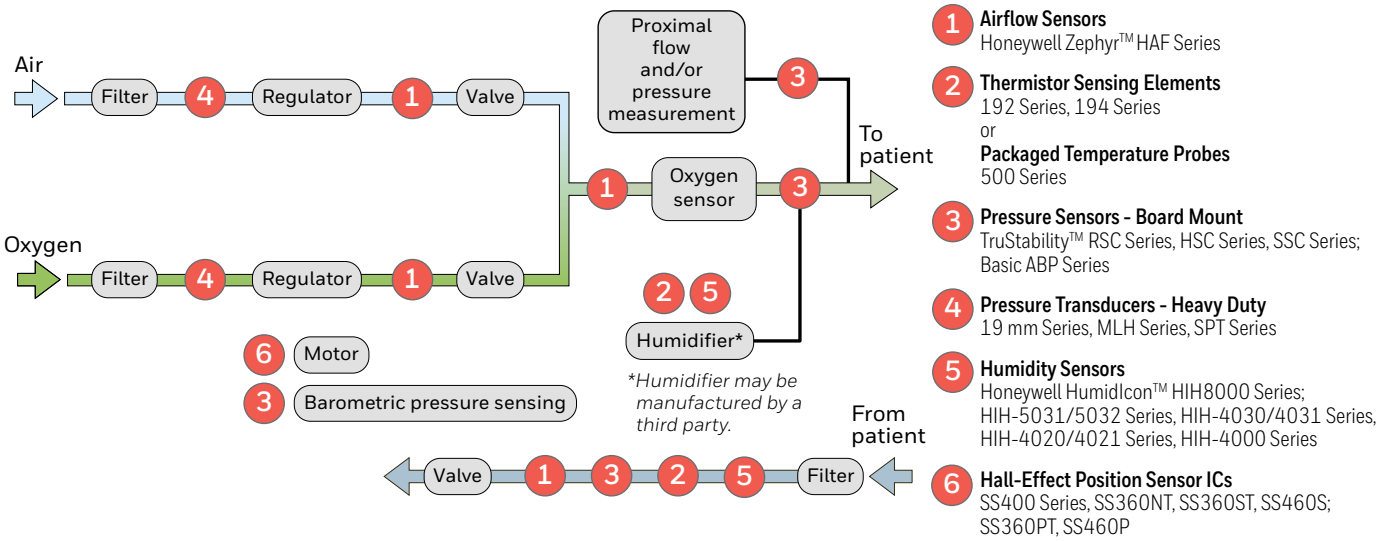
Respiratory: Ventilators

A ventilator is designed to move a mixture of air and oxygen into and out of a patient's lungs to either assist in breathing or, in some cases, do the mechanical breathing for a patient who is breathing insufficiently or is physically unable to breathe.

Sensor Solutions for Ventilators

- Airflow Sensors
- Thermistor Sensing Elements
- Packaged Temperature Probes
- Pressure Sensors and Transducers
- Humidity Sensors
- Hall-Effect Position Sensor ICs

Ventilator Block Diagram



Zephyr HAF Series - Low Flow

HAF Series - High Flow

Airflow Sensors in Ventilators

Honeywell Zephyr™ HAF Series

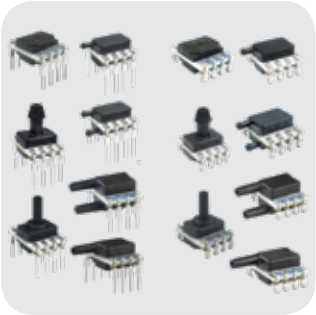
Zephyr Airflow Sensors are designed to measure the flow of air, oxygen, and nitrous oxide. They may be used so that the desired mixture, as set by the doctor, is delivered to the patient. The total mixture that is delivered to the patient is also measured and is displayed on the ventilator panel.

