User Manual

Sheath Fault Location System

MFM 10

Mess- und Ortungstechnik
Measuring and Locating Technologies

Elektrizitätsnetze
Power Networks

Kommunikationsnetze
Communication Networks

Rohrleitungsnetze
Water Networks

Abwassernetze
Sewer Systems

Leitungsortung
Line Locating

Issue: 4 (09/2012) - EN

Consultation with SebaKMT

The present system manual has been designed as an operating guide and for reference. It is meant to answer your questions and solve your problems in as fast and easy a way as possible. Please start with referring to this manual should any trouble occur.

In doing so, make use of the table of contents and read the relevant paragraph with great attention. Furthermore, check all terminals and connections of the instruments involved.

Should any question remain unanswered, please contact:

Seba Dynatronic **Mess- und Ortungstechnik GmbH**	**Hagenuk KMT** **Kabelmesstechnik GmbH**
Dr.-Herbert-Iann-Str. 6 D - 96148 Baunach	Röderaue 41 D - 01471 Radeburg / Dresden
Phone: +49 / 9544 / 68 – 0 Fax: +49 / 9544 / 22 73	Phone: +49 / 35208 / 84 – 0 Fax: +49 / 35208 / 84 249
E-Mail: sales@sebakmt.com http://www.sebakmt.com	

Terms of Warranty

SebaKMT accept responsibility for a claim under warranty brought forward by a customer for a product sold by SebaKMT under the terms stated below.

SebaKMT warrant that at the time of delivery SebaKMT products are free from manufacturing or material defects which might considerably reduce their value or usability. This warranty does not apply to faults in the software supplied. During the period of warranty, SebaKMT agree to repair faulty parts or replace them with new parts or parts as new (with the same usability and life as new parts) according to their choice.

This warranty does not cover wear parts, lamps, fuses, batteries and accumulators.

SebaKMT reject all further claims under warranty, in particular those from consequential damage. Each component and product replaced in accordance with this warranty becomes the property of SebaKMT.

All warranty claims versus SebaKMT are hereby limited to a period of 12 months from the date of delivery. Each component supplied by SebaKMT within the context of warranty will also be covered by this warranty for the remaining period of time but for 90 days at least.

Each measure to remedy a claim under warranty shall exclusively be carried out by SebaKMT or an authorized service station.

This warranty does not apply to any fault or damage caused by exposing a product to conditions not in accordance with this specification, by storing, transporting, or using it improperly, or having it serviced or installed by a workshop not authorized by SebaKMT. All responsibility is disclaimed for damage due to wear, will of God, or connection to foreign components.

For damage resulting from a violation of their duty to repair or re-supply items, SebaKMT can be made liable only in case of severe negligence or intention. Any liability for slight negligence is disclaimed.

Since some states do not allow the exclusion or limitation of an implied warranty or of consequential damage, the limitations of liability described above perhaps may not apply to you.

Contents

1 Safety Instructions

1.1 Basic Notes

Safety precautions

This handbook contains basic instructions for the commissioning and operation of the MFM 10. For this reason, it is important to ensure that the manual is always available to authorised and trained personnel. Operating personnel should read the manual thoroughly. The manufacturer will not be held liable for any injury or damage to personnel or property through failure to observe the safety precautions contained in this handbook.

The specific standards and regulations in each country must also be observed.

Labelling of safety instructions

Important instructions concerning personnel, operational and technical safety are marked in the text as follows:

Symbol	Description
 WARNING	Indicates a potential danger of an electric shock that may result in fatal or serious injury.
 CAUTION	Indicates a potential danger that may lead to slight or moderate injury.
	The notes contain important information and useful tips for using the system. Failure to observe them can render the measurement results useless.

Working with products from SebaKMT

It is important to observe the generally applicable electrical regulations of the country in which the device will be installed and operated, as well as the current national accident prevention regulations and internal company directives (work, operating and safety regulations).

After working on the system, it must be voltage-free and secured against reconnection as well as having been discharged, earthed and short-circuited.

Use genuine accessories to ensure system safety and reliable operation. The use of other parts is not permitted and invalidates the warranty.

Operating staff

This system and its peripheral equipment may only be operated by trained or instructed personnel. Anyone else must be kept away.

The system may only be installed by an authorised electrician. DIN VDE 0104 (EN 50191), DIN VDE 0105 (EN 50110) and the German accident prevention regulations (UVV) define an electrician as someone whose knowledge, experience and familiarity with the applicable regulations enables him to recognise potential hazards.

Repair and maintenance

Repair and maintenance work may only be performed by SebaKMT or authorised service partners. SebaKMT recommends having the system tested and maintained at a SebaKMT service centre once a year.

SebaKMT also offers its customers on-site service. Please contact your service centre as needed.

Electromagnetic radiation

This device is designed for industrial use according to EN 55011. When used at home it could cause interference to other equipment, such as the radio or television.

The interference level from the line complies with the limit curve B (living area), the radiation level complies with the limit curve A (industrial area). Once the living area is sufficiently far away from the planned area of operation (industrial area), equipment there will not be impaired.

Lifting and carrying

The device must only be lifted and carried using the handles provided on the top and side. Other parts of the device, such as the accessory bag or connecting cables, cannot withstand the forces caused by lifting the device and could break or tear off as a result.

1.2 General Safety Instructions and Warnings

Use only as intended

The operating safety is only guaranteed if the delivered system is used as intended. Incorrect use may result in danger to the operator, to the system and the connected equipment.

The thresholds listed in the technical data may not be exceeded under any circumstances. Condensation during the operation of SebaKMT products may result in danger to persons and devices through voltage arc-over. Prevent condensation before and during the measuring mode by cooling the measuring systems sufficiently. The operation of SebaKMT products in direct contact with water, aggressive substances and inflammatory gases and vapours is prohibited.

The MFM 10 is built to be robust and can withstand the stresses it can expect to be subjected to in demanding everyday use. Nevertheless, it is a precision measuring device which needs to be treated with the appropriate care. This applies in particular to the connection cable and the clamps, which play an important role in ensuring the device remains safe while the results of measurements remain precise.

Procedure in the event that the device malfunctions

The system may only be operated whilst it is in perfect working condition. In the event of damage, irregularities or malfunctions that cannot be resolved with the assistance of the operating instructions, the system must be shut down immediately and labelled accordingly. In such an event, the relevant management must be informed. Please contact SebaKMT Service immediately, to eliminate the malfunction. The system may only be started up again once the malfunction has been eliminated.

