

Measurement and Control Instrumentation

*Engineered for accuracy, durability, simplicity
and applicability in HVAC air systems and
industrial process control loops*

Transducer Accuracy

The accurate and stable control of airflow or static pressure is only possible when Specifying Engineers understand the importance of accuracy, application and product selection when specifying each of the control device to be utilized for a specific control loop. Airflow measurement and control is a three step process, requiring the selection and application of:

1. A primary measuring element;
2. Transducer; and
3. Loop controller.

The focus of this section is on the need for quality airflow transducers in order to help assure that accurate control is achieved.

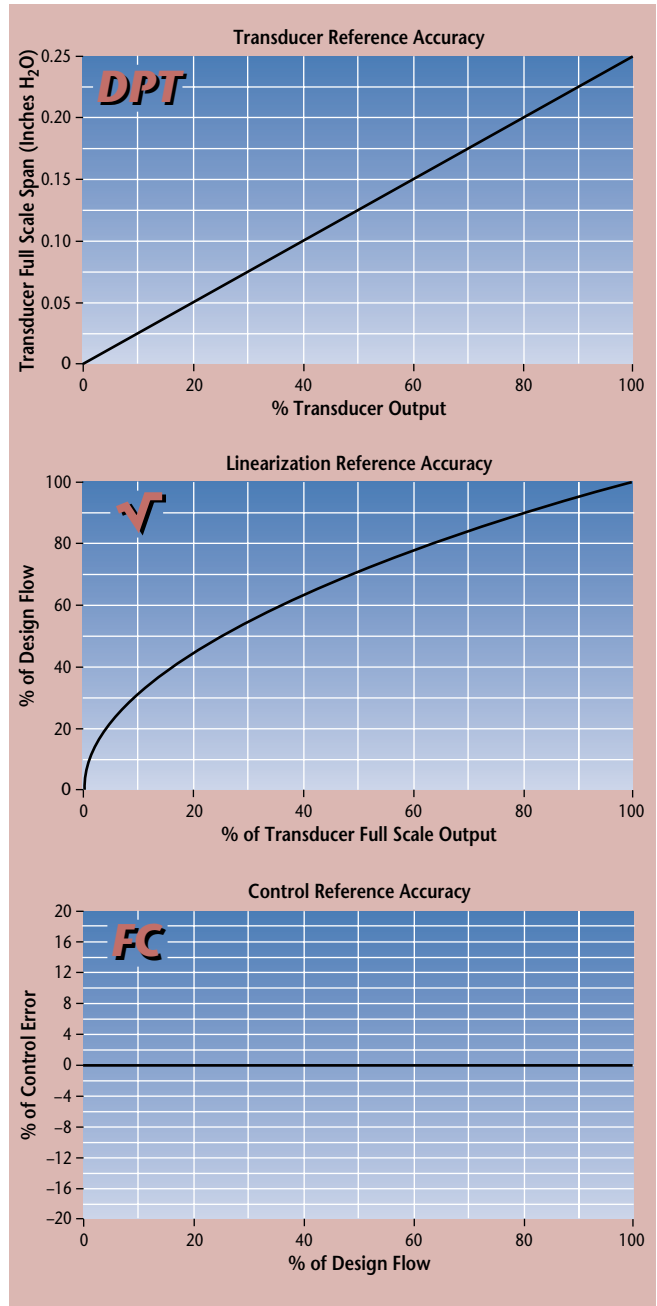
The expected overall accuracy of the control loop can be determined utilizing the standard “square root of the sum of the squares” equation. When applying this equation for airflow control it is important to note that the stated accuracy for the differential pressure transducer is a value based on its’ full scale output range. Therefore, due to the square root conversion required to make this signal linear to flow, even greater error will occur as the airflow system turns down. Add to this the issue of “signal to noise error” and the resulting control system performance is typically unacceptable.

