



6 mm Dielectric/Conductivity Sensor Specifications



Figure 1
6 mm diameter reusable dielectric/conductivity sensor

DESCRIPTION

Suitable for R&D, QA/QC and manufacturing applications with repetitive operations, the 6 mm dia. sensor is designed for use in presses, molds or harsh environments where a tiny, reusable dielectric/conductivity sensor is desired. It may be mounted so the electrode is flush with a platen or mold surface, insuring no interference with the flow of material during processing. The sensor is constructed with a stainless steel electrode embedded in a high temperature polymer insulator.

The 6 mm sensor is rated for operation up to 200 °C, and the dielectric signal is routed through a 10-foot (3 m) long conduit to a standard dielectric connector. The single electrode of the 6 mm sensor requires a nearby grounded metal surface for proper sensor operation. This configuration is effectively a set of parallel plate electrodes which needs correct determination of A/D ratio and base capacitance for accurate calibration. A/D ratio and base capacitance are typically measured experimentally and depend on exact mold and mounting configuration.

The 6 mm sensor does not have a thermocouple and cannot measure temperature by itself.

SPECIFICATIONS

Dimensions

Diameter at head	: 6.0 mm nominal
Height	: 12.0 mm nominal
Length, conduit	: 10' (3 m) nominal
Diameter, electrode	: 4.0 mm
Area, electrode	: 0.127 cm ²

Composition:

Electrode	: Stainless steel
Insulator	: Vespel
Conduit	: Steel
Cabling	: Teflon insulated

Operational:

Temperature, maximum	: 200 °C (392 °F)
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Sensor Parameters:

A/D ratio	: 0.282 cm ² / (mold gap in cm)
	Note—A/D ratio is typically determined empirically and varies with exact mold and mounting configuration

Base capacitance	: Determined empirically
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Thermocouple	: None
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Measurement, mid-con mode:

Log Conductivity	: Range varies with A/D ratio
Log Ion Viscosity	: Range varies with A/D ratio
Log Loss Factor	: Range varies with A/D ratio
Permittivity	: Not recommended for accurate measurement of permittivity, although trends are indicative

Measurement, high-con mode:

Log Conductivity	: Range varies with A/D ratio
Log Ion Viscosity	: Range varies with A/D ratio
Log Loss Factor	: Range varies with A/D ratio
Permittivity	: Not applicable



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OPERATING MODES

The 6 mm sensor may be used with all Lambient Technologies dielectric instruments in either mid-conductivity or high-conductivity mode. The sensor makes a bulk measurement of material between its single electrode and the surrounding metal, typically the opposite platen of the mold, in a parallel-plate configuration. The calibration factor for single electrode sensors is the *A/D ratio*, which refers to the ratio of the area of a parallel plate electrode divided by the distance between the plates. In the ideal case where mold separation distance *D* is much less than the electrode radius *R*, the *A/D ratio* for the 6 mm sensor is given by equation 1:

(eq. 1) $A/D = \text{Area of electrode} / \text{plate separation}$

Where: $A = \pi * R^2 = 0.127 \text{ cm}^2$
 $D = \text{separation of mold platens (cm)}$
 $R = \text{electrode radius} = 0.2 \text{ cm}$

And: $D \ll R$

Note that the *A/D ratio* has units of *cm* for use with CureView software.

Because fringing electric fields to the surrounding mold make equation 1 less accurate for larger values of *D*, the *A/D ratio* and base capacitance are most accurately determined experimentally.

For proper use of single electrode sensors, the metal platen holding the sensor must be grounded. The ground of the platen must be connected to the chassis ground of the dielectric measurement instrumentation as shown in Figure 2. If an upper platen is used, it must be grounded, also.