Five safety rules

The five safety rules must always be followed when working with HV (High Voltage):

1. De-energise
2. Protect against re-energising
3. Confirm absence of voltage
4. Earth and short-circuit
5. Cover up or bar-off neighbouring energised parts

Using cardiac pacemaker

Physical processes during operation of high voltage may endanger persons wearing a cardiac pacemaker when near these high voltage facilities.

Fire fighting in electrical installations

- According to regulations, carbon dioxide (CO_2) **is required to be used** as extinguishing agent for fighting fire in electrical installations.
- Carbon dioxide is electrically non conductive and does not leave residues. It is safe to be used in energized facilities as long as the minimum distances are maintained. A CO_2 fire extinguisher must be always available within electrical installations.
- If, contrary to the regulations, any other extinguishing agent is used for fire fighting, this may lead to damage at the electrical installation. SebaKMT disclaims any liability for consequential damage. Furthermore, when using a powder extinguisher near high-voltage installations, there is a danger that the operator of the fire extinguisher will get an electrical shock from a voltage arc-over (due to the powder dust created).
- It is essential to observe the safety instruction on the extinguishing agent.
- Applicable is DIN VDE 0132.

WARNING

Be careful when working with high voltage

Working on high voltage systems and equipment – especially in non-stationary operation – requires particular care and safety-conscious action on the part of test personnel. VDE regulations 0104 on setting up and operating electrical test systems, as well as EN 50191 and national standards and regulations must be strictly adhered to.

- The System generates a dangerous voltage of up to 10 kV. This is supplied via a HV connection cable to the test object.
- The test system may not be operated without supervision.
- Never fail to use safety equipment or put it out of operation.
- To prevent dangerous charge accumulation, earth all metal parts in the vicinity of the high voltage equipment.
- When high voltage is shut off, the cable under test is discharged by an internal discharge device. This discharge device is designed for a maximum test object capacity in compliance with the technical data. This value must not be exceeded. The discharge device may otherwise become damaged and charge may remain in the test object. The cable must therefore always be discharged in accordance with the applicable safety regulations, e.g. discharged using a discharge rod and then be shorted before the danger zone is accessed.

2 Technical Description

2.1 System Description

Intended use

For power cables and particularly for cables in the field of telecommunication, an undamaged cable sheath is an exceptionally important prerequisite to avoid serious cable faults which would influence the quality of supply. The conservation of the value of a cable is also determined by the attention paid to the condition of the sheath. Irrespective of the tests and diagnoses of the core insulation, the early recognition and elimination of sheath faults has a stabilising effect on the operational quality of a cable system.

The sheath fault location system MFM 10 was developed for this purpose. This device is used for the general measurement of insulating cable sheaths and, due its numerous applications, is regarded as the universal device for these measuring requirements. Accordingly, the MFM 10 permits in the easiest way the testing of cable sheaths and prelocation and pinpointing of cable sheath faults.

Function

To detect sheath faults, the MFM 10 works in test mode with a voltage of up to 10 kV (negative polarity), which also permits cables with a thicker outer sheath to be tested.

The pre-location of a detected sheath fault takes place using the voltage drop method, in which the current, voltage and resistance before and after the fault location are determined and considered in relation to the cable length. The necessary measuring and calculation steps take place automatically and, in a brief period, the distance to the fault is displayed. Due to bipolar measurement, falsifying thermoelectric and galvanic influences can be detected and mathematically eliminated.

The available current of up to 750 mA also enables the “burning” of difficult sheath faults, if necessary.

Furthermore, the MFM 10 is capable of generating a pulsed DC voltage which allows pinpointing of sheath faults with an earth fault locator. If the device is equipped with the “AF” option it simultaneously transmits a 8.44 kHz audio frequency signal into the cable when working in pinpointing mode.

Features The MFM 10 combines the following features in a single device:

- Easy and comfortable operation via rotary encoder (EasyGo) and touch screen
- Bipolar measurement
- Pre-location by means of the voltage drop method with a direct measurement of resistance
- Burning with up to 750 mA of continuous current
- Pinpointing with pulsed DC voltage
- Very fast, fully automatic measurement
- Independent from the resistance of supplementary wires and test leads
- Detection of correct hook-up to cable under test
- Fault locating of high resistive faults inside cables
- Detection, storage and data recording of fast processes (wipers, breakdowns)
- Logging and log data export to Easyprot software via USB
- Integrated discharge
- High-performance battery for power supply independent of the mains
- Robust IP53 trolley case with extendable handle
- Wide range input for the voltage supply

Scope of delivery The scope of delivery of the system includes the following:

- MFM 10
- HV connection cable, 4 m
- Mains connection lead, 2.5 m
- Earthing lead, 5 m
- 2 x measuring leads (incl. aligator clips), 0.5 m
- Motor vehicle charging lead, 3.5 m
- Accessory bag
- USB stick with Easyprot software
- Manual

Check the contents of the package for completeness and visible damage right after receipt. In the case of visible damage, the device must under no circumstances be taken into operation.

If something is missing or damaged, please contact your local sales representative.

Optional accessories The following optional accessories can also be ordered from SebaKMT Sales:

Accessory	Description	Item number
Connection set for HV cable terminations	Connection set with 8 larger connection clamps (e.g. for HV cable terminations) and connection cables 2 m in length (for the wiring at the far end of the cable)	118308004
High-voltage test cable HSK 36-10, 10 m	Longer HV connection cable (the individual colour-coded cables to connect to the test object are also longer).	118307484

2.2 Technical Data

The MFM 10 has the following parameters:

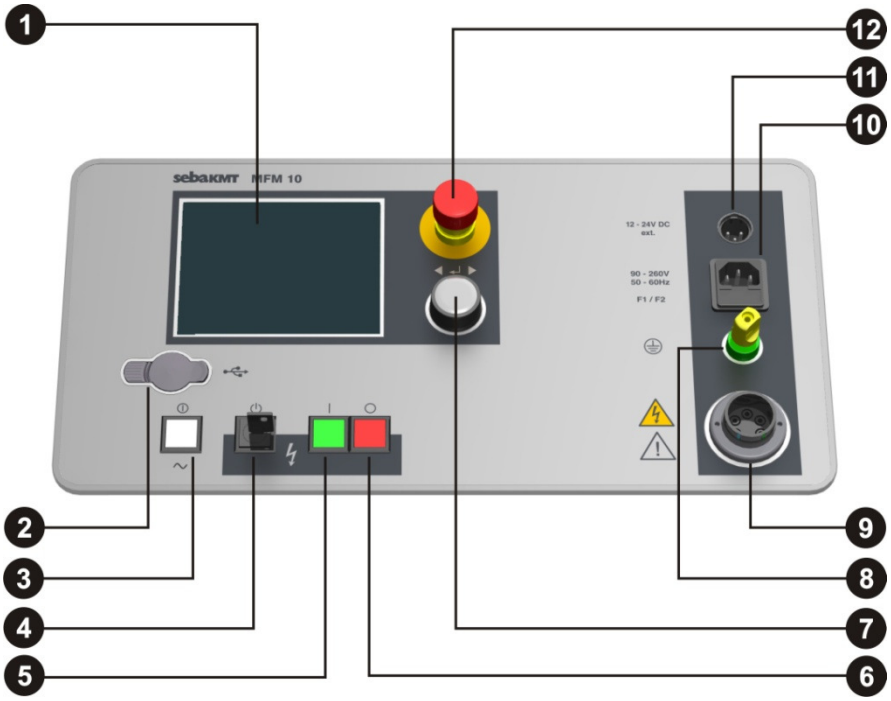
Parameter	Value
Output voltage	0 … 10 kV DC, bipolar
Output current	750 mA at 0.4 kV, 200 mA at 0.5 … 1.5 kV, 60 mA at 5 kV, 30 mA at 10 kV
Maximum permitted capacity of the test object	10 µF
Test voltage	0 … –10 kV
Pre-location	
• Method	Voltage drop method (fully automatic)
• Measuring accuracy	±0,1%
Pinpointing	
• Voltage	0 … -10 kV DC, pulsed
• Duty cycle	adjustable
• Pulse rates	0.5:1 / 1:2 / 1.5:0.5 / 1.5:3.5 4,8 Hz („vLoc“ A-frame of VivaxMetrotech) 3 Hz („SFL2“ A-frame of Metrotech)
• Audio frequency (devices with “AF” option only)	f = 8.44 kHz, Uo = 100 V_{RMS}, P = 15 W_{peak}
Power supply (rated voltage)	88 V … 264 V, 50 / 60 Hz
DC supply (for charging only)	12/24 V DC
Battery	Built-in NiMH battery (340 Wh)
Operating time whilst battery powered	approx. 2 hours[1]
Power consumption	max. 500 VA

[1] The value depends largely on the operating conditions. The value specified applies to continuous pinpointing with a rate of 1:3 at an output of 300 W.

Parameter	Value
Display	320 x 240 pixel LCD, LED backlight
Interfaces	USB port
Memory	2 GB flash memory for system and user data
Data logging	with a USB stick
Operating temperature	–25 °C ... +55 °C
Storage temperature	–40 °C ... +70 °C
Operating humidity	max. 93% relative humidity
Dimensions (W x H x D)	500 x 457 x 305 mm
Weight	25 kg
Protection class (according to IEC 61140 (DIN VDE 0140-1))	I (protective earthing)
Protection rating (according to IEC 60529 (DIN VDE 0470-1))	IP53 (with closed lid)

2.3 Connections, Controls and Display

The MFM 10 has the following connections, controls and display:



Element	Description
1	Touch-screen display
2	USB port
3	On/off push-button
4	HV “interlock” key switch
5	“HV ON” push-button
6	“HV OFF” push-button
7	Rotary encoder
8	Protective earthing connection
9	HV output **WARNING** The MFM 10 generates a dangerous voltage of up to 10 kV during HV operation. This is induced into the HV connection cable through the HV output.
10	Power supply socket with fuses F1 / F2 (2 x M6,3/250)
11	12 … 24 V DC charging socket
12	Emergency off button

