Operator's Manual

SIGMASCOPE® SMP350

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SIGMASCOPE® SMP350

Instrument for measuring the electrical conductivity of non-ferrous metals.

Document Order Number	912-528
Issue	05-2016 (valid from software versions FXA28 and FXB28)

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On our home page www.helmut-fischer.com you will find the addresses of our sole agencies and subsidiary companies around the globe.

Quality Assurance System of the Helmut Fischer GmbH

DIN EN ISO/IEC 17025	Calibration lab accredited for certified mass per unit area standards
DIN EN ISO 9001:2008	Management system certified by DNV GL - Business Assurance

1 Safety information

If you use the instrument as intended and observe the safety information, the instrument poses no danger.

Read and follow these instructions and observe the safety information. Also observe generally applicable safety and accident prevention regulations.

1.1 Read the operator's manual carefully before operating

- Make sure to read this operator's manual carefully before taking the instrument into operation.
- Keep the manual in a safe place, so that you will be able to consult it whenever necessary.

1.2 Warnings used

	ATTENTION	Indicates a danger that can lead to **damage** or **destruction** of the **product**.
	CAUTION	Indicates a danger that can lead to **minor or moderately severe injuries**.
	WARNING	Indicates a danger that can lead to **fatal or severe injuries**.
	DANGER	Indicates a danger that can lead **immediately** to **fatal or severe injuries**.

1.3 Symbols used

i	**Note** Indicates important information and notes.

1.4 Intended use

The SIGMASCOPE SMP350 instrument is used solely to measure the electrical conductivity of nonferrous metals and nonferrous alloys.

Only accessories approved or recommended by the manufacturer may be connected to the instrument.

Any use beyond this is not the intended use. The risk of damage ensuing therefrom is borne solely by the user.

1.5 Limitation of liability

The instrument manufacturer accepts no liability and responsibility for any kind of damage resulting from the use of the corrective diagrams and tables provided in the chapter "Appendix". The user uses the corrective diagrams and tables at their own responsibility. The manufacturer accepts no liability for damage of any kind caused by read-off errors and unsafe estimates.

The instrument manufacturer does not accept any loyalty and responsibility for conclusions drawn from measurements of the electrical conductivity (indirect measurement) and the interpretation of the measurement results.

Only continuous monitoring of the measurement devices by the user can guarantee the continued correctness of measurement readings. The instrument manufacturer accepts no liability and responsibility for subsequent damage caused by the use of incorrect measurement readings.

1.6 Safety of the electrical equipment

EMC

The instrument complies with the law on the electromagnetic compatibility of apparatus (2014/30/EC). The measured values are not influenced by the maximum values of the types of interference listed in standard EN 61000-6-2 (which refers to standards EN 61000 part 4-2, part 4-3, part 4-4, part 4-5, part 4-6 and part 4-11).

Low voltage

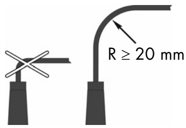
The instrument complies with the Low-Voltage Directive 2014/35/EC.

Product safety

The SIGMASCOPE SMP350 is a product as defined by the Product Safety Act.

Probe connection cable

ATTENTION	**Wire breakage** Bending the probes and other connection cables sharply can cause broken wires. It is then no longer possible to measure. ▶ Roll the probe connection cable into a radius of at least 20 mm (0.79 inch). ▶ Do not kink or pinch connection cables.



1.7 Servicing and repairs

Modifications, repairs as well as maintenance and service work on the instrument and accessories may be carried out only by service personnel authorised by the manufacturer.

Exceptions such as changing the batteries are described in these instructions.

1.8 Ambient conditions

Ambient temperature during operation: 0 ... +40 °C (+32 ... +104 °F)

Storage and transport temperature: +5 ... +60 °C (+41 ... +140 °F)

ATTENTION	**Risk of damage to the instrument from excessively high temperatures** When exposed to sunshine, the areas behind glass windows (e.g. in an automobile) can easily reach temperatures in excess of +60 °C (+140 °F). This can damage the instrument. ▶ Do **not** leave or store the instrument and accessories behind glass windows or next to heat sources such as radiators etc.!

ATTENTION	**Risk of damage to the instrument from acid** The instrument and accessories are **not acid-resistant**. ▶ Do **not** bring the instrument and accessories into contact with acids or acid containing liquids!

ATTENTION	**Hazard of short-circuit** The hazard of a short circuit exists if the instrument and accessories (especially the AC adapter plug) come into direct contact with liquids! ▶ Operate the instrument and accessories only at locations with a relative humidity of 30 % to 90 % (non-condensing). ▶ Leave or store the instrument and accessories only at locations with a relative humidity of 20 % to 80 % (non-condensing).

ATTENTION	**The instrument and accessories are not suitable for use in potentially explosive environments.** ▶ Do **not** operate the instrument and accessories in potentially explosive areas!

ATTENTION	**Risk of damage to the instrument from electrostatic charge** Electrostatic charges can damage components in the instrument or erase the memory in the instrument. ▶ Earth individuals who connect the probe to the instrument. ▶ Connect or plug in the probe only when the instrument is switched off! ▶ We recommend that the instrument be stored with the probe connected.

1.9 Disposal

	Disposal Do not dispose of waste electrical equipment and electronic accessories with household refuse. ▶ Put damaged or used batteries, waste electrical and electronic equipment in the appropriate collection bins! Please observe the regulations in your region for proper handling of waste electrical equipment and electronic accessories.

2 Description

The SIGMASCOPE SMP350 uses the phase-sensitive eddy current test method to measure the electrical conductivity of non-ferrous metals and non-magnetizable metals such as aluminium, copper and even stainless steel. The instrument is suitable for determining the electrical conductivity in accordance with DIN EN 2004-1 und ASTM E 1004.

It is also possible to draw conclusions about the hardness and strength of heat-treated materials from the measured conductivity. Heat damage and material fatigue can also be determined in this way. Keep in mind that such applications are based solely on specific empirical values!

2.1 Scope of supply

- SIGMASCOPE SMP350 instrument
- Probe(s) and reference part as specified in your order
- Support CD, FMP carrying case, batteries (alkaline), AC adapter plug, USB cable, short form manual, carrying strap and protective sleeve

Note

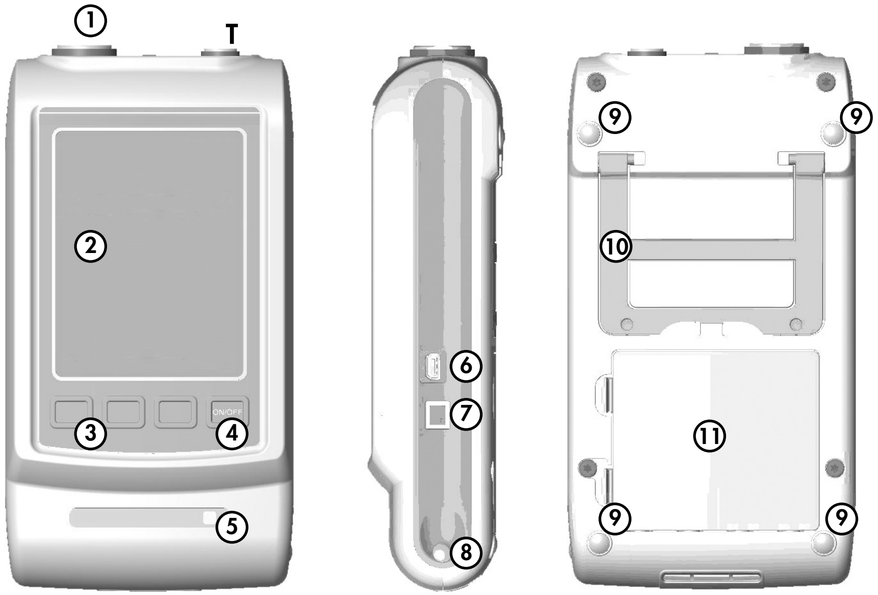
▶ Check the delivery for completeness and damage. Notify the responsible supplier about missing parts and damage. Retain the damaged packaging in order to file a damage claim with the freight forwarder.

▶ Retain the packaging for the possibility of subsequent shipment.

2.2 CE marking

The conformity evaluation was performed for the measurement system, consisting of the instrument and probe. This means that the CE mark on the instrument also applies to the connected probe. You can request the declaration of conformity from the manufacturer.

2.3 Instrument



Front view   Right side view   Rear view

① Probe connecting socket

T Connecting socket for the TF100A temperature probe

② Pressure-sensitive display = Touchscreen

③ Keys to open menus or functions directly

④ ON/OFF key, dual-purpose key; press and hold at least 1 s to switch instrument on/off

⑤ Power indicator light.
Green: Power is supplied via the AC adapter plug

⑥ USB port, for connection of a printer, PC, PC keyboard or USB flash drive

⑦ Connecting socket for the AC adapter plug

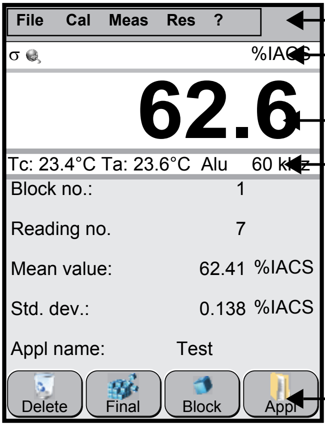
⑧ Stylus, for operating the touchscreen, for tapping command buttons and marking parameters

⑨ Anti-slip rubber nubs

⑩ Fold-out instrument stand

⑪ Battery compartment

2.4 Display - Touchscreen



Menu bar, description on page 7

Information bar (quantity to be measured or probe name, information symbols and unit of measurement), see page 7

Measurement panel, displays the measured value

Temperature, if the temperature correction display is enabled, and probe frequency

Information panel, see page 44

Command button area, description on page 9

Example of a measurement presentation with the statistics information area.

Menu bar

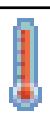
The instrument's functions are grouped under the items **File**, **Cal**ibration, **Meas**urement and **Res**ult (= Evaluation); see page 10. The individual instrument functions and entry windows are selected from pull-down menus.

Information bar

The quantity to be measured, together with the test method used, information symbols and set unit of measurement are displayed in this bar.

Quantity to be measured	Test method
σ	The instrument uses the phase-sensitive eddy current test method to measure the electrical conductivity.

Informationsymbols	
	Warning: **Wrong probe, measurement not possible**. The open application file was not created with the connected probe! Measurement is not possible!
	Green circular arrow: The **free-running display mode** is active.
	**Active specification limit monitoring**. Specification limit monitoring is enabled in the open application file.

Informationsymbols	
	**Protected application file**: The open application file is protected. Depending on the application setting, deleting, the **Cal** menu and/or the **File/Properties** menu are blocked.
	Flashing battery symbol: **Low battery voltage**. The batteries must be changed. i **Too low battery voltage can result in data loss!** When the battery voltage is too low, the instrument shuts off automatically without backing up the data in advance!
	**Closed block**, the measurement reading displayed closes a block. All values acquired since the last block was closed will be collected in this (new) measurement block.
	**Comment**. A comment is attached to a measurement block.
	**Measurement readings are not being saved**. The measurement readings are not being saved in the open application (file), but only shown on the display.
	**Active outlier check**. Outlier check is enabled in this application file.
	**Active curvature correction**. Curvature correction is enabled in this application file.
	**Monitors the temperature** probe connected to the instrument. The monitor function is enabled in this application file.

	Status displays for the USB connection to the PC
	Instrument as external drive (ActiveSync): Coloured symbol: **ActiveSync - connected** Grey symbol: **ActiveSync - not connected**
	Serial interface (virt. COM port): Coloured symbol: **virt. COM port - connected** Grey symbol: **virt. COM port - not connected**

Unit of measurement	
MS/m	SI base unit for the electrical conductivity
% IACS	Anglo-American unit of measurement for the electrical conductivity
°C	Derived SI unit for temperature
°F	Anglo-American unit of measurement for temperature
mm	Units of measurement based on the meter as SI base unit

Command button area

Command buttons for opening functions and menus directly. You can place up to 12 command buttons in the display; see page 134.

A description of all command buttons can be found on page 219.

	Command buttons (default setting)
Delete	Delete the displayed measurement reading ℹ Pressing the **Delete** key repeatedly successively deletes the current measurement reading that appears on the display.
Final	Opens the final evaluation, evaluation menu for the open application file
Block	Opens the block result, evaluation of the current block in the open application file
Appl	Opens another application file

2.5 Keys

The 4 keys below the display are automatically assigned to the functions of the (bottom) row of command buttons. This allows you to open the functions of the row of command buttons along the bottom edge of the display directly via the keys without the stylus.

Exception: **ON/OFF** key.
This key has two functions. In addition to its command button function, you always switch the instrument on/off with the **ON/OFF** key.

2.6 Menu structure

Main menus

File
New…
Open *(Application or Inspection plan)* ▶
Save
Save As…
Management ▶
Properties…
Lock… *(Functions for the open application file)*
Supervisor…
Quit Supervisormode
List of recently opened application files
Shutdown

Cal
Normalization…
Corrective calibration…
Delete corrective calibration
Check calibration
Temperature… *(monitoring, capturing)*
Temperature coefficient…

Submenus

File > Management ▶	
Copy, rename, move, delete files	Applications… Inspection plans… Exports… Graphics…

File > Properties...	
Settings are stored in the application file	Measurement *(i single readings, autom. block creation, outlier rejection)* Temperature correction *(on/off; monitoring)* Correction *(curvature correction only for FS40 probes)* Measurement acceptance *(by placing, External Start, Area measurement, automatic, manual, store readings on/off)* Display *(measurement presentation, value resolution)* Specification limits *(setting, monitoring)* Statistical display *(template)* Block result *(template)* Final result *(template)*

File > Supervisor... > 159	
Instrument settings	Control Panel Lock applikation(s) Assign probe[2] Unit COM-Export Statistical display - Template Block result - Template Final result - Template Keyboard *(Display)* Password automatic Save Cp and Cpk Probe frequency temperature calibration delete temperature cal. Pwr. save mode Master cal. warning Master calibration Recover factory calibration Air value acceptance Default settings

Meas
Free running mode *(continuous measurement value display)*
Note *(Enter a comment for a block or for the opened application file)*
Trigger external start
Inspection plan ▶

Res
Block result
Final evaluation
Delete all readings
Delete current block
Delete current reading
Export over COM port

?
Software version, connected probe, further instrument informations

File > Supervisor... > 159 > Control Panel	
Instrument settings	Language
	Power & Light
	Date/Time
	Locale - Time
	Locale - Date
	Printer *(printer type selection)*
	Calibrate touch
	USB connection
	Acoustic signals
	Mouse
	USB Keyboard
	Service settings[1]

Meas > Inspection plan ▶	
	Dummy Merkmal vor
	Dummy Merkmal zurück
	Dummy Teil vor
	Dummy Teil zurück
	Show image for inspection plan
	Dummy Bild für Merkmal anzeigen
	Zoom in
	Zoom out
	Restart
	Finish
	Cancel
	Edit last Inspection Plan

1 *For authorised service personnel only!*
2 *Submenu is enabled only, if the application opened was not created with the connected probe.*

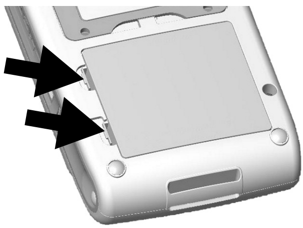
3 Start-up

- Place the batteries into the instrument; see page 12.
  Alternatively power supplies:
  - Option battery pack (604-144), see page 13
  - AC adapter plug, see page 14.
- Connect the probe to the instrument, see page 16.

3.1 Inserting/changing batteries

ATTENTION	**Risk of damage to the instrument** Use of defective batteries and the wrong battery types will damage the instrument. Leaking batteries destroyed the instrument's electronics. ► Use only undamaged batteries/rechargeable batteries. ► Use only the following types of alkaline batteries: Mignon, 1.5 V, LR6 - AA - AM3 - MN1500 ► Use only the following types of the NiMH rechargeable batteries: Mignon, 1.2 V, HR6 - AA

Procedure for changing batteries



1. Switch off the instrument: Press the **ON/ OFF** key for about 1 second.
2. Open the battery compartment cover.
3. Remove the old batteries.
4. Insert 4 new batteries.

ATTENTION	**Observe the correct polarity when inserting the batteries!**

5. Close the battery compartment cover.
   The instrument is now ready for use.

ATTENTION	**Recharge batteries in the instrument are not possible** Rechargeable batteries are not rechargeable in the instrument by using the AC adapter. ► Use a battery recharger for recharging batteries.

3.2 Inserting/changing battery pack (option)

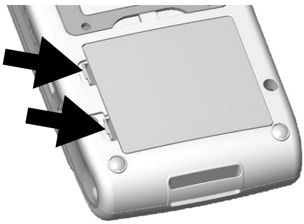
The battery pack (option, 604-144) is charged in the instrument using the AC adapter plug.

Charging time: Up to 4.5 h, depending on the charging state of the battery pack

Battery running time: ≥ 8 h

Procedure: Inserting the battery pack

1. Switch off the instrument: Press the **ON/OFF** key for about 1 second.
2. Open the battery compartment cover.
3. Remove the old batteries or the old battery pack.
4. Insert the new battery pack into the battery compartment with the small PCB downwards.



ATTENTION	**Observe the correct polarity when inserting the battery pack!**

5. Close the battery compartment cover.
6. Charging the battery pack: Connect the AC adapter plug to the instrument. The LEDs next to the device name displays the charging status:
   Green: Battery pack is charged
   Orange: Battery pack is charging
7. When the battery pack is charged, the instrument is ready for operation.

3.3 Connecting the AC adapter plug (scope of supply)

ATTENTION	**Risk of damage to the instrument from the wrong mains voltage** The wrong mains voltage can result in damage to the instrument and incorrect measurement readings! ► Connect the instrument to the electrical power socket only via the original AC adapter plug. ► The mains voltage must match the voltage stated on the nameplate of the AC adapter plug!

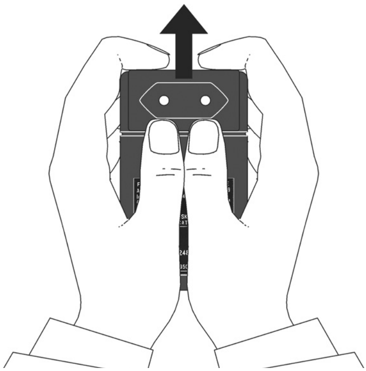
Procedure for connecting the AC adapter plug

1. Switch off the instrument: Press the **ON/OFF** key for about 1 second.
2. Insert the small connector on the AC adapter plug into the instrument.
3. Insert the AC adapter plug into the mains socket. How to change the appropriate plug for your mains sockets on the AC adapter plug is described in the following section.
4. Switch on the instrument again: Press the **ON/OFF** key. A green indicator light next to the instrument's name shows that power is being supplied via the AC adapter plug.

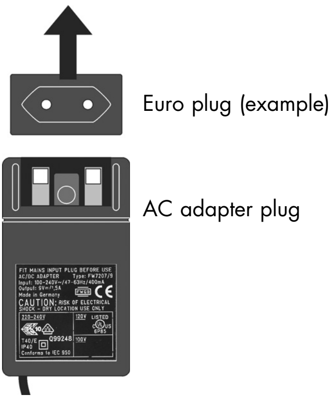
3.3.1 Changing the plug on the AC adapter plug

The plug on the AC adapter plug is replaceable. Change the plug to the type suitable for your country. The AC adapter plug adjusts automatically to mains voltages between 100 V~ and 240 V~ at 47 Hz to 63 Hz.

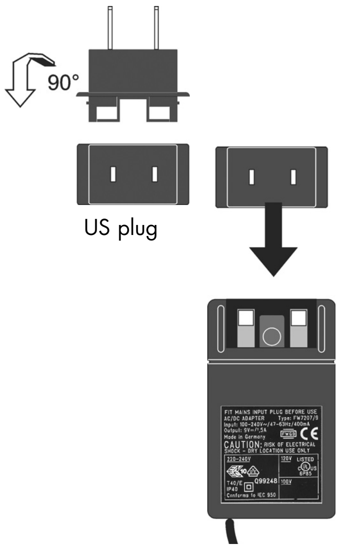
Changing the Euro plug to the US plug is described in the following by way of example. Various plug types are included in the scope of supply for the AC adapter plug.



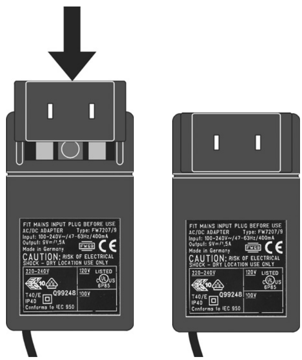
1. Press the plug upwards forcefully.
   A sharp click will be heard when you overcome the detent threshold.



2. Pull the Euro plug upwards out of the housing.



3. Insert the US plug into the guide slots of the housing.



4. Press the US plug downwards forcefully until it snaps into place (sharp click).

Example: Exchanging the US plug for the Euro plug on the AC adapter plug.

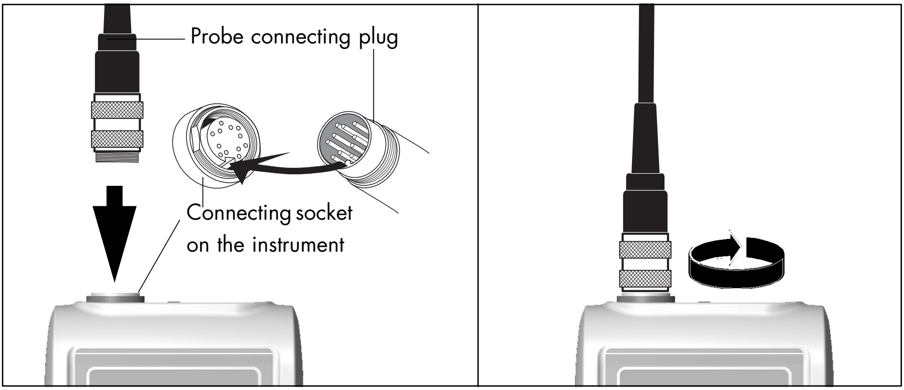
3.4 Connecting the probe to the instrument

► To measure the electrical conductivity, connect a probe to the instrument, e.g. from the FS40 probe family. The procedure is described in the following section.

► If you wish to measure the surface temperature with a separate temperature probe, attach a TF100A temperature probe to the instrument to measure the temperature. The procedure is described on page 17.

Procedure for connecting a probe

1. Switch off the instrument: Press the **ON/OFF** key for about 1 second. The display is now dark.
2. Connect probe to the instrument as shown in the following.



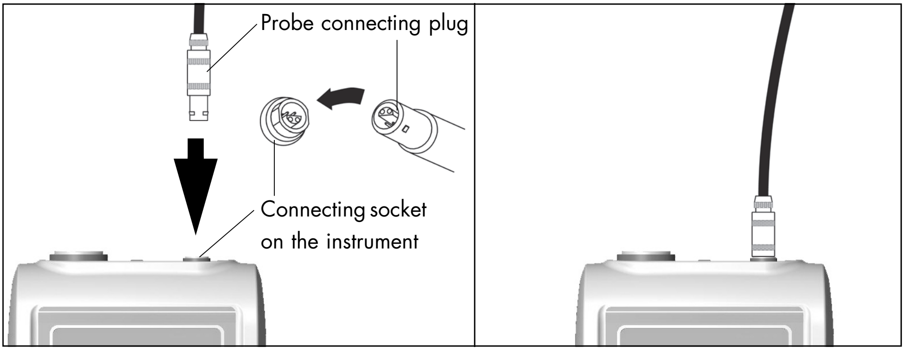
3. Switch on the instrument: Press the **ON/OFF** key for about 1 second.

What you can do next

- Connect the temperature probe to the instrument; see page 17.
- Create a file (application file) in the instrument; see page 22.
- Perform measurements; see page 65.

Procedure for connecting the TF100A temperature probe

1. Switch off the instrument: Press the **ON/OFF** key for about 1 second. The display is now dark.
2. Connect probe to the instrument as shown in the following.



3. Switch on the instrument: Press the **ON/OFF** key for about 1 second.

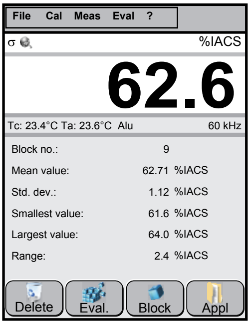
What you can do next

- Connect the conductivity probe to the instrument; see page 16.
- Make settings for acquisition of measurement readings; starting at page 33.
- Perform measurements; see page 65.

3.5 Switching on/off the instrument

► To switch on/off the instrument, press the **ON/OFF** key for about 1 second.

A tone sounds to indicate the start-up routine of the instrument.



Example: Measurement presentation

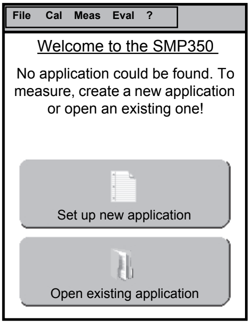
Once the start-up routine has completed, the last application file used with the connected probe opens automatically.

i	**Air value** The system must be adjusted before the application file opens. ► Hold the probe in the air and press the **OK** command button. For this, the distance to the next object must be at least 5 cm (1.97 inches)!

What you can do next

- Calibrate the instrument; see page 139
- Perform measurements; see page 65
- Change the application settings; see page 25
- Create new application; see page 22

i	**Instrument in battery mode - Note** After about 3 minutes, the instrument shuts off automatically if neither a measurement is acquired nor a key is pressed.



The menu to the side appears under the following conditions:

- No application file has been created in the instrument.
- There is no application file that was created with the probe connected to the instrument.

What you can do next

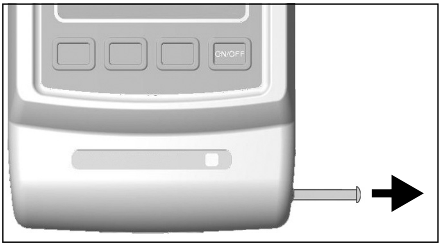
► Create an application file with the connected probe: Tap on the **Set up new application** command button; see page 22.

► Open an application file: Tap on the **Open existing application** command button; see also page 119.

Was the opened application not set up with the connected probe, you can assign the connected probe to the open application file; see page 149.

3.6 Operating the touchscreen (display)

The instrument is operated in a manner similar to that used for a smartphone. Operation involves basically using a stylus on the touchscreen.



Stylus for operating the touchscreen

The stylus is inserted from the right at the bottom of the housing.

Using the stylus on the touchscreen

The touchscreen (= pressure-sensitive display) recognizes the position of the stylus and in this way permits navigation on the display. The following possibilities are available:

Selection of characters and parameters: Using light pressure, press the stylus directly against the surface of the display.

Marking and moving fields: Using light pressure, move the stylus across the surface of the display without lifting.

Example of entering a file name (= application name). Using the stylus, tap the desired letters.

3.7 Connecting a PC keyboard

To simplify text entry, connect a PC keyboard to the instrument.

Before you start

- USB adapter 604-417 is needed for the connection.
- Make sure the instrument is switched off.

Connecting the PC keyboard to the instrument

► Using the USB adapter, connect the PC keyboard to the instrument.

4 The way to (the first) measurement

You will have your measurement readings after only 3 steps.

1. **Put the instrument into service**, see page 12.

   Insert batteries, connect probe and switch on instrument.

2. **Create a new file** or **open an existing file**.

   All relevant settings and parameters for a measuring application as well as the measurement readings acquired are saved in a file - in this context, we are speaking of an application or application file.

- Create a new application file, see page 22
- Open an application file, see page 91
- Make application settings, see section "Application file settings for measurement", page 25 .

3. **Make a measurement on the specimen**, see page 65.

   If the stated trueness of the measurement readings is not achieved, you must calibrate the instrument together with the connected probe. In this way, you will compensate for influencing factors that falsify the measurement.

   Influencing factors, see page 65 and 87

   Calibration, see section "Adjustment of the measurement system - Corrective calibration", page 139 .

i	**Influencing factors - Note** For measurement of the electrical conductivity there are no calibrated instruments as there are, for instance, when measuring the weight with a scale. On the contrary, the measuring results are influenced by the temperature, the materials and the shape of the specimen. With appropriate calibrations and settings, you can accommodate these individual aspects of your specimens and compensate for them.

5 Creating an application file in the instrument

All relevant settings for measurement of the electrical conductivity as well as the measurement readings acquired are saved in a file in the instrument. Such a file is called an application, abbreviated Appl, in the instrument.

Before you start

- The probe is connected to the instrument.
- Batteries have been placed in the instrument or the power supply is connected to the instrument.
- The instrument is switched on.

Creating an application file in the instrument

1. Tap on **File** > **New**.

   Alternatively, the **Set up new application** command button appears if an application file has not yet been created for the connected probe in the instrument. In this case, tap on this command button.
2. Enter the name for the application file.

> **Note**
> **Certain characters and letters are prohibited** for the file name:
> - /, \, period, comma, :, (,), *, ...
> - Letters such as ä, ö, ü

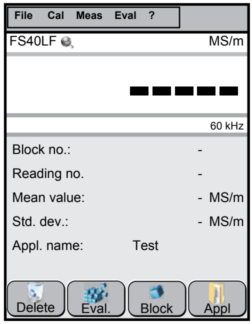
> **Note**
> Give the application file an unambiguous name such as the part number of the specimen, customer number etc. This simplifies selection of the appropriate file.

3. Tap on **OK**.
   A file with the assigned name is created and saved in the instrument.
4. Select the probe frequency: Tap on the desired frequency. A black dot identifies the enabled parameter. Refer to section "Selecting the probe frequency (possible only for type FS40 probes)", page 23 regarding selection.

5. Tap on **OK**.

   The prompt *Please hold the probe in the air* appears.
6. Hold the probe in the air. The distance to the next object should be at least 5 cm (1.97 inches).
7. Tap on **OK**.

   The empty measurement presentation for the newly created application file appears.



Example of a measurement presentation for a new application file with probe FS40LF

The probe name appears below the menu bar as long as no measurement reading has been acquired.

Selecting the probe frequency (possible only for type FS40 probes)

By selecting the probe frequency, you determine how deep the induced eddy currents of the probe penetrate into the material. This means to which material depth the electrical conductivity is measured. The following rule of thumb applies: The higher the probe frequency, the lower is the penetration depth of the eddy currents induced in the material.

Examples:

- Aluminium and probe frequency of 60 kHz
  Penetration depth of the induced eddy currents into the material: about 313 µm (12.32 mils)
  Minimum material thickness according to the rule of thumb $th_{min} \geq 3 \cdot \delta_0$ for measurements without influence of the material thickness: 940 µm (37.01 mils)
- Aluminium and probe frequency of 480 kHz
  Penetration depth of the induced eddy currents into the material: about 110 µm (4.33 mils)
  Minimum material thickness according to the rule of thumb $th_{min} \geq 3 \cdot \delta_0$ for measurements without influence of the material thickness: 330 µm (12.99 mils).

► **Always use the lowest possible probe frequency for the measurement!**
Higher probe frequencies can result in larger deviations in measurement readings.

	Notes
i	• Information on the effect of the probe frequency on the electrical conductivity measurement can be found on page 241. • Information on determining the lowest probe frequency for a given material thickness can be found on page 162.

What you can do next

- Make application settings; see page 25.
- Make instrument settings; see page 124
- Perform measurements; see page 65.

6 Application file settings for measurement

In the application file you specify how a conductivity measurement proceeds, e. g. whether you are assisted by specification limit monitoring and temperature correction while measuring.

Overview of possible application settings

Application settings	**Page**
Temperature correction: on/off	27
Temperature coefficient of the specimen material: enter/select	30
Curvature correction: on/off	31
Measurement acquisition: automatic/manual	33
Specification limit monitoring: on/off	36
Enter tolerance limits/tolerance range	36
Save measurement readings in blocks (groups): on/off	39
Measure despite considerable variation in measurement readings: Form representative measurement reading from several individual measurements: on/off	41
Outlier rejection: on/off	43
Save measurement readings: on/off	35
Select type of information area to be displayed in the measurement presentation	44
Analogue bar display: on/off	48
Select display resolution	49
Collect the desired statistical characteristics	50

Application settings	Page
Automatic instrument adjustment: on/off	51
Lock functions for the open application file	52
Change the probe frequency of the open application file	55
Assigning a new probe	149
Select measured variable (σ, phin, X) for the open application	56

Note

The  symbol in the information bar on the display indicates that some functions are blocked for this application file. Editing of application settings may also be blocked. If a blocking password was issued, you can, if necessary, change settings in the blocked function one time by entering the blocking password. The password prompt appears upon opening the blocked function.

Note

You can also open many functions directly by using command buttons. This eliminates the need to open frequently used functions always via the menu path. You can place up to 12 command buttons in the measurement value display; see page 134.

6.1 Temperature correction

Select whether and how you wish to measure the temperature for the temperature correction. The selection applies only to the open application file.

Open menu

▶ Tap on **File > Properties... > Temperature correction**

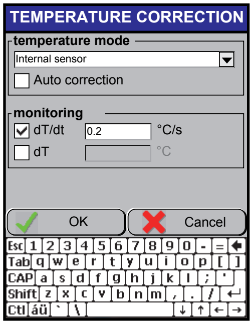
Make selection

1. In the **temperature mode** area, select the desired way to sense temperature. Tap in the selection window to open the selection list.

   Enable/disable the desired parameter: Tap on the desired parameter. A check mark indicates that the parameter is enabled.

   A description of the parameters can be found in the following section.

   Use the on-screen keyboard that appears to enter numbers.
2. Save the settings: Tap on the **OK** command button.
3. Switch back to the measurement presentation: Tap on the **Close** command button.



Example: The internal temperature sensor of the FS40 probe acquires the temperature measurement and a tone signals temperature changes of more than 0.2 °C per second.

Note

For a measurement with temperature correction, you need the temperature coefficient of the specimen material in addition to the specimen's temperature. Settings, see page 30.

Description of parameters

TEMPERATURE CORRECTION menu page

Parameter	Description
No correction	Temperature correction is disabled: The accuracy of electrical conductivity measurement readings made without temperature correction is lower than stated in the probe data sheet. For instance, a temperature increase of +1 °C reduces the electrical conductivity by about 0.4 % in the case of copper. See also page 68.
Manual input	Temperature correction is enabled: You measure the specimen's temperature with a temperature measuring instrument and enter the value manually by using the on-screen keyboard that appears on the display of the SIGMASCOPE instrument. See also page 69.
External sensor	Temperature correction is enabled: The TF100A temperature probe is used for the temperature measurement. See also page 69.
Internal sensor	Temperature correction is enabled: The internal temperature probe of the FS40 probe is used for the temperature measurement. See also page 69.
Auto correction (only in conjunction with the parameters **External sensor** or **Internal sensor**)	Disabled: The temperature measured by the temperature probe must be saved in the instrument manually. Enabled: The instrument continuously saves the measured temperature value. Useful only if the temperature probe remains in contact with the specimen continuously during the measurement.

Parameter	Description
	The instrument continuously acquires the temperature measured by the temperature probe. Even when, for instance, the temperature probe is lying on the table and is not in contact with the specimen. In this case, the air temperature is used for temperature correction, resulting in incorrect measurement readings!
dT/dt	Monitors the temperature probe connected to the instrument. Useful when the **Auto correction** parameter is enabled. Switch the monitoring function on or off. Consider the response time of the temperature probe that is measuring the specimen's temperature. We recommend values between 0.2 (0.36) and 0.5 °C/s (0.9 °F/s).
	The temperature probe requires some time to sense the true specimen temperature. During this time, the signal sounds repeatedly and the thermometer symbol flashes on the display.
dT	Monitors the temperature. Compares the temperature currently measured (**Sensor temperature** parameter) with the temperature saved in the instrument (**Current temperature** parameter). The **Auto correction** parameter is disabled! Enter a value by which the measured temperature is allowed to deviate. Example dT = 1 °C (1.8 °F), negative values are not accepted. If the newly measured temperature deviates by more than the value entered, a signal sounds repeatedly and a thermometer symbol flashes on the display. The signal is muted and the flashing thermometer disappears only after the new temperature value is acquired manually.

6.2 Entering the temperature coefficient of the specimen material

For a measurement with temperature correction, you need the temperature coefficient of the specimen material in addition to the specimen's temperature. The temperature coefficient is already stored in the instrument for some materials.

Open menu

▶ Tap on **Cal > Temperature coefficient...**

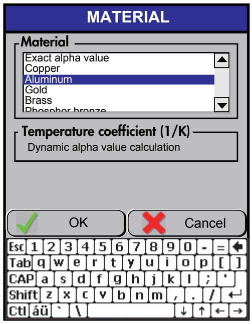
Make setting

1. Select the temperature coefficient for the specimen material from the list.

- If you select **Exact alpha value**: Enter the temperature coefficient for the specimen material directly into the entry field **Temperature coefficient (1/K)**. Tap in the entry field twice to mark it. Use the on-screen keyboard that appears to enter numbers.

  A description of the parameters can be found in the following section.

2. Save the settings: Tap on the **OK** command button.
3. Switch back to the measurement presentation: Tap on the **Close** command button.



Example: Aluminium is selected as the material; the temperature coefficient is determined automatically.

i	**Note** For a measurement with temperature correction, you need the temperature coefficient of the specimen material in addition to the specimen's temperature. Settings, see page 27.

Description of the parameters for the temperature coefficient

MATERIAL menu page

Parameter	Description
Material	List of materials whose typical temperature coefficients are stored in the instrument.

Parameter	Description
Exact alpha value	Select this list entry if you know the temperature coefficient of the current specimen material. An entry field appears under **Temperature coefficient (1/K)**; see Step 1. ● under "Make setting".
Temperature coefficient (1/K)	*Display of the typical temperature coefficient for the selected material.
Dynamic alpha value calculation	*For aluminium and copper alloys, the temperature coefficient is determined by the instrument.
Entry field	If you select the list entry **Exact alpha value**, a field for entering the temperature coefficient appears automatically. Entry, see Step 1. ● in section "Make setting".

* A list of sources for the calculations and typical alpha values stored in the instrument can be found in the Glossary section.

6.3 Curvature correction

You can compensate for the effect of the surface curvature by entering the diameter of curvature of the specimen in the instrument. The menu function **Correction** is available only for application files created with probe FS40 or FS40LF and a probe frequency of 60, 120, 240 or 480 kHz.

Open menu

► Tap on **File > Properties... > Correction**

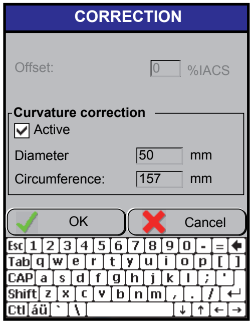
Make settings

1. Enter the specimen's diameter of curvature. Tap in the **Diameter** or **Circumference** entry field twice to mark it. Use the on-screen keyboard that appears to enter numbers.

   Permissible entries:
   ≥ 6 mm (0.24 inches) for the diameter
   ≥ 18.8 mm (0.74 inches) for the circumference

2. Save the settings: Tap on the **OK** command button.

3. Switch back to the measurement presentation: Tap on the **Close** command button.



Example: A diameter of curvature of 50 mm is entered.

i	**Note regarding calibration** Although you are measuring on curved parts, you must use smooth, flat standards/reference parts during the calibration! Otherwise, incorrect measurement readings will be obtained!

6.4 Measurement acquisition

The probe acquires the measurement reading. The measurement reading is transferred to the instrument and saved there. The measurement reading is acquired automatically when the probe is placed on the specimen (default setting). You can also acquire measurement readings manually, however.

Open menu

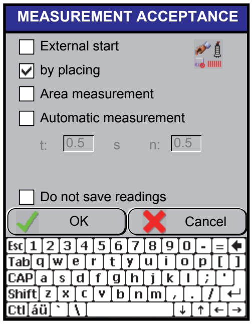
▶ Tap on **File > Properties... > Measurement acceptance**

Make settings

1. Enable/disable the desired parameter: Tap on the desired parameter. A check mark indicates that the parameter is enabled.

   For some parameters, you must make additional entries. Use the on-screen keyboard that appears to enter numbers.

   A description of the parameters can be found in the following section.
2. Save the settings: Tap on the **OK** command button.
3. Switch back to the measurement presentation: Tap on the **Close** command button.



*Example: The **by placing** parameter is enabled.*

Description of the parameters for measurement acquisition

MEASUREMENT ACCEPTANCE menu page

Parameter	Description
External start	Manual measurement acquisition Start measurement acquisition manually, e.g. by tapping on **Meas > Trigger external start**, see page 76.
by placing	Automatic measurement acquisition Start measurement acquisition automatically by placing the probe on the specimen.

Parameter	Description
Area measurement	Automatic measurement acquisition Continuous acquisition of the measurement reading while scanning the surface with the probe (within an area or along a line). The resultant mean value is then acquired automatically as an individual measurement. *Start area measurement* • Place the probe on the specimen; the **by placing** parameter is enabled • Start measurement acquisition manually; the **External start** parameter is enabled. *End area measurement* • Area measurement always ends automatically when the probe is lifted off the specimen.
i	Enabling the **Area measurement** parameter automatically disables and resets the **i individual values** parameter; see page 39.
Automatic measurement	
	Automatic measurement acquisition Acquisition of a measurement reading every x seconds. *Parameter* **t** Time interval during which the measurement readings are acquired. Smallest possible time interval: 0.2 s. **n** Total number of measurements that can be made up to probe liftoff. n = 0: Continuous measurement acquisition up to probe liftoff.

Automatic measurement

Start automatic measurement

- Place the probe on the specimen; the **by placing** parameter is enabled
- Start measurement acquisition manually; the **External start** parameter is enabled.

End automatic measurement

Measurement acquisition ends automatically after the specified number of measurement readings.

6.5 Saving/not saving measurement readings

Specify whether the measurement readings should be saved automatically in the open application file.

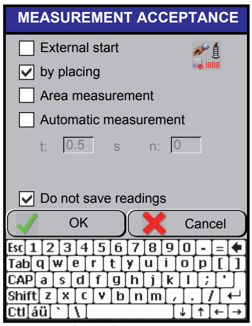
Open menu

▶ Tap on **File > Properties... > Measurement acceptance**

Make setting

1. Enable/disable the **Do not save readings** parameter: Tap on the parameter. A check mark indicates that the parameter is enabled.

   A description of the parameters can be found in the following section.
2. Save the settings: Tap on the **OK** command button.
3. Switch back to the measurement presentation: Tap on the **Close** command button.



*Example: The parameters **by placing** and **Do not save readings** are enabled.*

Description of the "Do not save reading" parameter

MEASUREMENT ACCEPTANCE menu page

Parameter	Description
Do not save readings	Parameter enabled (check mark is visible): **No** measurement readings are saved in the application file. Statistical evaluation is **not** possible. Parameter disabled: (default setting) The measurement readings are saved automatically in the open application file with every measurement acquisition.

6.6 Tolerance limits and specification limit monitoring

Tolerance limits need to be specified for the **Histogram display**, **Specification limits display** and **Material check** information areas in order to display the measurement reading distribution graphically in a predefined conductivity range in the measurement presentation. With the aid of specification limit monitoring, you can quickly and easily recognize whether the measurement reading is within the specified tolerance limits during the measurement.

Open menu

► Tap on **File > Properties... > Specification limits**

Make settings

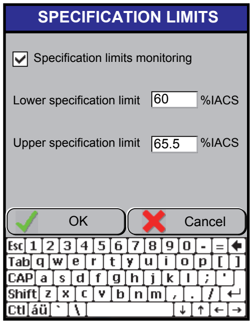
1. Enable/disable the **Specification limits monitoring** parameter: Tap on the parameter. A check mark indicates that the parameter is enabled.

   A description of the parameters can be found in the "Description of parameters" section on page 38.

2. Enter the values for the tolerance limits: Tap twice on the entry field to mark it. Use the on-screen keyboard that appears to enter numbers.

   If the parameters **Reference value** and **Tolerance** are displayed, refer to the following section "Material testing - Parameter entry".

