

ComfortSense

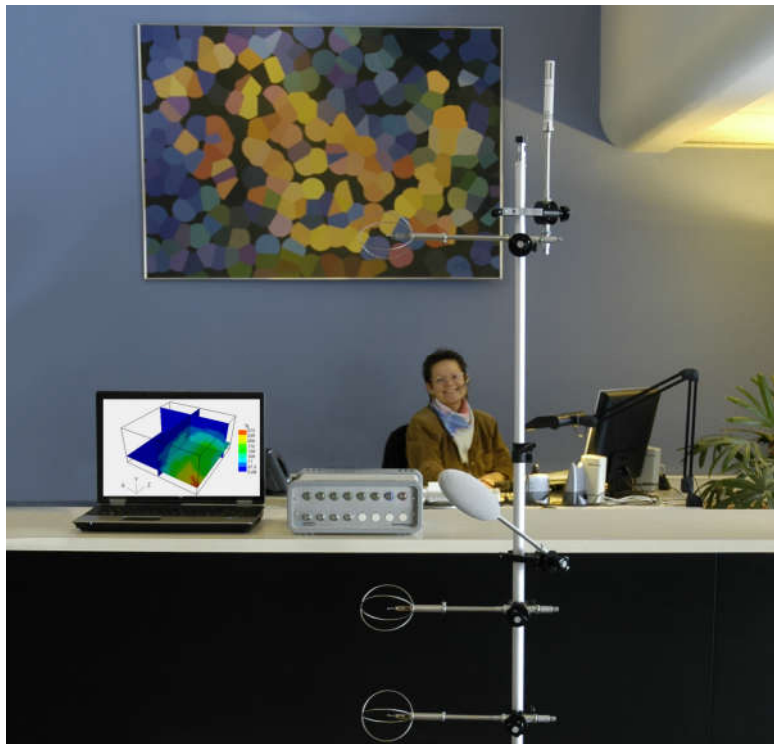
Thermal comfort measurement according to EN 13182, ISO 7726, ISO 7730, ASHRAE standard 55 and ASHRAE standard 113

Applications

- Air velocity and temperature, humidity and operative temperature measurements with up to 96 probes in indoor climate test rooms
- HVAC research and development
- Passenger comfort studies in the automotive and aviation industries
- Testing of ventilation components
- Building research
- Agricultural science and industry - livestock comfort
- Verification of CFD calculations
- Evaluation of heating and cooling system performance
- Evaluation of thermal sensation and discomfort for humans
- Personal ventilation

Features

- Traceable calibration of all probes
- Fast-response, omnidirectional probes for low air velocities
- Probe for high air velocities - temperature compensated
- Up to 96 measurement positions
- Interconnectable probe cables
- Built-in A/D converter with USB 2.0 interface
- Draught rate according to ISO 7730
- Application software with graphical presentation of results including Predicted Mean Vote (PMV) and Predicted Percentage Dissatisfied (PPD)
- Probe library and creation of measurement grid



Introduction

The ComfortSense system is designed for research and development of heating and air conditioning systems requiring multi-point measurements of air velocity and temperature. Draught measurements require omnidirectional sensors with a frequency response of at least 2 Hz, which is fulfilled by the present system.

Measurements near diffusers, grilles and supply nozzles require a higher velocity range, and directionally sensitive sensors can be used, provided that the main flow direction is known. For thermal comfort measurements, operative temperature and humidity probes are available, and in set-ups where manikins are used, special omnidirectional probes for built-in applications are available. The system includes both types of sensors.

Description

The ComfortSense system consists of a main frame with input channels for up to 16 probes. The omnidirectional probes measure both air velocity and temperature. Six frames can be connected so that up to 96 probes can be monitored simultaneously. The ComfortSense main frame has a built-in A/D converter with USB 2.0 interface.

We have made it easy to set up a measurement sequence and a measurement grid with selection of probes from a user library. The software delivers statistical results based on user-defined measurement cycles. The ruggedly designed probes and cables are perfectly suited for large test rooms.

System overview



54N90 ComfortSense main frame.

The ComfortSense frame

The compact 54N90 ComfortSense main frame can be configured with 2 to 16 input channels to suit both present and future measurement position needs. Up to 6 frames can be interconnected to cover up to 96 measurement positions. No time-consuming configuration of external A/D converters is needed - the built-in 16 bit A/D converter and USB 2.0 interface make setting up quick and easy.

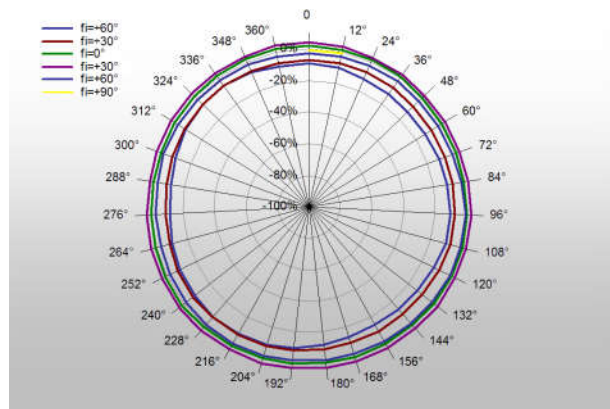


Range of probes.

