

MicroNet BACnet™

The MicroNet BACnet Unitary Controller is an interoperable controller with native BACnet, IP, and MS/TP communications support. The controller features Sensor Link (S-Link) support. LED status and output indication, screw terminal blocks, as well as a panel mount sub-base with removable electronics module.



Applications

The programmed unitary controller provides full unit control for valve controlled or damper controlled units, electric heat and DX.

Connectivity

The MicroNet BACnet Unitary Controller can function either in a standalone mode or as part of a BACnet building automation system (BAS) network.

Features

- The MicroNet BACnet Unitary Controller's sequence of operation and BACnet image are fully programmable using WorkPlace Tech Tool.
- Capability to function in standalone mode or as part of an BACnet building automation network.
- Extensive BACnet object and services support provides robust BAS integration and optimum use of network bandwidth.
- Integral MS/TP jack for direct connection of PC with WorkPlace Tech Tool.
- Removable electronics module mates with panel-mounted subbase.
- Optional plenum-rated enclosure.
- DIP switch addressable.
- Service pin button for BACnet "I am" message broadcast.
- Removable terminals for power and communications to facilitate commissioning.
- Isolated RS-485 transceiver for MS/TP communications.
- MS/TP baud rate selection from 9.6 up to 76.8 kbaud.
- LED indication of MS/TP communication activity, controller status, and UO and DO state.
- Firmware upgradeable over the network.
- Non-volatile storage of point history data and unconfirmed alarms.

Inputs from Wall Stat Sensor

Space Temperature: 32 to 122 °F (0 to 50 °C).

Local Setpoint: Adjustable within limits set by application program and sequence of operation.

Override Pushbutton: Occupancy control.

Input/Output Specifications

Universal Inputs (6): Universal Input characteristics are software-configured to respond to one of the following input types:

10 k Ω Thermistor with 11 K Ω , Shunt Resistor: Sensor operating range -40 to 250 °F/121 °C).

Analog Voltage: Range 0 to 5 Vdc.

Digital Dry switched contact; detection of closed switch requires less than 300 Ω resistance.; detection of open switch requires more than 1.5 IK.Q.

Digital Outputs – Triac (6) 12 VA at 24 Vac, 50/60 Hz, each output individually isolated.

Universal Outputs (3):

0 to 20 mA: Output load from 80 to 550 Ω

Communications

BACnet Networks: The MicroNet BACnet Unitary Controller incorporates an isolated RS-485 transceiver for BACnet MS/TP communications at

9.6 up to 76.8 kbaud: using standard MS/TP wiring methods, up to 128 devices can be connected to an MS/TP sub-net without repeaters.

S-Link The Sensor Link (S-Link) communications wiring provides power and a communication interface for one Wall Stat. This connection uses two-wire, unshielded cable and is not polarity sensitive. Maximum S-Link bus length is 200 ft (61 m).

BACnet Compliance

Conformance Class BACnet Application Specific Device (B-ASD) – Conformance Class 3.

In a continuing effort toward product improvement the following

PRODUCT INFORMATION IS SUBJECT TO CHANGE WITHOUT NOTICE

1) Dual-Mount Thermostat (Wall Thermostat)	4
A) Use	4
B) Keypad Layout and Display Icons	4
C) Adjusting Setpoints	4
D) Unoccupied Override	4
E) Remote Mounting (Wall Mounting)	5
F) Thermostat Accessories	6
2) Discharge Air, Outdoor Air, and Room Air Sensors	6
A) Description	6
B) Sensor Location	6
C) Measurement & Scale	7
D) Sensor Calibration	7
E) Sensing Room Temperature - Wall Thermostat vs. Room Air Temp. Sensor	7
3) System Diagnostics	7
A) Sensor Diagnostics with Display Points - Preferred Method	7
B) Display of Controller Diagnostics with dual-mount thermostat	8
C) Initiating Controller Self-Diagnostics	8
D) Controller Lights (LEDs)	8
4) Standard Inputs	9
A) Water Coil Low Limit	9
B) Occupancy Input	9
C) Change-over Input	9
D) Refrigerant Low Limit	9
5) Standard Outputs	9
A) Outdoor Air / Return Air Damper Actuator	9
B) Face and Bypass Damper Actuator	9
C) 2-Pipe Valve Controlled Unit	9
D) 4-Pipe Valve Controlled Unit	9
E) Binary (Relay) Outputs	10
6) Sequences of Operation	10
A) 2-Pipe unit (steam/water), Damper Control	11
B) 2-Pipe Unit (steam/water), Valve Control	12
C) 4-pipe unit (hot water or steam and chilled water), Damper Control	13
D) 4-pipe unit (hot water or steam and chilled water), Valve Control	14
E) Electric Heat Only	15
F) DX Cooling Only	16
G) DX Cooling with Electric Heat	17
H) DX Cooling with Wet Heat, Damper Control	18
I) DX Cooling with Wet Heat, Valve Control	19
J) Chilled Water Cooling with Electric Heat, Damper Control	20
K) Chilled Water Cooling with Electric Heat, Valve Control	21
7) Typical Unit Wiring	22
A) Control Diagram, 2-pipe Damper Control	22
B) Control Diagram, 2-pipe Valve Control	23
C) Control Diagram, 4-pipe, Damper Control	24
D) Control Diagram, 4-pipe, Valve Control	25
E) Control Diagram, DX with Electric Heat	26
F) Typical Power Diagrams	27
8) Parts List	28
A) Standard Control Parts	28
B) Instructions for Ordering Replacement Controllers	28
9) Troubleshooting Chart	29

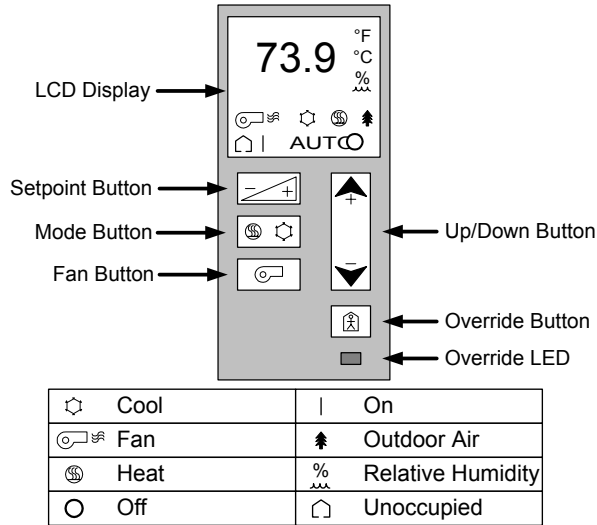
1) Dual-Mount Thermostat (Wall Thermostat)

A) Use

The dual-mount thermostat or "wall 'stat" is factory mounted in the unit for setpoint adjustment and diagnostics. As factory wired, this thermostat is NOT used to sense temperature. This thermostat may be removed from the unit and remotely mounted. In the remote location, the thermostat may be used for setpoint adjustment and diagnostics, but it can also be used to sense the space temperature. See Section 1-E for mounting details and instructions on using this thermostat to sense space temperature.

B) Keypad Layout and Display Icons

Figure 1 - Buttons & Icons



C) Adjusting Setpoints

The Mode Button and Fan Button are not used.

The setpoint button is used in conjunction with the up/down button to set one of four setpoints. Press the setpoint button once to get the first setpoint, twice for the second setpoint, etc. Use the up/down button to increase/decrease the setpoint value. The setpoints are:

Setpoint #	Point	Range	Default	Icons Displayed
1	Space Setpoint	65 - 85 °F	74 °F	°F
2	Unoccupied Offset	0 - 15 °F	5 °F	°F, Unoccupied
3	Minimum Position	0 - 100 %	10 %	%, Cool
4	Deadband	1.5-3 °F	2 °F	°F

- (1) Space Setpoint - Used to calculate the heating and cooling setpoints.
- (2) Unoccupied Offset - Used to calculate the unoccupied heating and cooling setpoints. This value is added to the cooling setpoint and subtracted from the heating setpoint.
- (3) Minimum Position - sets the minimum position of the outdoor air damper in terms of damper actuator position. Value is used only in occupied mode.
- (4) Deadband - offset value used calculate the heating and cooling setpoints.

Occupancy Offset = 0°F in occupied mode and Unoccupied Offset in unoccupied mode.

Heating setpoint = Space Setpoint - Deadband - Occupancy Offset. Cooling setpoint = Space Setpoint + Deadband + Occupancy Offset.

D) Unoccupied Override

A single press of the override button is used to provide a 2 hour unoccupied override. The override LED is lit during override. The occupancy override may be canceled by pressing the override button for more than 4 seconds, but less than 8 seconds.

E) Remote Mounting (Wall Mounting)

The dual-mount thermostat is factory mounted on the control panel. This thermostat may be mounted in the space for setpoint control and to sense the space temperature. This thermostat may be mounted directly to a wall, a 2x4 electrical box, a 1/4 DIN electrical box, or a surface mount electrical box.

The sensor link (S-LK) wiring requires at least 24 gauge, twisted pair, voice grade telephone wire. Shielded wire is not required; however, this cable type is recommended. The maximum wire length is 200 ft. The capacitance between conductors cannot be more than 32 pF per foot. If shielded cable is used, the capacitance between any one of the conductors and the other conductors (connected to the shield) cannot exceed 60 pF per foot.

The sensor link wiring must have dedicated wire pairs. These wire pairs must not be part of an active, bundled telephone trunk. The sensor link wiring should not be routed with any Class 1 power wiring. The sensor link wiring may be routed with any of the low voltage controller wiring

To remotely mount the thermostat:

- (1) Disconnect Unit power.
- (2) Unsnap the thermostat faceplate from the subbase. Remove the thermostat faceplate by placing the thumb in the center of the thermostat and pulling on the top edge of the plate.
- (3) Unscrew the two small screws that secure the thermostat to the subbase.
- (4) Disconnect the yellow S-LK wires from the S-LK/COM terminals of the unit controller and from terminals 1 and 2 of the subbase.
- (5) Remove the two screws that hold the subbase to the controller mounting plate.
- (6) Move the subbase to the mounting location and feed the sensor link (S-LK) wires through the back of the subbase.
- (7) Mount the subbase. The wiring terminals should be at the top end of the subbase. For direct wall-mount, 2x4 box mount, and surface mount boxes, use mounting holes 1 and 3. For 1/4 DIN boxes, uses mounting holes 1 and 2. See Figure 2. Use the appropriate flathead screws, such as 6-32 x 5/8", to attach the subbase to the box or wall. When attaching to directly to drywall, use anchors as necessary.
- (8) The sensor link wires (S-LK or U-link) connect to subbase terminals 1 and 2; these wires are not polarity sensitive. Connect the S-LK wires to the S-LK/COM terminals of the controller.
- (9) Push the excess wire back through the subbase and insulate the opening to minimize air drafts from an unconditioned space.
- (10) Hold the t'stat with the display out and oriented towards the top of the t'stat. Set the t'stat circuit board so that the bottom edge is captured by the mounting hooks near the bottom of the subbase.
- (11) Secure the t'stat to the subbase by tightening the two small screws near the top, outer edge of the t'stat.
- (12) Snap the faceplate back onto the t'stat. Snap in the bottom edge first and then the top edge.
- (13) If using the t'stat to detect space temperature, disconnect the unit mounted room air temperature sensor (RAT) from the controller (terminals UI1 and COM).
- (14) Apply unit power and verify t'stat operation.