3. Save the settings: Tap on the **OK** command button.



Example: The parameter ***Specification limits monotoring*** *is enabled and the tolerance limits are entered.*

4. Switch back to the measurement presentation: Tap on the **Close** command button.

i	**Notes** • Also select the tolerance limit presentation for the information area in the measurement presentation. Setting under **File > Properties... > Display**, see page 44. • The limit violation is signalled audibly only if the signal tone is enabled; see page 100.

Material testing - Parameter entry

If the **Material check** information area is selected for the measurement presentation (application setting in the **File > Properties... > Display** menu; see page 44), a reference value and a tolerance range need to be entered in the *SPECIFICATION LIMITS* menu window instead of the tolerance limits.

2. Proceed in Step 2 as follows:

   a Enter the **Reference value**. Select from the following possibilities:

   - Measure on the material once; this is intended to serve as reference. The measurement reading appears automatically in the

Reference value entry field.

- Enter the value in the **Reference value** entry field manually by using the on-screen keyboard.

b Enter the value for the **Tolerance**: Tap twice on the entry field to mark it. Use the on-screen keyboard that appears to enter the value.

Continue with Step 3 in the previous section "Make settings".

Description of parameters

SPECIFICATION LIMITS menu page

Parameter	Description
Specification limits monitoring	Switches visual and audible signalling of limit violations on/off. Measurement readings that lie outside the tolerance limits entered appear on the display in red and are identified by an arrow. In addition, the tolerance limit violation is indicated by an audible signal during measurement acquisition (default setting). The number of limit violations is saved and can be displayed in the statistical evaluation.
Lower specification limit	Entry field for the lower tolerance limit.
Upper specification limit	Entry field for the upper tolerance limit.
Reference value (Appears only in conjunction with the **Material check** information area)	Entry field for the reference value that the material to be tested typically should have. Entry by means of measurement or manually by means of on-screen keyboard.

Parameter	Description
Tolerance (Appears only in conjunction with the **Material check** information area)	Entry field for the tolerance range. The measurement readings that lie within the tolerance range are considered to be typical values. You can, for instance, sort material with typical values into one quality class. The reference value always lies in the centre of the tolerance range. Example: An entry of 2 means a tolerance range of ± 1 %IACS around the reference value.

Note

For the **File > Properties... > Measurement** application setting with an active **i individual values** parameter (value > 1) and the parameter **s** enabled, you must also enter the tolerance limits for the standard deviation that results from the individual measurement readings; see page 41.

6.7 Saving measurement readings in blocks

It is often helpful to collect the measurement readings in blocks and then evaluate them. Enable automatic block formation to form a closed block automatically while measuring after a specified number of measurement readings. The key symbol on the display identifies the last measurement reading of a block.

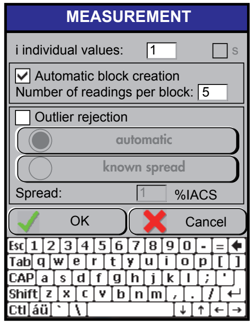
Examples of dividing measurement readings into blocks

- Collect all measurement readings for a specimen in a block. In this case, each measurement block then corresponds to one specimen.
- Collect all measurement readings for one side of a specimen in a block.
- Collect all measurement readings for a batch or lot in a block.

Open menu

▶ Tap on **File > Properties... > Measurement**

Make settings



*Example: The parameter **Automatic block creation** is enabled and the number of measurement readings per block is entered.*

1. Enable/disable the **Automatic block creation** parameter: Tap on the parameter. A check mark indicates that the parameter is enabled.

   A description of the parameters can be found in the following section.
2. Enter the number of measurement readings per block: Tap twice on the **Number of readings per block** entry field to mark it. Use the on-screen keyboard that appears to enter numbers.
3. Save the settings: Tap on the **OK** command button.
4. Switch back to the measurement presentation: Tap on the **Close** command button.

Note

You can enter a comment for each measurement block; see page 85.

Description of the parameters for automatic block formation

MEASUREMENT menu page

Parameter	Description
Automatic block creation	Collects a specified number of measurement readings to form a measurement block
Number of readings per block	Entry field for the number of measurement readings used to form a measurement block

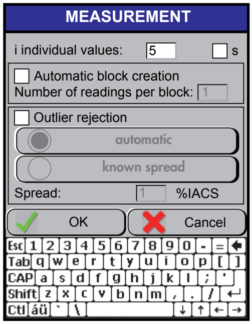
6.8 Form the representative measurement reading from several individual measurements

In the case of rough surfaces or inhomogeneous material, it is helpful to form a mean value from several measurements and then save it as a representative measurement reading in the application file. This method is especially well-suited for measurements on specimens where considerable variability of the measurement readings is to be expected.

Open menu

▶ Tap on **File > Properties... > Measurement**

Make settings



Example: The measurement reading displayed is formed from 5 individual measurements.

1. Enter the number of individual measurements used to form the representative measurement reading. Tap in the **i individual values** entry field twice to mark it. Use the on-screen keyboard that appears to enter numbers.

   Entry value: 1 ... 255

   A description of the parameters can be found in the following section.

   If you wish, also enable/disable the parameter **s**. Tap on the parameter. A check mark indicates that the parameter is enabled.
2. Save the settings: Tap on the **OK** command button.
3. Switch back to the measurement presentation: Tap on the **Close** command button.

Description of the parameters for forming the representative measurement reading

MEASUREMENT menu page

Parameter	Description
i individual values	Number of individual measurements used to form the representative measurement reading. The individual measurements are **not** saved in the application file.
s	The standard deviation for the representative measurement reading. The standard deviation results from the individual measurements and is saved in the application file.
i	**Notes** • Enabling the **Area measurement** parameter (**File > Properties... > Measurement acceptance**) automatically disables and resets the **i individual values** parameter; see page 33. • Formation of the representative measurement reading is **not** affected if outlier rejection is enabled. • With the parameter **s** enabled and specification limit monitoring active, tolerance limits also need to be entered for the standard deviation (**File > Properties... > Specification limits**).

6.9 Outlier rejection

The outlier rejection prevents incorrect evaluation as the result of erroneous measurement. Measurement readings that deviate considerably from the mean value are not considered in the statistical evaluation.

i	**Notes** • The outlier rejection is performed after each measured value. A corresponding display does not appear until after the 4th measurement reading at the earliest. • Automatic block formation is enabled: A minimum of 4 measurement readings per block is needed for the outlier rejection. • Since the number of measurement readings available, the mean value and the standard deviation change continually during the measurement, a measurement reading can also be recognized and identified as an outlier at a later point in time.

Open menu

▶ Tap on **File > Properties... > Measurement**

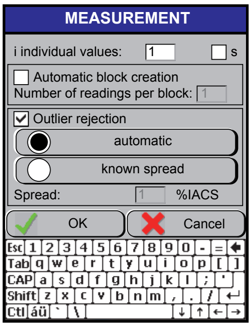
Make settings

1. Enable/disable the **Outlier rejection** parameter: Tap on the parameter. A check mark indicates that the parameter is enabled.

   Depending on whether the parameter is enabled, you may be required to make additional entries. Use the on-screen keyboard that appears to enter numbers.

   A description of the parameters can be found in the following section.

2. Save the settings: Tap on the **OK** command button.
3. Switch back to the measurement presentation: Tap on the **Close** command button.



Example: The outlier rejection based on the Grubbs test is enabled.

Description of the parameters for the outlier rejection

MEASUREMENT menu page

Parameter	Description
Outlier rejection	Monitors the measurement readings. Measurement readings that deviate significantly from the mean value are not considered when calculating the mean value, standard deviation etc.
automatic	The outlier rejection is based on the Grubbs test for a confidence level of P = 90 %.
known spread	The outlier rejection is performed for a confidence level of P = 90 % with a specified value for the variation in measurement readings.
i	**Note** Determine the value of the variation in measurement readings by measuring a representative random sample. The random sample should contain a minimum of 100 measurement readings! With this type of outlier rejection, it is assumed that the variation does not change for future measurements either.

6.10 Selecting the information panel to be displayed in the measurement presentation

You can display additional information in the information panel used for the measurement presentation. A description of the display areas can be found on page 7.

Information about the **Measurement panel** see page 48 and information about the **Display format** see Page 49.

The following information can be selected for display in the information area:

- **Statistical display**, list of selected statistical characteristics such as mean value and standard deviation of the measurement readings.
- **Histogram display**, presentation of the measurement readings in a histo-

gram for the specified tolerance range. Setting the tolerance limits; see page 36.

- **Specification limits display**, presentation of the measurement readings within the specified tolerance limits. Setting the tolerance limits; see page 36.
- **Material check**, graphical display of the measurement reading to determine whether it lies within the specified tolerance range or corresponds to the specified reference value. Sorting of materials on the basis of different electrical conductivities. Setting the tolerance range; see page 36.
- **Not displayed**, the information area is not displayed; the measurement reading appears alone in the centre of the display.

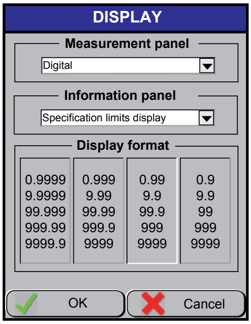
Open menu

▶ Tap on **File > Properties... > Display**

Make selection

1. Select the desired display in the **Information panel**. Tap in the selection window to open the selection list.

   A description of the parameters can be found in the following section.
2. Save the settings: Tap on the **OK** command button.
3. Switch back to the measurement presentation: Tap on the **Close** command button.

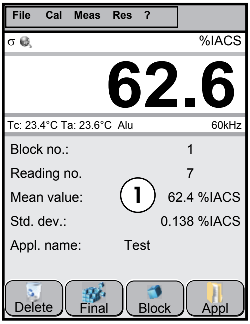
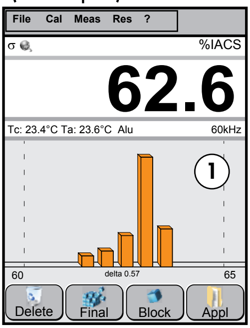


Example: Selection of the Specification limits display.

i	**Notes** • You must set tolerance limits for the **Histogram display** and **Specification limits display** information panel; see page 36. • You must enter a reference value with a tolerance range for the **Material check** information panel. You use the **Specification limits monitoring** parameter to enable or disable audible and visual signalling; see page 36.

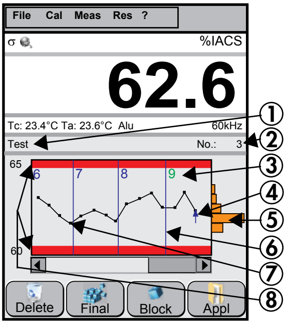
Description of the displays in the information panel for the measurement presentation

DISPLAY menu page, **Information panel**

<table>
<tr><th>Display</th><th>Description of the information panel</th></tr>
<tr><td>Statistic display (ex.)

</td><td>① List of statistical characteristics. Selection and description of the statistical characteristics to be shown on the display; see page 50.</td></tr>
<tr><td>Histogram display (example)

</td><td>① Histogram of measurement readings. The class widths (width of the rectangles) are always identical and are calculated automatically for the predefined tolerance range or from the span of measurement readings. A class width represents a conductivity range that varies with the tolerance range/span. The significance of the statistical results depends on the shape of the histogram, among other things. Deviation from a normal distribution may indicate systematic errors during measurement.</td></tr>
</table>

<table>
<tr><th>Display</th><th>Description of the information panel</th></tr>
<tr><td>

Specification limits display (example)



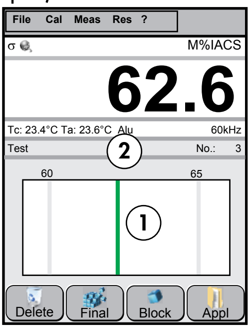
</td><td>

The measurement readings lie within the specified tolerance limits.

① Name of the open application file
② Number of the marked measurement reading in the block
③ Block number; green = block number of the marked measurement reading
④ Cursor, marks the displayed measurement reading.
⑤ Histogram, see histogram display
⑥ Closed block
⑦ Measurement reading
⑧ Range of specified tolerance limits

</td></tr>
<tr><td>

Material check (example)



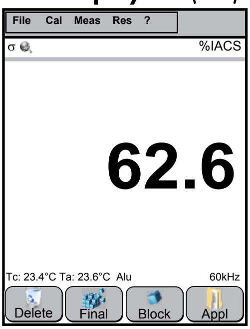
</td><td>

① Graphic display showing whether the measurement reading displayed lies within the specified tolerance range.
Green line: The measurement reading is in the typical range
Red line: The measurement reading is outside the typical conductivity range. The material must be sorted or belongs to a different material group.

② Left: Name of the open application file
Right: Number of the measurement reading in the current measurement block.

</td></tr>
<tr><td>

Not displayed (ex.)



</td><td>

Pure measurement presentation, without information panel. Display of the most recent measurement reading.

</td></tr>
</table>

6.11 Analogue bar display

An analogue bar display can be added to the measurement panel in the measurement presentation. Zoom in the analogue bar display only possible by using the command button **Analog+**. Placing the command button in the display see page 134 of the operator's manual.

Information about the **Information panel** see page 44 and information about the **Display format** see Page 49.

Open menu

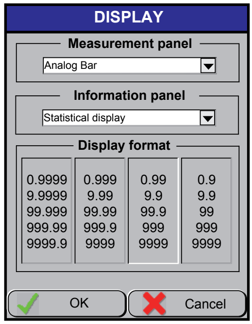
▶ Tap on **File > Properties... > Display**

Make selection

1. Select the desired display type in the **Measurement panel** area. Tap in the selection window to open the selection list.

   A description of the parameters can be found in the following section.

2. Save the settings: Tap on the **OK** command button.
3. Switch back to the measurement presentation: Tap on the **Close** command button.



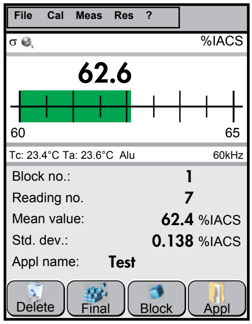
Example: The analogue bar display is selected.

Description of parameters

DISPLAY menu page, **Measurement panel**

Parameter	Description
Digital	Only the numerical value of the measurement reading appears in the measurement panel. The analogue bar display is disabled.

Parameter	Description
Analog Bar	The measurement reading appears as a numerical value and in an analogue bar display. Green bar: The measurement reading is in the tolerance range. Red bar: The measurement value is outside the tolerance range. *Example of a measurement presentation: Measurement value display with analogue bar display and statistics information area.*



6.12 Setting the display resolution for the measurement reading

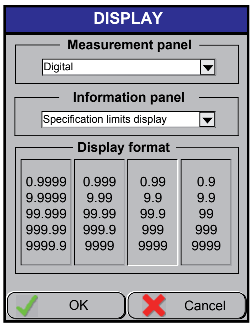
In this menu, you set how many decimal places will appear after the decimal point in the measurement reading display.

Open menu

▶ Tap on **File > Properties... > Display**

Make selection

1. Select the desired display resolution in the **Display format** area: Tap on the corresponding numeric column.
2. Save the settings: Tap on the **OK** command button.
3. Switch back to the measurement presentation: Tap on the **Close** command button.



Example: A maximum display resolution of 2 decimal places after the decimal point is selected.

6.13 Collecting the statistical characteristics

In the application file, you can collect the statistical characteristics for the measurement presentation **Statistic display** as well as for the **Block result** and **Final result** evaluations separately. The **Block result** and **Final result** templates are likewise used to print out the evaluations on a printer and save the evaluations in a pdf file (export file). You can thus save the template for a customer-specific inspection report directly in the application file.

Open menu

▶ Tap on **File > Properties... > Statistical display**

Or

▶ Tap on **File > Properties... > Block result**

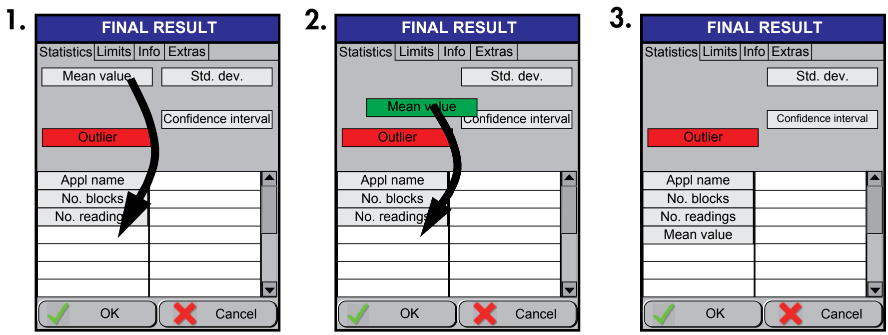
Or

▶ Tap on **File > Properties... > Final result**

Procedure for assembling the characteristics

You can display the statistical characteristics in one or two columns on the screen. The statistical characteristics available for selection are grouped thematically in tabs. A description of the statistical characteristics can be found starting at page 205.

1. Select the desired characteristic field in a tab.
   - Red field: Function is currently not active (e.g. outlier rejection disabled or no tolerance limits entered)
2. Pull the desired characteristic field into/out of a table field. For touchscreen operation, see page 20.
   - You can arrange the characteristic fields in the table in any way.
   - To remove a characteristic field from the table: Pull the desired characteristic field upward out of the table.
3. Repeat Steps 1 and 2 until all desired characteristic fields appear in the table.
4. Save the settings: Tap on the **OK** command button.
5. Switch back to the measurement presentation: Tap on the **Close** command button.



Example: The template for the final result should contain the mean value. To achieve this, simply move the ***mean value*** *characteristic field into the table.*

i	**Note on the templates for the block result and final result** The characteristic fields in the **Extras** tab appear only in the printout or the exported pdf file.

6.14 Automatic instrument adjustment

To make a measurement, the instrument needs a reference value. After being lifted off the specimen, the probe automatically captures a measurement reading in the air. This air value is the reference value that the instrument uses continually for adjustment. This prevents measurement errors, e.g. as the result of temperature drift.

In the case of automated measurements, it is possible that the probe may not have an opportunity to capture the air value continually while measuring. For this reason, you can disable air value monitoring for individual application files. In this case, you must capture an air value manually at regular intervals to avoid erroneous measurements!

ATTENTION	**Low measurement accuracy** Disabling air value monitoring compromises measurement accuracy! Disabling air value monitoring is helpful only during continuous measurement acquisition, providing that high measurement accuracy is not required. ▶ Measure the air value at regular intervals.

Open menu

▶ Tap on **File > Supervisor...* > Air value acceptance**

* Factory password: 159; for description, see page 126

Enabling and disabling air value monitoring

1. Tap on the **Show Air Value Warning** parameter.
   A check mark indicates that the parameter is enabled.
   No check mark indicates that the parameter is disabled.
2. Save the settings: Tap on the **OK** command button.
3. Switch back to the measurement presentation: Tap on the **Close** command button.

Other sections on this subject

- Measuring the air value manually; see page 138
- Performing a normalisation; see page 138
- Performing a corrective calibration; see page 139

6.15 Locking functions for the application file

You can lock the following functions for the open application file:

- Delete
- Calibrate
- Change the application settings

Before you start

- Application setting in the **File > Supervisor...* > Lock application(s)** menu: The **Single appl.** parameter is enabled; see also page 130.

  * Factory password: 159; for description, see page 126

Locking functions for the open application file

1. Tap on **File > Lock...**. The *LOCK APPLICATION(S)* menu window opens.
2. Enter the blocking password: Factory password 159
3. In the **locked functions** selection area, select the functions that you wish to block for the open application file. Tap on the desired functions. A check mark indicates that the function is blocked. A description of the parameters can be found further on in this section.
4. Save the settings: Tap on the **OK** command button.
5. Switch back to the measurement presentation: Tap on the **Close** command button.

i	**Note** For the blocked functions to remain functional in the open application file, open another application file and then once again the application file that was open when blocking was set up.

i	**Note** If necessary, you can execute the block function one time by entering the blocking password. The password prompt appears upon opening the blocked function. Factory-preset password: 159

Description of parameters

LOCK APPLICATION(S) menu page

Parameter	Description
locked functions	Applies to the open application file.
Delete reading	You cannot delete any measurement readings.

Parameter	Description
Delete application	You cannot delete the application file.
Normalization	You cannot perform a normalisation.
Calibration	You cannot perform a corrective calibration.
Properties	You cannot make any changes to the application settings.

6.16 Changing the probe frequency of the application file

Possible only for FS40, FS40LF and FS40HF probes!

ATTENTION	**All readings will be deleted** Changing of the probe frequency requires the deletion of all readings in the open application file!

By selecting the probe frequency, you determine how deep the induced eddy currents of the probe penetrate into the material. This means to which material depth the electrical conductivity is measured. As a general rule: The higher the probe frequency, the lower is the penetration depth of the eddy currents induced in the material.

Examples:

- Aluminium and probe frequency of 60 kHz
  The penetration depth (δ_0) of the induced eddy currents into the material: about 313 µm (12.32 mils).
  Minimum material thickness for measurements without thickness influence according to the rule of thumb $th_{min} \geq 3 \cdot \delta_0$: 940 µm (37 mils).
- Aluminium and probe frequency of 480 kHz
  The penetration depth (δ_0) of the induced eddy currents into the material: about 110 µm (4.33 mils).
  Minimum material thickness for measurements without thickness influence according to the rule of thumb $th_{min} \geq 3 \cdot \delta_0$: 330 µm (12.99 mils).

► **Always use the lowest possible probe frequency for the measurement!**
Higher probe frequencies can result in larger deviations in measurement readings.

i	**Note** • Information on determining the lowest probe frequency for a given material thickness can be found on page 162.

Open menu

▶ Tap on **File > Supervisor...* > Probe frequency**

* Factory password: 159; for description, see page 126

Changing the probe frequency

1. Select the desired probe frequency in the *PROBE FREQUENCY* menu window: Tap on the desired frequency. A check mark indicates the selected frequency.
2. Save the settings: Tap on the **OK** command button.

   A message window informs you that all readings of the open application file will be deleted.
3. Confirm the message: Tap on the **Yes** command button.
4. Switch back to the measurement presentation: Tap on the **Close** command button.

6.17 Select measured variable

The measurement value can displayed in different measured variables:

- Electrical conductivity value
- Normalised count rate
- Count rate

ATTENTION	**All readings will be deleted** Changing of the measured variable requires the deletion of all readings in the open application file!

Open menu

▶ Tap on **File > Supervisor...* > Unit**

* Factory password: 159; for description, see page 126

Changing the measured variable

1. Select the desired measured variable in the *UNIT* menu window: Tap on the desired button with the desired measured variable in the section *Display of reading (current Appl.)* of the menu window.
2. Save the settings: Tap on the **OK** command button.

   A message window informs you that all readings of the open application file will be deleted.
3. Confirm the message: Tap on the **Yes** command button.
4. Switch back to the measurement presentation: Tap on the **Close** command button.

Description of parameters

UNIT menu page, section ***Display of reading (current Appl.)***

Parameter	Description
σ	Display of the electrical conductivity measurement in the selected unit.
phin	Display of the normalized count rate. The measured count rates X of the probe are normalized to a reference range between 0 = 100 %IACS and 1 = 0 %IACS through appropriate computations. In general, displaying the normalized count rate is used to determine if the used calibration standards suitable for the current application.
X	Count rate = probe signal displayed as a number of electrical impulses. In general, displaying the count rate X is used to determine if there is a viable measurement signal for a particular measurement application.

7 Handling the probes

The measurement readings are always acquired with the aid of a probe or sensor.

Handling the probe when measuring the electrical conductivity

- Acquisition of measurement readings at a single spot: The measurement readings are acquired by repeatedly placing the probe on the specimen; see page 59 (default setting).
- Acquisition of measurement readings over an area: The probe slides over a certain area on the specimen's surface and in this way acquires the measurement reading; see page 61. In this case, the tip of the probe is subject to increased wear!

ATTENTION	**Influencing factors** The temperature and the geometric shape of the specimen have an effect on measurement of the electrical conductivity. • Information on these two influencing factors can be found starting at page 87 and in the "Glossary" section • Compensating for the influencing factors while measuring; see page 138 and in section "Adjustment of the measurement system - Corrective calibration", page 139 .

Handling the probe when measuring the temperature

- Measuring the specimen's temperature with the internal temperature probe of the FS40 probe; see page 59. In deviation from Step 3: Lightly press the probe against the specimen's surface for a few seconds until the displayed temperature value stabilizes. The temperature probe requires some time to sense the temperature of the specimen.
- Measuring the specimen's temperature with the TF100A temperature probe; see page 63.

7.1 Acquisition of measurement readings at a single spot – Basic procedure

Procedure (example: FS40 probe)

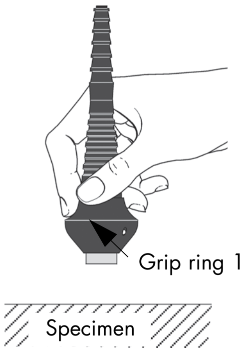
Flat specimens | **Convex specimens**

1. Always hold the probe by the grip ring as shown in the figure to the right.

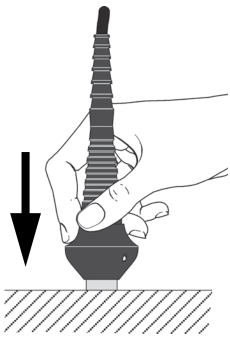
   Grip ring 1: Measuring on flat specimens

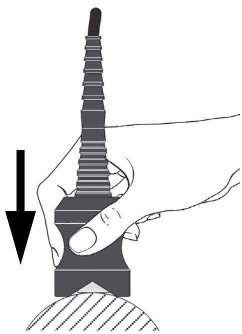
   Grip ring 2: Measuring on concave specimens.

   Changing the grip ring; see page 64.



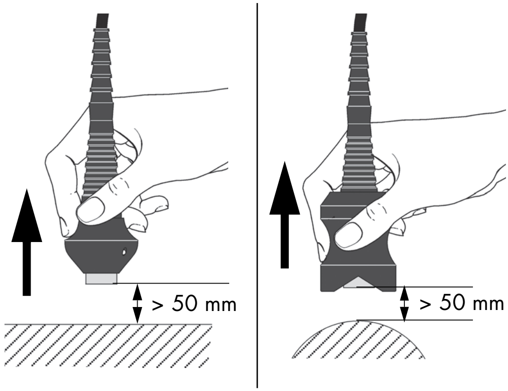
2. Place the probe on the specimen's surface without hesitating.
3. Lightly press the probe against the specimen's surface for a few seconds until a peeping tone signals that the measurement reading has been acquired and saved (default setting).





4. Lift the probe off the specimen to a distance of at least 50 mm (1.97 inches). This ends acquisition of the measurement reading.

5. Repeat Steps 2 to 4 to acquire additional measurement readings.



ATTENTION	**Probe connection cable** A kink or pinched point in the probe connection cable can result in a broken wire. Measurement is then not possible. ▶ Only bend the probe connection cable gently. Maintain a bending radius of at least 20 mm (0.79 inches). ▶ Provide adequate space; the probe cable must always be able to move freely.

ATTENTION	**Faulty measurement** Improper handling of the probe results in measurement errors. ▶ Always hold the probe at or above the grip ring. This prevents heat radiating from your hand from affecting the measurement. ▶ Place the probe on the specimen without hesitating. ▶ Always place the probe on the specimen vertically. ▶ Place the probe on the specimen gently.

What you can do next

- Change the grip ring on the conductivity probe; see page 64
- Perform measurements; see page 65

7.2 Acquisition of measurement readings over an area – Basic procedure

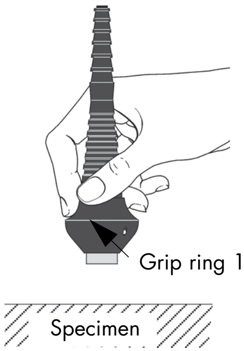
Procedure (example: FS40 probe)	**Flat specimens**	**Convex specimens**

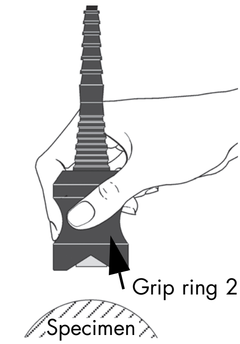
1. Always hold the probe by the grip ring as shown in the figure to the right.

   Grip ring 1: Measurements on flat specimens

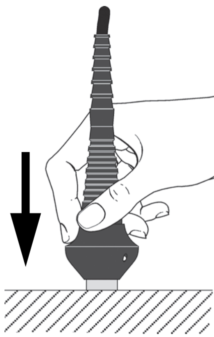
   Grip ring 2: Measurements on concave specimens.

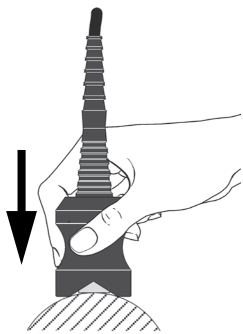
   Changing the grip ring; see page 64.



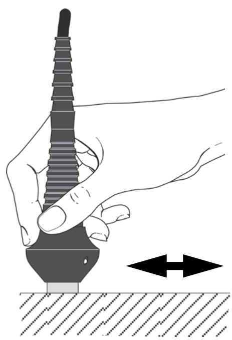


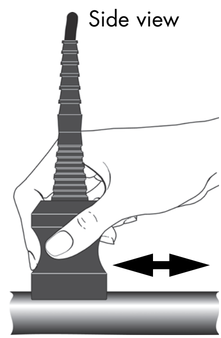
2. Place the probe on the specimen's surface without hesitating.





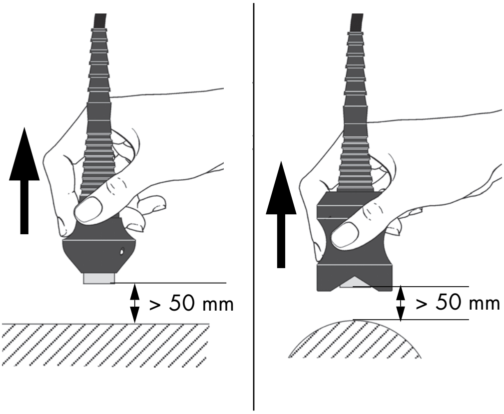
3. Move the probe across the surface.
4. Depending on the preset in the application file, the measurement readings are acquired automatically or manually and saved in the file; see page 35.





5. Lift the probe off the specimen to a distance of at least 50 mm (1.97 inches). This ends acquisition of the measurement reading.

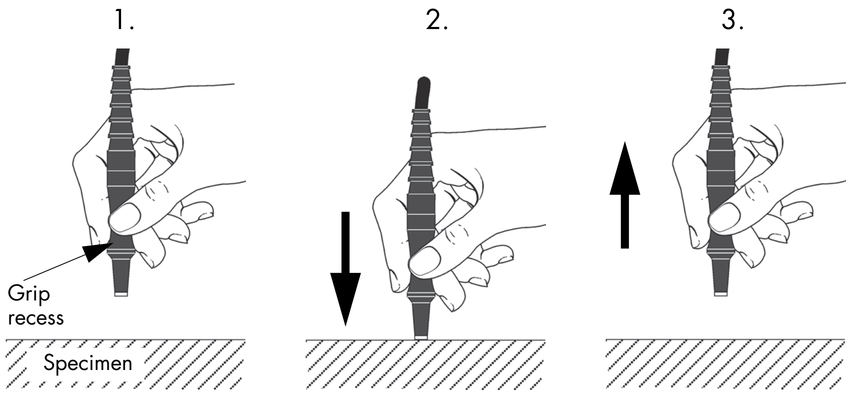
6. Repeat Steps 2 to 5 to acquire additional measurement readings.



ATTENTION	**Probe connection cable** A kink or pinched point in the probe connection cable can result in a broken wire. Measurement is then not possible. ► Only bend the probe connection cable gently. Maintain a bending radius of at least 20 mm (0.79 inches). ► Provide adequate space; the probe cable must always be able to move freely.

ATTENTION	**Faulty measurement** Improper handling of the probe results in measurement errors. ► Always hold probe by the grip ring. This prevents heat radiating from your hand from affecting the measurement. ► Place the probe on the specimen without hesitating. ► Always place the probe on the specimen vertically. ► Place the probe on the specimen gently. ► Scanning the surface with the probe subjects the tip of the probe to increased wear! A worn probe tip results of measurement errors. Replace the probe when the probe tip is worn.

7.3 Measuring the temperature – Basic procedure



1. Always hold the temperature probe at the grip recess as shown in the figure above.
2. Place the temperature probe vertically on the specimen's surface. Lightly press the temperature probe against the specimen's surface for about 10 to 20 seconds. The temperature probe requires some time to sense the temperature of the specimen.

   Depending on the preset in the application file, the measured temperature value is acquired automatically or manually and saved in the file; see page 27.
3. Lift the temperature probe off the specimen. This ends the temperature measurement.
4. Repeat Steps 2 to 4 for each specimen.

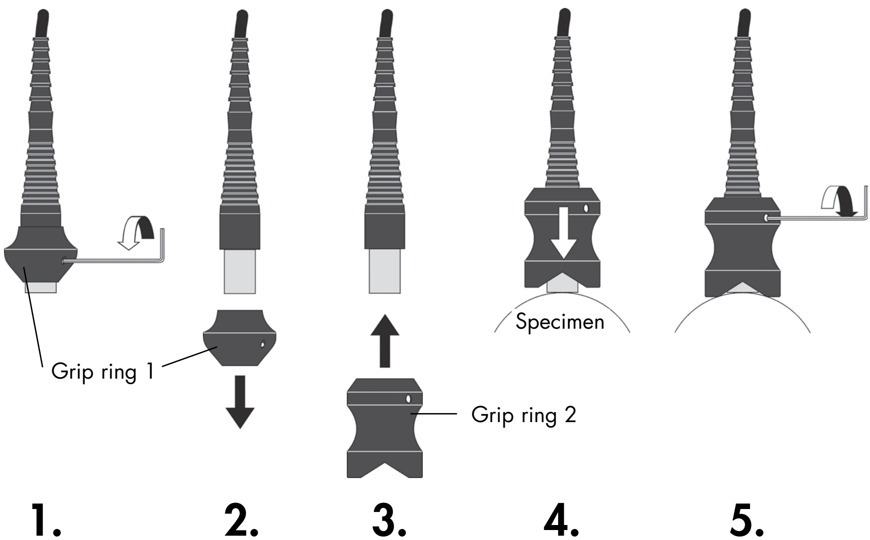
ATTENTION	**Probe connection cable** A kink or pinched point in the probe connection cable can result in a broken wire. Measurement is then not possible. ► Only bend the probe connection cable gently. Maintain a bending radius of at least 20 mm (0.79 inches). ► Provide adequate space; the probe cable must always be able to move freely.

ATTENTION	**Erroneous measurement** Improper handling of the temperature probe results in measurement errors. ► Always hold the temperature probe by the grip recess. This prevents heat radiating from your hand from affecting the measurement. ► Always hold the temperature probe on the specimen vertically.

7.4 Changing the grip ring on the conductivity probe type FS40

For measurements on convex parts, use grip ring 2. Grip ring 2 and an hex key are included in the scope of supply.

Procedure



8 Measurement

You always use a probe to obtain measurement readings. How the electrical conductivity is measured is pre-defined in the application file, e. g. with specification limit monitoring and temperature correction.

ATTENTION	**Influencing factors** The temperature and the geometric shape of the specimen have a significant effect on measurement of the electrical conductivity. • Information on the influencing factors can be found starting at page 87 and in the "Appendix".

i	**Note** Differences in the electrical conductivity can be used to draw conclusions about changes in the microstructure or to estimate how the material will behave. Such applications are based solely on specific empirical values. For this reason, generally application tables cannot be prepared.

8.1 Performing measurements

Before you start

- The probe is connected to the instrument.
- The instrument has been switched on for 2 to 3 minutes (warm-up time).
- The application file intended for use with the connected probe and current specimen is open. Additional notes on measuring with some application settings can be found in the following sections.
- Measuring on curved parts:
  Use grip ring 2 included in the scope of supply; see page 64. Check the entry for the curvature correction in the **File > Properties... > Correction**

menu. This function is not available for all probes. Alternative: Calibrate on a curved reference part.

- For transmission of the measurement readings to the PC during the measurement:
  The instrument is connected to the PC via the USB interface; for settings and how to proceed, see page 110.

Performing measurements

1. Place the probe softly on the specimen or scan the surface of the specimen with the probe (within an area or along the line). The procedure is described in the "Handling the probes" section, starting at page 58.

   Whether and how the measurement readings are stored in the application file depends on the application setting; see paragraphs below.
2. After acquiring the measurement reading, lift the probe off the specimen. As a standard feature, a signal tone confirms acquisition of the measurement reading.
   Repeat Steps 1 to 2 for additional measurements.

Notes

- If the anticipated trueness is not achieved, check the measuring accuracy of the opened application file; see page 144.
- If the anticipated trueness is **not** achieved, perform a corrective calibration; see page 139.
- We recommend that you check the accuracy of the instrument and probe at regular intervals through control measurements on the reference parts!

Further notes on measuring with some application settings can be found in the following sections.

Notes for measuring with the following application settings	Page
Measuring with and without temperature correction	68, 69
Entry of the temperature coefficient of the specimen material	30
Automatic or manual acquisition of the measurement reading	76, 77
Curvature correction enabled	75
Specification limit monitoring enabled	78
Saving measurement readings in blocks (groups) while measuring	79
Measuring despite considerable variation in measurement readings	79
Outlier check enabled	80
Measuring without saving measurement readings	81
Sorting	74

What you can do next

- Enter a comment about the measurement block or for the application file; see page 85
- Retrieve information about the measurement reading; see page 82
- Check the distribution of the specimen's electrical conductivity; see page 83
- Perform a corrective calibration if the anticipated trueness was not achieved; see page 139
- Check the current calibration level and/or the accuracy of the measurement system; see page 144
- Retrieve an evaluation; see page 102
- Print evaluation/measurement readings; see page 117
- Transfer measurement readings to the PC; see page 110
- Open a different application file; see page 91
- Create a new application file (measuring application); see page 22
- Change the application settings; see page 25

8.1.1 Notes for measuring without temperature correction

The trueness of electrical conductivity measurement readings made without temperature correction is lower than stated in the probe data sheet. For instance, a temperature increase of +1 °C reduces the electrical conductivity by about 0.4 % in the case of copper.

Example:

For a Cu specimen with 58 MS/m (100 %IACS) at a temperature of +20 °C (+68 °F), a temperature increase of 1 °C (1.8 °F) reduces the electrical conductivity by 0.23 MS/m (0.397 %IACS). With a typical measurement reading reproducibility of 0.2 % of the measurement reading, temperature differences in the specimen of 0.5 °C (0.9 °F) can be noticed when measuring.

ATTENTION	**Exact measurements possible only at a part temperature of +20 °C (+68 °F)** When measuring the electrical conductivity without temperature compensation, the specimen must have the same temperature as the calibration standard at the time the calibration was performed (±1 °C (±1.8 °F) according to the guidelines of BOEING AIRCRAFT). The data on the calibration standards usually applies to a material temperature of +20 °C (+68 °F). This means that for exact measurements, the part temperatures during the calibration and when measuring must be +20 °C (+68 °F).

Application setting

- **File > Properties... > Temperature correction** menu: **No correction**

Procedure

► Measure the specimen's electrical conductivity as described on page 65.

8.1.2 Notes for measuring with temperature correction

You achieve the trueness stated in the probe's data sheet only with temperature correction. For instance, a temperature increase of +1 °C (+1.8 °F) reduces the electrical conductivity by about 0.4 % in the case of copper. For Cu with an electrical conductivity of 58 MS/m (100 %IACS), this corresponds to about 0.23 MS/m (0.397 %IACS).

If temperature correction is enabled, the instrument always displays the electrical conductivity value referenced to +20 °C (+68 °F). Using the quantities "Sensor temperature" (Tc) and "Temperature coefficient of the specimen material", the instrument converts the actually measured value to the reference temperature of +20 °C (+68 °F).

Select your variant for temperature measurement

- Variant 1: You use a separate temperature measuring instrument to measure the temperature and enter the specimen temperature into the SIGMASCOPE instrument by means of the on-screen keyboard. - See page 69
- Variant 2: You use the integrated temperature sensor of the FS40, FS40LF or FS40HF probe connected to the SIGMASCOPE instrument to measure the temperature and transfer the displayed temperature value to the SIGMASCOPE instrument manually. - See page 71
- Variant 3: You use the TF100A temperature probe connected to the SIGMASCOPE instrument to measure the temperature continuously. The displayed temperature value is transferred automatically to the SIGMASCOPE instrument continuously. - See page 72

i	**Note** • For variants 1 and 2, we recommend that you display the **Temp.** command button in the measurement presentation. This gives you direct access to the *TEMPERATURE* menu page for entering the temperature. - Procedure, see page 134.

Notes for measuring with temp. correction and manual temperature entry

With this variant for temperature-compensated measurement of the electrical conductivity, you measure the specimen's temperature with a temperature measuring instrument and enter the measured temperature value manually into the SIGMASCOPE instrument.

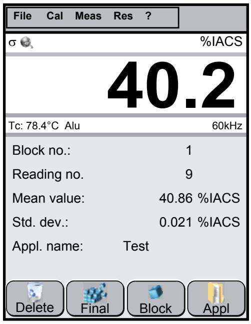
You must keep this in mind in addition to the "Performing measurements" section, page 65:

- A temperature measuring instrument with surface probe is available.
- The conductivity probe is connected to the instrument.
- Application settings
  File > Properties... > Temperature correction menu: **Manual input**.

  Cal > Temperature coefficient... menu: The temperature coefficient of the specimen material is entered/selected.

Procedure for measuring with temp. correction and manual temperature entry

1. Use your temperature measuring instrument to measure the temperature of the specimen.
2. Enter the measured temperature value in the SIGMASCOPE instrument:
   a Tap on **Cal > Temperature...** (alternative: **Temp.** command button). The *TEMPERATURE* dialogue window opens.
   b Enter the measured temperature value in the **Current temperature** entry field. (Corresponds to Tc in the measurement presentation).
   c Tap on the **OK** command button. The dialogue window closes.
3. Measure the specimen's electrical conductivity as described on page 65.



Example: Measurement presentation for temperature-corrected measurements with manual temperature entry.

*Tc: Temperature at which the temperature correction is performed = **Current temperature** in the dialogue window*

i	**Note** While measuring, regularly check the specimen's temperature as described in Step 1 and 2.

Notes for measuring with temperature correction and manual transfer of the measured temperature

With this variant of temperature-corrected measurement of the electrical conductivity, the specimen's temperature is sensed with a temperature probe connected to the instrument. The instrument does not use the measured temperature for temperature correction until manually actuated. This prevents, for instance, that the temperature of the air is used for temperature correction, because the temperature probe happens to be lying on the table.

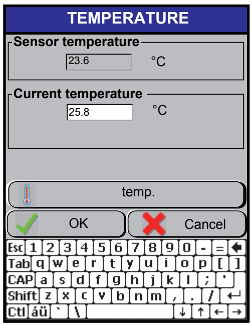
When the temperature monitoring function is enabled, temperature fluctuations outside of specifications are signaled.

You must keep this in mind in addition to the "Performing measurements" section, page 65:

- One of the FS40 conductivity probe types with built-in temperature probe is connected to the instrument.

  Tip: We recommend to measure the temperature by using the temperature probe TF100A, if the temperature difference between specimen material and ambient air is ≥ 5 °C (≥ 9 °F). The TF100A captures the material temperature in a shorter time as the temperature sensor of the FS40 probe.
- Application settings
  File > Properties... > Temperature correction menu: **Internal sensor**, alternative: **External Sensor** (= temperature measured by the TF100A temperature probe), and additional desired parameter settings.

  Cal > Temperature coefficient... menu: The temperature coefficient of the specimen material is entered/selected.



Example: TEMPERATURE dialogue window

Procedure for measuring with temperature correction and manual transfer of the displayed temperature value

1. Measure the temperature of the specimen:
   a Tap on **Cal > Temperature...** (alternative: **Temp.** command button). The *TEMPERATURE* dialogue window opens.
   b Place the conductivity probe or the temperature probe on the specimen surface and wait

until the temperature under **Sensor temperature** is stable. This may take some time. See also page 58.

