Variable Air Volume

Contents

Various Definitions VAV

HVAC system maintains indoor space air quality within specific design limits. Minimum and maximum design conditions and operational requirement are established for:

1. Space dry bulb temperature (thermal comfort)
2. Relative Humidity
3. Air changes
4. Outdoor ventilation air
5. Pace relative pressure
6. Acoustic level generated by HVAC systems (noise)

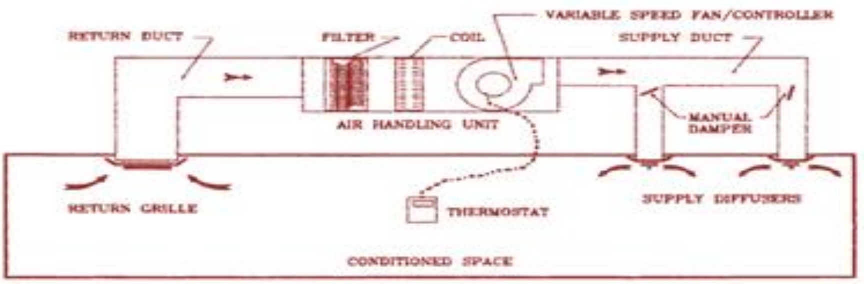
VAV is one of the most used and yet most controversial device of HVAC systems. Most VAV systems perform dry bulb temperature control function using a room thermostat to adjust the heat energy added to or removed from the conditioned space. This simplistic approach may be adequate in many applications, but it also produces limitations that have caused VAV systems to sometimes fail the overall HAVAC mission. A system that by design moves a constant volume of air to or from the conditioned space is not a VAV system. Systems that provide environmental control by radiation or convection methods are not VAV systems. All HVAC systems, large or small one terminal or hundreds of terminals, that vary the air volume is called VAV systems. Thus, a small 250cfm fan coil unit with a variable-speed fan is a type of VAV systems, and so is a 250,000cfm built-up air-handling system that uses multiple fans. Air conditioning Directory says VAV is “An HVAC system strategy through which the volume of air delivered to conditioned spaces is varied as a function of ventilating needs, energy needs, or both.

Variable Air Volume or VAV systems control the air volume. The simplest control is a simple On-Off control of fans but the complex damper controls are more common as variable speed control of fans is the most economic method to control the air volume. Air inflow rate varies according to the surrounding temperature.

Types of VAV systems.

VAV technology has been applied to a wide range of air handling units, duct and terminal device configurations. The following descriptions are of the most common configuration, and hybrids of these configurations are also possible, though less popular.

2.1 Single Zone – The smallest VAV system in the single-zone chilled/hot water fan coil or small air-handling unit is mounted nearby or within the conditioned space.[3]



2.2 Bypass – The next type of VAV system is the bypass VAV that is used frequently for light commercial buildings. Three equipment configurations of the bypass VAV are in general use:

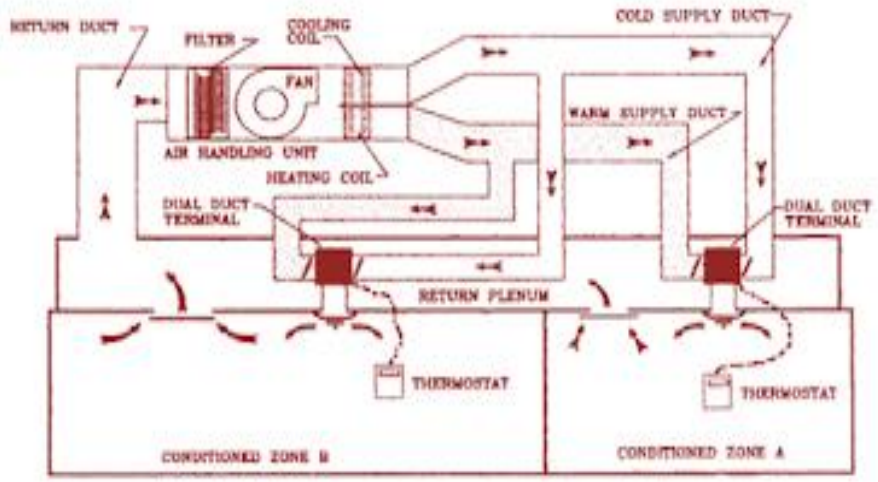
I. Duct bypass, with supply or primary air diverted from the duct
II. Terminal bypass, with the supply or primary air diverted at the terminal
III. Outlet/diffuser bypass, with the outlet device diverting the air back to the return.

