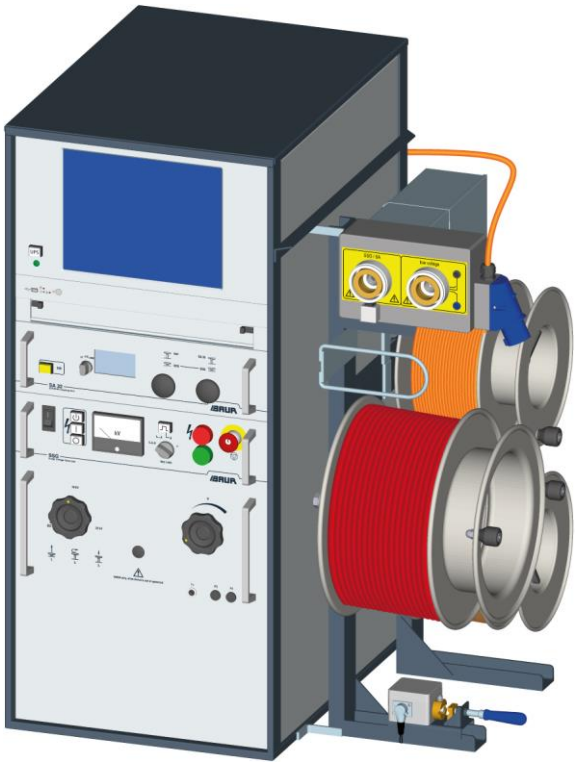
User manual

Cable fault location system

Syscompact 4000



The figure is illustrative including options

B A U R G m b H ▪ R a i f f e i s e n s t r . 8 ▪ 6 8 3 2 S u l z , A u s t r i a
T +43 5522 4941-0 ▪ F +43 5522 4941-3 ▪ www.baur.eu ▪ headoffice@baur.at

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1 ABOUT THIS MANUAL

1.1 Using this manual

This user manual contains all necessary information that is needed for the commissioning and operation of the described product.

- Read this user manual completely before operating the product for the first time.
- Consider this user manual to be a part of the product and store it in an easily accessible location.
- If this user manual is lost, please contact BAUR GmbH or your nearest BAUR representative (http://www.baur.eu/baur-worldwide).

1.2 Validity of this user manual

This user manual applies for the Syscompact 4000 cable fault location system and the BAUR system software for cable fault location from version 4.4 and describes all functions.

The availability of individual functions and methods depends upon the system configuration.

1.3 Structure of safety instructions

The safety instructions in this user manual are presented as follows:

Danger symbol 	**SIGNAL WORD**
	Type of danger and its source Possible consequences of violation. ▸ Measure to prevent the danger.

If a dangerous situation could arise at a specific step, the safety instruction is displayed immediately before this dangerous step and is shown as follows:

SIGNAL WORD

Type of danger and its source. Possible consequences of violation.

1. Measure to prevent the danger.

Danger levels

Signal words in the safety instructions specify the danger levels.

DANGER	Will lead to severe injuries or death.
WARNING	May lead to severe injuries or death.
CAUTION	May lead to light to moderate injuries.
NOTICE	May lead to material damage.

Danger symbols

	**General danger**
	**Risk of electric shock**
	**Danger of suffocation due to carbon dioxide**
	**Dangerous for persons with pacemakers**

1.4 View Settings

Symbol	Meaning
▸	You are requested to perform an action.
1. 2. ...	Perform the actions in this sequence.
a. b. ...	If an operation consists of several operating steps, they are specified with "a, b, c". Perform the operating steps in this sequence.
1 2 ...	Numbering in the legend
▪	List
	Indicates further information on the topic.
	Indicates tools required for the subsequent tasks.
	Indicates spare parts required for the subsequent tasks.
	Indicates required cleaning agents.

1.5 Note on the screenshots and graphics used

The setup of the system depends upon the configuration. The graphics show a possible system setup for the cable fault location system as an example.

The screenshots and graphics used are intended to illustrate the procedure and may differ from the actual state.

Cable drum rack

The connection diagrams and pictures of the system show the KTG M3 cable drum rack.

Connection diagrams

The connection diagrams for screened cables show the connection to 3-phase cables with separately screened phases as an example. The connection is the same for other cable types.

2 FOR YOUR SAFETY

All BAUR devices and systems are reliable and are manufactured as per state-of-the-art technology. The individual parts and the finished devices are subject to continuous testing by our qualified personnel as part of our quality assurance system. Each device is fully tested before delivery.

However, the operational safety and reliability in practice can be achieved only when all necessary measures have been taken. The responsible body[1] and operator[2] of the device or system are responsible for planning these measures and monitoring their implementation.

Before operating the device or system you should read and understand this user manual and the user manuals of all integrated devices.

2.1 Intended use

The system is used for the pre-location and pin-pointing of high-resistive, low-resistive and intermittent faults on low- and medium-voltage cables and for cable testing under DC voltage.

If the system is not used in accordance with this stipulation, safe operation cannot be guaranteed. The user is liable for any damage to persons and property resulting from incorrect operation!

Proper use also includes

- compliance with all instructions in this user manual, and all other applicable documents,
- compliance with the technical data and connection requirements given on the rating plate and in the user manual and any other applicable documents,
- compliance with the inspection and maintenance instructions for the system and its components.

2.2 Instructions for the operator

The product may be operated only by authorised and trained electrical engineers. An electrical engineer is a person who, owing to his professional education (electrical engineering), knowledge, experience and familiarity with the applicable standards and regulations, can assess the tasks assigned to him and detect possible dangers.

In addition, the operator must have:

- Knowledge of the technical equipment and operation of the product
- Knowledge of the testing and measurement procedures
- Knowledge of plant engineering (cable types, switchgear, etc.).

[1] Responsible body is the person or group that is responsible for the safe operation of the device and its maintenance (EN 61010-1, 3.5.12).

[2] Operator is the person who uses the device for its intended purpose (according to the definition of user in compliance with EN 61010-1, 3.5.11).

2.3 Avoiding dangers, taking safety measures

- When installing the test system and operating Syscompact 4000 observe the following rules and guidelines:
  - Accident prevention and environment protection rules applicable for your country
  - Safety instructions and regulations of the country where Syscompact 4000 is being used (according to the latest version)
  - EU/EFTA countries: EN 50191 *Installation and operation of electric testing systems*

    Other countries: The standard for installation and operation of electric testing systems applicable for your country
  - EU/EFTA countries: EN 50110 *Operation of electric systems*

    Other countries: The standard for operating electric systems applicable for your country
  - If necessary, other national and international standards and guidelines in accordance with the latest applicable version
  - Local safety and accident prevention regulations
  - Operational insurance association regulations (if any)

2.3.1 Forbidden for persons with pacemakers

DANGER

Magnetic and electromagnetic fields in the immediate surroundings of electric equipment

It is dangerous for persons with pacemakers and metal implants to stand in the immediate surroundings of electric equipment.

Magnetic and electromagnetic fields can damage and adversely affect the function of pacemakers and metal implants. This can be dangerous for the health of the concerned persons.

- Persons with pacemakers and metal implants must not stand close to high-voltage systems.

2.3.2 Operation only in a technical secure state

Safety, function and availability depend on the proper condition of the system.

- Operate the system and the integrated devices only in a technical perfect condition.
- In case of damage and malfunction, immediately stop the system, mark it accordingly and have the faults rectified by appropriately qualified and authorised personnel.
- Comply with the inspection and maintenance conditions.
- Use only accessories and original spare parts recommended by BAUR. The use of spare parts, accessories and special facilities that are not tested and approved by BAUR could adversely affect the safety, function and characteristics of the product.

2.3.3 Checking and maintaining the safety devices

The safety devices must be inspected regularly for proper condition and function. The system must not be operated in the case of defects or non-functional safety devices.

The safety devices must not be changed, bridged or switched off.

2.3.4 No operation during condensation

Condensation can form in devices and systems due to temperature fluctuations and high air humidity, which in some components can result in leakage currents, flashovers and short-circuits.

Maximum danger arises when relatively high air humidity and temperature fluctuations occur in a device consecutively, which is the case when storing the system or device in an unheated room or when placed outdoors, for example. When the system or device is then exposed to a high ambient temperature, the cold device surfaces cool the air in the immediate vicinity, which leads to formation of condensation even inside the device.

During this process, two factors are crucial:

- The higher the relative air humidity, the faster the dew point is reached and water is condensed.
- The higher the temperature difference between the surfaces and the ambient air, the stronger the tendency for condensation.

▸ Always prevent condensation in devices. Temper the device and system before and during the measurements so that no condensation occurs.

2.3.5 No operation in areas with risk of explosion and fire

Measurements in direct contact with water, in environments with explosive gases and in areas with fire risks are not permitted. Possible danger areas include e.g. chemical factories, refineries, paint factories, paint shops, cleaning plants, mills and stores of milled products, tank and loading plants for combustible gases, liquids and solid matter.

2.3.6 Dangers when working with high voltage

When performing tests and measurements with the system, dangerous - at times a very high - voltage is generated that is fed to the test object via an HV connection cable.

Personnel need to pay special attention and must be very careful while working with high electric voltage.

Commissioning and operation of the system are permitted only in compliance with the EN 50110 and EN 50191 (EU/EFTA countries) or with standards applicable in your country.

Observe 5 safety rules

▸ Comply with the following safety rules before beginning tasks in and on the electrical plant:

1. Disconnect the test object.
2. Secure against re-connection.
3. Verify absence of operating voltage.
4. Earth and short all phases.
5. Provide protection against adjacent live parts.

DANGER

High electrical voltage

Danger to life or risk of injury due to electric shock.

- Before commencing work, the operator must assess the risks for the specific working conditions. Protective measures are based on the risk assessment and must be followed at the workplace.
- Connect the system as described in this user manual.
- Pay particular attention to ensuring the test object and system are earthed correctly.
- Observe the warning and safety signs on the system. Always check whether the warning signs are available and are legible.
- Never put the safety devices out of operation. It is forbidden to bypass the safety devices.
- Ensure that adjacent live parts are secured against accidental contact and flashovers with suitable covers (insulation mats, insulating safety plates).
- Cordon off all metal parts in the area of the test object terminals (connection point and far end). Insulate and earth the metal parts to avoid dangerous charges.

The test object may still be live and carry dangerous voltage after a measurement, even after the system or device has been switched off.

- Before removing the safety precautions, discharge, earth and short circuit all live parts.

DANGER

Arcing fault when establishing a connection

Danger of burn injuries and electro-ophthalmia due to arcing fault.

- Use suitable personal protective equipment to protect against arcing faults.
- Cover the adjacent live parts with an insulating material.
- Use only undamaged connection cables.
- Secure the connection points and far end of the test object.
- Use special locking devices to lock connection points.

2.3.7 Danger during the system's surge mode

⚠ WARNING

Potential differences between the system and the earth

Danger to life or risk of injury due to electric shock.

Potential differences between the system and the earth are possible during surge mode when the system is positioned on the cable route. The greatest potential difference and dangerous contact voltage will occur in the case of a fault due to earth contact in a plastic-insulated low voltage cable without shielding.

Fault is near the system:

Voltage drops at the fault location. There is risk of electric shock if a person is standing over the fault location and touches the system connected to the station earth.

Fault is far away from the system:

As the system is at the same potential as the station earth, there can be a voltage difference between the system and the neutral earth in the event of a cable fault, which can lead to rising potential of the station earth. There is risk of electric shock if a person touches the system connected to the station earth.

- Place the system at a distance of several meters to the cable route or cable fault location.
- When positioning over the cable route, do not use measurement methods that use a surge voltage and do not isolate the system.

If it is not possible to avoid the hazard by means of a potential increase, take the following safety measures:

- If operating in 'surge mode', cordon off the system at distance of at least 1.5 m.
- During surge mode, people may only stand outside the cordoned off area.

2.3.8 Dangers from road traffic

- As tasks with systems are often carried out in the road traffic area, when assessing the danger also consider this danger area.
- When setting up the system, secure the work place and during testing and measurement tasks, observe the country-specific road traffic regulations, applicable national work safety and accident prevention regulations and local conditions.
- Moreover, dangers for the test personnel and road users must be ruled out. Test personnel must wear high visibility clothing that can be identified clearly by road users.

2.3.9 Guaranteeing immediate measures in an emergency

The device may be operated only if a second person with visual and audio contact to the tester is present and is in the position to detect possible dangers and to act immediately and properly.

2.3.10 Safety locking feature against unauthorised operation

- When leaving the device or the system, press the emergency off button and remove the key.
- Keep the key in a place that is inaccessible for unauthorised persons.

2.4 Special personal protective equipment

Personal protective equipment based on the risk assessment for the relevant working conditions is part of the safety concept of BAUR systems.

- Observe the internal operating instructions and the safety instructions applicable in your country.

The following safety equipment according to the state of the art can be necessary depending on the specific conditions in the work place:

Protection against electrostatic charging, crushing, slipping and other accidents:	▪ Safety footwear
Protection against electric dangers (arcing fault):	▪ Tested safety clothing ▪ Insulating helmet with visor ▪ Insulating protective gloves ▪ NH fuse puller with cuff
Protection against noise:	▪ Ear protection
Protection against dangers from road traffic:	▪ High-visibility vest according to EN 471 (Protection class 2) or according to the applicable standards in your country for high-visibility clothing for commercial use. **Important:** No high-visibility vests while working with electric arc hazard!
Hand protection:	▪ Safety gloves

3 PRODUCT INFORMATION

3.1 Overview of the available cable fault location methods

The following fault location methods are available to you with the Syscompact 4000 cable fault location system:

Fault analysis

- Insulation resistance measurement
- Determining the breakdown voltage*
- Cable testing with DC voltage*
- Cable sheath testing*

* This method is not supported by the BAUR system software.

Cable fault pre-location

- Time Domain Reflectometry (TDR)
- Secondary-multiple impulse method (SIM/MIM)
- Secondary-multiple impulse method used in DC mode: DC-SIM/MIM*
- Impulse current method (ICM)

* This method is not fully supported by the BAUR system software.

Cable fault pin-pointing

- Acoustic pin-pointing

* Pin-pointing is not supported by the BAUR system software.

▸ Follow the user manuals for the devices you are using for cable fault pin-pointing.

3.2 BAUR system software for cable fault location

3.2.1 Integrated user support

Online Help

The Online Help includes all detailed information that you need for operating the BAUR system software for cable fault location. It includes the user manuals for the system and the BAUR system software that you already have in printed form.

The description of all views and dialogs in the software are given exclusively in the Online Help.

You can open the Online Help from the BAUR system software. Depending on the menu from which you invoke the Online Help, the topic on that particular dialog or view is displayed in the Online Help. There are many ways to invoke the Online Help:

- If you need help on a dialog or view, press the *F1* key while you are in this window.

  The Online Help opens. The help page on the corresponding topic is displayed.
- If you need general information, in the upper menu bar, click on the ***Help*** > ***Help*** menu item.

  The Online Help opens. The start page of the Online Help is displayed.

For navigation in the Online Help, you can use the table of contents (***Contents*** tab), the index (***Index*** tab) and the free text search (***Search*** tab) on the left.

Info icon

Above the map or the diagrams you will find this symbol: ⓘ. When you click on this icon, you will get a brief overview of the selected fault location methods, the measurement sequence and the evaluation of the measurement results.

Tooltips

Tooltips are short description texts that provide information on operating controls (e.g. buttons or settings options). Tooltips appear when you rest the mouse pointer over an element.

3.2.2 BAUR GeoBase Map

BAUR GeoBase Map makes the following information available for the operator:

- Combination of road maps with the cable route and the BAUR cable database
- Display of cable route and fault positions via GPS.

- To acquire a license for the BAUR GeoBase Map or an update of the map material, please contact your BAUR representative.

3.2.3 License terms

All license terms for end users of the BAUR system software and BAUR GeoBase Map (option) are included in the BAUR end user license agreement.

- Carefully read the end user license agreement under ***Help*** > ***EULA***.

This BAUR end user license agreement is legally binding between you (a natural person or corporate entity) and BAUR GmbH for the BAUR system software and BAUR GeoBase Map (option). By installing, copying or using the BAUR system software and BAUR GeoBase Map (option) in any other way you agree to comply with the terms of the present end user license agreement.

If you do not agree to comply with the terms of this agreement, you are not authorised to use the BAUR system software and BAUR GeoBase Map (option). The two software products are subject to copyright laws and international copyright agreements as well as other laws and agreements on intellectual property.

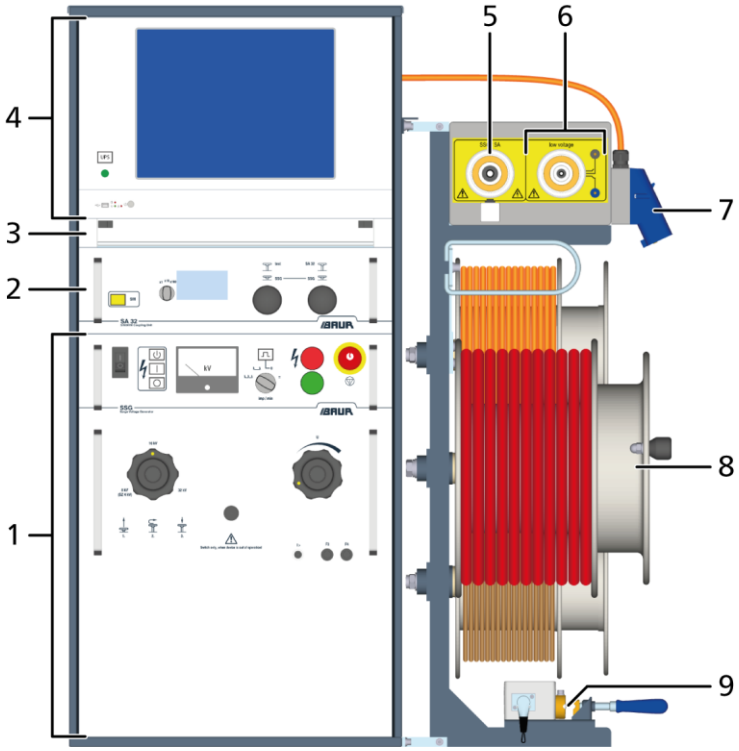
3.2.4 System requirements

The BAUR system software 4 is delivered installed and ready for operation. If you would like to use the BAUR system software 4 on another office PC, note the system requirements below:

System requirements	
Processor	Min. 1 GHz (32 bit or 64 bit)
Working memory	Min. 1 GB (32 bit) or min. 2 GB (64 bit)
Free hard disk space	Min. 10 GB (32 bit or 64 bit)
Operating system	Windows 7 Ultimate 32-bit (or higher)
Screen resolution	Min. 1280 x 1024

3.3 Full illustration

3.3.1 Front view



No.	Element	Function
1	SSG surge voltage generator	Is used to generate: ▪ Surge voltage ▪ DC voltage Further information: Chapter *SSG surge voltage generator* (on page 24)
2	SA 32 SIM/MIM coupling unit	Is used for the pre-location of high-resistive cable faults using the SIM/MIM method Further information: Chapter *SA 32 SIM/MIM coupling unit* (on page 26)
3	Drawer	Is used to store the PC keyboard
4	IRG 4000 time domain reflectometer with industrial PC	Is used in combination with the BAUR system software for cable fault location The time domain reflectometer is operated using the BAUR system software. Further information: Chapter *IRG time domain reflectometer* (on page 22)
	Monitor	Is used to display the user interface of the BAUR system software

No.	Element	Function
5	*SSG/SA* HV coaxial connection socket	Is used to connect the HV connection cable for measurements with the SSG Further information: Chapter *"SSG/SA" HV coaxial connection socket* (on page 30)
6	*low voltage* LV coaxial connection socket	Is used to connect the HV connection cable for: ▪ Insulation resistance measurements ▪ TDR measurements ▪ Measurements with external devices of up to 2.5 kV Further information: Chapter *"low voltage" LV coaxial connection socket* (on page 30)
	LV ports	Are used to connect the IRG time domain reflectometer or an external device of up to max. 2.5 kV, e.g. audio frequency transmitter or ohmmeter
7	Mains connection	Is used to connect the device to the mains voltage Further information: Chapter *Technical data* (on page 37)
8	KTG cable drum rack	Is used to store, unwind and wind up the connection cables Further information: ▪ Chapter *KTG M3 cable drum rack* (on page 28) ▪ Chapter *Connection cables to the KTG M3 cable drum rack* (on page 29)
9	Earth terminal	Is used for clamping one of the contact sockets of the protective earthing cable

3.3.2 Ports on the rear side of the system

All of the ports on the rear side of the system are connected by the manufacturer. In order not to impair the system's function, do not alter any of the connections to these ports.

3.4 IRG time domain reflectometer

The IRG time domain reflectometer with an integrated transient recorder is used for performing measurements and recording measurement data for all pre-location methods in the system on 1-phase and 3-phase cables.

When the PC is switched on, the IRG time domain reflectometer is automatically supplied with power. The IRG is centrally controlled via the BAUR system software.

Further information:

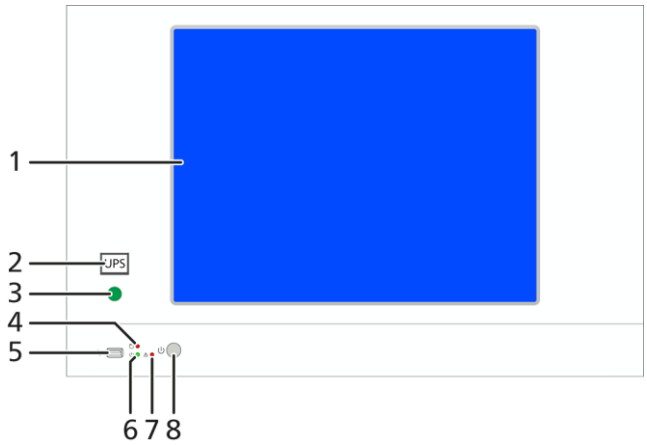
- Chapter *Industrial PC* (on page 23)
- Chapter *Technical data* (on page 37)

3.5 Industrial PC

The BAUR system software is installed on the PC that is integrated in the system. The BAUR system software 4 is used to perform cable fault analysis and pre-location and to control the IRG time domain reflectometer.

The illustration shows a PC with an uninterruptible power supply (UPS) as an example.

Control panel



No.	Element	Function
1	Monitor	Is used to display the user interface of the BAUR system software The monitor is configured by the manufacturer.
2	UPS key	Is used to switch the UPS on and off The PC is automatically switched on when the UPS is. Further information: Chapter *Uninterrupted power supply (option)* (on page 32)
3	Indicator light	Lights up when the UPS is switched on
4	LED	Flashes when the hard disk is accessed
5	USB connection	Is used to connect a USB cable or a USB drive
6	LED	Lights up when the IRG time domain reflectometer is switched on
7	LED	Indicates that extraneous voltage is present at the measurement input of the IRG time domain reflectometer The IRG checks whether extraneous voltage is present during: ▪ Insulation resistance measurement ▪ TDR measurement without voltage protection Further information: Chapter *PC faults (system with UPS)* (on page 133) Chapter *PC faults (system without UPS)* (on page 134)
8	ON/OFF button	Is used to switch the PC and the IRG on and off **Important:** Always shut down the PC and the IRG before switching off the uninterrupted power supply.

3.6 Insulation measuring device

The insulation measuring device is integrated in the time domain reflectometer and is used for measuring the insulation resistance.

The insulation measuring device is centrally controlled with the BAUR system software.

Technical data	
Measuring voltage	Max. 1,000 V
Measurement range	0.5 Ohm – 5 GOhm
Phase selection	L-N, L-L

3.7 SSG surge voltage generator

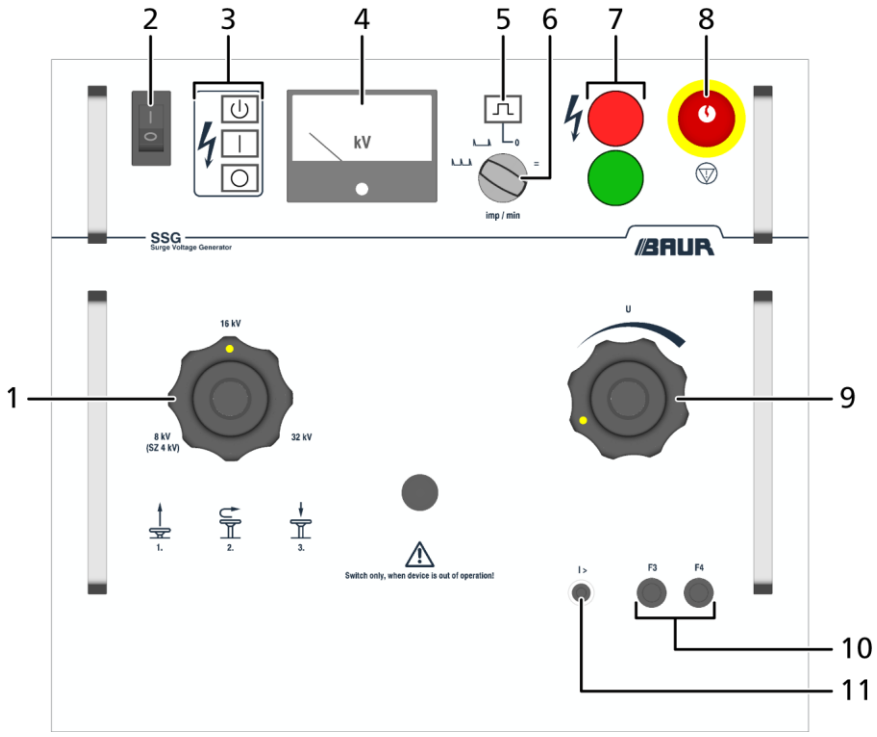
The SSG surge voltage generator is used to generate surge and DC voltage of up to 32 kV for cable fault location on high-, medium- and low-voltage cables.

To connect to the desired test object phase, connect the HV connection cable to the *SSG/SA* HV coaxial connection socket. You can adjust the settings and control the measurement sequences directly from the device control panel.

When measurements are performed with the surge voltage generator, the test object and the surge voltage generator are discharged via the internal discharge unit.

After discharge, the test object and the surge voltage generator are earthed via the earthing device of the SA 32 SIM/MIM coupling unit.

Control panel



No.	Element	Function
1	Selector switch for surge voltage range	Is used to select a surge voltage range
2	On/Off switch	Is used to switch the surge voltage generator on and off
3	button	Puts the surge voltage generator in the *Ready to switch on* operating state
	key	Puts the surge voltage generator in the *In operation* operating state
	button	Deactivates the high voltage release, activates the internal discharge units and puts the surge voltage generator in the *Ready for operation* operating state
4	Voltage indicator	Displays the actual voltage
5	key	Is used to release a single surge
6	*imp/min* selector switch	Is used to set the surge sequence or to select the DC voltage: : Rapid surge sequence : Slow surge sequence 0: No surge sequence The switch must be in this position so that a single surge can be released using the key. : DC voltage operation *NOTICE!* If, when switching to DC voltage operation, the surge capacitor of the SSG is live, this can lead to erosion on the short-circuit contacts within the device. ▸ Before switching to DC voltage operation, rotate the rotary switch all the way to the left.
7	Indicator lights	Indicate the system operating state: ▪ Green: *Ready for operation* ▪ Red: *Ready to switch on*, *In operation*
8	Emergency off button	Moves the system to the *Ready for operation* operating state. The emergency off button is equipped with a key lock to protect against restart, unauthorised start-up, and unauthorised or unintentional operation.
9	rotary knob	Is used to set the output voltage
10	Fuses *F3* + *F4*	Is used to protect the control unit: ▪ of the solenoids of the surge voltage generator ▪ of the solenoid of the SIM/MIM coupling unit Fuses: time lag, 3.15 A

No.	Element	Function
11	Overcurrent protection switch / >	Switches the surge voltage generator off in the event of overload The overcurrent protection switch is triggered both thermally and magnetically.

Technical data

Technical data			
	SSG 1100	**SSG 1500***	**SSG 2100***
Surge voltage ranges	0 – 8 kV 0 – 16 kV 0 – 32 kV	0 – 8 kV 0 – 16 kV 0 – 32 kV	0 – 8 kV 0 – 16 kV 0 – 32 kV
Surge sequence	10 or 20 pulses/min, single surge	20 or 30 pulses/min, single surge	10 or 20 pulses/min, single surge
Surge energy	1,100 J @ 8 / 16 / 32 kV	1,540 J @ 8 / 16 / 32 kV	2,050 J @ 8 / 16 / 32 kV
Charging capacitance	4 x 8.6 µF	4 x 12 µF	4 x 16 µF
DC voltage	0 – 32 kV	0 – 32 kV	0 – 32 kV
Max. output current (in DC voltage operation) depending upon surge voltage range			
0 – 8 kV:	560 mA	850 mA	850 mA
0 – 16 kV:	280 mA	425 mA	425 mA
0 – 32 kV:	140 mA	210 mA	210 mA

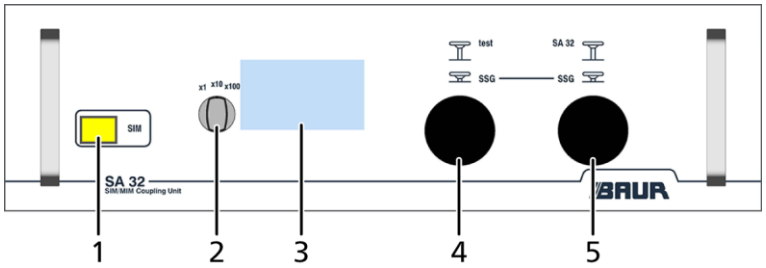
* Option instead of SSG 1100

3.8 SA 32 SIM/MIM coupling unit

The SA 32 SIM/MIM coupling unit is used for the pre-location of high-resistive cable faults using the SIM/MIM method.

