



**VARIABLE AIR VOLUME TERMINAL UNIT**

## General Information

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

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

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

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

Air terminal units are supplied with electric or electronic controls from all major control manufacturers.

COSMOS VAV's are AHRI certified. The Ratings are certified in accordance with **AHRI Standard 880**.



### SINGLE DUCT VARIABLE AIR VOLUME TERMINAL UNITS

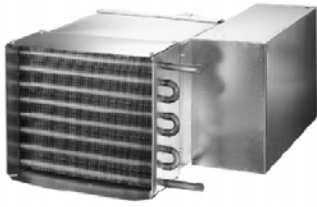
#### Model: VAV-PID

Basic terminal unit supplied with round inlet collar, a rectangular discharge outlet, and an externally mounted control mounting panel.



#### Model: VAV-PID-SL

Acoustically lined silencer is designed to further reduce discharge sound levels from the air terminal.



**Model: VAV-PID-WH**

Air terminal with hot water reheat coil is shipped as the integral part of an elongated air terminal casing.



**Model: VAV-PID-EH**

Electric heater is enclosed in an air terminal box which is attached to the air terminal discharge outlet.



**Model: VAV-BP**

Bypass terminal unit is a single duct pressure dependent air terminal unit, designed for use with constant volume flow and medium pressure packaged air handling systems roof top air conditioning units.



Pressure Independent  
Variable Air Volume Terminal Unit  
**Model: VAV - PID**

## ●●●● BASIC FEATURES

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

## ●●● OPERATING PRINCIPLE

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

## ●●● SOUND

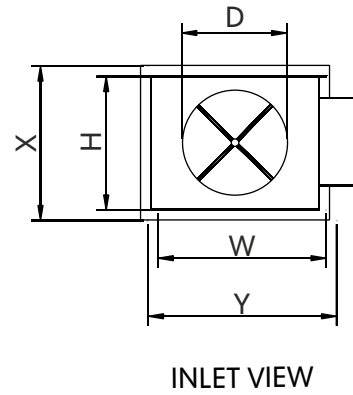
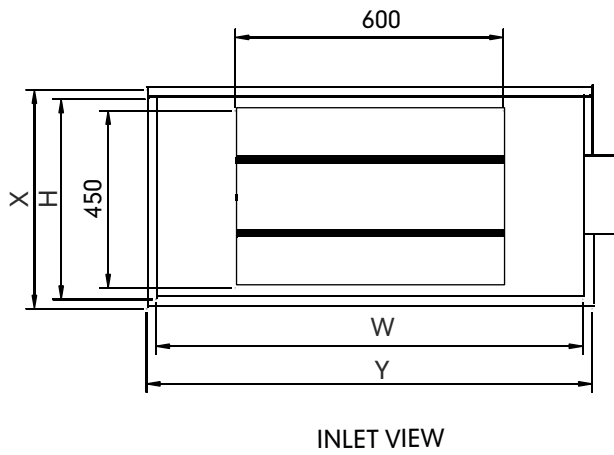
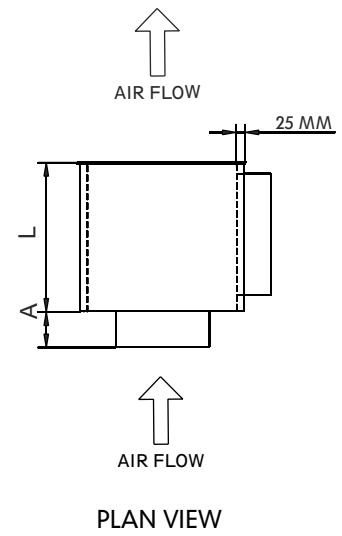
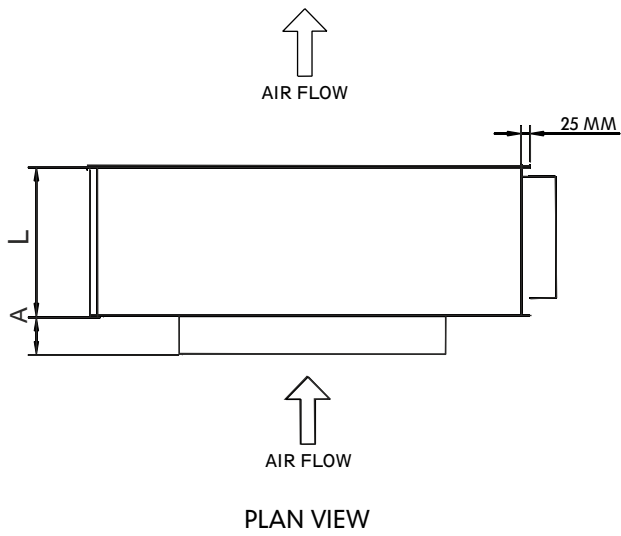
The goal in designing VAV systems is to operate air terminals at low pressures and airflows, while still satisfying the design conditions. The VAV - PID is designed for quiet performance at typical operating conditions. However for those critical sound applications, an integral sound attenuator is offered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

## ●●● FEATURES ●

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

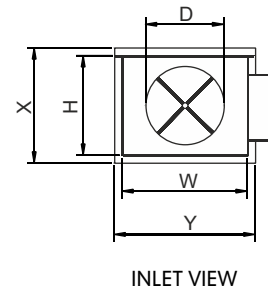
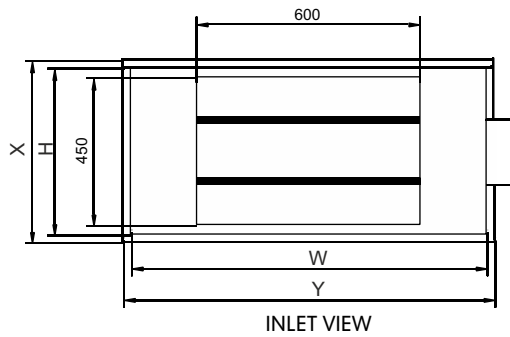
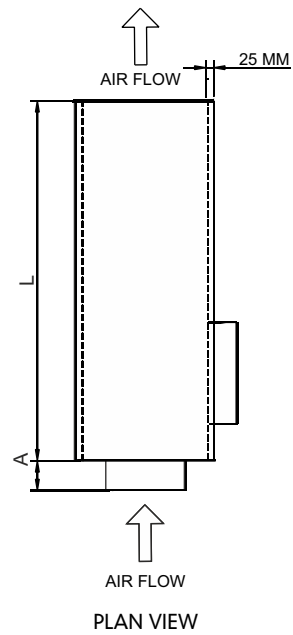
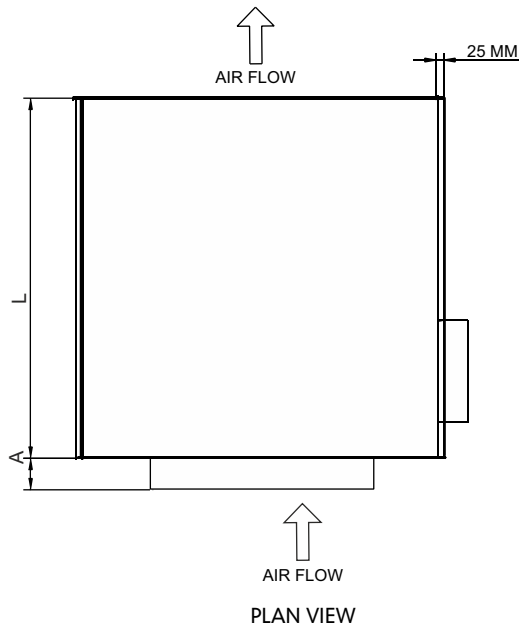
## ●●● OPTIONS ●●

- Cosmos VAV can be furnished without controls, with electronic analog controls, with factory-mounted direct digital controls (Siemens / Delta or equivalent).
- Integral discharge sound attenuator.
- Hanger brackets for 1/2" threaded rod support.



**VAV BASE UNIT - PID SERIES**

MODEL	CAPACITY (CFM)	"L"	"H"	"W"	"X"	"Y"	"A"	INLET "D"
VAV-PID-100	45 - 230	400	250	250	300	300	95	100
VAV-PID-125	70 - 360	400	250	250	300	300	95	125
VAV-PID-150	100 - 520	400	250	250	300	300	95	150
VAV-PID-175	140 - 710	400	250	300	300	350	95	175
VAV-PID-200	185 - 925	400	250	300	300	350	95	200
VAV-PID-250	290 - 1450	400	318	400	368	450	95	250
VAV-PID-300	420 - 2100	500	380	450	430	500	95	300
VAV-PID-350	580 - 2900	500	445	500	495	550	95	350
VAV-PID-400	740 - 3700	500	445	570	495	620	95	400
VAV-PID-600	1420 - 7100	700	450	900	500	950	200	400 x 600



**VAV BASE UNIT WITH ATTENUATOR - PID-SL SERIES**

MODEL	CAPACITY (CFM)	"L"	"H"	"W"	"X"	"Y"	"A"	INLET "D"
VAV-PID-SL-100	45 - 230	1150	250	250	300	300	95	100
VAV-PID-SL-125	70 - 360	1150	250	250	300	300	95	125
VAV-PID-SL-150	100 - 520	1150	250	250	300	300	95	150
VAV-PID-SL-175	140 - 710	1150	250	300	300	350	95	175
VAV-PID-SL-200	185 - 925	1150	250	300	300	350	95	200
VAV-PID-SL-250	290 - 1450	1150	318	400	368	450	95	250
VAV-PID-SL-300	420 - 2100	1150	380	450	430	500	95	300
VAV-PID-SL-350	580 - 2900	1150	445	500	495	550	95	350
VAV-PID-SL-400	740 - 3700	1150	445	570	495	620	95	400
VAV-PID-SL-600	1420 - 7100	1150	450	900	500	950	200	400 x 600

**ALL DIMENSIONS IN MM**





## ACOUSTICAL CONCEPT

**SOUND.** At the zone level, the terminal unit generates acoustical energy that can enter the zone along two primary paths. First, sound from the primary air valve can propagate through the downstream duct and diffusers before entering the zone (referred to as Discharge or Airborne Sound). Acoustical energy is also radiated from the terminal casing and travels through the ceiling cavity and ceiling system before entering the zone (referred to as Radiated Sound).

**NOISE CRITERIA (NC).** The bottom line acoustical criteria for most projects is the NC (Noise Criteria) level. This NC level is derived from resulting sound pressure levels in the zone. These sound pressure levels are the effect of acoustical energy (sound power levels) entering the zone caused by the terminal unit and other sound generating sources.

(central fan system, office equipment, environment, etc).

The unit of measurement is once again decibels; however, in this case decibels represent units of pressure (Pascals), since the human ear and microphones react to pressure variations.

There is no direct relationship between sound power levels and sound pressure levels. Therefore, we must predict the resulting sound pressure levels (NC levels) in the zone based in part by the published sound power levels of the terminal equipment. The NC levels are totally dependent on the project specific design, architecturally and mechanically. For a constant operating condition (fixed sound power levels), the resulting NC level in the zone will vary from one project to another.

## GENERAL DESIGN RECOMMENDATIONS FOR A QUIET SYSTEM



**THE AHU.** Sound levels in the zone are frequently impacted by central fan discharge noise that either breaks out (radiates) from the ductwork or travels through the distribution ductwork and enters the zone as airborne (discharge) sound. Achieving acceptable sound levels in the zone begins with a properly designed central fan system which delivers relatively quiet air to each zone.

**SUPPLY DUCT PRESSURE.** The primary factor contributing to noisy systems (including single duct applications) is high static pressure in the primary air duct. This condition causes higher sound levels from the central fan and also the terminal unit, as the primary air valve closes to reduce the pressure. This condition is compounded, when flexible duct is utilized at the terminal inlet, which allows the central fan noise and air valve noise to break out into the ceiling cavity and then enter the zone located below the terminal. Ideally, the system static pressure should be reduced to the point where the terminal unit installed on the duct run associated with the highest pressure drop has the minimum required inlet pressure to deliver the design airflow to the zone. Many of today's HVAC systems experience 0.5" w.g. pressure drop or less in the main trunk. For systems that will have substantially higher pressure variances from one zone to another, special attention should be

paid to the proper selection of air terminal equipment.

