Customer Application Note

Describing moving air accurately requires two pieces of information: speed and direction. This paper provides background information on both, and how to get best results when using Cambridge AccuSense sensors and instruments. For latest information and Tech Notes on various other topics, please also check our website at http://www.degreec.com.

AIRFLOW ACCEPTANCE ANGLE

DegreeC's Cambridge AccuSense Air Velocity Sensors are thermal anemometers that use the cooling effect of air passing by the heated device for determining the air speed. Any form of heat loss is translated to air speed.

AccuSense offers three different sensor head designs (*Fig. 1*). On the PC head a plastic frame protects the sensing element. The Low-Profile head is designed to be very small and uses a printed circuit board to hold the sensing element in the wind. Both the PC and the Low-Profile are used perpendicular to the flow such that the air currents go through the openings.

The third sensor head type is the XS Blade-type; it is used parallel to the currents just like a blade. The XS is used in applications where size matters most, in narrow spots, and where a bigger sensor may interfere with or redirect the flow.

Some sensor heads are directionally sensitive and the direction at which the flow approaches the sensor head can directly affect accuracy. Due to aerodynamics, mis-alignment can cause the airflow to go around the sensor head rather than across the sensing elements, which can lead to errors.

To learn about the limits of the technology, and to find the influence of the acceptance angle on airflow sensor readings, AccuSense performed the following experiment.

A PC, a Low-Profile, and an XS Sensor were inserted in the airflow of our high precision wind tunnel at room temperature. Readings were then recorded with the sensors turned in increments of 5° from the original position. This experiment was performed multiple times and at different speeds to ensure repeatability.

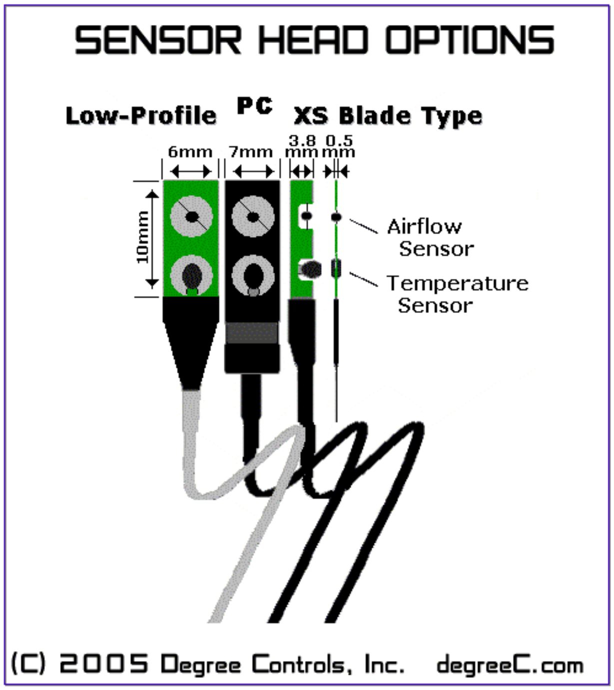

Fig. 1: Low-Profile (left), PC (center), and XS Sensor Heads.

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Fig. 2 shows the results for PC, Low-Profile, and XS Sensors. The horizontal axis shows the angle in degrees from perpendicular, at which the sensor head was facing the oncoming airflow. The vertical axis shows the error in percent compared to the sensor in the ideal (perpendicular) position to the flow.

The Low-Profile Sensor shows errors smaller than 2% within a 45° angle from perpendicular. The plastic covered PC head sensor allows an even greater angle since its construction funnels the airflow towards the sensor bead as it approaches the sensor head. For the PC angles within 60° from perpendicular result in errors less than 2%. The XS type sensor head does not show any degradation, no matter what the angle from the oncoming flow.

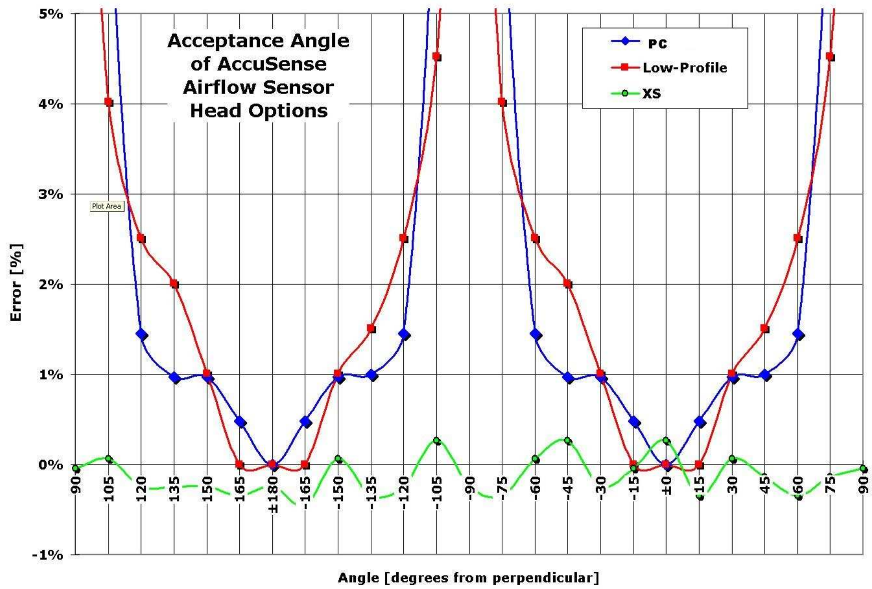

Fig. 2: Accuracy of AccuSense sensors vs. angle from perpendicular of oncoming airflow.

