LD6000

EN

OPERATING MANUAL

COMBINATION DETECTOR

TROTEC

AT WORK.

TRT-BALD6000-WM-04-EN

Table of Contents

This measuring device was designed and manufactured in line with the latest technological advancements and complies with the requirements as laid down in existing European and national guidelines. Conformity has been certified. The relevant declarations and documents are in the manufacturer's possession.

As the user you must read and adhere to the following safety instructions in order to ensure that this condition is maintained and that no danger results from the use of this device:

1. Safety Instructions

We do not accept any liability for any damages which might occur as a result of improper use or the non-observance of these instructions. The guarantee expires with immediate effect in such cases!

⚠ These instructions must be read in full before the device is put into operation for the first time!

For reasons of safety and CE compliance you may on no account carry out any changes or modifications on either the device itself or any other components which may be used in connection with this measuring device!

The following instructions must be adhered to before the device is taken into use:

- *Do NOT carry out measurements on live components.*
- *Please observe the measuring range of the measuring sensor.*
- *Please observe the operating and storage conditions.*
- *Do NOT immerse the sensor head of the hydrogen sensor in standing water or any other liquids and do not dip into sludge or any sludge-like substances.*
- *Do NOT bring the sensor head of the hydrogen sensor into contact with fine powder or powdery substances.*
- *The user is solely responsible for determining whether he or she considers the measuring results to be valid and for any conclusions that are reached or any measures that are taken as a result thereof. We can neither guarantee the validity of any measuring results nor can we accept liability for any such results. We are on no account able to accept liability for any damage which may be caused as a consequence of the use of these measuring results.*

2. Intended Use

The LD6000 is a combo detector designed to allow the user to carry out electroacoustic leak detection in pipe systems and to perform non-destructive pinpoint leak detection in systems which have been previously flooded with trace gas using the indicative measurement of different hydrogen concentrations.

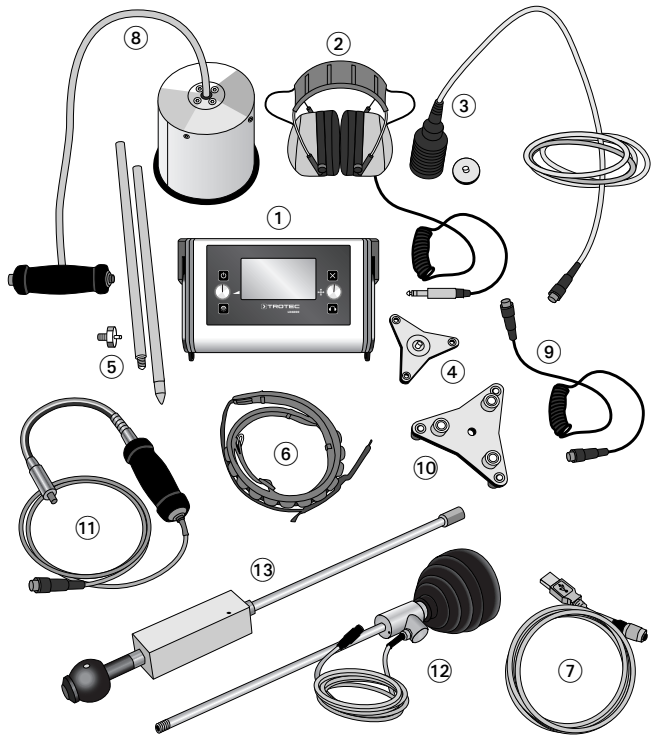
The device may be used for this purpose only and only within the technical data parameters as specified.

Any other use is considered to be not intended for this purpose.

In accordance with the EU (European Union) Directives on Waste Electrical and Electronic Equipment (WEEE), electronic equipment must not be treated as domestic waste, but must be disposed of professionally in accordance with Directive 2002/96EU of the EUROPEAN COUNCIL AND PARLIAMENT of 27 January 2003 regarding old electrical and electronic equipment.

Please dispose of this appliance in a manner appropriate to the relevant legal requirements at the end of its product life.

3. Scope of Delivery



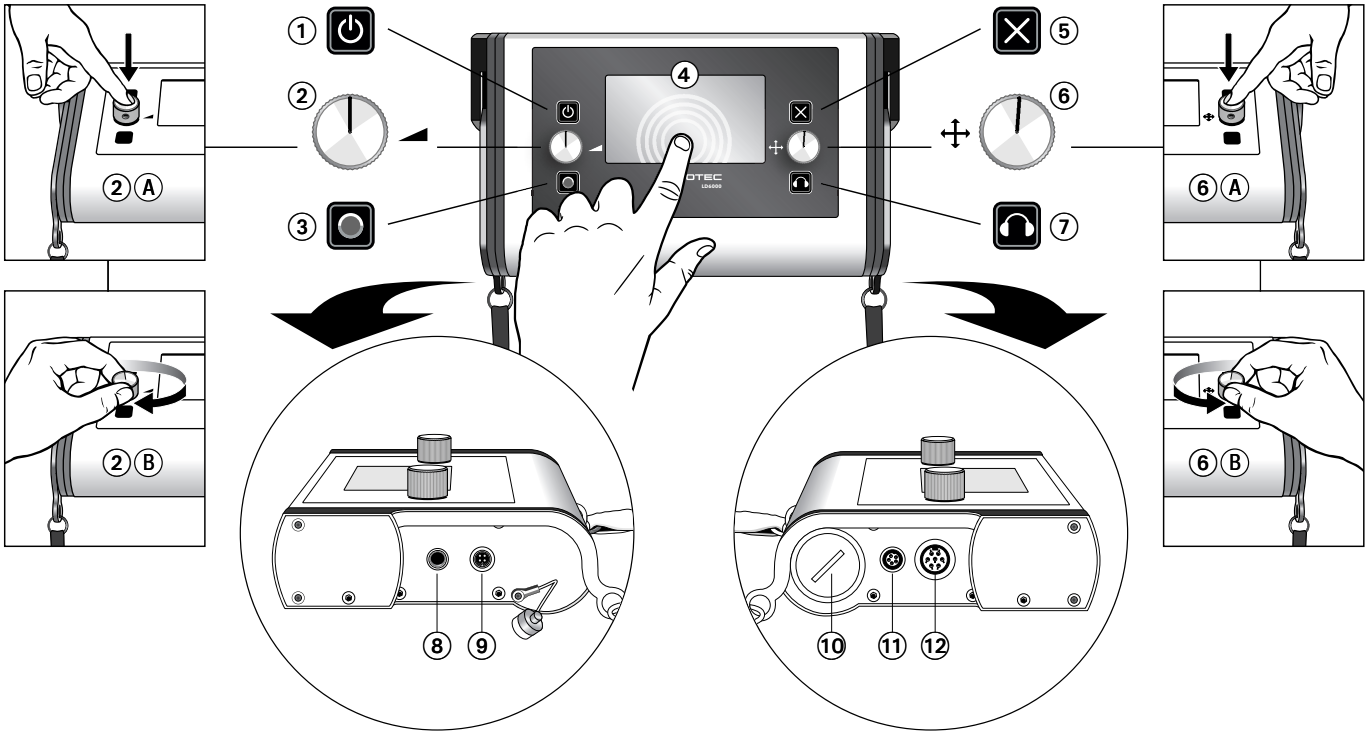
The following components are included in the standard scope of delivery:

- LD6000 measuring device ❶
- LD K – sound blocking headphones ❷
- LD6000 BM – universal microphone with magnet adapter ❸
- LD6000 DA – tripod adapter ❹
- LD6000 VL – stick extension with tip ❺
- LD6000 TG – shoulder strap ❻
- PC connecting cable, USB ❼
- LD6000 carry case

The following components are available as optional accessories:

- LD6000 BMW – wind protected ground microphone (with dead-man's button) ❽
- LD6000 VK – connecting cable ❾
- LD6000 BMW DA – tripod adapter for LD6000 BMW ground microphone ❿
- LD6000 H2 – hydrogen hand sensor ⓫
- LD6000 H2 – hydrogen ground sensor with integrated pump ⓬
- LD6000 H2 pump kit – for upgrading ground sensors without pumps ⓭

4. Control Elements and Connecting Ports



❶ On/Off key

❷ Left-hand volume dial

This dial has two functions: you can either press ❷ **A** or turn ❷ **B** the dual function dial. Turn the dial to adjust the volume of your headphones while measuring is being carried out. Press the dial to clear the current measurement series.

❸ Record button

❹ Touch display

You can also use the high resolution colour touch screen to carry out adjustments to the measuring device in place of the dial.

❺ Cancel key

❻ Right-hand navigation dial

This dial has two functions: you can either press ❻ **A** or turn ❻ **B** the dual function dial.

Turn the dial to access menu and setting functions and to specify selected settings. Press the dial to confirm selections and settings. The **navigation dial on the right** can also be used to execute a variety of settings which will be dealt with more closely in the following chapters.

❼ Headphone key

❽ Headphone jack

❾ Connection for PC cable

❿ Screw-on battery compartment lid

⓫ LD6000 H2 hydrogen sensor connecting port

⓬ Microphone jack

5. Powering Up and Operating the Device

5.1. Microphone Jack and Sensor Port

First place the batteries into the battery compartment of the LD6000 and connect all the components which you require to perform your specific measuring operation.

Headphones:

Connect the headphones to the headphone jack of the LD6000 if necessary *(see chapter 4, legend item ❽)*. Use the supplied LD K headphones only.

The headphones have been designed specifically for use with the LD6000 and for carrying out acoustic leak detection. The state-of-the-art electronics incorporated in the high-quality hearing protector capsule ensure optimal results while providing excellent soundproofing qualities.

5.1.1. Connecting the Microphones for Acoustic Leak Detection

Please be sure to use one of the following microphones only when carrying out acoustic leak detection with the LD6000.

LD6000 BM universal microphone

The LD6000 BM is a universal microphone which can be either be used as a **probe microphone** or a **contact microphone**. Connect the LD6000 VL extension kit to the universal microphone and use as a probe microphone to pinpoint leaks or screw on the optionally available magnet and use as a contact microphone when carrying out leak detection where ferromagnetic pipes, for example, are involved. The contact microphone can then be used in connection with the LD6000 DA tripod adapter as a **ground microphone** to locate any potential leaks.

Using the LD6000 BMW Ground Microphone

The LD6000 BMW is a wind-protected ground microphone which can be used when carrying out leak detection on solid, stable surfaces. The LD6000 BMW can be combined with the LD6000 DM tripod magnet for use on loose or unstable surfaces.

Depending on the type of acoustic measurement, the microphones can be connected to the LD6000 as follows:

The LD6000 BM as a Ground Microphone:

Connect the LD6000 DA tripod adapter to the base of the LD6000 BM and connect the microphone to the microphone jack *(see chapter 4, legend item ⓬)* of the LD6000.

The LD6000 BM as a Contact Microphone:

Connect the magnet base to the base of the LD6000 BM and connect the microphone to the microphone jack *(see chapter 4, legend item ⓬)* of the LD6000.

