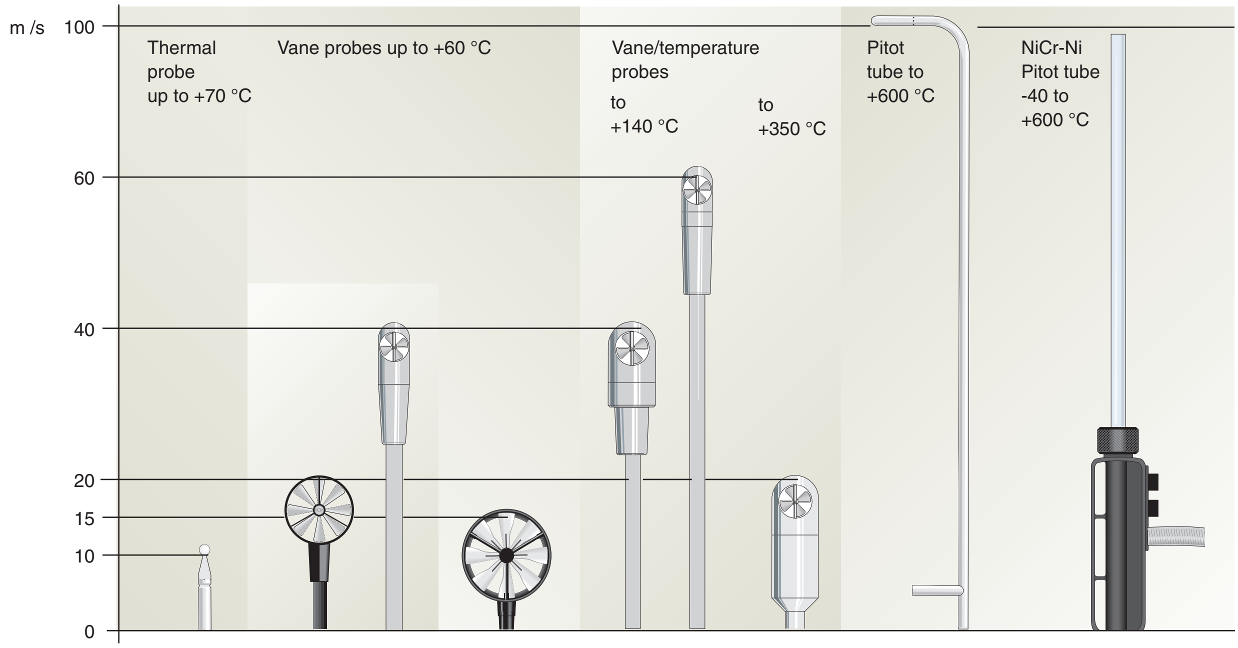
Measuring and application ranges of the velocity probes



Probe selection

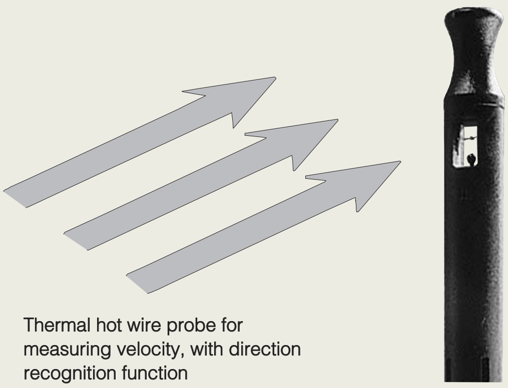
The flow measuring range 0 to 100 m/s can be divided into three sections:

- Low-speed velocity 0 to 5 m/s
- Mid-speed velocity 5 to 40 m/s
- High-speed velocity 40 to 100 m/s.

Thermal probes are used for accurate measurements in the range 0 to 5 m/s. Vane probes are ideal for velocities from 5 to 40 m/s. The measuring range of the Pitot tube depends on the differential probe used. The new 100 Pa probe can therefore be used for the exact measurement of the flow speed from approx. 1 m/s to 12 m/s. The Pitot tube yields optimum results in the higher velocity range. An additional criterion when selecting the correct velocity probe is the temperature. Thermal sensors can normally be used at up to approx. +70 °C. Special design vane probes can be used to maximum +350 °C. Pitot tubes are used for temperatures above +350 °C.

