

ICS II Sequence of Operation

General Operation

Description: OPERATING MODES and HEATING / COOLING SEQUENCE

Each Intelligent Control air handler is capable of being placed into several modes of operation. These modes generally work independently of the temperature controls, however some exceptions are noted in the various temperature control descriptions. In order to fully understand the actions of the ICS II Controller, the user must first determine which mode is in effect and whether the system is operating in the Heating or Cooling Sequence. To do this:

1. Go to the Operating Modes screen (Click on the Setpoint menu button, then click on the Operating Mode button.)
2. Select the air handler you're interested in (Use the small scroll bar near the Exit button.)
3. Note the Current Operating mode on the upper portion of the screen.
4. Go to the Current Settings screen for the air handler. (Click on the Air Handler menu button, then select the correct air handler using the small scroll bar at the upper left of the screen.)
5. Study the current temperatures and compare them to the Heating and Cooling Sequence descriptions below to determine which Sequence is in effect.

The Operating Modes are as follows:

START-UP

A "START-UP" mode occurs when power is applied to the air handler. The "START-UP" period lasts for approximately two minutes on models with modulating outdoor air capability and a few seconds on other models. When the start-up period is complete, the air handler will automatically go into the mode it was in before power was applied. During the "START-UP" period, the setpoints in the nonvolatile memory are checked and the Outside Air and Return Air Dampers are cycled to their end-of-stroke limit stops.

OFF

In this mode, the air handler will not run and all outside dampers are closed. The air handler continues to report status and other operating conditions to the Network PC or Remote Station.

MANUAL DAMPER

(This is applicable only to models with modulating outdoor air capability.) Whenever the fan is operating, the mixing dampers are fixed at the damper position set by the operator, except for override conditions such as Flush Mode and Exhaust Mode.

AUTO- PRESSURE

(This is applicable only to models with modulating outdoor air capability.) The air handler's pressure transducer compares the pressure inside the building to the pressure outside the building. Whenever the fan is operating, the dampers are automatically positioned to maintain the Pressure Setpoint at all times, except for two cases:

1. When the Economizer is active and more outdoor air is needed for cooling than is needed for pressurization, the Controller may increase the building pressure above the Pressure Setpoint, since it will bring in:
 - a) as much additional outdoor air as needed to maintain the Cooling Setpoint,
 - b) without causing the discharge temperature to drop below the Minimum Discharge Temperature Setpoint.
2. When the unit is configured for Evaporative Cooling, the Controller will force the AHU to 100% outdoor air whenever it energizes the Evap Cooler.

AUTO-NO PRESSURE

(This is applicable only to models with modulating outdoor air capability.) The **Auto No Pressure** control works identically to Auto-Pressure, except that the dampers revert to the Manual Damper position during the Cooling Mode unless the Economizer calls for more outdoor air. Auto-Pressure is generally a preferred mode of operation, however this scheme is sometimes appropriate.

FLUSH AND EXHAUST CONTROL

An air handler with the optional Flush or Exhaust Modes provides additional means of controlling temperature, humidity or contaminant levels in the building space. The air handler provides this mode based on an independent control such as a thermostat, humidistat or toxic gas sensor, and operates as follows:

When signaled to initiate the Flush Mode, the air handler will start (if not already on) and provide 100% outside air. The controller will also transmit a message code to the network signaling the Flush Mode condition.. Heat or cooling, if needed to maintain the temperature setpoints, will still be supplied to the building.

When so equipped and signaled to initiate the Exhaust Mode, the air handler will start (if not already on), open its outdoor exhaust damper, close its indoor discharge damper, open the return air damper fully and close the outdoor air dampers, providing powered exhaust of the building air. The burner will be shut off, and the controller will transmit a message code to the network signaling the Exhaust Mode condition.

NOTE: The Flush and Exhaust signals override the normal operation of the air handler as defined in the other sections of this manual. (This action takes place whether the air handler is in the OFF, OCCUPIED or UNOCCUPIED modes when the "start" signal occurs.)

The determination of whether the air handler is operating in a Heating or Cooling Sequence is as follows:

HEATING SEQUENCE

The air handler is in the Heating Sequence when:

1. The room temperature is below the Occupied Space Heating Setpoint, or
2. The room temperature has recently been below the Heating Setpoint and is still below the Occupied Space Cooling Setpoint.

COOLING SEQUENCE

The air handler is in the Cooling Sequence when:

1. The room temperature is above the Occupied Space Cooling Setpoint, or
2. The room temperature has recently been above the Cooling Setpoint and is still above the Occupied Space Heating Setpoint.

Note that the Heating and Cooling Setpoints cannot be set closer than 3F.

Description: SCHEDULE PERIODS

The air handler operating schedule is comprised of up to 21 Occupied Periods per week. All other periods are considered Unoccupied Periods.

In addition, there is a completely independent schedule available for control of any other device, such as lighting, an exhaust fan, etc. This separate schedule has the same number of Occupied Periods as the main air handler schedule.

