

## MEDICAL AND INDUSTRIAL APPLICATIONS

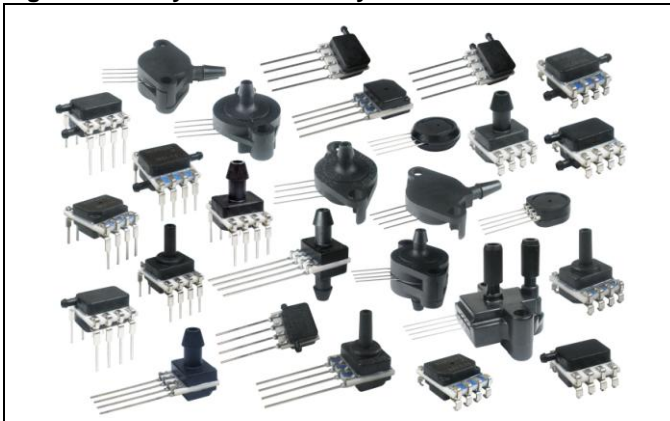
## Application Note

# Honeywell TruStability® Board Mount Pressure Sensors: HSC Series and SSC Series, Amplified Compensated Digital or Analog Output, $\pm 2.5$ mbar to $\pm 40$ mbar [ $\pm 1$ inH<sub>2</sub>O to $\pm 30$ inH<sub>2</sub>O]

### INTRODUCTION

The TruStability® High Accuracy Silicon Ceramic (HSC) Series and Standard Accuracy Silicon Ceramic (SSC) Series Board Mount Pressure Sensors are piezoresistive silicon pressure sensors offering an amplified compensated digital or analog output for reading pressure over the full scale pressure span in the ultra-low pressure range of  $\pm 2.5$  mbar to  $\pm 40$  mbar [ $\pm 1$  inH<sub>2</sub>O to  $\pm 30$  inH<sub>2</sub>O]. (See Figure 1.)

Figure 1. Honeywell TruStability® Pressure Sensors



### FEATURES AND BENEFITS (★=competitive differentiator)

- ★ **Proprietary Honeywell technology:** Combines high sensitivity with high overpressure and burst pressure—two performance factors that are difficult to achieve in the same product; this gives the customer more flexibility in sensor implementation and reduces the customer design requirements for protecting the sensor without sacrificing the ability to sense very small changes in pressure
- ★ **Industry-leading long-term stability:** Even after long-term use and thermal extremes, these sensors perform substantially better relative to stability than any other pressure sensor available in the industry today:
  - Minimizes system calibration needs
  - Maximizes system performance
  - Helps support system uptime by eliminating the need to service or replace the sensor during its application life
- ★ **Industry-leading Total Error Band (TEB):** Honeywell specifies TEB—the most comprehensive, clear, and meaningful measurement—that provides the sensor’s true accuracy over the compensated temperature range:
  - Eliminates individually testing and calibrating every sensor, which can increase their manufacturing time and process
  - Supports system accuracy and warranty requirements
  - Helps to optimize system uptime
  - Provides excellent sensor interchangeability—there is minimal part-to-part variation in accuracy
- ★ **Industry-leading accuracy:** Extremely tight accuracy of  $\pm 0.25$  %FSS BFSL (Full Scale Span Best Fit Straight Line):
  - Reduces software needs to correct system inaccuracies, minimizing system design time
  - Supports system accuracy and warranty requirements
  - Helps to optimize system uptime
- ★ **High burst pressures above 415 inH<sub>2</sub>O (1034 mbar):**
  - Allows the sensor to endure a wide range of conditions while maintaining a high level of sensitivity which measures even the smallest change in pressure
  - Can simplify the design process
- ★ **High working pressure ranges above 135 inH<sub>2</sub>O (336 mbar):** Allows ultra-low pressure sensors to be used continuously well above the calibrated pressure range
- ★ **Industry-leading flexibility:**
  - Modular, flexible design with many package styles (with the same industry-leading stability), pressure ports, and options simplify integration into the device manufacturer’s application
  - Available soon: single side liquid media option allows the end customer to use one port of the sensor with condensing humidity or directly with non-corrosive liquid media
- ★ **Repeatability:** Provides excellent repeatability, high accuracy and reliability under many demanding conditions

