

Excel 10

W7751B,D,F,H,J VARIABLE AIR VOLUME CONTROLLER

Light Commercial Building Solution

SYSTEM ENGINEERING

For information on the CARE/E-Vision Variable Air Volume Controller please see CARE/E-Vision Excel 10 W7751B,D,F,H,J System Engineering Guide Form no. 74-2949.

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INTRODUCTION

Description of Devices

The W7751B,D,F,H,J Excel 10 VAV II Box Controllers provide enhanced control solutions for single duct, dual duct and constant volume air terminal units. The controllers feature preprogrammed heating/cooling or reheat control algorithms for standard VAV Box control applications that are selected through the LonSpec software configuration tool. Additionally, the VAV II controllers use Echelon® LONWORKS® communication technology and the new Free Topology Transceiver (FTT) for greater installation flexibility. The Excel 10 VAV II Box Controllers are the first VAV Box Controllers in the marketplace from any manufacturer that use the LONMARK® VAV Controller compliance profile for true openness and interoperability with third party LONMARK devices. The controllers can be used in stand-alone applications or can be used in combination with Excel 10, Excel 15 Controllers, and LONSTATION™, to provide a complete and low cost control solution for light commercial buildings.

The W7751B,D,F,H,J Excel 10 VAV Box Controllers are configurable direct digital controllers designed for pressure independent or pressure dependent single duct VAV, dual duct VAV and constant volume air terminal unit control solutions. Five models are available including a low cost circuit board OEM version (W7751B) for internal panel mounting, two plenum mounted controllers complete with a wiring subbase for easy field installation (W7751D and F) and the low cost Smart VAV Actuators (W7751H and J) consisting of the Excel 10 Controller that is factory mounted and wired to a 90 second ML6161B Actuator. The W7751B,D,F, and H Excel 10 VAV Box Controllers contain an integral microbridge air flow sensor that provides flow measurement for pressure independent applications. The W7751J does not contain an air flow sensor, and is therefore for pressure dependent applications only. The controller configuration for all VAV II controllers is selected using a personal computer and the LONSPEC™ configuration tool. The Excel 10 VAV Box Controllers offer many features required in today's commercial buildings including energy saving setpoint reset for electrical demand limit control, standby setpoints for setpoint reset in the occupied mode and unoccupied setpoints for both heating and cooling. The control

solutions are scalable from stand-alone installations to a networked system using an XL15B as the network master and LONSTATION as a front-end.

In addition, the Excel 10 VAV II Box Controllers provide true open communication with the use of the LONMARK Controller compliance profile and the FTT for greater flexibility in network wiring and integration with third party LONMARK® devices.

The T7770 are direct-wired wall modules used in conjunction with W7751B,D,F,H,J Controllers. The zone controlled by the W7751 Controllers will typically use a T7770 Wall Module with a temperature sensor for space temperature measurement in a minimum system configuration. Additional features available in the T7770 model include analog setpoint input, override digital input pushbutton, override status LED and LONWORKS Bus network access jack.

The T7560 is a Digital Wall Module which includes a setpoint wheel, occupancy override buttons, and an LCD display of temperature, setpoint, fan status, and/or humidity.

The C7770A Air Temperature Sensor is a direct wired temperature sensor that is used to sense discharge or return air in a duct controlled by a W7751 Controller.

Control Application

VAV systems in commercial buildings typically incorporate a central air handler that delivers a modulated volume of air at a preconditioned temperature to multiple zones. Each zone is serviced by a VAV terminal box unit. Each box incorporates an air flow pickup assembly and motorized damper with optional fan and/or reheat coil. The controller determines and regulates the air flow of conditioned air to the space. The zone being fed by the terminal box will use a T7770 Wall Module or a T7560 Digital Wall Module for space temperature determination and access to the LONWORKS Bus network for operators. Fig. 1 shows a typical VAV box control application for the W7751B,D,F Controllers. Fig. 2 shows a typical VAV box control application for the W7751H Smart VAV Actuator. The W7751J Smart VAV Actuator has an application similar to Fig. 2 with no onboard air flow sensor. Table 1 shows the capabilities of the Excel 10 VAV Box Controllers.

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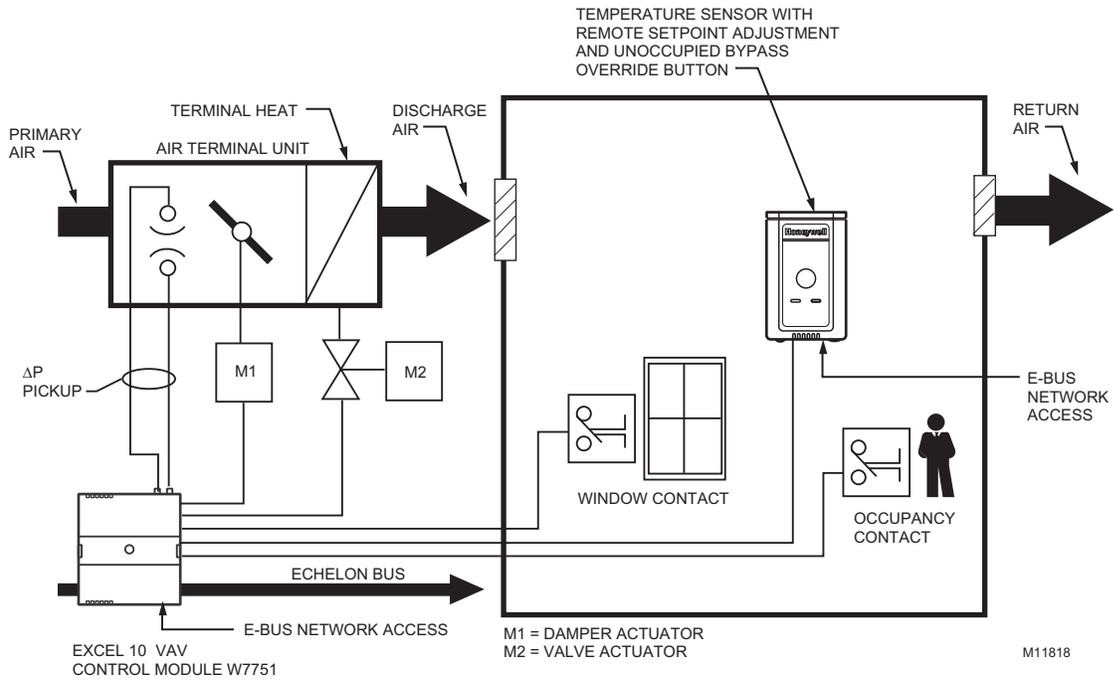


Fig. 1. Typical W7751B,D,F VAV box control application.

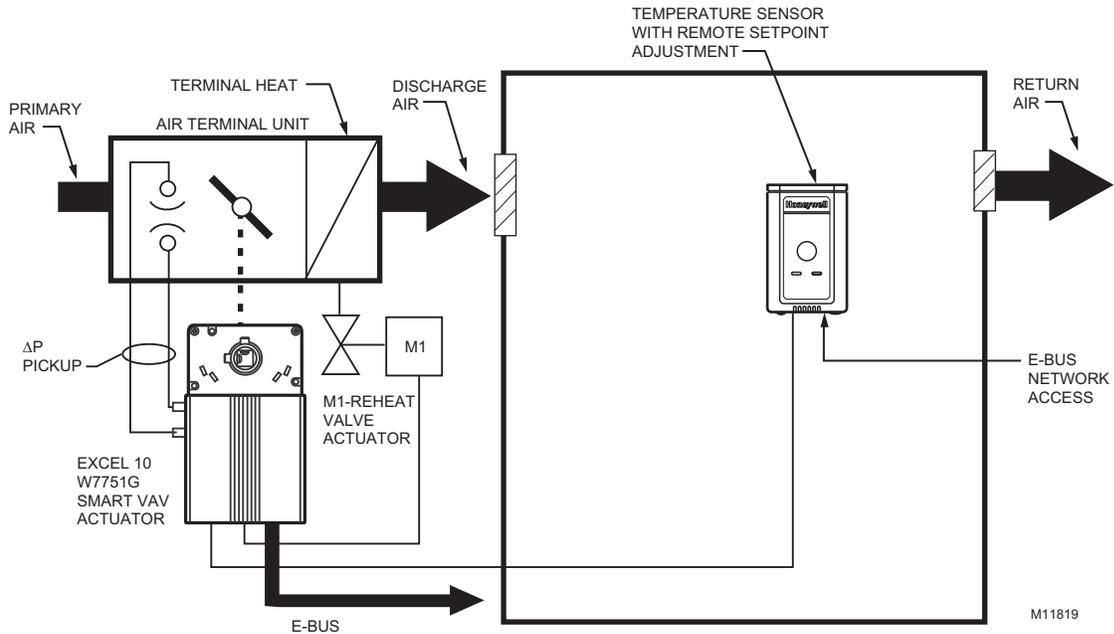


Fig. 2. Typical W7751H Smart VAV Actuator box control application.

Table 1. Excel 10 VAV Box Controller Capability.

Excel 10 VAV Box Controller Capability	W7751B,D,F	W7751H	W7751J
Fan			
None	X	X	X
Series	X	X	X
Parallel - Temp	X	X	X
Parallel - Flow	X	X	—
Parallel - PWM	X	X	X
Reheat			
None	X	X	X
One Stage Reheat	X	X ^b	X ^b
Two Stages Reheat	X	X ^b	X ^b
Three Stages Reheat	X	—	—
One Stage Periph	X	X ^b	X ^b
Floating Reheat (Two outputs)	X	X ^b	X ^b
Floating Periph (Two outputs)	X	X ^b	X ^b
Floating Reheat then Periph (Four outputs)	X	—	—
Floating Periph then Reheat (Four outputs)	X	—	—
PWM Reheat (One output)	X	X ^b	X ^b
PWM Periph (One output)	X	X ^b	X ^b
PWM Reheat then Periph (Two outputs)	X	X ^b	X ^b
PWM Periph then Reheat (Two outputs)	X	X ^b	X ^b
Exhaust Tracking			
Disabled	X	X	—
Enabled	X	X	—
Occupancy Sensor			
None	X	X	X
Connected	X	— ^a	— ^a
Window Contact			
None	X	X	X
Connected	X	— ^a	— ^a
Wall Module Configuration			
Local	X	X	X
Shared	X	X	X
Wall Module Type			
Sensor Only	X	X	Sensor Only
Wall Module Type			
Sensor and Setpoint	X	X	Sensor and Setpoint

Excel 10 VAV Box Controller Capability	W7751B,D,F	W7751H	W7751J
Sensor, Setpoint and Bypass	X	X	Sensor, Setpoint and Bypass
Sensor and Bypass	X	X	Sensor and Bypass
Exhaust Tracking			Exhaust Tracking
Air Temperature Sensor			
20K ohm air temperature sensors can be used in conjunction with wall modules. (Either a wall module or an air temperature sensor can be used with the W7751H, but not both.)	X	X	
Dual Duct Pressure Independent			
Flow mixing Cold and hot duct flow pickups	X ^c	X ^c	
Without flow mixing Cold and hot duct flow pickups	X ^c	X ^c	
Constant volume Cold and hot duct flow pickups	X ^c	X ^c	
With cold duct pickup only	X	X	
Constant volume with discharge pickup only	X ^d	X ^d	
Dual Duct Pressure Dependent			
With flow mixing	X	X	
Without flow mixing	X	X	

^a Available only via the network for the W7751H.

^b The W7751H Smart VAV Actuator provides damper control and two configurable outputs available for two stages of reheat, floating reheat (requires two outputs), PWM Reheat or Periph (one output required), PWM Reheat and Periph (two outputs required) or one stage of reheat or Periph (can be PWM also) and a serial or parallel fan.

^c These applications require two W7751 Excel 10 controllers per zone.

^d Flow sensor in discharge air. The temperature control loop controls the cool damper position and the flow controls adjust the heating damper position.

Control Provided

The W7751B,D,F,H,J Controllers are primarily intended for pressure independent, single or dual-duct VAV box control. Pressure independent control specifies that the individual zone terminal unit has a means for maintaining a consistent volume of air into the zone regardless of the input static pressure. The controller modulates the air flow into the zone to satisfy the Zone Temperature Setpoint. Minimum Air Flows

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are maintained except during emergency strategy periods or during building Unoccupied periods if using physical position stops, a MIN/MAX air flow is always maintained (see Table 2).

Pressure dependent control specifies that the damper position is controlled by space temperature only and not by a measurement of air flow volume. The amount of air delivered to the zone at any given damper position is dependent on the static pressure in the supply air duct (physical position stops, range stop pins, are used to keep the damper at a fixed position).

VAV systems generally only provide cool air to the zones; therefore, the W7751 Controller provides additional outputs for control of heating systems such as reheat coils for Heat mode or Morning warm-up mode operation. The heating equipment can be staged-resistive heating, staged 2-position (solenoid) valve, or modulated steam or hot water valve.

The possible modes of operation are listed in Table 2.

Table 2. Modes Of Operation For Excel 10 VAV Controller

Mode	Description	Events Causing a Controller to Switch to This Mode
Effective Occupancy		
OCCUPIED ^a	Controller is in Occupied mode.	Any of the following: Network input (nviTodEvent) containing time-of-day schedule flag from either an Occupancy Sensor Digital Input, or from the Network input (nviManOcc) for manual override to OCCUPIED mode.
STANDBY ^a	Controller is in Standby mode.	Network input (nviTodEvent) containing time-of-day schedule flag from the network must be OCCUPIED and the Occupancy Sensor Digital Input must be UNOCCUPIED.
UNOCCUPIED	Controller is in Unoccupied mode.	Network input (nviTodEvent) containing time-of-day schedule flag from the from either an Occupancy Sensor Digital Input, or from the Network input (nviManOcc) has a value of UNOCCUPIED.
Override Modes		
OCCUPIED ^a	Controller is in Occupied mode.	Network input (nviTodEvent) containing time-of-day schedule flag from the Network input (nviManOcc) for manual override to OCCUPIED mode.
UNOCCUPIED	Controller is in Unoccupied mode.	Network input (nviTodEvent) containing time-of-day schedule flag from the network input (nviManOcc) has a value of UNOCCUPIED.
BYPASS	User-initiated Bypass of the Unoccupied mode.	Digital input (Bypass pushbutton) has been pressed, and the Bypass duration timer has not yet expired, or the network input DestManualOcc has a value of BypassTime.
NOT ASSIGNED	No Bypass action.	No Override input received.
Operational Modes		
START-UP AND WAIT (followed by) FLOAT_OUT_SYNC	Flow Diversity on power-up provides a staggered start sequence to evenly apply the load to the supply fan and electrical system.	These modes occur on controller power-up, and after downloading to the controller from LONSPEC or going to auto mode to manual mode (NviManOcc). Temperature and flow control loops are disabled.
COOLING	The Excel 10 VAV Controller is controlling the Cooling mode.	Network input (DestHvacMode) containing AHU operational mode information from other LONWORKS Bus controllers that have the value of COOL/AUTO.
HEATING	The Excel 10 VAV Controller is controlling the Heating mode.	Network input (DestHvacMode) containing AHU operational mode information from other LONWORKS Bus controllers that have the value of HEAT/AUTO.
REHEAT	The Excel 10 VAV Controller is controlling the Reheating mode.	Network input (DestHvacMode) has the value of AUTO, so that when cool air is supplied to the box and the space temperature is below the Heating Setpoint, causes the Excel 10 VAV Controller control algorithm to energize the Reheat coil(s).
MORNING WARM-UP	The main AHU is supplying warm air and the box damper is set at (WarmupDmprPos)	Network input (DestHvacMode) containing AHU operational mode information from LONWORKS BUS controllers that have the value of MORNING WARM-UP.
NIGHT PURGE	The main AHU is supplying fresh (100 percent outdoor) air, and box damper is set at (PurgeDmprPos)	Network input (DestHvacMode) containing AHU operational mode information from LONWORKS Bus controllers that have the value of NIGHT PURGE.
PRESSURIZE	The box damper is set at (PressDmprPos)	Network input (DestHvacMode) containing smoke control signal from LONWORKS Bus controllers that have the value of PRESSURIZE.
DEPRESSURIZE	The box damper is set at (DepressDmprPos)	Network input (DestHvacMode) containing smoke control signal from LONWORKS Bus controllers that have the value of DEPRESSURIZE.
FLOW TRACKING	Temperature control is turned off. The box maintains a Flow Setpoint based on the sum of all of the controllers supplying the zone (the SrcBoxFlow controller provides other controllers with DestFlowTrack input).	Configuration parameter is box type (Flow_Tracking). FlowTrackOfst (Flow Offset) determines the differential between the boxes that are the supply air flow and the exhaust air flow.

^a Mode is not available for the W7751H,J.

Table 2. Modes Of Operation For Excel 10 VAV Controller (Continued)

Mode	Description	Events Causing a Controller to Switch to This Mode
MANUAL POSITION	Box damper is set to (ManDamp).	Typically this is done through LONSPEC by setting the point DamperPos to Manual mode.
Operational Modes		
MANUAL FLOW	Air Flow Setpoint is set to (DestManFlowSpt).	Typically this is done through LONSPEC by setting the point SupplyFlow to Manual mode.
MANUAL	See comments for FlowManState in Appendix D, Table D7. LONMARK.	—
CLOSED ^a	Indicates a window is open; box damper is set to (WinOpnDmprPos).	The (Window) Digital Input contacts are open and the controller is configured for a window sensor.
SELF TEST	Control algorithm is disabled; various hardware tests can be performed.	The variable (TestMode) was set to TESTING. NOTE: This mode is available in all Excel 10 VAV Controller versions (W7751B,D,F,H, and J).
I/O TEST	Control algorithm is disabled, various hardware tests can be performed (see I/O Test Mode, Application Step 7. Troubleshooting).	The I/O test pin/pad is shorted (see the I/O Test Mode, Application Step 7. Troubleshooting). NOTE: The I/O Test Mode is not available on the W7751H or J Smart VAV Actuators.
FLOAT_OUT_SYNC	Controller is synchronizing actuators.	Control loops are temporarily suspended. NOTE: For controllers that enter the Unoccupied mode, its actuators are controlled and resynchronize during a time frame of 125 percent of the actuators motor speed; for example, if an actuators motor speed is 90 seconds, the actuator would resynchronize after 112 seconds once its controller entered the Unoccupied mode. If a controller remains in continuous Occupied mode, the actuators that it controls resynchronize approximately once every 24 hours based on the CPU clock of the controller. If a controller remains in continuous Occupied mode it resynchronizes randomly during this time period of one hour.
DISABLED	Shutoff control algorithm	Network input (NviManOcc) containing AHU operational mode information from other LONWORKS Bus controllers that have the value of DISABLED.

^a Mode is not available for the W7751H,J.

Products Covered

This System Engineering Guide describes how to apply the Excel 10 family of W7751 VAV Controllers and related accessories to typical applications. The specific devices covered include:

- W7751B,D,F,H,J Controllers.
- T7770A through D Wall Modules.
- T7560A,B Digital Display Wall Module.
- Q7752A Serial Adapter.
- Q7740A,B FTT Repeaters.
- 209541B FTT Termination Module.

Organization of Manual

This manual is divided into three basic parts: the Introduction, the Application Process, and the Appendices that provide supporting information. The organization of the manual assumes a project is being engineered from start to finish. If an operator is adding to, or is changing an existing system, the Table of Contents can provide the relevant information.

Applicable Literature

The following list of documents contains information related to the Excel 10 family of VAV Box Controllers.

Form No.	Title
74-2076C	Excel 10 Technical Literature Collation
74-2942	Excel 10 W7751B,D,F Controller Specification Data
74-2953	Excel 10 W7751H Smart VAV Actuator Specification Data
74-2697	T7770A through G Wall Module Specification Data
74-2868	Excel 10 C7770A Air Temperature Sensor Specification Data
74-2954-1	Excel 10 Q7752A Serial Interface Specification Data
74-2858	Excel 10 Q7740A,B FTT Repeaters Specification Data
74-2937	Excel LONSPEC User's Guide
74-3097	T7560A,B Digital Wall Module Specification Data
95-7504	Excel 10 W7751B,D,F Controller Installation Instructions
95-7538	T7770A,B,C,D,E,F,G Wall Module Installation Instructions
95-7511	Excel 10 Q7752A Serial Interface Installation Instructions
95-7516	Excel 10 SLTA Connector Cable Installation Instructions
95-7555	Excel 10 Q7740A,B FTT Repeaters Installation Instructions
95-7554	Excel 10 209541B Termination Module Installation Instructions
95-7620	T7560A,B Digital Wall Module Installation Instructions

Product Names

The W7751 Controller is available in five models:

- W7751B VAV Box Controller for OEM mounting on a VAV box.
- W7751D VAV Box Controller mounts on either a standard 4 in. by 4 in. electrical junction box or a standard 5 in. by 5 in. electrical junction box (wire passes through junction box to wiring subbase). It can also be snapped onto standard EN 50 022 DIN rail 35 mm by 7.5 mm (1-3/8 in. by 5/16 in.).
- W7751F VAV Box Controller mounts into either a panel with screws or snaps onto standard EN 50 022 DIN rail 35 mm by 7.5 mm (1-3/8 in. by 5/16 in.). Wires are terminated externally to wiring subbase.
- W7751H and J Smart VAV Actuators are VAV controllers that are factory mounted to an ML6161B1000 Actuator. The actuator/controller assembly is field mounted to the VAV box damper shaft similar to the mounting of a standard actuator, and the controller wiring is terminated to the screw terminals that are located under a snap-on cover. The W7751J does not contain a microbridge airflow sensor and therefore supports pressure dependent applications only.

The T7770 Wall Module is available in five models:

- T7770A1006 Wall Module with temperature sensor. Use with Excel 5000 or Excel 10 Controllers.
- T7770A2004 Wall Module with temperature sensor and LONWORKS Bus network connection.
- T7770B Wall Module with temperature sensor, setpoint, and LONWORKS Bus network connection.
- T7770C Wall Module with temperature sensor, setpoint, Bypass button and LED, and LONWORKS Bus network connection.
- T7770D Wall Module with temperature sensor, Bypass button and LED, and LONWORKS Bus network connection.

NOTE: The T7770B,C Models are available with a relative scale plate adjustable in LonSpec $\pm 9^{\circ}\text{F}$ ($\pm 5^{\circ}\text{C}$).

The T7560 is available in two models:

- T7560A Wall Module with temperature sensor, Setpoint adjustment, Bypass button, and Fan override button.
- T7560B Wall Module with temperature/humidity sensor, Setpoint adjustment (temperature), Bypass button, and Fan override button.

Other products:

- Q7752A Serial Adapter.
- Q7740A,B FTT Repeaters
- 209541B FTT Termination Module
- ML6161 Series 60 Damper Actuator.
- M6410A Series 60 Valve Actuator (use with V5812 or V5813 Valves).
- ML684A Series 60 Versadrive Valve Actuator (use with V5011 and V5013 Valves).
- ML6464A Direct Coupled Damper Actuator, 66 lb.-in. torque, Series 60.
- ML6474 Direct Coupled Damper Actuator, 132 lb.-in. torque, Series 60.
- ML6185A Direct Coupled Damper Actuator, Spring Return, Series 60.
- ML7984B Direct Coupled Valve Actuator, PWM (use with V5011 or V5013F,G Valves).

- AK3781 LONWORKS Bus (non-plenum): 22 AWG (0.325 mm²) twisted pair solid conductor, non-shielded wire (one twisted pair).
- AK3782 LONWORKS Bus (non-plenum): 22 AWG (0.325 mm²) twisted pair solid conductor, non-shielded wire (two twisted pairs).
- AK3791 LONWORKS Bus (plenum): 22 AWG (0.325 mm²) twisted pair solid conductor, non-shielded wire (one twisted pair).
- AK3792 LONWORKS Bus (plenum): 22 AWG (0.325 mm²) twisted pair solid conductor, non-shielded wire (two twisted pairs).

Agency Listings

Table 3 provides information on agency listings for Excel 10 products.

Table 3. Agency Listings

Device	Agency	Comments
W7751B,D,F Controllers	UL	Tested and listed under UL916 (file number E87741).
	CSA	Listed (LR95329-3).
	FCC	Complies with requirements in FCC Part 15 rules for a Class A Computing Device. Operation in a residential area may cause interference to radio or TV reception and require the operator to take steps necessary to correct the interference.
	FCC	Complies with requirements in FCC Part 15 rules for a Class B Computing Device. Operation in a residential area can cause interference to radio or TV reception and require the operator to take steps necessary to correct the interference.
W7751H,J Smart VAV Actuators	UL	Tested and listed under UL916 (file number E87741).
	cUL	Tested and listed under UL916 (file number E87741).
	CE	General Immunity per European Consortium standards EN50081-1 (CISPR 22 Class B) and EN 50082-1:1992 (based on Residential, Commercial, and Light Industrial). EN 61000-4-2 IEC 1000-4-2 (IEC 801-2) Electromagnetic Discharge. EN 50140, EN 50204 IEC 1000-4-3 (IEC 801-3) Radiated Electromagnetic Field. EN 61000-4-4 IEC 1000-4-4 (IEC 801-4) Electrical Fast Transient (Burst). Radiated Emissions and Conducted Emissions. EN 55022:1987 Class B. CISPR-22: 1985.
	FCC	Complies with requirements in FCC Part 15 rules for a Class B Computing Device. Operation in a residential area may cause interference to radio or TV reception and require the operator to take steps necessary to correct the interference.
T7770A-D Wall Modules	UL	(Not applicable.)
	CSA	(Not applicable.)
	FCC	(Not applicable.)
T7560	CE	Emissions; EN50081-1, EN55022 (CISPR 22 Class B), Immunity 50082-1
	UL and cUL	Tested and listed under UL916, S8L9 Energy Management Equipment.
	FCC	Complies with requirements in FCC Part 15 rules for a Class B Computing Device.

