



***Insight* — Application Note 2.30**

Diagnosing Instruments and Sensors

Introduction

Occasionally it may be necessary to test either the LT-451 Dielectric Cure Monitor or the LTF-631 High Speed Dielectric Cure Monitor for proper operation. Investigating the various parts of the system is important to establish that a component is working as expected, or to determine that a component is faulty. The main, accessible links in the signal chain are:

- Computer to instrument connection
- Instrument to sensor or instrument to extension cable connection
- Sensor

This application note will show the proper connections at these various points and discuss how to test for proper operation.

Connecting to the Instrument

The CureView software interfaces to the LT-451 and LTF-631 through a single RS-232 serial port on the PC using a null-modem cable provided with the instrument. If desired, or if the PC has no RS-232 port, the PC may connect to an instrument through a USB port using a USB to RS-232 converter also provided with the instrument.

To confirm correct connection between the instrument and computer:

- Refer to Figure 1.a. or Figure 1.b. for the locations of connectors.
- Connect the RS-232 null modem cable from the instrument RS-232 port to the computer.
- If the computer uses a USB port, then connect the supplied RS-232 to USB converter between the null modem cable and the computer

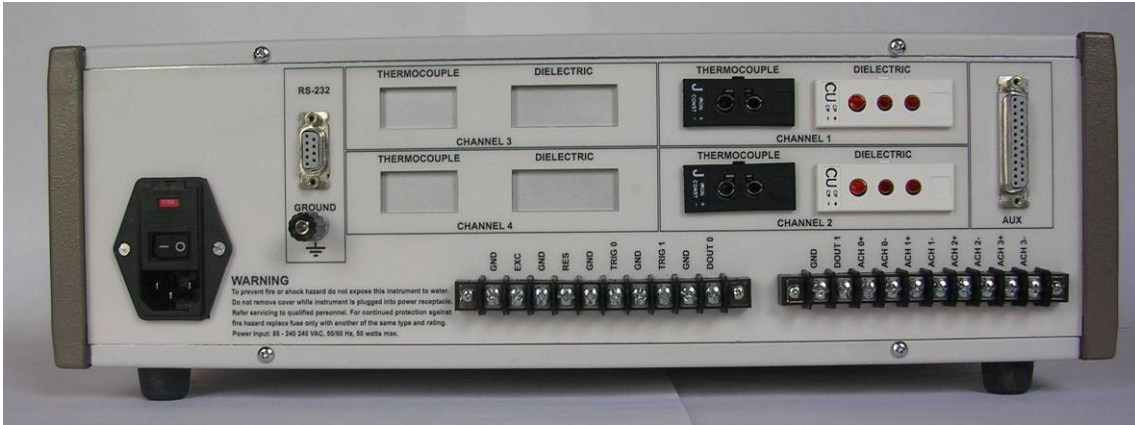


Figure 1.a.
LT-451 (old version) rear panel



Figure 1.b.
LT-451 (new version) / LTF-631 rear panel

Start the CureView software. CureView will automatically test each serial port on the PC, look for an instrument and indicate the connection status as shown on the following window:

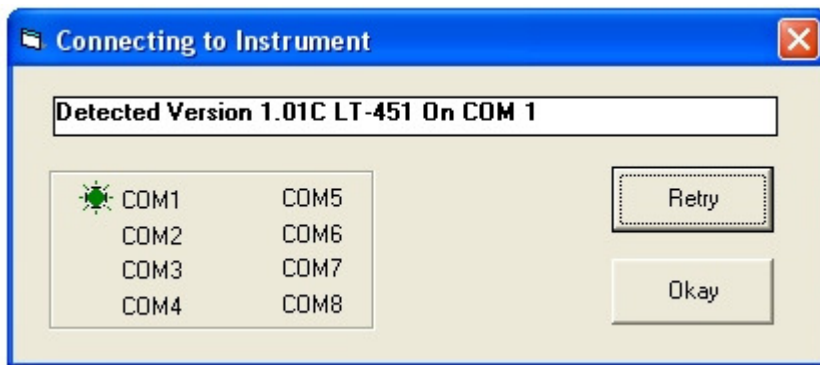


Figure 2
Serial port connection window

Click **Okay** to accept the connection. If no instrument is found, make sure the instrument is powered and ready and that the serial cable is connected correctly. Click **Retry** and CureView will look again for an instrument attached to the PC.

