Sensors and Flexible Heaters in Ventilator Applications

BACKGROUND

A medical ventilator is designed to move a mixture of air and oxygen into and out of the patient's lungs to either assist in breathing or, in some cases, mechanically breathe for the patient who is breathing insufficiently or is physically unable to breathe. (See Figure 1.)

Figure 1. Patient Breathing on a Ventilator

SOLUTIONS

Honeywell manufactures many products that may be used in ventilators. They are designed to help control pressure, airflow, temperature and humidity. (See Figure 2.)

Pressure Sensors

Ultra-Low Plastic Silicon: The ASDXL10G24R is designed to measure air and oxygen pressure so that the pressure doesn't exceed a desired level. The CPC Series (CPCL10GFC) and the SDX010IND4 may also be used; however, they require a customer-provided amplifier or ASIC-based solution for a signal conditioned output. Although this option may provide the customer increased design flexibility, it may take longer to design and may use more board space than the ASDXL Series. (See Table 1.)

Stainless Steel and Media Isolated: The MLH, 19 mm and SPT Series pressure sensors are designed to provide a sensing solution when high pressure, steel pressure port interface and/or corrosive media are present. A male threaded pressure port and stainless steel wetted surfaces provide an air and oxygen inlet. (See Table 1.)

Airflow Sensors

The AWM720P1 is designed to measure the flow of air and oxygen; it may used so that the desired mixture, as set by the doctor, is delivered to the patient. The total mixture that is delivered to the patient is also measured and displayed on the ventilator panel. The AWM5000 Series (AWM5104VN, AWM4300V and AWM3100V) may also be used; however, these are lower flow devices and may require a customer-created bypass. (See Table 2.)

Figure 2. Potential Honeywell Products used in Ventilators

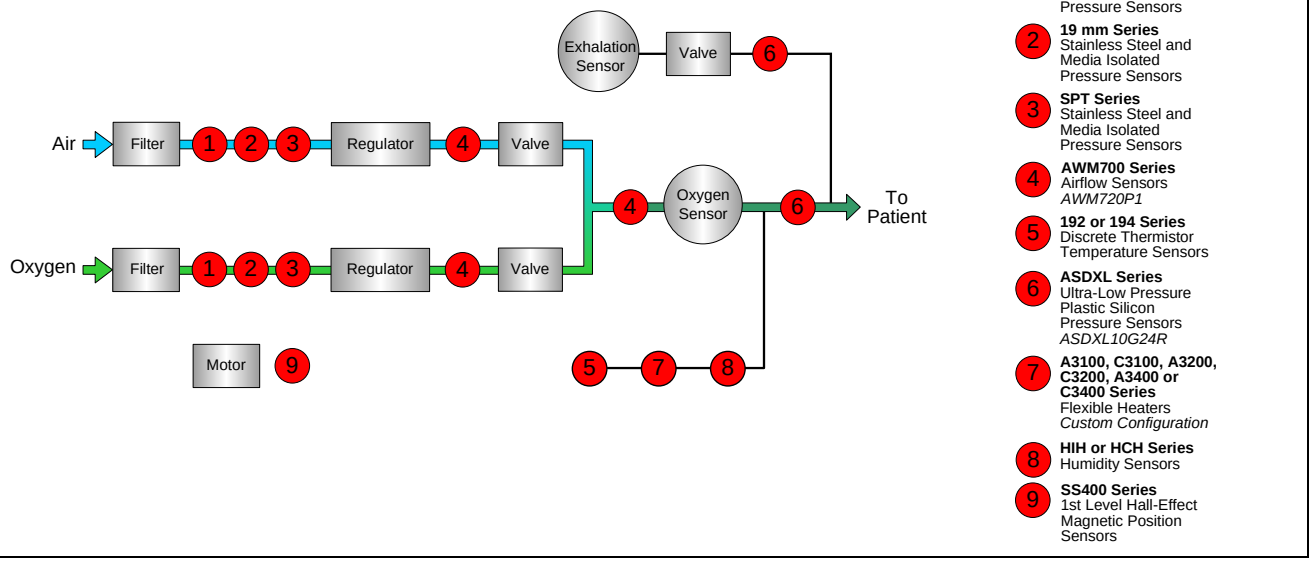

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Table 1. Pressure Sensors

Ultra-Low Pressure Plastic Silicon	Stainless Steel and Media Isolated		
ASDXL Series ***ASDXL10G24R***	**MLH Series**	**19 mm Series**	**SPT Series**
			
Features and Benefits			
• Repeatable output designed for enchanced accuracy and sensitivity over range of device • Customizable output designed for application flexibility • Fully compensated for ease of use	• Media isolated transducer (stainless steel wetted surfaces) designed for compatibility with many corrosive fluids and gases • Threaded pressure port designed for easy installation in customer manifold • Optional weldable interface designed to support a hermetic interface • Temperature-compensated electrical output • Amplified and non-amplified options		

