INSTRUCTION MANUAL

INSTRUMENT SOFWARE 6.0

Norsonic has always been at the forefront introducing new technology to sound level meters. The Nor150 Sound and Vibration Analyser sets a new standard for field instrumentation, featuring a large colour touch screen, on board camera, GPS, sound recording, voice and text notes, sophisticated marker handling and event triggers in addition to high resolution time profile, multi-frequency spectra, infrasound and ultrasound. The instrument is designed to cover a variety of applications and provides the user-friendliness of a smart phone with features normally found in complex laboratory instruments such as on board Building acoustic, Sound Intensity and STIPA modules. This instruction manual is updated to include the features in software version 6.



Nor150

SOUND ANALYSER

Norsonic

Nor150 User Guide – January 2026 Edition
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If you wish to communicate with us, please feel welcome.

Norsonic AS, Gunnersbråtan 2, N-3409 Tranby, Norway
+47 32 85 89 00 | info@norsonic.com | www.norsonic.com

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Finding the information you need

Thank you for choosing Norsonic!

The Nor150 has been designed to give you many years of safe, reliable operation.

Your approach to the Nor150 documentation depends on what you want to do and how much you already know.

This manual is divided into several sections plus an index. Each section provides useful and in depth information about the available features. Depending on your requirements and your familiarity with measurements as such, you may find that you use some parts of this manual quite often and others not at all.

A brief introduction of the user philosophy and use of the instrument is described in chapter 2. We recommend reading this chapter before use, and as a minimum, reading the safety instructions and precautions in chapter 1.

If you do not have this manual at hand, useful help is found in context sensitive help function in the instrument. In most pictures there is a red question mark "?" in the upper right corner of the display. Tap it to access the help function.



NOTE that the instruction manual describes a fully equipped instrument. Your version of the instrument may not have all the optional extensions available. Software extensions may be installed as retrofit at any time. Extensions like the dual channel option, camera and GPS cannot be installed as retrofit.

Denotes

Some denotes are used in the manual to ease the use and distinguish a keyboard key, a soft key or a menu.

VIEW denotes the **VIEW** button found on the rubber keyboard.

Stop denotes a soft key mostly found in the lower line of the display.

Instrument denotes a menu point.

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nor150
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Important information

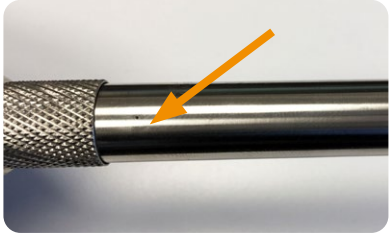
Please read all safety, precaution and storage information before use. These sections contain vital information to maintain safety and warranty.

Safety instructions

- Read these instructions.
- Follow all warnings and safety instructions.
- Do not use the instrument in rain or moisture.
- Keep the instrument out of corrosive atmosphere and do not use it in a hazardous area.
- Clean the instrument only with dry cloth, except for the display where special wipes are available.
- Do not place this instrument near any heat sources such as radiators, heat registers, stoves, or other apparatus that produce heat.
- Only use the original mains adapter supplied with the instrument.
- The internal battery is a Li-ion type. Make sure it is recycled properly if it is going to be replaced.
- Make sure the instrument and any accessories are not damaged in any way use.
- Only use attachments/accessories allowed or specified by Norsonic AS.
- Be careful when using the instrument on a tripod or in combination with a rotating boom.
- Unplug this instrument during lightning storms or when unused for long periods of time.
- Refer all servicing to qualified service personnel. There are NO user-serviceable parts inside.

Servicing is required when the instrument has been damaged in any way, such as power failure, battery failure or any plug is damaged, liquid has been spilled or objects have fallen into the apparatus, the instrument has been exposed to rain or moisture, does not operate normally, or has been dropped.

Important notice! Never block the tiny hole located at above the knurled screw on the preamplifier. This is the ventilation hole to equalize static pressure difference in the microphone. Blocking this hole may give wrong measurement results.



Caution!
Never expose the batteries to temperatures outside maximum operation temperature range; -10 °C / 14 °F to +50 °C / 122 °F.

Maximum storage temperature range is -30 °C / -22 °F to +50 °C / 122 °F. Room temperature is recommended for long time storage. Always fully charge the batteries before storage. Recharge batteries fully every third month for long time storage.

Never use mechanical damaged batteries.

Shipment of batteries via air or brought as hand luggage / luggage are governed by IATA / UN3481, PI 967 section II when shipped as a part of the instrument and PI 966 part II if shipped separate. See IATA standard for labelling the parcel and to acquire latest information about shipment instructions.

NOTE Damaged batteries are strictly prohibited to be shipped as airfreight or brought onto a plane as hand luggage or checked in luggage.

Precautions

You probably already know it but…

…. always turn on the password protection if you connect the instrument to a public or unsecured network. If not, the instrument is an easy victim for cyber-attack. It is a good practice to always use a FTP password regardless of the connection environment. Also, enable a password protection for the NorRemote program. *"Security" on page 2.*

… the microphone is an especially fragile device. It is easily broken, so take care.

…. always keep the microphone cartridge mounted on the preamplifier. This is the safest way to avoid damage and access of dirt on the contact pin between the preamplifier and microphone cartridge.

… keep the instrument in its carrying case, don't leave it everywhere.

… even the instrument is a field instrument, prevent it from direct contact with dust and moisture.

… Nor150 is a measurement instrument; protect it from impacts and strong vibration.

… never store the instrument with empty batteries. This may permanent damage the batteries.

… fully recharge batteries every month if the instrument is not in use.

… always calibrate the microphone before and after a measurement.

… send the instrument for verification at an accredited laboratory minimum every 24 months.

Note: The Nor150 is normally supplied with a Nor1225 free-field microphone, meeting the requirements for a Class 1 sound level meter in accordance with IEC 61672 and equivalent standards. Owing to the instrument's wide frequency range, it is also suitable for other applications such as infrasound and ultrasound measurements. In these cases, alternative microphone capsules and preamplifiers are required. Please consult your local Norsonic distributor or refer to the chapter on Infrasound/ Ultrasound for further information.

Taking a closer look at the instrument



Be sure to take utmost care when mounting a microphone cartridge onto a preamplifier. To avoid electrical shock from the 200 V polarization voltage always keep the preamplifier disconnected whenever you are mounting a cartridge onto a preamplifier and screw finger tight only!

The picture shows the Nor150 fitted with the standard preamplifier Nor1209 and the microphone Nor1225 mounted in sound channel one.

The instrument is powered from an internal rechargeable Li-ion battery pack. The battery is fully charged when leaving the factory, but due to self-discharge, you may experience the battery gauge shows a lower value than full. The batteries will be charged once the instrument is connected to mains via the supplied mains adapter Nor345x (x denotesversion number A,B,C...).

Always keep the microphone cartridge mounted on the preamplifier. This is the safest way to avoid damage and access of dirt on the contact pin between the preamplifier and microphone cartridge. The preamplifier input has extremely high input impedance (10 Giga ohms) in order not to load the microphone cartridge. Hence, dust, finger prints or other types of contamination may change the sensitivity of the microphone, especially at high humidity.

Switching ON/OFF

The instrument is toggled **ON/OFF** by pressing the lower right key . A short push is enough to start the instrument. The instrument is then going through an initial start-up procedure before showing a measurement display or the application selection menu.

A new push on the button produces a question on the screen, where you confirm that the instrument shall be turned off or lock/unlock the keyboard and the touch sensitive display.

You may force the instrument to turn off by pressing the **ON/OFF** key for more than 5 seconds.

Keyboard

The Nor150 is mainly operated via the touch screen. There is however a dedicated backlit rubber keyboard used for operation of the main important functions such as power **ON/OFF**, measurement **START/STOP**, **PAUSE** and **CALIBRATION**. The philosophy is that all important functions can be operated via the keyboard as well as the touch sensitive display.

The backlit keyboard enables easy operation in dark environment. The backlight level is factory preset, but may be adjusted in the *Power Setting* menu. A time out function is added that will turn off the keyboard light. Touching the screen or push a button will turn the light on again. You may turn off the keyboard light or reduce the power consumption. This setting is done in **SETUP** > *Instrument* > *Power Setting*.



It is recommended to use the measurement control buttons in the touch sensitive screen if you are measuring low noise levels. The rubber keyboard may generate acoustical noise that might influence your measurements at levels below 40 dBA.

In this manual the following symbols are used to indicate the keyboard buttons:

VIEW — View button (**VIEW**): Switch between the four available view setups. Each view can have its own result types displayed, and the cursor movements can be linked.

TBL — Table button **(TBL)**: Switch between graphical and numerical/table version of the results.

FUNC — Function button (**FUNC**): Rotating between selected measurement functions.

INFO — Information button (**INFO**): The info screen is available and shows important measurement settings even when the measurement is running and the menus therefore are not available.

CAL — Calibration button (**CAL**): Activates the calibration functions.

MEM — Memory button (**MEM**): Gives access to browse the memory system.

START STOP — Start/Stop button (**START/STOP**): Starts a measurement or Stops an ongoing measurement.

Pause/continue button (**I▶**): Temporarily prevents measured data to go into the global results. The pause is a toggle style function. It includes a graphical back-erase function.

SETUP — Setup button (**SETUP**): Gives access to the menu system. Display parameters are also available via pop-up menus which are context sensitive.

Cursor buttons (▶ ▲ ▼ ◀): Keys for moving the cursor in graphical and tabular displays. The cursor buttons may have different functionality in the different displays.

On/Off / Lock Keyboard button (**ON/OFF**): Turns the instrument On/Of or keyboard lock. A control question appears on the screen. Holding the button down for more than 5 seconds force the instrument to switch off. Pushing the button when the instrument is measuring will prompt you for keyboard lock only.

V button (✓ or **OK**): Exits the current menu and stores your current selections.

X button (✗): Exits a menu without doing your modifications.



Touch sensitive screen

The large 4.3” capacitive touch display is optimised for use both in dark environment as well as in sunlight. The Nor150 uses the latest technology for touch sensitive displays. The capacitive touch technology eliminates the use of a stylus or calibrating the XY position of the screen.

Manoeuvring in the menus follows the same use as on any smart phone or pad. I.e. in all menus use your finger to tap on the selection fields or drag on the selection wheels or table up/down.

Placing the finger for a few seconds in a graphical display or numerical table or pushing the √ button gives access to a context sensitive menu with various selections available for the current display – easy and intuitive.

The backlight brightness is preset from the factory to work in various environments. It is however possible to adjust it in the power setting menu to optimise it for the current light condition. It may be needed to increase the brightness in heavy sunlight, while dark environments may call for a lower setting. Additionally there is a time out function that will turn off the backlight after a preset time. Touch the screen or push a button and the light will be turned on again.

Please note that the use of the backlight makes a significant impact on the power consumption.

Use the measurement control (Start/Stop, Pause/Continue) in the touch sensitive display when you measure low noise levels. The touch sensitive display is completely noiseless compare to a traditional keyboard.

The Main Status LED

The multi-colour LED above the display indicates several operating states. Red colour indicates some type of error condition (like overload) while green colour is for positive information.

State	Color	Behavior	PWM	Description
Startup/Booting	Red	Continuous		Startup before instrument is in Idle/ ready mode.
Idle/ready	Blue	Continuous		Instrument is ready to start or measurement is finished.
Waiting for trigger	Blue	Blinking	Yes	Start is pressed, but instrument is waiting for trigger condition to be fulfilled.
Running	Green	Continuous		Instrument is measuring, no event.
Event trigger fulfilled(Audio, camera)	Green	Blinking	Yes	Any of the event triggers are fulfilled, recording or camera. The LED lights continuous as long as the recording/ video/picture is on
Overload	Red	Continuous		Instantaneous overload only, not latched.
Battery too low at start-up	Red	Blinking	No	Rapid flashing, before shutting down
Battery low when running	Yellow	Blinking	Yes	Instrument is running, the Green running state is turned into Orange.
After shutdown if battery low	Red	short ON long OFF		The LED will report some short red blink if you try to switch on the instrument after a battery shutdown to indicate that the battery has insufficient capacity to power on the instrument.
Charging	Yellow	Blinking	No	1 to 5 blink. 1 blink means 0-20 capacity. 5 blinks mean 80 to 100% capacity.

Input and output connectors

Input channel 1 is located at the top of the instrument. This is the “default” channel and is the channel used for most sound measurements.

Input channel 2 is mounted on the left-hand side of the instrument. This socket is wired identically to sound channel 1 on the top of the instrument.

Input channel 2 is optional and is not available as retrofit.



On the right-hand side of the instrument there are different communication sockets and the power socket. The mains adapter, Nor345, is connected to the large circular socket. See chapter *“Technical Specifications” on page 204“* for further description.



Several sockets are located behind the rubber cover on the bottom side of the instrument.

LAN socket

Mini USB socket

Normal USB socket

Micro SD card socket

Headset. This socket is intended for connecting a headset with microphone. The signals directly from the input sound channels or from an audio recording can be available so the operator can listen to it. The microphone input can be used to add voice notes to the measurements.

The socket accept a 4 pole 3,5 mm jack plug, normally found on headset with microphone for smartphones or the Norsonic headphone Nor4584.



On the use of the internal battery vs. external DC

The Nor150 comes with an internal Li-ion battery pack (Nor150/Battery) using the latest available charging technology. The battery pack is a so called smart battery where a built-in microprocessor holds all information about the power use and charging. The battery pack sends information to the instruments main processor about available capacity. Thus, the battery may be replaced with a fully charged one without any need for re-calibration of the battery gauge.

The battery pack shall always be installed, even if the unit is permanently powevered by an external source.

Battery lifetime is typically 6–9 hours (depends on measurement mode, use of backlight and interfaces etc). The battery pack is fitted with a fuel gauge. Push the switch below the row of LED's to verify the status of the battery.

A mains adapter type Nor345 is supplied with the instrument. This mains adapter will recharge the batteries (at least 80%) within 2 hours if the instrument is switched off. Longer time is needed if the mains adaptor shall power both the instrument and provide charging.

The instrument switches uninterrupted between mains adaptor and battery power. Hence, always keep the battery pack installed, even when continuously powering the instrument via the external power socket. This will increase the power redundancy.



An external DC voltage (10 – 28 V) can also be used to power the instrument. A cable for this purpose is available separately from Norsonic or our distributors. Please note that fast charging of the internal battery requires 13.2 V / 1.2 A.

Verify the real time clock if you change the batteries. It might be necessary to adjust it.

Charging the Internal Battery

We recommend that you use the mains adapter Nor345 for charging the battery pack. Connecting an external DC-source (10–28 V) to the instrument may do the same function if it can supply 1.2 A continuously. Icons in the upper line of the display indicate the battery condition and whether the instrument is connected to external power.

NOTE! Always fully recharge the battery before you store the instrument. Fully recharge every month if the instrument is not in use. The battery may be permanent damaged if this procedure is not followed.

The battery charging is turned off if the temperature is outside +5 to 40 °C (41 to 104 °F).

Max operating temperature is -10 to 50 °C (14 to 122 °F).

Maximum storage temperature is -30 to +60 °C (-22 to 140 °F).

If power fails

If the battery voltage drops below 9 V, the battery indicator turns red and after a short while the instrument will start to shut itself off. Any ongoing measurement will be terminated and stored. Memory contents are retained without the use of electrical power (flash memory). Upon inserting a fresh battery pack, or connecting to a proper DC voltage source, the instrument will start-up again, and ask the operator for the confirmation to store the previous measurement in the normal way.

Should the external power fail during a measurement, without any internal batteries installed (or the installed batteries have no power left), the instrument will be turned off immediately without storing the ongoing measurement. However, as the instrument automatically makes a backup storage every 2 minutes, the last file stored will include the correct results except for maximum the 2 last minutes prior to the power failure. Upon return of the external power, the instrument will automatically start to measure as if the **START/STOP** key had been pressed.

The Nor150 has a built in power saving feature that turns down the backlight and eventually switch itself off if left unattended in ready mode (I.e the instrument is not measuring or is in ended mode).

Power saving - maximize your battery power

The Nor150 has a sophisticated power saving system to maximize the battery power. In the *Setup / Instrument / Power Setting menu* you may adjust time-out for the brightness levels of the display and keyboard and turn off the GPS.

It is recommended to turn off the keyboard backlight if not needed, and tune down the display backlight to a reasonable level. Also, switch off GPS if not in use.

Unplug interface cables if not in use. Especially the LAN system draws quite much power when connected.

Some displays, like the L/t graph uses more CPU power and thus increases the power consumption. However, when the display turns off due to the backlight off time settings in the power saving menu, all display updating processes are turned off in order to optimise the power consumption.

Further, the l/t sampling rate and audio recording are influencing the DSP work load and thereby the power consumption. Optimising the measurement settings will also help on the power consumption.

Following these simple guidelines will help you to get as much out of the batteries as possible.

Optional extensions

The Nor150 comes with an extensive set of functions available in its basic version. Many other functions are available as optional extensions. The modular software design inside the Nor150 enables functional expansion to take place when you need it and not at the time you purchase the instrument.

This applies to all options except for hardware related options such as option 1 and 2, which cannot be added as retrofit.

All installed options remain in the instrument and there is no need for further loading of the options or add hardware modules when used.

Software maintenance

Norsonic provide regular firmware updates with new features and bug fixes. By carefully listening to our customers we implement their wishes to improve the handling of the instrument and expand it with new features. New software versions can be uploaded from our website and are free of charge if the version is on the same main software version level. A software upgrade fee is charged if you want to upgrade to the next main version (i.e. from version 2.xx to 3.xx), unless you have signed a maintenance contract. Please contact your local Norsonic dealer to receive more information about our software maintenance program. A new main version consists of several new features. Such features can be adaption to new revisions of measurement standards, new measurement functions or new and easier use of the instrument. In addition to new software versions, new option extensions are developed to expand the use of the instrument.

Your first measurement

Make sure you have read *"Important information" on page 19* and the section *"Taking a closer look at the instrument" on page 22* earlier in this instruction manual.

Assemble the instrument if it is not already done.

Turn on the Nor150

and wait for the start-up sequence to terminate. If needed connect the mains adapter Nor345. The upper line on the display shows a "fuel gauge" for the battery.

Select the transducer

When the instrument is delivered from the factory, data for the supplied microphone and preamplifier are entered as a selectable transducer in the input menu. Select **SETUP** > *Input* to see that it is selected.

Check the calibration

This is necessary to make sure you aquire results with correct level. Use a calibrator type Nor1256 or similar to produce the test signal. See *"Calibrating the instrument - field check" on page 62*.

Select a standard set up

The easy and repeatable way to perform a measurement is to select one of the stored set-ups from the memory. If none of these suit your needs, you can make your own and save them for later use. See *"Application Selection Menu - Predefined Setups" on page 101*".

Start and Stop of the measurement

So far only idle values have been displayed. By pushing the **START/STOP** button, the instrument will start to collect data, calculate averages, detect minimum and maximum values and so on. This activity will go on until the pre-set measurement time has expired or the operator pushes the **START/STOP** button again. All the values collected during the measurement will then be available for the user.

Starting a new measurement will delete all the previously measured data including indications of overload or under-range.

Saving the measurement to the memory

After the measurement is finished, all the results, markers and annotations can be saved together with the set up information to the memory. See section *"Storing a measurement - Memory Organising Menu" on page 97*".

How to change measurement settings

After making your first trial measurement you will probably like to change some of the measurement and display settings. What you should be aware of is the difference between measurement settings and display settings. What to measure, measurement time, trigger configurations etc. is set in various submenus. The same with the configuration of how you want to display and visualize the measurement parameters. All this is discussed in then next chapters. Take some time to read and try it out. Once you have made some favorite setup, store them and make them available for you in the startup screen. Cf *"Application Selection Menu - Predefined Setups" on page 101*.

Reducing the influence of the operator

If you experience that the presence of the operator (and the hand that holds the instrument) is influencing the sound field it is recommended idea to put the Nor150 on a tripod. A mounting hole at the rear side of the instrument with a standard camera thread is used.

Removing the influence of the instrument itself

Sometimes even the presence of the body of the Nor150 can influence the measurement more than desired, or the space may be narrow so only the microphone / preamplifier have space. A table of case reflections and uncertainties can be found in the specification section later in this manual. Then connect an extension cable between the preamplifier and the instrument. Using e.g. a 2 meter Nor1410A (with Lemo socket in both ends) will not influence the measurement quality. A microphone holder, Nor1261 or Nor1262, is available for the purpose.

Limiting the influence of wind and dust

The use of the windscreen Nor1451 will limit the influence of wind and dust on the microphone. These "foam-balls" are made of a special type of material, and they have a slight influence of the frequency response of the instrument. Therefore a windscreen correction has to be switched on. This is done in the *Input Menu* (available with the **SETUP** button).

When the wind screen is fitted and the correction is turned on the measurements performed will still be within the specifications of a type 1 sound level meter. The wind screen correction data and uncertainties are shown in a table in the specifications section later in this manual.

Similar, using one of the Norsonic outdoor microphones, corrections are needed. These corrections are automatically "turned on" if selecting one of the outdoor microphones available. This is further discussed later in this manual.

The measurement functions available

What is a Function? In the Nor150 the term is used to denote the combination of RMS (or Peak) detection with certain time constants (when applicable) and certain spectral weighting functions involving measurement duration whenever relevant. Examples of such functions are A-weighted L_{eq}, the A-weighted SPL etc.

The functions are based on the following data types:

SPL	The instantaneous Sound Pressure Level
L_{max}	The Maximum Sound Pressure Level time weighted
L_{min}	The Minimum Sound Pressure Level time weighted
L_{eq}	The Integrated Averaged SPL
L_E	The Sound Exposure Level
L_{PEAK}	The Maximum Peak Level
L_n	Statistical functions
T_{MAX5}	"Takt Maximal" – a special parameter measured mainly in Germany

To form a function you combine a data type with a time constant; Fast, Slow or Impulse and a spectral weighting function A, C, Z, octave or third octave band frequency analysis.

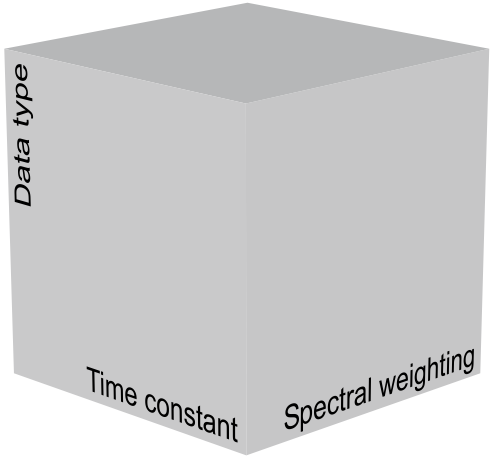


Figure 4.1 - A function can be described as a point in the three-dimensional space having data-type, time constant and spectral weighting as its three dimensions

The analyser does either full octave or third-octave analysis – FFT can be selected in addtion.

Special measurement function used in Building Acoustic, Sound Intensity mode or STIPA, are not discussed in this chapter.

Filling in the three dimensions with data types, time constant and spectral weighting, we arrive at the Function cube.

So far we have yet to mention statistics. In the Nor150 statistics are either based on SPL using a user defined time constant or Leq. The statistics can be presented in several ways – as statistical and cumulative distribution, but also as percentiles. There are 8 percentiles settings available. This must be set up in advance before a measurement.

The spectral weighting functions A, C and Z are measured simultaneously and in addition to the 1/3 or 1/1 octave filter bands (optional). You may also add one calculated network in ultrasound mode AU is added.

FFT (optional) can be measured simultaneously with 1/1 or 1/3 octave filter bands

Statistics can be calculated for Global values and for the time profiles A and B, and for the Moving (sliding) L_{eq} function.

Ln cannot be selected simultaneously for Global and Profile B or Moving Profile, since they are based on different measurement functions. Profile A and Global uses SPL (either Fast or Slow – selectable) while Profile B and Moving Profile uses Leq as base for the calculation of Percentiles.

All three time constants (exponential averaging), Fast, Slow and Impulse are measured in parallel.

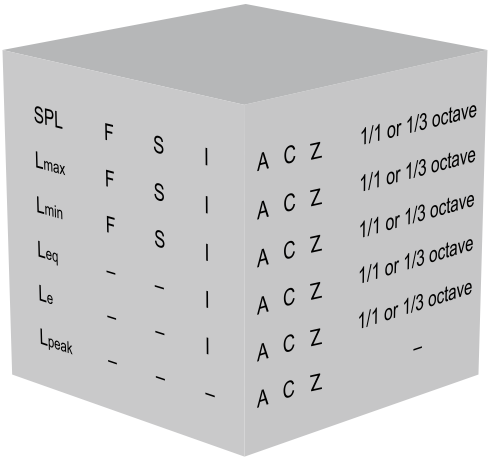


Figure 4.2 - The Function cube expresses a three-dimensional space with the data type (e.g. SPL), the time constant (e.g. F) and the spectral weighting (e.g. A-weighting) as the dimensions. A function will then be a point in this space. Note that not all the points in this space are defined. For example, the (normal) L_{eq} has no time constant and for the Nor145 the peak is not defined in octave and third octave bands.

The instrument measures all parameters both as global values and time profile values also in 1/1 octave band or 1/3 octave bands, if applicable. The user may configure which parameter to measure in order to limit the amount of data.

Global measurement values are a single set of measurement values describing the entire measurement. Such as L_{eq}, L_{max}, L_{min} etc. of the entire measurement as well as an octave or third octave spectrum. These are the same as the values you acquire with a traditional sound level meter.