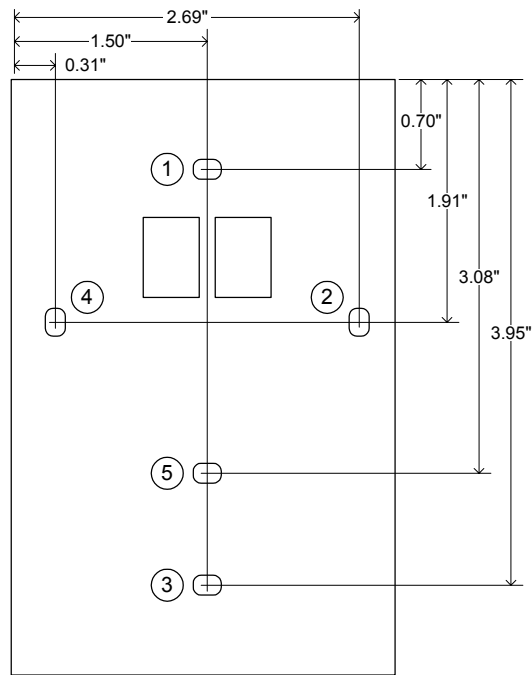


Figure 2 - Subbase Mounting Holes & Dimensions

F) Thermostat Accessories

The following accessories are not offered from the factory, but can be purchased from Invensys Building Systems.

- (1) Thermostat Locking Cover - When a locking cover is required for a dual-mount thermostat that is mounted in the space, Invensys part AT-1155 may be used.
- (2) Thermostat Guard - When a thermostat guard (non-locking) is required for a dual-mount thermostat, Invensys parts AT-1104 (Cast Aluminum) and AT-1163 (Wire Guard) may be used.
- (3) Remote Space Temperature Sensor - This sensor may be field wired in place of the factory mounted room air sensor (RAT). Unlike the dual-mount thermostat (which remains in the unit), this sensor does not allow setpoint adjustments nor does it provide a display. This is Invensys part TSMN-57011-850.

2) Discharge Air, Outdoor Air, and Room Air Sensors

A) Description

The discharge air, outdoor air, and room air sensors use a 2-wire, 10K-thermistor element with an 11K shunt. These sensors have a maximum error rate of +/- 0.36°F over 32° to 158°F. These sensors have a maximum drift of 0.045°F per year, over the 32° to 158°F temperature range.

B) Sensor Location

The discharge air temperature (DAT) sensor is located in the discharge air stream. On some units, this sensor is mounted in the discharge of the left most blower scroll. On later model units, this sensor is mounted behind the "front" access panel, with the sensor located between the coil and a fan inlet.

The outdoor air temperature (OAT) sensor is located on the left-end of the unit. This sensor projects into the outdoor air stream, immediately upstream of the outdoor air damper.

The room air temperature sensor (RAT) is located behind the decorative room air grille in "front" access panel. This sensor is mounted near the room air intake hole on the blower section. It is important that this sensor remain outside the blower compartment.

C) Measurement & Scale

At least one of the sensor wires must be disconnected from the controller before resistance measurements are taken. A digital multimeter or other low voltage ohmmeter may be used to measure the sensor resistance.

Important: Units with water/steam coils are equipped with a low limit thermostat. This thermostat is wired in parallel with the outdoor air temperature sensor, such that the sensor is shorted when the thermostat closes for low limit conditions.

Nominal Temperature vs. Resistance

°C	°F	Ohms
-40	-40	10517
-30	-22	10172
-20	-4	9654
-10	14	8933
0	32	8044
10	50	6938
20	68	5798
25	77	5238
30	86	4696
40	104	3707
50	122	2875
60	140	2206
70	158	1685
80	176	1287
90	194	986
100	212	760
110	230	590
120	248	462

D) Sensor Calibration

Out of range sensors must be replaced, as these sensors cannot be calibrated.

E) Sensing Room Temperature - Wall Thermostat vs. Room Air Temp. Sensor

These units are factory configured to use the room air temperature sensor (RAT) as the space temperature control point. The controller will use one of three inputs as the space temperature value. The first valid input, ordered as shown below, will be used as the space temperature input.

- (1) BACnet network - If the controller is connected to a BACnet network and this point is bound to a valid temperature, then this temperature shall be used as the space temperature input.
- (2) Room Air Temperature Sensor (RAT) - shall be used as the space temperature input if there is no network input.
- (3) Dual-Mount Thermostat (Wall t'stat) shall be used as the space temperature input, if the room air sensor input is not valid. The RAT sensor MUST be disconnected to allow the wall t'stat to sense room temperature.

3) System Diagnostics

A) Sensor Diagnostics with Display Points - Preferred Method

The display on the dual mount thermostat can be used to verify the unit controller is receiving an accurate temperature signal. This is the preferred method for verifying the operation of the temperature sensors, since the actual sensor values are displayed. A damaged sensor may provide an input that is within the allowable range of temperatures, but may be far from the true temperature.

The up and down keys of the thermostat can be used to view four controller points. The four points are (1) Space Temperature, (2) Discharge Air Temperature, (3) Outdoor Air Temperature, and (4) Outdoor Air damper position. A display value of "ABn" indicates that the sensor input is out of the allowed range (ABnormal). See Section 1 for details on the thermostat.

- (1) Space Temperature is the default display value. This value is obtained from one of three sources: Network, Room Air Temperature Sensor, and the dual mount thermostat.
- (2) The discharge air temperature is the value returned from the discharge air temperature sensor.
- (3) The outdoor air temperature is the value returned from the outdoor air temperature sensor.
- (4) The outdoor air damper position returns the percentage of full-scale output (20mA) being sent through the proportionally controlled actuator. Unlike the other display points, this is not a sensed value. This represents the percentage output of the control algorithm.

B) Display of Controller Diagnostics with dual-mount thermostat

This method will detect sensors that are out of the allowable scale, but it cannot detect a sensor that is out of calibration. This method requires inputs from the dual mount thermostat; see Section 1 for thermostat details, such as keypad layout. These diagnostics provide the following data: (1) Subnet Address; (2) Node Address; (3) Errors; (4) Alarms; (5) Temperature Offset; and (6) Relative Humidity Offset. Instructions on how to get to the diagnostic screen follow the explanation of diagnostic values.

- (1) Subnet Address - display indicates "Add" then displays the numerical value of the subnet address.
- (2) Node Address - display indicates "nod" then displays the numerical value of the node address.
- (3) Errors - The error displays the value of any current errors detected by the controller. The display indicates "Err" then displays a numerical code representing all the current errors. If the controller detects no errors, "---" is displayed instead of a numerical code. A single error code is used to display all errors. When the controller detects multiple errors, the error code is the sum of all current error codes. For example, if the controller detects errors 2, 4, and 8, error code 14 is displayed. The following table provides a list of the single error codes and suggested actions for each.

Code	Condition	Resolution Path
---	No Errors.	
1	EEPROM error	Test Controller
2	RAT sensor out of Range	Test RAT sensor - See Section 2
4	DAT sensor out of Range	Test DAT sensor - See Section 2
8	OAT sensor out of Range	Test OAT sensor - See Section 2
16	Analog Output Error	Test Controller
32	Calibration Error	Test Controller

This error condition is normal when the dual-mount thermostat is used to detect room temperature.

When an EEPROM error, Analog Output Error, or Calibration Error is detected, reset the controller by removing power for 15 seconds. If the error condition remains when power is re-applied to the controller, the controller is internally damaged and must be replaced.

- (4) Alarms - This code shows the error codes for the last four alarms reported by the controller. This feature is not supported.
- (5) Temperature Offset - This value adds an offset of -99 to 99°F to temperature value reported by the dual-mount thermostat. This value has no effect on the temperature reported by the room air sensor (RAT) sensor or a network space temperature value.
- (6) Humidity Offset - This value is NOT USED.

C) Initiating Controller Self-Diagnostics.

- (1) To initiate the diagnostics display, press both ends of the up/down key for 4 seconds. When diagnostics are initiated, the thermostat will display the address codes.
- (2) Press the UP/Down Key to scroll through the Address, Errors, and Alarms in this mode.
- (3) Press the Override key to display the Temperature Offset value. Use the Up/Down Key to adjust this value.
- (4) Press the Override key again to display to Humidity Offset value.
- (5) Press the Override key again to return to the Address, Errors, and Alarms display.
- (6) Press both ends of the up/down key to return to the normal display screen. The sensor will automatically return to the normal display screen if the keypad is idle for 30 seconds.

D) Controller Lights (LEDs)

The controller is equipped with a green status LED and a red receive LED.

4) Standard Inputs

The following inputs are the digital (binary) inputs used with the controller. Some items are optional and others are used only with specific control packages. Please see Section 6 for details on the unit sequence of operation.

A) Water Coil Low Limit

This input is attached to the coil used on all units with steam or water. When the low limit switch closes, it initiates low limit mode.

B) Occupancy Input

If the unit is connected to a network and the network occupancy input is bound to an occupancy controller, the network initiates occupied/unoccupied modes, regardless of the status of the physical occupancy input. Without a network, all units use controller digital input 1 (UI6) for the occupancy status input. When terminal UI6 is connected (input switch closed) to a common terminal, the controller switches to unoccupied mode, unless the unoccupied override button on the dual-mount thermostat is pressed. When terminal UI6 is disconnected from COM, the unit enters occupied mode.

This input may be factory connected to an optional day/night relay, where the relay coil must be field wired to an occupancy controller. This relay is factory wired so that the relay is energized for unoccupied mode and de-energized for occupied mode. When ordered, this relay is mounted on the control panel.

This input may be factory connected to an optional 7-day timeclock. This timeclock has an override switch (holiday switch) built into the clock face that can be used to force the unit into occupied or unoccupied modes. When ordered, this timeclock is mounted on the control panel.

C) Change-over Input

This input is used only on 2-pipe, systems with chilled water. A changeover switch (aquastat) is connected between controller terminals UI5 and COM. The switch contacts close when the switch senses that the water temperature is below 65°F, thus indicating that chilled water is available and initiating cooling mode. The unit enters heating mode when the contacts open at 85°F.

D) Refrigerant Low Limit

This input is used with DX coils on self-contained unit ventilators. A low limit switch is connected between controller terminals UI5 and COM. The switch contacts close when the DX coil temperature falls below 28°F, thus prompting the controller to disable the compressor.

5) Standard Outputs

Some output items are optional and others are used only with specific control packages. Please see Section 6 for details on the unit sequence of operation.

A) Outdoor Air / Return Air Damper Actuator

This actuator is connected to 24 VAC power and is controlled with a 4-20 mA signal from Analog Output 1 U01. The actuator will close the outdoor air damper on a power failure. A 4 mA signal drives the damper fully closed, while a 20 mA signal drives the actuator to full open position.

B) Face and Bypass Damper Actuator

This non-spring return actuator is connected to 24 VAC power and is controlled with a 4-20 mA signal from Analog Output 2 (U02). A 4 mA signal drives the damper into full bypass position (closed), while a 20 mA signal drives the actuator to the full face position (open).

C) 2-Pipe Valve Controlled Unit

A proportional valve is used on all 2-pipe (steam, chilled water and/or hot water) units. The valve actuator is connected to 24 VAC power and is controlled with a 0-20 mA signal from Analog Output 2 (U02). The valve will return to the full open position on a loss of power. A 0mA signal drives the valve fully open, while a 20 mA signal drives the valve fully closed.

D) 4-Pipe Valve Controlled Unit

A proportional valve is used to control the heating valve (steam or hot water) as described above.

A proportional valve is used to control the cooling valve (chilled water).

The valve actuator is connected to 24vac power and will fully close with a loss of power. Analog output (U03) drives the valve actuator. A 0ma signal drive the valve fully closed and a 20ma signal drives the valve fully open.

E) Binary (Relay) Outputs

- (1) Fan control - the Fan Relay (FR1) is connected to Output 1 (TO1). This output is energized to start the fan and de-energized to stop the fan
- (2) DX cooling Control - On self-contained units and units with DX cooling, the DX control circuit is connected to TO5. This output is energized to start the compressor/condenser and de-energized to disengage the compressor/condenser.
- (3) Electric Heat Control - 1st stage electric heat relay (HR1) is connected to TO2. 2nd stage electric heat relay (HR2) is connected to TO3. 3rd stage electric heat relay (HR3) is connected to TO4. These outputs are energized to engage the electric heat stage and de-energized to disengage the stage.
- (4) Radiant Heat Control - when this option is ordered on units with water/steam heating, a relay (HR1) is added to control radiant heat. The coil of this relay is connected to TO2.

6) Sequences of Operation

The following sequences of operation detail each ASHRAE Cycle II control configuration.