Thermal probes

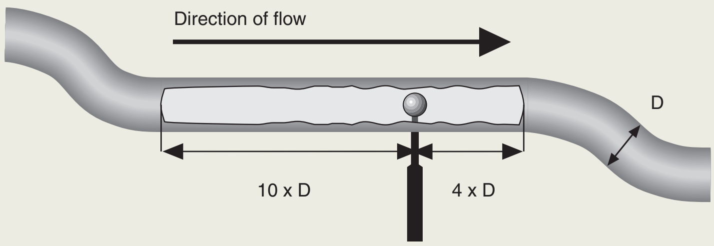
The principle of the thermal probe is based on a heated element from which heat is extracted by the colder impact flow. The temperature is kept constant via a regulating switch. The controlling current is directly proportional to the velocity. When thermal velocity probes are used in turbulent flows, the measured result is influenced by the flows impacting the heated body from all directions. In turbulent flows, a thermal velocity sensor indicates higher measured values than a vane probe. This can be observed especially during measurements in ducts. Depending on the design of the duct, turbulent flows can occur even at low velocities.



Thermal hot wire probe for measuring velocity, with direction recognition function

Location selection

You should measure in a straight part of the duct, if possible. The duct part should have a minimum of ten diameters of straight run before the measuring spot and four diameters of straight run after the measuring spot. The flow profile should not be interrupted in any way by flaps, dips, angles etc.



Vane probes

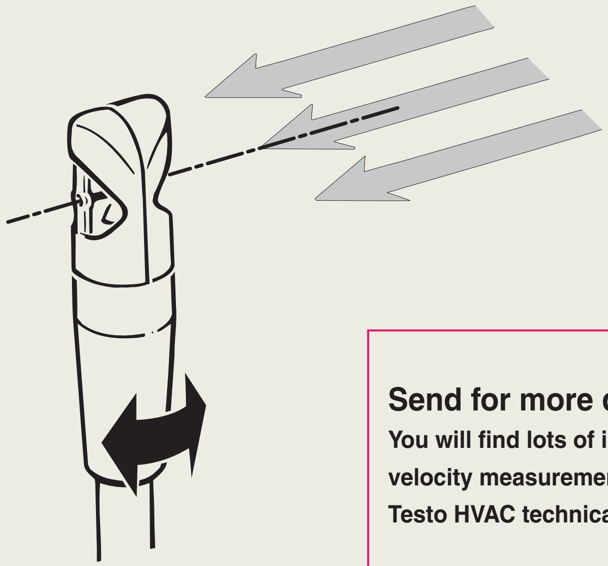
The measuring principle of the vane probe is based on the conversion of a rotation into electric signals. The agent which flows makes the vane rotate. An inductive proximity switch "counts" the revolutions of the vane and supplies a pulse sequence which is converted in the measuring instrument and is then indicated as a velocity value. Large diameters (Ø 60 mm, Ø 100 mm) are suitable for the measurement of turbulent flows (e.g. at outlet ducts) at smaller or medium velocities. Small diameters are more suitable for measurements in ducts in which case the duct cross-section must be 100 times bigger than the probe cross-section being impacted.

The 16 mm probe has proven to be very versatile. It is large enough to have good starting qualities and is small enough to withstand velocities of up to 60 m/s.

Positioning in the air current

The vane probe is set exactly if the flow direction is parallel to the vane axis. If the measuring probe is turned slightly in the air current, the value shown in the instrument changes. The measuring probe is positioned exactly in the air current if the value shown is at max.

When measuring in a duct there should also be a minimum of ten diameters of straight run before the measuring spot and four diameters of straight run after the spot for best results. By design, vanes are less influenced by turbulence than thermal probes or Pitot tubes.



Send for more details!

You will find lots of information on air velocity measurements in the informative Testo HVAC technical manual

Measuring velocity in ducts

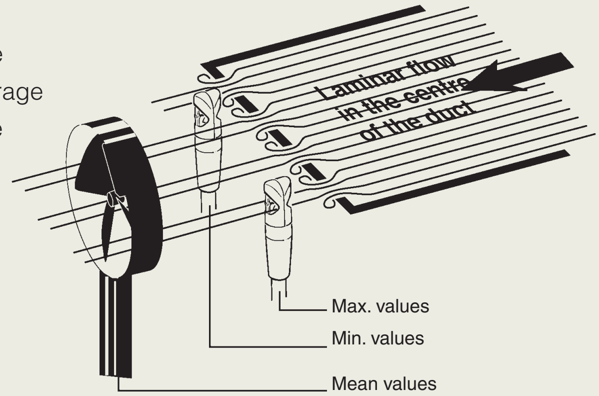
As part of approval measurements, indirect measuring procedures (grid measurements) are used to measure air flows.

The following procedures are suggested in VDI 2080/EN 12599:

- Trivial procedure for grid measurements in square cross-sections
- Centroidal axis procedures for grid measurements in circular cross-sections
- Loglinear procedure for grid measurements in circular cross sections.

