



ARDA

Ambient Rigid Dielectric Apparatus

User Manual

Rev. 1.00

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1 Safety Precautions

Please read the following safety precautions carefully before using this product.

Before Measuring with ARDA:

- Ensure that it is connected correctly with at least 2 BNC connections and up to 4 BNC connections.
- **Observe voltage and current limits.** Do not exceed the maximum voltage or current limits for any connectors and sockets.
- **Clean the case safely.** Use a damp cloth or a mild, water-based cleaner to clean the case. Clean the exterior only. Do not apply cleaner directly to the instrument, and do not allow any liquid to enter or spill onto the instrument.
- **Clean the electrodes correctly.** Use a clean damp isopropanol 99% tissue to clean the electrodes.
- **Do not open the case.** ARDA contains no user-serviceable parts and does not require internal maintenance or adjustment.

2 Inspection

ARDA is fully tested and inspected before shipment. Upon receipt, carefully unpack the Sample-cell and inspect it and all supplied accessories for any visible signs of damage.

If any damage is found, notify Eynocs immediately. Keep all original packaging materials until the Sample-cell has been thoroughly inspected and confirmed to be in good condition. The original packaging may be required as evidence in the event of damage during transportation.

2.1 Package Contents

ARDA is supplied with the following items:

- ARDA Sample-cell
- Four 25 cm BNC cables
- Short-circuit calibration standard
- 100 Ω calibration standard
- 100 pF calibration standard
- RC-Network Verification standard
- Tweezers 120mm long

3 Introduction

ARDA (Ambient Rigid Dielectric Apparatus) is a compact, fully enclosed dielectric measurement cell designed for the characterization of rigid, flat electrical insulating materials under ambient-temperature conditions.

It is designed for **dielectric constant (relative permittivity), capacitance, dissipation factor and related dielectric properties** measurements in accordance with the measurement principles described in **ASTM D150 – Standard Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation**. ASTM D150 covers measurements of relative permittivity, dissipation factor, loss index, power factor, phase angle and loss angle over a frequency range extending from below 1 Hz to several hundred megahertz.

With an exceptionally compact size of only **125 × 120 × 80 mm** excluding Micrometer, ARDA combines a guarded two-electrode measurement system with a **fully enclosed Faraday cage**, making it particularly suitable for measurements where very low signal levels and environmental electromagnetic interference are concerns.

3.1 Key Features

- **Compact footprint:** only **125 × 120 × 80 mm (L × W × H)** excluding Micrometer. **125 × 120 × 160 mm (L × W × H)** including Micrometer.
- **Fully enclosed Faraday cage** for electromagnetic shielding and improved measurement stability.
- Particularly suitable for **ultra-low-frequency and low-level dielectric measurements**, where external electrical interference can become significant.
- Designed for **rigid, flat insulating materials up to 15 mm thickness**.
- Designed for dielectric measurements **in accordance with ASTM D150**.
- **Precision micrometer adjustment** for accurate electrode positioning.
- **Integrated ratchet mechanism** for repeatable electrode contact and measurement force.
- **Two-electrode measurement configuration** with a guarded current-sensing electrode.
- **Spring-loaded guard ring** surrounding the current-measuring electrode.
- **40 mm diameter upper electrode**.
- **38 mm diameter lower current-measuring electrode**.
- **0.5 mm gap** between the current-measuring electrode and guard ring.
- **Ultra-flat electrode surfaces**.
- Standard **stainless-steel electrodes**.
- Optional **gold-plated stainless-steel electrodes**.

- **Frequency range up to 100 MHz**, depending on the analyzer and measurement configuration.
- Compatible with **rigid samples, liquid sample cells and disposable electrode configurations**.
- Direct integration with **Lamda and Zeus analyzers**.
- Up to **four BNC connections** for connection to external analyzers and measurement systems.
- Compact construction suitable for laboratory environments where bench space is limited.

3.2 ASTM D150 Measurement Capability

ARDA is designed to provide the electrode configuration and measurement environment required for dielectric characterization of solid electrical insulating materials according to the principles of **ASTM D150**.