Air Handler PC Screen

When looking at the single air handler screen, the AHU graphic will show the following:

1. Fan status (The fan wheel will be turning if it's on; stationary if off.)
2. Burner status (The gas train valves will display as open and the gas line downstream of the valves will be blue when the burner is on..)
3. Flame size (The flame will be visible and will be smaller or larger depending on the actual flame size.)
4. Damper position (The dampers move to show their approximate position.)
5. The actual operating conditions, including all temperatures and pressures and any errors. These are displayed in green text boxes.
6. Setpoints and other changeable parameters, including operating modes. These are shown in yellow text boxes. Click (with the PC mouse) on any yellow box to change that parameter.

Heating and Ventilating

Description: Direct Fired Heating

Occupied Periods

During an Occupied Period, the air handler fan will be "ON". For models with modulating outdoor air capability (AM or VAV styles), the mixing dampers operate as per the Operating Mode selected (e.g., Manual, Automatic Pressure, etc.).

The air handler's burner output will modulate and cooling output will be "ON" or "OFF" depending on the relationship between the building space temperature and the established setpoints.

When in the Heating Sequence, the 20% outdoor air damper will open, the burner will light, then modulate to maintain the Occupied Space Heating Setpoint. The control range is $\pm 2.5^{\circ}\text{F}$. The discharge temperature will be maintained between the Minimum and Maximum Discharge Setpoint values.

As a safety feature, if the air handler discharges air colder than the Low Temperature Shutdown setpoint for longer than five minutes, an error will occur and the air handler will be placed in the "OFF" mode.

When in the Cooling Sequence, the burner is shut off and the 20% outdoor air damper is open. For models with modulating outdoor air capability (AM or VAV styles), the relief output will energize if the space pressure rises 0.03" w.c. or more above the setpoint. If an Economizer type is selected, and the outdoor conditions allow it, outdoor air will be brought into the building for cooling.

Unoccupied Periods

During any Unoccupied Period, the air handler will only run when heat is required. The Controller will turn on both fan and burner when the space temperature drops below the Unoccupied Space Heating Setpoint. When on, the air handler will operate in the Operating Mode (e.g., Manual Damper or Auto Pressure) that is currently selected. If the space temperature increases above the Unoccupied Unit Off Setpoint, the air handler will turn off.

The Low Temperature Shutdown works the same as described above.

Description: Steam or Hot Water Heating (not yet available)

Control of a steam or hot water coil is accomplished with an analog (modulating) output from a separate ICS II Analog Output (AO) board.

When in the Heating Sequence, the AO board will modulate the heating coil control valve to maintain the building Occupied Space Heating Setpoint. The discharge temperature will be maintained between the Minimum and Maximum Discharge Setpoint values.

The Low Temperature Shutdown works the same as described above.

Air Handler PC Screen

For direct fired models, the burner flame is visible and changes size similarly to the actual flame. The dampers modulate on screen to reflect their actual position.

For coil models, (not yet determined)

Cooling

Description: Outdoor Air (Economizer) Cooling

There are two types of Economizer control:

The Dry Bulb Economizer is always available. Its logic assumes that it is always desirable to use outdoor air for cooling whenever the outdoor temperature is below a user-specified changeover value. Whenever the outdoor temperature is above the changeover value, the air handler will operate with the amount of outdoor air specified by the Manual Damper or Pressure Setpoint, depending on the current Operating Mode.

The Enthalpy Economizer (**not yet available**) requires that the air handler be equipped with mechanical cooling as well as additional indoor and outdoor humidity sensors. Its logic calculates the total energy (enthalpy) of both the indoor and outdoor air by using the temperature and humidity measured by the ICS II controller, then selects the air with the lowest energy content for cooling.

The Economizer Control may be de-activated if desired.

Dry Bulb Economizer

When:

1. the air handler is in the Cooling Sequence,
 2. the air handler is in the Auto Pressure Mode, and
 3. the outdoor air temperature is below the Economizer Changeover Setpoint,
- the Dry Bulb Economizer control brings in up to 100% outdoor air to maintain the Occupied Space Cooling Setpoint. Bringing in this additional outdoor air means that the building pressure may rise above the Pressure Setpoint. If it rises 0.03" w.c. or more above the setpoint, the Relief Output will be energized.

If, when bringing in outdoor air for cooling, the discharge temperature falls below the Minimum Discharge Temperature Setpoint, the amount of outdoor air will be reduced enough so that the discharge air temperature remains at or above the Minimum Discharge Temperature Setpoint.

Enthalpy

When:

1. the air handler is in the Cooling Sequence,
2. the air handler is in the Auto Pressure Mode, and
3. the outdoor air enthalpy (determined by outdoor air temperature and humidity) is below the room enthalpy,

the enthalpy economizer control brings in up to 100% outdoor air to cool the building.

See the Dry Bulb Economizer discussion above for Relief Output operation and Minimum Discharge Temperature control.

Description: Evaporative Cooling

When:

1. so equipped,
2. operating in the Cooling Sequence and
3. also operating in the Auto Pressure Mode,

the burner is shut off, the 20% outdoor air damper opens, the mixing dampers are positioned for 100% outdoor air and the cooling output energizes.