Abbreviations and Definitions

AHU -Air Handling Unit; the central fan system that includes the blower, heating equipment, cooling equipment, ventilation air equipment, and other related equipment.

Box -A VAV terminal unit box.

CAV -Constant Air Volume; a TUC that maintains a fixed air flow through the box.

CO -Carbon Monoxide. Occasionally used as a measure of indoor air quality.

CO₂ -Carbon Dioxide. Often used as a measure of indoor air quality.

cUL -Underwriters Laboratories Canada.

CVAHU -Constant Volume AHU; refers to a type of air handler with a single-speed fan that provides a constant amount of supply air to the space it serves.

DDF -Delta Degrees Fahrenheit.

DDWM -Digital Display Wall Module.

D/X -Direct Expansion; refers to a type of mechanical cooling where refrigerant is (expanded) to its cold state, within a heat-exchanging coil that is mounted in the air stream supplied to the conditioned space.

Echelon® - The company that developed the LON® bus and the Neuron® chips used to communicate on the LONWORKS Bus.

Economizer - Refers to the mixed-air dampers that regulate the quantity of outdoor air that enters the building. In cool outdoor conditions, fresh air can be used to supplement the mechanical cooling equipment. Because this action saves energy, the dampers are often referred to as *economizer dampers*.

EMI -Electromagnetic Interference; electrical noise that can cause problems with communications signals.

EMS -Energy Management System; refers to the controllers and algorithms responsible for calculating optimum operational parameters for maximum energy savings in the building.

EEPROM - Electrically Erasable Programmable Read Only Memory; the variable storage area for saving user setpoint values and factory calibration information.

EPROM - Erasable Programmable Read Only Memory; the firmware that contains the control algorithms for the Excel 10 Controller.

Firmware - Software stored in a nonvolatile memory medium such as an EPROM.

Floating Control - Refers to Series 60 Modulating Control of a valve or damper. Floating Control utilizes one digital output to pulse the actuator open, and another digital output to pulse it closed.

IAQ -Indoor Air Quality. Refers to the quality of the air in the conditioned space, as it relates to occupant health and comfort.

I/O -Input/Output; the physical sensors and actuators connected to a controller.

I x R -I times R or current times resistance; refers to Ohm's Law: $V = I \times R$.

K -Degrees Kelvin.

Level IV - Refers to a classification of digital communication wire. Formerly known as UL Level IV, but *not* equivalent to Category IV cable. If there is any question about wire compatibility, use Honeywell-approved cables (see Step 5 Order Equipment section).

LONWORKS Bus -Honeywell implementation of Echelon® LONWORKS® network for communication among Excel 10 Controllers.

LONWORKS® Bus Segment - One LONWORKS Bus section containing no more than 60 Excel 10s. Two segments can be joined together using a router.

NEC -National Electrical Code; the body of standards for safe field-wiring practices.

NEMA -National Electrical Manufacturers Association; the standards developed by an organization of companies for safe field wiring practices.

Node - A Communications Connection on a network; an Excel 10 Controller is one node on the LONWORKS Bus network.

NV -Network Variable; an Excel 10 parameter that can be viewed or modified over the LONWORKS Bus network.

OEM -Original Equipment Manufacturer; the company that builds the VAV boxes.

PC -An IBM compatible Personal Computer with 386 or higher processor and capable of running Microsoft® Windows® Version 3.1.

Pot -Potentiometer. A variable resistance electronic component located on the T7770B,C Wall Module; used to allow user-adjusted setpoints to be input into the Excel 10 Controller.

PWM -Pulse Width Modulated output; allows analog modulating control of equipment using a digital output on the controller.

RTD -Resistance Temperature Detector; refers to a type of temperature sensor whose resistance output changes according to the temperature change of the sensing element.

Subnet - LONWORKS Bus segment.

TOD -Time-Of-Day; the scheduling of Occupied and Unoccupied times of operation.

TCU -Terminal Control Unit; industry can refer to VAV box controllers such as the Excel 10 VAV Controller as TCUs.

TUC -Terminal Unit Controller; industry can refer to VAV box controllers such as the Excel 10 VAV Controller as TUCs.

VA -Volt Amperes; a measure of electrical power output or consumption as applies to an ac device.

Vac -Voltage alternating current; ac voltage rather than dc voltage.

VAV -Variable Air Volume; refers to either a type of air distribution system, or to the W7751 Excel 10 VAV Box Controller that controls a single zone in a variable air volume delivery system.

VOC -Volatile Organic Compound; refers to a class of common pollutants sometimes found in buildings. Sources include out-gassing of construction materials, production-line by-products, and general cleaning solvents. A VOC is occasionally used as a measure of indoor air quality.

W7751 - The model number of the Excel 10 VAV Box Controllers (also see VAV).

Wall Module - The Space Temperature Sensor and other optional controller inputs are contained in the T7560 or T7770 Wall Modules.

Zone Control Definitions

Variable Air Volume ATUs

Variable air volume (VAV) ATUs are commonly called VAV boxes. Each VAV box has a controller that controls the temperature of a room or zone by modulating a damper in the VAV box to vary the amount of conditioned air supplied to the zone rather than changing the temperature of the conditioned air. They are used in larger buildings that have many zones along with a central air handling fan that supplies conditioned air via a pressurized main air duct system. The central air handling fan has a separate equipment controller that controls discharge air temperature, humidity, and supply duct static pressure.

Air Terminal Unit Control

Air terminal units (ATUs) regulate the amount of conditioned air delivered to satisfy the temperature requirements of a room or space. ATUs are classified by air handling system design and are available in several configurations. ATUs may be of variable air volume or constant volume design, and may be used in single-duct or dual-duct air handling systems. ATU controls can be as basic as a room thermostat controlling a damper or a more complex direct digital controller operating a

damper, a terminal fan and enabling a reheat coil. In all cases, each ATU has a controller that is used to control the environment of the room or space.

Pressure-Dependent/Independent Control

Static pressure variations in an air handling system can affect terminal unit operation. Pressure-dependent terminal units are affected by changing duct static pressures because their damper position is determined by space temperature only. They may have mechanical or electric minimum and maximum air flow limits. Pressure-independent terminal units can automatically adjust to duct pressure changes because they contain air flow sensors and the controllers compensate for pressure changes in the main air distribution system. The damper position in pressure independent terminal units is determined by both space temperature and air flow volume.

Variable Air Volume ATUs (VAV)

Variable air volume (VAV) ATUs are commonly called VAV boxes. Each VAV box has a controller that controls the temperature of a room or zone by modulating a damper in the VAV box to vary the amount of conditioned air supplied to the zone rather than changing the temperature of the conditioned air. They are used in larger buildings that have many zones along with a central air handling Unit (AHU) that supplies conditioned air via a pressurized main air duct system.

Single Duct Variable Air Volume (VAV) Systems

Single duct VAV systems are used in over 80 percent of the VAV applications and employ one main supply air duct from the central air handling system. The air handling unit supplies cool air virtually one hundred percent of the time, with the only exception being a morning warm-up cycle that is used in buildings that are not continuously occupied, that temporarily raises the discharge air temperature of the central air handling system to quickly warm the building from its unoccupied zone temperatures to the occupied zone temperatures. Since the central air handling system is usually supplying cool air, single or multiple electric reheat coils or a modulating hot water (hydronic) reheat coil are often added in the VAV box discharge air duct to reheat the cool air when the zone becomes too cold. VAV boxes with reheat coils typically have a series or parallel fan in the VAV box to ensure air flow across the coil in the heating mode.

Pressure-Dependent Throttling VAV Boxes

Pressure dependent throttling VAV boxes are the simplest and least expensive ATU. A controller modulates a damper actuator according to the temperature in the zone. The pressure dependent VAV box usually has minimum and/or maximum damper position setpoint stops in the controller for limiting air volume. Because the unit is pressure dependent, the volume of air distributed to the zone at any given space temperature varies with the supply duct static pressure at the inlet of the VAV box. Maintaining a stable duct static pressure is important for proper operation and proper setting of the minimum damper position setpoint stop is essential for adequate circulation. When reheat coils and/or finned tube radiation are used the controller will set the damper position at a minimum position during the heating mode to ensure some air flow into the space and optimize heat transfer from the reheat coil. Pressure dependent VAV boxes are used in smaller buildings or in areas of larger buildings where the supply duct static pressure is low and stable.

Pressure-Independent VAV Boxes

Pressure-independent or variable constant-volume VAV boxes are essentially air flow control devices that deliver a constant volume of air to a conditioned space at a given temperature despite a varying supply duct static pressure. An air flow sensor in the inlet of the VAV box is used to measure the volume of air and the *VAV box controller resets the air flow volume setpoint as the thermal load changes in the space.* Therefore, a pressure independent VAV box controller provides two control sequences; zone temperature control and terminal unit air flow control. The controller usually has a minimum air flow setpoint to maintain air flow at light load conditions and a maximum air flow setpoint to limit the air flow to meet the design conditions for the zone. A single zone sensor can be used to control multiple VAV boxes with differing volume ratings. When reheat coils and/or finned tube radiation are used with this unit the controller will lower the air flow setpoint during the heating mode to ensure air flow into the room and optimize heat transfer from the reheat coil. Pressure independent VAV boxes are used in buildings with larger air handling systems that have constant duct static pressure fluctuations due to the large number of zones.

Series Fan Powered VAV Boxes

Series Fan-powered VAV boxes are similar to pressure dependent and/or pressure independent VAV boxes, except they include an integral fan in series with the VAV box discharge duct that recirculates space air at constant volume and enhances the air distribution in the zone. Primary air is modulated by the VAV box damper to meet space demand for cooling and as primary air modulates down, more plenum air is drawn in by the fan to maintain a constant discharge volume to the zone. Typically the series fan is on continuously during occupied hours, or it can be programmed to be activated as primary air decreases to ensure adequate air circulation. In addition to enhancing air distribution, the units serving the perimeter area of a building usually include a reheat coil that is sequenced with the primary air damper to supply heat when required. When the primary air system is not operating (nighttime or unoccupied control mode), the night operating mode of the controller enables the fan and the reheat coil to maintain the lower unoccupied temperature setpoint in the space. Series Fan Powered VAV boxes can be pressure independent or pressure dependent.

Parallel Fan Powered VAV Boxes

Parallel Fan Powered VAV boxes or Bypass Fan Induction Terminal Units are similar to Series Fan-powered VAV terminal units, except the fan is located in the return plenum and does not run continuously during occupied hours. When the zone temperature is low and the need for primary air decreases, the controller modulates the primary air damper to a minimum and enables the fan, which recirculates warm air from the return plenum into the zone acting as the first stage of reheat. If a reheat coil is used the fan is cycled on when the reheat coil is enabled. As the space warms, the reheat valve closes and the fan cycles off as the primary air damper opens to allow delivery of conditioned air from the air handling system. When heating is required in the unoccupied mode, the fan at the central air handling system remains off, the VAV box fan and the reheat coil are enabled and the zone is heated to a reduced night setback temperature using air from the return air plenum. Parallel Fan Powered VAV boxes can be pressure independent or pressure dependent.

Induction VAV Boxes

Induction VAV boxes use induced return air as the reheat medium which means no parallel fan is present in the VAV box. Induction VAV boxes are usually installed above the ceiling and draw return air from the plenum created by a false ceiling. The VAV box controller uses an air flow sensor for controlling air flow and a room sensor for controlling room temperature similar to pressure independent VAV boxes. The volume of air coming through the primary damper is controlled by positioning both dampers simultaneously so that as the primary air damper closes, the return air damper opens. Return air is thus drawn into the unit and recirculated into the space. Like pressure independent VAV boxes the controller resets the air flow setpoint of the controller as the thermal load changes in the conditioned space. For extremely cold design conditions, a reheat coil can be added.

The induction VAV ATU maintains satisfactory air motion at lower loads than a throttling VAV box can, however, the wide use of Parallel Fan Powered VAV boxes has now limited the use of Induction VAV boxes.

Single-Duct Constant Volume Zone Reheat Air Terminal Units

Single-Duct Constant Volume Zone Reheat Systems are used in low static pressure systems and have a heating coil (hot water, steam, or electric) in the branch supply duct to each zone. The central air-handling unit supplies constant temperature air and a manual balancing damper in each zone is set in a fixed position to determine the amount of air delivered to that zone. The volume of air delivered to each zone will change as the static pressure of the supply duct changes, however, in low static pressure systems the changes in the supply duct static pressure are small and do not have a dramatic effect on the amount air delivered to the zone. The control strategy used in single zone reheat systems is simple and involves activating electric heat or positioning a valve in conjunction to the zone temperature. In most cases this is accomplished using a simple space thermostat. However, direct digital controllers can be used in these cases to control multiple zone valve positions the reheat coil valve (or electric heating elements) as required to maintain space condition.

Dual Duct Air Handling Systems

In a dual-duct air handling system, supply air is divided at the central fan and hot air and cold air flow through separate ducts to the perimeter zones in the building. Dual-duct terminal units are essentially mixing boxes with two supply inlets and one discharge outlet. The air is allowed to mix in the mixing box section and is discharged out of a single duct into the zone. Since a source of heating is available reheat coils are not used in the zone. Basic dual-duct mixing systems were not economical because supply air was cooled and heated year round and modern energy codes prohibited their use in many cities in the U.S. except in critical applications like hospitals, nursing homes, etc. However, with direct digital controllers and networked systems the individual zone data can be used to reset hot and cold duct temperatures as needed, allowing dual duct systems to be used more often in today's applications. Dual duct systems are often used in conjunction with single duct systems in the same building.

Variable Constant Volume (Zero Energy Band) Dual-Duct VAV Boxes

Variable Constant Volume (Zero Energy Band) Dual-Duct VAV Boxes have inlet dampers (with individual damper actuators and air flow sensors) on the cooling and heating supply ducts. The air flow is pressure independent and the Dual Duct VAV Box controller uses the zone temperature to determine the required flow of hot and cold air from the respective ducts into the mixing box and resets the hot duct and cold duct air flow setpoints in sequence as space load changes. The Zero Energy Band (ZEB) is an energy conservation technique that allows temperatures to float between programmable settings to prevent the consumption of heating or cooling energy while the temperature is in this range. As space temperature rises to approach the controller setpoint, the hot air flow volume drops to zero. If space temperature continues to rise through the ZEB, the output signal from the controller modulates the cold-air damper open. The controller maintains adjustable minimum flows for ventilation, with no overlap of damper operations, during the ZEB when neither heating nor cooling is required. For example, if a zone had a setpoint of 74 degrees and a zero energy band of 2 degrees then the zone temperature would be allowed to float between 73 degrees and 75 degrees before the controller would use hot air to heat the zone or cool air to cool the zone. When the ZEB technique is properly used the comfort of the occupants is not sacrificed in the process of saving energy.

Dual Duct Constant Volume Systems

DUAL-DUCT MIXING BOX TERMINAL UNITS

Dual-duct mixing box terminal units generally apply to low-static pressure systems that require large amounts of ventilation. The warm duct damper and the cool duct damper are linked to operate in reverse of each other from a single damper actuator. The controller positions the mixing dampers through a damper actuator to mix warm and cool supply air to maintain space condition. Discharge air quantity depends on the static pressure in each supply duct at that location.

DUAL-DUCT CONSTANT VOLUME MIXING BOX TERMINAL UNITS

Dual-duct constant volume mixing box terminal units are typically used on high-static-pressure systems where the air flow quantity to each space is critical. The units are the same as those described in the previous paragraph, except that they include either an integral mechanical constant volume regulator or an air flow constant volume control furnished by the unit manufacturer to change the damper position to maintain a constant air flow volume with changes in duct static pressure.

Variable Volume/Variable Temperature (VVT)

VVT systems are also called commercial zoning systems and use a constant volume air supply (roof top unit, heat pump, small air handler) with heating, cooling and economizer functions and vary the flow rates and supply-air temperature into smaller, damper-controlled zones through a single duct distribution system. Each zone damper is modulated based on space temperature. However, damper control is based only on zone temperature and there is no flow control at the zone level as there is in a pressure independent variable air volume (VAV) system. Typically, the zone damper is modulated using an analog signal, providing excellent zone temperature control. A method of providing feedback of zone demand is

provided which allows a controller at the rooftop to provide the minimum required amounts of heating and cooling (using economizer when acceptable) based on zone demand.

Because a number of zone dampers can possibly be closed, there needs to be a way to relieve pressure in the supply duct. A bypass damper is normally added in a duct between the supply and return ducts to relieve pressure. The pressure relief damper is normally controlled by sensing supply duct pressure and opening to vent supply air directly to return. This is one difference between a commercial zoning system and true VAV. A true VAV air handler actually varies air volume through the blower.

VVT makes it possible to operate a single-zone heating/cooling unit with multiple-zones and is often used in smaller buildings. Small buildings are not appropriate for VAV systems because the heating and cooling loads are not large enough for a VAV system to operate properly. VVT systems also cost less than VAV systems due to the use of constant volume packaged units, lower pressure ductwork, and they often do not require expensive perimeter heat. The main difference between VAV and VVT is the fact that VAV systems vary the amount of air entering a zone and not the temperature, where a VVT system varies both the amount of air and the temperature of the air entering the zone.

Single Zone Rooftop Air Handling Unit Control (CVAHU)

Single-zone systems use a Constant Volume Air-Handling Unit (CVAHU) which are usually factory-packaged units mounted on the rooftop of the building, however, single zone air handling units can also be located in a mechanical room of buildings. Single zone units are used in smaller buildings, buildings that have a uniform heating/cooling load in large open zones, or in zones that have special comfort requirements that are different from other areas of the building. The building must also have the space available for the associated air handling equipment. Typical installations include; office/warehouse buildings, large open buildings such as supermarkets, restaurants, and ballrooms and lobbies of large buildings and hotels. Since single zone units are associated with only one zone, many single zone air handling units can be installed in a building. Fan volume control, as found in Variable Air Volume systems is not required, because fan volume and duct static pressure are set by the manufacturer to meet the design needs of the zone.

TEMPERATURE AND VENTILATION CONTROL

A single space controller or thermostat controls the heating coil, ventilation dampers, and cooling coil in sequence as thermal load varies in the conditioned space. On rooftop mounted units the heating coils are typically electric and the cooling is by a self contained air-conditioning system using direct expansion cooling coils. However, single zone air handling systems that are located in a mechanical room of a building often employ hot water (hydronic) heating coils and use chilled water coils for cooling. The ventilation dampers (Outdoor air, Return air, and Exhaust air) are controlled to use outdoor air for the first-stage cooling when the conditions are appropriate. When outdoor air temperature or heat content (enthalpy) rises to the point that it can no longer be used for cooling, an outdoor air limit control overrides the signal to the ventilation dampers and moves them to the minimum ventilation position, as determined by the minimum positioning switch or the minimum position setpoint in the controller.

Indoor air quality control is also accomplished with the Single Zone controller using sensors and control strategies that increase the minimum position of the outdoor air damper to allow more fresh air into the building when the indoor air quality is poor. A zero energy band often separates the heating and cooling control ranges, thus saving energy.

Unitary Equipment Control

Unitary equipment includes natural convection units, radiant panels, unit heaters, unit ventilators, fan coil units, and heat pumps. Unitary equipment does not require a central fan. Depending on design, unitary equipment may perform one or all of the functions of HVAC - ventilation, filtration, heating, cooling, humidification and distribution. Unitary equipment frequently requires a distribution system for steam or hot and/or chilled water.

Control of unitary equipment varies with system design. Typically, a room thermostat provides a signal to a controlled device to regulate the unit. The unit may use a day/night thermostat for operation at lower setpoints during unoccupied hours. If the unit has a fan, a time clock may be used to turn the fan off at night, and a night thermostat may be used to control the temperature within night limits. When DDC control is used all of the thermostat and time clock functionality is contained in the controller.

Communications

Refer to LONWORKS Bus Wiring Guidelines form, 74-2865 for complete description of network topology rules.

LONMARK® Functional Profile

W7751 Controllers support the LONMARK® Functional Profile number 8010 VAV Controller, version 1.0 (Fig. 3).

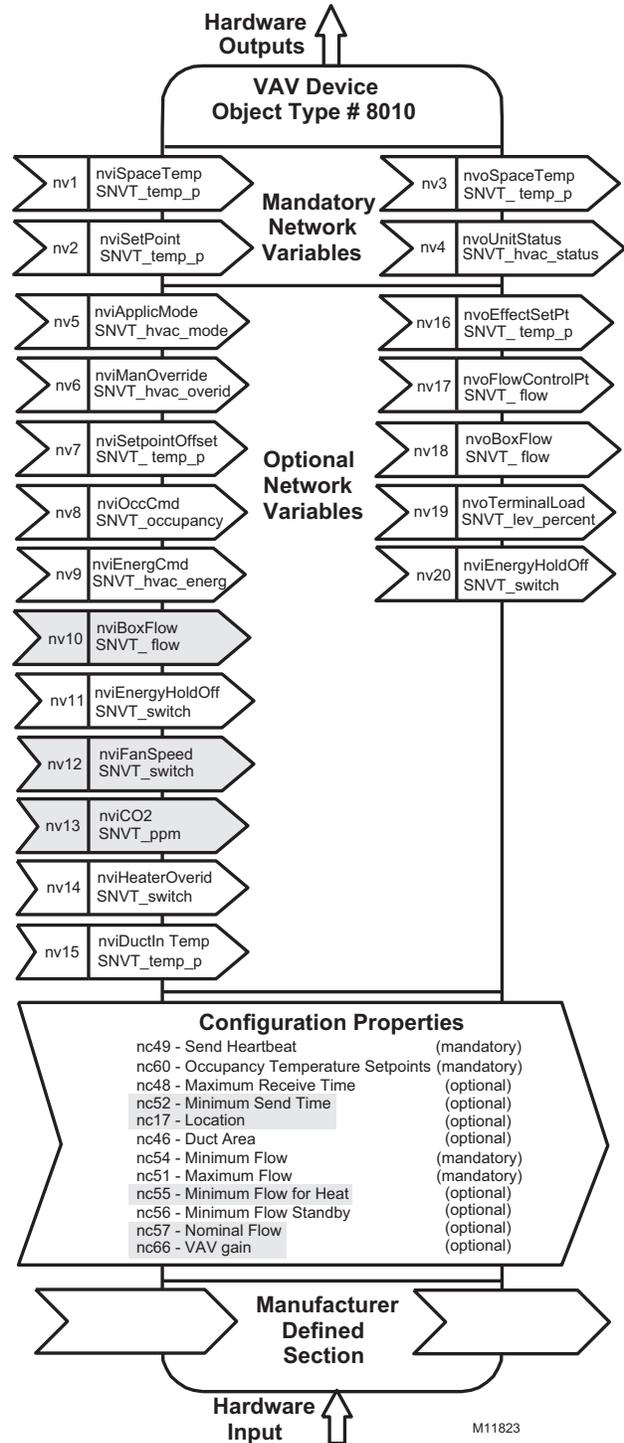


Fig. 3. Functional profile of LONMARK® compliant VAV object details (variables not implemented in Excel 10 VAVII are greyed).

DIGITAL INPUTS

5 total on W7751B,D,F, 1 on the W7751H and J (reserved for the wall module Bypass pushbutton). Dry-contact inputs are sensed using a 9 mA at 4.8 volts detection circuit. It is very important that the device used contains high quality, non-corroding contacts with resistivity that does not degrade; that is, increase over time. Use noble metal (such as gold or silver), pimpled or sealed contacts to assure consistent, long-term operation.

- Wall Module Bypass Pushbutton—Momentary DI (Fixed location - See Appendix B—Sequences of Operation for bypass details.)
- Hardware test (Fixed location - not available on the W7751H and J).
- Three of the following Digital Inputs (DIs) can be configured when using the W7751B,D,F, (not available on the W7751H and J):
- Window Monitor—Contact Closed = Window is Closed
Occupancy Switch—Contact Closed = Room is Occupied;
Contact Open = Room is Unoccupied
Heat/Cool change over—Contact Closed = Heat
Monitoring input—Contact Closed = input off or closed (input reportable on network).

