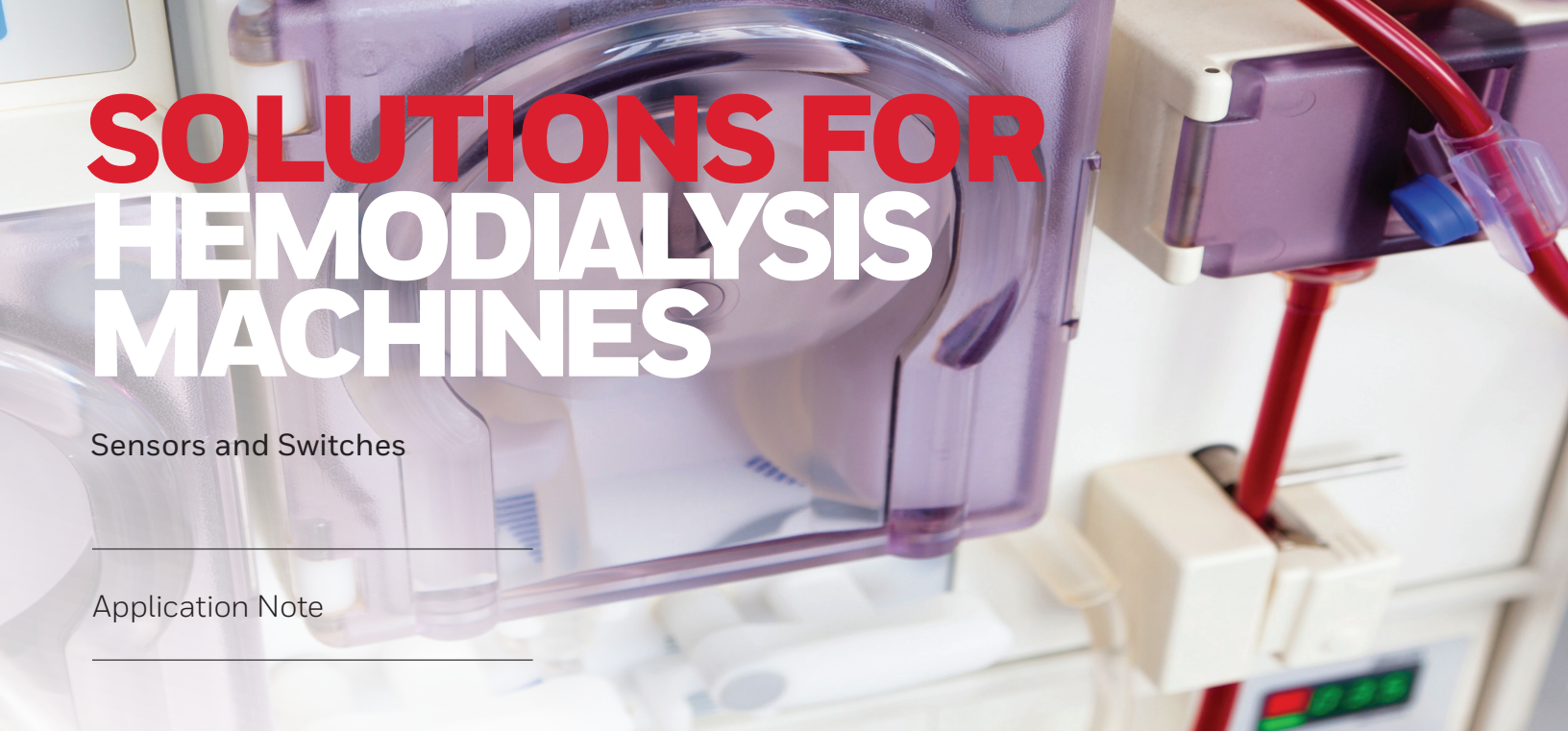




SOLUTIONS FOR HEMODIALYSIS MACHINES

Sensors and Switches

Application Note

Honeywell manufactures many sensors and switches which may be used in hemodialysis machines (see Figure 1). This application note shows how these solutions provide dialysate cartridge presence/absence detection, fluid pressure/flow and temperature measurement, and smooth motor control output.

BACKGROUND

Hemodialysis machine treatments replace some kidney functions by removing waste and fluid from the bloodstream via diffusion and osmosis of solutes and fluid across a semipermeable dialysis membrane.

Blood in one compartment is pumped along one side of the membrane while a dialysate (a crystalloid solution that acts as a sponge for impurities) is pumped along the other side, in a separate compartment, in the opposite direction.