The LD6000 BM as a Probe Microphone:

Connect the tip of the LD6000 VL to the base of the LD6000 BM either with or without the extension piece and connect the microphone to the microphone jack *(see chapter 4, legend item ⓬)* of the LD6000.

LD6000 BMW Ground Microphone:

Connect the LD6000 DM tripod magnet to the base of the LD6000 BMW if necessary. Connect the LD6000 VK connecting cable to the microphone and plug the microphone into the microphone jack *(see chapter 4, legend item ⓬)* of the LD6000.

5.1.2. Connecting the Hydrogen Sensor for Trace Gas Detection

The LD6000 H2 hydrogen sensor can be connected to the LD6000 to carry out non-destructive leak detection in systems that have previously been flooded with trace gas. Connect the sensor to the hydrogen sensor port *(see chapter 4, legend item ⓫)* of the LD6000.

You will find instructions on how to carry out measuring in chapter 9 and further practical information guidelines regarding the use of trace gas in leak detection in chapter 15.2.

5.2. Powering On and Off

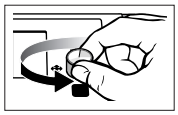
Press the On/Off key to **power on** *(see chapter 4, legend item ❶)*. The start screen appears and changes to the main menu as soon as the measuring device is ready for use.

Press the On/Off key and hold for approx. 3 seconds to **power off** *(see chapter 4, legend item ❶)*.

6. Navigation and Menu Structure

6.1. Navigation

The LD6000 has a number of menu and selection boxes which you can select by either using the touch screen or the **navigation dial on the right**. When using the touch screen, simply briefly place your finger on the menu or selection box you wish to select.



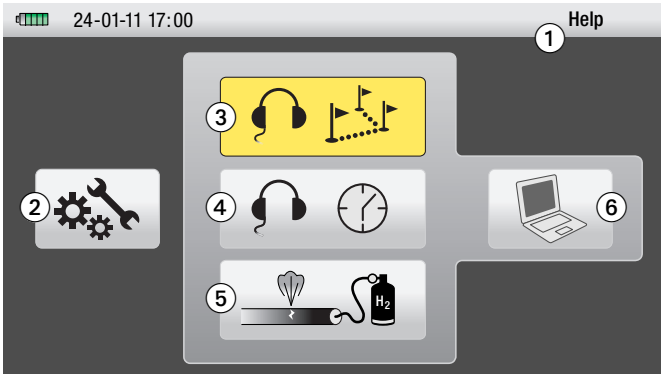
You can also turn the dial either clockwise or anticlockwise continuously to go through all the menu or selection boxes in order to get to the box you wish to select.

Active menu items or selection boxes are highlighted in yellow.

Press the dial when you are finished to confirm your selection. The menu or selection box which you have selected will now be shown.

Press the ***cancel key*** to leave the menu or selection box which is just being shown and return to the last command line which was confirmed.

6.2. Main Menu



You are in the main menu when you power on the LD6000 for the first time. You can navigate to the following sectors from there:

- Help menu ❶ *(chapter 6.3)*
- Setting menu ❷ *(chapter 6.4)*
- Measuring operation with acoustic leak and pipe detection ❸ *(chapter 7)*
- Measuring operation acoustic long term measurements ❹ *(chapter 8)*
- Measuring operation trace gas detection ❺ *(chapter 9)*
- PC data transfer ❻ *(chapter 11)*

Press ***menu*** in the upper screen bar or the ***cancel key*** to return to the main menu from the selected sector.

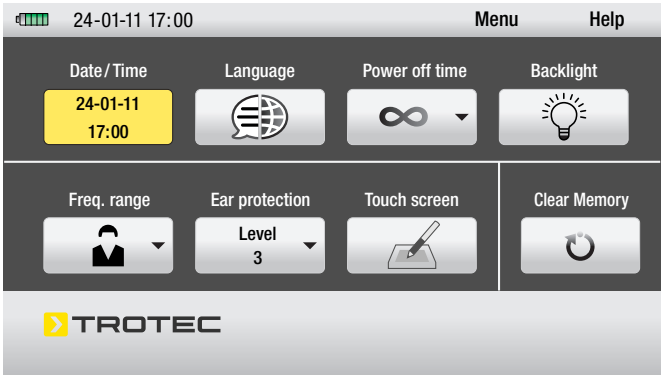
6.3 Help

The LD6000 is equipped with an integrated help function which can be accessed from either side. Navigate to the menu item ***Help*** in the upper menu bar as described in chapter 6.1. to get to the Help main page. Scroll to the Help topic which you would like to find out more about and confirm your selection by pressing the dial on the right to get to the help text you need.

Press the door symbol within the help sector to navigate back out of the help sector step by step. Return to the Help main page from a Help text by pressing the door symbol. Press the door symbol to return to the main menu from the Help main page.

Press the ***cancel key*** to leave the help sector immediately. You will then return to the main menu.

6.4. Settings



You can reach the menu ***Settings*** via the Settings symbol in the main menu.

Navigate to the settings you wish to select and carry out your selection in order to perform the following configurations:

6.4.1. Time and Date

Use the dial on the right to navigate to the selection field of your choice. The selection field you have chosen will be marked with a red border. Press the dial on the right to confirm your selection. The field you have selected is now active and highlighted in yellow.

Press the dial again or press the ***cancel key*** to deactivate the field you have selected.

When the selection field is active, you can enter a value by turning the dial on the right and pressing the dial to confirm that the value you have entered is correct. You can now navigate to the next selection field.

To enter the value via the touch screen, first press your finger against the selection field which you wish to activate and then enter the value using the number pad. Press OK to confirm that the value you have entered is correct and press DEL to clear the value.

Press the ***cancel key*** or the door symbol on the screen to leave the setting menu.

6.4.2. Languages

You can select from one of several display languages. Scroll down to the language you wish to select and press the dial on the right to conform your selection.

Press the ***Cancel key*** or the door symbol on the screen to leave the setting menu.

6.4.3. Power Off Time

You can conserve battery power by selecting a time between 1 and 60 minutes after which the device then automatically powers off when not in use.

Repeat the procedure as described in Time and Date *(see chapter 6.4.1.)* to enter the length of time you have selected.

6.4.4. Backlight

The brightness of the display can be adjusted from 0 to 100 % to suit your individual requirements. There is also a scale with three individual colour segments which show you just how much battery power the brightness setting you have selected consumes.

The batteries will last longest when the scale is green and used up fastest when the scale is red.

Turn the dial on the right to increase or dim the brightness and leave the menu by either pressing the dial or by pressing the ***cancel key*** or the door symbol on your screen.

6.4.5. Frequency Range

With the LD6000 a frequency range of 0 - 4,000 Hz can be analyzed. Each of the measuring modes that can be used during acoustic leak detection has both a selection of predefined filters as well as a selection of user-defined filters which can be configured in the setting window ***Frequency Range.***

The settings of the high pass filter (HP), the low pass filter (LP) and the maximum breadth of the colour spectrum can all be changed.

Repeat the procedure as described in Time and Date *(see chapter 6.4.1.)* to enter the configuration you have selected.

6.4.6. Hearing Protection

The LD6000 is equipped with an automatic sound absorber which ensures that hearing protection guidelines according to BGV B3 (formerly VBG 121) (BGV - Accident Prevention & Insurance Association) are complied with when used with the headphones included in the scope of delivery.

The noise protection intensity of the headphones can be adapted individually to suit the user. The intensity ranges from 0 (relatively low) to 3 (maximum). Each of the three stages complies with the requirements as laid down in VBG 121.

The configuration corresponds to the procedure for setting the time and date as described in chapter 6.4.1.

6.4.7. Touch Screen

You can use this setting window to deactivate the touch screen function or to carry out a calibration or performance check.

Use the dial on the right to navigate to the selection field of your choice and confirm your selection by pressing the dial.

If on/off has been selected, you can activate or deactivate the touch screen function respectively by pressing the dial.

To leave the setting menu either press the dial or press the ***Cancel key*** or the door symbol on the screen.

6.4.8. Clear Memory

You can clear two different memory values in this window setting.

Clear Memory clears all the values that have been saved into the device.

Clear Parameter Memory clears all the user-defined configurations for the high pass filter, low pass filter and the maximum breadth of the frequency spectrum in the window setting Frequency Range (see chapter 6.4.5.).

You can also use the touch screen to clear the memory or use the dial on the right to navigate to the selection field you have chosen before pressing the dial to confirm your choice. A tick symbol will appear to acknowledge that the memory has been cleared.

To leave the setting menu either press the dial or press the cancel key or the door symbol on the screen.

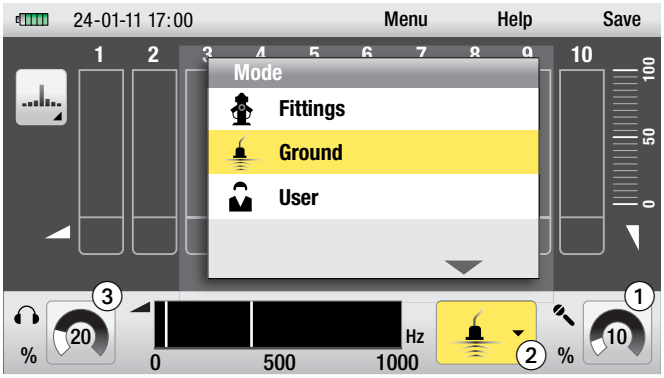
7. Acoustic leak and pipe detection

In order to be able to carry out acoustic leak detection with the LD6000, first activate the symbol for your acoustic leak detection measuring operation in the main menu and confirm your selection.

How to get to the display.

Your measuring device is preset to Smart mode. In addition to the Smart mode, you may choose to select the F&L (frequency and volume) and the V mode (level mode) or the pipe detection PULSE mode (acoustic pipe detection using the pulse wave generator). The individual measuring modes will be explained in detail in chapters 7.2 to 7.5.

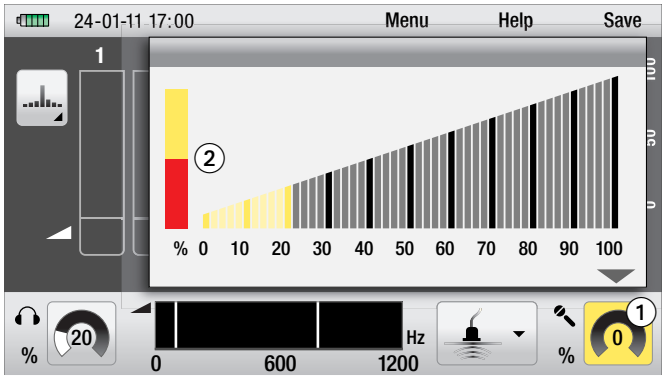
Regardless of the measuring mode you have selected, the following parameters can be set for all the measuring modes that can be used to carry out leak detection in the same consistent manner:



1. Sensor sensitivity setting
2. Selection of predefined filter settings
3. Volume setting

7.1. Parameter Settings in the Acoustic Modes

7.1.1. Manual sensor sensitivity adjustment



To set the sensitivity of the sensor which is connected to your leak detection device, navigate in the display window to the symbol for the sensor sensitivity setting ❶, activate the symbol and confirm your selection.

