iWorx by Taco Electronic Solutions

Application Guide

505-054

VAV Series Auxiliary Sensor Module

Self-Contained Interoperable Controller Model CMV

SUPERSEDES: April 6, 2017 EFFECTIVE: April 6, 2017

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VAV2 SERIES

The VAV2 Series is comprised of two stand-alone microprocessor-based controllers for either pressure independent Variable Air Volume terminal units (VAVI-2) or pressure dependent Variable Volume and Temperature terminal units (VAVD-2). This document contains information for both the VAVI-2 and VAVD-2 controllers. Information that is specific to one controller is marked as either VAVI-2 or VAVD-2.

The VAV2 Series controls commercial unitary heating, ventilating, and air conditioning (HVAC) equipment. It performs a wide range of terminal box applications with various combinations of sensors and actuators.

Overview

Digital input is provided for occupancy (OCC) sensing. Analog inputs are provided for a primary air temperature sensor, an analog 0-5VDC IAQ Sensor, and a discharge air temperature sensor. A two-wire serial interface is provided for a thermostat. The controller incorporates digital outputs (triacs) for fan start/stop and two-stage heating or heating valve open/close.

An analog output is provided for modulated reheat control. An integrated actuator is included for damper positioning. Two analog outputs are provided for modulated reheat control and a 0-10VDC fan.

The controller is based on LonWorks® networking technology. It can be networked to a higher-level control system for monitoring and control applications.

Features

- On-board air-flow sensor (VAVI-2)
- Integral damper actuator
- Automatic Flow Constant calculation (VAVI-2)
- Optional indoor air quality (IAQ) sensor input (0-5 VDC) with optional air quality compensation
- Optional discharge air temperature (DAT) monitoring
- Two stages of electric reheat or floating point or modulating 0-10V setpoint hot water reheat valves
- Option to use auxiliary local heat sources for first stage of heating
- Parallel or series fan
- Analog or digital fan
- Pressure independent flow control (VAVI-2)
- Pressure dependent flow control (VAVD-2)
- Individual temperature setpoints for occupied/unoccupied heating
- Thermostat with space temperature, setpoint adjust, occupancy override
- Integrates with Chilled Beam controllers (CHB1, CHB2), pressure independent Multiplex Package Unit controller (MPU), and pressure dependent Variable Air Volume Package Unit Controller (VPU).
- “Stand Alone Mode” for independent operation
- Selection between thermostat types: TS30x or 10K Precon type III thermistor
- Optional normally open dry contact occupancy sensor input
- Optional Primary Air Temperature sensor for use in "Stand Alone Mode"
- Automatic configuration with the Local Control Interface (LCI)
- Alarm/Event reporting
- Networked operation using LonWorks Technology

PURPOSE OF THIS GUIDE

The *iWorx® VAV2 Series Application Guide* provides application information for the VAV2 Series Controller.

The reader should understand basic HVAC concepts, intelligent environmental control automation, and basic LONWORKS networking and communications. This Application Guide is written for:

- Users who engineer control logic
- Users who set up hardware configuration
- Users who change hardware or control logic
- Technicians and field engineers of Taco Electronic Solutions, Inc.

REPRESENTATIONS AND WARRANTIES

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iWorx® products shall only be used for the applications identified in the product specifications and for no other purposes. For example, iWorx® products are not intended for use to support fire suppression systems, life support systems, critical care applications, commercial aviation, nuclear facilities or any other applications where product failure could lead to injury to person, loss of life, or catastrophic property damage and should not be used for such purposes.

Taco Electronic Solutions, Inc. will not be responsible for any product or part not installed or operated in conformity with the Document and instructions or which has been subject to accident, disaster, neglect, misuse, misapplication, inadequate operating environment, repair, attempted repair, modification or alteration, or other abuse. For further information, please refer to the last page of this Document for the company's Limited Warranty Statement, which is also issued with the product or available at www.taco-hvac.com.

APPLICABLE DOCUMENTATION

See the table below for additional documentation that may be applicable to this controller.

Description	Audience	Purpose
iWorx® LCI Application Guide, Document No. 505-002	– Application Engineers – Installers – Service Personnel – Start-up Technicians – End user	Provides instructions for setting up and using the iWorx® Local Control Interface.
iWorx® VPU2 Application Guide, Document No. 505-010	– Application Engineers – Installers – Service Personnel – Start-up Technicians – End user	Provides instructions for setting up and using the iWorx® VPU controller.
iWorx® MPU2 Application Guide, Document No. 505-009	– Application Engineers – Installers – Service Personnel – Start-up Technicians – End user	Provides instructions for setting up and using the iWorx® MPU controller.
iWorx® TS100 Series Installation Guide, Document No. 502-015	– Application Engineers – Installers – Service Personnel – Start-up Technicians – End user	Provides instructions for installing and using the iWorx® TS100 Series sensors.

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Description	Audience	Purpose
iWorx® TS300 Series Installation Guide, Document No. 502-017	– Application Engineers – Installers – Service Personnel – Start-up Technicians – End user	Provides instructions for installing and using the iWorx® TS300 Series sensors.
http://www.iWorxWizard.com	– Application Engineers – Wholesalers – Contractors	An on-line configuration and submittal package generator based on user input. Automatically generates bill of materials, sequence of operations, flow diagrams, wiring diagrams, points and specifications.
Additional Documentation	*LonWorks FTT-10A Free Topology Transceiver User's Guide,* published by Echelon Corporation. It provides specifications and user instructions for the FTT-10A Free Topology Transceiver. See also: www.echelon.com/support/documentation/manuals/transceivers.	

INSTALLATION INSTRUCTIONS

General

This symbol is intended to alert the user to the presence of important installation and maintenance (servicing) instructions in the literature accompanying the equipment.

WARNING: Electrical shock hazard. Disconnect **ALL** power sources when installing or servicing this equipment to prevent electrical shock or equipment damage.

Make all wiring connections in accordance with these instructions and in accordance with pertinent national and local electrical codes. Use only copper conductors.

Static Electricity

Static charges produce voltages that can damage this equipment. Follow these static electricity precautions when handling this equipment.

- Work in a static free area.
- Touch a known, securely grounded object to discharge any charge you may have accumulated.
- Use a wrist strap when handling printed circuit boards. The strap must be secured to earth ground.

Location

Avoid locations where corrosive fumes, excessive moisture, vibration or explosive vapors are present.

Avoid electrical noise interference. Do not install near large contactors, electrical machinery, or welding equipment.

This equipment is suitable for indoor or outdoor use. Preferably, or as required by National Electrical Code, the unit is intended to be installed within an electrical control enclosure. Operate where ambient temperatures do not exceed 122 °F (50 °C) or fall below 32 °F (0 °C) and relative humidity does not exceed 90%, non-condensing.

FCC Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference. This equipment can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment to a power source different from that to which the receiver is connected.
- Consult the equipment supplier or an experienced radio/TV technician for help.

You are cautioned that any changes or modifications to this equipment not expressly approved in these instructions could void your authority to operate this equipment in the United States.

BEFORE INSTALLING

About this Document

The instructions in this manual are for the Terminal Unit Controller controllers.

Inspecting the Equipment

Inspect the shipping carton for damage. If damaged, notify the carrier immediately. Inspect the equipment for damage. Return damaged equipment to the supplier.

What is Not Included with this Equipment

- A power source for the equipment electronics and peripheral devices.
- Tools necessary to install, troubleshoot and service the equipment.
- The screws or DIN rail needed to mount the device.
- Peripheral devices, such as sensors, actuators, etc.
- Cabling, cabling raceway, and fittings necessary to connect this equipment to the power source, FTT-10A network and peripheral devices.

INSTALLATION

Warning: Electrical shock hazard. To prevent electrical shock or equipment damage, disconnect **ALL** power sources to controllers and loads before installing or servicing this equipment or modifying any wiring.

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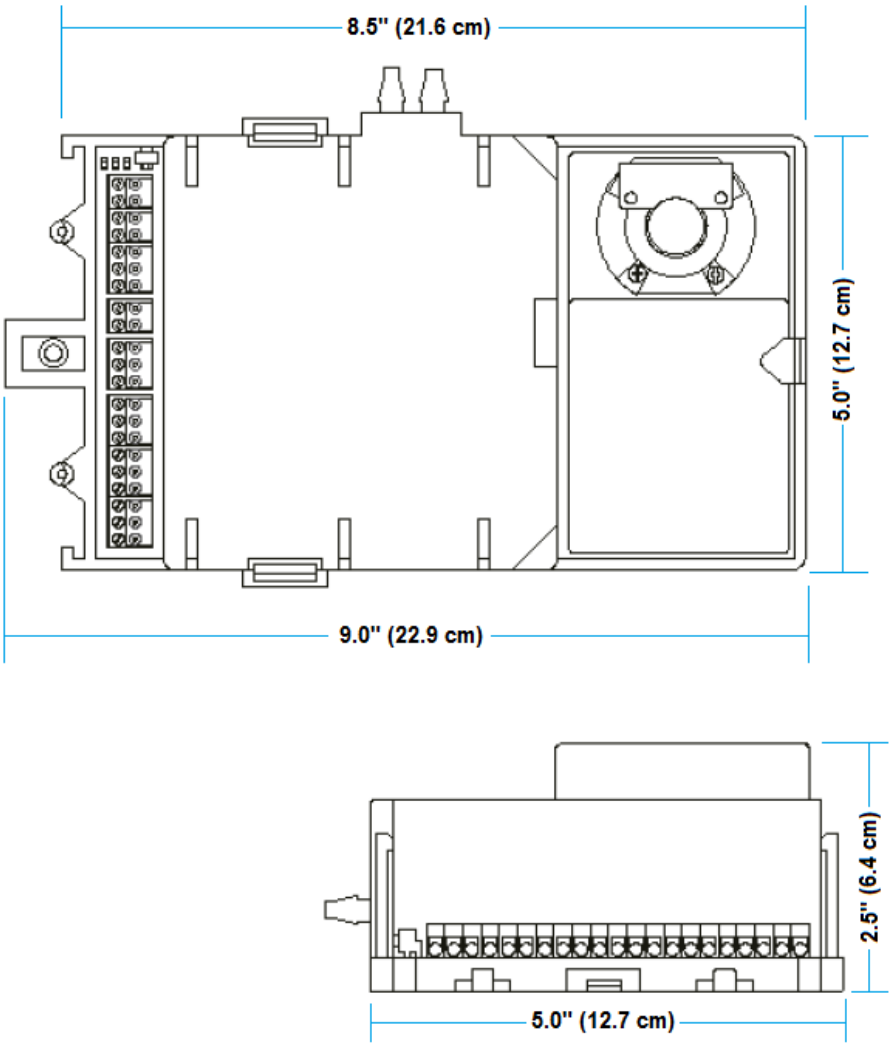
Mounting the Device

1. Open the damper halfway.
2. Press the black motor release on the motor housing and rotate the actuator so that its flat edge is parallel to the edge of the housing as shown in Figure 1.
3. Slide the controller down over the damper shaft so that the shaft goes through the round opening above the actuator motor.
4. Tighten the retaining nuts to secure the actuator to the damper shaft.
5. Remove tape that secures the mounting screw to the mounting tab at the left of the controller.
6. Drive the mounting screw through the hole in the mounting tab and into the metal of the damper box.
7. Set the motor stops to prevent the actuator motor from over driving the damper.
   a. Rotate the damper shaft until the damper is completely closed.
   b. Loosen the screw that holds the low stop, and slide it around until it rests against the actuator.
   c. Tighten the screw to secure the low stop.
   d. Rotate the damper until it is completely open and set the high stop.
8. (VAVI-2) Attach the differential pressure sensor tubes from the duct to the inputs at the top of the controller. Attach the "Low" and "High" tubes to the "Low" and "High" attachment points on the controller.
9. Wire the controller (see “Routing Cabling to the Device” below).

Figure 1: Mounting Dimensions



Routing Cabling to the Device

Cabling used to connect the power source and cabling used to connect the FTT-10A network must remain separated within the control enclosure and wiring conduit.

Grounding the Device

The ground terminal (T8) must be securely connected to earth ground. Failure to properly ground this equipment may increase the risk of electrical shock and the possibility of interference to radio/TV reception.

For best performance, connect the power supply common terminal (T7) to the same external point as the ground terminal (T8).

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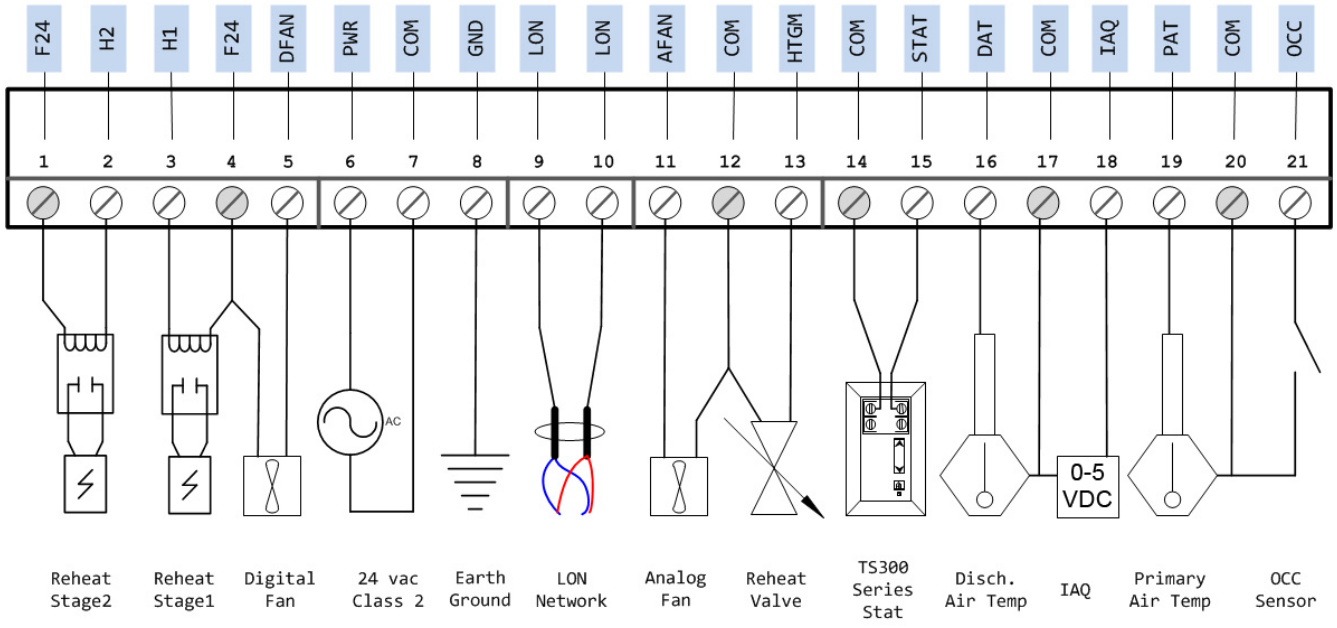
WIRING INFORMATION

WARNING: Terminals 7, 12, 14, 17 and 20 are connected internally on all Terminal Unit Controller controllers. Disconnect **ALL** power sources when installing or servicing this equipment to prevent electrical shock or equipment damage.

Figure 2: VAV2 Series Terminal Connections



Connecting Input Devices

Thermostat (STAT)

To connect a TS-3xx series sensor to the unit, attach one wire from the thermostat to STAT (T15) and the other to the adjacent common (T14). Alternately, a 10K Precon Type III thermistor may be installed at the same points when the W2 jumper is placed in the "T" position and the thermostat type is changed to Precon III.

Discharge Air Temperature (DAT)

To connect the discharge air thermistor to the unit, attach one wire from the thermistor to DAT (T16) and the other wire to the adjacent common (T17). The thermistor used must be 10K Precon Type III.

Indoor Air Quality (IAQ)

To connect the analog CO_2 level sensor to the unit, attach the positive wire from the sensor to IAQ (T18) and the ground wire to the adjacent common (T17). The sensor output must be a 0 to 5V IAQ sensor.

Primary Air Temperature (PAT)

To connect the primary air temperature to the unit, attach one wire from the thermistor to PAT (T19) and the other wire to the adjacent common (T20). The thermistor used must be 10K Precon Type III.

To connect the digital occupancy sensor to the unit, attach one wire of the sensor to OCC (T21) and the other to the

Connecting Output Devices

Heat Stage 1, 2 (H1, H2)

The heating stage outputs must be connected to 24 VAC pilot relays with EMF protection. Connect Heat Stage 1 to H1 and the adjacent common (T4). Connect Heat Stage 2 To H2 and the adjacent common (T1).

Digital Fan Start/Stop (DFAN)

The digital fan output must be connected to a 24 VAC pilot relay if the load is greater than 1 amp. If the load is less than 1 Amp, connect the fan to DFAN (T5) and the adjacent common (T4). If the controller is being used with auxiliary heat sources, this output is used as the auxiliary heat output.

Analog Fan (AFAN)

To connect the analog fan output, attach one wire to AFAN (T11) and the other wire to the adjacent common (T12).

Modulated Heating Valve (HTGM)

To connect the modulated heating valve output, attach one wire to HTGM (T13) and the other wire to the adjacent common (T12).

Other Connections

Network (LON)

Network wiring must be twisted pair. One network wire must be connected to terminal NETA (T9) and the other network wire must be connected to terminal NETB (T10). Polarity is not an issue since an FTT-10A network is used for communications.

Power (PWR)

Connect one output wire from a 24 VAC power supply to PWR (T6) and the other output wire from the power supply to the adjacent common terminal (T7).

Ground (GND)

Terminal GND (T8) must be connected to earth ground. Failure to properly ground this equipment will result in improper operation. Improper grounding may also increase the risk of electrical shock, and may increase the possibility of interference with radio and TV reception.

SPECIFICATIONS

Electrical

Inputs

- Cabling: twisted shielded pair, 18 AWG recommended—500 feet max. (152 meters)
- Resolution: 10 bit

Thermostat Network

- 12 Volt nominal, internally limited to 0.04 A

Primary Air Temperature, Discharge Air Temperature Sensors

- Precon Type III 10K thermistor

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Indoor Air Quality

- Dry Contact
- Normally open
- 5 Volts DC max

Outputs

Digital Fan Start/Stop, Heating Stages 1 & 2 or Heating Valve Open & Close

- 20 to 28 Volts AC
- 0.7A maximum each

Analog Fan, Modulated Heating Valve

- 0 to 10 Volts DC
- 2K Ohm minimum load
- 8 bit resolution

Power

Power Requirements

- 24 VAC nominal, 100VA max (requires an external class 2 supply)

Power Consumption

- 15VA with no external loads, maximum limited by the class 2 supply rating

Recommended Sensor Wire

Cable Type	Pairs	Details	Taco Catalog No.
18AWG	1	Stranded Twisted Shielded Pair, Plenum	WIR-018

FTT-10A Network

- Speed: 78KBPS
- 42.4 Volts DC max
- Cabling: Maximum node-to-node distance: 1312 feet (400 meters)
- Maximum total distance: 1640 feet (500 meters)

Cable Type	Pairs	Details	Taco Catalog No.
Level 4 22AWG (0.65mm)	1	Unshielded, Plenum, U.L. Type CMP	WIR-022

For detailed specifications, refer to the *FTT-10A Free-Topology Transceiver User's Guide* published by Echelon Corporation (www.echelon.com/support/documentation/manuals/transceivers).

Mechanical

Housing

- Dimensions: 5.0" (12.7 cm) high, 9.0" (22.9 cm) wide, 2.5" (6.4 cm) deep
- ABS Polycarbonate

Weight

- Controller weight: 29 ounces (0.82 kilograms)
- Shipping weight: 40 ounces (1.1 kilograms)

Electronics

- Processor: 3150 Neuron 10 MHz
- Flash: 48 Kilobytes
- SRAM: 8 Kilobytes
- Termination: 0.197” (5.0 mm) Pluggable Terminal Blocks, 14-22 AWG

Environmental

- Temperature: 32 °F to 140 °F (0 °C to 60 °C)
- Humidity: 0 to 90%, non-condensing

Agency Listings

- UL Listed for US and Canada, Energy Management Equipment PAZX and PAZX7.

Agency Compliances

- FCC Part 15 Class A

APPLICATION DESCRIPTION

The VAV2 Series controllers maintain the temperature of a space to a user-defined setpoint by modulating the flow of air through the primary damper. The controllers may control a series or parallel fan through one digital output and one analog output, and may control reheat using a floating point, modulating 0-10V or ON/OFF stages.

The controller monitors the air temperature in the space using an attached digital thermostat module or thermistor. The algorithm is based on the space temperature input, cooling setpoint, heating setpoint, minimum and maximum airflow (VAVI-2) or minimum and maximum position (VAVD-2). Taco does not recommend using mechanical (or "hard") stops to define Minimum or Maximum positions.

The controller operates in the cooling mode when the primary air source is providing cooled air and the supply air temperature is below the current space temperature. The controller modulates the damper to provide the required amount of cooling to the space.

When the space temperature is below the cooling setpoint, the controller closes the damper to maintain the minimum airflow setpoint (VAVI-2) or minimum damper position (VAVD-2). As the zone temperature rises above the cooling set-point, the setpoint is regulated between the minimum and maximum airflow setpoints (VAVI-2) or the minimum and maximum damper positions (VAVD-2).

If the space temperature drops below the heating setpoint during the primary cooling mode, local reheating is activated to heat the space. The reheat may be accomplished via electric reheat, floating setpoint, or modulating 0-10v reheat valves. The controller modulates a floating setpoint hot water valve actuator based on its full stroke travel time and calculated desired position. The desired position is calculated by a Proportional + Integral (PI) control algorithm based on the zone temperature and a heating setpoint. The heating stages are sequenced on and off with a time proportioned control algorithm to minimize excessive cycling.

The controller operates in the primary heating mode when the primary air source is providing heated air and the supply air temperature is above the current space temperature. When the space temperature is above the heating setpoint, the controller closes the damper to maintain the minimum airflow setpoint (VAVI-2) or damper position (VAVD-2). As the zone temperature drops below the heating setpoint, the setpoint is regulated between the minimum and maximum air-flow setpoint or damper position. The damper is modulated to provide the required amount of heating to the space.

The controller operates in the ventilation mode when the primary air source is not providing heated or cooled air. In this mode, the damper is modulated to 55% of the flow (VAVI-2) or position (VAVD-2) range.

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The controller operates in one of two occupancy states: occupied or unoccupied. The active occupancy state is determined by the LCI. If an LCI is not detected, then the controller's backup schedule is used. During the occupied period, the controller maintains the comfort level to user defined heating and cooling setpoints. During the unoccupied period, the heating setpoint is set back and the cooling setpoint is set up by a user defined amount.

The series fan is energized during the occupied periods; it is off during unoccupied periods unless the control calls for heating or cooling. During occupied periods, the parallel fan is energized when air flow drops below a programmable setpoint (VAVI-2), or when the zone temperature drops below the heating setpoint. During standby and warm-up peri-ods, the fan is temperature controlled. The parallel fan is always off during unoccupied periods. The fan is always the first stage of reheat.

A local CO2 sensor connected directly to the controller monitors the Indoor Air Quality (IAQ). The controller participates in system-wide IAQ operation initiated by the primary air source controller (MPU2 or VPU2). When a local IAQ alarm condition exists, the controller reports the condition to the primary air source controller. The primary air source controller provides fresh air to the zone by turning on the system fan and modulating the economizer. The primary air source controller signals the VAV-2 to begin IAQ alarm operation.

During IAQ alarm operation, the VAV2 Series controller opens the damper to the configured maximum flow (VAVI-2) or position (VAVD-2). The temperature setpoints are reset to allow the space temperature to rise or drop a configurable limit from setpoint. This permits fresh airflow into the zone even if the temperature setpoints are exceeded. If the IAQ sensor is connected directly, an IAQ alarm is reported to the LCI.

In standalone mode, the controller functions independently from the central HVAC system and is not associated with any master device. It assumes that only cool air is being provided by the central HVAC system, and provides local heating as necessary without communicating a demand to any master controller. If the Primary Air Temperature (PAT) is installed, the controller uses the temperature reading on the PAT to determine whether the primary air source is in heating or cooling.

