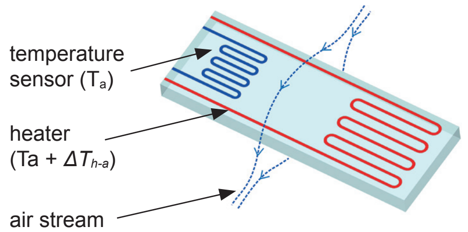
Air Velocity Measurement with Hot-Film Anemometers

Operation Principle

The E+E air velocity measuring devices employ E+E sensors manufactured in state-of-the-art thin film technology and are based on the thermal anemometric measurement principle.

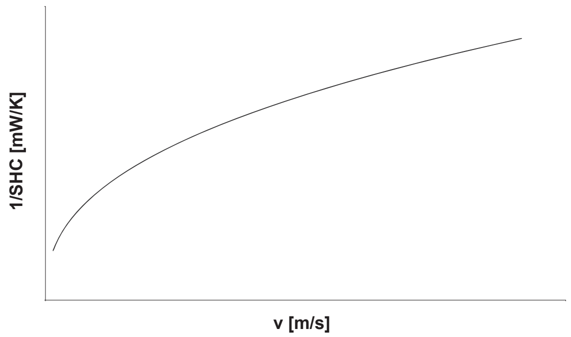


An E+E air velocity sensor consists of two resistors deposited on a thin glass substrate. One resistor is used as temperature (T) sensor and measures the temperature of the ambient air flowing along the sensor (T_a).

The second resistor is used as a heater with temperature $T_h > T_a$. The faster the air flows along the sensor, the stronger the cooling effect on the heater. The electrical power P necessary to keep constant the T difference between the heater and the ambient, $\Delta T_{h\text{-}a}$, is the measure for the air velocity.

The sensor characteristic is non-linear and can be described using the self-heating coefficient SHC.

$$1/SHC = \frac{P}{\Delta T_{h-a}}$$



The linearization of the E+E transduces is performed during their individual factory adjustment and calibration.

The Accuracy of E+E Air Velocity Measuring Devices

The measurement accuracy depends both on the performance of the measuring instrument and on the correct installation in the application

For best accuracy, each E+E air velocity transducer is factory adjusted in a low-turbulence wind tunnel. With a high-precision Laser Doppler Anemometer (LDA) used as reference, the overall uncertainty of the factory calibration Ucal is minimal.

The total measurement uncertainty U_{total} specified for the E+E measurement device is calculated in accordance with EA-4/02 (European Accreditation, Evaluation of the Measurement Uncertainty in Calibration) and with GUM (Guide to the Expression of Uncertainty in Measurement).

$$U_{total} = k \cdot \sqrt{\left(\frac{U_{cal}}{2}\right)^2 + \left(\frac{u_{accuracy}}{\sqrt{3}}\right)^2}$$

U_{cal} = the uncertainty of the factory calibration
$u_{accuracy}$ = the accuracy of the measurement device (linearity and reproducibility)
k = enhancement factor which defines the confidence interval.
Commonly k=2, corresponding to a confidence level of 95%.

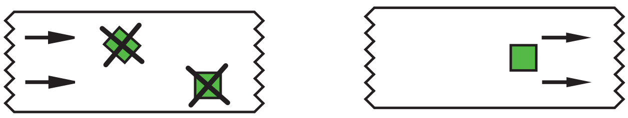
As designated laboratory (NMI) responsible for maintaining the National Standard for Air Flow Velocity in Austria, E+E Elektronik represents the highest instance in air velocity calibration.

Mounting Guidelines for Air Velocity Measuring Devices

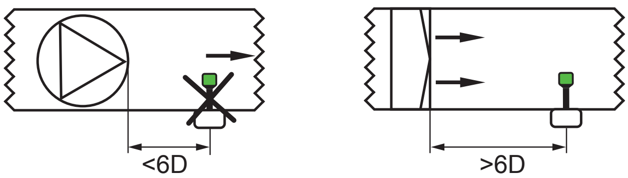
For accurate measurement results it is of paramount importance to place the sensing probe at a location with low turbulence, such as after filters, rectifiers, heaters or coolers. Turbulence appears after obstructions like fans, bends, junctions or section changes in the duct (diffusers / confusers), so the probe shall be placed far enough from these. The minimum length of the settling zone (straight duct section without obstructions whatsoever) between the probe and the source of turbulence depends on the diameter of the duct. An "equivalent diameter" D_{gl} can be defined for a rectangular duct with dimensions a · b:

$$D_{gl} = \frac{2 \cdot a \cdot b}{a + b}$$

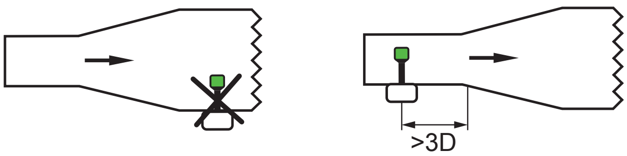
The following pictures supply guidelines for correct installation of air velocity transducers with respect to location and to minimum recommended settling zones.



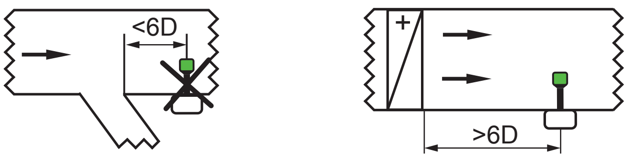
Install the sensor in the middle of the duct.



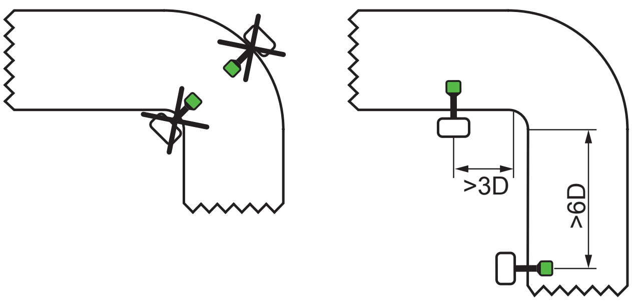
The preferred position of the sensor is after a filter.



Place the sensor in front of the diffusers at a position with high air velocity.



Place the sensor at a position with laminar (non turbulent) flow.
Turbulence appears after fans as well as after bends, junctions, air heater, air cooler, filters, flaps or diameter changes in the duct.



Maintenance of the E+E Air Velocity Transmitters

Due to the absence of moving parts, the E+E air velocity transmitters are not subject to wear. The construction (shape, dimensions and materials) of the hot film air velocity sensor is per se highly insensitive to dust and dirt. No maintenance is required under normal environmental conditions. For operation in polluted environment it is advisable to periodically clean the sensing head by washing it in isopropyl alcohol, preferably in an ultrasound cleaner. Alternatively shake it gently few minutes in a pot with isopropyl alcohol and let it dry free. Do not touch or rub the sensor and do not use any mechanical tools for cleaning.