User Manual
Correlator

Correlux C-3

Mess- und Ortungstechnik
Measuring and Locating Technologies

Elektrizitätsnetze
Power Networks

Kommunikationsnetze
Communication Networks

Rohrleitungsnetze
Water Networks

Abwassernetze
Sewer Systems

Leitungsortung
Line Locating

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Consultation with SebaKMT

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

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

Should any question remain unanswered or should you need the help of an authorized service station, please contact:

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

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

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

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

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

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

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

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

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

For FCC:

- User Information acc. to FCC15.21:

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

- Part 15 Statement gem. FCC 15.19/RSS Gen Issue 3 Sect. 7.1.3

This device complies with Part 15 of the FCC Rules and with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:
(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment should be installed and operated with a minimum distance of 30 centimeters between the radiator and your body.

Contents

Consultation with SebaKMT **3**

Terms of Warranty **4**

1 Safety Instructions **7**
1.1 General Safety Instructions and Warnings 7
1.2 General Notes 7

2 Frequently used menus **9**
2.1 Start menu 9
2.2 Pipe data menu 11
2.3 Correlation menu 13
2.4 Correlation menu (Offline measurement) 15
2.5 Correlation analysis menu 17
2.6 Frequency analysis menu 19
2.7 Audio menu 21
2.8 Audio menu (in Pinpointing mode) 23

3 Technical description **25**
3.1 Function 25
3.2 Features of the set 26
3.3 Communication of the components 26
3.4 Power supply 27
3.5 Scope of delivery 27
3.6 Technical data 28

4 The Correlator **31**
4.1 Design 31
4.2 Power supply 33
4.3 Design of the user interface 34
4.4 Basics of operation 35
4.4.1 Input methods 35
4.4.2 Entering identification numbers (IDs) 35
4.4.3 Entering text 36
4.4.4 Sorting devices in lists and tables 37
4.4.5 ESC pushbutton and Back button 37
4.5 Commissioning 38
4.5.1 Switch the correlator ON/OFF 38
4.5.2 Basic settings at initial start-up 38
4.5.3 Change the language 39
4.5.4 Enable/Disable the touch screen (touch sensitivity) 40
4.5.5 Activate the display light 40
4.6 Systeme settings 41

4.6.1 Basic settings 41
4.6.2 System info 43
4.6.3 Store the settings 43
4.7 Hardware reset 43
4.8 Communication 44
4.8.1 Connection between the correlator and the sensors 44
4.8.2 Connection between the correlator and the computer 44

5 The Power transmitters 45
5.1 Design 45
5.2 Identification number (ID) 46
5.3 Power supply 47
5.4 Commissioning 47

6 The Multi sensors 49
6.1 Design 49
6.2 Identifikationsnummer (ID) 49
6.3 Power supply 50
6.4 Switching ON/OFF 50
6.5 Installation 51
6.6 Adapter 51

7 Online measurement - Realtime correlation with 2 sensors 53

8 Offline measurement - Multipoint correlation with preprogrammed sensors 57

9 "Map" function 63

10 Sound velocity measurement 67
10.1 Velocity measurement in Online measurement mode 67
10.2 Velocity measurement in Offline measurement mode 70
10.2.1 Introduction 70
10.2.2 Determining the sound speed 71

11 GPS position data 73
11.1 Introduction 73
11.2 Determine and save GPS coordinates 73
11.3 Distance measurement and navigation via GPS 75

1 Safety Instructions

1.1 General Safety Instructions and Warnings

	• Do not drop the device / the system's components or subject it / them to strong impacts or mechanical shocks. • The limits described under Technical Data may not be exceeded. • The device / system must be in a technically perfect condition for measurement. • The indicated degree of protection can only be ensured if plugs or the provided protection caps are put in all sockets of the device. • The plugs of the supplied connection cables are only compliant to the indicated degree of protection as long as they are plugged in. Plugs which are not connected or which are connected in a wrong way are not protected from water and dust ingress. • If the O-ring seal of a socket is obviously damaged, it must be replaced in order to ensure the total protection against water and dust ingress.

1.2 General Notes

Safety precautions

This manual contains basic instructions for the commissioning and operation of the device / system. For this reason, it is important to ensure that the manual is always available to the authorised and trained operator. He needs to read the manual thoroughly. The manufacturer is not liable for damage to material or humans due to non-observance of the instructions and safety advices provided by this manual.

Locally applying regulations have to be observed!

Labelling of safety instructions

The following signal words and symbols are used in this manual and on the product itself:

Signal word / symbol	Description
CAUTION	Indicates a potential hazard which may result in moderate or minor injury if not avoided.
NOTICE	Indicates a potential hazard which may result in material damage if not avoided.
	Serves to highlight warnings and safety instructions. As a warning label on the product it is used to draw attention to potential hazards which have to be avoided by reading the manual.
	Serves to highlight important information and useful tips on the operation of the device/system. Failure to observe may lead to unusable measurement results.

Check contents

Check the contents of the package for completeness and visible damage right after receipt. In the case of visible damage, the device must under no circumstances be taken into operation. If something is missing or damaged, please contact your local sales representative.

Working with products from SebaKMT

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

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

Repair and maintenance

Repair and maintenance work has to be carried out by SebaKMT or authorised service partners using original spare parts only. SebaKMT recommends having the system tested and maintained at a SebaKMT service centre once a year.

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

Special transportation requirements

The lithium batteries of the device are dangerous goods. The transport of the batteries itselves and of devices which contain such batteries is subject to regulations based on the UN Model Regulations “Transport of Dangerous Goods” (ST/SG/AC.10-1).

Please inform yourself about the transportation requirements and follow them when shipping the device.

Electromagnetic radiation

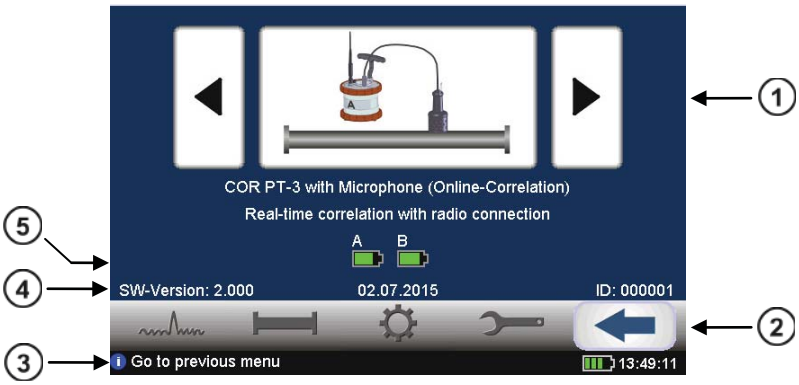
This device is designed for industrial use. When used at home it could cause interference to other equipment, such as the radio or television.

The interference level from the line complies with the limit curve B (living area), the radiation level complies with the limit curve A (industrial area) according to EN 55011. Given that living areas are sufficiently far away from the planned area of operation (industrial area), equipment in living areas will not be impaired.

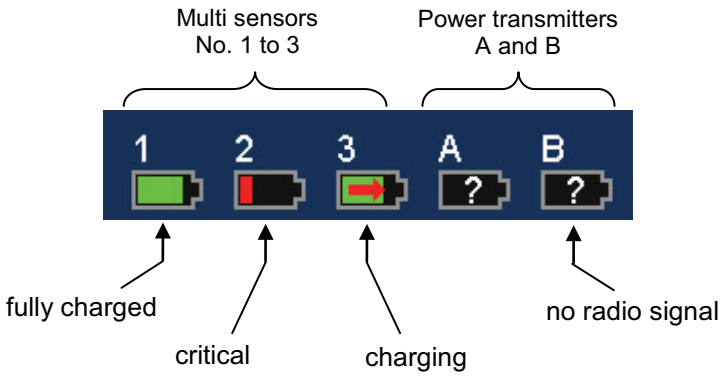
2 Frequently used menus

2.1 Start menu

The Start menu appears on the screen after the device has been switched on. In addition, the "ESC" pushbutton takes you back directly to the Start menu from every menu level.



Element	Description
1	**Measuring mode selection** Arrow buttons … Run forward / backward through the available measuring methods. Big central button … Opens the relevant measuring mode menu or starts the correlation.
2	**Main menu** Starts the **Correlation** Opens the **Pipe data** menu Opens the **Tools** menu Opens the **System settings** menu Goes **Back** to the previous menu
3	**Info line** This line provides **information** on the display, comments and notes on how to proceed. On the right, the Correlator's **battery status** and the **time** are shown. this symbol indicates info texts this symbol indicates warnings this symbol indicates that an Offline measurement is in progress shows the Correlator battery level
4	Firmware version / Date / Identification number (ID) of the device

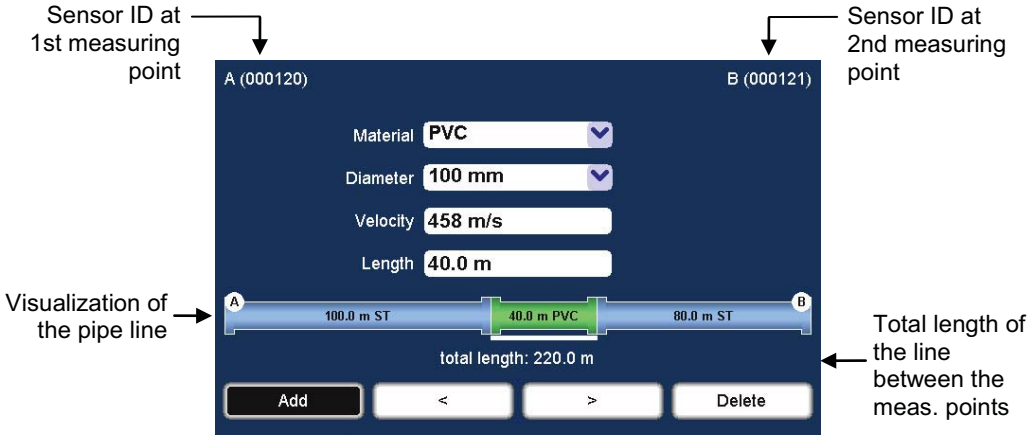
Element	Description
5	Battery level of the received Power transmitters or Multi sensors. 

2.2 Pipe data menu

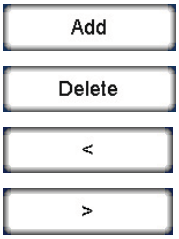
In the Pipe data menu the properties of the pipe can be specified.

The menu can be opened by

- tapping the button in the main menu
- tapping the button between the two diagrams in the Correlation menu, representing the pipe (see next section: button ③)

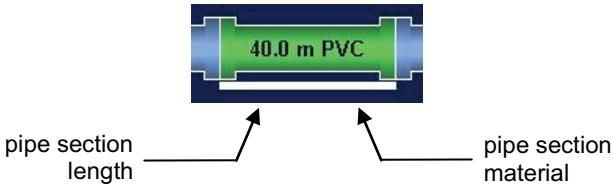


Drop-Down Lists:	Material	…	Select the pipe section's material.
	Diameter	…	Select the pipe section's diameter.
Input fields:	Velocity	…	Input field for the pipe section's sound velocity. The displayed value automatically adjusts to the selected pipe material. The value can be entered manually when needed as well. For this purpose, tap the field. A numeric keypad for input opens.
	Length	…	Select the pipe section's length. Tap the field. A numeric keypad for input opens.



Use these buttons to devide the pipe line displayed in up to 12 sections.

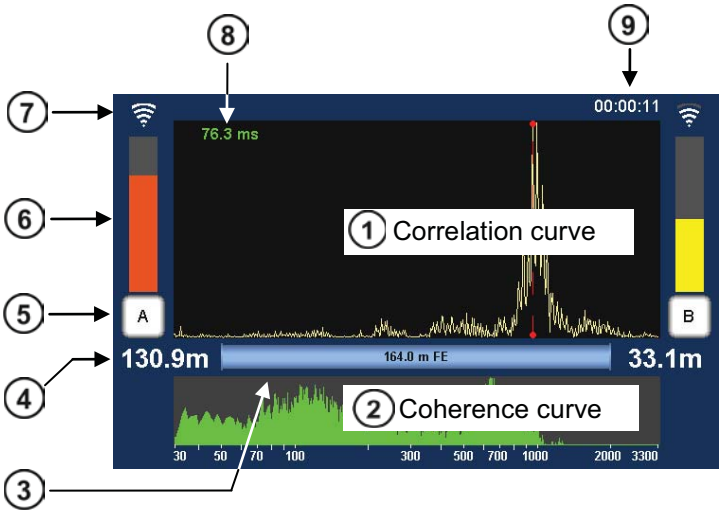
Use these buttons to move from one pipe section to the next.



The selected pipe section is "highlighted" with a white bar. The pipe parameters in the four input fields refer to this section.