When a heating failed alarm is received from the primary air controller, the VAV2 Series controller modulates its damper to the maximum airflow (VAVI-2) or position (VAVD-2).

If the space temperature exceeds a programmable limit, a high limit alarm is reported to the LCI. If the space temperature drops below a programmable limit, a low limit alarm is reported to the LCI. When the space temperature returns to the proper range, a return to normal message is generated.

Figure 3: VAVI-2 with Electric Reheat and Fan

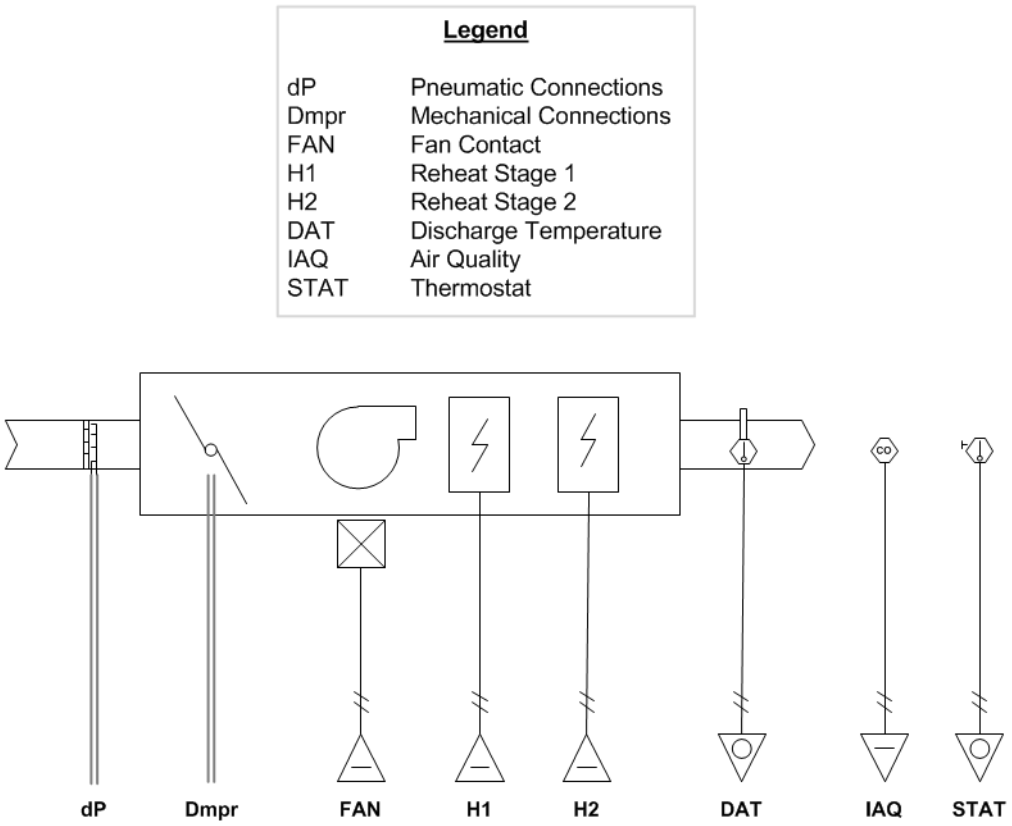

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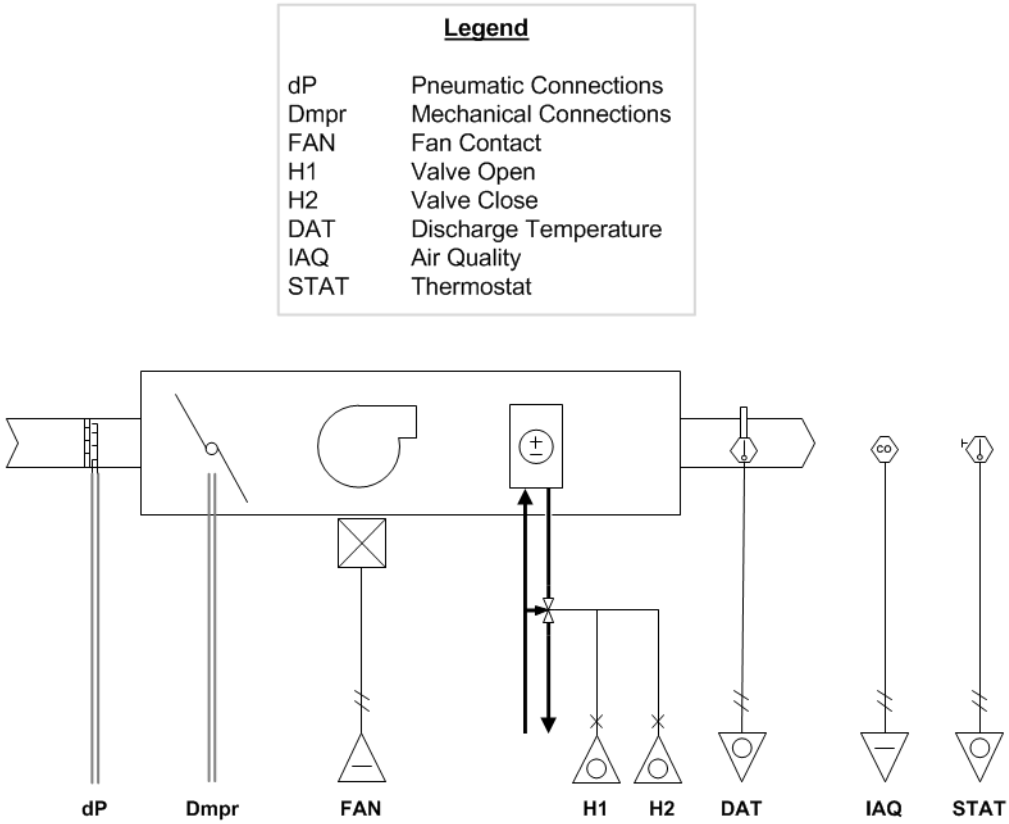
Figure 4: VAVI-2 with Floating Point Reheat and Fan



SEQUENCE OF OPERATION

This section describes the detailed sequence of operation for the VAV2 Series zone control.

Operational Mode

The VAV2 Series operates in four operating modes: primary heating, primary cooling, primary fan only, and primary off.

The controller operates as a stand alone unit until it is grouped under a primary source device at the LCI. In stand alone mode, the controller functions independently from the central HVAC system, is not associated with any master device, and uses the Primary Air Temperature (PAT) sensor to determine the operating mode of heating or cooling. The operating mode is heating when the PAT is above 90 °F. When the operating mode is heating, the PAT must drop below 80 °F to enter the cooling mode. A one-minute cycle time is enforced before changing the stand-alone operating modes.

If the PAT sensor is not connected, the PAT temperature input reads -30 °F and the operational mode defaults to cooling. The stand-alone mode is automatically entered at startup or when communication with the primary controller is lost for 10 minutes; stand-alone mode is not configurable.

Once the controller is grouped under a master device that controls the primary air source HVAC equipment, the master device determines the current operating mode. The operational mode information is periodically transferred to the con-troller over the communications network. The following information is transferred to the VAV2 Series controller from the primary air source controller:

- Operational Mode (primary cool, primary heat, primary off, primary fan only)
- Alarm Conditions (IAQ Mode, Heat Failed On)
- Occupancy Mode (occupied, unoccupied)
- Supply Air Temperature

The primary air source device determines the operational mode based on the zone demand information supplied by each of the VAV2 Series zone controllers. Each VAV2 Series controller periodically transfers its zone demand informa-tion to the primary air source controller over the communications network. The following information is transferred to the primary air source controller:

- Space Temperature
- Calculated Heating Setpoint
- Calculated Cooling Setpoint
- IAQ Sensor Status (safe, alarm)
- Local Alarm (VAV2 Series shutdown)
- Occupancy Mode (occupied, unoccupied, occupied extension)
- Supplemental Heat Status (on, off)

Occupancy Mode

A remote device on the network normally provides the current occupancy mode. There are two modes of occupancy: occupied and unoccupied. A push button on the local thermostat can be used to force the occupancy mode from unoccupied to occupied. The occupancy sensor on the VAV2 can also be used to force the mode from unoccupied to occupied.

Setpoint Calculations

The occupied setpoint, occupied heating offset, occupied cooling offset and setpoint adjustment limit are configured values.

Occupied Mode

The calculated heating and cooling setpoints are derived by subtracting the occupied heating offset and adding the cooling offset to the occupied setpoint. The zero energy band (ZEB) for occupied periods is the band between the heating and cooling setpoints. The effective setpoint for occupied periods is the configured setpoint:

$$ZebOccupied = HeatingOffset + CoolingOffset$$

$$EffectiveSetpoint = ConfiguredSetpoint \text{ OR } OverriddenSetpoint$$

$$HeatingSetpoint = EffectiveSetpoint - HeatingOffset$$

$$CoolingSetpoint = EffectiveSetpoint + CoolingOffset$$

The thermostat may bypass the effective setpoint with an overridden setpoint. The setpoint offset is the difference between the effective setpoint and the overridden setpoint, and is limited to the configured setpoint adjustment.

The setpoint offset is also added to the calculated heating and cooling setpoints. The setpoint offset only applies in the occupied period; it has no affect in the unoccupied period.

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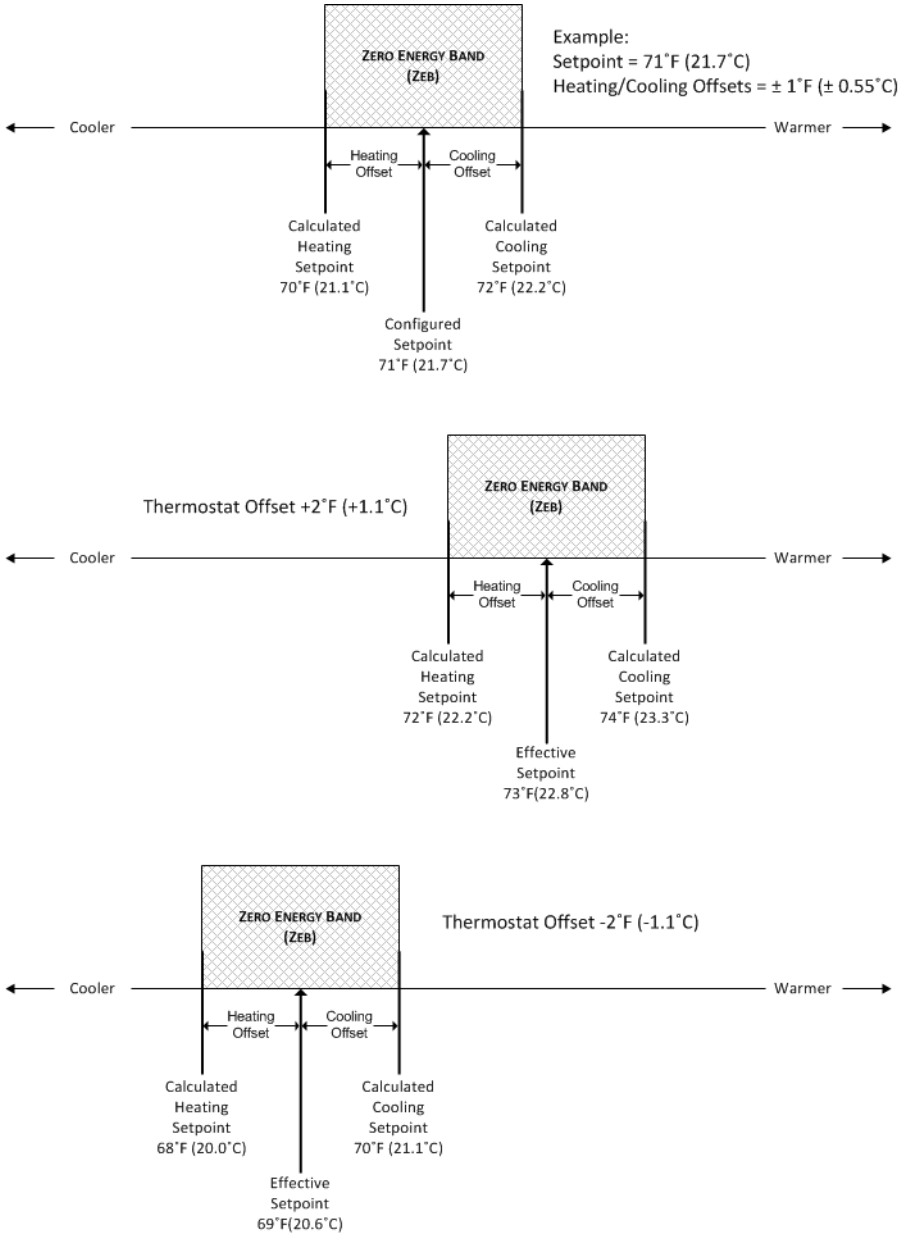
Note that the actual programmed heating and cooling setpoints are not changed. The thermostat setpoint offset is simply added to the programmed setpoints to derive the calculated values.

Figure 5: Occupied Setpoints



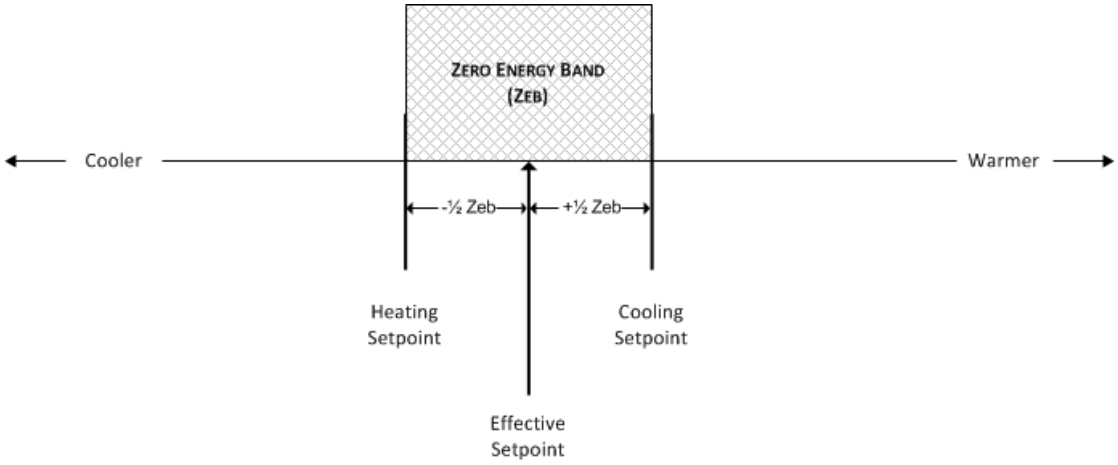
Unoccupied Mode

The heating and cooling setpoints for unoccupied periods are configured values. As with occupied periods, the zero energy band for unoccupied periods is the band between the heating and cooling setpoints. The effective setpoint for unoccupied periods is the calculated midpoint between the heating and cooling setpoints.

$$ZebUnoccupied = CoolingSetpointUnoccupied - HeatingSetpointUnoccupied$$

$$EffectiveSetpoint = HeatingSetpointUnoccupied + ½\ ZebUnoccupied$$

Figure 6: Effective Setpoints



Damper Control

The primary air damper actuator is controlled based on the current operating mode, space demand and occupancy mode. Taco does not recommend using mechanical (or "hard") stops to define Minimum or Maximum positions.

Occupied Mode

During the occupied period when the primary air source is cooling, the damper operates in the primary cooling mode. When the primary air source is heating, the damper operates in the primary heating mode. During ventilation mode, the damper follows a special set of rules; see “Damper Operation in Ventilation Mode” on page 20.

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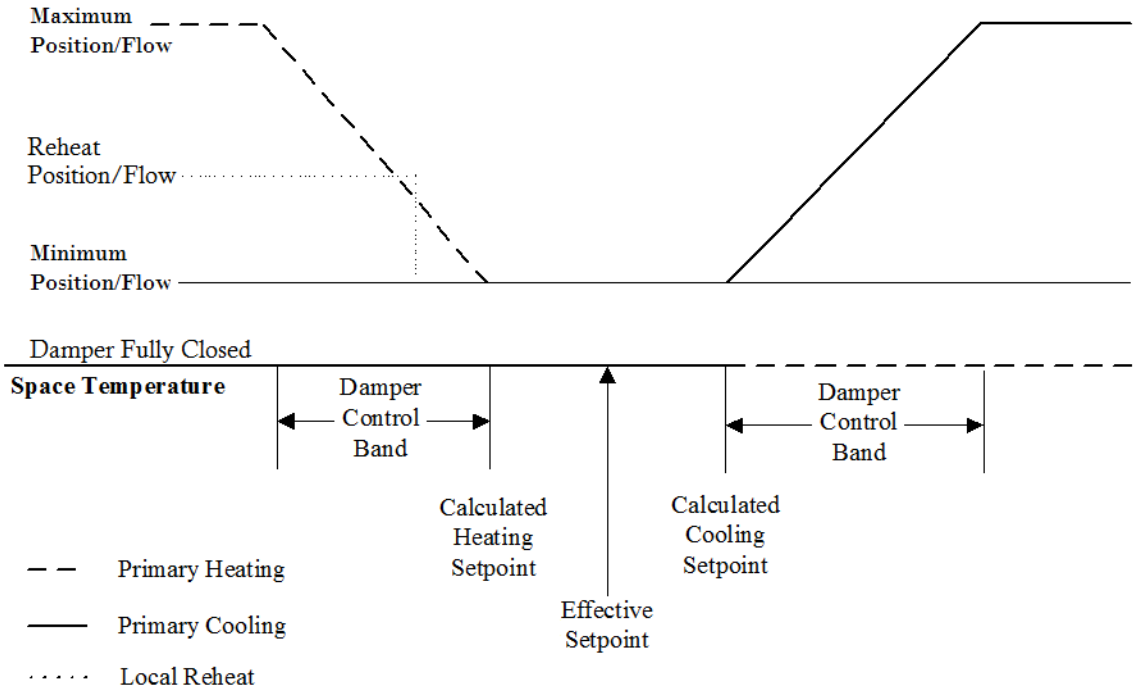
Zone overheating and overcooling are prevented by keeping the damper closed until the supply air temperature is below the current heating setpoint or above the cooling setpoint.

Figure 7: Occupied Damper Control



Unoccupied Mode

During the unoccupied period, the unoccupied heating and cooling setpoints are used. The damper control is the same as the occupied mode. However, when the space temperature is between the cooling and heating setpoints and the zone demand has been satisfied, the damper is fully closed instead of a minimum position/flow.

Note that the range from Heating Setpoint to Cooling Setpoint is generally larger in Unoccupied mode.

Heating/Cooling Output and Position/Flow Setpoints

The absolute actuator position is a value from 0 to 100 where 0 moves the damper to its absolute fully closed position and 100 moves the damper to its absolute fully open position. The configuration values for Minimum and Maximum position (VAVD) are in units of actuator position. The configuration values for Minimum and Maximum flow (VAVI) are in units of CFM.

The displayed heating and cooling outputs range from 0 to 100 percent of output range where the output range is the minimum position/flow to the maximum position/flow.

When the temperature equals the setpoint, the heating and cooling outputs are 0 percent; when the temperature differs from the setpoint by the full control band, the heating or cooling output is 100 percent.

When the temperature differs from the setpoint by a fraction of the control band, the heating or cooling output is the fraction in percent. The position/flow setpoint is the fraction of the output range.

Heat/Cool Output (%) = 100 X (SpaceTemp - Setpoint) / ControlBand

Flow/Pos Setpoint = MinFlow/Pos + (Heat/Cool Output X (MaxFlow/Pos - MinFlow/Pos))

Example 1:

The minimum and maximum flow rates on a VAVI are configured to 100 CFM and 500 CFM. If the mode is “OFF,” then both the heating and cooling outputs are 0 percent but the flow rate is still 100 CFM.

If the temperature is 2 degrees from setpoint and the control band is 4 degrees, the output is 2/4 or 50 percent and the flow rate setpoint is 50 percent of the flow range, or 300 CFM.

100 CFM + 50% X (500 CFM - 100 CFM) = 300 CFM

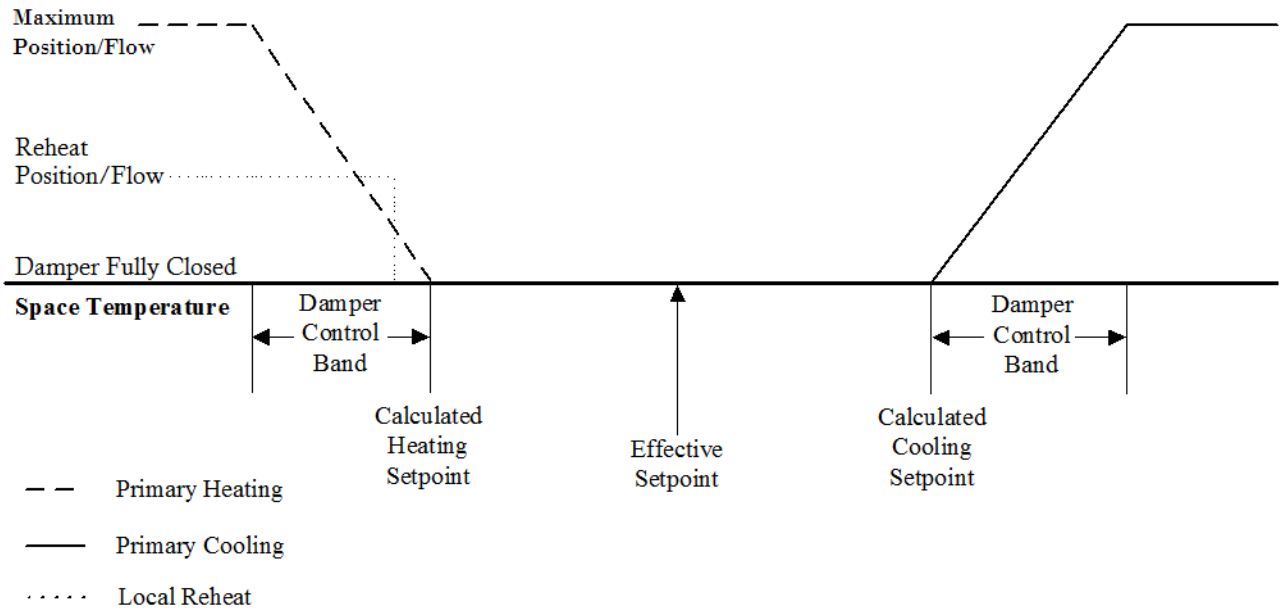
Example 2:

The minimum and maximum positions on a VAVD are configured to 20 and 100. If the mode is “OFF,” then both the heating and cooling outputs are 0 percent but the damper position is 20 (the minimum actuator position).

If the temperature is 2 degrees from setpoint and the control band is 4 degrees, the output is 2/4 or 50 percent and the actuator is set to 50 percent of the position range, or 60.

20 + 50% X (100 - 20) = 60

Figure 8: Unoccupied Damper Control



Damper Operation in Ventilation Mode

The controller operates in the ventilation mode when the primary air source is not providing heated or cooled air. In this mode, the damper is modulated to 55% of the flow (VAVI-2) or position (VAVD-2) range.

Damper Operation with Primary Cooling

During primary cooling mode, the primary air source supplies cool air to the zones. A control loop is used to calculate a required airflow or damper position setpoint to satisfy the space demand. The calculation is based on the space temperature, calculated cooling setpoint and calculated heating setpoint (space demand). The damper is then modulated to maintain the calculated airflow setpoint or damper position.

As the space temperature rises above the calculated cooling setpoint, the VAV2 Series controller enters the cooling mode. The control loop regulates the calculated airflow setpoint or damper position over a range defined by the damper control band. When the space temperature is above the damper control band, the control loop maintains the maximum flow setpoint or damper position.

When the space temperature is at or below the calculated cooling setpoint, the control loop maintains the minimum flow setpoint or damper position. The minimum flow or damper position is maintained provided the space temperature remains between the calculated cooling and heating setpoints.

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As the space temperature drops below the calculated heating setpoint, the controller enters the local heating mode. If local reheat has been configured and a reheat flow setpoint or damper position has been defined, the control maintains the reheat flow setpoint or damper position.