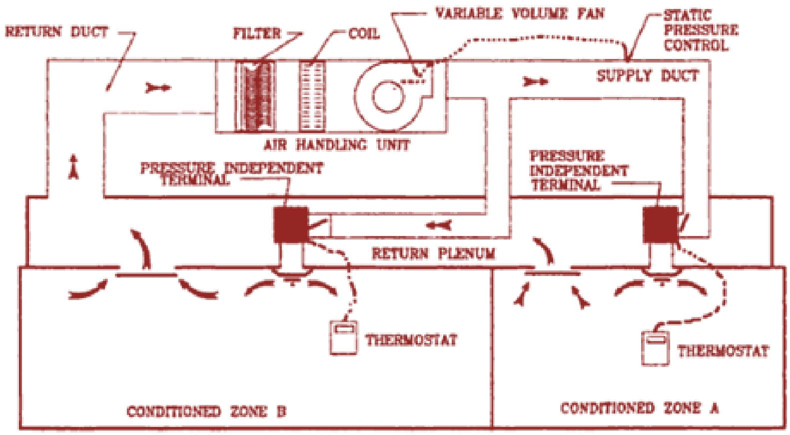
The bypass VAV system uses a single supply duct from the fan that terminates in an air valve assembly that either directs the air to the conditioned space or diverts it back to the air handling return systems via a return plenum or duct.

2.3 Dual Duct – A dual-duct VAV system provides control of the conditioned zone temperature through the use of zone control device that modulate the amount of air delivered from each of the ducts.

2.4 Single Duct pressure independent – The next classification of VAV system is the more popular single-duct pressure-independent terminal system that modulated the flow of air to each zone through a terminal device that regulates the flow of supply air in the response to the zone temperature.[3]

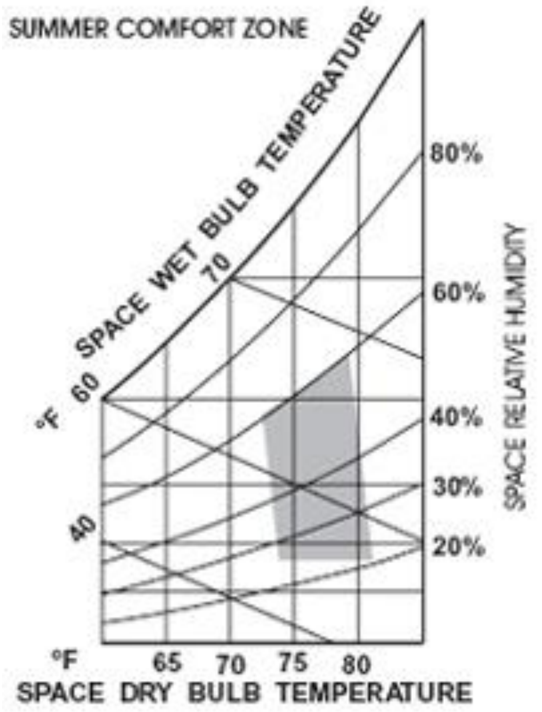
3]

