

User Manual

Cable Fault Locator

KMK 8

Mess- und Ortungstechnik Measuring and Locating Technologies

Elektrizitätsnetze
Power Networks



Kommunikationsnetze
Communication Networks



Rohrleitungsnetze
Water Networks



Abwassernetze
Sewer Systems



Leitungsortung
Line Locating



CONSULTATION WITH MEGGER

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:

Megger Limited

Archcliffe Road
Kent CT17 9EN

T: +44 1304 502100

F: +44 1304 207342

E: uksales@megger.com

Seba Dynatronic

Mess- und Ortungstechnik GmbH

Dr.-Herbert-lann-Str. 6
D - 96148 Baunach

T: +49 9544 68 – 0

F: +49 9544 22 73

E: sales@sebakmt.com

Hagenuk KMT

Kabelmesstechnik GmbH

Röderaue 41
D - 01471 Radeburg / Dresden

T: +49 35208 84 – 0

F: +49 35208 84 249

E: sales@sebakmt.com

Megger USA

Valley Forge Corporate Centre
2621 Van Buren Avenue
Norristown, PA 19403 USA

T: +1 610 676 8500

F: +1 610 676 8610

© Megger

All rights reserved. No part of this handbook may be copied by photographic or other means unless Megger have before-hand declared their consent in writing. The content of this handbook is subject to change without notice. Megger cannot be made liable for technical or printing errors or shortcomings of this handbook. Megger also disclaims all responsibility for damage resulting directly or indirectly from the delivery, supply, or use of this matter.

TERMS OF WARRANTY

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

Megger guarantees that at the time of delivery Megger products are free from faults in material and workmanship which would reduce their value and serviceability to a large degree. This warranty does not cover any error in the software supplied. During the warranty period Megger will repair faulty parts or replace them with new parts or parts as new (with the same usability and life as new parts) at their discretion.

Further warranty claims, in particular those from consequential damage, cannot be accepted. Each component and product replaced in accordance with this warranty becomes the property of Megger.

All warranty claims versus Megger expire after a period of 12 months from the date of delivery. Each component supplied by Megger in the context of warranty will also be covered by this warranty for the remaining period of time, but at least for 90 days.

Each measure to remedy a warranty claim must be carried out exclusively by Megger or one of their authorised service stations.

It is a precondition for accepting a warranty claim that the customer complains about the fault, in a case of an immediately detectable fault within 10 days from the date of delivery.

This warranty does not cover any fault or damage caused by exposing a product to conditions which are not in accordance with this specification, by storing, transporting or using it improperly, or having it serviced or installed by a workshop not authorised by Megger. No claim will be accepted in case of wear and tear, will of God, or connection to foreign components.

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

CONTENTS

1	INTRODUCTION	1-1
1.1	Application	1-1
1.2	Application Guide for Fault Location.....	1-4
1.2.1	Active Bridge	1-5
1.2.2	Passive Wheatstone-Bridge	1-5
1.2.3	End to End Synchronic Measuring Method	1-5
1.3	General Features	1-6
2	KEYBOARD, SOCKETS AND LEDS	2-1
2.1	Connectors & Balance Controls.....	2-4
3	OPERATING INSTRUCTIONS	3-5
3.1	Start up and general rules	3-5
3.2	Calibration	3-6
3.3	Storage and Recall of Measuring Results	3-8
3.4	Provided Special Actions after Measurements.....	3-9
4	TDR MEASUREMENTS.....	4-1
4.1	Principles of Operation	4-1
4.2	Settings before Measurement.....	4-3
4.3	Test of a Single Pair.....	4-6
4.4	Waveform Evaluation.....	4-7
4.5	Location of Cross Talk Points	4-8
4.6	Comparison of Two Pairs	4-8
4.7	Comparison to Stored Result.....	4-9
4.8	Application Guide (General Hints for TDR)	4-10
4.9	Typical Waveforms	4-11
4.10	Obtaining the Missing V/2	4-15
5	ACTIVE BRIDGE.....	5-1
5.1	Interference Voltage Measurement (AC and DC).....	5-1
5.2	Resistance Measurements	5-2
5.2.1	Loop Resistance Measurement (2 WIRE).....	5-2
5.2.2	Loop Resistance Measurement (2-WIRE & GND)	5-4
5.2.3	Resistance Difference Measurement	5-5
5.2.4	Insulation Resistance Measurement	5-6
5.3	Capacitance Measurements	5-8
5.3.1	Capacitance Measurement (2 WIRE).....	5-9
5.3.2	Capacitance Measurement (2 WIRE&GND)	5-10
5.3.3	Capacitive Balance Measurement.....	5-12
5.4	DC Fault Location with MURRAY Method	5-13
5.5	DC Fault Location with K�upfm�uller Method	5-15
5.6	DC Fault Location with 3 Point Method	5-18

5.7	DC Fault Location with repeated KÜPFMÜLLER method	5-20
5.8	AC Fault Location with Interruption Measurement	5-23
5.9	AC Fault Location with repeated KÜPFMÜLLER method	5-24
6	PASSIVE BRIDGE	6-1
6.1	Principles of Operation	6-1
6.2	Loop Resistance Measurement	6-2
6.3	Insulation Resistance Measurement	6-3
6.4	Resistance Difference Measurement	6-5
6.5	DC Fault Location with MURRAY Method	6-7
6.6	DC Fault Location with 3 Point Method	6-10
6.7	DC Fault Location with Küpfmüller Method	6-14
6.8	AC Fault Location with Küpfmüller Method	6-18
6.9	Capacitive Balance Measurement	6-22
7	END TO END SYNCHRONOUS MEASUREMENT	7-1
8	PRE MEASUREMENTS	8-1
8.1	Survey of Pair Condition	8-1
8.2	AC DC Voltage Measurement	8-3
8.3	Loop Resistance Measurement	8-4
8.4	Insulation Resistance Measurement	8-5
8.5	DC Current Measurement	8-6
8.6	Cable Temperature Measurement	8-7
9	AUTOMATIC TEST SEQUENCES	9-1
9.1	Automatic Quick Test	9-1
9.2	Automatic Quality Test	9-2
10	BATTERY MANAGER	10-1
10.1	Battery Capacity Indication	10-1
10.2	Normal Charging	10-1
10.3	Fast Charging	10-2
10.4	Regenerating Charge Process	10-2
10.5	Initial Charging	10-2
10.6	Automatic Battery Switch-Off	10-3
10.7	Battery Life Expectancy	10-3
10.8	Charging During Measurement	10-3
11	USB PORTS	11-1
11.1	Result Transfer from KMK 8 to USB flash drive	11-2
11.2	Result Transfer from USB flash drive to KMK 8	11-3
12	STATUS & OPTIONS	12-1
13	UPGRADE (KMK8U.EXE)	13-1

14	DEMOPROGRAMM (KMK8D.EXE).....	14-1
15	SETTINGS.....	15-1
16	LOOP CLOSING DEVICE KLC 8	16-1
17	INTELLIGENT SLAVE KMK 80S (OPTIONAL)	17-1
18	SPECIFICATIONS.....	18-3
18.1	General Specifications.....	18-3
18.2	TDR	18-5
18.3	Active Bridge	18-7
18.4	Passive Bridge.....	18-11
18.5	Pre Measurements	18-15
18.6	Quick Test	18-19
18.7	Quality Test	18-20
19	SCOPE OF DELIVERY AND OPTIONAL ACCESSORIES ...	19-1

1 INTRODUCTION

This Operating Manual is intended to help the user in operating Cable Fault Locator KMK 8 explaining the operation rules. While following the instructions as given below, it is recommended to use the demo program found on the CD inside the carrying case. Running the demo under WINDOWS will show you the front panel of the instrument with display and keyboard. By clicking with the mouse on the keyboard, the “virtual” KMK 8 will behave as the real instrument, helping the user to carry out complete measuring procedures, but of course only “virtually”.

1.1 Application

KMK 8 hand-held small size instrument is intended to test the quality of telecom cables during installation and to locate cable faults. That combined instrument provides the followings:

- Time Domain Reflectometer (TDR)
- Active bridge for comfortable automatic, and accurate DC, AC fault location and resistance, capacitance measurements on lines with only small interference voltages
- Passive Wheatstone bridge for DC, AC fault location and resistance, capacitive measurements on lines with heavy interference voltages
- A voltage measurement module for measurements of AC and DC interference voltages at cable systems.
- Voltage meter module to measure the DC and AC interference voltages on the line
- Warning and information-systems continuously informing the user about interference voltages to ensure the best measurement accuracy.
- Remote control system for the far end loop closing device

In TDR mode KMK 8 can be used, to locate...

- Open ends
- Shorted conductors
- Water damage
- Screen faults (interruption)
- Loose connectors
- Crimp faults
- Simple or double split
- Branches
- Capacitance networks
- Unwanted loading coils
- Change of cable type

In active bridge mode KMK 8 provides:

DC fault location methods like:

- Murray,
- 3 Point
- K pfm ller
- Repeated K pfm ller

AC fault location methods like:

- Line break
- Repeated K pfm ller

The measurement of parameters like:

- Loop resistance
- Resistance difference
- Insulation resistance
- Cable capacity
- Capacitive unbalance
- AC, DC voltage

In passive bridge mode KMK 8 provides:

DC fault location methods like:

- Murray,
- K pfm ller
- 3 Point

AC fault location methods like:

- K pfm ller
- Capacitive unbalance

End to End synchronous current measurement with

- Graaf method using the DC interference voltages for fault location

The measurement of parameters like:

- Loop resistance
- Resistance difference
- Insulation resistance

KMK 8 provides remote control for far end devices like:

- KLC 8 loop closing device to close or open the loop during the measurement (e.g fault location with Küpfmüller method).
- KMK 80S slave unit to measure the current at the far end in case of fault location with Graaf method

1.2 Application Guide for Fault Location

We are talking about cable fault when the insulation resistance of one or more pairs (between wire and wire or between wire and ground) becomes too low.

That usually occurs after strong rains wetting the insulation material in discrete points (typically not along the whole cable).

During the trouble shooting the first task is to locate that points. The name of this process is "DC Fault Location".

Performing calculations KMK 8 always supposes that there is only one faulty point on the tested cable.

In the opposite case the cable should be split into sections containing only one faulty point so as to measure them one by one.

The fault location can be disturbed when the fault resistance interconnects the faulty wire with a DC voltage source (e.g. an active pair using DC voltage).

The applicable fault location method depends on the characteristics of cable fault. In **PRE MEASUREMENT,S/PAIR CONDITION** survey mode KMK 8 provides an extremely useful help for the user to find the best method.

From the point of view of interference voltages the cable faults can be included into three groups:

- The AC interference voltages are low and the DC voltage isn't intermittent
- The AC interference voltages are high but the DC voltage isn't intermittent
- The AC and DC interference voltages are extremely high and intermittent

KMK 8 offers three fault location methods for the above mentioned three groups:

- Active bridge - when the interference voltages are low
- Passive Wheatstone bridge - when the interference voltages are high but moderately intermittent
- End to End synchronic measurement - when the interference voltages are extremely high and intermittent (Graaf method)

1.2.1 Active Bridge

The active bridge provides quick, comfortable, very accurate and automatic measurements. There are two measuring modes to select:

- **Sensitive mode** providing extremely accurate test results even if the measured fault resistances are very high. But high AC interference voltages may overload the bridge indicator.
- **Protected mode** providing accurate test result even in the presence of medium level interference voltages (if the fault resistances are not higher than 3 to 5 MOhm)

It is recommended to start the measurement with sensitive mode. When the interference voltages overload the indicator a warning appears informing the user that the result can be inaccurate. In that case the measurement should be repeated in protected mode.

1.2.2 Passive Wheatstone-Bridge

The passive bridge is not sensitive for external AC interference voltages but its usage is not as comfortable as that of the active bridge. Measuring methods like K upfm uller or Three-point methods require two or three consecutive measurements. Measuring error may occur if the level of DC interference voltage changes between the measurements.

1.2.3 End to End Synchronic Measuring Method

In the worst case due to high and intermittent AC and DC interference voltages neither the active nor the passive bridge can provide satisfactory result.

In that case the best tool is the improved version of Graaf method using the interference voltages for the measurement. (No other measuring voltage is added to it).

KMK 8 performs current measurements at the two ends of the tested cable at the same time and calculates the location of fault of the rate of currents. That means:

The higher is the interference voltage the easier to locate a fault!

The only drawback is: two instruments are necessary working in Master-Slave mode. In that mode KMK 8 can communicate with another KMK 8 or with an intelligent slave device like the KMK 80S.

1.3 General Features

KMK 8 has a graphic display an easy to use menu system and a many-sided help system providing extremely simple operation for the user.

The displayed test results can be stored in the internal memory of the instrument and transferred to PC:

KMK 8 has two USB ports for the transfer of test results:

- USB A host-port for USB flash drive (indirect transfer)
- USB B device-port for PC connection (direct transfer)

The indirect transfer is advantageous for the users who are not allowed to install special drivers to their PCs.

IMPORTANT NOTE

**For the time of measurements the PC should be disconnected!
High voltages on the line may interference the measurements or in the worst case destroy the instrument or the PC!**

KMK 8 calculates the cable length and the distance to fault by means of the pre-programmed or user defined cable parameters and the preset temperature.

KMK 8 is equipped with an internal rechargeable NiMH battery and a processor controlled automatic charger-discharger circuit providing the following functions:

- Battery capacity indication
- Charging process control
 - Normal charging
 - Fast charging
 - Battery regeneration
 - Battery initialization
 - Protection against deep discharging












The battery can be charged from mains or from 12V car-battery or using a 100 ... 240 V AC charger.

2 KEYBOARD, SOCKETS AND LEDS



Controls

	<p>Switches the KMK 8 on and off. The instrument has an automatic switch-off feature to save battery life: switch-off takes place automatically 10 minutes after the latest keystroke. (see section 15.1).</p>
<p>F1 F6</p>	<p>The function of the six Function keys depends on the active measuring mode.</p>
<p>START STOP</p>	<p>Starts or stops the selected measurement, sequence or process.</p>
<p>ENTER</p>	<p>This key is intended to acknowledge a selected measurement mode or a new parameter, or to carry out other changes.</p>

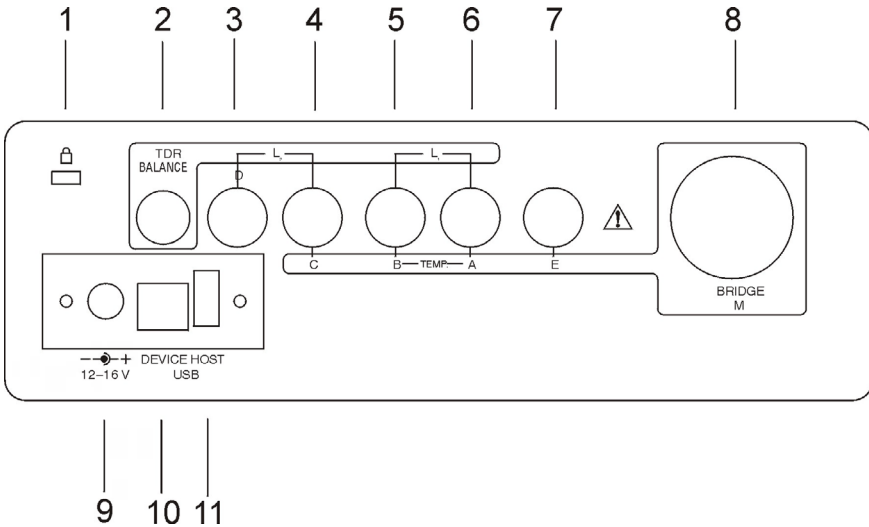
 	These keys are intended to select the required measuring mode or to change a parameter.
 	These keys are intended to select the required option and to adjust the position of vertical line cursor.
	This key is intended to enter a minus sign or to set a vertical marker in TDR mode
	This key can be used to cancel something.
	This key is intended to call the help function.
	This key can be used for LCD contrast adjustment.
	This key can be used for the control of back light..
	This key enters '0' (or a space pressing it twice) and in TDR mode activates the SMOOTH function
	This key enters '1'.

<div style="border: 1px solid black; border-radius: 10px; padding: 5px; text-align: center;"> ABC 2 </div>	This key enters '2' or A B C letters when required
<div style="border: 1px solid black; border-radius: 10px; padding: 5px; text-align: center;"> DEF 3 </div>	This key enters '3' or D E F letters when required.
<div style="border: 1px solid black; border-radius: 10px; padding: 5px; text-align: center;"> GHI 4 </div>	This key enters '4' or G H I letters when required.
<div style="border: 1px solid black; border-radius: 10px; padding: 5px; text-align: center;"> JKL 5 </div>	This key enters '5' or J K L letters when required.
<div style="border: 1px solid black; border-radius: 10px; padding: 5px; text-align: center;"> MNO 6 </div>	This key enters '6' or M N O letters when required.
<div style="border: 1px solid black; border-radius: 10px; padding: 5px; text-align: center;"> PQRS 7 </div>	This key enters '7' or P Q R S letters when required.
<div style="border: 1px solid black; border-radius: 10px; padding: 5px; text-align: center;"> TUV 8 </div>	This key enters '8' or T U V letters when required.
<div style="border: 1px solid black; border-radius: 10px; padding: 5px; text-align: center;"> WXYZ 9 </div>	This key enters '9' or W X Y Z letters when required.

LEDs

<input type="checkbox"/> MAINS	Mains indicator
<input type="checkbox"/> CHARGE	Charge indicator
<input type="checkbox"/> MEAS	Measurement indicator
<input type="checkbox"/> REMOTE	Remote control indicator

2.1 Connectors & Balance Controls

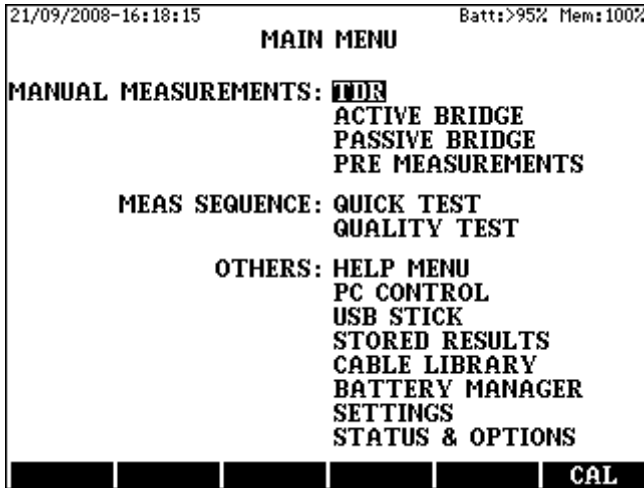


1	Anti-theft protection
2	TDR balance
3	Socket to connect wire D in bridge modes, and L2 in TDR mode
4	Socket to connect wire C in bridge modes, and L2 in TDR mode
5	Socket to connect wire B in bridge modes, and L1 in TDR mode
6	Socket to connect wire A in bridge modes, and L1 in TDR mode
7	GND
8	Bridge balance M
9	2.1/5.5 mm coaxial connector for mains or 12 V car adapter
10	USB connector for connecting a PC
11	USB connector for connecting an USB flash drive

3 OPERATING INSTRUCTIONS

3.1 Start up and general rules

- Switch the instrument on.
- First the opening display appears showing the name and e-mail address of the manufacturer **sebakm**.
- After the percentage of the **BATTERY LEVEL** will be shown.
- 2 seconds later, self-test indication and the **MAIN MENU** appears.



Basically, the user should follow the instructions appearing at the bottom of each display in all measurement modes.

- In most cases, the measuring, setting and editing modes are selected by the menu-driven operation system. For selection use the vertical cursor keys and then press **ENTER**.
- The various cable and test parameters can be selected with the function keys: **F1** to **F6**. To facilitate and speed up operation, some of the measuring modes can be selected directly with them too.
- The measurements can be started or stopped with the **START/STOP** key. To return back to the previous display, press **ESC**.

3.2 Calibration

Pressing the **CAL (F6)** key the **CALIBRATION** menu appears providing two options:

- Calibration of test leads
- Self-calibration

Calibration of Test Leads

In that mode not only the resistance of test leads **A**, **B**, and **E** but also the relay resistances of the input switch field will be measured, stored and during the measurements compensated as well.

During the manufacturing process the actual resistance values were stored but before the measurement of very low resistances or resistance differences a repeated calibration is recommended.

Before calibration short the far ends of the three test leads and after:

- Select the **CAL OF TEST LEADS** option of **CALIBRATION** menu
- Press **ENTER**

When the calibration is completed three resistance values are displayed containing the test lead and relay resistances.

These resistances will be taken into consideration at the following measuring modes:

- Resistance 2-wire
- Resistance 2-wire&gnd
- Resistance difference
- Fault location Murray-Method
- Fault location 3 Point-Method
- Fault location K upfm uller- Methods

Self calibration

- Select the **SELF CALIBRATION** option of **CALIBRATION** menu
- Press **ENTER**

Doing so the calibration parameters of active and passive bridges are measured

The accuracy of the **active** bridge is based on the measurement of a built in normal resistor of high preciosity. The result of that measurement is stored as a reference value.

The accuracy of the **passive** bridge is based on the measurement of a built in reference voltage source of high preciosity. The result of that measurement is stored as a reference value.

During the calibration process the offset voltages of amplifiers are measured and stored as well.

3.3 Storage and Recall of Measuring Results

When a test is completed the result can be saved in each measuring mode under a user given object name There are four identifiers of each stored results:

- **OBJECT** (user given name)
- **DATE** (automatically added)
- **TIME** (automatically added)
- **MODE** (automatically added)

The automatically added identifiers are very comfortable for the user, as the time is different for each test result, the same object name can be used repeatedly

Note:

The name of operator should be given before starting a measurement.

- Select **SETTINGS/OPERATOR'S NAME**
- Type the name in as it is usual at mobile phones
- Press **ENTER**

Saving of test results:

Having the test finished:

- Press the **SAVE (F1)** key
- Type an object name and press **ENTER**

Recall of test results.

- Enter the **MAIN MENU/STORED RESULTS** option
- Select the required result and press **ENTER**

Deleting a test result

- Enter the **MAIN MENU/STORED RESULTS** option
- Select the result to be deleted and press **DELETE (F3)**
- If you are sure press **YES (F2)**

Deleting all of the test results

- Enter the **MAIN MENU/STORED RESULTS** option
- Enter the group to be deleted and press **EMPTY (F1)**
- If you are sure press **YES (F2)**

3.4 Provided Special Actions after Measurements

KMK 8 measures the physical parameters of the tested pair like loop resistance, insulation resistance, Lx/L value or capacitance.