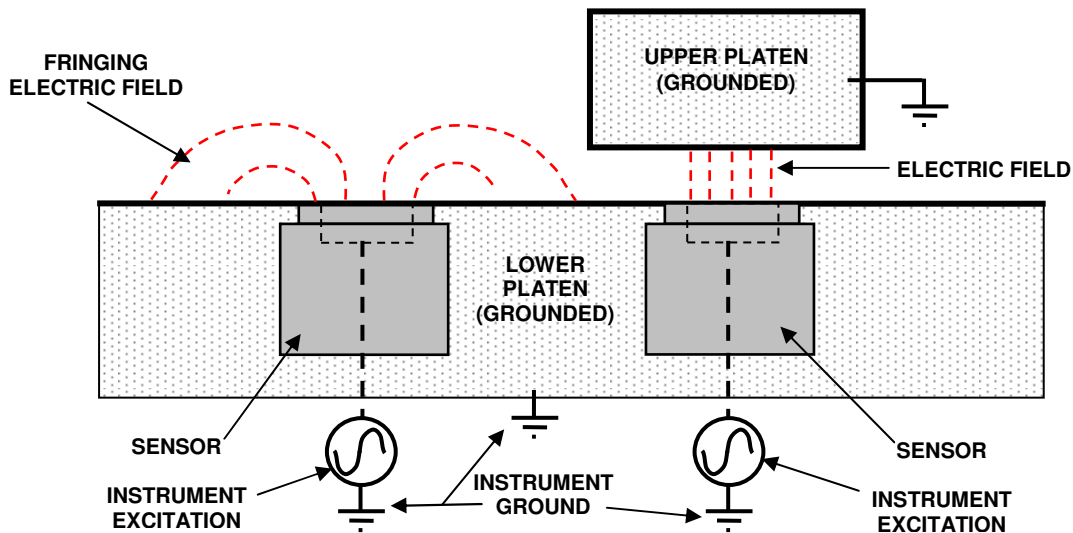


Figure 2
Proper grounding of platens or mold

6 mm SENSOR FORM FACTOR

The 6 mm sensor is constructed with a stainless steel electrode embedded in a Vespel insulator. The head of the sensor has the same dimensions as a Kistler pressure sensor. The sensor is connected to a 10-foot (3 meter) long steel conduit terminated with a standard three-terminal dielectric connector. The conduit is connected to the dielectric instrument ground through the "G" terminal of the connector. The 6 mm sensor does not have a thermocouple and cannot measure temperature by itself. Figure 3 shows the entire sensor assembly consisting of sensor, conduit and dielectric connector.



Figure 3
6 mm sensor assembly

The 6 mm sensor head and strain relief have the dimensions shown in Figure 4. Dimensions in brackets are in millimeters. Dimensions not in brackets are in inches.