A) 2-Pipe unit (steam/water), Damper Control

Fan Operation

The supply fan shall run continuously in the occupied and tenant (unoccupied) override modes. The fan shall cycle with calls for cooling or heating in the unoccupied mode.

End-of-Cycle Valve Operation

The end of cycle valve shall open when the face and bypass damper opens to the coil face. The valve shall open when the outside air temperature falls below 40°F and shall remain open until the temperature exceeds 44°F.

Cooling Operation – Face and Bypass Damper

The unit enters cooling mode when the optional changeover t'stat contacts close to indicate that chilled water is available or the network input calls for cooling only operation. The network input shall have precedence over the local changeover t'stat. When chilled water is unavailable, outdoor air may be used for cooling; please see the Outdoor Air Damper control section for operational details.

If the discharge air temperature falls below the low limit setpoint (default 55°F), the damper shall close to the coil face. The damper shall remain closed until the discharge air temperature rises more than 2°F above setpoint.

When the space temperature exceeds the cooling setpoint, a proportional-integral control loop shall position the face and bypass damper to maintain the space temperature.

Heating Operation – Face and Bypass Damper

The unit enters heating mode when the optional changeover t'stat contacts open to indicate that hot water is available or when the network input calls for heating only operation. The network input shall have precedence over the local changeover t'stat.

If the discharge air temperature rises above the discharge air temperature high limit setpoint (default 130°F), the damper shall close to the coil face. The damper shall remain closed until the discharge air temperature falls more than 10°F below the setpoint.

If the discharge air temperature falls below the low limit setpoint (default 55°F) or the low limit thermostat trips (closes), the damper shall open to the coil face. The damper shall not close until the discharge air temperature rises more than 2°F above setpoint and the low limit thermostat opens.

When the space temperature falls below the heating setpoint, a proportional-integral control loop shall position the face and bypass damper to maintain the space temperature.

Radiation Heating Control (Optional)

This radiation heating output is enabled ONLY when the unit is in heating mode (see Heating Operation).

The radiation heating control output shall be energized when the space temperature falls more than 0.5°F below the heating setpoint. This output shall be de-energized when the space temperature exceeds the heating setpoint by 0.5°F.

Outdoor Air Damper Control

The outdoor air damper shall be closed in the unoccupied mode, regardless of the space temperature.

The outdoor air damper shall close when the low limit t'stat trips (closes) and shall not open until the t'stat opens.

The outdoor air damper shall close when the discharge air temperature falls below the minimum low limit setpoint (default 53°F). The damper shall not open until the discharge air temperature exceeds the setpoint by more than 2°F.

The outdoor air damper shall be closed if the space temperature rises more than 3°F above the cooling setpoint, while chilled water is available (changeover t'stat closed). The damper will not open until the space temperature falls to less than 2°F above the cooling setpoint. If chilled water is not available, the damper continues to operate under normal control.

The outdoor air damper shall be closed if the space temperature falls more than 3°F below the heating setpoint. The damper will not open until the space temperature rises to within 2°F of the heating setpoint.

The outdoor air damper shall close to minimum position when the discharge air temperature falls below the low limit setpoint (default 55°F). The damper shall fully close when this condition is maintained for more than 5 minutes. The damper shall return to normal control when the discharge air temperature rises more than 2°F above the setpoint.

The outdoor air damper shall close to minimum position when the economizer operation is disabled via the network input.

The outdoor air damper shall close to minimum position when the outdoor air temperature exceeds 68°F, while chilled water is available. If chilled water is unavailable, the damper continues to operate under normal control.

The outdoor air damper shall be controlled with a proportional control loop based upon the deviation from setpoint. The outdoor air damper shall begin to modulate open from minimum position when the space temperature exceeds the (space setpoint - 0.5°F). The outdoor air damper shall be fully open when the space temperature rises 1.5°F above the setpoint. Except as noted in the paragraphs above, the outdoor air damper shall not close beyond minimum position during occupied operation.

B) 2-Pipe Unit (steam/water), Valve Control

Fan Operation

The supply fan shall run continuously in the occupied and tenant (unoccupied) override modes. The fan shall cycle with calls for cooling or heating in the unoccupied mode.

Cooling Operation

The unit enters cooling mode when the optional changeover t'stat contacts close to indicate that chilled water is available or the network input calls for cooling only operation. The network input shall have precedence over the local changeover t'stat. When chilled water is unavailable, outdoor air may be used for cooling; please see the Outdoor Air Damper control section for operational details.

If the discharge air temperature falls below the low limit setpoint (default 55°F), the control valve shall be closed. The valve shall remain closed until the discharge air temperature rises more than 2°F above setpoint.

When the space temperature exceeds the cooling setpoint, a proportional-integral control loop shall position the control valve to maintain the space temperature.

Heating Operation

The unit enters heating mode when the optional changeover t'stat contacts open to indicate that hot water is available or when the network input calls for heating only operation. The network input shall have precedence over the local changeover t'stat.

If the discharge air temperature rises above the discharge air temperature high limit setpoint (default 130°F), the control valve shall be closed. The valve shall remain closed until the discharge air temperature falls more than 10°F below the setpoint.

If the discharge air temperature falls below the low limit setpoint (default 55°F) or the low limit thermostat trips (closes), the control valve shall open. The valve shall not close until the discharge air temperature rises more than 2°F above setpoint and the low limit thermostat opens.

When the space temperature falls below the heating setpoint, a proportional-integral control loop shall position the control valve to maintain the space temperature.

Radiation Heating Control (Optional)

This radiation heating output is enabled ONLY when the unit is in heating mode (see Heating Operation).

The radiation heating control output shall be energized when the space temperature falls more than 0.5°F below the heating setpoint. This output shall be de-energized when the space temperature exceeds the heating setpoint by 0.5°F.

Outdoor Air Damper Control

The outdoor air damper shall be closed in the unoccupied mode, regardless of the space temperature.

The outdoor air damper shall close when the low limit t'stat trips (closes) and the damper shall not open until the t'stat opens.

The outdoor air damper shall close when the discharge air temperature falls below the minimum low limit setpoint (default 53°F). The damper shall not open until the discharge air temperature exceeds the setpoint by more than 2°F.

The outdoor air damper shall be closed if the space temperature rises more than 3°F above the cooling setpoint, while chilled water is available (changeover t'stat closed). The damper will not open until the space temperature falls to less than 2°F above the cooling setpoint. If chilled water is not available, the damper continues to operate under normal control.

The outdoor air damper shall be closed if the space temperature falls more than 3°F below the heating setpoint. The damper will not open until the space temperature rises to within 2°F of the heating setpoint.

The outdoor air damper shall close to minimum position when the discharge air temperature falls below the low limit setpoint (default 55°F). The damper shall fully close when this condition is maintained for more than 5 minutes. The damper shall return to normal control when the discharge air temperature rises more than 2°F above the setpoint.

The outdoor air damper shall close to minimum position when the economizer operation is disabled via the network input.

The outdoor air damper shall close to minimum position when the outdoor air temperature exceeds 68°F, while chilled water is available. If chilled water is unavailable, the damper continues to operate under normal control.

The outdoor air damper shall be controlled with a proportional control loop based upon the deviation from setpoint. The outdoor air damper shall begin to modulate open from minimum position when the space temperature exceeds the (space setpoint - 0.5°F). The outdoor air damper shall be fully open when the space temperature rises 1.5°F above the setpoint. Except as noted in the paragraphs above, the outdoor air damper shall not close beyond minimum position during occupied operation.

C) 4-pipe unit (hot water or steam and chilled water), Damper Control

Fan Operation

The supply fan shall run continuously in the occupied and tenant (unoccupied) override modes. The fan shall cycle with calls for cooling or heating in the unoccupied mode.

Cooling Operation

The unit enters cooling mode via the network mode input. When no valid network input is available, the unit operates in automatic mode and engages cooling as required to maintain setpoint.

The face and bypass damper drives to the full bypass position when the discharge air temperature exceeds the high limit setpoint (default 130°F). The damper shall not return to normal control until the discharge air temperature falls more than 10°F below the high limit setpoint.

The damper drives to full bypass position when the discharge air temperature falls below the low limit setpoint (default 55°F) or the low limit thermostat closes. The damper returns to normal operation when the discharge air temperature exceeds the low limit setpoint by 2°F and the low limit thermostat opens.

When the space temperature exceeds the cooling setpoint a proportional-integral control loop shall position the face & bypass damper to maintain the space temperature. When the space temperature falls below the cooling setpoint, the face & bypass damper shall be closed (bypass).

The cooling EOC valve output is energized (valve opened) when the face and bypass damper is opened to the coil face with a call for cooling.

Heating Operation - Face and Bypass Damper

The unit enters heating mode via the network mode input. When no valid network input is available, the unit operates in automatic mode and engages heating as required to maintain setpoint.

The face and bypass damper drives to the full bypass position when the discharge air temperature exceeds the high limit setpoint (default 130°F). The damper shall not return to normal control until the discharge air temperature falls more than 10°F below the high limit setpoint.

The face and bypass damper shall drive to full-face airflow if the low limit thermostat trips (closes), the discharge air temperature falls below the discharge air temperature low limit setpoint (default 55°F), or the unit is in cooling mode. The damper shall return to normal operation when the low limit thermostat opens, the discharge air temperature exceeds the discharge air temperature low limit by 2°F, AND the unit exits cooling mode.

When the space temperature falls below the heating setpoint, a proportional-integral control loop shall position the face & bypass damper to maintain the space temperature.

Heating Operation - End-of-Cycle (EOC) Valve

The heating EOC valve returns to the open position when the face and bypass damper is opened to the coil face with a call for heating.

The heating EOC valve returns to the open position when the outdoor air temperature falls below 40°F and this valve shall remain open until the outdoor air temperature exceeds 44°F.

Radiation Heating Control (Optional)

The radiation heating output is enabled ONLY when the unit is not in cooling mode via the network input.

The radiation heating control output shall be energized when the space temperature falls more than 0.5°F below the heating setpoint. This output shall be de-energized when the space exceeds the heating setpoint by 0.5°F.

Outdoor Air Damper Control

The damper shall be closed in the unoccupied mode, regardless of the space temperature.

The damper shall be immediately closed if the low limit thermostat trips.

The damper shall be immediately closed if the discharge air temperature falls more than 2°F below the low limit setpoint (default 55°F).

The damper shall drive closed when the discharge air temperature is below the low limit setpoint for 5 minutes.

The damper shall be closed if the space temperature falls more than 3°F below the heating setpoint. The damper will not open until the space temperature rises within 2°F of the heating setpoint.

The damper shall be closed if the space temperature rises more than 3°F above the cooling setpoint. The damper will not open until the space temperature falls to less than 2°F above the cooling setpoint. This control shall be disabled when the damper configuration input (UI05) is closed. When DI02 is closed, the damper shall NOT be forced closed upon a wide deviation from the cooling setpoint.

The damper shall close to minimum position when the discharge air temperature falls below the low limit setpoint or when economizer operation is disabled via the network input (Econ_Disable).

The damper closes to minimum position when the outdoor air temperature exceeds changeover (default 68°F).

The damper shall be controlled with a proportional control loop based upon the deviation from setpoint. The damper shall begin to modulate open from minimum position when the space temperature exceeds the (space setpoint - 0.5°F). The outdoor air damper shall be fully open when the space temperature rises 1.5°F above the setpoint. Except as noted in the paragraphs above, the outdoor air damper shall not close beyond minimum position during occupied operation.

D) 4-pipe unit (hot water or steam and chilled water), Valve Control

Fan Operation

The supply fan shall run continuously in the occupied and tenant (unoccupied) override modes. The fan shall cycle with calls for cooling or heating in the unoccupied mode.

Cooling Operation

The cooling valve shall close when the network input calls for heating only operation, the low limit thermostat (LLT) closes, or the discharge air temperature falls below the low limit setpoint (default 55°F). Valve operation shall be suspended until the unit is placed into automatic or cooling mode by the network input, the low limit thermostat opens, and the discharge air temperature exceeds the low limit setpoint by more than 2°F.