ASTM D150 addresses the determination of:

- Relative permittivity / dielectric constant
- Dissipation factor / loss tangent
- Loss index
- Power factor
- Phase angle
- Loss angle

The standard also provides guidance on electrode configurations, apparatus and measurement techniques for dielectric measurements.

ARDA's guarded electrode configuration is particularly useful for dielectric measurements because the guard helps control the effective measurement area and reduce the influence of unwanted surface-current and fringe-current paths.

3.3 Fully Enclosed Faraday Cage

A major feature of the ARDA is its **fully enclosed Faraday cage** surrounding the measurement assembly.

At ultra-low frequencies, dielectric measurements can involve extremely small currents and high-impedance measurement conditions. Environmental electromagnetic fields, mains-frequency interference, radio-frequency signals and other electrical noise sources can therefore affect measurement stability and accuracy.

The enclosed shielding of ARDA provides a controlled electromagnetic environment around the sample and electrodes, helping to minimize the influence of external electrical interference.

This makes ARDA particularly suitable for **ultra-low-frequency dielectric measurements**, while the same shielding concept also benefits sensitive measurements across the broader operating frequency range.

3.4 Micrometer and Ratchet Function

ARDA is equipped with a **precision micrometer mechanism** for controlled and repeatable adjustment of the upper electrode position.

The micrometer incorporates a **ratchet mechanism** that helps provide a consistent adjustment force when bringing the electrode into contact with the sample. This allows the user to apply a more repeatable mechanical force between the electrodes and sample, improving measurement re-productibility.

The ratchet should be used for the **final electrode adjustment and contact pressure**. Avoid applying excessive force once the desired contact has been established.

The micrometer also allows the electrode spacing to be adjusted precisely, including positioning the upper electrode at its maximum height for **open calibration**.

Important: Do not force the micrometer beyond its mechanical limits. When the ARDA is placed into storage, return the sample cell to the **fully screwed-down position** as described in the storage instructions.

3.5 Guarded Two-Electrode System

ARDA uses a precision **two-electrode configuration** consisting of:

- **40 mm upper voltage/output electrode**
- **38 mm lower current-measuring electrode**
- **Spring-loaded guard ring**
- **0.5 mm separation between the measuring electrode and guard**

The guard ring surrounds the current-sensing electrode and helps define the active measurement area. This reduces the influence of unwanted surface currents and fringe effects and improves the re-productibility of measurements on high-resistivity and insulating materials.

3.6 Electrode Surface

ARDA uses **ultra-flat stainless-steel electrodes**. This standard stainless-steel electrode configuration provides a robust measurement surface for general dielectric characterization.

For applications requiring an alternative electrode surface, **gold-plated stainless-steel electrodes** are available as an option.

The electrode construction is intended to provide a stable and repeatable interface between the sample and measurement system.

3.7 Sample Capacity

ARDA is designed for **rigid, flat samples up to 15 mm in thickness**.

The available sample space can also be used with alternative sample configurations, including:

- Rigid solid dielectric samples
- Liquid sample cells
- Disposable electrode systems

The ability to use liquid sample cells within the available sample space extends the application range of the apparatus beyond conventional rigid solid samples.

Disposable electrode configurations can be used where rapid sample exchange or minimization of sample-to-sample contamination is important.

3.8 Analyzer Integration

ARDA is optimized for use with the **Eynocs Lamda and Zeus analyzer platforms**.

When used with compatible Eynocs analyzers, the cell can be integrated directly without conventional external measurement cables, providing a compact measurement configuration.

For use with other compatible impedance analyzers, LCR meters or dielectric measurement systems, ARDA provides **up to four BNC connections**.

The four-terminal connection concept allows the electrode connections to be interfaced directly with external measurement electronics and provides flexibility when integrating the cell with different analyzers.

3.9 Compensation and Calibration

For accurate dielectric measurements, particularly at low capacitance and low loss levels, appropriate **open, short and system compensation** should be performed according to the connected analyzer and measurement configuration.

