

VPU2 Air Control – Pressure Independent Multi-Zone Self-Contained Interoperable Controller Model UCP-1

SUPERSEDES: April 2, 2015

EFFECTIVE: June 30, 2015

Plant ID: 001-4026

Table of Contents

VPU2	3	Cooling Sequence	25
Overview	3	Economizer Operation	29
Features	3	Dehumidification	30
Purpose of This Guide	3	Fan Operation	30
Representations and Warranties	4	Static Pressure Control	30
Applicable Documentation	4	Soft Start Ramping	31
Installation Instructions	5	Fan Proof	31
General	5	VPU2 and VAVI Communications	31
Static Electricity	5	Power On/Reset Delay	32
FCC Compliance	5	Supply Air Temperature Monitoring	32
Before Installing	5	Smoke Detection	32
About this Document	5	Mixed Air Low Limit Detection	32
Inspecting the Equipment	5	Filter Status	32
What is Not Included with this Equipment	6	Indoor Air Quality	32
Equipment Location	6	Real Time Clock (RTC)	33
Selecting a Power Source	6	Local Backup Schedule	33
Installation	6	Runtime Accumulation	33
Mounting the Device	6	Alarms and Events	34
Routing Cabling to the Device	7	Automatic Configuration	34
Grounding the Device	7	Controller Identification	34
Wiring Information	8	Inputs	35
Connecting Input Devices	10	Outputs	35
Connecting Output Devices	11	Configuration	36
Other Connections	12	Alarms	42
Protocol	13	Troubleshooting	43
Specifications	13	Diagnostic LEDs	43
Electrical	13	Troubleshooting Tips	44
Mechanical	14		
Application Description	15		
Sequence of Operation	17		
Occupancy State	17		
Operational Mode	18		
Setpoint Calculations	20		
Supply Air Setpoint Reset Curve	20		
Outside Air Temperature Lockouts	21		
Heating Sequence	22		

THIS PAGE LEFT BLANK INTENTIONALLY

VPU2

The VPU2 is a self-contained microprocessor-based controller for one Variable Air Volume (VAV) package unit. Applications include VAV package units with up to four stages of cooling, or a floating point control valve or a modulated output (valve or variable speed circulator) two stages of heating, or a floating point control valve or a modulated output (valve or variable speed circulator) an economizer, and a variable speed fan. The VPU2 is designed for integrated networked operation with the iWorx® Local Control Interface (LCI) and up to 56 VAV terminal unit controllers.

Overview

Digital inputs are provided for fan status, mixed air low limit indication, smoke detector, and filter status. Analog inputs are provided for mixed air temperature, return air humidity, supply air temperature and supply duct static pressure. An indoor air quality (IAQ) input can be configured for analog or digital operation.

The VPU2 incorporates digital outputs in the form of triacs for fan start/stop, four cooling stages, two heating stages and a two-position economizer. In addition, two analog outputs are provided to control a modulated economizer and variable speed fan drive.

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

Features

- Four stages of cooling, or floating point valve control or a modulated output (valve or variable speed circulator)
- Two stages of heating, or floating-point valve control or a modulated output (valve or variable speed circulator)
- Dehumidification
- Modulated fan speed
- Digital or modulated economizer
- Economizer enabled based on enthalpy calculations or dry bulb
- Minimum cycle timers for stages
- Runtime accumulation for heating, cooling and fan
- Local backup schedule
- Maximum of 56 zones (VAV boxes)
- Supply air temperature safety limits
- Time proportioned control of the staged outputs to reduce cycling
- Proportional + Integral control of the modulated economizer, modulated heating, modulated cooling, and static pressure
- Mixed air low limit protection, filter status, fan proof, freeze stat, and smoke detection inputs
- IAQ compensation based on IAQ alarm input or zone controller alarm
- Outside Air Temperature cutoffs
- Automatic morning warm-up sequence
- LONWORKS interface to building automation systems
- Automatic configuration with the LCI
- Alarm/Event reporting

PURPOSE OF THIS GUIDE

The *iWorx® VPU2 Application Guide* provides application information for the VPU2 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

This Document is subject to change from time to time at the sole discretion of Taco Electronic Solutions, Inc. All updates to the Document are available at www.taco-hvac.com. When installing this product, it is the reader's responsibility to ensure that the latest version of the Document is being used.

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
<i>iWorx® VPU2 Application Guide</i> , Document No. 505-010 (this document)	<ul style="list-style-type: none"> – Application Engineers – Installers – Service Personnel – Start-up Technicians – End user 	Provides instructions for setting up and using the iWorx® VPU2 controller.
<i>iWorx® LCI Application Guide</i> , Document No. 505-002	<ul style="list-style-type: none"> – Application Engineers – Installers – Service Personnel – Start-up Technicians – End user 	Provides instructions for setting up and using the iWorx® Local Control Interface.
<i>iWorx® VAV Application Guide</i> , Document No. 505-011	<ul style="list-style-type: none"> – Application Engineers – Installers – Service Personnel – Start-up Technicians – End user 	Provides instructions for setting up and using the iWorx® VAV Series controller.
http://www.iWorxWizard.com	<ul style="list-style-type: none"> – 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	<i>LonWorks FTT-10A Free Topology Transceiver User's Guide</i> , 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



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



CAUTION: Risk of explosion if battery is replaced by an incorrect type. Contains lithium type battery; dispose of properly.



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 that are suitable for 167 °F (75 °C).

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.

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 VPU2 controller, which support one Variable Air Volume package unit.

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.

Equipment Location



Abide by all warnings regarding equipment location provided earlier in this document.

Optimally, the equipment should be installed within a secure enclosure.

If the equipment is to be installed outdoors, it must be contained within a protective enclosure. The enclosure must maintain internal temperature and humidity within the ranges specified for this equipment.

The equipment must be installed within 500 feet of all input peripherals (smoke detectors, sensors, etc.) that are connected to the equipment.

Selecting a Power Source

This equipment requires a UL recognized Class 2 external power source (not supplied) to operate. The controller power input requires a voltage of 24 Volts AC.

To calculate power source current requirements, add the power consumption of all peripheral devices to that of the controller.

The controller and sensor power supplies can use the same power source. If both are using the same power source, the loads must have EMF protection. This protection can be integral to the load, or installed in the 24 VAC wiring across the load's coil.

To provide necessary RFI and transient protection, the controller's ground (GND) pin (T40) must be connected to earth ground or the earth ground of the packaged unit's enclosure ground. Failure to properly ground the controller may cause it to exceed FCC limits. Excessive noise could also produce inaccurate sensor data. The power source must be capable of operating with this connection to ground.

INSTALLATION

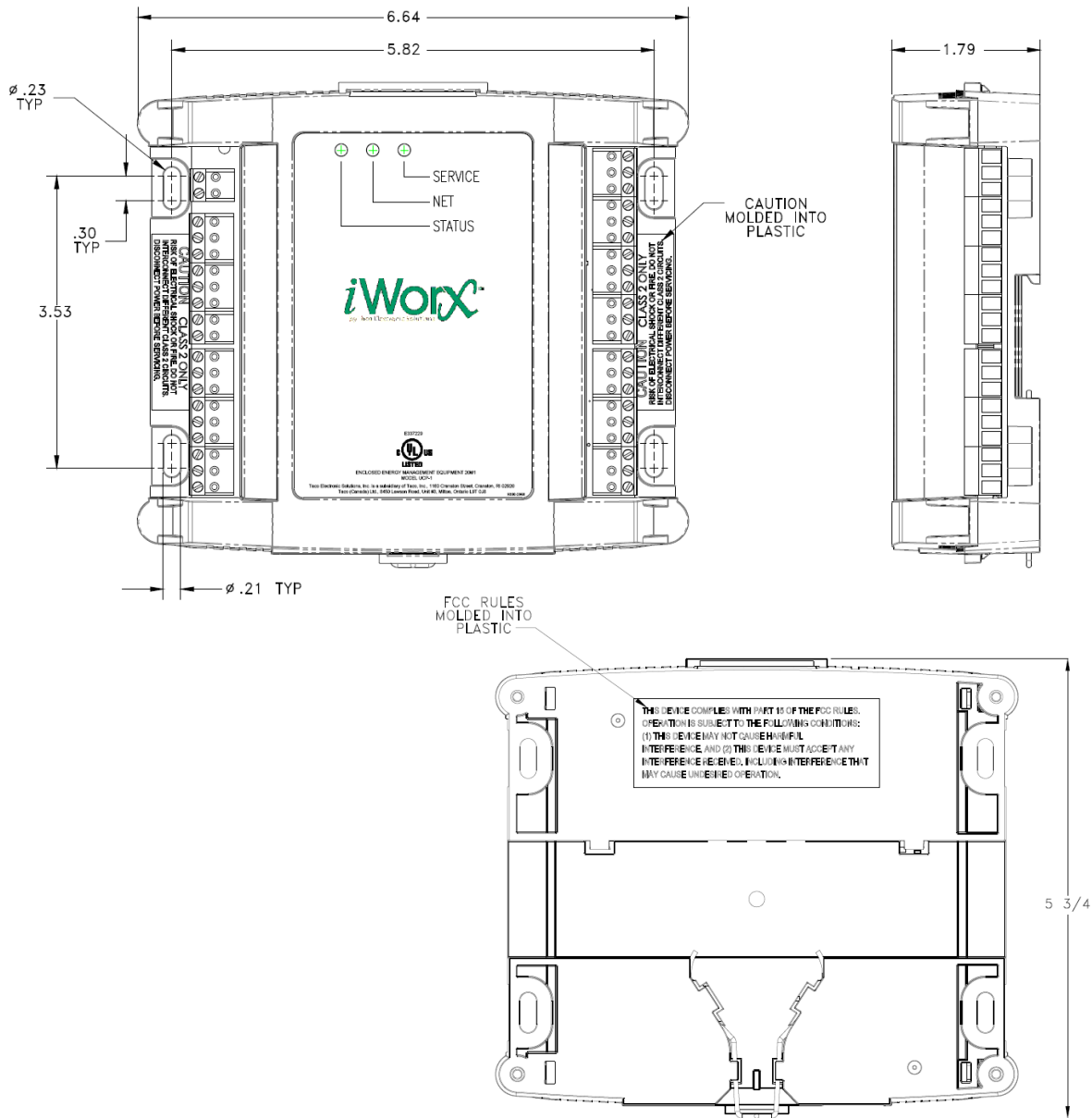


Warning: Electrical shock hazard. To prevent electrical shock or equipment damage, disconnect **ALL** power sources to controllers and loads before installing or servicing this equipment or modifying any wiring.

Mounting the Device

1. Select a mounting location. Enclosure mounting is recommended.
2. Hold the controller on the panel you wish to mount it on. With a marker or pencil mark the mounting locations on the panel.
3. Using a small drill bit pre-drill the mounting holes.
4. Using two #6 pan head screws, mount the controller to the panel.
5. Wire the controller (See Routing Cabling to the Device).

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 (T40) must be securely 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/TV reception.



For best performance, connect the power supply common terminal (T38) to the same external point as the ground terminal (T40).

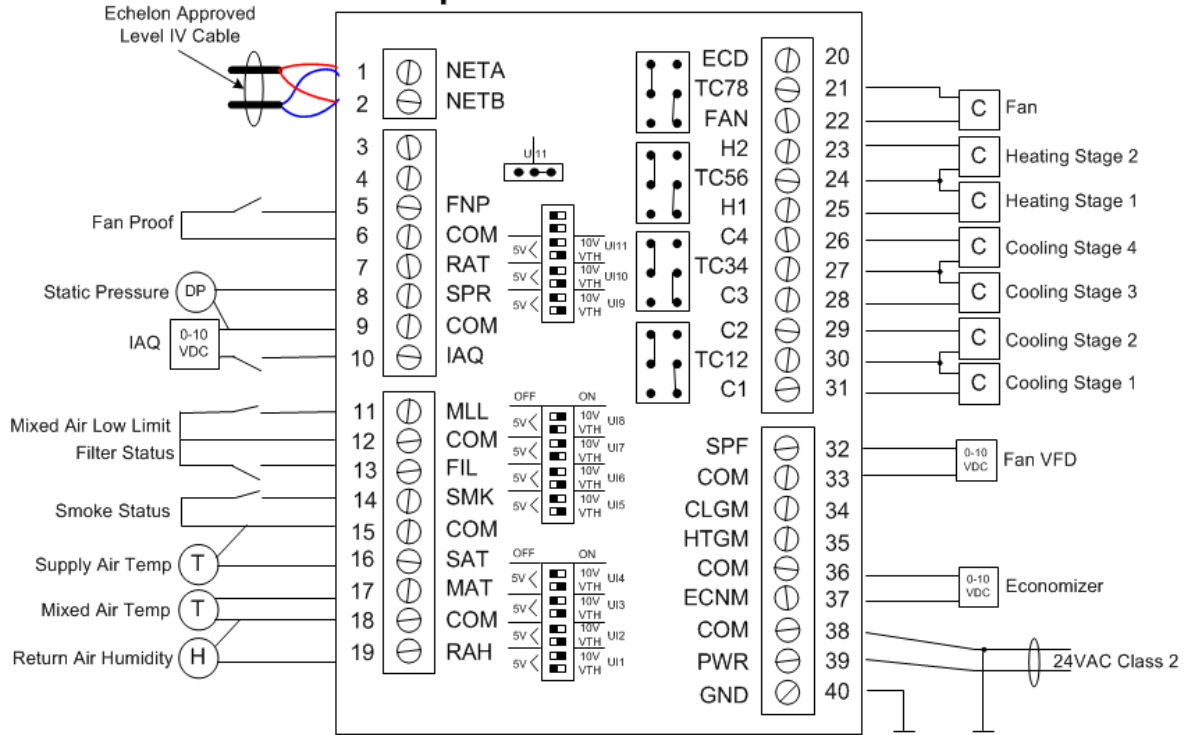
WIRING INFORMATION



WARNING: Terminals 6, 9, 12, 15, and 18 are connected internally on all VPU2 controllers. Disconnect **ALL** power sources when installing or servicing this equipment to prevent electrical shock or equipment damage.

