Be sure. testo

Practical guide
Measurement tasks on residential ventilation systems

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1. Introduction: Why take measurements?

Towards the end of the 20th century, there was an increase in the construction of better insulated buildings and passive houses. However, for all the advantages that both types of houses brought with them, they also had one noticeable disadvantage: the building shell of these houses was often so airtight that the exchange of air was made considerably more difficult. As a result, both the moisture created in the building (due to exhalation, sweating, cooking, showers, etc.) and any odors (cooking, toilet) could no longer be adequately transported outside through joints (on the frames of windows and doors, on roller shutter boxes, through basement windows, etc.) as was the case in older buildings. Instead, too little fresh air from outside was getting into the interior of the building.

A balanced ventilation system solves these problems by providing defined aeration and ventilation of the building. However, for a balanced ventilation system to run efficiently and perform its tasks optimally, important standards must be observed and a wide range of measurement tasks carried out during commissioning and regular inspections. This practical guide outlines exactly what these parameters are. On the following pages, you will also learn what measuring technology you need in order to carry out the measurements required for balanced ventilation systems.

2. What are the risks of an incorrectly configured ventilation system?

Systems for balanced ventilation should be regularly checked by taking measurements during commissioning and operation. This is the only way to ensure that all planned values, such as the air exchange rate, are being adhered to, and to guarantee the associated configuration and operation of the entire system in accordance with the specifications.

Failure to check the system using suitable measurement technology, or inadequate checking of the system, carries two risks:

Risk 1:
The system's settings are too high

If the balanced ventilation system produces too much power, the resulting increased volume flow will cause both a significant increase in energy consumption and excessive air flows in the room. The former has a noticeable effect on your wallet and the latter on your well-being. Excessively loud operating noise from the fan could also become a problem in this case. A vacuum can also be created, which can have dangerous consequences in an apartment building, especially in conjunction with furnaces.

Risk 2:
The system's settings are too low

If the balanced ventilation system's settings are too low, the nominal volume flow rates will not be attained and the air exchange rate cannot be guaranteed. Apart from the air quality, this has an effect primarily on the CO_2 levels in the air as well as the relative humidity. The humidity level in particular can become a real problem, since this promotes the growth of mold.

3. What does this mean for measurement applications in practice?

When a residential ventilation system is put into operation, the focus is usually completely on the full functional test and the overall adjustment of the system. These measures ensure that the required minimum air exchange rate is achieved. These steps are also used to adjust the total volume flow rates, as well as the correct ratio of total supply and total exhaust air volume flows. It also helps to optimize the individual air volumes in the rooms.

All measurement and adjustment results must be recorded in a corresponding report. During handover to the customer, measurement and test reports must be handed over in addition to the ventilation concept, ventilation design/calculation, operating and maintenance instructions and description of the ventilation system.

Regular maintenance and, where necessary, repair of a residential ventilation system is essential to ensure long-term economical and ecological operation. If any cleaning work is carried out, care must be taken to ensure that any settings or adjustments are not altered. The need for filter replacement is usually determined by the degree of contamination, the permissible excess differential pressure or by previously agreed time intervals.

When selecting the correct measuring instruments, it is therefore important to ensure that they allow for straightforward documentation. This can be by means of simple export functions (csv) or report generation (PDF) directly in the measuring instrument.

4. What should be considered for measurement applications involving residential ventilation systems?

Determination of the total air volume flow of a ventilation control unit

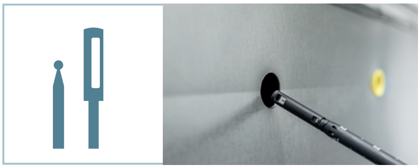
In order to ensure that the ventilation control unit provides sufficient total air volume flow in line with the planning, and to achieve the required volume flow rates in the individual rooms, the total volume flow quantity must be determined. There are two ways to do this:

- Direct determination of volume flow by carrying out a measurement in the ventilation duct
- Indirect determination of volume flow by carrying out a differential pressure measurement at the fans for the ventilation control unit

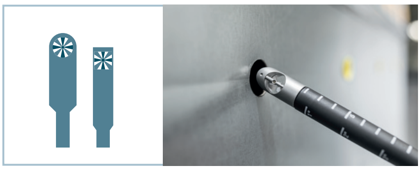
Volume flow measurement in ventilation ducts

It is important to select the appropriate probe. In the case of centralized residential ventilation systems, use a thermal probe or a vane probe, depending on the size of the building or ventilation system:

Low flow velocities up to 5 m/s:
Thermal probes

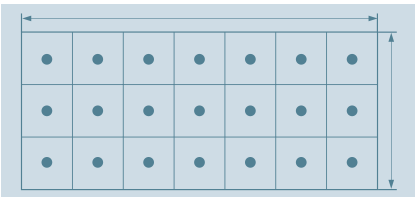


Mean flow velocities 5 m/s – 20 m/s:
Vane probes with minimal diameters



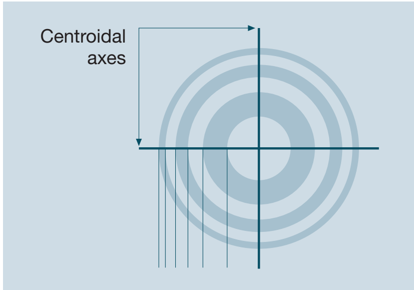
Simple method for grid measurements in rectangular cross-sections

First, the velocity field inside the rectangular duct cross-section is divided into equally sized measurement areas. The measuring point is located in the center of each. Where there is an even velocity profile, a representative result is achieved even with a small number of measuring points. However, if large differences in the flow velocity are ascertained over the cross-section, the number of measuring points is to be increased.



Centroidal axis method for grid measurements in circular cross-sections

The circular duct cross-section is divided into rings of equal area, with the measuring point located on the ring's centroidal axis. The measurement is evaluated via arithmetic averaging of the individual measuring values.



The individual velocity measuring values are used to derive the mean flow velocity, from which the volumetric air flow is then calculated.

$$\dot{V} = A \cdot \bar{v} \cdot 3600$$

$\dot{V}$ = volume flow in m^3/h
v = mean flow velocity in m/s
A = flow cross-section in m^2

Example: A cross-section A of 0.5 m^2 and a measured mean velocity of 2 m/s gives a volume flow of 3600 m^3/h.

Compatible measuring instruments

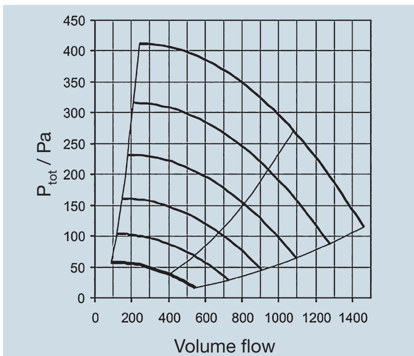
testo 440 Hot Wire Kit
(order no. 0563 4400)

testo 440 16 mm Vane Kit
(order no. 0563 4401)

Differential pressure measurement at the central unit

For this method, you need a pressure gauge and the characteristic curve data sheet for the ventilation system. The characteristic curve data sheet is usually provided by the manufacturer of the central unit.

The total volume flow at the central unit is determined preferably using the measuring equipment available at the factory. This normally consists of pressure taps. A pressure gauge is connected to these and determines the differential pressure. Based on the measured differential pressure and the power setting configured for the fan on the ventilation system, determine the total air volume flow using the characteristic curve data sheet.



To determine the volume flow of the ventilation system using the specific fan characteristic curve and the differential pressure, please proceed as follows: Move along the Y-axis until you reach the measured differential pressure value. From there, move to the right using the curved support lines until you cross the fan characteristic curve. You can read the current volume flow rate of the system at the corresponding X-value of the characteristic curve.

Example: You measure a differential pressure of 200 Pa. Between the two auxiliary lines (between ~160 and 240 Pa), you also follow the imaginary curve until you intersect the fan characteristic curve at approx. 750 m^3/h.

Compatible measuring instruments

testo 440 dP – Air Velocity & IAQ Measuring Instrument including differential pressure sensor (order no. 0560 4402)

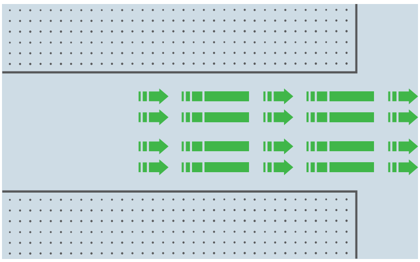
testo 510i – Differential Pressure Measuring Instrument operated via smartphone (order no. 0560 1510)

Determination of the volume flow in individual rooms

In order to optimize the ventilation technology, it is essential to accurately measure the volume flow at the individual supply and exhaust air outlets in the building. These different types of outlets bring with them different characteristics which must be taken into account:

Measurements at standard supply air outlets

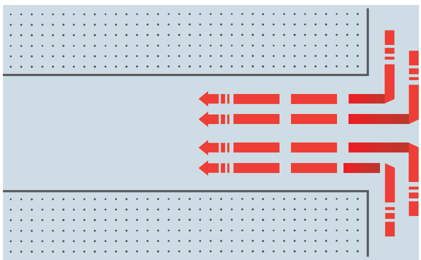
The testovent 417 measurement funnel allows you to measure at standard supply air outlets more accurately and, above all, faster. The funnel therefore enables you to measure with more speed and accuracy.



