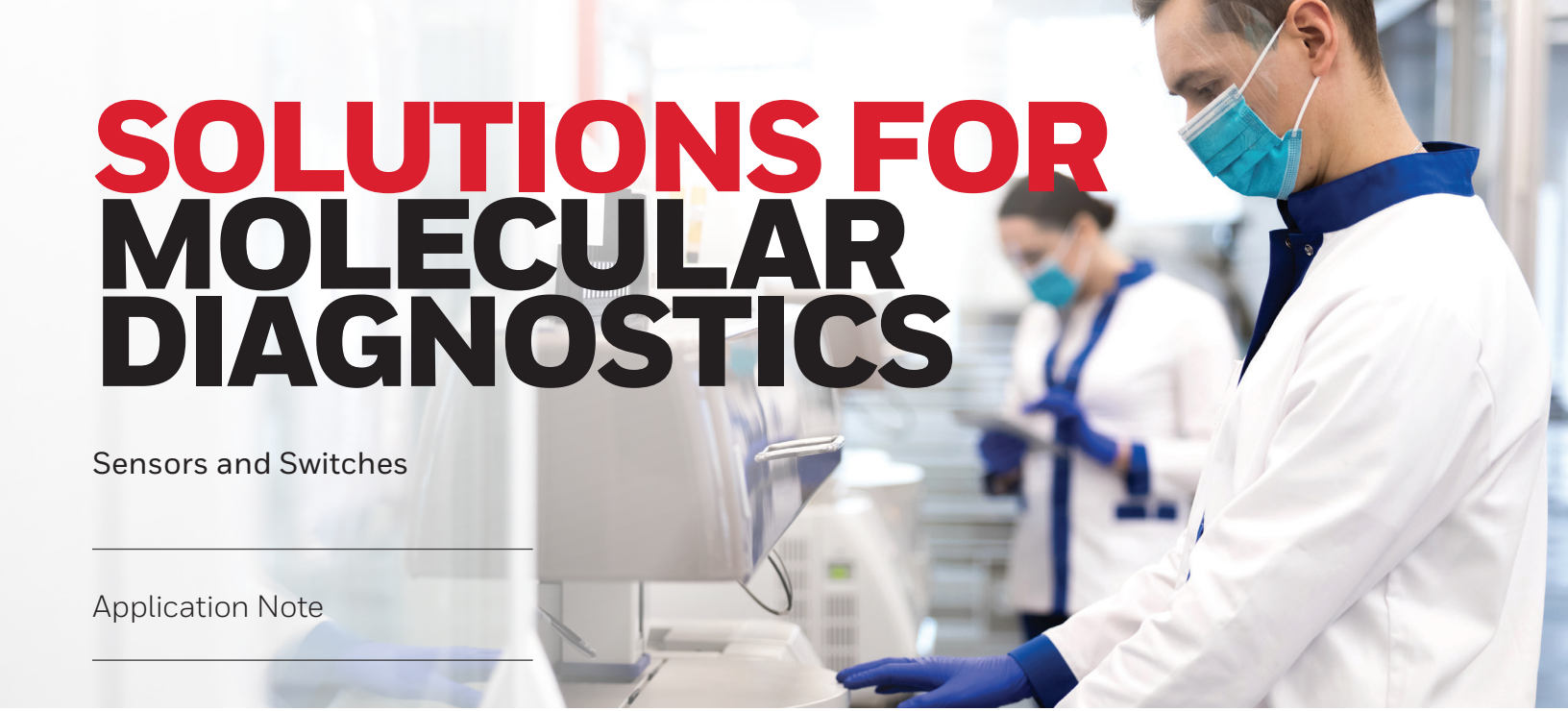


SOLUTIONS FOR MOLECULAR DIAGNOSTICS



Sensors and Switches

Application Note

Molecular Diagnostics (MDx) is the process of studying molecules (DNA and RNA testing) to identify a disease (such as, cancer) or a genetic condition.

BACKGROUND

Molecular diagnostics is one of the most technologically advanced and fastest growing areas within the medical laboratory testing. Molecular diagnostics (testing DNA and RNA) is used to explore and diagnose infectious disease, hematopathology and genetics conditions. Applications range from clinical and veterinary testing, transplant compatibility testing and forensic testing. These sequencing devices offer reliable disease diagnosis as lab testing is increasingly having a greater impact on the precise treatment and care of patients.

Some of the most vital molecules in cell biology, Deoxyribonucleic acid (DNA) and Ribonucleic acid (RNA) are responsible for the storage and reading of genetic information for all life forms. DNA is a blueprint for an organism's genetic information as it replicates and stores genetic material. RNA converts the genetic material within DNA to a configuration used to build proteins, and then sends it to ribosomal protein factories.