Figure 2: Typical VPU2 Wiring - Example A

Variable Air Unit with Staged Heating & Cooling and Modulated Economizer; Triac Outputs wired as Power Sourced



Symbols

- 10 K ohm Precon Type III thermistor
- 24VAC pilot relay or contactor coil
- 0-10 VDC signal

DIP Switches

OFF	ON	
5V <		10V VTH INVALID
5V <		10V VTH Thermistor or Digital Input
5V <		10V VTH 10V Input
5V <		10V VTH 5V Input

Output Jumper Positions

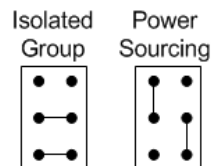
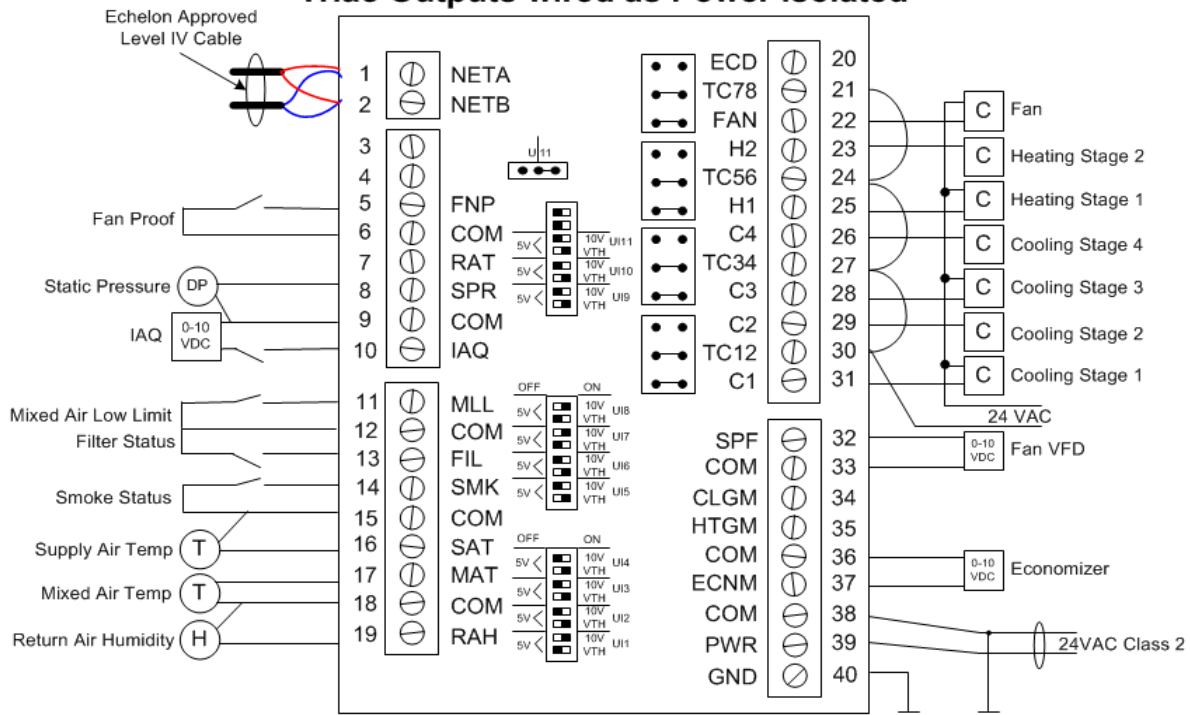


Figure 3: Typical VPU2 Wiring - Example B

**Variable Air Unit with Staged Heating & Cooling and Modulated Economizer;
Triac Outputs wired as Power Isolated**



Symbols

- 10 K ohm Precon Type III thermistor
- 24VAC pilot relay or contactor coil
- 0-10 VDC signal

DIP Switches

OFF	ON	
5V <		10V VTH INVALID
5V <		10V VTH Thermistor or Digital Input
5V <		10V VTH 10V Input
5V <		10V VTH 5V Input

Output Jumper Positions

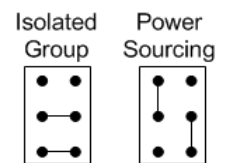
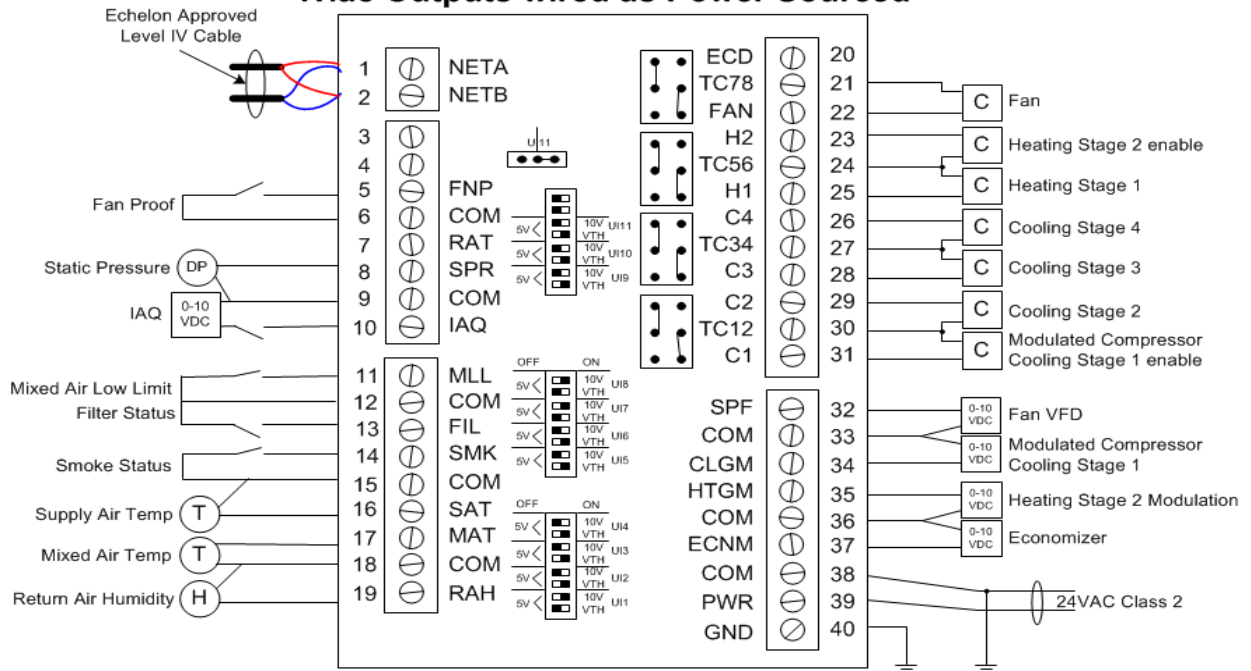


Figure 4: Typical VPU2 Wiring - Example C

**Variable Air Unit with Staged & Analog Heating / Cooling and Modulated Economizer;
Triac Outputs wired as Power Sourced**



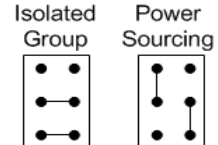
Symbols

- 10 K ohm Precon Type III thermistor
- 24VAC pilot relay or contactor coil
- 0-10 VDC signal

DIP Switches

OFF	ON	
5V <		10V VTH INVALID
5V <		10V VTH Thermistor or Digital Input
5V <		10V VTH 10V Input
5V <		10V VTH 5V Input

Output Jumper Positions



Connecting Input Devices

Return Humidity (RAH)

To connect the Return Air Humidity sensor to the unit, connect the positive wire from the sensor to RAH (T19) and the other wire to the adjacent common (T18). The sensor must be of the 0-10 Volt type.

If global indoor air humidity readings are being provided over the network, it is not necessary to attach a return air humidity sensor directly to the VPU2.

Mixed Air (MAT)

To connect the Mixed Air thermistor to the unit, attach one wire from the thermistor to MAT (T17) and the other wire to the adjacent common (T18). The thermistor used must be 10K Precon Type III.

Supply Air (SAT)

To connect the Supply Air thermistor to the unit, attach one wire from the thermistor to SAT (T16) and the other wire to the adjacent common (T15). The thermistor used must be 10K Precon Type III.

Smoke Detector (SMK)

To connect the smoke detector switch to the digital input, attach one wire of the contact to SMK (T14) and the other wire to the adjacent common (T15). This must be a dry contact normally open switch. This input is for indication only. A separate smoke detector should be wired into a fire alarm system if the generation of a fire alarm is required.

Filter Status (FIL)

To connect the filter switch to the digital input, attach one wire of the contact to FIL (T13) and the other wire to the adjacent common (T12).

Mixed Air Low Limit (MLL)

This must be a dry contact normally open switch. To connect the low limit indication switch to the digital input, attach one wire of the contact to MLL (T11) and the other wire to the adjacent common (T12). This must be a dry contact normally open switch.

Indoor Air Quality (IAQ)

This must be a dry contact normally-open switch. To connect the digital CO₂ level sensor to the unit, attach one wire from the sensor to IAQ (T10) and the other wire to the adjacent common (T9). For a digital sensor, this must be a dry contact, normally closed switch. For an analog sensor, it must be of the 0-10V type.

Static Pressure (SPR)

To connect the static pressure sensor to the analog input, attach the positive wire from the sensor to SPR (T8) and the other wire to the adjacent common (T9). The sensor must be analog, 0 to 10 volt type.

Return Air Temperature (RAT)

To connect the return air temperature thermistor to the analog input, attach one wire of the sensor to RAT (T7) and the other wire to the adjacent common (T6).

Fan Proof (FNP)

To connect the fan proof switch to the digital input, attach one wire of the contact to FNP (T5) and the other wire to the adjacent common (T6). This must be a dry contact, normally closed switch. If you are not providing a fan proof input, T5 and T6 must be shorted (jumpered) together.

Connecting Output Devices

Modulated Economizer (ECNM)

The modulated economizer output can be set to 0-10 V max through the control logic. Connect the positive wire from the damper actuator to ECNM (T37) and the other wire to the adjacent common (T36). See preceding figures for details.

Modulated Heating (HTGM)

The modulated heating output can be set to 0-10 V max through the control logic. Connect the positive wire from the heating output to HTGM (T35) and the other wire to COM (T36). See preceding figures for details.

Modulated Cooling (CLGM)

The modulated cooling output can be set to 0-10 V max through the control logic. Connect the positive wire from the cooling output to CLGM (T34) and the other wire to COM (T33). See preceding figures for details.

Modulated Static Pressure Fan (SPF)

The modulated static pressure fan output can be set to 0-10 V max through the control logic. Connect the positive wire from the fan output to SPF (T32) and the other wire to COM (T33). See preceding figures for details.

Cooling Stage 1 or Cooling Floating Point Valve Open (C1)

The cooling stage output must be connected to a 24 VAC pilot relay if the load is greater than 1 Amp. See preceding figures for details. If the load is less than 1 Amp, connect cooling stage 1 to C1 (T31) and TC12 (T30). For control of a floating point valve, connect C1 as the valve open signal.

Cooling Stage 2 or Cooling Floating Point Valve Close (C2)

The cooling stage output must be connected to a 24 VAC pilot relay if the load is greater than 1 Amp. See preceding figures for details. If the load is less than 1 Amp, connect cooling stage 2 to C2 (T29) and TC12 (T30). For control of a floating point valve, connect C2 as the valve close signal.

Cooling Stage 3 (C3)

The cooling stage output must be connected to a 24 VAC pilot relay if the load is greater than 1 Amp. See preceding figures for details. If the load is less than 1 Amp, connect to C3 (T28) and TC34 (T27).

Cooling Stage 4 (C4)

The cooling stage output must be connected to a 24 VAC pilot relay if the load is greater than 1 Amp. See preceding figures for details. If the load is less than 1 Amp, connect to C4 (T26) and TC34 (T27).

Heating Stage 1 or Heating Floating Point Valve Open (H1)

The heating stage output must be connected to a 24 VAC pilot relay if the load is greater than 1 Amp. See preceding figures for details. If the load is less than 1 Amp, connect heating stage 1 to H1 (T25) and TC56 (T24). For control of a floating point heating valve, connect H1 (T25) as the valve open signal. TC56 (T24) is the common.

Heating Stage 2 or Heating Floating Point Valve Close (H2)

The heating stage output must be connected to a 24 VAC pilot relay if the load is greater than 1 Amp. See preceding figures for details. If the load is less than 1 Amp, connect heating stage 2 to H2 (T23) and TC56 (T24). For control of a floating point heating valve, connect H2 (T23) as the valve close signal. TC56 (T24) is the common.

Fan (FAN)

The fan output must be connected to a 24 VAC pilot relay if the load is greater than 1 Amp. See preceding figures for details. If the load is less than 1 Amp, connect the fan to FAN (T22) and TC78 (T21).

Two Position Economizer (ECD)

The two-position economizer output must be connected to a 24 VAC pilot relay if the load is greater than 1 Amp. See preceding figures for details. If the load is less than 1 Amp, connect the economizer to ECD (T20) and TC78 (T21).

Other Connections

Network (LON)

Network wiring must be twisted pair. One network wire must be connected to terminal NETA (T1) and the other network wire must be connected to terminal NETB (T2). 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 (T39) and the other output wire from the power supply to the adjacent common terminal (T38). T38 must be connected to earth ground.

Ground (GND)



Terminal GND (T40) 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.

Protocol

The VPU2 is based on the LONWORKS® networking technology and can be networked to a higher-level control system for monitoring and control applications. For additional information on the Protocol reference the *LonWorks FTT-10A Free Topology Transceiver User's Guide*, published by the Echelon Corporation.