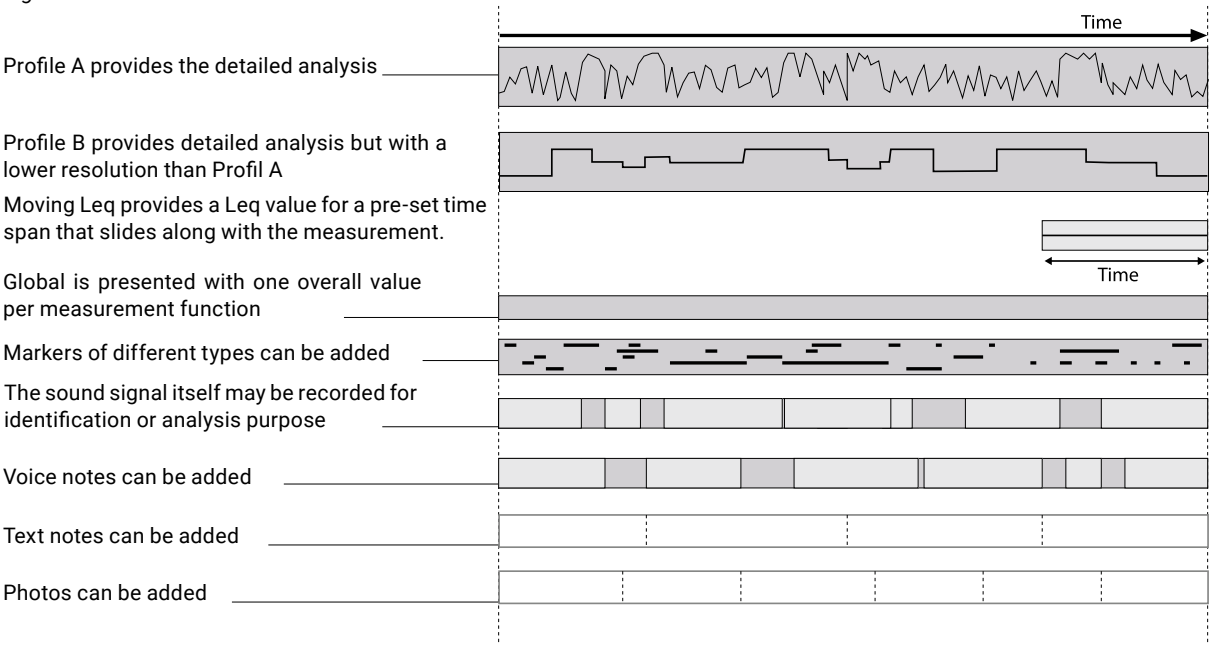
Level vs. time (L(t)), also known as **time profile** or electronic level recorder is a part of the basic functionality.

Three time profiles are available, Profile A, Profile B and Profile Moving. Profile A is the main profile from where the other two are extracted. Thus the **period length** must be set longer than profile A, but shorter than Global measurement for Profile B and Profile Moving. It can be specified in Hours, Minutes and Seconds and it must be a multiple of the Profile A period length.

Profile B and Moving disable the **Pause/Continue** and **Stop/Continue** features.

The time profile resolution span is from 5 ms (10 ms in dual channel mode) to 24 hours. To avoid overloading the Digital Signal Processor – DSP some limitations are set dependent of the selected profile time and the number of selected measurement parameters;

Figure 4.3 - The main features - an overview



Single channel and profile A selected:

<25 ms: One multispectrum function and No Audio recording.

>=25 ms: If audio recording is enabled, 3 multispectrum functions are allowed.

>=1 sec: No limitation.

Dual channel and profile A selected:

10 ms is minimum profile time.

<25 ms: One multispectrum function and no audio recording.

>=25 ms: 3 multispectrum functions and no audio recording.

>=100 ms: 3 multispectrum functions and dual channel audio recording with 12 kHz sampling rate or single channel audio recording with 48 kHz sampling rate.

>=1s: No limitation on multispectrum functions and dual channel audio recording with 12 kHz sampling rate or single channel audio recording with 48 kHz sampling rate.

Please Note: The dual channel audio recording is limited to a sampling rate of 12 Khz.

There is no limit to the of number weighting network functions (A, C and Z), only the multispectrum functions.

If time profile B or Profile Moving is selected:

- Profile B and moving must be a multiple of profile A.
- Profile B and moving does not offer the multi-spectrum feature.
- Profile B and Moving time resolution must be shorter than Global measurement time.
- It is not possible to continue a measurement if the measurement is elapsed or the stop is activated manually.

The term **Multispectrum** is octave or third octave values acquired in the time profile. One spectrum is measured per profile period. This requires a relatively high amount of calculation power due to the amount of data calculated. The highest work load however is triggered audio recording.

Statistics. There are eight percentiles available. The class width is 0.2 dB over the entire 130 dB range. Each of the eight percentiles can be set to any value between 0,1% to 99,9%.

The statistical distribution calculation applies to the spectral weighting networks (A, Z and C) as well as all the individual filter bands (if applicable). The statistics is also calculated for each period of the time profile, providing the time profile resolution is set to one minute or more in the profile A.

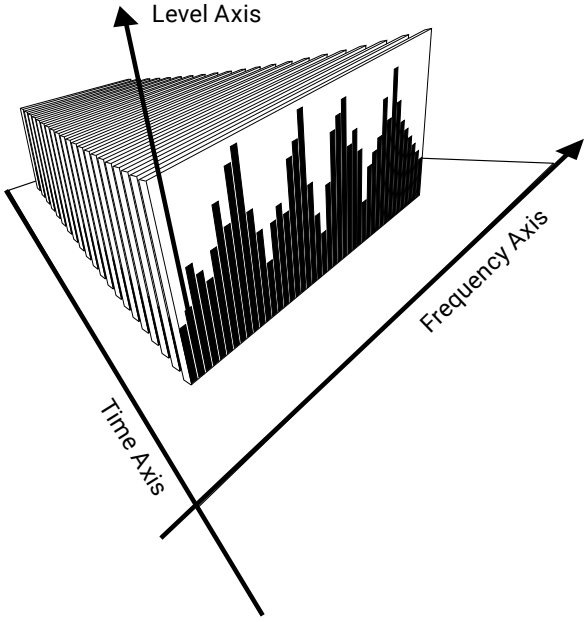


Figure 4.4 - Multi-spectra is a set of spectra captured at equidistant moments in time corresponds to setting up the analyser to measure the level vs. time involving frequency analysis in octaves or third-octaves.

The graphical back-erase feature *(Figure 4.5)*, which deletes the most recent seconds (0-20 sec back erase) of acquired global data prior to a pause upon resuming, updates the statistics buffers as well as maintain consistency.

For the statistical sampling the user can select either Fast or Slow time constant, irrespective of what time constant(s) the frequency analysis as such employs.

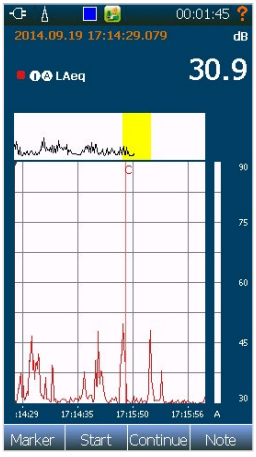


Figure 4.5

Setting up the analyser

The organisation of the display

After the Nor150 is turned on, the applications selection screen appears *(Figure 5.1)*. If you just pass this screen or tap on the "last used" icon, the instrument will show the same types of displays as when you left it last time. If this is the first time you start your instrument, some predefined views will be there for you.



Figure 5.1 - Applications

If a specific set up is selected in the applications selection screen, the associated functions and views will also be loaded.

The display *(Figure 5.2)* is divided in three main sections. On the top is a status bar holding information about the current state and at the bottom is a row with quick access keys. See *"The status bar"* and *"The soft key bar"* chapter on the next pages for detailed explanation. The middle part is either one full or two half displays that can be customized to your needs. By holding your finger on a graph (the white coloured area) for a couple of seconds, a context sensitive menu will be displayed, alternatively pushing the √ button located between the arrow keys on the keyboard.

The display settings will be saved in the instrument so you can recall them back again next time you want to use the instrument.

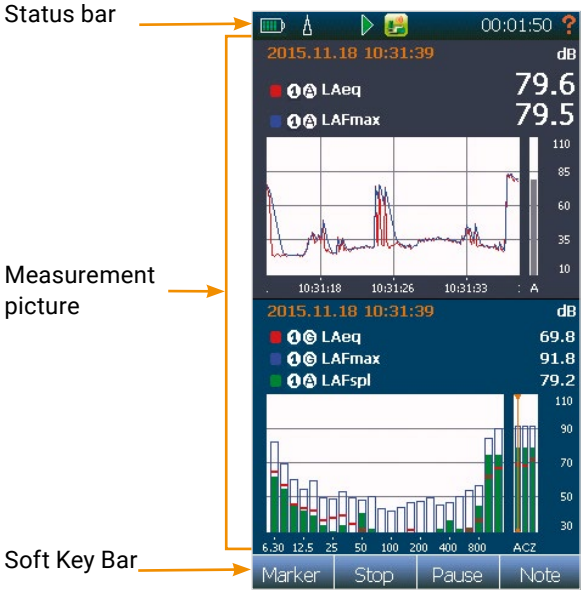
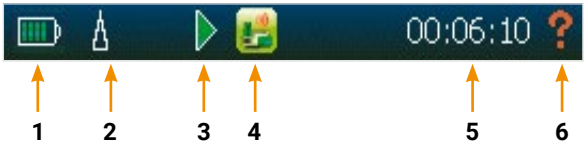


Figure 5.2

The status bar

The status bar at the top of the display provides useful information about the instrument and the on-going measurement.

The status bar



1 Battery gauge

2 Overload indication

3 Measurement status – Ready, waiting for trigger, running, pause, ended, stored, locked

4 Application mode

5 Real time clock in ready mode. In all other modes the measurement time is displayed

6 Help function

The status bar is not displayed in the menus.

Symbol # 1 Battery gauge / external power



Battery gauge. Exact capacity can be found in the Info menu. Press the **INFO** button to open this menu



External power connected.
Battery is not charging.



External power is connected.
Battery is charging.

Symbol # 2; Overload indication


No overload.


Instantaneous overload. The symbol will turn to yellow after the overload disappear if a measurement is running. The LED on the front will also turn to red during an overload.


Latched overload. This indicates that there has been an overload during the measurement.

Please note! A dual channel instrument will display two overload icons if both channels are activated, unless only one icon is displayed.

Symbol # 3, Measurement status


Ready mode.


Waiting for global trigger to fulfil the set trigger condition.


Measurement running.


Measurement finished. Measurement is not saved.


Measurement saved.


Locked. This icon has two meanings; If the keyboard and touch screen are locked, it will replace the help icon (question mark). Additionally, a write protected setup is indicated with the same icon, but it appears in the left part of the status line. A locked setup is additionally indicated with “greyed out” fields in the menus which are blocked by the write protection feature.

Symbol # 4, Application mode


Environmental


Building acoustics


Sound Intensity


STIPA


Connected to NorCloud

The soft key bar

In the bottom of the touch screen or on the left in landscape mode there are four soft keys. In some menus there are soft keys found elsewhere also. Some of the soft keys open up a “scroll down” menu with more functions. The following table shows the symbols that are used on the screen to indicate selectable functions.


Exits the current menu and stores your current selections (√). Works in parallel with the √ button on the keyboard.


Exits a menu without doing your modifications (✘). Works in parallel with the ✘ button on the keyboard.



Opens the **Marker** selection menu in the measurement picture or jump between markers in ended mode.



Starts a measurement, works in parallel with the Start button found on the keyboard.



Stops a measurement, works in parallel with the Stop button found on the keyboard.



Pause an ongoing measurement and remove the paused values from the overall measurement. Time profile is continuing, but a pause marker is inserted in the time profile while paused. This button works in parallel with the ⏯ (Pause/Continue) button found on the keyboard.



Continue: Continues a paused measurement, works in parallel with the ⏯ (Pause/Continue) button found on the keyboard.



Note: Opens up a menu where Recording, Camera, Voice and Text notes can be enabled.



Show/Hide: Hide - Used in the application menu. It toggles between Show and Hide. Push on the Show button to enable the application start up menu. Push on the Hide to disable the application start up menu.



Alpha/Numerical on-screen input keyboard. Switches between the parameter wheel(s) and a traditional numerical keyboard.



Add: Used in the menus to add a new item e.g. a new input device to the transducer selection.



Delete: Removes selected item.
Please note: usually there is no undo of a delete.



+ and **-**: Used for increasing or decreasing numerical values.



Calibrate: Starts an auto-calibration process in the calibration picture.



The softkey bar may have more function in other modes (Building Acoustic and Sound intensity application). These softkeys are described in the chapters describing these applications.

The measurement picture

The main part of the display is for the measurement results. The configuration of the measurement picture (named Views) is very flexible supporting a variety of different views dependent on the selected measurement application.

The measurement display can either be a single or dual type frame. The dual type frame is useful if you want to combine for instance Level vs Frequency, L/f and Level vs Time, L/t data in the same display, while the single type frame gives you a better resolution and workspace if that is preferred. All single type views, except from the Sound level meter, SLM, view, can be selected as landscape view. I.e. the display is turned 90 degrees to take advantage of a wider horizontal axis for time or frequency.

The following graphical displays are available:

- Sound level meter (SLM).
- Level vs time – available as portrait and landscape.
- FFT available as portrait and landscape.
- Level vs frequency – available as portrait and landscap.
- Combined cumulative and statistical percentage – available as portrait and landscape.

Special graphical displays are available in other applications such as BA, STIPA and Sound Intensity.

Each graphical view has an associated numerical table available. Just push the **TBL** button to access it.

Up to four different views can be configured. Each view can either be a single or dual type. Use the **VIEW** button to switch between each of the four different views. For easy use you may turn off the views so that you at the extreme only have one view to deal with.

NOTE! You must configure which measurement functions you want to display in each of the views.

The instrument may measure more parameters than displayed on the screen. Each graphical view can display up to 3 measurement parameters simultaneously. You may however configure up to eight different parameters per view to display. Use the **FUNC** button to scroll through the selected parameters.

On-screen menus

Context sensitive menus *(Figure 5.3)* are available when needed. They give access to several of the parameters that decide the look and feel of the view you are looking at.

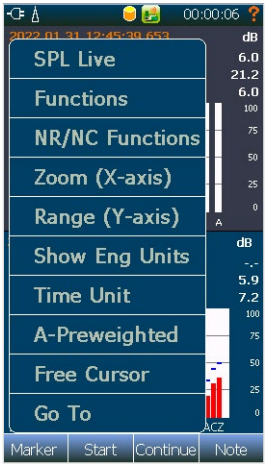


Figure 5.3

The context sensitive menu is accessed in two different ways.

1. Place your finger on one of the graphical (or numerical) displays and hold it there for a couple of seconds, and the menu will appear.
2. Push the √ button on the keyboard and the menu will appear instantly.

In dual view the context menu is assigned to the active view.

On-screen menus:

SPL Live	Selecting SPL Live will update the SPL values in the L(f) view also after the measurement is finished. SPL Live feature does not apply to retrieved measurements from memory or to other views than L(f)
Functions	Select display parameters, networks and functions, and how this shall be displayed
NR/NC/RC Functions	Select which of the NR/NC/RC rating curves that shall be applied. Only available in L/f display. The function is turned on in **SETUP** > *Measurement* > *Frequency setting*s.
Zoom (X-axis)	X-axis zoom function.
Range (Y-axis)	Y-axis range
Show Eng Units	Toggles between Engineering units and dB
Time unit	Changes from periods to absolute or relative time on the X-axis.
A-Preweighted	Select A-preweighted. Selecting A-preweighting will add the A-weighting to the frequency spectra. Apply only to L(f) view. Note: This is a display function. The stored date will be unweighted.
Free cursor	Disconnects the cursor in the current view from following the other cursors. Enables the context sensitive menu again and select Link Cursor to set it back. When you Link Cursors again, the cursors in the other displays will jump to the cursor position in the view you are linking the cursors.
Go To	This opens up a submenu where you may key in the cursor position. Very useful when working with large L(t) files. Not applicable in running mode.
Select A-postweighted.	Selecting A-postweighting will add the A-weighting to the frequency spectra. Apply only to L(f) view. Note. This is a display function. The stored date will be unweighted. A real pre weighted function is added from V6. This is enabled in the frequency setting in the measurement menu.

Different display types may show different contents.

Activate and deactivate the result displays

If the display is split in two halves you can tap on any of the display parts to set it active *(Figure 5.4)*. The other half then turns inactive (greyish). An inactive display is still live updated.

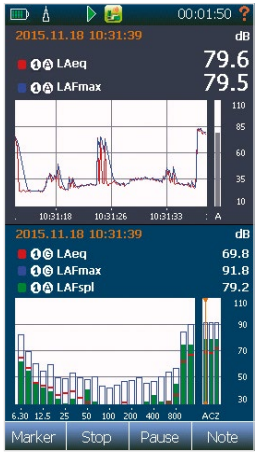


Figure 5.4

The purpose of the active/inactive setting is to determine which of the two displays the key buttons shall update.

Tapping an inactive display part will set it back to “normal” state.

While active you can also decide if the current view shall follow the general cursor selections. The function is called “Unlink”. It gives an easy way to look at the measurement at two different frequencies or in two places in time simultaneously.

The statistical distribution (Ln) view cannot be linked or connected in a similar way.

Cursor handling

As discussed in the previous chapter, the cursor will move in all display views if they are “linked”. This is useful if you want to move in the time domain and update the frequency domain accordingly. In the time domain (the level vs time view) you move in time with the horizontal arrow keys (or simply tap on the screen). In the level vs time view you may also move in the frequency domain with the vertical arrow keys. Similar you move in the frequency domain in the level vs frequency view with the horizontal arrow keys (or tap on the screen) and in the time domain with the vertical arrow keys.

The single level versus time view offers a compressed graph at the top of the graph. You may use this graph to rapidly move to a certain time. The yellow shaded area is the current displayed view in the large graph.

The context sensitive menu offers a Go to function for the level vs time and level vs frequency view. This is especially useful for large time profile measurements with high resolution.

Another useful function is to jump between markers. This feature is found in the context sensitive menu.

NOTE! You cannot move cursor in the time domain while measuring.

The main menu system - an overview

The main menu appears when pushing the **SETUP** key on the front panel *(Figure 5.5)*. Manoeuvring in the menus follows the same use as on any smart phone or pad. I.e. in all menus use your finger tapping on the selection fields or dragging on the selection wheels or drag a table up/down. The menu is organized so that you start on the top and manoeuvre downwards when setting up a measurement.

Use the ✓ or ✘ button to leave the main menu and return to the measurement pictures. While the sub- menus are on the screen you store and exit the currently shown selections using the ✓ button or leave without any changes using ✘. You may use either the display soft keys or the hard keys on the keyboard.

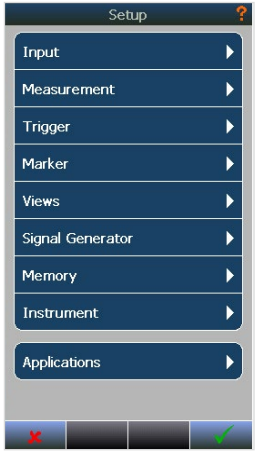


Figure 5.5

Input	Your transducers, microphones and preamplifiers are specified and connected to the analyser in the Input menu.
Measurement	All basic measurement parameters are set here, such as measurement parameters, time profile resolution, overall measurement time, Time constants, Filter frequency response and resolution etc.
Trigger	The trigger menu defines how to start a measurement and how to setup the event triggers.
Marker	Defines what the individual markers represent and how they are displayed in the graphical displays.
Views	Defines the graphical and numerical views consisting of four individual views that may contain almost any combination of display types and measured functions.
Signal Generator	The signal generator (optional) provides test signals that match your measurement needs.
Memory	Setup and configuration of the memory. Define file naming, path etc. Results can be organized in folders and projects.
Instrument	This menu contains instrument specific settings like date and time, language, number formats, power saving setting, interface setting etc.
Applications	Access the factory predefined applications and user defined settings.

On/Off/Available/Disabled indication

In most menus there are indications whether something is selected or not *(Figure 5.6)*. The green tick means that the function is selected and the red X means that it is not.

A greyish menu indicates that this function is not available *(Figure 5.7)*. Either due to the state the instrument is in, or that an option is not enabled.

A menu selection containing a submenu is indicated with an ▶ *(Figure 5.8)*.



Figure5.6



Figure 5.7



Figure 5.8

Selecting the different views and the parameters to display

Nor150 offer four different views that you can customize. You may rotate between the active views using the **VIEW** button. If wanted, some (but not all) of the views can be left unused. One view must be activated in the *Setup/ Views* menu.

Push the **SETUP** key and then the *Views* to access the *View* setup menu *(Figure 6.1)*. Each view has two menu points which can be turned on or off. Simply turn on one, two or none to set the current view to a single, dual or off.

If only one selection in a view is active, as indicated in View 2 *(Figure 6.1)*, this view will use the whole available screen area. Otherwise, the two selected displays will use the upper and lower halves of the screen area respectively.

As can be seen, View 3 and 4 are not active in this example. The View button will therefore only switch between View 1 and 2 when it is pressed.

NOTE! Landscape displays and the Ln display arare only available as single frame pictures.

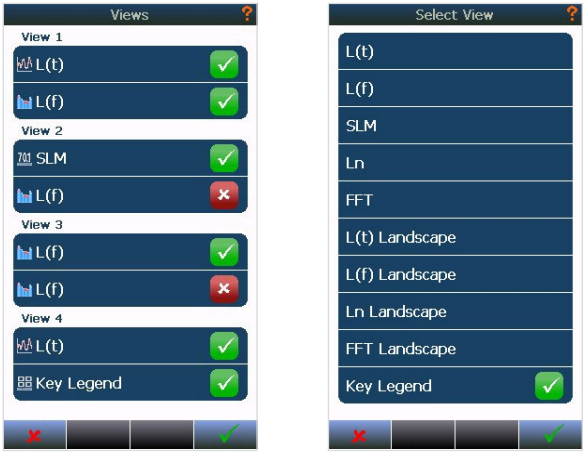


Figure 6.1

The Key Legend is a special function that allows you to replace one view in a dual-view configuration with two soft keys *(Figure 6.2)*. This feature is particularly useful for starting and stopping measurements with one-handed operation of the instrument.

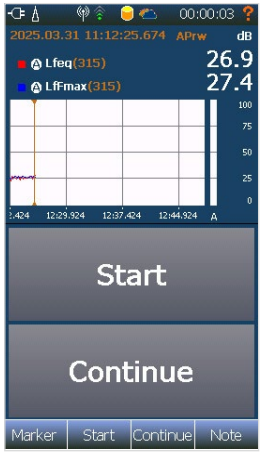


Figure 6.2

Each view can either be a single or dual type frame except from L(t)(landscape), L(f)(landscape), Ln(landscape) and Ln.

Available views are

SLM - Sound level meter display, only showing global values *(Figure 6.3)*.

L(t) - Level vs time display is a Profile display showing the selected level function versus time, but no global values. – available as portrait in single and dual frame mode *(Figure 6.4)*.

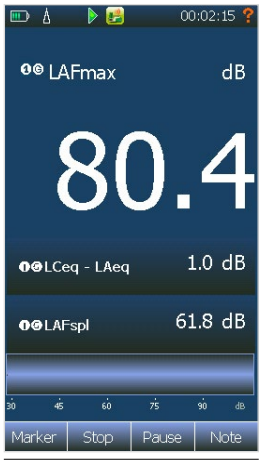


Figure 6.3

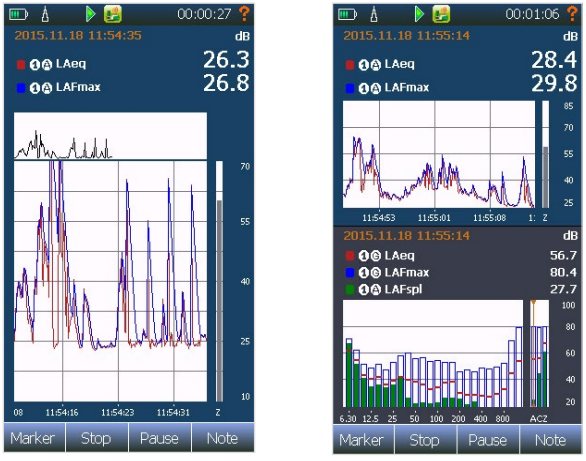
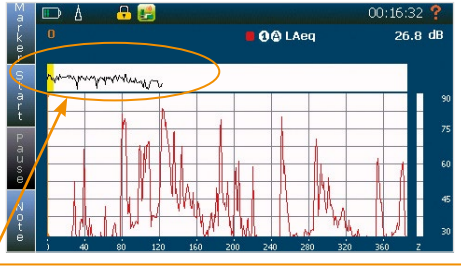


Figure 6.4 - Single and dual frame mode

L(t) (landscape) *(Figure 6.5)* – same as *Figure 6.4*, but only available as landscape (wide) in single frame mode. I.e. The graphical display is turned 90 degrees.



Above the L/t graph is an additional graph that shows the entire L/t trace. The yellow marked area represents the part of the trace that is displayed in the main L/t view. You may tap on the compressed curve to move the main L/t curve to the same point. This function is not available in the dual view frame mode.

Figure 6.5

L(f) - Level vs frequency display *(Figure 6.6)* is a Spectrum display and can show spectra for both the on-going time profile and the global results at the same time. Available as portrait in single and dual frame mode.

L(f) (landscape) *(Figure 6.7)* – same *Figure 6.6*, but only available as landscape (wide) in single frame mode. I.e. The graphical display is turned 90 degrees.

Ln - Combined cumulative and statistical percentage display *(Figure 6.8)*. Only available as single frame display.