The SA 32 SIM/MIM coupling unit also offers the option of performing cable and cable sheath testing if the surge voltage generator is operated in DC mode.

Control panel



No.	Element	Function
1	Indicator light *SIM*	Lights up when a measurement using the SIM/MIM method is underway
2	Selector switch for the sensitivity of the current indicator	Is used to set the sensitivity of the current indicator Positions: *x1*, *x10*, *x100*
3	Current indicator	Shows the actual current during the cable or cable sheath test
4	Drawbar *test|SSG*	Is used to select between the fault location methods with surge voltage and cable testing with DC voltage ▪ Drawbar pushed in: Is used for fault location methods with surge voltage ▪ Drawbar pulled out: Is used for cable tests with DC voltage. The current indicator is activated.
5	Drawbar *SA 32|SSG*	▪ Drawbar pushed in: The SIM/MIM coupling unit is deactivated. The measurement is performed with the SSG surge voltage generator. ▪ Drawbar pulled out: The SIM/MIM coupling unit is active. A measurement can be performed according to the SIM/MIM method.

Overview of the positions of drawbars for various applications

Application	Drawbar *test|SSG*	Drawbar *SA 32|SSG*
Impulse current method (ICM)	pushed in	pushed in
Acoustic pin-pointing	pushed in	pushed in
Secondary-multiple impulse method (SIM/MIM)	pushed in	pulled out
Cable testing with DC voltage	pulled out	pushed in

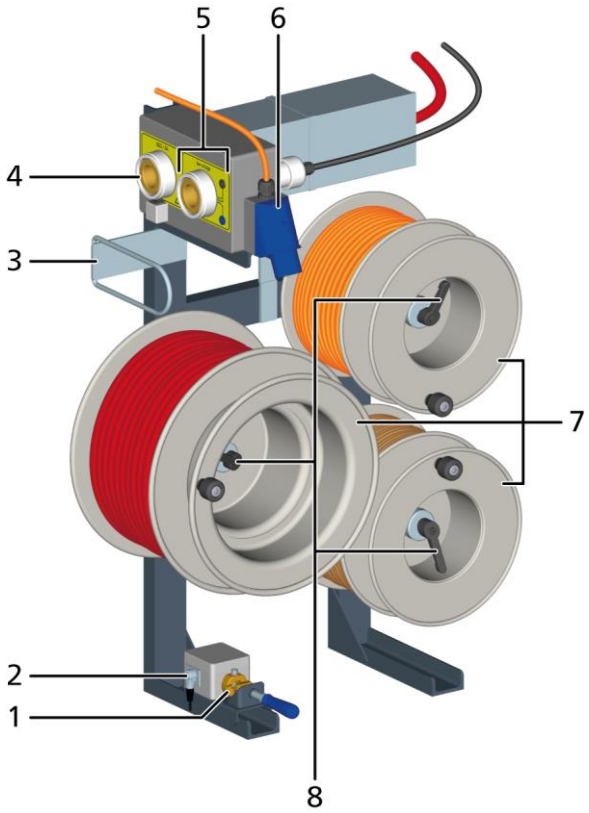
Further information:

- Chapter *Cable and cable sheath testing* (on page 84)
- Chapter *Cable fault pre-location* (on page 88)
- Chapter *Cable fault pin-pointing* (on page 110)

3.9 KTG M3 cable drum rack

The KTG M3 cable drum rack is permanently mounted on the Syscompact 4000 and is used to store, unwind and wind up the connection cables.

Use the cable drum rack only with the supplied cables or with cables of same specification.



No.	Element	Function
1	Earth terminal	Is used for clamping one of the contact sockets of the protective earthing cable
2	Port for the external emergency off unit (option)	Is used to connect an external emergency off unit If no external emergency off unit is being used, this port is bridged with a bypass plug.
3	Cable guide clamp	Is used for proper guiding of the connection cables
4	*SSG/SA* HV coaxial connection socket	Is used to connect the HV connection cable for measurements with the SSG Further information: Chapter *"SSG/SA" HV coaxial connection socket* (on page 30)

No.	Element	Function
5	*low voltage* LV coaxial connection socket	Is used to connect the HV connection cable for: ▪ Insulation resistance measurements ▪ TDR measurements Measurements with external devices of up to 2.5 kV Further information: Chapter *"low voltage" LV coaxial connection socket* (on page 30)
	LV ports	Are used to connect the IRG time domain reflectometer or an external device of up to max. 2.5 kV, e.g. audio frequency transmitter or ohmmeter
6	Mains connection	Is used to connect the device to the mains voltage Further information: Chapter *Technical data* (on page 37)
7	Cable drum	Is used to store the connection cables Further information on the connection cables: Chapter *Connection cables to the KTG M3 cable drum rack* (on page 29)
8	Uncoiling brake for cable drum	Is used to fix the cable drum and to prevent unintentional unwinding of the connection cable

Further information on operating the cable drum rack: Chapter *Unwinding and winding up the connection cables* (on page 38)

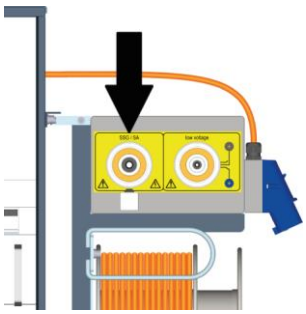
3.10 Connection cables to the KTG M3 cable drum rack

Cable	Function	Minimum bending radius
HV connection cable with HV plug, nominal voltage (DC) 80 kV	Is used to connect to the test object	100 mm
Mains supply cord, 3 x 4 mm^2, 32 A CEE plug	Is used to connect the system to the mains voltage	75 mm
Protective earthing cable, 16 mm^2	Is used to connect the system to the protective earthing	75 mm

3.11 "SSG/SA" HV coaxial connection socket

The HV coaxial connection socket is used to connect the HV connection cables for measurements with the SSG.

The HV coaxial connection socket is equipped with a microswitch that prevents the system from being put into the *Ready to switch on* operating state when the HV connection cable is not connected correctly.

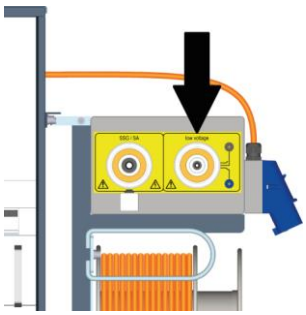


3.12 "low voltage" LV coaxial connection socket

The LV coaxial connection socket is used to connect the HV connection cables for:

- the insulation resistance measurement
- the TDR measurement
- measurements with external devices of up to max. 2.5 kV

The LV coaxial connection socket is equipped with two LV ports that can be connected to an external device, e.g. an audio frequency transmitter or insulation measuring device with an output voltage of up to max. 2.5 kV (max. current 24 A).



3.13 Safety devices

3.13.1 Discharge and earthing device

The SSG surge voltage generator has an integrated discharge unit. The SA 32 SIM/MIM coupling unit has an integrated earthing device.

Once the HV has been switched off using the ○ key or by pressing the emergency off button, the SSG and the test object are discharged and earthed. The system status changes to the *Ready for operation* operating state and the green indicator light on the SSG illuminates.

The discharge and earthing device is also automatically activated when the microswitch of the HV coaxial connection socket is opened or the system is disconnected from the mains voltage.

Discharging, earthing and short-circuiting the test object

Even if the test object and the HV system components have been discharged, the test object can still carry dangerous voltage. Cables have a capacitance and can continue to hold a charge even after switching off the surge voltage generator or can be recharged after a temporary short-circuit due to recurring voltages.

- Before touching the test object, discharge, earth and short it: at the connection point and at the far end.
- You may touch the plant parts that were under voltage only if they are visibly earthed and short-circuited.

3.13.2 Calculating the minimum discharge time

The minimum discharge time for the surge capacitor of the SSG and the test object is calculated thus: **5 x R x (Ci + Cp)**.

R Discharging resistance

C_i Capacitance of surge capacitor

C_p Capacitance of test object

	SSG 1100	SSG 1500*	SSG 2100*
Capacitance of surge capacitor C_i			
8 kV position:	34.4 µF	48 µF	64 µF
16 kV position:	8.6 µF	12 µF	16 µF
32 kV position:	2.15 µF	3 µF	4 µF
Discharging resistance of the SSG			
for the surge capacitor:	16.5 kOhm	16.5 kOhm	16.5 kOhm
for the test object:	16.5 kOhm	16.5 kOhm	16.5 kOhm

* Option instead of SSG 1100

Recommended discharge and earth rod (option):

GDR 40-250	
Max. permissible voltage	40 kV
Max. permissible discharge energy	600 J
Discharging resistance	250 kOhm
Time between two discharges	10 min

3.13.3 Emergency off button

The emergency off button is located on the front panel of the SSG surge voltage generator and is equipped with key and lock for protection against unauthorised or unintentional operation.

- In the event of danger, immediately press the emergency off button on the SSG surge voltage generator.

  - The SSG is switched off.
  - The SSG and the test object are discharged and short-circuited against the protective earth.

    Note: The test object is not automatically disconnected from the system. You must disconnect the test object from the system yourself.
  - The system status changes to the *Ready for operation* operating state and the green indicator light on the SSG illuminates.
- To operate the system again after pressing the emergency off button, unlock the emergency off button.

3.13.4 Microswitch monitoring for measurements using the "SSG/SA" HV coaxial connection socket

The HV coaxial connection socket is equipped with a microswitch that prevents the system from being put into the *Ready to switch on* operating state when the HV connection cable is not connected correctly.

If the HV connection cable is not connected securely enough, the power supply of the SIM/MIM coupling unit and the SSG surge voltage generator will be interrupted. The SSG and the test object will be discharged and short-circuited.

3.14 Power supply

The system can be supplied with power via an existing mains supply on site.

Permissible supply voltage: 220 – 230 V, 50/60 Hz

Depending upon the configuration of the system, you can connect external devices to the supply voltage via an optional safety contact socket.

3.14.1 Mains voltage supply

The mains voltage supply is provided via a mains supply cord (3 x 4 mm^2) that is wound up on a cable drum. If necessary, use a country-specific adapter.

3.14.2 Uninterrupted power supply (option)

The system may be optionally equipped with a 500 VA uninterruptible power supply (UPS).

If the mains voltage falls below a defined voltage value, the UPS takes over the power supply to the PC, the monitor and the IRG time domain reflectometer. After a power failure, the PC remains on for approx. 10 min.

- To switch on the UPS, press the UPS key next to the PC monitor.

  The PC is switched on automatically.

Technical data	
Output power	300 W / 500 VA
Output voltage	AC 230 V
Output frequency	47 - 63 Hz
Input voltage	AC 230 V
Input frequency	47 - 63 Hz
Battery type	Maintenance-free, sealed lead battery with suspended electrolyte, leak-proof

3.15 Operating states of the system

3.15.1 “Out of operation” operating state

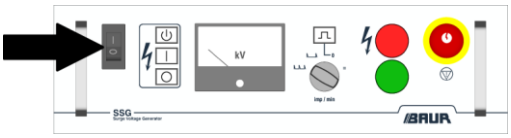
- All safety measures necessary before stepping into the test area have been met.
- All power supplies, signal and control electric circuits are switched off.

3.15.2 “Ready for operation” operating state

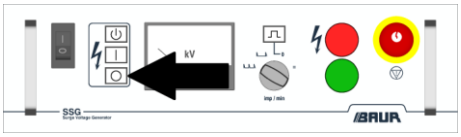
- The safety measures of the *Out of operation* operating state that are necessary before stepping into the danger area are still in place.
- The power supplies for the signal and control current circuits of the switching devices are switched on.
- The test voltage supply is switched off and secured against accidental start.
- The green indicator light on the SSG surge voltage generator comes on.

Procedure

- To put the system into the *Ready for operation* operating state, switch on the SSG surge voltage generator using the On/Off switch.



- To put the system back into the *Ready for operation* operating state after a measurement, deactivate the high voltage release. To do this, press the ○ key on the SSG surge voltage generator.

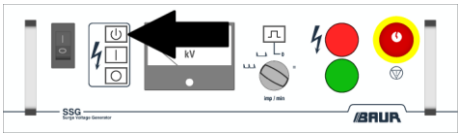


3.15.3 “Ready to switch on” operating state

- All accesses to the test area are closed. The safety measures of the *Out of operation* operating state that are necessary before stepping into the danger area are lifted.
- The test voltage supply is switched off.
- The red indicator light on the surge voltage generator comes on.

Procedure

- To switch the system to the *Ready to switch on* operating state, release the high voltage on the SSG surge voltage generator. To do this, press the ⏻ key on the surge voltage generator.

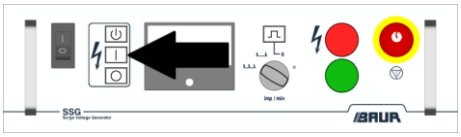


3.15.4 “In operation” operating state

- All accesses to the test area are closed.
- The system is in the *Ready to switch on* operating state.
- One or more test voltage supplies are switched on.
- The red indicator light on the surge voltage generator comes on.
- The | key illuminates.

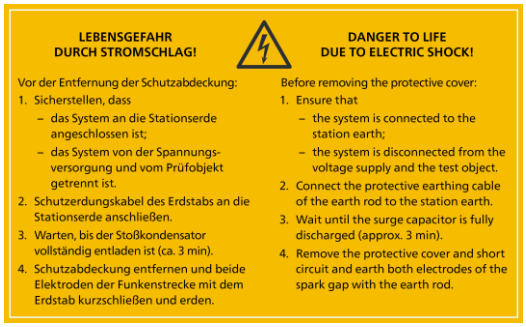
Procedure

- To switch the system to the *In operation* operating state, switch on the high voltage. To do this, press the | key on the SSG surge voltage generator.

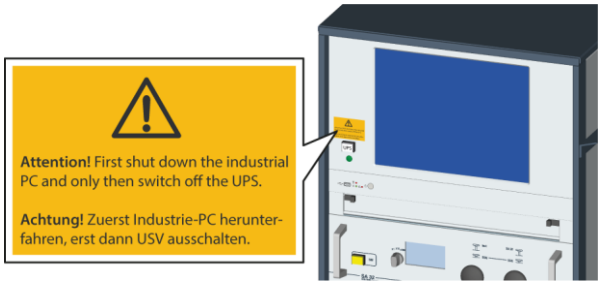


3.16 Safety and information signs

Warning sign about high voltage on the SSG surge voltage generator



Information sign about the correct switching off sequence for systems with UPS

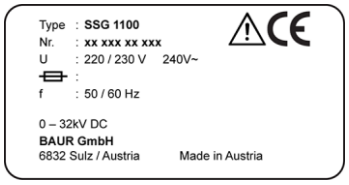


Symbols on ports and connection cables

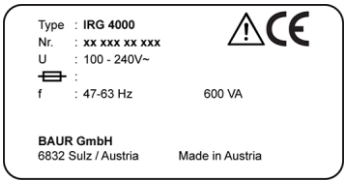
Symbol	Description
	▪ Warns against high electrical voltage and a possible risk of electric shock ▪ Indicates the HV connection cable
	General warning sign Indicates that there is a potential risk of danger when using the product and hence the user manual must be observed
	Indicates the screen of the HV connection cable that is connected to the station earth of the test object as the operational earthing
	Indicates the protective earthing cable

Rating plates

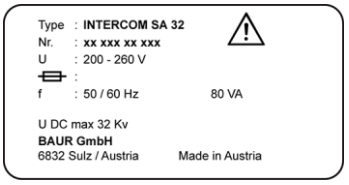
SSG surge voltage generator



IRG 4000 time domain reflectometer



SA 32 SIM/MIM coupling unit



Element	Description
Type	Device designation
Nr.	Serial number
U	Supply voltage If several supply voltages are possible, these are given consecutively one after another.
⊟	Not applicable here
f	Mains frequency
VA	Max. recorded apparent output ▪ On the IRG 4000: 600 VA ▪ On the SA 32: 80 VA
0 – 32 kV (on the SSG)	Max. surge voltage range of the SSG
U DC max. 32 Kv (on the SA 32)	Max. DC output voltage of the SA 32
⚠	General warning sign Indicates that there is a potential risk of danger when using the product and hence the user manual must be observed
CE	CE mark Indicates that the device or system conforms to CE.
BAUR GmbH 6832 Sulz / Austria	Name and address of the manufacturer
Made in Austria	Indicates the country in which the device was manufactured.

4 TECHNICAL DATA

IRG 4000 time domain reflectometer	
Pulse voltage	TDR 20 – 200 V
Pulse width	20 ns – 1.3 ms
Voltage-proof up to	400 V, 50/60 Hz
Output impedance	8 – 2,000 Ohm
Input signal gain	Dynamic range 107 dB (-63 to +44 dB)
View range	10 m – 1,000 km (at v/2 = 80 m/µs)
Accuracy	0.1% relating to the measurement result
Data rate	400 MHz
Resolution	0.1 m (at v/2 = 80 m/µs)
Velocity of propagation (v/2)	20 – 150 m/µs, adjustable
Measurement modes	▪ Automatic measurement mode ▪ Differential measurement ▪ Mean value calculation ▪ Continuous measurement ▪ Stop after recording the change ▪ Envelope curve display for the location of intermittent faults
Storage capacity	> 100,000 measurements (hard disk limit)
Display	TFT monitor acc. to offer
User interface languages	user interface available in 22 languages
Data export format	PDF
GIS interface (option):	Export/import GIS data
Data synchronisation	USB
BAUR GeoBase Map	90 days test licence
Option	Full version

Insulation resistance measurement	
Voltage	up to 1,000 V
Measurement range	0 ohm – 5 Gohm
Surge voltage generator	
Surge voltage ranges	0 – 8 kV, 0 – 16 kV, 0 – 32 kV
Surge energy	1,100 J
Option SSG 1500	1,540 J
Option SSG 2100	2,050 J
Surge sequence	10 or 20 pulses/min, single surge
Option SSG 1500	20 or 30 pulses/min, single surge
DC voltage	0 – 32 kV
Max. output current (in DC mode)	560 mA (0 – 8 kV)
Option SSG 1500/SSG 2100	850 mA (0 – 8 kV)
System	
Power supply	220 – 230 V, 50/60 Hz
Options	▪ 110 – 120 V, 50/60 Hz (with external auto transformer) ▪ 240 V, 50/60 Hz (with conversion kit for mains supply)
Ambient temperature	0°C to +50°C
extended temperature range*	-20°C to +60°C
Storage temperature	-40°C to +60°C
Dimensions (W x H x D)	Approx. 935 x 1,145 mm x 775 mm (incl. KTG M3 cable drum rack)
Weight	From 195 kg (depending upon equipment)
Degree of protection	IP22
Safety and EMC	CE-compliant in accordance with Low Voltage Directive (2014/35/EU), EMC Directive (2014/30/EU), EN 60068-2-ff Environmental testing

* Limited display performance possible

5 UNWINDING AND WINDING UP THE CONNECTION CABLES

The procedure is described for KTG M type of cable drum racks as example.

5.1 Unwinding the connection cable from the KTG M cable drum

1. Make sure that the connection cable is not connected anywhere. Otherwise you cannot unwind the cable.
2. Pull the connection cable plug from its holder.

   Leave the plugs of the connection cables you don't need in their holders.
3. Release the uncoiling brake on the cable drum you want: To do this, turn the appropriate brake lever anti-clockwise (approx. half a turn, do not turn fully).

4. Unwind the connection cable to the desired length.

   Guide the connection cable through the cable guide clamp. This arranges the cable in such a way that on closing the rear doors of the cable test van, it goes into the cable outlet and does not get jammed.
5. Attach the uncoiling brake to the cable drum: To do this, turn the brake lever clockwise.

This prevents the cable from unwinding unintentionally.

5.2 Winding up the connection cable on the KTG M cable drum

Prerequisite

The connection cable is voltage-free.

Further information:

- Chapter *Ensuring there is no voltage at the work place* (on page 42)
- Chapter *Discharging and earthing the test object* (on page 118)

Procedure

1. Disconnect the connection cables and lay them straight without loops. Make sure that the connection cables do not drag over sharp objects.
2. Check the connection cables for cracks, damage and any dirt.
3. If dirty, clean the connection cables with a lint-free cloth.
4. Remove the connection cables from the cable guide clamp.
5. Release the uncoiling brake on the cable drum you want: To do this, turn the appropriate brake lever anti-clockwise (approx. half a turn, do not turn fully).

6. Wind up the connection cable manually.
7. Ensure that the connection cable is distributed evenly on the cable drum.
8. Once the connection cable has been wound up, attach the uncoiling brake to the cable drum: To do this, turn the brake lever clockwise.

This prevents the connection cable from unwinding unintentionally.

9. Place the plugs of the connection cables in their holders on the cable drum rack.

6 CHECKS TO PERFORM BEFORE COMMISSIONING

1. Operate the system only in a technical perfect condition.
2. Check the system and mechanical connections for damage.
3. Check other devices for damage that are not integrated in the system and that you intend to use.
4. Check electrical connections and connection cables for damage.
   Use only undamaged connection cables.
5. Check the safety devices regularly for proper condition and function.
   This particularly applies for signal systems, emergency off units, earthing and short-circuit devices and ports.

7 CONNECTING THE SYSTEM

Follow the information below:

- The safety instructions in the chapter *For your safety* (on page 12)
- Local safety and accident prevention regulations
- Safety instructions and regulations according to the state-of-the-art
- National and international standards and guidelines in the latest applicable version:
  EN 50110 for the operation of electrical installations (EU/EFTA countries);
  EN 50191 for the erection and operation of electrical test installations (EU/EFTA countries)
  or applicable standards in your country.
- Employers' liability insurance association regulations (if any)

▸ Use appropriate personal protective equipment (PPE) for protection against electric shock and burning due to possible arcing faults in compliance with the local work safety and accident prevention regulations.

7.1 Setting up the system

⚠ WARNING

Potential differences between the system and the earth possible

Danger to life or risk of injury due to electric shock.

If a cable fault is located near to the system, there may be potential differences between the system and the earth in surge mode.

- ▸ Place the system at a distance of several meters to the cable route or cable fault location.
- ▸ If operating in 'surge mode', cordon off the system at distance of at least 1.5 m.
  During surge mode, people may only stand outside the cordoned off area.
- ▸ Before starting surge mode, check the cable route for potential dangers.

▸ Select the installation location for the system in such a way that

- A stable base is guaranteed and the system cannot tip over,
- The system is easy to access for the connections and operation.
- sufficient safety distances are maintained. In this regard, comply with EN 50110 for operation of electric systems (EU/EFTA countries) or the relevant standards applicable in your country.

7.1.1 Placing the system in the road traffic area

When placing the system in the road traffic area:

- Wear a high visibility vest so that road users can recognise you better.
- Position the system as far away from the moving traffic as possible.
- Secure the work place in compliance with the applicable national work safety and accident prevention regulations as well as local conditions.

7.2 Ensuring there is no voltage at the work place

Before connecting the test object follow the 5 safety rules:

1. Disconnect the test object.
2. Secure against re-connection.
3. Verify absence of operating voltage.
4. Provide protection against adjacent live parts.
5. Earth and short all phases.

Note:

- If the **cable sheath is not earthed**, establish a short earth connection to the station earth. The station earth is the neutral point of the earth connections.
- The earthing conductor should be as short as possible and show low impedance. Use a copper **earthing conductor with a cross-section of min. 16 mm**^{2}.

7.3 Preparing the test object terminals

The test object terminals are **the connection point and the far end** of the test object.

1. Disconnect all operating resources that are connected to the test object and are not designed for the stipulated test voltage.
2. Cordon off all metal parts, e.g. lighting masts at the test object terminals or insulate them with insulating safety plates.
3. Earth all metal parts at the terminals to avoid dangerous charging.
4. All cables that are used in danger zones can also carry high voltage potential outwards. Therefore, remove these cables from the danger zone or ensure low-resistive earthing and short-circuit.
5. Follow the cable line and ensure that no work is being carried out underground on gas lines and that there are no other danger points.

7.4 Connecting the test object

7.4.1 Safety instructions

⚠ WARNING

Danger due to electric voltage, flashovers at the connection point, or arcing fault on connection

Electric shock on touching live and active parts and due to residual charges and induction voltages;

Burns, electro-ophthalmia, hearing damage.

- Use suitable personal protective equipment against electric shocks and arcing faults.
- Observe the phase breaks.
- Ensure that adjacent live parts are secured against accidental contact and flashovers with suitable covers (insulation mats, insulating safety plates).
- You may touch the parts that were under voltage only if they are visibly earthed and short-circuited.

7.4.2 Various connection options for cable fault location

Depending on the measurement method, select the right connection option:

▪ Cable fault analysis: ▪ Cable fault location: ▪ Cable testing: ▪ Acoustic pin-pointing:	Chapter *Connecting the HV connection cable to a phase of the test object* (on page 43)
Cable sheath testing:	Chapter *Connecting the HV connection cable to the test object screen* (on page 48)

7.4.3 Connecting the HV connection cable to a phase of the test object

Two connection sockets are available on the system for connecting the HV connection cable:

- *SSG/SA*: For measurements with the SSG
- *low voltage*: For insulation resistance measurements, TDR measurements and measurements with external devices of up to 2.5 kV (LV)

Prerequisites

- The workplace must be disconnected from the power supply.
- The connection points and far end are prepared for the measurement.
- The protective earthing cable of the earth rod is connected to the station earth.

Further information:

- Chapter *Ensuring there is no voltage at the work place* (on page 42)
- Chapter *Preparing the test object terminals* (on page 42)

Connection diagram

- Measurement with LV: Cable with shielded phases (on page 45)
- Measurement with the SSG: Cable with shielded phases (on page 46)
- Measurement with the SSG: Unscreened cable with 3 phases (on page 47)
- Measurement with the SSG: Acoustic pin-pointing of cable breaks (on page 48)

Procedure

The following description is an example for how to connect the system to a 3-phase test object. Connecting the system to a 1-phase test object is similar.

1. Unwind the protective earthing cable to the required length.
2. Connect the protective earthing cable to the station earth - as close as possible to the station earth connection.
3. Clamp one of the contact sockets of the protective earthing cable to the earthing terminal on the cable drum rack.

   When doing so, ensure that the connection between the connection point of the protective earthing cable and the earth terminal is as short as possible.
4. The HV connection cable screen is used for the operational earthing. The operational earthing closes the electric circuit and is used for the return cable of the impulse current. It is therefore particularly important for the operational earthing port to be connected properly to the correct connection point.

   Connect the screen of the HV connection cable to the station earth. Select the location for connecting the screen to the station earth as follows:

   - as close as possible to the location where the cable screens of the test object phases are connected to the station earth, and
   - as close as possible to the location where the test object phases are connected to the station earth.
5. Connect the HV connection cable to the test object phase to test. Proceed as follows:
   a. Unwind the HV connection cable to the required length.
   b. Connect the HV connection cable to the test object phase to test.

   Measurement with LV:

   c. Connect the system HV connection cable to the *low voltage* LV coaxial connection socket.
   d. For the insulation resistance and TDR measurement, connect the connection cables of the IRG to the LV ports.

   If an external device is to be used for the measurement, connect the external device to the LV ports. Further information: Chapter *Connecting an external device to the system* (on page 50)

Measurement with SSG:

- Connect the system HV connection cable to the *SSG/SA* HV coaxial connection socket.

6. Remove the earthing and the short-circuit connection from the phase to be tested at the connection point and at the far end.
7. Make sure that the phases not being tested are earthed and shorted.
8. Make sure that the jumper plug on the cable drum rack is inserted in the port for the external emergency off unit.

Locating cable breaks

In the event of cable breaks in the 1-phase cable:

- Short the faulty phase with the screen and with the station earth at the far end.

In the event of cable breaks in the multi-phase cable:

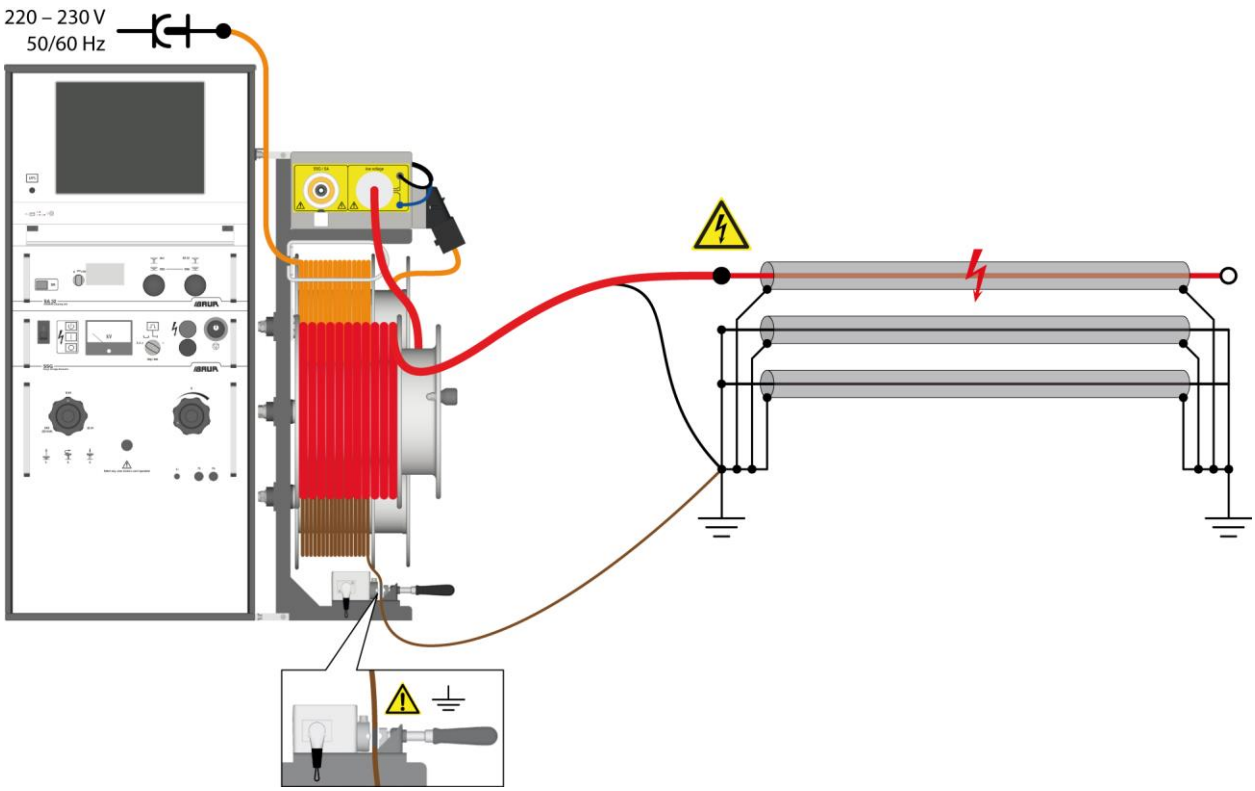
- Short all phases with the screen and with the station earth at the far end.

