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Gap Power Model HLTM5000 Electroacoustic Leak Locator



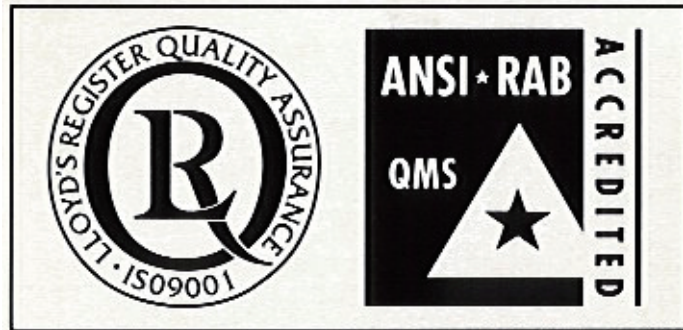
Operation Manual





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Revision B November 2006



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1 Description

1.1 General

The new HL 5000™ Leak Locator is designed to facilitate the implementation of a complete water leak detection program - from the preliminary survey, to pre-location, to pinpointing. Although designed with the water utility in mind, the HL 5000™ can also be used for finding leaks in any pipe distribution network from which pressurized liquid creates sound when escaping from a leak.

Sound from a water leak is constant; it does not go away. The HL 5000™ utilizes a special feature called Dual Segment Analysis (DSA) to simultaneously display both the minimum constant leak sound value of a leak and the total current sound value. In addition, the results of each measurement can be automatically stored for a comparison of leak sound levels along a series of sequential listening points (see Section 3.8 on Memory Mode, pp 18 - 19).

The HL 5000™ is the first leak locator that when in leak detection mode, utilizes computer-enhanced reduction of extraneous sound. Intermittent impulse sounds/disturbances are automatically suppressed and do not interfere with the display of consistent, minimum sound values. There are times, however, when the ability to receive and focus on impulse sounds are desirable. When using impulse generating devices (such as Metrotech's RSP3) to help locate non-metallic pipes, the HL 5000™ should be placed in Pipe Location Mode (see Section 3.10 on Pipe Location w/RSP3 on p. 20).

1.2 Construction

The construction of the HL 5000™ is solid. The durable plastic housing of the receiver is water resistant and built to withstand normal field operation. The comfortably spaced soft keys on the front of the control panel allow even a gloved operator to easily navigate between features. The LCD display is equipped with a backlight for operation at night or in other poor lighting conditions.

The HL 5000™ is powered by 8 AA batteries that are housed behind an easily removed cover in the base of the unit.

The multi-pin microphone cable connector is designed to allow a quick, but secure, waterproof connection to the receiver. The headphones are connected via a watertight, ¼ mono instrument plug.

1.3 Technical data

Analysis bandwidth:	0 Hz 4000 Hz
Filter cut-off frequencies:	0 70 Hz, 106 Hz, 160 Hz, 240 Hz, 360 Hz, 540 Hz, 800 Hz, 1200 Hz, 1800 4000 Hz
Memory Recordings:	9 dual displays
Continuous Monitoring:	3, 10, & 30 min options
LCD Display:	5.1 x 1.4 in
LCD Illumination:	Backlight
Power Supply 1:	8 x AA batteries, 1.5 Volt
Power Supply 2:	8 x 1.2 V rechargeable batteries (option)
Battery Life:	> 35 hrs (battery), > 15 hrs rechargeable battery
Storage:	9 measurements
Operating Temperature:	15 to 120 °F
Storage Temperature:	15 to 155 °F
Protection Class (Operating):	IP 54
Dimensions (L x W x D):	8.5 x 3.75 x 4.33 in
Weight: HL 5000	2.6 lbs (with batteries)
Weight: GM-50	7.7 lbs (w/ carrying handle)
Weight: PAM U	2.2 lbs

1.4 HL 5000™ Configurations

1.4.1 HL 5000™-1

Includes receiver w/standard software, universal PAMU40 microphone, cable, 2-extension rods, contact spike, tri-point ground plate, hard case and operation manual.

1.4.2 HL 5000™-2

Includes receiver w/standard software, universal PAMU40, wind protected GM-50 microphones, cable, 2-extension rods, contact point, tri-point ground plate, hard case and operation manual.

1.4.3 HL 5000™-3

Includes receiver w/professional software, universal PAMU40 microphone, magnetic adapter, cable, 2-extension rods, contact point, tri-point ground plate, hard case and operation manual.

1.4.4 HL 5000™-4

Includes receiver w/professional software, universal PAMU40 and wind protected GM-50 microphones, cable, 2 extension rods, contact point, tri-point ground plate, hard case and operation manual.