The measurement system can be configured to compensate for parasitic capacitance, residual impedance and phase errors associated with the cell, connections and measurement electronics.

For ASTM D150 measurements, the effective measurement capacitance and empty-cell contribution must be taken into account when calculating the dielectric properties of the sample. Established ASTM D150 measurement systems use empty-cell measurements and appropriate corrections to determine relative permittivity and dissipation factor.

Calibration standards and reference samples are supplied for system verification.

3.10 Measurement Principle

During measurement, the sample is positioned between the two electrodes. The electrodes establish a defined electric field through the sample while the guarded current electrode measures the resulting current.

The connected analyzer determines the electrical response of the sample and can derive parameters such as:

- Capacitance
- Relative permittivity / dielectric constant
- Dissipation factor / loss tangent
- Loss index
- Phase angle
- Power factor

The exact calculation and compensation procedure depends on the analyzer and measurement configuration.

For dielectric materials, the dissipation factor is related to the ratio of the loss component of complex permittivity to its real component, and ASTM D150 defines the relevant relationships between these quantities.

3.11 High-Frequency Capability

ARDA supports measurements at frequencies of **up to 100 MHz**, depending on the analyzer, sample properties, connection configuration and measurement conditions.

The combination of:

- Guarded electrode geometry
- Short electrical paths
- Shielded measurement environment
- Direct analyzer integration
- Four-terminal BNC interfacing

makes ARDA suitable for measurements extending from very low frequencies through high-frequency dielectric characterization.

3.12 Compact and Laboratory-Friendly Design

Despite its broad measurement capability, ARDA has a particularly small mechanical footprint:

125 mm × 120 mm × 80 mm (L × W × H) excluding Micrometer

This compact design makes the cell suitable for laboratory benches, characterization stations and automated measurement systems where available space is limited.

The fully enclosed construction also provides a controlled measurement environment while protecting the electrode assembly from accidental contact and reducing exposure to external electrical interference.

4 Cleaning the Electrodes

Keep the electrode surfaces clean and free from dust, residue and contamination to ensure stable and reproducible measurements.

To clean the electrodes, use a **clean, lint-free tissue lightly dampened with 99% isopropanol (IPA)**. Gently wipe the electrode surfaces without applying excessive pressure or using abrasive materials.

Allow the electrodes to **fully dry before installing a sample or performing a measurement**.

Important: Do not use abrasive cleaners, abrasive materials or sharp objects on the electrode surfaces. Take particular care not to scratch or damage the precision electrode surfaces or the guard ring.

5 Storage of the Sample Cell

When ARDA is not in use, the **sample cell must be screwed all the way down into the fully closed/storage position.**

Keeping the sample cell fully screwed down during storage protects the electrode assembly and maintains the mechanical position of the measurement system. It also prevents unnecessary movement of the electrode mechanism during handling, transport and storage.

Important: Always return the sample cell to the fully screwed-down position before storing or transporting ARDA.

6 Calibrations Procedures

Before performing measurements with ARDA, allow the connected analyzer to **warm up and reach a stable operating condition**. Calibration should only be performed after the recommended analyzer warm-up period has been completed.

The **analyzer connection mode and cable/wire mode must always match the actual ARDA connection configuration**. The same configuration must be maintained during calibration and subsequent measurements.

For best measurement stability, keep ARDA connected to the analyzer during the warm-up period and perform the calibration using the same measurement configuration that will be used for subsequent measurements.

6.1 Analyzer Warm-Up and Configuration

Switch on the analyzer and allow it to warm up according to the analyzer's recommended warm-up time.

Before starting calibration, verify that:

- ARDA is connected to the analyzer.
- The **analyzer connection mode matches the selected cable/wire mode**.
- The selected cable/wire configuration corresponds to the actual physical connections between the analyzer and ARDA.
- The measurement configuration and cabling are in their final configuration.
- ARDA is at the intended ambient measurement conditions.
- No sample or calibration standard is installed unless specifically required for the analyzer warm-up procedure.

