User manual

Time domain reflectometer

IRG 4000 portable

Table of contents

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.

1.2 Applicable documents

This user manual applies in conjunction with the following documents:

- User manual for the BAUR software
- User manual for all devices that are additionally used for measurements

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**
	**Warning about arcing faults**
	**Risk of falling**
	**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 screenshots and graphics used are intended to illustrate the procedure and may differ from the actual state.

2 FOR YOUR SAFETY

All BAUR devices and systems are manufactured according to the state of the art and are safe to operate. 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 and system is 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.

Make sure that the responsible body and persons working with the device or system have carefully read through and understood the user manual for the device or system, as well as the user manuals for all associated devices, before starting work.

The responsible body and operator of the device or system are responsible for any injuries or damage resulting from non-compliance with this user manual.

2.1 Intended use

The IRG 4000 portable time domain reflectometer is used in combination with the BAUR Software 4 for cable fault location, especially on long land and submarine cables.

The following fault location methods can be performed with the time domain reflectometer:

- Insulation resistance measurement
- Time domain reflectometry (TDR)

Additional cable fault location methods are possible in combination with other BAUR cable fault location systems.

If the device is used without observing this condition, safe operation cannot be guaranteed. The operator or 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,
- Compliance with the technical data and connection requirements given on the rating plate and in the user manual,
- Compliance with the inspection and maintenance tasks.

[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).

2.2 Instructions for the operator

The device may only be operated 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 IRG 4000 portable and the devices used,
- Knowledge of the testing and measuring techniques,
- Knowledge of plant engineering (cable types, switchgear, etc.),
- Knowledge of high-voltage technology and the safe handling of high voltage.

2.3 Avoiding dangers, taking safety measures

- When installing the testing system and operating the IRG 4000 portable observe the following regulations and guidelines:
  - Accident prevention and environmental protection regulations applicable for your country
  - Safety instructions and regulations of the country where IRG 4000 portable is being used (according to the latest version)
  - EU/CENELEC countries: EN 50191 *Erection and operation of electrical test equipment*

    Other countries: The standard for erection and operation of electric test equipment applicable for your country
  - EU/CENELEC countries: EN 50110 *Operation of electrical installations*

    Other countries: The standards for operating electrical installations applicable in your country
  - If necessary, other national and international standards and guidelines in the latest applicable version
  - Local safety and accident prevention regulations
  - Employers' liability insurance association regulations (if any)
- Use the personal protective equipment for protection against electric shock and burning due to possible arcing faults in compliance with the local work safety and accident prevention regulations.

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 of the product only if it is in a technically safe condition

Safety, function, and availability depend on the proper condition of the device. Upgrades, modifications, or alterations to the device are strictly prohibited.

- Operate the device only in a technically perfect condition.
- In case of damage and malfunction, immediately stop the device, mark it accordingly and have the faults rectified by appropriately qualified and authorised personnel without delay.
- Comply with the inspection and maintenance conditions.
- Never take apart the device. There are no operator-serviceable or -repairable components inside the device.
- Use only accessories and original spare parts recommended by BAUR. The use of spare parts, accessories and special fittings that have not been tested and approved by BAUR could adversely affect the safety, function and characteristics of the device.

2.3.3 No unauthorised modifications to the device

Accessories and spare parts

Upgrades, modifications, or alterations to the device are strictly prohibited.

- Use only accessories and original spare parts recommended by BAUR. The use of spare parts, accessories and special fittings that have not been tested and approved by BAUR could adversely affect the safety, function and characteristics of the device.

Device configuration

The device you receive from BAUR is preconfigured and ready for operation.

Changes to the device configuration may be carried out only after approval from and, if necessary, under the instruction of BAUR After Sales Service. Arbitrary changes to the device configuration can adversely affect the safety, functions, and properties of the device. Faults and problems caused by unauthorised changes to the device configuration are not covered by the warranty.

Reinstallation of the BAUR Software

The BAUR Software is preconfigured by the manufacturer according to your device. If the BAUR Software is not reinstalled properly, configuration data could be lost, and faults could occur. In this case, there is no guarantee that the device will function without problems.

- Contact BAUR BAUR After Sales Service to check if it is actually necessary to reinstall the BAUR Software and if so, arrange for this to be done properly.

  Faults due to improper reinstallation of the BAUR Software are not covered by the warranty.

External software

You may only install software that is required for carrying out measurement tasks and that has been explicitly approved by the authorised person in the company. Only the system administrator is permitted to carry out all software installations.

You are not permitted to install any additional programs without prior approval. This particularly applies for downloaded programs such as computer games, utilities, plug-ins for browsers, etc.

Faults and any changes in system settings due to installed external software are not covered by the warranty.

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 electric voltage

When performing measurements with the IRG 4000 portable, especially in combination with a surge voltage or HV generator, a dangerous (at times very high) voltage is generated and is fed to the test object via an HV connection cable. The responsible body and operator need to pay special attention and must be very careful when working with high electric voltage. Before commencing work, the responsible body must assess the risks for the specific working conditions. Protective measures are based on the risk assessment and must be followed at the workplace.

Commissioning and operation of the IRG 4000 portable is only permitted in compliance with EN 50110 (EU/CENELEC countries) or the relevant 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.

2.3.7 Working under danger of falling, performing tasks at heights

If performing connection and measurement tasks at workplaces that are more than 1 m above ground, special safety measures must be taken to prevent accidents involving falls.

DANGER

Danger of falling while working at heights

Danger to life, risk of injury due to fall

- Secure workplaces posing risk of falling with safety devices (e.g. railings, platforms, scaffolds, frameworks).
- Use personal safety equipment to protect against falling (e.g. belts)
- Cover or block places where there is danger of falling or stumbling.
- Tasks performed at heights must be supervised by a second person.

2.3.8 Protecting the laptop against malware and other threats from the Internet

No anti-virus or cyber security software is installed on the laptop.

NOTICE

Damage to the laptop due to malware from the Internet

As soon as an Internet connection has been established, the malware (e.g. viruses, trojans) may cause significant damage to the laptop via the Internet.

- Regularly install Windows updates.
- Use a firewall.
- Use anti-virus software and update it regularly.
- Take all other necessary precautions to protect the laptop against viruses and other threats.

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 devices.

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

The following state-of-the-art protective equipment may be necessary depending on the specific conditions in the workplace:

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 applications. **Important:** No high-visibility vests while working with electric arc hazard!
Hand protection:	▪ Protective gloves

3 PRODUCT INFORMATION

Information on the technical data as well as standard delivery, accessories and options can be found in Chapter *Data sheet* (on page 46).

