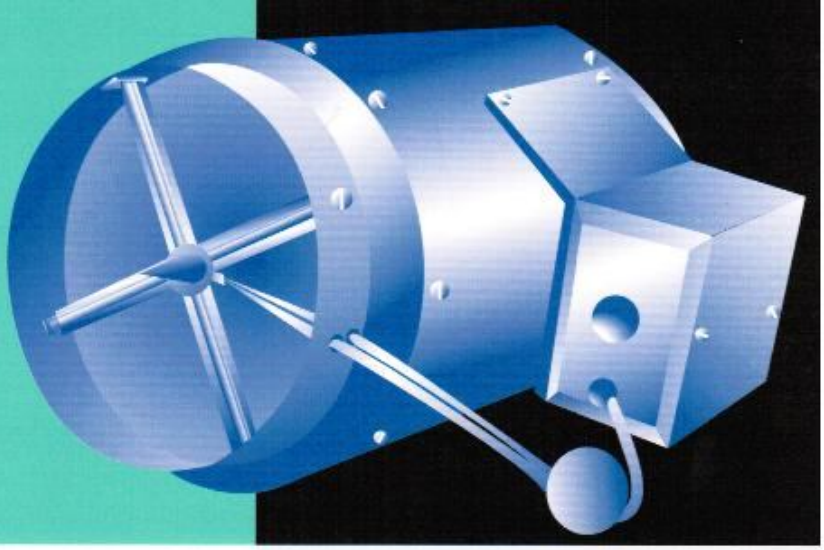
Engineered for
Versatile Application
and Energy Conservation



CONNOLS-AIR
TERMINAL UNITS

HIGHEST QUALITY AIR DISTRIBUTION EQUIPMENT

VARIABLE AIR VOLUME SYSTEM

VARIABLE AIR VOLUME SYSTEM FOR MODERN BUILDINGS

The variable air volume (VAV) system is applicable to most modern buildings in which an all-air type air conditioning system can be successfully applied. The VAV system is most ideal for interior areas of both single & multi-storey, multi-rooms buildings whenever these occupied areas require cooling.

The VAV system supplies a varying quantity of air at a constant temperature to an occupied space to balance heat gain or loss so as to achieve and maintain the desired space conditions. The system also responds directly to solar load conditions. For example, during the course of a typical morning, the east side of a office building will receive more solar heat gain. An increased volume of air is required to balance the additional solar heat gain, and that of the lighting equipment and occupancy heat gain. While on the west side of the office building, only the air required to balance lighting equipment and occupancy heat gains is necessary and this will be delivered by the VAV air terminal units. During the off-duty periods when there is also a decrease in demand for air-conditioning, only the required amount of air is delivered by the VAV air terminal units. VAV system is designed to handle all such variations to meet different demands for air required in buildings. Any zones can be completely shut off without upsetting other areas, and portions of the air conditioning system can operate independently at anytime.

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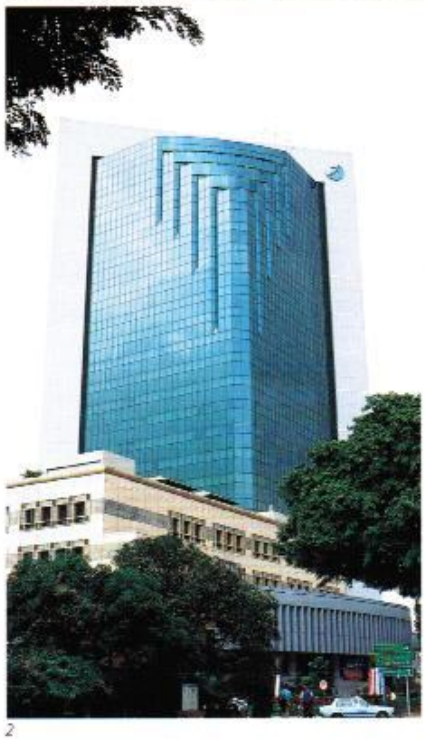
ADVANTAGES OF VARIABLE AIR VOLUME SYSTEM

The VAV system furnishes very high quality temperature control whenever individual zone control is required. Compared with other types of air systems, such as double duct or multi-zone system, the VAV system offers inherent savings in both installation and operating costs. Installation costs are reduced because only single supply ducts are required, and operating costs are reduced as only the air called for by the thermostat is conditioned and distributed. Power consumption depends on the actual cooling load – not on a theoretical maximum.

APPLICATION OF VARIABLE AIR VOLUME SYSTEM

VAV systems are widely used in office buildings, hospitals, schools, department stores and shopping centres, whenever individual zone control is desired. Where simultaneous heating and cooling of different areas within a structure are required, the VAV system can be coupled with a supplementary heating system such as a hot water coil or electric radiation type heater for perimeter heating, combined with accessories like noise silencers, multiple-outlet silencers and multiple-outlet plenums.

VAV system can also be installed in existing high energy air systems for system energy conservation.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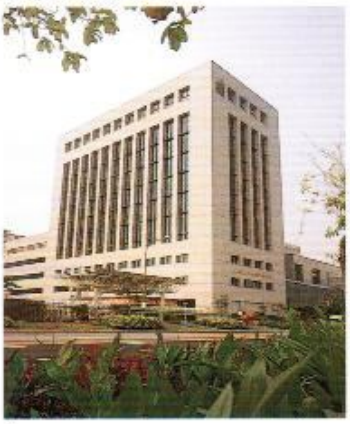
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1. *1,762 Connol-Air terminal units were installed at Defence Technology Towers A & B (Mindef).*
2. *1,393 Connols-Air terminal units were installed at Inland Revenue House.*
3. *714 Connols-Air terminal units were installed at Singapore Immigration building.*
4. *1,070 Connols-Air terminal units were installed at Temasek Polytechnic.*

All Connols-Air terminal units installed at the above-mentioned buildings are DDC pressure independent units with networking.

VAV & CAV AIR TERMINAL UNITS

V750 CONNOLS-AIR TERMINAL UNITS

MODEL V750-1 : Pressure Independent VAV Air Terminal Unit

MODEL V750-D : Pressure Dependent VAV Air Terminal Unit

MODEL V750-C : Constant Air Volume Air Terminal Unit

Designed for efficient control of room temperature and with energy conservation in mind, the *Connols-Air* terminal units are the most reliable devices available for precise control of air volume. V750 air terminal units are recommended for use in the retrofit of existing high energy air systems or in new building constructions. In many retrofit type systems, the V750 air terminal units are applicable directly to a system where the older high pressured type equipment has been deactivated but not removed.

CONSTRUCTION

The V750 terminal units are constructed of double casing of 0.7 or 1.0mm hot-dip pre-galvanised steel in mill finish, with 25mm thick fibreglass insulation in between the inner and outer casings. Insulation comply with the requirement of NFPA90A. The V750 blade is constructed of double-skin galvanised steel plates with felt all round to provide a good seal. Steel control housing comes with each air terminal unit to protect the control components against dust & damage (except for certain DDC controller models which are factory-encased in PVC housing). The air terminal units are available in standard sizes of 5, 6, 7, 8, 10, 12,14, 16, 18 and covering an air flow range of up to 2500 l/s.

APPLICATION

The V750 terminal units are available for both system pressure-independent and system pressure-dependent variable volume (VAV) operation & constant air volume (CAV) applications, depending on the control sequence selected. Supply air capacities can range from 50 l/s to 2500 l/s, depending on the air terminal sizes.

CONTROLS

The V750 air terminal units can be supplied with pneumatic or electronic analog controls for stand-alone operations. Microprocessor direct digital control (DDC) air terminal units are also available for stand-alone operations or for integration with building automation system for central monitoring and controls.

FEATURES OF CONNOLS-AIR TERMINAL UNIT

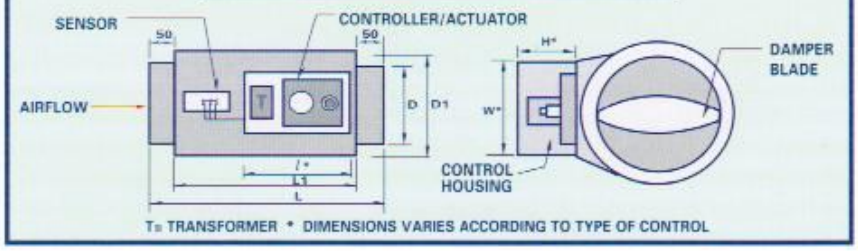
- Double-skin casing construction ensures low radiated noise and absence of fibreglass erosion.
- Double-skin blade with felt seal all round ensures rigidity of the blade and low air leakage.
- Blade is designed to close at 60 degrees so as to provide more linear flow characteristic and, hence, more precise modulation of air flow.
- Accurate control of air volume is possible with accurate multi-point pressure differential flow sensor.
- A wide range of temperature controllers is available for all types of control functions.
- A wide choice of control options is available such as electronic analog, pneumatic and direct digital microprocessor controls for stand-alone operations or integration with building automation systems.
- Low minimum pressure loss for energy conservation.
- Each unit has a P or PID cooling control algorithm, depending on the type of controller installed.

ACCESSORIES

The V750 air terminal units can be coupled with accessories such as hot water coils and electric heaters for reheat and winter heating purposes. High performance silencers and multiple outlet silencers are also available to meet low noise requirements.

FIGURE 1: V750 TERMINAL BOX CONSTRUCTION

FIGURE 2: DIMENSIONS OF V750 AIR TERMINAL BOX



T= TRANSFORMER * DIMENSIONS VARIES ACCORDING TO TYPE OF CONTROL

TABLE 1

SIZE	L	D	L1	DI
5	470	124	369	175
6	470	150	369	201
7	470	175	369	226
8	470	201	369	251
10	521	251	419	302
12	572	302	470	353
14	635	353	533	403
16	686	403	585	454
18	737	454	635	505

MICROPROCESSOR DIRECT DIGITAL CONTROLLED (DDC) PRESSURE INDEPENDENT VAV TERMINAL UNIT

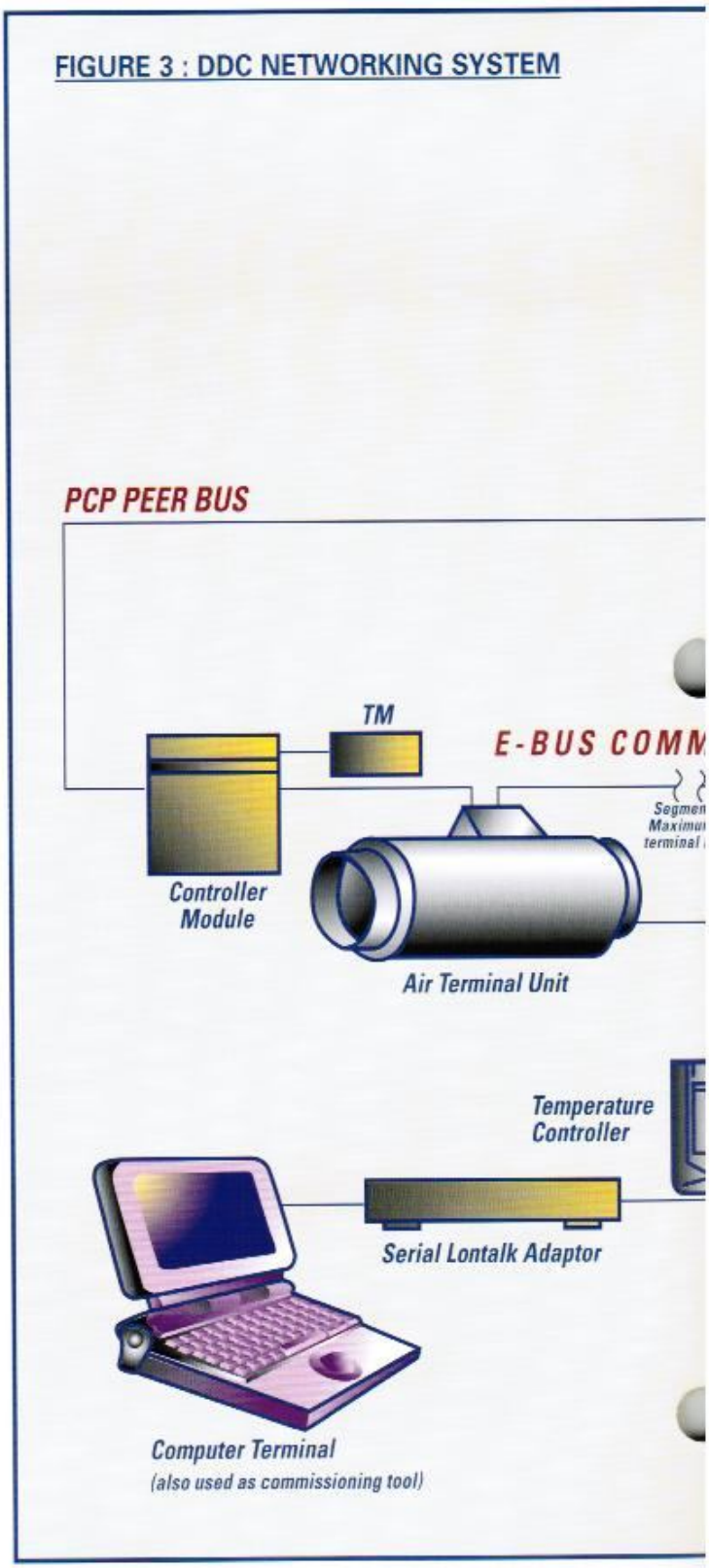
SYSTEM FEATURES

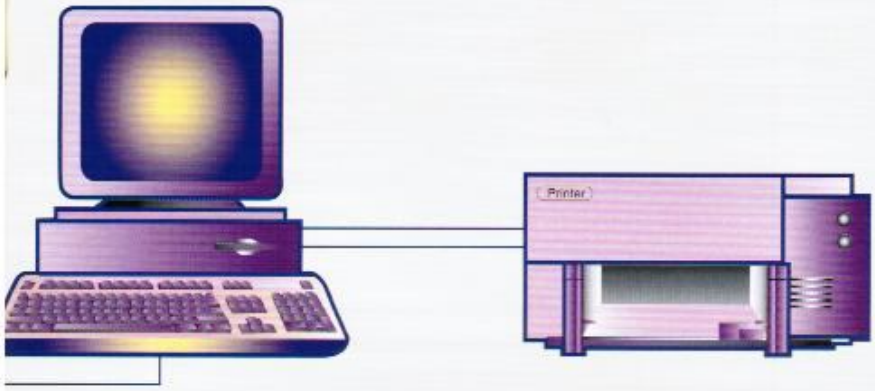
- *Uses industry open communication protocol, Echelon Lonwork network (E-bus) protocol.*
- *High-speed 78 kilobaud communications network.*
- *120 air terminal units per zone controller module.*
- *Easy user access to airflow sensor inputs.*
- *Provides proportional integral derivative (PID) temperature control.*
- *Floating or modulating hot water reheat and up to three-stage electric reheat.*
- *Series and induction fan.*
- *Individual zone pressurization for supply and exhaust control.*
- *Factory configured via EEPROM with critical user parameter default values.*
- *Motion sensor interface for enhanced energy savings.*
- *Pressurizes and depressurizes, night purges, and morning warm-up sequences support.*
- *Provides diagnostic capability.*
- *Allows for remote modification of system parameters from a central location.*
- *Allows for remote monitoring of system parameters from a central location.*
- *Airflow limit adjustment at the temperature controller.*
- *Actual airflow readout at the temperature controller.*

DESCRIPTION OF DEVICES

Connols-Air microprocessor based V750 pressure independent VAV air terminal units are the latest, state-of-the-art, high quality terminal units which provide good control accuracy and capabilities required in every modern intelligent building of today. The VAV air terminal units are capable of stand-alone operation. However, optimum functional benefits are derived when network communication capabilities are used. *Connols-Air* stand-alone VAV air terminal units with DDC controller may be integrated in a communication system at a later stage. This can be done with the addition of networking devices such as zone manager or controller module, router or repeater module and terminal module.