Ln (landscape) *(Figure 6.9)* - same as *Figure 6.8*, but displayed as landscape (wide). I.e. The graphical display is turned 90 degrees.

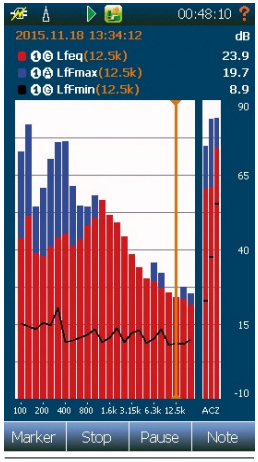


Figure 6.6

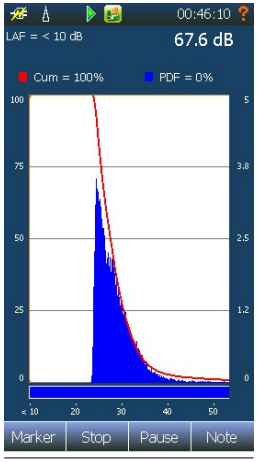


Figure 6.8

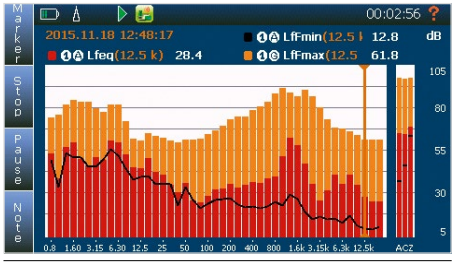


Figure 6.7

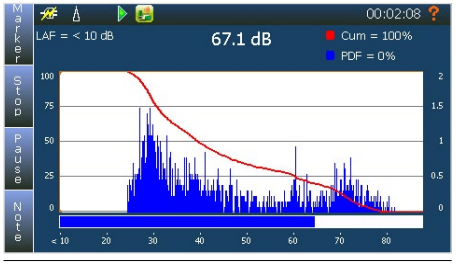


Figure 6.9

FFT - Displays the FFT spectra *(Figure 6.10)*. Available as portrait in single and dual frame mode.

FFT (landscape) Displays the FFT spectra as landscape *(Figure 6.11)*. Only available as single frame view.

NOTE! Building Acoustic and Sound Intensity mode offers other views than described here.

Use the **VIEW** button to switch between each of the four different views. For easy use you may turn off views so that you at the extreme only have one view to deal with.

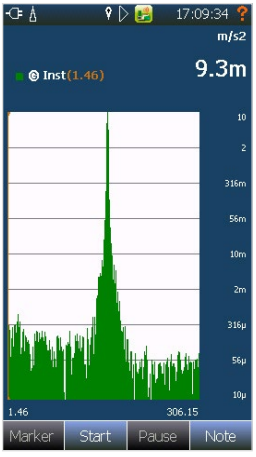


Figure 6.10

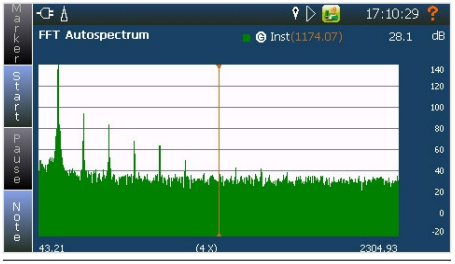


Figure 6.11

Push the **SETUP** key and then the *Views* to access the *View* setup menu *(Figure 6.12)*. Each view has two menu points which can be turned on or off. Simply turn on one, two or none to set the current view to a single, dual or off.

If only one selection in a view is active, as indicated in View 2 *(Figure 6.12)*, this view will use the whole available screen area. Otherwise, the two selected displays will use the upper and lower halves of the screen area respectively.

As can be seen, View 3 and 4 are not active in this example. The View button will therefore only switch between View 1 and 2 when it is pressed.

NOTE! *Landscape* **displays and the** *Ln* **display are only available as single frame pictures.**



Figure 6.12



Figure 6.13

Display Skins – Background Color

The default skin is **Light**. A **Dark** skin is available and can be enabled by toggling the button located at the end of the **SETUP** > *View menu* (*Figure 6.13*).

Please note that the skin setting applies to all modes, but can only be changed in "Environmental Mode" – Not in BA, NorCloud or Stipa model

Function selection – selecting the measurement parameters

The different views can show different types of results (or the same result in different ways). But you can only show result for functions that are selected for measurement. I.e. the parameters you want to display in any of the views must be measured. Use **SETUP** > *Measurement* > *Functions* menu to select the measurement parameters necessary for your measurement. The parameters you select here will be available to select for configuration of the different views.

You may combine data from channel one and channel two in the same view.

Be careful when selecting the measurement parameters. Do not select more functions than what you really need. Too many functions may slow down the performance of the measurement system and make it complicated for you to select the interesting functions to display. In addition, having many functions selected take more space when storing and longer time to save or load.

Return to the measurement display and use the context sensitive submenu to customize or filter your display selection for each of the views. Hold your finger on the display for a couple of seconds or push the **OK** button, and the context sensitive menu appears. Select the Functions in the context sensitive menu *(Figure 6.14)*. This gives access to a menu where you may select up to eight parameters per View. The View Function setup is a combination of channel information, data or result type information and finally information about how you want this information to be displayed.

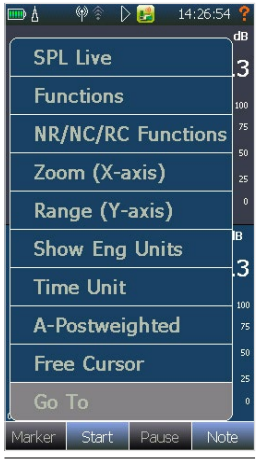


Figure 6.14



Figure 6.15

Function setup - Figure 6.15

Max Functions in View	Selects how many parameters you like to display simultaneously. Up to three parameters may be displayed simultaneously. Select one if you need good readability, two or three if you want more parameters to be displayed simultaneously. Back in the measurement display you use the **FUNC** button below the display to rotate between the selected functions if your selections of measurement parameter excess the number of functions to display in the view.
Channel for Idle data	Selects which channel the SPL value in idle mode should be acquired from. This is greyed out if channel 2 is turned off or option not fitted.

Select Function setup - Figure 6.16

Select Function (Figure 6.16)	Selecting a Function access a submenu where you select measurement parameter type, colour, drawing order and shape. See separate description. Already selected parameters may be turned on/off or modified.
Channel	Select which sound channel data shall be retrieved from. Only applicable if the instrument is fitted with the dual channel option and channel 2 is switched on. Else, this function is greyed out.
Report	Select whether the data shall be acquired from the global or one of the profile reports or the moving report. Due to the nature of the view, some views gives you only the option to select only global or profile data; **SLM** – Global only **L(t)** – Profile reports or moving **L(f)** – Profile A and Global **Ln** - Not applicable. This menu is fixed and not possible to configure.
Function	A list of available measurement functions will be present. Once a function is selected an additional field may be present above the list of available functions. The selection here is either time constant (Fast, Slow or Impulse) if an exponential average function is selected (SPL, Max or Min) or Normal or Impulse if a time averaged function is selected (Leq or LE). **Note!** Some of these choices may not be available since it is dependent on the settings done in the **SETUP** – *Measurement* menu.
Colour	Select which colour to use in the graphical view.
Shape	Select which shape to use. Applies only for the L(f) picture. Available shapes are; • Step Line • Rectangle • Framed rectangle • Line
Draw order	Apply to the L(f) picture only. Define the draw order, whether the bargraph shall be drawn back, middle or front.
Locked to View	If turned on, this parameter will always be displayed when the **FUNC** button is used to scroll through the selected measurement parameters.
Follow cursor	The selected data presented will follow the cursor position.
Bind Network or Frequency	Opposite to follow cursor, and locks the selected data to the selected frequency or network.

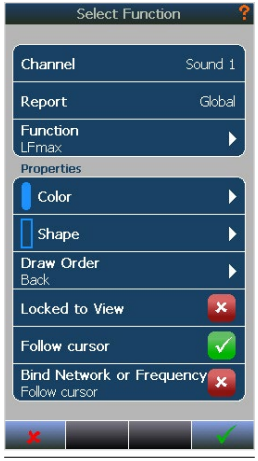


Figure 6.16

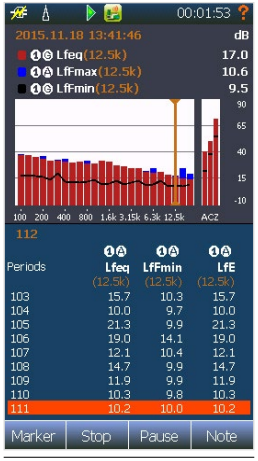


Figure 6.17

SPL Live in ended mode

It is possible to select live SPL update of the L(f) – Level vs frequency display after a measurement is finished. This feature is only offered for the L(f) view. Use the context sensitive menu to turn SPL live on/off. See *Figure 5.3*.

Numerical tables

Each graphical display has a numerical table as an alternative. Use the **TBL** button to switch between graphical and numeral display *(Figure 6.17)*.

The **TBL** button is assigned to the active window. To produce a picture like the one shown below, first tap the lower display so it is active then use the **TBL** button to switch the lower display numerically.

Input selection Menu

The *Input* selection menu is where you select which transducer to use for your measurement. You may also add new transducers or modify existing transducers or access the calibration menu. The Nor150 may be fitted with two sound channels (optional).

In the example in *Figure 7.1*, only *Sound Channel 1* is active. *Channel 2* is switched off. A transducer named "1209&1225" is connected to *Sound Channel 1* and BT2" is connected to *Sound Channel 2*, but switched off.

Selecting the menu *Sound Channel 1* or *Sound Channel 2* access a sub menu for selection of available sensors *(Figure 7.2)*, a short cut to the *Calibration* menu and a list of available corrections like *Random Incident*, *Windscreen* and *High Level*. The corrections available are dependent on the selected transducer.

The Transducers button opens up a menu for adding, removing or modify transducers. See description in a separate section *"The Transducer menu" on page 57*.

Noise Compass turns on / off reading data from the Noise Compass Nor1297. Data acquired from the Noise Compass is not visible on the Nor150 screen, but are stored together with the measurement data for later analysis in NorReview, or directly in NorCloud.



Figure 7.1

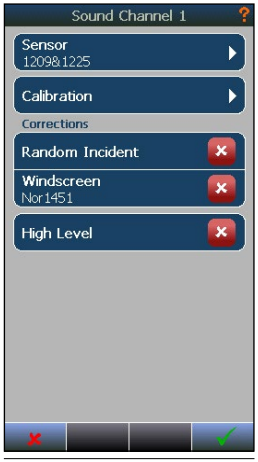


Figure 7.2

Weather Station turns on / off reading data from the weather station. Data acquired is not visible on the Nor145 screen, but are stored together with the measurement data for later analysis in NorReview, or directly in NorCloud. You may select which weather parameter to measure in the Setup/Measurement/ Weather functions menu.

The Sound channel 1 or 2 menu

The Sensor button accesses a list of available sensors *(Figure 7.3)*. Adding, removing or modifying a sensor cannot be done from the list offered here. This is discussed in a separate chapter below. You may find that a sensor is greyed out. This means that this sensor is already assigned to the other Sound channel and is not available.

The Calibration button access the *Calibration* menu. This is the same as pushing the **CAL** button. The *Calibration* menu is discussed in detail later.

Dependant on the selected sensor type there will be a set of corrections that may be added. These corrections are;



Figure 7.3

Line and Vibration sensor

No corrections available.

Microphones

Random incident. When turned on, a frequency correction is added so that the free-field response is changed to a Random Incident type (only available if a free-field type microphone is selected.

Windscreen. Turn this correction on if the normal 60 mm windscreen Nor1451 is used. This adds a frequency compensation in order to compensate for the change in frequency response caused by the windscreen.

High Level. Only available if an external polarized microphone is selected. For Nor1225 which is a microphone that require 200 V polarization voltage, the sensitivity can be reduced by approximately 10 dB by lowering this polarization voltage. The level range can therefore be extended without changing the microphone cartridge. This feature shall be used in combination with the Nor1225 cartridge only. It will not work with prepolarized microphones such as the Nor1227.

When this feature is selected, the polarization voltage is lowered from 200 V to 70 V. Reducing the polarization voltage alter the tension in the diaphragm. A correction network is therefore applied automatically to compensate for the change in frequency response of the microphone due to the lower polarization voltage.

NOTE that theHigh Level correction will depend on the type of microphone, and shall only be applied when using microphone cartridge type Nor1225. Please note that you should calibrate with an acoustical calibrator if you change this setting.

Outdoor microphones

If any of the outdoor microphones Nor1214, Nor1216, Nor1217 or Nor1218 is selected, the corrections above will disappear and be replaced by the two following ones;

Orientation correction. This adds correction to the outdoor microphones listed above dependent on the sound incidence. Apply Horizontal for normal environmental noise such as traffic noise, construction site noise etc. Apply Vertical only when the noise incidence is consistently coming from above, such as under or close to an air flight path.

Windscreen Nor4576. Only available if Horizontal correction is selected. This correction should be enabled if the large 200 mm windscreen is added to any of the outdoor microphones listed above.

Selecting Nor1210 or a "non-standard" outdoor microphone offers no corrections.

The Transducer menu

The selections *Transducer* opens up a menu where you may edit add or delete existing sensors *(Figure 7.4)*. You may also use this menu to acquire information about the sensors.

In the *Transducers* menu a list of the already added transducers is shown. As a minimum, one Microphone will be available. This is the transducer set from the factory and is normally denoted 1209&1225. The picture above shows a list of several microphones, one line sensor and several outdoor microphones.

If you tap on one of the fields in this case *1209&1225* a submenu with all the relevant parameters for this transducer will be available *(Figure 7.5)*. Several are locked and cannot be edited.

The available fields differ from type of sensor, but the most common fields are discussed in table on next page.

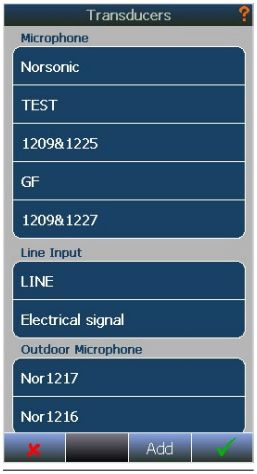


Figure 7.4



Figure 7.5

Name	The name of the sensor. Give each of your microphone / preamplifier combinations a name so they are easy to recognize. Name is not a locked field and may be edited.
Calibration history	Opens up a L(t) graph which holds historical data of the calibration. Move cursor to obtain information about previous calibrations. Please note that this is the values obtained each time you perform a calibration in the calibration menu. Must not be mixed with the data obtained at the annual verification normally performed by an external accredited laboratory.
Microphone capsule - Type	When adding a new microphone, you may choose from a list of pre-defined sensors or a non-predefined sensor. Choosing a predefined sensor will pre-set some of the fields below. This is a locked field and cannot be altered.
Microphone capsule - Serial number	The microphone cartridge serial number. This is a locked field and cannot be altered.
Microphone capsule - Underscale Spectrum	Here you may add information about the self-noise values of your sensor. This is used to indicate under scale condition in the SLM view. Values displayed in the SLM view below the under-scale spectrum value will be denoted with < in front of the measured value.
Preamplifier - Type	This is the type of preamplifier. When adding a new preamplifier, you may choose from a list of predefined sensors or a non-predefined sensor. Choosing a predefined sensor will pre-set some of the fields below. This is a locked field and cannot be altered once the information is stored.
Preamplifier - Serial Number	The preamplifier serial number. This is a locked field and cannot be altered.
Microphone Check – Reference Level	This is the expected reference used for remote microphone check via NorCloud. To determine the level follow the procedure for microphone check described on page 43. Key in the obtained number in the Reference Level field.
Microphone Check – Tolerance	Key inn the tolerance for the Reference Level. Default is 0,5dB.
Verification - Laboratory	The name of the calibration laboratory that performed the last verification of the transducer.
Verification - Date	The date of the last verification. The instrument will use this date and the Verification Interval to calculate a due date warning. A warning will appear on the screen when the due date for the verification is less than 30 days. Set the Interval to 0 if you want to avoid the verification due date warning.

Verification - Verified sensitivity	This is the sensitivity that was obtained when the last verification was performed. A typical sensitivity 50 mV/Pa microphone is -26 dB. This value is given in dB relative to 1V/Pascal. This value is used as a new "reference" line in the calibration history graph. As times goes by, the actual sensitivity may drift a little bit. If it drifts off, this is clearly seen in the calibration history view, and if it changes too much the system will refuse to calibrate correctly. See *"Calibrating the instrument - field check" on page 62*".
Verification - Interval	This is the time interval, in months, between each verification.
Preamplifier - Gain	Here you add preamplifier gain. Normally the preamplifier attenuates the signal from the microphone due to its input capacitance. Hence you should enter a negative number. Negative gain=attenuation. For Norsonic preamplifiers this value is in the range of -0.2 to -0.5 dB. Set this to 0 dB if you do not know the gain. The result will be that you will measure a deviation between the open circuit sensitivity given on the microphone calibration certificate and the actual value you obtain when calibrating the instrument with an acoustic calibrator. You may use this difference and key that in to obtain a value closer to the open circuit sensitivity.
Preamplifier - IEPE	IEPE on or off. Off, means a traditional powered preamplifier. On means that the IEPE power is added to the signal line on the Lemo connector.

Adding a new sensor

With reference to the previous chapter, start by adding a name and then type. Current available selections are;

- Microphone
- Vibration Sensor
- Line Input
- Outdoor microphone

If a *Predefined sensor* is selected several fields are selected and locked.

Some microphone cartridges require a polarization voltage to work properly while other microphone types are pre-polarized. Pre-polarized microphones are normally marked with one or two thin ring(s) on the outside of the cartridge. By selecting the proper microphone type from the list, the polarization voltage will be set correctly.

Select the microphone type e.g. Nor1225.

Key in the serial number of this microphone.

Typical nominal microphone sensitivity values are:

mV/Pa	dB rel. 1V/Pa	Microphone types
50	-26	Nor 1220, Nor1225, Nor1227, Nor1228, Nor1230, Nor1239
12.5	-38	Nor1236
4	-48	Nor1245

Preamplifier selection

Select preamplifier type. Only types that will work with your microphone will be displayed. It is dependent on polarization voltage. If polarization voltage is required then a “traditional” preamplifier with a multi-pin (7 pin Lemo) socket is needed. Pre-polarized microphones can also be used on preamplifiers with IEPE type of connection.

IEPE (Integral Electronics Piezoelectric) is the generic name for transducers with built-in electronics powered by a constant current source. A number of other acronyms are in use, such as ICP®, DeltaTron®, ISOTRON®, PIEZOTRON®, CCLD® and CCP®.

Using other transducers

The Nor150 supports a variety of transducers. A typical use is the low noise microphone GRAS 40HL which may be directly connected to the Nor150. You need to specify this as a Non predefined sensor. This is an external polarized microphone, so the 200 V polarization voltage must be turned on. It has internal gain of 20 dB. Hence the sensitivity is typical -1,4 dB re 1 V/Pa instead of -26 dB re 1 V/Pa for a normal 50 mV/Pa microphone such as the Nor1225.

Adding a Vibration sensor

Adding a predefined vibration sensor is as easy as adding any other predefined sensor. Adding a non predefined sensor will prompt you for some more fields to fill in. This is the measurand, m/s for a velocity sensor and m/s^2 for an accelerometer. Additionally you need to select IEPE powered sensor, if applicable.

Adding or modifying an intensity probe is described in *“Sound intensity” on page 140.*

Units and Reference levels

The Nor145 supports various measurands (units) and reference levels, depending on the sensor type and application. These settings are configured in the Sensor Administration Menu, based on the selected sensor type: Microphone, Vibration Sensor, or Line Input.

The available measurands/units include:

- dB
- mm/s
- mm/s²

Additionally, you can toggle between engineering units (linear scale) and dB in the context-sensitive menu. If engineering units are selected, the stored values will be in dB.

The reference levels offered are also determined by the selected sensor type.

Microphones

Microphones are defaulted to 20 × 10^{-6} Pa, but you can select other reference levels if needed. To adjust this setting, you must uncheck “Predefined Sensor” to gain access to the reference level configuration.

Using alternative reference levels can be beneficial for applications such as underwater acoustics or similar specialized measurements

Pressure in water re 1x10^{-6}Pa
Particle Velocity re 50x10^{-9} m/s
Particle Velocity re 1x10^{-6} m/s

Units are dB, but you may select engineering units in the context sensitive menu.

Vibration sensors

Selecting a vibration sensor offers 1x10^{-6} m/s^2 as reference level while if you select mm/s, the 1x10^{-9} m/s is selected as reference level.

mm/s and mm/s^2 are available if you select vibration sensor in the input menu. In the context sensitive menu you may also select dB.

Line input

Line input offers a reference level to 1 Volt and 1x10^{-6} Volt.

You may switch between engineering units and dB in the context sensitive menu.

Hint! A quick access to the context sensitive menu is to push the OK button instead of the traditional way to tap a couple of sec on the display.

Calibrating the instrument - field check

Calibration (or field check) is the normal way to ensure that the sound level meter measures the level with sufficient accuracy. To check the level we need a sound calibrator. The use of sound calibrators dates back to the days when it was easier to design a stable sound calibrator than a stable sound level meter. Today, sound measuring instruments are, in general, as stable as sound calibrators. However, measuring microphones are very delicate devices designed to fulfil very rigid specifications. This makes them vulnerable and subject to damage if not taken well care of. Using a sound calibrator is just as much a verification of proper operation as it is a device of adjusting the sensitivity of sound measuring instruments.

The Nor150 is calibrated by clicking the **CAL** button or in the **SETUP** > *Input* > *Channels* > *Calibration* menu.

When to calibrate

Calibration of the Nor150 should preferably take place before a measurement session is commenced, or whenever required by applicable standards.

Carrying out the field check / calibration

You will need a sound calibrator of sufficient accuracy, i.e. a class 1 sound calibrator as defined by the IEC 60942 standard such as the Norsonic sound calibrator Nor1251, Nor1255 and Nor1256.

The Nor1255 has a nominal sound pressure of 114.0 dB at 1 kHz. In order to compensate for effects due to diffraction around the microphone, we recommend adjusting the sound level meter to indicate 113.9 dB (diffuse field and wind screen corrections off), providing you are calibrating a ½" free-field type microphone. Other correction may apply for different types of microphones.

Do as follows:

1 **Mount the calibrator onto the microphone**. Switch on the sound calibrator and wait until the level has stabilized. Information on how long time this will take should be available from the documentation accompanying your sound calibrator.

Note: Allow the sensor to stabilize before calibration. Never calibrate the instrument before three minutes after switching the instrument on.

NOTE that frequency compensations, such as windscreen and or diffuse field, are disabled in the calibration menu in order to simplify the calibration. All you have to do is to compensate -0.1 dB for the difference between the pressure and free field if you are calibrating a free-field microphone using a 1000 Hz calibrator. The frequency corrections are enabled again when leaving the calibration mode. Hence, you may therefore obtain a different level when entering back to the measurement mode from what you obtained in the calibration mode if you have a correction switched on.

2 **Enter calibration mode**. Press the **CAL** key to gain access to the *Calibration* menu *(Figure 8.1)*. Nor150 offers two different ways to perform an acoustical calibration, *Manual* or *Auto*. The third option *Mic. Check* is an electrical verification of outdoor microphones.

3 **Know the output level of your sound calibrator.** Some sound calibrators have an output level of 94 dB, while others (like the Nor1255 which is used in the example below) have an output level of 114 dB. Some have an output of 124 dB (like the Nor1253). Unless you know the output level of your sound calibrator you won't be able to know what level the measuring instrument is supposed to show. The output level is normally printed on the sound calibrator or stated in its accompanying user documentation.

4 **Free-field microphones require lower settings.** Be aware of the fact that instruments using free-field microphones shall be adjusted to a value slightly lower than the output level of the sound calibrator. For a half-inch cartridge this will typically amount to 0.1 dB lower for calibrators producing a 1000 Hz calibration signal (e.g. the sound level meter should then be set to 113.9 dB when using a 114 dB @ 1000 Hz sound calibrator). Other frequencies will require different correction values.

5 **Set the sensitivity.** Select either *Manual* or *Auto*.

Do not use *Mic. Check*. See separate chapter for description of this feature.

In Manual mode *(Figure 8.2)* you simply use the **+** and **-** to adjust the sensitivity until you read correct level. New values are set with the √. The old value is preserved with the ✘ button.

In Auto *(Figure 8.3)* you select the calibrator level and frequency and push the **Calibrate** soft key button. The instrument will automatically perform a calibration. The level is displayed in the L(t) trace in the calibration menu. New values are set with the √. The old value is preserved with the ✘ button.

Calibrating outdoor microphone Nor1214, Nor1216, Nor1217 or Nor1218! Please note: All frequency corrections are turned off, when entering into the calibration menu. Perform calibration and calibrate the microphone as a normal free-field microphone. I.e.-0.1 dB if using a 1000 Hz calibrator.When leaving the calibration menu, you will observe that the level measured with the calibrator on, is different from what obtained in the calibration mode. This is correct, and is due to the frequency correction added. If Horizontal position is selected the signal will be about 0.1 dB higher than the calibrated signal, in vertical position the signal will be 0.3 dB lower than the calibrated level.