Today, the most common approach has been to select (size) all of the terminals based on the worst case (highest inlet static pressure) condition. Typically, this results in 80% (or higher) of the terminal units being oversized for their application, this in turn results in much higher equipment costs, but more importantly, drastically reduced operating efficiency of each unit. This consequently decreases the ability to provide comfort control in the zone.

A more prudent approach is to utilize a pressure reducing device upstream of the terminal unit on those few zones close to the central fan. This device could simply be a manual quadrant type damper, if located well upstream of the terminal inlet. In tight quarters, perforated metal can be utilized as a quiet means of reducing system pressure. This approach allows all of the terminal units to experience a similar (lower) inlet pressure. They can be selected in a consistent manner at lower inlet pressure conditions that will allow more optimally sized units.

Inlet duct that is the same size as the inlet collar & as straight as possible will achieve the best acoustical performance. For critical applications, flexible duct should not be utilized at the terminal inlet.

## RADIATED SOUND

The Table E1 of Appendix E provides typical radiated sound attenuation values for three types of ceiling: Type 1 - Glass Fiber; Type 2 - Mineral Fiber; Type 3 - Solid Gypsum Board. Since Mineral Fiber tile ceilings are the most common material used in commercial buildings, these values have been used to tabulate Radiated NC levels.

**The following table provides the calculation method for the sound total attenuation values based on ARI Standard 885 - 98**

Octave Band						
	2	3	4	5	6	7
Environmental Effect	2	1	0	0	0	0
Ceiling / Space Effect	16	18	20	26	31	36
<b>Total Attenuation Deduction</b>	<b>18</b>	<b>19</b>	<b>20</b>	<b>26</b>	<b>31</b>	<b>36</b>

The ceiling / space effect assumes the following conditions

1. 5/8" (16) tile, 20 lb.ft-3 (313 kg./m<sup>3</sup>) density
2. The plenum is at least 3 feet (914) deep
3. The plenum space is either wide (over 3D fees [9 m]) or lined with insulation
4. The ceiling has no significant penetration directly under the unit

## DISCHARGE SOUND

The Table E1 of Appendix E provides typical discharge sound attenuation values for three sizes of terminal unit.

### 1. SMALL BOX

Less than 300 cfm (142 l/s)  
(Discharge Duct 8" x 8" [203 x 203])

### 2. MEDIUM BOX

300-700 cfm (142 -330 l/s)  
(Discharge Duct 12" x 12" [305 x 305])

### 3. LARGE BOX

Greater than 700 cfm (330 l/s)  
(Discharge Duct 15" x 15" [381 x 381])

These attenuation values have been used to tabulate Discharge NC levels applied against the terminal airflow volume and not terminal unit size.

**The following tables provide the calculation method for the discharge sound total attenuation values based on ARI Standard 885-98**

Small box						
Octave Band						
< 300 cfm	2	3	4	5	6	7
Environmental Effect	2	1	0	0	0	0
5 ft. (1.5 m) 1" (25) Duct Lining	2	6	12	25	29	18
Branch Power Division (1 outlet)	0	0	0	0	0	0
5 ft. (1.5 m) 8 in. dia (200) Flex duct	6	10	18	20	21	12
End Reflection	9	5	2	0	0	0
Space Effect	5	6	7	8	9	10
<b>Total Attenuation Deduction</b>	<b>24</b>	<b>28</b>	<b>39</b>	<b>53</b>	<b>59</b>	<b>40</b>

Medium box						
Octave Band						
300 - 700 cfm	2	3	4	5	6	7
Environmental Effect	2	1	0	0	0	0
5 ft. (1.5 m) 1" (25) Duct Lining	2	4	10	20	20	14
Branch Power Division (2 outlet)	3	3	3	3	3	3
5 ft. (1.5 m) 8 in. dia (200) Flex duct	6	10	18	20	21	12
End Reflection	9	5	2	0	0	0
Space Effect	5	6	7	8	9	10
<b>Total Attenuation Deduction</b>	<b>27</b>	<b>29</b>	<b>40</b>	<b>51</b>	<b>53</b>	<b>39</b>

Large box						
Octave Band						
> 700 cfm	2	3	4	5	6	7
Environmental Effect	2	1	0	0	0	0
5 ft. (1.5 m) 1" (25) Duct Lining	2	3	9	18	17	12
Branch Power Division (3 outlet)	5	5	5	5	5	5
5 ft. (1.5 m) 8 in. dia (200) Flex duct	6	10	18	20	21	12
End Reflection	9	5	2	0	0	0
Space Effect	5	6	7	8	9	10
<b>Total Attenuation Deduction</b>	<b>29</b>	<b>30</b>	<b>41</b>	<b>51</b>	<b>52</b>	<b>39</b>

1. Flexible duct is non-metallic with 1.0" (25mm) insulation
2. Space effect (room size and receiver location) 2500ft<sup>3</sup>. (69m<sup>3</sup>) and 5.0ft. (1.5m) distance from source



**Engineering Data**

PID Discharge & Radiated Sound

Model : VAV - PID

**MINIMUM INLET STATIC PRESSURE**

Model	Airflow (CFM)	DISCHARGE							NC Levels	RADIATED							NC Levels
		SOUND POWER LEVEL (dB)								SOUND POWER LEVEL (dB)							
		125	250	500	1000	2000	4000	125		250	500	1000	2000	4000			
100	45	51	44	36	31	30	20	-	44	29	25	20	-	-	-		
	100	56	49	40	36	34	24	-	48	38	30	26	24	20	-		
	150	60	54	46	40	37	30	15	53	44	35	34	31	22	-		
	200	64	58	50	44	40	34	20	56	48	38	38	36	28	16		
	230	66	61	52	46	42	37	22	59	34	41	41	40	31	20		
125	70	51	42	35	31	28	21	-	36	29	-	-	-	-	-		
	100	52	43	37	32	29	22	-	37	26	-	-	-	-	-		
	150	54	46	40	36	32	26	-	42	28	22	20	-	-	-		
	200	58	51	44	40	35	29	-	49	37	27	22	21	-	-		
	300	60	56	50	45	41	33	15	56	49	37	31	29	23	16		
360	65	60	54	49	44	38	17	62	41	44	36	34	29	23			
150	100	53	45	34	31	29	21	-	50	41	25	-	-	-	-		
	200	57	49	38	34	31	24	-	52	44	29	21	20	-	-		
	300	61	54	44	40	34	27	16	55	50	34	25	25	-	17		
	400	65	60	49	44	38	32	17	58	54	39	29	28	25	22		
	500	68	64	53	48	41	35	22	59	59	43	33	34	30	28		
520	69	65	55	50	42	36	23	60	60	45	35	35	32	30			
175	140	54	43	39	34	32	25	-	47	28	27	22	-	-	-		
	200	55	45	40	36	34	26	-	48	32	29	24	21	-	-		
	300	56	49	45	41	35	30	-	52	38	32	28	24	20	-		
	400	58	54	49	46	39	34	-	55	43	37	33	29	24	15		
	500	60	58	53	51	42	35	15	57	47	40	39	34	28	17		
600	62	63	56	56	45	38	21	59	50	43	41	37	31	20			
710	64	67	60	61	48	42	25	63	54	47	47	43	35	25			
200	185	54	43	40	39	31	24	-	49	34	28	23	-	-	-		
	200	54	43	40	39	31	24	-	49	34	28	23	-	-	-		
	400	56	49	46	43	36	29	-	53	38	34	30	25	20	-		
	600	59	54	52	48	40	34	-	58	45	38	37	33	26	18		
	800	61	59	57	52	44	37	15	62	50	44	42	39	33	23		
925	62	63	61	56	48	41	20	66	53	47	46	45	38	28			
250	290	49	44	42	36	31	25	-	56	40	31	26	24	22	16		
	500	53	47	44	39	33	27	-	58	41	32	27	26	24	18		
	700	58	50	50	44	39	32	-	62	43	34	30	28	25	23		
	900	62	56	52	48	44	38	-	66	44	35	31	31	28	28		
	1100	66	60	56	52	46	41	16	68	46	37	34	33	30	31		
1300	70	63	60	56	50	44	21	71	48	39	35	36	31	35			
1450	74	66	62	59	53	47	26	74	50	41	37	38	34	38			
300	420	55	49	46	40	38	32	-	50	43	36	30	27	22	-		
	700	57	51	48	41	39	33	-	52	44	37	31	28	23	-		
	1000	61	54	51	43	41	35	-	58	46	39	33	30	24	18		
	1300	64	56	54	44	43	38	-	60	49	42	36	33	26	21		
	1600	68	58	57	46	45	40	18	64	51	44	38	34	28	26		
1900	70	60	59	48	46	41	21	68	53	47	40	36	30	31			
2100	73	62	61	49	48	43	25	70	55	48	42	38	31	33			
350	580	55	48	48	43	39	33	-	55	41	31	27	27	23	15		
	1000	58	49	49	44	40	34	-	57	42	32	28	28	24	17		
	1400	62	53	53	46	42	37	-	64	45	34	31	31	27	26		
	2000	68	57	55	49	43	41	18	72	48	38	34	36	32	36		
	2400	70	59	57	50	44	43	21	77	51	40	36	39	35	42		
2800	73	61	60	53	46	45	25	79	53	42	39	41	36	45			
2900	73	61	60	53	46	45	25	79	53	42	39	41	37	45			
400	740	57	51	50	42	38	32	-	49	42	38	31	33	24	-		
	1200	58	52	51	43	39	33	-	51	43	39	33	35	26	-		
	1700	62	56	54	46	42	36	-	54	46	42	35	37	28	15		
	2200	64	58	56	48	44	38	-	56	48	45	38	40	33	18		
	2700	68	60	58	50	46	40	18	60	50	47	41	42	36	21		
3200	71	62	60	52	48	42	22	63	52	49	43	44	37	25			
3700	74	64	61	54	50	44	26	66	54	51	46	45	40	28			
600	1420	68	65	63	60	56	54	22	54	49	49	43	38	35	23		
	2000	69	66	64	60	57	54	23	55	50	50	44	40	36	23		
	3000	71	68	65	61	58	55	26	57	53	52	46	42	39	26		
	4000	74	70	67	63	61	57	28	63	57	56	50	46	42	31		
	5000	78	72	70	65	62	59	31	67	61	58	51	49	45	33		
6000	80	68	71	66	64	61	33	70	65	61	54	54	49	36			
7100	82	76	71	67	65	62	36	72	66	63	56	56	51	38			