FIGURE 3 : DDC NETWORKING SYSTEM

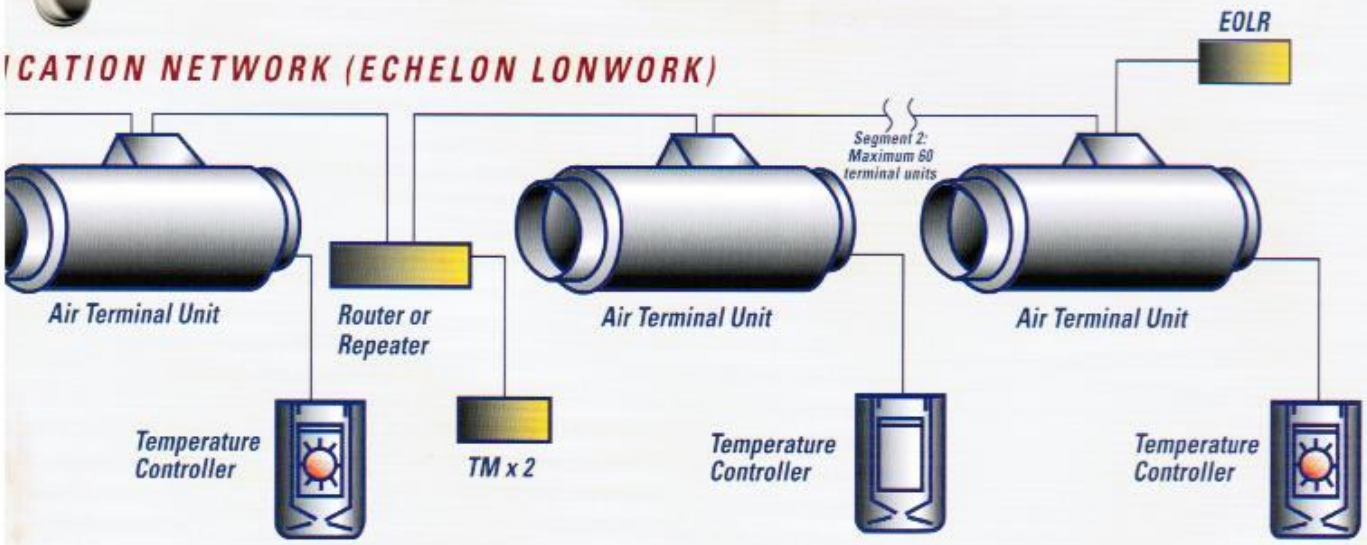




Central Host Computer

Printer

ICATION NETWORK (ECHELON LONWORK)



Note

- One zone controller module supports up to 120 air terminal units.
- One E-bus segment supports up to 60 air terminal units.
- Maximum E-bus segment : 1500 metres.
- One router is required to extend up to 120 number of air terminal units or 3000 metres.
- One central host computer supports up to 87 zone controller modules.
- TM – Terminal Module.

MICROPROCESSOR DIRECT DIGITAL CONTROLLED (DDC) PRESSURE INDEPENDENT VAV TERMINAL UNIT

V750 air terminal unit is furnished with a direct digital controller, damper actuator, accurate multiple points differential flow sensor and a room temperature controller. In a minimum system configuration, the VAV terminal unit is used together with a basic version of temperature controller for space temperature measurement. Other models of temperature controller are available with additional features including analog setpoint input, override digital input push button, override status led and network jack (for easy access to the communication network).

DDC NETWORKING SYSTEM

Connols-Air VAV air terminal units can be networked via a twisted pair to a zone controller module that connects up to a maximum of 120 units of V750 air terminal units on the same network bus. The data transfer rate of communication bus between air terminal units is 78 kilobaud in Daisy Chain configuration, using industry open communication protocol, Echelon Lonworks Network Protocol (E-bus). This allows for interaction with other Echelon systems that are required practically in every modern intelligent buildings. The zone controller module can be connected to the PCP peer bus network to form a true integration in the BMS network. Figure 3 (on pages 6 & 7) shows an overview of this typical system layout.

The zone controller module is a programmable master controller which provides energy management, control and monitoring functions.

The maximum number of VAV terminal units that can be installed in an E-bus segment is 60. By adding a router, the maximum number of air terminal units can be increased to 120. Maximum E-bus network length is limited to 1500 metres. By adding a router, the maximum length of the E-bus network can be increased to 3000 metres.

CONTROL APPLICATION

Typical VAV terminal system in a commercial building incorporates a central air handler that delivers modulated volume of air at a pre-conditioned temperature to multiple zones. Each zone may be serviced by one or multiple VAV air terminal units. Each *Connols-Air* VAV terminal unit incorporates an accurate multiple points airflow pickup sensor and a motorized damper. The VAV controller determines and regulates the flow of conditioned air to the space. The zone being fed by the air terminal unit will use a temperature controller for space temperature determination with E-bus network access for operators. Figure 4 shows a typical VAV terminal unit control application.

FIGURE 4: TYPICAL AIR TERMINAL UNIT CONTROL APPLICATION

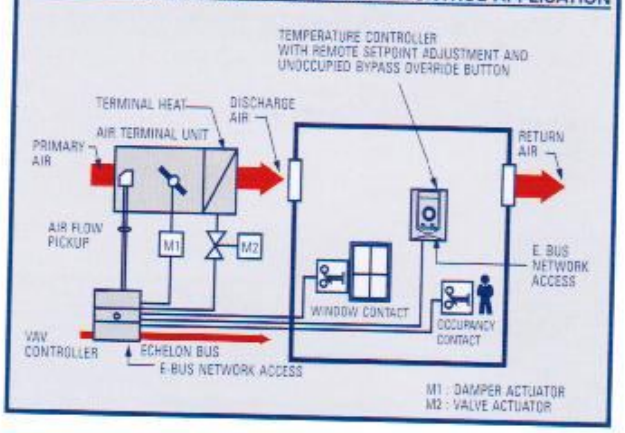
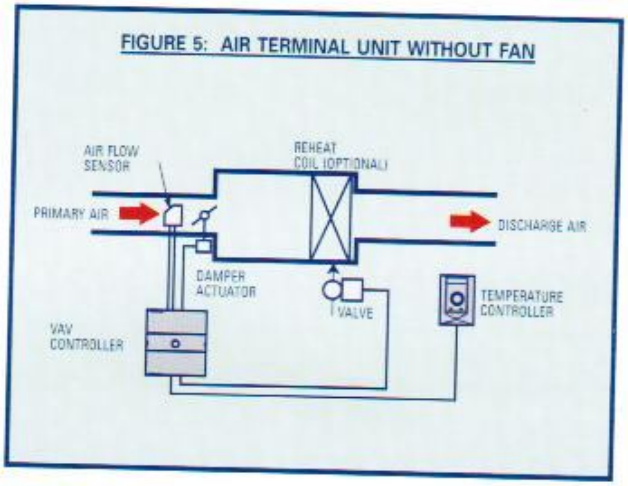


FIGURE 5: AIR TERMINAL UNIT WITHOUT FAN



CONTROL PROVIDED

The DDC Controller in the *Connols-Air* single-duct pressure independent VAV terminal unit has a means for maintaining a constant volume of air into the zone regardless of the duct static pressure. The VAV controller modulates the airflow into the zone to satisfy the zone temperature setpoint. Minimum airflows are maintained except during emergency strategy periods or during unoccupied periods in the building. Generally, VAV systems provide only cool air to the zones, therefore, the air terminal unit controller provides additional outputs for the 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 hot water.

MICROPROCESSOR DIRECT DIGITAL CONTROLLED (DDC) PRESSURE INDEPENDENT VAV TERMINAL UNIT

SYSTEM CONFIGURATIONS

Connols-Air VAV terminal control is field configurable using resident application programs. It supports One-to-Many and Many-to-One sharing capabilities through software configurations.

An example of a One-to-Many function is that of an UNOCCUPIED mode that is being sent from the central host computer to the selected V750 air terminal units for the required control (at unoccupied mode). As for Many-to-One function, it can be achieved when an average temperature of a few rooms are required. Table 2 below provides an overview of the VAV controller configuration options.

VAV TERMINAL UNIT FANS OPTION

Each VAV terminal unit can have a Series fan, a Parallel fan, or no fan. See figure 5 (on page 8) for a terminal unit with no fan.

A Series fan is intended to run continuously when the main air handler is on and it is in line with the primary airflow through the terminal unit (see figure 6).

A Parallel fan is not in line with the primary air stream. Instead, the fan can add return air from the plenum into the air stream that is being delivered to the occupied space. The VAV controller turns on the Parallel fan when the space temperature falls below the setpoint as the first stage of reheat (see figure 7).

REHEAT COILS OPTION

Each VAV terminal unit contains one or more coils for reheating the air delivered to the occupied space. The VAV controller can control staged electric heat elements, solenoid valves or modulating valves.

The staged reheat coil

The staged reheat control algorithm can control one, two, or three stages of reheat. The stages are activated through Triac digital outputs, one for each stage, wired to 24 Vac contactors. These outputs can also control 24 volt solenoid valves on hot water coils instead of electric heat elements. Figure 8 (on page 10) depicts a typical VAV terminal unit with staged reheat.

Modulating reheat coil

The modulating control is provided through two Triac digital outputs – one to pulse the valve actuator open and one to pulse it close. Damper control output Triacs operate in the same manner. Figure 9 (on page 10) depicts a typical VAV terminal unit with modulating reheat.

FIGURE 6: SERIES AIR TERMINAL UNIT FAN

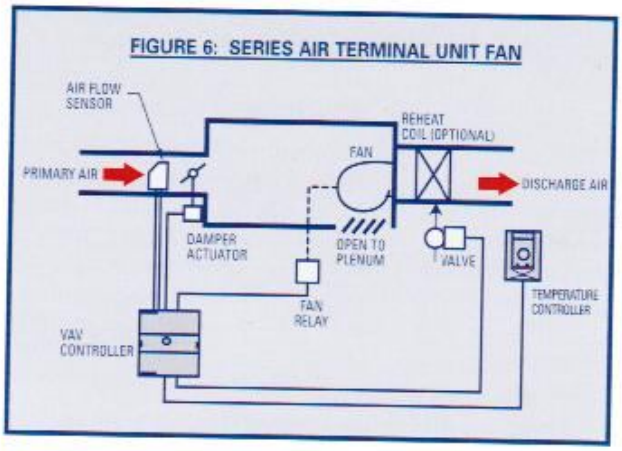


FIGURE 7: PARALLEL AIR TERMINAL UNIT FAN

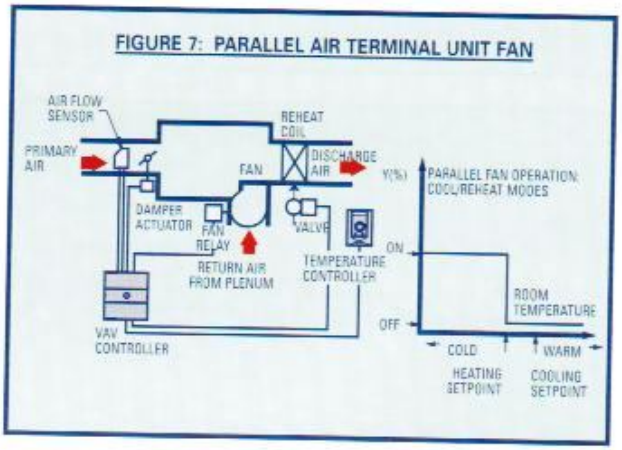


TABLE 2: OVERVIEW OF VAV CONTROLLER CONFIGURATION OPTIONS

OPTIONS	POSSIBLE CONFIGURATIONS
TYPES OF TERMINAL FAN	• None • Series fan • Parallel fan
TYPES OF REHEAT COIL	• None • One stage • Two stage • Three stage • Modulating valve
EXHAUST TRACKING OPTION	• Disabled • Enabled (no temperature control)
OCCUPANCY SENSOR	• None • Connected: contacts closed equals occupied
WINDOW SENSOR	• None • Connected: contacts closed equals window closed
TEMPERATURE CONTROLLER OPTION	• Local (directly wired to the terminal unit) • Shared (wired to another terminal unit)
TEMPERATURE CONTROLLER TYPE	• Sensor only • Sensor and setpoint adjust • Sensor, setpoint adjust and bypass • Sensor and bypass

MICROPROCESSOR DIRECT DIGITAL CONTROLLED (DDC) PRESSURE INDEPENDENT VAV TERMINAL UNIT

FIGURE 8: STAGED REHEAT COILS

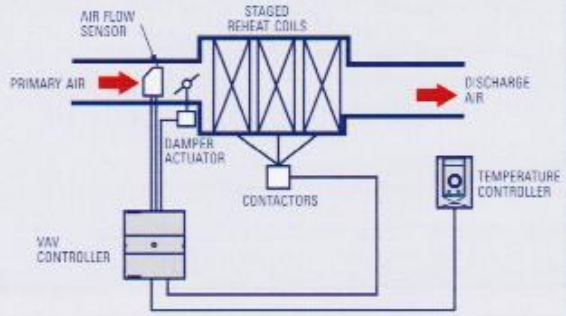
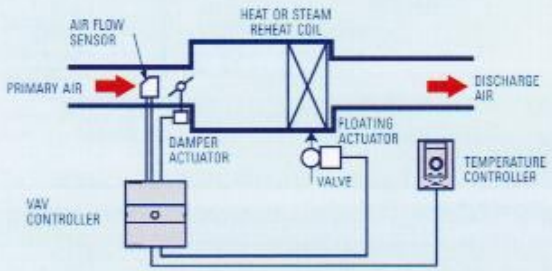


FIGURE 9: MODULATING REHEAT COILS



Notes

- *Units that are exhaust tracking cannot have terminal fan or terminal heat.*
- *If it is desirable to have one supply unit acting as a master and to have another supply unit in the same area following the same control, do not select Flow Tracking. Instead select the second unit with a configuration that does not have a temperature sensor. In the One-to-One networks option, select the Share Wall module option so that the second unit can control its flow, (specified by its own maximum & minimum and reheat flow setpoints) based on the control algorithm of the first unit.*

EXHAUST TRACKING OPTION

The basic flow control algorithm can be run in either of the two modes: the Temperature Control mode, where the flow rate is modulated to maintain the space air temperature, or, the Exhaust Tracking Control mode, where the exhaust flow rate is modulated to track the supply airflow elsewhere (in other controllers). If exhaust tracking is selected, the temperature controller is not required because the space temperature is not checked in the exhaust tracking control algorithm. Instead, the airflow removed from the space is based on the sum of up to five flow rate signals sent over the E-Bus from other controllers (plus or minus a differential). Use the exhaust tracking mode only as required by the job specifications. Temperature control for the space is provided by the supply boxes only (not the Exhaust Tracking Box).

OCCUPANCY SENSOR OPTION

The VAV Controller provides a digital input for connection to an Occupancy sensor, such as passive infrared motion detector, that contains a dry contact closure to indicate whether people are present in the space. A contact closure indicates the space is occupied. For more details, contact the factory or your nearest *Connols-Air* representatives.

WINDOW OPTION

A digital input is also provided for detecting whether a window in the space is opened. The VAV controller can be connected to a dry contact or a set of contacts wired in series (for monitoring multiple windows) to verify whether the window(s) are closed. The algorithm expects a contact closure to indicate that the windows are 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 Zero Damper Position (typically zero low value). For further details, contact our factory or your nearest *Connols-Air* representatives.

TEMPERATURE CONTROLLER OPTIONS

There are four basic varieties of temperature controllers (details are available upon request). A temperature controller can be shared among two or more VAV terminal units. When configuring the VAV controller, the temperature controller's information must be made available for the control algorithm. (Information on configuring VAV controller is available from *Connols-Air* factory upon request).

MICROPROCESSOR DIRECT DIGITAL CONTROLLED (DDC) PRESSURE INDEPENDENT VAV TERMINAL UNIT

Connols-Air DDC VAV controller can be configured to control any of the following 16 possible terminal unit equipment arrangements. For the detailed descriptions of the control sequences of operation and application wiring diagram for each of the 16 applications, consult our factory or your nearest *Connols-Air* representatives.

APPLICATIONS OF V750 AIR TERMINAL UNIT

1. Pressure independent cooling only.
2. Pressure independent cooling with single stage electric reheat.
3. Pressure independent cooling with two stage electric reheat.
4. Pressure independent cooling with three stage electric reheat.
5. Pressure independent cooling with modulating reheat.
6. Pressure independent cooling with Parallel fan.
7. Pressure independent cooling with Parallel fan and single stage reheat.
8. Pressure independent cooling with Parallel fan and two stage reheat.
9. Pressure independent cooling with Parallel fan and three stage reheat.
10. Pressure independent cooling with Parallel fan and modulating reheat.
11. Pressure independent cooling with Series fan.
12. Pressure independent cooling with Series fan and single stage reheat.
13. Pressure independent cooling with Series fan and two stage reheat.
14. Pressure independent cooling with Series fan and three stage reheat.
15. Pressure independent cooling with Series fan and modulating reheat.
16. Return/exhaust fan tracking, damper only.

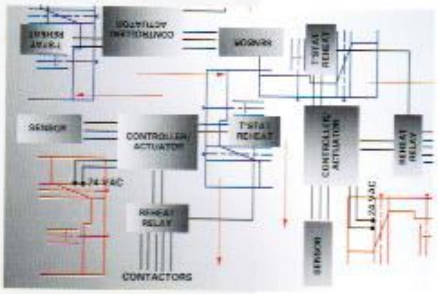
On the occasions where it is required to supply Constant Air Volume (CAV) to the space, applications 1 to 16 can be used by assigning maximum & minimum airflow setpoints to the same value.

ALARMS

The VAV controller is capable of self-diagnosis and will report any of the following alarm conditions to the zone controller module. The alarm conditions can then be broadcast through the network and viewed on the central host computer or the computer terminal via the temperature controller access jack. Immediate actions can then be taken to rectify the alarm conditions. For detailed information on these alarm conditions, consult your nearest *Connols-Air* representatives.

