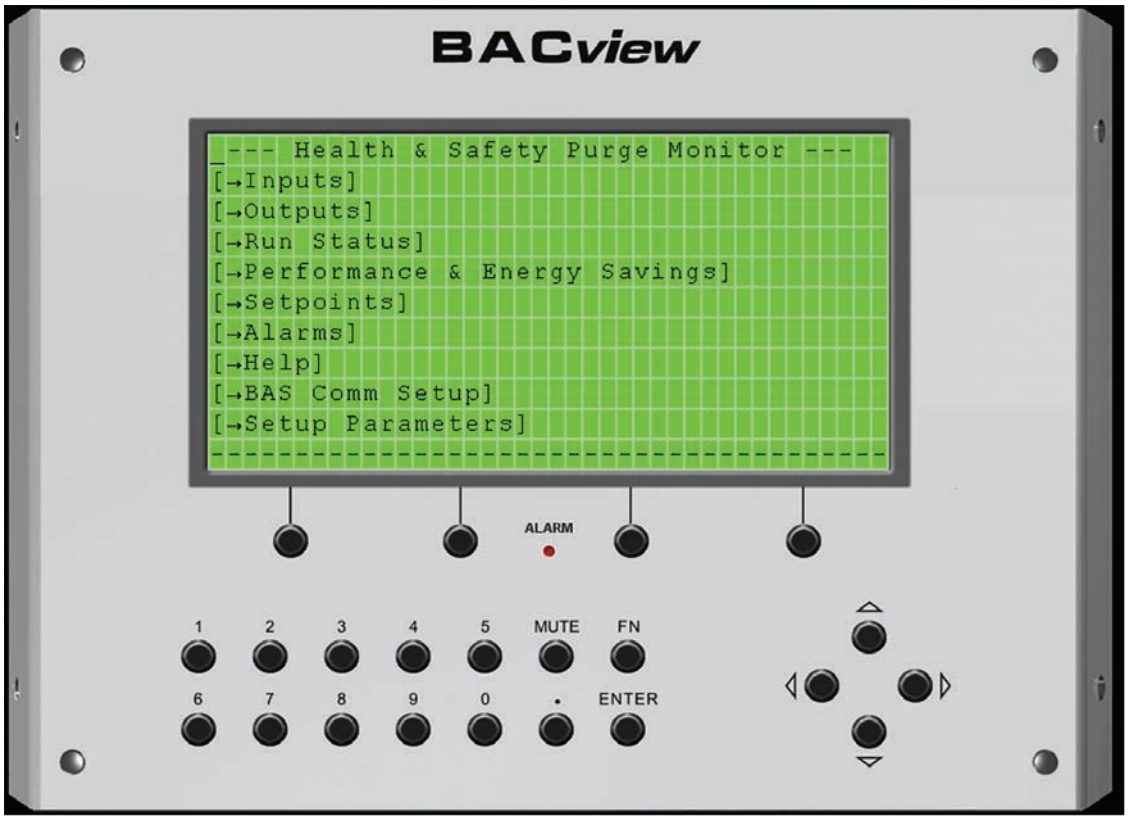
**FIGURE 9.** Setpoints shown within the "Critical Alarm" section of the keypad.

| Parameter | Value | Description |
|---|---|---|
| No wheel rotation alarm | ON/OFF (OFF) | Set this parameter to ON to configure this alarm as critical |
| Reverse wheel rotation alarm | ON/OFF (OFF) | Set this parameter to ON to configure this alarm as critical |
| Low purge pressure alarm | ON/OFF (ON) | Set this parameter to ON to configure this alarm as critical |
| Low seal pressure alarm | ON/OFF (ON) | Set this parameter to ON to configure this alarm as critical |
| Speed mult out of range alarm | ON/OFF (OFF) | Set this parameter to ON to configure this alarm as critical |
| Wheel VFD alarm | ON/OFF (OFF) | Set this parameter to ON to configure this alarm as critical |

# 5: OUTPUTS PROVIDED BY THE HSM CONTROL LOGIC

Navigating the BACview keypad in the same manner as outlined for inputs allows the user to view the many important performance points monitored by the HSM. This section discusses how and where to locate the many outputs available and, more importantly, defines those that are the most beneficial.

When navigating the home screen (which is seen after hitting any key when looking at the initial "standby" screen containing the SEMCO phone number), outputs of interest are contained within 5 of the main headings. Outputs are located within the "**Inputs**", "**Outputs**", "**Run Status**", "**Performance and Energy Savings**" and the "**Alarms**" sections.



## Inputs

The input section includes much of the data reported from sensors feeding information to the HSM. This includes status points, pressure differentials, airflows, temperature, and humidity conditions of the monitored airstreams along with the associated psychrometric conditions (calculated by the HSM control logic). **Figure 10** shows all of the data displayed in the "**Input**" section.

**FIGURE 10.** Status and performance state points shown within the "Input" section of the keypad

Inputs:

| Parameter | Value | Description |
|---|---|---|
| Off/Auto Switch Input | ON/OFF | Start switch input status |
| BAS Auto Com Start | ON/OFF | BAS start command status |
| No Wheel Rotation Detector | SAFE/TR IPPED | Rotation detector alarm status |
| Reverse Wheel Rotation Detector | SAFE/TRIPPED | Reverse rotation alarm status |
| Wheel VFD Fault | SAFE/TRIPPED | Wheel VFD fault status |
| -- Pressures -- | | |
| Supply Side Wheel DP | "H2O | Enthalpy wheel supply side wheel differential pressure |
| Supply CFM | CFM | Calculated supply cfm (based on supply side wheel dp) |
| Exhaust Side Wheel DP | "H2O | Enthalpy wheel exhaust side wheel differential pressure |
| Return CFM | CFM | Calculated return cfm (based on exhaust side wheel dp) |
| Wheel Purge Pressure DP | "H2O | Enthalpy wheel purge pressure, OAp -RAp |
| Purge CFM | CFM | Calculated purge cfm (based on purge pressure dp) |
| Effective Purge CFM | CFM | Calculated effective purge cfm ( purge cfm adjusted for wheel rpm) |
| -- Temperatures-- | | |
| Outdoor Temperature | °F | Outdoor air temperature entering wheel |
| Average Supply Temp | °F | Average supply air temperature leaving wheel |
| Point Supply Temp | °F | Point sensor supply air temperature leaving wheel |
| Return Temp | °F | Return air temperature entering wheel |
| Exhaust Temp | °F | Exhaust air temperature leaving wheel |
| -- Humidities -- | | |
| Outdoor RH | %RH | Outdoor air relative humidity entering wheel |
| Return RH | %RH | Return air relative humidity entering wheel |
| Supply RH | %RH | Supply air relative humidity leaving wheel |
| -- Dewpoint, Grains, Enthalpy -- | | |
| Outdoor Dewpoint | °F | Calculated outdoor air dewpoint entering wheel |
| Outdoor Grains | grains | Calculated outdoor air grains entering wheel |
| Outdoor Enthalpy | Btu/lb | Calculated outdoor air enthalpy entering wheel |
| Supply Dewpoint | °F | Calculated supply air dewpoint leaving wheel |
| Supply Grains | grains | Calculated supply air grains leaving wheel |
| Supply Enthalpy | Btu/lb | Calculated supply air enthalpy leaving wheel |
| Return Dewpoint | °F | Calculated return air dewpoint entering wheel |
| Return Grains | grains | Calculated return air grains entering wheel |
| Return Enthalpy | Btu/lb | Calculated return air enthalpy entering wheel |

## Outputs

The "Outputs" window includes the status of alarm relays as well as the wheel speed and frequency inverter signal. This window also includes the wheel bypass damper relay. This is only used if the project has a bypass damper installed to allow air to be diverted around the wheel during economizer operation to save fan energy. This is a standard option included in the HSM but is often not utilized. **Figure 11** shows all of the data displayed on the "**Outputs**" window.

**FIGURE 11.** Status and performance points shown within the "Outputs" section of the keypad

Outputs:

| Parameter | Value | Description |
|---|---|---|
| Alarm Relay | ON/OFF | Unit alarm |
| Enthalpy Wheel Start Relay | ON/OFF | Enthalpy wheel VFD enable |
| Rotation Detector Power | ON/OFF | Rotation detector enable |
| No Wheel Rotation Alarm Relay | ON/OFF | No wheel rotation alarm |
| Reverse Wheel Rotation Alarm Relay | ON/OFF | Reverse wheel rotation alarm |
| Wheel Bypass Damper Relay (option) | ON/OFF | Enthalpy wheel bypass damper enable |
| -- Signals -- | | |
| Enthalpy Wheel VFD % Signal | 0-100% | Enthalpy wheel VFD % output command |
| Enthalpy Wheel Speed | 0-20 RPM | Enthalpy wheel rpm command |

## Run Status

The "Run Status" window also includes the status of alarm relays as well as airflow values, purge flow estimate and airstream temperatures. **Figure 12** shows all of the data displayed on the "**Run Status**" window.

**FIGURE 12.** Status and performance points shown within the "Run Status" section of the keypad

Run Status:

| Parameter | Value | Description |
|---|---|---|
| Enthalpy Wheel Start Relay | ON/OFF | Enthalpy wheel VFD enable status |
| Alarm Relay | ON/OFF | Unit alarm status |
| Wheel Bypass Damper Relay (option) | ON/OFF | Enthalpy wheel bypass damper enable status |
| Enthalpy Wheel Speed | 0-20 RPM | Enthalpy wheel rpm command |
| Supply CFM | CFM | Calculated supply cfm (based on supply side wheel dp) |
| Return CFM | CFM | Calculated return cfm (based on exhaust side wheel dp) |
| Purge CFM | CFM | Calculated purge cfm (based on purge pressure dp) |
| Effective Purge CFM | CFM | Calculated effective purge cfm (purge cfm adjusted for wheel rpm) |
| Wheel Purge Pressure | "H2O | Enthalpy wheel purge pressure, OAp-RAp |
| Outdoor Temperature | °F | Outdoor air temperature entering wheel |
| Average Supply Temp | °F | Average supply air temperature leaving wheel |
| Point Supply Temp | °F | Point sensor supply air temperature leaving wheel |
| Return Temp | °F | Return air temperature entering wheel |
| Exhaust Temp | °F | Exhaust air temperature leaving wheel |

## Performance and Energy Savings

The "Performance and Energy Savings" window includes the total energy wheel recovery effectiveness, current cooling and heating energy savings, accumulated cooling and energy savings as well as the current cost information stored within the HSM device. **Figure 13** shows all of the data displayed on the "**Performance and Energy Savings**" window.

**FIGURE 13.** Performance and energy values shown within the "Performance & Energy Savings" section of the keypad

Performance & Energy Savings:

| Parameter | Value (default) | Description |
|---|---|---|
| -- Wheel Performance -- | | |
| Wheel Effectiveness | % | Calculated enthalpy wheel effectiveness |
| -- Energy & Savings Calculations -- | | |
| Heating MBH | MBH | Calculated enthalpy wheel heating MBH |
| Accum Heating MMBTUH | MMBTUH | Accumulated enthalpy wheel heating MMBTUH |
| Accum Heating Savings | $ | Accumulated enthalpy wheel heating savings |
| Cooling MBH | MBH | Calculated enthalpy wheel cooling MBH |
| Cooling Tons | Tons | Calculated enthalpy wheel cooling tons |
| Accum Cooling Ton-Hrs | Ton-Hrs | Accumulated enthalpy wheel cooling ton-hrs |
| Accum Cooling Savings | $ | Accumulated enthalpy wheel cooling savings |
| -- Energy & Savings Settings -- | | |
| Cooling Cost $/Ton-Hr | $ (0.10) | Cooling cost per ton-hr |
| Heating Cost $/MMBTU | $ (12.00) | Heating cost per MMBTU |
| Clear Accum Cooling Ton-Hrs | ON/OFF (OFF) | Clear accumulated cooling ton-hrs & savings values. Turn ON to clear values, then turn back OFF. |
| Clear Accum Heating MMBTU | ON/OFF (OFF) | Clear accumulated heating MMBTU & savings values. Turn ON to clear values, then turn back OFF. |
| Beginning Cooling Ton-Hrs | Ton-Hrs (0) | Offset value added into accumulated cooling ton-hrs (useful if accumulated cooling ton-hrs are cleared or lost) |
| Beginning Heating MMBTU | MMBTU (0) | Offset value added into accumulated heating MMBTU (useful if accumulated heating MMBTU are cleared or lost) |

## Alarms

The "Alarms" window includes some of the most important information provided by the HSM device (See **Figure 14**). This is where the user will find which alarm has tripped if an alarm light is lit on the face of the main panel.