The importance of quality transducer performance specifications for successful airflow control is commonly overlooked by Specifying Engineers. The following graphs are intended to illustrate the importance of accuracy, span selection and signal conditioning when specifying airflow transducers, and hopefully, encourage the engineering community to utilize performance specifications which will assure airflow measurement accuracy. The equation used for calculating velocity and velocity pressure for each of the various graphs shown is:

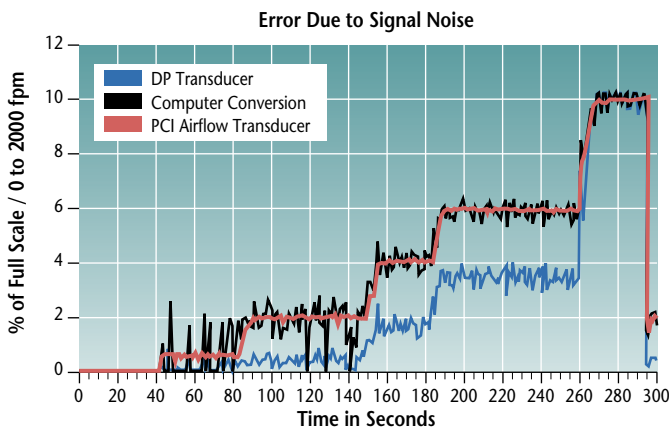
$$\frac{Q}{A} = V \quad \text{or} \quad \left(\frac{V}{C}\right)^2 \cdot \rho = p_w$$

Where:

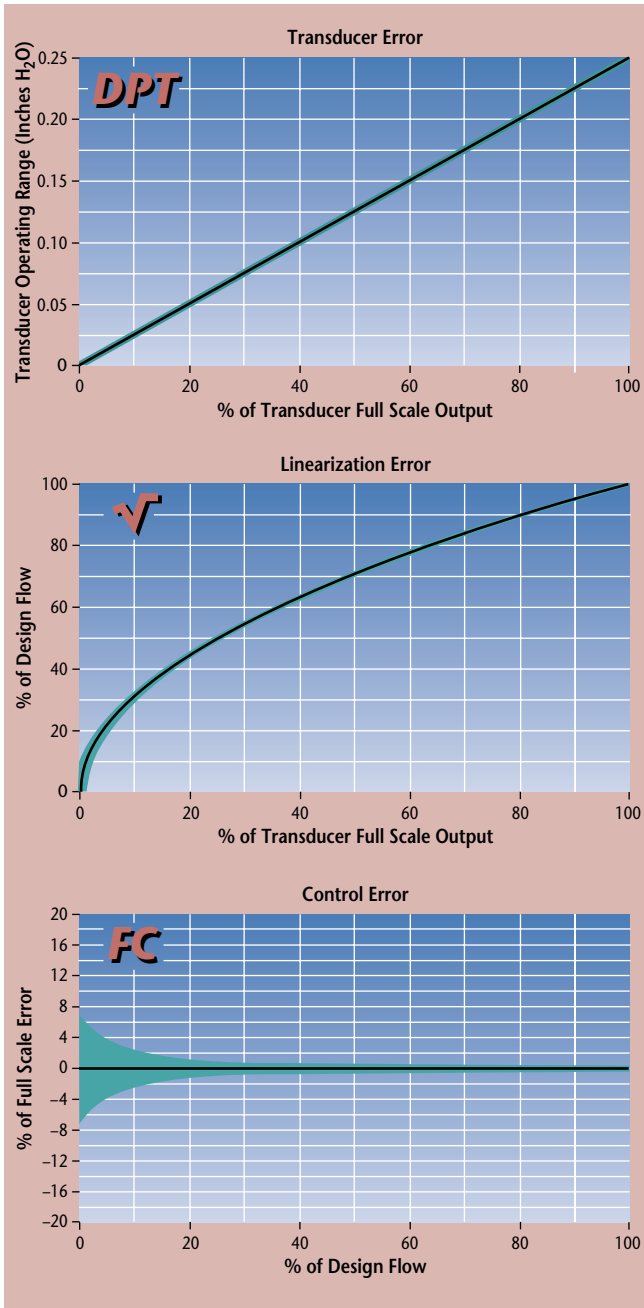
Q = air volume, in cfm C = 1096.5
 A = area, in ft² ρ = standard air density, 0.0749 lb/ft³
 V = velocity, in fpm p_w = velocity pressure, in inches H₂O



