SC160

Sound Level Meter

Spectrum Analyser

User's Manual

M_SC160_v1053_20170705_EN

This version of the manual is valid for instruments with serial number from T224738

ENGLISH

CONTENTS

1. GENERAL FEATURES

The **SC160** is a class 2 integrating-averaging sound level meter that complies with IEC 60651:01 and IEC 60804:00 international regulations and their EU counterparts EN 60651:94/A1:94/A2:01 and EN 60804:00. It also complies with ANSI S1.4:83/A1:01 and ANSI S1.43:97(A2:02).

The **SC160** is also a spectrum analyser measuring in real time and in octave bands*. It covers a frequency range from 22 Hz and 22,5 kHz with class 2 octave filters, which comply with IEC 61260:1995/A1:01 and ANSI S1.11:04 type 2.

***ATTENTION:** The Spectrum Analyser mode in octave bands is optional. Reference number SC160sb does not have this option. If you wish to incorporate it you should acquire module FB160. Reference number SC160cf does incorporate the analyser mode in octave bands.

1.1 How the instrument works

The **SC160** may be used either as a sound level meter or as a spectrum analyser.

As a sound level meter it simultaneously measures the following functions:

- The sound pressure level with 'S', 'F' and 'I' time averaging and their maximum and minimum values during the measurement period.
- The peak sound pressure level.
- The sound exposure level, also known as SEL.
- The equivalent continuous sound pressure level with programmable consecutive integration time T and its maximum and minimum values, also known as L_{eq}.
- The equivalent continuous sound pressure level or L_{eq} during the measurement period.
- The total percentile levels corresponding to 1, 5, 10, 50, 90, 95 and 99 % of the entire measurement and the partial levels of each T interval with frequency weighting A.

All these functions are measured simultaneously with the following frequency weightings:

- Frequency weighting A.
- Frequency weighting C.
- Frequency weighting Z (zero): frequency weighting equivalent to 0 dB from 10 Hz to 20 kHz.

As a spectrum analyser it measures the following functions simultaneously and in real time:

- The equivalent continuous sound pressure level with programmable consecutive integration time T and without frequency weighting for each octave band centred on frequencies of 31.5, 63, 125, 250, 500, 1000, 2000, 4000, 8000 and 16000 Hz.
- The maximum of the peak sound pressure level of the T integration interval for each of the octave bands.
- The equivalent continuous sound pressure level of the T integration interval with frequency weighting A, C and Z.
- The maximum of the peak sound pressure level of the T integration interval with frequency weighting A, C and Z.
- The noise assessment, in real time, using the NC curves criterion and the NR curves rating.

See APPENDIX A for the names and definitions of each of the functions measured.

1.2 Main features of the SC160

The **SC16**0 is a user-friendly sound level meter that allows you to make sound measurements quickly and conveniently.

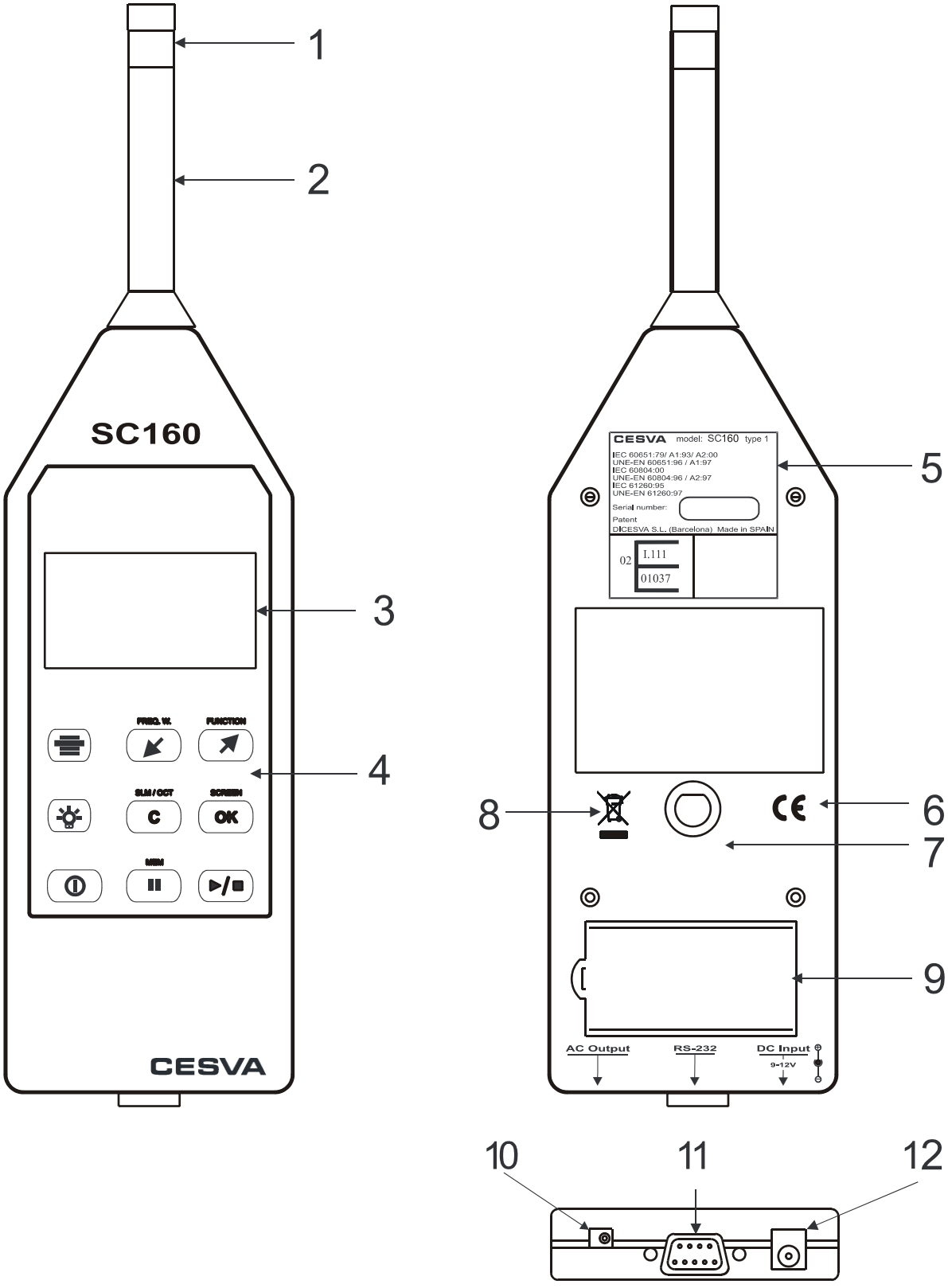
The most important features of the SC160 are the following:

- The SC160 has a single user range; there is therefore no need to adjust the scale prior to beginning a measurement, whatever the sound event to be measured.
- Whether you use it as a sound level meter or spectrum analyser, the SC160 simultaneously measures all functions with all the available frequency weightings (A, C and Z).
- The SC160 microphone is detachable. You can unscrew it and move it away from the SC160 by using the extension cable (CN-ITV).
- The SC160 is equipped with communications software, allowing you to configure the instrument and download all the recorded data and real-time measurements into a personal computer. This way they are available in electronic format.
- The SC160 AC output is designed to pick up the direct preamplifier signal. This allows you to make a calibrated recording on a D.A.T. and subsequently analyse it both quantitatively (impulse or tonal sound level analysis) and qualitatively (exceptional sound event detection – shouts, undesirable noises, etc.). The SC160 is equipped with a 40 dB built-in amplifier to adapt the measurement range to the dynamic range of the recording.
- The SC160's graphic screen displays the measured functions in both graphic and numeric formats. The graphic display is highly practical when it comes to studying a sound event, evaluating its time history or analysing its spectral contents. The SC160's screen lights up at the push of a button, allowing you to work in dim conditions or in the dark.
- The SC160's membrane keyboard is absolutely flat. This way its excellent sound response is never impaired.
- The SC160 has an internal memory for storing the data measured. The storage of this data in the memory can be set, allowing the form of data recording to be adapted to the kind of measurement being conducted.
- The SC160 stores in its memory the time and date of the last time the sensitivity was modified (see 2.2.3).
- The SC160 has multiple language support and once a language is selected, it will remain selected even if the unit is turned OFF (see paragraph 2.6.5).

1.3 Description of the SC160

The main components of the **SC160** are listed below, the numbers corresponding to those in the outline drawing:

1. **½'' condenser microphone**. The SC160 works with the P-05 microphone. This kind of microphone is removable. To move it away from the SC160 body, use the CNR-ITV cable.
2. **Preamplifier**. Non-removable preamplifier.
3. **Screen**. Illuminated LCD graphic screen.
4. **Membrane keyboard**. Extra-flat keyboard designed to reduce the reflections that may reach the microphone from the sound level meter case.
5. **Characteristics plate**. Showing the make, model and serial number of the sound level meter, along with all the standards it complies with as class 2.
6. **CE mark**. European approval mark.
7. **Tripod mount**. Built-in support for tripod with standard ¼" W thread (TR-40).
8. **WEEE mark**. Symbol indicating separate collection for electrical and electronic equipment.
9. **Battery cover**. To change the battery, simply remove the cover.
10. **AC output**. Direct output from the preamplifier without frequency weighting. Specially designed to make recordings in D.A.T. medium.
11. **RS-232 input/output connector**. D-Sub 9 pin-connector for serial connection of the sound level meter to a personal computer.
12. **DC input**: Input with which to connect to a DC mains supply (9-12 V, 100 mA). (A-201)


1
2
SC160
3
FREQ. W.
FUNCTION
4
SLM / OCT
SCREEN
C
OK
MEM
CESVA
CESVA model: SC160 type 1
IEC 60651:79/ A1:93/ A2:00
UNE-EN 60651:96 / A1:97
IEC 60804:00
UNE-EN 60804:96 / A2:97
IEC 61260:95
UNE-EN 61260:97
Serial number:
Patent
DICESVA S.L. (Barcelona) Made in SPAIN
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01037
5
8
6
7
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AC Output
RS-232
DC Input
9-12V
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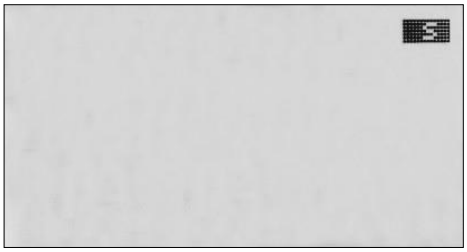
12

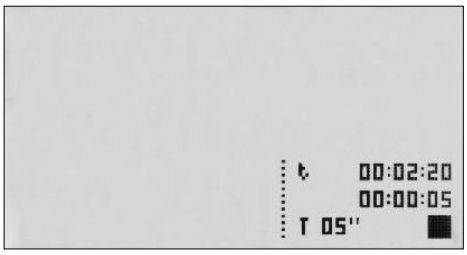
1.4 Screen

The SC160 mode in use is always indicated in the top right-hand corner of the screen:



- S Sound Level meter mode
- 1/1 Octave band Spectrum Analyser

While the SC160 is measuring, the following information appears at the bottom right of the screen:

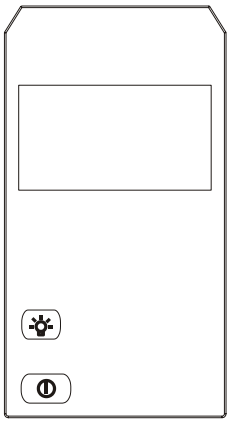


- The measurement time t elapsed
- The integration time elapsed (between 0 and T). (For L_T the SC160 carries out consecutive integrations of T time, whether it is functioning as a sound level meter or spectrum analyser)
- The T integration time (for L_T only)
- Indication of the state of the measurement:
  - ■ measurement completed
  - ▶ measurement in progress (flashing when storing in memory)
  - ❚❚ measurement temporarily paused

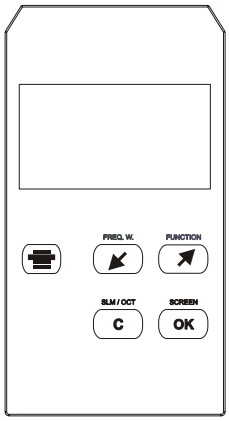
Note: Do not confuse the elapsed measuring time (t) with the integration time (T)

1.5 Using the keyboard

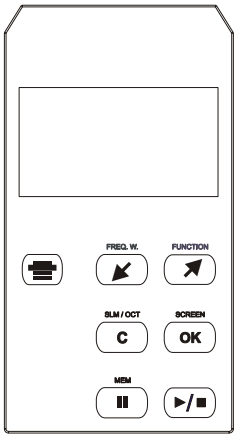
The following tables show the function of the different keys of the **SC160**:



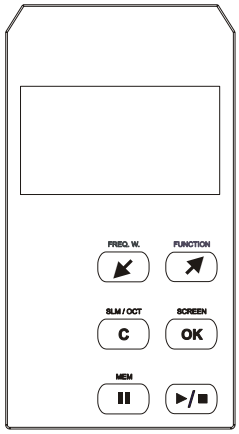
GENERAL KEYS:	
⏻	Key for switching the SC160 on and off (RED)
☼	Key for turning the screen light on and off



SC160 MENU KEYS:	
☰	Key to access the SC160 menu
↙	Key to move downwards in the menu
↗	Key to move upwards in the menu
OK	Key to confirm or switch options
C	Key to return to the previous menu



SC160 SOUND LEVEL METER KEYS:	
▶/■	Key to begin or terminate a measurement
MEM II	a) Key to temporarily interrupt a measurement (PAUSE) (while the SC160 is in ▶) b) To start recording data into memory (when SC160 is stopped i.e. ■)
FREQ. W. ↙	Key to select the frequency weighting displayed on the screen
FUNCTION ↗	Key to select the function displayed on the screen
SCREEN OK	Key to select the desired sound level meter screen: numerical, graphic or statistical
SLM / OCT. C	Key to switch from sound level meter to spectrum analyser and vice versa
☰	Key to access the preferred numerical screen, from the numerical screen only



SC160 SPECTRUM ANALYSER KEYS:	
▶/■	Key to begin or terminate a measurement
MEM II	a) Key to temporarily interrupt a measurement (PAUSE) (while the SC160 is in ▶) b) To begin recording (when SC160 is in ■)
FREQ. W. ↙	Key to return to the previous octave band
FUNCTION ↗	Key to go on to the next octave band
SCREEN OK	Key to select the desired spectrum analyser screen: numerical spectrum analysis, graphic spectrum analysis or NC and NR curves
SLM / OCT. C	Key to switch from the spectrum analyser to the sound level meter and vice versa

2. USING THE SC160

This chapter contains all the necessary information to configure and adjust the SC160 and carry out sound level and spectrum measurements.

2.1 First steps

This section describes what to do before starting to use the SC160.

2.1.1 Material and literature

The first step is to check that all the material and literature supplied with the SC160 is there:

Material:

- SC160 sound level meter
- Case
- Wind screen
- 9 V alkaline battery
- RS-232 serial connection cable to connect the instrument to a PC
- Communication software to download data into a PC: CESVA **Capture Studio**

Literature:

- Sound level meter User's Manual
- Warranty
- Verification certificate

Should anything be missing, contact your official CESVA distributor.

