GreenTrol® Automation Inc.

OAC CONTROLLERS

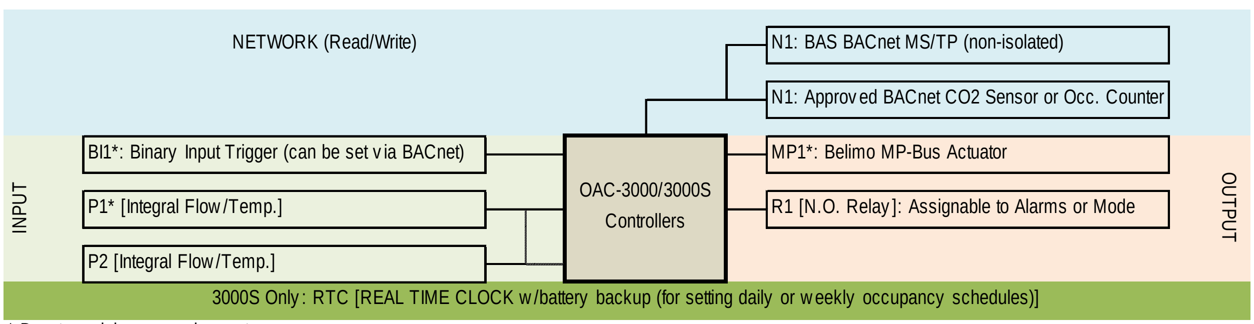
Controller Module Operation

1. OAC HARDWARE ARCHITECTURE

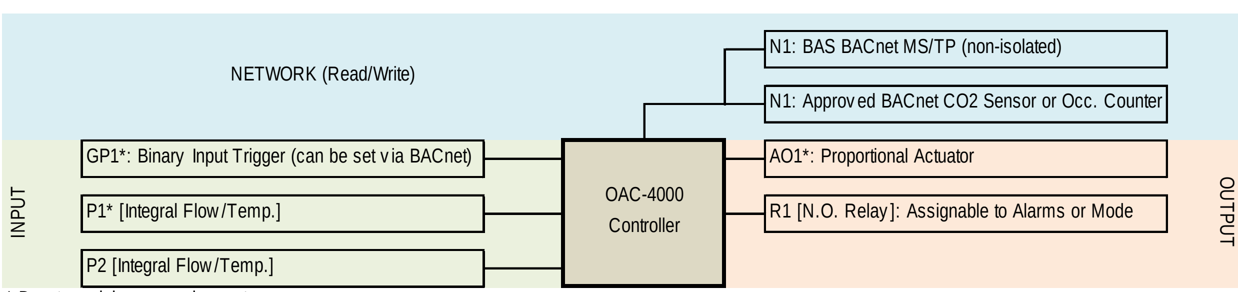
OAC Outdoor Air Controllers are based on GreenTrol Automation's 3000, 3000S, 4000 and 5000 hardware architecture. The OAC-3000 and OAC-3000S have a physical binary input (BI1). The OAC-4000 and OAC-5000 use a general-purpose input factory configured as a binary input (GP1 configured as BI1). The binary input is used to trigger occupied outdoor airflow control. The OAC-3000 and OAC-3000S modulate MP-Bus actuators provided by GreenTrol. The OAC-4000 and OAC-5000 modulate proportional analog actuators or fan speed controllers having an analog input for speed control. The OAC-3000S has a built-in real-time clock for occupancy scheduling. The OAC-5000 has an additional general purpose input factory configured as an analog input (GP2 configured as AI1) that can be configured to read an analog CO_2 sensor and an additional analog output (AO2) that is configured for airflow output.

All architectures support GreenTrol Automated integrated IAT, one or two sensor node, thermal dispersion airflow/temperature measuring devices (P1 and/or P2), have a contact closure relay (R1), and provide one non-isolated BACnet MS/TP connection (N1). The MS/TP connection can be configured for approved MS/TP airflow measurement devices in lieu of the integrated sensors, approved MS/TP DCV sensors and/or connection to a building automation system. All controllers support full read/write privileges as a BACnet master.