2.3 Correlation menu

After starting a correlation the result is displayed in the following view:

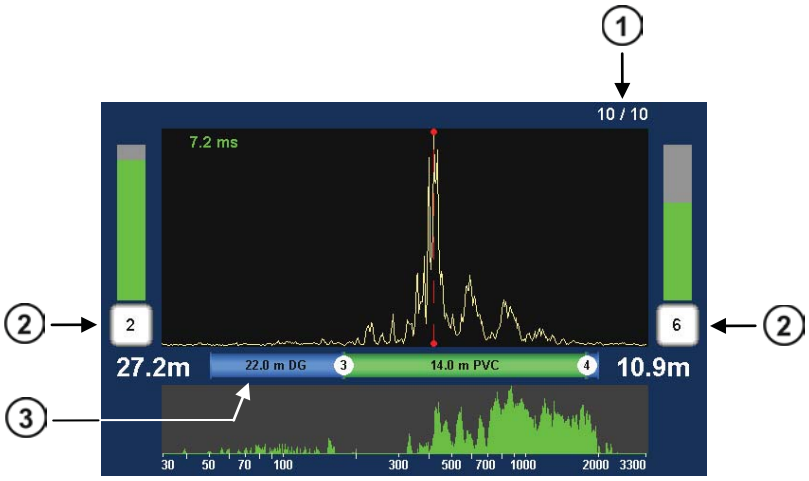


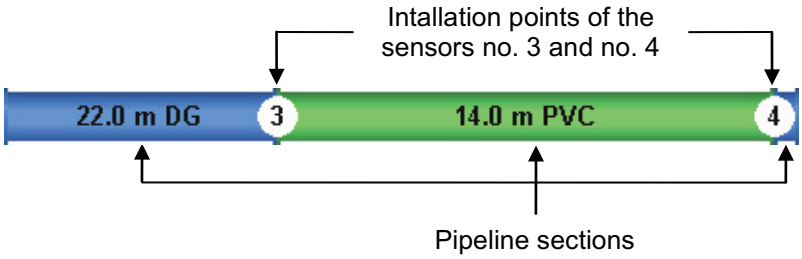
Element	Description
1	**Correlation curve** Result from comparing the recordings of the two sensors with regard to the delay time of the signals. Tap the diagram area to open the Correlation analysis menu which provides a number of analysis tools.
2	**Coherence curve** Result from comparing the recordings of the two sensors with regard to the frequency range of the recordings. Tap the diagram area to open the frequency filter settings.
3	**Pipeline between A and B** The grafic illustrates the pipeline between the measuring points A and B with all its sections. Tap the grafic to open the Pipe data menu.
4	**Distance from the measuring point to the leak**
5	**Measuring point A / B** Indicates whether the Power transmitter A or B is installed at this measuring point. Tap the button to open the Audio menu which can be used to listen to the leak noise.
6	**Noise level at the measuring point** The height of the bar reflects the noise level at the measuring point.
7	**Quality of the radio link between transmitter and Correlator**
8	**Lag value** Indicates the delay of the leak noise between the two sensors. The colour of the numbers shows how reliable the result of this correlation is: **green** … "good" correlation, reliable result **yellow** … correlation is not optimal **red** … "bad" correlation; unreliable result

Element	Description
	negat. … the leak is on the left from the center of the line **posit.** … the leak is on the right from the center of the line
9	**Term of the correlation** Specifies how long the displayed correlation is already running. Any interruption resets the counter to 00:00:00.

2.4 Correlation menu (Offline measurement)

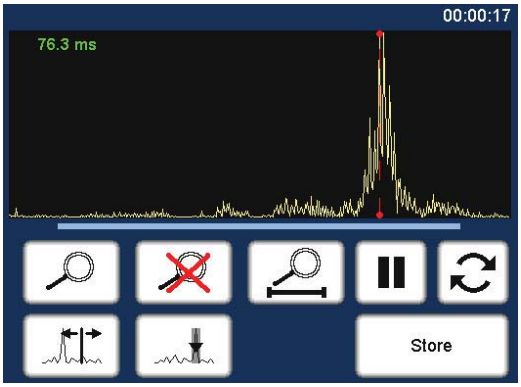
In Offline measurement mode with Multi sensors, the Correlation menu differs in the following aspects from the menu in Online measurement mode.



Element	Description
1	**Number of correlated audio blocks** The displayed curve is the result of an averaging from up to 10 single correlations (due to 10 noise recordings during one measurement period). The index shows how many single correlations are included in the calculation.
2	**Number of the sensor at the measuring point**
3	**Pipeline between the measuring points** The grafic illustrates the pipeline between the measuring points. Tap the grafic to open the Pipe data menu. 

2.5 Correlation analysis menu

Tapping the **Correlation curve** always opens the following menu which provides tools for analysing the correlation.

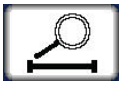


Zoom … to magnify a section of the curve

Tap the button, then mark the area to be magnified in the diagram, i.e. tap and draw out the required range.

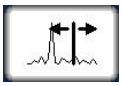
Zoom-Reset … to reset the curve to its initial state

Magnification and suppression are abolished. The entire correlation curve is displayed.



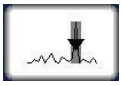
Zoom opt. … to magnify the curve optimally, relative to the measuring distance

Exactly the part of the correlation curve is shown, which refers to the pipe between the two measuring points.



Move cursor … to read the lag value or the distance to the leak at any point of the curve

Tap the button, then move the vertical red line in the diagram.



Suppress … to hide a section of the curve

Tap the button, then mark the area to be suppressed in the diagram, i.e. tap and draw out the required range.

Suppress individual audio blocks (only Offline measurement)

Opens a menu showing the 10 single correlations of this pair of sensors. "Bad" single-correlations can be 'deactivated' and, by this means, excluded from the total-correlation.

Tap the button. In the menu that opens, tap the required fields to remove/set the checkmark. Use the Back button to return to the correlation analysis menu.

Pause

Interrupts the current correlation.

Continue

Continues the interrupted correlation, but does not reset the averaging.

Refresh

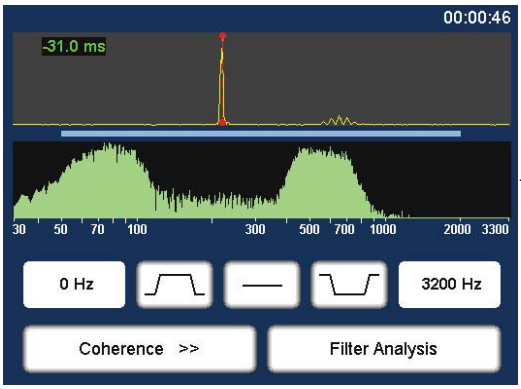
Resets the averaging and restarts the correlation.

Store

Opens the Correlation management menu to store the displayed correlation data in the Correlator's data base.

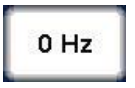
2.6 Frequency analysis menu

Tapping the **Coherence curve** always opens the following menu which provides tools for analysing the frequency range.



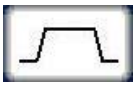
Correlation curve

Coherence curve



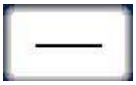
Lower frequency limit

Shows the lower limit of the adjusted frequency range.
Tap the button to change the value.



Bandpass … to isolate a frequency range

Tap the button, then mark the required range in the frequency diagram. The correlation is updated. The frequencies outside the selected range are suppressed.



Filter reset

Tap the button to reset the frequency filter settings to the initial state.

Bandstop … to suppress a frequency range

Tap the button, then mark the required range in the frequency diagram. The correlation is updated. The selected frequency range is suppressed.

Upper frequency limit

Shows the upper limit of the adjusted frequency range.
Tap the button to change the value.

Frequency spectrum

Allows to change between the following frequency diagram options:

Coherence … Coherence of the recordings of both sensors.

Spectrum L … Frequency spectrum of the sensor on the left.

Spectrum R … Frequency spectrum of the sensor on the right.

Spectrum L+R … Frequency spectra of both sensors.

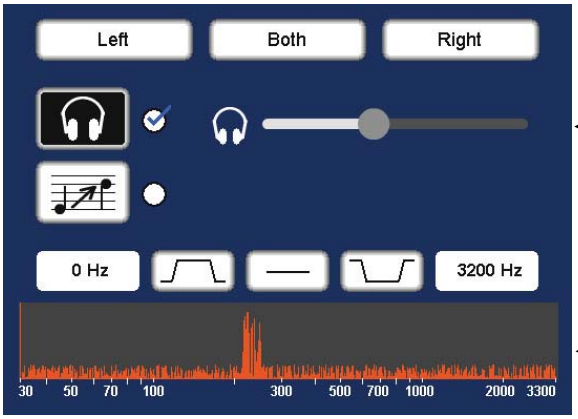
- Orange curve … Sensor A
- Yellow curve … Sensor B

Automatic search for best filter

Provides 10 possible filter settings.

2.7 Audio menu

Tapping the buttons **A / B / Sensor number** (5) in the Correlation menu opens the Audio menu which allows listening to the leak noise using the delivered headphones.



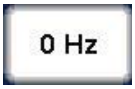
Listen only to the left sensor
Only the noise recorded by the sensor on the left is reproduced.

Listen to both sensors
The combined noise of both sensors is reproduced.

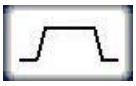
Listen only to the right sensor
Only the noise recorded by the sensor on the left is reproduced.

Headphones ON/OFF
Tap the button to enable / disable the connected headphones.

Pitching ON/OFF
This function lifts very low frequencies artificially up to a higher frequency range to make them more audible to humans.



Audio filter: Lower limit
Shows the lower limit of the frequency range to be reproduced on the headphones. Tap the button to change the value.



Audio filter: Bandpass
Specify the frequency range to be reproduced. Frequencies out of this range are suppressed.

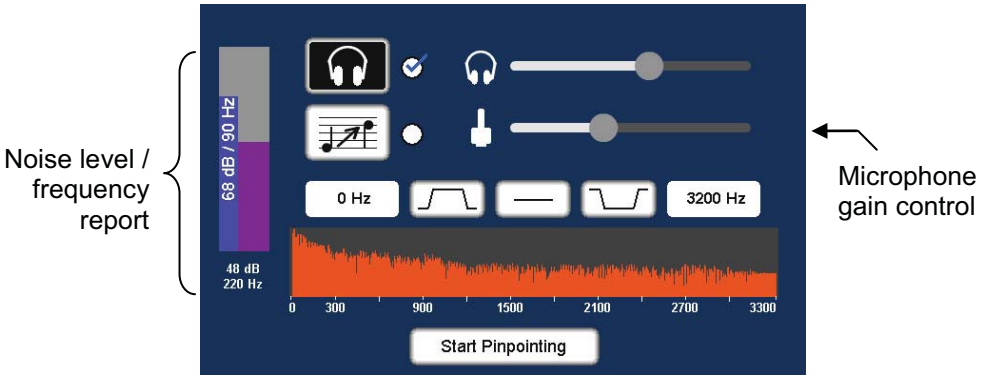
Audio filter: Reset
Tap the button to reset the audio filter settings to the initial state.

Audio filter: Bandstop
Specify the frequency range to be suppressed on the headphones. Only the frequencies outside the selected range are reproduced.

Audio filter: Upper limit
Shows the upper limit of the frequency range to be reproduced on the headphones. Tap the button to change the value.

2.8 Audio menu (in Pinpointing mode)

In Pinpointing mode, the Audio menu differs in the following aspects from the standard Audio menu:



On the left, the **Instantaneous value** and the **Minimum value** of the current measurement are displayed.

Narrow bar: **Instantaneous value**

- The bar's height represents the current noise level.
- The bar's color illustrates the frequency of the current noise.
- Additionally, level and frequency are displayed inside the bar numerically.

Wide bar: **Minimum value**

- The bar's height represents the lowest noise level of the measurement.
- The bar's color illustrates the frequency of this lowest noise.
- Additionally, level and frequency are displayed below the bar graph numerically.

By means of the second slide control the **gain of the ground microphone** can be adjusted.

Slide to the left	…	Decrease the microphone gain
Slide to the right	…	Increase the microphone gain

3 Technical description

3.1 Function

The Correlux C-3 correlator locates leaks in drinking water pipes.

Pressurized water at the leak location creates a noise which travels out in all directions of the pipe. This noise is recorded, amplified and sent wirelessly to the correlator by two sensors (piezo microphone, hydrophone) which are attached to the pipe (e.g. valve, hydrants). The Correlux C-3 compares both signals (correlation) and calculates the exact distance to the leakage on the basis of the delay time of the signals, the sensor spacing and the sound velocity in the pipe.

The Correlux C-3 is suitable for both immediate measurement ("Online measurement") as well as time-shifted measurement ("Offline measurement" or "Night measurement")).

Online measurement

In a so-called Online measurement, the noise recording and the correlation of the data take place at the same time.

Step	Description
1	Installing the Power transmitters "A" and "B" at two measuring points.
2	Noise recording, at the same time data transfer and live data correlation on the Correlator.

Offline measurement

In a so-called Offline measurement, the correlation of the measured data takes place only after the noise recording has been terminated.

Step	Description
1	Programming the sensors (Multi sensors and Power transmitters) using the Correlator.
2	Installing the sensors at up to 8 measuring points.
3	Noise recording, immediately or at a preset time (e.g. at night).
4	Collecting the sensors.
5	Reading and analyzing the measured data using the Correlator.

Pinpointing

To determine the exact location of the leak after the correlation, a pinpoint search can be performed using the Multi sensors or the ground microphone connected to the correlator.

