

# SPECTANO 100

## User Manual



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# 1 About this User Manual

This SPECTANO 100 User Manual provides in-depth information about *SPECTANO 100*, its installation, designated use, configuration and operation. Moreover, it includes a detailed description of the *SPECTANO Analyzer Suite*. The SPECTANO 100 User Manual is available in PDF format on the DVD delivered with *SPECTANO 100* and can be accessed directly on the OMICRON Lab website [www.omicron-lab.com](http://www.omicron-lab.com).

## Safety symbols used

In this User Manual, the following symbols indicate safety instructions for avoiding hazards:



### DANGER

Death or severe injury will occur if the appropriate safety instructions are not observed.



### WARNING

Death or severe injury can occur if the appropriate safety instructions are not observed.

### CAUTION

Minor or moderate injury may occur if the appropriate safety instructions are not observed.

### NOTICE

Equipment damage or loss of data possible

## 2 Safety instructions

Before operating *SPECTANO 100* and its accessories, read the following safety instructions carefully. If you do not understand some of the safety instructions, contact OMICRON Lab before proceeding. When working with *SPECTANO 100*, observe the five safety rules (see chapter 2.2 "Five safety rules" ) and all other safety instructions in this User Manual.

You are responsible for every application that makes use of an OMICRON or OMICRON Lab product. *SPECTANO 100* may only be operated by trained personnel. Any miss-operation can result in damage to property or persons.

Maintenance and repair of *SPECTANO 100* and its accessories is only permitted by qualified experts either at OMICRON Lab or at certified repair centers.

### 2.1 Operator qualifications and safety standards

Testing and measuring with *SPECTANO 100* and its accessories like the *DTS1* dielectric test sample box must be carried out only by qualified, skilled and authorized personnel working with voltages up to 200 V<sub>peak</sub> AC and DC.

Before starting to work, clearly establish the responsibilities. Personnel receiving training, instructions, directions, or education on *SPECTANO 100* must be under constant supervision of an experienced operator. Measuring with *SPECTANO 100* must comply with the internal safety instructions as well as additional relevant documents like national and international safety standards:

- EN 50191 (VDE 0104) "Erection and Operation of Electrical Test Equipment"
- EN 50110-1 (VDE 0105 Part 100) "Operation of Electrical Installations"

Moreover, observe all applicable regulations for accident prevention in the country and at the site of operation.

The manufacturer or the distributors are not liable for damage resulting from unintended usage. The user alone assumes all responsibility and risks.

#### 2.1.1 Additional operator qualifications for testing with high and low voltage systems

The operator must be:

- Familiar with recognized operating practices and procedures for working on high and low voltage systems.
- Familiar with the five safety rules.
- Authorized to perform the required work on the equipment of the power distribution network.
- Trained in the proper use of all necessary personal safety equipment.

## 2.2 Five safety rules

Before connecting any test leads to a test object, always observe the five safety rules for working with high power:

- ▶ Disconnect completely.
- ▶ Secure against re-connection.
- ▶ Verify that the installation is dead.
- ▶ Carry out grounding and short-circuiting.
- ▶ Provide protection against adjacent live parts.

## 2.3 Operating the measurement setup

The safety instructions given here always apply when operating the *SPECTANO 100*. They are supplemented by further notes and warnings applicable for specific actions only. Such specific notes and warnings are given where necessary in this user manual.

In addition to the safety instructions given in this manual, always observe the applicable company internal safety instructions and safety documents.

In case of any problems or questions, or if you do not understand some safety instructions, contact the OMICRON Lab Technical Support (refer to chapter “Technical support”).

- ▶ Read the safety instructions and setup information described in this User Manual before operating *SPECTANO 100* or its accessories. In addition, read the manuals of all devices included in the test setup. Any maloperation can result in damage to property or persons.
- ▶ Use *SPECTANO 100* and its accessories only in a technically sound condition and when its use is in accordance with the safety regulations for the specific job site and application.
- ▶ Before using *SPECTANO 100*, always ensure that neither the device nor its accessories are damaged.
- ▶ Connect the equipotential ground of *SPECTANO 100* with a solid connection of at least 6 mm<sup>2</sup> cross-section and not longer than 20 meters to a ground connection in the laboratory. Never handle *SPECTANO 100* without grounding it.
- ▶ Ensure that all ground connections are in good condition, clean and free of oxidation.
- ▶ Connect all parts of the test cell which have to be connected to ground according to the related manual.
- ▶ Only use the delivered grounded AC power supply DRA SUPPLY to power *SPECTANO 100*. Never use power outlets without protective ground (PE).
- ▶ Always turn off *SPECTANO 100* (with the power switch on the back) before connecting or disconnecting cables or changing the test cell. Be especially careful when using unsafe adapter cables (e.g. BNC adapter).
- ▶ Ensure that no dangerous voltages are present at touchable parts of the test setup. If this is not possible due to, for example, unsafe adapter cables or connectors or unsafe test cells always,
  1. Secure the danger zone with clearly visible barriers before performing tests.
  2. Prevent the presence of other persons in the potentially dangerous area around the test object

## 2.4 Orderly measures

The SPECTANO 100 Quick Start Guide, SPECTANO 100 User Manual, or the e-book version of one of these documents must always be available where *SPECTANO 100* is being used. All users of *SPECTANO 100* must read and observe the safety instructions described in the documents and all relevant installation and operation instructions.

*SPECTANO 100* and its accessories like the *DTS1* dielectric test sample box may be used only as described in the SPECTANO 100 Quick Start Guide or the User Manual. Any other use is not in accordance with the local safety regulations. The manufacturer and the distributor are not liable for damage resulting from improper usage. The user alone assumes all responsibility and risk.

Full compliance with the local safety regulations also includes following the instructions provided in the SPECTANO 100 Quick Start Guide or the User Manual.

## 2.5 Designated use

*SPECTANO 100* and its accessories are especially designed for testing dielectric solid and liquid materials together with a suitable dielectric material test cell and test system.

Examples of dielectric material analysis use cases and applications:

<i>SPECTANO 100</i> characterizes, analyzes and determines the insulation, polarization or dielectric losses of solid and liquid materials such as:	<i>SPECTANO 100</i> achieves information on:
Electrical insulation paper/cellulose Nanomaterials (nano-composites) Dielectric components Epoxy resin Polymers Insulation oils Display technologies like glasses or polymers Solar cells etc.	Dielectric properties Material aging Material structure Space charges in multilayer insulation Surface or film thickness of coatings Curing processes

## 2.6 Disclaimer

The advisory procedures and information contained within this document have been compiled as a guide to the safe and effective operation of *SPECTANO 100*. It has been prepared in conjunction with application engineers and the collective experience of the manufacturer.

The in-service conditions for the use of *SPECTANO 100* may vary between customers and end-users.

Consequently, this document is offered as a guide only. It shall be used in conjunction with the customers own safety procedures, maintenance program, engineering judgment, and training qualifications.

If *SPECTANO 100* or its accessories are used in a manner not specified by the manufacturer or used with third party test devices and cables, the protection provided by *SPECTANO 100* or its accessories may be impaired, and this may result in damage to property or persons.

## 3 Compliance statements and recycling

### 3.1 Compliance statements

#### **Declaration of conformity (EU)**

The equipment adheres to the guidelines of the council of the European Community for meeting the requirements of the member states regarding the electromagnetic compatibility (EMC) directive, the low voltage directive (LVD) and the RoHS directive.

#### **FCC compliance (USA)**

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

#### **Declaration of compliance (Canada)**

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

## 3.2 Recycling



**This test set (including all accessories) is not intended for household use. At the end of its service life, do not dispose of the test set with household waste!**

### **For customers in EU countries (incl. European Economic Area)**

OMICRON test sets are subject to the EU Waste Electrical and Electronic Equipment Directive 2012/19/EU (WEEE directive). As part of our legal obligations under this legislation, OMICRON offers to take back the test set and ensure that it is disposed of by authorized recycling agents.

### **For customers outside the European Economic Area**

Please contact the authorities in charge for the relevant environmental regulations in your country and dispose the OMICRON test set only in accordance with your local legal requirements.

## 4 PC requirements

The following table shows the minimum requirements your computer needs to run *SPECTANO Analyzer Suite*.

Table 4-1 *SPECTANO Analyzer Suite* PC requirements

Characteristic	Requirement
Processor	Current Intel or Intel compatible CPU
Memory (RAM)	2 GB, 4 GB recommended
Graphics resolution	Super VGA (1024×768), higher resolution recommended
Graphics card	UDirectX 11 with Direct2D support
USB interface	USB 2.0 or higher
Operating system	Windows 10

## 5 Introduction

### 5.1 SPECTANO 100

*SPECTANO 100*, in conjunction with its accessories or as stand-alone unit, is a test system for dielectric analysis of solid and liquid materials. It combines the time-domain and frequency-domain analysis within a wide frequency range from 20  $\mu\text{Hz}$  up to 5 kHz in one device and provides an output voltage range from 100 mV to 200  $V_{\text{peak}}$ . The designated use of *SPECTANO 100* is the analysis of dielectric characteristics of liquid and solid materials such as:

- Impedance, capacitance and resistance
- Complex permittivity  $\epsilon$
- Loss factor  $\tan\delta$

*SPECTANO 100* can be used for a wide range of different applications:

- Dielectric analysis of solid and liquid dielectric materials, for example, polymers, cellulose-based materials, oil, and other insulation materials
- Monitoring of polymerization and hardening processes
- Analysis of nanocomposites
- Research on dielectrics
- Analysis of ceramics
- Analysis of thin films

### 5.2 Methods

The following list gives a short overview of methods and test cell types which can be used together with *SPECTANO 100* to analyze dielectric materials. However, also measurements of dielectric materials or components without electrode arrangements are possible like capacitors or coils.

#### **Solid dielectric materials:**

- Parallel plate method
  - Contacting electrode method used with rigid metal electrodes
  - Contacting electrode method used with rigid metal electrodes and coated solid test material
  - Contacting electrode method used with thin film electrodes
  - Non-contacting electrode method (gap occupied by air or liquid, on one or both sides of the solid test material)
  - Tube or cylindrical electrode method

#### **Liquid dielectric materials:**

- Coaxial probe method
- Parallel plate method
- Tube or cylindrical electrode method

### 5.3 *DTS1* dielectric test sample box

The *DTS1* dielectric test sample box is an accessory for demonstrating and testing the functionality of *SPECTANO 100* without a sample test cell. The *DTS1* is a demo box containing two samples: a high-precision, low-loss 1 nF capacitor and a RC circuit simulating a dielectric sample with losses. The main application areas of the *DTS1* are in training and demonstration purposes but it can also be used for detecting errors in a cable setup.

### 5.4 Frequency domain spectroscopy (FDS)

By using the frequency domain spectroscopy (FDS), the dielectric properties of the solid or liquid material under test are measured by frequency sweep (5  $\mu$ Hz to 5 kHz). The FDS allows fast measurements at high frequencies but requires long measurement times at lower frequencies.

### 5.5 Polarization current method (PDC)

In the polarization current (PDC) method, a DC voltage is applied to the device under test for a specific time and the polarization current is measured. From the polarization current, the dielectric response is evaluated, and the dielectric frequency characteristic is calculated using Fourier transformation. The PDC method is faster than the FDS at very low frequencies, but the upper frequency is limited due to the finite rise time of the DC pulse. The test frequency range for the PDC method is 20  $\mu$ Hz to 100 mHz.

### 5.6 Combined mode (FDS and PDC)

*SPECTANO 100* combines the PDC with the FDS principle and thus significantly reduces the testing time to exclusive frequency domain measurements. PDC measurements can be accomplished in a short time but are limited to low frequencies while FDS measurements are feasible for high frequencies but take very long at low frequencies. It combines the advantages of both principles. It measures data in the time domain for frequencies below 100 mHz. This reduces the measurement time up to 75% compared to exclusive FDS measurements. For example, a FDS measurement from 1 kHz to 100  $\mu$ Hz will take 11 hours, *SPECTANO 100* will acquire this data in less than 3 hours using the combined FDS and PDC measurement. The maximum test frequency range for the combined mode is 20  $\mu$ Hz to 5 kHz.

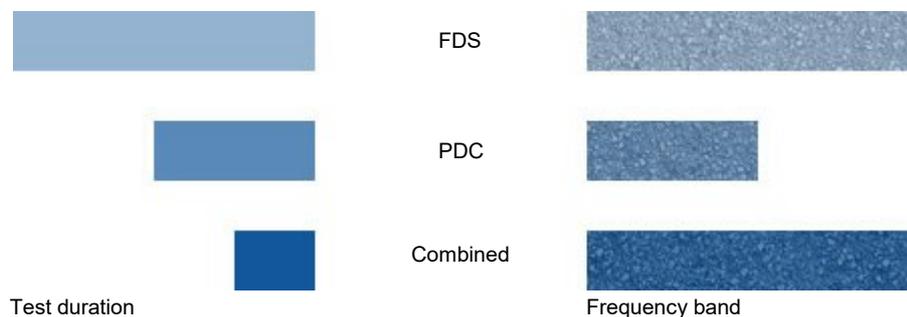


Figure 5-1

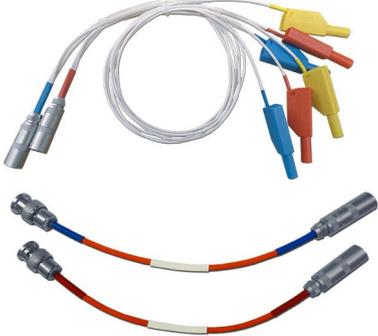
Comparison of measurement methods

## 5.7 Scope of delivery and ordering information

### 5.7.1 Main package

Description	Part No.	Picture
<i>SPECTANO 100</i> main device	OL000400	
<i>DTS1</i> dielectric sample test box		
2 × Triaxial standard cable (1.5 m)		
Specific grounded <i>SPECTANO 100</i> power supply		
CD ROM incl. <i>SPECTANO Analyzer Suite</i> and User Manual (English)		
Quick Start Guide (printed) (English)		
USB cable (1.5 m)		

## 5.7.2 Optional accessories

Description	Part No.	Picture
2 × Triaxial-to-4 mm plug adapter cable set	OL000451	
2 × Triaxial-to-BNC connector adapter cable set	OL000452	

# 6 Device description

## 6.1 SPECTANO 100

### 6.1.1 Connectors and operating controls



#### Warning

##### Death or severe injury caused by high voltage or current

- ▶ Do not touch the **OUTPUT** connector when the red LED is on or blinks.
- ▶ Always ensure that no dangerous voltages are present at any touchable part of the device.
- ▶ Before handling *SPECTANO 100* in any way, connect its equipotential ground terminal with a solid connection of at least 6 mm<sup>2</sup> cross-section and not longer than 20 meters to the ground terminal in the laboratory.

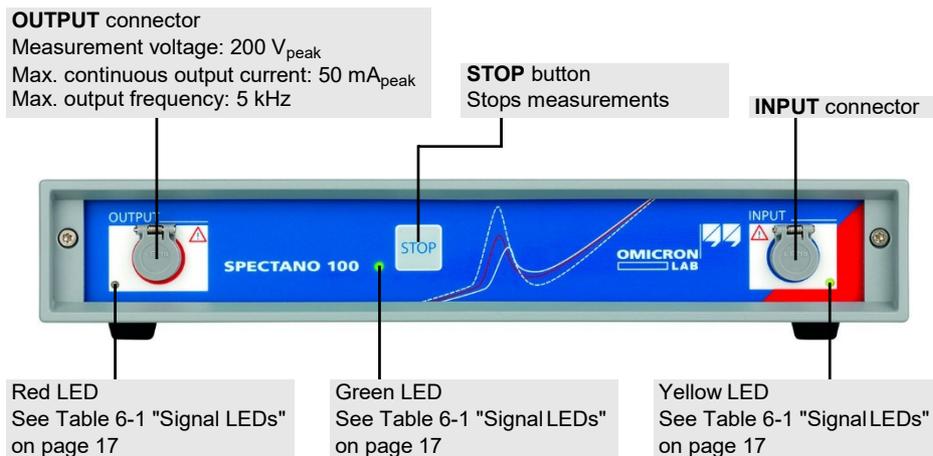


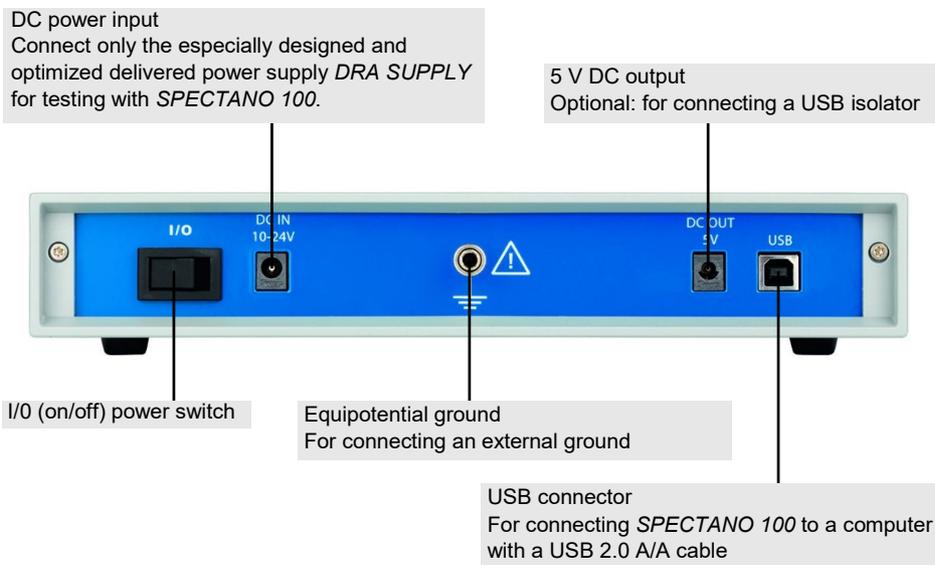
Figure 6-1 *SPECTANO 100* front view

Table 6-1 Signal LEDs

LED	State	Description
Green	On	Signals that the power switch is on.
Yellow	Blinking	Signals the input activity: <ul style="list-style-type: none"> <li>• Measurement results are available in <i>SPECTANO 100</i> which are not saved. (This can happen when the computer is disconnected from <i>SPECTANO 100</i> after the measurement was started.).</li> <li>• An error has occurred during measurement (Measurement is stopped.). After a computer has been connected to <i>SPECTANO 100</i>, the error information is sent to the computer and the LED is on.</li> </ul>
Red	On or blinking	Signals dangerous voltage on the <b>OUTPUT</b> connector.
	Blinking	A measurement is running.
	On for approx. 10 s	The test object is being depolarized after a measurement has been stopped by <i>SPECTANO Analyzer Suite</i> , manually or due to an error.