After CureView has found an instrument and the user has clicked **Okay**, CureView will initialize and display the Main Window.

Connecting Sensors and Extension Cables

Dielectric sensors with leads are connected to a dielectric sensor connector as shown in Figure 3.

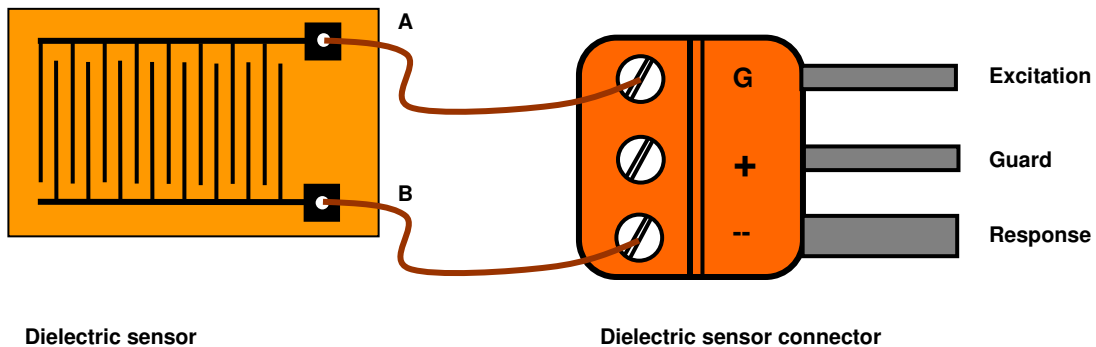


Figure 3
Connecting dielectric sensors with leads

Sensors with leads are connected as follows:

- One lead is connected the screw terminal labeled "G."
- The other lead is connected to the screw terminal labeled "-" or "E."

Note that terminals "G" and "-" or "E" are the outermost terminals of the dielectric sensor connector. The center terminal is for the guard signal, which is used with extension cables to reduce noise on the response line.

Dielectric sensors may be connected to a dielectric extension cable to allow placement of the sensor up to 20 feet away from the instrument. A sensor is connected to an extension cable as shown in Figure 4.

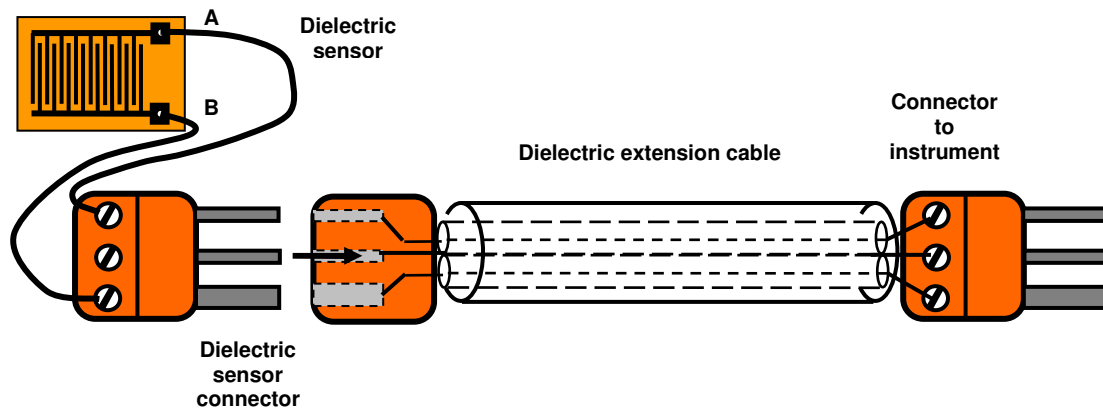


Figure 4
Connecting a dielectric sensor to the extension cable

The maximum recommended length of shielded extension cables is 20 feet.

Note: Phase error in the response signal increases at high frequencies with long cables. This phase error decreases measurement accuracy of high ion viscosities (low conductivities) at frequencies above 10 KHz for cables longer than about five feet.

To confirm correct connection between the sensor and the end of the dielectric sensor connector or the extension cable:

- Use an ohmmeter to check for electrical continuity from electrode "A" of the sensor to pin "G" on the dielectric sensor connector.
- Check for electrical continuity from electrode "B" of the sensor to pin "-" (or "E") on the dielectric sensor connector.
- Dielectric sensors have symmetric electrodes, so it is unimportant which electrode is connected to pin "-" (or "E"), or pin "G."