# Honeywell TruStability® Pressure Sensor: HSC Series and SSC Series, Amplified Compensated Digital or Analog Output, $\pm 2.5$ mbar to $\pm 40$ mbar [ $\pm 1$ inH<sub>2</sub>O to $\pm 30$ inH<sub>2</sub>O]

- ★ **Onboard signal conditioning:** Typically allows for the removal of signal conditioning components from the PCB, reducing costs and simplifying production processes
- ★ **Wide variety of pressure ranges:** From  $\pm 2.5$  mbar to  $\pm 40$  mbar [ $\pm 1$  inH<sub>2</sub>O to  $\pm 30$  inH<sub>2</sub>O] provide support for many unique applications
- ★ **Meets IPC/JEDEC J-STD-020D.1 Moisture Sensitivity Level 1 requirements:**
  - Allows the customer to avoid the thermal and mechanical damage during solder reflow attachment and/or repair that lesser rated products would incur
  - Allows unlimited floor life when stored as specified ( $\leq 30$  °C/85 %RH), simplifying storage and reducing scrap
- ★ **Insensitive to mounting orientation:**
  - Allows customers to position the sensor in the most optimal point in the system, eliminating the concern for positional effects
  - Increases flexibility of use within the application
- ★ **Insensitive to vibration:** Reduces susceptibility to application-specific vibration that occurs with changes in pressure, minimizing inaccurate pressure readings
- ★ **Custom calibration:** Typically allows for the removal of additional components associated with signal conditioning from the PCB, reducing PCB size as well as costs often associated with those components (e.g., acquisition, inventory, assembly)
- ★ **Internal diagnostic functions:** Increases system reliability
- **Energy efficient:** Extremely low power consumption (operating supply voltage as low as 3.27 Vdc):
  - Reduces power consumption
  - Provides extended battery life
  - Promotes energy efficiency
- **Output:** I<sup>2</sup>C- or SPI-compatible 14-bit digital output (min. 12-bit sensor resolution) accelerates performance through reduced conversion requirements and the convenience of direct interface to microprocessors or microcontrollers; analog output also available
- **Small size:** Miniature 10 mm x 10 mm [0.39 in x 0.39 in] package is very small when compared to most board mount pressure sensors:
  - Occupies less area on the PCB
  - Typically allows for easy placement on crowded PCBs or in small devices
- **RoHS compliant**
- **Protected by multiple global patents**

## POTENTIAL APPLICATIONS

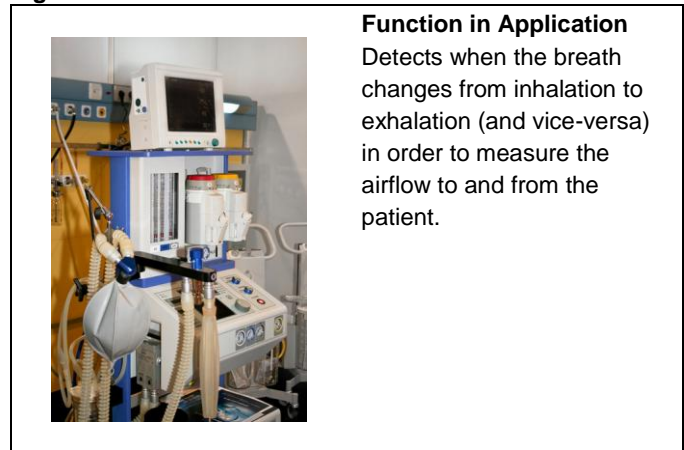
Figures 2 through 11 show a variety of potential applications in which these products may be used.