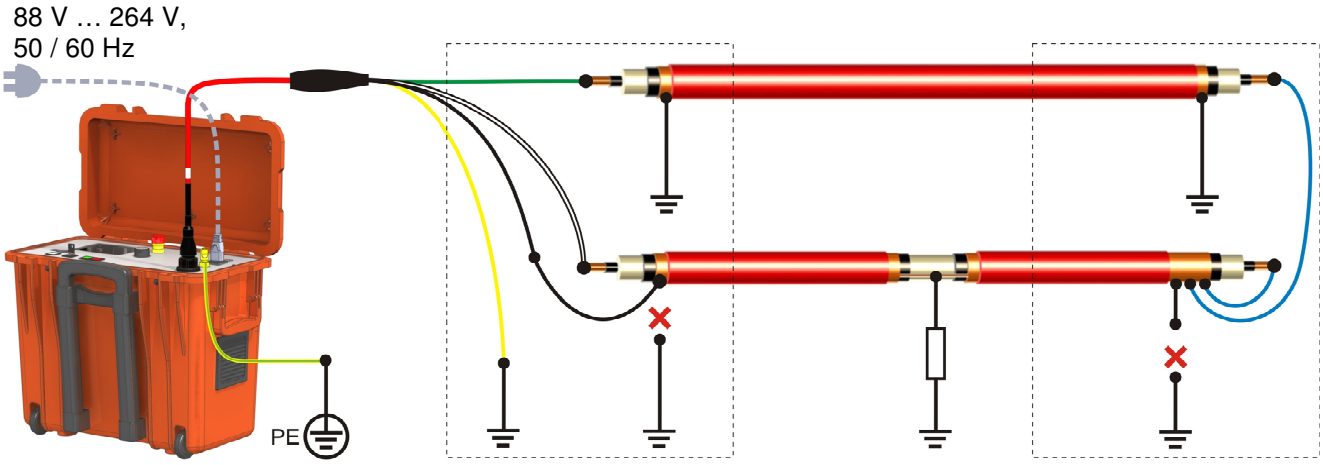
3 Commissioning

WARNING

Safety instructions for commissioning

- The safety guidelines for the operation of mobile testing systems often differ from one network operator to another and are frequently subject to national regulations (such as the German BGI 5191). Before the measurement session, find out what the applicable guidelines are and follow the rules set out therein precisely, in respect of the organisation of work and the commissioning of the mobile test system.
- Before connecting the test object, always follow the general safety instructions and the five safety rules in particular (see page 7).
- Select a location that is sufficient for the weight and size of the system and which ensures that it stands securely.
- The air inlet and outlet vents on both sides of the device may not be covered during operation.
- When setting up and connecting the device, make sure that it does not impair the function of any other systems or components. If other systems and components have to be modified in order to set up and operate the device, be sure to reverse these actions when the work is finished. Always take the special requirements of these systems and components into account and only carry out work on them after consulting and obtaining approval from whoever is in charge of them.
- All cables which are out of operation and not tested must be shorted and earthed.
- The protective earth connection (8) must always be connected to a suitable earthing point (e.g. station earth). Inadequate protective earth, especially when operating the MFM 10 by battery, can raise the potential of the device, and the hazardous voltages produced make it unsafe to handle.
- Since the voltage applied to the test object can assume values that pose a risk of incidental contact, the cable ends must be shielded in accordance with VDE 0104 to avoid this. When doing so, be sure to take all cable branchings into account.

Connection diagram The following figure shows the simplified connection diagram:



Electrical connection In principle, the connection diagram shown above applies for all operating modes. Connection leads that are not required are automatically switched off.

Connect the system in the following order:

Step	Description
1	Using the earthing cable, the protective earthing connection ❽ of the MFM 10 is connected to a suitable point on the protective earth system (station earth).
2	Plug in and tighten the HV connection cable to the HV output ❾ on the device, in compliance with the alignment specified by the guide grooves.
3	Connect the **yellow** connection lead to the earthing busbar of the cable system that is to be tested.
4	Connect the **black** connection lead to the screen of the cable that is to be tested. When testing the sheath of cables for which the probability of a sheath fault is very low, steps 5 to 6 can be omitted and, instead, all of the screens at the far or near end of the cable system can be bridged. In this way, all sheaths are tested in a single step, without having to reconnect at the far end. In this procedure, the capacity of the measured object is the sum of the capacities of all the connected screens and, of course, must not exceed the maximum capacity of 10 µF! If the test result indicates that a screen is affected by earth leakage, the electrical connection must be corrected and each sheath individually tested.

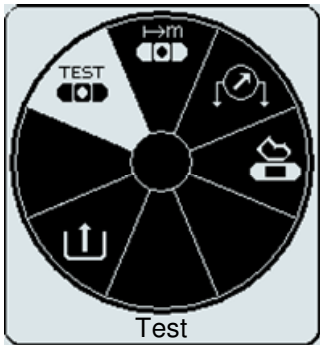
Step	Description
5	The pre-location using the voltage drop method requires two healthy auxiliary conductors. Connect the **white** connection lead to the phase conductor of the cable that is to be tested. Connect the **green** connection lead to the phase conductor (auxiliary conductor) of an additional cable that is part of the system. Instead of the phase conductor, an intact screen can also serve as the auxiliary conductor.
6	At the far end of the cable, connect the auxiliary conductors with the screen of the cable that is to be tested. To achieve optimal results during pre-location, you should use separate connection clamps to connect the auxiliary conductors to the screen. The clamp of the auxiliary conductor connected to the white connection lead should be placed closer to the far end of the screen than the one of the auxiliary conductor connected to the green connection lead (see connection diagram). Make sure the contact is of good quality (remove or clean any dirt or corroded surfaces).
7	As the output voltage is applied between screen and earth, the **earthing of the screens and the auxiliary conductors must be removed**! If there are any voltage transformers, they must be separated from the test object.
8	If the unit is to be powered through the mains, connect the supplied mains power cable to the power supply socket (8) of the MFM 10 and a mains socket. Otherwise, the device on being switched on is automatically powered by the internal battery. In which event, ensure that the battery has a sufficient charge. If necessary, charge the battery (see page 33).

4 Operation

4.1 Switching On the System

As soon as the device receives voltage through the power supply socket, 10 it automatically starts charging the battery. A corresponding message appears on the display.

The MFM 10 is started by pressing the on/off push-button 3. After a few seconds, the system is ready for use. The main menu appears in the display.

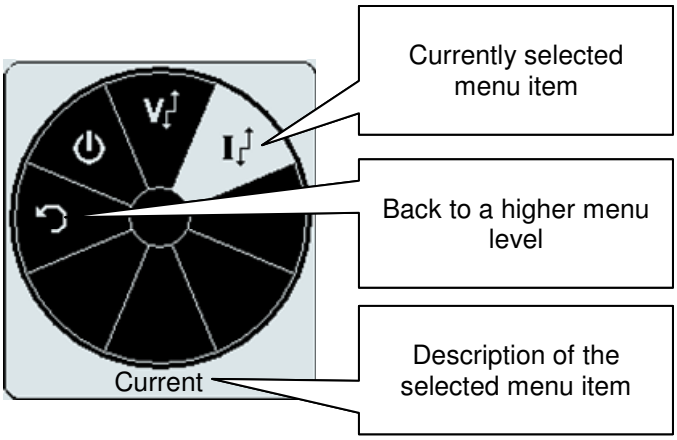


In this state, the high voltage source is still switched off and the high voltage output earthed via a discharge resistor.

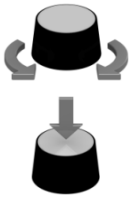
4.2 General Operation

Navigation within the menus

Navigation within the menus is accomplished almost entirely via the circular selection menu:



The operation of the system with the rotary encoder 7 is as follows:



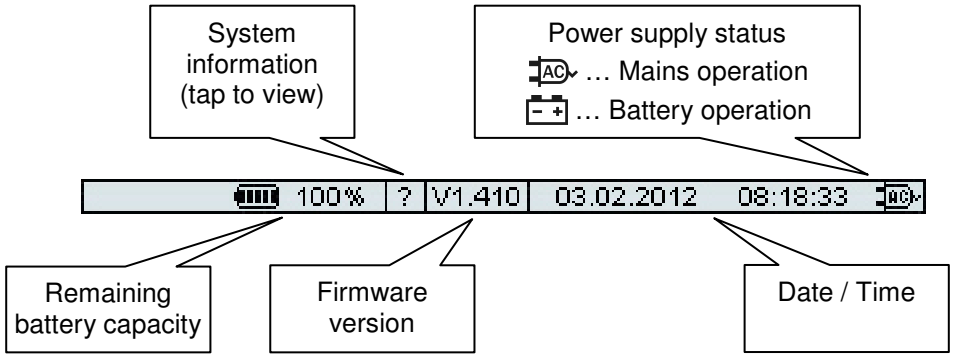
- Select a menu item
- Increase or decrease the value of a variable parameter

- Call up the selected menu item
- Confirm the settings made

Alternatively, almost all the steps can be accomplished directly on the touch screen.