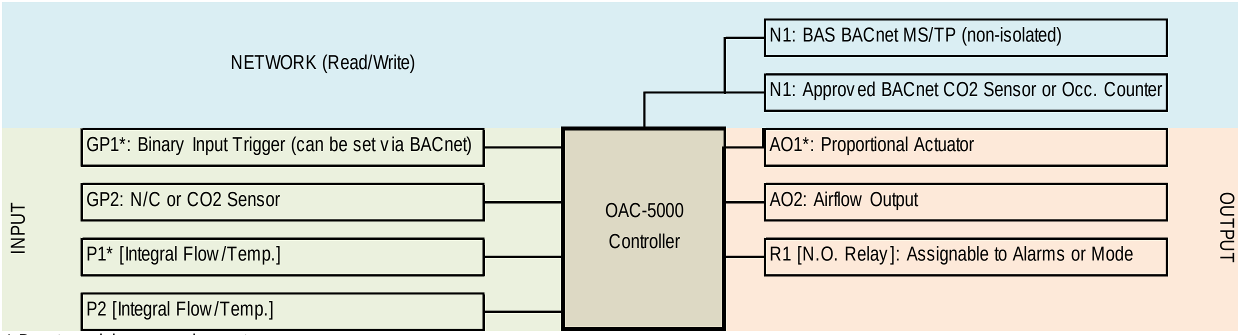
Figure 1-1 OAC Application Specific Hardware Architecture



* Denotes minimum requirements



* Denotes minimum requirements



* Denotes minimum requirements

2. OUTDOOR AIR CONTROL (OAC) METHODS

2.1. Methods Supported

OAC controllers support four modulating outdoor air control methods and one non-modulating method during occupied mode. The OAC method is selected during firmware configuration.

2.2. Modulating Control Methods

Modulating control continuously modifies the signal, MP1 or AO1, to the outdoor air actuator using one or more PID control loops and sensor inputs to maintain setpoint within a user defined deadband when occupied mode is detected. OAC controllers support fixed and variable setpoint control.

2.2.1 FIXED SETPOINT CONTROL METHODS

Fixed setpoint control maintains a user defined airflow or CO_2 setpoint. OAC controllers support the following fixed setpoint modulating control methods:

- FLOW: maintains a user defined fixed airflow setpoint
- CO2: maintains a user defined fixed CO_2 setpoint bound by optional upper and lower airflow limits

2.2.1.1. Airflow Setpoint Control [OAC=FLOW, default]

Modulates MP1 or AO1 to maintain a user defined airflow setpoint. The setpoint can be entered during firmware configuration or during normal operation by pressing either the ↑ or ↓ pushbuttons on the main circuit board.

2.2.1.2. Improved CO_2 Demand Control Ventilation (CO_2-DCV) [OAC=CO2]

Modulates MP1 or AO1 to maintain a user defined CO_2 setpoint. The setpoint can be entered during firmware configuration or during normal operation by pressing either the ↑ or ↓ pushbuttons on the main circuit board.

OAC controllers reset the outdoor airflow setpoint to maintain the desired CO_2 level. As a result, minimum and maximum ventilation airflow limits can be set by the user. Setting airflow limits significantly improves traditional CO_2-DCV that relies on fixed damper positions which are affected by damper hysteresis, fan speed changes and wind/stack pressure variations.

2.2.2 VARIABLE SETPOINT CONTROL METHODS

Variable airflow setpoint control, or population based-DCV, satisfies the ventilation requirements of ASHRAE Standard 62.1 at all population levels and is an improvement over CO_2-DCV.

The population of the ventilation zone is used to calculate the required breathing zone outdoor airflow rate. There is no user defined airflow setpoint. The breathing zone outdoor airflow rate, Vbz, is determined using the estimated population and values for the ventilation rate required per person, Rp, the ventilation rate required per floor area, Ra, and the ventilation zone floor area, Az. Values for Rp, Ra and Az should be modified for the specific space type during firmware configuration.