## MEDICAL

### 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. (See Figure 2.)

**Figure 2. Ventilator**



### Customer Benefits

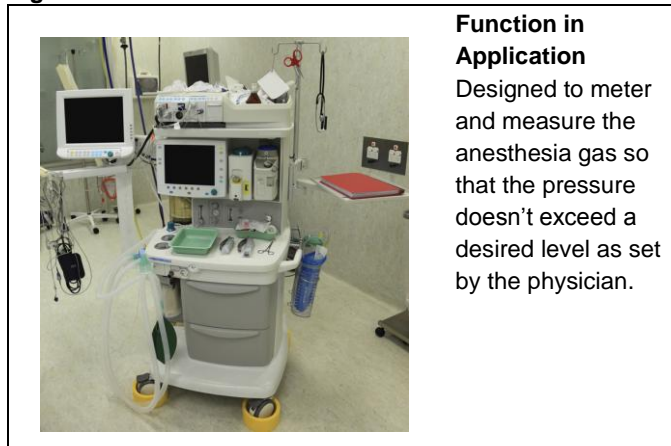
- **Industry-leading stability:** Stability is a measure of how little the output signal of the pressure sensor will change from measurement to measurement
- **Sensitive:** High sensitivity and accuracy with a tight Total Error Band enables measurement of very low airflow rates
- **Easy to design in:**
  - Small package with integrated signal conditioning reduces the number of components needed to implement the sensor, enabling size reduction of the end product
  - Easy to implement into a pneumatic system that can experience a wide variety of pressure ranges because the durability of the sensor addresses the concern that the sensor can become damaged due to sudden increases in pressure (e.g., the patient coughs)
  - Modular flexible design, customization of pressure ranges, connections, calibration and temperature compensation simplifies integration with systems that are getting smaller and smaller
- **Safety:** Enhanced accuracy and sensitivity with minimal drift over time and temperature enhances patient safety and therapy effectiveness by sensing when patient is breathing on own to wean off the device

# Honeywell TruStability® Pressure Sensor: HSC Series and SSC Series, Amplified Compensated Digital or Analog Output, $\pm 2.5$ mbar to $\pm 40$ mbar [ $\pm 1$ inH<sub>2</sub>O to $\pm 30$ inH<sub>2</sub>O]

## Anesthesia Machines

An anesthesia machine is designed to deliver drugs to patients to help eliminate pain and other unwanted sensations. The continuous flow anesthesia machine provides an accurate and constant supply of medical gases (such as air, oxygen and nitrous oxide), mixed with an accurate concentration of anesthetic vapor (such as isoflurane), and delivers this mixture to the patient at a desired pressure and flow. (See Figure 3.)

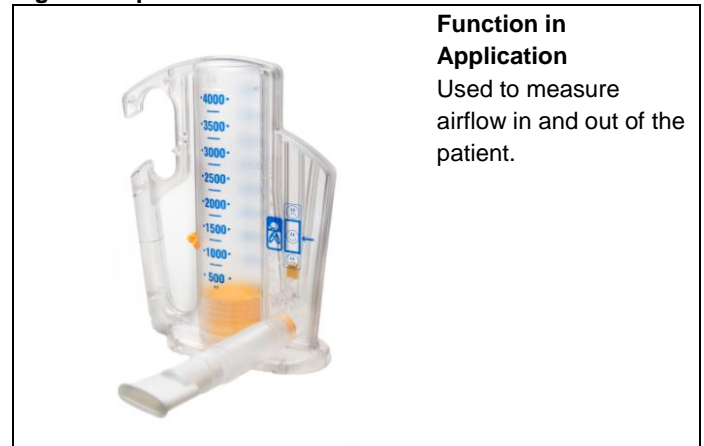
**Figure 3. Anesthesia Machine**



## Spirometers

A spirometer is inserted into the mouth of the patient to measure the amount of air and the rate of air that is breathed in and out over a specified period of time. It is useful as a preliminary test to determine the condition of the lungs in asthma, bronchitis, and emphysema patients, to determine the cause for shortness of breath, and to assess the effects of medication. (See Figure 4.)