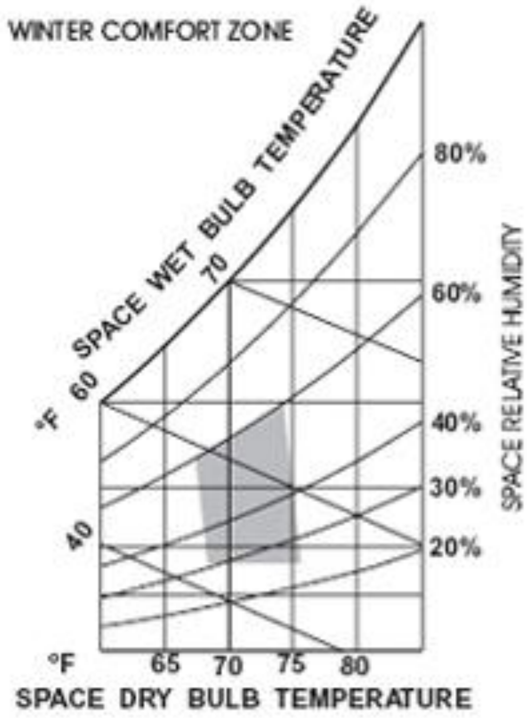




2.5 Packaged – VAV systems can be obtained as complete pre-engineered packages with the refrigeration system consisting of a direct expansion refrigeration coil that is supplied by integral or remote compressors. An intrinsic control problem with variable airflow through the refrigerant coils is the danger of the coil freezing up at low load and airflows. The refrigeration capacity control method used in these systems and the anticipated lowest load become very critical. Like the direct refrigerant systems, most packaged systems use centrifugal control dampers in a draw-through design.

2.6 VAV Exhaust and ventilation Systems - The last type of VAV system is the exhaust/ventilation system, used not so much for temperature control but for removing or displacing air damp air inside the conditioned space.





Applications of VAV

VAV or Variable Air Volume systems are used to control both the ventilation and temperature to satisfy the requirements of a building. Central VAV systems are considered to be the most energy efficient method to air condition buildings. By designing central systems instead of distributed systems, a greater efficiency can be obtained.

The efficiency comes from utilizing larger fans and larger chillers which have much higher efficiencies than small motors and distributed air-cooled chillers. Savings are also seen from the decreased maintenance requirements.

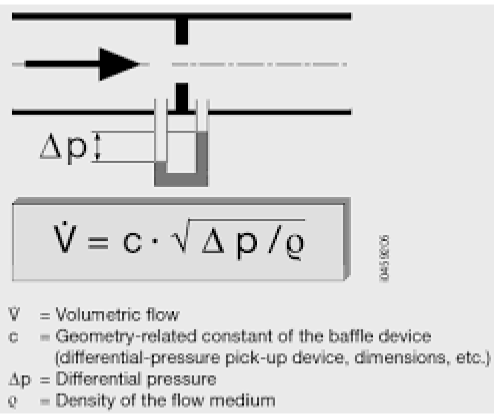
Advantages of VAV.

A properly designed VAV HVAC system can be one of the most energy efficient and comfortable systems for the space occupants. Interior air quality, noise, and overall comfort are generally excellent with a properly designed, installed and operating system. The flexibility and adaptability of the system to changing load conditions is the key feature. Because the systems are generally capable of moving large volumes of air, many problems such as interior painting, smoke, and other sources of air contamination can be removed more effectively than with any other system.VAV technology allows a single system to provide simultaneous heating and cooling without a seasonal changeover.

The noise produced by the VAV system is reduced at off-peak load periods, and drafts are also less of a problem at off-peak airflows. The fan capacity control, especially with modern electronic variable-speed drives, reduces the energy consumed by fans, which can be a substantial part of the total cooling energy requirements of a building. Dehumidification is greater with VAV systems than it is with constant-volume system, which modulates the discharge air temperature to attain part load cooling capacity. A VAV system also has other advantages it monitors and controls pressurization in laboratories for increased safety, it readily adapts to adding or moving fume hoods around during remodelling, and it improves fume hood safety monitoring. The advantages of the VAV system make up for the fact that the system may not have the lowest first cost.

Disadvantage of VAV

There are several historical characteristics of VAV systems that often are viewed negatively. VAV systems can cause poor ventilation and indoor air quality if the terminal devices do not maintain adequate air circulation and the exchange of the outdoor air is not maintained independent of thermal load. Supply diffusers at lower-than-design flow rates can mix the supply air with the space air less efficiently and damping of cool air from overhead diffuser is often a source of occupant complaints. The required accuracy and complexity of the control system is often a problem when control system is not properly installed. Large all-air systems require ductwork that may be larger than the space available above the ceilings, and compromises in duct sizing lead to noise under design conditions and even inadequate supply duct pressure to operate the terminal correctly. Zealous effort to conserve energy may cause loss of proper dehumidification of ventilation air, and lack of proper maintenance can result in systems overburdened by dirt filters. If ceiling plenums are used for return air, the fans can pull contaminated air from adjacent zones causing an IAQ problem. In general, these complaints and shortcomings of the applied VAV technology are not intrinsic or generic, and they should have limited impact if the application, design, construction, and operation of the VAV system are properly addressed.