SPECIFICATIONS

Electrical

Inputs

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

- Resolution: 10 bit

Mixed Low Limit, Filter Status, Smoke Detect, Local IAQ Alarm

- Dry Contact
- Normally Open
- 5 Volts DC Max

Fan Proof

- Dry Contact
- Normally Closed
- 5 Volts DC Max

Return Air Humidity, Static Pressure

- 0 - 10 Volts DC

Mixed Air Temperature, Supply Air Temperature, Return Air Temperature

- Precon Type III 10K thermistor

Outputs

Cooling Stages 1, 2, 3, & 4; Heating Stages 1 & 2; Fan Start/Stop; Two-position Economizer

- 24 Volts AC
- 1A @ 50C, 0.5A @ 60C, limited by the Class 2 supply rating

Modulated Economizer, Modulated Static Pressure Fan

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

Power

Power Requirements

- 24VAC (20VAC to 28VAC), requires an external Class 2 supply

Power Consumption

- 7.2W 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
- 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: 5.55" (141mm) high, 6.54" (166 mm) wide, 1.75" deep (44 mm)
- ABS

Weight

- Controller Weight: 0.70 pounds (0.32 kilograms)
- Shipping Weight: 1.0 pounds (0.46 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

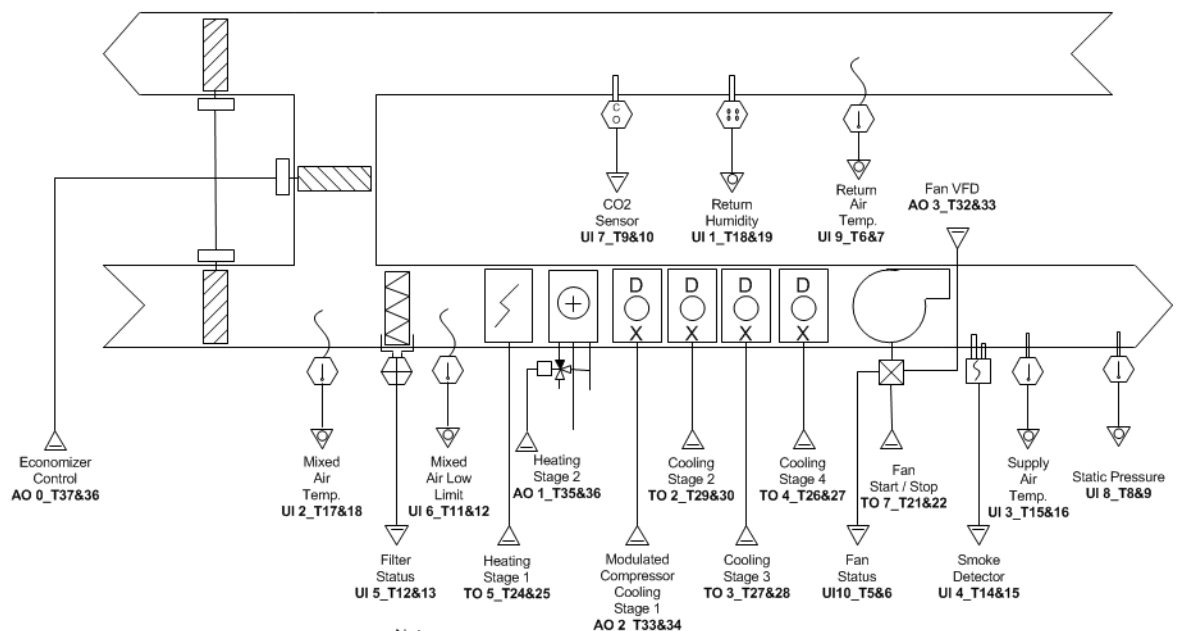
- FCC Part 15 Class A

APPLICATION DESCRIPTION

The VPU2 is a Variable Air Volume (VAV) package unit controller for controlling supply air temperature and supply air duct static pressure. Figure 5 and Figure 6 illustrate typical VPU2 applications. The VPU2 operates in conjunction with up to 56 VAVI zone controllers. Control is achieved by modulating the economizer position and sequencing the heating and cooling stages based on the current supply air temperature requirements. In addition, the VPU2 controls the supply fan speed to maintain a supply duct static pressure setpoint.

Figure 5: VPU2 Application with Staged Heating & Cooling and Modulated Economizer

Variable Air Unit with Staged & Analog Heating / Cooling and Modulated Economizer; Triac Outputs wired as Power Sourced



Wire designations

Point Type & Number_Terminal # & Terminal #
 Example:
 UI 1_T18&19
 Universal Input 1_Terminals 18 & 19

Notes:

- * There can be only One modulated heating and cooling stage and it can be designated as any stage position
- * If points are not required delete from flow diagram and associated wiring diagram.

The VPU2 controls the starting and stopping of the supply air fan. During the occupied and warm-up periods, the fan runs continuously. The fan cycles on during the unoccupied periods when a zone is in extended occupancy or when there is a call for emergency heating. The fan speed control operates to maintain a configurable system static pressure setpoint. Fan speed is calculated by a Proportional + Integral (P+I) control loop based on the measured static pressure and setpoint. As the pressure increases above the pressure setpoint, the fan speed output is throttled back. As the pressure decreases below the pressure setpoint, the output is increased.

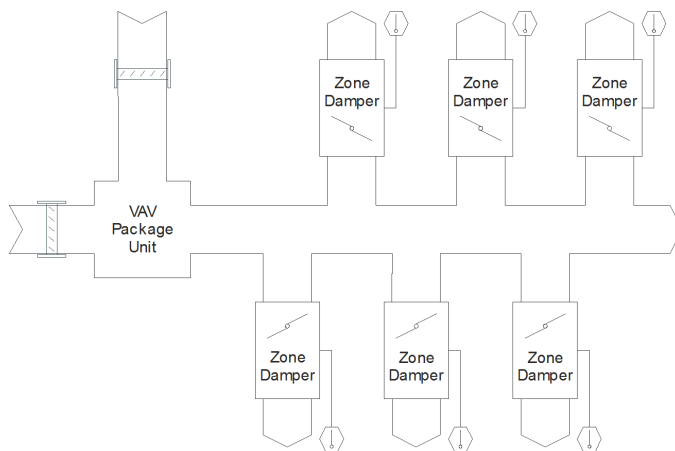
The enthalpies of the outside and inside air are calculated periodically. A comparison is performed to determine if “free cooling” is available. If “free cooling” is available, the economizer is enabled. Free cooling can also be enabled based on a dry-bulb comparison of the outdoor air temperature and indoor temperature. The system can use either a two-position or modulated economizer. If a two-position economizer is employed, it is energized when there is a call for cooling. It is used as the first stage of cooling to take advantage of the energy savings. The two-position economizer output is off when the modulating economizer feature is disabled.

If a modulated economizer is employed and “free cooling” is available the modulated economizer position is calculated by a Proportional + Integral (P+I) control loop. The control is based on the mixed air temperature and setpoint. As the temperature increases above the mixed air setpoint the economizer is modulated open. The economizer is modulated closed as the temperature decreases below the mixed air setpoint. The economizer is modulated to its minimum position when the economizer is disabled. The economizer can optionally be disabled during the unoccupied periods. When free cooling is available, mechanical cooling will not be enabled until the economizer is fully open (100%) for three minutes at which time mechanical cooling will be enabled. This will help in preventing low suction and icing of the cooling coils.

Either type of economizer can be disabled during unoccupied periods.

The VPU2 operates in one of four states: morning warm-up/cool-down, occupied, unoccupied, or shutdown. A host device on the network determines the active operating mode. An optional backup schedule is provided for cases when the host device is not available. The operating state determines if the VPU2 is in heating mode or cooling mode.

Figure 6: VAV Zone Control System



Cooling is accomplished through control of up to four stages of cooling, or one floating point cooling valve or control of one analog cooling output (valve or variable speed circulator).

When the operating mode is cooling (occupied and extended occupancy), the cooling stages are sequenced on and off with a time-proportioned control algorithm to minimize excessive cycling. The sequencing is based on the supply air temperature and cooling setpoint. The cooling stages are interlocked with the economizer control. If the economizer is enabled, the cooling stages do not sequence on until the economizer has reached its open position.

If configured for modulated analog output the cooling output position is calculated by a P + I control loop based on the supply temperature and the cooling setpoint. As the temperature increases above the cooling setpoint, the cooling output will be modulated open. The cooling output will be modulated closed as the temperature decreases below the cooling setpoint.

If configured for a floating point valve control the cooling valve is calculated by a P + I control loop based on the supply temperature and cooling setpoint. As the temperature increases above the cooling setpoint, the valve will be modulated open. The valve will be modulated closed as the temperature decreases below the cooling setpoint.

Heating is accomplished through control of up to two stages of electric heating, or control of one floating point heating valve or control of one analog output.

When the operating mode is heating (morning warm-up), the heating stages are sequenced on and off with a time-proportioned control algorithm to minimize excessive cycling. The sequencing is based on the supply air temperature and heating setpoint. Heating can also be controlled with a floating-point control of a valve.

The heating output position is calculated by a P + I control loop based on the supply temperature and the heating setpoint. As the temperature decreases below the heating setpoint, the heating output will be modulated open. The heating output will be modulated closed as the temperature increases above the heating setpoint.

If configured for a floating point valve control the heating valve is calculated by a P + I control loop based on the supply temperature and cooling setpoint. As the temperature decreases below the heating setpoint, the valve will be modulated open. The valve will be modulated closed as the temperature increases above the heating setpoint.

In both the heating and cooling modes the supply air temperature setpoint may be reset by the zone demand.

The VPU2 can also monitor the supply air temperature to determine if the heating and cooling are operating properly. During the cooling mode, if the supply air temperature fails to drop below the cooling operational limit after a pre-determined time period, a cooling failed alarm is reported to the LCI.

During the heating mode, if the supply air temperature fails to rise above the heating operational limit after a pre-determined time period, a heating failed alarm is reported to the LCI.

As a safety device, the controller can optionally monitor the supply air temperature to determine if the heating stages have failed on. If the supply air temperature rises above the heating high limit setpoint, the fan energizes. If the supply air temperature does not drop below the setpoint after a pre-programmed time delay, the fan speed is overridden off. A heating high limit exceeded alarm is reported to the LCI and all of the zone controllers.

An indoor air quality input is provided. If an indoor air quality alarm is detected, the supply air fan is energized and the economizer is overridden to supply fresh air to the zones. In addition, an alarm condition can be signaled by one of the zone controllers. When an alarm condition exists, the controller energizes the supply air fan and overrides the static pressure setpoint to the IAQ alarm setpoint. The controller attempts to clear the IAQ condition by allowing the economizer to open more than usual. If the condition has not been cleared after a programmable delay, an alarm is sent to the LCI.

The VPU2 monitors a digital input to determine the presence of smoke. When the input indicates smoke, the controller immediately turns off the fan and all stages of heating and cooling. An alarm is reported to the LCI when this condition exists. The VPU2 remains in the shutdown alarm state until it is reset.

A digital input is provided on the VPU2 to monitor the status of the air filter. An external pressure switch is wired to the input to determine when the filter becomes dirty. An alarm is reported to the LCI when this condition exists.

Mixed air low limit protection is provided through a digital input. If a low limit condition exists, the VPU2 turns off all stages of heating and cooling along with the supply air fan. If heating is controlled by a floating-point valve, the valve is opened fully to prevent equipment damage. An alarm is reported to the LCI when this condition exists. The VPU2 remains in the shutdown alarm state until it is reset.

The VPU2 monitors an input to determine if the fan is operating properly. When the input indicates a fan failure, the controller immediately turns off the fan and all stages of heating and cooling. An alarm is reported to the LCI when this condition exists.

The VPU2 monitors the runtime of the cooling stages, heating stages and fan. When any one of the runtimes exceeds a programmable limit, a maintenance alarm is reported to the LCI.

When the Return Air humidity rises above the humidity setpoint, dehumidification is enabled by enabling the cooling stages, if modulated cooling is enabled; the cooling output goes to 100%. Dehumidification is disabled, when return air humidity drops below the setpoint by 3%.

SEQUENCE OF OPERATION

This section describes the detailed sequence of operation for the VPU2 control algorithms.

Occupancy State

The VPU2 operates in one of three occupancy states: extended occupancy, occupied, or unoccupied. A host device on the network determines the active operating mode. An optional backup schedule is provided for cases when the host device is not available.

In addition, the VPU2 polls each zone controller (VAVI) to determine if extended occupancy (bypass) has been requested. During unoccupied periods when extended occupancy has been requested, the VPU2 enters the occupied mode of operation. At least once every 5 seconds a different zone controller is polled.

Operational Mode

The VPU2 operates in one of three operating modes: primary heating, primary cooling, and primary off. The operating mode determines whether warm or cool air is supplied to the zone controllers. The VPU2 determines the operating mode based on its internal schedule state, which is determined based on the occupancy state and internal configuration variables. The VPU2 can be in one of the following operational states: morning warm-up, occupied, extended occupancy, emergency heating, shutdown, and emergency.

Morning Warm-up

The purpose of morning warm-up is to heat up the unoccupied zones to a comfortable level before the zones are occupied. During morning warm-up, the VPU2 is in heating mode: the fan is energized, the static pressure is controlled, the economizer is disabled, and the heating stages are controlled. The VPU2 enters the morning warm-up state from shutdown, bypass, or emergency heating states.

The VPU2 must be configured at the LCI to perform morning warm-up; a reference VAV zone must be selected, and the optimum start time for heating must be configured. If the reference zone requires heating, and morning warm-up is configured, the LCI advances the occupancy start time of the VPU2 and passes the number of minutes the occupancy has been advanced. The VPU2 remains in morning warm-up until the reference zone temperature is within 1 °F of the heating setpoint, or until the optimum start time has expired.

The VPU2 informs all of its associated VAVI controllers, regardless of their occupancy state, that morning warm-up is being performed, to allow all associated VAVIs to take advantage of the heating mode. During morning warm-up, all VAVI controllers control to their occupied setpoints, regardless of their occupancy state. After morning warm-up, the VPU2 enters the occupied state and delays the staging of cooling for one stage time.

Morning Cool Down

Similarly to morning warm-up, the VPU2 can perform morning cool-down, cooling the soon-to-be occupied zones to a comfortable level before occupancy. Morning cool-down is exactly like the occupied state, but the occupancy time has been advanced.

The VPU2 must be configured at the LCI to perform morning cool-down: a reference VAV zone must be selected and the optimum start time for cooling must be configured. If the reference zone requires cooling, the VPU2 enters the occupied state.

Unlike morning warm-up, the VPU2 does not inform its associated zone controllers that it is in morning cool-down. Only the VAVI controllers that are in the same group take advantage of the cooling and control to their occupied setpoints.

Occupied

A remote device on the network (such as an LCI) provides the current occupancy mode. There are two modes of occupancy; occupied and unoccupied. The VPU2 is in the occupied state if the VPU2 is scheduled for occupancy.

In addition, the current occupancy mode is periodically retrieved from each of the zone controllers. If at least one zone controller is currently in occupancy or occupancy extension mode the occupancy mode is overridden to the occupied state (See Extended Occupancy).

