

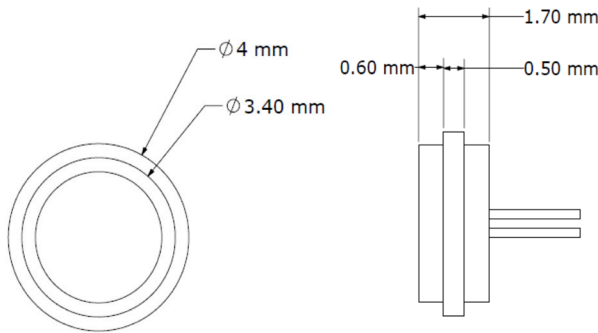


## Making medical devices smarter, long-term.

### TiSense Module

The TiSense Module, a MEMS piezo-resistive sensor integrated into a chronic implantable sensor module, was designed for customers seeking an implant duration that is greater than Millar's standard catheter-based offerings. This newly designed sensor, made of a titanium housing, allows for implantation periods of greater than 5 years, when integrated into a medical device. TiSense is an absolute, half-bridge sensor and measures incident pressure with respect to an internal vacuum. The sensor connections exit via a hermetically sealed feedthrough port and require two 3K $\Omega$  bridge completion resistors outside the module to complete the bridge. The system will require a barometric pressure sensor external to the module to correct for changes in atmospheric pressure. TiSense does not include signal-conditioning electronics within the module. The module is filled with silicone oil which communicates pressure from a thin membrane in the front face. All body contacting portions are constructed from titanium. The pins from the feedthrough are platinum-iridium and the module can be tested in accordance with customer provided specifications.

### Drawing & Diagram



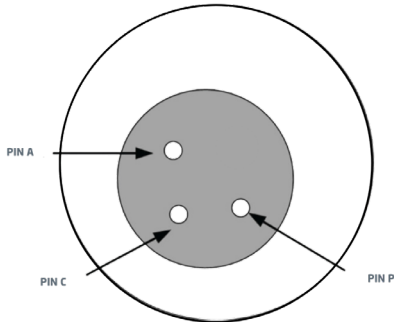
Mechanical Specifications					
Parameter	Min	Typical	Max	Units	Notes
Height of Module	1.57	1.7	1.83	mm	Pin length not included.
Diameter of Module	3.87	4	4.13	mm	
Material	Titanium Grade 2				
Number of Pins	3				
For production use, it is recommended to use a flex PCB to terminate the pins.					

*Drawing: Left (Front view) and Right (Sideview) of TiSense module. Wires can be attached to the pins through soldering; however, care should be taken to not expose the pins to an extended duration of heat during the soldering process. For production use, it is recommended to use a flex PCB with via holes to terminate the pins.*

### Technical Specifications

Parameter	Range	Notes
<b>Sensor Operation Specifications</b>		
Operational Pressure Range	510 - 1010 mmHgA	Range is $\pm 250$ mmHg centered around atmospheric pressure (760 mmHgA). There can be $\pm 15$ mmHg variation in atmospheric pressure at the time of characterization.
Accuracy Error	-0.5 - 0.5 % of applied pressure	Includes errors from non-linearity over a range of 500 mmHg applied pressure.
<b>Electrical Specifications</b>		
Resistance	2.2 - 4.2 K $\Omega$	Resistance of each sensing element as measured from C-A pin or C-P pin.
Excitation Range	1 - 6 Volts DC	
Sensitivity of Sensor	$\mu V/V/mmHg$	10 $\mu V$ signal per volt of excitation per mmHg incident pressure. When completed with equivalent 3K resistors into a full bridge.
<b>Environmental Specifications</b>		
Operational Temperature Range	35 - 39 deg.C	
Storage Temperature Range	20 - 40 deg.C	Storage range until further testing is performed.