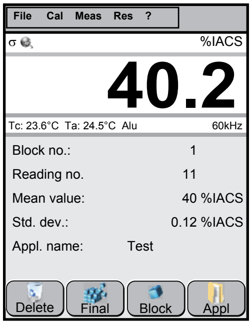
Sensor temperature	Temperature currently measured with the temperature probe. Corresponds to Ta in the measurement presentation
Current temperature	Temperature that the instrument uses for the temperature correction = Specimen temperature. Corresponds to Tc in the measurement presentation

c Tap on the **Temp.** command button. The temperature value is acquired from the temperature probe and displayed under **Current temperature**.

d Tap on the **OK** command button. The dialogue window closes.

e Lift the probe or temperature probe off the specimen.

2. Measure the specimen's electrical conductivity as described on page 65.
3. Repeat Steps 1 and 2 for each specimen.



Example: Measurement presentation for temperature-corrected measurements with manual transfer of the measured temperature.

> **Note**
> While measuring, regularly check the specimen's temperature as described in Step 1.

Notes for measuring with temperature correction and automatic acquisition of the continuously measured temperature values

With this version of temperature-compensated measurement of the electrical conductivity, the specimen's temperature is measured continuously and used for the temperature correction. This requires a temperature probe to measure the specimen's temperature continuously.

When the temperature monitoring function is enabled, temperature fluctuations outside of specifications are signaled along with the time of the temperature measurement.

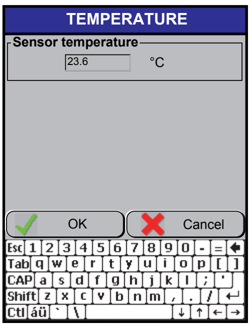
You must keep this in mind in addition to the "Performing measurements" section, page 65:

- The TF100A temperature probe is connected to the instrument.
- The conductivity probe is connected to the instrument.
- Application settings
  File > Properties... > Temperature correction menu: **External sensor** is selected and **Auto correction** is enabled.

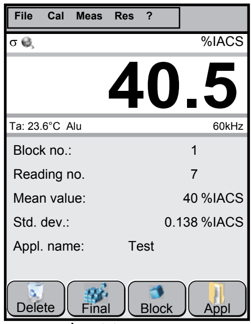
  Cal > Temperature... menu: The temperature coefficient of the specimen material is entered/selected.

Procedure for measuring the temperature correction and automatic acquisition of the measured temperature

1. Place the temperature probe on the specimen. The temperature probe must be in contact with the specimen continuously during the entire measurement. Use a support stand as necessary.
2. Check the specimen's temperature: Tap on **Cal > Temperature...** (alternative: **Temp.)** command button.
   a Continue with Step 3 only after the displayed temperature value has stabilized.
   b Press the **OK** command button to leave the dialogue window.
3. Measure the specimen's electrical conductivity as described on page 65.
4. Repeat Steps 1 to 3 for each specimen.



Example: TEMPERATURE dialogue window



Example: Measurement presentation for temperature-corrected measurements with automatic acquisition of the measured temperature.

Ta: Temperature currently measured by the temperature probe. This is the temperature also used for the temperature correction.

8.1.3 Sorting and testing materials

By measuring the electrical conductivity, you can sort and test the quality of materials quickly and easily.

Examples

- Sorting and quality assurance of materials
- Checking of alloys, e.g. homogeneity, segregation processes in CuCr alloys
- Checking of components for heat damage, material fatigue and cracks
- Sorting of scrap

i	**Note** Differences in the electrical conductivity can be used to draw conclusions about changes in the microstructure or to estimate the materials behaviour, e. g. hardness and strength. Such applications are based solely on specific empirical values. For this reason, generally application tables cannot be prepared.

You must keep this in mind in addition to the "Performing measurements" section, page 65:

- Application settings:
  File > Properties... > Display menu: **Material check** is selected in the **Information panel**; see page 44.

  File > Properties... > Specification limits menu: The **Reference value** and the **Tolerance** range are entered; see also page 36.

Identification of the measurement reading in the information area

- Green line: The measurement reading is within the usual range of conductivity
- Red line: The measurement reading is outside the usual range of conductivity. For example, the component must be replaced for this reason, the material must be sorted or belongs to a different material group.

8.1.4 Notes on measuring with curvature correction

A curvature correction that compensates for the effect of the specimen's curvature on the measurement result is available for measurements with FS40 probe types.

You must keep this in mind in addition to the "Performing measurements" section, page 65:

- The FS40 probe (example) is connected to the instrument.
- The specimen's diameter of curvature is entered in the **File > Properties... > Correction** menu; see page 31.

Icon in the information bar of the display

: Curvature correction is enabled.

ATTENTION

Incorrect measurement readings

Different values for the specimen's diameter of curvature and the menu entry (**File > Properties... > Correction** menu) will result in incorrect measurement readings.

- ▶ Measure only on specimens whose diameter of curvature matches that in the **File > Properties... > Correction** menu.
- ▶ Before making the measurement, enter the diameter of curvature or circumference of the specimen in the **File > Properties... > Correction** menu.

Note

Adjust the device as described on page 139 in the following cases:

- The anticipated trueness is **not** achieved.
- The curvature correction of the instrument is not being used, for instance, because you are measuring on a smaller diameter of curvature or the curvature correction function in the instrument does not support the connected probe.

8.1.5 Notes on measuring with manual acquisition of the measurement reading (External start)

Manual acquisition of the measurement reading is helpful when the measurement location is difficult to reach, for instance, when measuring in pipes, holes or grooves. This lets you calmly place the probe in the exact position before you acquire the measurement reading manually with a keystroke.

Measurement options	Description
Acquisition of a single measurement reading	With the probe in position, acquire the measurement reading manually, e.g. with a keystroke.
Area measurement	Continuous acquisition of the measurement reading while scanning the surface with the probe (within an area or along a line). The resultant mean value is then acquired automatically as an individual measurement. Start the **area measurement** (acquisition of the measurement reading) manually, e.g. with a keystroke.
Automatic measurement	A measurement reading is acquired every x seconds. Start the **automatic measurement** (acquisition of the measurement reading) manually, e.g. with a keystroke.

You must keep this in mind in addition to the "Performing measurements" section, page 65:

- Application setting in the **File > Properties... > Measurement acceptance** menu: The **External start** parameter is enabled and, if desired, the **Area measurement** or **Automatic measurement** parameter as well; see also page 33.

Procedure - Measuring with manual acquisition of the measurement reading (External Start)

1. Place the probe on the specimen or scan the surface of the specimen with the probe (within an area or along the line). The procedure is described in the "Handling the probes" section, starting at page 58.
2. Use one of the following possibilities to start manual acquisition of the measurement reading:

- Tap on **Meas > Trigger external start**.
- Tap the **Ext** command button if it is visible in the display. To add the **Ext** command button; see page 134.
- Send the "ES" control command via the USB interface. For an overview of the control commands see page 211.

3. Lift the probe off the specimen, ending the measurement. Repeat Steps 1 to 3 for additional measurements.

8.1.6 Notes for measuring with automatic acquisition of the measurement reading (by placing)

Measurement options	Description
Acquisition of a single measurement reading	Every time the probe is placed on the specimen, the measurement reading is acquired automatically.
Area measurement	Continuous acquisition of the measurement reading while scanning the surface with the probe (within an area or along a line). The resultant mean value is then acquired automatically as an individual measurement. Start the **area measurement** (acquisition of the measurement reading) by placing the probe on the specimen.
Automatic measurement	A measurement reading is acquired every x seconds. Start the **automatic measurement** (acquisition of the measurement reading) by placing the probe on the specimen.

You must keep this in mind in addition to the "Performing measurements" section, page 65:

- Application setting in the **File > Properties... > measurement acceptance** menu: The **by placing** parameter is enabled and, if desired, the **Area measurement** or **Automatic measurement** parameter as well; see also page 33.

8.1.7 Notes on measuring with specification limit monitoring

To measure with specification limit monitoring, we recommend that the tolerance limits be displayed in the form of a measurement presentation. This allows you to see where the measurement reading lies in the display with the preset tolerance limits.

You must keep this in mind in addition to the "Performing measurements" section, page 65:

- Application settings:
  File > Properties... > Specification limits menu: The **Specification limits monitoring** parameter is enabled and tolerance limit values (reference value, tolerance) are entered; see also page 36.

  File > Properties... > Display menu: **Specification limits display** is selected in the **Information panel**; see page 44.

Icons in the information bar of the display

 : Specification limit monitoring is enabled.

Identification of a tolerance limit violation in the display

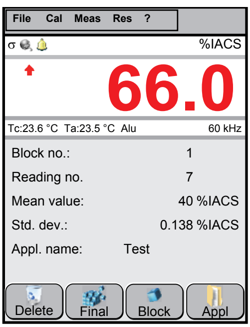
123 :The measurement reading is displayed in red

↑ :The measurement reading is above the upper tolerance limit

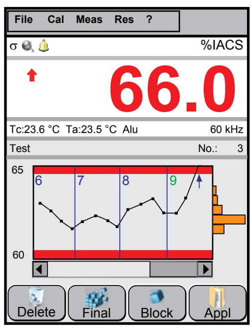
↓ :The measurement reading is below the lower tolerance limit

Red bar when analog bar graph display is enabled

Measurement presentations - Examples



Example: Measurement value display with statistics in the information area. The measurement reading is above the specified upper tolerance limit.



Example: Measurement value display with tolerance limits in the information area. The measurement reading is above the specified upper tolerance limit.

8.1.8 Notes on measuring with automatic formation of measurement blocks

It is often helpful to collect the measurement readings in measurement blocks and then evaluate them. Enable automatic block formation to form a block automatically while measuring after a specified number of measurement readings.

Examples of dividing measurement readings into blocks

- All measurement readings for a specimen are collected in a block. In this case, each measurement block corresponds to one specimen.
- All measurement readings for one side of a specimen are collected in a block.
- All measurement readings for a batch or lot are collected in a block.
- Matrix measurement: The measurement is made by rows and the measurement readings for a row form a block. With the aid of matrix evaluation, you can determine whether the distribution of the electrical conductivity lengthwise and crosswise exhibits significant differences; see also page 107.

You must keep this in mind in addition to the "Performing measurements" section, page 65:

- Application setting in the **File > Properties... > Measurement** menu: The **Automatic Block creation** parameter is enabled and the number of measurement readings per block is entered; see also page 39.

Icon in the information bar of the display

 : The key symbol appears at the last measurement reading in a block.

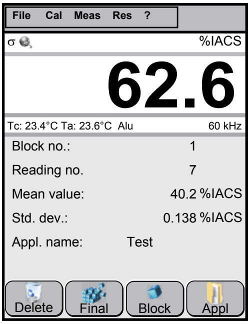
8.1.9 Notes on measuring despite considerable variation in measurement readings

In the case of rough surfaces or inhomogeneous material, it is helpful to form a mean value from several measurements and then save it as a representative measurement reading in the application file. This method is especially well-suited for measurements on specimens where considerable variability of the measurement readings is to be expected.

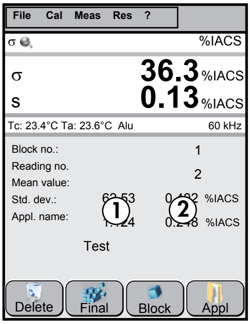
You must keep this in mind in addition to the "Performing measurements" section, page 65:

- Application setting in the **File > Properties... > Measurement** menu: The number of individual values is entered for the **i individual values** parameter; see also page 41.
- When measuring the representative measurement reading, an extra window appears with a list of the individual measurements taken. The individual measurements cannot be retrieved later.

Measurement presentations - Examples



*Example: Measurement value display only with activated parameter **i individual values***



*Example: Measurement value display only with activated parameter **i individual values** and **s***

Meanings:

σ Representative measurement reading

s Standard deviation of the representative measurement reading

① Mean value of the representative measurement readings (σ) with the associated standard deviation shown beneath

② Mean value of the standard deviations (s) of the representative measurement readings with the associated standard deviation shown beneath

8.1.10 Notes on measuring with outlier rejection

The outlier check prevents incorrect evaluation as the result of erroneous measurement. Measurement readings that deviate considerably from the mean value are not considered in the statistical evaluation.

You must keep this in mind in addition to the "Performing measurements" section, page 65:

- Application setting in the **File > Properties... > Measurement** menu: The **Outlier rejection** parameter is enabled; see also page 43.
- The outlier rejection is performed after each measured value. A corresponding display does not appear until after the 4th measurement read-

ing at the earliest.

- If automatic formation of measurement blocks is enabled, a minimum of 4 measurement readings per block is needed for the outlier rejection.
- Since the number of measurement readings available, the mean value and the standard deviation change continually during the measurement, a measurement reading can also be recognized and identified as an outlier at a later point in time.

Icon in the information bar of the display

 : Outlier rejection is enabled.

Identification of a measurement reading in the display as an outlier

123 :The measurement reading is displayed in red

 :Red exclamation mark before the measurement reading

8.1.11 Notes on measuring without saving the measurement readings

No measurement readings are saved in the application file while measuring. As a result, statistical evaluation is **not** possible.

You must keep this in mind in addition to the "Performing measurements" section, page 65:

- Application setting in the **File > Properties... > Measurement acceptance** menu: The **Do not save readings** parameter is enabled; see also page 35.

Icon in the information bar of the display

: Saving of measurement readings is disabled.

8.2 Retrieving information in the various measurement presentations

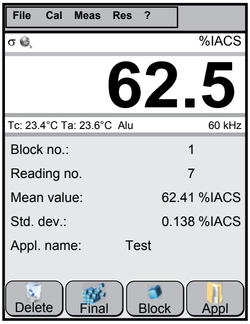
Depending on the information area selected, you can retrieve a variety of information:

Browsing through individual measurements

Statistical display information area

▶ Tap on the **Up** and **Down** command buttons. You can find out how to show the command buttons on the display on page 134.

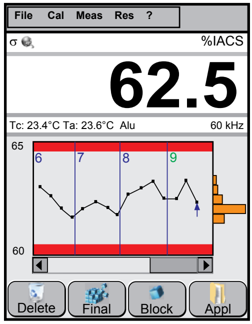
Example



Tolerance limits information area

▶ Tap on the individual dots in the curve displayed; the respective measurement reading appears above. The blue arrow shows the selected measurement reading.

Example

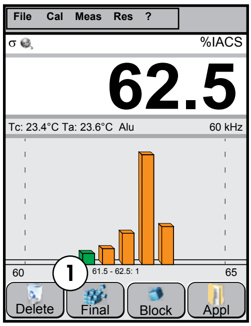


Histogram display information area - Retrieving information for a class

▶ Using the stylus, press on the bar (class) to display the class limits and number of measurement readings in this class (1). The selected bar changes colour when tapped.

The information for the selected bar (class) appears on the display as long as the stylus is pressed against the bar.

The most recent measurement reading appears in the measurement value display.



Example

8.3 Measure with continuous measurement value display

With this measuring variant, you scan the specimen's surface with the probe and can follow the distribution/fluctuation in electrical conductivity values on the display. You can switch continuous measurement value display on/off at any time.

Examples:

- Inspecting for cracks
- Checking for heat damage
- Determining material fatigue

Properties

- Continuous display of the measurement readings
- Continuous output of the measurement readings at the USB interface
- **No** saving of measurement readings

Switching continuous measurement value display on/off

► Tap on **Meas > Free running mode**.

activated: ✓ **Free running mode** and appear in the information bar on the display

deactivated: **Free running mode**

Before you start

- The probe is connected to the instrument.
- The instrument is switched on.
- The application file intended for use with the connected probe and current specimen is open.
- For measurements with curved parts:
  Use grip ring 2 included in the scope of supply, see page 64; Check the entry for curvature correction: **File > Properties... > Correction** menu. This function is not available for all probes. Alternative: Calibrate on a curved reference part.
- For transmission of the measurement readings to the PC:
  The instrument is connected to the PC via the USB interface; for settings and how to proceed, see page 113.

Measuring with continuous measurement value display (free-running display mode)

1. Tap on **Mess > Free running mode**.
2. Place the probe vertically on the specimen's surface.
3. Move the probe across the surface. The procedure is described in the "Handling the probes" section, starting at page 61.

   While scanning the surface, you can follow the continuous measurement value display on the screen. At the same time, the measurement readings are sent to the USB interface continuously.
4. Lift the probe off the specimen.
5. Tap on **Meas > Free running mode**.

The measurement is ended.

i	**Notes** • In conjunction with the **External start** parameter, you can manually save the currently displayed value in the instrument. Setting: **File > Properties... > Measurement acceptance**, see page 33. • When measuring with continuous measurement value display, switch on the analogue bar display. This allows you to identify measurement reading fluctuations quick-ly. In conjunction with the preset specification limits, you can tell from the bar colour whether the measurement readings are outside (red) or within (green) the specifi-cation limits. Application setting: **File > Properties... > Display**, see page 48.

What you can do next

- Open a different application file, seepage 91.
- Create a new application file (measuring application); see page 22.
- Change the application settings; seepage 25.
- To perform measurements without **Free running mode**, see page 65.

8.4 Entering a comment for a measurement block and the open application file

You can enter comments for each measurement block and the application file.

Examples of a comment for the application file

- Notes for the customer and about the specimen
- Notes about what to observe when measuring, cross reference to internal company rule

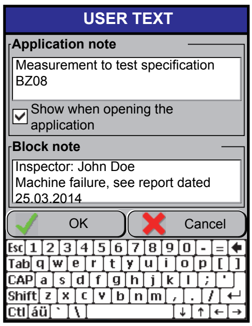
Examples of a comment about a measurement block

- Notes about the specimen or batch
- Entry of the inspector's name

Open menu

► Tap on **Meas > Note**

Enter comment



Example: Comment entry for application file and currently displayed block

1. Tap in the desired field.

   A description of the parameters can be found farther on in this section.
2. Enter your text. Use the on-screen keyboard that appears to enter the text.
3. Save the comment entered: Tap on the **OK** command button.

Symbol in the information bar of the display

: There is a comment about the currently displayed block.

Description of parameters

USER TEXT menu page

Parameter	Description
Application note	Field for entry of a comment text for the entire application file. Maximum of 2 lines with about 60 characters per line. The comment text for the application file can be viewed in the **Meas > Note** menu and edited if necessary. If so defined in the template, the comment text appears in the printout and in the pdf export file.
Display when opening the application	When opening the application file, the comment from the **Application note** field appears in an information window.
Block note	Field for entry of a comment about the current measurement block. Maximum of 3 lines with about 60 characters per line. The comment text for the measurement block can be viewed in the **Meas > Note** menu and edited if necessary. If so defined in the template, the comment text appears in the printout and in the pdf export file.

What you can do next

- Make application settings; for an overview, see page 25.
- Define the template for the block result and final result; see page 50 and page 133.
- Change the instrument settings; for an overview, see page 124.
- Make settings for data transmission; see page 110.
- Perform measurements; see page 65

9 Evaluating measurement readings - Information you need to know

The electrical conductivity is a good measurand for detecting even the slightest material differences - also at a depth of several millimetres. It is, however, important to know that the measurement can be distorted by external factors. In order to evaluate the trueness of the measurement readings, it is thus essential to know these influencing factors.

9.1 What is electrical conductivity

Metals conduct electric current to different degrees. This ability is called the electrical conductivity and is a physical quantity just like the current strength (measured in amps) or the voltage (measured in volts). The two units of measurement MS/m and %IACS are used for the electrical conductivity around the world. Both units of measurement are available in the instrument.

9.2 Metals with the same electrical conductivity

Metals with the same electrical conductivity exist. For example, by alloying copper, practically any electrical conductivity value can be produced. For this reason and under certain circumstances, measuring the electrical conductivity alone does NOT suffice to identify a material unambiguously. To establish the authenticity of fine gold, for instance, additional measurements such as the weight and dimensions are necessary.

Example

- Tungsten and gold:
  Nearly the same density but differing in the electrical conductivity
- Gold-plated steel coin:
  Can have the same electrical conductivity as a Krugerrand coin

9.3 Corrosion-inhibiting and protective coatings

The measuring method used has the advantage that it can measure the electrical conductivity of specimens without touching the surface directly. This means also that you can measure through a protective or corrosion-inhibiting coating or through a foil as long as this coating/foil is not electrically conductive! The size of the gap depends on the probe. Details can be found in the corresponding probe data sheet, "Distance compensation" section.

9.4 Relief/embossing

Measurements made directly on the embossing yield false measurement readings. The deeper the relief, the greater is the measurement error. If several measurements are taken on the embossing, the measurement readings can fluctuate.

Example

- Fine gold: Measurements taken on the embossing, the measurement readings can fluctuate by 2 to 3 MS/m (3.5 to 5.2 %IACS)

Tip

- Avoid measuring directly on the embossing.
- If measurements on the embossing are unavoidable, perform many measurements on the embossing in order to estimate the fluctuation in measurement readings. In this case, measuring with a continuous measurement value display as described on page 83 is recommended.

9.5 Distance of the probe to the specimen edge

There is no measurement error as long as the probe is completely supported by the surface of the specimen. The farther the probe protrudes past the edge of the specimen, the greater the measurement error is. Additional information can be found in the corresponding probe data sheet.

9.6 Material thickness

The FS40 probe types can measure at different probe frequencies. For testing thinner parts, the probe frequencies of 60 and 480 kHz are ideal. Which probe frequency is suitable for the measurement depends basically on the electrical conductivity of the alloy used to make the specimen.

The electrical conductivity values measured will be too high or too low if the probe senses a greater thickness than the actual thickness of the specimen. In this case, use of the measuring method employed is restricted, yielding false measurement readings. For this reason, it is very important to open the application file with the appropriate, preset probe frequency prior to the measurement. Rule of thumb: The higher the probe frequency, the shallower the depth of penetration into the material is. Additional information on the effect of material thickness can be found starting at page 162.

Examples

- For aluminium and a probe frequency of 60 kHz, a minimum material thickness of about 0.94 mm (37 mils) results.
- For aluminium and a probe frequency of 480 kHz, a minimum material thickness of about 0.33 mm (13 mils) results.

9.7 Temperature

The temperature of the specimen has a significant effect on measurement of the electrical conductivity. For every material, the effect of temperature can be expressed by the "temperature coefficient of electrical resistance" (α). For some materials, the temperature coefficients are already stored in the instrument. Selecting the temperature coefficient; see page 30.

You can ensure a high level of measurement accuracy by taking the current specimen temperature into account when measuring the electrical conductivity of the specimen.

Examples and notes

- Copper: A temperature increase of +1 °C (+1.8 °F) reduces the electrical conductivity of copper by about 0.4 %.

- We recommend using the temperature probe TF100A for temperature measurements with temperature differences ≥ 5 °C (≥ 9 °F), between the specimen material and the ambient air. Its faster reaction time compared to the temperature probe in the FS40 probe means that the TF100A can detect the current material temperature of the specimen in a shorter time. This allows you to achieve increased measurement accuracy in the same measurement time.

9.8 Specimen curvature

In addition to the temperature, the curvature of the surface at the measurement location affects measurement of the electrical conductivity. For measurements with FS40 probe types, use the built-in curvature correction; see page 31. Alternatively, by performing a corrective calibration on geometrically identical or similar reference parts, you can compensate for the influence of curvature. Another possibility is to use correction tables that you prepared yourself. Additional information on the effect of curvature can be found starting at page 164.

9.9 Measurement uncertainty of the measuring result

According to the ISO/IEC Guide 98-3, the measurement uncertainty of the measurement result is a combination of uncertainties resulting from various influencing variables.

Examples of possible influencing variables:

- Influences from the measurement system (instrument with connected probe)
- Stochastic influences affecting the measurement
- Influencing variables affecting the measurement (e.g. temperature, material properties, etc.)

You can determine the measurement uncertainty of the measurement system using the **Check calibration** function. Procedure see page 144.

If at all possible, you should always minimise the influencing variables affecting measurement through a corrective calibration. You can usually minimise the stochastic influences by increasing the repeat measurements.

10 What would you like to do?

For an overview of activities that affect one or several application files and thus the measurement, see page 91.

For an overview of device settings that affect all application files, see page 99.

All about application files

What would you like to do	Page
Acquire or save measurement readings automatically/manually Open menu: **File > Properties... > Measurement acceptance**	33
Air value capturing; Open menu: **Meas > Air value**	
Analogue bar display, show in display Open menu: **File > Properties... > Display** Zoom in: Tap on command button **Analog+**	48 134
Application file, save, copy, delete, rename, move Open menu: **File > Management > Applications... > Edit**	119
Application file, create new; Open menu: **File > New...**	22
Application file, check the calibration state of the open file	144
Application file, open Open menu: **File > Open > Application...** ▶ Tap on the desired file and then on the **Open** command button. Every time you open an application file, you must measure the air value!	119
Browse through the blocks ▶ Tap on **Res > Block result** and on the command button **Previous** or **Next**	
Browse through measurement readings ▶ Use arrow command buttons **Up** and **Down**	
Change probe frequency Open menu: **File > Supervisor...* > Probe frequency**	55

What would you like to do	Page
Check the calibration state of the opened application Open menu: **Cal > Ceck calibration**	144
Comment, enter for a application file; Open menu: **Meas > Note**	85
Compile statistical characteristics Only for the open application file, see page For all future application files, see page Open menu: **File > Properties... > Statistical display** Open menu: **File > Properties... > Block result** Open menu: **File > Properties... > Final result**	 50 133
Copy a file/folder Open menu: • **File > Management > Applications...**, command button **Edit** • **File > Management > Graphics...**, command button **Edit** • **File > Management > Exports...**, command button **Edit**	120
Corrective calibration, perform corrective calibration Open menu: **Cal > Corrective calibration...**	139
Create a template for file export **Create** a template for hardcopy printout	50 133
Create new application file; Open menu: **File > New...**	22
Curvature correction, enabling/disabling Open menu: **File > Properties > Correction**	31
Cut and paste an application file, see "**Rename** a file/folder"	
Default settings Open menu: **File > Supervisor...* > Default settings**	136
Delete all measurement readings in the open application file ► Tap on **Res > Delete all readings**	
Delete the displayed measurement reading ► Tap on **Res > Delete current reading**	

What would you like to do	Page
Delete the displayed measurement block ▶ Tap on **Res > Delete current block**	
Delete a file/folder Open menu: • **File > Management > Applications...**, command button **Edit** • **File > Management > Graphics...**, command button **Edit** • **File > Management > Exports...**, command button **Edit**	122
Device adjustment, perform automatically Open menu: **File > Supervisor...* > Air value acceptance**	51
Display, select display resolution Open menu: **File > Properties... > Display**	49
Display, select the information to be displayed Open menu: **File > Properties... > Display**	44
Display, show analogue bar display Open menu: **File > Properties... > Display**	48
Enable/disable air value warning Open menu: **File > Supervisor...* > Air value acceptance**	51
Enter a comment; Open menu: **Meas > Note**	85
Evaluation, open **FDD** (Factory Diagnosis Diagram) ▶ Tap on **Res > Final evaluation > FDD**	103
Evaluation, open **Final result** ▶ Tap on **Res > Final evaluation > Final result**	103
Evaluation, open **Histogram** ▶ Tap on **Res > Final evaluation > Histogram**	103
Evaluation, open **Matrix evaluation** ▶ Tap on **Res > Final evaluation > Matrix evaluation**	103

What would you like to do	Page
Evaluation, open **Probability chart** ▶ Tap on **Res > Final evaluation > Probability chart**	103
Export file, copy, delete, rename, move Open menu: **File > Management > Exports...**, command button **Edit**	119
Export the block result, see "**Save** the block result in a pdf file"	
Export, see "**Save** the evaluation cumulative frequency in a pdf file"	
Export, see "**Save** the evaluation factory diagnosis diagram (FDD) in a pdf file"	
Export, see "**Save** the evaluation histogram in a pdf file"	
Export the final result, see "**Save** the final result in a a pdf file"	
Folder, copy, rename, move, delete, see under "Copy...", "Rename...", "Move..." or "Delete..."	119
Folder, create folder for different file types • Application file, open menu: **File > Management > Applications...**, command button **Edit** • Export file, open menu: **File > Management > Exports...**, command button **Edit** • Graphic file, open menu: **File > Management > Graphics...**, command button **Edit**	123
Free-running display mode	83
Graphic file, copy, delete, rename, move Open menu: **File > Management > Graphics...**, command button **Edit**	119
Hide a measurement reading, only possible for the last measurement reading in a block. The hidden measurement reading is not taken into account for the statistical evaluation. In the measurement value display, 5 dots appear for the hidden measurement reading. ▶ Tap on **Res > Delete current reading** and the command button **Hide**	
Image, see "**Save** graphic in the instrument"	
Import a graphic, see "**Save** graphic in the instrument"	

What would you like to do	Page
Information panel, select the information to be displayed in the measurement presentation Open menu: **File > Properties... > Display**	44
Lock functions for the open application file Open menu: **File > Lock...**	130
Material test	74
Measure despite considerable variation in measurement readings	79
Measure reference value of air Open menu: **Cal > Normalization...** ▶ Hold the probe in the air and tap the **OK** command button. The distance to the next object must be at least 5 cm (1.97 inches)!	138
Measure, sorting and testing materials	74
Measure with automatic or manual acquisition of meas. reading	76
Measure with continuous measurement value display	83
Measure with curvature correction	75
Measure with formation of measurement blocks	79
Measure with outlier check	80
Measure with specification limit monitoring	78
Measure without saving the measurement reading	81
Measure without/with temperature correction	68
Measured variable, select the measured variable	56
Measurement panel, select the information to be displayed Open menu: **File > Properties... > Display**	44
Measurement reading, see "**Browse** through measurement readings"	
Measurement reading, delete measurement readings, see "Delete..."	
Measurement reading, save measurement readings, see "Save..."	

What would you like to do	Page
Measurement reading, select display resolution Open menu: **File > Properties... > Display**	49
Measurement reading • See "Hide a measurement reading..." • See "Show the hidden measurement reading"	
Measurement reading, form measurement reading from several individual measurements; For measurements with considerable variation in measurement readings Open menu: **File > Properties... > Measurement**	41
Move a file/folder Open menu: • **File > Management > Applications...**, command button **Edit** • **File > Management > Graphics...**, command button **Edit** • **File > Management > Exports...**, command button **Edit**	122
Normalisation; Open menu: **Cal > Normalization...**	138
Open an application file, see "**Application file,** open"	
Outlier check, enable/disable Open menu: **File > Properties... > Measurement**	43
Perform **corrective calibration** Open menu: **Cal > Corrective calibration...**	139
Print the block result ▶ Tap on **Res > Block result > Print**	117
Print the evaluation as a cumulative frequency ▶ Tap on **Res > Final evaluation > Probability chart > Print**	117
Print the evaluation as a histogram ▶ Tap on **Res > Final evaluation > Histogram > Print**	117
Print the evaluation in the factory diagnosis diagram (FDD) ▶ Tap on **Res > Final evaluation > FDD > Print**	117

What would you like to do	Page
Print the final result ▶ Tap on **Res > Final evaluation > Final result > Print**	117
Probe frequency, change the probe frequency of FS40 probe types Open menu: **File > Supervisor...* > Probe frequency**	55
Rename a file/folder Open menu: • **File > Management > Applications...**, command button **Edit** • **File > Management > Graphics...**, command button **Edit** • **File > Management > Exports...**, command button **Edit**	121
Save as, save application file under a new name and/or in a different directory; Open menu: **File > Save As...**	120
Save/do not save measurement readings Open menu: **File > Properties... > Measurement acceptance**	35
Save graphic in the instrument The procedure is described in the "Exchanging files with a PC" section. Only the jpg and bmp graphic formats are processed by the instrument.	112
Save measurement readings in blocks (groups) Open menu: **File > Properties... > Measurement**	39
Save or acquire measurement readings automatically/manually Open menu: **File > Properties... > Measurement acceptance**	33
Save, save changes in the application file ▶ Tap on **File > Save**	120
Save the block result in a pdf file ▶ Tap on **Res > Block result** and on the command button **Export**	108
Save the evaluation cumulative frequency in a pdf file ▶ Tap on **Res > Final evaluation > Probability chart** and on the command button **Export**	108

What would you like to do	Page
Save the evaluation factory diagnosis diagram (FDD) in a pdf file ▶ Tap on **Res > Final evaluation > FDD** and on button **Export**	108
Save the evaluation histogram in a pdf file ▶ Tap on **Res > Final evaluation > Histogram** and on the command button **Export**	108
Save the final result in a a pdf file ▶ Tap on **Res > Final evaluation > Final result** and on the command button **Export**	108
Secure, see "**Lock** functions for the open application file Open menu: **File > Lock...**"	
Show Analogue Bar Display; Open menu: **File > Properties... > Display**	48
Show the hidden measurement reading, only possible if the 5 dots for the hidden measurement reading appear in the measurement value display. ▶ Tap on **Res > Delete current reading**	
Specification limit monitoring, enable/disable limit monitoring Open menu: **File > Properties... > Specification limits**	36
Statistical characteristics, see "**Compile** statistical characteristics"	
Subdirectory, see "**Folder**, create folder for different file types"	
Temperature coefficient, enter/select for the specimen material Open menu: **Cal > Temperature coefficient...**	30
Temperature correction, enable/disable for the electrical conductivity measurement Open menu: **File > Properties... > Temperature correction**	27
Template for file export see "**Create** a template for file export" **Template** for hardcopy printout see "**Create** a template for hardcopy printout"	
Tolerance limits, see "Specification limit monitoring"	

* *Factory password: 159*

Instrument settings

What would you like to do	Page
Batteries, insert/change batteries	12
Calibrate, to calibrate the double-click speed for the USB mouse, see "**USB mouse**, calibrate the double-click speed"	
Calibrate, to calibrate the touchscreen, see "**Touchscreen**, calibrate touchscreen"	
Command buttons, place command buttons in the measurement presentation Open menu: **File > Supervisor...* > Keyboard**	134
c_p and c_{pk}, settings for calculating the factors, see also the "Glossary" section. Open menu: **File > Supervisor...* > Cp and Cpk**	
Data transmission, select the statistical characteristics to be transmitted to a PC Open menu: **File > Supervisor...* > COM-Export**	114
Data transmission, select the transmission format via USB Open menu: **File > Supervisor...* > Control Panel > USB connection**	111
Date and **time,** set the current date and time in the instrument Open menu: **File > Supervisor...* > Control Panel > Date/Time**	
Date, set the locale date format for the display Open menu: **File > Supervisor...* > Control Panel > Locale - Date**	
Default settings, perform an instrument reset Open menu: **File > Supervisor...* > Default settings**	136
Display illumination setting Open menu: **File > Supervisor...* > Control Panel > Power & Light**	129
Factory setting, perform an instrument reset Open menu: **File > Supervisor...* > Default settings**	136
Device shutoff, set automatic instrument shutoff Open menu: **File > Supervisor...* > Control Panel > Power & Light**	

What would you like to do	Page
Enable/Disable Message „The probe was not calibrated with this device!“	
Keyboard shortcuts, place command buttons in the meas. presentation Open menu: **File > Supervisor...* > Keyboard**	134
Language, select language for display text and keyboards Open menu: **File > Supervisor...* > Control Panel > Language**	127
Lock selected functions Open menu: **File > Supervisor...* > Lock application(s)**	130
Password, change password for the supervisor menu Open menu: **File > Supervisor...* > Password**	
Password, delete password for the supervisor menu Open menu: **File > Supervisor...* > Default settings**	136
Power source, select power source Open menu: **File > Supervisor...* > Control Panel > Power & Light**	129
Power-saving mode, setting Open menu: **File > Supervisor...* > Pwr. save mode**	129
Printer type setting, for the printer to be connected at the device Open menu: **File > Supervisor...* > Control Panel > Printer**	117
Save, set automatic saving of data Open menu: **File > Supervisor...* > automatic Save**	
Secure all applications in the instrument Open menu: **File > Supervisor...* > Lock application(s)**	130
Signal tones, enable/disable signal tones Open menu: **File > Supervisor...* > Control Panel > Acoustic signals** A red cross on the command button indicates that the signal tone is disabled.	

What would you like to do	Page
Standby mode, set change over time to standby mode Open menu: **File > Supervisor...* > Control Panel > Power & Light**	129
Supervisor mode, to exit Open menu: **File > Quit Supervisormode**	
Templates, create templ. for displaying the statistical characteristics For all future application files, see page Only for the open application file, see page Open menu: **File > Supervisor...* > Statistical display - Template** Open menu: **File > Supervisor...* > Block result - Template** Open menu: **File > Supervisor...* > Final result - Template**	 133 50
Time, set the current date and time in the instrument Open menu: **File > Supervisor...* > Control Panel > Date/Time**	
Time, set the locale time format for display Open menu: **File > Supervisor...* > Control Panel > Locale - Time**	
Touchscreen, calibrate touchscreen Open menu: **File > Supervisor...* > Control Panel > Calibrate touch**	
Unit of measurement, select unit of measurement Open menu: **File > Supervisor...* > Unit**	132
USB connection, select the transmission format Open menu: **File > Supervisor...* > Control Panel > USB connection**	111
USB keyboard, set the properties Open menu: **File > Supervisor...* > Control Panel > USB Keyboard**	
USB mouse, calibrate the double-click speed Open menu: **File > Supervisor...* > Control Panel > Mouse**	

* *Factory password: 159*

11 Evaluation

The instrument saves you the sometimes complicated and time-consuming mathematical calculations need for statistical evaluation of the measurement readings. The evaluation is updated continuously during measurement. You can retrieve the following evaluations:

- Block result, evaluation of a measurement block; see page 102
- Final evaluation, evaluation of a group of measurement blocks in different result presentations; see page 103

Before you start

- The instrument is switched on.
- The desired application file is open.

11.1 Block result

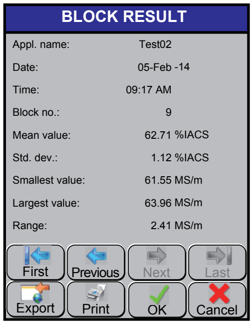
Evaluation of a measurement block. You receive a list of statistical characteristics as the result.

Open the block result

▶ Tap on **Res > Block result**

The *BLOCK RESULT* menu page opens.

- Selection of statistical characteristics; see page 44 and page 133.
- Description of the statistical characteristics; see page 200.
- Description of the command buttons; see page 219



Example of a block result

What would you like to do next:

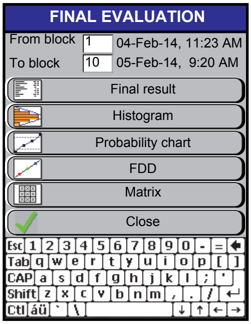
- Leave the block result and switch back to the measurement presentation: Tap on the command button **OK**.
- Save block result as pdf file (export): Tap on the **Export** command button; see page 108.
- Print out the block result on a printer: Tap on the **Print** command button; see page 117.

11.2 Final evaluation

Evaluation of a group of measurement blocks. The following result presentations are available:

- Final result, list of statistical characteristics
- Histogram, graphical representation of the measurement reading distribution
- Cumulative frequency, graphical representation of the measurement reading distribution
- FDD, graphical representation of the measurement reading distribution
- Matrix evaluation, variance analysis-based evaluation of the measurement readings

Open the final evaluation



Example of the FINAL EVALUATION menu page

1. Tap on **RES > Final evaluation**

   The *FINAL EVALUATION* menu page opens.
2. Define the block group you wish to evaluate.

   Tap in the entry field twice to mark it. Use the on-screen keyboard that appears to enter numbers.

   a **from block**: Enter the number of the first block in the desired block group.

   b **to block**: Enter the number of the last block in the desired block group.
3. Tap on the command button with the desired evaluation representation:
   - Final result; for additional information, see page 104
   - Histogram; for additional information, see page 104
   - Cumulative frequency; for additional information see page 105
   - FDD; for additional information see page 106
   - Matrix evaluation; for additional information, see page 107

What would you like to do next:

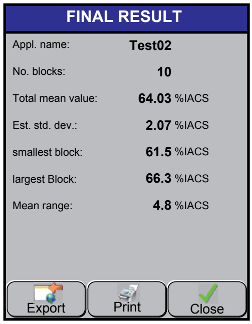
- Leave the evaluation representation and switch back to the measurement presentation: Tap on the command button **Close**

- Save evaluation representation as pdf file (export): Tap on the **Export** command button; see page 108.
- Print out the evaluation representation on a printer: Tap on the **Print** command button; see page 117.

11.2.1 Menu page *FINAL RESULT*

Description of the *FINAL RESULT* menu page

- Selection of statistical characteristics; see pages 133 and 50.
- Description of the statistical characteristics; see page 200 and the "Glossary" section.



Example of a final result

11.2.2 Menu page *HISTOGRAM*

You can easily see the distribution of the electrical conductivity in a batch (lot, production unit) from the histogram. Deviation from a normal distribution indicates systematic errors during measurement.

Prerequisites for evaluation as a histogram

- At least 30 measurement readings

Description of the *HISTOGRAMM* menu page

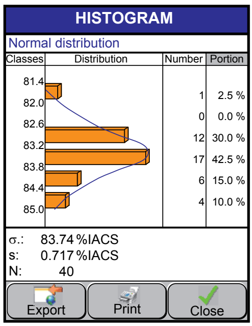
Classes: Uniform distribution of the measured electrical conductivity values in the selected block group.

Distribution: Representation of the number of measurement readings per class as a bar.

Number: Number of measurement readings per class

Portion (command button): Percentage of measurement readings per class

Total (command button): Sum total of the percentages.



Example of a histogram

Only one of the two command buttons is visible at a time

- Description of the statistical characteristics; see page 200 and the "Glossary" section.

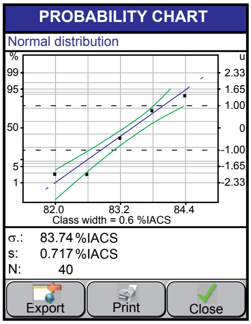
11.2.3 Menu page *PROBABILITY CHART*

You can easily read the number of measurement readings from the sum frequency chart, that are less than or equal to a particular electrical conductivity, for instance, the probable reject rate in a batch, lot or production series. Deviation from a normal distribution indicates systematic errors during measurement.

Prerequisites for evaluation as a cumulative frequency

- At least 5 measurement readings

Description of the *PROBABILITY CHART* menu page



Example of a cumulative frequency

%: Cumulative frequency in percent, corresponds to the **Total** data in the final evaluation **Histogam**.

u: Measurement uncertainty

Blue line: Regression line for normally distributed measurement readings

Green curves: Confidence interval (error cone) for a confidence level of 95 %

- $5 \leq n < 30$ measurement readings: The cumulative frequency of the individual measurements is displayed. Testing of whether the measurement readings are normally distributed is performed via the Kolmogoroff-Smirnoff test.
- $n \geq 30$ measurement readings: The cumulative frequency of the number of measurement readings in terms of the classes is displayed. In addition, the confidence interval (error cone) is displayed for a confidence level of 95 %. Testing of whether the measurement readings are normally distributed is performed via the chi-squared test.
- If the readings are normally distributed, the instrument automatically calculates a regression line.
- If the readings are not normally distributed, the instrument automatically calculates a regression line as well as the skewness and the kurtosis.

- Description of the statistical characteristics; see page 200 and the "Glossary" section

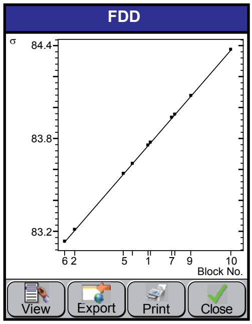
11.2.4 Menu page *FDD*

The FDD (factory diagnosis diagram) provides a quick overview of the variation and distribution of the electrical conductivity. Furthermore, individual comparisons of the measurement blocks are possible. Using the FDD, you can evaluate your production process or, for instance, depict differences between different deliveries in incoming inspection.

Prerequisites for an evaluation in the FDD

- At least 3 measurement blocks with the same fixed block size

Description of the *FDD* menu page



Example of an FDD in the Diagram view

▶ Tap on the **View** command button to select other representations. A check mark identifies the selected view.

Diagram view: Display of the block mean values in ascending order. Statistically related values (no systematic differences) have the same colour.

Diagram with error bar view: Display of the block mean values in ascending order with additional indication of the variation (scatter) within the respective measurement block.

Diagram of Mean Values view: Display of the block mean values in ascending order of block numbers.

