Mini-Varicon™
Dielectric/Conductivity Sensor
Specifications

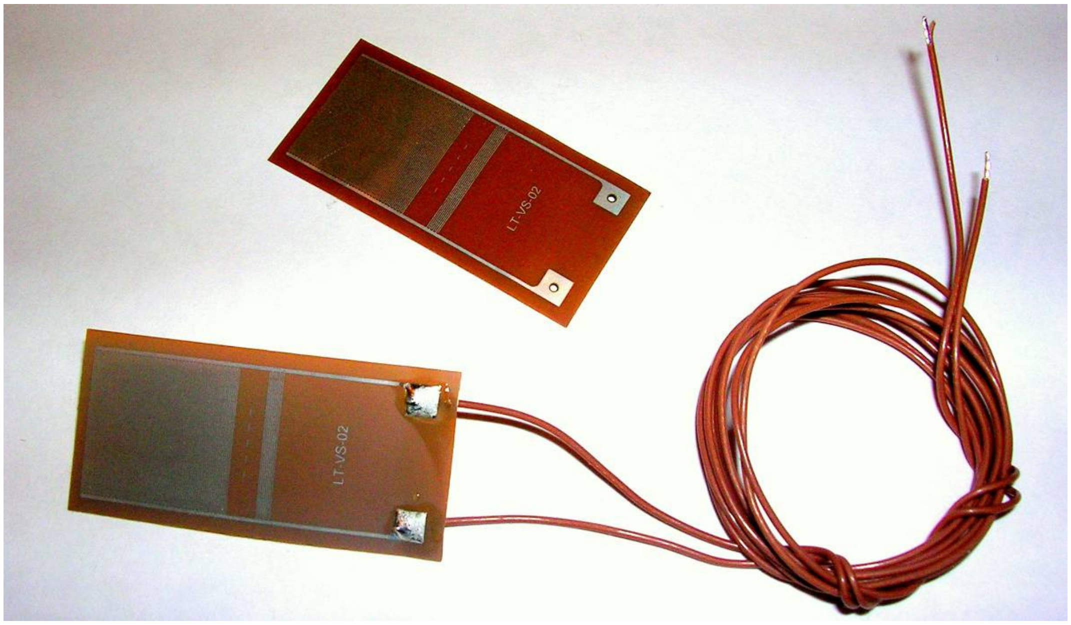

Figure 1
Mini-Varicon Dielectric/Conductivity Sensor

DESCRIPTION

The Mini-Varicon sensor is a thin, flexible dielectric sensor designed for cost-sensitive use with presses, molds, bulk materials or laminates. Patterned on a polyimide substrate, the electrode array is designed to allow a choice of high or low sensitivity, selected by either using the whole sensor or cutting off a portion of the array at a designated line. The Mini-Varicon sensor can be supplied without leads, or with custom-length Teflon-insulated leads attached.

The Mini-Varicon sensor head is 1.5″ (4.0 cm) long and only 0.004″ (100 um) thick. The tin-plated electrodes have 0.004″ (100 um) widths and spaces. The Mini-Varicon sensor can measure the dielectric/conductive properties of materials within approximately 0.004″ (100 um) of the electrode surface.

The Mini-Varicon sensor is suitable for high pressure applications and is ideal for measuring the dielectric properties and cure state of epoxies, bulk molding compound (BMC), sheet molding compound (SMC), silicones, thermosets, urethanes, RIM and composite materials. When used without leads, the sensor will tolerate temperatures up to 375 °C. When supplied with leads, the sensor will operate up to 200 °C.

GENERAL SPECIFICATIONS

Dimensions:

Length, sensor head	:	1.6″ (4.0 cm)
Width, sensor head	:	0.75″ (1.9 cm)
Thickness, sensor head	:	0.004″ (100 um)
Width, electrode	:	0.004″ (100 um)
Spacing, electrode	:	0.004″ (100 mm)

Composition:

Substrate, sensor head	:	Polyimide
Electrodes	:	Copper with tin flash
Lead insulation	:	Teflon

Operational:

Temperature, maximum	:	375 °C (700 °F) without leads
	:	200 °C (392 °F) with supplied leads

Sensor Parameters:		A/D ratio	Base capacitance
Configuration A (mid sensitivity)	:	80 cm	~25 pF*
Configuration B (low sensitivity)	:	7.2 cm	~ 3 pF*

* Actual value may vary

Temperature sensor : None

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SENSOR CONFIGURATIONS

The Mini-Varicon sensor may be used with all Lambient Technologies dielectric instruments in either mid-conductivity or high-conductivity mode. Normally the sensor is making a surface measurement of material between the interdigitated electrodes, shown close-up in Figure 2. The electrodes are grouped into two areas, with 40 and 4 pairs of fingers each, and the sensitivity of the sensor may be decreased by removing the large section at cut-lines B-B. The two Mini-Varicon sensor configurations are described below:

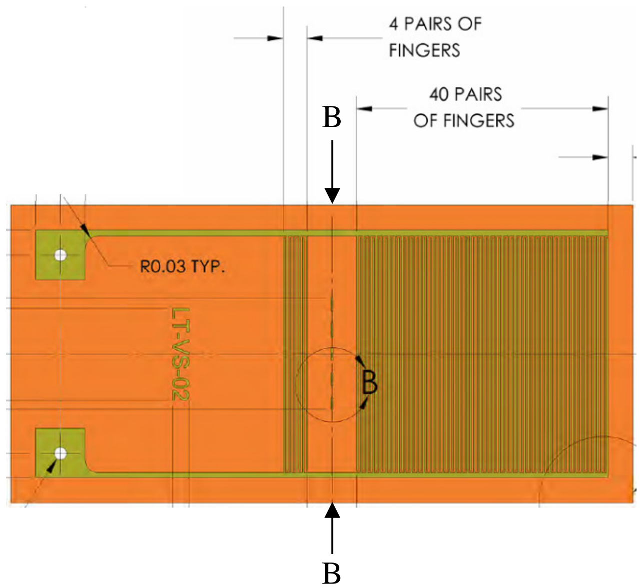

Figure 2
Close-up view of Mini-Varicon electrodes
(Configuration A for maximum sensitivity)

Configuration A:
Mid sensitivity
For Low to Mid-Conductivity materials
A/D ratio = 80 cm, Base Capacitance = ~25 pF

Configuration A is the result when the entire sensor head is used, and is shown in Figure 2. Configuration A is designed to have the same parameters as the NETZSCH Instruments 036S IDEX sensor, and can be used if a sensor is required to have the same response as the 036S.

Note: When using Configuration A, the applied material must cover both electrode areas for correctly calibrated measurements. See **LAYUP TECHNIQUES**.

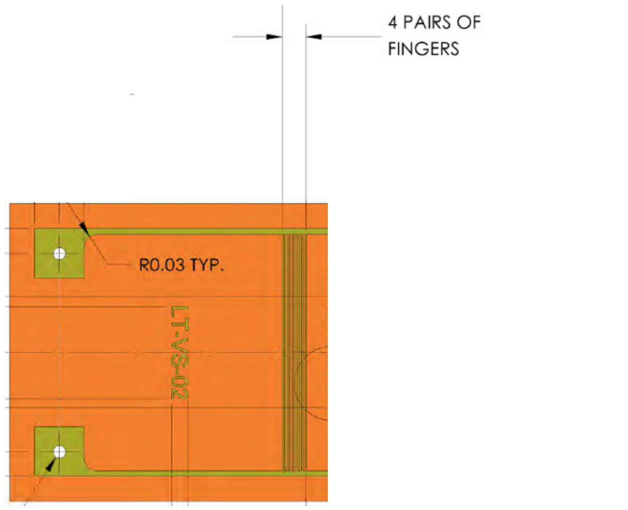

Figure 3
Mini-Varicon electrodes after cutting at line B-B
(Configuration B)

Configuration B:
Low sensitivity
For High Conductivity materials
A/D ratio = 7.2 cm, Base Capacitance = ~3 pF

Configuration B is the result when the sensor head is cut at line B-B, and is shown in Figure 4. The electrode area is 1/11th of the area of Configuration A, with 1/11th the sensitivity. Configuration B is designed to be used for highly conductive materials such as fluids.

SPECIFICATIONS

Dimensions:

Length, sensor head	: 1.6″ (4.0 cm)
Width, sensor head	: 0.75″ (1.9 cm)
Thickness, sensor head	: 0.004″ (100 um)
Width, electrode	: 0.004″ (100 um)
Spacing, electrode	: 0.004″ (100 mm)

Composition:

Substrate, sensor head	: Polyimide
Electrodes	: Copper with tin flash
Lead insulation	: Teflon

Operational:

Temperature, maximum	: 375 °C (700 °F) without leads
	: 200 °C (392 °F) with supplied leads
Frequency, mid-con mode	: 0.1 Hz – 100 KHz
Frequency, high-con mode	: 0.001 Hz – 100 KHz

Sensor Parameters:	A/D ratio	Base capacitance
Configuration A	: 80 cm	~25 pF*
Configuration B	: 7.2 cm	~ 3 pF*

* Actual value may vary

Temperature sensor : None

Configuration A (A/D ratio = 80)

Mid-con mode

Log Conductivity	: -13 to -4 Log(siemens/cm)
Log Ion Viscosity	: 4 to 13 Log(ohm-cm)
Log Loss Factor	: -1 to 4
Permittivity	: 1 to 10^2

(Not recommended for accurate measurement of permittivity, although trends are indicative)

Configuration B (A/D ratio = 7.2 cm)

