

Sensors in Infusion Pumps

An Application Note

Background

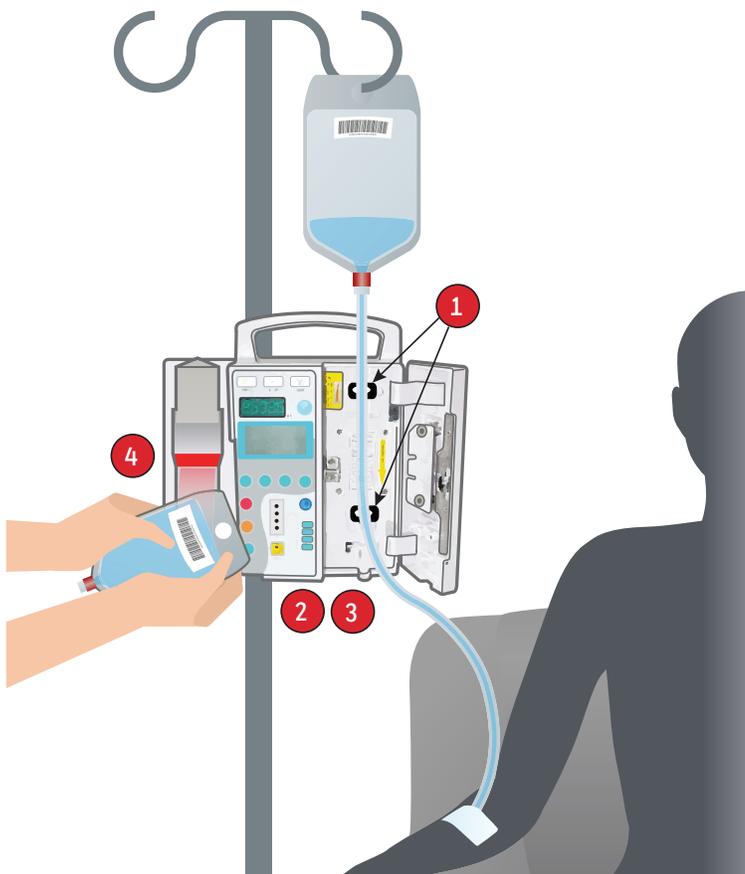
An infusion pump, typically a screw pump that pushes on a syringe or cartridge, is used to deliver small amounts of medication to a patient intravenously.

Solutions

Honeywell manufactures many products that may be used in infusion pumps. They are designed to provide occlusion detection, monitor fluid flow, provide output for smooth motor control, and support the identification and delivery process. (See Figure 1.)



Figure 1. Potential Honeywell Products Used in Infusion Pumps



- 1 Force Sensors**
FSA Series, FSG Series, FSS Series, FSS-SMT Series, TBF Series, 1865 Series
- 2 Pressure Sensors - Board Mount**
TruStability™ HSC Series, SSC Series
- 3 Magnetic Sensor ICs**
Hall-Effect: SS400 Series; SS360NT, SS360ST, SS460S
or
Magnetoresistive:
Nanopower Series (SM353LT, SM353LT)
Standard Power Series (SM351RT, SM451R, SM353RT, SM453R)
- 4 OEM 2D Scan Engines**
N6600 Series

Force Sensors

Customer Benefits: Reliable, sensitive, stable

These sensors provide occlusion detection to ensure there isn't a blockage in the tube that delivers the medication to the patient. If the tube becomes blocked, the force sensor alerts the patient, nurse or doctor via an audible alarm that the therapy isn't being delivered. (See Table 1.)