**DANGER****Death or severe injury caused by high voltage or current**

- ▶ Do not handle *SPECTANO 100* without grounding it according to the safety instructions
- ▶ Do not use power outlets without protective ground (PE).
- ▶ Only use the delivered grounded AC power supply *DRA SUPPLY* to power
- ▶ *SPECTANO 100*.
- ▶ Connect the *SPECTANO 100* power supply only to a power outlet that is equipped with protective ground (PE).

Figure 6-2 *SPECTANO 100* rear view

## 6.1.2 Cleaning

To clean *SPECTANO 100* and its accessories, use a cloth dampened with isopropanol alcohol.

**DANGER****Death or severe injury caused by high voltage or current**

- ▶ Do not clean *SPECTANO 100* when the device is powered.
- ▶ Do not clean *SPECTANO 100* when connected to the test object.
- ▶ Before cleaning *SPECTANO 100* and its accessories, always switch the device off and disconnect the test object, accessories and connection cables.

## 6.2 DTS1 dielectric test sample box



### DANGER

Death or severe injury caused by high voltage or current

- ▶ Use the *DTS1* box only together with the *SPECTANO 100* test device and the delivered accessories and cables.
- ▶ Read the safety instructions in 2 "Safety instructions" in this User Manual before using the *DTS1* box together with the *SPECTANO 100* test device.

### NOTICE

Equipment damage possible

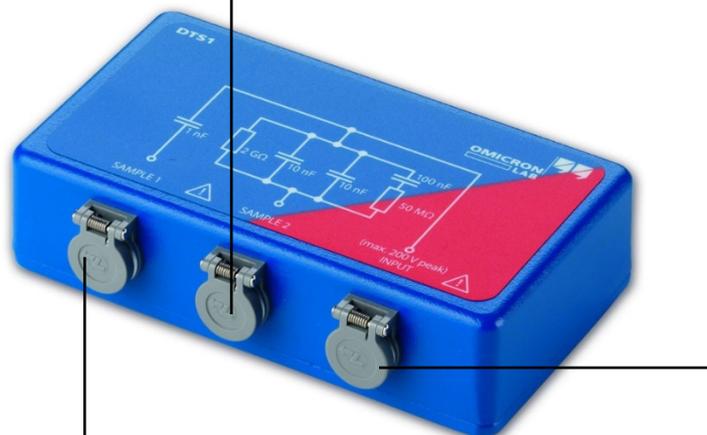
- ▶ Do not supply a continuous input current  $> 50 \text{ mA}_{\text{peak}}$ . An overload at the
- ▶ *SPECTANO 100* input can cause damages of the device.
- ▶ Always configure the max. test output voltage and the input test frequency for the connected test object so that the maximum input current will not be reached.
- ▶ For information on how to configure the output signals for testing with the
- ▶ *DTS1* dielectric test sample box, see "Technical data" in the *SPECTANO 100* User Manual.

#### Sample 2

RC circuit (for more information, see the front panel of the *DTS1* box) to connect to the **INPUT** connector of *SPECTANO 100*

#### Input connector (signal source input)

Max. continuous input current:  $50 \text{ mA}_{\text{peak}}$   
to connect to the **OUTPUT** connector of *SPECTANO 100*



#### Sample 1

to connect to the **INPUT** connector of *SPECTANO 100*

Figure 6-3 *DTS1* dielectric test sample box

## 7 Preparation of test material and test cell

### 7.1 Solid materials

The following sections base on the international standards for analysis of the dielectric properties of solid electrical insulation like ASTM D150-18 (ASTM D150-11), D-257-14, IEC 62631-2-1-2018-02 (IEC 60250) or IEC 62631-3-1.

#### 7.1.1 Preparation of solid material test cells

The measured dielectric properties can be influenced by the presence of conductive contaminations or moisture on the test cell or the material sample surface. Thus, the test cell and its electrodes or contact surfaces must be cleaned before measurement.

##### NOTICE

- ▶ Follow the cleaning, warning and safety instructions of the test cell manual.
- ▶ The used solvents or cleaning agents must previously been checked to ensure that they do not contain contaminations which can influence the measurements. Ensure that the used solvent or cleaning agent leads to correct results of known low permittivity and dielectric losses. Some cleaning procedure examples can be found in the international standards like described above.



##### DANGER

##### Death or severe injury caused by fire, poisoning or chemical burn

Ensure the safety conditions for using solvents. Protect persons and equipment against fire and toxic effects. Read the safety instructions of the solvent or cleaning agent before cleaning.

#### 7.1.2 Preparation of solid test material

The measurement error of the permittivity is not only caused by capacitance measurement error (see 8.1 "Error correction"), but also by the error in the solid test material dimensions and structure. Therefore, cut or model the test material accurately and measure the test material sample so that its dimensional error will not affect the permittivity value.

##### Size and thickness

In general, the size of the solid material should be large enough to allow its measurement with the required accuracy. Typically, a capacitance of at least 100 pF should be formed by the sample (size and thickness) and test cell. If the capacity is lower, the accuracy is limited and noise influences can prevent a good measurement result, especially if the dielectric has low losses. Therefore, usually a low sample thickness is used.

**Flatness**

The surface of the test material must be flat at all points. If the surface of the test material is not flat, an air gap between the electrode and the solid test material causes measurement errors.

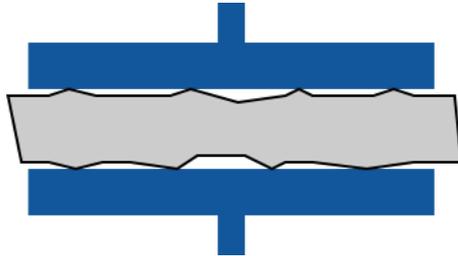


Figure 7-1 Example of a non-uniform solid material sample

The thickness must be determined systematically over the area of the solid material that is used in the electrical measurement and shall be uniform within  $\pm 1\%$  of the average thickness.

**Note:** Measurement errors caused by non-uniformity have a high influence when the solid test material is thin.

### 7.1.3 Electrode adjustment of solid material test cells

Adjust the two electrodes until they are parallel to each other for accurate measurement. Moreover, ensure that also the solid test material is fully contacted (parallel). Perform this adjustment in the following cases:

- Before starting a measurement
- After changing the electrodes or the sample

The following figures show examples of a correct and wrong adjustment of one example test cell.

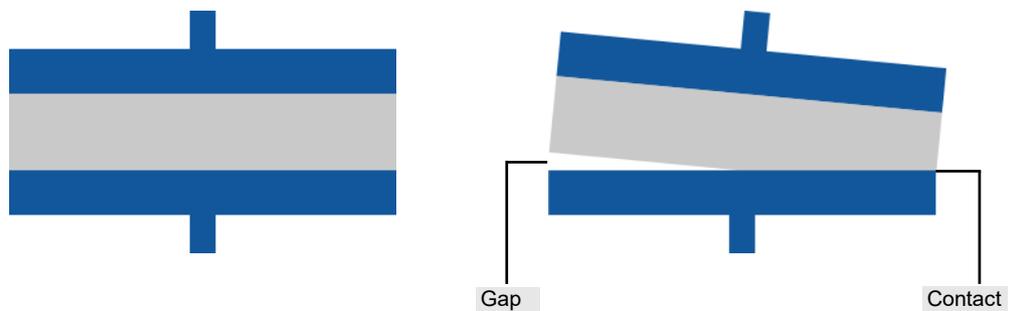


Figure 7-2 Correct (left picture) and wrong (right picture) adjustment of the test cell

**Note:** The adjustment procedure and kind of adjustment depend on the used test cell. Read the test cell manual for more information on the test cell specific adjustment procedure.

For more information on sample dimension or test setup improvement, see our application notes available at [www.omicron-lab.com](http://www.omicron-lab.com).

## 7.2 Liquid materials

The following sections base on the international standards for analysis of the loss characteristics and permittivity of liquid electrical insulation like ASTM D924-15 (ASTM D924-08) or IEC 60247-2004-02.

### 7.2.1 Preparation of liquid material test cells

Cleaning the test cell is of paramount importance when measuring the dielectric characteristics because they are defected by the presence of conductive contaminations or moisture on the test cell surfaces. For this reason, clean and dry the test cell or minimum the contact surfaces prior testing.

#### NOTICE

- ▶ Follow the cleaning, warning and safety instructions of the test cell manual.
- ▶ The used solvents or cleaning agents must previously been checked to ensure that they do not contain contaminations which can influence the measurements. Ensure that the used solvent or cleaning agent leads to correct results of known low permittivity and dielectric losses. Some cleaning procedure examples can be found in the international standards like described above.



#### DANGER

##### Death or severe injury caused by fire, poisoning or chemical burn

Ensure the safety conditions for using solvents. Protect the personal and equipment against fire and toxic effects. Read the safety instructions of the solvent or cleaning agent before cleaning.

### 7.2.2 Preparation of liquid test material and filling the test cell

Store the liquid test material in its original sealed container and protect it against light. Some liquids, such as oils of petroleum origin, change when exposed to sunlight. Allow the sealed container to stand in the room in which the test will be made for a sufficient period of time to guarantee that the liquid test material has the same room temperature before it is opened.

When insulating liquids are heated to high temperatures, some of their dielectric characteristics change with time. It is possible that these changes will influence the measurement results. It is therefore necessary to keep the time, needed for the liquid test material to attain temperature equilibrium with the test cell, at a minimum. It is essential that the procedures described in the international standards for the general and routine testing of the dielectric properties of liquids are strictly followed.

In general, always rinse the test cell with a portion of the liquid test material to be tested before the test cell is filled.

## 8 Setup improvements

### 8.1 Error correction

To eliminate, for example, the stray capacitances and unknown capacitances between the leads of the used test cell, we recommend performing reference measurements by using a reference material with a known permittivity (e.g. air). The following error correction is based on the air reference example and proceeds as follows:

1. Depending on your test cell type, insert either a spacer between the electrodes or adjust the electrodes with a locking screw so that you can measure the air gap height.

**Note:** We recommend using a small spacer (lower than 5 mm) consisting of a material with low permittivity and especially low losses, for example PTFE or PE. Moreover, the spacer surface must be flat at all points.

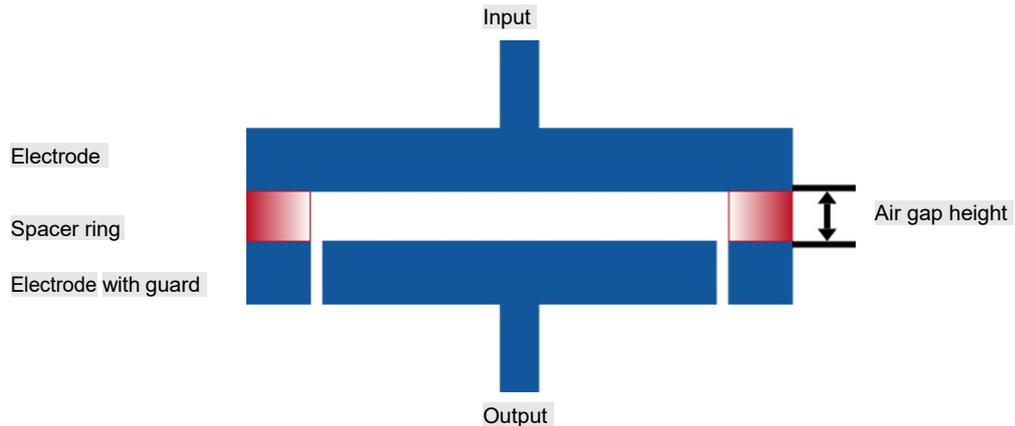


Figure 8-1 Adjusting the air gap height by using a spacer

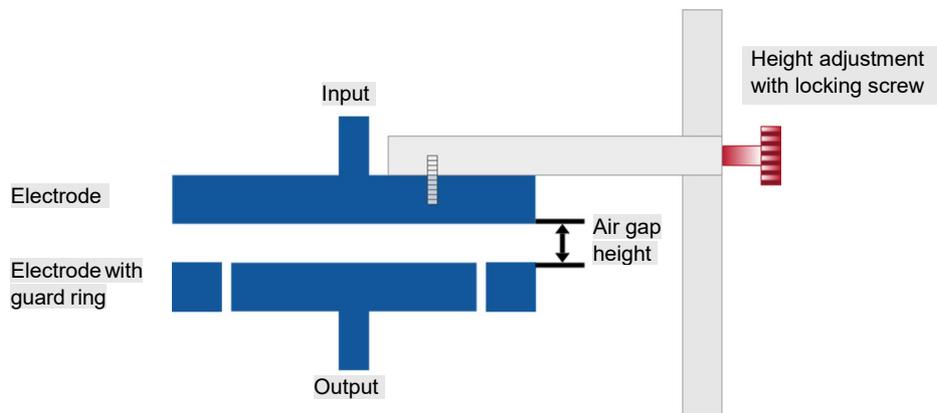


Figure 8-2 Adjusting the air gap height by using a locking screw

2. Perform the air reference measurement(s) by using *SPECTANO Analyzer Suite* as described in 10.4 "Perform reference measurements".

**Note:** We recommend adjusting the air space height equal to the thickness of the sample probe under test. If it is not possible, we recommend performing two air reference measurements with different air spaces. Preferably, make a first measurement with the spacer that is higher than the sample thickness and a second measurement with the spacer that is lower than the sample thickness.

For more information on sample dimension or test setup improvement, see our application notes available at [www.omicron-lab.com](http://www.omicron-lab.com).

## 8.2 Electrodes for solid dielectric material analysis

The used electrodes should be parallel and must have a proper contact to the material sample to ensure a good contact and reliable measurement results. Air inclusions should be avoided.

### “Soft” material sample

In this case, a proper material contact with electrodes may not be an issue but the pressure from the electrodes may deform the material sample, what can possibly change the measured permittivity.

### “Rigid” material sample

In this case, a deformation of the sample under pressure may not be significant but as shown in the following figure, areas with no sufficient contact between electrodes and material sample surface will prevent a homogeneous current flow through the sample. This leads to measurement results which do not represent the properties of the material volume.

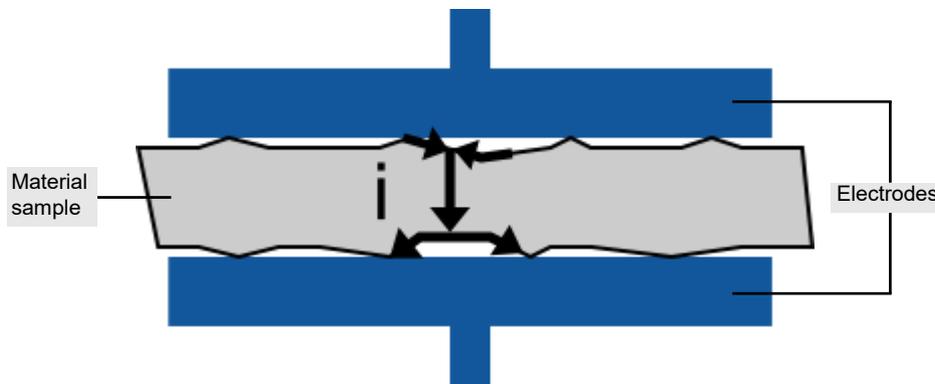


Figure 8-3 Bad contact between material sample surface and electrodes<sup>1</sup>

1. This image refers to the IEEE Transactions on Dielectrics and Electrical Insulation Vol. 20, No. 3; June 2013, paper "Enhanced Accuracy in Dielectric Response Material Characterization by Air Reference Method" from Xiangdong Xu, Tord Bengtsson, Jörgen Blennow and Stanislaw M. Gubanski.

## 8.2.1 Thin film electrodes or coating

A simple solution to avoid high pressure on the material sample and to improve the contact between sample material and electrode is the measurement with thin film electrodes or an additional coating surface.

Thin film electrodes or a coating surface between material sample and electrodes improve the contact which increases current flow and reduces the signal-to-noise ratio also when using low test voltages. The measurement error caused by the current flow along the material sample surface at the non-contacted areas is less than using rigid metal electrodes. There are several types of thin film electrode or coating materials, such as:

- Metal foil
- Conductive paint
- Silver coating
- Sprayed metal
- Evaporated metal
- Metal spattering

For more details, refer to the international standards like ASTM D150-18 (ASTM D150-11), D-257-14, IEC 62631-2-1-2018-02 (IEC 60250) or IEC 62631-3-1.

**Note:** When attaching a thin film electrode, the gap width between the guarded thin film electrode and the guard thin film ring should be as small as possible.

## 8.2.2 Guard electrodes

When measuring the dielectric properties of solid materials without guarding, the measurement is influenced by stray capacitances at the edge of the solid test material, as shown in the following figures.

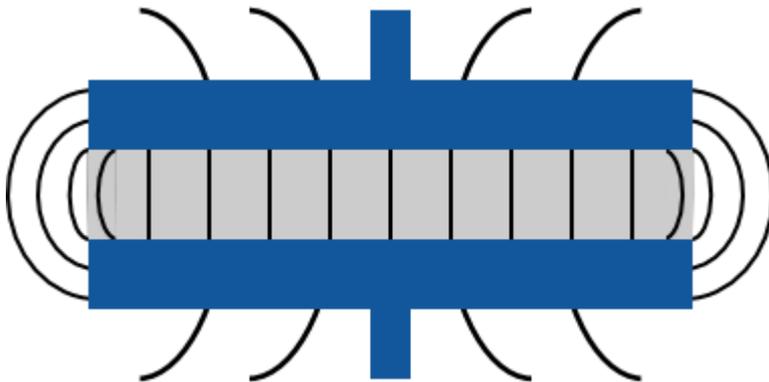


Figure 8-4 Lines of electric force, unguarded electrode<sup>1</sup>

1. This image refers to the standard ASTM D150-11.

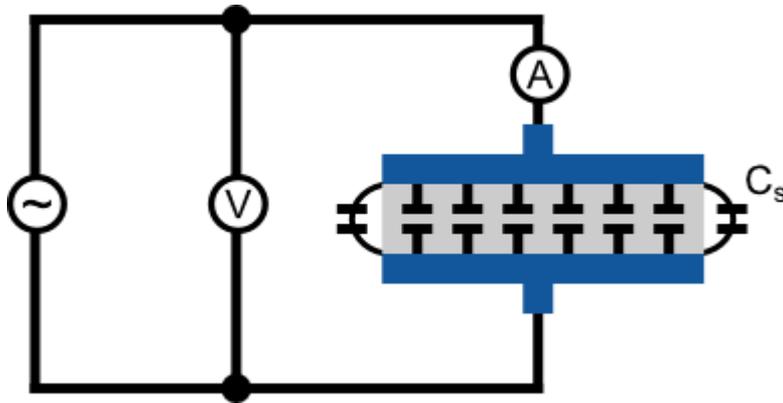


Figure 8-5 Measurement circuit, unguarded electrode ( $C_s$  is stray capacitance)

When using a guard electrode, the stray capacitances will be guarded as shown in the following figures. With this setup it is possible to measure the dielectric properties of the solid test material accurately, because the stray capacitances are not measured. Additionally, the influence of surface currents is eliminated by the guard electrodes. This is especially important for samples with a high-volume resistivity.