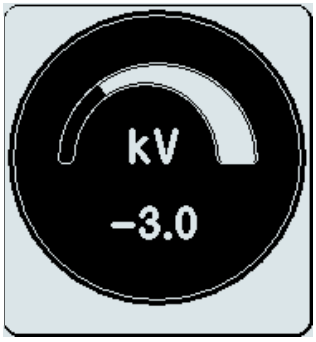
Status bar

The status bar at the bottom of the screen provides the following information:



Adjusting the test or measuring parameters

When setting a variable parameter, the following view appears:



The value of the parameter can then be varied by turning the rotary encoder within the permissible range of values and pressing it briefly to confirm.

As the output voltage settings can be bi-polar (depending on the operation mode), the voltage value always has a positive or negative prefix.

To change the polarity, the voltage must first be reset to 0. The polarity can then be selected, by continuing to rotate the rotary encoder anticlockwise.

4.3 Security Mechanisms

Introduction

The safety circuit of the system permanently tests all security-related parameters and switching operations on the system as soon as an operating mode is selected that activates the HV output. Should the safety circuit detect a deviation from the monitored conditions while in high voltage mode, high voltage is immediately switched off and the HV output is discharged. The fault that occurred is shown in the display and must be eliminated before operation can be resumed.

The safety circuit's conditions

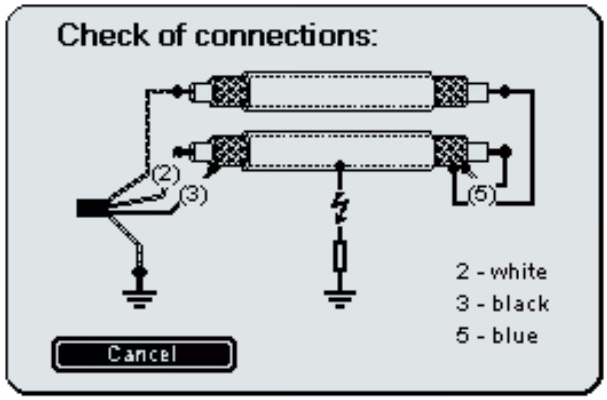
The following conditions must be fulfilled in order to perform tests under high voltage:

- The HV "interlock" key switch 4 must be in the ⏻ position.
- The EMERGENCY OFF switch 12 must not be pressed.
- F-Ohm: The transfer resistance between protective earth and operational earth must not exceed a certain threshold (possible fault sources: missing protective earth connection, poor earthing conditions or HV plugs that are not securely bolted).
- The HV connection cable must be correctly connected (see below).

Check of connections

If activated in system settings (see page 20), an automatic connection check takes place upon activation of the test and prelocation operating modes. In order to get the mode started, the check must result in reasonable resistance values between the individual connections.

In the case of any deviations, the wiring diagram corresponding to the selected operating mode is displayed. The following figures shows the screen view after a failed connection check in prelocation mode:



In this case the system should be turned off and the connections should be checked and corrected.

4.4 System Settings

The setup menu which is divided into following categories can be accessed via the menu item from the main menu:

Category	Setting	Description
General	**Date / Time**	Correct date and time settings are required for the logging function.
	Sprache	Selection of the interface language.
Test	**Current Limit**	Enables/disables the possibility to set a current limit in test operating mode.
	Test of connections	Enables/disables the automatic connection check (see previous page) in the test operating mode.
	Flash over detection	Enables / disables automatic flash-over detection with abrupt termination of the test.
	EasyProt report	Enables/disables the logging function. If this function is active, a dialog box prompts you to store the logged data right after the sheath test has been finished. This requires a USB flash drive to be plugged into the USB port 2.
Prelocation	**Test of connections**	Enables/disables the automatic connection check (see previous page) in the prelocation operating mode.
Service		Access to this password protected area is restricted to authorized service personnel only.

4.5 Operating Modes

4.5.1 Testing a Cable Sheath - TEST

Introduction

Testing the integrity of a cable sheath with an easy to perform insulation or dielectric test is useful for the early detection of imminent cable faults.

Such a test should be carried out for the first time within the scope of an acceptance test and subsequently at regular intervals as well.

Test parameter

In preparation of sheath testing, the following test parameters must be set:

Menu item	Description
V	**Voltage** The test voltage can be set within the range of 0 to –10 kV. In terms of the relevant standards (such as e.g. VDE 0276), which may however differ from the local regulations or standards, the following guidelines are specified: • PVC cable ≤3 kV • PE medium voltage cable ≤5 kV • PE high voltage cable ≤10 kV
I	**Current** If enabled in the system settings (see page 20), the current can be limited to a maximum value. The limitation can be removed by selecting **0** or the maximum value.
	Test duration The duration of the test can be specified within a range of 0 to 60 minutes. In the relevant standards (e.g. VDE 0276), the duration of the test is specified between 5 to 10 minutes depending on the cable type. At a setting of **0** minutes, the MFM 10 runs in continuous operation mode and must be stopped manually.

Procedure Proceed as follows to perform sheath testing:

Step	Description
1	In the main menu, call up the menu item TEST
2	Set voltage and test duration in accordance with the type of cable to be tested (see previous page).
3	Start the test via the menu item ⏻.
4	Press the “HV ON” push-button 5.
	Result: The test voltage is ramped up and the cable screen charged. Sudden changes or just one single fast increase of the current during the voltage rise are a clear indication of a sheath fault and are logged by the system. During the further course, brief current increases are also continuously monitored. After a voltage flash-over (if activated in system settings (see page 20)) or the expiry of the test duration, the high voltage switches off automatically.
5	If the test is run in continuous operation mode, the high voltage must be manually deactivated with the “HV OFF” push-button 6.
6	If this has been activated in the system settings (see page 20), a query will be issued at the end of the test whether the log should be saved. To do so, a USB stick must be inserted into the USB port 2 after which the **Yes** button must be pressed.