VAV box Pressure drop

ΔTP = ΔSP + ΔVP

$$V = 4{,}005\sqrt{p_{velocity}}$$

Therefore :

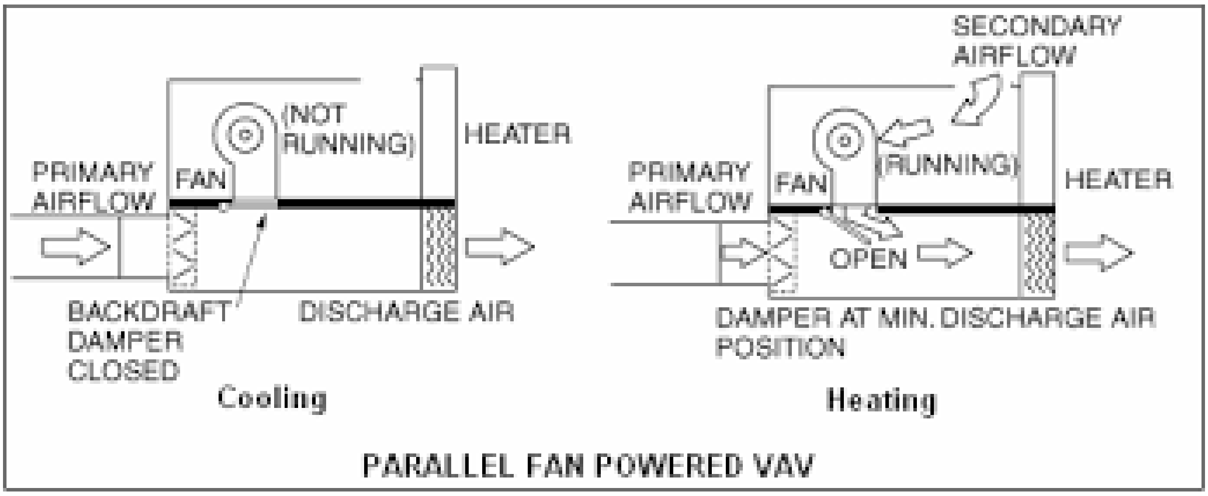
$$p_{velocity} = \left(\frac{V}{4{,}005}\right)^2$$

V = Velocity in feet per minute

4,005 = A units conversion constant

$p_{velocity}$ = Velocity pressure in inches water column

Where: ΔTP: Total pressure drop
ΔSP: Static pressure drop
ΔVP: Velocity pressure drop
Where: v(in) and v(out) are the inlet and outlet velocities
Q is the airflow rate
D is the box inlet diameter W and H are the inside (clear) width and height of the box outlet (outside dimensions less insulation thickness) 4005 constant facto