The probes

Draft probes - 54T33 and 54T34

The new range of high-precision probes are made of stainless steel. Both directional characteristics, overall accuracy



Directional characteristics for 54T33 draft probe.

and frequency response have been improved to a high performance level which fully complies with international standards.

The 54T33 draught probe is equipped with an omnidirectional thin-film sensor for measuring air velocity and a small fast-response thermistor for measuring air temperature. The velocity sensor consists of two quartz spheres 3 mm in diameter, coated with a thin film of nickel and covered by a quartz layer. One of the spheres is kept at a constant over-temperature relative to the other and the energy needed for maintaining this over-temperature is measured.

A unique transfer function converts the measured heat loss into an air velocity. The delicate spherical sensor is



Manikin equipped with 54T34 draft probes.

well protected by a robust cage. Due to the slim-line design, the probe obstruction of the flow is minimal. The 54T33 draft probe is suitable for indoor climate applications such as testing of ventilation components, and can easily be mounted on a tripod or a traversing system.

The manikin version of the 54T34 draft probe is very compact, with a flexible cable connection to the probe tip, making it suitable for building into a manikin for passenger comfort applications.

High Velocity probe - 54T35

The 54T35 probe is temperature compensated and equipped with a set of robust velocity and temperature sensors. It covers velocities from 0.1 m/s to 30 m/s and temperatures from -20°C to 80°C. Suited for test of fans, blowers and other ventilation components.

Humidity probe - 54T37

The sensor used in the 54T37 Humidity probe measures the relative humidity directly. The measuring principle is based on the hygroscopic properties of a polymer enclosed between two electrodes. The thin polymer film either absorbs or releases water vapour as the relative humidity in the ambient air rises or falls. The dielectric properties of the polymer film depend on the amount of water vapour contained in it; as the relative humidity changes, the dielectric properties of the film change and so the capacitance of the sensor changes. From the measured value of the capacitance the unit calculates the relative humidity.

Operative temperature probe - 54T38

The measuring element of the 54T38 operative temperature probe has an ellipsoidal shape with a diameter of 56 mm and a length of 160 mm. The sensor element is a nickel wire coil, measuring the average surface temperature of the ellipsoid.

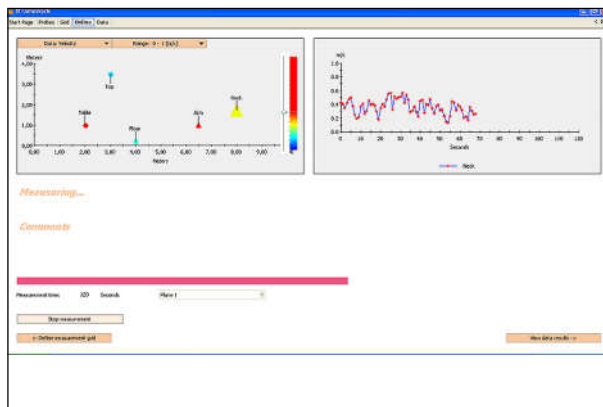
The form and size of the measuring element facilitate direct measurement of the operative temperature. Its size is chosen so the heat loss ratio between radiation and convection is similar to that of the human body.

The shape of the measuring element is chosen so that hot or cold surfaces have a similar influence on the sensor as on the human body. The sensor element simulates a standing person when it is vertical, a sitting person when tilted 30°C from vertical and a reclining person when in the horizontal position.

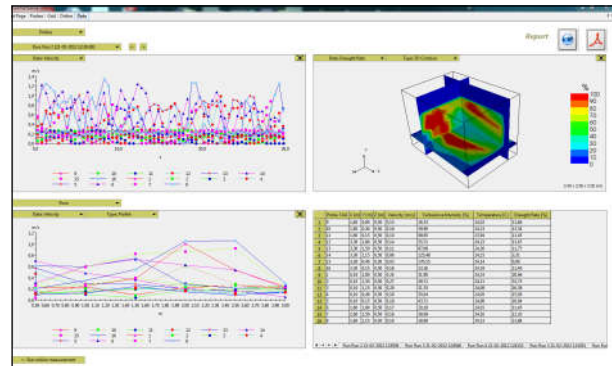
The colour and surface structure of the measuring element is chosen to simulate an average dressed person as closely as possible.