Measurement with LV: Cable with shielded phases

This connection diagram applies for:

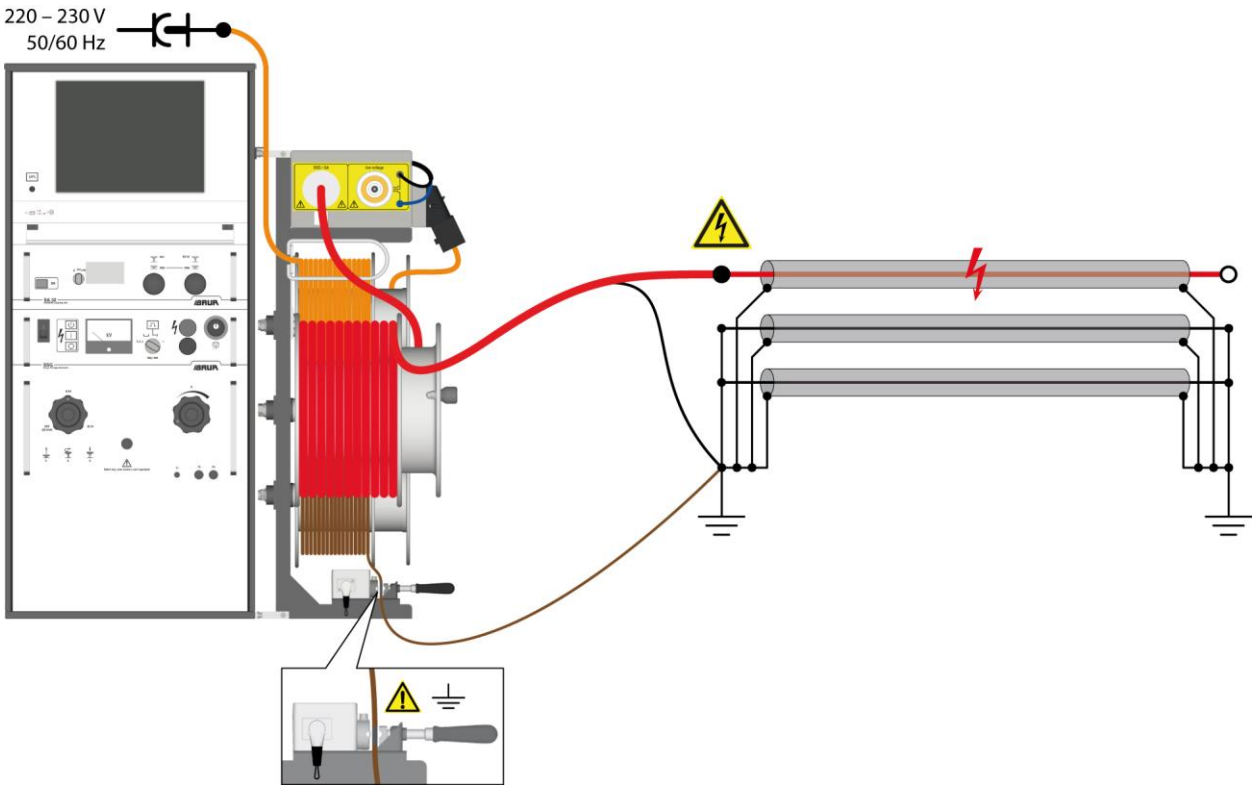
- Insulation resistance measurements
- TDR measurements
- Measurements with external devices of up to max. 2.5 kV

The illustration shows an example of a connection diagram with a 3-phase test object. Connecting the system to a 1-phase test object is similar.



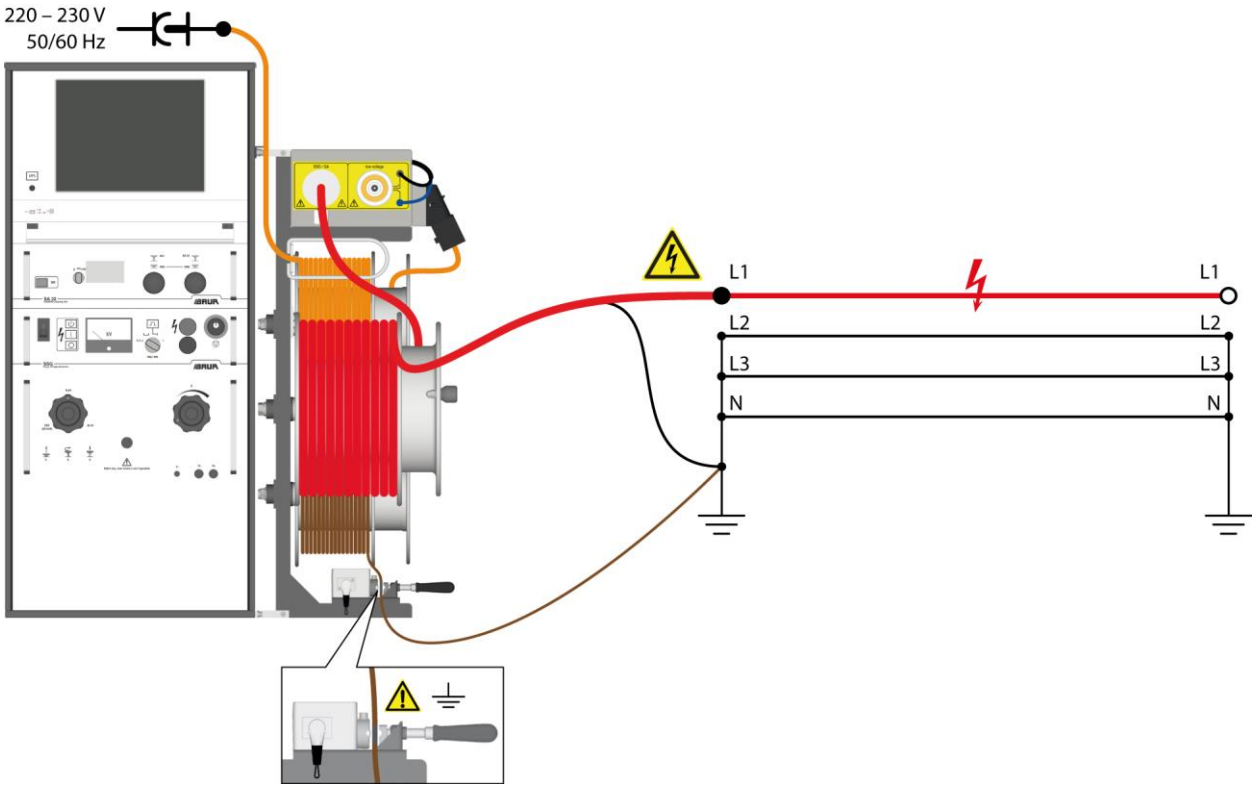
Measurement with the SSG: Cable with shielded phases

The illustration shows an example of a connection diagram with a 3-phase test object. Connecting the system to a 1-phase test object is similar.

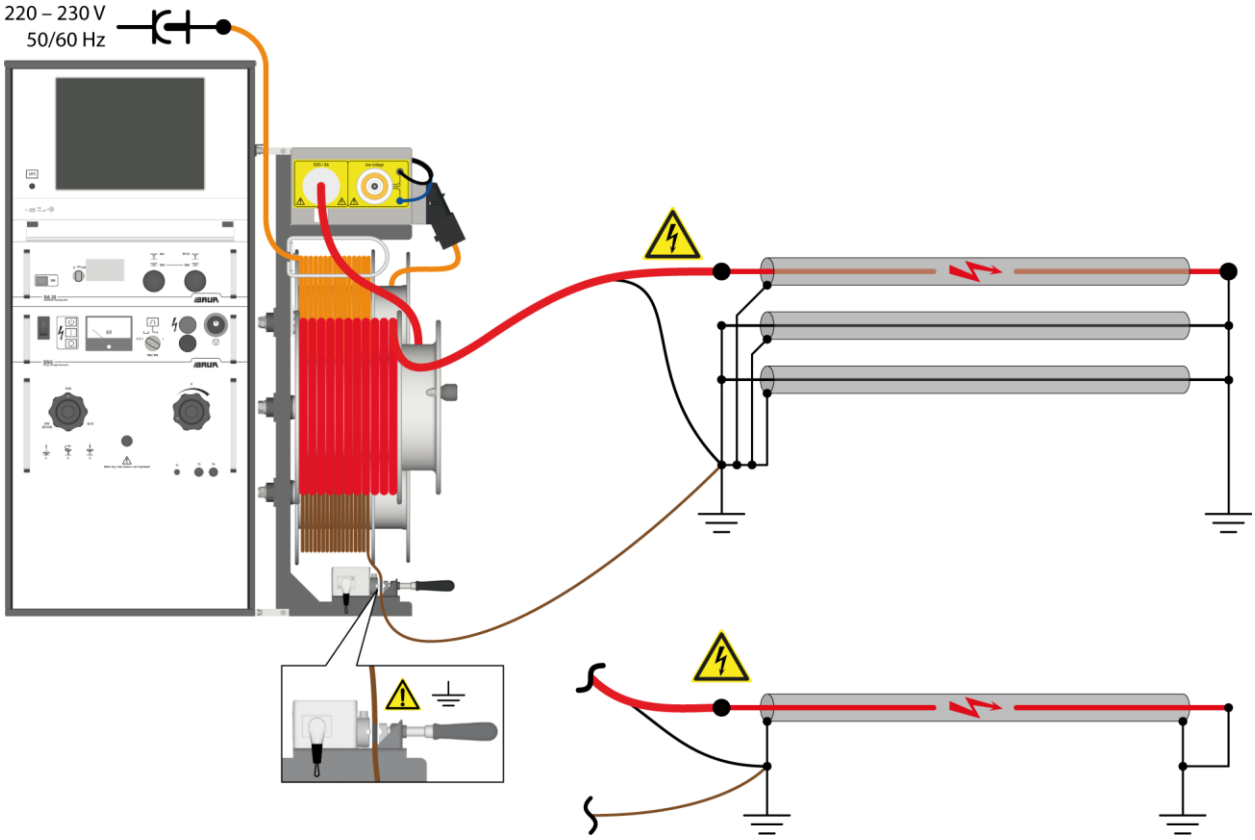


Measurement with the SSG: Unscreened cable with 3 phases

The illustration shows an example of a connection diagram with a 3-phase test object. Connecting the system to a 1-phase test object is similar.



Measurement with the SSG: Acoustic pin-pointing of cable breaks



7.4.4 Connecting the HV connection cable to the test object screen

This connection option applies for the cable sheath testing.

Prerequisites

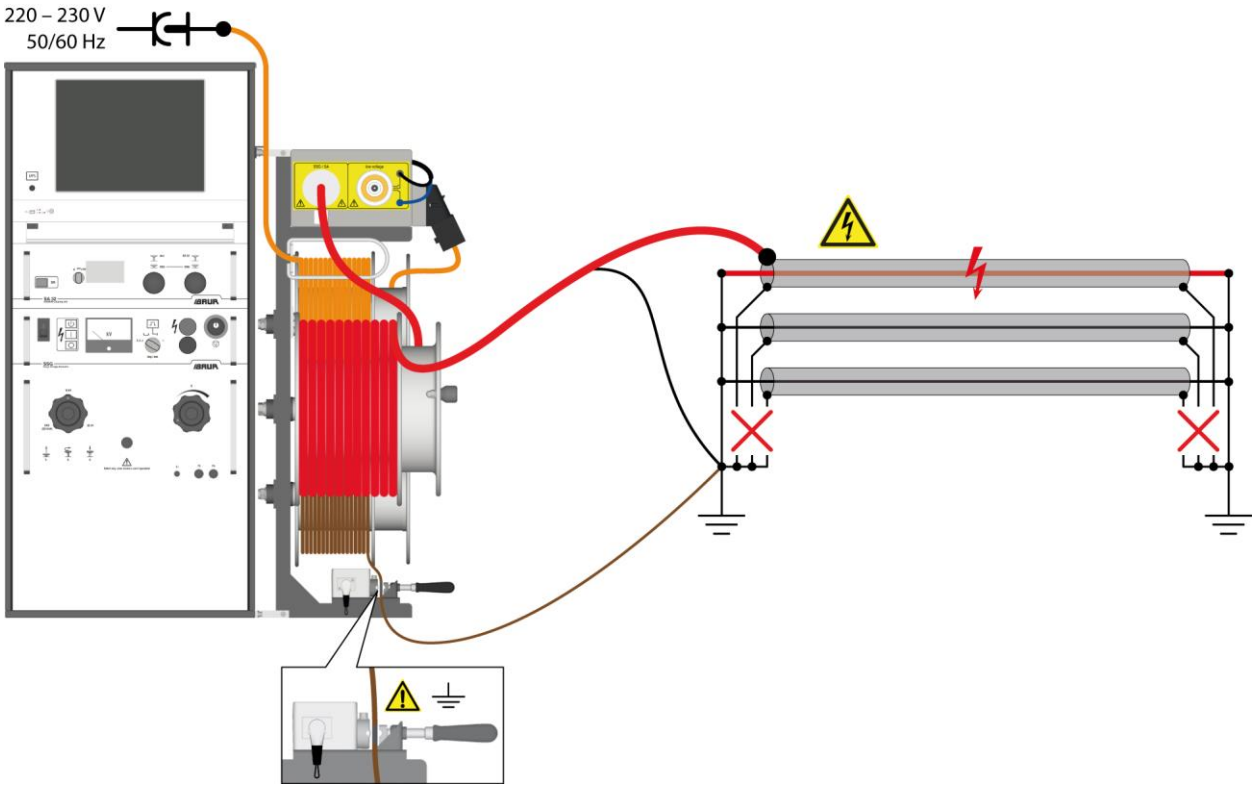
- The workplace must be disconnected from the power supply.
- The connection points and far end are prepared for the measurement.
- The protective earthing cable of the earth rod is connected to the station earth.

Further information:

- Chapter *Ensuring there is no voltage at the work place* (on page 42)
- Chapter *Preparing the test object terminals* (on page 42)

Procedure

The following description and the illustration are examples for how to connect the system to a 3-phase test object. Connecting the system to a 1-phase test object is similar.



1. Unwind the protective earthing cable to the required length.
2. Connect the protective earthing cable to the station earth - as close as possible to the station earth connection.
3. Clamp one of the contact sockets of the protective earthing cable to the earthing terminal on the cable drum rack.

   When doing so, ensure that the connection between the connection point of the protective earthing cable and the earth terminal is as short as possible.
4. The HV connection cable screen is used for the operational earthing. The operational earthing closes the electric circuit and is used for the return cable of the impulse current. It is therefore particularly important for the operational earthing port to be connected properly to the correct connection point.

   Connect the screen of the HV connection cable to the station earth. Select the location for connecting the screen to the station earth as follows:

   - as close as possible to the location where the cable screens of the test object phases are connected to the station earth, and
   - as close as possible to the location where the test object phases are connected to the station earth.
5. Make sure that the screens of all phases of the test object are disconnected from the station earth at both ends: at the connection point and at the far end.

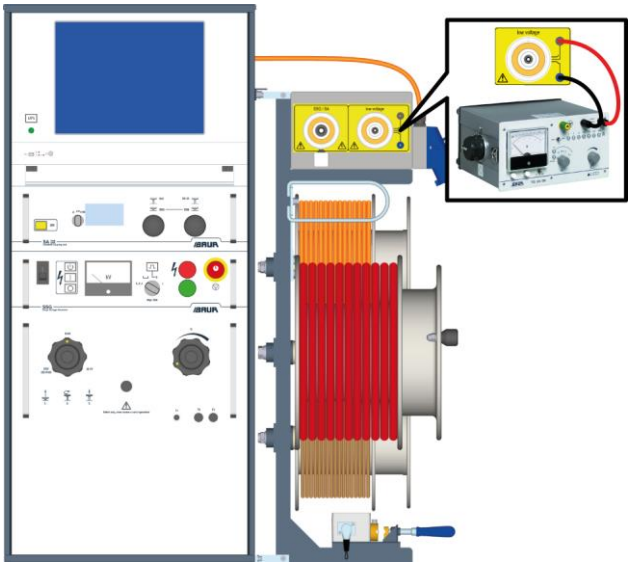
6. Connect the HV connection cable to the screen of the test object phase to test. Proceed as follows:
   a. Unwind the HV connection cable to the required length.
   b. Connect the HV connection cable to the screen of the test object phase to test.
   c. Connect the system HV connection cable to the *SSG/SA* HV coaxial connection socket.
7. Make sure that the phases not being tested are earthed and shorted.
8. Make sure that the jumper plug on the cable drum rack is inserted in the port for the external emergency off unit.

7.4.5 Connecting an external device to the system

There are two LV ports on the *low voltage* LV coaxial connection socket. You can use these LV ports to connect e.g. an external insulation measuring device or an audio frequency transmitter. The LV ports are designed for external devices of up to 2.5 kV.

Connection example for TG 20/50

An external insulation measuring device is connected as illustrated for the TG 20/50.



1. Connect the external device to the *low voltage* LV coaxial connection socket on the LV ports (see image).
2. Connect the external device to a suitable power supply (if needed).

The measurements with the external devices that are connected to the LV ports are performed via the system's HV connection cable. Further information on connecting the HV connection cable: Chapter *Connecting the HV connection cable to a phase of the test object* (on page 43)

7.5 Connecting the system to the supply voltage

1. Measure the mains voltage with a voltmeter.
2. Compare the mains voltage with the specifications in the technical data for the system.
   Further information: Chapter *Technical data* (on page 37)

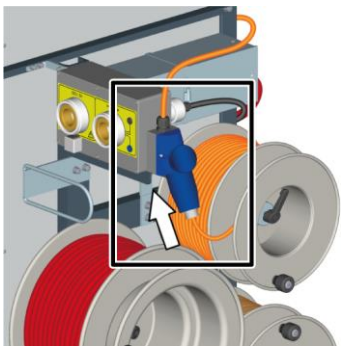
3. Make sure that the mains supply earth is not isolated from the station earth.

   ⚠ CAUTION

   High electric voltage through potential increase. Risk of personal injury due to electric shock. Damage to property due to potential differences from mains input to the housing.
4. Pull the plug of the mains supply cord from its holder.
5. Release the uncoiling brake on the cable drum: To do this, turn the appropriate brake lever anti-clockwise.
6. Unwind the mains supply cord to the required length.
7. Connect the system to the mains voltage. If necessary, use a country-specific adapter.

   If you have only one mains port via the SCHUKO® power socket, use an adapter with the SCHUKO® 16 A plug type (option).
8. Connect the plug on the mains supply cord cable drum to the coupler socket on the system.

   The figure is illustrative.



7.6 Securing the test area

1. Mark out the path for pedestrians.
2. Protect the test lead (connection cable), e.g. with cable bridges or rubber mats. The cables must be protected against damage and there must be no danger of people tripping.
3. If the connection creates a hazard for the testing personnel and pedestrians, mark them.
4. The area around the test structure (test area) must be demarcated from workplaces and traffic in such a way that
   - *except for the tester, no other person can remain in the test area,*
   - *except for the tester, no other person can access the test area,*
   - *persons standing outside the boundary cannot reach the operating elements of the test system located inside the boundary.* (EN 50191)

   The minimum height of individual boundaries must be 1 m.
5. If the system is cordoned off from general areas only with ropes, chains or bars, the entire test structure must be monitored during the test in compliance with EN 50191. If the test structure includes several local test areas, security guards must be appointed for each test area. But it is important that the testing personnel and the security guards understand each other well.
6. Mark the test area and terminals clearly. It must be very obvious that a cable test is in progress.
7. Make sure that unauthorised persons cannot access the local mains stations.

8 COMMISSIONING

Follow the information below:

- The safety instructions in the chapter *For your safety* (on page 12)
- Local safety and accident prevention regulations
- Safety instructions and regulations according to the state-of-the-art
- National and international standards and guidelines in the latest applicable version:
  EN 50110 for the operation of electrical installations (EU/EFTA countries);
  EN 50191 for the erection and operation of electrical test installations (EU/EFTA countries)
  or applicable standards in your country.
- Employers' liability insurance association regulations (if any)

8.1 Safety instructions

⚠ WARNING

Residual voltage in test object

Danger to life, risk of injury due to electric shock.

Cables have a capacitance and can continue to carry load even after switching off the HV generator or can be recharged after a temporary short-circuit due to recurring voltages.

- Before touching the test object, discharge, earth and short it: at the connection point and at the far end.
- You may touch the plant parts that were under voltage only if they are visibly earthed and short-circuited.

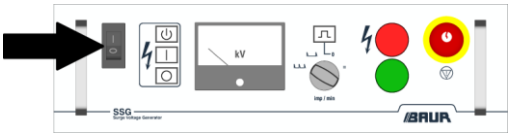
8.2 Switching on the system and starting the BAUR system software

Prerequisites

- The system is earthed correctly.
- The test object is connected properly.
- The system is connected to the appropriate supply voltage.
  Further information: Chapter *Connecting the system to the supply voltage* (on page 50)

Procedure

1. Switch on the SSG surge voltage generator using the On/Off switch.



   - The system status changes to the *Ready for operation* operating state.
   - The green indicator light comes on.
2. Switch the PC on:
   Systems with UPS
   ▸ Switch the UPS on with the UPS key next to the PC monitor.
   The PC is switched on automatically.
   Systems without UPS
   ▸ Switch the PC on with the ⏻ On/Off key.
3. To start the BAUR system software, select it from the program list in Windows.
   Alternatively, double-click on the shortcut icon for the BAUR system software on the desktop. The system software opens.

Further information on performing measurements and various fault location methods:

- Chapter *Cable fault analysis* (on page 77)
- Chapter *Cable and cable sheath testing* (on page 84)
- Chapter *Cable fault pre-location* (on page 88)
- Chapter *Cable fault pin-pointing* (on page 110)

9 OPERATING AND CONFIGURING THE BAUR SYSTEM SOFTWARE

9.1 Login

Rights of individual users can be set up with the user login administration. If you don't need the user and rights administration, you can disable the login message.

9.1.1 User roles and rights

There are two user roles: *Engineer* or *Administrator.* The difference between the two roles is the ability to define voltages per measurement method and nominal voltage and to create users. All other functions are available for every user.

The *Service* role is automatically assigned to BAUR After Sales and cannot be managed.

Overview of available user roles and their rights

Role	Rights
Administrator	All functions of the BAUR system software, including the additional Administrator rights: ▪ User administration: Create new users, assign rights, enable and disable login ▪ Define the threshold values for various fault types during the insulation resistance measurement ▪ Define the max. permissible voltage, the recommended voltage and other voltage details per method and nominal voltage
Engineer	All functions of the BAUR system software, except the additional Administrator rights
Service	This role is assigned to BAUR After Sales.

9.1.2 Creating users

Prerequisite

You have Administrator rights for the BAUR system software.

Procedure

1. In the ***Tools*** menu, select the ***Settings*** menu item.
2. In the ***Settings*** dialog, select the ***User management*** tab.
3. Click the ***Add new user*** button.
   In the list of users, a new user is displayed with an automatically generated name.
4. To define the name and rights of the new user, in the list, click on the new user and click on the  icon.
   A dialog to define the new user opens.
5. Enter the user name and password.

6. Confirm the password by re-entering it.
7. Note down this password and store it in a safe place.
8. In the ***Available user roles*** area, click on a role that you want to assign to the new user.
9. To apply this role, click the << button.
   The applied role is displayed in the ***User roles*** area.
10. If you want to take away a role assigned to the user, click the >> button.
    The role is removed from the ***User roles*** area.
11. Click the ***OK*** button to confirm the entries.

9.1.3 Changing the user properties

Prerequisite

You have Administrator rights for the BAUR system software.

Procedure

1. To change the name, password or rights of a user, click on the icon of the respective user.
   A dialog to define the user opens. The roles assigned to the user are displayed in the ***User roles*** area.
2. You can change the name and/or password of the user as required.
3. If you want to assign a role to the user, in the ***Available user roles*** area click on the respective role and click the << button.
   The applied role is displayed in the ***User roles*** area.
4. If you want to take away a role assigned to the user, click the >> button.
   The role is removed from the ***User roles*** area.
5. Click the ***OK*** button to confirm the entries.

9.1.4 Enabling Login

Prerequisite

You have Administrator rights for the BAUR system software.

Procedure

1. In the ***Tools*** menu, select the ***Settings*** menu item.
2. In the ***Settings*** dialog, select the ***User management*** tab.
3. In the lower area of the dialog, enable the ***Display login dialog*** checkbox.
   The next time you start the BAUR system software, you will be prompted for the Login information.

9.1.5 Logging into the system

If the Login checkbox is enabled, on starting the software, the Login dialog is displayed.

1. Enter your user name and password.
   If you have forgotten your Login information, contact your BAUR representative (http://www.baur.eu/baur-worldwide).
2. Click the ***Login*** button.

9.2 Operation of the BAUR system software for cable fault location

9.2.1 Key combinations

You can use various key combinations for quick navigation in the software.

Key/Key combination	Function
F1	Opens the Online Help
F11	Opens and closes the Full screen view
Ctrl -	Zooms out the view
Ctrl +	Zooms in the view
Ctrl+O	Opens the ***Select cable route*** dialog In this dialog, you can search for cable routes, select cable routes or delete cable routes.

9.2.2 Evaluating reflection images

Performing measurements as part of the cable fault pre-location produces so-called reflection images. These reflection images make it easier to locate cable faults. In addition to these images, you can evaluate the reflection images in detail (with cursors and context menus in the reflection images).

Evaluation with cursors

Cursors are available for evaluating the reflection images. Cursors enable you to mark fault and joint positions precisely or to measure distances and fault distances.

You can identify the cursor type by the cursor flag.

Cursor flag	Cursor name	Meaning
	***End of cable route***	Displays the automatically detected end of cable route If the software detects a big positive reflection after a TDR or SIM/MIM measurement, it interprets this reflection as the cable end and automatically sets the ***End of cable route*** cursor after the measurement. In the cursor flag, you can see after how many meters or feet the end of the cable route was detected. ▸ Compare this value with the cable length known to you and if needed, adjust the cable length or velocity of propagation. Further information: *Adjusting the cable length and velocity of propagation* (on page 94)
	***Cable fault***	Displays the position where a possible fault was detected automatically If the software detects a possible fault position in the reflection image, after the measurement, the ***Cable fault*** cursor is set automatically. In the cursor flag, you can see after how many meters or feet (measured from the start of the cable route) the fault was detected.

Cursor flag	Cursor name	Meaning
	***Start of cable route***	Displays the original start of the cable route This cursor is only displayed when a trace has been moved. In the cursor flag, you can see by how many meters or feet the start of the cable route has been moved.
	***Info cursor***	Displays a manually set cursor

A context menu is available for each cursor, which offers you access to other functions.

Cursor name	Context menu item	Meaning
End of cable route	***Confirm as fault position***	Is used to confirm the cursor position as the cable fault position You can further select the phase on which the measurement was performed. Further information: Chapter *Confirming cursor positions* (on page 59)
	Confirm as end of cable route	Is used to confirm the cursor position as the end of the cable route Further information: Chapter *Confirming cursor positions* (on page 59)
	Delete	Deletes the cursor
	Properties...	Opens the cursor properties (name and position of cursor)
Cable fault	***Confirm as fault position***	Is used to confirm the cursor position as the cable fault position You can further select the phase on which the measurement was performed. Further information: Chapter *Confirming cursor positions* (on page 59)
	Delete	Deletes the cursor
	Properties...	Opens the cursor properties (name and position of cursor)
Start of cable route	***Delete***	Deletes the cursor
	Properties...	Opens the cursor properties (name and position of cursor)
Info cursor (added manually)	***Confirm as fault position***	Is used to confirm the cursor position as the cable fault position You can further select the phase on which the measurement was performed. Further information: Chapter *Confirming cursor positions* (on page 59)
	Confirm as joint position	Is used to confirm the cursor position as joint position Further information: Chapter *Confirming cursor positions* (on page 59)

Cursor name	Context menu item	Meaning
	Confirm as end of cable route	Is used to confirm the cursor position as the end of the cable route Further information: Chapter *Confirming cursor positions* (on page 59)
	Select reference cursor	Is used to select another Info cursor as reference cursor Further information: ▪ Chapter *Measuring the distance between two cursors* (on page 59) ▪ Chapter *Calculating the fault distance* (on page 60)
	Save	Saves the cursor at this position The saved cursor is still displayed after restarting the software.
	Delete	Deletes the cursor
	Properties...	Opens the cursor properties (name and position of cursor)

Evaluation with context menus in reflection images

If the reflection images are not clear, for example, because two traces are too close to each other, you can adjust the display of the trace. From the context menu in the reflection image, you can change the amplitude of a trace, use a trace as a reference curve and compare two traces with each other.