Evaluation of the test results Generally, the results of a sheath test can be divided into the following categories:

Test result	Description / action
The cable sheath passed the voltage test without any irregularity.	The cable sheath is intact and within the scope of normal, regular cycles should continue being tested.
During the test increased leakage current values were detected	If the determined leakage current values are above the limits specified by the cable owner, the tested cable should be examined in more detail soon or at least a shorter testing cycle should be introduced.
There were one or more breakdowns in the cable sheath during the test.	If possible, the sheath fault should immeadiately be pre-located (see page 23) and subsequently pinpointed.

4.5.2 Pre-Locating a Sheath Fault - ↦m

Introduction

In order to substantially reduce the time required for pinpointing, the pinpointing of the location of the sheath fault is preceded by a pre-location. This reduces the risk of the fault location unintentionally "drying up" during the course of a lengthy pinpointing.

Due to thermo-electric or galvanic effects there can be offset voltages on top of the actual measured voltage during the measurement. To elimate these effects, the pre-location is performed with bipolar voltages, i.e., the system automatically performes two measurements (one with positive and one with negative polarity).

The length of the cable must to be known for the sheath fault pre-location!

Measuring parameters

In preparation of sheath fault pre-location, the following parameters must be set:

Menu item	Description
V	**Voltage** The device always carries out pre-location bipolar and fully automatically. The amount of the voltage can be set within the range of 0 kV to 10 kV. The voltage should be set to the value at which the sheath fault occurred during the previous test.
↦m	**Cable length** The length of the connected cable in metres.

Procedure

Proceed as follows to perform sheath fault pre-location:

Step	Description
1	In the main menu, call up the menu item ↦m.
2	Set the voltage and the cable length.
3	Start the fault location via the menu item ⏻.
4	Press the "HV ON" push-button (5).
	Result: The device runs through the automatic fault location algorithm. Readings are taken from the near and far ends of the cable, respectively, with both voltage polarities and the fault distance determined, using the voltage drop method.
	If the "HV OFF" push-button (6) is pressed during the automatic pre-location, operation may not be stopped and high voltage may not be turned off until the current sub-step is finished. Accordingly, in emergencies the emergency off button must always be used, as the high voltage is then immediately switched off and the cable discharged.
5	On completion of the measurement, the high voltage is switched off and the cable discharged. The fault distance that has been determined can be read in the display.

Multiple sheath faults

Several sheath faults at the same cable can lead to measurement errors and false distance data.

However, there are signs which indicate multiple faults and consequently should be taken into consideration during pre-location.

If there are several faults with earth-contact, the displayed distance is an average of the complete cable length. Therefore, special attention is required if the measured fault distance is similar to 50% of the complete cable length.

Highly scattered distance values at changing test voltages can also potentially indicate the presence of multiple faults, as the faults generally have different ignition voltages.

At the same time, these different ignition voltages offer an approach which allows pre-location to be carried out even on sheaths with multiple faults. The most ignitable fault can be measured first by carefully increasing the test voltage. After it has been located and repaired, a further pre-location can be carried out.

4.5.3 Pinpointing a Sheath Fault -

Introduction

During sheath fault pinpointing, the MFM 10 transmits direct current pulses at an adjustable rate into the screen affected by the earth fault.

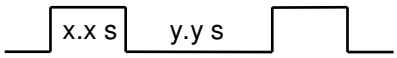
With each coupled pulse, the current flowing into the ground forms voltage gradients in the area around the fault, the centre of which can be located precisely with the assistance of a sheath fault locator and its earth rods (step voltage method).

"AF" option

For devices equipped with the "AF" option, a 8.44 kHz audio frequency signal is transmitted in parallel to the pulsed DC voltage. This signal, which can be evaluated using a suitable receiver, allows an exact line tracing to be carried out.

Measuring parameters

In preparation of sheath fault pinpointing, the following parameters must be set:

Menu item	Description
V	**Voltage** The voltage can be set within the range of 0 to –10 kV. The voltage value of the previous test should be used.
I	**Current** To prevent further damage to the cable sheath during the time-consuming pinpointing procedure or to limit the step voltage arising around the fault position, the current can be limited.
	Duty cycle Relationship between the duration of the direct current pulse and the interval between two pulses. You can choose from the following options: **x.x s – y.y s**  **A-vLoc** Special pulse rate (3 Hz) for the "vLoc" A-frame of VivaxMetrotech. **A-SFL2** / **Dx** Special pulse rate (4.8 Hz) for the "SFL2" A-frame of Metrotech.

Procedure Proceed as follows to perform sheath fault pinpointing:

Step	Description
1	In the main menu, call up the menu item .
2	Set the voltage, the current and the duty cycle.
3	Start the pinpointing via the menu item .
4	Press the “HV ON” push-button 5.
	Result: The MFM 10 with the set pulsing couples the DC pulse in the screen affected by the earth fault. Devices equipped with the "AF" option transmit a 8.44 kHz audio frequency signal in parallel.
5	Locate the fault location or trace the line (devices with “AF” option only) with the assistance of a suitable receiver (e.g. ESG, A-frame or FL 10). For detailed instructions on how to use the receiver, please read the respective manual. **WARNING** • Do not leave the system in operation unattended and accessible to the third parties. Lock the location securely or instruct an authorised person to monitor the system. • Due to the current emerging into the ground at the fault location, a step potential is produced. Depending on the current rating and the respective ground and weather conditions, this voltage can exhibit different values near the fault location. When pinpointing with the aid of a earth leakage detector, close attention must be paid to the respective voltages measured in order to detect dangerous voltages in time. In such an event, the current rating on the MFM 10 must be reduced accordingly.
6	After completing the pinpointing of the sheath fault, press the “HV OFF” push-button 6 to switch off the pulsed DC.

4.5.4 Burning -

Introduction The available current of up to 750 mA also enables a fault conversion by the so-called “burning” of difficult sheath faults (e.g. high-impedance or intermittent faults).

In which the thermal reaction to the electric arc converts the hydrocarbons of the cable insulation at the fault location into conductive carbon. The fault resistance is lowered and accordingly pre-location and pinpointing is easier.