**Figure 4. Spirometer**



## **Customer Benefits**

- **Industry-leading stability:** Stability is a measure of how little the output signal of the pressure sensor will change from measurement to measurement
- **Sensitive:** Effectively senses the smallest amount of anesthesia gas to determine how much is being delivered to the patient
- **Industry-leading accuracy:** Enhances patient safety by accurately measuring the volume and mixture of gases to deliver the correct mixture at a desired pressure and flow
- **Durable:** Anesthesia applications require that the pressure sensor survive the high humidity, stickiness and by-products inherent in anesthesia gas in order to precisely measure the airflow of the exhalation
- **Safety:** Industry-leading 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 to wean off the device
- **Easy to design in:**
  - Small package with integrated signal conditioning reduces the number of components needed to implement the sensor, enabling size reduction of the end product
  - Modular flexible design, customization of pressure ranges, connections, calibration and temperature compensation simplifies integration with systems

## **Customer Benefits**

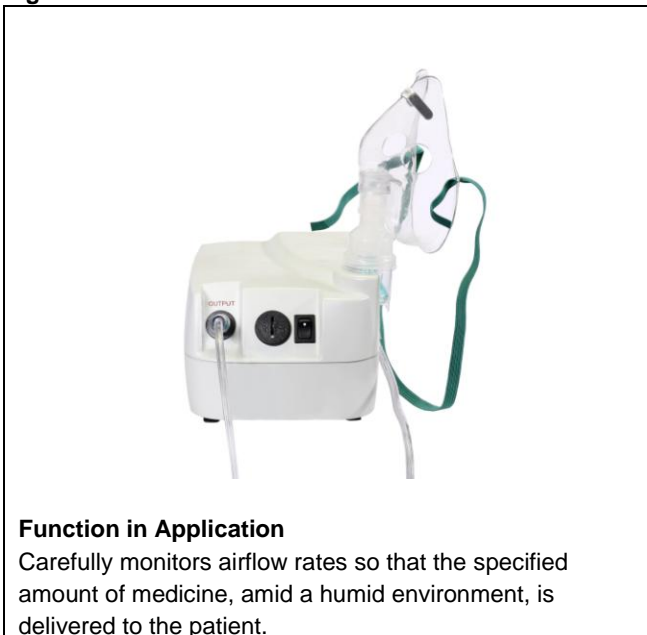
- **Durable:** A spirometer subjects the pressure sensor to “dirty” air that contains allergens such as pollen, mold, and dander from pets, as well as irritants such as dust, amid a damp and humid environment; the pressure sensor must be able to withstand these tough conditions
- **Industry-leading stability:** Stability is a measure of how little the output signal of the pressure sensor will change from measurement to measurement
- **Sensitive and accurate:** Able to withstand dirty environments while maintaining high sensitivity with tight Total Error Band to obtain accurate readings to low airflow rates
- **Easy to design in:**
  - Small package with integrated signal conditioning reduces the number of components needed to implement the sensor, enabling size reduction of the end product
  - Modular flexible design, customization of pressure ranges, connections, calibration and temperature compensation simplifies integration with systems that are getting smaller and smaller

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## Nebulizers

A nebulizer is a mouthpiece device used to administer medication in the form of a mist inhaled into the lungs to help open the bronchial tubes. It is often used to treat respiratory diseases such as asthma, cystic fibrosis, chronic bronchitis, and emphysema. Additionally, premature infants, infants with asthma and cystic fibrosis, or those with pneumonia, bronchitis or bronchiolitis may need nebulizer treatments. Because infants cannot hold a mouthpiece, a nebulizer with a mask is often used. (See Figure 5.)