Should the wheels be stopped or operating at a slower than normal speed during the cooling season, this is where to check to see if a critical alarm has been initiated and, if so, which one. Any time routine maintenance is completed, it will be common for the low pressure alarms to be tripped due to loss of system pressure. In such cases, the alarms can be cleared within this window or by simply cycling the start stop switch on the face of the main HSM panel.

**FIGURE 14.** Alarm status and reset shown within the "Alarms" section, see Section 8 for troubleshooting details

Alarms:

| Parameter | Value | Description |
|---|---|---|
| Alarm Relay | ON/OFF | Unit alarm status |
| Critical Alarm Status | ON/OFF | Critical alarm status. When a critical alarm is active, the wheel with either stop or go to a preset speed (see Run Preset Spd w/ Crit Alarm in Advanced Setpoints). |
| No Wheel Rotation Alarm | SAFE/TRIPPED | No wheel rotation alarm status. This alarm is activated when the wheel rotation detector trips due to lack of wheel rotation. |
| Reverse Wheel Rotation Alarm | SAFE/TRIPPED | Reverse wheel rotation alarm status. This alarm is activated when the reverse wheel rotation detector trips due to the wheel rotating in the wrong direction. |
| Low Purge Pressure Alarm | SAFE/TRIPPED | Low purge pressure alarm status. This alarm is activated when the purge pressure is lower than the Low Purge P Alarm Setpt for 5 continuous minutes. The alarm is not enabled until 5 minutes after wheel startup. |
| Low Seal Pressure Alarm | SAFE/TRIPPED | Low seal pressure alarm status. This alarm is activated when the purge pressure is less than the Supply Side Wheel DP + 0.5" for 5 continuous minutes. The alarm is not enabled until 5 minutes after wheel startup. |
| Speed Mult Out of Range Alarm | SAFE/TRIPPED | Speed multiplier out of range alarm status. This alarm is activated when the purge cfm ratio differs from the supply side wheel pressure drop ratio by more than the Allowable Speed Mult Diff for 5 continuous minutes. |
| Wheel VFD Alarm | SAFE/TRIPPED | Enthalpy wheel VFD alarm status. This alarm is activated when the wheel VFD fault is generated. |
| Temp Sensor Out of Range | SAFE/TRIPPED | Temperature sensor out of range alarm status. This alarm is activated when a temp sensor value falls outside the normal range for 5 continuous minutes. |
| RH Sensor Out of Range | SAFE/TRIPPED | RH sensor out of range alarm status. This alarm is activated when an RH sensor value falls outside the normal range for 5 continuous minutes. |
| Press Sensor Out of Range | SAFE/TRIPPED | Pressure sensor out of range alarm status. This alarm is activated when a pressure sensor value falls outside the normal range for 5 continuous minutes. |
| Clear Alarm | ON/OFF (OFF) | Turn clear alarm ON, and then back OFF, to clear latched alarms |

# 6: KEY FEATURES AND INFORMATION BENEFICIAL TO THE END USER

## Low Purge Pressure Alarm

One of the primary functions of the HSM is to monitor purge pressure within a variable volume (VAV) or variable pressure system to ensure effective purge. This is accomplished by slowing the wheel speed relative to a reduction in the purge pressure across the fixed purge section. During the setup process, the purge angle is set to accommodate the high flow – high pressure condition. When at low load conditions, when the purge pressure becomes inadequate to provide effective operation, the HSM will slow the wheel while optimizing recovery performance. This accomplishes purge requirements as the airflow through the recovery wheel is reduced, less wheel volume is required to achieve the desired recovery performance.

The purge monitoring function operates automatically once the HSM is setup and commissioned as outlined within the installation section contained within the appendix. The low pressure alarm provides an additional level of safety in critical applications by monitoring the purge pressure to ensure that it is at least 1 inwg, the minimum necessary for effective operation. Should the purge pressure drop below 1 inwg for more than 5 minutes, an alarm is triggered.

It is critical that if the pressure transducer is zeroed, no pressure across the transducer should exist. All fans must be off or all tubes disconnected temporarily to be sure that the zero is accurate.

## Low Seal Pressure Alarm

The low seal pressure alarm is a secondary safety to ensure proper operation of the purge and wheel system. This sensor senses the difference in pressure between the supply and return airstreams to ensure that the supply (clean airstream) is at least .5 inwg. higher in pressure than the return airstream.

If it is not, then the alarm will be energized. The causes of this fault will be the same as for the low purge pressure fault discussed in more detail above.

## Sensor Out of Range Alarm

Code within the program looks at the temperature, humidity and pressure sensors feeding the HSM and determines if the value being provided is outside of the range associated with normal operation. The primary purpose of this feature is to protect the system against a failed sensor. This alarm should always be set up as a non-critical alarm.

## No Rotation Wheel Alarm

The rotation detector senses a magnetic disc located on the rim of the energy wheel to confirm rotation. If the magnet fails to register within a predetermined period of time, lack of rotation is confirmed and a no rotation wheel fault is shown. In addition to displaying this alarm on the keypad, a light on the outside of the main panel is energized. This alarm should always be set up as a non-critical alarm.

## Reverse Rotation Wheel Alarm

The rotation detector uses two sensors to sense the magnetic disc located on the rim of the energy wheel to confirm that the wheel is rotating in the correct direction. If the magnet is not sensed in the correct sequence multiple times, reverse rotation is determined and a reverse rotation wheel fault is shown. In addition to showing this alarm on the keypad, a light on the outside of the main panel is energized.

Avoiding reverse rotation is critical since the wheel purge section is rendered ineffective if the wheel is rotating in the incorrect direction. Carry-over will be increased from below approximately .045% to as high as 5-10% of the exhaust air concentration.

This alarm should typically be set up as a non-critical alarm although in very critical applications, it may be set to critical status to ensure that the wheel is setup properly and turning in the correct direction.

## Wheel VFD Alarm

Should the wheel inverter trip, an alarm will be reported to the HSM. Inverter trips occur if the motor fails, is overloaded, if the power to the inverter is out of specifications, among other reasons. If this alarm is detected, the inverter trip must be cleared at both the inverter and within the HSM using the keypad. Cycling power to the inverter will clear most common faults (see inverter manual).

The inverter will provide information describing the cause of the trip. If repeated trips occur, there could be a problem with the motor or inverter settings. Contact SEMCO for guidance.

## Airstream Temperatures, Humidity, Pressure and Enthalpy Values

The HSM displays and records temperature, relative humidity and pressure loss data around the wheel(s). Temperature data is shown for the outdoor air, supply air, return air and exhaust air. Relative humidity, absolute humidity (shown as grains) and enthalpy values are shown for the outdoor, supply and return airstreams. Pressure loss values are shown for the supply air and return air streams.

These values are primarily used for the wheel control logic built into the HSM including enthalpy based summer winter change over, active frost prevention algorithms and a resettable supply air temperature.

At any time the user can move through the “Inputs” section of the keypad to see these conditions around the recovery wheel and ensure the wheel is functioning properly.

## Wheel Airflows

The HSM uses SEMCO’s patented AQFlow technology to convert the measured pressure loss across the supply and return air sides of the recovery wheel into an estimate of system airflow. If multiple wheels are installed in the same plenum, this will be factored into the program during startup and the flow reported will reflect the airflow volume of the total system.

This feature is used to approximate both the total recovery effectiveness as well as the energy savings over time. It is also a convenient check against any other field installed flow devices within the system to indicate airflow.

## Energy Wheel Total Recovery Effectiveness

By using the estimated system airflow along with the temperature and absolute humidity values reported for each airstream, the real time effectiveness of the system can be calculated. Within the practical limitations of field mounted sensors and the accuracy of the instrumentation, the HSM provides an indication of system performance at any moment in time. This is shown in the “Performance and Energy Savings” section of the keypad.

The effectiveness will modulate during the heating season to provide the desired supply air temperature set point and, under extreme conditions, to avoid frost formation on the wheel surface (assuming this frost prevention option is activated).

## Heating BTUs and Cooling Tons Recovered

Using the system airflow along with the temperature and absolute humidity values reported for each airstream, the real time cooling (tons) or heating/humidification (BTUs) energy is calculated and reported. These values represent the increase or decrease in total energy (enthalpy) across the supply air side of the wheel, corrected for mass flow and other appropriate constants. Since the wheel is being controlled to provide the desired set point only the energy actually recovered is reported.

Looking at these values on design (extreme) cooling or heating days provides the user with an excellent indication of how much chiller and boiler capacity is being offset by the performance of the energy recovery wheel.

## Accumulated Heating BTUs and Cooling Tons Recovered

The HSM stores the real time heating and cooling savings data and accumulates it over time to provide the ability to see how much energy has been saved by the total energy wheel. Heating savings and cooling savings are shown separately.

Accumulated energy savings are shown as Tons Hours (cooling) and Millions of BTUs (heating/humidification) as well as in dollars. User supplied energy costs (see section 3.1) are used to calculate the energy cost savings.

# 7: BASIC SEQUENCE FOR RECOVERY WHEEL SPEED CONTROL MODULATION

## Wheel speed control

The total energy wheel modulates between approximately 20 rpm and .2 rpm to maintain the desired supply temperature set point when operating in heating mode, rotating at approximately .2 RPM in economizer mode, and rotates at 20 RPM in summer cooling mode.

- **Cooling mode:** If the outdoor enthalpy level is greater than the return air enthalpy level and the outdoor air temperature is greater than 75°F, the mode is summer cooling and the wheel speed is at its maximum.
- **Heating mode:** If the outdoor enthalpy is less than the return air enthalpy, the outdoor air temperature is less than 75°F temperature set point, and the supply air leaving the wheel is below the desired temperature set point, the wheel is modulated between the minimum speed and maximum speed to maintain the supply temperature set point.
- **Economizer mode:** If the outdoor enthalpy is less than the return air enthalpy, the outdoor air temperature is less than 75°F temperature set point, and the supply air leaving the wheel is above the desired temperature set point, the heating demand is at 0 so the wheel is modulated to its minimum speed of approximately .2 RPM to minimize any energy recovery to provide the desired free cooling.
- **Purge monitor mode:** As described previously, should the purge pressure be reduced due to a change in system pressure typical in VAV systems, the maximum wheel speed may be reduced somewhat to ensure proper purge. All other aspects of the control modes mentioned above operate as described but with a somewhat lower maximum speed limit.

## Frost control mode

The HSM can also accept a frost control set point. The wheel speed will be limited to prevent the exhaust temperature from dropping below the frost control set point. The frost control set point can be dew point based, automatically (active frost prevention) calculated by the controller using the return air temperature and relative humidity in conjunction with the outdoor temperature. Alternatively the frost set point can be a manual temperature input. The entire frost control feature can be enabled or disabled, depending upon the application.

If the occupied space is humidified and the climate can experience outdoor air temperatures below 20°F, then preheat coils may be required. If preheat coils are used, the frost prevention control is not necessary. A manual frost set point may still be used as a backup to the preheat coils.

If the space is not humidified and a preheat coil is not used, then the active humidity control is likely the best option since the set point is automatically chosen for the application based on actual field conditions.

For questions regarding which method to use or set point recommendations, contact SEMCO.

# 8: TROUBLESHOOTING AND RESETTING ALARMS

**Figure 15** summarizes the various alarm points discussed previously within section 5. The user is alerted to an alarm trip by the red alarm light located on the face of the main panel.

For routine alarms like loss of rotation, low seal pressure or low purge pressure resulting from maintenance on the system simply cycle the power since the cause for this alarm is known. However, if an alarm is unexpected go to the "**Alarms**" section in the key pad to determine which alarm has tripped and then refer to **Figure 15** for guidance on how best to trouble shoot the alarm.