ALARM CONDITIONS

- Flow sensor failure error
- Temperature sensor failure error
- Remote setpoint potentiometer failure error
- A/D converter calibration out of range error
- Tracking flow error
- Share temperature controller error
- Invalid setpoint error
- EMS command error
- Command mode error
- Emergency mode error
- Manual occupancy error
- Occupancy sensor error
- Flow input error
- Shared temperature error
- Window sensor error
- Fan failure error
- Hardware/software compatibility error



CONNOLS-AIR ELECTRONIC ANALOG & PNEUMATIC CONTROLLED AIR TERMINAL UNITS.

CONNOLS-AIR ELECTRONIC ANALOG CONTROLLED VAV TERMINAL UNIT

The V750 electronic analog controlled terminal unit is furnished with an integral flow controller/actuator which is contained in a custom-made steel housing, a room thermostat and a flow sensor. Live readouts can be obtained at the flow controller and the room thermostat. Minimum and maximum flow can also be set and adjusted at the thermostat. Unless otherwise specified, the room thermostat will have a proportional band of 1.1°C. The VAV terminal unit is supplied with either of these sensors : a single point hot wire sensor, a single point pressure differential sensor or a multiple point pressure differential sensor – all of which provide accurate sensing of airflow. The air terminal unit operates as a stand-alone independent unit. Electronic analog flow controllers operate with 24 Vac power supply and each terminal unit is provided with a step-down transformer. With the appropriate control device and relay, the V750 unit can be fitted with electric or hot water heater for perimeter cooling/reheat application.

OPERATION OF V750 ANALOG PRESSURE INDEPENDENT VAV TERMINAL UNIT

The flow controller of V750 analog pressure independent VAV terminal unit receives two inputs, one from the airflow sensor and the other from the room thermostat. The airflow sensor continually monitors the quantity of air going through the terminal box and feedbacks the signal to the flow controller. On the other hand, the room thermostat continually monitors the room temperature and compares it to the setpoint temperature. The thermostat then sends the required signals to the flow controller which compares the two inputs. The flow controller will then send a control signal to the actuator that modulates the air terminal box damper, allowing the required amount of air to flow through the unit until the required room temperature is obtained.

STANDARD OPERATING CONTROL SEQUENCE

COOLING ONLY OR HEATING ONLY (FIGURES 10 & 11)

Airflow is held constant in accordance with the room thermostat demand. Should there be any upstream duct pressure fluctuations, it can be detected immediately by the airflow sensor which transmits the signal directly to the flow controller. The flow controller then transmits the signals to the damper actuator to close or open the damper in order to compensate for the increase or decrease of the upstream duct pressure, respectively.

When the room thermostat senses a change in the space temperature, it transmits a reset signal to the flow controller. The flow controller then compares the reset signal with the signal received from the air flow sensor, and regulates the air terminal box damper accordingly, ensuring the right amount of air supply, hence maintaining the space temperature within the setpoint of the room thermostat.

FIGURE 10: COOLING ONLY

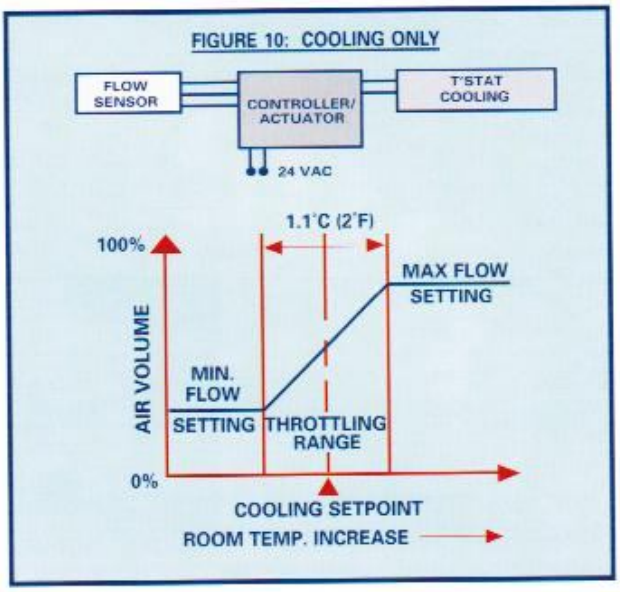
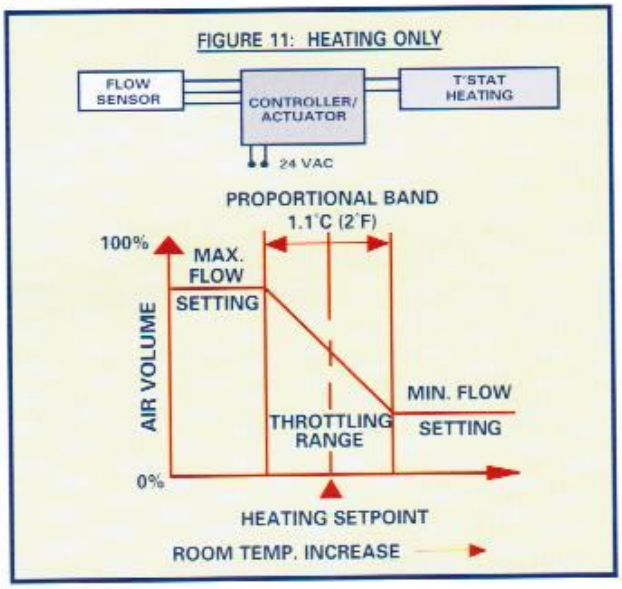


FIGURE 11: HEATING ONLY



The proportional band of the room thermostat is fixed at 1.1°C, i.e. ± 0.55°C of the setpoint temperature. At the space temperature of 0.55°C above the temperature setpoint, the airflow through the VAV terminal unit will be maintained at a pre-selected maximum setting. At the space temperature of 0.55°C below the temperature setpoint, the airflow through the VAV terminal unit will be maintained at a pre-selected minimum setting as shown on figure 10. This response to temperature changes applies to "Cooling Only" operation.

For "Heating Only" operation the response is reversed as shown on figure 11.

CONNOLS-AIR ELECTRONIC ANALOG CONTROLLED VAV TERMINAL UNIT

DAY-NIGHT COOLING (FIGURE 12)

The "Day-Night" room thermostat features separate temperature set-points and separate minimum/maximum velocity limits for day and night time operations. The automatic changeover relay energizes either the day or night mode of the thermostat.

The operating sequence for the day and night cooling modes is identical to the "Cooling Only" operation, except that the temperature controller for this application has 2 temperature setpoints, one for the day and another for the night.

HEATING- COOLING (FIGURE 13)

The heating-cooling thermostat features separate temperature setpoints and separate minimum/maximum velocity limits for heating and cooling operations. The automatic changeover relay energizes either the heating or the cooling mode of the thermostat, in response to the space temperature.

The operating sequence for heating and cooling cycle is similar to the "Heating Only" and "Cooling Only" applications.

VAV terminal unit for "Heating-Cooling" application is supplied with electric or hot water coil reheater. During winter, when the space temperature falls below 18.3°C, the reheater coil is energized and the thermostat setpoint switches over from the cooling to the heating setpoint. The reheater will be de-energized when the space temperature reaches 23.9°C and the thermostat then switches over to the cooling mode.

Safety controls, such as airflow switch and high temperature cut-out switch, are incorporated into these terminal units to ensure that the operation of the heater is safe.

COOLING WITH REHEAT AND AUXILIARY LIMIT (FIGURE 14)

The thermostat features a separate temperature setpoint and a separate auxiliary velocity limit for reheat control. The reheat relay may energize up to three stages of the electric reheat, in response to the thermostat.

The operating sequence of the cooling mode is similar to "Cooling Only" application, except that the reheat mode is energized with pre-selected auxiliary velocity limit once the space temperature falls below 0.55°C – below the thermostat cooling setpoint. The thermostat has a proportional band of 1.1°C.

At the space temperature of 0.55°C above the thermostat setpoint, the air flow through the air terminal unit will be maintained at a pre-selected maximum setting. At the space temperature of 0.55°C below the thermostat setpoint,

FIGURE 12: DAY-NIGHT COOLING

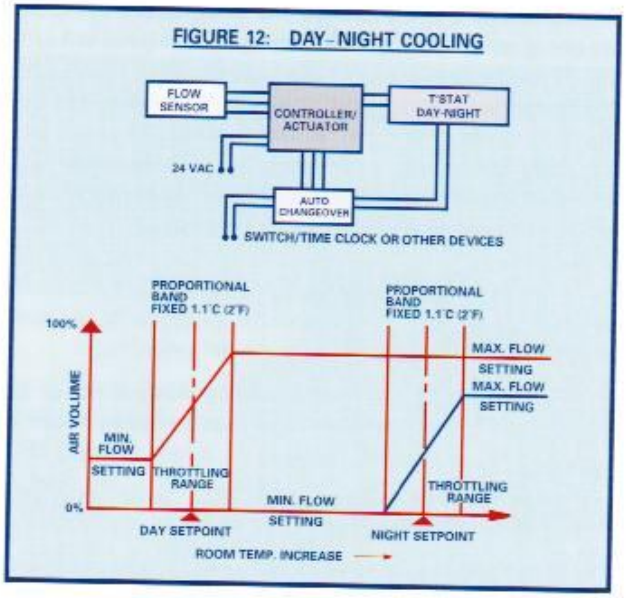
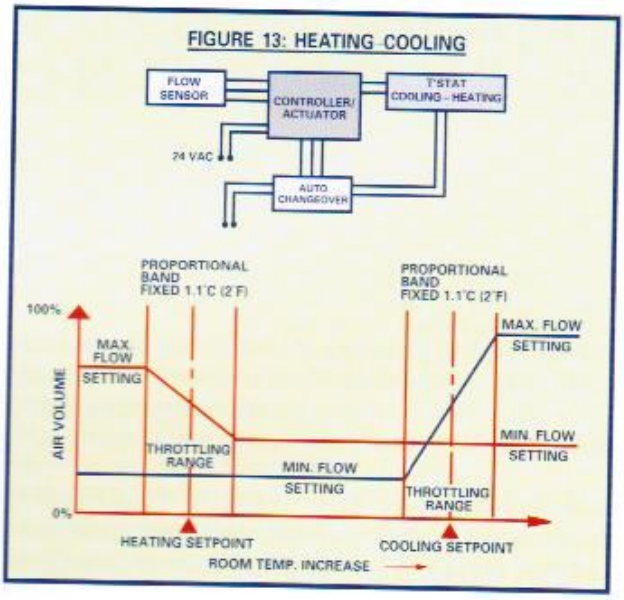


FIGURE 13: HEATING COOLING



the airflow through the VAV terminal box will be maintained at a pre-selected minimum setting.

With further decrease in space temperature, the heating side of the thermostat is activated, initiating the auxiliary velocity limit automatically as shown on figure 9 (on page 10). Airflow is maintained at the pre-selected auxiliary setting.

CONNOLS-AIR ELECTRONIC ANALOG CONTROLLED VAV TERMINAL UNIT

In response to the thermostat, the three stages of reheat are energized in sequence. The first stage is energized at 0.27°C above the heating setpoint. The second stage is energized 0.27°C below the heating setpoint. The third stage is energized 0.55°C below the heating setpoint.

COOLING WITH REHEAT AND MORNING WARM-UP (FIGURE 15)

The thermostat features a separate temperature setpoint for reheat control and an auxiliary velocity limit for morning warm-up. The reheat relay energizes up to three stages of electric reheat while the automatic changeover initiates the auxiliary setpoint during the morning warm-up.

The operation sequence of the cooling mode is similar to "Cooling Only" application, except that the reheat mode is energized once the space temperature falls below 0.55°C (below the thermostat cooling setpoint). The reheat thermostat has a proportional band of 1.1°C.

At the space temperature of 0.55°C above the thermostat setpoint, the airflow through the VAV terminal unit will be maintained at a pre-selected maximum setting. At the space temperature of 0.55°C below the thermostat setpoint, the airflow through the VAV terminal box will be maintained at a pre-selected minimum setting.

With further decrease in space temperature, the heating side of the thermostat is activated, energizing up to three stages of the electric heat. The first stage is energized at 0.27°C above the heating setpoint. The second stage is energized at 0.27°C below the heating setpoint. The third stage is energized at 0.55°C below the heating setpoint.

During the morning warm-up, at a duct temperature of above 23.9°C, the auxiliary velocity limit is initiated automatically. Airflow is maintained at the pre-selected auxiliary setting as shown on figure 15.

COOLING WITH TIME PROPORTIONING ELECTRIC REHEAT (FIGURE 16)

The reheat-cooling thermostat features separate temperature setpoints for reheat & cooling operation and minimum/ maximum velocity limits for cooling operation.

The operating sequence during the cooling mode is similar to the "Cooling Only" operation except that the reheat mode is energized once the space temperature falls below the pre-set reheat temperature setting. In the reheat mode, the relay will control the ON and OFF time of the reheater, in proportion to the difference between the space temperature and the pre-set heating temperature setting. The relay also controls the space temperature within 1.1°C proportional band in the reheat mode. The airflow will be controlled at pre-set minimum air setting of 45% of maximum air setting, whichever is greater.

FIGURE 14: COOLING WITH REHEAT & AUXILIARY LIMIT

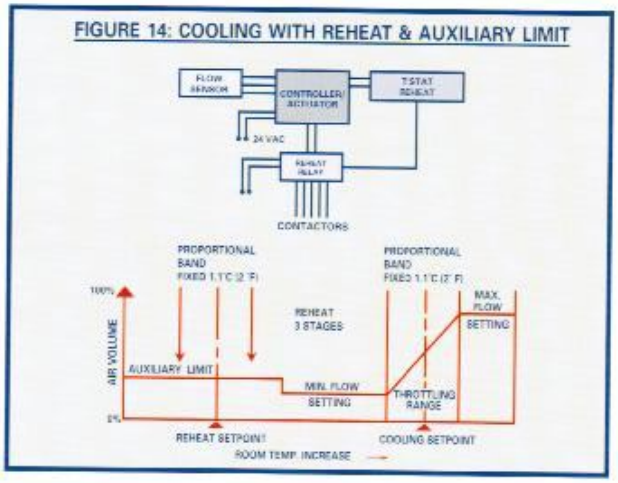


FIGURE 15: COOLING WITH REHEAT & MORNING WARM-UP

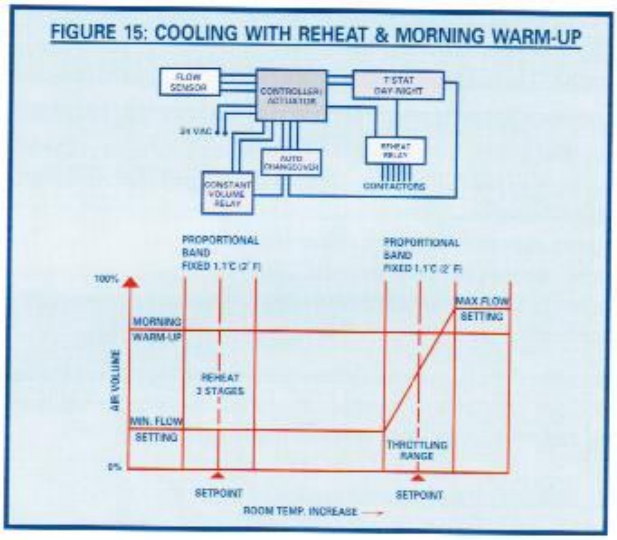
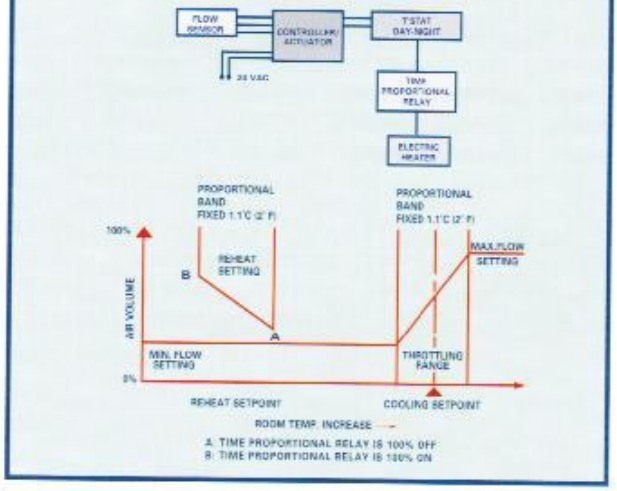
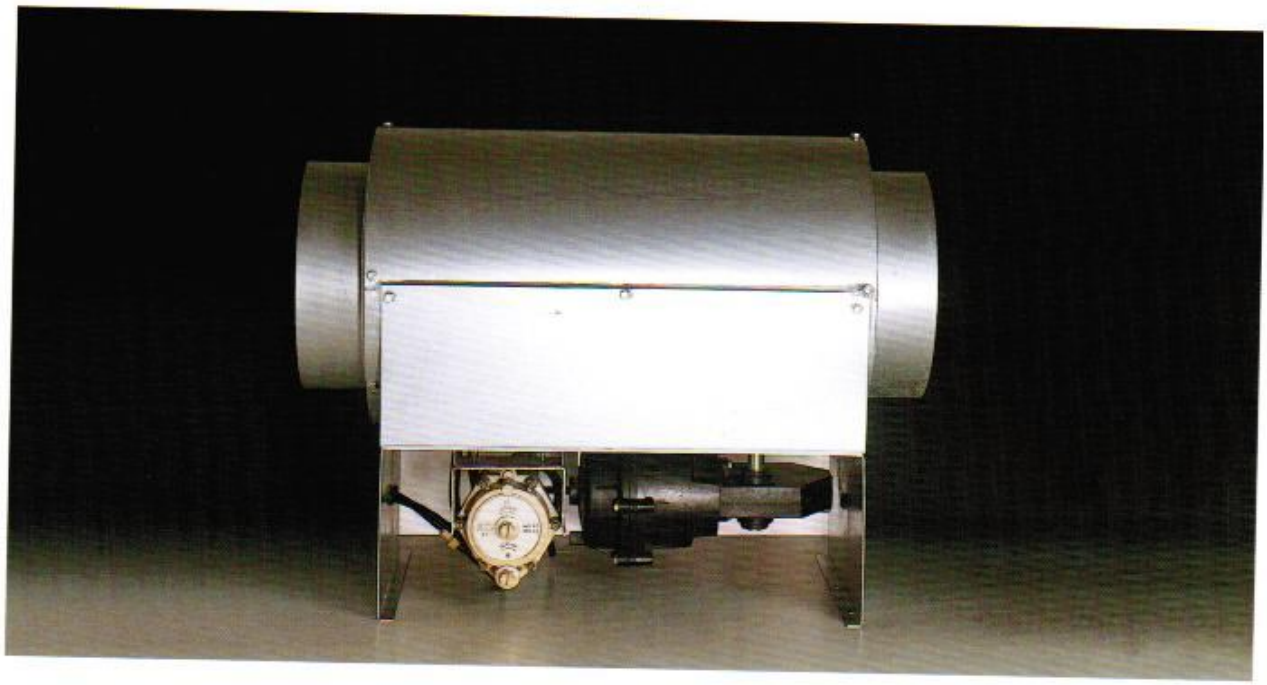