2.1.2 SC160 power supply

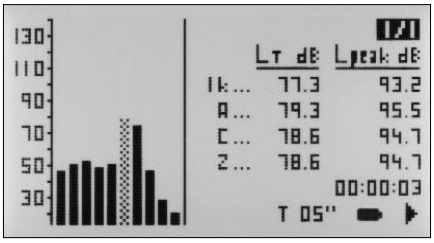
Before turning the SC160 on, the first thing to do is connect it to a battery or other power supply. *Note: The components referred to in the text are indicated in the outline on page 7 and listed in parenthesis, e.g. [11]*

The **SC160** sound level meter is fed by a 6LF22-type alkaline or lithium battery or by direct current [12]. For DC supply use the CESVA A-201 model mains feeder. If both systems are used at the same time, the SC160 selects the one offering the higher voltage. The maximum permitted input voltage is 12.0 volts. This means a "12 V" car battery should only be connected to the SC160 through the A-101 converter as such a battery can be up to 14 V.

To fit the battery, raise the battery compartment lid [9] at the rear of the SC160. Put the battery inside and press it down until it clicks into place (see figure).

When the battery is insufficiently charged to allow the SC160 to work properly, a battery icon appears in the bottom right-hand corner of the sound level meter screen (see figure).

When this icon appears, the SC160 battery must be replaced. The SC160 will show the symbol for 5 minutes (if a measurement or a recording is in progress). Then it will stop measuring, the “BATTERY FLAT” message will appear on the screen and then the SC160 will automatically switch itself off. Do not use rechargeable batteries, nor attempt to recharge the flat battery.



To replace the battery, stop the measurement in progress and switch the sound level meter off. To remove the battery, open the battery compartment and pull the battery up from the end opposite the connector, as shown in the figure.

TIPS:

When an external power source is used (mains feeder or battery), it is recommended that new batteries be fitted.

If the SC160 is to remain unused for some time, remove the battery to prevent damage caused by battery leakage.

Always carry spare batteries, as it may not always be easy to find new ones.

2.1.3 Connecting and disconnecting the microphone, using the extension cable

The SC160 microphone is completely detachable. This allows it to be moved it away from the sound level meter and user. In this way the SC160 can be operated far from the place of measurement, thereby avoiding possible interference. To do this, use the CESVA CNR-ITV extension cable.

WARNING! : When connecting or disconnecting the microphone, the sound level meter must be switched off.

To detach the microphone from the sound level meter, simply unscrew it by hand (no tools).

To reconnect the microphone to the sound level meter, simply screw it back on.

2.2 Beginning a measurement

2.2.1 Starting the SC160

To start the SC160, press the key: ⏻

The CESVA logo will appear on screen together with the SC160 sound level meter model. A few seconds later, the initial screen predetermined in the menu configuration option will appear.

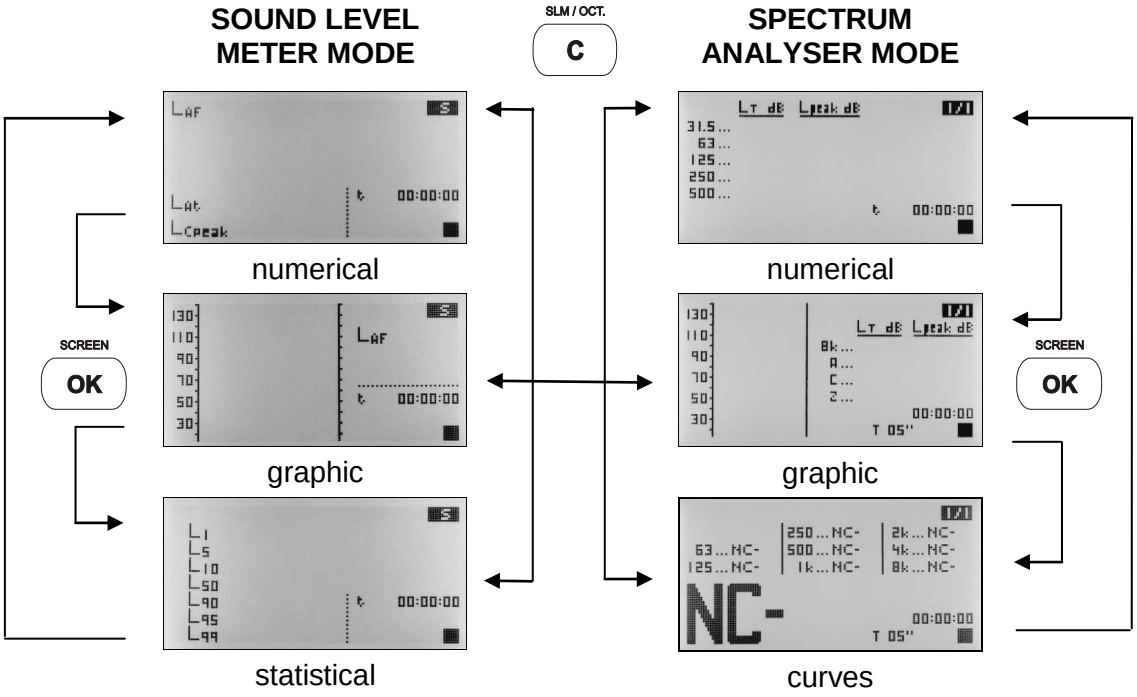
If the SC160 does not switch on, check that a fully charged battery is fitted or that it is connected to a suitable power supply.

2.2.2 Selecting the measurement mode

Once the sound level meter is switched on the initial screen appears, which may be one of the three sound level meter mode screens or one of the three spectrum analyser mode screens.

To display the different screens belonging to each mode, press the key: SCREEN **OK** (SCREEN)

As long as the SC160 is stopped (■) it is possible to switch between sound level meter mode and spectrum analyser mode by pressing this key: SLM / OCT. **C**



2.2.3 Checking the SC160

It is advisable to check the **SC160** before beginning a measurement, adjust its sensitivity (if necessary), and check it again once the measurement has terminated.

To check the **SC160** use the CESVA model **CB004** or **CB006** sound calibrator as follows:

1) Insert the **SC160** into the **CB004** or **CB006** calibrator, introducing the microphone into the calibration cavity (see figure). Make sure the microphone reaches the bottom of the cavity and is parallel to the calibrator axis. This may require a little effort since the sound level meter must fit exactly into the calibrator. Insert the SC160 gently; otherwise the microphone may be damaged.

2) Turn the calibrator on and check the state of the batteries. The luminous indicator must be lit throughout the calibration process. The calibrator generates a tone of 94 dB at 1 kHz.

3) Apply the free field to pressure corrections of the microphone at 1 kHz and those corresponding to the influence of atmospheric pressure, temperature and humidity in the calibrator. The free field to pressure correction for **P-05** CESVA microphone at 1 kHz is -0.1 dB. That is the SC160 should be set to read 93,9dB.

4) Switch the SC160 to numeric sound level meter mode (2.3.3) using the keys:

5) Select the sound pressure level with fast time weighting (FAST) $\mathbf{L_{AF}}$, $\mathbf{L_{CF}}$ or $\mathbf{L_{ZF}}$ as the function to measure. NOTE: The frequency weighting makes no difference since calibration takes place at 1 kHz.

6) Begin measuring with the SC160 in numeric sound level meter mode: 

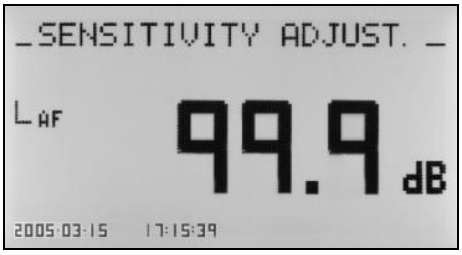
7) Check that the value which appears at the top of the screen (large digits) coincides with the value of 94.0 dB corrected with the corresponding corrections (normally 93.9 dB).

If the value of the reading differs more than ± 0.3 dB from the calculated value, the sound level meter sensitivity needs adjusting. If not, the meter is reading correctly and there is no need to readjust its sensitivity.

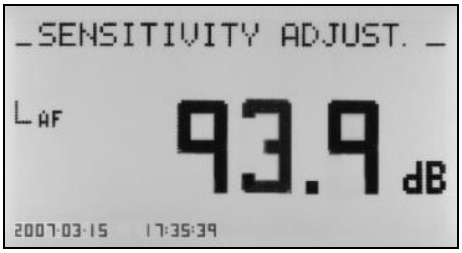
IMPORTANT: The sensitivity of the SLM must only be adjusted by authorised, technically qualified personnel. Readjustment of the sensitivity entails the loss of traceability in the calibration of the instrument.

If the results of checking the SC160 show a deviation of more than 0.3 dB, adjust the sensitivity as follows:

1) Press the key ▶/■ to terminate the measurement process.
2) Do not switch the calibrator off; keep it in the calibration position.
3) Next press ☰ to access the **SC160** menu.
4) Access the SETTINGS ➔ SENSITIVITY ADJUST option.
5) The display will show the sound pressure level measured by the **SC160**:



6) Use the keys ↙ and ↗ to adjust the calculated value (94 dB + corrections).
7) Confirm by pressing the OK key (the sensitivity will be modified and the date and time will be updated). Then press C to return to the SC160 menu.



2.3 Measuring in sound level meter mode

The sound level meter mode is suitable for measuring global sound pressure levels, both instantaneous and averaged based on integration (equivalent level). The **SC160** measures all the functions simultaneously with all the frequency weightings (A, C and Z) and provides statistical data of the measurements, including maximum and minimum values and percentiles (see APPENDIX A).

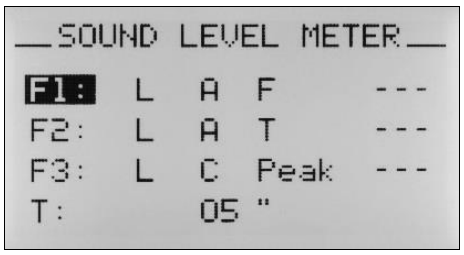
Outstanding among the applications of the **SC160** are its ability to measure the sound level of noisy activities, urban road traffic, and machines such as pneumatic drills and pumps, to measure appropriate parameters to ensure sound protection for workers and to measure sound parameters to evaluate levels of sound pollution, etc.

2.3.1 Prior adjustments: Preferential screen and integration time

Before beginning a measurement in sound level meter mode, the following parameters should be set:

- The three functions that appear simultaneously on the numeric preferential screen.
- The integration time for the equivalent continuous sound pressure level function with T integration time. This integration is carried out in consecutive T-second intervals.

To set these parameters, access the SETTINGS ➔ MEASURING ➔ SOUND LEVEL METER option on the SC160 menu (2.6.2).



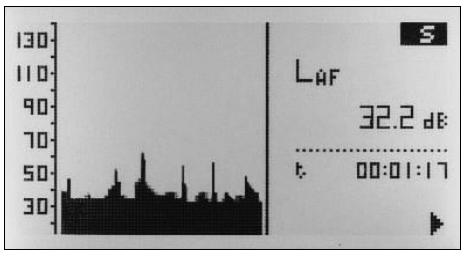
When the above screen appears, select the function to be set, F1, F2, F3 or T, by using the ↙ and ↗ keys, then press OK. Use the C key to cancel.

Modify the F1, F2 and F3 functions as follows:

- Select frequency weighting A, C or Z using ↙ and ↗ and press OK.
- Select the acoustic function using ↙ and ↗ and press OK to confirm. The following functions are available:
  - Fast (F)
  - Slow (S)
  - Impulse (I)
  - Equivalent level with programmable integration time (T)
  - Equivalent level with total integration time (t)
  - Sound exposure level (E)
  - Peak level (Peak).
- Using the keys ↙, ↗ and OK, select the value of the function required: instantaneous (- - -), minimum (min) or maximum (max).

For more information on the names of the different functions, see Appendix A.

The preferential numeric screen of the sound level meter mode displays the main function (F1) in large digits in the top right-hand corner of the screen and the two secondary functions (F2 and F3) in the bottom left-hand corner. The function defined in F1 is the one displayed on the graphic screen of the sound level meter mode.



Modify the T parameter as follows:

- Select its numerical value using ↙ and ↗ and confirm by pressing OK. The T integration time may be set from:
  - 1 to 59 seconds (1'' – 59 '')
  - 1 to 59 minutes (1' – 59')
  - 1 to 99 hours (1H – 99 H)

- Finally, select the time units in seconds (''), minutes (') or hours (H) using ↙ and ↗. Then press OK to confirm. Use the C key to cancel and return to the menu and again to go to the measurement screen.

2.3.2 Beginning a measurement

First of all, check that there is no measurement in progress (■). If there is, (▶ or ❚❚), press ▶/■ to stop it.

Next, switch the SC160 to sound level meter mode and select the screen to be displayed (numeric, graphic or statistical sound level meter), either from the **SC160** menu or by pressing the keys:

SCREEN OK SLM / OCT. C

Once the screen has been selected, press ▶/■ to start the measurement process.

2.3.3 Function display

The SC160 measures all functions simultaneously. Described below are the different formats in which the acoustic functions are displayed while measurement is in progress. If the kind of display, the function or the frequency weighting is changed, this does not interrupt the measurement in progress.

Numeric sound level meter mode

When the numeric sound level meter mode accessed, it shows the preferred screen, which displays functions F1, F2 and F3, defined in the configuration of the preferred numeric screen of the sound level meter mode (2.3.1). This allows the three preferred functions to be shown, on the same screen, of all those that the sound level meter measures.

The frequency weighting displayed for the three functions is changed by pressing FREQ. W. ↙.

By pressing FUNCTION ↗ the displayed function is changed (see table) accessing the other functions measured by the SC160.

The numeric screen of the sound level meter mode displays the following information:

- The main function (large digits)
- The secondary functions: except on the preferred screen, these are the maximum and minimum values of the main function (see table).

Main function	Secondary function 1	Secondary function 2
F1	F2	F3
L_{XF}	L_{XFmax}	L_{XFmin}
L_{XS}	L_{XSmax}	L_{XSmin}
L_{XI}	L_{XImax}	L_{XImin}
L_{XT}	L_{XTmax}	L_{XTmin}
L_{Xt}	L_{XE}	L_{Xpeak}
X: may be any frequency weighting, A, C or Z		

The preferred screen is displayed once again by pressing  .

The graphic sound level meter mode is accessed by pressing 

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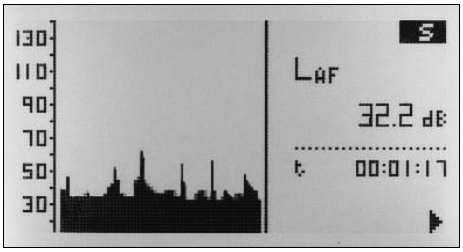
Graphic sound level meter mode

This screen displays the following information:



- The numerical value of the function defined as F1 on the sound level meter mode preferred screen (2.3.1).
- The time history of this function (60 values).

The statistical sound level meter mode is accessed by pressing 

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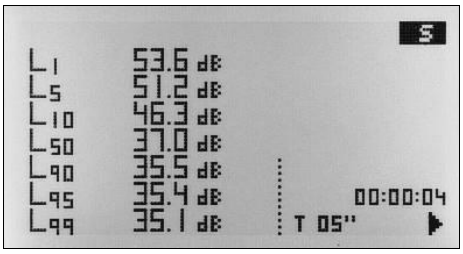
Statistical sound level meter mode

This screen displays the following information:



- Value of the partial percentiles L_1, L_5, L_{10}, L_{50}, L_{90}, L_{95} and L_{99} of each consecutive T duration interval (integration time) with frequency weighting A.

The numeric sound level meter mode is accessed by pressing SCREEN OK.