The most common test methodologies utilized by molecular diagnostic machines are

- Polymerase Chain Reaction (PCR) and RT- PCR
- High-throughput gene sequencing
- In-situ nucleic acid hybridization

Polymerase Chain Reaction (PCR) and RT- PCR

Polymerase chain reaction (PCR) is a relatively simple and common molecular biology technique that amplifies and detects DNA and RNA sequences. PCR is highly sensitive, requires only a few hours. Only small volumes are required for single reactions.

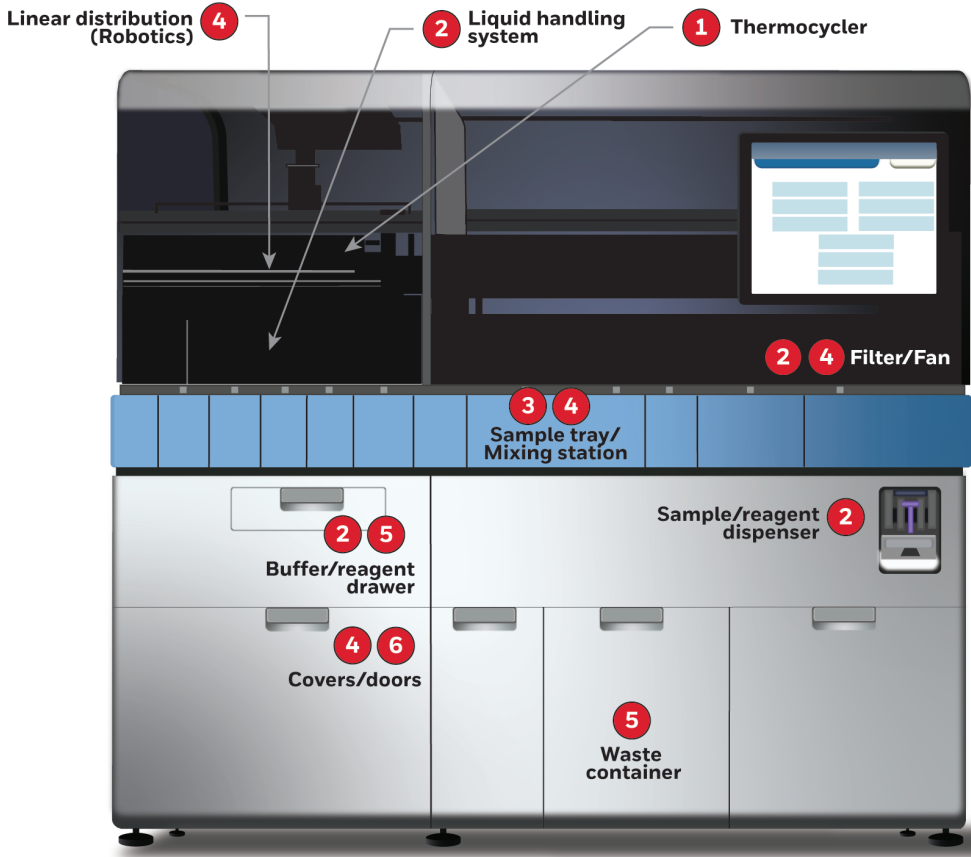
Reverse transcription PCR (RT-PCR) uses RNA as a template and adds an additional process step. RT-PCR is the benchmark technology for the detection and/or comparison of RNA levels. A wide range of RNA abundance can be measured and it provides insight into both qualitative and quantitative data¹.

SOLUTIONS FOR MOLECULAR DIAGNOSTIC APPLICATIONS

- Board-Mount Pressure Sensors
- Temperature Sensors
- Barcode Scan Engines & Software
- Magnetic Sensors
- Force Sensors
- Basic and AML Switches

Honeywell

Figure 1. Solutions for Molecular Diagnostics

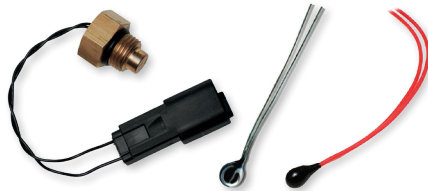


- 1 **Temperature Sensors**
192 Series, 194 Series, 500 Series
- 2 **Board-Mount Pressure Sensors**
20PC; TruStability™ HSC & SSC Series, Basic ABP & ABP2 Series
- 3 **Barcode Scan Engines & Software**
N670X/N660X Series; SwiftDecoder™
- 4 **Magnetic Sensors**
SS360/SS460 Series
- 5 **Force Sensors**
MicroForce FMA Series
- 6 **Basic and AML Switches**
DM, ZD, ZW and V15W Basics; AML Series (PB & Rockers)

High-throughput gene sequencing
This method enables rapid sequencing of the base pairs in DNA or RNA samples. This methodology is key to enabling the development of personalized medicine.