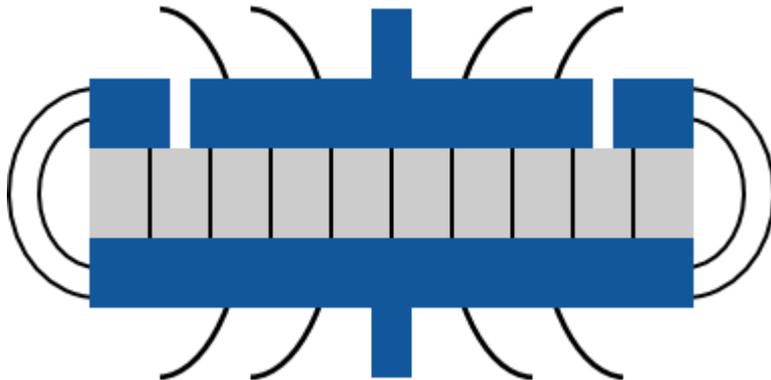


Figure 8-6 Lines of electric force, guarded electrode<sup>1</sup>

1. This image refers to standard ASTM D150-11.

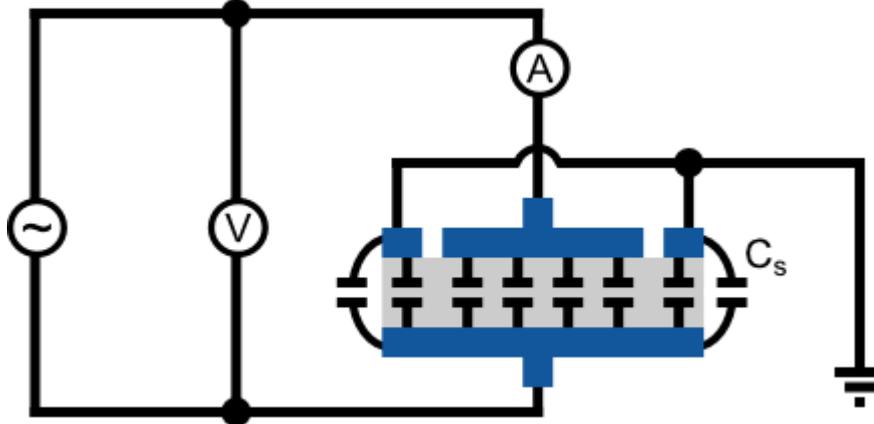


Figure 8-7 Measurement circuit, guarded electrode ( $C_s$  is stray capacitance)

### 8.3 Stable environment

The permittivity and dielectric losses vary with temperature and humidity. Therefore, we recommend measuring the sample in a stable environment.

### 8.4 Shielding of low signal measurements

To improve the signal-to-noise ratio for low current measurements, do the following improvements on the test setup:

- ▶ Put the test cell and/or test device into an EMC box to shield the test system from external noise.
- ▶ Increase the test voltage.
- ▶ Separate guard and ground.
- ▶ Ensure the cabling is also shielded.

For more information on sample dimension or test setup improvement, see our application notes available at [www.omicron-lab.com](http://www.omicron-lab.com).

## 9 Installation

Before operating *SPECTANO 100* for the first time, use the delivered packing list to verify that all components of the test system are available.



### DANGER

**Avoid serious injury or death caused by worn-out, chafed, or otherwise damaged parts of *SPECTANO 100* or its accessories.**

- ▶ Before operating *SPECTANO 100*, always make sure that neither the device nor its accessories are damaged.
- ▶ Immediately replace any damaged device or accessory.



### DANGER

**Avoid serious injury or death caused by unsuitable accessories.**

Only use the original components and accessories supplied by OMICRON.

### 9.1 Install *SPECTANO Analyzer Suite*

**Note:** Install *SPECTANO Analyzer Suite* before connecting *SPECTANO 100* to the computer.

For the minimum requirements your computer needs to run *SPECTANO Analyzer Suite*, see chapter 4 "PC requirements". To install *SPECTANO Analyzer Suite*, put the delivered *SPECTANO Analyzer Suite* DVD in the DVD drive of your computer, or download the latest version from our webpage [www.omicron-lab.com](http://www.omicron-lab.com), and follow the instructions on the screen.

## 9.2 Power up SPECTANO 100



### DANGER

#### Death or severe injury caused by high voltage or current

- ▶ Use only the delivered accessories and cables to ensure the safety standard of *SPECTANO 100*.
- ▶ Read the safety instructions in chapter 2 "Safety instructions" in this User Manual before powering up *SPECTANO 100*.
- ▶ Before powering up *SPECTANO 100*, ensure that
  - ▶ a solid connection of at least 6 mm<sup>2</sup> cross-section and not longer than 20 meters is connected between its equipotential ground and any ground connection in the laboratory.
  - ▶ the whole test system is grounded properly.
  - ▶ only the delivered grounded AC power supply *DRA Supply* is connected.
  - ▶ the test object is connected correctly.

To power up *SPECTANO 100* by using the delivered AC power supply:

1. Plug the DC output connector of the AC power supply into the DC power input on the *SPECTANO 100* rear panel (see Figure 6-2 "SPECTANO 100 rear view").
2. Connect the AC power supply with the power cable.
3. Plug the mains plug of the power cable into the power outlet.
4. Press the I/O power switch on the *SPECTANO 100* rear panel.

## 9.3 Connect *SPECTANO 100* to the computer

*SPECTANO 100* communicates with the computer through USB interface (see chapter 4 "PC requirements"). To connect *SPECTANO 100* to the computer:

1. Connect the USB 2.0 or higher cable to the USB connector on the *SPECTANO 100* rear panel.
2. Connect the USB cable to the USB connector of your computer by using the delivered USB 2.0 cable.

## 9.4 Connect *SPECTANO 100* to a test object

You can connect *SPECTANO 100* to a test cell for liquid or solid materials. This section describes how to connect *SPECTANO 100* to the most common test cell types.



### DANGER

#### Avoid serious injury or death caused by

- carrying out the testing procedure incorrectly.
  - carrying out the connection incorrectly.
  - not clearly established responsibilities of the personnel involved.
  - either not or incorrectly applied safety rules and instructions.
  - dangerous voltages at touchable parts of the device, test cell or sample.
  - dangerous voltages at the **OUTPUT** connector of the device.
  - using another power supply than the delivered one (*DRA SUPPLY*).
  - electric shock from hazardous parts of the device, test cell or sample.
- ▶ Always observe the five safety rules (see chapter 2 "Safety instructions").
  - ▶ Before performing a test with *SPECTANO 100*, all on-site procedures and methods for personal safety and all safety instructions in this User Manual must be discussed with all personnel involved so that they are familiar with and fully understand all safety rules and instructions.
  - ▶ Before each test, the responsibility of all personnel involved must clearly be established, and the testing workflow must be determined.
  - ▶ Make sure to exactly comply with the workflow described in this User Manual.
  - ▶ Never perform tests without having secured the danger zone with clearly visible barriers and having placed all parts with hazardous voltage within the barriers.



### DANGER

#### Death or severe injury caused by high voltage or current

- ▶ Before handling *SPECTANO 100* in any way, connect its equipotential ground terminal with a solid connection of at least 6 mm<sup>2</sup> cross-section and not longer than 20 meters to the ground terminal in the laboratory.
- ▶ Do not connect or operate *SPECTANO 100* without proper grounding connection.
- ▶ Before handling *SPECTANO 100* in any way, connect the test object to ground properly.
- ▶ Do not connect or operate *SPECTANO 100* with a broken, dirty or oxidized ground terminal or connection cables.
- ▶ Do not use power outlets without protective ground (PE).
- ▶ Only use the delivered AC power supply to power *SPECTANO 100*.

Standard connection cable is the delivered high-temperature low-noise triaxial cable with a 1:1 connection of the inner conductor, the inner shield (guard) and the outer shield (ground). Connect the red-labeled cable to the **OUTPUT** connector of *SPECTANO 100* and the blue-labeled cable to the **INPUT** connector of *SPECTANO 100*.



Figure 9-1 Standard high-temperature low-noise triaxial cable

Depending on the connection type of the test cell, OMICRON Lab offers the following adapters:

- High-temperature low-noise triaxial-to-BNC adapter with inner and outer shield connected to the BNC outer shield

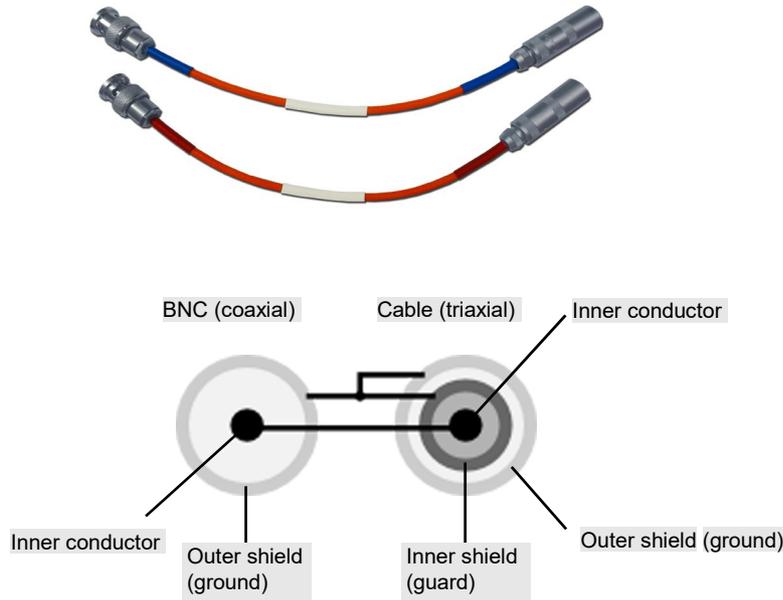


Figure 9-2 High-temperature low-noise triaxial-to-BNC adapter

- Triaxial-to-4 mm plug adapter  
The three contacts (inner conductor, inner shield and outer shield) of the triaxial connection are led through separately. They end in a 4 mm plug. Additionally, each cable has a shield which is connected to the inner shield (guard) of the triaxial connection.

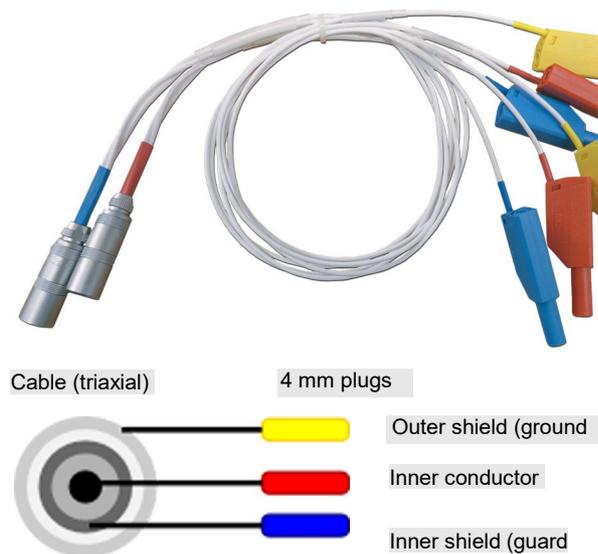


Figure 9-3 Triaxial-to-4 mm plug adapter

To connect the adapter cable to *SPECTANO 100*:

1. Connect the standard triaxial cable according to the color code to the *SPECTANO 100* **OUTPUT** and **INPUT** connectors.
2. Connect the adapter cables with the corresponding color code to the standard triaxial cable.

### 9.4.1 Typical setup for a test cell with guard ring



**DANGER**

**Death or severe injury caused by high voltage or current**

- ▶ Do not touch the **OUTPUT** connector when the red LED is on or blinks.
- ▶ Always ensure that no dangerous voltages are present at any touchable part of the device, test cell or sample.
- ▶ Do not touch the output if the guard (inner shield of the triaxial connection) is identical with the ground (outer shield of the triaxial connection).

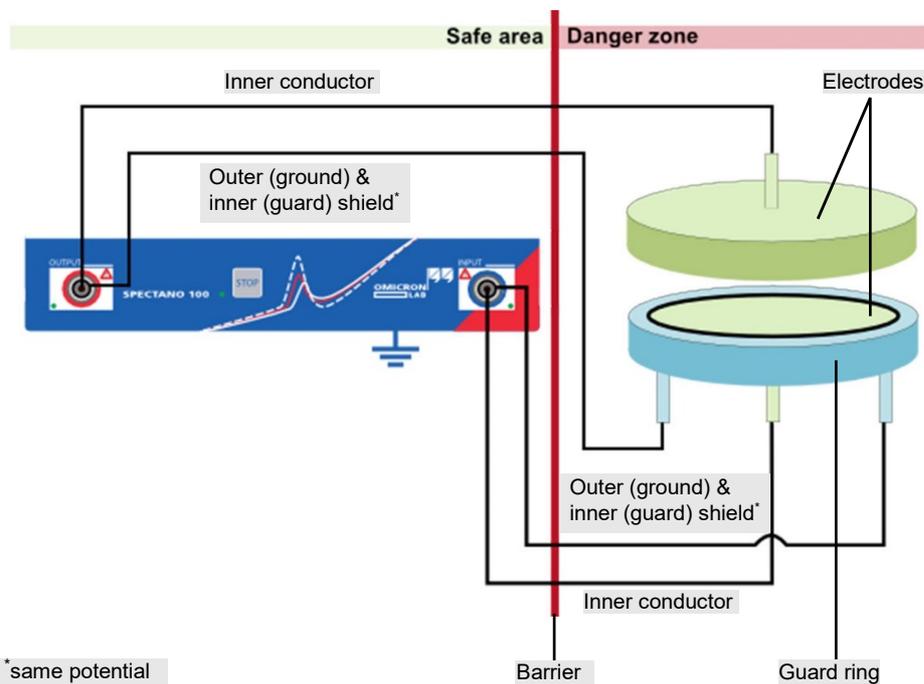


Figure 9-4 Connecting *SPECTANO 100* to a test cell with guard ring

**NOTICE**

The safe area is only safe if the delivered cables and adapters are used. Otherwise, this can also be a danger zone.

To connect *SPECTANO 100* to a test cell with guard ring:

1. Ground *SPECTANO 100* according to the safety rules (see chapter 2.2 "Five safety rules").
2. Connect the standard triaxial cable according to the color code to the *SPECTANO 100* **OUTPUT** and **INPUT** connectors:
  - Red-labeled cable to the **OUTPUT** connector
  - Blue-labeled cable to the **INPUT** connector
3. Depending on the test cell connection (BNC or 4 mm plug), connect one of the adapter cables described earlier in this chapter with the corresponding color code to the standard triaxial cable:
  - Red-labeled adapter cable to the red marked standard cable
  - Blue-labeled adapter cable to the blue marked standard cable
4. Connect the adapter cables to the test cell with guard ring according to the schematic diagram.

**Note:** If you are using the triaxial-to-4 mm plug adapter cable, be aware that the inner shield (guard) and the outer shield (ground) are not connected.

For more information and example connections to different types of test cells, see chapter 13. "Test cell configurations" in the *SPECTANO 100* User Manual.

## 9.4.2 Typical setup for a test cell without guard ring



### DANGER

#### Death or severe injury caused by high voltage or current

- ▶ Do not touch the **OUTPUT** connector when the red LED is on or blinks.
- ▶ Always ensure that no dangerous voltages are present at any touchable part of the device, test cell or sample.
- ▶ Do not touch the output if the guard (inner shield of the triaxial connection) is identical with the ground (outer shield of the triaxial connection).

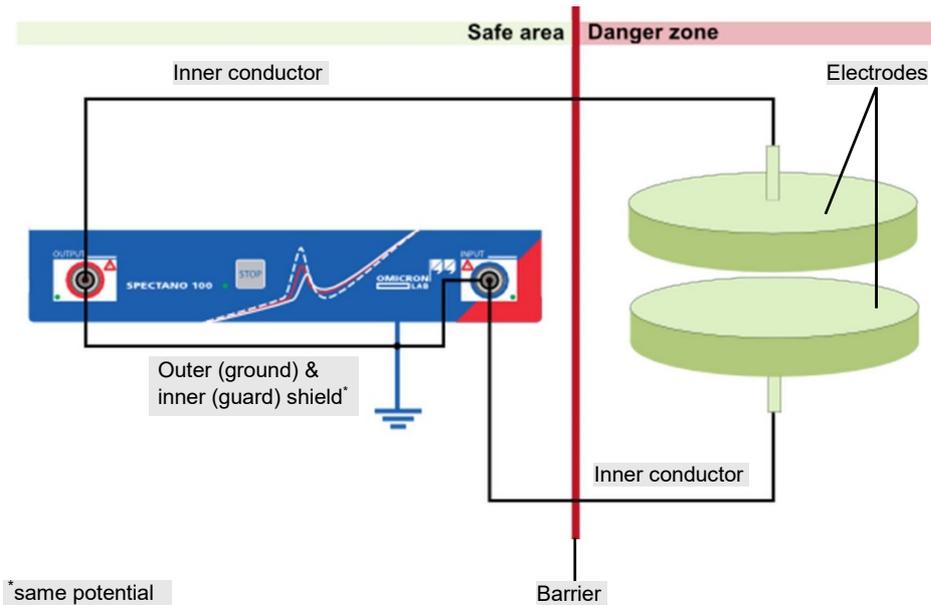


Figure 9-5 Connecting *SPECTANO 100* to a test cell without guard ring

**NOTICE**

The safe area is only safe if the delivered cables and adapters are used. Otherwise, this can also be a danger zone.

To connect *SPECTANO 100* to a test cell without guard ring:

1. Ground *SPECTANO 100* according to the safety rules (see chapter 2.2 "Five safety rules").
2. Connect the standard triaxial cable according to the color code to the *SPECTANO 100* **OUTPUT** and **INPUT** connectors:
  - Red-labeled cable to the **OUTPUT** connector
  - Blue-labeled cable to the **INPUT** connector
3. Depending on the test cell connection (BNC or 4 mm plug), connect one of the adapter cables described earlier in this chapter with the corresponding color code to the standard triaxial cable:
  - Red-labeled adapter cable to the red marked standard cable
  - Blue-labeled adapter cable to the blue marked standard cable
4. Connect the adapter cables to the test cell without guard ring according to the schematic diagram.

**Note:** If you are using the triaxial-to-4 mm plug adapter cable, be aware that the inner shield (guard) and the outer shield (ground) are not connected.

For more information and example connections to different types of test cells, see chapter 13. "Test cell configurations" in the *SPECTANO 100* User Manual.

## 9.5 Connect *SPECTANO 100* to the *DTS1* dielectric test sample box

To test the functionality of *SPECTANO 100* without a sample cell, connect *SPECTANO 100* to the *DTS1* dielectric test sample box by using the delivered standard triaxial cables as shown in the following figure.