**Engineering Data**

PID Discharge & Radiated Sound

Model : VAV - PID

**0.50" INLET STATIC PRESSURE**

Model	Airflow (CFM)	DISCHARGE							NC Levels	RADIATED							NC Levels
		SOUND POWER LEVEL (dB)								SOUND POWER LEVEL (dB)							
		125	250	500	1000	2000	4000	125		250	500	1000	2000	4000			
100	45	55	47	41	37	36	26	-	48	33	29	23	-	-	-		
	100	60	52	46	41	38	31	15	53	42	33	29	26	22	-		
	150	64	58	50	46	42	36	20	58	48	38	36	34	28	18		
	200	66	62	54	48	45	40	22	60	52	42	40	40	33	21		
	230	70	65	56	51	47	43	27	64	55	44	44	44	37	26		
125	70	55	45	40	36	33	28	-	39	24	-	-	-	-	-		
	100	56	47	42	37	34	29	-	41	26	-	-	-	-	-		
	150	58	51	45	40	37	32	-	46	32	23	21	21	20	-		
	200	61	55	49	44	40	35	16	51	39	30	25	25	22	-		
	300	65	60	54	49	45	39	21	59	51	40	34	33	29	20		
	360	68	63	58	53	48	43	21	64	58	47	39	38	34	27		
150	100	56	49	39	35	34	28	-	53	44	30	22	-	-	-		
	200	60	52	43	38	36	30	15	55	48	34	25	22	-	15		
	300	64	58	49	44	39	33	20	58	53	39	30	28	23	21		
	400	67	62	53	47	42	36	20	60	57	43	33	32	28	26		
	500	70	65	56	50	44	38	23	61	60	46	36	36	32	30		
	520	71	67	58	52	45	40	26	62	62	48	38	38	35	32		
175	140	58	48	44	37	37	32	-	51	32	31	24	22	20	-		
	200	59	50	45	39	38	33	-	52	36	33	26	24	21	-		
	300	60	54	49	44	40	35	15	55	42	36	31	28	25	15		
	400	62	58	53	49	43	38	15	58	46	40	36	33	29	18		
	500	63	62	56	53	46	40	20	60	50	43	40	37	32	21		
	600	64	65	59	57	48	42	23	61	53	45	43	40	34	22		
	710	66	56	63	63	51	45	16	65	56	49	48	45	38	27		
200	185	59	48	45	43	36	30	-	51	36	32	26	22	20	-		
	200	59	48	45	43	36	30	-	51	36	32	26	22	20	-		
	400	60	53	50	48	40	34	-	56	42	37	32	29	25	16		
	600	62	58	55	52	44	38	15	60	48	42	39	36	31	21		
	800	63	61	59	55	47	41	17	64	52	46	43	41	36	26		
925	64	62	60	59	50	44	18	67	55	49	48	46	40	30			
250	290	54	48	46	39	36	30	-	57	45	38	32	29	28	17		
	500	57	51	48	42	38	32	-	59	46	39	33	31	29	20		
	700	62	55	52	47	43	37	-	63	48	40	35	33	30	25		
	900	66	59	56	51	46	41	16	66	49	40	36	35	32	28		
	1100	70	62	60	54	50	44	21	70	50	42	38	36	34	33		
	1300	72	65	62	58	52	46	23	72	50	42	38	38	34	36		
	1450	76	68	64	61	55	50	28	74	52	44	40	40	36	38		
300	420	58	55	51	46	44	39	-	53	47	42	35	32	28	15		
	700	60	56	52	47	45	40	-	55	48	43	36	33	29	16		
	1000	64	58	55	48	46	41	-	60	50	44	38	35	30	21		
	1300	67	60	58	49	47	42	17	63	52	46	40	36	31	25		
	1600	70	61	60	50	48	43	21	66	54	48	41	37	32	28		
	1900	72	62	62	51	50	44	23	68	55	49	42	38	33	31		
2100	74	64	63	52	51	45	26	71	57	50	44	40	34	35			
350	580	58	54	53	50	46	40	-	57	46	38	33	32	30	17		
	1000	61	54	54	50	46	41	-	59	47	39	34	33	31	20		
	1400	65	57	57	52	47	43	15	66	49	41	36	36	33	28		
	2000	70	61	59	53	48	46	21	73	52	43	39	40	36	37		
	2400	72	62	60	54	48	47	23	77	54	44	40	42	38	42		
	2800	74	63	61	55	49	48	26	80	55	45	41	43	39	46		
	2900	74	64	62	55	49	48	26	80	55	45	42	44	39	46		
400	740	61	56	54	49	45	39	-	53	46	43	36	37	30	16		
	1200	62	57	55	50	46	40	-	54	47	44	37	38	31	17		
	1700	65	60	57	51	48	42	16	58	50	46	40	40	34	20		
	2200	68	62	60	53	50	44	18	60	52	48	42	43	37	22		
	2700	70	64	62	55	51	45	21	62	54	50	44	45	40	23		
	3200	73	65	63	56	52	46	25	65	55	51	46	46	41	27		
	3700	75	66	64	57	53	47	27	67	56	52	47	47	43	30		
600	1420	71	69	68	65	61	58	27	58	53	53	48	42	38	27		
	2000	72	70	68	65	62	58	28	59	54	54	49	44	40	28		
	3000	74	71	69	66	63	59	30	61	57	56	51	46	42	31		
	4000	77	73	71	67	65	61	32	66	61	60	54	50	45	35		
	5000	80	75	73	69	66	63	35	70	64	62	56	53	48	37		
	6000	82	73	74	70	68	64	36	73	67	64	58	56	51	38		
7100	84	78	75	71	69	65	38	75	69	66	60	58	53	41			

**Engineering Data**

PID Discharge & Radiated Sound

Model : VAV - PID

**1.0" INLET STATIC PRESSURE**

Model	Airflow (CFM)	DISCHARGE							NC Levels	RADIATED							NC Levels
		SOUND POWER LEVEL (dB)								SOUND POWER LEVEL (dB)							
		125	250	500	1000	2000	4000	125		250	500	1000	2000	4000			
100	45	58	51	46	42	41	32	-	52	36	32	25	23	22	-		
	100	64	56	51	46	44	38	20	58	46	36	32	30	29	18		
	150	68	62	56	51	48	43	25	62	52	42	38	38	36	23		
	200	70	66	58	54	52	46	27	66	56	46	42	44	40	28		
	230	73	68	61	56	54	48	31	68	58	48	46	47	42	31		
125	70	58	51	45	40	38	34	-	43	28	-	-	-	-	-		
	100	59	53	47	42	40	36	-	45	29	21	20	21	21	-		
	150	62	56	50	45	43	39	17	50	34	26	24	25	25	-		
	200	65	60	54	49	46	42	21	55	42	34	29	30	30	15		
	300	69	65	59	54	51	47	26	63	54	45	38	38	36	25		
360	71	68	62	57	53	49	27	67	60	50	42	43	40	30			
150	100	59	52	44	40	39	34	-	56	48	35	26	22	-	16		
	200	62	57	48	44	42	37	17	58	52	39	30	27	21	20		
	300	67	62	54	49	45	40	23	61	57	45	35	33	28	26		
	400	71	66	58	52	48	43	25	63	61	49	39	37	33	31		
	500	73	69	61	55	50	45	28	65	64	52	41	40	37	35		
520	73	70	63	56	50	45	30	65	65	53	42	42	39	36			
175	140	62	53	48	39	42	38	17	55	36	34	27	25	25	15		
	200	63	55	50	42	43	39	18	57	40	36	29	27	27	17		
	300	65	59	53	47	46	42	21	59	46	40	34	32	31	20		
	400	66	64	58	53	49	45	22	62	51	44	39	37	35	23		
	500	68	67	61	57	51	47	26	64	54	47	43	41	38	26		
600	69	70	64	60	53	49	30	65	57	49	46	44	40	27			
710	70	74	67	65	55	51	33	68	62	53	51	49	44	32			
200	185	62	52	49	48	41	36	17	54	43	36	29	26	25	-		
	200	62	52	49	48	41	36	17	54	43	36	29	26	25	-		
	400	64	58	54	53	45	40	16	59	47	41	35	33	31	20		
	600	66	63	60	57	50	45	21	63	52	46	42	40	38	25		
	800	68	67	63	60	53	48	25	67	57	50	46	45	42	30		
925	68	70	67	63	55	50	28	70	60	53	50	50	45	33			
250	290	58	52	50	43	40	35	-	58	50	44	37	34	33	18		
	500	62	55	52	45	43	38	-	60	52	46	39	36	35	21		
	700	67	60	56	51	47	42	20	65	53	47	41	38	36	27		
	900	71	64	60	55	51	46	22	68	54	48	42	40	38	31		
	1100	74	66	64	58	54	50	26	71	56	49	44	42	40	35		
1300	78	70	66	62	57	52	31	74	56	50	44	44	40	38			
1450	80	72	67	64	59	54	33	76	57	50	45	45	41	41			
300	420	61	60	55	53	50	45	17	56	51	46	40	37	34	20		
	700	63	62	57	54	51	46	20	59	53	48	41	38	35	22		
	1000	67	64	60	55	53	48	21	63	55	50	44	40	37	25		
	1300	71	66	62	56	54	49	23	66	57	52	46	42	38	28		
	1600	74	67	64	57	55	50	26	70	58	53	47	43	39	33		
1900	76	68	66	58	56	52	28	72	60	54	48	44	40	36			
2100	77	69	67	61	58	54	30	74	63	56	49	46	41	38			
350	580	62	59	58	56	52	47	16	58	50	45	39	38	36	18		
	1000	65	60	60	57	53	49	16	61	52	46	40	39	38	22		
	1400	69	63	62	59	54	52	20	68	55	48	43	42	41	31		
	2000	73	67	65	60	55	54	25	75	58	51	46	46	44	40		
	2400	76	68	66	61	55	55	28	79	59	52	47	48	45	45		
2800	78	70	67	62	56	56	31	82	60	53	48	49	46	48			
2900	78	70	67	62	56	56	31	82	61	53	49	50	46	48			
400	740	65	60	59	55	51	45	16	56	51	47	40	40	35	21		
	1200	66	61	60	56	52	47	17	58	52	48	42	42	37	22		
	1700	69	64	62	58	54	49	21	62	54	50	44	44	40	23		
	2200	72	66	64	60	56	46	23	64	57	52	47	47	43	26		
	2700	76	68	66	62	58	49	28	68	59	54	50	49	46	31		
3200	78	70	68	63	59	53	31	69	60	56	51	50	47	32			
3700	80	71	69	64	60	54	33	71	61	57	52	51	49	35			
600	1420	74	73	71	69	66	62	32	61	56	57	52	45	41	32		
	2000	75	73	72	70	67	62	32	62	58	58	54	47	42	33		
	3000	77	74	74	71	68	63	33	65	61	61	56	50	45	36		
	4000	81	77	76	72	70	65	37	70	65	64	59	54	49	38		
	5000	83	78	77	74	71	67	38	73	68	67	61	57	52	42		
6000	82	80	78	75	73	69	40	76	71	69	63	60	54	45			
7100	87	81	79	76	74	70	42	79	73	71	65	62	56	47			

**Engineering Data**

PID Discharge & Radiated Sound

Model : VAV - PID

**1.5" INLET STATIC PRESSURE**

Model	Airflow (CFM)	DISCHARGE							NC Levels	RADIATED							NC Levels
		SOUND POWER LEVEL (dB)								SOUND POWER LEVEL (dB)							
		125	250	500	1000	2000	4000	125		250	500	1000	2000	4000			
100	45	61	53	49	45	45	36	16	56	39	34	27	25	26	16		
	100	66	58	54	50	48	42	22	60	48	38	33	32	32	21		
	150	70	64	58	54	52	47	27	65	54	43	40	40	38	27		
	200	73	68	62	58	54	50	31	68	58	46	44	46	43	31		
	230	75	71	64	60	56	53	33	71	44	49	47	50	47	35		
125	70	61	54	48	43	43	39	16	45	36	21	*	21	24	-		
	100	62	56	50	45	44	40	17	47	34	23	21	23	26	-		
	150	64	59	53	48	46	44	20	52	36	29	26	28	30	-		
	200	68	63	57	52	49	47	25	58	44	37	32	34	34	18		
	300	72	68	62	57	54	50	30	65	56	47	41	42	41	27		
	360	74	71	66	60	57	54	31	70	47	53	45	46	45	33		
150	100	61	55	48	43	43	38	16	59	50	38	30	25	-	20		
	200	64	59	52	46	46	41	20	60	54	42	34	30	24	22		
	300	69	64	57	52	48	44	26	63	59	47	38	36	31	28		
	400	72	69	61	55	51	48	28	65	63	51	41	39	36	33		
	500	75	72	64	58	53	49	32	66	67	54	44	44	40	38		
	520	75	73	66	60	54	50	33	68	68	56	46	45	42	38		
175	140	65	56	51	41	45	42	21	58	39	37	29	28	29	18		
	200	66	58	52	44	47	43	22	59	43	39	31	30	30	20		
	300	67	62	57	48	48	47	23	62	49	42	35	34	35	23		
	400	69	66	60	54	52	50	25	65	53	46	40	39	38	27		
	500	70	70	64	58	54	50	30	67	57	49	45	43	41	30		
	600	71	74	66	62	56	52	35	68	60	51	47	46	44	31		
	710	73	78	70	67	59	55	38	71	63	55	53	51	48	35		
200	185	66	56	52	51	45	40	22	57	45	38	31	28	29	17		
	200	66	56	52	51	45	40	22	57	45	38	31	28	29	17		
	400	67	61	57	55	49	44	20	61	49	44	37	35	35	22		
	600	69	66	62	60	53	48	25	65	55	48	43	42	40	27		
	800	70	70	66	63	55	51	28	69	59	53	48	47	46	32		
	925	71	73	70	66	59	54	32	72	62	56	52	52	50	36		
250	290	61	55	52	45	43	38	16	59	54	49	42	37	37	23		
	500	65	59	55	48	45	40	17	62	55	51	43	39	38	25		
	700	70	62	60	54	51	45	23	65	57	52	45	41	40	27		
	900	74	66	62	57	54	50	26	68	58	52	46	43	42	31		
	1100	78	70	66	60	57	52	31	72	59	54	48	44	42	36		
	1300	80	73	69	64	60	54	33	74	60	54	48	46	44	38		
	1450	84	75	70	66	62	58	38	77	61	55	50	49	45	42		
300	420	64	64	59	57	54	50	22	59	55	50	44	41	39	23		
	700	66	65	60	58	55	51	23	61	56	51	45	41	40	25		
	1000	70	67	63	60	56	52	25	67	58	53	48	44	41	30		
	1300	73	69	66	61	57	54	27	69	60	55	49	45	42	32		
	1600	75	71	68	61	58	55	30	72	62	57	51	46	43	36		
	1900	78	72	70	62	60	56	31	75	63	58	52	47	44	40		
	2100	80	74	71	64	60	58	33	77	64	59	53	49	45	42		
350	580	64	63	62	60	57	53	21	59	54	50	43	42	41	23		
	1000	67	64	62	61	57	54	21	62	55	51	45	43	42	25		
	1400	71	67	65	63	59	56	25	69	57	53	47	46	44	32		
	2000	76	70	67	64	61	59	28	76	61	55	49	50	48	41		
	2400	78	72	68	65	62	59	31	81	62	56	50	52	50	47		
	2800	80	73	70	66	63	60	33	83	63	57	52	53	50	50		
2900	80	73	70	66	63	61	33	83	64	57	52	53	50	50			
400	740	68	63	62	59	56	50	20	59	54	50	44	43	39	23		
	1200	69	64	63	60	56	51	21	61	55	51	45	45	41	25		
	1700	72	68	64	62	58	52	26	64	58	52	47	47	43	27		
	2200	75	70	68	64	60	54	28	66	59	55	50	50	47	30		
	2700	78	72	70	66	62	56	31	68	61	57	52	52	50	32		
	3200	80	73	71	67	63	57	33	72	63	58	54	53	50	36		
	3700	82	74	72	68	64	58	36	74	64	59	55	54	52	38		
600	1420	76	75	74	72	69	65	35	64	59	60	56	48	43	35		
	2000	77	76	74	73	70	65	36	65	60	61	57	50	44	36		
	3000	79	77	75	74	71	66	37	66	63	63	59	52	47	38		
	4000	82	79	79	75	73	68	38	72	67	67	62	56	50	42		
	5000	85	81	80	77	74	70	41	76	70	69	64	59	53	45		
	6000	87	83	81	78	76	71	43	79	74	71	66	63	56	47		
	7100	89	84	81	79	77	72	45	80	75	73	68	65	58	48		