Further information on evaluation with context menus:

- Chapter *Scaling the amplitude of a trace* (on page 60)
- Chapter *Moving the trace* (on page 61)
- Chapter *Defining the trace as the reference curve* (on page 61)
- Chapter *Displaying the difference area between two traces* (on page 61)
- Chapter *Displaying the difference curve of two traces* (on page 62)
- Chapter *Displaying the mean curve of two traces* (on page 62)
- Chapter *Adding a horizontal line in the reflection image* (on page 63)

Adding, moving and saving cursors

1. Double-click in the reflection image.
   A cursor is added.
2. Repeat step 1 until the desired number of cursors has been added.
3. To move a cursor, click on the cursor flag and hold down the mouse button to drag the cursor to the desired position.
4. To save a cursor at a certain position, right-click on the cursor flag and select the ***Save*** context menu item.
   Note: A cursor will only still be displayed in the software, even after restart, once you have added and saved it manually.

Confirming cursor positions

Confirming the cursor position as the fault position

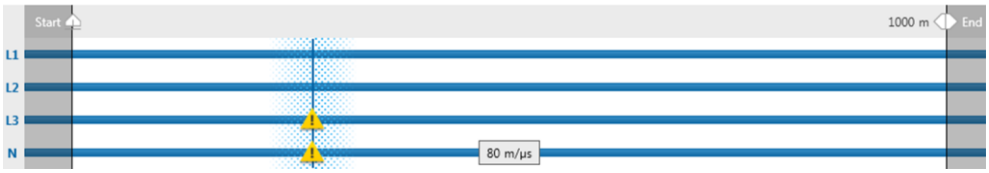


Figure: Cable image with fault position and tolerance range

1. In the reflection image, right-click on the cursor flag.
2. In the context menu, select the ***Confirm as fault position*** menu item.
3. In the extended context menu, select the phase where the fault occurred.

   The fault position is displayed in the reflection image and in the cable image. A tolerance range is displayed around the pre-located fault position and the fault can be located within this range. In the cable image, the faulty phase is also indicated with an error symbol.

   The cursor is no longer displayed.

Note: This function is not available for the ***ICM*** method. With this method, the fault distance is calculated using a different procedure. Further information: Chapter *Evaluating the ICM transient image* (on page 107)

Confirming the cursor position as the joint position

This action can be performed only with ***Info cursor*** type cursors.

1. In the reflection image, right-click on the cursor flag.
2. In the context menu, select the ***Confirm as joint position*** menu item.

   The joint is displayed in the reflection image and in the cable image.

   The cursor is no longer displayed.

Confirming the cursor position as the end of the cable route

This action can be performed only with ***Info cursor*** or ***End of cable route*** type cursors.

1. In the reflection image, right-click on the cursor flag.
2. In the context menu, select the ***Confirm as end of cable route*** menu item.
3. Select whether the cable length or the velocity of propagation should be adjusted in the previous section and click the ***OK*** button.

   The selected parameter is modified.

Measuring the distance between two cursors

This function is available only after a measurement with the ***TDR*** or ***SIM/MIM*** pre-location method.

1. Double-click in the reflection image at the desired position.

   A cursor with the letter A is added.
2. Double-click in the reflection image at a second position.

   A cursor with the letter B is added.
3. To move a cursor, click on the cursor flag and hold down the mouse button to drag the cursor to the desired position.

4. Right-click on the cursor flag of one of the cursors and select the ***Select reference cursor*** context menu item.
5. Select the letter of the other cursor.

   A blue bar with the distance is displayed (in meters or feet).
6. To save this displayed distance, right-click on the blue bar and select the ***Save*** context menu item.

   Note: The displayed distance will only still be displayed, even after restarting the software, once you have saved it.

Calculating the fault distance

This function is available only after a measurement with the ***ICM*** method.

1. You can insert a horizontal auxiliary guide line to precisely position the cursors used for calculating the fault distance. For this, right-click in the reflection image and select the ***Add horizontal line*** context menu item.
2. To move the line, click on the line and hold down the mouse button to drag it to the desired position.
3. Double-click in the reflection image at the beginning of a reflection period.

   A cursor with the letter A is added.
4. Double-click in the reflection image at the end of a reflection period.

   A cursor with the letter B is added.
5. To position a cursor precisely, click on the cursor flag and hold down the mouse button to drag the cursor to the desired position.
6. Right-click on the cursor flag of one of the cursors and select the ***Select reference cursor*** context menu item.
7. Select the letter of the other cursor.

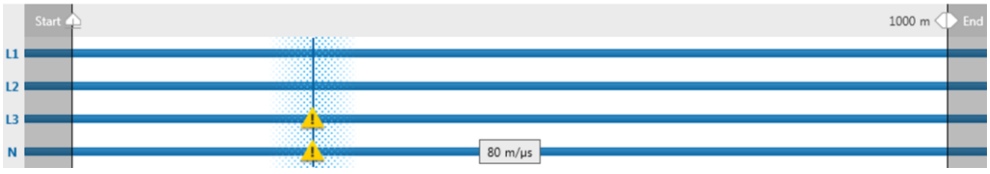
   A blue bar with the fault distance is displayed (in meters or feet). The fault distance is produced from the time difference between two cursors minus the test lead length (in ns).
8. To save this displayed fault distance, right-click on the blue bar and select the ***Save*** context menu item.

   Note: The displayed fault distance will only still be displayed, even after restarting the software, once you have saved it.

Confirm as fault position

- To confirm the fault distance as the fault position, right-click on the blue bar and select the ***Confirm as fault position*** context menu item.

  The fault position is displayed in the cable image. A tolerance range is displayed around the pre-located fault position and the fault can be located within this range. The faulty phase is also indicated by a fault symbol.



Scaling the amplitude of a trace

1. To select a trace, double-click on the trace in the list of completed measurements.

   The trace is shown in bold in the reflection image and in the list of completed measurements.
2. In the reflection image, right-click on the selected trace and select the ***Scale the amplitude*** context menu item.

3. Set the amplitude.
4. To save the settings, click the ***OK*** button.
5. To reset the scaling to 100%, right-click on the trace and select the ***Reset the amplitude*** context menu item.

Moving the trace

1. To select a trace, double-click on the trace in the list of completed measurements.

   The trace is shown in bold in the reflection image and in the list of completed measurements.
2. In the reflection image, click on the selected trace and hold down the mouse button to drag it to the desired position.
3. To reset the trace to its original position, in the reflection image, right-click on the moved trace and select the ***Reset the curve position*** context menu item.

Defining the trace as the reference curve

1. To select a trace, double-click on the trace in the list of completed measurements.

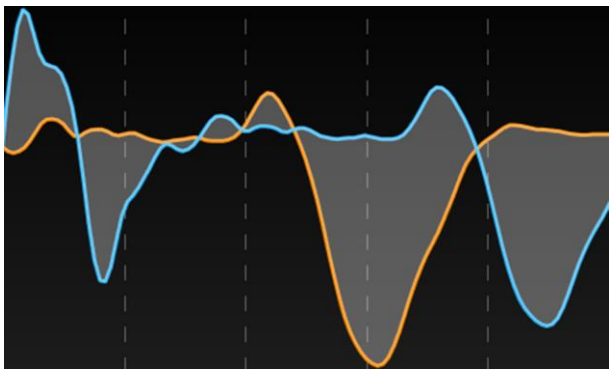
   The trace is shown in bold in the reflection image and in the list of completed measurements.
2. In the reflection image, right-click on the selected trace and select the ***Use as reference curve*** context menu item.

   In the reflection image, this trace is displayed as a dotted line.

   In the list of completed measurements, the word ***Reference*** is displayed with this trace.
3. To stop using the trace as a reference curve, right-click in the reflection image and select the ***Clear the reference curve*** context menu item.

Displaying the difference area between two traces

You can highlight the differences between two traces more distinctly by displaying the area between these traces.



1. To select a trace, double-click on the trace in the list of completed measurements.

   The trace is shown in bold in the reflection image and in the list of completed measurements.
2. To select the second trace, double-click on the second trace in the list of completed measurements.

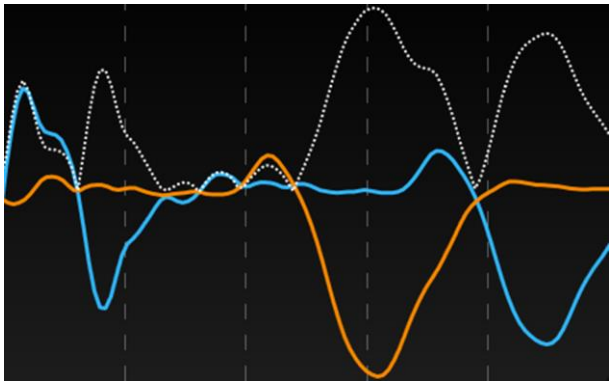
   Both traces are shown in bold in the reflection image and in the list of completed measurements.

3. In the reflection image, right-click on one of the selected traces and select the ***Display the difference area*** context menu item.

   The area between the two selected traces is shown in a bright colour.
4. To hide the difference area, right-click in the reflection image and select the ***Hide the difference area*** context menu item.

Displaying the difference curve of two traces

You can highlight the differences between two traces more distinctly by displaying a difference curve. To calculate the difference curve, the difference between each point of the two selected traces is calculated. The resulting values are displayed as a white curve.



1. To select a trace, double-click on the trace in the list of completed measurements.

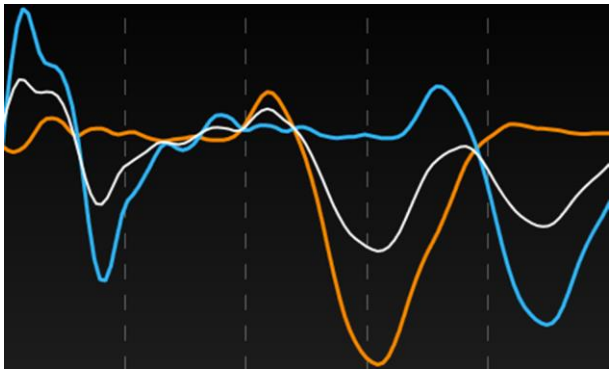
   The trace is shown in bold in the reflection image and in the list of completed measurements.
2. To select the second trace, double-click on the second trace in the list of completed measurements.

   Both traces are shown in bold in the reflection image and in the list of completed measurements.
3. In the reflection image, right-click on one of the selected traces and select the ***Display the difference curve*** context menu item.

   The difference curve is displayed as an additional white curve.
4. To hide the difference curve, right-click in the reflection image and select the ***Hide the difference curve*** context menu item.

Displaying the mean curve of two traces

If the curve course is uneven, you can display a mean curve. To calculate the mean curve, the points of the two selected traces are added and divided by 2. The resulting values are displayed as a white curve.



1. To select a trace, double-click on the trace in the list of completed measurements.

   The trace is shown in bold in the reflection image and in the list of completed measurements.
2. To select the second trace, double-click on the second trace in the list of completed measurements.

   Both traces are shown in bold in the reflection image and in the list of completed measurements.
3. In the reflection image, right-click on one of the selected traces and select the ***Display the mean curve*** context menu item.

   The mean curve is displayed as an additional white curve.
4. To hide the mean curve, right-click in the reflection image and select the ***Hide the mean curve*** context menu item.

Adding a horizontal line in the reflection image

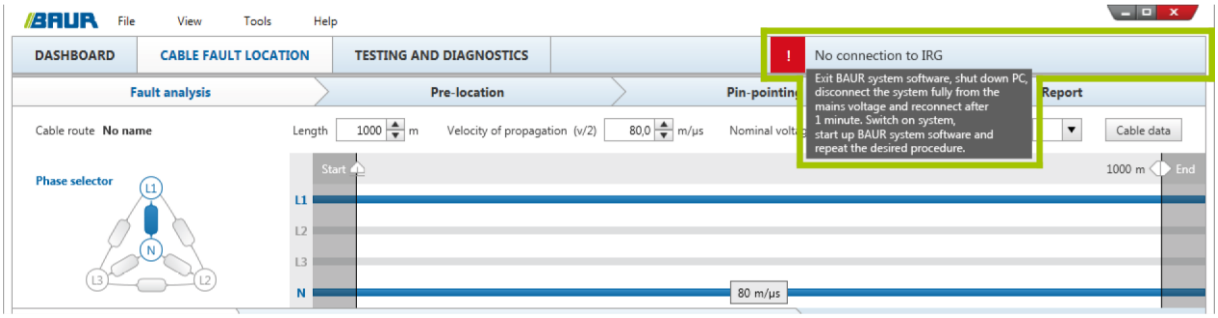
This function is available only after a measurement with the ***ICM*** pre-location method. The horizontal line is a tool for positioning the cursor more precisely so as to calculate the fault distance.

1. Right-click in the reflection image and select the ***Add horizontal line*** context menu item.
2. To move the line, click on the line and hold down the mouse button to drag it to the desired position.
3. To delete the horizontal line, right-click on the line and select the ***Delete*** context menu item.

9.3 System messages

The system generates information and error messages to help you while performing measurements.

Notifications bar



The information and error messages are displayed at the top right of the screen - in the notifications bar. When you rest the mouse pointer over a system message, a tooltip displays detailed information on the fault or the current status.

The error message is displayed until the fault is rectified.

In the information messages, on the right, you will see a cross that you can use to hide the information messages.

Measurement dialog

Information on the current measurement as well as faults that occur during the measurement are displayed in the bottom area of the ***Start/stop measurement*** dialog. Information is shown in blue font, faults in red.

Further information on the meaning of error messages and corrective measures: Chapter *Errors and corrective measures* (on page 129)

9.4 Software configuration

9.4.1 Selecting the language

Tools > ***Settings*** > ***Language and units***

1. In the ***Tools*** menu, select the ***Settings*** menu item.
2. In the ***Settings*** dialog, select the ***Language and units*** tab.
3. In the ***Language*** list, select the desired language.
   List of available languages: Chapter *Technical data* (on page 37)
4. To save the settings, click the ***OK*** button.
5. To display the BAUR system software in the selected language, restart the software.
   The user interface is displayed in the selected language. Reports already created are also displayed in the selected language.

9.4.2 Selecting the system of units

Tools > ***Settings*** > ***Language and units***

1. In the ***Tools*** menu, select the ***Settings*** menu item.
2. In the ***Settings*** dialog, select the ***Language and units*** tab.
3. To display units in the metric system (meters and degrees Celsius), in the ***System of units*** list, select ***Metric units (SI)***.
   To display units in the Anglo-American system (feet and degree Fahrenheit), in the ***System of units*** list, select ***GB/US units***.
4. To save the settings, click the ***OK*** button.

The units are displayed in the selected system of units.

9.4.3 Activating the simulation mode

Tools > ***Simulation mode***

1. In the ***Tools*** menu, select the ***Simulation mode*** menu item.
2. Restart the software to be able to work in the simulation mode.
   If the simulation mode is enabled, the text ***Simulation mode*** is displayed in the upper menu bar.

9.4.4 Setting up quick access buttons on the Dashboard

1. In the ***Tools*** menu, select the ***Settings*** menu item.
2. In the ***Settings*** dialog, select the ***Dashboard*** tab.
3. In the ***Select buttons*** list, enable up to three functions.
4. To save the settings, click the ***OK*** button.
   The enabled functions are displayed as buttons in the ***QUICK ACCESS*** area in the Dashboard.

9.4.5 Activating options

1. In the ***Tools*** menu, select the ***Settings*** menu item.
2. In the ***Settings*** dialog, select the ***Options*** tab.
   The available and activated options, including corresponding option code, are displayed.
3. You require an option code to activate an option. For this, take note of the displayed hardware identifier and contact your BAUR representative (http://www.baur.eu/baur-worldwide).
   You will receive an option code for each option that is to be activated.
4. Enter the option code in the input field and click on the ***Activate*** button.
   The option is displayed as activated.
5. To save the settings, click the ***OK*** button.
6. Restart the software to be able to use the options in the BAUR system software.

9.4.6 Entering cable routes

1. In the Dashboard, in the ***QUICK ACCESS*** area, click the ***Enter new cable route*** button.
   Alternately, in the ***File*** menu, select the ***Enter new cable route*** menu item or right-click in the BAUR GeoBase Map and select the ***Enter new cable route*** context menu item.
   The ***Cable data*** dialog opens.
2. Select the ***General information*** tab.
   You can now enter the following properties, amongst others, for the cable route:
   - Cable route name
   - Length of the cable route
   - Velocity of propagation (v/2)
   - Number of phases
   - Name of the substation at the start of the cable route
   - Name of the substation at the end of the cable route
   - Nominal voltage (Uo/U)

Note: The ***Nominal voltage (Uo/U)*** selection list contains the nominal voltages that were entered under ***Tools*** > ***Voltage assistant*** and were activated for display in the selection list.

Further information: Chapter *Entering the nominal voltage* (on page 66)

3. To map the cable route on the map, select the ***Map*** tab.

   Further information: Chapter *Mapping the cable route on the map* (on page 67)
4. To add the joint positions on the cable route, select the ***Joints*** tab.

   Further information: Chapter *Entering joints* (on page 68)
5. To add images, select the ***Images*** tab.

   Further information: Chapter *Adding images* (on page 69)
6. To save the settings, click the ***OK*** button.

   The new cable route is created with the entered cable data and is displayed in the ***CABLE ROUTES*** area.

Adding measurement data to a new or existing cable route after the measurement

1. In the dashboard, select the ***CABLE FAULT LOCATION*** tab without selecting the cable route.

   The ***Cable route*** information bar displays ***No name*** as the name of the cable route as well as the standard data stored for cable length, velocity of propagation, nominal voltage and number of phases.
2. To modify the standard data, in the ***Cable route*** information bar, enter the desired data.
3. Perform the analyses and measurements.

   After completing the cable fault location on the cable route - on closing the software or switching to the Dashboard and selecting a cable route - the ***Save measurement data*** dialog opens.
4. Select if you want to enter a new cable route for the measurement data, if you want to add the measurement data to an existing cable route or if you want to discard the measurement data.

   Alternately, you can enter a new cable route for the measurement data any time by clicking the ***Cable data*** button in the cable image.

9.4.7 Entering the nominal voltage

- In the cable image or in the ***Cable data*** dialog, enter the nominal voltage in the ***Nominal voltage (Uo/U)*** selection list.

  Recommendation: Now set the parameter values for the insulation resistance measurement and the voltage specifications for this new nominal voltage for each measurement method. To do this, you require Administrator rights.

  Further information:

  - Chapter *Setting the parameters for insulation resistance measurement* (on page 73)
  - Chapter *Setting the voltage specifications per method (voltage assistant)* (on page 75)

Entering the nominal voltage in the Voltage assistant dialog

Prerequisite

You have Administrator rights for the BAUR system software.

Procedure

1. In the ***Tools*** menu, select the ***Voltage assistant*** menu item.
2. In the ***New nominal voltage (Uo/U)*** input field, enter the name of the desired nominal voltage.

3. Click the ***Add nominal voltage*** button.

   The nominal voltage is added with standard data and is displayed in the ***Default nominal voltage*** selection list. In addition, the nominal voltage is displayed in the ***Nominal voltage (Uo/U)*** selection lists of the cable image and the ***Cable data*** dialog.
4. To set the parameters for the insulation resistance measurement, select the ***Insulation measurement*** tab and enter the new parameters.
5. To set the voltage specifications per measurement method, select the ***Pre-location*** tab and enter the voltage specifications per method.
6. To change the name of the nominal voltage, in the ***Nominal voltage (Uo/U)*** input field, enter the desired name.
7. To hide the nominal voltage, disable the ***Display nominal voltage*** checkbox.

   Note: If you hide a nominal voltage, it is no longer displayed in the ***Nominal voltage (Uo/U)*** selection list of the cable image and the ***Cable data*** dialog. However, the nominal voltage is still displayed in the ***Voltage assistant*** selection list in the ***Default nominal voltage*** dialog.
8. To save the settings, click the ***OK*** button.

9.4.8 Deleting cable routes

1. In the ***File*** menu, select the ***Select cable route*** menu item.
2. In the ***Select cable route*** dialog, select the cable route that you want to delete.
3. Click the ***Delete cable route*** button.

   Alternately, click on the ✖ icon of the cable route.
4. To confirm the message, click the ***Yes*** button.

   The cable route is deleted.

9.4.9 Mapping the cable route on the map

Prerequisites

- The BAUR GeoBase Map is available.
- The cable route is known.

Procedure

1. In the ***CABLE ROUTES*** area, click on the icon of the cable route that you want to edit.
2. In the ***Cable data*** dialog, select the ***Map*** tab.

   The icon is marked on the map and stands for the substation at the start of the cable route.
3. To specify a substation at the end of the cable route, click the ***Add station*** button.

   A second icon is marked on the map and stands for the substation at the end of the cable route.

   The cable route is displayed as a dashed line.
4. To move a substation, click on the icon and hold down the mouse button to drag it to the desired location.
5. Click on the cable route to insert a route point to move the route.

   The cable route becomes a continuous line, a route point is displayed.
6. To change the route of the cable, click on the route point and hold down the mouse button to move it to the desired location.
7. Repeat steps 5 and 6 until the marked cable route matches the real cable route.

The software automatically calculates the marked length of the cable route. If the marked length exceeds the specified length, the cable route turns red.

8. To save the settings, click the ***OK*** button.

9.4.10 Entering joints

Entering joints in the Cable data dialog

1. In the Dashboard, in the ***CABLE ROUTES*** area, click on the icon of the cable route for which you want to enter joints.

   Alternately, in the ***CABLE FAULT LOCATION*** tab, click the ***Cable data*** button.
2. Select the ***Joints*** tab.

   You can now enter the following joint properties:

   - Identification number
   - Position
   - Year of installation
   - Installation temperature
   - Construction type
   - Manufacturer
3. To save the joint, click the ***Save/update joint*** button.

   The joint is displayed in the ***Available joints*** list.
4. To enter more joints, click the ***Enter new joint*** button.

Entering joints via the joint search

This joint search is possible only after a measurement with the ***TDR*** or ***SIM/MIM*** pre-location method.

1. After performing a measurement with a suitable pre-location method, in the list of completed measurements, enable the checkbox of a single trace.
2. In the reflection image, click the ***Search for joints*** button.

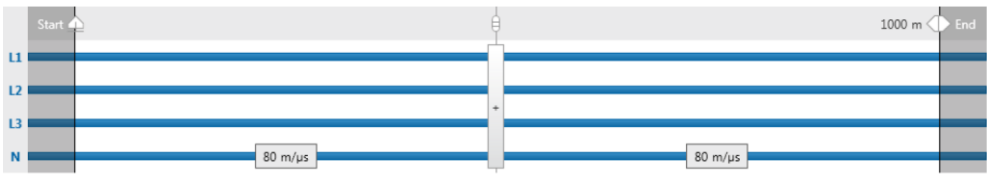
   Possible joint positions are displayed in the reflection image and in the cable image with dotted lines.
3. To decrease or increase the sensitivity of the joint search, move the slider to the left or right.
4. To confirm a joint, in the cable image, right-click on the dotted joint and select the ***Confirm joint*** context menu item.

   The joint is added to the cable route and is displayed in the cable image.
5. To move the joint, click on the joint and hold down the mouse button to drag it to the desired position.

Entering joints directly in the cable image

1. In the ***CABLE FAULT LOCATION*** tab, in the cable image, right-click at the point where you want to add the joint and select the ***Add joint*** context menu item.

   A joint is displayed in the cable image.



2. To move the joint, click on the joint and hold down the mouse button to drag it to the desired position.

Entering joint properties

1. To enter the joint properties, right-click on the joint in the cable image and select the ***Properties...*** context menu item.

   You can now enter the following joint properties:

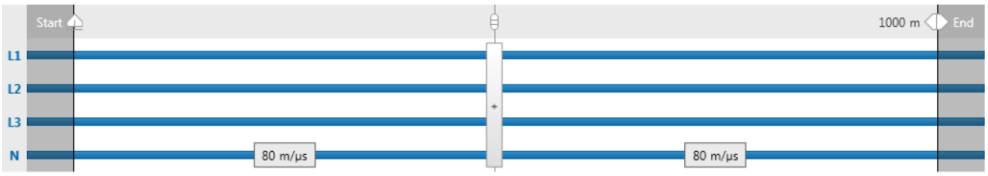
   - Identification number
   - Position
   - Year of installation
   - Installation temperature
   - Construction type
   - Manufacturer
   - Name of person who installed the joint
   - Comments

2. To save the settings, click the ***OK*** button.

Note: You can enter the most important joint properties in the ***Cable data*** > ***Joints*** dialog.

9.4.11 Deleting joints

1. In the Dashboard, in the ***CABLE ROUTES*** area, select the cable route from where you want to delete the joint.
2. Select the ***CABLE FAULT LOCATION*** tab.
3. In the cable image, right-click on the joint that you want to delete.



4. Select the ***Delete*** context menu item.

   The joint is deleted without any confirmation message.

9.4.12 Adding images

1. In the Dashboard, in the ***CABLE ROUTES*** area, click on the icon of the cable route for which you want to enter an image.
2. In the ***Cable data*** dialog, select the ***Images*** tab.
3. Click the ***Add image*** button.
4. In the ***Add image*** dialog, select the ***Browse*** button.
5. Select the folder where the image is saved and click on the image.
6. Click the ***OK*** button.
7. To change the name of the image, in the ***Name*** input field, enter another name.
8. To insert a description for the image, enter text in the ***Image description*** input field.
9. Click the ***Add*** button.
10. Repeat steps 4 to 9 for each additional image you want to add.
11. To save the settings, click the ***OK*** button.

9.4.13 Editing properties of a cable section

A cable section is a section of the cable route between two joints or between a joint and the termination.

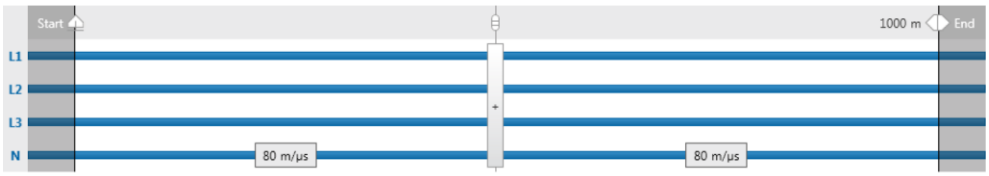


Figure: Cable image with a joint and two cable sections

1. In the Dashboard, in the ***CABLE ROUTES*** area, select the cable route where you want to edit the cable sections.
2. Select the ***CABLE FAULT LOCATION*** tab.
3. Right-click in the cable image (in the area of the desired cable section) and select the ***Properties...*** context menu item.

   You can now enter the following properties for the cable section:

   - Identification number
   - Velocity of propagation (v/2)
   - Year of installation
   - Manufacturer
   - Insulation
   - Comments
4. To save the settings, click the ***OK*** button.

9.4.14 Velocities of propagation (v/2)

Cable type	Insulation	Velocity of propagation (v/2)
Power cable, nominal voltage: 1 kV		
NKBA	Soaked paper insulation	73 - 88 m/µs
NYY	PVC	74 - 90 m/µs
NAKLEY	Soaked paper insulation	81 - 88 m/µs
NYCY	PVC	75 - 79 m/µs
NAKLEY	Soaked paper insulation	81 - 88 m/µs
NA2XY	XLPE	Approx. 80 m/µs
HV cable, nominal voltages: 10 kV, 20 kV, 30 kV, 110 kV		
N(A)KBA	Soaked paper insulation	79 - 84 m/µs
NA2XS(F)2Y	XLPE	81 m/µs

Cable type	Insulation	Velocity of propagation (v/2)
NA2YSY	PE	76 m/µs
NHEKBA	Soaked paper insulation	73 - 80 m/µs
NKY	Soaked paper insulation	58.5 m/µs
A2YHS(2)Y	PE	83 - 87 m/µs
StYHS2Y	PE	69.6 m/µs
Telecommunication cable		
Switchboard cable	PVC	85 m/µs
HF cable	Paper 0.4 mm core diameter	105 m/µs
KX switchboard cable	Full PE 0.5/3.0	96 m/µs
KX-RGU 220	Full PE 50 Ohm	99 m/µs
KX-179 BU	Teflon 75 Ohm	99 m/µs
KX-HF cable	Full PE 2.3/10 60 Ohm	100 m/µs
KX 2.6/9.5	Styroflex 75 Ohm	144 m/µs

Note: The specifications are based on empirical values and vary depending on the cable manufacturer. The exact specifications of the cable manufacturer for a cable are given in the relevant data sheet.

9.5 Data exchange

The BAUR system software offers the following options for exchanging data:

- Export/import of the cable database

  All cable routes including corresponding measurement data will be exchanged. This makes it possible, e.g., to make the data available for analysis to a measurement engineer in the office or to exchange data between different systems.

- Export/import of GIS data

  The cable data as well as the cable routes are exchanged as vector data in a defined format (GEOJSON). This makes it possible, e.g. to import cable routes into the BAUR system software that were already established in a geographical information system (GIS).

  The data exchange format must be complied with for the data exchange to work.

  ▸ To obtain information on the format of the exchange file, please contact your BAUR representative (http://www.baur.eu/baur-worldwide).

- Importing cable data from the BAUR system software 3

  The cable data of the BAUR system software 3 is transferred into the BAUR system software 4 as cable routes.

- Data backup

  Optionally, the cable database and all system settings and/or the system protocols may be exported.

9.5.1 Exporting cable database

1. In the ***Tools*** menu, select the ***Data exchange*** menu item and then ***Export cable database***.
2. Select the folder in which you want to save the file.
3. To save the file under a different name, enter a name in the ***File name*** input field.
   Note: The file name must not contain the following characters: \ / : * ? "< > |
4. Click the ***Save*** button.
   All cable routes including pertinent measurement data are saved in the selected folder as a ZIP file.