3.1 Available measurement methods

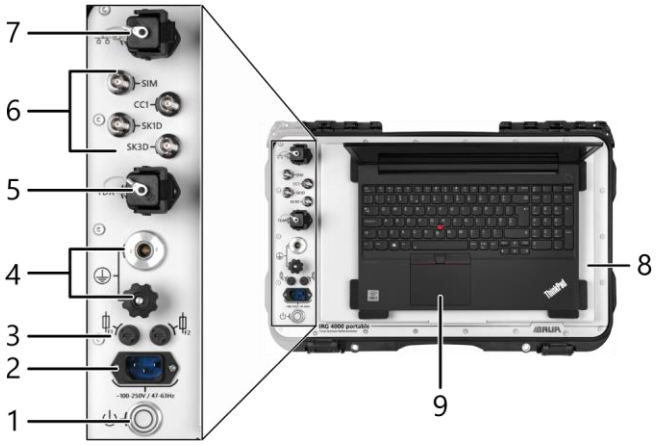
Measurements using the following methods are possible with the IRG 4000 portable:

- Insulation resistance measurement
  Further information: Chapter *Insulation resistance measurement* (on page 25)
- Time Domain Reflectometry (TDR)
  Further information: Chapter *TDR: Time Domain Reflectometry* (on page 27)

Additional cable fault location methods are possible in combination with other BAUR cable fault location systems.

Information on the methods and measurement parameters that can be set can be found in the user manual for the BAUR Software.

3.2 Full illustration



No.	Element	Function
1	⏻ key	Is used to switch the device on and off When the device is switched on, the ⏻ key lights up and remains in the depressed position.
2	Mains voltage connection	Is used to connect the device to the mains voltage Mains voltage: AC 100 – 240 V, 50/60 Hz
3	Fuses *F1* + *F2*	Are used to protect the device Fuses: T 4 AH (4 A time lag)
4	Protective earthing connections	Are used to connect the protective earthing: ▪ for the device ▪ for the hand cable drum of the TDR connection cable (option)
5	*TDR* port	Is used to connect the IRG 4000 portable for insulation resistance measurement and TDR measurement Further information: Chapter *Connecting the device* (on page 20)
6	*SIM*, *CC1*, *SK1D*, and *SK3D* ports	Are used to connect the IRG 4000 portable for other cable fault location methods Other cable fault location methods are only available in certain system configurations. Information on system configurations can be obtained from your BAUR representative.
7	Ethernet port	Is used for data transmission between the device and the laptop
8	Cable compartment	Is used to store the connection cables
9	Laptop	The laptop with the BAUR Software installed on it forms the graphical interface for controlling the time domain reflectometer. The measurements are configured and controlled in the BAUR Software, and the measurement results are also evaluated and saved there.

3.3 Power supply

The IRG 4000 portable is supplied via the mains voltage.

- Before connecting the device to the mains voltage, make sure that the mains voltage matches the specifications on the rating plate.

The laptop can be supplied with power in battery mode or via the power supply unit that is included with it. The laptop's battery is charged while it is being supplied with power via the power supply unit.

3.4 Connection cables and accessories

3.4.1 Standard connection cables

The connection cables are located in the cable compartment of the IRG 4000 portable transport case as standard.

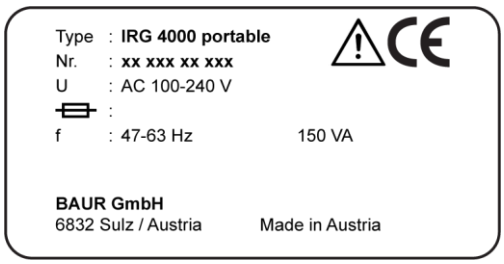
Figure	Cable	Length	Function
	Protective earthing cable Cross section: 10 mm²	5 m	Is used to connect the device to the protective earthing
	Mains supply cord	2.5 m	Is used to connect the device to the mains voltage
	Connection cables	3 m	Is used to connect the device to the test object The connection cable has 4 quick-acting 1 A / 50 kA @ AC 600 V fuses
–	Ethernet cable	10 m	Is used for data transmission between the device and the laptop

3.4.2 TDR connection cable

The optional TDR connection cable is used to perform insulation resistance measurements and TDR measurements.

The TDR connection cable meets measurement category CAT IV/600 V and has 4 quick-acting 1 A / 50 kA @ AC 600 V fuses.

3.5 Rating plate



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
⚠	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 CHECKS TO PERFORM BEFORE COMMISSIONING

1. Check the device and mechanical connections for damage.
2. Check electrical connections and cables for damage.
   Use only undamaged connection cables.

5 CONNECTING THE DEVICE

5.1 Installing the device

- Comply with the applicable accident prevention regulations and local conditions.
- Select the place of installation for the device in such a way that
  - a stable base is guaranteed,
  - the device and the test object are easy to access for the connections and operation.
  - sufficient safety distances are maintained. You must comply with EN 50110 for the operation of electrical installations (EU/CENELEC countries) or the relevant standards applicable in your country.

5.2 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. Earth and short all phases.
5. Provide protection against adjacent live parts.

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}.

5.3 Preparing the test object terminals

The connection point and the far end represent the two terminals of the test object.

1. Disconnect all equipment that is connected to the test object and is not designed for the stipulated test voltage.
2. Cordon off all metal parts, e.g. lighting masts, at the terminals of the test object or insulate them with insulating safety plates.
3. Earth all metal parts at the terminals to avoid dangerous charging.
4. Follow the cable route and ensure that no work is being carried out underground on gas lines and that there are no other danger points.

5.4 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, and hearing damage.

- Use suitable personal protective equipment against electric shocks and arcing faults.
- Observe the isolating distances.
- 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.

⚠ WARNING

High electric voltage through potential increase

A fault can cause flashovers in the device. In this case, a potential increase of the housing is possible due to high short-circuit currents.

Danger due to the potential increase is reduced when a protective earthing is connected properly.

- Connect the protective earthing carefully. The protective earthing cable should be as short as possible and of low impedance.