Commissioning & Facilities Management Perspective
VAV Box Detail

Design Notes

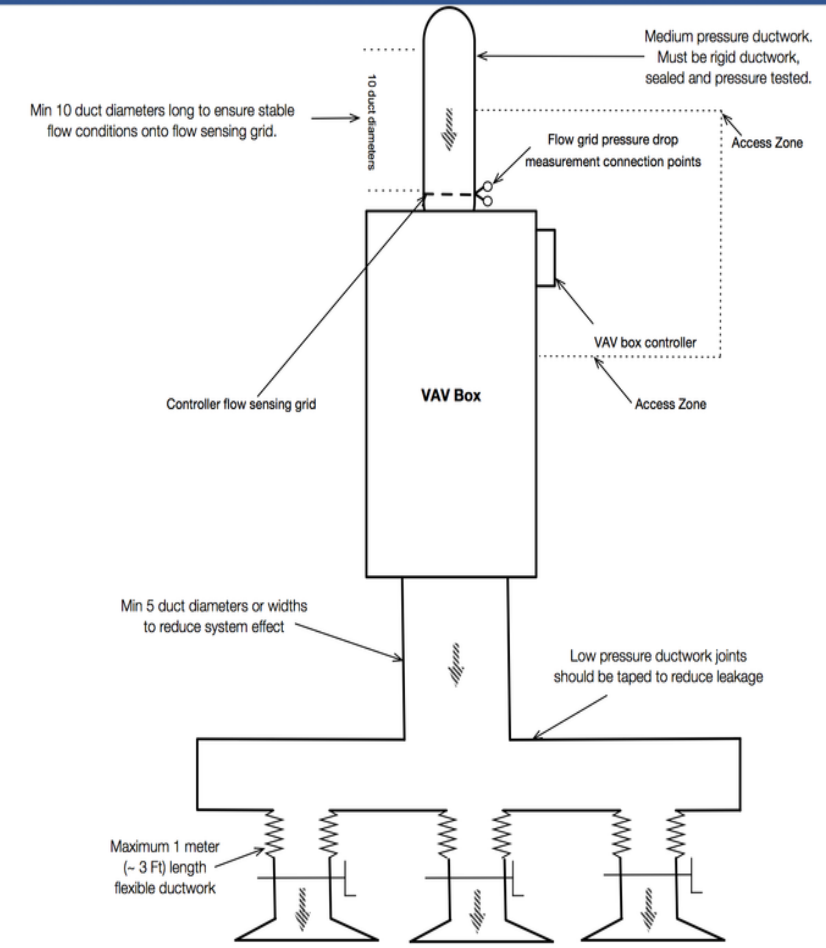
1. Include a typical VAV box detail in tender drawings.
2. Explicitly specify ductwork materials and leakage testing for high/medium pressure side ductwork to a SMACNA or DW143 standard.
3. Explicitly specify ductwork sealing methods on high/ medium pressure and low pressure ductwork.

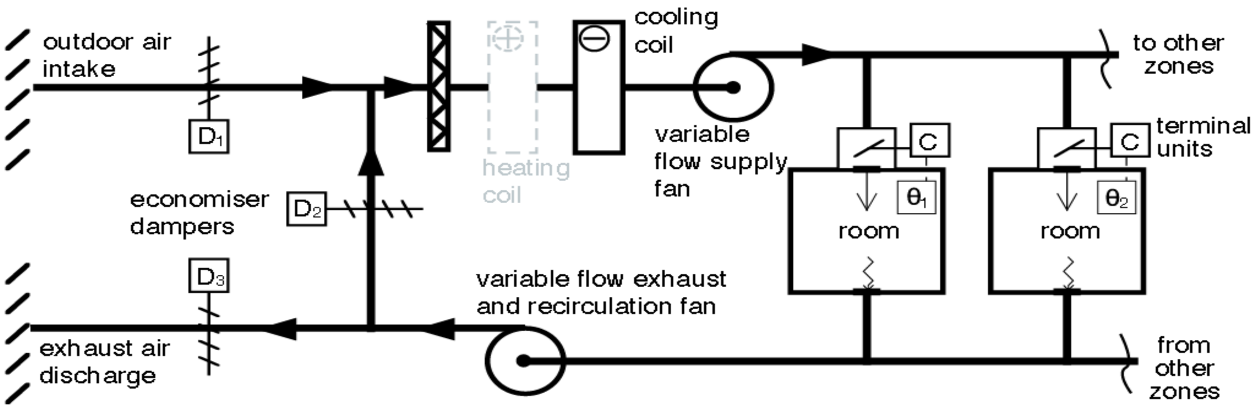
Installation Notes

1. Respect the ductwork inlet and outlet configurations required for stable airflow conditions. On the inlet (10ø) and outlet (5ø or widths) of the box.
2. Ensure the ductwork is sealed as specified to reduce conditioned air leakage.
3. No flexible ductwork ever on high pressure side of the VAV box.
4. Max 1 Meter (~ 3Ft) of flexible ductwork on low pressure side of VAV box. Install flexible ductwork as straight as possible to reduce airflow resistance and noise generation.
5. Ensure access zone is made available for Commissioning and Facilities Maintenance.