FIGURE 16: COOLING WITH TIME PROPORTIONING ELECTRIC REHEAT

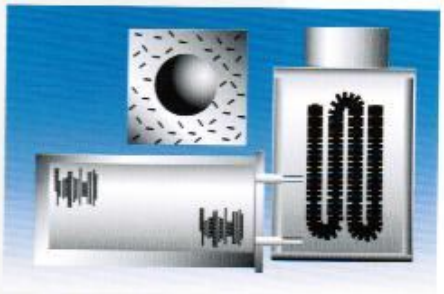


CONNOLS-AIR PNEUMATICALLY CONTROLLED PRESSURE INDEPENDENT VAV TERMINAL UNIT



The standard V750 VAV terminal unit is furnished with a reset volume controller, a pneumatic actuator, a differential flow sensor and a direct or reverse acting thermostat. The controller and actuator are housed in a metal enclosure. The VAV terminal unit may be supplied with a single point pressure or a multiple point pressure differential sensor, both of which provide accurate sensing of the airflow. The terminal unit operates as a stand-alone independent unit. The pneumatic flow controller operates with a maximum of 20 psi compressed air which directly controls the pneumatic actuator.

The operation of the pneumatically controlled pressure VAV terminal unit is quite similar to the analog controlled VAV terminal unit. The reset volume controller receives two inputs–one from the airflow sensor and the other from the room thermostat. The airflow sensor continually monitors the quantity of air going through the terminal unit and makes feedback of the signal to the reset volume controller at the same time. The room thermostat, on the other hand, monitors the room temperature continually and compares it to the setpoint temperature and sends the required signals to the reset volume controller (which will compare the two inputs), and a control signal is also sent to the pneumatic actuator. The pneumatic actuator will then modulate the VAV terminal unit damper continuously, allowing the required quantity of air through until the room setpoint temperature is obtained. The reset volume controller responds immediately to any changes in room temperature and fluctuations in duct pressure.



ACCESSORIES

- MULTI-OUTLET SILENCER (MOS)
- MULTI-OUTLET PLENUM (MOP)
- HIGH PERFORMANCE SILENCER
- WATER COIL REHEATER
- ELECTRIC REHEATER

ACCESSORIES

FIGURE 17: MULTI-OUTLET SILENCER (MOS)

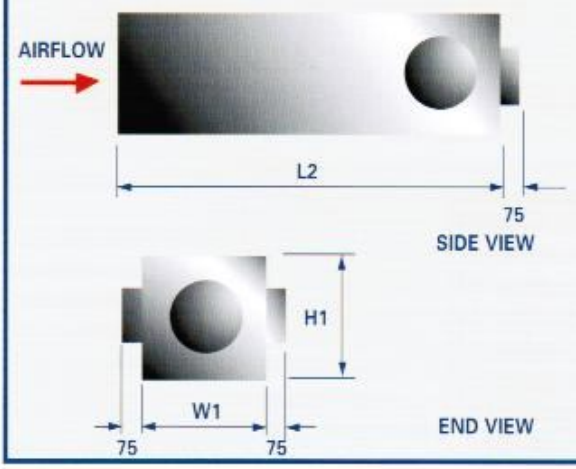
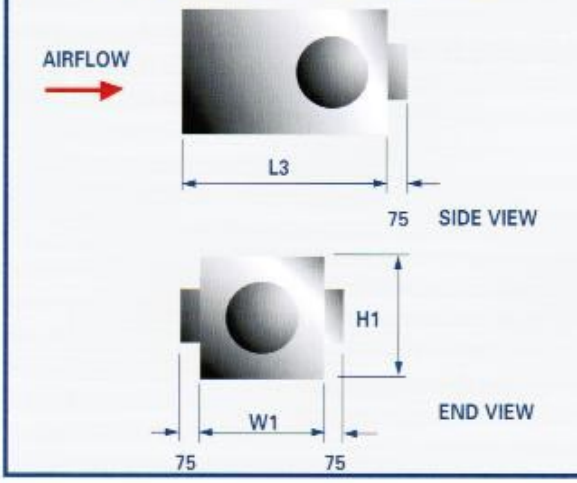


FIGURE 18: MULTI-OUTLET PLENUM (MOP)



MULTI-OUTLET SILENCER (MOS) & PLENUM (MOP)

The MOS acts as an air distribution plenum and a noise absorber. It is constructed of 0.7t to 1.0t mm galvanised steel, internally lined with 25mm thick tissue-lined fibreglass insulation. It is available in various standard lengths according to the number of outlets required. Noise attenuation property of MOS are shown on table 18 (on page 30).

The MOP acts as an air distribution unit with multi-outlets. It is constructed of 0.7t to 1.0t mm galvanised steel internally lined with 25mm thick tissue-lined fibreglass insulation. Length of MOP varies according to the number of outlets. Noise attenuation property of MOP are shown on table 18 (on page 30).

All round outlets on the MOS and MOP can be fitted with manual butterfly dampers. Lid for blanking-off spare outlet can be provided upon request. These are optional items (please specify in your order). Flexible insulated duct is recommended between the MOS (or MOP) discharge and the diffuser; a minimum length of 2 metres is suggested. Standard MOP and MOS dimensions and outlet arrangements are shown on tables 4 and 5 (on page 21). For customized outlet sizes and arrangements, please consult your nearest *Connols-Air* representatives.

ACCESSORIES

TABLE 4: DIMENSIONS OF MOP & MOS (WHEN VAV IS CONNECTED TO MOP & MOS, SILENCER OR REHEATER)

AIR TERMINAL UNIT SIZE	WIDTHS AND HEIGHTS OF MOP & MOS								LENGTHS OF MOP & MOS		
	WITH AIR TERMINAL UNIT ONLY		WITH CS SILENCER NOTE 1		WITH ELECTRIC REHEATER		WITH HOT WATER REHEATER		NO. AND SIZE OF OUTLET	MOS NOTE 2	MOP NOTE 2
	w1	h1	w1	h1	w1	h1	w1	h1	No. x Dia	L2	L3
5	250	250	227	227	450	300	351	280	2 x 150	800	450
6	250	250	252	252	450	300	524	280	4 x 150	1050	550
7	300	275	278	278	450	300	524	318	4 x 200	1150	650
8	400	300	303	303	450	300	524	330	4 x 200	1150	650
10	450	375	354	354	450	400	621	380	6 x 200	1450	950
12	600	400	455	455	450	400	1006	458	6 x 200	1450	950
14	650	500	556	556	550	550	1006	481	8 x 200	1750	1250
16	750	550	606	606	625	625	1006	580	10 x 200	2050	1550
18	900	600	657	657	750	750	1006	580	10 x 250	2300	1800

Note 1: When used with CS silencer, w1 and h1 may vary from the dimensions above depending on the model of CS silencer selected.
Note 2: L2 and L3 dimensions depend on the number of outlets and outlet arrangements.
Note 3: Please confirm all dimensions with our factory when ordering.

TABLE 5: STANDARD OUTLET ARRANGEMENT (PLAN VIEW)

OUTLETS	1	2	3	4	5	6	7	8	9	10
AIRFLOW LEFT TO RIGHT	A, B	C, D, E	F	G	H	I	J	K	L	M
AIR TERMINAL UNIT SIZE										
5	200	150	150	–	–	–	–	–	–	–
6	–	200	200	150	–	–	–	–	–	–
7	–	–	200	200	200	150	–	–	–	–
8	–	–	200	200	200	200	–	–	–	–
10	–	–	250	250	200	200	–	–	–	–
12	–	–	–	250	200	200	–	–	–	–
14	–	–	–	–	–	250	250	200	–	–
16	–	–	–	–	–	–	–	250	250	200
18	–	–	–	–	–	–	–	–	–	250

Note : For other outlet arrangements, please contact our factory .

ACCESSORIES

HIGH PERFORMANCE SILENCERS

- The silencers are produced in three different lengths of 600mm, 900mm and 1200mm.
- The silencers are made of double-skin construction with 0.7 to 1.0mm thick galvanised steel outer casing and 0.5mm thick galvanised steel perforated inner tube.
- Inlet and discharge collar may be provided at the ends of the silencer when required.
- For insertion loss and generated noise of silencers, refer to table 18 (on page 30).
- For w2 and h2 dimensions, refer to figure 19 and table 6 (on this page).

WATER COIL REHEATER

- Reheater casing is constructed of high quality galvanised steel sheet.
- For w3, w4 and h3, h4 dimensions, see table 7 (on this page).
- Water reheat coils are constructed of 12.5mm OD tube with seat connections and aluminium fins.
- Special 3-rows and 4-rows coil sections are available upon request. For consultation, contact your nearest *Connols-Air* representatives.
- For hot water performance data, please consult our factory or your nearest *Connols-Air* representatives.

ELECTRIC REHEATER

- Electric heater is of the metal-sheathed enclose black heat type. Standard heater has watt density of 31kw/m^2.
- Electric heater section is supplied with high temperature cut-off switch and flow switch as a standard safety measure.
- For electric reheater performance data, please consult our factory or your nearest *Connols-Air* representatives.

TABLE 6: SILENCER DIMENSIONS

AIR TERMINAL UNIT SIZE	MODEL	D	w2	h2
5	CS 50	127	227	227
6	CS 50	152	252	252
7	CS 50	178	278	278
8	CS 50 CS 75	203	303 353	303 353
10	CS 50 CS 75	254	354 404	354 404
12	CS 50 CS 75	305	405 455	405 455
14	CS 50 CS 75 CS 100	356	456 506 556	456 506 556
16	CS 75 CS 100	406	556 606	556 606
18	CS 75 CS 100	457	607 657	607 657

TABLE 7: REHEATER DIMENSIONS

AIR TERMINAL UNIT SIZE	HOT WATER COIL REHEATER SIZE (mm)		ELECTRIC REHEATER SIZE (mm)	
	w3	h3	w4	h4
5	326	210	350	300
6	496	210	450	300
7	496	248	450	300
8	496	260	450	300
10	596	310	450	400
12	981	388	500	450
14	981	411	550	550
16	981	460	625	625
18	981	510	750	750

FIGURE 19: HIGH PERFORMANCE SILENCER

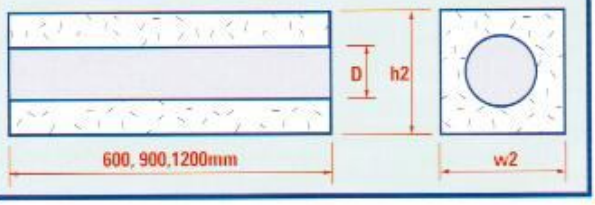


FIGURE 20: WATER COIL REHEATER

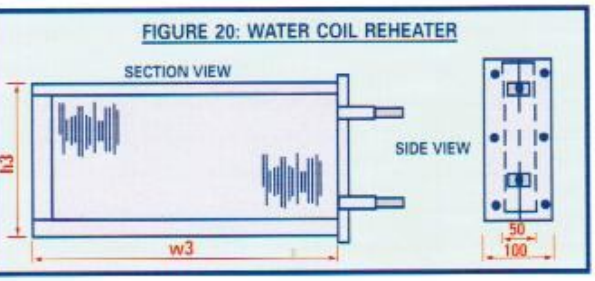
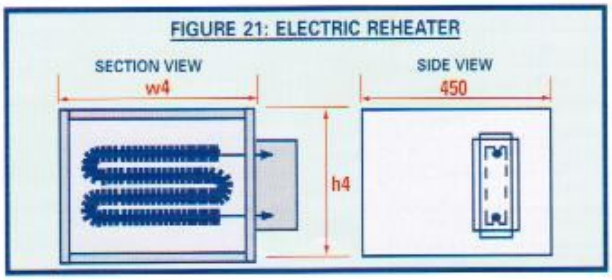