The sensor sensitivity settings window opens.

The microphone amplification factor that has been currently selected is displayed on a scale from 0 to 100 %. Turn the dial on the right or touch the touch screen and pull your finger to the sensitivity value which you would like to select.

The sensitivity value is ideal when the control bar ❷ on the left is half red, as shown. Press the *cancel key* to leave the window without changing the sensitivity value.

Press the dial on the right to confirm the new setting or press the *cancel key*. You can also confirm the setting change by pressing the symbol for the sensor sensitivity ❶ on the touch screen.

Important: The current measurement series will be cleared when any changes are carried out to the sensitivity settings!

The sensitivity value you have selected will either be displayed as a number or in the form of a tachometer in the symbol for the sensitivity setting ❶.

7.1.2. Automatic sensor sensitivity adjustment

In addition to the manual adjustment function, the LD6000 is also equipped with an automatic adjustment function which enables you to set the sensor sensitivity independently to the optimum setting.

To use this automatic function, navigate to the symbol for the sensor sensitivity settings in the display ❶, activate the symbol and confirm your selection.

The sensor sensitivity setting window ❷ opens.

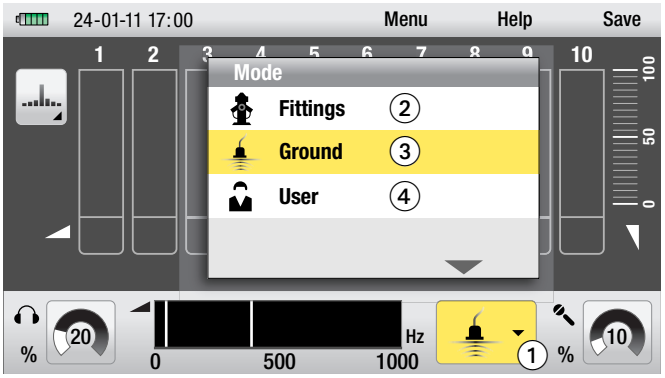
Press the *record button* and keep pressed until you hear a signal tone.

The acoustic signal tells you that the amplification has been automatically set to the optimum setting.

To close the settings window, press the right-hand dial or the *cancel key*. Alternatively you may close the window by pressing the sensor sensitivity setting symbol ❶ on the touchscreen.

7.1.3. Selecting the Filter Presetting

You can select one of three filters when carrying out acoustic leak detection. Each of the filters can be changed individually during measuring.



To select one of the predefined filter settings, navigate to the filter mode symbol ❶ on the display, activate the symbol and confirm your selection.

The window for the filter presetting selection opens.

There are three presettings to choose from:

- Fittings ❷

  There is a predefined frequency range from 0 to 2,000 Hz with a 200 Hz high pass filter and an 800 Hz low pass filter which are ideal for checking the status of fittings and hydrants.

- Ground ❸

  There is a predefined frequency range from 0 to 1,000 Hz with a 50 Hz high pass filter and a 400 Hz low pass filter which are ideal for checking the status of pipe runs. This is the factory default setting and therefore the setting when the device is put into operation for the first time.

- User ❹

  This presetting uses the filter range which you, the user, defined according to your own specific ***filter preferences*** *(see chapter 6.4.5)*. When this product leaves the factory the frequency range is from 0 to 1,200 Hz with a 100 Hz high pass filter and an 800 Hz low pass filter.

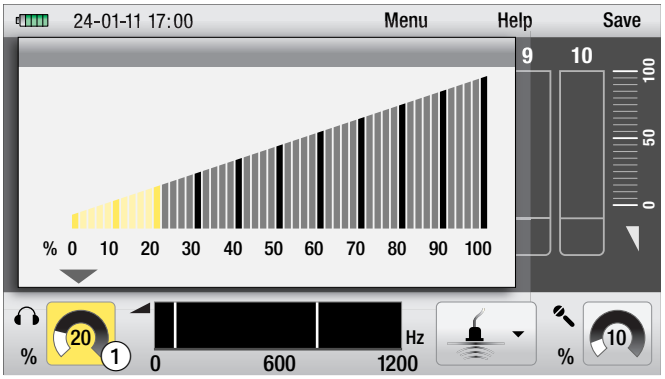
To carry out the setting, navigate in the window to the presetting ❷, ❸ or ❹ which you wish to select, activate the setting and confirm your selection by pressing the dial on the right. The window then closes and the symbol for the selected filter setting appears as the filter mode symbol ❶.

Press the *cancel key* to leave the window without changing the filter setting.

Important: The current measurement series will be cleared when any changes are carried out to the filter settings!

In addition to the predefined filters, you can change the predefined filter settings manually in all the measuring modes at any time between individual measurements while leak detection is being carried out. In order to do so, follow the instructions as described in chapter 7.7.

7.1.4. Volume Setting



You can adjust the volume of the headphones to suit your requirements. The volume does not depend on the predefined hearing protection intensity *(see chapter 6.4.6.)* which you may have selected.

The volume you have selected will either be displayed as a number or in the form of a tachometer in the symbol for the volume of the headphones ❶.

Changing the Volume Before or After Measuring:

To change the volume of your headphones before or after measuring, navigate in the window to the symbol for selecting the headphone volume ❶, activate the symbol and confirm your selection.

The window for selecting the headphone volume opens.

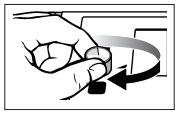
The volume that has been selected for your headphones is displayed on a scale from 0 to 100 %. Turn the dial on the right or touch the touch screen and pull your finger to the volume which you would like to select.

Press the *Cancel key* to leave the window without changing the volume setting.

Press the dial on the right to confirm the new setting or press the *Cancel key*. You can also confirm the setting change by pressing the symbol for the headphone volume ❶ on the touch screen.

A change in volume has no affect on the measuring curve and the current measurement series is not cleared.

Changing the Volume During Measuring:



You can change the volume at any time during measuring by either turning the dial clockwise if you would like to turn up the volume or anti-clockwise if you wish to turn down the volume.

7.2. Smart Mode

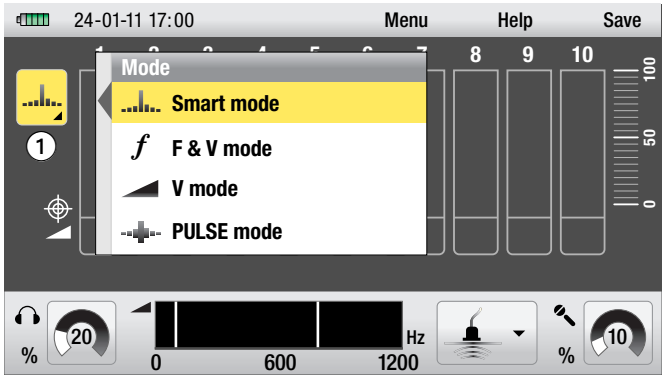
7.2.1. Mode Description

The Smart Mode displays a double bar comprising a noise level indicator and the smart indicator for enhanced leak detection.

The smart indicator is based on a complex calculation and analysis system which includes factors like frequency, sound levels and evaluations.

This algorithm has been tried and tested and is especially effective when background noise levels are high and the sound emitted by the leak is very quiet.

7.2.2. Mode Selection



The measuring mode symbol ❶ on the display shows which mode has been set.

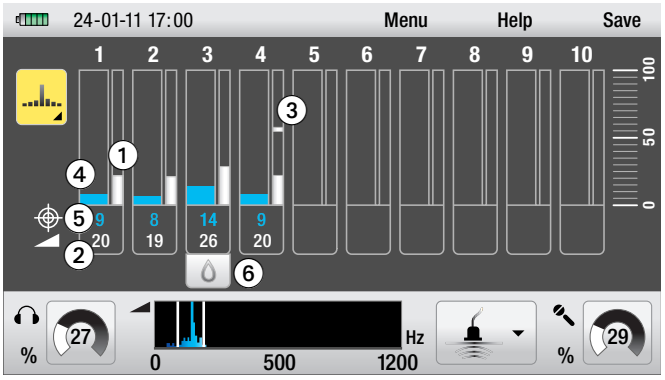
If the smart mode has not already been set, navigate to the measuring mode symbol ❶, activate the symbol and confirm your selection.

The window for selecting the measuring mode will then open.

To set the smart mode, navigate to the list item smart mode and confirm your selection by pressing the right-hand dial.

The window will close and the smart mode symbol will be shown ❶.

7.2.3. Measuring Procedure



Press the *record button* to start measuring. Keep the button pressed for the duration of the measuring operation. The device will stop measuring when the *record button* is no longer pressed.

The display can show a measurement series which is made up of the last ten individual measurements.

The first measurement is displayed on Position 1. Each further measurement – beginning with Position 2 – will be placed on an ascending position. When Position 10 has been reached, the oldest of the ten measurements, i.e. the measurement on Position 1 will be cleared so that the last measurement that was taken last is always on Position 10.

The double bar can be used to visualise the following information in smart mode:

The right-hand, thin bar ❶ shows the sound amplitude on a sound level scale from 0 to 100. The grey bar represents the minimum measured value, i.e. the quietest sound that is relevant for the detection of the leak. This value is also displayed as a number below the bar ❷.

In addition the sound value that is currently being measured is displayed as such on the bar ❸.

The left-hand, broad bar ❹ is the smart indicator. The smart indicator is based on a complex set of calculations and analysis methods *(see chapter 7.2.1)*.

The higher the smart indicator value, the more reliable the information on the leak. The smart indicator bar also displays the colour of the frequency which was used for the calculation that is required to provide an indication on the whereabouts of the leak. According to the rule of thumb, the closer the leak, the higher the smart indicator bar value and the lighter the colour.

The smart indicator bar value is also displayed as a number next to the actual bar ❺.

The symbol of a waterdrop ❻ is used to denote the highest minimum sound level in the measurement series and therefore the point at which a leak is most likely.

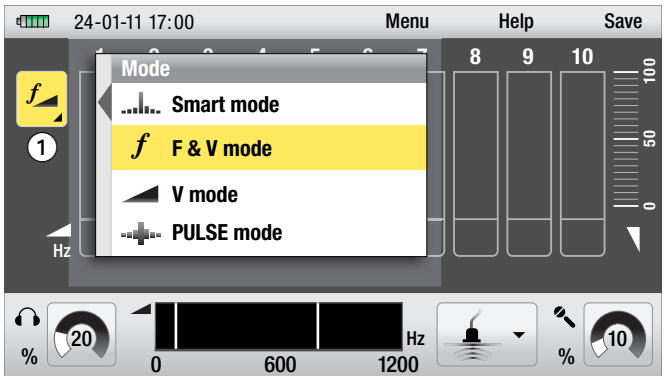
Because the measuring values determined during leak detection are not determined using a specific mode, but only shown in a specific mode, measuring modes can be changed between individual measurements and the measurements that were taken prior to the mode change can be either analysed or measuring can be continued. The measurement series remains unaffected and is not cleared.

7.3. F&V Mode (Frequency and Volume)

7.3.1. Mode Description

The sound amplitude of the minimum measured value (bar height) and the frequency range with the highest sound amplitude (bar colour) are displayed as a bar in F&V mode.