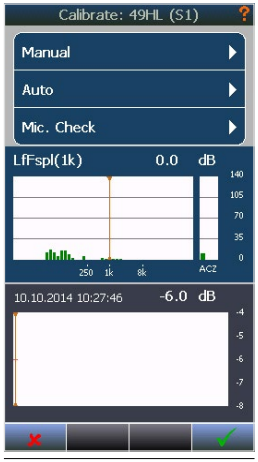


Figure 8.1



Figure 8.2

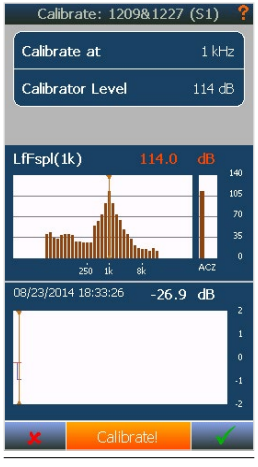


Figure 8.3

Auto calibrate does not take into account the free-field correction -0,1 dB @ 1000 Hz. Thus set the calibrator to 0,1 dB lower then the nominal level of the calibrator 113,9 for a 114 dB and 94,8 for a 94 dB calibrator providing you are calibrating at 1000 Hz.

Calibrating a vibration sensor

Calibrating a vibration sensor follows the same user interface principle as calibrating a microphone. In most cases a vibration sensor is calibrated with its real units, such as m/s or m/s^2. The units used in the calibration menu allows the settings for the sensor given in the sensor administration menu.

Microphone check

For long term monitoring purposes, it is often handy to be able to check the functionality of the measurement system along the signal line from microphone/ preamplifier until the display of the instrument without the use of an external calibrator. The Nor150 has a builtin Mic. Check feature that allows this (also called SysCheck).

Pin 1 on the microphone input socket is able to supply a known voltage signal to the Norsonic Preamplifier Nor1209. By enabling this constant voltage signal, the entire measurement chain including the microphone is tested, and the display will show the corresponding measured value in dB. Hence, if this value is constant from the previous check, it is highly likely that the overall functionality of the measurement chain is constant.

The procedure for using this Mic. Check feature is as follows:

1. Perform a normal calibration of the entire instrument by use of an external acoustical calibrator (see the previous pages in this chapter for details) before the first time you use the Mic. Check to establish a “reference level”
2. Remember to turn off/remove the calibrator.
3. Press the **CAL** > *Mic. Check* to open the *Mic. Check* menu.

   Place the cursor on the 1 kHz bar and read the level. The level will be dependent of the actual previous sensitivity calibration as well as the individual preamplifier and microphone in use. Normally, using the Norsonic Preamplifier Nor1209 and Microphone Nor1225, the level will be approx. 90 dB with a rahter large variation from instrument to instrument (up to 4dB is normal). The Nor1227 will normally return a value of about 94 dB. The exact level is not so important. What is important is that the level you read the following times should not deviate much from your initial level. The Mic. Check level is mainly determined by the microphones cartridge capacitance. Hence, a ¼” microphone will return a much lower signal level than 90 dB. The Mic. Check feature works also with the Norsonic Dehumidifier Nor1284 and Nor1285 mounted.
4. It is recommended to not adjust the sensitivity level. Just leave the menu either by the cancel or OK button. If you leave by using the OK button, the date and sensitivity value will be updated.

If an external device should be controlled by the Mic. Check feature, go to the digital I/O menu. **SETUP** > *Instrument* > *Digital I/O* and select *Mic. Check* on the I/O line you have connected your device to. For the Nor1210 using a Nor512 unit, you shall use digital I/O line 3. This will then start the electrostatic actuator in the Nor1210.



NOTE/CAUTION: Always turn off the Mic. Check when calibrating the system with an acoustical calibrator. If not you will add the acoustical and the Mic. Check tone together resulting in a wrong calibration value, often observed as unstable calibration value.

Measurement Setup Menu

There are a large number of parameters that can be selected for a measurement. Use the **SETUP** key and then the *Measurement* selection to configure the various measurement parameters *(Figure 9.1)*.

Setting the measurement time - Global and Profile time

Global and Profile Time *(Figure 9.2)* opens up a sub menu where you set the following;

Global Time is the overall measurement time for the whole measurement sequence. In Repeat or Synchro mode the global measurement time is repeated until the stop button is pressed.

Profile A is the time period length, also known as the duration of each element (time slice) in profile A.

Profile B is the time period length, also known as the time duration of each element (time slice) in profile B. When Profile B is activated the period length in profile A is 1 sec. The period length for Profile B must be a multiple of Profile A, but shorter than the Global (overall) measurement time.



Figure 9.1

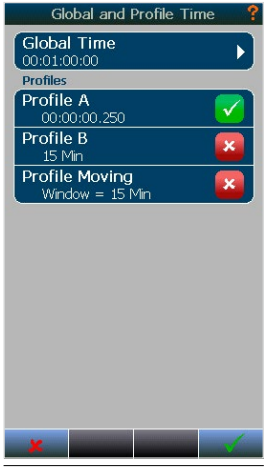


Figure 9.2

Profile Moving. This is the time length of the Moving Leq calculation. This is a sliding window updating a new Leq value for the entire moving window every time Profile A calculates a new value. The period length must be a multiple of Profile A, but shorter than the Global (overall) measurement time.



Figure 9.3



Figure 9.4

Selecting Time Weighting

Time Weightings. (Figure 9.3) In this menu, you set which time weighting functions you want to use. The instrument is capable of measure all three available time constants, Fast, Slow and Impulse in parallel. In the same menu you also define which time constant to be used in idle mode (ready mode).

Frequency settings -selecting weighting networks, 1/1 and 1/3 octave, FFT, Ultrasound and NC/NR/RC rating

Frequency settings. (Figure 9.4) In this menu you configure time frequency weighting filters, 1/1 octave or 1/3 octave filters, FFT ultrasound mode and the NR/NC/RC Calculations. In the Frequency weightings submenu you select the weighting network functions. In this menu you may also design your own weighting networks based on the 1/3 or 1/1 octave spectra.

The instrument measures up to four time weighting filters (A, C and Z and AU, or a calculated network) in parallel. You may also define which of the filters that shall be used in idle mode (readymode).

Filter On/Off. Turns the real time 1/1 or 1/3 octave band filters on/off.

Bandwidth selects 1/1 or 1/3 octave.

Lower Frequency Limit selects lower frequency. from 0,4Hz in 1/3 and. From 0,8 Hz in ultrasound mode and 1/3 octave. Values for 1/1 octave are 0,5 and1Hz.

Upper Frequency Limit selects the upper frequency band limit. 20Khz for 1/3 octave normal mode and 40kHz for ultrasound. 16kHz and 31.5Khz for 1/1 octave.

Pre-weighted Filter. Adds a pre-weighting to the 1/3 or 1/1 octave band filters: A, C or No weighting. Default setting is No Weighting, meaning that the signal sent to the octave band filters has a flat frequency response.

FFT On/Off. Turns on the FFT feature. The FFT calculation are performed in parallel with the 1/3 or 1/1 octave band.

Select Resolution. Select between 1.46Hz / 16384 lines or 2.93Hz / 8192 lines. Upper frequency is 22000Hz. This setting is independent of the frequency range setting of the 1/1 or 1/3 octave bands. In ultrasound mode the # of lines remains the same, but the resolution is lower, 2.93 or 5.85Hz.

Ultrasound. Selects ultrasound on/off. See *"Infrasound / Ultrasound" on page 75.*

Frequency Weightings in Nor150

The main frequency weightings used in the Nor150 are true weighting networks, designed in accordance with the IEC 61672 standard. These are measured in parallel with 1/1 and 1/3 octave spectra and remain unaffected by the frequency range settings of the 1/1 or 1/3 octave band filters.

However, one limitation should be noted:

- If the lower frequency of the 1/1 or 1/3 octave filter is set above 6.3 Hz, an analog high-pass filter at 6.3 Hz is enabled.
- This does not affect the A- and C-weighting filters, due to the high attenuation at low frequencies.
- The Z-weighting filter, FFT calculation and Audio recording will follow the attenuation of the analog high-pass filter at low frequencies.

New Features in Software v5

Several key features were introduced in SW v5, including:

1. Ultrasound mode
   - A true AU ultrasound weighting filter is available in ultrasound mode.
2. Calculated Weighting Networks
   - These filters are calculated from the 1/1 or 1/3 octave band filters and are dependent on the selected frequency range.
   - Predefined calculated networks include: A, B, C, G, and Z.
   - Users can also define custom weighting filters.

Important Considerations:

- **For constant, non-impulsive sounds, the difference between calculated and true filters is negligible.**
- **For highly impulsive sounds, the variable delay between filter bands may reduce accuracy compared to true weighting networks.**
- **Display Distinction:**
  - **True filters are displayed in large white capital letters.**
  - **Calculated filters are displayed in small orange capital letters.**
- **Measurement Parameter Settings:**
  - **Calculated networks follow the Global and Profile A settings.**
  - **Profile B and moving are not affected.**

New features in software v6

In SW v6 and above, a true pre-weighting function was introduced.

- In the Frequency Setting menu, you can select:
  - A-weighting
  - C-weighting
  - No weighting (default)
- If A- or C-weighting is applied, the frequency response of the 1/1 and 1/3 octave filters will be adjusted accordingly.
- The default setting (No weighting) should generally be used, unless specific standards require pre-weighting such as the IEC 61400-11 ed3 standard for Wind Turbine Generator Systems – Acoustic Noise Measurement Techniques requires A-weighting before the octave band filters.

Additional Notes:

- **Pre-weighting does not affect FFT calculations or** audio recordings.
- The previous pre-weighting function (available in SW version 5 and earlier) has been renamed to post-w**eighting.**
  - Post-weighting is a display function that can be enabled in the context-sensitive menu.
  - If pre-weighting (A or C) is enabled, post-weighting is automatically disabled.

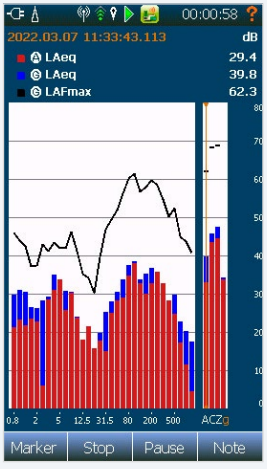


Figure 9.5 - A small orange letter indicates a calculated network. Here shown with g-network.

NR/NC Calculations. (*Figure 9.6*) Turn on calculation of NR, NC and RC II rating. The values are listed in the numerical table. A graphical weighting curve is also displayed if 1/1 octave is selected. You select which rating curve to be displayed in the level vs. Frequency context sensitive menu. *Cf. chapter 5. Figure 5.3.* This selection may be done after the measurement is finished.

Please note that you must switch on Lfeq (calculation of LEQ frequency spectrum) in the Functions menu since the rating curves are calculated from the Lfeq values.



Figure 9.6

High-pass input filter

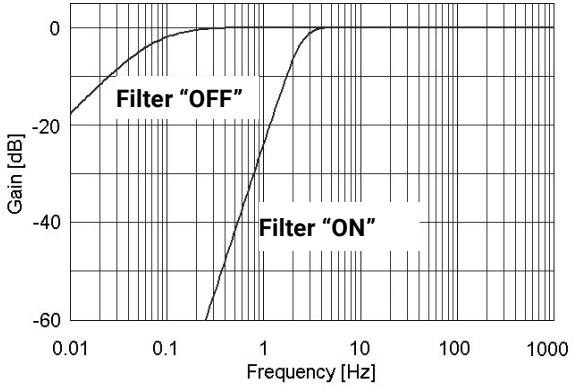
The instrument is equipped with an analog high-pass filter to reduce noise from wind or other sources with frequencies in the lower end of the frequency range.

The filter is automatically turned on when the 1/1- or 1/3-otave filter is set equal to or higher than 6,3 Hz and turned off when a lower frequency is selected.

When this filter is “Off” the lower frequency response is -3 dB at 0.08 Hz (or -0.5 dB at 0.25 Hz). The setting of this filter may have a great influence especially on the Z network and low-frequency band filtered levels.

Filter type: 3rd order HP filter (-3 dB at 3 Hz, Butterworth response).

For instruments without octave band filter, the highpass filter is always on.



Highpass filter frequency response

Statistics - Percentiles

Percentiles (%). (Figure 9.7) The instrument can collect samples from one of the time weightings F or S for statistical calculations of the sound level. The statistical distribution function may be calculated for both Global and all the profile reports and all weighting networks and filter bands, providing that the time resolution is more than 1 minute. Up to eight percentiles values may be measured. Each percentile can be set with a resolution of 0.1 %, just tap on the Percentile you want to edit. The complete statistical data can be shown both graphically and numerically in the View called Ln. *See Figure 6.6.*

Ln cannot be selected simultaneously for Global/profile A and Profile B / profile Moving, since they are based on different measurement functions. In the Percentiles menu you can select “Calculation source” = LFSPL, LSSPL or Leq.

If LFSPL or LSSPL is selected, Ln can only be selected/activated for Global report and Profile A report.

If Leq is selected, Ln can be selected/activated for Profile B and/or Moving report.

Ln view will show data for Global statistics only.

Selection measurement parameters

Functions. (Figure 9.8) In the function list you select which measurement parameters you want to measure. The list is dynamic, based on the selections done in the Time Weightings, Frequency Weightings, Filter and Percentiles menu. The column denoted G is global values while the column PA, PB and PMov are profile values. lobal value will automatically be turned on if you select the profile value.



Figure 9.7



Figure 9.8

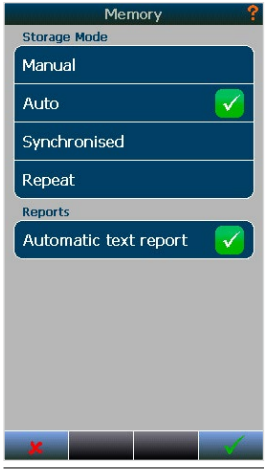


Figure 9.9

It is not possible to select profile B and Moving for the 1/3 or 1/1 octave valuesIt is not possible

Configure Audio Recording format

Audio Recording. Defines the fidelity of the audio recording, gain and pre-trigger. The resolution must be set to 16 bit if you want to replay the audio recording on the instrument itself. All formats are however supported in NorReview. Audio Recording is described more in detail in *"Recording the sound - Audio record and replay" on page 87*.

Configure camera

Camera. The Nor150 fitted with option 1 offers a support for various camera types. In this menu you configure the use of external camera(s). The camera configuration and use is described in *"Camera" on page 91*.

Configure measurement storage mode

Storage Mode. Here you set the storage mode. Nor150 offers four different storage modes.

- *Manual*, which requires that acquired data are stored manually by the operator before the next measurement is made. A dialogue box will appear to verify that you want to discard the measurement if you forget to store it.
- *Automatic,* which causes the acquired data to be stored automatically upon measurement termination, regardless of the reason for termination – irrespective of whether termination took place because the duration expired or because you pressed **STOP**.
- *Synchronized.* In nature equal to repeat, but the instrument synchronizes itself with the next full hour of the time of day. To be active, synchronized requires a minimum measurement time (duration) of 5 minutes per individual measurement.

- *Repeat*, which causes the instrument to store the acquired data and then restart immediately and make another measurement using the same measurement setup and duration. Repeat applies to measurements terminated by themselves only. If you terminate a measurement by pressing stop, the instrument will not restart. There is no time gap between the measurements.
- *Automatic text report.* This feature generates a text report containing all measurement data for direct import to Excel or other programs accepting .txt files. You can use windows explorer to browse and open the file. The .TXT format is not very efficient so this feature is only available if the Profile A resolution is 1 second or above. It will automatically be disabled if the resolution is set less than1 second.

Synchronized – an example
Assume that you set up the instrument to measure in periods of one hour and that you start the measurement at 08:52:40. The first period will last 7 minutes and 20 seconds ending at 09:00:00. The next measurement will be started at 09:00:00, followed by a new measurement each full hour.

We recommend to use of the synchronized feature for measurement periods which are either a multiple of one hour or one hour divided by a whole number as the feature has been designed with this limitation in mind.

If you want to apply short measurement periods below a few minutes, we generally recommend using the level versus time feature instead (time profile), since this gives you a much more flexible way of displaying and work with the stored data.

Weather Station

A submenu *(Figure 9.10)* is avalable where you can select which parameter to log. Supported weatherstation is Thies Clima US model 4.9200.00.000.

The data logged from the weather station is not visible on the Nor150 display but is stored along with the measurement data for later analysis in NorReview or NorCloud.



Figure 9.10

FFT

Introduction

When the FFT option 13 is installed, the instrument can make a narrow-band frequency analysis of the input signal and calculate the auto spectrum. The signal is sampled with a sampling frequency of 48 kHz, 96 kHz in ultrasound mode.. Two resolutions may be selected, 1.46 Hz (16384 line) or 2.92 Hz (8192 lines) with an upper frequency of 22 kHz. This allows the signal to be analysed with a constant frequency resolution of 1.46 Hz or 2,92 Hz. The signal strength may be displayed in logarithmic [dB] or linear units [m/s or m/s^2].

If ultrasound mode is enabled, the sampling frequency is 96 kHz and the two frequency resolutions are 2,92 Hz with 16384 lines and 5,84 Hz with 8192 lines. Upper frequency is 44 kHz.

How to select FFT

The FFT is selected in the *Setup/measurement menu/ Frequency settings*.

Additionally, you must select FFT in the *Setup/Views menu* to display it on the screen. FFT is measured and stored regardless of the setting in the *View* menu.

Making a measurement

The FFT calculation is performed in parallel with 1/1 or 1/3 octave band analysis and the weighting networks enabled. The trigger handling and measurement time is not related to the FFT calculation, but follows the measurement parameters selected for the weighting networks and the 1/3 or 1/1 octave band given in the setup/measurement/functions menu.

The averaged FFT result is continuously updated on the screen during the measurement. The measurement may be stopped before the selected number of periods is reached by pressing **STOP**. The duration of each single FFT-period is approx. 700ms.

Additionally, you may select the instantaneous value. Selection is made in the **Function** button in context sensitive menu. See *Figure 10.2*.

During and after a measurement, the result is displayed as shown in the example on *Figure 10.1*. The FFT is also available as a single frame portrait and landscape. Numerical values are available using the **TBL** button. Using the split view as shown in figure 10.1 is an easy way to move along the frequency axis. Simply tap on the 1/3 octave cursor, and the cursor in the FFT spectrum will update accordingly.

The frequency range may be zoomed or compressed. The compression factor is adjusted in a power of 2 sequence using the context sensitive menu shown in *Figure 10.2*. If the display is compressed, more spectral lines are displayed as one line. The cursor value will show the maximum value for all the lines represented by the cursor position. In order to read the values for each spectral line, you have to zoom until the compression factor is 1.

You may swap between dB and engineering units in the context sensitive menu.

Calibration

The instrument has to be calibrated with 1/1 or 1/3 octave bands or one of the weighting networks as described in *"Calibrating the instrument - field check" on page 62*. The readout may be in decibel or engineering units.

Corrections

The correction for random response, windscreen, outdoor microphone and preamplifier gain also applies for the FFT calculation.

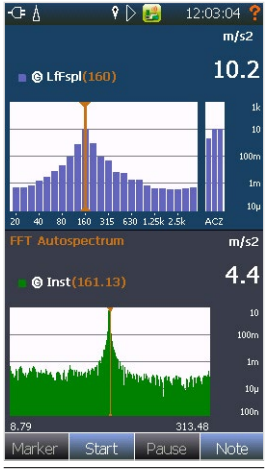


Figure 10.1

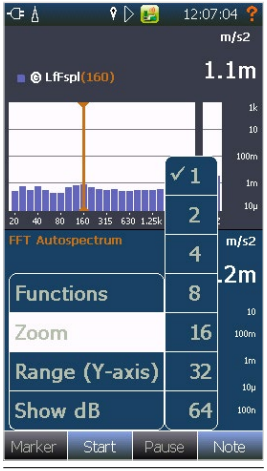


Figure 10.2

Infrasound / Ultrasound

Infrasound

The demand for infrasound measurements is increasing, particularly for applications involving low-frequency noise from wind farms, ships, and aircraft. The Nor150 is well suited for such measurements but requires a dedicated microphone, such as the GRAS 40AN. The GRAS 40AN has a typical frequency response of 0.5 Hz to 20 kHz (±2 dB). The preamplifier Nor1209 has a low frequency cut off -3dB @1Hz. Thus, it should be considered to use a preamplifier with a lower cut off frequency, such as the GRAS26AI which has a flat response to 1 Hz (-0.2dB)

The GRAS 40AN is mechanically compatible with the Nor1225 and can therefore be used with the Nor1216 and Nor1217 outdoor microphone systems together with Nor1209. GRAS26AI is not suitable due to the mechanical dimensions.

Instrument Configuration

To ensure correct low-frequency measurements, configure the Nor150 as follows:

- Disable **Ultrasound**, if enabled.
- Set the **Lower Frequency Limit** to **0.4 Hz** under **SETUP** > *Measurement* > *Frequency Settings* > *Lower Frequency Limit*.

Microphone Considerations

The low-frequency response of a measurement microphone depends on the size of the back-vented pressure equalization hole. Over time, microphones may develop pinholes in the diaphragm, which can increase the low cut-off frequency. These effects are not detected by standard sound calibrators or during IEC 61672 laboratory calibration. It is therefore recommended to request a dedicated low-frequency calibration to ensure that the microphone's low-frequency performance remains within specification.

Ultrasound

The ultrasound option 14 extends the upper frequency of the 1/3 octave filters to include the 40kHz band (31,5kHz band in 1/1 octave mode), the FFT to 44,34kHz and turn on the AU weighting network. The AU network is measured in addition to A, C and Z.

The frequency response characteristics of sound level meters as required by the IEC 61672 are not specified above 20 kHz. Thus, these instruments are not suitable for measuring the ultrasonic airborne energy emitted, for example, by ultrasonic cleaners, welding machines and high-speed milling and lathe machines. Further, these instruments may give a too high reading of the audio-frequency part of the sound emitted by such equipment, because the ultrasound may increase the reading of the A-weighted values. The AU filter is designed to overcome the latter challenge, namely by adding a well-defined low pass filter, the U-filter to the A network to minimize the influence the ultra sound. The U filter is specified in IEC 61012

Where the measurement of the ultrasonic component frequencies is required, one practice is to measure the unweighted sound pressure level using a suitable ¼" microphone system and a narrow band or one-third octave band filter.

In ultra-sonde mode, the sampling frequency is increased to 96kHz and the 1/3 octave and the FFT frequency range is extended to include the 40kHz filter band.

An applicable measurement standard is the VDI 3766 – 2012 – Guidelines for ultrasound measurements.

This option is especially designed to measure the content of ultrasound at a workplace. Since the Nor145 is capable to measure also the traditional weighting networks in parallel with the AU filter, you may do a full assessment of both normal noise and ultra sound noise at a workplace in one measurement.

The ultra sound mode is turned on in the **SETUP** > *Measurement* > *Frequency setting menu*. The AU network will replace a possible calculated network as the fourth weighting network. The AU network is denoted with the letter U. *Cf Figure 11.1.*

HINT! To get a more detailed picture you may measure both the 1/3 octave specter and the FFT spectrum up to 40kHz. Additionally, the instrument may record the microphone signal with 24bit, 96kHz sampling rate.

You define which parameters and time weighting functions you want to measure in the measurement setting menu *(Figure 11.2)*.

The standard microphone Nor1227 is not suitable for ultrasound measurement. A ¼" prepolarized free-field microphone such as the GRAS40BE is recommended. You may connect this microphone to the Nor1209 preamplifier via a ½" preamplifier to ¼" microphone adaptor or use a ¼" preamplifier. To minimize the influence from the instrument housing and the operator, a tripod and an extension cable is recommended.

The *Figure 11.3* shows the frequency response of the A-network in normal mode (grey line), in ultrasound mode (orange line) and AU network.

Something to consider!

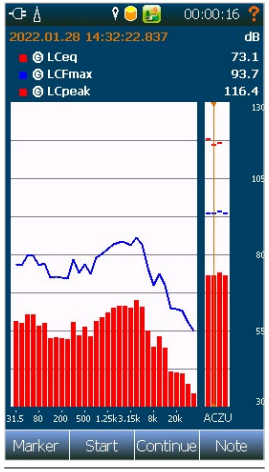


Figure 11.1



Figure 11.2

Please note that you may obtain higher A weighted values when measured in ultrasound mode compared to measurements obtained in normal mode, or if comparing results obtained with other instruments. Most digital sound level meters have a sampling frequency of 44 to 48kHz which will limit the calculation of the A-network above the ½ of the sampling frequency. Thus, sound levels above ½ the sampling frequency will not be measured. In ultrasound mode you will measure values following the A-curve up to about 48kHz before the antialiasing filter cuts the response.

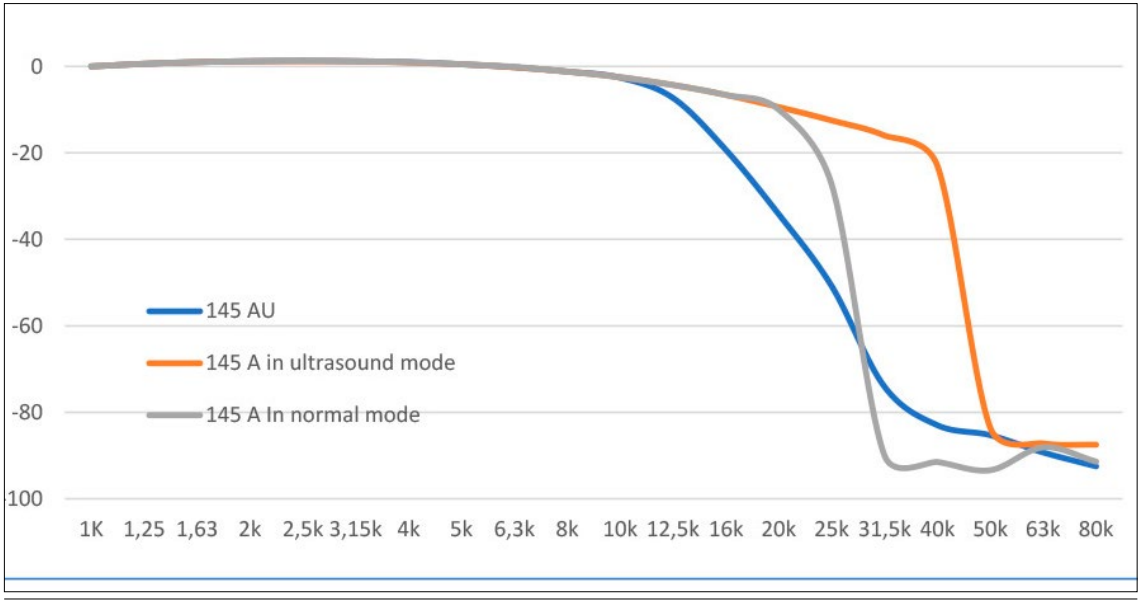


Figure 11.3

Trigger Selection Menu

The *Trigger* menu (*Figure 12.1*) is used for two purposes; to start the overall measurement, the Global measurement and to specify the condition of the event triggers.