DIGITAL OUTPUTS

8 total on W7751B,D,F (configurable locations), 4 total on W7751H and J (2 fixed position damper outputs and 2 configurable outputs). Configurable digital output options.

- Floating damper open (fixed location on W7751H,J)
- Floating damper closed (fixed location on W7751H,J)
- Reheat types
- Reheat (floating) valve open
- Reheat (floating) valve closed
- PWM
- Stage 1
- Stage 2 or Three stage binary control
- Stage 3 (not available on W7751H,J)
- Peripheral Heating types
- Peripheral heat (floating) valve open
- Peripheral heat (floating) valve closed
- PWM
- Stage 1
- Fan (Series or Parallel)
- On/Off
- PWM
- Auxiliary (On when occupied, Off when unoccupied or Standby)
- Normal (On/Off)
- Pulsed (requires two pairs open and closed)
- Network (up to 2 outputs commanded from the network)

- Normal (On/Off)
- Pulsed (requires two pairs open and closed)

Triac Outputs on the W7751B,D,F Model:

Power ratings: 20 Vac to 30 Vac at 25 mA MIN to 1.0A
MAX current for any voltage.

(For W7751H, a minimum of 25 mA at 20 Vac and a maximum of 400 mA at 30 Vac.)

IMPORTANT

When any device is energized by a Triac, the device must be able to sink a minimum of 25 mA.

NOTE: Triacs sink current to the 24 Vac common (terminals 10 on the W7751B model, or terminals 2 and 4 on the W7751D,F models, or terminal 2 on the W7751H,J models). The controller and all Triac loads must be wired to the same 24 Vac source.

IMPORTANT

If non-Honeywell motors, actuators, or transducers are to be used with Excel 10 Controllers, Triac compatibility must be verified (see previous NOTE).

Configurations**General**

Table 4 lists the general mechanical equipment options available with the W7751 VAV Box Controller. See Table 1 for Excel 10 VAV Box Controller capabilities. All VAV boxes are assumed to have an air flow pickup for connecting to the Microbridge flow through pressure sensor on the Excel 10 VAV Controller except for the W7751J. Also, each box must have a flow-regulating damper that is controlled by a Series 60 (floating) type actuator such as the Honeywell ML6161 or a PWM type actuator.

IMPORTANT

- *The Excel 10 VAV Controller is designed to work with Series 60 (floating) Damper Actuators that have a full stroke damper actuator time between 20 and 600 seconds (0.333 to 10 minutes) or PWM Damper Actuators that have a minimum time (zero percent) of 0.1 second and a maximum overall time of 600 seconds (0.1 second to 10 minutes).*
- *The W7751H Excel 10 VAV Controller is designed to work only with the Series 60 (floating) damper actuator (ML6161B) that has a full stroke damper actuator time of 90 seconds.*

Table 4. Configuration Options Summary For W7751 Controllers.

Option	W7751B,D,F Possible Configurations	W7751H,J Possible Configurations
Fan	1. None	1. None
	2. Parallel Temperature	2. Parallel Temperature
	3. Parallel Flow	3. Parallel Flow ^a
	4. Parallel PWM	4. Parallel PWM
	5. Series	5. Series
Type of Reheat Coil	1. One stage	1. One stage
	2. Two stages or Three Stage Binary	2. Two stages or Three Stage Binary
	3. Three stages	3. Series 60 Modulating electric valve, or pneumatic via transducer.
	4. Series 60 Modulating electric valve, or pneumatic via transducer.	4. Pulse Width Modulating electric valve, or pneumatic via transducer.
	5. Pulse Width Modulating electric valve, or pneumatic via transducer.	5. None
	6. None	
Type of Peripheral Heat^b	1. One stage	1. One stage
	2. Series 60 Modulating electric valve, or pneumatic via transducer.	2. Series 60 Modulating electric valve, or pneumatic via transducer.
	3. Pulse Width Modulating electric valve, or pneumatic via transducer.	3. Pulse Width Modulating electric valve, or pneumatic via transducer.
	4. None	4. None
Window Open Option	1. None	1. None
	2. Local Window Open Digital Input - directly wired to the controller. (Contacts closed means Window Closed.)	
Monitor switch Option	1. None	1. None
	2. Local Monitor switch (general purpose) Digital Input -directly wired to the controller. (Contacts closed means that the switch is closed.)	
Occupancy Sensor Option	1. None	1. None
	2. Local Occupancy sensor Digital Input - directly wired to the controller. (Contacts closed means occupancy sensed.)	2. Network (DestOccSensor signal received via the LONWORKS Bus).
Heat/Cool Changeover switch Option	1. None	1. None
	2. Local Heat/Cool change over switch Digital Input directly wired to the controller. (Contacts closed means select Heat Mode.)	
Wall Module Option	1. Local (direct wired to the box)	1. Local (direct wired to the box)
	2. Shared (wired to another box)	2. Shared (wired to another box)
Wall Module Type	1. Sensor only	1. Sensor only
	2. Sensor and Setpoint adjust	2. Sensor and Setpoint adjust
	3. Sensor, Setpoint adjust and Bypass	3. Sensor, Setpoint adjust and Bypass
	4. Sensor and Bypass	4. Sensor and Bypass
	5. None	5. None
Air Temperature Sensor	1. Discharge Air Temperature	1. Discharge Air Temperature ^c
	2. Supply Air Temperature	2. Supply Air Temperature ^c
	3. None	3. None

^a Not available on the W7751J.

^b If both Reheat and peripheral heat are used in the same application:

- Both must be same output type such that both are: staged, floating or PWM.
- The first and second stage ordering is selectable between stage 1 - reheat, stage 2 peripheral or stage 1- peripheral, stage 2 reheat.

^c Only 1 Analog input is configurable on the W7751H and only if the T7770A or D (no Space temperature setpoint) Wall modules are used.

Type of Box Fan

Each VAV box that is controlled by a W7751B,D,F,H,J can have a series fan (see Fig. 22), a parallel fan (see Fig. 23), or no fan (Fig. 4).

The air temperature sensor cannot be used on the W7751H Smart VAV Actuator with wall modules that have a setpoint.

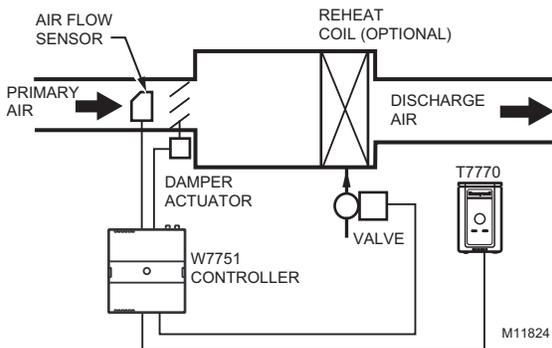


Fig. 4. VAV box (without fan).

Fig. 5 through 21 illustrate the W7751B,D,F,H,J VAV Controllers that have a box type of (single duct) with DestHvacMode in (the default of Auto).

Refer to Fig. 5 to see VAV box modes for Pressure_Independent or Pressure_Dependent, Reheat type Float_Reheat/Float_Periph, Non-Proportional.

Pressure Type:

Pressure Independent or Pressure Dependent).

Reheat Type: Float_Reheat or Float_Periph.

Proportional Reheat Flow: Disable.

Periph Min Pos: Greater than 0%.

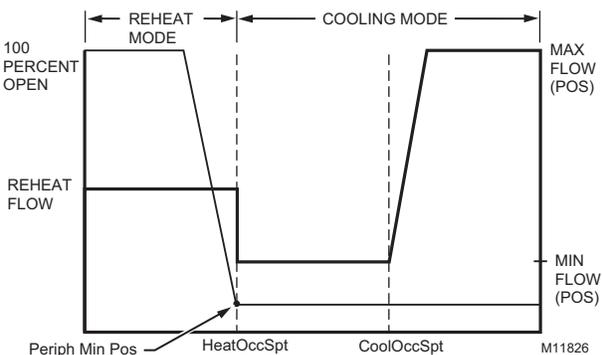


Fig. 5. VAV box modes for Reheat Type Float_Reheat/Float_Periph, Non-Proportional. (suited for Peripheral heat control because the Peripheral output closes to a minimum position (Periph Min Pos) at HeatOccSpt).

Refer to Fig. 6 to see VAV box modes for Pressure_Independent or (Pressure_Dependent), Reheat type Float_Reheat/Float_Periph, Proportional.

Pressure Type:

Pressure Independent or (Pressure_Dependent).

Reheat Type: Float_Reheat or Float_Periph.

Proportional Reheat Flow: Enable.

Periph Min Pos: Equals 0.

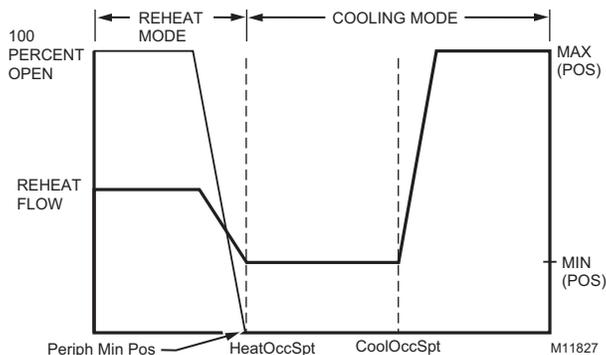


Fig. 6. VAV box modes for Reheat Type Float_Reheat/Float_Periph, Proportional. (suited for Reheat control because the Reheat closes to zero percent at HeatOccSpt).

Refer to Fig. 7 to see VAV box modes for Pressure_Independent or (Pressure_Dependent), Reheat type Float_Reheat/Float_Periph, Proportional.

Pressure Type:

Pressure Independent or (Pressure_Dependent).

Reheat Type: Float_Reheat or Float_Periph.

Proportional Reheat Flow: Enable.

Periph Min Pos: Greater than 0%.

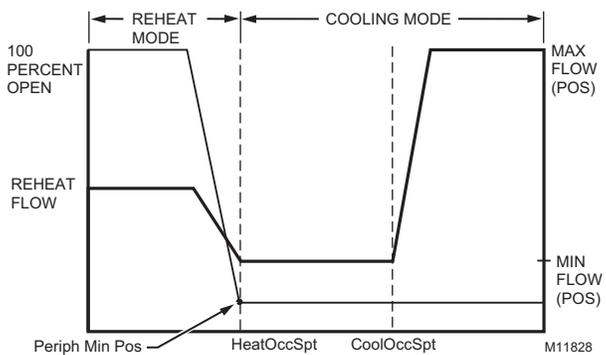


Fig. 7. VAV box modes for Reheat Type Float_Reheat/Float_Periph, Proportional. (suited for Peripheral heat control because the Peripheral output closes to a minimum position [Periph Min Pos] at HeatOccSpt).

NOTE: Refer to Fig. 8 to see VAV box modes for Reheat type Elec_ThreeStage - Proportional.

Pressure Type:

Pressure Independent or (Pressure_Dependent).

Reheat Type: Elec_ThreeStage or (Elec_ThreeStageBin), (Elec_OneStage), (Elec_TwoStage).

Proportional Reheat Flow: Enable.

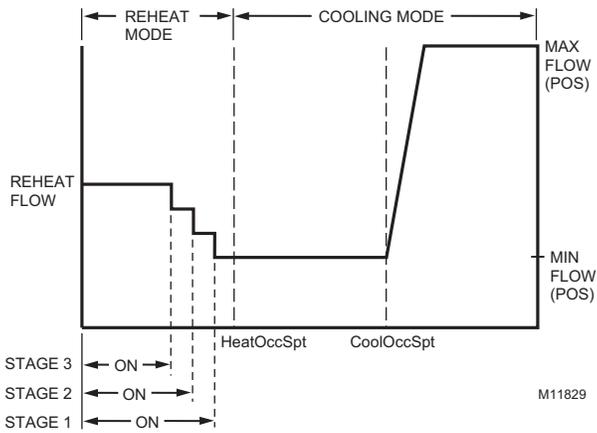


Fig. 8. VAV box modes for Reheat Type Elec_ThreeStage - Proportional.

Refer to Fig. 9 to see VAV box modes for Reheat type Elec_ThreeStage - Non-Proportional.

Pressure Type: Pressure Independent or (Pressure_Dependent).

Reheat Type: Elec_ThreeStage or (Elec_ThreeStageBin), (Elec_OneStage), (Elec_TwoStage).

Proportional Reheat Flow: Disable.

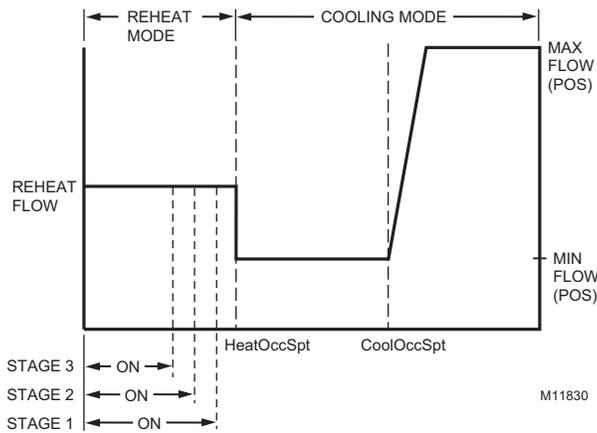


Fig. 9. VAV box modes for Reheat Type Elec_ThreeStage - Non-Proportional.

Refer to Fig. 10 to see VAV box modes for Reheat type PeriphThenReheat - Proportional.

Pressure Type: Pressure Independent or (Pressure_Dependent).

Reheat Type: Float_Periph_Reheat or (PWM_Periph_Reheat).

Proportional Reheat Flow: Enable.

Periph Min Pos: 0% or greater.

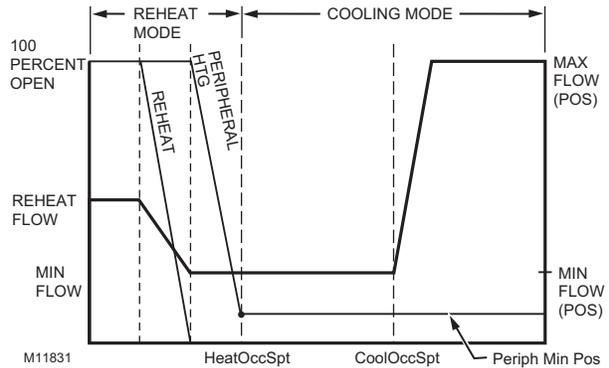


Fig. 10. VAV box modes for Reheat type Peripheral Heating Then Reheat - Proportional (Float_Periph_Reheat/PWM_Periph_Reheat).

Refer to Fig. 11 to see VAV box modes for Reheat type ReheatThenPeriph - Proportional.

Pressure Type: Pressure Independent or (Pressure_Dependent).

Reheat Type: Float_Reheat_Periph or (PWM_Reheat_Periph).

Proportional Reheat Flow: Enable.

Periph Min Pos: 0% or greater.

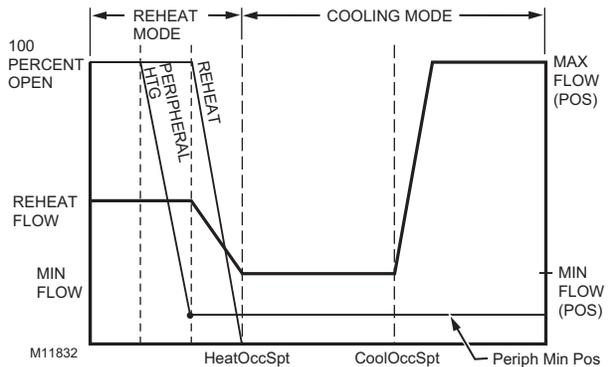


Fig. 11. VAV box modes for Reheat Type Reheat Then Peripheral Heating Proportional (Float_Reheat_Periph/PWM_Reheat_Periph).

Refer to Fig. 12 to see VAV box modes for Press_Dependent, Reheat type Float_Reheat/FloatHotDuctPrDep, Non-Proportional.

Pressure Type: Pressure_Dependent.

Reheat Type: FloatHotDuctPrDep.

Proportional Reheat Flow: Disable.

Periph Min Pos: 0% or greater.

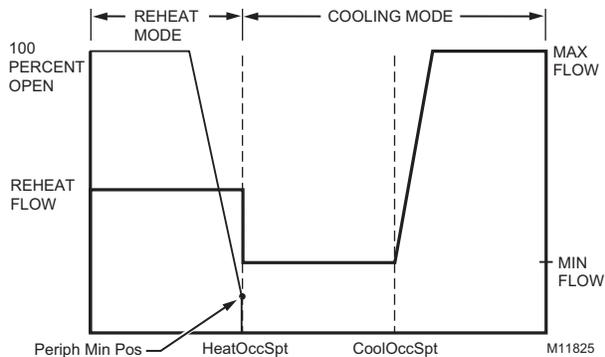


Fig. 12. VAV box modes for Reheat Type Float_Reheat/Float_Periph, no minimum position, reheat goes to zero percent in cooling mode Non-proportional (suited for Reheat control because the Reheat closes to zero percent at HeatOccSpt).

Refer to Fig. 13 to see VAV box modes for Pressure Dependent, Reheat type Float_Reheat/Float_Periph.

Pressure Type: Pressure_Dependent.

Reheat Type: Float_Reheat/Float_Periph.

Proportional Reheat Flow: Disable.

Periph Min Pos: 0% or greater.

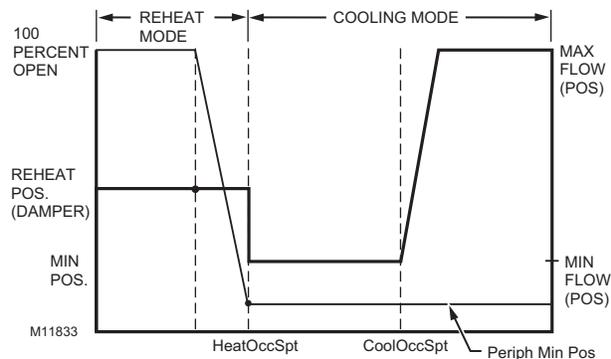


Fig. 13. VAV box modes for Pressure Dependent, Reheat Type Float Reheat/Float_Periph.

A Series fan is intended to run continuously when the main air handler is on and is in-line with the primary air flow through the box. This configuration is sometimes referred to as Variable Volume Supply with Constant Volume Discharge (VVS/CVD).

NOTE: The location of the heating coils can be in the discharge, as shown in Fig. 14, or in the plenum return.

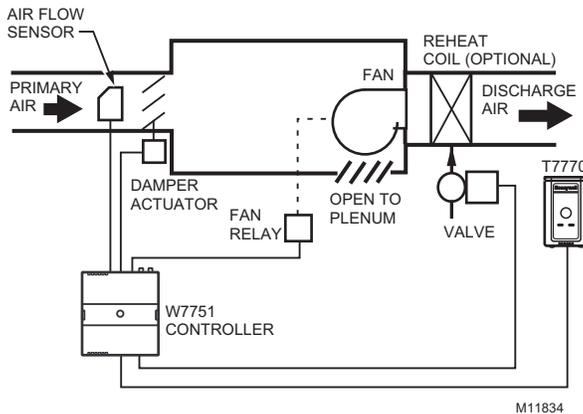


Fig. 14. Series VAV box fan.

A parallel fan, see Fig. 15, is not located in the primary air stream, but is designed to add return air from the plenum into the air stream delivered to the space. The Excel 10 VAV Controller turns on the parallel fan when the space temperature falls below Setpoint as a first stage of reheat (Parallel Temp), or if the air flow falls below a minimum air flow setpoint to maintain a minimum air flow to the space (Parallel Flow).

NOTE: The location of the heating coils can be in the discharge, as shown in Fig. 15, or as part of the plenum air return, either before or after the fan.

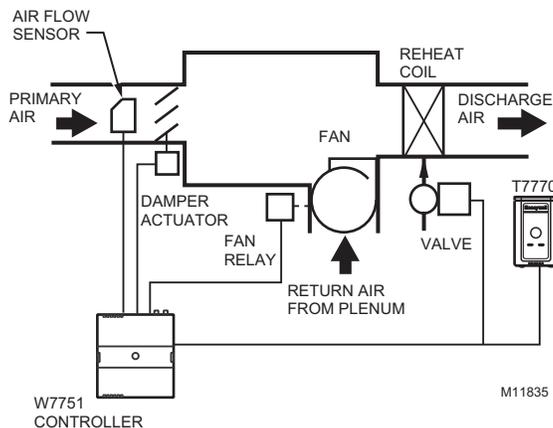


Fig. 15. Parallel VAV Box Fan.

See Fig. 16 and Fig. 17 to see the Heat/Cool Modes for Parallel Temperature/Flow VAV box fans.

**PARALLEL FAN TEMP OPERATION:
COOL/REHEAT MODES**

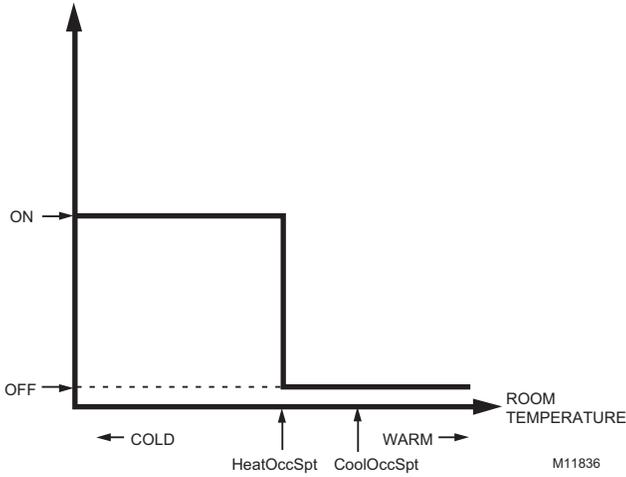


Fig. 16. Parallel fan temperature operation: for Cool/Reheat modes.

**PARALLEL FAN FLOW OPERATION:
COOL/REHEAT MODES**

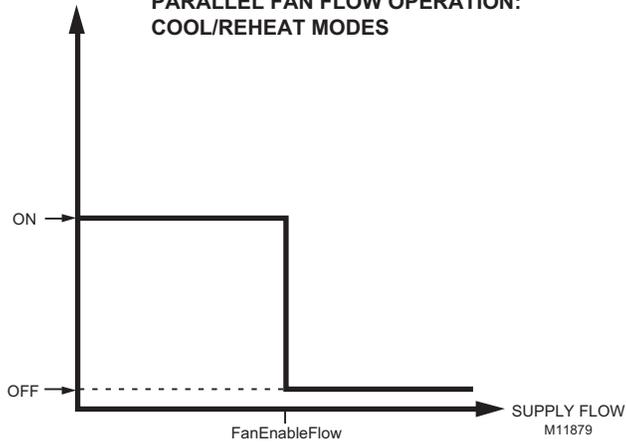


Fig. 17. Parallel fan flow operation: for Cool/Reheat modes.

Refer to Fig. 18 to see Dual Duct, Pressure Independent, with flow mixing that has cold and hot duct flow pickups.

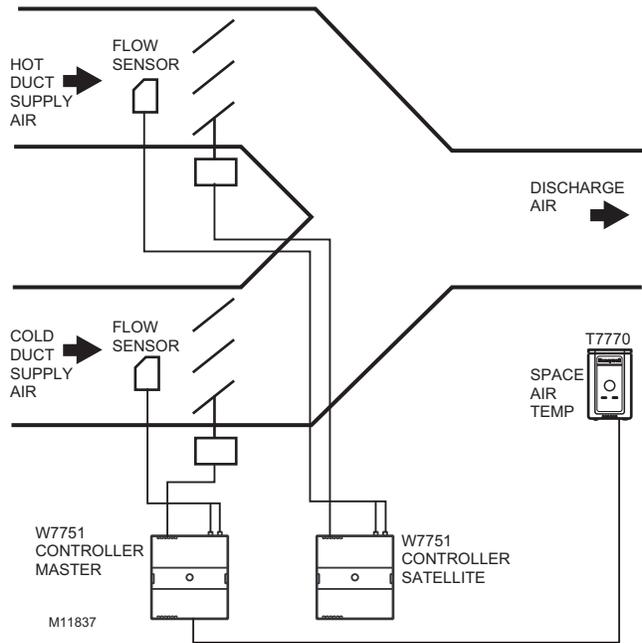


Fig. 18. Dual Duct, Pressure Independent, with flow mixing that has cold and hot duct flow pickups (uses a satellite Excel 10 for hot duct).

DUAL DUCT FLOW MIXING (FOR SETUP AND CALIBRATION REFER TO THE DUAL DUCT CALIBRATION PROCEDURE IN APPENDIX B)

Master Flow Configuration: Master_Flow_Mix.

Master Reheat Configuration: DualDuctReheat.

Satellite Flow Configuration: Satel_Flow_Mix.

Satellite Reheat Configuration: DualDuctReheat.