5.5 Connecting the device

Connection diagram

- Cable with 3 screened phases (on page 21)
- Cable with 1 screened phase (on page 21)
- Unscreened cable with 3 phases (on page 21)
- Connection diagrams with the optional TDR connection cable (on page 22)

Procedure

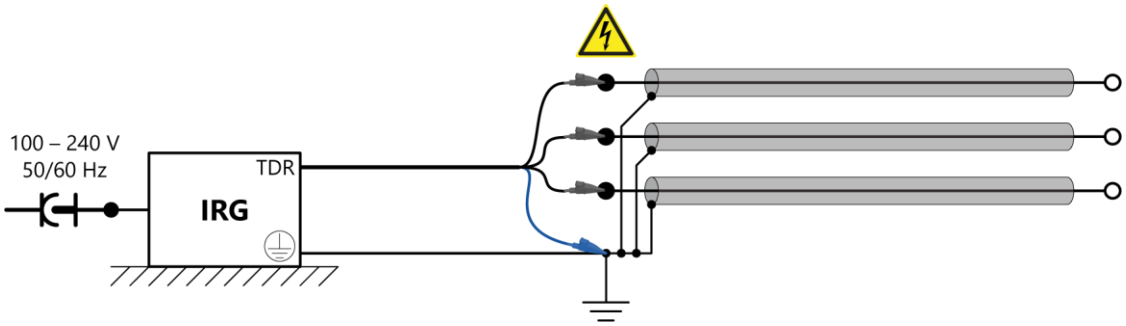
1. Make sure that the connection point is de-energised.
   Further information: Chapter *Ensuring there is no voltage at the work place* (on page 19)
2. Make sure that the connection points and the far end are prepared for the measurement tasks.
   Further information: Chapter *Preparing the test object terminals* (on page 19)
3. Earth the device: Use the protective earthing cable to connect the protective earthing connection of the IRG 4000 portable to the station earth.

4. Unwind the connection cable up to the test object.
5. Connect the connection cable to the test object phase to be tested. Observe the relevant connection diagram.

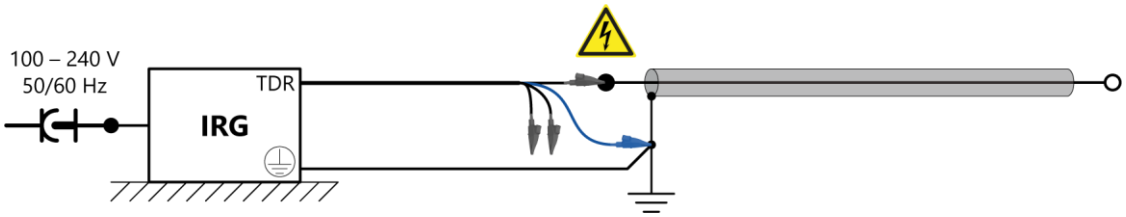
   Observe the labelling of the connection cable (*L1*, *L2*, *L3*, *N*).
6. For measurements with the optional TDR connection cable: Connect the protective earthing cable of the hand cable drum to the IRG 4000 portable protective earthing connection.
7. Connect the connection cable that is connected to the connection panel of the IRG 4000 portable to the *TDR* port.
8. Connect the device to the supply voltage.

   Further information: Chapter *Connecting the device to the supply voltage* (on page 24)