Table view: Tabular list of block mean values in ascending order.
σ = Block mean value / s = Standard deviation within the block /
n = Number of measurement readings per block (= block size) / Block = Block number

- Description of the statistical characteristics; see page 200 and the "Glossary" section

11.2.5 Menu page *MATRIX EVALUATION*

The measurement blocks together with their measurement readings form a matrix that is evaluated lengthwise and crosswise. The variance analysis used for the matrix evaluation provides information as to whether there are differences in the lengthwise and crosswise directions.

Schematic representation of an evaluation of measurement readings

Evaluation in the lengthwise direction

Block 1	Block 2	Block 3
Reading 1	Reading 1	Reading 1
Reading 2	Reading 2	Reading 2
Reading 3	Reading 3	Reading 3
Reading 4	Reading 4	Reading 4

Evaluation in the crosswise direction

Block 1	Block 2	Block 3
Reading 1	Reading 1	Reading 1
Reading 2	Reading 2	Reading 2
Reading 3	Reading 3	Reading 3
Reading 4	Reading 4	Reading 4

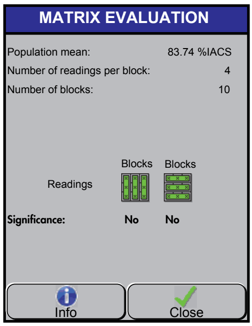
Prerequisites for a matrix evaluation

- At least 2 measurement blocks with the same fixed block size

Description of the *MATRIX EVALUATION* menu page

Info command button: Shows the variance analysis-based evaluation

- Description of the statistical characteristics; see "Glossary" section



Example of a matrix evaluation

12 Export

The block result and the various presentation forms for the final evaluation (final result, histogram, cumulative frequency and FDD) can be saved as a pdf file in the instrument.

Before you start

- The instrument is switched on.
- The desired application file is open.

Saving the block result as a pdf file (export file)

1. Open the block result: Tap on **Res > Block result**.
2. Select the desired block.
3. Save the export file: Tap on the **Export** command button.
4. Enter a name for the file. Use the on-screen keyboard that appears to enter it. To change the folder, tap the **Directory...** command button.
5. Tap on the **OK** command button; this returns you to the evaluation presentation.
   Depending on the template setting, it may be necessary to enter a user text, fixed text and application comment. You return to the evaluation presentation only after completing these.

   Depending on the template settings, graphics, images and text that do not appear on the display will be printed out; see pages 133 and 50.
6. Switch back to the measurement presentation: Tap on the **OK** command button.

Saving the final evaluation as a pdf file (export file)

1. The final evaluation menu: Tap on **Res > Final evaluation**.
2. Determine the desired block group and enter the individual block numbers.
3. Select the desired evaluation presentation: Tap on the appropriate command button.

   Information about the various evaluation presentations can be found on page 103.

4. Save the export file: Tap on the **Export** command button.
5. Enter a name for the file. Use the on-screen keyboard that appears to enter it. To change the folder, tap the **Directory...** command button.
6. Tap on the **OK** command button; this returns you to the evaluation presentation.
   Depending on the template setting, it may be necessary to enter a user text, fixed text and application comment. You return to the evaluation presentation only after completing these.

   Depending on the template settings, graphics, images and text that do not appear on the display will be printed out; see pages 133 and 50.
7. Switch back to the measurement presentation: Tap on the **Close** command button.

What you can do next

- Transfer an export file to a PC; see page 112
- Define a template for the export file; see page 50 and 133

13 Data transfer

The instrument and the PC communicate with one another via the USB port. Depending on the data that you wish to transfer between the PC and instrument, you must set the appropriate transmission format for the USB port in the instrument.

Active Sync (external drive) transmission format

With the aid of the ActiveSync Windows program (Windows 7 and higher: Windows Mobile Device Center) the PC recognizes the connected instrument as an external drive. Using Windows Explorer, you can then copy or move files from the PC to the instrument and vice versa; see page 112.

Install the following components to operate the instrument as an external drive on the PC:

- USB driver for the Active Sync mode
- ActiveSync synchronisation software (Windows 7 and higher: Windows Mobile Device Center)

The USB driver and the synchronisation software are contained on the support CD included in the scope of supply.

Virtual COM port transmission format (serial interface)

The USB port is operated as a serial interface. The following functions are possible:

- Transfer of measurement readings and the statistical characteristics from the instrument to the PC; see page 113.
- Remote control of the instrument by sending commands from the PC to the instrument; see page 116.
- Request measurement readings and other data (e.g. name of the current application file) from a PC; see instructions for Fischer DataCenter program in the Operator's Manual included in the scope of supply.

Install the following driver to operate the USB port as a serial interface:

- USB driver for the virt. COM port mode.

The USB driver is contained on the support CD included in the scope of supply.

13.1 Setting the transmission format for the USB port

Open menu

▶ Tap on **File > Supervisor... > Control Panel > USB connection**
* Factory password: 159; for description, see page 126

Select the operating mode

1. Tap on the desired command button. A black dot identifies the enabled transmission format. A description of the parameters can be found in the table of this section.
2. If you wish, switch off the status display: Tap on the parameter. A check mark indicates that the parameter is enabled.

Description of parameters

USB CONNECTION menu page

Parameter	Description
ActiveSync	On the PC, the instrument appears as an external drive. Files can be moved between, copied to/ from or deleted from the instrument and PC.
virt. COM port	You can transfer measurement readings and statistical characteristics to a PC. You can retrieve information from the instrument from the PC and control instrument functions.
Show state	Switch on/off the symbol in the information bar on the display to show the transmission format. This makes sense if you use only one transmission format for the USB port.

13.2 Exchanging files with a PC

When working with files, the instrument operates as an external drive connected to the PC.

Examples:

- Moving or copying PDF files from the instrument to the PC. You can open PDF files only on the PC.
- Copying graphics from the PC to the instrument, e.g. to incorporate the company logo into the template for the final evaluation.

Before you start

- The **ActiveSync** communication program is installed in the PC (Windows 7 and higher: Windows Mobile Device Center).

  Use the support CD included in the scope of supply for installation and follow the instructions for the installation program.
- The USB driver for the **ActiveSync** transmission format is installed in the PC.

  Use the support CD included in the scope of supply for installation and follow the instructions for the installation program.
- The instrument is connected to the PC via the USB port. Use the USB cable included in the scope of supply.
- The instrument is switched on.
- The **ActiveSync** transmission format is set in the instrument, under **File > Supervisor...* > Control Panel > USB connection**; see page 111.
  * Factory password: 159; for description, see page 126

Copying, moving or deleting files

► Use Windows Explorer on the PC to copy, move and delete files as usual.

- PC: After the instrument is connected to the PC, the **ActiveSync** synchronisation software opens automatically (Windows 7 and higher: Windows Mobile Device Center).
- PC: In Windows Explorer, the instrument appears as an additional drive with the name "**Windows CE**".
- The files in the instrument are saved in the following subdirectories:

  Fischer\Application: Standard directory for application files

Fischer\Export: Standard directory for export files. Files that were exported from the evaluation menus, e.g. as pdf file.

Fischer\Graphic: Standard directory for image files that you can incorporate into the templates for the block result and final result. The instrument supports the image formats jpg and bmp.

13.3 Transferring measurement readings and statistical characteristics to a PC

You can transfer the measurement readings and statistical characteristics to the PC while measuring or afterwards. The presets in the instrument determine which files can be transferred.

Before you start

- The USB driver for the **virt. COM port** transmission format is installed in the PC.

  Use the support CD included in the scope of supply for installation and follow the instructions for the installation program.
- The data import program is open in the PC, e.g. Fischer DataCenter (scope of supply) or MS Excel with the PC-Datex plug-in from FISCHER or other CAQ programs
- The instrument is connected to the PC via the USB port. Use the USB cable included in the scope of supply.
- The instrument is switched on.
- The **virt. COM port** transmission format is set in the instrument, under **File > Supervisor...* > Control Panel > USB connection**; see page 111.
  * Factory password: 159; for description, see page 126
- The data that you wish to transfer are selected in the instrument under **File > Supervisor...* > COM-Export**, see page 114.
  * Factory password: 159; for description, see page 126
- The desired application file is open.

ATTENTION	**Disruption of the data transfer** The data transfer will disrupted by switching off the instrument! ▶ Disable the automatic instrument shutoff for data transfer, see from page 129.

Sending data to the PC while measuring (online)

▶ Make a measurement on the specimen.

Depending on the settings in the *COM-EXPORT* menu window, the individual measurement readings and the block mean value are transferred to the PC continuously while measuring.

Sending data to the PC after measuring (offline)

▶ Send the files from the open application file to the PC: Tap on **Res > Export over COM port**.

Depending on the settings in the *COM-EXPORT* menu window, individual measurements and the block mean value, for instance, are transferred to the PC.

13.3.1 Selecting statistical characteristics for transferring to a PC

Open menu

▶ Tap on **File > Supervisor...* > COM-Export**

* Factory password: 159; for description, see page 126

Make selection

1. Enable/disable the desired parameter: Tap on the desired parameter. A check mark indicates that the parameter is enabled.

   Select the group separator character: Tap in the selection window to open the selection list and select the desired character.

   A description of the parameters can be found in the following section.

2. Save the settings: Tap on the **OK** command button.
3. Return to the measurement representation: Tap on each **Close** command button.

Description of the characteristics

COM-EXPORT menu page

Characteristic	Description
Individual values	All saved measurement readings in the open application file are transferred.
Group separator	A separator character is transmitted for each closed block.
Block mean value	The mean values are transmitted for all blocks.
Block standard deviation	The standard deviations for each block mean value are transmitted
Block date/time	The date and time of the closed block are transferred for each block.
Mean value of i individual values	All representative measurement readings in the open application file are transferred. **These values are transferred only while measuring (online)!** When transferring data after measuring (offline), this characteristic is ignored! The representative measurement readings are then treated as individual values.
i	In conjunction with the **Individual values** parameter, the individual measurements that are used to calculate the representative measurement reading are also transferred during an online measurement. See also page 41.
Finished Blockresult	The statistical characteristics and texts for the selected block result are transferred.

13.4 Controlling the instrument from a PC

Before you start

- The USB driver for the virt. COM port transmission format is installed on the PC.

  Use the support CD included in the scope of supply for installation and follow the instructions for the installation program.
- The terminal emulation software for controlling the instrument is open on the PC, e.g. HyperTerminal from Microsoft.
- The instrument is connected to the PC via the USB port. Use the USB cable included in the scope of supply.
- The instrument is switched on.

  The **virt. COM port** transmission format is set in the instrument, under **File > Supervisor...* > Control Panel > USB connection**; see page 111.
  * Factory password: 159; for description, see page 126

ATTENTION	Disruption of the data transfer
	The data transfer will disrupted by switching off the instrument! ▶ Disable the automatic instrument shutoff for data transfer, see from page 129.

Controlling the instrument from the PC

▶ Send the desired control command to the instrument. The instrument sends the desired data and information back to the PC.

The necessary transmission formats and a list of control commands can be found starting at page 211.

14 Printing

The block result and the various presentation forms for the final evaluation (final result, histogram, cumulative frequency and FDD) can be printed out directly from the instrument with the aid of a printer.

Before you start

- The instrument is switched on.
- The printer is connected to the instrument via the USB port.
- The type of printer connected is set in the instrument; see page 118.
- The desired application file is open.

Printing the block result

1. Open the block result: Tap on **Res > Block result**.
2. Using the arrow command buttons, select the desired block.
3. Start the printout: Tap on the **Print** command button.

   Depending on the template settings, graphics, images and text that do not appear on the display will be printed out; see pages 133 or 50.
4. Switch back to the measurement presentation: Tap on the **OK** command button.

Printing the final evaluation

1. The final evaluation menu: Tap on **Res > Final evaluation**.
2. Determine the desired block group and enter the individual block numbers.
3. Select the desired evaluation presentation: Tap on the appropriate command button.

   Information about the various evaluation presentations can be found on page 103.
4. Start the printout: Tap on the **Print** command button.

   Depending on the template settings, graphics, images and text that do not appear on the display will be printed out; see pages 133 and 50.

5. Switch back to the measurement presentation: Tap on the **Close** command button.

What you can do next

- To define the template for the paper printout, see page 50 and 133

14.1 Settings for the connected printer

Open menu

▶ Tap on **File > Supervisor...* > Control Panel > Printer**.

* Factory password: 159; for description, see page 126

Settings in the menu window *PRINTER*

1. Select the printer type. Tap in the selection window to open the printer selection list.

   Please contact or your local FISCHER representative if you do not find your printer type in the instrument's printer list.
2. If you wish, change the standard settings for the paper size, margins and print quality.
3. Save the settings: Tap on the **OK** command button.
4. Switch back to the measurement presentation: Tap on the **Close** command button.

What you can do next

- Print the block result or final evaluation; see page 117
- Perform measurements; see page 65

15 Managing files and folders

File management in the instrument functions the same way as file management in a PC.

You can save the following files in separate folders in the instrument:

- Application file, contains measurement settings and measurement readings, saved in folder: Fischer\Application
- X port file (pdf), contains one block result or one of the final evaluations, saved in folder: Fischer\Export
- Graphic file (jpg, bmp) from a PC that was saved in the instrument, saved in folder: Fischer\Graphic

What would you like to do?

- Open an application file; see page 119
- Save an application file; see page 120
- Save an application file under a new name and/or in a different folder; see page 120
- Copy a file/folder; see page 120
- Rename a file/folder; see page 121
- Move a file/folder; see page 122
- Delete a file/folder; see page 122
- Create a new folder; see page 123

15.1 Opening an application file

Open an application file

1. Tap on **File > Open > Application**

   Alternative: Tap on command button **Appl**
2. Select the desired application file from the list: Tap on the file name. A dark blue bar marks the selected file.
3. Tap on the **Open** command button to open the selected file. The application file that has been open until then is automatically saved and closed.

The opened application file appears with the measurement presentation set for this file.

15.2 Saving an application file

You should save the open application file regularly to back up all setting changes and the measurement readings in the instrument. If automatic saving of data is disabled, you must initiate saving manually at regular intervals.

The following options for saving are available:

- Save the application file under the same name and in the same directory; see Procedure – Save
- Save the application file under a new name and/or in a different directory; see Procedure – Save As

Procedure – Save

▶ Tap on **File > Save**.

All data and settings for the open application file are saved in the file.

Procedure – Save As

1. Tap on **File > Save As...** .
2. If you wish, enter a new file name and/or select the desired directory with the aid of the **Directory** command button.
3. Tap on the **OK** command button to complete the saving process. The measurement presentation for the application file just saved re-appears.

15.3 Copying a file or folder

If similar measuring applications are pending, it helps to copy an application filed whose application settings are appropriate to a great extent. In this way, you will not need to make many, or possibly any, application settings. You can copy folders in the same way.

Copying a file/folder

1. In which domain do you wish to copy the file or folder:
   - Application: Tap on **File > Management > Applications...**
   - Export: Tap on **File > Management > Exports...**

- Graphic: Tap on **File > Management > Graphics...**

2. Tap on the desired file name/folder name. A dark blue bar identifies the selection. To change the folder, select the desired folder and tap the **Open** command button.
3. Tap on the **Edit > Copy** command button.
4. Paste the file/folder: Tap on the **Edit > Paste** command button. To change the folder, select the desired folder and tap the **Open** command button. If the copy is saved in the same folder, the name of the copy starts with "Copy of".
5. Rename the file copy as described in Step 3. in section "Renaming a file or folder" on page 121.
6. Tap on the **OK** command button to return to the measurement presentation.

15.4 Renaming a file or folder

Renaming a file/folder

1. In which domain do you wish to rename the file or folder:
   - Application: Tap on **File > Management > Applications...**
   - Export: Tap on **File > Management > Exports...**
   - Graphic: Tap on **File > Management > Graphics...**
2. Tap on the desired file name/folder name. A dark blue bar identifies the selection. To change the folder, select the desired folder and tap the **Open** command button.
3. Tap on the **Edit. > Rename** command button.
4. Enter a new name for the file/folder. Use the on-screen keyboard for this.
5. Tap on the **OK** command button.
6. Tap on the **OK** command button to return to the measurement presentation.

15.5 Moving a file or folder

Before you start

- One or more folders are created in the instrument; see page 123

Moving a file/folder

1. In which domain do you wish to move the file or folder:
   - Application: Tap on **File > Management > Applications...**
   - Export: Tap on **File > Management > Exports...**
   - Graphic: Tap on **File > Management > Graphics...**
2. Tap on the desired file name/folder name. A dark blue bar identifies the selection. To change the folder, select the desired folder and tap the **Open** command button.
3. Tap on the **Edit > Cut** command button.
4. Open the destination folder: Select the desired folder and tap on the **Open** command button.
5. Paste the file/folder into the destination folder: Tap on the **Edit > Paste** command button.
6. Tap on the **OK** command button to return to the measurement presentation.

15.6 Deleting a file or folder

Deleting a file or folder

1. In which domain do you wish to delete the file or folder:
   - Application: Tap on **File > Management > Applications...**
   - Export: Tap on **File > Management > Exports...**
   - Graphic: Tap on **File > Management > Graphics...**
2. Tap on the desired file name/folder name. A dark blue bar identifies the selection. To change the folder, select the desired folder and tap the **Open** command button.
3. Tap on the **Edit > Delete** command button.

4. Tap on the **Yes** command button.
5. Tap on the **OK** command button to return to the measurement presentation.

15.7 Creating a new folder

Creating a new folder

1. For which domain to you wish to create a new folder:
   - Application: Tap on **File > Management > Applications...**
   - Export file: Tap on **File > Management > Exports...**
   - Graphic file: Tap on **File > Management > Graphics...**
2. Tap on the **Edit > New directory** command button.
3. Enter a name for the new folder. Use the on-screen keyboard for this.
4. Tap on the **OK** command button.
5. Tap on the **OK** command button to return to the measurement presentation.

16 Instrument settings

The display language, date and time are general instrument settings and apply to all application files. The following table contains an overview of possible instrument settings and how to access their menus.

Overview of instrument settings

Instrument setting	Open menu
Automatic saving of data, set the save interval	**File> Supervisor...* > automatic Save**
Automatic instrument shutoff; see page 129	**File > Supervisor...* > Control Panel > Power & Light**
Automatic switch to **standby mode**; see page 129	**File > Supervisor...* > Control Panel > Power & Light**
c_p and c_{pk}, settings for calculating the indexes	**File> Supervisor...* > Cp and Cpk**
Data transmission, selection of data; see page 114	**File > Supervisor...* > COM-Export**
Date, set the locale date format for the display	**File > Supervisor...* > Control Panel > Locale - Date**
Date and **time,** set the current date and time in the instrument	**File > Supervisor...* > Control Panel > Date/Time**
Calibrate **touchscreen**, calibrate the display in accordance with instructions.	**File > Supervisor...* > Control Panel > Calibrate touch**
Change **password** for access to the supervisor menu	**File> Supervisor...* > Password**
Create **templates** for displaying the statistical characteristics, see page 133.	**File > Supervisor...* > Statistical display - Template** **File > Supervisor...* > Block result - Template** **File > Supervisor...* > Final result - Template**

* Factory password: 159; for description, see page 126

Instrument setting	Open menu
Delete **password**	**File > Supervisor...* > Default settings**
Display illumination; see page 129	**File > Supervisor...* > Control Panel > Power & Light**
Enable or disable **signal tone** when measuring and for the monitoring functions	**File > Supervisor...* > Control Panel > Acoustic signals**
Enable or disable the message „The probe was not calibrated with this device!“, see page 137	**File > Supervisor...* > Master cal. warning**
Place **command buttons** in the measurement presentation, see page 134	**File > Supervisor...* > Keyboard**
Restore **default settings** in the instrument	**File > Supervisor...* > Default settings**
Secure, functions for application files, see page 130	**File > Supervisor...* > Lock application(s)**
Select **language** (display text, keyboards), see page 127.	**File > Supervisor...* > Control Panel > Language**
Select **printer type**	**File > Supervisor...* > Control Panel > Printer**
Select **power source**, see page 129.	**File > Supervisor...* > Control Panel > Power & Light**
Select **unit of measurement**; see page 132	**File > Supervisor...* > Unit**
Set up **power saving mode**, see page 129	**File > Supervisor...* > Pwr. save mode**
USB connection, select the operating mode, see page 111	**File > Supervisor...* > Control Panel > USB connection**
USB keyboard, set the properties	**File > Supervisor...* > Control Panel > USB keyboard**
USB mouse, calibrate the double-click speed	**File > Supervisor...* > Control Panel > Mouse**

* Factory password: 159; for description, see page 126

Instrument setting	Open menu
Time, set locale time format for the display	**File > Supervisor...* > Control Panel > Locale - Time**
Service area, access only for authorised service personnel.	**File > Supervisor...* > Control Panel > Service settings**
* Factory password: 159; for description, see page 126	

16.1 Supervisor menu

All instrument settings can be found in the **Supervisor** menu. For security, access is protected by a password.

Open menu

1. Tap on **File > Supervisor...**
2. Enter the password. The factory password is 159. Use the on-screen keyboard that appears to enter it.
3. Tap the **OK** command button to open the **Supervisor** menu.

What you can do next

- Open menus for instrument settings
- Open the **Control Panel** menu overview
- Leave the menu, see next section

Leave the menu

► Tap on the **Close** command button. This returns you to the measurement presentation.

	Note
	After you return to the measurement presentation, you still have unrestricted access to the **Supervisor** menu for a few minutes. During this period, you are not prompted to enter the password again. • Indication of unprotected access to the **Supervisor** menu: Green menu bar • Automatic deactivation of unrestricted access to the **Supervisor** menu: after about 3 minutes • Manual deactivation of unrestricted access to the **Supervisor** menu: Tap on **File > Quit Supervisormode**.

16.2 Selecting a language

Various language are available for the following displays and keyboards.

- Display texts
- USB keyboard that you can attach to the instrument

In addition, you can make settings for the on-screen keyboard in this menu. The on-screen keyboard appears automatically in menu windows with entry fields.

Open menu

▶ Tap on **File > Supervisor...* > Control Panel > Language**

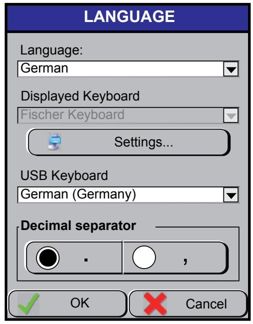
* Factory password: 159; for description, see page 126

Select a language

1. Select the desired language in the various areas. Tap in the selection window to open the selection list.

   Press the **Settings...** command button to configure the on-screen keyboard.

   A description of the parameters can be found in the following section.
2. Save the settings: Tap on the **OK** command button.
3. Return to the measurement representation: Tap on each **Close** command button.



*Example: Select the language **German** for the display and USB keyboard*

i	**Note** The language selected for the display appears only after restarting the instrument.

Description of parameters

LANGUAGE menu page

Parameter	Description
Language	Language selection window for display texts.
Displayed Keyboard	On-screen keyboard, appears automatically on menu pages with entry fields. For additional settings, tap on the **Settings...** command button.
Settings...	You use this command button to open the Settings menu for the on-screen keyboard. For a description of parameters, see menu page section ***Soft Keyboard Options***
USB Keyboard	Language selection window for the USB keyboard that you can connect to the USB port of the instrument.

Soft Keyboard Options menu page (**Settings...** command button)

Parameter	Description
Large keys **Small keys**	Key size selection. The larger the keys, the greater the space the keyboard occupies on the display.
Use gestures for	You can also use certain stylus movements on the display instead of the Space, Back, Shift and Enter keys.
OK	Command button for saving the settings and closing the menu window.
X	Corresponds to the **Cancel** command button. Closes the menu window without saving the settings.

16.3 Power source and display of illumination

Open menu

► Tap on **File > Supervisor...* > Control Panel > Power & Light**

* Factory password: 159; for description, see page 126

Description of parameters

POWER & LIGHT menu page

Parameter	Description
Power Scheme: **AC Power** **Battery Power**	• Display indicating whether the instrument is supplied with voltage by the batteries or the power supply (scope of supply). • Selects whether the instrument should be supplied with voltage by the battery pack (604-144) or directly by the power supply (scope of supply). Tap in the selection window to open the selection list.

Parameter	Description
Mode change	Tap in the selection windows to open the selection list.
Switch state to idle:	Selects the number of minutes after which the instrument should switch to the standby mode when there is no activity.
Turn device Off:	Selects the number of minutes after which the instrument should shut off when there is no activity.
Brightness	Sets the display illumination in the two instrument's modes standby and active. Use the slide controller for the setting.

16.4 Lock selected functions for application files

You can lock the following functions for all or individual application files:

- Delete
- Calibrate
- Change the application settings

In addition, a special password can be specified for the locking function. Only an individual who knows the locking password can, if necessary, temporarily disable locking for an open application file. Factory password: 159.

Set up locking

1. Tap on **File > Supervisor...* > Lock application(s)**

   * Factory password: 159; for description, see page 126

2. Select the application file to be blocked: Tap on the desired parameter. A black dot identifies the enabled parameter.

   All applications:
   The selected functions are locked for all application files saved in the instrument.

   a The **locked functions** selection area appears on the *LOCK APPLICATION(S)* menu page.

b Tap on the desired functions. A check mark indicates that the function is locked. A description of the parameters can be found farther on in this section. Continue with Step 3.

Single appl.
Selected functions can be blocked for the open application file. Continue with Step 3. To lock the current application file, see page 52.

3. Assign a locking password, if desired:
   a Tap on the **Modify password...** command button.
   b Enter the locking password twice.
   c Tap on the **OK** command button to save the locking password.
4. Save the settings: Tap on the **OK** command button.
5. Switch back to the measurement presentation: Tap on the **Close** command button.

i	**Note for the "All applications" parameter enabled** The selected functions are locked for all application files that are opened after locking has been set up. For the locked functions to remain functional in the open application file, open another application file and then once again the application file that was open when locking was set up.

Description of parameters

LOCK APPLICATION(S) menu page

Parameter	Description
locked functions	Applies to all application files saved in the instrument.
Delete reading	You cannot delete any measurement readings.
Delete application	You cannot delete any application file.
Normalization	You cannot normalise any application file.
Calibration	You cannot perform a corrective calibration for any application file.

Parameter	Description
Properties	You cannot change the application settings for any application file.

What you can do next

- Lock functions for the open application file if you have selected the **Single appl.** parameter, see page 52.

16.5 Selecting units of measurement

Select the desired unit(s) of measurement for the various quantities to be measured. Changing the unit of measurement affects all application files.

Open menu

▶ Tap on **File > Supervisor...* > Unit**

* Factory password: 159; for description, see page 126

Description of parameters

UNIT menu page

Parameter	Description
Temperature	
°C	SI-based unit of measurement for the temperature
°F	Anglo-American unit of measurement for temperature
σ	
%IACS	Anglo-American unit of measurement for the electrical conductivity
MS/m	SI-based unit for the electrical conductivity

16.6 Creating templates for displaying the statistical characteristics

You can define templates with statistical characteristics for the **Statistical display** measurement presentation as well as the **Blocke result** and **Final result** evaluations. These templates can also be used to print out the evaluation on a printer and save the evaluations in a PDF file (export file).

i	**Notes** • Changes in these templates apply solely to all newly created application files! • To define templates only for the open application file, see page 50.

Open menu

▶ Tap on **File > Supervisor...* > Statistical display - Template**

* Factory password: 159; for description, see page 126

Or

▶ Tap on **File > Supervisor...* > Block result - Template**

* Factory password: 159; for description, see page 126

Or

▶ Tap on **File > Supervisor...* > Final result- Template**

* Factory password: 159; for description, see page 126

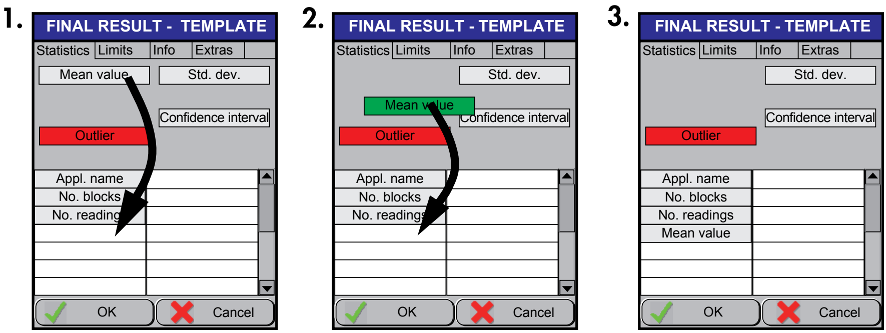
Procedure for assembling the characteristics

You can display the statistical characteristics in one or two columns on the screen. The statistical characteristics available for selection are grouped thematically in tabs. A description of the statistical characteristics can be found on page 200.

1. Select the desired characteristic field in a tab.
- Red field: Function is currently not active (e.g. outlier check disabled or no tolerance limits entered)
2. Pull the desired characteristic field into/out of a table field. For touch-screen operation, see page 20.

- The characteristic fields can be arranged in any way in the table.
- To remove a characteristic field from the table: Pull the desired characteristic field upward out of the table.

3. Repeat Steps 1 and 2 until all desired characteristics appear in the table.
4. Save the settings: Tap on the **OK** command button.
5. Switch back to the measurement presentation: Tap on the **Close** command button.



*Example: The template for the final result should contain the mean value. To achieve this, simply move the **Mean value** characteristic field into the table.*

i	**Note on the templates for the block result and final result** The characteristic fields in the **Extras** tab appear only in the printout or the exported pdf file.

16.7 Placing command buttons in the measurement presentation

You can also open many functions directly by using command buttons. This eliminates the need to open frequently used functions always via a menu path. You can place up to 12 command buttons in the measurement presentation.

Changes in this menu page affect all application files in the instrument.

The command buttons available for selection are grouped thematically in tabs. A description of the command buttons can be found on page 219.

Open menu

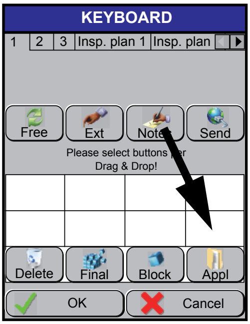
▶ Tap on **File > Supervisor...* > Keyboard**

* Factory password: 159; for description, see page 126

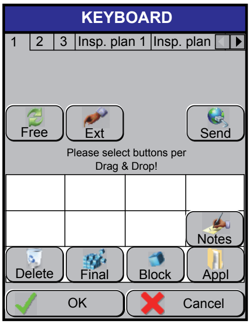
Procedure for placing command buttons in the measurement presentation

1. Select the desired command button in a tab.
2. Pull the desired command button into/out of a table field. For touchscreen operation, see page 20.
   - The command buttons can be arranged in any way in the table.
   - To remove a command button from the table: Pull the desired command button upward out of the table.
3. Repeat Steps 1 and 2 until all desired command buttons appear in the table.
4. Save the settings: Tap on the **OK** command button.
5. Switch back to the measurement presentation: Tap on the **Close** command button.

1.



2.



Example: Adding the "Add comment" command button.

16.8 Restoring default settings in the instrument

ATTENTION	**All settings and entries are reset to the factory setting** Executing the **Default settings** menu restores all application settings of open application files, the assigned passwords and the instrument settings to the default factory settings!

i	**Note - To retain application settings** Create an application file without application settings as a dummy. Open the dummy application file and then execute the **Default settings** menu. This resets only the instrument settings and the passwords to the default factory setting. All settings for the application files remain unchanged.

Procedure

1. Tap on **File > Supervisor...* > Default settings**

   * Factory password: 159; for description, see page 126
2. Switch back to the measurement presentation: Tap on the **Close** command button.

16.9 Message „The probe was not calibrated with this device!"

Probes shipped by FISCHER are master-calibrated. A master characteristic forms the basis for the conversion of the probe signal into the reading (electrical conductivity). Such a master characteristic is stored in the probe for each probe frequency.

Because of technical reasons, the FS40HF probe must be master-calibrated together with the instrument, which will use for measurements later on. This means, probe and instrument form a system comprised of two components adjusted to one another.

Close the message

The following message appears if the connected probe has not been master-calibrated with the connected instrument: „The probe was not calibrated with this device!".

► Tap on the **OK** command button to close the message.

You can measure with the probe. In this case, however, it may not possible to keep the measurement accuracy specified in the technical data sheet of the probe.

This message will continue to appear until the probe has been master-calibrated with the connected instrument.

Suppress the message permanently

1. Open menu: **File > Supervisor...* > Master cal. warning**

   * Factory password: 159; for description, see page 126
2. Disable the parameter: Tap on the parameter **Show warning**. An empty check box indicates that the parameter is disabled.
3. Save the settings: Tap on the **OK** command button.
4. Switch back to the measurement presentation: Tap on the **Close** command button.

What can you do next

- We recommend sending the probe with the instrument to your FISCHER service partner for master-calibration.
- A corrective calibration may be performed as an alternative to meet the specified trueness for a certain section of the measurement range.

17 Adjustment of the measurement system – Normalisation

For a measurement to be true, the instrument and the probe, the so-called measurement system, must be adjusted to at least one reference value. Adjustment to a reference value is called normalisation. If trueness is not achieved despite normalisation, perform a corrective calibration; see page 139.

Normalisation is the simplest way to adjust the measurement system. The instrument automatically measures the air value whenever the probe is lifted off specimen. The air value serves the instrument as a reference for the zero point (0 %IACS or 0 MS/m). If the instrument cannot perform the normalisation automatically on its own, you are requested to measure the air value. You can also perform the normalisation manually at any time.

When to perform:

- After creating a new application file
- When opening an application file
- After a new probe has been assigned to the application file
- While measuring, performed automatically by the instrument

Before you start

- The probe is connected to the instrument.
- The instrument has been switched on for 2 to 3 minutes (warm-up time).

Procedure

1. Initiate normalisation: Tap on **Cal > Normalization...**.
2. Hold the probe in the air. The distance to the next object must be at least 5 cm (1.97 inches)!
3. Press the **OK** command button.

This ends normalisation.

18 Adjustment of the measurement system - Corrective calibration

During the corrective calibration, the instrument and the probe, the so-called measurement system, is adjusted to the reference value of air (conductivity value 0 MS/m or 0 %IACS) and at least one additional conductivity value. You can use up to 4 standards (= reference parts) when performing the corrective calibration.

The corrective calibration applies only to the probe frequency and conductivity range for the standards used (set in the open application file).
Example: Standards with 22 and 34 MS/m (39 and 59 %IACS). Exact measurement with the trueness (accuracy) stated in the technical probe data sheets is possible only in the range between 22 and 34 MS/m. For measurements outside this conductivity range (e. g. at 10 MS/m or 17 %IACS), you need to perform a new corrective calibration (possibly in a new, different application file).

When to perform

- If the stated trueness cannot be achieved.
  This may, for instance, be related to ageing of the electronic components.
- If the curvature correction of the instrument is not being used, for instance, because you are measuring on a smaller diameter of curvature or the curvature correction function in the instrument does not support the connected probe. In these cases, you can take the curvature of the specimen into account with a corrective calibration.
- If the check of the current calibration state is negative with the **Check calibration** menu function.

Note

- ▶ We recommend that you check the accuracy of the instrument and probe at regular intervals through control measurements on the reference parts!
- ▶ You can check the accuracy of the corrective calibration using the **Check calibration** menu function. You can find a description from page 144.

Important to know

- You can perform a corrective calibration only for the open appl. file.
- The probes supplied by FISCHER are pre-calibrated (calibrated against a master).

Temperature

- When performing the corrective calibration, you must take the effect of temperature on the electrical conductivity measurement into account. Either the temperature and the temperature coefficient or the material of the standard must be known (corrective calibration with temperature correction) or the standards must be at a temperature of +20 °C (+68 °F) (e.g. standards in a temperature-controlled water bath; corrective calibration without temperature correction).
- You can also perform the corrective calibration without temperature correction. In this case, the measured values are automatically referenced to +20 °C (+68 °F). You thus need to ensure that the temperature of the standard is +20 °C (+68 °F) (e. g. place standards in temperature-controlled water bath). How to perform the corrective calibration with temperature correction is described in the "Procedure" section. In deviation from the procedure described there, press the **No Temp.** button in Step 6. . The temperature and temperature coefficient data are then not needed.
- For application files with automatic temperature acquisition enabled (see page 27), it is essential that the corrective calibration be performed with temperature correction (with automatic acquisition of the temperature from the temperature sensor and entry of the temperature coefficient α or selection of the standard material).

Curvature

- The corrective calibration is generally carried out without curvature correction, even if it is enabled for the open application file. Enabled curvature correction is disabled automatically when the corrective calibration is performed.
- The "Curvature correction" menu function requires a corrective calibration on smooth, flat standards if anything! Otherwise, incorrect measurement readings will be obtained!
- If the corrective calibration is carried out on curved reference parts, you must disable curvature correction when measuring on similarly curved specimens!

For the corrective calibration you need:

- 1 to max. 4 standards (= reference parts). The values for the standards must be in the range of the electrical conductivity to be measured.
- Temperature coefficient or material name of the standards used. You can find the temperature coefficient, the electrical conductivity and the material on the certificate for the standard.
- Material temperature of the standard used.
- Instrument with connected probe that has been switched on for at least 10 minutes (warm-up time).
- Open application file in which the corrective calibration is to be performed.

ATTENTION	**Accuracy** Carry out the corrective calibration carefully, since it determines the accuracy with which subsequent measurements can be performed. - Remember that the measurements can never be more exact than the corrective calibration!

ATTENTION	**Operating temperature of the instrument** Before a corrective calibration is carried out, the instrument with connected probe must have been switched on for at least 10 minutes! This is necessary to ensure that all components in the unit have reached their operating temperature. The result will otherwise be mismeasurement! ► For this purpose, disable automatic shutoff of the unit in the **File > Supervisor...* > Control Panel > Power & Light** menu; see page 129. ► Connect the instrument with its power supply to the power source; see page 14.

Procedure - Corrective calibration

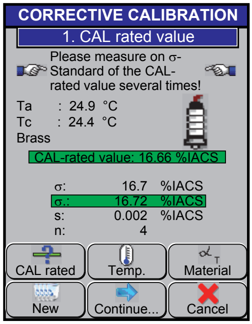
1. To open the corrective calibration: Tap on **Cal > Corrective calibration...**.
2. Hold the probe in the air. The distance to the next object must be at least 5 cm (1.97 inches)!
3. Press the **OK** command button.
4. Select the number of standards that you wish to use for the corrective calibration. Tap on the desired command button. A dot identifies the selection.
5. Tap on the **Continue...** command button
6. Acquisition of the standard's temperature (1):
   a Measure the temperature of the standard. How you must acquire the temperature is specified in the application settings; see also page 69.
   b Entry or acquisition of the temperature of the standard:
   - Acquisition of the sensor temperature: Tap on the **temp.** command button to acquire the measured temperature.
   - Manual entry: Enter the measured temperature value in the entry field.

   c Tap on the **OK** command button. This completes entry/acquisition of the temperature of the standard.
7. Enter the rated value for the standard (1):
   a Tap on the **CAL-rated value** command button.
   b Type in the rated value for the standard (1).

ATTENTION	**Observe the unit of measurement** When entering the rated value, note the specified unit of measurement in the instrument!

   c Tap on the **OK** command button. This completes entry of the rated value.
8. Enter the temperature coefficient for the standard (1):
   a Tap on the **Material** command button.
   b Select the appropriate material or enter the temperature coefficient for the standard.
   c Tap on the **OK** command button. This completes entry of the temperature coefficient.

9. Check the temperature of the standard (1).
   a Check and update the temperature of the standard as described in Step 6. .
10. Measure the standard (1). As a rule, 5 to 10 measurements are enough.
11. Tap on the **Continue...** command button.
12. Do you have additional standards available for the corrective calibration:
    - Yes, repeat steps 6. to 12.
    - No, continue with step 13.
13. Tap the **OK** command button to end the corrective calibration.
14. Tap the **OK** command button to close the information window. Repeat the corrective calibration if it was not successful.



Example: Corrective calibration menu screen

What you can do next

- Perform measurements; see page 65.
- Checking the current calibration state, see page 144.

18.1 Deleting the corrective calibration

You can delete the corrective calibration in the open application file. In this case, the factory calibration in the probe is restored.

Procedure

1. Tap on **Cal > Delete corrective calibration**.
   This menu command is available only if a corrective calibration was already carried out for the open application file.
2. Tap on the **Yes** command button to execute the deletion.

The corrective calibration for the open application file has been deleted.

What you can do next

- Perform measurements with the factory calibration
- Perform a corrective calibration; for procedure, see page 139

19 Checking the current calibration state

The **Check calibration** menu function checks whether the mean value of the check measurement matches the reference value of the standard to within the scope of measurement uncertainty (in accordance with ISO/IEC Guide 98-3).

When to perform

- Acquisition of the current calibration state of the measurement system, i.e. how accurately does the measurement system measure in the opened application file
- Acquisition of the measurement uncertainty of the measurement system for the measuring application of the opened application file, e.g. necessary for measurements, whose measurement uncertainty is acquired according to ISO/IEC Guide 98-3

Important to know

- Using the menu function, you can check the calibration state and the measuring accuracy of the measurement system. The result of the check applies only to the open application file and its measuring application.
- If a corrective calibration is saved in the open application file, the check must be carried out under the same conditions under which the corrective calibration was carried out. For example, at the same temperature, with the same standard etc.
- The determined measurement uncertainty only applies to a small area around the reference value of the standard for which the control measurement was performed. If you wish to determine the measurement uncertainty for a measurement range, perform control measurements on two standards limiting the measurement range. You can determine the measurement uncertainty for this measurement range through a linear interpolation of the two measurement uncertainties of the control measurements on the two standards.

You need the following for the control measurement:

- 1 to max. 4 standards (= reference parts), used for the corrective calibration. If no corrective calibration is saved in the application file, use the standards from the scope of supply of the connected probe.

- Certificates in which the tolerance or the measurement uncertainty (k=2) for the used standards is specified.

Accuracy

The calibration accuracy is limited by the measurement uncertainty of the standard. The measurement uncertainty of the corrective calibration may not be smaller than the measurement uncertainty of the standards used. To improve the calibration accuracy, you must use standards with smaller measurement uncertainties for the corrective calibration.

ATTENTION

Operating temperature of the instrument

Before a control measurement is carried out, the instrument with connected probe must have been switched on for at least 10 minutes! This is necessary to ensure that all components in the unit have reached their operating temperature. The result will otherwise be mismeasurement!

- ▶ For this purpose, disable automatic shutoff of the unit in the **File > Supervisor...* > Control Panel > Power & Light** menu; see page 129.
- ▶ Connect the instrument with its power supply to the power source; see page 14.

Procedure - Checking the calibration

1. Open the **Check calibration** menu function: Tap **Cal > Check calibration**.
2. Enter the **CAL-rated value** for the current standard (= reference part):

   a Type in the nominal value (= reference value) for the standard (1).

   ATTENTION

   Observe the unit of measurement

   When entering the CAL nominal value, note the specified unit of measurement in the display!

   b Tap the **OK** command button. This completes entry of the CAL-rated value.

3. Select the form in which the specification of the measurement uncertainty for the used standard is available.

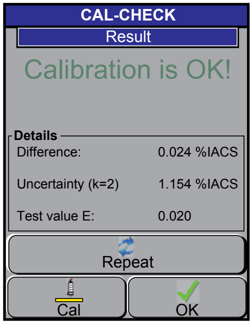
Parameter	Description
Tolerance [*Unit of measurement*]	A tolerance is specified for the standard. Example: 16.66 %IACS ± 0.35 %IACS
rel. Tolerance [%]	A percentage tolerance is specified for the standard. Example: 16.66 %IACS ± 2.1%
U(k=2) [*Unit of measurement*]	An extended measurement uncertainty is specified for the standard, for an extension factor k = 2. Example: 16.66 %IACS ± 1 %IACS

4. Enter the measurement uncertainty for the used standard.

ATTENTION	**Observe the unit of measurement** When entering the measurement uncertainty, note the specified unit of measurement in the display!

5. Tap the **OK** command button to confirm the settings.
6. Perform a control measurement on the standard (1). We recommend carrying out 10 or more measurements on the standard (= CAL-rated value).
7. Tap the **OK** command button to start the check.