NOTE: In order for this application to function properly, the following bindings have to be made through refer points in LonSpec. Bind nvoShare from the master to nviShare of the satellite and bind nvoBoxFlow from the satellite to nviFlowTrack of the master.

Dual duct flow mixing uses two control devices, a master (for the cold duct) and a satellite (for the hot duct) to provide pressure independent control. If there is a need for cooling, dual duct flow mixing will control temperature to the cooling setpoint, setting the flow control setpoint for the cold duct between min flow and max flow while setting the hot duct flow setpoint to zero. If the temperature of the space is between the cooling and the heating setpoints, the cold duct will control to the min flow while the hot duct flow is set to zero. If there is a need for heating, the controllers will try to control to the heating setpoint by first modulating the cold duct flow from min flow to zero while simultaneously modulating the hot duct flow from zero to min flow. If there is additional need for heat, the hot duct will modulate from min flow to max flow while the cold duct is set to zero. Since during the initial heating load, both the hot and cold duct are supplying air, we have flow mixing.

See Fig. 19 for Heat/Cool Modes for Dual Duct, Pressure Independent, with flow mixing, that has cold and hot duct flow pickups.

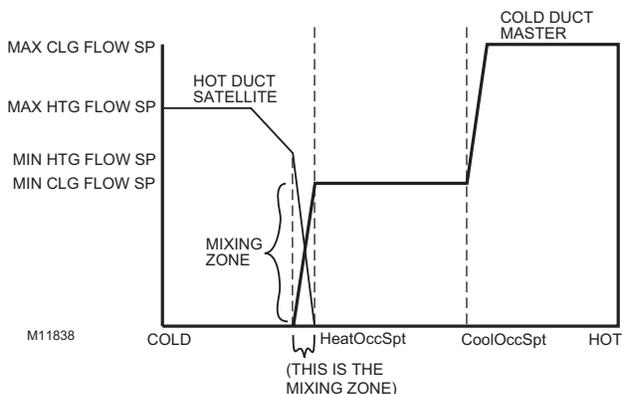


Fig. 19. Heat/Cool Modes for Dual Duct, Pressure Independent, with flow mixing, that has cold and hot duct flow pickups.

See Fig. 20 for Dual Duct, Pressure Independent, without flow mixing, that has cold and hot duct flow pickups.

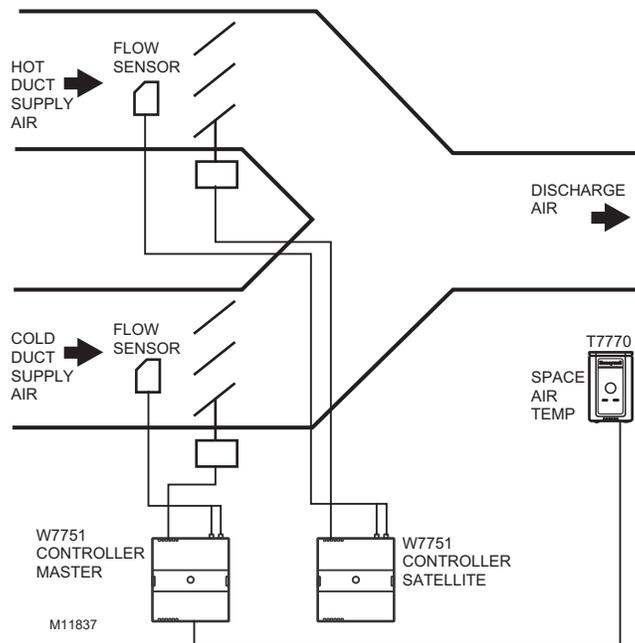


Fig. 20. Dual Duct, Pressure Independent, without flow mixing, that has cold and hot duct flow pickups (uses a satellite Excel 10 for hot duct).

DUAL DUCT NO FLOW MIXING (FOR SETUP AND CALIBRATION REFER TO THE DUAL DUCT CALIBRATION PROCEDURE IN APPENDIX B)

Master Flow Configuration: Flow_Normal.

Master Reheat Configuration: DualDuctReheat.

Satellite Flow Configuration: Satel_No_Flow_Mix.

Satellite Reheat Configuration: DualDuctReheat.

NOTE: In order for this application to function properly, the following bindings have to be made through refer points in LonSpec. Bind nvoShare from the master to nviShare of the satellite and bind nvoBoxFlow from the satellite to nviFlowTrack of the master.

Dual duct flow mixing uses two control devices, a master (for the cold duct) and a satellite (for the hot duct) to provide pressure independent control. If there is a need for cooling, dual duct flow mixing will control temperature to the cooling setpoint, setting the flow control setpoint for the cold duct between min flow and max flow while setting the hot duct flow setpoint to zero. If the temperature of the space is between the cooling and the heating setpoints, the cold duct will control to the min flow while the hot duct flow is set to zero. If there is a need for heating, the controllers will try to control to the heating setpoint by first setting the cold duct flow to zero then modulating the hot duct flow from min flow to max flow; During the heating and cooling only one damper is being used at any one time to provide heating or cooling, this provides no flow mixing.

See Fig. 21 for Heat/Cool Modes for Dual Duct, Pressure Independent, without flow mixing that has cold and hot duct flow pickups.

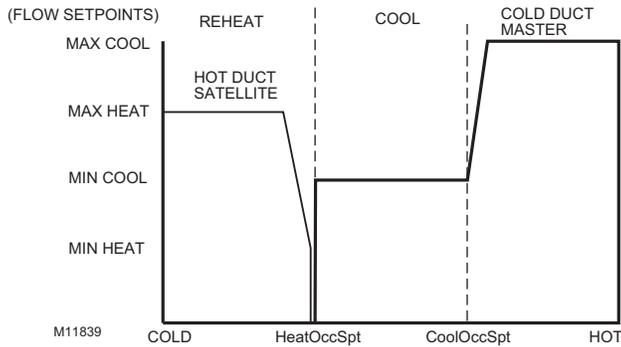


Fig. 21. Heat/Cool Modes for Dual Duct, Pressure Independent, without flow mixing that has cold and hot duct flow pickups.

See Fig. 22 for Dual Duct, Pressure Independent cooling, Pressure Dependent heating with flow mixing that has cold duct flow pickup.

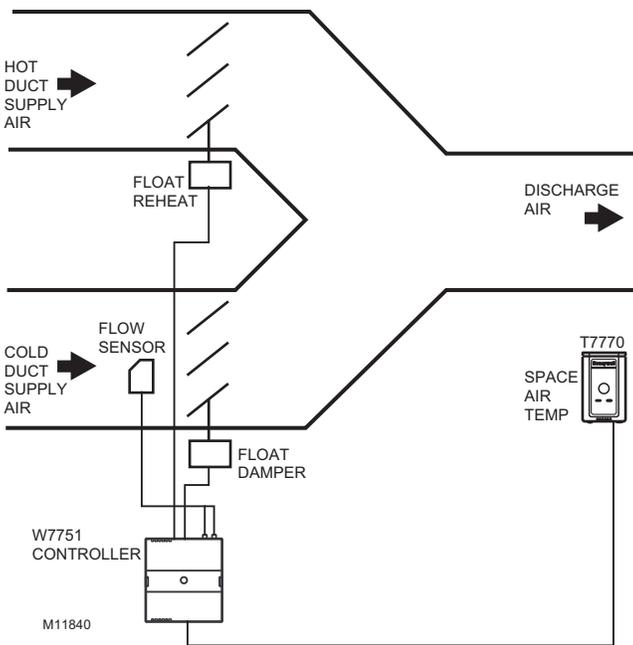


Fig. 22. Dual Duct, Pressure Independent cooling, Pressure Dependent heating with flow mixing that has cold duct flow pickup.

See Fig. 23 for Heat/Cool Modes for (Reheat = Float Reheat) Dual Duct, Pressure Independent cooling and Pressure Dependent heating, with flow mixing that has cold duct flow pickup.

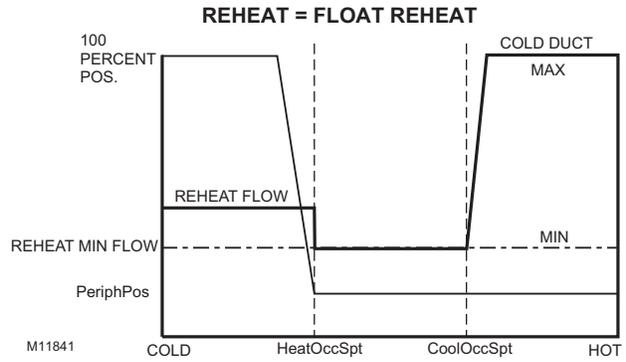


Fig. 23. Heat/Cool Modes for (Reheat = Float_Reheat) Dual Duct, Pressure Independent cooling and Pressure Dependent heating, with flow mixing that has cold duct flow pickup.

DUAL DUCT FLOW MIX (PRESSURE INDEPENDENT COOLING, PRESSURE-DEPENDENT HEATING USING ONE EXCEL 10)

Box Type: Dual Duct

Flow Configuration: Flow Normal.

Reheat configuration: Float_Reheat.

Dual duct flow mixing uses one control device to provide pressure independent control of the cold duct. The Floating Reheat, which is traditionally wired to a heating valve actuator, is wired to a hot duct damper instead. PeriphPos is used to set the minimum hot duct damper position, which applies during both reheat and cooling modes. Flow mixing is achieved by mixing hot duct and cold duct air, which takes place during the cooling mode when minimum hot duct position is not zero (PeriphPos), or during the reheat mode if the cold duct Reheat Flow value is not zero.

See Fig. 24 for Heat/Cool Modes for (Reheat = Float Hot Duct Pressure Dependent) Dual Duct, Pressure Independent cooling and Pressure Dependent heating, with flow mixing that has cold duct flow pickup.

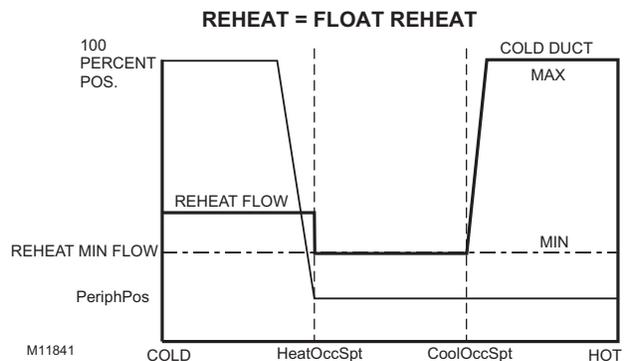


Fig. 24. Heat/Cool Modes for (Reheat = FloatHotDuctPrDep) Dual Duct, Pressure Independent cooling and Pressure Dependent heating, with flow mixing that has cold duct flow pickup.

DUAL DUCT FLOW MIX (ALTERNATE CONFIGURATION)

Flow configuration: Flow Normal.

Reheat configuration: Float HotDuct Pressure.

This configuration is the same as the previous description, however, setting PeriphPos to a minimum hot duct position that only applies during reheat mode. During cooling mode, the hot duct damper goes to zero, thus conserving energy. Flow mixing is achieved by mixing hot duct and cold duct air during the reheat mode when the cold duct Reheat Flow value is not zero.

See Fig. 25 for Dual Duct, Pressure Independent cooling and heating, constant volume with hot and cold duct flow pickups.

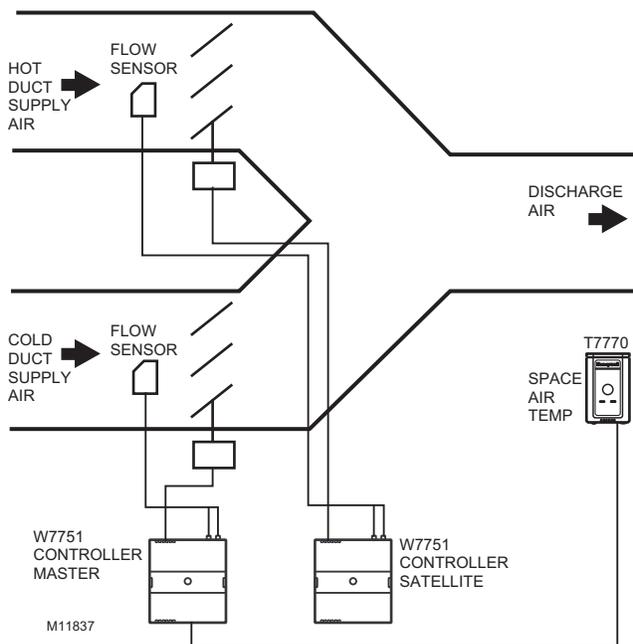


Fig. 25. Dual Duct, Pressure Independent cooling and heating, constant volume with hot and cold duct flow pickups.

DUAL DUCT CONSTANT VOLUME (FOR SETUP AND CALIBRATION REFER TO THE DUAL DUCT CALIBRATION PROCEDURE IN APPENDIX B)

Master Flow Configuration: Master_Const_Flow.

Master Reheat Configuration: DualDuctReheat.

Satellite Flow Configuration: Satel_Const_Flow.

Satellite Reheat Configuration: DualDuctReheat.

NOTE: In order for this application to function properly, the following bindings have to be made through refer points in LonSpec. Bind nvoShare from the master to nviShare of the satellite and bind nvoBoxFlow from the satellite to nviFlowTrack of the master.

Dual duct flow mixing uses two control devices, a master (for the cold duct) and a satellite (for the hot duct) to provide pressure independent control. The dual duct constant volume application tries to control the space to the cooling setpoint only. During unoccupied, the controller will try to control the temperature to either the unocc heating (if the space temperature is less than the unocc heating setpoint) or unocc cooling setpoint (if the space temperature is greater than the unocc cooling setpoint). The controller is always in cooling mode, adjusting the cool air from min flow to max flow while simultaneously adjusting the warm air from max flow to min flow.

See Fig. 26 for Heat/Cool Modes for Dual Duct, Pressure Independent cooling and heating, constant volume with hot and cold duct flow pickups.

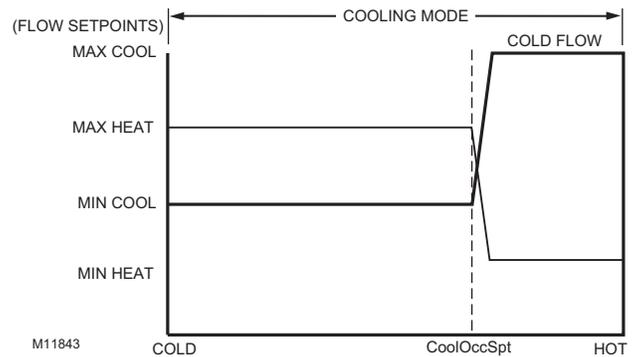


Fig. 26. Heat/Cool Modes for Dual Duct, Pressure Independent cooling and heating, constant volume with hot and cold duct flow pickups.

See Fig. 27 for Dual Duct, Pressure Dependent cooling and heating, with Flow mixing and no flow pickups.

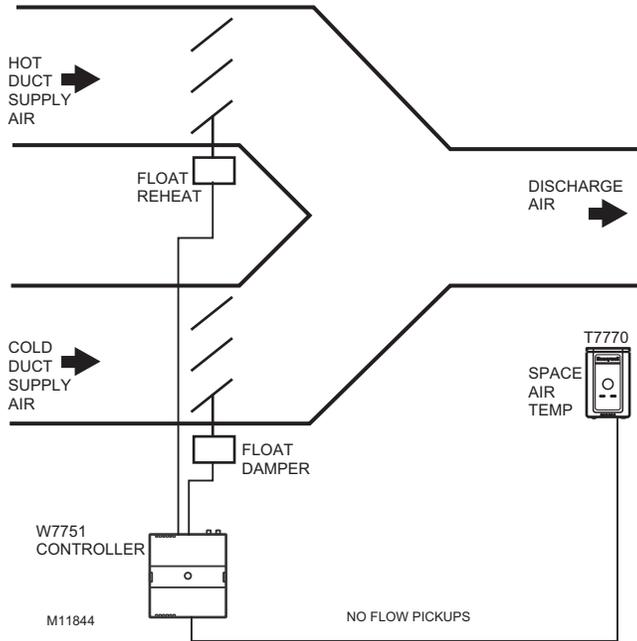


Fig. 27. Dual Duct, Pressure Dependent cooling and heating, with Flow mixing and no flow pickups.

See Fig. 28 for Heat/Cool Modes for (Reheat = Float Reheat) Dual Duct, Pressure Dependent cooling and heating, with flow mixing and no flow pickup.

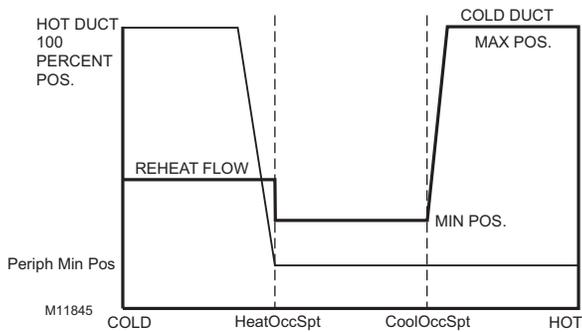


Fig. 28. Heat/Cool Modes for (Reheat = Float Reheat) Dual Duct, Pressure Dependent cooling and heating, with flow mixing with no flow pickups.

DUAL DUCT PRESS FLOW MIX (PRESSURE-DEPENDENT COOLING AND HEATING USING ONE EXCEL 10)

Flow configuration: Flow Normal.

Reheat configuration: Float Hotduct Pressure Dependent.

Dual duct flow mixing uses one control device to provide pressure dependent control of the cold and hot ducts. The Floating Reheat, which is traditionally wired to a heating valve actuator, is wired to a hot duct damper instead. PeriphPos is used to set the minimum hot duct damper position, which applies during both reheat and cooling modes. Flow mixing is achieved by mixing hot duct and cold duct air, this takes place during the cooling mode when minimum hot duct position is not zero, or during the reheat mode if the cold duct Reheat Flow value is not zero.

See Fig. 29 for Heat/Cool Modes for Dual Duct, Pressure Dependent cooling and heating, with Flow mixing and no flow pickups.

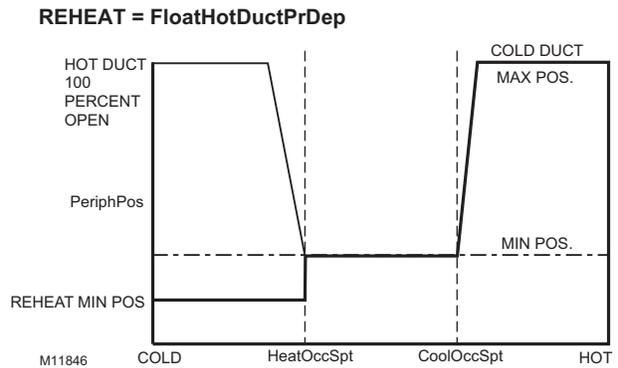


Fig. 29. Heat/Cool Modes for Dual Duct, Pressure Dependent cooling and heating, with Flow mixing and no flow pickups.

DUAL DUCT PRESS FLOW MIX (ALTERNATE CONFIGURATION)

Flow configuration: Flow Normal.

Reheat configuration: Float Hotduct Pressure Dependent.

This configuration is the same as the previous description, however, setting PeriphPos to a minimum hot duct position that only applies during reheat mode. During cooling mode, the hot duct damper goes to zero, thus conserving energy. Flow mixing is achieved by mixing hot duct and cold duct air during the reheat mode when the cold duct Reheat Flow value is not zero.

See Fig. 30 for Dual Duct, Pressure Independent discharge, with Constant Volume and Discharge air flow pickup.

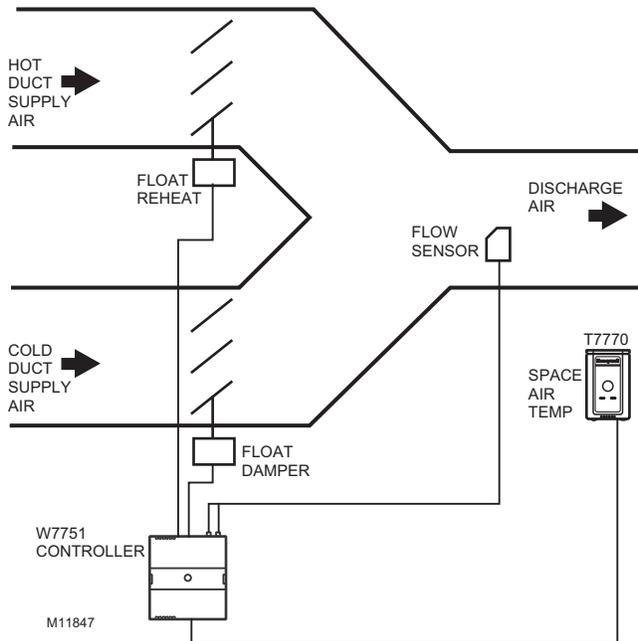


Fig. 30. Dual Duct, Pressure Independent discharge, with Constant Volume and Discharge air flow pickup.

DUAL DUCT DISCHARGE SENSOR CONSTANT VOLUME (PRESSURE-INDEPENDENT DISCHARGE USING ONE EXCEL 10)

Flow configuration: Dual Duct Discharge Sensor Constant.

Reheat configuration: Float_Reheat.

Dual duct flow mixing uses one control device to provide pressure independent control of the cold duct and total discharge air. In this control sequence, the temperature sensor controls the Hot duct damper position from the PeriphPos minimum hot duct position to the 100 percent position. The discharge flow sensor, which picks up the cumulative flow of both the cold and hot duct air flows, is used to determine the total flow of air. This total flow of air is used to control the cold duct damper, using whatever amount of cold air is necessary to maintain a single flow value of MaxFlow. (Be aware that setting the Max flow too high with a small heating flow capacity will not let the cold damper go to zero during a high demand for heat.)

See Fig. 31 for Heat/Cool Modes for Dual Duct, Pressure Independent Cooling and Pressure Dependent Heating, with Constant Volume and Discharge air flow pickup.

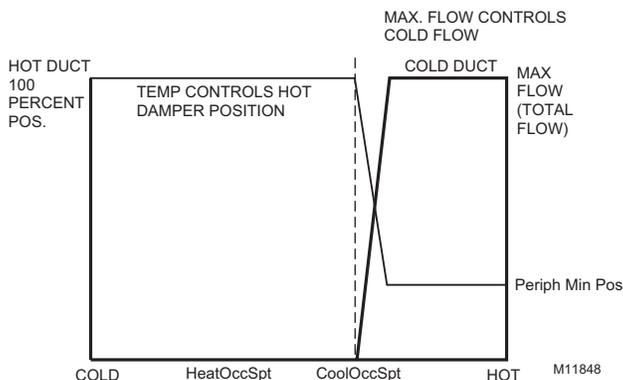


Fig. 31. Heat/Cool Modes for Dual Duct, Pressure Independent Cooling and Pressure Dependent Heating, with Constant Volume and Discharge air flow pickup.

See Fig. 32 for Dual Duct, Pressure Dependent cooling and heating, with no Flow mixing and no flow pickups.

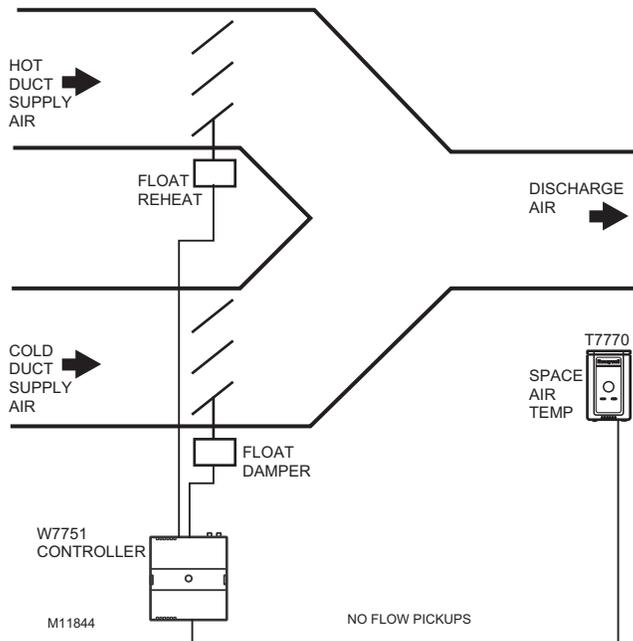


Fig. 32. Dual Duct, Pressure Dependent cooling and heating, with no Flow mixing and no flow pickups.

DUAL DUCT PRESS FLOW MIX (PRESSURE-DEPENDENT COOLING AND HEATING USING ONE EXCEL 10)

Flow configuration: Flow Normal.

Reheat configuration: Float HotDuct Pressure Dependent.

Dual duct flow mixing uses one control device to provide pressure dependent control of the cold and hot ducts. The Floating Reheat, which is traditionally wired to a heating valve actuator, is wired to a hot duct damper instead. PeriphPos will be set to a minimum hot duct position that only applies during reheat mode. During cooling mode, the hot duct damper goes to zero, thus conserving energy. Flow mixing is avoided by

setting the cold duct Reheat Flow Value to zero. The minimum flow value to the space will be the minimum hot duct damper position during reheat mode or the cold duct min position during cooling.

