

Dielectric Cells for Different Applications

This application note describes various dielectric cells for measuring dielectric constant and dissipation factor on solids, powders and liquids. A complete system for dielectric constant measurements includes an LCR meter for capacitance and dissipation factor measurements, the dielectric cell, and the connecting cables and adapters. This system allows rapid, precise measurements over a wide frequency range.

Dielectric cells are manufactured by a number of companies. The dielectric cells shown in this application note are manufactured by Dielectric Products Company of Watertown, MA. QuadTech LCR Meters have been tested with these dielectric cells. The dielectric cells and LCR meters described in this application note are available directly from QuadTech. Please see www.quadtech.com for ordering information.

Types of Dielectric Cells

Cell Type (DPC Part Number)	Cell Body	To Test
Rigid Dielectric Cell (LD-3)	Three terminals; shielded, stainless-steel; vertical electrodes lapped flat to <0.050 mils; with guard ring	Solids, semi-solids; plastics, epoxy; thin film; laminates; PC boards
High Temperature Rigid Dielectric Cell (LD-3T)	Three terminals; shielded, stainless-steel; vertical electrodes lapped flat to <0.050 mils; with guard ring	At elevated temperatures to 250° C: solids, semi-solids; plastics, epoxy; thin film; laminates; PC boards
Liquid Cell (350)	Two terminals, shielded, stainless-steel; vertical, concentric electrodes	Oils, solvents, water; non-viscous chemicals; salts
Powder and Paste Cell (MC-100)	Three terminals; shielded, stainless-steel; horizontal, flat electrodes	Paste, grease, very viscous material, liquids, powder
Teflon Standard Cell (TS-100)	Teflon Standard with nominal value of 2.0	

The complete assembly of a 7600 Plus Precision LCR Meter and an LD-3 rigid dielectric test cell is shown in Figure 1. QuadTech offers a wide variety of LCR meters covering the frequency range from 10Hz to 2MHz, which can be used with any of the dielectric cells.

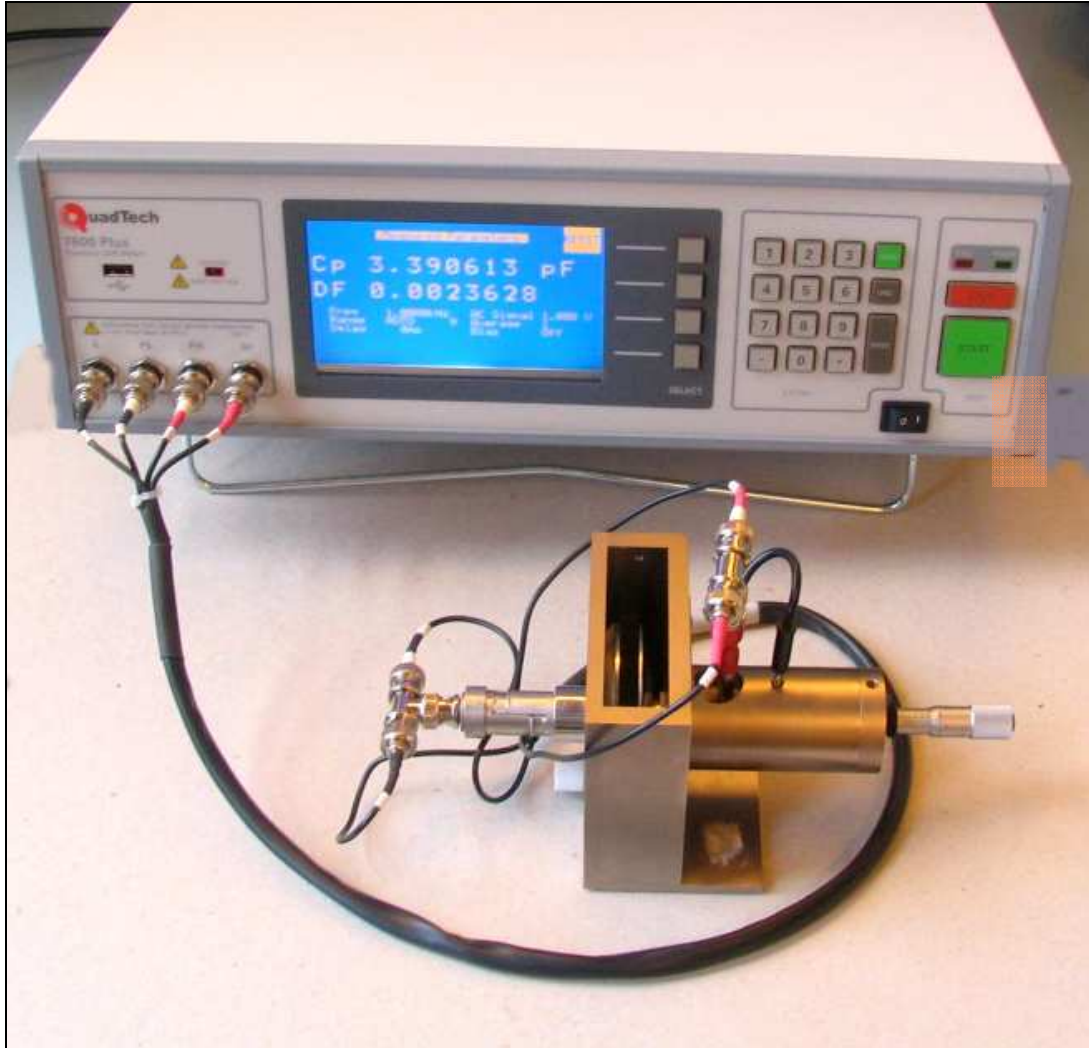


Figure 1 QuadTech 7600 Plus Precision LCR Meter Connected to an LD-3 Rigid Dielectric Cell

LD-3 Rigid Dielectric Cell

The LD-3 Rigid Dielectric Cell is designed for testing rigid flat materials. Material up to 8cm (3-1/8 inches) with a maximum thickness of 1.1 cm (7/16 inch) can be used in the dielectric cell. The dielectric cell is made up of two electrodes. One electrode is fixed with a grounded guard ring and the other is movable via a micrometer. The micrometer allows precise measurement of electrode spacing. The grounded guard ring reduces fringe effects to improve measurements.