Vbz can be corrected for the zone ventilation effectiveness and the total outdoor air can be corrected for the worst-case expected ventilation efficiency on multi-zone systems during firmware configuration when the total population of the ventilation zone is estimated. The resulting airflow setpoint is Voz.

Variable setpoint control modulates MP1 or AO1 to maintain the calculated value for Voz. OAC controllers support the following variable setpoint modulating control methods:

- CO2/OAF: maintains a calculated airflow setpoint using the calculated population bound by optional upper and lower airflow limits
- COUNT: maintains a calculated airflow setpoint using the counted population bound by optional upper and lower airflow limits

2.2.2.1. CO2/OAF Population Estimation-DCV [OAC=CO2/OAF]

The CO2/OAF method uses a steady-state algorithm that estimates the population of the ventilation zone using indoor/outdoor CO_2 levels, metabolic activity and the measured outdoor airflow rate. The outdoor CO_2 level and metabolic activity can be modified during firmware configuration.

2.2.2.2. Direct Count-DCV [OAC=COUNT]

The COUNT method uses one to four door mounted occupancy counters to determine the occupancy of the ventilation zone.

2.3. Non-modulating Control Methods

OAC controllers support the following non-modulating method when occupied mode is detected:

- FIXED: maintains a user defined fixed damper position

3. OAC OUTPUT

3.1. Mode Detection

The active control mode is determined by the status of the binary input trigger. The trigger can be configured to be active when the input is high (above the trigger threshold) or low (below the trigger threshold).

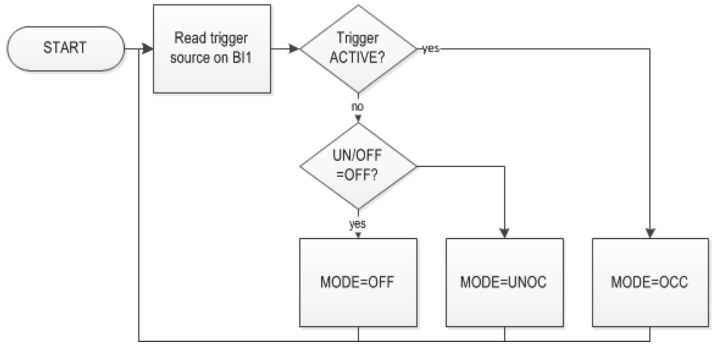
The OAC control mode trigger source can be a binary 0 to 24 VAC/VDC signal source from a thermostat or application controller. The trigger can also be the actuator control signal on packaged units using a 2-position intake damper. Replace the 2-position actuator with the appropriate analog or MP-Bus proportional actuator and use the 2-position 24 VAC control signal as the binary trigger. The binary trigger can also be provided via BACnet by the host control system.

OAC controllers detect the following modes of operation:

- Off Mode
- Unoccupied Mode
- Occupied Mode

Mode detection logic is shown in Figure 3-1.

Figure 3-1 Mode Detection Logic



3.1.1. ENHANCED MODE DETECTION (OAC-3000S)

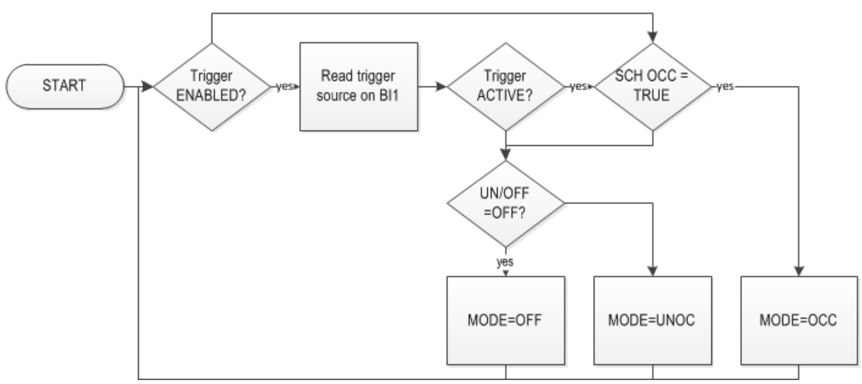
The OAC-3000S has a built-in real-time clock (RTC) to enhance operation during unoccupied modes. A schedule can be configured for individual days or weekdays/weekends and will enable occupied status (OCC = TRUE) when the time and day fall within the occupancy start time and duration specified.