When the space temperature exceeds the cooling setpoint, a proportional-integral control loop shall position the cooling valve to maintain the space temperature. When the space temperature falls below the cooling setpoint, the cooling valve shall close.

Heating Operation

The heating valve shall close when the discharge air temperature exceeds the high temperature limit setpoint (default 130°F) or when the network input calls for cooling only operation. Valve operation shall be suspended until the discharge air temperature falls more than 10°F below the limit setpoint and network allows the unit to operate in automatic or heating modes.

The heating valve shall fully open when the low limit thermostat (LLT) closes or the discharge air temperature falls below the low limit setpoint (55°F). Valve operation is suspended until the low limit thermostat opens and the discharge air temperature exceeds the low limit setpoint by more than 2°F.

When the space temperature falls below the heating setpoint, a proportional-integral control loop shall position the heating valve to maintain the space temperature. When the space temperature exceeds the heating setpoint, the heating valve shall close.

Radiation Heating Control (Optional)

The radiational heating output is enabled ONLY when the unit is not in cooling mode via the network input.

The radiational heating control output shall be energized when the space temperature falls more than 0.5°F below the heating setpoint. This output shall be de-energized when the space temperature exceeds the heating setpoint by 0.5°F.

Outdoor Air Damper Control

The outdoor air damper shall be closed in the unoccupied mode, regardless of the space temperature.

The outdoor air damper shall be immediately closed if the low limit thermostat trips.

The outdoor air damper shall be immediately closed if the discharge air temperature falls more than 2°F below the discharge air low limit setpoint (default 55°F).

The outdoor air damper shall drive closed if the discharge air temperature remains below the low limit setpoint for 5 minutes.

The outdoor air damper shall be closed if the space temperature falls more than 3°F below the heating setpoint. The damper will not open until the space temperature rises within 2°F of the heating setpoint.

The outdoor air damper shall be closed if the space temperature rises more than 3°F above the cooling setpoint. The damper will not open until the space temperature falls to less than 2°F above the cooling setpoint. This control shall be disabled when the damper configuration input (UI05) is closed. When DI02 is closed, the damper shall NOT be forced closed upon a wide deviation from the cooling setpoint.

The outdoor air damper shall close to minimum position when the discharge air temperature falls below the low limit setpoint or economizer operation is disabled via the network input (Econ_Disable).

The outdoor air damper shall close to minimum position when the outdoor air temperature exceeds the changeover setpoint (default 68°F).

The outdoor air damper shall be controlled with a proportional control loop based upon the deviation from setpoint. The outdoor air damper shall begin to modulate open from minimum position when the space temperature exceeds the (space setpoint - 0.5°F). The outdoor air damper shall be fully open when the space temperature rises 1.5°F above the setpoint. Except as noted in the paragraphs above, the outdoor air damper shall not close beyond minimum position during occupied operation.

E) Electric Heat Only

Fan Operation

The supply fan shall run continuously in the occupied and tenant (unoccupied) override modes. The fan shall cycle with calls for cooling or heating in the unoccupied mode.

Cooling Operation

When the space temperature exceeds the cooling setpoint, the supply fan shall start (Unoccupied mode).

Heating Operation

There is a fixed 15-second delay between the engagement of each electric heat stage. Each electric heat stage must be engaged for 1 minute (minimum ON timer) and each stage cannot be re-engaged for 1 minute after being switched OFF (minimum OFF timer). These delays are built into the unit controller.

The staging delays are bypassed and all electric heat is immediately disabled when the discharge air temperature exceeds the adjustable high limit setpoint (default 130°F). Heating operation shall remain disabled until the discharge air temperature falls more than 10°F below the high limit setpoint.

If the network input is set to **Cooling Only** mode then electric heat is disabled under all conditions. If the network input is set to **Auto** or **Heat Only** modes, electric heat operation is enabled and electric heating will be automatically engaged when the discharge air temperature falls below the discharge air temperature low limit setpoint. When the discharge air temperature falls below the low limit setpoint default (55°F), the first stage of electric heat is engaged. If the temperature falls below the minimum discharge temperature setpoint (53°F), all stages of electric heat are engaged. In this condition, the integral staging timer controls the electric heat.

When the space temperature falls below the heating setpoint, electric heating shall be staged on to maintain the space temperature. A proportional-integral control loop and built-in digital sequencer shall be used to control up to 3 stages of electric heat. When the space temperature exceeds the heating setpoint, all electric heat stages shall be staged OFF.

Outdoor Air Damper Control

The outdoor air damper shall be closed in the unoccupied mode, regardless of the space temperature conditions.

The outdoor air damper shall be closed if the discharge air temperature falls below the discharge air minimum setpoint (default 53°F) and remain closed until the discharge air temperature exceeds the setpoint plus 2°F.

The outdoor air damper shall be closed if the discharge air temperature remains below the discharge air low limit setpoint (default 55°F) for more than 5 minutes. The damper shall not open until the discharge air temperature exceeds the setpoint plus 2°F.

The outdoor air damper shall be closed if the space temperature falls more than 3°F below the heating setpoint. The damper will not open until the space temperature rises within 2°F of the heating setpoint.

The outdoor air damper shall close to minimum position when the discharge air temperature falls below the low limit setpoint.

The outdoor air damper shall close to minimum position when the economizer operation is disabled via the network input.

The outdoor air damper shall close to minimum position when the outdoor air temperature exceeds 68°F.

The outdoor air damper shall be controlled with a proportional control loop based upon the deviation from setpoint. The outdoor air damper shall begin to modulate open from minimum position when the space temperature exceeds the (space setpoint - 0.5°F). The outdoor air damper shall be fully open when the space temperature rises 1.5°F above the setpoint. Except as noted in the paragraphs above, the outdoor air damper shall not close beyond minimum position during occupied operation.

F) DX Cooling Only

Fan Operation

The supply fan shall run continuously in the occupied and tenant (unoccupied) override modes. The fan shall cycle with calls for cooling or heating in the unoccupied mode.

Cooling Operation

The unit enters cooling mode via the network mode input. When no valid network input is available, the unit operates in automatic mode and engages cooling as required to maintain setpoint. Compressor operation shall be disabled when the network variable is set to disable compressor operation.

Compressor operation is subject to an integrated minimum cycle timer, except as stated. This timer requires a minimum run-time of 2 minutes and a minimum off-time of 3 minutes per cycle.

Compressor operation shall be disabled when the outdoor air temperature falls below 59°F. Compressor operation shall not be enabled until the outdoor air temperature rises above 61°F.

Compressor operation shall be immediately disabled when the refrigerant low limit switch closes. Compressor operation shall not resume until the refrigerant low limit switch opens AND the 3-minute timeguard has expired.

Compressor operation shall be immediately disabled when the water coil low limit switch closes. Compressor operation shall not resume until this limit switch opens AND the 3-minute timeguard has expired.

Compressor operation shall be immediately disabled when the discharge air temperature falls more than 4°F below the discharge air low limit setpoint (default 55°F). Compressor operation shall not resume until the discharge air temperature rises more than 2°F above the setpoint and the 3-minute timeguard has expired.

When the space temperature exceeds the cooling setpoint, the compressor shall be started. The compressor shall run until the space temperature falls 0.5°F below the cooling setpoint.

Heating Operation

The supply fan shall be engaged when the space temperature falls below the heating setpoint.

Outdoor Air Damper Control

The outdoor air damper shall be closed in the unoccupied mode, regardless of the space temperature.

The outdoor air damper shall be immediately closed if the low limit thermostat trips.

The outdoor air damper shall be immediately closed if the discharge air temperature falls more than 4°F below the low limit setpoint (default 55°F).

The outdoor air damper shall be immediately closed if the refrigerant low limit switch closes (RLL).

The outdoor air damper shall be closed if the space temperature falls more than 3°F below the heating setpoint. The damper will not open until the space temperature rises within 2°F of the heating setpoint.

The outdoor air damper shall drive closed if the discharge air temperature remains more than 2°F below the low limit setpoint for 5 minutes.

The outdoor air damper shall close to minimum position when economizer operation is disabled via the network input or the network application mode is set to heating only.

The outdoor air damper shall close to minimum position when the discharge air temperature falls more than 2°F below the low limit setpoint.

The outdoor air damper shall close to minimum position when the outdoor air temperature exceeds the changeover setpoint (default 68°F).

The outdoor air damper shall be controlled with a proportional control loop based upon the deviation from setpoint. The outdoor air damper shall begin to modulate open from minimum position when the space temperature exceeds the (space setpoint - 0.5°F). The outdoor air damper shall be fully open when the space temperature rises 1.5°F above the setpoint. Except as noted in the paragraphs above, the outdoor air damper shall not close beyond minimum position during occupied operation.

G) DX Cooling with Electric Heat

Fan Operation

The supply fan shall run continuously in the occupied and tenant (unoccupied) override modes. The fan shall cycle with calls for cooling or heating in the unoccupied mode.

Cooling Operation

Compressor operation is normally subject to a 2-minute minimum run time and a 3-minute minimum off time between cycles. The compressor shall be immediately disabled (disengaged) if the DX coil low limit switch (LLR) input closes, the discharge air falls below the minimum limit setpoint (default 53°F), or an electric heat stage is engaged. Compressor operation shall not be allowed until the DX coil low limit switch opens, the discharge air temperature rises more than 2°F above the discharge air low limit setpoint (default 55°F), and all electric heat stage outputs are disengaged.

Compressor operation shall be disabled, subject to the cycle timer, when the network calls for heating only operation, compressor operation is disabled via the network, there is a request for heating, the discharge air temperature falls below the discharge air low limit setpoint (55°F), or the outside air temperature falls below 59°F. Once disabled by the temperature setpoints, compressor operation shall not be enabled until the discharge air temperature exceeds the low limit setpoint by 2°F, and the outside air temperature exceeds 61°F.

When the space temperature exceeds the cooling setpoint and compressor operation is enabled, the compressor shall be started. The compressor shall run until the space temperature falls 0.5°F below the cooling setpoint.

Heating Operation

There is a fixed 15-second delay between the engagement of each electric heat stage. Each electric heat stage must be engaged for 1 minute (minimum ON timer) and each stage cannot be re-engaged for 1 minute after being switched OFF (minimum OFF timer). These delays are built into the unit controller.

The staging delays are bypassed and all electric heat is immediately disabled when the discharge air temperature exceeds the adjustable high limit setpoint (default 130°F). Heating operation shall remain disabled until the discharge air temperature falls more than 10°F below the high limit setpoint.

If the network input is set to **Cooling Only** mode then electric heat is disabled under all conditions. If the network input is set to **Auto** or **Heat Only** modes, electric heat operation is enabled and electric heating will be automatically engaged when the discharge air temperature falls below the discharge air temperature low limit setpoint. When the discharge air temperature falls below the low limit setpoint default (55°F), the first stage of electric heat is engaged. If the temperature falls below the minimum discharge temperature setpoint (53°F), all stages of electric heat are engaged. In this condition, the integral staging timer controls the electric heat.

When the space temperature falls below the heating setpoint, electric heating shall be staged on to maintain the space temperature. A proportional-integral control loop and built-in digital sequencer shall be used to control up to 3 stages of electric heat. When the space temperature exceeds the heating setpoint, all electric heat stages shall be staged OFF.

Outdoor Air Damper Control

The outdoor air damper shall be closed in the unoccupied mode, regardless of the space temperature conditions.

The outdoor air damper shall be closed if the discharge air temperature falls below the discharge air minimum setpoint (default 53°F) and remain closed until the discharge air temperature exceeds the setpoint plus 2°F.

The outdoor air damper shall be closed if the discharge air temperature remains below the discharge air low limit setpoint (default 55°F) for more than 5 minutes. The damper shall not open until the discharge air temperature exceeds the setpoint plus 2°F.

The outdoor air damper shall be closed if the space temperature falls more than 3°F below the heating setpoint. The damper will not open until the space temperature rises within 2°F of the heating setpoint.

The outdoor air damper shall close to minimum position when the discharge air temperature falls below the low limit setpoint.

The outdoor air damper shall close to minimum position when the economizer operation is disabled via the network input.

The outdoor air damper shall close to minimum position when the outdoor air temperature exceeds 68°F.

