

Application Note Series

HVAC Series – Analyzing Airflow

Product Platform: Instrumentation &
Embedded Air Velocity Sensing

Products:

°C SPAR Sensor Pole Array System

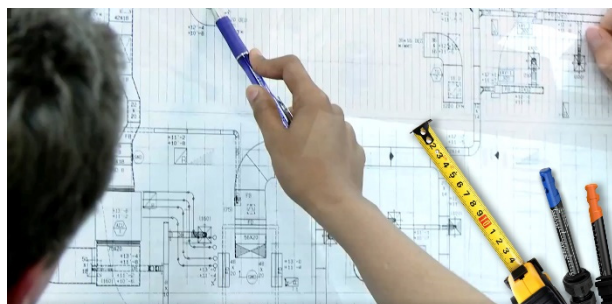
°C Port Data Acquisition Instrument

AccuTracTM Software

F-Series Air Velocity & Air Temperature Sensor

Purpose: Most accurate measurement of airflow in ducts for control, monitoring and viewing

Testing Range: 0.15 m/s to 20 m/s [30 fpm to 4000 fpm]



Part 1: In-Duct Airflow Measurement

ABSTRACT:

Indoor environmental conditions directly affect the health, comfort and productivity of a building's occupants, equipment longevity and overall energy costs. Accurate measurement of air velocity in HVAC ducts provides the information needed to examine and calculate the optimal airflow in HVAC systems. Larger HVAC ducts require a different set of tools than smaller diameter ducts. [Degree Controls](#) is your trusted partner for single and multi-point airflow sensing and control.

Airflow Measurement Standards:

Degree Controls has been developing airflow-critical solutions and airflow analysis tools for over 20 years. When asked about where and how to take air velocity measurements in a duct, Degree Controls points to well-established standards and guidelines from [ASHRAE](#), the

Application Note Series

HVAC Series – Analyzing Airflow

American Society of Heating, Refrigerating and Air-Conditioning Engineers. [ANSI/ASHRAE Standard 41.2](#) prescribes methods for air velocity and airflow measurement, and [ANSI/ASHRAE Standard 111](#) provides procedures for measurement, testing, adjusting, balancing, evaluating, and reporting the performance of building heating, ventilating, and air-conditioning systems in the field.

Where to Measure Airflow:

Volumetric airflow measurement accuracy depends on measurement location. ASHRAE recommends placing the airflow transducer at least 7.5 duct diameters downstream and 3 duct diameters upstream from obstructions or changes in airflow direction. For accurate and reliable air velocity readings, place the [air velocity sensor](#) in stable, laminar flow:

- away from bends or junctions in ducts and
- away from turbulence caused by fans, filters or other heating and cooling devices.

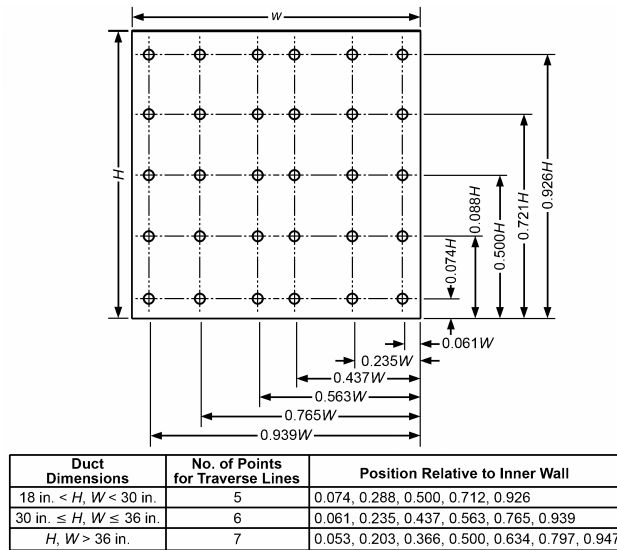
How to Measure Airflow:

Airflow can vary across the cross sectional area of a duct. Measurement accuracy improves by taking measurements at multiple points and then calculating the mean. ASHRAE provides guidance on the number and location of measuring points within a plane for both rectangular and circular ducts. A minimum of 25 points is specified for rectangular or square ducts, and a minimum of 18 points is specified for circular ducts. Reference the figures below to determine:

1. Number of measuring points
2. Placement of measuring points

Application Note Series

HVAC Series – Analyzing Airflow



Note: Example duct has 5 × 6 (H × W) measurement pattern, as for rectangular duct of 24 × 30 in.