Figure 9-6 Connecting *SPECTANO 100* to the *DTS1* dielectric test sample box for measuring on the **Sample 1** connector <sup>1</sup>



### DANGER

#### Death or severe injury caused by high voltage or current

- ▶ Before handling *SPECTANO 100* in any way, connect its equipotential ground terminal with a solid connection of at least 6 mm<sup>2</sup> cross-section and not longer than 20 meters to the ground terminal in the laboratory.
- ▶ Do not connect or operate *SPECTANO 100* with a broken, dirty or oxidized ground terminal or connection cables.
- ▶ Do not use power outlets without protective ground (PE).
- ▶ Only use the delivered AC power supply to power *SPECTANO 100*.
- ▶ Do not touch the output if the guard (inner shield of the triaxial connection) is identical with the ground (outer shield of the triaxial connection).
- ▶ Always ensure that no dangerous voltages are present at any touchable part of the device or the *DTS1* box.

<sup>1</sup> For measuring on the **Sample 2** connector, connect the blue-labeled cable to the **Sample 2** connector.

## 9.6 Connect *SPECTANO 100* to Dielectric Sample Holder *DSH 100*

Connect *SPECTANO 100* to OMICRON Lab's *DSH 100 Dielectric Sample Holder* by using the delivered triaxial cables as shown in the following figure



Figure 9-7 Connecting *SPECTANO 100* to *DSH 100*

### CAUTION



**Minor or moderate injury may occur if the appropriate safety instructions are not observed.**

- ▶ Read the safety instructions in this user manual as well as the safety instructions and corresponding chapters in the *DSH 100* user manual first.
- ▶ Always connect the *SPECTANO 100* and *DSH 100* earth terminal to safety ground using a proper ground connection when voltage levels  $>30\text{ V}_{AC}$  or  $>60\text{ V}_{DC}$  are present in the setup.

# 10 SPECTANO Analyzer Suite

In this chapter you will learn how to test dielectric materials with *SPECTANO Analyzer Suite* and manage the test data. The chapter is structured as follows:

- Section 10.1 "Start view" gives you an overview on the
  - *SPECTANO Analyzer Suite* start view.
- Section 10.2 "Create a new test" describes the workflow for creating a new test.
- Section 10.4 "Perform reference measurements" explains how to correct the measurements to improve the accuracy of the measurement results.
- Section 10.5 "Perform analysis" is about performing an analysis of the measurement results.
- In chapter 10.6 "View measurement results" you will find a detailed description of the result view workspace.
- Finally, in chapter 10.7 "Settings", all *SPECTANO Analyzer Suite* settings are described in a nutshell.

## 10.1 Start view

After starting *SPECTANO Analyzer Suite*, the start view opens. In the start view, you can select different user tasks designed to support you during diagnostic testing of dielectric materials and management of test data.

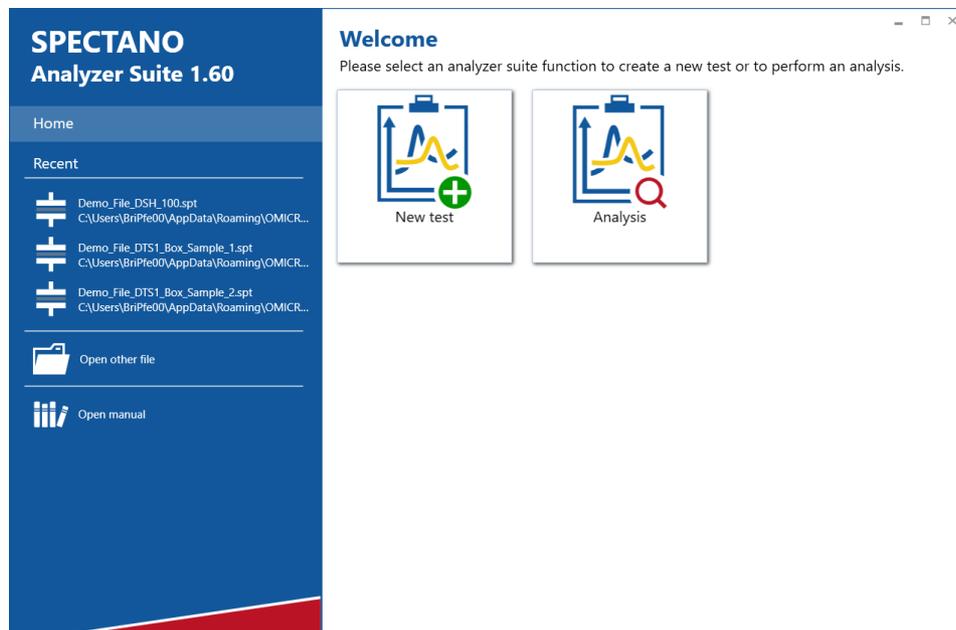


Figure 10-1 *SPECTANO Analyzer Suite* start view

*SPECTANO Analyzer Suite* supports the following user tasks.

Table 10-1 User tasks

Button	User task	Action
	Create new test	Click the <b>New test</b> button to create a new test (see 10.2 "Create a new test" on page 41).
	Perform analysis	Use the analysis macros provided by OMICRON Lab available at the Software download area under <a href="http://www.omicron-lab.com/">www.omicron-lab.com/</a>

In the left area of the start view, *SPECTANO Analyzer Suite* provides the following controls.

Table 10-2 Start view controls

Control/Command	Description
<b>Home</b>	Displays the start view.
<b>Recent</b>	Displays a list of the recently opened files. To open a file, click the file in the list. <b>Recent</b> contains three default sample files containing measurement results with the <i>Dielectric Sample Holder DSH 100</i> and <i>DTS1</i> dielectric test sample box.
<b>Open another file</b>	Opens a dialog box for selecting the file you want to open.
<b>Open manual</b>	Opens the <i>SPECTANO 100</i> User Manual.

*SPECTANO Analyzer Suite* supports the following file formats.

Table 10-3 Supported file formats

File name extension	Description
.spt	<i>SPECTANO 100</i> test file

## 10.2 Create a new test

When creating a new test, *SPECTANO Analyzer Suite* guides you through the test workflow. This section describes the test workflow step by step.

To create a new test:

1. Start *SPECTANO Analyzer Suite*.
2. In the start view, click the **New test** button . The test view opens with the **File** tab selected on the ribbon. On the left of the test view, the Navigation pane displays steps of the test workflow.

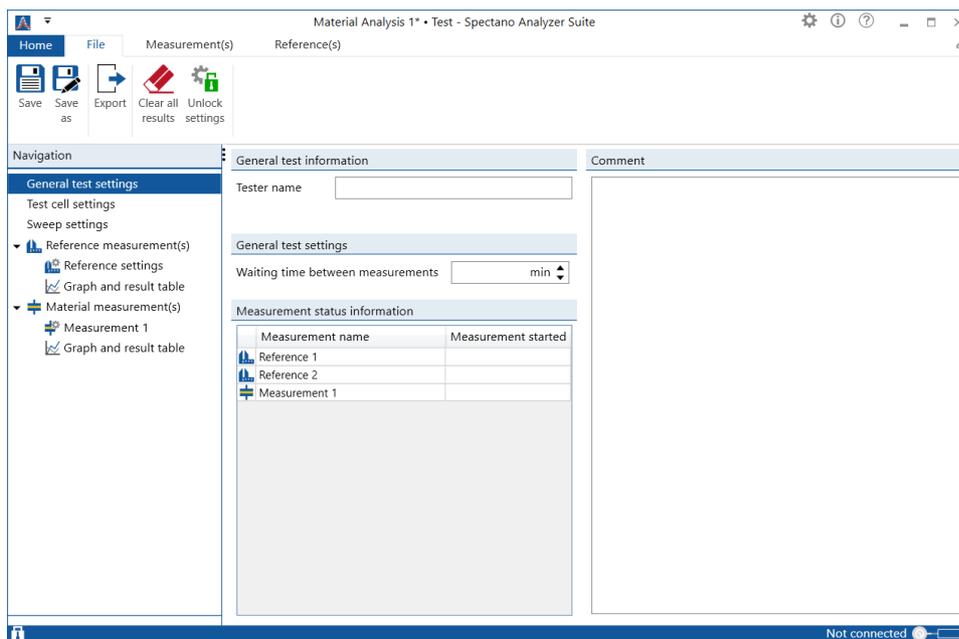


Figure 10-2 Test view: **File** tab

3. Under **General test settings**, enter the settings (see Table 10-9 "General test settings").
4. In the Navigation pane, click **Test cell settings**.  
Under **Test cell configuration**, select the test cell type, and then enter the test cell settings (see Table 10-10 "Test cell settings").
5. In the Navigation pane, click **Sweep settings**, and then enter the settings (see Table 10-11 "Sweep settings").

**Note:** The sweep settings depend on the measurement mode selected under **Measurement mode**.

- We recommend correcting measurements to improve the accuracy of the measurement results. The purpose of this correction is to eliminate the unknown capacitances like stray capacitance or capacitance between connecting leads or between leads and the electrodes and to correct any measurement offset. If you want to correct the measurement, perform the reference measurement(s) as described in chapter 10.4 "Perform reference measurements".

**Note:** You can perform the reference measurements before or after the material measurements. In both cases you have to enter the reference settings as described in chapter 10.4 "Perform reference measurements".

- In the Navigation pane, click **Material measurement(s)**, and follow the instructions and recommendations displayed in the test view.
- In the Navigation pane, select the measurement you want to perform, and then enter the measurement settings (see Table 10-13 "Measurement settings").

**Note:** The reference and measurement settings depend on the test cell type selected in the test cell settings and on the measurement mode selected in the sweep settings under **Measurement mode**.

- In the Navigation pane, click **Graph and result table**. On the ribbon, the **Measurement(s)** tab is selected automatically.

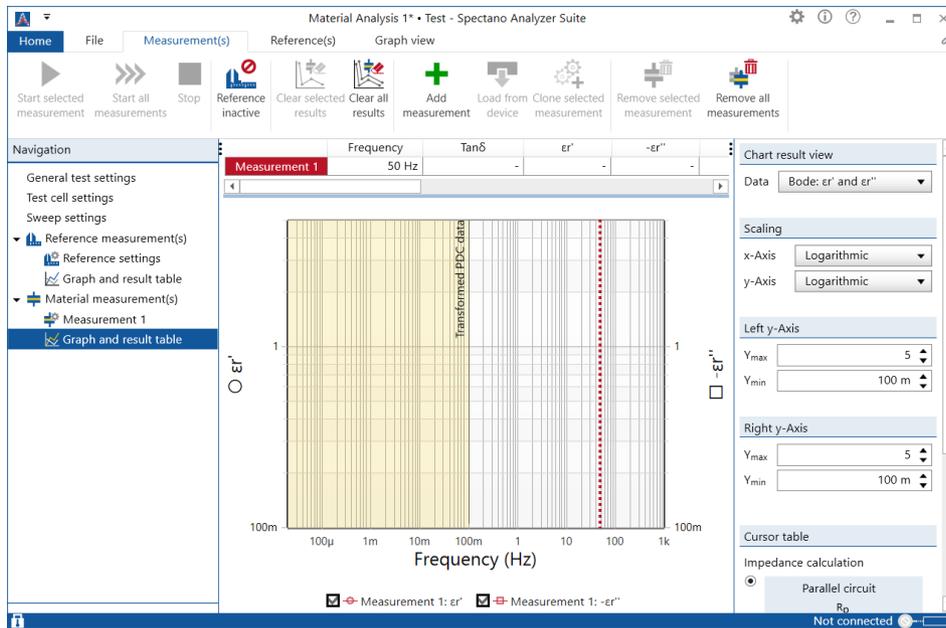


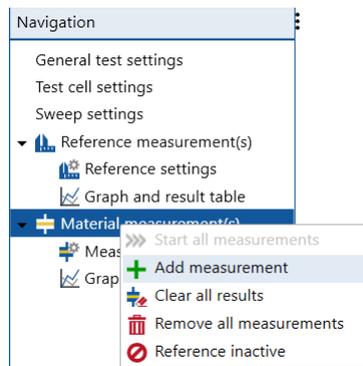
Figure 10-3 Test view: **Measurement(s)** tab

## 10.3 Perform measurements

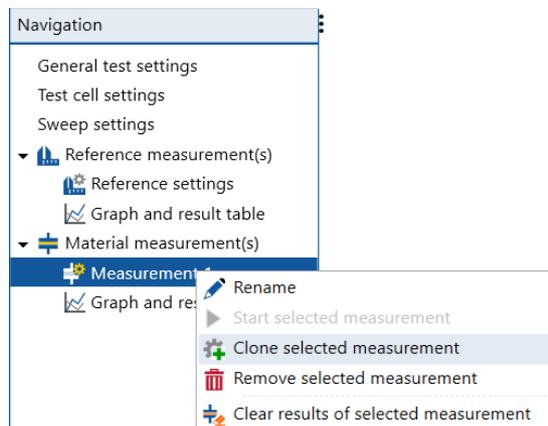
After you have created a new test, you can add measurements to the test. By default, every test includes at least one measurement. You can add additional measurements and clone (copy a measurement with settings but without results) selected measurements.

To add a measurement to the test:

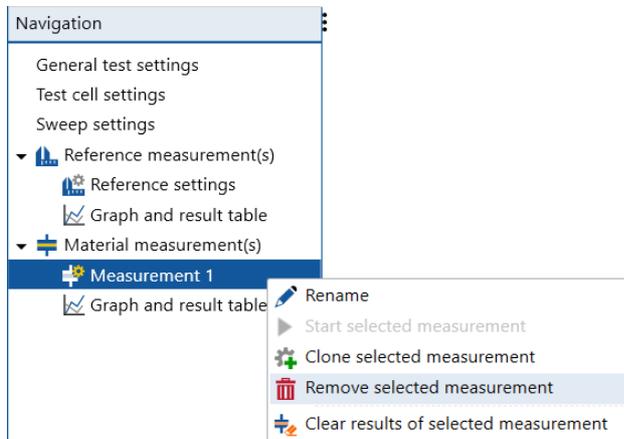
1. Click the **Add measurement** button  on the ribbon or on the **Material Measurement(s)** context menu. A new measurement is added to the list under **Material measurement(s)**.



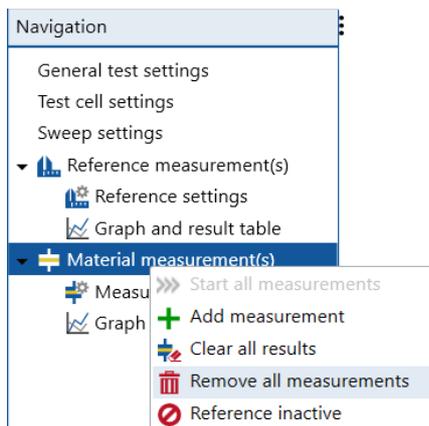
2. Click the new measurement in the list, and then configure the measurement as described in 10.2 "Create a new test".
3. To clone a measurement, select the specific measurement in the Navigation list and click the **Clone measurement** button  on the ribbon or in the context menu of the selected measurement. A new measurement with the settings of the selected measurement, but without results, is added to the list under **Material measurement(s)**.



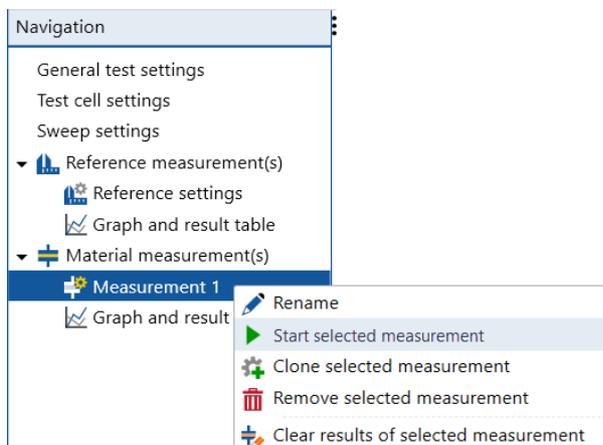
- To delete a specific measurement, select the measurement in the Navigation list and click the **Remove selected measurement** button  on the ribbon or in the context menu of the selected measurement.



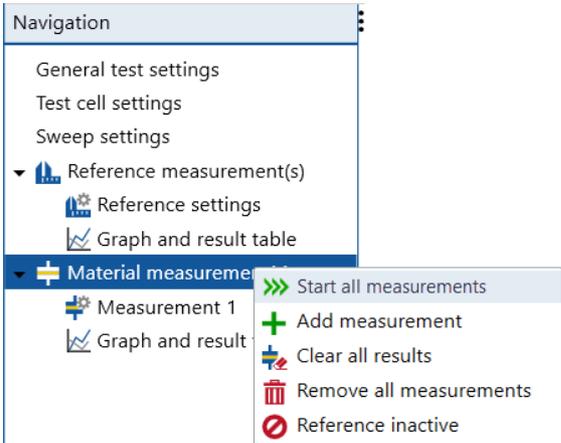
- To delete all measurements, click the **Remove all measurements** button  on the ribbon or in the **Material Measurement(s)** context menu.



- To perform a single measurement, select the specific measurement and click the **Start selected measurement(s)**  button on the ribbon or in the context menu of the selected measurement.



- 7. To perform a measurement sequence, click the **Start all measurements** button  on the ribbon or icon the **Material Measurement(s)** context menu.



The status bar at the bottom of the test view displays

- the status of *SPECTANO 100* device on the right sight of the status bar
- the setting status of the test file settings (locked , unlocked ) on the left sight of the status bar
- status of measurement performing on the left side of the status bar
- 

The following table describes the *SPECTANO 100* statuses.

Table 10-4 *SPECTANO 100* status

Symbol Status	Description
 <b>Device connected</b>	Device is connected but no data/results are saved and available on the device.
 <b>Device busy</b>	Test settings are being sent to the device or the device is being reset to the <b>Device connected</b> status after a measurement has finished.
 <b>Measurement running</b>	A measurement is running.
 <b>Error</b>	An error occurred.
 <b>Data available</b>	New data/results or the data of the last measurement are saved and available on the device for loading into the <i>SPECTANO Analyzer Suite</i> . The device is connected and ready to start a new measurement.
 <b>Not connected</b>	Device is not connected.

After the measurements have finished, you can save them by using the Save and Save as commands on the File tab. To export the saved measurements in a Microsoft Excel spreadsheet, click Export on the File tab. To import the saved measurements into SPECTANO Analyzer Suite, click the test file under Recent files or click Open in the home view.

## 10.4 Perform reference measurements

### 10.4.1 Measurement procedure

#### Reference settings

To perform reference measurements:

1. Start *SPECTANO Analyzer Suite*.
2. In the start view, click the **New test** button . The test view opens with the **File** tab selected on the ribbon. On the left of the test view, the Navigation pane displays the steps of the test workflow.