3.2 Features of the set

The Correlux C-3 set mainly comprises the following components:

- **Correlator**
- **2 Power transmitters with microphone**
  for recording the leak noise at two measuring points and sending the recorded data to the correlator for an Online correlation

The set can be extended by the following components:

- **up to 8 Multi sensors**
  for recording the leak noise at up to 8 measuring points simultaneously, followed by an Offline correlation
- **hydrophones**
  for recording the leak noise directly at the water column
- **a ground microphone**
  for pinpointing the leak after correlation

The **Transport case** offers space for the Correlator, 2 Power transmitters and 3 Multi sensors. The case is not only for storage and transportation purposes, but also functions as a charging station for the devices.

3.3 Communication of the components

The components of the system communicate with each other in the following ways:

Participating devices	Communication channel
Correlator ↔ Power transmitter	Short range radio (digital or analogue)
Correlator ↔ Multi sensors	Short range radio (digital)
Correlator ↔ Computer	USB cable
Correlator ↔ Ground microphone	Connection cable

3.4 Power supply

The Correlator, the Power transmitters and the Multi sensors come with internal rechargeable Li-Ion batteries.

The storage places of the individual devices in the transport case function as charging stations. As soon as a device is placed in/on its station in the case, the device is automatically charged, provided the case is connected to mains or to a 12 Volt vehicle power supply.

NOTE

When connected to the electrical system of a car, the transport case is powered by the vehicle's battery, even while the vehicle is not in operation. This could result in the complete discharge of the vehicle battery.

When you park the car, disconnect the Correlux transport case from the vehicle power supply.

You can find more information in the chapters which describe the individual devices.

3.5 Scope of delivery

Standard accessory

The basic set comprises the following devices and accessories:

Part	Description	Art.no.
COR C-3	Correlator	1006550
COR PT-3A	Power transmitter A	1004779
COR PT-3B	Power transmitter B	1004780
PAM CORR-2	2 x active universal microphone for COR PT-3	820019615
CPK 3-B	Case for COR C-3 (Basis)	2007235
LG C-3	Charging unit for CPK 3/CMK 3	1006646
LK 13	Car charging adaptor, 3.5m	810000006
KR 22-5	Stereo headphones	810002087
VST T-1	2 x extension rod for PAM T-2/U	810000103
VK 77	Connection cable set Sebalog D (USB)	820012451
	2 x nylon cord 3mm blue, 2m	304035025
CSW CorreluxView C-3	PC software	1006584

Additional accessory

The following devices and accessories are available to extend the basic set.

Part	Description	Art.no.
COR MS-3	Multi sensor	1004815
CMK 3-8-MS	Case for 8 Multi sensors COR MS-3	2005301
LOG TP	Trivet adaptor	128309877
LOG MWA	Magnetic angled adaptor	118303355
	Set of labels COR C-3 (1 - 8)	2007321

3.6 Technical data

Correlux C-3 is specified by the following parameters:

Correlator COR C-3

Parameter	Value
Display	5,7" VGA color display 640 x 480 pixels
Operation	Touch display, Rotary encoder with ENTER function, On/Off pushbutton
Power supply	Internal rechargeable Li-Ion battery, 12 V DC charging pins
Operating time	min. 16 h
PC interface	USB
Connections	Sensor (microphone/hydrophone), 12 V DC / headphones (combined) USB / GPS (combined) External antenna 1 (digital radio) External antenna 2 (analogue radio)
Dimensions	250 x 190 x 100 mm
Weight	1.9 kg
Degree of protection	IP 65

Power transmitter COR PT-3A/B

Parameter	Value
Sensor	Piezo sensor with active amplifier (standard) / hydrophone (optional)
Indicators	I/O LED (device On/Off) Radio LED (radio module On/Off)) Row of LEDs (battery status or measured noise level)
Operation	On/Off pushbutton
Power supply	Internal rechargeable Li-Ion battery, inductive charging
Operating time	min. 12 h
Connections	Sensor (microphone/hydrophone), Radio antenna
Dimensions (without handle)	Ø 125 x 111 mm
Weight (without sensor)	0.9 kg
Degree of protection	IP 68

Sensor PAM CORR-2

Parameter	Value
Type	Piezo sensor with magnetic adaptor (to be connected to Power transmitter or Correlator)
Active amplification	yes
Dimensions	Ø 38 x 78 mm
Weight	0.4 kg

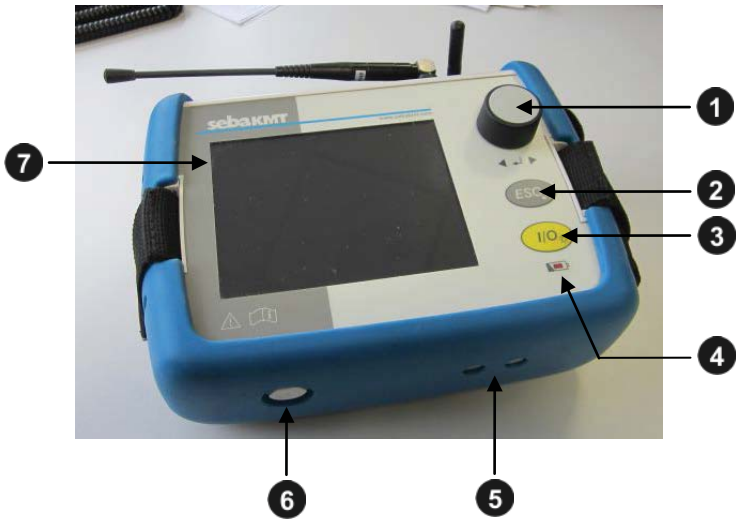
Multi sensor COR MS-3

Parameter	Value
Sensor	Integrated piezo sensor with active amplifier
Adaptor	Magnetic adaptor
Indicators	Status LED
Operation	On/Off magnetic switch
Power supply	Internal rechargeable Li-Ion battery, inductive charging
Operating time	min. 16 h
Dimensions	Ø 45 x 115 mm
Weight	0.4 kg
Degree of protection	IP 68

4 The Correlator

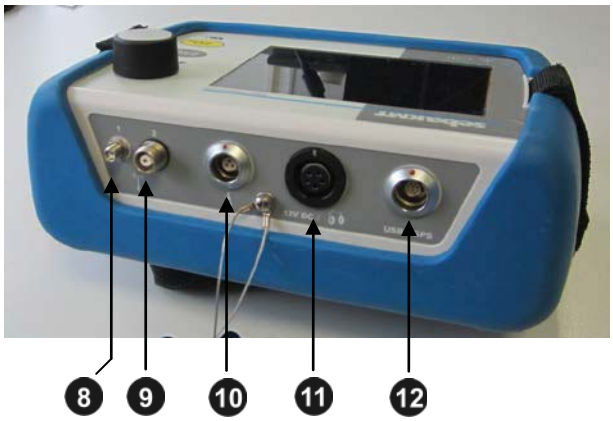
4.1 Design

The device has the following control elements and external features:



Element	Description
1	**Rotary encoder** Turning … Leads through the buttons and input fields displayed Pressing … Executes the selected button or enters the input field
2	**ESC pushbutton** exits the current menu and returns to the Start menu
3	**I/O pushbutton** Short pressing … Switches the device on or activates the backlight Long pressing … Switches the device off
4	**Charging indicator light**
5	**Charging pins** to charge the device wireless in the transport case
6	**Ventilation / venting membrane**
7	**Touch screen** (the Touch function can be enabled/disabled in the sytem settings)

The device has the following connection sockets:



Element	Description
8	**Antenna 1 (digital radio)** data transfer in Offline measurement mode
9	**Antenna 2 (analogue radio)** data transfer in Online measurement mode
10	**Microphone** connection socket for ground microphone
11	**12V DC** connection socket for headphones
12	**USB / GPS** combined connection socket for • USB cable • GPS receiver

4.2 Power supply

The Correlator is fitted with an internal rechargeable Li-ion battery. This can power the device for approximately 16 hours. The battery's present charge level is shown continuously by the battery symbol bottom right of the screen.

When the battery is low, a warning tone is heard and a warning message appears on the screen. The device must then be recharged, otherwise, it switches itself off automatically.

Charging The correlator is charged wirelessly in the C-3 transport case.

As soon as the device is situated at it's storage place in the case, it is recharged via the two pins ❺, provided the case is connected to mains or a 12 Volt vehicle power supply. The red indicator light ❹ is lit while the device is charging.

The correlator is switched on during the entire charging process and can not be deactivated. After the end of charging, the device remains switched on for the Auto-OFF period specified in the system settings.

Charging takes approximately 12 hours.

Heat is generated while charging. The charging station in the case therefore has a temperature switch. The charger switches off automatically when it gets too warm in the case. It turns back on as soon as the degree of heat has fallen below a certain level.

NOTE

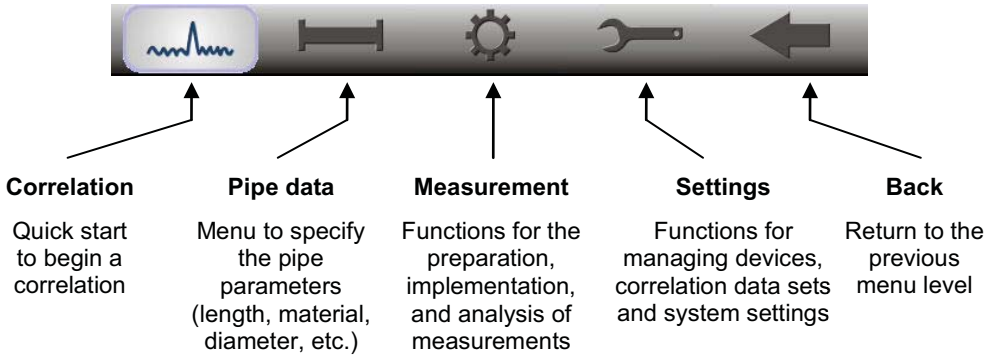
In order to prevent damage, observe the following precautions when charging:

- Use only the charging station in the transport case. Do not use other chargers.
- The ambient temperature should be between 10°C and 35°C (50°F and 95°F).
- To avoid heat accumulation, do not close the lid of the case at high ambient temperatures during charging.
- If you experience problems with the battery, please contact your SebaKMT sales partner. Do not open the device yourself.

4.3 Design of the user interface

All the menu levels on the Correlator's user interface consist of a large **display area**, the **main menu** bar and an **info bar**.

Main menu Using the buttons in the main menu bar you can access the individual functions of the device.



Info bar The info bar provides the following information (from left to right):

- a help text with short explanations for the selected element (button / field / box) or on how to proceed
- the battery symbol indicates the charge level of the battery
- the correlator's internal time

4.4 Basics of operation

4.4.1 Input methods

Entries can be made directly on the screen or via the rotary encoder.

2 ways of entering data

Touch display	**Rotary encoder**
The correlator screen is touch-sensitive. All entries can be made directly on the screen.	The correlator has a rotary encoder. All entries can be made using the rotary encoder.
↓	↓
The buttons or fields displayed can be called or executed by tapping with your finger.	**Turn** the rotary encoder to navigate through the displayed buttons. **Press** the encoder to call the selected button (ENTER function).

You can always switch between operating via touch screen and operating via rotary encoder.

4.4.2 Entering identification numbers (IDs)

Introduction Various functions require the identification numbers (IDs) of the Power transmitters or Multi sensors to be specified.

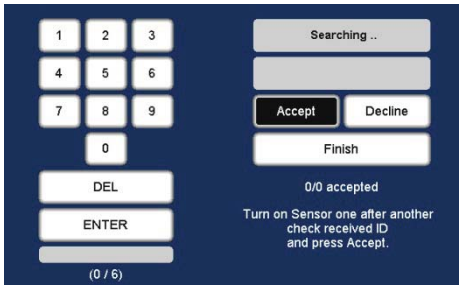
The ID is deduced from the last six digits of the device's serial number (short: SN). You find the serial number on the nameplate of the device.

Example:

Serial number (SN):	**0888000225**
Identification number (ID):	**000225**
Entry on correlator / PC:	**225**

You can enter device IDs manually or you can use the "Automatic device detection". Automatic detection means that, when a device is activated its ID is sent to the Correlator. There, it is detected and displayed.

For entering a device ID the following screen view, or a similar one, opens:



DEL … Deletes the last character
ENTER … Confirms and completes the input
Accept … Accepts and enters the automatically detected ID
Decline … Does not accept the automatically detected ID
Finish … Completes the automatic detection

Manual entry For the manual entry of IDs, the number pad displayed is used. Confirm your entry with the ENTER button.

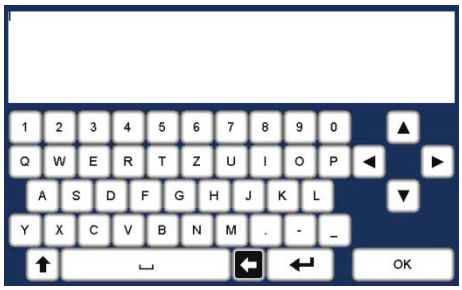
When inputting an ID, the preceding zero digits can be omitted.
Thus, if the ID is ‘000225’, you need only enter ‘225’.