Table 2. Airflow Sensors

AWM700 Series ***AWM720P1***	Features and Benefits
	• Enhanced response time and repeatability promotes quicker equipment decision making and machine accuracy • Small size may allow use in more compact machines • Standard port allows use of off-the-shelf pneumatic connectors • Medical industry standard 22 mm tapered port • Connector designed to secure electrical contact, promoting enhanced reliability • Low turbulence enhances accuracy by providing a faster, more accurate reading • Low pressure drop aides system design

Discrete Thermistor Temperature Sensors
Air from ventilators that is warm and moist helps provide the patient with a comfortable breathing situation and may reduce sore throats caused by breathing cold, dry air. As such, the temperature of the air delivery system is often monitored and controlled to help ensure that the air stream is maintained at the desired level of warmth. The 192 and 194 Series are installed directly into the air stream and are designed to monitor and control the air temperature. The sensor is coupled to a microcontroller designed to measure air stream temperature and interact with the controller which controls and regulates the temperature of the air stream. Honeywell offers several types of configurations. The packaged sensors are available as discrete components for customer-built assemblies, or Honeywell can provide a full assembly solution that the customer may simply pigtail into the system. (See Table 3.)

Humidity Sensors
The HIH-4000, HIH-4020/21, HIH-4030, HIH-4602 and HCH-1000 Series may be used to deliver warm and moist air, which often enhances patient comfort. When introducing moisture into the air stream, it must be monitored and controlled. Honeywell's humidity sensors are installed either directly into the air stream or in a parallel branch. The sensor is coupled to a microcontroller designed to measure the humidity of the air stream and to interact with the controller that ensures the correct level of moisture is present. (See Table 4.)

Flexible Heaters
Moisture introduced into the air stream is generated by either mist or heated vapor. This is often best accomplished by heating water to a vapor and introducing it into the air stream. This method often has an advantage over the misting method as it creates vapor, as well as heat. The A3100, C3100, A3200, C3200, A3400 and C3400 Series flexible heaters are custom-designed to customer requirements. On-board sensors such as thermistor thermal links and electrical fuses are commonly added. (See Table 5.)

1st Level Hall-Effect Magnetic Position Sensors
The robust and durable SS400 Series is designed to provide enhanced output accuracy for smooth motor control that reduces noise and vibration in motor assembly fan systems. Its 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 Table 6.)

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Table 3. Discrete Thermistor Temperature Sensors

192, 194 Series	Features and Benefits
	• Bare leads (192 Series) or insulated leads (194 Series) designed for improved application flexibility • Resistance temperature curve interchangeability designed to offer standardization of circuit components and simplification of design/replacement, as well as potential cost savings • Small size often eases use in confined spaces

Table 4. Humidity Sensors

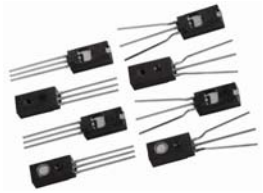
HIH-4000 Series	HIH-4020/4021 Series	HIH-4030 Series	HIH-4602 Series	HCH-1000 Series
				
Features and Benefits				
• SIP mountable in standard 0.050 in or 0.100 in lead spacing • Available with or without moisture/contamination filter for application flexibility • Accurate to ±3.5% RH • Analog voltage output		• Surface mount designed to support many production lines (available in 1,000-piece reels) • Available with or without moisture/ contamination filter for enhanced application flexibility • Accurate to ±3.5% RH • Analog voltage output	• Rugged, TO-5 packaging available with on-board temperature sensing • Available with or without temperature output option • Accurate to ±3.5% RH • Analog voltage output for humidity, resistance output for temperature	• Capacitance output • Most cost effective

Table 5. Flexible Heaters

A3100, C3100, A3200, C3200, A3400, C3400 Series	Features and Benefits
	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

Table 6. 1st Level Hall-Effect Magnetic Position Sensors

SS400 Series	Features and Benefits
	• Quad Hall-effect design minimizes effects of mechanical or thermal stress on output, and promotes a stable output • Unipolar, bipolar or bipolar latch magnetics and customizable operate/release points provide application flexibility • 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

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⚠ WARNING

PERSONAL INJURY

DO NOT USE these products as safety or emergency stop devices or in any other application where failure of the product could result in personal injury.

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. 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.**

While we provide application assistance personally, through our literature and the Honeywell web site, it is up to the customer 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 printing. However, we assume no responsibility for its use.

⚠ WARNING

MISUSE OF DOCUMENTATION

- The information presented in this application note is for reference only. Do not use this document as a product installation guide.
- Complete installation, operation, and maintenance information is provided in the instructions supplied with each product.

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

SALES AND SERVICE

Honeywell serves its customers through a worldwide network of sales offices, representatives and distributors. For application assistance, current specifications, pricing or name of the nearest Authorized Distributor, contact your local sales office or:

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