FIGURE 21: ELECTRIC REHEATER



ACCESSORIES

ARRANGEMENT OF AIR TERMINAL UNIT AND ACCESSORIES

FIGURE 22: DIMENSIONS OF AIR TERMINAL UNITS

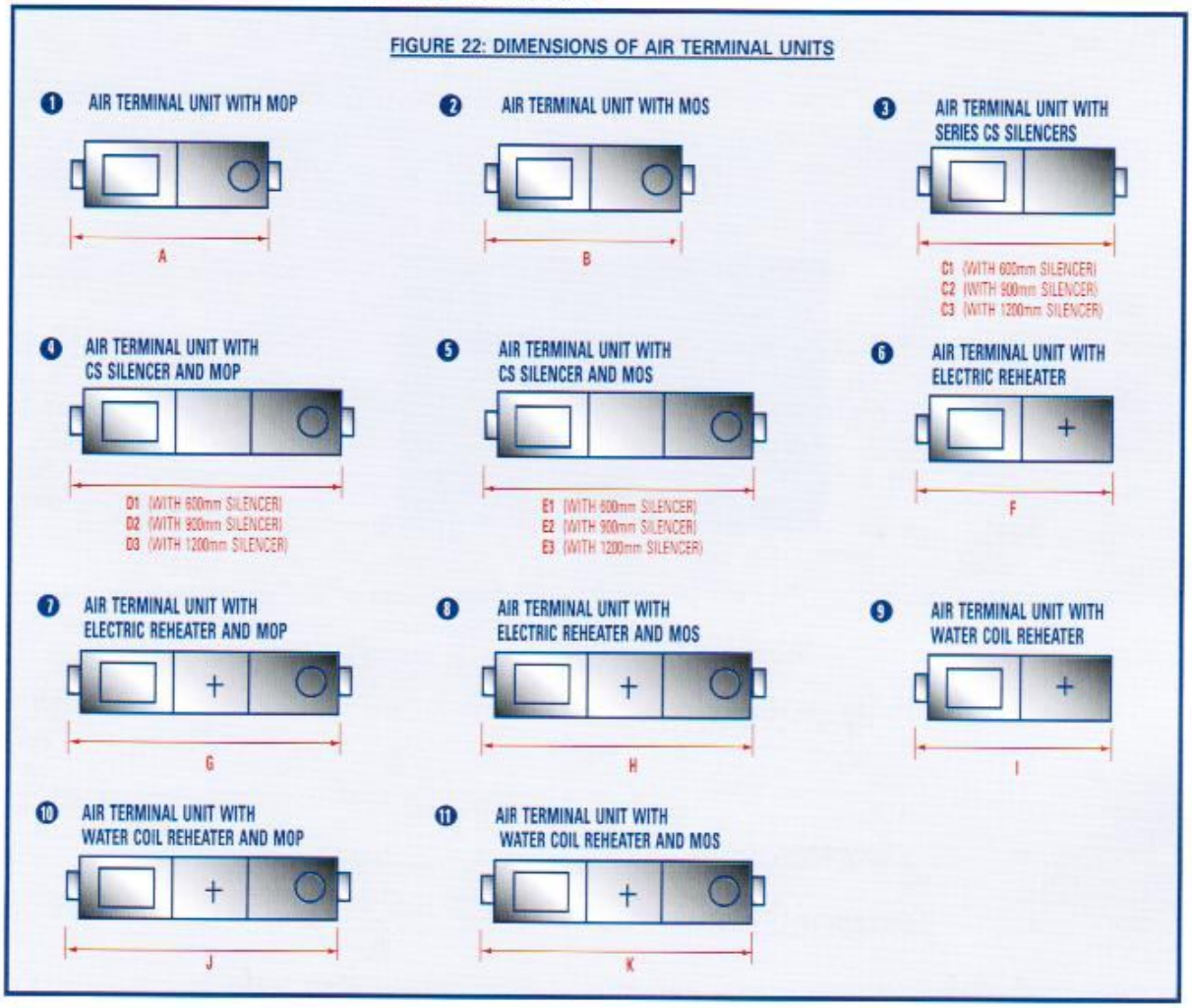


TABLE 8 : PHYSICAL DIMENSIONS OF AIR TERMINAL UNITS AND ACCESSORIES

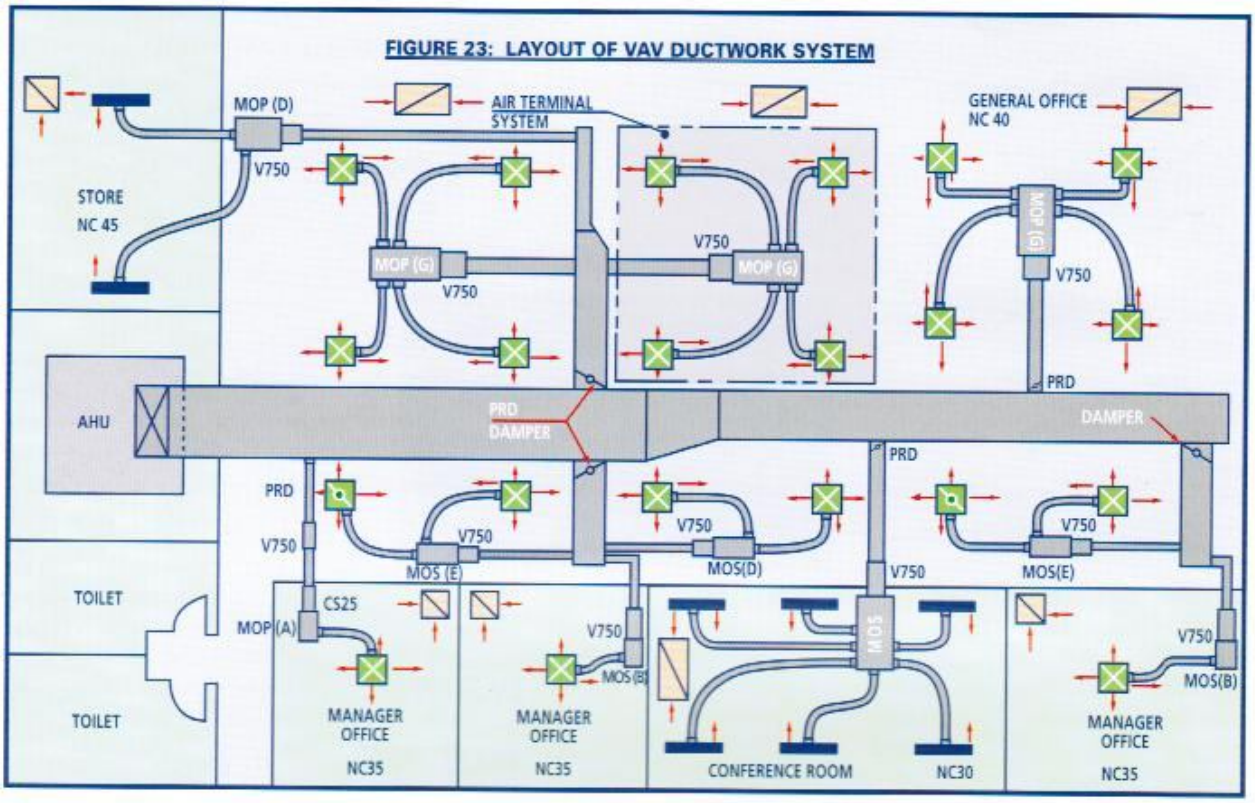
AIR TERMINAL UNIT SIZE	AIR TERMINAL UNITS WITH MOP AND MOS ONLY											AIR TERMINAL UNITS WITH ELECTRIC REHEATER			AIR TERMINAL UNITS WITH WATER REHEATER		
	A	B	C1	C2	C3	D1	D2	D3	E1	E2	E3	F	G	H	I	J	K
5	870	1220	1020	1320	1620	1470	1770	2070	1820	2120	2420	870	1320	1670	720	1170	1520
6	970	1470	1020	1320	1620	1570	1870	2170	2070	2370	2670	870	1420	1920	720	1270	1770
7	1070	1570	1020	1320	1620	1670	1970	2270	2170	2470	2770	870	1520	2020	720	1370	1870
8	1070	1570	1020	1320	1620	1670	1970	2270	2170	2470	2770	870	1520	2020	720	1370	1870
10	1421	1921	1071	1371	1671	2021	2321	2621	2521	2821	3121	921	1871	2371	771	1721	2221
12	1472	1972	1122	1422	1722	2072	2372	2672	2572	2872	3172	972	1922	2422	1122	2072	2572
14	1835	2335	1185	1485	1785	2435	2735	3035	2935	3235	3535	1035	2285	2785	1185	2435	2935
16	2186	2686	1236	1536	1836	2786	3086	3386	3286	3586	3886	1086	2636	3136	1236	2786	3286
18	2487	2987	1287	1587	1887	3087	3387	3687	3587	3887	4187	1137	2937	3437	1287	3087	3587

Note 1: Dimensions will vary according to the size and outlet arrangements of MOP and MOS.
Note 2: Please confirm all dimensions with our factory when ordering.

DESIGN SELECTION AND APPLICATION CONSIDERATION.

DESIGN SELECTION AND APPLICATION CONSIDERATION

FIGURE 23: LAYOUT OF VAV DUCTWORK SYSTEM



ABBREVIATIONS

MOP	: MULTIPLE OUTLET PLENUM	MOS	: MULTIPLE OUTLET SILENCER
PRD	: PRESSURE REDUCING DAMPER	CS	: HIGH PERFORMANCE SILENCER

DUCT DESIGN FOR VAV SYSTEM

A VAV system consists of supply air fan, ductwork, air terminal unit and air diffusers. Proper design and selection of these components are essential to ensure proper functioning of the system. The supply air fan which is normally located in the air handling unit must have the necessary controls to prevent excessive built-up of duct pressure. Such controls include inlet guide vanes, fan speed controller or variable pitch blade which essentially controls the supply air volume as required by the duct static pressure sensors located downstream.

When designing ductwork, it is necessary to consider the return air requirements and location of the duct static pressure sensor. Ideally, ductwork must be designed to match the pressure drop of the terminal unit to prevent built-up of excessive pressure at the terminal unit. While V750 terminal units can operate with excessive inlet static pressure, this can result in higher noise levels and reduced damper movement, thereby impairing zone control. It is, therefore, recommended that a pressure reducing damper be installed at each duct take-off for system balancing (see figure 23). Alternatively, the static regain duct design method can be used especially for large system which involves a large number of take-offs. This duct design method requires very little dampering and hence terminal unit selection and system balancing are greatly simplified.

DESIGN SELECTION AND APPLICATION CONSIDERATION

AIR TERMINAL UNIT SELECTION

Proper duct design, as described on page 26, ensures minimum generated noise from the VAV terminal unit. However due to the close proximity of the air terminal unit to the air diffuser, its generated noise can reach the air-conditioned space easily. For better control, the V750 air terminal units should be selected to operate at their maximum rated airflow with the damper in full open position. This can ensure maximum damper movement and optimum zone control.

Silencers, such as our MOS which is a multiple outlet silencer with a noise attenuation section, may be used to reduce the generated noise of the VAV terminal unit. For critical applications, our high performance series CS silencers are recommended. For best results, these silencers should be located at least 4 equivalent diameter downstream from the VAV terminal unit. For more details of the MOS and CS silencers, please refer to pages 20 and 22 .

NOISE CONSIDERATION

It is recommended that a qualitative noise analysis be carried out for each critical terminal system to determine the maximum noise from the VAV terminal unit. An example of such an analysis is shown on page 31 and data required for the analysis are provided on tables 9 to 18 (on pages 27 to 30).

In order to achieve best results and to meet the specified noise criteria, careful planning of the duct and equipment layout before construction is essential. The following points should also be considered:

- Install a pressure reducing damper at each duct take-off for balancing and preventing excessive pressure built-up at the VAV terminal unit. Model MD 2 damper is an ideal device for this purpose. Ask for the relevant catalogue from your *Connols-Air* representatives.
- Locate the VAV terminal unit away from the take-off as far as possible, so as to ensure that there is a minimum straight length distance equivalent to 3 diameters from the take-off.
- For critical VAV terminal system and for low noise requirement, consider the use of our high performance and multiple outlet silencers. These silencers can also reduce upstream duct bourne noise.
- Do not undersize flexible duct. Use VAV diffusers with acoustic plenum. Locate balancing damper at the multiple outlet discharge or at the inlet to the diffuser acoustic plenum so that the noise generated by the balancing damper can be attenuated by the acoustic plenum. Our diffusers such as TD, TDA, LSD, KLC, NKP, and P diffusers with acoustic plenum are effective in reducing upstream noise.
- Flexible duct may have sound attenuating property but it can also generate significant noise if the duct velocity is high and the installation is not properly carried out. To prevent this, flexible duct should be stretched to avoid unnecessary bend. Do not connect flexible duct directly to the diffuser neck as this will often result in uneven or turbulent flow, poor air distribution and excessive noise. The presence of damper at the diffuser will significantly increase the noise discharge from the diffuser.
- Use purpose-designed VAV diffusers to ensure proper air distribution. Our true VAV diffusers with pressure-compensated air volume damper can maintain good horizontal air throw at reduced flow and prevent air dumping.
- Do not oversize the air terminal unit to reduce generated noise. As mentioned earlier, this limits the range of modulation and can result in poor control. Instead, use silencers for better results.

NOISE ANALYSIS

ALLOWANCE FOR MULTIPLE OUTLET

When two equal noise sources are mixed, the resulting sound pressure level will always be 3 dB higher. However, if the two noise levels differ by 10 dB, the resulting sound pressure level is the same as the higher noise source as the effect of the lower noise source is insignificant. Table 9 indicates the dB to be added to the loudest noise level for varying differences in noise source.

Alternatively, table 10 indicates the dB to be added to the discharge sound power level from the air outlets for room with multiple outlets.

TABLE 9: ADDITION OF NOISE SOURCES

DB DIFFERENCE BETWEEN SOURCES (dB)	0	1	2	3	4	5	6	7	8	9	10
DB TO BE ADDED TO LOUDEST SOURCES (dB)	3	2.5	2	1.5	1.5	1	1	0.5	0.5	0	0

TABLE 10: ADDITION OF OUTLET NOISE

NO OF OUTLETS	1	2	3	4	OR MORE
DB TO BE ADDED	0	3	5	6	

DESIGN SELECTION AND APPLICATION CONSIDERATION

ALLOWANCE FOR FLOW DIVISION

When the flow from the VAV terminal unit is divided into different outlets, the sound energy from the terminal unit is reduced according to the proportion of the downstream duct cross-sectional areas. If the VAV terminal unit is supplying air to two outlets and the downstream duct outlets are equal in areas as shown on figure 24, one half of the sound energy goes into each duct and the sound pressure level in each duct is 3 dB lower than the VAV terminal unit discharge sound pressure level.

To calculate the division of sound energy when the downstream ducts are not equal in sizes, use table 11 on this page.

ROOM ABSORPTION

The NC levels indicated in the performance data on pages 34 to 39 have included 10 dB for room absorption for a soft room size of 50 square metres with carpet, hardwall and ceiling. For other room sizes and furnishings, use the room absorption indicated on table 12 on this page.

To determine VAV terminal unit casing radiation with transmission loss through the ceiling, the room absorption shown on table 12 should be used in conjunction with the ceiling transmission loss shown on table 13 on this page.

MULTIPLE OUTLET PLENUM (MOP) AND MULTIPLE OUTLET SILENCERS (MOS) ATTENUATION

Significant noise reduction can be obtained with the use of MOP or MOS. This reduction is the result of large volume and absorptive surface areas of the plenum. Additional absorption can be obtained from the geometric configuration of the plenum. As it is quite impossible to test the attenuation of plenum due to the almost infinite variations of plenum size and outlets (size, shape, location, no. of outlets, etc), estimated attenuation of standard size MOP and MOS are presented on table 18 (on page 30) as a guide, based on R.J. Wells recommendation.

FIGURE 24: MOP WITH 2 EQUAL OUTLETS

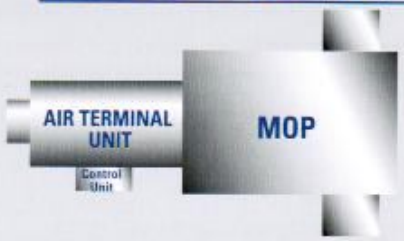


TABLE 11: DIVISION OF SOUND ENERGY

FLOW DIVISION	5%	10%	15%	20%	25%	30%	40%	50%	80%
DB TO BE DEDUCTED	-13	-10	-8	-7	-5	-4	-3	-2	-1

TABLE 12: ROOM ATTENUATION, dB

		ROOM SIZE (m^2)				
		20	50	100	150	400
TYPES OF ROOM	SOFT Carpet • Hardwall • Ceiling	–8	–10	–11	–13	–16
	AVERAGE Carpet • Hardwall • Ceiling	–6	–8	–11	–12	–16
	HARD Tile Floor • Hardwall • Ceiling	–4	–5	–6	–7	–10

TABLE 13: CEILING TRANSMISSION LOSS, dB

RECOMMENDED CEILING TRANSMISSION LOSS	dB REDUCTION OCTAVE BAND CENTRE FREQUENCES, Hz					
	125	250	500	1000	2000	4000
ALL TYPES OF CEILING WITH LIGHT FITTINGS	–3	–3	–3	–3	–3	–3

TABLE 14: NOISE CRITERIA

NC	SOUND PRESSURE LEVEL OCTAVE BAND CENTRE FREQUENCIES, dB re 20 µpa					
	2 125	3 250	4 500	5 1000	6 2000	7 4000
20	40	33	26	22	20	17
25	45	38	31	27	24	22
30	48	42	35	31	30	28
35	53	46	40	36	34	33
40	57	51	45	41	39	38
45	60	54	49	46	44	43
50	64	59	54	51	49	48
55	68	63	58	56	55	53
60	71	67	63	61	60	58
65	75	72	68	66	64	63
70	79	76	72	71	70	69

* *For criterical application, the MOP or MOS selected should be tested for noise attenuation.*

DESIGN SELECTION AND APPLICATION CONSIDERATION

TABLE 15: SOUND INSERTION LOSS OF FLEXIBLE DUCT (dB)

FLEXIBLE DIA (mm)	DUCT LENGTH (mm)	OCTAVE BAND CENTRE FREQUENCIES, Hz					
		125	250	500	1000	2000	4000
150	900	5	7	12	13	16	10
	1800	8	11	23	33	30	16
	2750	12	13	29	36	37	22
	3650	13	16	34	37	38	26
175	900	5	6	11	13	14	9
	1800	7	10	20	29	27	14
	2750	10	13	28	35	34	18
	3650	13	16	32	36	36	22
200	900	3	5	10	12	11	8
	1800	6	9	20	25	22	13
	2750	8	12	27	32	30	17
	3650	12	15	31	35	34	22
250	900	3	3	9	10	10	7
	1800	3	7	19	23	19	10
	2750	5	10	27	31	27	15
	3650	10	13	29	34	34	18
300	900	1	3	7	8	9	5
	1800	4	5	18	19	18	10
	2750	7	10	24	28	26	12
	3650	8	13	27	32	31	16

Note • *Above data are based on flexible duct with 25mm thick, 32kg/m³ fibreglass insulation.*
• *Insertion loss data are based on duct air velocity of 12m/s.*

TABLE 16: GENERATED SOUND POWER LEVEL OF FLEXIBLE DUCT LW, dB re10^{-12} WATTS

FLEXIBLE DIA (mm)	DUCT LENGTH (mm)	OCTAVE BAND CENTRE FREQUENCIES, Hz					
		125	250	500	1000	2000	4000
150	900	34	29	–	–	–	–
	1800	34	30	21	–	–	–
	2750	34	27	23	20	–	–
	3650	35	31	22	–	–	–
175	900	34	32	25	–	–	–
	1800	33	30	21	–	–	–
	2750	–	28	21	–	–	–
	3650	33	32	24	22	–	–
200	900	36	37	28	22	–	–
	1800	35	30	27	22	–	–
	2750	34	35	29	21	–	–
	3650	35	28	–	–	–	–
250	900	34	32	21	–	–	–
	1800	38	35	28	23	–	–
	2750	37	33	22	–	–	–
	3650	38	34	21	–	–	–
300	900	35	32	27	24	–	–
	1800	33	31	24	20	–	–
	2750	33	30	22	20	–	–
	3650	33	27	23	–	–	–

Note • *Above data based on straight duct run.*
• *Sound power level are based on 4m/s duct air velocity.*
• *"–" represents sound level below 20 dB.*