Commissioning Notes

1. Commissioning Authority or Manager to sample witness and verify ductwork pressure leakage testing.
2. Commissioning Authority or Manager to undertake sample inspections of ductwork installation quality and report deficiencies on the Cx Issues log.

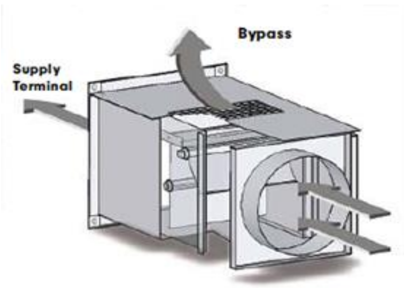


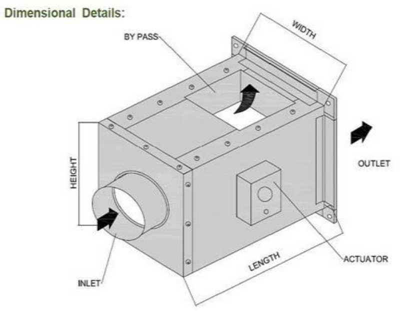


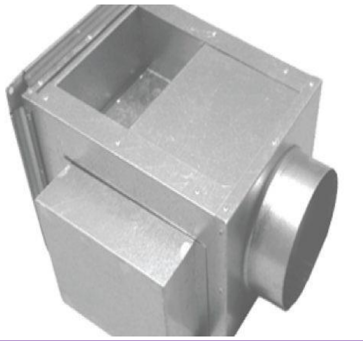
BYPASS VAV TERMINAL UNIT

Introduction

Bypass VAVs combine the advantages of proven air handling concepts to give complete zoning flexibility from a single zone source. The VAVs complement by providing excellent temperature control and central air distribution with unlimited zoning. The added advantage of multi-zone systems are by supplying centralized air distribution from unwanted zones to demand related zones.







Systems Principle of Operation:

Airflow AC Bypass Terminal Unit is a single duct pressure dependent air terminal unit, designed for use with popular constant volume low and medium pressure packaged air handling systems or roof top air conditioning units at low prime cost. Temperature control is achieved by supplying only enough conditioned air to the space to satisfy room thermostat demand. Excess air is diverted (bypassed) directly to the return air ceiling plenum for free or ducted return. Airflow to each occupied zone will vary on thermostat demand, from full flow to shut-off or to a set minimum air volume.

Bypass terminals can be added to a single-zone constant volume system to provide zoning without the energy penalty of a conventional reheat system, providing low first cost with minimum fan controls. The Combination of efficient pressure independent VAV & VFD driven AHU is more energy efficient compared to these system. Its most frequent application is on small systems.

Standard Features:

1. Casing 22 gauge galvanized sheet with round inlets. Outlets are square with four side flange. Damper well design for reliable long term operation. The internal linkage is smooth due to frictionless double nylon bushings.
2. 12 x 12 mm plated steel drive shaft.