The three terminal electrical connections are made via GR-874 connection on the fixed electrode side (optional BNC to GR-874 adapter is available) and banana connection on the movable electrode side. A 1 Meter BNC to BNC-T cable set is available for connection to the cell.

LD-3 Specifications

Size:	4" x 4" x 7.5" depth
Weight:	8.1 lbs
Materials:	303 Stainless and Teflon
Terminals:	Three terminals with grounded guard ring
Connectors:	GR874 and banana jack
Electrodes:	2.5" fixed measuring electrode with 2.87 outer dia. guard ring, 2.87" movable electrode
Sample Size:	0.005" to 0.35" thick and 3.125" square or 2.87" diameter
Frequency Range:	50Hz to 1MHz



Figure 2 LD-3 Rigid Dielectric Cell

LD-3T High-Temperature Rigid Dielectric Cell

The LD-3T High-Temperature Rigid Dielectric Cell is designed for testing rigid flat materials at elevated temperatures in an oven. The dielectric cell can be used in environments up to 200° C.

Material up to 8cm (3 1/8 inches) with a maximum thickness of 1.1 cm (7/16 inch) can be used in the dielectric cell. The dielectric cell is made up of two electrodes. One electrode is fixed with a grounded guard ring and the other is movable via a micrometer. The micrometer allows precise measurement of electrode spacing. The grounded guard ring reduces fringe effects to improve measurements.

The three terminal electrical connections are made via GR-874 Connection on the fixed electrode side (optional BNC to GR-874 adapter is available) and banana connection on the movable electrode side. A 1-meter, high-temperature Teflon BNC to BNC-T cable set is available for connection to the cell.

LD-3T Specifications

Size:	4" x 4" x 7.5" depth
Weight:	8.1 lbs
Materials:	303 Stainless and Teflon
Terminals:	Three terminals with grounded guard ring
Connectors:	GR874 and banana jack
Electrodes:	2.5" fixed measuring electrode with 2.87 outer dia. guard ring, 2.87" movable electrode
Sample Size:	0.005" to 0.35" thick and 3.125" square or 2.87" diameter
Frequency Range:	50Hz to 1MHz
Temperature:	400° F / 200° C.



Figure 3 LD-3T High-Temperature Rigid Dielectric Cell

MC-100 Powder and Paste Dielectric Cell

The MC-100 Dielectric Cell is designed for measurements of dielectric constant and dissipation factor on viscous or paste materials. The cell consists of two electrodes that are adjustable from 0 to .001 inch. Accuracy of the setting is 0.000125 inch. The electrodes are positioned horizontally. Materials are applied into the center of the lower ring. The top electrode then sandwiches the material between the electrodes.

The cell can be used with viscous material such as pastes, grease, extremely small samples, liquids, and powders such as printer toner.

MC-100 Specifications

Materials:	Stainless with Pyrex or acrylic glass cylinder
Terminals:	Three terminals with grounded shield
Connectors:	GR874 and banana jack
Electrodes:	1" diameter



Figure 4 MC-100 Powder and Paste Dielectric Cell

350 Liquid Dielectric Cell

The 350 Liquid Dielectric Cell is designed for in-process testing of liquids. The dielectric constant and dissipation factor can be measured as the liquid flows through the cell. The dielectric constant of the material is determined via a simple formula that is provided with the cell. The cell can be used with most liquid materials including water, oils, solvents, and non viscous chemical and salt solutions.

350 Specifications

Terminals:	Two terminals with grounded shield
Material:	Stainless
Connectors:	GR874 and banana jack
Dimensions:	Overall Length 14cm and diameter 4 cm,
Dimensions electrode:	28mm diameter at base and 31mm at collar, length: 8.1 cm base to collar
Electrodes:	Vertically positioned electrodes separated by 0.046"



Figure 5 350 Liquid Cell

TS-100 Teflon Standard Cell

The TS-100 Teflon Standard is an invaluable tool in verifying the operation of any rigid dielectric cell such as the LD-3 and LD-3T. The TS-100 consists of a 7.5cm (3 inches) diameter and 5mm (0.235 inch) thick Teflon standard. The Teflon Standard is calibrated using a GenRad/QuadTech 1620A Capacitance Bridge at 70° F at 1kHz. The Teflon Standard will have a nominal dielectric constant of 2.0.

TS-100 Specifications

Nominal Size:	3" outer dia. x 0.235"
Flatness:	Within 50 millionths of an inch
Nominal K:	2.0
Calibration:	Calibrated value using LD-3 Cell and GR/QuadTech 1620A at 1kHz, 70° F.



Figure 6 TS-100 Teflon Standard Cell

Bibliography: QuadTech's Application Note Library

035012 Measurements of Dielectric Constant and Loss using an LD-3 Cell and 7600 LCR Meter

035054 Measuring Electric Properties of Copier/Printer Toner

035113 Measurement of Dielectric Constant and Loss: 1900 LCR and LD-3 Dielectric Cell

035169 Practical Guide to Avoiding Errors in Measurement When Using a Rigid Dielectric Cell

035057 Measuring the Dielectric Constant of PVC Compounds

035010 A Guide to LCR Measurements