♦ PRECISION INSTRUMENTS FOR TEST AND MEASUREMENT ♦

LDC-1

Liquid Dielectric Cell
User Manual

LDC-1 IM January 2025

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WARRANTY

We warrant that this product is free from defects in material and workmanship and, when properly used, will perform in accordance with applicable IET specifications. If within one year after original shipment, it is found not to meet this standard, it will be repaired or, at the option of IET, replaced at no charge when returned to IET. Changes in this product not approved by IET or application of voltages or currents greater than those allowed by the specifications shall void this warranty. IET shall not be liable for any indirect, special, or consequential damages, even if notice has been given to the possibility of such damages.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

Revision	Description
January 2025	Initial Release

WARNING

OBSERVE ALL SAFETY RULES
WHEN WORKING WITH HIGH VOLTAGES OR LINE VOLTAGES.

Dangerous voltages may be present inside this instrument. Do not open the case
Refer servicing to qualified personnel

HIGH VOLTAGES MAY BE PRESENT AT THE TERMINALS OF THIS INSTRUMENT

WHENEVER HAZARDOUS VOLTAGES (> 45 V) ARE USED, TAKE ALL MEASURES TO AVOID ACCIDENTAL CONTACT WITH ANY LIVE COMPONENTS.

USE MAXIMUM INSULATION AND MINIMIZE THE USE OF BARE CONDUCTORS WHEN USING THIS INSTRUMENT.

Use extreme caution when working with bare conductors or bus bars.

WHEN WORKING WITH HIGH VOLTAGES, POST WARNING SIGNS AND KEEP UNREQUIRED PERSONNEL SAFELY AWAY.

CAUTION

DO NOT APPLY ANY VOLTAGES OR CURRENTS TO THE TERMINALS OF THIS INSTRUMENT IN EXCESS OF THE MAXIMUM LIMITS INDICATED ON THE FRONT PANEL OR THE OPERATING GUIDE LABEL.

Contents

SAFETY PRECAUTIONS

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific WARNINGS elsewhere in this manual may impair the protection provided by the equipment. Such noncompliance would also violate safety standards of design, manufacture, and intended use of the instrument.

IET Labs assumes no liability for the customer's failure to comply with these precautions.

The LDC-1 complies with INSTALLATION CATEGORY I as well as POLLUTION DEGREE 2 in IEC61010-1.

If an instrument is marked CAT I (IEC Measurement Category I), or it is not marked with a measurement category, its measurement terminals must not be connected to line-voltage mains.

The LDC-1 is an indoor use product.

 DANGEROUS PROCEDURE WARNINGS 

Comply with all WARNINGS - Procedures throughout in this manual and instructions on the instrument prevent you from potential hazard. These instructions contained in the warnings must be followed.

BEFORE APPLYING POWER

Verify that all safety precautions are taken. Make all connections to the instrument before applying power. Note the instrument's external markings described under "Safety Symbols".

GROUND THE INSTRUMENT

This is a Safety Class I instrument. To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The power terminal and the power cable must meet International Electrotechnical Commission (IEC) safety standards.

 **WARNING** 

Although the LDC-1 is designed with full attention to operator safety, serious hazards could occur if the Liquid Dielectric Cell is used improperly and these safety instructions are not followed.

- DO NOT Operate in an Explosive Atmosphere
- Do not operate in the presence of inflammable gasses or fumes
- Operation of any electrical instrument in such an environment clearly constitutes a safety hazard
- Use Caution around live circuits and whenever hazardous voltages > 45 V are present

Safety Symbols

General definitions of safety symbols used on the instrument or in manuals are listed below.

Caution symbol: the product is marked with this symbol when it is necessary for the user to refer to the instruction manual.

Hazardous voltage symbol: the product is marked with this symbol when high voltage maybe present on the product and an electrical shock hazard can exist.

Indicates the grounding protect terminal, which is used to prevent electric shock from the leakage on chassis. The ground terminal must connect to earth before using the product

Direct current.

Alternating current.

Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

On supply.

Off supply.

Hot surface. Avoid contact. Surfaces are hot and may cause personal injury if touched.

Disposal

Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC
This product complies with the WEEE Directive (2002/96/EC) marking requirements.
The affixed label indicates that you must not discard this electrical/ electronic product in domestic household waste.
Product Category: With reference to the equipment types in the WEEE directive Annex 1, this product is classified as a “Monitoring and Control instrumentation” product.

Do not dispose of electrical appliances as unsorted municipal waste, use separate collection facilities.

Contact your local government for information regarding the collection systems available. If electrical appliances are disposed of in landfills or dumps, hazardous substances can leak into the groundwater and get into the food chain, damaging your health and well-being.

When replacing old appliances with new one, the retailer is legally obligated to take back your old appliances for disposal.