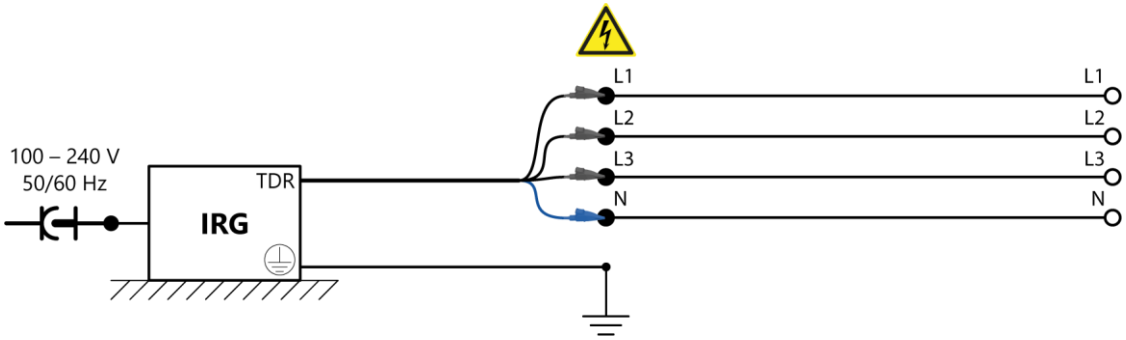
5.5.1 Cable with 3 screened phases



5.5.2 Cable with 1 screened phase

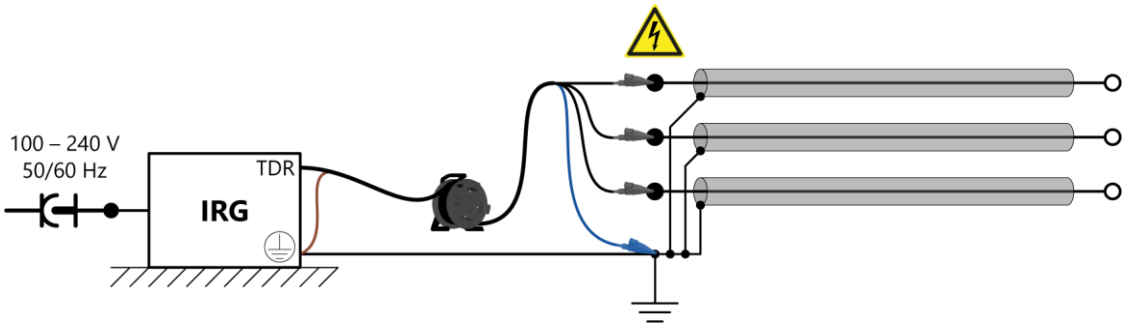


5.5.3 Unscreened cable with 3 phases

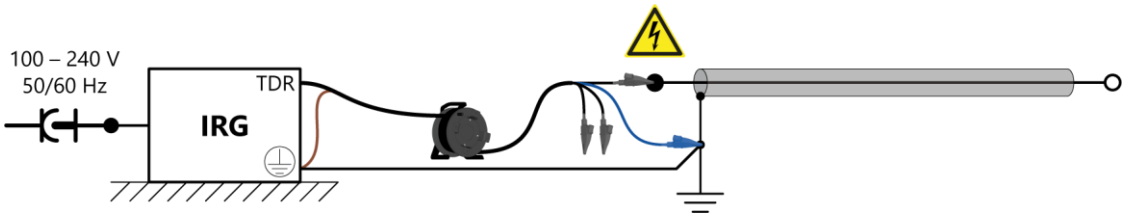


5.5.4 Connection diagrams with the optional TDR connection cable

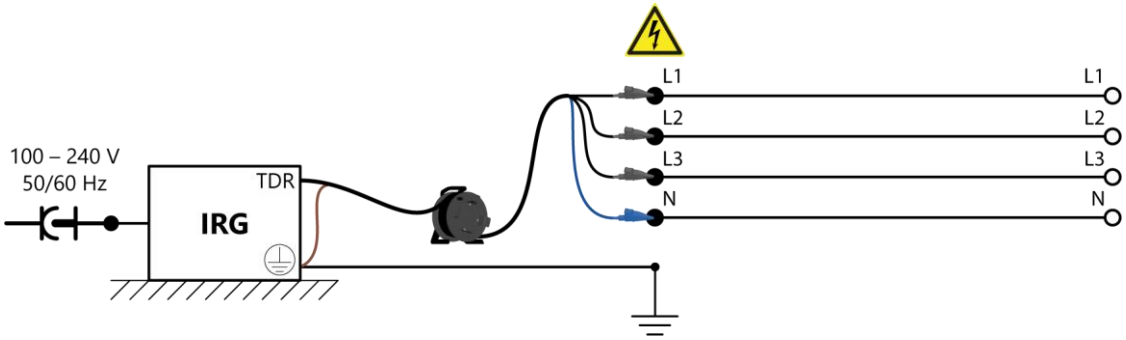
Cable with 3 screened phases



Cable with 1 screened phase

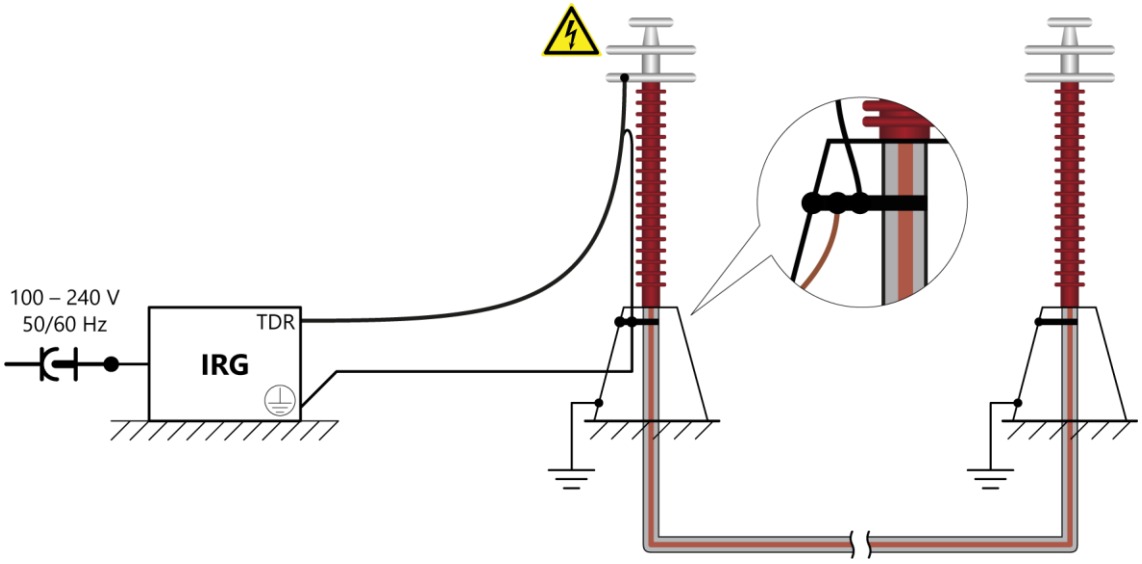


Unscreened cable with 3 phases



5.6 Connecting the device with the optional HV connection cable

The illustration shows an example of a connection diagram for a 1-phase test object.



1. Make sure that the connection point is de-energised.
   Further information: Chapter *Ensuring there is no voltage at the work place* (on page 19)
2. Make sure that the connection points and the far end are prepared for the measurement tasks.
   Further information: Chapter *Preparing the test object terminals* (on page 19)
3. Earth the device: Use the protective earthing cable to connect the protective earthing connection of the IRG 4000 portable to the station earth.
4. Connect the HV connection cable and its screen to the test object phase to be tested. Proceed as follows:
   a. The HV connection cable screen is used for the operational earthing. Connect the HV connection cable screen to the station earth as close as possible to the screen of the test object phase to be tested.
      Make sure that the connection is as short as possible and there are no loops.
   b. Connect the HV connection cable to the test object.
   c. Make sure that the screen of the HV connection cable and the unscreened part of the HV connection cable are spaced far enough apart that they do not touch or cross each other.
   d. Connect the HV connection cable that is connected to the connection panel of the IRG 4000 portable to the *TDR* port.
5. Connect the device to the supply voltage.
   Further information: Chapter *Connecting the device to the supply voltage* (on page 24)
6. Remove the earthing and short-circuit connection from the phase to be tested: at the connection point and at the far end.

5.7 Connecting the device to the supply voltage

1. Connect the IRG 4000 portable to the mains voltage using a mains supply cord. If necessary, use a country-specific adapter.

   Note that the mains supply earth is not isolated from the station earth.

   NOTICE! If the voltage is too low, the system will not work properly; if it is too high it may damage the device.
2. Ensure that the mains voltage matches the specifications on the rating plate.

5.8 Securing the test area

1. Mark out the path for pedestrians.
2. Secure the connection cables, e.g. with cable bridges or rubber mats. The connection cables must be protected against damage and there must be no danger of people tripping.
3. If the connection of the device obstructs test personnel and pedestrians, these obstructions must be clearly marked.
4. Check that no-one is located in the vicinity of the test assembly (test area).
5. The 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 prohibition zone,*
   - *Persons standing outside the boundary cannot reach the operating elements of the test installations located inside the boundary.* (EN 50191)

   The minimum height of individual boundaries must be 1 m or correspond to the local safety regulations and standards.
6. If the device is cordoned off from generally accessible areas only with ropes, chains or bars, the entire test assembly must be monitored during the test in compliance with EN 50191. If the test assembly 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.
7. Make sure that unauthorised persons cannot access the device and test area.
8. Mark the test area and terminals clearly. It should be immediately apparent that cable testing or measurement tasks are being performed on the cable system.
9. Make sure that unauthorised persons cannot access the connection point and the far end of the test object.
10. Make sure that the workplace is de-energised, and that the connection point and the far end of the test object are prepared for the measurement tasks.

    Further information:
    - Chapter *Ensuring there is no voltage at the work place* (on page 19)
    - Chapter *Preparing the test object terminals* (on page 19)

6 COMMISSIONING

1. Make sure that the device is connected properly.
   Further information: Chapter *Connecting the device* (on page 19)
2. Switch on the device via the ⏻ key on the connection panel.
   The ⏻ key lights up and remains in the depressed position.
3. Switch on the laptop.
   The laptop automatically establishes the Wi-Fi connection to the IRG 4000 portable. If the connection is not established automatically, you can connect the laptop manually.
   Further information: Chapter *Wi-Fi connection does not start automatically* (on page 41)
   Alternatively, you can also connect the laptop to the IRG 4000 portable via the ethernet cable.
4. Start the BAUR software 4.
   The Dashboard opens.