Table 1. Force Sensors

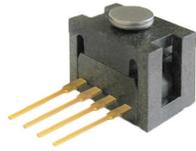
FSA SERIES	FEATURES
	<ul style="list-style-type: none"> • Wide variety of force ranges <ul style="list-style-type: none"> - Newton (N): 5, 7.5, 10, 15, 20, 25 - pound (lb): 1, 1.5, 2, 3, 5 - gram (g): 500, 750 - kilogram (kg): 1, 2 • Total Error Band of $\pm 5\%$ FSS • Accuracy of $\pm 3\%$ FSS • Ratiometric analog, or SPI- or I²C-compatible digital output • Fully calibrated and temperature compensated over a temperature range of 5°C to 50°C [41°F to 122°F] • Overforce of 15 lb [6804 g] • Supply voltage of 3.3 Vdc typ. or 5.0 Vdc typ. • Low power consumption of 13 mW (analog) or 20 mW (digital) • Excellent part-to-part repeatability • Enhanced reliability • Stable interface plunger • Internal diagnostic functions available • REACH and RoHS compliant
FSG SERIES	FEATURES
	<ul style="list-style-type: none"> • Piezoresistive sensing technology designed to provide precise, often reliable force sensing in a compact, commercial-grade package • Wheatstone bridge circuit design provides inherently stable mV outputs over force range • Package design incorporates a patented modular construction • Innovative elastomeric technology and engineered molded plastics result in load capacities of 5.5 kg overforce • Stainless steel plunger provides enhanced mechanical stability and is adaptable to a variety of potential applications
FSS SERIES, FSS-SMT SERIES	FEATURES
	<ul style="list-style-type: none"> • Piezoresistive sensing technology designed to provide precise, reliable force sensing in a compact, commercial-grade package • Wheatstone bridge circuit design provides inherently stable mV outputs over force range • Package design incorporates a patented modular construction • Innovative elastomeric technology and engineered molded plastics result in load capacities of 4.5 kg overforce • Stainless steel ball provides enhanced mechanical stability and is adaptable to a variety of applications • Output has low sensitivity to mounting stresses • High resistance to electrostatic discharge (8 KV) meets ESD Sensitivity Classification Level 3 • Electrically ratiometric output accommodates supply voltage variations, leading to low ratiometricity error • Small size minimizes space on the printed circuit board, simplifying incorporating the sensor into the customer's design • Low deflection (30 microns typical at full scale) helps reduce measurement error • Low voltage supply allows for use in battery powered applications. • Provides enhanced sensitivity without compromising signal integrity, resulting in low system noise and reducing measurement errors • Direct mechanical coupling of the actuation ball to the sense element eliminates coupling errors and keeps mechanical hysteresis to a minimum • Surface mount technology (SMT) option allows for automated assembly and may eliminate hand soldering

Table 1. Force Sensors (continued)

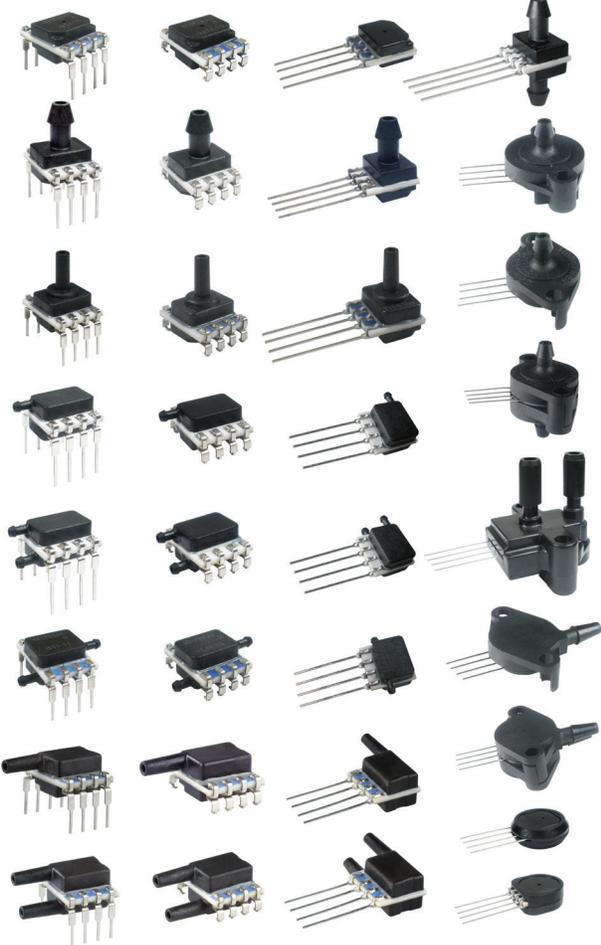
TBF SERIES BASIC	FEATURES
	<ul style="list-style-type: none"> • Designed for customers who require a simple, high quality, cost-effective, mV output, unamplified, temperature-compensated sensor for potential use in medical and industrial applications • Solid state, piezoresistive, gage pressure transducer mounted in a plastic package, special silicone gel transmits applied pressure to a silicon piezoresistive MEMS die mounted on a robust ceramic substrate • For applications where force is applied by a flexible membrane to the sensor, such as infusion pumps, the precision height silicone diaphragm provides long life and is a reliable replacement for older force or load cell transducers • Silicone rubber diaphragm allows compatibility with some liquid media applications • Smallest package size in its class (7 mm x 7 mm x 3,89 mm) • Wide pressure range of 1 bar to 10 bar 100 kPa to 1 MPa 15 psi to 150 psi • Tight accuracy specification of $\pm 0.15\%$ FSS • Wide operating temperature range of -20°C to 85°C [-4°F to 185°F] • Low power consumption allows for potential use in battery operated applications • Stable offset voltage • Not sensitive to mounting orientation • RoHS2 compliance
1865 SERIES	FEATURES
	<ul style="list-style-type: none"> • Silicon pressure/force interface diaphragm • Pressure measurement for liquid media • Medical-grade materials • 8-pin DIP electrical connection • Choice of voltage or constant current excitation • Temperature compensated • Enhanced performance • Reliable replacement for older force or load cell transducers • Silicone rubber diaphragm allows potential compatibility with liquid media applications • Laser-trimmed compensation may be specified to operate with a constant current or voltage supply