Proposition 65 Warning for California Residents

WARNING: Cancer and Reproductive Harm - www.P65Warnings.ca.gov.

This product may contain chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm

Chapter 1

INTRODUCTION

1.1 Introduction

The LDC-1 Liquid Dielectric Cell is designed for measurement of dielectric constant and impedance on a wide range of electrically insulating liquids according to ASTM D924 Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.

The dielectric cell is made up of cell body along with a container to hold liquids. The container two electrodes and multiple spacers.

Chapter 2

SPECIFICATIONS

SPECIFICATIONS

Terminals: 4-terminal connection via BNC connector 2.2 cm (0.866”) spacing for direction connection to an LCR meter

Electrodes: 2-terminal connection via 38 mm electrodes

Applicable LCR Meters: 1920 and 7660 Precision LCR Meters

Frequency: < 30 MHz for direct connection

Maximum Voltage: 42 V peak

DUT Thickness: 0.3, 0.5, 1, 2, 3, 5 mm

Temperature: 0°C to 55°C

Dimensions: 13 cm H x 11.5 cm W x 16 cm D

Weight: 1.7 kg (3.75 lb)

ORDERING INFORMATION

LDC-1 Liquid Dielectric Cell
Includes:
- **Instruction Manual**
- **Accessory Kit**

Chapter 3

OPERATION

3.1 Initial Inspection and Setup

The LDC-1 was carefully inspected before shipment. It should be in proper electrical and mechanical order upon receipt.

Contents:

1 Liquid Dielectric Material Test Cell
2 Fixture body
3 Small funnel
4 Open Correction Kit
5 Spacer
6 Foam bottom
7 Foam top
8 Outer box

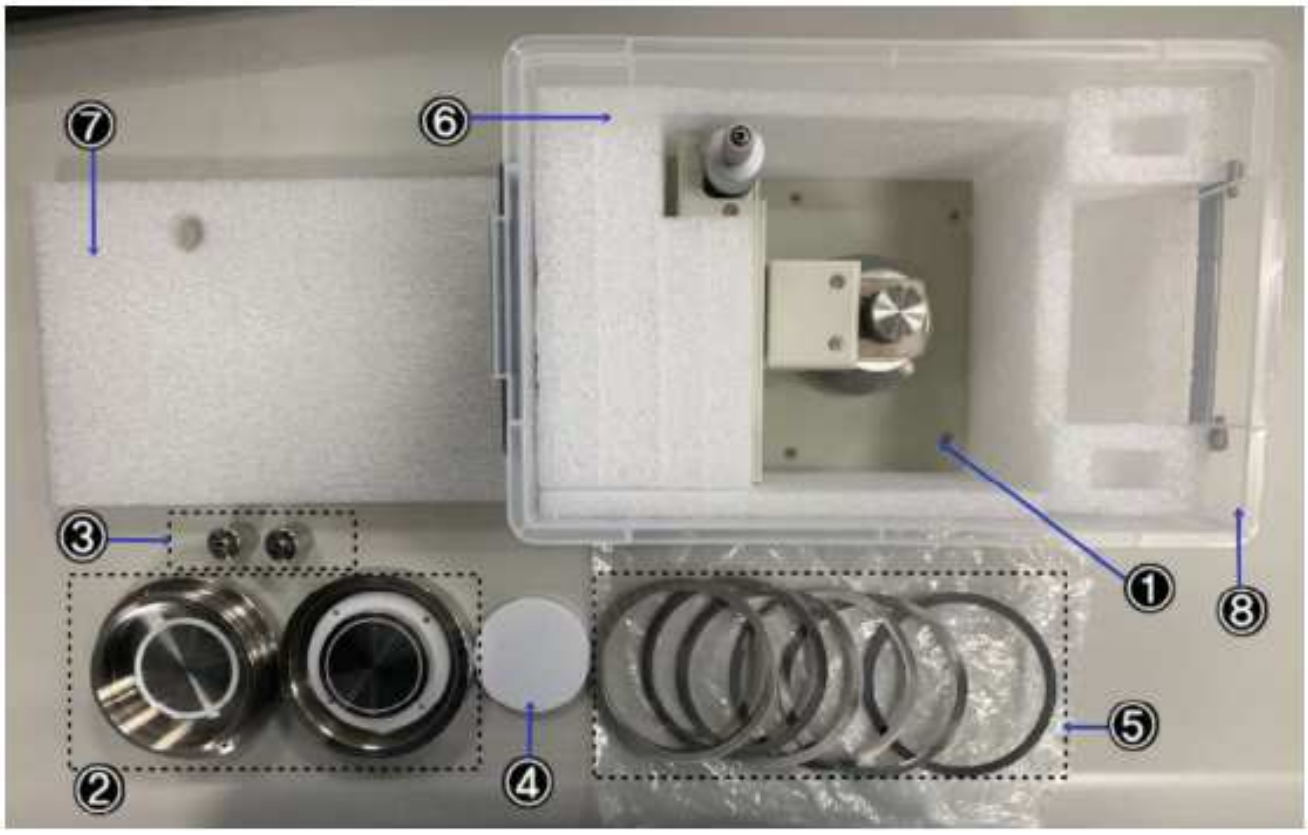

Figure 1-1 Contents of LDC-1

3.2 LDC-1 Main Fixture Parts

The main cell parts of the LDC-1 consists of:

1 Fixture body - Main support for connection to the LCR meter
2 Fixed electrode plate - Bottom part of liquid container
3 Liquid cell - Where the liquid is contained. This is one of the measurement electrodes.
4 Small funnel - Used to pour liquid into cell container
5 Movable electrode - Moves up and down with moveable body
6 Moveable Body - Moves the top electrode up or down by rotating the micrometer
7 Micrometer - Micrometer is used to move the top electrode up or down and provides an indication of the spacing between the electrodes.
8 - 4 x BNC connectors for connection to the LCR meter.
9 Lever - Allows the user to lock the BNC connectors to the LCR meter.

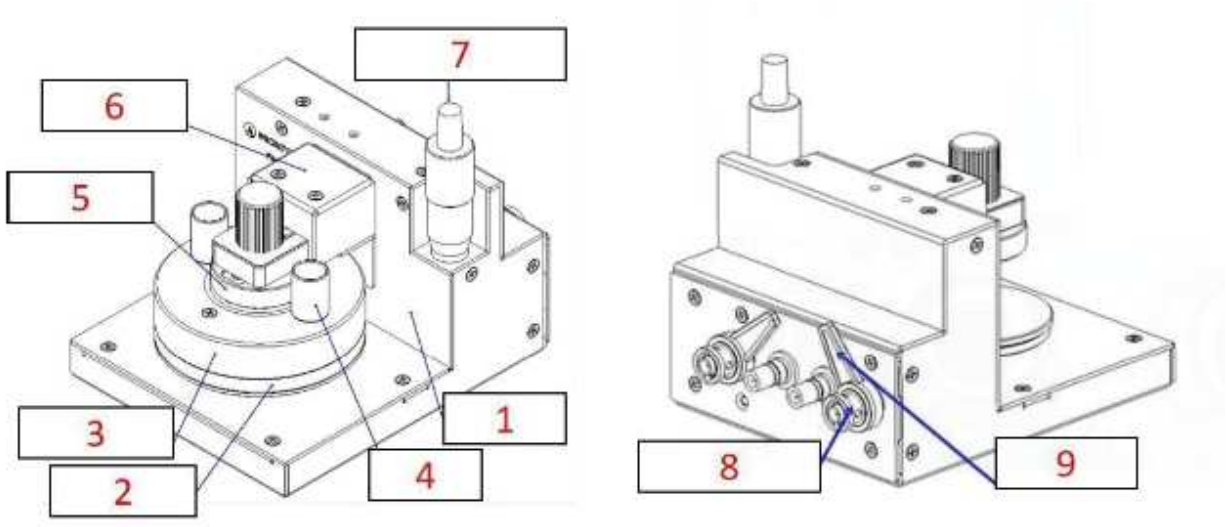

Figure 1-2 Fixture Parts

3.3 LDC-1 Accessories

The LDC-1 is delivered with the following accessories:

1 Open correction kit - For open correction/compensation
2 Liquid container - Container for liquid sample
3 Small Funnel - Allows for pouring liquid into container
4 Spacers - various thickness spacers for use with the Liquid Container

Figure 1-3 Accessories

3.4 General Considerations

The LDC-1 should be directly connected to the 1920 or 7660 Precision LCR Meter.

Cable length selection in the LCR meter should be set to 0 meter as the LDC-1 is directly connected to the front panel.

3.4.1 Basic measurement method

- Connect LDC-1 to BNC terminals on front of LCR Meter
- Set desired: frequency, voltage. Cp and Df, average, speed etc on the LCR meter
- Perform Short Compensation 3.4.3
- Perform Open Compensation 3.4.4
- Determine Fixture Correction 3.4.5
- Perform measurements per 3.5

3.4.2 Attached the required electrode

Notice: The electrode plate spacing adjustment is performed using the micrometer. It is important to rotate the micrometer using the small knob which has clutch to prevent overtightening and damage to the cell.

The 5 mm or 38 mm electrode screws onto the Electrode Holder.

Figure 1-4 Attaching 38 mm Electrode

The electrode is chosen so that the entire piece of material being tested is larger than the electrode by at least 2 times the thickness of the material.

This means the material being tested must be at least 5 mm in diameter + 2 x thickness of the sample in mm.

If the material being measured is greater than 5 mm and < 38 mm use the 5 mm electrode.

If the material is larger than 38 mm then use the 38 mm electrode.