Supply air: In the case of supply air outlets, there is a directed air flow, which you can accurately record using the testo 440 and compatible vane anemometer.

Measurements at exhaust air outlets

A funnel is essential for measuring the exhaust air. The reason: there is no directed flow profile available for exhaust air as the air is sucked out of the room in a funnel-like pattern. This means there is no definable area in the room from which the volume flow can be determined. This challenge is easily solved with the aid of the testovent 417 funnel. This is because the funnel creates defined flow conditions at some distance from the plate outlet in a fixed cross-section.



Exhaust air: In the case of exhaust air outlets, the air is drawn in from all directions. To generate an air flow that can be measured accurately, a funnel must therefore be used.

Compatible measuring instruments

testo 440 100 mm Vane Kit with Bluetooth (order no. 0563 4403)

testovent 417 – Flow Straightener Kit (order no. 0554 4173)

Another, extremely simple measuring method is the use of the K-factor. K-factor is the abbreviation for calibration factor. At a pressure tapping point, this is used to determine the differential pressure in relation to the static pressure within the component - for example in a fan or in an outlet. The corresponding component has a K-factor. The manufacturer must first determine this factor in the laboratory for the corresponding component and also state it on the type plate. This value can be used to calculate the volume flow from the measured pressure difference. If you are using the testo 440 dP, you just need to select the K-factor option in the menu to start measuring the volume flow. Then you must enter the K-factor that the manufacturer has specified for the corresponding component. The measuring instrument automatically calculates the volume flow.

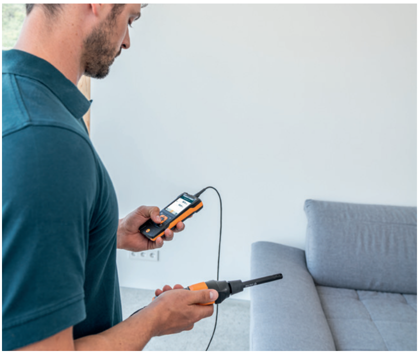
Compatible measuring instrument

testo 440 dP – Air Velocity & IAQ Measuring Instrument including differential pressure sensor
(order no. 0560 4402)

Determination of the air temperature

When commissioning and maintaining domestic ventilation systems, the temperature of the air plays an important role for air conditioning technicians. Temperature measurements are usually taken at the central unit, in the supply air ducts and in the ventilated rooms.

Temperature measurement in rooms



When measuring the indoor air temperature, only the temperature of the air is recorded. The use of radiation-protected thermometers with stainless steel tubes enables measurement influences due to heat emissions from walls, radiators, windows and furnishings to be intentionally excluded. The sensor is positioned in the middle of the room at a height of 60 cm.

Temperature measurement in ducts

When determining the air temperature in ventilation ducts, the measuring probe also has an effect on the result. Heat conduction and turbulence can significantly falsify the measurement result. For this reason, special attention must be paid to the immersion depth and position of the probe in the air flow:

- The immersion depth of the measuring probe in the ventilation duct should ideally be 10, but at least 5 probe diameters.
- The position of the measuring probe in relation to the air flow is essential for measuring accuracy. Ideally, the measurement should be carried out in an elbow and against the direction of flow, since turbulence is only created downstream of the measuring element. Measurement perpendicular to the air flow is

simpler in most cases, but results in increased measurement uncertainties. In narrow ducts, measurement at an angle to the flow is recommended in order to meet the required insertion depths.

Compatible measuring instruments

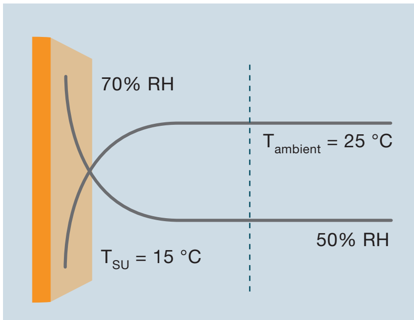
testo 440 Humidity Kit with Bluetooth® (order no. 0563 4404)

testo 605i – Thermohygrometer operated via smartphone (order no. 0560 2605 02)

Determination of the relative humidity

Determination of the relative humidity in rooms

At constant absolute humidity, the relative humidity depends on the air temperature. With surfaces whose temperature deviates considerably from the room temperature, there is a risk of stratification and increased humidity values. For this reason, you should not measure humidity near external walls, but in the middle of the room.