To display the total percentiles (for the entire measurement) stop the measurement as they can only be calculated after the measurement is complete (see sections 2.3.4 and 2.3.5).

NOTE: The functions' values will be refreshed on the screen every second.

2.3.4 Stopping and pausing a measurement

The measurement is temporarily paused by pressing ❚❚/●. The state of measurement indicator will switch from ▶ to ❚❚. While the SC160 is in pause position (❚❚) the functions measured may be consulted until the time when the process was paused. To resume measuring, press ▶/■. The measurement will continue to the end of the 'T' period selected.

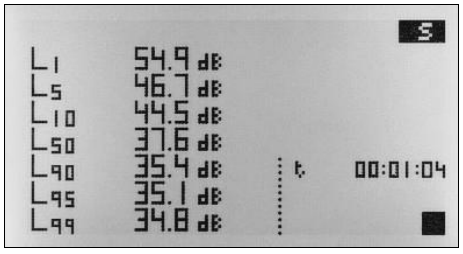
The measuring process is stopped by pressing ▶/■. The state of measurement indicator will switch from ▶ to ■.

2.3.5 Consulting the data measured

While the SC160 is stopped (■) all the functions measured may be consulted.

This is done the same way as described in section 2.3.3. on displaying data while a measurement is in progress.

When a measurement is stopped (■) the total value of the percentiles (belonging to the total measurement time t) can be displayed. The statistical sound level meter mode screen displays the following information:



- Total value of the percentiles L_1, L_5, L_{10}, L_{50}, L_{90}, L_{95} and L_{99} with frequency weighting A.
- Total measurement time t.

2.4 Measuring in spectrum analyser mode

The spectrum analyser mode is ideal for making real-time measurements of equivalent continuous sound pressure levels and peak sound pressure levels, of octave bands centred on frequencies 31.5, 63, 125, 250, 500, 1,000, 2,000, 4,000, 8,000 and 16,000 Hz (without frequency weighting) and global values with all the frequency weightings (A, C and Z). The SC160 can also evaluate this spectrum by the NC (Noise Criterion) curves and NR (Noise Rating) curves. These are standardised curves for assessing room noise.

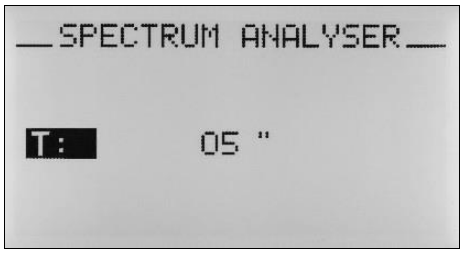
Outstanding features here include measurement of sound insulation and frequency analysis of industrial, environmental and work-place noise, evaluation of room noise especially from HVAC systems, etc.

2.4.1 Prior adjustments: Integration time

Before beginning a measurement in spectrum analyser mode, it is advisable to set the following parameters:

- The 2 frequency weightings, chosen from A, C and Z, used to calculate the global acoustic values displayed on the spectrum analyser mode screens.
- The integration time (T) used in the evaluation of spectral and global levels. This integration takes place in consecutive intervals of length T.

To set this parameter, access the option SETTINGS ➔ MEASURING ➔ SPECTRUM ANALYSER on the SC160 menu.



Press OK to begin setting the T parameter and then follow the procedure detailed below:

- Select its numerical value using ↙ and ↗ and confirm by pressing OK. T integration time may be configured from:
  - 1 to 59 seconds (1'' – 59 '')
  - 1 to 59 minutes (1' – 59')
  - 1 to 99 hours (1H – 99 H)
- Finally select the time units in seconds (''), minutes (') or hours (H) using ↙ and ↗ and press OK to confirm. Use the C key to cancel.
- If "t" is selected as the integration time numerical value (it lies between values 1 and 99), the integration time will coincide with the measurement time. This is a practical option when it comes to evaluating the ideal integration time. To apply this option, carry out a measurement with "t" integration time and calculate the time needed for the bands in which you are interested to stabilise.

2.4.2 Beginning a measurement

First, check that there is no measurement in progress (■). If there is (▶ or ❚❚), press ▶/■ to stop it.

Next, switch the SC160 to spectrum analyser mode and select the screen to be displayed (numerical, graphic or room noise analyser), either through the SC160 menu or using the keys:

SCREEN OK SLM / OCT. C

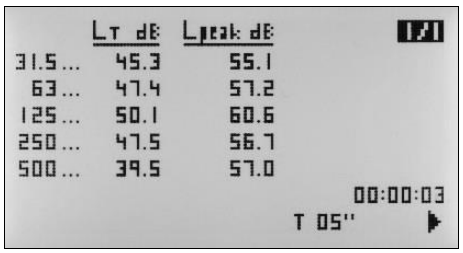
Once the desired screen has been selected, press ▶/■ to start the measurement process.

2.4.3 Function display

The **SC160** measures all functions simultaneously. The different ways to display the acoustic functions while a measurement is in progress are described below. If the display, the octave band or the frequency weighting is changed, the measurement continues. While a measurement is in progress, it is not possible to switch from the spectrum analyser mode to the sound level meter mode.

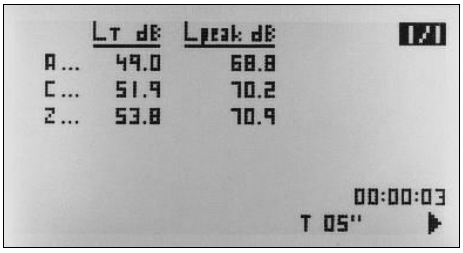
Numerical analyser mode

This screen displays the following information in real time:



- The equivalent continuous sound pressure level with T integration time for octave bands centred on the frequencies 31.5, 63, 125, 250, 500, 1,000, 2,000, 4,000, 8,000 and 16,000 Hz (without frequency weighting).
- The peak sound pressure level of the T interval for octave bands centred on the frequencies 31.5, 63, 125, 250, 500, 1,000, 2,000, 4,000, 8,000 and 16,000 Hz (without frequency weighting).

This screen also displays the following data in real time (press ↙ (left) or ↗ (right) to display it)

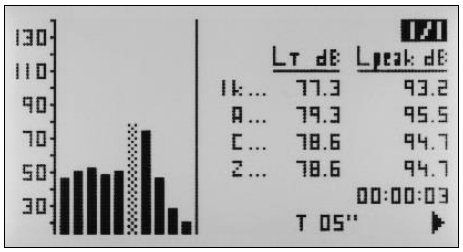


- The equivalent continuous overall sound pressure level with T integration time and with frequency weightings (A, C and Z).
- The maximum of the peak sound pressure level of the T integration interval with frequency weighting (A, C and Z).

The graphic analyser mode is accessed by pressing SCREEN OK .

Graphic analyser mode

This screen displays the following information in real time:



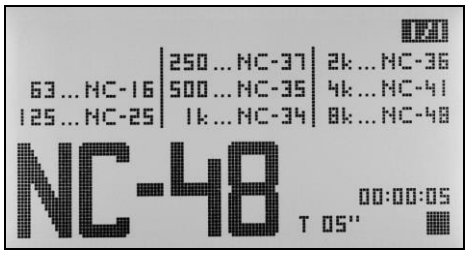
- A graph of the equivalent continuous sound pressure levels with T integration time (bars) in real time for octave bands centred on the frequencies 31.5, 63, 125, 250, 500, 1,000, 2,000, 4,000, 8,000 and 16,000 Hz (without frequency weighting).
- The numerical value of the equivalent continuous sound pressure level with T integration time and peak sound pressure level of the T interval for the selected octave band (bar) (without frequency weighting).
- The central frequency of the selected octave band (bar).
- The equivalent continuous overall sound pressure level with T integration time and peak sound pressure level of the T interval with frequency weighting A, C and Z.

To change the selected octave band (bar) press ↙ (left) and ↗ (right).

The room noise analyser is accessed mode by pressing SCREEN OK.

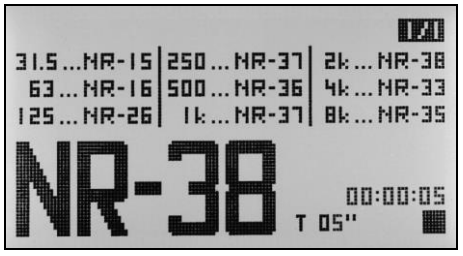
Curves mode

This screen displays the following information in real time:



- The highest NC curve not exceeded by the measured spectrum appears at the bottom left. This is the NC curve that defines the noise measured.
- The NC curve value for each octave band not exceed in that band appears at the top. This information is useful to check which octave band makes the greatest contribution to the NC curve. There must be at least one octave band with an NC curve equal to the one corresponding to the noise measured.

This screen also displays the following data in real time (press ↗ (right) to display it):



- The highest NR curve not exceeded by the measured spectrum appears at the bottom left. This is the NR curve that defines the noise measured.
- In the upper part appears, for each octave band, the NR curve value not exceed in that band. This information is useful to check which octave band has the maximum contribution to the NR curve. That is to say, at last there must be one octave band with an NR curve equal to the one corresponding to the measured noise.

The numeric analyser mode is accessed by pressing SCREEN OK .

NOTE: The values of the functions are refreshed on the screen every second.

2.4.4 Stopping and pausing the measurement

The measurement process can be temporarily paused or stopped by pressing ▮▮ . The state of measurement indicator will switch from ▶ to ▮▮. While the **SC160** is on pause (▮▮) it remains possible to consult the functions measured until the measurement was temporarily interrupted. To resume measurement, press ▶/■ .

The measurement process is stopped by pressing ▶/■ . The state of measurement indicator will switch from ▶ to ■.

2.4.5 Consulting the data measured

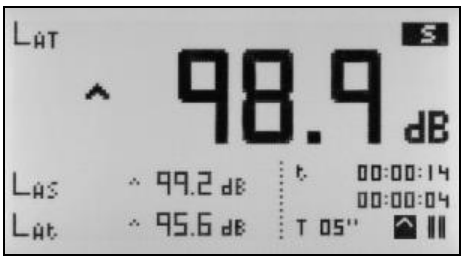
All the functions measured may be consulted while the **SC160** is not measuring (■).

This is done in the same way as described in section 2.4.3 on displaying data while a measurement is in progress.

2.5 Overload and over range indicator

The **SC160** has an overload indicator for each function. If a function has been overloaded during a measurement, the **^** sign will appear before its value. When a function has registered overload, its reading is incorrect.

While there is an overload, the sign ^ will appear in the bottom right-hand corner of the screen.



When **over** appears in the indication of the value of a function, this means that the value measured exceeds the upper limit of the measurement range (over-range). When this happens, the maximum range of the SC160 has been exceeded and the current level cannot be known, thus any such measurements should be discarded.

2.6 The SC160 menu: Register management and settings

This section covers all the options accessible from the SC160 menu, the major features of which include register management and SC160 settings (screens, language, date and time, etc).

When supplied, the SC160 is already programmed with a default setting that allows you to carry out measurements without first having to reset the instrument before beginning to measure.

2.6.1 Accessing the menu

To access the SC160 menu press  .

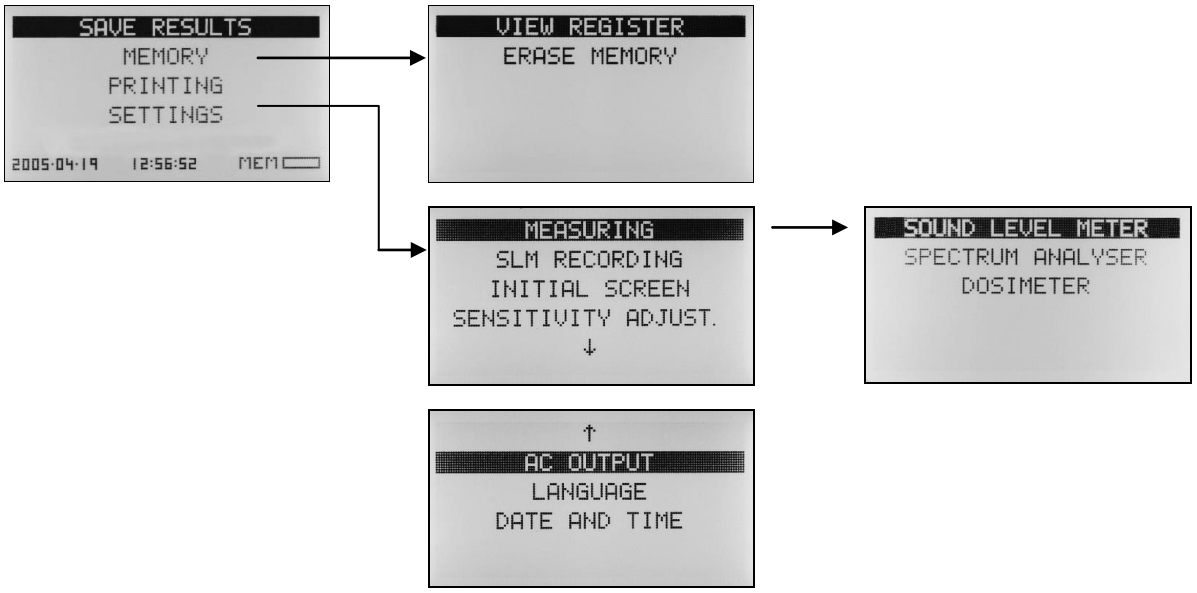
The following screen will appear:

This screen shows the main settings menu together with the date and time on the SC160 clock. Information is also available on the state of the memory, indicating the amount of memory occupied.

- Memory empty ➔ 
- Memory full ➔ 

2.6.2 The SC160 menu

The SC160 sound level meter menu has the following structure:



To move through the settings menu, use the keys described in section 1.5

Below is a list of the options accessible from the menu:

2.6.3 Register management

- SAVE RESULTS:
  When this option is selected, the SC160 stores the final results of all the functions measured, in the memory. The SC160 indicates the register number in which the data has been saved. For more information, see section 3.1
- MEMORY:
  This option facilitates management of the SC160 memory.
    - MEMORY ➔ VIEW REGISTER
      This allows the registers recorded in the sound level meter to be displayed. For further information, see section 3.4
    - MEMORY ➔ ERASE MEMORY
      This option allows the SC160 memory to be completely erased. All the registers stored in the memory (results and recordings) will be deleted. For further information, see section 3.5

2.6.4 Printing

- PRINTING:
  This option allows the RS-232 port to be prepared for connection to a serial printer. For further information, see chapter 4.

2.6.5 Settings

- SETTINGS:
  This option allows several features of the SC160 to be set, such as definition of the initial screen, adjustment of the clock/calendar, of the language or of the sensitivity of the SC160.
    - SETTINGS ➔ MEASURING ➔ SOUND LEVEL METER
      This option defines the three acoustic functions displayed on the preferred screen of the numeric sound level meter mode and the integration time of the equivalent continuous sound pressure level T. For more information, see section 2.3.1.
    - SETTINGS ➔ MEASURING ➔ SPECTRUM ANALYSER
      This option defines the integration time used in evaluation of spectral and overall T levels. For more information, see section 2.4.1.
    - SETTINGS ➔ MEASURING ➔ DOSIMETER
      This option is to set the three acoustic parameters of the optional dosimeter module. For further information, see section 8.
    - SETTINGS ➔ SLM RECORDING
      This option sets the periodicity and the functions stored by the SC160 when it makes a recording. For more information, see section 3.3.
    - SETTINGS ➔ INITIAL SCREEN:
      This option is to select the predetermined screen that will appear every time the SC160 is turned on.
        - NUMERICAL SLM: sets the sound level meter mode with predetermined numeric display screen.