Additional parameters can be calculated when:

- Cable parameters and temperature are known or
- The exact length of the cable is known.

The calculated additional parameters

At fault location modes:

- Cable length (DTS) in meters
- Distance to fault (DTF) in meters

At loop resistance and capacitance measurement:

- Length (DTS) in meters when the cable parameters and cable temperature are known
- Ohm/km value when the cable length is known

At insulation resistance measurement:

- Ohm/km value when the cable length is known

At insulation capacitance measurement:

- Length (DTS) in meters when the cable parameters are known
- nF/km value when the cable length is known

Steps of calculation

The display always shows the cable type and temperature value selected during the last measurement.

To change the cable type

- Press the **C.LIBR (F6)** key
- Select a new cable type and press **ENTER**
- Press **ESC**

To change the cable temperature

- Press the **TEMP.(F4)** key,
- Type in the temperature value and press **ENTER**.

Doing so KMK 8 automatically calculates the new values

When the cable length is known

- Press the **LENGTH (F5)** key
- Type in the length value and press **ENTER**

For returning to the normal display

- Press the **LENGTH (F5)** key
- Press **ENTER**

4 TDR MEASUREMENTS

4.1 Principles of Operation

KMK 8 in Time Domain Reflectometer (TDR) mode utilizes the radar principle. A measuring pulse is transmitted down a cable. When that pulse reaches the end of the cable or a fault along the cable, a certain part or all the pulse energy is reflected back to the instrument.

KMK 8 measures the time taken by the pulse to travel down the cable, see the problem, and reflect back. Then converts this time to distance and displays the information as a waveform.

The displayed waveform shows all impedance changes along the cable.

The amplitude of any reflection is determined by the degree of the impedance change.

Distance to fault is displayed on the screen after the cursor is positioned to the start of the reflected fault pulse

Application

KMK 8 in Time Domain Reflectometer (TDR) mode can be used, to locate several cabling problems like:

- Open ends
- Shorted conductors
- Water damage
- Screen fault (interruption)
- Loose connectors
- Crimp faults
- Simple or double split
- Branches
- Capacitance networks
- Unwanted loading coils
- Change of cable type

In addition, the KMK 8 can also be used to ascertain shipping damage of cable reels and for inventory management.

Measuring Modes

Test of a single pair

- L1** Transmission and reception of the test pulses over L1; this is the most frequently used basic mode of operation.
- L2** The same as the L1 mode above but L2 is used instead of L1

Long time measurement

L1 LONG TIME

L1 mode measurements are repeatedly done for a long time. All the obtained waveforms are displayed together and so the intermittent faults are to be seen.

L2 LONG TIME

The same as L1 LONG TIME but L2 is used instead of L1

Location of cross talk points

XTALK One of the pairs is connected to the L1 sockets and the other one to the L2 sockets. The measuring pulse is transmitted via L2 and the reflected pulses are received via L1. This mode is typically used for locating simple or double split.

Comparison between two pairs

- L1&L2** this mode is the combination of the L1 and L2 modes. Two waveforms are simultaneously displayed.
- L1- L2** In this mode, the difference between two waveforms is displayed. The typical use of this mode is to find close in faults, because the balance between two cables may be better than between one cable and the internal balance control.

Comparison with memory

A waveform stored in memory can be used for comparison of the cable conditions before and after a critical period, or a repair job.

L1 & MEMORY

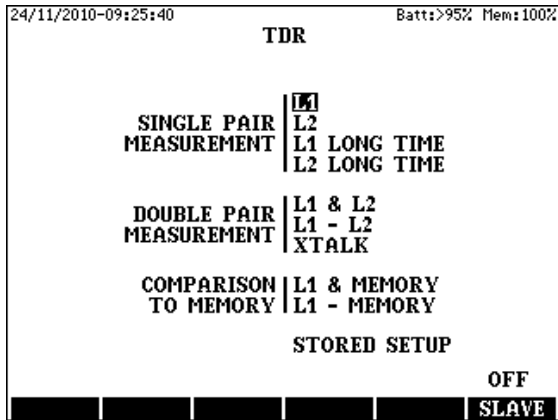
In this mode, two waveforms are simultaneously displayed.

L1 - MEMORY

In this mode, the difference between two waveforms is displayed

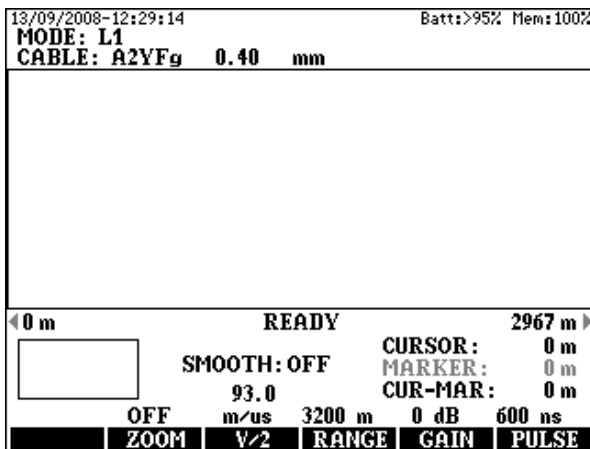
4.2 Settings before Measurement

Entering the **TDR** option of **MAIN MENU** the following display appears:



Measuring mode selection

Select the wanted measuring mode in the **TDR MENU** with the $\uparrow\downarrow$ keys and press **ENTER**. Having the mode selected the measuring display appears belonging to the selected mode.



Setting the Propagation Velocity

After mode selection the next step is to set the appropriate velocity factor. The propagation velocity of electromagnetic waves in cable depends on:

- The permittivity (ϵ) of insulation material of cable.
- The presence and inductance of load coils.

The following units are regularly used to characterize a cable:

Half Propagation Velocity (V/2) m/ μ s

Velocity of Propagation (VOP) %

The definition of VOP:
$$\text{VOP} = \frac{\text{WAVE VELOCITY IN CABLE}}{\text{LIGHT VELOCITY IN SPACE}} \times 100 \%$$

To change the unit of propagation velocity:

- Enter the **GENERAL SETTINGS** option of the **MAIN MENU**
- Select the **PV UNIT** option and press **ENTER**

The default value of V/2 is 100 m/ μ s. To change it before starting the measurement press key **V/2 (F3)** and then the following display appears:

24/11/2010-09:28:58	Batt:>95% Mem:100%	
HALF PROPAGATION VELOCITY V/2		
<table border="1" style="margin: auto;"> <tr> <td>$V/2 = \frac{\text{WAVE VELOCITY IN CABLE}}{2} \text{ m}/\mu\text{s}$</td> </tr> </table>		$V/2 = \frac{\text{WAVE VELOCITY IN CABLE}}{2} \text{ m}/\mu\text{s}$
$V/2 = \frac{\text{WAVE VELOCITY IN CABLE}}{2} \text{ m}/\mu\text{s}$		
ACTUAL VALUE: 100.0 m/μs (45 to 149)		
CALCULATION BY KNOWN DISTANCE		
EDIT	C. LIBR.	
CURSOR CURMAR		

The new value can be set directly or recalled from the cable library.

To give a new value directly

- Press the **EDIT (F2)** key
- Type in the required new value
- Press **ENTER**

To get the new a value from the cable library:

- Press the **C.LIBR (F3)** key
- Select the required cable type
- Press **ENTER**
- By pressing **ESC** return to the measuring display

(If the propagation velocity is not known, see section 7.3)

Setting the Measuring Range

After setting the $V/2$ value the next step is to select the shortest range covering the full cable length.

- Press the **RANGE** key
- Select the required range with the $\uparrow\downarrow$ keys

4.3 Test of a Single Pair

After setting the mode range and propagation velocity the measurement can be started by pressing the **START/STOP** key. The measurement is running repeatedly until a following **START/STOP** keystroke.

- In **L1** and **L2** measuring modes the last waveform is displayed. To save battery life, the measurement is automatically stopped after one-minute elapsed time.
- In **L1 LONG TIME** and **L2 LONG TIME** modes all the obtained waveforms are displayed together showing the intermittent faults. In these modes there is no time out.

Balance Adjustment

Adjust the rotary **BALANCE** control to minimize the transmit pulse at the start of waveform. (In the **XTALK** and **L1-L2** modes, the balance control is not effective.)

Gain Adjustment

Because of the attenuation of the cable under test, the amplitude of the reflected pulse will decrease as the distance to the reflection location increases. To obtain suitable reflected pulse amplitude, the gain should be set as follows:

- Press the **GAIN (F5)** key
- Select the required gain with the $\uparrow\downarrow$ keys

The gain can be adjusted between 0 and 90 dB in 6 dB steps

Setting Transmit Pulse Width (optional)

In case of high cable attenuation, a better reading may sometimes be obtained by using a wider pulse. Therefore, if required, the pulse width can be changed as follows:

- Press the **PULSE (F6)** key
- Select the required width by the $\uparrow\downarrow$ keys
-

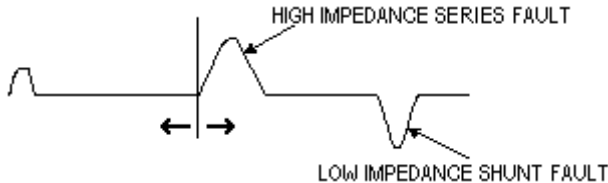
Storage of waveform

The displayed waveforms can be stored with key **STO (F1)**

4.4 Waveform Evaluation

Reading Distance to Fault

After the measurement process is terminated, move the cursor with the horizontal cursor keys to the start point of the reflected pulse.



The displayed value of the cursor shows the distance to fault. Remember to deduct the length of the test leads.

Waveform Expansion (ZOOM)

The waveform can be shown in more detail around the cursor line by using the **ZOOM** facility. The amount of horizontal expansion can be selected as follows:

- Using the ← → keys move the cursor to the point around which you want to expand the waveform
- Press the **ZOOM (F2)** key
- Select the required ZOOM value with the ↑↓ keys

On the down left corner of the display there is a “ZOOM INFO” showing information about the non visible part of trace if the ZOOM is on

Use of Marker

The marker appears as a vertical grey line and can be placed to any selected point of the waveform. Displayed are the position of marker and the cursor, further the true distance from marker to cursor.

To measure the distance between any two points, the marker should be used as follows:

- Move the cursor to the point from which the distance is to be measured (e.g. reflection from a known point or from the change of the cable type), and set the marker by pressing **MARKER**.
- Move the cursor to the point to which the distance measurement is to be carried out.

The distance between these points is directly shown by the display.

The Smoothing Function

Because of the attenuation losses, the reflection from a fault long way down the cable may be much smaller than a regular reflection from a nearby fault. The amplitude display of near reflections can be reduced by the smoothing function as follows:

- Press the **SMOOTH** key
- Select the required reduction with the $\uparrow\downarrow$ keys

4.5 Location of Cross Talk Points

In **XTALK** mode one of the pairs is connected to the L1 sockets, and the other one to the L2 sockets. The measuring pulse is transmitted on L2 socket the reflected pulses are received on L1. This mode is typically used for locating splits and resplits. The steps of measurement are similar for the L1 and L2 modes.

(The **BALANCE** control is not operational in this mode.)

The displayed waveforms can be stored with key **STO (F1)**

4.6 Comparison of Two Pairs

The comparison is used to identify the differences between a known good cable and a faulty one. There are two methods of comparison:

- **L1 & L2** mode
- **L1 - L2** mode

Comparison in the L1 & L2 mode

In the **L1 & L2** mode, two waveforms are simultaneously displayed, one for L1 and the other for L2 (L2 is blue).

The steps of measurement are similar to the **L1** and **L2** modes.

For the evaluation of the two waveforms the **CURSOR**, **MARKER** and **ZOOM** facilities are available. Using the \uparrow and \downarrow keys, the L2 waveform can be vertically shifted.

Comparison in the L1 - L2 mode

In this mode, the difference between the L1 and the L2 waveform is displayed. Using this method, the reflections caused by the common features of the two cables can be separated from reflections caused by cable faults. This method is a convenient way to find close-in faults, as two similar cables may balance each other more accurately than one cable and the internal **BALANCE** control. (The **BALANCE** control is not operational.) The steps of measurement and the waveform evaluation are the same as the **L1 & L2** mode.

Storage of waveform

The displayed waveforms can be stored with key **STO (F1)**

4.7 Comparison to Stored Result

Waveforms stored in memory can be used for comparison of the cable conditions before and after a critical period, or before and after a repair job. The stored waveform and the recently obtained waveform can only be compared if the main parameters are the same. As the main parameters are stored together with the waveform, the actual measurement must be performed with the stored settings (V/2, RANGE, PULSE WIDTH, GAIN). Accordingly, in this mode, the controls of the above mentioned parameters are not operational. There are two methods of comparison:

Comparison in L1 & MEMORY mode

In this mode, the stored and the actually obtained waveforms are displayed together (the stored waveform is blue).

Measurement steps:

- Enter the **L1 & MEMORY** option of **TDR MENU**. The list of stored waveforms is now displayed.
- Select the memory location containing the stored waveform to be used for comparison and press **ENTER**.
- Start the measurement by pressing the **START/STOP** key.

For evaluation, the **CURSOR**, **MARKER** and **ZOOM** facilities can be used as in the single pair investigation. The vertical position of the stored Waveform can be shifted with the $\uparrow \downarrow$ keys.

Comparison in L1 - MEMORY mode

In this mode, the difference between the obtained and the stored Waveform is displayed. Measurement steps:

- Enter the **L1 - MEMORY** option of **TDR MENU**. The list of stored waveforms is now displayed.
- Select the memory location containing the stored waveform to be used for comparison and press **ENTER**.
- Start the measurement by pressing the **START/STOP** key.

For evaluation, the **CURSOR**, **MARKER** and **ZOOM** facilities can be used as in the single pair investigation

4.8 Application Guide (General Hints for TDR)

Reflections can be classified to fall into two groups:

- Regular reflections
- Reflections from faults (irregular reflections)

Regular reflections

Even faultless pairs may produce reflections caused by inherent discontinuities such as joints or cable type changes.

Reflections from faults

A faulty pair produces regular reflections and, in addition, reflections from the fault. Because of the attenuation losses, the reflection from a fault long way down the cable may be much smaller than a regular reflection from a nearby discontinuity.

A suitable method to distinguish regular and irregular reflections is to compare the faulty cable with a good one. By using the L1-L2 method, the regular reflections caused by the common features of the two pairs will be canceled but the reflections due to faults will remain unchanged.

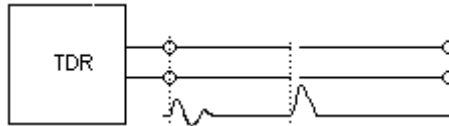
In telephone cables there are several pairs of conductors. The physical length of the pairs depends on their position in the cable. The length is increasing with the distance of the layer from the center. Consequently, the physical length of pairs can be longer than the cable length, and the propagation velocity ($V/2$) may be different for different layers. Therefore, in case of comparative tests, the two pairs compared should be in the same layer.

If there is more than one fault, the first one may reflect so much from the pulse energy that the subsequent fault may not be seen. Therefore, having located and eliminated the first fault, the cable section following the fault should be tested again.

4.9 Typical Waveforms

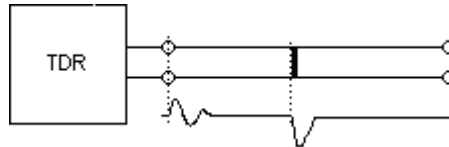
Open end (series faults)

The reflection is a positive (upward going) pulse.
No reflected pulse from the far end.



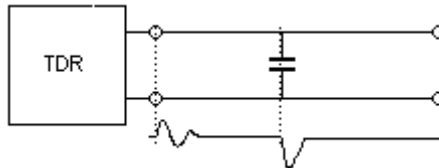
Short circuit (shunt fault)

The reflection is a negative (downward going) pulse. No reflected pulse from the far end.



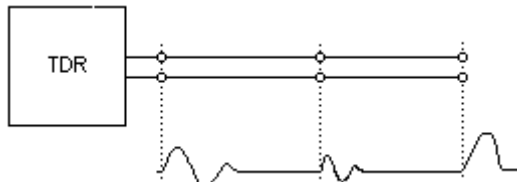
Capacitance network

The reflection is negative (downward going pulse).



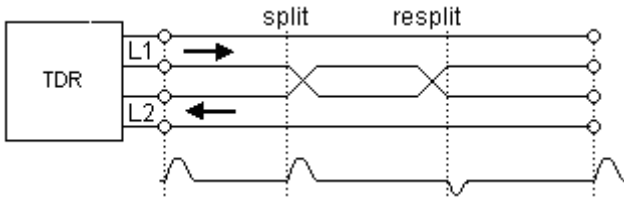
Joints (splices)

The joints produce 'S' shaped reflections.



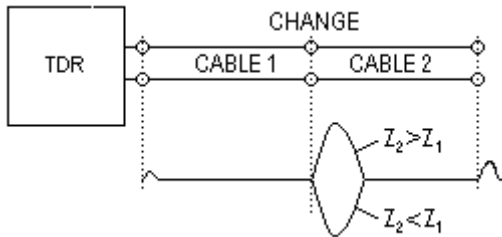
Imple and double splits

Splits and resplits produce cross talk.



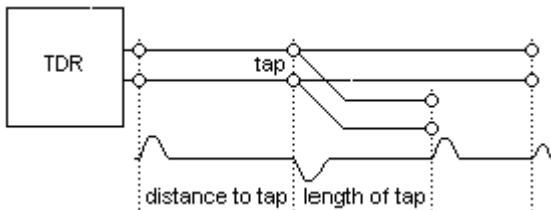
Change of cable type (mismatch)

The amplitudes of the reflected pulses are determined by the degree of impedance changes.



Taps (tee joints)

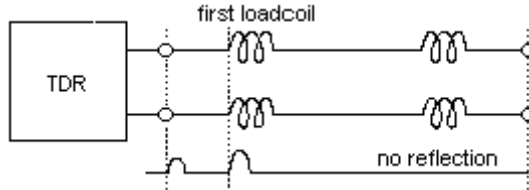
A tap produces two pulses, one at the beginning and the other at the end of the tap.



The troubleshooting may be difficult if the tested pair is tapped at many points. In this case, the test should be progressively done with moving from tap to tap.

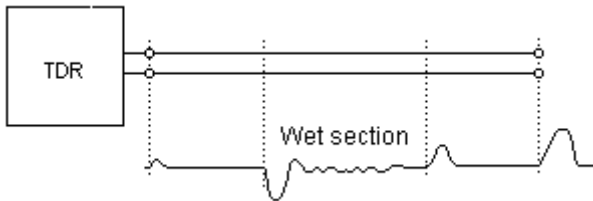
Load coils

Load coils produce positive (upward going) reflections. Generally, TDR's can not 'see' beyond the first loading coil. For fault location beyond the loading coil, the TDR should be connected to another point following the coil.



Wet section

The presence of water causes a capacitance increase. Therefore, there are two pulses: one from the beginning, the other from the end of the wet section.



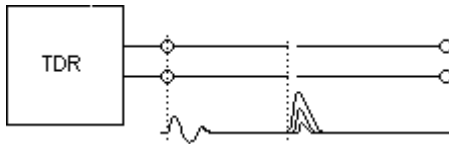
Screen fault

If the metallic screen of the cable is broken (interrupted), the position of the break can be located by connecting the test leads to the screen and to as many conductors as possible. The screen must not be grounded.



Loose contacts

The loose contacts can be detected in LONG TIME modes. In these modes measurements are repeatedly done for a long time. All the obtained waveforms are displayed together and so the intermittent faults are to be seen.



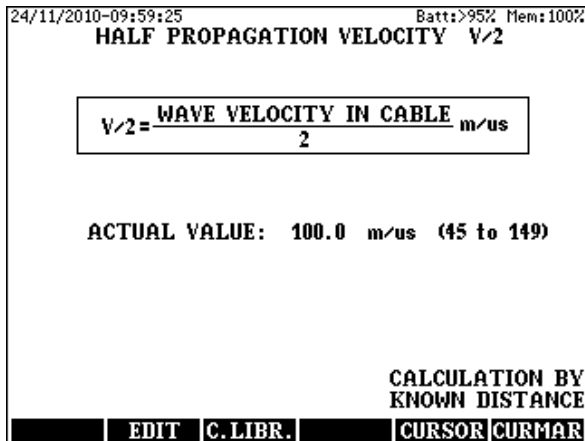
4.10 Obtaining the Missing V/2

The V/2 value can be determined in following cases:

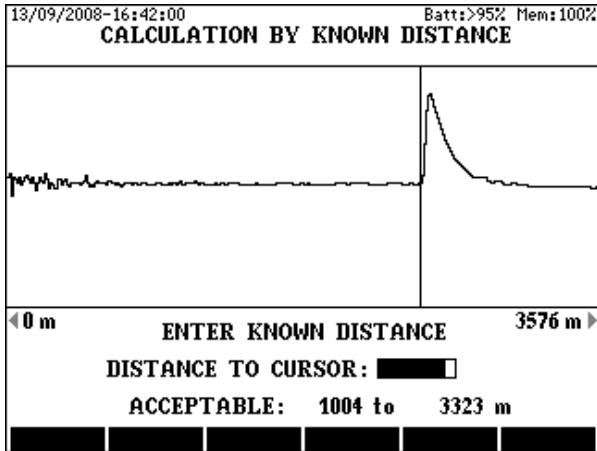
- The length of the cable or the distance to a known point is known. (eg. join box, change of cable-type etc.)
- A sample of the same cable is available with a known length
- The distance between two points is known.