TABLE 17: INSERTION LOSS OF HIGH PERFORMANCE ATTENUATOR

LENGTH (mm)				600mm						900mm						1200mm					
AIR TERMINAL UNIT SIZE	DIAMETER (mm)	MODEL	w2 X h2 (mm)	ATTENUATION, dB OCTAVE BAND CENTRE FREQUENCIES, Hz						ATTENUATION, dB OCTAVE BAND CENTRE FREQUENCIES, Hz						ATTENUATION, dB OCTAVE BAND CENTRE FREQUENCIES, Hz					
				125	250	500	1K	2K	4K	125	250	500	1K	2K	4K	125	250	500	1K	2K	4K
5	130	CS 50	230 x 230	8	13	29	35	31	29	12	19	37	40	34	31	15	22	41	46	42	34
		CS 100	330 x 330	13	17	27	37	37	31	19	27	39	42	38	33	–	–	–	–	–	–
6	156	CS 50	256 x 256	7	12	24	33	30	28	10	15	32	38	33	30	14	20	39	44	41	32
		CS 100	356 x 356	11	16	25	35	35	27	13	21	34	40	36	31	–	–	–	–	–	–
7	181	CS 50	281 x 281	6	11	22	31	29	24	9	15	30	35	32	27	13	18	37	43	40	28
		CS 100	381 x 381	10	15	23	33	33	24	12	19	32	38	35	29	–	–	–	–	–	–
8	207	CS 50	307 x 307	6	10	20	29	28	17	9	14	28	32	31	25	12	17	36	41	39	27
		CS 100	407 x 407	9	13	22	31	32	20	12	18	30	35	33	29	16	24	37	42	41	30
10	257	CS 50	357 x 357	5	10	19	27	26	16	8	13	26	30	29	20	10	15	32	37	34	23
		CS 100	457 x 457	7	12	21	29	29	19	11	16	28	34	32	24	14	21	33	38	38	26
12	308	CS 50	408 x 408	4	9	18	25	21	14	7	12	24	27	28	17	8	13	28	32	29	19
		CS 100	508 x 508	7	10	20	27	27	16	10	16	27	33	31	21	13	17	30	36	35	24
14	359	CS 50	459 x 459	4	8	17	24	20	14	7	12	24	26	26	16	–	–	–	–	–	–
		CS 100	559 x 559	7	10	19	26	25	16	10	15	26	33	31	20	–	–	–	–	–	–
16	409	CS 50	509 x 509	3	7	17	22	16	9	6	11	21	25	23	13	–	–	–	–	–	–
		CS 100	609 x 609	5	9	19	25	20	13	8	14	24	30	28	17	–	–	–	–	–	–
18	460	CS 50	560 x 560	2	6	15	20	14	7	4	9	19	22	20	11	–	–	–	–	–	–
		CS 100	660 x 660	4	9	17	23	17	12	7	13	22	26	23	15	–	–	–	–	–	–

Note • *For dimensions w2 and h2 , refer to figure 19 and table 6 on page 22.*
• *Insertion loss are obtained in an acoustic laboratory according to BS 4718 and ASTM E477.*

DESIGN SELECTION AND APPLICATION CONSIDERATION

TABLE 18: ATTENUATION OF MOP AND MOS

	AIR TERMINAL UNIT SIZE	MOP & MOS		MOP	MOS	OUTLET		MOP ATTENUATION, dB OCTAVE BAND CENTRE FREQUENCIES, Hz						MOS ATTENUATION, dB OCTAVE BAND CENTRE FREQUENCIES, Hz					
		w1	h1	L2	L3	Dia	No.	125	250	500	1000	2000	4000	125	250	500	1000	2000	4000
ROUND INLET	5	227	227	450	800	150	1	1	7	12	17	17	17	4	10	15	20	20	20
	5	250	250	450	800	150	2	1	7	12	16	16	16	4	10	16	20	20	20
	6	250	250	450	850	200	2	0	5	10	14	14	14	3	9	14	19	19	19
	6	250	250	550	1050	150	4	0	5	10	12	12	12	4	10	15	19	19	19
	7	300	275	650	1150	200	4	0	5	10	12	12	12	4	9	15	18	18	18
	7	278	278	650	1150	200	4	0	5	9	12	12	12	3	9	14	18	18	18
	7	278	278	800	1300	150	6	1	6	10	12	12	12	4	10	15	19	19	19
	8	400	300	650	1150	200	4	0	6	10	12	12	12	4	9	14	18	18	18
	8	353	353	650	1150	200	4	0	5	10	12	12	12	4	9	14	18	18	18
	10	450	375	950	1450	200	6	1	6	10	11	11	11	3	9	14	17	17	17
	10	404	404	950	1450	200	6	1	6	9	11	11	11	3	9	14	17	17	17
	12	600	400	950	1450	200	6	1	6	10	12	12	12	3	8	13	16	16	16
	12	455	455	950	1450	200	6	0	5	8	10	10	10	2	8	12	15	15	15
	14	600	500	1250	1750	200	8	1	6	9	11	11	11	3	8	12	15	15	15
	14	556	556	1250	1750	200	8	1	6	9	10	10	10	3	8	12	15	15	15
	16	750	550	1550	2050	200	10	2	7	10	12	12	12	3	8	12	14	14	14
	16	606	606	1550	2050	200	10	1	6	9	10	10	10	3	8	12	14	14	14
	18	900	600	1800	2300	250	10	2	7	11	13	13	13	3	8	12	14	14	14
	18	657	657	1800	2300	250	10	1	6	9	10	10	10	2	8	11	13	13	13
OPEN INLET	5	350	300	450	800	150	1	0	0	6	10	10	10	0	4	9	14	14	14
	5	351	280	450	800	150	2	0	0	5	9	9	9	0	4	9	13	13	13
	6	450	300	550	1050	150	4	0	0	5	8	8	8	0	4	9	13	13	13
	6	524	280	550	1050	150	4	0	0	5	8	8	8	0	4	9	13	13	13
	7	450	300	650	1150	200	4	0	1	5	8	8	8	0	4	10	13	13	13
	7	524	318	650	1150	200	4	0	0	5	8	8	8	0	4	9	12	12	12
	8	450	300	650	1150	200	4	0	1	5	8	8	8	0	4	10	13	13	13
	8	524	330	650	1150	200	4	0	0	5	8	8	8	0	4	9	12	12	12
	10	450	400	950	1450	200	6	0	1	5	7	7	7	0	4	9	12	12	12
	10	621	380	950	1450	200	6	0	1	6	8	8	8	0	4	9	12	12	12
	12	500	450	950	1450	200	6	0	1	5	7	7	7	0	4	9	11	11	11
	12	1006	458	950	1450	200	6	0	0	5	9	9	9	0	3	7	10	10	10
	14	550	550	1250	1750	200	8	0	1	5	6	6	6	0	4	8	11	11	11
	14	1006	481	1250	1750	200	8	0	2	6	9	9	9	0	3	8	10	10	10
	16	625	625	1550	2050	200	10	0	2	5	6	6	6	0	4	8	10	10	10
	16	1006	530	1550	2050	200	10	0	2	7	9	9	9	0	3	8	10	10	10
	18	750	750	1800	2300	250	10	0	1	5	6	6	6	0	3	7	9	9	9
	18	1006	580	1800	2300	250	10	0	2	6	9	9	9	0	4	8	10	10	10

Note:

- *Insertion loss data are estimated, based on the modified model of R.J.Wells which gives an approximation of the attenuation of the MOP and MOS.*
- *The attenuation of MOP and MOS has been limited by reducing the sound absorption coefficients of the absorption material to a maximum of 0.6 at 500Hz, 1000Hz, 2000Hz and 4000Hz octave.*
- *Attenuation has been estimated based on the nearest outlet to the VAV discharge.*
- *Attenuation with open inlet are for VAV terminal units with reheater.*
- *Tests on MOP and MOS have confirmed that the estimated attenuation as shown on table 18 is achievable.*

DESIGN SELECTION AND APPLICATION CONSIDERATION

EXAMPLE OF NOISE ANALYSIS

Consider a conference room of the size of 8m x 4m as shown on figure 23 (on page 26) with carpeted floor, hardwalls and fibreglass ceiling board. The cooling and NC requirements are as follows:

Air quantity

688 cfm

Noise Criteria

NC 30

Pressure Loss

50 Pa

No. of linear diffusers c/w acoustic plenum

1200mm length x 1 slot with 150mm diameter inlet – 6 numbers.

Select a VAV terminal unit to serve 6 diffusers in order to meet the above-mentioned requirements.
We will select a size 7 unit with a minimum pressure loss of 47 Pa.

AIR TERMINAL GENERATED NOISE

		OCTAVE BAND CENTRE FREQUENCIES (HZ)					
		125	250	500	1000	2000	4000
1	Unit Generated Sound Power Level at 125 Pa	57	55	56	48	44	40
2	Allow For MOS Attenuation (table 18 on page 30)	-4	-10	-15	-19	-19	-19
3	Allow For Flow Division (table 11 on page 28)	-8	-8	-8	-8	-8	-8
4	Allow For Flexible Duct Attenuation, 1.2m Straight Length (table 15 on page 29)	-6	-8	-16	-20	-20	-12
5	Allow For 6 Diffusers (table 10 on page 27)	+6	+6	+6	+6	+6	+6
6	Resultant SWL at Duct Discharge	45	35	23	7	6	7
7	Effect of Flexible Duct SWL At 4m/s Air Velocity (table 16 on page 29)	36	37	28	22	18	18
8	Discharge SWL To Room (compare 6 and 7)	45	39	29	22	18	18

AIR TERMINAL RADIATED NOISE

9	Unit Radiated SWL At 125 Pa	46	44	43	33	33	26
10	Ceiling Transmission Loss	-3	-3	-3	-3	-3	-3
11	Radiated SWL To Room	43	41	40	40	30	23
12	Resultant Room Noise, Add 8 and 11 (table 9 on page 27)	47	43	40	40	30	24
13	Allow For Room Absorption (table 12 on page 28)	-6	-6	-6	-6	-6	-6
14	Resultant Room Sound Pressure Level	41	37	34	34	24	18
15	NC 30 (table 14 on page 28)	48	42	35	35	30	28

The size 7 VAV terminal unit is selected with Multiple Outlet Silencers (MOS) and therefore, meets the specified noise criteria of NC 30. This is based on the assumption that the diffuser selected has a noise level of at least 5 dB lower than the specified noise criteria.

AIR TERMINAL UNIT

PERFORMANCE DATA.

PERFORMANCE DATA

GENERATED NOISE OF V750 TERMINAL UNIT ONLY

UNIT SIZE	AIR FLOW		MIN. PRESS. LOSS	SOUND POWER LEVEL Lw, dB re 10^{-12} WATTS													
				@125 Pa (0.5"W.G.) OCTAVE BAND CENTRE FREQUENCIES, Hz							@250 Pa (1.0"W.G.) OCTAVE BAND CENTRE FREQUENCIES, Hz						
	I/S	CFM		125	250	500	1k	2k	4k	NC	125	250	500	1k	2k	4k	NC
5	43	90	18	42	41	41	38	35	29	26	43	43	44	44	41	34	34
	59	125	28	45	42	41	40	37	30	29	45	44	45	45	42	35	34
	83	175	47	46	43	43	42	39	31	31	48	47	48	47	43	37	36
	94	200	61	49	45	43	44	41	34	33	51	49	48	48	46	38	37
	106	225	76	50	45	45	45	42	35	34	52	50	49	48	47	40	38
	118	250	90	52	47	45	46	43	36	35	52	51	51	49	48	41	39
	142	300	125	53	52	50	47	44	37	36	54	54	52	51	49	42	40
6	94	200	4	43	40	42	43	40	33	32	46	44	45	46	45	38	35
	118	250	6	48	43	45	43	40	35	32	52	47	48	47	46	40	37
	142	300	10	50	45	46	45	42	36	34	53	49	50	49	48	41	39
	165	350	14	51	47	47	45	43	38	35	54	52	51	50	49	43	40
	189	400	19	52	47	47	46	44	40	36	56	53	52	52	50	45	41
	213	450	24	52	49	47	46	44	42	36	57	54	53	53	51	47	42
	236	500	31	53	50	49	47	45	45	37	60	56	55	54	52	50	43
	260	550	38	53	52	49	48	45	47	37	60	55	56	54	52	52	44
7	142	300	7	49	45	44	41	38	30	30	53	48	48	45	46	41	37
	189	400	14	52	47	47	43	40	33	32	56	52	52	49	47	43	38
	236	500	31	53	50	49	45	42	37	34	60	55	55	52	48	45	41
	283	600	34	55	54	54	46	43	39	39	64	59	58	53	49	47	44
	331	700	49	57	55	56	48	44	40	41	66	61	62	55	50	48	48
	378	800	66	58	58	58	50	45	42	44	67	63	64	58	52	49	50
	425	900	88	59	60	60	53	47	43	46	68	64	66	59	53	50	52
8	142	300	5	46	44	42	36	33	24	26	51	47	46	41	41	32	32
	189	400	9	50	47	46	39	35	25	32	54	51	51	45	42	34	36
	236	500	15	53	50	49	42	38	29	34	58	55	55	48	44	37	40
	283	600	22	55	52	52	44	40	30	37	63	57	58	51	46	38	43
	331	700	32	56	53	54	46	41	32	39	64	59	61	53	47	40	47
	378	800	42	57	56	56	48	43	36	41	65	61	63	56	50	42	49
	472	1000	70	58	60	60	53	47	40	46	66	65	66	59	52	45	52
10	189	400	4	49	44	43	38	34	24	27	53	47	48	43	41	32	33
	283	600	9	54	49	48	40	39	29	33	58	53	53	47	44	36	38
	378	800	16	55	53	52	45	40	35	37	60	57	57	51	46	41	42
	472	1000	25	57	57	55	49	43	37	40	62	61	61	55	50	42	47
	567	1200	36	59	60	60	53	48	40	45	64	62	63	58	52	44	49
	661	1400	49	61	63	63	58	51	43	49	66	66	67	62	56	49	53
	779	1600	66	64	66	67	61	54	46	53	69	69	70	64	58	52	57
12	378	800	7	53	54	42	47	39	31	37	57	57	56	51	46	39	41
	567	1200	17	55	55	55	49	41	33	40	60	58	59	55	49	41	44
	756	1600	30	60	61	62	55	47	40	48	64	64	64	60	53	46	49
	944	2000	48	62	64	66	58	52	43	52	66	67	68	62	56	50	51
	1133	2400	70	64	66	68	60	55	46	55	69	69	71	64	56	53	57
14	567	1200	7	53	53	53	46	38	30	38	55	54	55	55	49	42	44
	756	1600	13	55	55	57	48	40	33	40	59	59	60	56	51	44	46
	944	2000	22	58	59	61	51	44	38	47	62	61	62	67	52	45	48
	1133	2400	34	59	61	64	54	48	41	50	65	64	66	60	53	48	53
	1322	2800	49	60	62	64	55	49	43	53	66	66	68	63	55	49	54
	1511	3200	67	61	64	66	59	52	46	53	67	68	70	65	58	52	57
	1700	3600	90	62	65	69	62	55	48	56	68	69	72	66	60	54	58
16	756	1600	8	52	53	53	48	39	33	38	56	56	56	53	49	43	42
	944	2000	13	55	57	56	50	44	36	41	59	59	58	55	51	45	44
	1133	2400	20	56	59	59	52	46	40	45	61	61	61	58	52	47	47
	1322	2800	29	58	61	60	53	47	41	46	63	63	64	60	53	48	50
	1511	3200	37	59	63	62	56	50	44	48	65	66	66	62	56	50	52
	1700	3600	48	61	64	64	59	52	46	50	66	67	67	63	58	52	54
	1889	4000	60	63	66	66	62	54	47	53	68	69	68	65	59	54	56
	2078	4400	76	66	68	67	65	56	49	54	70	71	70	67	61	56	57
	2267	4800	84	69	70	69	68	58	50	57	71	74	72	68	64	57	58
18	944	2000	5	52	55	51	48	43	37	37	55	57	54	53	50	44	42
	1133	2400	7	53	56	53	50	44	38	39	56	58	56	55	51	45	44
	1322	2800	9	56	59	55	50	45	39	40	60	61	59	56	51	46	45
	1511	3200	13	57	61	57	52	47	42	43	62	63	61	58	54	48	47
	1700	3600	17	59	62	59	55	48	43	45	63	64	62	60	55	49	49
	1889	4000	21	59	63	60	56	49	44	46	64	66	64	61	56	51	50
	2078	4400	25	60	63	60	56	50	45	46	65	66	64	62	56	51	51
	2267	4800	31	60	65	61	57	51	47	47	65	68	65	63	57	52	52
	2456	5200	37	61	67	62	60	52	48	49	66	70	66	64	58	53	53

Note:

- Test data obtained generally in accordance to ISO 5220, ISO 5135, ISO 3741 and related standards.
- NC values are based on 10 dB room absorption in all octave bands.
- All pressure indicated are differential pressure measured across the VAV terminal box.
- "–" represents noise level below 20 dB.