- GRAPHICAL SLM: sets the sound level meter mode with predetermined graphic display screen.
- STATISTICAL SLM: sets the sound level meter mode with predetermined statistical display screen.
- NUMERICAL RTA: sets the spectrum analyser mode with predetermined graphic display screen.
- GRAPHICAL RTA: sets the spectrum analyser mode with predetermined graphic display screen.
- NC RTA: sets the spectrum analyser mode with predetermined room noise screen.

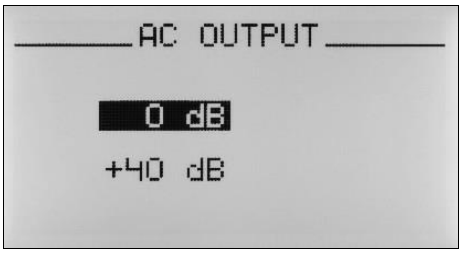
- SETTINGS ➔ SENSITIVITY ADJUSTMENT:

  This option allows the sensitivity of the SC160 to be adjusted. For more information, see section 2.2.3 (checking the SC160).

- SETTINGS ➔ AC OUTPUT

  The SC160 AC output signal is directly proportional to the preamplifier output.

  This option allows the gain of this output to be adjusted: 0 dB or 40 dB.



- SETTINGS ➔ LANGUAGE

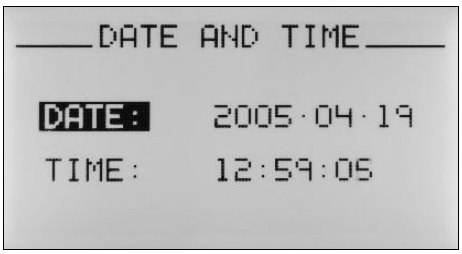
  This allows the language in which all the messages and menus of the SC160 will be displayed to be selected.

  To do this, when the unit is turned ON, select MENU ➔ to SETTINGS ➔ OK ➔ to LANGUAGE ➔ OK ➔ Select the language ➔ OK.

  A measurement can now be selected, by pressing C or the unit can be turned OFF

- SETTINGS ➔ DATE AND TIME

  This option allows the date and time of the SC160 clock to be adjusted.

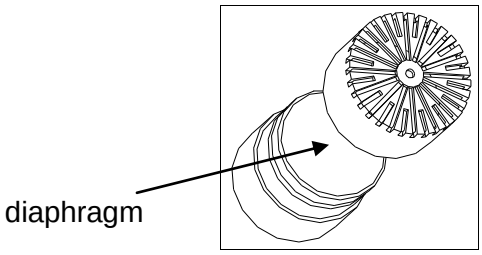


2.7 Turning the SC160 off

To turn the SC160 off, make sure that no measurement is in progress (■), then press:

2.8 Precautions

- Attach or detach the microphone manually only, never use tools. Never do this when the **SC160** is operating.
- Never dismantle the microphone, as this might cause permanent damage.
- Keep the microphone away from dust and sharp objects.
- Avoid excessive humidity and sudden changes in temperature, since this may cause condensation on the microphone.
- Never remove the protective grid from the microphone unless absolutely necessary. Never touch the diaphragm, unless it is very dirty. Then very carefully remove the dust using a very fine camelhair brush.



- If anything knocks the **SC160**, this is picked up by the microphone and may alter the value of the measurement.
- If the **SC160** is going to be exposed to vibrations, it should be isolated. Pads of foam rubber or similar material are usually sufficient.
- When measurements are being taken in the open air, place the windscreen on the microphone, since the wind may produce noise which may affect the accuracy of the measurement.
- If measurements are taken holding the **SC160** manually, this should be done with the arm outstretched. To avoid interference, use of the **TR-40** tripod and the **CNR-ITV** microphone extension cable is recommended. Remember to turn the **SC160** off before removing the microphone.
- It is advisable to check the **SC160** before and after every measurement, using the acoustic calibrator. See section 2.2.3.
- To manipulate the equipment (remove the preamplifier, microphone, ...), this must be turned off and unplugged from the power supplies.
- Remove the battery if the **SC160** is not going to be used for a long period.
- The CESVA **SC160** sound level meter is built for long-term reliability. Should any anomaly occur that cannot be solved by changing the battery or consulting the manual, take the **SC160** to an official CESVA dealer. Never, under any circumstances, have it repaired by non-qualified personnel.
- The **SC160** is equipped with an internal clock fed by a 3V CR2032 lithium button-type battery, which allows it to keep date and time and settings. The average life span of this lithium battery is 10 years.
- When the 3 V battery runs out, the internal SC160 calendar/clock returns to 00:00 hours on 01/01/2000. Access the SC160 menu to consult the calendar. The battery must be

replaced immediately. Remove it from the slot in the battery compartment (see photo) and replace it with a new one or contact an official CESVA dealer.

This equipment can only work with the accessories described in the accessories section. In the case of different accessories being used, resulting in a failure in the equipment, CESVA will accept no responsibility for this failure. In this case the equipment will lose its warranty.

2.9 Advice for carrying out measurements

To avoid the influence of the operator during the measurement process (screen effect) it is advisable to move the sound level meter away from the operator's body (while still being able to read the display). A tripod is recommended for maximum accuracy in measurements. The microphone's axis must point to the sound source.

For indoor measurements it is also advisable to move the sound level meter away from reflective surfaces (walls, objects, floors).

For outdoor measurements the sound level meter microphone must be protected with a windscreen and it is advisable to check environmental conditions (temperature, humidity, atmospheric pressure).

For long / mid term unattended outdoor measurements, the TK1000 outdoor kit is recommended to protect the equipment from environmental agents (wind, rain, humidity).

The measurement range specifications of the sound level meter must be taken into account for the measurement of low sound levels. In order to measure sound levels lower than those specified by the lower limit range, the self generated noise from the sound level meter must be taken into account.

3. DATA REGISTRATION

The values of the measured functions measured may be stored in the **SC160** internal memory. When the unit is switched off, the data is saved and may be retrieved and displayed directly from the **SC160** or transferred to a PC. The memory may be erased directly from the **SC160**.

Two kinds of registers may be stored in the memory:

- The final results of a measurement
- Continuous recordings of functions with programmable recording time.

3.1 Saving results

Once a measurement has been completed (■), the results may be stored in the memory. To do this select the SAVE RESULTS option from the main menu The SC160 indicates the memory number under which the data has been saved.

The **SC160** saves the following information:

- Sound level meter mode:
    - Sound pressure level with 'F' time weighting (Fast)
    - Sound pressure level with 'S' time weighting (Slow)
    - Sound pressure level with 'I' time weighting (Impulse)
    - Equivalent continuous sound pressure level with T integration time

  And their maximum and minimum values.
    - The equivalent continuous sound pressure level for the entire measurement
    - The sound exposure level (SEL)
    - The peak sound pressure level

  All measured with frequency weightings A, C and Z.
    - Measurement and integration times
    - Total percentiles 1%, 5%, 10%, 50%, 90%, 95%, 99% with A frequency weighting.
- Spectrum analyser mode:
    - The equivalent continuous sound pressure level with T integration time for the octave bands centred on the frequencies 31.5, 63, 125, 250, 500, 1,000, 2,000, 4,000, 8,000 and 16,000 Hz (without frequency weighting).
    - Peak sound pressure level of the T interval for the octave bands centred on the frequencies 31.5, 63, 125, 250, 500, 1,000, 2,000, 4,000, 8,000 and 16,000 Hz (without frequency weighting).
    - Equivalent continuous overall sound pressure level with T integration time and frequency weightings A, C and Z.
    - Maximum peak sound pressure level of the T interval and with frequency weightings A, C and Z
    - The integration time T.

The SC160 may store a total of 1,000 final results in both sound level meter mode and spectrum analyser mode.

3.2 Making a recording

A recording consists of making a measurement and storing a series of functions in the memory with a defined periodicity. These functions and the periodicity are specified in the recording setting. The recordings in sound level meter mode can be set. The main difference between the different kinds of recording lies in the “number of functions / storage time” ratio (see 3.3.). The spectrum analyser mode has only one kind of recording.

Before beginning a recording, make sure no measurement is in progress (■).

To begin a recording, press MEM ▮▮. The screen will display the kind of recording together with the register number. The functions selected in the kind of recording will be periodically stored in the memory until the recording is terminated by pressing ▶/■. During the recording process, the measurement in progress icon (▶) will flash on and off.

3.3 Kinds of recording

3.3.1 Recording in sound level meter mode

The option SETTINGS ➔ SLM RECORDING sets the periodicity and the functions that the SC160 stores in the memory while recording in sound level meter mode. Four possibilities are available:

- **ALL every second**: this saves all the functions measured in sound level meter mode (see 3.1.) second by second.
- **F1, F2 AND F3 every second**: this saves the three programmed functions on the preferred screen second by second.
- **F1 every second**: this saves the main programmed function on the preferred screen second by second.

The three types of recording are intended for measurements of short duration.

- **L_T and partial percentiles every T seconds**: this saves every T (integration time) the equivalent continuous level with A, C and Z weighting together with the partial percentile levels corresponding to 1, 5, 10, 50, 90, 95 and 99 % of the T interval.

These kinds of recording are designed for measurements of long duration, such as environmental noise or traffic noise studies.

The following table shows the memory storage capacity of the different kinds of sound level meter mode recordings.

Type of recording	Storage capacity
ALL every second	1 hour 23 minutes
F1, F2 AND F3 every second	33 hours 37 minutes
F1 every second	78 hours 28 minutes
L_T and partial percentiles every T seconds	T= 1 s ➔ 11 hours 12 minutes T= 1 min ➔ 28 days T= 5 min ➔ 4 months 20 days T= 1 hour ➔ 4 years 8 months

F1, F2 and F3 are the acoustic functions selected by the user on the preferred screen. They may be any of the 54 different functions the SC160 measures in sound level meter mode.

3.3.2 Recording in spectrum analyser mode

Recording in spectrum analyser mode cannot be set. When carrying out a recording in spectrum analyser mode, the SC160 stores all the functions measured in the memory every T seconds (integration time) (see 3.1). The following table shows the storage capacity for recordings in spectrum analyser mode.

Type of recording	Storage capacity
• Equivalent continuous level of T + Maximum peak level of each octave band • Equivalent continuous global sound pressure level with T + maximum overall peak sound pressure level with frequency weighting A, C and Z. every T interval	T= 1 s ➔ 4 hours 26 minutes T= 1 min ➔ 11 days 2 hours T= 5 min ➔ 1 month 25 days T= 1 hour ➔ 1 year 10 months

The maximum storage times in both modes may be distributed among as many registers as desired, as long as they do not exceed 1,000.

When the internal memory is full, no recording may be made and no final result may be stored. If this is attempted, "MEMORY FULL" will appear on the screen. If the memory fills up before the end of a recording, data recording stops, although measurement continues.

When carrying out a recording in spectrum analyser mode with T≠t the data recording and measurement stop if the memory fills up before the end of the recording.

3.4 Viewing registers

This option allows the final results of the registers stored in the **SC160** memory to be displayed on the screen. To use the option, access VIEW REGISTER on the SC160 menu.

To select the register to be displayed press ↙ , ↗ and OK. An index will appear on-screen showing all the registers stored in the memory (register number + date and time of the beginning of the recording process).

To display the different functions, follow the procedure described in sections 2.3.5 and 2.4.5. Information on the graphic SLM screen is not available.

3.5 Erasing memory

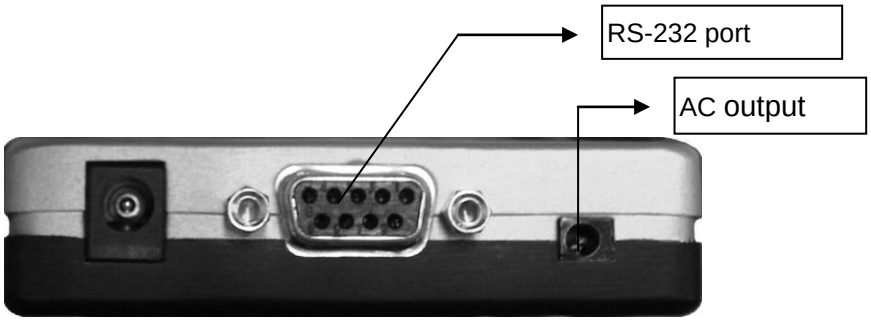
This option allows the memory to be completely erased. Before proceeding, the SC160 requests confirmation.

NOTE: If the power supply to the sound level meter is suddenly interrupted in the middle of a recording, the recording will be incomplete and will not be displayed on screen of the SC160. The message "INCOMPLETE RECORDING" will appear on screen when trying to display. We therefore recommend that when connecting the SC160 to the direct current A-200 or AM201 feeder, new batteries are inserted into the sound level meter, because in the event of a power cut the unit will commute to battery feed. If the mains feed is not restored before the battery runs out, just before the batteries go flat the SC160 will stop measuring and gradually switch itself off.

4. DATA TRANSFER

The **SC160** is equipped with 2 data outputs:

- The AC output: an analogue output directly proportional to the preamplifier output.
- The RS-232 communication port: a bi-directional digital serial port for communication with a PC.



4.1 Data transference to a PC: Communication software

The communications software supplied with the **SC160** (CESVA **Capture Studio**) allows the following operations to be carried out:

- Transmission to a PC, in real time, of data measured by the SC160.
- Downloading of the registers stored by the SC160.
- Management of the registers (erasure, etc.).
- Programming of the sound level meter (time, sound level meter or spectrum analyser mode functions, etc.).

To transfer data, connect the RS-232 port of the sound level meter to a computer serial port by means of the serial cable supplied.

For more information about how the software application works, access its help menu.

The RS-232 output is a port that complies with the RS232C, EIA232D and CCITTV28 regulations. The connector is a sub-D, 9 contact type. The contacts are configured as follows:

Contact	Function
2	TX
3	RX
5	GND (mass)

The transmission format is as follows:

Speed	9600 bits/s
Data bits	8
Stop bits	1
Parity	None

4.2 The AC output: Recording calibrated measurements

The AC output is proportional to the preamplifier output. This allows a Digital Audio Tape (D.A.T) to be connected to this output with the CNA-030 cable and a calibrated recording of a measurement to be made. To do this, proceed as follows:

1) Connect the SC160 AC output to the D.A.T. recorder.
2) Adjust the input gain of the D.A.T. recorder and the output gain of the AC output (see section 2.6.5) to adapt the measured signal range to the D.A.T. recording dynamic range.
3) Begin recording.
4) Record a calibration signal, preferably by using the calibrator. It is enough to record the 1 kHz and 94 dB tone generated by the calibrator.
5) Begin measuring.
6) Once the measurement is complete, record the calibration signal again.

The signal recorded on D.A.T. may be analysed later by adjusting the D.A.T. output and the analysis equipment input stage in order to ensure that the calibration sign measurement is correct.

The SC160 AC output also enables the user to listen to the signal being measured and to ascertain whether it is being influenced by noises other than those being measured.

4.3 Printing from the SLM

In order to print, the PRINTING option of the SC160 menu must be activated. While it is activated, it will not be possible to carry out serial communication with a PC. When the SC160 is switched off, the PRINTING option is automatically deactivated.

Real-time printout of the measured functions is available for the sound meter (S) and octave band spectrum analyser (1/1) measurement modes.