Pressure Sensors - Board Mount, Low Pressure

Customer Benefits: Stable, reliable, efficient, accurate, sensitive

These products are designed to monitor and control the flow of fluid. (See Table 2.)

Table 2. Pressure Sensors - Board Mount, Low Pressure

TRUSTABILITY™ HSC SERIES, SSC SERIES	FEATURES
	<ul style="list-style-type: none"> • Temperature compensation and calibration provide an amplified signal, typically allowing removal of components associated with signal conditioning from the PCB, increasing space and reducing associated costs • Industry-leading stability often eliminates need for calibration after PCB mount, and periodically over time • Digital ASIC output in either I²C or SPI protocols from digital sensors accelerates performance through reduced conversion requirements and the convenience of direct interface to microprocessors and microcontrollers • Multiple packaging, mounting, power, and signal options combine with customized calibration capabilities increases application flexibility

Magnetic Sensor ICs

Customer Benefits: Cost-effective, quiet, accurate, efficient, effective

These durable products are designed to provide enhanced output accuracy for smooth motor control that reduces noise and vibration in motor assembly fan systems. Their small size often reduces replacement costs and 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. (See Tables 3 and 4.)

Table 3. Hall-effect Sensor ICs

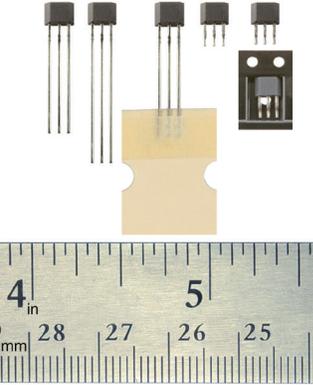
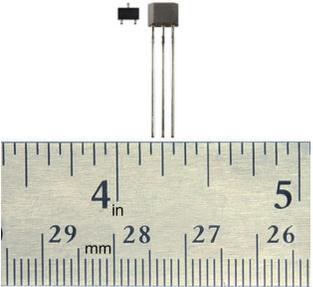
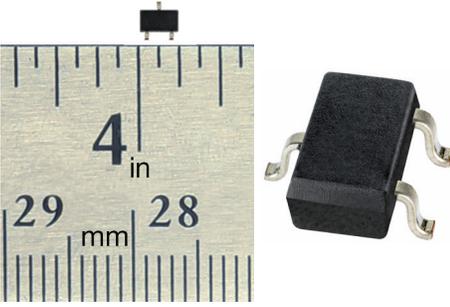
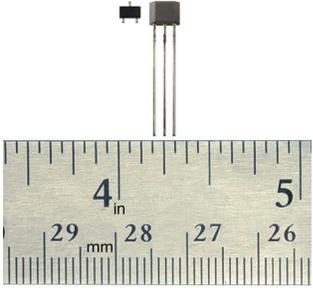
SS400 SERIES	FEATURES
 <p>Five SS400 Series Hall-effect sensor ICs are shown. Four are in a quad package (SS400) and one is in a TO-92 package (SS400T). A ruler below shows the dimensions in inches (4 to 5) and millimeters (25 to 28).</p>	<ul style="list-style-type: none"> • Quad Hall-effect design minimizes effects of mechanical or thermal stress on output, and promotes a stable output • Unipolar, bipolar or latching magnetics and customizable operate/release points • Negative compensation slope optimized to match negative temperature coefficient of lower-cost magnets, providing robust design over wide temperature range • Band gap regulation promotes stable operation over supply voltage range • Low power consumption enhances energy efficiency
S360NT, SS360ST, SS460S	FEATURES
 <p>Two S360NT, SS360ST, or SS460S Hall-effect sensor ICs are shown. One is in a TO-92 package and the other is in a SOT-23 package. A ruler below shows the dimensions in inches (4 to 5) and millimeters (26 to 29).</p>	<ul style="list-style-type: none"> • Fastest response time in its class • No chopper stabilization • High sensitivity • Latching magnetics • Wide operating voltage range of 3 Vdc to 24 Vdc • Built-in reverse voltage • Durable design • RoHS-compliant material meets Directive 2002/95