Section 4 of this document provides a tutorial on how to navigate around the key pad, how to find the alarms section and how best to clear the alarms. In addition, the SEMCO Total Energy recovery wheel O&M manual should be used to address wheel items including motors, belts, bearings, inverters, controls and other items not addressed in this manual. If a problem is not addressed in this manual or the Energy Recovery Wheel Owner's Manual (available online at www.semcohvac.com), feel free to contact the SEMCO field service department.

**FIGURE 15.** Potential causes for alarm signals with recommendations

| | Alarm | Possible Cause | Action |
|---|---|---|---|
| 1 | No wheel rotation | No signal to the motor<br>Broken belt<br>Loose belt<br>Bad motor<br>Bad sensor, positioning, or wiring | Check frequency out at wheel VFD<br>Replace belt<br>Tighten belt tensioner<br>Replace motor<br>Check wheel O&M for rotation detector information |
| 2 | Counter wheel rotation | Incorrect inverter setting<br>No signal to the motor<br>Broken belt<br>Bad motor<br>Bad sensor, positioning, or wiring | Check direction in inverter settings<br>Check frequency out at wheel VFD<br>Replace belt<br>Replace motor<br>Check wheel O&M for rotation detector information |
| 3 | Low purge pressure | Fans off or modulated down<br>Fan failure<br>Filter loaded<br>Bad sensor, tube, or wiring | Normal for maintenance reset alarm<br>Fix fan then reset alarm<br>Change filters<br>Check pressure sensor and connections |
| 4 | Low pressure | Fans off or modulated down<br>Fan failure<br>Filter loaded<br>Bad sensor, tube, or wiring | Normal for maintenance reset alarm<br>Fix fan then reset alarm<br>Change filters<br>Check pressure sensor and connections |
| 5 | Speed mult out of range | Fans off or modulated down<br>Fan failure<br>Filter loaded | Contact SEMCO |
| 6 | Wheel VFD trip | Motor overloaded<br>Bad power<br>Bad inverter settings | Check wheel for drag or binding, reset inverter<br>Consider signal conditioner<br>Contact SEMCO |
| 7 | Sensor out of range | Bad sensor or wiring<br>Bad expander board channel | Replace<br>Contact SEMCO |

# 9: REMOTE COMMUNICATIONS AND TRANSFERRING DATA

Communications with the SEMCO HSM can be accomplished in two ways in addition to the keypad communications previously discussed. These options include remote communications via the internet and transferring data from the HSM to the building automation system.

## Remote Communications

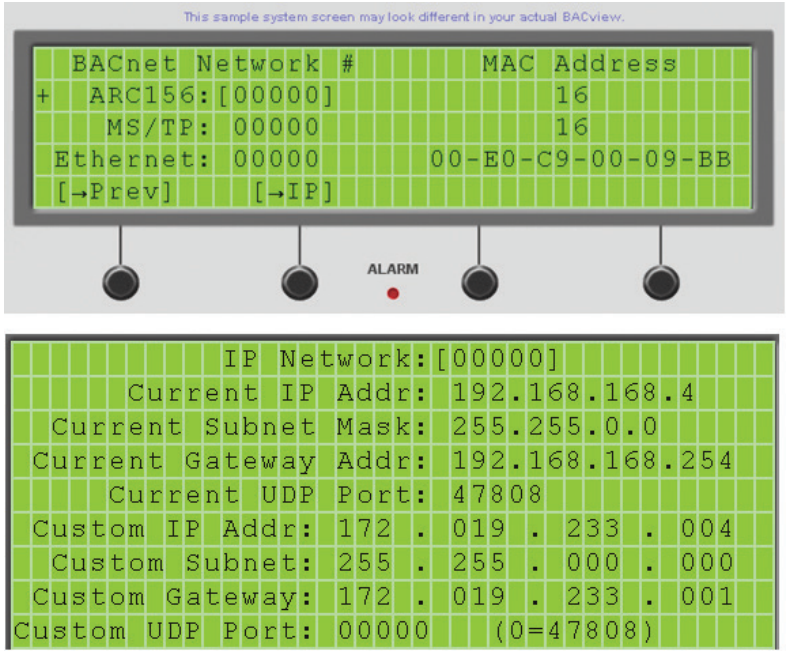
A standard feature built into the HSM is the ability to communicate over the internet through the Ethernet port provided within the HSM main panel. Provided that remote communications are provided to SEMCO (i.e. VPN access), SEMCO can provide remote assistance for any questions that may exist or troubles that may be experienced with the system. This allows data trends to be set up, enabling SEMCO to provide factory support to conditions that have been maintained or experienced within the wheel system. Trend data displaying energy savings, wheel performance, and wheel conditions may be provided.

Using this feature is highly recommended, especially for critical or high end applications since in most cases experienced assistance can be provided in a very timely fashion. The data provided is especially helpful to designers that would like to document the operation of the recovery systems and to owners interested in actual energy performance. This is especially true for LEED projects.

To enable effective remote communications several steps are required by the end user prior to commissioning

- Assign a static IP address to the controller within the HSM. This address needs to be placed within the controller along with the appropriate subnet mask and gateway address. This can be placed within the HSM using the keypad (See **Figure 16**).
- Arrange for the appropriate remote access to the device and port configurations, provided by the user's IT department. Information can be supplied to address any security concerns. It is often best to have the SEMCO controls group work directly with the user's IT department to complete this stage.
- Connect the Ethernet cable from the user's network to the HSM panel and input the necessary information into the keypad.

**FIGURE 16.** BACnet IP networking windows contained within the HSM keypad



## Integration in a Building Automation System

In addition to having access to information via the keypad, users may also see data of interest provided from the HSM to the BAS. The SEMCO HSM is built upon Automated Logic controllers which offer numerous options for connecting to BAS systems. On-board communication protocols consist of BACnet over IP, BACnet over ARCnet, BACnet MS/TP at 9600 bps or 38.4 kbps, Modbus, and Johnson N2 over EIA-232/485.

Communication with various BAS systems might require custom programming by SEMCO and should be addressed in advance of ordering the system. If this was not done, contact SEMCO to determine what is required to set up communication.

## Hardwired data

Digital outputs are connected to relays to allow for a hard connection to do the following:

- Send an alarm signal to allow the user to know that an alarm has been experienced. The specific alarm in question can be identified at the keypad
- Allow for a remote start/stop signal
- Allow for an adjustment to the wheel supply setpoint (0-10V signal)

# 10: APPENDIX

## Setup Procedure

### Contents of this Document:



# HSM STARTUP PROCEDURE PART 1: GATHERING USER PROVIDED DATA PRIOR TO THE SITE VISIT

## Gathering user provided data before commissioning

A number of important data items need to be correctly loaded into the HSM program. Some of these are obtained from the end user and should be identified and obtained prior to visiting the site. This data can be obtained from the SEMCO regional sales manager or inside sales. It is essential that this be done correctly for the system to function as desired and obtained before reaching the site to avoid delays.

This section provides guidance for identifying and inserting the known and user supplied data. Additional data will have to be obtained at the site by connecting to the HSM device or by using the keypad to gather actual operating conditions. Gathering field data for unknown inputs will be addressed in Part 2.

1) Setpoint information (see section 3.1 of this document)

   What is the winter wheel setpoint (typically 55°F) and will this set point need to be adjusted at the keypad or via the BAS?

1) User provided energy values for savings calculations and trends

   What should be used for cost of cooling($/ton) and heating/humidification($/million BTUs)?

   As discussed in section 3.1, if the user provided information is not known or if the user is unsure, use the default values for these inputs.

2) Wheel design parameters for the energy/performance calculations

   What are the design supply and return airflows? What is the wheel effectiveness shown in the SEMCO submittals?

This information is important to know prior to visiting the site and can be obtained from the project submittal or the sales department. When the system is operating as desired, you should check the flows and effectiveness numbers reported against the HSM.

**Form 1** has been prepared to help organize this information. Please use it as a guide to obtain the information needed to preset the program logic prior to commissioning.

**Form 1: Important User Provided Input Parameters**

| | Item | Suggestions |
|---|---|---|
| 1 | Determine supply air wheel winter set point | Typically 55 degf, see submittals |
| 2 | Energy cost per million BTUS heating | Ask sales or use $12 for input |
| 3 | Energy cost per Ton of cooling | Ask sales or use $.1/ton |
| 4 | Will wheel set point be reset by BAS | Check with sales and submittal |
| 5 | Design supply airflow | Check with sales and submittal |
| 6 | Design return airflow | Check with sales and submittal |
| 7 | Wheel effectiveness at design | Check with sales and submittal |

**IMPORTANT:** Print out this form and fill in the information and place these settings within the HSM program file or keypad prior to commissioning.

## Gathering known input data before commissioning

Most other inputs are found in the submittal information. Many are defaults that are used for commissioning the HSM, while some of these are modified after successful commissioning. These inputs are discussed in this section.

1) Wheel sizes (SEMCO model number) and number of wheels served by each HSM

2) Seal pressure and purge pressure alarms should checked to ensure that they are set to the correct default conditions. The purge pressure off-set should be set to a value of 1". This ensures a minimum purge pressure of 1" and will alarm if the pressure is ever below this value.

   To ensure that the seal leakage is going from the clean (supply) to the dirty (exhaust) air stream, the seal pressure differential factor should be at least +.5". This ensures proper seal pressure by confirming that the supply air pressure loss plus the seal pressure differential factor is always less than the purge pressure differential. Under these conditions, the leakage will always go in the proper direction.

3) Sensor out of range and speed multiplier out of range – The HSM has factory settings that will alarm if a sensor is bad or out of range. These factory defaults should be used but they can be altered as needed for different applications.

   The speed multiplier is a secondary check of the pressure transducers relative to the wheel speed. This should remain at the factory default.

4) Critical alarm and status alarm functions (IMPORTANT) – The alarm section allows the five alarm functions to be set at either critical or status levels. The five alarm functions include no rotation, reverse rotation, low seal pressure, low purge pressure and speed multiplier out of range.

For initial commissioning, **IT IS ACCEPTABLE** that all five alarm functions be set to OFF for status mode until commissioning is completed.

**Form 2** provides the default inputs that should be used for commissioning as discussed in this section. They are summarized in this table for simplicity. Once these inputs are in place along with the user defined inputs previously discussed, the HSM is ready for commissioning.

**Form 2: Important Program Defaults to Input Prior to Commissioning**

| | Item | Value | Parameter Location |
|---|---|---|---|
| 1 | Set BAS auto start to on | on | Consult BAS |
| 2 | Size of the wheel(s) served by the HSM | | review submittal – Setup Parameters |
| 3 | Number of wheels served by HSM | | review submittal – Setup Parameters |
| 4 | Set BAS wheel supply temp set point | 55 | Consult BAS |
| 3 | Set Keypad wheel supply temp set point | 55 | Setpoints |
| 4 | Purge pressure offset | 1" | Setpoints – Advanced Settings |
| 5 | Seal pressure differential factor | .5" | Consult Semco |
| 6 | Disable purge pressure alarm during setup | OFF | Setpoints – Advanced Settings |
| 7 | Disable seal pressure alarm during setup | OFF | Setpoints – Advanced Settings |
| 8 | Set all alarms to status for set up | OFF | Alarms – Critical Alarms |

# HSM STARTUP PROCEDURE PART 2: SITE INSPECTION PRIOR TO HSM STARTUP AND COMMISSIONING

## Site inspection prior to commissioning

Prior to the commissioning process, a number of items should be checked to ensure that the field work has been properly completed and that the system is ready for HSM setup. This portion of the setup involves questions for the controls and air balancing contractors so it is important that they are accessible prior to commissioning.

**1)** Sensor Locations -

Outdoor and return air sensors – As they are located in well mixed airstreams, they can be located in almost any convenient place within these compartments. The outdoor sensor must be located **AFTER** the outdoor fan if the fan is in the blow through configuration.

The exhaust air temperature sensor and the supply air combination temp/RH sensor – this sensor is used to report the average supply air humidity condition. It **MUST** be located approximately 1/3 **INTO** the rotation (the 1:00 position assuming an over-under arrangement with the supply air on top), as the wheel passes from the return into the supply air stream. The sensor should be placed approximately one half the distance between the shaft and the rim to ensure the best reading (See **Figure 17**).