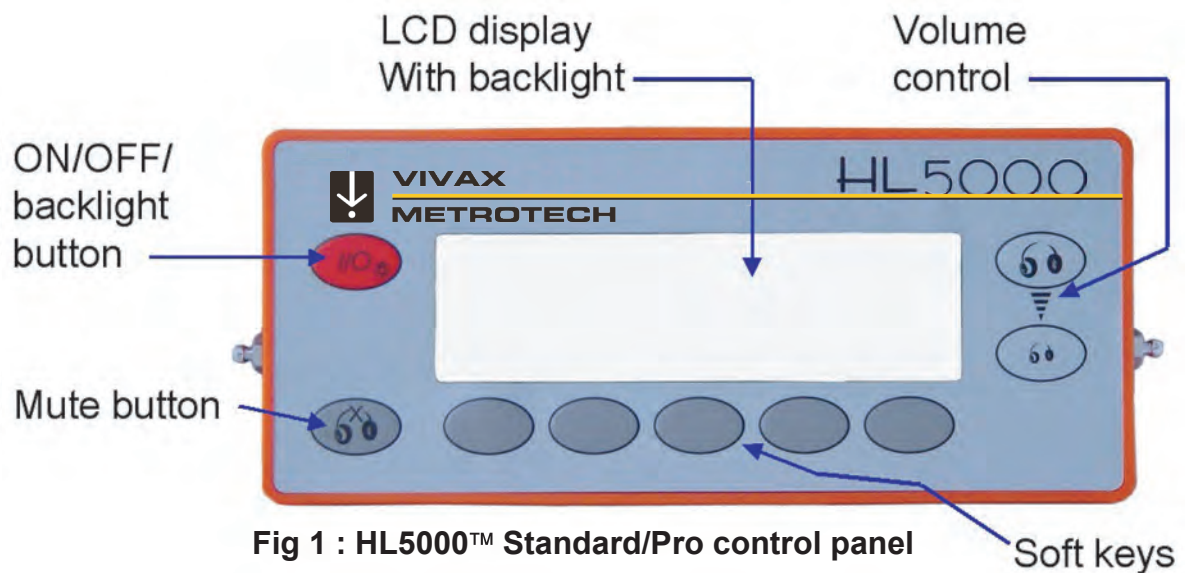
1.4.5 Accessories

GM50 ground microphone	GM50
GM50 magnetic plate	PAM-W-1-D
PAMU40 microphone	PAM-U-M
PAMU40 plate	11504
Headphones	158096
Extension rod	VST T-1
Magnetic adapter	110030010
Valve adapter 1.65"	AD S-42
Valve adapter 0.78"	AD S-20
Carrying case	11543

2 Getting to know the HL 5000™

Before using the HL 5000™, it is recommended that you take some time to become familiar with the unit and its features.

2.1 HL 5000 Controls



2.2 Connection of Components and Accessories

The HL 5000™ is designed specifically for use with Metrotech components and accessories. Attempting to connect other headphones or microphones to the equipment may cause damage to the unit and lead to equipment failure. Fig. 2 illustrates the headphone and microphone connections, respectively, on the sides of the receiver.



Fig 2 : Side view left and right with connections

2.3 Battery Compartment

To access the battery compartment, loosen the two screws on the underside of the unit and remove the base plate (Fig.3). Eight AA batteries power the HL 5000™. When installing or replacing batteries in the unit, be sure that the positive and negative terminals of each battery are correctly aligned.

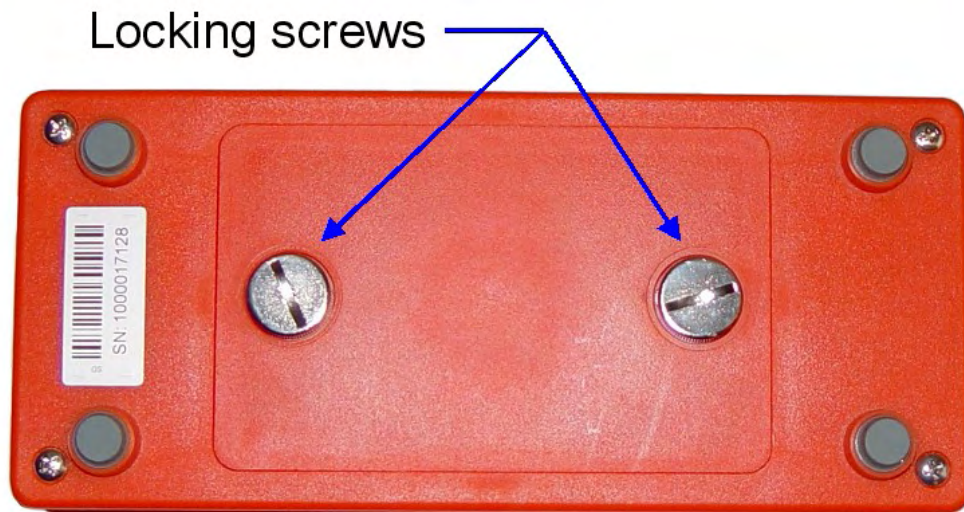



Fig 3 : Battery access plate

2.4 Automatic Battery Monitoring

While the HL 5000™ is in operation, the battery level is monitored continuously. The battery symbol in the top right of the display will begin to flash when there are approximately 4 hours of battery life remaining.

2.5 Backlight

With the equipment on, briefly push the on/off button . The backlight for the display will be activated / deactivated.

2.6 Microphones

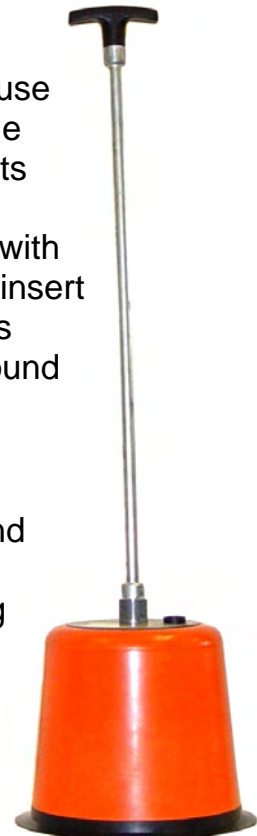
The microphones are connected to the HL 5000™ via a multi-pin cable connection on the right hand side of the equipment (see Fig. 2). There are two microphones available for use with the HL 5000™: the PAM U 40 Universal/Contact Microphone and the GM-50 Wind-Protected Ground Microphone. The following sections detail each of the two microphones and the various configurations of the PAM U 40.

2.6.1 GM50

The GM-50 is an active piezo ground microphone for use on pavement and other hard surfaces. The microphone is particularly well shielded from the wind by virtue of its bell shaped housing and rubber skirt. The carrying handle/rod, once inserted, is securely locked in place with a quick, quarter-turn to the right. The ability to quickly insert and remove the handle after placing the microphone is particularly helpful when trying to reduce unwanted sound created by strong winds blowing against the handle.

Important note:

Piezo-electric microphones like those in the GM-50 and PAM U 40 provide superior performance but can be damaged when subjected to impact. When positioning the microphone, avoid dropping it onto hard surfaces; instead, carefully place it in position.