The outdoor air damper shall be controlled with a proportional control loop based upon the deviation from setpoint. The outdoor air damper shall begin to modulate open from minimum position when the space temperature exceeds the (space setpoint - 0.5°F). The outdoor air damper shall be fully open when the space temperature rises 1.5°F above the setpoint. Except as noted in the paragraphs above, the outdoor air damper shall not close beyond minimum position during occupied operation.

H) DX Cooling with Wet Heat, Damper Control

Fan Operation

The supply fan shall run continuously in the occupied and tenant (unoccupied) override modes. The fan shall cycle with calls for cooling or heating in the unoccupied mode.

Cooling Operation

The unit enters cooling mode via the network mode input. When no valid network input is available, the unit operates in automatic mode and engages cooling as required to maintain setpoint. Compressor operation shall be disabled when the network variable is set to disable compressor operation.

Compressor operation is subject to an integrated minimum cycle timer, except as stated. This timer requires a minimum run-time of 2 minutes and a minimum off-time of 3 minutes per cycle.

Compressor operation shall be disabled when the outdoor air temperature falls below 59°F. Compressor operation shall not be enabled until the outdoor air temperature rises above 61°F.

Compressor operation shall be immediately disabled when the refrigerant low limit switch closes. Compressor operation shall not resume until the refrigerant low limit switch opens AND the 3-minute timeguard has expired.

Compressor operation shall be immediately disabled when the water coil low limit switch closes. Compressor operation shall not resume until this limit switch opens AND the 3-minute timeguard has expired.

Compressor operation shall be immediately disabled when the discharge air temperature falls more than 4°F below the discharge air low limit setpoint (default 55°F). Compressor operation shall not resume until the discharge air temperature rises more than 2°F above the setpoint and the 3-minute timeguard has expired.

Compressor operation shall be disabled when there is an active call for heating.

When the space temperature exceeds setpoint, the compressor shall start and the face & bypass damper driven open to the coil face. The compressor shall run until the space falls 0.5°F below the cooling setpoint.

Heating Operation

The unit enters heating mode via the network mode input. When no valid network input is available, the unit operates in automatic mode and engages heating as required to maintain setpoint.

The face and bypass damper moves to bypass position and the heating end-of-cycle (EOC) valve closes when the discharge air temperature exceeds the high limit setpoint (default 130°F). This damper and valve shall not return to normal control until the discharge air temperature falls more than 10°F below the high limit setpoint.

The face and bypass damper shall move to full face airflow and the heating EOC valve shall open when the low limit thermostat trips (closes) or the discharge air temperature falls below the low limit setpoint (default 55°F). The damper and valve shall return to normal operation when the low limit thermostat opens AND the discharge air temperature exceeds the discharge air temperature low limit by 2°F.

When the space temperature falls below the heating setpoint, a proportional-integral control loop positions the face and bypass damper to maintain the space temperature. The heating EOC valve opens when the face and bypass damper opens with a call for heating.

The heating EOC valve opens when the outside air temperature falls below 40°F.

Radiation Heating Control (Optional)

The radiation heating output is enabled ONLY when the unit is not in cooling mode via the network input.

The radiation heating control output shall be energized when the space temperature falls more than 0.5°F below the heating setpoint. This output shall de-energize when the space temperature exceeds the heating setpoint by 0.5°F.

Outdoor Air Damper Control

The outdoor air damper shall be closed in the unoccupied mode, regardless of the space temperature.

The outdoor air damper shall be immediately closed if the low limit thermostat trips.

The outdoor air damper shall be immediately closed if the discharge air temperature falls more than 4°F below the low limit setpoint (default 55°F).

The outdoor air damper shall be closed if the refrigerant low limit switch closes (RLL) or if the space temperature falls more than 3°F below the heating setpoint. The damper will not open until RLL opens and the space temperature rises within 2°F of the heating setpoint.

The outdoor air damper shall drive closed if the discharge air temperature remains more than 2°F below the low limit setpoint for 5 minutes.

The outdoor air damper shall close to minimum position when economizer operation is disabled via the network input, the network application mode is set to heating only, when the discharge air temperature falls more than 2°F below the low limit setpoint, or the outdoor air exceeds the changeover setpoint (default 68°F).

The outdoor air damper shall be controlled with a proportional control loop based upon the deviation from setpoint. The outdoor air damper shall begin to modulate open from minimum position when the space temperature exceeds the (space setpoint - 0.5°F). The outdoor air damper shall be fully open when the space temperature rises 1.5°F above the setpoint. Except as noted in the paragraphs above, the outdoor air damper shall not close beyond minimum position during occupied operation.

I) DX Cooling with Wet Heat, Valve Control

Fan Operation

The supply fan shall run continuously in the occupied and tenant (unoccupied) override modes. The fan shall cycle with calls for cooling or heating in the unoccupied mode.

Cooling Operation

The unit enters cooling mode via the network mode input. When no valid network input is available, the unit operates in automatic mode and engages cooling as required to maintain setpoint. Compressor operation shall be disabled when the network variable is set to disable compressor operation.

Compressor operation is subject to an integrated minimum cycle timer, except as stated. This timer requires a minimum run-time of 2 minutes and a minimum off-time of 3 minutes per cycle.

Compressor operation shall be disabled when the outdoor air temperature falls below 59°F. Compressor operation shall not be enabled until the outdoor air temperature rises above 61°F.

Compressor operation shall be immediately disabled when the refrigerant low limit switch closes. Compressor operation shall not resume until the refrigerant low limit switch opens AND the 3-minute timeguard has expired.

Compressor operation shall be immediately disabled when the water coil low limit switch closes. Compressor operation shall not resume until this limit switch opens AND the 3-minute timeguard has expired.

Compressor operation shall be immediately disabled when the discharge air temperature falls more than 4°F below the discharge air low limit setpoint (default 55°F). Compressor operation shall not resume until the discharge air temperature rises more than 2°F above the setpoint and the 3-minute timeguard has expired.

Compressor operation shall be disabled when there is an active call for heating.

When the space temperature exceeds the cooling setpoint, the compressor shall be started. The compressor shall run until the space temperature falls 0.5°F below the cooling setpoint.

Heating Operation

The unit enters heating mode via the network mode input. When no valid network input is available, the unit operates in automatic mode and engages heating as required to maintain setpoint.

The heating valve closes when the discharge air temperature exceeds the high limit setpoint (default 130°F). This valve shall not return to normal control until the discharge air temperature falls more than 10°F below the high limit setpoint.

The heating valve shall drive open when the low limit thermostat trips (closes) or the discharge air temperature falls below the discharge air temperature low limit setpoint (default 55°F). The valve shall return to normal operation when the low limit thermostat opens AND the discharge air temp. exceeds the discharge air temperature low limit by 2°F.

When the space temperature falls below the heating setpoint, a proportional-integral control loop positions the heating valve to maintain the space temperature.

Radiation Heating Control (Optional)

The radiation heating output is enabled ONLY when the unit is not in cooling mode via the network input.

The radiation heating control output shall be energized when the space temperature falls more than 0.5°F below the heating setpoint. This output shall be de-energized when the space temperature exceeds the heating setpoint by 0.5°F.

Outdoor Air Damper Control

The outdoor air damper shall be closed in the unoccupied mode, regardless of the space temperature.

The outdoor air damper shall be immediately closed if the low limit thermostat trips.

The outdoor air damper shall be immediately closed if the discharge air temperature falls more than 4°F below the low limit setpoint (default 55°F).

The outdoor air damper shall be immediately closed if the refrigerant low limit switch closes (RLL).

The outdoor air damper shall be closed if the space temperature falls more than 3°F below the heating setpoint. The damper will not open until the space temperature rises within 2°F of the heating setpoint.

The outdoor air damper shall drive closed if the discharge air temperature remains more than 2°F below the low limit setpoint for 5 minutes.

The outdoor air damper shall close to minimum position when economizer operation is disabled via the network input or the network application mode is set to heating only.

The outdoor air damper shall close to minimum position when the discharge air temperature falls more than 2°F below the low limit setpoint.

The outdoor air damper shall close to minimum position when the outdoor air temperature exceeds the changeover setpoint (default 68°F).

The outdoor air damper shall be controlled with a proportional control loop based upon the deviation from setpoint. The outdoor air damper shall begin to modulate open from minimum position when the space temperature exceeds the (space setpoint - 0.5°F). The outdoor air damper shall be fully open when the space temperature rises 1.5°F above the setpoint. Except as noted in the paragraphs above, the outdoor air damper shall not close beyond minimum position during occupied operation.

J) Chilled Water Cooling with Electric Heat, Damper Control

Fan Operation

The supply fan shall run continuously in the occupied and tenant (unoccupied) override modes. The fan shall cycle with calls for cooling or heating in the unoccupied mode.

Cooling Operation

Cooling operation is disabled when the network input is set to **Heating Only** mode.

The end-of-cycle (EOC) valve shall be opened when the low limit thermostat trips (closes) and the damper shall move to full bypass position.

If the discharge air temperature falls below the low limit setpoint (default 55°F), the damper shall move to full bypass position and the cooling end-of-cycle (EOC) valve shall close. The damper and valve shall not return to normal control until the discharge air temperature exceeds the setpoint by more than 2°F.

When the space temperature exceeds the cooling setpoint, a proportional-integral control loop shall position the face and bypass damper to maintain the space temperature. The cooling EOC valve opens when the damper opens to the coil face for cooling.

Heating Operation

There is a fixed 15-second delay between the engagement of each electric heat stage. Each electric heat stage must be engaged for 1 minute (minimum ON timer) and each stage cannot be re-engaged for 1 minute after being switched OFF (minimum OFF timer). These delays are built into the unit controller.

The face and bypass damper is opened to the full face position with a call for electric heat.

The staging delays are bypassed and all electric heat is immediately disabled when the discharge air temperature exceeds the adjustable high limit setpoint (default 130°F). Heating operation shall remain disabled until the discharge air temperature falls more than 10°F below the high limit setpoint.

If the network input is set to **Cooling Only** mode then electric heat is disabled under all conditions. If the network input is set to **Auto** or **Heat Only** modes, electric heat operation is enabled and electric heating will be automatically engaged when the discharge air temperature falls below the discharge air temperature low limit setpoint. When the discharge air temperature falls below the low limit setpoint default (55°F), the first stage of electric heat is engaged. If the temperature falls below the minimum discharge temperature setpoint (53°F), all stages of electric heat are engaged. In this condition, the integral staging timer controls the electric heat.

When the space temperature falls below the heating setpoint, electric heating shall be staged on to maintain the space temperature. A proportional-integral control loop and built-in digital sequencer shall be used to control up to 3 stages of electric heat. When the space temperature exceeds the heating setpoint, all electric heat stages shall be staged OFF.

Outdoor Air Damper Control

The outdoor air damper shall be closed in the unoccupied mode, regardless of the space temperature.

The outdoor air damper shall close when the low limit t'stat trips (closes) and the damper shall not open until the t'stat opens.

The outdoor air damper shall close when the discharge air temperature falls below the minimum low limit setpoint (default 53°F). The damper shall not open until the discharge air temperature exceeds the setpoint by more than 2°F.

The outdoor air damper shall be closed if the space temperature rises more than 3°F above the cooling setpoint, while chilled water is available (changeover t'stat closed). The damper will not open until the space temperature falls to less than 2°F above the cooling setpoint. If chilled water is not available, the damper continues to operate under normal control.

The outdoor air damper shall be closed if the space temperature falls more than 3°F below the heating setpoint. The damper will not open until the space temperature rises to within 2°F of the heating setpoint.

The outdoor air damper shall close to minimum position when the discharge air temperature falls below the low limit setpoint (default 55°F). The damper shall fully close when this condition is maintained for more than 5 minutes. The damper shall return to normal control when the discharge air temperature rises more than 2°F above the setpoint.

The outdoor air damper shall close to minimum position when the economizer operation is disabled via the network input.

The outdoor air damper shall close to minimum position when the outdoor air temperature exceeds 68°F, while chilled water is available. If chilled water is unavailable, the damper continues to operate under normal control.