During the occupied state the controller is normally in the cooling mode. If the mixed air temperature is 7 °F colder than the supply temperature (as can happen during cold winter weather), the controller enters the heating mode, and heats the air to the cooling setpoint. Also, the fan is energized, the static pressure is controlled, and the economizer is enabled. In heating mode, the controller compensates for the colder air being brought in by setting the economizer to its minimum position.

The VPU2 enters the occupied state from shutdown, extended occupied, morning warm-up, and emergency heating states. It remains in the occupied state until the VPU2 goes into the unoccupied state and no associated zone controllers are occupied.

The current operational mode information is periodically transferred to the VAVI over the communications network. The following information is transferred to the VAVI from the primary air source controller:

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

Shutdown

When the space being controlled by the VPU2 is unoccupied, the controller operates in the shutdown state. The air handler package unit is off, and there is no control of the static pressure or duct temperature.

The VPU2 is in the shutdown state when the occupancy status is “unoccupied,” and no associated controllers are occupied or in extended occupancy. The VPU2 enters the shutdown state from Occupied, Extended Occupancy and Emergency Heating Stages.

The controller can enter an unoccupied cooling state from shutdown when an associated VAVI zone controller's space temperature is 1 °F warmer than its unoccupied cooling setpoint. During this cooling state, the controller is in cooling mode; the fan is energized, the static pressure is controlled, the economizer is enabled provided it has been configured to operate in the unoccupied mode, and the cooling stages are controlled. The controller remains in the cooling state for thirty minutes or until no associated controllers are requiring cooling, after which the VPU2 reverts to the shutdown state.

Extended Occupancy

When the VPU2 is in Shutdown state and a VAVI zone controller has indicated extended occupancy, the controller enters the Extended Occupancy state (also known as *Bypass*). The Extended Occupancy state acts identically to the Occupied State.

The VPU2 remains in the extended occupancy state until the VAVI's extended occupancy is over, the VPU2 enters morning warm-up or cool-down, the VPU2 enters the occupied state, or the VPU2 enters the Shutdown state.

Emergency Heating

The VPU2 enters the emergency heating state from shutdown when an associated VAVI zone controller's space temperature is 10 °F colder than its unoccupied heating setpoint. During the emergency heating state, the VPU2 is in heating mode: the fan is energized, the static pressure is controlled, the economizer is disabled, and the heating stages are controlled. The VPU2 remains in the emergency heating state for thirty minutes, after which the VPU2 reverts to the shutdown state.

Emergency

The VPU2 enters the emergency state (from any state) when there is an emergency condition. Emergency conditions are:

- Mixed air low limit
- Heat stuck on
- Fan failure
- Smoke alarm

During the emergency state, the air handler package unit is off and there is no control of the static pressure or duct temperature. The VPU2 remains in the emergency state until the controller is reset.

Setpoint Calculations

The supply air heating and cooling setpoints are programmable values. The effective setpoint is a calculated value based on the current operating mode. The effective setpoint is set to the heating setpoint when the operational mode is heating. It is set to the cooling setpoint when the operational mode is cooling.

Additionally the heating and cooling setpoints may be reset based on the greatest zone demand.

Supply Air Setpoint Reset Curve

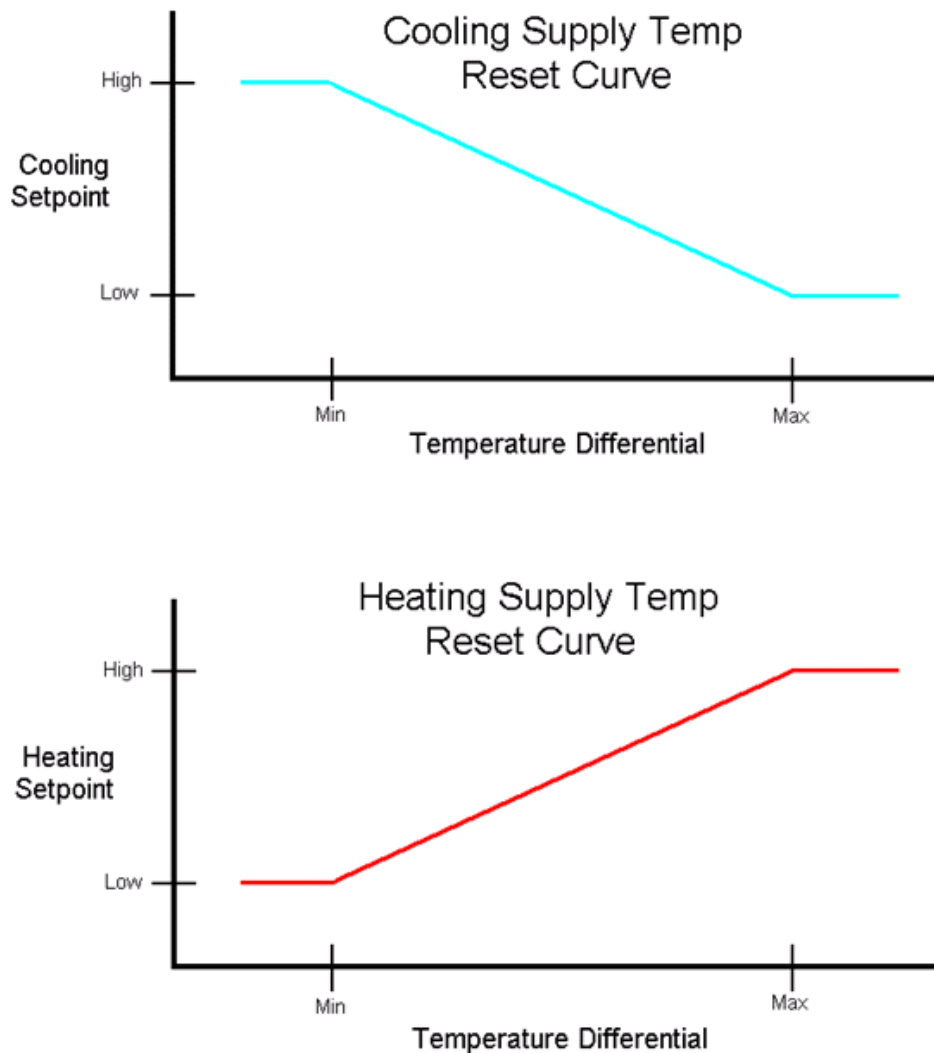
If the *Supply Temperature Setpoint Reset Curve* is enabled, the VPU2 keeps track of the differential between each zone's space temperature and its temperature setpoint. The VPU2 selects the zone with the greatest differential and uses that *Temperature Differential* to adjust the *Supply Temperature Setpoint*.

If the *Temperature Differential* is less than the *Temperature Differential Minimum*, then the *Supply Temperature Setpoint Low* will be used. If the *Temperature Differential* is greater than the *Temperature Differential Maximum*, then the *Supply Temperature Setpoint High* is used.

When the *Temperature Differential* lies between the *Temperature Differential Maximum* and *Temperature Differential Minimum*, the *Supply Temperature Setpoint* is linearly interpolated between the *Supply Setpoint High* and *Supply Setpoint Low*.

When the *Temperature Differential Maximum* is set to 0, the *Supply Temperature Setpoint Reset Curve* is disabled and the VPU2 operates with the usual heating and cooling supply air temperature setpoints.

Figure 7: Supply Temp Reset Curves



Outside Air Temperature Lockouts

Heating can be disabled during warm weather by setting the outdoor air temperature heating lockout *Max OAT Heat*. If the OAT is above the heating lockout temperature, the primary heating mode is disabled and the controller can only be in the primary off or primary cooling modes. This feature requires a controller that broadcasts the OAT, such as an ASM2 be installed on the network.

Cooling can be disabled during cold weather by setting the outdoor air temperature cooling lockout *Min OAT Cool*. If the OAT is below the cooling lockout temperature, the primary cooling mode is disabled and the controller can only be in the primary off or primary heating modes. This feature requires a controller that broadcasts the OAT, such as an ASM2 be installed on the network.

The economizer can be disabled during excessively warm or cool weather by setting the outdoor air temperature economizer lockouts *Max OAT Econ* and *Min OAT Econ*. If the OAT is above the *Economizer Max OAT*, or below the *Economizer Min OAT*, the economizer is disabled. During an IAQ emergency, the *Economizer Min OAT* is lowered by the *IAQ Settings Temperature Reset*, while the *Economizer Max OAT* is raised by the same value. This feature requires a controller that broadcasts the OAT, such as an ASM2, be installed on the network.

Heating Sequence

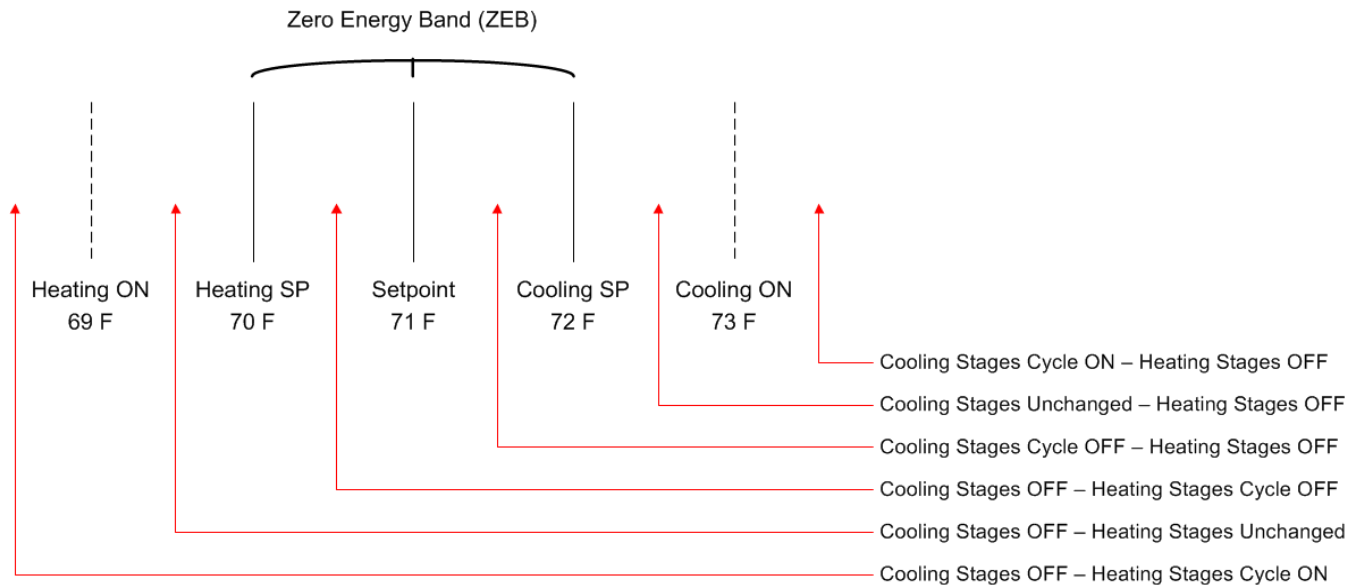
The controller provides support for either two stages of heating or one floating point or 0-10V modulating heating output (valve or variable speed circulator). You can specify which type of heat you are using through configuration parameters.

Heating Stages

The heating sequence is initiated when the current operating mode calls for heat. The electric heating stages are sequenced based on the supply air temperature, the heating setpoint and the control band. When the supply air temperature drops below the heating setpoint minus the control band, a stage is turned on. If the supply air temperature remains below the control band for an additional time-period, the next available stage is turned on. If all zone temperature readings are within 0.5 °F of their setpoints, the next stage does not cycle on. This cycle continues until all available stages have been energized.

After the supply temperature has risen above the heating setpoint, the first available stage is turned off. If the supply air temperature remains above the heating setpoint for an additional time-period, the next available stage is turned off. This cycle continues until all available stages have been de-energized. If the supply air temperature rises above the heating setpoint plus control band all of the stages immediately cycle off.

Figure 8: Staged Heating and Cooling



Heating with Floating Point Control

The heating stage outputs can be configured for floating point control of a heating valve. Floating point control is enabled when *Heating Stages* are set to zero and the *Heating Valve Travel Time* is non-zero. The H1 output is the valve open signal and the H2 output is the valve close signal.

After a reset, the floating point valve is calibrated by closing the valve for a period of the travel time. This ensures that the valve is fully closed. When the valve is at its calculated 0% or 100% position, the valve is overdriven for 30 seconds to ensure that the valve is fully closed or open.

The floating point control is similar to the heating modulated algorithm. If the space temperature is below the heating setpoint, the valve is driven open. When the space temperature is above the heating setpoint, the valve is driven closed. There is a +/- 1 °F (0.55 °C) deadband around the setpoint to prevent the valve from dithering. During mixed air low limit alarms, the heating valve is driven to 100%.

Heating with Modulated Output (Valve or Variable Speed Circulator)

The calculated heating loop setpoint is derived from the heating setpoint and the loop proportional gain.

$$\text{CalcHeatingLoopSp} = \text{CalcHeatingSp} - \frac{1}{2}(\text{Kp})$$

The heating output is modulated by a P+I control loop based on the heating loop setpoint and the supply temperature. The P+I control loop will modulate the output to maintain a constant supply temperature. As the temperature decreases below the heating loop setpoint, the heating output will be modulated open. The heating output will be modulated closed as the temperature increases above the heating loop setpoint.

To prevent the integral component from becoming too large, there is anti-wind up reset protection. This protection clamps the integral value when all of the components add up to more than 100% or less than 0%. The following equations are used for P+I control:

$$\text{Kp} = \text{Proportional Gain}$$

$$\text{Ki} = \text{Integral Gain}$$

$$\text{Error} = \text{HeatingLoopSp} - \text{SpaceTemp}$$

$$I = I + (\text{Ki} \times \text{Error})$$

$$\text{HeatPosition} = (\text{Kp} \times \text{Error}) + I$$

Temperature control only occurs when the operational mode is heating or morning warm-up, or when heating is required to heat the mixed air temperature to reach the supply air setpoint. During unoccupied and cooling periods, the heating valve is driven to 0%. During mixed air low limit alarms, the heating valve is driven to 100%.

The floating point control is similar to the heating staging algorithm. If the supply air temperature is below the supply air setpoint, the valve is driven open. When the supply air temperature is above the supply air setpoint, the valve is driven closed. There is a +/- 2 °F deadband around the setpoint to prevent the valve from dithering.