2.6.2 PAM U 40 Universal Microphone

The PAM U 40 is a piezo-electric microphone that was developed primarily as a contact and/or survey microphone. With the use of various adapters, however, it is very effective in nearly all leak detection situations.

Sensor Rod Configuration:



This configuration allows the operator to quickly survey the distribution system for leak sound by touching the tip of the rod to points of contact like valves, hydrants, or even the pipe itself. It also enables the PAM U 40 to serve as an effective ground microphone by pushing the spike into the soil where conditions allow it.

Extension rods give the operator the option of maintaining a comfortable, upright position while working or to reach deeper contact points. They also, however, can provide greater exposure to wind and other interfering sounds.

Fig 4 : PAM U 40 with sensor rod

Magnetic Configuration:



When holding the microphone, even the smallest movements by the operator can create loud sounds that interfere with the measurement.

The magnet in this configuration allows the sensor to be placed on ferromagnetic (metals containing iron are magnetic) contact points (such as hydrants and valves) and remain still during measurement. This configuration provides excellent transmission of sound vibrations to the sensor because of the magnet's strong connection with the contact point.

Fig 5 : PAM U 40 with magnet

Caution: Whenever possible, grasp and pull the microphone itself – not the cable – when removing the microphone from a magnetic contact point. This will help prevent possible damage to the microphone cable.

2.7 Headphones

The supplied headphones with ambient sound insulation come standard with the HL 5000™. These electro-dynamic headphones provide excellent reproduction of leak sounds while blocking out ambient sound to 85 dB.




Fig 6 : Headphones

3 Operation

3.1 Connection and Removal of Attachments

Always make sure that the HL 5000™ is off when connecting or removing the headphones or the microphone.

3.2 Turning the Unit On

After attaching both a microphone and the headphones, press the On/Off button  on the control panel of the unit. The welcome screen, displaying the current software version number and the battery status, will appear while the unit is powering up.

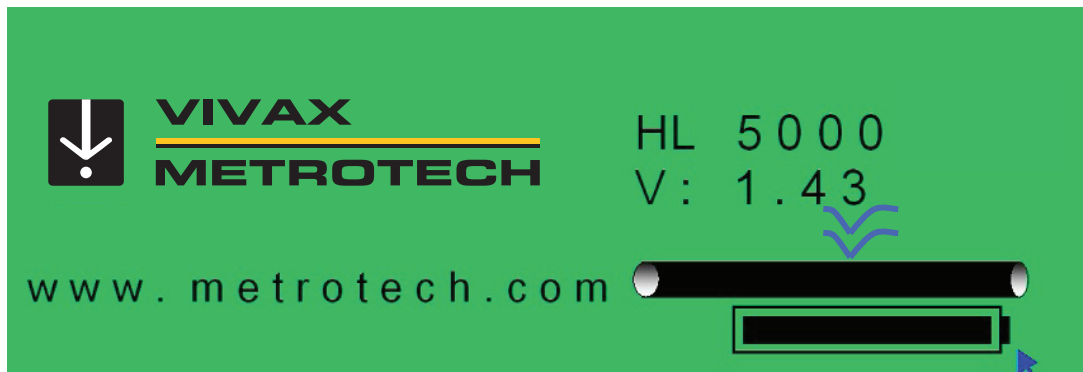


Fig 7 : Display at switch on

Battery status 

After a few seconds, the opening menu appears with the last equipment settings.

Setting the headphone volume

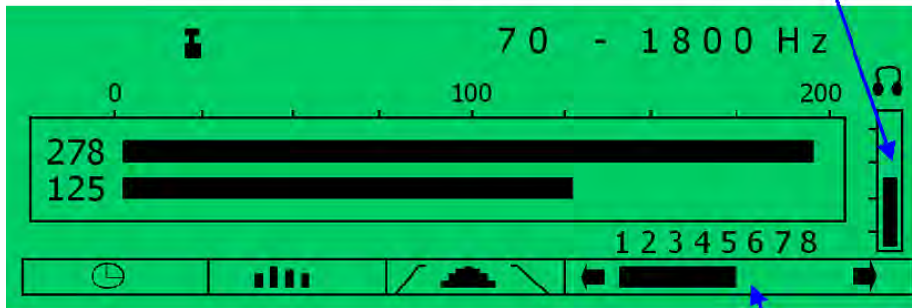


Fig 8 : Main Screen with Main Menu

Amplification
setting

3.3 Headphone Volume and Microphone Amplification (Gain)

The HL 5000™ is equipped with separate controls for volume and gain to accommodate different user preferences across a variety of leak detection situations.

3.3.1 Setting the volume

The user can set the headphone volume by using the two soft keys on the far right of the front panel (see Fig. 9).

Note: Adjusting headphone volume affects *only* the operator's ability to hear the sounds that are being processed by the instrument. Microphone gain (amplification of sound processed by the unit) is not affected.

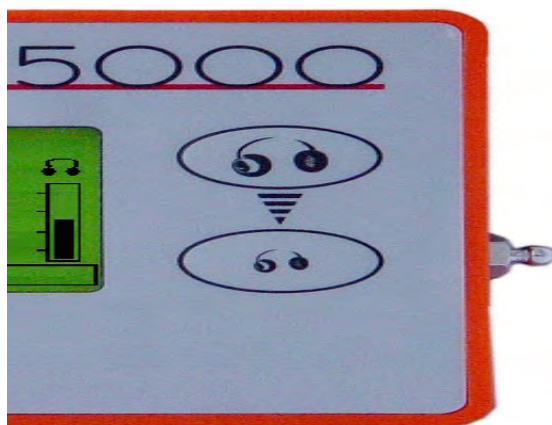


Fig. 9: Soft Keys for Setting the Volume

3.3.2 Setting the gain

The amplification of the microphone signal, or gain, adjusts the level of sound passed from the microphone to the receiver for processing. A high gain setting would allow the equipment to detect and process far-off and/or low-level sounds more easily; close proximity to a leak or loud leak