The sound level meter (S) mode prints out the three functions programmed as F1, F2 and F3 second by second:

CESVA SC160 T217947

2003-11-03 16:25:46

	L AF	L At	L CPeak
00:00:01	46.8	45.9	66.8
00:00:02	48.1	46.8	67.2
00:00:03	47.1	46.9	69.5
00:00:04	45.5	46.6	69.5
00:00:05	47.5	46.4	69.5
00:00:06	45.9	46.4	69.5
00:00:07	44.5	46.2	69.5
00:00:08	46.4	54.1	93.9
00:00:09	45.9	53.7	93.9
00:00:10	45.8	53.3	93.9
00:00:11	45.3	53.0	93.9

The spectrum analyser mode prints out, every T, the spectral and global values with frequency weightings A, C and Z:

CESVA SC160 T217947

2003-11-03 16:26:27

T 01"

Z	C	A	31.5	63	125	250	500	1k	2k	4k	8k	16k
58.0	54.3	47.0	52.2	42.6	45.3	49.9	45.1	41.5	37.5	32.0	27.6	21.3
61.6	56.4	45.9	58.7	41.3	40.5	47.5	43.6	40.9	37.2	31.8	26.1	20.1
77.9	77.8	77.8	56.3	48.6	52.1	65.7	70.2	73.5	73.9	62.2	57.3	50.1
65.9	64.5	64.3	55.9	42.6	40.6	48.6	45.2	63.9	49.2	33.1	30.1	32.2
75.7	75.6	76.2	56.2	41.2	41.3	49.7	48.9	75.1	67.8	41.1	27.6	21.0
60.8	55.3	45.5	56.9	41.3	40.2	45.5	43.1	41.1	37.3	31.6	25.7	19.8
58.8	52.8	46.2	51.3	40.5	40.7	47.4	43.8	42.1	36.4	31.3	25.6	19.7
70.4	70.1	70.5	55.8	39.4	40.4	47.7	46.0	69.6	61.0	36.7	27.2	20.3
59.5	54.0	45.3	54.8	40.3	40.8	46.8	42.5	40.5	37.1	32.3	25.4	19.6

The serial printer must have 80 columns.

The format for printing is the same as the one used for the data transference in section 4.1

5. TECHNICAL SPECIFICATIONS

5.1 Measurement range

L_F, L_S, L_I, L_E, L_t and L_T functions			
Lower limit of the indicator:	0 dB		
Upper limit of the indicator:	137.0 dB		
Operating limits are modified by the sensitivity of the microphone.			
Starting point for linearity tests	94 dB		
For P-05	FREQUENCY WEIGHTING		
	A	**C**	**Z**
Primary Range			
Upper limit	113.0	113.0	113.0
Lower limit	36.0	38.5	40.0
Electric Measurement Range (with nominal sensitivity of the microphone) at 1kHz:			
Upper limit	137.0	137.0	137.0
Upper limit for crest factor 3:	130.0	130.0	130.0
Upper limit for crest factor 5:	126.0	126.0	126.0
Upper limit for crest factor 10:	120.0	120.0	120.0
Lower limit	19.0	21.4	32.2
Linear measurement range at 31.5 Hz:			
Upper limit	97,6	134,0	137,0
Lower limit	30,3	34,1	40,2
Linear measurement range at 4 kHz:			
Upper limit	138,0	136,2	137,0
Lower limit	30,3	34,1	40,2
Linear measurement range at 8 kHz:			
Upper limit	135,9	134,0	137,0
Lower limit	30,3	34,1	40,2
Electrical Noise (with nominal sensitivity of the microphone without preamplifier)			
Maximum	12.0	12.1	23.1
Typical	9.1	11.4	18.5
Total Noise at 20ºC (electrical + thermic of the microphone)			
Maximum	27.1	31.0	39.0
Typical	25.3	29.0	35.0

Note: the intrinsic noise is measured with equivalent levels with integration time greater than 30 seconds

L_{peak} Function	
Lower limit of the indicator: Upper limit of the indicator: Operating limits are modified by the sensitivity of the microphone.	0 dB 140 dB
Linear measurement range with P-05 Upper limit Lower limit	 140 dB 55.0 dB

Note: For electrical noise tests, use the ADM0P05 adapter with the TP001 termination.

5.2 Detector - Functions L_F, L_S and L_I

For electrical calibration, use the ADM0P05 adapter.

Maximum error in the maximum response to a tone burst		
Function	**Duration of the tone burst (ms)**	**Maximum error (dB)**
L_F	200	+ 1.0, - 2.0
L_S	500	± 2.0
L_I	20 5	± 2.0 ± 3.0

Maximum error for signals with crest factor ≤ 3:	± 1.0 dB
Maximum error for signals with crest factor ≤ 5:	± 1.0 dB
Maximum overshot: L_F : L_S :	 1.1 dB 1.6 dB
Maximum error of level linearity (31.5 to 12500 Hz):	± 1.0 dB
Maximum error of differential level linearity(31.5 to 12500 Hz):	± 0.3 dB

Peak detector - L_I function	
Decay rate:	2.9 dB/s ± 1.0 dB/s
Onset time constant:	< 3.5 ms

5.3 Peak detector - L_{peak} function

Onset time constant:	< 75 µs

5.4 Display update rates

Display update rate	1 s
When a measurement starts the value of the functions that depend on the integration time T will appear when the integration time T is finished. This value will be updated every second but the changes on the display will not show until the integration time T is finished.	
Clock accuracy	
The clock is accurate to within 10 seconds per 24 hours.	

5.5 Integrator - L_T, L_t and L_E functions

Linearity range:	110 dB
Pulse range:	65 dB
Response time to a steady input signal:	2 s

5.6 Frequency weighting

Frequency weightings available	
Function	**Weighting**
L_{peak}	A, C or Z
L_F	A, C or Z
L_S	A, C or Z
L_I	A, C or Z
L_E	A, C or Z
L_T	A, C or Z
L_t	A, C or Z
L_x (percentiles)	A

The following table shows the A and C frequency weightings and tolerance for class 2.

Frequency (Hz)	Weighting A (dB)	Weighting C (dB)	Tolerance for class 2 (dB) 61672	Tolerance for class 2 (dB) 60651 / 60804
16	- 56.7	- 8.5	+ 5,5; -∞	+ 5; -∞
31.5	- 39.4	- 3.0	± 3,5	± 3,0
63	- 26.2	- 0.8	± 2,5	± 2,0
125	- 16.1	- 0.2	± 2,0	± 1,5
250	- 8.6	- 0.0	± 1,9	± 1,5
500	- 3.2	- 0.0	± 1,9	± 1,5
1,000	0	0	± 1,4	± 1,5
2,000	+ 1.2	- 0.2	± 2,6	± 2,0
4,000	+ 1.0	- 0.8	± 3,6	± 3,0
8,000	- 1.1	- 3.0	± 5,6	± 5,0
16,000	- 6.6	- 8.5	+ 6,0; -∞	+ 5; -∞

Frequency weighting Z (zero) is equivalent to 0 dB from 10 Hz to 20 kHz. The tolerance for type 2 is the one defined by frequency weightings A and C.

5.7 AC output

Frequency weighting:	Linear
Typical voltage at 137 dB and 1 kHz Gain: 0 dB: Gain: 40 dB:	 38 Vrms 3.8 Vrms (max)
Upper limit:	7 Vpeak
Output impedance:	100 Ω
Gain	0 or 40 dB ± 0.2 dB
Connector with 1.3 mm central pin	Central pin ➔ AC signal

5.8 Octave filters

Frequency evaluation system	Base 10
Reference attenuation	0 dB
Operative linearity range	The same as the measurement range

Octave band nominal central frequencies	
Nominal central frequency	**Exact base 10 frequency**
31.5 Hz	31.623 Hz
63 Hz	63.096 Hz
125 Hz	125.89 Hz
250 Hz	251.19 Hz
500 Hz	501.19 Hz
1 kHz	1,000 Hz
2 kHz	1,995.3 Hz
4 kHz	2,511.9 Hz
8 kHz	7,943.3 Hz
16 kHz	15,849 Hz

5.9 Measurement range (octave band spectrum analyser)

L_T Function	
for P-05:	
Measurement range (with linearity error lower than 0.4 dB):	
Octave bands with nominal central frequency	
Lower than 63 Hz: Upper limit:	137 dB
Lower limit:	30 dB
From 63 Hz to 8 kHz: Upper limit:	137 dB
Lower limit:	15 dB
Higher than 8 kHz: Upper limit:	137 dB
Lower limit:	20 dB
The noise (electrical + thermal of the microphone) is, as a minimum, 10 dB lower than the lower limit of the measurement range.	

5.10 Microphone

CESVA P-05			
½ ″ prepolarised condenser microphone with preamplifier			
Nominal sensitivity	16.0 mV/Pa in reference conditions		
Nominal Impedance	3,000 Ω		
Maximum SPL	145 dB		
Sound field correction generated by B&K model 4226 multifunction sound calibrator in free field			
Frequency (Hz)	**Correction (dB)**	**Frequency (Hz)**	**Correction (dB)**
31,5	0,0	*2.000*	0,3
63	0,0	*4.000*	0,5
125	0,0	*8.000*	1,8
250	0,0	*12.500*	6,4
500	0,0	*16.000*	8,7
1.000	0,1		
Correction due to reflections in the case of the sound level meter with microphone P-05			
Frequency (Hz)	**Correction (dB)**	**Frequency (Hz)**	**Correction (dB)**
63	*0,00*	*800*	*-0,13*
80	*-0,03*	*1000*	*-0,30*
100	*-0,08*	*1250*	*0,28*
125	*-0,10*	*1600*	*0,03*
160	*-0,05*	*2000*	*-0,30*

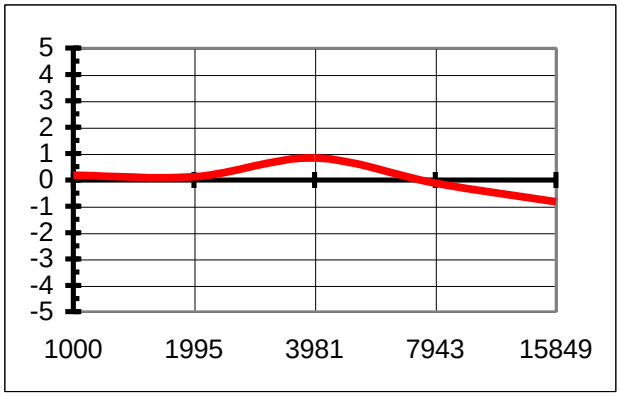
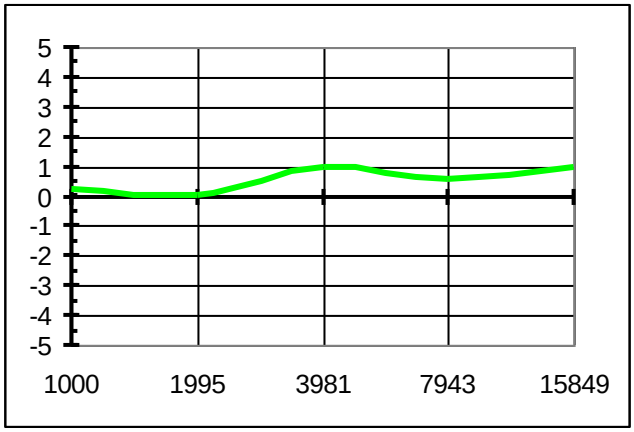
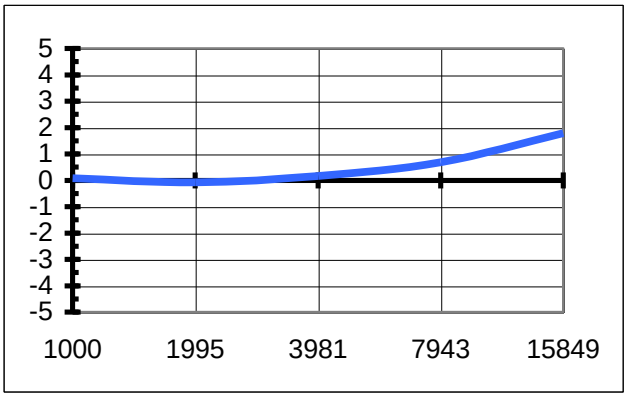
200	*0,07*	*2500*	*-0,01*
250	*0,10*	*3150*	*0,21*
315	*0,08*	*4000*	*0,30*
400	*0,04*	*5000*	*0,26*
500	*0,00*	*6300*	*0,28*
630	*0,00*	*8000*	*0,30*

5.11 Directivity

Sensitivity variation at 30°, 90° anf 150º			
Frequency (kHz)	**30° (dB)**	**90° (dB)**	**150° (dB)**
0.25 – 1	0	0.1	0.3
>1 – 2	0.2	0.2	0.7
>2 – 4	0.5	0.6	1.8
>4 – 8	1.0	2.2	3.5

5.12 Effect of the accessories on the microphone

Corrections for the effects of the PVM-05 windscreen	
Frequency (Hz)	**Correction microphone P-05 (dB)**
1000 Hz	0.00
1259 Hz	0.10
1585 Hz	0.20
1995 Hz	0.30
2512 Hz	0.35
3162 Hz	0.30
3981 Hz	0.25
5012 Hz	0.10
6310 Hz	-0.20
7943 Hz	-0.55

Effect of the outdoor kit TK-1000	 Effect of the TK-1000 windscreen  Effect of the TK-1000 rain cover  Effect of the TK-1000
Effect of the extension cables	The extension cables do not influence into the measuring frequency band. A recalibration is no necessary when using the extension cables.

5.13 Reference conditions

Type of sound field:	Free
Reference direction	Perpendicular to the microphone diaphragm
Reference sound pressure level:	94 dB (referred to 20 μPa)
Reference frequency:	1 kHz
61672 Reference temperature: Reference relative humidity: Reference atmospheric pressure:	 23 °C 50 % 101'325 kPa
60651 / 60804 Reference temperature: Reference relative humidity: Reference atmospheric pressure:	 20 °C 65 % 1.013 mbar

5.14 Warm-up time

Warm-up time	30 seconds
Stabilization time after changes in environmental conditions	5 minutes

5.15 Influence of temperature

Operation range:	0 to +40 °C
Maximum error (0 to 40°C):	0.9 dB
Storage without batteries	-20 to +60 °C

5.16 Influence of humidity

Operation range:	25 to 90 %
Maximum error at 25%< R.H.<90% at 40°C and 1 kHz:	0.9 dB
Storage without batteries:	< 93 %

5.17 Electromagnetic Compatibility

Classification group	Z
Influence of the Magnetic Fields	In a magnetic field of 80 A/m (1 oersted) at 50 Hz or 60 Hz, the reading will be under 25 dB(A)
Sound pressure level at which the SC160 meets the requirements of radiated electromagnetic field.	74 dBA
Set of accessories tested in the verification of the electromagnetic compatibility requirements.	The ones described in chapter 5.24
Configuration for the normal mode of working and position that produces the greatest radio frequency.	Sound level meter mode, L_{AF} function. SC160 horizontal, with the main axis of the SC160 (preamplifier) parallel to the field propagation direction with horizontal polarization With all leads connected, and with the A-200 feeder.
Configuration for the normal mode of working and position that produces the greatest susceptibility (least immunity) to a.c. power and radio frequency fields.	Sound level meter mode, L_{AF} function. SC160 vertical, with the main axis of the SC160 (preamplifier) perpendicular to the field propagation direction with horizontal polarization With all leads connected, and with the A-200 feeder.
The SLM complies with the basic specifications in standard 61672-1 for the required immunity to a.c. power frequency and radio frequency fields.	
No difference in emission is observed from the normal mode of operation with the equipment vertical, with all cables connected and with the A-200 mains feeder.	
The equipment shows no degradation or operating loss after being exposed to electrostatic discharges.	