**Engineering Data**

PID Discharge & Radiated Sound

Model : VAV - PID

**3.0" INLET STATIC PRESSURE**

Model	Airflow (CFM)	DISCHARGE							NC Levels	RADIATED							NC Levels
		SOUND POWER LEVEL (dB)								SOUND POWER LEVEL (dB)							
		125	250	500	1000	2000	4000	125		250	500	1000	2000	4000			
100	45	65	58	54	50	52	43	21	60	43	37	29	30	33	21		
	100	70	63	59	55	54	48	27	65	52	42	35	37	39	27		
	150	74	68	64	60	58	53	32	70	58	47	42	45	46	33		
	200	76	72	66	62	62	56	35	72	62	50	46	50	50	36		
	230	79	75	69	65	63	59	38	75	65	53	49	54	53	40		
125	70	65	59	53	48	49	46	21	49	39	25	24	26	32	-		
	100	66	61	55	50	50	48	22	51	37	27	26	29	33	-		
	150	68	64	59	53	53	50	25	56	40	34	30	34	37	16		
	200	71	68	62	56	56	53	28	61	47	41	36	39	42	22		
	300	76	73	67	62	61	58	35	69	59	52	45	47	48	32		
	360	78	76	71	65	64	61	37	74	66	58	50	52	53	38		
150	100	64	60	53	48	49	45	20	63	54	44	35	30	24	25		
	200	68	64	57	52	51	48	25	64	58	48	38	34	28	27		
	300	73	69	63	57	55	51	31	67	63	53	44	40	36	33		
	400	76	73	67	60	57	56	33	69	67	57	47	44	41	38		
	500	79	76	70	63	59	56	37	71	70	60	50	48	45	41		
	520	79	77	72	65	60	57	38	71	71	62	51	49	47	42		
175	140	70	61	56	45	51	49	27	62	44	41	31	33	35	23		
	200	71	63	57	47	52	50	28	63	47	43	33	35	37	25		
	300	72	68	61	52	54	53	30	66	53	46	38	39	41	28		
	400	73	72	65	58	58	56	32	68	58	50	43	44	44	31		
	500	75	76	69	62	60	58	37	70	61	53	47	48	47	33		
	600	76	78	71	65	62	60	38	72	64	55	50	51	50	36		
	710	77	83	75	71	64	62	43	75	68	59	55	56	54	40		
200	185	70	60	56	56	50	47	27	61	50	43	34	32	35	22		
	200	70	60	56	56	50	47	27	61	50	43	34	32	35	22		
	400	72	65	62	60	55	51	26	63	54	48	40	39	41	25		
	600	74	71	67	65	59	55	31	68	60	53	46	46	47	31		
	800	75	75	71	68	62	59	35	71	64	57	51	51	52	35		
	925	76	78	75	71	65	61	38	77	66	60	55	56	56	42		
250	290	66	60	53	49	48	44	22	61	59	56	49	43	43	31		
	500	70	63	57	51	50	46	23	63	61	58	50	45	44	33		
	700	75	67	62	56	55	51	30	67	62	59	52	47	46	33		
	900	79	71	56	61	59	55	32	70	64	60	53	49	48	35		
	1100	82	74	58	64	62	58	36	74	64	60	54	50	48	38		
	1300	86	77	72	68	64	60	41	76	66	61	56	52	50	41		
	1450	89	80	75	70	67	63	45	78	66	62	57	54	51	43		
300	420	67	71	64	65	61	57	31	65	60	57	50	46	46	32		
	700	69	72	65	66	62	58	32	65	61	58	51	47	47	33		
	1000	73	74	68	67	63	60	33	68	63	60	54	49	48	35		
	1300	76	76	71	68	64	61	36	72	65	62	55	51	49	37		
	1600	79	77	72	69	65	62	37	75	66	63	57	52	50	40		
	1900	82	78	74	70	66	63	38	77	68	64	58	54	51	42		
	2100	83	80	75	70	67	64	40	83	69	65	59	54	52	50		
350	580	68	69	67	67	64	61	28	61	60	57	50	48	48	32		
	1000	70	70	68	68	64	62	28	64	61	58	51	49	50	33		
	1400	75	73	70	70	65	64	32	71	63	60	53	52	52	35		
	2000	79	76	73	71	66	67	36	78	67	63	57	56	55	43		
	2400	82	78	74	72	67	67	38	82	68	63	58	58	56	48		
	2800	84	79	75	73	67	68	38	85	69	64	59	59	57	53		
	2900	84	80	75	73	67	69	40	85	70	65	59	60	58	53		
400	740	72	69	67	66	63	59	27	64	59	54	49	47	45	28		
	1200	73	70	68	67	64	60	28	65	60	55	50	49	47	30		
	1700	76	72	69	70	66	61	31	68	62	58	53	52	50	33		
	2200	80	75	72	72	68	62	35	72	65	60	56	54	53	36		
	2700	82	77	74	73	69	64	37	74	67	62	58	56	56	38		
	3200	85	78	76	74	70	65	40	76	68	63	59	57	57	41		
	3700	87	79	77	75	71	66	42	78	69	64	60	58	59	43		
600	1420	79	79	78	78	74	70	38	67	63	65	61	51	46	40		
	2000	80	79	79	78	75	70	38	68	64	66	62	53	48	41		
	3000	83	80	80	79	76	71	40	71	67	68	64	56	50	43		
	4000	86	82	82	80	78	73	42	76	71	71	67	60	54	47		
	5000	88	84	84	82	79	75	45	79	74	74	70	63	57	50		
	6000	90	86	85	83	81	76	47	82	77	76	72	66	59	52		
	7100	92	87	86	84	82	77	48	85	79	78	73	68	61	55		

**NOISE CRITERIA QUICK REFERENCE**

Model	Airflow (CFM)	Min. Op. Pressure (in. wc)	DISCHARGE (Ps)				RADIATED (Ps)			
			0.5"	1.0"	1.5"	3.0"	0.5"	1.0"	1.5"	3.0"
100	45	0.002	-	-	16	21	-	-	16	21
	100	0.012	15	20	22	27	-	18	21	27
	150	0.027	20	25	27	32	18	23	27	33
	200	0.049	22	27	31	35	21	28	31	36
	230	0.066	27	31	33	38	26	31	35	40
125	70	0.006	-	-	16	21	-	-	-	-
	100	0.012	-	-	17	22	-	-	-	-
	150	0.027	-	17	20	25	-	-	-	16
	200	0.049	16	21	25	28	-	15	18	22
	300	0.113	21	26	30	35	20	25	27	32
	360	0.164	21	27	31	37	27	30	33	38
150	100	0.011	-	-	16	20	-	16	20	25
	200	0.044	15	17	20	25	15	20	22	27
	300	0.101	20	23	26	31	21	26	28	33
	400	0.18	20	25	28	33	26	31	33	38
	500	0.283	23	28	32	37	30	35	38	41
	520	0.306	26	30	33	38	32	36	38	42
175	140	0.011	-	17	21	27	-	15	18	23
	200	0.023	-	18	22	28	-	17	20	25
	300	0.051	15	21	23	30	15	20	23	28
	400	0.09	15	22	25	32	18	23	27	31
	500	0.141	20	26	30	37	21	26	30	33
	600	0.203	23	30	35	38	22	27	31	36
	710	0.283	16	33	38	43	27	32	35	40
200	185	0.011	-	17	22	27	-	-	17	22
	200	0.013	-	17	22	27	-	-	17	22
	400	0.051	-	16	20	26	16	20	22	25
	600	0.115	15	21	25	31	21	25	27	31
	925	0.275	18	28	32	38	30	33	36	42
250	290	0.01	-	-	16	22	17	18	23	31
	500	0.031	-	-	17	23	20	21	25	33
	700	0.061	-	20	23	30	25	27	27	33
	900	0.101	16	22	26	32	28	31	31	35
	1100	0.152	21	26	31	36	33	35	36	38
	1300	0.213	23	31	33	41	36	38	38	41
	1450	0.266	28	33	38	45	38	41	42	43
300	420	0.012	-	17	22	31	15	20	23	32
	700	0.032	-	20	23	32	16	22	25	33
	1000	0.066	-	21	25	33	21	25	30	35
	1300	0.111	17	23	27	36	25	28	32	37
	1600	0.169	21	26	30	37	28	33	36	40
	1900	0.237	23	28	31	38	31	36	40	42
	2100	0.29	26	30	33	40	35	38	42	50
350	580	0.012	-	16	21	28	17	18	23	32
	1000	0.036	-	16	21	28	20	22	25	33
	1400	0.071	15	20	25	32	28	31	32	35
	2000	0.144	21	25	28	36	37	40	41	43
	2400	0.207	23	28	31	36	42	45	47	48
	2800	0.281	26	31	33	38	46	48	50	53
2900	0.301	26	31	33	40	46	48	50	53	
400	740	0.011	-	16	20	27	16	21	23	28
	1200	0.028	-	17	21	28	17	22	25	30
	1700	0.057	16	21	26	31	20	23	27	33
	2200	0.095	18	23	28	35	22	26	30	36
	2700	0.144	21	28	31	37	23	31	32	38
	3200	0.202	25	31	33	40	27	32	36	41
	3700	0.269	27	33	36	42	30	35	38	43
600	1420	0.004	27	32	35	38	27	32	35	40
	2000	0.009	28	32	36	38	28	33	36	41
	3000	0.02	30	33	37	40	31	36	38	43
	4000	0.035	32	37	38	42	35	38	42	47
	5000	0.055	35	38	41	45	37	42	45	50
	6000	0.08	36	40	43	47	38	45	47	52
	7100	0.112	38	42	45	48	41	47	48	55