Procedure when the distance to a known point is available

- Connect the cable to the L1 sockets and obtain a waveform in L1 mode by setting the appropriate measuring range and a V/2 value around 100 m/μs.
- Place the cursor to the start point of the pulse reflected from the known place. The displayed **CURSOR** position will be different from the distance to the known point
- Stop the measurement with the **START/STOP** key
- Press the **V/2 (F3)** key and the following display appears:



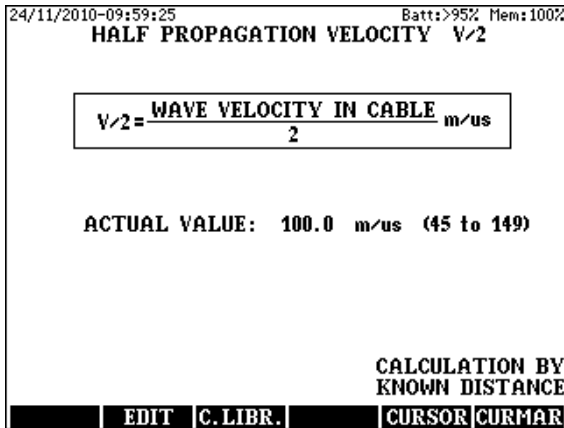
- Call the calculation page with the **CURSOR (F5)** key



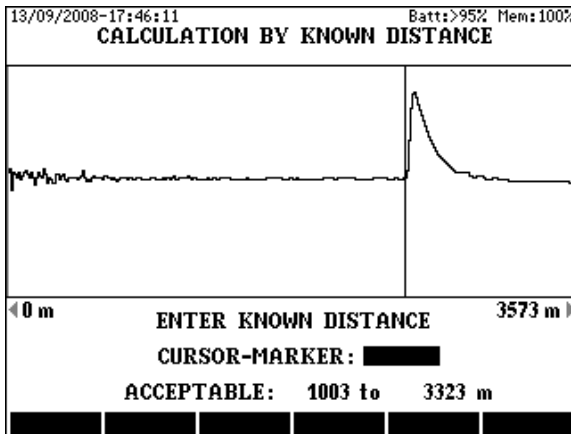
- Using the numeric keys, type in the known distance
- Press the **ENTER** key and the proper $V/2$ value will be set automatically

Procedure when the distance between two points is known

- Connect the cable to the L1 sockets and obtain a waveform in the L1 mode by setting the appropriate measuring range and a V/2 value around 100 m/μs.
- Place the cursor to the start point of the pulse reflected from the first known point, and set the marker by pressing **MARKER**
- Place the cursor to the starting point of the pulse reflected from the second known point
- Stop the measurement with **START/STOP** key
- Press the **V/2 (F3)** key and the following display appears



- Call the calculation page with the **CURMAR (F6)** key



- Using the numeric keys, type in the known distance
- Press the **ENTER** key and the proper $V/2$ value will be set automatically

5 ACTIVE BRIDGE

Having the **ACTIVE BRIDGE** selected in the **MAIN MENU** the following Display appears:

```

16/02/2010-11:06:25                               Batt:>95% Mem:100%
ACTIVE BRIDGE MEASUREMENTS
DISTURBING VOLTAGE: AC-DC MEASUREMENT
    RESISTANCE: 2 WIRE
                2 WIRE & GND
                RESISTANCE DIFFERENCE
                INSULATION RESISTANCE
    CAPACITANCE: 2 WIRE
                2 WIRE & GND
                CAPACITIVE BALANCE
    DC FAULT LOCATION: MURRAY METHOD
                      3 POINT METHOD
                      KÜPFMÜLLER METHOD
                      REPEATED KÜPFMÜLLER
    AC FAULT LOCATION: INTERRUPTION
                      REPEATED KÜPFMÜLLER

```

5.1 Interference Voltage Measurement (AC and DC)

KMK 8 has a measuring module with balanced input to measure AC and DC voltages at the same time. Measuring range is 1 to 300 V DC and 1 to 200 V AC, input impedance 2 MOhm

IMPORTANT NOTE

During that measurement the PC connection must be removed!
High voltages on the line may destroy the instrument or the PC!

Mode selection

- Select the **AC-DC MEASUREMENT** mode and press **ENTER**

Input selection

- Pressing the **Vab(F3)**, **VaE(F4)** or **VbE(F5)** key KMK 8 measures the AC, DC voltages continuously between the selected two inputs.
- The measuring range can be changed with the **SCALE (F2)** key
- Pressing **AUTO (F6)** KMK 8 performs all the AC-DC voltage measurements after each other. In auto mode the results can be saved with key **SAVE (F1)**. The measurement can be restarted with key **START/STOP**

5.2 Resistance Measurements

The active bridge of KMK 8 provides four resistance-measuring modes:

- **2 WIRE**
- **2 WIRE & GND**
- **RESISTANCE DIFFERENCE**
- **INSULATION RESISTANCE**

Before resistance measurement the instrument measures the AC and DC interference voltages. The results are displayed only when high interference voltages may cause the impairment of measurement accuracy.

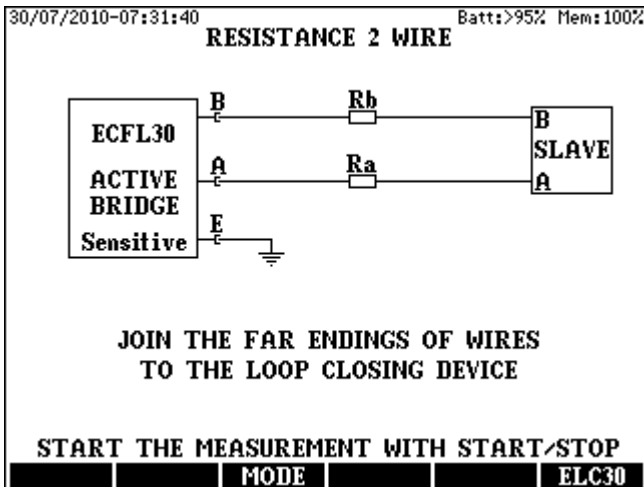
The resistance measurement is automatically performed independently of the results of voltage measurement but in case of high voltage indication a repeated measurement is recommended.

The resistance measurement is performed twice, first without and after with measuring voltage. The double measuring method provides accurate result because the effect of disturbing DC voltage can be compensated.

5.2.1 Loop Resistance Measurement (2 WIRE)

Test Procedure

Select the **RESISTANCE / 2 WIRE** mode and press **ENTER** and then the measuring arrangement appears:



The far ending of the tested pair should be joined manually or by means of the remote controllable loop-closing device KLC 8.

Two measuring modes are provided: **Sensitive** or **Protected** mode. It is recommended to start the measurement with sensitive mode. When the interference voltages overload the indicator a warning appears informing the user that the result can be inaccurate. In that case the measurement should be repeated in protected mode.

- Select the proper mode with the **MODE (F3)** key
- Start the measurement with the **START/STOP** key

Having the measurement completed the test results appear.

Displayed Test Results

- Loop resistance **RI, Ra, and Rb** (Ra and Rb is calculated as $RI/2$)
- Cable length (calculated of cable parameters and RI)

To change the cable type

- Press the **C.LIBR (F6)** key
- Select a new cable type and press **ENTER**
- Press **ESC**

To change the cable temperature

- Press the **TEMP.(F4)** key,
- Type in the temperature value and press **ENTER**.

When the cable length is known

- Press the **LENGTH (F5)** key
- Type in the length value and press **ENTER**

For returning to the normal display

- Press the **LENGTH (F5)** key and press **ENTER**

To save the test result press the **SAVE (F1)** key

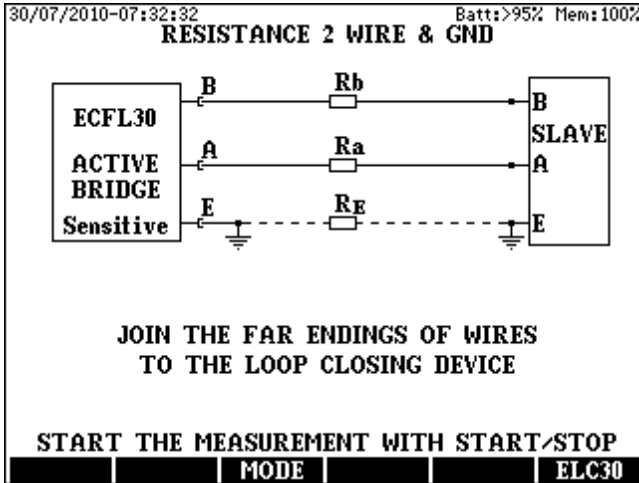
Notice:

In case of short cables the calibration of test leads is recommended.

5.2.2 Loop Resistance Measurement (2-WIRE & GND)

Test Procedure

Select the **RESISTANCE/2 WIRE & GND** mode and press **ENTER** and then the measuring arrangement appears:



The far ending of the tested pair should be joined manually or by means of the remote controllable loop-closing device KLC 8.

Two measuring modes are provided: **Sensitive** or **Protected** mode.

It is recommended to start the measurement with sensitive mode. When the interference voltages overload the indicator a warning appears informing the user that the result can be inaccurate. In that case the measurement should be repeated in protected mode.

- Select the proper mode with the **MODE (F3)** key
- Start the measurement with the **START/STOP** key

Having the measurement completed the test results appear.

Displayed Test Results

- **RI** Loop resistance
- **Ra, Rb** Wire resistances
- **RE** Sheath resistance

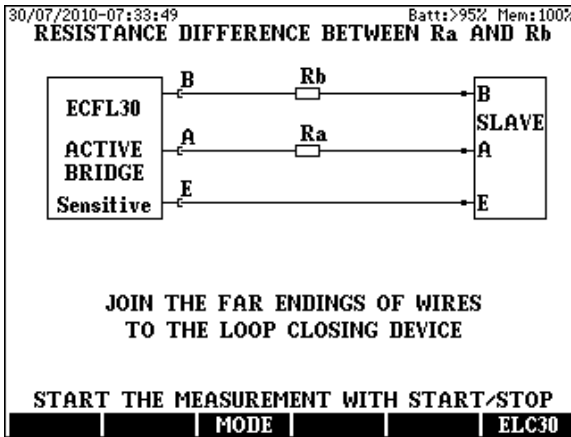
To save the test result press the **SAVE (F1)** key

5.2.3 Resistance Difference Measurement

The difference between the wire resistances of a pair is usually small compared to the wire resistances. KMK 8 has to measure the small difference of high resistances, therefore the calibration of test leads is recommended.

Test Procedure

Select the **RESISTANCE DIFFERENCE** mode and press **ENTER** and then the measuring arrangement appears.



This measurement is implemented as a Murray measurement. The far ending of the tested pair should be joined manually or by means of the remote controllable loop-closing device KLC 8.

Two measuring modes are provided: **Sensitive** or **Protected** mode.

It is recommended to start the measurement with sensitive mode. When the interference voltages overload the indicator a warning appears informing the user that the result can be inaccurate. In that case the measurement should be repeated in protected mode.

- Select the proper mode with the **MODE (F3)** key
- Start the measurement with the **START/STOP** key

Having the measurement completed the test results appear.

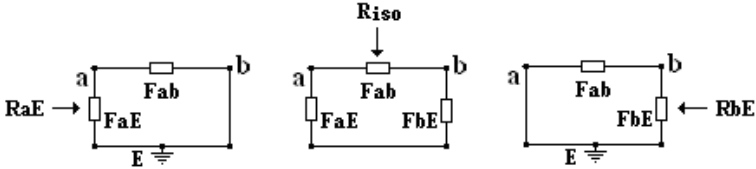
Displayed Test Results

- **RI = Ra+Rb** loop resistance
- **ΔR = Ra-Rb** resistance difference
- **2 ΔR / RI** (in %)
- **Ra** and **Rb** calculated of **RI** and **ΔR**

To save the test result press the **SAVE (F1)** key.

5.2.4 Insulation Resistance Measurement

The insulation resistance measurement is performed in the following arrangement:



$R_{iso} = Fab$ parallel with $(FaE + FbE)$

$R_{aE} = Fab$ parallel with FaE

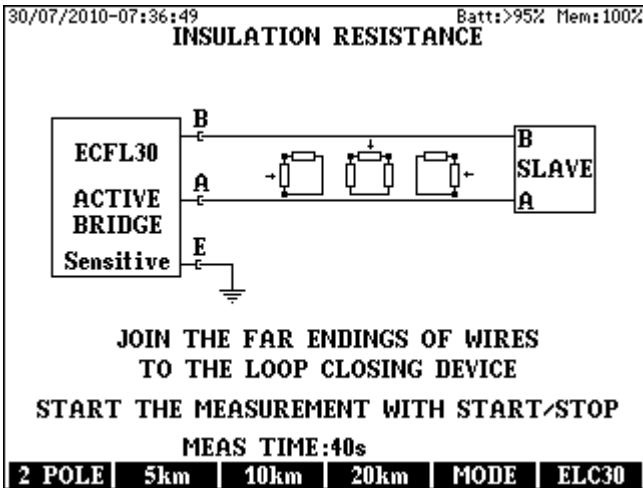
$R_{bE} = Fab$ parallel with FbE

The physical resistances are marked as: **Fab**, **FaE** and **FbE**

Test Procedure

Select the **INSULATION RESISTANCE** mode and press **ENTER**

The measuring arrangement appears on the display.



The far endings of the tested pair should be open.

Two measuring modes are provided: **Sensitive** or **Protected** mode. It is recommended to start the measurement with sensitive mode. When the interference voltages overload the indicator a warning appears informing the user that the result can be inaccurate. In that case the measurement should be repeated in protected mode.

- Select the proper mode with the **MODE (F5)** key

The measurement time depends on the cable length. The proper range can be selected with the **F2** to **F4** keys

- Start the measurement with the **START/STOP** key

Having the measurement completed the test results appear.

Displayed Test Results

- **Riso** resistance between wire **a** and wire **b**
- **RaE** resistance between wire **a** and GND (wire **b** joined to **GND**)
- **RbE** resistance between wire **b** and GND (wire **a** joined to **GND**)
- **Vab, VaE** and **VbE** AC and DC measured disturbing voltages

Calculation of Ω /km when the cable length is known

- Press the **LENGTH (F5)** key
- Type in the length value and press **ENTER**

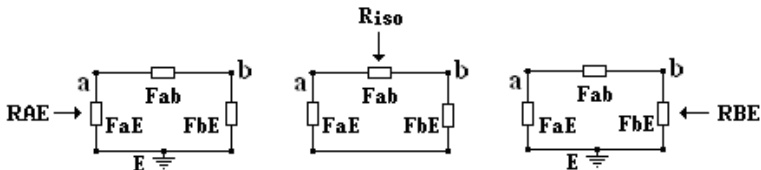
For returning to the normal display

- Press the **LENGTH (F5)** key and press **ENTER**

Notice:

The cheap and simple instruments can perform only 2 Pole measurements. For the sake of comparison KMK 8 also provides the 2 Pole measuring mode. To select that mode press **2 POLE (F1)** key

The 2 Pole measurement is performed in the following arrangement:



Riso = Fab parallel with (FaE + FbE)

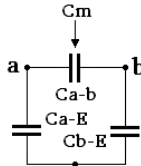
RAE = FaE parallel with (Fab + FbE)

RBE = FbE parallel with (Fab + FaE)

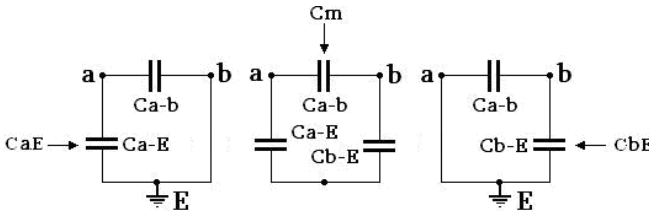
5.3 Capacitance Measurements

The active bridge of KMK 8 provides several capacitance measuring modes like:

- **2 WIRE** mode for the measurement of C_m mutual capacitance between wire a and wire b in the following arrangement:

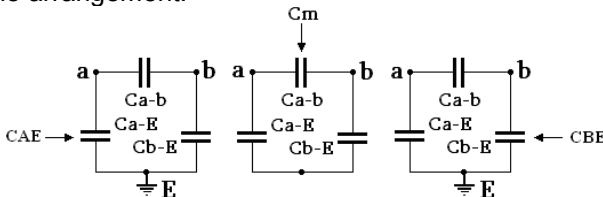


- **2 WIRE & GND** mode for capacitance measurement according to norm EN 50289-1-5:2001 in the following arrangement:



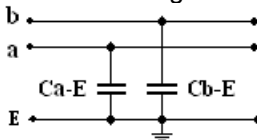
(Measuring results are marked as: C_m , CaE and CbE)

- **2 WIRE & GND** mode for the measurement of capacitances in 2 Pole arrangement:



(Measuring results are marked as: C_m , CAE and CBE)

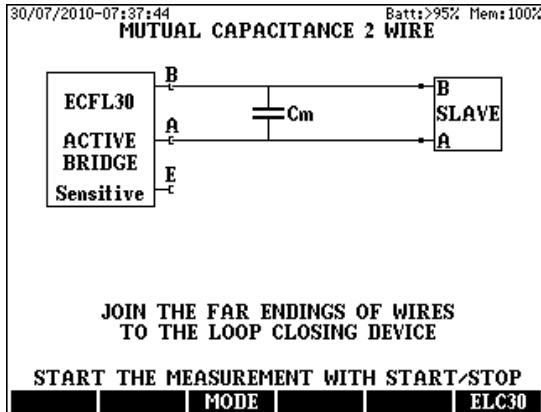
- **2 WIRE & GND** mode for physical capacitance Measurement
(The results are marked as: **Ca-b**, **Ca-E** and **Cb-E**)
- **CAPACITIVE BALANCE** mode for the measurement of balance between $Ca-E$ and $Cb-E$ with a high accuracy.



5.3.1 Capacitance Measurement (2 WIRE)

Test Procedure

Select the **CAPACITANCE/2-WIRE** mode and press **ENTER** and then the measuring arrangement appears:



The far end of the tested pair has to be open.

Two measuring modes are provided: **Sensitive** or **Protected** mode.

It is recommended to start the measurement with sensitive mode. When the disturbing voltages overload the indicator a warning appears informing the user that the result can be inaccurate. In that case the measurement should be repeated in protected mode.

- Select the proper mode with the **MODE (F3)** key
- Start the measurement with the **START/STOP** key

Having the measurement completed the following results appear:

Displayed Test Result

- **C_m** Mutual capacitance
- **tan δ** of mutual capacitance
- **DTS** Cable length (calculated of cable parameters)

To change the cable type

- Press the **C.LIBR (F6)** key
- Select a new cable type and press **ENTER**
- Press **ESC**

Calculation of nF/km when the cable length is known

- Press the **LENGTH (F5)** key
- Type in the length value and press **ENTER**

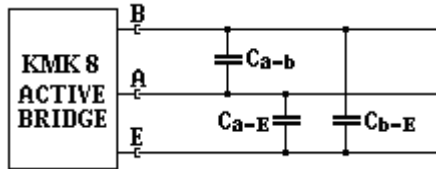
For returning to the normal display

- Press the **LENGTH (F5)** key and press **ENTER**

5.3.2 Capacitance Measurement (2 WIRE&GND)

Test Procedure

Select the **CAPACITANCE/2-WIRE&GND** mode and press **ENTER** and then the measuring arrangement appears:



The far endings of the tested pair should be open.

Two measuring modes are provided: **Sensitive** or **Protected** mode.

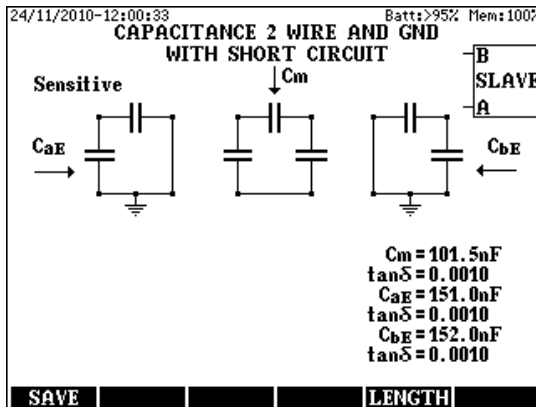
It is recommended to start the measurement with sensitive mode. When the disturbing voltages overload the indicator a warning appears informing the user that the result can be inaccurate. In that case the measurement should be repeated in protected mode.

- Select the proper mode with the **MODE (F5)** key
- Start the measurement with the **START/STOP** key

Having the measurement completed the following results appear:

Displayed Test Results (According to norm EN 50289-1-5:200)

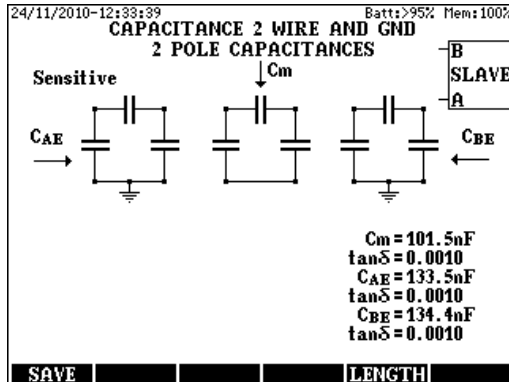
- **C_m** capacitance and **tan δ** between wire **a** and wire **b**
- **C_{aE}** capacitance and **tan δ** between wire **a** and **GND**
- **C_{bE}** capacitance and **tan δ** between wire **b** and **GND**



The cheap and simple instruments can perform only 2 Pole measurements. For the sake of comparison KMK 8 also provides the 2 Pole evaluating mode. For 2 Pole evaluations press the **2 POLE (F2)** key before starting the measurement

Displayed Test Results in 2 Pole mode.

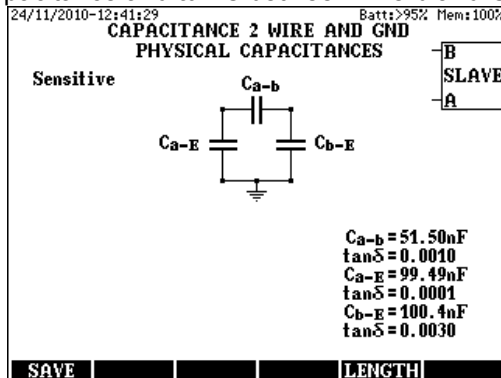
- **C_m** capacitance and **tan δ** between wire **a** and wire **b**
- **CAE** capacitance and **tan δ** between wire **a** and **GND**
- **CBE** capacitance and **tan δ** between wire **b** and **GND**



To see the physical capacitances press the **PHYS (F3)** key

Displayed Test Results in Physical mode

- **Ca-b** capacitance and **tan δ** between wire **a** and wire **b**
- **Ca-E** capacitance and **tan δ** between wire **a** and **GND**
- **Cb-E** capacitance and **tan δ** between wire **b** and **GND**



Calculation of nF/km when the cable length is known

- Press the **LENGTH (F5)** key
- Type in the length value and press **ENTER**

For returning to the normal display

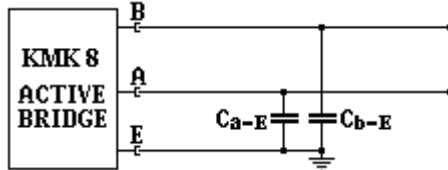
- Press the **LENGTH (F5)** key and press **ENTER**

To save the test result press the **SAVE (F1)** key

5.3.3 Capacitive Balance Measurement

Test Procedure

Select the **CAPACITIVE BALANCE** mode and press **ENTER** and then the measuring arrangement appears:



The far endings of the tested pair should be open.