Heating with Stages and Modulation

The controller can combine its staged and modulated modes. In the combined mode of operation, the modulated output is considered to be one of the stages. The stage to be associated with modulation is selected in the *Staged Heating* configuration page.

Modulation starts when the selected stage would normally start (i.e., if stage 2 is selected as the modulating stage, it starts if stage 1 has been active for the staging interval and the temperature is still below the heating control band).

If the modulating stage is not the last stage, subsequent stages are activated once the *Stage Threshold* percentage has been met by the modulating output and has remained there for the duration of the *Staging Interval*.

In order to maintain a smooth total heating output, the modulating output responds to subsequent stages activating or deactivating. It does so by clearing its interval output when a subsequent stage is activated:

$$I = 0$$

$$\text{Modulating Output} = K_p \times \text{Error}$$

It forces its interval output to the *Staging Interval* whenever a subsequent stage is deactivated. This feature prevents large jumps in overall heating output.

$$I = \text{Staging Threshold}$$

$$\text{Modulating Output} = (K_p \times \text{Error}) + I$$

Figure 9: Modulated Staging with 2 Stages; 2nd Stage Modulating

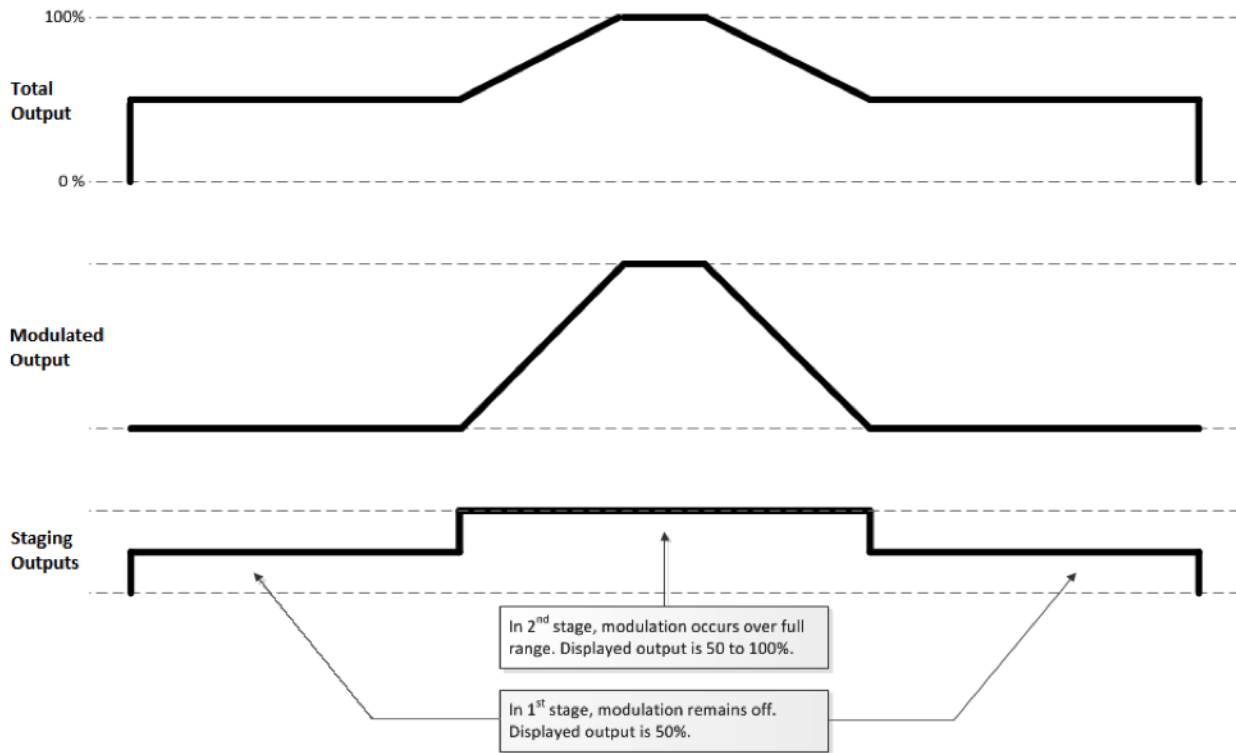
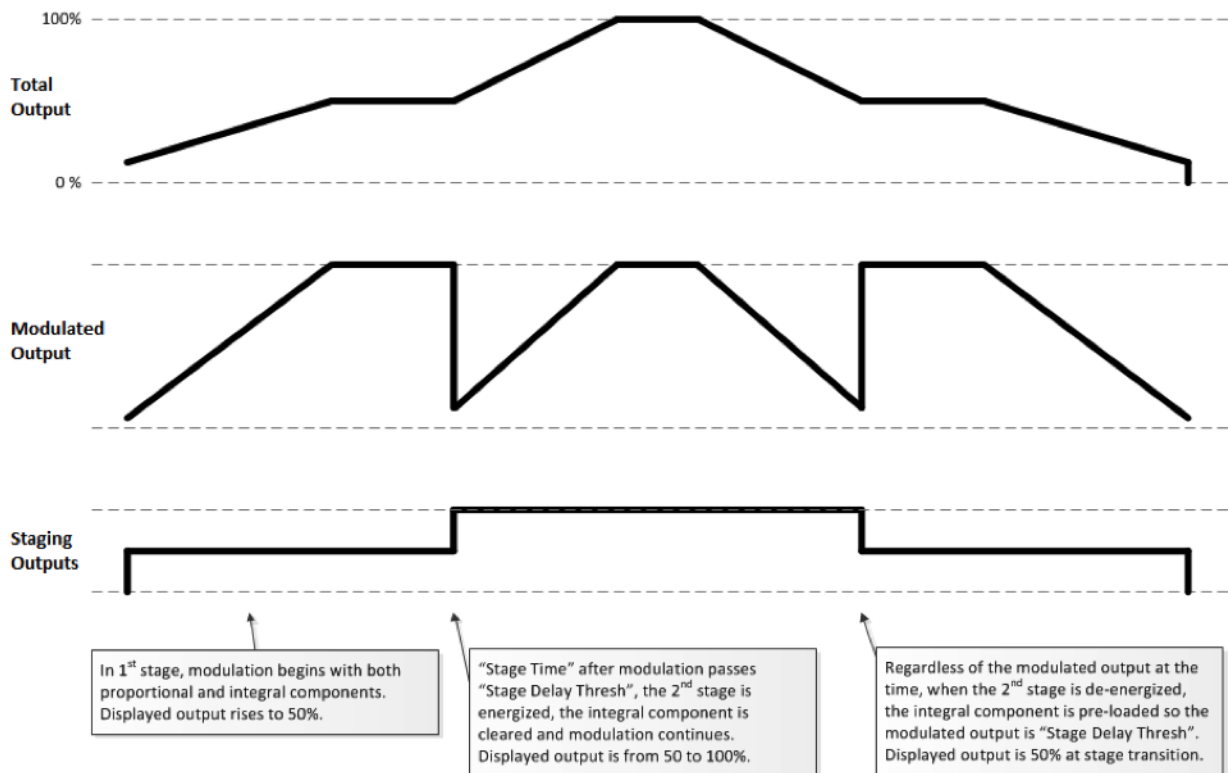


Figure 10: Modulated Staging with 2 Stages; 1st Stage Modulating

Cooling Sequence

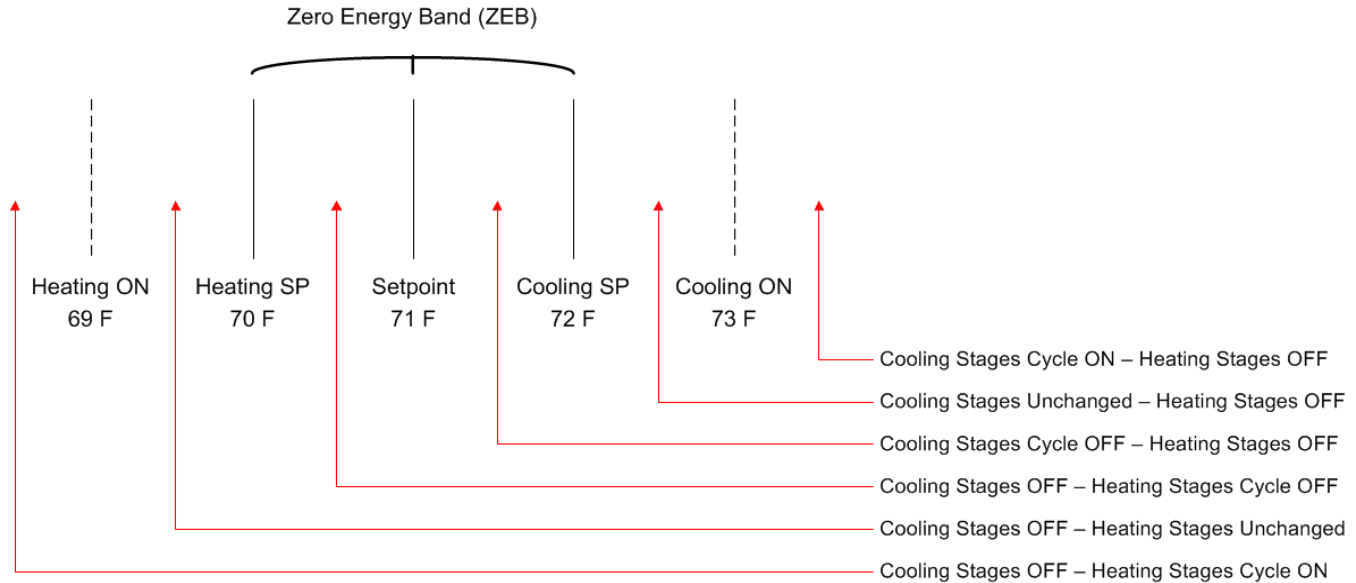
The controller provides support for either four compressor stages of cooling or one floating point or 0-10V modulating cooling output (valve or variable speed circulator). You can specify which type of cooling you are using through configuration parameters.

Cooling Stages

The cooling sequence is initiated when the current operating mode calls for cool. The cooling compressor stages are sequenced based on the supply temperature, the cooling setpoint and the control band. When the supply air temperature rises above the cooling setpoint plus the control band, a stage is turned on. If the supply air temperature remains above the control band for an additional time-period, the next available stage is turned on. If all zone temperature readings are within 0.5 °F of their setpoints, the next stage does not cycle on. This cycle continues until all available stages have been energized.

After the supply temperature has dropped below the cooling setpoint, the first available stage is turned off. If the supply air temperature remains below the cooling setpoint for an additional time-period, the next available stage is turned off. This cycle continues until all available stages have been de-energized. If the supply air temperature drops below the cooling setpoint plus control band all of the stages immediately cycle off.

Figure 11: Staged Heating and Cooling



Cooling with Floating Point Control

The cooling outputs can be configured for floating point control of a cooling valve. Floating point control is enabled when *Cooling Stages* is set to zero and the *Cooling Valve Travel Time* is non-zero. The C1 output is the valve open signal and the C2 output is the valve close signal.

After a reset, the floating point valve is calibrated by closing the valve for a period of the travel time. This ensures that the valve is fully closed. When the valve is at its calculated 0% or 100% position, the valve is overdriven for 30 seconds to ensure that the valve is fully closed or open.

The floating point control is similar to the cooling modulated algorithm. If the space temperature is above the cooling setpoint, the valve is driven open. When the space temperature is below the cooling setpoint, the valve is driven closed. There is a +/- 1 °F (0.55 °C) deadband around the setpoint to prevent the valve from dithering. During mixed air low limit alarms, the cooling valve is driven to 100%.

Cooling with Modulated Output (Valve or Variable Speed Circulator)

The calculated cooling loop setpoint is derived from the cooling setpoint and the loop proportional gain.

$$CalcCoolingLoopSp = CalcCoolingSp - \frac{1}{2}(Kp)$$

The cooling output is modulated by a P+I control loop based on the cooling loop setpoint and the space temperature. The P+I control loop will modulate the output to maintain a constant space temperature. As the temperature increases above the cooling loop setpoint, the cooling valve will be modulated open. The cooling output will be modulated closed as the temperature decreases below the cooling loop setpoint. When unoccupied mode is entered, the cooling loop setpoint is set up through a separate unoccupied cooling setpoint.

To prevent the integral component from becoming too large, there is anti-wind up reset protection. This protection clamps the integral value when all of the components add up to more than 100% or less than 0%. The following equations are used for P+I control:

$$K_p = \text{Proportional Gain}$$

$$K_i = \text{Integral Gain}$$

$$\text{Error} = \text{CoolingLoopSp} - \text{SpaceTemp}$$

$$I = I + (K_i \times \text{Error})$$

$$\text{CoolPosition} = (K_p \times \text{Error}) + I$$

Supply Air Temperature Lockout

To eliminate cooling stages coming on when the economizer has satisfied the SAT, the VPU2 monitors the Supply Air Temperature (SAT) and compares it to the *SAT Cooling Limit*. Should the SAT fall below the *SAT Cooling Limit*, additional cooling will not be enabled. If the SAT rises above the *SAT Cooling Limit*, additional cooling will be enabled as needed.

Cooling with Stages and Modulation

The controller can combine its staged and modulated modes. In the combined mode of operation, the modulated output is considered to be one of the stages. The stage to be associated with modulation is selected in the *Staged Cooling* configuration page.

Modulation starts when the selected stage would normally start (i.e., if stage 2 is selected as the modulating stage, it starts if stage 1 has been active for the *Staging Interval* and the temperature is still above the cooling control band).

If the modulating stage is not the last stage, subsequent stages are activated once the *Stage Threshold* percentage has been met by the modulating output and has remained there for the duration of the *Staging Interval*.