Automatic detection To the right of the number pad, there are fields and buttons for the automatic sensor detection. The devices concerned must be close to the correlator.

To register a Power transmitter to the correlator, briefly press the **I/O** pushbutton of the device. To register a Multi sensor, briefly move a magnet past the sensor's **I/O** area, so that the LED lights up briefly. As a result, the device's ID is sent, detected by the Correlator and displayed there. Use the provided buttons to accept or decline the ID. This way, multiple sensor IDs can be registered to the Correlator in quick succession.

4.4.3 Entering text

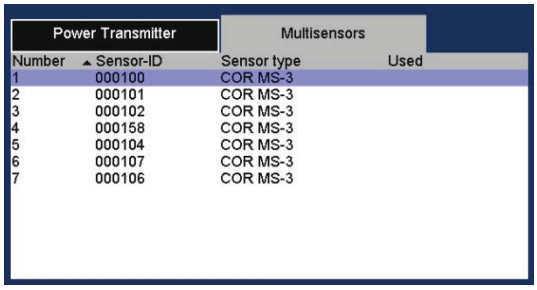
To input comments or similar, a virtual keyboard appears on the screen. Enter the required text and confirm with **OK**.



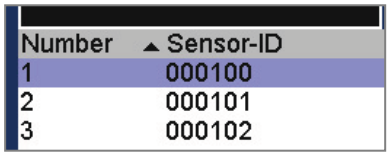
4.4.4 Sorting devices in lists and tables

In various menus, device IDs or other information are listed in a kind of table.

For example, the following picture shows a list of all Multi sensors registered to a Correlator (the so called 'sensor pool').



If a black triangle can be seen in the header of a column, you have the chance to change the sort order (ascending / descending) according to the parameter shown in the header. Just tap the respective header.



Changing the sort order is only possible via touch screen, not via the rotary encoder.

4.4.5 ESC pushbutton and Back button

You can use the **ESC** pushbutton ❷ to cancel any started function and exit each menu. This immediately returns you to the start screen.

You can use the Back button in the main menu bar to return to the previous menu level.

4.5 Commissioning

4.5.1 Switch the correlator ON/OFF

Switching ON

The correlator is switched on with the **I/O** pushbutton ❸. The boot process takes a few seconds, then the Start menu appears on the screen. The device is now ready.

Switching OFF

To switch the correlator off, press the **I/O** pushbutton until the screen turns off (approx. 2 seconds).

Auto-OFF

The Commander automatically switches off if no input is made within a specified time period. This timespan can be configured in the system settings.

4.5.2 Basic settings at initial start-up

When the correlator is switched on for the first time, two consecutive 'Welcome menus' appear on the screen. There, some basic system settings have to be made before the Start menu can be entered.

Language, date and time

In the menu that appears first, use the upper pull-down list to select your language. The Correlator's operating language immediately adapts to your selection. After that, give the remaining requested details.

Line	Description
Daylight saving time	Select whether currently is winter or summer time.
Date format	Select a format for the correlator's system time. DD … Day MM … Month YYYY … Year
Date / Time	Enter the current time (hours:minutes:seconds) and date (day:month:year).

Confirm with **OK**. The menu is closed. The settings are accepted. You have the chance to change these settings again in the Correlator's system settings menu, at any time.

Devices of your set Specify in the next menu, which devices are part of your Correlux C-3 set. Activate the relevant checkbox/es.

The statements made here determine which measuring methods will be offered in the Correlators Start screen.

Example: If you select no checkbox except "COR PT-3", the Online measurement method "COR PT-3 with microphone" will be the only available method in the Start screen.

Confirm with **OK**. The settings are accepted. The menu is closed and the Start menu appears.

You have the chance to change these settings again in the correlator's system settings menu, at any time.

4.5.3 Change the language

The operating language can be changed in the system settings of the device.

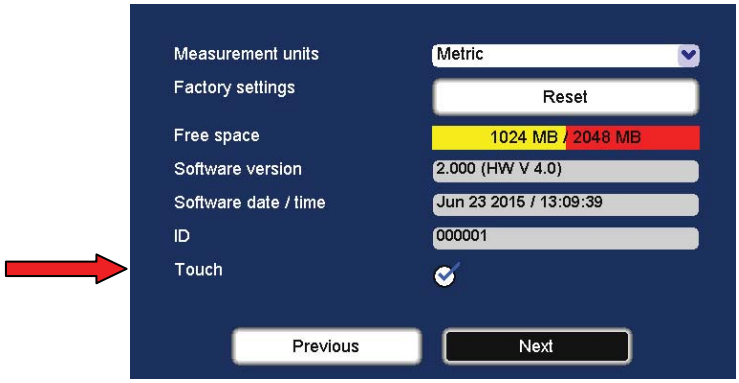
If currently a foreign language is set, call the Start menu (**ESC** button) and follow these symbols:

Next to the second flag you find a pull-down list with all available languages.

4.5.4 Enable/Disable the touch screen (touch sensitivity)

The touch function of the screen can be disabled/enabled. As long as the function is switched off the correlator can only be operated using the rotary encoder.

Proceed as follows:

Step	Description
1	In the main menu, tap the button .
2	In the displayed menu, tap the **System settings** button.
	Result: The system settings menu is opened. Use the buttons **Next** and **Previous** to browse through the available settlings.
3	Look for the **Touch** option. Enable/Disable the corresponding checkbox. 

4.5.5 Activate the display light

The display light is switched on by

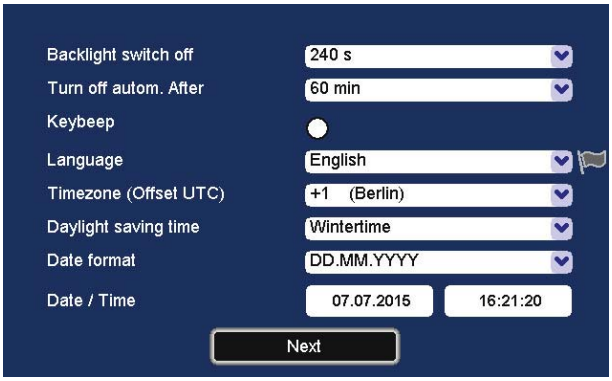
- touching the screen (provided the touch function is not disabled)
- turning the rotary encoder
- pressing the **I/O** pushbutton briefly

The light remains on for a certain time period. The length of this period (a maximum of 4 minutes) can be adjusted in the system settings.

4.6 Systeme settings

By means of the **System settings** various device settings can be customized to the needs of the user. Furthermore, the menu provides useful information on the status of the device and the firmware used.

To access the **System settings** menu, proceed as follows:

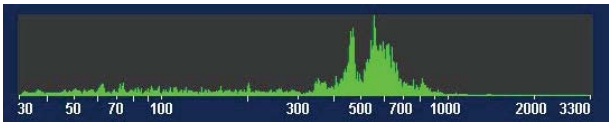
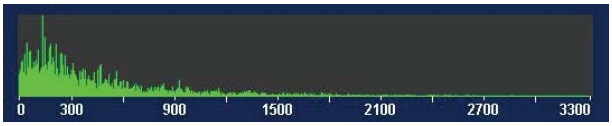
Step	Description
1	In the main menu, tap the button .
2	In the displayed menu, tap the **System settings** button.
	Result: The system settings menu is opened. Use the buttons **Next** and **Previous** to browse through the available settlings. 

4.6.1 Basic settings

The following basic settings can be made

	Line	Description
Backlight	**Backlight switch off**	Select a period of time for the backlight until it is switched off automatically. Explanation: If no entry is made, the display light is switched off automatically after a period of time. Specify the length of this period here. If you select **never**, the backlight will remain on permanently.
Auto-OFF	**Turn off autom. after**	Select a period of time for the correlator until it is switched off automatically. Explanation: If no entry is made, the device switches itself off automatically after a period of time. Specify the length of this period here. If you select **never**, the correlator will remain switched on permanently.

Key tone	**Keybeep**	Activate/deactivate the key tone that sounds when a button is tapped or the rotary encoder is pressed.
Language	**Language**	Select your language.
Time and date	**Timezone**	Select the time zone for where you are.
	Daylight saving time	Select whether it is currently winter or summer time.
	Date format	Select the date format to be used by the correlator. DD … Day MM … Month YYYY … Year
	Date / Time	Enter the current date and time (hour:minute:second) for the correlator.
Format of units	**Measurement units**	Select the system of units to be used. Metric … Used in Europe and most countries in the world Imperial … Used in the US
Reset system settings	**Factory settings**	Tap the **Reset** button if you want to reset all system settings to factory defaults.
Touch screen ON/OFF	**Touch**	Enable/Disable the touch function of the screen. As long as the function is switched off the correlator can only be operated using the rotary encoder.
Averaging during correlation	**Averaging**	Select the averaging interval. Explanation: When performing an Online measurement, the calculation will automatically be restarted and the displayed correlation curve will be updated at regular intervals. **no averaging** … No averaging takes place. **20 s** … Averaging of the correlation curve takes place in a 20 seconds interval. **unlimited** … Averaging of the correlation curve takes place with every new received measuring data package.
Available measuring methods in Start menu	**Available quick start buttons**	Specify which devices are part of your Correlux C-3 set. Enable/Disable the relevant checkbox/es. Explanation: The statements made here determine which measuring methods will be offered in the correlator's Start screen. Example: If you select no checkbox except "COR PT-3", the Online measurement method "COR PT-3 with microphone" will be the only available method on the Start screen.

Frequency scale linear / logarithmic	**Frequency scale**	Select if the X-axis of the coherence diagram in the Correlation menu shall ascend in a linear or logarithmic way. Explanation: The frequency range of the Correlux C-3 system is from 0 to 3.300 Hz. The logarithmic view results in a wider display area for lower frequencies. **logarithmic:**  **linear:** 

4.6.2 System info

The **System settings** menu has the following information on the device and the firmware currently in use:

Line	Description
Free space	The correlator's free memory space in MB
Software version	Firmware version
Software date/time	Date of last firmware update
ID	Identification number of the correlator

4.6.3 Store the settings

When leaving the system settings menu all the settings are automatically stored and accepted.

4.7 Hardware reset

If the correlator stops responding to inputs (neither from touch screen nor from rotary encoder or pushbuttons), a hardware reset can be performed.

Hold down the rotary encoder ❶ and the **ESC** pushbutton ❷ at the same time for about one second. The correlator restarts automatically. This usually rectifies the malfunction.

If the malfunction persists after this normal reset, try the following: Hold down the rotary encoder and the **ESC** pushbutton at the same time for about three seconds. The correlator switches off. Wait about a minute before switching the device back on. The correlator should now function correctly again.

4.8 Communication

4.8.1 Connection between the correlator and the sensors

Short range radio is used for communication between the correlator and the sensors (Power transmitters and Multi sensors)

Digital radio is used for Online measurements. Analogue radio is used for Offline measurements. Therefore, the correlator is equipped with two radio antennas.

Antenna 1 … Digital radio
Antenna 2 … Analogue radio

4.8.2 Connection between the correlator and the computer

The delivered VK 77 connection cable is used to connect the correlator to a PC/laptop.

This connection is needed for

- correlation data transfer to computer
- firmware update file transfer to the correlator

Connecting To connect the correlator to a computer, proceed as follows:

Step	Description
1	In the main menu, tap the button .
2	In the displayed menu, tap the **Connect to PC** button.
3	Establish the cable connection. Connect the round plug of the cable to the **USB/GPS** socket 12 of the correlator. Markings on the plug and socket ensure that the plug is lined up correctly. You must feel the plug engage.
4	Tap the **Connect** button on the correlator.
	Result: The connection is made. The correlator is automatically detected by the computer as a mass storage device. As soon as the "Connected" message on the correlator's screen appears, data can be transferred.

If no connection is made, check the cable connection again. If necessary, disconnect the correlator from the computer, restart it or perform a reset, and follow steps 1 to 4 once again.

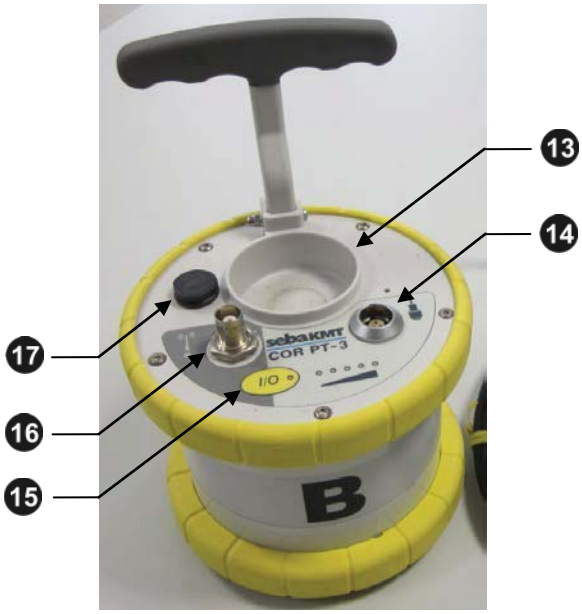
Disconnecting To end the connection, select the **Disconnect** button on the correlator. As soon as the "Disconnected" message appears, the connection cable can be removed.