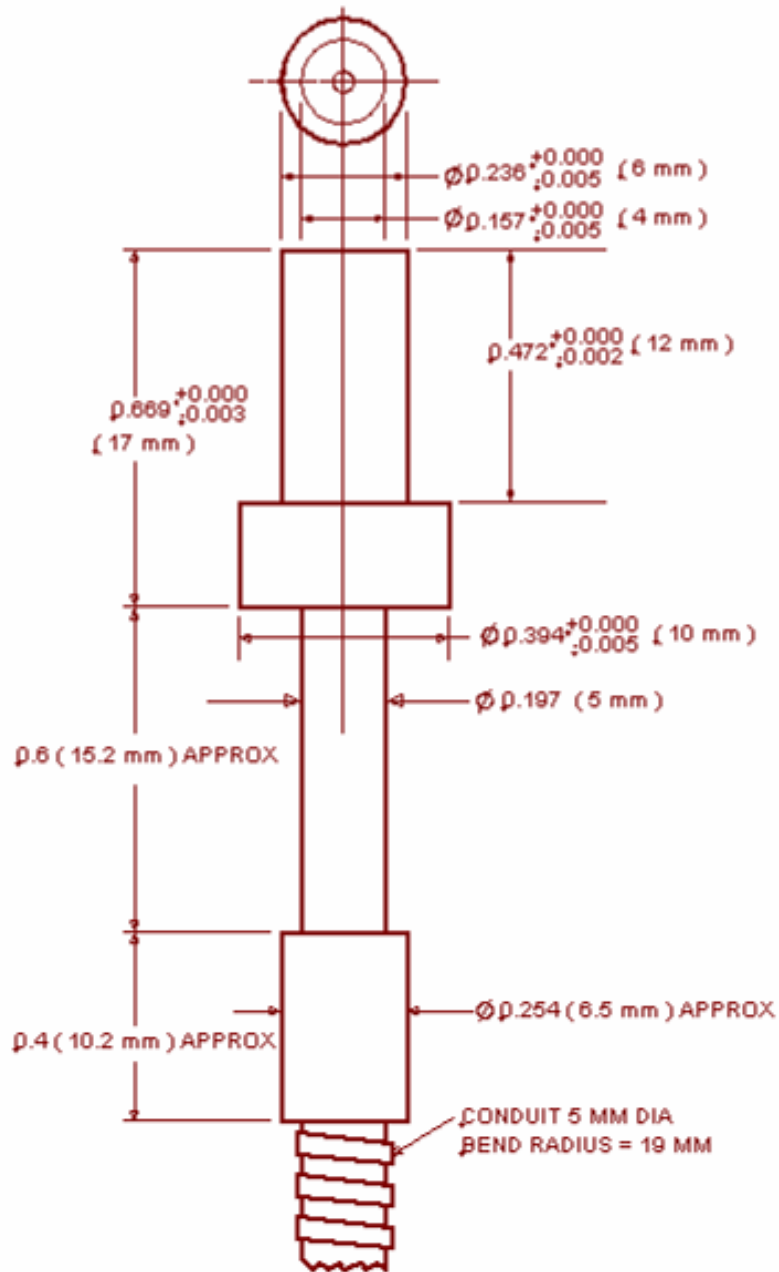


Figure 4
Dimensions of 6 mm sensor

INSTALLATION

The 6 mm sensor is designed for mounting from the rear side of a mold or platen as shown in Figure 5. It is recommended that silicone lubricant be applied to the side of the sensor before installation, to facilitate removal when necessary.

It is important to support the rear side of the sensor to prevent high pressures from pushing it into the mold or platen.

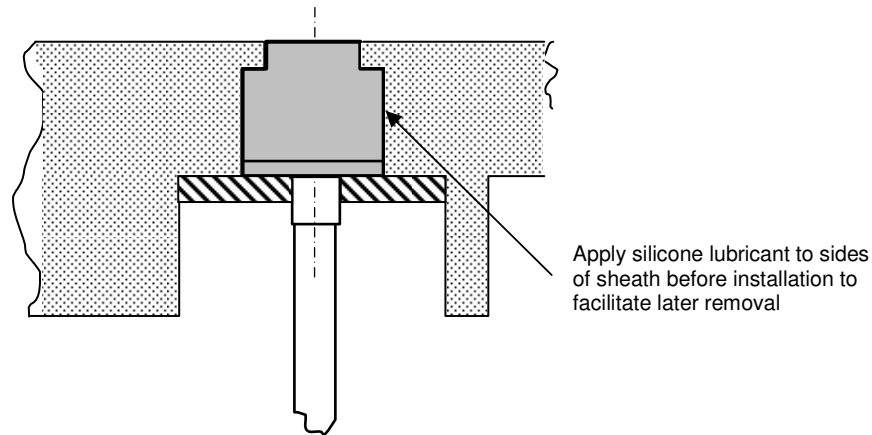


Figure 5
Sensor installation
Mounting from rear

CARE AND HANDLING

Always apply mold release to the surface of the sensor before use with curing material. A silicone based mold-release is recommended to reduce conductive contributions to the measurement. Damage to the sensor may result if mold release is not used and cured material is peeled from the surface.

Do not apply excessive strain to the conduit. The conduit is securely attached to the sensor body, but the signal wires inside it are not designed to withstand excessive pulling forces.

TEST PROCEDURE

The recommended configuration for testing the 6 mm sensor is shown below in Figure 6. The sensor is mounted in one platen of a mold and the other platen, if any, is at a separation of 20 mm or greater to minimize its effect on the fringing electric field. Under this condition the electrode of the sensor primarily detects the grounded metal of the platen that surrounds it. The material above the sensor is air.