In order to maintain a smooth total cooling output, the modulating output responds to subsequent stages activating or deactivating. It does so by clearing its interval output when a subsequent stage is activated:

$$I = 0$$

$$\text{Modulating Output} = K_p \times \text{Error}$$

It forces its interval output to the *Staging Interval* whenever a subsequent stage is deactivated. This feature prevents large jumps in overall cooling output.

$$I = \text{Staging Threshold}$$

$$\text{Modulating Output} = (K_p \times \text{Error}) + I$$

Figure 12: Modulated Staging with 2 Stages; 2nd Stage Modulating

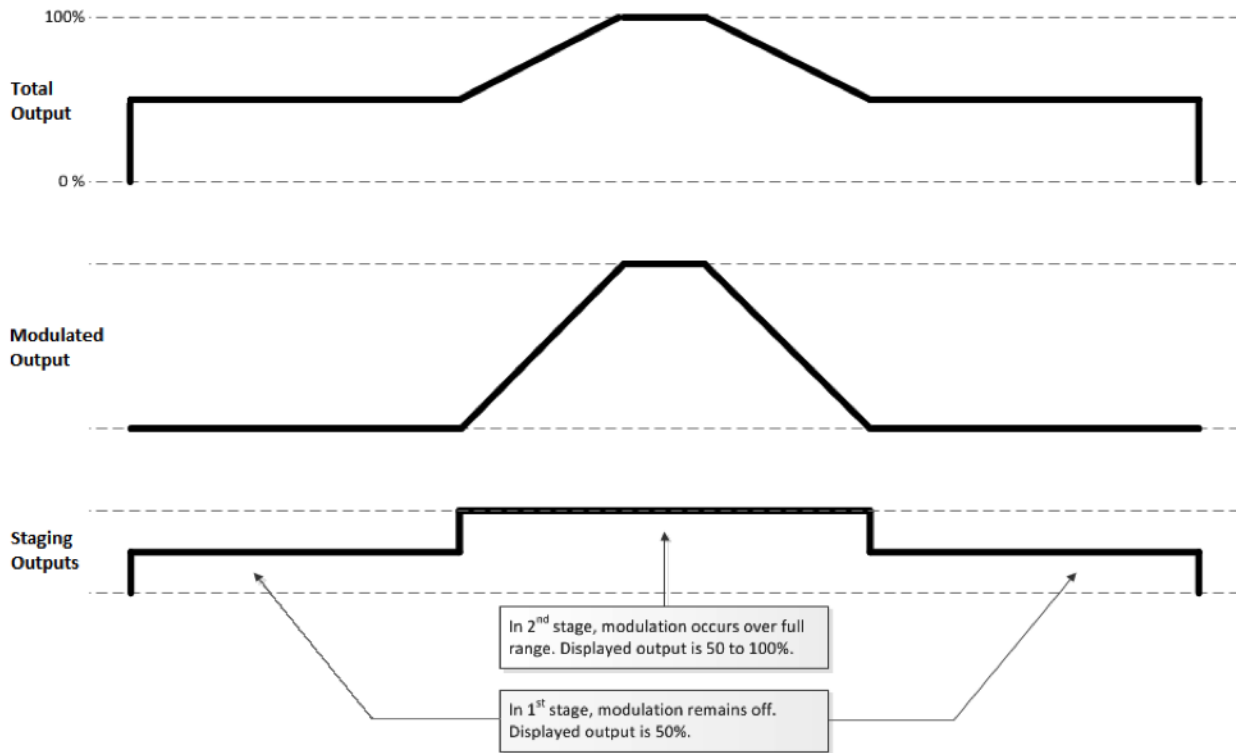
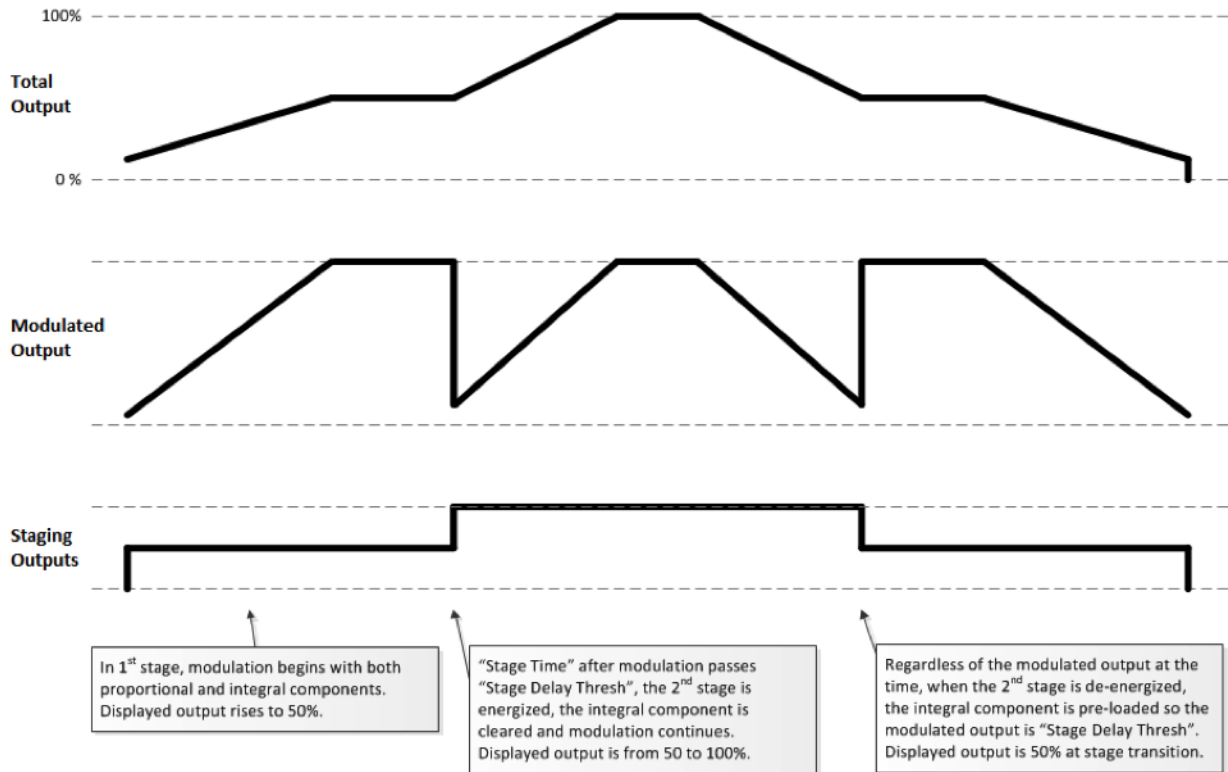


Figure 13: Modulated Staging with 2 Stages; 1st Stage Modulating



Economizer Operation

The controller may be configured for either a two-position or a modulated economizer. The economizer is enabled based on the availability of “free cooling” from the outdoor air. Free cooling is determined by dry bulb or enthalpy comparisons. To provide maximum energy savings, the cooling stages are delayed for three minutes to allow free cooling to cool the space.

Dry Bulb Comparisons

Free cooling is determined based on a comparison of outdoor air temperature and indoor air temperature. When the outdoor air temperature is a programmable amount below the indoor air temperature, free cooling is enabled. When the outdoor air temperature rises above the indoor temperature, free cooling is disabled.

Enthalpy Comparison

An enthalpy calculation is performed periodically to determine if “free cooling” is available from the outside air. The outside enthalpy is calculated based on the outside air temperature and humidity. The outside temperature and humidity are measured by an external device (such as an ASM) on the network and sent to the controller. The same calculation is performed on the inside air based on the space temperature and return air humidity. The inside enthalpy minus the outside enthalpy must be greater than the Free Cooling Setpoint in order for the economizer to be used for free cooling.

Optionally, an ASM can measure the indoor air humidity globally. In this case, a return air humidity sensor would not be required at each VPU2.

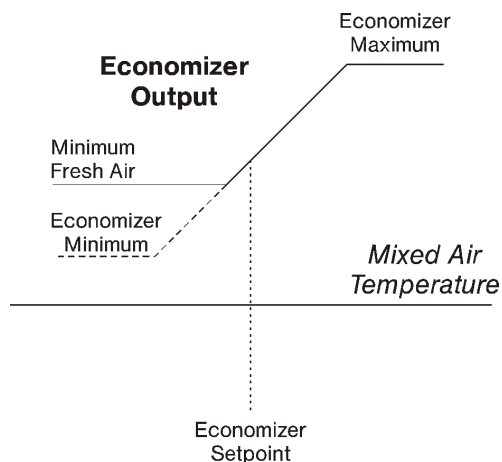
Two-position Economizer Control

When configured, the two-position economizer is enabled when free cooling is available as determined by the enthalpy or dry bulb calculations. When the economizer is enabled, the economizer triac output is energized. When the economizer is disabled, the economizer output is de-energized. A configuration parameter is available to optionally disable the economizer during unoccupied periods.

Modulated Economizer Control

The modulated economizer is enabled when there is “free cooling” available as determined by the enthalpy or dry bulb calculations. A configuration parameter is available to optionally disable the economizer during unoccupied periods.

Figure 14: Economizer Control.



When the economizer is enabled, a control loop modulates the economizer output position to maintain a constant mixed air temperature. During this free cooling state, cooling stages do not run. If free cooling cannot bring the mixed air temperature down to setpoint, then cooling stages are allowed to run after three minutes of the economizer output reaching 100%.

If an IAQ condition occurs, the economizer modulates open to 100% to allow fresh air into the space. This occurs immediately when an IAQ condition is first detected and may clear the condition before an alarm is sent to the LCI.

When the IAQ condition clears, the economizer returns to the operation it was in prior to the IAQ state - if it was free cooling before the IAQ occurred, it returns to free cooling. If it was mechanical cooling before the IAQ occurred, it returns to mechanical cooling.

When the economizer is disabled, it closes completely. A configuration parameter is available to optionally disable the economizer during unoccupied periods.

Dehumidification

The VPU2 can be configured to keep humidity below a given setpoint. If the Setpoint is set to zero, dehumidification is disabled. When the humidity is above the Setpoint dehumidification begins and stops when the humidity drops below Setpoint minus 3%.

Dehumidification stops when the reference zones (VAVI) space temperature drops below the heating setpoint minus the control band offset. Dehumidification is also disabled when the unit is in heating.

During dehumidification, the operating mode will be displayed as "Dehumid," the cooling outputs will stage on and the stage timer is enforced, or modulating output or floating point valve will be set to 100%.

Fan Operation

During Morning Warm-up, Occupied, Extended Occupancy, and Emergency Heating states, the fan runs continuously. During the shutdown state, the fan is off.

The fan can be overridden from the LCI or another host controller. When the fan is overridden, the static pressure P+I loop control is disabled and the integral sum is cleared to prevent anti-windup reset. The fan's modulated output can be overridden between 0 and 100%. If the desired speed is greater than the current speed, the speed is ramped up to the desired speed based on the *Soft Start Ramp* setting.

Static Pressure Control

Static pressure control is achieved by modulating a variable speed drive based on the measured static pressure in the supply duct. The static pressure sensor input has maximum range of 5.000" W.C. with a minimum resolution of 0.005" W.C.

The fan speed output is modulated by a P+I control loop based on the static pressure loop setpoint and the supply static pressure measurement. The P+I control loop modulates the output to maintain a constant static pressure within the supply air duct. As the supply static pressure decreases 0.025" W.C. below the static pressure loop setpoint, the output is modulated towards its maximum value. The output is modulated towards its minimum value as the supply static pressure increases to 0.025" W.C. above the static pressure loop setpoint. When the static pressure is within ± 0.025 " W.C. of the static pressure setpoint, the damper output remains at its current level.

To prevent the integral component from becoming too large, there is anti-wind up reset protection. This protection clamps the integral value when all of the components add up to more than 100% or less than 0%. The following equations are used for P+I control:

$$K_p = \text{Proportional Gain}$$

$$K_i = \text{Integral Gain}$$

$$\text{Error} = \text{SupplyStaticPressure} - \text{LoopSetpoint}$$

$$I = I + (K_i \times \text{Error})$$

$$\text{BypassPosition} = (K_p \times (\text{Error} + I)) + 50.00\%$$

A separate static pressure setpoint is provided to increase the supply static pressure when an IAQ alarm condition exists. The fan speed control maintains the IAQ alarm pressure setpoint as long as an IAQ alarm condition exists.

Programmable minimum and maximum outputs are provided for the fan speed. These settings can be reversed for reverse air movement. Overrides are provided to assist in system air balancing during commissioning.

Soft Start Ramping

The VPU2 can be configured to soft start ramp to prevent damage to the ducts and equipment when the fan is first energized. Setting the soft start ramp rate to 0% per second or 100% per second disables soft start ramping. The soft start ramping clamps the P+I output to the current ramp rate. Soft start ramping ends when the static pressure is within the deadband, greater than the pressure setpoint, or when the soft start ramp reaches 100%. Once soft start ramping ends, the P+I loop's integral sum is backwards calculated to create a smooth transition to the static pressure P+I loop control.

Fan Proof

A fan status input is provided for monitoring the operation of the fan. When the fan is initially turned on, there is a 30 second delay before the fan status is checked. If at any time after the delay, the fan status indicates the fan is not running, a fan failure condition is generated. The heating and cooling stages are interlocked with the fan. When a fan failure condition exists, the heating stages, cooling stages and the fan immediately turn off. The controller must be reset to clear this condition.

NOTE: If not providing a fan proof switch, the dipswitch for the fan proof input must be configured with the (0-10V) switch set to "on" and "Vth" set to "off." After a fan failure, the controller's status LED changes from green to solid red. To return the controller to normal operation after the failure condition is resolved, you must reset the controller by removing and reapplying power or by using the controller reset feature on the LCI.

VPU2 and VAVI Communications

The VPU2 polls an associated VAVI controller every 5 seconds to transfer information necessary for control.

The following information is transferred from the VPU2 to the VAVI controller:

- Operational Mode: primary cool, primary heat, and primary off
- Occupancy Mode: occupied, unoccupied, and bypass (denotes morning warm-up)
- Alarm Conditions: IAQ Mode and Heat Failed On

The following information is transferred from the VAVI to the VPU2 controller:

- Zone temperature
- Calculated Heating Setpoint
- Calculated Cooling Setpoint
- IAQ Sensor Status (safe, alarm)
- Local Alarm (VAVI shutdown)
- Occupancy Mode: occupied, unoccupied, and occupied extension)
- Supplemental heat status: on, off

Associating VAVIs

In order for the VPU2 and VAVIs to share information the controllers need to be associated. To associate the VAVIs to the VPU2 you first need to select the VPU2 from the LCI's list of controllers. Once the VPU2 has been selected depress the HVAC Setup button then the Zone Members button. There is a list of all VAVIs on the network that will be displayed along with the designation "Included" or "Excluded." To include a VAVI, simply depress the desired VAVI in the list and it will show "Included" and the color will change to Red. After all the desired associations are complete depress the **Save** button so the information will be sent to all associated controllers.