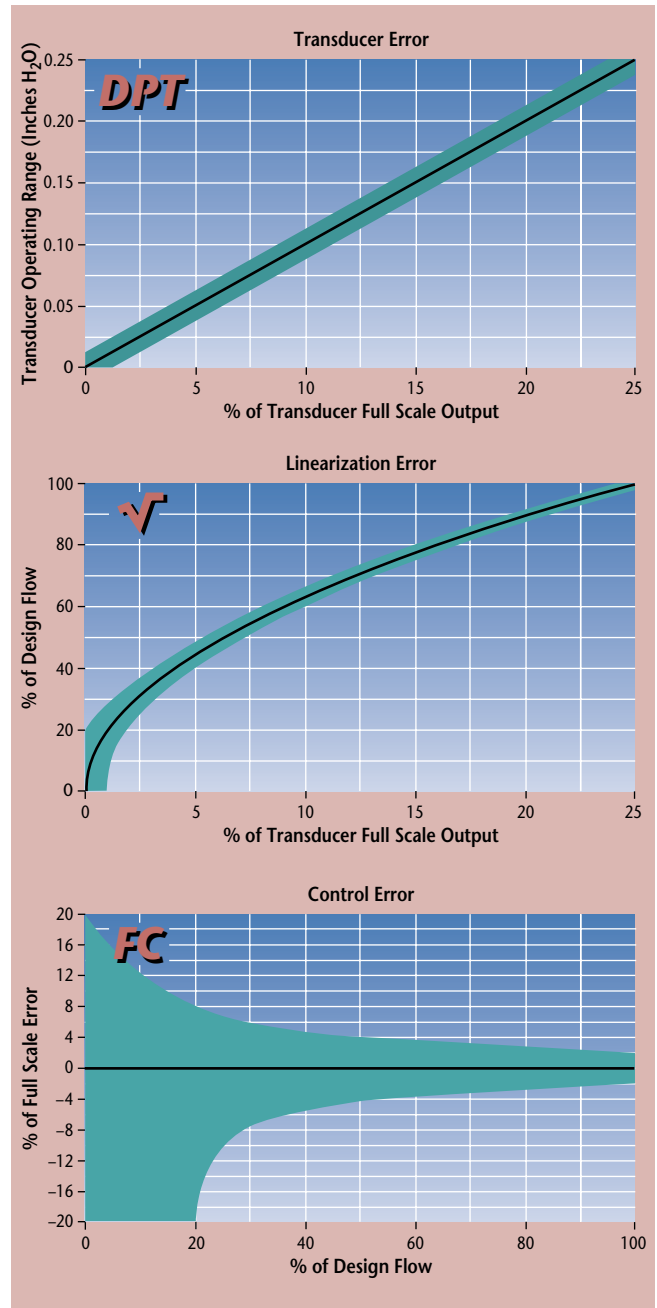
“Reference Accuracy” meaning zero instrument inaccuracy. These graphs are used as the basis for comparing real world inaccuracy.



Graphic illustration of why a DDC system performance is greatly enhanced when utilizing an input from a quality airflow transmitter. This graph was created using data logged output values from a differential pressure transducer, the mathematical conversion of the differential pressure transducer output to airflow as interpreted by a DDC system, as well as the accurate and stable output of PCI’s airflow transducer.



Expected accuracy from a properly specified and selected flow transmitter, having a maximum span of .25" water column and ±0.5% accuracy.