Figure 1 ASHRAE Guidance for Rectangular Ducts

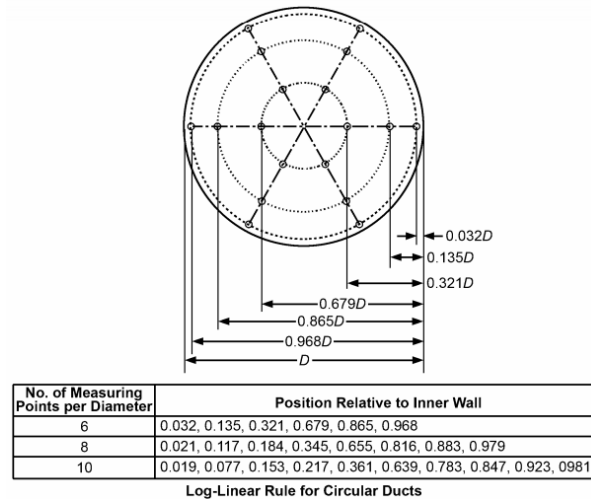


Figure 2 ASHRAE Guidance for Circular Ducts

From ASHRAE Standard 111, Traversing a Rectangular Duct:

The number of data points to be taken along each side of the duct depends on the width of that side of the duct. For duct sides less than 30 inches, 5 traversal points must be taken along that side. For duct sides of 30 to 36 inches, 6 points must be taken. For duct sides greater than 36 inches, 7 points must be taken. Multiply the numbers provided in the table times the duct dimension to get insertion depth for the sensor probe.

From ASHRAE Standard 111, Traversing a Circular Duct:

The preferred method is to drill 3 holes in the duct at 60° angles from each other in order to cover all locations recommended using the log-linear method for circular ducts. Three traverses are taken across the duct, averaging the velocities obtained at each measuring point. Then the average velocity is multiplied by the duct area to get the flow rate.

Part 2 of our *HVAC Series – Analyzing Airflow* explains why the Degree Controls [°C SPAR Sensor Pole Array](#) is ideal for in-duct HVAC airflow measurement.

Application Note Series

HVAC Series – Analyzing Airflow

Part 2: °C SPAR is Ideal for Multi-Point In-Duct Measurements

Note: Part 1 of our *HVAC Series – Analyzing Airflow - In-Duct Airflow Measurement* presents methods to measure airflow for HVAC air distribution.

The [°C SPAR Sensor Pole Array](#) from Degree Controls is optimal for in-duct HVAC airflow analysis. It is a linear array of airflow sensors assembled into a single tube element with USB outputs. The °C SPAR is designed for multipoint experimentation where there are predefined measurement locations, just as shown in the [Log-Tchebycheff Rule](#) for calculating volumetric flow within ducts. With the °C SPAR, air velocity, temperature, and humidity can be measured and recorded at multiple points in real-time for building duct performance testing.



Figure 3 °C SPAR

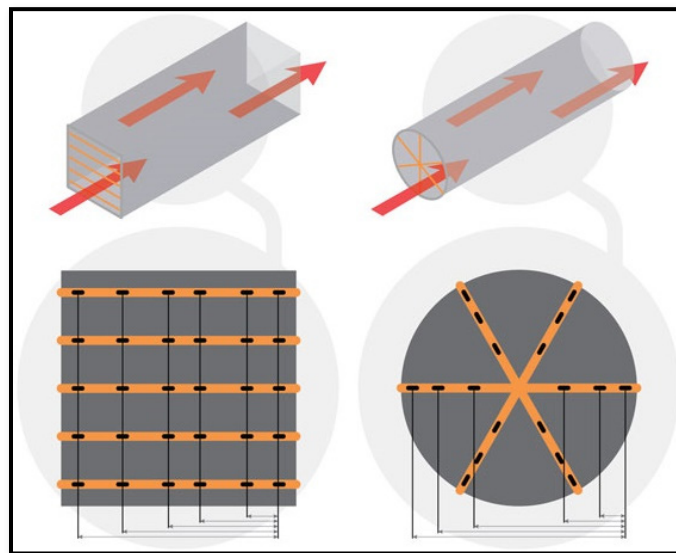


Figure 4 ANSI/ASHRAE Standard for Traversing a Duct

°C SPAR Benefits

The °C SPAR is built to client specified dimensions, including tube length, sensor quantity, pitch, and calibration range. °C SPARs reduce set-up time



Figure 5 Fully Configurable °C SPAR Sensor Pole Array System

Application Note Series

HVAC Series – Analyzing Airflow

by eliminating complex fixturing that goes along with making multiple measurements across a plane, and °C SPARs increase test repeatability. Very little impedance is imparted to the air-flow profile.