5 The Power transmitters

5.1 Design

Each Power transmitter has an active amplifier for the microphone signal, a data memory, a rechargeable Li-Ion battery, a digital radio module and an analog radio module with antenna inside.

The devices have the following external characteristics:



Element	Description
13	**Sensor storage place**
14	**Sensor socket** for connecting the microphone / hydrophone
15	**I/O pushbutton** short pressing … switches the device on long pressing … switches the device off
16	**Ventilation / venting membrane**
17	**Antenna socket** for connecting the analog radio antenna

Indicator light The Power transmitters have the following lights (LEDs):

Element	Description
18	**Row of LEDs** lit green … represents the current battery level lit red … represents the noise level
19	**Radio LED** lit green … the device is switched on flashing … the device is charging not lit … the device is switched off
20	**I/O LED** lit red … the device is in "Active" mode, noise measurement in progress measurement data is being sent to the correlator not lit … the device is in "Stand-by" mode, no measurement in progress, no radio traffic

5.2 Identification number (ID)

Each Power transmitter has its own six-digit identification number (short: ID). Using this ID the device in the correlator and the Correlux View PC software can be managed and clearly identified.

The ID is deduced from the last six digits of the device's serial number (short: SN). You find the serial number on the nameplate of the device.

When inputting an ID on the correlator or computer, the preceding zero digits can be omitted.

5.3 Power supply

The Power transmitters are fitted with internal rechargeable Li-Ion batteries which can power the devices for at least 12 hours.

Battery level

On the device, the current battery status is indicated by the row of LEDs 18 when it is green. (Red light represents the recorded noise.) If only one of five LEDs is lit, the device should be charged. Otherwise, it switches itself off automatically.

In the Start menu of the correlator two battery icons indicate the current battery status of the Power transmitters, provided both devices are switched on and in reach.

To know the exact battery state of a Power transmitter, read the unit's configuration and see the **Battery level** line in the respective menu.

Charging

The Power transmitters are charged wirelessly in the transport case.

As soon as the devices are situated at their storage places in the case, they are recharged inductively, provided the case is connected to mains or to a 12 Volt vehicle power supply.

Charging takes approximately 12 hours. The row of LEDs 18 indicates the charging progress. The **I/O**-LED 20 is flashing during the process. It returns to permanent light as soon as the battery is full.

⚠	**NOTE** **In order to guarantee the devices' water and dirt resistance, any repairs must be carried out by SebaKMT or an authorised service partner.** Do not open a Power transmitter yourself. If you have problems with the battery, please contact your SebaKMT service partner.

5.4 Commissioning

Switching ON/OFF

To turn a Power transmitter on, briefly press the **I/O** pushbutton 15. The **I/O** LED is lit. To turn the device off, press the button until the LED goes out.

Stand-by

The Power transmitter's sensor storage place 13 is fitted with a magnetic switch. As a result, the transmitter "knows" whether the microphone is currently in use or not.

As long as the microphone rests in the storage place, the Power transmitter remains in "Stand-by" mode. The internal analog radio module stays off as no measuring data needs to be transferred. This saves battery power.

As soon as the microphone is taken from the storage place, the Power transmitter switches from "Stand-by" to "Active" mode. The internal radio module is activated and, from now on, the recorded data are directly sent to the correlator. The row of LEDs switches from green to red and represents the recorded noise level.

6 The Multi sensors

6.1 Design

Each Multi sensor has a highly sensitive piezo microphone with active amplifier, a data memory, a rechargeable Li-Ion battery and a radio module with antenna inside.

The devices have the following external characteristics:

Element	Description
22	**Indicator light** flashes green … battery OK flashes yellow … battery critical flashes red … device needs to be re-charged flashes rapidly … device is charging no light … device is turned off
23	**ON/OFF contact area I/O**
24	**Magnetic foot (replaceable)**
25	**Type plate**
26	**Carrying ring (removeable)**

6.2 Identifikationsnummer (ID)

Each Multi sensor has its own six-digit identification number (short: ID). Using this ID the device in the correlator and the Correlux View PC software can be managed and clearly identified.

The ID is deduced from the last six digits of the device's serial number (short: SN). You find the serial number on the nameplate of the device.

When inputting an ID on the correlator or computer, the preceding zero digits can be omitted.

6.3 Power supply

Battery level The Multi sensors are fitted with internal rechargeable Li-Ion batteries which can power the devices for at least 16 hours.

In the Start menu of the correlator up to eight battery icons can be seen. They indicate the current battery status of the registered Multi sensors in reach. To know the exact battery state of a Multi sensor, read the unit's configuration and see the **Battery level** line in the respective menu.

When the battery level of a Multi sensor falls below a certain threshold, the indicator light of the device will blink red. The unit must then be recharged, otherwise it switches itself off automatically.

Charging The Multi sensors are charged wirelessly in the transport case.

As soon as the sensors are situated at their storage places in the case, they are recharged inductively, provided the case is connected to mains or to a 12 Volt vehicle power supply.

Charging takes approximately 6 hours. The units' indicator lights are rapidely flashing during the process. The indicator lights turn to permanent green light as soon as the battery is full.

	CAUTION **No objects must be put into empty charging stations.** **Risk of fire due to the induction !** **The charging stations are for transport and charging of the Multi sensors only.**

	NOTE **In order to guarantee the devices' water and dirt resistance, any repairs must be carried out by SebaKMT or an authorised service partner.** Do not open a Multi sensor yourself. If you have problems with the battery, please contact your SebaKMT service partner.

6.4 Switching ON/OFF

The Multi sensors have an internal magnetic switch.

To turn a Multi sensor on, briefly hold a magnet (e.g. the foot of another Multi sensor) in front of the sensor's **I/O** area 23. The device turns on. The indicator light flashes 3 times.

To turn the device off, hold a magnet in front of the **I/O** area for approximtely 2 sconds. The indicator light will flash 2 times before it goes out.

6.5 Installation

The Multi sensors should be installed directly on the pipe but, however, you can also attach them to valve rods or hydrants, for example, or any other position along the pipeline that is easily accessible. Due to their powerful magnet, the sensors can also be attached horizontally to ferromagnetic surfaces.

There must be the best possible contact between the sensor foot or the mounted adapter (see below) and the pipe. If need be, clean the contact point thoroughly (preferably with a wire brush).

6.6 Adapter

The magnetic foot of the Multi sensor can be unscrewed and replaced by another adaptor, e.g. by the optional magnetic angled adaptor.

7 Online measurement – Realtime correlation with 2 sensors

Checklist prior to measurement

- Are the batteries of the Power transmitters and the Correlator charged?
- Are the antennas properly connected to the Power transmitters and the Correlator?
- Are the microphones/hydrophones properly connected to the Power transmitters?
- Has the radio of each Power transmitter been tested?

  (For this, take the transmitter's microphone from the storage place 13. The Radio LED 19 must now be lit. If not, put the microphone back to the storage place, switch the transmitter off and on again and repeat the test.

Start a correlation

Deploy the Power transmitters at the required measuring points and start the correlation. Proceed as follows:

Step	Description
1	Take the Power transmitter „A“ (orange) and go to the first measuring point. Place the microphone on the pipe (or, alternatively, install the hydrophone). Turn the Power transmitter on.
2	Take the Power transmitter „B“ (yellow) and go to the second measuring point. Place the microphone on the pipe (or, alternatively, install the hydrophone). Turn the Power transmitter on.
3	Take the Correlator and choose a position half way between the measuring points. Turn the Correlator on.
4	In the Start menu, select the required Online measuring mode **COR PT-3 with microphone** or **COR PT-3 with hydrophone**.
	Result: The Correlation menu appears. The correlation is started and displayed.

Rate the correlation Use the following questions to assess the quality of the displayed correlation.

Question 1: Is the radio signal of both transmitters strong enough?

The radio symbol (1) shows:
strong signal

How to proceed: Continue the measurement and start a detailed analysis.

The radio symbol (1) shows:
weak signal

Meaning: continuous correlation hardly or not possible

How to proceed:

- Move closer to the Power transmitter in question
- Place the transmitter higher (e.g. on a wall or on a traffic cone or similar)
- If necessary, place the transmitter at an other measurement point
- If possible, there should be a direct line of sight connection between Correlator and transmitter

If still no connection can be made, conduct an Offline measurement instead of the Online measurement

Question 2: Is the correlation result reliable?

The curve shows one clear peak;
the lag value (2) is green or yellow and does not fluctuate

Meaning: the result is reasonable

How to proceed: Continue the measurement and start a detailed analysis.

The curve shows no clear peak;
the lag value (2) is red and fluctuating

Meaning: there is no leak or no accurate localization is possible

How to proceed: If you still suppose a leak to be here, the following can help:

- Access the system settings menu, adjust the „Averaging“ to “unlimited” and restart the correlation.

- Conduct an Offline measurement (at night) instead of the Online measurement.

Listen to leak noise

You have the chance to listen to the sound in the pipe “live”, in order to judge whether a leak noise or a background noise can be heard.

Use the **12 V DC** socket to connect the delivered headphones to the Correlator. In the Correlation menu, tap the button A or B to open the Audio menu.

Use the Back button to return to the Correlation menu.

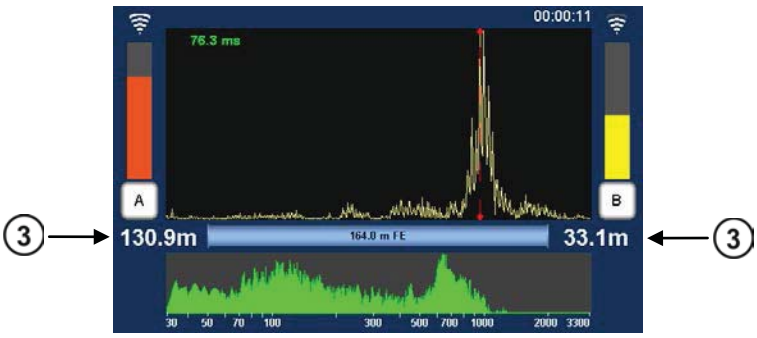
Enter pipe parameters

If you assess the correlation as ”good“, in the next step specify the properties of the pipe in order to be able to calculate the distance to the leak.

Proceed as follows:

Step	Description
1	In the Correlation menu, tap the button between the two diagrams representing the pipe or use the button in the main menu.
	Result: The Pipe data menu is opened.
2	Reproduce the pipeline. Use the **Add** and **Delete** buttons to devide the line into sections.
3	Enter the pipe data (material, diameter, length) for each section.
4	Use the Back button to return to the Correlation menu or the Start menu. The entered pipe data are accepted
	Result: In the Correlation menu, the distance from transmitter **A** or **B** to the leak is displayed now.

Rate the leak position Assess whether the leak position seems plausible or not.



Question 1: Is one of the values 3 zero or close to zero?

No

Meaning: The values seem plausible.

How to proceed: Continue the measurement and start a detailed analysis.

Yes

Meaning: The leak is located precisely at the measuring point or outside the correlated pipe section.

How to proceed: Cancel the measurement. Take the relevant transmitter and look for a new installation point in order to enlarge the measuring length. Then start a new correlation.

Question 2: Does each value 3 show the half of the measuring length

No

Meaning: The values seem plausible.

How to proceed: Continue the measurement and start a detailed analysis.

Yes

Meaning: The leak is located precisely half way between the measuring points or a measuring error has occurred (so called ‘center point correlation’).

How to proceed: Cancel the measurement. Take one of the transmitters and look for a new installation point in order to enlarge the measuring length. Then start a new correlation.

Detailled analysis Use the various tools to analyze the displayed correlation:

- When you tap the displayed correlation curve, the **Correlation analysis menu** with the relevant tools opens.
- When you tap the displayed coherence curve, the **Frequency analysis menu** with the relevant tools opens.

Use the Back button to return to the Correlation menu.

Some settings for calculating and presenting the correlation curve can be changed in the System settings menu.

8 Offline measurement - Multipoint correlation with preprogrammed sensors

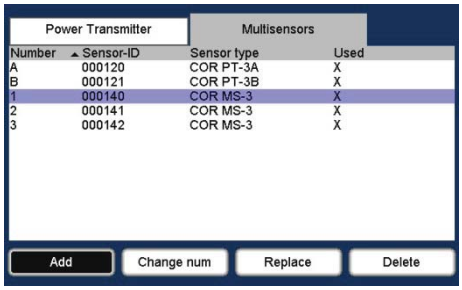
A group of 2 to 8 sensors is programmed for measurement and then deployed at the measuring points. Multi sensors and/or Power transmitters can be used. The measurement is carried out by all sensors simultaneously. During the measurement, there is no contact between the sensors or between the sensors and the Correlator. After the measurement, the sensors are collected and the recorded data is read, then correlations can be carried out and displayed on the Correlator.

Checklist prior to measurement

- Is there a digital or printed pipe network plan of the relevant measuring area with all pipe parameters?
- Are the batteries of the relavant devices charged?
- If Power transmitters will be used: Are the microphones properly connected?

