Medical In-Line Sensors
Piezoceramics in Ultrasonic Applications
Medical In-Line Sensors

CeramTec specialises in the design and manufacture of In-Line Sensors for a variety of medical equipment such as infusion pumps, enteral feeding pumps, dialysis equipment and other fluid management applications.

Our range of Medical In-line sensors offer non-invasive detection of air bubbles, pressure changes and flow rate measurements of fluids in flexible tubes. In lines leading into or out of the body it is vital that variables such as air content, pressure and flow rate are monitored, therefore our safety critical sensors are an important part of high level medical care.

Our scope of supply can range from bare tuned piezo ceramic disc or plate to a fully functional packaged sensor. The sensors can either be selected from our standard range, discussed further on the inside pages, or more frequently are designed to suit specific OEM needs. Our dedicated design team are able to develop custom solutions for a wide range of applications that fully meet the customers’ requirements. Finally our team sees these designs through to production in one of our ISO13485 factories.
Why choose CeramTec safety critical products:

- Designed and manufactured to ISO13485 quality standard in the UK
- Comprehensive range to cover most fluid handling applications
- Electronics factory programmable to match specific customer tubing requirements
- Compact and robust design
- Customisation including multiple sensor solutions in one module reduces overall cost and installation times
- Contract sub-assembly option utilizing CeramTec in-house piezo ceramic from our catalogue of industry leading materials

**CUSTOM SENSORS**

The majority of our customers specify unique features and requirements for their sensors. Our design team can help to optimise housing geometry, materials and performance to suit the specific application. Tubing used in each application might also influence clamping method used, dimensions needed for tube diameter and coupling required for tubing material, all of which we can design for.

We can also design sensors with a combination of functions such as air in-line, occlusion, optical sensing, temperature measurement and flow rate.

Our sensors are typically used in the following applications:

- Infusion Pumps
- Haemodialysis
- Transfusions
- Liquid Dispensing

- Enteral Feeding Pumps
- Blood Processing Equipment
- Contrast Injectors
- Cardiopulmonary bypass
CeramTec has a range of air bubble sensors to suit a variety of applications. These sensors will detect the presence of air bubbles in flexible tubing for example in infusion lines. All the sensors can be mounted in any orientation and are designed to be dry coupled to flexible tubing such as PVC or silicone. Our range covers a large range of tube sizes and are IP67 rated and RoHS compliant.

**Model 09254**
This sensor is designed for small diameter tubing around 3/32" (2.4mm) outside diameter where low flow rates and volumes are required, such as accurate liquid dispensing and insulin pumps.

**Model 09168**
This sensor is designed for tubes around 3/16" (4.7mm) outside diameter and are used extensively in liquid handling applications.
Model 09267
This sensor is designed for tubes around ¼” (6.3mm) outside diameter where bigger flow rates are required. Typical applications include haemodialysis, blood apheresis, cardio-pulmonary bypass.

Model specifications:

<table>
<thead>
<tr>
<th>Model Number</th>
<th>09254</th>
<th>09168</th>
<th>09267</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tubing Outer Diameter</td>
<td>2.2mm – 3.5mm</td>
<td>4mm – 4.6mm</td>
<td>5.5mm – 7mm</td>
</tr>
<tr>
<td>Bubble size detection</td>
<td>1µl</td>
<td>1µl</td>
<td>5µl 1</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>10°C – 40°C</td>
<td>10°C – 40°C</td>
<td>10°C – 40°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-20°C – 70°C</td>
<td>-20°C – 70°C</td>
<td>-20°C – 70°C</td>
</tr>
<tr>
<td>Drive circuit incorporated</td>
<td>9001/001</td>
<td>Custom option 2</td>
<td>9001/001</td>
</tr>
<tr>
<td>Operating Voltage</td>
<td>5Vdc</td>
<td>1-5Vrms</td>
<td>5Vdc</td>
</tr>
<tr>
<td>Casing material</td>
<td>PoM-C</td>
<td>SBS / PC blend</td>
<td>PoM-C</td>
</tr>
</tbody>
</table>

1 1µl can be detected if the tube is compressed in the channel using a hinged clamp mechanism
2 This small sensor is designed for use in confined spaces and does not include on board electronics. Electronics can be sold separately or the sensor customised to include the electronics on board

Electronic Characteristics:

<table>
<thead>
<tr>
<th>Model Number</th>
<th>9001/000</th>
<th>9001/001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive Voltage (Vcc)</td>
<td>3-5Vdc</td>
<td>5Vdc</td>
</tr>
<tr>
<td>Output</td>
<td>Analogue (0.5 – 2.5Vdc)</td>
<td>Digital (0 / Vcc)</td>
</tr>
<tr>
<td>Self-test facility</td>
<td>No</td>
<td>Yes, simulates air</td>
</tr>
<tr>
<td>Factory Programmable functions</td>
<td>No</td>
<td>Upper threshold Lower threshold Output high or low for air</td>
</tr>
<tr>
<td>Response times</td>
<td>100µs</td>
<td>250µs</td>
</tr>
<tr>
<td>Power consumption</td>
<td>25mW</td>
<td>25mW</td>
</tr>
</tbody>
</table>
Occlusion Sensors

CeramTec designs and manufactures accurate pressure sensors using piezo-resistive technology. They can detect both negative pressure caused by upstream blockages and positive pressure caused by downstream blockages in the tubing. Tube contact sensors offer non-invasive detection of pressure changes in a flexible tube without the requirement of a disposable cassette. They are suitable for use with a soft thin walled tubing and are ideal where blocked tube detection is required.

**09186 Occlusion Sensor**

This occlusion sensor combines MEMS Silicon machined technology and precision machined lid and catch to provide accurate on contact relative pressure measurements.

**Combination Sensors**

Often both occlusion sensors and bubble detectors are required simultaneously, CeramTec can provide both these sensors in one housing with a single connection. Combining the two sensors reduces the number of suppliers and the footprint needed.

<table>
<thead>
<tr>
<th>General sensor performance characteristics*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube outside diameter</td>
</tr>
<tr>
<td>Typical Output</td>
</tr>
<tr>
<td>Span</td>
</tr>
<tr>
<td>Recoverable over force</td>
</tr>
<tr>
<td>Destructive force</td>
</tr>
<tr>
<td>Environmental</td>
</tr>
</tbody>
</table>

* Based on 5V DC drive voltage and 4.0mm OD x 0.75 wall thickness PVC tube (Tygon B-44-4X)

This image is an example of a custom sensor combining bubble and occlusion sensors. Additional sensing technologies can also be added, such as blood leakage detectors, thermistors and micro switches, to detect correct tube insertion and fluid temperature.
Ultrasonic Level Sensors
For Non-invasive Level Measurement

Utilising CeramTec’s extensive range of piezo materials and expert design team, we have developed custom solutions for global medical device manufacturers based on the technology behind our 09279 level sensors to detect the level of a variety of liquids in disposable sets. Solutions have been found for a variety of common complex problems, with some of the benefits being:

- Dry couple to rigid or flexible, disposable or reusable chambers
- Multiple levels can be detected on chambers of any size with the minimum and maximum levels as close as 4mm apart
- Pulse echo or through-beam (transmit and receive) technology, depending on the complexity of the chamber
- Multiple levels can be monitored using a single sensor block
- Detects foam as air, unlike capacitive sensors which detect foam as liquid
- Not affected by liquid or chamber colour
- Highly temperature stable
- Built in electronics with choice of connections

The new ultrasonic sensor is capable of detecting the presence of liquid within a container, and by being attached in a fixed position, can be used as a point level detector. Due to its novel dry-couplant design, the sensor is non-invasive and requires no acoustic gels or liquid and leaves no mess. Capable of working with containers like drip chambers as small as 15mm in diameter, this transducer provides a flexible and accurate way of measuring liquid levels spanning applications from liquid drug handling to dialysis and contrast injection. The same technology can be used to monitor continuous levels by using programmable electronics, giving real time fluid depth in a container.

Mechanical Specification
- Uses ultrasonic pulse/echo measurement technique; the acoustic signal is reflected from the container wall back to the sensor
- Housing made from tough, chemical resistant polymer
- Innovative compliant coupling layer
- Level measurement accuracy ~2mm
- Attached using an adjustable strap made from medical grade plastic
- 28AWG wires with black insulated main cable
- Available with or without drive electronics

APPLICATIONS
- Liquid dispensing
- Industrial
- Dialysis
- Liquid drug handling
- Contrast injection
- Bottle filling

KEY FEATURES
- Removable and reusable
- Dry-coupled
- Compact size
- Range 10-300mm
The measured values mentioned before were determined for test samples and are applicable as standard values. The values were determined on the basis of DIN-/DIN-VDE standards and if these were not available, on the basis of CeramTec standards. The values indicated must not be transferred to arbitrary formats, components or parts featuring different surface qualities. They do not constitute a guarantee for certain properties. We expressly reserve the right to make technical changes.