**Engineering Data**

With Integral Discharge Sound Attenuator

Model: VAV - PID-SL

**DISCHARGE SOUND PRESSURE**

Model	Airflow (CFM)	1" Inlet Static Pressure							NC Levels	1.5" Inlet Static Pressure							NC Levels	3" Inlet Static Pressure							NC Levels
		SOUND POWER LEVEL (dB)								SOUND POWER LEVEL (dB)								SOUND POWER LEVEL (dB)							
		125	250	500	1000	2000	4000			125	250	500	1000	2000	4000			125	250	500	1000	2000	4000		
100	45	56	49	41	29	29	24	-	59	51	44	32	33	28	-	63	56	49	37	40	35	18			
	100	62	54	46	33	32	30	17	64	56	49	37	36	34	20	68	61	54	42	42	40	25			
	150	66	60	51	38	36	35	22	68	62	53	41	40	39	25	72	66	59	47	46	45	30			
	200	68	64	53	41	40	38	25	71	66	57	45	42	42	29	74	70	61	49	50	48	30			
	230	71	66	56	43	42	40	29	73	69	59	47	44	45	31	77	73	64	52	51	51	36			
125	70	56	49	40	27	26	26	-	59	52	43	30	31	31	-	63	57	48	35	37	38	18			
	100	57	51	42	29	28	28	-	60	54	45	32	32	32	15	64	59	50	37	38	40	20			
	150	60	54	45	32	31	31	15	62	57	48	35	34	36	17	66	62	54	40	41	42	22			
	200	63	58	49	36	34	34	19	66	61	52	39	37	39	22	69	66	57	43	44	45	26			
	300	67	63	54	41	39	39	24	70	66	57	44	42	42	28	74	71	62	49	49	50	32			
360	69	66	57	44	44	41	25	72	69	61	47	45	46	29	76	74	66	52	52	53	35				
150	100	57	80	39	27	27	26	-	59	53	43	30	31	30	-	62	58	48	35	37	37	17			
	200	60	55	43	31	30	29	16	62	57	47	33	34	33	17	66	62	52	39	39	40	22			
	300	65	60	49	36	33	32	21	67	62	52	39	36	36	24	71	67	58	44	43	43	29			
	400	69	64	53	39	36	35	23	70	67	56	42	39	40	26	74	71	62	47	45	48	32			
	500	71	67	56	42	38	37	26	73	70	59	45	41	41	30	77	74	65	50	47	48	35			
520	71	68	58	43	38	37	27	73	71	61	47	42	42	31	77	75	67	52	48	49	36				
175	140	60	51	43	27	31	30	15	63	54	46	29	34	34	19	68	59	51	33	40	41	25			
	200	61	53	45	30	32	31	16	64	56	47	32	36	35	20	69	61	52	35	41	42	26			
	300	63	57	48	35	35	34	18	65	60	52	36	37	39	21	70	66	56	40	43	45	27			
	400	64	62	53	41	38	37	20	67	64	55	42	41	42	22	71	70	60	46	47	48	30			
	500	66	65	56	45	40	39	23	68	68	59	46	43	42	28	73	74	64	50	49	50	35			
600	67	68	59	48	42	41	27	69	72	61	50	45	44	32	74	76	66	53	51	52	36				
710	68	72	62	53	44	43	32	71	76	65	55	48	47	37	75	81	70	59	53	54	41				
200	185	60	50	44	36	30	28	15	64	54	47	39	34	32	20	68	58	51	44	39	39	25			
	200	60	50	44	36	30	28	15	64	54	47	39	34	32	20	68	58	51	44	39	39	25			
	400	62	56	49	41	34	32	-	65	59	52	43	38	36	18	70	63	57	48	44	43	25			
	600	64	61	55	45	39	37	19	67	64	57	48	42	40	22	72	69	62	53	48	47	28			
	800	66	65	58	48	42	40	22	68	68	61	51	44	43	26	73	73	66	56	51	51	33			
925	66	68	62	51	44	42	25	69	71	65	54	48	46	30	74	76	70	59	54	53	36				
250	290	57	50	46	33	31	28	-	60	53	48	35	34	31	15	65	58	49	39	39	37	21			
	500	61	53	48	35	34	31	-	64	57	51	38	36	33	16	69	61	53	41	41	39	22			
	700	66	58	52	41	38	35	18	69	60	56	44	42	38	22	74	65	58	46	46	44	29			
	900	70	62	56	45	42	39	21	73	64	58	47	45	43	25	78	69	62	51	50	48	31			
	1100	73	64	60	48	45	43	25	77	68	62	50	48	45	30	81	72	66	54	53	51	35			
1300	77	68	62	52	48	45	30	79	71	65	54	51	47	32	85	75	68	58	55	53	40				
1450	79	70	63	54	50	47	32	83	73	66	56	53	51	37	88	78	71	60	58	56	43				
300	420	60	58	51	44	43	39	15	63	62	55	48	47	44	20	66	69	60	56	54	51	28			
	700	62	60	53	45	44	40	17	65	63	56	49	48	45	21	68	70	61	57	55	52	30			
	1000	66	62	56	46	46	42	19	69	65	59	51	49	46	22	72	72	64	58	56	54	31			
	1300	70	64	58	47	47	43	21	72	67	62	52	50	48	25	75	74	67	59	57	55	33			
	1600	73	65	60	48	48	44	25	74	69	64	52	51	49	27	78	75	68	60	58	56	35			
1900	75	66	62	49	49	46	27	77	70	66	53	53	50	30	81	76	70	61	59	57	36				
2100	76	67	63	52	51	48	29	79	72	67	55	53	52	32	82	78	71	61	60	58	38				
350	580	61	57	55	48	46	42	-	63	61	59	52	51	48	18	67	67	64	59	58	56	26			
	1000	64	58	57	49	47	44	-	66	62	59	53	51	49	18	69	68	65	60	58	57	26			
	1400	68	61	59	51	48	47	18	70	65	62	55	53	51	22	74	71	67	62	59	59	30			
	2000	72	65	62	52	49	49	23	75	68	64	56	55	54	26	78	74	70	63	60	62	34			
	2400	75	66	63	53	49	50	27	77	70	65	57	56	54	30	81	76	71	64	61	62	36			
2800	77	68	64	54	50	51	30	79	71	67	58	57	55	32	83	77	72	65	61	63	37				
2900	77	68	64	54	50	51	30	79	71	67	58	57	56	32	83	78	72	65	61	64	38				
400	740	64	59	56	47	45	40	15	67	62	59	51	50	45	17	71	68	64	58	57	54	26			
	1200	65	60	57	48	46	42	16	68	63	60	52	50	46	20	72	69	65	59	58	55	27			
	1700	68	63	59	50	48	44	18	71	67	61	54	52	47	25	75	71	66	62	60	56	30			
	2200	71	65	61	52	50	41	22	74	69	65	56	54	49	27	79	74	69	64	62	57	33			
	2700	75	67	63	54	52	44	27	77	71	67	58	56	51	30	81	76	71	65	63	59	36			
3200	77	69	65	55	53	48	30	79	72	68	59	57	52	32	84	77	73	66	64	60	38				
3700	79	70	66	56	54	49	32	81	73	69	60	58	53	35	86	78	74	67	65	61	41				
600	1420	73	72	68	61	60	57	31	75	74	71	64	63	60	34	78	78	75	70	68	65	37			
	2000	74	72	69	62	61	57	31	76	75	71	65	64	60	35	79	78	76	70	69	65	37			
	3000	76	73	71	63	62	58	32	78	76	72	66	65	61	36	82	79	77	71	70	66	39			
	4000	80	76	73	64	64	60	36	81	78	76	67	67	63	37	85	81	79	72	72	68	41			
	5000	82	77	74	66	65	62	37	84	80	77	69	68	65	40	87	83	81	74	73	70	43			
6000	81	79	75	67	67	64	38	86	82	78	70	70	66	42	89	85	82	75	75	71	46				
7100	86	81	76	68	68	65	41	88	83	81	71	71	67	44	91	87	83	76	76	72	47				

## AHRI CERTIFIED RATINGS POINTS

### AHRI Certified Radiated Sound Power Data

Unit Size	Rated Airflow CFM	Minimum Operating Pressure ( Inch W. G. )	Standard Ratings - Sound Power Level, dB re 10 <sup>-12</sup> Watt					
			1.5 inch Static Pressure					
			Octave Band Center Frequency, Hz					
			125	250	500	1000	2000	4000
4	230	0.06	71	44	49	47	50	47
5	360	0.16	70	47	53	45	46	45
6	520	0.30	68	68	56	45	45	42
7	710	0.28	71	63	55	53	51	48
8	925	0.27	72	62	56	52	52	50
10	1450	0.26	77	61	55	50	49	45
12	2100	0.29	77	64	59	53	49	45
14	2900	0.30	83	64	57	52	53	50
16	3700	0.26	74	64	59	55	54	52
24 X 16	7100	0.11	80	75	73	68	65	58

### AHRI Certified Discharge Sound Power Data

Unit Size	Rated Airflow CFM	Minimum Operating Pressure ( Inch W. G. )	Standard Ratings - Sound Power Level, dB re 10 <sup>-12</sup> Watt					
			1.5 inch Static Pressure					
			Octave Band Center Frequency, Hz					
			125	250	500	1000	2000	4000
4	230	0.06	75	71	64	60	56	53
5	360	0.16	74	71	66	60	57	54
6	520	0.30	75	73	66	60	54	50
7	710	0.28	73	78	70	67	59	55
8	925	0.27	71	73	70	66	59	54
10	1450	0.26	84	75	70	66	62	58
12	2100	0.29	80	74	71	64	60	58
14	2900	0.30	80	73	70	66	63	61
16	3700	0.26	82	74	72	68	64	58
24 X 16	7100	0.11	89	84	81	79	77	72

- Ratings are certified in accordance with AHRI Standard 880.
- Duct end corrections included in sound power levels per AHRI Standard 880.





## NOISE CRITERIA (NC) NOTES

OCTAVE BAND CENTER FREQUENCY (Hz)						
RADIATED	125	250	500	1000	2000	4000
Type 1 - Glass Fiber	19	19	21	25	29	35
Type 2 - Mineral Fiber	18	19	20	26	31	36
Type 3 - Gypsum Board	23	26	25	27	27	28

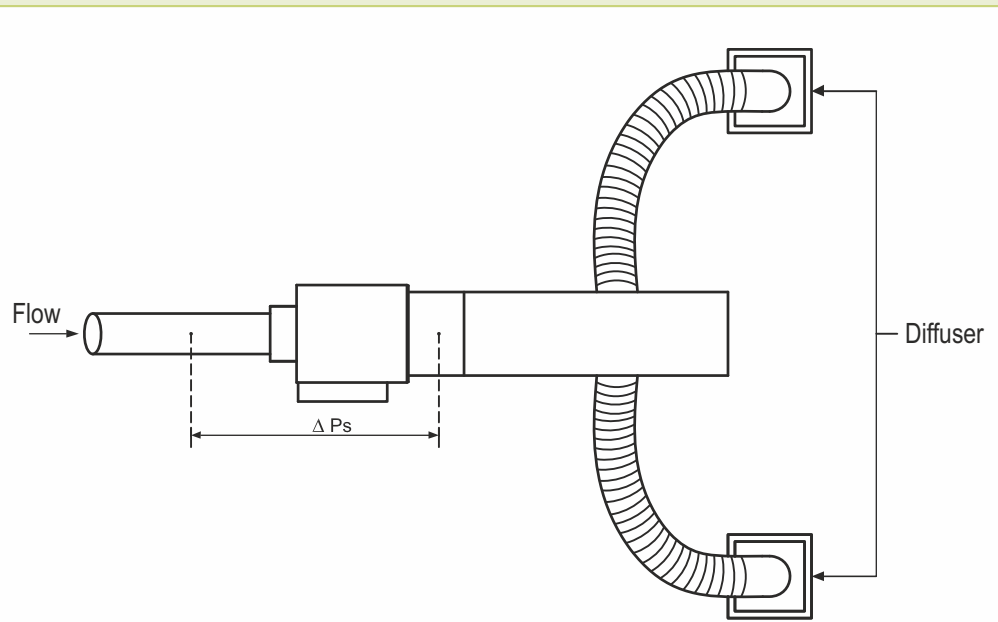
OCTAVE BAND CENTER FREQUENCY (Hz)						
DISCHARGE	125	250	500	1000	2000	4000
Small Terminal	24	28	39	53	59	40
Medium Terminal	27	29	40	51	53	39
Large Terminal	29	30	41	51	52	39