During unoccupied periods, the minimum flow setpoint or damper position is set to zero. This feature allows the damper to close completely when the space demand has been satisfied. Note that when the controller is providing air to a hydronic system (for example, a Chilled Beam Controller [CHB]), the damper maintains the minimum flow setpoint or damper position even in unoccupied periods.

Damper Operation with Primary Heating

During primary heating mode, the primary air source supplies warm air to the zones. A control loop is used to calculate a required airflow setpoint or damper position to satisfy the space demands. The calculation is based on the space temperature and calculated heating setpoint (space demand). The damper is then modulated to maintain the calculated airflow setpoint or damper position.

As the space temperature drops below the calculated heating setpoint, the controller enters heating mode. The control loop regulates the calculated airflow setpoint or damper position over a range defined by the damper control band. When the space temperature is below the damper control band, the control loop maintains the maximum flow setpoint or damper position.

When the space temperature is at or above the calculated heating setpoint, the control loop maintains the minimum flow setpoint or damper position.

During unoccupied periods, the minimum flow setpoint or damper position is set to zero. This feature allows the damper to close completely when the space demand has been satisfied. Note that when the controller is providing air to a hydronic system (for example, a Chilled Beam Controller [CHB]), the damper maintains the minimum flow setpoint or damper position even in unoccupied periods.

Damper Operation with Primary Fan Only or Primary Off

The operation of the damper when the Primary is set to “Off” or “Fan Only” depends on: the IAQ state, whether the Pri-mary damper is stuck heating, whether the VAV2 Series controller is in local reheat mode, whether the temperature is within ventilation range, whether the room is occupied, and whether the VAV2 Series controller is supplying air to a hydronic system.

Regardless of all other conditions, if the Primary damper is stuck heating, or there's an IAQ condition that isn't overrid-den, the VAV2 Series controller opens the damper to the configured maximum value.

Assuming those conditions are false, if the VAV2 Series controller is in reheat mode then the damper is opened to the configured reheat value. If the VAV2 Series controller is not in reheat mode and the supply air temperature is within ventilation range, the damper is opened to 55 percent. Lastly, if the room is occupied, or the VAV2 Series controller is supplying air to a hydronic device (e.g., CHB) then the damper is set to the configured minimum value, otherwise it is fully closed.

The operation of the damper when the Primary is “Off” or “Fan Only” is summarized in the following table:

Either IAQ or Primary Damper is Stuck?	Local Reheat?[1]	Ventilation Range?[2]	Occupied or Hydronic?	Damper Setpoint
Yes	Yes	Yes	Yes	Configured Maximum Value
			No	
		No	Yes	
			No	
	No	Yes	Yes	
			No	
		No	Yes	
			No	

Either IAQ or Primary Damper is Stuck?	Local Reheat?[1]	Ventilation Range?[2]	Occupied or Hydronic?	Damper Setpoint
No	Yes	Yes	Yes	Configured Reheat Value
			No	
		No	Yes	
			No	
	No	Yes	Yes	Ventilation Value (55%)
			No	
		No	Yes	Configured Minimum Value
			No	Fully Closed

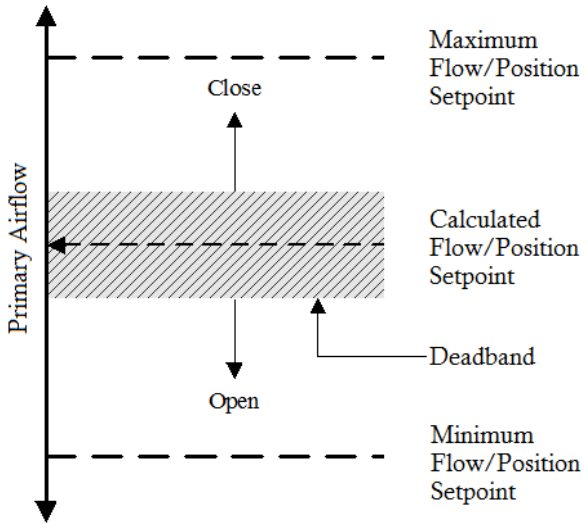
[1] When the Primary is Off, the only reheat mode allowed is Auxiliary heating.

[2] Ventilation range is when the supply air temperature is between 65° and 80°F (between 18.3° and 26.6°C).

Damper Actuator Control

The VAV2 Series controller supports an integral 2-10V modulating actuator for controlling the damper position. The actuator supplies a feedback signal to the controller which indicates the damper position.

Figure 9: Damper Actuator Control



VAVI-2 Actuator Control

The VAVI-2 modulates the actuator to maintain the calculated flow setpoint. An integral flow transducer measures the primary airflow. The Flow Rate (CFM), Velocity Pressure (inches WC) and Actuator Position (0-100) are displayed on the LCI.

When the primary airflow is below the calculated flow setpoint, the damper is driven open. When the primary airflow is above the calculated flow setpoint, the damper is driven closed. The damper maintains its position when the primary airflow equals the calculated flow setpoint. A dead band is provided around the calculated flow setpoint to prevent unnecessary movement of the damper due to minor flow fluctuations. When the calculated flow setpoint is zero, the control drives the damper closed.

VAVD-2 Actuator Control

The VAVD-2 controller sets the actuator position directly. The Actuator Position (0-100) is displayed on the LCI.

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When the damper position is below the calculated damper position, the damper is driven open. When the damper position is above the calculated position, the damper is driven closed. The damper maintains its position when the damper position equals the calculated damper position. A dead band is provided around the calculated damper position to prevent unnecessary movement of the damper due to minor calculation fluctuations. When the calculated damper position is zero, the control drives the damper closed. The feedback signal provides the current position of the actuator.

Local Heating

Reheat control is based on the space temperature, calculated heating setpoint, heating control band and primary mode. The Local Heating Type is set from the Local Reheat screen. The options for Local Heating Type are:

Local Reheat Setting	Meaning
Disabled	Reheat is not used
FSP or Modulated	Floating point (H1, H2) or 0-10VDC (AO1) modulated hot water valve
1 Stage	Single stage electric or two-position ON/OFF hot water valve (H1)
2 Stages	Two stage (H1, H2) electric heat

The purpose of reheat is to heat cold air from the primary when the local room temperature indicates that the space needs heating rather than cooling. Two other types of reheat are available in the System Options screen:

System Options Setting	Meaning
Supplemental	Provides additional heat when primary is heating or fan only
Auxiliary	Local heat source used as first stage without communicating demand to primary

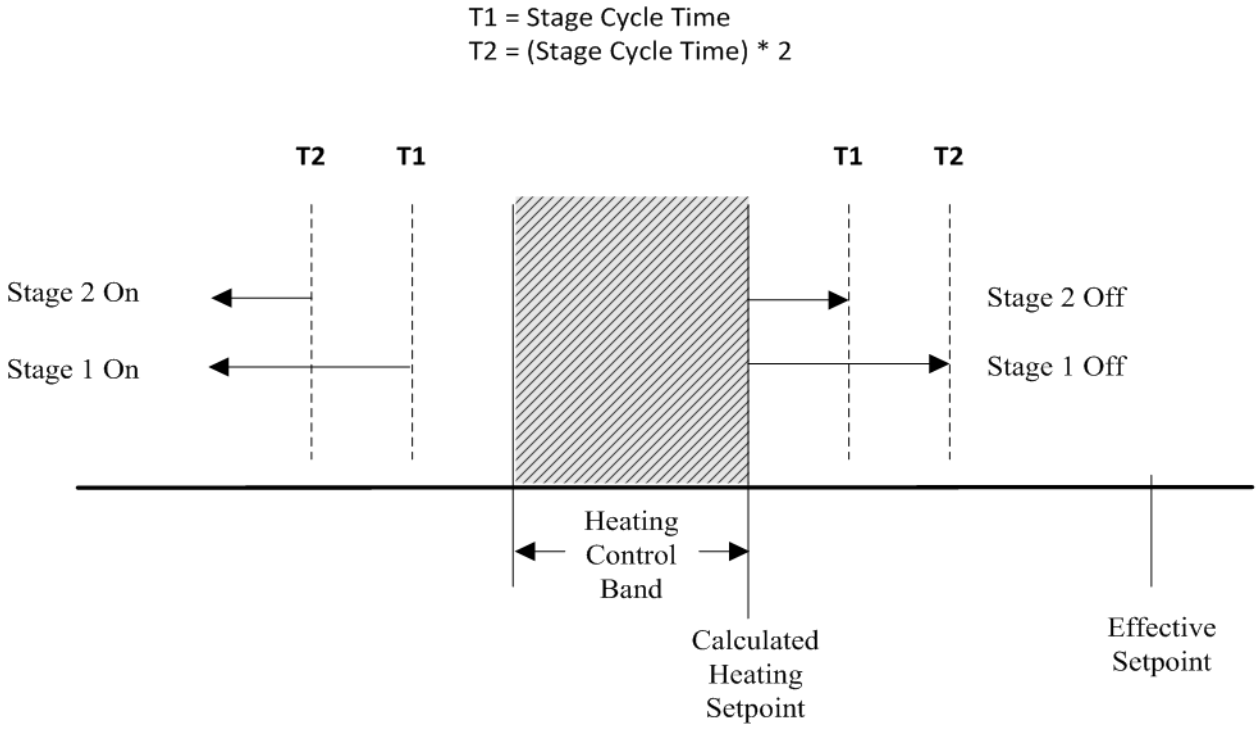
Table 1: Supplemental and Auxiliary Heating *

Primary Mode	System Option Supplemental Enabled	System Option Auxiliary Enabled	REHEAT (H1 & H2) is...
HEAT	OFF	OFF	Not allowed
HEAT	OFF	ON	Not allowed
HEAT	ON	OFF	Ok
HEAT	ON	ON	Invalid Configuration**
COOL	OFF	OFF	Ok
COOL	OFF	ON	Ok
COOL	ON	OFF	Ok
COOL	ON	ON	Invalid Configuration**
FAN ONLY	OFF	OFF	Ok
FAN ONLY	OFF	ON	Ok
FAN ONLY	ON	OFF	Ok
FAN ONLY	ON	ON	Invalid Configuration**
OFF	OFF	OFF	Not allowed
OFF	OFF	ON	Ok - delay demand to primary until after programmed delay
OFF	ON	OFF	Not allowed
OFF	ON	ON	Invalid Configuration**

* Table applies to software versions 5.0 and above.

** Invalid Configuration - If this “System Options” configuration is attempted, both settings will be forced OFF.

Figure 10: Electric Heating Stages



DURING PRIMARY COOLING MODE: when the space temperature drops below the calculated heating setpoint, the VAV-2 enters reheat mode. If the space temperature drops below the heating control band for a predefined period of time, the first stage is turned on. If the space temperature remains below the heating control band for an additional period of time, the second stage is turned on. As the space temperature rises above the calculated heating setpoint for a predefined period of time, the second stage is turned off. If the space temperature remains above the calculated heating setpoint for an additional period of time, the first stage is turned off. When the zone temperature rises above the zone setpoint, all of the heating stages turn off.

DURING LOCAL HEATING: the damper modulates to the reheat flow (VAVI-2) or damper position (VAVD-2) setpoint. Reheat is interlocked with the parallel fans operation if enabled. The parallel fans act as the first stage of heating; the reheat stages wait one time interval for the fans to provide heat to the space first.

DURING PRIMARY HEATING MODE: when the space temperature drops below the calculated heating setpoint and the primary airflow is at its maximum, the VAV-2 enters supplemental heating mode if enabled. The heating is cycled on in the same manner as reheat. The parallel fans are not available as the first stage of heat during supplemental heating operation.

DURING PRIMARY OFF AND PRIMARY FAN ONLY MODES: the local heating is disabled.

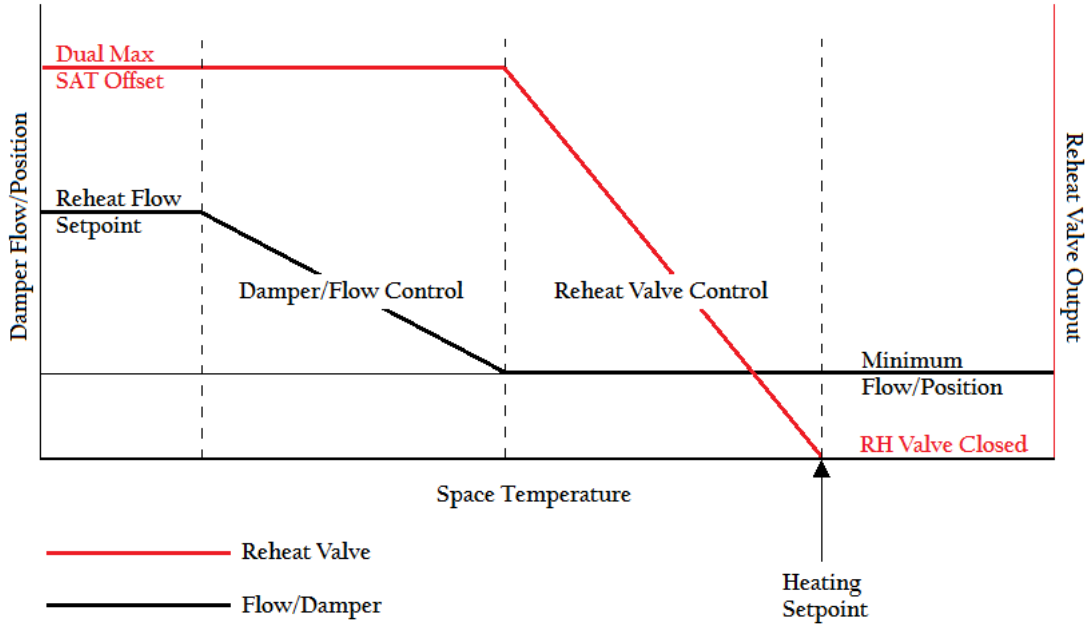
Modulated Hot Water Valve Reheat

When the space temperature is above the heating setpoint, the modulated hot water reheat valve is fully closed (0%). When the space temperature falls below the heating setpoint, the controller adds heat to the space using "dual maximum mode" control as described in ASHRAE 90.1-2013.

As the space temperature falls below the calculated heating setpoint, the reheat valve begins to open by an amount proportional to the heating setpoint minus the space temperature, while maintaining the damper position / flow rate at the configured minimum. During this time, the supply air temperature (also called the discharge air temperature) is monitored.

If the supply air temperature rises above the space temperature plus the configured *Dual Max SAT Offset*, the reheat valve holds its position where it is and the damper / flow rate is increased to add more heat to the space. As more heat is required, the damper position / flow rate is modulated up to the configured *Reheat Damper Position Setpoint* or *Reheat Flow Setpoint*.

Figure 11: Modulated Reheat Valve



In addition to the control algorithm described above, the hot water valve remains fully closed if any of the following conditions exist:

- Primary is off
- Primary is fan only
- Primary is heating but supplemental heating is not enabled
- Reheat Valve Travel time is zero (unconfigured)

Note that the parallel fans are not available as the first stage of heat during supplemental heating operation.

The hot water valve may be floating point controlled (using H1, H2) or 0-10VDC controlled (using AO1). Each of these uses the same algorithm for modulating the value, but the 0-10VDC Analog Output valve requires that *AO Min* and *AO Max* are configured with *AO Max* greater than *AO Min*.

Auxiliary Heating Mode

The VAV2 Series controller may use auxiliary heat such as radiant floor heat or fin tube as first stage heating without communicating a heating demand to the central HVAC system. In this mode, the controller's parallel fan outputs are used as the auxiliary heat output. (The controller's fan type must be set to Temperature Controlled Parallel). If addi-tional heating is needed, second stage demand is communicated to the control system as described under Electric Heating Stages. The duration of the auxiliary heating stage is configurable.

Parallel Fan Operation

There are two programmable modes of operation for the parallel fan terminal unit: flow-controlled (VAVI-2) and temper-ature-controlled, available on both VAVI-2 and VAVD-2 controllers.

In flow-controlled operation, the fan energizes if the air flow drops below a programmable setpoint during occupied periods. During standby periods and occupied temperature-controlled operation, the fan turns on if the zone temperature drops below the heating setpoint.

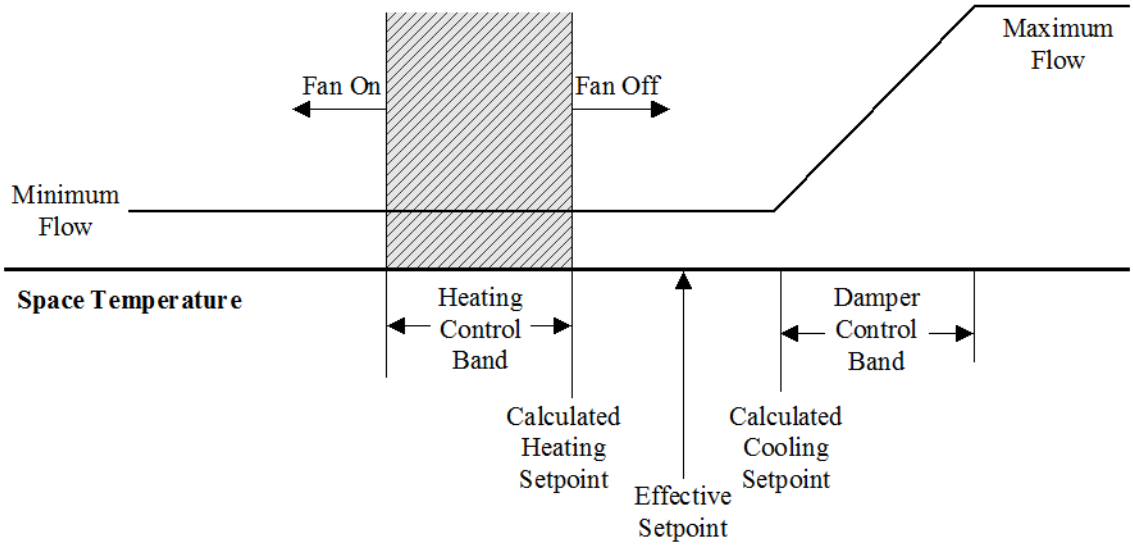
Temperature-Controlled Parallel Fan Operation

During occupied periods when the operational mode is primary cooling, the parallel fan is the first stage of heating when the zone requires heat. When the space temperature drops below the heating control band, the parallel fan energizes. The fan remains energized until the space temperature rises above the calculated heating setpoint.

The fan operation during unoccupied periods is same as in the occupied period except that the calculated heating setpoint is set back to the unoccupied value.

The parallel fan is disabled when the operational mode is primary heating, primary off and primary fan only. The fan is also disabled during supplemental local heating.

Figure 12: Parallel Fan - Temperature-Controlled



Flow-Controlled Parallel Fan Operation (VAVI-2)

During occupied periods when the operational mode is primary cooling, the parallel fan is the first stage of heating when the airflow drops below the fan flow setpoint. When the space temperature drops below the heating control band the parallel fan energizes. The fan remains energized until the space temperature rises above the calculated heating setpoint.

The fan operation during unoccupied periods is same as in the occupied period except that the calculated heating setpoint is set back to the unoccupied value and that during unoccupied periods, the fan is temperature-controlled.

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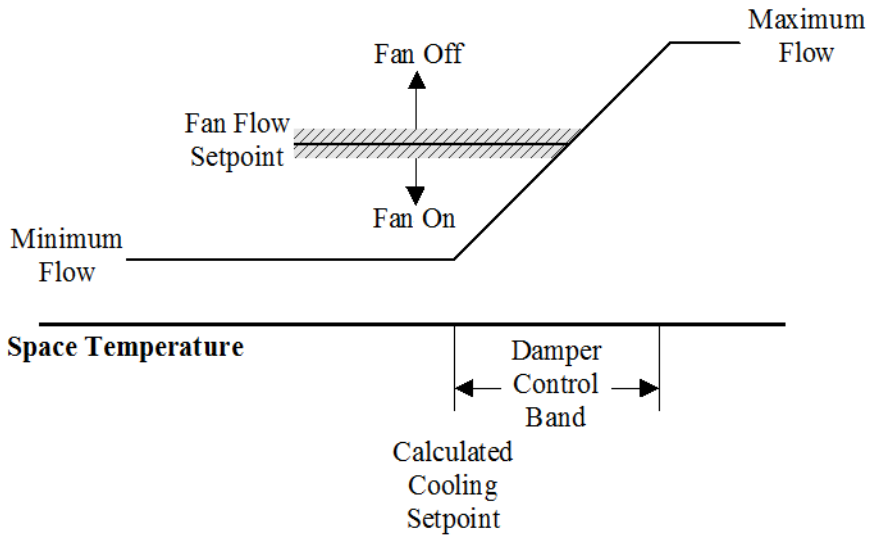
The parallel fan is disabled when the operational mode is primary heating, primary off and primary fan only. The fan is also disabled during supplemental local heating.

Figure 13: Parallel Fan - Flow-Controlled



Series Fan Operation

During occupied periods, the series fan always runs. During unoccupied periods, the series fan remains off unless there is a call for heating or cooling. Any time the damper closes completely, the series fan will turn off..

Indoor Air Quality (IAQ)

The indoor air quality (IAQ) feature allows the VAV2 Series controller to interface with the primary air source controller to maintain the quality of indoor air within the zone's acceptable limits. The IAQ sensing device is defined as local or system-wide (global) IAQ. Local IAQ is defined as a VAV2 Series controller with an IAQ sensor attached. If the VAV is supplying air to a chilled beam controller (CHB), then this is also considered part of the local zone. System-wide IAQ consists of an IAQ sensor attached to the primary air source controller. In this case the IAQ would be mounted in the return air duct.

When an IAQ condition is sensed by the VAV2 Series controller in local IAQ mode, only the damper of the VAV2 Series controller with the active alarm condition is able to enter the IAQ mode of operation. The VAV2 Series controller signals the primary air source controller indicating that a local IAQ condition exists in the zone. The primary air source controller energizes the supply air fan in an attempt to provide additional fresh air to the zone. When the primary air source controller receives an IAQ alarm, the primary air source controller opens the economizer and signals the VAV2 Series controller that IAQ mode has been entered. The VAV2 Series controller modulates the damper to maintain the programmed maximum airflow setpoint or damper position. When the IAQ alarm condition ceases to exist, the VAV2 Series controller signals the primary air source controller and resumes normal control of the damper.

Note that the VAV2 Series controller configured for Local IAQ responds immediately to a local IAQ condition;

however, there is a configurable delay before the IAQ alarm is sent to the primary air source.

The VAV2 Series controller has a temperature reset function for IAQ alarm operation. The temperature reset function allows the space temperature to rise above or drop below the calculated control setpoints by a configurable amount. This feature allows time for the indoor air quality to improve. During IAQ alarm operation, if the space temperature rises above or drops below the temperature reset limit, the VAV2 Series controller resumes normal damper control to main-tain comfort within the zone. Once the space temperature brought within the calculated control setpoints and an IAQ alarm condition still exists, the VAV2 Series controller resumes the IAQ mode of operation.

The VAV2 Series controller optionally participates in system-wide (global) IAQ alarm operation. In this case the primary air source controller signals the VAV2 Series controller indicating IAQ mode of operation is active.

Stand-Alone Mode

In this mode, the controller functions independently from the central HVAC system and is not grouped under a primary source device. The VAV2 Series controller uses the Primary Air Temperature (PAT) sensor to determine the operating mode of heating or cooling. The operating mode is heating when the PAT is above 90°F. When the operating mode is heating, the PAT must drop below 80°F to enter the cooling mode. A one-minute cycle time is enforced before changing the operating modes.

If the PAT sensor is not connected, the PAT temperature input reads -30°F and the operating mode is cooling.

The stand-alone mode is automatically entered at startup or when communication with the primary controller is lost for 10 minutes; stand-alone mode is not configurable. The VAV2 Series controller operates in stand-alone mode until it is grouped under a primary source device at the LCI, and returns to stand-alone mode if it is ungrouped.

Heating Failed

The VAV2 Series controller receives information about the state of the HVAC heating equipment from the primary air source controller. A signal is sent to the VAV2 Series controller when the HVAC heating has failed to turn off. To help prevent overheating of the equipment, the VAV2 Series controller overrides the calculated setpoint and positions the damper to maximum flow/position.