Ultrafiltration occurs by increasing the hydrostatic pressure across the membrane by applying a negative pressure to the dialysate compartment of the dialyzer. This pressure gradient causes water and dissolved solutes to move from the blood to the dialysate. The cleansed blood returns via the circuit back to the body.

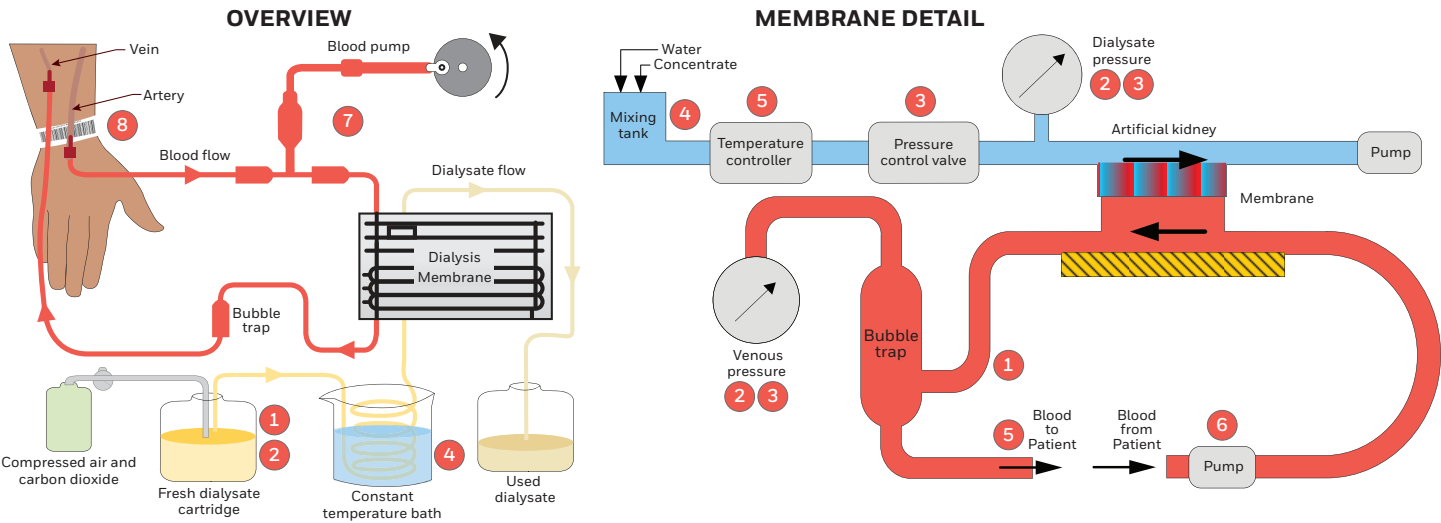
SOLUTIONS

Honeywell sensor and switch solutions are designed to enhance the performance and reliability of hemodialysis machines and ensure the safe administration of the treatment to the patient (See Figure 1).

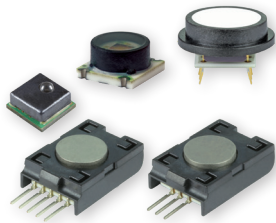
SOLUTIONS FOR HEMODIALYSIS MACHINE APPLICATIONS

- Force Sensors
- Pressure Sensors – Board Mount
- Pressure Sensors – Heavy Duty
- Flexible Heaters
- Temperature Sensors
- Magnetic Position Sensor ICs
- Basic and AML Switches
- Barcode Scan Engines & Software

Figure 1. Solutions for Hemodialysis Machine Applications



- 1 Force Sensors**
MicroForce FMA Series, 1865 Series, FSA Series, TBF Series
- 2 Pressure Transducers - Heavy Duty**
13 mm Series, 19 mm Series, MIP Series
- 3 Pressure Sensors - Board Mount**
TruStability™, HSC Series, SSC Series, TSC Series; Basic ABP/ABP2 Series, 26PC Flow-Through Series
- 4 Flexible Heaters**
A3100 Series, C3100 Series, A3200 Series C3200 Series, A3400 Series, C3400 Series in custom assemblies
- 5 Thermistor Sensing Elements**
192 Series, 194 Series
- 6 Hall-effect Position Sensor ICs**
SS400 Series; SS360NT, SS360ST, SS460S
- 7 Basic and AML Switches**
V15W, ZD and ZW Series Sealed Basics; AML Series (Pushbutton and Rocker)
- 8 Barcode Scan Engines & Software**
N670X & N660X Series; SwiftDecoder™



FORCE SENSORS

[MicroForce FMA Series](#); [FSA Series](#); [TBF Series](#); [1865 Series](#)

Functions/Actions

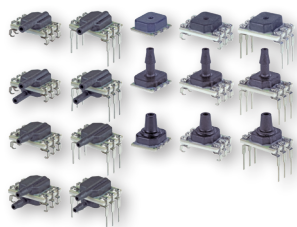
- Provides non-invasive measurement of blood or dialysate pressure
- Enhanced quality and reliability
- Early detection of occlusions enhances patient safety
- Reduces the need for additional calibrations

Honeywell force sensors (see Table 1) are used in a non-invasive manner to measure the blood or dialysate pressure within a tube to ensure the pressure is within agreed operating parameters. Force sensors simplify cleaning and sterilization of equipment before each treatment.