Due to the lower temperature on the outside wall, the sensor shows a higher relative humidity there than in the middle of the room despite constant absolute humidity.

Determination of the relative humidity in ducts

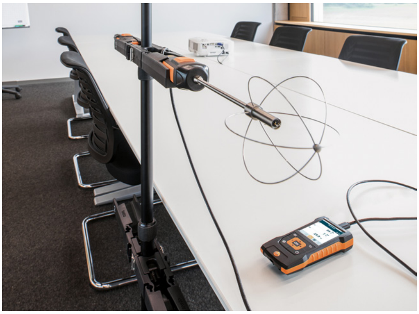
When measuring humidity in ducts, the focus is on the absolute humidity. Measurements are primarily taken upstream and downstream of moisture-related components such as air heaters or humidifiers. However, measurements are also taken at points where air flows with different absolute humidity levels, such as where circulating air and outside air mix. If no additional drying or humidification is carried out in the duct, it can be assumed that the measured absolute humidity remains constant over long distances and that no condensation forms on cold surfaces. For the sake of simplicity, it is assumed that the air directly behind an air washer is saturated with moisture. Therefore the temperature is measured at this point, which can be set approximately equal to the dew point temperature. The same applies analogously to efficient condensation traps. If the temperature is then measured in the air-conditioned room, the relative humidity can be determined on-site using tables. In practice, however, only determining the humidity with a humidity measuring instrument provides values that can be used for calculations, since measurements must also be taken on humidifiers with a humidification level of less than 100% (e.g. only 80% RH downstream of the humidifier).

Compatible measuring instruments

testo 440 Humidity Kit with Bluetooth® (order no. 0563 4404)

testo 605i – Thermohygrometer operated via smartphone
(order no. 0560 2605 02)

Measurement of the degree of turbulence



If there are indications that people perceive the air flow to be unacceptable or if noticeable effectiveness of air terminal devices is determined or can be expected, this condition can be assessed objectively by determining the degree of turbulence and the draught risk. The appropriate measuring instrument, with a turbulence probe, measures air velocity and air temperature and automatically calculates the draught risk and degree of turbulence.

Compatible measuring instrument

testo 440 Indoor Comfort ComboKit with Bluetooth® (order no. 0563 4408)

Sound measurement

It may be necessary to measure the sound pressure level in the occupied area of the dwelling in order to check objectively whether any annoying noises are being caused by operating the ventilation system or ventilation unit with nominal ventilation. Using the appropriate measuring instrument, this measurement can be carried out professionally at given points or in the form of a long-term measurement and can also be documented and further processed afterwards using PC software.

Compatible measuring instrument

testo 816-1 – Sound Level Meter (order no. 0563 8170)

Measurement of the electrical power consumption of fans

In order to determine specific effective power consumption of fans in a ventilation system, and thus ensure that it corresponds to the product characteristics for the respective operating points (nominal ventilation and optional humidity protection ventilation, reduced ventilation, or intensive ventilation), it may be necessary to measure the current and voltage at the fan. To be able to document this measurement digitally afterwards too, we recommend using a clamp meter with app function.

Compatible measuring instrument

testo 770-3 – Clamp Meter with Bluetooth® (order no. 0590 7703)

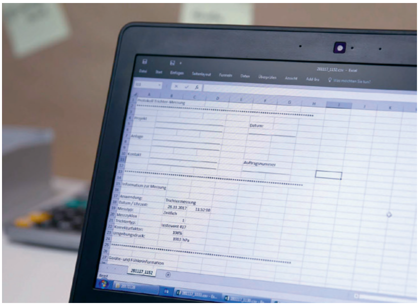
5. How are the readings documented?

Whether it's required by standards, specified by the client or simply for your own protection as a contractor: there can be many reasons for documenting measurement results. Therefore, this feature must also be taken into account when selecting suitable measuring instruments for residential ventilation systems.

Print-out on site

With the IRDA/Bluetooth printer from Testo, you can print out the measurement results of the testo 440 directly on site, wirelessly, in the form of a report to hand over to the customer or to store in your records.

Data export via USB



The testo 440 IAQ measuring instrument stores up to 7500 measurement reports, which you can then transfer to a PC as a .csv file via USB for further processing with Excel, for example.

Readings can then be transferred to a progression chart, or viewed individually for detailed assessment. Integration into your own test report is also possible without any problems.

Digital documentation via app

With the Testo Smart Probes, you can add photos to measurement data reports and export them on site as PDF, csv or JPEG (progression graph). All formats can be conveniently sent directly via e-mail.

The PDF constitutes a complete measurement report, which contains all relevant information: measurement data, measuring instruments used, customer data, your contact details and comments.

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