Note: This option is not available for AR models. **Evaporative cooling will be energized only when the air handler is in the Auto Pressure mode.**

Description: Mechanical Cooling

The Low Temperature Shutdown works the same as described above under Direct Fired Heating . The 20% outdoor air damper is closed at all times during the Cooling Sequence when the air handler has a mechanical cooling system.

DX (refrigerant) Coil Control.

When in the Cooling Sequence, the burner is shut off and the cooling output(s) will energize in sequence to maintain the room at the Occupied Space Cooling Setpoint. The control range is $\pm 1.5^{\circ}\text{F}$. If an Economizer is selected and the Operating Mode and outdoor conditions allow it, outdoor air will also be brought into the building for cooling.

Chilled Water Coil Control (not yet available)

When in the Cooling Sequence, the burner is shut off and the cooling output modulates to maintain the room at the Occupied Space Cooling Setpoint. If an economizer type is selected and the Operating Mode and outdoor conditions allow it, outdoor air will also be brought into the building for cooling.

Air Handler PC Screen

When evaporative cooling is present and energized, the cooling section of the air handler graphic turns light blue.

When mechanical cooling is present and energized, the cooling section of the air handler graphic displays one bar of light blue for each stage of energized cooling.

The mixing dampers always display their actual position.

Humidity Control

Description: Humidity Control with a Heating-only system

The RAPID **Humidity Control Algorithm** (HCA) is an optional feature and is only active during the Occupied Period. It is enabled by setting the Relative Humidity Setpoint to a value less than 95% and currently can be set only via the PC interface program (not the Remote Station).

Once enabled, the HCA monitors the space relative humidity continuously. If the space relative humidity reaches the Humidity Setpoint, the air handler is forced into the Heating Sequence, the burner is ignited and the space temperature is raised until the humidity falls below the setpoint. This occurs independently of the Occupied Space Heating or Cooling Setpoints and may warm the space above those Setpoints.

The Relief Output will not energize when the HCA is enabled until the building space temperature is at least as warm as the outdoor air temperature. This prevents introducing warm, potentially humid air onto building contents that may still be cool from the previous night. Since there is little sense in trying to “cool” with air that is warmer than the room, this is more of a safety feature than a practical concern. The HCA may be disabled by entering a setpoint of higher than 95%.

When the HCA is employed, an appropriate humidity sensor must be connected to the Controller and located in a representative spot. Further specifications for the Humidity Control Algorithm can be found in the "Intelligent Control System Service Technician Manual".

Description: Humidity Control with Mechanical Cooling (Reheat)

The RAPID Reheat Control is an optional feature and is only available when the air handler also has mechanical cooling and is configured for Reheat Control. The 20% outdoor air damper is closed at all times during the Cooling Sequence. Note that during the Heating Sequence, Humidity Control works as described above, except that the relief output is energized if the space pressure rises 0.03" w.c. or more above the setpoint, and is NOT restricted by the indoor vs. outdoor temperature.

Reheat with DX Coil Cooling

If the space relative humidity reaches the Humidity Setpoint, the cooling output(s) will energize in sequence to maintain the room at the Humidity Setpoint. The control range is $\pm 2\%RH$.

If, while the cooling is energized to control the space relative humidity, the room temperature falls below the Occupied Space Cooling Setpoint, the Reheat Output will also be energized. (This output must be connected to a solenoid or relay which turns on a heating coil to warm the discharge air.)

Reheat with Chilled Water Coil Cooling (not yet available)

If the space relative humidity reaches the Humidity Setpoint, the cooling output modulates to maintain the room at the Humidity Setpoint. The control range is $\pm 2\%RH$.

If, while the cooling is energized to control the space relative humidity, the room temperature falls below the Occupied Space Cooling Setpoint, the (analog) Reheat Output will also be modulated to maintain the Cooling Setpoint. (This output must be connected to a control valve which modulates a heating coil to warm the discharge air.)

Air Handler PC Screen

When cooling is present and energized, the cooling section of the air handler graphic displays one bar of light blue for each stage of energized cooling. (A light red coil section is displayed whenever the reheat output is energized.)

The mixing dampers always display their actual position.

Miscellaneous

Auxiliary Output

One of the air handler's digital outputs can be turned on by a variety of conditions that are monitored by the Controller. These conditions include the time of week, a rise in any analog input level, mode, etc.

Third Party Interface

One input is available to monitor an external signal which is intended to turn the air handler on and off. This signal can be from a third party DDC system, a manually initiated override switch, or any other switching control device.

When the external signal is present, the air handler is placed in either the Occupied or Unoccupied Period operation, depending on the time of day. When the external signal is removed, the air handler is placed in the Off mode.

Underpressure “Energy Alert” Control

When:

1. the air handler is in an Occupied Period,
2. is in the Automatic Pressure Mode, and
3. has been unable to maintain a building pressure within .01" w.c. of the pressure setpoint for ten (10) consecutive minutes,

the control system will place the air handler in Unoccupied Period operation and minimum outside air position. This will be maintained for twenty (20) minutes or until the under pressure condition has been corrected. The control system will then return the unit to the previous (Occupied Period and Automatic Pressure Mode) mode.

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