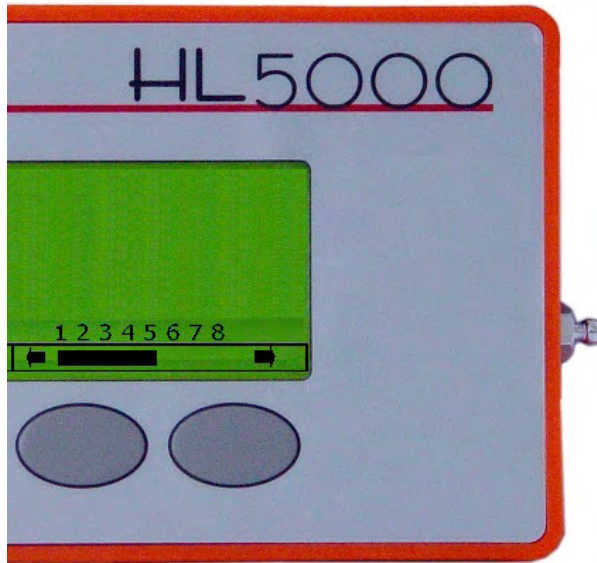


Fig 10 : Soft Keys for Gain Adjustment

sounds would not require as much amplification and therefore allow the operator to use a lower gain setting.

Actual pinpointing of a leak's location involves measuring the leak sound level at a number of different points along the line and then comparing the measurements to one another to determine the point at which the leak sounds are loudest. Although a high microphone gain setting (7-8) is desirable when initially surveying for leak sounds, a medium gain setting (3-5) is recommended when comparing actual leak sound levels at different points along the line.

Note: Adjusting the gain (done by using the two soft keys found on the bottom right of the front panel - see Fig. 10) will affect both the displayed sound levels and headphone volume. The bar over the top of the two buttons (Fig. 10) shows the gain setting on a scale from 1 (min) to 8 (max).

3.4 The Main Screen

When performing leak detection, one of the difficulties faced by operators is how to identify and measure the sound made by a leak when other interfering sounds are also present. The HL 5000™ utilizes a feature called Dual Segment Analysis (DSA) to differentiate between the two types of sounds. Leak sounds, when present, do not change or go away; they are constant. Other sounds (wind blowing, passing cars, dogs barking) within range of the microphone will vary and show changes in volume and intensity or disappear altogether. DSA allows the HL 5000™ to analyze all the sounds detected by the microphone and separate those sounds that are constant and unchanging (like those caused by a water leak) from those that are caused by elements of the surrounding environment. The levels of each type of sound are then displayed by separate bar graphs on the main screen.

The Main Screen (Fig. 11) reveals both the current total sound level (top bar) and the minimum constant leak sound level (bottom bar) for all sound frequencies currently selected by the user (see Section 3.5 on Filter Selection). Measurement of sound levels takes place when the unit is on and the headphones are not muted. When the headphones are muted, the unit is placed in stand-by mode and the last measured sound levels remain displayed. When the unit is returned to measurement mode (un-muted) the measurement cycle begins again and any changes in the two sound levels are re-calculated and displayed.

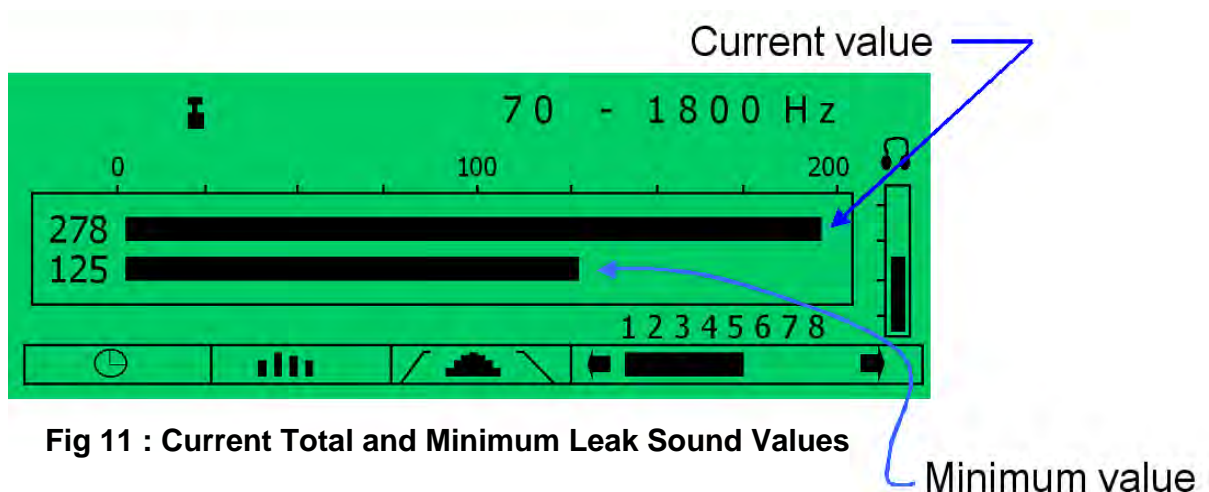


Fig 11 : Current Total and Minimum Leak Sound Values




3.5 Filter Setting (HL 5000 Professional)

3.5.1 What are filters?

One of the characteristics of a sound is its frequency. Technically speaking, the frequency of a sound is the number of waves generated by that sound per cycle. The greater the number of waves per cycle, the higher the frequency of the sound. In turn, the higher the frequency a sound has, the higher in pitch that sound will be. Low-frequency sounds are low-pitched; high-frequency sounds are high-pitched. Leaks on plastic and PVC lines typically create low-frequency sounds and are low-pitched to the ear; leaks on copper and other metallic lines tend to create high-frequency sounds and are high-pitched to the ear.

The HL 5000™ is designed to measure and display sound levels at frequencies from 0 to 4,000 Hz. On the Filter Menu screen, this broad spectrum is divided into 9 smaller frequency bands arranged in ascending order (0 - 70, 106, 160, 240, 360, 540, 800, 1200, 1800 - 4000 Hz) and each of these smaller frequency bands is called a filter. Any sound that the HL 5000™ hears and analyzes is broken down into the individual frequencies that created the sound, and the process of selecting specific frequency bands, or filters, for the HL 5000™ to focus on - or to ignore - is referred to as “setting the filters.”