Associating the Reference Zone; VAVI

In order for the VPU2 and reference VAVI to share information the controllers need to be associated. To associate the reference VAVI to the VPU2 you first need to select the VPU2 from the LCI's list of controllers. Once the VPU2 has been selected depress the HVAC Setup button then the Reference Zone button. There you will see a list of all VAVIs on the network along with the designation "Included" or "Excluded" for each. To include the reference VAVI, simply depress the desired VAVI in the list and it will show "Included" and the color will change to Red. After all the desired associations are complete, depress the **Save** button so the information will be sent to all associated controllers. The VPU2 may have only one (1) reference zone.

Power On/Reset Delay

The VPU2 imposes a thirty second delay after being powered on or after a reset. No control takes place until after the thirty second delay has expired.

Supply Air Temperature Monitoring

The VPU2 monitors the supply air temperature to determine if the heating and cooling stages are operating properly. During heating mode, if the supply air temperature does not rise above the heat mode alarm setpoint after a 10-minute delay a heat mode alarm is generated. During cooling mode, if the supply air temperature does not drop below the cool mode alarm setpoint after a 10-minute delay, a cool mode alarm is generated.

The VPU2 has provisions for detecting a gas valve that has become stuck in the open position. The stuck gas valve sequence helps to prevent overheating the HVAC unit.

During periods when the operational mode is primary off or primary fan only, if the supply air temperature rises above 175 °F the system fan is started. If the supply air temperature does not drop below 150 °F after 5 minutes, the fan speed decreases to 0% and an alarm is sent to the zone controllers and LCI. The zone controllers react to the alarm by positioning their dampers to the maximum position.

During periods when the operational mode is primary cooling, if the supply air temperature does not drop below 100 °F after 15 minutes, the cooling mode is terminated and the controller enters the primary off operational mode. The primary off logic then checks for the stuck gas valve condition.

Smoke Detection

A smoke detector input is provided. If the smoke detector indicates smoke is present then all of the stages and the fan turn off. Once the situation has been corrected, reset the controller to clear this condition.

Mixed Air Low Limit Detection

An input is provided for a mixed air low limit detection device. If a low limit condition is detected, all of the stages and the fan turn off. Once the low limit is corrected, reset the controller to clear this condition.

Filter Status

The filter status input is monitored to determine if the filter is operating properly. The input is used to indicate that maintenance is required on the filter. The unit is not shut down due to a filter alarm.

Indoor Air Quality

An indoor air quality input is provided. If an indoor air quality alarm is indicated while the space is occupied, the supply air fan is energized and the economizer is overridden to supply fresh air to the space. The source of an indoor air quality signal can be a digital sensor providing an on/off signal or a configurable analog sensor.

Setup of the analog sensor requires the IAQ sensor settings to be populated. A Min, Max, Setpoint, and Offset can be specified.

When an indoor air quality condition is sensed by the controller, the economizer is opened to 100%. If the mixed air temperature drops too low, the economizer modulates in an attempt to maintain the IAQ MAT setpoint while still allowing fresh air into the system.

The 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. During IAQ Alarm operation, if the space temperature rises above or drops below the temperature reset limit, the controller resumes normal economizer control to maintain a comfort space temperature. Once the space temperature is brought within the calculated setpoints and an IAQ Alarm condition still exists, the controller resumes the IAQ mode of operation.

The controller has a configurable alarm delay function. This function allows the controller to attempt to clear the IAQ condition with the economizer before triggering an alarm. If the IAQ condition is still present after the IAQ Alarm Delay, the alarm message is sent to the LCI.

Return Air IAQ

The VPU2 can read the status of an IAQ sensor placed in the return air duct. When the IAQ sensor indicates that contaminants are above a preset limit, the VPU2 energizes the fan. After a preset time delay, the economizer is enabled to supply fresh air to the zones. All of the zones are made aware of the IAQ alarm condition. Any zone configured to participate in return air IAQ modulates its damper open. Heating and cooling operate as normal.

Local Zone IAQ

The VPU2 can receive the status of local IAQ sensors connected to discrete inputs on each zone controller (VAVI). When the local zone IAQ sensor indicates that contaminants are above a preset limit, the VPU2 energizes the fan. After a preset time delay, the economizer is enabled to supply fresh air to the zones. Only the VPU2 and local zone controller participate in local zone IAQ. Heating and cooling operate as normal.

Real Time Clock (RTC)

The RTC will be set or synchronized by the LCI each day at midnight. The controller will utilize the RTC in conjunction with its local backup schedule during periods when the LCI is not available.

Local Backup Schedule

The LCI normally determines the operating mode. You can define a local backup schedule for situations when the LCI is not available. When the controller detects that the LCI is not available (after 10 minutes without communications), it resorts to the local backup schedule that has been configured. If the local backup schedule is disabled, the controller defaults to the occupied mode.

The occupied and unoccupied times are used in determining the current operating mode of the controller when it is running the backup schedule. They are configured by the user. By default, both the unoccupied and occupied times are set to zero, which disables the local backup schedule. This causes the controller to default to the occupied mode of operation when communications are lost to the LCI for 10 minutes or longer.

Runtime Accumulation

The total runtime is accumulated for the heating, cooling, and fan outputs. The runtimes can be used to indicate that maintenance is required on the equipment controlled by these outputs. An operator or maintenance personnel can reset the runtime once servicing has been performed. The runtimes are accumulated in volatile memory (RAM). Once a day they are backed up to non-volatile memory (NVRAM). When the VPU2 is reset, the runtimes are copied from NVRAM to RAM.

Alarms and Events

The VPU2 detects certain alarm conditions and sends them to LCI. Before this can occur, the VPU2 must have been configured by the LCI.

Input Alarms

The VPU2 monitors the status of the analog and digital inputs and generates alarms for the following events:

- Fan Failure
- Smoke Detect
- Mixed Air Low Limit Condition
- Dirty Filter
- Indoor Air Quality

Supply Air Temperature Alarms

The following alarms can be generated based on supply air monitoring.

- Cooling Failed
- Heating Failed
- Heat Stuck On

Maintenance Alarm

A VPU2 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.

Automatic Configuration

The VPU2 and iWorx® Local Control Interface (LCI) use a self-configuring network management scheme requiring no external tools, binding, or LONWORKS knowledge. The LCI recognizes and configures the VPU2 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 VPU2 with LNS or other LONWORKS tools if they wish.

The LCI also provides network supervision of the VPU2. The LCI periodically sends a "ping" message to the VPU2, 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.

CONTROLLER IDENTIFICATION

Once the VPU2 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 VPU2, and the meanings and default values for controller parameters. For more information on using the LCI, see the *iWorx® LCI Application Guide*.

Inputs

The Inputs screen displays the current values of the VPU2's inputs. These values cannot be changed.

Input	Range	Description
Outside Temp	-29 to 230 °F (-34.4 to 110 °C)	The outside air temperature communicated through the LCI from the ASM controller.
Smoke Detector	Normal, Smoke	Status of the smoke detector.
Fan Status	Off, On	Status of the fan proof switch.
Low Limit	Normal, Freeze	Status of the mixed air low limit indication switch.
Filter Status	Normal, Dirty	Status of the filter status switch.
Indoor Air Qual	Normal, Alarm	Status of the IAQ alarm sensor when defined as Digital.
Occupancy Mode	Occupied, Unoccupied, Bypass	Occupancy mode of the controller.
Supply Air Temp	-29 to 230 °F (-34.4 to 110 °C)	Temperature of the supply air duct.
Mixed Air Temp		Temperature of the mixed air plenum.
Return Air Temp		Temperature of the return air duct.
Return Air Humidity	0.00 to 100.00%	Humidity inside the return air duct.
Static Pressure	0.00 to 5.00" WC (0 to 0.181 PSI) (0 to 1246 Pa)	Pressure in the supply air duct.
Inside Enthalpy	0.0 to 60.0 BTU/lb 0.0 to 139.6 kjoule/kg	Calculated inside air enthalpy.
Out Enthalpy	2.0 to 60.0 BTU/lb 3.0 to 139.6 kjoule/kg	Calculated outside air enthalpy.
IAQ	0 to 4000 ppm	Reading of the indoor air quality sensor when defined as Analog.

Outputs

This screen displays the current values of the VPU2's outputs. These values cannot be changed.

This screen also displays the current status of each device in the VPU2's group. Each device is displayed on its own line, and is identified as being off, in heating mode, or in cooling mode.

Output	Range	Description
Mode	Heat, Cool, Off, Fan, Free Cooling, Dehumid, Shut Down	Operating Mode
Heat Output	0.00% to 100.00%	Current state of the heating output.
VFD Output	0.00% to 100.00%	Current state of the VFD output.
Cool Output	0.00% to 100.00%	Current state of the cooling output.

Output	Range	Description
Economizer Output	0.00% to 100.00%	Current status of the economizer output.
Fan Output	0.00% or 100.00%	Current status of the fan output.
In Alarm?	On, Off	Alarm indication.

This screen also displays the current status of each device in the VPU2's group. Each device is displayed on its own line, and is identified as being off, in heating mode, or in cooling mode.

Configuration

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
Setpoints	Structure	N/A	Setpoint Settings
Supply Temp Reset Curve	Structure	N/A	Reset Curve Settings
Pressure Settings	Structure	N/A	Fan VFD settings
Staged Cooling	Structure	N/A	Staged Cooling Settings
Modulated Cooling	Structure	N/A	Modulated Cooling Settings
Floating SP Cooling	Structure	N/A	Floating Point Valve Cooling Settings
Staged Heating	Structure	N/A	Staged Heating Settings
Modulated Heating	Structure	N/A	Modulated Heating Settings
Floating SP Heating	Structure	N/A	Floating Point Valve Heating Settings
Economizer	Structure	N/A	Economizer Settings
Free Cooling	Structure	N/A	Free Cooling Settings
Dehumidification	Structure	N/A	Dehumidification Settings
Runtime Limits	Structure	N/A	Runtime Limit Settings
Backup Occ Time	Structure	N/A	Backup schedule settings for Occupied
Backup Unocc Time	Structure	N/A	Backup schedule settings for Unoccupied
IAQ Mode	Digital, Analog	Digital	Type of IAQ sensor
IAQ Settings	Structure	N/A	Settings for the IAQ alarm
IAQ Sensor	Structure	N/A	Settings for the IAQ analog sensor
Cutoff Temps	Structure	N/A	Provides entries for cutoff temperatures for heating, cooling, and economizer functions.

Commissioning

Displays VPU2 settings that are useful during commissioning of the unit.

Setting	Range	Default	Description
Override Mode	Off, Fan VFD %, Fan VFD 0%, Fan VFD 100%	Off	Set to any value besides "Off" to place the controller into that override mode.
Fan VFD Percentage	0.00% to 100.00%	0.00%	Fan setting to use when the controller is placed in "Fan VRD %" override mode.

Setpoints

This screen displays the heating and cooling setpoints used by the VPU2 controller. Use the up and down arrow keys to select a value to change, then use **-** or **+** to increase or decrease the value (or utilize **USE KEYS** to directly enter the desired value). Press **Save** to save your changes or **Back** to return to the Setup screen.

Setpoint	Range	Default	Description
Cooling Setpoint	45.0 to 65 °F (7.22 to 18.33 °C)	55.00 °F (12.78 °C)	Temperature setpoint for the cooling mode.
Heating Setpoint	55.00 to 130.0 °F (12.8 to 54.4 °C)	90.00 °F (32.22 °C)	Temperature setpoint for the heating mode.
Supply Cool Limit	0.00 to 30.0 °F (0.00 to 16.6 °C)	10 °F (5.5 °C)	Minimum temperature change from cooling setpoint in 10 minutes to avoid a cooling failed alarm.
Supply Heat Limit	0.00 to 30.0 °F (0.00 to 16.6 °C)	10 °F (5.5 °C)	Minimum temperature change from heating setpoint in 10 minutes to avoid a heating failed alarm.

Supply Temp Reset Curve

Displays all of the Supply Temp Reset settings and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Min Differential	0.00 to 30.0 °F (0.00 to 16.6 °C)	0.00 °F (0.00 °C)	Differential at or below which the supply air is at it coolest.
Max Differential	0.00 to 30.0 °F (0.00 to 16.6 °C)	0.00 °F (0.00 °C)	Differential at or above which the supply air is at it warmest.
Cool Setp Low	45.0 to 65.0 °F (7.22 to 18.3 °C)	45.0 °F (7.22 °C)	Lowest cooling SP when the zone is at its warmest.
Cool Setp High	45.0 to 65.0 °F (7.22 to 18.3 °C)	65.0 °F (18.3 °C)	Highest cooling SP when the zone is at its coolest.
Heat Setp Low	55.0 to 130.0 °F (12.8 to 54.4 °C)	80.0 °F (26.67 °C)	Lowest heating SP when the zone is at its warmest.
Heat Setp High	55.0 to 130.0 °F (12.8 to 54.4 °C)	130.0 °F (54.4 °C)	Highest heating SP when the zone is at its coolest.

Pressure Settings

Displays all of the Static pressure settings and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Setpoint	-2.5 to 5.00" W.C. (-623 to 1246 Pa)	1.0" W.C. (249 Pa)	Setpoint for supply air static pressure.
IAQ Setpoint	-2.5 to 5.00" W.C. (-623 to 1246 Pa)	1.5" W.C. (374 Pa)	Setpoint for supply air static pressure used when an IAQ alarm is present.
Kp	0.0 to 100.00% per F	5.00%	Proportional gain of the economizers P+I control loop.
Ki	0 to 100% per 0.1" W.C.	0.05%	Integral gain of the economizer's P+I control loop.
Minimum Output	0.0 to 10.0 V	0.0 V	Minimum voltage output for the fan VFD.
Maximum Output	0.0 to 10.0 V	10.0 V	Maximum voltage output for the fan VFD.
Press Min	-2.5 to 5.00" W.C. (-623 to 1246 Pa)	0.00" W.C. (0 Pa)	Static pressure to report when the analog input receives 0 volts.
Press Max	-2.5 to 5.00" W.C. (-623 to 1246 Pa)	2.00" W.C. (498 Pa)	Static pressure to report when the analog input receives 10 volts.
Soft Start Rate	0.00 to 100.00%	0.00%	Percentage of fan output increase per second.