9.5.2 Importing cable database

1. In the ***Tools*** menu, select the ***Data exchange*** menu item and then ***Import cable database***.
2. Select the folder where the cable routes including the pertinent measurement data are saved as ZIP file.
3. Select the required file.
4. Click the ***OK*** button.
   All cable routes including pertinent measurement data will be imported.

9.5.3 Exporting GIS data

1. In the ***Tools*** menu, select the ***Data exchange*** menu item and then ***Export GIS data***.
2. Select the folder in which you want to save the file.
3. To save the file under a different name, enter a name in the ***File name*** input field.
   Note: The file name must not contain the following characters: \ / : * ? "< > |
4. Click the ***Save*** button.
   The cable data as well as the cable route are saved to the selected directory in a GEOJSON format.

9.5.4 Importing GIS data

Prerequisite

The GIS data are available as vector data in a GEOJSON format.

- To obtain information on the format of the exchange file, please contact your BAUR representative (http://www.baur.eu/baur-worldwide).

Procedure

1. In the ***Tools*** menu, select the ***Data exchange*** menu item and then ***Import GIS data***.
2. Select the folder in which the GIS data are saved.
3. Select the required file.
4. Click the ***OK*** button.
   The data are imported.

9.5.5 Importing cable data from BAUR system software 3

Prerequisite

- The cable data is available in the *C:\BaurMeasure* folder or in the DAT file format.

Procedure

Tools > ***Data exchange*** > ***Import cable data from system software 3***

- In the ***Tools*** menu, select the ***Data exchange*** menu item and then ***Import cable data from system software 3***.

  Importing cable data directly from the *C:\BaurMeasure* folder

  - Select the ***From local folder*** option and click on the ***Start import*** button.

  Importing cable data from a DAT file

  a. Select the ***From export file*** option and click on the ***Start import*** button.
  b. Select the folder in which the DAT file is stored.
  c. Select the required file.
  d. Click the ***OK*** button.
  The cable data are imported.

9.5.6 Backing up data

Tools > ***Data exchange*** > ***Data backup inc. system protocols***

1. In the ***Tools*** menu, select the ***Data exchange*** menu item and then ***Data backup inc. system protocols***.
2. Select the data that you want to export.
3. Click the ***Backup*** button.
4. Select the folder in which you want to save the file.
5. To save the file under a different name, enter a name in the ***File name*** input field.
   Note: The file name must not contain the following characters: \ / : * ? "< > |
6. Click the ***Save*** button.
   The selected data is saved to the selected folder as a ZIP file.

9.6 Basic settings for fault location methods

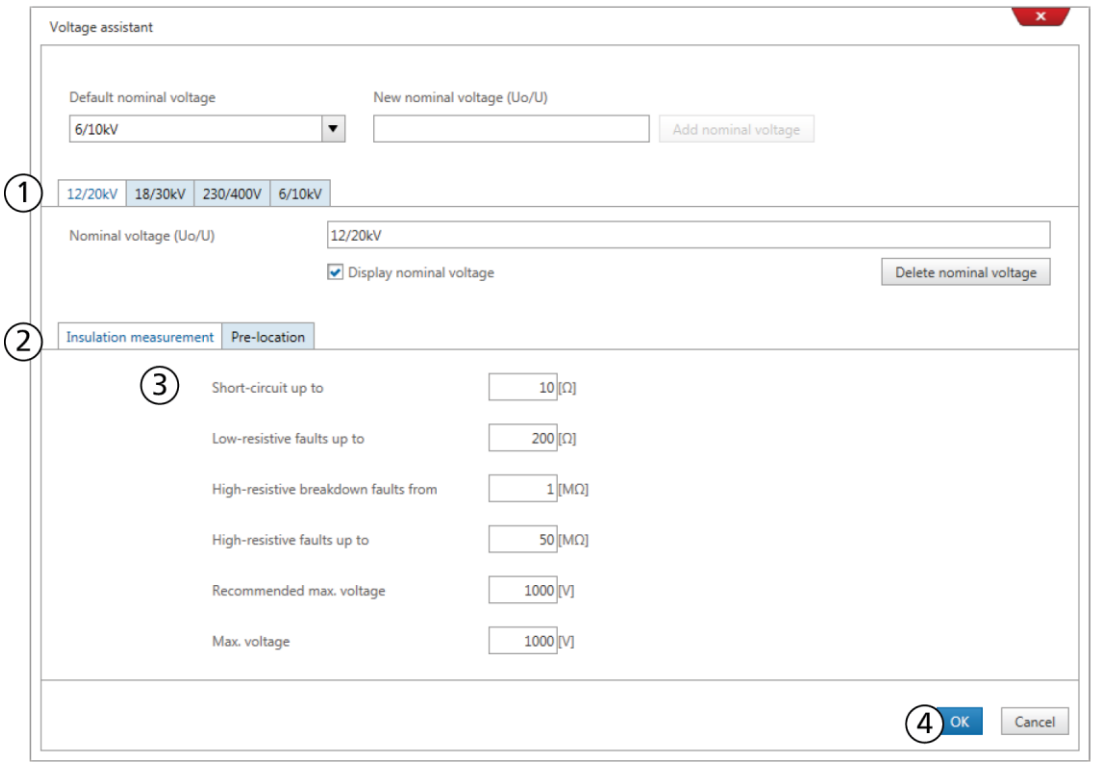
9.6.1 Setting the parameters for insulation resistance measurement

Prerequisite

You have Administrator rights for the BAUR system software.

Procedure

Tools > ***Voltage assistant***.



1. In the ***Voltage assistant*** dialog, click on the nominal voltage for which you want to set the parameters for the insulation resistance measurement.
2. Click the ***Insulation measurement*** tab.
3. Enter the parameters.
4. Click the ***OK*** button.
   The parameters are applied.

Overview of available parameters

Parameters	Function
Short-circuit up to	Is used to enter the threshold value up to which the cable fault is displayed as a short-circuit
Low-resistive faults up to	Is used to enter the threshold value up to which the cable fault is displayed as a low-resistive fault
High-resistive breakdown faults from	Is used to enter the threshold value from which the cable fault is displayed as a breakdown fault
High-resistive faults up to	Is used to enter the threshold value up to which the cable fault is displayed as a high-resistive fault
Recommended max. voltage	Is used to enter the voltage that is proposed in the ***Measurement*** dialog of the insulation resistance measurement
Max. voltage	Is used to enter the maximum permissible voltage for the insulation resistance measurement

9.6.2 Setting the voltage specifications per method (voltage assistant)

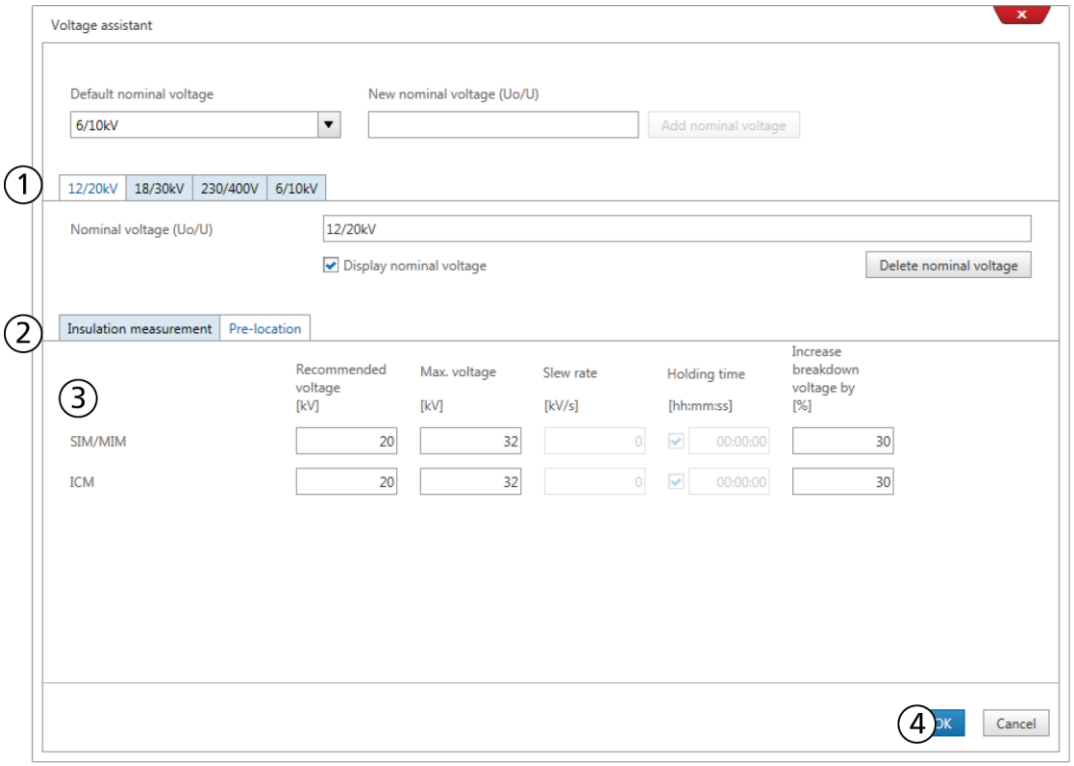
In the BAUR system software, you can set the maximum permissible voltage, recommended voltage and other voltage parameters for each method and nominal voltage. These voltage parameters are proposed when selecting the method for the cable route of the nominal voltage in question.

Prerequisite

You have Administrator rights for the BAUR system software.

Procedure

Tools > ***Voltage assistant***



1. In the ***Voltage assistant*** dialog, click on the nominal voltage for which you want to modify the voltage specifications.
2. Click the ***Pre-location*** tab.
3. Enter the voltage specifications per method.
4. Click the ***OK*** button.
   The modified values are applied.

Overview of available settings

Setting	Function
Recommended voltage	Is used to enter the voltage at which the fault location with the relevant measurement method is to be started The recommended voltage is displayed in the ***Measurement*** dialog before the measurement starts.

Setting	Function
Max. voltage	Is used to enter the maximum permissible voltage for cables of the selected nominal voltage During the measurement, the voltage should be increased only up to this maximum permissible voltage. The max. voltage is displayed in the ***Measurement*** dialog before the measurement starts.

The availability of other parameters depends upon the system configuration.

10 CABLE FAULT ANALYSIS

10.1 Insulation resistance measurement

10.1.1 About insulation resistance measurement

By measuring the insulation resistance phase-to-earth potential and phase-to-phase, you can ascertain the position of the fault (between two phases or between phase and earth potential) and the type of fault. Different methods are suitable for the cable fault location depending on the type of fault.

Following fault types are distinguished depending on the insulation resistance:

- Short-circuits
- Low-resistive cable faults
- High-resistive cable faults

With high-resistive faults a further distinction is made between:

- Resistance faults: Cable faults that do not ignite on applying higher voltages, but which conduct and can change their resistance
- Breakdown faults: Very high-resistive cable faults that ignite repeatedly from a specific voltage onwards

10.1.2 Setting the measurement parameters

1. In the dashboard, select the ***CABLE FAULT LOCATION*** tab and then the ***Fault analysis*** tab.
2. To open the ***Settings*** dialog, click on the icon.
3. Set the measurement parameters for the insulation resistance measurement.
   The defined parameters are automatically applied.
   The following table provides an overview of the parameters that you can define.

Measurement parameter	Setting	Function
Measuring device	***IRG***	Is used for measurements with the IRG time domain reflectometer that is integrated into the system
	External device	Is used for measurements with an external device The external device is not controlled via the BAUR system software. If you perform the measurement with an external device you can still manually enter the values determined in this way. Further information: Chapter *Entering resistance values manually* (on page 79)
Port	***TDR HV***	Is used for measurements with the HV connection cable
	TDR LV	Is used for measurements with the TDR connection cable (depending upon system configuration)

Measurement parameter	Setting	Function
Measuring technique	***Earth-referenced***	Is used for measurements with connection to the earth potential The electric field is measured against earth (earth-referenced). This measuring technique is recommended for cable faults due to earth contact.
	Floating	Is used for measurements without connection to the earth potential This measuring technique enables measurements free from earth effects.

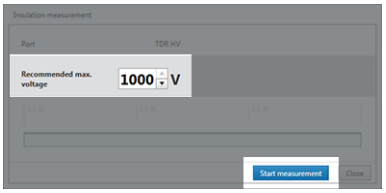
10.1.3 Performing an insulation resistance measurement

Prerequisites

- The test area is secured.
- The test object is connected properly.
  Further information: Chapter *Connecting the test object* (on page 43)
- The system is ready for operation.
  Further information: Chapter *Commissioning* (on page 52)

Procedure

1.	**BAUR system software 4** 	Select ***CABLE FAULT LOCATION*** > ***Fault analysis***. The ***Insulation measurement*** method is automatically selected.
2.		In the phase selector, select the combination(s) with which you are going to perform the measurement (phase - earth potential, phase - phase).
3.		If you want to change the measurement parameters, click on the ⚙ symbol.
4.		Click the ***Start measurement*** button.

5.		In the ***Measurement*** dialog, enter the maximum voltage at which the insulation resistance measurement should be performed, then click on the ***Start measurement*** button. Further information on the parameters of the insulation resistance measurement: Chapter *Setting the voltage specifications per method (voltage assistant)* (on page 75) The measurement is performed. Once the measurement is complete, the measured resistance values are displayed in the analysis diagram.
End measurement or connect other phase		
6.		To protect the system against restarting, press the emergency off button and remove the safety key.

DANGER

Dangerous voltage on the test object and other live plant parts. Danger to life, risk of injury from high electric voltage.

7.		Before touching the test object, discharge, earth and short it: at the connection point and at the far end. You may touch the plant parts that were under voltage only if they are visibly earthed and short-circuited.

Next steps

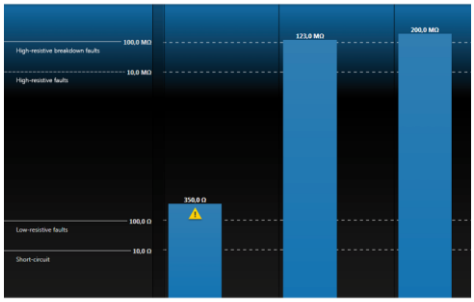
- Evaluating resistance values: Chapter *Evaluating resistance values* (on page 79)
- Comparing current measurement results with earlier results: Chapter *Comparing resistance values with the previous values* (on page 80)
- Inserting measurement results into the report: Chapter *Inserting measurement results in the report* (on page 80)

10.1.4 Entering resistance values manually

1. In the ***Insulation measurement*** view, click the ***Enter values*** button.
   Alternately, in the bottom area of the analysis diagram, you can click on any phase combination (blue), e. g. L1-N.
   The ***Enter resistance values*** dialog opens.
2. Enter the resistance values and select the unit, e.g. MOhm.
3. To save the resistance values you entered, click the ***Save*** button.
   The entered values are displayed in the analysis diagram and faults are assigned to fault types.
   Further information: Chapter *Setting the parameters for insulation resistance measurement* (on page 73)

10.1.5 Evaluating resistance values

The fault analysis is performed automatically in the BAUR system software after measurement of the insulation resistance or after manual input of the resistance values. The results of the analysis are displayed in the analysis diagram.



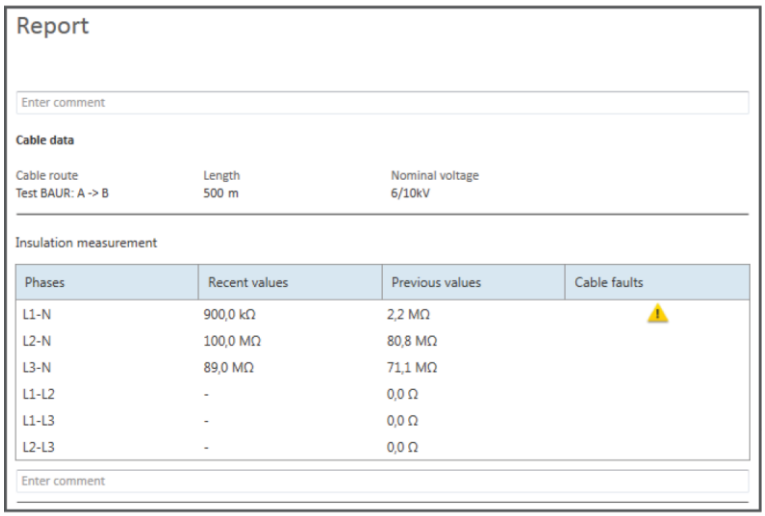
The threshold values for the various fault types are taken from the voltage assistant (under ***Tools*** > ***Voltage assistant***). You require Administrator rights to change these threshold values. Further information: Chapter *Setting the parameters for insulation resistance measurement* (on page 73)

10.1.6 Comparing resistance values with the previous values

1. To compare the current resistance values with the resistance values from previous measurements, in the ***Insulation measurement*** view, click the ***Previous values*** button.
2. In the ***Previous values*** dialog, check the desired measurement and click the ***OK*** button.
   The previous measurement results are displayed as a grey bar next to the current values in the analysis diagram.
3. To hide the previous resistance values, right-click in the analysis diagram and select the ***Hide previous values*** context menu item.

10.1.7 Inserting measurement results in the report

1. To insert the resistance values in the report, click the ***Insert graph in report*** button.
2. Enter a name for the graph and click the ***OK*** button.
   The resistance values are exported to the report in table format.



Report

Enter comment

Cable data

Cable route	Length	Nominal voltage
Test BAUR: A -> B	500 m	6/10kV

Insulation measurement

Phases	Recent values	Previous values	Cable faults
L1-N	900,0 kΩ	2,2 MΩ	⚠
L2-N	100,0 MΩ	80,8 MΩ	
L3-N	89,0 MΩ	71,1 MΩ	
L1-L2	-	0,0 Ω	
L1-L3	-	0,0 Ω	
L2-L3	-	0,0 Ω	

Enter comment

10.2 Determining the breakdown voltage

10.2.1 About determining the breakdown voltage

To select a suitable fault location procedure, it is necessary to check whether the cable can be charged and to determine the breakdown voltage. For this, a DC voltage is applied to each phase for a brief period.

The determined breakdown voltage is used to set the optimum voltage for the fault location.

10.2.2 Performing measurements for breakdown voltage determination

Safety instructions for determining the breakdown voltage

⚠ WARNING

Arcing faults and noise that can damage hearing as a result of cable breakdown

Danger to life as a result of electric shock, burns, electro-ophthalmia, hearing damage.

- Use suitable personal protective equipment against electric shocks and arcing faults.
- Use ear protection.
- Keep a safe distance from the connection point of the test object according to the nominal voltage of the network.

NOTICE

Erosion on short-circuit contacts inside the device caused by switching the operating mode under voltage

- Only switch the SSG surge voltage generator to DC voltage operation when it is in a de-energised state (Position: =).

Prerequisites

- The test area is secured.
- The test object is connected properly.
  Further information: Chapter *Connecting the test object* (on page 43)
- The system is ready for operation.
  Further information: Chapter *Commissioning* (on page 52)
- The drawbars on the SA 32 SIM/MIM coupling unit are pushed in (position: *SSG*).

Procedure

1. **SA 32 SIM/MIM coupling unit**

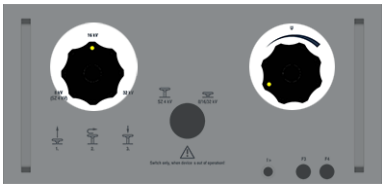
Set the sensitivity selector switch of the current indicator to the desired position.

Recommendation: *x100* position (highest setting)

2. 

Pull out the *test*|*SSG* drawbar until it reaches the stop (position: *test*).

3. **SSG surge voltage generator**



Using the selector switch (left), choose a voltage range.

4. Rotate the U rotary switch all the way to the left.

5. 

Release the high voltage: To do this, press the ⏻ key.

The system status changes to the *Ready to switch on* operating state. The red indicator light comes on.

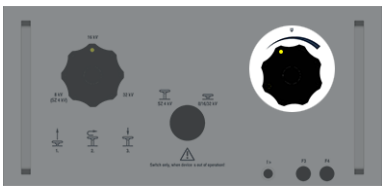
6. 

Set the *imp/min* selector switch to the = position (dc voltage).

7. 

Switch on the high voltage: To do this, press the | key.

The system status changes to the *In operation* operating state. The red indicator light and the | key light up.

8. 

Using the U rotary switch, increase the output voltage. When doing this, take into account the maximum permissible voltage for the cable.

9. **SA 32 SIM/MIM coupling unit**

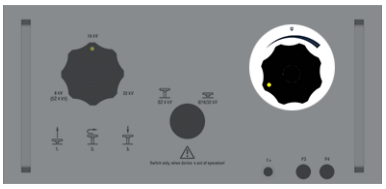
Observe the current indicator during the measurement.

10. **SSG surge voltage generator**

As soon as the current indicator deflects to the SA 32: read off the value displayed on the SSG voltage indicator. This is the breakdown voltage.

11. If no breakdown was achieved, increase the voltage (if permitted) and repeat the measurement.

End measurement or connect other phase

12.	**SSG surge voltage generator** 	Rotate the rotary switch all the way to the left.
13.		Press the key. The system changes to the safe *Ready for operation* operating state. The green indicator light comes on.
14.		To protect the system against restarting, press the emergency off button and remove the safety key.
15.	**SA 32 SIM/MIM coupling unit** 	Press in the drawbar (position: *SSG*).

DANGER

Dangerous voltage on the test object and other live plant parts. Danger to life, risk of injury from high electric voltage.

16.		Before touching the test object, discharge, earth and short it: at the connection point and at the far end. You may touch the plant parts that were under voltage only if they are visibly earthed and short-circuited.

11 CABLE AND CABLE SHEATH TESTING

11.1 About cable testing

During the cable testing, a voltage is applied between phase and screen for a specific period to test the insulation. The test is considered successful if no breakdown occurs.

The test duration and the voltage are defined by applicable standards based on the insulating material.

Note: The DC voltage is not suitable for cable testing of mixed, XLPE and PE insulated cables. On one hand, substantial faults are not detected with this testing technology. On the other hand, high DC voltage test levels can damage the dielectric.

11.2 About cable sheath testing

The cable sheath testing is used to look for outer cable damage (sheath faults) and is recommended for new systems, after repairs and for periodic checks.

While checking for mechanical faults, a DC voltage is applied between cable sheath and earth. According to DIN VDE 0276, PE sheaths are tested with DC voltage up to 5 kV and PVC sheaths with DC voltage up to 3 kV. If increased leakage current is measured during the test, the sheath could be damaged.

11.3 Performing a cable or cable sheath test

11.3.1 Safety instructions for performing a test

⚠ WARNING

Risk of arcing faults and noise that can damage hearing as a result of cable breakdown during testing.

Danger to life as a result of electric shock, burns, electro-ophthalmia, hearing damage.

- Use suitable personal protective equipment against electric shocks and arcing faults.
- Use ear protection.
- Keep a safe distance from the connection point of the test object according to the nominal voltage of the network.

NOTICE

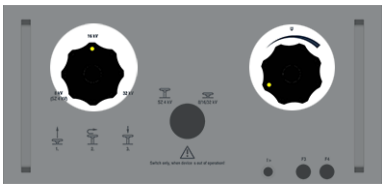
Erosion on short-circuit contacts inside the device caused by switching the operating mode under voltage

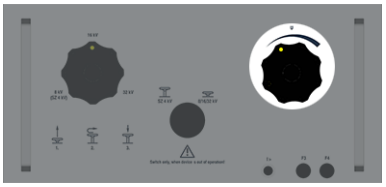
- Only switch the SSG surge voltage generator to DC voltage operation when it is in a de-energised state (Position: ⎓).

11.3.2 Prerequisites

- The test area is secured.
- The test object is connected properly.
  Further information: Chapter *Connecting the test object* (on page 43)
- The system is ready for operation.
  Further information: Chapter *Commissioning* (on page 52)
- The drawbars on the SA 32 SIM/MIM coupling unit are pushed in (position: *SSG*).

11.3.3 Procedure

1.	**SA 32 SIM/MIM coupling unit** 	Set the sensitivity selector switch of the current indicator to the desired position. **Recommendation:** *x100* position (highest setting)
2.		Pull out the *test*|*SSG* drawbar until it reaches the stop (position: *test*).
3.	**SSG surge voltage generator** 	Using the selector switch (left), choose a voltage range.
4.		Rotate the ⏚ rotary switch all the way to the left.
5.		Release the high voltage: To do this, press the ⏻ key. The system status changes to the *Ready to switch on* operating state. The red indicator light comes on.
6.		Set the *imp/min* selector switch to the ⎓ position (dc voltage).
7.		Switch on the high voltage: To do this, press the | key. The system status changes to the *In operation* operating state. The red indicator light and the | key light up. The cable test starts.

8. 

Using the rotary switch, increase the output voltage. When doing this, take into account the maximum permissible voltage for the cable.

9. **SA 32 SIM/MIM coupling unit**

SSG surge voltage generator

Observe the current and voltage indicators during the measurement.

Cable testing: The cable test is considered successful if the target voltage has been reached and no breakdown has occurred within the preset time.

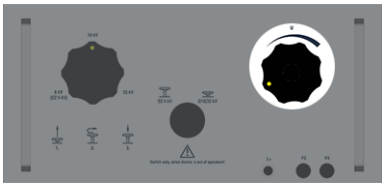
Cable sheath testing: The cable sheath test is considered successful if no breakdown takes place and the leakage current does not exceed the specified value. This defined value depends on the sheath material, cable length and number of joints.

10. If a breakdown occurs, end the cable test.

Note: After a breakdown, the surge voltage generator automatically switches to burn mode.

End test or connect other phase

11. **SSG surge voltage generator**



Rotate the rotary switch all the way to the left.

12. 

Press the key.

The system changes to the safe *Ready for operation* operating state. The green indicator light comes on.

13. 

To protect the system against restarting, press the emergency off button and remove the safety key.

14. **SA 32 SIM/MIM coupling unit**

Press in the drawbar (position: *SSG*).

DANGER

Dangerous voltage on the test object and other live plant parts. Danger to life, risk of injury from high electric voltage.

15. Before touching the test object, discharge, earth and short it: at the connection point and at the far end.

You may touch the plant parts that were under voltage only if they are visibly earthed and short-circuited.

12 CABLE FAULT PRE-LOCATION

12.1 Safety instructions for cable fault location

⚠ WARNING

Potential differences between the system and the earth possible

Danger to life or risk of injury due to electric shock.

If a cable fault is located near to the system, there may be potential differences between the system and the earth in surge mode.

- Place the system at a distance of several meters to the cable route or cable fault location.
- If operating in ‘surge mode’, cordon off the system at distance of at least 1.5 m.

  During surge mode, people may only stand outside the cordoned off area.
- Before starting surge mode, check the cable route for potential dangers.

NOTICE

Erosion on short-circuit contacts inside the device caused by switching the operating mode under voltage

- Only switch the SSG surge voltage generator to DC voltage operation when it is in a de-energised state (Position: ⎓).

12.2 TDR: Time Domain Reflectometry

12.2.1 About the TDR method

Areas of application

- To detect the cable length and to test the velocity of propagation
- To check if all phases are equal in length and if there is a cable break
- To detect joints and other impedance changes
- To compare healthy and faulty phases

Measurement principle

A transmitting pulse is fed into the cable. When the transmitting pulse reaches a position with impedance change (cable ends, faults or joints), a part of the pulse energy is reflected to the time domain reflectometer. These reflections are recorded and presented in a graph.

The amplitude of a reflection is determined by the extent of the impedance change, which is defined by the reflection factor *r*:

$$r = \frac{Z_2 - Z_1}{Z_2 + Z_1}$$

r Reflection factor

Z_1 Cable impedance up to impedance change

Z_2 Impedance of a change in the cable route (e.g. fault or joint)

If the impedance of a change Z_2 is greater than the cable impedance Z_1, the reflection factor is positive. In the reflection image, the open cable end is displayed by a positive reflection.

If the impedance of a change Z_2 is less than the cable impedance Z_1, the reflection factor is negative. In the reflection image, a short-circuit or a low-resistive fault is displayed by a negative reflection:

To determine the fault distance, the time gap between the transmitting pulse and the reflecting pulse is measured. The fault distance is calculated with the following formula.

$$l = t \times \frac{v}{2}$$

l Fault distance

t Time gap between the transmitting pulse and the reflecting pulse

v/2 Velocity of propagation

This formula shows that it is necessary to specify a correct velocity of propagation for precise determination of the fault distance. If the velocity of propagation is not known, it can be calculated with the cable length.

Note: Time Domain Reflectometry not is suitable for locating high-resistive cable faults, as they produce very minor or no impedance changes at the fault position.

12.2.2 Setting the measurement parameters

CABLE FAULT LOCATION > ***Pre-location***

1. In the method selection list, select the **TDR** method.
2. To open the ***Settings*** dialog, click on the  icon.

3. In the ***Settings*** dialog, select the ***Measurement parameters*** tab.
4. Set the measurement parameters.

   The defined parameters are automatically applied. The following table provides an overview of the parameters that you can define.