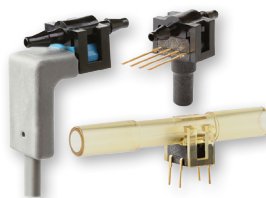
TABLE 1. FORCE SENSORS FEATURES			
MICROFORCE FMA SERIES		TBF SERIES	
• Amplified and temperature compensated		• Unamplified and temperature compensated	
• Small form factor: 5 mm x 5 mm [0.20 in x 0.20 in]		• Analogue (mV) output	
• Digital output (I ² C/SPI) simplifies new designs		• Liquid media compatibility	
FSA SERIES		1865 SERIES	
• Wide variety of force ranges		• Unamplified and temperature compensated	
• Analogue or digital (I ² C/SPI) output		• Analogue (mV) output	
• Large coupling area simplifies integration within application		• Liquid media compatibility	



TruStability®
HSC, SSC, TSC Series



Basic ABP Series



26PC Series



MIP Series



13 mm & 19 mm
Series

PRESSURE SENSORS AND TRANSDUCERS

Board Mount: TruStability® HSC, SSC, TSC, Basic ABP Series; 26PC Flowthrough Series

Heavy Duty: MIP Series; 13mm/19mm Series

Functions/Actions

- Monitor and regulate the dialysate flow on the outside of the dialysis filter to enable the filter to capture contaminants within the blood
- Improve treatment efficiency and reduce the time it takes to remove fluid from the peritoneum

Honeywell's board mount pressure sensors and heavy duty pressure transducers (see Table 2) are designed to provide enhanced performance and reliability. Board mount pressure sensors are typically used on the blood side of the dialysis equipment to monitor and regulate blood flow to and from the patient during the dialysis procedure. Failure to control this blood flow may cause the patient severe discomfort and potential heart failure. After each treatment the sensors need to be sterilized to prevent bacteria contamination.

TABLE 2. PRESSURE SENSORS AND TRANSDUCERS FEATURES

TRUSTABILITY® HSC, SSC, TSC SERIES

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

BASIC ABP2/ABP SERIES

- Pressure range 5 mbar to 25 bar
- Measures absolute, gage and differential
- Amplified and temperature compensated
- Analogue or digital (I²C/SPI) output
- Supports liquids and dry gases

26PC FLOWTHROUGH SERIES

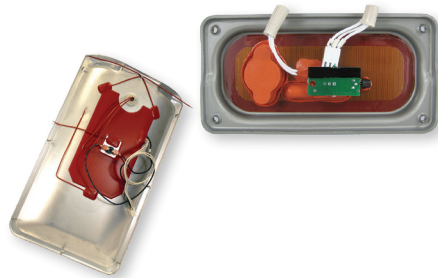
- Liquid flow sensor with robust media compatibility
- True wet/wet differential sensing for increased application flexibility
- Unamplified and temperature compensated
- Analog (mV) output for customers who want to do their own calibration
- Small sensor dead-space simplifies cleaning of sensors

MIP SERIES

- Pressure range 1 bar to 60 bar
- Extensive media compatibility
- Ratiometric and current output
- High over/burst protection
- Wide choice of port options

13 MM & 19 MM SERIES

- Small size for use on portable equipment
- High impedance and low current draw for battery operation
- Constant current for use with 4 mA to 20 mA amplifier integrated circuits
- Oil-free, isolated sensor reduces risk of leakage and contamination
- Flush mount, non-corrugated diaphragm for easy sanitation



FLEXIBLE HEATERS

[A3100 Series, C3100 Series,](#)
[A3200 Series, C3200 Series,](#)
[A3400 Series](#)

[C3400 Series in Custom Assemblies](#)

Function/Action

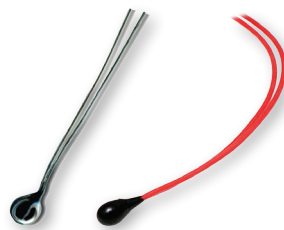
- Temperature monitoring and control
- Honeywell's flexible heaters (see Table 3) are designed to provide controlled heat for blood or dialysate warming to body temperature prior to re-entry into the body. This may be accomplished by either heat exchange constant temperature bath) or direct heat through warming plates. These flexible heaters are custom-designed to customer requirements.