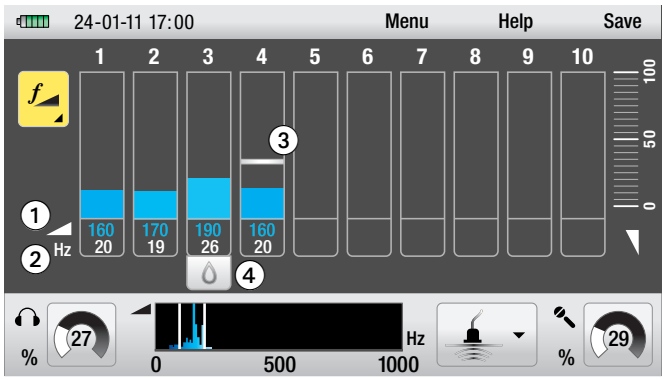
7.3.2. Mode Selection



The measuring mode symbol ❶ on the display shows which mode has been set. If the F&V mode has not already been set, navigate to the measuring mode symbol ❶, activate the symbol and confirm your selection. The window for selecting the measuring mode will then open.

To set the F&V mode, navigate to the list item F&V mode and confirm your selection by pressing the right-hand dial. The window will close and the F&V mode symbol will be shown ❶.

7.3.3. Measuring Procedure



Press the *record button* to start measuring. Keep the button pressed for the duration of the measuring operation. The device will stop measuring when the *record button* is no longer pressed.

The display can show a measurement series which is made up of the last ten individual measurements. The first measurement is displayed on Position 1. Each further measurement – beginning with Position 2 – will be placed on an ascending position. When Position 10 has been reached, the oldest of the ten measurements, i.e. the measurement on Position 1 will be cleared so that the last measurement that was taken last is always on Position 10.

The single bars are used to visualise the following information in F&V mode:

As is the case in V mode, the height of the bar shows the sound amplitude on a sound level scale from 0 to 100. In addition, the colour of the bar visualises the frequency range with the highest noise amplitude. The brighter the colour, the higher the frequency.

The sound level ❶ and frequency ❷ are also shown as a number under the bars.

In addition, the sound value that is currently being measured is displayed in the form of a bar ❸.

The symbol of a waterdrop ❹ is used to denote the highest minimum sound level in the measurement series and therefore the point at which a leak is most likely.

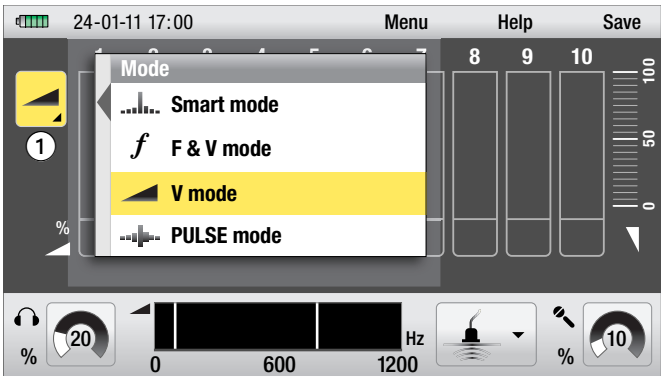
Because the measuring values are not determined using a specific mode, but only shown in a specific mode, measuring modes can be changed between individual measurements and the measurements that were taken prior to the mode change can be either analysed or measuring can be continued. The measurement series remains unaffected and is not cleared.

7.4. V Mode (Level Mode)

7.4.1. Mode Description

In V mode, the measured minimum value only is displayed as a single bar.

7.4.2. Mode Selection



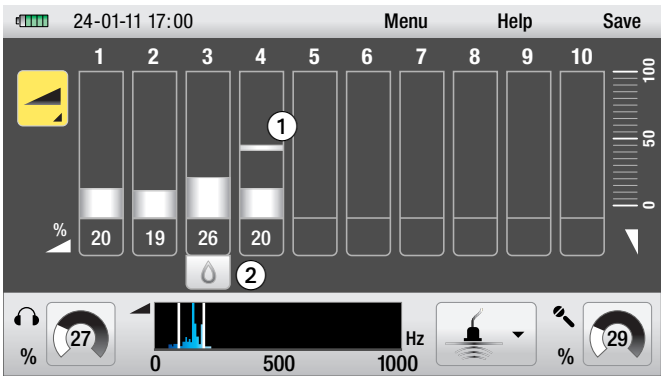
The measuring mode symbol ❶ on the display shows which mode is currently being used. If the V mode has not been set, navigate to the measuring mode symbol ❶, activate the symbol and confirm your selection.

The window for selecting the measuring mode will then open.

To set the V mode, navigate to the list item V mode and confirm your selection by pressing the right-hand dial.

The window will close and the V mode symbol will be shown ❶.

7.4.3. Measuring Procedure



Press the *record button* to start measuring. Keep the button pressed for the duration of the measuring operation. The device will stop measuring when the *record button* is no longer pressed. The display can show a measurement series which is made up of the last ten individual measurements.

The first measurement is displayed on Position 1. Each further measurement – beginning with Position 2 – will be placed on an ascending position. When Position 10 has been reached, the oldest of the ten measurements, i.e. the measurement on Position 1 will be cleared so that the last measurement that was taken last is always on Position 10.

When in V mode, the height of the bar shows the noise amplitude of the measured minimum value on a sound level scale from 0 to 100.

In addition, the value that is being currently measured is displayed on the bar ❶.

The symbol of a waterdrop ❷ is used to denote the highest minimum sound level in the measurement series and therefore the point at which a leak is most likely.

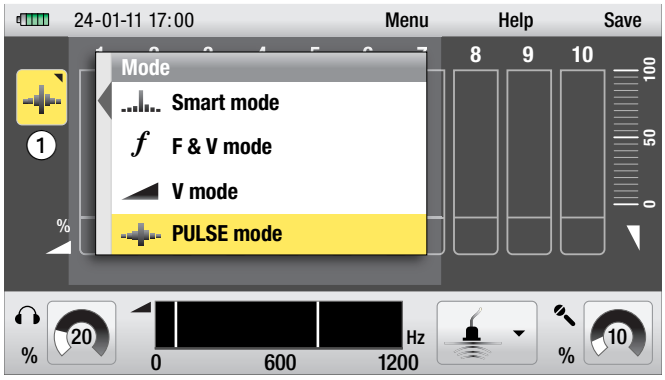
Because the measuring values during leak detection are not determined using a specific mode, but only shown in a specific mode, measuring modes can be changed between individual measurements and the measurements that were taken prior to the mode change can be either analysed or measuring can be continued. The measurement series remains unaffected and is not cleared.

7.5. PULSE mode (acoustic pipe detection using a pulse wave generator)

7.5.1. Mode description

The pulse wave generator produces a pressure wave which is repeated periodically and can be picked up further down the pipe by the LD6000 and a connected ground microphone. This enables you to detect non-metallic water pipes up to a depth of 2 metres without first having to interrupt any services or turn off any water supplies.

7.5.2. Mode selection



The measuring mode symbol ❶ displayed in the display shows you which mode has been currently selected. If the PULSE mode has not already been selected, navigate to the measuring mode symbol ❶, activate the symbol and confirm your selection.

The measuring mode selection window opens.

To set the PULSE mode, navigate to the list item PULSE mode and confirm your selection by pressing the right-hand dial.

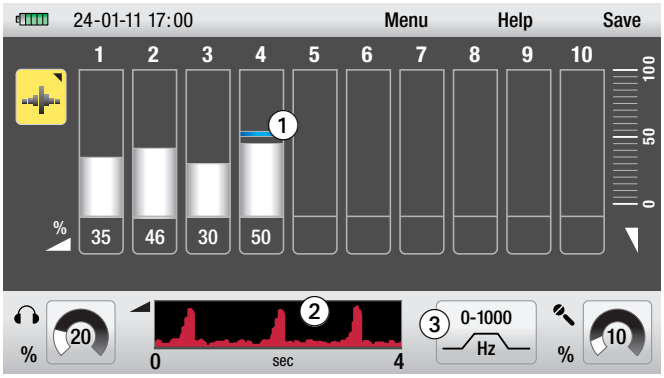
The window closes and the PULSE mode symbol is displayed as a measuring mode symbol ❶.

7.5.3. Measuring operation

Press the *record button* to start a measurement and release the *record button* to stop the measurement. The measurement will last for as long as you keep the *record button* pressed.

The last ten individual measurements can be displayed as a measurement series in the display. The first measurement is displayed on position 1 and each new measurement is displayed in ascending form from position 2 upwards. When the tenth measurement has been carried out, the first position, ie. the oldest measurement will be deleted and the last measurement will be displayed on position 10.

In PULSE mode, the height of the bar shows the sound amplitude of the measured minimum value on a scale of 0 to 100.



In addition, the current measurement is displayed as a bar value ❶.

The bar which shows the actual value is a practical aid for detecting pipes because it clearly shows the impulse which the LD-PULS is generating. The volume and frequency of the impulse are at their highest directly above the pipe.

The interval and intensity of the impulses are displayed visually in a four-second window on the bottom time axis ❷.

7.5.4. Filter settings in PULSE mode

In contrast to the leak detection filter presettings (see chapter 7.1.3.), a filter mode symbol ❸ which is only available in this mode appears in PULSE mode.

There is a predefined frequency range with a 0 Hz high pass filter and a 1,000 Hz low past filter. This is the factory setting which you would use for your first measurement.

The frequency range can be adjusted at any time to suit your individual requirements. To adjust the frequency range, navigate to the filter mode symbol ❸, activate the symbol and confirm your selection.

The acoustic filter adjustment window opens.

Follow the instructions for adjusting the filter frequencies as described in chapter 7.7.1.

We recommend that you do NOT use the automatic function (chapter 7.7.2.) in PULSE mode. Instead we recommend that you adjust the filter frequencies manually. As a rule, the following applies: the greater the distance between the LD6000 and the LD-PULS, the lower the frequency you should select. A frequency window ranging from 0 - 350 Hz has proved to be particularly effective when working in the field.

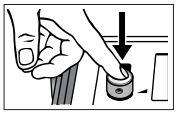
7.6. Clear Current Measurement Series

As many as 10 single measurements can be carried out with the LD6000 and used as a measurement series which can then be seen on the display. This series remains in the memory – even when the device is powered off – unless certain parameters are changed.

This function is of a particular advantage in the field as this means that the last measuring value can then be “carried over” to the next measuring point where the measurement series can then be continued.

It must be pointed out that the measurement series will be cleared as soon as the sensor sensitivity settings or the predefined filter settings are changed.

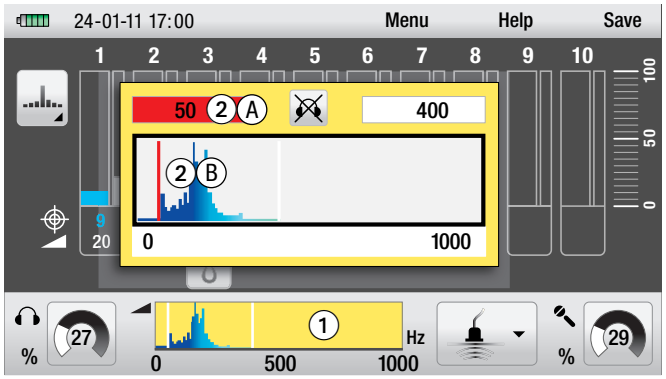
Follow the instructions in chapter 10 to find out more on how the measurement series can be saved permanently.