Staged Cooling/Heating

Displays all of the staged heating or cooling settings and provides access to edit these parameters from a single screen.

Setpoint	Range	Default	Description
Stages	0 to 4 (cooling) 0 to 2 (heating)	4 2	Number of stages controlled. Set to zero to disable heating or cooling.
Control Band	0 to 10 °F (0 to 5.6 °C)	1.0 °F (0.6 °C)	Value used to modify the calculated heating and cooling setpoints to form the temperature range in which local heating or cooling is enabled.
Stage Time	0 to 255 min	5 min	The rate at which stages are sequenced.
Stage Delay Thresh	0 to 100%	99%	Modulated threshold that must be surpassed before the next stage may be turned on.
Modulating Stage	No Mod Stage, Stage 1 Mod, Stage 2 Mod	No Mod Stage	Stage with modulated output

Modulated Heating/Cooling

Displays all of the modulated heating or cooling settings and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Kp	0.00 to 100.00% (per °F)	5.00%	Proportional gain of the cooling P+I control loop.
Ki	0.00 to 100.00%	0.05%	Integral gain of the cooling P+I control loop.
Out Min	0.0 to 10.0 V	0.0 V	Minimum output voltage for modulated heating or cooling.
Out Max	0.0 to 10.0 V	0.0 V	Maximum output voltage for modulated heating or cooling. If set to 0, Modulation is disabled.

Floating SP Heating/Cooling

Displays all of the floating point heating or cooling settings and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Kp	0.0 to 100.00% per F	5.00%	Proportional gain of the economizers P+I control loop.
Ki	0 to 100.00%	0.05%	Integral gain of the economizer's P+I control loop.
Travel Time	0.0 to 600 sec	0	Total time it takes for the valve to travel from fully closed to fully open. If set to 0 floating point is disabled.
Deadband	0.0 to 100.0%	10%	The desired setpoint must be this far or greater from the actual position before modulating the actuator.

Economizer

Displays all the economizer settings and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Economizer Type	Disabled, 2 St Unocc On, 2 St Unocc Off, Mod Unocc. On, Mod Unocc. Off	Disabled	Type of Economizer: Disabled, Two State and ON when unoccupied, Two State and OFF when unoccupied, Modulated and ON when unoccupied or Modulated and OFF when unoccupied.
Setpoint	40.00 to 70.00 °F (4.44 to 21.11 °C)	55.00 °F (12.78 °C)	Setpoint used for controlling the economizer.
Min Fresh Air	0.00 to 100.00%	10.0%	Minimum fresh air position for the modulated economizer.
Kp	0.00 to 100.00% (per °F)	5.00%	Proportional gain of the economizer's P+I control loop.

Setting	Range	Default	Description
Ki	0.00 to 100.00%	0.05%	Integral gain of the economizer's P+I control loop.
Min AO Voltage	0.0 to 10.0 V	0.0 V	Minimum output voltage for the modulated economizer.
Max AO Voltage	0.0 to 10.0 V	10.0 V	Maximum output voltage for the modulated economizer.

Free Cooling

Displays all the free cooling settings and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Type	Rtn Air Humidity, Global Humidity, DryBulb temp	Rtn Air Humidity	Type of free cooling comparison to be performed.
Enthalpy Offset	0.0 to 60.0 BTU/lb (0.0 to 139.86 kjoule/kg)	5.0 BTU/lb 11.6 kjoule/kg	Difference between inside enthalpy and outside enthalpy that enables or disables the economizer.
Drybulb Offset	0.0 to 20.0 °F (0.0 to 11.1 °C)	5.00 °F (2.78 °C)	Difference between zone temperature and outside temperature that enables or disables the economizer.

Dehumidification

Displays all the dehumidification settings and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Type	Occupied, Always enabled	Occupied	Defines when dehumidification is enforced.
Setpoint	0.00 to 100.00%	0%	Humidity Setpoint
Shutoff offset	0 to 10.0 °F (0 to 5.56 °C)	2.00 °F (1.11 °C)	Difference between zone temperature and outside temperature that enables or disables the economizer.

Runtime Limits

Displays all the runtime limit settings and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Cooling	0 to 65535 hours	1000 hours	Runtime limit for cooling after which a maintenance alarm is generated.
Heating	0 to 65535 hours	1000 hours	Runtime limit for heating after which a maintenance alarm is generated.
Fan	0 to 65535 hours	1000 hours	Runtime limit for the fan after which a maintenance alarm is generated.

Backup Occ Time / Unocc Time

Displays all the backup schedule settings and provides access to edit these parameters from a single screen.

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

IAQ Settings

Displays all the IAQ settings and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
IAQ Delay Time	0 to 1000 minutes	5 minutes	Time delay before reporting an IAQ alarm.
Temp Reset Limit	0 to 15 °F (0 to 8.3 °C)	5 °F (2.78°C)	Temperature Reset Limit to ensure comfort temperature during IAQ Alarm conditions.
Deadband	0 to 400 ppm	0 ppm	Deadband to allow the IAQ to recover from the alarm condition.

IAQ Sensor

Displays all the IAQ sensor settings and provides access to edit these parameters from a single screen.

Setting	Range	Default	Description
Min	0 to 4000 ppm	0 ppm	Minimum ppm sensor setting.
Max	0 to 4000 ppm	0 ppm	Maximum ppm sensor setting.
Setpoint	0 to 4000 ppm	0 ppm	Setpoint.
Offset	0 to 4000 ppm	0 ppm	Offset to the sensor reading.

Cutoff Temp

Displays all the OAT cutoff settings and provides access to edit these parameters from a single screen. A value of -4.0 disables the cutoff temperature setting.

Setting	Range	Default	Description
Max OAT Heat	-7.6 to 122 °F (-22 to 50 °C)	-4 °F	Outside air temperature above which heating is disabled.
Max OAT Cool	-7.6 to 122 °F (-22 to 50 °C)	-4 °F	Outside air temperature below which cooling is disabled.
Max OAT Econ	-7.6 to 122 °F (-22 to 50 °C)	-4 °F	Outside air temperature above which the economizer is disabled.
Min OAT Econ	-7.6 to 122 °F (-22 to 50 °C)	-4 °F	Outside air temperature below which the economizer is disabled.
SAT Cooling Limit	45 to 65 °F (7.22 to 18.3 °C)	55 °F (12.8 °C)	Supply air temperature below which additional cooling will not be enabled.

Alarms

The table below describes the alarms you may encounter and how they are reset.

Alarm	Range	Alarm Trigger	Alarm Reset
Fan Failure	Normal, Alarm	Occurs when the fan input detects that the fan is not running after a 30-second grace period after the fan has been activated.	The cause of the emergency condition must be resolved and the controller must be reset.
Smoke	Normal, Alarm	Occurs when the smoke alarm input detects the presence of smoke.	The cause of the emergency condition must be resolved and the controller must be reset.
Mixed Air Low Limit	Normal, Alarm	Occurs when the mixed air temperature drops below the Low Limit that has been set, indicating a freeze condition.	The cause of the emergency condition must be resolved and the controller must be reset.
Filter	Normal, Alarm	Occurs when the Filter Alarm input detects that the filter needs to be replaced.	Automatic when the dirty filter is replaced.
Indoor Air Quality	Normal, Alarm	Occurs when the IAQ sensor detects inadequate indoor air quality.	Automatic when air quality returns within normal parameters.
Heating Failure	Normal, Alarm	Occurs when Supply Air temperature is <i>Supply Heat Limit</i> degrees from the setpoint 10 minutes after entering heating mode.	The cause of the emergency condition must be resolved.
Cooling Failure	Normal, Alarm	Occurs when Supply Air temperature is <i>Supply Cool Limit</i> degrees from the setpoint 10 minutes after entering cooling mode.	The cause of the emergency condition must be resolved.
Heat Stuck On	Normal, Alarm	Occurs when the mode is primary off or primary fan only if the supply air temperature does not drop below 150 °F after five minutes.	The cause of the emergency condition must be resolved.
Maintenance	Normal, Alarm	Occurs when the fan, heating, or cooling operating hours have exceeded their Runtime limit.	To clear the alarm, a user must enter a new value for the alarm limit or reset the accumulated times to zero.

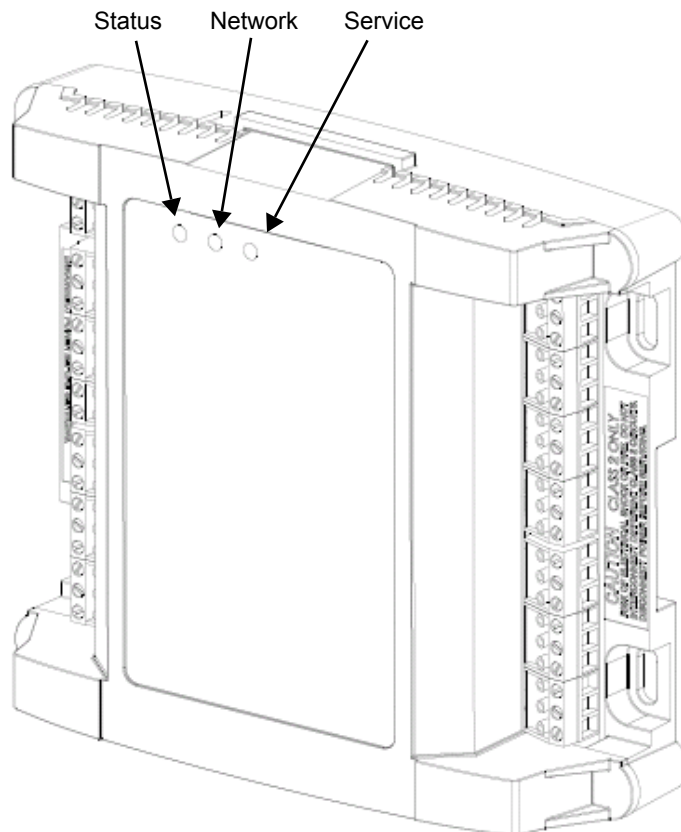
TROUBLESHOOTING

Diagnostic LEDs

The controller has 3 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	<ul style="list-style-type: none"> - Solid green when running and configured by an LCI (networking) - Flashing green when running and NOT configured by an LCI (stand-alone) - Solid red when a fault condition exists (control shut down) - Blinking Red - the controller has a device failure - Solid Amber - The controller has not received a LCI ping message in over 10 minutes and is part of a network.
Network	<ul style="list-style-type: none"> - 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
Service	<ul style="list-style-type: none"> - Illuminated when the service pin is depressed or when a controller gets configured by the LCI.

Figure 15: VPU2 Controller LEDs



Troubleshooting Tips

The table below provides solution to some common problems you may encounter.

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.
Can my iWorx® system contain multiple VPU2 controllers?	Yes, provided that you do not exceed the maximum number of controllers that can be handled by the Local Control Interface (LCI).
Thermistor readings fluctuate rapidly, sometimes by several degrees.	The controller is not properly grounded. The controller's ground (GND) pin (T40) must be connected to earth ground. Also ensure that the controller's digital inputs are dry contacts and that no voltage is being applied or switched to the inputs.
How do I associate my VAVI controllers with the VPU2?	Use the VPU2's grouping mechanism, specifically Zone Members on the <i>HVAC Setup</i> screen of the LCI.

Getting Help

Components within an iWorx® VPU2 controller cannot be field repaired. If there is a problem with a controller, follow the steps below before contacting your local TES representative or TES technical service.

1. Make sure controllers are connected and communicating to desired devices.
2. Record precise hardware setup indicating the following:
 - Version numbers of applications software.
 - Controller firmware version number.
 - A complete description of difficulties encountered.

Notes:

LIMITED WARRANTY STATEMENT

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).

In order to obtain service under this warranty, it is the responsibility of the purchaser to promptly notify the local TES stocking distributor or TES in writing and promptly deliver the subject product or part, delivery prepaid, to the stocking distributor. For assistance on warranty returns, the purchaser may either contact the local TES stocking distributor or TES. If the subject product or part contains no defect as covered in this warranty, the purchaser will be billed for parts and labor charges in effect at time of factory examination and repair.

Any TES product or part not installed or operated in conformity with TES instructions or which has been subject to accident, disaster, neglect, misuse, misapplication, inadequate operating environment, repair, attempted repair, modification or alteration, or other abuse, will not be covered by this warranty.

TES 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 sold for such purposes.

If in doubt as to whether a particular product is suitable for use with a TES product or part, or for any application restrictions, consult the applicable TES instruction sheets or in the U.S. contact TES at 401-942-8000 and in Canada contact Taco (Canada) Limited at 905-564-9422.

TES reserves the right to provide replacement products and parts which are substantially similar in design and functionally equivalent to the defective product or part. TES reserves the right to make changes in details of design, construction, or arrangement of materials of its products without notification.

TES OFFERS THIS WARRANTY IN LIEU OF ALL OTHER EXPRESS WARRANTIES. ANY WARRANTY IMPLIED BY LAW INCLUDING

WARRANTIES OF MERCHANTABILITY OR FITNESS IS IN EFFECT ONLY FOR THE DURATION OF THE EXPRESS WARRANTY SET FORTH IN THE FIRST PARAGRAPH ABOVE.

THE ABOVE WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR STATUTORY, OR ANY OTHER WARRANTY OBLIGATION ON THE PART OF TES.

TES WILL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, INDIRECT OR CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OF ITS PRODUCTS OR ANY INCIDENTAL COSTS OF REMOVING OR REPLACING DEFECTIVE PRODUCTS.

This warranty gives the purchaser specific rights, and the purchaser may have other rights which vary from state to state. Some states do not allow limitations on how long an implied warranty lasts or on the exclusion of incidental or consequential damages, so these limitations or exclusions may not apply to you.

CONTROLS MADE EASY®

Taco Electronic Solutions, Inc., 1160 Cranston Street, Cranston, RI 02920
Telephone: (401) 942-8000 FAX: (401) 942-2360.

Taco (Canada), Ltd., 8450 Lawson Road, Unit #3, Milton, Ontario L9T 0J8.
Telephone: 905/564-9422. FAX: 905/564-9436.

Taco Electronic Solutions, Inc. is a subsidiary of Taco, Inc.
Visit our web site at: <http://www.taco-hvac.com>