Two measuring modes are provided: **Sensitive** or **Protected** mode.

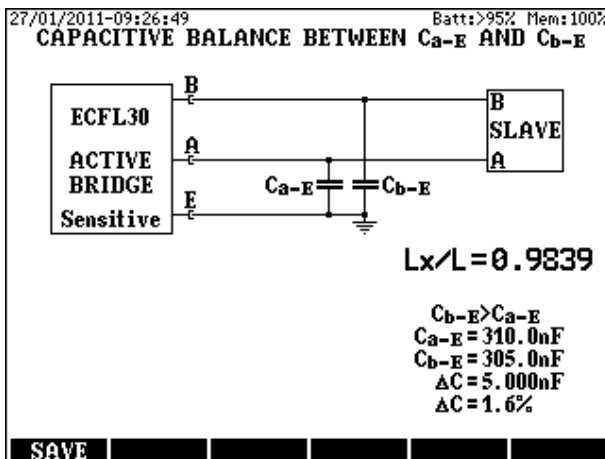
It is recommended to start the measurement with sensitive mode. When the disturbing voltages overload the indicator a warning appears informing the user that the result can be inaccurate. In that case the measurement should be repeated in protected mode.

- Select the proper mode with the **MODE (F3)** key
- Start the measurement with the **START/STOP** key

Having the measurement completed the following results appear:

Displayed Test Results

- **Lx/L** relative capacitance rate
- **Ca-E** wire capacitance
- **Cb-E** wire capacitance
- **$\Delta C = Ca-E - Cb-E$** capacitance difference
- **$\Delta C\% = 2 \Delta C / (Ca-E + Cb-E)$** difference in percents



5.4 DC Fault Location with MURRAY Method

The Murray-method applicable when the two wires of the pair have the same gauge (\emptyset), the same length, are made of the same material and only one of them is leaky. To provide the specified accuracy, the good wire's insulation resistance between wire and ground must be at least 1000 times greater than the faulty wire's insulation resistance between wire and ground.

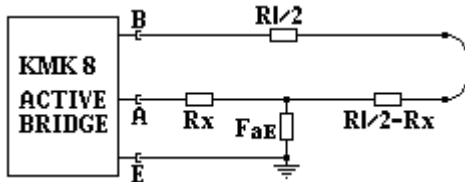
The insulation resistance of the healthy wire must be higher than 10 M Ω even if the fault resistance of the faulty wire is smaller than 10 k Ω .

The measurement can be performed if the healthy and faulty wires are taken from different pairs.

That method can be applied when both wires of the faulty pair are wet but another healthy pair is available. The two pairs must be in the same cable.

Test Procedure

Select the **MURRAY** mode and press **ENTER** and then the measuring arrangement appears



The far ending of the tested pair should be joined manually or by means of the remote controllable loop-closing device KLC 8.

The faulty wire should be connected to socket A.

Two measuring modes are provided: **Sensitive** or **Protected** mode.

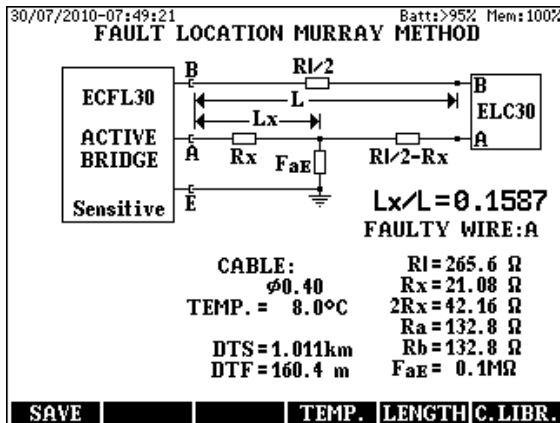
It is recommended to start the measurement with sensitive mode. When the interference voltages overload the indicator a warning appears informing the user that the result can be inaccurate. In that case the measurement should be repeated in protected mode.

- Select the proper mode with the **MODE (F3)** key
- Start the measurement with the **START/STOP** key

Having the measurement completed the following results appear:

Displayed Test Results

- **Lx/L** relative distance of fault compared to the cable length
- **Rx** wire resistance between the instrument and fault
- **2Rx** the double of wire resistance between the instrument and fault
- **RI** loop resistance
- **FaE** fault resistance
- **Ua-E** the voltage of a DC source connected serial to FaE.
That voltage shows the short between the faulty and an active wire. It is displayed only when its effect is not negligible.
- **DTS** (calculated of the cable parameters and RI)
- **DTF** (calculated of the cable parameters, RI and Lx/L)



To change the cable type

- Press the **C.LIBR (F6)** key
- Select a new cable type and press **ENTER**
- Press **ESC**

To change the cable temperature

- Press the **TEMP.(F4)** key,
- Type in the temperature value and press **ENTER**.

Doing so KMK 8 automatically calculates the new values.

When the cable length is known

- Press the **LENGTH (F5)** key
- Type in the length value and press **ENTER**

For returning to the normal display

- Press the **LENGTH (F5)** key
- Press **ENTER**

To save the test result press the **SAVE (F1)** key

5.5 DC Fault Location with K upfm uller Method

The K upfm uller-method is applicable when the two wires of the pair have the same gauge (\varnothing), the same length, are made of the same material and both of them are leaky. An accurate result can be obtained when the two K opfm uller conditions are fulfilled:

$$F_{aE} + F_{bE} > 100 \times R_I$$

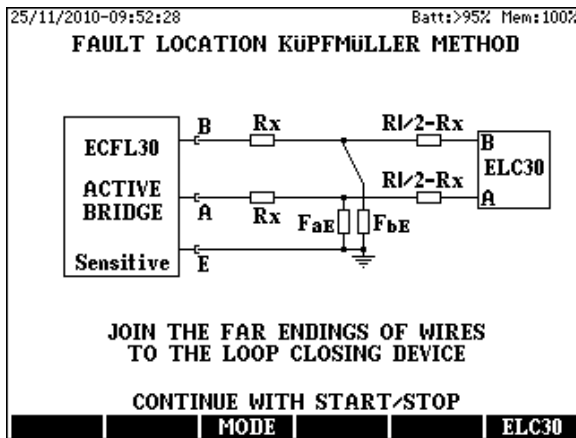
$$0,5 > F_{aE} / F_{bE} > 2$$

Thanks to the high accuracy of the active bridge acceptable accuracy can be reached when the tested line is free of interference voltages and the following condition is fulfilled:

$$0,9 > F_{aE} / F_{bE} > 1,1$$

Test Procedure

Select the **DC FAULT LOCATION/K UPFM ULLER METHOD** and press **ENTER** and then the measuring arrangement appears:



The K upfm uller method requires two part measurements.

- First measurement with open loop
- Second one with closed loop

The far endings of the tested pair can be open and joined manually or by means of the remote controllable Loop-Closing Device **KLC 8**.

Having the far endings of the tested pair opened

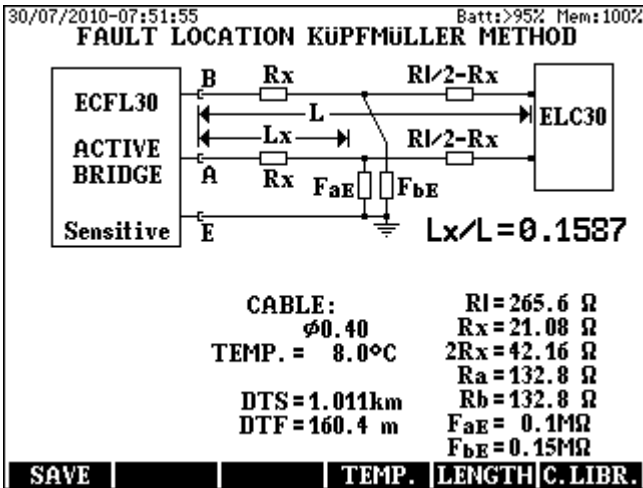
- **Start the first** measurement with the **START/STOP** key

Having the far endings of the tested pair shorted

- **Start the second** measurement with the **START/STOP** key

If the remote control function is switched on and the Loop-Closing Device is connected, the instrument automatically performs the second K pfm ller measurement.

When the second measurement is completed the following results appear:



Displayed Test Results

- **Lx/L** relative distance of fault compared to the cable length
- **Rx** wire resistance between the instrument and fault
- **2Rx** the double of wire resistance between the instrument and fault
- **RI** loop resistance
- **FaE** and **FbE** fault resistances
- **Ua-E** the voltage of a DC source connected serial to FaE.or FbE
These voltages show the short between the faulty and an active wire. They are displayed only when their effect is not negligible
- **DTS** (calculated of the cable parameters and RI)
- **DTF** (calculated of the cable parameters, RI and Lx/L)

To change the cable type

- Press the **C.LIBR (F6)** key
- Select a new cable type and press **ENTER**
- Press **ESC**

To change the cable temperature

- Press the **TEMP.(F4)** key,
- Type in the temperature value and press **ENTER**.

Doing so KMK 8 automatically calculates the new values.

When the cable length is known

- Press the **LENGTH (F5)** key
- Type in the length value and press **ENTER**

For returning to the normal display

- Press the **LENGTH (F5)** key
- Press **ENTER**

Notice:

Two measuring modes are provided: **Sensitive** or **Protected** mode. It is recommended to start the measurement with sensitive mode. When the interference voltages overload the indicator a warning appears informing the user that the result can be inaccurate. In that case the measurement should be repeated in protected mode. The proper mode can be selected with the **MODE (F3)** key.

To save the test result press the **SAVE (F1)** key

5.6 DC Fault Location with 3 Point Method

The purpose of the test is to find the location of the insulation fault. This test is applicable when the two wires of the pair have different gauges and only one of them is leaky. The ratio of the good wire insulation to the leaky wire insulation must be at least 1000.

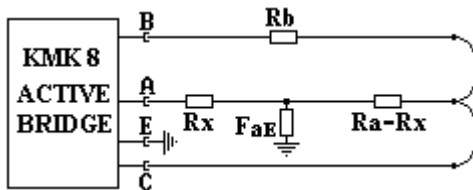
For that measurement, a third auxiliary wire is required (Wire C)

The resistance of auxiliary wire has no effect on the measurement.

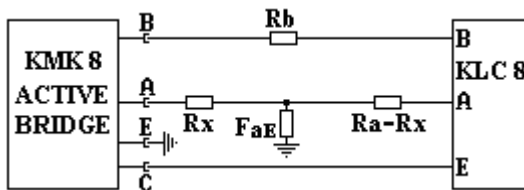
During the test the far endings of the tested pair and the auxiliary wire should be interconnected manually or by means of the remote controllable Loop-Closing Device **KLC 8**.

Test Procedure

Select the **3 POINT METHOD** mode, press **ENTER** and then the measuring arrangement appears

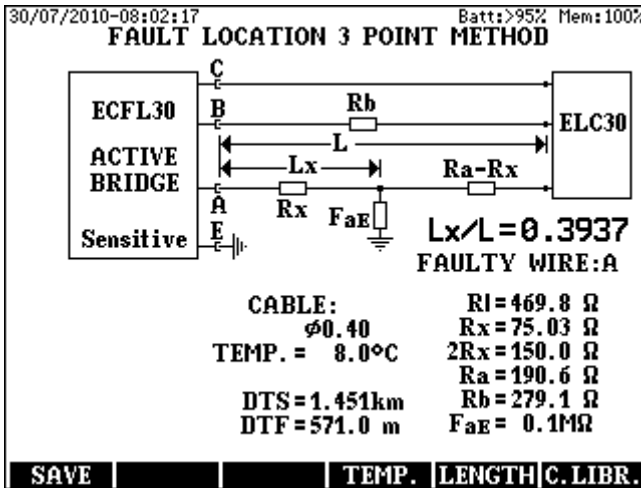


The remote control function of the instrument can be switched on or off with the **KLC 8 (F6)** key.



- The measurement can be started with the **START/STOP** key

Having the measurement completed the following display appear:



Displayed Test Results

- Lx/L relative distance of fault compared to the cable length
- **FAULTY WIRE: A or B**
- Rx resistances between connection point to fault point
- $2R_x = (Lx/L) \times R_I$
- R_I loop resistance ($R_I = R_a + R_b$)
- R_a and R_b wire resistances
- F_{aE} or F_{bE} fault resistances

To save the test result press the **SAVE (F1)** key

Notices

When wire A is faulty then $Lx/L = Rx/Ra$ and the F_{aE} insulation resistance is displayed. When $Lx/L > 1$ is indicated then the result is incorrect. Please exchange the A and B wires and repeat the measurement.

Two measuring modes are provided: **Sensitive** or **Protected** mode.

It is recommended to start the measurement with sensitive mode. When the interference voltages overload the indicator a warning appears informing the user that the result can be inaccurate. In that case the measurement should be repeated in protected mode. The proper mode can be selected with the **MODE (F3)** key.

5.7 DC Fault Location with repeated KÜPFMÜLLER method

That method is a sequence of repeated KÜPFMÜLLER measurements. It is applicable when none of the wires of a cable is free of fault. That method is very useful in case of intensely changing fault resistances, DC voltages or electrolytic voltages.

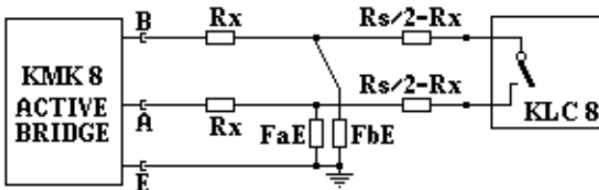
That method requires 16 part measurements alternating:

- 8 measurements with open loop (L)
- 8 measurements with closed loop (K)

The far endings of the tested pair should be connected to KLC 8 remote controllable loop closing devices.

Test Procedure

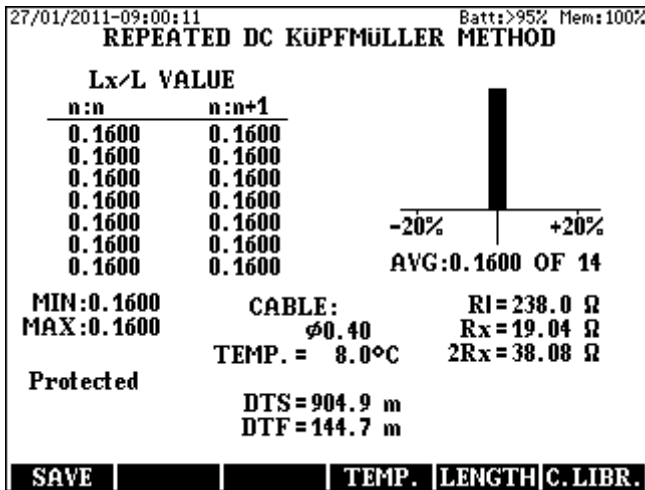
Select the **DC: REPEATED KÜPFMÜLLER** mode and press **ENTER** and then the measuring arrangement appears:



- The measurement can be started with the **START/STOP** key

When the 16 part measurements are ready KMK 8 evaluates the results. In the course of evaluation the results of the first two measurements and Lx/L values unlikely differing from the average are omitted.

Having the test sequence completed the result display appears:



During the calculation process all L and K values are used twice. That are marked at the header of result display with n:n and n:n+1

The result display contains:

- All the 14 remaining Lx/L values (the unlikely ones are marked with asterisks.)
- The average of Lx/L values
- The number of Lx/L values (used for average calculation)
- The minimum and maximum of Lx/L value
- Histogram showing the distribution of Lx/L values
- **R_x** wire resistance between the instrument and fault
- **2R_x** the double of wire resistance between the instrument and fault
- **RI** loop resistance
- **DTS** (calculated of the cable parameters and RI)
- **DTF** (calculated of the cable parameters, RI and Lx/L)

To save the test result press the **SAVE (F1)** key

Evaluation by means of Histogram

In case of high disturbing voltages the Lx/L values calculated out of the results of part measurements may show remarkable dispersion and the user can't be sure that automatic average calculation produces really proper value.

Therefore a **HISTOGRAMM** is provided showing the dispersion of calculated part results.

The histogram presents the Lx/L values along the horizontal axis.

- The width of bars is 7% of average value
- The height of bars shows the prevalence of Lx/L values
- The bars used for the average calculation are black
- The unused bars are grey

At the evaluation of histogram the user should consider:

- The histogram of a **perfect measurement** is a black bar showing that the results of all part measurements were within a $\pm 3.5\%$ range around the average.
- The histogram of a **sufficient measurement** is absolutely symmetrical but some results are in the neighboring bars around the average.
- The histogram of a **doubtful measurement** is generally unsymmetrical and the dispersion is irregular. In that case the measurement should be repeated with another wire combination.
- When the level of interference voltage is too high the whole histogram and the test results can be **unacceptable**. In this case try to repeat the test in protected mode or with the passive bridge of KMK 8.

Notice:

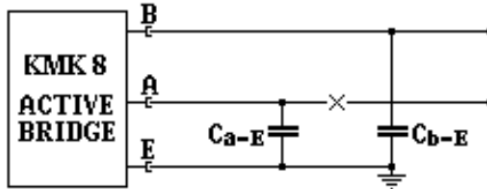
Two measuring modes are provided: **Sensitive** or **Protected** mode.

It is recommended to start the measurement with sensitive mode. When the interference voltages overload the indicator a warning appears informing the user that the result can be inaccurate. In that case the measurement should be repeated in protected mode. The proper mode can be selected with the **MODE (F3)** key

5.8 AC Fault Location with Interruption Measurement

Test Procedure

Select the **INTERRUPTION** mode and press **ENTER** and then the measuring arrangement appears



The far endings of the pair should be open.

- Start the measurement pressing the **START/STOP** key

Displayed Test Results

- **Lx/L** relative distance of fault compared to the cable length
- **Ca-E** wire capacitance between the instrument and fault
- **Cb-E** ground capacitance of wire b

To save the test result press the **SAVE (F1)** key

Calculation of **DTF** when the cable parameters are known

When the cable type is known the length (**DTS**) and the distance to fault (**DTF**) can be calculated of the measured capacitances.

- To enter or change the cable type press the **C.LIBR (F6)** key select a cable type and press **ESC**

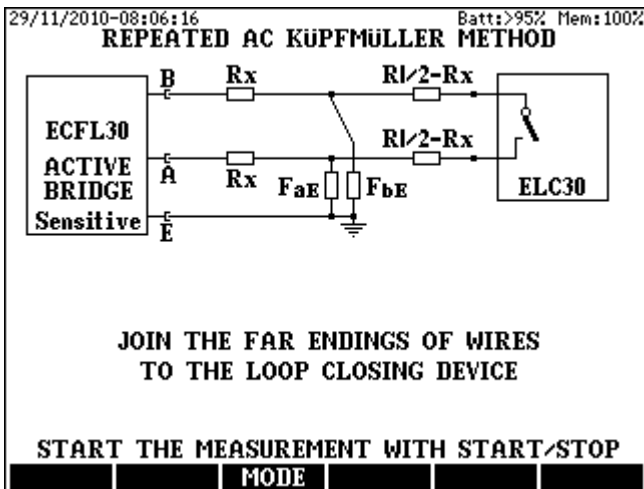
Calculation of **DTF** when the cable length is known

The **DTF** can be calculated from the **Lx/L** value when the length is known. To enter the length of the cable press the **LENGTH (F5)** key, type in the length value and press **ENTER**

5.9 AC Fault Location with repeated KÜPFMÜLLER method

The process of the measurement is similar to DC method.
The only difference is: the measuring voltage is 11 Hz AC instead of DC.
The AC method provides accurate test result in case of changing electrolytic voltages

Select the **AC: REPEATED KÜPFMÜLLER** mode and press **ENTER** and then the measuring arrangement appears:

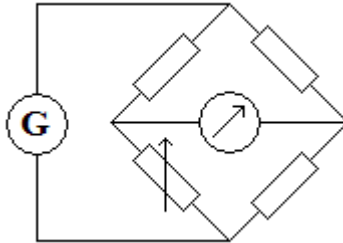


- Start the first measurement pressing the **START/STOP** key

6 PASSIVE BRIDGE

6.1 Principles of Operation

In **PASSIVE BRIDGE** mode KMK 8 applies the classic Wheatstone bridge arrangement consisting of fix and variable resistors, generator and null-indicator.



- The generator produces 100 V DC or 100 Vp, 11 Hz AC
- The null-indicator contains a 11 Hz low pass filter
- The variable resistor is a high precision potentiometer (Helipot)

The passive bridge of KMK 8 can be manually balanced by means of the Helipot (like it is usual at the conventional bridges), but the reading of potentiometer resistance is electronic.

That solution combines the good features of conventional bridges with the comfort of micro processor controlled circuits.

- The passive bridge measures accurately even in the presence of AC interference voltages.
- The electronic „reading“ of potentiometer provides quick and accurate calculation of fault location (L_x/L)

Applications

DC Fault Location

- Fault location with Murray-Method
- Fault location with 3 Point-Method
- Fault location with K upfm uller-Method
- Resistance difference measurement

AC Fault Location

- Fault location with K upfm uller-Method
- Capacitance balance measurement

KMK 8 applies the generator and the null-indicator also for resistance measurements like

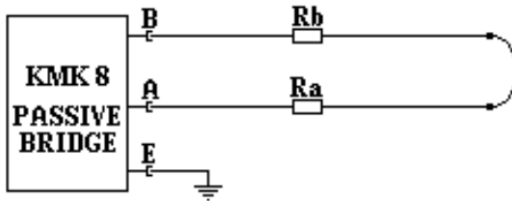
- Loop resistance measurement
- Insulation resistance measurement

6.2 Loop Resistance Measurement

The purpose of that measurement is to measure the loop resistance. **KMK 8** measures the loop resistance accurately even in the presence of AC interference voltages on the line.

Test Procedure

Select the **LOOP RESISTANCE** mode and press **ENTER** and then the measuring arrangement appears.



The far endings of the tested pair should be joined manually or by means of the remote controllable loop-closing device KLC 8.