7 INSULATION RESISTANCE MEASUREMENT

7.1 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.

Further information is given in the user manual for the BAUR software.

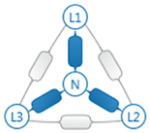
- To open the user manual, press the F1 key in the open BAUR software.

7.2 Performing an insulation resistance measurement

1. Secure the test area and connect the test object properly.
   Further information: Chapter *Connecting the device* (on page 19)
2. Switch on the device and start the BAUR Software.
   Further information: Chapter *Commissioning* (on page 25)

In the BAUR software

1. In the dashboard, select the ***CABLE FAULT LOCATION*** tab and then the ***Fault analysis*** tab.
   The ***Insulation measurement*** method is automatically selected.
2. All phase combinations to earth potential are automatically selected in the phase selector. If you also want to measure the insulation resistance between the phases, in the phase selector, click on the desired phase combinations.



3. If you want to change the settings for the measurement, click on the  icon.
   Further information: User manual for the BAUR software (press the *F1* key)
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.
   The measurement is performed.
   When the measurement is complete, it finishes automatically. You can also end the measurement early by cancelling it.
   The measured resistance values are displayed in the analysis diagram and faults are assigned to fault types. 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: User manual for the BAUR software (press the *F1* key)
6. To close the ***Measurement*** dialog, click the ***Close*** button.

Next steps

- Evaluating resistance values: User manual for the BAUR software (press the *F1* key)
- Inserting measurement results into the report: *Inserting measurement results in the report* (on page 26)
- Creating a report: *Creating a report* (on page 31)
- If you do not wish to perform further measurements: *Ending a measurement* (on page 32)

7.3 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.

8 TDR: TIME DOMAIN REFLECTOMETRY

8.1 About the TDR method

TDR measurement is used as an overview measurement:

- 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

Further information is given in the user manual for the BAUR software.

- To open the user manual, press the F1 key in the open BAUR software.

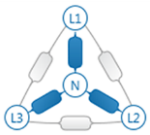
8.2 Performing the TDR measurement

1. Secure the test area and connect the test object properly.
   Further information: Chapter *Connecting the device* (on page 19)
2. Switch on the device and start the BAUR Software.
   Further information: Chapter *Commissioning* (on page 25)

In the BAUR software

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

1. All phase combinations to earth potential are automatically selected in the phase selector. If you also want to perform the TDR measurement between the phases, click on the required phase combinations in the phase selector.



2. If you want to change the settings for the measurement, click on the icon.
   The first measurement must be performed in automatic measurement mode. From the second measurement onwards, you can change the settings. Further information: User manual for the BAUR software (press the *F1* key)
3. Click the ***Start measurement*** button.
4. In the ***Measurement*** dialog, click 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.
   When the measurement is complete, it finishes automatically. You can also end the measurement early by cancelling it.
5. To close the ***Measurement*** dialog, click the ***Close*** button.

Next steps

- Evaluating the reflection image: *Evaluating TDR reflection images* (on page 28)
- Inserting the reflection image into the report: *Inserting a reflection image into the report* (on page 30)
- Creating a report: *Creating a report* (on page 31)
- If you do not wish to perform further measurements: *Ending a measurement* (on page 32)

8.3 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:

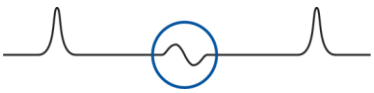
Open cable end

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

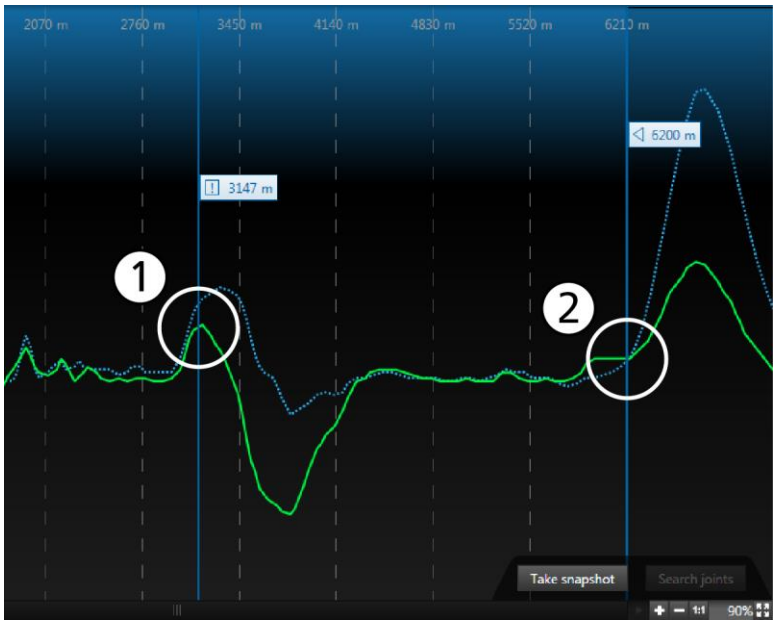
The reflection is a negatively decreasing pulse. There is no pulse from the far end.



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)

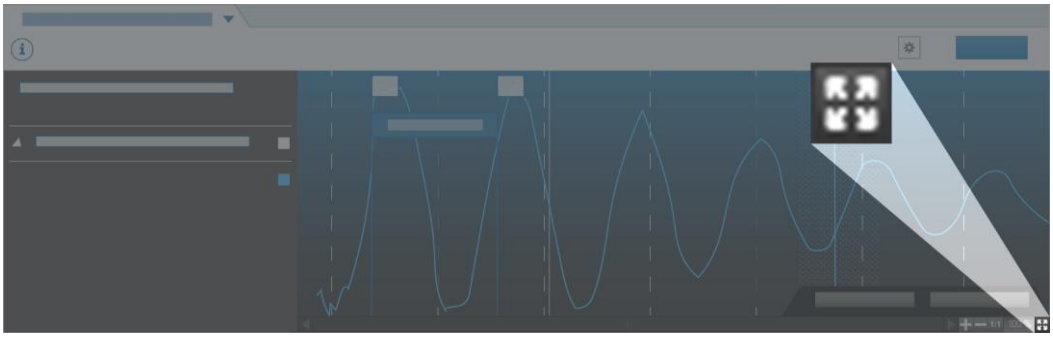
1. If possible, compare the traces of a healthy and a faulty phase.
   The differences in the traces clearly indicate possible fault positions.
2. Double-click to set a cursor at the position where the two traces separate.
   If you are unable to compare traces of two phases, set the cursor at the position 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.