In-situ nucleic acid hybridization
According to the National Human Genome Research Institute, “In-situ hybridization is a laboratory technique in which a single-stranded DNA or RNA sequence, called a probe, is allowed to form complementary base pairs with DNA or RNA present in a tissue or chromosome sample. The probe has a chemical or radioactive label attached to it so that its binding can be observed.”

SOLUTIONS
Honeywell sensors and switches are used extensively within molecular diagnostic equipment to ensure the accuracy of measurement and improve the efficiency, performance, reliability and safe operation of equipment (See Figure 1).



TEMPERATURE SENSORS

[192/194 Series; 500 Series](#)

Function/Action

- Heating and cooling of reaction tubes in the thermocycler

The 192/194 Series (see Table 1) is installed at various points within the molecular diagnostic machine’s thermocycler to monitor the temperature of the reaction tubes and control fan operation. If the temperature of the thermocycler deviates from the operating specification, it can impact the performance of the equipment.

Packaged temperature sensors are available as discrete components for customer-built assemblies, or Honeywell can provide a full assembly solution that can simply pigtail into the system.

TABLE 1. TEMPERATURE SENSOR FEATURES

192/194 SERIES

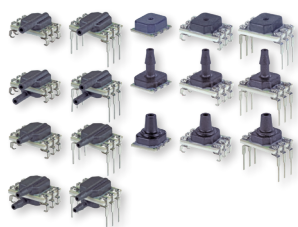
- Resistance temperature curve interchangeability
- Enhanced life
- Small size
- Epoxy coated

500 SERIES

- Air/gas, surface, immersion and liquid level
- NTC type output
- Enhanced sensitivity
- Small package size
- Easy to install
- Enhanced reliability, accuracy and stability/low drift



TruStability®
HSC Series



Basic ABP Series



20PC Series

BOARD-MOUNT PRESSURE SENSORS

Board Mount: TruStability® HSC; Basic ABP & ABP2; 24PC FlowThrough Series

Functions/Actions

- Senses leaks within the liquid handling system
- Detects when filters are becoming clogged and need to be cleaned/replaced
- Monitors filling level for reagent and buffer containers to alert when they need to be emptied
- Measures fluid volume: both air and occlusion in pipetting system within the sample/reagent dispenser

Board mount pressure sensors (see Table 2) are extensively used within medical equipment due to high levels of accuracy, sensitivity, reliability and small-size. Pressure sensors are used to check for leaks and levels, control the filling volume of reagent applied to the sample and also monitor the liquid level in the reagent containers to determine when this needs to be refilled.

TABLE 2. BOARD MOUNT PRESSURE SENSOR FEATURES

TRUSTABILITY® HSC SERIES

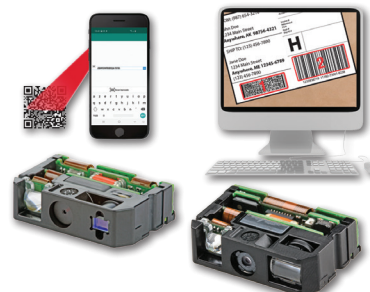
- Pressure range 1.6 mbar to 10 bar
- Absolute, gage and differential
- Amplified and temperature compensated
- Analog or digital (I²C/SPI) output
- Supports liquids and dry gases

BASIC ABP2/ABP SERIES

- Pressure range 5 mbar to 12 bar
- Absolute, gage and differential
- Amplified and temperature compensated
- Analog or digital (I²C/SPI) output
- Supports liquids and dry gases

24PC FLOWTHROUGH SERIES

- Pressure range 0.5 psi to 250 psi
- Absolute, differential, wet-wet differential, gage and vacuum gage
- Robust media compatibility
- Selectable seals available to match media used
- Also available in DIP, SIP and SMT packages



BARCODE SCAN ENGINE & SOFTWARE

N670X, N660X, SwiftDecoder™

Functions/Actions

- Automated, more accurate and faster tracking of patient samples and results
- Ensures the right sample and equipment match the right patient

Honeywell barcode scan engines, modules and decoding software are used in medical applications to help improve patient safety and enhance operational effectiveness.

Tracking patient samples, results and equipment can enhance patient's safety when the patient and/or equipment is relocated. Historical readings can be bound to a particular patient if needed, by associating the patient ID to the results.