Local Backup Schedule

An LCI normally provides the occupancy mode, but a local backup schedule may be configured in case the LCI becomes unavailable. If the VAV2 Series controller is unable to communicate with the LCI for ten minutes, the VAV2 Series controller operating mode is determined according to the configured backup schedule.

The factory default setting for the local backup schedule is disabled (times are set to zero). If the VAV2 Series controller tries to access the local backup schedule when it is disabled, the controller defaults to the occupied mode. To enable the local backup schedule, the occupied and unoccupied times must be configured in the local backup schedule menu. The local backup schedule determines the operating mode when accessed.

Runtime Accumulations

Total runtime is accumulated for the local heating outputs. The runtime is used to indicate that maintenance is required on the equipment controlled by these outputs. The runtime is also used to calculate the energy usage of electric reheat stages. An operator or maintenance personnel should reset the runtime once servicing has been performed. The run-times are accumulated in volatile memory (RAM). Once a day they are backed up to non-volatile memory (EEPROM). When the VAV2 Series controller is reset, the runtimes are copied from EEPROM to RAM.

Alarm and Event Reporting

The VAV2 Series controller detects certain alarm conditions and reports them to the LCI. Before this occurs, the VAV2 Series controller must be configured by the LCI. The controller monitors the status of the inputs and generates alarms for the following events:

Indoor Air Quality (IAQ) Alarm

The VAV2 Series controller monitors the analog IAQ sensor and generates an "indoor air quality alarm" when the sen-sor reading is above the configured alarm setpoint. If the VAV is supplying air to a Chilled Beam unit (CHB) then an IAQ error at the Chilled Beam also causes an “indoor air quality alarm.”

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Thermostat Failure

The VAV2 Series controller automatically detects the presence of the thermostat and monitors its status. If the thermo-stat fails to communicate with the VAV2 Series controller, a “thermostat failure alarm” is generated and the status LED turns red. If the space temperature is overridden by a host controller, the alarm is disabled.

Maintenance Alarm

The VAV2 Series controller provides programmable run limits for generating runtime maintenance alarms. When the cooling runtime, heating runtime or fan runtime exceeds these limits, a maintenance alarm is sent to the LCI.

Space Temperature Alarms

The VAV2 Series controller generates high and low limit alarms for the space temperature. A programmable space temperature alarm limit offset is provided. The temperature limits are calculated based on the control setpoints and the alarm limit offset:

When the measured space temperature exceeds the high limit, a high limit alarm is generated. When the space temperature drops below the low limit, a low limit alarm is generated. A return to normal is generated when the space temperature is between the high and low limit. The space temperature alarms are delayed by 30 minutes when the occupancy mode changes from unoccupied to occupied. This permits the space to reach the operating setpoints before generating an alarm.

Stuck Damper Alarm

If the controller detects that it is unable to change the damper position, a 'stuck damper alarm' is sent to the LCI. This alarm is enabled on the *Stuck Damper Alarm* configuration screen.

Starved Box Alarm (VAVI-2)

If the controller detects that it is not receiving sufficient airflow from the central HVAC system to meet its airflow setpoint even though the damper is at 100%, a 'starved box alarm' is sent to the LCI. This alarm is enabled on the *Starved Box Alarm* configuration screen.

Commissioning Mode

Manual override of the damper control is provided from the Commissioning screen for use during installation and air balancing of the zone. The overrides permit the installer/balancer to override the damper with the following options:

Option	Effect
Enable=No/Yes	Manual overrides are disabled (the default) or enabled.
Damper OvrMode	Damper override mode may be set to one of the following: – Set Position - The damper position moves to the configured position. – Set Flow (VAVI-2) - The damper position moves to achieve the configured flow rate. – Fully Open - The damper is fully opened. – Fully Closed - The damper is fully closed. – Minimum Position (VAVD-2) - The damper moves to the configured minimum position. – Maximum Position (VAVD-2) - The damper moves to the configured maximum position. – Minimum Flow (VAVI-2) - The damper moves to achieve the configured minimum flow rate. – Maximum Flow (VAVI-2) - The damper moves to achieve the configured maximum flow rate. – Calibrate Flow (VAVI-2) - As an alternative to entering the flow constant on the Press Independent page, a one-step calibration is performed. The user measures actual air flow and enters it on the configuration screen. The flow constant is calculated using this value.
Digital Fan=Off/On	The digital fan (DFAN) is turned off (the default) or on.

Option	Effect
Analog Fan	The analog fan (AFAN) is set to the configured percent output: 100% = 10VDC.
Stage n Reheat	The Reheat Stage (1 or 2) is turned off (the default) or on.
Analog Reheat	The analog reheat output is set to the configured percent output: 100% = 10VDC.

Communication with Associated Devices

The controller is capable of communicating and sharing information with other controllers on the network.

The communication between MPU, VPU or CHB and VAV2 Series controllers is configured by the LCI. To make an association between the other controller and a VAV2 Series, press the *Zone Member* button in the individual controller page for the other controller. The MPU, VPU or CHB act as the master and the VAV2 Series acts as the slave. Up to 32 VAV2 Series controllers may be associated to a single MPU2; up to 60 VAV2 Series controllers may be associated to a single VPU2. CHB-VAV2 Series associations are one-to-one.

There may be multiple VPU2 and/or MPU2 controllers with associations on the same network as long as the total number of controllers does not exceed the maximum node number of 63.

During the association process, the master controller receives a configuration message from the LCI containing the Neuron ID of the VAV2 Series. Once associated, the other controller exchanges messages with the VAV2 Series.

To disassociate a VAV2 Series controller from its master controller, deselect the desired controllers from the list of members. When all the controllers have been deselected, press the *Save* button.

Automatic Configuration

The VAV2 Series and iWorx® Local Control Interface (LCI) use a self-configuring network management scheme requir-ing no external tools, binding, or LONWORKS knowledge. The LCI recognizes and configures the VAV2 Series when the controller's service pin is pressed. The controller's status light flashes green until the controller is configured, and is solid green after the controller is configured. Once the service pin has been pressed, no further action is required by the user; the controller is fully accessible to the LCI. Users may bind to SNVTs on the VAV2 Series with LNS or other LONWORKS tools if they wish.

The LCI also provides network supervision of the VAV2 Series. The LCI periodically sends a "ping" message to the VAV2 Series, which elicits a response. If the response fails, an alarm is displayed on the LCI. The LCI also uses the "ping" message to refresh the occupancy mode and other system wide data.

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CONTROLLER IDENTIFICATION

Once the VAV2 Series is properly installed and recognized by the Local Control Interface (LCI), the LCI can be used to configure the settings of the controller. This section describes the commands available on the LCI for configuration of the VAV2 Series, and the meanings and default values for controller parameters. For more information on using the LCI, see the *iWorX LCI Application Guide.*

Network Inputs

The VAV2 Series controller allows a network manager to write to Network Input Variables for the purpose of overriding the configuration, operation and outputs of the controller. The variables are listed below.

Values written to the NVIs have absolute priority over any other controller operation.

- *nviSpaceTemp* overrides the space temperature as obtained from the thermostat, sensor, or ASM module and is used by the controller for temperature control. Writing to this variable is also reflected in the controller's output of the space temperature as displayed on the LCI.
- *nviSetpoint* overrides the setpoint as obtained from the thermostat, the LCI or from a pre-configured schedule. Writing to this variable is also reflected in the controller's output of the effective setpoint as displayed on the LCI.
- *nviOAT* overrides the outside air temperature as obtained from the a sensor, or ASM module and is used by the controller for warm weather shutdown determination (WWSD). Writing to this variable is also reflected in the controller's output of the outside air temperature as displayed on the LCI.
- *nviOccCmd* overrides the occupancy as obtained from the thermostat. Writing to this variable is also reflected in the controller's output of the occupancy mode. Note that this is NOT the occupancy sensor. The occupancy sensor hardware input (OCC) is still displayed on the LCI based on its configuration.
- *nviResetRuntime* is a command to reset the heating runtime. If the value sent is 0, then no reset occurs; if the value sent is 1, then the runtime is reset.
- *nviOverride* is a structure (defined below) that overrides the actuator position on the controller. These values allow the network controller to directly control the actuator.
- *nviLiaqState* overrides the local IAQ state on the controller. Note that this does NOT override the IAQ state of the master controller (i.e. MPU or VPU). This network variable allows the Chilled Beam Controller (CHB) to override the IAQ state.

Table 2: Network Variable Inputs

Internal Variable Name	Format	Range	Description
nviSpaceTemp	SNVT_temp_p	-29 to 230 °F (-34 to 110 °C)	Space temperature
nviSetpoint	SNVT_temp_p	-29 to 230 °F (-34 to 110 °C)	Setpoint
nviOAT	SNVT_temp_p	-29 to 230 °F (-34 to 110 °C)	Outside Air Temperature
nviOccCmd	SNVT_occupancy	-1 = no override 0 = Occupied 1 = Unoccupied 2 = Bypass 3 = Standby	Occupancy Command
nviResetRuntime	SNVT_lev_disc	0 = no reset 1 = reset runtime	Reset heating runtime
nviOverride	SNVT_hvac_overrid	Override Params	Override actuator position
nviLiaqState	SNVT_lev_disc	-1 = no override 0 = IAQ OFF 1 = IAQ ON	Override local IAQ state
nviPrimAirTemp	SNVT_temp_p	-29 to 230 °F (-34 to 110 °C)	Primary Air Temperature

Inputs

The Inputs screen displays the current values of the controller's inputs. These values cannot be changed.

Setting	Range	Description
Outside Temp	-29 to 230 °F (-33.9 to 110 °C)	The outside air temperature communicated through the LCI from the ASM controller, if available.
Space Temperature	-29 to 230 °F (-33.9 to 110 °C)	The space temperature reported from the SLink or thermistor.
Primary Air Temp	-29 to 230 °F (-33.9 to 110 °C)	Temperature of the primary air duct.
Discharge Temp	-29 to 230 °F (-33.9 to 110 °C)	Temperature of the supply air duct.
Indoor Air Qual	Normal, Alarm	IAQ Status.
Occupancy Sensor	Off, On	Status of the occupancy sensor when a thermistor is used for space temperature.
Occupancy Mode	Occupied, Unoccupied, Bypass	Occupancy mode of the controller.
Velocity Press (VAVI-2)	0 to 4 in WC (0 to 1000 Pa)	Velocity pressure inside air duct.
IAQ Sensor	0 to 5600 ppm	Reading on the analog IAQ sensor input.

Outputs

This screen displays the current values of the controller's outputs. These values cannot be changed.

Setting	Range	Description
Mode	Off, Heat, Cool	Operating mode.
Heat Output	0.00% to 100.00%	Current state of the heating output.
Reheat Output	0.00% to 100.00%	Current state of the reheat output.
Cool Output	0.00% to 100.00%	Current state of the cooling output.
Fan Output	0.00% or 100.00%	Current state of the fan output.
In Alarm?	No, Yes	Alarm indication.
Actuator Position	0.00% to 100.00%	Current position of the actuator.
Box Flow (VAVI-2)	0 to 10,000 CFM (0 to 4,720 L/s)	Current box flow rate.

Configuration

Once the controller is properly installed and recognized by the LCI, the LCI can be used to configure the settings of the controller. This section describes the commands available on the LCI for configuration of the controller and the descriptions and defaulted values for the controller parameters.

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All Settings

Displays all of the controller's settings and provides access to edit all parameters from a single screen. Some parameters (defaulted as Structure) will be described in individual tables below.

Setting	Range	Default	Description
Commissioning	Structure	N/A	Commissioning settings
System Options	Structure	N/A	System option settings
Thermostat	Structure	N/A	Thermostat settings
Setpoints	Structure	N/A	Setpoint settings
WWSD	-30 to 230 °F (-34 to 110 °C)	69 °F (20.6 °C)	Warm Weather Shutdown temperature when configured for radiant floor heat
Starved Box Alarm (VAVI-2)	Structure	N/A	Starved box alarm settings (VAVI-2)
Damper Stuck	Structure	N/A	Damper stuck settings
Press Independent (VAVI-2)	Structure	N/A	Pressure Independent settings (VAVI-2)
Press Dependent (VAVD-2)	Structure	N/A	Pressure Dependent settings (VAVD-2)
Indoor Air Quality	Structure	N/A	IAQ settings
Local Reheat	Structure	N/A	Local Reheat settings
Damp Ctl Band	0 to 20.0 °F (0 to 11.1 °C)	2.0 °F (1.1 °C)	Value added to calculate the cooling setpoint or subtract from the calculated heating setpoint to from the damper modulation range.
Fan Settings	Structure	N/A	Fan Settings
Backup Occ Time	Structure	N/A	Backup schedule settings
Backup Unocc Time	Structure	N/A	Backup schedule settings

Commissioning

Displays all of the controller‘s editable settings for this category and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Enable	No, Yes	No	Enables the commissioning value overrides.
Dmpr Ovr Mode	Off, Set Position, Set Flow (VAVI-2), Fully Open, Fully Closed, Minimum Position/Flow, Maximum Position/Flow, Calibrate Flow (VAVI-2)	Off	Do not override damper. Set damper position to user entered value. Set flow rate setpoint to user entered value. Fully open the damper. Fully close the damper. Set the position or flow to configured minimum. Set the position or flow to the configured maximum. Calibrate the flow.
Set Position	0.00 to 100.00%	0.00%	Damper position if Dmpr Ovr Mode is “Set Position”.
Set Flow Rate (VAVI only)	0 to 10000 CFM (0 to 4720 LPS)	0 CFM (0 LPS)	Actual flow rate if Dmpr Ovr Mode is “Calibrate”. Target flow rate if Dmpr Ovr Mode is “Set Flow”.
Digital Fan	Off, On	Off	Digital fan output.
Analog Fan	0.00 to 100.00%	0.00%	Analog fan output.
Stage 1 Reheat	Off, On	Off	Stage 1 reheat output.
Stage 2 Reheat	Off, On	Off	Stage 2 reheat output.
Analog Reheat	0 to 100%	0%	Analog reheat output.

System Options

Displays all of the controller‘s editable settings for this category and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Local IAQ Alarm?	Off, On	Off	Set to “On” to enable IAQ features using input from the local IAQ sensor or chilled beam (CHB) controller.
Global IAQ Alarm?	Off, On	Off	Set to “On” to enable IAQ features using input from the master air handler’s IAQ sensor.
Supplemental Heat?	Off, On	Off	Enables supplemental heating.
Reverse Damper?	Off, On	Off	Reverse direction of the damper actuator.
Aux Heating Mode?	Off, On	Off	Set to “On” to use auxiliary heating as first stage of heating.
Display IAQ Alarm?	Off, On	Off	Set to “On” to enable reporting of the IAQ alarm.

Thermostat

Displays all of the controller‘s editable settings for this category and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Type	SLink, Precon III, Precon II, Not used	SLink	Type of space sensor. Note: Use “SLink” for TS300 Series sensor.
Occupancy Extension	0 to 1000 minutes	60 minutes	Allowable occupancy extension time.
Alarm Temp Offset	0 to 10 °F (0 to 5.6 °C)	5.0 °F (2.8 °C)	Degrees below the heating setpoint or above the cooling setpoint to trigger a low or high limit alarm.
Temperature Offset	-10.0 to 10.0 °F (-5.6 to 5.6 °C)	0 °F (0 °C)	Degrees to be added to the actual zone temperature. This setting is used as a means to calibrate the actual temperature reading of a Precon III thermistor.
Accumulated Ext Occ	0-1000 minutes	0 minutes	Accumulated occupancy extension time.

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Setpoints

Displays all of the controller‘s setpoints and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Setpoint	50 to 95° F (10 to 35° C)	71° F (21.2° C)	Setpoint for occupied time periods.
Cooling Offset	0 to 10° F (0 to 5.6° C)	1° F (0.6° C)	This value is used to calculate the cooling setpoint by adding to the configured setpoint above.
Heating Offset	0 to 10° F (0 to 5.6° C)	1° F (0.6° C)	This value is used to calculate the heating setpoint by subtracting it from the configured setpoint above.
SP Adjust Limit	0 to 10° F (0 to 5.6° C)	2° F (1.1° C)	The maximum setpoint adjustment allowed - this limits the setpoint adjustment on the thermostat.
Unocc Cooling	50 to 95° F (10 to 35° C)	82° F (27.7° C)	Cooling setpoint for unoccupied time periods.
Unocc Heating	50 to 95° F (10 to 35° C)	60° F (15.5° C)	Heating setpoint for unoccupied time periods.

Starved Box Alarm (VAVI-2)

Displays all of the controller‘s editable settings for this category and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Seconds	0 to 6554	0	Duration of starved box that triggers an alarm. Value is set to 0 to disable starved box alarm. To enable, value must be at least 10 seconds.
Setpoint	0 to 10000 CFM	0 CFM	Flow setpoint error that triggers a starved box alarm. Setpoint must be at least 20 percent of the Press Independent / Max Flow value to be detected.

Damper Stuck

Displays all of the controller‘s editable settings for this category and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Seconds	0 to 6554 seconds	0	Duration of stuck damper that triggers an alarm. Value is set to 0 to disable stuck damper alarm. To enable, value must be at least 10 seconds.
Setpoint	0 to 100%	10%	Position error that triggers a stuck damper alarm. Values less than 10% are changed to 10% to avoid false alarms.

Press Independent (VAVI-2)

Displays all of the controller‘s editable settings for this category and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
K Factor	0 to 10000 CFM (0 to 4720 L/s)	468 CFM (221 L/s)	K Factor for the terminal box in use. Also known as “Flow Constant” or “Flow@1 in WC”. A value of 468 CFM is typical for a 6" Titus VAV box
Min Flow	0 to 10000 CFM (0 to 4720 L/s)	100 CFM (47.2 L/s)	Minimum desired airflow through the terminal box.
Max Flow	0 to 10000 CFM (0 to 4720 L/s)	500 CFM (236.0 L/s)	Maximum desired airflow through the terminal box.
Flow Deadband	2 to 50%	15%	Deadband before damper is moved to modulate flow.”
Reheat Flow Setpoint	0 to 10000 CFM (0 to 4720 L/s)	200 CFM (94 L/s)	Airflow setpoint used if local reheat is active; if used, must be set greater than *Min Flow*.
Fan Flow Setpoint	0 to 10000 CFM (0 to 4720 L/s)	200 CFM (94 L/s)	Airflow setpoint used when parallel flow is selected.

Press Dependent (VAVD-2)

Displays all of the controller‘s editable settings for this category and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Min Position	0.0 to 100.0%	20.00%	Minimum desired position of the terminal box damper. Taco does not recommend using mechanical (or "hard") stops to define Minimum or Maximum positions.
Max Position	0.0 to 100.0%	100.00%	Maximum desired position of the terminal box damper. Taco does not recommend using mechanical (or "hard") stops to define Minimum or Maximum positions.
Reheat Position	0.0 to 100.0%	50.00%	Damper position used if local reheat is active; must be set equal to or greater than *Min Position*.
Fan Damper Position	0.0 to 100.0%	50.00%	Damper position used when fan is on.

Indoor Air Quality

Displays all of the controller‘s editable settings for this category and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
IAQ Delay Time	0 to 1000 min	5 min	Delay time before reporting a local IAQ alarm.
Temp Reset Limit	0 to 14.9 °F (0 to 8.3 °C)	5 °F (2.8 °C)	Space temperature reset limit for IAQ alarm operation.
Sensor Max	0.0 to 6553.5 ppm	2000 ppm	PPM reading on IAQ sensor that corresponds to a 10V input.
Setpoint	0.0 to 6553.5 ppm	1200 ppm	Setpoint for alarm and damper/flow rate compensation to begin.
Control Band	0.0 to 6553.5 ppm	100 ppm	Control band for IAQ.

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Local Reheat

Displays all of the controller‘s editable settings for this category and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Local Heating Type	Disabled, FSP or Modulated, 1 Stage, 2 Stage	Disabled	“Disabled” - reheat is not used. “FSP or Modulated” - Floating point (H1, H2) or 0-10VDC (AO1) hot water valve. “1 Stage” - Single stage electric heat or two-position ON/OFF hot water valve (H1). “2 Stage” -Two stage electric heat (H1, H2).
Control Band	0 to 10 °F (0 to 5.6 °C)	1 °F (0.65 °C)	Control band used in modulating reheat - must be non-zero for valve modulation to occur.
Valve Travel or Stage Time	0 to 65535 sec	300 sec	This setting is used for both the travel time for floating point valve control and stage time for reheat stages - must be non-zero for any non-auxiliary reheat to occur.
Dual Max Enable	No, Yes	Yes	"No" - valve is modulated while damper position or flow rate is held at reheat setpoint. "Yes" - valve modulated up to max temperature then damper position or flow rate increased up to dual max SAT offset.
Dual Max SAT Offset	0 to 50 °F (0 to 27.8 °C)	15 °F (8.3 °C)	Maximum allowed temperature difference between space temp and SAT during normal reheat.
Auxiliary Stage Time	0 to 65535 sec	60 sec	Duration of auxiliary heating stage.
Runtime Limit	0 to 65535 hr	1000 hr	Runtime limit for the heating stages after which a maintenance alarm is generated. Zero disables the alarm.
Valve AO Min	0.0 to 10.0 V	0.0 V	Minimum output voltage when the analog valve is used (AO1).
Valve AO Max	0.0 to 10.0 V	10.0 V	Maximum output voltage when the analog valve is used (AO1).

Fan Settings

Displays all of the controller‘s editable settings for this category and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Fan Type	Disabled, Series Fan, Parallel (Temp), Parallel (Flow)	Disabled	Type of fans controller by the VAV-2 Series. * Set to “Parallel (Temp)” if running the VAV-2 Series in Auxiliary Heating mode. * “Parallel (Flow)” is for VAVI-2 only.
Analog Fan Speed	0.00 to 100.00%	0.00%	Analog fan output value.

Backup Occ Time / Backup Unocc Time

Backup times for unoccupied and occupied mode are stored in the controller. It uses these times when the network interface to the LCI is unavailable.

Setting	Range	Default	Description
Hours	0 to 23	0	Hour to start occupied/unoccupied times.
Minutes	0 to 59	0	Minute to start occupied/unoccupied times.

Alarms

Alarm	Range	Alarm Trigger	Alarm Reset
Thermostat Failure	Normal, Alarm	The thermostat fails to communicate with the controller.	Communication between thermostat and controller is re-established.
Maintenance Alarm	Normal, Alarm	When the Heating Runtime exceeds the limit set.	Button *Reset Runtimes* gets pressed after servicing the equipment.
Space Temperature High	Normal, Alarm	SpaceTemp > (CalcCoolingSp + Coolband + AlarmLimitOffset)	Space Temp returns below High Limit.
Space Temperature Low	Normal, Alarm	SpaceTemp < (CalcHeatingSp - Heatband -AlarmLimitOffset)	Space Temp returns above Low Limit.
Indoor Air Quality (IAQ)	Normal, Alarm	Local IAQ condition or the CHB signals an IAQ condition.	The IAQ condition clears or the CHB signals that the IAQ condition has cleared.
Stuck Damper	Normal, Alarm	The controller is unable to move the damper.	The controller is able to move the damper again.
Starved Box (VAVI-2)	Normal, Alarm	Insufficient airflow even when the damper is at maximum. Can be disabled in the System Options screen.	Airflow setpoint is reached.

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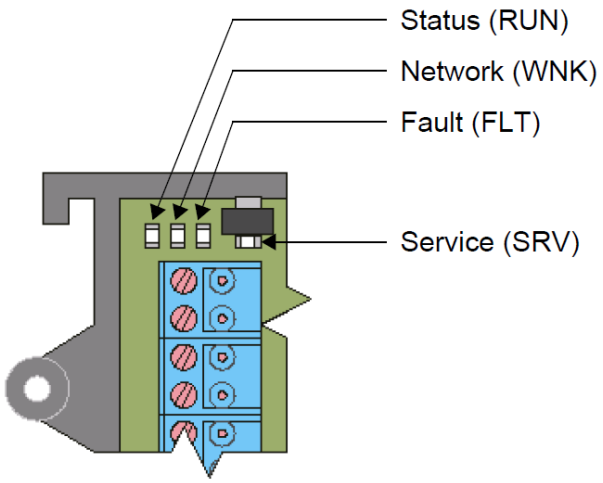
TROUBLESHOOTING

Diagnostic LEDs

The controller has 4 LED indicators. These indicators can aid in troubleshooting equipment operation problems. The following table lists the functions of the controller's LEDs in the order they appear from left to right on the unit.