Measuring parameters In preparation of the burning process, the following parameters must be set:

Menu item	Description
V	**Voltage** The voltage can be set bipolar (see page 18) within the range of −10 kV to +10 kV. The voltage value of the previous test should be used.
I	**Current** To prevent damage to the cable sheath, the current can be limited.

Procedure Proceed as follows to operate the device in burning mode:

Step	Description
1	In the main menu, call up the menu item .
2	Set the voltage and the current.
3	Start the test via the menu item .
4	Press the “HV ON” push-button 5.
	Result: The test voltage is ramped up and the cable screen charged. The respective voltage applied and the current passing through are shown in the display. Via the V menu item, the output voltage can be changed during burning which makes it possible to observe the response of the fault in real-time.
	Exceeding or falling short the thresholds −400 V, 0 V and +400 V results in a range shift, which due to system constraints is associated with a brief shutdown of the output voltage. Therefore, to avoid interruption of the burning process, these thresholds should not be crossed when changing the output voltage during burning.
5	Terminate the burning process by pressing the “HV OFF” push-button 6.
6	Afterwards, try to pre-locate (see page 23) the sheath fault again.

4.6 Special applications

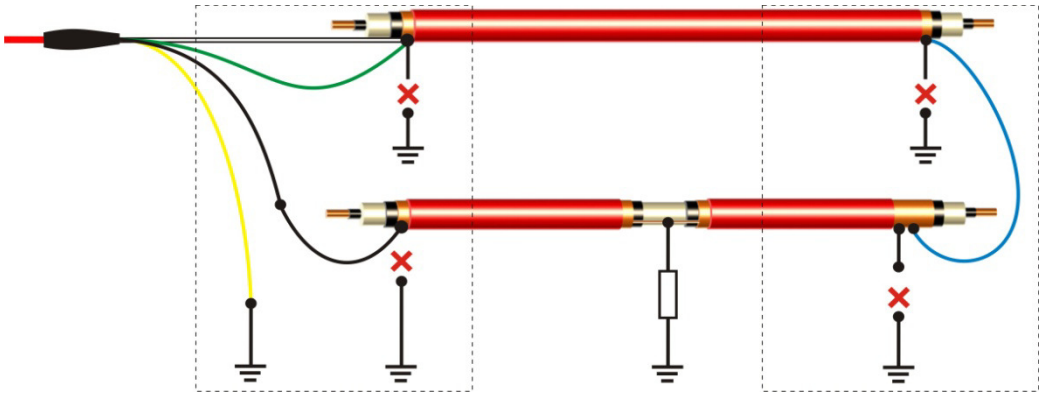
Pre-location using one auxiliary conductor only

This method of pre-locating a sheath fault should only be used when absolutely unavoidable, e.g. when no second, fault-free auxiliary conductor is available.

The precision will be impaired in the same way as the simple Murray loop bridge is impaired by the effects of the contact resistances, but should remain comparatively higher.

Furthermore, the auxiliary conductor must be fault-free and of the same type (cross section, material) as the faulty conductor.

It is connected as follows:



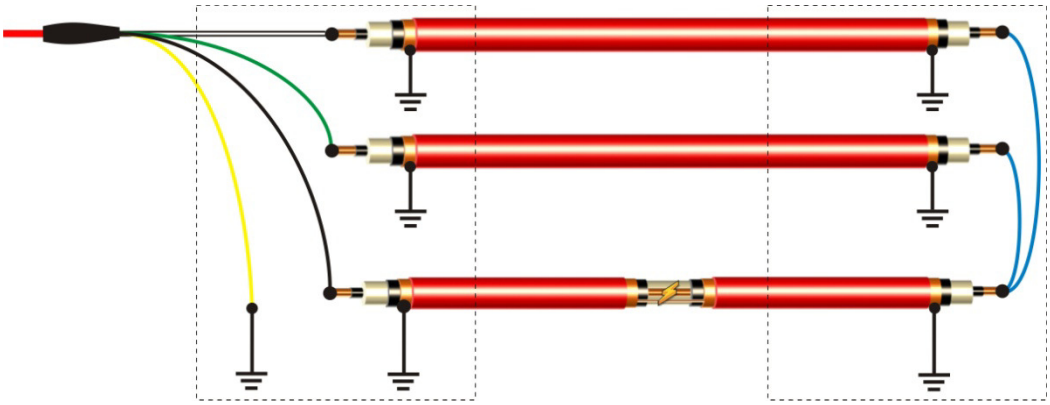
For this type of pre-location, the **double cable length** must be entered!

Pre-location of non-earthed inner conductor faults

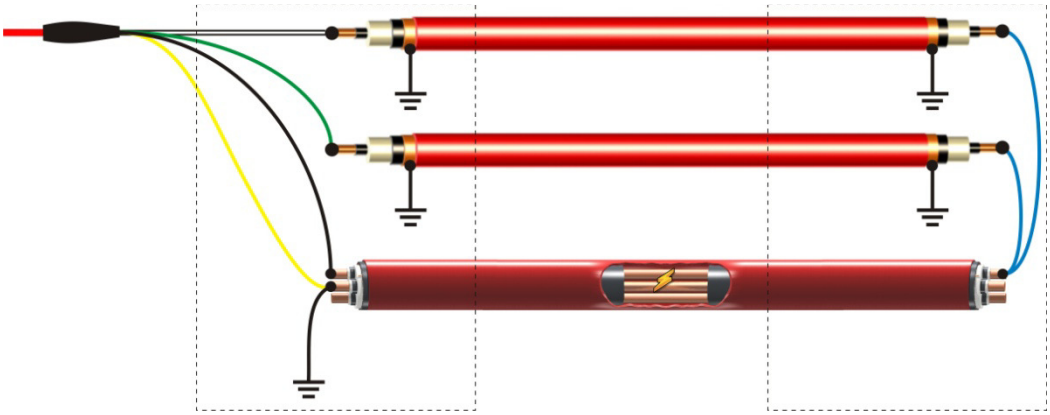
Using the MFM 10, it is possible to locate non-earthed faults in inner conductors. In MV cables with standard cross sections in particular, faults with a fault resistance of several MΩ can be pre-located to within a few metres.