To clear the individual measurements or the measurement series shown on the display, press the dial on the left and keep pressed for 3 seconds. All 10 positions on the display have now been cleared and are empty.

7.7. Adjusting the filter and switching on the acoustic function

7.7.1. Manual filter frequency adjustment



You can change the preselected filter frequencies at any time between individual measurements in each of the three acoustic leak detection measuring modes.

Navigate to the frequency range display ❶, activate the display and confirm your selection.

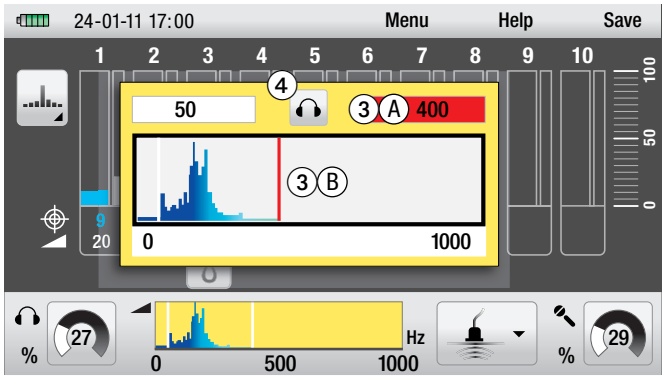
The window for the acoustic filter adaption will then open.

The high pass filter, the low pass filter, the frequency spectrum and the status symbol for the acoustic activation are all presented on the display.

The frequency spectrum is also presented as a colour gradient. Dark colours indicate low frequency sounds and bright colours indicate high frequency sounds.

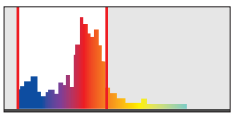
The preset high pass filter is active. This is indicated by the red high pass filter value field ❷ A and the red high pass filter bar ❷ B in the frequency band.

To change the frequency value of the high pass filter, turn the right-hand dial or touch the touch screen and pull the high pass filter bar to the position where you would like it to be.

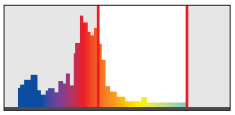


To change the frequency value of the low pass filter, press the right-hand dial once. The low pass filter is now active. This is indicated by the red high pass filter value field ❸ A and the red high pass filter bar ❸ B in the frequency band.

To set the frequency value of the high pass filter, turn the right-hand dial or touch the touch screen and pull the high pass filter bar to the position where you would like it to be.



Wrong filter adaptation



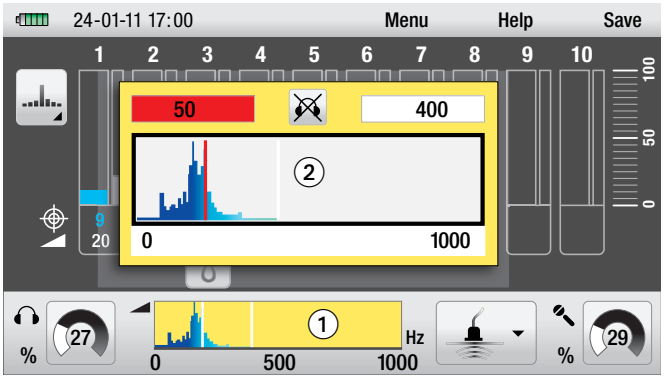
Right filter adaptation

When working in the field, the setting for the low pass filter is ideal when all the high frequency sounds lie within the selected range and the high pass filter is set so that the bottom left-hand sector of the selection box is on the right-hand sloping flank of the biggest part of the spectrum.

Press the ***cancel key*** to leave the window.

7.7.2. Automatic filter frequency adjustment

In addition to the manual adjustment function, the LD6000 is also equipped with an automatic adjustment function which enables you to set the frequency ranges independently to the optimum setting.



To use this automatic function, navigate to the frequency range display ❶ in the display and confirm your selection.

The acoustic filter adjustment window ❷ opens.

Press the ***record button*** and keep pressed until you hear a signal tone.

The acoustic signal tells you that the frequency values for the high pass filter and the low pass filter have now been automatically set to the optimum setting.

To close the window, press the ***cancel key***.

7.7.3. Switching on the acoustic function during filter adjustment

The LD6000 is equipped with a function which allows you to activate the acoustics while the filter is being adapted.

This function can be turned on or off by pressing the headphone key. The status symbol for the acoustic activation function in the window ❹ shows the current function status.

When this function is active, the sound from the microphone is passed on through to the headphones while the filter is being adapted.

This means that you can either enter numerical values to set the limits for the frequency ranges you wish to select or you can set the limits using the acoustic method.

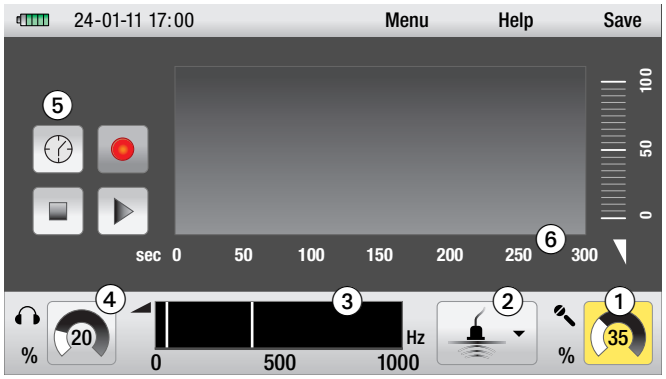
8. Acoustic Long-Term Measuring

You can carry out long-term measuring with the LD6000 in order to determine over a longer period whether a certain sound can be attributed to either a leak or a sound that is coming from the surrounding area (noises generated by a canal, pump etc.)

To select the acoustic long-term measuring mode, activate the symbol for acoustic long-term measuring in the main menu and confirm your selection.

You will then arrive at the display.

8.1. Parameter Settings for Acoustic Long-Term Measuring



You can set the following parameters and carry out the following actions on the display:

- Set the sensor sensitivity ❶
- Select the filter presetting ❷
- Adapt the filter and activate the acoustics manually ❸
- Set the volume ❹
- Set time intervals for long-term measuring ❺
- Start long-term measuring *(chapter 8.2)*
- Clear the display *(chapter 8.2)*
- Stop/continue long-term measuring *(chapter 8.2)*

Setting the sensor sensitivity ❶:

To set the sensor sensitivity, perform the same steps as described for current measurements in chapter 7.1.1.

Selecting the filter presetting ❷:

To select the filter presetting, perform the same steps as described for current measurements in chapter 7.1.2.

Adapting the filter and activating the acoustics manually ❸:

To adapt the filter and activate the acoustics manually, perform the same steps as described for current measurements in chapter 7.6.

Setting the volume ❹:

To select the volume for long-term measuring, perform the same steps as described for current measurements in chapter 7.1.3.

In addition, the volume function for long-term measuring can be deactivated at any time by pressing the ***headphone key***.

The volume that has been set is not affected by the mute function. The mute function mutes the headphones.

Selecting the time intervals for long-term measuring ❺:

There are four predefined time intervals available for selection: 5, 15, 30 and 60 minutes.

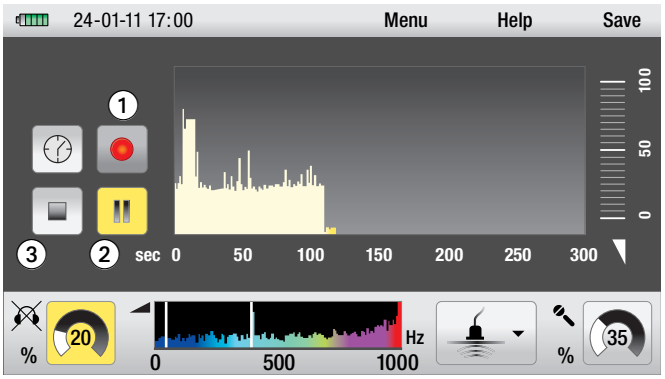
To select a time interval, navigate to the time interval symbol ❺ on the display and confirm your selection.

The window for setting the time interval will open.

Navigate to the time interval you wish to select by pressing the right-hand dial or by touching the touch screen and confirm your selection by pressing the right-hand dial or press the ***cancel key***.

The time scale ❻ on the display will now display the time interval that has been selected.

8.2. Measuring Procedure



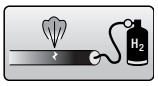
Press the ***record button*** or the record symbol ❶ on the display to start long-term measuring. The measurement begins and ends with the preselected times.

You can interrupt the recording at any time by pressing the pause symbol ❷, the record symbol ❶ or the ***record button***. Continue measuring by pressing the pause symbol, the record symbol or the ***record button***.

To clear the long-term measurement series on the display, press either the left-hand dial and keep pressed for 3 seconds or by pressing the clear symbol ❸ on the display.

9. Trace Gas Detection

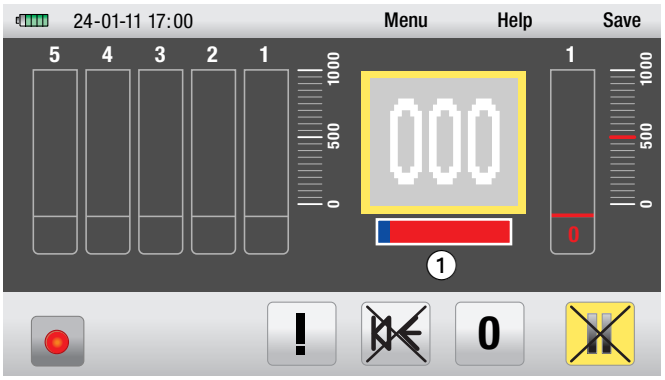
The LD6000 is excellently-suited for detecting leaks together with the optionally available LD6000 H2 hydrogen sensor and the formation gas type 95/5, which comprises 95 % nitrogen and 5 % hydrogen.



To select the trace gas detection, activate the symbol for the trace gas detection in the main menu and confirm your selection.

You will then arrive at the display.

9.1. Putting the Device into Operation



As soon as you change to trace gas detection on the display when the hydrogen sensor is connected, the device recognises the sensor and warms it up to operating temperature.

This warm-up phase takes approximately 3 minutes and is displayed as a blue progress bar ❶ below the numerical display.

The sensor self-calibrates during the warm-up phase. This self-calibration is designed to determine the base value for the different hydrogen concentrations that are detected during measuring.