Global Trigger

The upper selection, Global Measurement, specifies how to start (trigger) the measurement, while the lower frame, Events, specify the settings of the event trigger. Global Measurement is the overall measurement. The Global measurement time (duration) is specified in the *Global Time* in the *Measurement* menu. For most application the **Start** button is used to start (trigger) a measurement. It is however, often required to start a measurement based on other criteria's than to push the start button. The Nor150 has a variety of choices found in the *Global Measurement* menu (*Figure 12.2*).

Independent on the selections made in the Global Trigger menu, the START button must be pressed to activate the setting. The measurement icon in the upper bar in the display will turn into "waiting" indicated by ⌛ icon to show that the instrument is ready to measure once the global trigger condition is fulfilled.



Figure 12.1



Figure 12.2

Manual Trigger	The measurement start is controlled by the Start/stop button on the keyboard and the soft buttons in the display. A delayed start of 0 - to 180 sec is available.
Clock Trigger	The measurement start is controlled by the real time clock.
On Next Full Hour	The measurement will start once the real time clock in the Nor150 passes the next full hour.
External Trigger	The measurement will start once the external trigger is activated. I.e. a digital signal on the I/O socket pin 1. The hand switch Nor263A or Nor263B is suitable for this use.
Threshold	Configuration of threshold trigger.

The *Global Trigger Threshold* menu *(Figure 12.3)* configure *The trigger Level*, *Threshold type* and *Trigger function*.



Figure 12.3

Level Below	The measurement will start once the level is below the set trigger level. In addition to the level, the measurement parameter can also be specified.
Level Above	The measurement will start once the level is above the set trigger level. In addition to the level, the measurement parameter can also be specified.
Level Exceeds	The measurement will start once the level exceeds the set trigger level. It derivates from the Level Above in which case it will trigger once the level is more than the set trigger level, the Level Exceeds must be below, and then exceed the set trigger to fulfil the trigger condition. In addition to the level, the measurement parameter can also be specified.
Level Drops	The measurement will start when the level drops below the set trigger level. It derivates from the Level Below in which case it will trigger once the level is less than the set trigger level, the Level Drops Below must be above, and then drop below the set trigger to fulfil the trigger condition. In addition to the level, the measurement parameter can also be specified.

In the trigger function menu you configure which function to trigger on. The functions can only be SPL functions *(Figure 12.4)*. Only functions from channel 1 can be used.



Figure 12.4

The Event Trigger

An event is a significant change in the sound level for more than a minimum period of time. The amount of level change required is predefined by you by setting a threshold level. Hence, the purpose of the event triggers is to start an action based on the event. A typical action can be to start an audio recording if the noise exceeds a certain level. The event trigger criteria (and On/Off status) is controlled in the second frame in the Event Trigger menu *(Figure 12.5)*. To picture an overview of the event trigger there is a certain terminology associated with events – see *Figure 12.6*.



Figure 12.5

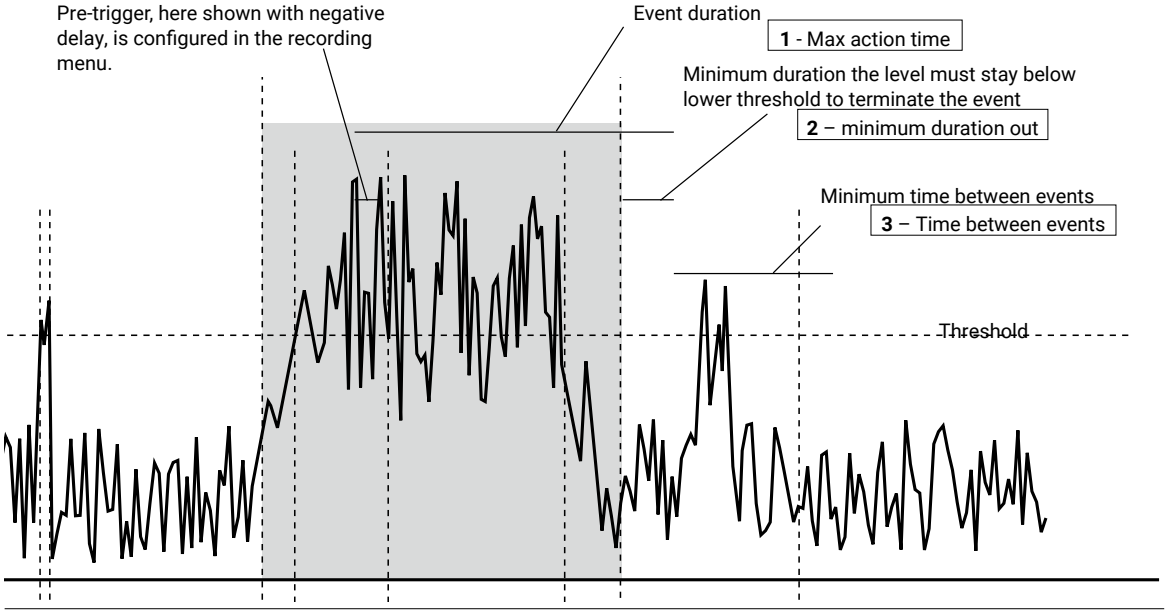


Figure 12.6 - Event related terminology

Each of the five event triggers can be configured independently. The main purpose of offering five instead of one trigger is to associate different trigger levels during a certain time period. Each of the five triggers is connected to the real time clock. This means that you may configure one trigger level for a certain period of the day, and another one for the evening and a third one for the night, or simply turn off the event trigger for a certain period of the day.

The upper selection frame “Event Trigger” is where you set the type of event trigger.

External; The event will be enabled if the hand switch type 263A or B is used, similar as pin number one on the digital I/O socket is enabled.

Threshold; The threshold trigger is a sophisticated trigger with several possibilities. Pushing the *Threshold* button opens up a submenu *(Figure 12.7)* where the threshold trigger is specified.

Both *External* and *Threshold* trigger may be activated simultaneously.

Start Level
This is the start trigger level.

Stop Level
This is the stop trigger level.

Threshold type
Above: Trigger once the level is above the set trigger level.
Below - Trigger once the level is below the set trigger level.

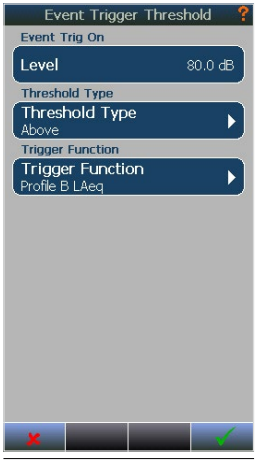


Figure 12.7

Trigger function
Set trigger channel measurement function, the report, and Frequency (if applicable).

Channel selects from which sound channel your trigger source is.

Reports. In the reports you may choose any of the selected profiles; Profile A, Profile B and Profile Moving.

Profile A. Use Profile A if you want an instantaneous trigger.

Profile B is typically used if you want a “less nervous” trigger.

Profile Moving is typically used if you want a relative trigger. Say, you want a trigger level above the background noise. In this case you may trigger on a statistical value.

There is a difference in how the threshold trigger is calculated for the different profiles. In Profile B and Profile Moving, the trigger is fulfilled when the complete level for one profile period is above (or below) the set trigger level. That means that the trigger is checked after an entire period is calculated. This differs from trigging on profile A, where the trigger is fulfilled once the level reaches the set trigger level. That means that the trigger is checked during the profile period. Example; If you have one minute time resolution for profile A, a trigger level of 60 dB and trigger parameter is Leq. Once the Leq value within the current period is above 60 dB the trigger condition is fulfilled, even if the Leq level drops below 60 dB for the entire one minute period. Profile B however, will not trigger in this case, since the trigger level is checked after a time period is finished.

Max Action Time
This is the maximum time the event shall be active. The event action is terminated when the maximum Action Time is reached.

Min Duration Out
This is the minimum duration the event trigger condition is not fulfilled.

Time Between events
This is the minimum time between events. An event will be rejected if it occurs before the minimum time is reached.

Time Span
Here you specify which time span of the day the event trigger settings shall be active.

The time span and thereby the new setting for trigger level etc. becomes only active each time a new global measurement is started. Hence, using the time span feature requires that you either use Repeat or Syncro storage mode with a global measurement resolution that matches the time span.

I.E. Say you want 70 dB trigger level between 0700 and 1600, then 60 dB from 1600 to 2200 and 40 dB from 2200 to 0700. Configure then 3 event triggers with the corresponding time span and trigger level. Select global time resolution to 1 hour and synchronised as storage mode in the measurement menu.

Event Action
In the lower frame you specify the Event action. Software version below 1.2 do not offer the Picture Event function, only Audio recording.

The Event action can be Recording, Camera or Digital Output. Camera can be picture or video defined in the Camera sub menu. The camera IP address and settings are done in the **SETUP** > *Measurement* > *Camera menu* - see *"Camera" on page 91*.

Setting the audio recording quality and pre-trigger is done in the **SETUP** > *Measurement* > *Audio Recording* menu. This setting is common for the audio recording regardless of which action that starts it; an event trigger, external hand switch, a marker etc.

The internal camera does not offer triggered picture. This function is only available on external cameras. See separate chapter for how to configure an external camera to work with the Nor150.

Working with Markers

Setting up Markers - the Marker Setup menu

Have you ever made a measurement where you later found out that you desperately need to identify the cause of the level? Recording the audio may be one answer, but for attended measurement it may be more convenient to add markers to the measurement.

Markers can be inserted into a running measurement. In the *Marker Setup* menu *(Figure 13.1)* there are up to 10 different markers available. Each marker can be set to sound incidents that are interesting to note in a measurement. Markers are connected to a specific period in the profile measurement.

There are two types of markers; single markers and toggle markers. A single marker is mainly used to indicate short duration sound events, while toggle markers typically are for noise events that last longer such as pass by noise of a train or similar types of noise.

In addition to selecting whether the marker is a single or toggle type, the real name and colour is also possible to configure in the sub menu associated with each marker. The marker will be added to the time profile with the selected colour. A single marker appears as a dotted vertical line, while the toggle marker appears as a horizontal line *(Figure 13.2)*.



Figure 13.1

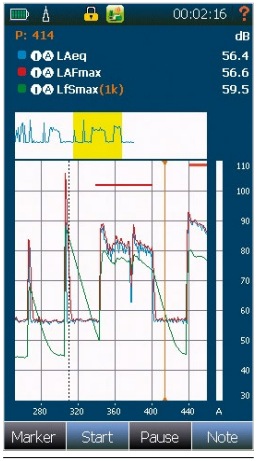


Figure 13.2

Each marker may also start an action. The following actions can be assigned to a marker.

Recording: The marker will start an audio recording. Setting of the audio recording such as pre-trigger, # of bits and sampling is set in the *Audio Recording* menu found in the *Measurement* menu.

Picture: A picture is taken when the marker is activated. This feature is only available on external cameras. See *"Camera" on page 91* describing the camera functions.

Digital Output: A digital output line will be set when the marker is activated. A digital output must be assigned to the marker. This is configured in the *Digital I/O* menu found in the *Instrument Setup* menu.

Reference tone: This will add tone signal to the time profile in the similar way as an audio recording. Mainly used for adding a "calibrated" sound level to the start of a measurement. The signal type, level and excitation time is set in the *Reference Tone Setup* found in the *Instrument Setup* Menu.

System specified markers

In addition to the user defined markers described above, other markers may be inserted by the instrument itself.

Pause marker: As discussed in *"Pausing and resuming a measurement" on page 95*, a yellow toggle marker including a blue shaded field indicates the duration of the pause. The values obtained in the pause area are removed from the global measurement, but remain in the profile. The single marker "P" is added to the periods to denote that these periods contain data acquired in pause mode.

Continue: A red single marker labelled "C" for continues is inserted in the time profile if you terminate an ongoing measurement prematurely by pressing the **STOP** key and later resume the measurement by pressing ⏯. The "C" marker will be added to the period within which the ⏯ key was pressed.

Recording: An orange recording marker is added to the profile during recording of the signal.

Signal Overload: A red marker is added to the profile if the input circuit is overloaded. I.E. the measured signal is higher than the measurement range.

DSP Work Overload: A black marker is added to the profile if some of the specified tasks have been omitted due to work overload for the signal processor.

Battery Marker: A marker is inserted when the instrument is powered from the internal batteries.

Event Marker: An event marker is inserted when the event trigger condition is fulfilled.

The Property button at the top of the menu gives you the option to turn on/off the battery marker and/or the Event marker. Please note that the battery and event markers will be available in NorReview regardless of the setting in this menu.

Adding a marker to an ongoing measurement

An on-screen selection with the available markers appears in the measurement picture when the **Marker** button is activated. This menu *(Figure 13.3)* then remains on the screen until it is closed with a new push on the marker selection field. Active markers remain active even when the menu is closed.

Several markers can be active simultaneously. The marker button turns orange when active.

The number of markers are counted up and presented as a number in front of the marker.



Figure 13.3

Marker Reaction time

When working with markers, you may sometimes need a delay before setting the marker to ensure precise placement. This functionality is available in the *Marker Properties* menu, located within the *Marker Setup* menu.

You can configure a delay ranging from 0 to 10 seconds, allowing you enough time to adjust the cursor position before the marker is applied.

Working with markers - post processing

Once a measurement is elapsed, or recalled from memory, you may edit, delete, move or jump between markers. Unlike setting a marker which can be done in any view, regardless of type, you can only perform post processing in the L/t view.

The post processing marker management menu is a context sensitive menu. If you place the cursor on a user added marker and open the context sensitive menu you will find one menu point named marker. This submenu offers three choices; Move, Delete or Add.

Move: The marker you placed the cursor on is moved to where you place the cursor by tapping on the new position.

Delete: The cursor you placed the cursor on before you entered the menu is deleted.

Add: The available markers appear. Select the new marker and tap on the screen where you want the end position to be. Start position is where the cursor was placed before you entered the menu. A single marker will be added at the cursor position.

Jump between markers: Place the cursor on a marker. Tap on the *Marker* key and use the ◀ ▶ on the keyboard to jump to the next marker, left or right.

Recording the sound - Audio record and replay

The Nor150 allows storing the sound signal itself obtained by the microphone if the appropriate option 4 is installed. The most common application is for identification purposes (by listening to the sound signal). Dependent on the selected quality of the recording format, the signal may also be used for further analysis.

The recording quality is available in several flavours serving slightly different purposes. The main disadvantage for using an unnecessary high quality is large files which consumes a large part of the storing medium, increased calculation power and handling time due to the large amount of data.

The Audio setup *(Figure 14.1)* is found under **SETUP** > *Measurement* > *Audio Recording*.

Sampling Rate/Resolution. Three different Resolutions, 8 – 16 – 24 bit, and two sampling frequencies, 12 kHz and 48 kHz, give in total 6 different formats for the recorded sound. The sampling frequency of 48 kHz in combination with 24 bit resolution reflects closely to the basic accuracy of the instrument and should be used if further processing of the signal is requested. When the sampling frequency is set to 12 kHz, only frequencies up to 5 kHz can be reproduced.

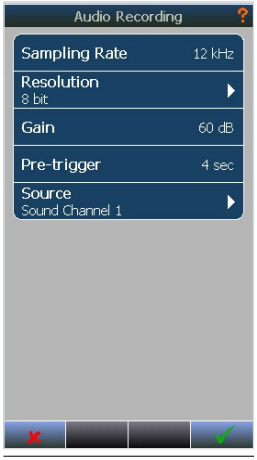


Figure 14.1

However, in most cases this is sufficient for noise source identification. Note that the best format consumes twelve times as much memory as the simplest for storing a recording with a certain duration.

Select 16 bit resolution if you want to replay the audio recording on the Nor150 itself. NorReview as well as most media players accept all formats.

Gain. The instrument has a large dynamic range – exceeding 120 dB. This means that if you try to play back the recorded sound after having transferred the files to your PC, you will – in most cases – hear nothing! The reason why is that most soundcard/PC solutions simply can't handle the high dynamic range. To overcome this problem you may introduce a gain applied to the recorded sound only – the rest of the measurement is left unaffected. The drawback is that the dynamic range for the recording is reduced accordingly so a sound recording overload may occur with no overload being detected by the instrument. All other parts of the measurement are left unaffected by this gain setting.

The upper range for the recording will be the upper level for the instrument minus the selected recorder gain. The upper range for the instrument is dependent of the calibration, but is normally 130 dB (140 dB peak). The recording gain may be selected in steps of 6 dB (2x) from 0 dB to 60 dB.

Pre-trigger. The pre-trigger function allows the start of the sound recording to be recorded up to 120 sec before the recording was triggered.

The duration of a recording and how it shall be started is configured in the Trigger Menu. Please refer to *Chapter "Trigger Selection Menu" on page 78* for further details.

Channel. Instruments equipped with the dual channel option allow you to record from either of the two channels or both channels simultaneously. Please note that dual channel recording is limited to 12 kHz sampling rate.

Making a recording

The start of a recording may be done in many ways. Manually by pressing the **Note** soft key and then *Recording.*

Manually by connecting the audio recording action to a Marker.

Manually using the remote hand switch Nor263 connected to the I/O port.

Threshold triggered by connecting the Audio recording to one or several of the event triggers.

For a level triggered recording the recording will start during a measurement if the level in the selected network or filter band fulfils the trigger criterion. The length of the recording is selected as a part of the trigger setup discussed in *"Trigger Selection Menu" on page 78*.

The recording file is automatically assigned to the current measurement. A marker is inserted in the L/t profile. See *Figure 14.2*. The figure also shows the Note menu open. The orange (as well as the orange **Note** button) indicates that there is an ongoing recording in addition to the orange marker.

If you want to make an automatic recording lasting for the whole measurement, set a very low threshold (e.g.: 0,0 dB) and select the Max action time to 0 min and 0 sec.

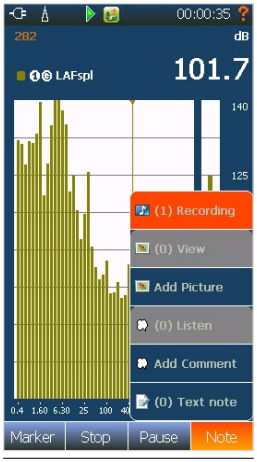


Figure 14.2

The Time Span feature offered in the Event menu enables a different setting of the audio recording during a day. Each event may have its own Time Span. More details are found in *Chapter "Trigger Selection Menu" on page 78.*

Listening - replaying an audio recording

Once a measurement is elapsed, or recalled from memory, you may replay an audio recording if applicable. Place the cursor at the audio recording marker you want to listen to and enable the context sensitive menu and select play. The audio recording is now replayed via the headphone socket.

NOTE! 16 bit format is required to be able to replay audio recording on the instrument itself. NorReview supports all formats.

Be sure that you have configured the headphone socket to replay the audio recording and not set it to listen to the microphone signal itself. This is set in the **SETUP** > *Instrument* > *Analogue Output* > *Headset* menu. Select Playback. Here you also adjust the replay level.

Push the **Marker** softkey and then the left or right arrow key to move to the next audio recording. Please note that this function moves the cursor to the next marker regardless of type.

All recordings are made in a standardized WAV-format which allows most media-players to play the recorded file if they are transferred to a PC. We recommend using NorReview to work with the time profile data and listening to the audio recordings.

Software version V1.2 and above offers some additional functionality and user friendliness.

Audio recordings may be replayed via the note menu followed by the playback button. This gives you a list of all the captured audio recordings. However, this feature does not connect the recording to the applicable event marker. If this is needed, push the marker button and then jump to the right marker using the left/right arrow key, as described above. Open the context sensitive menu and select view or play button. The latter method assigns the correct recording to the marker. The recording may also be replayed in NorReview.

Insert a reference tone as a recording

When listening to a recording, it may be required to make the playback with the same actual sound level at the listener's ears as the original sound was at the spot of the actual measurement. In such cases a reference tone with a pre-defined level may be recorded during the measurement, and later replayed through the listener's loudspeaker system at the spot of the replay. The reference tone is configured in the **SETUP** > *Instrument* > *Reference Tone* menu. Here you select Level – 0 to -50 dB, Signal type- white, pink or sine, Excitation Time – 1 to 60 seconds, and Frequency if Sine is selected as signal Type.

The Reference Tone is activated by a marker. See *Chapter "Working with Markers" on page 84*. Only one of the markers can be assigned to activate the reference tone.

Camera

The Nor150 fitted with option 1 offers support for various camera types. External camera(s) is configured in the **SETUP** > *Measurement* > *Camera menu*. The internal camera is not affected by the setting in this menu. Basically the Nor150 supports three types of cameras, The internal camera, Device and IP cameras.

Internal camera.

The internal camera may only be used before and after a measurement. The pictures taken with the internal camera is automatically assigned to the next measurement if taken before a measurement, and assigned to the elapsed measurement if taken after, provided that the instrument is in stored or ended state.

To take a picture press the **Note** soft button to access the Add Picture button. Ref *Figure 15.1*. Use the ✓ button to take a picture and the ✘ leave the camera mode.

Device camera

A device camera is a camera found on pads and smart phones. The NorVirtual app enables you to add pictures an voice comments before, during and after a measurement. It does not support event triggered pictures. This requires an IP camera.

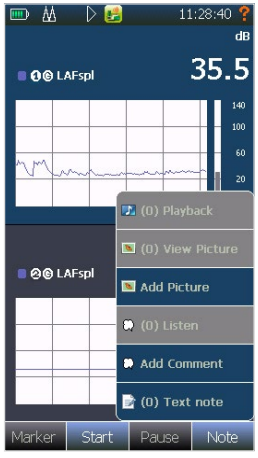


Figure 15.1



Figure 15.2

The NorVirtual App replaces the former NorRemote App. NorVirtual is a 1:1 copy of the display and keyboard on the Nor150. It allows you to do a full remote control of the instrument on your smartphone as if you had the instrument in your hands.

The pictures are transferred together with the measurement. It is not possible to view pictures obtained with a device camera on the instrument, but in NorReview V6 and above.

IP camera.

IP cameras are fully supported directly from the Nor150 including event trigger control. This is the recommended solution for permanent or semi-permanent noise monitoring via NorCloud. From software version 5 both picture and video are available. We support the Axis F and M series range of IP cameras, which are proven to be robust and reliable.

IP camera communication follows a standard protocol, but to avoid possible conflicts a few camera types are tested for compatibility with NorCloud and Nor150. These are the Axis F and the Axis M2025-LE and M3037-PVE cameras!

Configure and set up the camera as follow;

1. Connect to the camera or the network the camera is connected to in the **SETUP** > *Instrument* > *Communication* > *WLAN* menu if you are using a WLAN connection or in the *LAN* menu if you are using a cabled LAN connection. See *"Instrument Specific Setup" on page 190* and section describing "Communication" if further instructions is needed.
2. In the **SETUP** > *Measurement* > *Camera* > *Allow Device camera(s)* menu you add a new connection to the IP camera.
3. Once the camera is configured it will be visible in the Camera Selection menu. The camera you added is by default turned off. Remember to turn it on. See *Figure 15.3*.
4. In the *Event Trigger menu,* set a proper trigger level for the camera and turn the camera on. See *Figure 15.2*.

Note, the camera will not become visible if you for some reason have an unsuccessful connection

Hint. You may use one trigger for audio recording, and another trigger (and trigger level) for the camera if needed.

5. The pictures are available in the **Note** on screen menu on the Nor150 after the measurement is finish. The pictures follow the measurement data and can be viewed in other Norsonic programs such as NorReview. Video is not available on the instrument, but in NorReview and NorCloud.

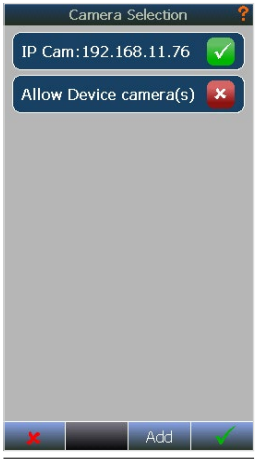


Figure 15.3 - Camera selection menu, shown with one IP camera added. This menu will just contain the device camera selection before an IP cam is added.

Voice and Text notes

You may add notes prior to, during and after a measurement. There are three types of notes, voice, text and picture. Each of these notes can be added as global note and profile note. A global note applies to the entire measurement, while the profile note will produce a marker and is meant to add additional description related to an event. You may add several profile notes, but only one global. For voice notes you need a proper headset with microphone connected to the headphone socket found on the rear input connector panel. In addition you need to select Playback in the **SETUP** > *Instrument* > *Analog Output* > *Headset* menu. The Norsonic headset Nor4584 is suitable for this use. Most other type of headset with microphone and a 3,5 mm jack plug is also suitable.

You may also speak in voice comments on your smartphone using the NorVirtual app.