**Note:** The Navigation pane is displayed independently of the tab selected on the ribbon.

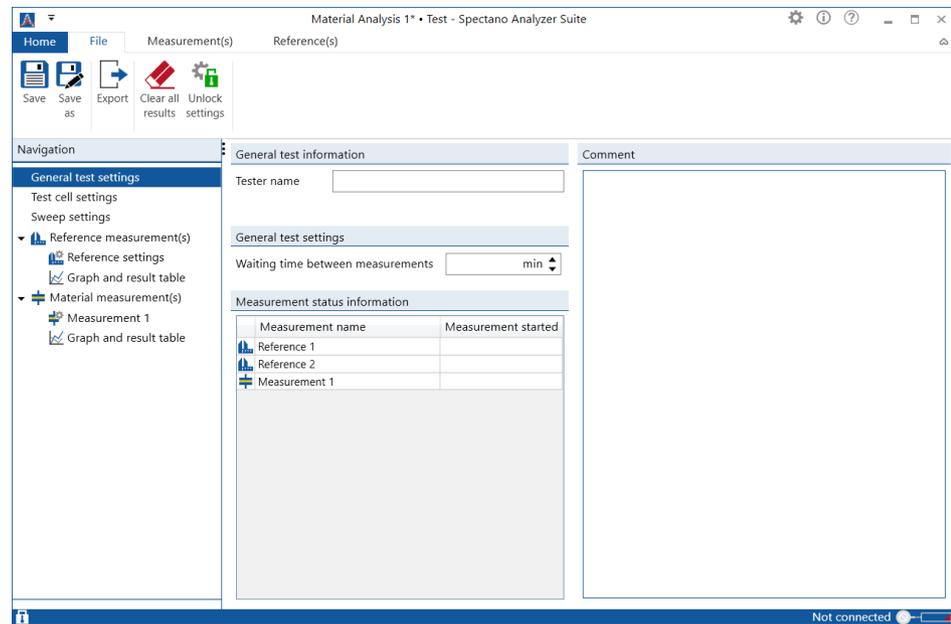


Figure 10-4 Test view: **File** tab

3. In the Navigation pane, click **General test settings**, and then enter the settings (see Table 10-9 "General test settings").
4. In the Navigation pane, click **Test cell settings**.

Under **Test cell configuration**, select the test cell type, and then enter the test cell settings (see Table 10-10 "Test cell settings").

- In the Navigation pane, click **Sweep settings**, and then enter the settings (see Table 10-11 "Sweep settings".)

**Note:** The sweep settings depend on the measurement mode selected under **Measurement mode**.

- In the Navigation pane, click **Reference measurement(s)**, and follow the instructions and recommendations displayed in the test view.
- In the Navigation pane select **Reference settings**, and then enter the reference settings (see Table 10-12 "Reference settings")

**Note:** The reference settings depend on the test cell type selected in the **Test cell settings** and the measurement mode selected in the sweep settings under **Measurement mode**.

### Disk electrodes and DSH 100 Dielectric Sample Holder

The following reference measurement procedure applies to the disk electrodes. For the cylindrical electrodes and other geometries, see "Cylindrical electrodes and other geometries" later in this section.

The next steps of the reference measurement differ, depending on whether the reference sample thickness is equal to the sample thickness of all material measurements or the sample thickness for at least one material measurement is not equal to the reference sample thickness.

#### Reference sample thickness is equal to the material sample thickness

In this case, perform one reference measurement:

- In the Navigation pane, click **Reference measurement(s)**, and then click **Graph and result table**. On the ribbon, the **Reference(s)** tab will be selected automatically.
- Click the **Start reference** button  on the ribbon, and then click **Start** next to **Reference (1)**.
- The reference measurement is running, and the measurement results are displayed in the graph view.
- After the reference measurement has finished, the **Start reference** button  displays the status performed .
- Now, you can start the correction procedure (see chapter 10.4.2 "Correction procedure").

**Note:** You can perform the reference measurements before or after the material measurements.

#### Reference sample thickness is not equal to the material sample thickness

In this case, perform two reference measurements with different reference sample thicknesses:

**Note:** We recommend performing the first measurement with a reference thickness higher than the sample thickness and the second measurement with a reference thickness lower than the sample thickness.

- In the Navigation pane, click **Reference measurement(s)**, and then click **Graph and result table**. On the ribbon, the **Reference(s)** tab selects automatically.
- Click the **Start reference** button  on the ribbon, and then click **Start** next to **Reference (1)**.

3. The reference measurement is running, and the measurement results are displayed in the graph view.
4. After the first reference measurement has finished, the **Start reference** button  displays the status performed .
5. Click **Start** next to **Reference (2)**.
6. The reference measurement is running, and the measurement results are displayed in the graph view.
7. After the second reference measurement has finished, the **Start reference** button  displays the status performed .
8. Now, you can start the correction procedure (see chapter 10.4.2 "Correction procedure").

**Note:** You can perform the reference measurements before or after the material measurements.

## Cylindrical electrodes and other geometries

### Cylindrical electrodes

In this case, perform one reference measurement:

1. In the Navigation pane, click **Reference measurement(s)**, and then click **Graph and result table**. On the ribbon, the **Reference(s)** tab is selected automatically.
2. Click the **Start reference** button  on the ribbon, and then click **Start** next to **Reference 1**.
3. The reference measurement is running, and the measurement results are displayed in the graph view.
4. After the reference measurement has finished, the **Start reference** button  displays the status performed .
5. Now, you can start the correction procedure (see 10.4.2 "Correction procedure" later in this chapter).

**Note:** You can perform the reference measurements before or after the material measurements.

### Other geometries

The **Reference measurement(s)** section and the automated correction procedure is not available for other geometries. To determine the vacuum capacitance  $c_0$  read chapter 13.8 "Other geometries" "Vacuum capacitance  $c_0$  and correction procedure".

## 10.4.2 Correction procedure

You can perform the procedure for correcting the measured material capacitance before or after performing the material measurements. In both cases, the error correction proceeds as follows:

- 1 In the Navigation pane, click **Material measurement(s)**, the **Graph and result table** opens automatically.
- 2 Click the **Reference** button  on the ribbon to correct all measurements. (For the calculation logic, see chapter 10.4.3 "Correction logic and calculation" ). Then all measurements in the **Navigation** will be marked with the following icon , and the icon of the button will change to  , indicating that the correction is active.
- 3 To deactivate the correction again, click the **Reference** button . Then all measurement results will be reset to the original data (not corrected), the icon in the **Navigation** changes back to performed  , and the icon of the button will change to  , indicating that the correction is deactivated.

## 10.4.3 Correction logic and calculation

### Disk electrodes and DSH 100 Dielectric Sample Holder

The following reference measurement procedure applies to the disk electrodes. For the cylindrical electrodes and other geometries, see "Cylindrical electrodes and other geometries" later in this section.

The correction logic and calculation differ depending on whether the reference sample thickness is equal to the sample thickness of all material measurements or the sample thickness for at least one material measurement is not equal to the reference sample thickness.

#### Reference sample thickness is equal to the material sample thickness

In this case, only one reference measurement is to be performed. If you click the **Reference** button  on the ribbon, the capacitance results and thus the permittivity,  $\tan\delta$  and the impedance results of all measurements displayed in the navigation pane, will be corrected according to the following formulas:

$$c'_{u(\text{air})} = c'_{\text{meas.}(\text{air})} - c_0(\text{air}) \quad (\text{Eq. 10-1})$$

$$c''_{u(\text{air})} = c''_{\text{meas.}(\text{air})} \quad (\text{Eq. 10-2})$$

$$c'_{\text{corrected}(\text{material})} = c'_{\text{meas.}(\text{material})} - c'_{u(\text{air})} \quad (\text{Eq. 10-3})$$

$$c''_{\text{corrected}(\text{material})} = c''_{\text{meas.}(\text{material})} - c''_{u(\text{air})} \quad (\text{Eq. 10-4})$$

where  $c_u$  is unknown stray capacitance.

**Note:** If you add a new measurement with the sample thickness  $h$  not equal to the reference sample thickness after activating the correction of the measurement results, the correction will be deactivated, and all corrected measurements will be reset to the non-corrected results.

#### Reference sample thickness is not equal to the material sample thickness

In this case, both reference measurements have to be performed. If you click the **Reference** button  on the ribbon, the capacitance results and thus the permittivity,  $\tan\delta$  and the impedance results of all measurements, displayed in the navigation pane, will be corrected by using linear interpolation of the reference measurement results. By interpolating the results, an approximate value of  $c_u(t)$  for the actual sample thickness  $h$  is found.

**Cylindrical electrodes**

The following correction procedure applies to the **Cylindrical electrodes**. For other geometries see “Reference measurement for other geometries” earlier in this section.

In this case, only one reference measurement is to be performed. If you click the **Reference** button  on the ribbon, the capacitance results and thus the permittivity,  $\tan\delta$  and the impedance results of all measurements, displayed in the navigation pane, will be corrected according to the following formulas:

$$c'_{u(\text{air})} = c'_{\text{meas.}(\text{air})} - c_0(\text{air}) \quad (\text{Eq. 10-5})$$

$$c''_{u(\text{air})} = c''_{\text{meas.}(\text{air})} \quad (\text{Eq. 10-6})$$

$$c'_{\text{corrected}(\text{material})} = c'_{\text{meas.}(\text{material})} - c'_{u(\text{air})} \quad (\text{Eq. 10-7})$$

$$c''_{\text{corrected}(\text{material})} = c''_{\text{meas.}(\text{material})} - c''_{u(\text{air})} \quad (\text{Eq. 10-8})$$

where  $c_u$  is unknown stray capacitance.

**Other Geometries**

The automated correction procedure is not available for “Other geometries”. To determine the vacuum capacitance  $c_0$  read chapter 13.8 “Other geometries” “Vacuum capacitance  $c_0$  and correction procedure”.

## 10.5 Perform analysis

To perform an analysis, use the analysis Excel file macros provided by OMICRONLab, available at [www.omicron-lab.com](http://www.omicron-lab.com).

## 10.6 View measurement results

This section describes the workspace for viewing measurement results. To open the result view workspace, click **Graph and result table** under **Reference measurement(s)** or **Material measurement(s)** in the Navigation pane.

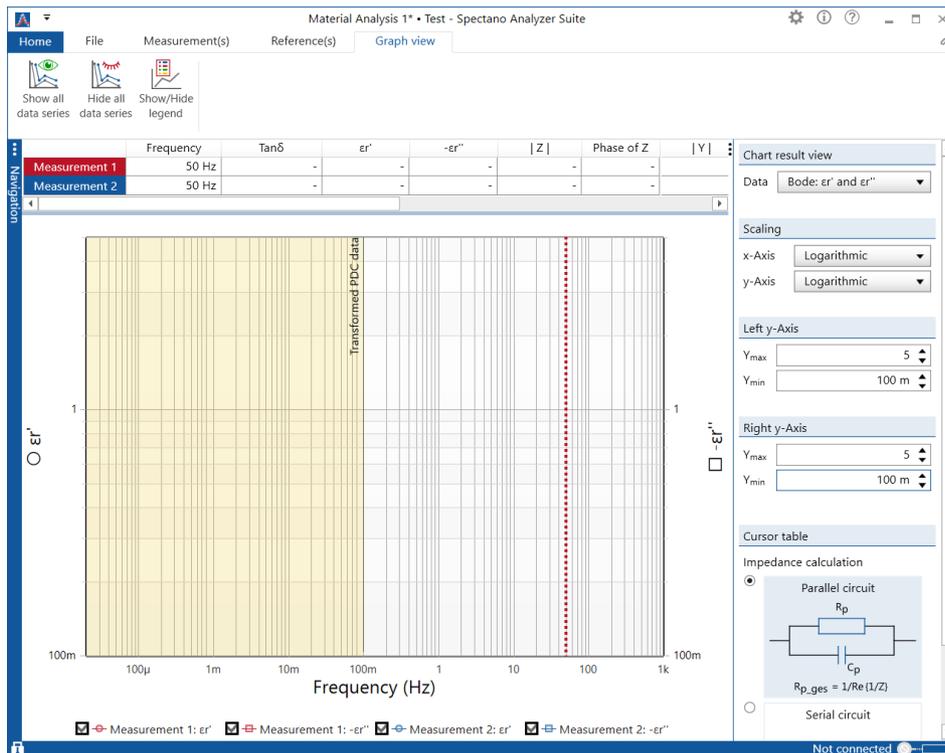


Figure 10-5 Result view workspace

The result view workspace displays measurement results numerically as well as graphically. On the right, the workspace provides controls for displaying the results.

## 10.6.1 Numerical results

The measurement results are displayed numerically on the top of the result view workspace. You can display the measurement results in frequency domain and in time domain. For information on how to select the result display, see 10.6.3 "Result view controls".

The following table describes the numerical measurement results in the frequency domain.

Table 10-5 Numerical measurement results in the frequency domain

Data	Description
$\tan\delta$ /Power factor <sup>1</sup>	Measured dissipation factor/power factor
$\epsilon_r'$	Measured real part of the complex relative permittivity
$\epsilon_r''$	Measured imaginary part of the complex relative permittivity
$ Z $	Absolute value of the measured impedance
Phase of Z	Phase of the measured impedance
$ Y $	Absolute value of the measured admittance
Phase of Y	Phase of the measured admittance
$C_p/C_s$ <sup>2</sup>	Measured parallel/series capacitance
$R_p/R_s$ <sup>2</sup>	Measured parallel/series resistance
$c'$	Measured real part of the complex capacitance
$c''$	Measured imaginary part of the complex capacitance
R	Measured resistance
X	Measured reactance

1. Set by the **Loss angle result** option in the **Options** dialog box (see Figure 10-10 "Options dialog box")
2. Set by the **Impedance calculation** control (see 10.6.3 "Result view controls")

The following table describes the numerical measurement results in the time domain (PDC).

Table 10-6 Numerical measurement results in the time domain (PDC)

Data	Description
Polarization current	Measured polarization current
Depolarization current	Measured depolarization current
R(t)	Measured electrical resistance over time

Table 10-6 Numerical measurement results (time domain) (continued)

<b>Data</b>	<b>Description</b>
G(t)	Measured electrical conductivity over time
$\rho(t)$ <sup>1</sup>	Measured specific resistance over time
$\sigma(t)$ <sup>1</sup>	Measured specific conductivity over time
Polarization index	Index of how fast the depolarization current is decreasing (Tangent)

1. Only available for test cells with disk electrodes and *DSH 100* Dielectric Sample Holder

## 10.6.2 Graphical result view

The result view workspace displays the measurement results graphically in different views. You can control the graphical display by the result view controls (see 10.6.3 "Result view controls") and via the shortcut menu. To open the shortcut menu, right-click in the graphical view.

Table 10-7 Shortcut context menu of the graphical view

<b>Command</b>	<b>Description</b>
Show or hide legend	Shows or hides the graph legends
Hide all data series	Hides graphical results of all reference or material measurements.
Show all data series	Shows graphical results of all reference or material measurements.
Reset axes	Resets the default settings of the x-axis and y-axis.
Reset zoom	Resets the zoom default setting.
Optimize view of...	Opens context menu to optimize the graphical display of the x-axis and y-axis either for all measurements or a specific single measurement
Auto optimize...	Opens context menu to auto optimize the graphical display of the x-axis and y-axis either for all measurements or a specific single measurement

### 10.6.3 Result view controls

With the control options on the right of the result view workspace, you can control how the measurement results are displayed. The following table describes the result view controls.

Table 10-8 Result view controls

Control		Description
<b>Chart result view</b>		
Data	Bode: $\tan\delta$	Bode diagram displaying the tangent delta ( $\tan\delta$ ) versus frequency
	Bode: R and $X^1$	Bode diagram displaying the resistance and reactance versus frequency
	Bode: $c'$ and $c''$	Bode diagram displaying the complex capacitance versus frequency
	Bode: $\epsilon r'$ and $\epsilon r''$	Bode diagram displaying the complex relative permittivity versus frequency
	Bode: $ Z $ and Phase <sup>1</sup>	Bode diagram displaying the absolute value and phase of the impedance versus frequency
	Bode: $ Y $ and Phase <sup>1</sup>	Bode diagram displaying the absolute value and phase of the admittance versus frequency
	PDC: $I_{pol}$ and $I_{depol}$ <sup>2</sup>	Polarization current, depolarization current, polarization index, specific <sup>3</sup> and electrical resistance or conductivity in time domain
	Cole-Cole: Complex Z <sup>1</sup>	Cole-Cole diagram displaying complex impedance
	Cole-Cole: Complex C <sup>1</sup>	Cole-Cole diagram displaying complex capacitance
Cole-Cole: Complex $\epsilon r$ <sup>1</sup>	Cole-Cole diagram displaying complex relative permittivity	
<b>Scaling</b>		
x-Axis	Select the scaling of the x-axis (linear or logarithmic).	
y-Axis	Select the scaling of the y-(linear or logarithmic).	
<b>Left y-Axis</b>		
Ymax	Select the maximum value of the left y-axis.	
Ymin	Select the minimum value of the left y-axis.	
<b>Right y-Axis</b>		
Ymax	Select the maximum value of the right y-axis.	
Ymin	Select the minimum value of the right y-axis.	

Table 10-8 Result view controls (continued)

Control	Description
<b>Cursor table</b>	
<b>Impedance calculation</b> <sup>4</sup>	
Parallel circuit	Select the parallel equivalent circuit as dielectric model.
Serial circuit	Select the serial equivalent circuit as dielectric model.
<b>x-Axis</b> <sup>5</sup>	
Xmax	Select the maximum value of the right x-axis.
Xmin	Select the minimum value of the right x-axis.

1. Only available for material measurements
2. Only available for the PDC and combined measurement modes selected in the sweep settings under **Measurement type**.
3. Specific resistance and conductivity are only available for DSH 100 and Disk electrode test cell selection.
4. The impedance calculation affects only the numerical measurement results Rp/Rs and Cp/Cs displayed in the table but not the Bode diagram of R and X.
5. Only seen in the **Chart result view** PDC: Ipol and Idepol and the three Cole-Cole chart views.

**Note:** Some result view controls are not available for all chart result views.

## 10.7 Settings

The following table describes the general test settings.

Table 10-9 General test settings

Data	Description
<b>General test information</b>	
Tester name	Name of the tester
<b>General test settings</b>	
Waiting time between measurements	Time interval between successive measurements if more measurements are performed in a test run
<b>Measurement status information</b>	
Measurement name	Name of the measurement
Measurement started	Date and time the measurement started

*SPECTANO Analyzer Suite* supports testing with the following test cell configurations:

- Test cell with disk electrodes
- OMICRON Lab's Dielectric Sample Holder *DSH 100* (disk electrode type)
- Test cell with cylindrical electrodes
- Other geometries

**Note:** More information about the different test cell configurations can be found in chapter 13. "Test cell configurations" of the *SPECTANO 100* user manual.

The following table describes the test cell settings.