5.18 Influence of vibration

For frequencies from 20 to 1,000 Hz and 1 m/s^2:	< 75 dB(A)

5.19 Battery & External supply

Battery	
One 6LF22-type 9-volt battery	
Battery life with continuous use: Sound Level Meter Spectrum Analyser *(The typical battery life with the display lighted can be reduced by 50% in respect of the above values)*	 13 hours 9 hours

External Supply	
Voltage input range	9 -12 V DC ⊕—◉—⊖
Minimum supply current	100 mA
For DC supply use the CESVA A-201 model mains feeder	

5.20 Dimensions and weight

Dimensions:	294 x 82 x 19 mm
Weight:	With battery 508 g Without 466 g

5.21 Calibration

Use the CESVA CB004 or CB006 acoustic calibrator and consult section 2.2.3.

5.22 Standards

Standards
EN 61672-1:03 class 2, EN 60651:94 (A1:94) (A2 :01) class 2, EN 60804:00 class 2, EN 61260:95 (A1:01) class 2
IEC 61672-1:02 class 2, IEC 60651:01 class 2, IEC 60804:00 type 2, IEC 61260:95 (A1:01) class 1
ANSI S1.4:83 (R2001) class 2, ANSI S1.43:97(R2002) class 2, ANSI S1.11:04 class 2
CE mark. Complies with 73/23/CEE and CEM 89/336/CEE low-tension regulations, the latter amended by 93/68/CEE.
CESVA instruments as manufacturer of electric or electronic equipment hereby confirms that this product was put on the market after 13 August 2005 and complies with 2002/96/CE and 2003/108/CE directives about Waste from Electrical and Electronic Equipment (WEEE).  Also, the product is marked with the following symbol, which indicates that it is subject to separate collection..

5.23 Notes

Notes
Should your **SC160** cease to comply with any of these specifications, contact your nearest official CESVA service technicians, who will gladly check, adjust and/or repair it for you.
The **SC160** should be calibrated and tested by a competent entity, at least, once a year.

5.24 Accessories

Standard accessories
Case (FNS-020)
Wind screen (PVM-05)
9 volt battery
SFT030 software for PC
CN-201 cable for connection to a PC

Optional accessories
CB004 Class 2 acoustic calibrator
Tripod (TR-40) and (TR050)
Transport briefcase 48x37x16 cm (ML040)
Transport briefcase 39x32x12 cm (ML-10)
Special outdoors briefcase 51x38x15 cm (ML060)
Mains feeder (A-200)
DC converter/regulator (A-100) for external battery (car battery)
Microphone extension cable 30 m (CNR-ITV)
Tripod support (TR002)
Serial-USB converter (CN-USB)
AC output audio cable (CN-DAT)
Serial printer (IM003)
Outdoor kit (TK1000)

6. APPENDIX A

6.1 Function summary table

6.1.1 Sound level meter mode functions

Function	Frequency weighting	Nomenclature	Maximum value	Minimum value
Sound pressure level with fast time weighting (Fast)	A	L_{AF}	L_{AFmax}	L_{AFmin}
	C	L_{CF}	L_{CFmax}	L_{CFmin}
	Z	L_{ZF}	L_{ZFmax}	L_{Zfmin}
Sound pressure level with slow time weighting (Slow)	A	L_{AS}	L_{ASmax}	L_{ASmin}
	C	L_{CS}	L_{CSmax}	L_{CSmin}
	Z	L_{ZS}	L_{ZSmax}	L_{Zsmin}
Sound pressure level with impulse time weighting (Impulse)	A	L_{AI}	L_{AImax}	L_{AImin}
	C	L_{CI}	L_{CImax}	L_{CImin}
	Z	L_{ZI}	L_{ZImax}	L_{ZImin}
Equivalent continuous sound pressure level with integration time T	A	L_{AT}	L_{ATmax}	L_{ATmin}
	C	L_{CT}	L_{CTmax}	L_{CTmin}
	Z	L_{ZT}	L_{ZTmax}	L_{ZTmin}
Equivalent continuous sound pressure level of the entire measurement	A	L_{At}	-	-
	C	L_{Ct}	-	-
	Z	L_{Zt}	-	-
Sound exposure level S.E.L.	A	L_{AE}	-	-
	C	L_{CE}	-	-
	Z	L_{ZE}	-	-
Peak sound pressure level	A	L_{Apeak}	-	-
	C	L_{Cpeak}	-	-
	Z	L_{Zpeak}	-	-
Measurement time	-	t	-	-
Integration time	-	T	-	-
Percentile 1%	A	L_1	-	-
Percentile 5%	A	L_5	-	-
Percentile 10%	A	L_{10}	-	-
Percentile 50%	A	L_{50}	-	-
Percentile 90%	A	L_{90}	-	-
Percentile 95%	A	L_{95}	-	-
Percentile 99%	A	L_{99}	-	-

6.1.2 Spectrum analyser mode functions

Function	Name	TOTAL	31.5	63	125	250	500	1 k	2 k	4 k	8 k	16 k
Equivalent continuous sound pressure level with integration time T	L_T	A C Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
Sound pressure peak level	L_{peak}	A C Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z

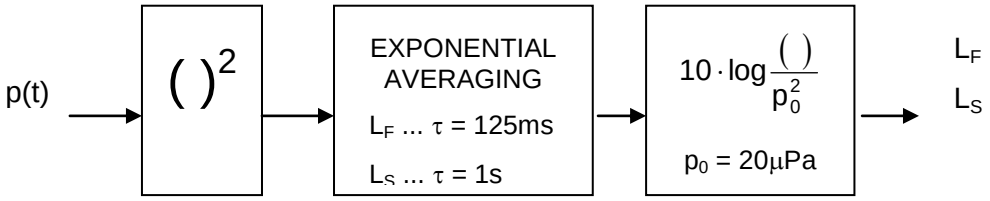
All functions, in both sound level meter and spectrum analyser modes, are measured simultaneously.

6.2 Definition of functions

6.2.1 Sound pressure level with fast and slow time weightings

L_F (Fast) RMS value with 125 ms fast exponential averaging, in decibels.

L_S (Slow) RMS with 1 s slow exponential averaging, in decibels.



p(t): instantaneous sound pressure

To obtain a stable reading, sound level meters feature two kinds of responses: 'F' and 'S'. The 'F' response has an exponential averaging circuit time constant of τ = 125 ms, and the 'S' response of τ = 1 s.

'F' response is recommended for measuring sound levels that fluctuate relatively little, such as vehicle noise, while 'S' response is recommended for noises that vary more.

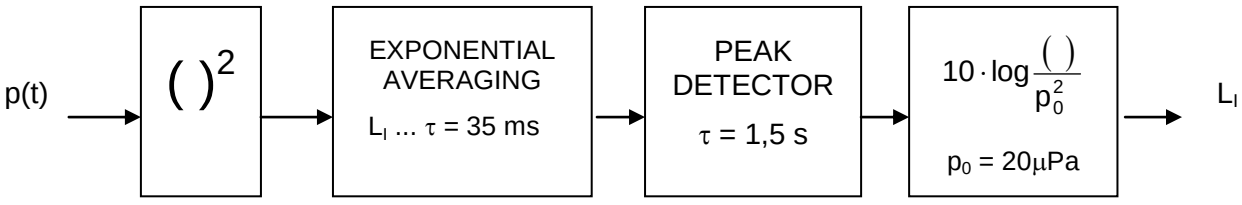
$$L_{S,F} = 20 \cdot \log \left(\frac{\left(\frac{1}{\tau} \int_{-\infty}^{T} p^2(\zeta) \cdot e^{-(t-\zeta)/\tau} d\zeta \right)^{1/2}}{p_o} \right)$$

p(t): instantaneous sound pressure

p_0: reference sound pressure (20 μPa)

6.2.2 Sound pressure level with 'I' time weighting

L_I (Impulse) Maximum short-term RMS value with exponential averaging of 35 ms, in decibels.



p(t): instantaneous sound pressure

The 'I' characteristic is designed to detect impulse noise, like shots or blows. The 'I' function has a very fast exponential averaging circuit time constant: τ = 35 ms, and a peak detector that retains the measured value long enough for it to be displayed.

6.2.3 Sound pressure peak level

L_{peak} (Peak) The highest absolute instantaneous sound pressure value from the beginning of the measurement, in decibels.

6.2.4 Equivalent continuous sound pressure level

L_T and **L_t** Equivalent continuous sound pressure level. This is the linear average of the instantaneous sound pressure square from the beginning t_1 to the end t_2. The duration of the measurement is therefore $T = t_2 - t_1$

$$L_{eqT} = 10 \cdot \log\left(\frac{1}{T}\int_{t_1}^{t_2}\frac{p^2(t)}{p_0^2}dt\right)$$

p(t): instantaneous sound pressure

p_0: reference sound pressure (20 μPa)

T: duration of the measurement

The equivalent sound pressure level is the pressure level that, kept constant throughout the entire measurement interval, has the same sound energy as the sound event measured.

The equivalent continuous sound pressure level function is ideal for measuring variable sound events such as road traffic or sound events that due to their long duration cover a wide range of sound pressure levels, such as environmental measurements.

Percentile levels are the perfect complement to the equivalent continuous sound pressure level function.

The **SC160** measures the equivalent continuous sound pressure levels **L_t** and **L_T**.

The **L_t** equivalent level is the equivalent level of the interval measured, that is, for each instant it gives us the value of the equivalent level from the beginning of the measurement to that instant. When measurement has been completed, the **L_t** value corresponds to the equivalent level of the entire measurement from beginning to end.

The **L_T** equivalent level is the equivalent level corresponding to integration time T (a programmable parameter). Every T interval the **SC160** shows the equivalent level of the last T interval.

6.2.5 Sound exposure level (SEL)

L_E (SEL) Sound exposure level. This is the sound level that, kept constant for 1 second, presents energy equivalent to the energy accumulated throughout the entire measurement, in decibels.

$$L_E = 10 \cdot \log\left(\frac{1}{T_0}\int_0^T\frac{p^2(t)}{p_0^2}dt\right)$$

p(t): instantaneous sound pressure

p_0: reference sound pressure (20 μPa)

T: duration of the measurement

T_0: 1 second

Its relationship to the sound exposure level is as follows:

$$L_{eqT} = L_E - 10 \cdot \log\left(\frac{T}{T_0}\right)$$

6.2.6 Percentile levels

L_{99}, L_{95}, L_{90}, L_{50}

L_{10}, L_5 and L_1 These are the levels that were exceeded during 99%, 95%, 90%, 50%, 10%, 5% and 1% of the analysis time, in decibels. The **L_{AF}** function is used to calculate them.

In some English speaking countries, the percentile levels are known as the exceedance levels, or the statistical levels, or simply as L_n values, where 'n' is a number from 0.1 to 99.9.

7. APPENDIX B: Reverberation Time Module

The reverberation time measurement (RT) module of the **SC160** Sound Level Meter allows:

- The simultaneous measurement of the reverberation time T_{20} and T_{30} by the interrupted noise method for the octave bands of 63, 125, 250, 500, 1000, 2000, and 4000 Hz RTI.
- The automatic detection of the decay curve and the evaluation of its slope through a least square approximation.
- The possibility of storing the results in memory: Values of T_{20}, T_{30} and decay curves, for all octave bands.

The RT measurement module is not included with the **SC160**. It is an optional module and it can be acquired when buying the **SC160** or later. To incorporate it simply contact an official CESVA distributor and supply him with the serial number of the sound level meter. A CD with the activation program will then be sent.

7.1 Activation of the Reverberation Time Module

NOTE: Once a module has been activated, it cannot be deactivated.

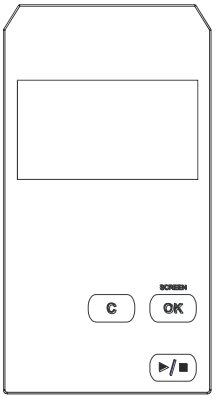
To activate the reverberation time module (RT):

- Insert the accompanying CD into the CD-ROM drive. The activation program 'SC160 RT module Activator' will be automatically executed. If it does not, execute the SETUP.EXE program in the CD-ROM drive.
- Follow the steps shown on the screen.

To verify that your SLM has the RT module activated.

Verify that the sound level meter is switched on and stopped (■), press the key C sequentially until the new mode appears. It can be identified by the title that appears on the screen when changing the mode "REVERBERATION TIME 1/1" or by the indicator shown at the top right of the screen RTI.

7.2 Using the keyboard



SC160 REVERBERATION TIME KEYS	
▶/■	Key to begin or terminate a reverberation time measurement
OK	Key to confirm the various steps of the process of RT measurement
C	Key to change the mode, when the SC160 is in ■

7.3 Using the SC160

7.3.1 Starting the SC160

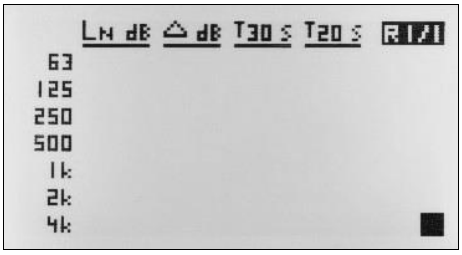
To start the SC160, press the key: ⏻

The CESVA logo, together with the **SC160** sound level meter model will appear on the screen. A few seconds later, the initial screen predetermined in the menu setting option will appear.

If the **SC160** does not switch on, check that a fully charged battery is fitted or that it is connected to a suitable power supply.

7.3.2 Accessing the Reverberation Time Mode

Switch on the **SC160** and check there is no measurement in progress (■), press the MODE C key sequentially until “REVERBERATION TIME 1/1” appears. Then the Reverberation Time mode screen will appear. This mode will be distinguished by the R 1/1 indication that will appear in the top right corner of the screen



7.3.3 Measuring the Reverberation Time

The reverberation time mode of the **SC160** measures simultaneously the reverberation time (T_{20} and T_{30}) for all the octave bands (from 63 Hz to 4 kHz) by the interrupted noise method.

This method consists of obtaining the sound pressure level decay as a function of time inside the room that is being studied. This decay is obtained by exciting the room with random noise of broadband or of limited bandwidth and recording the decay level of the sound pressure when the noise emission is cut abruptly.

To carry out this measurement, an omni directional sound pressure source (FPA-120) is used to emit a broadband noise (pink noise).

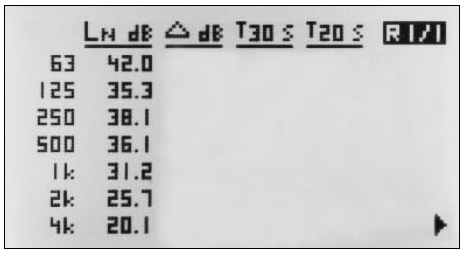
The applications of this mode include the measurement of reverberation time in rooms, the measurement of the absorption coefficient in reverberant rooms, the measurement of acoustic insulation in buildings and of building elements.

7.3.4 Beginning a measurement

First of all, check that there is no measurement in progress (■). If there is, (▶ or ❚❚), press ▶/■ to stop it.