Supply/Returns

The air vent greatly changes the relatively uniform flow inside the duct. Areas of higher flow velocity are created at the free vent surfaces and areas of low flow velocity and swirl at the grids. The flow profile steadies at a distance from the grid depending on the grid design but is usually 20 cm. For best accuracy, a large diameter vane is recommended. The area of the vane helps to get an average reading of the turbulent flow from the grid.



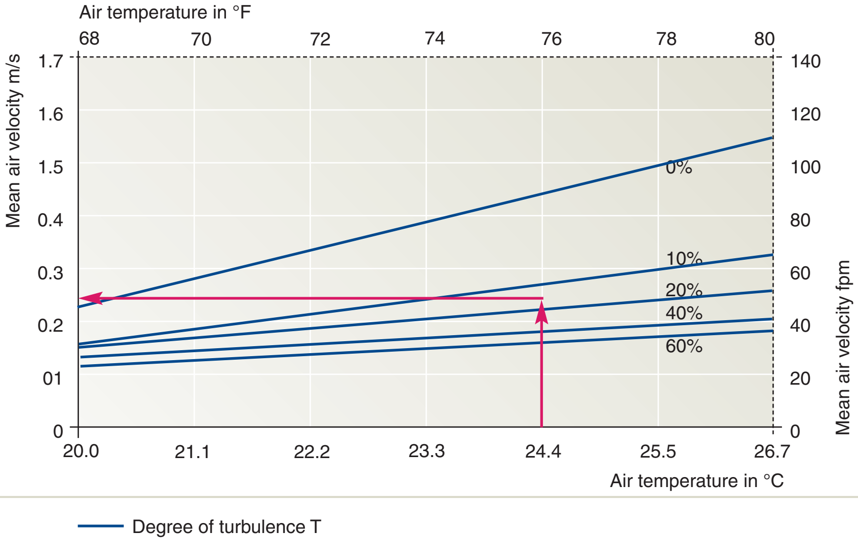
Measurements at suction apertures using a volume flow funnel

Even without the disturbing effects of a grid in an aperture, the lines of flow are not directional and the flow profile is irregular. Because a partial vacuum in the duct draws air out of the room in a funnel shape even a short distance from the aperture, there is no defined area in the room over which a measurement could be made. Therefore, only the duct or funnel measurement yields reproducible results. Measuring funnels of various sizes are available for such applications.
These create defined flow conditions at a known distance from the grid with a fixed volume.
A velocity probe is positioned centrally and secured. The volume flow is calculated from the velocity multiplied by the funnel factor (e.g. funnel factor 22).

Measuring ambient air velocity using testo 400 in accordance with DIN 1946 Part 2, ANSI/Ashrae 55-1992

Ambient air velocity is a very important parameter in the thermal comfort of people in rooms. testo 400 supplies the current and mean air velocities. The maximum permissible mean air velocity depends on the air temperature measured by testo 400 and the amount of turbulence calculated from the air velocity. The example shows a permissible mean air velocity of 0.26 m/s with an air temperature measured at 24.4 °C and an automatically calculated degree of turbulence of 10%.

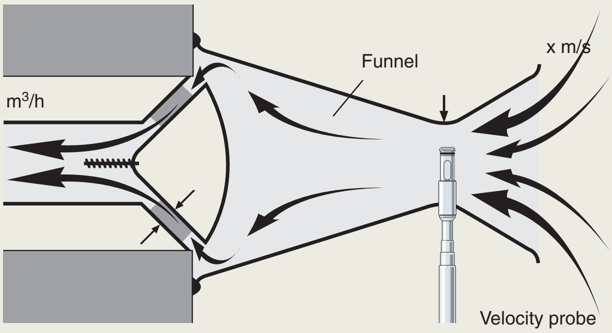
Ambient air velocity



Measuring volume flow with a funnel

$$v\left[\frac{m^3}{h}\right] = x\,[m/s] * 22$$

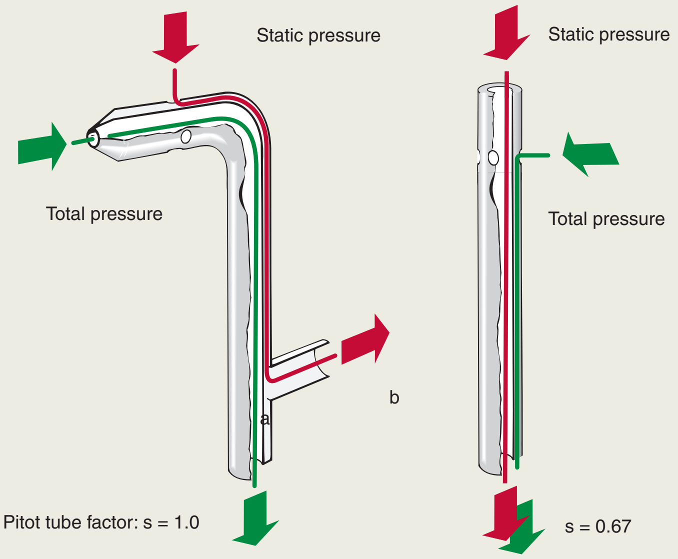
v = Volume
x = Velocity
22 = Funnel factor