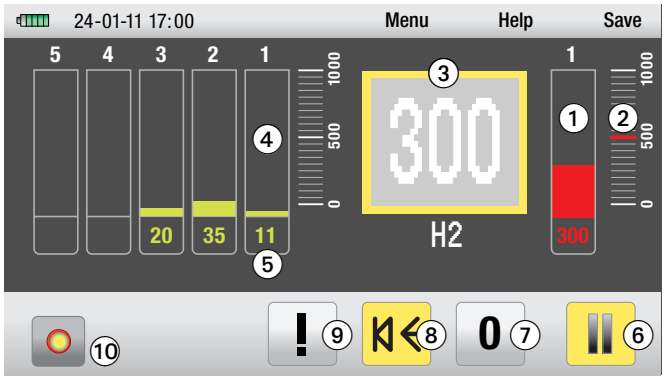
The sensor calibrates independently according to the existing hydrogen concentration in the surrounding air.

This is why it is especially important that you ensure that the sensor is not near a hydrogen source during the warm-up phase.

We therefore recommend that you either go outside into the open with the LD6000 during the warm-up phase or remain in place where you know that the hydrogen concentration is lower (< 1 ppm H_2).

As soon as the sensor has reached its operating temperature the warm-up bar disappears and the LD6000 is ready to use.

9.2. Display



You can read and adjust the following parameters and carry out the following actions on the display for trace gas detection:

- Bar display ❶ and the number which displays the current value underneath it.
- Preset alarm value ❷
- Digital display with the current measuring value ❸
- Five position bars for the bar display ❹ and the numerical display ❺ of the previous 5 measurements beginning with Position 1 for the last measurement up to Position 5 for the fifth of the last previous 5 measurements.
- Start/Stop symbol ❻ to start and stop a measurement
- Perform zero calibration ❼
- Switch the measuring tone on and off ❽
- Define the alarm threshold ❾
- Record symbol for the measurement operation ❿

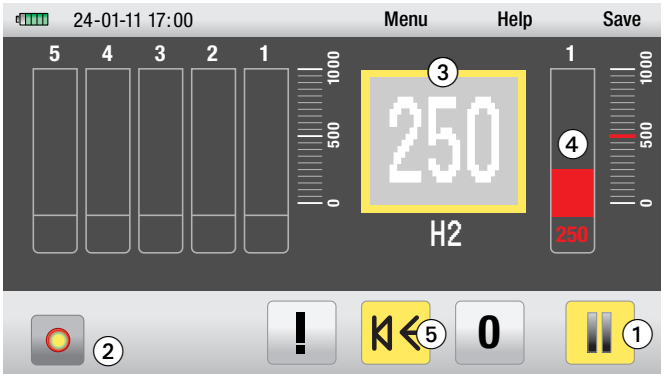
The functions and setting possibilities of these parameters will be explained in detail in the following chapters.

9.3. Normal Measuring with Acoustic Feedback

Information on the displayed values:

The LD6000 H2 hydrogen sensor is able to detect highly resolved hydrogen concentrations from 10 to 20,000 ppm.

The LD6000 displays the detected hydrogen concentrations as digits but without an accompanying value in a range from 0 to 1,000 digits.
Important: *The correlation from display and H_2 concentration is not linear, but logarithmic.* ***The displayed digital value does not automatically correspond with the ppm value!***



Starting Measuring:

Press the start/stop symbol ❶ on the touch screen or press the ***record button*** to begin a measurement. The measurement and will be continued until one of the keys is pressed to discontinue measuring.

A pulsating record symbol ❷ indicates that measuring is being carried out.

The current measuring value is either displayed as a number on the digital display ❸ or as both as a number and a bar on the right-hand red bar display ❹.

The display value increases if you get closer to an area with a higher hydrogen concentration. The value decreases again when you move away from this area or enter adjoining areas with lower hydrogen concentrations.

There is a hydrogen concentration of 250 digits on the display as shown in the example.

Activating the Acoustic Feedback:

As it may become difficult to keep an eye on the display the whole time while trying to detect the direction which the biggest trace gas increase is coming from, the LD6000 is also equipped with an acoustic feedback to help you during leak detection.

The LD6000 is equipped with a signal display which is connected to a piezo element and additionally able to transmit a signal tone to the connected LD K headphones.

The acoustic feedback is initially set to “deactivated”.

To activate the acoustic feedback, navigate to the measuring tone symbol ❺ with the right-hand dial and activate the symbol by either pressing the dial or by directly touching the touch screen where the measuring tone symbol ❺ is.

When the acoustic feedback is activated, the sound is emitted via both the connected headphones as well as the internal piezo element.

The **sound is emitted** in the same volume and the same frequency **via the piezo element**. The tone sequence increases when the measuring values increase and decreases when the measuring values decrease.

The **sound is emitted** in the same volume as a continuous tone **via the headphones**. The frequency depends on the measuring value. The frequency increases when the measuring values increase (the tone becomes higher) and decreases when the measuring values decrease (the tone becomes higher).

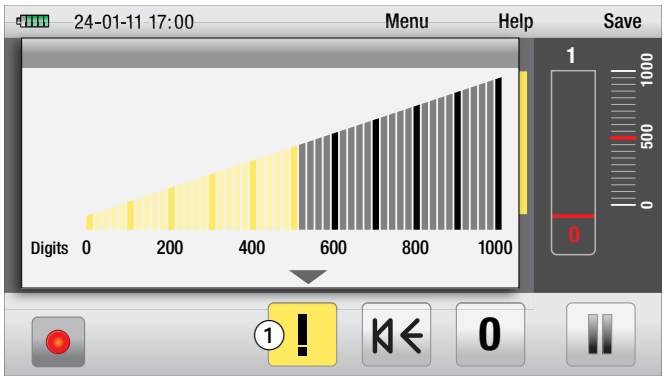
9.4. Defining Alarm Thresholds

In order to allow you to identify certain hydrogen concentrations more easily, the LD6000 is equipped with a permanent alarm function with alarm thresholds that can be configured individually. The factory setting is 500 digits.

An acoustic alarm sounds when the alarm threshold is exceeded. The warning tone sounds different than the standard feedback signal.

When the **alarm tone sounds via the piezo element**, the signal changes constantly in a tone sequence with long tones in short intervals.

When the **alarm tone sounds via the headphones**, the continuous tone is emitted without interruption with maximum frequency when the predefined alarm thresholds have been exceeded.



To set the alarm threshold which you wish to select, navigate in the display window to the symbol for the threshold setting ❶, activate the symbol and confirm your selection.

The window for setting the alarm threshold will then open.

The current alarm threshold is displayed on a step scale ranging from 0 to 1,000 digits.

You can select a new threshold value by either turning the dial on the right or placing a finger on the touch screen and pulling it to the value which you wish to select.

Press the *cancel key* to leave the window without changing the threshold value.

Press the dial on the right to confirm your selection or press the *cancel key*.

9.5. Measuring with Zero Calibration

It may become necessary to use the zero calibration function to define a reference value during measuring so that fluctuating hydrogen concentrations at different measuring points can be defined more clearly.

As soon as a reference value has been defined a value that is relative to the newly defined reference value appears on the display.

This can be of particular advantage when sections of pipe are measured in areas with high hydrogen concentrations, because it allows you to narrow down the position of the leak on a step-by-step basis.

To determine a reference value, navigate to the zero calibration symbol with the right-hand dial and activate the symbol by pressing the dial. You can also activate the zero calibration symbol by touching the symbol on touch screen.

Important: The current measurement series is cleared when zero calibration is performed!

When you perform a zero calibration you are defining the existing hydrogen concentration, i.e. the current measuring value, as the new reference value.

This in turn changes the displayed measurement value when compared to the normal measurement with zero calibration.

The digit display now shows two values: the relative measured value (relative to the defined reference value, 000-display at the point of zero calibration) as large digits in the middle of the digit display and the measured absolute measured value as reference value when zero calibration was carried out in the lower right-hand area of the digital display.

The displayed value changes as follows when the hydrogen concentration increases: the relative measured value shows the increasing values in relation to the defined reference value. The absolute measured value shows the actual existing hydrogen concentration.

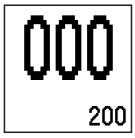
The relative measured value is not only displayed on the digital display but also on the red bar display as well as on the numerical display below.

If the hydrogen concentration sinks below the defined reference value, the displayed relative measured value no longer changes (000), but the absolute measured value still displays the existing hydrogen concentration.

Here an example to explain how this works:

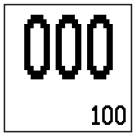
There are different hydrogen concentrations in three fictive adjoining zones. The concentration in Zone 1 is 200 digits, the concentration in Zone 2 is 300 digits the concentration in Zone 3 is 100 digits.

First measuring is carried out in Zone 1.
The measured value on the display is 200 digits.



Now a zero calibration is carried out in Zone 1 and the existing hydrogen concentration (200 digits) is defined as the reference value. When a second measurement is carried out in Zone 1, the digital display now shows a relative measured value of 000 and an absolute measured value of 200.

A new measurement is carried out in Zone 2. The digital display now shows a relative measured value of 100 and an absolute measured value of 300.



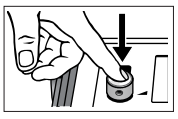
Then measuring is carried out in Zone 3. After the measurement has been carried out, the digital display only shows the absolute measured value 100 and no measuring value (000).

Important: The defined alarm thresholds are always set with regard to the relative measured value! An alarm threshold of 150 digits, as shown in the example above, would only trigger a signal after the first measurement in Zone 1 before zero calibration was carried out, even though the absolute measured value that was measured in Zone 1 (after zero calibration) and also in Zone 2 was above the alarm threshold.

9.6. Clearing the Measurement Series / Clearing Zero Calibration

You can use the clear function to clear both the measurement series and the zero calibration in trace gas mode.

Either of the two cannot be cleared individually. You can either clear both of them or neither of them.



Press the left hand dial to clear both the zero calibration and the current measurement series. Both memory parameters are now cleared. There are now no measuring values and no reference value.

To save measurement series permanently into the memory, follow the instructions as described in chapter 10.

10. Saving and Loading Measuring Data

Any measurement reading and any measurement series can be saved to the internal memory of the LD6000 permanently and either called up at a later point or transferred to your PC.

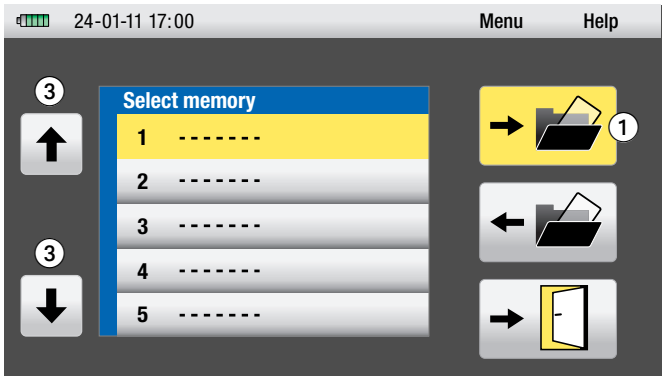
The menu item *"save"* is only visible when you are in a measuring mode.

To save a measurement or a measurement series into the memory, navigate to the menu item *"save"* with the right-hand dial and press the dial to confirm your selection.

You can also use the touch screen to select the memory item *"save"*.

The display now changes to the memory page.