Benefits to Customer

- **High 2.5% accuracy:** Allows for very precise airflow measurement, often ideal for demanding applications with high accuracy requirements.
- **Customizable:** Allows the sensor to be designed to meet specific end-user needs.
- **High sensitivity at very low flows:** Allows the customer's application to detect presence or absence of airflow.
- **High stability:** Reduces errors due to thermal effects and null shift to provide accurate readings over time, often eliminating need for system calibration after printed circuit board (PCB) mount and periodically over time.
- **Low pressure drop:** Low pressure drop typically improves patient comfort in medical applications, and reduces noise and system wear in components such as motors/pumps.
- **Saves customers time and money:** Linear output provides a more intuitive sensor signal than the raw output of basic airflow sensors, often eliminating the need for customers having to linearize the output which can help to reduce production and design costs and implementation time.

192 Series and 194 Series

500 Series



TruStability RSC Series

TruStability HSC Series, SSC Series

MLH Series

Thermistor Sensing Elements in Ventilators

192 Series, 194 Series

Warm, moist air from ventilators helps to provide the patient with a comfortable breathing situation and may reduce sore throats caused by breathing cold, dry air. As such, the temperature of the air delivery system is often monitored and controlled to provide an air stream at a desired level of warmth. Thermistor sensing elements are installed directly into the air stream and are designed to monitor the air temperature. The sensor is coupled to a microcontroller designed to measure air stream temperature and interact with the controller which controls and regulates the temperature of the air stream. The packaged sensors are available as discrete components for customer-built assemblies, or Honeywell can provide a full assembly solution that the customer may simply pigtail into the system.

Benefits to Customer

- **Cost-effective:** Resistance temperature curve interchangeability designed to offer standardization of circuit components and simplification of design/replacement enhances cost-effectiveness.
- **Flexible:** Bare leads (192 Series) or insulated leads (194 Series) are designed to provide application flexibility.
- **Small:** Small size often eases use in confined spaces.

Packaged Temperature Probes

500 Series

Packaged temperature probes perform the same function in this application as thermistor sensing elements (monitor air temperature).

Benefits to Customer:

- **Flexible:** Wide selection of housing, resistance, and termination options.
- **Customizable:** Variety of custom or off-the-shelf products available.

Pressure Sensors/Transducers in Ventilators

Board Mount Pressure Sensors: TruStability™ RSC, HSC Series, SSC Series, Heavy Duty Pressure Transducers: MLH Series, 19 mm Series, SPT Series

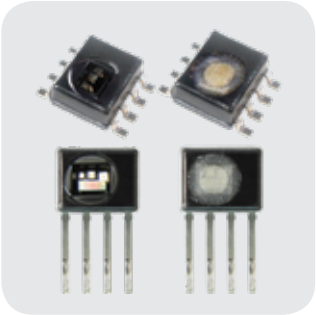
Honeywell's TruStability Series board mount pressure sensors are designed to measure air and oxygen pressure to ensure it does not exceed a desired level. The MLH Series, 19 mm Series, and SPT Series heavy duty pressure transducers are designed to provide a sensing solution when high pressure, steel pressure port interface, and/or corrosive media are used. A male threaded pressure port and stainless steel wetted surfaces provide an air and oxygen inlet.

Benefits to Customer

- **Accurate:** Enhances patient safety by measuring volume and mixture of gases to deliver the mixture at a desired pressure and flow:
  - TruStability sensors' exceptional accuracy is a result of leading-edge technology, precise manufacturing processes, and temperature compensation and calibration. The RSC Series provides high 24-bit resolution and the Total Error Band after auto zero is as low as ±0.25 %FSS. The Total Error Band of the HSC Series and SSC Series depends on the pressure range, with the HSC Series as low as ±1 %FSS and the SSC Series as low as ±2 %FSS.
  - MLH Series' accuracy depends upon the pressure range: above 300 psi 0.25 %FSS; below 300 psi 0.5 %FSS; 19 mm Series offers 0.25 %FSS; SPT Series offers 0.25 %FSS.

19 mm Series

SPT Series



HumidIcon HIH8000 Series

HIH-4030, HIH-4031 Series,
HIH-5030, HIH-5031 Series

HIH-4020/4021 Series

- **Compatible:** Wetted materials or media isolated packaging (materials resistant to certain contaminants or media) offer compatibility with many harsh environments and resistance to certain contaminants.
- **Easy to design in:** Customization of pressure ranges, connections, calibration, and temperature compensation minimize customer's design-in effort.
- **Easy to use:** Small package with integrated signal conditioning reduces the number of components needed to implement the sensor, enabling size reduction of the end product.
- **Safe:** Enhanced accuracy, sensitivity, and stability with minimal drift over time and temperature enhances patient safety and therapy effectiveness by sensing when patients are breathing on their own and are ready to wean off the device.
- **Stable:** Stability is a measure of how little the output signal of the pressure sensor will change from measurement to measurement. The long-term stability of Honeywell's TruStability sensors is the best in the industry.