See Fig. 33 for Heat/Cool Modes for Dual Duct, Pressure Dependent cooling and heating, with no Flow mixing and no flow pickups.

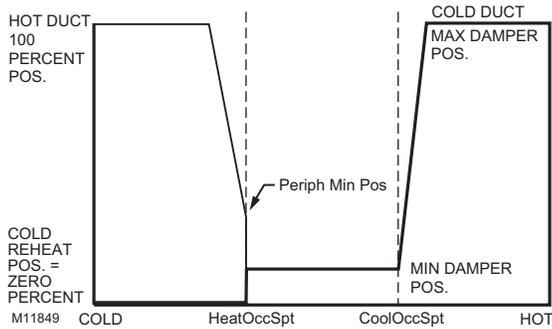


Fig. 33. Heat/Cool Modes for Dual Duct, Pressure Dependent cooling and heating, with no Flow mixing and no flow pickups.

See Fig. 34 for Dual Duct, Pressure Independent Heating and Cooling, with Discharge air flow pickup.

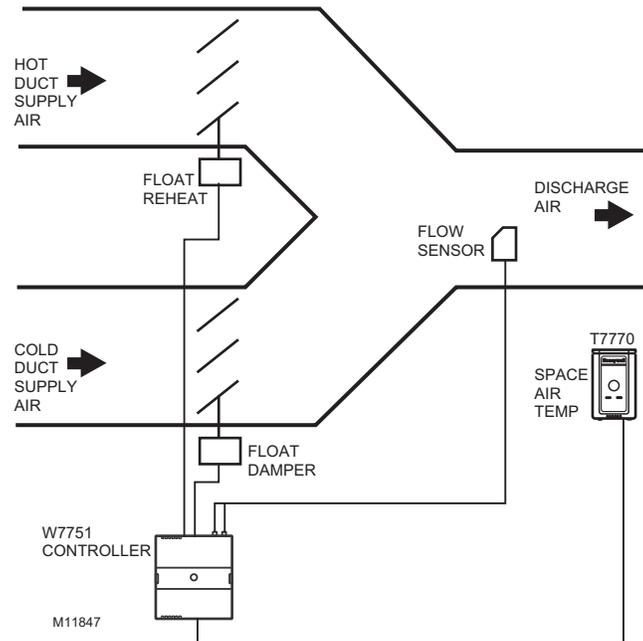


Fig. 34. Duct, Pressure Independent Heating and Cooling, with Discharge air flow pickup.

DUAL DUCT PRESSURE-INDEPENDENT (PRESSURE-INDEPENDENT COOLING AND HEATING USING ONE EXCEL 10)

Flow configuration: Dual Duct Discharge Sensor.

Reheat configuration: Float_Reheat.

Dual duct flow mixing uses one control device to provide pressure independent control of the cold and hot ducts. The Floating Reheat, which is traditionally wired to a heating valve actuator, is wired to a hot duct damper instead. During reheat mode, only the hot duct damper is controlled and the cold duct is closed. During the cooling mode, only the cold duct damper is controlled, and the hot duct is closed.

See Fig. 35 for Heat/Cool Modes for Dual Duct, Pressure Independent Heating and Cooling, with Discharge air flow pickup.

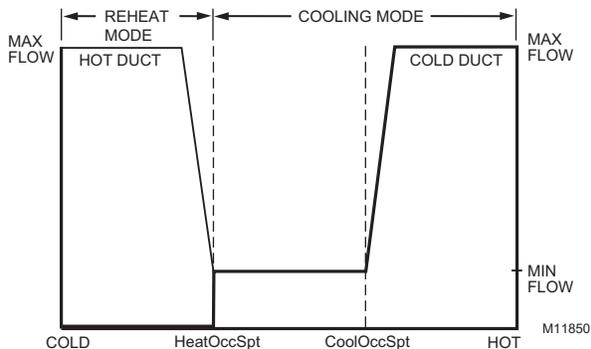


Fig. 35. Heat/Cool Modes for Dual Duct, Pressure Independent Heating and Cooling, with Discharge air flow pickup.

See Fig. 36 for Single Duct, Pressure Independent Cooling, with PWM Parallel Fan.

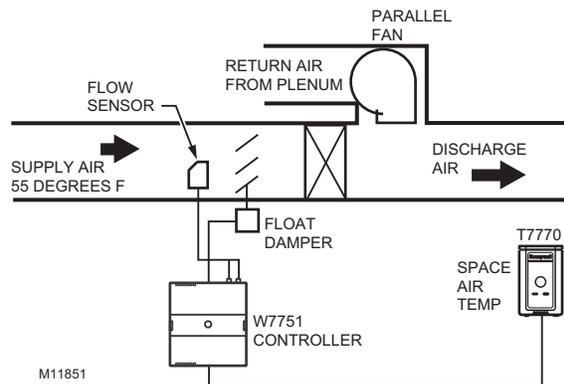


Fig. 36. Single Duct, Pressure Independent Cooling, with PWM Parallel Fan.

PWM FAN

Use this only with single duct configurations. The PWM fan is a variable fan that controls the amount of return air or return plenum air to the space. The PWM fan acts in opposite to the cooling duct damper position for pressure dependent operation, or in opposite to the cooling duct flow for pressure independent.

See Fig. 37 for Modes for Single Duct, Pressure Independent Cooling, with Parallel Fan.

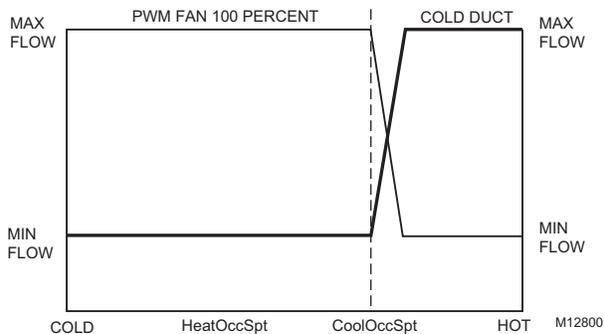


Fig. 37. Modes for Single Duct, Pressure Independent Cooling, with Parallel Fan.

W7751 Controller	Box Type Selected in LONSPEC	Flow Type Selected in LONSPEC
1	Single Duct	Flow Normal
2	Single Duct	Flow Normal
3	Single Duct	Flow Normal
4	Flow Tracking	Flow Tracking

Additionally, in the Menu Selection: Network>Refer Points in Network Menu in LONSPEC, refer the nvoFlowTrack of controller number 1 to the nviFlowTrack of number 2; the nvoFlowTrack of number 2 to the nviFlowTrack of number 3; and the nvoFlowTrack of number 3 to the nviFlowTrack of number 4.

EXHAUST TRACKING FLOW CONTROL

An example of Exhaust Tracking is shown in Fig. 38. To configure Exhaust Tracking Flow Control Application in LONSPEC, follow the configurations shown in the table below (see “Tab: Configuration” on page 34 for more information on parameters).

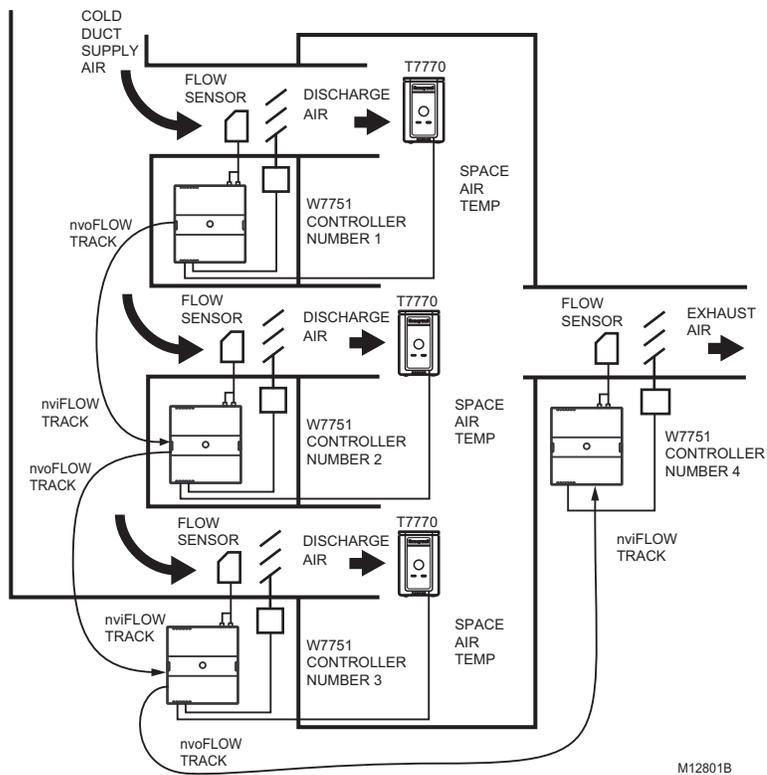


Fig. 38. Exhaust Tracking Flow Control.

SHARE WALL MODULE

An example of sharing wall modules between three VAV controllers (Wall Module is hard-wired to Controller 1 in the figure) is shown in Fig. 39. To configure Exhaust Tracking

Flow Control Application in LONSPEC, follow the configurations shown below (see “Tab: Configuration” for more information on parameters).

Additionally, in the Refer Points Configuration Screen (LONSPEC Menu Selection Network>Refer Points) set VAV number 1 as Source controller, and refer the nvoShare point to point nviShare in Destination controllers VAV number 2 through VAV number 4.

W7751 Controller	Flow Type Selected in LONSPEC	Box Type Selected in LONSPEC	Wall Module Type
1	Flow Normal	Single Duct	Sensor Setpoint
2	Share Wall Module	Single Duct	No Sensor
3	Share Wall Module	Single Duct	No Sensor
4	Share Wall Module	Single Duct	No Sensor

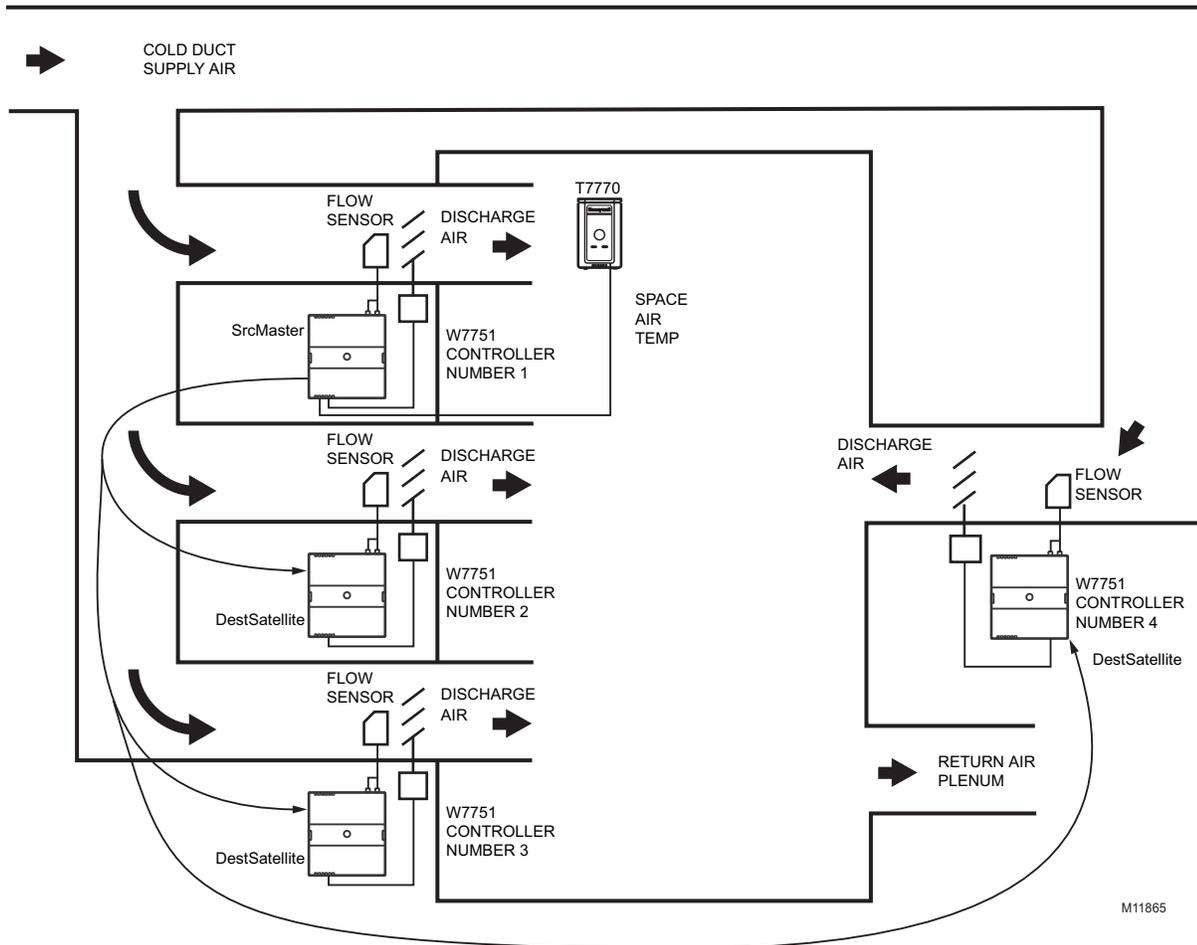


Fig. 39. Share Wall Module.

Type of Reheat Coil

Each VAV box can contain a coil(s) for reheating the air delivered to the space. The Excel 10 VAV Controller can control staged electric heat elements, solenoid valves, PWM, Series 60 (floating) or pneumatic modulating valves.

NOTE: Pneumatically actuated valves can be controlled using a floating-to-pneumatic transducer device. Transducer devices are also available to convert the floating outputs to a voltage signal.

The staged reheat control algorithm can control one, two, or three stages of reheat (a third stage of reheat is only available if configured as three stage binary control on the W7751H Smart VAV Actuator). In addition to the proportional, integral, derivative (PID) control algorithm, the Excel 10 VAV Box Controller has an intelligent anticipation cyclers incorporated into the staged reheat algorithm. The anticipator control works in unison with the PID temperature control algorithm and cycles the staged reheat coil providing space temperature control with the accuracy of modulating reheat. The stages are activated through Triac digital outputs, one for each stage, wired to 24 Vac contactors. These outputs can also control

24 Vac solenoid valves on hot water coils instead of electric heat elements. Fig. 40 depicts a typical VAV box with staged reheat.

The Series 60 modulating control is provided through two Triac digital outputs, one to pulse the valve actuator open and one to pulse it closed. Damper control output Triacs operate similarly.

PWM control positions the actuator based on the length, in seconds, of the pulse from the digital output. For PWM, the controller outputs a pulse whose length consists of two parts, a minimum and a maximum. The minimum pulse time represents the analog value of zero percent (also indicating a signal presence) and the maximum pulse length that represents an analog value of 100 percent. If the analog value is greater than zero percent, an additional time is added to the minimum pulse time. The length of time added is directly proportional to the magnitude of the analog value. The PWM actuator will begin to use the analog value at the end of the pulse and will continue to use this value until a new pulse is received. Refer to Appendix B under PWM Control for an example. Series 60 actuators are generally less expensive than those for PWM, but the trade-off is that PWM requires only a single controller digital output while floating control uses two digital outputs. See Fig. 41 for a VAV box with a Series 60 floating actuator.

PNEUMATIC VALVE ACTUATOR CONTROL

Pneumatic hot water or steam valve actuator control can be provided through either PWM using one Triac digital output or by Series 60 using two Triac digital outputs as is used for the Series 60 electric control. These two outputs are used to control the transducer interface that converts to a pneumatic signal. See Fig. 42 for a pictorial of a VAV box with a pneumatic valve actuator configuration.

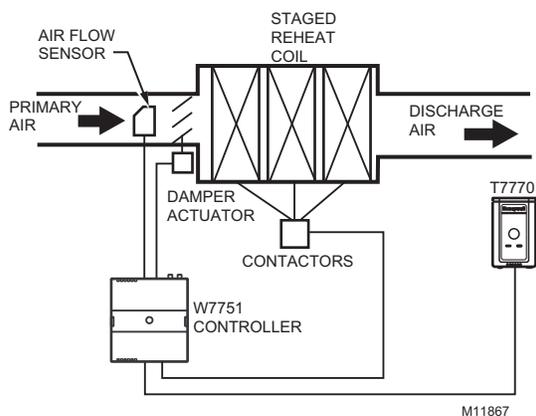


Fig. 40. VAV box with staged reheat coils.

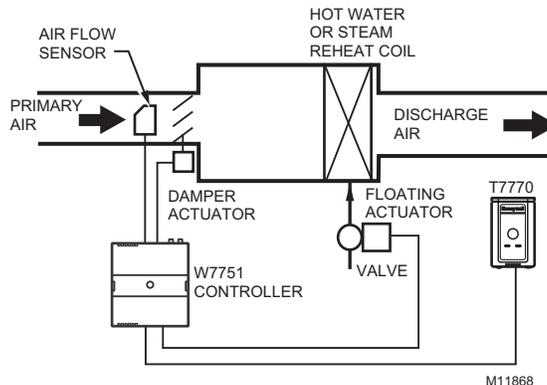


Fig. 41. VAV box with modulating reheat coil (Series 60 floating).

IMPORTANT

When choosing the pneumatic pressure range, make sure that the close-off pressure is 2 to 3 psi greater than that of the spring range. When using a spring range of 5 to 10 psi with 10 psi as the Closed position, do not use the 0 to 10 psi transducer; use the 0 to 20 psi transducer as the recommended selection.

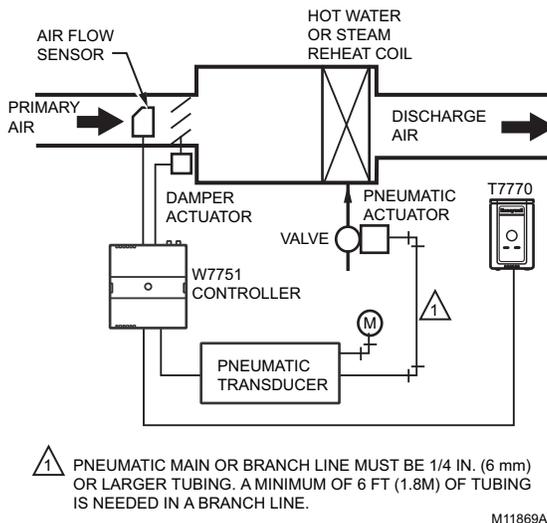


Fig. 42. VAV box with modulating reheat coil (pneumatic valve actuator).

Exhaust Tracking Option

The basic flow control algorithm can be run in either of two modes: the Temperature Control mode, where the flow rate is modulated to maintain the space temperature and the Exhaust Tracking Control mode (refer to Fig. 38), where the exhaust flow rate is modulated to track the supply air flow in other controllers. If exhaust tracking is selected, the air flow removed from the space is based on the sum of flow rate signals sent over the LONWORKS Bus from other controllers (plus or minus a differential). Use the Exhaust Tracking Control mode only as required by the job specifications.

Occupancy Sensor

W7751B, D, F Excel 10 VAV Controllers provide a digital input for connection to an Occupancy Sensor (W7751H Smart Actuator requires a Network input for this application, Refer to Note 2 below). This is a device, such as a passive infrared motion detector, that contains a dry contact (see following NOTE) closure to indicate whether or not people are present in the space. The Excel 10 VAV Controller expects a contact closure to indicate that the space is Occupied. Prepare Wiring Diagrams for details on wiring connections.

The control algorithm in the Excel 10 VAV Controller uses the Occupancy Sensor, if configured, to determine the Effective Occupancy (see Table 2 on page 8) mode of operation. If the Time Of Day (TOD) schedule indicates an Occupied state, and the Occupancy Sensor contact is closed, the Effective Occupancy mode will be Occupied. However, if the TOD schedule indicates an Occupied state and the Occupancy Sensor contact is open, then the Effective Occupancy mode will be STANDBY. The flow control algorithm will then control to the STANDBY Cooling and Heating Setpoints.

If the Occupancy Sensor is not configured, a local controller can be put in the STANDBY mode only by either a one-to-one association of the occupancy sensor from another Excel 10 VAV Controller to the local controller, or by receiving the STANDBY mode signal via the LONWORKS Bus.

NOTES:

1. The Excel 10 VAV Controller has limited power available (only 9 mA at 4.8 volts) for checking the digital inputs for contact closures. It is very important that the device used contains high quality, noncorroding contacts with resistivity that does not degrade; that is, increase over time. Use noble metal (such as gold or silver), pimpled or sealed contacts to assure consistent, long term operation.
2. The W7751H has no configurable digital inputs. If the W7751H Smart Actuator requires the occupancy sensor, then it must be bound over the network (LONWORKS Bus) to another W7751 VAV controller that has that physical digital input.

The recommended devices for use with the Excel 10 VAV Controller are the EL7628A1007 Ceiling Mount Infrared or the EL7680A1008 Wall Mounted Wide View Infrared Occupancy Sensors. If ultrasonic sensors are required, the EL7611A1003 and the EL7612A1001 Occupancy Sensors are recommended. An EL76XX Power Supply/Control Unit is required for use with these occupancy sensors. The EL7630A1003, can power up to four sensors, and is multitapped for several line voltages. The EL7621A1002 can power three sensors and connects to 120 Vac line voltage. The EL7621A1010 can also power three sensors but connects to 277 Vac line voltage.

Window Open/Closed Digital Input

W7751B, D, F Excel 10 VAV Controllers provide a digital input to detect whether a window in the space was opened (Not available on W7751H,J Smart Actuator models). The Excel 10 VAV Controller can be connected to a dry contact or a set of contacts wired in series (for monitoring multiple windows) to verify that the window(s) are closed. The algorithm expects a contact closure to indicate the window is closed. If an open

window is detected, the algorithm changes the mode of operation to CLOSED, which commands the box damper to the position set in ZeroDmprPos (typically zero or a low value).

If the Window Sensor is not configured, a W7751B,D,F and H Controller can be put in the CLOSED mode using the CLOSED mode signal via the LONWORKS Bus.

NOTE: (This is the same NOTE as in the Occupancy Sensor section.) The Excel 10 VAV Controller has limited power available (only 9 mA at 4.8 volts) for checking the digital inputs for contact closures. It is very important that the device used contains high quality, non-corroding contacts with resistivity that does not degrade; that is, increase over time. Use noble metal (such as gold or silver), pimpled or sealed contacts to assure consistent, long term operation.

Heat/Cool Change Over

W7751B, D, F Excel 10 VAV Controllers provide a digital input for connection to an Heat/Cool change over input. The Excel 10 VAV Controller expects a contact closure to indicate that the controller will be put into the heat mode or an open contact to be put into the cooling mode.

NOTE: (This is the same NOTE as in the Occupancy Sensor section.) The Excel 10 VAV Controller has limited power available (only 9 mA at 4.8 volts) for checking the digital inputs for contact closures. It is very important that the device used contains high quality, non-corroding contacts with resistivity that does not degrade; that is, increase over time. Use noble metal (such as gold or silver), pimpled or sealed contacts to assure consistent, long term operation.

Wall Module Options

As previously discussed, there are four basic varieties of T7770 Wall Modules (see Product Names and Construction sections). Also, a T7770 can be shared among two or more W7751 Controllers. A T7560A, Digital Display Wall Module (LCD Display) can also be used in place of the T7770.

COMMON TEMPERATURE CONTROL (SHARE WALL MODULE)

When one or more terminal units serve a common area and a single temperature sensor is specified or is desired to be used for these boxes, the Share Wall Module option can be configured (refer to Table 39 on page 30). One Excel 10 VAV Controller will be configured with a wall module and have the desired options. The other Excel 10 VAV Controller(s) will be configured without wall modules. Use LONSPEC Refer network points option to bind the Wall Module information between the Source (nvoShare) and Destination (nviShare) controllers. In this particular case, the Master temperature control algorithm will control both the Master and Satellite controller outputs.

However, an alternative method is to bind the SpaceTempOut of the source controller that has the wall module connected to it, to the nviSpaceTemp in each of the destination controllers that do not have wall modules. Each controller would use its own temperature control algorithm and internal setpoints. This method could be used when there are many VAV boxes serving the same zone that have different configurations which do not allow using the Share Wall Module option.

NOTE: Be aware of a potential problem the (SpaceTempOut and nviSpaceTemp) method could allow, since each VAV box is executing its own temperature control algorithm (there could be some conflicting control. For example: One box could be cooling at Max flow and another box could be at Min flow or even in the reheat mode.

The following **IMPORTANT** items apply to the Share Wall Module option.