Saving Measuring Data



To save your measuring data, navigate to the display symbol *Save Measuring Value* ❶ and confirm your selection by pressing the right-hand dial.

You can also confirm your selection directly by pressing the symbol *Save Measuring Value* on the touch screen.

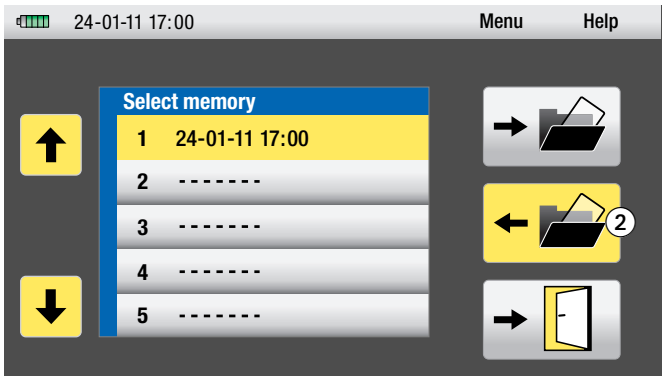
The measuring values can then be saved to any memory space you wish. Turn the right-hand dial to navigate to 1 of the 20 memory spaces and confirm your selection by pressing the display symbol *Save Measuring Value* ❶.

The measuring value is now on the memory space which you previously selected.

You can navigate to memory spaces outside the touch screen display by touching the navigation symbols ❸.

You can either leave the memory page by pressing the cancel key or the door symbol on the display.

Loading Measuring Data



To call up any data that you have previously saved, navigate to the display symbol *Load Measuring Data* ❷ and confirm your selection by pressing the right-hand dial.

You can also confirm your selection directly by pressing the symbol *Load Measuring Data* on the touch screen.

You can then call up the measuring data you have saved from any one of the memory spaces. Turn the right-hand dial to navigate to the memory space you wish to select and confirm your selection by pressing the display symbol *Load Measuring Data* ❷.

The measuring value you have selected is now displayed.

11. Transferring Measuring Data To A PC

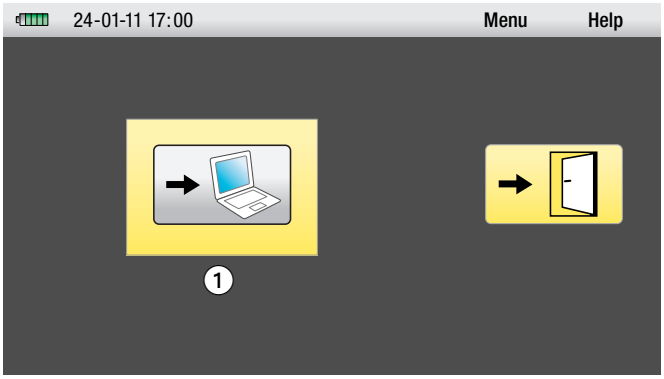
The measuring values which you have saved to your internal memory can be transferred to your PC for further assessment or documentation.

You will need the PC connecting cable included in the scope of delivery and a software tool which you can download free of charge at *www.trotec.com*.

The software tool which you may choose to download is absolutely free of charge and is not a part of the standard scope of delivery. The software is provided without any form of support and any form of guarantee. The intuitive user interface is exceptionally easy to work with and understand. Further information regarding the software and its use can be found in the application included.

To transfer your data to the PC, navigate to the main menu and select the *Data Transfer* display symbol *(see chapter 6.2)*.

The display now changes to the memory transfer page.



Please ensure that your PC is connected to the LD6000 and then navigate to the display symbol *Data Transfer* ❶. Confirm your selection and follow the instructions as shown on your PC.

12. Troubleshooting

Acoustic leak detection – List of possible errors or faults:

Error/Fault Description	Possible Cause	Recommended Action
No sound in the headphones	1. The sound receiver or the headphones are not connected properly	Check the connections between the connected sound receiver and the connected headphones and the LD6000.
	2. Wrong filter settings	Select a broader frequency range, e.g. 50 to 2,000 Hz and generate a clearly audible sound by scratching a surface or turning on a radio, for example. If the action you have carried out causes the numerical or bar display to change and these sounds can be clearly heard in your headphones, then you can be sure that the headphones and microphone are working properly. Now carry out the measurement again and adapt the frequency range to suit the measuring operation.
	3. The cable that connects the sound receiver and the unit appears to be defective.	• Check the connections between the connected sound receiver and the LD6000. • Replace the cable with a spare cable if possible or use the cable from a second LD6000 to check to see if the sound receiver is working properly.
	4. The cable that connects the headphones to the unit appears to be defective (in such a case the sound level indicator on the display still works properly!)	• Check the connections between the connected headphones and the LD6000. • Connect a spare pair of headphones which you may have or another pair from a second LD6000 to the unit and check the function again.
	5. Memory settings	If the actions that you have carried out have not been successful, then go to ***"Clear memory"*** in the menu and clear the parameter memory. If you can still not hear anything over the headphones, then please contact our Customer Support Centre.
The screen remains blank.	1. The batteries are empty	Replace the batteries inside your unit with new ones of the same high quality and type.
	2. The unit is defective	Please contact our Customer Support Centre.
Display brightness too dim	1. The brightness setting has not been set correctly.	Go to the menu item ***"Settings"*** and increase the display brightness.
	2. Battery power very low	Replace the batteries inside your unit with new ones of the same high quality and type.
The company logo remains on the display	1. The unit is defective	Please contact our Customer Support Centre.

Trace Gas Detection – List of possible errors or faults:

Error/Fault Description	Possible Cause	Recommended Action
You cannot commence measuring, **the cross symbol above the function key does not disappear,** **the sensor does not warm up**	1. The sensor cable has not been connected properly.	• Check the connections between the connected H2 sensor and the LD6000. • Replace the sensor with a spare sensor if possible or use the sensor from a second LD6000 to check to see if the sensor is working properly.
	2. Port/Jack or plug defective	• Check the connections between the connected H2 sensor and the LD6000. • Replace the sensor with a spare sensor if possible or use the sensor from a second LD6000 to check to see if the sensor is working properly.
	3. Cable defective	• Check the connections between the connected H2 sensor and the LD6000. • Replace the sensor with a spare sensor if possible or use the sensor from a second LD6000 to check to see if the sensor is working properly.
	4. Sensor defective	Please contact our Customer Support Centre.
No or hardly any display of existing gas concentrations	1. Sensor was connected to the unit in a room with existing gas concentrations	Leave the room and go somewhere where existing hydrogen levels are normal, e.g. out in the open. ***Power up the unit AGAIN*** and then return to the room which you had previously left.
	2. Sensor defective	Please contact our Customer Support Centre.
Reaction time too long	1. Sensor is not working properly	Please contact our Customer Support Centre.

13. Changing the Battery, Cleaning and Maintenance

Changing the Battery

There is a battery symbol above the menu bar on the left-hand side of the display that shows you how much power you batteries have left. The more green segments there are, the higher the battery capacity. If there is only one red segment left, then the batteries need to be replaced very soon.

As soon as the battery voltage drops below the strength that is required to power the unit, a warning symbol starts to blink in the middle of the display. The batteries should be replaced immediately.

Change the batteries as follows:

Power off the unit. Unscrew and remove the battery compartment lid *(see chapter 4, legend item ⑩)*, take out the used batteries and replace them with new ones.

Please make sure that the poles of the batteries you are inserting are properly aligned with the poles inside the battery compartment.

To power the LD6000, you may either choose to use high quality batteries type LR14 C 1.5 V (recommended capacity ≥ 4,500 mAh) or rechargeable batteries.

When using rechargeable batteries, you must make sure that you only use NIMH rechargeable batteries, type HR14 1.2 V.

Do not dispose of batteries in household waste. Do not throw into water or fire. Please make sure that you dispose of your used batteries according to existing government guidelines and regulations.

Cleaning and Maintenance

LD6000 Measuring Device

Use a slightly moist, lint-free cloth only to clean the main unit. Do NOT use any detergents or cleaning fluids. Use clean, clear water only.

We recommend that you remove the batteries from the battery compartment when you are not planning on using your measuring device for a longer period.

LD6000 H2 hydrogen sensor

The measuring tip of the hydrogen hand sensor is equipped with a brass-coloured hexagonal protection cap (sinter filter) which is designed to protect the sensor system.

Use compressed air to remove any dirt particles which might happen to settle on the sinter filter.

Unscrew the sinter filter from the measuring tip and direct the jet of compressed air from behind – from the direction of the inner thread of the filter – towards the filter element to remove any dirt particles from the filter element. Replace the sinter filter back on the sensor tip and screw back on.

The swan-neck hydrogen hand sensor can be cleaned with a slightly moist, lint-free cloth if necessary.

14. Technical Data

Technical data	LD6000
Article no.	3.110.008.010
Operating mode	Acoustic leak detection (F&V, Smart, long-term measuring), pipe detection and trace gas leak detection
Measuring and device functions	Measuring modes for minimum level, averaged level, pulse wave measurements, simultaneous F&V analysis, logging function, automatic functions for setting filter frequencies and sensor sensitivity, memory preference for manual filter settings, sound level overmodulation protection, trace gas detection with concentration-dependent signal (optic and acoustic)
Controls	Either via touchscreen, keys or control dial
Amplification	120 dB low noise factor
Input impedance	1MΩ
Filter	Up to 256 can be configured individually (for stick sensor and ground microphone)
Frequency spectrum	0 - 4,000 Hz
Display	Colour LCD (automatic illumination), 480 x 272 pixels
Battery check	Via micro-controller
Output impedance	≤ 10 Ω
Power supply	4 x batteries type LR14 C 1.5 V
Operating time	up to 14 h in non-stop operation, up to 40 h in normal operation
Connections	Bayonet nut connector (microphone / sensor), 6.3 mm jack plug (headphones), USB
Protection class	IP54
Housing	Aluminium, powder-coated
Temperature conditions	During operation: -5 °C to +55 °C; Storage: -25 °C to +65 °C
Dimensions approx.	L 210 x W 160 x H 60 mm
Weight approx.	1,050 g

Technical data	LD6000 H2 hydrogen hand sensor
Article no.	3.110.008.011
Response sensitivity	1 ppm H_2
Measuring range	10 ppm H_2 to 20,000 ppm H_2
Resolution	1 ppm H_2
Reaction time	0.5 s
Type	Hand sensor with flexible swan-neck (length 50 cm) and 160 cm connecting cable for LD6000
Temperature conditions	During operation: -10 °C to +60 °C; Storage -20 °C to +60 °C

Technical data	LD6000 H2 hydrogen ground sensor incl. pump
Article no.	3.110.008.020
Response sensitivity	1 ppm H_2
Measuring range	10 ppm H_2 to 20,000 ppm H_2
Resolution	1 ppm H_2
Reaction time	0.5 s
Type	Ground sensor with active pump, two-part rod (length approx. 1 m) and rubber collar as well as approx. 200 cm long connecting cable for LD6000. Weight 1.1 kg.
Pump module	integrated, see technical data LD6000 H2 pump kit
Temperature conditions	During operation: -10 °C to +60 °C; Storage -20 °C to +60 °C

Technical data	LD6000 H2 pump kit
Article no.	3.110.008.030
Pump performance	1.5 litres/minute
Power supply	9 V block battery IEC 6LR61/6F22
Power input	approx. 45 mA
Dimensions	L 480 mm x W 40 mm x H 40 mm
Weight	500 g

The LD6000 H2 pump kit is a standard part of the LD6000 H2 hydrogen ground sensor (article no. 3.110.008.020). It can, however, also be ordered separately in order to upgrade existing LD6000 H2 ground sensors without an integrated pump.