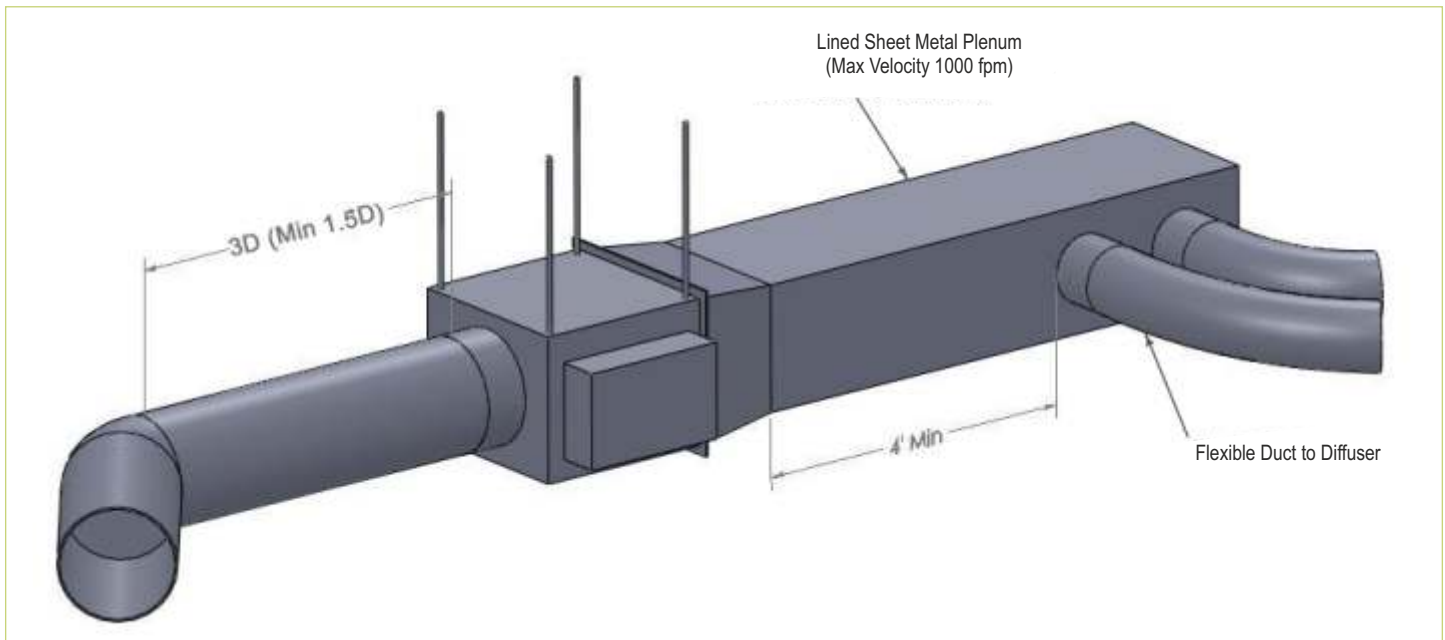
1. A hyphen (-) indicates that the NC is lower than 15.
2. Noise Criteria (NC) is found using ARI Standard 885-98 Appendix E (2002 Addendum):
  - a. Radiated NC is found using the type 2 ceiling (mineral fiber) condition.
  - b. Discharge NC is found using the large terminal condition due to the multitude of possible discharge duct sizes.
3. ARI Standard 885-9B Appendix E, Table E1. Typical Sound Attenuation Values, dB.



## PRESSURE DROP EXPLANATION

1.  $\Delta P_s$  is the static pressure drop across the terminal unit from the inlet to the discharge.
2. Minimum  $\Delta P_s$  across the unit is the pressure drop across the terminal unit from the inlet to the discharge with the damper in full open position. The minimum  $\Delta P_s$  must be maintained in order to supply the rated air flow through the terminal unit. Minimum  $\Delta P_s$  values are provided for the basic assembly only and the basic assembly combined with accessories such as attenuator. The minimum  $\Delta P_s$  across the terminal unit and accessories does not include resistance of the downstream ductwork or diffusers. To determine the minimum inlet static pressure required to achieve rated air flow the downstream resistance must be added to the minimum  $\Delta P_s$ .
3.  $\Delta P_t$  is the total pressure drop across the terminal unit from the inlet to the discharge. Total pressure includes both the static pressure drop and velocity pressure drop. Velocity pressure drop is due to the reduced duct velocity at the terminal unit discharge.
4. NC at  $\Delta P_s$  across the unit is the NC level produced by the terminal unit with the listed static pressure drop from the inlet to the discharge ( $\Delta P_s$ ). The listed  $\Delta P_s$  is the excess static pressure removed by the terminal unit damper.





**Quiet VAV and Plan Terminal Recommended Installation**

## ACOUSTIC DESIGN CONSIDERATIONS ●●●●

To ensure an acceptable NC level in the occupied space, several design considerations should be taken into account.

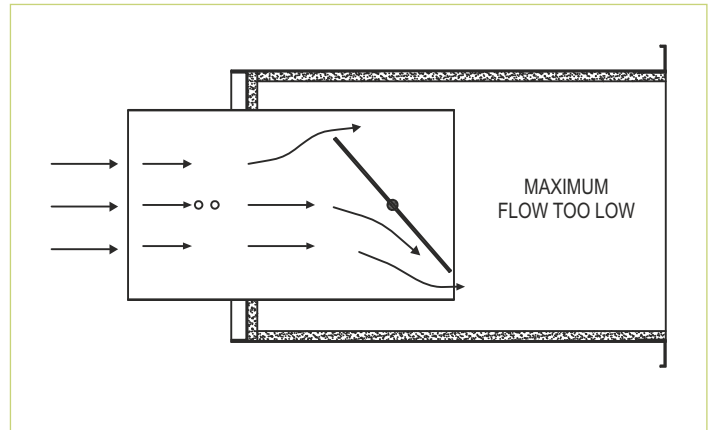
1. Select a terminal which will operate in the mid to low area of its operating range.
2. Design duct systems to provide adequate but not excessive static pressure at the primary air inlet. Excess static pressure generates noise.
3. Locate terminals above non-critical areas like corridors, closets or file areas. This will isolate critical areas from potential sources of radiated noise.
4. Locate terminal to allow maximum length of lined discharge ductwork. Consider a larger number of smaller diffusers to minimize discharge sound.
5. Flex duct and fibreglass duct board allows significantly greater breakout noise than metal duct and should be avoided. Flex duct can also generate sound if bending, folding or sagging takes place.
6. Locate terminal units in the largest plenum volume available for increased reduction of radiated noise.
7. A ceiling with high transmission loss will help reduce radiated sound.
8. Avoid locating terminals near return air openings. This allows a direct path for radiated noise to enter the space.
9. The use of acoustically lined flex duct on the diffuser will reduce discharge sound.

## TERMINAL INSTALLATION AND APPLICATION PRECAUTIONS - AVOIDING COMMON ERRORS AND PROBLEMS

### Sizing Terminals

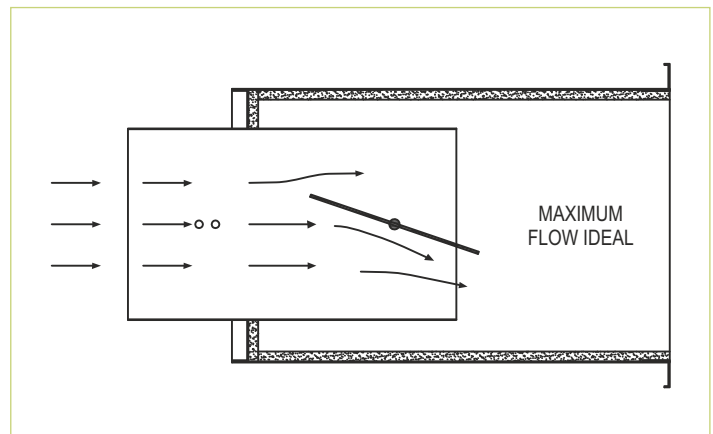
Select terminals based upon recommended air volume ranges. The pressure independent terminals' main feature is its ability to accept factory calibrated minimum and maximum airflow limits that correspond to the designers space load and ventilation requirements for a given zone.

A common misconception is that oversizing a terminal will make the unit operation quieter. In reality, the terminal damper will have to operate in a pinched-down condition most of the time which may actually increase noise levels to the space. Control accuracy may suffer as the terminal is only using a fraction of its total damper travel or stroke. In addition, the low inlet velocities may be insufficient to produce a readable signal for the sensor and reset controller. This means minimum settings may not hold with a resultant loss of control accuracy and undesirable hunting. The recommended selection for maximizing performance is to size the terminals maximum airflow limit for 70% - 85% of its rated capacity (approx. 2000 fpm) in accordance with the catalog recommendations. For accurate control the minimum setting guideline is not lower than 20% of the units rated total capacity.



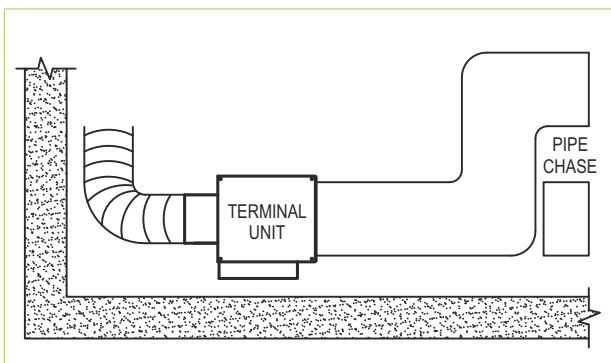
#### Severe Throttling

Oversized terminals will operate in a near closed position even at maximum airflow. Control accuracy may also suffer



#### Ideal Throttling

Correctly sized terminal will utilize the majority of its damper travel and improve performance



#### Restricted Installation, Poor Location

### Observe Space Restrictions

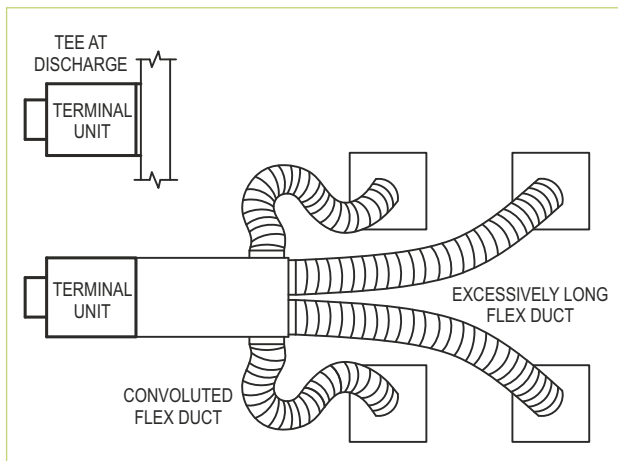
During the design phase try and ensure terminals are located for ease of installation, optimum performance and maintenance accessibility. Alongside figure shows all of the worst conditions: a convoluted inlet and control connections are restricted as the terminal is against a wall and the outlet restricted condition reduces performance.

## Optimize Inlet Conditions

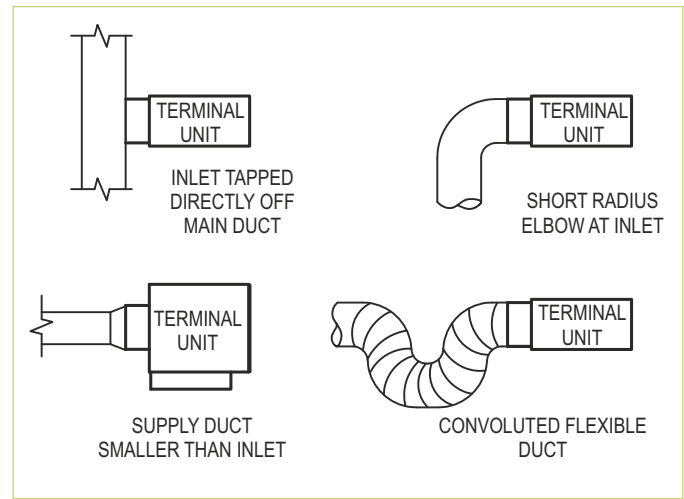
The type of duct and its approach may have a large and adverse impact on both pressure drop and control accuracy. Alongside figure shows several typical poor conditions that generate unwanted turbulence. Although multi-point sensors can compensate to a large degree, good design practice should always prevail. "COSMOS" recommends wherever possible, a straight duct inlet connection with a minimum length of two duct diameters, the same size as the inlet. Terminal collars are undersized to suit nominal ductwork dimensions. The inlet duct slips over the terminal inlet collar and is fastened and sealed in accordance with job specifications. Never insert a duct inside the inlet collar, control calibration will be adversely affected. Sometimes it is not possible due to space restrictions to provide an ideal inlet condition, in this case field adjustment of the airflow settings on the velocity controller may be required to compensate. The use of flow straightening devices (equalizing grids) are recommended after short radius elbows that are immediately ahead of the terminal and where terminals are unavoidably tapped directly off the main duct.