IMPORTANT

- *The type of reheat option must be the same in each unit; for example, all units must be either staged electric heat or steam/hot water heat.*
- *If the staged heat option is present, the source controller (with temperature sensor) must have the same or greater number of stages as any destination controller.*
- *Some or all of the destination controllers can be configured without any heat option.*
- *If the Share Wall Module option is used, the destination controllers will not use any Internal Temperature Setpoints. The source controller Setpoints, as well as Occupancy and Command mode status, will be used in each destination controller.*
- *Each destination controller will have and use its own MAX, MIN, and Reheat Flow Setpoints.*
- *Share Wall Module option can also be used when none of the terminal units have any heating coils.*
- *If any units have terminal fans, the type, either serial or parallel, must be the same and the source controller must be configured with a fan.*

Sensor Options

The C7770A, C7031C1031 or C7031C1033 Air Temperature Sensors are direct-wired temperature sensors that are used to sense discharge or return air in a duct controlled by a W7751 Controller.

NOTE: The C7770A, C7031C1031 or C7031C1033 Air Temperature Sensors cannot be used with the T7770B,C Wall Modules when controlling any W7751H,J Controller.

Pneumatic Retrofit Applications

For projects with existing pneumatically-actuated reheat valves, the Excel 10 VAV Controller output must be converted to a pneumatic signal using a transducer device developed for use with Excel 10 VAV Controllers. Be sure to observe the following Important.

IMPORTANT

Pneumatic transducers should not be used to control VAV box dampers; Instead use ML6161B1000 Motors. Pneumatic transducers are intended to control only pneumatic reheat valves.

APPLICATION PROCESS

Overview

The application engineer must review the Direct Digital Control (DDC) job requirements. This includes the Sequences of Operation for the W7751 VAV units, and for the system as a whole. Usually there are variables that must be passed between the W7751 VAV Controllers and other zone controller(s), or central plant controller(s) that are required for optimum system-wide operation. Typical examples are the TOD Occ/Unocc signal, the outdoor air temperature, demand limit control signal, and smoke control mode signal.

It is important to understand these interrelationships early in the job engineering process to ensure implementation when configuring the controllers.

LONSPEC PC Software is used to configure W7751 Controllers to match their intended application. The LONSPEC User's Guide form, 74-2937 provides details for operating the PC software. Refer to the LONSPEC User's Guide form, 74-2937 for application selections and steps to configure the VAV controllers.

The process of configuring Excel 10 VAV Controllers is the same for the W7751B (OEM) model as it is for the W7751D,F,H,J models. In all five cases, the process involves giving the Excel 10 VAV Controller information. There are three general categories of information:

1. **Hardware I/O Assignment**
The Excel 10 VAV Controller must be informed about the physical equipment wired to its terminals.
2. **Personality Information**
Each controller must be given information about its particular VAV box and the zone it serves. Examples are the Space Temperature Setpoints for each mode (Occupied Cool, Occupied Heat, Standby Cool, etc.), the Maximum and Minimum Flow Setpoints, etc., balancing the box is also included in this category.
3. **ID Assignment.**

The specific parameters to be configured in each of these three categories are discussed in the following subsections.

IMPORTANT

The W7751H Smart VAV Actuator is a physically smaller controller in the Excel 10 family product line. It has a factory-mounted ML6161B1000 Actuator and was designed for basic VAV box control applications. It has all of the control and communications functionality of the W7751B,D,F Controllers with the exception of the following. Physical digital inputs for window open/closed or an occupancy sensor or physical outputs for stage three reheat. It also does not contain a network access communications jack or a self-test input.

Step 1. Create Bill of Materials

After reviewing the job requirements, a bill of materials can be created for ordering purposes. For a list of Honeywell part numbers, "Product Names" on page 10.

Step 2. Configure Controllers

Default Hardware Configuration

Excel 10 VAV Controller models have specific terminals preassigned for the wall module inputs and output. Each of the other allowable analog (resistive) and digital inputs along with digital outputs are fully configurable through the LONSPEC tool and can be assigned to any of the appropriate input or output terminals.

IMPORTANT

- Excel 10 VAV Controllers are not capable of controlling both a staged type reheat device and a modulating reheat device in the same VAV box.
- The W7751H,J Smart VAV Actuators are physically smaller controllers in the Excel 10 family product line. Both Smart VAV Actuators contain a factory-mounted ML6161B1000 Actuator and were designed for basic VAV box control applications. They have all of the control and communications functionality of the W7751B,D,F Controllers with the exception of the following: Physical digital inputs for window open/closed or an occupancy sensor or physical outputs for stage three reheat. Additionally, the controllers do not contain a network access communications jack or a self-test input. The W7751J does not have an air flow pick-up capability.

Configuration Screens for VAV Controllers

The configuration process is performed in a series of screens seen as file tabs under the menu option **Controller>Application Selection** in LONSPEC. The following tables in this section list the options and variables found in each configuration screen. There are seven configuration screens (file tabs):

1. Configuration
2. Input
3. Control Parameters
4. Flow Pickup Table
5. PID
6. Misc Parameters
7. Wiring

The specific parameters and equipment to be configured in each of these categories are tabulated in the following subsections.

NOTE: To set the following configuration parameters, use the LONSPEC PC tool. These sections describe the various parameters and the allowable settings. For details on using LONSPEC, refer to the LONSPEC User Guide (form 74-2937).

TAB: CONFIGURATION

The available options for the Configuration screen with the default values shown are listed in Table 5.

Table 5. VAV Controller Configuration Options.

Function	Configuration options	Default	Cross Reference Heading(s)
General Configuration			
Controller Type	Standard/OEM Smart Actuator	Standard/OEM	"Description of Devices"
Pressure Type	Pressure Dependent Pressure Independent	Pressure Independent	"Pressure-Dependent/-Independent Control"
Box Type	Single Duct Dual Duct Flow Tracking	Single Duct	"Single Duct Variable Air Volume (VAV) Systems" "Dual Duct Air Handling Systems"
Wall Module Type	No Sensor Sensor Sensor Override Sensor Setpoint Sensor Setpoint Override LCD Wall Module	Sensor Setpoint Override	"Wall Module Options"
Morning Warmup Type	Fixed Flow Modulating flow with Reheat Modulating flow without Reheat CZS TerminalLoad	Fixed Flow	"Morning Warm-Up"
Output Settings			
Flow Type	Depends on Box Type and Pressure Type; see below for combinations allowed.	Flow Normal	"Zone Control Definitions"

Table 5. VAV Controller Configuration Options. (Continued)

Function	Configuration options	Default	Cross Reference Heading(s)
Reheat Type	No Reheat One Stage Reheat Two Stage Reheat Three Stage Reheat Three Stage Bin Reheat One Stage Periph Float Reheat Float Periph Reheat Float Reheat Then Periph Float Periph Then Reheat PWM Reheat PWM Periph PWM Periph then Reheat PWM Reheat Then Periph	No Reheat	"Type of Reheat Coil" Also see Reheat Definitions below.
Fan Type	No Fan Serial Fan Parallel Temp Control Parallel Flow Control Parallel PWM Control	Serial Fan	"Type of Box Fan"
Optional Output: Aux	Unassigned Auxillary_Maintain Auxillary_Pulse	Unassigned	
Optional Output: Free	Unassigned Free_Net_Maintain Free_Net_Pulse	Unassigned	
Motor Speed			
Dmpr Mtr Spd	20 to 900 Sec	90 Sec	See configuration field descriptions below.
Reheat Mtr Spd	20 to 900 Sec	90 Sec if floating Reheat Type selected	
PWM Settings			
PWM Period	0.1 to 600 Sec	25.6 Sec	See configuration field descriptions below.
PWM Zero	0.1 to 25.6 Sec	0.1 Sec	
PWM Full	0.1 to 25.6 Sec	25.5 Sec	

NOTE: The reheat outputs can be used to control peripheral heating equipment in the space, such as fin tube radiation.

The following describes the configuration fields for several of the Configuration selections.

>> Wall Module Type: A T7770 (or LCD) Wall Module needs to be connected to the controller. Examples are Temperature Sensor Only or Temperature Sensor plus Bypass Switch, etc. Excel 10 VAV Controller can share wall module information with other controllers. This can be done when two or more boxes serve the same space area. Both the temperature sensor and the setpoint potentiometer can be shared.

>> Fan Type: Excel 10 VAV Controllers support five possibilities for the type of Fan in the VAV box

- None (no VAV box fan exists).
- Series (a Series type; VAV box fan exists).

- Parallel Temp (a Parallel type, VAV box fan exists and is used in conjunction with reheat). This allows the VAV box parallel fan, to draw in external return plenum or room temperature air, to add warm air to the VAV discharge air. This parallel fan temp acts like the first stage of reheat.
- Parallel Flow (a Parallel type, VAV box fan exists and is used when there is not enough primary system air) This allows the VAV box parallel fan to draw in external return plenum or room temperature air to be added to the VAV discharge if the airflow is below a certain flow. This parallel flow guarantees a certain amount of air being delivered to the space, such as an application to prevent condensation of humid air on a window.
- Parallel PWM (a Parallel type, VAV box fan exists and the fan speed is controlled based on cool demand)

Reheat Type Definitions

A floating actuator is a motor that opens when control voltage is applied to the open terminal, and closes when control voltage is applied to the close terminal. For example a 90 second Series 60 motor will open to 50 percent if voltage is applied to the open terminal for 45 seconds (assuming the motor started in the closed position).

A PWM actuator is an actuator that will be closed at a minimum single pulse width measured in seconds and will be opened at a maximum single pulse width. For example on a 28.1 second PWM actuator, a 0.1 second pulse (the PWM Zero value) will close the actuator to zero percent, a 14 second pulse (assuming PWM Full = 28.1 seconds) will move that actuator to 50 percent and a 28 second pulse will move the actuator to 100 percent position. In general, PWM actuators will require the command to be repeated every pulse period, so in this example a 50 percent pulse of 14 seconds must be initiated every 28.1 seconds. If the signal is given once and then the connection is either open or shorted, the actuator will stay in its current position.

Stages are digital on/off controls such as steam valves, water valves, or electric coils. Reheat stages are typically turned off if there is insufficient air flow. Reheat stages are not affected by air flow if a series fan ensuring air flow is used. If reheat stages are configured and no stages are active, the controller will control at Min air flow. If one or more stages are active and proportional reheat is disabled, then the controller will control at Reheat air flow. Peripheral Stages do not care about air flow.

Peripheral Heat is a valve or stage used to control perimeter radiation.

Reheat Heat is a valve or stage used to warm up cool air inside the air duct being controlled.

Proportional reheat (if enabled) allows the reheat air flow to change proportionally, between 0 to 100 percent reheat demand, the flow control setpoint will change from min flow setpoint to Max Reheat flow setpoint, respectively. Digital reheat stages will pick appropriate proportional values.

>> Reheat Type: There are sixteen possibilities for the type of reheat coil(s) in the box:

- No Reheat: no reheat coil exists in the VAV box
- One Stage Reheat: a staged On/Off control only, reheat coil exists in the box
- Two Stage Reheat: two stages of reheat exist in the VAV box
- Three Stage Reheat: three stages of reheat exist in the VAV box; not available for the W7751H,J.
- Three Stage Bin Reheat: using two physical stages of reheat controlled as three, for example: stage 1, stage 2, then stage 1 and 2 together. This type of reheat works similar to a 3-way light bulb: Off, low, medium and high using just two elements; available on the W7751H,J.
- One Stage Periph: a staged On/Off control only, baseboard radiation is an example of peripheral heating. This stage is not affected by air flow safeties.
- Float Reheat**: Modulating reheat valve (Series 60 floating control provided through two Digital Output points, one that pulses to open a steam or hot water valve and one that pulses to close the valve. Minimum position refers to the network variable nciAux1SetPt.ubPeriphMinPosS1.
- Float Periph Reheat* One modulating peripheral reheat stage. Stages is controlled via floating motor.
- Float Reheat Then Periph* One modulating reheat stage and one modulating peripheral reheat stage. Both stages are controlled via floating motors. Control turns on reheat valve first then peripheral valve.

- Float Periph Then Reheat* One modulating peripheral reheat stage and one modulating reheat stage. Both stages are controlled via floating motors. Control turns on peripheral reheat valve first then reheat valve.
- PWM ReHeat** One modulating reheat stage controlling via a pulse width modulation motor.
- PWM Periph* One modulating Peripheral reheat stage controlling via a pulse width modulation motor.
- PWM Periph then ReHeat* One modulating reheat stage and one modulating peripheral reheat stage. Both stages are controlled via a pulse width modulation motor. Control turns on peripheral valve first then reheat valve.
- PWM ReHeat then Periph* One modulating reheat stage and one modulating peripheral reheat stage. Both stages are controlled via a pulse width modulation motor. Control turns on reheat valve first then peripheral valve.
- Dual Duct Reheat: Reheating provided by second hot duct. A satellite controller can be used in conjunction with the master controller to control the hot duct.
- Float Hotduct Pressure Dependent*** Reheating using a hot duct damper controlled by the floating reheat outputs in the pressure dependent case only.

NOTES: Pneumatic hot water valves can be controlled with a Pneumatic Transducer.

- * applies minimum position to the peripheral value during all modes (Cooling, Reheat, Etc.).
- ** applies minimum position to the reheat value during all modes (Cooling, Reheat, Etc.).
- *** applies minimum position to the reheat value during all modes except Cooling.

>> Flow Type: The flow type defines the control flow algorithm used by the controller. The selection available depends on the Pressure Type and the Box Type that are selected in the Configuration Screen.

- Flow Normal: The flow is controlled to satisfy the temperature control algorithm.
- Flow Tracking: The temperature control is turned off and the air flow setpoint equals the sum of SrcFlowTrack and Flow Offset (Control Parameters). Flow tracking can be used to pressurize or de-pressurize an area by having one or more VAV boxes deliver air to the space and one or more exhaust air from the space. By delivering or exhausting more air than is normally exhausted or delivered, the space can be pressurized or de-pressurized. Typically one or more boxes deliver air to the space and one box exhausts air from the space. Several nodes (controlling incoming air) can be bound in a daisy-chain to sum the total incoming flow. The last incoming air node is bound to the exhaust node. This setting is automatically selected if Pressure Type of Pressure Independent and Box Type of Flow Tracking are selected.
- Share Wall Module: The temperature control loop is turned off and the flow is controlled by the wall module at another node. In this case nvoShare is bound to nviShare of another node and the information received in nvoShare is used to control the air flow. The other node has the temperature sensor connected to it and

- controls the space temperature by its own damper and the other dampers of all nodes bound to it. This feature (Single Duct Box Type only), is used when only one temperature sensor is used in a large area to control several nodes.
- DD Master Constant Volume: The master node is connected to a cold air supply duct in a dual duct application and controls the air flow to the space. The satellite is connected to the hot duct. The master commands the satellite nodes damper via DestSatellite. The temperature control loop in the master is enabled and the temperature control loop in the satellite is disabled. Both the master and satellite have air flow sensors. The master controls the satellite so that the total air supplied is always a constant volume. When cooling is called, more Cool air is supplied to the space. When heating is called, more warm air is supplied to the space.
 - DD Satel Constant Volume: Refer to the description above for DD Master Constant Volume.
 - DD Master Flow Mix: The master node is connected to a cold air supply duct in a dual duct application and controls the air flow to the space. The satellite node is connected to the hot duct. The master node commands the satellite nodes damper via DestSatellite. Both the master and satellite have air flow sensors. The temperature control loop is enabled in the master and disabled in the satellite. Both warm air and cold air can be supplied to the space at the same time in the transition from heating to cooling or from cooling to heating - Flow mixing.
 - DD Satel Flow Mix: Refer to the description for DD Master Flow Mix.
 - DD Master No Flow Mix: Master node is connected to a cold air supply duct in a dual duct application and controls the air flow to the space. The satellite node is connected to the hot duct. Master node commands the satellite nodes damper via DestSatellite. Both the master and satellite have air flow sensors. The temperature control loop is enabled in the master and disabled in the satellite. Only warm air or cold air may be supplied to the space at the same time. When cooling is called, only Cool air is supplied to the space. When heating is called, only warm air is supplied to the space.
 - DD Satel No Flow Mix: Refer to the description for DD Master No Flow Mix.
 - Dual Duct Discharge Sensor: The node is connected to control both the cold and hot air supply damper. The physical damper outputs control the cold supply damper and the reheat physical floating outputs controls the hot air damper. The node has an air flow sensor measuring the total discharge air flow. The temperature control loop is enabled, and either warm air or cold air is supplied to the space. When cooling is called, only Cool air is supplied to the space (damper on hot duct is fully closed). When heating is called, only warm air is supplied to the space. There is no satellite node in this case. ReHeat Type is set to Float Reheat for this case.
 - Dual Duct Discharge Sensor Constant Volume: The node is connected to control both the cold and hot air supply damper. Physical damper outputs control the cold supply damper and the reheat physical floating outputs controls the hot air damper. The node has an air flow sensor measuring the total discharge air flow. The temperature control loop is enabled. Both warm air and cold air can be supplied to the space at the same time in the transition from heating to cooling or from cooling to heating. Reheat Type is set to Float Reheat for this case. Measured flow controls the cold duct damper Position and space temperature controls the hot duct damper Position.
 - Flow Normal: The node is connected to control both the cold and hot air supply damper. The physical damper outputs control the cold supply damper and the reheat physical floating outputs controls the hot air damper. The node has an air flow sensor measuring the cold duct air flow. The temperature control loop is enabled. Both warm air and cold air can be supplied to the space at the same time in the transition from heating to cooling or from cooling to heating. Reheat Type is set to Float Reheat for this case. Measured flow controls the cold duct damper Position and space temperature controls the hot duct damper Position.

TAB: INPUT

The available options for the VAV Input screen with the default values shown are listed in Table 6.

Table 6. VAV Controller Input Options.

Function	Configuration options	Default	Cross Reference Heading(s)
Analog Input Configuration			
Analog 1: If No Sensor, Sensor, or Sensor Override is selected in Configuration Tab> Wall Module Type (see above section)	Discharge Temp NTC Supply Temp NTC Unused AI	Unused AI	See configuration field descriptions below.
Analog 2			
Remote Stpt: If Sensor Setpoint, Sensor Setpoint Override, or LCD Wall Module is selected in Configuration Tab> Configuration > Wall Module Type	Absolute Relative	Absolute	“Sensor Options” “Tab: Configuration”
Digital Input Configuration			
Digital 1*	Heat Cool ChangeOver	Unused DI	“Heat/Cool Change Over”; Table 4; “Occupancy Sensor”; “Window Open/Closed Digital Input”; and “Window Sensor”.
Digital 2*	Monitor Switch		
Digital 3*	Occ Sensor Unused DI Window Open		

* Once a digital input configuration is selected for one digital input, it cannot be used again for another digital input.

The following describes some of the configuration fields for the Input selections:

>> Remote setpoint:

The user-adjustable setpoint potentiometer can work in either of two ways, relative (this uses a positive or negative offset of the programmed setpoint) or absolute, which means that if the dial says 74°F, the controller uses 74°F for the setpoint if it is within the setpoint limits specified by the Standby Setpoints.

>> Analog 1 or 2:

- Discharge Temp NTC reports the current discharge temperature for remote monitoring and or logging purposes.
- Supply Temp NTC is the temperature of the air being supplied to the VAV control box. It is used by the control process to put the controller into the heat mode.

TAB: CONTROL PARAMETERS

The available options for the VAV Control Parameters screen with the default values shown are listed in “VAV Control Parameters Options.” on page 39.

Table 7. VAV Control Parameters Options.

Function	Configuration options	Default	Cross Reference Heading(s)
Cooling Setpoints			In addition to headings referenced below,
Occupied	50 to 95°F	73.4°F	"Remote Setpoint" See also Configuration fields listed below this table.
Standby	50 to 95°F	77°F	
Unoccupied	50 to 95°F	82.4°F	
Heating Setpoints			
Occupied	50 to 95°F	69.8°F	"Remote Setpoint" See also Configuration fields listed below this table.
Standby	50 to 95°F	66.2°F	
Unoccupied	50 to 95°F	60.8°F	
Flow Setpoints			
Maximum	301 to 138840 CFM	1000 CFM	"Common Operations." See also Configuration fields listed below this table.
Minimum	0 to 301 CFM	199 CFM	
Max Reheat	301 to 138840 CFM	301 CFM	
Standby	0 to 138840	100 CFM	
Duct Area			
Area: If CustomArea is selected for Dia, Area can be specified; otherwise area is automatically set based on Dia	0 to 4 ft ²	0.5245 ft ²	See Configuration fields listed below this table.
Dia	CustomArea 4_In_Round 5_In_Round 6_In_Round 8_In_Round 10_In_Round 12_In_Round 14_In_Round 16_In_Round 18_In_Round 20_In_Round 22_In_Round 24_In_Round 26_In_Round	CustomArea	
Wall Module Setpoint Limits			
Low Lim	55 to 90 deg	55°F	"Setpoint Limits (Low Lim and High Lim)"
High Lim	55 to 90 deg	85°F	

The following describes the configuration fields for the Control Parameter selections:

Cooling Setpoints

>> Occupied: Space Temperature Setpoint to be maintained during occupancy while in COOL mode operation.

>> Standby: Space Temperature Setpoint to be maintained during standby while in COOL mode operation. This value is also used to provide an upper limit on the user adjustable remote setpoint pot (wall module).

>> Unoccupied: Space Temperature Setpoint to be maintained during unoccupied mode while in COOL mode operation.

Heating Setpoints

>> Occupied: Space Temperature Setpoint to be maintained during occupancy while in HEAT/REHEAT mode operation.

>> Standby: Space Temperature Setpoint to be maintained during standby while in HEAT/REHEAT mode operation. This value is also used to provide an upper limit on the user adjustable remote setpoint pot (wall module).

>> Unoccupied: Space Temperature Setpoint to be maintained during unoccupied mode while in HEAT/REHEAT mode operation.

Flow Setpoints

>> Maximum: Air flow rate not to be exceeded during normal Occupied operation.

>> Minimum: Minimum air flow rate to be maintained during normal operation.

>> Max Reheat: Air flow rate to be maintained during reheat operation

>> Standby: Air flow rate to be maintained during STANDBY operation.

Duct Area

>> Area/Dia: The cross-sectional area of the duct at the location of the air flow pickup must be entered. This is used to convert the measured velocity pressure into air flow in Cubic Feet per Minute (CFM) or Meters Cubed Per Hour (m3h). This value can be entered in LONSPEC in units of square feet or (square meters) or as the duct diameter for a round duct, in inches (meters) via a list box.

TAB: PICKUP TABLE

The type of physical air flow pickup to be used with this box must be chosen. There is a linearization table associated with each standard type, and once selected, this table is included in the next download to the controller.

The available options for the VAV Pickup Table screen with the default values shown are listed in Table 8.

Table 8. VAV Controller Pickup Table Options.

Function	Configuration Options	Default	Cross Reference Heading(s)
Differential Pressure, Pt 1 to Pt 10	0 to 2 inw	Pt 1: 0 inw Pt 2: 0.00391 inw Pt 3: 0.00977 inw Pt 4: 0.01978 inw Pt 5: 0.03979 inw Pt 6: 0.07983 inw Pt 7: 0.1499 inw Pt 8: 0.2998 inw Pt 9: 0.7998 inw Pt 10: 1.59985 inw	"Air Flow Control Sequences of Operation"
Velocity, Pt 1 to Pt 10	0 to 3500 ft/min	Pt 1: 0 ft/min Pt 2: 285 ft/min Pt 3: 404 ft/min Pt 4: 572 ft/min Pt 5: 757 ft/min Pt 6: 1074 ft/min Pt 7: 1526 ft/min Pt 8: 2139 ft/min Pt 9: 3026 ft/min Pt 10: 3391 ft/min	
Create New Sensor Type	Select from a listbox of choices or create a custom sensor	Custom Sensor	

TAB: PID

The following control gains should be adjusted only by authorized personnel. For most applications, no adjustment is necessary. The available options for the VAV PID screen with the default values shown are listed in Table 9.

Table 9. VAV Controller PID Options.

Function	Configuration Options	Default	Cross Reference Heading(s)
Cooling			
Throttling Range	1 to 20 DDF	3 DDF	"Control Application" and "Type of Reheat Coil"
Integral Action	0 to 5000 Sec	4000 Sec	
Derivative Action	0 to 255 Sec	0 Sec	
Heating			
Throttling Range	1 to 20 DDF	5 DDF	"Control Application" and "Type of Reheat Coil"
Integral Action	0 to 5000 Sec	2400 Sec	
Derivative Action	0 to 255 Sec	0 Sec	

TAB: MISC PARAMETERS

The available options for the VAV Misc Parameters screen with the default values shown are listed in Table 10.

Table 10. VAV Controller Misc Parameters Options.