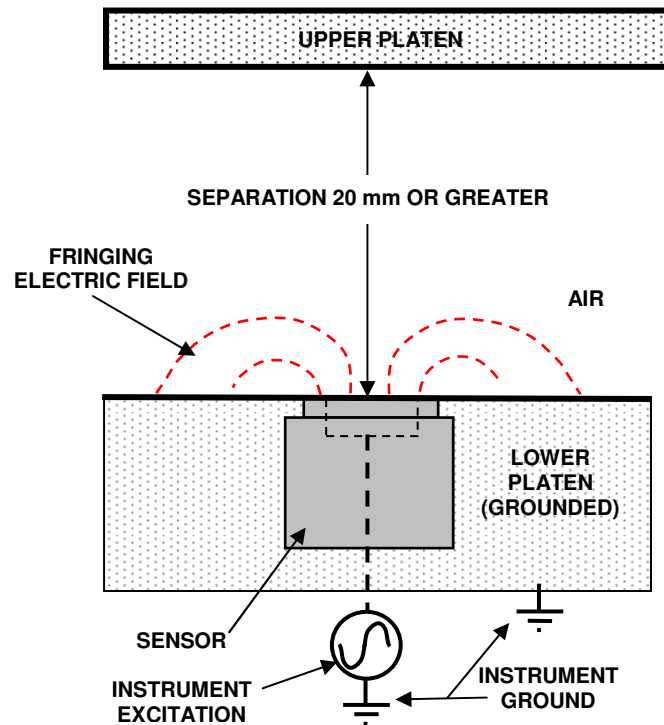


Figure 6
Recommended configuration for testing the 6 mm sensor

Use the following procedure to test whether the sensor is operating properly:

1. Set excitation frequency to 1.0 KHz.
2. Measure gain and phase in air using the CureView test window.
3. Note that the following effects which may cause inaccurate results:
 - The first several measurements may be unstable because the mid-conductivity circuit requires time to settle after a change in frequency. Repeat the test measurement several times until the results are stable.
 - Motion of the user or other people near the sensor may induce noise in the measurement. Avoid motion near the sensor during a test.

4. The response of a clean, dry sensor in air at 1.0 KHz, 20°C:
 - Mid-conductivity interface in subtraction (default) mode
 - Gain : -50 to -40 dB (typ)
 - Phase : -5° to 5° (typ)
 - Exact results may vary depending on cable length and other factors.
 - Results that differ substantially from the above may indicate a sensor that is dirty, moist or damaged. Refer to the following section on cleaning. If the sensor response after cleaning is still outside the typical range, please consult with Lambient Technologies.
5. For an additional confirmation of proper operation, place a sample of material on the sensor and repeat the test measurement. The gain-phase results should change, indicating that the sensor has detected and responded to a different dielectric material.

CLEANING

Careful use of a spatula or other scraping tool to remove samples will not damage the sensor, provided that mold release was applied to the sensor before curing.

Clean sensors with acetone, trichlorethylene or other solvent to remove oils and contaminants. Solvents or water adsorbed onto the surface of the sensor normally will not interfere with cure monitoring because it is released at elevated temperature, and would not be present at typical process temperatures.

At room temperature, however, adsorbed solvent or water will appear as an additional conductive component and may dominate the measurement. In this case the gains in air may be elevated (less negative, approaching 0 dB at low frequencies) and phases may be significantly negative. Heating the sensor above 100 °C for a short time should remove adsorbed material.

LAY-UP TECHNIQUES

1. Place samples on the sensor, insuring good contact with the electrodes.
2. Solid samples, or solid samples which melt during processing, will require applied pressure. The sensors are designed to withstand high pressures and temperatures up to 200 °C.
3. Composite materials containing graphite or other conductive fibers will require use of a filter layer to prevent shorting of the electrode to ground. Glass cloth with small pore size, or fiberglass felt, is recommended for these situations.

INSTRUMENT COMPATIBILITY

Compatible with:

Micromet Instruments/Holometrix-Micromet

Eumetric System II Microdielectrometer
Eumetric System III Microdielectrometer
Eumetric 100A
ICAM 1000/1500/2000
MDE Series 10/20 Cure Monitor

NETZSCH Instruments

DEA 230/1
DEA 230/2
DEA 230/10
DEA 231/1
DEA 231/4



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