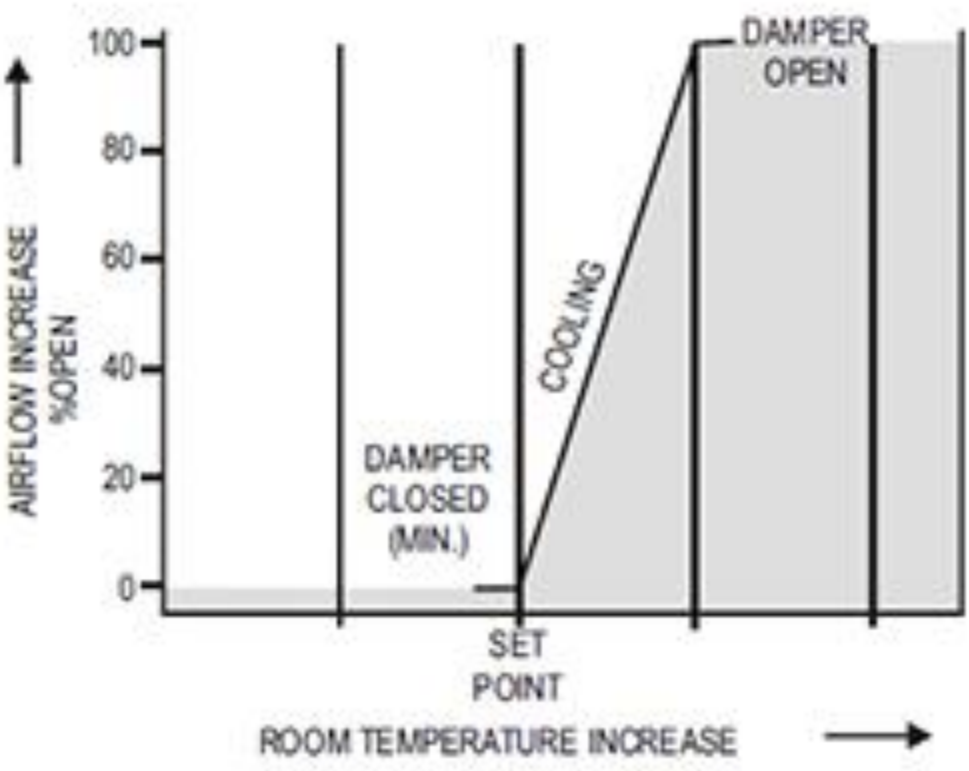
3. Internally lined casing utilizing opencell electrometric nitrile foam rubber, fiberfree, super silent & micro ban resistant.
4. Size range from 150 mm to 400 mm with capacities from 400 CFM to 2800 CFM
5. Compact low profile design is ideally suited for installation in tight space
6. Electronics control factory supply & mounted.
7. Variety of control options available, based on applications.
8. Electronic thermostat & actuator provide accurate mounting control.

Unique Damper Design

Airflow AC Bypass terminal units utilize a unique damper for superior control and performance. A common problem with standard pivoted single blade damper designs is objectionable noise and loss of modulation due to pulsating and / or a snap-closing action of the valve. This is caused by a poor valve design, which struggle to modulate turbulent airflow arid require excessive torque.

The **Airflow AC** damper eliminates these problems. The special damper design smoothly modulates between supply and bypass conditions essentially self - balancing, requirement.

The precisely design damper operates with minimum torque.



Cosmos Modulating Controls

Power Consumption: - 15 VA peak
Ambient limit: - Storage and operation -10 to 50 Deg C, Humidity-0 to 95 RH Non condensing
Mounting: - Actuator - Direct mounting on VAV shaft/box Communicating Thermostat - On the wall in occupied area.
Actuator Specs: - 4 VA, 24 Vac/dc, 30 - 180 sec stroke Guaranteed for 60,000 operations minimum.
Power Supply: - 24 V ac for the controller 40 VA transformer 230 V to 24V

Installation Features

Side bypass discharge for easy access to balancing dampers
Factory-installed controls
All round collars accommodate standard spiral and flex duct sizes

Sizes as per Airflow Selection

	Airflow			Inlet Dia	Width	Height	Length	Bypass
S.no	CFM	litter/sec	Model	mm	mm	mm	mm	mm
1	0-400	0-189	Airflow AC-15	150	300	200	500	140x86
2	0-700	0-330	Airflow AC-20	200	350	250	500	190x100
3	0-1100	0-520	Airflow AC-25	250	400	300	600	240x115
4	0-1600	0-755	Airflow AC-30	300	450	350	600	290x130
5	0-2100	0-991	Airflow AC-35	350	450	400	600	440x135
6	0-2800	0-1322	Airflow AC-40	400	500	450	600	440x200
7	0-3200	0-1510	Airflow AC-45	450	600	500	650	500*250