Table 10-10 Test cell settings

Data	Description
<b>Test cell type selection</b>	
Test cell type	Box to select the type of test cell
<b>Test cell configuration</b>	
Guard ring	Select the <b>Guard ring</b> check box for a test cell with guard ring
Coated	Select the <b>Coated</b> check box for a coated test cell
<b>Test cell settings</b> <sup>1</sup>	
Coating material	Coating material of the test cell
Electrode material	Material of the test cell's electrode
Electrode/Coating diameter (d)	Diameter of the test cell's electrode or if <b>Coated</b> is selected: Diameter of the coating located between the electrodes and the sample or between the electrodes/guard ring and the sample (more information in chapter 13. "Test cell configurations")
Inner diameter of sample (d <sub>1</sub> )	Inner diameter of the material sample

Table 10-10 Test cell settings (continued)

<b>Data</b>	<b>Description</b>
Outer diameter of sample (d <sub>2</sub> )	Outer diameter of the material sample
Guard gap (g)	Gap of the guard ring
Electrode length (l)	Length of the test cell's electrode

1. Depends on the test cell type selected under **Test cell configuration**.

The following table describes the sweep settings.

Table 10-11 Sweep settings

<b>Data</b>	<b>Description</b>
<b>Test modes</b>	
Select a test mode	Select the measurement mode for your test: <ul style="list-style-type: none"> <li>• <b>FDS (only)</b>: Frequency Domain Spectroscopy (5 µHz...5 kHz)</li> <li>• <b>PDC (only)</b>: Polarization and Depolarization Current Method (20 µHz...99 mHz)</li> <li>• <b>Combined</b>: Combines the FDS and PDC methods in one measurement (20 µHz...5 kHz). The PDC method is used for frequencies below the set limit by transforming the PDC results to FDS results to reduce the measurement time up to 75% compared to frequency domain measurements (FDS).</li> </ul>
<b>PDC to FDS conversion</b> <sup>1</sup>	
Use PDC method for frequencies below	Switching frequency between the FDS and PDC methods
Convert FDS from PDC data until	Defines the low-frequency limit of the transformation from PDC to FDS.
Do not re-calculate stable PDC data	Select the <b>Do not re-calculate stable PDC data</b> check box if you do not want to recalculate the PDC data when the data does not change with the increasing time of the PDC measurement.
<b>Sampling points</b>	
Points generation	Select <b>Auto</b> to generate default frequency sweep list. Select <b>Custom</b> to specify your own frequency sweep list.
Start frequency	Start frequency of frequency sweep
Stop frequency	Stop frequency of frequency sweep
FDS points per decade <sup>5</sup>	Sample points per decade when using the FDS method

Table 10-11 Sweep settings (continued)

Data	Description
PDC points per decade <sup>4</sup>	Sample points per decade when using the PDC method
Restore default list	Restore the list by resetting the start frequency, stop frequency and points per decade.
Frequency sweep list	Displays the specified frequency points defined automatically (fixed list) or by a customer frequency list (writable)
Generate from automated sweep list <sup>3</sup>	Button under custom frequency list selection to generate the custom list from the automated frequency list. In the custom section the frequency list can be changed manually
Estimated sweep time <sup>2</sup>	Estimated sweep time including start frequency, stop frequency and points per decade (sample points).

1. Only available for the combined measurement mode selected under **Test modes**.
2. The estimated sweep time is not equal to the estimated measurement time displayed in the status bar during a measurement. The estimated measurement time additionally includes the polarization time, the depolarization time and the selected noise suppression filter time.
3. Only available in the **Custom** frequency list setting view
4. Only available for PDC only or combined measurement mode selected under **Test modes**.
5. Only available for FDS only or combined measurement mode selected under **Test modes**.

The following table describes the reference settings.

Table 10-12 Reference settings

<b>Data</b>	<b>Description</b>
<b>General measurement settings</b>	
Temperature	Temperature of the test cell/sample
Humidity	Environmental relative humidity
<b>Reference settings</b>	
Material type	Type of the material for reference measurement Default = Air
Sample thickness reference 1 (h) <sup>1</sup>	Sample thickness of reference measurement number 1
Sample thickness reference 2 (h) <sup>1</sup>	Sample thickness of reference measurement number 2
$c_0$ reference 1 <sup>2</sup>	Vacuum capacitance of the test cell with air gap of air reference measurement number 1
$c_0$ reference 2 <sup>1,2</sup>	Vacuum capacitance of the test cell with air gap of air reference measurement number 2
<b>PDC settings</b> <sup>3</sup>	
Output voltage (DC)	Peak output voltage for the PDC method
Record depolarization data	Select the <b>Record depolarization data</b> check box to record and display the depolarization current.
Depolarization time	Time interval during which the test object discharges
<b>FDS settings</b> <sup>4</sup>	
Output voltage (AC)	Peak output voltage for the FDS method

Table 10-12 Reference settings (continued)

Data	Description
Noise suppression	Select the <b>Standard</b> or <b>Improved</b> option for the suppression of the noise interference. If you select <b>Improved</b> , the noise-to-signal ratio and, consequently, the measurement accuracy will be improved but the measurement time will increase.
<b>Pre-measurement checks</b>	
Check for noise and connectivity problems	Select the <b>Check for noise and connectivity problems</b> check box to check for noise and connectivity problems before starting a test.
Delay the start of the measurement until <sup>3</sup>	
The depolarization current falls below	Select this option and enter the threshold depolarization current to delay the start of the measurement until the depolarization current falls below the threshold.
The time elapsed	Select this option and enter the time limit to delay the start of the measurement until the time limit elapsed.

1. Only available for test cells with disk electrodes
2. For the specified geometry of the electrodes, *SPECTANO Analyzer Suite* calculates the vacuum capacitance automatically. If you select **Others** in the test cell settings, enter the vacuum capacitance manually.
3. Only available for the PDC and combined measurement modes selected in the sweep settings under **Measurement mode**.
4. Only available for the FDS and combined measurement modes selected in the sweep settings under **Measurement mode**.

The following table describes the measurement settings.

Table 10-13 Measurement settings

Data	Description
<b>General measurement settings</b>	
Temperature	Temperature of the test cell/sample
Humidity	Environmental relative humidity
<b>Material sample settings</b>	
Material type	Type of the material sample
Serial number	Serial number of the material sample
<b>Sample thickness</b>	
Position A <sup>1</sup>	Sample thickness at position A
Position B <sup>1</sup>	Sample thickness at position B
Position C <sup>1</sup>	Sample thickness at position C
Position D <sup>1</sup>	Sample thickness at position D

Table 10-13 Measurement settings (continued)

<b>Data</b>	<b>Description</b>
Position E <sup>1</sup>	Sample thickness at position E
Average (h) <sup>1</sup>	Average thickness of the material sample
Max. uniformity <sup>1</sup>	Accuracy of the sample uniformity
<b>Vacuum capacitance</b>	
Vacuum capacitance $c_0$ <sup>2</sup>	Vacuum capacitance of the test cell
<b>PDC settings<sup>3</sup></b>	
Output voltage (DC)	Peak output voltage for the PDC method
Record depolarization data	Select the <b>Record depolarization data</b> check box to record and display the depolarization current.
Depolarization time	Time interval during which the test object discharges
<b>FDS settings <sup>4</sup></b>	
Output voltage (AC)	Peak output voltage for the FDS method
Noise suppression	Select the <b>Standard</b> or <b>Improved</b> option for the suppression of the noise interference. If you select <b>Improved</b> , the noise-to-signal ratio and, consequently, the measurement accuracy will be improved but the measurement time will increase.
<b>Pre-measurement checks</b>	
Check for noise and connectivity problems	Select the <b>Check for noise and connectivity problems</b> check box to check for noise and connectivity problems before starting a test
Delay the start of the measurement until <sup>3</sup>	
The depolarization current falls below	Select this option and enter the threshold depolarization current to delay the start of the measurement until the depolarization current falls below the threshold.
The time elapsed	Select this option and enter the time limit to delay the start of the measurement until the time limit elapsed.

1. Applies to disk electrodes.

2. For the specified geometry of the electrodes, *SPECTANO Analyzer Suite* calculates the vacuum capacitance automatically. If you select **Others** in the test cell settings, enter the vacuum capacitance manually.

3. Only available for the PDC and combined measurement modes selected in the sweep settings under **Measurement mode**.

4. Only available for the FDS and combined measurement modes selected in the sweep settings under **Measurement mode**.

## 10.8 Commands

### File tab

On the **File** tab on the test view ribbon, *SPECTANO Analyzer Suite* provides the following commands.

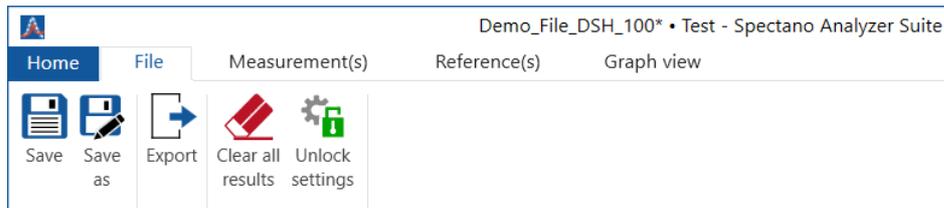


Figure 10-6 Test view ribbon: **File** tab

Table 10-14 Commands on the **File** tab

Command	Description
 <b>Save</b>	Saves a test file.
 <b>Save as</b>	Opens a dialog box for saving a test file.
 <b>Export</b>	Exports a test file.
 <b>Clear all results</b>	Deletes all measurement results.
 <b>Unlock settings</b>	Settings can be changed after performing a measurement(s).  ATTENTION: Locking is not possible anymore after unlocking the settings.

**Measurement(s) tab** On the **Measurement(s)** tab on the test view ribbon, *SPECTANO Analyzer Suite* provides the following commands.

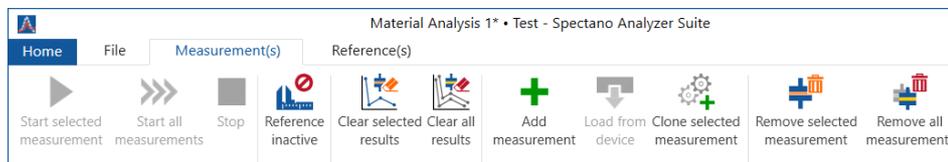


Figure 10-7 Test view ribbon: **Measurement(s)** tab

Table 10-15 Commands on the **Measurement(s)** tab

Command	Description
 <b>Start selected measurement</b>	Starts the measurement selected in the <b>Navigation</b> pane
 <b>Start all measurements</b>	Perform all measurements in a sequence
 <b>Stop</b>	Stops all measurements in a sequence or the selected single measurement.
 <b>Reference button</b> <sup>1</sup>	Click the <b>Reference</b> button  to correct all measurements.
	Click the <b>Reference</b> button  again to deactivate the correction.
 <b>Clear selected results</b>	Deletes results of selected material measurement. The reference measurement results are preserved
 <b>Clear all results</b>	Deletes results of all material measurements. The reference measurement results are preserved.
 <b>Add measurement</b>	Adds a measurement.

1. Only available for *DSH 100*, Disk and Cylindrical electrode selectable under **Test cell settings**.

Table 10-16 Commands on the **Measurement(s)** tab (continued)

Command	Description
 <b>Load from device</b>	Load the results from the device to the selected measurement.  <b>Note:</b> The settings are not loaded. For more information, see 10.10 "Load from the device".
 <b>Clone selected measurement</b>	Creates a copy of the selected material measurement. Then a new material measurement is added with the settings of the selected measurement.
 <b>Remove selected measurement</b>	Removes the selected material measurement. The reference measurement results are preserved.
 <b>Remove all measurements</b>	Removes all added material measurements and adds a new measurement with default settings and without results. The reference measurement results are preserved.

**Reference(s) Tab**

On the **Reference(s)** tab on the test view ribbon, *SPECTANO Analyzer Suite* provides the following commands. This tab is only available for *DSH 100*, Disk and Cylindrical electrodes selectable under **Test cell settings**.

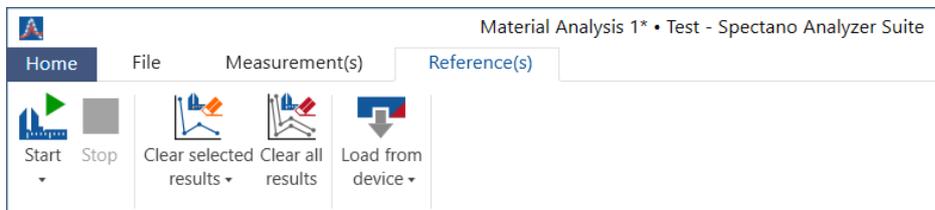
Figure 10-8 Test view ribbon: **Reference(s)** tab

Table 10-17 Commands on the **Reference(s)** tab

Command	Description
 <b>Start</b>	Opens a submenu in which you can select to perform reference measurement (1) or (2) <sup>1</sup> .
 <b>Stop</b>	Stops the reference measurement.
 <b>Clear selected results</b>	Opens a drop-down list from which you can select the reference measurement whose results you want to delete.
 <b>Clear all results</b>	Deletes results of all reference measurements. The material measurement results are preserved.
 <b>Load from device</b>	Opens a drop-down list from which you can select the reference measurement into which you want to load the results from the device.  <b>Note:</b> The settings are not loaded. For more information, see 10.10 "Load from the device".

1. For Cylindrical electrode selection under **Test cell settings** only one reference is available.

**Graph view tab**

On the **Graph view** tab on the test view ribbon, *SPECTANO Analyzer Suite* provides the following commands. This tab is only visible if the Reference or Material measurement **Graph and Result view** is selected.

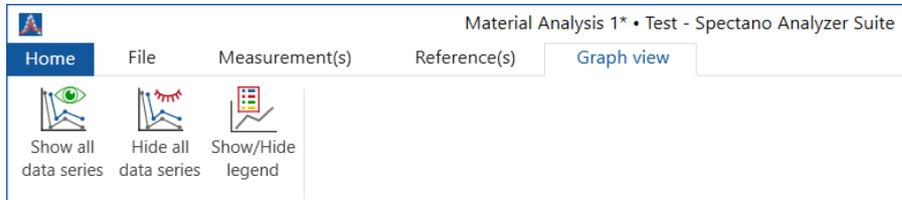


Figure 10-9 Test view ribbon: **Measurement(s)** tab

Table 10-18 Commands on the **Measurement(s)** tab

Command	Description
 <b>Show all data series</b>	Activates all data series (Measurements or references) and displays them in the graph.
 <b>Hide all data series</b>	Deactivates all data series (Measurements or references) and hides them in the graph.
 <b>Show/Hide legend</b>	Activates or deactivates the legend below the graph for optimizing the graph size.

## 10.9 Home view

The *SPECTANO Analyzer Suite* home view provides access to the frequently used commands. To open the home view, click the **Home** tab on the test view ribbon.

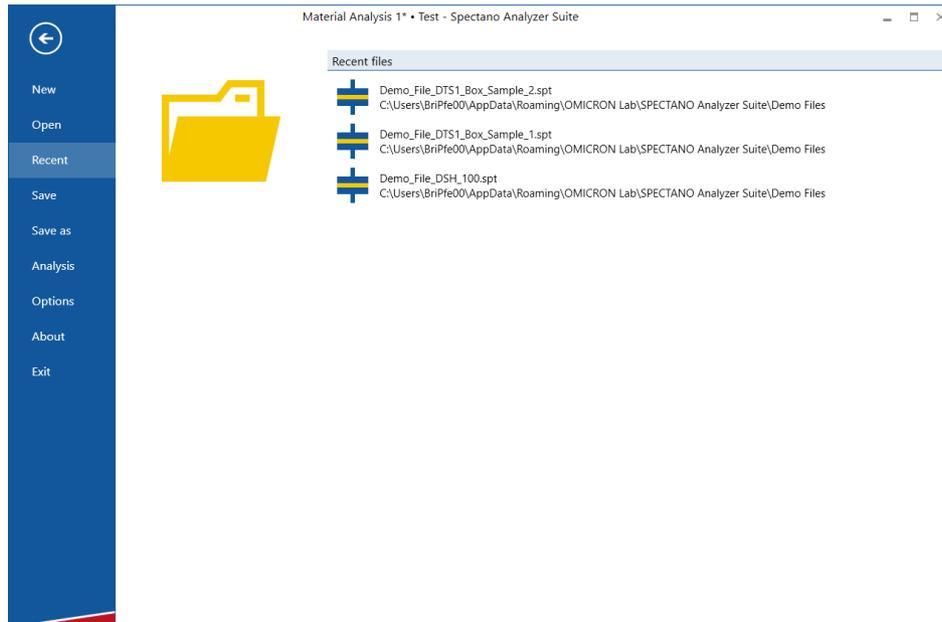


Figure 10-10 *SPECTANO Analyzer Suite* home view

In the home view, *SPECTANO Analyzer Suite* provides the following commands.

Table 10-20 Commands in the home view

Command	Description
<b>New</b>	Opens the test view (see 10.2 "Create a new test").
<b>Open</b>	Opens a dialog box for selecting the file you want to open.
<b>Recent</b>	Displays a list of the recently opened files. To open a file, click the file in the list.
<b>Save</b>	Saves a test file.
<b>Save as</b>	Opens a dialog box for saving a test file.

Table 10-21 Commands in the home view (continued)

Command	Description
<b>Analysis</b>	Opens the analysis view (see 10.5 "Perform analysis").
<b>Options</b>	Opens a dialog box for setting general options (see Figure 10-11 "Options dialog box" and Table 10-22 "SPECTANO Analyzer Suite options").
<b>About</b>	Displays information about <i>SPECTANO Analyzer Suite</i> .
<b>Exit</b>	Closes <i>SPECTANO Analyzer Suite</i> .

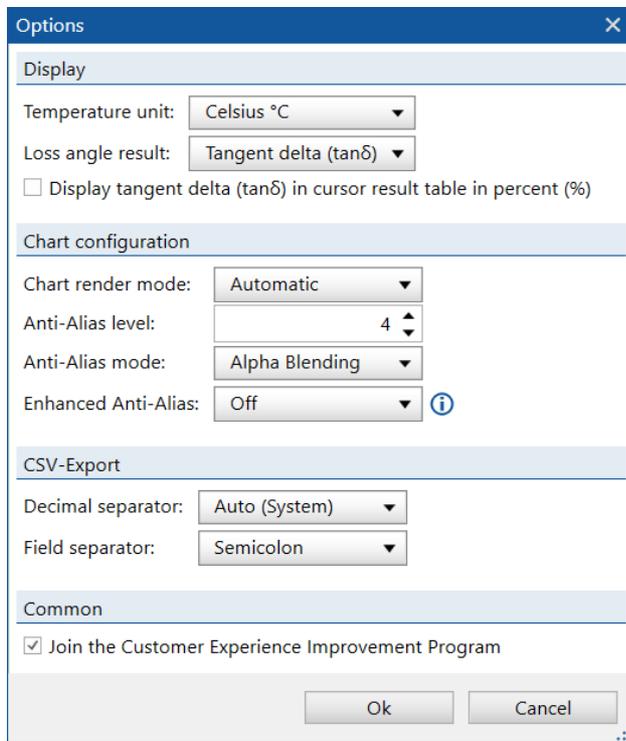


Figure 10-11 Options dialog box

Table 10-22 SPECTANO Analyzer Suite options

Option	Description
<b>Display</b>	
Temperature unit	Temperature unit in which all temperature values are displayed
Loss angle result	Loss-angle characteristic used to display measurement results
Display tangent delta (tanδ) in cursor result table in percent (%)	Select the <b>Display tangent delta (tanδ) in cursor result table in percent (%)</b> check box to display the tanδ results in percent.