**Figure 5. Nebulizer**



## **Customer Benefits**

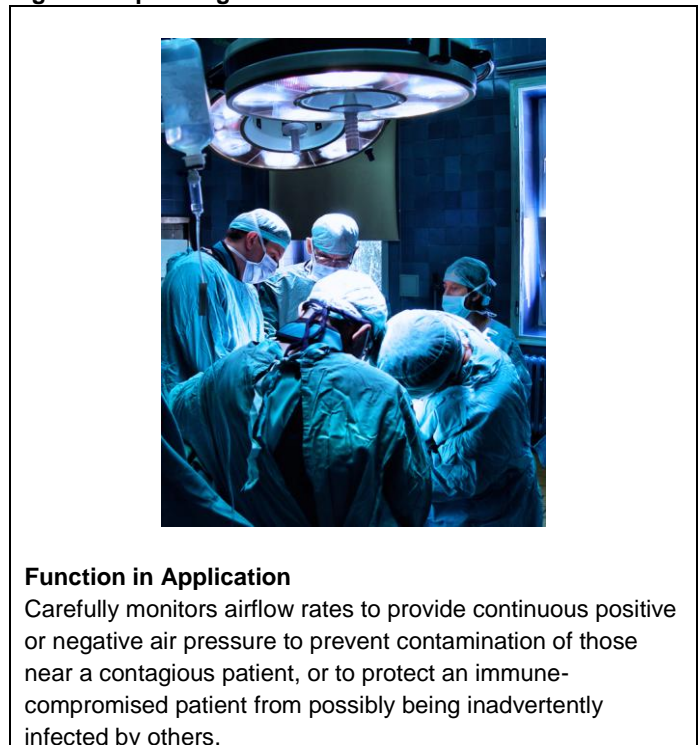
- **Durable:** Resilient to humidity and dirty air while still providing high sensitivity and accuracy to measure very low airflow rates
- **Industry-leading stability:** Stability is a measure of how little the output signal of the pressure sensor will change from measurement to measurement
- **Easy to design in:**
  - Small package with integrated signal conditioning reduces the number of components needed to implement the sensor, enabling size reduction of the end product
  - Modular flexible design, customization of pressure ranges, connections, calibration and temperature compensation simplifies integration with systems that are getting smaller and smaller

## Hospital Room Air Pressure

Hospital room air pressure standards are mandated by the Centers for Disease Control (CDC), the American Institute of Architects (AIA), and the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE).

- **Negative air pressure:** Patients with airborne diseases (when respiratory droplets from one person can easily contaminate the next person, such as pulmonary tuberculosis, H1N1 flu, and measles) should be placed in rooms where air pressure is lower than the hallway's air pressure
- **Positive air pressure:** Immune-compromised patients (individuals who struggle to fight infections because their immunity system is not properly functioning due to HIV, AIDS, pregnancy or chemotherapy) should be placed in rooms where the air pressure is higher than the hallway's air pressure
- **Operating rooms:** The CDC, AIA and ASHRAE also stipulate that operating rooms maintain positive air pressure so that airborne contaminants do not infiltrate the surgical area (See Figure 6.)