The controller can be configured to operate solely on the schedule or use the schedule with the binary input trigger (logical AND) to activate occupied mode.

Press the ↓ and {ENT} buttons simultaneously during normal operation to configure schedule functions.

Enhanced mode detection logic for the OAC-3000S is shown in figure 3-2.

Figure 3-1 Enhanced Mode Detection Logic (OAC-3000S Only)



3.2. OAC Actuator and Fault Signal Outputs

The OAC actuator control output signal is provided on AO1 and is dependent on active mode, OAC method, control status and sensor status.

4. NORMAL OPERATION (NO FAULTS)

4.1. Off Mode (MODE=OFF)

The OAC controller MP1 or AO1 to 0% (damper closed)

4.2. Unoccupied Mode (MODE=UNOC)

The OAC controller modulates the output of MP1 or AO1 to maintain a user defined unoccupied airflow setpoint, UNOC SET whenever UNOC SET is greater than zero.

Note: Unoccupied airflow control is only available when a modulating minimum outdoor air control method is selected.

4.3. Outdoor Air Mode (MODE=OA)

The OAC controller sets MP1 or AO1 based on the minimum outdoor air control (OAC) method selected in SECTION 2.

5. CONTROL FAULT HANDLING

5.1. Control States

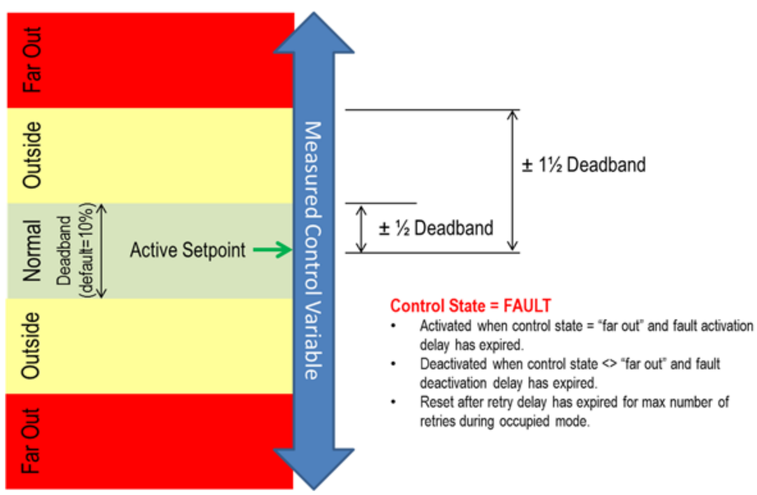
During modulating control, OAC controllers monitor the active control state (Figure 5-1). Control states are categorized as follows:

- Inactive (not in a modulating control mode)
- Normal (within/equal to active setpoint ± 0.5 deadband)
- Outside (outside active setpoint ± 0.5 deadband)
- Far Out (outside active setpoint ± 1.5 deadband)
- Control Fault (Far Out for greater than specified fault activation delay period)

Active control faults are indicated on the LCD as follows:

- Outside High, + indicated after measured output
- Outside Low, - indicated after measured output
- Far Out High, ++ indicated after measured output
- Far Out Low, -- indicated after measured output
- Control Fault High, flashing ++ after measured output
- Control Fault Low, flashing -- after measured output

Figure 5-1 Control States



5.2. Mode Dependent Control Fault Operation

5.2.1. UNOCCUPIED AIRFLOW MODE CONTROL FAULTS

5.2.1.1. Unoccupied Airflow Control Fault

An active unoccupied airflow control fault sets MP1 or AO1 to 0% (damper closed).