8.3.1 Full screen view

In the full screen view, the reflection image and the cable image are displayed on the full screen; the other areas are hidden.

Open full screen view

- In the reflection image, click the button in the bottom right corner:

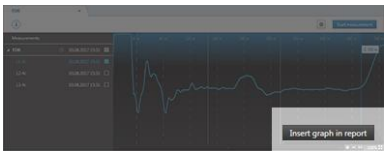


Close full screen view

- Click the button or press the *Esc* key on the keyboard.

8.4 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.

9 CREATING A REPORT

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

1. If not yet selected: Select a cable route (***File*** > ***Select cable route*** or ***DASHBOARD*** > ***CABLE ROUTES*** area).
2. Select ***CABLE FAULT LOCATION*** > ***Report***.

   You can customise the report header, show and hide graphs of measurements, and record additional information.

   You can save the report in the software and export it as a PDF. You can also load earlier reports.

Further information is provided in the user manual for the BAUR software (press *F1* key).

10 ENDING A MEASUREMENT

10.1 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.

10.1.1 Discharging

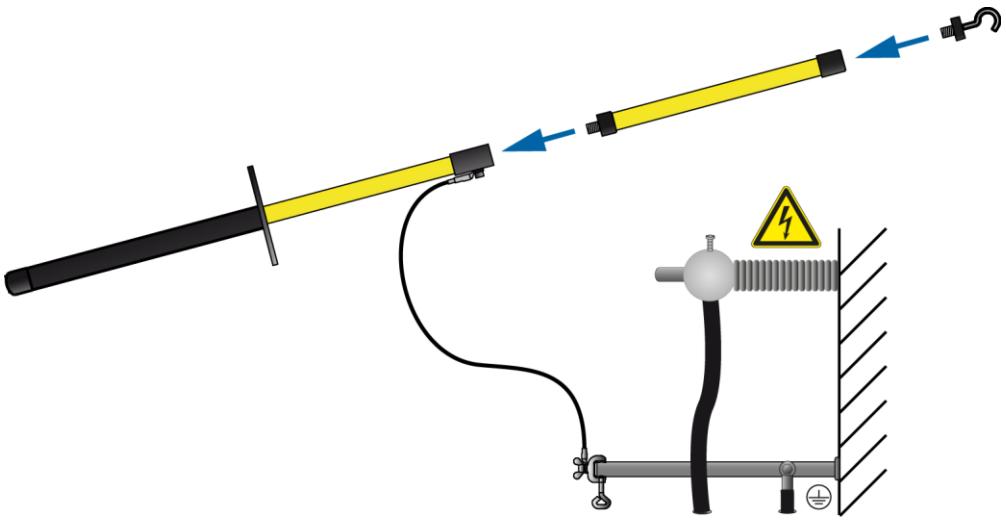
DANGER

Dangerous voltage in test object

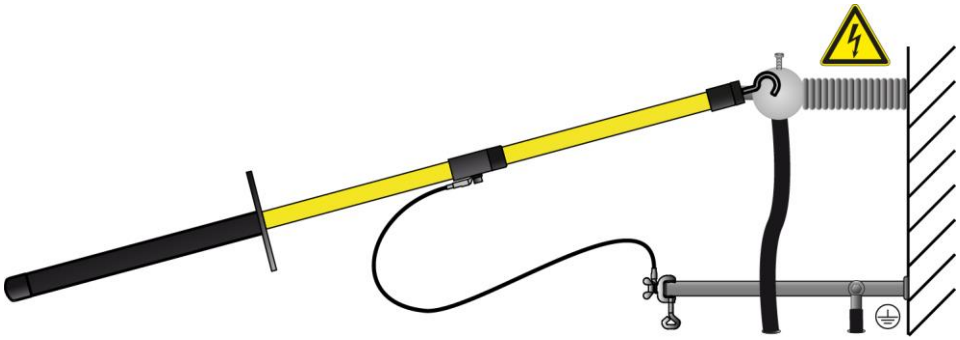
Danger to life or risk of injury due to electric shock or electric arcs.

- 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.

10.1.2 Earthing

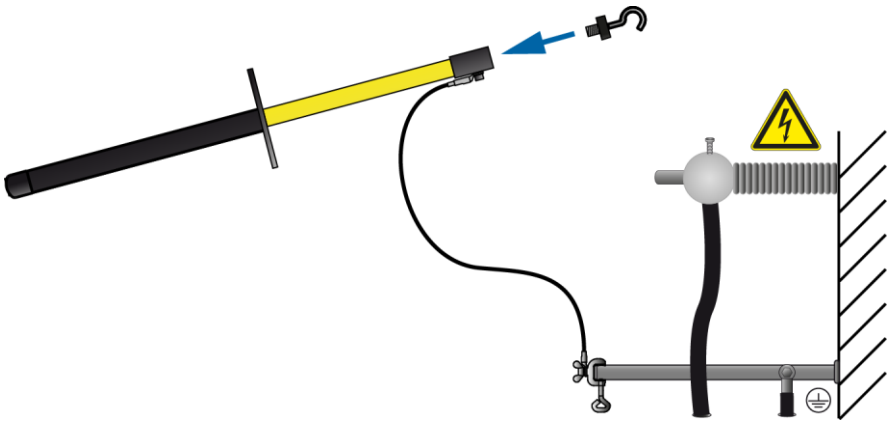
DANGER

Dangerous voltage in test object

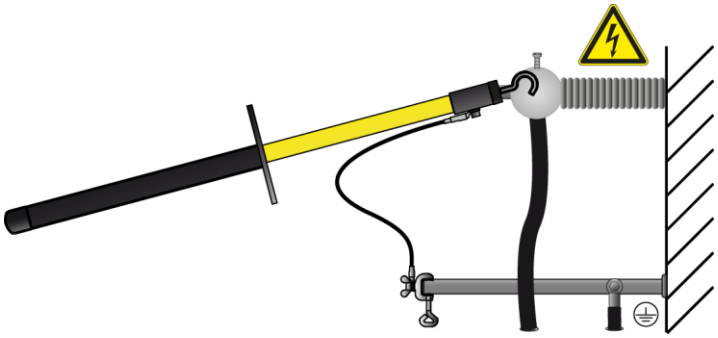
Danger to life or risk of injury due to electric shock or electric arcs.

- 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.

10.2 Taking the device and the test area out of operation

⚠ 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 assembly.
- Never disconnect the earth connections as long as power and other periphery connections are still connected.