PERFORMANCE DATA

GENERATED NOISE OF V750 TERMINAL UNIT ONLY

UNIT SIZE	AIR FLOW I/S	AIR FLOW CFM	MIN. PRESS. LOSS	SOUND POWER LEVEL Lw, dB re 10^{-12} WATTS @375 PA (1.5"W.G.) OCTAVE BAND CENTRE FREQUENCIES, Hz 125	250	500	1K	2K	4K	NC	@500 PA (2.0"W.G.) OCTAVE BAND CENTRE FREQUENCIES, Hz 125	250	500	1K	2K	4K	NC
5	43	90	18	43	45	47	50	49	41	40	43	45	49	50	50	47	41
	59	125	28	45	47	49	50	49	42	40	45	48	51	52	52	47	43
	83	175	47	50	50	52	52	50	43	41	49	52	53	55	54	48	45
	94	200	61	53	53	53	53	51	44	42	51	54	55	56	54	49	45
	106	225	76	53	54	53	54	52	44	43	54	55	56	57	55	49	46
	118	250	90	56	56	54	55	53	46	44	56	58	58	58	56	50	47
	142	300	125	57	58	56	58	53	47	47	58	59	58	60	57	50	49
6	94	200	4	47	48	49	50	51	44	42	46	48	52	53	53	46	44
	118	250	6	53	51	51	52	52	45	43	52	52	54	54	54	47	45
	142	300	10	56	53	53	52	53	46	44	57	55	55	55	55	48	46
	165	350	14	60	56	55	55	54	48	45	60	58	57	57	57	50	48
	189	400	19	62	58	57	57	55	50	46	62	60	59	59	58	51	49
	213	450	24	62	62	59	58	56	52	47	63	63	61	60	59	52	50
	236	500	31	64	62	60	60	57	54	48	64	65	62	62	61	54	52
	260	550	38	65	63	62	61	58	56	50	66	65	64	63	62	55	53
7	142	300	7	55	51	51	49	52	46	42	55	53	54	52	53	47	44
	189	400	14	61	55	56	53	53	49	42	61	57	57	56	57	48	48
	236	500	31	63	60	59	56	54	51	45	64	62	60	59	58	51	49
	283	600	34	67	61	62	60	55	52	49	67	64	64	62	59	52	51
	331	700	49	68	63	63	60	56	53	49	69	65	65	64	59	53	53
	378	800	66	70	64	65	63	57	53	52	70	65	67	64	60	55	53
	425	900	88	71	66	68	64	60	55	54	72	67	70	67	62	57	57
8	142	300	5	53	49	49	45	47	38	38	53	51	52	50	51	45	41
	189	400	9	59	51	54	49	48	40	39	59	54	56	53	53	46	43
	236	500	15	62	57	57	52	49	42	42	63	59	59	55	54	48	45
	283	600	22	66	60	60	55	51	43	46	66	62	62	58	55	49	46
	331	700	32	67	62	62	57	52	45	48	67	64	64	59	56	50	49
	378	800	42	69	64	65	60	54	47	51	70	67	67	62	58	51	53
	472	1000	70	71	67	68	63	57	49	56	73	69	70	65	60	53	56
10	189	400	4	57	50	52	47	47	39	38	58	52	52	49	50	44	41
	283	600	9	61	57	57	50	49	42	42	61	58	57	54	52	46	43
	378	800	16	65	60	61	56	52	46	47	66	61	61	59	57	50	48
	472	1000	25	67	64	64	60	56	48	50	68	65	64	61	59	52	50
	567	1200	36	69	66	65	61	56	50	51	70	67	68	65	60	53	52
	661	1400	49	71	68	70	65	60	54	57	73	69	71	67	62	56	58
	779	1600	66	73	71	73	67	62	57	60	75	72	74	69	64	59	61
12	378	800	7	61	59	59	56	52	47	45	53	60	60	59	57	50	48
	567	1200	17	63	61	62	61	56	49	50	60	63	64	63	60	53	52
	756	1600	30	68	67	66	65	59	53	54	66	69	69	67	63	57	56
	944	2000	48	70	69	70	66	60	57	57	69	72	73	70	64	59	60
	1133	2400	70	74	72	73	67	61	59	60	72	76	77	73	65	61	64
14	567	1200	7	58	57	57	58	55	48	47	60	59	59	60	58	52	47
	756	1600	13	62	60	60	60	55	49	49	65	63	62	63	59	54	51
	944	2000	22	64	63	64	62	57	50	51	67	65	65	65	61	55	53
	1133	2400	34	68	66	67	64	59	53	54	70	68	68	67	63	57	55
	1322	2800	49	69	68	69	67	60	54	56	72	70	70	69	64	58	57
	1511	3200	67	71	70	71	69	62	56	59	74	72	72	71	65	60	59
	1700	3600	90	72	71	73	70	63	57	60	76	73	74	72	66	61	62
16	756	1600	8	59	58	57	57	54	49	46	62	60	59	60	57	53	49
	944	2000	13	61	61	61	60	57	50	49	64	63	63	62	60	56	52
	1133	2400	20	64	63	63	62	58	53	51	67	65	65	64	61	57	53
	1322	2800	29	66	66	66	64	59	54	53	69	67	67	66	62	58	55
	1511	3200	37	68	68	68	67	61	55	56	71	69	69	68	64	59	57
	1700	3600	48	70	69	71	68	61	56	58	72	71	70	69	65	60	58
	1889	4000	60	72	72	73	71	64	58	60	74	73	72	71	67	62	60
	2078	4400	76	74	74	75	73	66	60	62	76	75	74	73	69	64	62
	2267	4800	84	76	77	78	75	68	61	65	78	77	76	74	71	65	63
18	944	2000	5	58	59	58	58	56	51	47	61	61	60	59	59	55	50
	1133	2400	7	60	60	59	60	57	52	49	63	63	61	62	60	56	51
	1322	2800	9	62	63	62	61	58	53	50	65	65	64	63	61	57	51
	1511	3200	13	65	65	65	64	60	54	53	67	67	66	65	63	58	54
	1700	3600	17	68	66	66	66	59	54	55	69	69	67	66	63	59	56
	1889	4000	21	68	68	68	67	61	56	55	70	70	69	68	65	60	57
	2078	4400	25	69	69	68	67	62	57	56	71	71	70	69	65	61	58
	2267	4800	31	71	71	70	68	63	58	57	73	72	71	70	66	62	59
	2456	5200	37	72	71	71	69	63	58	58	74	73	71	71	67	63	60

Note:

- *Test data obtained generally in accordance to ISO 5220, ISO 5135, ISO 3741 and related standards.*
- *NC values are based on 10 dB room absorption in all octave bands.*
- *All pressure indicated are differential pressure measured across the VAV terminal box.*
- *"–" represents noise level below 20 dB.*

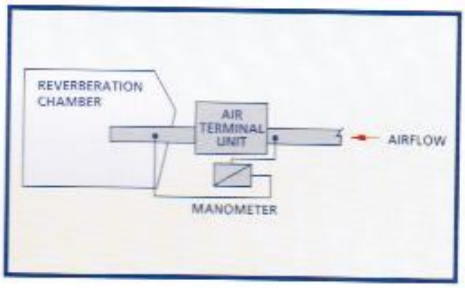
PERFORMANCE DATA

GENERATED NOISE OF V750 TERMINAL UNIT ONLY

UNIT SIZE	AIR FLOW I/S	AIR FLOW CFM	MIN. PRESS. LOSS	SOUND POWER LEVEL Lw, dB re 10^{-12} WATTS @750 PA (3.0"W.G.) OCTAVE BAND CENTRE FREQUENCIES, Hz 125	250	500	1K	2K	4K	NC
5	43	90	18	41	38	51	51	53	53	45
	59	125	28	41	46	51	56	56	53	47
	83	175	47	48	52	55	58	58	53	49
	94	200	61	51	55	57	59	59	54	50
	106	225	76	54	57	58	61	59	54	50
	118	250	90	58	60	61	61	60	55	51
	142	300	125	58	61	60	62	60	55	51
6	94	200	4	44	48	55	57	58	51	49
	118	250	6	51	53	57	57	58	52	49
	142	300	10	57	56	58	58	59	54	50
	165	350	14	60	59	58	59	60	56	51
	189	400	19	63	62	61	61	62	58	53
	213	450	24	64	64	63	62	63	60	54
	236	500	31	65	67	64	64	64	63	55
	260	550	38	67	67	66	64	65	66	58
7	142	300	7	55	54	57	56	59	52	50
	189	400	14	61	60	59	59	61	60	52
	236	500	31	65	64	62	61	62	62	54
	283	600	34	68	66	67	64	63	62	54
	331	700	49	70	68	68	65	63	62	54
	378	800	66	71	69	69	67	64	63	56
	425	900	88	73	69	71	69	65	64	58
8	142	300	5	53	52	55	54	55	51	46
	189	400	9	59	57	57	56	57	51	48
	236	500	15	64	61	60	58	58	53	49
	283	600	22	66	63	63	60	59	54	50
	331	700	32	69	65	65	61	59	54	51
	378	800	42	71	67	67	64	61	55	54
	472	1000	70	75	70	71	67	63	57	58
10	189	400	4	59	56	53	53	57	50	48
	283	600	9	61	61	57	55	58	53	49
	378	800	16	67	63	62	60	60	54	51
	472	1000	25	71	66	64	63	62	56	53
	567	1200	36	73	70	70	68	64	57	54
	661	1400	49	76	72	73	70	66	60	60
	779	1600	66	79	75	77	73	68	63	64
12	378	800	7	63	61	61	59	59	53	50
	567	1200	17	67	65	65	64	63	57	54
	756	1600	30	74	71	71	70	66	61	59
	944	2000	48	79	75	76	74	68	61	63
	1133	2400	70	81	79	80	78	69	63	67
14	567	1200	7	61	60	60	61	61	56	52
	756	1600	13	67	64	64	66	63	59	55
	944	2000	22	69	66	66	67	64	60	55
	1133	2400	34	72	69	69	69	66	61	58
	1322	2800	49	75	71	71	70	67	62	61
	1511	3200	67	77	73	73	72	68	64	60
	1700	3600	90	79	74	74	74	69	65	63
16	756	1600	8	64	65	61	62	61	58	52
	944	2000	13	67	65	64	64	63	59	54
	1133	2400	20	69	67	66	67	65	61	56
	1322	2800	29	72	69	69	68	66	62	57
	1511	3200	37	73	71	70	69	67	63	58
	1700	3600	48	75	72	71	71	68	64	59
	1889	4000	60	77	74	73	73	70	65	62
	2078	4400	76	79	76	75	75	72	66	65
	2267	4800	84	80	78	77	77	74	67	66
18	944	2000	5	65	63	62	61	61	58	52
	1133	2400	7	65	65	63	64	63	60	54
	1322	2800	9	68	67	66	65	64	61	55
	1511	3200	13	69	69	67	66	66	62	57
	1700	3600	17	71	70	68	68	66	63	58
	1889	4000	21	72	72	71	70	68	64	59
	2078	4400	25	73	72	71	71	69	65	60
	2267	4800	31	75	73	73	72	70	66	61
	2456	5200	37	76	74	73	73	70	66	62

Note:

- *Test data obtained generally in accordance to ISO 5220, ISO 5135, ISO 3741 and related standards*
- *All pressure indicated are differential pressure measured across the VAV terminal box*
- *Generated sound from the VAV terminal box are measured in the reverberation chamber as shown below:*
- *Tabulated generated room NC values are based on 10 dB room absorption ; the resulting room NC for any applications may vary from the tabulated NC values, depending on actual room absorption and system characteristics.*
- *"–" represents noise level below 20 dB.*



PERFORMANCE DATA

RADIATED NOISE OF V750 TERMINAL UNIT ONLY

UNIT SIZE	AIR FLOW		MIN. PRESS. LOSS	SOUND POWER LEVEL Lw, dB re 10^{-12} WATTS													
				@125 PA (0.5"W.G.) OCTAVE BAND CENTRE FREQUENCIES, Hz							@250 PA (1.0"W.G.) OCTAVE BAND CENTRE FREQUENCIES, Hz						
	l/S	CFM		125	250	500	1K	2K	4K	NC	125	250	500	1K	2K	4K	NC
5	43	90	18	28	25	22	21	20	–	–	29	27	25	27	26	23	–
	59	125	28	31	26	22	23	22	–	–	31	28	26	28	27	24	–
	83	175	47	32	27	24	25	24	20	–	34	31	29	30	28	26	–
	94	200	61	35	29	24	27	26	23	–	37	33	29	31	31	27	21
	106	225	76	36	29	26	28	27	24	–	38	34	30	31	32	29	22
	118	250	90	38	31	26	29	28	25	–	38	35	31	32	33	30	23
	142	300	125	39	36	31	30	29	26	–	40	38	33	34	34	31	25
6	94	200	4	29	24	23	26	25	22	–	32	28	26	29	30	27	20
	118	250	6	34	27	26	26	25	24	–	38	31	29	30	31	29	21
	142	300	10	36	29	27	28	27	25	–	39	33	31	32	33	30	23
	165	350	14	37	31	28	28	28	27	20	40	36	32	33	34	32	25
	189	400	19	38	31	28	29	29	29	22	42	37	33	35	35	34	27
	213	450	24	38	33	28	29	29	31	24	43	40	34	36	36	36	28
	236	500	31	39	34	30	30	30	34	27	46	41	36	37	37	39	31
	260	550	38	39	36	30	31	30	36	28	46	39	37	37	37	41	33
7	142	300	7	38	34	31	26	27	–	–	42	37	35	30	35	27	26
	189	400	14	41	36	34	28	29	–	–	47	41	39	34	36	29	26
	236	500	31	42	39	36	30	31	23	20	49	45	42	37	37	31	27
	283	600	34	44	43	41	31	32	25	25	53	48	45	38	38	33	30
	331	700	49	46	44	43	33	33	26	27	55	50	49	40	39	34	34
	378	800	66	47	47	45	35	34	28	30	56	52	51	43	41	35	36
	425	900	88	48	49	47	38	36	29	33	57	53	53	44	42	36	37
8	142	300	5	35	33	29	21	22	–	–	40	36	33	26	30	–	20
	189	400	9	39	36	33	24	24	–	–	46	40	38	30	31	20	23
	236	500	15	42	39	36	27	27	–	20	49	44	42	33	33	23	26
	283	600	22	44	41	39	29	29	–	23	52	46	45	36	35	24	30
	331	700	32	45	42	41	31	30	–	25	53	48	48	38	36	26	33
	378	800	42	46	45	43	33	32	22	27	54	50	50	41	39	28	35
	472	1000	70	47	49	47	38	36	26	32	55	54	53	44	41	31	37
10	189	400	4	38	32	31	25	21	–	–	42	35	36	30	28	–	20
	283	600	9	43	37	36	27	26	–	20	47	41	41	34	31	21	25
	378	800	16	44	41	40	32	27	20	24	49	45	45	38	33	26	30
	472	1000	25	46	45	43	36	30	22	27	51	49	49	42	37	27	34
	567	1200	36	48	48	48	40	35	25	33	53	50	51	45	39	29	36
	661	1400	49	50	51	51	45	38	28	36	55	54	55	49	43	34	40
	779	1600	66	53	54	55	48	41	31	40	58	57	58	51	45	37	43
12	378	800	7	42	42	40	34	26	–	24	46	45	44	38	33	24	29
	567	1200	17	44	43	43	36	28	–	28	48	46	47	42	36	26	31
	756	1600	30	49	49	50	42	34	25	35	53	52	52	47	40	31	36
	944	2000	48	51	52	54	44	39	28	39	55	55	56	49	43	35	41
	1133	2400	70	53	54	56	47	42	31	41	58	57	59	51	45	38	44
14	567	1200	7	42	41	41	33	25	–	25	44	42	43	42	36	27	31
	756	1600	13	44	43	45	35	27	–	30	48	47	48	43	38	29	33
	944	2000	22	46	46	48	38	31	22	33	52	49	52	45	39	31	36
	1133	2400	34	48	49	52	41	35	26	36	54	52	54	47	40	33	39
	1322	2800	49	49	50	52	42	36	28	36	55	53	56	50	42	34	41
	1511	3200	67	50	52	54	46	39	31	38	56	56	58	52	45	37	43
	1700	3600	90	51	53	57	49	42	33	42	57	57	60	53	47	39	46
16	756	1600	8	43	41	43	37	27	21	27	47	44	46	42	37	31	31
	944	2000	13	46	45	46	39	32	26	31	50	47	48	44	39	33	33
	1133	2400	20	47	47	49	41	34	28	34	52	49	51	47	40	35	36
	1322	2800	29	49	49	50	42	35	29	35	54	51	54	49	41	35	38
	1511	3200	37	50	51	52	45	38	32	37	56	54	56	51	44	38	40
	1700	3600	48	52	52	54	48	40	34	39	57	55	57	52	46	40	41
	1889	4000	60	54	54	56	51	42	35	41	59	57	58	54	47	42	43
	2078	4400	76	57	56	57	54	44	37	43	61	59	60	56	49	44	45
	2267	4800	84	60	58	59	57	46	38	46	62	62	62	57	52	45	46
18	944	2000	5	43	43	41	37	31	25	25	46	45	44	42	38	32	31
	1133	2400	7	44	44	43	39	32	26	27	47	46	46	44	39	33	33
	1322	2800	9	47	47	45	39	33	27	30	51	49	49	45	39	34	34
	1511	3200	13	48	49	47	41	35	30	32	53	51	51	47	42	36	36
	1700	3600	17	50	50	49	44	36	31	34	54	52	52	49	43	37	38
	1889	4000	21	50	51	50	45	37	32	35	55	54	54	50	44	39	39
	2078	4400	25	51	51	50	45	38	33	35	56	54	54	51	44	39	39
	2267	4800	31	51	53	51	46	39	35	36	56	56	55	52	45	40	41
	2456	5200	37	52	55	52	49	40	36	38	57	58	56	53	46	41	42