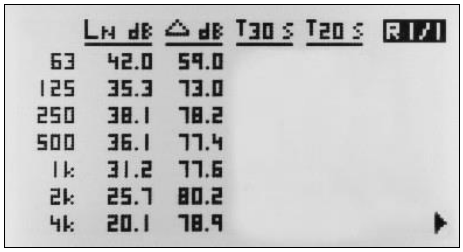
Next, switch the **SC160** to reverberation time mode and proceed as follows:

- Make sure that the sound pressure source is stopped.
- Press ▶/■ to start the measurement process. First it will measure the sound pressure level corresponding to the background noise L_N. This level will appear on the screen for every octave band (Equivalent level of 1 second in dB).

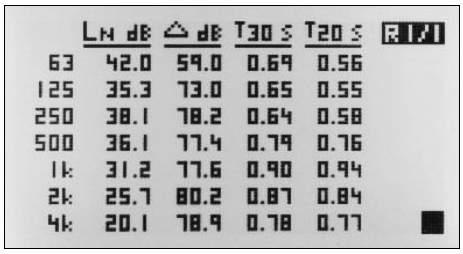


- Press OK to validate this measurement. These values will stop oscillating and become fixed. These values will be taken as the background noise level to calculate the RT. A new column of values will appear on the screen corresponding to the increase in the sound pressure level in respect of the background noise Δ (in dB).

- Increase the sound pressure level progressively until a sound pressure level of 35 dB above the background noise is reached in order to calculate T_{20} and 45 dB above the background noise to calculate T_{30}.
- When the source is emitting the necessary sound pressure level, wait a few seconds to allow the acoustic field to reach a stable state.
- Press OK to validate this level. These values will stop oscillating and become fixed. The initial maximum levels to calculate the RT will be obtained from these values.

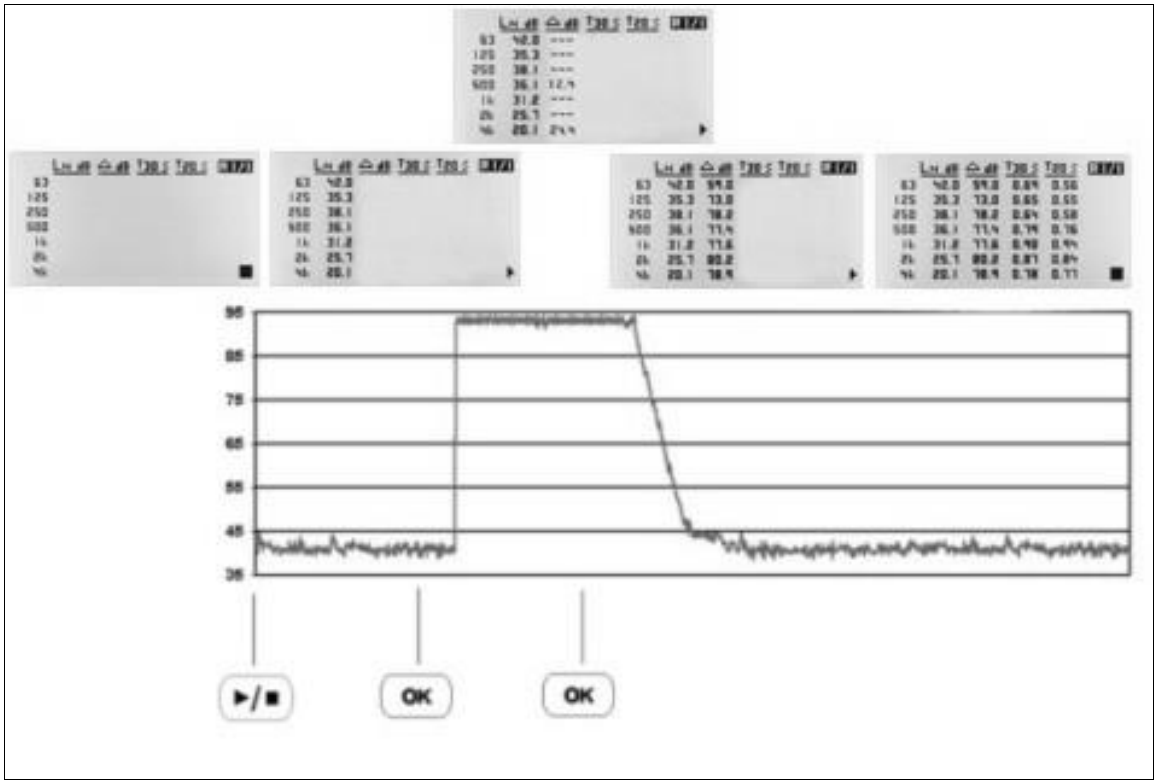


- From this instant, the **SC160** will wait until the noise emission is interrupted.
- Stop the noise emission.
- A few seconds after the noise emission stops, the values of T_{30} and T_{20} will appear on the screen and the measurement will finish automatically, with (■)showing on the screen.



The **SC160** also measures the decay curves of the sound pressure level, but this can only be displayed by recording the final result of the measurement and downloading these data on to the computer using the CESVA **CAPTURE Studio** software application.

The graphic below shows the whole Reverberation Time measurement process.



7.3.5 Stopping the measurement

While the measurement is in progress, it can be stopped by pressing ►/■ . The state of measurement indicator will switch from ► to ■.

7.3.6 Overload and Over range indicator

The **SC160** has an overload indicator. While there is an overload, the sign ^ appears in the bottom right-hand corner of the screen.

If the sign **^** appears during the measurement the **SC160** will not validate the values measured and it will not move on to the next step of the measurement.

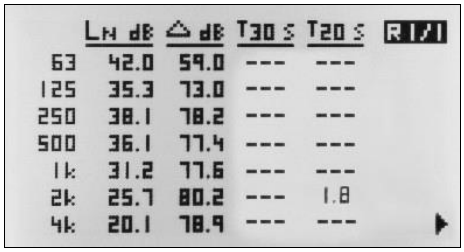
If the overload occurs during the decay curve measurement, the measurement will be aborted automatically.

When **over** appears in the indication of the value of a function, this means that the value measured exceeds the upper limit of the measurement range (over-range).

7.3.7 --- Indicator

If the --- indicator appears after finishing a measurement, this may be because:

- The sound pressure level above the background noise reached is not enough to calculate the parameter (T_{20} ➔ Δ>35 dB and T_{30} ➔ Δ>45)
- The reverberation time cannot be calculated.



7.3.8 Turning the SC160 off

To turn the SC160 off, first make sure that no measurement is in progress (■), then press 

7.3.9 Menu of SC160

While no measurement is in progress (■) the SC160 menu can be accessed by pressing: 

All the options of the menu are available.

To return to the reverberation time mode, press: 

7.4 Data register

The values of the functions measured may be stored in the **SC160** internal memory. When the unit is switched off, the data is saved and may be retrieved and displayed directly from the SC160 or transferred to a PC. The memory may be erased directly from the **SC160**.

7.4.1 Saving results

Once a measurement has been completed (■), the results may be stored in the memory. Do this by selecting the SAVE RESULTS option from the main menu The **SC160** indicates the memory number under which the data has been saved.

The **SC160** saves the following information for the octave bands centred at 63, 125, 250, 500, 1000, 2000 and 4000 Hz frequencies:

- Reverberation Time mode:
    - Reverberation Time T_{20} and T_{30}.
    - Sound pressure level of background noise.
    - Initial maximum sound pressure level.

- Decay curve: Time history of the sound pressure level decay.

The SC160 may store a total of 100 final results in reverberation time mode.

7.4.2 View register

This option enables the final results of the registers stored in the **SC160** memory to be displayed on the screen. To use this option, access VIEW REGISTER on the **SC160** menu.

The **SC160** allows the required register to be selected, using the ↙ , ↗ and OK keys, with index appearing on-screen showing all the registers stored in the memory (register number + date and time of the beginning of the measurement process).

Information on the decay curve is not available.

7.5 Technical Specifications

7.5.1 Measurement Range

The decay curves are measured from the equivalent levels (linear averaging) with integration time:

Integration time of the equivalent level	
63 Hz	40 ms
125 Hz	20 ms
250 Hz	10 ms
500 Hz	10 ms
1 kHz	10 ms
2 kHz	10 ms
4 kHz	10 ms

The range of measurement for the T_{20} and T_{30} functions is:

T_{20}	
63 Hz	0.48 s to 17.1 s
125 Hz	0.24 s to 17.1 s
250 Hz	0.12 s to 17.1 s
500 Hz	0.12 s to 17.1 s
1 kHz	0.12 s to 17.1 s
2 kHz	0.12 s to 17.1 s
4 kHz	0.12 s to 17.1 s

T_{30}	
63 Hz	0.48 s to 11.4 s
125 Hz	0.24 s to 11.4 s
250 Hz	0.12 s to 11.4 s
500 Hz	0.12 s to 11.4 s
1 kHz	0.12 s to 11.4 s
2 kHz	0.12 s to 11.4 s
4 kHz	0.12 s to 11.4 s

7.5.2 Estimation of the slope of the decay curve

The estimation of the slope of the decay curve is automatically achieved from the lineal regression by least square approximation of itself.

7.5.3 Standards of measurement and calculation

Measurements and calculations can be made according the following standards:

Standards of measurement and calculation
ISO 3382-1 Measurements of the reverberation time in performance spaces
ISO 3382-2 Measurements of the reverberation time in ordinary rooms
ISO 354 Measurement of sound absorption in a reverberation room
ISO 140 Measurement of sound insulation in buildings and of building elements

7.6 Function summary table

7.6.1 Reverberation time mode functions

Function	**Freq. Weigh.**	**63**	**125**	**250**	**500**	**1 k**	**2 k**	**4 k**
Reverberation TimeT_{30}		X	X	X	X	X	X	X
Reverberation Time T_{20}		X	X	X	X	X	X	X
Sound pressure level of the background noise	-	X	X	X	X	X	X	X
Initial maximum sound pressure level	-	X	X	X	X	X	X	X
Time history of the decay curve	-	X	X	X	X	X	X	X

X: available - : without freq. weighing

All the functions are measured simultaneously

7.7 Definition of functions

7.7.1 Decay curve

Decay Curve Decay of the sound pressure level against time inside the room after the source is stopped. This decay can be measured after a real cut of the continuous emission of a sound source in the room that is being studied.

7.7.2 Reverberation Time

T_{30} Is the time in seconds that is required for the sound pressure level to decrease by 60 dB, calculated on a line from a lineal regression by least squares approximation of a decay curve measured from a level 5 dB below the initial level, to a level 35 dB below it.

T_{20} Is the time in seconds that is required for the sound pressure level to decrease by 60 dB, calculated on a line from a lineal regression by least squares approximation of a decay curve measured from a level 5 dB below the initial level, to a level 25 dB below it.

The reverberation time of a room is one of the most important parameters to evaluate its acoustic properties. Its measurement has important applications in the field of noise control in rooms, concert halls and lecture rooms. The reverberation time measurement is essential for calculation of acoustic insulation in buildings and of building elements, and for the measurement of absorption in a reverberant room.

The reverberation time parameter is defined in the International Standard ISO 3382-1 / ISO 3382-2.

8. APPENDIX C: Dosimeter Module for the assessment of noise in the workplace

The dosimeter module for the assessment of noise in the workplace of the **SC160** adds a new measurement mode that is perfect for the application of the Directive 2003/10/CE which adapts to technical progress the regulation on protection of the health and safety of workers against risks regarding the exposure to noise; in The Member States, the corresponding transposition to national law.

This dosimeter module allows all parameters needed to be simultaneously measured to assess the levels of noise to which workers are exposed when wearing hearing protectors, or not (SNR, HML and Octaves).

The **SC160** measures simultaneously the equivalent level with frequency weighting A and C [L_{At}, L_{Ct}], daily noise exposure level [$L_{EX,8h}$] (ISO 1999), Noise exposure in Pa^2h [E] and noise dose [DOSE] referred to a programmable Criterion Level [L_C], and, of course, also the Peak Level with C frequency weighting [L_{Cpeak}] (ISO 1999).

Moreover, the **SC160** enables the measurement to be carried out during a time shorter than the exposition time, because it shows on the screen all parameters projected to the expected exposure time (programmable projection time [t_p]).

To evaluate the exposure to noise taking into account the attenuation of the individual hearing protectors worn by the worker, the **SC160**, beside measuring the equivalent level with frequency weighting A and C [L_{At}, L_{Ct}] (SNR and HML method), simultaneously carries out a real time frequency analysis with frequency weighting A and by octave bands from 63 Hz to 8 kHz (Octave method).

The huge memory of the **SC160** allows the time history of the parameters measured to be stored (time periods longer than a week), and afterwards recalculated for any desired time interval.

The **SC160** helps with the assessment and measurement of exposure to noise and also provides all the data needed to inform and train about the significance and potential risks of the results of the assessment and measurement.

Moreover, It is helpful to design and run a reduction programme and to choose suitable hearing protectors.

The dosimeter module for the assessment of noise in the workplace is not included with the **SC160**. It is an optional module and it can be acquired when buying the **SC160** or later. To incorporate it, simply contact an official CESVA distributor and supply them with the serial number of the sound level meter and carry out the transaction. In a few days a CD with the activation program will arrive.

8.1 Dosimeter module activation

NOTE: Once a module has been activated, it cannot be deactivated.

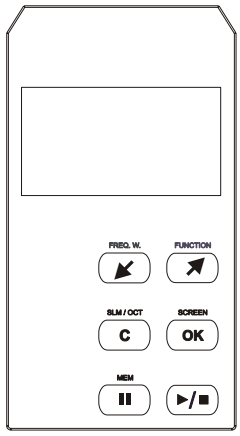
To activate the Dosimeter Module (DS), proceed as follows:

- Insert the accompanying CD in the CD-ROM drive. The activation program 'SC160 DS module Activator' will be executed automatically. If not, execute the SETUP.EXE program in the CD-ROM drive.
- Follow the steps indicated.

To verify that the SLM has the DS module activated:

Switch on the **SC160** and press the C key sequentially until the new module appears. It can be identified by the title “DOSIMETER” (module for the assessment of noise in the workplace).

8.2 Using the keyboard for the dosimeter mode



SC160 Keys DOSIMETER mode:	
▶/■	Key to begin and to finish a measurement.
II/●	a) Key to temporarily interrupt a measurement (PAUSE) (while the SC160 is on ▶) b) To start recording data into the memory (when SC160 is stopped i.e. ■)
FREQ. W.	Key to return to the previous octave band
FUNCTION	Key to go on to the next octave band or select between the numerical screen and the numerical screen with projected parameters
SCREEN OK	Key to select the required Dosimeter mode screen: Numerical screen, 1/1 Spectrum analyser screen or graphic screen
C	Key to change mode when the SC160 is in ■

8.3 Using the SC160

8.3.1 Switching on the SC160

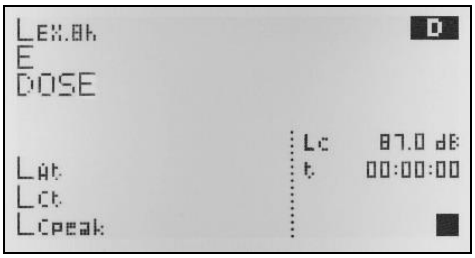
To switch on the **SC160**, press the key: ⏻

The CESVA logo, along with the **SC160** sound level meter model will appear on the screen. A few seconds later, the initial screen predetermined in the settings menu option will appear.

If the **SC160** does not switch on, check that fully charged batteries are fitted or that it is connected to a suitable power supply.