Function	Configuration Options	Default	Cross Reference Heading(s)
Percent Max Flow			
Window	0 to 100%	0%	See Configuration Field descriptions below this table.
Reheat	0 to 100%	50%	
Minimum	0 to 100%	0%	
Maximum	0 to 100%	100%	
Standby	0 to 100%	50%	
Press	0 to 100%	100%	
Depress	0 to 100%	0%	
Purge	0 to 100%	50%	
Warmup	0 to 100%	50%	
Bypass Settings			
Time	0 to 1080 Min	180 Min	See Configuration Field descriptions below this table.
Type	Bypass Normal	Normal	
Priority	Last Net	Net	
Other Misc Parameters			
Periph Minimum Pos	0 to 100%	0%	See Configuration Field descriptions below this table.
Demand Limit Offset	0 to 10 DDF	3 DDF	
Temp Ramp Rate	0 to 36°F/h	4°F/h	
Fan Flow Setpoint	0 to 13883 CFM	0 CFM	
Fresh Air Required	0 to 13883 CFM	0 CFM	

Percent Max Flow

- >> Window: Maximum air flow when a Window is Open
- >> Reheat: Maximum air flow during HEAT/REHEAT mode.
- >> Minimum: Air flow rate not to go below this value during normal Occupied operation.
- >> Maximum: Air flow rate not to be exceeded during normal Occupied operation.
- >> StandBy: Maximum air flow rate during STANDBY mode.
- >> Press: Damper position based on the air flow setpoint during Smoke Control operation. For pressurization (Pressure Independent). Physical damper position goes to a position as commanded during Smoke Control operation. For depressurization (Pressure Dependent).
- >> Depress: Damper position based on the air flow setpoint during Smoke Control operation. For depressurization (Pressure Independent). Physical damper position goes to a position as commanded during Smoke Control operation. For depressurization (Pressure Dependent).
- >> Purge: Damper position based on the air flow setpoint during Night Purge operation (Pressure Independent). Physical damper position goes to a position as commanded during Night Purge operation (Pressure Dependent).

>> Warmup: Damper position based on the air flow setpoint during Morning Warm-Up operation (Pressure Independent). Physical damper position goes to a position as commanded during Morning Warm-Up operation (Pressure Dependent).

Bypass Settings

>> Time: Bypass Time is the time between the pressing of the override button at the wall module and the return to the original occupancy state. When the Bypass state is activated, the bypass timer is set to the Bypass time.

>> Type: OverrideType specifies the behavior of the override button on the wall module. There are two possible states that have the following meanings:

NORMAL causes override button to set Override state to OC_BYPASS for BypassTime (default 180 minutes), when the override button is pressed for approximately 1 to 4 seconds, or to set the override state to UNOCC when the button has been pressed for approximately 4 to 7 seconds. When the button is pressed longer than approximately 7 seconds, then the override state is set to OC_NUL (no manual override is active).
 BYPASS causes override button to set override state to OC_BYPASS for BypassTime (default 180 minutes), on the first press (1 to 7 seconds). On the next press, the override state is set to OC_NUL (no manual over ride is active).

>> Priority: There are two possible states which have the following meanings:

LAST-Specifies that the last command received from either the wall module or DestManualOcc determines the effective override state.

NET-Specifies that when DestManualOcc is not OC_NUL, then the effective occupancy is DestManualOcc regardless of the wall module override state.

Other Misc Parameters:

>> Periph Minimum Position: Percentage for peripheral valve minimum position.

>> Demand Limit Offset: Degrees of offset for demand limit. Activated when DestDlcShed is True or active.

>> Temp Ramp Rate: Ramp rate for temperature.

>> Fan Flow Setpoint: Setpoint in cfm for fan flow.

>> Fresh Air Required: Amount of fresh air required in cfm. FreshAirRatio is equal to FreshAir Req divided by SrcBoxFlow. When this ratio is large (greater than 100 percent) there is insufficient fresh air being supplied to the zone even if the supply air is 100 percent fresh air. When the ratio is small, there is sufficient fresh air being supplied to the zone. The ratio is used for coordination within the HVAC subsystem and energy management decisions by the supply equipment.

TAB: WIRING

By selecting an item from the Configured Output list and moving it to the left screen, and subsequently moving an item to the Configured Output list allows the user to specify specific terminal positions for selected outputs. For more details, please see the LONSPEC User's Guide.

Commissioning

Commissioning refers to the activities performed to optimize the VAV box operation to meet the job specification requirements and overall fine tuning of the box control. LONSPEC is the tool used to perform these activities, as described in Appendix B

ID NUMBER

Each Excel 10 VAV Controller is shipped with an internal Identification Number from the factory. This ID number is on a removable sticker on the inside of the W7751 housing. When assigning the ID numbers, the procedure used depends on if the controllers were installed at the site or if they can be configured one at a time on a bench top.

The ID number can either be manually entered or a node can broadcast its ID number on the LONWORKS Bus. The commissioning tool (LONSPEC) is used to perform both methods (see LONSPEC User's Guide, form 74-2937).

Step 3. Troubleshooting

Troubleshooting Excel 10 Controllers and Wall Modules

In addition to the following information, refer to the Installation Instructions and Checkout and Test manual for each product. See the Applicable Literature section for form numbers.

Temperature Sensor and Setpoint Potentiometer Resistance Ranges

T7770 or C7770A Air Temperature Sensors have the following specified calibration points, which are plotted in Fig. 43:

Temperature (°F)	Resistance Value (ohms)
98	11755
80	18478
70	24028
60	31525
42	52675

The T7770 Wall Module setpoint potentiometers have the following calibration points:

Temperature (°F)	Resistance Value (ohms)
85	1290
70	5500
55	9846

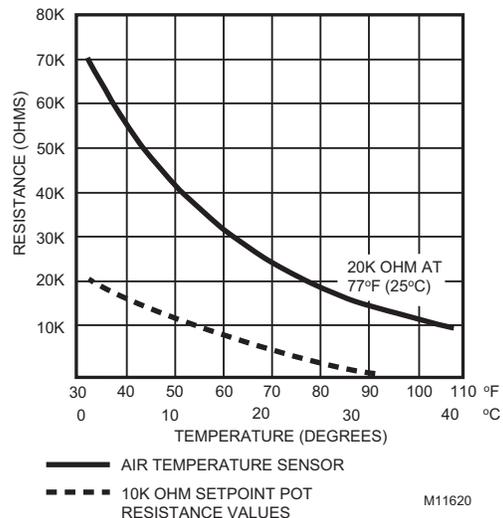


Fig. 43. Temperature sensor resistance plots.

Alarms

When an Excel 10 has an alarm condition, it reports it to the central node on the LONWORKS Bus. See Table 11.

Information contained in an alarm message is:

- Subnet Number: LONWORKS Bus subnet that contains the Excel 10 node that has the alarm condition.
- Node Number: Excel 10 node that has the alarm condition (see Network Alarm).
- Alarm Type: Specific alarm being issued. An Excel 10 can provide the alarm types listed in Table 11.

NOTE: The node can be reset by switching the node to MANUAL and then to the normal operating mode.

Also, the Excel 10 VAV Controller variables, *AlarmLogX*, where X is 0 through 4, that store the last five alarms to occur in the controller, are available. These points can be viewed through LONSPEC.

Certain alarm conditions are suppressed conditionally as follows:

If an input Excel 10 VAV Controller variable (except RmtFlow1) with failure detect is bound to the same node as the Excel 10 VAV Controller variable Alarm, then the Excel 10 VAV Controller variable Alarm and AlarmLogX do not report the related Excel 10 VAV Controller variable receive failure error and its associated return to normal. Suppression only occurs when the Excel 10 VAV Controller variable Alarm is bound to only one node using LONWORKS subnet node addressing. Suppression occurs only after the input Excel 10 VAV Controller variable has actually received an Excel 10 VAV Controller variable from the node since the latest application restart (or power-up condition). The Excel 10 VAV Controller

variable Error contains all the detected current errors even though they can be suppressed for reporting by the Excel 10 VAV Controller variable Alarm and AlarmLogX.

Broadcasting the Service Message

The Service Message allows a device on the LONWORKS Bus to be positively identified. The Service Message contains the controller ID number and, therefore, can be used to confirm the physical location of a particular Excel 10 VAV Controller in a building.

There are two methods of broadcasting the Service Message from an Excel 10 W7751 Controller. One uses a hardware service pin button on the W7751B,D,F,H,J Controllers.

NOTE: When pressing the W7751D,F,H service pin button, use a non-metallic object to press the button through the access holes.

Table 11. Excel 10 Alarms.

Name of alarm or error bit	Alarm type number	Meaning of alarm code or error bit
NO_ALARM	0	No alarms presently detected.
COMM_FAILED	1	One or more NV inputs have failed to receive an update within their specified FAILURE_DETECT_TIME.
SENSOR_FAILED	2	One or more sensors have failed.
INVALID_CONFIG	3	The binding of network variables is inconsistent with the configuration.
INVALID_SETPOINT	4	One of the Setpoints is not in the valid range.
NODE_DISABLED_ALM	5	The control algorithm has stopped because the controller is in DISABLED_MODE, MANUAL, or FACTORY_TEST mode. No more alarms are reported when the controller is in the DISABLED_MODE. Alarms continue to be reported if the controller is in the MANUAL, or FACTORY_TEST mode.
FROST_PROTECT_ALM	6	The space temperature is below the frost alarm limit 42.8°F (6°C) when the mode is FREEZE_PROTECT. The alarm condition remains until the temperature exceeds the alarm limit plus hysteresis.
SMOKE_ALARM	7	When the node enters the Pressurize or DePressurize mode, then the node issues the SmokeAlarm.
Comm_Failed_Rtn	129	Return to no alarm after being in an alarm condition. This code is added numerically to another alarm code to indicate that the alarm condition has returned to normal.
Sensot_Failed_Rtn	130	
Invalid_Config_Rtn	131	
Invalid_Setpt_Rtn	132	
Node_Disabled_Rtn	133	
Frost_Protect_Rtn	134	
Smoke_Alarm_Rtn	135	
ALM_NOTIFY_DISABLED	255	The alarm reporting was turned off by NviManOcc. No more alarms are reported via nvoAlarm until NviManOcc turns on alarm reporting or on application restart.

The other involves using the LONSPEC, as follows:

When an *Assign ID* command is issued from the LONSPEC commissioning tool, the node goes into the SERVICE_MESSAGE mode for five minutes. In the SERVICE_MESSAGE mode, pressing the occupancy override button on the remote wall module (refer to Fig. 83 for override button location) causes the Service Message to be broadcast on the network. All other functions are normal in the

SERVICE_MESSAGE mode.

If an Excel 10 VAV Controller does not have an override button connected, it can still broadcast the Service Message on the network by temporarily shorting the controller Bypass Input terminal to the Sensor Ground terminal (on the W7751D,F short terminals 24 to 26, on the W7751B short terminals 20 to 22 and on the W7751H short terminals 7 and 5).

APPENDICES

Appendix A: Creating a Work Bench to Configure Excel 10 W7751D,F VAV Controllers

Fig. 44 illustrates one possible test-bed setup for configuring Excel 10 VAV Controllers offsite. This setup allows W7751D,F Controllers to be plugged in, configured from a PC running LONSPEC, and removed quickly and easily.

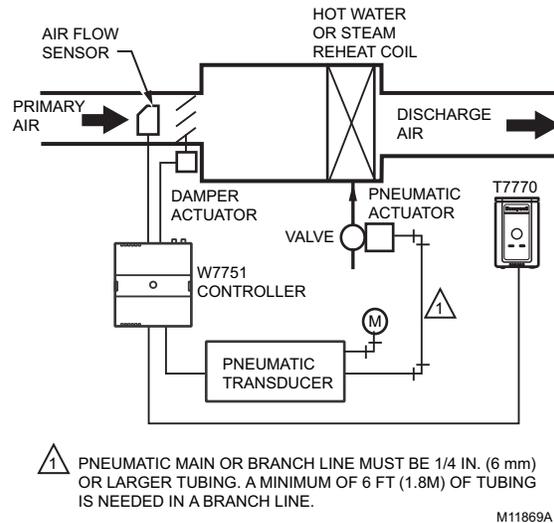


Fig. 44. Excel 10 VAV Controller configuration work bench.

Appendix B: Using LONSPEC to Commission a W7751 Controller

Job Commissioning

Commissioning updates the controller with the configuration in the LONSPEC database. The purpose of commissioning is to download the information you configure from the LONSPEC database to the controller's database.

ID Number

Each Excel 10 VAV Controller is shipped with an internal Identification Number from the factory. This ID number is on a removable sticker on the inside of the W7751 housing. When assigning the ID numbers, the procedure used depends on if the controllers were installed at the site or if they can be configured one at a time on a bench top.

The ID number can either be manually entered or a node can broadcast its ID number on the LONWORKS Bus.

BENCH TOP CONFIGURING

Appendix A presents a simple work bench arrangement of the required hardware and the associated wiring connections to configure Excel 10 W7751D,F Controllers. Proceed as follows:

IMPORTANT

The data file used for this configuration must be used at the job site so the commissioning data matches the controllers.

1. With power disconnected to the housing subbase, insert the controller circuit board (contained in the housing cover) into the subbase unit.
2. Apply power to the controller, and insert the Serial Interface cable into the jack on either the Excel 10 W7751D or F Controllers (see Appendix A).
3. Use the LONSPEC PC tools to configure the controller.

NOTE: See the LONSPEC User's Guide, form 74-2937, for further details.

4. Use the ID number sticker on the controller or press the bypass button on the wall module.
5. When configuration is completed, power down and remove the W7751D,F from the subbase.
6. Mark the controller with the location reference so the installer knows where to install each controller in the building.
7. Repeat with next W7751D,F to be configured.

CONFIGURING IN THE FIELD

If the controllers were installed at the site, the procedure to assign the node numbers to the Excel 10 VAV Controller is as follows:

1. Instruct the installer to remove the ID sticker from each controller during installation and to affix it to either the job blueprint at the appropriate location or to a tabulated list. Be sure the installer returns these prints to the application engineer after the controllers are installed.
2. Connect to the LONWORKS Bus with the LONSPEC PC tool.
3. Proceed to configure the W7751 per the LONSPEC User's Guide, form 74-2937 (using the job prints for location reference for the controllers)

Sensor Calibration

The space temperature and the optional resistive inputs can all be calibrated. The wall module setpoint potentiometer *can not* be calibrated. Perform the sensor calibration by adding an offset value (either positive or negative) to the sensed value using LONSPEC menus (see the LONSPEC user's guide, form 74-2937).

The temperature sensor in the Excel 10 wall modules can be calibrated to correct for sensor inaccuracies, wire resistance, etc. This allows the Excel 10 VAV Controller to sense the space temperature with a high degree of accuracy by applying a correction to the sensor input.

PROCEDURE

Select the controller being worked on with LONSPEC by right-clicking a controller on the subnet in the workspace and selecting **Calibrate** from the menu (see the LONSPEC User Guide for details on using LONSPEC).

The list of controllers appears on the screen. Choose the specified controller from the list and click OK.

The calibration screen provides a list of sensors. After selecting a sensor, the actual value of the sensor displays. Enter an offset value that represents the true value that the sensor should be detecting. Click the **Calibrate** button to store the offset value in the controller.

Air Flow Balancing (for Pressure-Independent Applications Only)

In addition to the ten point Flow Pickup Calibration Table, the Excel 10 VAV Controller provides for 3-point (Maximum, Minimum, and Zero) Air Flow Calibration. This allows the box to be adjusted so it can be certified that the box provides the flow rates specified by the consulting engineer. When balancing is complete, the actual flow from a box should be within 5 to 10 percent of the indicated air flow (as shown on the LONSPEC screen).

NOTE: There are many sources of error in flow-hood measurements. Flow hood meters typically attain accuracy to within plus or minus three to five percent of full flow. The error can be due to the device being out of calibration, or that it was last calibrated with a different style of diffuser. Even the operator technique plays a role in obtaining repeatable, accurate flow readings. When working with slotted

diffusers, *do not use* a hood; use a velocity-probe type of instrument. Follow the diffuser manufacturer's recommendation for how to best measure the air flow through their products.

PROCEDURE**IMPORTANT**

Prior to air flow balancing for the first time, perform a zero flow calibration procedure. To do so, power the Excel 10 VAV Controller for one hour or more before performing the procedure.

Select the controller being worked on with LONSPEC (see the LONSPEC User's Guide, form 74-2937, for general details on using LONSPEC). Due to inconsistencies in VGA display cards and modes, be sure to maximize the LONSPEC window on the screen. This assures that all LONSPEC activities are user viewable.

Using LONSPEC and with the controller connected, right click on the VAV II controller in the subnet area and select the Calibrate option. Alternatively, select the Controller menu and choose Calibrate to open the Calibrate Controller dialogue box. The Excel 10 VAV II calibration allows for both temperature and flow calibration. Click the tab for Flow Calibration within the Sensor Calibration screen for VAV II. For specifics, please refer to the LONSPEC User's Guide, form 74-2937 to set the flow calibration for maximum, minimum, zero, and setpoint values.

RESETTING AIR FLOW CALIBRATION TO FACTORY DEFAULTS

Select the Action button titled "Reset" on the Flow Calibration tab to reset to factory defaults.

VAVII Calibration Sequence

To calibrate a dual duct VAV box that has flow mixing with constant volume using two W7751 Controllers, follow the procedure shown below:

1. Create the Master controller in LONSPEC:
 - a. Add a VAVII controller to the network.
 - b. Configure inputs and outputs through Application Selection under the Controller menu:
 - (1) Configuration Tab:
 - (a) Select controller type (Standard/OEM, or Smart).
 - (b) Select Box Type (Dual Duct).
 - (c) Select Flow Type (DD Master Constant Volume).
 - (d) Select Pressure Type (Pressure Independent).
 - (e) Select Wall Module Type.
 - c. The Reheat Type will be Dual Duct Reheat, the Fan Type will be No Fan, and Morning Warm-up Type will be Fixed Flow.
 - d. Enter correct motor speed value (default is 90 sec).
 - (1) Input Tab:
 - (a) Select Remote Setpoint (Absolute or Relative).
 - (b) Select any additional Analog or Digital inputs.
 - (2) Control Parameters Tab:
 - (a) Enter the desired Flow Setpoints.
 - (b) Enter the correct Duct area or select the duct diameter from the drop-down list.
 - (3) Flow Pickup Table Tab:

- (a) Select correct Flow Pickup from the Sensor Type drop-down list.
 - (b) Click the OK button to save the changes and exit the Application Selection screen.
2. Create the Satellite controller in LONSPEC:
 - a. Add a VAVII controller to the network.
 - b. Configure the inputs and the outputs through the Application Selection under the Controller menu:
 - (1) Configuration Tab:
 - (a) Select controller type (Standard/OEM, or Smart).
 - (b) Select Box Type (Dual Duct).
 - (c) Select Flow Type (DD Satel Constant Volume).
 - (d) Select Pressure Type (Pressure Independent).
 - (e) Select Wall Module Type.
 - (f) The Reheat Type will be Dual Duct Reheat, the Fan Type will be No Fan, and Morning Warm-up Type will be Fixed Flow.
 - (g) Enter correct motor speed value (default is 90 sec).
 - (2) Input Tab:
 - (a) There will be no Remote Setpoint for the Satellite controller.
 - (b) Select any additional Analog or Digital inputs.
 - (3) Control Parameters Tab:
 - (a) Enter desired Flow Setpoints. They should be the same as the Master controller setpoints.
 - (b) Enter correct Duct area or select the duct diameter from the drop-down list.
 - (c) There are no Cooling or Heating Setpoints or Remote Setpoint limits available for the Satellite controller.
 - (4) Flow Pickup Table Tab:
 - (a) Select correct Flow Pickup from the Sensor Type drop-down list.
 - (b) Click the OK button to save the changes and exit the Application Selection screen.
3. Bind Points:
 - a. Select Network Menu item > Refer Points.
 - b. Select Source controller to be master Excel 10.
 - c. Select Satellite controller to be Destination Excel 10.
 - d. Under Source Controller points, select nvoBoxFlow.
 - e. Under Destination Excel 10 Points, select nviFlowTrack.
 - f. Click the Add button to add binding to the References list box. This completes the binding required between Master and Satellite controllers.
 - g. Click Close to exit the Refer Excel 10 Points dialog box.
4. Commission Master and Satellite Controllers:
 - a. Go to Online mode.
 - b. Select Assign Neuron ID (Controller menu item):
 - (1) Use the wall module Pushbutton on the Master controller wall module to assign the ID for Master or manually enter the ID for both Master and Satellite controllers. The status for both controllers should be Not Commissioned.
 - (2) Close the dialog box.
 - c. Commission both Master and Satellite controllers.
5. Calibrate Air Flow:
 - a. To calibrate the Master controller—Select Master controller (Cold Duct Damper).
 - b. Select Calibration (Controller menu item) and Flow Calibration Tab.
 - c. Select Reset to load the factory defaults (this is done so the controller has good starting values for the zero, minimum, and maximum calibration).
 - d. Select Zero to perform Zero Calibration (this process takes a couple of minutes to complete).
 - e. When calibration is complete, close the Air Flow Zero Calibration dialog box.
 - f. Select Maximum to perform maximum calibration.
 - g. When Maximum Calibration Status displays Setpoint reached, enter measured flow, then enter the measured value and click Calibrate.
 - h. When calibration is complete, close the Air Flow Maximum Calibration dialog box.
 - i. Select Minimum to perform minimum calibration.
 - j. When Minimum Calibration Status displays Setpoint reached, enter measured flow, then enter the measured value and click Calibrate.
 - k. When calibration is complete, close the Air Flow Minimum Calibration dialog box.
 - l. Close the Air Flow Calibration and the VAVII Sensor Calibration dialog boxes.
 - m. Select Satellite controller (Hot Duct Damper).
 - n. To balance the Hot Duct Damper, the Cold Duct Damper has to be closed.
6. Close Damper:
 - a. Right Click the master controller and select Controller Diagnostics.
 - b. Enter a value of 0.0% for the damper position and then click Set.
 - c. Click Close.
 - d. Select No on the next dialog box to not put the controller into Auto mode.
 - e. To calibrate the satellite controller, repeat step 5.
 - f. Select the master controller and controller diagnostics.
 - g. Click Close and select Yes to put the controller in the Auto Mode.
7. Verify Calibration.
 - a. Select Master controller (Online Mode).
 - b. Select Monitor mode (Controller menu item).
 - c. Verify Cold/Hot Duct Flow values and if the VAV box is reaching setpoints.

Appendix C: Sequences of Operation

This Appendix provides the control sequences of operation that are pressure independent or pressure dependent. In pressure dependent applications, the reheat setpoint will default from CFM (m3h) to a fixed percent open position for the damper.

NOTE: Pressure dependent applications require physical minimum and maximum position stops on the damper actuator.

Common Operations.

The Excel 10 VAV temperature control applications have common configuration options. However, Exhaust Flow Tracking, does not perform temperature control at all, and is strictly a flow control algorithm; therefore, it does not share the common operations. This section describes the common operations.

Each application can have any or all of these devices configured with the restriction that every Excel 10 VAV Controller that controls temperature *must* have a temperature sensor (either wired directly to the controller or shared from another Excel 10 VAV Controller).

ROOM TEMPERATURE SENSOR (RMTEMP)

This is the room space temperature sensor. This sensor is the T7770 Wall Module or the T7560A,B LCD Wall Module. When it is configured, it provides the temperature input for the W7751 temperature control loop. If it is not configured, it is required that a room temperature sensor value be transmitted from another W7751 Controller with a wall module in the same zone. If no valid room temperature value is available to the W7751 Controller, the temperature control algorithm in the controller is disabled, causing the heating and cooling control outputs to be turned off.

It can be required that either Wall Module or Room Temperature sharing be provided from another Excel 10 VAV Controller with a wall module or temperature sensor. The room temperature sensor can be calibrated via LONSPEC (see Temperature Sensor Calibration in Appendix B).

REMOTE SETPOINT

NOTE: The C7770A Air Temperature Sensor (DischargeTempNTC or SupplyTempNTC) or the setpoint pot options are selectable in LONSPEC. (Either one or the other can be selected, but not both on the W7751H or J Controller.)

This is the Setpoint Potentiometer contained in the T7770 or T7560A,B Wall Module. When configured, this occupant value is set to calculate the actual cooling or heating Occupied Setpoint. There are two options for how to calculate the actual setpoint to be used by the temperature control algorithm: (Offset) and (Absolute Middle). When SetPtKnob is set to Offset, the Wall Module setpoint knob represents a number from -9° to +9°F (-5° to +5°C) which is added to the software occupied setpoints for the heat and the cool modes (CoolOccSpt and HeatOccSpt).

When SetPtKnob is set to Absolute Middle, the setpoint knob becomes the center of the Zero Energy Band (ZEB) between the cooling and heating occupied setpoints. The size of the ZEB is found by taking the difference between the software heating and cooling occupied setpoints; therefore, for Absolute Middle, the actual setpoints are found as follows:

$$\begin{aligned} \text{RmTempActSpt (in cooling mode)} &= \text{RmtStptPot} + \\ & \quad (\text{CoolOccSpt} - \text{HeatOccSpt}) / 2 \\ \text{RmTempActSpt (in reheat mode)} &= \text{RmtStptPot} - \\ & \quad (\text{CoolOccSpt} - \text{HeatOccSpt}) / 2 \end{aligned}$$

During Standby and Unoccupied times, the remote setpoint pot is not referenced, and the software setpoints for those modes are used instead.