1. Exit the BAUR software by clicking on the ***Exit*** menu item in the ***File*** menu.
2. Shut down and switch off the laptop.
3. Switch off the IRG 4000 portable via the ⏻ key.
   The ⏻ key is no longer illuminated.
4. To disconnect the device 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. Put away the connection cables.
   TDR connection cable (option): Wind the TDR connection cable up onto the hand cable drum.
8. If necessary, remove the cordoning.
9. 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.
10. Remove the barriers and marking of the test area.

11 MAINTENANCE AND CARE

11.1 Safety instructions

⚠ WARNING

Dangerous voltage in device components and adjacent live parts

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

- You may touch the live parts and connection accessories that were under voltage only if they are discharged and earthed.
- Cover the live plant parts properly.

NOTICE

Damage to device due to improper handling

The user is liable for damages caused due to improper maintenance or care.

- Never take apart the device. This can lead to device damages. Inside the device there are no components that could be serviced or repaired by the user.
- Maintenance tasks must be carried out only by personnel trained and authorised by BAUR

Establishing and ensuring voltage-free state

1. Switch off the device before starting any maintenance tasks.
2. To disconnect the device completely from the supply voltage, pull out the mains plug.

11.2 Checking and cleaning the connection cables and accessories

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.

Required equipment

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

Checking and cleaning after each use

1. Each time after using the device, clean all the connection cables used and, if necessary, wind them up onto the respective cable drum.
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

- Before and after each time you use the device, check the condition of all the connection cables. If necessary, to do this, unwind the connection cables from the cable drum and examine them for cracks, damage, and any dirt.
- Regularly check all connection accessories for damage and dirt.

11.3 Cleaning the device

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.

Required equipment

- Mild detergent
- Lint-free cleaning cloth

Procedure

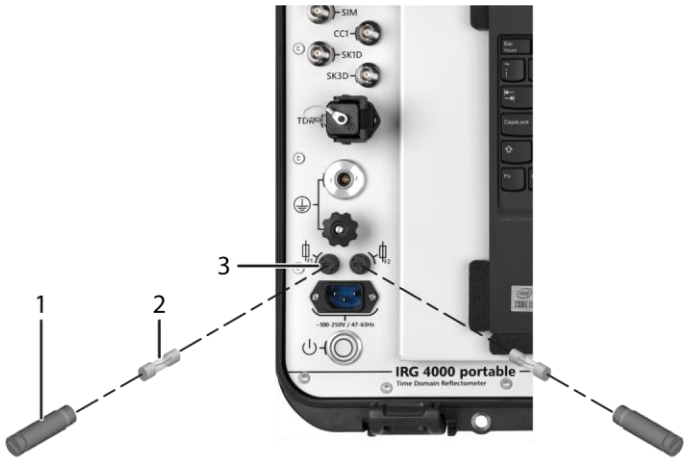
1. Switch off the device and disconnect it from the supply voltage.
   Further information: Chapter *Taking the device and the test area out of operation* (on page 35)
2. Make sure that all live parts in the immediate vicinity are covered.
3. If required, clean the device surfaces with mild detergent and a lint-free cloth.
   NOTICE! Device damage due to leaking fluids.
4. Do not allow liquids to leak into the devices.
   Note: Please note that protection against water according to IP67 degree of protection is only ensured when the IRG 4000 portable transport case is closed.

11.4 Replacing the device protection fuses

Required equipment

- Flat-blade screwdriver 1.2 x 6.5 mm
- Fuses: T 4 AH (4 A time lag)

Procedure



1	Fuse cartridge
2	Fuse
3	Groove

1. Unscrew the fuse cartridge (1) from the groove (3).
2. Replace the fuse (2).
3. Screw the fuse cartridge (1) back into the groove (3).

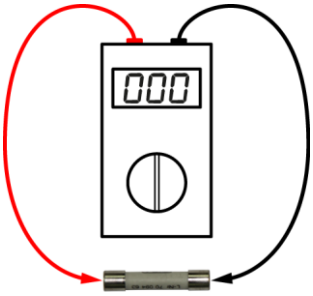
11.5 Checking and replacing the fuses in the connection cable

The IRG 4000 portable connection cable and the optional TDR connection cable both have 4 fuses each.

Required equipment

- Multimeter
- Fuse: quick-acting, 1 A / 50 kA @ AC 600 V

Procedure

1.		Unscrew one of the fuse holders from the connection cable.
2.		Remove the fuse from the fuse holder.
3.		Check if the fuse is working. For this, perform a continuity check with a multimeter. If the fuse is not working, replace the faulty fuse with a functioning one.
4.		Insert the fuse into the fuse holder.
5.		Screw the fuse holder back onto the connection cable.
6.		Check the remaining fuses of the connection cable.

12 FAULTS AND ERROR MESSAGES

NOTICE
Damage to device due to improper handling The user is liable for damages caused due to repairs. ▸ Never take apart the device. This can lead to device damages. Inside the device there are no components that could be serviced or repaired by the user. ▸ Repairs must be carried out only by personnel trained and authorised by BAUR

1. In the event of damage and malfunction, stop the device immediately.
2. Mark the faulty device accordingly.
3. Have the faults rectified by appropriately qualified personnel authorised by BAUR.

Error messages in the BAUR Software 4

Information on the error messages can be found in the user manual for the BAUR software.

12.1 Wi-Fi connection does not start automatically

▸ If the laptop does not establish the Wi-Fi connection automatically, connect it manually via the Windows settings.

- Network name: *IRG4000P_xxxx*
  xxxx represents the last four characters of the device serial number.
- Password: Device serial number
  The device serial number can be found on the rating plate. Further information: Chapter *Rating plate* (on page 18)

13 TRANSPORTATION AND STORAGE

13.1 Transportation

During transportation, or if you send the device to BAUR GmbH, a BAUR representative or the Technical Service department for repair or for any other reason, please follow the instructions below:

- *NOTICE!* Damage to device due to improper transportation.

  During transportation, ensure that the environmental conditions are as specified in the technical data for the device.

  Further information: *Data sheet* (on page 46)
- Protect the device against strong vibrations.
- Protect the device against moisture.
- Protect the device against unauthorised access.

13.2 Storage

- During storage, comply with the ambient conditions specified in the technical data for the device.

  Further information: *Data sheet* (on page 46)
- Protect the device and its components against moisture.
- Protect the device and its components against unauthorised access.

14 WARRANTY AND AFTER SALES

Warranty

For warranty claims, please contact BAUR GmbH or your local BAUR representative. 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.

BAUR GmbH

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

15 DISPOSAL

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

Device components do not belong in the domestic waste.