8. The result of the check appears in the display. A description of all command buttons can be found in the following table on page 147. You can find additional information on the parameters and measurement uncertainty in the Glossary chapter.
9. Tap **OK** to exit the menu function.



Example: Result of the calibration state of the open application file

Menu page ***CAL-CHECK; Result***

Parameter	Description
Calibration is OK!	The mean value of the check measurement matches the nominal value (= reference value) of the standard to within the scope of measurement uncertainty (in accordance with ISO/IEC Guide 98-3). This means that the difference between the mean value and the nominal value cannot be distinguished from the specified measurement uncertainty of the standard.
Calibration is not OK!	Carry out a new corrective calibration, as the measured mean value of the control measurement has an excessive error to the nominal value of the standard. Tap the **Cal** command button to perform a new corrective calibration.
Details *area*	
Difference	Difference between the mean value from the control measurement and the nominal value (= reference value) of the standard used for measurement.
Uncertainty (k=2)	Measurement uncertainty of the measurement system for the measuring application of the open application file. This value takes the measurement uncertainty (= standard deviation) of the control measurement and the specified measurement uncertainty of the standard used for management into account.

Parameter	Description
Test value E	Ratio of **difference** to **measurement uncertainty (k=2)**. **E** ≤ **1**: The measurement accuracy for the opened application file is ok for this standard and cannot be further improved by this standard. **E > 1**: The mean value of the control measurement has an excessive deviation to the nominal value of the standard used for measurement. Perform a corrective calibration to improve the measurement accuracy for the opened application file.

What you can do next

- Repeat the check for the same or another standard. Tap the **Repeat** command button and start with step 2.
- Perform a corrective calibration if the check was negative. Press the **Cal** command button; carry out the corrective calibration from page 139.

20 Assigning a new probe

The instrument detects when a different probe is connected to it, which it should do on the basis of the probe identifier in the current application file.

Reason: Every probe has its own identifier. The probe is "logged in" under this identifier in the application file.

A new probe of the same type can be assigned (e.g. with the probe identifier A8) to the application files that were created with a particular probe (probe identifier A1). Neither the settings nor the measurement readings in these application files will be lost through this action. It is not necessary to create new application files for the new probe.

Reasons for assigning a new probe

- Replacement of a defective probe

Assigning a new probe to an open application file or several application files

1. Switch off the instrument: Press the **ON/OFF** key for about 1 second.
2. Connect the new probe to the instrument; see page 16.
3. Switch on the instrument: Press the **ON/OFF** key for about 1 second.
4. Has an application file with the connected probe already been created in the instrument?
   - If yes, continue with Step 6.
   - If no, continue with Step 5.
5. The welcome screen presents the following selection options:
   - **Set up new application**
   - **Open existing application**

   a Tap the command button **Open existing application** and select the desired application file to which the probe should be assigned.

   b Continue with Step 7.
6. The application file that was last open with the connected probe now opens.

   a Tap the command button **Appl** and select the desired application file to which the probe should be assigned.

7. A message appears stating that the application opened was not created with the connected probe. The name of the missing probe and a warning triangle flash alternately in the information bar.
8. Tap on **OK** to close the message. Measurements are not possible.
9. Tap on **File > Supervisor* > Assign probe**.

   **Factory password: 159*

   The *ASSIGN PROBE* menu opens.
10. Select whether the connected probe should be assigned to only the open application file or all application files that were created with the old probe identifier. Tap the appropriate command button.
11. Tap the **OK** command button to start the assigning.

    A message appears stating that the connected probe was signed to the application(s).
12. Tap the **Yes** command button to close the message.
13. Perform a normalisation: Hold the probe in the air and tap the **OK** command button.
14. Tap the **Close** command button to leave the Supervisor menu.

You can now take measurements with the connected probe in the open application file.

	Notes
i	• When a probe is assigned to one or several applications, it's corrective calibrations are deleted and the user must carry out a new corrective calibration for each of these applications. Topic corrective calibration see at page 139. • Assigning probe FS40HF: The message „The probe was not calibrated with this device!“ appears, if the connected probe has not been master-calibrated with the connected instrument! Further information see page 137.

21 Malfunctions - What should you do?

Malfunction/Message	Cause	Remedy	Page
No display on screen	The instrument is not switched on.	Switch on the instrument.	18
	The instrument has switched off automatically (automatic shut-off when operating without connection to the mains).	Switch on the instrument.	18
	The instrument's rechargeable battery is not charged and the instrument is not connected to the mains.	• Connect the instrument to the mains. • Insert new batteries into the instrument	14 12
Instrument responds inaccurately to your tap.	Touch calibrated inaccurately.	Perform a touch calibration: **File > Supervisor > 159 > Control Panel > Calibrate touch**	
Probe doesn't measure	The **by placing** parameter is deactivated in the **File/Properties/Measurement acceptance** menu.	Activate the **by placing** parameter (a check mark is visible).	33
	The measurement reading is acquired on triggering of "External start".	Trigger "External start" by tapping on **Meas/trigger external start**. Alternative: Press the **Ext** command button if it is visible on the display.	33 134
	The probe was not placed on the specimen correctly.	Place the probe on the specimen correctly.	58

Malfunction/Message	Cause	Remedy	Page
Probe doesn't measure	An incorrect probe is connected to the instrument. The probe name flashes in the information bar on the display.	Connect the probe used when creating the current application file (measuring application memory).	16
	Measurement on unsuitable specimen material, e.g. plastic, iron	Measure only on electrically conductive material.	
	Probe requires a new air value (reference value).	Follow the on-screen instructions. Alternatively, perform a normalisation: **Cal > Normalization...**	
	The application file selected was incorrect.	Select the appropriate application file for the present specimen.	119
	The corrective calibration failed.	Perform the corrective calibration again.	138 139
	The probe is faulty.	Change the probe. Contact our service department.	
Incorrect measurement readings	The application file selected was incorrect.	Select an appropriate application file for the present specimen.	119
	The corrective calibration for the present measuring application was performed with unsuitable standards.	Delete the corrective calibration and perform it again with suitable reference parts/standards.	143 139

Malfunction/Message	Cause	Remedy	Page
Incorrect measurement readings	The probe was not placed on the specimen correctly.	Place the probe on the specimen correctly.	58
	The instrument is being operated close to strong magnetic fields.	Find another location for the measurements (measurement environment) or remove the source of the magnetic field.	
	The temperature of the specimen was not taken into account. Specimen temperature ≠ 20 °C (68 °F)	► Bring the specimen to a temperature of +20 °C, e.g. in a water bath.	
		► Measure with temperature correction.	69
		► Perform the corrective calibration at the temperature at which the measurement is made. The standards during the corrective calibration must have the same temperature as the specimens when they are measured.	139
	The curvature of the specimen was not taken into account.	► Use standards with the same curvature during the corrective calibration.	140
		► Measure with curvature correction	75
	The probe is unable to acquire an "air" reference value.	► Perform a normalisation.	138
		► Switching off and on the instrument.	

Malfunction/Message	Cause	Remedy	Page
Printer is not working	The printer is not switched on.	Switch the printer on.	
	The printer is not connected to the mains.	Connect the printer to the mains.	
	The printer is not connected to the instrument.	Connect the printer to the USB port on the instrument.	6
	The USB connecting cable between the instrument and printer is faulty.	Change the USB connecting cable.	
	The wrong printer type was selected in the instrument.	Select the printer type in the instrument that matches the connected printer. Open menu: **File > Supervisor... > 159 > Control Panel > Printer**	
	Data output is disabled.	Switch the desired data output on.	113
	The automatic instrument shutoff is enabled.	Disable the automatic instrument shutoff: **File > Supervisor... > 159 > Control Panel > Power & Light**	129
No data transmission to the PC	The wrong transmission format is set in the instrument.	Set the appropriate transmission format in the instrument.	111
	Wrong COM port is selected on the PC.	Check settings and correct as necessary.	
	Install missing USB driver in the PC.	Install the USB driver from the support CD.	110

Malfunction/Message	Cause	Remedy	Page
No data transmission to the PC	The USB connecting cable between the instrument and PC is faulty.	Change the USB connecting cable.	
	The automatic instrument shutoff is enabled.	Disable the automatic instrument shutoff: **File > Supervisor... > 159 > Control Panel > Power & Light**	129
Message: Wrong password! Please enter the correct password!	The wrong supervisor password was entered.	Enter the password again. The entry is case sensitive!	
	The wrong locking password was entered.	Enter the password again. The entry is case sensitive!	
Message: Readings and CAL-rated values does not match! Corrective calibration could not be finished!	Wrong standards were used during the corrective calibration. The entered standard value does not match the measured value.	Perform the corrective calibration again and use the appropriate standards.	139

Malfunction/Message	Cause	Remedy	Page
Message: The probe was not calibrated with this device!	The connected probe did not undergo a master calibration with this instrument at the factory.	Close the message window. You can measure with the probe without observing the specification of the probe data sheet. We recommend sending the probe with the instrument to your FISCHER service partner for master-calibration.	137
Message: Reading out of measuring range!	The probe was not placed on the specimen correctly.	Perform the measurement again and place the probe on the specimen correctly.	58
	The probe is close to other metal parts.	Remove the other metal parts from the measurement range and perform the measurement again.	
	The measurement reading is not verified by a calibration.	Perform a corrective calibration.	139
	The measurement was performed on the wrong specimen material	Use the appropriate specimen for measurement.	
Message: Please hold the probe in the air!	The instrument needs the reference value for air	Hold the probe in the air and tap the **OK** command button. The distance to the next object must be at least 5 cm (1.97 inches)!	

Malfunction/Message	**Cause**	**Remedy**	**Page**
Is the probe really in the air? Please hold the probe in the air.	The instrument can not capture the reference value for air	Hold the probe in the air and tap the **OK** command button. ℹ The distance to the next object must be at least 5 cm (1.97 inches)!	
Your device is not ready for operation. Please contact the service team.	The instrument detected an internal error	Send the instrument with the connected probe to your FISCHER service office. See www.helmut-fischer.com	
Message: Please perform a normalization!	The instrument needs the reference value for air	Hold the probe in the air and tap the **OK** command button. ℹ The distance to the next object must be at least 5 cm (1.97 inches)!	
Note: Xn-value out of intervals.	The corrective calibration was performed with an unsuitable calibration standard.	Delete the corrective calibration and perform the corrective calibration again. Check the standard values entered. The standard values must not be too close to one another.	143 139

22 Technical data

Instrument model	SIGMASCOPE® SMP350
Instrument platform	MS Windows® CE-based user software
Display	Graphical display/touchscreen
Keyboard/operation	Membrane keys, softkey board (freely assignable keys) and command buttons
Test method	Phase-sensitive test method
Measurement range	FS40 probe family: 0.5 ... 108 %IACS or 0.3 ... 63 MS/m
Dimensions	Instrument (L x W x H): 170 mm x 89 mm x 40 mm / 6.7 " x 3.5 " x 1.6 "§ Touchscreen (L x W): 75 mm x 55 mm / 2.95 " x 2.2 "
Weight	395 g (without probe, ready to use)
Permissible ambient temperature during operation	0 ... +40 °C (+32 ... +104 °F)
Permissible storage temperature	+5 ... +60 °C (+41 ... +140 °F)
Permissible relative humidity during operation	30 ... 90 % (non-condensing)
Permissible relative humidity during storage	20 ... 80 % (non-condensing)
Connections	Probe: 10-pin round plug Temperature probe TF100A: 4-pin Lemo plug, series 0S AC adapter plug: 2-pin barrel connector USB interface: USB 2.0-compatible
USB port	Mini-AB for connection of a printer, PC, PC keyboard or USB flash drive
Power consumption	0.9 W

Storage capacity	256 MBytes for applications and measurement readings
Minimum time interval between two measurements	Approx. 2 seconds
Measurement range, trueness and repeatability	Depends on the connected probe. Corresponding data can be found in each probe's data sheet.
Power source	Batteries: 4 x MIGNON 1.5 V, LR 6 - AA - AM3 - MN1500 (scope of supply) AC adapter plug (scope of supply) Input: 100 - 240 V~ / 47 - 63 Hz / 400 mA Output: 9 V⎓ / 1.5 A The AC adapter plug adjusts automatically to current main voltage Rechargeable battery pack, 2100 mAh (optional); can be charged in the instrument when the AC adapter is connected 4 individual rechargeable batteries, Mignon, NiMH, HR6 - AA, 1.2 V; cannot be charged in the instrument!
Batterie pack (Option)	Article no.: 604-144 Charging time: Up to 4.5 h, depending on the charging state of the battery pack Battery running time: ≥ 8 h

Temperature probe TF100A

Sensor	PT100, class B, permissible deviation according to DIN IEC 751
Probe diameter	6 mm (0.24 inches)
Measurement range	-20 ... +80 °C (-4 ... +176 °F)
Correctness	± 5 °C (± 32.9 °F) at +20 °C (+68 °F) ambient temperature
Min. meas. area	∅ 6 mm (0.24 inches)

23 Appendix

This section contains in-depth descriptions of the influencing factors and explanations of the terms used in this operator's manual. In addition, it contains correction tables for conductivity values measured on thin specimens (minimum of material thickness th_{min}) and convex curvatures as well as for plated aluminium-based materials listed in BOEING specification BAC 5651.

Table of contents of the appendix

23.1 Influence of material thickness

Insufficient material thickness falsifies the measuring result greatly. This minimum thickness depends on the material and the probe frequency and results from the penetration depth of the induced eddy currents in the material.

In general, the following holds for the penetration depth δ of the eddy currents in a nonferrous metal:

$$\delta = \delta_0 = K \cdot \frac{656.5}{\sqrt{f \cdot \sigma}} \text{ mm}$$

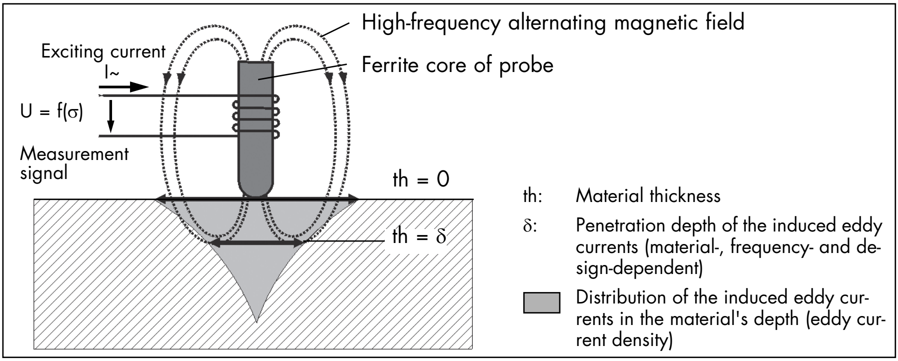
δ: Penetration depth of the induced eddy currents [mm]

δ_0: Standard penetration depth of the induced eddy currents for a given measuring frequency, probe design and given material

K: Probe specific factor, depending of probe design; For FS40-probe family: K = 0.9

f: Measuring frequency (= probe frequency) [Hz]

σ: Electrical conductivity [%IACS]



Principle of alternating magnetic field penetration and distribution of the induced eddy currents and their distribution into the depth of nonmagnetisable metal.

The minimum thickness can be calculated by using the following rule of thumb:

$$th_{min} \geq 3 \bullet \delta_0$$

th_{min} : Minimum material thickness at which a conductivity measurement is possible.

δ_0 : Standard penetration depth of the induced eddy currents (depends on the material, frequency and design of the probe).

Depending on the probe frequency used, the corresponding minimum material thickness th_{min} for various materials can be taken from Figure 23.1: on the next page. Observe our limitation of liability on page 2.

Example:

"Figure 23.1:" gives a minimum of th_{min} of 930 µm material thickness for aluminium and a probe frequency of 60 kHz. Changing the probe frequency to 480 kHz yields a th_{min} of 330 µm.

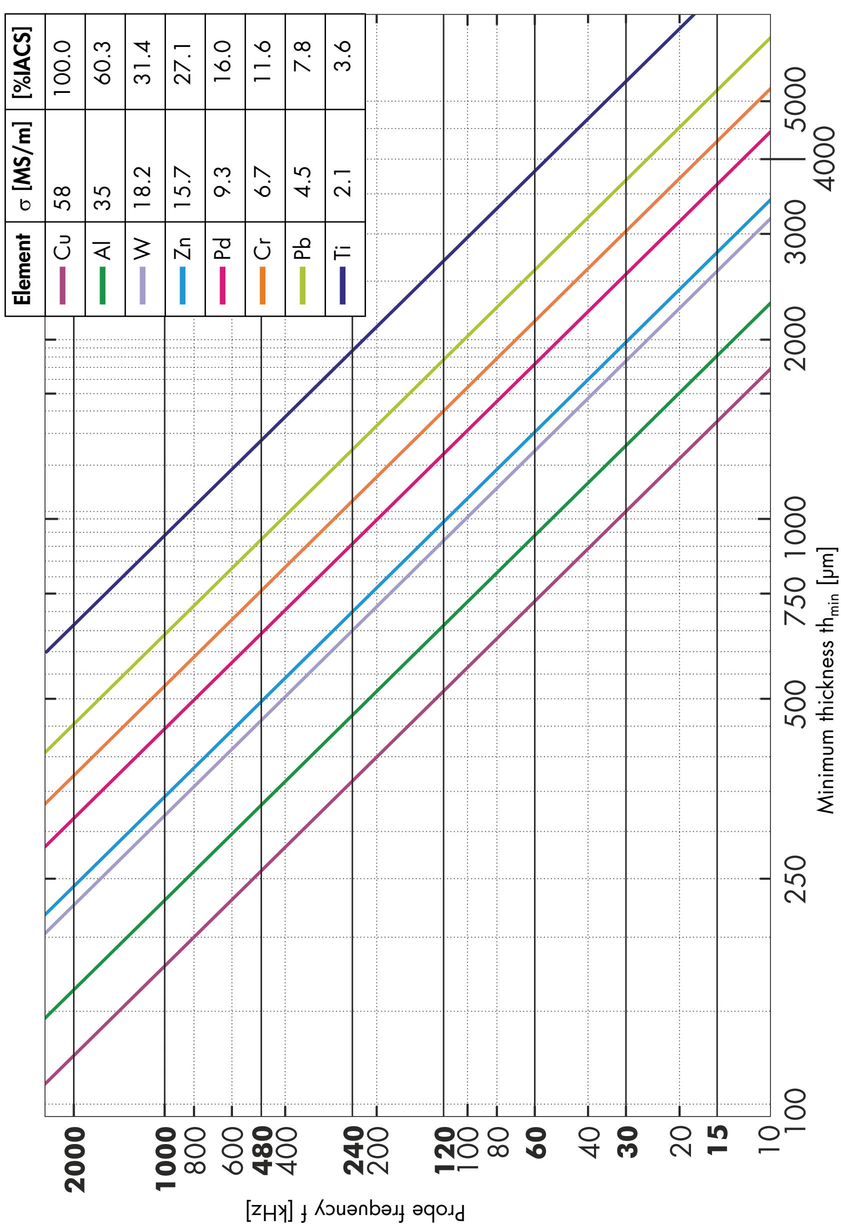


Figure 23.1: Minimum material thickness th_{min} as a function of the frequency f for various materials and their electrical conductivities σ.

23.2 Influence of the curvature of cylindrical specimens

In addition to the temperature, the curvature of the specimen affects the conductivity measurement. The effect on the conductivity measurement increases with decreasing diameter of curvature. As an example, Figure 23.2: shows the relative conductivity error as a function of the diameter of curvature for 3 different materials (for the FS40 probe and a probe frequency of 60 kHz). Diameters of curvature starting at 6 mm (0.24 inches) can be taken into account with the aid of the **File > Properties... > Correction** menu (see page 31). Observe our liability waiver on page 2.

Curvature correction (menu function) is possible only in conjunction with the FS40 probe types!

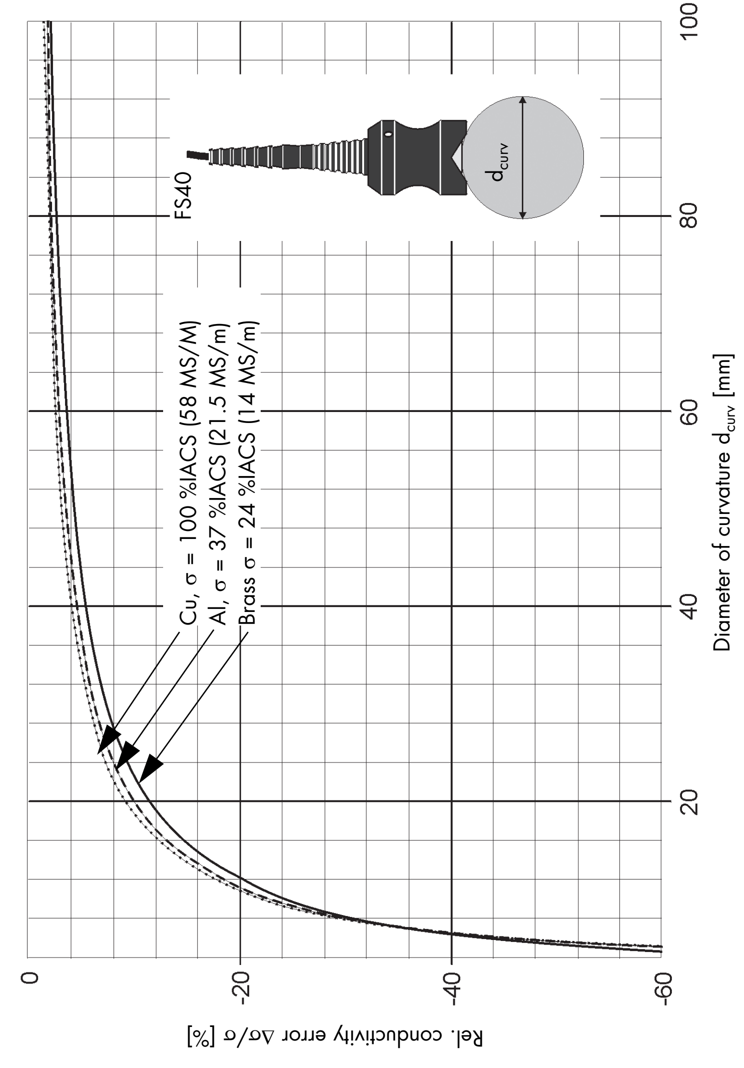


Figure 23.2: *Relative conductivity error Δσ/σ as a function of the diameter of curvature d_{curv} of the specimen for the FS40 probe at a probe frequency of 60 kHz.*

23.3 Correction tables from BOEING specifications BAC 5651 and BSS 7351

The conductivity measurement can be affected or distorted by the curvature of the specimen, the thickness of the specimen (failure to achieve the specified minimum material thickness) and any possible cladding (e.g. aluminium foils used in the aircraft industry) as well as by the temperature. The tables contained in this section apply solely to the FS40 probe and are used for **manual correction** of the conductivity values after measurement.

The true conductivity values of the specimen material and the distorted conductivity values measured (displayed values) are listed in the tables. There are corresponding correction tables for each frequency of the FS40 probe (60, 120, 240 and 480 kHz).

The following tables have been prepared on the basis of the BOEING specifications BAC 5651 and BSS 7351 and must be used.

The correction values were determined solely from original standards provided by BOEING in accordance with BOEING specification BAC 5651. The tables must be used as stipulated in BOEING specification BSS 7351.

i	**Note** To use the tables, we recommend creating an application file with temperature correction enabled. Create an application file; see page 22. Enable temperature correction; see page 27. Select the material (substrate material, alpha value); see page 30.

ATTENTION	**Incorrect measurement readings** The "curvature correction" function must be disabled for the open application file in order to use the following correction tables!

Note

If using the BOEING tables is not absolutely necessary, we recommend enabling curvature correction in the instrument in addition to temperature correction for the measurement. The curvature correction in the instrument provides higher accuracy and correction takes place over the entire measurement range. Enable curvature correction; see page 31.

23.3.1 BSS 7351, Correction table for convex specimens, measurements at a probe frequency of 60 kHz

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 60 kHz										
	Diameter of curvature in inches *(cm)*										
	0.25 *0.63*	**0.375** *0.95*	**0.50** *1.27*	**0.75** *1.91*	**1.00** *2.54*	**1.50** *3.81*	**2.00** *5.08*	**3.00** *7.62*	**3.50** *8.89*	**4.00** *10.16*	**5.00** *12.70*
	Electrical conductivity values in %IACS measured for each diameter of curvature										
20	11.5	14.0	16.5	18.0	18.5	19.0	19.0	19.5	19.5	19.5	19.5
21	12.5	15.0	17.5	19.0	19.5	20.0	20.0	20.5	20.5	20.5	20.5
22	13.0	15.5	18.0	19.5	20.5	21.0	21.0	21.5	21.5	21.5	21.5
23	13.5	16.5	19.0	20.5	21.5	22.0	22.0	22.0	22.5	22.5	22.5
24	14.0	17.0	20.0	21.5	22.0	23.0	23.0	23.0	23.5	23.5	23.5
25	15.0	18.0	20.5	22.5	23.0	24.0	24.0	24.0	24.0	24.5	24.5
26	15.5	18.5	21.5	23.5	24.0	25.0	25.0	25.0	25.0	25.5	25.5
27	16.0	19.0	22.5	24.0	25.0	25.5	26.0	26.0	26.0	26.5	26.5
28	16.5	20.0	23.0	25.0	26.0	26.5	27.0	27.0	27.0	27.5	27.5
29	17.5	20.5	24.0	26.0	27.0	27.5	27.5	28.0	28.0	28.0	28.5
30	18.0	21.5	25.0	27.0	28.0	28.5	28.5	29.0	29.0	29.0	29.5
31	18.5	22.0	25.5	28.0	28.5	29.5	29.5	30.0	30.0	30.0	30.5
32	19.5	23.0	26.5	28.5	29.5	30.5	30.5	31.0	31.0	31.0	31.5
33	20.0	23.5	27.5	29.5	30.5	31.5	31.5	32.0	32.0	32.0	32.5

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 60 kHz										
	Diameter of curvature in inches *(cm)*										
	0.25 *0.63*	**0.375** *0.95*	**0.50** *1.27*	**0.75** *1.91*	**1.00** *2.54*	**1.50** *3.81*	**2.00** *5.08*	**3.00** *7.62*	**3.50** *8.89*	**4.00** *10.16*	**5.00** *12.70*
	Electrical conductivity values in %IACS measured for each diameter of curvature										
34	20.5	24.5	28.0	30.5	31.5	32.0	32.5	32.5	33.0	33.0	33.5
35	21.0	25.0	29.0	31.5	32.5	33.0	33.5	33.5	34.0	34.0	34.5
36	22.0	26.0	30.0	32.0	33.5	34.0	34.5	34.5	35.0	35.0	35.5
37	22.5	26.5	30.5	33.0	34.5	35.0	35.0	35.5	36.0	36.0	36.5
38	23.0	27.5	31.5	34.0	35.0	36.0	36.0	36.5	37.0	37.0	37.5
39	23.5	28.0	32.5	35.0	36.0	37.0	37.0	37.5	37.5	38.0	38.5
40	24.5	28.5	33.0	36.0	37.0	38.0	38.0	38.5	38.5	39.0	39.5
41	25.0	29.5	34.0	36.5	38.0	39.0	39.0	39.5	39.5	40.0	40.5
42	25.5	30.0	35.0	37.5	39.0	39.5	40.0	40.5	40.5	41.0	41.5
43	26.0	31.0	35.5	38.5	40.0	40.5	41.0	41.5	41.5	42.0	42.5
44	27.0	31.5	36.5	39.5	41.0	41.5	42.0	42.5	42.5	43.0	43.5
45	27.5	32.5	37.5	40.5	41.5	42.5	43.0	43.5	43.5	44.0	44.5
46	28.0	33.0	38.0	41.0	42.5	43.5	43.5	44.0	44.5	44.5	45.5
47	28.5	34.0	39.0	42.0	43.5	44.5	44.5	45.0	45.5	45.5	46.0
48	29.5	34.5	39.5	43.0	44.5	45.5	45.5	46.0	46.5	46.5	47.0
49	30.0	35.5	40.5	44.0	45.5	46.5	46.5	47.0	47.5	47.5	48.0
50	30.5	36.0	41.5	45.0	46.5	47.0	47.5	48.0	48.5	48.5	49.0
51	31.0	37.0	42.0	45.5	47.5	48.0	48.5	49.0	49.5	49.5	50.0
52	32.0	37.5	43.0	46.5	48.0	49.0	49.5	50.0	50.5	50.5	51.0
53	32.5	38.0	44.0	47.5	49.0	50.0	50.5	51.0	51.0	51.5	52.0
54	33.0	39.0	44.5	48.5	50.0	51.0	51.5	52.0	52.0	52.5	53.0
55	34.0	39.5	45.5	49.0	51.0	52.0	52.0	53.0	53.0	53.5	54.0
56	34.5	40.5	46.5	50.0	52.0	53.0	53.0	54.0	54.0	54.5	55.0
57	35.0	41.0	47.0	51.0	53.0	53.5	54.0	55.0	55.0	55.5	56.0
58	35.5	42.0	48.0	52.0	54.0	54.5	55.0	55.5	56.0	56.5	57.0

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 60 kHz										
	Diameter of curvature in inches *(cm)*										
	0.25 *0.63*	**0.375** *0.95*	**0.50** *1.27*	**0.75** *1.91*	**1.00** *2.54*	**1.50** *3.81*	**2.00** *5.08*	**3.00** *7.62*	**3.50** *8.89*	**4.00** *10.16*	**5.00** *12.70*
	Electrical conductivity values in %IACS measured for each diameter of curvature										
59	36.5	42.5	49.0	53.0	54.5	55.5	56.0	56.5	57.0	57.5	58.0
60	37.0	43.5	49.5	53.5	55.5	56.5	57.0	57.5	58.0	58.5	59.0

23.3.2 BSS 7351, Correction table for convex specimens, measurements at a probe frequency of 120 kHz

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 120 kHz										
	Diameter of curvature in inches *(cm)*										
	0.25 *0.63*	**0.375** *0.95*	**0.50** *1.27*	**0.75** *1.91*	**1.00** *2.54*	**1.50** *3.81*	**2.00** *5.08*	**3.00** *7.62*	**3.50** *8.89*	**4.00** *10.16*	**5.00** *12.70*
	Electrical conductivity values in %IACS measured for each diameter of curvature										
20	12.0	14.5	16.5	18.0	18.5	19.5	19.5	19.5	19.5	19.5	19.5
21	13.0	15.0	17.5	19.0	19.5	20.5	20.5	20.5	20.5	20.5	20.5
22	13.5	16.0	18.5	20.0	20.5	21.5	21.5	21.5	21.5	21.5	21.5
23	14.0	16.5	19.0	21.0	21.5	22.5	22.5	22.5	22.5	22.5	22.5
24	15.0	17.5	20.0	21.5	22.5	23.0	23.5	23.5	23.5	23.5	23.5
25	15.5	18.0	21.0	22.5	23.5	24.0	24.0	24.5	24.5	24.5	24.5
26	16.0	19.0	21.5	23.5	24.5	25.0	25.0	25.5	25.5	25.5	25.5
27	16.5	19.5	22.5	24.5	25.0	26.0	26.0	26.0	26.5	26.5	26.5
28	17.5	20.5	23.5	25.0	26.0	27.0	27.0	27.0	27.5	27.5	27.5
29	18.0	21.0	24.0	26.0	27.0	28.0	28.0	28.0	28.0	28.5	28.5
30	18.5	22.0	25.0	27.0	28.0	28.5	29.0	29.0	29.0	29.5	29.5
31	19.5	22.5	26.0	28.0	29.0	29.5	30.0	30.0	30.0	30.5	30.5

Electr. conductivity value of the material in % IACS	**FS40 probe, probe frequency 120 kHz**										
	Diameter of curvature in inches *(cm)*										
	0.25 *0.63*	**0.375** *0.95*	**0.50** *1.27*	**0.75** *1.91*	**1.00** *2.54*	**1.50** *3.81*	**2.00** *5.08*	**3.00** *7.62*	**3.50** *8.89*	**4.00** *10.16*	**5.00** *12.70*
	Electrical conductivity values in %IACS measured for each diameter of curvature										
32	20.0	23.5	26.5	29.0	30.0	30.5	30.5	31.0	31.0	31.0	31.5
33	20.5	24.0	27.5	29.5	30.5	31.5	31.5	32.0	32.0	32.0	32.5
34	21.5	25.0	28.5	30.5	31.5	32.5	32.5	33.0	33.0	33.0	33.5
35	22.0	25.5	29.0	31.5	32.5	33.5	33.5	34.0	34.0	34.0	34.5
36	22.5	26.5	30.0	32.5	33.5	34.5	34.5	35.0	35.0	35.0	35.5
37	23.0	27.0	31.0	33.5	34.5	35.0	35.5	35.5	36.0	36.0	36.5
38	24.0	28.0	32.0	34.0	35.5	36.0	36.5	36.5	37.0	37.0	37.5
39	24.5	28.5	32.5	35.0	36.0	37.0	37.0	37.5	38.0	38.0	38.5
40	25.0	29.5	33.5	36.0	37.0	38.0	38.0	38.5	39.0	39.0	39.5
41	26.0	30.0	34.5	37.0	38.0	39.0	39.0	39.5	39.5	40.0	40.5
42	26.5	31.0	35.0	38.0	39.0	40.0	40.0	40.5	40.5	41.0	41.5
43	27.0	31.5	36.0	38.5	40.0	40.5	41.0	41.5	41.5	42.0	42.5
44	28.0	32.5	37.0	39.5	41.0	41.5	42.0	42.5	42.5	43.0	43.5
45	28.5	33.0	37.5	40.5	41.5	42.5	43.0	43.5	43.5	44.0	44.5
46	29.0	34.0	38.5	41.5	42.5	43.5	43.5	44.0	44.5	44.5	45.5
47	29.5	34.5	39.5	42.0	43.5	44.5	44.5	45.0	45.5	45.5	46.0
48	30.5	35.5	40.0	43.0	44.5	45.5	45.5	46.0	46.5	46.5	47.0
49	31.0	36.0	41.0	44.0	45.5	46.0	46.5	47.0	47.5	47.5	48.0
50	31.5	36.5	42.0	45.0	46.5	47.0	47.5	48.0	48.5	48.5	49.0
51	32.5	37.5	42.5	46.0	47.0	48.0	48.5	49.0	49.5	49.5	50.0
52	33.0	38.0	43.5	46.5	48.0	49.0	49.5	50.0	50.0	50.5	51.0
53	33.5	39.0	44.5	47.5	49.0	50.0	50.0	51.0	51.0	51.5	52.0
54	34.5	39.5	45.0	48.5	50.0	51.0	51.0	52.0	52.0	52.5	53.0
55	35.0	40.5	46.0	49.5	51.0	51.5	52.0	52.5	53.0	53.5	54.0
56	35.5	41.0	47.0	50.5	52.0	52.5	53.0	53.5	54.0	54.5	55.0

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 120 kHz										
	Diameter of curvature in inches *(cm)*										
	0.25 *0.63*	**0.375** *0.95*	**0.50** *1.27*	**0.75** *1.91*	**1.00** *2.54*	**1.50** *3.81*	**2.00** *5.08*	**3.00** *7.62*	**3.50** *8.89*	**4.00** *10.16*	**5.00** *12.70*
	Electrical conductivity values in %IACS measured for each diameter of curvature										
57	36.0	42.0	47.5	51.0	53.0	53.5	54.0	54.5	55.0	55.5	56.0
58	37.0	42.5	48.5	52.0	53.5	54.5	55.0	55.5	56.0	56.5	57.0
59	37.5	43.5	49.5	53.0	54.5	55.5	56.0	56.5	57.0	57.5	58.0
60	38.0	44.0	50.0	54.0	55.5	56.5	56.5	57.5	58.0	58.0	59.0

23.3.3 BSS 7351, Correction table for convex specimens, measurements at a probe frequency of 240 kHz

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 240 kHz										
	Diameter of curvature in inches *(cm)*										
	0.25 *0.63*	**0.375** *0.95*	**0.50** *1.27*	**0.75** *1.91*	**1.00** *2.54*	**1.50** *3.81*	**2.00** *5.08*	**3.00** *7.62*	**3.50** *8.89*	**4.00** *10.16*	**5.00** *12.70*
	Electrical conductivity values in %IACS measured for each diameter of curvature										
20	12.5	14.5	16.5	18.0	18.5	20.0	20.0	20.0	20.0	20.0	20.0
21	13.0	15.5	17.5	19.0	19.5	21.0	21.0	21.0	21.0	21.0	21.0
22	14.0	16.0	18.5	20.0	20.5	22.0	22.0	22.0	22.0	22.0	22.0
23	14.5	17.0	19.0	21.0	21.5	22.5	22.5	22.5	22.5	22.5	23.0
24	15.0	17.5	20.0	21.5	22.0	23.5	23.5	23.5	23.5	23.5	23.5
25	16.0	18.5	21.0	22.5	23.0	24.5	24.5	24.5	24.5	24.5	24.5
26	16.5	19.0	22.0	23.5	24.0	25.5	25.5	25.5	25.5	25.5	25.5
27	17.0	20.0	22.5	24.5	25.0	26.5	26.5	26.5	26.5	26.5	26.5
28	18.0	20.5	23.5	25.5	26.0	27.0	27.5	27.5	27.5	27.5	27.5
29	18.5	21.5	24.5	26.0	27.0	28.0	28.0	28.5	28.5	28.5	28.5
30	19.0	22.0	25.0	27.0	28.0	29.0	29.0	29.5	29.5	29.5	29.5

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 240 kHz										
	Diameter of curvature in inches *(cm)*										
	0.25 *0.63*	**0.375** *0.95*	**0.50** *1.27*	**0.75** *1.91*	**1.00** *2.54*	**1.50** *3.81*	**2.00** *5.08*	**3.00** *7.62*	**3.50** *8.89*	**4.00** *10.16*	**5.00** *12.70*
	Electrical conductivity values in %IACS measured for each diameter of curvature										
31	20.0	23.0	26.0	28.0	28.5	30.0	30.0	30.0	30.5	30.5	30.5
32	20.5	23.5	27.0	29.0	29.5	31.0	31.0	31.0	31.5	31.5	31.5
33	21.0	24.5	27.5	29.5	30.5	31.5	32.0	32.0	32.0	32.5	32.5
34	21.5	25.0	28.5	30.5	31.5	32.5	33.0	33.0	33.0	33.5	33.5
35	22.5	26.0	29.5	31.5	32.5	33.5	33.5	34.0	34.0	34.0	34.5
36	23.0	26.5	30.0	32.5	33.5	34.5	34.5	35.0	35.0	35.0	35.5
37	23.5	27.5	31.0	33.5	34.5	35.5	35.5	36.0	36.0	36.0	36.5
38	24.5	28.0	32.0	34.0	35.5	36.5	36.5	37.0	37.0	37.0	37.5
39	25.0	29.0	32.5	35.0	36.0	37.0	37.5	37.5	38.0	38.0	38.5
40	25.5	29.5	33.5	36.0	37.0	38.0	38.5	38.5	39.0	39.0	39.5
41	26.5	30.5	34.5	37.0	38.0	39.0	39.0	39.5	40.0	40.0	40.5
42	27.0	31.0	35.0	38.0	39.0	40.0	40.0	40.5	40.5	41.0	41.5
43	27.5	32.0	36.0	38.5	40.0	41.0	41.0	41.5	41.5	42.0	42.5
44	28.5	32.5	37.0	39.5	41.0	41.5	42.0	42.5	42.5	43.0	43.5
45	29.0	33.5	38.0	40.5	42.0	42.5	43.0	43.5	43.5	44.0	44.5
46	29.5	34.0	38.5	41.5	43.0	43.5	44.0	44.5	44.5	45.0	45.5
47	30.5	35.0	39.5	42.0	43.5	44.5	44.5	45.0	45.5	45.5	46.5
48	31.0	35.5	40.5	43.0	44.5	45.5	45.5	46.0	46.5	46.5	47.0
49	31.5	36.5	41.0	44.0	45.5	46.5	46.5	47.0	47.5	47.5	48.0
50	32.0	37.0	42.0	45.0	46.5	47.0	47.5	48.0	48.5	48.5	49.0
51	33.0	38.0	43.0	46.0	47.5	48.0	48.5	49.0	49.5	49.5	50.0
52	33.5	38.5	43.5	46.5	48.5	49.0	49.5	50.0	50.0	50.5	51.0
53	34.0	39.5	44.5	47.5	49.5	50.0	50.0	51.0	51.0	51.5	52.0
54	35.0	40.0	45.5	48.5	50.0	51.0	51.0	52.0	52.0	52.5	53.0
55	35.5	41.0	46.0	49.5	51.0	51.5	52.0	52.5	53.0	53.5	54.0

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 240 kHz										
	Diameter of curvature in inches *(cm)*										
	0.25 *0.63*	**0.375** *0.95*	**0.50** *1.27*	**0.75** *1.91*	**1.00** *2.54*	**1.50** *3.81*	**2.00** *5.08*	**3.00** *7.62*	**3.50** *8.89*	**4.00** *10.16*	**5.00** *12.70*
	Electrical conductivity values in %IACS measured for each diameter of curvature										
56	36.0	41.5	47.0	50.5	52.0	52.5	53.0	53.5	54.0	54.5	55.0
57	37.0	42.5	48.0	51.0	53.0	53.5	54.0	54.5	55.0	55.5	56.0
58	37.5	43.0	48.5	52.0	54.0	54.5	55.0	55.5	56.0	56.5	57.0
59	38.0	44.0	49.5	53.0	55.0	55.5	55.5	56.5	57.0	57.0	58.0
60	39.0	44.5	50.5	54.0	56.0	56.0	56.5	57.5	58.0	58.0	59.0

23.3.4 BSS 7351, Correction table for convex specimens, measurements at a probe frequency of 480 kHz

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 480 kHz										
	Diameter of curvature in inches *(cm)*										
	0.25 *0.63*	**0.375** *0.95*	**0.50** *1.27*	**0.75** *1.91*	**1.00** *2.54*	**1.50** *3.81*	**2.00** *5.08*	**3.00** *7.62*	**3.50** *8.89*	**4.00** *10.16*	**5.00** *12.70*
	Electrical conductivity values in %IACS measured for each diameter of curvature										
20	13.0	15.0	17.0	18.0	18.5	19.5	19.5	19.5	19.5	19.5	19.5
21	13.5	15.5	18.0	19.0	19.5	20.5	20.5	20.5	20.5	20.5	20.5
22	14.0	16.5	18.5	20.0	20.5	21.0	21.5	21.5	21.5	21.5	21.5
23	15.0	17.0	19.5	21.0	21.5	22.0	22.0	22.5	22.5	22.5	22.5
24	15.5	18.0	20.5	21.5	22.5	23.0	23.0	23.5	23.5	23.5	23.5
25	16.0	18.5	21.0	22.5	23.0	24.0	24.0	24.5	24.5	24.5	24.5
26	16.5	19.5	22.0	23.5	24.0	25.0	25.0	25.0	25.5	25.5	25.5
27	17.5	20.0	23.0	24.5	25.0	26.0	26.0	26.0	26.5	26.5	26.5
28	18.0	21.0	23.5	25.0	26.0	27.0	27.0	27.0	27.0	27.5	27.5