3.5.2 Filter Selection


While the unit is in listening or measurement mode, go to the filter selection screen. This is done by pressing the soft key  under the Filter Menu icon found on the Main Screen.  


The 9 vertical bars displayed on the Filter Selection screen (one for each corresponding filter) show the user how much (or how little) each individual frequency is contributing toward the overall sound(s) being processed by the HL 5000™ at that moment. The presence or absence of activity on any particular frequency, or filter, can help the user decide whether or not to select it for measurement. When a filter, or group of filters is selected for measurement, three things happen:

1. On the Filter Selection screen, a horizontal bar will be displayed beneath the selected filter or filters (Figure 12).
2. When the unit is placed in normal Listening Mode (the Main Screen), Memory, or Continuous Listening Modes, the HL 5000™ will focus on measuring the constant, minimum leak sound levels of only the frequencies selected by the user on the Filter Selection screen. Unwanted sounds of interference, such as the hum of power lines, for example, can be minimized or completely eliminated by not selecting the filter (in this case, the 0-70 Hz filter) associated with the sound.
3. The selected filters/frequency range will be displayed in the upper right-hand corner of the Main Screen.

Sound activity on all the filters will continue to be visible on the Filter Selection screen (allowing the user to decide when it is appropriate to change the filter settings), but only sounds generated by the selected frequencies (filters) will be measured by the HL 5000™ when the unit is in other modes of operation.

Filters are selected or de-selected by using the lower (Fig.13) and upper (Fig. 14) cut-off soft keys found underneath of and to the right of the individual frequency bars, respectively.

When selecting or de-selecting filters using the lower cut-off,  the user will automatically begin with the lowest selected filter. By pressing either the left- or right-arrow soft keys, the user will be able to add or remove filters to those already selected.

When selecting or de-selecting filters using the upper cut-off,  the user will automatically begin with the highest selected filter. By pressing either the left- or right-arrow soft keys, the user will be able to add or remove filters to those already selected.