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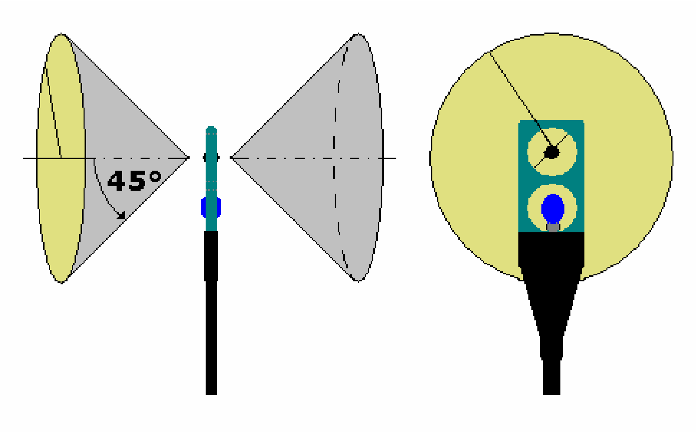

Fig. 3: Airflow acceptance angle for PC and Low-Profile sensor heads as recommended by AccuSense.

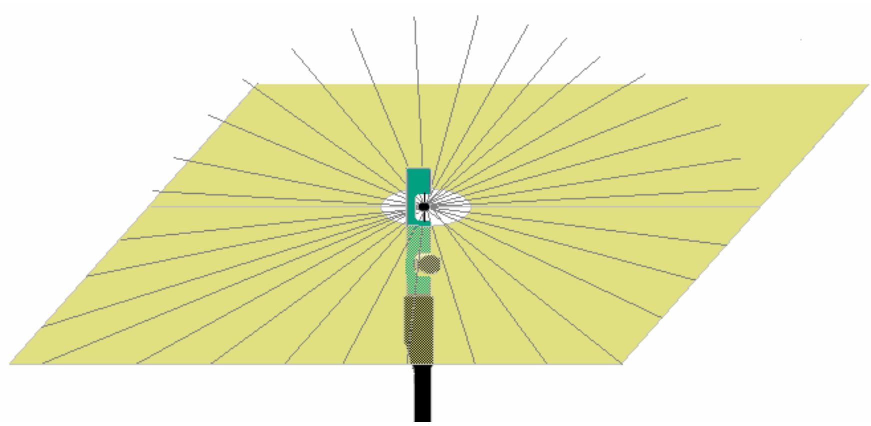

Fig. 4: Illustration of omni-directional XS sensor head.

Deviation of the probe from true alignment in the air stream is called yaw and pitch. *Fig. 3* pictorially shows the results from th e experiment for the PC and Low-Profile sensor heads.

If airflow approaches from within an imaginary cone with a 90° angle at the tip, the error caused by the acceptance angle will not exceed 2% compared to a reading taken perpendicular to the airflow.

The Graph in Fig. 2 is symmetrical, which shows that both the PC and Low-Profile sensors are non-directional, and that it does not matter if the airflow approaches the sensor from one direction or the other.

The experiment also showed that the XS sensor heads are not affected by the angle of the oncoming flow. In other words, the *XS Series are omni-directional airflow sensors*. Fig. 4 illustrates that characteristic.

Most airflow sensors are directionally sensitive, including the Accusense thermal anemometers. The PC and Low-Profile sensor heads were tested and found to have acceptance angles of ±60° and ±45° from perpendicular. The XS blade type sensor head was found to be omni-directional since it did not show any errors when the acceptance angle was changed.

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NOTES:

1) DegreeC guarantees calibration of their NIST traceable sensors and instrumentation for 12 months. To always ensure accurate readings, we recommend recalibration once a year.
2) Air always takes the path of least resistance - usually the widest opening. Therefore, select an airflow sensor that will not block the flow, otherwise the readings will not be a true reflection of the airflow.
3) Close to fans the airflow is usually extremely turbulent and shows a corkscrew-like pattern.
4) At low air speeds warm air is caused to rise from the heated sensor (convection). This self-generated airflow can cause a false reading. Below 0.15 m/s (30 fpm) readings should not be considered accurate.

Please let us know your questions or comments on this document and our products in general. We are a customer driven company, and feedback is very important to us.

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