The C7770A Air Temperature Sensor is a direct-wired temperature sensor that is used to sense discharge, supply or return air in a duct that can be controlled by an Excel 10 W7751 VAV Controller. When configured, this provides the temperature input for the VAV controller setpoint inputs.

SETPOINT LIMITS (LOW LIM AND HIGH LIM)

Remote setpoint pot limits are provided by Low Lim and High Lim. The occupied setpoints used in the control algorithms are limited by these parameters.

When the setpoint knob is configured to be of type Absolute Middle, the lowest actual setpoint allowed is equal to Low Lim, and the highest actual setpoint allowed is equal to High Lim. When the setpoint knob is configured to be an Offset type, the lowest actual setpoint allowed is equal to HeatOccSpt - Low Lim, and the highest allowed is equal to CoolOccSpt + High Lim.

BYPASS MODE (STATUSOVERRIDE AND STATUSLED)

During Unoccupied periods, the facility occupant can request that Occupied temperature control setpoints be observed by depressing the Bypass pushbutton on the wall module. When activated, the controller remains in Bypass mode until:

1. Bypass Duration Setting has timed out (BypassTime), or
2. User again presses the Wall Module pushbutton to switch off Bypass mode, or
3. Occupancy schedule (NviTodEvent network input) switches the mode to Occupied.
4. User sets the DestManualOcc network point to Null.

The LED on the Wall Module (StatusLed) indicates the current bypass mode status (see the T7770C,D Wall Module Override LED section).

BYPASSTIME

BypassTime is the time between the pressing of the override button at the wall module (or initiating OC_BYPASS via DestManualOcc) and the return to the original occupancy state. When the bypass state has been activated, the bypass timer is set to BypassTime (default of 180 minutes).

OVERRIDE TYPE

OverrideType specifies the behavior of the override button on the wall module. There are two possible states that have the following meanings:

NORMAL-Causes the override button to set the Override state to OC_BYPASS for BypassTime (default 180 minutes), when the override button has been pressed for approximately 1 to 4 seconds, or to set the override state to UNOCC when the button has been pressed for approximately 4 to 7 seconds. When the button is pressed longer than approximately 7 seconds, then the override state is set to OC_NUL (no manual override is active).

BYPASS causes the override button to set the override state to OC_BYPASS for BypassTime (default 180 minutes), on the first press (1 to 7 seconds). On the next press, the override state is set to OC_NUL (no manual over ride is active).

OVERRIDE PRIORITY

Override Priority configures the override arbitration between DestManualOcc, DestBypassState, and the wall module override button. There are two possible states which have the following meanings:

LAST-Specifies that the last command received from either the wall module or DestManualOcc determines the effective override state.

NET-Specifies that when DestManualOcc is not OC_NUL, then the effective occupancy is DestManualOcc regardless of the wall module override state.

STANDBY MODE

The digital input for an occupancy sensor (usually a motion detector, or can be a time clock) provides the controller with a means to enter an energy-saving Standby mode whenever there are no people in the room. Standby mode occurs when the scheduled occupancy is Occupied, and the occupancy sensor detects no people currently in the room (digital input contacts Closed means people are in the room, and contacts Open means the room is Unoccupied). When in Standby mode, the Excel 10 VAV Controller uses the Standby Cooling (or Heating) Setpoint (CoolStbySpt or HeatStbySpt) for the Actual Space Temperature Setpoint.

WINDOW SENSOR

The digital input for a window contact provides the algorithm with a means to disable its temperature control activities if someone has opened a window or door in the room. When a window is detected to be Open (digital input contacts Open equals window open), the box damper is commanded to control a damper to a configured percentage of maximum CFM (m3h) air flow for the ZeroDmprPos setting. Normal temperature control resumes when the window closes.

CAV CONTROL

On the occasion where it is required to supply Constant Air Volume (CAV) to the space. This can be accomplished by setting the Maximum and Minimum and Reheat Air Flow Setpoints to the same value.

CONTINUOUS UNOCCUPIED MODE

This mode is entered when a wall module is configured with a bypass button that was pressed for four to seven seconds, causing the wall module LED to blink. This mode can also be entered via a network command (ManualOcc set to Unoccupied). If the controller is in this mode, it reverts to the Unoccupied Setpoints and control. The controller remains in this mode indefinitely or until the bypass button is pressed to exit the mode or a network command is sent to clear the mode.

SHARE WALL MODULE

If one or more terminal units serve a common area, and it is specified (or desired) to use a single temperature sensor for these boxes, the Share Wall Module option can be configured. Refer to the Cautions and Notes in the Wall Module Options section, Common Temperature Control (Shared Wall Module subsection).

The operation of the *satellite* controllers follows the temperature control and modes of the controller with the temperature sensor module. For example, this includes Temperature Setpoints and Occupied/Unoccupied/Standby/Bypass, modes. Each *satellite* controller performs flow loop control with its own Maximum, Minimum and Reheat Flow Setpoints, but is directed by the primary controller. For example, if the primary control is at 50 percent of flow; that is, 500 CFM (849 m3h) for MAX/MIN values of 1000/0 CFM (1700/0 m3h), then the *satellite* is also at 50 percent of its own Flow Setpoints, such as 400 CFM (680 m3h) for MAX/MIN values of 800/0 CFM (1360/0 m3h). Similarly, the primary unit directs the percent open or number of heating stages on for the *satellite* units.

NIGHT PURGE

If a terminal unit is put into the Night Purge mode via program (or manual) control, CmdMode set to (Night Purge), the controller performs the following functions (It):

- Disables the temperature control loop.
- Disables the flow control loop.
- Controls a damper to a configured percentage of maximum CFM (m3h) air flow (PurgeDmprPos).
- Enables terminal fan.

MORNING WARM-UP

A Morning Warm-Up cycle commands the Excel 10 VAV Controller to open its VAV box to a preselected position to allow the conditioned space to warm up. (On boxes with reheat, the reheat is locked out during the Warm-Up mode.) When Morning Warm-Up is completed, Excel 10 VAV Controllers are commanded to the Occupied condition.

If a unit is put into Morning Warm-Up mode via program (or manual) control, CmdMode set to (Morning Warm-Up), then the controller disables its temperature and flow loops and performs the following functions (It):

- Controls a damper to a configured percentage of maximum CFM (m3h) air flow (MornWarmupPos).
- Enables terminal fan.
- Disables local heat (staged or modulating).

SMOKE CONTROL

The Excel 10 VAV Controller supports two smoke-related modes, Pressurize, and Depressurize. When the controller is placed in one of these two modes via a network command, the box damper is commanded to a fixed position specified in a separate user-adjustable Setpoint for each mode, and the temperature control function is disabled.

DEMAND LIMIT CONTROL

When a high-electrical-demand signal is received via the LONWORKS Bus network, the controller applies a DicBumpTemp Setpoint to the current PID error value. This has the effect of bumping the temperature control point to save energy. This offset bumps the cooling control point upward, and bumps the heating control point downward.

START-UP

Upon initial start-up or on a restart after power failure, the Excel 10 VAV Controller neuron ID number is used as a random number that assigns the controller to one of two groups, even or odd. Based on this determination, one group of controllers drives its actuators open and the other group drives its actuators closed. Only on initial power-up can a controller drive its actuators to go open. Controllers in these groups go through a controlled restart with different time delays to assure smooth air handling unit start-up, minimizing air distribution problems.

NOTE: After a controller download via LONSPEC, the delayed reset time is bypassed and the controller starts after a 40-second initialization.

AIR FLOW CONTROL SEQUENCES OF OPERATION

The primary function of the temperature-control applications is to regulate the quantity in Meters Cubed per Hour or CFM, of supply air delivered to the space to control the space temperature. The algorithm assumes there is cold air in the duct; therefore, as the box damper is opened wider, the space becomes cooler.

Dual Duct, Pressure-Independent, with Flow Mixing, with Cold and Hot Duct Flow Pickups (Uses a Satellite Excel 10 for Hot Duct)

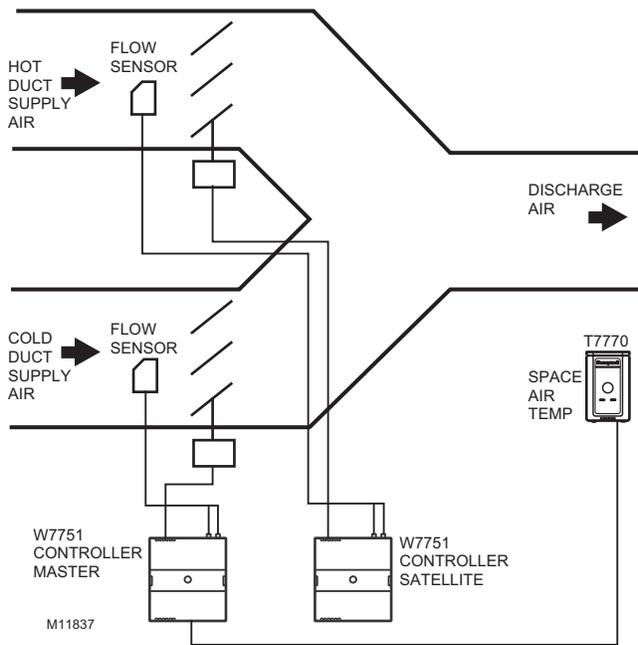


Fig. 45. Dual Duct, Pressure Independent, with flow mixing, with cold and hot duct flow pickups (uses a satellite Excel 10 for hot duct).

DUAL DUCT FLOW MIXING (FOR SETUP AND CALIBRATION REFER TO THE DUAL DUCT CALIBRATION PROCEDURE IN APPENDIX B)

Master Flow Configuration: DD Master Flow Mix.

Master Reheat Configuration: DualDuctReheat.

Satellite Flow Configuration: DD Satel Flow Mix.

Satellite Reheat Configuration: DualDuctReheat.

NOTE: In order for this application to function properly, the following bindings have to be made through refer points in LonSpec. Bind nvoShare from the master to nviShare of the satellite and bind nvoBoxFlow from the satellite to nviFlowTrack of the master.

Dual duct flow mixing uses two control devices, a master (for the cold duct) and a satellite (for the hot duct) to provide pressure independent control. If there is a need for cooling, dual duct flow mixing will control temperature to the cooling setpoint, setting the flow control setpoint for the cold duct between min flow and max flow while setting the hot duct flow setpoint to zero. If the temperature of the space is between the cooling and the heating setpoints, the cold duct will control to the min flow while the hot duct flow is set to zero. If there is a need for heating, the controllers will try to control to the heating setpoint by first modulating the cold duct flow from min flow to zero while simultaneously modulating the hot duct flow from zero to min flow. If there is additional need for heat, the hot duct will modulate from min flow to max flow while the cold duct is set to zero. Since during the initial heating load, both the hot and cold duct are supplying air, we have flow mixing.

Dual Duct, Pressure-Independent, without Flow Mixing, with Cold and Hot Duct Flow Pickups (Uses a Satellite Excel 10 for Hot Duct)

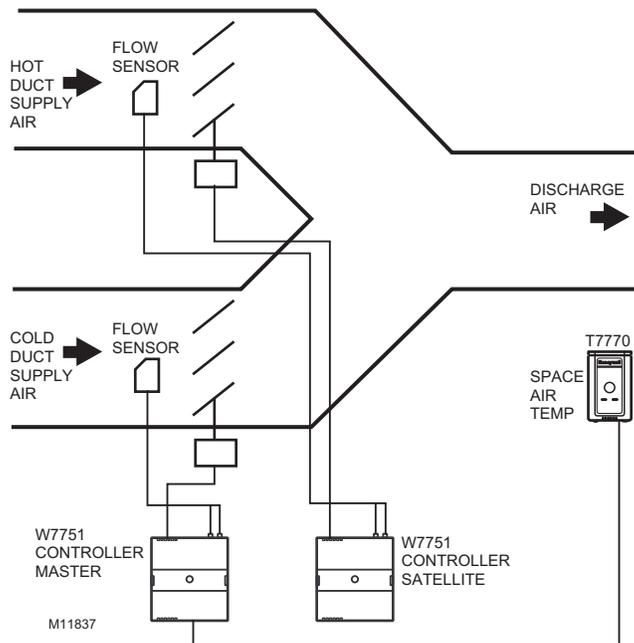


Fig. 46. Dual Duct, Pressure Independent, without flow mixing, that has cold and hot duct flow pickups (uses a satellite Excel 10 for hot duct).

DUAL DUCT NO FLOW MIXING (FOR SETUP AND CALIBRATION REFER TO THE DUAL DUCT CALIBRATION PROCEDURE IN APPENDIX B)

Master Flow Configuration: Master_No_Flow_Mix.

Master Reheat Configuration: DualDuctReheat.

Satellite Flow Configuration: Satel_No_Flow_Mix.

Satellite Reheat Configuration: DualDuctReheat.

NOTE: In order for this application to function properly, the following bindings have to be made through refer points in LonSpec. Bind nvoShare from the master to nviShare of the satellite and bind nvoBoxFlow from the satellite to nviFlowTrack of the master.

Dual duct flow mixing uses two control devices, a master (for the cold duct) and a satellite (for the hot duct) to provide pressure independent control. If there is a need for cooling, dual duct flow mixing will control temperature to the cooling setpoint, setting the flow control setpoint for the cold duct between min flow and max flow while setting the hot duct flow setpoint to zero. If the temperature of the space is between the cooling and the heating setpoints, the cold duct will control to the min flow while the hot duct flow is set to zero. If there is a need for heating, the controllers will try to control to the heating setpoint by first setting the cold duct flow to zero then modulating the hot duct flow from min flow to max flow; During the heating and cooling only one damper is being used at any one time to provide heating or cooling, this provides no flow mixing.

Dual Duct, Pressure-Independent Cooling, Pressure-Dependent Heating with Flow Mixing, with Cold Duct Flow Pickup

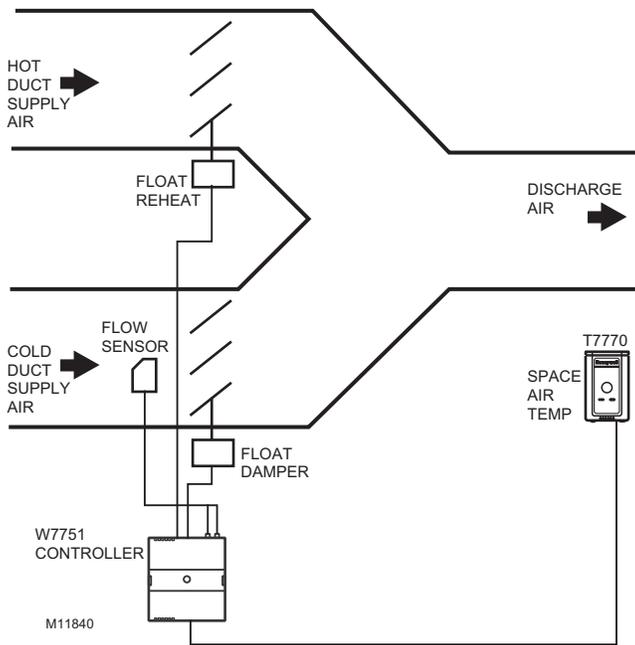


Fig. 47. Dual Duct, Pressure Independent cooling, Pressure Dependent heating with flow mixing, with cold duct flow pickup.

DUAL DUCT PRESS FLOW MIX (PRESSURE INDEPENDENT COOLING AND PRESSURE DEPENDANT HEATING USING ONE EXCEL 10)

Pressure type: Pressure Independent.

Flow Configuration: Dual Duct Discharge Sensor.

Reheat Configuration: Float Reheat.

Dual duct flow mixing uses one control device to provide pressure independent control of the cold duct. The Floating Reheat, which is traditionally wired to a heating valve actuator, is wired to a hot duct damper instead. PeriphPos is used to set the minimum hot duct damper position, which applies during both reheat and cooling modes. Flow mixing is achieved by mixing hot duct and cold duct air, which takes place during the cooling mode when minimum hot duct position is not zero (PeriphPos), or during the reheat mode if the cold duct Reheat Flow value is not zero.

DUAL DUCT PRESS FLOW MIX (ALTERNATE CONFIGURATION)

Pressure type: Pressure Independent.

Flow Configuration: DD_CDFlowSensor.

Reheat Configuration: FloatHotDuctPrDep.

This configuration is the same as the previous description, however, setting PeriphPos to a minimum hot duct position that only applies during reheat mode. During cooling mode, the hot duct damper goes to zero, thus conserving energy. Flow mixing is achieved by mixing hot duct and cold duct air during the reheat mode when the cold duct Reheat Flow value is not zero.

Dual Duct, Pressure-Independent Cooling and Heating, Constant Volume with Hot and Cold Duct Flow Pickups

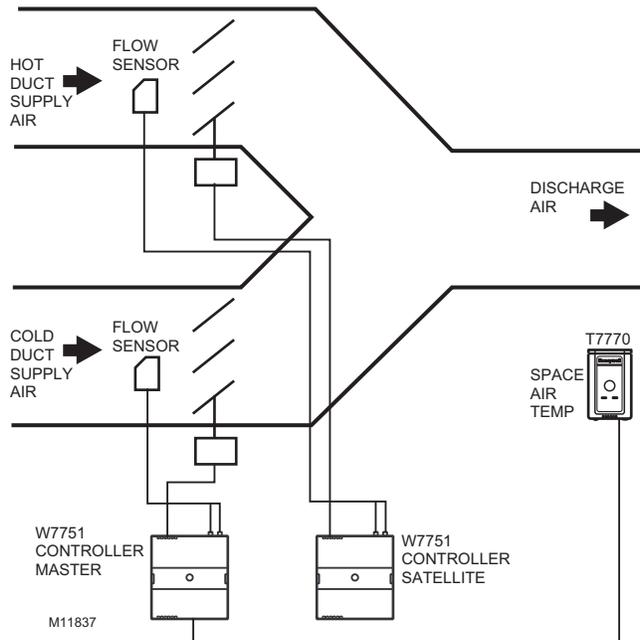


Fig. 48. Dual Duct, Pressure Independent cooling and heating, constant volume with hot and cold duct flow pickups.

DUAL DUCT CONSTANT VOLUME

Master Flow Configuration: DD Master Constant Volume.

Master Reheat Configuration: DualDuctReheat.

Satellite Flow Configuration: DD Satel Constant Volume.

Satellite Reheat Configuration: DualDuctReheat.

NOTE: In order for this application to function properly, the following bindings have to be made through refer points in LonSpec. Bind nvoShare of the master to nviShare of the satellite and bind nvoBoxFlow from the satellite to nviFlowTrack of the master.

Dual duct flow mixing uses two control devices, a master (for the cold duct) and a satellite (for the hot duct) to provide pressure independent control. The dual duct constant volume application tries to control the space to the cooling setpoint only. During unoccupied, the controller will try to control the temperature to either the unocc heating (if the space temperature is less than the unocc heating setpoint) or unocc cooling setpoint (if the space temperature is greater than the unocc cooling setpoint). The controller is always in cooling mode, adjusting the cool air from min flow to max flow while simultaneously adjusting the warm air from max flow to min flow.

Dual Duct, Pressure-Dependent Cooling and Heating, with Flow Mixing and No Flow Pickups

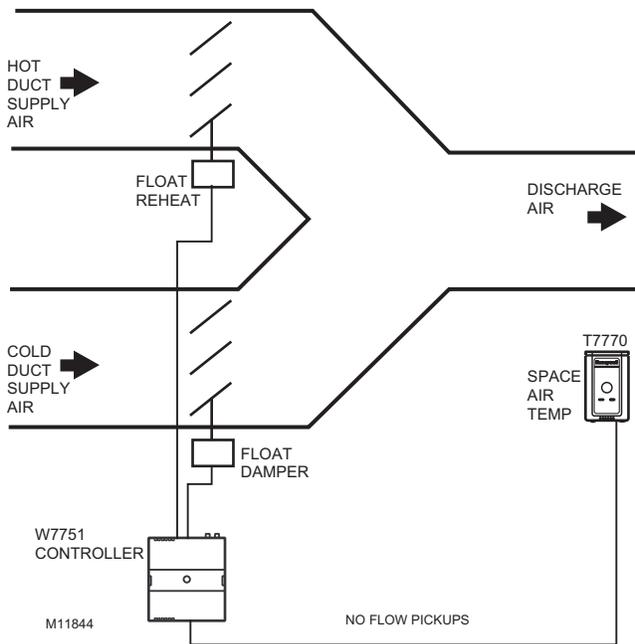


Fig. 49. Dual duct, pressure dependent cooling and heating, with Flow mixing and no flow pickups.

DUAL DUCT PRESS FLOW MIX (PRESSURE DEPENDENT COOLING AND HEATING USING ONE EXCEL 10)

Pressure type: Pressure Dependand.

Flow configuration: Flow Normal.

Reheat Configuration: Float HotDuct Pressure Dependent.

Dual duct flow mixing uses one control devices, to provide pressure dependent control of the cold and hot ducts. The Floating Reheat, which is traditionally wired to a heating valve actuator, is wired to a hot duct damper instead. PeriphPos is used to set the minimum hot duct damper position, which applies during both reheat and cooling modes. Flow mixing is achieved by mixing hot duct and cold duct air, which takes place during the cooling mode when minimum hot duct position is not zero, or during the reheat mode if the cold duct Reheat Flow value is not zero.

Dual Duct Press Flow Mix: (Alternate Configuration).

Pressure type: Pressure Dependand.

Flow Configuration: Flow Normal.

Reheat Configuration: Float HotDuct Pressure Dependand.

This configuration is the same as the previous description, however, setting PeriphPos to a minimum hot duct position that only applies during reheat mode. During cooling mode, the hot duct damper goes to zero, thus conserving energy. Flow mixing is achieved by mixing hot duct and cold duct air during the reheat mode when the cold duct Reheat Flow value is not zero.

Dual Duct, Pressure-Independent Cooling and Pressure-Dependent Heating, with Constant Volume and Discharge Air Flow Pickup

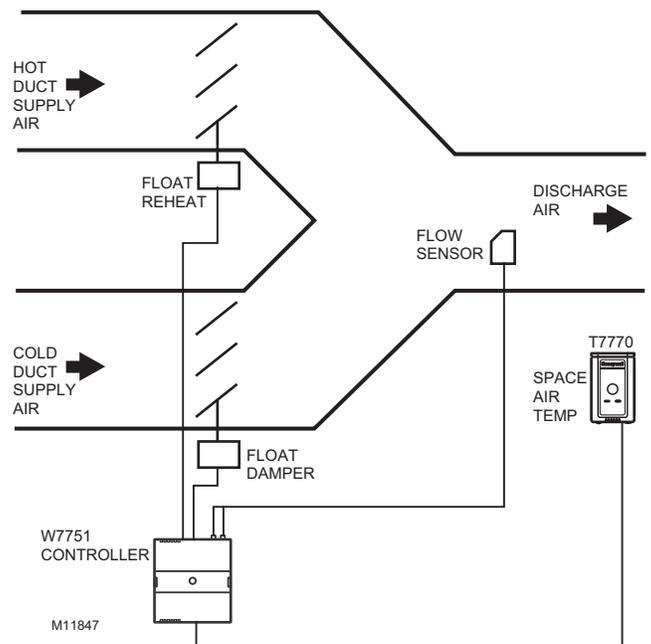


Fig. 50. Dual Duct, Pressure Independent cooling and Pressure Dependent heating, with Constant Volume and Discharge Air Flow pickup.

EXCEL 10 W7751B,D,F,H,J VARIABLE AIR VOLUME CONTROLLER

DUAL DUCT DISCHARGE SENSOR CONSTANT VOLUME (PRESSURE DEPENDENT COOLING AND HEATING USING ONE EXCEL 10)

Pressure Type: Pressure Dependent.

Flow configuration: Dual Duct Discharge Sensor Constant Vo.

Reheat configuration: Float_Reheat.

Dual duct flow mixing uses one control device, to provide pressure independent control of the cold duct and total discharge air. In this control sequence, the temperature sensor controls the Hot duct damper position from the PeriphPos minimum hot duct position to 100 percent position. The discharge flow sensor, which picks up the cumulative flow of both the cold and hot duct air flows, is used to determine the total flow of air. This total flow of air is used to control the cold duct damper, using whatever amount of cold air is necessary to maintain a single flow value of MaxFlow. (Be aware that setting the Max flow too high with a small heating flow capacity will not let the cold damper go to zero during a high demand for heat).

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Automation and Control Solutions

Honeywell International Inc.
1985 Douglas Drive North
Golden Valley, MN 55422
customer.honeywell.com

Honeywell Limited-Honeywell Limitée
35 Dynamic Drive
Scarborough, Ontario M1V 4Z9