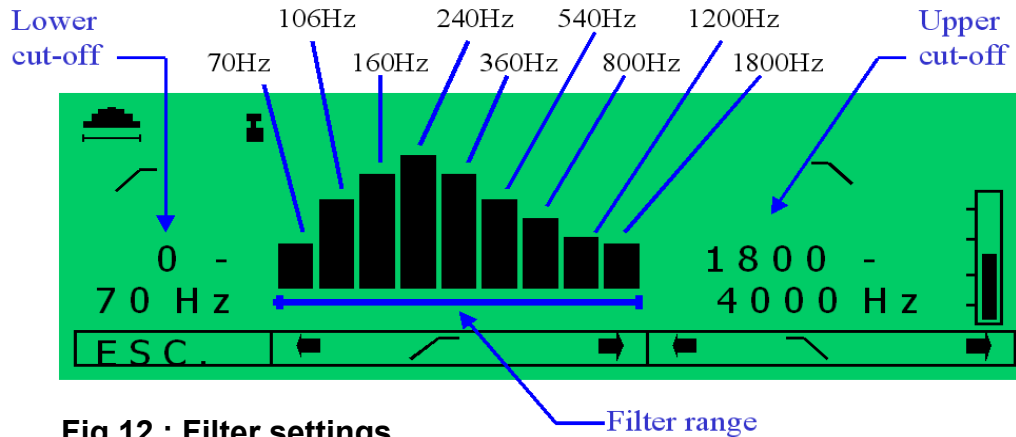


Fig 12 : Filter settings

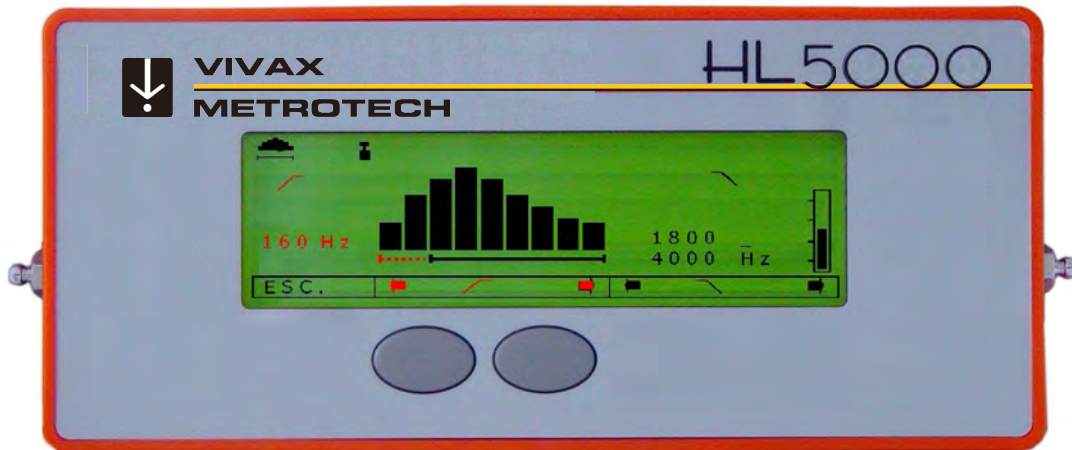


Fig 13 : Adjusting the lower filter cut-off frequency

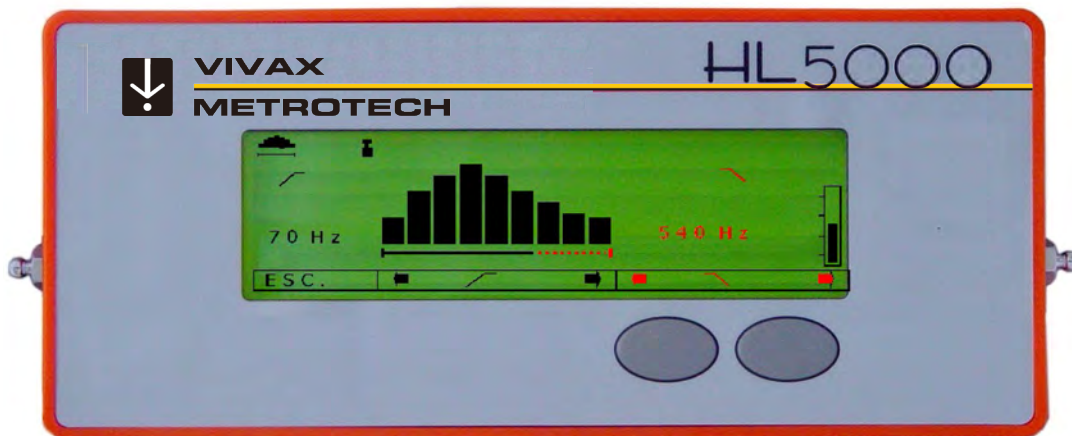


Fig 14 : Adjusting the upper filter cut-off frequency

After the filters have been selected, use the ESC soft key to return to the main menu.

3.6 Filter selection in the field

Filter selection on the HL 5000™ is largely determined by the type of pipe material the suspected leak is on and whether the operator is pre-locating or pinpointing the leak. In order to detect any potential leak sound, an operator may want to use all available filters when attempting to pre-locate a leak. When actually pinpointing the location of the leak, an operator may want to select only the filter or filters on which the constant minimum leak sound is most active.

As a general rule, leak sounds on plastic pipes (and very large diameter pipes of any type pipe material) tend to be low frequency (106 - 540 Hz); leak sounds on metallic and other high-density pipe materials (like asbestos cement) tend to be higher frequency (360 - 1200 Hz). In addition, because the ground itself muffles sound, leak sounds detected with a ground microphone tend to be lower in frequency than those detected with a contact microphone placed in direct contact with the line. The following are two suggested filter settings:

3.6.1 Filter selection A (Ground microphone GM50, PAM U 40 with ground plate).

When using a ground microphone, a filter range of 240 Hz - 540 Hz is recommended.

3.6.2 Filter Setting B: Contact Microphone (Pam U 40 w/ Spike or Extension Rods).

For measurements directly on the pipe with the sensor spike, a filter range of 540 Hz - 1200 Hz is recommended.

3.6.3 Leak Detection Process and Filter Selection

When conducting leak detection in areas where the specific pipe material is known, an operator may want to set the filters

according to the above guidelines. It is possible, however, for leak sounds to be outside of the expected filter settings so a more systematic, 2-stage process is recommended:

1. Select all available filters and survey the system for any leak sound. When potential leak sound is detected, continue pre-location with all filters active until the loudest area of sound is located. Go to the Filter Selection screen (Figure 12) and see what specific frequency (or frequencies) is most active.
2. Set the HL 5000™ so that only the 2 or 3 frequencies showing the most activity are selected (Section 3.5.2). Return to the areas where the suspected leak sound was loudest and measure the leak sound level using the selected filters. The point at which the filtered leak sound is loudest, pinpoints the location of the leak.

3.7

Mute button




Pressing the mute button on the control panel one time places the HL 5000™ in stand-by mode. When the unit is in standby mode, no sound is passed through to the headphones and no sound measurements are taken. Pressing the button a second time returns the unit to listening/measurement mode, at which time the displayed values on the Main Screen are updated.

Caution:

Even careful placement of the microphone can result in extremely loud sounds in the headphones. To protect the hearing of the operator, it is recommended that headphones be muted before moving the microphone.

3.8 The Memory Mode

The Memory Mode function is used to compare a series of sequentially recorded measurements and can be used for pre-locating or pinpointing leaks.

To activate the memory mode function, press the memory soft Key  on the control panel (Fig. 1). The LCD display simultaneously switches to the memory mode screen and the first memory measurement is activated. Pressing the mute button one time after the unit is in memory mode will put the unit in stand-by mode and store the current memory measurement. Pressing it a second time brings the unit out of stand-by mode and activates the next measurement. By repeating this process, up to nine values can be stored, one after the other. When more than nine values are measured, the first value will be deleted and all other values will be shifted one position to the left. In this way, the last nine values are always visible.

An individual memory measurement consists of a dual segment analysis (DSA), showing the current total sound value (narrow column) and the minimum leak sound value (wide column - Fig. 15).