15. Information for Use in the Field

15.1. Acoustic Leak Detection

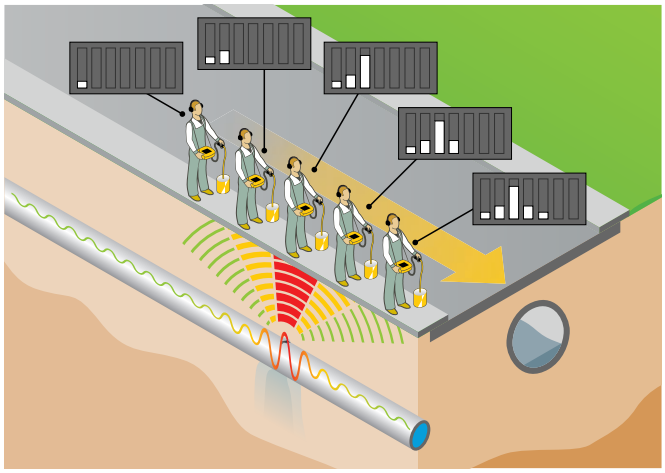
15.1.1. How Sound Is Created

When there is a leak in a high pressure pipe system, water that leaks out generates sound that is caused by the friction that occurs when the water escapes through the hole at high speed. This also leads to oscillations in the pipe itself. The sound is carried along the pipe and can be picked up at contact points (valves, hydrant, fittings) which can actually be quite far from the actual leak itself and transformed into audible sound by structure-borne sound microphones.

15.1.1.1. Ground-Borne Sound

When water that is escaping from a leak comes into contact with the ground, then this causes the parts of the ground that it comes into contact with to oscillate. The sound spreads out from the leak in circles and can be picked up by a ground microphone near the actual leak. The frequency of these signals lies between 30 and 700 Hz.

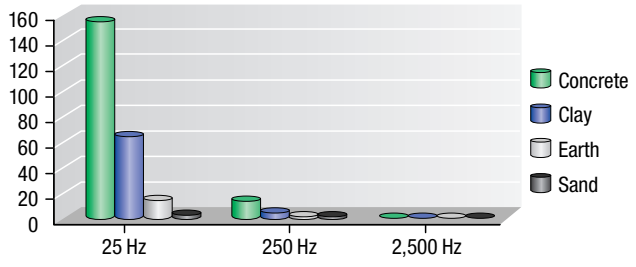
Frequencies whose wave lengths are smaller than the depth that the pipes have been laid in are strongly absorbed because of the low pass effect of the surrounding soil. This means that only the low frequencies normally reach the surface of the ground.



If the water has been escaping from the leak for a relatively long period of time, a water blister sometimes forms and continues to contain the water that is leaking from the pipe. The sound that is transmitted through the ground is therefore barely audible and is almost impossible to pick up with a ground microphone.

The sound caused by the leak can be made audible again if compressed air can be fed into the pipe system that is being examined. In such a case the compressed air is fed into the pipe system with a minimal amount of overpressure via a hydrant or house connecting point. This combination of water and air generates a sound at the leak that is clearly audible.

The diagram below shows the influence of the ground formation on the distance that the ground-borne sound waves can travel with reference to the leak frequency in metres. Low frequency sounds spread out further than high frequency sounds, and compact ground conducts the sound to the surface better than ground which is not as compact.



15.1.1.2. Structure-Borne Sound

Structure-borne sound oscillations occur when water escapes from a leak with high pressure and at a correspondingly high speed which causes the pipe in question to oscillate.

The sound that is generated at the point where water is escaping spreads out to all sides of the pipe. Small diameter or thin steel pipes will oscillate strongly and the sound that the leak is causing can be picked up at a considerable distance from the leak itself. Thick pipes or pipes made of synthetic material, on the other hand, do not oscillate as strongly and the sound that the leak generates does not spread out nearly as far.

The frequency and the material of the pipes play a major role as far as the distance that the sound travels is concerned. As is the case with ground-borne sound, low frequency sounds travel further distances and softer materials like PVC or PE pipes absorb the energy that the leak causes more strongly than metallic pipes.

15.1.1.3 Current Induced Sound

Current-borne sound is generated at narrow points or bottlenecks, for example at valves that are only half or partly open, at household connecting points where pipes can have differing diameters or dimensions or when corrosion has formed and pipes are crusted with rust on the inside. These factors can cause turbulent currents which can generate frequencies of over 4,000 Hz.

15.1.1.4 Interference Factors

Sounds from surrounding sources that have been absorbed and filtered by the ground have a similar frequency spectrum to the sound that a leak generates. The interference this causes can be likened to stop and go traffic on the roads, but with the difference that such a traffic situation is far more disruptive with regard to traffic flow when it happens on a major road than somewhere in the centre of a small town.

The higher the pressure in the pipe on which an inspection is to be carried out, the higher the amount of energy that forms at the leak. This means that leaks become less audible if the pressure in the pipe is lower than 3 bar. If the pressure is lower than 1.5 bar, then a leak cannot be heard even when in it is in the close vicinity.

15.1.2. Schematic Leak Detection

In order to keep costs down it often makes sense to adopt a systematic approach to carrying out leak detection. This is especially true when water pipes are concerned, for example. The first thing you need to know is the course of the pipe. You will also need to differentiate clearly between the ***preliminary leak detection stage*** and the ***stage which involves pinpointing the actual leak***. If this first stage were not to be performed, then the whole length of the pipe would have to be inspected order to determine the exact spot where the leak is.

15.1.2.1 Narrowing Down the Leak Using a Stick Microphone

You can narrow down the position of a leak by inspecting the parts of the pipe system that you are able to access with the probe tip of the stick microphone. Particular attention must be paid the type of sound that is recorded: leaks generate a dull, muffled sound and valves produce a brighter, sharper sound. Both sounds are very helpful when it comes to narrowing down the position of a leak, but it is important to remember that similar sounds – like that of water flowing through the pipe – can be generated when water is taken from the pipe via a tap for example.

When narrowing down the leak, it is important to ensure that no value exceeds the range on the display otherwise you will be unable to tell what the actual value was. The fact that the measuring values can be saved into the internal memory is an added benefit, as it can then be “carried over” to the place where measuring is to be carried out next.

This method allows you to determine the section of pipe with the highest sound intensity without changing the control settings. The next leak detection stage can then be carried out on this particular section of pipe over ground.

15.1.2.2 Pinpointing the Leak Using a Ground Microphone

If you have managed to detect a defective section of pipe using the stick microphone, you can use the ground microphone to pinpoint the leak. Always make sure that the distance between any two points that you have selected for the ground microphone is not too far apart as you could otherwise end up missing the leak. As a rule, the distance apart should not be more than one metre.

15.1.2.3 Pipe Detection with Pulse Wave Generator

The LD6000 is equipped with a special PULSE mode (see chapter 7.5.) for acoustic pipe detection in combination with a separately available pulse wave generator, for example the LD-PULS.

The pulse generator generates up to 60 oscillations per minute. These oscillations can be carried along the pipes up to a distance of 600 metres in especially favourable con-ditions. They can then be picked up by the ground microphone.

The LD-PULS pulse generator has proved invaluable when working with both non-metallic and metallic pipes which because of transformer stations or high-tension underground power cables cannot be detected using conventional detection methods.

15.2. Leak Detection with Trace Gas

15.2.1 Functioning Principle

The optionally available LD6000 H2 hydrogen hand sensor is excellently suited for trace gas detection in combination with the LD6000. In such cases, the pipe that is to undergo inspection is flooded with forming gas 95/5 (95 % nitrogen, 5 % hydrogen).

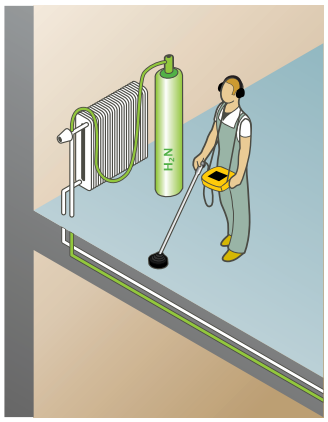
Because of its specific structure, hydrogen is able to permeate almost all materials like earth, concrete, floor tiles etc. It can then be easily traced at the surface with the LD6000 and the connected hydrogen sensor.

Forming gas 95/5 is neither toxic nor flammable. This means that it can be considered harmless and even used in fire-protected industrial areas. You must, however, always make sure that you you follow the rules and regulations that apply to such areas.

15.2.2 How to Carry Out Leak Detection with a Forming Gas

After the pipe that is to undergo inspection has been emptied, the gas bottle is connected and the pipe is then filled slowly from one end until the hydrogen sensor at the other end of the pipe or at a control point along the pipe signals that gas concentrations have been detected. Then the second end is sealed and the pressure is gradually increased until the inspection pressure has been reached.

It might then take several minutes or even hours for the gas to reach the surface. This depends on the leak and the type of ground and surface. It takes approximately 60 minutes for the gas to reach the surface when ground in green areas, for example, is slightly moist and the pipes are circa 1.5 m under the ground. You have to follow the path of the pipes repeatedly until the gas escapes through the surface. Then look for the highest concentration within the area where the gas has escaped and mark this point to show that this is where the leak is.



15.2.3 Determining Correct Quantities Using Experience Gained in the Field

If a pressure test with water has already been carried out on the pipe, then the pressure at which water no longer escapes through the leak can be used to calculate the quantity of gas that is needed. If not the operating pressure can be used.

On this basis and with the help of the volume table below, it is possible to calculate the maximum amount of forming gas that is required to locate the leak:

Formula: G = VL x L x D

G =	Amount of gas with regard to inspection pressure (L)
VL =	Volume in litres with regard to the length of pipe in metres (L)
L =	Length of pipe (m)
D =	Inspection pressure (bar)

Example:

A DN 125 pipe is 300 metres long and is to be filled with a pressure of 5 bar:

Volume per metre x length =

12.27 litres x 300 metres =

3,681 litres at 1 bar pressure.

At 5 bar pressure: 3681 litres x 5 bar = 18,405 litres

Because a standard 50 litre bottle contains 10,000 litres of gas at 200 bar, two such bottles of forming gas were required in the above example.

You should also keep in mind when planning how much gas you will need that in addition you will need a reserve for the gas that escapes at the leak.

Volumen table of various pipe diameters for calculating gas amounts

Pipe diameter in mm	VL (volume in litres with regard to the length of pipe in metres)
40	1.26
50	1.96
60	2.83
80	5.02
100	7.85
125	12.27
150	17.66
200	31.4
250	49.06
300	70.65

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