The outdoor air damper shall be controlled with a proportional control loop based upon the deviation from setpoint. The outdoor air damper shall begin to modulate open from minimum position when the space temperature exceeds the (space setpoint - 0.5°F). The outdoor air damper shall be fully open when the space temperature rises 1.5°F above the setpoint. Except as noted in the paragraphs above, the outdoor air damper shall not close beyond minimum position during occupied operation.

K) Chilled Water Cooling with Electric Heat, Valve Control

Fan Operation

The supply fan shall run continuously in the occupied and tenant (unoccupied) override modes. The fan shall cycle with calls for cooling or heating in the unoccupied mode.

Cooling Operation

Cooling operation is disabled when the network input is set to **Heating Only** mode.

If the discharge air temperature falls below the low limit setpoint (default 55°F), the chilled water valve shall be closed. The valve shall remain closed until the discharge air temperature rises more than 2°F above setpoint.

The chilled water valve shall be opened when the low limit thermostat trips (closes) and this valve shall remain open until the low limit thermostat opens.

When the space temperature exceeds the cooling setpoint, a proportional-integral control loop shall position the control valve to maintain the space temperature.

Heating Operation

There is a fixed 15-second delay between the engagement of each electric heat stage. Each electric heat stage must be engaged for 1 minute (minimum ON timer) and each stage cannot be re-engaged for 1 minute after being switched OFF (minimum OFF timer). These delays are built into the unit controller.

The staging delays are bypassed and all electric heat is immediately disabled when the discharge air temperature exceeds the adjustable high limit setpoint (default 130°F). Heating operation shall remain disabled until the discharge air temperature falls more than 10°F below the high limit setpoint.

If the network input is set to **Cooling Only** mode then electric heat is disabled under all conditions. If the network input is set to **Auto** or **Heat Only** modes, electric heat operation is enabled and electric heating will be automatically engaged when the discharge air temperature falls below the discharge air temperature low limit setpoint. When the discharge air temperature falls below the low limit setpoint default (55°F), the first stage of electric heat is engaged. If the temperature falls below the minimum discharge temperature setpoint (53°F), all stages of electric heat are engaged. In this condition, the integral staging timer controls the electric heat.

When the space temperature falls below the heating setpoint, electric heating shall be staged on to maintain the space temperature. A proportional-integral control loop and built-in digital sequencer shall be used to control up to 3 stages of electric heat. When the space temperature exceeds the heating setpoint, all electric heat stages shall be staged OFF.

Outdoor Air Damper Control

The outdoor air damper shall be closed in the unoccupied mode, regardless of the space temperature.

The outdoor air damper shall close when the low limit t'stat trips (closes) and the damper shall not open until the t'stat opens.

The outdoor air damper shall close when the discharge air temperature falls below the minimum low limit setpoint (default 53°F). The damper shall not open until the discharge air temperature exceeds the setpoint by more than 2°F.

The outdoor air damper shall be closed if the space temperature rises more than 3°F above the cooling setpoint, while chilled water is available (changeover t'stat closed). The damper will not open until the space temperature falls to less than 2°F above the cooling setpoint. If chilled water is not available, the damper continues to operate under normal control.

The outdoor air damper shall be closed if the space temperature falls more than 3°F below the heating setpoint. The damper will not open until the space temperature rises to within 2°F of the heating setpoint.

The outdoor air damper shall close to minimum position when the discharge air temperature falls below the low limit setpoint (default 55°F). The damper shall fully close when this condition is maintained for more than 5 minutes. The damper shall return to normal control when the discharge air temperature rises more than 2°F above the setpoint.

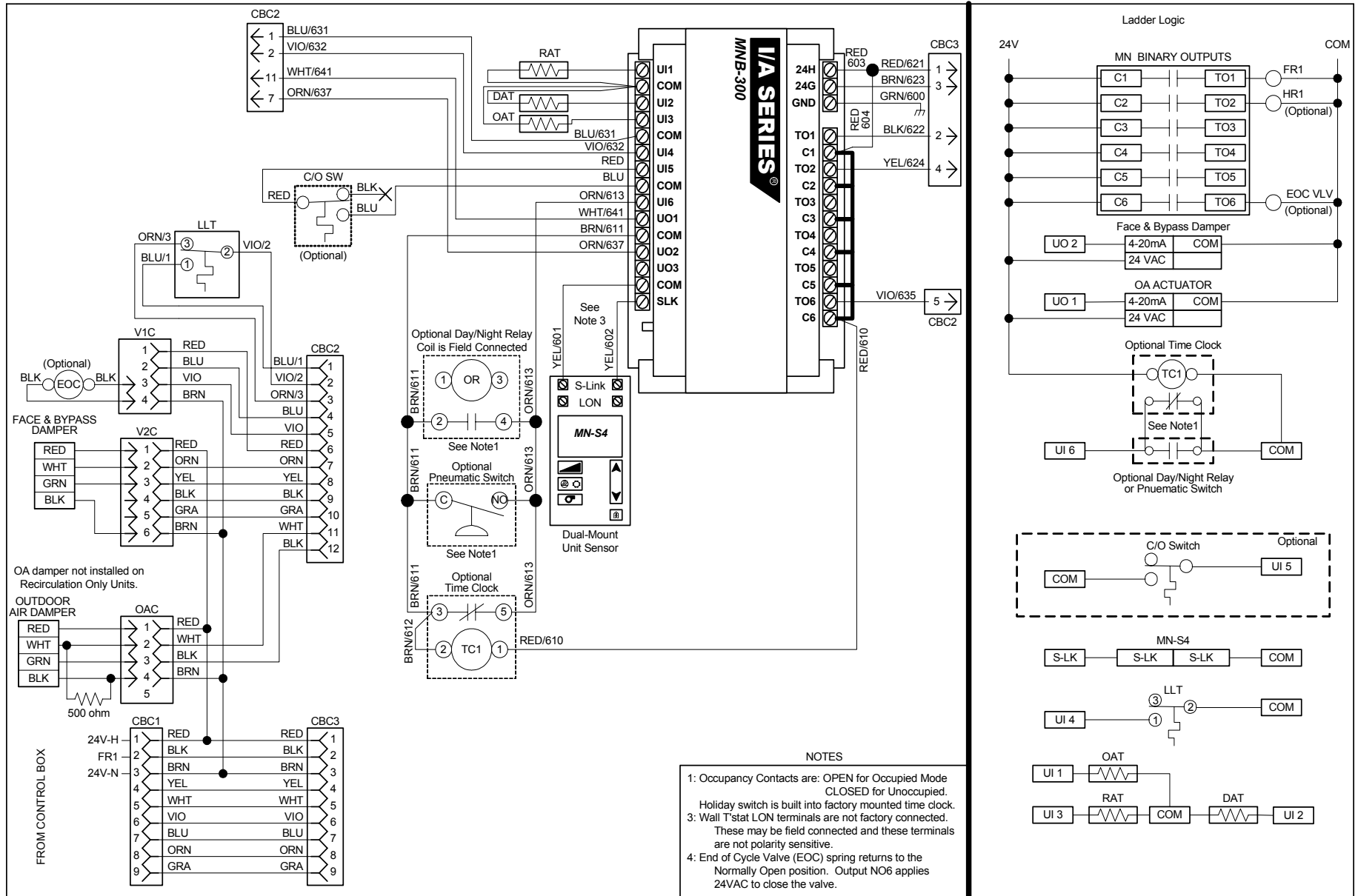
The outdoor air damper shall close to minimum position when the economizer operation is disabled via the network input.

The outdoor air damper shall close to minimum position when the outdoor air temperature exceeds 68°F, while chilled water is available. If chilled water is unavailable, the damper continues to operate under normal control.

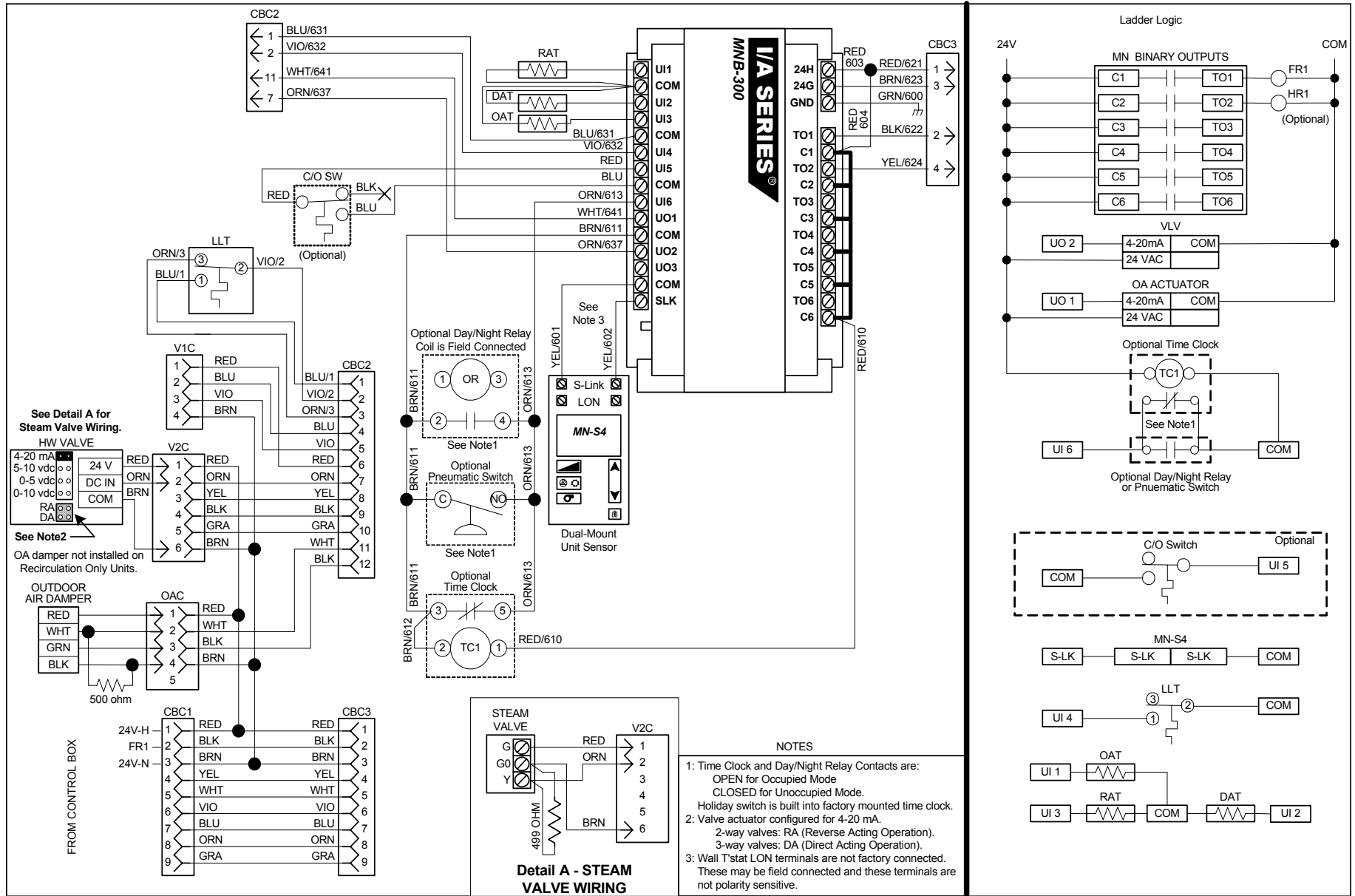
The outdoor air damper shall be controlled with a proportional control loop based upon the deviation from setpoint. The outdoor air damper shall begin to modulate open from minimum position when the space temperature exceeds the (space setpoint - 0.5°F). The outdoor air damper shall be fully open when the space temperature rises 1.5°F above the setpoint. Except as noted in the paragraphs above, the outdoor air damper shall not close beyond minimum position during occupied operation.