Expected accuracy from a typically selected flow transmitter, having a maximum span of 1.00" water column and ±1.0% accuracy.

The scenario utilized for the above two (2) sets of graphs is for a variable air volume control system in which the maximum design air velocity through the airflow measuring station is 2,000 feet per minute. The first set of graphs show excellent control accuracy when utilizing a transducer meeting the accuracy, span and signal conditioning performance specification required for airflow control. The second set of graphs exemplifies the cause

of many control system failures due to poor performance criteria being specified for the airflow transducer. The control contractor is only responsible to select and furnish a transducer which meets the specification. Therefore, the Specifying Engineer must issue a transducer performance specification that will meet the operational expectations of the airflow control system.

Differential Pressure & Flow Transducers



PCI's transducer family

This brochure describes instruments that are “stand-alone” components of a complete control system. This is, they are mounted in their own separate enclosure and are usually wall-mounted. The same instruments can be combined into one enclosure which would be the control panel for an entire system or major subsystem. The four families of instruments covered herein are Series DPT Differential Pressure Transducers, Series FT Flow Transducers, Series FI Flow Indicators, and output signal conditioning modules.

Series DPT Differential Pressure Transducers

DPT Transducers measure pneumatic input differential pressure and converts that signal to a electronic analog output signal that is sent to a controller or indicating device. These transducers require a 24 VAC/VDC power input. DC output signal is carried on a twisted pair of wires.

Series FT Flow Transducers

FT Transducers are similar to the DPT Series except that both total and static pressure inputs are required. The difference between the two pressures is velocity pressure that is converted by the transducer to velocity (fpm) or with the duct area known, to airflow (cfm). The output is a electronic analog signal for use by a controller or indicator.

Features of each model are identified and described below.

PCI's Variable Capacitance

Pressure Transducers are simple and very reliable sensors designed for high accuracy measurement of low differential pressures. A lightweight, ultra-responsive stainless steel diaphragm and an insulated electrode form the variable capacitor. A unique electronic circuit detects the change in capacitance and produces a 4 to 20 mA DC current output signal linear to the measured differential pressure. The high level output signal, the excellent long term stability and the fast dynamic response of the PCI transducer makes it ideal for a wide range of commercial, industrial, laboratory and aerospace applications.

The Automatic Zeroing Circuit

performs a zero calibration of the differential pressure transducer output at user-selected intervals. Uninterrupted control and/or indication is maintained at the last output value during the approximate two second calibration

period. The transducer resumes its real-time analog output response after zero calibration is complete.

The Signal Scaling Circuit converts the differential pressure signal (static pressure, or velocity pressure converted to velocity in fpm or airflow in cfm) to a user-specified full scale value.

The Digital Display shows the converted transducer output signal on a 0.5" high four-digit light-emitting diode (LED) which is door mounted for local monitoring capability.

The Square Root Extractor Circuits are used in all flow transducers to conform the output to the square root curve of velocity vs. velocity pressure. This circuit is essential for signal accuracy when the output is made linear to velocity or airflow.

The Analog Meter is a diaphragm-actuated differential pressure gage directly connected through bulkhead fittings and tubing to the static pressure or airflow measuring element.

This provides a continuous and direct indication of the true measured value independent of the hydraulics or electronics of other control components, and thus provides a instant visual check on the system status. The meter is provided with either a dual scale (fpm and cfm) for airflow readings or a single scale in inches of water for pressure readings. The indicating scales may also be customized for a specific design need.

Surface-mounted Steel Enclosures are used for housing the electronic circuit boards. The enclosures are manufactured to NEMA 12 specifications and have welded seams, external mounting feet and a solid neoprene cover gasket. The standard finish is grey polyurethane enamel over phosphatized and primed surface. Pressure connections are convenient bulkhead compression fittings suitable for 1/4" OD metallic or thermoplastic tubing. Electrical connections are made via a standard 1/2" electrical conduit connector.