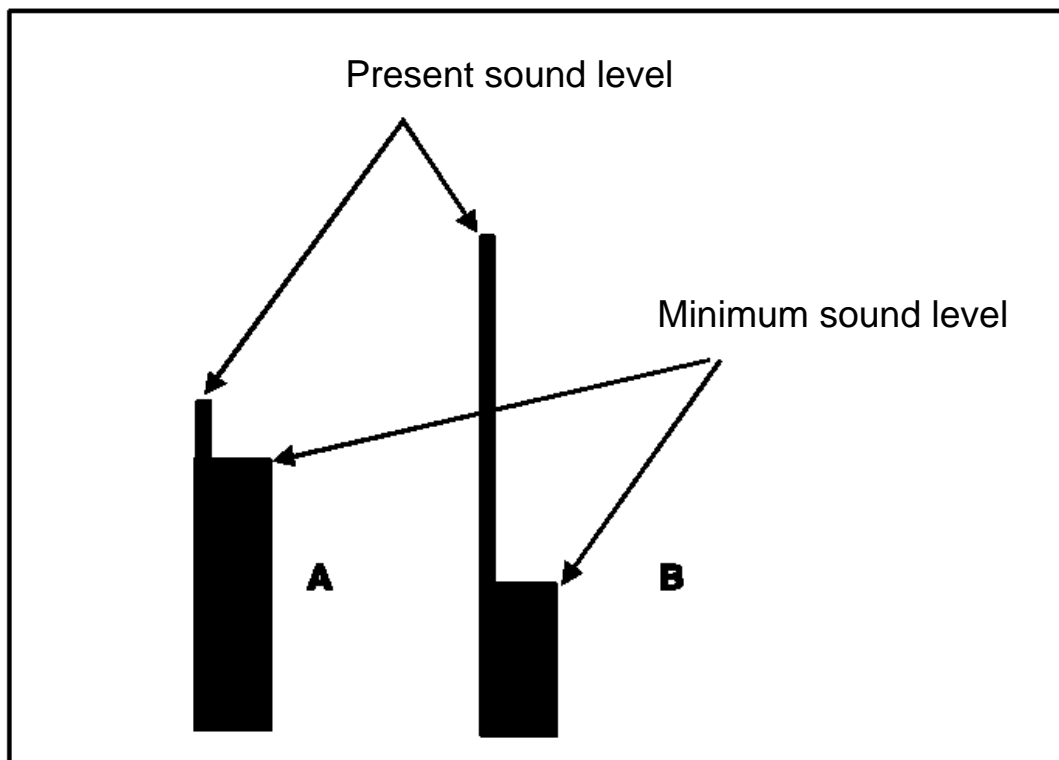


Fig 15 : Dual segment analysis (DSA)

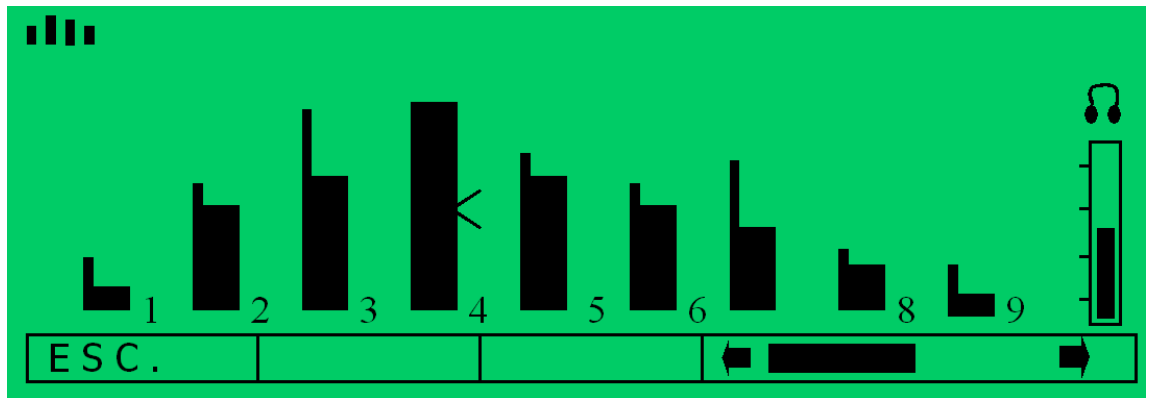




Fig 16: Memory measurement


Changes in the minimum leak value (wide column) are particularly significant; as the operator gets closer to the leak, the minimum leak sound level increases with each new measurement. Conversely, it will decrease as the operator moves further away from the leak. Figure 16 shows a series of memory measurements first moving close to the leak, and then away from the leak sound. The HL 5000™ places a small symbol to the right of the memory measurement with the highest minimum leak sound, helping the operator identify the area closest to the leak. To exit the memory mode, press the ESC soft key.

3.9 Continuous Measurement (HL5000 Professional)

Continuous Measurement mode allows the operator to set the microphone in position and monitor sound levels at that location over short periods of time. Operators often use this feature to see what happens to a leak sound when a nearby valve is closed and re-opened.

To enter continuous measurement mode, press the soft key below the continuous measurement symbol  on the Main Screen.

The HL 5000™ can continuously measure leak sound for 3, 10, or 30-minute intervals. When in continuous measurement mode, repeatedly press the  soft key until the desired length of measurement period has been selected (Fig. 17).

Pressing the  (start) soft key will begin the measurement, during which time the results will be displayed by a graph on the screen.

The measurement can be stopped before the end of the set measurement period by pressing the ■ (stop) soft key.

Figure.17 illustrates a typical sound level graph created during a continuous measurement. After positioning the microphone in contact with the water line he or she wished to monitor, the operator activated the continuous measurement mode on the HL 5000™. He or she then closed and, after a short time, re-opened the valve supplying water to the line being monitored. In this case, the graph shows that the leak sound disappeared when the valve was closed and reappeared when the valve was opened again.

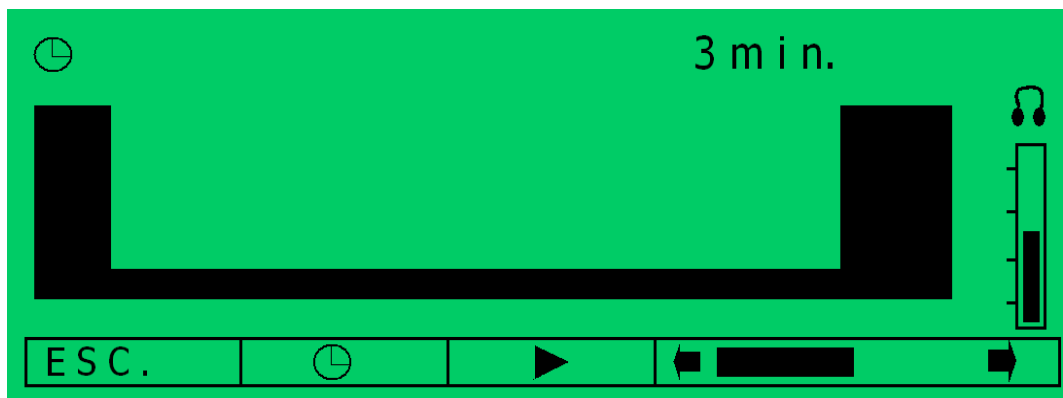



Fig 17: Continuous Memory Measurement Display

Pressing the ESC soft key will exit the continuous measurement mode and return the user to the main screen.