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 480 kHz										
	Diameter of curvature in inches *(cm)*										
	0.25 *0.63*	**0.375** *0.95*	**0.50** *1.27*	**0.75** *1.91*	**1.00** *2.54*	**1.50** *3.81*	**2.00** *5.08*	**3.00** *7.62*	**3.50** *8.89*	**4.00** *10.16*	**5.00** *12.70*
	Electrical conductivity values in %IACS measured for each diameter of curvature										
29	18.5	21.5	24.5	26.0	27.0	27.5	28.0	28.0	28.0	28.5	28.5
30	19.0	22.5	25.5	27.0	28.0	28.5	29.0	29.0	29.0	29.5	29.5
31	20.0	23.0	26.0	28.0	29.0	29.5	29.5	30.0	30.0	30.5	30.5
32	20.5	23.5	27.0	29.0	29.5	30.5	30.5	31.0	31.0	31.0	31.5
33	21.0	24.5	27.5	29.5	30.5	31.5	31.5	32.0	32.0	32.0	32.5
34	22.0	25.0	28.5	30.5	31.5	32.5	32.5	33.0	33.0	33.0	33.5
35	22.5	26.0	29.5	31.5	32.5	33.5	33.5	34.0	34.0	34.0	34.5
36	23.0	26.5	30.0	32.5	33.5	34.5	34.5	35.0	35.0	35.0	35.5
37	23.5	27.5	31.0	33.0	34.5	35.0	35.5	35.5	36.0	36.0	36.5
38	24.5	28.0	32.0	34.0	35.5	36.0	36.5	36.5	37.0	37.0	37.5
39	25.0	29.0	32.5	35.0	36.0	37.0	37.0	37.5	38.0	38.0	38.5
40	25.5	29.5	33.5	36.0	37.0	38.0	38.0	38.5	39.0	39.0	39.5
41	26.0	30.5	34.5	37.0	38.0	39.0	39.0	39.5	39.5	40.0	40.5
42	27.0	31.0	35.0	37.5	39.0	40.0	40.0	40.5	40.5	41.0	41.5
43	27.5	32.0	36.0	38.5	40.0	41.0	41.0	41.5	41.5	42.0	42.5
44	28.0	32.5	37.0	39.5	41.0	41.5	42.0	42.5	42.5	43.0	43.5
45	29.0	33.0	37.5	40.5	42.0	42.5	43.0	43.5	43.5	44.0	44.5
46	29.5	34.0	38.5	41.0	42.5	43.5	44.0	44.5	44.5	45.0	45.5
47	30.0	34.5	39.5	42.0	43.5	44.5	44.5	45.5	45.5	46.0	46.5
48	30.5	35.5	40.0	43.0	44.5	45.5	45.5	46.0	46.5	46.5	47.5
49	31.5	36.0	41.0	44.0	45.5	46.5	46.5	47.0	47.5	47.5	48.0
50	32.0	37.0	42.0	45.0	46.5	47.5	47.5	48.0	48.5	48.5	49.0
51	32.5	37.5	42.5	45.5	47.5	48.0	48.5	49.0	49.5	49.5	50.0
52	33.0	38.5	43.5	46.5	48.0	49.0	49.5	50.0	50.5	50.5	51.0

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 480 kHz										
	Diameter of curvature in inches *(cm)*										
	0.25 *0.63*	**0.375** *0.95*	**0.50** *1.27*	**0.75** *1.91*	**1.00** *2.54*	**1.50** *3.81*	**2.00** *5.08*	**3.00** *7.62*	**3.50** *8.89*	**4.00** *10.16*	**5.00** *12.70*
	Electrical conductivity values in %IACS measured for each diameter of curvature										
53	34.0	39.0	44.5	47.5	49.0	50.0	50.5	51.0	51.5	51.5	52.0
54	34.5	40.0	45.0	48.5	50.0	51.0	51.5	52.0	52.0	52.5	53.0
55	35.0	40.5	46.0	49.0	51.0	52.0	52.5	53.0	53.0	53.5	54.0
56	35.5	41.5	46.5	50.0	52.0	53.0	53.0	54.0	54.0	54.5	55.0
57	36.5	42.0	47.5	51.0	53.0	54.0	54.0	55.0	55.0	55.5	56.0
58	37.0	42.5	48.5	52.0	54.0	54.5	55.0	55.5	56.0	56.5	57.0
59	37.5	43.5	49.0	53.0	54.5	55.5	56.0	56.5	57.0	57.5	58.0
60	38.5	44.0	50.0	53.5	55.5	56.5	57.0	57.5	58.0	58.5	59.0

23.3.5 BSS 7351, Measurements on thin, unclad substrate material at a probe frequency of 60 kHz

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 60 kHz						
	Unclad substrate material thicknesses in inches *(mm)*						
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	≥ **0.063** ≥ *1.60*
	Electrical conductivity values in % IACS measured for each unclad substrate material thickness						
26	13.5	19.0	23.5	27.5	27.5	26.5	26.0
27	14.0	20.0	25.0	28.5	29.0	27.5	27.0
28	14.5	21.0	26.5	29.5	30.0	28.5	28.0
29	15.5	22.5	28.0	31.0	31.0	29.5	29.0
30	16.0	24.0	29.0	32.0	32.0	30.5	30.0

Electr. conductivity value of the material in % IACS	**FS40 probe, probe frequency 60 kHz**						
	Unclad substrate material thicknesses in inches *(mm)*						
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**≥ 0.063** *≥ 1.60*
	Electrical conductivity values in % IACS measured for each unclad substrate material thickness						
31	19.0	25.5	30.5	33.0	33.0	31.5	31.0
32	20.5	27.0	32.0	34.5	33.5	32.5	32.0
33	21.0	28.0	33.0	35.5	34.5	33.5	33.0
34	22.0	29.5	34.0	36.5	35.5	34.5	34.0
35	22.5	30.5	35.5	37.5	36.5	35.5	35.0
36	23.0	32.0	36.5	38.5	37.5	36.5	36.0
37	24.0	33.0	38.0	40.0	38.5	37.5	37.0
38	24.5	34.5	39.0	41.0	39.5	38.5	38.0
39	25.0	35.5	40.5	42.0	40.0	39.0	39.0
40	26.0	37.0	41.5	43.0	41.0	40.0	40.0
41	27.5	38.0	43.0	44.5	42.0	41.0	41.0
42	30.0	38.5	44.5	45.5	43.5	42.0	42.0
43	32.5	39.0	46.0	46.5	44.5	43.0	43.0
44	35.0	40.0	47.5	47.5	45.5	44.0	44.0
45	37.0	40.5	49.0	49.0	46.5	45.0	45.0
46	38.0	42.0	50.0	49.5	47.5	46.0	46.0
47	39.0	43.5	51.0	50.5	48.5	47.0	47.0
48	40.0	45.5	52.5	51.5	49.0	48.0	48.0
49	40.5	47.0	53.5	52.5	50.0	49.0	49.0
50	41.5	48.5	54.5	53.5	51.0	50.0	50.0
51	42.0	50.0	56.0	54.0	52.0	51.0	51.0
52	43.0	52.0	57.0	55.0	53.0	52.0	52.0
53	44.0	53.5	58.0	56.0	53.5	53.0	53.0
54	44.5	55.0	59.0	57.0	54.5	54.0	54.0

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 60 kHz						
	Unclad substrate material thicknesses in inches *(mm)*						
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	≥ **0.063** ≥ *1.60*
	Electrical conductivity values in % IACS measured for each unclad substrate material thickness						
55	45.5	56.5	60.5	58.0	55.5	55.0	55.0
56	46.5	58.0	61.5	58.5	56.5	56.0	56.0
57	47.0	60.0	62.5	59.5	57.5	57.0	57.0
58	48.0	61.5	64.0	60.5	58.0	58.0	58.0
59	49.0	63.0	65.0	61.5	59.0	59.0	59.0
60	50.0	64.5	66.0	62.5	60.0	60.0	60.0
61	51.5	65.5	67.0	63.5	61.0	61.0	61.0
62	53.0	66.5	67.5	64.0	62.0	62.0	62.0
63	54.5	67.5	68.5	65.0	63.0	63.0	63.0
64	56.0	68.5	69.5	66.0	64.0	64.0	64.0
65	57.5	69.5	70.5	67.0	65.0	65.0	65.0

23.3.6 BSS 7351, Measurements on clad aluminium, cladding types 2014 and 2219, at a probe frequency of 60 kHz

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 60 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
26	18.0	25.0	28.5	30.5	29.0	28.5	29.0	30.5	31.5	28.5	28.5	29.5	30.0	30.5
27	18.5	25.5	29.5	31.5	30.0	29.5	30.0	31.5	32.0	29.5	29.5	30.0	30.5	31.5

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 60 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
28	20.0	26.5	30.5	32.5	31.0	30.5	31.0	32.5	33.0	30.0	30.5	31.0	31.5	32.5
29	22.0	27.0	32.0	33.5	32.0	31.5	32.0	33.0	34.0	31.0	31.5	32.0	32.5	33.0
30	23.5	28.0	33.0	34.5	32.5	32.0	33.0	34.0	34.5	32.0	32.5	33.0	33.5	34.0
31	24.0	30.5	34.0	35.5	33.5	33.0	34.0	35.0	35.5	33.0	33.0	33.5	34.0	35.0
32	25.0	32.0	35.5	36.5	34.5	34.0	34.5	35.5	36.5	33.5	34.0	34.5	35.0	35.5
33	26.0	33.0	36.5	37.5	35.5	35.0	35.5	36.5	37.0	34.5	35.0	35.5	36.0	36.5
34	27.0	33.5	37.5	38.5	36.5	36.0	36.5	37.5	38.0	35.5	36.0	36.5	37.0	37.5
35	28.0	34.5	38.5	39.5	37.5	36.5	37.5	38.0	39.0	36.5	36.5	37.0	37.5	38.0
36	29.0	35.0	39.5	40.5	38.0	37.5	38.5	39.0	39.5	37.5	37.5	38.0	38.5	39.0
37	29.5	36.0	40.5	41.5	39.0	38.5	39.0	40.0	40.5	38.5	38.5	39.0	39.5	40.0
38	30.5	36.5	42.0	42.5	40.0	39.5	40.0	41.0	41.5	39.0	39.5	40.0	40.5	41.0
39	31.5	37.5	43.0	43.5	41.0	40.5	41.0	41.5	42.0	40.0	40.5	41.0	41.0	41.5
40	32.5	38.0	44.0	44.0	42.0	41.0	42.0	42.5	43.0	41.0	41.5	41.5	42.0	42.5
41	34.5	39.5	45.0	45.0	42.5	42.0	42.5	43.5	44.0	42.0	42.0	42.5	43.0	43.5
42	37.0	41.5	46.5	46.0	43.5	43.0	43.5	44.0	44.5	43.0	43.0	43.5	43.5	44.0
43	39.5	43.5	47.5	47.0	44.5	44.0	44.5	45.0	45.5	43.5	44.0	44.0	44.5	45.0
44	42.0	45.0	48.5	48.0	45.5	44.5	45.0	45.5	46.0	44.5	45.0	45.0	45.5	45.5
45	44.0	47.0	50.0	49.0	46.5	45.5	46.0	46.5	46.5	45.5	45.5	46.0	46.0	46.5
46	45.0	48.0	51.0	49.5	47.5	46.5	47.0	47.0	47.5	46.5	46.5	46.5	47.0	47.0
47	45.5	48.5	52.0	50.5	48.0	47.5	47.5	48.0	48.5	47.0	47.5	47.5	48.0	48.0
48	46.0	49.5	53.0	51.5	49.0	48.0	48.5	49.0	49.0	48.0	48.0	48.5	48.5	49.0
49	47.0	50.0	54.0	52.0	50.0	49.0	49.5	49.5	50.0	49.0	49.0	49.5	49.5	49.5
50	47.5	51.0	55.0	53.0	50.5	50.0	50.0	50.5	50.5	50.0	50.0	50.0	50.0	50.5
51	48.0	51.5	56.0	54.0	51.5	51.0	51.0	51.0	51.5	51.0	51.0	51.0	51.0	51.0

23.3.7 BSS 7351, Measurements on clad aluminium, cladding types 2024, 7075, 7079 and 7178, at a probe frequency of 60 kHz

Electr. conductivity value of the materials in % IACS	FS40 probe, probe frequency 60 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
26	15.5	20.0	26.0	29.0	29.0	28.5	27.0	27.5	28.0	28.5	28.5	29.5	30.0	30.5
27	16.0	21.0	27.5	30.5	30.0	29.5	28.0	28.5	29.0	29.5	29.5	30.0	30.5	31.5
28	17.0	22.5	28.5	31.5	31.0	30.5	29.0	29.5	30.0	30.0	30.5	31.0	31.5	32.5
29	18.0	23.5	30.0	32.5	32.0	31.5	29.5	30.5	31.0	31.0	31.5	32.0	32.5	33.0
30	18.5	25.0	31.5	33.5	32.5	32.0	30.5	31.5	31.5	32.0	32.5	33.0	33.5	34.0
31	20.5	26.5	32.5	34.5	33.5	33.0	31.5	32.0	32.5	33.0	33.0	33.5	34.0	35.0
32	21.5	28.0	33.5	35.5	34.5	34.0	32.5	33.0	33.5	33.5	34.0	34.5	35.0	35.5
33	22.5	29.0	34.5	36.5	35.5	35.0	33.5	34.0	34.5	34.5	35.0	35.5	36.0	36.5
34	23.0	30.5	36.0	37.5	36.5	36.0	34.5	35.0	35.0	35.5	36.0	36.5	37.0	37.5
35	24.0	31.5	37.0	38.5	37.5	36.5	35.5	36.0	36.0	36.5	36.5	37.0	37.5	38.0
36	24.5	32.5	38.0	39.5	38.0	37.5	36.5	37.0	37.0	37.5	37.5	38.0	38.5	39.0
37	25.5	34.0	39.5	40.5	39.0	38.5	37.5	37.5	38.0	38.5	38.5	39.0	39.5	40.0
38	26.5	35.0	40.5	41.5	40.0	39.5	38.5	38.5	39.0	39.0	39.5	40.0	40.5	41.0
39	27.0	36.0	42.0	42.5	41.0	40.5	39.5	39.5	40.0	40.0	40.5	41.0	41.0	41.5
40	28.0	37.5	43.0	43.5	42.0	41.0	40.5	40.5	41.0	41.0	41.5	41.5	42.0	42.5
41	30.0	38.5	44.0	44.5	42.5	42.0	41.0	41.5	41.5	42.0	42.0	42.5	43.0	43.5
42	32.5	39.5	45.5	45.5	43.5	43.0	42.0	42.5	42.5	43.0	43.0	43.5	43.5	44.0
43	35.0	40.5	46.5	46.5	44.5	44.0	43.0	43.5	43.5	43.5	44.0	44.0	44.5	45.0
44	37.5	42.0	48.0	47.5	45.5	44.5	44.0	44.5	44.5	44.5	45.0	45.0	45.5	45.5
45	40.0	43.0	49.0	48.5	46.5	45.5	45.0	45.0	45.5	45.5	45.5	46.0	46.0	46.5
46	41.0	44.0	50.5	49.5	47.5	46.5	46.0	46.0	46.0	46.5	46.5	46.5	47.0	47.0
47	41.5	45.0	51.5	50.5	48.0	47.5	47.0	47.0	47.0	47.0	47.5	47.5	48.0	48.0

Electr. conductivity value of the materials in % IACS	FS40 probe, probe frequency 60 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
48	42.0	46.0	52.5	51.5	49.0	48.0	47.5	48.0	48.0	48.0	48.0	48.5	48.5	49.0
49	43.0	47.0	53.5	52.0	50.0	49.0	48.5	49.0	49.0	49.0	49.0	49.5	49.5	49.5
50	43.5	47.5	54.5	53.0	50.5	50.0	49.5	49.5	50.0	50.0	50.0	50.0	50.0	50.5

23.3.8 BSS 7351, Measurements on clad aluminium, cladding types 3003 and 6061, at a probe frequency of 60 kHz

Electr. conductivity value of the materials in % IACS	FS40 probe, probe frequency 60 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
36	24.5	32.5	38.0	39.5	38.0	37.5	38.5	39.0	39.5	40.0	41.0	41.5	42.5	43.5
37	25.5	34.0	39.5	40.5	39.0	38.5	39.0	40.0	40.5	41.0	41.5	42.5	43.5	44.5
38	26.5	35.0	40.5	41.5	40.0	39.5	40.0	41.0	41.5	42.0	42.5	43.0	44.0	45.0
39	27.0	36.0	42.0	42.5	41.0	40.5	41.0	41.5	42.0	42.5	43.0	44.0	45.0	46.0
40	28.0	37.5	43.0	43.5	42.0	41.0	42.0	42.5	43.0	43.5	44.0	45.0	45.5	46.5
41	30.0	38.5	44.0	44.5	42.5	42.0	42.5	43.5	44.0	44.5	44.5	45.5	46.0	47.0
42	32.5	39.5	45.5	45.5	43.5	43.0	43.5	44.0	44.5	45.0	45.5	46.0	46.5	47.5
43	35.0	40.5	46.5	46.5	44.5	44.0	44.5	45.0	45.5	45.5	46.0	46.5	47.0	48.0
44	37.5	42.0	48.0	47.5	45.5	44.5	45.0	45.5	46.0	46.5	46.5	47.0	47.5	48.5
45	40.0	43.0	49.0	48.5	46.5	45.5	46.0	46.5	46.5	47.0	47.5	48.0	48.5	49.0

Electr. conductivity value of the materials in % IACS	FS40 probe, probe frequency 60 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
46	41.0	44.0	50.5	49.5	47.5	46.5	47.0	47.0	47.5	48.0	48.0	48.5	49.0	49.5
47	41.5	45.0	51.5	50.5	48.0	47.5	47.5	48.0	48.5	48.5	49.0	49.0	49.5	50.0
48	42.0	46.0	52.5	51.5	49.0	48.0	48.5	49.0	49.0	49.5	49.5	50.0	50.0	50.5
49	43.0	47.0	53.5	52.0	50.0	49.0	49.5	49.5	50.0	50.0	50.0	50.5	51.0	51.5
50	43.5	47.5	54.5	53.0	50.5	50.0	50.0	50.5	50.5	51.0	51.0	51.0	51.5	52.0
51	44.5	48.5	55.5	54.0	51.5	51.0	51.0	51.0	51.5	51.5	51.5	52.0	52.0	52.5
52	45.0	49.5	56.5	54.5	52.5	51.5	52.0	52.0	52.0	52.5	52.5	52.5	53.0	53.0
53	46.0	50.5	57.5	55.5	53.0	52.5	52.5	53.0	53.0	53.0	53.0	53.5	53.5	53.5
54	46.5	51.5	58.5	56.5	54.0	53.5	53.5	53.5	53.5	54.0	54.0	54.0	54.0	54.0
55	47.5	52.5	59.5	57.5	54.5	54.0	54.5	54.5	54.5	54.5	54.5	54.5	54.5	55.0
56	48.0	53.5	61.0	58.0	55.5	55.0	55.0	55.0	55.5	55.5	55.5	55.5	55.5	55.5

23.3.9 BSS 7351, Measurements on thin, unclad substrate material at a probe frequency of 120 kHz

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 120 kHz						
	Unclad substrate material thicknesses in inches *(mm)*						
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	≥ **0.063** ≥ *1.60*
	Electrical conductivity values in % IACS measured for each unclad substrate material thickness						
26	21.0	26.0	28.0	27.5	26.5	26.0	26.0
27	22.0	27.5	29.0	28.5	27.5	27.0	27.0
28	23.0	29.0	30.5	29.5	28.0	28.0	28.0

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 120 kHz						
	Unclad substrate material thicknesses in inches *(mm)*						
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	≥ **0.063** ≥ *1.60*
	Electrical conductivity values in % IACS measured for each unclad substrate material thickness						
29	24.0	31.0	31.5	30.5	29.0	29.0	29.0
30	25.5	32.5	32.5	31.0	30.0	30.0	30.0
31	29.0	33.5	33.5	32.5	31.0	31.0	31.0
32	31.0	35.0	34.5	33.5	32.0	32.0	32.0
33	32.0	36.0	36.0	34.0	33.0	33.0	33.0
34	33.0	37.5	37.0	35.0	34.0	34.0	34.0
35	34.0	38.5	38.0	36.0	35.0	35.0	35.0
36	35.0	40.0	39.0	37.0	36.0	36.0	36.0
37	36.0	41.0	40.0	38.0	37.0	37.0	37.0
38	37.0	42.5	41.0	39.0	38.0	38.0	38.0
39	38.0	43.5	42.0	40.0	39.0	39.0	39.0
40	39.0	45.0	43.5	41.0	40.0	40.0	40.0
41	41.0	46.0	44.0	42.0	41.0	41.0	41.0
42	43.0	47.0	45.0	42.5	42.0	42.0	42.0
43	45.5	48.0	46.0	43.5	43.0	43.0	43.0
44	47.5	49.0	47.0	44.5	44.0	44.0	44.0
45	49.5	50.0	47.5	45.5	45.0	45.0	45.0
46	51.0	51.0	48.5	46.5	46.0	46.0	46.0
47	52.0	52.0	49.5	47.5	47.0	47.0	47.0
48	53.0	53.0	50.5	48.5	48.0	48.0	48.0
49	54.0	54.0	51.5	49.5	49.0	49.0	49.0
50	55.0	55.0	52.0	50.5	50.0	50.0	50.0
51	56.0	56.0	53.0	51.5	51.0	51.0	51.0
52	57.0	57.0	54.0	52.5	52.0	52.0	52.0
53	58.0	58.0	55.0	53.5	53.0	53.0	53.0

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 120 kHz						
	Unclad substrate material thicknesses in inches *(mm)*						
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	≥ **0.063** ≥ *1.60*
	Electrical conductivity values in % IACS measured for each unclad substrate material thickness						
54	58.5	59.0	56.0	54.5	54.0	54.0	54.0
55	59.5	60.0	56.5	55.0	55.0	55.0	55.0
56	60.5	61.0	57.5	56.0	56.0	56.0	56.0
57	61.5	62.0	58.5	57.0	57.0	57.0	57.0
58	62.5	63.0	59.5	58.0	58.0	58.0	58.0
59	63.5	64.0	60.5	59.0	59.0	59.0	59.0
60	64.5	65.0	61.5	60.0	60.0	60.0	60.0
61	65.5	66.0	62.0	61.0	61.0	61.0	61.0
62	67.0	67.0	63.0	62.0	62.0	62.0	62.0
63	68.0	68.0	64.0	63.0	63.0	63.0	63.0
64	69.0	69.0	65.0	64.0	64.0	64.0	64.0
65	70.0	70.0	66.0	65.0	65.0	65.0	65.0

23.3.10 BSS 7351, Measurements on clad aluminium, cladding types 2014 and 2219, at a probe frequency of 120 kHz

Electr. conductivity value of the materials in % IACS	FS40 probe, probe frequency 120 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
26	27.0	32.0	31.0	30.5	29.0	30.0	32.0	33.5	35.0	30.0	31.0	31.5	32.5	33.5
27	28.5	33.0	32.0	31.5	30.0	31.0	33.0	34.5	35.5	31.0	31.5	32.5	33.5	34.5

FS40 probe, probe frequency 120 kHz

Electr. conductivity value of the materials in % IACS	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
28	30.0	34.0	33.0	32.5	31.0	32.0	33.5	35.5	36.5	32.0	32.5	33.5	34.5	35.5
29	32.0	35.0	34.0	33.5	32.0	33.0	34.5	36.5	37.5	33.0	33.5	34.5	35.5	36.5
30	34.0	36.5	35.0	34.0	32.5	34.0	35.5	37.5	38.5	34.0	34.5	35.5	36.0	37.5
31	34.5	37.5	35.5	35.0	33.5	35.0	36.0	38.0	39.0	34.5	35.0	36.0	37.0	38.0
32	35.5	38.5	36.5	36.0	34.5	35.5	37.0	38.5	39.5	35.5	36.0	36.5	37.5	38.5
33	36.5	39.5	37.5	36.5	35.5	36.5	38.0	39.0	40.5	36.0	36.5	37.5	38.0	39.0
34	38.0	40.5	38.5	37.5	36.5	37.5	38.5	40.0	41.0	37.0	37.5	38.0	39.0	40.0
35	39.0	41.5	39.5	38.5	37.5	38.0	39.5	40.5	41.5	38.0	38.5	39.0	39.5	40.5
36	40.5	42.5	40.5	39.5	38.0	39.0	40.0	41.5	42.0	38.5	39.0	40.0	40.5	41.5
37	41.5	43.5	41.5	40.5	39.0	40.0	41.0	42.0	43.0	39.5	40.0	40.5	41.0	42.0
38	43.0	44.5	42.5	41.0	40.0	41.0	42.0	42.5	43.5	40.5	41.0	41.5	42.0	42.5
39	44.0	45.5	43.0	42.0	41.0	41.5	42.5	43.5	44.0	41.0	41.5	42.0	42.5	43.5
40	45.5	46.5	44.0	43.0	41.5	42.5	43.5	44.0	45.0	42.0	42.5	43.0	43.5	44.0
41	46.5	47.5	45.0	43.5	42.5	43.5	44.0	45.0	45.5	43.0	43.0	43.5	44.0	45.0
42	47.5	48.0	46.0	44.5	43.5	44.0	45.0	45.5	46.0	43.5	44.0	44.5	45.0	45.5
43	48.5	49.0	46.5	45.0	44.0	45.0	45.5	46.0	46.5	44.5	44.5	45.0	45.5	46.0
44	49.5	49.5	47.5	45.5	45.0	45.5	46.0	47.0	47.5	45.0	45.5	46.0	46.5	47.0
45	50.5	50.5	48.0	46.5	45.5	46.5	47.0	47.5	48.0	46.0	46.0	46.5	47.0	47.5
46	51.5	51.5	49.0	47.0	46.5	47.0	47.5	48.0	48.5	47.0	47.0	47.5	47.5	48.0
47	52.5	52.0	49.5	48.0	47.5	48.0	48.5	49.0	49.5	47.5	48.0	48.0	48.5	49.0
48	53.5	53.0	50.5	48.5	48.5	48.5	49.0	49.5	50.0	48.5	48.5	49.0	49.0	49.5
49	54.5	54.0	51.0	49.5	49.0	49.5	50.0	50.0	50.5	49.0	49.5	49.5	50.0	50.0
50	55.5	55.0	52.0	50.5	50.0	50.5	50.5	51.0	51.0	50.0	50.0	50.5	50.5	51.0
51	57.0	55.5	53.0	51.0	51.0	51.0	51.5	51.5	52.0	51.0	51.0	51.0	51.5	51.5

23.3.11 BSS 7351, Measurements on clad aluminium, cladding types 2024, 7075, 7079 and 7178, at a probe frequency of 120 kHz

Electr. conductivity value of the materials in % IACS	FS40 probe, probe frequency 120 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
26	23.0	27.5	29.5	28.5	29.0	30.0	27.5	29.0	29.5	30.0	31.0	31.5	32.5	33.5
27	24.0	29.0	30.5	29.5	30.0	31.0	28.5	30.0	30.5	31.0	31.5	32.5	33.5	34.5
28	25.5	30.0	31.5	30.5	31.0	32.0	29.5	31.0	31.5	32.0	32.5	33.5	34.5	35.5
29	27.0	31.5	32.5	31.5	32.0	33.0	30.5	32.0	32.5	33.0	33.5	34.5	35.5	36.5
30	28.5	33.0	33.5	32.5	32.5	34.0	31.5	33.0	33.5	34.0	34.5	35.5	36.0	37.5
31	30.5	34.0	34.5	33.5	33.5	35.0	32.5	33.5	34.0	34.5	35.0	36.0	37.0	38.0
32	32.0	35.5	35.5	34.0	34.5	35.5	33.5	34.0	34.5	35.5	36.0	36.5	37.5	38.5
33	33.0	36.5	36.5	35.0	35.5	36.5	34.5	35.0	35.5	36.0	36.5	37.5	38.0	39.0
34	34.0	37.5	37.5	36.0	36.5	37.5	35.5	36.0	36.5	37.0	37.5	38.0	39.0	40.0
35	35.5	39.0	38.5	37.0	37.5	38.0	36.5	37.0	37.5	38.0	38.5	39.0	39.5	40.5
36	36.5	40.0	39.5	38.0	38.0	39.0	37.5	38.0	38.0	38.5	39.0	40.0	40.5	41.5
37	38.0	41.0	40.5	39.0	39.0	40.0	38.5	38.5	39.0	39.5	40.0	40.5	41.0	42.0
38	39.0	42.5	41.5	39.5	40.0	41.0	39.0	39.5	40.0	40.5	41.0	41.5	42.0	42.5
39	40.0	43.5	42.5	40.5	41.0	41.5	40.0	40.5	41.0	41.0	41.5	42.0	42.5	43.5
40	41.5	44.5	43.5	41.5	41.5	42.5	41.0	41.5	41.5	42.0	42.5	43.0	43.5	44.0
41	43.0	46.0	44.0	42.5	42.5	43.5	42.0	42.0	42.5	43.0	43.0	43.5	44.0	45.0
42	45.0	47.0	45.0	43.0	43.5	44.0	42.5	43.0	43.5	43.5	44.0	44.5	45.0	45.5
43	46.5	48.0	45.5	44.0	44.0	45.0	43.5	44.0	44.0	44.5	44.5	45.0	45.5	46.0
44	48.5	49.0	46.5	44.5	45.0	45.5	44.5	44.5	45.0	45.0	45.5	46.0	46.5	47.0
45	50.5	50.0	47.0	45.5	45.5	46.5	45.0	45.5	45.5	46.0	46.0	46.5	47.0	47.5
46	51.5	51.0	48.0	46.5	46.5	47.0	46.0	46.5	46.5	47.0	47.0	47.5	47.5	48.0
47	52.5	52.0	49.0	47.0	47.5	48.0	47.0	47.0	47.5	47.5	48.0	48.0	48.5	49.0

Electr. conductivity value of the materials in % IACS	FS40 probe, probe frequency 120 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
48	53.5	53.0	50.0	48.0	48.5	48.5	48.0	48.0	48.0	48.5	48.5	49.0	49.0	49.5
49	54.5	54.0	50.5	49.0	49.0	49.5	48.5	49.0	49.0	49.0	49.5	49.5	50.0	50.0
50	55.5	55.0	51.5	50.0	50.0	50.5	49.5	50.0	50.0	50.0	50.0	50.5	50.5	51.0

23.3.12 BSS 7351, Measurements on clad aluminium, cladding types 3003 and 6061, at a probe frequency of 120 kHz

Electr. conductivity value of the materials in % IACS	FS40 probe, probe frequency 120 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
36	36.5	40.0	39.5	38.0	38.0	39.0	40.0	41.5	42.0	43.0	44.0	45.5	46.5	48.5
37	38.0	41.0	40.5	39.0	39.0	40.0	41.0	42.0	43.0	43.5	44.5	46.0	47.0	49.0
38	39.0	42.5	41.5	39.5	40.0	41.0	42.0	42.5	43.5	44.5	45.0	46.5	47.5	49.0
39	40.0	43.5	42.5	40.5	41.0	41.5	42.5	43.5	44.0	45.0	45.5	47.0	48.0	49.5
40	41.5	44.5	43.5	41.5	41.5	42.5	43.5	44.0	45.0	45.5	46.5	47.5	48.5	50.0
41	43.0	46.0	44.0	42.5	42.5	43.5	44.0	45.0	45.5	46.0	47.0	48.0	49.0	50.0
42	45.0	47.0	45.0	43.0	43.5	44.0	45.0	45.5	46.0	46.5	47.5	48.5	49.0	50.5
43	46.5	48.0	45.5	44.0	44.0	45.0	45.5	46.0	46.5	47.5	48.0	49.0	49.5	51.0
44	48.5	49.0	46.5	44.5	45.0	45.5	46.0	47.0	47.5	48.0	48.5	49.0	50.0	51.0
45	50.5	50.0	47.0	45.5	45.5	46.5	47.0	47.5	48.0	48.5	49.0	49.5	50.5	51.5

Electr. conductivity value of the materials in % IACS	FS40 probe, probe frequency 120 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
46	51.5	51.0	48.0	46.5	46.5	47.0	47.5	48.0	48.5	49.0	49.5	50.0	51.0	52.0
47	52.5	52.0	49.0	47.0	47.5	48.0	48.5	49.0	49.5	49.5	50.0	50.5	51.5	52.0
48	53.5	53.0	50.0	48.0	48.5	48.5	49.0	49.5	50.0	50.5	50.5	51.0	52.0	52.5
49	54.5	54.0	50.5	49.0	49.0	49.5	50.0	50.0	50.5	51.0	51.0	51.5	52.0	53.0
50	55.5	55.0	51.5	50.0	50.0	50.5	50.5	51.0	51.0	51.5	52.0	52.0	52.5	53.0
51	56.5	56.0	52.5	50.5	51.0	51.0	51.5	51.5	52.0	52.0	52.5	52.5	53.0	53.5
52	57.5	57.0	53.5	51.5	51.5	52.0	52.0	52.5	52.5	52.5	53.0	53.0	53.5	54.0
53	58.5	58.0	54.0	52.5	52.5	52.5	53.0	53.0	53.0	53.5	53.5	53.5	54.0	54.5
54	59.5	59.0	55.0	53.5	53.5	53.5	53.5	53.5	54.0	54.0	54.0	54.0	54.5	54.5
55	60.5	60.0	56.0	54.0	54.0	54.5	54.5	54.5	54.5	54.5	54.5	54.5	55.0	55.0
56	61.5	61.0	57.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.5	55.5

23.3.13 BSS 7351, Measurements on thin, unclad substrate material at a probe frequency of 240 kHz

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 240 kHz						
	Unclad substrate material thicknesses in inches *(mm)*						
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	≥ **0.063** ≥ *1.60*
	Electrical conductivity values in % IACS measured for each unclad substrate material thickness						
26	28.0	28.5	27.0	26.0	26.0	26.0	26.0
27	29.0	29.5	28.0	27.0	27.0	27.0	27.0
28	30.0	30.5	29.0	28.0	28.0	28.0	28.0

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 240 kHz						
	Unclad substrate material thicknesses in inches *(mm)*						
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	≥ **0.063** ≥ *1.60*
	Electrical conductivity values in % IACS measured for each unclad substrate material thickness						
29	31.5	31.5	29.5	29.0	29.0	29.0	29.0
30	33.0	32.5	30.5	30.0	30.0	30.0	30.0
31	35.0	33.5	32.0	31.0	31.0	31.0	31.0
32	36.0	34.5	33.0	32.0	32.5	32.5	32.0
33	37.5	35.5	34.0	33.0	33.5	33.5	33.0
34	38.5	36.0	34.5	34.0	34.5	34.5	34.0
35	39.5	37.0	35.5	35.0	35.5	35.5	35.5
36	40.5	38.0	36.5	36.0	36.5	36.5	36.5
37	41.5	39.0	37.5	37.0	37.5	37.5	37.5
38	42.5	40.0	38.5	38.0	38.5	38.5	38.5
39	44.0	40.5	39.5	39.0	39.5	39.5	39.5
40	45.0	41.5	40.5	40.0	40.5	40.5	40.5
41	46.0	42.5	41.5	41.0	41.5	41.5	41.5
42	46.5	44.0	42.5	42.0	42.5	42.5	42.5
43	47.5	45.0	43.0	43.0	43.5	43.5	43.5
44	48.0	46.5	44.0	44.0	44.5	44.5	44.5
45	49.0	47.5	45.0	45.0	45.5	45.5	45.5
46	50.0	48.5	46.0	46.0	46.5	46.5	46.5
47	51.0	49.5	47.0	47.0	47.5	47.5	47.5
48	52.0	50.0	48.0	48.0	48.5	48.5	48.5
49	53.0	51.0	49.0	49.0	49.5	49.5	49.5
50	54.5	52.0	50.0	50.0	50.5	50.5	50.5
51	55.5	52.5	51.0	51.0	51.0	51.5	51.0
52	56.5	53.5	52.0	52.0	52.0	52.0	52.0
53	57.5	54.5	53.0	53.0	53.0	53.0	53.0

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 240 kHz						
	Unclad substrate material thicknesses in inches *(mm)*						
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	≥ **0.063** ≥ *1.60*
	Electrical conductivity values in % IACS measured for each unclad substrate material thickness						
54	58.5	55.5	54.0	54.0	54.0	54.0	54.0
55	60.0	56.0	55.0	55.0	55.0	55.0	55.0
56	61.0	57.0	56.0	56.0	56.0	56.0	56.0
57	62.0	58.0	57.0	57.0	57.0	57.0	57.0
58	63.0	58.5	58.0	58.0	58.0	58.0	58.0
59	64.0	59.5	59.0	59.0	59.0	59.0	59.0
60	65.5	60.5	60.0	60.0	60.0	60.0	60.0
61	66.0	61.5	61.0	61.0	61.0	61.0	61.0
62	67.0	62.5	62.0	62.0	62.0	62.0	62.0
63	68.0	63.5	63.0	63.0	63.0	63.0	63.0
64	68.5	64.5	64.0	64.0	64.0	64.0	64.0
65	69.5	65.5	65.0	65.0	65.0	65.0	65.0

23.3.14 BSS 7351, Measurements on clad aluminium, cladding types 2014 and 2219, at a probe frequency of 240 kHz

Electr. conductivity value of the materials in % IACS	FS40 probe, probe frequency 240 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
26	32.5	33.0	31.0	33.0	31.5	33.5	36.0	39.5	41.5	33.5	34.5	36.0	37.5	39.5
27	33.5	34.0	32.0	34.0	32.5	34.5	37.0	40.0	42.0	34.5	35.5	37.0	38.5	40.0

FS40 probe, probe frequency 240 kHz

Electr. conductivity value of the materials in % IACS	**Unclad substrate material thicknesses in inches** *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
28	34.5	35.0	33.0	34.5	33.5	35.0	37.5	41.0	43.0	35.5	36.0	37.5	39.0	41.0
29	35.5	36.0	33.5	35.5	34.0	36.0	38.5	41.5	43.5	36.0	37.0	38.5	40.0	41.5
30	36.5	37.0	34.5	36.5	35.0	37.0	39.0	42.5	44.0	37.0	37.5	39.0	40.5	42.5
31	37.5	37.5	35.5	37.5	36.5	38.0	40.0	42.0	44.0	37.5	38.0	39.5	40.5	42.0
32	38.5	38.0	36.5	38.5	37.0	39.0	41.0	42.5	44.0	38.0	39.0	40.0	41.0	42.5
33	39.5	39.0	37.0	39.0	38.0	39.5	41.5	43.0	44.5	39.0	39.5	40.5	41.5	43.0
34	40.0	39.5	38.0	40.0	38.5	40.0	42.0	43.5	45.0	39.5	40.0	41.5	42.5	43.5
35	41.0	40.5	39.0	40.5	39.5	41.0	43.0	44.0	45.5	40.5	41.0	42.0	43.0	44.0
36	42.0	41.5	39.5	41.5	40.5	41.5	43.5	44.5	46.0	41.0	41.5	42.5	43.5	44.5
37	42.5	42.5	40.5	42.0	41.0	42.5	44.0	45.5	46.5	42.0	42.5	43.5	44.0	45.5
38	43.5	43.0	41.0	43.0	42.0	43.0	44.5	46.0	47.0	42.5	43.0	44.0	44.5	46.0
39	44.5	44.0	42.0	43.5	42.5	44.0	45.5	46.5	47.5	43.5	44.0	44.5	45.5	46.5
40	45.0	45.0	43.0	44.5	43.5	44.5	46.0	47.0	48.0	44.0	44.5	45.5	46.0	47.0
41	45.5	45.5	43.5	45.0	44.0	45.0	46.5	47.5	48.5	45.0	45.5	46.0	46.5	47.5
42	46.0	46.0	44.5	45.5	45.0	46.0	47.0	48.0	49.0	45.5	46.0	46.5	47.5	48.0
43	46.0	46.0	45.0	46.5	45.5	46.5	48.0	49.0	49.5	46.0	46.5	47.0	48.0	49.0
44	46.5	46.5	46.0	47.0	46.5	47.5	48.5	49.5	50.5	47.0	47.0	48.0	48.5	49.5
45	46.5	46.5	46.5	48.0	47.5	48.0	49.0	50.0	51.0	47.5	48.0	48.5	49.0	50.0
46	47.0	47.5	47.0	48.5	48.0	48.5	49.5	50.5	51.0	48.0	48.5	49.0	49.5	50.5
47	48.0	48.0	48.0	49.0	48.5	49.0	50.0	51.0	51.5	49.0	49.0	49.5	50.0	51.0
48	49.0	49.0	48.5	50.0	49.5	50.0	50.5	51.5	52.0	49.5	49.5	50.0	50.5	51.5
49	50.0	50.0	49.5	50.5	50.0	50.5	51.0	51.5	52.0	50.0	50.5	50.5	51.0	51.5
50	51.0	50.5	50.0	51.0	50.5	51.0	51.5	52.0	52.5	50.5	51.0	51.5	51.5	52.0
51	51.5	51.5	51.0	52.0	51.5	52.0	52.0	52.5	53.0	51.5	51.5	52.0	52.0	52.5

23.3.15 BSS 7351, Measurements on clad aluminium, cladding types 2024, 7075, 7079 and 7178, at a probe frequency of 240 kHz

Electr. conductivity value of the materials in % IACS	FS40 probe, probe frequency 240 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
26	29.0	28.5	28.0	29.5	31.5	33.5	29.5	32.0	32.5	33.5	34.5	36.0	37.5	39.5
27	30.5	29.5	29.0	30.0	32.5	34.5	30.0	32.5	33.5	34.5	35.5	37.0	38.5	40.0
28	31.5	30.5	30.0	31.0	33.5	35.0	31.0	33.5	34.5	35.5	36.0	37.5	39.0	41.0
29	33.0	31.5	31.0	32.0	34.0	36.0	32.0	34.0	35.0	36.0	37.0	38.5	40.0	41.5
30	34.0	32.5	31.5	33.0	35.0	37.0	33.0	35.0	36.0	37.0	37.5	39.0	40.5	42.5
31	35.0	33.5	33.0	34.0	36.5	38.0	34.0	35.5	36.5	37.5	38.0	39.5	40.5	42.0
32	36.0	34.5	34.0	35.0	37.0	39.0	35.0	36.5	37.5	38.0	39.0	40.0	41.0	42.5
33	37.0	35.5	34.5	36.0	38.0	39.5	36.0	37.5	38.0	39.0	39.5	40.5	41.5	43.0
34	38.0	36.0	35.5	36.5	38.5	40.0	36.5	38.0	39.0	39.5	40.0	41.5	42.5	43.5
35	39.0	37.0	36.5	37.5	39.5	41.0	37.5	39.0	39.5	40.5	41.0	42.0	43.0	44.0
36	40.5	38.0	37.0	38.5	40.5	41.5	38.5	40.0	40.5	41.0	41.5	42.5	43.5	44.5
37	41.5	39.0	38.0	39.0	41.0	42.5	39.0	40.5	41.5	42.0	42.5	43.5	44.0	45.5
38	42.5	40.0	39.0	40.0	42.0	43.0	40.0	41.5	42.0	42.5	43.0	44.0	44.5	46.0
39	43.5	40.5	40.0	41.0	42.5	44.0	41.0	42.5	43.0	43.5	44.0	44.5	45.5	46.5
40	44.5	41.5	40.5	42.0	43.5	44.5	41.5	43.0	43.5	44.0	44.5	45.5	46.0	47.0
41	45.5	42.5	41.5	42.5	44.0	45.0	42.5	44.0	44.5	45.0	45.5	46.0	46.5	47.5
42	46.0	43.5	42.5	43.5	45.0	46.0	43.5	44.5	45.0	45.5	46.0	46.5	47.5	48.0
43	46.5	44.5	43.5	44.0	45.5	46.5	44.0	45.5	45.5	46.0	46.5	47.0	48.0	49.0
44	47.0	45.5	44.0	45.0	46.5	47.5	45.0	46.0	46.5	47.0	47.0	48.0	48.5	49.5
45	47.5	46.5	45.0	46.0	47.5	48.0	45.5	46.5	47.0	47.5	48.0	48.5	49.0	50.0
46	48.0	47.0	46.0	46.5	48.0	48.5	46.5	47.5	47.5	48.0	48.5	49.0	49.5	50.5
47	49.5	48.0	47.0	47.5	48.5	49.0	47.5	48.0	48.5	49.0	49.0	49.5	50.0	51.0
48	50.5	49.0	47.5	48.0	49.5	50.0	48.0	49.0	49.0	49.5	49.5	50.0	50.5	51.5

Electr. conductivity value of the materials in % IACS	FS40 probe, probe frequency 240 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
49	51.5	50.0	48.5	49.0	50.0	50.5	49.0	49.5	50.0	50.0	50.5	50.5	51.0	51.5
50	52.5	51.0	49.5	50.0	50.5	51.0	49.5	50.5	50.5	50.5	51.0	51.5	51.5	52.0