Model Number	Features									
	2 Wire	3 Wire	4 Wire	Variable Capacitance Transducer	Automatic Zeroing	Signal Scaling	Digital Display	Square Root Extraction	Analog Display	Enclosure
Differential Pressure Transducers										
DPT-4001	✓			✓						
DPT-4003		✓		✓						
DPT-4005			✓	✓		✓				✓
DPT-4005AZ			✓	✓	✓	✓				✓
DPIT-4005M			✓	✓		✓			✓	✓
DPIT-4005D			✓	✓		✓	✓			✓
DPIT-4005MAZ			✓	✓	✓	✓			✓	✓
DPIT-4005DAZ			✓	✓	✓	✓	✓			✓
Flow Transducers										
FT-1001	✓			✓				✓		
FT-1005			✓	✓		✓		✓		✓
FT-1005AZ			✓	✓	✓	✓		✓		✓
FIT-1005M			✓	✓		✓		✓	✓	✓
FIT-1005D			✓	✓		✓	✓	✓		✓
FIT-1005MAZ			✓	✓	✓	✓		✓	✓	✓
FIT-1005DAZ			✓	✓	✓	✓	✓	✓		✓

Indicating Modules



PCI's flow indicating meters

Series FI Flow Indicators

Models FI-1000 Flow Indicators hold factory-mounted single meter and the FI-3000 Flow Indicators hold factory-mounted multiple meters. Each indicating meter is identified with an engraved label showing the equipment or system number; the primary element to which it is connected; and the operating design values. The Model FI-2000 Portable Meter is labeled only with the range of the meter, and is furnished with two 10 foot lengths of 1/4" OD polyurethane tubing, male quick-connect fittings and a carrying handle.

Features of each model are identified and described below.

The Analog Meter is a diaphragm-actuated differential pressure gage directly connected through bulkhead fittings and tubing to the static pressure or airflow measuring element. This provides a continuous and direct indication of the true measured value independent of the hydraulics or electronics of other control components, and thus provides a instant visual check on the system status.

The meter is provided with either a dual scale (fpm and cfm) for airflow readings or a single scale in inches of water for pressure readings. The indicating scales may also be customized for a specific design need.

Multiple Analog Meters are two or more analog meters as described above.

Surface-mounted Steel Enclosures are used for multiple analog meter applications. They are constructed of 16 gage steel to NEMA 12 specifications,

and are coated inside and out with beige color textured powder paint. Pressure connections are convenient bulkhead compression fittings suitable for 1/4" OD metallic or thermoplastic tubing.

Surface-mounted Brushed Aluminum Enclosures are made of 16 gage material and have no NEMA rating. Pressure connections are convenient bulkhead compression fittings suitable for 1/4" OD metallic or thermoplastic tubing.

Model Number	Features				
	Analog Meter	Multiple Meters	Surface Mounted Steel Enclosure	Aluminum Enclosure	Portable Aluminum Carry Case
<i>Flow Indicators</i>					
FI-1000	✓			✓	
FI-2000	✓				✓
FI-3000	✓	✓	✓		

Function Modules



PCI's scaling and alarm modules

Control Function Modules

PCI offers a number of function modules for signal transmission, input alarming and signal ramping. All of these modules include filtering and signal conditioning to reduce susceptibility to transients and noisy operating conditions.

The Signal Transmitter provides dual DC signal outputs proportional to a DC input signal. This product is very useful for scaling signal levels from one amplitude to another, as well as for converting from voltage to current.

The Alarm Module monitors a DC input signal and provides two sets of SPDT, 3 amp alarm relays, each having its' own adjustable setpoint and integral LED to indicate the alarm status. The module can be supplied in either a HI/HI, HI/LOW, or LOW/LOW alarm configuration.

The Ramp Module produces a DC output signal over an adjustable time rate setting based on the closure of an external contact. This module has integral LED's indicating that the ramp module's output is at minimum, or has reached a maximum output state. The ramp module is very useful for establishing the gradual opening or closing of a control damper.