Pitot tube

The Pitot tube opening takes on the complete pressure and conducts it to connection (a) in the pressure probe. The pure static pressure is taken up by a lateral slot and conducted to connection (b). The resulting differential pressure is a dynamic flow-dependent pressure which is then analysed and indicated.

As with thermal probes, the Pitot tube is more likely to react to turbulent flows than a vane probe. Therefore, a free inlet and outlet path must also be ensured during Pitot tube measurements.



$$v = s \cdot \sqrt{\frac{2 \cdot p}{\rho}}$$

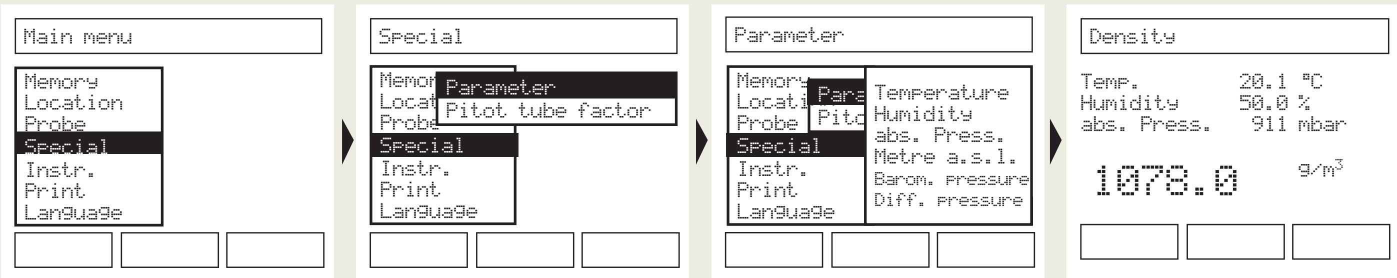
v = Velocity in m/s
s = Pitot tube factor
ρ = Air density in kg/m³
p = Differential pressure in Pascal measured in Pitot tube

Absolute pressure offset

Measuring errors occur often because a mean density of 1200 g/m³ is used in calculations. When measuring outer air flows, the actual air density can deviate by up to ± 10% from the given mean value. Therefore an inaccuracy in the air flow of up to ± 5% can result.

The testo 400 can compensate for this by activating an automatic conversion for the Pitot tube pressure to velocity. Multi-point averaging can then be carried out directly in m/s values.

It is important that the correct air humidity is input in the configuration menu or that you measure absolute pressure, temperature and humidity with the 0638 1645 absolute pressure probe and a temperature/humidity probe. testo 400 automatically calculates density on the basis of the measured values.



The correct air density can be easily input in testo 400

Density factors

Barometric pressure | Metres above sea level

Absolute pressure in the duct | Temperature | Humidity

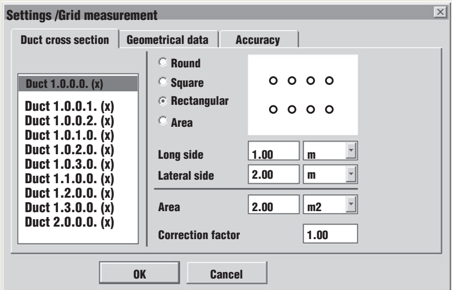
D E N S I T Y

Assessment of VAC systems on location

The "VAC module" option was developed for testo 400 to carry out quick and rational assessment of VAC systems. This new option carries out measurements on site quickly and efficiently and automatically provides printouts. Inaccurate data calculations as well as the time consuming entry of date and time are eliminated with testo 400. testo 400, with its VAC module, is currently the only measuring system worldwide with which a quick and objective assessment of the functionality of a ventilation system can be carried out. Evaluations can be carried out without any additional calculations. The measurement stipulations are based on internationally recognised standards; VDI 2080 in Germany, Euronorm (EN) 12599/Draft and Ashrae standards in the US.

