

**Appendix B: VAV Controller
Flow Calculation Constants**

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VAV Controller Flow Calculation Constants

Introduction

This section provides flow calculation constants for some commonly used box manufacturers.

Key Concepts

About Flow Calculation Constants

A flow calculation constant is referred to as the flow multiplier in Variable Air Volume (VAV) controller applications created with HVAC PRO software. Other common terms for this constant are K-constant or pickup gain.

The following is the standard equation for calculating flow:

$$Flow = Area * 4005 * \sqrt{\frac{P_{Velocity}}{PickupGain}}$$

Rearranging the previous equation allows calculation of the flow multiplier (pickup gain):

$$Pickup\ Gain = \left(\frac{Area * 4005}{Flow} \right)^2 * P_{Velocity}$$

Flow is in cubic feet per minute (cfm).

Area is in square feet.

4005 is a constant specific to this equation.

$P_{Velocity}$ is in inches water column (w.c.).

For more information on the flow multiplier, see the *VAV System Operation Theory* section of the *VAV Terminal Control Applications Application Note (LIT-6375120)*.

The VAV box flow calculation constants in this document represent constants used by some common box manufacturers.

Note: These constants are subject to change without notice due to the manufacturers' design changes. Contact the specific manufacturer if you require any other information relative to accuracy.

Note: Flow constants are based on laboratory data. Actual jobsite cfm readings may differ due to the accuracy of the balancer's flow measurement equipment and due to turbulence and leakage.

Carnes Company

Damper characteristics include:

- 90° travel
- clockwise rotation to close
- 3/8 in. round shaft

Table 1: Carnes Company Box Information

Box Type	Model Number
Standard Sensor	--
Cross-Flow Sensor	--

Table 2: Carnes Company Standard Sensor Constants

Inlet Size (in.)	cfm @ 1 in. w.c.	Constants	
		Area (sq ft)	K
5	335	0.130	2.4
6	495	0.188	2.3
7	668	0.258	2.4
8	904	0.338	2.2
10	1487	0.532	2.1
12	2170	0.769	2.0
14	2973	1.05	2.0
16	4080	1.37	1.8
9 x 12	1980	0.750	2.3
16 x 18	5200	1.875	2.1
16 x 24	6475	2.50	2.4

Table 3: Carnes Company Cross-Flow Sensor Constants

Inlet Size (in.)	cfm @ 1 in. w.c.	Constants	
		Area (sq ft)	K
5	323	0.130	2.6
6	474	0.188	2.5
7	690	0.258	2.2
8	950	0.338	2.0
10	1417	0.532	2.3
12	2120	0.769	2.1
14	2908	1.05	2.1
16	3700	1.37	2.2
9 x 12	1930	0.750	2.4
16 x 18	5450	1.875	1.9
16 x 24	7400	2.50	1.8

Environmental Technologies, Inc. (ETI)

Damper characteristics include:

- round butterfly dampers
- 90° damper stroke
- clockwise rotation to close
- 1/2 in. round shaft
- full open and full close damper stops

Table 4: ETI Box Information

Box Type	Model Number
--	SDR
--	CFR
--	VFR

Table 5: ETI Constants

Inlet Size (in.)	cfm @ 1 in. w.c.	Constants	
		Area (sq ft)	K
4	248	0.079	1.628
5	392	0.126	1.657
6	433	0.184	2.896
8	841	0.333	2.515
10	1355	0.525	2.408
12	1976	0.761	2.379
14	2750	1.04	2.294
16	3596	1.36	2.294
18	4470	1.74	2.43
19	6377	2.72	2.918
22	8760	3.56	2.642

Metal Industries

Damper characteristics include:

- 90° travel
- either direction to close
- 3/8 in. square shaft

Table 6: Metal Industries Box Information

Box Type	Model Number
Single Duct	
(Cooling Only)	
With:	
• Electric Reheat	--
• HW Reheat	--
• Special Pickups	--
• Retro Kits	--
Constant to VAV (6-8-10)	
• Square Retros	--
Dual Duct	--
Fan Induction	--
Bypass	--

Table 7: Metal Industries Constants

Inlet Size (in.)	cfm @ 1 in. w.c.	High Gain Unit* cfm @ 1 in. w.c.	Constants	
			Area (sq ft)	K
6	600	250	0.20	1.78
8	1100	820	0.35	1.62
10	1700		0.55	1.68
12	2500		0.79	1.60
14	3250		1.07	1.74
16	4400		1.40	1.62
18 x 16	6200		2.00	1.67
520 (20 x 16)	6200		2.22	2.06
524 (24 x 16)	7200		2.67	2.20

* High Gain Unit is available at no charge.

Nailor Industries, Inc.