Electronic to Pneumatic Transducer

This device is utilized on electronic/pneumatic control systems for converting a DC input signal into a proportional pneumatic output. The unique design of this transducer allows for field setting of the pneumatic output range, as well as manual setting of the devices output.

The E/P transducer is non-position sensitive nor is it susceptible to variations in instrument air. This is due to the integral pressure transducer utilized to monitor and control the devices final output value.



PCI's electronic to pneumatic transducer

Reference Conversion Factors

Length

<i>Metric/English</i>			<i>English/Metric</i>		
Multiply	By	To Obtain	Multiply	By	To Obtain
millimetre (mm)	0.03937008	inch	inch (in.)	25.4	millimetre
millimetre (mm)	0.00328084	foot	inch (in.)	2.54	centimetre
centimetre (cm)	0.3937008	inch	foot (ft.)	304.8	millimetre
centimetre (cm)	0.0328084	foot	foot (ft.)	30.48	centimetre
metre (m)	3.28084	foot	foot (ft.)	0.3048	metre
metre (m)	1.093613	yard	yard (yd.)	0.9144	metre
kilometre (km)	0.6213712	mile	mile (mi.)	1.609344	kilometre

Area

<i>Metric/English</i>			<i>English/Metric</i>		
Multiply	By	To Obtain	Multiply	By	To Obtain
millimetre ² (mm ²)	0.001550003	inch ²	inch ² (in. ²)	645.16	millimetre ²
millimetre ² (mm ²)	0.00001076391	foot ²	inch ² (in. ²)	6.4516	centimetre ²
centimetre ² (cm ²)	0.1550003	inch ²	foot ² (ft. ²)	92,903.04	millimetre ²
centimetre ² (cm ²)	0.001076391	foot ²	foot ² (ft. ²)	929.0304	centimetre ²
metre ² (m ²)	10.763910	foot ²	foot ² (ft. ²)	0.09290304	metre ²
metre ² (m ²)	1.195990	yard ²	yard ² (yd. ²)	0.8361274	metre ²

Volume

<i>Metric/English</i>			<i>English/Metric</i>		
Multiply	By	To Obtain	Multiply	By	To Obtain
centimetre ³ (cm ³)	0.06102376	inch ³	inch ³ (in. ³)	16.38706	centimetre ³
metre ³ (m ³)	35.31466	foot ³	foot ³ (ft. ³)	0.02831685	metre ³
metre ³ (m ³)	1.307951	yard ³	foot ³ (ft. ³)	28.31685	litre
metre ³ (m ³)	1000.0	litre	yard ³ (yd. ³)	0.7645549	metre ³

Velocity and Flow

<i>Metric/English</i>			<i>English/Metric</i>		
Multiply	By	To Obtain	Multiply	By	To Obtain
litre/second (l/s)	2.1188797	feet ³ /minute	foot/minute (fpm)	0.00508	metre/second
litre/minute	0.03531466	feet ³ /minute	foot/minute (fpm)	0.3048	meter/minute
metre/second (m/s)	196.8504	foot/minute	feet ³ /minute (cfm)	0.47194750	litre/second
meter/minute	3.280840	foot/minute	feet ³ /minute (cfm)	28.31685	litre/minute
metre ³ /second (m ³ /s)	2118.880	foot ³ /minute	foot ³ /minute (cfm)	0.0004719474	metre ³ /second

Pressure

<i>Metric/English</i>			<i>English/Metric</i>		
Multiply	By	To Obtain	Multiply	By	To Obtain
pascal	0.00040147	inches of water	inches of water	249.1	pascal
kilopascal	0.2953	inches of mercury	inches of mercury	3.3864	kilopascal
kilopascal	0.14504	pounds per square inch	pounds per square inch	6.8948	kilopascal
centimetres of water	0.3937	inches of water	inches of water	2.540	centimetres of water

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