Measurement parameter	Setting	Function
Port	***TDR HV***	Is used for measurements with the HV connection cable
	TDR LV	Is used for measurements with the TDR connection cable (depending upon system configuration)
Measurement mode	***Automatic***	The measurement parameters are defined automatically by the software. The first measurement must always be performed in this mode; other measurement modes are not available. If a measurement was performed in the ***Automatic*** measurement mode, it is displayed with the icon in the list of completed measurements.
	Individual	The measurement parameters can be customised.
	Continuous	The measurement parameters can be customised. The measurement runs continuously. The measured values are recorded and overwritten permanently.
	Mean value calculation	The measurement parameters can be customised. The measurement runs continuously. The average of the measured values is calculated.
	Stop after change	The measurement parameters can be customised. The measurement runs continuously. If a fault is detected, the measurement is automatically aborted.
	Envelope mode	This mode is particularly suitable for locating intermittent faults. Faulty traces are recorded until the measurement is stopped manually. Each impedance change is automatically saved immediately; the recorded measurement data is displayed as an envelope curve. In this way, very minor changes also remain immediately and permanently visible.
Impedance	8 – 2,000 ohm	Is used to set the input impedance
Pretrigger	0.02 – 100 µs	Is used to set how many microseconds before the trigger the signal starts recording
Input signal gain	Dynamic range 107 dB (-63 to +44 dB)	Is used to set the input signal amplification
Pulse width	0.02 – 1,300 µs	Is used to set the pulse width The pulse width is set automatically depending on the measuring range. Narrow pulses have high resolution, however, they have a lower range due to the higher damping. They are especially suitable for shorter cables. When using wide pulses, the range increases and the resolution decreases.

Measurement parameter	Setting	Function
Pulse voltage	20 – 200 V	Is used to set the pulse voltage High pulses lead to magnified reflections. Consequently, the reflection images are easier to evaluate. However, if the pulse voltage is set too high, it can lead to overload. Moreover, in the case of pulses that have been set too high, signals, e.g. from joints, can be increased so much that they become difficult to differentiate from a fault reflection.
Voltage-proof input	Yes/No	Enables and disables the input protection of the installed time domain reflectometer If ***Yes*** is selected, the input protection is activated up to AC 400 V.

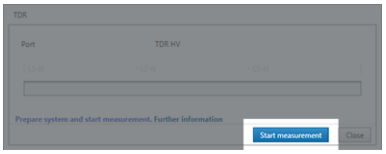
12.2.3 Performing the TDR measurement

Prerequisites

- The test area is secured.
- The test object is connected properly.
  Further information: Chapter *Connecting the test object* (on page 43)
- The system is ready for operation.
  Further information: Chapter *Commissioning* (on page 52)

Procedure

1.	**BAUR system software 4** 	Select ***CABLE FAULT LOCATION*** > ***Pre-location*** > ***TDR***.
2.		In the phase selector, select the combination(s) with which you are going to perform the measurement (phase - earth potential, phase - phase).
3.		Click on the ⚙ symbol and select the appropriate port: • ***TDR HV***, if you perform the measurement via the HV connection cable connected to the *low voltage* LV coaxial connection socket. • ***TDR LV***, if you perform the measurement via the TDR connection cable. Further information: Chapter *Setting the measurement parameters* (on page 89)

4.		Click the ***Start measurement*** button.
5.		In the ***Measurement*** dialog, select the ***Start measurement*** button. The measurement is performed. The traces are displayed. Cursors are set automatically at the measured cable end and at the cable fault if applicable.
End measurement or connect other phase		
6.		To protect the system against restarting, press the emergency off button and remove the safety key.

DANGER

Dangerous voltage on the test object and other live plant parts. Danger to life, risk of injury from high electric voltage.

7.		Before touching the test object, discharge, earth and short it: at the connection point and at the far end. You may touch the plant parts that were under voltage only if they are visibly earthed and short-circuited.

Next steps

- Evaluating the reflection image:
  - Chapter *Evaluating TDR reflection images* (on page 92)
  - Chapter *Evaluating reflection images* (on page 56)
- Adjusting the cable length and velocity of propagation: Chapter *Adjusting the cable length and velocity of propagation* (on page 94)
- Displaying possible joints: Chapter *Searching for joints* (on page 94)
- Inserting the reflection image into the report: Chapter *Inserting a reflection image into the report* (on page 102)

12.2.4 Evaluating TDR reflection images

The reflections can be divided into two groups:

- Normal reflections

  Even healthy phases can show reflections. These reflections are caused by inhomogeneities such as bends, connection points, meeting points of cable sections with different insulations or joints.

- Reflections caused by faults

  A faulty phase shows normal reflections as well as reflections caused by faults. Due to the damping losses in the cable, a fault that is far away reflects a smaller pulse than a fault that is close by.

  To differentiate normal reflections from reflections caused by faults, it is always recommended comparing the traces of a faulty and a healthy phase.

Typical traces:

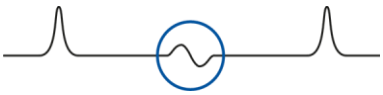
Open cable end

The reflection is a positively increasing pulse. There is no pulse from the far end.

If the positive reflection is displayed before the actual cable end, there could be a cable break or the cable length could be incorrect.

Short-circuit or low-resistive fault

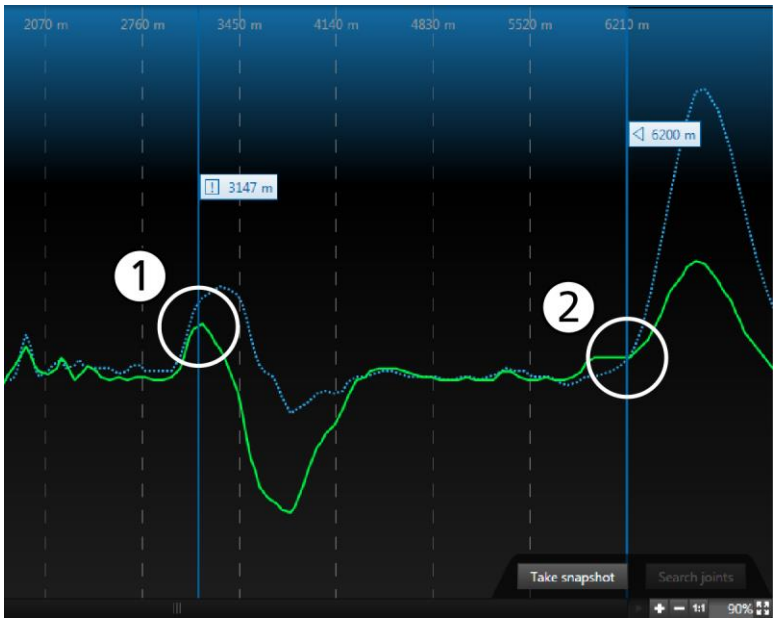
The reflection is a negatively decreasing pulse. There is no pulse from the far end.



Changes in cable type, joints (impedance changes)

The amplitude of the reflecting pulse depends on the extent of the impedance change. The joints generate s-shaped reflections.

Procedure during evaluation



1	Fault position (negative reflection)
2	Cable end (positive reflection)

1. If possible, compare the traces of a healthy and a faulty phase.
   The differences in the traces clearly indicate possible fault positions.
2. Double-click to set a cursor at the position where the two traces separate.
   If you are unable to compare traces of two phases, set the cursor at the position where the trace points downwards.
3. If required, adjust the position of the fault cursor. To do so, click on the flag of the fault cursor and hold down the mouse button to move the cursor to the desired position.
4. To confirm the fault position, right-click on the cursor flag and select the ***Confirm as fault position*** context menu item.
5. In the extended context menu, select the phase where the fault occurred.

The fault position is displayed in the reflection image and in the cable image. A tolerance range is displayed around the pre-located fault position and the fault can be located within this range.

The cursor is no longer displayed.

12.2.5 Adjusting the cable length and velocity of propagation

1. If the software detects a big positive reflection, it interprets this reflection as a cable end and automatically sets an appropriate cursor after the measurement. Check the cursor position.
2. If required, adjust the position of the cursor. To do this, click on the cursor flag and hold down the mouse button to move the cursor to the desired position.
3. You now have two options:

   - **Confirming the cursor position as the end of the cable route**

   a. Right-click on the cursor flag and select the ***Confirm as end of cable route*** context menu item.

   The ***Confirm as end of cable route*** dialog opens.

   b. Select whether the cable length or the velocity of propagation should be adjusted in the previous section and click the ***OK*** button.

   The selected parameter is modified.

   - **Confirming the cursor position as the fault position**

   If the positive reflection in the TDR reflection image clearly differs from the specified cable length, there could be a cable break.

   a. In this case, right-click on the cursor flag and select the ***Confirm as fault position*** context menu item.

   b. In the extended context menu, select the phase where the fault occurred.

   The fault position is displayed in the reflection image and in the cable image. A tolerance range is displayed around the pre-located fault position and the fault can be located within this range.

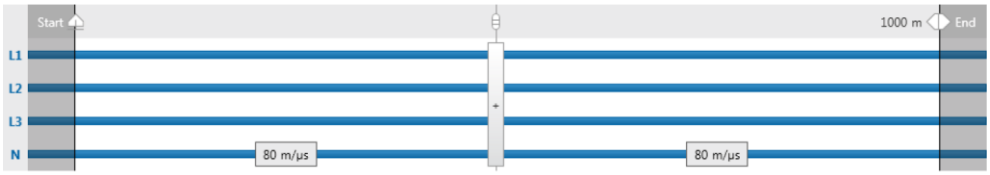
   The cursor is no longer displayed.

12.2.6 Searching for joints

1. In the list of completed measurements, enable the checkbox of a single trace.
2. In the reflection image, click the ***Search for joints*** button.

   Possible joint positions are displayed in the reflection image and in the cable image with dotted lines.
3. To decrease or increase the sensitivity of the joint search, move the slider to the left or right.
4. To confirm a joint, in the cable image, right-click on the dotted joint and select the ***Confirm joint*** context menu item.

   The joint is added to the cable route and is displayed in the cable image.



5. To move the joint, click on the joint and hold down the mouse button to drag it to the desired position.
6. To enter the joint properties, right-click on the joint and select the ***Properties...*** context menu item.

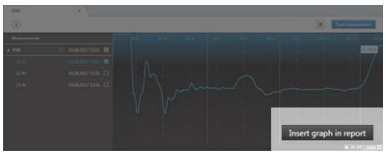
You can now enter the following joint properties:

- Identification number
- Position
- Year of installation
- Installation temperature
- Construction type
- Manufacturer
- Name of person who installed the joint
- Comments

7. To save the settings, click the ***OK*** button.

12.2.7 Inserting a reflection image into the report

1. If you want to insert the reflection image in the report, click the ***Insert graph in report*** button.



2. Enter a name for the graph and click the ***OK*** button.

12.3 SIM/MIM: Secondary-Multiple Impulse Method

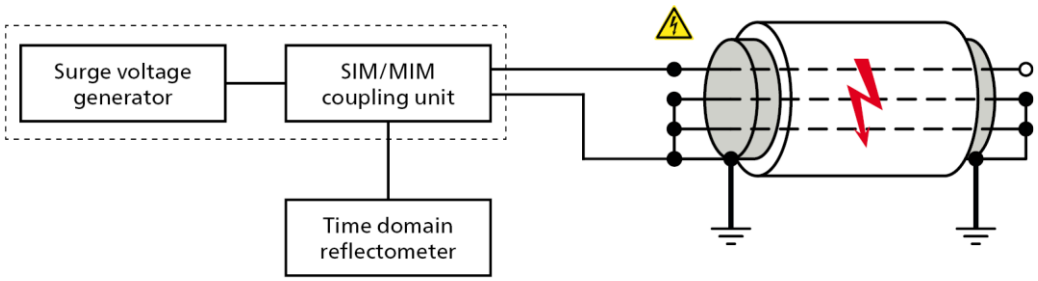
12.3.1 About the SIM/MIM method

The secondary-multiple impulse method (SIM/MIM) is the most well-established and precise pre-location method and in most cases, performs fast fault pre-location. It is used for pre-locating high-resistive faults.

The SIM/MIM method is based on the electric arc surge method. With this method, first a reflection image is recorded without a fault or with a high-resistive fault. As high-resistive faults result in very minor or no impedance changes at the fault position, no fault is visible on this reflection image. Therefore, it is also called “healthy trace”. Then, a HV surge pulse is fed into the defective cable (phase), which ignites an electric arc at the fault position and temporarily converts the fault into a low-resistive connection. Reflection measurements are taken at the precise moment of the ignition. To do this, multiple LV pulses are fed into the cable and are reflected negatively at the temporarily low-resistive fault location. The reflection image is displayed on screen without and with an electric arc. The fault position at the negative reflection is clearly visible by comparing the reflection images. The fault distance is calculated from the duration of the pulse and the velocity of propagation (v/2).

The breakdown time can be delayed or the duration of the breakdown can be shorter due to the varying properties of the cable fault. The multiple automatic reflection measurements ensure that the correct time at which the fault becomes low-resistive will be recorded.

Main circuit diagram



DC-SIM/MIM: secondary/multiple impulse method used in DC mode

The secondary-multiple impulse method in DC mode (DC-SIM/MIM) is recommended for the pre-location of high-resistive breakdown faults.

Unlike the usual SIM/MIM method, with the DC-SIM/MIM method, the cable is charged with DC voltage through the surge voltage generator (capacitor-supported) until a breakdown occurs at the fault position. In doing so, in a chargeable cable, the cable capacitance is used to charge the energy and to reach a more intensive breakdown. In this way, high-resistive faults with delayed ignition can be located reliably. Precisely at the time of the ignition, reflection measurements are completed. The reflection image is displayed on screen without and with an electric arc. The fault position on the negative reflection is clearly visible by comparing the reflection images. The fault distance is calculated from the duration of the pulse and the velocity of propagation (v/2).

The evaluation of the reflection images is performed exactly as in the SIM/MIM method.

12.3.2 Setting measurement parameters

CABLE FAULT LOCATION > ***Pre-location***

1. In the method selection list, select the ***SIM/MIM*** method.
2. To open the ***Settings*** dialog, click on the icon.
3. In the ***Settings*** dialog, select the ***Measurement parameters*** tab.
4. Set the measurement parameters.

   The defined parameters are automatically applied. The following table provides an overview of the parameters that you can define.

Measurement parameter	Setting	Function
Port	***SIM 1***	Is used by default for SIM/MIM measurements
	SIM 2	Is used if other surge voltage generators are available.
Measurement mode	***Automatic***	The measurement parameters are set automatically. Measurement sequence: A healthy trace is first created and the fault traces are then recorded. If a measurement was performed in the ***Automatic*** measurement mode, it is displayed with the icon in the list of completed measurements.

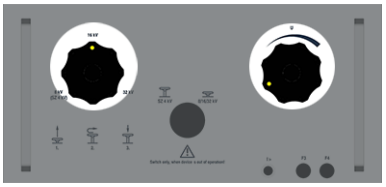
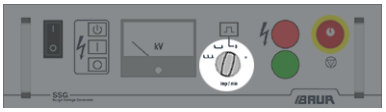
Measurement parameter	Setting	Function
	Individual	The measurement parameters can be customised.
	Continuous	A reference trace is recorded and then faulty traces are recorded until the measurement is stopped manually.
	Mean value calculation	A reference trace is recorded and then faulty traces are recorded until the measurement is stopped manually. The mean of measurement results is calculated continuously.
	Envelope mode	The measurement parameters can be customised. This mode is particularly suitable for locating intermittent faults. A healthy trace is recorded and then faulty traces are recorded until the measurement is stopped manually. Each impedance change is automatically saved immediately; the recorded measurement data is displayed as an envelope curve. In this way, very minor changes also remain immediately and permanently visible.
Impedance	8 – 2,000 ohm	Is used to set the input impedance
Pretrigger	0.02 – 100 µs	Is used to set how many microseconds before the trigger the signal starts recording
Trigger delay	100 – 650 µs	Is used to set the time between the trigger and the start of the measurement following the trigger
Input signal gain	Dynamic range 107 dB (-63 to +44 dB)	Is used to set the input signal amplification
Pulse width	0.02 – 1,300 µs	Is used to set the pulse width The pulse width is set automatically depending on the measuring range. Narrow pulses have high resolution, however, they have a lower range due to the higher damping. They are especially suitable for shorter cables. When using wide pulses, the range increases and the resolution decreases.
Pulse voltage	20 – 160 V	Is used to set the pulse voltage High pulses lead to magnified reflections. Consequently, the reflection images are easier to evaluate. However, if the pulse voltage is set too high, it can lead to overload. Moreover, in the case of pulses that have been set too high, signals, e.g. from joints, can be increased so much that they become difficult to differentiate from a fault reflection.
Number of pulses	1 – 20	Is used to set the number of faulty traces that are recorded
Pause between pulses	100 – 650 µs	Is used to set the time between two LV pulses

12.3.3 Performing the SIM/MIM measurement

Prerequisites

- The test area is secured.
- The test object is connected properly.
  Further information: Chapter *Connecting the test object* (on page 43)
- The system is ready for operation.
  Further information: Chapter *Commissioning* (on page 52)
- The drawbars on the SA 32 SIM/MIM coupling unit are pushed in (position: *SSG*).

Procedure

1.	**SA 32 SIM/MIM coupling unit** 	Pull out the *SA 32*|*SSG* drawbar until it reaches the stop (position: *SA 32*). The *SIM* indicator light comes on. The fan can be heard.
2.	**SSG surge voltage generator**	Using the selector switch (left), choose a voltage range.
3.		Rotate the ⏚ rotary switch all the way to the left.
4.		Release the high voltage: To do this, press the ⏻ key. The system status changes to the *Ready to switch on* operating state. The red indicator light comes on.
5.		Set the *imp/min* selector switch to the 0 position (single surge).
6.		Switch on the high voltage: To do this, press the | key. The system status changes to the *In operation* operating state. The red indicator light and the | key light up.
7.	**BAUR system software 4** 	Select ***CABLE FAULT LOCATION*** > ***Pre-location*** > ***SIM/MIM***.
8.		In the phase selector, click on the phase on which you are performing the measurement.

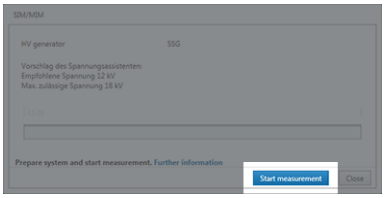
9. 

If you want to change the measurement parameters, click on the ⚙ symbol.

Further information: Chapter *Setting measurement parameters* (on page 96)

10. 

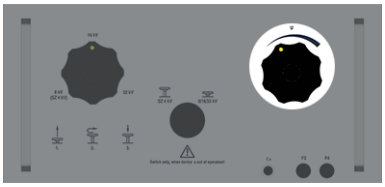
Click the ***Start measurement*** button.

11. 

In the ***Measurement*** dialog, select the ***Start measurement*** button.

The measurement is performed. The healthy trace is displayed. The ***Waiting for breakdown*** message is displayed.

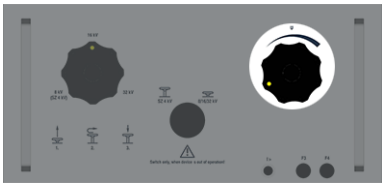
12. **SSG surge voltage generator**



Set the surge voltage to 20-30% higher than the breakdown voltage using the U rotary switch.

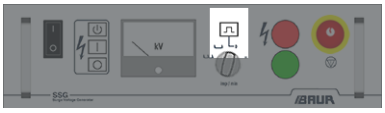
Further information: Chapter *Performing measurements for breakdown voltage determination* (on page 81)

The capacitors in the surge voltage generator are charged up; you can read off the actual voltage on the voltage indicator.

13. 

When the desired target voltage has been reached, turn the U rotary switch for the output voltage all the way to the left.

The capacitors are charged and ready to emit the voltage.

14. 

Release a single surge: To do this, press the ⎍ key.

The time domain reflectometer automatically performs further measurements. The traces are displayed in the BAUR system software. Cursors are set automatically at the measured cable end and at the cable fault if applicable.

End measurement or connect other phase

15. **SSG surge voltage generator**

Press the ○ key.

The system changes to the safe *Ready for operation* operating state. The green indicator light comes on.

16. 

To protect the system against restarting, press the emergency off button and remove the safety key.

17.	**SA 32 SIM/MIM coupling unit** 	Press in the drawbar (position: *SSG*). The *SIM* indicator light goes out.

DANGER

Dangerous voltage on the test object and other live plant parts. Danger to life, risk of injury from high electric voltage.

18.		Before touching the test object, discharge, earth and short it: at the connection point and at the far end. You may touch the plant parts that were under voltage only if they are visibly earthed and short-circuited.

For measurements with DC voltage (DC-SIM/MIM)

For DC-SIM/MIM measurements, adjust the settings on the surge voltage generator as follows:

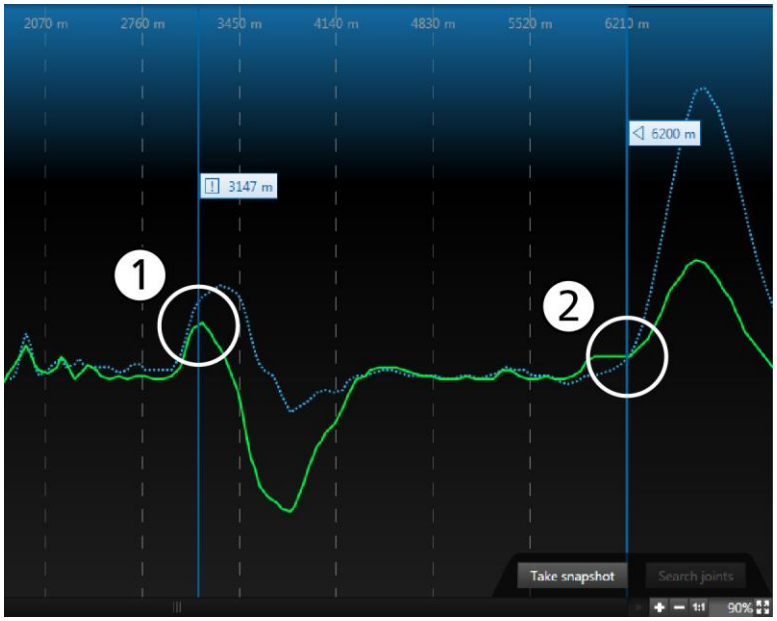
- Set the *imp/min* selector switch to the ⎓ position (dc voltage).
- Using the U rotary switch, increase the output voltage until the metallic noise of a breakdown can be heard.

Next steps

- Evaluating reflection images:
  - Chapter *Evaluating SIM/MIM reflection images* (on page 100)
  - Chapter *Evaluating reflection images* (on page 56)
- Displaying possible joints: Chapter *Searching for joints* (on page 102)
- Inserting the reflection image into the report: Chapter *Inserting a reflection image into the report* (on page 102)

12.3.4 Evaluating SIM/MIM reflection images

The healthy trace and the first trace of the ignited fault are displayed in the reflection image. The fault cursor is set automatically after the measurement.



1 Fault position (negative reflection)
2 Cable end (positive reflection)

1. Compare both traces. A negative reflection is visible at the fault position. The two traces split at this point.

   To display other traces, in the list of completed measurements, enable the checkbox of the respective trace.
2. If required, adjust the position of the fault cursor. To do so, click on the flag of the fault cursor and hold down the mouse button to move the cursor to the desired position.
3. To confirm the fault position, right-click on the cursor flag and select the ***Confirm as fault position*** context menu item.
4. In the extended context menu, select the phase where the fault occurred.

   The fault position is displayed in the reflection image and in the cable image. A tolerance range is displayed around the pre-located fault position and the fault can be located within this range.

   The cursor is no longer displayed.

Notes

- If the fault position is not properly visible in the reflection image, repeat the measurement at increased voltage (if permitted).

  Further information: Chapter *Performing the SIM/MIM measurement* (on page 98)

If the fault position is still not properly visible:

- Measure the insulation resistance again.

  The faulty trace may have changed due to the applied high voltage. After about three measurements, it is recommended measuring the insulation resistance again.

  Further information: Chapter *Performing an insulation resistance measurement* (on page 78)

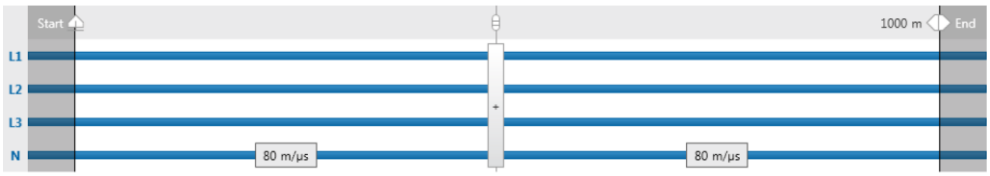
Further information on evaluating the reflection image and using the cursor: Chapter *Evaluating reflection images* (on page 56)

12.3.5 Searching for joints

1. In the list of completed measurements, enable the checkbox of a single trace.
2. In the reflection image, click the ***Search for joints*** button.

   Possible joint positions are displayed in the reflection image and in the cable image with dotted lines.
3. To decrease or increase the sensitivity of the joint search, move the slider to the left or right.
4. To confirm a joint, in the cable image, right-click on the dotted joint and select the ***Confirm joint*** context menu item.

   The joint is added to the cable route and is displayed in the cable image.



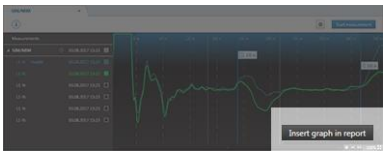
5. To move the joint, click on the joint and hold down the mouse button to drag it to the desired position.
6. To enter the joint properties, right-click on the joint and select the ***Properties...*** context menu item.

   You can now enter the following joint properties:

   - Identification number
   - Position
   - Year of installation
   - Installation temperature
   - Construction type
   - Manufacturer
   - Name of person who installed the joint
   - Comments
7. To save the settings, click the ***OK*** button.

12.3.6 Inserting a reflection image into the report

1. If you want to insert the reflection image in the report, click the ***Insert graph in report*** button.



2. Enter a name for the graph and click the ***OK*** button.

12.4 ICM: Impulse current method

12.4.1 About the ICM method

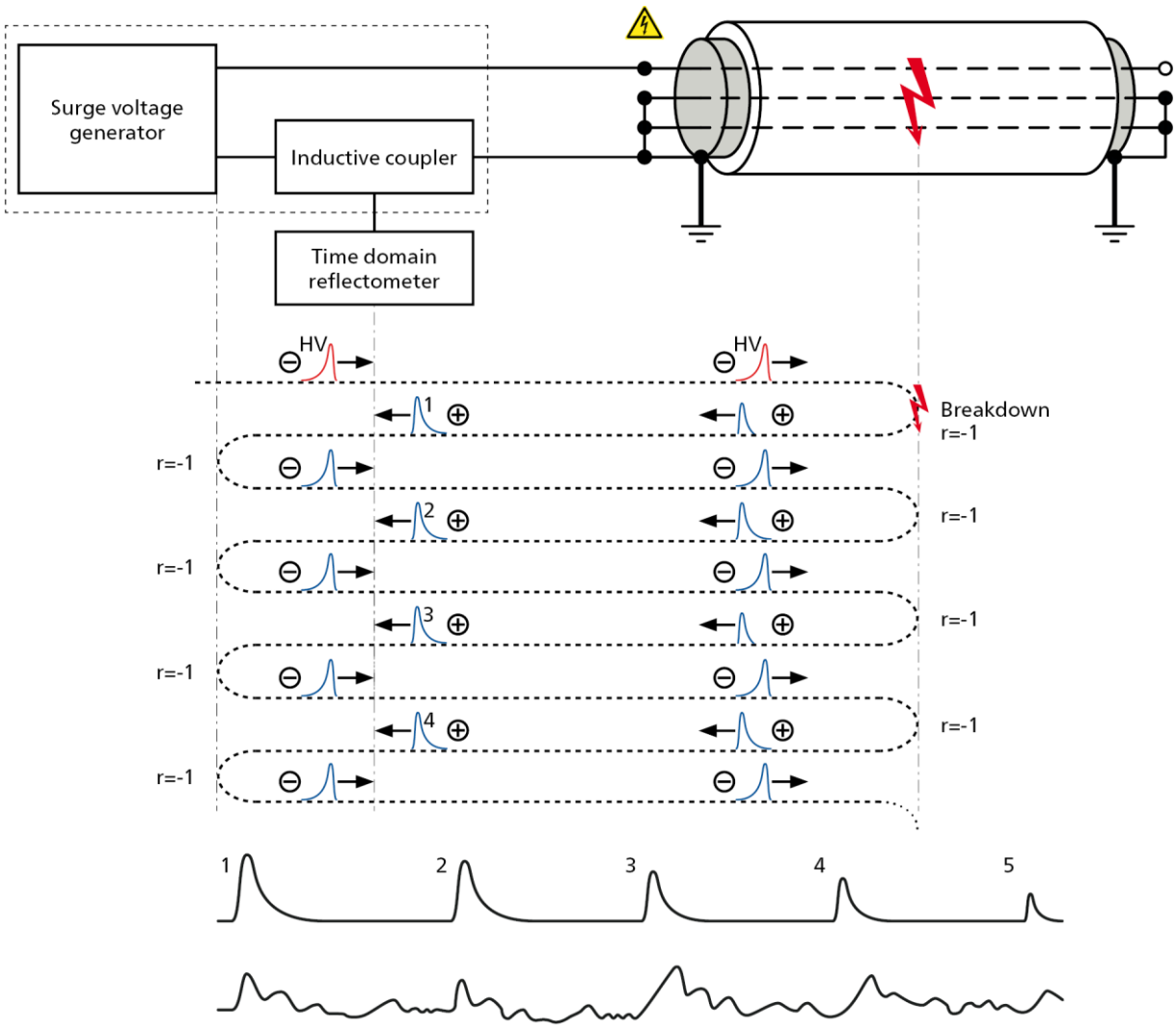
The impulse current method (ICM) is suitable for pre-location of the following cable faults:

- high-resistive faults
- wet faults

- faults in long cables
- faults that cannot be located with the Time Domain Reflectometry due to high pulse damping

A breakdown is generated at the fault through a HV surge pulse. The breakdown produces a travelling wave that drifts between the connection point of the surge voltage generator and the fault with alternating polarity. The current ratio of this transient wave is evaluated and the time interval between the periodically recurring reflections is measured. The distance of the fault position from the connection point is calculated from the measured time and the velocity of propagation in the cable.