Check to make sure outermost pins on the dielectric sensor connector do not have a short circuit between them.

Connecting Sensors to an Instrument

Dielectric sensors or sensors with extension cables may be plugged into an instrument as shown in Figure 5.

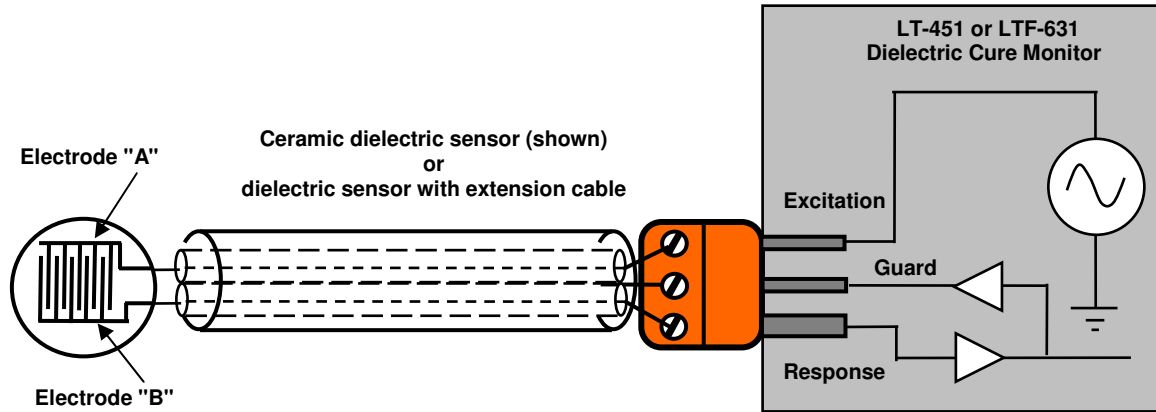


Figure 5
Connecting a dielectric sensor to an instrument

Note: Dielectric sensors may be connected to the LT-451 or LTF-631 dielectric cure monitors with unshielded leads, but data at low signal levels or at the end of cure may be noisy due to electrical interference. To reduce noise, sensor leads should be shielded and connected to the instrument guard drive whenever possible.

Testing System Operation with Supplied Test Circuits

After confirming all connections are correct and secure, the entire measurement system may be tested for proper operation. Use the Dielectric Test Plug, which is a 20 pF mica capacitor wired into a Dielectric Sensor Connector as shown in Figure 6.

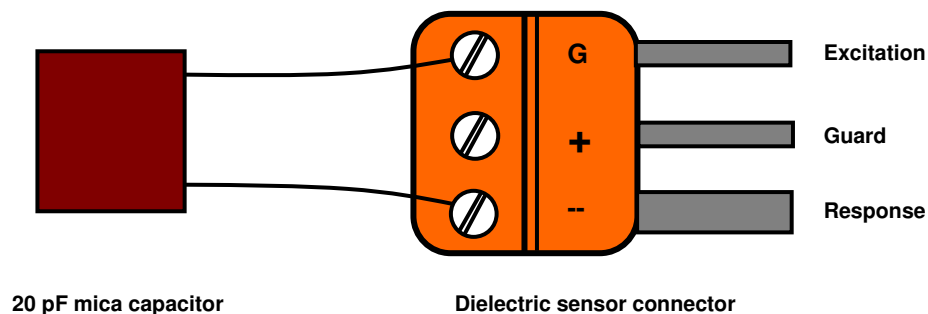



Figure 6.
Test Plug with 20 pF mica capacitor

The instrument also comes with a Thermocouple Test Plug, which is a thermocouple plug with a small value resistor to simulate a thermocouple at approximately ambient temperature.

Figure 7 shows the CureView Main window toolbar.



Figure 7
Main window toolbar

Toolbar icon buttons allow easy execution of CureView functions. Click the  icon to make a single measurement.

To test system operation:

- Insert the Dielectric Test Plug into the dielectric channel selected for testing.
- Insert the Thermocouple Test Plug into corresponding thermocouple Channel.
- Make single measurements at:
 - 1Hz, 10Hz 100 Hz, 1 KHz, 10 KHz and 100 KHz for the LT-451.
 - 10Hz, 100 Hz, 1 KHz and 10 KHz for the LTF-631.