The °C SPAR is compatible with the [°C Port](#) family of data acquisition instruments to aggregate sensor data. The C° Port instrument, paired with the [AccuTrac™ Software](#) toolset, collects air velocity, air temperature, as well as humidity and altitude (or barometric pressure) data real-time and displays, saves, reviews, graphs, and prints without export to another program. AccuTrac™ is flexible and easy to use, and data can be saved in common file formats such as .xlsx, .csv and jpeg.



Figure 6 Multi-Channel Data Acquisition Instrumentation

Part 3 of our *HVAC Series – Analyzing Airflow* discusses available configuration options from Degree Controls and describes our [embedded platform](#) solution for a large duct application.

Application Note Series

HVAC Series – Analyzing Airflow

Part 3: Configurable Air Velocity Sensing & Controls for Duct Airflow Measurement

Note: Part 2 of our *HVAC Series – Analyzing Airflow* - °C SPAR is Ideal for Multi-Point In-Duct Measurements explains why the Degree Controls [°C SPAR Sensor Pole Array](#) is ideal for in-duct HVAC airflow measurement.

Embedded Air Velocity Sensing Platform Provides Versatility:

The [embedded air velocity sensing](#) platform by Degree Controls empowers users with a range of configuration options for the many diverse industry applications that exist. A variety of velocity ranges, mechanical lengths, supply voltages, output communication types, as well as probe and remote head sensor styles are available.



°C SPAR with Analog Output:

For clients with their own data loggers, or where analog based communication and control systems have been pre-established, the °C SPAR can be configured with our [F-Series](#) of air velocity and temperature sensors. The voltage output may be configured 0-5V or 0-10V, and can be augmented with simultaneous digital communication for next generation systems.

Embedded Solution for Air Velocity Measurement In-Duct:

Degree Controls has the products and experience to meet the many airflow measurement and testing scenarios faced by our clients.

We met application specific requirements to:

*convey average velocity across a duct area to the client's BMS (Building Management System)
as a 0-10V analog output*

with a set of our [F500 series sensors](#). For this large duct application, the sensors were modified to communicate in a master/slave arrangement over addressed UART communication:

1. Each slave sensor communicates velocity reading(s) to its neighboring slave, or master.
2. The master sensor receives velocity readings from all slave sensors.