Main circuit diagram

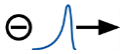


HV surge pulse of the surge voltage generator that is fed into the test object and that generates a breakdown at the fault.

This breakdown produces a transient wave that spreads to the test object.

Transient wave that is reflected from the fault to the connection point of the surge voltage generator.

As the continuous electric arc produced by the breakdown is low-resistive, the polarity of the transient wave is reversed each time.



Transient wave that is reflected from the connection point of the surge voltage generator.

As the connection point is low-resistive, the polarity of the transient wave is reversed each time.

1, 2, 3 ... Reflection period number

r Reflection factor

12.4.2 Setting measurement parameters

CABLE FAULT LOCATION > ***Pre-location***

1. In the method selection list, select the ICM method.
2. To open the ***Settings*** dialog, click on the  icon.
3. In the ***Settings*** dialog, select the ***Measurement parameters*** tab.
4. Set the measurement parameters for the ICM measurement.
   The defined parameters are automatically applied.
   The following table provides an overview of the parameters that you can define.

Measurement parameter	Setting	Function
Port	***SK 1D***	The ICM measurement is only performed via the ***SK 1D*** port (inductive coupling). There are no other settings.
Measurement mode	***Automatic***	The measurement parameters are defined automatically by the software. The first measurement must always be performed in this mode; other measurement modes are not available. If a measurement was performed in the ***Automatic*** measurement mode, it is displayed with the  icon in the list of completed measurements.
	Individual	The measurement parameters can be customised.
Pretrigger	0.02 – 100 µs	Is used to set how many microseconds before the trigger the signal starts recording
Input signal gain	Dynamic range 107 dB (-77 to +30 dB)	Is used to set the input signal amplification

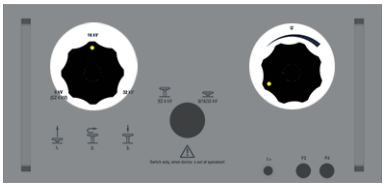
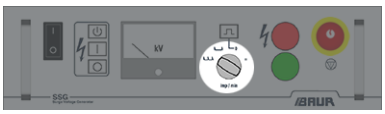
12.4.3 Performing ICM measurements

Prerequisites

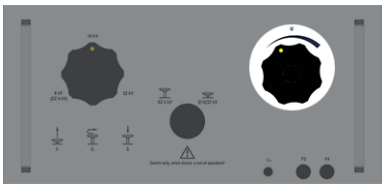
- The test area is secured.
- The test object is connected properly.
  Further information: Chapter *Connecting the test object* (on page 43)
- The system is ready for operation.
  Further information: Chapter *Commissioning* (on page 52)

- The drawbars on the SA 32 SIM/MIM coupling unit are pushed in (position: *SSG*).

Procedure

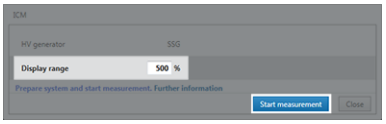
1.	**SSG surge voltage generator**	Using the selector switch (left), choose a voltage range.
2.		Rotate the rotary switch all the way to the left.
3.		Release the high voltage: To do this, press the key. The system status changes to the *Ready to switch on* operating state. The red indicator light comes on.
4.		Using the *imp/min* selector switch, select the desired surge sequence: : slow surge sequence : rapid surge sequence **Note:** The number of surges emitted per minute for a slow or rapid surge sequence depends upon the surge voltage generator. Further information: Chapter *SSG surge voltage generator* (on page 24)
5.		Switch on the high voltage: To do this, press the key. The system status changes to the *In operation* operating state. The red indicator light and the key light up.
6.	**BAUR system software 4** 	Select ***CABLE FAULT LOCATION*** > ***Pre-location*** > ***ICM***.
7.		In the phase selector, click on the phase on which you are performing the measurement.
8.		If you want to change the measurement parameters, click on the symbol. Further information: Chapter *Setting measurement parameters* (on page 104)
9.		Click the ***Start measurement*** button.

10. **SSG surge voltage generator**



Using the U rotary switch, increase the output voltage until the metallic noise of a breakdown can be heard.

11. **BAUR system software 4**



If necessary, change the display range in relation to the cable length in the ***Measurement*** dialog.

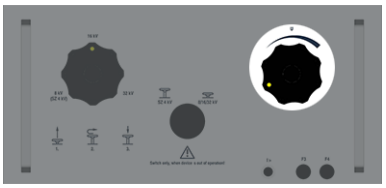
To ensure that many reflection periods can be presented for a better evaluation, enter at least 300% to 500%. The display range will show the three-fold or five-fold cable length.

12. Click the ***Start measurement*** button.

The measurement is performed. The transient image is displayed.

End measurement or connect other phase

13. **SSG surge voltage generator**



Rotate the U rotary switch all the way to the left.

Press the ○ key.

The system changes to the safe *Ready for operation* operating state. The green indicator light comes on.

14. 

To protect the system against restarting, press the emergency off button and remove the safety key.

⚠DANGER

Dangerous voltage on the test object and other live plant parts. Danger to life, risk of injury from high electric voltage.

15. Before touching the test object, discharge, earth and short it: at the connection point and at the far end.

You may touch the plant parts that were under voltage only if they are visibly earthed and short-circuited.

Next steps

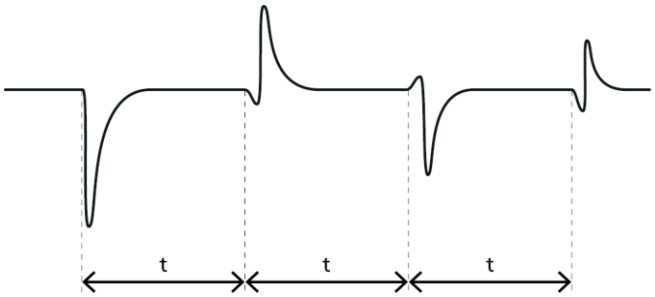
- Evaluating the transient image:
  - Chapter *Evaluating the ICM transient image* (on page 107)
  - Chapter *Evaluating reflection images* (on page 56)
- Inserting the transient image into the report: Chapter *Inserting a transient image into the report* (on page 109)

12.4.4 Evaluating the ICM transient image

Typical ICM traces are shown below.

Fault is not ignited

If the fault is not ignited, the transient wave is reflected from the open cable end with opposite polarity.



t Pulse duration

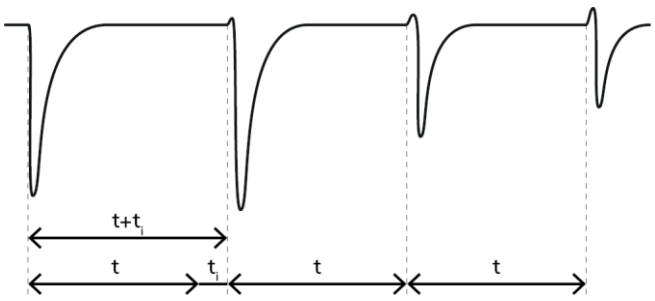
Transient image after a breakdown

The breakdown produces a travelling wave at the fault that drifts between the connection point of the surge voltage generator and the fault with alternating polarity. The current part of the transient wave is recorded through an inductive coupling and displayed with the help of the time domain reflectometer. The time gap between the periodically repetitive transients is used to calculate the fault distance to the connection point.

The first reflection contains an ignition lag (t_i), i.e. the ionization time of the charger carrier before a breakdown. Therefore, the second or third reflection period is included for the evaluation. Subsequent periods are weakened by multiple reflections and can distort the measurement result.

It can also happen that the impulse current does not generate a breakdown when the fault occurs for the first time and is reflected back with same polarity in the direction of the fault from the cable end. This doubles the applied voltage and leads to breakdown on the second occurrence of the fault.

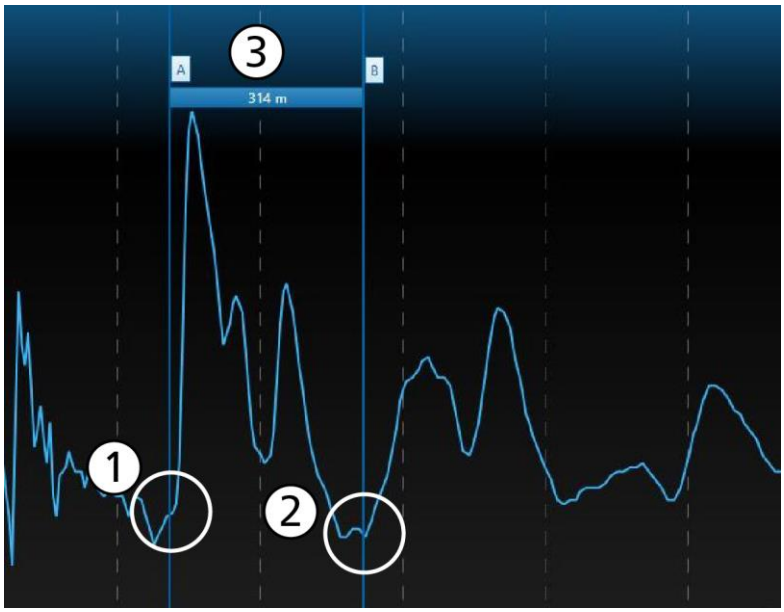
As each impedance change, such as joint or connection point, triggers reflections, they must be considered during the evaluation. This can make it difficult to evaluate a transient image in a branched cable.



t Pulse duration

t_i Ignition lag time in the first reflection period (ionization time)

Procedure



1. You can insert a horizontal auxiliary guide line to precisely position the cursors used for calculating the fault distance. To do this, right-click in the transient image and select the ***Add horizontal line*** context menu item.
2. To move the line, click on the line and hold down the mouse button to drag it to the desired position.
3. Double-click in the transient image at the beginning of a reflection period.

   A cursor is added (1).

   Note: Do not use the first reflection period for the evaluation, as it is distorted by the ignition lag.
4. Double-click in the transient image at the end of this reflection period.

   A second cursor is added (2).
5. If required, adjust the position of the cursor. To do this, click on the cursor flag and hold down the mouse button to move the cursor to the desired position.
6. Right-click on the cursor flag of the first cursor and select the ***Select reference cursor*** context menu item.
7. In the list, select the reference cursor that you set at the end of the reflection period.

   A bar (3) with the fault distance is displayed between the two cursors.

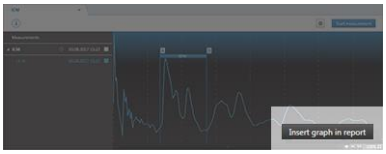
   The fault distance is produced from the distance between the two cursors minus the test lead length.
8. To confirm the fault distance as the fault position, right-click on the blue bar and select the ***Confirm as fault position*** context menu item.

   The fault position is displayed in the cable image. A tolerance range is displayed around the pre-located fault position and the fault can be located within this range. The faulty phase is also indicated by a fault symbol.

Recommendation: If the reflection periods are not clear, increase the voltage (if permitted) and repeat the measurement.

12.4.5 Inserting a transient image into the report

1. If you want to insert the transient image in the report, click the ***Insert graph in report*** button.



2. Enter a name for the graph and click the ***OK*** button.

13 CABLE FAULT PIN-POINTING

With cable fault pin-pointing, the fault is located and marked precisely on the cable route.

- Always begin the cable fault pin-pointing with a visual inspection.

  This will help you determine if the fault is due to visible external reasons, e.g. construction measures, and subsequently help you locate the fault quickly.

You need additional devices to pin-point the cable fault. Once you have determined the precise location of the fault, you can enter the fault position in the BAUR GeoBase Map and insert the map section into the report. Further information: Chapter *Inserting a map section with fault position into the report* (on page 113)

13.1 Acoustic pin-pointing

13.1.1 About acoustic pin-pointing

Acoustic pin-pointing is suitable for pin-pointing high-resistive cable faults and cable and phase breaks in buried cables and cable systems. The prerequisite for applying this method is that a breakdown must take place at the fault.

Surge voltage pulses are fed into the faulty phases of the cable, which lead to breakdowns at the fault. The breakdowns result in an acoustic and magnetic signal. During acoustic pin-pointing, a ground microphone is used to look for the location where the breakdown noise is loudest. The breakdown noise can be best heard directly over the fault.

13.1.2 Performing acoustic pin-pointing

Safety instructions for the system's surge mode

⚠ WARNING

Potential differences between the system and the earth possible

Danger to life or risk of injury due to electric shock.

If a cable fault is located near to the system, there may be potential differences between the system and the earth in surge mode.

- Place the system at a distance of several meters to the cable route or cable fault location.
- If operating in 'surge mode', cordon off the system at distance of at least 1.5 m.

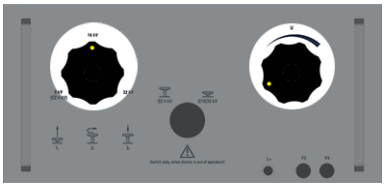
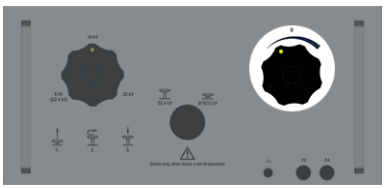
  During surge mode, people may only stand outside the cordoned off area.
- Before starting surge mode, check the cable route for potential dangers.

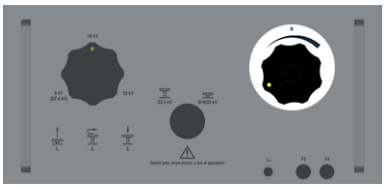
Prerequisites

- The test area is secured.
- The test object is connected properly.
  Further information: Chapter *Connecting the test object* (on page 43)
- The drawbars on the SA 32 SIM/MIM coupling unit are pushed in (position: *SSG*).
- Required equipment: signal receiver, ground microphone

▸ Follow the user manuals for the devices you are using for cable fault pin-pointing.

Procedure

1.	**SSG surge voltage generator**	Using the selector switch (left), choose a voltage range.
2.		Rotate the rotary switch all the way to the left.
3.		Release the high voltage: To do this, press the key. The system status changes to the *Ready to switch on* operating state. The red indicator light comes on.
4.		Using the *imp/min* selector switch, select the desired surge sequence: : slow surge sequence : rapid surge sequence **Note:** The number of surges emitted per minute for a slow or rapid surge sequence depends upon the surge voltage generator. Further information: Chapter *SSG surge voltage generator* (on page 24)
5.		Switch on the high voltage: To do this, press the key. The system status changes to the *In operation* operating state. The red indicator light and the key light up.
6.		Using the rotary switch, increase the output voltage until the metallic noise of a breakdown can be heard.
7.		Connect the signal receiver to the ground microphone.

8.		Locate the cable fault with the signal receiver and the ground microphone. If the breakdown noise can be heard clearly, use the acoustic signal to guide yourself during the pin-pointing. If the conditions are not suitable for a pure acoustic pin-pointing, you can also measure the magnetic signal.
End measurement or connect other phase		
9.	**SSG surge voltage generator** 	Rotate the U rotary switch all the way to the left.
10.		Press the ○ key. The system changes to the safe *Ready for operation* operating state. The green indicator light comes on.
11.		To protect the system against restarting, press the emergency off button and remove the safety key.

⚠DANGER

Dangerous voltage on the test object and other live plant parts. Danger to life, risk of injury from high electric voltage.

12.		Before touching the test object, discharge, earth and short it: at the connection point and at the far end. You may touch the plant parts that were under voltage only if they are visibly earthed and short-circuited.

Next step:

Inserting a map section with fault position into the report: Chapter *Inserting a map section with fault position into the report* (on page 113)

13.2 Inserting a map section with fault position into the report

Prerequisites

- The BAUR GeoBase Map is available.
- A cable route is selected and its path marked on the BAUR GeoBase Map.

Procedure

1. Once you have pin-pointed the fault, correct the fault position in the BAUR system software if necessary: To do this, right-click on the fault position in the cable image and select the context menu item ***Properties...***.
2. Enter the correct fault position and click the ***OK*** button.
3. To insert the map section with the fault position into the report, click the ***Insert graph in report*** button.
4. Enter a name for the graph and click the ***OK*** button.

14 REPORT PREPARATION

14.1 Creating reports

You can create a report immediately after completing the cable fault location or later.

Prerequisite

A cable route is selected.

Procedure

1. Select the ***CABLE FAULT LOCATION*** tab.
2. If required, create snapshots of the measurement results in the ***Fault analysis***, ***Pre-location*** or ***Pin-pointing*** tabs and insert these graphs in the report.
3. Select the ***Report*** tab.

   The preview displays the report for the selected cable route. The report contains cable data of the selected cable route and graphs of the measurement results, if any.
4. If you want to show or hide existing graphs, in the graphs list, enable or disable the checkbox of the respective graph.
5. If required, set up the report header.

   Further information: Chapter *Setting up headers for reports* (on page 114)
6. To enter additional information on the entire report or on a graph, click in the ***Enter comment*** input field and enter the information.
7. Click the ***Save*** button.
8. To save the report under a different name, enter a name in the ***Report name*** input field.
9. Click the ***OK*** button.

   The report is created with the relevant settings, saved with the cable route and displayed in the Dashboard in the ***LATEST REPORTS*** area.

   Note: You cannot modify or delete a saved report.
10. To prepare another report for this cable route, click the ***New*** button.

14.2 Setting up headers for reports

1. In the dashboard, select the ***CABLE FAULT LOCATION*** tab and then the ***Report*** tab.
2. To open the ***Settings*** dialog, click on the  icon.

   All settings that you make will apply for the report header.
3. If required, enter an address in the ***Address*** input field.
4. To set the address orientation, select one of the ***Text alignment*** radio buttons.
5. Click the ***Select logo*** button to display a logo in the header.
6. In the ***Select image*** dialog, in the ***File type*** selection list, select the file type and the folder where the image is located.
7. Click the image you want.
8. Click the ***OK*** button.

   The image is applied and displayed as a logo in the report header.

14.3 Exporting reports

1. Open a saved report.

   Further information: Chapter *Opening reports* (on page 115)

   Alternately, you can directly export a report after the cable fault location by changing to the ***Report*** tab and carrying out the other steps described here.
2. If required, set up the report header.

   Further information: Chapter *Setting up headers for reports* (on page 114)
3. Click the ***Export*** button.
4. In the ***File system*** list, select the folder where you want to export the report.
5. To create a new folder, enter a name in the ***New folder*** input field and click the ***New folder*** button.
6. To save the report under a different name, enter a name in the ***File name*** input field.

   Note: The file name must not contain the following characters: \ / : * ? "< > |
7. Click the ***OK*** button.

   The report is saved in PDF format in the selected folder.

14.4 Opening reports

- In the Dashboard, double-click on the report you want in the ***LATEST REPORTS*** area.

If several reports were created for several cable routes, the list of last reports can be very long. In such cases, you can open the report in another way. Proceed as follows:

1. In the Dashboard, in the ***CABLE ROUTES*** area, select the cable route for which you want to open the report.
2. Select the ***CABLE FAULT LOCATION*** tab and then the ***Report*** tab.
3. Click the ***Load*** button.
4. In the reports list, click on the report you want.
5. Click the ***OK*** button.

15 FINISHING A MEASUREMENT

15.1 Safety instructions for decommissioning

DANGER

Dangerous voltage in test object.

Danger to life or risk of injury due to electric shock.

- **Before touching, discharge, earth and short-circuit:** The test object at the connection point and at the far end.
- You may touch the parts that were under voltage only if they are visibly earthed and short-circuited.
- Disconnect the earth connections as the last connection of the test setup.
- Never disconnect the earth connections as long as power and other periphery connections are still connected.

15.2 Taking the system and the test area out of operation

Prerequisites

- The system is in the *Ready for operation* operating state.
  Further information: Chapter *"Ready for operation" operating state* (on page 33)
- The test object is discharged, grounded and short-circuited.
  Further information: Chapter *Discharging and earthing the test object* (on page 118)

Procedure

WARNING

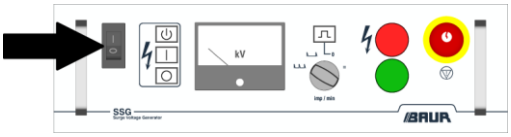
High electrical voltage

Electric shock on touching live and active parts and due to residual charges if earthing is removed too early

- Disconnect the earth connections as the last connection of the test setup.
- Never disconnect the earth connections as long as power and other periphery connections are still connected.

NOTICE
Data loss as a result of incorrect switching off sequence for systems with UPS
▸ Shut down the PC and only then switch off the uninterrupted power supply (UPS).

1. Switch the system off on the surge voltage generator with the On/Off switch.



2. Press the emergency off button on the surge voltage generator and remove the safety key from the emergency off button.
3. Close the BAUR system software and shut down the PC:
   a. In the ***File*** menu, click on the ***Exit*** menu item to exit the BAUR system software.
   Alternately, click on the cross on the top right.
   b. Shut down the PC.
   The IRG time domain reflectometer is switched off.
   The UPS (if present) remains switched on.
   c. Systems with UPS: switch off the UPS. To do this, press the UPS key next to the PC monitor.
4. To disconnect the system completely from the supply voltage, pull out the mains plug.
5. Disconnect the connection cables in the reverse order from the order in which they were connected.
   Important: Finally, disconnect the earth cable last.
6. Clean the connection cables.
7. Wind up the connection cables onto the cable drum or clear them away.
8. Further information: Chapter *Unwinding and winding up the connection cables* (on page 38)
9. If necessary, remove the cordoning.
10. Remove the earthing and the short-circuit on the test object only if no subsequent work is required and if the test object is to be put back into operation by the responsible individuals.
11. Remove the barriers and marking of the test area.

15.3 Exiting the measurement with the emergency off button during emergencies

▸ Press the emergency off button on the SSG surge voltage generator.

- The SSG is switched off.

- The SSG and the test object are discharged and short-circuited against the protective earth.

  Note: The test object is not automatically disconnected from the SSG. You must disconnect the test object from the SSG yourself.
- The system status changes to the *Ready for operation* operating state and the green indicator light on the SSG illuminates.
- No measurement can be performed as long as the emergency off button is pressed.

15.4 Discharging and earthing the test object

DANGER

Dangerous voltage in test object.

Danger of electric shock or risk of injury

- **Before touching, discharge, earth and short-circuit:** The test object at the connection point and at the far end.
- You may touch the plant parts that were under voltage only if they are visibly earthed and short-circuited.
- Connect the discharge and earth rod correctly to the station earth.
- Only use the discharge and earth rod if its surface is clean and dry.
- Hold the discharge and earth rod only at the handles!
- Observe the minimum discharge period in accordance with the capacitance of the test object.

15.4.1 Discharging

DANGER

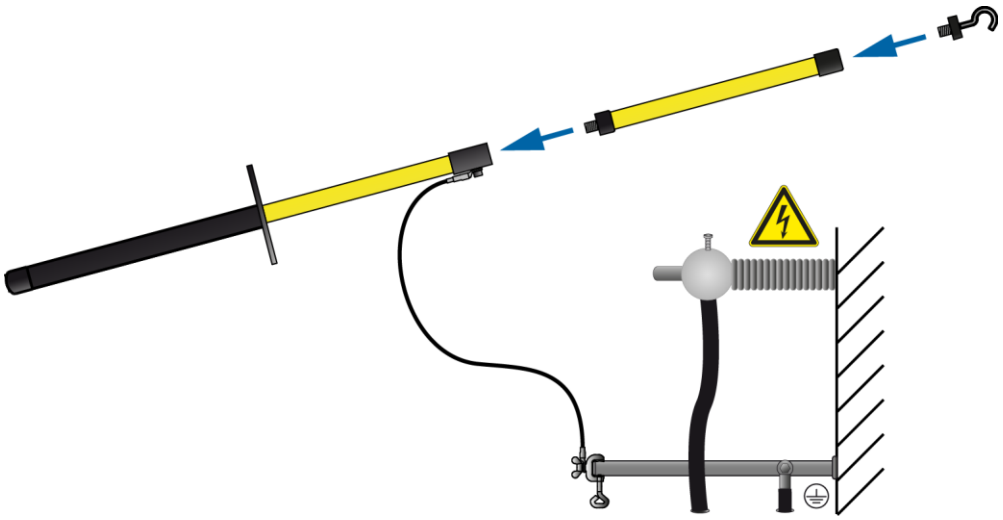
Dangerous voltage in test object

Danger to life or risk of injury due to electric shock or electric arcs.

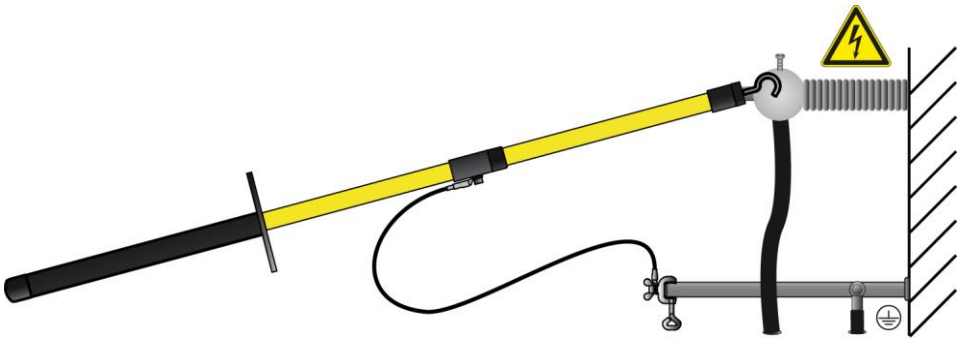
- Use suitable personal protective equipment against electric shocks and arcing faults.
- Keep a distance of at least 50 cm from the protective earthing cable of the discharge and earth rod.

1. If not yet connected, connect the earth cable of the protective earthing cable of the discharge and earth rod to the station earth.
2. Assemble the discharge rod:
   a. Screw the hook onto the discharge part.

b. Screw the discharge part onto the handle.



3. Use the black handle to hold the discharge and earth rod and make contact with the test object by touching it with the tip of the discharge and earth rod.



4. Observe the minimum discharge period in accordance with the capacitance of the test object.

15.4.2 Earthing

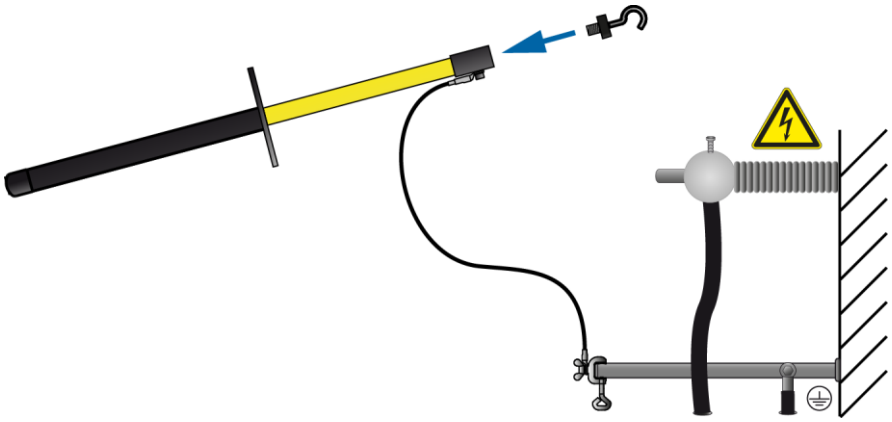
DANGER

Dangerous voltage in test object

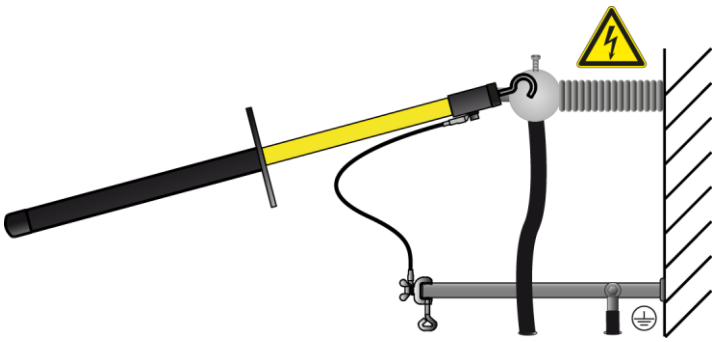
Danger to life or risk of injury due to electric shock or electric arcs.

- Use suitable personal protective equipment against electric shocks and arcing faults.
- Keep a distance of at least 50 cm from the protective earthing cable of the discharge and earth rod.

1. If not yet connected, connect the earth cable of the protective earthing cable of the discharge and earth rod to the station earth.
2. Assemble the earth rod: Screw the hook into the handle.



3. Contact the test object with the tip of the earth rod.



4. Immediately after earthing, connect the earthing and short-circuit equipment to the test object.

16 MAINTENANCE AND CARE

16.1 Safety instructions

⚠ WARNING

Dangerous voltage in system components and adjoining live plant parts

Danger to life, risk of injury due to electric shock.

- You may touch the live plant parts and connection fittings that were under voltage only after they have been discharged and earthed.
- Cover the live plant parts properly.

⚠ WARNING

Easily accessible live parts

Danger to life, risk of injury due to electric shock.

Once the system has been opened, live parts will be accessible. The surge voltage generator integrated within the system has a capacitor comprising two separate sub-capacitors. These sub-capacitors can still hold a residual charge, even when switched off.

- Never take the system apart. Inside the device there are no components that could be serviced or repaired by the user.
- Maintenance and repair work must only be carried out by personnel trained and authorised by BAUR.

Establishing and ensuring voltage-free state

1. Switch off the system before starting any maintenance and cleaning tasks.
2. To disconnect the system completely from the power supply, pull out the mains plug.
3. To protect the system against restarting, press the emergency off button on the surge voltage generator and remove the safety key from the emergency off button.
4. Use safety signs to secure the work area.