Note:

- *Test data obtained generally in accordance to ISO 5220, ISO 5135, ISO 3741 and related standards.*
- *NC values are based on 10 dB room absorption in all octave bands.*
- *All pressure indicated are differential pressure measured across the VAV terminal box.*
- *"–" represents noise level below 20 dB.*

PERFORMANCE DATA

RADIATED NOISE OF V750 TERMINAL UNIT ONLY

UNIT SIZE	AIR FLOW		MIN. PRESS.	SOUND POWER LEVEL Lw, dB re 10^{-12} WATTS													
				@375 PA (1.5"W.G.) OCTAVE BAND CENTRE FREQUENCIES, Hz							@500 PA (2.0"W.G.) OCTAVE BAND CENTRE FREQUENCIES, Hz						
	l/S	CFM	LOSS	125	250	500	1K	2K	4K	NC	125	250	500	1K	2K	4K	NC
5	43	90	18	29	29	28	33	34	30	25	42	41	49	50	51	47	41
	59	125	28	30	31	30	33	34	31	25	42	47	50	53	53	47	44
	83	175	47	36	34	33	35	35	32	26	49	52	53	55	54	48	45
	94	200	61	39	37	34	36	36	33	27	51	54	55	56	54	49	45
	106	225	76	39	38	34	37	37	33	28	54	55	56	57	55	49	46
	118	250	90	42	40	35	38	38	35	29	56	58	58	58	56	50	47
	142	300	125	43	42	37	41	38	36	30	58	59	58	60	57	50	49
6	94	200	4	33	32	30	33	36	33	27	46	48	52	53	53	46	44
	118	250	6	39	35	32	35	37	34	28	52	52	54	54	54	47	45
	142	300	10	42	37	34	35	38	35	29	57	55	55	55	55	48	46
	165	350	14	46	40	36	38	39	37	29	60	58	57	57	57	50	48
	189	400	19	48	42	38	40	40	39	31	62	60	59	59	58	51	49
	213	450	24	48	46	40	41	41	41	33	63	63	61	60	59	52	50
	236	500	31	50	46	41	43	42	43	35	64	65	62	62	61	54	52
	260	550	38	51	47	43	44	43	45	37	66	65	64	63	62	55	53
7	142	300	7	44	40	38	34	41	32	31	55	53	54	52	53	47	44
	189	400	14	50	44	43	38	42	35	32	61	57	57	56	57	48	48
	236	500	31	52	49	46	41	43	37	33	64	62	60	59	58	51	49
	283	600	34	56	50	49	45	44	38	35	67	64	64	62	59	52	51
	331	700	49	57	52	50	45	45	39	36	69	65	65	64	59	53	53
	378	800	66	59	53	52	48	46	39	37	70	65	67	64	60	55	53
	425	900	88	60	55	55	49	49	41	40	72	67	70	67	62	57	57
8	142	300	5	42	38	36	30	36	24	27	53	51	52	50	51	45	41
	189	400	9	48	40	41	34	37	26	28	59	54	56	53	53	46	43
	236	500	15	51	46	44	37	38	28	29	63	59	59	55	54	48	45
	283	600	22	55	49	47	40	40	29	30	66	62	62	58	55	49	46
	331	700	32	56	51	49	42	41	31	31	66	64	64	59	56	50	49
	378	800	42	58	52	52	44	43	32	33	67	65	66	62	58	51	53
	472	1000	70	60	56	55	48	46	35	37	73	69	70	65	60	53	56
10	189	400	4	46	38	40	34	34	24	25	56	52	52	49	50	44	41
	283	600	9	50	45	45	37	36	27	27	61	58	57	54	52	46	43
	378	800	16	53	48	48	42	39	30	33	66	61	61	59	57	50	48
	472	1000	25	56	52	52	47	43	33	36	68	65	64	61	59	52	50
	567	1200	36	58	54	53	48	43	35	37	70	67	68	65	60	53	52
	661	1400	49	60	56	58	52	47	39	43	73	69	71	67	62	56	58
	779	1600	66	62	59	61	54	49	42	46	75	72	74	69	64	59	61
12	378	800	7	50	47	47	43	39	32	32	53	60	60	59	57	50	48
	567	1200	17	52	49	50	48	43	34	37	60	63	64	63	60	53	52
	756	1600	30	57	55	54	52	46	38	41	66	69	69	67	63	57	56
	944	2000	48	59	57	58	53	47	42	43	69	72	73	70	64	59	60
	1133	2400	70	63	60	61	54	48	44	46	72	76	77	73	65	61	64
14	567	1200	7	47	45	45	45	42	33	34	60	59	59	60	58	52	47
	756	1600	13	51	48	48	47	42	34	36	65	63	62	63	59	54	51
	944	2000	22	53	51	52	49	44	35	38	67	65	65	65	61	55	53
	1133	2400	34	57	54	55	51	46	38	40	70	68	68	67	63	57	55
	1322	2800	49	59	56	57	53	47	39	42	72	70	70	69	64	58	57
	1511	3200	67	60	58	59	56	49	41	45	74	72	72	71	65	60	59
	1700	3600	90	61	59	61	57	50	42	46	76	73	74	72	66	61	62
16	756	1600	8	50	46	47	46	42	37	35	62	60	59	60	57	53	49
	944	2000	13	52	49	51	49	45	38	38	64	63	63	62	60	55	52
	1133	2400	20	55	51	63	51	46	41	40	67	65	65	64	61	57	53
	1322	2800	29	57	54	56	53	47	42	42	69	67	67	66	62	58	55
	1511	3200	37	59	56	58	56	49	43	45	71	69	69	68	64	59	57
	1700	3600	48	61	57	61	57	49	44	46	72	71	70	69	65	60	58
	1889	4000	60	63	60	63	60	52	46	49	74	73	72	71	67	62	60
	2078	4400	76	65	62	65	62	54	48	51	76	75	74	73	69	64	62
	2267	4800	84	67	65	68	64	56	49	55	78	77	76	74	71	65	63
18	944	2000	5	49	47	48	47	44	39	36	61	61	60	59	59	55	50
	1133	2400	7	51	48	49	49	45	40	38	63	63	61	62	60	56	51
	1322	2800	9	53	51	52	50	46	41	39	65	65	64	63	61	57	51
	1511	3200	13	56	53	55	53	48	42	42	67	67	66	65	63	58	54
	1700	3600	17	59	54	57	55	48	42	44	69	69	67	66	63	59	56
	1889	4000	21	59	56	57	56	49	44	45	70	70	69	68	65	60	57
	2078	4400	25	60	57	58	56	50	45	45	71	71	70	69	65	61	58
	2267	4800	31	62	59	59	57	51	46	46	73	72	71	70	66	62	59
	2456	5200	37	63	59	60	58	51	46	47	74	73	71	71	67	63	60

Note:

- Test data obtained generally in accordance to ISO 5220, ISO 5135, ISO 3741 and related standards.
- NC values are based on 10 dB room absorption in all octave bands.
- All pressure indicated are differential pressure measured across the VAV terminal box.
- "–" represents noise level below 20 dB.

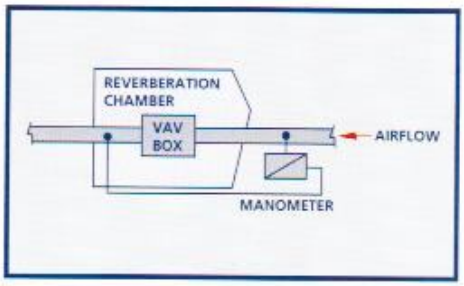
PERFORMANCE DATA

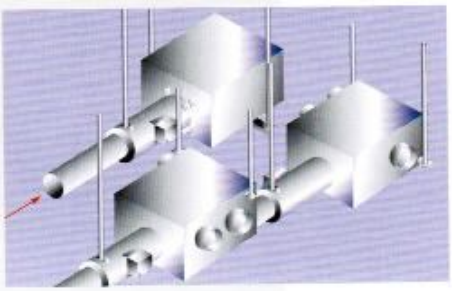
REDIATED NOISE OF V750 TERMINAL UNIT ONLY

UNIT SIZE	AIR FLOW		MIN. PRESS.	SOUND POWER LEVEL Lw, dB re 10^{-12} WATTS @750 PA (3.0"W.G.) OCTAVE BAND CENTRE FREQUENCIES, HZ						
	I/S	CFM	LOSS	125	250	500	1K	2K	4K	NC
5	43	90	18	42	42	51	51	53	53	44
	59	125	28	43	47	51	56	56	53	47
	83	175	47	48	52	55	58	58	53	49
	94	200	61	51	55	57	59	59	54	50
	106	225	76	54	57	58	61	59	54	50
	118	250	90	58	60	60	61	60	55	51
	142	300	125	58	61	60	62	60	55	51
6	94	200	4	46	48	55	57	58	51	49
	118	250	6	52	53	57	57	58	52	49
	142	300	10	57	56	58	58	59	54	50
	165	350	14	60	59	58	59	60	56	51
	189	400	19	63	62	61	61	62	58	53
	213	450	24	64	64	63	62	63	60	54
	236	500	31	65	67	64	64	64	63	55
	260	550	38	67	67	66	64	65	66	58
7	142	300	7	55	54	57	56	59	52	50
	189	400	14	61	60	59	59	61	60	52
	236	500	31	65	64	62	61	62	62	54
	283	600	34	68	66	67	64	63	62	54
	331	700	49	70	68	68	65	63	62	54
	378	800	66	71	69	69	67	64	63	56
	425	900	88	73	69	71	69	65	64	58
8	142	300	5	53	52	55	54	55	51	46
	189	400	9	59	57	57	56	57	51	48
	236	500	15	64	61	60	58	58	53	49
	283	600	22	66	63	63	60	59	54	50
	331	700	32	69	65	65	61	59	54	51
	378	800	42	71	67	67	64	61	55	54
	472	1000	70	75	70	71	67	63	57	58
10	189	400	4	59	56	53	53	57	50	48
	283	600	9	61	61	57	55	58	53	49
	378	800	16	67	63	62	60	60	54	51
	472	1000	25	71	66	64	63	62	56	53
	567	1200	36	73	70	70	68	64	57	54
	661	1400	49	76	72	73	70	66	60	60
	779	1600	66	79	75	77	73	68	63	64
12	378	800	7	63	61	61	59	59	53	50
	567	1200	17	67	65	65	64	63	57	54
	756	1600	30	74	71	71	70	66	61	59
	944	2000	48	79	75	76	74	68	61	63
	1133	2400	70	81	79	80	78	69	63	67
14	567	1200	7	61	60	60	61	61	56	54
	756	1600	13	67	64	64	66	63	59	55
	944	2000	22	69	66	66	67	64	60	55
	1133	2400	34	72	69	69	69	66	61	58
	1322	2800	49	75	71	71	70	67	62	61
	1511	3200	67	77	73	73	72	68	64	60
	1700	3600	90	79	74	74	74	69	65	63
16	756	1600	8	64	65	61	62	61	58	52
	944	2000	13	67	65	64	64	63	59	54
	1133	2400	20	69	67	66	67	65	61	56
	1322	2800	29	72	69	69	68	66	62	57
	1511	3200	37	73	71	70	69	67	63	58
	1700	3600	48	75	72	71	71	68	64	59
	1889	4000	60	77	74	73	73	70	65	62
	2078	4400	76	79	76	75	75	72	66	65
	2267	4800	84	80	78	77	77	74	67	66
18	944	2000	5	65	63	62	61	61	58	52
	1133	2400	7	65	65	63	64	63	60	54
	1322	2800	9	68	67	66	65	64	61	55
	1511	3200	13	69	69	67	66	66	62	57
	1700	3600	17	71	70	68	68	66	63	58
	1889	4000	21	72	72	71	70	68	64	59
	2078	4400	25	73	72	71	71	69	65	60
	2267	4800	31	75	73	73	72	70	66	61

NOTE:

- *Test data obtained generally in accordance to ISO 5220, ISO 5132, ISO 3741 and related standards.*
- *All pressure indicated are differential pressure measured across the VAV terminal box.*
- *Rediated sound from the VAV terminal box are measured in the reverberation chamber as shown below, it has not allowed for ceiling transmission loss. Refer to ceiling manufacturers for sound transmission loss data.*
- *Tabulated rediated room NC values are based on 10 dB room absorption , the resulting room NC for any applications may vary from the tabulated NC values, depending on actual room absorption and system characteristics.*
- *"-" represents noise level below 20 dB.*





CONNOLS-AIR TERMINAL UNIT INSTALLATION & GUIDE SPECIFICATION.

GUIDE SPECIFICATIONS

- The tenderer shall furnish DDC controlled pressure independent VAV terminal unit as required. The terminal unit, its controller and actuator must be supplied by the VAV box manufacturer to ensure full compatibility. The terminal unit casing will be of double-skin construction to prevent erosion of the fibreglass insulation and ensure low casing radiated noise. The damper blade shall be of double-skin rigid construction with felt seal to keep air leakage, when closed, to below 2% of nominal air rating at pressure differential of 750 Pascals across the VAV terminal unit. Damper blade shall close at 60^0 to provide more linear flow characteristic and precise modulation of airflow. The VAV terminal unit shall have a precision multiple point differential airflow sensor for accurate monitoring and control of airflow. Factory installed Multiple Outlet Plenum (MOP) will be provided at the discharge to the VAV terminal unit for distribution of airflow to the air diffusers. Each outlet to the MOP will have a manual throttling damper for balancing of air flow to each diffuser. The MOP shall be engineered in size to ensure minimum re-generated noise. The MOP shall be constructed of 1mm thick hot-dip galvanised steel sheet and internally lined with 25mm thick high density semi-rigid coated fibreglass board. Acoustic properties of the MOP proposed for use shall be submitted for approval.

- In the selection of VAV terminal unit, the tenderer shall not oversize the unit as a means to keep the discharge noise low. Instead the tenderer shall perform acoustic analysis to ensure that the required NC level are met and where necessary, proprietry made high performance silencer shall be used to reduce the noise to the required level. Alternatively, Multiple Outlet Silencer (MOS) may be used. Performance characteristics of silencers proposed shall be submitted for approval. Pressure loss through the VAV terminal unit shall not exceed 50 Pascals. All performance data submitted shall be tested in according to International Standard Organisation code ISO 5220, ISO 5135 and ISO 3741.

- A pressure reducing damper shall be installed at each branch duct take-off to keep the pressure in the branch duct to the minimum required.

- Each VAV controller shall work with a temperature controller or thermostat. The temperature controller shall have a built-in temperature sensor, a local temperature setpoint adjustment knob, a bypass button and an remote override LED. This LED will display manual override mode of the VAV controller.

- Each temperature controller shall come with a network access plug to enable notebook to get access to the points and parameters on the VAV box controllers bus.

- Each time the bypass button is depressed for 2 seconds to 4 seconds, the LED located on the temperature controller shall be on continuously , initiating the bypass mode. When the bypass expires, the LED shall go off. Each time the occupant depresses the bypass timer in VAV controllers that is connected to this temperature controller, it shall load the bypass timer. The default bypass timer shall be on for three hours.

- Each time the bypass button is held for more than 4 seconds, the continuous unoccupancy override mode shall be invoked. The LED shall flash once per second to enunciate this mode. Unoccupied setpoint shall be observed until the mode is terminated.

- To terminate both operations as mentioned above, depress the bypass button for less than 1 second. The LED shall go off and no override mode shall be active.

- The VAV terminal unit shall be capable of operating in full "stand-alone" operation and no additional controller is needed for performing the DDC Control. Centralised control through the communication shall be linked back to the central host computer for ease of maintenance. Each VAV box controller operating parameters, set-points, and schedules shall be stored in non-volatile EEPROM memory to prevent memory loss due to power failure on the controller.

- The controller shall have the provisions to accept the following digital inputs for control :
  - Occupancy override
  - Window open contact
  - Wall module bypass

- The VAV box controller shall be field configurable using resident application programs. It shall support One-to-Many and Many-to-One sharing capabilities through software configuration. An example of One-to-Many function is that of an UNOCCUPIED mode which is sent from the central to the selected VAV box controllers for the required control at unoccupied mode. Many-to-One function can be achieved when the average temperature of a few rooms is required.

- The VAV box controllers shall be networked via a twisted pair to a Zone Controller Module (concentrator/controller), capable of connecting up to a maximum of 120 VAV terminal units on the same network bus. The Zone Controller Module will be connected to the PCP peer bus network to form a true integration into the IBMS network. The data transfer rate of communication bus between air terminal unit controllers shall have a minimum of 78 kilobaud in Daisy Chain configuration, using industry open communication protocol such as Echelon LONWORKS Network Protocol. It shall be possible to connect the VAV box controllers bus up to a distance of 1500 metres without repeaters/routers.