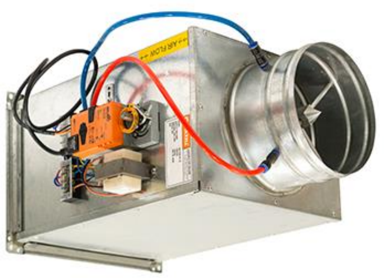
PRESSURE INDEPENDENT VAV TERMINAL UNIT

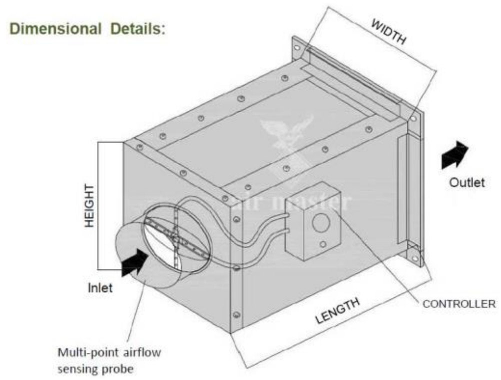
Airflow AC make single duct air terminals are designed to regulate the flow of conditioned air in single duct air distribution system. Air terminals include; Basic air terminal, Air terminal with sound attenuator, Air terminal with hot water reheat coil, Air terminal with electric heater and Bypass air terminal.

Airflow AC VAV Terminals are available with wide range of standard control sequence and work equally well in constant volume and variable volume system.

Airflow AC VAV terminal units consist of a casing with a circular inlet spigot, a rectangular outlet connection with integral noise reduction of opencell nitrile foam rubber, a damper blade for air volume control and a cross-flow differential pressure sensor for measuring air volume.

Airflow AC VAV Air terminals are available for both system pressure independent and pressure dependent applications, depending on the control sequence selected. Terminal units are recommended for use in duct systems with static pressure up to 3" water gauge. Supply air capacities are ranges from 45 CFM to 7100 CFM, depending on air terminal size. Air terminal units are supplied with electric or electronic controls from all major control manufacturers.





Basic Features

Airflowac VAV terminal, features a primary inlet with an integral damper and a discharge plenum. It is lined with insulation to provide sound absorption and thermal resistance, It is designed to meet the needs of today's VAV systems.

Operating Principle

The VAV - PI is the most common air terminal unit offered by Airflow ac. It operates on the principle that as cooling load is satisfied, the primary damper modulates closed to restrict airflow to the space so that a constant space temperature is maintained. As the space cooling load is further satisfied, the VAV - PI closes to a pre-set minimum flow which is usually determined by the minimum level of ventilation required in the space. In addition, the VAV - PI can also be used at full shut-off for those applications where minimum ventilation requirements are not necessary. Upon call for heat the damper shuts down to minimum.

Features

1. Precisely design flow sensor grid.
2. A wide variety of sizes (10) results in a total flow range of 45 to 7100 cfm.
3. Heavy duty 22 gauge casing construction.
4. Industry standard round inlet collars sized to accept either flexible or rigid duct.
5. Internally lined casing utilizing opencell elastomeric nitrile foam rubber, fiberfree, super silent & micro ban resistant.
6. Round damper blade constructed of elastomeric gasket sandwiched between two heavy-duty 22 gauges galvanized steel plates, resulting in low-air leakage.
7. Shaft with Delran bearings. Shaft features a position indicator for easy identification of damper angle.
8. 25mm flange connection on the discharge plenum**.**

Sound

The goal in designing VAV systems is to operate air terminals at low pressures and airflows, while still satisfying the design conditions. The VAV - PI is designed for quiet performance at typical operating conditions. However for those critical sound applications, an integral sound attenuator is offered as an option (VAV- PI SL).

Options

Airflowac VAV can be furnished without controls, with electronic analogy controls, with factory-mounted direct digital controls (Siemens / Delta or equivalent).
Integral discharge sound attenuator.
Hanger brackets for ½" threaded rod support.

Sizes As per Airflow

S.no	Airflow CFM	Model	Inlet Dia mm	Width mm	Height mm	Length mm
1	45-230	Airflow AC PIV-10	100	300	200	400
2	70-360	Airflow AC PIV-12	125	300	200	400
3	100-520	Airflow AC PIV-15	150	300	200	400
4	140-710	Airflow AC PIV-17	175	300	250	400
5	185-925	Airflow AC PIV-20	200	300	250	400
6	290-1450	Airflow AC PIV-25	250	400	300	400
7	420-2100	Airflow AC PIV-30	300	450	350	500
8	580-2900	Airflow AC PIV-35	350	450	400	500
9	740-3700	Airflow AC PIV-40	400	500	450	500
10	1000-5000	Airflow AC PIV-45	450	600	500	700
11	1420-7100	Airflow AC PIV-60	600x400	900	450	700