### Connection Diagram

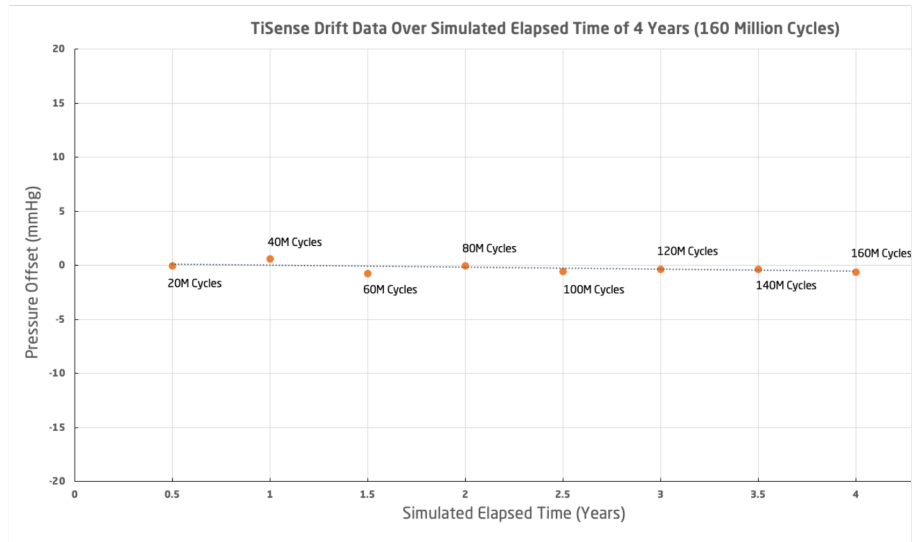


Backside view of TiSense Module

The three pins of the TiSense module can be trimmed to desired length. The positive and negative designations are dependent on the values of the C-A and C-P resistors.

Pin	Function
A	Negative (-) Signal pin
C	Center pin of half-bridge
P	Positive (+) Signal pin

### Drift Testing



In laboratory testing, sensor (n=1) was:

- Immersed in body temperature water (37 °C) to simulate actual body conditions.
- Exposed to >160M representative cardiac pressure cycles, representing >4 years of cardiac pressure cycles.

### Reliability Testing

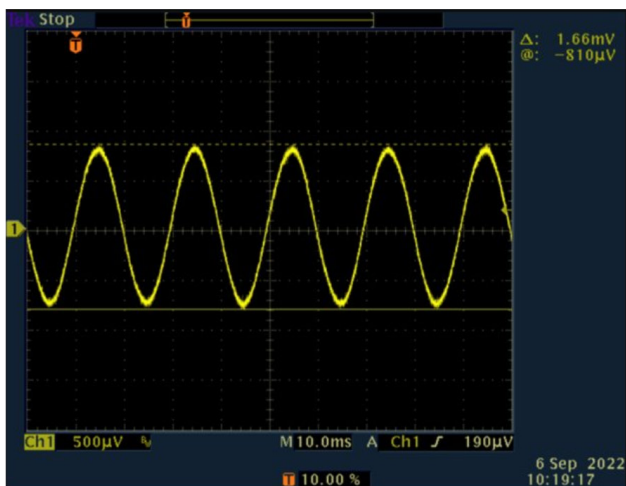


Figure 1: Scope data output from unit MA000044 at the beginning of the test. 3V excitation, Pressure input is 80-120 mmHg. Measured sensitivity is 13.8  $\mu\text{V/V/mmHg}$ .

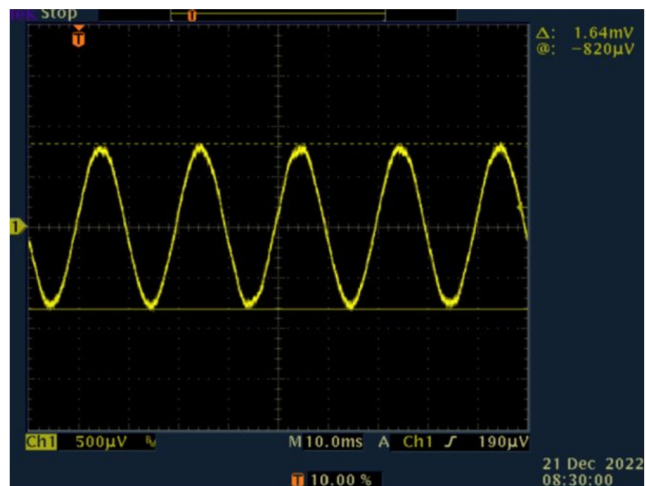


Figure 2: Scope data output from unit MA000044 at the end of the test. 3V excitation, Pressure input is 80-120 mmHg. Measured sensitivity is 13.66  $\mu\text{V/V/mmHg}$ .

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