It is recommend to place a piece of paper over the fixed electrode on the bottom to prevent scratching the electrode.

Screw the electrode on to the Electrode Holder only finger tight do not over tighten.

3.4.3 Short Circuit Compensation

- Assemble the top and bottom halves of the liquid cell. Do not include the Open Correction Kit.
- Place the Liquid Cell on the bottom electrode
- Rotate small knob on the micrometer until the top electrode contacts top of the Liquid Cell.
- On the LCR meter perform a Short Compensation
- After the short has been performed measurement of Rs or Z should be very close to 0 Ω.

Figure 1-5 Open/Short Calibration Plate on Bottom Electrode with no Cover

3.4.4 Open Circuit Compensation

- Install the Open Correction Kit onto the bottom halve of the Liquid Cell.
- Assemble the top and bottom halves of the liquid cell. Make sure to include the Open Correction Kit.
- Rotate the small knob on the micrometer until the top electrode contacts with the Liquid Cell.
- On the LCR meter perform a Open Compensation

- After the open has been performed measurement of Cp should be less than 0.1 pF.

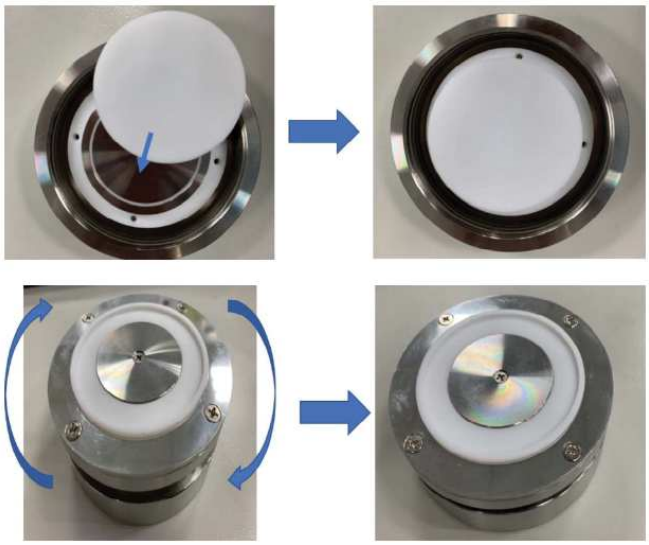

Figure 1-6 Open Compensation Kit placed on bottom halve of liquid cell then screw on top halve

3.4.5 Fixture Correction

- Attach the 5 mm or 38 mm electrode onto the Electrode Holder.
- Place the Calibration Standard onto the bottom electrode
- Rotate the small knob on the micrometer until the top electrode contacts with the Calibration Standard.
- Note the micrometer reading
- Perform a measurement of Cp and note as Csample
- Rotate small knob on the micrometer so that the Calibration Standard can be removed.
- Rotate small knob on the micrometer back to the micrometer reading that Csample was measured at.
- Perform a measurement of Cp and note as Cair
- Dielectric constant of the Calibration Standard is suppose to be 2.000
- Calculate dielectric constant correction as

kcorrection = (Csample / Cair) - 2.000

- The Correction Factor kcorrection should be subtracted from any measured Dielectric Constant k.

3.5 Dielectric Constant Measurements

- Relative permittivity (εr) can be calculated from the ratio of the capacitance of
- a material to that of air (nearly equal to that of a vacuum). The standard
- measurement sequence is as follows:
- 1. Prepare the test fixture for use.
- 2. Connect the test fixture.
- 3. Check the SHORT residual.
- 4. Set the instrument for capacitance measurement.
- 5. Do a SHORT compensation.
- 6. Do the air capacitance (Co) measurement.
- 7. Do the liquid capacitance and resistance (Cp, Rp) measurement.
- 8. Drain the liquid (after measurement)
- 9. Do the data processing- Calculate dielectric parameter from measurement
- data.
- Attach the 5 mm or 38 mm electrode onto the Electrode Holder.
- Place the sample to be tested onto the bottom electrode
- Rotate small knob on the micrometer until the top electrode contacts with the sample.
- Note micrometer reading
- Perform a measurement of Cp and Df and note as Csample and Dfsample
- Rotate small knob on the micrometer so that the sample can be removed.
- Rotate small knob on the micrometer back to the micrometer reading that Csample was measured at.
- Perform a measurement of Cp and Df and note as Cair and Dfair
- Dielectric constant of the sample is calculated as

k = (Csample / Cair) - kcorrection

- Dissipation factor of the sample is calculated as

Df = Dfsample - Dfair

3.6 Environmental Conditions

For optimal accuracy, the LDC-1 should be used in an environment of 0°C to 55°C.

Humidity should be maintained at laboratory conditions.

3.7 Cleaning

The electrodes and other parts of the cell can be cleaned using a soft cloth and denatured alcohol.