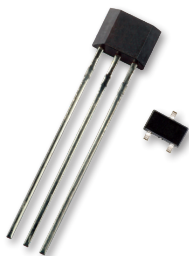
TABLE 3. SCAN ENGINE AND SOFTWARE FEATURES

N670X, N660X SERIES SCAN ENGINES

- Slim height makes it easier to fit compact devices
- Wider operational temperature range
- Available with SR or HD optics
- Delivers motion tolerance of up to 6 m/s
- Lower power consumption
- Parallel or MIPI interface availability

SWIFTDECODER™ SOFTWARE

- More quickly and reliably scans millions of barcodes
- Faster barcode scanning
- Capable of aggressive and more accurate reading
- Effectively reads poor quality barcodes



MAGNETIC SENSORS

[SS360/SS460](#)

Function/Action

- Acts as switches for covers and doors
- Senses position of robotics
- Controls fan speed and efficiency
- Provides both sample position and identification
- Detects open covers

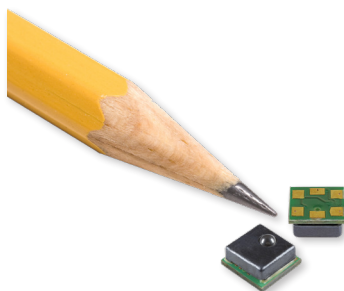
Magnetic Hall-effect Sensor ICs are designed to provide reliable, highly accurate output for smooth motor/fan control and operation that reduces noise and vibration and improves efficiency (see Table 4). Magnetic sensors can also be used to sense when a door panel or flap is open or ajar to ensure the safe operation of the equipment. Its solid state reliability often reduces repair and maintenance costs.

Their small size allows for design into many compact, automated, lower-cost assemblies. A thermally balanced integrated circuit is designed to provide proper fan functionality.

TABLE 4. MAGNETIC SENSOR FEATURES

SS360/SS460

- Fast response time
- No chopper stabilization
- High sensitivity; latching magnetics
- Wide operating voltage range



FORCE SENSORS

[MicroForce FMA Series](#)

Function/Action

- Monitors filling level for reagent and buffer containers to alert when they need to be emptied
- Detection of buffer and waste container fill level

Force sensors (see Table 5) can be used to monitor reagent filling levels within molecular diagnostic machines. In addition, they can be used to determine the presence and weight of the reagent containers to alert when these need to be refilled.

Direct mechanical coupling allows for easy interface with the sensor, coupling with tubing, membrane or a plunger, providing repeatable performance and a reliable mechanical interface to the application.

TABLE 5. FORCE SENSOR FEATURES

FMA SERIES

- Amplified and temperature compensated
- Accuracy: $\pm 2\%$ FSS typical
- Small form factor: 5 mm x 5 mm [0.20 in x 0.20 in]
- Digital (I²C/SPI) output
- Available in a wide variety of standard and configurable force ranges
- Stable, stainless steel sphere interface
- Internal diagnostic functions available



BASIC AND AML PUSHBUTTON SWITCHES

[DM, V15W, ZW Series](#); [ZD Series](#); [AML Series](#)

Function/Action

- Used as on/off operator controls, as well as detection for covers, panels and doors

MICRO SWITCH basic switches can be used as presence/detection for covers, panels and doors acting as a fail-safe to prevent switching the machine when doors/panels are ajar (see Table 6). Several Series are sealed to protect against fluids.

MICRO SWITCH AML Series are available as pushbuttons, key switches and rockers/paddles (see Table 6). They are often used in medical equipment as off/on operator controls on the external face of the equipment.

TABLE 6. BASIC AND PUSHBUTTON SWITCH FEATURES

MICRO SWITCH BASIC SWITCHES

- Watertight, dust tight; leaded versions are sealed to IP67
- High current capacity
- Many different switch characteristics, actuators, and terminations
- Miniature and subminiature size
- Lower power consumption
- Choice of momentary, push-pull, or pull-to-charge actions (DM)

AML PUSHBUTTON SWITCHES

- Pushbuttons, paddles, rockers, key-actuated and indicators within AML Series for coordinated panel appearance
- Less than 1.75 inch panel depth
- Furnished lighted or unlighted



⚠ WARNING IMPROPER INSTALLATION

- Consult with local safety agencies and their requirements when designing a machine control link, interface and all control elements that affect safety.
- Strictly adhere to all installation instructions.

Failure to comply with these instructions could result in death or serious injury.

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 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 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.**

While Honeywell may provide application assistance personally, through our literature and the Honeywell web site, it is buyer's sole responsibility to determine the suitability of the product in the application.

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

FOR MORE INFORMATION

Honeywell Advanced Sensing Technologies services its customers through a worldwide network of sales offices and distributors. For application assistance, current specifications, pricing, or the nearest Authorized Distributor, visit sps.honeywell.com/ast or call:

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¹ Bustin SA, Benes V, Nolan T, Pfaffl MW (June 2005). "Quantitative real-time RT-PCR--a perspective". J. Mol. Endocrinol. 34 (3): 597-601.