5.2.2. OCCUPIED OUTDOOR AIRFLOW MODE CONTROL FAULTS

5.2.2.1. Occupied Airflow Control Fault

An active occupied airflow control fault sets MP1 or AO1 to the fixed minimum position value for MIN POS established during firmware configuration (default = 10%).

5.2.2.2. CO_2 Control Fault

A CO_2 control fault only affects operation when OAC is set to CO2.

If DCVMAX is set to NONE, an active CO_2 control fault sets MP1 or AO1 to the fixed minimum position value for MIN POS established during firmware configuration (default = 10%).

If DCVMAX is not set to NONE, an active CO_2 control fault maintains DCV MAX.

If DCVMAX is not set to NONE and an active airflow control fault is active, an active CO_2 control fault sets AI1 to the fixed minimum position value for MIN POS established during firmware configuration (default = 10%). OAC modulating control is disabled.

5.3. Control Fault Recovery

Control is restored when the active fault is not present for the specified fault deactivation delay period.

Since control is disabled when an active control fault is present, it is not likely that the fault will be cleared. The OAC controller allows for a user specified number of retries after a specified retry delay.

OAC controllers log the cumulative time the controller is in each control state in non-volatile memory. Times can be viewed by navigating through the system diagnostics menus.

Press the {ESC} and ↑ buttons simultaneously during normal operation to enter the advanced setup, tools and diagnostics menus.

6. SENSOR FAULT HANDLING

6.1. Sensor Fault Detection

The OAC controller has a built-in sensor diagnostic system that detects full or partial airflow sensor, CO_2 sensor or occupancy counter failure.

6.2. Sensor Fault Operation

6.2.1. AIRFLOW SENSOR FAILURE

A partial airflow sensor failure averages functioning airflow sensor nodes and does not disrupt control operation. A complete airflow sensor sets MP1 or AO1 to the fixed minimum position value for MIN POS established during firmware configuration (default = 10%). OAC modulating control is disabled.

6.2.2. DCV SENSOR FAILURE

A DCV sensor is either a CO_2 sensor or an occupancy counter. A CO_2 sensor failure only affects operation when OAC is set to CO2 or CO2/OAF. An occupancy counter failure only affects operation when OAC is set to COUNT.

If DCVMAX is set to NONE, a DCV sensor failure sets MP1 or AO1 to the fixed minimum position value for MIN POS established during firmware configuration (default = 10%). EMOAC modulating control is disabled.

If DCVMAX is not set to NONE, a DCV sensor failure maintains DCV MAX.

If DCVMAX is not set to NONE and an active airflow control fault is active, a DCV sensor failure sets MP1 or AO1 to the fixed minimum position value for MIN POS established during firmware configuration (default = 10%). OAC modulating control is disabled.

6.3. Sensor Fault Recovery

Control is restored when the sensor fault is no longer present.

OAC controllers maintain active trouble codes and trouble history in non-volatile memory. Trouble codes and history and can be viewed by navigating through the system diagnostics menus.

Press the {ESC} and ↑ buttons simultaneously during normal operation to enter the advanced setup, tools and diagnostics menus.

7. CONTACT CLOSURE RELAY

The contact closure relay, R1, may be assigned to one or more notification alarms or the active control mode.

7.1. Notification Alarm Assignment [R1 ASGN=ALRMS, default]

The contact closure relay, R1, closes when a bound notification alarm is active. To assign the contact closure relay to notification alarms, set R1 ASNG to ALRMS (default) during hardware configuration.

Note: Individual alarms must be bound to R1 during firmware configuration for an active alarm to close the relay.