Application Note Series

HVAC Series – Analyzing Airflow

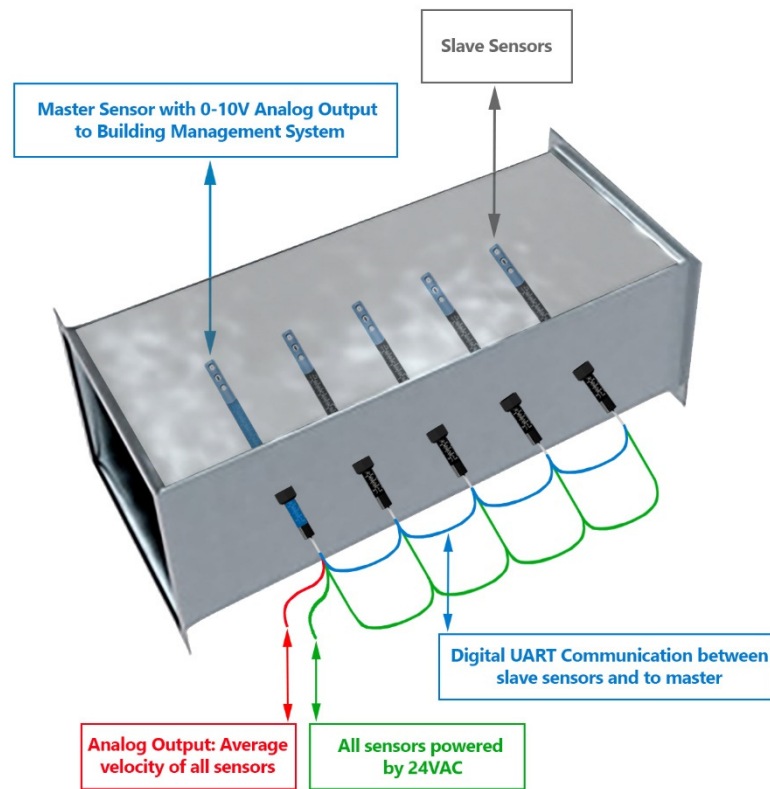


Figure 7 Set of F500 Master/Slave Air Velocity & Temperature Sensors

The master sensor first records its own velocity reading and then averages all readings from sensors in the network. Next, the master sensor uses its 0-10V analog output to transmit the average velocity to the BMS or monitoring system.

All sensors are powered by universal 24VAC. Sensors are connected with a latching connector and 0.6 m [2 ft] of cable. The master sensor itself has 2 m [6.6 ft] flying leads to connect to the BMS system.

The master sensor can communicate to as many as 15 slave sensors. This flexible solution ships as a kit, and master and slave sensors already addressed.

Part 4 of our *HVAC Series – Analyzing Airflow* reviews airflow sensors as key elements of HVAC control systems.

Application Note Series

HVAC Series – Analyzing Airflow

Part 4: Airflow Sensor is Key Element of HVAC Control System

Note: Part 3 of our *HVAC Series – Analyzing Airflow - Configurable Air Velocity Sensing & Controls for Duct Airflow Measurement* discusses available configuration options from Degree Controls and describes our [embedded platform](#) solution for a large duct application.

A well run HVAC control system is conducive to a healthy and comfortable indoor environment, helps maintain equipment life expectancy, and helps save costs. The control system is only as good as its sensing devices. [Degree Controls](#) airflow sensors are key elements of HVAC control systems.

Care should be taken in choosing the right airflow sensor for your application. Close attention should be paid to both sensor mounting and location to ensure that it will function according to published specifications. Here are some sensor considerations to evaluate:

- Check the specs against the environment the sensor will be used in.
- Consider outside influences such as vibration, spray water or debris. Decide if any special provisions will be needed for protection.
- Determine where the sensor will be mounted. Avoid mounting the sensor in turbulent locations caused by elbows or duct size changes. Follow ASHRAE best practices.
- Determine the insertion depth needed for the application. The main airflow cavity surrounding the flow thermistor should be in the center of the duct when the sensor is installed.
- Be mindful of the size of the airflow probe. A probe may impact flow and thus airflow measurements in a small cross-sectional duct. An airflow sensor with [remote head](#) or low profile head may be needed.
- Find out what airflow velocities the sensor is expected to encounter. Choose the sensor velocity range accordingly.



Figure 8 F-Series Air Velocity & Air Temperature Sensor

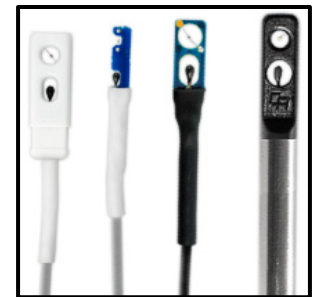


Figure 9 Sensor Head Options

Application Note Series

HVAC Series – Analyzing Airflow

- Understand the sensor flow direction and whether it is [non-directional](#) or [bidirectional](#). The main airflow cavity surrounding the flow thermistor must be orientated perpendicular to airflow being monitored in order for it to function as designed.



Figure 10 Orientation Indicator

Figure 11 Airflow Cavity

- Mount the sensor securely. Do not overtighten °C-Clamps.
- Dress the sensor cable. Allow a sufficient cable bend radius and loop to prevent stress and premature wear. The wiring system should allow for serviceability.
- Maintain sensor signal integrity. Avoid excessive cable length, and keep cabling separate from high voltage lines.



Figure 12 Gland Fitting



Figure 13 °C-Clamp

CONTACT:

To find out more about Degree Controls' sensor products and solutions, contact us at 1-877-degreeC, or visit our website at www.degreeC.com. Email sales inquiries to sales@degrec.com.

Degree Controls, Inc.
300 Innovative Way
Suite 222
Nashua, NH 03062-5746
USA