For the LT-451/LTF-631 typical results are shown below in Table 1:

Table 1
Typical results with Dielectric Test Circuit

Freq (Hz)	Gain (dB) Subtraction mode (default)	Gain (dB) Non-Subtraction mode	Phase (deg)	Temp (°C)
1	-38 ± 6	-40 ± 6	0 ± 10	25 - 35
10	-38 ± 4	-40 ± 4	0 ± 6	25 - 35
100	-38 ± 4	-40 ± 4	0 ± 6	25 - 35
1 K	-38 ± 4	-40 ± 4	0 ± 6	25 - 35
10 K	-38 ± 4	-40 ± 4	0 ± 6	25 - 35
100 K	-38 ± 4	-40 ± 4	0 ± 6	25 - 35

Exact results may vary due to instrument internal capacitances, and use of cabling and connectors.

Subtraction mode is the default configuration with shipment of an instrument. For more details, please refer to the LT-451/LTF-631 manual, **Chapter 7--Mid-conductivity Measurement Modes**.

The Thermocouple Test Plug connects the two contacts of the thermocouple input and produces a measurement of approximately room temperature (~20 °C). Exact results of the thermocouple measurement will vary and tend to be around 30 °C.

Test System Operation with 100 Kohm, 1% Resistor

A high value resistor may be used to perform a more detailed test of instrument operation. To do such a test, first make a test circuit with a 100 Kohm, 1% resistor wired into a dielectric sensor connector as shown in Figure 8.

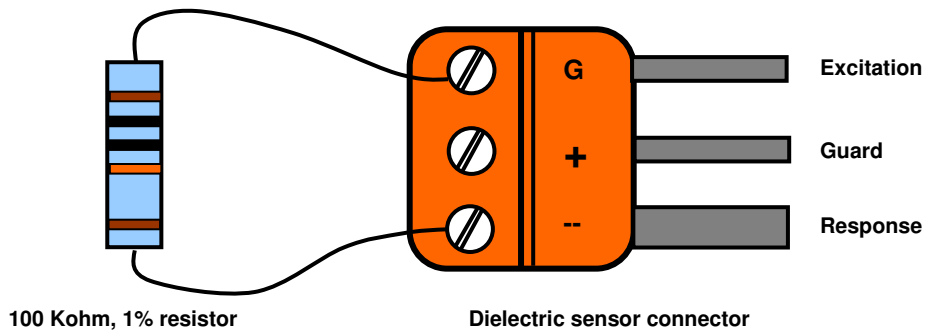


Figure 8.
Test circuit with 100 Kohm, 1% resistor

The Dielectric Test Plug included with the instrument is useful for testing low signal operation, when the expected gain is about -40 dB and the expected phase is approximately 0° for all frequencies. Use of a 100 Kohm, 1% resistor tests the gain and phase measurement over a broader range and therefore provides added information about the system.

To test system operation:

- Insert the 100 Kohm, 1% resistor into the dielectric channel selected for testing.
- Insert the Thermocouple Test Plug into the corresponding thermocouple channel.
- Make test measurements at:
 - 1Hz, 10Hz 100 Hz, 1 KHz, 10 KHz and 100 KHz for the LT-451.
 - 10Hz 100 Hz, 1 KHz and 10 KHz for the LTF-631.

For the LT-451/LTF-631, typical results are shown below in Table 2:

Table 2
Typical gain-phase results with 100 Kohm, 1% resistor

Freq (Hz)	Subtraction mode Gain (dB)	Non-Subtraction mode Gain (dB)	Phase (deg)
1	-0.0 ± 2	-0.0 ± 2	-0.0 ± 5
10	-0.0 ± 2	-0.0 ± 2	-0.7 ± 3
100	-0.1 ± 2	-0.1 ± 2	-7.2 ± 3
1 K	-4.1 ± 2	-4.1 ± 2	-51.4 ± 3
10 K	-22.1 ± 2	-22.1 ± 2	-84.4 ± 4
100 K	-41.3 ± 2	-41.2 ± 2	-67.3 ± 5

Checking Ceramicomb-1" Sensor Connections

The Ceramicomb-1" ceramic sensor consists of a pair of electrodes embedded in a ceramic substrate. These electrodes are connected to contacts on the three-pin dielectric connector at the end of a length of conduit. In addition, the sensor has a thermocouple with a two-pin thermocouple connector. Figure 9 shows the sensor with electrodes at one end and the dielectric and thermocouple connectors at the other.