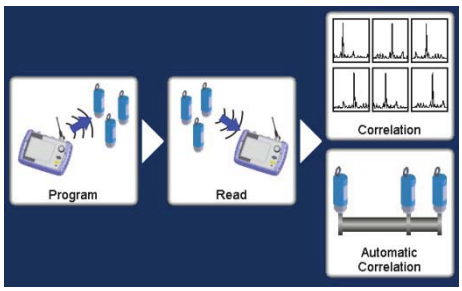
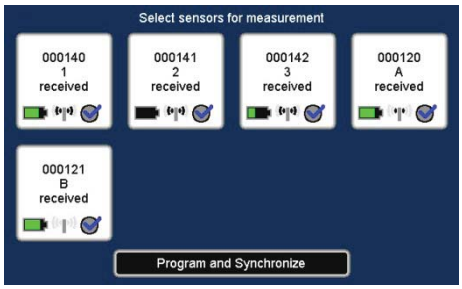
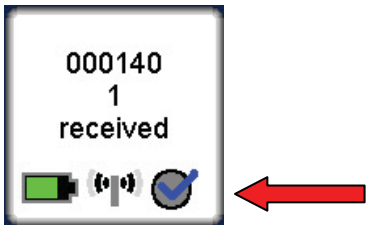
Registering sensors

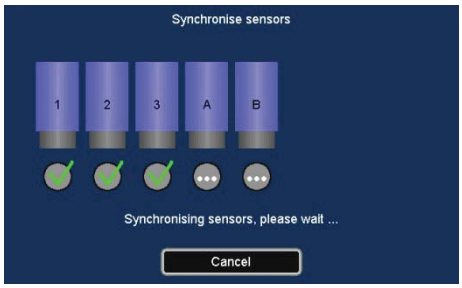
Add all the required sensors to the Correlator's Multi sensor pool:

Step	Description
1	In the Start menu, navigate to the required Offline measuring mode using the arrow buttons.
2	In the main menu, tap the button .
3	In the displayed menu, tap the **Sensor management** button.
4	In the displayed menu, tap the **Edit/Manage** button.
5	Use the displayed menu to register all sensors which are to be used. If Power transmitters are to be used, they have to be added here as well. A maximum of 8 sensors is possible. 
6	Use the **ESC** pushbutton to return to the Start menu.

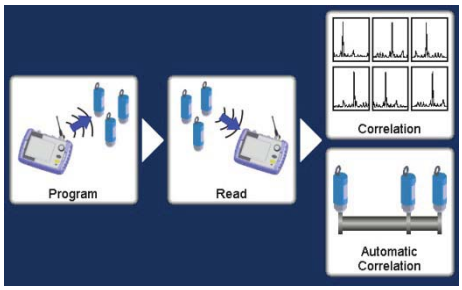
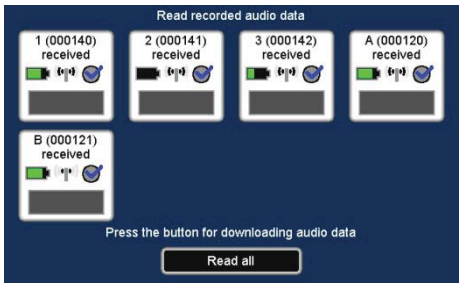
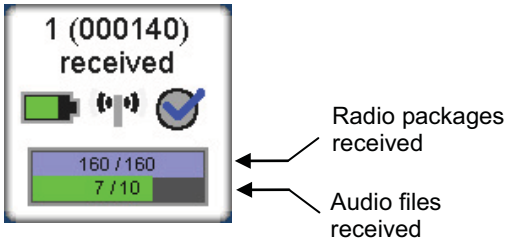
Programming and deploying sensors

Configure the sensors for the measurement:

Step	Description
7	All sensors must be turned on.
8	In the Start menu, select the required Offline measuring mode.
9	In the displayed menu, tap the **Program** button. 
	Result: In the displayed menu, the up to 8 fields represent the sensors of the Correlator's sensor pool. 
10	Select the sensors that shall be programmed. Tap the appropriate field to enable/disable the checkbox. Only "enabled" sensors will be programmed and can be part of the measurement. 
11	Tap the **Program and Synchronize** button.

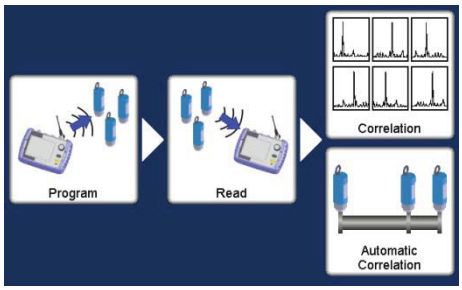
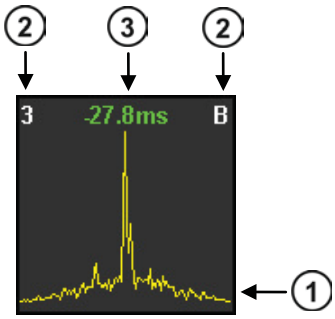
Step	Description	
12	In the menu displayed, decide whether the measurement shall be carried out immediately or at a later time. Tap one of the two buttons:	
	Instantaneous measurement (Explanation: measurement takes 2min30sec and starts directly after the sensors have been deployed)	**Custom measurement** (Explanation: Start and end time of the measurement are set by the user)
13	Use the **Time offset** field to specify the period of time which it will take to deploy the sensors at the individual measuring points. The entered time span will later be used as a "countdown to measurement".	Use the **Start of measurement** field to specify when the measurement shall start. Use the **End of measurement** field to specify when the measurement shall be finished.
14	Tap the **OK** button.	Tap the **OK** button.
	Result: The sensors are programmed and synchronized successively. The progress of the operation is shown on the screen.  When the operation is completed, a countdown appears on the screen showing the time remaining before the measurement starts.	
15	Deploy the sensors at the measuring points.	Deploy the sensors at the measuring points.
	Result: Once the countdown reached zero, the sensors start measuring. A new countdown of 2min 30sec is displayed on the Correlator screen representing the total time of the measurement. During this time, the sensors simultaneously record 10 audio blocks, each of 3 seconds length. Once the countdown reached zero, the measurement is completed.	**Result:** The sensors start measuring at the programmed time. A new countdown is displayed on the Correlator screen showing the time remaining until the programmed end of measurement. During this time, the sensors simultaneously record 10 audio blocks, each of 3 seconds length. Once the countdown reached zero, the measurement is completed.
16	When the measurement is completed, collect the sensors. **NOTE** **Do not switch off the sensors.** **Otherwise the recorded data would be lost.**	

Reading out data To read the measuring data from the sensors, proceed as follows:

Step	Description	
1	In the Start menu, select the required Offline measuring mode.	
2	In the displayed menu, tap the **Read** button.  	
	Result: The Correlator successively contacts all sensors. Thereby, the devices are synchronized again. Then, the following menu appears:  	
3	If you want to read the audio files of all sensors, tap the **Read all** button.	If you want to read just one sensor, tap the field of the sensor in question.
	Result: The audio files are successively transferred. The progress of the operation is shown in the individual fields.  	

Use the **ESC** pushbutton to return to the Start menu.

Correlation

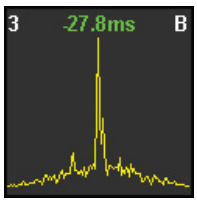
Step	Description
1	In the Start menu, select the required Offline measuring mode.
2	In the displayed menu, tap the **Correlation** button. 
	Result: A "Multi correlation" is carried out, which means that the values of all sensors are correlated with each other. The process can take some seconds. Subsequently, the correlation results for all sensor pairs are shown in thumbnails. 

Element	Description
1	Correlation curve
2	Sensor numbers of the two devices whose data are correlated.
3	Time distance from the middle of the pipe line to the leak. The color of the digit indicates the quality of the correlation. green … good correlation, clear result yellow … no clear result red … bad correlation; no leak or no clear lokalization possible negat.value … the leak is on the left from the center point posit. value … the leak is on the right from the center point

Rate correlations

The Multi correlation gives you an overview of the noise situation along the measured pipeline. In the ideal case, the pipe sections where leaks are most likely can be identified at a glance.

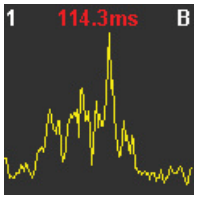
Rate the displayed correlations.



"Good correlation"

- clear peak
- lag value is green
- lag value is not zero

Probability of a leak is high



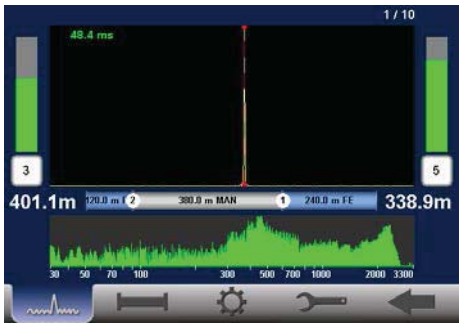
"Bad correlation"

- more than one peak
- lag value is yellow or red
- lag value is zero or nearly zero

No leak or no clear localization possible

If the Multi correlation shows at least one "good correlation" with one clear peak, the probability of a leak between the respective sensors is high.

Take a closer look at the good correlations. Tap the relevant thumbnail. The Correlation menu for this sensor pair is opened.



To be able to calculate the distance to the leak the properties of the pipe have to be specified.

How to proceed if there are pipe data

You can call the Pipe data menu directly and enter the parameters for the pipe between the two sensors.

However, we recommend instead to switch to the **"Map"** menu now. This menu offers a good overview of the used sensors and the sections of the pipe. The Map menu can not only be used to specify the pipe parameters for all pipe sections, but also to carry out more correlations. You find detailed information about the Map function in a separate section of this manual.

How to proceed if there are no pipe data

If there is no complete pipe data available, you have the chance to switch now to the **"Velocity measurement"** menu.

This menu is for:

- Calculating the distance between a sensor and the leak, although material and diameter of the pipe are unknown.
- Calculating the sound velocity in the pipe. The value can then be adopted for further correlations.

You find detailed information on how to use the Velocity measurement function in a separate section in this manual.

9 "Map" function

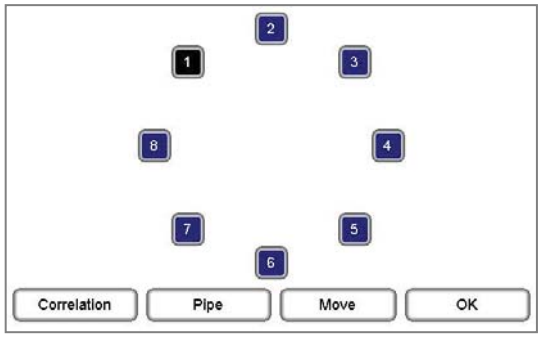
The Map function is a very clear and comfortable way to work with Offline Measurement data.

In the Map menu, the existing pipe network can be reproduced on the screen. The sensors used are shown as icons. Pipelines can be drawn between these icons and the pipe parameters can be specified.

As soon as the network is drawn, the correlation of every possible sensor pair can be started and displayed.

Access the Map

To access the Map menu, proceed as follows:

Step	Description
1	In the main menu, tap the button .
2	In the displayed menu, tap the **Map** button.
	Result: The following menu is opened.  The square boxes represent the Multi sensors (1 to 8) or Power transmitters (A + B) used in the measurement. The icons can be arranged realistically to each other by hand or, if the GPS coordinates of the measuring points have been determined and stored with the Correlator, at the touch of a button.

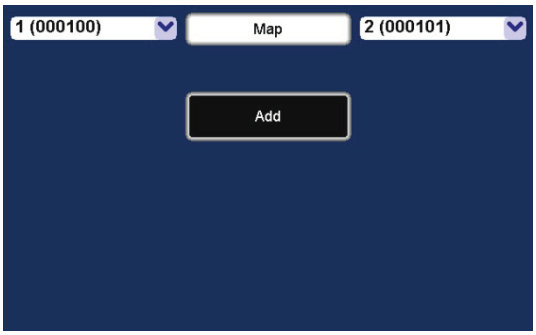
Arrange sensor icons

The sensor icons can be moved and repositioned on the screen. (Only possible via touch screen, not possible via rotary encoder).

Proceed as follows:

Step	Description
1	Tap the **Move** button.
2	Tap and move the sensor icons on the screen. If GPS coordinates of the measuring points have been stored, you can use the **GPS** button to arrange the sensor icons automatically.
3	Conclude with **OK**.

Draw pipelines To draw, change or delete pipelines in the map, proceed as follows:

Step	Desccription
1	Tap the sensor icon which represents the start point of the line.
2	Tap the sensor icon which represents the end point of the line.
3	Tap the **Pipe** button.
	Result: If there is no line between the two sensors in question so far, first the following screen appears. There, tap the **Add** button. 
	Result: The Pipe data menu is opened.
5	You can devide the displayed pipeline into individual sections if the line between the sensors is not consistently of the same material or diameter. Use the buttons **Add** and **Delete** to create or remove pipe sections. To select a section, tap directly on the relevant section in the graph or use the two arrow keys. The currently selected section is underlined white.
6	Enter the pipe data (material, diameter, length) for each pipe section.

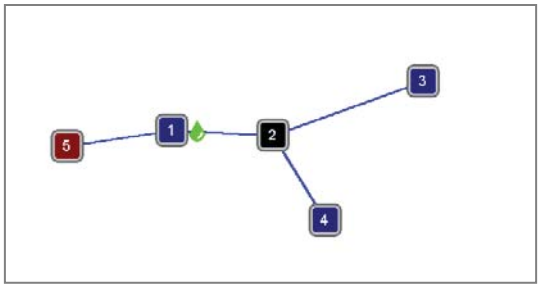
Use the Back button to return to the Map menu.