Adding text and voice notes

Push the **Note** soft button on the touch screen and select either *Text note, Add Picture* or *Add comment*. Notes added prior to a measurement assume you are in ready mode. I.e. no recalled measurement or ended measurement available on the screen. The note(s) will be added to the coming measurement. Notes added to an elapsed measurement will be assigned to the elapsed measurement. These notes are so called global notes.

Similar, notes may be added to an ongoing measurement. These notes are called time profile notes. The text note will produce a single marker, while the voice (comment) note will produce a toggle marker.

You may also add text to the global note while the measurement is running. To access the global note, press **Text Note** as usual and then the soft key **Global** found on the soft key bar in the bottom of the display. If you add a global text note prior to the measurement, and want to add more info after a measurement, you may add the information as additional text, or modify the existing text for the text note, while the voice note only offer the possibility to replace the one you made prior to the measurement.

Retrieving text and voice notes.

You may read the text notes by placing the cursor on the single marker and push the *Note* and then *Text* note button. To read the global note, just press the *Text* note button and then the **Global** soft key.

A voice note is replayed in the same way as an audio recording. Simply place the cursor within the marker field and open the context sensitive menu either by placing your finger for some seconds on the cursor/ marker or push the **OK** button on the keyboard.

Select *Play* to replay the voice comment. To replay a global voice note, Comments recorded before or after a measurement is replayed by pushing the **Note** soft button and then the **Listen** soft button *(Figure 16.1)*. A selection list appears with the available comments files (*Figure 16.2)*. Select one and push enter to replay. Only the comments before and after the measurement is listed. Comments recording during a measurements are replayed by placing the cursor on the comment marker indicated by green colour *(Figure 16.3)*.

You may push the *Marker* button to enable the jump to next marker function.

Pictures, Voice and Audio recordings may be viewed / replayed via the note menu followed by the corresponding note button (*Playback* or *Listen* button). This gives you a list of all the captured pictures, audio recordings or voice notes.

However, this feature does not connect the notes to the applicable event marker. If this is needed, push the marker button and then jump to the right marker using the left/right arrow key.

Open the context sensitive menu and select *view* or *play* button. The latter method assigns the correct note to the marker. The notes may also be viewed in NorReview version 6 and above.

HINT! To jump between markers, push the marker button and use the left right arrow key to jump to the next marker.

NOTE! The number in brackets added in front of the soft keys in the Note menu is the number of notes added. This feature is available in Software version 1.2 and above

Nor150 connected to the NorVirtual app running on a smartphone is a neat solution for setting markers and adding comments to a measurement.

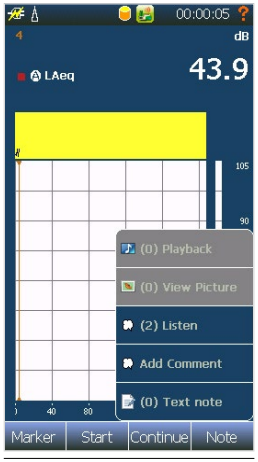


Figure 16.1



Figure 16.2

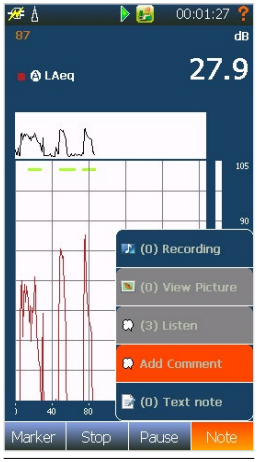


Figure 16.3

Pausing and resuming a measurement

Extensive pause and continue functions are available. When paused, the instrument will produce and display the time profile for the last 20 seconds of the measurement. The time cursor can be moved backwards in one seconds step to remove the unwanted noise. Data acquired to the right of the time cursor in the pause picture will be removed from the global measurement once the measurement is resumend. This applies to the statistical values in global as well. If there was an overload in the selected time span, this will also be deleted from the overall measurement.

The data removed in the pause picture *(Figure 17.1)* is not removed from the time profile. Instead a pause marker is inserted in the time profile for easy identification of the paused area. The markers are also transferred to the post processing and reporting program NorReview where you may refine the pause marker setting.

Figure 17.2 shows a paused area which is indicated by a greyish background followed by a yellow horizontal marker line.

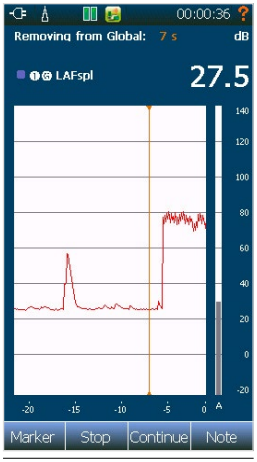


Figure 17.1

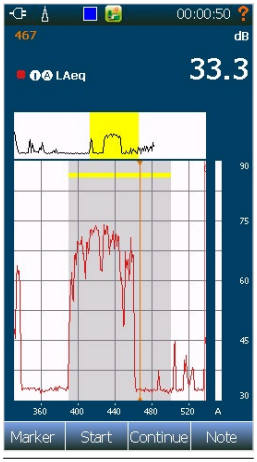


Figure 17.2

Please note! The yellow area in the summary graph above the main L/t graph is not indicating the paused area, but the current view in the summarized graph

NOTE! Pause function is not available if Synchronized or Repeat storage mode is selected.

It is also possible to resume a measurement after **Stop** is pressed. Once you press **Stop**, the **Continue** function becomes available. Opposite to **Pause/ Continue**, the **Stop/Continue** sequence also removes data from the time profile in addition to Global. A red single marker labelled C is inserted in the time profile as shown in *Figure 17.3*. Notify the discontinuity in the time axis at the Continue marker.

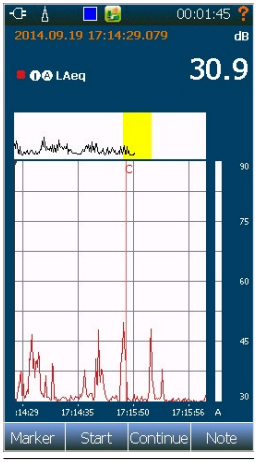


Figure 16.3

The difference between a “Pause” and a “Hold” function

In the sound level meter standard IEC 61672 Ed.2.0 there is a request for a “hold” function so that the operator has the possibility to manually read out more measured values (max and peak) while the measurement still runs. In the Nor150 this type of function is not needed since every level-display can have several parameters displayed simultaneously. It is up to the operator which results to display at any time. Hence no data will be lost due to the handling of the analyser while the measurement is running.

The **Pause** function is implemented in this analyser to facilitate removal of unwanted signal contributing to the overall measurement results.

Storing a measurement - Memory Organising Menu

The **MEM** button is used to retrieve a stored measurement. You may also via a context sensitive menu, rename, move, delete, send to a drop box in NorCloud and recall information from a single measurement. Similar, you may move, delete or rename a directory.

Starting from software version 6, a 'Previous/Next' feature has been added to the soft key line, allowing users to easily scroll through measurements when recalling a measurement.

When opening a repeat or synchronised measurement you are prompted to tell which of the measurement in the series of measurements you want to open. Ref *Figure 18.1*.

Further memory handling, file naming etc is organised in the memory menu found under **SETUP** > *Memory*, *Figure 18.2*. Here you configure the file name conventions, storage destination, move, rename and delete files or directories. This is also where you store and manage your setups. This menu also contains a "*Set Factory Default*" feature and a "*Save Debug Log*" feature.



Figure 18.1



Figure 18.2

Storage Folder: Here you select the folder where you want to store your measurements and you can also create new folders. Use the ↑ soft key to move up in the folder system. Push on the desired directory or storage media to select or move down in the memory system. **NEW** creates a new folder.

The instrument supports SDSC, SDHC and SDXC micro SD cards. The card must be class 10 or better.

NOTE. Changing the SD card requires a reboot of the instrument. Information about the files and directories are built up at power on, to speed up the access when working with the memory. Only changes in the structure is amended as long as the instrument is powered.

It is important to know the different storage modes and what features they offer.

The configuration of the storage mode is set in the **SETUP** > *Measurement* > *Storage Mode.*

A short description of the storage mode is repeated below;

Manual - Results are not stored. If you want to keep the results save them manually by pressing the **MEM** button.

Auto - Every measurement is automatically stored after it is finished. There are guidelines in the lover frame on how new file names are supposed to be generated.

Repeat - The results are saved and a new measurement similar to the first one is immediately started.

Synchronised - Similar as Repeat, but the next measurement is synchronised with the clock.

HINT! It is recommended to change the SD card frequently to avoid data loss. Back up or transfer data to another media. A memory card containing a higher number of files will slow down the performance of the storing process.

File name

The instrument offers a sophisticated file naming system with a variety of options.

You may either enter the file name manually when you store the file. This is only possible if you have selected manual as storage mode. Default suggestion is according to the settings in the *Memory* menu.

If *Auto*, *Synchronised* or *Repeat* is chosen as storage mode the default automatic file naming is chosen. This stores a file with the date and time at the time the measurement was stored. A more sophisticated naming is enabled if you turn on “Filename Base” and “Start Index”. The instrument will store the measurements automatically and increase the file index by 1. You may however choose which number to enumerate from (Start Index). In any case the time and date will be added to the filename.

Say you have a project consisting of several locations and several measurements on each location. You may then name your directory with the project name, say “Project Highway” and make subfolders under this directory, say “Route 66”.

File Name Base. Here you specify the start name / default name of each location. Say “Sunny beach”.

Start Index. The index is added to the File Name Base. If you start on one, the first file will be named “Sunny beach 1” plus the time and date.

There is a limitation of 1000 measurements if you use the same letters in the first 4 letters of a filename. For automatic measurement names (timestamp), there will be a limit of 1000 measurements per year on the same SD card. The same apply if you use a Filename base with 4 letters or more, you can save up to 1000 measurements with the same filename base, on the same SD card. This limitation does not apply to repeat or synchro mode, because the incremental index is the first part of the measurement name.

Unique Measurement identifier

When storing a measurement it is automatically given a unique identifier (number) that will follow this specific measurement. The identifier can be viewed in the INFO screen (pressing the **INFO** button) and can never be changed.

Save and Manage Measurement setup

Storage and management of setup files are done in the *Manage Setup files* menu. Push the *Manage Setup files* button to get access tot he *Setup Management menu*. *(Figure 18.3)*.

If you have made a measurement setup you will like to reuse, store it using the *Save Measurement Setup* as button.This gives access to a submenu where you key in setup name and decide if you want to show it as an icon in the “application start up menu”, *“Application Selection Menu - Predefined Setups” on page 101*, and if you want to write protect it.

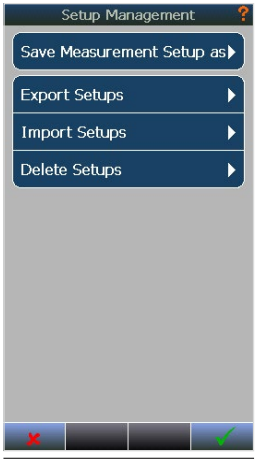


Figure 18.3

The *Setup management menu* offers also the possibility to *Export Setup* to a SD card or *Import Setup menu* from an SD card or *Delete setups* file.

The Export / Import function is very convenient to duplicate a setup to several instruments.

Write Protected Setup

A write protected setup will disable the possibility to change settings. I.E. it is not possible to change any settings related to the measurement. These fields will be “greyed out” to indicate that this function is disabled. Further is a write protected setup indicated with a padlock symbol in the status line.

Send to NorCloud, Rename, Delete, Move, Open, Info

A file or directory may be renamed, deleted, sent to NorCloud, open or moved. These features are offered in context sensitive menu in the *Memory* menu or pushing the **MEM** button. Touch the desired file or directory for a couple of seconds to gain access to the context sensitive menu *(Figure 18.4)*. Open a file is also offered if you enter the menu from the **MEM** button.

The Send to NorCloud feature pushes your measurement data to your “drop box” in NorCloud. It requires you have a NorCloud account. The data in NorCloud can be downloaded to a PC for further reporting and processing. This is a convenient way for you to share data from a device in the field to a colleagues in the office.



Figure 18.4

Info displays vital information about the measurement, such as measurement time, measurement functions and so on.

The icon in front of the name indicates type of measurement. A small red C indicates that the measurement is a repeat or synchro type.

It is also possible to delete all measurements in the setup/memory menu. This feature deletes all files on the memory card. This may take several minutes.

Set Factory default

The set factory default feature is found in the *Setup/Memory* menu. This will revert all settings you have done back to a factory default setting, except from calibration sensitivity, stored measurement data and data in the sensor database.

Save Debug Log

Although every effort is done to ensure a stable and bug free software it might happened that you experience problems. The Save Debug Log feature allows you to manually store a debugging log onto SD card or a USB stick, if you want to report an unexpected fault or crash to our support desk. This is a great help for our software developer to refine the software to ensure a stable and reliable instrument.

Application Selection Menu - Predefined Setups

The *Application menu* is normally the first menu that appears after the instrument is powered on and the boot sequence is finished. This is the menu where you may select your favourite setup or other setups dependent on your measurement application *(Figure 19.1)*.

You may hide this menu and let the analyser start up directly in the measurement picture. With the soft button **Hide**. This is a toggle button so you may revert by pushing **Show**. To access the menu if it is not shown at start-up push **SETUP** > *Applications*.



Figure 19.1

There are three different types of Setups; Instrument mode, indicated by large icons. Standard setup, indicated by small icons with an orange frame and User defined setups indicated by small icons.

Instrument mode is where you select the main measurement task, such as environmental measurements, building acoustics, intensity etc.

These modes are indicated by large icons with a picture symbolizing the application. Tapping on a large icon gives access to a list of setups that are available for this application. These setups are grouped in three categories;

1. **Last used.** The last used is the same as tapping on the large icon “last used”
2. **Standard setups.** Standard setup is a set of pre-programmed setups, usually meant for a measurement task in accordance to a national or international standard. The instrument is pre-set for each country. Hence, only the country dependant standard for the country where the instrument is sold will be available. This prevents the user from scrolling through a long list of non-applicable standards.
3. **User defined setup** - setups created by the user itself.

Selecting a setup, except from “last used” will open a “measurement info” picture *(Figure 19.2)* which holds the most important information about this setup. At the top of the information picture there is a menu point where you may decide if the setup shall be visible as an icon (shortcut) in the *Application* menu. It is recommended that you select the most popular setups to be visible as icons. These icons will have the same picture as the instrument mode it belongs to, but is slightly smaller. A standard setup is in addition indicated with an orange frame.

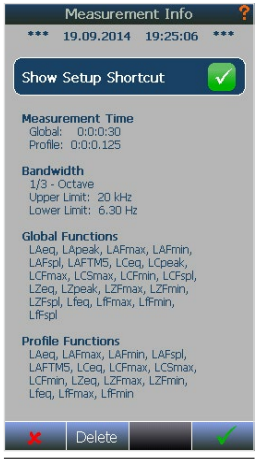


Figure 19.2

Creating a user defined setup

A user defined setup is stored via **SETUP** > *Memory* > *Save Setup as*. Select if the setup shall be visible as an icon in the *Application Selection* menu, or just in the list stored under the desired application icon. You may later change this. Please see previous chapter *“Storing a measurement - Memory Organising Menu” on page 97*. You may also choose to set the setup as write protected. This means that it is not possible to change the setting when it is used. Please note that a write protected setup is still possible to delete.

Please Note. Factory and user defined setup files are only visible for the current mode you are in. I.E: You will not see factory and user defined setup files for Building Acoustic mode if you currently are in Environmental mode.

Signal Generator (Optional)

The signal generator option facilitates the use of the instrument for various applications. The main use is sound insulation and reverberation time measurements

Figure 20.2 shows the available noise types. The noise excitation can also be synchronized with the measurement sequence.

The frequency of the sine and band-pass filtered noise can be set in 1/3 octave bands from 6,3 Hz to 20 kHz.

The built-in signal attenuator is adjustable in 1 dB steps from 0 dB to 50 dB attenuation. 0 dB equals to 1Vrms.

The signal generator output is on the multi plug located on the right-hand side of the instrument. The signal is on pin 15. Ground is pin 14 and the connector housing. Two cables are available for this purpose;

Nor4514A; 2m signal generator cable with BNC connector.

Nor4513B; Same as above, but with simultaneous connection to RS-232 interface and signal generator output.

Software version 5 and above supports wireless connection via Wi-Fi to the Nor282 power amplifier.



Figure 20.1



Figure 20.2

To enable Wi-Fi communication, both the Nor150 and Nor282 must be properly configured. You can either connect both devices to the same router/network, or connect the Nor282 directly to the Nor150's Access Point (refer to the Nor282 User Manual for details).

To establish the connection, go to the “Signal Generator” menu on the instrument and connect to the Nor282. If the Nor282 does not appear in the list of available devices, you can manually add it by pressing the “Add” softkey and entering the IP address of the Nor282.

Once the connection is successfully established, the Nor282 will take over as the signal generator and function in the same manner as the internal signal generator.

Note. The USB dongle included with the Nor150 is not suitable for this application. Instead, use a wireless router such as the TP-Link TL-WR802N, which is compact and well-suited for this setup.

Connect Nor282 in “Signal generator” menu in the in the instrument. If Nor282 does not appear in the list of available devices, you can add it manually by pressing the “Add” softkey and enter the IP address of Nor282.

When the connection is successfully established, the Nor282 will take over as the signal generator and operate the same way as the internal signal generator.

Note. The STIPA excitation and Swept Sine signal are handled slightly differently compared to other noise types. These are available through the headphone output, and not via the 15pin I/O socket.

Building Acoustic

Introduction

When equipped with the required program option(s), Nor150 is well suited for measurement of building acoustics in the form of measuring reverberation time and sound insulation.

The Building Acoustics mode allows measurement of building acoustics parameters according to the ISO 16283 series of International Standards as well as National Standards like DIN, BS, SS, SIA, etc.

Measurements are made in one-third octave bands and the results are reported for each band as well as frequency-weighted indices according to ISO 717-1 and ISO 717-2.

Full octave measurements are possible by selecting the ISO 10052 standard.

The mode is entered by pressing **SETUP** followed by *Applications (Figure 210.1)*. Select *Building Acoustics* from the available applications.

A list of predefined setups is ready to be picked *(Figure 21.2)*.

Instruments equipped with only the "Reverberation program option" will only display the functionality of the Reverberation and Project modes described in this section of the Instruction Manual.



Figure 21.1

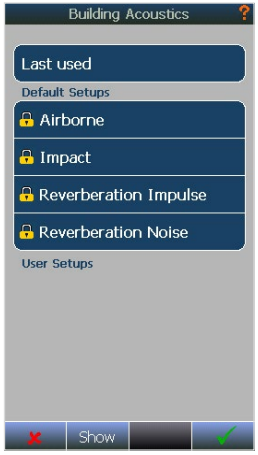


Figure 21.2

In this manual we often talk about

BA for Building Acoustics.

Airborne for Airborne Sound Insulation calculations.

Impact for Impact Sound Insulation calculations.

Reverberation or *RT* for Reverberation Time calculations.

BGN for Background noise.

Measurement Mode

The Measurement mode appears after starting the instrument or changing into BA mode. This is the mode where measurements are taken, contrary to Project Mode where the accepted measurements and calculated results are presented. The soft key in the lower left corner lets you switch between these two display modes. The Measurement mode may not be accessible and therefore the soft key is greyed out if an already stored BA measurement has been loaded and is currently open. Pushing the Cancel (✘) button will close the current measurement project and start a new one. If you want to reuse some or all of the current data click Yes when prompted and select the wanted data to be reused (see *"Start a new project" on page 130"*).

Upon loading an existing project from the memory, pressing the softkey **Activate** will allow additional measurements to be made inside the loaded project (see *"Continue an existing project" on page 130*).



Figure 21.3

Colour assignment

Colours are used to make the views more intuiative for the operator The colour assignment is fixed and cannot be changed by the user.

For single-channel instrument, or dual channel instruments operating in single channel mode, different colours are used to indicate the different measurement types *(Figure 21.3)*.

Level- Source room: **Red**
Level- Receiving room: **Blue**
Background noise: **Black**
Reverberation time: **Green**

For dual channel mode, different colours are used to indicate the different channels *(Figures 21.4 - 21.7)*.

Channel 1: **Red**
Channel 2: **Blue**

Display views in Measurement Mode

The Measurement mode has a fixed set of display views. Unlike the Environmental Mode these views cannot be modified and therefore the setup menu item “Views” is not available.

While a single channel instrument will have two views, a dual channel instrument will offer four different views. The different views are toggled by pushing the **VIEW** button.

NOTE! The first time a view is activated the appearance is lagged due to the process of creating the graphs.

Single-Channel views

Figure 21.4 shows a split display with a L(f) on top of a L(t) graph. *Figure 21.5* is a full screen L(f) graph.

There is a header line showing the selected standard, the measurement type (Level, BGN, RT) and the source position (#A...#I).

The function name is supplemented with the corresponding colour, channel number, and for Level measurements with the assigned room type (S = Source, R = Receiving) *(Figure 21.6)*.

Dual-Channel views

Figure 21.7 shows a split display with a L(f) on top of a L(t) graph with the activated channels in it. *Figure 21.8* is a full screen L(f) graph of the Receiving room channel(s).

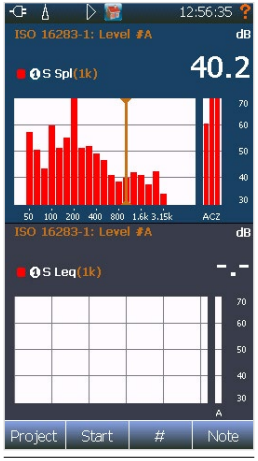


Figure 21.4

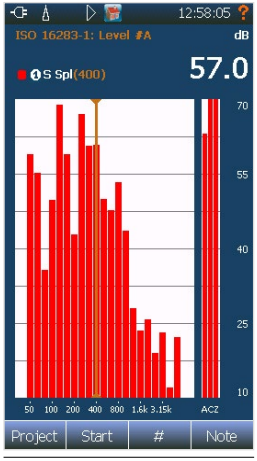


Figure 21.5



Figure 21.6

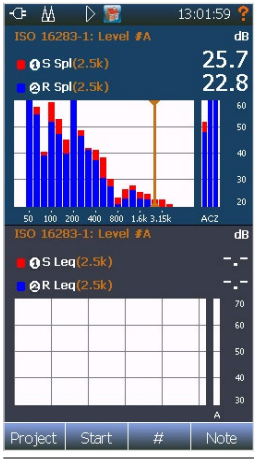


Figure 21.7

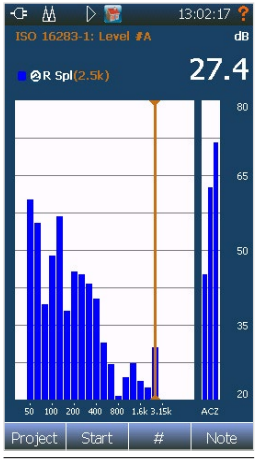


Figure 21.8

Figure 21.9 is a full screen L(f) graph of the Source room channel(s). And *Figure 21.10* is a dual L(f) graph of the source and the receiving room.

There is a header line showing the selected standard, the measurement type (Level, BGN, RT) and the source position (#A...#I).

The function name is supplemented with the corresponding graph colour, channel number, and for Level measurements with the assigned room type (S = Source, R = Receiving).

On-screen menus

Context sensitive menus *(Figure 21.11)* are available when needed. They give access to several of the parameters that influence the look and the view you are looking at. See chapter *"Setting up the analyser" on page 38* for more information.

The automatic Y-axis range can be activated individually for Level, Reverberation and Rating graphs.

NOTE! Auto Range does not work while in idle or running state. The Auto Range will be triggered on Ended/Stopped or when displaying already accepted data.

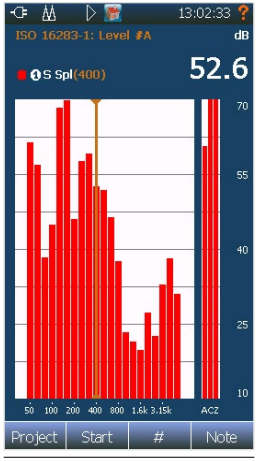


Figure 21.9

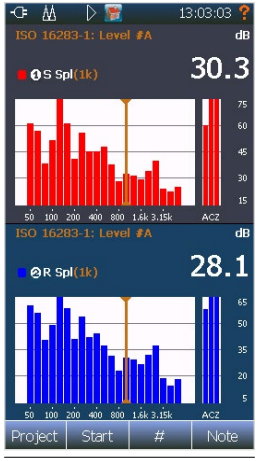


Figure 21.10

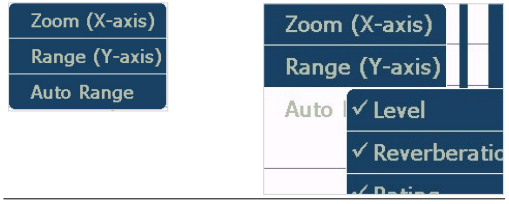


Figure 21.11

Setup

There are different *Setup menus* available in order to adjust the Building Acoustics parameters (*Figure 21.12*). Push the **SETUP** button and select the appropriate sub-menus. Some of the menus, sub-menus or parameters may be greyed out and cannot be changed as soon as the first measurement has been taken. Therefore make sure you have set-up the parameters correctly before starting a measurement. By pushing the ✘ button or the **NEW** soft key a new project will be initialized and full access to the measurement parameters will be gained.

