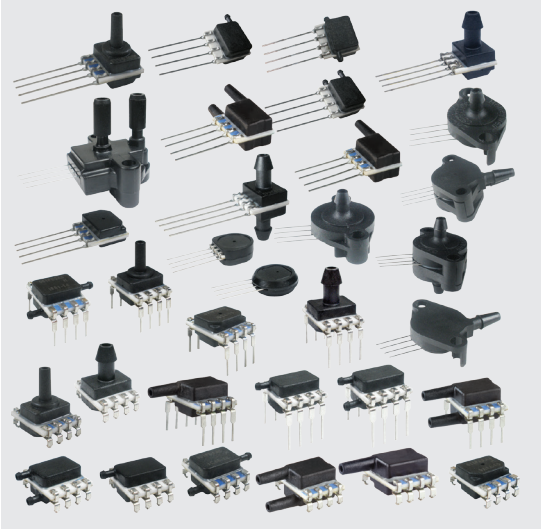
Honeywell | Medical

MEASURING PRESSURE IN MEDICAL CHEMISTRY ANALYZERS

A Honeywell White Paper

Abstract



One of the challenges designers face when selecting pressure sensors for medical equipment applications is sensor performance in condensing humidity. Tradeoffs in functionality, packaging, and cost can complicate the selection process. In addition, there are few sensing options for medical devices that require liquid compatibility outside of large, heavy media-isolated pressure transducers. These sensing devices were once the only choice for designers before the introduction of liquid-compatible, board-mounted sensors.

When used with applications with low or medium pressure requirements, including gas or liquid chromatography, chemistry analyzers, ventilators, and blood analysis and diagnostic equipment, pressure sensors must interface directly with liquid media or deal with humid environments while providing accurate pressure measurements for a variety of media including expired air, reagents, samples, and cleaning fluids. In applications with a pressure range of less than 150 psi, and with size constraints, a board-mounted pressure sensor is often the preferred solution, offering the right balance of functionality, package size, reliability, and cost.

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Measuring Pressure in Medical Chemistry Analyzers

Liquid Media Compatibility

For the most accurate pressure reading, sensors should be positioned in close proximity to the media being measured. However, not all pressure sensors are liquid compatible, creating a key challenge for medical device designers. In many cases, they need to design in additional components such as a bypass or a filter to address humidity issues, or rethink the positioning of components, particularly the tubing, in the system to keep any fluids from contacting the sensor. This can result in additional design time and cost.

Liquid and Humidity Protection

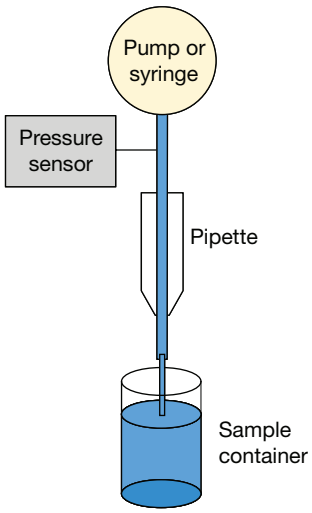
Many sensor manufacturers have developed board-mounted products that protect against liquid media and high humidity environments for medical device applications that require low to medium pressure measurements. These sensors also help simplify designs by eliminating the need for additional protection features or product redesigns so the fluids will not contact the sensor.

Pressure Sensors in Chemistry Analyzers

In addition to providing accuracy and repeatability at low pressures in chemistry analyzer applications, pressure sensors need to withstand higher pressures during flushing and cleaning. As an example, a board-mounted, liquid media-compatible pressure sensor is often a good choice for a chemistry analyzer because it requires the precise measurement of fluid passing through the system repeatedly.