Show Leak Once the pipe net in the map is created, the correlation calculations for all sensor pairs are automatically updated in the background.

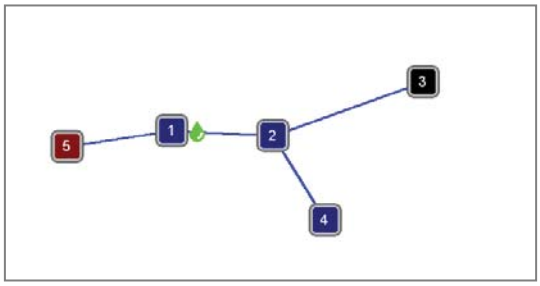
You can display the calculated leak between two sensors in the map. Proceed as follows:

Step	Description
1	Tap the first sensor.
2	Tap the second sensor.
	Result: The leak position is marked on the map with a drop icon, provided the correlation between the two sensors in question found a leak noise.

Example: The correlation of the line from sensor 5 to 2 results in a leak at the marked position.

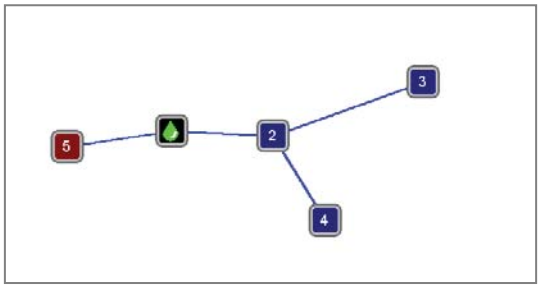


The correlation of the line from sensor 5 to 3 results in a leak at the very same position.



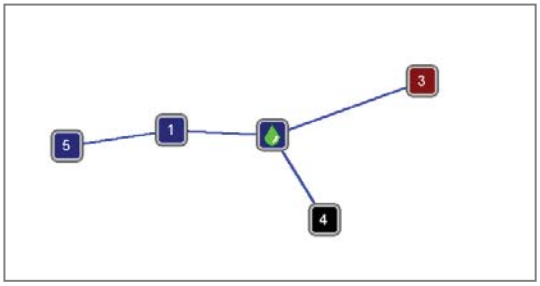
The correlation of the line from sensor 5 to 1 shows the drop icon right at sensor 1.

This indicates either that the leak is right at sensor 1 or that the leak is near sensor 1 but outside the correlated pipeline section.

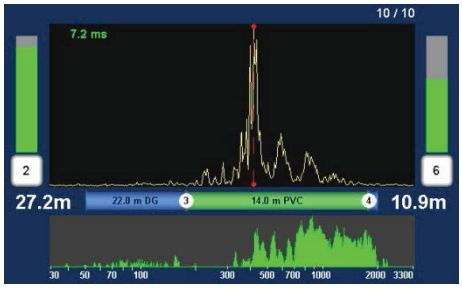


The correlation of the line from sensor 3 to 4 shows the drop icon right at sensor 2.

This indicates either that the leak is right at sensor 2 or that the leak is near sensor 2 but outside the correlated pipeline section.



Start correlation To start the correlation between two sensors, proceed as follows:

Step	Description
1	Tap the first sensor (start point of the pipeline section to be correlated).
2	Tap the second sensor (end point of the pipeline section to be correlated).
3	Tap the **Correlation** button.
	Result: The Correlation menu is opened and the correlation curve is displayed. 

Use the various analysis tools:

- When you tap the displayed correlation curve, the **Correlation analysis menu** with the relevant tools opens.
- When you tap the displayed coherence curve, the **Frequency analysis menu** with the relevant tools opens.
- When you tap the buttons that symbolize the sensors at the measuring points (e.g. 2 and 6), the **Audio menu** opens which can be used to listen to the stored leak noise. For that, connect the delivered headphones to the **12 V DC** socket of the Correlator.

Use the Back button to return to the previous menu.

Some settings for calculating and presenting the correlation curve can be changed in the system settings.

10 Sound velocity measurement

The Correlux C-3 system can be used to perform a sound velocity measurement in order to determine the actual speed of sound in a pipe section.

This function is useful when no reliable information on the pipe material is available for a pipe section or the entire measurement area. The calculated sound speed is then accepted by the Correlator and used for the correlation.

The calculation of the speed of sound is possible in both the Online measurement as well as the Offline measurement mode.

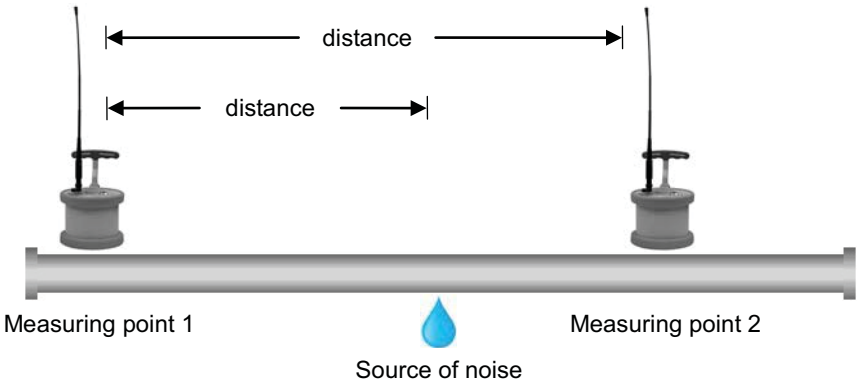
10.1 Velocity measurement in Online measurement mode

The **Velocity measurement** function compares the measuring values of the Power transmitters while they are recording the noise from one specific source. The sound velocity in the pipe is calculated using the sound delay.

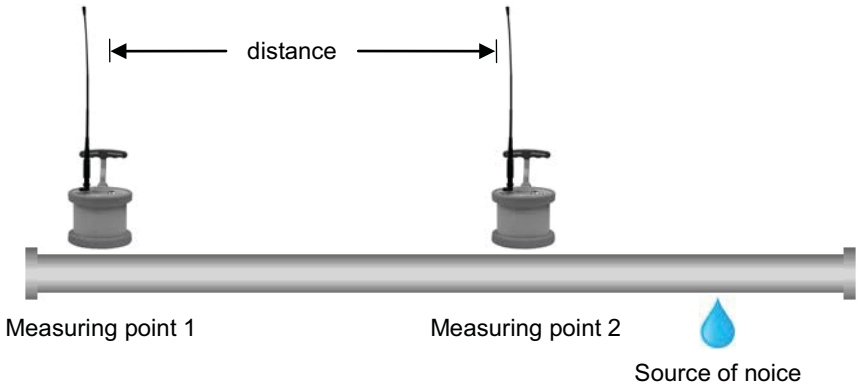
There must be a source of noise on the pipe, which is clearly measurable for both sensors. If such a noise source does not exist, it must be created artificially, for example, by opening a fire hydrant.

Requirements The following conditions must be met in order to use the function:

- Two Power transmitters (PT-A and PT-B) at two measuring points.
- The distance between the two measuring points must be known.
- The noise must be clearly measurable for both sensors.
- The source of noise may be inside or outside the measuring section.
- The source of noise should not be half way between the measuring points.
- If the source of noise is inside the measuring section, the distance from the first measuring point to the sound source must be known.

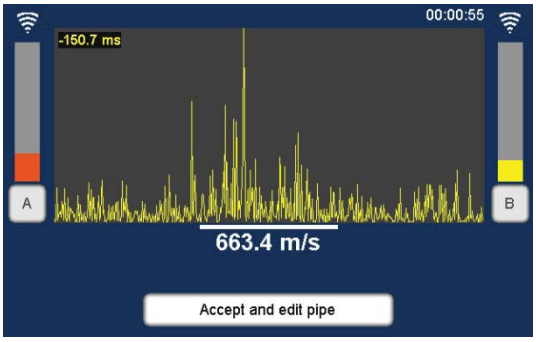


- If the source of noise is outside the measuring section, the measuring points and sound source must be arranged as shown on the following picture.



Procedure Proceed as follows:

Step	Description	
1	Position the Power transmitters at the measuring points, attach the sensors (microphones/hydrophones) and switch the devices on. There must be radio contact between the Power transmitters and the Correlator. (If there is a connection, the two battery symbols in the Correlator's Start screen reproduce the Power transmitters' battery level. Question marks are shown if the Power transmitters are not available.)	
2	Make sure the required sound source does exist.	
3	use the two arrow buttons to go to the required Offline measuring mode ("COR PT-3").	
4	In the main menu, tap the button .	
5	In the displayed menu, tap the **Tools** button.	
6	In the displayed menu, tap the **Velocity measurement** button.	
	Result: The corresponding menu opens.	
7	Specify whether the source of noise is inside or outside the measuring section. Tap the appropriate button: ↙ **Leak outside sensors** ↘ **Leak between sensors**	
8	Specify the length of the measuring section. Tap the **Distance between sensors** button.	Specify the length of the measuring section. Tap the **Distance between sensors** button.
9		Specify the distance from the first measuring point to the sound source. Tap the **Distance from left sensor** button.

Step	Description
10	Tap the **OK** button.
	Result: The correlation starts. The sound velocity in the pipe is calculated and displayed below the correlation curve.  The result is considered reliable if the following criteria are met: • The radio signal from both transmitters is good or excellent. • The lag value (top left of the diagram) is green and seems plausible. • The displayed sound velocity seems stable and plausible If no reliable result is shown, you can use the **Cancel** button to terminate the measurement and leave the menu.
11	Tap the **Accept and edit pipe** button.
	Result: The Pipe data menu opens. There, for the Material and Diameter input fields, the “Manual” option is automatically selected. The recently calculated sound velocity is accepted and shown in the corresponding field. Once the length of the pipe section is changed in this menu, the sound velocity measurement must be performed again.

Use the Back button to return to the Start menu.

Use the button to start a new correlation between the Power transmitters. The determined sound velocity will be used for the calculation. This applies until the pipe parameters are changed in the Pipe data menu, or the entire correlation data are reset in the Settings menu.

10.2 Velocity measurement in Offline measurement mode

10.2.1 Introduction

The **Velocity measurement** function compares the measuring values of three sensors which have recorded a shared noise. As a result, the following applications are possible:

Application options

Determining the sound velocity in the pipe
(for an unknown pipe material)

The actual sound velocity in the pipe is calculated.

This value can then be adopted for the pipe section being analysed as a pipe parameter.

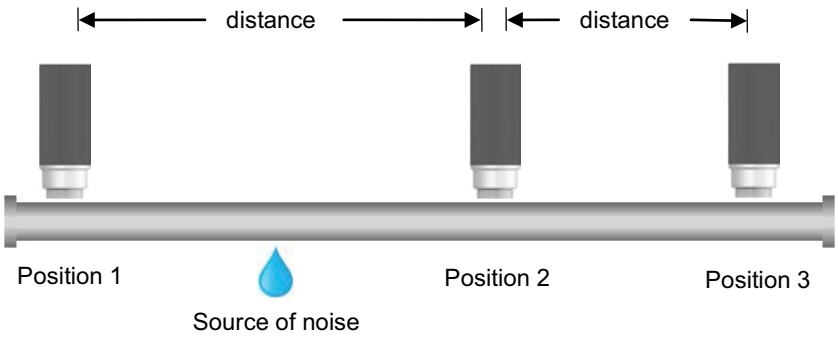
The correlation curve will be updated on this basis.

Determining the position of a leak
(despite unknown pipe material)

The distance from a certain measuring point to the leak position is calculated.

Requirements The following conditions must be met in order to use the function:

- A measurement (night or instantaneous measurement) with at least 3 sensors has been performed.
- The measured data has been read and saved with the Correlator.
- Between the three considered sensors exists a clearly perceptible source of noise. (The louder the noise, the lower are the negative effects of any potential interference on the result of the sound velocity calculation).
- The lengths of the pipe sections between the measuring points must be known.
- The measuring points and sound source must be arranged as shown on the following picture.

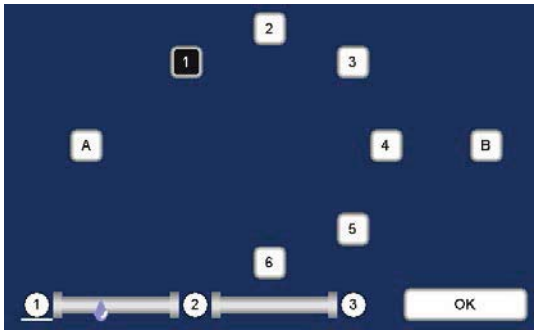
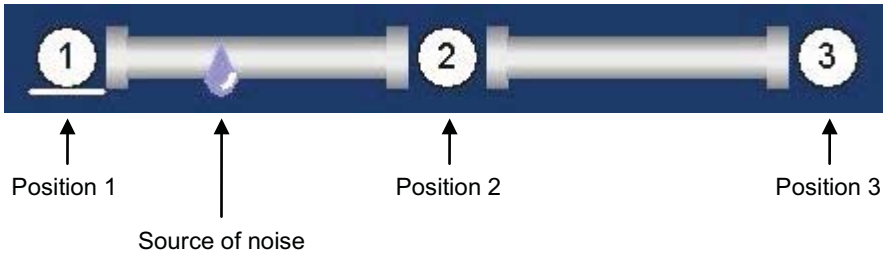


There must be one sensor „in front of“ the sound source (Position 1).