## Observe Zoning Requirements

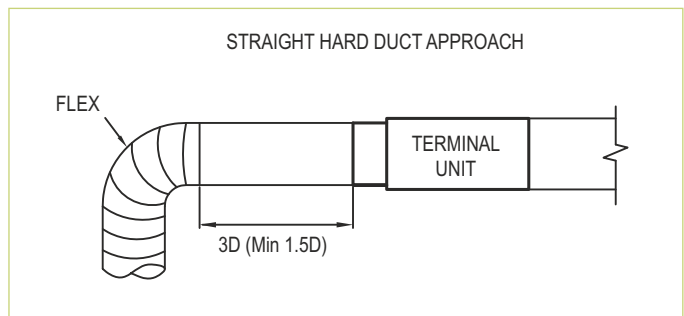
Correctly sizing terminals with regard to the physical conditions of the occupied space is vital to ensure acceptable performance. One large terminal serving a space with divided work areas may result in the single thermostat only providing acceptable temperature control where it is located. The other space(s) served may be too cold or too hot if it has differing space load requirements.



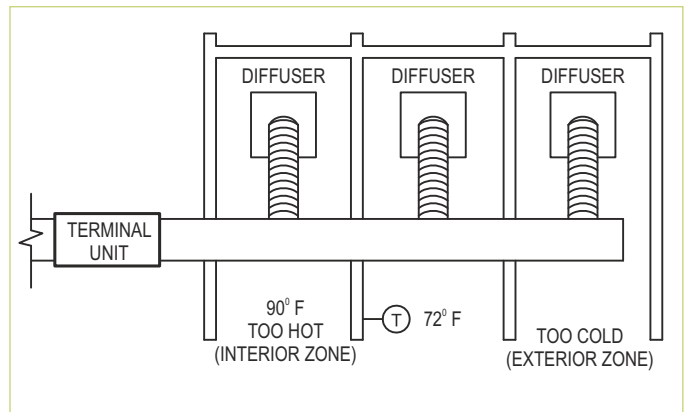
**Poor Discharge Conditions**



**Poor Inlet Conditions**



**Ideal Inlet Conditions**



**Poor Zone Application**

## Optimize Discharge Conditions

Poor discharge duct connections may have an adverse affect on pressure drop. Try and avoid installing tees, transitions and elbows close to the inlet discharge. Avoid long runs of flex and keep short flex runs as straight as possible. Make curves as shallow as possible and ensure that the entrance condition to diffuser outlet is straight.



## SELECTION PROCEDURE & GENERAL INFORMATION



The primary factor contributing to noisy systems is high static pressure in air duct. This condition causes higher sound levels from the central fan and also higher sound levels from the terminal unit, as the primary air valve closes to reduce the pressure. This condition is compounded when flexible duct is utilized at the terminal inlet, which allows the central fan noise and air valve noise to break out into the ceiling cavity and then enter the zone located below the terminal. Ideally, the system static pressure should be reduced to the point where the terminal unit installed on the duct run associated with the highest pressure drop has the minimum required inlet pressure to deliver the design airflow to the zone.

To date, the most common approach has been to select (size) all of the terminals based on the worst case (highest inlet pressure) condition. Typically, this results in 80% of the terminal units being oversized for their application. This leads to drastic reduction in operating efficiency of each unit. This consequently decreases the ability to provide comfort control in the zone. Inlet duct that is the same size as the inlet collar and as straight as possible will achieve the best acoustical performance. For critical applications, flexible duct should not be utilized at the terminal inlet.

Example of how to size Cosmos VAV using the following parameters:

1. Max. primary airflow is 600 cfm.
2. Min. primary airflow is 150 cfm.
3. Inlet static pressure is 1.0".
4. Downstream static pressure drop is 0.2".
5. Radiated NC to be less than 30.
6. Discharge NC to be less than 30.

### Step 1

Compare Max and Min airflow to ranges found in the table Model 175 and 200 both fall within the range.

### Step 2

Check if there is sufficient static pressure. For model 175 at 600 cfm, static pressure drop is 0.203, for model 200 at 600 cfm, the static pressure drop is 0.115. Unit static pressure is then added to the downstream static pressure drop and compared to inlet static pressure. The sum of pressures for both the models are less than the inlet static pressure available. Therefore, both are still valid possibilities.

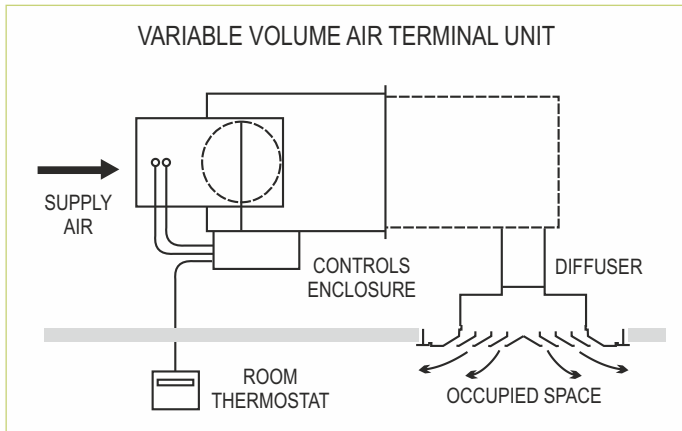
### Step 3

The acoustical requirements are checked against radiated and discharge tables. For model 175 the discharge NC is 30 and radiated is 27, this does not meet the requirement for the discharge NC to be less than 30. For model 200, the discharge NC is 21 and the radiated NC is 25. Since model 200 meets all requirements, it would be best choice for this example.

## INTRODUCTION TO VAV TERMINAL CONTROLS

The control of air temperature in a space requires that the variable heating and/or cooling loads in the space are offset by some means. Space loads vary within a building and are influenced by many factors. These may include climate, season, time of day and zone position within the building i.e. interior or exterior zone and geographic orientation. Other variable loads include people, mechanical equipment, lighting, computers etc.

In an air conditioning system compensating for the loads is achieved by introducing air into the space at a given temperature and quantity. Since space loads are always fluctuating the compensation to offset the loads must also change in a corresponding manner. Varying the air temperature or varying the air volume or a combination of both in a controlled manner in response to changing load conditions will offset the space load as required.



**Typical Pressure Independent terminal unit controls and installation**

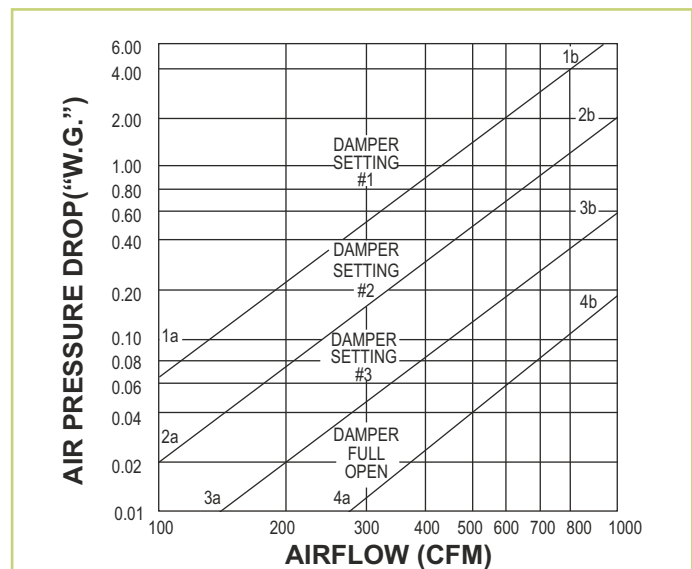
The variable air volume terminal unit or VAV box allows us to vary the air volume into a room and depending on type selected, also lets us vary the air temperature into a room. The VAV terminal unit may be pressure dependent or pressure independent. This is a function of the control package.

VAV terminals are the most energy efficient means of providing control as the central system supply may be sized based on the simultaneous peak demand of the total zones. The diversity factor allows a reduction in capacity as the central unit does not have to be sized for the sum of the peak demands of the entire building.

## PRESSURE DEPENDENT

A device is said to be pressure dependent when the flow rate passing through it varies as the system inlet pressure fluctuates. The flow rate is dependent on both the inlet pressure and the damper position of the terminal unit.

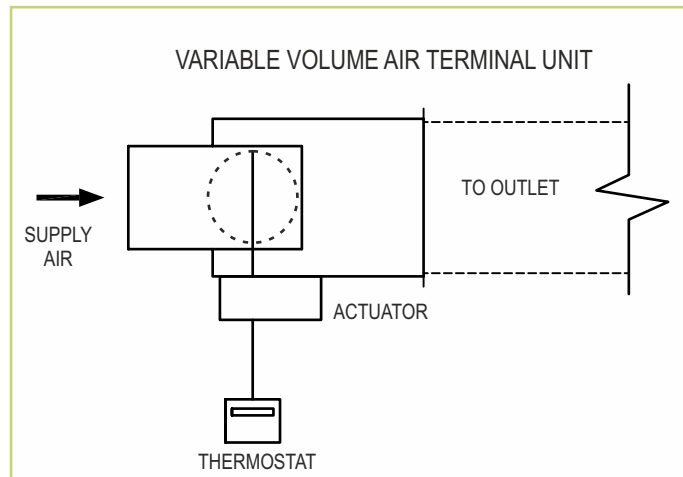
The pressure dependent terminal unit consists of a damper and a damper actuator controlled directly by a room thermostat. The actuator is modulated in response to room temperature only and acts as a damper positioner. (There is no flow sensor or reset controller). Since the air volume varies with inlet pressure, the room may experience temperature swings until the thermostat repositions the damper. Excessive airflow may also lead to unacceptable noise levels in the space. The logarithmic graph shown in alongside figure illustrates a pressure dependent terminals' reaction to dual pressure changes for several given damper positions. The line 1a - 1b represents one



**Pressure Dependent terminal damper**

damper setting or position . As duct pressure increases, so does the airflow over the damper with the flow rate varying in proportion to the square root of the static pressure drop across the terminal. This characteristic is typical of any fixed orifice or in this case a throttling damper. Lines 2a - 2b and 3a - 3b represent additional random positions as the damper moves toward the full open position, line 4a - 4b. Pressure dependent terminals are therefore more prone to constant hunting when static pressures fluctuates at the terminal inlet, as the thermostat is responding to variations inflow that it didn't call for control accuracy is therefore poorer, when compared to a pressure independent terminal. The pressure dependent terminal is for applications where neither pressure independence nor airflow limit regulation is required at the terminal. An example is a constant volume central air supply where the downstream static pressure is held constant by other controls. Another example utilizes a

constant volume central fan and zone bypass dampers that respond to static pressure variations and short circuit excess is directly back to the air handler.



**Pressure Dependent terminal controls**

## PRESSURE INDEPENDENT

A device is said to be pressure independent when the flow rate passing through it is maintained constant regardless of variation in system inlet pressure.

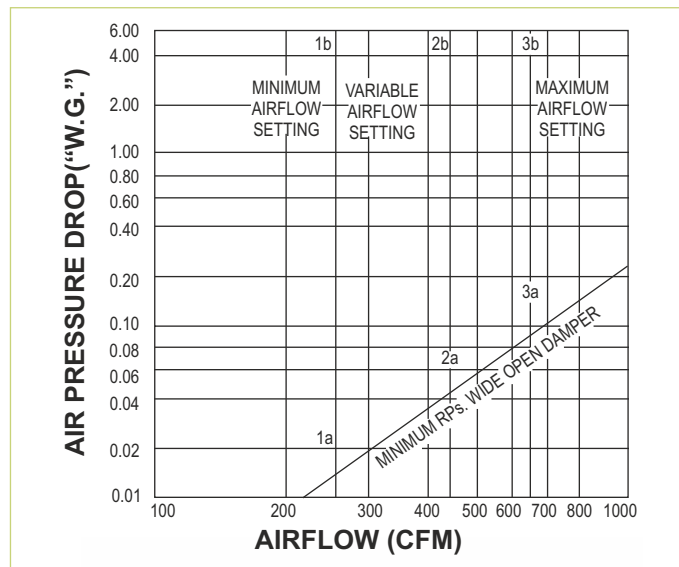
The pressure independent control is achieved with the addition of a flow sensor & flow controller to the VAV box. The controller maintains a preset volume by measuring the flow through the inlet and modulating the damper in response to the flow signal. The preset volume can be varied between calibrated minimum or the maximum limits by the thermostat output.