(**NOTE:** If rotated 90 degrees, for a side by side configuration, the sensor would be located at the 4:00 position with the return on the left and the supply on the right, assuming counter-clockwise rotation. If rotation is clockwise, it would be located at the 1:00 position once again.)

Supply air averaging sensor – The averaging temperature sensor should be placed across the supply air leaving face of the energy wheel and located such that an average distribution of the airflow crosses the sensor.

The pressure transducers – They can be mounted within the AHU on the wheel cassette or on the outside of the AHU with the HSM panel, whichever is easiest. In either case, be sure to zero out the transducers **WITHOUT** any pressure across the device before commissioning or collecting data for set up.

It is **CRITICAL** that the range of the pressure transducers be set correctly. The proper range for the two pressure transducers measuring the loss across the wheels (pressure transducers 1 and 3 in **Figure 18**) should be set to a range of 2.5". The pressure transducer that measures the purge pressure between the outdoor and return airstreams (transducer 2 in **Figure 18**) should be set to 10".

The pressure range is set inside the pressure transducer housing with the cover removed. Older versions of the pressure transducer have a dip switch which should be set to the appropriate pressure range condition.

Newer pressure transducers, as seen in the following photo, have a rotary dial that needs to be rotated to the appropriate numerical setting that


Photo of pressure transducer

**FIGURE 17.** The exhaust air temperature sensor and the supply air combination temp/RH sensor location.

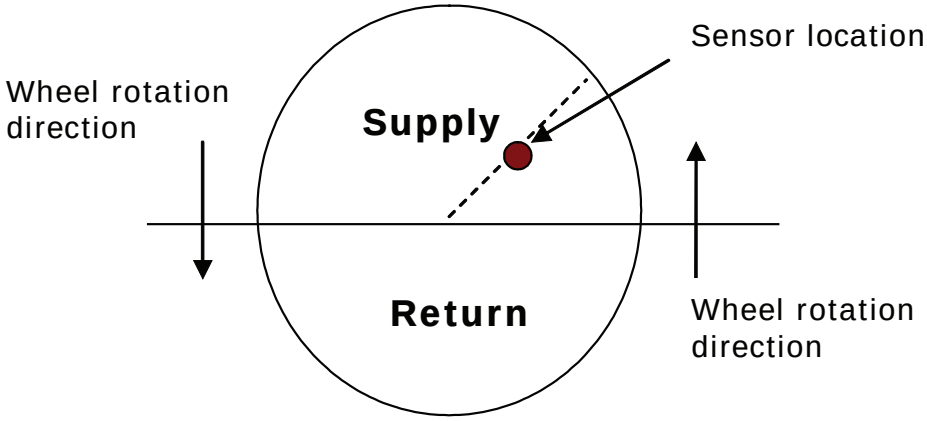
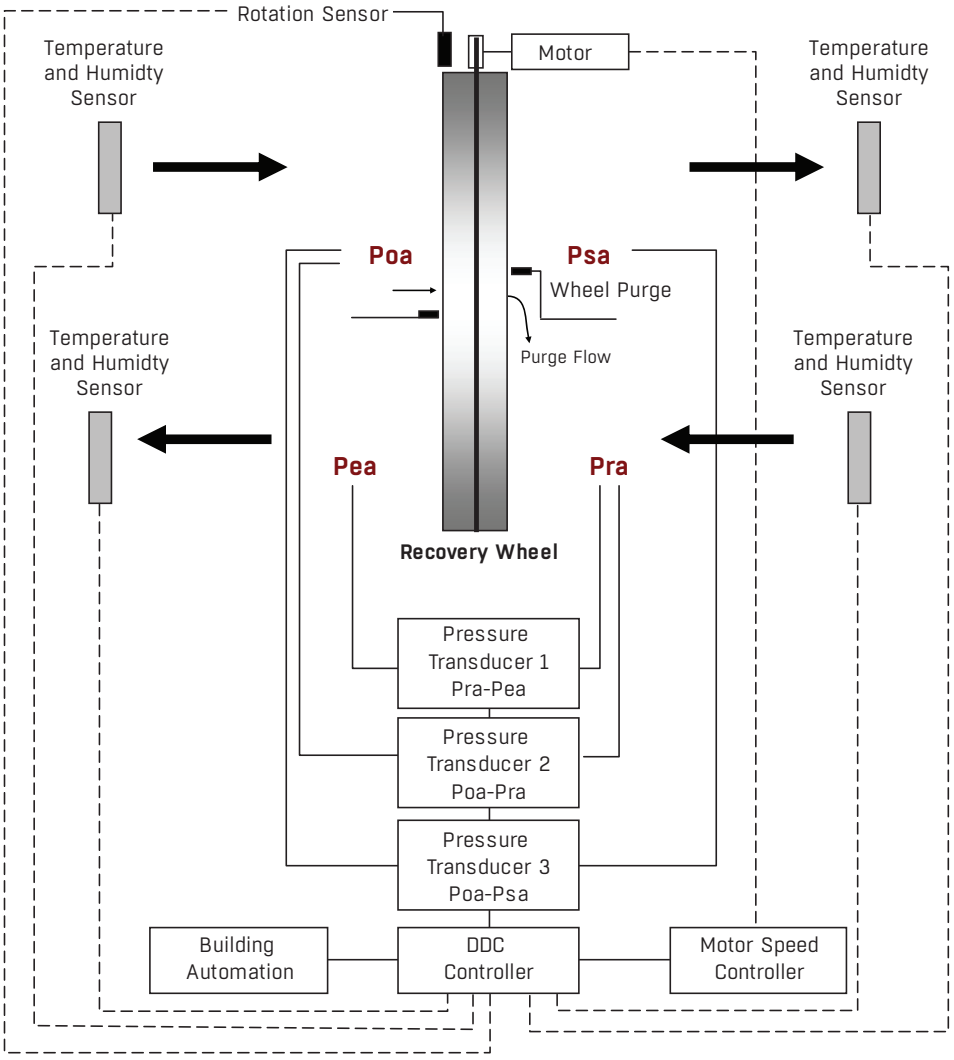



**FIGURE 18.** Simplified schematic of components and sensors included with the HSM



matches the desired pressure range. In the photo, the pen is pointing at the dial where the dial arrow is confirming a setting of 7. As shown on the chart attached to the inner surface of the transducer face panel, this setting of 7 corresponds to a pressure range of 10". Please refer to the sticker on the inner surface of the face panel to determine which number the rotating dial should be set to. The 2.5" range used for the two wheel pressure loss transducers correspond to a numerical setting of 4 while the 10" setting required by the purge pressure transducer needs to be set to 7.

2) Check the location and adjustment of the rotation detector proximity switches, if applicable. Be certain that the magnet is facing in the correct direction and that the gap between the sensor and magnet is correct (see rotation detector adjustment guide in wheel O&M).

3) Seal adjustment – it is very important to have proper seal adjustment before beginning the HSM commissioning process.

   Since the seals that divide the two airstreams (those that run along the bearing bars), the outdoor airstream and the return airstream are not impacted by wheel deflection it is suggested that the seals do not rub on the wheel.

   It is best to find and mark the "high spot" on the wheel, then slowly rotate the wheel by hand setting the seal with a slight gap at this high spot as it turns on full cycle. Rotate the wheel by hand several times to be certain that these seals are set correctly.

   The supply and exhaust air circumference seals can be impacted by the air pressure which may cause deflection at high pressure loss conditions or when very large wheels are involved. It is best that these seals be adjusted with the airflow at max, whenever possible, using the same procedure mentioned above for the outdoor and return airstreams.

4) Check wheel rotation on all wheels to be certain and verify proper direction.

5) Check all connections to the board and confirm that the sensors have been landed correctly. Use the program or keypad to determine if all sensors are reading values that make sense and that power is provided when needed. Place a hand on the sensor to be sure that it reads at the correct keypad location. With the system off, blow very gently into the pressure tubes to be sure that the correct pressure is being read.

6) Check with the controls contractor to ensure that all ductwork has been connected and that the system can be operated at actual design, full flow conditions. **This is essential for proper commissioning and obtaining the proper purge angle setting. If this cannot be done, call the factory to discuss whether or not to continue the HSM setup.**

**Form 3** has been prepared as a quick reference guide to help ensure that all steps have been taken prior to the final HSM commissioning. It is a good idea to print this form out and check off each item as they are completed.

## Form 3:

**Check list summary prior to commissioning**

- ❑ Ensure the controller has a program by checking the keypad and if possible connecting directly to the controller
- ❑ Insert the wheel model number and the number of wheels served by HSM
- ❑ Insert the keypad wheel temperature setpoint and turn the supply setpoint source to keypad
- ❑ All five alarm functions may be set to critical mode **OFF**
- ❑ Insert energy costs for heating and cooling
- ❑ Check that all sensors are in place, properly connected and functioning as desired
- ❑ Check that all seals are adjusted properly and that the wheel is rotating in the correct direction
- ❑ Check that the rotation detector sensors are installed correctly, that the magnet is facing in the right direction and that rotation is detected at the board
- ❑ Check with the controls contractor to confirm which connections are to be made between the BAS and the HSM system (i.e. remote start/stop, remote wheel temperature setpoint adjustment, alarms, communications) and that they are made correctly
- ❑ Check with the controls contractor/air balance contractor to confirm that all ductwork is connected and that the systems can be operated at the design maximum airflow conditions

# HSM STARTUP PROCEDURE PART 3: SETUP AND COMMISSIONING OF THE HSM DEVICE

Once the parameters are loaded into the program and the field inspection is completed, then the setup/commissioning of the Health and Safety Monitor can be completed.

The most important step in this process is the acquisition of the "unknown or field-obtained" data specific and unique to the project site. This must be done **carefully and correctly** to obtain the information to input these parameters into the HSM program code:

- Purge setting (angle) required for maximum system airflow (Setup Parameters – Wheel Parameters)
- Purge volume required at full wheel speed (Setup Parameters – Max Condition Settings)
- Supply side pressure loss at maximum flow (Setup Parameters – Max Condition Settings)

To obtain this information, follow these steps.

**1)** Check all pressure transducers **without airflow** – proper pressure transducer operation is critical to the operation of the HSM. The pressure across the purge section controls the purge monitor operation. The pressure loss measured across the wheel estimates system airflows. If these are not operating properly, contaminant carry-over can exist.

Before operating the fans, check to be certain that the transducers are functioning properly, that the correct airstream is being measured by the appropriate pressure transducer and that the pressure transducers are zeroed out at the no-flow condition.

A good way to check the transducers is to blow into the pressure probe to create a pressure, check to see if the display on the pressure transducer is reading a realistic value and is a positive pressure. Then, check the reading at the transducer against the number reported in the program.

If you have not already, check the range setting for the transducers to be sure they are correct. Please refer to the section discussed in Part 2 item 2 of this document if there are any questions. In some extreme cases, the purge pressure may exceed 10" and a higher setting/transducer will be required.

Check ALL sensors. If they all appear to be functioning, then move on to the next step.

**2)** Check all pressure transducers **with airflow** – with the assistance of the controls contractor (if not a SEMCO system) and operate the fans at typical system conditions.

For this phase of testing, it is best to have a digital pressure measuring device (i.e. TSI or Shortridge), to check the pressure readings coming back to the HSM under actual operating conditions.

It is likely you will need to drill access holes to measure the pressures across the four quadrants of the wheel while the system is operational. Be sure to have both a drill bit suitable for drilling a hole large enough to accommodate the pressure tubes **AND** plugs to finish off these holes when testing is completed.

With the system operational, look through the program or keypad to ensure that the pressures reported for the purge pressure and wheel pressure make sense. If there are any questions at this point, go no further and contact Semco for assistance.

**3)** Operate the system at the maximum airflow/pressure, set the purge angle and determine the purge flow at maximum flow condition for insertion into the HSM program.

To accomplish this, you will need the assistance of the local controls contractor AND all of the

**FIGURE 19.** Purge Index Settings

| Pressure Difference Range (in. w.g.) | Purge Index Setting |
|---|---|
| 0.00 - 0.99 | Consult SEMCO |
| 1.00 - 1.5 | 6 |
| 1.6 - 2.0 | 5 |
| 2.1 - 3.0 | 4 |
| 3.1 - 6.0 | 3 |
| 6.1 - 10.0 | 2 |
| > 10.0 | 1 |

ductwork needs to be completed, boxes connected, etc. Once the system is operating at the maximum flow conditions and all of the pressure transducers are functioning correctly, use the purge pressure and the chart provided to determine the correct purge setting (See **Figure 19**).