Other components, such as NTC thermistors, RTDs or solid state temperature sensors, may be added for temperature monitoring and control.

TABLE 3. FLEXIBLE HEATERS FEATURES

A3XXX, C3XXX SERIES

- Although no standard product is available for this custom application, Honeywell offers a variety of material sets in heating elements, as well as insulation, to meet our customers needs



TEMPERATURE SENSORS

[192/194 Series](#)

Function/Action

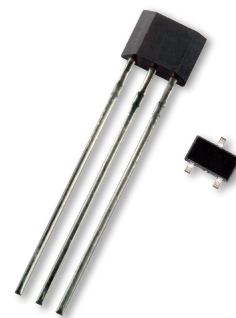
- Temperature measurement across the dialysis membrane

Temperature directly affects the permeation rate across the dialysis membrane. The 192 Series and 194 Series thermistor sensing elements (see Table 4) provide temperature measurement for enhanced control of this variable. The sensor is coupled to a microcontroller designed to monitor the temperature of the operation and to interact with the controller to help regulate the temperature of the system. Honeywell offers several configurations. These packaged sensors are available as discrete components for custom-built assemblies, as well as full assembly solutions that the customer may simply pigtail into the system.

TABLE 4. TEMPERATURE SENSORS FEATURES

192/194 SERIES

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



MAGNETIC SENSORS

[SS360/SS460; SS400 Series](#)

Function/Action

- Control motors and sense motor speed

Hall-effect position sensor ICs (see Table 5) are designed to provide reliable, highly accurate output for smooth motor control that reduces noise and vibration in the machine's motor assembly and improves its efficiency. Their solid state reliability often reduces repair and maintenance costs, and its small size allows for design into many compact, automated, lower-cost assemblies. A thermally-balanced integrated circuit provides consistent operation over the full temperature range.

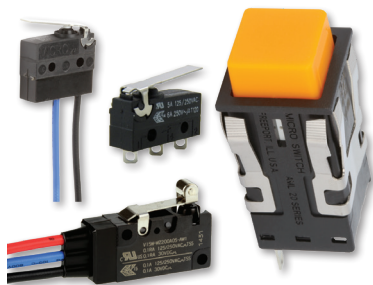
TABLE 5. MAGNETIC SENSORS FEATURES

SS360/SS460

- 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

SS400

- Quad Hall-effect design
- Unipolar, bipolar or latching
- Optimized slope compensation
- Wide temperature range



BASIC AND AML PUSHBUTTON SWITCHES

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

Function/Action

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

Honeywell MICRO SWITCH basic switches (see Table 6) can be used as on/off operator controls. MICRO SWITCH basic switches can also 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. Several series are sealed to protect against fluids.

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

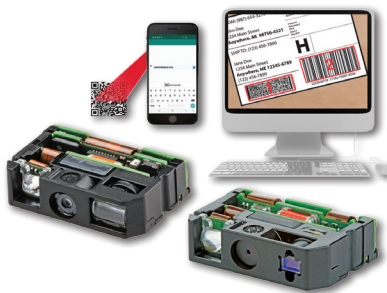
TABLE 6. BASIC AND PUSHBUTTON SWITCHES FEATURES

MICRO SWITCH BASICS

- 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

AML PUSHBUTTONS

- 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



BARCODE SCAN ENGINES & SOFTWARE

[N670X & N660X Series, SwiftDecoder™](#)

Function/Action

- Barcode scan engines and software help ensure the right treatment is administered to the right patient by reading the barcodes on the IV bag and on the patient wrist band.

Honeywell barcode scan engines, modules and decoding software (see Table 7) are used in medical applications to help improve patient safety and enhance operational effectiveness.

Integrating Honeywell barcode reading OEM solutions supports automated, more accurate and faster tracking of patient and caregiver IDs, ensuring the right medication, treatment and equipment match the right patient, and tracking and validating sample IDs and associated information in the work flow.

TABLE 7. SCAN ENGINES AND SOFTWARE FEATURES

N670X, N660X SERIES SCAN ENGINES

- Small form-factor
- Wider operational temperature range
- Available with SR or HD optics
- Parallel or MIPI interface
- Low power consumption

SWIFTDECODER™ SOFTWARE

- Faster barcode scanning
- High accuracy and repeatability
- Reads damaged/poor quality barcodes
- Omni-directional



⚠ 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 [our website](#) or call:

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