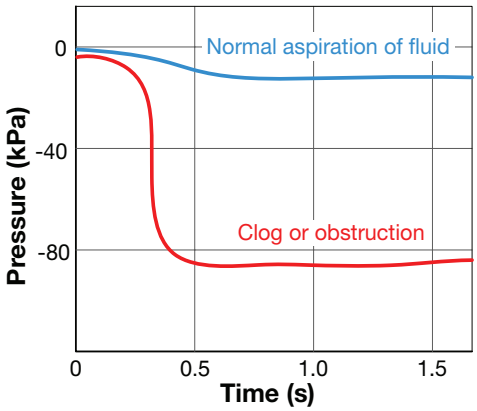
Typically, in a chemistry analyzer a pipette draws the sample fluid and deposits it into another vial or container for mixing or analysis (see Figure 1). Pressure sensors are used to ensure that the right amount of fluid is being measured while the sample is being drawn. They can also be used to detect obstructions or misplacement of the pipette in the sample vial (see Figure 2), and if air is being drawn instead of fluid.

Figure 1. Fluid Handling in a Chemistry Analyzer



A pressure sensor ensures that the correct amount of fluid is being measured while the sample is being drawn.

Figure 2. Pressure Sensor Detecting Obstruction in a Pipette



Some systems will compare the pressure profile of the aspiration to a known "good" or "bad" profile.

These pressure sensors need to provide high accuracy, stability and repeatability at low pressure levels. However, in the same systems they also need to withstand higher pressures that are produced when the fluid pathway is flushed or cleaned. All of this is done while in direct contact with the liquid media being measured.

Selecting Pressure Sensors (See Figure 3.)

The following attributes should be considered by design engineers when selecting a pressure sensor for use in a chemistry analyzer:

- **Liquid-media compatibility:** Since many medical device applications have the potential to be in contact with fluids and gases, designers should always consider pressure sensors with liquid media compatibility to simplify their designs. Liquid media compatibility allows the sensor to withstand direct liquid media contact or condensing humidity. This option should be a key consideration when the sensor is subjected to high humidity. Additionally, designers should understand what types of fluids may be in contact with the pressure sensor to ensure that it is compatible with those fluids.

- **Ease of implementation:** Designers also should evaluate pressure sensors that are fully compensated, amplified, and calibrated for easier implementation. These sensors can eliminate components from the printed-circuit board related to signal conditioning. Advantages range from space savings and enhanced reliability to lower costs and faster implementation.

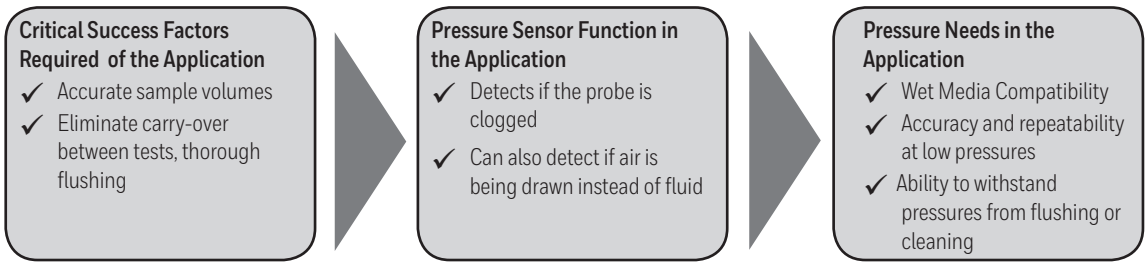


Figure 3. Overview of a Pressure Sensor in a Chemistry Analyzer

- **Accuracy:** Designers should consider pressure sensors that provide precise measurement of a specific amount of fluid passing through the system at the same rate, repeatedly, which is a key requirement for analytical equipment.
- **Application requirements:** Selecting the right pressure sensor depends on the application's requirements. As an example, a low-cost, unamplified, uncompensated pressure sensor with liquid media compatibility may be all that's required for an alarm circuit.
- **Flexibility:** Designers should consider pressure sensors that offer flexible configurations through options for port styles, packaging, output types (analog and digital), and other features.