8.3.2 Accessing the Dosimeter mode

Switch on the **SC160** and check there is no measurement running (■), press the C key sequentially until the heading; "DOSIMETER" appears. Then the dosimeter mode will appear on the screen. This mode can be identified by the D indication that will appear at the top right corner of the screen.



8.3.3 Turning off the SC160

To turn off the SC160, check that no measurement is running (■) and press: ⏻

8.3.4 SC160 Menu

While there is no measurement running (■) the **SC160** menu can be accessed by pressing: ☰

All the menu options are available.

To go back to the measurement mode press: C

8.4 Measuring in dosimeter mode

This module makes a real time analysis of the acoustic parameters to assess noise in the workplace: daily noise exposure level ($L_{EX,8\ h}$), sound exposure (E) and the noise dose (DOSE), all parameters with frequency weighting A. Also, the dosimeter mode can project these parameters to the predicted exposure time for measurement times shorter than the exposure time. The dosimeter mode also measures the equivalent continuous sound pressure level with frequency weighting A and C (L_{At} and L_{Ct}) and the peak sound pressure level with frequency weighting C (L_{Cpeak}).

The frequency analysis of this mode shows the equivalent continuous sound pressure level for the octave bands centred on frequencies 63 Hz – 8 kHz with frequency weighting A.

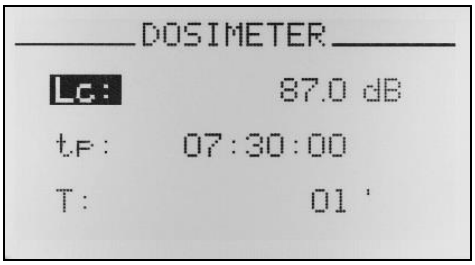
Finally, the graphic display shows the time history of the equivalent continuous sound pressure level with programmable consecutive integration time T and with frequency weighting A.

8.4.1 Prior adjustments

Before beginning a measurement, the following parameters should be set:

- Criterion level (L_C): the constant exposure to this level for eight hours results in a 100 % noise DOSE
- Projection time (t_p): predicted noise exposure time
- Integration time (T): integration time for the measurement of equivalent continuous sound pressure level. The dosimeter module saves the time history for the parameters (L_{Cpeak}, L_{AT}, L_{CT}, and L_{Toct})

To set these parameters select the SETTINGS ➔ MEASURING ➔ DOSIMETER option from the **SC160** menu.



When the above screen appears, select the parameter to be set; L_C, t_p or T using the ↙ and ↗ keys, then press OK. Use the C key to cancel.

To modify the L_c parameter, proceed as follows:

- Select the numerical value using the ↙ and ↗ keys and press OK.

To modify the t_p parameter, proceed as follows:

- Set the hours value using ↙ and ↗ and press OK to confirm, repeat this process to set the minutes value. The projection time t_p is set from (HH:mm:00):
    - 0 to 99 for HH (Hours)
    - 0 to 59 for mm (minutes)

The minimum projection time is 1 minute.

To modify the T parameter, proceed as follows:

- Select the numerical value using ↙ and ↗ and confirm by pressing OK. T integration time may be set from
    - 1 to 59 seconds (1'' – 59 '')
    - 1 to 59 minutes (1' – 59')
    - 1 to 99 hours (1H – 99 H)
- Finally select the time units: seconds (“), minutes (‘) or hours (H) with the help of ↙ and ↗ and press OK to confirm. Use C to cancel or return to the menu.

8.4.2 Beginning a measurement

First of all, ensure that the sound level meter has no measuring process in progress (■). If it has (▶ or ❚❚), press ▶/■ to stop it.

Next, set the **SC160** to dosimeter mode and choose the screen to be displayed (numeric, 1/1 Spectrum analyser or graphic), with the following keys:

MODE C SCREEN OK

Once the screen has been selected, press ▶/■ to start the measurement process.

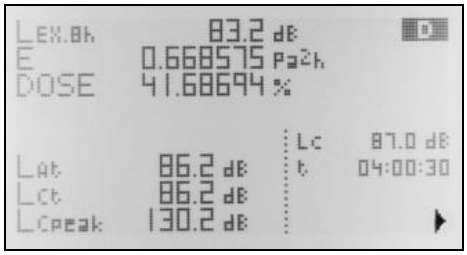
8.4.3 Function display

The **SC160** measures all functions simultaneously.

Described below are the different ways of displaying the acoustic functions for the assessment of noise in the workplace while measurement is taking place. If the kind of display (screen) or the octave band selected (spectrum analyser screen) is changed, measurement will continue uninterrupted. While measurement is in progress, however, it is not possible to switch from one measurement mode to another.

Numerical screen

This screen shows, in real time, the following information:

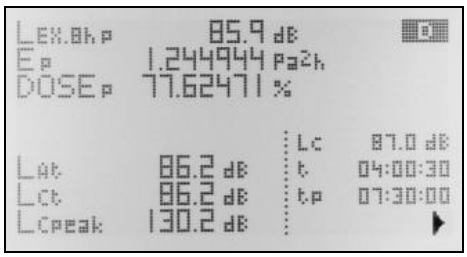


- Daily noise exposure level ($L_{EX,8h}$).
- Sound Exposure (E).
- Noise dose (DOSE).
- Equivalent continuous sound pressure level with frequency weighting A and C corresponding to the measurement time (L_{At} and L_{Ct}).
- Peak sound pressure level with frequency weighting C corresponding to the measurement time (L_{Cpeak})
- Criterion level (L_C)
- Measurement time (t)

By pressing  the projected parameters are displayed.

The projected parameters determine the sound exposure if the measured level remains constant during the projection time.

The projected parameters enable the sound exposure to be evaluated for measurement times shorter than the configured projection time t_p.



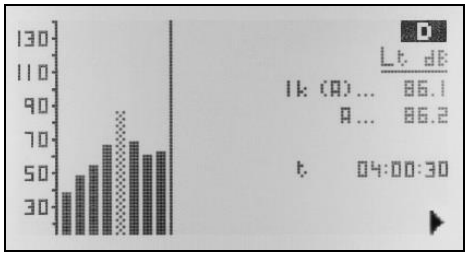
- Projected daily noise exposure level ($L_{EX,8h\ p}$)
- Projected sound exposure (E_p)
- Projected noise dose ($DOSE_p$)
- Measurement time (t) and projected time (t_p)

To return to the previous screen, press [↗].

When a register recovered from the memory is displayed on the screen the sound level meter uses the L_C criterion level and the t_p projection time set. This feature allows evaluations for a register according to the L_C criterion level and the t_p projection time set on the sound level meter.

1/1 Spectrum analyser screen

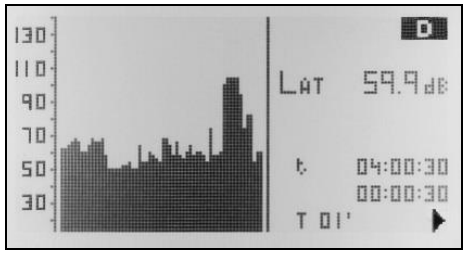
This screen shows, in real time, the following information:



- Graph of the equivalent continuous sound pressure level with the integration time corresponding to the measurement time (▉ bars) in real time for octave bands centred on frequencies 63, 125, 250, 500, 1000, 2000, 4000 and 8000 Hz (with frequency weighting A).
- Numerical value of the equivalent continuous sound pressure level with the integration time equal to the measurement time for the selected octave band (▩ bar) (with frequency weighting A).
- Central frequency of the selected octave band (▩ bar)
- Overall equivalent continuous sound pressure level with the integration time corresponding to the measurement time and with frequency weighting A.
- Measurement time (t)

Graphic screen

This screen shows, in real time, the following information:



- Time history (60 values) of the equivalent continuous sound pressure level with integration time T and frequency weighting A.
- Measurement time (t) and the elapsed integration time

8.4.4 Interrupting the measurement

By pressing [II/●] the measurement is temporarily interrupted. The state of measurement indicator will change from ▶ to ▮▮. While the **SC160** is paused (▮▮) the measured functions

may continue to be consulted prior to the temporary interruption of measurement. To resume measurement, press ▶/■ .

By pressing ▶/■ the measurement is stopped. The state of measurement indicator will change from ▶ to ■.

8.4.5 Consulting measured data

While the SC160 is not measuring (■), all the measured functions may be consulted.

To do this, follow the same procedure as described in section 8.4.3 on viewing data while a measurement is in progress.

8.4.6 Overload indicator

The SC160 is equipped with an overload indicator for each function. If overloading occurs during a measurement, the **^** sign will appear before the function affected by overloading. When a function registers overload, its corresponding measurement will be incorrect.

When overloading occurs, the ^ indication appears in the bottom right-hand corner of the screen.

8.5 Data registering

The **SC160** can record in its internal memory the values of the functions measured. When switching on the equipment, the recorded data will not be lost and can be retrieved and displayed directly from the **SC160** or transmitted to a PC. The memory can be erased directly from the **SC160**.

Two kinds of registers may be saved in the memory:

- The final results of a measurement.
- Continuous recordings of functions with programmable recording time.

8.5.1 Saving final results

Once a measurement has been completed (■), the results may be stored in the memory by selecting the SAVE RESULTS option from the main menu. The **SC160** will indicate the register number in which to record the data.

The **SC160** stores the following information.

- Equivalent continuous sound pressure level with frequency weighting A corresponding to the measurement time (L_{At}).
- Equivalent continuous sound pressure level with frequency weighting C corresponding to the measurement time (L_{Ct})
- Equivalent continuous sound pressure level with the integration time corresponding to the measurement time, with frequency weighting (A) for each octave bands centred on frequencies 63, 125, 250, 500, 1000, 2000, 4000 and 8000 Hz
- Overall peak sound pressure level with frequency weighting C corresponding to the measurement time (L_{Cpeak})
- Daily noise exposure level ($L_{EX,8h}$)
- Sound exposure (E)

- Equivalent continuous sound pressure level with frequency weighting A corresponding to the last integration interval T (L_{AT})
- Equivalent continuous sound pressure level with frequency weighting C corresponding to the last integration interval T (L_{CT})
- Equivalent continuous sound pressure level corresponding to the last integration interval T, with frequency weighting (A) for each one of the octave bands centred on frequencies 63, 125, 250, 500, 1000, 2000, 4000 and 8000 Hz
- Peak sound pressure level of the integration interval T with frequency weighting C (L_{Cpeak})
- Measurement time t, integration time T and the elapsed integration time
- Date and time of the beginning of the measurement

DOSE, $DOSE_p$, $L_{EX,8h\ p}$, E and E_p functions are not saved. Every time that a register is recovered these functions are calculated according L_C and t_p values set on the sound level meter.

The SC160 has capacity for up to 1000 final results.

8.5.2 Making a recording

A recording consists of making a measurement and storing a series of functions in the memory with a defined periodicity. These functions and the periodicity are specified in the recording setting. The main difference between the different kinds of recording lies in the "number of functions / storage time" ratio. See section 8.5.3.

Before beginning a recording, make sure there is no measurement in progress (■).

To begin a recording, press  . The screen will display the kind of recording along with the register number. Next the functions selected for the type of recording will be saved periodically in the memory until the recording is stopped by pressing  . During the recording process, the measurement in progress icon (▶) will flash on and off.

8.5.3 Kinds of recording

The dosimeter mode stores the following information:

T Functions: once each integration interval T has come to an end, the following values are stored in the memory:

- Equivalent continuous sound pressure level with frequency weighting A (L_{AT})
- Equivalent continuous sound pressure level with frequency weighting C (L_{CT})
- Equivalent sound pressure level corresponding to the last integration interval T, with frequency weighting (A) for each one of the octave bands centred on frequencies 63, 125, 250, 500, 1000, 2000, 4000 and 8000 Hz
- Peak sound pressure level of the integration interval T with frequency weighting C (L_{Cpeak})

When the measurements ends, the final results are saved:

- Equivalent continuous sound pressure level with frequency weighting A corresponding to the measurement time (L_{At})
- Equivalent continuous sound pressure level with frequency weighting C corresponding to the measurement time (L_{Ct})

- Equivalent continuous sound pressure level with the integration time corresponding to the measurement time, with frequency weighting (A) for each one of the octave bands centred on frequencies 63, 125, 250, 500, 1000, 2000, 4000 and 8000 Hz.
- Overall peak sound pressure level with frequency weighting C corresponding to the measurement time (L_{Cpeak})
- Daily noise exposure level ($L_{EX,8h\ p}$)
- Sound Exposure (E).
- Equivalent continuous sound pressure level with frequency weighting A corresponding to the last integration interval T (L_{AT})
- Equivalent continuous sound pressure level with frequency weighting C corresponding to the last integration interval T (L_{AT})
- Equivalent continuous sound pressure level corresponding to the last integration interval T, with frequency weighting (A) for each one of the octave bands centred on frequencies 63, 125, 250, 500, 1000, 2000, 4000 and 8000 Hz
- Peak sound pressure level of the interval with frequency weighting C (L_{Cpeak})
- Measurement time t, integration time T and the elapsed integration time
- Date and time of the beginning of the measurement

DOSE, $DOSE_p$, $L_{EX,8h\ p}$, E and E_p functions are not saved. Every time a register is recovered these functions are calculated according to the L_C and t_p values set on the sound level meter.

The storage capacity according to the programmable integration time is in the following table.

Storage capacity					
T= 1 s	➔	10	hours	13	minutes
T= 1 min	➔	25	days	13	hours

The storage times for each type of recording correspond to one single recording, until the memory is completely full.

The **SC160** has capacity for up to 1000 registers (final results or recordings) of any kind.

When the built-in memory is full, no more recordings can be made and no more final results saved. If this is attempted, the 'MEMORY FULL' message will appear on screen.

8.6 Viewing the register

This option allows the final result of the registers stored in the **SC160** memory to be displayed on screen. Access the option by selecting MEMORY ➔ VIEW REGISTER from the **SC160** menu.

By pressing  ,  and 

, it is possible to select the register to be viewed. The screen will display an index of all the registers stored in the memory (register number + date and time when the measurement process began).

To view the different functions, follow the procedure described in section 8.4.3.

8.7 Technical specifications.

The technical features of the measurement parameters are in accordance with chapter 5 of this manual.

8.7.1 Standards

Standards
IEC 61672 class 2, IEC 60804:00 type 2, IEC 60651:01 class 2
DIRECTIVE 2003/10/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, 6 February 2003 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise)

8.8 Functions definitions

8.8.1 Daily noise exposure level

$L_{EX,8h}$ Daily noise exposure level normalized to 8 hours, with frequency weighting A.

$$L_{EX,8h} = L_{At} + 10\lg(t/T_0)$$

L_{At}: Equivalent continuous sound pressure level with frequency weighting A corresponding to the measurement time

t: Measurement time

T_0: Normalization time (8 Hours)

8.8.2 Sound exposure

E Sound exposure, time integral of the instantaneous squared sound pressure over a specified measurement time, expressed in $Pa^2 \cdot h$.

$$E = \left(\int_0^t p_A^2(t) \cdot dt \right)$$

$p_A(t)$: Instantaneous sound pressure with frequency weighting A

8.8.3 Dose

DOSE Relationship between the energy of the measurement interval and the maximum energy allowed with respect to the criterion level L_c for 8 hours. Expressed as a percentage (%).

$$DOSE = 10^{\frac{(L_{EX,8h} - L_c)}{10}}$$

$L_{EX,8h}$: Daily noise exposure level (dBA).

L_C: Criterion level (dBA).

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