Mid-con mode

Log Conductivity	:	-12 to -3 Log(siemens/cm)
Log Ion Viscosity	:	3 to 12 Log(ohm-cm)
Log Loss Factor	:	0 to 5
Permittivity	:	1 to 10^2

(Not recommended for accurate measurement of permittivity, although trends are indicative)

Note about base capacitance:

The base capacitance in the dielectric measurement software may need to be adjusted if additional cabling connects the sensor to the dielectric instrument. Base capacitance will also vary with the arrangement of leads attached to the sensor. *To reduce base capacitance, avoid twisting the leads together; instead, let the leads run parallel to each other with some distance between them.*

Adjusting the base capacitance is necessary to obtain reasonably accurate measurements of permittivity. If the user is only concerned about loss factor or ion viscosity, the base capacitance adjustment is not critical. Ion viscosity is not sensitive to base capacitance.

TEST MEASUREMENT (Typical results—actual results may vary)

Sensor configuration	A	B
A/D ratio	80 cm	7.2 cm
Base capacitance	25 pF	3 pF
$Gain_{Mid-con}$	-41 to -30 dB	-55 to -44 dB
$Phase_{Mid-con}$	-3 to +3 deg	-6 to +6 deg

Table 1
Typical 10 Hz test results in air @ 20° C

Results that differ significantly from those in Table 1 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 Instruments.

CLEANING

Clean sensors with acetone, trichlorethlyene 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 may appear as an additional conductive component that 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 and return the response in air to reference values listed in the **TEST MEASUREMENT** section.

LAY-UP TECHNIQUES

1. To prevent a short circuit between the bond pads, sensors with attached leads should not contact electrically conductive surfaces.

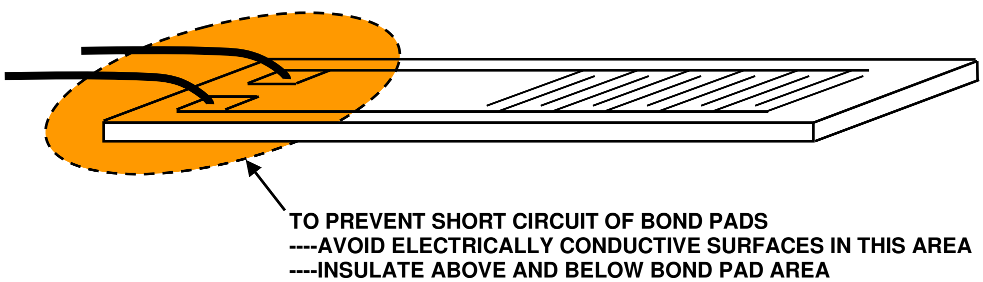

Figure 4
Insulating bond pad area

A good way to prevent short circuits of the sensor is to apply Kapton or polyimide tape to the sensor or to the surface on which the sensor will rest.

2. To reduce base capacitance, avoid twisting the leads together; instead, let the leads run parallel to each other with some distance between them.

3. Place samples on the sensor, insuring good contact with the electrodes. Cover both electrode arrays when using Configuration A as shown in Figure 5.

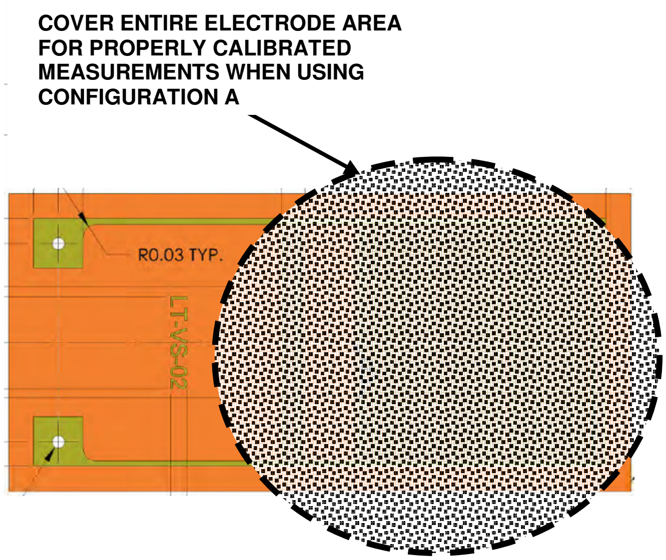

Figure 5
Sample application area for Configuration A

4. Solid samples, or solid samples which melt during processing, will require applied pressure. The sensors with attached leads are designed to withstand high pressures and temperatures up to 200 °C. Sensors without leads will tolerate temperatures up to 375 °C.

5. The thickness of the sample should be at least 0.004" (100 um), otherwise the sensor will also detect air or material on the other side of the sample.

6. Composite materials containing graphite or other conductive fibers will require use of a filter layer to prevent shorting of the electrodes. Glass cloth with small pore size, or fiberglass felt, is recommended for these situations.

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