Pressure Sensor Solutions

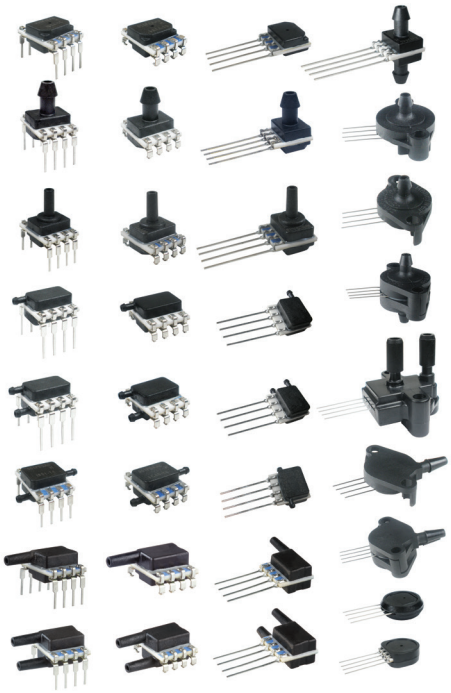
Figure 3 presents an overview of the critical success factors required in a chemistry analyzer, the function a pressure sensor performs in the application, and the general attributes of a pressure sensor.

Honeywell offers a variety of board-mounted pressure sensors designed to measure chemistry analyzer fluid volume and detect air and occlusion in the pipetting system. Following is an overview of several board-mount pressure sensors:

TruStability™ HSC Series, SSC Series (See Figure 4.)

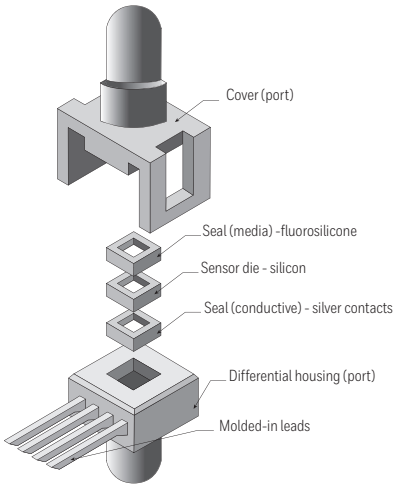
- Pressure range ±1.6 mbar to ±10 bar | ±160 Pa to ±1 MPa | ±0.5 inH_2O to ±150 psi
- For use when:
  - Accuracy and TEB (Total Error Band) of ±1 %FSS to ±3 %FSS (HSC Series) or ±2 %FSS to ±5 %FSS (SSC Series) is required
  - Measuring gases or water (wet on one side)
  - Ultra-low or low pressure ranges are needed
  - Performance is the key driver
- Amplified analog
- Digital output
- Ease of installation
- Many housing/port styles
- Seal options allow for use in a wide range of liquid media and humid environments (See Figure 5.)

Figure 4. Honeywell TruStability™ HSC Series, SSC Series, TSC Series, NSC Series



Honeywell TruStability™ HSC, SSC, TSC and NSC Series board-mounted pressure sensors provide a wide range of configuration options to expedite design and development time.

Figure 5. Exploded view of Honeywell TruStability™ HSC Series, SSC Series, TSC Series, and NSC Series



Seal options allow for use in a variety of liquid media and humid environments

TruStability™ HSC Series Ultra-Low Pressure (See Figure 4.)

- Extremely tight Total Error Band due to Honeywell's patented sense die design, in-house compensation and calibration, and mechanical package design:
  - ±3 %FSS for 2 inH_2O span
  - ±1.5 %FSS for 3 inH_2O to 5 inH_2O span
  - ±1 %FSS above 5 inH_2O span
- Virtually insensitive to mounting orientation (<0.15 %FSS) and very low vibration sensitivity (MIL-STD-202G, Method 204D, Condition B (15 g, 10 Hz to 2 Hz)) due to Honeywell's patented sense die design
- High resolution (min. 0.03 %FSS analog, 12-bits digital) due to the use of sensors specifically designed for ultra-low pressures, not just amplifying higher range sensors
- Port 1 can be exposed to non-corrosive, non-ionic liquids when the liquid media option is selected
- Extremely tight accuracy of ±0.25 %FSS BFSL: inherently a linear sense die design/diaphragm