If this setting does not match that currently in place, set the purge to the required setting called for **UNLESS SF6 TESTING HAS BEEN COMPLETED ON THIS UNIT; IF SO LEAVE THE PURGE SETTING AS IT IS AND INPUT THE PURGE ANGLE USED IN THE PROGRAM IN THE SETUP PARAMETER SECTION.**

If the pressure conditions are such that the program is fluctuating between two settings, pick the larger of the two for your final position. Be certain to note what the final purge angle setting is and include it in any reports.

**IMPORTANT:** Once the purge angle setting is made, be certain that it is secure and that the purge seal is set correctly. If this comes loose, it will damage the wheel and this must not be allowed to happen. Therefore, take your time when making this purge seal modification. Please refer to the SEMCO wheel owners manual.

**4)** Input the purge volume at maximum airflow in the Setup Parameter section under max condition settings in the keypad.

Once the system is operating with the proper purge angle setting and at maximum system flow/ pressure, record the calculate purge volume which is located above the purge volume at maximum airflow parameter.

**5)** Input the supply side pressure loss at maximum flow in the setup parameter section of the keypad

Once again, with the system operating at its maximum flow, note the supply side pressure loss shown in the Setup Parameter section of the keypad, under max condition settings. This value needs to be entered into the parameter labeled “supply side delta P at maximum flow”. (Note that for convenience, the supply side delta P at maximum flow is located directly below the supply side pressure loss) Check to confirm that the correct number is reading after this input is completed.

After inputting these parameters when the system becomes stable at the maximum flow conditions, if possible trend or capture pressure and flow data at these conditions prior to moving ahead to the minimum flow conditions.

**6)** Confirm that the HSM wheel control function is operating as desired when the system is operated at reduced/minimum flow.

To do so, have the controls contractor operate the system at the minimum flow setting that it could ever operate at. This could be as low as 25-30% of the maximum flow condition for a VAV application. Note the two flow conditions by recording data at maximum and minimum flow conditions.

When the system is operating at its minimum flow condition, the HSM will calculate the settings for proper purge control. As a result, the wheel speed should be reduced over that previously observed when the flow conditions were at the maximum setting.

If this initial setup is occurring during off-peak conditions, then the actual wheel speed might be limited by the desired supply air set point and not the "purge control wheel speed limit". To confirm that the control system is working under these conditions, compare the temperature setpoint found in the Setpoint section, with the Average Supply Temp found in the Inputs section. If the setpoint matches the desired leaving conditions and it is not in summer mode the wheel speed is being limited by temperature setpoint.

**7)** Check the keypad and confirm that the keypad program is functional.

If possible, with the computer connected, check all of the items provided by the keypad to ensure that the program is correct and that the keypad is functional. This will be particularly important for projects where remote access to this panel is not provided. If all parameters reported on the keypad agree with the computer screen, then the installation and commissioning should be complete.

The keypad program has been specifically written such that the entire setup of the HSM can be accomplished through the keypad alone. Naturally, direct connection will be preferable since trending and graphics will be available.

# HSM STARTUP PROCEDURE PART 4: FINAL CHECKOUT AND TESTING OF THE HSM DEVICE

Once all inputs are completed and the system is functioning as desired, it is ready for a final system checkout. Let the system operate at the airflow called for by the system controls.

**1)** At this point, go back to the keypad and verify settings changed for the initial commissioning phase, this includes:

- If the BAS system is connected to the auto start/stop terminals of the ALC board, make sure the unit is in auto and ask the controls contractor to provide a start command. Confirm that it is functional.
- If the BAS system is controlling the supply temperature setpoint turn the "setpoint source" (Setpoint section on keypad) to **BAS** and confirm that a valid supply air setpoint is being provided. Both a software point and a hardwired 0-10VDC two wire connection (45°F to 75°F) is provided. The BAS may choose between "comm" and "wired" control. When using a keypad setpoint make sure the "setpoint source" is set to **KEYPAD**.
- Change the purge pressure and seal pressure alarm disables to **OFF** to allow these alarms to function (Advanced Setpoints – Alarm Settings).
- Turn **ON** any alarm function that is desired to be a critical alarm (Alarms – Critical Alarms). Be aware that going into "critical alarm" will stop or slow the wheel (depending upon the critical alarm speed default setting).

As discussed in section 3.1, for critical applications it is recommended that the user consider setting the low seal pressure and low purge pressure alarms to the **ON** position (critical) with the others remaining off (status). In most cases, it is also best to set the reduced wheel speeds during both heating and cooling season when a critical alarm is observed.

The winter setting is higher than the cooling setting should a critical alarm be observed on an extreme cold day, if preheat is not in place, then substantial recovery is still required. Contact SEMCO with any questions concerning the selection of these conditions if the default values do not appear to be optimum.

**2)** Observe the program/keypad to confirm the following parameters are operating as desired:

- That the reported temperature and humidity values look correct
- That the reported system airflows and wheel pressure values appear correct (compare these with the values listed within Form 1 included in this document and/or the project submittals)
- That the system seal and purge pressures look correct
- That the wheel supply air control set point is being maintained if heating
- That the wheel performance is in line with expectations? (Check the wheel at full rotational speed, check the reported performance against the project files, but in almost all cases with full wheel speed, this should be 70% or greater)
- Are energy savings being calculated and accumulated?
- Is the predicted wheel speed shown in the Output section of the keypad agreeing with the actual wheel speed observed?

If all values and alarms have been checked and appear to be operating as desired, then the device should be operating properly.

## Form 4:

**Final list for HSM checkout and confirmation of proper operation**

- ❑ Check out all pressure transducers for proper location and function before the system fans are operated. Check to be certain that the correct range setting for the transducers are being used and that the pressures are reading correctly.
- ❑ With the fans operational, check the pressure transducers against the TSI or shortridge.
- ❑ Operating the system at maximum airflow, determine the necessary purge index setting and move the wheel purge accordingly. Adjust and test the purge angle wheel seals.
- ❑ After inserting the purge index setting, note the purge airflow at maximum flow conditions. Insert this value into the "purge volume at maximum conditions". Note the supply side pressure loss at maximum system airflow. Insert this value into the "supply side delta pressure at maximum condtions"
- ❑ Reduce the system airflow significantly **or** override the purge pressure by temporarily locking it to a much lower number then observe if the wheel speed limit is functioning correctly. If it is, remember to unlock the temporary pressure setting.
- ❑ If BAS is controlling the wheel temperature setpoint, turn the "Use BAS setpoint" parameter in the keypad.
- ❑ Change the purge pressure and seal pressure switches to **OFF** to allow these alarm functions to work (Setpoints – Advanced Setpoints).
- ❑ Turn **ON** the alarms in the critical alarm section that should be set to critical (only low seal pressure and low purge pressure are recommended to be critical). Then set the winter low speed setting to 8, the cooling season low speed setting to 4 and the temperature change over to 45°F, all of which are found in the advanced setpoint section.
- ❑ Allow the system to function normally and watch for any alarms. If so troubleshoot. If not, check the rest of the system functions.
- ❑ Observe all reported temperature and humidity readings, and determine if they look correct. When in doubt, check against a digital measuring device.
- ❑ Check the reported system airflows and pressure losses. Compare them with the values shown for the original design parameters included in Form 1 in section 1.
- ❑ Check to be sure that the system seal and purge pressures look correct.
- ❑ Check the reported wheel effectiveness. Does it look correct? An adequate driving force is required for this assessment.
- ❑ Are the energy savings being accumulated and do they look correct? If possible set up a trend for savings to act as a backup if the accumulated value gets cleared.
- ❑ Is the predicted wheel speed shown in the keypad correct when compared to actual wheel speed?
- ❑ Is all data required by the BAS system, the remote start – stop, the remote temperature setpoint, the alarm signal, and communications working correctly if required?
- ❑ Check all readings through the keypad to ensure that the keypad program is functioning correctly.
- ❑ Explain the basics to the local maintenance staff, show them how to use the keypad and to reset any alarms. Let them know that each time the unit is shut down, the alarms will have to be cleared.
- ❑ Take note of the final program settings, especially the setup parameter section.
- ❑ Determine if there is going to be an Ethernet connection to the unit to be observed by SEMCO. If so, ensure that this static IP address is in place PRIOR TO the visit for commissioning the HSM device and be prepared to check this connection with SEMCO before leaving the site.

# HSM STARTUP PROCEDURE PART 5: ROTATION DETECTOR

## Reverse Rotation Detector with Health & Safety Monitor

- Sensors should be spaced about 1.5" center to center.
- Sensors must be wired so that the magnet on a properly rotating wheel passes by sensor 2 first, immediately followed (1.5" later) by sensor 1.
- The air gap between the sensor faces and the magnet should be about 0.6".
- The south pole of the magnet, which is usually marked with a red dot, must face outward (towards sensor).
- Set Jumper 1 to 15 minutes.
- Check that Jumper 2 is set to 2 sensors.
- Verify that both sensors are able to detect the magnet by watching the sensor motion LEDs.
- Verify that the Reverse alarm works by rotating the wheel backwards and watching the Reverse alarm LED.
- Verify that the Motion alarm works by stopping the wheel and waiting for the appropriate amount of time and watching the motion alarm LED.
- After starting the wheel, verify that the wheel is turning in the correct direction and that the Reverse Rotation Detector does not go into alarm after the first few rotations.