7.2. Mode Assignment [R1 ASGN=MODE]

The contact closure relay, R1, closes and can enable an external device, such as a start relay for a booster fan or exhaust fan, when the specified mode is active. To assign the contact closure relay to the active control mode, set R1 ASNG to MODE during hardware configuration. Select the desired active control mode, unoccupied mode (R1 ACTMOD=UNOC), occupied mode (R1 ACTMOD=OCC) or both unoccupied and occupied modes (R1 ACTMOD=OCCUNO), that enables the contact closure relay.

8. NOTIFICATION ALARMS

OAC controllers have built-in notification alarms. Notification alarms are automatically displayed at position 11 on the LCD and can be individually bound to the contact closure relay, R1, when R1 ASGN is set to ALRMS. Notification alarms are also available via BACnet.

8.1. System Status Alarms

8.1.1. SYSTEM TROUBLE ALARM [TRBL ALARM]

The alarm can become active during any mode. The system trouble alarm is active when any malfunction of the controller module, airflow measuring device or installed DCV sensor is detected. The alarm is enabled by default and configured for automatic reset. Active trouble codes and trouble code history are viewed using built-in diagnostic tools.

8.2. Mode Dependent Setpoint Alarms

The following mode dependent setpoint alarms are available:

- Unoccupied Airflow Alarm
- Outside Airflow Alarm (Occupied airflow alarm)
- CO_2 Alarm

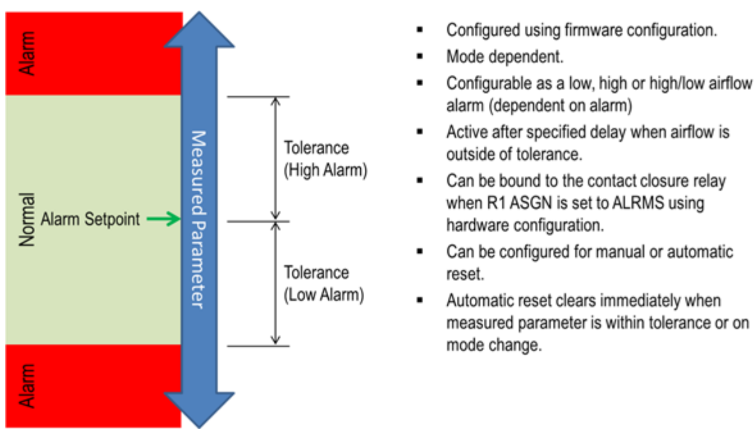
Notification alarms are disabled by default and must be enabled during firmware configuration to become active.

Notification alarms can be configured to reset automatically when the mode changes and/or alarm status is no longer active, or require manual reset. Active, manually reset, notification alarms are cleared by pressing the {ESC} button or via BACnet.

Each notification alarm has unique type (high, low or high/low), tolerance and delay parameters. Alarm history is maintained in non-volatile memory.

Notification alarm parameters can be modified during firmware configuration.

Figure 8-1 Setpoint Notification Alarms



8.2.1. UNOCCUPIED AIRFLOW ALARM [UNOC ALARM]

The alarm can only become active during unoccupied mode when the unoccupied airflow setpoint (UNOC SET) is greater than zero. The alarm uses the unoccupied airflow setpoint as the default alarm setpoint. The alarm can be set as a high, low or high/low airflow alarm.

8.2.2. OUTDOOR AIRFLOW ALARM [OA ALARM]

The alarm can only become active during occupied mode and any OAC method except when the OAC method is set to CO2. The alarm uses the active OA airflow setpoint (OA SET) when the OAC method is set to FLOW, CO2/OAF or COUNT. The alarm uses a user defined airflow setpoint when the OAC method is set to FIXED. The alarm can be set as a high, low or high/low airflow alarm.

8.2.3 CO_2 ALARM [CO2 ALARM]

The alarm can become active during any mode and with any OAC method. A CO_2 sensor must be installed and configured for the alarm to be available. The alarm uses the CO_2 setpoint (CO2 SET) when the OAC method is set to CO_2 or a user defined CO_2 setpoint for all other methods. The alarm is only available as a high CO_2 alarm.