23.3.16 BSS 7351, Measurements on clad aluminium, cladding types 3003 and 6061, at a probe frequency of 240 kHz

Electr. conductivity value of the materials in % IACS	FS40 probe, probe frequency 240 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
36	40.5	38.0	37.0	38.5	40.5	41.5	43.5	44.5	46.0	47.0	48.5	50.0	52.0	54.5
37	41.5	39.0	38.0	39.0	41.0	42.5	44.0	45.5	46.5	47.5	48.5	50.5	52.0	54.5
38	42.5	40.0	39.0	40.0	42.0	43.0	44.5	46.0	47.0	48.0	49.0	50.5	52.5	54.5
39	43.5	40.5	40.0	41.0	42.5	44.0	45.5	46.5	47.5	48.5	49.5	51.0	52.5	54.5
40	44.5	41.5	40.5	42.0	43.5	44.5	46.0	47.0	48.0	49.0	49.5	51.0	52.5	54.5
41	45.5	42.5	41.5	42.5	44.0	45.0	46.5	47.5	48.5	49.5	50.0	51.5	53.0	54.5
42	46.0	43.5	42.5	43.5	45.0	46.0	47.0	48.0	49.0	50.0	51.0	52.0	53.5	55.0
43	46.5	44.5	43.5	44.0	45.5	46.5	48.0	49.0	49.5	50.5	51.5	52.5	54.0	56.0
44	47.0	45.5	44.0	45.0	46.5	47.5	48.5	49.5	50.5	51.0	52.0	53.5	54.5	56.5
45	47.5	46.5	45.0	46.0	47.5	48.0	49.0	50.0	51.0	51.5	52.5	54.0	55.0	57.0
46	48.0	47.0	46.0	46.5	48.0	48.5	49.5	50.5	51.0	52.0	53.0	54.0	55.0	56.5
47	49.5	48.0	47.0	47.5	48.5	49.0	50.0	51.0	51.5	52.5	53.0	54.0	55.0	56.5

Electr. conductivity value of the materials in % IACS	FS40 probe, probe frequency 240 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
48	50.5	49.0	47.5	48.0	49.5	50.0	50.5	51.5	52.0	52.5	53.0	54.0	55.0	56.0
49	51.5	50.0	48.5	49.0	50.0	50.5	51.0	51.5	52.0	52.5	53.5	54.0	55.0	56.0
50	52.5	51.0	49.5	50.0	50.5	51.0	51.5	52.0	52.5	53.0	53.5	54.0	54.5	55.5
51	53.5	52.0	50.5	50.5	51.5	52.0	52.0	52.5	53.0	53.0	53.5	54.0	54.5	55.5
52	54.5	53.0	51.0	51.5	52.0	52.5	52.5	53.0	53.0	53.5	53.5	54.0	54.5	55.0
53	55.5	54.0	52.0	52.0	53.0	53.0	53.5	53.5	53.5	53.5	54.0	54.0	54.5	55.0
54	56.5	55.0	53.0	53.0	53.5	53.5	54.0	53.5	54.0	54.0	54.0	54.0	54.5	54.5
55	57.5	56.0	53.5	54.0	54.0	54.5	54.5	54.0	54.0	54.0	54.0	54.0	54.5	54.5
56	58.5	57.0	54.5	54.5	55.0	55.0	55.0	54.5	54.5	54.5	54.5	54.0	54.0	54.0

23.3.17 BSS 7351, Measurements on thin, unclad substrate material at a probe frequency of 480 kHz

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 480 kHz						
	Unclad substrate material thicknesses in inches *(mm)*						
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	≥ **0.063** ≥ *1.60*
	Electrical conductivity values in % IACS measured for each unclad substrate material thickness						
26	28.0	28.5	27.0	26.0	26.0	26.0	26.0
27	29.0	29.5	28.0	27.0	27.0	27.0	27.0
28	30.0	30.5	29.0	28.0	28.0	28.0	28.0
29	31.5	31.5	29.5	29.0	29.0	29.0	29.0
30	33.0	32.5	30.5	30.0	30.0	30.0	30.0

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 480 kHz						
	Unclad substrate material thicknesses in inches *(mm)*						
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	≥ **0.063** ≥ *1.60*
	Electrical conductivity values in % IACS measured for each unclad substrate material thickness						
31	35.0	33.5	32.0	31.0	31.0	31.0	31.0
32	36.0	34.5	33.0	32.0	32.5	32.5	32.0
33	37.5	35.5	34.0	33.0	33.5	33.5	33.0
34	38.5	36.0	34.5	34.0	34.5	34.5	34.0
35	39.5	37.0	35.5	35.0	35.5	35.5	35.5
36	40.5	38.0	36.5	36.0	36.5	36.5	36.5
37	41.5	39.0	37.5	37.0	37.5	37.5	37.5
38	42.5	40.0	38.5	38.0	38.5	38.5	38.5
39	44.0	40.5	39.5	39.0	39.5	39.5	39.5
40	45.0	41.5	40.5	40.0	40.5	40.5	40.5
41	46.0	42.5	41.5	41.0	41.5	41.5	41.5
42	46.5	44.0	42.5	42.0	42.5	42.5	42.5
43	47.5	45.0	43.0	43.0	43.5	43.5	43.5
44	48.0	46.5	44.0	44.0	44.5	44.5	44.5
45	49.0	47.5	45.0	45.0	45.5	45.5	45.5
46	50.0	48.5	46.0	46.0	46.5	46.5	46.5
47	51.0	49.5	47.0	47.0	47.5	47.5	47.5
48	52.0	50.0	48.0	48.0	48.5	48.5	48.5
49	53.0	51.0	49.0	49.0	49.5	49.5	49.5
50	54.5	52.0	50.0	50.0	50.5	50.5	50.5
51	55.5	52.5	51.0	51.0	51.0	51.5	51.0
52	56.5	53.5	52.0	52.0	52.0	52.0	52.0
53	57.5	54.5	53.0	53.0	53.0	53.0	53.0
54	58.5	55.5	54.0	54.0	54.0	54.0	54.0
55	60.0	56.0	55.0	55.0	55.0	55.0	55.0

Electr. conductivity value of the material in % IACS	FS40 probe, probe frequency 480 kHz						
	Unclad substrate material thicknesses in inches *(mm)*						
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	≥ **0.063** ≥ *1.60*
	Electrical conductivity values in % IACS measured for each unclad substrate material thickness						
56	61.0	57.0	56.0	56.0	56.0	56.0	56.0
57	62.0	58.0	57.0	57.0	57.0	57.0	57.0
58	63.0	58.5	58.0	58.0	58.0	58.0	58.0
59	64.0	59.5	59.0	59.0	59.0	59.0	59.0
60	65.5	60.5	60.0	60.0	60.0	60.0	60.0
61	66.0	61.5	61.0	61.0	61.0	61.0	61.0
62	67.0	62.5	62.0	62.0	62.0	62.0	62.0
63	68.0	63.5	63.0	63.0	63.0	63.0	63.0
64	68.5	64.5	64.0	64.0	64.0	64.0	64.0
65	69.5	65.5	65.0	65.0	65.0	65.0	65.0

23.3.18 BSS 7351, Measurements on clad aluminium, cladding types 2014 and 2219, at a probe frequency of 480 kHz

Electr. conductivity value of the materials in % IACS	FS40 probe, probe frequency 480 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
26	33.0	35.5	34.5	38.0	36.0	39.0	42.5	47.5	50.5	39.0	40.5	42.5	45.0	47.5
27	33.5	36.0	35.0	38.5	36.5	39.5	43.5	48.0	51.0	39.5	41.0	43.0	45.5	48.0
28	34.5	37.0	36.0	39.5	37.5	40.0	44.0	48.5	51.5	40.0	41.5	43.5	45.5	48.5
29	35.0	37.5	36.5	40.0	38.0	41.0	44.5	49.0	51.5	40.5	42.0	44.0	46.0	49.0

Electr. conductivity value of the materials in % IACS	FS40 probe, probe frequency 480 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
30	35.5	38.5	37.5	41.0	38.5	41.5	45.0	49.0	52.0	41.0	42.5	44.5	46.5	49.0
31	37.0	39.5	38.5	41.5	39.5	42.5	45.5	49.5	52.5	41.5	43.0	45.0	47.0	49.5
32	37.5	40.0	39.0	42.0	40.0	43.0	46.0	50.0	52.5	42.0	43.5	45.5	47.5	50.0
33	38.5	40.5	40.0	43.0	40.5	43.5	46.5	50.5	53.0	42.5	44.0	46.0	47.5	50.5
34	39.0	41.5	40.5	43.5	41.5	44.0	47.0	50.5	53.0	43.0	44.5	46.5	48.0	50.5
35	39.5	42.0	41.5	44.0	42.0	44.5	47.5	51.0	53.5	44.0	45.0	47.0	48.5	51.0
36	40.5	43.0	42.0	44.5	42.5	45.0	48.0	51.5	53.5	44.5	45.5	47.5	49.0	51.5
37	41.0	43.5	42.5	45.0	43.0	45.5	48.0	51.5	54.0	45.0	46.0	48.0	49.5	51.5
38	41.5	44.0	43.5	46.0	44.0	46.0	48.5	52.0	54.0	45.5	46.5	48.5	50.0	52.0
39	42.5	45.0	44.0	46.5	44.5	46.5	49.0	52.5	54.5	46.5	47.5	49.0	50.5	52.5
40	43.0	45.5	45.0	47.0	45.0	47.0	49.5	52.5	54.5	47.0	48.0	49.5	51.0	52.5
41	43.5	46.0	45.5	47.5	46.0	47.5	50.0	53.0	55.0	47.5	48.5	49.5	51.0	53.0
42	44.5	46.5	46.0	48.0	46.5	48.0	50.0	53.0	54.5	48.0	49.0	50.0	51.5	53.0
43	45.0	47.5	46.5	48.5	47.5	48.5	50.5	53.0	54.5	48.5	49.0	50.5	51.5	53.0
44	45.5	48.0	47.0	49.0	48.0	49.0	50.5	53.0	54.5	49.0	49.5	50.5	52.0	53.0
45	46.0	48.5	47.5	49.5	49.0	49.5	51.0	53.5	54.5	49.5	50.0	51.0	52.0	53.5
46	47.0	49.0	48.5	50.0	49.5	50.0	51.5	53.5	54.5	50.0	50.5	51.5	52.5	53.5
47	47.5	49.5	49.0	50.5	50.0	50.5	51.5	53.5	55.0	50.5	51.0	52.0	52.5	53.5
48	48.0	50.0	49.5	51.0	50.5	51.0	52.0	54.0	55.0	51.0	51.5	52.0	53.0	54.0
49	48.5	51.0	50.0	51.5	51.0	51.5	52.5	54.0	55.0	51.5	52.0	52.5	53.0	54.0
50	49.5	51.5	51.0	52.0	51.5	52.0	53.0	54.5	55.0	52.0	52.5	53.0	53.5	54.5
51	50.0	52.0	51.5	52.5	52.0	52.5	53.0	54.5	55.5	52.5	53.0	53.5	54.0	54.5

23.3.19 BSS 7351, Measurements on clad aluminium, cladding types 2024, 7075, 7079 and 7178, at a probe frequency of 480 kHz

FS40 probe, probe frequency 480 kHz

Electr. conductivity value of the materials in % IACS	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
26	28.0	27.0	29.0	32.5	36.0	39.0	32.0	36.0	37.5	39.0	40.5	42.5	45.0	47.5
27	29.0	28.0	30.0	33.0	36.5	39.5	32.5	36.5	38.0	39.5	41.0	43.0	45.5	48.0
28	30.0	29.0	31.0	34.0	37.5	40.0	33.5	37.5	38.5	40.0	41.5	43.5	45.5	48.5
29	31.0	29.5	32.0	34.5	38.0	41.0	34.5	38.0	39.0	40.5	42.0	44.0	46.0	49.0
30	31.5	30.5	32.5	35.5	38.5	41.5	35.0	38.5	39.5	41.0	42.5	44.5	46.5	49.0
31	33.0	32.0	34.0	36.5	39.5	42.5	36.5	38.5	40.0	41.5	43.0	45.0	47.0	49.5
32	33.5	33.0	35.0	37.0	40.0	43.0	37.0	39.5	40.5	42.0	43.5	45.5	47.5	50.0
33	34.5	34.0	35.5	38.0	40.5	43.5	38.0	40.0	41.5	42.5	44.0	46.0	47.5	50.5
34	35.5	34.5	36.5	38.5	41.5	44.0	38.5	40.5	42.0	43.0	44.5	46.5	48.0	50.5
35	36.5	35.5	37.5	39.5	42.0	44.5	39.5	41.5	42.5	44.0	45.0	47.0	48.5	51.0
36	37.0	36.5	38.0	40.5	42.5	45.0	40.0	42.0	43.5	44.5	45.5	47.5	49.0	51.5
37	38.0	37.5	39.0	41.0	43.0	45.5	41.0	43.0	44.0	45.0	46.0	48.0	49.5	51.5
38	39.0	38.0	40.0	42.0	44.0	46.0	41.5	43.5	44.5	45.5	46.5	48.5	50.0	52.0
39	40.0	39.0	40.5	42.5	44.5	46.5	42.0	44.5	45.5	46.5	47.5	49.0	50.5	52.5
40	40.5	40.0	41.5	43.5	45.0	47.0	43.0	45.0	46.0	47.0	48.0	49.5	51.0	52.5
41	41.5	41.0	42.5	44.0	46.0	47.5	43.5	45.5	46.5	47.5	48.5	49.5	51.0	53.0
42	42.5	42.0	43.0	44.5	46.5	48.0	44.5	46.0	47.0	48.0	49.0	50.0	51.5	53.0
43	43.0	42.5	44.0	45.5	47.5	48.5	45.0	47.0	47.5	48.5	49.0	50.5	51.5	53.0
44	44.0	43.5	44.5	46.0	48.0	49.0	45.5	47.5	48.0	49.0	49.5	50.5	52.0	53.0
45	44.5	44.5	45.5	46.5	49.0	49.5	46.5	48.0	48.5	49.5	50.0	51.0	52.0	53.5
46	45.5	45.5	46.5	47.5	49.5	50.0	47.0	48.5	49.0	50.0	50.5	51.5	52.5	53.5
47	46.5	46.5	47.0	48.0	50.0	50.5	48.0	49.0	50.0	50.5	51.0	52.0	52.5	53.5

FS40 probe, probe frequency 480 kHz

Electr. conductivity value of the materials in % IACS	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
48	47.5	47.0	48.0	48.5	50.5	51.0	48.5	50.0	50.5	51.0	51.5	52.0	53.0	54.0
49	48.0	48.0	48.5	49.5	51.0	51.5	49.0	50.5	51.0	51.5	52.0	52.5	53.0	54.0
50	49.0	49.0	49.5	50.0	51.5	52.0	50.0	51.0	51.5	52.0	52.5	53.0	53.5	54.5

23.3.20 BSS 7351, Measurements on clad aluminium, cladding types 3003 and 6061, at a probe frequency of 480 kHz

FS40 probe, probe frequency 480 kHz

Electr. conductivity value of the materials in % IACS	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
36	37.0	36.5	38.0	40.5	42.5	45.0	48.0	51.5	53.5	56.0	58.0	61.5	65.0	69.5
37	38.0	37.5	39.0	41.0	43.0	45.5	48.0	51.5	54.0	56.0	58.5	61.5	65.0	69.5
38	39.0	38.0	40.0	42.0	44.0	46.0	48.5	52.0	54.0	56.5	58.5	61.5	64.5	69.0
39	40.0	39.0	40.5	42.5	44.5	46.5	49.0	52.5	54.5	56.5	58.5	61.5	64.5	68.5
40	40.5	40.0	41.5	43.5	45.0	47.0	49.5	52.5	54.5	56.5	58.5	61.5	64.5	68.5
41	41.5	41.0	42.5	44.0	46.0	47.5	50.0	53.0	55.0	56.5	58.5	61.0	64.0	67.5
42	42.5	42.0	43.0	44.5	46.5	48.0	50.0	53.0	54.5	56.5	58.0	60.5	63.5	66.5
43	43.0	42.5	44.0	45.5	47.5	48.5	50.5	53.0	54.5	56.5	58.0	60.0	62.5	65.5
44	44.0	43.5	44.5	46.0	48.0	49.0	50.5	53.0	54.5	56.0	57.5	59.5	62.0	65.0
45	44.5	44.5	45.5	46.5	49.0	49.5	51.0	53.5	54.5	56.0	57.5	59.0	61.0	64.0

Electr. conductivity value of the materials in % IACS	FS40 probe, probe frequency 480 kHz													
	Unclad substrate material thicknesses in inches *(mm)*													
	0.016 *0.406*	**0.020** *0.508*	**0.025** *0.635*	**0.032** *0.813*	**0.040** *1.016*	**0.050** *1.27*	**0.063** *1.60*	**0.080** *2.032*	**0.090** *2.286*	**0.10** *2.54*	**0.11** *2.794*	**0.125** *3.175*	**0.14** *3.556*	**0.16** *4.064*
	Electrical conductivity values in % IACS measured for each clad substrate material thickness													
46	45.5	45.5	46.5	47.5	49.5	50.0	51.5	53.5	54.5	56.0	57.0	59.0	61.0	63.5
47	46.5	46.5	47.0	48.0	50.0	50.5	51.5	53.5	55.0	56.0	57.0	59.0	60.5	62.5
48	47.5	47.0	48.0	48.5	50.5	51.0	52.0	54.0	55.0	56.0	57.0	58.5	60.0	62.0
49	48.0	48.0	48.5	49.5	51.0	51.5	52.5	54.0	55.0	56.0	57.0	58.5	59.5	61.5
50	49.0	49.0	49.5	50.0	51.5	52.0	53.0	54.5	55.0	56.0	57.0	58.0	59.5	61.0
51	50.0	50.0	50.0	50.5	52.0	52.5	53.0	54.5	55.5	56.0	57.0	58.0	59.0	60.5
52	51.0	50.5	51.0	51.0	53.0	53.0	53.5	55.0	55.5	56.0	56.5	57.5	58.5	60.0
53	51.5	51.5	51.5	52.0	53.5	53.5	54.0	55.0	55.5	56.0	56.5	57.5	58.0	59.5
54	52.5	52.5	52.5	52.5	54.0	54.0	54.0	55.0	55.5	56.0	56.5	57.0	58.0	58.5
55	53.5	53.5	53.0	53.0	54.5	54.5	54.5	55.5	56.0	56.0	56.5	57.0	57.5	58.0
56	54.5	54.0	54.0	54.0	55.0	55.0	55.0	55.5	56.0	56.0	56.5	56.5	57.0	57.5

23.4 Description of the statistical characteristics and parameters

The **Statistical display** information area, the **Block result** and the **Final result** can contain the following statistical characteristics.

Characteristic	Description
Mean value	**Statistical display** and **Block result**: Arithmetic mean of the measurement readings in a measurement block
Total mean value	**Final result**: Arithmetic mean of the block mean values
Std. dev.	**Statistical display** and **Block result**: Standard deviation = Variation of measurement readings around the mean value of a measurement block
Est. std. dev.	**Final result**: Estimated value of the standard deviation of the population mean
Appl name	Name of the open application file
Coeff. o. var.	**Statistical display** and **Block result**: Coefficient of variation = Percent variation of the displayed block
Est. COV	**Final result**: Estimated value of the coefficient of variation for the selected block group
min. value	**Statistical display** and **Block result**: Smallest measurement reading in the displayed measurement block
smallest block	**Final result**: Smallest block mean value in the selected block group
max. value	**Statistical display** and **Block result**: Largest measurement reading in the displayed measurement block
largest Block	**Final result**: Largest block mean value in the selected block group

Characteristic	Description
Range	**Statistical display** and **Block result**: Difference between the largest and smallest value
Mean range	**Final result**: Difference between the largest and smallest block
lower spec. lim.	Lower tolerance limit entered in the open application file
upper spec. lim.	Upper tolerance limit entered in the open application file
No. < LSL	**Statistical display** and **Block result**: Number of measurement readings below the lower tolerance limit **Final result**: Number of block mean values below the lower tolerance limit
No. > USL	**Statistical display** and **Block result**: Number of measurement readings above the upper tolerance limit **Final result**: Number of block mean values above the upper tolerance limit
No. readings	**Statistical display** and **Block result**: Number of measurement readings per measurement block. When the outlier check is enabled, the measurement readings identified as outliers during measurement are not considered in the evaluation. **Final result**: Number of measurement readings in the open application file. Displayed only when block formation disabled.
No. blocks	**Statistical display** and **Final result**: Number of measurement blocks in the open application file
Block No.	**Statistical display** and **Block result**: Number of currently open measurement block

Characteristic	Description
Reading No.	**Statistical display**: Consecutive number of the measurement reading in the open measurement block
Diameter	Diameter of the cylinder or surface curvature entered in the open application file for curvature correction. Setting; see page 31.
Outlier	Number of measurement readings in the open measurement block identified as outliers **Final result**: Number of measurement readings identified as outliers in the selected block group.
Confidence interval	Range within which the mean value occurs with a certain probability, usually 95 %.
Mean confidence interval	**Final result**: Range within which the mean value occurs with a certain probability, usually 95 %.
Block size	**Final result**: Block size set in the open application file
Std. dev. sa	**Final result**: Variation in block mean values corrected for the variation in individual values within the measurement blocks
Cp	**Final result**: Process capability index Cp. Cp considers the variation of the process in relation to the width of the tolerance range (USL - LSL). In practice, Cp = 1.33 is usually required.
Cpk	**Final result**: Process capability index Cpk. Cpk considers the location of the mean value in relation to the tolerance limits. In practice, Cpk = 1.33 is usually required.
First block	**Final result**: Number of the first block in the block group from which the final evaluation should occur.

Characteristic	Description
Last block	**Final result**: Number of the last block in the block group from which the final evaluation should occur.
Circumference	Circumference of the cylinder entered in the open application file for curvature correction, setting see page 31
Histogram *Appears only in the printout and the export file*	**Final result** and **Block result**: A histogram shows the number of all measurement readings in certain conductivity ranges (= classes). The class widths (width of the rectangles) are always identical and are calculated automatically for the predefined tolerance range. The significance of the statistical results depends on the shape of the histogram, among other things. Deviation from a normal distribution may indicate systematic errors during measurement. • The representation is based on the selected block group. • At least 30 measurement readings are needed for the histogram representation.
FDD *Appears only in the printout and export file*	**Final result**: The **F**actory **D**iagnosis **D**iagram provides a quick general overview of the variation and distribution of measurement readings and block mean values within specified tolerance limits. The FDD assists you during the evaluation of the production process or can show differences between different deliveries during incoming inspection. • The representation is based on the selected block group.
User text 1,2,.. *Appears only in the printout and the export file*	**Block result** and **Final result**: Text fields which you can assign any names. Each time a printout or file export is started, these text fields open and you can enter any information or comments.
Static text 1, 2, … *Appears only in the printout and the export file*	**Block result** and **Final result**: Fields with arbitrary texts that you prepare once in the template and which appear each time the results file is printed out or exported.

Characteristic	Description
Appl. notes *Appears only in the printout and the export file*	Comment for the application file that was entered under **Meas > Note**; see page 85.
Block notes *Appears only in the printout and the export file*	**Block result**: Comment for the displayed measurement block that was entered under **Meas > Note**; see page 85.
Probability chart *Appears only in the printout and the export file*	**Block result** and **Final result**: From the cumulative frequency graph, you can see the percentage of measurement readings equal to or less than a certain electrical conductivity value. • At least 5 measurement readings are needed for representation in the form of a cumulative frequency graph. • The representation is based on the selected block group.
Grafic 1, 2, ... *Appears only in the printout and the export file*	**Block result** and **Final result**: Placeholder for a graphic in the results report (e.g. company logo). You can copy graphic files to the instrument from a PC; see page 112. • Possible file formats: bmp and jpg
Block result	**Final result**: The block results of all selected measurement blocks appear in the final result.
Date	**Block result**: Date of the closed block.
Time	**Block result**: Time of the closed block.

23.5 Overview of statistical characteristic fields

A description of statistics terms can also be found in the "Glossary" section starting at page 228.

Characteristic	Description
Mean value	**Statistical display** and **Block result**: Arithmetic mean of the measurement readings in a measurement block **Final result**: Arithmetic mean of the block mean values
Std. dev.	**Statistical display** and **Block result**: Standard deviation = Variation of measurement readings around the mean value of a measurement block **Final result**: Estimated value of the standard deviation of the population mean
Appl name	Name of the open application file
Coeff. o. var.	**Statistical display** and **Block result**: Coefficient of variation = Percent variation of the displayed block **Final result**: Estimated value of the coefficient of variation for the selected block group
min. value	**Statistical display** and **Block result**: Smallest measurement reading in the displayed measurement block **Final result**: Smallest block mean value in the selected block group

Characteristic	Description
max. value	**Statistical display** and **Block result**: Largest measurement reading in the displayed measurement block **Final result**: Largest block mean value in the selected block group
Range	**Statistical display** and **Block result**: Difference between the largest and smallest value **Final result**: Difference between the largest and smallest block
lower spec. lim.	Lower tolerance limit entered in the open application file
upper spec. lim.	Upper tolerance limit entered in the open application file
No. < LSL	**Statistical display** and **Block result**: Number of measurement readings below the lower tolerance limit **Final result**: Number of block mean values below the lower tolerance limit
No. > USL	**Statistical display** and **Block result**: Number of measurement readings above the upper tolerance limit **Final result**: Number of block mean values above the upper tolerance limit
No. readings	**Statistical display** and **Block result**: Number of measurement readings per measurement block. When the outlier check is enabled, the measurement readings identified as outliers during measurement are not considered in the evaluation. **Final result**: Number of measurement readings in the open application file. Displayed only when block formation disabled.

Characteristic	Description
No. blocks	**Statistical display** and **Final result**: Number of measurement blocks in the open application file
Block No.	**Statistical display** and **Block result**: Number of currently open measurement block
Reading No.	**Statistical display**: Consecutive number of the measurement reading in the open measurement block
Diameter	Diameter of the cylinder or surface curvature entered in the open application file for curvature correction. Setting; see page 31.
Outlier	**Statistical display** and **Block result**: Number of measurement readings in the open measurement block identified as outliers **Final result**: Number of measurement readings identified as outliers in the selected block group.
Confidence interval	**Final result:** Range within which the mean value occurs with a certain probability, usually 95 %.
Block size	**Final result**: Block size set in the open application file
Std. dev. sa	**Final result**: Variation in block mean values corrected for the variation in individual values within the measurement blocks
Cp	**Final result**: Process capability index Cp. Cp considers the variation of the process in relation to the width of the tolerance range (USL - LSL). In practice, Cp = 1.33 is usually required.

Characteristic	Description
Cpk	**Final result**: Process capability index Cpk. Cpk considers the location of the mean value in relation to the tolerance limits. In practice, Cpk = 1.33 is usually required.
First block	**Final result**: Number of the first block in the block group from which the final evaluation should occur.
Last block	**Final result**: Number of the last block in the block group from which the final evaluation should occur.
Circumference	Circumference of the cylinder entered in the open application file for curvature correction, setting see page 31
Histogram	**Final result** and **Block result**: A histogram shows the number of all measurement readings in certain conductivity ranges (= classes). The class widths (width of the rectangles) are always identical and are calculated automatically for the predefined tolerance range. The significance of the statistical results depends on the shape of the histogram, among other things. Deviation from a normal distribution may indicate systematic errors during measurement. • The representation is based on the selected block group. • At least 30 measurement readings are needed for the histogram representation. • The histogram appears only in the printout or a pdf export file.

Characteristic	Description
FDD	**Final result**: The **F**actory **D**iagnosis **D**iagram provides a quick general overview of the variation and distribution of measurement readings and block mean values within specified tolerance limits. The FDD assists you during the evaluation of the production process or can show differences between different deliveries during incoming inspection. • The representation is based on the selected block group. • The FDD appears only in the printout or a pdf export file.
User text 1,2,..	**Block result** and **Final result**: Text fields which you can assign any names. Each time a printout or file export is started, these text fields open and you can enter any information or comments. • The user text appears only in the printout or a pdf export file.
Static text 1, 2, ...	**Block result** and **Final result**: Fields with arbitrary texts that you prepare once in the template and which appear each time the results file is printed out or exported. • The fixed text appears only in the printout or a pdf export file.
Appl. notes	**Block result** and **Final result**: Comment for the application file that was entered under **Meas > Note**; see page 85. • The comment text appears only in the printout or a pdf export file.
Block notes	**Block result**: Comment for the displayed measurement block that was entered under **Meas > Note**; see page 85. • The comment text appears only in the printout or a pdf export file.

Characteristic	Description
Probability chart	**Block result** and **Final result**: From the cumulative frequency graph, you can see the percentage of measurement readings equal to or less than a certain electrical conductivity value. • At least 5 measurement readings are needed for representation in the form of a cumulative frequency graph. • The representation is based on the selected block group. • The cumulative frequency graph appears only in the printout or a pdf export file.
Grafic 1, 2, ...	**Block result** and **Final result**: Placeholder for a graphic in the results report (e.g. company logo). You can copy graphic files to the instrument from a PC; see page 112. • Possible file formats: bmp and jpg • The graphic appears only in the printout or a pdf export file.
Block result	**Final result**: The block results of all selected measurement blocks appear in the final result.
Date	**Block result**: Date of the closed block.
Time	**Block result**: Time of the closed block.

23.6 RS232 interface commands

Setting in the instrument

- The transmission format **virt. COM port** is set in the instrument under **File > Supervisor... > Control Panel > USB- connection**; see page 111.

23.6.1 Transmission formats

- All input and output data is transmitted as ASCII strings followed by a CRLF (Carriage Return Line Feed).
  CR = ASCII13
  LF = ASCII10
- End each command with CR or CRLF.
- The instrument can receive a maximum of 20 characters per command.

23.6.2 Control commands

Overview of control commands

Command to instrument	Description
BACK	Move the cursor in the text field back one space in the instrument. Corresponds to the backspace key on the on-screen keyboard.
BLOCK	Open the block result in the instrument
CAL	Open the corrective calibration in the instrument
DAT0 … DAT999	Request the date and time of a closed block for a certain block (block number) from the instrument. Example: Send the command "DAT2" Response of the instrument: Date and time the third block of the open application file was closed. Response of the instrument in the event of an error: "NAK"

Command to instrument	Description
DEL	Delete the last measurement reading acquired from the instrument. Hide the older measurement reading displayed in the instrument.
DELMSW	Delete all measurement readings in the open application file from the instrument. Response of the instrument: ACK Response of the instrument in the event of an error: "NAK"
ENTER	Confirm an entry or setting in the instrument. Corresponds to the ENTER key on the on-screen keyboard.
ES	Trigger a measurement; the measurement reading is saved in the instrument. Response of the instrument: Measurement reading Response of the instrument in the event of an error: "- - - -"
ESC	Cancel the dialogue in the instrument. Corresponds to the **Cancel** command button in the instrument. ESC = ASCII27 = ESC key of the PC keyboard
ESL	Measure the air value. **ATTENTION: Only possible in conjunction with the command SDS2** (automatic air value measurement disabled)**!** The air value is determined from this number of measurements according to the numeric value which follows directly after the command. -, 0 and 1: Air value is determined with one measurement > 2: The air value is determined from n measurements. Example: ESL5, the air value is determined from 5 measurements. The air value is only determined from stable measurement readings. If they are not stable, the measurement sequence is repeated within the timeout time until the measured values become stable. Standard timeout time: 4 s Response of the instrument: ACK Response of the instrument in the event of an error: "NAK"

Command to instrument	Description
ESM	Measurements with attached probe. The mean value is determined from this number of measurements according to the numeric value which follows directly after the command. 0 or 1: Measurement reading from a measurement is displayed and saved in the instrument > 2: The air value is determined from n measurements and saved in the instrument. Example: ESM5, the mean value is determined from 5 measurements. The mean value is only determined from stable measurement readings. If they are not stable, the measurement sequence is repeated within the timeout time until the measured values become stable. Standard timeout time: 4 s Response of the instrument: Mean value from the specified number of measurements Response of the instrument in the event of an error: "NAK"
ESTOUT	Change timeout time. Period in which measurement readings are recorded. ESTOUT4000: 4 s, default setting Example: ESTOUT6000 = Timeout time of 6 s
FINAL	Open the final evaluation in the instrument
GG	Request the set block size in the open application file from the instrument. Response of the instrument: Set block size Response of the instrument if no block size is set: 0
GGS	Request the setting of whether the **Group separator** parameter is enabled for the open application file from the instrument. Response of the instrument: 0 = The parameter **Group separator** is disabled 1 = The parameter **Group separator** is enabled

Command to instrument	Description
GNB	Request the number of measurement blocks in the open application file from the instrument. Response of the instrument: Number of blocks
IE	Request the number of individual measurements used to form the representative measurement reading (i-single readings) from the instrument. Response of the instrument: Number of measurement readings
LSL	Request the lower set tolerance limit in the open application file from the instrument. LSL0: Request lower tolerance limit of coating 1 LSL1: Request lower tolerance limit of coating 2. Response of the instrument: Lower tolerance value Response of the instrument in the event of an error: "NAK"
NAM	Request the file name of the open application file from the instrument. Response of the instrument: Name of the open application file
OK	Confirm the dialogue in the instrument. Corresponds to the **OK, Close** and **Open** command buttons in the instrument.
PBNAME	Request the name of the probe used when creating the open application file from the instrument. Response of the instrument: Name of the probe Response of the instrument in the event of an error: "NAK"
PBSERNR	Request the serial number of the probe used when creating the open application file from the instrument. Response of the instrument: Serial number of the probe Response of the instrument in the event of an error: "NAK"

Command to instrument	Description
PE	Request the set group parameter from the instrument. Response of the instrument: Display of the group separator for the open application file
PG0	Group separator "GS" (ASCII29)
PG1	Group separator "," (ASCII44)
PG2	Group separator "*" (ASCII42)
PG3	Group separator ";" (ASCII59)
PG6	Group separator "#" (ASCII35)
PG7	Group separator ":" (ASCII58)
PT0	No output to the USB port of the instrument
PT1	Send the **individual values** without group separator to the PC via the USB port during the measurement.
PT2	Send the **individual values** with **group separator** to the PC via the USB port during the measurement. No group separator is sent in conjunction with the i individual values setting.
PT3	Send the block mean value to the PC via the USB port following each closed block during the measurement.
PT4	Send the **block mean value** and the **block standard deviation** to the PC via the USB port following each closed block during the measurement.
PT6	Send the **mean value of i individual values** to the PC via the USB port during the measurement. See also page 113.
PT7	Send the entire block result to the PC via the USB port following each closed block during the measurement. The command is not executed in conjunction with the i-single readings setting.

Command to instrument	Description
RM	Enable/disable remote mode. In remote mode, error messages are suppressed. There is also no warning that the air value must be remeasured. RM0: Remote mode disabled RM1: Remote mode enabled Response of the instrument: ACK Response of the instrument in the event of an error: "NAK"
SAM	Request the characteristics from the instrument in accordance with the setting in the *COM-EXPORT* menu. Response of the instrument: Data from the open application file in accordance with the instrument settings in the *COM-EXPORT* menu.
SAVE	Save the open application filed in the instrument. Corresponds to the **File > Save** command in the instrument.
SDS	Enable/disable the automatic air value measurement. SDS1: On, automatic air value measurement is enabled (dynamic mode, factory setting) SDS2: Off, automatic air value measurement is disabled (static mode) Response of the instrument: ACK Response of the instrument in the event of an error: "NAK"
SGS	Enable or disable the group separator in the instrument, in the *COM-EXPORT* menu. SGS1: Enables the group separator in the instrument. SGS0: Disables the group separator in the instrument. Response of the instrument: ACK Response of the instrument in the event of an error: "NAK"
SPACE	Insert a space in a text field in the instrument. Corresponds to the spacebar on the on-screen keyboard.
STATE	Check the measurement readiness of the instrument. Response of the instrument: 1 = Ready for measurement Response of the instrument in the event of an error: -1

Command to instrument	Description
SWA	Open the indicated application file in the instrument. Entry: SWA*CRLF* *Path**File nameCRLF* Entry example: SWA*CRLF* \Fischer\Application\Test.app*CRLF* The application file with the file name "Test" in the directory \Fischer\Application\ is opened. Response of the instrument: ACK Response of the instrument in the event of an error: "NAK"
SWD	Display the measurement reading in the instrument together with the unit of measurement. Response of the instrument: ACK Response of the instrument in the event of an error: "NAK"
SWES	Set the type of measurement acquisition in the instrument. For a description of the parameter, see page 33. Entry example: SWES1 The **by placing** parameter is enabled in the instrument on the *MEASUREMENT ACCEPTANCE* menu page. You can enable the following parameters in the instrument on the *MEASUREMENT ACCEPTANCE* menu page: 0: **External start** parameter 1: Parameter **by placing** 2: **External Start** parameter and **by placing** 3: **External Start** parameter and **Automatic measurement** 4: **by placing** parameter and **Automatic measurement** 5: **External Start** parameter and **Area measurement** 6: **by placing** parameter and **Area measurement**
SWX	Display the measurement reading as count rate in the instrument. Response of the instrument: ACK Response of the instrument in the event of an error: "NAK"

Command to instrument	Description
	Attention Switching the measurement value display, e.g. from electrical conductivity to count rate, deletes all measurement readings in the open application file.
SWXN	Display the measurement reading as normalised count rate in the instrument. Response of the instrument: ACK Response of the instrument in the event of an error: "NAK"
	Attention Switching the measurement value display, e.g. from electrical conductivity to normalised count rate, deletes all measurement readings in the open application file.
VV	Request software version from the instrument. Response of the instrument: Instrument type and software version
XN or y	Retrieve the currently transmitted normalised count rate from the probe. Response of the instrument: Normalised count rate Response of the instrument in the event of an error: "NAK"
XX or z	Retrieve the currently transmitted count rate from the probe. Response of the instrument: Count rate Response of the instrument in the event of an error: "NAK"

23.7 Overview of command buttons on the display

Command button with coloured symbol: Command button function active.

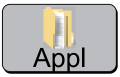
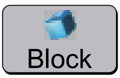
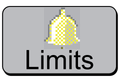
Command button with grey symbol: Command button function inactive.

Command buttons for opening functions directly and placement in the display; see page 219.

Command buttons on the menu pages; see page 221.

23.7.1 Command buttons for opening functions directly

Placement of command buttons in the display; see page 134.

Command button	Description
	Switch application file, opens the *OPEN APPLICATION* menu page to select an application file; identical to tapping on **File > Open > Application...**
	Open final evaluation, opens the *FINAL EVALUATION* menu page for selection of additional options for the result presentation; identical to tapping on **Res > Final Evaluation**
	Open block result, opens the *BLOCK RESULT* menu page; identical to tapping on **Res > Block result**
	Deletes the displayed or selected measurement reading.
	Enable/disable specification limit monitoring and enter or review the tolerance limits. Open the *SPECIFICATION LIMITS* menu page; see also page 36.
	Start measurement acquisition manually by tapping on the **Ext** command button; identical with tapping on: **Meas > trigger external start**, see also page 33 and 76.
	Enable and disable continuous measurement value display; see also page 83.

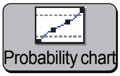
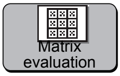
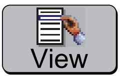
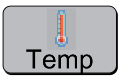
Command button	Description
Notes	Open the *USER TEXT* window to enter or read information about the current measurement block or open application file; identical with tapping on: **Meas > Note**, see also page 85.
α_T Material	Enter the temperature coefficient of the specimen material. Open the *MATERIAL* menu page to select or enter the temperature coefficient of the specimen material; identical with tapping on: **Cal > Temperature coefficient...**; see also page 30.
Up	Scroll through the individual measurements from older to newer values.
Down	Scroll through the individual measurements from newer to older values.
Zero	Start normalisation. Hold the probe in the air and tap the **OK** command button. The distance to the next object must be at least 5 cm (1.97 inches)! Identical with tapping on: **Cal > Normalization...**
Cal	Start corrective calibration; identical with tapping on: **Cal > Corrective calibration...** . Perform a corrective calibration; see page 139.
Temp.	Temperature acquisition, open the *TEMPERATUR* menu page to enter or acquire the temperature measured by the temperature probe; identical with tapping on: **Cal > Temperature...**; see also page 69.
Send	Send data to a PC following measurement in accordance with the settings in the **File > Supervisor...*** **> COM-Export** menu. Identical with tapping on: **Res > Export over COM port**. For information on data transfer, see page 110. **Factory password: 159*
Prop	Make application settings, open the *PROPERTIES* menu window for selection of additional setting menus for the open application files; identical with tapping on: **File > Properties...**, see page 25.

Command button	Description
Analog+	Zoom in the analogue bar display. Tap many times on the command button to zoom in the limit range in up to 5 zoom levels. Zoom out: Tap the command button again after the 5th zoom level.

23.7.2 Command buttons on the menu pages

Command button	Description
OK	▶ Save settings and leave menu page. ▶ Leave menu page and return to measurement presentation
Open	Open the selected application file
Close	Leave menu page and return to measurement presentation
Cancel	▶ Leave menu page without saving the settings ▶ Cancel operations such as exporting or printing out data
First	Jump to block number 1
Last	Jump to last measured block
Previous	Move back one block
Next	Move forward one block

Command button	Description
Back	Leave subdirectory
Repeat	Repeat procedure, e.g., check of the corrective calibration in menu function **Check calibration**.
Appl	Switch application file, opens the *OPEN APPLICATION* menu page to select an application file; identical to tapping on **File > Open > Application**
Open	Open selected subdirectory
Export	Export the block result to a pdf file in accordance with the template setting.
Print	Print out the block result directly on the printer connected to the instrument in accordance with the template setting.
Final	Open final evaluation, opens the *FINAL EVALUATION* menu page for selection of additional options for the result presentation; identical to tapping on **Res > Final evaluation**.
Block	Open block result, open the *BLOCK RESULT* menu page; identical with tapping on **Res > Block result**.
Final result	Open final result; see page 104
FDD	Open FDD presentation; see page 106
Histogram	Open histogram presentation; see page 104

Command button	Description
	Open cumulative frequency presentation; see page 105
	Open matrix evaluation; see page 107
	Deletes the displayed or selected measurement reading.
	File organization in application management; open pull-down menu to create, cut, copy, paste, delete or rename application files; see page 119.
	Switch view, opens a pull-down menu to select a different result view; see page 106.
	Show additional information.
	Acquire the measured temperature as the reference value for the conductivity measurement.

23.8 Master calibration

A main characteristic curve provides the basis for converting the probe's signal into the measurement reading (electrical conductivity) and is established with the aid of calibration standards. A main characteristic curve is saved in the probe for each probe frequency.

ATTENTION	**Master calibration = Irreversible change** With a master calibration, the main characteristic curve in the probe is changed irreversibly! If the main calibration curve is not correct, you can no longer acquire any correct measurement readings with the probe! ▶ Use only assured, certified calibration standards for the master calibration! ▶ You must take the effect of temperature into account during the master calibration: Either through use of standards temperature-controlled to 20 °C (68 °F) in water or an oil bath or by entering the temperature coefficients of the standards and measuring the standard's current temperature. ▶ Perform the master calibration **very carefully**.

When to perform

- Only under exceptional conditions, e.g. in certain service situations. Before performing a master calibration, it is essential that you speak with a FISCHER service location!

Important to know

- The probes supplied by FISCHER have already undergone a master calibration!
- The master calibration is performed for the connected probe and probe frequency displayed in the measurement presentation of the open application file. A master calibration must be performed for each probe frequency.

For the master calibration you need

- At least 5 (max. 8) conductivity standards must be available for the master calibration. One standard must be a Cu standard with an electrical conductivity value between 97 and 103 %IACS (56.6 - 60.1 MS/m) and a second standard must have a conductivity value of ≤ 10 %IACS (5.8 MS/m).
- The electrical conductivity values (σ) for the standards used must be known. If the temperature coefficients (α) of the standards are not known, it is necessary to ensure that the standards have a constant material temperature of +20 °C (68 °F) during the master calibration (e.g. by placing the standards in an suitable, temperature-controlled water bath).