The application software

The versatile application programme incorporates a probe library from which the probes to be used in the measurement are selected. When positioning the probes in a grid pattern, the software allows the spatial position of each probe, as well as the traversing step of the grid, to be defined. In the graphical presentation of results, a warning indication is shown in the positions where the air velocity or temperature exceeds a user-defined level. The software performs linearization of air velocity and temperature inputs, calculation of statistical values and presentation of results in a table, graphical plot and as an Excel-compatible file.

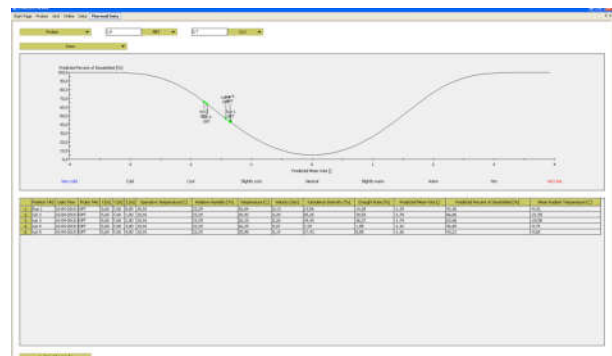


On-line display of probe data and warning indicator.



Data presentation with 3D contour plot animation.

All air velocity probes are temperature compensated and during calibration they are referenced to standard atmospheric pressure 101,325 kPa. To make a further improvement of the accuracy the velocity readings can be compensated by user input of current barometric pressure and relative humidity. A 3D contour plot gives direct and intuitive perception of the measured data, as well as to identify problematic zones. The operator can zoom, rotate and arrange all 3 planes individually and even run an animation of the 3 planes.



Presentation of PMV and PPD calculations.

Calculated statistical values include:

- Mean air velocity and temperature
- Standard deviation of air velocity
- Turbulence intensity
- Draught rate according to ISO 7730
- Predicted Mean Vote - PMV
- Predicted Percentage Dissatisfied - PPD
- Mean Radiant Temperature

The cables

A great deal of effort has gone into designing a supreme probe cable offering excellent connectivity, flexibility and robustness. The cables are available in standard lengths of 5, 10 and 20 m, and the cables can be interconnected if a measurement set-up involves longer distances.

Technical specifications



54N90 ComfortSense main frame



54T35 Robust Velocity and Temperature probe and 54T33 Draft probe



54T34 Draft probe - manikin version

54N90 ComfortSense main frame

Anemometer channels	up to 16
Output channels	2 (monitoring channel 1 & 2)
Interface	USB 2.0
Built-in A/D converter, 16 bit, 250 kS/s	

54T33 Draft probe

Velocity range	0.05-5 m/s, indicates up to 10 m/s
Accuracy	0-1 m/s: $\pm 2\%$ OR* ± 0.02 m/s 1-5 m/s: $\pm 5\%$ OR* 5-10 m/s: $\pm 10\%$ OR*
Time constant	< 0.1 s
Frequency response (90%)	2 Hz
Acceptance angle - relative to probe axis	0-1 m/s : $\pm 160^\circ$ 1-5 m/s: $+50^\circ$ to $+130^\circ$
Temp. reading range	-20°C to +80°C
Accuracy at velocities above 0.1 m/s, radiation excluded	0°C to +45°C: $\pm 0.2K$ -20°C to +60°C: $\pm 0.3K$ +60°C to 80°C: $\pm 0.5K$
Storage temperature	-30°C to +80°C

54T35 Robust Velocity and Temperature probe

Velocity range	0.1 - 30 m/s
Accuracy	0.2 - 20 m/s: $\pm 2\%$ OR* ± 0.02 m/s 20 - 30 m/s: $\pm 5\%$ OR*
Time constant - velocity	Typically 2-3 sec.
Time constant - temperature	Typically 4-5 sec.
Temperature compensation error on velocity, in the temperature range 0°C to 45°C	less than 0.2% of reading per 1°C change in air temperature
Temperature reading range	-20°C to +80°C
Accuracy at velocities above 0.5 m/s, radiation excluded	$\pm 0.5K$

54T34 Draft probe - Manikin version

Velocity range	0.05-5 m/s, indicates up to 10 m/s
Accuracy	0-1 m/s: $\pm 2\%$ OR* ± 0.02 m/s 1-5 m/s: $\pm 5\%$ OR* 5-10 m/s: $\pm 10\%$ OR*
Time constant	< 0.1 s
Frequency response (90%)	2 Hz
Acceptance angle - relative to probe axis	0-1 m/s : $\pm 160^\circ$ 1-5 m/s: $+50^\circ$ to $+130^\circ$
Temp. reading range	-20°C to +80°C
Accuracy at velocities above 0.35 m/s, radiation excluded	0°C to +45°C: $\pm 0.4K$ -20°C to +60°C: $\pm 0.4K$ +60°C to 80°C: $\pm 0.5K$
Storage temperature	-30°C to +85°C

*) Of Reading