LED	Indication
Status	– Solid green when running and configured by an LCI – Flashing green when running and NOT configured by an LCI
Network	– Yellow while the controller is transmitting data onto the FTT-10A network – Green when there is network activity – Off when there is no network activity
Fault	– Solid red when a fault condition exists
Service	– Illuminated when the service pin is pushed

Figure 14: Terminal Unit Controller Controller LEDs



Troubleshooting Tips

The following table provides tips on resolving common issues.

Problem	Solution
Controller is not running and Status LED is not illuminated.	No power to controller. Verify the voltage on the controller's power connector (24 VAC).
How do I reset the controller?	The controller can be reset by the LCI, or you can cycle power to the controller. Refer to the LCI documentation for more information on resetting the controller using the LCI.
I am using a TS303 thermostat and cannot force the fan ON.	On the VAV2 Series controller, the Fan Override button is disabled. Model TS303 is not recommended for use with VAV2 Series controllers.
On other iWorx® controllers, the status LED will turn Red when the controller has entered a fault mode that requires a reset. Are there any such modes on the VAV2 Series?	Yes, but it doesn't require a reset. As with any of the controllers, if the controller detects that no TS300 series sensor is present, an alarm is issued, the controller enters fault mode, and the LED is turned red. However, this type of failure doesn't require a manual reset.

Problem	Solution
Can VAV2 Series controllers have independent schedules?	Yes, each VAV2 Series controller on the network can be part of a different LCI group containing a different schedule. Remember the LCI is limited to 16 groups and 16 schedules.
What is the maximum number of VAV2 Series controllers that the LCI can support?	Since VAV2 Series controllers require either a VPU2 or MPU2 controlling the air-handling unit, the LCI can support up to 32 VAVD controllers per MPU2 and up to 60 VAVI controllers per VPU2. Remember the LCI can only support a maximum of 63 control-lers.
When will the damper be controlled to the minimum flow value?	The damper will be controlled to the minimum flow value when the space temperature is satisfied.
Is there any provision for an air balancer to override the VAV box damper?	Yes, using the LCI there is a mode that an air balancer can manipulate the damper or set it to maintain a specified flow.
My VAV2 Series boxes are not enter-ing heating or cooling mode.	Have the controllers been grouped with an VPU2 or MPU2? Have you sent the grouping information to the controllers?
My temperature and flow readings are fluctuating rapidly.	Verify that the VAV2 Series is properly grounded. There must be a wire jumper between terminals T7 and T8.

Getting Help

Components within an iWorx® controller, sensor, or power supply cannot be field repaired. If there is a problem with a unit, follow the steps below before contacting your local TES representative or TES technical service.

1. Make sure controllers, sensors, and power supplies are connected and communicating to desired devices.
2. Record precise hardware setup indicating the following:

   Version numbers of application software.

   Device and/or firmware version number.

   A complete description of difficulties encountered.

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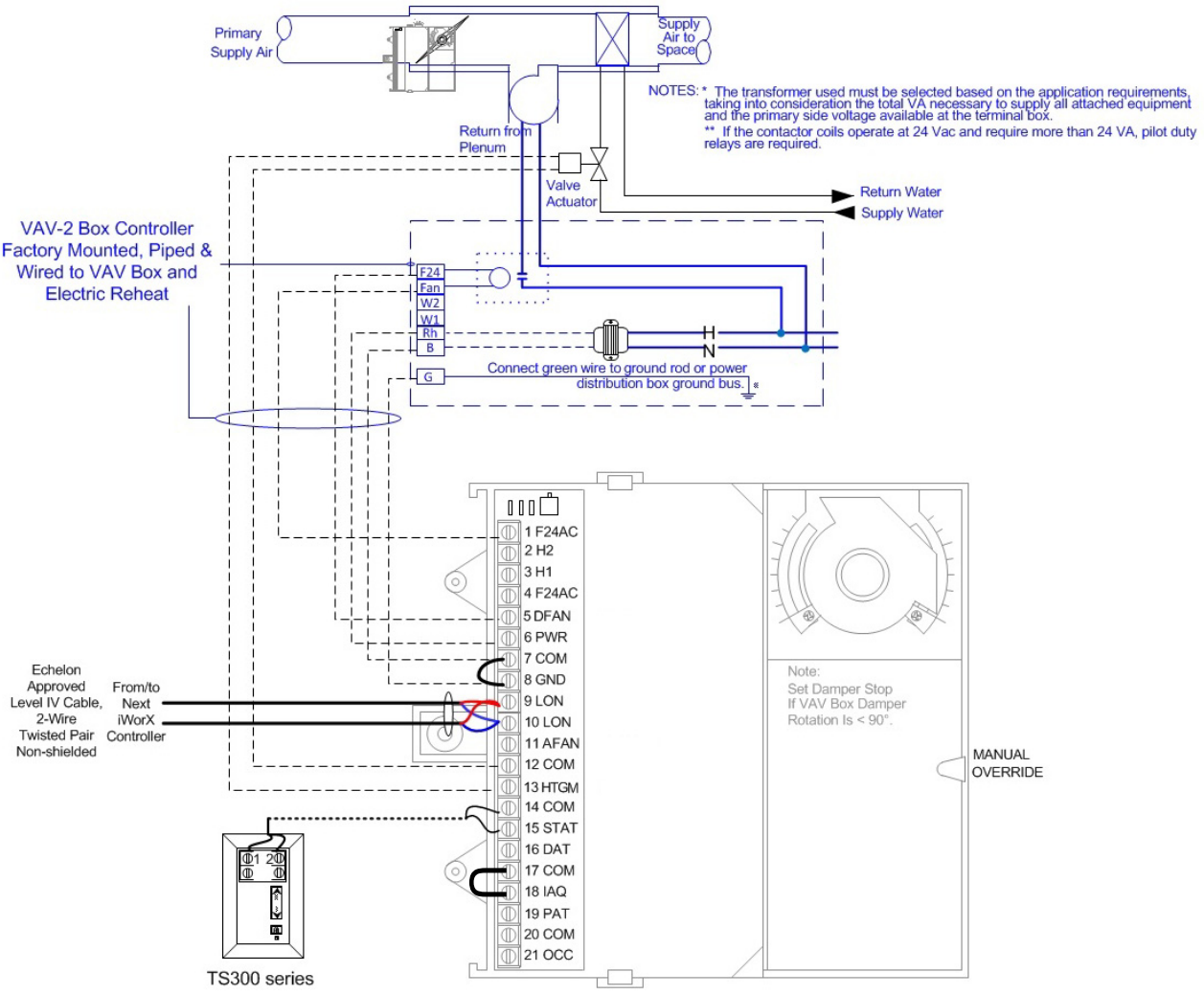
APPENDIX: TYPICAL APPLICATION WIRING

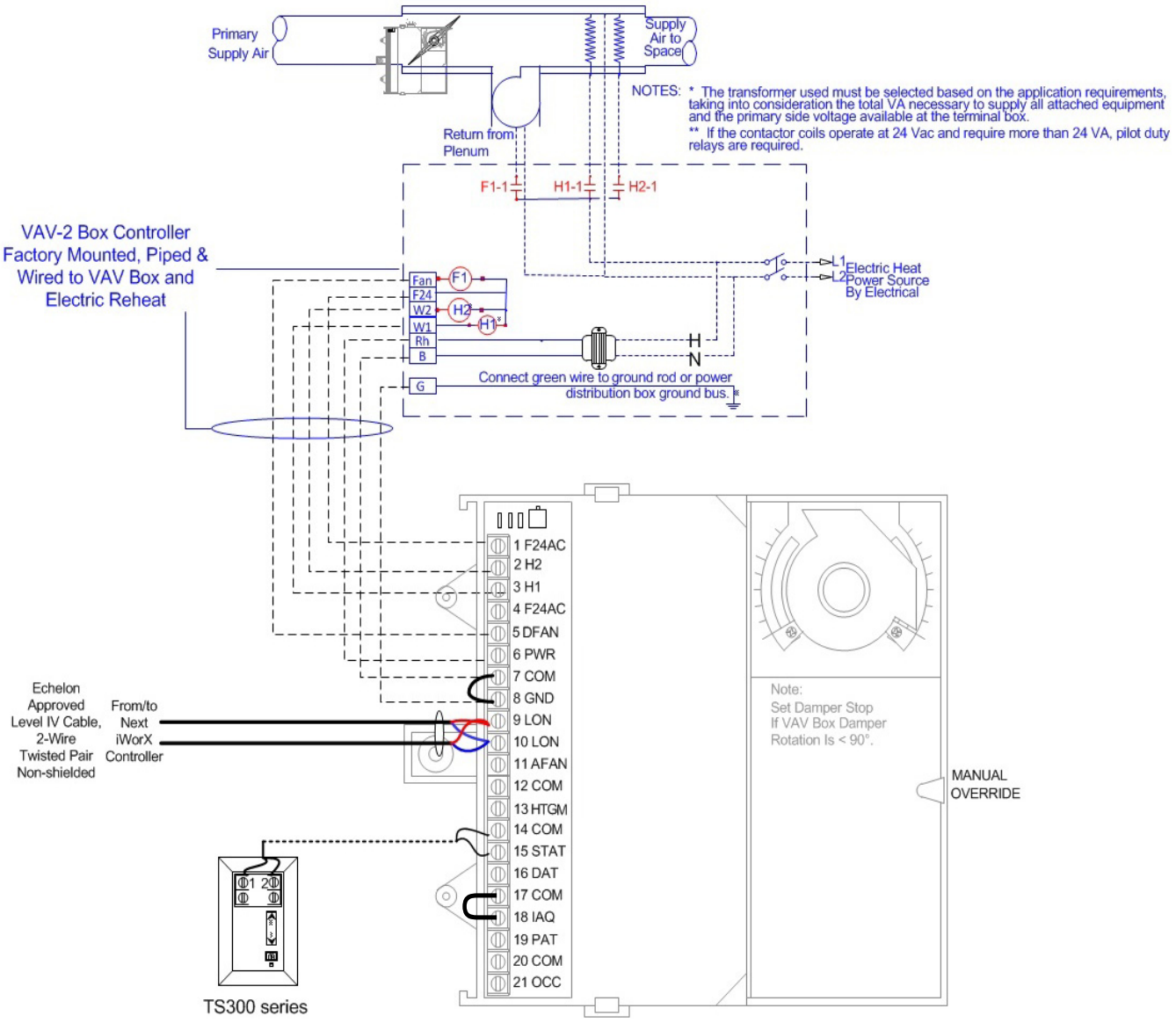
This section provides a range of sample wiring diagrams for typical applications involving a VAV2 Series controller.

Figure 15: Parallel Fan, Pressure Dependent VAVD-2 Box with Modulated HW Reheat



Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

Figure 16: Parallel Fan, Pressure Dependent VAVD-2 Box with Electric Reheat



Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

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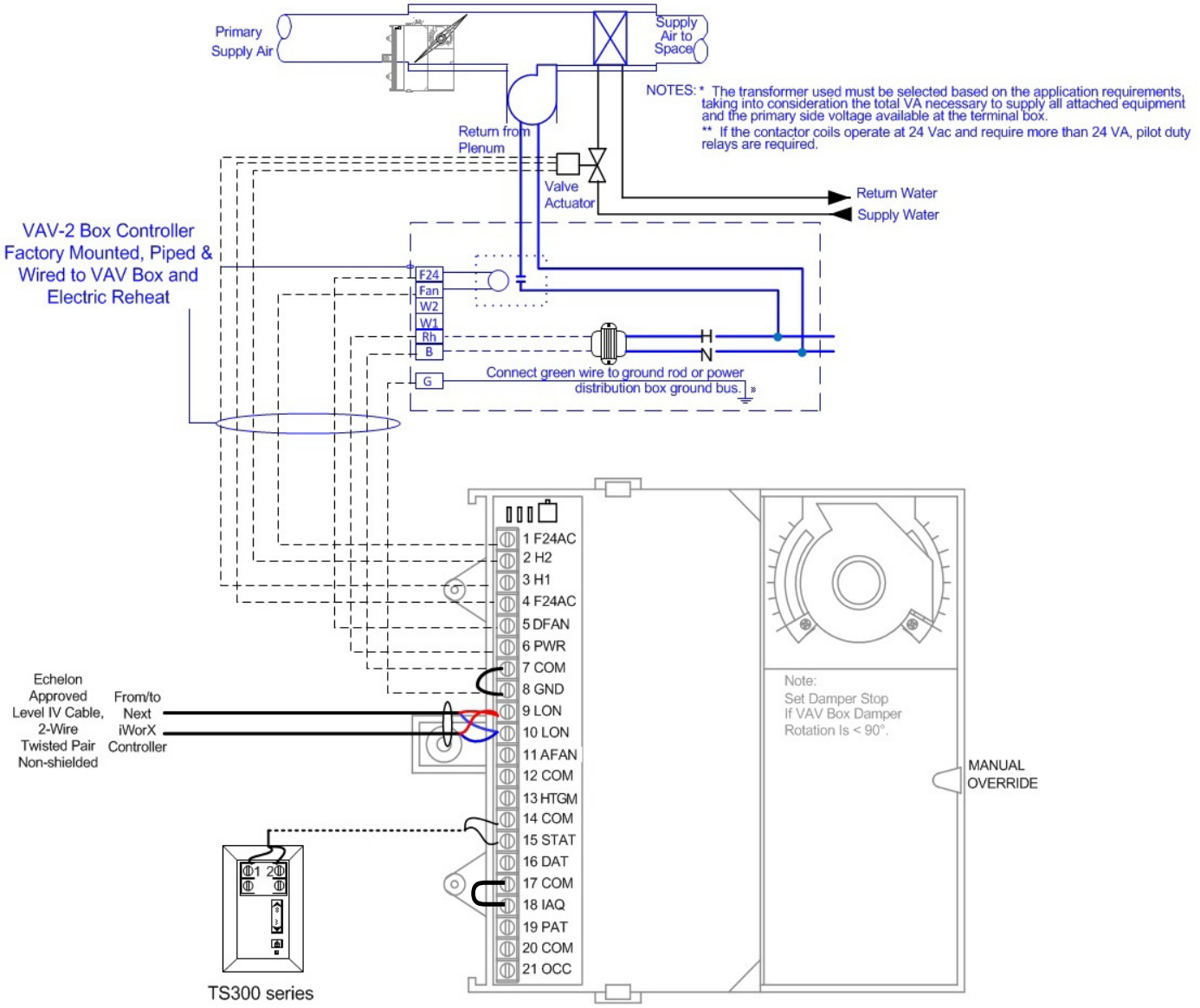
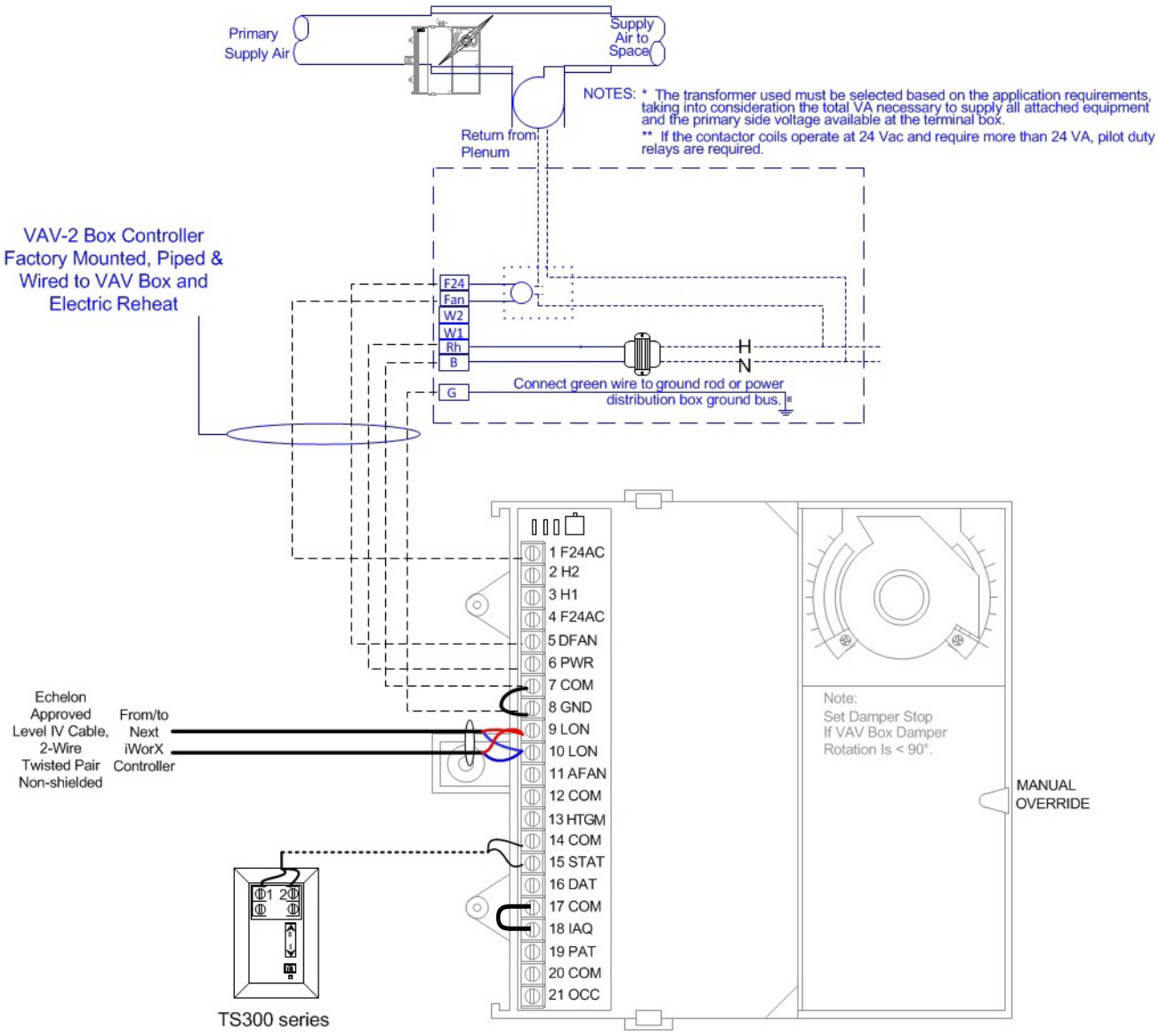
Figure 17: Parallel Fan, Pressure Dependent VAVD-2 Box with Floating Point HWV Reheat



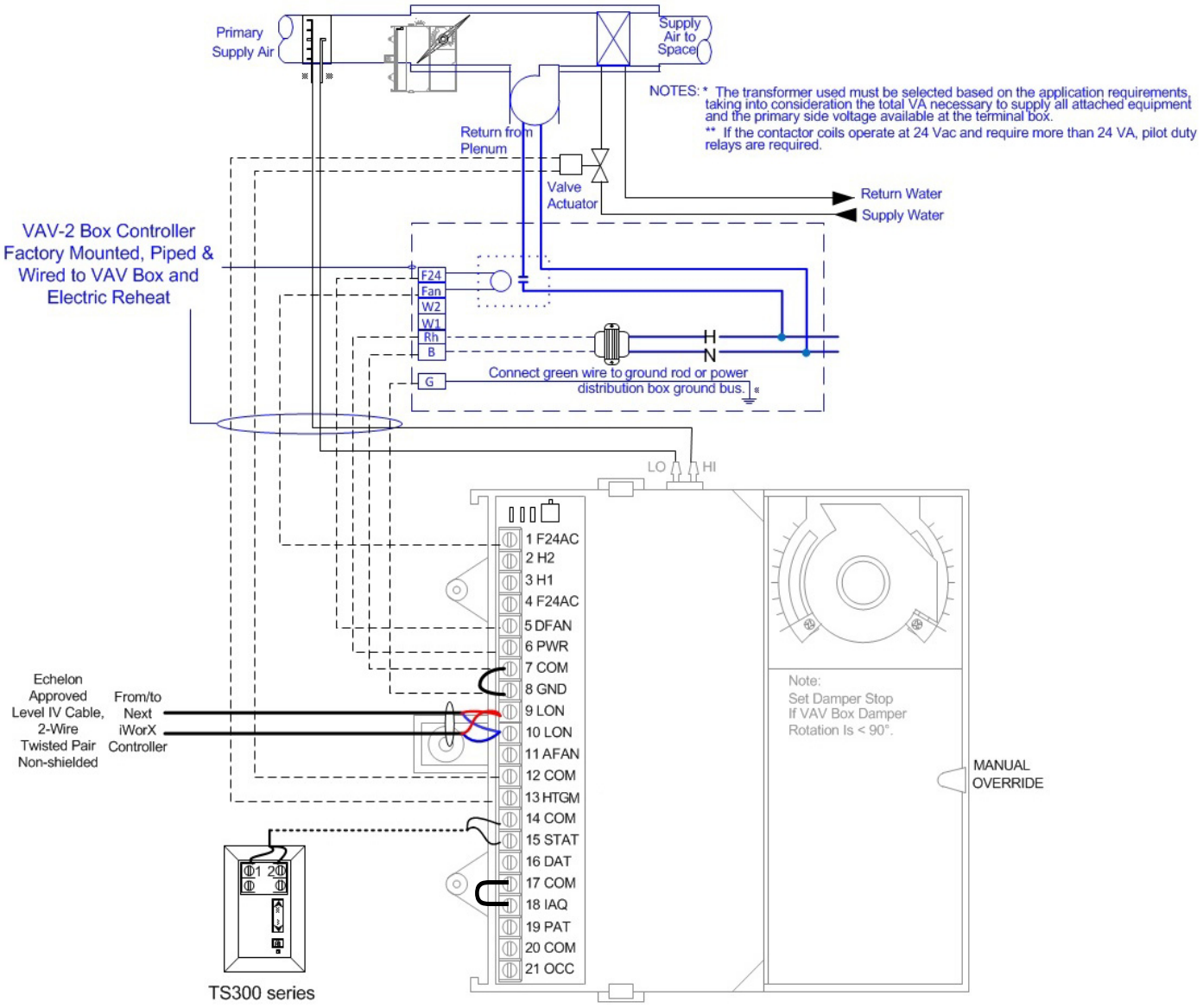
Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