Damper characteristics include:

- 90° travel (retrofit units) or 45° travel (single duct, dual duct, and fan powered units)
- counterclockwise rotation to open
- 1/2 in. shaft

Table 8: Nailor Industries, Inc. Box Information

Box Type	Model Number
Retrofit Terminal Unit	
Round	36 VRR
Square or Rectangular	36 VRS
Single Duct Terminal Unit	
	3000 Series
Dual Duct Terminal Unit	
	3200 Series
Series Fan Power Terminal Unit	
	35S
	35SST
Parallel Fan Power Terminal Unit	
	35P

Table 9: Nailor Industries, Inc. Constants for Retrofit Terminal Units

Round Units		Square or Rectangular Units	
Unit Size (in.)	K Constant	Unit (Port) Size	K Constant
4	2.33	7	2.10
5	2.68	8	2.11
6	2.29	9	2.06
7	2.03	10	2.06
8	1.76	11	2.10
9	1.77	12	2.11
10	2.24	13	2.11
12	2.11	14	2.10
14	2.02	15	2.08
16	1.94	16	2.14
--	--	17	2.14
--	--	18	2.11
--	--	19	2.06

Table 10: Nailor Industries, Inc. Constants for Single Duct and Dual Duct Terminal Units

Inlet Size (in.)	Constants	
	Area (sq ft)	K
4	0.081898	2.33
5	0.129622	2.68
6	0.188254	2.29
7	0.257795	2.03
8	0.338244	1.76
9	0.429601	1.77
10	0.531866	2.24
12 (oval)	0.7381	1.75
14 (oval)	0.951045	1.87
16 (oval)	1.16399	1.65
24 x 16	2.632053	2.00

Table 11: Nailor Industries, Inc. Constants for Series and Parallel Fan Power Terminal Units

Inlet Size (in.)	Constants	
	Area (sq ft)	K
6	0.188254	2.33
8	0.338244	2.68
10	0.531866	2.24
12	0.769123	2.11
14	1.050012	2.02
16 (oval)	1.16399	1.94
18 (oval)	1.693604	2.11

E.H. Price, Ltd. (Winnipeg, Canada)

Damper characteristics include:

- 90° travel
- counterclockwise rotation to close
- 1/2 in. round shaft

Table 12: E.H. Price, Ltd. Box Information

Box Type	Model Number
Single Duct	
(Cooling Only)	SDV5000/8000
Fan Powered Terminal Units	
Series Fan (Constant Volume)	FDC5000/8000
Parallel Fan	FDV5000/8000
Dual Duct*	DDS5000/8000 DDQ5000/8000

* Different constants are provided for dual duct downstream (total flow) sensors and inlet sensors.

Table 13: E.H. Price, Ltd. Constants for Single Duct, Fan Powered, and Dual Duct Inlet Boxes

Inlet Size (in.)	cfm @ 1 in. w.c.	Constants	
		Area (sq ft)	K
4	350	0.087	1.00
5	450	0.136	1.47
6	470	0.196	2.80
7	700	0.267	2.34
8	935	0.349	2.24
9	1190	0.442	2.21
10	1560	0.545	1.96
12	2210	0.785	2.03
14	3050	1.069	1.97
16	4010	1.396	1.94
24 x 16	8000	2.667	1.78

Table 14: E.H. Price, Ltd. Constants for Dual Duct Downstream (Total Flow) Boxes

Inlet Size (in.)	cfm @ 1 in. w.c.	Constants	
		Area (sq ft)	K
4	230	0.087	2.31
5	360	0.136	2.30
6	417	0.196	3.56
7	574	0.267	3.48
8	768	0.349	3.31
9	1003	0.442	3.11
10	1334	0.545	2.68
12	1908	0.785	2.72
14	2929	1.069	2.14
16	3764	1.396	2.21

TITUS

Damper characteristics for all units include:

- 90° travel
- counterclockwise rotation to close
- 1/2 in. diameter damper shaft

Table 15: TITUS Box Information

Box Type	Model Number
Single Duct (Cooling Only)	DESV DECV
Fan-Powered Terminal Units	
Series Fan (Constant Volume)	DTFC DTQS DFCL
Parallel Fans (Variable Volume)	DMFV DTQP DFVL
Dual Duct Terminal Units	DEDV DEDC DMDV

Table 16: TITUS Constants for Inlet Sensor Applications *

Inlet Size (in.)	cfm @ 1 in. w.c.	Constants	
		Area (sq ft)	K
4	273	0.087	1.63
5	390	0.136	1.95
6	448	0.196	3.07
7	667	0.267	2.57
8	904	0.349	2.39
9	1167	0.442	2.30
10	1436	0.545	2.31
12	1891	0.785	2.76
14	3015	1.069	2.02
16	3839	1.395	2.12
20	2106	0.778	2.19
22	2106	0.778	2.19
26	2498	1.000	2.57
40	7176	2.667	2.22

* Includes all units except Quiet Constant Volume (QCV) retrofit units.

Table 17: TITUS Constants for Discharge Sensor Dual Duct Applications

Inlet Size (in.)	cfm @ 1 in. w.c.	Constants	
		Area (sq ft)	K
4	240	0.098	2.67
5	384	0.157	2.68
6	538	0.222	2.73
7	733	0.292	2.55
8	997	0.395	2.52
9	1254	0.625	3.98
10	1640	0.773	3.56
12	2619	1.003	2.35
14	3808	1.401	2.17
16	4810	1.68	1.96

The Trane Company

The Trane Company boxes contain an internal actuator. When ordering, select part number AP-VMA1430, which is a controller without an actuator.

Table 18: The Trane Company Constants – D and E Style Air Valve

Box	Inlet Size (in.)	cfm @ 1 in. w.c.	Constants		Actuator Time (seconds)
			Area (sq ft)	K	
03	5	310	0.1364	3.105	384
06	6	482	0.1963	2.660	384
11	8	898	0.3491	2.424	384
17	10	1439	0.5454	2.304	360
24	12	2086	0.7854	2.274	360
32	14	2823	1.0690	2.300	360
42	16	3719	1.3963	2.261	360



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