- The measurement can be started with the **START/STOP** key

Having the measurement completed the following results appears:

Displayed Test Results

- Loop resistance **RI** (**Ra** and **Rb** is calculated as $RI/2$)
- Cable length (calculated of cable parameters and **RI**)

To change the cable type

- Press the **C.LIBR (F6)** key
- Select a new cable type and press **ENTER**
- Press **ESC**

To change the cable temperature

- Press the **TEMP.(F4)** key,
- Type in the temperature value and press **ENTER**.

When the cable length is known

- Press the **LENGTH (F5)** key
- Type in the length value and press **ENTER**

For returning to the normal display

- Press the **LENGTH (F5)** key and press **ENTER**

To save the test result press the **SAVE (F1)** key

Notice: In case of short cables the calibration of test leads is recommended.

6.3 Insulation Resistance Measurement

The purpose of that measurement is to measure the insulation resistance. **KMK 8** measures the insulation resistance accurately even in the presence of AC interference voltages on the line.

There are two measuring ranges: up to 300 MΩ and up to 10 GΩ

Measuring times:

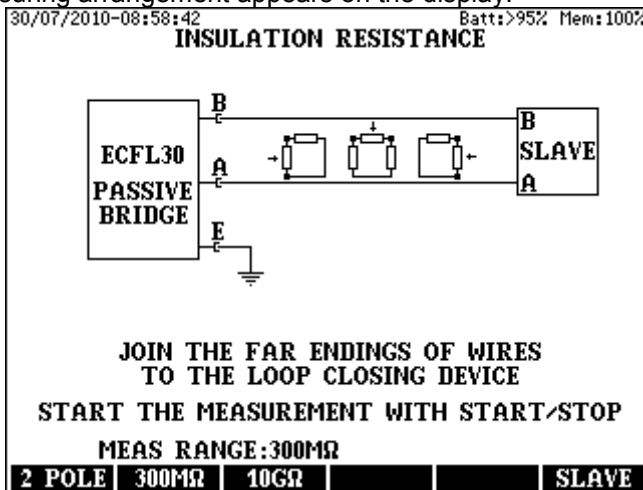
- 3 x 20 sec for the 300MΩ range
- 3 x 35 sec for the 10 GΩ range

The relatively long measuring time is necessary because of the capacitance of the measured cable.

Test Procedure

Select the **INSULATION RESISTANCE** mode and press **ENTER**

The measuring arrangement appears on the display:



The far endings of the tested pair have to be open.

- Select the required measuring range with pressing the **300MΩ (F2)** or **10GΩ (F3)** key
- Start the measurement with the **START/STOP** key

Having the measurement completed the following results appears

Displayed Test Results

- **Riso** resistance between wire **a** and wire **b**
- **RaE** resistance between wire **a** and GND (wire **b** joined to **GND**)
- **RbE** resistance between wire **b** and GND (wire **a** joined to **GND**)
- **Vab, VaE** and **VbE** AC and DC interference voltages

Calculation of Ω /km when the cable length is known

- Press the **LENGTH (F5)** key
- Type in the length value and press **ENTER**

For returning to the normal display

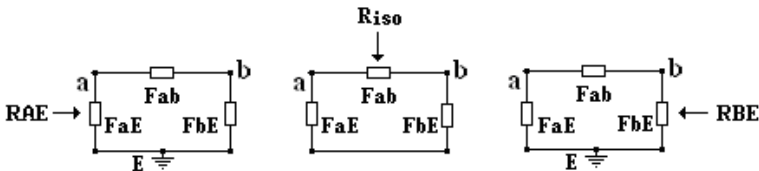
- Press the **LENGTH (F5)** key and press **ENTER**

To save the test result press the **SAVE (F1)** key

Notice:

The cheap and simple instruments can perform only 2 Pole measurements. For the sake of comparison KMK 8 also provides the 2 Pole measuring mode. To select that mode press **2 POLE (F1)** key

The 2 Pole measurement is performed in the following arrangement:



Riso = Fab parallel with (FaE + FbE)

RAE = FaE parallel with (Fab + FbE)

RBE = FbE parallel with (Fab + FaE)

6.4 Resistance Difference Measurement

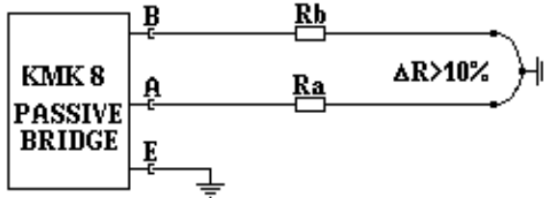
The purpose of that measurement is to measure the resistance difference between wire **a**, and wire **b**. KMK 8 measures the resistance difference accurately even in the presence of AC interference voltages on the line.

This measurement is implemented as a Murray measurement. The results are calculated out of the loop resistance and Mk (L_x/L) values.

Test Procedure

Select the **RESISTANCE DIFFERENCE** mode and press **ENTER**

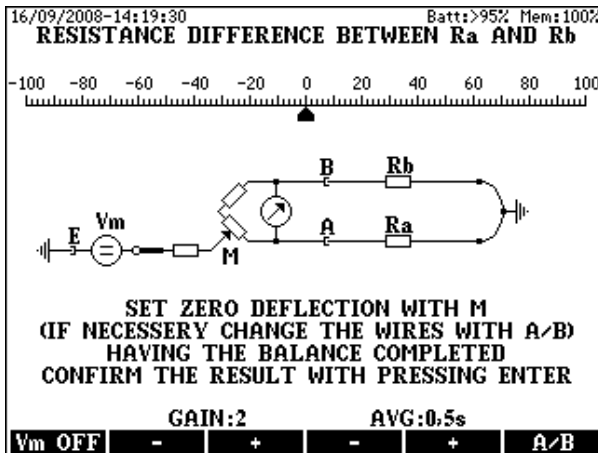
The measuring arrangement appears on the display:



The far endings of the tested pair should be joined to the ground manually or by means of the remote controllable loop-closing device KLC 8.

- Select the required measuring range with pressing the $\Delta R < 10\%$ (F2) or $\Delta R > 10\%$ (F3) key
- Start the measurement with the **START/STOP** key

Having the measurement started the following display appears after a few seconds and the bridge is ready for balancing



Bridge Balancing

- Select the minimum gain with key **F2**
- Switch the measuring voltage off with the **Vm OFF (F1)** key and keep it pressed until the pointer reaches a stable position. While the key is pressed KMK 8 measures the disturbing DC voltage. After releasing the key, KMK 8 performs a null-correction compensating the effect of disturbing voltage. The null point remains in the middle.
- Set the pointer to the 0 point with the M balancing potentiometer
- Increase the gain gradually with key **F3** and repeat the first two points until reaching the perfect balance. The balance is perfect when the gain is 4 or 5 and the pointer stands on the 0 point with pressed and released **F1** key as well.
- The device performs numerous measurements per second. The pointer shows the result of the last measurement. When the line is too noisy the pointer is waving around a middle point and the reading is difficult. The waving of pointer can be reduced by average calculation. Five averaging times are provided: 0, 0.5, 1, 2 or 4 sec. (Zero means: no averaging). The averaging time can be changed with keys **F4** and **F5**
- When the balancing is completed press **ENTER** and the results appear

Displayed Test Results

- **MK** value
- **RI = Ra+Rb** loop resistance
- **Ra** and **Rb** (Ra and Rb is calculated as RI/2)
- **ΔR = Ra-Rb** resistance difference
- **2 ΔR / RI** resistance difference in percents

To save the test result press the **SAVE (F1)** key

Notice

The difference between the wire resistances of a pair is usually small compared to the wire resistances. KMK 8 has to measure the small difference of high resistances, therefore the calibration of test leads is recommended.

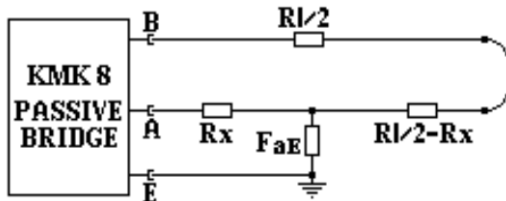
6.5 DC Fault Location with MURRAY Method

The Murray-method applicable when the two wires of the pair have the same gauge (\varnothing), the same length, are made of the same material and only one of them is leaky. To provide the specified accuracy, the good wire's insulation resistance between wire and ground must be at least 1000 times greater than the faulty wire's insulation resistance between wire and ground. The insulation resistance of the healthy wire must be higher than 10 M Ω even if the fault resistance of the faulty wire is smaller than 10 k Ω . The passive bridge of KMK 8 measures accurately even in the presence of AC interference voltages on the line.

The measurement can be performed if the healthy and faulty wires are taken from different pairs. That solution can be applied when all the two wires of the faulty pair are wet but another healthy pair is available. The two pairs must be in the same cable

Test Procedure

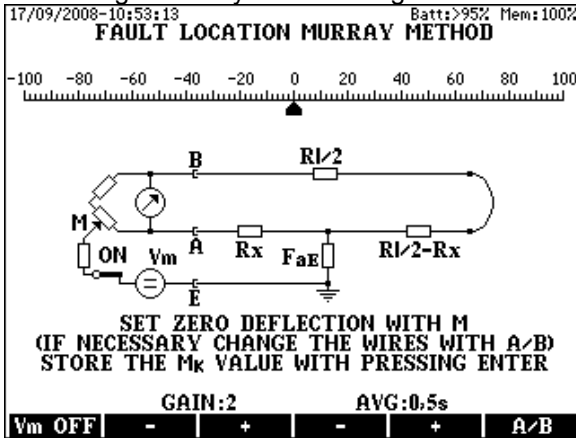
- Select the **DC FAULT LOCATION/MURRAY METHOD**
- Press **ENTER** and then the measuring arrangement appears



The far ending of the tested pair should be joined manually or by means of the remote controllable loop-closing device KLC 8.

- Start the measurement with the **START/STOP** key

Having the measurement started the following display appears after a few seconds and the bridge is ready for balancing.



Bridge Balancing

- Select the minimum gain with key **F2**
- Switch the measuring voltage off with the **Vm OFF (F1)** key and keep it pressed until the pointer reaches a stable position. While the key is pressed KMK 8 measures the disturbing DC voltage.
- After releasing the key, KMK 8 performs a null-correction compensating the effect of disturbing voltage. The null point remains in the middle. Set the pointer to the 0 point with the M balancing potentiometer
- Increase the gain gradually with key **F3** and repeat the first two points until reaching the perfect balance. The balance is perfect when the gain is 4 or 5 and the pointer stands on the 0 point with pressed and released **F1** key as well.
- The device performs numerous measurements per second. The pointer shows the result of the last measurement. When the line is too noisy the pointer is waving around a middle point and the reading is difficult. The waving of pointer can be reduced by average calculation.
- Five averaging times are provided: 0, 0.5, 1, 2 or 4 sec. (0= no averaging)
- The averaging time can be changed with keys **F4** and **F5**. When the balancing is completed press **ENTER** and the results appear.

Displayed Test Results

- **MK** value
- **Lx/L** relative distance of fault compared to the cable length
- **Rx** wire resistance between the instrument and fault
- **2Rx** double wire resistance between the instrument and fault
- **RI** loop resistance
- **FaE** fault resistance
- **DTS** (calculated of the cable parameters and **RI**)
- **DTF** (calculated of the cable parameters, **RI** and **Lx/L**)

To change the cable type

- Press the **C.LIBR (F6)** key
- Select a new cable type and press **ENTER**
- Press **ESC**

To change the cable temperature

- Press the **TEMP.(F4)** key,
- Type in the temperature value and press **ENTER**.

When the cable length is known

- Press the **LENGTH (F5)** key
- Type in the length value and press **ENTER**

For returning to the normal display

- Press the **LENGTH (F5)** key
- Press **ENTER**

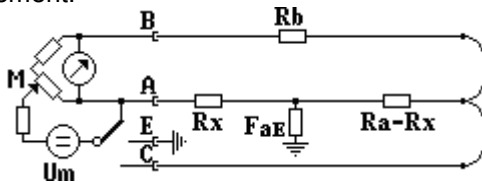
To save the test result press the **SAVE (F1)** key.

6.6 DC Fault Location with 3 Point Method

The purpose of the test is to find the location of the wire-to-ground insulation fault. This test is applicable when the two wires of the pair have different gauges and only one of them is leaky. The ratio of the good wire insulation to the leaky wire insulation must be at least 1000. The passive bridge of KMK 8 measures accurately even in the presence of disturbing longitudinal AC voltages on the line.

For that measurement a third, auxiliary wire is required between KMK 8 and the far end. The resistance of auxiliary **wire c** has no effect on the accuracy. The far endings of the tested pair should be joined to the wire **c** manually or by means of the remote controllable loop-closing device KLC 8.

The test arrangement:



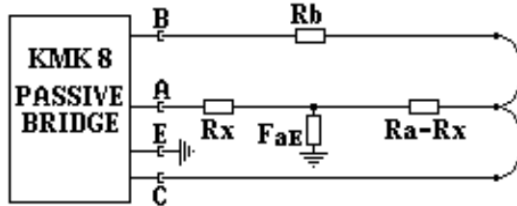
The 3 Point method requires three part-measurements:

- Measurement 1. The generator **Um** is connected to wire **A**. The result is **MK1** (Practically always 0)
- Measurement 2. The bridge should be balanced when the generator **Um** is connected to the **ground**. The result is **MK2**.
- Measurement 3. The bridge should be balanced when the generator **Um** is connected to wire **C**. The result is **MK3**.

The Lx/L value is calculated out of **MK1**, **MK2** and **MK3**

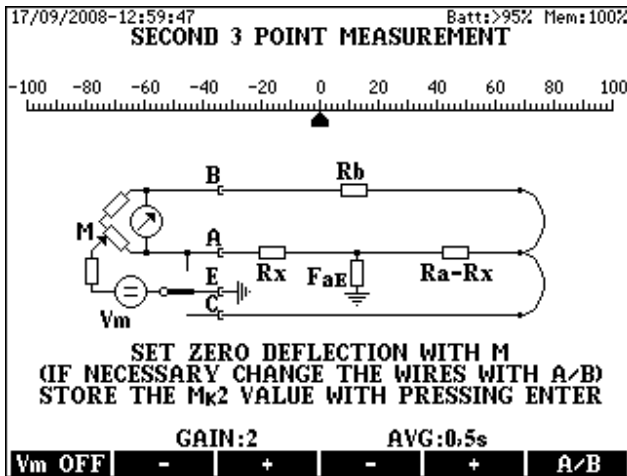
Test Procedure

- Select the **DC FAULT LOCATION/3 POINT METHOD**
- Press **ENTER** and then the measuring arrangement appears



- Start the measurement with the **START/STOP** key

Having the **START/STOP** key pressed KMK 8 automatically performs the first measurement without balancing and stores the MK1 value. When the first measurement is completed the bridge is ready for balancing and the following display appears:



Bridge Balancing

- Select the minimum gain with key **F2**
- Switch the measuring voltage off with the **Vm OFF(F1)** key and keep it pressed until the pointer reaches a stable position. While the key is pressed KMK 8 measures the disturbing DC voltage. After releasing the key, KMK 8 performs a null-correction compensating the effect of disturbing voltage. The null point remains in the middle.
- Set the pointer to the 0 point with the M balancing potentiometer
- Increase the gain gradually with key **F3** and repeat the first two points until reaching the perfect balance. The balance is perfect when the gain is 4 or 5 and the pointer stands on the 0 point with pressed and released **F1** key as well.

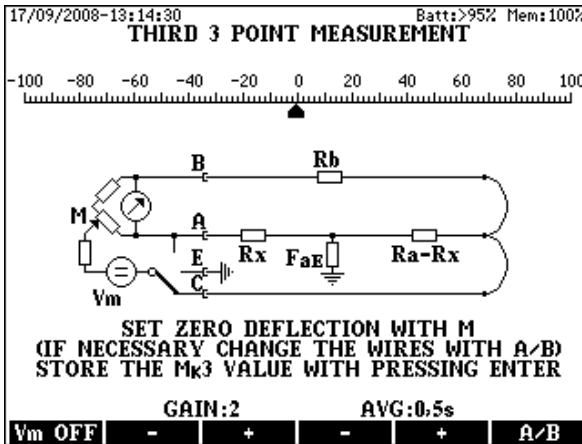
The indicator performs numerous measurements per second. The pointer shows the result of the last measurement. When the line is too noisy the pointer is waving around a middle point and the reading is difficult.

The waving of pointer can be reduced by average calculation.

Five averaging times are provided: 0, 0.5, 1, 2 or 4 sec. (Zero means: no averaging).

- The averaging time can be changed with keys **F4** and **F5**
- When the balancing is completed press **ENTER** to store the result (MK2) and to call the picture of the third measurement.

Doing so the following display appears and the bridge is ready for the third balancing:



Balance the bridge again and press **ENTER** to store the result (**MK3**) and to call the result display.

Displayed Test Results

- **MK1, MK2** and **MK3** values
- **Lx/L** relative distance of fault compared to the cable length
- **Rx** wire resistance between the instrument and fault
- **2Rx** double wire resistance between the instrument and fault
- **RI** loop resistance
- **FaE** fault resistance
- **DTS** (calculated of the cable parameters and **RI**)
- **DTF** (calculated of the cable parameters, **RI** and **Lx/L**)

To change the cable type

- Press the **C.LIBR (F6)** key
- Select a new cable type and press **ENTER**
- Press **ESC**

To change the cable temperature

- Press the **TEMP.(F4)** key,
- Type in the temperature value and press **ENTER**.

When the cable length is known

- Press the **LENGTH (F5)** key
- Type in the length value and press **ENTER**

For returning to the normal display

- Press the **LENGTH (F5)** key
- Press **ENTER**

To save the test result press the **SAVE (F1)** key

6.7 DC Fault Location with K upfm uller Method

The K upfm uller-method applicable when the two wires of the pair have the same gauge (\varnothing), the same length, are made of the same material and both of them are leaky. An accurate result can be obtained when the two K opfm uller conditions are fulfilled:

$$FaE + FbE > 100 \times Rl$$

$$0,5 > FaE / FbE > 2$$

The passive bridge of KMK 8 measures accurately even in the presence of AC interference voltages on the line.

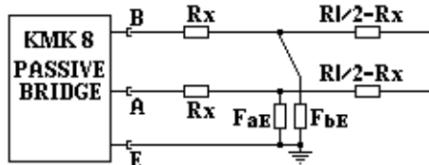
The K upfm uller method requires two part-measurements

- Measurement 1: Performed with **open** loop. The result is **ML**
- Measurement 2: Performed with **closed** loop. The result is **MK**

The Lx/L value is calculated out of **ML** and **MK**.

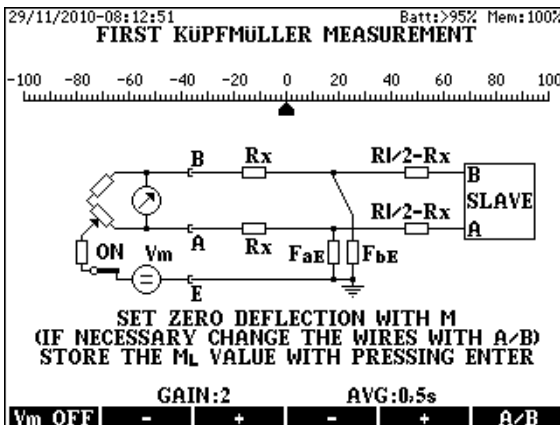
Test Procedure

- Select the **DC FAULT LOCATION/K UPFM ULLER METHOD**
- Press **ENTER** and then the measuring arrangement appears



- Start the first measurement pressing the **START/STOP** key

Having the measurement started the following display appears after a few seconds and the bridge is ready for balancing:

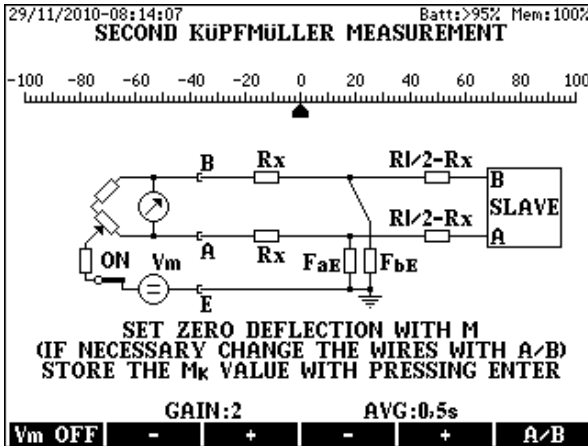


Bridge Balancing

- Select the minimum gain with key **F2**
- Switch the measuring voltage off with the **Vm OFF(F1)** key and keep it pressed until the pointer reaches a stable position. While the key is pressed KMK 8 measures the disturbing DC voltage. After releasing the key, KMK 8 performs a null-correction compensating the effect of disturbing voltage. The null point remains in the middle.
- Set the pointer to the 0 point with the M balancing potentiometer.
- Increase the gain gradually with key **F3** and repeat the first two points until reaching the perfect balance. The balance is perfect when the gain is 4 or 5 and the pointer stands on the 0 point with pressed and released **F1** key as well. The device performs numerous measurements per second. The pointer shows the result of the last measurement. When the line is too noisy the pointer is waving around a middle point and the reading is difficult. The waving of pointer can be reduced by average calculation. Five averaging times are provided: 0, 0.5, 1, 2 or 4 sec. (Zero means: no averaging). The averaging time can be changed with keys **F4** and **F5**.
- When the balancing is completed press **ENTER** to store the result (**ML**).

Before the second measurement the loop should be closed. Close it manually or by means of the remote controllable loop-closing device KLC 8.

In case of manual control start the second measurement pressing the **START/STOP** key and the bridge is ready for the second balancing:



Balance the bridge again and press **ENTER** to store the result (**MK**) and to call the result display.

Displayed Test Results

- **ML** and **MK** values
- **Lx/L** relative distance of fault compared to the cable length
- **Rx** wire resistance between the instrument and fault
- **2Rx** double wire resistance between the instrument and fault
- **RI** loop resistance
- **FaE** and **FbE** fault resistances
- **DTS** (calculated of the cable parameters and **RI**)
- **DTF** (calculated of the cable parameters, **RI** and **Lx/L**)

To change the cable type

- Press the **C.LIBR (F6)** key
- Select a new cable type and press **ENTER**
- Press **ESC**

To change the cable temperature

- Press the **TEMP.(F4)** key,
- Type in the temperature value and press **ENTER**.