Figure 18: Parallel Fan, Pressure Dependent VAVD-2 Box without Reheat



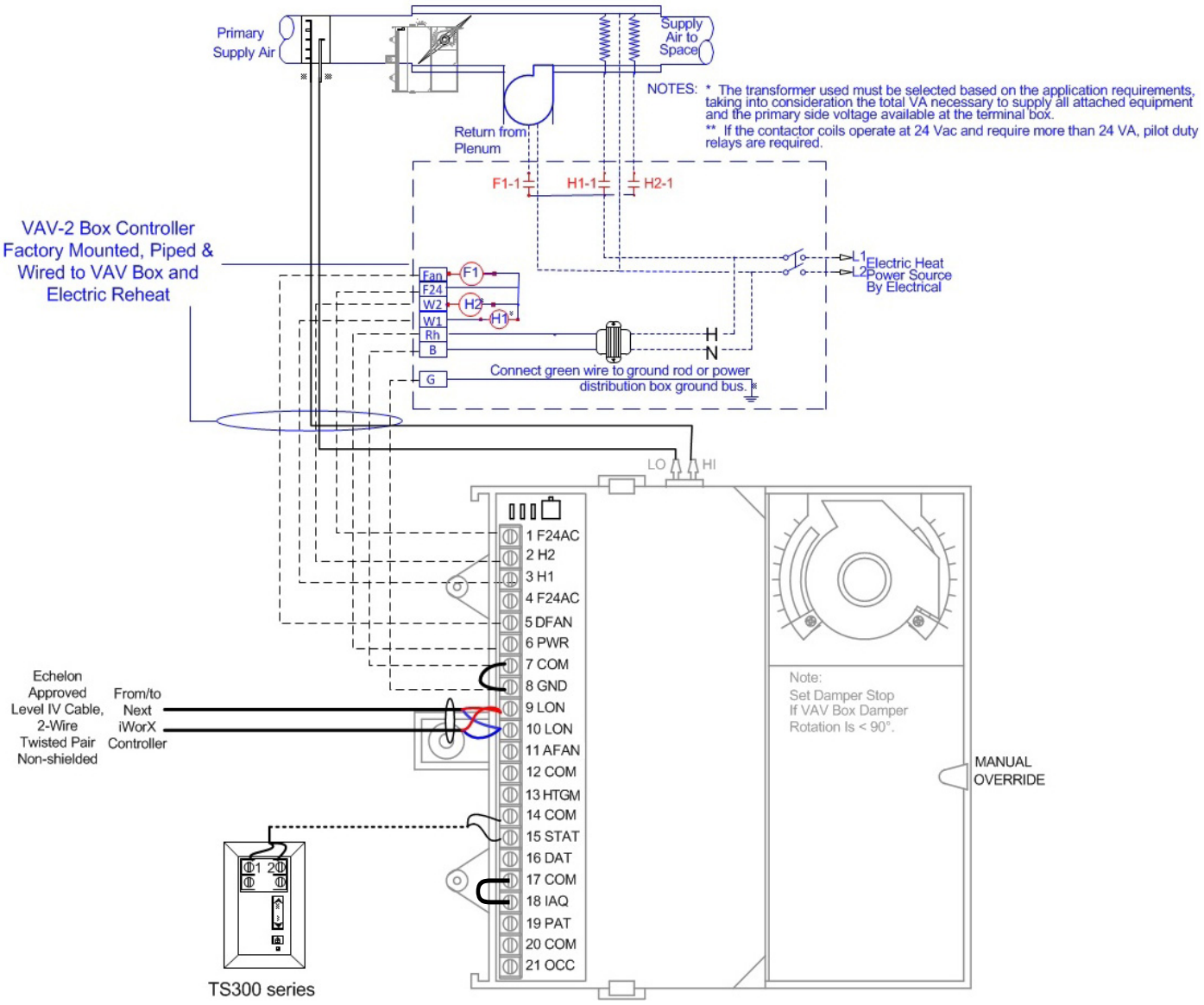
Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

Figure 19: Parallel Fan, Pressure Independent VAVI-2 Box with Modulated HW Reheat



Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

Figure 20: Parallel Fan, Pressure Independent VAVI-2 Box with Electric Reheat



Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

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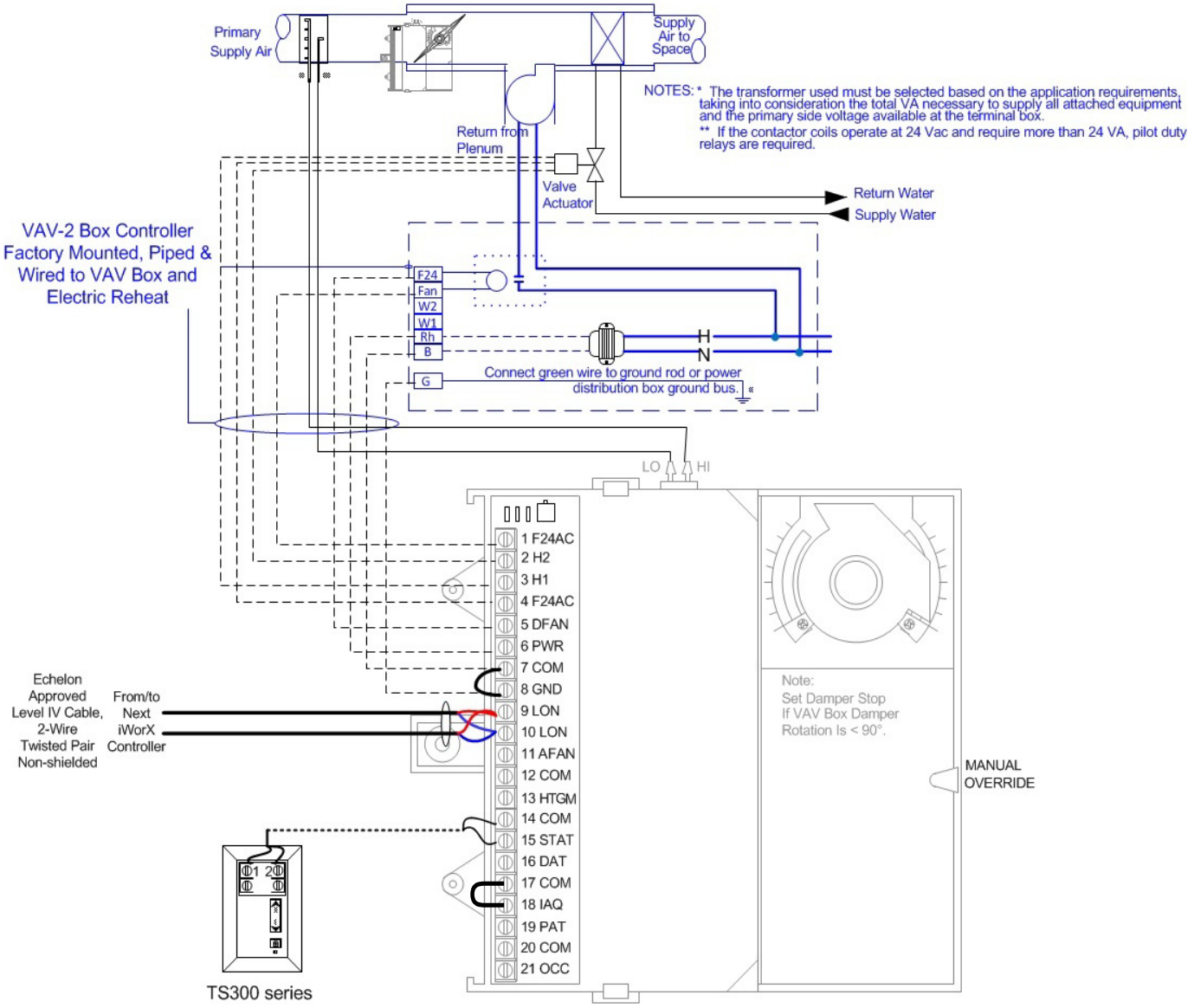
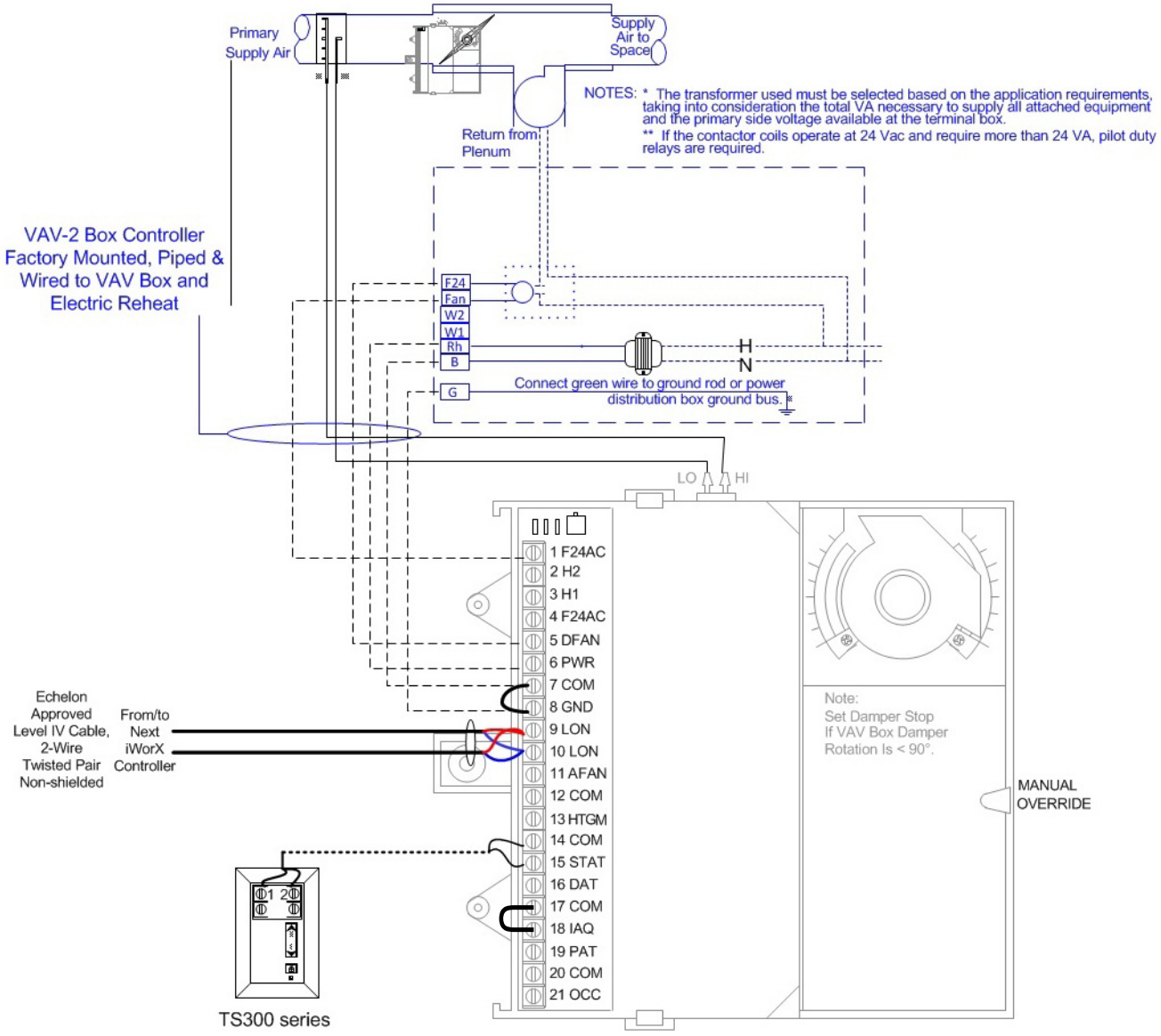
Figure 21: Parallel Fan, Pressure Independent VAVI-2 Box with Floating Point HWV Reheat



Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

Figure 22: Parallel Fan, Pressure Independent VAVI-2 Box without Reheat



Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

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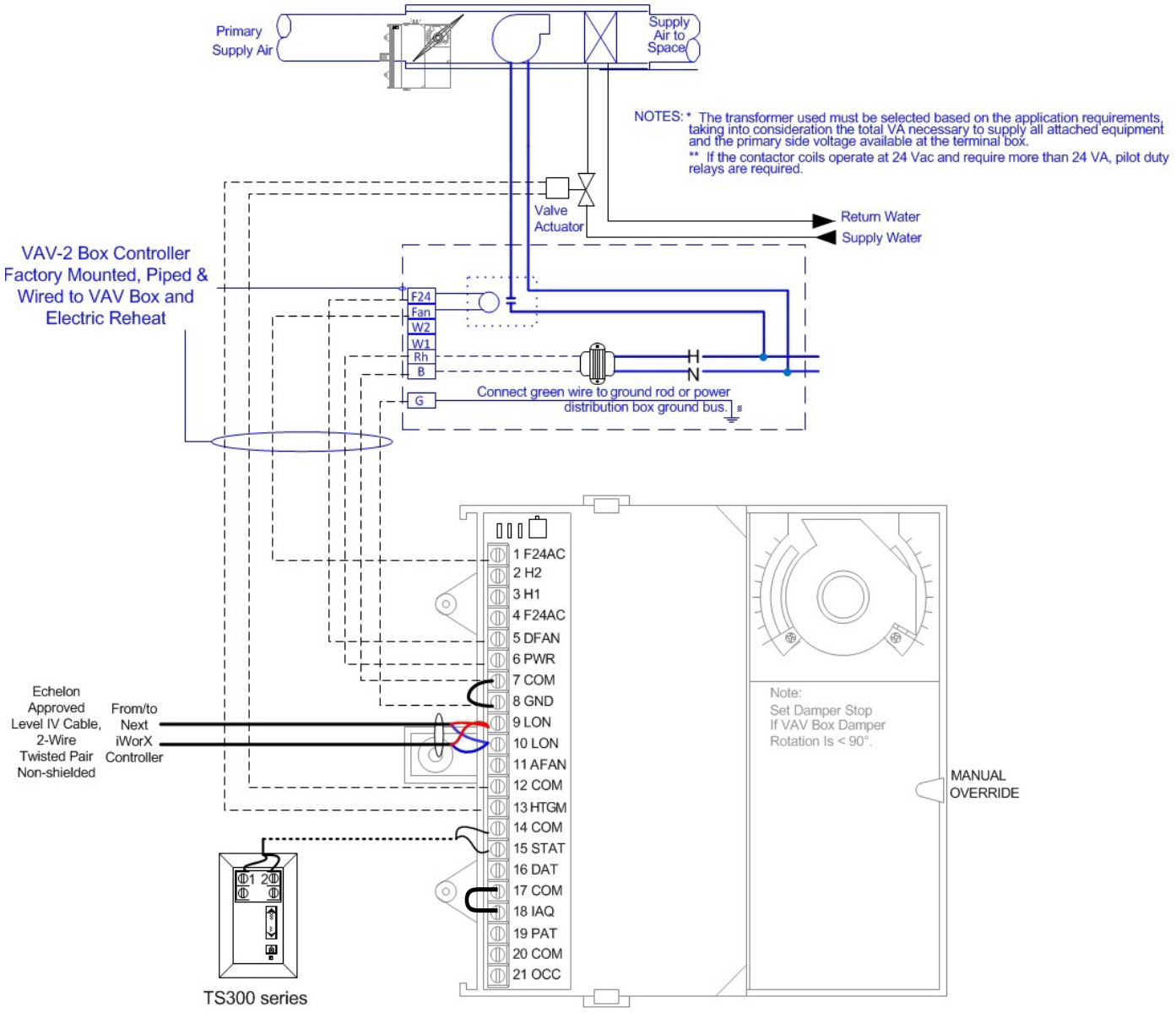
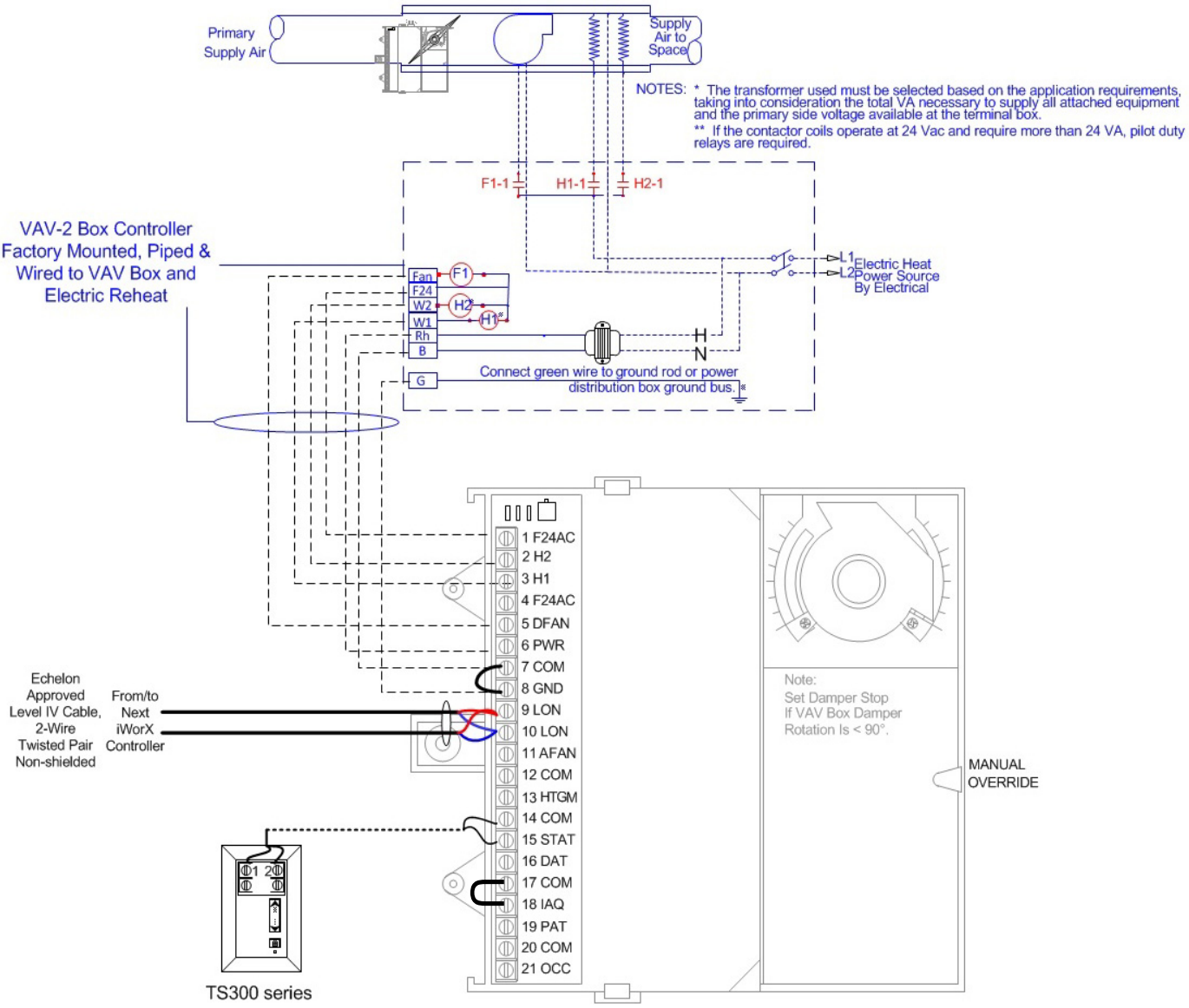
Figure 23: Series Fan, Pressure Dependent VAVD-2 Box with Modulated HW Reheat



Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

Figure 24: Series Fan, Pressure Dependent VAVD-2 Box with Electric Reheat



Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

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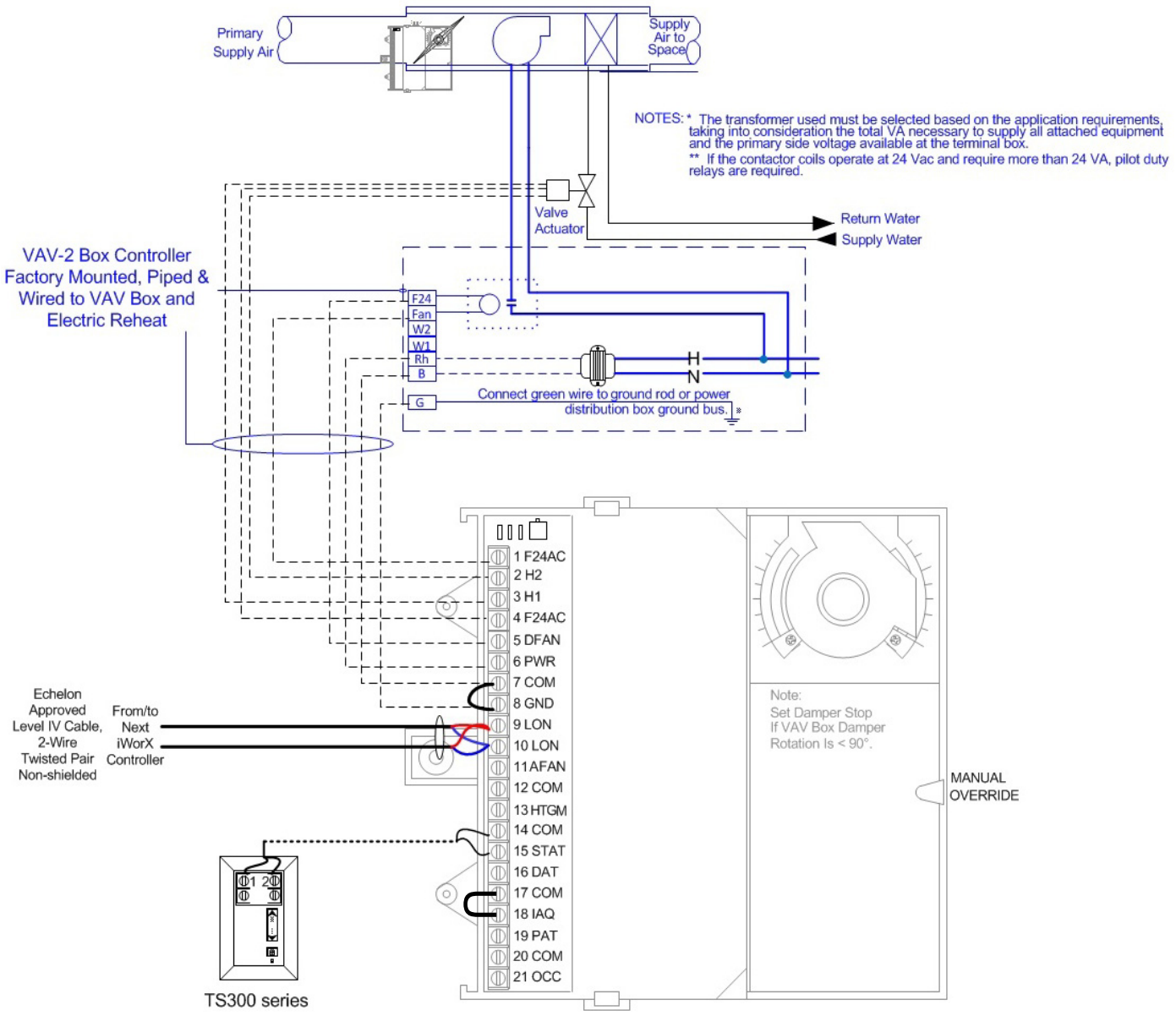
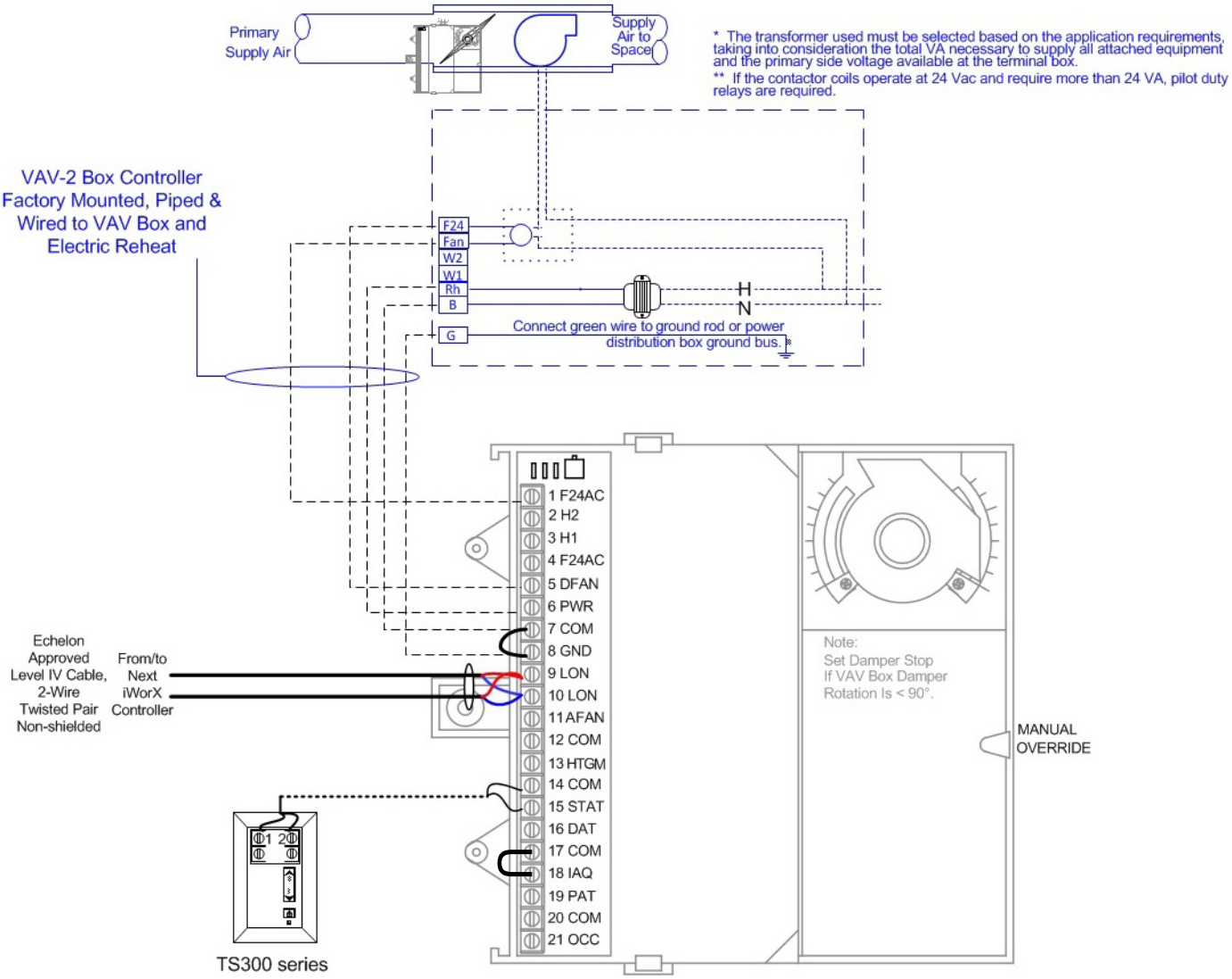
Figure 25: Series Fan, Pressure Dependent VAVD-2 Box with Floating Point HWV Reheat



Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

Figure 26: Series Fan, Pressure Dependent VAVD-2 Box without Reheat



Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

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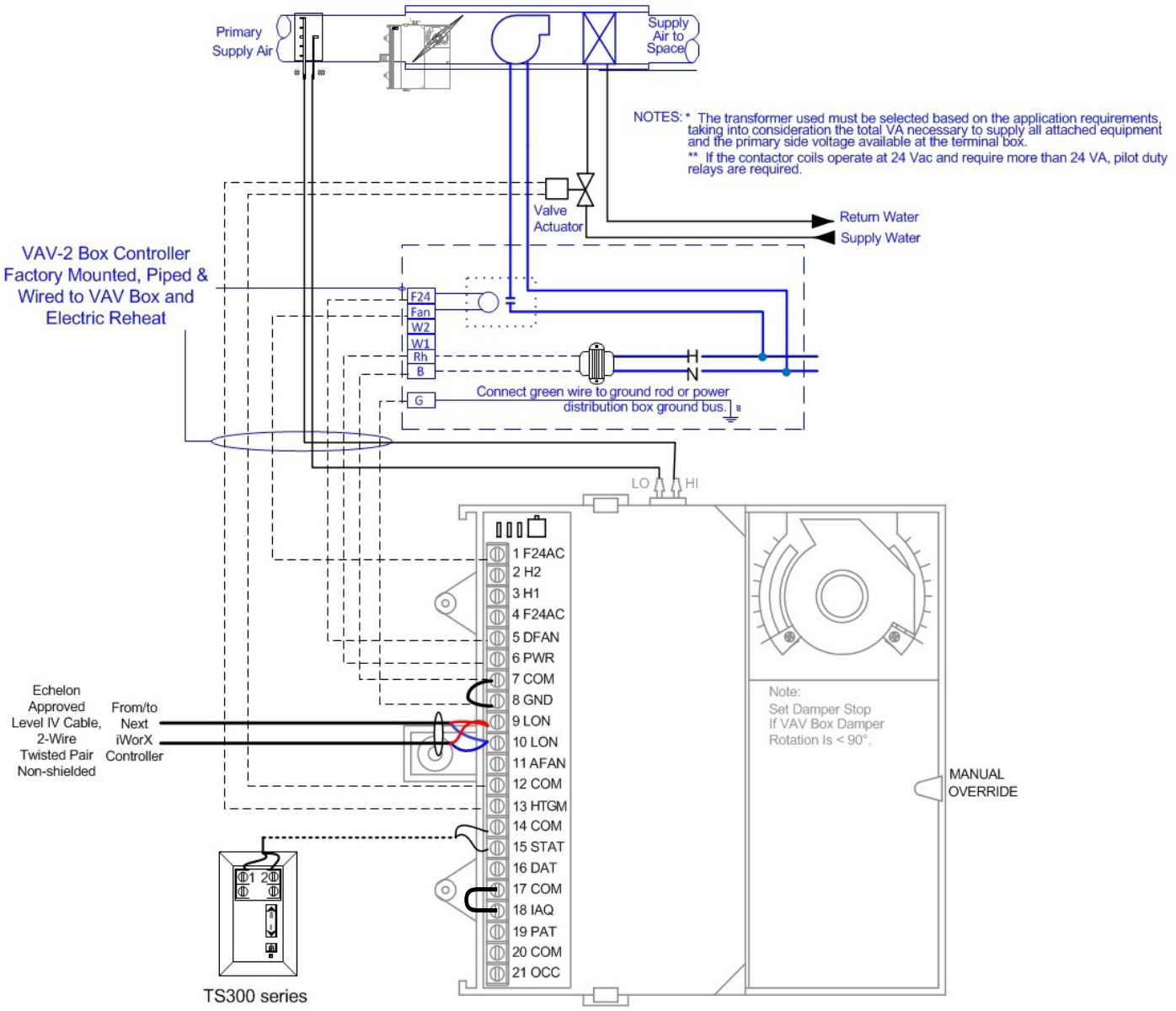
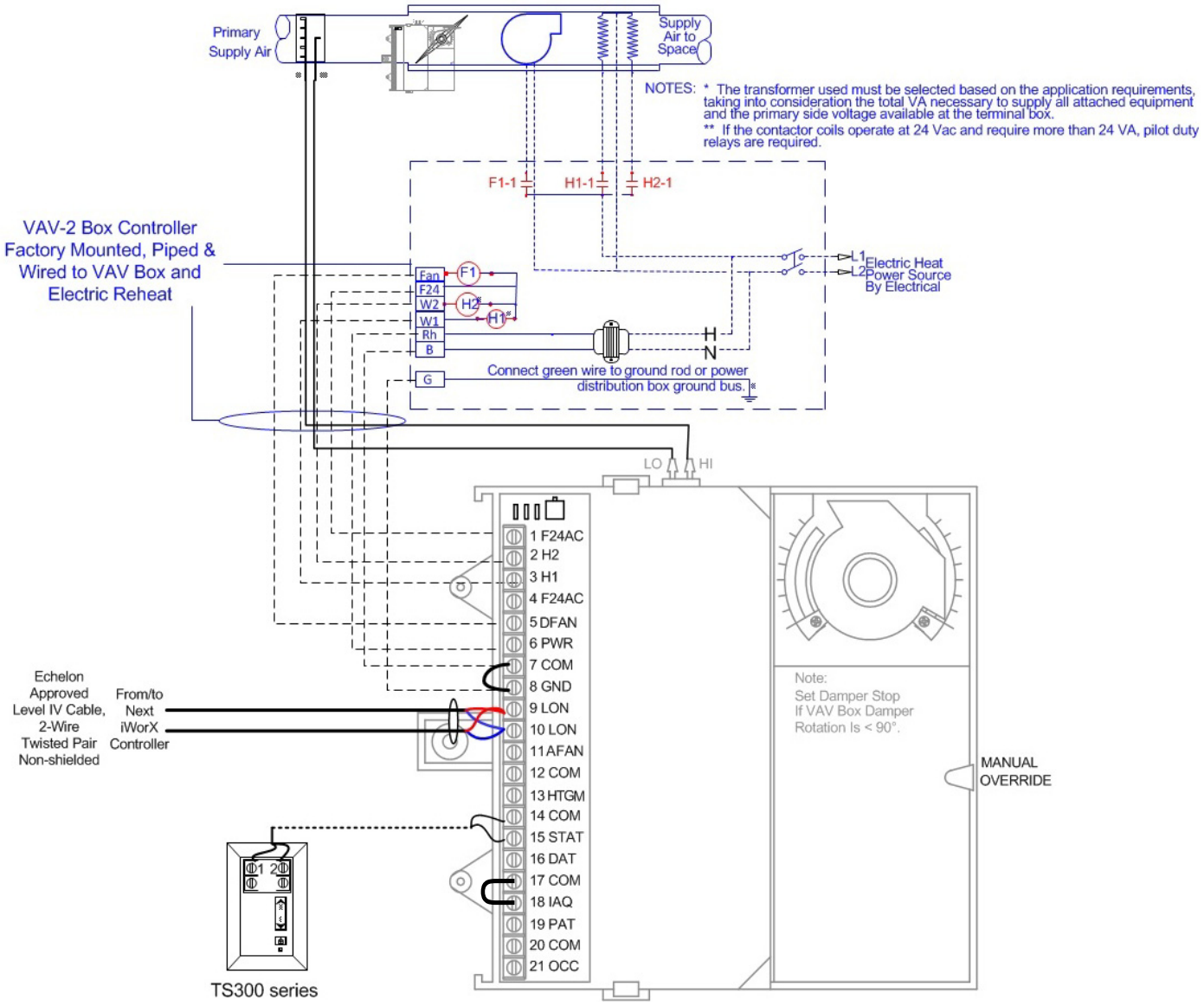
Figure 27: Series Fan, Pressure Independent VAVI-2 Box with Modulated HW Reheat



Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

Figure 28: Series Fan, Pressure Independent VAVI-2 Box with Electric Reheat



Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

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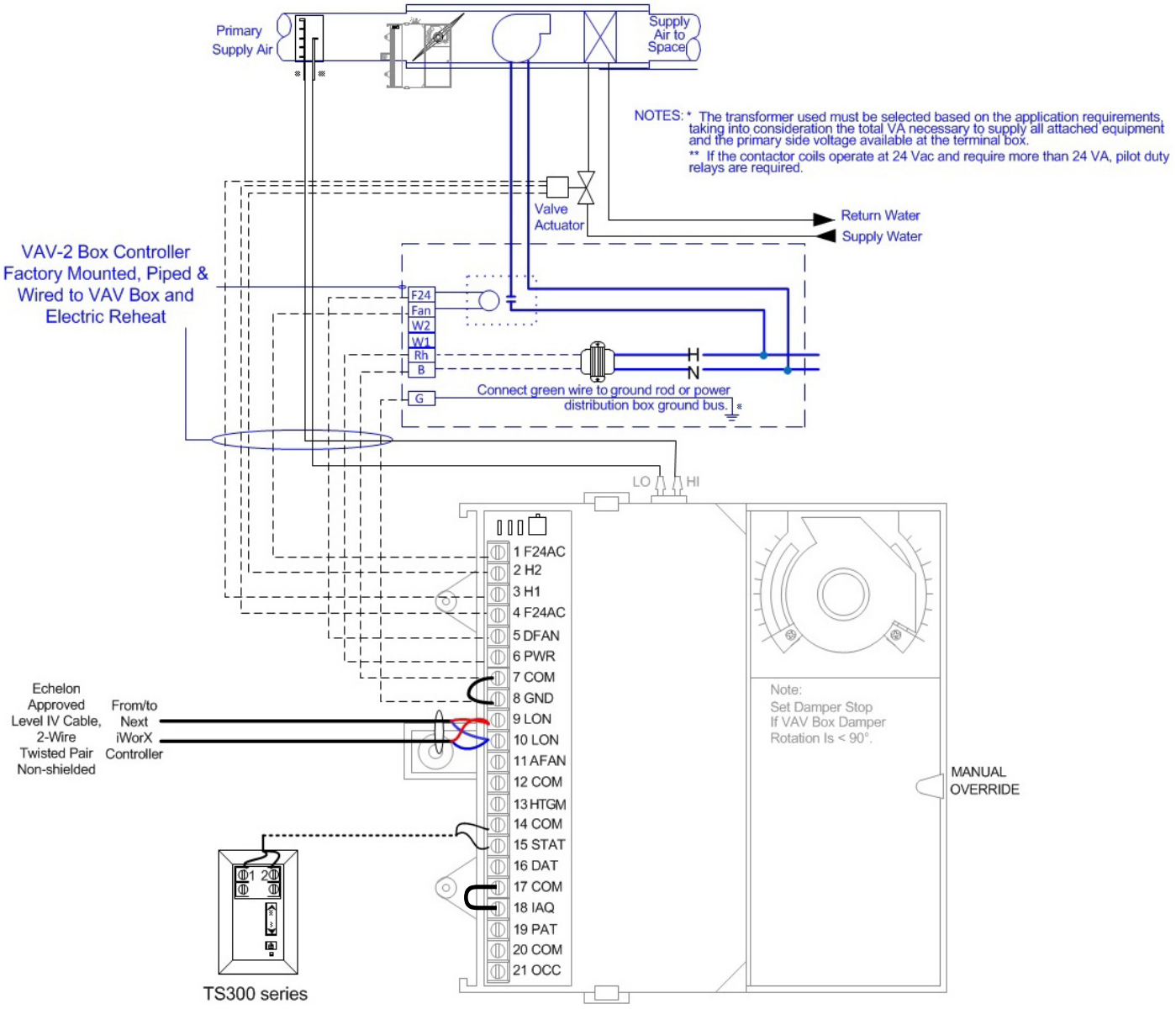
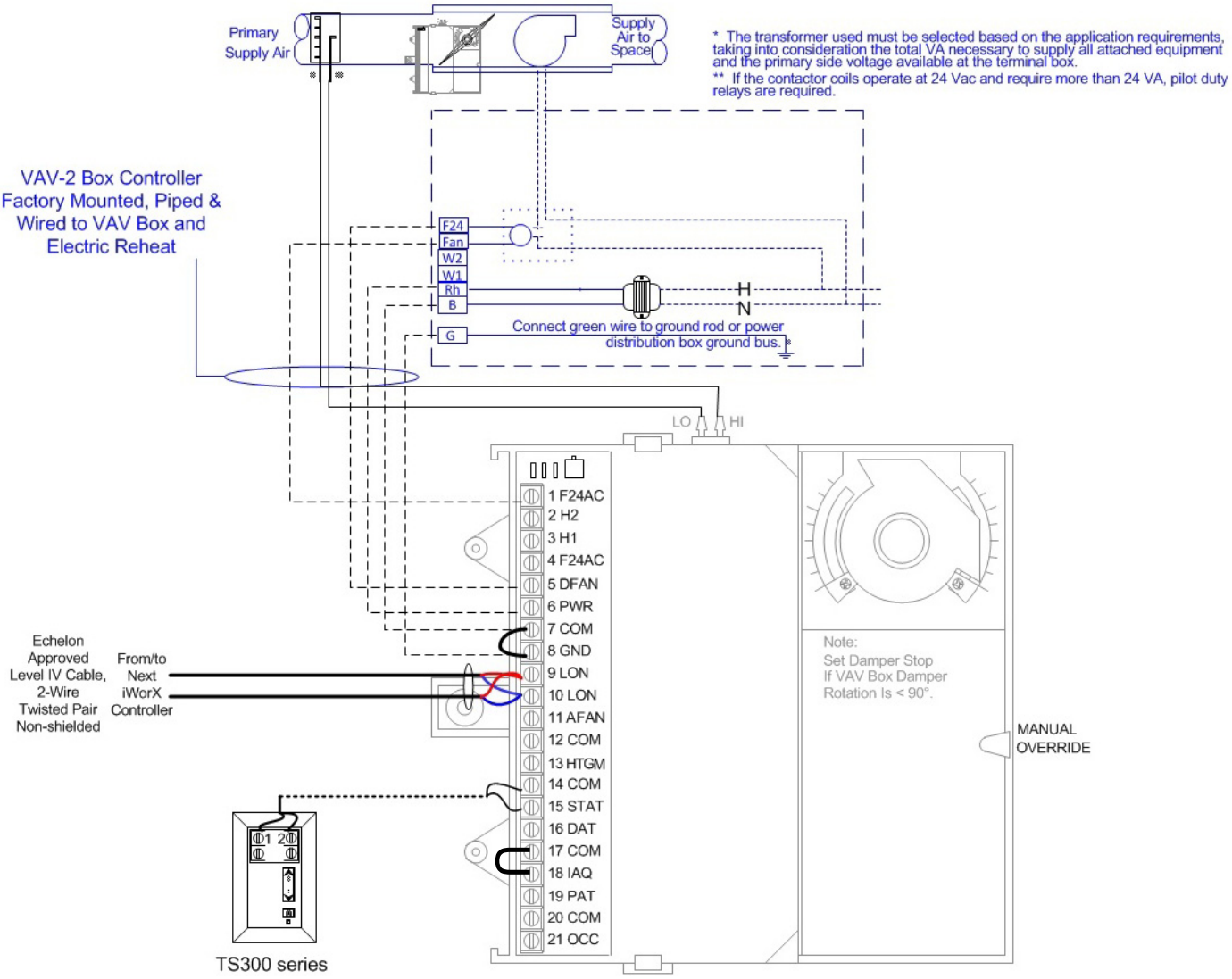
Figure 29: Series Fan, Pressure Independent VAVI-2 Box with Floating Point HWV Reheat



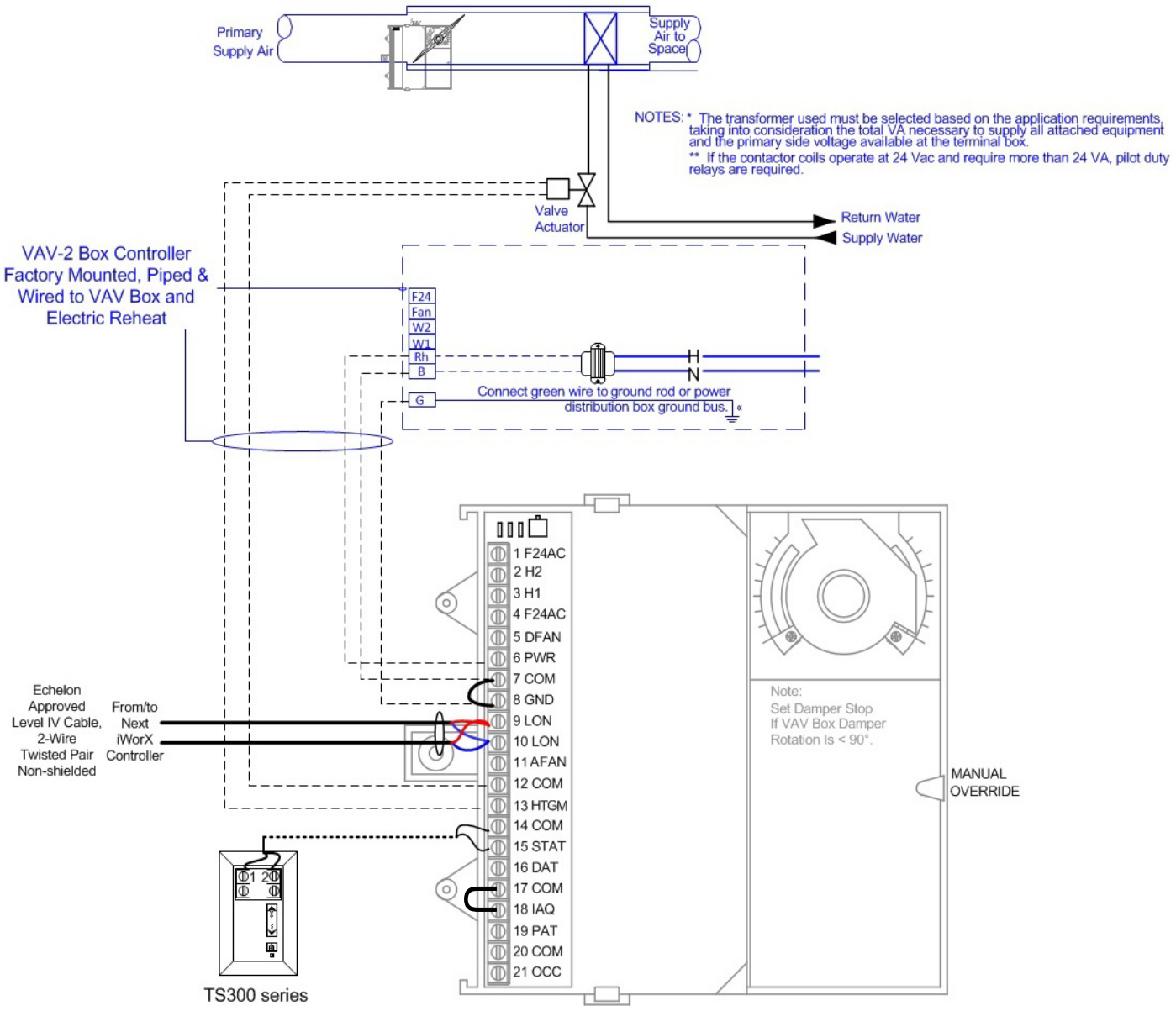
Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

Figure 30: Series Fan, Pressure Independent VAVI-2 Box without Reheat



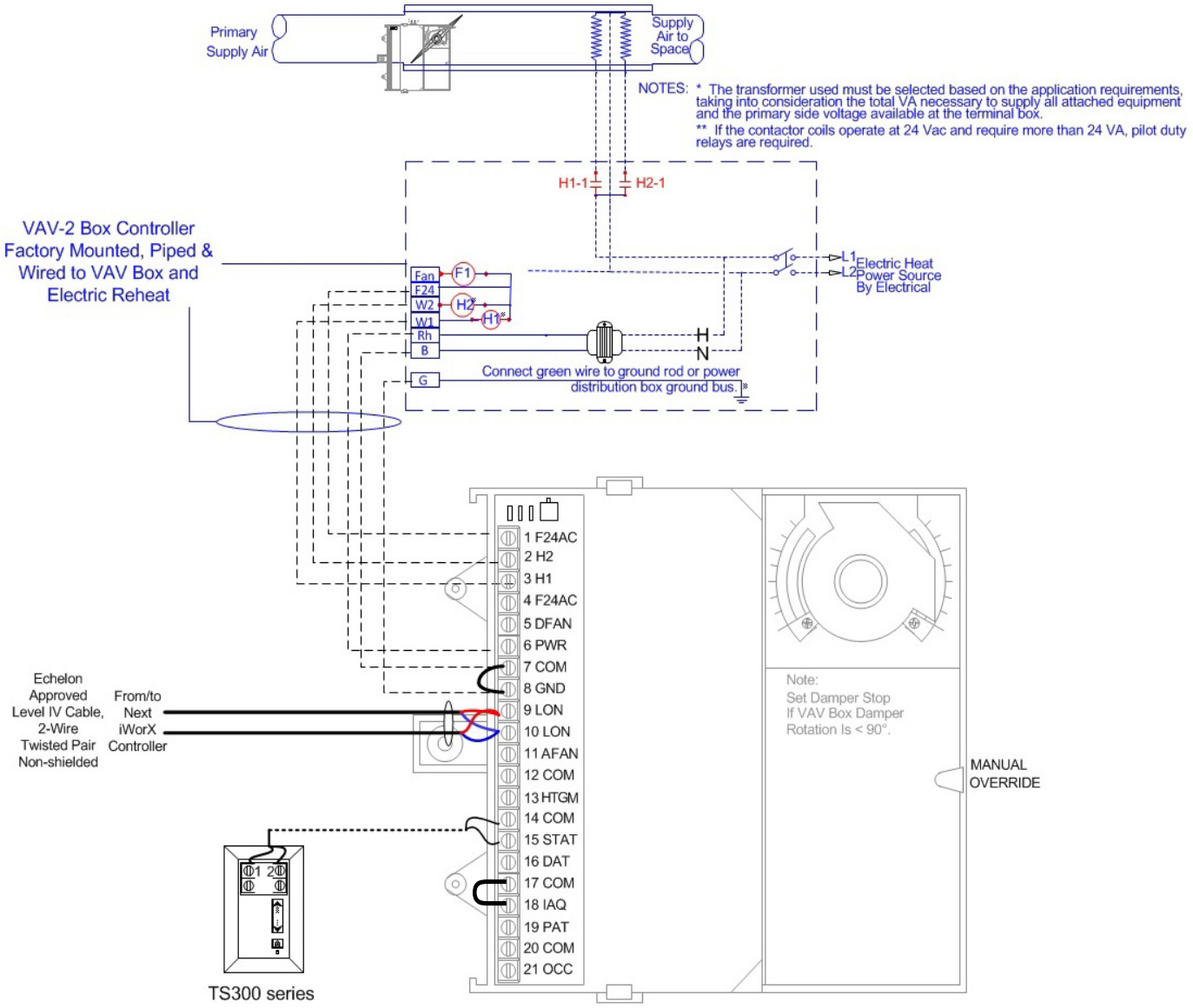
Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