**Figure 6. Operating Room**



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## Customer Benefits

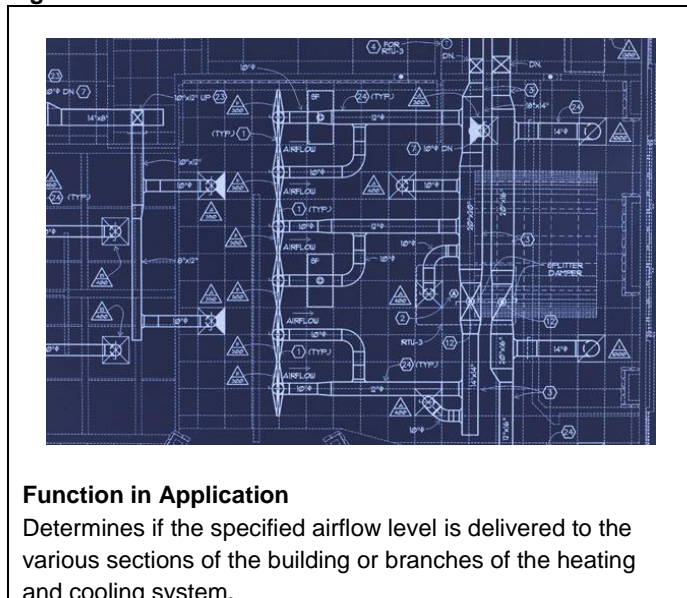
- **Industry-leading stability:** Stability is a measure of how little the output signal of the pressure sensor will change from measurement to measurement
- **Sensitive and accurate:** Able to withstand dirty environments while maintaining high sensitivity with tight Total Error Band to obtain accurate readings at low airflow rates
- **Safety:** High accuracy and sensitivity with minimal drift over time and temperature enhances the safety of those near a patient who can easily contaminate others, as well as protects an immune-compromised patient from contamination by others
- **Easy to design in:**
  - Small package with integrated signal conditioning reduces the number of components needed to implement the sensor, enabling size reduction of the end product
  - Modular flexible design, customization of pressure ranges, connections, calibration and temperature compensation simplifies integration with systems that are getting smaller and smaller

## INDUSTRIAL

### VAV (Variable Air Volume) Control

VAV is a type of heating, ventilating, and/or air conditioning (HVAC) system. VAV systems control the volume of air to different areas of the heating and cooling system, varying the airflow so that the proper airflow and temperature levels are maintained. (See Figure 7.)

**Figure 7. Airflow Schematic**



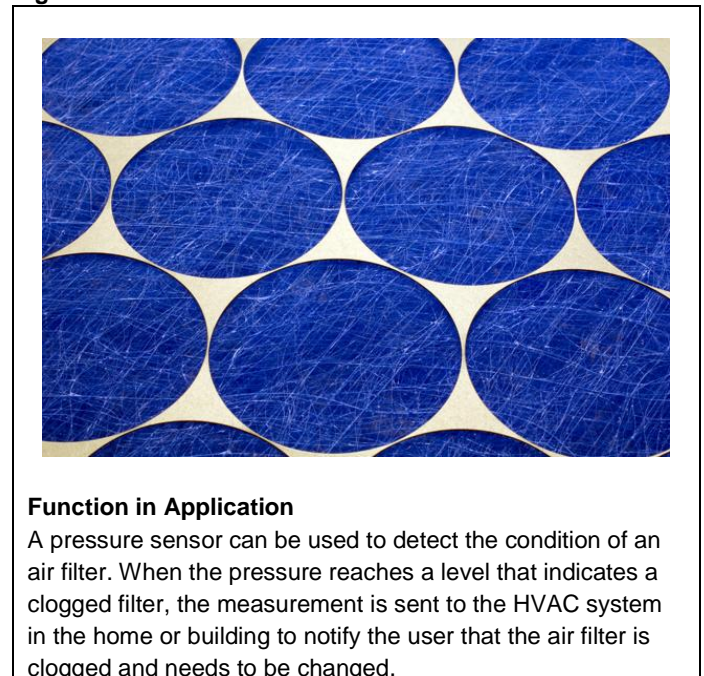
## Customer Benefits

- **High sensitivity:** Detects extremely low airflow rates in highly dynamic ranges of airflows while maintaining ability to withstand contaminants that may be in the airflow stream

### Clogged HVAC Air Filter Detection

A clogged or dirty air filter in an HVAC system will slow airflow rates and make the HVAC system work harder to maintain the temperature setpoint of the area, wasting energy. Additionally, a clogged or dirty air filter can lead to increased HVAC system maintenance costs and/or early failure of the system. In a clear air filter, the air moves easily through the filter; therefore, the pressure on both sides of the filter is the same. When an air filter becomes clogged, pressure on the clogged side increases; pressure on the unclogged side is low. (See Figure 8.)