When the cable length is known

- Press the **LENGTH (F5)** key
- Type in the length value and press **ENTER**

For returning to the normal display

- Press the **LENGTH (F5)** key
- Press **ENTER**

To save the test result press the **SAVE (F1)** key

6.8 AC Fault Location with K upfm uller Method

The K upfm uller-method applicable when the two wires of the pair have the same gauge (\emptyset), the same length, are made of the same material and both of them are leaky. An accurate result can be obtained when the two K upfm uller conditions are fulfilled:

$$\mathbf{FaE + FbE > 100 \times RI}$$

$$\mathbf{0,5 > FaE / FbE > 2}$$

The passive bridge of KMK 8 measures accurately even in the presence of disturbing longitudinal AC voltages on the line.

The K upfm uller method requires two part-measurements

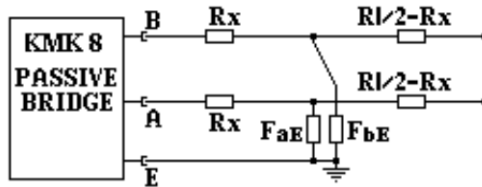
Measurement 1: Performed with **open** loop. The result is **ML**

Measurement 2: Performed with **closed** loop. The result is **MK**

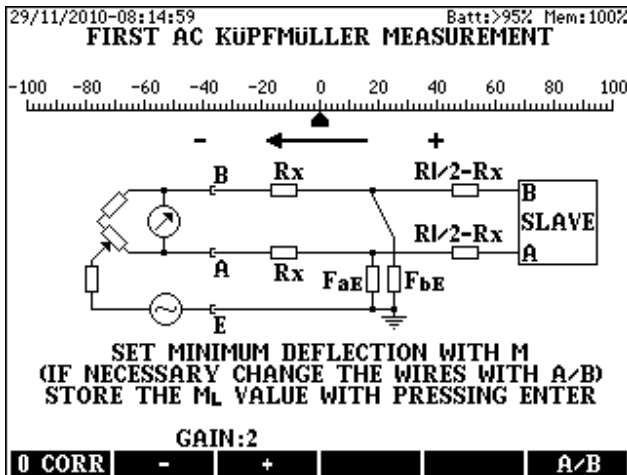
The Lx/L value is calculated out of ML and MK

Test Procedure

- Select the **AC FAULT LOCATION/KÜPFMÜLLER METHOD**
- Press **ENTER** and then the measuring arrangement appears



Start the first measurement pressing the **START/STOP** key and after a few seconds the bridge is ready for balancing:

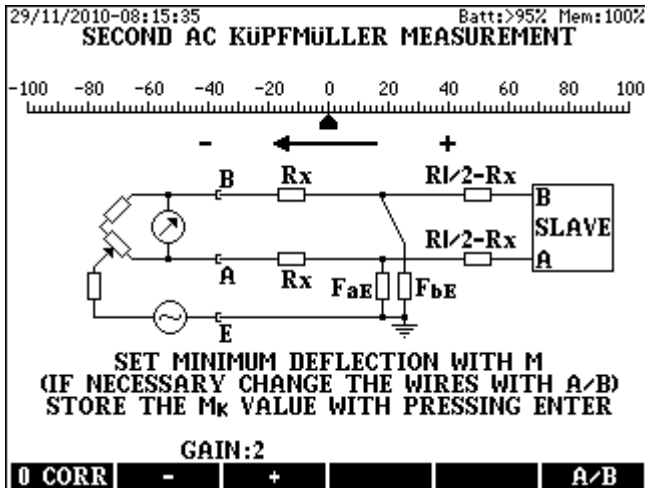


Bridge Balancing

- Select the minimum gain with key **F2**.
- Set the pointer to the **minimum** point of the scale with the M balancing potentiometer. The minimum point may be on the negative or positive side of the scale
- Press the **0 KORR (F1)** key to shift the pointer to the middle of the scale
- Increase the gain gradually with key **F3** and repeat the first three points until reaching the perfect balance. The balance is perfect when the gain is 5 and the pointer stands on the minimum
- When the balancing is completed press **ENTER** to store the result (ML).
- Before the second measurement the loop should be closed. Close it manually or by means of the remote controllable loop-closing device KLC 8.

In case of manual control:

- Start the second measurement pressing the **START/STOP** key and the bridge is ready for the second balancing:



Balance the bridge again and press **ENTER** to store the result (MK) and to call the result display.

Displayed Test Results

- **ML** and **MK** values
- **Lx/L** relative distance of fault compared to the cable length
- **Rx** wire resistance between the instrument and fault
- **2Rx** double wire resistance between the instrument and fault
- **RI** loop resistance
- **FaE** and **FbE** fault resistances
- **DTS** (calculated of the cable parameters and **RI**)
- **DTF** (calculated of the cable parameters, **RI** and **Lx/L**)

To change the cable type

- Press the **C.LIBR (F6)** key
- Select a new cable type and press **ENTER**
- Press **ESC**

To change the cable temperature

- Press the **TEMP.(F4)** key,
- Type in the temperature value and press **ENTER**.

When the cable length is known

- Press the **LENGTH (F5)** key
- Type in the length value and press **ENTER**

For returning to the normal display

- Press the **LENGTH (F5)** key
- Press **ENTER**

To save the test result press the **SAVE (F1)** key

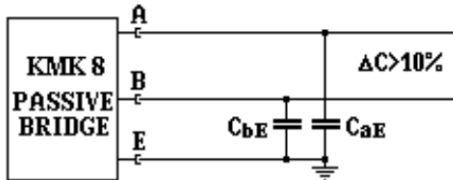
6.9 Capacitive Balance Measurement

The purpose of that measurement is to measure the balance between the ground capacitances C_{a-E} and C_{b-E} .

The passive bridge of KMK 8 measures accurately even in the presence of disturbing longitudinal AC voltages on the line.

Test Procedure

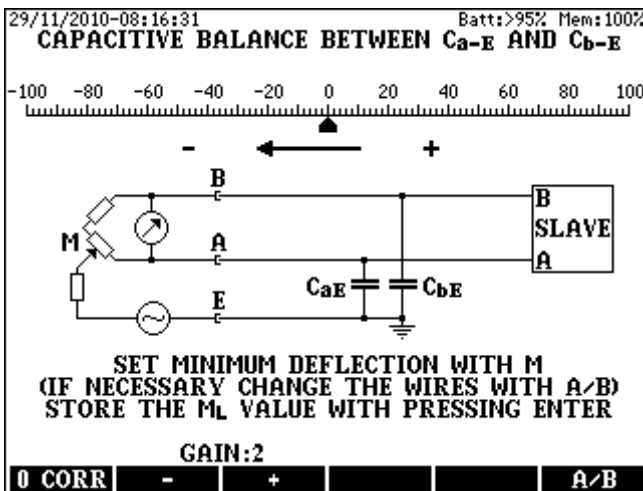
- Select the **AC FAULT LOCATION/CAPACITIVE BALANCE** mode
- Press **ENTER** and the measuring arrangement appears:



The far endings of the tested pair have to be open.

- Select the required measuring range with pressing the $\Delta C < 10\%$ (F2) or $\Delta C > 10\%$ (F3) key
- Start the measurement with the **START/STOP** key

Having the measurement started the following display appears after a few seconds and the bridge is ready for balancing



Bridge Balancing

- Select the minimum gain with key **F2**.
- Set the pointer to the **minimum** point of the scale with the **M** balancing potentiometer. The minimum point may be on the negative or positive side of the scale
- Press the **0 KORR (F1)** key to shift the pointer to the middle of the scale
- Increase the gain gradually with key **F3** and repeat the first three points until reaching the perfect balance. The balance is perfect when the gain is 5 and the pointer stands on the minimum
- When the balancing is completed press **ENTER** to store the result (ML) and to call the result display.

Displayed Test Results

- **ML** value
- **Lx/L** rate
- Unbalance %

To save the test result press the **SAVE (F1)** key

Notice

The result is calculated out of the measured **ML** value

7 END TO END SYNCHRONOUS MEASUREMENT

The purpose of that measurement is fault location when due to high and intermittent disturbing voltages neither the active nor the passive bridge can provide satisfactory result.

In that case KMK 8 provides the improved version of Graaf method using the disturbing voltages itself for the measurement. (No other measuring voltage is added).

At that measuring mode two instruments are connected to the ends of the tested pair in MASTER-SLAVE arrangement. The two instruments perform current measurement at the same time and communicate over the tested pair. The Master calculates the location of fault out of the rate of currents. That means:

- The higher is the disturbing voltage the easier to locate a fault!
- That method can be used only in the presence of disturbing voltages between the A and B wires

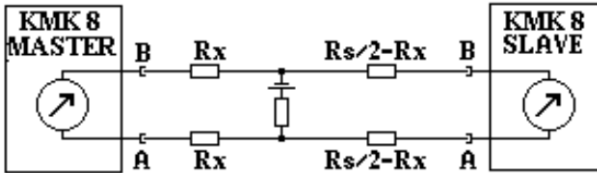
KMK 8 can be programmed as MASTER and SLAVE as well.

Mode selection is in the **PASSIVE BRIDGE MEASUREMENTS** menu.

For SLAVE function a simplified version of the KMK 8 (KMK 80S) is available as optional accessory.

Test Procedure

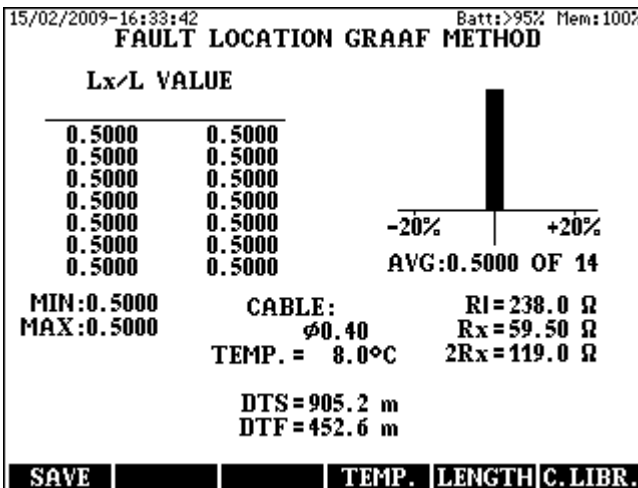
Select the **GRAAF MASTER** mode in the **PASSIVE BRIDGE** menu and then the measuring arrangement appears.



The measurement can be started with the **START/STOP** key KMK 8 performs 16 consecutive synchronous measurements at both sides. The duration of that automatic test sequence is approx. 80 sec.

When the 16 part measurements are ready KMK 8 evaluates the results. In the course of evaluation the results of the first two measurements and **Lx/L** values unlikely differing from the average are omitted.

Having the test sequence completed the result display appears:



The displayed Test results

- All the 14 remaining **Lx/L** values (the unlikely ones are marked with asterisks.)
- The average of **Lx/L** values
- The number of **Lx/L** values (used for average calculation)
- The minimum and maximum of **Lx/L** value
- Histogram showing the distribution of **Lx/L** values
- **Rx** wire resistance between the instrument and fault
- **2Rx** the double of wire resistance between the instrument and fault
- **RI** loop resistance
- **DTS** (calculated of the cable parameters and **RI**)
- **DTF** (calculated of the cable parameters, **RI** and **Lx/L**)

To save the test result press the **SAVE (F1)** key

Evaluation by means of Histogram

In case of low disturbing voltages the **Lx/L** values calculated out of the results of part measurements may show remarkable dispersion and the user can't be sure that automatic average calculation produces really proper value.

Therefore a **HISTOGRAMM** is provided showing the dispersion of calculated part results.

The histogram presents the **Lx/L** values along the horizontal axis.

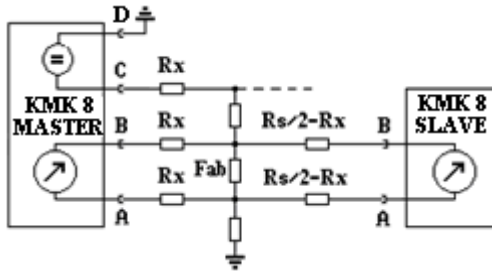
- The width of bars is 7% of average value
- The height of bars shows the prevalence of **Lx/L** values
- The bars used for the average calculation are black
- The unused bars are grey

At the evaluation of histogram the user should consider:

- The histogram of a **perfect measurement** is a black bar showing that the results of all part measurements were within a $\pm 3.5\%$ range around the average.
- The histogram of a **sufficient measurement** is absolutely symmetrical but some results are in the neighboring bars around the average.
- The histogram of a **doubtful measurement** is generally unsymmetrical and the dispersion is irregular. In that case the measurement should be repeated with another wire combination.
- When the level of disturbing voltage is too low the whole histogram and the test results can be **unacceptable**. In this case try to repeat the test with the passive bridge of KMK 8.

Notes:

That method can be used only when the DC loop current exceeds $10 \mu\text{A}$
KMK 8 provides additional "disturbing voltage" to increase the loop current if an auxiliary wire is available. ($U_m=100\text{V}$, $R_i=100\text{k}\Omega$)



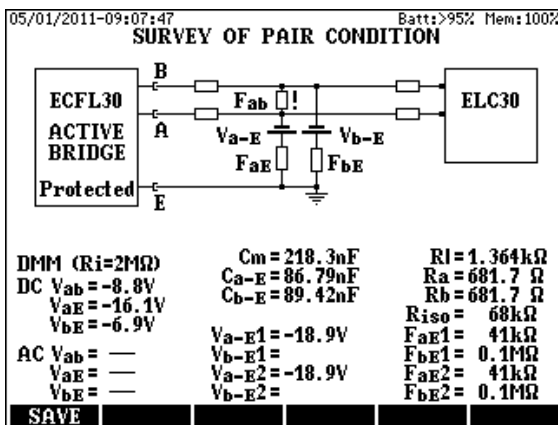
8 PRE MEASUREMENTS

8.1 Survey of Pair Condition

KMK 8 provides an extremely useful test sequence to find the best fault location method: **PRE MEASUREMENTS / PAIR CONDITION**

The test sequence consists of the following measurements:

- **DC** and **AC** interference voltage measurement
- Mutual capacitance **Cm**
- Physical capacitance between wires and GND (**Ca-E** und **Cb-E**)
- Loop resistance **RI**
- Resistance of wires a and b, **Ra** and **Rb**
- Resistance between wire a and wire b **Riso**
- Fault resistances **FaE** and **FbE**
- Voltage sources cascaded with **FaE** and **FbE**, **Va-E** and **Vb-E**
- The fault resistances and source voltages are measured twice to see the intensity of fluctuation



Notices:

To perform that **PAIR CONDITION** survey the remote controllable loop closing device KLC 8 (or KMK 80S) is definitely necessary!

AUTO mode is set as default in **PAIR CONDITION** measurement.

AUTO mode means: KMK 8 performs the measurement in **Sensitive**-mode. If the input amplifier becomes overloaded the process is repeated in **Protected**-mode.

If the effect of disturbers is so strong that the amplifier is overloaded even in protected mode as well a warning appears:

The Active Bridge is overloaded please use the Passive Bridge!

By means of **PAIR CONDITION** survey the technicians can get useful information about the condition of the tested pairs.

1. As a first step the shunt resistances **FaE1** and **FbE1** are measured.

A cascaded DC source is displayed if the shunt resistor interconnects the tested wire with an active neighbor wire and therefore a disturbing voltage of $>5\text{ V}$ appears. (5 V is negligible beside the 100 V measuring voltage of KMK 8). These results inform the technician about the magnitude of shunt resistors and disturbing DC voltages.

2. Indication of disturbing DC and AC voltages $>1\text{ V}$. (The indicated DC voltage can be lower than the disturbing voltage if the shunt resistance is not much smaller than the input resistance of DMM)

3. The measurement of physical capacitances (**Ca-E** and **Cb-E**) provides information about the break or high unbalance of wires.

4. Measurement of fault resistances and the voltages of disturbing DC sources. These measurements are performed twice to see the intensity of fluctuation. The fluctuation can be intensive if the shunt resistance or the disturbing voltage is strongly intermittent. In that case the obtained results can be false.

5. Loop resistance (**RI**) measurement

6. Checking the rate between the insulation and loop resistances. If the rate is less than 100 the **Fab !** warning appears.

7. At last the resistance of wire a and wire b are measured. Normally **Ra = Rb**. In case of resistive unbalance the recommended fault location method is 3 Point measurement with the passive bridge of KMK 8.

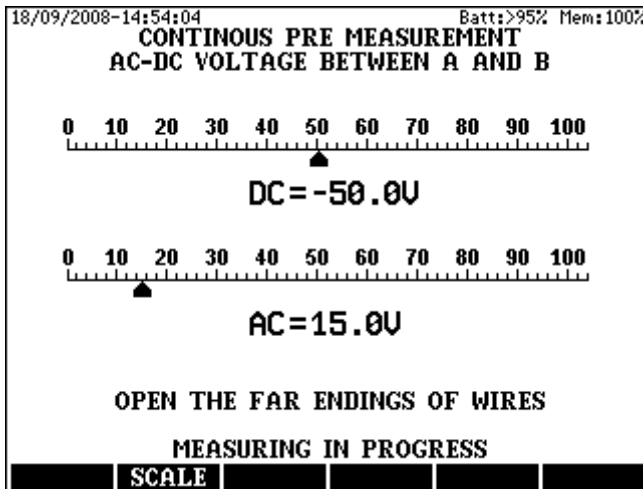
8.2 AC DC Voltage Measurement

The purpose of that measurement is to get quick information about the DC and AC interference voltages between the wires of the tested pair.

Test Procedure

- Open the far endings of the tested pair
- Select the **PRE MEASUREMENTS /AC-DC VOLTAGE** mode and press **ENTER**

The measurement starts automatically. KMK 8 measures continuously until stopping the measurement with the **START/STOP** key.



The sensitivity can be changed with the **SCALE (F2)** key.

Displayed Test Results

- DC-AC voltages in graphic form
- DC-AC voltages in digital form

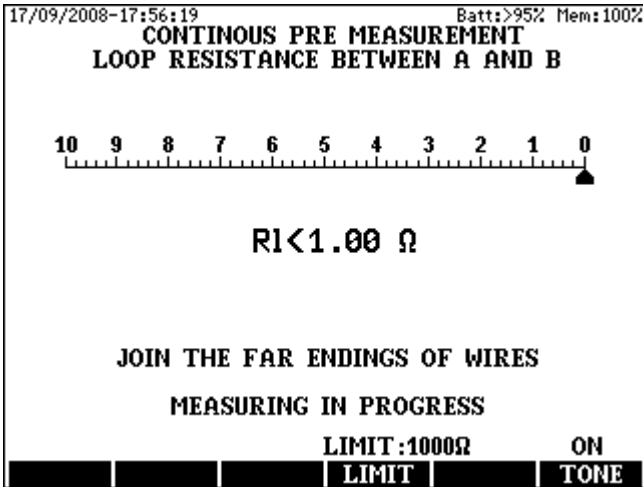
8.3 Loop Resistance Measurement

The purpose of that measurement is to get quick information about the loop resistance of numerous pairs. For the sake of quick measurement the compensation of DC interference voltages is disabled.

Test Procedure

- Join the far endings of the tested pair manually or by means of the remote controllable loop-closing device KLC 8.
- Select the **PRE MEASUREMENTS /LOOP RESISTANCE** mode and press **ENTER**

The measurement starts automatically. KMK 8 measures continuously until stopping the measurement with the **START/STOP** key.



Purpose of that service is to find the pair of wires that has a strap or is shorted (perhaps at its far end). If the resistance measured between the wires is smaller than the preset limit, then you will hear a buzzing sound

To set the resistance limit below which the buzzer is working press the **LIMIT (F4)** key and type in the wanted limit

The buzzer can be switched on and off with the **TONE (F6)** key

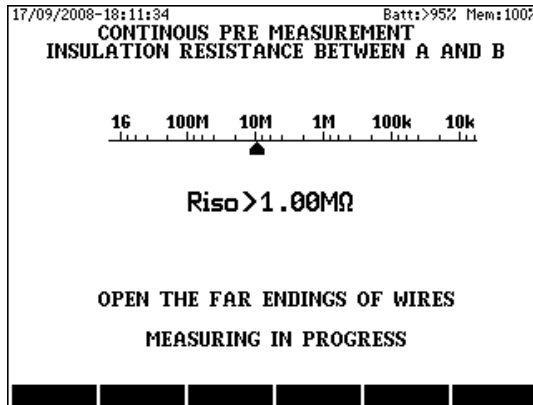
8.4 Insulation Resistance Measurement

Purpose of the test is to measure the insulation resistance between the a and b wires. KMK 8 in this mode provides fast measurement of pairs which are not affected by interference volatges! The measuring range is 10 kΩ to 300 MΩ.

Test Procedure

- Open the far endings of a and b wires
- Select **PRE MEASUREMENTS/INSULATION RESISTANCE** mode and Press **ENTER**

The measurement starts automatically. KMK 8 measures continuously until stopping the measurement with the **START/STOP** key.



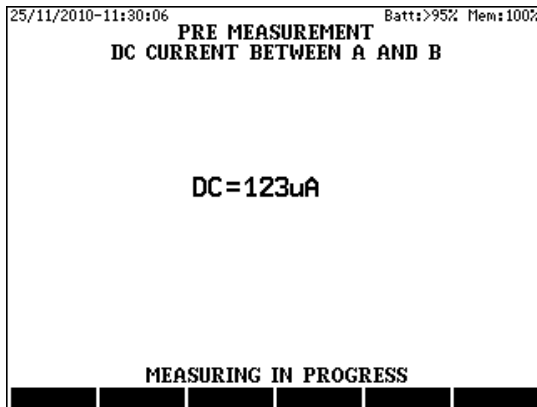
8.5 DC Current Measurement

Purpose of the test is to measure the DC loop current. Internal resistance: 1 Ohm, measuring range: 3 μ A to 1 A.

Test Procedure

- Join the far endings of the tested pair manually or by means of the remote controllable loop-closing device KLC 8.
- Select the **PRE MEASUREMENTS / DC CURRENT** mode and press **ENTER**

The measurement starts automatically. KMK 8 measures continuously until stopping the measurement with the **START/STOP** key.



8.6 Cable Temperature Measurement

The purpose of the test is to measure the temperature of a cable.

Test Procedure

- Enter **PRE MEASUREMENTS/CABLE TEMPERATURE** mode.
- Plug the thermometer probe (supplied as option) into KMK 8 as shown on the display and put the probe near the cable.
- Wait a few minutes until the surface temperature of the probe reaches the cable temperature and start the measurement pressing the **START/STOP** key.