7) Typical Unit Wiring

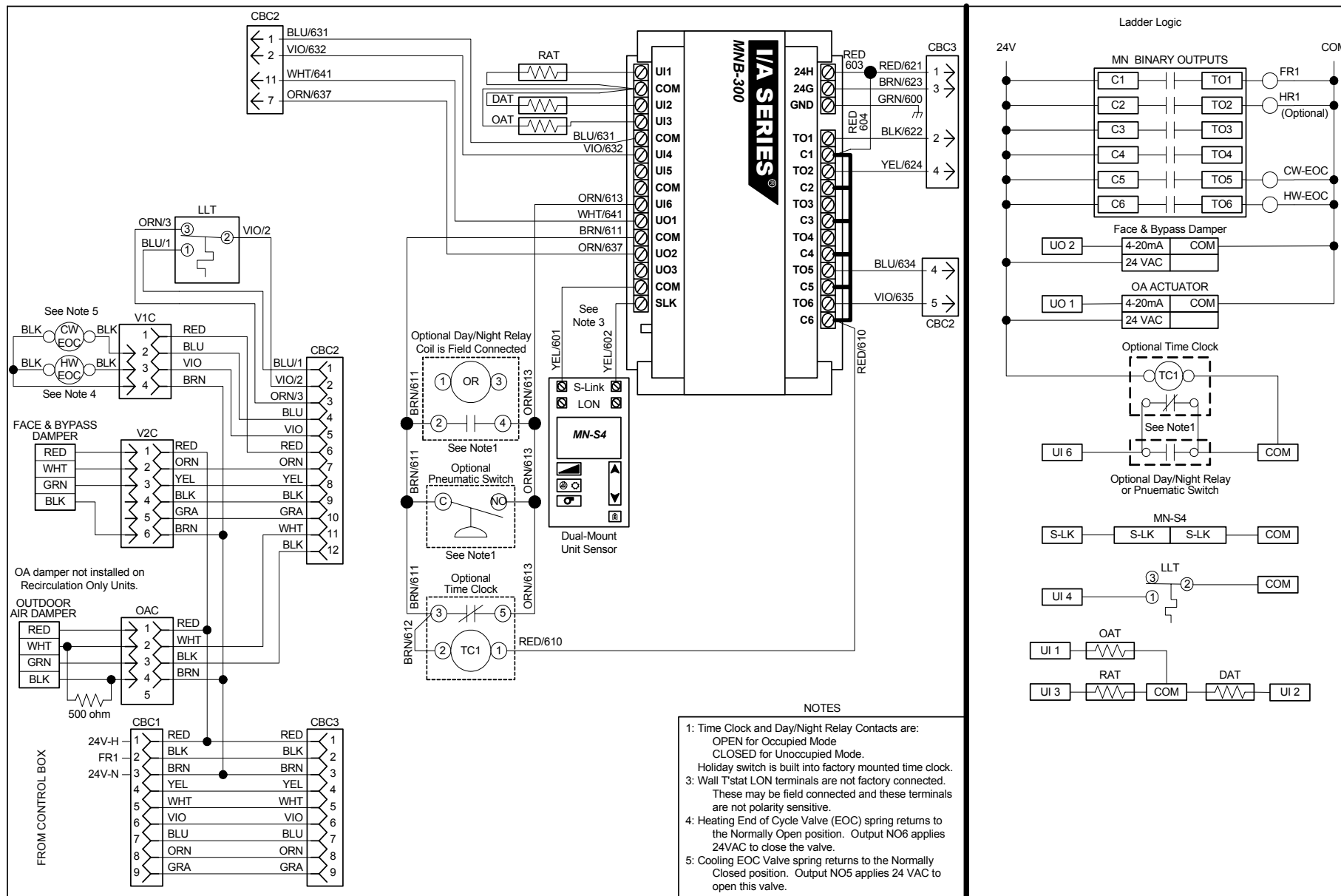
A) Control Diagram, 2-pipe Damper Control



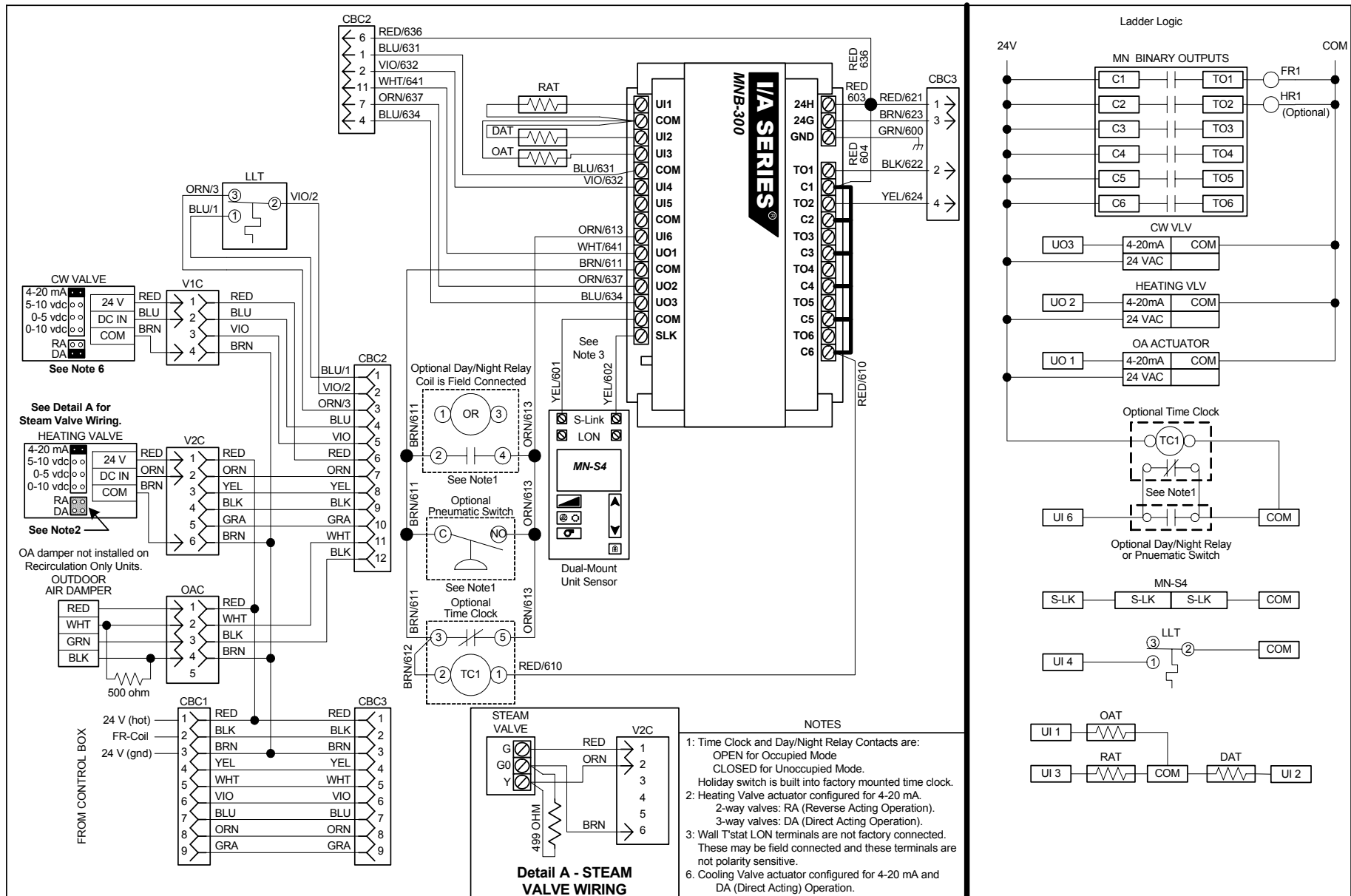
B) Control Diagram, 2-pipe Valve Control



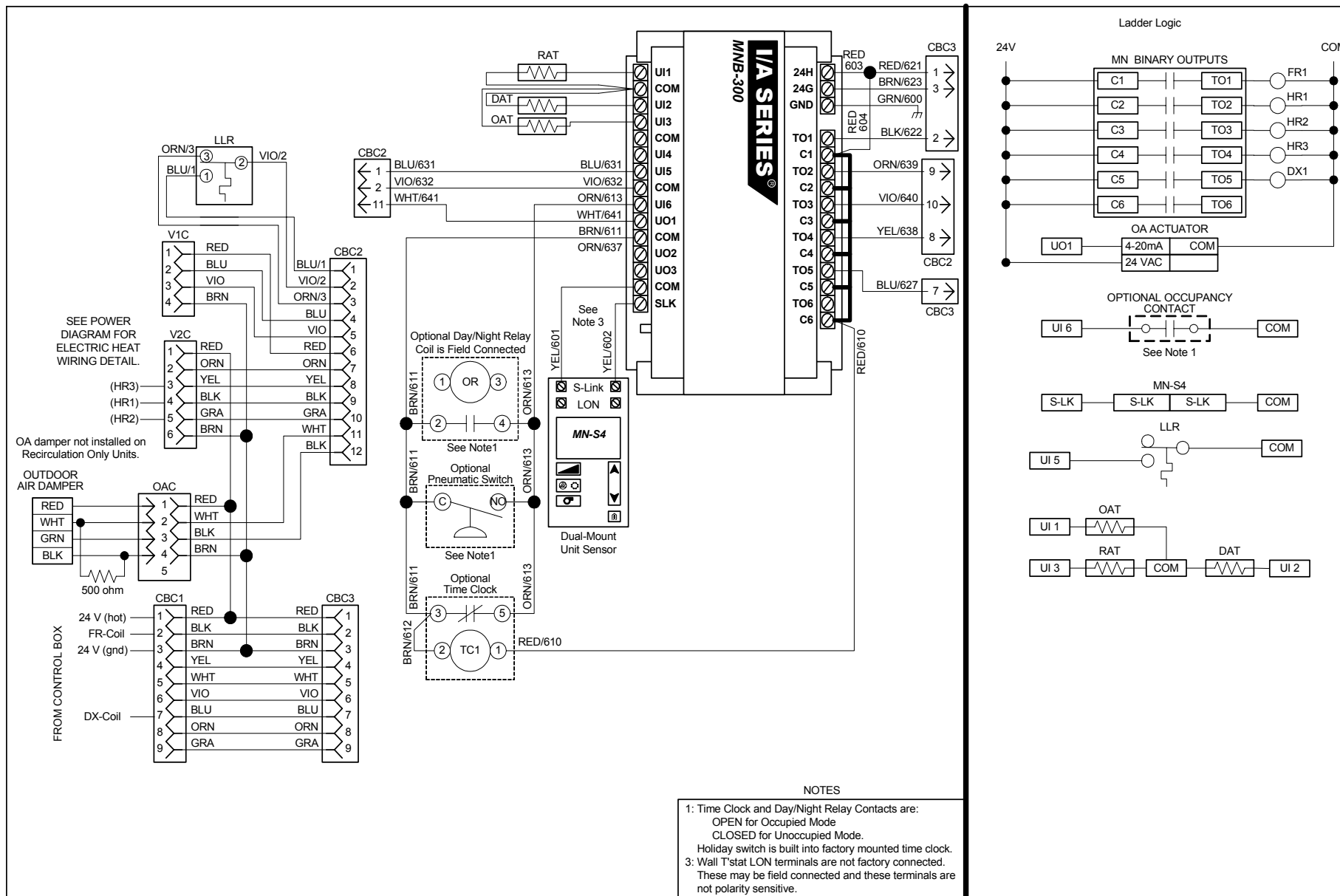
C) Control Diagram, 4-pipe, Damper Control