In these cases (especially on very high-impedance inner conductor faults) the correct connection method has a significant effect on the accuracy of the measurement.

For a fault between the inner conductor and the screen occur, the faulty cable and the fault-free auxiliary conductor (green / white) must be connected as follows:



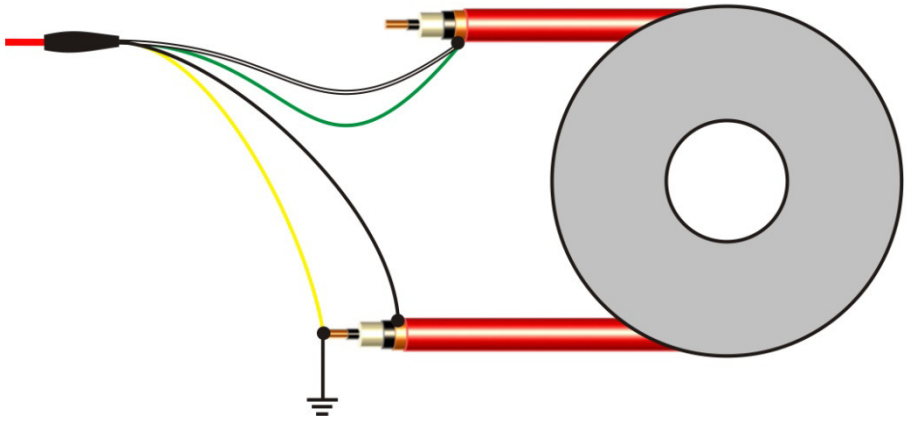
For a fault between two adjacent inner conductors of a multicore cable, the yellow connection cable must be connected to the second, faulty inner conductor which must, in turn, be connected to earth.



Pre-location when there is direct access to both ends of the cable

Under certain circumstances, pre-location can also be performed on a spooled cable which allows the MFM 10 to be connected directly to both end of the cables.

To pre-locate an inner conductor fault, the cables only have to be connected to the two faulty conductors as shown in the following illustration (screen/inner conductor or inner conductor/inner conductor):



Pre-locating a sheath fault, in contrast, requires a conductive sheath with is used as a return conductor for the fault current. The yellow connection cable must, in this case, be connected to the earthed outer sheath. The contact for the conductive sheath must be established very carefully (e.g. using copper mesh tape which is looped tightly around the sheath several times and pressed securely in place using pipe clamps or cable ties).

The reference point for the measured fault distance is the end of the cable to which the black and yellow lines were connected.

Pre-location for cables with a conductive outer layer installed in pipes

For this application, the conductive outer sheath of the cable is used as a return path for the fault current. Accordingly, the outer sheath must be earthed at as many places as possible to ensure the fault current can flow out of the pipe and into the ground. An earth point like this can e.g. be established with the aid of copper mesh tape (see above).

4.7 Concluding the test

Once the measurement has been completed, the system can be switched off with the on/off push-button (2).

The test object is to be earthed and short-circuited as well as checked that it has been completely discharged (e.g. using a properly sized discharge rod).

Afterwards, the MFM 10 can be disconnected from the test object.

 **WARNING**	• Follow the five safety rules (see page 7). • Even if proper disconnection and automatic discharging via the internal discharging device has taken place, system components that have been under voltage should only be touched once they have been discharged using an adequate discharging rod and visibly earthed and shorted. • Only undo the earthing and short circuiting measures when the test object is to be operated again.

5 Processing log data

When log data are exported after a test is complete, the files are written to the *\Prot* directory on the USB flash drive.

The name of the file is comprised of the current date and a serial number. For larger test series, making notes about the sequence of the tests is recommended to make classify them easier later on.

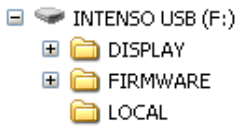
The lean logging software Easyport which is stored on the supplied USB stick is suitable for viewing, printing and archiving the logs.

Double-clicking on the file *EasyProt.exe* allows you to install the software in the *C:\EasyProt* directory on your workplace computer. It can then be launched using the desktop link.

For more detailed information on using the software, please read the integrated Online help.

6 Updating the firmware

Proceed as follows to update the firmware:

Step	Description
1	Register as a user on the SebaKMT homepage and download the latest firmware version from the user area.
2	Save the *MFM10_<Version>.exe* file to the root directory of an empty USB flash drive.
3	Execute the file and confirm the following message with **OK**.
	Result: The directory structure of the USB flash drive should then look as follows: 
4	Plug the USB flash drive into the USB port of the MFM 10 which **has to be switched off**.
5	Briefly de-energize the MFM 10 by pulling the power cord. Afterwards, reconnect the power cord and power on the unit.
6	The boot process is interrupted by a message which has to be confirmed with **YES** (by touching the button on the screen).
	Result: The new firmware is installed.

installation of the new firmware may take a few minutes and requires several automatic restarts. Do not unplug the flash drive or power off the system during the whole installation process! After the installation is done, the MFM 10 performs one last automatic restart, whereupon the main menu is displayed.

7 Maintenance and care

Maintenance It is not necessary to open the housing of the device to commission and operate the system. Opening the housing causes the immediate termination of all warranty claims!

The connections and connection leads of the system must be regularly tested to ensure that they are free of defects and intact, in accordance with the applicable national and company-specific arrangements.

Storage If the device is not used for a lengthy period, it should be stored in a dust-free and dry environment. Continuous moisture (humidity) especially when combined with dust can reduce critical insulating clearances that are essential for safe high-voltage operation.

Store the unit always at a full state-of-charge. Apply topping charge every six months.

Charge The internal battery can be recharged in two ways:

- Through the mains connection lead, which connects the power supply socket 10 to an appropriate mains socket
- Through the motor vehicle charging cable, which connects the charging socket 11 with the 12 V DC on-board voltage of a motor vehicle

As soon as one of these connections is made, the display is activated and the progress of the charging process is shown. It takes about 4 to 6 hours to charge the battery completely.

As soon as the device is switched on, the charging process is interrupted, i.e. charging is not possible whilst it is in operation!

Fuse Replacement If the device cannot be switched on when the power supply is connected, the two fuses which are located next to the power socket 10 should be checked. The fuse holder must be pulled out.

If broken, the fuses should be replaced with appropriate type M6,3/250 micro-fuses (5 x 20 mm).