Test Results

- Cable Temperature **TEMP.**

KMK 8 is able to measure temperature within -20 C and $+60\text{ C}$.

The measured temperature can be stored by pressing the **TEMP. (F3)** key i.e. the temperature field of the subsequent loop resistant measurement or fault location measurement will be updated to this value.

9 AUTOMATIC TEST SEQUENCES

9.1 Automatic Quick Test

The purpose of the automatic quick test is to get rough estimate about the features of an unknown pair of wires. Measuring time is: ~45 sec.

The list of measurements:

AC, DC voltages:

- Between wire **a** and wire **b**
- Between wire **a** and **E** (GND)
- Between wire **b** and **E** (GND)

Insulation resistance (Maximum 300 MΩ)

- Between wire **a** and wire **b**
- Between wire **a** and **E** (GND), b connected to ground
- Between wire **b** and **E** (GND), a connected to ground

Capacitance

- Between wire **a** and wire **b**
- Between wire **a** and **E** (GND), b connected to ground
- Between wire **b** and **E** (GND), a connected to ground

Capacitive unbalance

- Between Ca-E and Cb-E

Test Procedure

- Open the far endings of a and b wires
- Select **MEAS SEQUENCE/QUICK TEST** mode and Press **ENTER** and then the following display appears:

30/07/2010-09:18:08		Batt:>95% Mem:100%	
AUTOMATIC QUICK TEST			
	ab	aE	bE
DC			
AC			
ISO			
C			
			B SLAVE A E
CAPACITIVE BALANCE			
	Lx/L	BAL	
JOIN THE FAR ENDINGS OF WIRES TO THE LOOP CLOSING DEVICE			
START THE MEASUREMENT WITH START/STOP			
			SLAVE

- Start the measurement with the **START/STOP** key
- The test results can be saved by pressing the **SAVE (F1)** key

10 BATTERY MANAGER

Battery Charging Modes

KMK 8 is equipped with a processor controlled automatic charger-discharger circuit providing the following functions:

- Battery capacity indication
- Charging process control:
 - Normal charging
 - Fast charging
 - Battery regeneration
 - Battery initialization
 - Protection against deep discharging

These functions can be reached in **MAIN MENU / BATTERY MANAGER**

10.1 Battery Capacity Indication

The battery manager system continuously measures the battery state. When KMK 8 is switched on battery information appears showing the actual state of battery in % form.

10.2 Normal Charging

When the mains adapter is connected and the battery level sinks below 60% the automatic circuit starts normal charging with 0.1C (C is the nominal capacity of the built in battery)

When the full charge is reached the control system automatically stops charging and the **BATTERY LEVEL >95 %** indication appears.

The **CHARGE** indicator LED is lighted while the charging is in progress. When full charge is reached, the charger is automatically switched off, and the **CHARGE** indicator LED goes out.

10.3 Fast Charging

When **FAST CHARGING** is selected in the **BATTERY MANAGER MENU** the battery is charged with a relatively high current (0.5 C) for approx. 2 to 3 hours during which the instrument can't be used. In this mode after a short time the instrument is automatically switched off. If temperature of the battery exceeds the environment by 10°C the charging is automatically finished.

The blinking of **CHARGE** indicator LED indicates that the process is in progress.

When the charging is completed the charge indicator goes out, and the instrument stays switched off.

Switching the instrument on during the process:

- Information can be obtained about the current battery
- The process can be aborted by pressing the **ABORT (F3)** key.

10.4 Regenerating Charge Process

In this mode the battery is discharged and fast charged. The instrument can't be used during this process. To start regenerating process:

- Enter **MAIN MENU/BATTERY MANAGER**
- Select the **REGENERATING** option and press **ENTER**

In the first phase, discharging message is displayed. In the second phase, the instrument is automatically switched off, and the charge indicator LED is blinking. The process can be interrupted with the **ABORT (F3)** key.

10.5 Initial Charging

The initialization is the first charging of battery. It is necessary when the **INITIAL CHARGING RECOMMENDED** warning appears (The same process is required when the battery is replaced.) The process can be started with the **START/STOP** key

During the 2 to 3 hour process the battery state measuring system will be calibrated. The initial process can be skipped or interrupted but in these cases always the **BATTERY LEVEL IS UNKNOWN** battery charging level indication appears when the instrument is switched on. Therefore the skipping or interruption of the process is not recommended.

DO NOT CHARGE THE BATTERIES WHEN THE AMBIENT TEMPERATURE IS BELOW +5 °C OR OVER +45 °C.

10.6 Automatic Battery Switch-Off

If the inner temperature of the KMK 8 exceeds 55°C, the internal battery is automatically switched off to prevent it from being damaged. As the charging condition is unknown after the device can be switched on again, fast charging should be as soon as possible.

10.7 Battery Life Expectancy

KMK 8 is equipped with a NiMH battery pack consisting of peak quality Panasonic cylindrical battery cells type: HHR380A. The guaranteed life expectancy of HHR380A cells is more than 500 charge /discharge cycles that means around 3500 to 4000 operating hours.

Beyond 500 charge /discharge cycles the capacity of cells may decrease and finally they have to be replaced.

The degradation of battery can be easily recognized in the following way:

- Charge the battery with **Fast Charging** method
- After that start a **Regenerating Charge Process**

The regenerating process normally takes around 7 to 8 hours. In case of an old battery the duration is much less (4 to 5 hours)

10.8 Charging During Measurement

Since the measurement may be disturbed by interference voltages caused by the mains supply, it is highly recommended to disconnect the mains cable or the car adapter during measurement.

11 USB PORTS

The USB data transfer is an option and can be used only if it is activated for the KMK 8 device!

KMK 8 has two USB ports for the transfer of test results:

- USB A host-port for USB flash drive (Indirect transfer)
- USB B device-port for PC connection (direct transfer)

USB A port for USB flash drive

KMK 8 can be connected to a USB flash drive via USB A interface. The USB flash drive provides data transfer between a PC and KMK 8 without installing a special device driver to the PC. Data is transferred to the **KMK 8** folder of the flash drive.

This solution is advantageous for the user who does not have administrative right to install a special driver to his PC.

USB B port for PC connection

KMK 8 can be connected to a PC via USB B interface. When you first connect KMK 8 to a PC, you need to install a device driver supplied with KMK 8 PC Control Program.

The ELQ30c.exe control program provides the following features:

- Transfer and post processing of test results
- Checking the HW and SW version and other features of KMK 8
- Transfer between PC and USB flash drive and vice versa

IMPORTANT NOTES

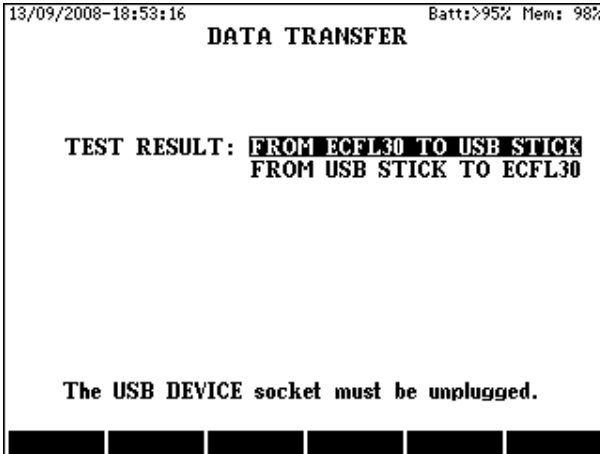
**For the time of measurements the PC should be disconnected !
High voltages on the line may disturb the measurements or in the worst case destroy the instrument or the PC!**

The USB data transfer is an option and can be used only if it is activated in KMK 8

11.1 Result Transfer from KMK 8 to USB flash drive

- Plug the USB flash drive into the **USB host Port** of KMK 8
- Enter the **MAIN MENU/USB FLASH DRIVE** option

Doing so the **DATA TRANSFER** page appears



Select and enter the **FROM KMK 8 TO USB FLASH DRIVE** option

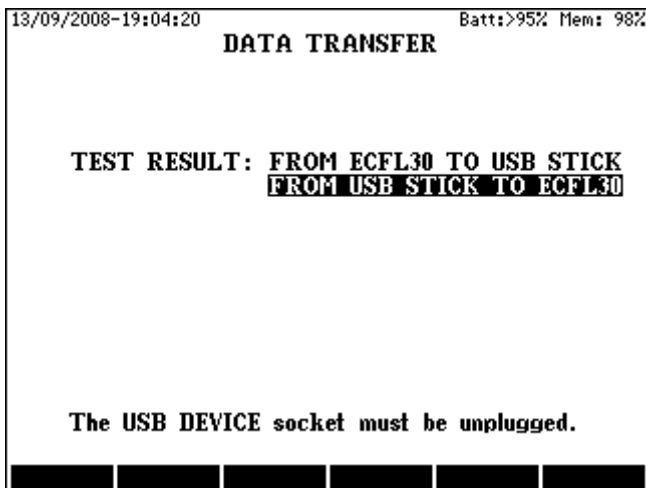


To copy one result, draw the highlight to the wanted name and press the **ONE (F3)** key. To copy all test results press the **ALL (F1)** key.

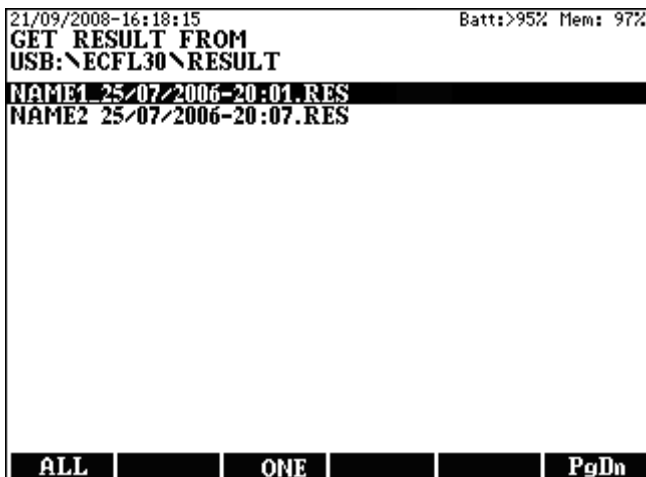
11.2 Result Transfer from USB flash drive to KMK 8

- Plug the USB flash drive into the **USB host Port** of KMK 8
- Enter the **MAIN MENU/USB FLASH DRIVE** option

Doing so the **DATA TRANSFER** page appears



Select and enter the **FROM USB FLASH DRIVE TO KMK 8** option:



To copy one result, draw the highlight to the wanted name and press the **ONE (F3)** key. To copy all test results press the **ALL (F1)** key

12 STATUS & OPTIONS

STATUS & OPTION point of the **MAIN MENU** provides useful hardware and software information:

29/11/2010-08:20:10		Batt:>95% Mem:100%
ABOUT		
DEVICE TYPE		ECFL30
SERIAL NUMBER		1234567890
INTERNAL ID		00DS1
CPU CARD NUMBER		12345
IF CARD NUMBER		67890
CALIBRATION DATE		29/11/2010-07:49:35
CHARGER VERSION		0102030405
BOOT VERSION		1
SOFTWARE VERSION		3.78
HARDWARE VERSION		12345/67890
OPTIONS		
PC CONTROL		ACTIVE

IMPORTANT NOTES

Data transfer between the KMK 8 device and a PC does only work, if the instruments software and the PC software have the same version number!

13 UPGRADE (KMK8u.exe)

The software of KMK 8 can be upgraded without disassembling the instrument. The new software version can be downloaded from a PC using the upgrade file made by the manufacturer. This file contains the description of the upgrade process.

To set ECFL to upgrade mode:

- Enter **SETTINGS** menu
- Select the **UPGRADE** option with the vertical cursor keys
- Press **ENTER**

Doing so KMK 8 is ready for upgrade. To return without upgrade switch the instrument off.

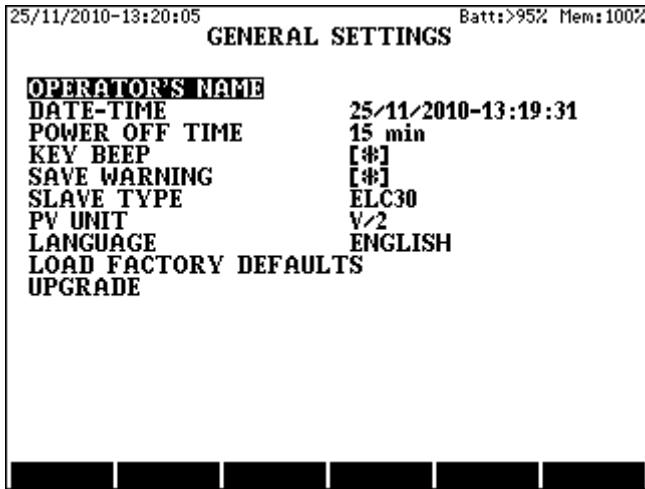
14 DEMOPROGRAMM (KMK8d.exe)

Running the demo program the front panel of the instrument with display and keyboard is shown. By clicking with the mouse on the keyboard, the “virtual” KMK 8 will behave as the real instrument, helping the user to carry out complete measuring procedures, but of course only virtually.

15 SETTINGS

In setting mode some important parameters can be set.

The menu of general settings can be reached from the **MAIN MENU**



The date and time can be typed in with the number keys. The name of operator can be typed in like an SMS at mobile phones. (Space by key **0** twice, backspace by **←**, accept by **ENTER**, escape by **ESC**)

To change the other parameters:

- Select the parameter by the vertical cursors and press **ENTER**.
- Change parameter by the vertical cursors and press **ENTER**.

16 LOOP CLOSING DEVICE KLC 8

The purpose of KLC 8 is to close or open the far endings of the tested pair. The loop-closing device has three test leads:

- The red lead for wire **A**
- The black lead for wire **B**
- The green Lead for **GND** (Cable sheath) or for wire **C**

The loop-closing device is remote controlled by KMK 8. There are the following switch configurations:

- All of the three wires (**A**, **B** and **E**) are open (For Insulation resistance, capacitance and voltage measurement)
- **A** and **B** wires are closed but **E** is open (for loop resistance measurements and fault location with Murray- and K upfm uller method)
- All of the three wires (**A**, **B** and **E**) are joined (For 2-wire & GND measurement, resistance difference measurement and fault location with 3 Point method)
- **A** and **B** wires are periodically closed and open with a time interval of 5 s (For TDR measurements). The user can start and stop the process trough KMK 8, but it automatically stops after 10 minutes
- wires are periodically closed and open with a time interval of 15 s. (For REPEATED K UPFM ULLER test with passive bridge). The user can start and stop the process trough KMK 8, but it automatically stops after 10 minutes
- **A** and **B** wires are periodically closed and open by remote control (For fault location with REPEATED K UPFM ULLER method and TDR)

The loop closing device KLC 8 can be switched on/off with the ON/OFF key. The actual state of the device is indicated by a LED

Switching KLC 8 on

- The LED lights green for one second if the battery level is OK.
- The LED lights yellow for one second if the battery level is low.
- The LED lights red for one second if the battery is down.

When KLC 8 is switched on the LED flashes in every five seconds

Switching KLC 8 off

- The LED is blinking green for a few seconds

KLC 8 switches off automatically 4 hours after the latest remote control command.

The device is powered from three pieces of AA (LR6) batteries

The life of a battery set is around 1200 hours

17 INTELLIGENT SLAVE KMK 80S (OPTIONAL)

The functions of KMK 80S in End to End Synchronous mode:

Measurement of line current and transfer the measuring results to the Master KMK 8

The functions of KMK 80S in other modes:

To close or open the far endings of the tested pair

The loop-closing device has four test leads:

- The red lead for wire **A**
- The black lead for wire **B**
- The green lead for **E (GND)**
- The yellow lead for **C** auxiliary wire

The loop-closing device is remote controlled by KMK 8

There are eight switch configurations:

- All of the wires (**A**, **B**, **C** and **E**) are open (for Insulation resistance, capacitance and voltage measurement)
- **A** and **B** wires are closed but **E** and **C** are open (for loop resistance measurements and fault location with Murray- and K upfm uller method).
- Wires **A**, **B** and **E** are joined and **C** is open (for 2-wire & GND measurement, resistance difference measurement)
- Wires **A**, **B** and **C** are joined and **E** is open (for fault location with 3 Point method).
- **A** and **B** wires are periodically closed and opened with a time interval of 5 s. The user can start and stop the process through KMK 8, but it automatically stops after 10 minutes.
- **A** and **B** wires are Join the far endings of the tested pair with a time interval of approx. 15 s. (for REPEATED K UPFM ULLER test with passive bridge). The user can start and stop the process through KMK 8, but it automatically stops after 10 minutes.
- **A** and **B** wires are periodically closed and open by remote control (for fault location with REPEATED K UPFM ULLER method and TDR).
- **A** and **B** wires are connected to the current measuring circuit of KMK 8S.

The loop closing device KMK 80S can be switched on with the ON key. When the device is switched on the green **ON** LED is blinking in every five seconds. The device can be switched off with the OFF key. The red LOW BATTERY LED lights if the battery is down. KMK 8 switches off automatically 4 hours after the latest remote control command. The device is powered from four pieces of AA (LR6) batteries. The life of a battery set is around 1200 hours

18 SPECIFICATIONS

18.1 General Specifications

Power supply:

Internal rechargeable NIMH battery pack

Operation time approx. 8 hours
(Without backlight)

Charging (without taking the battery pack out)

From 100 to 240 V mains with mains adapter

From 12 V car battery with car adapter

Charging time less than 3 hours
(Fast charging mode)

Display 320 x 240 dot graphic LCD with backlight

Connectors

Connector for mains or 12V car adapter 2.1/5.5 mm coaxial

L1 and L2 line connectors 4 mm banana sockets

Ground connector 4 mm banana socket

USB A USB 1.1 host port for USB-Stick
(FAT 16 file system supported)

USB B USB 1.1 device port to connect PC
(Device driver provided)

Over voltage protection (at $R_i > 5 \text{ k}\Omega$)

Between a and b or ground 500 V DC, 350 V AC

Longitudinal voltage 60 V AC

Memory locations

For test results 50

For cable parameters 50

Ambient temperature ranges

Reference23±5°C
Rel. humidity 45% to 75%

Normal operation 0 to +40°C
Rel. humidity 30% to 75% *(<25g/m³)

Limits of operation -5 to +45°C
Rel. humidity 5% to 95% *(<29g/m³)

Storage and transport..... -40 to +70°C
Rel. humidity 95% at +45°C *(<35g/m³)

Dimensions.....224 x 160 x 75 mm

Weight (Including battery pack)..... ca. 1.8 kg

Protection classII
(in accordance with IEC 61140)

Measurement category.....300V CAT II
(in accordance with IEC (EN) 61010-1)

* Without condensation

18.2 TDR

Measuring ranges (V/2=100 or V/2=10 for loaded cable)

- | | |
|-------------------------------|---------|
| 1. For non loaded cable | 16 m |
| 2. For non loaded cable | 32 m |
| 3. For non loaded cable | 64 m |
| 4. For non loaded cable | 160 m |
| 5. For non loaded cable | 320 m |
| 6. For non loaded cable | 640 m |
| 7. For non loaded cable | 1600 m |
| 8. For non loaded cable | 3200 m |
| 9. For all cables | 6400 m |
| 10. For all cables | 16000 m |
| 11. For all cables | 32000 m |

Maximum range depends on cable type and condition

Evaluation of results

- | | |
|------------------------------|------------|
| With Cursor and Marker | In meters |
| Changing of waveform | ~4 pro/sec |

Zoom Maximum 16

Accuracy

- | | |
|----------------------|---------------|
| Fault location | 0.2% of range |
| Resolution | 0.01 m |

Propagation velocity

For non loaded cables

- | | |
|-----------|----------------------|
| V/2 | 45 to 149 m/ μ s |
| VOP | 30 to 99 % |

For loaded cables

- | | |
|-----------|----------------------|
| V/2 | 1.2 to 30 m/ μ s |
| VOP | 0.8 to 20 % |

Measuring modes

L1, L2	Test of single pair
L1 LONG TIME L2 LONG TIME	Location of intermittent faults
XTALK	Transmit on L2, Receiving on L1
L1 & L2 L1 – L2	Comparison of two pairs
L1 & MEMORY L1 - MEMORY	Comparison to memory

Pulse characteristics

Widths:

For non loaded cables: .4, 6, 10, 30, 60, 100, 300, 600 ns 1, 3, 6 μ s

For loaded cables: 330 μ s

Amplitude:..... peak to peak 1.3 to 12V into 120 Ω

The pulse amplitude automatically changes with gain and width

Line connections..... 120 Ohm balanced

Balance control 50 to 270 Ω

Gain control

Range 0 to 90 dB

Steps6 dB/step

Distance dependent amplitude correction (Smooth) provided

18.3 Active Bridge**Disturbing Voltage**Measuring range

DC voltage..... up to 300 V

AC voltage..... up to 200 V rms

Accuracy..... $\pm 3\% \pm 1 \text{ V}$ Frequency range..... 15 to 300 HzInput resistance..... 2 M Ω Test results..... AC, DC voltage between:
wire a and b, wire a and GND, wire b and GND**Loop Resistance**Measuring range..... 1 Ω to 10 k Ω Accuracy..... $\pm 0.3\% \pm 0.1 \Omega$ **Resistance Difference**Loop resistance range..... 10 to 5000 Ω Accuracy..... $\pm 0.2\%$ of loop resistance $\pm 0.2 \Omega$ Lx/L- value resolution..... 1/1000Test results..... Lx/L, Ri, Ra, Rb, $\Delta R\Omega$, $\Delta R\%$

Insulation Resistance

Measuring range 10 kΩ to 300 MΩ

Measuring voltage 100 V

Measuring time (Depends on cable length)

For < 5 km cable length ~30 sec

For 5 km to 10 km cable length ~60 sec

For 10 km to 20 km cable length ~90 sec

DC disturbing voltage compensation Enabled

Test results Resistance between: wire a and wire b (Rab)
wire a and GND, wire b joined to GND (RaE)
wire a and GND, wire b joined to GND (RbE)
AC, DC voltages: a-b, a-E, b-E

Accuracy

100 MΩ to 300 MΩ 5 %

10 MΩ to 100 MΩ 3 %

100 kΩ to 10 MΩ 2 %

10 kΩ to 100 kΩ 5% ±1kΩ

Capacitance

Measuring range 10 nF to 2 (10) μF

Accuracy ±2% ±0.2 nF

Measuring voltage 11 Hz, 100 V

Test results Capacitance between: wire a and wire b (Cab)
wire a and GND, wire b joined to GND (CaE)
wire a and GND, wire b joined to GND (CbE)