3.10 Pipe Location Using the RSP-3 (HL5000 Professional)

Most of today's technology for locating non-metallic water lines involves creating sound impulses on the water line itself and then tracing the line by hearing those sounds with an acoustic listening device like the HL 5000™. When in normal leak measurement mode, the HL 5000™ suppresses intermittent impulse sounds, but when placed in Line Location Mode, it easily detects impulse sounds (like those generated by Metrotech's RSP-3 Plastic Pipe Locator, sold separately) and becomes a valuable tool for helping to locate non-metallic lines.


To enter Pipe Location Mode, press the impulse image  soft key (second soft key from left) while the Welcome Screen is still displayed.

When in Line Location Mode, the impulse image will be visible in the top left corner of the Main Screen and the measured sound level will be displayed by a single, wide bar. Upon entering location mode, the filters on the HL 5000™ are automatically set to a low range of frequencies, but, if desired, can be changed manually by the operator (see Filter Setting, section 3.5.2).


Once placed in Line Location Mode, the HL 5000™ will stay in line location mode until it is switched off. When the unit is turned on again, it will be in normal leak detection mode.

3.11 Switching off the HL 5000™



The equipment is switched off by pressing and holding the  button until the images on the LCD disappear. When the unit is turned off, any stored measurements will be lost.

The HL 5000 will switch off automatically after 35 minutes of continuous operation.

In memory mode  the equipment will remain on as long as it remains in use. After 35 minutes of inactivity, the unit will switch off automatically.

4 Troubleshooting

4.1 Unit Will Not Switch On

Check to make sure batteries are correctly installed.

Replace batteries.

4.2 Battery Monitor Does Not Function

Check to make sure all batteries are correctly installed.

Replace batteries.

4.3 No sound can be heard

Check the headphone connection.

Press the mute button  to restore the sound.

4.4 Scratching Sounds In the Headphones

Check all microphone connections.

4.5 Service Centers

If the instrument does not function properly, replace the batteries as described above. If the equipment still malfunctions, contact one of our Metrotech Customer Service departments for assistance:

Vivax-Metrotech Corporation

3251 Olcott Street,
Santa Clara, CA 95054, USA
Website : www.vivax-metrotech.com

Sales & Sales Support:
T/Free : +1-800-446-3392
Tel : +1-408-734-1400
Fax : +1-408-734-1415
Email : sales@metrotech.com

Application Support:

T/Free : +1-800-624-6210
Tel : +1-408-454-7159
Fax : +1-408-743-5597
Email : applications@metrotech.com

Service & Repairs:

T/Free : +1-800-638-7682
Tel : +1-408-962-9990
Fax : +1-408-734-1799
Email : service@metrotech.com

All Other Department:

T/Free : +1-877-330-1647
Tel : +1-408-734-3880
Fax : +1-408-962-9993

CanadaVivax Canada Inc.

400 Esna Park Drive,
Unit 17, Markham,
Ontario, L3R 3K2, Canada
Tel : +1-289-846-3010
Website : www.vivax-metrotech.com
Email : CanadianSales@vivax.biz

EuropeSebaKMT

Seba Dynatronic
Mess-und Ortungstechnik GmbH
Dr.-Herbert-Iann-Str. 6,
96148 Baunach, Germany.
Tel : +49-9544-680
Fax : +49-9544-2273
Website : www.sebakmt.com
Email : service@sebakmt.com

Australasia SebaKMT AUS

Unit 1, 176 South Creek Road,
Cromer NSW 2009, Australia
Tel : +61-2-9972-9244
Fax : +61-2-9972-9433
Website : www.sebakmtaus.com
Email : sales@sebakmtaus.com
service@sebakmtaus.com

Leidi Utility Supply (Shanghai) Ltd.

Rm405 3rd Building No. 641, Tianshan Rd,
Shanghai, China 200336
Tel : +86-21-5187-3880
Fax : +86-21-5168-5880
Website : www.leidi.com
Email : info@leidi.cn

Or call the factory for the nearest authorized Metrotech repair station.

Additional Metrotech Instruments: Pipe and Cable Locators, Multi Frequency Locators, Magnetic Locators, Fiber Optic Cable Locating System, Leak Detectors, Valve Box Locators, High Power Transmitter, Correlators, Sound Data Loggers and Marker Detector.

APPENDIX

A1 APWA Marking Colors - The following color markings have been established by the American Public Works Association (APWA):

Conductor	Color
Electric power lines, cables, or conduits	Red
Communication lines, cables, conduits, CATV	Orange
Gas, oil, petroleum, or other gaseous materials	Yellow
Sewers, storm and sanitary, drain lines	Green
Water, irrigation, or slurry lines	Blue

Note: If you have any questions regarding marking requirements or procedures in the United States, please call you local One Call Center. International customers: please check with your local regulatory authorities or utility companies. Required color markings may vary between different countries.

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WARRANTY

THERE ARE NO WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY, BEYOND THOSE STATED HEREIN.

Metrotech warrants its equipment to be free from defects in workmanship and material under normal and proper use and service for one year from date of purchase by original user. Metrotech assumes no obligation to repair or replace equipment which has been altered or repaired by other than a Metrotech-approved procedure, been subject to misuse, misapplication, improper maintenance, negligence, or accident; has had its serial number or any part thereof altered, defaced or removed; or been used with parts other than those approved by Metrotech. Warranty does not include batteries. Expendable items such as fuses and lamps are excluded.

Any detection product proved defective under this warranty will be repaired or replaced free or charge at the Metrotech Corporation factory or approved Metrotech repair station. The equipment should be returned to our factory by prepaid transportation after requesting and receiving return authorization from our Service Department.

Metrotech's obligations are limited to repair or replacement of broken or defective parts, which have not been abused, misused, altered, or accidentally damaged, or at the option of Metrotech, to refund of the purchase price. Metrotech assumes no liability for removal or installation costs, consequential damages, or contingent expenses of any other nature.