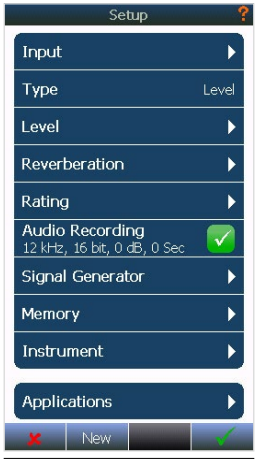


Figure 21.12



Figure 21.13

Input - Setup

The *Input selection* menu *(Figure 21.13)* is identical with the one explained in the chapter *"Selecting the different views and the parameters to display" on page 47*. Only the possibility to assign a channel to a room type is an additional feature.

Under Position click a channel to assign it to a room type *(Figure 21.14)*.

Type - Setup

Toggle the measurement type by clicking the menu item. The measurement type selector *(Figure 21.15)* is used to select which kind of measurement to perform when hitting the **START** button. The selection is Level, Background noise or Reverberation Time.

TIP: When in Measurement display mode, use the FUNC key to toggle the measurement type.

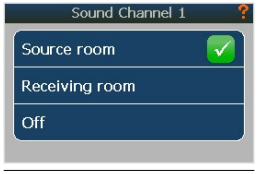


Figure 21.14



Figure 21.15

Level - Setup (Figure 21.16)

- *Level Duration* is used for pre-setting the measurement duration for the source and/or receiving room level measurements. Most Standards require 15 s for measurements down to 50 Hz and 6s for measurements down to 100 Hz.
- *Background noise Duration* is used for pre-setting the measurement duration for the background noise in the receiving room.
- *Filter* enables the user to switch between 1/3- and 1/1-octave measurements. Please note that for all but one currently supported building acoustics testing Standards in the Nor150 system, only the 1/3-octaves are selectable. If ISO 10052 is the selected standard, the bandwidth is automatically set to 1/1 octaves and set back to 1/3 octaves in all other cases.

  Lower frequency is used for selecting the lowest frequency band to be measured. In the BA mode, the minimum is 0,4 Hz for 1/3-octaves.
  Upper frequency is used for selecting the highest frequency band to be measured. In the BA mode, the maximum is 20 kHz for 1/3-octaves.

- *Source Position* is used for indicating the different loudspeaker or tapping machine positions. This may be a requirement by the standard. Instead of entering this setup menu to change the source position, use the # soft key in SPL mode display *(Figure 21.17)*.



Figure 21.16

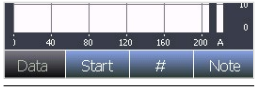


Figure 21.17

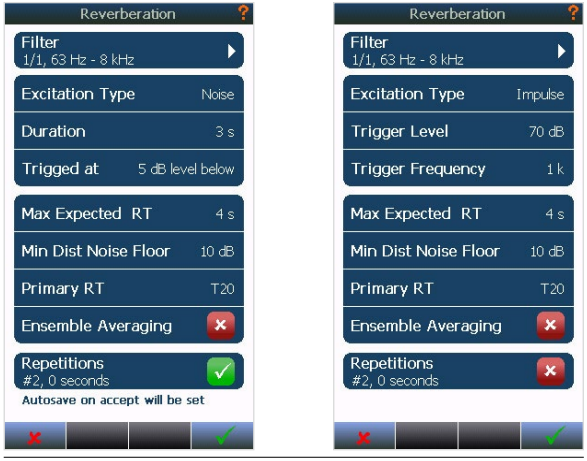


Figure 21.18

Reverberation - Setup (Figure 21.18)

- *Filter* enables the user to switch between 1/3- and 1/1-octave measurements. Please note that for all but one currently supported building acoustics testing Standards in the Nor150 system, only the 1/3-octaves are selectable. If ISO 10052 is the selected standard, the bandwidth is automatically set to 1/1 octaves and set back to 1/3 octaves in all other cases.
- *Excitation Type* is used for selecting the actual method for detecting the correct decay. Noise is used for operation with the internal noise generator, and Impulse is used for operation with an external impulsive signal. When used with Impulse, the Nor145 will always calculate the reverberation times based on the backward integrated decay.
- *Duration* is setting the time duration of the active noise excitation before the decays are measured.
- *Trigged at* is setting the start point for the reverberation time calculation. “5 dB level below”

starts below the calculation 5 dB below the excitation noise level (or max level at impulse excitation). “100 - 300 ms” normally starts at 5 dB below but adjust this point to be within a 100 - 300 ms range after excitation noise is turned off.

- *Max expected RT* is setting the maximum reverberation time to be measured. In reality, this setting controls the period length of each sample along the decay. The available settings of 4s, 8s, 16s and 32s are corresponding to sample periods of 5ms, 10ms, 20ms and 40ms respectively.
- *Min distance to noise floor* sets the minimum difference between the lower calculation range for the selected RT function and the background noise level. The background noise level for the RT calculation is handled individually for each frequency band, and is set identical to the horizontal part of the decay measurement after the decays have decreased below the RT calculation range.
- *Primary RT function* is used for selecting between the reverberation time functions T20, T30, T15 or EDT/Tmax. The selected function will be used for the calculation in the rating part. All functions present the result as the time for the theoretical 60dB decay time, but the calculation ranges are individual for each function. EDT starts at 0 dB below the excitation level and end -10 dB below. All the other functions start at -5 dB below the excitation level, but ends at -20, -25 and -35 dB respectively.
- *Ensemble Averaging* When performing reverberation time measurements in multiple positions, a special feature for Ensemble averaging may be used to average the decay curves before calculation the reverberation time value.
- *Repetitions*. A new feature in firmware version 6 is repetitive reverberation time measurements. Up to 20 repetitions can be selected, with a configurable delay between repetitions ranging from 0 to 20 seconds.

Rating – Setup

This *Rating* menu *(Figure 21.19)* contains several sub-sections for setting the different properties of the upcoming sound insulation calculation, or, for pre-entering text descriptions for a final test report document.

Standard:

- *Standard (Figure 21.20)* is used for selecting the different field Standards such as *ISO* or other national groups like *DIN*, *ASTM...*
- *Type (Figure 21.21)* is the selection of *Airborne*, *Impact* or *Façade*.
- *Number* is used for the selection of possible multiple Standard numbers within the set *Category*, *Standard* and *Type*.
- *Subtype* is used when required in cases such as selecting Staggered Rooms of the ISO 16283-1.

NOTE: Changing standard while there is already acquired measurement data will initiate a new project. You will be asked to save your current work and may be prompted to reuse the data. See *“Start a new project” on page 130* **for more information.**



Figure 21.19



Figure 21.20

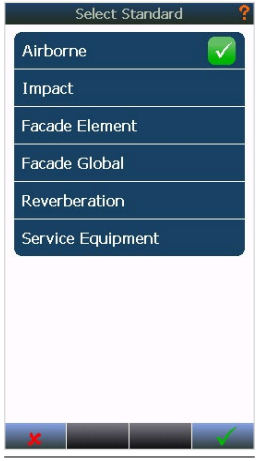


Figure 21.21



Figure 21.22

Source (Figure 21.22)

- *Volume* Volume is the actual volume of the source room given in m^3. For the source room, this value is calculated based on entered values for width, height and length of the actual room. If the room is non-square, and the final volume is known, the user may simply enter '1' for width and height and the actual volume as length to get the correct volume for the calculations.
- *Temperature* is the air temperature measured in ˚C.
- *Pressure* is the air pressure measured in kPa.
- *Humidity* is the humidity in the source room measured in %.
- *Condition* may be used for describing the condition of the source room.
- *Type* may be used for describing the actual type of source room.
- *Location* may be used for describing the location of the source room.

Receiving (Figure 21.23)

- *Volume* is the actual volume of the receiving room given in m^3. For the receiving room, this value is calculated based on entered values for width, height and length of the actual room. If the room is non-square, and the final volume is known, the user may simply enter '1' for width and height and the actual volume as length to get the correct volume for the calculations.
- *Temperature* is the air temperature measured in ˚C.
- *Pressure* is the air pressure measured in kPa.
- *Humidity* is the humidity in the receiving room measured in %.
- *Condition* may be used for describing the condition of the receiving room.
- *Type* may be used for describing the actual type of receiving room.
- *Location* may be used for describing the location of the receiving room.



Figure 21.23



Figure 21.24



Figure 21.25



Figure 21.26

Test Specimen

- *Area (Figure 21.24)* is the size of the common partition in square meters. This value is calculated based on entered values for width and height of the actual test specimen. If no values are available for the Test Specimen, the values used as the Width and Height for the Receiving Room are automatically used as default values. For non-square objects, and the final size is known, the user may simply enter '1' for width and the actual size as height to get the correct area for the calculations.

Any special calculation rules for the area used in the calculations are indicated in the *Rating setup* overview. One example is the use of the maximum value of either entered Test Specimen area S or the entered Receiving Room volume divided by 7.5 *(Figure 21.25)*.

Various parameters (Figure 21.26)

- *BGN Corrections* is used for activating corrections to the measured values in the final calculations. By activating the tick-box, the receiving room average values will be corrected for the measured background noise level when measured. The selected Standard automatically gives the details for such corrections.
- *1/10 dB Accuracy* tick-box is used for making the final sound insulation index calculation in 1/10 dB step instead of the normal 1 dB step. This is handy when making small adjustment to the test object that cannot be measured with 1 dB final resolution.
- *Ref. curve* tick-boxes may be selected to have the reference curves being drawn either fixed, and/or Shifted. This allows the user to draw the red reference curve according to the pre-set fixed position in the selected Standard, and/ or, according to the calculated position for the final sound insulation index.
- *Adjacent Band Test* is a feature that evaluates the maximum level difference between adjacent 1/3 octave bands in the sending room. The maximum deviation allowed depends on the selected standard. 8 dB for ISO16283-1 and its national versions.

  Also, the Swedish SS 25267 and the Swiss SIA 181 uses 8dB. British standard BS EN 140-4 use 6 dB. A warning will apply in the result table indicated by a neutral smiley 😐 if the values are outside the limit.

Audio Recording

A new feature in firmware version 6 is Audio Recording in Building Acoustic mode. This feature will start the audio recording according to the settings in the sub menu. A zero to 120 sec pre trigger allows capture of audio recording prior to measurement start.

Signal Generator - Setup (Figure 21.27)

- Use the tick-box to activate the signal generator manually. Otherwise leave it to OFF, it will be turned ON automatically when starting a measurement.
- *Level* is used to set the output signal level in the range from 0 to -50 dB, where 0 dB corresponds to 1 Vrms.
- *Signal Type* is used to select between *Pink Noise* or *White Noise*.
- Use cable Nor4514A to connect to the Noise generator signal to the power amplifier.
- Alternatively, if you are a lucky user of the Nor282 power amplifier, use the Wi-Fi option to connect to the amplifier. Connect the Nor282 in *Signal generator* menu. If Nor282 doesn't appear in the list of available devices, you can add it manually by pressing the **Add** softkey and enter the IP address of Nor282. When the connection is successfully established, the Nor282 will take over as the signal generator and operate the same way as the internal signal generator

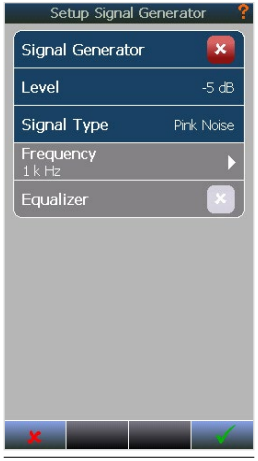


Figure 21.27



Figure 21.28

Memory – Setup (Figure 21.28)

- *Storage Folder* Specify a folder where you want to have your measurement projects stored. See *"Storing a measurement - Memory Organising Menu" on page 97* for more information.
- *Auto Save On Accept* is used to automatically save your measurement project upon acceptance. You will be prompted for a file name at first use.
- *Save Measurement Setup as* is used to store your own setup. See *"Creating a user defined setup" on page 102* for detailed information.
- *Save Debug Log* will store the system internal log files to a removable media. You may be asked to pass these log files to Norsonic.

Making the Level measurements

As soon as all measurement parameters have been set, the instrument is ready for measuring. Set the measurement type to Level (Tip: use the **FUNC** key) and set the corresponding source position #A...#I by using the # soft key. Now, push either the large **START/STOP** key or the Start soft key to run the measurement. The Nor150 will now automatically activate the noise generator.

The display will then show the frequency spectrum of the source and/or receiving room and, depending on the selected view, combined with the A-weighted level vs time values. Each graphical view has an associated numerical table available. Just push the **TBL** button to access it.

Remember: A single channel instrument has two views *(Figure 21.29 / 21.30)*, while a dual channel instrument will offer 4 different views *(Figures 21.31, 21.32, 21.33 and 21.34)*. To toggle through the different views, push the **VIEW** button.

In the frequency spectrum, the SPL values are shown as filled bar graphs, the Leq values as a line, and the Lmax values as a step-line. The current duration of the measurement is displayed in the upper right corner. The function information is extended by the ongoing microphone position (#1, #2, etc).

Single-Channel views while measuring:

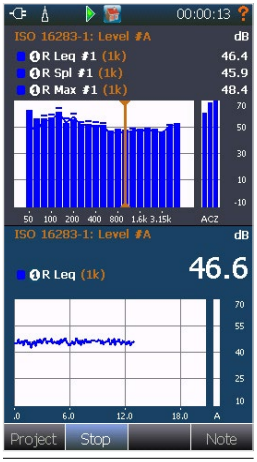


Figure 21.29

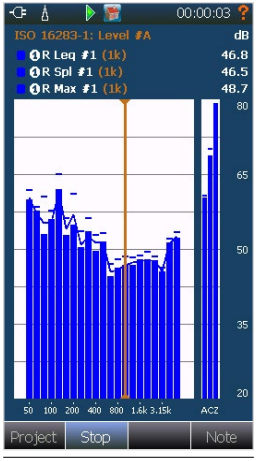


Figure 21.30

Dual-Channel Views 1 - 4 while measuring:

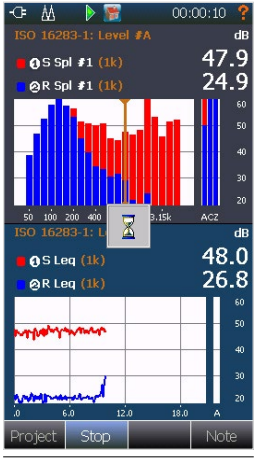


Figure 21.31

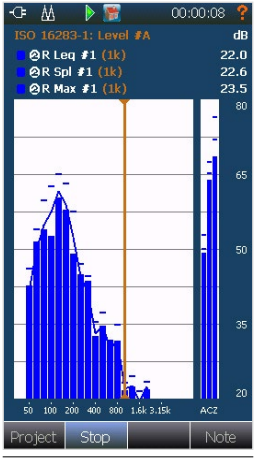


Figure 21.32

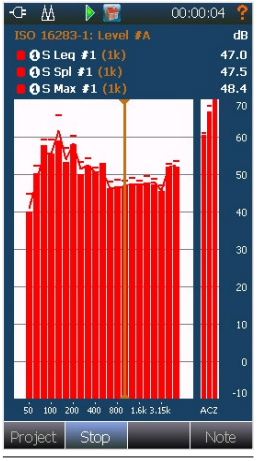


Figure 21.33

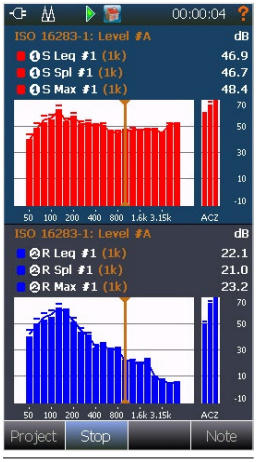


Figure 21.34

When the pre-set measurement duration is ended, or the **Stop** key is pushed the display changes its appearance. The frequency bar graph of the first view changes to a line graph. If measured beforehand, a black line will indicate the average level of the previously measured background noise. *Figures 21.35 and 21.36.*

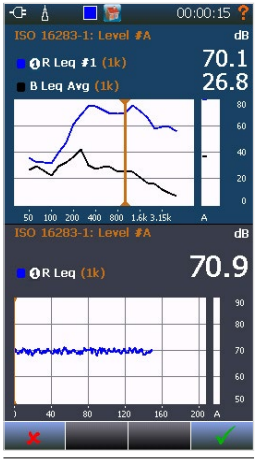


Figure 21.35 - Single channel view with Bgn

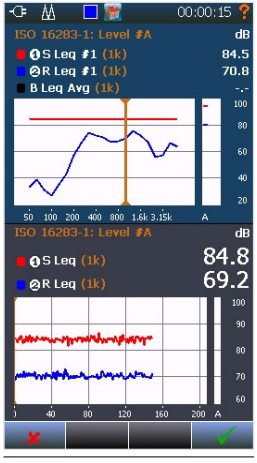


Figure 21.36 - Dual channel view with Bgn

The bottom menu now presents ✓ and ✘ keys for the acceptance or cancellation of this performed measurement.

Upon accepting the measurement, these values are taken into account and put into the calculation of the average level. Cancellation of the measurement will discard the values and the average values remains unchanged.

It is a good idea to save your work frequently. We advise you to store your measurement project each time you have accepted a measurement. Activate the 'Auto Save On Accept' option in the Memory setup and the system will to take care of this task for you.

Removing disturbances in the Level measurements

In case an unexpected disturbance appears during the Level measurement, the operator may use the **PAUSE/CONT** feature to remove this. As soon as the disturbance has occurred, press the **PAUSE/CONT** key, and the measurement will be paused. Upon pushing the **PAUSE/CONT** again, the last few seconds of the measurement will be removed, and the measurement continued. The number of seconds to be removed with this back-erase feature is set in the **SETUP** > *Level/ Pause Backerase* menu.

This back-erase feature is also available when making the Background noise measurements

Making the Background noise measurements

Set the measurement type to Background noise (Tip: use the **FUNC** key). Push either the large **START/STOP** key or the **Start** soft key to run the measurement. The display will then show the frequency spectrum of the receiving room in the same way as for the level measurements *(Figure 21.37)*. Each graphical view has an associated numerical table available. Just push the **TBL** button to access it.

The background noise measurements must be accepted or cancelled in the same way as the level measurements.

Additional background noise measurement positions may now be measured by a new click on the **Start** key.

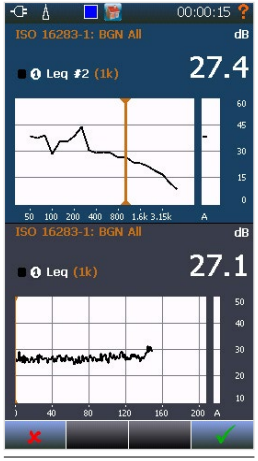


Figure 21.37

Making the Reverberation time measurements

Set the measurement type to Reverberation time (Tip: use the **FUNC** key). Push either the large **START/STOP** key or the **Start** soft key to run the measurement. If the excitation type is Noise, the Nor150 will now automatically activate the noise generator. In case of Impulse excitation, the Nor150 will trigger on an impulse signal.

The display *(Figure 21.38)* will then show the frequency spectrum of the receiving room and, depending on the selected view, combined with the level vs time values.

As soon as the reverberation time measurements is ended, the display will turn to show the calculated reverberation times as a function of frequency and, depending on the selected view, the decay with the calculated decay line and indicator lines for the T_{30}/ T_{20}/ T_{15}/EDT.

Each graphical view has an associated numerical table available. Just push the **TBL** button to access it *(Figures 21.39 / 21.40)*.

If the signal-to-noise ratio is insufficient for calculating the reverberation time, the sign "-.-" will be displayed instead of a value. If the reverberation time measured is too short compared to the values for minimum reverberation times, the '<' sign will be shown to the left of the value. Insufficient distance to noise floor will be marked with a 'B'.

Use the **FUNC** key to show the values for the different RT functions (T_{20} – T_{30} – T_{15} – EDT/T_{max}).

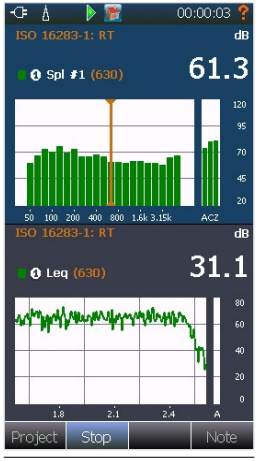


Figure 21.38

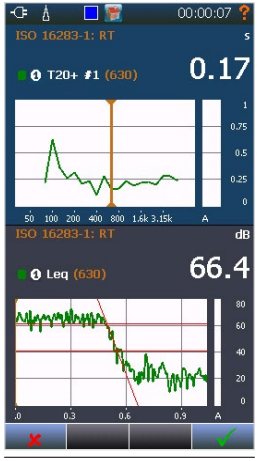


Figure 21.39

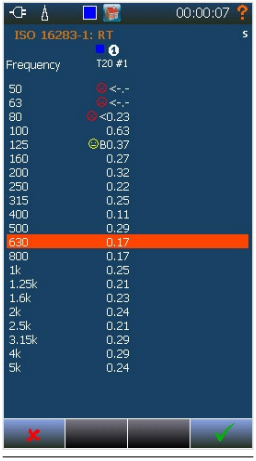


Figure 21.40

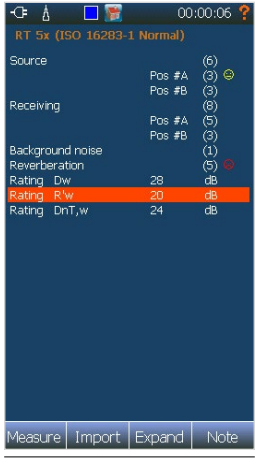


Figure 21.41

IMPORTANT NOTE: This is just a display feature and has no impact of the function used for the rating calculation. The calculation will use the 'Primary RT function' as specified in the Reverberation Setup no matter what is on your display.

The bottom menu presents √ and ✘ keys for the acceptance or cancellation of this performed measurement.

Upon accepting the measurement, these values are taken into account and put into the calculation of the averaged reverberation times. Cancellation of the measurement will discard the values and the average value remains unchanged.

It is a good idea to save your work frequently. We advise you to store your measurement project each time you have accepted a measurement. Activate the 'Auto Save On Accept' option in the Memory setup and the system will to take care for you of this task.

Project Mode

This is the mode where the accepted measurements and calculated results are presented, and at the same time giving an overview of the current project with all the individual measurement displayed in a project-tree structure. The Project mode comes up either by pressing the lower left soft button **Project** or when opening a saved project from the storage *(Figure 21.41)*. In the latter case you may continue to measure by pressing the Activate softkey in the lower left corner of the display.

The Project mode may not be accessible and therefore the soft key is greyed out if no accepted measurements are available. Pushing the ✘ will close the current measurement project and start a new one. If you want to reuse some or all of the current data click Yes when prompted and select the wanted data to be reused (see *"Start a new project" on page 130*).

Display views in Project Mode

The Project Mode has a fixed set of 4 display views. Select the desired measurement function with the project cursor before pressing the **VIEW** key.

Unlike to the Environmental Mode these views cannot be modified and therefore the setup menu item "Views" is greyed out. The **TBL** key behaves a little bit different, too. It doesn't only turn a graph into a table as expected, it also changes the dual type frame into a single type (and vice versa). The different views are displayed by pushing the **VIEW** button.

NOTE! The first time a view is activated the appearance is lagged due to the process of creating the graphs.

Within the Project Mode there is a distinction between the views presenting the rating results (Rating) and the views presenting the accepted measurements (Reverberation, Receiving, Source and Background). Use the soft key **Report** to switch to the different data types. It starts with the Rating data and will rotate in the following order *(Figure 21.42)*.



Figure 21.42

A quicker navigation method within the current project is to use the arrow keys in the Project view to select the interesting part of the project with the cursor line. Either in the Collapsed view *(Figure 21.43)* by selecting the main group (Source, Receiving, Background, Reverberation or Rating), or in the Expanded view (*Figure 21.44)* in which each individual measurement can be selected with the cursor. Then, a press on the View button will show the desired project details as described in the next sections. Switching between Collapsed view and Expanded view is done by use of the softkeys.

After viewing the desired results, the operator may switch back to Project view by use of the **Project** softkey.

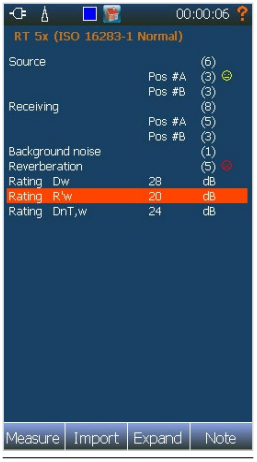


Figure 21.43

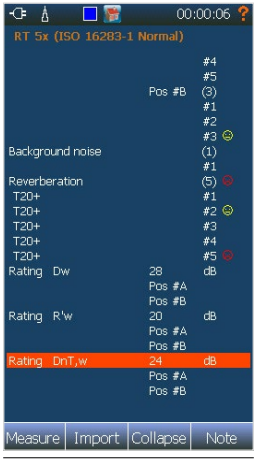


Figure 21.44

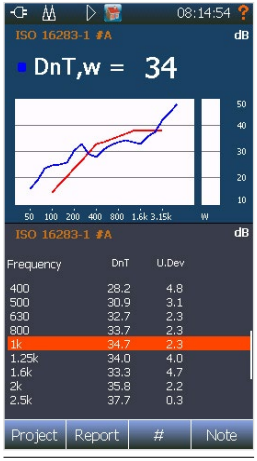


Figure 21.45

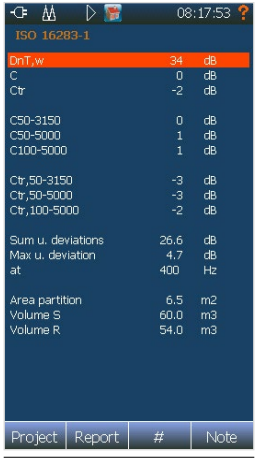


Figure 21.46

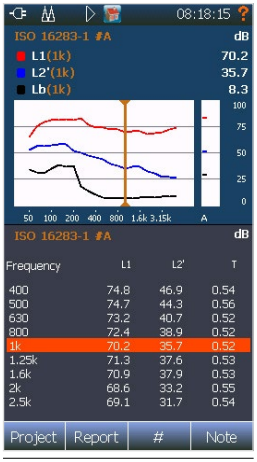


Figure 21.47

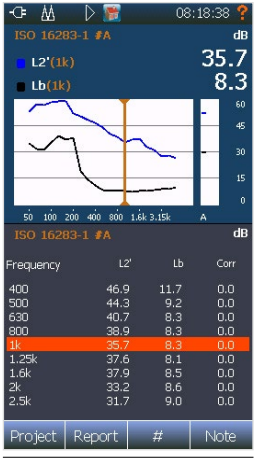


Figure 21.48

Rating views 1 - 4

Rating View-1

Figure 21.45 presents the calculated sound insulation together with the single number index according to the selected standard in a dual frame. The upper frame shows the results graphically while the lower frame contains the numerical values. Use the **TBL** key to expand either of them to full screen. The header line contains the selected standard and may show background noise correction information (*Bgn too high). The calculated index may be viewed with or without background noise correction. Activate the function in the *Rating Setup*.