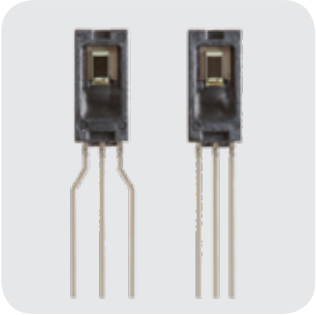
Humidity Sensors in Ventilators

Honeywell HumidIcon™ HIH8000 Series, HIH-4030/4031 Series, HIH-5030/5031 Series, HIH-4020/4021 Series, HIH-4000 Series

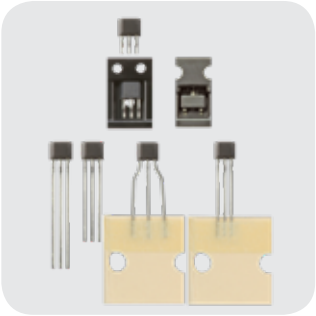
Honeywell's humidity sensors help deliver warm and moist air, which often enhances patient comfort. When introducing moisture into the air stream of a ventilator, it must be monitored and controlled. Honeywell's humidity sensors are installed either directly into the air stream or in a parallel branch. The sensor is coupled to a microcontroller designed to measure the humidity of the air stream and to signal the controller that the desired level of moisture is present.

Benefits to Customer

- **Industry-leading long term stability (1.2 RH% over 5 years):** Minimizes system performance issues, helps support system uptime, and eliminates the need to recalibrate the sensor in the application (HumidIcon).
- **Industry-leading Total Error Band (TEB) (±5 %RH):** Provides the sensor's true accuracy reducing manufacturing time, supports system warranty requirements, helps optimize system uptime, and provides excellent sensor interchangeability (HumidIcon).
- **Lowest total cost solution:** Offers customers the lowest total cost solution due to the sensor's industry-leading Total Error Band and being a combined humidity/temperature sensor (HumidIcon).
- **Accurate:** Enhanced stability, accuracy, and response time over the entire humidity range of 0 %RH to 100 %RH supports demanding system performance requirements, even in many condensing environments.
- **Cost-effective:** Surface mount device (SMD) packaging on tape and reel allows for use in automated, high-volume, lower-cost pick-and-place manufacturing.
- **Durable:** Multi-layer construction and a hydrophobic filter provides enhanced resistance to condensation and contaminants.
- **Flexible:** Small, space-saving housing profile allows for application flexibility; utilizing a low current draw allows for use in low-current-drain, battery-operated systems.



HIH-4000 Series



SS400 Series; SS360NT, SS360ST, SS460S; SS360PT, SS460P

Hall-Effect Position Sensor ICs in Ventilators

SS400 Series; SS360NT, SS360ST, SS460S; SS360PT, SS460P

These Hall-effect position sensor ICs are designed to provide enhanced output accuracy for smooth motor control that reduces noise and vibration in many potential applications, including ventilator motor assembly fan systems. Their small size often allows for design into many compact, automated, lower-cost assemblies. A thermally-balanced integrated circuit that is accurate over a full temperature range is designed to provide proper fan functionality.

Benefits to Customer

- **Accurate:** Enhanced accuracy and linearity over a 0 V to 5 V output span enables an extended sensing range.
- **Circuit protection:** Reverse voltage/polarity protection provides circuit protection.
- **Cost-effective:** Small sensor size allows for compact designs and automated, lower-cost assemblies.
- **Effective:** Thermally-balanced integrated circuit enhances proper fan function.
- **Energy-efficient:** Low power consumption enhances energy efficiency.
- **Quiet:** Industry-leading sensor output accuracy for smooth motor control enables low audible noise and reduces motor vibration.