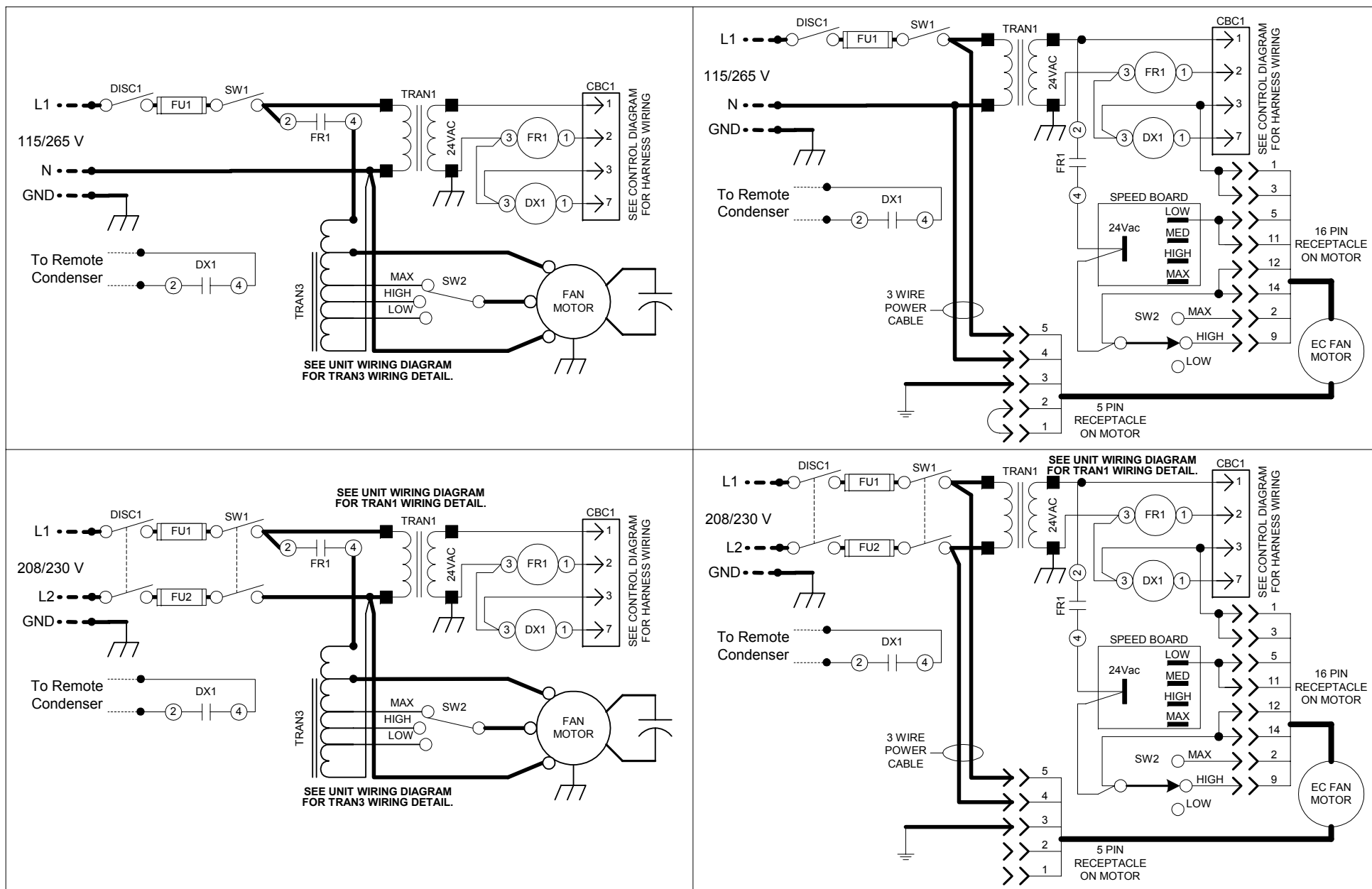
D) Control Diagram, 4-pipe, Valve Control



E) Control Diagram, DX with Electric Heat



F) Typical Power Diagrams



8) Parts List

A) Standard Control Parts

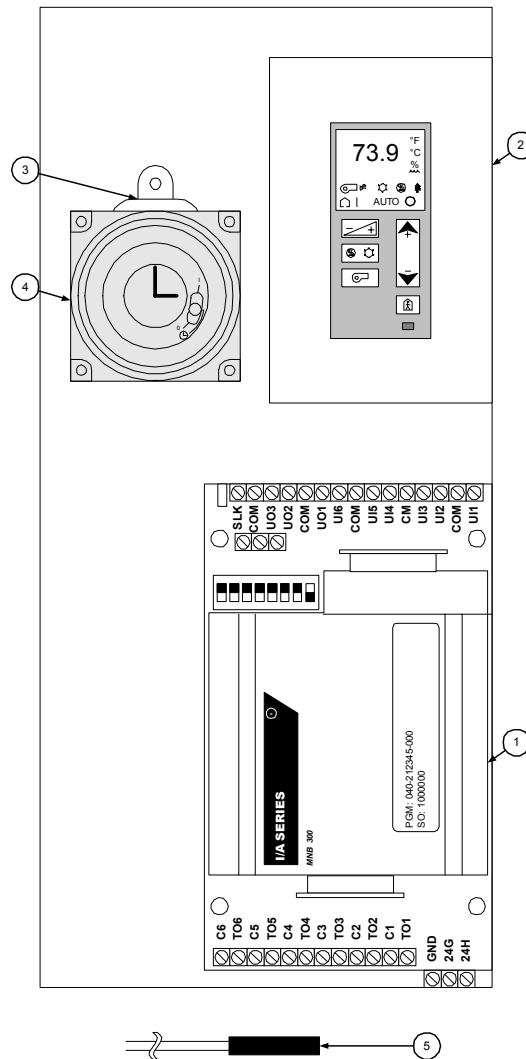


Figure 4

Ref.	Description	P/N
1	MNB Unit Controller	010-075007-000
2	MN-S4 Dual Mount Thermostat	UV0395
3	Day/Night Relay	112000
4	24V, 7Day Timeclock	UV0400
5	Discharge, Room, or Outdoor Air Temperature Sensor	UV0401
Not shown	Fan Relay	112000
Not shown	Outdoor Air Damper Actuator	103209
Not shown	Face & Bypass Damper Actuator	103208

B) Instructions for Ordering Replacement Controllers

When ordering a replacement controller, it is necessary to provide information to determine which control program must be loaded into the controller. The factory can determine which program is needed from the complete unit model number and serial number; however, for quickest service, please provide the control program name (PGM) and original sales order (SO) number listed on the program ID label of the original unit controller. See figure 4 for the location of this label.

9) Troubleshooting Chart

Symptom	Check	Explanation
Fan Runs Continuously	Unit in Occupied Mode?	Fan runs continuously in Occupied and Tenant Override Modes.
	Unit in Unoccupied Mode?	Shut down is delayed 1 minute on transition to unoccupied mode.
	Discharge Air Temp. Input	Fan is forced on when DAT exceeds 130°F or when DAT falls below DAT low limit setpoint. Fan is locked-on until DAT is between the low limit setpoint and 110°F. The fan is also engaged if the DAT sensor fails.
	Space Temp & Setpoints	Fan operates with call for cooling or heating. If a conditioning mode is NOT available, the unit will run the fan. For example, on a heating only unit, the supply fan will be engaged when the space temperature exceeds the unoccupied cooling setpoint.
	Sensor Values & Locations	Verify that the room, outdoor, and discharge air temperature sensors are installed in the correct locations and that they are operating normally.
	Controller NO1 Output	NO1 is energized (24 VAC) with a call for the fan.
	Fan Relay	NO1 energizes the fan relay. Check the wiring and relay contacts.
Fan Won't Run	Unit in Unoccupied Mode?	The fan operates only with calls for heating or cooling.
	Wall 'stat Fan Icon OFF?	If the fan icon is not ON, the controller is not calling for the fan. Check the setpoints, space conditions, and occupancy modes.
	Wall 'stat Fan Icon ON?	If the fan icon is ON, the controller has engaged the fan output.
	Controller NO1 Output	If the fan icon is ON, 24 VAC should be on the NO1 terminal. If no voltage is present, Make sure that there is continuity between the controller NO1 pin and the subbase.
	Fan Relay	Verify that the fan relay coil is connected to NO1 and neutral. When the controller engages the fan, a nominal 24V is applied across the coil of the fan relay. Check the fan motor wiring and relay contacts.
	Fan Motor	Refer to the unit wiring diagram; check the fan motor wiring.
Space Too Warm (Heat Mode)	Discharge Air Temp. Input	When the DAT falls below the DAT low limit setpoint or the DAT sensor fails, heat is engaged. Where applicable: Heating Valve is Opened. Electric Heat is Engaged. Face & Bypass damper driven to full face position. Outdoor air damper is closed.
	Sensor Values & Locations	Verify that the room, outdoor, and discharge air temperature sensors are installed in the correct locations and that they are operating normally.
	Water Coil Low Limit Switch	When the water coil low limit switch trips, it shorts the OAT sensor input to signal the low limit condition. If the switch trips or the OAT sensor fails, heat is engaged as described above.
	Outdoor Air Temp. Input	Check the heating valve operation - HEATING VALVE MUST BE PIPED FOR NORMALLY OPEN OPERATION.
	Heating Valve	Refer to the unit wiring diagram. Check for a stuck contact on the electric heat control relays.
Space Too Warm (Cool Mode)	Discharge Air Temp. Input	When the DAT falls below the DAT low limit setpoint or the DAT sensor fails, cooling is disabled. Where applicable: Cooling Valve is Closed. Face & Bypass damper driven to full bypass position. Compressor is disabled. Outdoor air damper is closed.
	Sensor Values & Locations	Verify that the room, outdoor, and discharge air temperature sensors are installed in the correct locations and that they are operating normally.
	Water Coil Low Limit Switch	When the water coil low limit switch trips, it shorts the OAT sensor input to signal the low limit condition. If the switch trips or the OAT sensor fails, the outdoor air damper is closed.
	Outdoor Air Temp. Input	On 2-pipe cooling and heating units the changeover switch closes when the water supply falls below 63°F. Is this switch installed so that it properly detects the supply water temperature?
	Changeover (Aquastat)	Compressor operation is disabled when the RLL switch closes.
	Refrigerant Low Limit (Optional)	Does the cooling valve open? Is the heating valve closed?
	Cooling/Heating Valve(s)	Is chilled water available at correct temperature and flow rate? Is compressor operation disabled?
Space Too Cool (Cool Mode)	Adequate Cooling Capacity	Check the location and operation of the room (return) air temperature (RAT) sensor or the wall 'stat. The RAT must be disconnected when the wall 'stat is mounted in the space and used to detect space temperature.
	Room Air Sensor	Verify that the room, outdoor, and discharge air temperature sensors are installed in the correct locations and that they are operating normally.
	Sensor Values & Locations	Verify cooling valve operation.
Space Too Cool (Heat Mode)	Cooling Valve Operation	Heating is disabled when the DAT input exceeds 130°F or the DAT sensor fails. Heating remains disabled until the DAT falls below 110°F.
	Discharge Air Temp Input	Verify that the room, outdoor, and discharge air temperature sensors are installed in the correct locations and that they are operating normally.
	Sensor Values & Locations	Does the heating valve open? Is the cooling valve closed?
	Cooling/Heating Valve(s)	Is hot water/steam available at correct temperature and flow rate?
Outdoor Air Damper Won't Close	Adequate Heating Capacity	Outdoor air damper will open to minimum position in occupied mode and tenant override modes.
	Unit in Occupied Mode?	Measure the control signal to the actuator. The actuator will drive fully closed with a signal of 4 mA or less. The actuator will drive fully open with a signal of 20 mA. Verify that the outdoor air/ return air dampers can turn without binding.
Outdoor Air Damper Won't Open	Damper Actuator	The outdoor air damper is closed during unoccupied mode.
	Unit in Occupied Mode?	When the DAT falls below the DAT low limit setpoint or the DAT sensor fails, the Outdoor air damper is closed.
	Discharge Air Temp. Input	When the water coil low limit switch trips, it shorts the OAT sensor input to signal the low limit condition. If the switch trips or the OAT sensor fails, the damper closes.
	Water Coil Low Limit Switch	If the space temperature falls more than 3°F below the heating setpoint, the outdoor air damper closes. The damper shall remain closed until the space temperature is within 2° of the heating setpoint. On chilled water units, if the space temperature rises more than 3°F above the cooling setpoint the outdoor air damper will close. The damper shall remain closed until the space temperature is within 2° of the cooling setpoint.
Outdoor Air Damper Won't Open	Space Temperature Input	