Figure 31: Pressure Dependent VAVD-2 Box with Modulated HW Reheat



Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

Figure 32: Pressure Dependent VAVD-2 Box with Electric Reheat



Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

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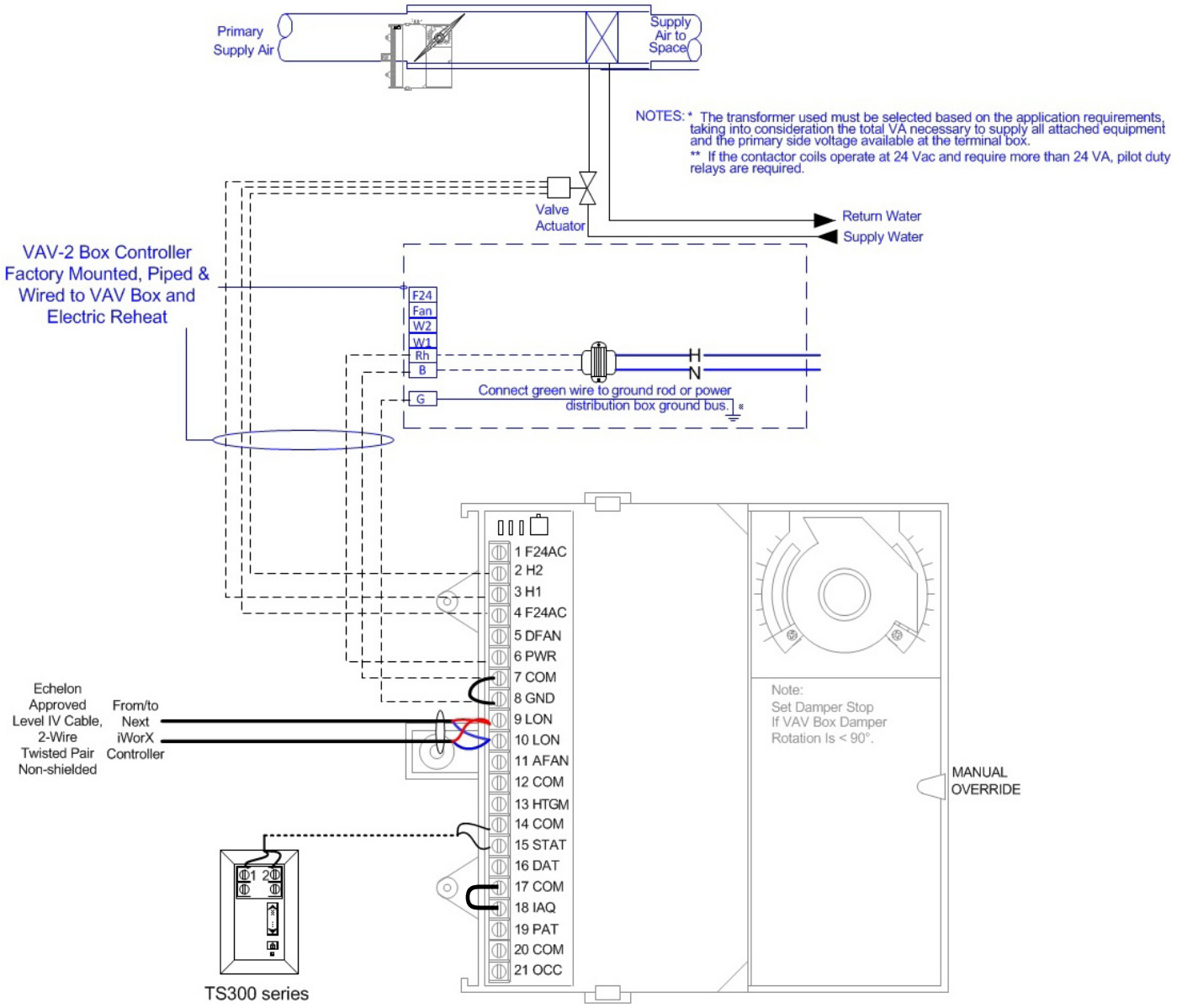
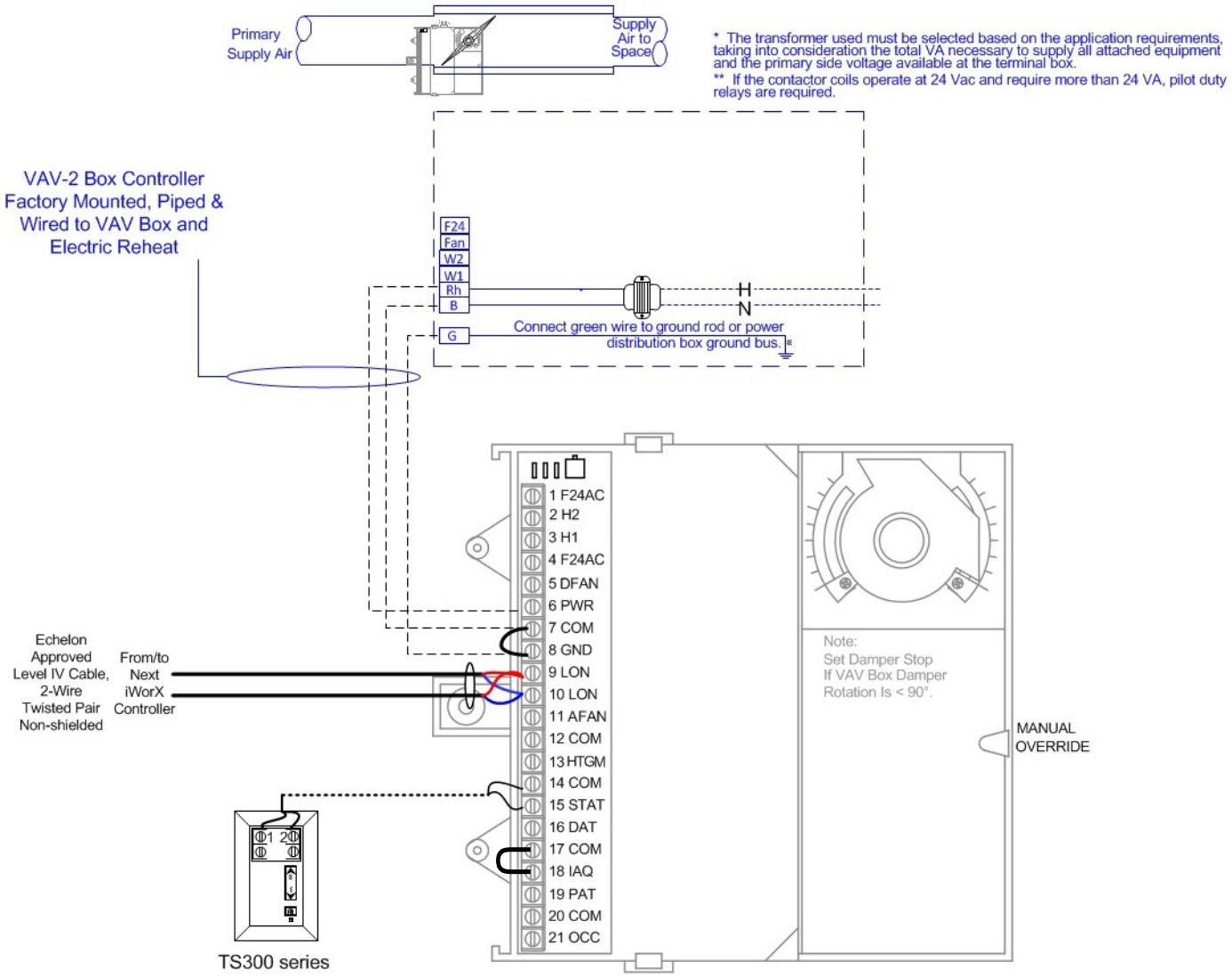
Figure 33: Pressure Dependent VAVD-2 Box with Floating Point HWV Reheat



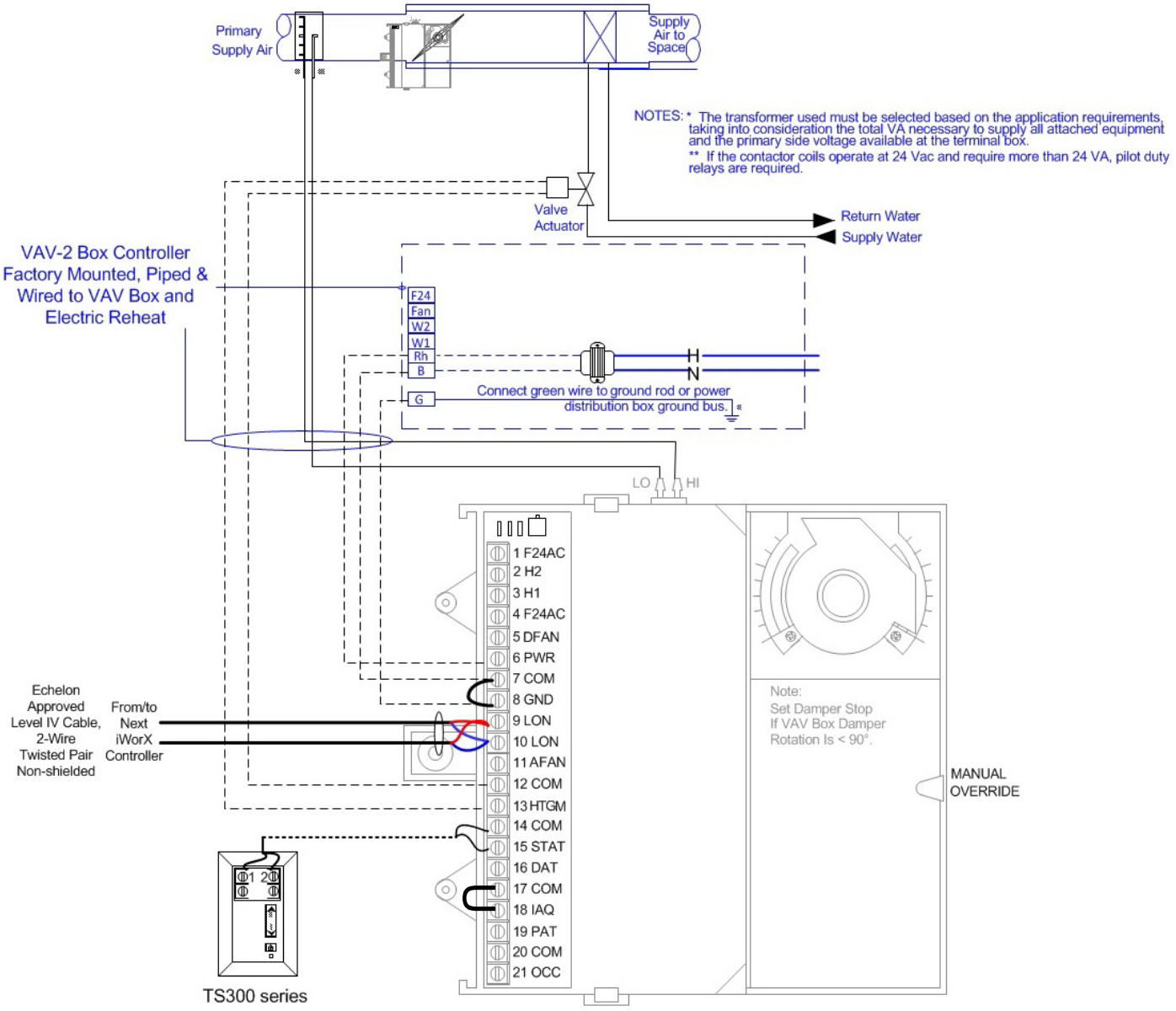
Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

Figure 34: Pressure Dependent VAVD-2 Box without Reheat



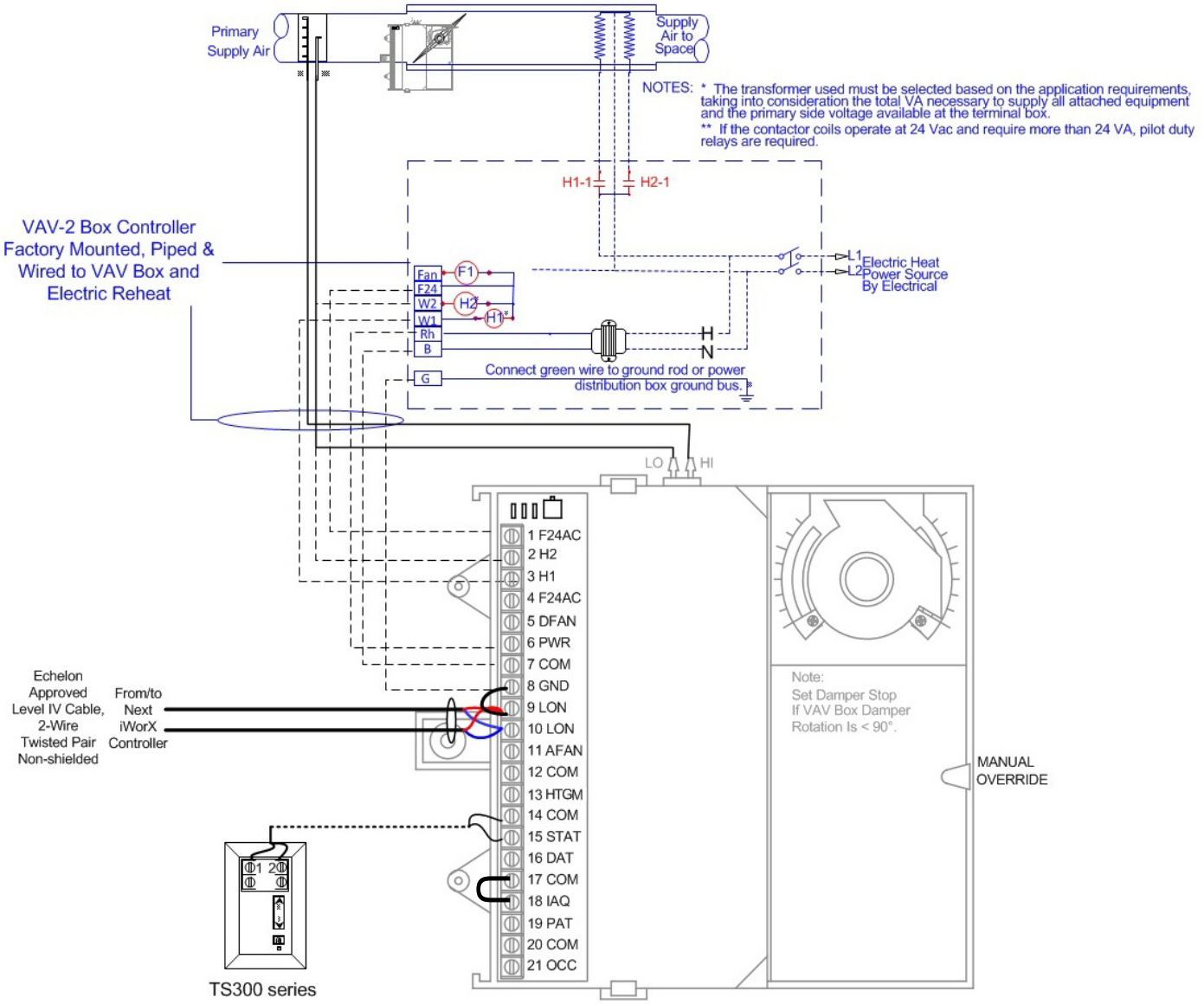
Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

Figure 35: Pressure Independent VAVI-2 Box with Modulated HW Reheat



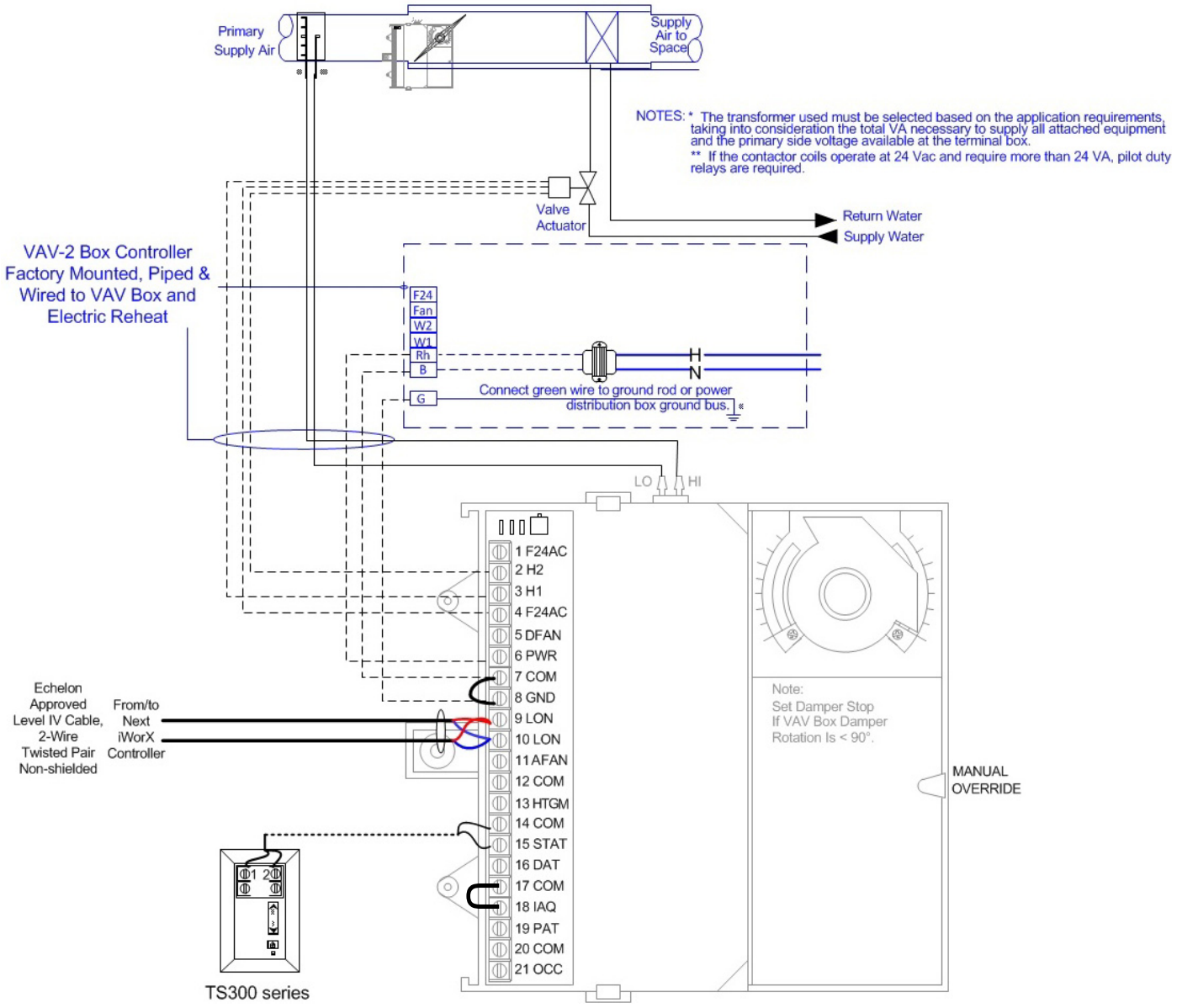
Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

Figure 36: Pressure Independent VAVI-2 Box with Electric Reheat



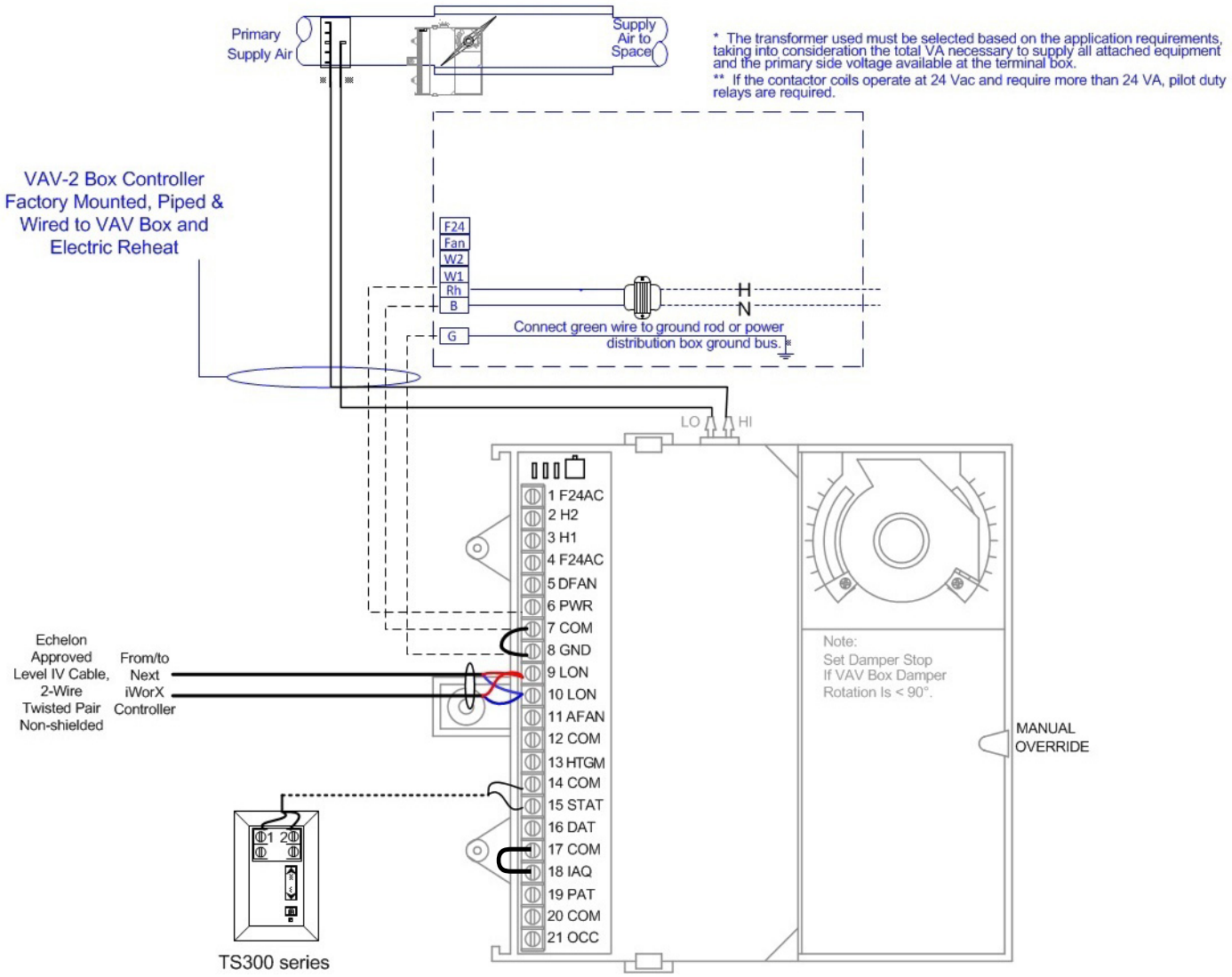
Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

Figure 37: Pressure Independent VAVI-2 Box with Floating Point HWV Reheat



Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

Figure 38: Pressure Independent VAVI-2 Box without Reheat



Note: Factory installed jumper between terminal 17 & 18, IAQ Sensor. Remove the jumper when installing analog CO2 Sensor.

Notes:

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Taco Electronic Solutions, Inc. (TES) will repair or replace without charge (at the company's option) any product or part which is proven defective under normal use within one (1) year from the date of start-up or one (1) year and six (6) months from date of shipment (whichever occurs first).

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