Capacitive Balance

<u>Measuring range</u>	10 nF to 2000 nF
<u>Accuracy of Lx/L value</u>	±0.2%
<u>Resolution of Lx/L-value</u>	1/1000
<u>Measuring voltage</u>	11 Hz, 100 Vp
<u>Test results</u>	Capacitance between wire a and GND (Ca-E) Capacitance between wire b and GND (Cb-E) Lx/L, ΔC, ΔC%

DC Fault Location with Murray, Küpfmüller and 3 Point Methods

<u>Loop resistance range</u>	1 Ω to 10 kΩ
<u>Fault resistance range</u>	up to 100 MΩ
<u>Accuracy of Lx/L value</u> (R I = 2kΩ, Lx/L=0,1 to 1)	
Fault resistance < 1 MΩ	±0.2%
Fault resistance 1 MΩ to 5 MΩ	±0.3%
Fault resistance 5 MΩ to 25 MΩ	±0.5%
Fault resistance 25 MΩ to 100 MΩ	±2.0%
 <u>Resolution of Lx/L-value</u>	 1/1000
<u>Measuring voltage</u>	100 V
<u>DC disturbing voltage compensation</u>	Enabled
<u>Test results</u>	
Murray and 3 Point	Lx/L, Rx, 2Rx, RI, Ra, Rb, FaE or FbE
Küpfmüller	Lx/L, Rx, 2Rx, RI, Ra, Rb, FaE and FbE

DC-AC Fault Location with REPEATED KÜPFMÜLLER Method

<u>Loop resistance range</u>	1 Ω to 2k Ω
<u>Fault resistance range</u>	up to 5 M Ω
<u>Accuracy of Lx/L value</u> (R I = 2k Ω , Lx/L=0,1 to 1)	
Fault resistance < 1 M Ω	$\pm 1\%$
Fault resistance 1 M Ω to 5 M Ω	$\pm 2\%$
<u>Resolution of Lx/L-value</u>	1/1000
<u>Measuring voltage</u>	DC or 11 Hz AC, 100 V
<u>Test results</u>	Lx/L, RI

AC Fault Location Interruption

<u>Measuring range</u>	up to 20 km (Depends on cable type)
<u>Accuracy</u>	$\pm 2\% \pm 0.2$ nF
<u>Test results</u>	Lx/L, Ca-E, Cb-E, ΔC , $\Delta C\%$

18.4 Passive Bridge

Insulation Resistance

<u>Measuring range</u>	10 kΩ to 300 MΩ
	10 kΩ to 10 000 MΩ
<u>Measuring voltage</u>	100 V
<u>DC disturbing voltage compensation</u>	Enabled
<u>Test results</u>	Resistance between: wire a and wire b (Rab) wire a and GND, wire b joined to GND (RaE) wire a and GND, wire b joined to GND (RbE) AC, DC voltages: a-b, a-E, b-E

Accuracy

5 000 MΩ to 10 000 MΩ	30 %
100 MΩ to 5 000 MΩ	20 %
50 MΩ to 100 MΩ	10 %
10 kΩ to 50 MΩ	5% ±1kΩ

Loop Resistance

<u>Measuring range</u>	1Ω to 10 kΩ
<u>Accuracy</u>	±0.3% ±0.3 Ω

Resistance Difference

<u>Loop resistance range</u>	10 to 5000 Ω
<u>Accuracy</u>	±0.2% of loop resistance ±0.2 Ω
<u>Resolution of Lx/L (Mk)-value</u>	
In range $\Delta R < 10\%$	1/10000
In range $\Delta R > 10\%$	1/1000
<u>Test results</u>	Mk, RI, Ra, Rb, $\Delta R\Omega$, $\Delta R\%$

DC Fault Location with Murray, Küpfmüller and 3 Point Methods

<u>Loop resistance range</u>	1 Ω to 10 kΩ
<u>Fault resistance range</u>	up to 100 MΩ
<u>Accuracy of Lx/L value</u> (R I = 2kΩ, Lx/L=0,1 to 1)	
Fault resistance < 1 MΩ	±0.2%
Fault resistance 1 MΩ to 5 MΩ	±0.3%
Fault resistance 5 MΩ to 25 MΩ.....	±0.5%
Fault resistance 25 MΩ to 100 MΩ.....	±2.0%

<u>Resolution of M value</u>	1/1000
<u>Measuring voltage</u>	100 V

Test results

Murray.....	Mk, Lx/L, Rx, 2Rx, RI, Ra, Rb, FaE or FbE
Küpfmüller	ML, Mk, Lx/L, Rx, 2Rx, RI, Ra, Rb, FaE and FbE
3 Point.....	Mk1, Mk2, Mk3, Lx/L, Rx, 2Rx, RI, Ra, Rb, FaE or FbE

AC Fault Location with Küpfmüller Method

<u>Loop resistance range</u>	1 Ω to 10 kΩ
<u>Fault resistance range</u>	up to 25 MΩ
<u>Accuracy of Lx/L value</u> (R I = 2kΩ, Lx/L=0,1 to 1)	
Fault resistance < 1 MΩ	±0.3%
Fault resistance 1 MΩ to 5 MΩ	±0.5%
Fault resistance 5 MΩ to 25 MΩ.....	±1.0%
<u>Resolution of M value</u>	1/1000
<u>Measuring voltage</u>	11 Hz, 100 V
<u>Test results</u>	ML, Mk, Lx/L, Rx, 2Rx, RI, Ra, Rb, FaE and FbE

AC Fault Location Capacitive Balance

<u>Measuring range</u>	10 nF to 2000 nF
<u>Accuracy of Lx/L value</u>	±0.2%
<u>Resolution of Lx/L value</u>	
In range Lx/L=0.9 to 1.1	1/10000
In range Lx/L<0.9 or Lx/L>1.1	1/1000
<u>Measuring voltage</u>	11 Hz, 100 V
<u>Test results</u>	ML, Lx/L, Ca-E/Cb-E %

Fault Location Graaf Method

<u>Loop resistance range</u>	10 Ω to 10 kΩ
<u>DC current range</u>	5 μA to 1A
<u>Accuracy (I>10 μA)</u>	±0.3% bis ±2%

18.5 Pre Measurements

Disturbing Voltages

Measuring range

DC voltage..... up to 300 V

AC voltage..... up to 200 V eff

Measuring mode..... Repeated measurements

Accuracy..... $\pm 3\% \pm 1 \text{ V}$

Frequency range..... 15 to 300 Hz

Input resistance..... 2 M Ω

Test results..... AC, DC voltage between wire a and wire b

Loop Resistance

Measuring range..... 1 Ω to 10 k Ω

Measuring mode..... Repeated measurements

DC disturbing voltage compensation..... Disabled

Accuracy (without disturbing voltages)

In % of test result $\pm 0.5\% \pm 0.2 \Omega$

Test results..... Resistance between wire a and wire b

Insulation Resistance

<u>Measuring range</u>	10 k Ω to 300 M Ω
<u>Measuring mode</u>	Repeated measurements
<u>DC disturbing voltage compensation</u>	Disabled
<u>Measuring time</u>	~ 3 sec
<u>Measuring voltage</u>	100 V
<u>Accuracy</u> (without disturbing voltages)	
In % of test result	20 %

Test results Resistance between wire a and wire b

DC Current

<u>Measuring range</u>	10 μ A to 1A
<u>Measuring mode</u>	Repeated measurements
<u>Accuracy</u>	\pm 1% bis 10%

Temperature (with Pt 1000 temperature probe)

<u>Temperature range</u>	-20 to +60 $^{\circ}$ C
<u>Resolution</u>	0.1 $^{\circ}$ C
<u>Accuracy</u>	\pm 1 $^{\circ}$ C

Survey of Pair ConditionDisturbing voltage

Measuring range..... up to 300 V DC, 200 V AC
Test results AC, DC voltage between: wire a and wire b
wire a and GND, wire b and GND
Accuracy..... $\pm 3\%$ $\pm 1V$

Insulation

Measuring range..... 10 k Ω to 100 M Ω
Measuring voltage 100 V
DC disturbing voltage compensation Enabled
Test results between wire a and GND (FaE)
between wire b and GND (FbE)
Accuracy
10 k Ω to 50M Ω 5 % $\pm 1k\Omega$
50 M Ω to 100 M Ω 10 %

DC voltage source

Measuring range..... up to 100 V DC
Test results voltage source: cascade with FaE (Va-E)
cascade with FbE (Vb-E)

Capacitance

Measuring range 10 to 2000 nF
Measuring voltage 11 Hz, 100 V
Test results Capacitance between: wire a and GND (Ca-E)
wire b and GND (Cb-E)
Accuracy..... $\pm 2\%$ ± 200 pF

Loop and wire resistance

Measuring range 1Ω to 10 kΩ

Test results Loop resistance (RI)

Resistance of wire a (Ra)

Resistance of wire b (Rb)

Warnings

Events Overloaded, Intermittent

18.6 Quick Test

Disturbing voltage

Measuring range.....	up to 300 V DC, 200 V AC
Test results	AC, DC voltage between: wire a and wire b wire a and GND, wire b and GND
Accuracy	normal

Insulation resistance

Measuring range.....	10k Ω to 300 M Ω
Measuring voltage	100 V
Measuring time	~3 x 20 sec
DC disturbing voltage compensation.....	Enabled
Test results	Resistance between: wire a and wire b (Rab) wire a and GND, wire b joined to GND (RaE) wire a and GND, wire b joined to GND (RbE)

Accuracy

100 M Ω to 300 M Ω	20 %
50 M Ω to 100 M Ω	10 %
10 k Ω to 50 M Ω	5 % \pm 1k Ω

Capacitance

Measuring range.....	10 to 2000 nF
Measuring voltage	11 Hz, 100 V
Test results	Capacitance between: wire a and wire b (Cab) wire a and GND, wire b joined to GND (CaE) wire a and GND, wire b joined to GND (CbE)
Accuracy	\pm 2%, \pm 200pF

Capacitive Balance

Measuring voltage	11 Hz, 100 V
Test results	Ca>Cb or Cb>Ca, Lx/L, unbalance %
Resolution.....	1/1000

18.7 Quality Test

Insulation resistance

Measuring range.....	10kΩ to 10 000 MΩ
Measuring voltage	100 V
Measuring time	~3 x 35 sec
DC disturbing voltage compensation.....	Enabled
Test results	Resistance between: wire a and wire b (Rab) wire a and GND, wire b joined to GND (RaE) wire a and GND, wire b joined to GND (RbE)

Accuracy

5 000 MΩ to 10 000 MΩ	30 %
100 MΩ to 5 000 MΩ	20 %
50 MΩ to 100 MΩ	10 %
10 kΩ to 50MΩ	5% ±1kΩ

Capacitance

Measuring range	10 to 2000 nF
Measuring voltage	11 Hz, 100 V
Test results	Capacitance between: wire a and wire b (Cab) wire a and GND, wire b joined to GND (CaE) wire a and GND, wire b joined to GND (CbE)
Accuracy.....	±2%, ±200pF

Capacitive Balance

Measuring voltage	11 Hz, 100 V
Test results	Ca>Cb or Cb>Ca, Lx/L, unbalance %
Resolution	1/1000

Loop resistance

Measuring range 1Ω to 10kΩ
Accuracy ±0.3% ±0.1 Ω

Resistance difference

Loop resistance range 1 Ω to 5 kΩ
Accuracy ±0.2% of loop resistance ±0.2 Ω
Resolution 1/1000
Test results Ra, Rb, ΔRΩ, ΔR%

19 SCOPE OF DELIVERY AND OPTIONAL ACCESSORIES**Scope of delivery:**

Cable fault locator KMK 8
Operating manual
Short form operation instruction
Calibration certificate
PC control program (Result transfer) on CD
Ground cable
2-wire test lead (red/black)
2-wire test lead (blue/yellow)
Loop closing device KLC 8
Mains adapter AC 100 ... 240V
USB cable
USB flash drive
Battery pack (built-in)
Carrying case

Options

KMK 80S (active remote-controlled slave unit) 118305622
Temperature probe KTS 8 - PT 1000 118305623
Car battery adapter 118305659
Calibration report 118305624
Mains adapter (UK version) 118305657
Mains adapter (US version) 118305658



Tento symbol indikuje, že výrobek nesoucí takovéto označení netze likvidovat společně s běžným domovním odpadem. Jelikož se jedná o produkt obchodovaný mezi podnikatelskými subjekty (B2B), netze jej likvidovat ani ve veřejných sběrných dvorech. Pokud se potřebujete tohoto výrobku zbavit, obraťte se na organizaci specializující se na likvidaci starých elektrických spotřebičů v blízkosti svého působení.



Dit symbool duidt aan dat het product met dit symbool niet verwijderd mag worden als gewoon huishoudelijk afval. Dit is een product voor industrieel gebruik, wat betekent dat het ook niet afgeleverd mag worden aan afvalcentra voor huishoudelijk afval. Als u dit product wilt verwijderen, gelieve dit op de juiste manier te doen en het naar een nabij gelegen organisatie te brengen gespecialiseerd in de verwijdering van oud elektrisch materiaal.



This symbol indicates that the product which is marked in this way should not be disposed of as normal household waste. As it is a B2B product, it may also not be disposed of at civic disposal centres. If you wish to dispose of this product, please do so properly by taking it to an organisation specialising in the disposal of old electrical equipment near you.



Този знак означава, че продуктът, обозначен по този начин, не трябва да се изхвърля като битов отпадък. Тъй като е B2B продукт, не бива да се изхвърля в обществени контейнери за отпадъци. Ако желаете да изхвърлите продукта, го занесете в пункт, специализиран в изхвърлянето на старо електрическо оборудване.



Dette symbol viser, at det produkt, der er markeret på denne måde, ikke må kasseres som almindeligt husholdningsaffald. Eftersom det er et B2B produkt, må det heller ikke bortkasseres på offentlige genbrugsstationer. Skal dette produkt kasseres, skal det gøres ordentligt ved at bringe det til en nærliggende organisation, der er specialiseret i at bortkaffe gammelt el-udstyr.



Sellise sümboliga tähistatud tooted ei tohi käidelda tavalise olmejäätmena. Kuna tegemist on B2B-klassi kuuluva tootega, siis ei tohi seda viia kohaliku jäätmekäitluspunkti. Kui soovite selle toote ära viia, siis viige see lähimasse vanade elektriseadmete käitlemisele spetsialiseerunud ettevõttesse.



Tällä merkinnällä ilmoitetaan, että kyseisellä merkinnällä varustettua tuotetta ei saa hävittää tavallisen kotitalousjätteen seassa. Koska kyseessä on yritysten välisen kaupan tuote, sitä ei saa myöskään vietiä kullutustien käyttöön tarkoitettuihin keräyspisteisiin. Jos haluatte hävittää tämän tuotteen, ottakaa yhteyttä lähimpään vanhojen sähkölaitteiden hävittämiseen erikoistuneeseen organisaatioon.



Ce symbole indique que le produit sur lequel le figure ne peut pas être éliminé comme un déchet ménager ordinaire. Comme il s'agit d'un produit B2B, il ne peut pas non plus être déposé dans une déchetterie municipale. Pour éliminer ce produit, amenez-le à l'organisation spécialisée dans l'élimination d'anciens équipements électriques la plus proche de chez vous.



Cuireann an siombail seo in iúl ná cheart an táirgeadh atá marcáilte sa tsíle seo a dhíuasciart sa chóras fuoilí teachlaigh. Os nud é gur táirgeadh ghno le gnó (B2B) é, ní feidir é a dhíuasciart ach oiread in ionaid dhíuasciartha phobail. Más mian leat an táirgeadh seo a dhíuasciart, déan é a thóigáil ag eagraíocht gar duit a sanfheidhmiúinn i ndíuasciart sean-theas leictigh.



Dieses Symbol zeigt an, dass das damit gekennzeichnete Produkt nicht als normaler Haushaltsabfall entsorgt werden soll. Da es sich um ein B2B-Gerät handelt, darf es auch nicht bei kommunalen Wertstoffhöfen abgegeben werden. Wenn Sie dieses Gerät entsorgen möchten, bringen Sie es bitte sachgemäß zu einem Entsorger für Elektroaltgeräte in Ihrer Nähe.



Αυτό το σύμβολο υποδεικνύει ότι το προϊόν που φέρει τη σημαση αυτή δεν πρέπει να απορρίπτεται μαζί με τα οικιακά απορρίματα. Καθώς πρόκειται για προϊόν B2B, δεν πρέπει να απορρίπτεται σε δημοτικά σημεία απορριμής. Εάν θέλετε να απορρίψετε το προϊόν αυτό, παρακαλούμε όπως να το παραδώσετε σε μία υπηρεσία συλλογής ηλεκτρικού εξοπλισμού της περιοχής σας.



Ez a jelzés azt jelenti, hogy az ilyen jelzéssel ellátott termék tilos a háztartási hulladékokkal együtt kidobni. Mivel ez vállalati felhasználású termék, tilos a lakosság számára fenntartott hulladékgyűjtőbe dobni. Ha a terméket ki szeretné dobni, akkor vigye azt el a lakóhelyéhez közeli működő, elhasznált elektromos berendezések begyűjtésével foglalkozó hulladékkezelő központhoz.



Questo simbolo indica che il prodotto non deve essere smaltito come un normale rifiuto domestico. In quanto prodotto B2B, può anche non essere smaltito in centri di smaltimento cittadino. Se si desidera smaltire il prodotto, consegnarlo a un organismo specializzato in smaltimento di apparecchiature elettriche vecchie.



Ši zīme norāda, ka izstrādājumu, uz kura tā atrodas, nedrīkst iznest kopā ar parastiem mājstaimniecības atkritumiem. Tā kā tas ir izstrādājums, ko cits citam pārdos un lieto tikai uzņēmumi, tad nedrīkst arī iznest atkritumos tādās izgāztuvēs un atkritumu savāktnēs, kas paredzētas vietējiem iedzīvotājiem. Ja būs vajadzīgs šo izstrādājumu iznest atkritumos, tad rīkojieties pēc noteikumiem un nogādājiet to tuvākajā vietā, kur īpaši nodarbojas ar vecu elektrisku ierīču savākšanu.



Šis simbols rodo, kad joo paženklinto gaminio negalima išmesti kaip paprastų buitinių atliekų. Kadangi tai B2B (verslas verslui) produktas, jo negalima atiduoti ir buitinių atliekų tvarkymo įmonėms. Jei norite išmesti šį gaminį, atlikite tai tinkamai, atiduodami jį arti jūsų esančiai specializuotai senos elektrinės įrangos utilizavimo organizacijai.



Dan is-simbolu jindika li l-prodott li huwa mmarkat b'dan il-mod m'għanduh jintrema bħal skart normali tad-djar. Minhabba li huwa prodott B2B, ma jistax jintrema wkoll f'centri civici għar-rimi ta' l-iskart. Jekk tkun tixtieq tarmi dan il-prodott, jekk jogħġbok għamel dan kif suppost billi tiegħu għand organizzazzjoni fir-qrib li tispecjalizza fir-rimi ta' tagħmir qadim ta' l-eletriku.



Dette symbolet indikerer at produktet som er merket på denne måten ikke skal kastes som vanlig husholdningsavfall. Siden dette er et bedriftsprodukt, kan det heller ikke kastes ved en vanlig miljøstasjon. Hvis du ønsker å kaste dette produktet, er den riktige måten å gi det til en organisasjon i nærheten som spesialiserer seg på kassering av gammelt elektrisk utstyr.



Ten symbol oznacza, że produktu ninie opatrzonym nie należy usuwać z typowymi odpadami z gospodarstwa domowego. Jest to produkt typu B2B, nie należy go więc przekazywać na komunalne składowiska odpadów. Aby we właściwy sposób usunąć ten produkt, należy przekazać go do najbliższej placówki specjalizującej się w usuwaniu starych urządzeń elektrycznych.



Este símbolo indica que o produto com esta marcação não deve ser deixado fora juntamente com o lixo doméstico normal. Como se trata de um produto B2B, também não pode ser deixado fora em centros cívicos de recolha de lixo. Se quiser desfazer-se deste produto, faça-o correctamente entregando-o a uma organização especializada na eliminação de equipamento eléctrico antigo, próxima de si.



Acest simbol indică faptul că produsul marcat în acest fel nu trebuie aruncat ca și un gunoi menajer obișnuit. Deoarece acesta este un produs B2B, el nu trebuie aruncat nici la centrele de colectare urbane. Dacă vreți să aruncați acest produs, vă rugăm s-o faceți într-un mod adecvat, ducând-ul la cea mai apropiată firmă specializată în colectarea echipamentelor electrice uzate.



Tento symbol znamená, že takto označený výrobek sa nesmie likvidovať ako bežný komunálny odpad. Keďže sa jedná o výrobok triedy B2B, nesmie sa likvidovať ani na mestských skládkach odpadu. Ak chcete tento výrobok likvidovať, odneste ho do najbližšej organizácie, ktorá sa špecializuje na likvidáciu starých elektrických zariadení.



Ta simbol pomeni, da izdelka, ki je z njim označen, ne smete zavreči kot običajne gospodinske odpadke. Ker je to izdelek, namenjen za druge proizvajalce, ga ni dovoljeno odlagati v centrih za civilno odlaganje odpadkov. Če želite izdelek zavreči, prosimo, da to storite v skladu s predpisi, tako da ga odpeljete v bližnjo organizacijo, ki je specializirana za odlaganje stare elektrifne opreme.



Este símbolo indica que el producto así señalado no debe desecharse como los residuos domésticos normales. Dado que es un producto de consumo profesional, tampoco debe llevarse a centros de recogida selectiva municipales. Si desea desearchar este producto, hágalo debidamente acudiendo a una organización de su zona que esté especializada en el tratamiento de residuos de aparatos eléctricos usados.



Den här symbolen indikerar att produkten inte får blandas med normalt hushållsavfall då den är förbrukad. Eftersom produkten är en så kallad B2B-produkt är den inte avsedd för privata konsumenter, den får således inte avfallshanteras på allmänna miljö- eller återvinningsstationer då den är förbrukad. Om ni vill avfallshandera den här produkten på rätt sätt, ska ni lämna den till myndighet eller företag, specialiserad på avfallshandling av förbrukad elektrisk utrustning i ert närområde.