**Troubleshooting:**

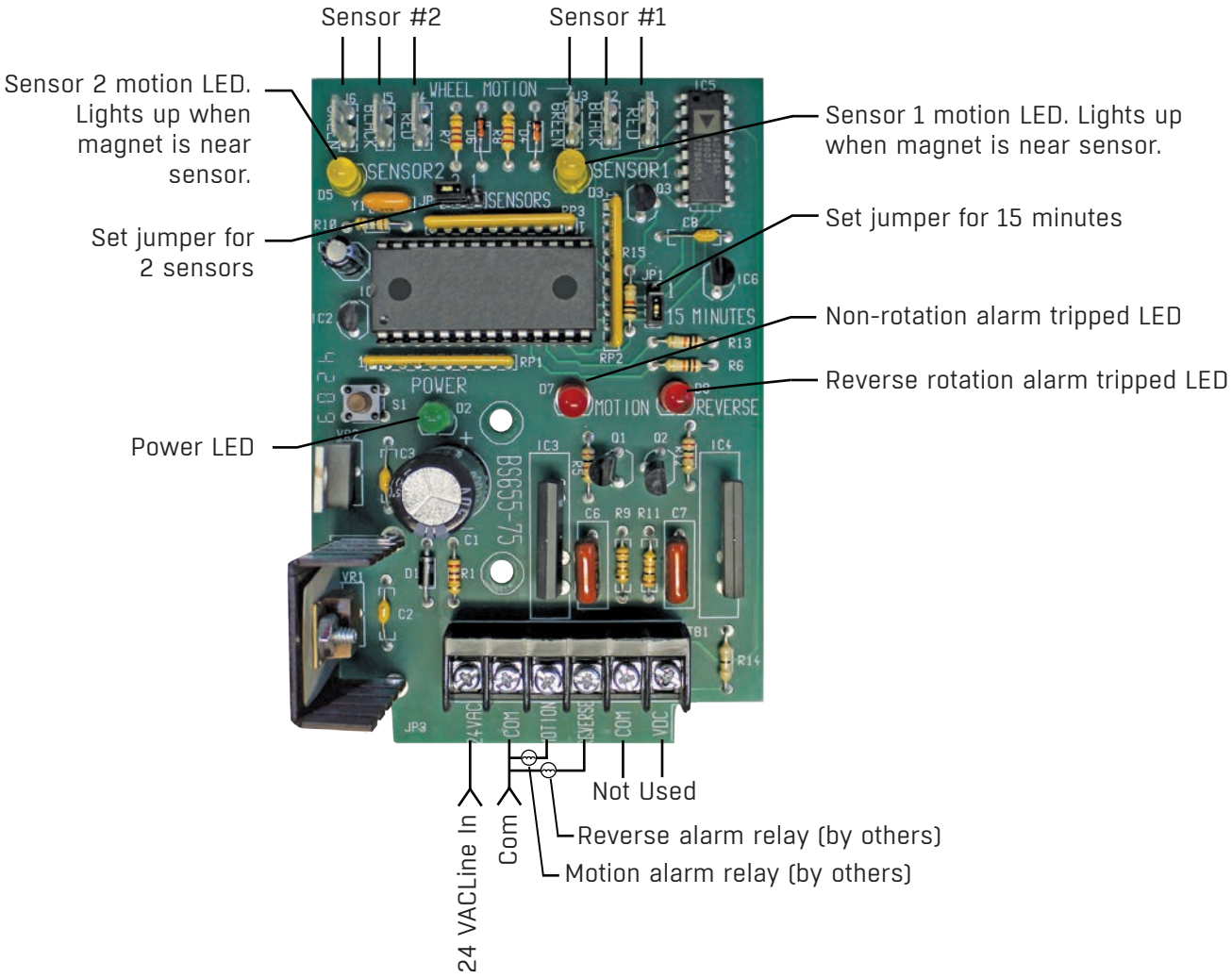
| Symptom | Possible Cause | Proposed Action |
|---|---|---|
| Sensor LED's do not light up when the magnet passes. | Magnet orientation is incorrect. | Flip magnet over so that south pole is facing outward. |
| | Air gap between sensors and magnet is too great. | Adjust air gap to 0.6" |
| Sensor LED stays on even when magnet is not present. | Sensor wired incorrectly. | Wire sensor according to labels on the board. |
| | Bad sensor or bad circuit board. | Disconnect sensor from board and reconnect. If the Sensor LED stays on when the sensor is disconnected then replace the circuit board. If the Sensor LED only stays on when the sensor is connected then replace the sensor. |
| Motion alarm trips even though wheel is turning. | Sensor 1 is not detecting the magnet. | Adjust air gap between Sensor 1 and magnet to 0.6". |
| Reverse alarm trips even though the direction of rotation is correct. | Sensors are mounted too close together. | Adjust center to center distance of sensors to about 1.5". |
| | Air gap between sensors and magnet is too small. | Adjust air gaps to 0.6". |
| | Sensor 2 is not detecting the magnet before sensor 1. | Swap sensor wiring on board. |
| Reverse alarm does not trip even when wheel is rotating backward. | Power to the board was turned on while magnet was between sensors. | Cycle power to the board and try again. If the wheel tends to come to rest with the magnet near the sensors, consider moving the magnet to another quadrant. |
| | Sensors installed/wired backwards | Swap sensor wiring on board. |
| Voltmeter doesn't indicate alarm at motion or reverse terminals. | Semi-conductor output requires a load such as a relay coil to trigger. | Add load to circuit. If no result, replace board. |

**If there are any questions regarding these instructions, please call SEMCO Engineering at 573-443-1481.**

**PROXIMITY SENSORS**

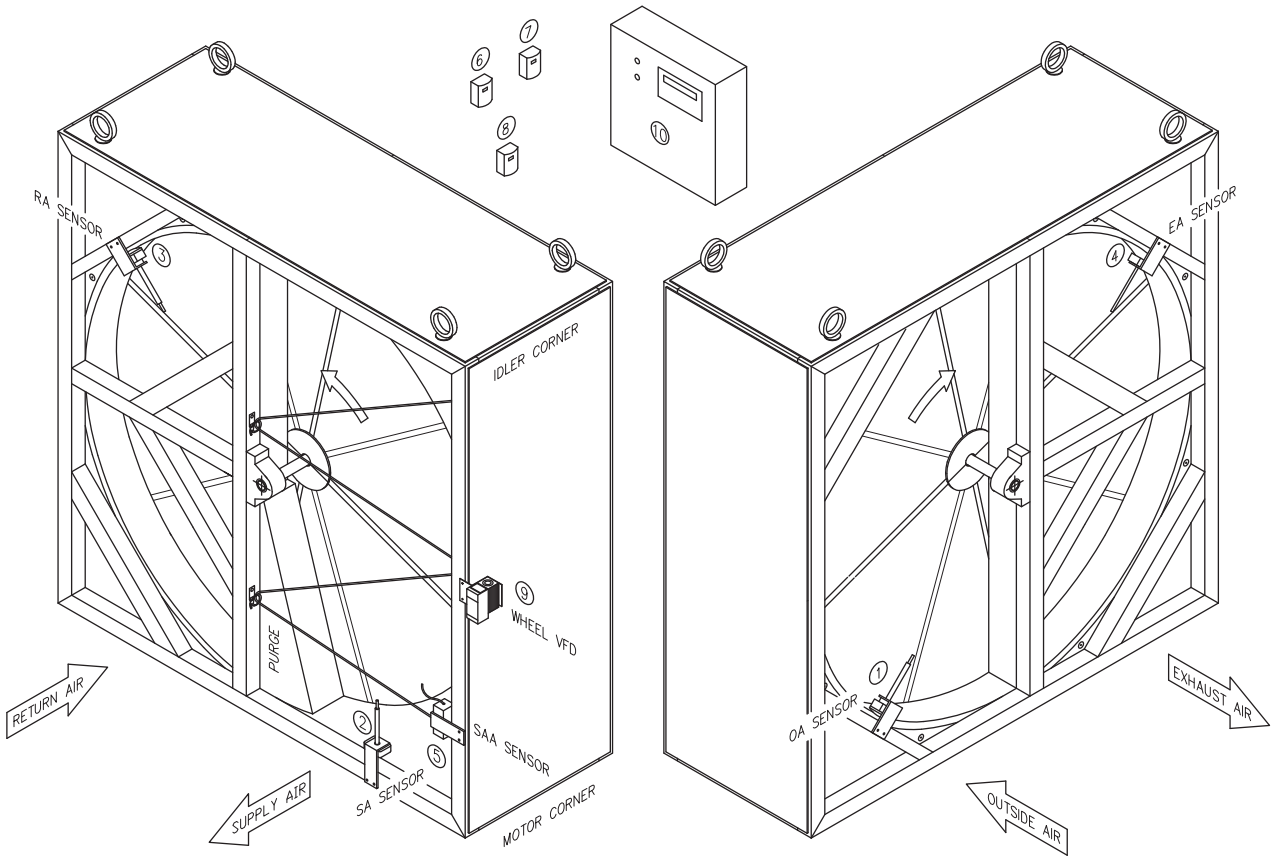
**TARGET MAGNET**


**ROTATION DETECTOR WITH REVERSE ROTATION DETECTION**



# HSM STARTUP PROCEDURE PART 6: INSTALLATION SUMMARY AND WIRING SCHEMATICS

## Health and Safety Monitor (HSM) installation in arr. “A” energy recovery wheel (typ. sizes 24-46)




THE FOLLOWING HEALTH & SAFETY MONITOR COMPONENTS ARE ALL TYPICALLY SHIPPED LOOSE FOR FIELD INSTALLATION AND WIRING BY OTHERS:

① COMBINATION TEMPERATURE / RH SENSOR FOR OUTDOOR AIR ENTERING WHEEL
② COMBINATION TEMPERATURE / RH SENSOR FOR SUPPLY AIR LEAVING WHEEL
③ COMBINATION TEMPERATURE / RH SENSOR FOR RETURN AIR ENTERING WHEEL
④ POINT TEMPERATURE SENSOR FOR EXHAUST AIR LEAVING WHEEL
⑤ AVERAGING TEMPERATURE SENSOR FOR SUPPLY AIR LEAVING WHEEL
⑥ PRESSURE TRANSDUCER TO MEASURE THE OUTDOOR / SUPPLY SIDE WHEEL PRESSURE DROP
⑦ PRESSURE TRANSDUCER TO MEASURE THE RETURN / EXHAUST SIDE WHEEL PRESSURE DROP
⑧ PRESSURE TRANSDUCER TO MEASURE THE WHEEL PURGE PRESSURE
⑨ VARIABLE FREQUENCY DRIVE (VFD) FOR WHEEL DRIVE MOTOR
⑩ HEALTH & SAFETY MONITOR (HSM) CONTROL PANEL ASSEMBLY, 36” X 24” X 8”
⑪ WHEEL ROTATION DETECTOR TARGET MAGNET (NOT SHOWN)
⑫ WHEEL ROTATION DETECTOR SENSORS (QTY 2, NOT SHOWN)
⑬ OTHER INSTALLATION MATERIALS INCLUDING SENSOR MOUNTING BRACKETS, STATIC TIPS, STATIC TUBING, AND PLENUM CABLE (NOT SHOWN)

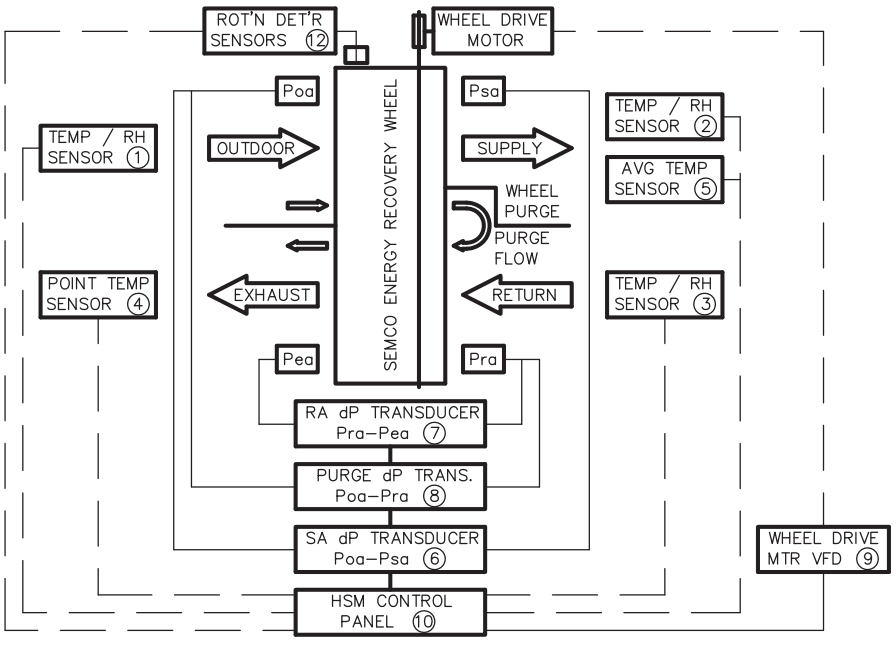
## General Summary of Field Installation Required

(refer to previous page for wheel illustration with item numbers referenced below)