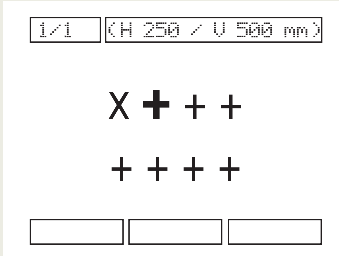
The velocity measuring instrument knows the duct dimensions

Easy preparation of measurement on location. All data related to the measurement location are entered, prior to the measurement, in your testo 400 via PC. All you have to do on site is call up the current location to access the information available in testo 400. The measurement results are saved in the location name selected by you. The volume flow is calculated using the duct data saved in the instrument.



Measurement stipulation integrated

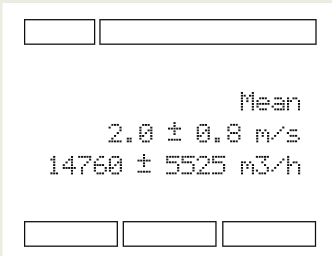
User-guided processing of measurement stipulation in accordance with standard. The measurement points are displayed in testo 400. testo 400 assigns the respective coordinates in the duct to the selected measurement point.

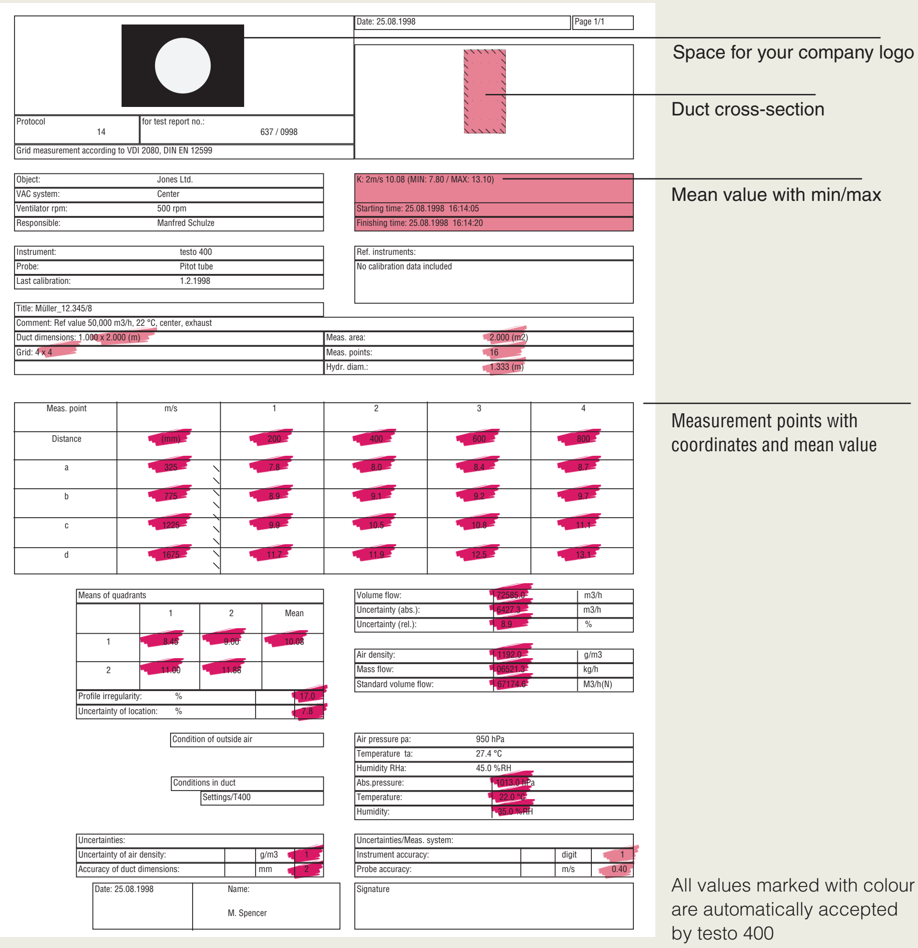


+ Meas. pts specified by measurement specification
+ Selected measurement point
x Previously measured measurement point

Assessment of overall uncertainty on location

Overall uncertainty is made up of the irregularity of the velocity profile, location inaccuracy, inaccuracy of the duct dimensions, accuracy of the velocity measurement system used and the number of measurement points.
testo 400 takes all of these influences into consideration. In this way, the overall uncertainty of the measurement can be assessed directly on location.





Printout of measurement results in standard layout

The PC software uses all of the relevant data in testo 400 and shows them in the measurement protocol for each individual location. Time-consuming entry of all the readings and other parameters are thus eliminated. Processing of the measurement protocols is made much easier and quicker.