Do not perform the calibration until the analyzer has reached a stable operating temperature.

Important: If the analyzer connection mode or cable/wire mode is changed after calibration, the calibration should be considered invalid and the calibration procedure should be repeated.

6.2 Short Calibration

Perform the **short calibration using the dedicated short standard**.

Connect the short standard to the appropriate measurement terminals and perform the analyzer's **Short Calibration** procedure.

6.3 100 Ω Load Calibration

Perform the **load calibration using the dedicated 100 Ω load standard**.

Connect the **100 Ω load standard** to the appropriate measurement terminals and perform the analyzer's **Load Calibration** procedure.

6.4 Open Calibration

For the open calibration, ensure that no sample or calibration standard is positioned between the electrodes.

Raise the **upper electrode to its maximum possible height** to create the largest practical separation between the electrodes.

Perform the analyzer's **open calibration** with ARDA in this configuration.

After completion of the calibration, return the upper electrode to the required measurement position.

6.5 Reference Calibration and Verification – Lamda / Zeus

When using ARDA with a **Lamda** or **Zeus**, perform a reference calibration using the supplied **100 pF calibration standard**.

Position the 100 pF reference standard correctly in ARDA measurement fixture and perform the **reference calibration** using the analyzer's calibration procedure.

After calibration, use the same **100 pF standard for verification**. The measured capacitance should correspond to the nominal value of the calibration standard within its specified tolerance.

This verification checks the complete measurement chain, including **ARDA electrode system, connections, analyzer and calibration settings**.

6.6 Reference Calibration – Omega

When using the ARDA with the **Eynocs Omega analyzer**, perform the **Reference Calibration in the same physical configuration as the Open Calibration**.

Raise the **upper electrode to its maximum possible height** and ensure that no sample or external reference standard is installed between the electrodes.

Start the Omega **Reference Calibration** procedure. The Omega uses its **internal reference capacitors** during this calibration; no external calibration capacitor is required.

The reference calibration compensates for the measurement system while ARDA is connected to the Omega in the same configuration used for subsequent measurements.

After completing the reference calibration, return the upper electrode to the required measurement position.

6.7 Important

Calibration should be repeated whenever the **measurement configuration, cabling, electrode arrangement or analyzer settings** are changed significantly or on weekly basis.

For the most reproducible results, allow the analyzer and measurement system to reach thermal stability before calibration and measurement.

7 Technical Specifications

Parameter	Specification
Product	ARDA – Ambient Rigid Dielectric Apparatus
Max applied Voltage	100 V
Max applied Current	1 A
Application	Dielectric and impedance characterization
Standards	Designed for measurements in accordance with ASTM D150
Sample type	Rigid, flat dielectric/insulating materials
Maximum sample thickness	15 mm
Dimensions (L × W × H)	125 × 120 × 80 mm excluding Micrometer
Temperature operation	Ambient; no integrated temperature control
Micrometer Resolution	2 μm
Micrometer Movement	Ratchet mechanism
Electrode configuration	Two-electrode system
Guard	Spring-loaded guard ring
Upper electrode	40 mm diameter electrode
Upper electrode connections	Red and Blue Ringed BNC-Connector
Lower electrode	38 mm diameter current-measuring electrode
Lower electrode connections	Green and Yellow Ringed BNC-Connector
Guard gap	0.5 mm
Standard electrode material	Stainless steel
Optional electrode material	Gold-plated stainless steel
Shielding	Fully enclosed Faraday cage
Frequency range	Up to 100 MHz*

Low-frequency capability	Suitable for ultra-low-frequency measurements
Direct connection	Eynocs Lamda and Zeus
External analyzer connection	Up to 4 × BNC
Sample configurations	Rigid samples, liquid sample cells, disposable electrodes
Compensation	Analyzer-dependent open/short/system compensation
Measurement parameters	Capacitance, relative permittivity, dissipation factor and related dielectric parameters

*The achievable frequency range depends on the connected analyzer, measurement configuration, cabling, sample properties and measurement conditions.