Figure 9
Ceramiccomb-1" dielectric/conductivity sensor

Figure 10 shows the wiring and connections in the Ceramiccomb-1" sensor. The thermocouple has no electrical contact with the sheath and conduit which surround it. The dielectric sensor also has no electrical contact with the sheath and conduit. Finally, the thermocouple is electrically isolated from the dielectric sensor.

Schematic of Ceramiccomb-1"

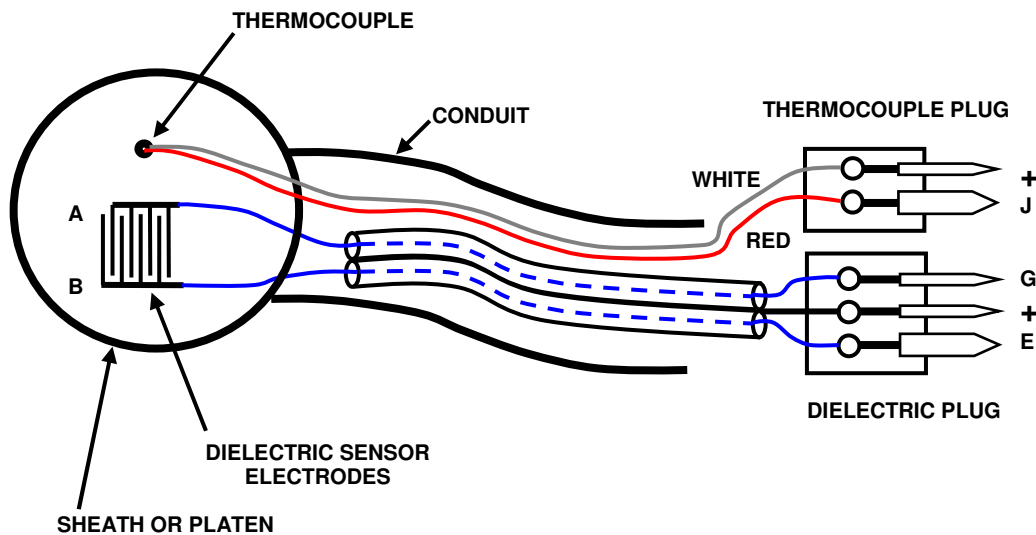


Figure 10
Schematic of wiring and connections in Ceramiccomb-1" sensor

Figures 11 and 12 show close-up views of the sensor head and the dielectric connector.



Figure 11
Close-up view of sensor head



Figure 12
Close-up view of dielectric connector
(Green ground wire not present
in all configurations)

Test Procedure

Use an ohmmeter to check continuity between connectors on the sensor. Follow the steps in Table 3

Table 3
Test procedure to verify sensor connections

Step	Measure Resistance Between Points		Expected Result
1	+ on TC connector	J on TC connector (Large pin)	5 to 10 ohms
2	+ on TC connector	Sheath and conduit	Open circuit
3	+ on TC connector	G on dielectric connector	Open circuit
4	+ on TC connector	+ on dielectric connector	Open circuit
5	+ on TC connector	E on dielectric connector (Large pin)	Open circuit
6	G on dielectric connector	Sheath and conduit	Open circuit
7	G on dielectric connector	+ on dielectric connector	Open circuit
8	G on dielectric connector	E on dielectric connector (Large pin)	Open circuit
9	+ on dielectric connector	Sheath and conduit	Open circuit
10	+ on dielectric connector	E on dielectric connector (Large pin)	Open circuit
11	E on dielectric connector (Large pin)	Sheath and conduit	Open circuit
12	G on dielectric connector	Electrode A of dielectric sensor (One of the electrodes)	Continuity (Resistance < 10 ohms)
13	E on dielectric connector (Large pin)	Electrode B of dielectric sensor (The other electrode)	Continuity (Resistance < 10 ohms)

If either the thermocouple or dielectric connector is removed and reconnected, then use this test procedure to verify correct connection of the sensor.

Conclusion

If results of the described tests deviate substantially from normal performance, please contact Lambient Technologies for support and assistance.



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