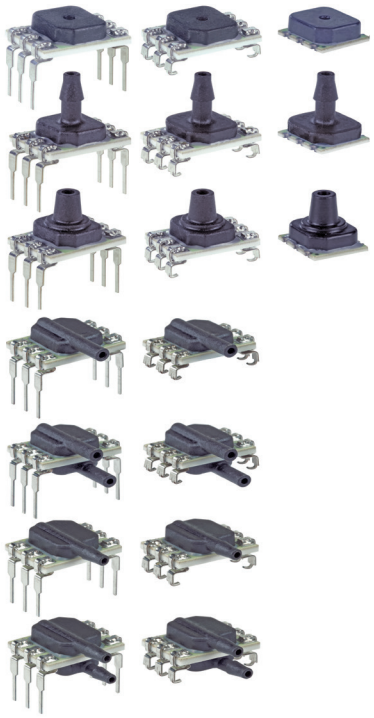
TruStability™ TSC Series (See Figure 4.)

- Pressure range ±60 mbar to ±10 bar | ±6 kPa to ±1 MPa | ±1 psi to ±150 psi
- Compensated and unamplified for those customers that require temperature compensation but want to do their own amplification
- Back-side sensing allows for wet capability on one port; port 1 can be exposed to non-corrosive, non-ionic liquids
- For use with water (wet on one side)
- Ease of installation
- Many housing/port styles
- Millivolt analog output

TruStability™ NSC Series (See Figure 4.)

- Pressure range ±2.5 mbar to ±10 bar | ±250 Pa to ±1 MPa | ±1 inH_2O to ±150 psi
- Uncompensated and uncalibrated for those customers who want to do their own compensation, calibration, and amplification
- Back-side sensing allows for wet capability on one port: port 1 can be exposed to non-corrosive, non-ionic liquids
- For use with water (wet on one side)
- Ease of installation
- Many housing and port styles
- Millivolt analog output

Figure 6. Honeywell Basic ABP Series



Basic ABP Series (See Figure 6.)

- Pressure range 60 mbar to 10 bar | 6 kPa to 1 MPa | 1 psi to 150 psi
- Amplified and compensated
- Analog or digital output
- Single or dual ports
- Small package
- Select the ABP Series if cost is a major concern and some sensor performance can be de-rated
- Fewer porting and housing options than the HSC Series and SSC Series
- Digital or analog out

24PC Series, 26PC Series (See Figure 7.)

- Pressure range 0.5 psi to 250 psi (SIP, DIP); 1 psi to 15 psi (SMT)
- Unamplified and uncompensated (24PC)
- Unamplified, temperature compensated and calibrated (26PC)
- Full liquid wet/wet differential sensing avoids having to use a media isolated sensor
- Absolute (24PC), differential, wet-wet differential, gage
- Very small SMT package
- Many port styles
- Fluorosilicone, EPDM, silicon and neoprene seals (DIP and SIP)
- Pick and place features (SMT)
- Rugged mounting features
- Proven quality and reliability
- Ease of installation

Figure 7. Honeywell 24PC Series, 26PC Series

Conclusion

Honeywell's liquid-compatible, board-mounted pressure sensors are meeting the challenges involved with pressure sensing in high-humidity environments such as those found in medical chemistry analyzers,

These small, accurate, flexible, and easy-to-install pressure products with wet-wet media capabilities range from compensated, digital output versions with tight Total Error Band and high resolution down to low-cost, unamplified, uncompensated, analog output versions that allow customers to do their own compensation, calibration, and amplification.

Warranty/Remedy

Honeywell warrants goods of its manufacture as being free of defective materials and faulty workmanship during the applicable warranty period. Honeywell's standard product warranty applies unless agreed to otherwise by Honeywell in writing; please refer to your order acknowledgment 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 that Honeywell, in its sole discretion, 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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