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

16 INDEX

IRG 4000 portable

BAUR time domain reflectometer

Figure and screenshot are illustrative

Reliable cable fault location with minimum effort

- Portable time domain reflectometer, particularly suitable for offshore use
- Creation of TDR fingerprints
- Easy operation thanks to the intuitive operational concept
- Maximum precision with high resolution and sampling rate

The IRG 4000 portable time domain reflectometer is used in combination with the BAUR system software for cable fault location, especially on long land and submarine cables.

Thanks to the proven operational concept, cable faults can be located more rapidly and easily with the IRG 4000 portable. The BAUR Software 4 is intuitive to operate and supports the operator in isolating faults. Using the IRG 4000 portable, TDR fingerprints of cables can be created that allow comparisons against existing reference measurements. Changes in the cable can therefore be detected immediately.

For increased safety and more convenient operation, the IRG 4000 portable can be operated with the laptop via Wi-Fi from a safe distance and from a protected location.

The IRG 4000 portable is a field-compatible time domain reflectometer that can be used as a portable standalone device or in combination with BAUR cable fault location systems. An optionally available HV connection cable set also enables you to work on HV cable terminations up to 10 metres high.

Fault location methods

- TDR: time domain reflectometry (1- and 3-phase)
- Insulation resistance measurement up to 1,000 V (option)
- Envelope curve display for intermittent faults – even small changes in impedance are made visible and saved.
- Further fault location methods possible in combination with other BAUR devices and systems

Features

- Remote control and data transmission by removable laptop via Wi-Fi or Ethernet connection
- Everything needed for the measurement combined in one case – time domain reflectometer, laptop, connection cables
- Transport case with wheels and trolley handle – easy to move, dustproof, shockproof and weatherproof according to IP67
- Automatic detection of cable end and fault position
- Automatic saving of all measurement data
- Storage for more than 100,000 measurements
- Interface to GIS databases (option)
- Measurement category CAT II/600 V

  In combination with the optional TDR connection cable up to CAT IV/600 V

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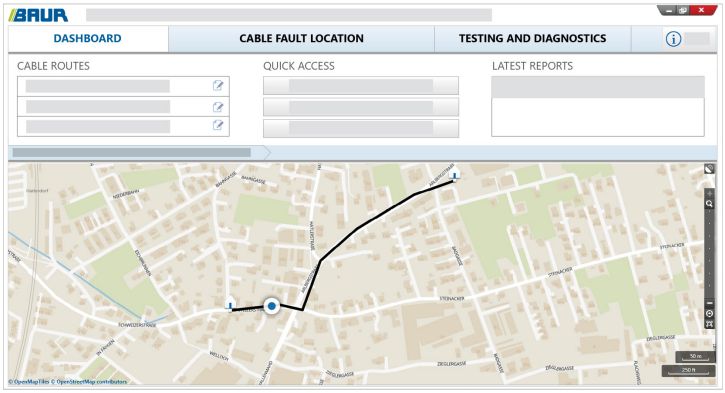
IRG 4000 portable

Time domain reflectometer for mobile cable fault location

The intuitive operational concept



- Intuitive modern user interface in multiple languages – no long introduction or familiarisation period is required
- Integration of road maps*:
  - Unique combination of road maps, including the cable route
  - Cable routes and cable faults displayed on the map
- Cable Mapping Technology CMT: Overview of cable accessories and faults in relation to the cable length
- All data on the cable route such as geographic position*, voltage level, joints, all measured values, etc. are automatically saved and can be accessed at any time.
- Quick and easy compilation of clear and precise measurement logs – with freely selectable company logo, comments and figures of the traces.

Easy and convenient to operate

- Safe and weather-protected operation by remote control and data transmission from the IRG 4000 portable via Wi-Fi or Ethernet connection
- Proven Windows operating system
- Standard data interfaces on the laptop for connecting additional equipment, e.g. printer or external data carriers
- GIS interface* enables an exchange of cable data between your GIS database and the BAUR software.

Online system

- Online support via the Internet
  - With your permission, BAUR's customer service department can access your laptop, identify your problem and quickly find a solution.
  - During the fault location, your engineers can share the desktop with the test engineer on site and support him in the analysis of the measurement results (where applicable, a licence for a desktop-sharing program may be required).

* Option

Screenshot is illustrative

Data sheet: BAUR GmbH · 826-134-3 · 07.2021 · Subject to modifications

Technical data

Pulse reflectometry	
Pulse voltage	20 – 200 V
Pulse width	20 ns – 1.3 ms
Output impedance	8 – 2,000 Ohm
Input signal gain	Dynamic range 107 dB (-63 to +44 dB)
Display 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

BAUR Software 4 – system requirements	
Operating system	Windows 10
.NET-Framework	4.8
Memory	4 GB RAM Recommended: 8 GB RAM
Display	Resolution min. 1280 x 1024 pixels Recommended: 1920 x 1080 pixels

Insulation resistance measurement (option)	
Voltage	up to 1,000 V
Measurement range	0 ohm – 5 GOhm
General	
Storage capacity	> 100,000 measurements (hard disk limit)
Export format for report	PDF
Power supply	100 – 240 V, 50/60 Hz
Max. power consumption	150 VA (without laptop)
Voltage-proof up to	400 V, 50/60 Hz
Measurement category	CAT II/600 V In combination with the optional TDR connection cable up to CAT IV/600 V
Degree of protection	
Case opened	IP54
Case closed	IP67
Dimensions (W x H x D)	Approx. 624 x 297 x 500 mm
Weight	Approx. 19.1 kg (without laptop)
Ambient temperature	0°C to +50°C
extended temperature range*	-20°C to +60°C
Storage temperature	-20°C to +60°C
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

Standard delivery

- IRG 4000 portable time domain reflectometer in transport case, incl.
  - Mains supply cord, 2.5 m
  - Earth cable, 5 m, with earth terminal
  - 3-phase connection cable, 3 m, with connection clips and fuses
  - Ethernet cable, 10 m
  - User manual
- Laptop incl.
  - pre-installed Windows operating system
  - pre-installed BAUR Software 4 (cable fault location)
  - Carrying bag

Accessories and options

- HV connection cable set, incl.
  - HV connection cable, 15 m, with connection clip
  - Earth cable, 10 m, with earth terminal
  - Earth cable, 5 m, with earth terminal
- Transport case for HV connection cable set
- TDR connection cable, 3-phase, 25 m, on hand cable drum, incl. earth cable, 5 m
- TDR connection cable, 3-phase, 50 m, on hand cable drum, incl. earth cable, 5 m
- BAUR Software 4 for office PC (office installation)

Optional software functions

- Insulation resistance measurement
- GIS interface
- Mapping (countries available on request)

Contact:

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