Table 10-22 *SPECTANO Analyzer Suite* options (continued)

Option	Description
<b>Chart configuration</b>	
Chart render mode	For detailed information, see 10.9.1 "Chart render mode" later in this section.
Anti-Alias settings	For detailed information, see 10.9.2 "Anti-Alias settings" later in this section.
<b>CSV-Export</b>	
Decimal separator	Choose your decimal separator of choice.
Field separator	Configure the separator between two values/fields.
<b>Common</b>	
Join the Customer Experience Improvement Program	The Customer Experience Improvement Program collects information about how you use <i>SPECTANO Analyzer Suite</i> without interrupting you. This helps OMICRON Lab to identify which features to improve. No collected information is used to identify or contact you. We encourage you to join the program to help improving <i>SPECTANO Analyzer Suite</i> .

### 10.9.1 Chart render mode

**Note:** We recommend not changing the chart configuration rendering options. For the default settings, see Figure 10-10 "Options dialog box".

- The automatic mode checks which render option is the best for the chart view in the following order:
  - Hardware: checks if graphic card has DX 11 option.  
If the graphic card doesn't have DX 11, the next mode will be proofed, otherwise the Hardware mode will be used.
  - Hardware (DX9): checks whether the graphic card has DX 9 option, otherwise the rendering will be forced to DX 9.  
If the graphic card doesn't have DX 9, the next mode will be set.
  - Software rendering: In this case the rendering will be performed by the CPU and not the graphic card.

**Note:** This setting requires more CPU capacity and will slow down *SPECTANO Analyzer Suite*.

If, for example, a blank chart is displayed with the automatic rendering setting (graphic card does not support DX 11), you can change the chart render mode to the following options:

- Hardware: select if graphic card has DX 11.
- Hardware (DX 9): Select if graphic card does not support DX 11 but DX 9.
- Software: Select if the graphic card supports neither DX 11 nor DX 9.

## 10.9.2 Anti-Alias settings

In computer graphics, anti-aliasing is a graphic filter which improves the appearance of polygon edges, so they are not "jagged" but are smoothed out on the screen. With these settings, the chart view can be improved by smoothing the chart lines, markers, grid lines and text.

The level of anti-aliasing determines how smooth polygon edges are (and how much video memory it consumes).

**Anti-Alias level** is the overall scene anti-aliasing factor. Availability depends on the hardware. Higher values give better appearance but cost of performance. Set 0 or 1 to maximize the performance.

**Note:** Changing the Anti-Alias settings can incur a performance cost for the graphic card and requires more video memory.

## 10.10 Load from the device

### 10.10.1 Automatic load from the device

The current measurement of the test file gets an ID while saving during measurement. This ID is identical with the ID of the measurement saved on the device which is online.

The results are loaded automatically from the device to the corresponding measurement in the test file as far as the measurement ID of the test or the backup file is the same as the measurement ID saved on the device. Otherwise the results can be loaded manually.

**Note:** Only the results but not the settings are loaded from the device.

### 10.10.2 Manual load from device

The results can be manually loaded from the device to a selected measurement in the test file by using the **Load from device** command on the Test view ribbon.

**Note:** Because only the results and not the settings are loaded from the device, ensure that the settings in the test file are the same as those used for the measurement results saved on the device.

# 11 Troubleshooting

## 11.1 USB connection and/or power supply is missing

If the status bar displays **Not connected**  , then *SPECTANO Analyzer Suite* does not communicate with the *SPECTANO 100* device.

In this case, check whether:

- the USB cable is connected both to *SPECTANO 100* and to the computer.
- the power supply is connected to *SPECTANO 100*.
- *SPECTANO 100* is switch on.

After the power supply and the USB cable are connected and *SPECTANO 100* is switched on, the status bar will show **Device connected**  .

## 11.2 Lost communication

The loss of power supply can cause loss of communication between *SPECTANO 100* and the computer. In this case the status bar displays **Not connected**  .

Also, other events like computer shut down or sleep can cause loss of the communication.

**Note:** Data loss during measurement is possible if the communication between *SPECTANO 100* and the computer is lost. In this case:

- ▶ Ensure that the power manager settings of your computer match the measurement settings so that the computer does not shut down switches to sleep mode during measurement. Depending on the frequency range and the measurement sequence settings, a measurement can take hours or even days.
- ▶ After the communication has been lost, check whether:
  - the power supply is correctly connected to *SPECTANO 100*.
  - *SPECTANO 100* is switched on.

After the power supply and the USB cable are connected and *SPECTANO 100* is switched on, the status bar will show **Device connected**  .

## 11.3 Measuring small capacitances – increased noise level

If measuring of dielectric materials with a low capacitance shows an increased noise level, check whether the guard and the ground in your measurement system are separated. Separate the guard and the ground, if needed. Shield the test cell and the test system and ensure that the cabling is also shielded.

For more information on how to increase the capacitance of your test sample or on test setup improvement, see our application notes available at [www.omicron-lab.com](http://www.omicron-lab.com).

## 11.4 Backup file

A backup file is created and updated every 10 s when settings are changed, or a measurement is running. If, for example, an error occurs during a measurement, the settings and the results are saved in the backup file.

You can find the backup file on your hard disk in ProgramData\OMICRON Lab\Spectano Analyzer\Backup.

**Note:** The backup file will be deleted after the test file has been saved.

## 12 Technical data

### 12.1 Output

Voltage range	$\pm 100$ mV to $\pm 200$ V <sub>peak</sub>
Max. current	50 mA <sub>peak</sub>

### 12.2 Input

FDS <sup>1</sup> input resistance	<2 $\Omega$
PDC <sup>2</sup> input resistance	2 k $\Omega$
FDS measurement current	$\leq 50$ mA <sub>peak</sub>
PDC measurement current	$\leq 10$ mA

1. Frequency Domain Spectroscopy
2. Polarization Depolarization Current (Time Domain Method)

### 12.3 Frequency range of

FDS mode	5 $\mu$ Hz to 5 kHz
PDC mode	20 $\mu$ Hz to 99 mHz
Combined <sup>3</sup> mode	20 $\mu$ Hz to 5 kHz

3. This mode combined the FDS and PDC method in one measurement.

### 12.4 Measurement range <sup>4</sup>

Impedance	100 $\Omega$ to 20 T $\Omega$
Capacitance	10 pF to 100 $\mu$ F
Tan $\delta$	$\leq 3 \times 10^{-4}$

4. Depends on chosen measurement mode, voltage and frequency.

## 12.5 Measurement accuracy @ 23 °C ±5 °C

Impedance	
Capacitance <sup>5</sup>	0.5% + 1 pF
PDC current	0.5% ± 1 pA
Tanδ <sup>6</sup>	
for 1 mHz < f < 100 Hz	1% + 3×10 <sup>-4</sup>
for f < 1 mHz	2% + 5×10 <sup>-4</sup>
for f > 100 Hz	2% + 5×10 <sup>-4</sup>

5. Capacitance accuracy for frequencies 100 mHz to 5 kHz

6. Tanδ accuracy for capacitances > 100 pF

## 12.6 Measurement time (Combined mode)

2 mHz to 1 kHz	approx. 15 min
100 μHz to 1 kHz	<3 h
10 μHz to 1 kHz	<6 h

## 12.7 DRA power supply

Input voltage	100 V <sub>AC</sub> to 240 V <sub>AC</sub>
Input frequency	50 Hz to 60 Hz
Power	≤45 W
Output voltage	12.0 V <sub>DC</sub>
Output current	≤3 A

## 12.8 Environmental requirements

Temperature range	Operating	-10 °C to +55 °C (-31 °F to +131 °F)
	Storage	-10 °C to +65 °C (-31 °F to +149 °F)
Relative humidity	Operating	10% to 95% non-condensing
	Storage	10% to 95% non-condensing
Maximum altitude	2000 m	
Climate	Tested according to EN 60068-2-78	
Vibration	Tested according to EN 60068-2-6 Frequency range 10 Hz to 50 Hz Acceleration 2 g, 20 cycles per axis	
Shock	Tested according to EN 60068-2-27, 15 g/11 ms, half-sine pulse, each axis	

## 12.9 Mechanical data

Dimensions (w × h × d)	260 mm × 50 mm × 256 mm (10.25 inch × 2 inch × 10.5 inch)
Weight	2.3 kg (5 lb)

## 13 Test cell configurations

### 13.1 About this chapter

This chapter helps to

- decide which test cell configuration must be selected in the *SPECTANO Analyzer Suite* for your specific test cell
- get more information about which test cell type must be used for specific applications according to international standards or customized processes and measurements.

### 13.2 Why offering a test cell type selection?

The test cell type selection in the *SPECTANO Analyzer suite* provides the possibility to get the vacuum capacitance  $c_0$  for the most common test cell types automatically, without the need to calculate these parameters manually. The vacuum capacitance is needed to calculate the relative permittivity  $\epsilon_r$ .

**Please note**, the selection of a test cell type in the *SPECTANO Analyzer Suite*

- depends **not only** on the test cell type.
- It **also** depends on the international standard.

**Thus**, read the following chapters carefully to ensure that you will get the correct calculated values.

## 13.3 Disk electrode with Guard ring

### 13.3.1 IEC standards

According to the latest IEC standards for the analysis of dielectric and resistive properties of solid and liquid insulating materials

- IEC 62632-2-1-2018-02: AC methods for solid insulating material analysis
- IEC 60247-2004: AC methods for liquid insulating material analysis
- IEC 62631-3-1-2017-03: DC methods for solid insulating material analysis

Disk electrodes with Guard ring should be used for DC methods or AC methods for frequencies < 10 MHz.

In comparison to IEC 60250, the latest IEC standards for AC methods base on the demands on different frequency ranges.

For AC methods with frequencies > 10 MHz, the recommendation is to use Disk electrodes without Guard ring to ensure a measurement accuracy as defined in the international standard documents.

IEC 60250-1969 (AC methods) is replaced by the more general IEC 62632-2-1-2018. This standard is defined for frequencies up to 300 MHz. It describes, next to the requirements of Disk electrodes with Guard ring, the ranges and applications of other test cell geometries such as Disk electrodes without Guard ring or Cylindrical electrodes.

### 13.3.2 ASTM standards

The latest ASTM standards for the analysis of dielectric and resistive properties of solid and liquid insulating materials using Disk electrodes with Guard ring are:

- D150-18: AC methods for solid insulating material analysis, (replacement of ASTM D150-11)
- D924-15: AC methods for liquid insulating material analysis
- D257-14: DC methods for solid insulating material analysis

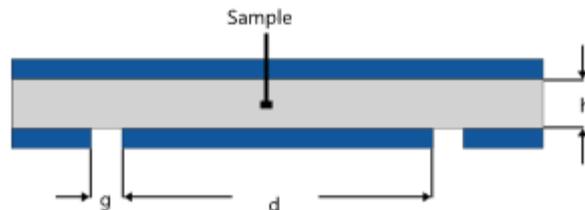
### 13.3.3 Test cell type selection in SPECTANO Analyzer Suite

Although you have a Disk electrode with Guard ring, the selection in the software depends on the vacuum capacitance  $c_0$  calculation and IEC/ASTM standard.

Table 13-1 SPECTANO Analyzer Suite test cell selection according to different standards

Standards	Vacuum capacitance $c_0$	SPECTANO Analyzer Suite selection
<u>AC method for solids:</u> IEC 62632-2-1-2018 ASTM D150-18 ASTM D150-11	$c_0 = \epsilon_0 \frac{A}{h};$ $A = \frac{\pi}{4}(d + B \cdot g)^2$	Other geometries: calculate $c_0$ manually (see chapter 13.7 "Other geometries" for more information on other test cells  OR Disk electrode with Guard ring, if the correction function B is not needed. The percentage error and thus the need of the correction function B depends on the permittivity of the material, the sample thickness and the electrode diameter. For more information see the IEC standard 62632-2-1 (2018), ASTM D150-18 or ASTM D150-11.
<u>AC method for solids:</u> IEC 60250-1969  <u>AC method for liquids:</u> IEC 60247-2004 ASTM D257-14	$c_0 = \epsilon_0 \frac{A}{h};$ $A = \frac{\pi}{4}(d + g)^2$	Disk electrode with Guard ring
<u>DC method for solids:</u> IEC 62631-3-1-2017 ASTM D257-14	%	Disk electrode with Guard ring Note: also an AC method standard is needed, please check the two selection definitions above. Select Disk electrode with Guard ring if only the DC method is needed. DC results (time domain) are displayed in the frequency domain using a Fourier transformation. Depending on the selected test cell and the needed IEC standard, the calculated frequency domain results $c_0$ and relative permittivity $\epsilon_r$ could be wrong.

- $c_0$  Vacuum capacitance
- $\epsilon_0$  Vacuum permittivity  
8.8541878176 x 10<sup>-12</sup> F/m
- d Electrode diameter
- g Guard gap
- h Sample thickness
- B Edge correction function
- A Area



### 13.3.4 Correction procedure

#### Solid insulating materials

Electrode systems with guarding and suitable connections ensure a precise measurement by shunting edge currents from spurious external voltages away from the measuring circuit. This reduces the probability of a measurement error significantly. In theory the edge capacitances  $c_e$  are zero.

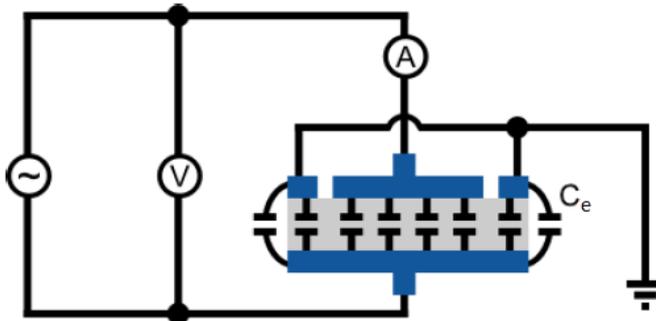


Figure 13-2 Measurement circuit, guarded electrode

Nevertheless, stray capacitances of the test cell or between the leads and to ground are not shunted. The of such capacitance could still influence the measurement accuracy for example of thin samples ( $\mu\text{m}$  range). We recommend to

- Perform a standardized air reference measurement using the *SPECTANO Analyzer Suite*
- Activate the correction to display the corrected capacitance and relative permittivity  $\epsilon_r$  values. For more information about the air reference correction and its equations read chapter “10.4 Perform reference measurements”.

In addition, we recommend using a material sample diameter equal to the measurement electrode diameter as shown in *Figure 13-2* to ensure an optimal measurement accuracy. At least the material should cover the Guard ring half as seen in the image below (has to contact the Guard ring 50%).

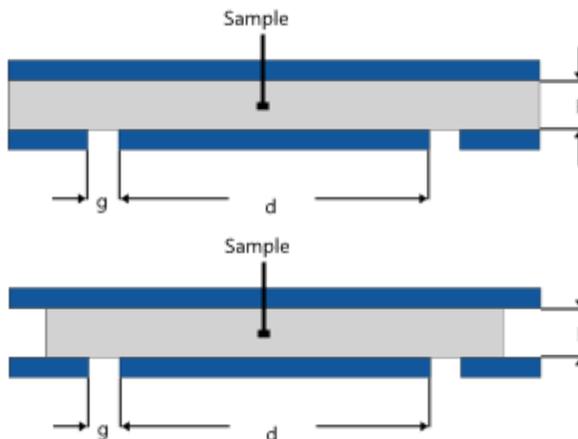


Figure 13-3 Sample dimension recommendations for high accuracy measurements using a guarded electrode

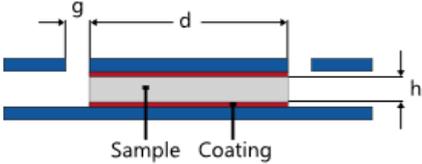
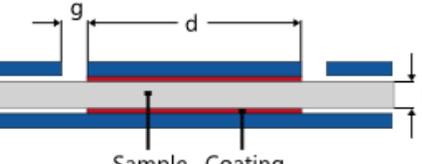
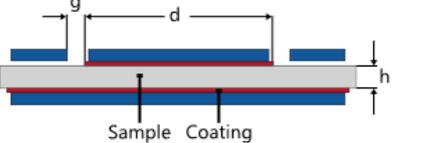
**Liquid Insulating materials**

Edge capacitances are not the problem for the analysis of liquid insulating materials using a Disk electrode arrangement with Guard ring. Nevertheless, stray capacitances of the test cell or between the leads and to ground are influencing the measurement accuracy. We recommend performing the air reference correction steps described in the solid insulating material analysis chapter “Solid insulating materials” on the page before.

**13.3.5 Coating**

Coatings are used to improve the contact between electrode and material surface. The diameter  $d$  for the calculation of the vacuum capacitance  $c_0$  depends on the coating type.

Table 13-2 Disk electrode with Guard ring using different coating types

Coating type	Diameter $d$ to enter in the <i>SPECTANO Analyzer Suite</i>
<p>Sample diameter = Guard electrode diameter = Coating diameter</p> 	<p><math>d</math> = Electrode diameter</p>
<p>Guard electrode diameter = Coating diameter <math>\neq</math> Sample diameter</p> <p>Sample diameter = Measurement electrode diameter</p> 	<p><math>d</math> = Electrode diameter</p>
<p>Guard electrode diameter <math>\neq</math> Coating diameter <math>\neq</math> Sample diameter</p> <p>Sample diameter <math>\neq</math> Measurement electrode diameter</p> 	<p><math>d</math> = Coating diameter</p>

## 13.4 DSH 100 (Dielectric Sample Holder)

OMICRON Lab's *DSH 100* is a Disk electrode test cell with Guard ring and is designed for the analysis of solid insulating materials.

The *SPECTANO Analyzer Suite* offers a *DSH 100* test cell selection with pre-defined dimensions. Thus, you only have to enter the material type for documentation and the reference and material sample thickness for the automated calculation of the vacuum capacitance  $c_0$  and out of this the relative permittivity  $\epsilon_r$ .

Depending on the international standard, it might be necessary to select the test cell '*Other geometries*'.

- For more information see 13.2.3 "Test cell type selection in SPECTANO Analyzer Suite".
- For more information about the stray capacitance correction see chapter "13.2.4 Correction procedure".
- For more information about coating see chapter "13.2.5 Coating".