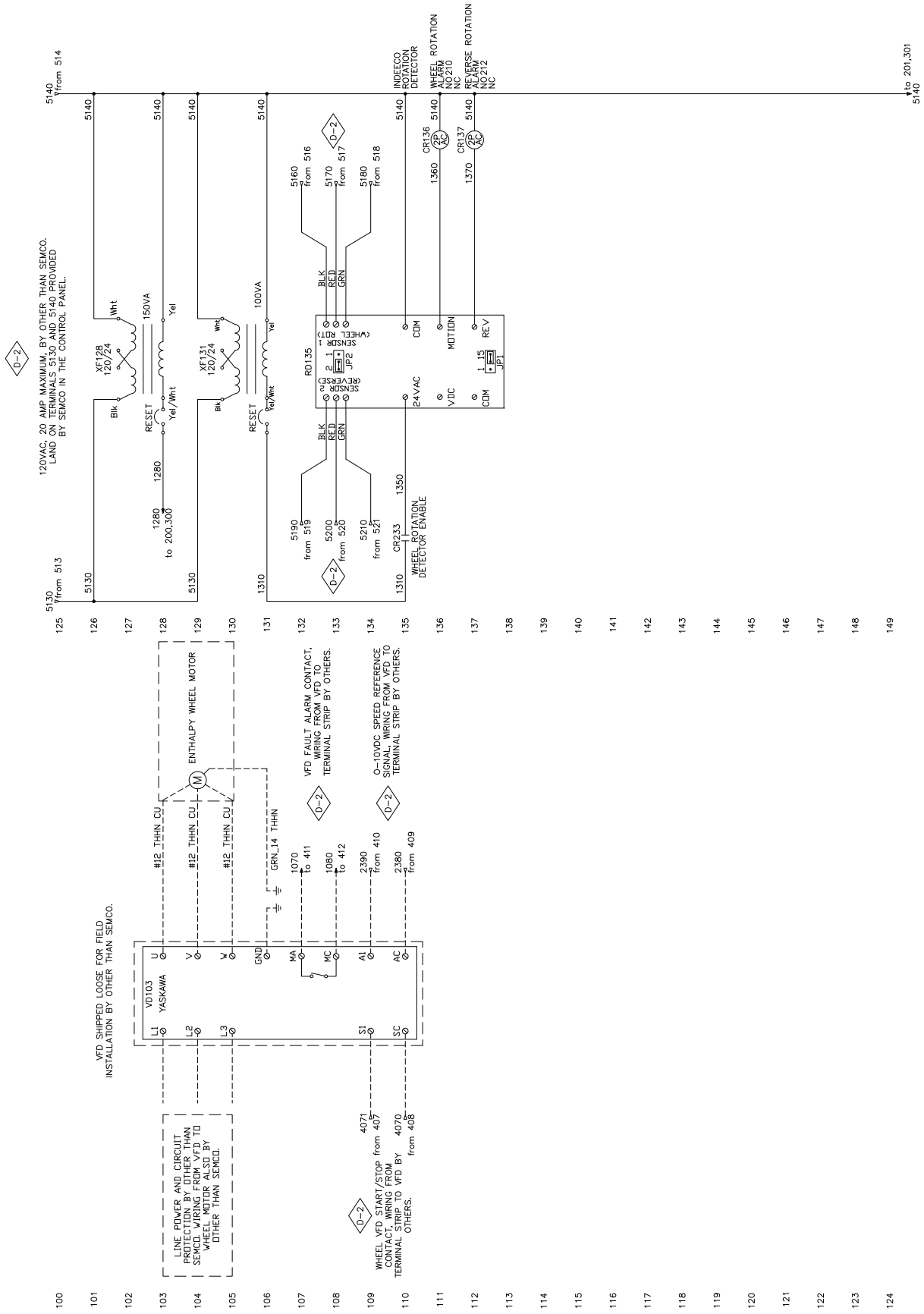
### GENERAL SUMMARY OF FIELD INSTALLATION REQUIRED

**(REFER TO SHEET 1 OF 2 FOR WHEEL ILLUSTRATION WITH ITEM NUMBERS REFERENCED BELOW)**

* IMPORTANT: WHEEL FRAME, ROTOR, AND MEDIA INSTALLATION INTO AIR HANDLER MUST BE FULLY COMPLETE PRIOR TO INSTALLATION OF THE HEALTH & SAFETY MONITOR CONTROL PACKAGE.
* INSTALL CONTROL PANEL ASSEMBLY ⑩ AS CONVENIENT, TYPICALLY ON OUTSIDE OF AIR HANDLER NEAR WHEEL.
* INSTALL VFD ⑨ FOR WHEEL DRIVE MOTOR AS CONVENIENT, TYPICALLY INSIDE AIR HANDLER NEAR WHEEL DRIVE MOTOR ON SUPPLY AIR SIDE OF WHEEL. RUN POWER WIRING TO LINE SIDE OF VFD, AND RUN WIRING FROM LOAD SIDE OF VFD TO WHEEL DRIVE MOTOR. WIRE WHEEL VFD START / STOP, SPEED REFERENCE SIGNAL, AND FAULT ALARM CONTACTS FROM WHEEL VFD TO CONTROL PANEL.
* INSTALL ROTATION DETECTOR TARGET MAGNET ⑪ ONTO WHEEL RIM.
* INSTALL ROTATION DETECTOR SENSORS ⑫ AND WIRE TO CONTROL PANEL.
* INSTALL COMBINATION TEMP / RH SENSOR ① ON THE OUTDOOR AIR SIDE OF WHEEL AND WIRE TO CONTROL PANEL.
* INSTALL COMBINATION TEMP / RH SENSOR ③ ON THE RETURN AIR SIDE OF WHEEL AND WIRE TO CONTROL PANEL.
* INSTALL TEMPERATURE AVERAGING SENSOR ⑤ ON THE SUPPLY AIR SIDE OF WHEEL AND WIRE TO CONTROL PANEL.
* INSTALL COMBINATION TEMP / RH SENSOR ② ON THE SUPPLY AIR SIDE OF WHEEL APPROX. 60 DEGREES INTO WHEEL ROTATION AND WIRE TO CONTROL PANEL.
* INSTALL POINT TEMP SENSOR ④ ON THE EXHAUST AIR SIDE OF WHEEL APPROX. 60 DEGREES INTO WHEEL ROTATION AND WIRE TO CONTROL PANEL.
* INSTALL PRESSURE TRANSDUCER ⑥ WHERE CONVENIENT TO MEASURE THE OUTDOOR / SUPPLY SIDE WHEEL PRESSURE DROP. MOUNT STATIC TIPS IN THE AIR HANDLER ON THE OUTDOOR AIR AND SUPPLY AIR SIDES OF THE WHEEL, AND RUN TUBING FROM EACH STATIC TIP BACK TO THE TRANSDUCER. CONNECT THE OUTDOOR AIR STATIC TUBE TO THE HIGH CONNECTION ON THE TRANSDUCER, AND THE SUPPLY AIR STATIC TUBE TO LOW. WIRE TRANSDUCER TO CONTROL PANEL.
* INSTALL PRESSURE TRANSDUCER ⑦ WHERE CONVENIENT TO MEASURE THE RETURN / EXHAUST SIDE WHEEL PRESSURE DROP. MOUNT STATIC TIPS IN THE AIR HANDLER ON THE RETURN AIR AND EXHAUST AIR SIDES OF THE WHEEL, AND RUN TUBING FROM EACH STATIC TIP BACK TO THE TRANSDUCER. CONNECT THE RETURN AIR STATIC TUBE TO THE HIGH CONNECTION ON TRANSDUCER, AND THE EXHAUST AIR STATIC TUBE TO LOW. WIRE TRANSDUCER TO CONTROL PANEL.
* INSTALL PRESSURE TRANSDUCER ⑧ WHERE CONVENIENT TO MEASURE THE WHEEL PURGE PRESSURE. MOUNT STATIC TIPS IN THE AIR HANDLER ON THE OUTDOOR AIR AND RETURN AIR SIDES OF THE WHEEL, AND RUN TUBING FROM EACH STATIC TIP BACK TO THE TRANSDUCER. CONNECT THE OUTDOOR AIR STATIC TUBE TO THE HIGH CONNECTION ON TRANSDUCER, AND THE RETURN AIR STATIC TUBE TO LOW. WIRE TRANSDUCER TO CONTROL PANEL.
* RUN POWER WIRING TO CONTROL PANEL ⑩ .