The logarithmic graph shown in figure illustrates pressure independent terminals typical airflow settings and characteristics.

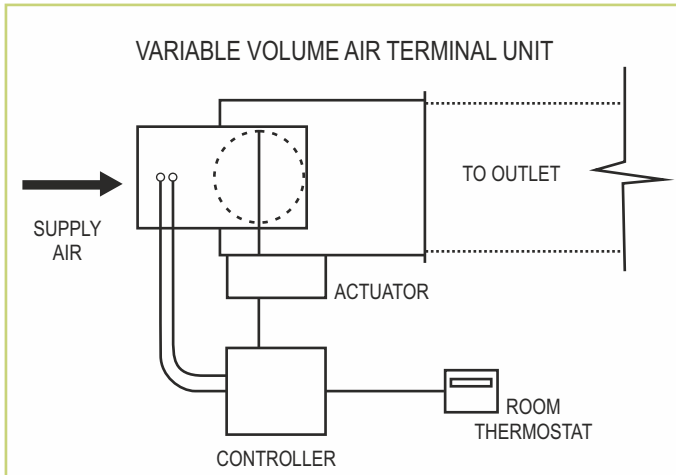
The vertical lines 1a - 1b and 3a - 3b represent the calibrated minimum & maximum airflow settings respectively, that are adjusted at the flow controller. Line 2a - 2b represents any intermediate airflow setting maintained by the flow controller in response to thermostat demand. The damper will modulate (open and close) as required to hold the airflow setting constant up & down. This vertical line regardless of upstream static pressure variations airflow will only change when the thermostat signal (demand) changes

the vertical lines are cut off by the diagonal line 1a - 3a, which represents the minimum operating static pressure requirement of the terminal unit for the given airflow - the pressure drop across the terminal with the damper in the fully open position.

Pressure independence assures the proper distribution of air to the conditioned space as required and allows the



**Pressure Independent terminal damper**



**Pressure Independent terminal controls**

engineer to know that the design limits specified will be maintained. Maximum and minimum airflow limits are important for maintaining proper air distribution.

- Maximum airflow limit prevents over-cooling and excess noise in the occupied space.
- Minimum airflow limits assures that proper ventilation is maintained.

## TYPES OF CONTROLS

The various VAV controls available may include some or all of the following common components.

### a) Flow Sensor / Pick-up

This device monitors the primary air inlet, measures air velocity and provides a feedback signal to the controller which directs the operation of the damper actuator. This control loop is the essence of the pressure independent operation.

### b) Room Thermostat or Temperature Sensor

A room thermostat senses the room temperature, allows set point adjustment and also signals the controller to direct the

damper actuator accordingly. Digital controls utilize a temperature sensor. Setpoint changes are managed by the digital controller.

### c) Flow Controller

This device is 'the brain' and receives the signals from the Flow Sensor and the Room Thermostat or Temperature Sensor and processes the data to regulate the damper actuator.

### d) Damper Actuator

This device receives the commands from the controller and opens or closes the damper to change or maintain the required airflow setting.

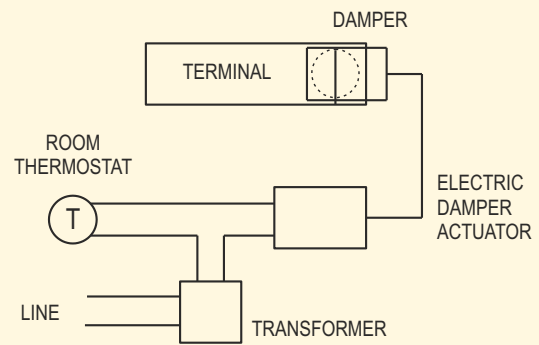
## TRADITIONAL

The room thermostat has single-pole-double-throw (SPDT) contacts. A rise in temperature drives a slow cycling damper actuator open in the cooling mode and a fall in temperature reverses the actuator in the heating mode. Thermostat response time to room temperature change is typically less than the actuator response time. Control is sluggish and large temperature swings may result.

**State of the Art** : Micro-processor based P + I thermostat provides superior control.

## ELECTRIC SYSTEMS (PRESSURE DEPENDENT)

Electric controls operate at 24 VAC powered by a transformer usually mounted within the control box of the terminal. These systems have no velocity sensor & no controller. There is no compensation for duct pressure fluctuations.



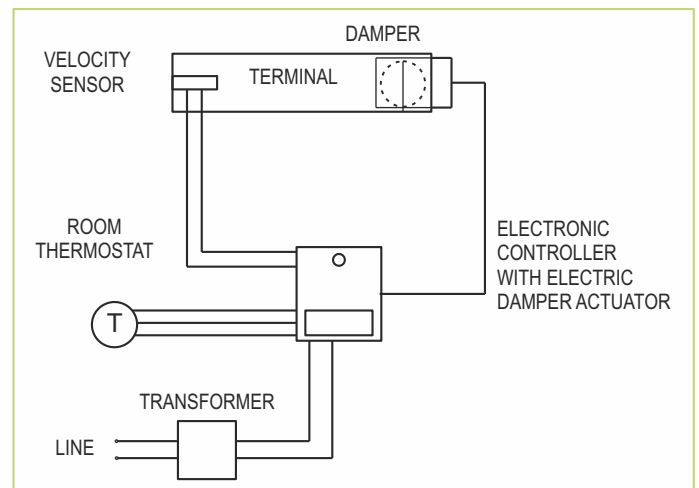
Electric Control Schematic

## ANALOG ELECTRONIC SYSTEMS (PRESSURE INDEPENDENT)

Analog electronic controls operate at 24 VAC powered by a transformer usually mounted within the control box of the terminal.

The electronic controls feature a velocity sensor (the pneumatic multi-point type with an electronic transducer) and an electronic velocity controller. They provide a proportional control function.

The electronic thermostat is selected from one of these types; cooling, heating, cooling with reheat or cooling-heating. Analog electronic controls compensate for changes in duct pressure.



Analog Electronic Control Schematic

## DIGITAL CONTROL OVERVIEW

A direct digital controller uses a digital computer to implement control algorithms on one or multiple control loops. Interface hardware allots the digital computer to process signals from various input devices. The control software calculates the required state of the output devices such as valve and damper actuators and fan starters. The output devices are then positioned to the calculated state via interface hardware.

The basic principles of temperature control for heating, ventilation and air conditioning systems are well established. These control strategies have been implemented using pneumatic, electric, and analog electronic control devices. In this computer age, the micro-processor technology is now available in application

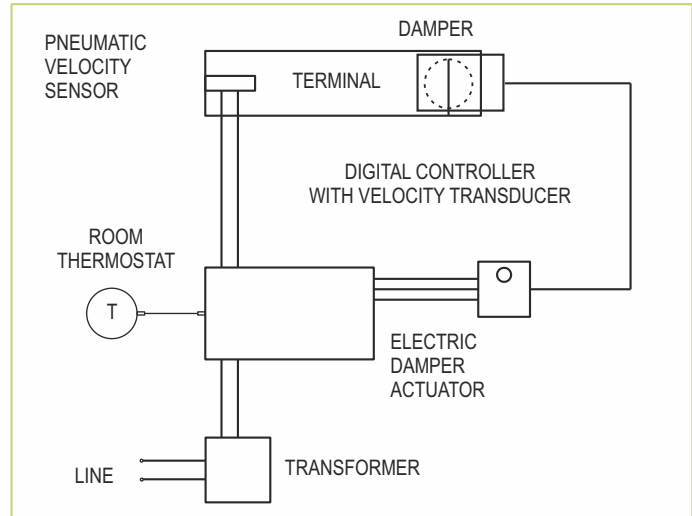
specifically designed for HVAC control. Micro-processor based controllers bring cost effective, state of the art computing power to the control of VAV terminal units, air handling units, packaged heating and cooling units and entire building HVAC systems.

Micro-processor based controllers use direct digital control to replace conventional pneumatic or analog electronic controls. A direct digital controller takes input signals from sensors to generate numbers, processes, this information digitally as directed by the programmed sequence of operation, and generates control action through binary on/off output or analog output voltages.

## DIRECT DIGITAL CONTROL (DDC) SYSTEMS (PRESSURE INDEPENDENT)

These micro-processor based electronic controls also operate at 24 VAC powered by a transformer usually mounted within the control box of the terminal. The flow signal from a pneumatic or electronic velocity sensor and signals from the room temperature sensor are converted to digital impulses in the specialized micro-computer controller. The program usually includes a proportional, integral and derivative (PID) control algorithm for excellent and highly accurate operation.

The controller not only performs the reset and volume control functions, but also can be programmed and adjusted either locally or remotely. It can link to other controller and interface with fans, lighting and other equipment. Control can be centralized in one computer DDC Controls compensate for changes in duct pressure.



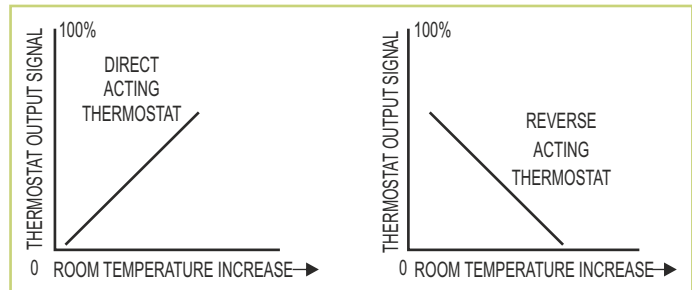
**Digital Control Schematic**

## CONTROLS TERMINOLOGY

### Thermostat Action

**Direct Acting** means that a room temperature increase causes a corresponding increase in thermostat output (pressure or voltage).

**Reverse Acting** means that a room temperature increase causes a corresponding decrease in the thermostat output.



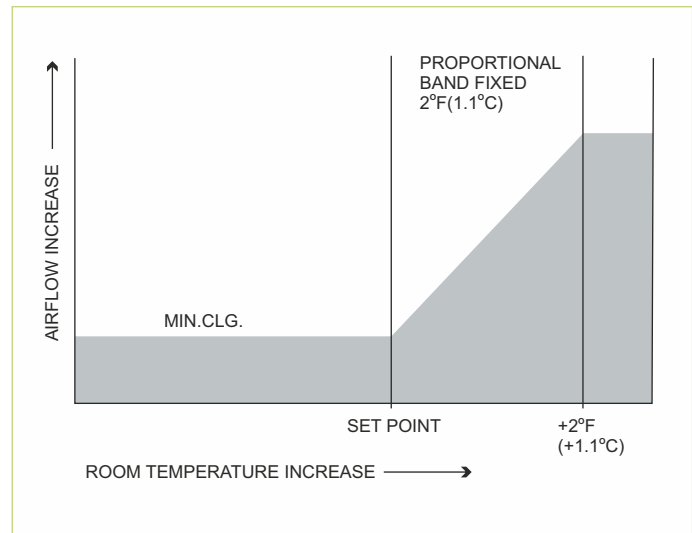
**Thermostat Action**

## CONTROLS

### CONTROL SEQUENCE - COOLING ONLY

The operating sequence for a cooling application is as follows

1. On a rise in space temperature the thermostat regulates the Controller / Actuator to increase the airflow. At 2°F (1.1°C) above thermostat set point, the maximum airflow is maintained at a preselected setting.
2. On a decrease in space temperature, the thermostat regulates the Controller / Actuator to reduce airflow. At thermostat set point the minimum airflow is maintained at a preselected setting.
3. Airflow is held constant in accordance with thermostat demand. Any changes in duct air velocity due to static pressure fluctuate are sensed and compensated for, resulting in pressure independent control.







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