Table 4. Magnetoresistive Sensor ICs

NANOPOWER SERIES SM353LT, SM353LT	FEATURES
 <p>Two SM353LT magnetoresistive sensor ICs are shown. One is in a TO-92 package and the other is in a SOT-23 package. A ruler below shows the dimensions in inches (4) and millimeters (28 to 29).</p>	<ul style="list-style-type: none"> • High sensitivity: 7 Gauss typ., 11 Gauss max. (SM351LT); 14 G typ., 20 Gauss max. (SM353LT) • Nanopower: Average current of 360 nA typ. (SM351LT) and 310 nA typ. (SM353LT) • Supply voltage range of 1.65 Vdc to 5.5 Vdc • Omnipolar sensing activates with either pole from a magnet • Temperature range of -40 °C to 85°C [-40°F to 185°F] • Push-pull output does not require external pull-up resistor • Non-chopper stabilized design • RoHS-compliant materials meet Directive 2002/95/EC • SOT-23 package
STANDARD POWER SERIES SM351RT, SM451R, SM353RT, SM453R	FEATURES
 <p>Two magnetoresistive sensor ICs are shown. One is in a TO-92 package and the other is in a SOT-23 package. A ruler below shows the dimensions in inches (4 to 5) and millimeters (26 to 29).</p>	<ul style="list-style-type: none"> • Magnetic sensitivities: <ul style="list-style-type: none"> - Ultra-high sensitivity (SM351RT and SM451R): For applications requiring ultra-high magnetic sensitivity (7 Gauss typ., 11 Gauss max.) - Very high sensitivity (SM353RT and SM453R): For applications requiring very high magnetic sensitivity (14 Gauss typ., 20 Gauss max.) • Package styles: <ul style="list-style-type: none"> - SOT-23 (SM351RT, SM353RT) supplied on tape and reel (3000 units per reel) - Flat TO-92-style (SM451R, SM453R) • Supply voltage range of 3 Vdc to 24 Vdc • Omnipolar sensing activates with either pole from a magnet • Temperature range of -40°C to 85°C [-40°F to 185°F] • RoHS-compliant materials meet Directive 2002/95/EC

OEM 2D Scan Engines

Customer Benefits: Fast, accurate, small

This product is designed to help provide barcode scanning ability, helping to verify treatment procedures as they are being delivered. (See Table 5.)

Table 5. OEM 2D Scan Engines

N6600 SERIES	FEATURES
	<ul style="list-style-type: none"> • Ultra-compact: The slimmest height in the industry at 6.8 mm [0.27 in] • MIPI interface available: Supports the latest technology trends for shorter design cycles • Optimized white illumination: Simplifies reading barcodes; highly visible aimer provides a clear, sharp and easily observed target area • Enhanced scan performance: Provides fast scan speed, ultra-fast motion tolerance up to 5 m/s, excellent reading capability for poorly printed barcodes, and support for color barcodes and full symbology • Adaptus 6.0 imaging technology: Quickly and accurately reads barcodes and OCR fonts with best-in-class range and enhanced motion tolerance, even hard-to-read codes and those on mobile phone screens

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.**

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

To learn more about Honeywell's sensing and switching products, call 1.800.537.6945, visit sensing.honeywell.com, or e-mail inquiries to info.sc@honeywell.com. To learn more about Honeywell's scan engines and barcode software, visit honeywellaidc.com.

Honeywell Safety and Internet of Things

9680 Old Bailes Road
Fort Mill, SC 29707
www.honeywell.com