# Wiring Schematic, 1 of 5



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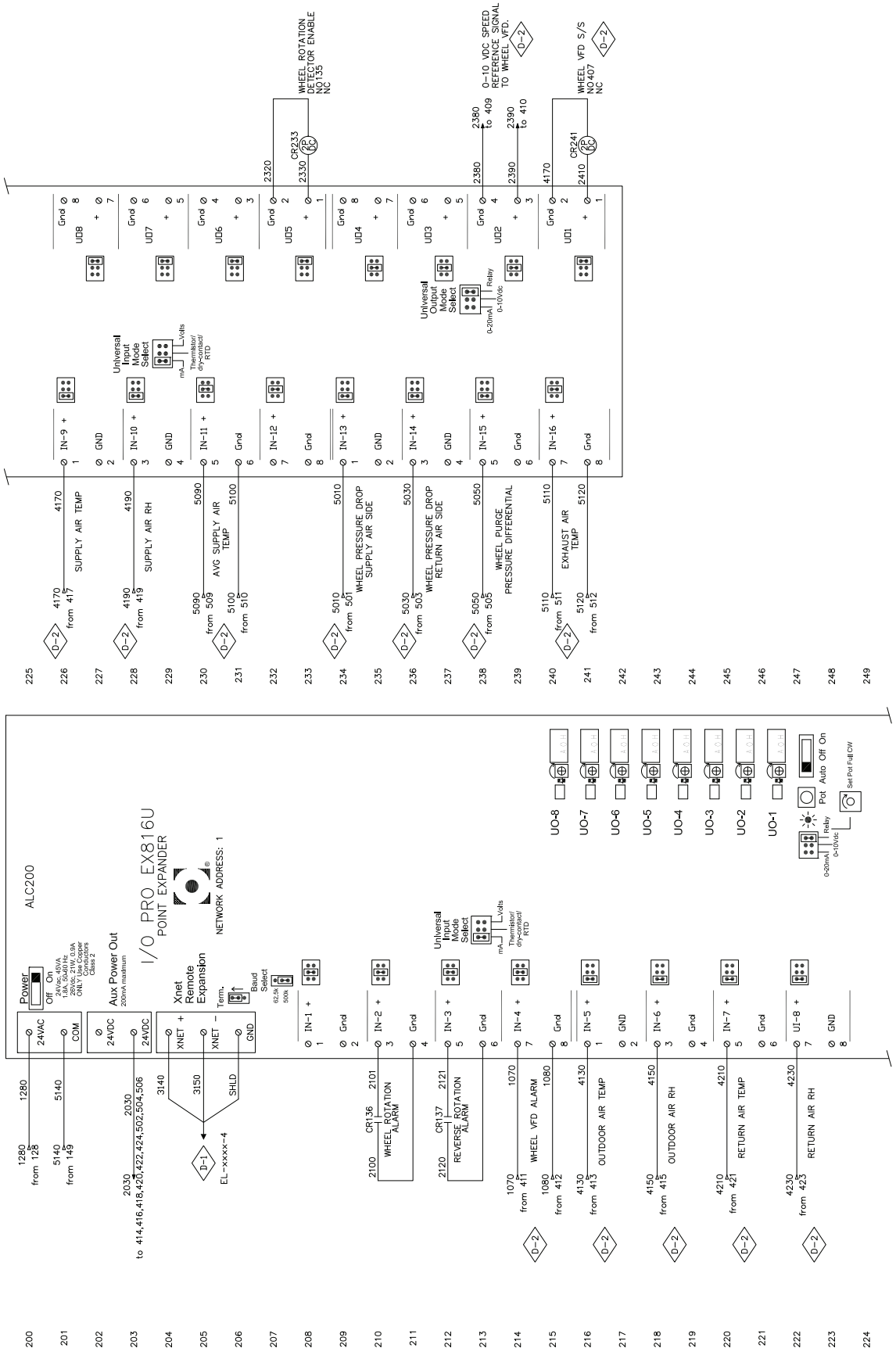
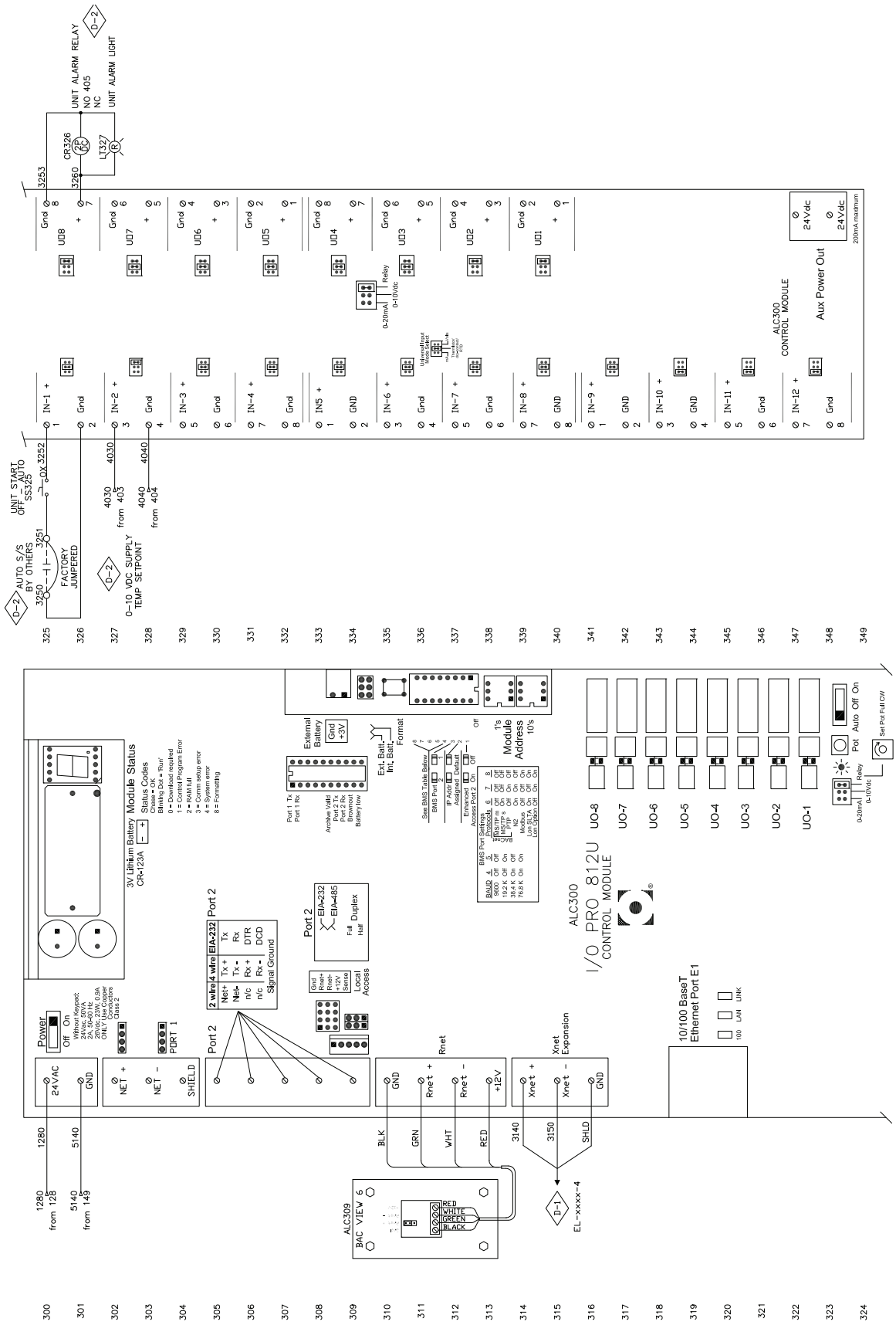
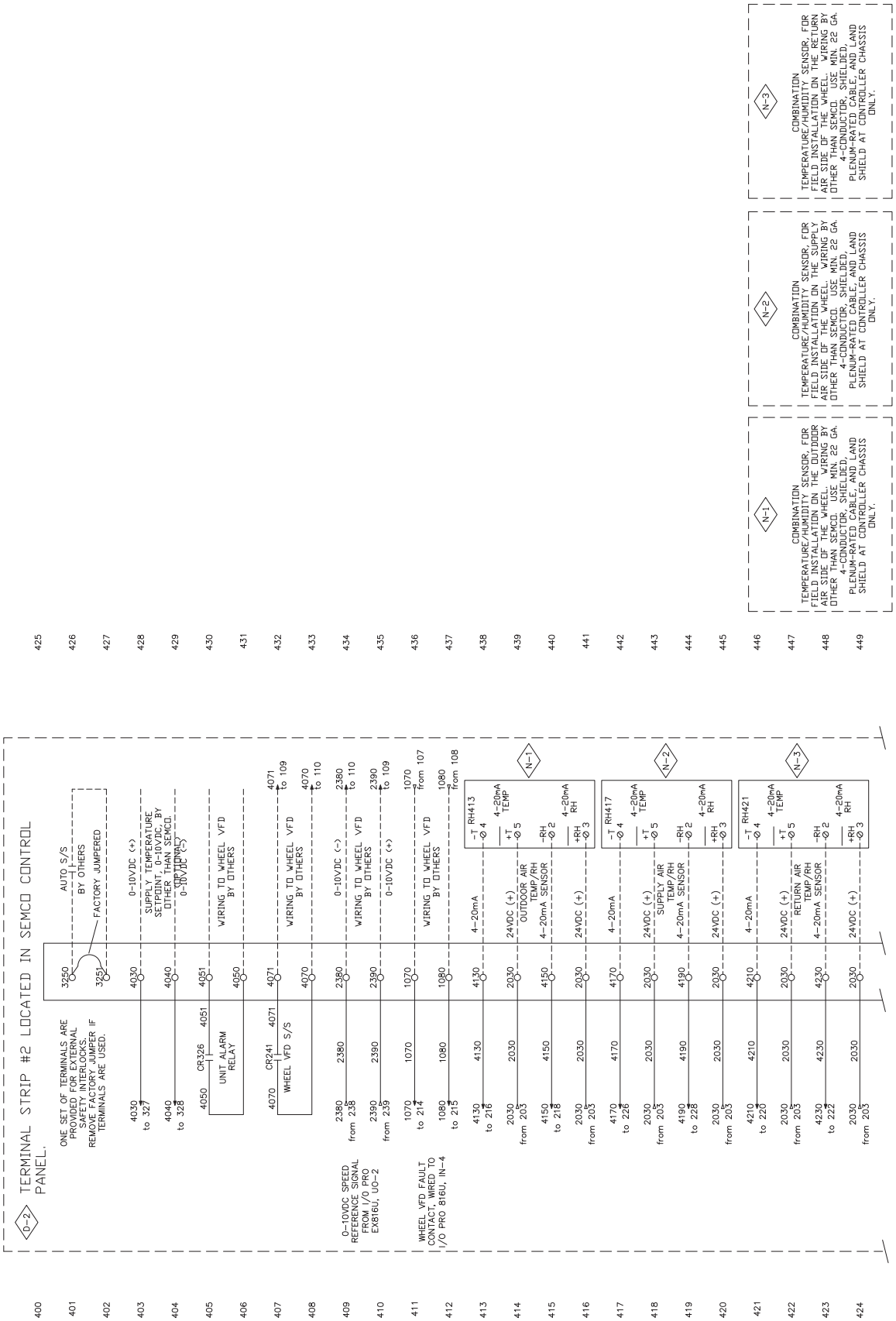


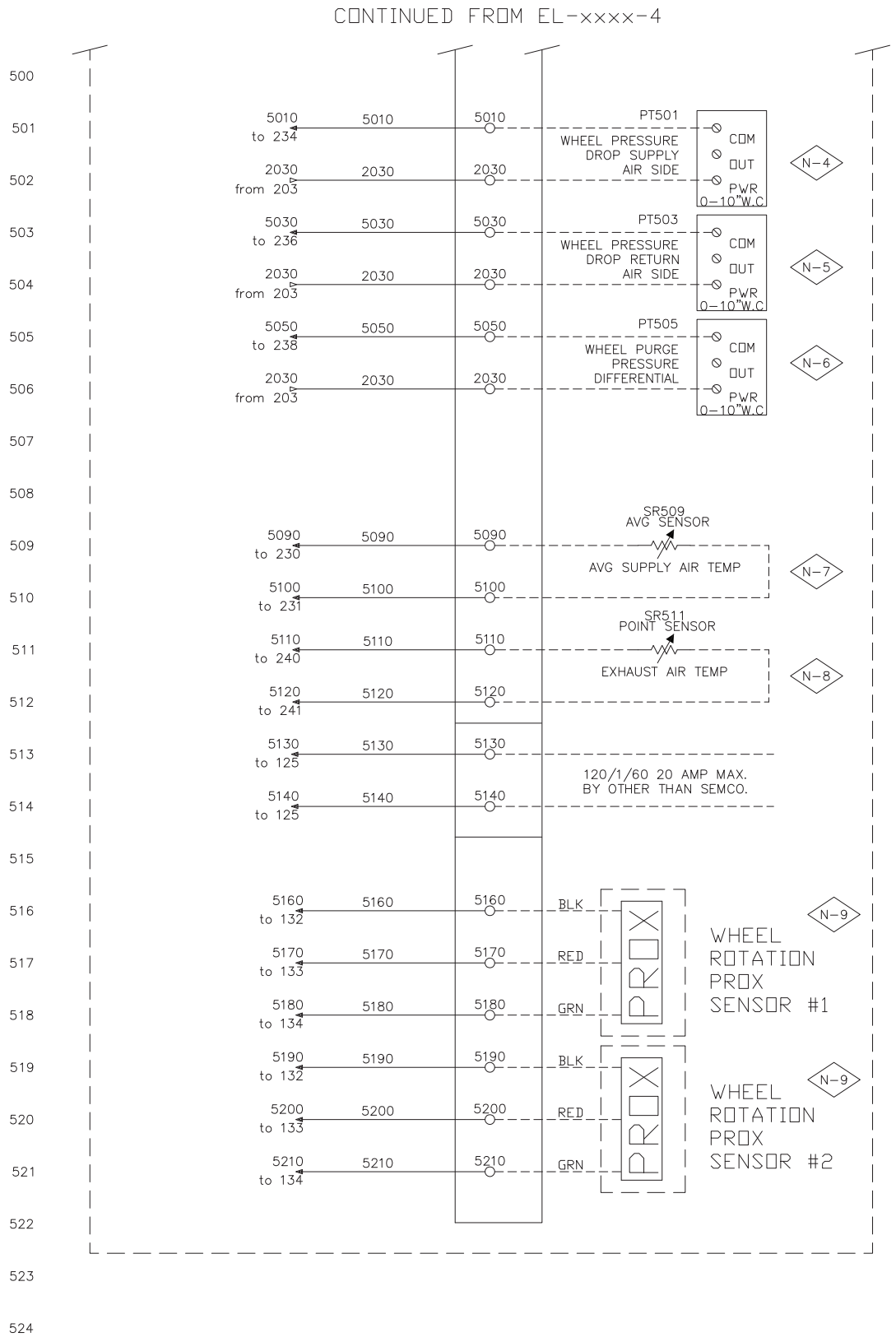
# Wiring Schematic, 3 of 5



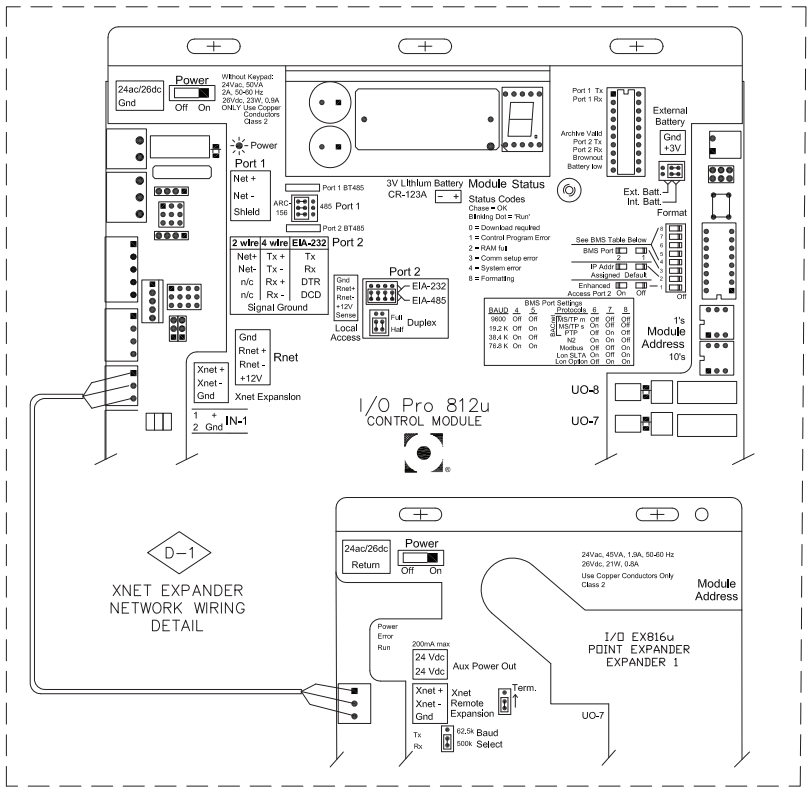
# Wiring Schematic, 4 of 5



# Wiring Schematic, 5 of 5



# Wiring Schematic, 5 of 5 continued



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