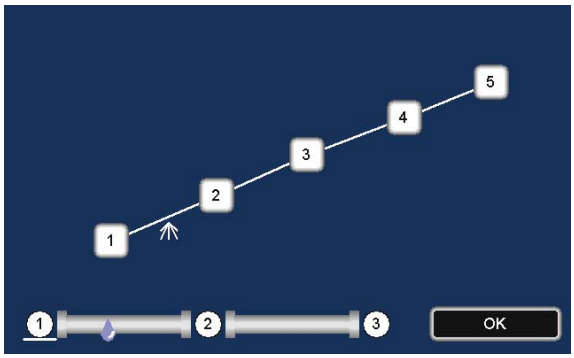
There must be two sensors “behind” the sound source (Positions 2 and 3).

10.2.2 Determining the sound speed

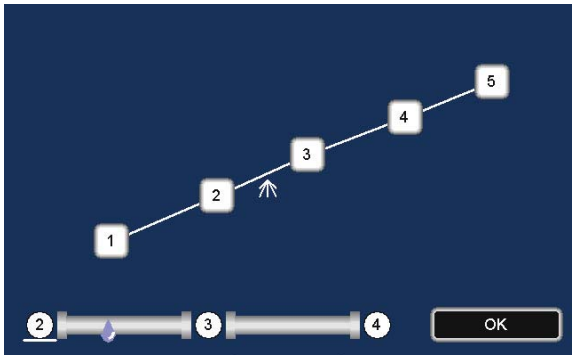
To calculate the sound velocity in the pipe, proceed as follows:

Step	Description
1	In the Start menu of the Correlator, use the two arrow buttons to go to the required Offline measuring mode (“COR MS-3”).
2	In the main menu, tap the button .
3	In the displayed menu, tap the **Tools** button.
4	In the displayed menu, tap the **Velocity measurement** button.
	Result: The following menu opens.  The square boxes represent the Multi sensors (1 to 8) or Power transmitters (A + B) used in the measurement. The scheme below illustrates how the sensors must be positioned in relation to the source of noise. Take care to follow this scheme when selecting the three sensors for the measurement. Otherwise the result of the calculation may be wrong. 
5	Select the sensor which represents Position 1 (sensor “in front of” the sound source) by tapping the required box.
	Result: The number of the selected sensor is shown at position 1. The white highlighting switches to position 2.
6	Select the sensor which represents Position 2 (first sensor “behind” the sound source).
7	Select the sensor which represents Position 3 (second sensor “behind” the sound source).
8	Tap the **OK** button.

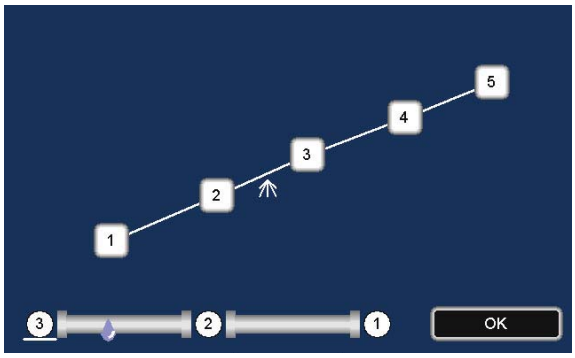
Example 1: The source of noise is located between the sensors 1 and 2.
Entry on the Correlator: first, sensor 1 (in front of the sound source), then sensors 2 and 3 (behind the sound source).



Example 2: The source of noise is located between the sensors 2 and 3.
Possible entry on the Correlator: first, sensor 2, then sensors 3 and 4.



Possible entry on the Correlator: first, sensor 3, then sensors 2 and 1.



11 GPS position data

11.1 Introduction

You can use the Correlator to determine and store the GPS coordinates of the individual measuring points.

GPS data facilitate the management and analysis of the measured data in the Offline measurement. For some analysis capabilities GPS data are even a prerequisite.

Requirements The GPS receiver **LOG GPS-3** has to be connected to the Correlator.

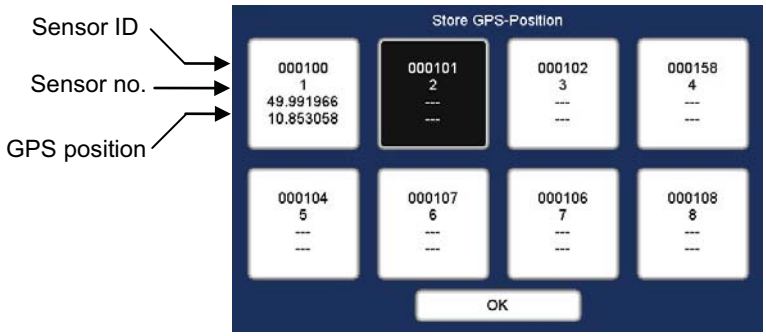
The GPS module is connected using the **USB/GPS** socket ⓬. Observe the markings on the plug and socket. You must feel the plug engage. The GPS module is powered via the USB connection. The device switches on immediately after connection and is ready for operation. The status LED lights up. The device is detected automatically by the Correlator. Further settings are not required.

11.2 Determine and save GPS coordinates

To determine the GPS position for a sensor, you must take the Correlator and proceed as close as possible to the installed device.

Proceed as follows:

Step	Description
1	In the main menu, tap the button .
2	In the displayed menu, tap the **Store GPS position** button.
	Result: The following menu is opened. The up to 8 fields represent the sensors registered to the Correlator's "Multisensor pool".



(continued on next page)

Step	Description
3	Tap the field of the sensor whose position is to be determined.
	Result: The GPS menu is opened. The GPS receiver is searching for available satellites. After a while, the current GPS time is displayed. As soon as the position of the Correlator can be calculated, the current latitude and longitude are specified. You can change the format for displaying the GPS position. Tap the **GPS format** button repeatedly to select one of the following formats: • Decimal degrees • Degrees, minutes • Degrees, minutes, seconds The vertical green bar at the right of the screen indicates how high the accuracy is with which the position can currently be determined.
4	Wait until the position has leveled out on a reliable value. The bar to the right should show an accuracy of 100%. The first time the position is determined after connecting the GPS module may take a little time. The Correlator should not be moved during this phase. It is best to put it down somewhere.
5	Tap the **Store** button.
	Result: The coordinates are accepted. The display returns to the previous menu.

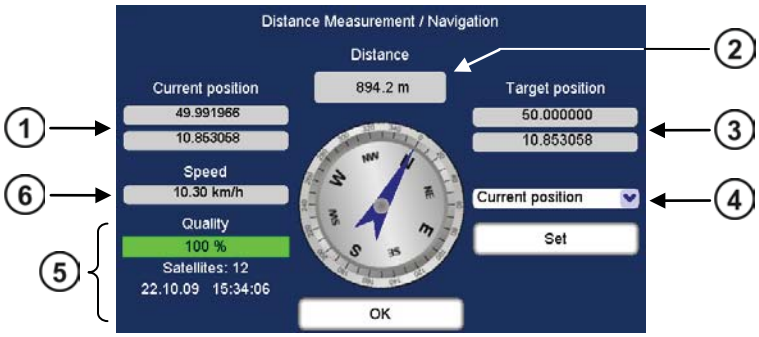
11.3 Distance measurement and navigation via GPS

You can use the GPS function of the Correlator to determine the distance between two points. You can also use the function as a guide to find a stored measuring point.

Access the menu To open the GPS menu, proceed as follows:

Step	Description
1	In the main menu, tap the button .
2	In the displayed menu, tap the **Tools** button.
3	In the displayed menu, tap the **Distance measurement / Navigation** button.

The menu is structured as follows:



Element	Description
1	**Current position** Indicates the current position of the Correlator. Once the Correlator is moved, the displayed value is adapted.
2	**Distance** Indicates the linear distance between the Current position and the Target position.
3	**Target position** Indicates the GPS position of the point, which was defined as Target position.
4	**Sensor list** List of all sensors, i.e. measuring points, whose GPS coordinates have been determined and stored. One of these sensor installation points can be selected and specified as Target position.
5	top down: Positioning accuracy for the Correlator position (in percent). Number of available GPS satellites. The current GPS date and GPS time.
6	Speed at which the Correlator is currently moved.

Distance from here to a measuring point

You can calculate the distance from your current position to a stored measuring point.

In the drop-down list ④, select the sensor which is installed at the relevant measuring point.

The GPS coordinates of the measuring point are adopted and displayed as the new Target position. The distance information is updated and displays the distance between the Correlator and the measuring point.

Distance from here to any location

You can calculate the distance from your current position to any other location.

Proceed as follows:

Step	Description
1	In the drop-down list ④, select **Current position**.
2	Tap the **Set** button.
	Result: The GPS coordinates of your current location are adopted and displayed as the new Target position.
3	Take the Correlator and proceed to the desired other location.
	Result: The distance information is permanently updated and displays the distance from your current location to the Target position.

Navigating to a location

You can use the directional sign of the GPS menu to guide you to a measuring point.

Proceed as follows:

Step	Description
1	In the drop-down list ④, select the sensor which is installed at the relevant measuring point.
	Result: The GPS coordinates of the measuring point are adopted and displayed as the new Target position.
2	Go into the direction the compass needle shows. The target location is reached when the "Current position" coordinates match the "Target position" coordinates. The direction specified by the compass needle is reliable, as long as you are in motion, but once you stand still at a place, the needle begins to rotate and the direction shown is no longer reliable.

Tento symbol indikuje, že výrobek nesoucí takovéto označení nelze likvidovat společně s běžným domovním odpadem. Jelikož se jedná o produkt obchodovaný mezi podnikatelskými subjekty (B2B), nelze 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 působiště.

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 изхърля и в градски пунктове за отпадъци. Ако желаете да извърлите 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 bortskaffes på offentlige genbrugsstationer. Skal dette produkt kasseres, skal det gøres ordentligt ved at bringe det til en nærliggende organisation, der er specialiseret i at bortskaffe gammelt el-udstyr.

Sellise sümboliga tähistatud toodet ei tohi käidelda tavalise olmejäätmena. Kuna tegemist on B2B-klassi kuuluva tootega, siis ei tohi seda viia kohalikku jäätmekäitluspunkti. Kui soovite selle toote ära visata, 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 viedä kuluttajien käyttöön tarkoitettuihin keräyspisteisiin. Jos haluatte hävittää tämän tuotteen, ottakaa yhteys lähimpään vanhojen sähkölaitteiden hävittämiseen erikoistuneeseen organisaatioon.

Ce symbole indique que le produit sur lequel il 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 nár cheart an táirgeadh atá marcáilte sa tslí seo a dhiúscairt sa chóras fuíoll teaghlaigh. Os rud é gur táirgeadh ghnó le gnó (B2B) é, ní féidir é a dhiúscairt ach oiread in ionaid dhiúscartha phobail. Más mian leat an táirgeadh seo a dhiúscairt, déan é a thógáil ag eagraíocht gar duit a sainfheidhmíonn i ndiúscairt sean-fhearas leictrigh.

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 σήμανση αυτή δεν πρέπει να απορρίπτεται μαζί με τα οικιακά απορρίματα. Καθώς πρόκειται για προϊόν B2B, δεν πρέπει να απορρίπτεται σε δημοτικά σημεία απόρριψης. 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 terméket tilos a háztartási hulladékokkal együtt kidobni. Mivel ez vállalati felhasználású termék, tilos a lakosság számára fenntartott hulladékgyűjtőkbe dobni.Ha a terméket ki szeretné dobni, akkor vigye azt el a lakóhelyéhez közel 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.

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

Šis simbolis rodo, kad juo 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'għandux jintrema bħal skart normali tad-djar. Minħabba li huwa prodott B2B , ma jistax jintrema wkoll f'ċentri ċiviċi għar-rimi ta' l-iskart. Jekk tkun tixtieq tarmi dan il-prodott, jekk jogħġbok għamel dan kif suppost billi tieħdu għand organizzazzjoni fil-qrib li tispeċjalizza fir-rimi ta' tagħmir qadim ta' l-elettriku.

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 nim opatrzonego 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 deitado fora juntamente com o lixo doméstico normal. Como se trata de um produto B2B, também não pode ser deitado 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 şi un gunoi menajer obişnuit. Deoarece acesta este un produs B2B, el nu trebuie aruncat nici la centrele de colectare urbane. Dacă vreţi să aruncaţi acest produs, vă rugăm s-o faceţi într-un mod adecvat, ducând-ul la cea mai apropiată firmă specializată în colectarea echipamentelor electrice uzate.

Tento symbol znamená, že takto označený výrobok 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 gospodinjske 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 električne opreme.

Este símbolo indica que el producto así señalizado 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 desechar 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 avfallshantera den här produkten på rätt sätt, ska ni lämna den till myndighet eller företag, specialiserad på avfallshantering av förbrukad elektrisk utrustning i ert närområde.