## 13.5 Disk electrode without Guard ring

### 13.5.1 IEC standards

According to the IEC standards for the analysis of dielectric and resistive properties of solid and liquid insulating materials

- IEC 60250-1969: AC methods for solid material analysis
- IEC 60247-2004: AC methods for liquid insulating material analysis
- IEC 62631-3-1-2017-03: DC methods for solid material analysis

you can use a Disk electrode without Guard ring for DC method or AC method analysis. IEC 60250-1969 is replaced by IEC 62632-2-1-2018-2. The following table describes the differences between these two standards:

Table 13-3 Differences between IEC 60250-1969 and IEC 62632-2-1-2018-02

	IEC 60250-1969	IEC 62632-2-1-2018-02
Frequency range	15Hz to 300MHz	0.1Hz to 10MHz
Test cell types	Disk electrode with Guard ring Disk electrode without Guard ring Cylindrical electrode with Guard ring Cylindrical electrode without Guard ring etc.	Disk electrode with Guard ring

In comparison to IEC 60250, the latest IEC standards for AC methods, such as IEC 62632-2-1-2018-02 base on the demands on different frequency ranges.

Thus, for AC methods with frequencies < 10 MHz it is recommended to use Disk electrodes with Guard ring to ensure a measurement accuracy as defined in the international standard documents.

### 13.5.2 ASTM standards

The latest ASTM standards for the analysis of dielectric and resistive properties of solid and liquid insulating materials using Disk electrodes without Guard ring are:

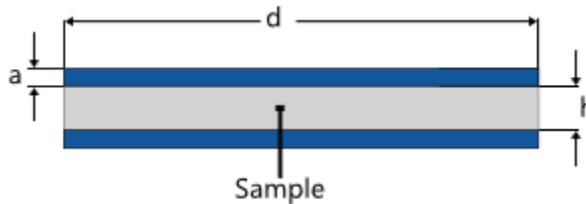
- D150-18: AC methods for solid insulating material analysis (replaced ASTM D150-11)
- D924-15: AC methods for liquid insulating material analysis
- D257-14: DC methods for solid insulating material analysis

### 13.5.3 Test cell type selection in SPECTANO Analyzer Suite

Table 13-4 SPECTANO Analyzer Suite test cell selection according to different standards

Standards	Vacuum capacitance $c_0$	SPECTANO Analyzer Suite selection
<u>AC method for solids:</u> IEC 60250-1969 ASTM D150-18 ASTM D150-11  <u>AC method for liquids:</u> IEC 60247-2004 ASTM D257-14	$c_0 = \epsilon_0 \frac{A}{h};$ $A = \frac{\pi}{4} \cdot d^2$	Disk electrode without Guard ring
<u>DC method for solids:</u> IEC 62631-3-1-2017 ASTM D257-14	%	Disk electrode without Guard ring

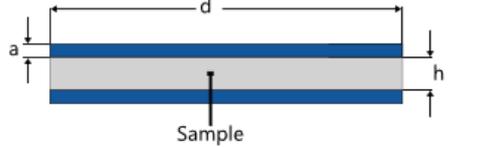
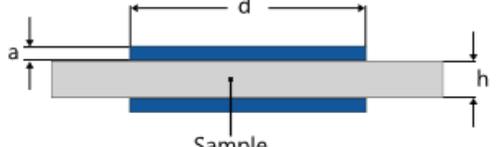
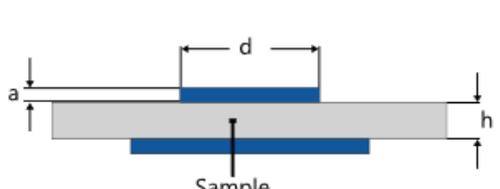
- $c_0$  Vacuum capacitance
- $\epsilon_0$  Vacuum permittivity  
8.8541878176 x 10<sup>-12</sup> F/m
- $d$  Electrode diameter
- $h$  Sample thickness
- $A$  Area
- $a$  Thickness of electrode



### 13.5.4 Correction procedure

#### Solid insulating materials

Table 13-5 Electrode and sample size combination of un-guarded electrode setup

Electrode and sample size combination	Cross section/Profile
Sample diameter = Electrode diameter	
Sample diameter $\neq$ Electrode diameter High voltage electrode diameter = Measurement electrode diameter	
Sample diameter $\neq$ Electrode diameter High voltage electrode diameter $\neq$ Measurement electrode diameter	

For electrodes without guarding, the electrodes shall

- either extend to the edge of the sample or
- be smaller than the sample.

In the latter case, it is acceptable for the upper and lower electrode to be equal or unequal in size. If they are equal in size and smaller than the sample, the edge of the sample must extend the electrodes by at least twice the sample thickness.

The choice between these electrode types will depend on convenience of application of the electrodes, and on the type of measurement adopted.

When the electrodes extend to the edge of the sample, these edges must be sharp to guarantee a precise measurement.

When equal-size electrodes smaller than the specimen are used, it is difficult to center them unless the specimen is translucent, or an aligning fixture is mounted.

When measuring the dielectric properties of solid materials without guarding, the measurement is influenced by stray capacitances at the edge  $c_e$  of the solid test material, as shown in *Figure 13-3*.

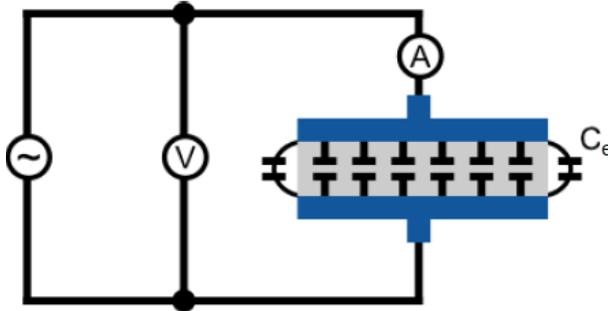


Figure 13-4 Measurement circuit, un-guarded electrode

The influence of the edge capacitances is smallest for the case of electrodes extending to the edge of the specimen (electrode diameter = sample diameter) and largest for unequal electrodes. Thus, the correction of the edge capacitance  $c_e$  depends on the electrode and sample size combination. The international standards IEC 60250-1969, D150-11, D150-18 (AC methods) describe how the measurement accuracy can be improved using edge capacitance correction calculations.

The edge correction calculations do not include the correction of the stray capacitances of the test cell or between the leads and to ground influence the measurement accuracy. Thus, instead of the correction calculation we recommend to

- Perform a standardized air reference measurement using *the SPECTANO Analyzer Suite*
- Activate the correction to display the corrected capacitance and relative permittivity  $\epsilon_r$  values. For more information about the air reference correction and its equations read chapter 10.4 "Perform reference measurements".

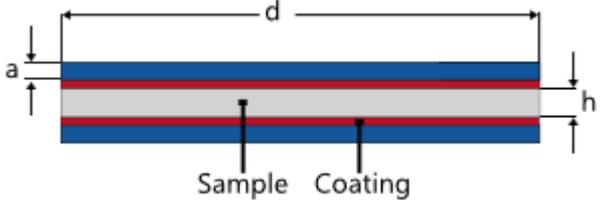
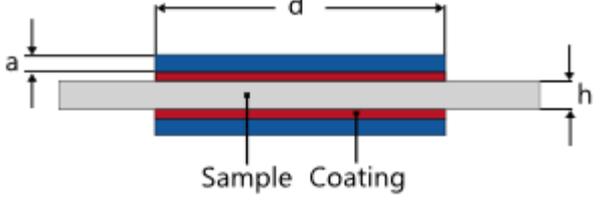
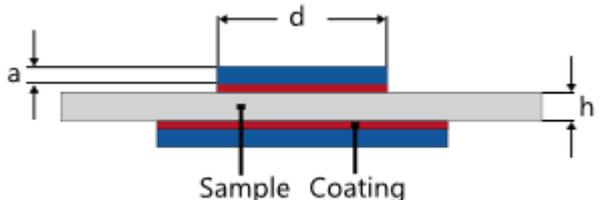
### Liquid insulation materials

Edge capacitances are not a problem for the analysis of liquid insulating materials using a Disk electrode arrangement with Guard ring. Nevertheless, stray capacitances of the test cell or between the leads and to ground are influencing the measurement accuracy. We recommend performing the air reference correction steps described in the solid insulating material analysis chapter "Solid insulating materials".

### 13.5.5 Coating

Coatings are used to improve the contact between electrode and material surface. The diameter  $d$  for the calculation of the vacuum capacitance  $c_0$  depends on the coating type.

Table 13-6 Disk electrode with Guard ring using different coating types

Coating type	Diameter $d$ to enter in the SPECTANO Analyzer Suite
<p>Sample diameter = Electrode diameter = Coating diameter</p>  <p style="text-align: center;">Sample Coating</p>	<p><math>d</math> = Electrode diameter</p>
<p>Electrode diameter = Coating diameter <math>\neq</math> Sample diameter High voltage electrode and coating diameter = Measurement electrode and coating diameter</p>  <p style="text-align: center;">Sample Coating</p>	<p><math>d</math> = Electrode diameter</p>
<p>Electrode diameter <math>\neq</math> Coating diameter <math>\neq</math> Material diameter High voltage electrode and coating diameter <math>\neq</math> Measurement electrode and coating diameter</p>  <p style="text-align: center;">Sample Coating</p>	<p><math>d</math> = Measurement electrode diameter</p>

## 13.6 Cylindrical electrode with Guard ring

### 13.6.1 IEC standards

According to the IEC standards for the analysis of dielectric and resistive properties of solid and liquid insulating materials

- IEC 60250-1969: AC methods for solid insulating material analysis
- IEC 60247-2004: AC methods for liquid insulating material analysis
- IEC 62631-3-1-2017-03: DC methods for solid insulating material analysis

you can use a Cylindrical electrode test cell with Guard ring for AC and DC method analysis. IEC 60250-1969 is replaced by IEC 62632-2-1-2018-2. The following table describes the differences between these two standards:

Table 13-7 Differences between IEC 60250-1969 and IEC 62632-2-1-2018-02

	IEC 60250-1969	IEC 62632-2-1-2018-02
Frequency range	15 Hz to 300 MHz	0.1 Hz to 10 MHz
Test cell types	Disk electrode with Guard ring Disk electrode without Guard ring Cylindrical electrode with Guard ring Cylindrical electrode without Guard ring etc.	Disk electrode with Guard ring

In comparison to IEC 60250, the latest IEC standards such as 62632-2-1-2018-02 base on the demands on different frequency ranges.

**Note:** Cylindrical test cell types are not described anymore in the latest IEC standard for the analysis of dielectric properties of solid insulating materials.

### 13.6.2 ASTM standards

The latest ASTM standards for the analysis of dielectric and resistive properties of solid and liquid insulating materials using Cylindrical electrodes with Guard ring are:

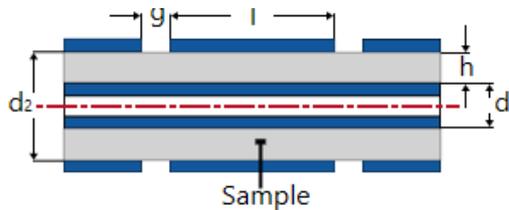
- D150-18: AC methods for solid insulating material analysis (replaces ASTM D150-11)
- D924-15: AC methods for liquid insulating material analysis
- D257-14: DC methods for solid insulating material analysis

### 13.6.3 Test cell type selection in SPECTANO Analyzer Suite

Table 13-8 SPECTANO Analyzer Suite test cell selection according to different standards

Standards	Vacuum capacitance $c_0$	SPECTANO Analyzer Suite selection
<u>AC method for solids:</u> IEC 60250-1969 ASTM D150-18 ASTM D150-11 <u>AC method for liquids:</u> IEC 60247-2004 ASTM D924-15	$c_0 = \epsilon_0 \cdot \frac{2\pi \cdot (l + g)}{\ln\left(\frac{d_2}{d_1}\right)}$	Cylindrical electrode with Guard ring
<u>DC method for solids:</u> 62631-3-1-2017 ASTM D257-14	%	Cylindrical electrode with Guard ring Note: The automated calculation of the specific resistance and conductivity is actually only implemented in the <i>SPECTANO Analyzer Suite</i> for Disk electrodes. All other DC parameter as the polarization current, depolarization current, electrical resistance or electrical conductivity are also available for Cylindrical electrodes. The automated calculation of the specific resistance and conductivity for Cylindrical electrodes will be implemented in the future. For the calculation of the specific resistance and conductivity using Cylindrical electrodes please perform a .csv export.

- $c_0$  Vacuum capacitance
- $\epsilon_0$  Vacuum permittivity  
8.8541878176 x 10<sup>-12</sup> F/m
- $l$  Electrode length
- $g$  Guard gap
- $d_2$  Outer diameter of sample
- $d_1$  Inner diameter of sample



### 13.6.4 Correction procedure

Electrode systems with guarding and suitable connections ensure a precise measurement by shunting edge currents from spurious external voltages away from the measuring circuit. This reduces the probability of a measurement error significantly. In theory the edge capacitances  $c_e$  are zero.

Nevertheless, stray capacitances of the test cell or between the leads and to ground are not shunted. The presence of such capacitances could still influence the measurement accuracy, for example, of thin samples ( $\mu\text{m}$  range). We recommend to

- Perform a standardized air reference measurement using the SPECTANO Analyzer Suite
- Activate the correction to display the corrected capacitance and relative permittivity  $\epsilon_r$  values. For more information about the air reference correction and its equations read chapter 10.4 Perform reference measurements.

## 13.7 Cylindrical electrode without Guard ring

### 13.7.1 IEC standards

According to the IEC standards for the analysis of dielectric and resistive properties of solid and liquid insulating materials

- IEC 60250-1969: AC methods for solid insulating material analysis
- IEC 60247-2004: AC methods for liquid insulating material analysis
- IEC 62631-3-1-2017-03: DC methods for solid insulating material analysis

you can use a Cylindrical electrode test cell without Guard ring for AC and DC method analysis. IEC 60250-1969 is replaced by IEC 62632-2-1-2018-2. The following table describes the differences between these two standards:

Table 13-9 Differences between IEC 60250-1969 and IEC 62632-2-1-2018-02

	IEC 60250-1969	IEC 62632-2-1-2018-02
Frequency range	15 Hz to 300 MHz	0.1 Hz to 10 MHz
Test cell types	Disk electrode with Guard ring Disk electrode without Guard ring Cylindrical electrode with Guard ring Cylindrical electrode without Guard ring etc.	Disk electrode with Guard ring

In comparison to IEC 60250, the latest IEC standards such as IEC 62632-2-1-2018-02 base on the demands on different frequency ranges.

Cylindrical test cell types are not described anymore in the latest IEC standard for the analysis of dielectric properties of solid insulating materials.

### 13.7.2 ASTM standards

The latest ASTM standards for the analysis of dielectric and resistive properties of solid and liquid insulating materials using Cylindrical electrodes without Guard ring are:

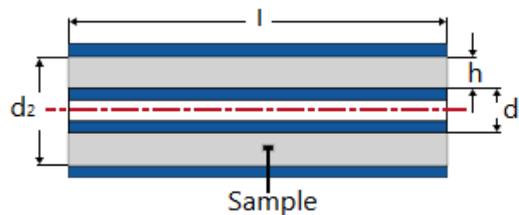
- D150-18: AC methods for solid insulating material analysis (replaces ASTM D150-11)
- D924-15: AC methods for liquid insulating material analysis
- D257-14: DC methods for solid insulating material analysis

### 13.7.3 Test cell type selection in SPECTANO Analyzer Suite

Table 13-10 SPECTANO Analyzer Suite test cell selection according to different standards

Standards	Vacuum capacitance $c_0$	SPECTANO Analyzer Suite selection
<u>AC method for solids:</u> IEC 60250-1969 ASTM D150-18 ASTM D150-11 <u>AC method for liquids:</u> IEC 60247-2004 ASTM D924-15	$c_0 = \epsilon_0 \cdot \frac{2\pi \cdot l}{\ln\left(\frac{d_2}{d_1}\right)}$	Cylindrical electrode with Guard ring
<u>DC method for solids:</u> 62631-3-1-2017 ASTM D257-14	%	Cylindrical electrode with Guard ring Note: The automated calculation of the specific resistance and conductivity is actually only implemented in the <i>SPECTANO Analyzer Suite</i> for Disk electrodes. All other DC parameters as the polarization current, depolarization current, electrical resistance or electrical conductivity are also available for Cylindrical electrodes. The automated calculation of the specific resistance and conductivity for Cylindrical electrodes will be implemented in the future. For the calculation of the specific resistance and conductivity using Cylindrical electrodes please perform a .csv export.

- $c_0$  Vacuum capacitance
- $\epsilon_0$  Vacuum permittivity  
8.8541878176 x 10<sup>-12</sup> F/m
- $l$  Electrode length
- $d_2$  Outer diameter of sample
- $d_1$  Inner diameter of sample



### 13.7.4 Cable Analysis

For the analysis of a cable dielectric layer, select the test type Cylindrical electrode without Guard ring in the *SPECTANO Analyzer Suite* software. Please note, that according to measurement accuracy, repeatability or reporting for cables, different international standards are valid. The standards described in this document are only valid for the analysis of dielectric and resistive properties of solid and liquid insulating materials.

## 13.8 Other geometries

Select 'Other geometries' in the *SPECTANO Analyzer Suite* software in case of

- Using for example
  - Unsymmetrical electrode arrangements
  - Non-contacting electrode arrangements
  - Finger electrodes
  - Sensors used for the determination of dielectric parameter as permittivity,  $\tan\delta$ , capacitance, relative or electrical conductivity etc.
  - Customized setups which cannot be covered with the symmetrical electrodes
- Analyzing, for example, the dielectric parameters of electronic components or HV -- components as rotor/stator bars.

### 13.8.1 Vacuum capacitance $c_0$

For the selection 'Other geometries' the vacuum capacitance  $c_0$  will not be calculated automatically. There are two possibilities how to determine the vacuum capacitance of your measurement setup:

1. Calculation
2. Measurement using a LC meter or the *SPECTANO 100*

For the measurement you can use the *SPECTANO 100* and the *SPECTANO Analyzer Suite*. Perform a measurement with an inserted solid or liquid material sample. Therefore,

1. Add a measurement to your *SPECTANO 100 Analyzer Suite* file
2. Name the added measurement 'c<sub>0</sub> determination'.
3. Start the 'c<sub>0</sub> determination' measurement
4. Perform a .csv export
5. Determine  $c_0 = \text{Average of } c'(f)$
6. Enter the determined  $c_0$  result into the *SPECTANO 100 Analyzer Suite* file which you have created for the analysis of your material.

## 13.8.2 Correction procedure

The automated air reference correction procedure according to the international standards is not implemented in the SPECTANO Analyzer Suite software for the selection 'Other geometries'.

If a correction of the results is needed, please use the possibility to "add measurements". With this function you can perform, for example, an air reference measurement using one or more material measurements. Afterwards, you can use the .csv export to perform your customized correction procedure. Another possibility would be to use the SPECTANO Automation Interface. This interface allows to create your own program, for example, using MatLab, C# or Python. This offers the advantage of implementing the correction algorithm and displaying the corrected results automatically, without the need of performing an export.

# Support

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