16.2 Maintenance schedule

Interval	Task

Interval	Task
After each use	▸ Check and clean the connection cables and the connection accessories. Further information: Chapter *Checking and cleaning the connection cables and accessories* (on page 125)
Monthly	▸ Check the condition of all connection cables. Further information: Chapter *Checking and cleaning the connection cables and accessories* (on page 125)
Every 12 months (with frequent use, every 6 months or as required)	▸ Check the discharging resistance of the discharge unit. Further information: Chapter *Testing the discharge unit* (on page 125)
Every 12 months (with frequent use, every 6 months or as required)	▸ Check the ignition voltage of the spark gap. Further information: Chapter *Checking the ignition voltage of the spark gap* (on page 122)
Every 12 months (or as required depending on the conditions of use)	▸ Clean the HV components inside the system. For this purpose, contact BAUR GmbH or your nearest BAUR representative (http://www.baur.eu/baur-worldwide).
As required depending on the conditions of use	▸ Clean the system components. Further information: Chapter *Cleaning system components* (on page 126)

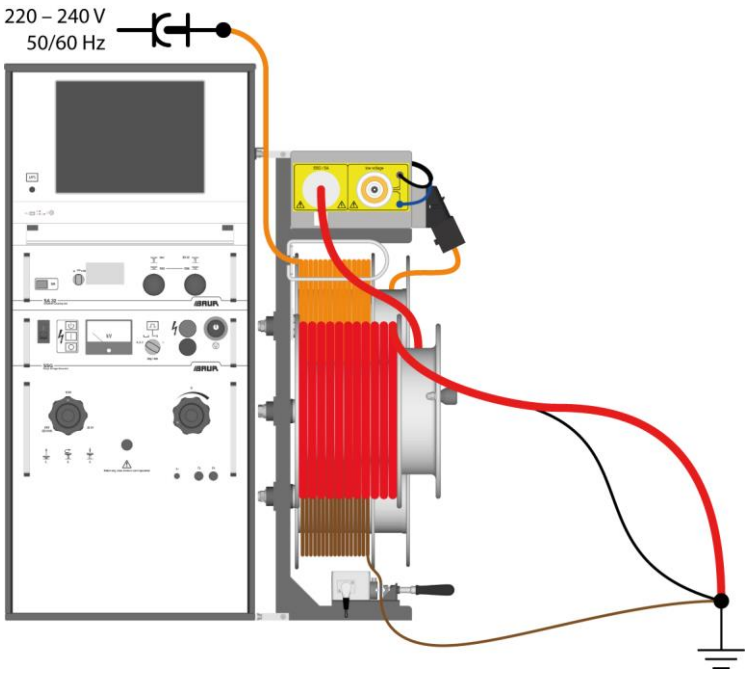
16.3 Checking the ignition voltage of the spark gap

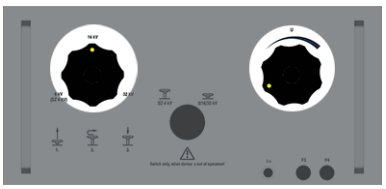
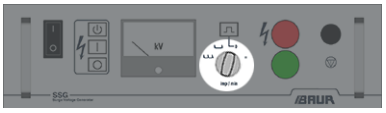
▸ Check the ignition voltage of the spark gap every 12 months or as required. The ignition voltage must be between 500 and 1000 volts.

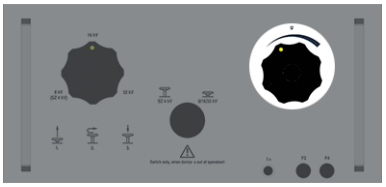
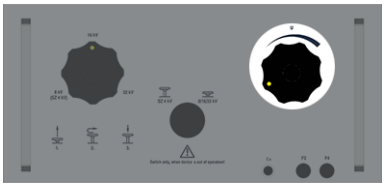
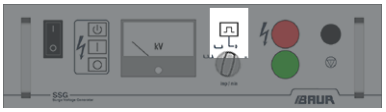
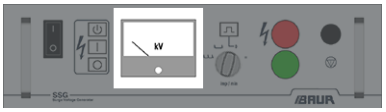
Prerequisites

- The drawbars on the SA 32 SIM/MIM coupling unit are pushed in (position: *SSG*).
- The system is connected to the supply voltage.
  Further information: Chapter *Connecting the system to the supply voltage* (on page 50)

Procedure



1.		Connect the system to the station earth.
2.		Connect the HV connection cable and the screen of the HV connection cable to the station earth.
3.		Switch on the surge voltage generator using the On/Off switch. The green indicator light comes on.
4.		Using the selector switch (left), choose the voltage range 0 – 8 kV (position: *8 kV*).
5.		Rotate the ⏚ rotary switch all the way to the left.
6.		Release the high voltage: To do this, press the ⏻ key. The system status changes to the *Ready to switch on* operating state. The red indicator light comes on.
7.		Set the *imp/min* selector switch to the 0 position (single surge).
8.		Switch on the high voltage: To do this, press the | key. The system status changes to the *In operation* operating state. The red indicator light and the | key light up.

9.		Set the surge voltage to 4 kV using the U rotary switch.
		The capacitors in the surge voltage generator are charged up; you can read off the actual voltage on the voltage indicator.
10.		When the desired target voltage has been reached, turn the U rotary switch for the output voltage all the way to the left. The capacitors are charged and ready to emit the voltage.
11.		Release a single surge: To do this, press the ⎍ key.
12.		Pay attention to the voltage indicator. A single surge is triggered. As long as the surge voltage is > 1 kV, the voltage should collapse with a single surge.
13.		Repeat the measurement. Reduce the surge voltage step by step and release a single surge each time. As long as the surge voltage is > 1 kV, the voltage should collapse with a single surge. When the voltage is less than 1 kV, the voltage should no longer collapse. In this case, the ignition voltage is within the permissible range. If the voltage continues to collapse, even under 1 kV, contact your nearest BAUR representative (http://www.baur.eu/baur-worldwide).

Completing the ignition voltage check

14.		Press the ○ key. The system changes to the safe *Ready for operation* operating state. The green indicator light comes on.

⚠DANGER

Dangerous voltage on the test object and other live plant parts. Danger to life, risk of injury from high electric voltage.

15.		Before touching the test object, discharge, earth and short it: at the connection point and at the far end. You may touch the plant parts that were under voltage only if they are visibly earthed and short-circuited.

16.4 Testing the discharge unit

- Check the discharge unit works correctly every 12 months or as required. The discharging resistance of the discharge unit must be 16.5 kOhm (± 10%).

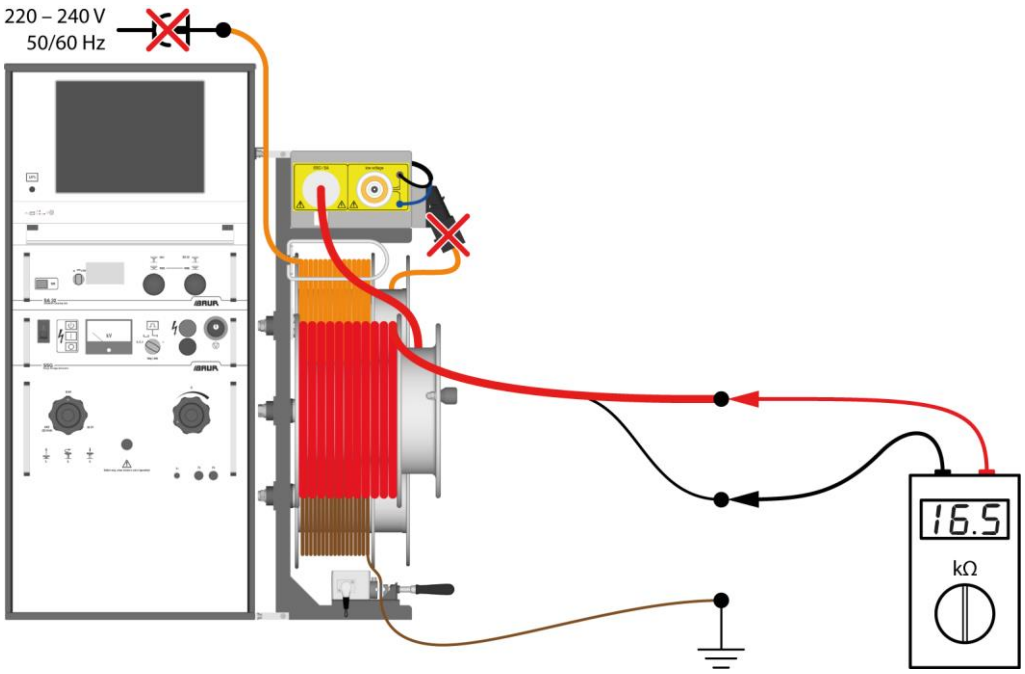
Prerequisites

- The resistance measurement is performed before the system is put into operation.
  This is because the residual charge in the surge capacitors and the thermal heating of the resistances influence the resistance measurement.
- The system is switched off and is disconnected from the mains voltage.
- The system is earthed correctly.

Required equipment

Ohmmeter

Procedure



1. Connect the ohmmeter to the HV connection cable and the screen of the HV connection cable.
2. Measure the resistance between the HV connection cable and the screen.
   The resistance must be 16.5 kOhm (± 10%).
3. If the measured resistance deviates from 16.5 kOhm by more than 10%, contact your nearest BAUR representative (http://www.baur.eu/baur-worldwide).

16.5 Checking and cleaning the connection cables and accessories

WARNING

	Dangerous voltage in system components and adjoining live plant parts Danger to life, risk of injury due to electric shock. ▸ You may touch the live plant parts and connection fittings that were under voltage only after they have been discharged and earthed. ▸ Cover the live plant parts properly.

NOTICE

Damage to cable due to aggressive cleaning agents

- ▸ Do not use any abrasive, corrosive cleaning agents or strong solvents.
- ▸ Ensure material compatibility.
- ▸ Do not clean the connection cables with acetone or thinner.

- Mild cleaning agents or petroleum ether
- Lint-free cleaning cloth

Checking and cleaning after each use

1. Each time after using the system, clean the connection cables.
2. Check the connection cables for damage.
   Cracks, breaks or other damage in the connection cable can damage the cable.
3. If dirty, clean the connection accessories with a lint-free cloth.
   Dirty or corroded contacts can affect the measurement and are often the cause for device damage.

Regular inspection

- ▸ Every four weeks, check the condition of all connection cables. To do this, unwind the connection cables and examine them for cracks, damage and any dirt.
- ▸ Regularly check all connection accessories for damage and dirt.

16.6 Cleaning system components

⚠ WARNING

Residual voltage in connection fittings and in the live system components

Danger to life, risk of injury due to electric shock.

- ▸ You may touch the connection fittings that were under voltage only after they have been discharged and earthed.

NOTICE
Damage to the device may be caused by using the wrong cleaning agents ▸ Do not use any abrasive, corrosive cleaning agents or strong solvents. ▸ Ensure material compatibility. ▸ Do not clean the product with acetone or thinner. ▸ Never clean electrical devices with water.

Prerequisites

- Live plant parts located close by are covered.
- The system is switched off and is disconnected from the supply voltage. Further information: Chapter *Safety instructions* (on page 121)

1. If required, clean the device surfaces with mild detergent and a lint-free cloth.
   NOTICE! Damage to the device due to leaking fluids.
2. Do not allow liquids to leak into the devices.

16.7 Regular calibration

It is important to calibrate the system regularly to ensure that the technical data given in this user manual are guaranteed. We recommend calibrating it once a year. The calibration may only be carried out by personnel trained and authorised by BAUR.

▸ For information on calibration, contact your nearest BAUR representative (http://www.baur.eu/baur-worldwide).

16.8 Updating the anti-virus software

An anti-virus software is installed on the system by the manufacturer.

▸ Update this anti-virus software regularly to be always protected from computer viruses.

16.9 Replacing the PC's BIOS battery

If the incorrect date and time are displayed in the operating system installed on the PC, the PC's BIOS battery may be too weak.

Prerequisite

The system is switched off and is disconnected from the mains voltage.

	CR2032 button cell battery

Procedure

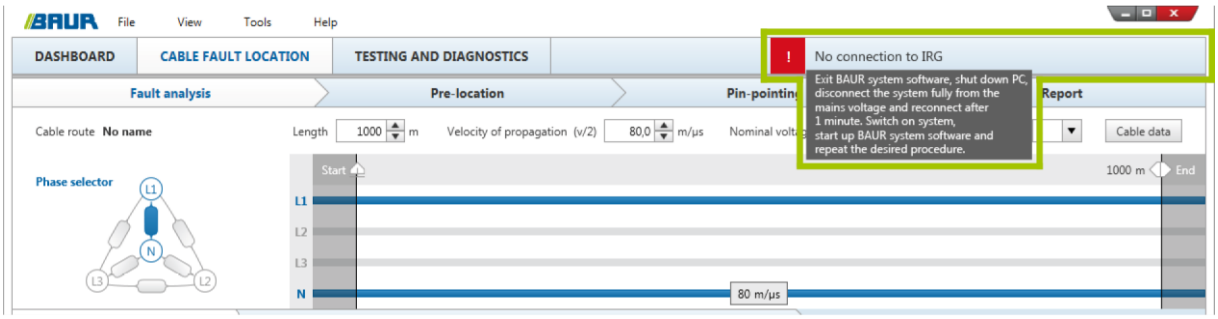
1. Depending upon the configuration of the system, there is a protective cover over the PC ports on the rear side of the system. Remove the protective cover.
2. Remove the old button cell battery from the *CR2032* battery compartment.
3. Insert the new button cell battery into the *CR2032* battery compartment.

Note the polarity of the button cell battery: the correct polarity is written on the battery compartment.

4. Replace the protective cover back over the ports.

17 ERRORS AND CORRECTIVE MEASURES

17.1 Error messages and corrective measures (notifications bar)



The system generates information and error messages to help you while performing measurements. The error messages are displayed at the top right of the screen in the notifications bar. When you rest the mouse pointer over a system message, a tooltip displays detailed information.

The error message is displayed until the fault is rectified.

Error message	Possible cause / Corrective measures
No connection to IRG	The connection to the integrated IRG time domain reflectometer has been interrupted. 1. Exit the BAUR system software. 2. Shut down the PC. 3. Disconnect the system completely from the mains voltage. 4. After approx. 1 minute, once again connect the system to the mains voltage. 5. Switch on the system, start up the BAUR system software and repeat the desired procedure. If the fault occurs again: ▸ Contact BAUR After Sales Service and provide the displayed error code or error message.
IRG error	Fault in IRG time domain reflectometer ▸ Look for the error code in the table and rectify the problem according to the description. Further information: Chapter *IRG errors* (on page 131) If the fault occurs again: ▸ Contact BAUR After Sales Service and provide the displayed error code or error message.

Error message	Possible cause / Corrective measures
No GPS signal	Contact with a minimum of four GPS satellites is required for exact determination of the location. If the GPS signal is weak or contact is with three or fewer GPS satellites, the GPS signal cannot be received. For example, this can be the case in halls or streets with high building fronts. The function of the system and the BAUR system software is not affected. The display of the cable route and any fault positions via GPS in the BAUR GeoBase Map does not work. ▸ Make sure that direct connection to GPS satellites is possible. ▸ Wait for a valid GPS signal.
No GPS connection	The GPS receiver is not working. The function of the system and the BAUR system software is not affected. The display of the cable route and any fault positions via GPS in the BAUR GeoBase Map does not work. ▸ Contact BAUR After Sales Service.

17.2 Error messages and corrective measures (Measurement dialog)

Error message	Possible cause / Corrective measures
Load determination failed.	The cause could be a faulty test setup or a low-resistive cable fault. 1. Carry out an insulation resistance measurement. The measured resistance value should be high-resistive. 2. If the value is low-resistive or the fault persists: Check the test setup. If the test setup is correct and the fault persists, there could possibly be a low-resistive cable fault. ▸ Perform a TDR measurement. If there is no low-resistive cable fault and the fault reoccurs: ▸ Close the dialog and repeat the process. If the fault occurs again: 1. Exit the BAUR system software. 2. Shut down the PC. 3. Disconnect the system completely from the mains voltage. 4. After approx. 1 minute, once again connect the system to the mains voltage. 5. Switch on the system, start up the BAUR system software and repeat the desired procedure. If the fault occurs again: ▸ Contact BAUR After Sales Service and provide the displayed error code or error message.

Error message	Possible cause / Corrective measures
Short-circuit during load determination	▸ Check the test setup. ▸ Close the dialog and repeat the process. If the fault occurs again: 1. Exit the BAUR system software. 2. Shut down the PC. 3. Disconnect the system completely from the mains voltage. 4. After approx. 1 minute, once again connect the system to the mains voltage. 5. Switch on the system, start up the BAUR system software and repeat the desired procedure. If the fault occurs again: ▸ Contact BAUR After Sales Service and provide the displayed error code or error message.
Over-voltage during load determination	▸ Check the test setup. If the fault occurs again: ▸ Close the dialog and repeat the process. If the fault occurs again: 1. Exit the BAUR system software. 2. Shut down the PC. 3. Disconnect the system completely from the mains voltage. 4. After approx. 1 minute, once again connect the system to the mains voltage. 5. Switch on the system, start up the BAUR system software and repeat the desired procedure. If the fault occurs again: ▸ Contact BAUR After Sales Service and provide the displayed error code or error message.

17.2.1 IRG errors

Error message/error code	Possible cause / Corrective measures

Error message/error code	Possible cause / Corrective measures
No IRG trigger	The integrated IRG time domain reflectometer cannot perform the desired action. ▸ Close the dialog and repeat the process. If the fault occurs again: 1. Exit the BAUR system software. 2. Shut down the PC. 3. Disconnect the system completely from the mains voltage. 4. After approx. 1 minute, once again connect the system to the mains voltage. 5. Switch on the system, start up the BAUR system software and repeat the desired procedure. If the fault occurs again: ▸ Contact BAUR After Sales Service and provide the displayed error code or error message.
IRG errors: [ERROR CODE] IRG request '[ERROR CODE]' rejected. Time limit for IRG request '[ERROR CODE]' has exceeded.	Fault in IRG time domain reflectometer ▸ Look for the error code in the table and rectify the problem according to the description. If an error code is displayed that does not appear in this table: ▸ Contact BAUR After Sales Service and provide the displayed error code.
WARN-IRG4000-CTRL-UNSAFE-TEMPERATURE WARN-IRG4000-RMIO-UNSAFE-TEMPERATURE	The IRG time domain reflectometer has too high or too low an operating temperature. 1. Close the dialog and wait a few minutes. 2. Repeat the process. If the fault occurs again: ▸ Contact BAUR After Sales Service and provide the displayed error code or error message.
ERR-IRG4000-RMIO-VOLTAGE-AT-TDR-1-L1	▸ Ensure that the extraneous voltage is switched off, or perform the TDR measurement with active voltage protection.
ERR-IRG4000-RMIO-LOAD-IS-TO-HIGH	The capacitive load is too high.
ERR-IRG4000-CTRL-OPERATION-FAILED ERR-IRG4000-RMIO-OPERATION-FAILED ERR-IRG4000-RMIO-UARTPROTO-PARAMETER-RANGE	▸ Close the dialog and repeat the process. If the fault occurs again: 1. Exit the BAUR system software. 2. Shut down the PC.

Error message/error code	Possible cause / Corrective measures
HINT-IRG4000-CTRL-FPGA-MEASUREMENT	3. Disconnect the system completely from the mains voltage. 4. After approx. 1 minute, once again connect the system to the mains voltage. 5. Switch on the system, start up the BAUR system software and repeat the desired procedure. If the fault occurs again: ▸ Contact BAUR After Sales Service and provide the displayed error code or error message.
ERR-IRG4000-CTRL-INITIALIZATION-FAILURE ERR-IRG4000-CTRL-UARTPROTO-CRC ERR-IRG4000-RMIO-INITIALIZATION-FAILURE ERR-IRG4000-RMIO-UARTPROTO-CRC HINT-IRG4000-CTRL-EEPROM-FILESYSTEM HINT-IRG4000-CTRL-FGA-INIT-FACTORY HINT-IRG4000-CTRL-FPGA-INIT-MAINCONFIG HINT-IRG4000-CTRL-INTERNALFAULT HINT-IRG4000-CTRL-IO-EXPANDER HINT-IRG4000-CTRL-TEMPERATURESENSOR HINT-IRG4000-CTRL-UARTRMIO-TIMEOUT HINT-IRG4000-RMIO-ECHOMETER HINT-IRG4000-RMIO-EEPROM-FILESYSTEM HINT-IRG4000-RMIO-INTERNALFAULT HINT-IRG4000-RMIO-RESISTANCE-MEASUREMENT HINT-IRG4000-RMIO-TEMPERATURESENSOR HINT-IRG4000-RMIO-VOLTAGESOURCE	1. Exit the BAUR system software. 2. Shut down the PC. 3. Disconnect the system completely from the mains voltage. 4. After approx. 1 minute, once again connect the system to the mains voltage. 5. Switch on the system, start up the BAUR system software and repeat the desired procedure. If the fault occurs again: ▸ Contact BAUR After Sales Service and provide the displayed error code or error message.

17.3 PC faults (system with UPS)

Fault	Possible cause / Corrective measures
The PC does not start, even though the UPS key has been pressed.	The battery of the Uninterrupted Power Supply (UPS) is empty. 1. Connect the system to the mains voltage. 2. Wait a few minutes until the battery of the UPS is charged. 3. Press the UPS key on the PC. The PC starts automatically.

Fault	Possible cause / Corrective measures
The PC does not start, even though the ⏻ On/Off key has been pressed.	The uninterrupted power supply (UPS) is switched off. ▸ Press the UPS key on the PC. The PC starts automatically.
	The battery of the Uninterrupted Power Supply (UPS) is empty. 1. Connect the system to the mains voltage. 2. Wait a few minutes until the battery of the UPS is charged. 3. Press the UPS key on the PC. The PC starts automatically.
The ⚠ LED lights up.	Extraneous voltage is present at the measurement input of the IRG time domain reflectometer. 1. End the measurement immediately. 2. Check the test setup. If extraneous voltage remains present: 1. End the measurement immediately. 2. Have the extraneous voltage switched off. For TDR measurements: ▸ Perform the TDR measurement with activated voltage protection.
The PC no longer responds.	The PC has crashed. 1. To switch off the PC, hold down the On/Off key ⏻ for approx. 5 seconds. 2. To restart the PC after it has been switched off, press the On/Off key ⏻ once again.

If the fault recurs after the recommended rectification measures have been performed:

▸ Contact BAUR After Sales Service.

17.4 PC faults (system without UPS)

Fault	Possible cause / Corrective measures
The PC does not start, even though the ⏻ On/Off key has been pressed.	The system is not supplied with voltage. 1. Connect the system to the mains voltage. 2. Press the On/Off key ⏻ on the PC.

Fault	Possible cause / Corrective measures
The ⚠ LED lights up.	Extraneous voltage is present at the measurement input of the IRG time domain reflectometer. 1. End the measurement immediately. 2. Check the test setup. If extraneous voltage remains present: 1. End the measurement immediately. 2. Have the extraneous voltage switched off. For TDR measurements: ▸ Perform the TDR measurement with activated voltage protection.
The PC no longer responds.	The PC has crashed. 1. To switch off the PC, hold down the On/Off key ⏻ for approx. 5 seconds. 2. To restart the PC after it has been switched off, press the On/Off key ⏻ once again.

If the fault recurs after the recommended rectification measures have been performed:

▸ Contact BAUR After Sales Service.

17.5 Online support session

With your permission, BAUR After Sales can access your system computer, identify problems and quickly find a solution. To do this, you can use the already installed TeamViewer program which can be invoked from the user interface of the BAUR system software. Your engineers can also use this function to share the Desktop with the test engineer on site during the fault location and assist him in analysing the measurement results.

The TeamViewer program meets the highest requirements for data protection and security. TeamViewer connections run over fully secured and encrypted data channels. Each time it is started, TeamViewer generates a new dynamic password, which together with the unique ID offers security against unauthorised access to the system. In this way, only persons to whom you have given the ID and password will have access to your computer.

To allow an external expert access to your system computer, you will also require internet access.

1. To set up internet access, insert a UMTS modem (UMTS stick) or a WLAN stick into the USB 3.0 port of the PC.
2. If required, install additional software (e.g. drivers).
3. Enter the necessary data for internet access.
4. Note that online support by BAUR After Sales is available only during service hours after making a telephone appointment with one of our employees. During the entire online support session, you must remain near the system computer and in contact with the BAUR After Sales employee.

Starting an online support session

Prerequisites

- Internet access is set up and working.
- BAUR After Sales or the required technical expert is informed and is available.
- Telephone connection is established.

Procedure

1. To start the online support session, in the ***Tools*** menu, select the ***Start online support session*** menu item.
2. Call the BAUR After Sales or the technical expert and share the ID and password that will be displayed.

   BAUR After Sales or the technical expert can connect to your system computer and assist you.
3. During the entire online support session, you must remain near the system computer and in contact with the BAUR After Sales employee.

18 TRANSPORTATION AND STORAGE

18.1 Transportation

18.1.1 Ensure the following when transporting

NOTICE
Damage to the device caused by improper transportation and incorrect storage ▸ Always transport the device as intended. ▸ Comply with the ambient conditions specified in the technical data for this system.

- ▸ Protect all system components against the following during transportation:
  - ▪ Damage,
  - ▪ Vibrations,
  - ▪ Dampness and humidity.
- ▸ Transport and store the system so that it always remains in an upright position.
  Otherwise the system may become damaged.
- ▸ When transporting the system, secure the uncoiling brake to the cable drum.

18.1.2 Transporting the system in vehicles

1. Transport the system so that it always remains in an upright position.
2. Secure the system to prevent it from sliding or tipping over.

18.2 Storage

- ▸ Store the system so that it always remains in an upright position.
- ▸ During storage, comply with the ambient conditions specified in the technical data of the product. Information on the technical data is given in the corresponding section of this user manual.
- ▸ Protect the system and components from humidity.
- ▸ Protect the system against unauthorised access.

19 WARRANTY AND AFTER SALES

Warranty

For warranty claims, please contact BAUR GmbH or your local BAUR representative (http://www.baur.eu/baur-worldwide). Warranty is cancelled in case of misuse. Wear parts are excluded from the warranty.

After Sales

For questions contact BAUR GmbH or your BAUR representative (http://www.baur.eu/baur-worldwide).

BAUR GmbH

Raiffeisenstraße 8
6832 Sulz / Austria
service@baur.at
www.baur.eu

20 DISPOSAL

The final decommissioning and disposal of the system must be carried out only in compliance with country-specific laws, regulations and standards.

System components do not belong in the domestic waste.

- Dispose of electrical system components in accordance with the applicable national regulations.
- Dispose of the various system components in an environmentally friendly manner and in accordance with the applicable national regulations.

21 DECLARATIONS OF CONFORMITY

21.1 Declaration of conformity for the Syscompact 4000

We

declare, under our sole responsibility, that the BAUR product

Syscompact 4000 cable fault location system

to which this declaration refers, conforms to the following standards or standard documents:

- Low Voltage Directive 2014/35/EC
  EN 61010-1:2010
  EN 50191:2010
- EMC Directive 2014/30/EU
  EN 55011:2009 + A1:2010
  EN 61000-4-2:2009
  EN 61000-4-4:2012
- Environmental testing
  EN 60068-2-ff

Signed: Dr. Markus Baur, CEO

Sulz, 11/10/2017

21.2 Declaration of Conformity for IRG 4000

We

declare, under our sole responsibility, that the BAUR product

IRG 4000 BAUR time domain reflectometer

to which this declaration refers, conforms to the following standards or standard documents:

- Low Voltage Directive 2014/35/EC
  EN 61010-1:2010
- EMC Directive 2014/30/EU
  EN 55011:2009 + A1:2010
  EN 61000-3-2:2014
  EN 61000-4-2:2009
  EN 61000-4-4:2012
  EN 61000-4-5:2014
  EN 61000-4-11:2004
- Environmental testing
  EN 60068-2-ff

Signed: Dr. Markus Baur, CEO

Sulz, 11/10/2017

21.3 Declaration of conformity for SSG 1100, SSG 1500 and SSG 2100

We

declare, under our sole responsibility, that the BAUR product

SSG 1100 / SSG 1500* / SSG 2100* surge voltage generators

to which this declaration refers, conforms to the following standards or standard documents:

- Low Voltage Directive 2014/35/EC
  EN 61010-1:2010
  EN 50191:2010
- EMC Directive 2014/30/EU
  EN 55011:2009 + A1:2010
  EN 61000-4-2:2009
  EN 61000-4-4:2012
- Environmental testing
  EN 60068-2-ff

Signed: Torsten Berth, Technical Director
Dr. Eberhard Paulus, Director QM/QS

Sulz, 14/12/2015

* Options instead of SSG 1100

21.4 Declaration of conformity for the SA 32

We

declare, under our sole responsibility, that the BAUR product

SA 32 SIM/MIM coupling unit

to which this declaration refers, conforms to the following standards or standard documents:

- Low Voltage Directive 2014/35/EC
  EN 61010-1:2010
- EMC Directive 2014/30/EU
  EN 55011:2009 + A1:2010
  EN 61000-4-2:2009
  EN 61000-4-4:2012
- Environmental testing
  EN 60068-2-ff

Signed: Torsten Berth, Technical Director

Dr. Eberhard Paulus, Director QM/QS

Sulz, 14/12/2015

22 USER INTERFACE

The user interfaces are described in the Online Help of the BAUR system software.

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BAUR GmbH

Raiffeisenstraße 8
6832 Sulz / Austria
headoffice@baur.at
www.baur.eu

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