ATTENTION	**Operating temperature of the instrument** Before a master calibration is carried out, the instrument with connected probe must have been switched on for at least 10 minutes! This is necessary to ensure that all components in the unit have reached their operating temperature. The result will otherwise be mismeasurement! ► For this purpose, disable automatic shutoff of the unit in the **File > Supervisor...* > Control Panel > Power & Light** menu; see page 129. ** Factory password: 159* ► Connect the instrument with its power supply to the power source; see page 14.

Procedure

Open menu: **File > Supervisor...* > Master calibration**

** Factory password: 159*

► The procedure for performing a master calibration is similar to that for performing a corrective calibration; see page 139. You must use the routine for all standards.

ATTENTION	**Accuracy** Carry out the master calibration carefully, since it determines the accuracy with which subsequent measurements can be performed. - Remember that measurements can never be more accurate than the master calibration!

23.9 Calibration of the temperature sensor

Adjustment of the temperature sensor in type FS40 probes or the TF100A temperature probe. The sensor temperature is used for temperature correction during the conductivity measurement. The surface temperature of the specimen is measured by the temperature sensor and shown on the display. This eliminates the need for an extra temperature measuring instrument.

When to perform

- In case the initial calibration, i.e. factory settings, are unsatisfactory, you can use the **temperature calibration** menu to re-calibrate the temperature sensor.

Important to know

- The temperature probes/temperature sensors supplied by FISCHER are already calibrated!
- The temperature calibration is performed for the connected temperature sensor selected for the open application file. Setting the temperature sensor; see page 27.

You need the following for the calibration

- For temperature calibration, 1 part with a known, defined reference temperature must be available (max. 2).
- For calibration at 2 temperatures, the reference temperatures of the two parts must differ by at least +5 °C (9 °F).

ATTENTION	**Accuracy** Errors during calibration influence the measuring accuracy! ► The reference temperature must be stable during the entire calibration process! For instance, use temperature-controlled standards in a water or oil bath.

Procedure

Open menu: **File > Supervisor...* > temperature calibration**

** Factory password: 159*

► Perform the calibration as described in the information for the calibration routine.

ATTENTION	**Accuracy** Carry out the calibration carefully, since it determines the accuracy with which subsequent measurements can be performed. - Remember that measurements can never be more accurate than the calibration!

23.10 Deleting the temperature calibration

You can delete the temperature calibration for the open application file. In this case, the factory calibration in the probe is restored.

Procedure

1. Tap on **File > Supervisor...* > delete temperature cal.**

   ** Factory password: 159*

   This menu command is available only if a calibration was already carried out for the open application file.
2. Tap on the **Yes** command button to execute the deletion.

The temperature calibration for the open application file has been deleted.

23.11 Glossary (technical terms and formulas)

α *see Temperature coefficient* α

Accuracy
Qualitative description for how close the measurement results are to the true value. The accuracy is usually divided into *trueness* and *precision*.

Adjustment *see Calibration*

Application
Measuring application of the user.
Application also designates the file in which the coefficients from the corrective calibration, the parameter settings and the measurement readings for a specific measuring task of the user are saved.

Application selection
Menu page(s) in the instrument on which all previously created applications are listed. Application selection via **APPL** command button or the **File > Open** menu.

Application file
File that contains all data, settings and measurement readings relevant for a measuring application.

Application memory
Memory area in the instrument in which all application files are saved.

Automatic block formation
After a specified number of measurements, a closed block is formed automatically. Instead of the single readings, the block mean values are used in the statistical evaluation.

Baud
Unit for the speed at which information (data) can be transmitted. 1 baud corresponds to a transmission rate of one bit per second.

Baud rate
Transmission rate. Used primarily in connection with terminal programs in data transmission applications. Since data are transmitted via a serial interface in this instrument, calculations are based on bits per second.

Bell curve *see Normal distribution*

Bidirectional data exchange
Data can be sent and received by both participants (for instance, from the instrument to the PC and from the PC to the instrument).

Bit

Binary digit. 1 bit is the smallest representation unit in a binary number system. The value of a bit can be either 0 or 1. The bit as smallest information unit in a computer forms the basis of every computer system. 8 bits are combined to form a byte and several bytes to form a word.

Block

Group of measurement readings. Several measurement readings are collected in a block. The end of the block (closed block) is indicated on the display by a key symbol.

Block closure

Designation after n measurement readings. A closed block can be formed automatically or manually by means of a command button. Generally, the block closure is indicated on the display by a key symbol.

Block result

Statistical evaluation of the measurement results in a block: mean value, standard deviation, coefficient of variation, range, smallest, largest measurement reading, number of measurement readings in a block etc.

Block size

Number of measurement readings collected in a block.

Block mean value *see* σ.

Block, open

Group of measurement readings that do not yet form a closed block.

Carriage Return (CR)

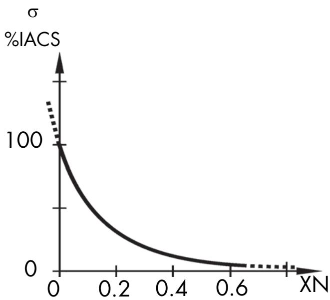
Carriage return. CR is a character from the ASCII character set (ASCII13) and has the following function: when entering data or commands, the line in which a person currently is working is closed by pressing the CR key (Enter or Return key on the PC keyboard) and the information entered is processed accordingly. The cursor is then placed at the beginning of the line again. CR is usually used together with the character LF (Line Feed) to begin the next line at the beginning of the line.

Calibration

The term "calibration" is used in this Operator's Manual as a general term for adjustment and calibration: adjustment of the measurement system (probe and instrument) with calibration standards to the *measuring application*.

Calibration curve

(characteristic curve, main characteristic curve) Quantitative relationship between the measurement signal from the probe and a scale for the electrical conductivity represented by *calibration standard*s.



The electrical conductivity σ is presented in relation to the normalized count rate XN as calibration curve.

If a *corrective calibration* has not yet been performed, the calibration curve is identical to the *main characteristic curve*. The corrective calibration smoothes response variations of electrical components in the measurement system and adjusts the calibration curve to the geometric shape of the specimen (e.g. curvature). The coefficients of the corrective calibration are saved in the open application file.

Calibration standard

(calibration standards, setting standards) Object whose conductivity was determined with the most accurate possible *test method*.

Capability indexes

The process capability is assessed on the basis of the indexes Cp and Cpk. For a more detailed description, see the documents of Ford Guideline Q101.
The capability index Cp is a measure of the variation of a process as well as its ability to manufacturing parts to specification continuously. If a Cp factor of 1.33 is achieved or exceeded, a capable process can be assumed.
The capability index Cpk considers the location of the mean value in relation to the tolerance limits. If Cpk = Cp the mean value lies exactly at the centre of the tolerance range, which corresponds to the ideal value and is the objective. In practice, Cpk should be ≥ Cp.

$$Cp = \frac{USL - LSL}{6 \cdot \hat{\sigma}}$$

$$Cpk = \left\{ \frac{USL - \sigma..}{3 \cdot \hat{\sigma}} \quad ; \quad \frac{\sigma.. - LSL}{3 \cdot \hat{\sigma}} \right\}$$

$$Cpk = \left\{ \frac{USL - \sigma..}{3 \cdot \hat{\sigma}} \quad ; \quad \frac{\sigma.. - LSL}{3 \cdot \hat{\sigma}} \right\}$$

The smaller value always applies

$\sigma..$: Mean value of the group mean values

$\hat{\sigma}$: Estimated value of the theoretical standard deviation

$$\hat{\sigma} = \sqrt{\frac{1}{n_{Bl}} \cdot \sum_{i=1}^{n_{Bl}} s_i^2}$$

s_i: Standard deviation of the blocks

n_{Bl}: Number of blocks

USL: Upper specification limit

LSL: Lower specification limit

Characteristic curve *see Calibration curve*

Check

An essential component of *monitoring the measurement devices*. It is based on the use of *calibration standard*s or, better yet, comparison specimens and serves to check the *calibration* and assure measurement stability.

Chi-squared test

Statistical-mathematical test method to confirm a normal distribution of the current measurement readings (for more than 30 measurement readings).

Class

Region between a lower and and upper class limit (specification limits). The measurement readings in a *series of measurements* can all be arranged into such classes if they cover the measurement range without interruption. The content of the class (frequency or number of measurement readings in a class) plotted versus the classes is called a *histogram*.

Coefficient of variation *V*

Confidence interval *see u*

Confidence level *see u*

Confidence limits

Region in the sum frequency chart in which the sum curve lies. The true quantile fraction for the particular feature (e. g. conductivity) lies within these limits with 95% certainty (confidence level). For a normal distribution, the confidence limits p_{upper} and p_{lower} are calculated as follows:

$$p_{lower} = \frac{\sigma - \sigma.}{\hat{\sigma}} - \left(1.96 \cdot \sqrt{\frac{1}{n} + \frac{\left(\frac{\sigma - \sigma.}{\hat{\sigma}}\right)^2}{2n-2}} \right)$$

$$p_{upper} = \frac{\sigma - \sigma.}{\hat{\sigma}} + \left(1.96 \cdot \sqrt{\frac{1}{n} + \frac{\left(\frac{\sigma - \sigma.}{\hat{\sigma}}\right)^2}{2n-2}} \right)$$

p_{lower}: Lower confidence limit
p_{upper}: Upper confidence limit
σ: Measurement reading
σ. Mean value
n: Number of all individual measurements
$\hat{\sigma}$ Estimated value of the standard deviation σ of the population

For measurement readings that are not normally distributed, the confidence limits are drawn as a polygon in the sum frequency chart and calculated as follows:

$$p_{lower}(i) = y_p(i) - \left(1.96 \cdot \sqrt{\frac{1}{n} + \frac{(y_p(i))^2}{2n-2}} \right)$$

$y_p(i)$: y-values of the polygon (sum curve for measurement readings that are not normally distributed) with i = 1 to n - 1.

$$p_{upper}(i) = y_p(i) + \left(1.96 \cdot \sqrt{\frac{1}{n} + \frac{(y_p(i))^2}{2n-2}} \right)$$

Corrective calibration

One- or two-point calibration. Adjustment of the instrument with 1 or 2 calibration standards. The corrective calibration encompasses calibration and adjustment. During corrective calibration, the main characteristic curve (calibration curve) is adjusted to changes of the measurement system (caused, for instance by component aging) or the geometric shape of the specimen. The coefficients obtained are saved in the open application file. The *main characteristic curve* itself remains untouched.

Count rate

Probe signal comprising the real and imaginary part of the probe impedance. The actual measurement reading, the phase angle Phi, is calculated from these count rates (X). Phi is directly related to the quantity to be measured σ, the electrical conductivity.
Usually, the display of the count rates X serves to establish whether a measurable effect even exists for a special measuring application.

Normalised count rate. With the aid of an appropriate calculation, the phase angles determined during the measurement are normalised to a reference range between

XN = 0 = 100 %IACS and XN = 1 = 0 %IACS. This means that these normalised count rates (= normalised phase angles Phn) are comparable regardless of the particular probe. Electrical conductivity values greater than 100 %IACS or 58 MS/m yield negative values for XN (Phn), see *Calibration curve*.
Using the normalised count rate, it is possible to determine whether the measurement lies in a suitable range for the current measuring application. The standards used for calibrations must lie in a certain XN range. This can be checked easily by displaying XN.

Cp *see Capability indexes*

Cpk *see Capability indexes*

CR *see Carriage Return (CR)*

Cu
Abbreviation for copper

Cumulative frequency
The cumulative frequency is the fraction (in percent) whose electrical conductivity is less than or equal to a certain measurement reading. The cumulative frequency in terms of the electrical conductivity can be read from a sum frequency chart. Example: It is found that 9 % of the parts have an electrical conductivity less than or equal to 39 %IACS (about 22 MS/m).

Cumulative frequency graph
Graphical presentation method that can be used to check whether measurement readings are normally distributed. A normal distribution appears in a cumulative frequency graph (also called cumulative frequency plot) as a straight line.

Curvature correction
In addition to the temperature, the curvature of the specimen affects the conductivity measurement. The effect on the conductivity measurement increases with decreasing diameter of curvature. As an example, the graphic on page 164 shows the relative conductivity error as a function of the diameter of curvature for 3 different materials (for the FS40 probe and a probe frequency of 60 kHz). The influence of curvature depends on the diameter of curvature and the conductivity of the specimen as well as the probe frequency used. For type FS40 probes, this functional relationship is saved in the **File > Properties... > Correction** menu for cylindrical specimens. After the specimen diameter has been entered, the instrument displays the corrected conductivity value. The **Correction** menu can be used to compensate diameters of curvature starting at 6 mm (0.24 inches). **Curvature correction is possible only in conjunction with type FS40 probes!**

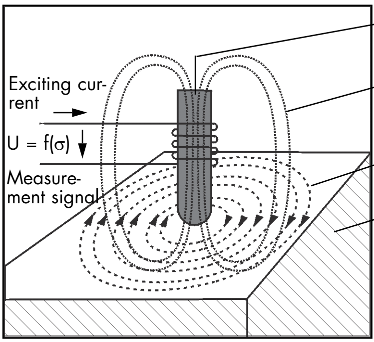
Difference
Measurement error to the nominal value (= reference value) of the standard. Parameter in the check result of the menu function **Check calibration**.

Difference between the arithmetic mean value $\overline{x}_m$ from the control measurement and the nominal value $\overline{x}_r$ (= reference value) of the standard used for measurement.
$|\overline{x}_m - \overline{x}_r|$
The data only applies to the open application file for which the check was performed.

DIP switch
DIP = Dual Inline Package = ready-to-install electronic component. In this case, a series of small switches. They are used on printers to change the default setting of the printer.

E value see *Test value E*

Eddy current test method
The exciting current generates a high-frequency magnetic field that induces eddy currents in the material. The formation of eddy currents depends on the electrical conductivity of the material. The measurement signal, which senses the reaction of the magnetic field associated with the eddy currents to the original magnetic field, is a function of the electrical conductivity.



Principle of the eddy current test method

Error cone *see Confidence limits*

Estimated value of the coefficient of variation *see* $\hat{V}$

Estimated value of the standard deviation *see* $\hat{\sigma}$

Evaluation
Calculation of statistical quantities such as mean value, standard deviation etc. as well as the graphical representation of the measurement values, for instance, in a sum frequency chart.

Evaluation menu
Evaluation menu for evaluating and presenting the measurement readings as well as for transferring the measurement readings, evaluations and representations to a PC

via the USB port, or printing out on a printer. Open the evaluation menu via the **Final** command button or the **Res** menu.

External start
Setting in the **File > Properties... > Measurement acceptance** menu function. Measurement acquisition is not started by placing the probe on the specimen, but rather by pressing the **Ext** command button, by tapping on **Meas > Trigger external start** or by sending the G0 command from a connected PC.

Excess *see Kurtosis*

FDD
Graphical representation of the mean values of the measurement blocks (= components) in a ranking with ascending values.
Application:
With the aid of the FDD, any existing systematic differences between electrical conductivities can be displayed in graphical form quickly and clearly.

Final result
Evaluation of all measurement readings or selected blocks in an application file.

Free-running display mode
Continuous measurement value display while the probe is placed on the specimen. Switch on the free-running display mode by means of the **Free** command button or via **Meas > Free running mode**.

Frequency distribution *see Histogram*

Gaussian distribution *see Normal distribution*

Gaussian normal distribution *see Normal distribution*

Gaussian normal probability plot *see Cumulative frequency graph*

Group separator
Identification at the end of the block indicating that the measurement data can be transferred to the PC. Standard ASCII character 29.

Grubbs test
Method used to check for outliers. Method developed by Grubs to check whether the largest or the smallest individual measurement can be considered an outlier.

GUM
Abbreviation for the guide ISO/IEC Guide 98-3, "**G**uide to Expression of **U**ncertainty in **M**easurement".

Histogram
Graphical representation of all measurement readings in an application file in *class-*

es (e. g. conductivity ranges, coating thickness ranges) based on their frequency of occurrence, where the class frequency is shown by the size of a rectangle. The individual class widths (width of the rectangles) are always identical and are calculated automatically by the instrument from the range of the measurement readings. A class width represents a conductivity range that varies with the range the measurement readings. The significance of the statistical results depends on the shape of this distribution, among other things. Deviation from the *normal distribution* may indicate systematic errors during measurement.

Individual measure value
Measurement reading acquired and displayed or printed out after measuring at the measurement location one time.

Interface
Transition or connecting point between components, circuits or programs. Exchange of data takes place via the interface. With serial interfaces, the data are transmitted in individual bits (i.e. one bit after another); with parallel interfaces, several bits are transmitted simultaneously. See also *RS232 interface and USB interface*

Instrument memory
Memory area in the instrument in which all application files, export files and graphic files are saved.

Kolmogoroff-Smirnoff test
Statistical-mathematical test method to confirm a normal distribution of the current measurement readings (for 5 to 30 measurement readings).

Kurtosis
Measure of how peaked (excess) or flat (kurtosis) a distribution is compared to a *normal distribution*. A positive kurtosis indicates a relatively narrow and peaked distribution. A negative kurtosis indicates a relatively flat and broad distribution. The kurtosis is zero for a normal distribution.

Largest value
Largest measured value in a *series of measurements*.

LF *see Line Feed*

Line Feed
(LF) line feed. Advancing of the paper in a printer by one line. Usually used together with the character CR (Carriage Return) to begin the next line at the beginning of the line.

LSL
Lower specification limit; the smallest measurement reading permitted at the measurement location.

Main characteristic curve

(Probe characteristic curve, calibration curve) Basic characteristic curve of the measurement system. The main characteristic curve provides the basis for determining the measurement readings, since it establishes the relationship between the probe signal and electrical conductivity. The coefficients of the main characteristic curve are saved in the probe connector.

Material thickness

Insufficient material thickness affects the measurement. The minimum thickness depends on the material and the *probe frequency* and results from the penetration depth of the induced eddy currents in the material.
The minimum thickness can be calculated by using the following rule of thumb:

$$th_{min} \geq 3 \bullet \delta_0$$

th_{min} : Minimum material thickness at which a conductivity measurement is possible.

δ_0 : Standard penetration depth of the induced eddy currents (depends on the material, frequency and design of the probe).

Depending on the probe frequency used, the corresponding standard penetration depths δ_0 for various materials can be found in the graphic on page 162.

Max

Largest measurement reading in a *series of measurements*.

Maximum *see Max*

Mean (average) range *see R.*

Mean value *see σ. or σ..*

Mean value of the block mean values *see σ..*

Measure

To measure means to compare!

The probe's signal at the measurement location is compared with the probe's signal from the *calibration standard*. The instrument converts the probe's signal into the measuring result by means of the *calibration curve*, and displays it in the set *unit of measurement*.

Measuring application

Properties of the specimen regarding quantity to be measured, material, geometric dimensions, permeability etc. Selection of the test method, measurement presentation, probe and instrument are based on these.

Measuring application memory *see Application memory*

Measurement error

Difference between the actual and measured value of a quantity. In instruments, a distinction is drawn between random (unforeseeable) and systematic (correctable) measurement errors. The random measurement errors determine the *repeatability*. The systematic measurement errors affect the *trueness* and the *reproducibility*. And actual practice, systematic measurement errors predominate by far. Systematic measurement errors can be attributed to 1. incorrect calibration, 2. operating or personnel-related errors or 3. fluctuations of the measuring conditions (inhomogeneity, instability, aging of the material etc). Their effect is usually in one direction. Factors 1 and 2 can be prevented or corrected or considered in the result through appropriate action.

Measurement location

A limited and clearly defined location on the reference surface of the specimen at which the electrical conductivity is to be determined.

Measurement presentation

Manner in which the measurement readings are represented and evaluated.

Measurement range

Region between two specification limits within which a measurement with the specified *trueness* and *precision* can be acquired. In a narrower sense, this means the span of the scale on an analogue measuring instrument. The measurement range depends on the *test method*, the type of probe and also the *measuring application*.

Measurement reading

Numerical value displayed on an instrument, together with the unit of measurement. The measurement reading can be obtained as the result of a single reading or as the arithmetic mean value of the results of several individual readings (e.g. in the case of an averaged display value (i single readings)).

Measurement uncertainty *see u*

Measuring accuracy *see Accuracy*

Measuring mode

In the state, the instrument can acquire and display measurement readings. Representation on the display is based on the set *measurement presentation*.

Measuring probe *see Random sample*

Menu page

Display(s) of information relating to instrument settings or for creating, setting or modifying an application file. An overview of instrument menus can be found on page 124.
If the size of the display is insufficient to show all data/parameters, the remaining data/parameters appear on other pages, as in a book.

Memory

Component of a microprocessor-controlled instrument. Information are saved in the memory (parameter settings, calibration coefficients, measurement readings); see *Application memory*.

Monitoring the measurement devices

A quality assurance task. It consists of verifying after specified time intervals whether the measurement device (instrument, probe) is still working properly and correctly calibrated and appropriate measures may need to be taken (recalibrate or repair instrument ...); see also *Check*.

Min

Smallest measurement reading in a *series of measurements*.

Minimum *see Min*

Minimum thickness *see Material thickness*

NC

Abbreviation for non conductive metals

NF

Abbreviation for nonferrous metals

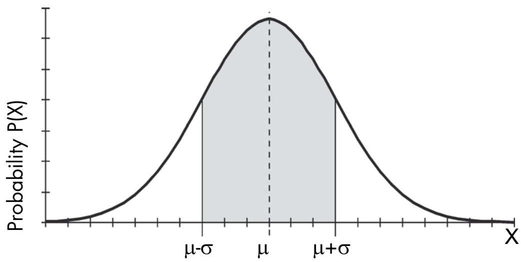
Ni

Abbreviation for nickel

Normal *see Calibration standard*

Normal distribution

Gaussian normal distribution, Gaussian distribution, bell curve.
Probability distribution discovered in 1794 by C. F. Gauss.
If a quantity X is normally distributed, then 68.3 % of the observed values of X lie in the interval of variation σ around the mean value μ of the quantity X. This means that $\mu - \sigma \le X \le \mu + \sigma$ applies to 68.3 % of the observed values. This interval is identified by the gray area under the curve in the following figure.



Probability distribution P(X) of a normally distributed quantity X

The probability distribution P(X) is symmetrical about the mean value μ of the normally distributed quantity X. *Skewness* and *kurtosis* are zero for a normal distribution. Often, the populations investigated in engineering are approximately normally distributed. The following, however, is of great significance: If several identically sized random samples are taken from any population (blocks) and their mean values (block mean values) are calculated, then these mean values are normally distributed (central limit theorem).
The mean value of the mean values of these random samples (block mean values) is an estimated value ($\hat{\mu} = \sigma$.) for the mean value μ of the population. Because of the normal distribution, it is possible to calculate the measurement uncertainty *u* with the aid of the *standard deviation* of the mean values of the random samples.
Whether a quantity is normally distributed can be established in a *sum frequency chart*, where a normal distribution is represented as a straight line.
Testing of whether the current measurement readings (random samples) are normally distributed is performed in the instrument via the *Kolmogoroff-Smirnoff-test* (up to 30 measurement readings) and the *chi-squared test* (more than 30 measurement readings).

Normalisation

In this Operator's Manual, the term "normalisation" means measuring the air value. This is needed for internal adjustment of the measurement system in order to compensate for possible drift of the measurement system components.

Normalised count rate *see Count rate*

Off-Line

State of a device (printer or PC) connected to the instrument during which no data can be received.

Open block

Group of measurement readings that do not yet form a closed block.

On-Line

State of a device (printer or PC) connected to the instrument during which data can be received. In this state, the device is ready for use.

Outlier

Measurement readings that are considerably smaller or larger than the remaining measurement values in the *series of measurements* and which as a result can be considered unexpected and rejected.

Outlier check

Is used to prevent distortion of the measurement result by outliers. The outlier check can be based on either the Grubbs test or the sigma outlier check (specification of a known variation). Measurement readings that are detected as outliers by the outlier check are not considered in the statistical evaluation.

Parity

A method used to test for errors in which the sum of the digits in all bit groups transmitted without errors must always be even or odd. During data transmission, parity bits are added to the data bits for each character or byte to be transmitted. For each word, this bit is set such that the total of the ones of a bit always yields an even or odd number. This corresponds to even or odd parity. Which parity applies must be established prior to data transmission. By checking the parity, the recipient can check whether transmission errors occurred.

Part *see Specimen*

Phi *see Count rate*

Phn *see Count rate*

Population

All parts or specimens to be measured. In practice, for instance, all parts in a production unit, batch etc.

Precision

Agreement between the individual measuring results under clearly specified test conditions; comprises *reproducibility* and *repeatability*.

Probability plot *see Cumulative frequency graph*

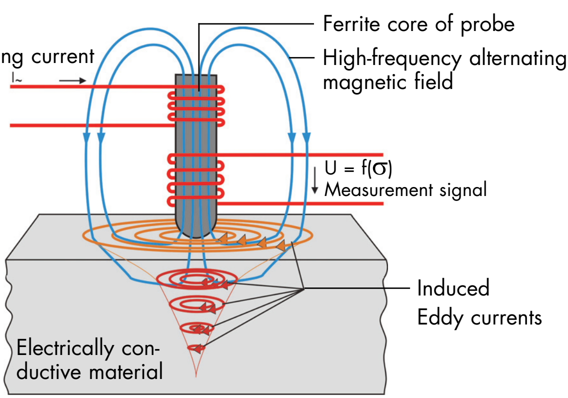
Probe

Sensing element that employs a specific test method to supply an electrical signal to the instrument. This signal is proportional to the electrical conductivity and is converted in the instrument with the aid of the *main characteristic curve* and possibly the calibration coefficients of the open application file into a corresponding conductivity value. Probes from FISCHER are all pre-calibrated at the factory (undergo a master calibration).

Probe characteristic curve *see Main characteristic curve*

Probe frequency

A generator supplies the collectivity probe with an AC current at a specific frequency. The penetration depth of the eddy currents induced in this way depends on the frequency used (probe frequency). A frequency commonly used in practice and recommended in many test specifications lies in the range of 60 kHz. The penetration depth of the eddy currents induced in the material determines the minimum thickness of the specimen. The higher the probe frequency, the shallower is the penetration depth of the eddy currents induced in the material.



Principle of the phase sensitive eddy current test method

For a rule of thumb for calculating the minimum thickness, see section "Influence of material thickness" on page 162.

Quality assurance

All measures in a facility intended to ensure that controlled production can take place in a manner to meet the quality requirements. One partial aspect is quality monitoring, of which electrical conductivity measurement is in turn a part.

R

The range R equals the difference between the largest measurement reading (maximum) σ_{max} and the smallest measurement reading (minimum) σ_{min} in a *series of measurements*.

$$R = \sigma_{max} - \sigma_{min}$$

R.

Mean (average) range over all block ranges.

$$R. = \hat{\sigma} \cdot d_2$$

R.: Mean range

$\hat{\sigma}$: Estimated value of the standard deviation σ of the population

d_2: Factor, depends on the sample size; can be found in commonly available reference books.

Random measurement errors *see Measurement error*

Random sample

A few parts taken from the *population*. In practice, a small portion of a production lot is extracted from production by using rules that ensure random selection and the measuring results obtained from it are extrapolated to the lot (batch, production unit).

Range *see R*

Reference surface

A defined area of the specimen's surface with a known electrical conductivity.

Repeatability

Measuring repeatedly under constant conditions at the same measurement location results in random deviations of the measurement readings. Constant conditions means taking measurements on the same specimen by using a specified method, in short intervals with the same instrument, by the same observer and at the same place. The standard deviation of measurement readings acquired under repeatability conditions is a measure of the repeatability. A large standard deviation or measurement uncertainty for an instrument means poor repeatability. The smaller the standard deviation, the better is the repeatability. The repeatability depends on the test method and the characteristics of the instrument as well as the characteristics of the specimen. Repeatability can be improved by forming the mean value from a *series of measurement*s (i-single reading).

Reproducibility

Designation for the differences between individual measuring results under comparable conditions. Comparable conditions means measurements on a specimen taken by means of a specified method, e.g. at different moments in time or with different instruments or by different observers or at different places. Measuring results that were obtained by different individuals with different instruments at different places on identical specimens must be comparable. Reproducibility is the basis for calculating the confidence interval for the expected value.

RS232 interface

Serial interface standardised in the USA. Used for connection between PC and instrument, for instance.

σ

Display of the electrical conductivity measurement in the respective unit. The attribute to be measured can viewed directly on the display, e.g. 25 %IACS.

$\sigma.$

Mean value of the individual measurements, called the arithmetic mean ($\sigma.$). The arithmetic mean $\sigma.$ is the sum total of all individual measurements σ_i in a *series of measurements* (in a block) divided by the number of measurements.

$$\sigma. = \frac{\sigma_1 + \sigma_2 + \sigma_3 + ... + \sigma_n}{n} = \frac{1}{n} \cdot \sum_{i=1}^{n} \sigma_i$$

$\sigma.$	Mean value (block mean value)
n	Number of measurement readings (in a block)
σ_i	Individual measurements (in a block)

σ..

Mean value of the block mean values for selected blocks. As with the arithmetic mean (σ.), the block mean values are totalled and divided by the number of blocks evaluated n_{Bl}.

$$\sigma.. = \frac{1}{n_{Bl}} \cdot \sum_{i=1}^{n_{Bl}} \sigma._i$$

σ..	Mean value of the block mean values
n_{Bl}:	Number of blocks
$\sigma._i$	Block mean values

$\hat{\sigma}$

Estimated value of the standard deviation σ of the population. Generated only in the final result for applications in which automatic block formation is enabled.

$$\hat{\sigma} = \frac{R.}{d_2}$$

$\hat{\sigma}$:	Estimated value of the standard deviation σ of the population
R.	Mean range
d_2:	Factor, depends on the sample size; can be found in commonly available tables.

or in the case of stated specification limits:

$$\hat{\sigma} = \frac{USL - LSL}{6 \cdot Cp}$$

$\hat{\sigma}$:	Estimated value of the standard deviation σ of the population
USL:	Upper specification limit
LSL:	Lower specification limit
Cp:	Capability index (default setting 1.33)

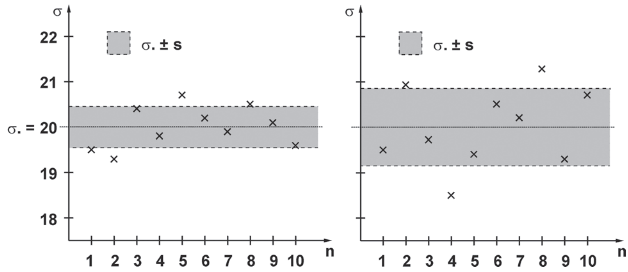
s

The standard deviation s is a measure of the variation of individual measurement readings around their common mean value in a *series of measurements*. It equals the mean square deviation of the individual measurements from the mean value and is calculated as follows:

$$s = \sqrt{\frac{1}{n-1} \cdot \sum_{i=1}^{n} (\sigma. - \sigma_i)^2}$$

s:	Standard deviation
σ.:	Mean value of the individual measurements
n:	Number of individual measurements
σ_i:	Individual measurements

The following figure illustrates how two very different series of measurements can have different standard deviations while having the same mean value.



Series of measurements with the same mean value σ. and different standard deviations

sa

Variation of block mean values, corrected on the basis of the variation in individual measurements. sa is only calculated if the measurement was made with a fixed block size (automatic block formation enabled) and the variation in block mean values obtained from variance analysis cannot be explained from the variation within the blocks. At least 5 blocks must be available for the calculation and the variation in block mean values around the population mean (s_{II}) needs to be significantly greater than $\hat{\sigma}$.

If, for instance, the same number of measurements per measuring point is taken at several measuring points and the measurements per measuring point are collected in a block, then s_{II} is a measure of the instrument variation (with a sufficiently smooth and solid coating surface) and sa is the product variation adjusted for the instrument variation.

$$sa = \hat{\sigma} \cdot \sqrt{\frac{F_{beo} - 1}{n_{Bl}}}$$

sa: Variation in block mean values

$\hat{\sigma}$: Estimated value of the standard deviation σ of the population.

n_{Bl}: Number of blocks

F_{beo}: Quantile of the F distribution (observed), with s_{II} as the variation in group mean values around the population mean

$$F_{beo} = \frac{s_{II}^2}{\hat{\sigma}^2};$$

$$s_{II} = \sqrt{n_i} \cdot \sqrt{\frac{1}{n_{Bl} - 1} \cdot \sum_{Bl = 1}^{n_{Bl}} (\sigma._{Bl} - \sigma.._{Bl})^2}$$

$\sigma._{Bl}$: Block mean value

$\sigma.._{Bl}$: Mean value of the block mean values

n_{Bl}:Number of blocks

n_i: Block size (number of single readings per block)

Series of measurements
Sequence of individual measurements between two block or final results.

Setting standard *see Calibration standard*

Sigma limits around a regression line
The sigma limits around the regression line in the cumulative frequency graph represent the confidence interval around the straight line in which the straight line with a confidence level of 95 % lies (the value of 95 % is defined internally in the instrument).

SIGMASCOPE
Protected trademark of Helmut Fischer GmbH Institut für Elektronik und Messtechnik in Germany and other countries. This instrument name signifies that the phase-sensitive eddy current test method is the test method used for the conductivity measurement. Measurement of the electrical conductivity of nonferrous metals.

Skewness
Measure of the asymmetry of a monomodal probability distribution around its mean value. A positive skewness indicates a distribution whose maximum is shifted toward values larger than the mean value. A negative skewness indicates a distribution whose maximum is shifted toward values smaller than the mean value. For a symmetrical distribution, the skewness is zero (normal distribution).

Smallest value
Smallest measured value in a *series of measurements*.

Specification limits
The upper specification limit (USL) is the largest measurement reading, the lower specification limit (LSL) is the smallest measurement reading permitted for the measurement location.

Specimen
Object on whose surface measurements are made in order to determine the electrical conductivity.

Standard deviation *see s*

Start bit
With asynchronous serial data transmission, a start bit is sent before the data word being transmitted. The transition from the logical one to the logical zero of the start allows the recipient to synchronize to the following data bits.

Statistical evaluation
Calculations with the measurement readings based on statistical-mathematical methods.

Statistics

Result of a *series of measurements*, i. e. summary of a large number of individual measurements in a few characteristics (e. g. mean value, standard deviation etc.).

Stop bit

With asynchronous serial data transmission, a stop bit is added to the data word being transmitted. 1 to 2 logical ones are used. After the stop bit, the sender remains at logical one until the start bit of the next character.

Student factor *see t*

Supervisor menu

This menu is password-protected to prevent unintentional changes of parameter settings. Password: 159.

Systematic measurement error *see Measurement error*

t

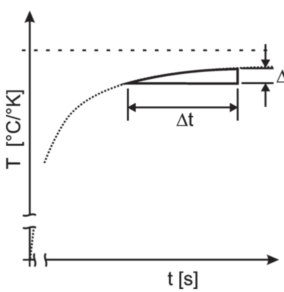
The Student factor t can be found in commonly available reference books (e.g. Graf, Henning, Stange, Wilrich: Formeln und Tabellen der angewandten mathematischen Statistik; Springer-Verlag) and is listed as follows:

$$t_{\left(1-\frac{\alpha}{2}\right);f}$$

Example: At a confidence level of 95 % and n > 200 (and this 199 degrees of freedom, since f = n - 1), the Student factor is $t_{97.5;\,199} = 1.96$.

ΔT/Δt

Temperature change per second. When measuring the temperature, every temperature sensor/probe requires a certain amount of time to sense the specimen's temperature. Starting from its current temperature, the temperature sensor attempts to match the specimen's temperature. This matching process follows an e-function and appears graphically as follows:



The marked triangle shows the temperature increase ΔT over a certain time interval Δt (e.g. 1 second).

Figure at left:
Detail of a temperature curve as a function of time t.

With the aid of the monitoring function ΔT/Δt (**File > Properties... > Temperature cor-**

rection menu) changes in the specimen's temperature and the thermal stability of the specimen can be observed. For exact measurements, the temperature fluctuations must not be too large.

Temperature coefficient α

Material characteristic. The temperature coefficient of the electrical resistance is the ratio of the relative change in resistance to the temperature change.

The following sources are the basis of the temperature coefficients stored in the instrument: "Nondestructive Testing Handbook", Vol. 4 "Electromagnetic Testing" (American Society for Nondestructive Testing, 1986), ASTM Standard B193-02, "Standard Test Method for Restivity of Electrical Conductor Materials" as well as our own measurements.

For Cu and Al/Al alloys, the calculation is performed dynamically using the measured, pre-corrected electrical conductivity values on the basis of the functional relationship between the electrical conductivity and temperature coefficient.

Test method

Procedure and method for obtaining information about the properties of the specimen. The test method is based on scientific knowledge and depends on the *measuring application*.

Test value E

Coefficient for the measurement accuracy/quality of the calibration of the opened application file. This test value is calculated in the **Check calibration** menu function from the measurement readings of the control measurement and the characteristics of the standard on which the control measurement was carried out. The test value is the result of the ratio of *difference* to *uncertainty (k=2)*.

E $\leq$ **1**: The measurement accuracy for the opened application file is ok for this standard and cannot be further improved by this standard. The difference between the mean value from the control measurement and the nominal value (= reference value) of the standard used for measurement cannot be distinguished from the measurement uncertainty of the calibration *(measurement uncertainty (k=2))*.

E > 1: The mean value of the control measurement has an excessive deviation to the nominal value of the standard used for measurement. Perform a corrective calibration to improve the measurement accuracy for the opened application file.

$$\text{Test value E} = \frac{|\bar{x}_m - x_r|}{\sqrt{(U_m(\text{k=2}))^2 + (U_r(\text{k=2}))^2}}$$

$$U_m(\text{k=2}) = 2 \cdot t(68.27\,\%, \text{n - 1}) \cdot \frac{s(\bar{x}_m)}{\sqrt{n}}$$

$$U_r(\text{k=2}) = 1.653 \cdot \frac{T}{\sqrt{3}}$$ (Gl. 1) or entry value for U(k=2)

$\bar{x}_m$: Arithmetic mean value for the control measurement

x_r: Nominal value of the standard for which the control measurement was performed

U_m: Measurement uncertainty (k=2) of the control measurement based on stochastic errors

t: Student factor (can be found in commonly available reference books e.g. "Formeln und Tabellen der angewandten mathematischen Statistik" by Graf, Henning, Stange and Wilrich). For example, at a 68.27 % confidence level (k=1) and n = 10, the Student factor is $t_{68.27;\,9} = 1.07$.

s: Standard deviation of the mean value $\bar{x}_m$ from the control measurement

n: Number of control measurements on the standard

U_r: Specified measurement uncertainty (k=2) of the standard, direct entry value or, with specified tolerance level, the calculation takes place according to the formula Gl. 1

T: Amount of the specified tolerance data of the standard

1.653: Factor for the confidence level of 95.45 % (k=2), resulting from the variance of the rectangular distribution. For the confidence level of 68.27 % (k=1), the factor is 1.

Tolerance limits *see Specimen*

Transmission rate *see Baud rate*

True value *see Trueness*

Trueness

Agreement between the "true" value and the mean value of the measuring results that can be obtained continually under practical conditions. The "true" value is understood to be a value known on the basis of mathematical-theoretical principles. Since such values very seldom occur, a value usually obtained from national or international working standards is accepted as "correct". This "correct" value is frequently designated the "true" value.

Two-point calibration *see Curvature correction*

u

Every instrument generates random measurement errors (see also *Accuracy*). The assumed "true" value (μ) of the quantity being measured lies in an interval around the measured mean value σ. of a *series of measurements* with a certain probability (the confidence level). The interval is also called the confidence range. The limits of this interval are at a distance u from the mean value μ corresponding to the measurement uncertainty.

$$\sigma. - u \le \mu \le \sigma. + u$$

The measurement uncertainty u is calculated according to the following formula for a normally distributed *population* and a specified confidence level (1 - α):

$$u = \frac{t \cdot s}{\sqrt{n}}$$

t Student factor (can be found in commonly available reference books such as "Formeln und Tabellen der angewandten mathematischen Statistik"; by Graf, Henning, Stange, Wilrich, Springer-Verlag). For example, at a 95% confidence level and n > 200, the Student factor is $t_{97.5;\,199} = 1.96$.

s: Standard deviation

n: Number of measurements

If the coefficient of variation V is inserted into the formula instead of the standard deviation, the relative measurement uncertainty u_{rel} is obtained in %.

$$u_{rel} = \frac{t \cdot V}{\sqrt{n}}[\%]$$

u scale

Ordinate scale at the right in the printout of the sum frequency chart. Linear transformation of the measurement readings into standardised measurement readings u. The transformation is used for comparison and analysis purposes. The standardised features are dimensionless; their arithmetic mean u is zero and their standard deviation σ(u) is always 1.

$$u = \frac{x - \mu}{\sigma}$$

u: Feature
x: Measurement reading
μ: Mean value of the population
σ: Standard deviation of the population

Uncertainty (k=2)

Parameter in the result display in the menu function **Check calibration**. It states the measurement uncertainty of the calibration of the open application file (measurement accuracy of the open application file). This combined measurement uncertainty takes the measurement uncertainty (U_m) of the control measurement and the specified measurement uncertainty (U_r) of the standard (= reference part) into account for a confidence level of 95.45 %, corresponding to the extension factor k=2. The calculations are made according to ISO/IEC Guide 98-3.

Uncertainty (k=2) = $\sqrt{(U_m(k=2))^2 + (U_r(k=2))^2}$

$$U_m(\text{k=2}) = 2 \cdot t(68.27\ \%, \text{n - 1}) \cdot \frac{s(\bar{x}_m)}{\sqrt{n}}$$

$U_r(\text{k=2}) = 1.653 \cdot \frac{T}{\sqrt{3}}$ (Gl. 1) or entry value for U(k=2)

U_m: Measurement uncertainty (k=2) of the control measurement based on stochastic errors
t: Student factor (can be found in commonly available reference books e.g. "Formeln und Tabellen der angewandten mathematischen Statistik" by Graf, Henning, Stange and Wilrich). For example, at a 68.27 % confidence level (k=1) and n = 10, the Student factor is $t_{68.27;\,9}$ = 1.07.
s: Standard deviation of the mean value $\bar{x}_m$ from the control measurement
n: Number of control measurements on the standard
U_r: Specified measurement uncertainty (k=2) of the standard, direct entry value or, with specified tolerance level, the calculation takes place according to the formula Gl. 1
T: Amount of the specified tolerance data of the standard
1.653: Factor for the confidence level of 95.45 % (k=2), resulting from the variance of the rectangular distribution. For the confidence level of 68.27 % (k=1), the factor is 1.

Unit of measurement

Unit in which the measurement reading is displayed. %IACS and MS/m are common in conductivity measurement, 100 %IACS = 58 MS/m.

USB interface

Interface for connecting an instrument to a PC, printer, USB flash drive or USB keyboard

USL

The upper specification limit is the largest measurement reading permitted at the measurement location.

V

Coefficient of variation. Percent variation of a *series of measurements*, i. e. standard deviation in terms of the mean value. V [%] is a characteristic process constant. A sudden change in V [%] indicates a change in process conditions. V [%] is calculated as follows:

$$V = \frac{s}{\sigma.} \cdot 100[\%]$$

V: Coefficient of variation
s: Standard deviation
σ. Mean value

$\hat{V}$

Estimated value of the coefficient of variation.

$$\hat{V} = \frac{\hat{\sigma}}{\sigma..} \cdot 100[\%]$$

$\hat{V}$: Estimated value of the coefficient of variation
$\hat{\sigma}$: Estimated value of the standard deviation σ of the population
σ.. Mean value of the block mean values

Variance

Mean square deviation. The square root of the variance is called the standard deviation (*s*).

$$s^2 = \frac{1}{n-1} \cdot \sum_{i=1}^{n} (\sigma_i - \sigma.)^2$$

s^2: Variance
σ.: Mean value
σ_i: Individual measurements
n Number of measurement readings

Variation in mean block values *see sa*

X *see Count rate*

XN *see Count rate*

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