**Figure 8. Air Filter**



## Customer Benefits

- **Economical:** Ensures that the user changes the filter only when it is required, reducing replacement costs
- **Energy-efficient:** Because the system is notified when the filter is clogged, the user can change the filter immediately to maximize energy savings

# Honeywell TruStability® Pressure Sensor: HSC Series and SSC Series, Amplified Compensated Digital or Analog Output, ±2.5 mbar to ±40 mbar [±1 inH<sub>2</sub>O to ±30 inH<sub>2</sub>O]

## Static Duct Pressure

To achieve the proper amounts of heated/ cooled air into each branch of the HVAC system at the same time, the static pressure in all of the ducts must be equalized. This can be challenging due to different duct sizes and the various bends and turns in each section of the ductwork. To achieve equilibrium and optimal efficiency in an HVAC system, especially in dynamic heating and cooling systems, precise static pressure must be measured in the different duct branches. (See Figure 9.)

**Figure 9. Air Conditioning Ducts in a Large Building**



### **Function in Application**

Precise pressure level measurement in a section of the duct work at a specific point in time. This measurement is fed back to the HVAC control system which will adjust to maintain equilibrium throughout the duct system.

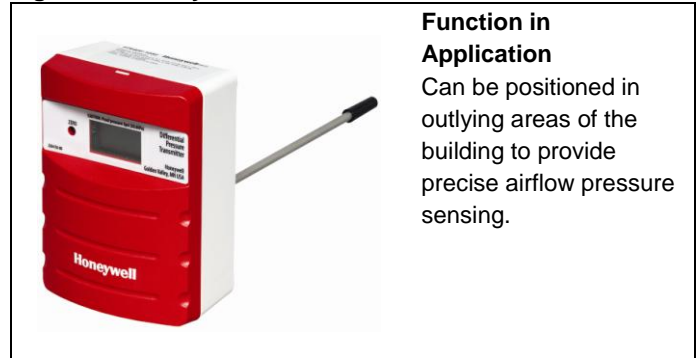
### **Customer Benefits**

- **Efficiency:** Static duct pressure is an indication of the HVAC system's operating condition
- **Cost-effective:** Increased efficiency helps reduce operating costs

## HVAC Transmitters

Many buildings do not have HVAC system controls in all sections of the building. Instead, transmitters are used in a particular branch of the system so the HVAC master controller can adjust its airflow delivery to those different branches based on information the transmitters send to the HVAC master controller. (See Figure 10.)

**Figure 10. Honeywell Transmitter**



### **Customer Benefits:**

- **Cost-effective:** Reduces system costs by eliminating the need for multiple HVAC system controllers.

## Indoor Air Quality

In chemical labs, it is critical that chemical fumes are expelled from the area to ensure personnel safety. (See Figure 11.)

**Figure 11. Chemist at Work under a Lab Hood**



### **Function in Application**

Measures airflow so that an alarm alerts the HVAC system to inform the user that dangerous chemical fumes could be building up.

### **Customer benefits:**

- **Safety:** Enhances worker safety

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## WARRANTY/REMEDY

Honeywell warrants goods of its manufacture as being free of defective materials and faulty workmanship. Honeywell's standard product warranty applies unless agreed to otherwise by Honeywell in writing; please refer to your order acknowledgement or consult your local sales office for specific warranty details. If warranted goods are returned to Honeywell during the period of coverage, Honeywell will repair or replace, at its option, without charge those items it finds defective. **The foregoing is buyer's sole remedy and is in lieu of all other warranties, expressed or implied, including those of merchantability and fitness for a particular purpose. In no event shall Honeywell be liable for consequential, special, or indirect damages.**

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Specifications may change without notice. The information we supply is believed to be accurate and reliable as of this printing. However, we assume no responsibility for its use.

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