- Use the **FUNC** key to display other calculated functions (e.g. R'w) - *Figure 21.49*.
- Use the **#** soft key to have a specific source position (#A...#I) displayed - *Figure 21.50*.



Figure 21.49

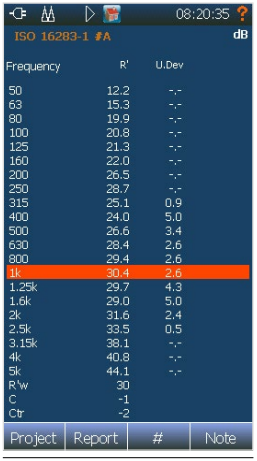


Figure 21.50

Rating View-2

Figure 21.46 is a plain numerical table to present the single number index along with the spectrum adaption terms. Furthermore it contains the sum of unfavourable deviations and the maximum unfavourable deviation from the single number index calculation. Information regarding the room and element dimensions can be found as well.

- Use the **FUNC** key to display other calculated functions (e.g. R'w).
- Use the # soft key to have a specific source position (#A...#I) displayed.

The **TAB** key has no function.

Rating View-3

This view *(Figure 21.47)* contains all numerical results of the analysis plus a level overview graph.

If the rating is based on the rating results of the individual source positions (e.g. ISO 16283) then no total average values are available, only the individual ones. Switch to a specific source position #A...#I by clicking the # soft key.

The screen shot shows the data for source position #A

- L1: average sound pressure level in the source room.
- L2 or L2': average sound pressure level in the receiving room (L2' means it's corrected for background noise).
- Lb: average sound level pressure level of the background noise in the receiving room.
- T: reverberation time in the receiving room.

Screen shot with no total average values available *(Figure 21.51)*.

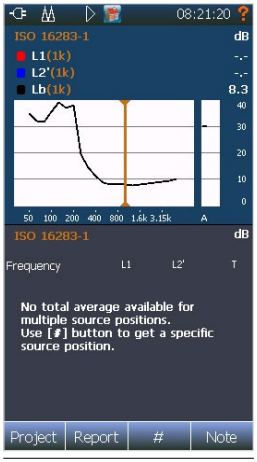


Figure 21.51

Rating View-4

This view *(Figure 21.48)* contains information about the influence of the background noise to the receiving room levels. If the difference of the receiving room level and the background noise level is below a certain limit, corrections are applied according to the selected standard.

If the rating is based on the rating results of the individual source positions (e.g. ISO 16283) then no total average values are available, only the individual ones. Switch to a specific source position #A...#I by clicking the # soft key.

The screenshot shows the data for source position #A

- The header line may indicate that corrections are made so that the values are at the limit of the measurement (*Bgn too high).
- L2 or L2': average sound pressure level in the receiving room (L2' means it's corrected for background noise).
- Lb: average sound level pressure level of the background noise in the receiving room.
- Corr: applied correction values according to the standard.

The background noise correction can be activated or de-activated in the *Rating Setup.*

Measurements views 1 – 4

Use the soft key **Report** to switch to the measurement data types. Alternatively, use the **Project** soft key to jump back into the Project view, then select another main group, and press the **VIEW** button. The measurement types follow after the Rating type in this order *(Figure 21.52)*:

The different views are displayed by pushing the **VIEW** button.

NOTE! The first time a view is activated the appearance is lagged due to the process of creating the graphs.

The views for the reverberation time and the views for the sound pressure levels are in principle the same. It is only the unit and the scaling that is different.

For the reverberation time data use the **FUNC** key to show the different RT functions (T_{20} – T_{30} – T_{15} – EDT/ T_{max}).

IMPORTANT! This is just a display feature and has no impact of the function used for the rating calculation. The calculation will use the 'Primary RT function' as specified in the *Reverberation Setup* no matter what is on your display.



Figure 21.52

View 1- 4 for reverberation time measurements

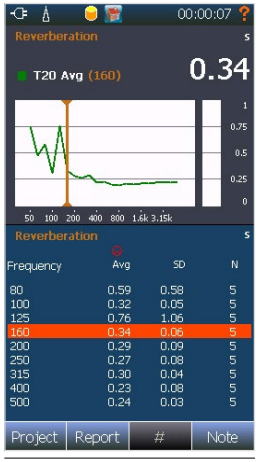


Figure 21.53

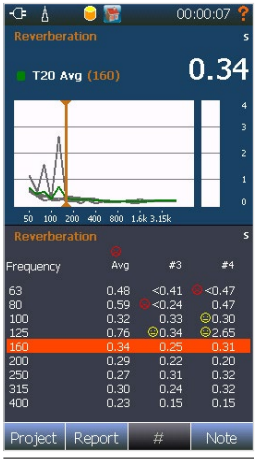


Figure 21.54

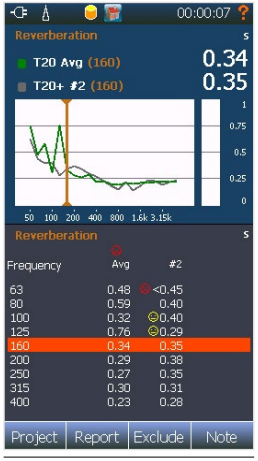


Figure 21.55



Figure 21.56

View 1 - 4 for receiving room measurements

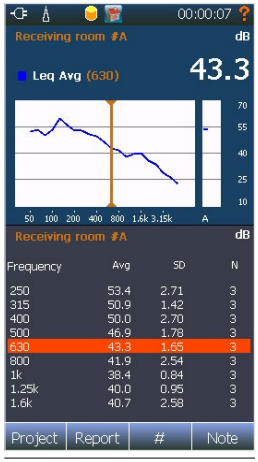


Figure 21.57

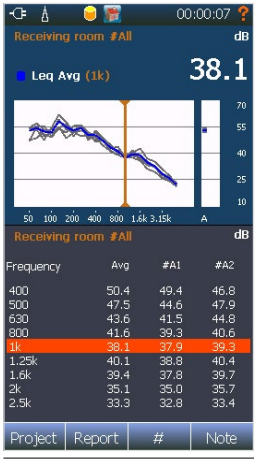


Figure 21.58

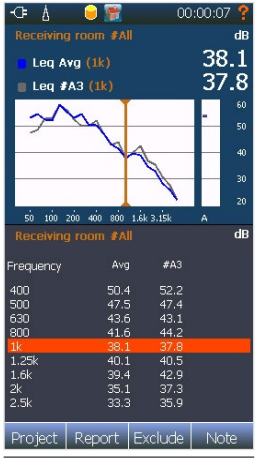


Figure 21.59



Figure 21.60

Measurement View-1

View-1 presents the average of accepted measurements in a graphical and numerical way. It covers all microphone and source positions. If available, use the # soft key to display the average of a specific source position #A…#I.

Screen shot of Receiving room total average (All) *(Figure 21.61)*.

- Avg: Energetic (Level) or linear (Reverberation) average of accepted measurements.
- SD: Standard Deviation of the average.
- N: Number of measurements included in the average.

Screen shot of Receiving average limited to source position #A *(Figure 21.62)*.

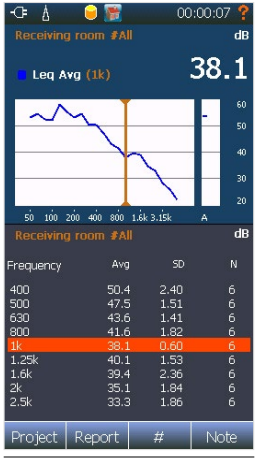


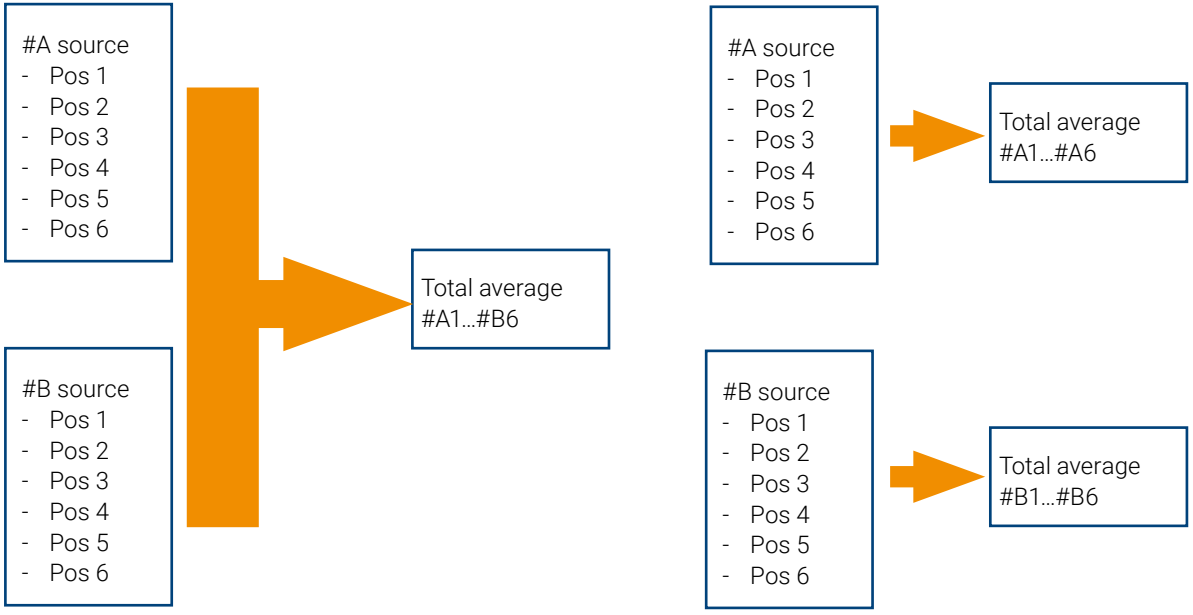
Figure 21.61



Figure 21.62

Measurement View-2

View-2 displays the average and its included measurements graphically and in a table. This is helpful to see how the different microphone positions vary. If available, use the # soft key to display the average of a specific source position #A...#I and the measurements belonging to it.



Screen shot *(Figure 21.63)* of Receiving room total (All) average and its measurements

- Avg: Energetic (Level) or linear (Reverberation) average of accepted measurements.
- #A1…#B6: The individual measurements (microphone positions). The measurements are labelled with the corresponding source position and the microphone position number (#A1, #A2… #B5, #B6).

On the upper frame use the ▲▼ keys on the keyboard to scroll the measurement positions. On the table frame use the ◀▶ keys.

Screen shot *(Figure 21.64)* of Receiving average on source position #B. The numerical table has been scrolled to position #2 and #3.

Measurement View-3

View-3 displays the average and just one of its measurements graphically and in a table.

On the upper frame use the ▲▼ arrow keys on the keyboard to scroll the measurement positions. On the table frame use the ◀▶ arrow keys.

Screen shot *(Figure 21.65)* of total average together with microphone position 3 at source position #B (#B3).

- Avg: Energetic (Level) or linear (Reverberation) average of accepted measurements.

Screen shot *(Figure 21.66)* of Receiving average on source position #A. The numerical table has been scrolled to position #3.

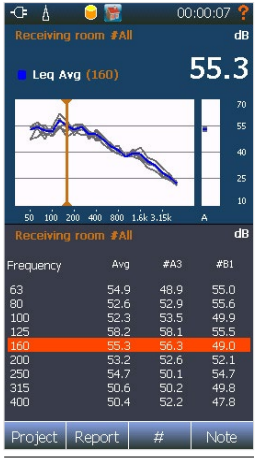


Figure 21.63

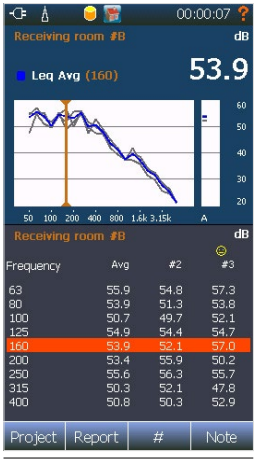


Figure 21.64

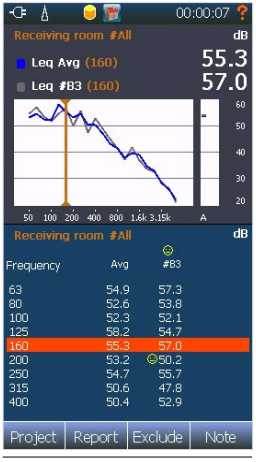


Figure 21.65

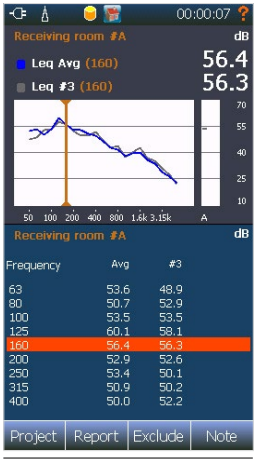


Figure 21.66

Measurement View-4

View-4 presents the selected microphone position (not the average!) from the previous view as a Level vs frequency L(f) and Level vs time (L(t) graph. Use the ▲▼ arrow keys on the keyboard to select a different microphone position.

This view is helpful for evaluating the reverberation time decay line for a specific microphone position or the signal steadiness in the receiving or source room for level measurements.

Screen shot *(Figure 21.67)* of Reverberation time data for microphone position #3.

Use the **FUNC** key to select a different reverberation time function (T20, T30, T15, EDT/Tmax).

Screen shot *(Figure 21.68)* of position #5 and function T30. Due to high background level for the T30 calculation, the indicated RT value has a 'B' added.

Screen shot *(Figure 21.69)* of Receiving room data for microphone position #A4.



Figure 21.67

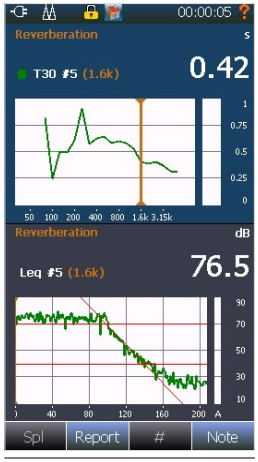


Figure 21.68

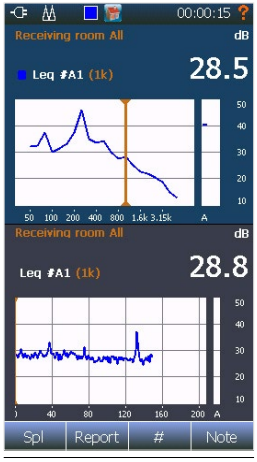


Figure 21.69

Exclude measurement positions

To exclude individual measurement positions data from the calculated average, use the soft key Exclude available in the Measurement View-3 *(Figure 20.65)* and Measurement View-4 *(Figure 20.66)*. This position will then be marked with an ✘ both in the Measurement Views *(Figure 21.70)* and in the Project View *(Figure 21.71)*. To include any excluded measurement position again, use the soft key Include in the same Measurement Views for the excluded measurement positions.

Adjust reverberation decay line

To adjust the calculated reverberation decay line for individual measurement positions, use the soft key Adjust available in the Measurement View-4 in the Reverberation Report *(Figure 21.57)*. A new screen will appear *(Figure 21.72)* in which the ◀ ▶ arrow keys move the decay line horizontally to a new position. The ▲ ▼ arrow keys adjust the angle of the decay line which also adjust the calculated reverberation time *(Figure 21.73)*.

When the decay line is brought to a desired position/angle, press the ✓ to confirm. To cancel the new value/position of the decay line, simply press the ✘, and the value of the reverberation time reverts to the original value. The new value of the reverberation time is displayed with an 'H' (handmade) *(Figure 21.74)*, and this value will now be used in the calculations. In the Project view, a yellow neutral warning smiley will indicate that this reverberation time value has been corrected manually *(Figure 21.75)*.



Figure 21.70

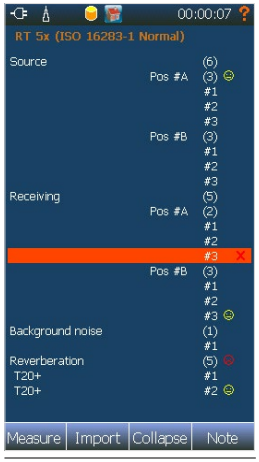


Figure 20.71

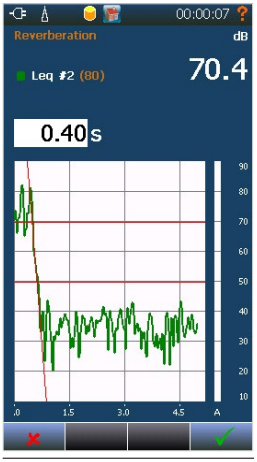


Figure 21.72

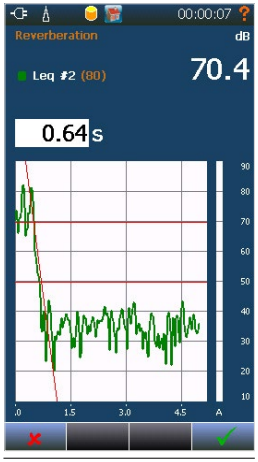


Figure 21.73



Figure 21.74

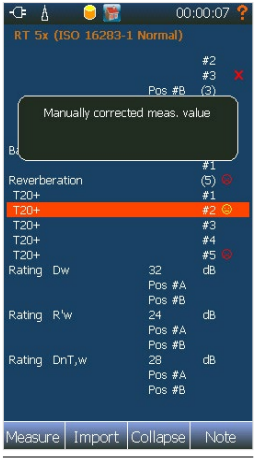


Figure 21.75

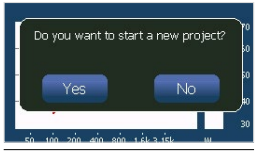


Figure 21.76

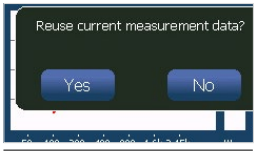


Figure 21.77

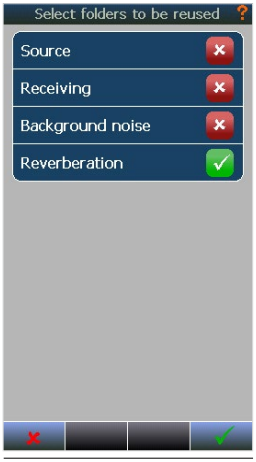


Figure 21.78

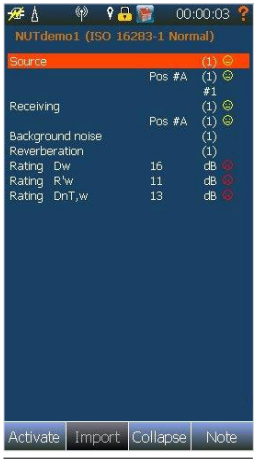


Figure 21.79

Start a new project

To start a new project pushing the ✘ button to close the current measurement project and start a new one. You may be asked to save the current data *(Figure 21.76)*.

If you want to reuse some or all the current data click *Yes* when prompted *(Figure 21.77)* and select the wanted folders to be reused *(Figure 21.78)*.

Continue an existing project

To continue measuring on an existing project, load the appropriate project from the memory. This project is by default locked for editing or adding new measurement positions in order to avoid deleting important data. However, use the softkey **Activate** prior to start additional measurement which then will be used in the rating calculations together with the previous stored data *(Figure 21.79)*.

The instrument may continue a pre-defined project which has been setup by the Nor850 software version 3.x or newer. All parameters, report info and settings for the building acoustic test project may be selected and stored by the Nor850, and then transferred to the instrument by use of the NorConnect transfer software version 3.x or newer. At the site, the operator loads the actual project from the instrument memory, press the **Activate** softkey, and start taking the actual measurements.

Speech Intelligibility by STIPA

Introduction – What is STIPA

Speech transmission index – STI

The speech transmission index, STI, has shown to be a valuable tool for objective rating the speech intelligibility. From its first presentation in Acustica in 1971 the method has been refined and developed for various applications. The International Electrotechnical Commission, IEC, has launched the fifth revision of the International Standard specifying the method for calculating the index as IEC 60268-16. Essential for this development was the work carried out at TNO Human Factors in the Netherlands, and in particular the pioneers Tammo Houtgast and Herman Steeneken.

The STI-methods can be used to compare speech transmission quality at various positions and under various conditions within the same listening space; in particular it is useful for assessing the effect of changes in acoustic properties. This includes effects from the presence of an audience or of changes in a sound system. The methods are also able to predict the absolute rating of the speech transmission quality with respect to intelligibility when comparing different listening spaces under similar conditions or assessing a speech communication channel.

Development of STI

The basis for the STI-index is that the intelligibility of speech is largely based on the slow modulation of the strength of the sound pressure signal that acts as a carrier. For the full STI-method, the carrier is a stationary gaussian noise signal divided in seven bands in octave steps ranging from 125 Hz to 8 kHz. The bandwidth of each band is one-half octave. Each of the bands is modulated with 14 modulation frequencies - one by one. The modulation frequencies are selected in one-third octave steps from 0,63 Hz to 12,5 Hz. This gives in total 98 combinations. In the STI-context, the square of the sound pressure is called intensity. The intensity is the quantity being modulated. A small loudspeaker playing the modulated excitation signal, acts as a talker.

The sound in the listener position is received by a microphone. The level and the degree of modulation in each octave band is used to determine the speech transmission index. Noise and reverberation in the room will reduce the observed degree of modulation. The method also considers the effect of the most common types of distortions such as harmonic distortion and intermodulation. However, other forms of non-linearity, like frequency shifts and frequency multiplications, are not treated effectively.

In order to fully take care of the effects of non-linearity, it is important that the basic signal being modulated is a noise signal with a high crest-factor, a spectral distribution similar to the long-term speech spectrum, and that the main modulation frequency is selected one by one. The measurement of the full STI therefore has to be performed as a sequence of measurements. If each of the 98 combinations is measured for 10 seconds, the total measurement time will be about a quarter of an hour. The need for such a long measurement time in order to obtain the STI-value in one position of a room limits the applicability of the full STI-method.

The STI-method may be modified in different ways to reduce the time needed for the measurement. If the system to be measured is regarded as linear, then a number of solutions exist. The excitation signal may be modulated with all modulation frequencies simultaneously and the components may be separated after reception by the use of filters or Fourier analysis. A more common method is to calculate the complex modulation transfer function from the impulse response of the room.

If the impulse response can be regarded as a well-behaved room response with an exponential decaying envelope characterized by the reverberation time, the modulation transfer function at frequency, F, may be calculated directly from the value of the reverberation time, T, and the effective signal-to-noise ratio, S/N, in dB. A simplified formula, not taking the effects of masking and the threshold of hearing into consideration, indicated the following relationship:

$$m(F) = \frac{1}{\sqrt{1 + \left(2\pi F \frac{T}{13{,}8}\right)^2}} \frac{1}{1 + 10^{(-S/N)/10}}$$

As seen from this formula, a limited signal-to-noise ratio reduces the modulation transfer function for all frequencies. A long reverberation time reduces the modulation most for the highest modulation frequencies. The IEC-standard also considers masking effects and the absolute threshold of hearing.

The STI is a value between 0 to 1 based on a weighted average of the modulation indexes for the different combination of carrier frequencies and modulation frequencies. The STI-value 1 indicates an excellent transmission channel.

STIPA

In order to simplify the direct measurement, the RASTI-method (now obsolete) and later the STIPA-method was developed. STIPA is based on the same carrier frequencies as the full STI, but each carrier frequency is modulated by only two frequencies.

The STIPA-method handles effects due to reverberation in the room and distortions commonly found in public address systems. It also performs well for room acoustics and has therefore in nearly all cases replaced the RASTI-method. The measurement time for a STIPA-measurement is 10 – 25 seconds.

Note that the STIPA-method consider the absolute level of the sound and mimic effects from the threshold of hearing as well as level dependent masking. Calibration of the sound level meter is therefore important. Therefore, the STI value will be lower for speech levels below 50 dB and above 80 dB.

Modulation frequency [Hz]	Carrier frequency [Hz]						
	125	250	500	1 k	2 k	4 k	8 k
0,63	√	√	√	√	√	√	√
0,8	√	√	√	√	√	√	√
1	√	√	√	√	√	√	√
1,25	√	√	√	√	√	√	√
1,6	√	√	√	√	√	√	√
2	√	√	√	√	√	√	√
2,5	√	√	√	√	√	√	√
3,15	√	√	√	√	√	√	√
4	√	√	√	√	√	√	√
5	√	√	√	√	√	√	√
6,25	√	√	√	√	√	√	√
8	√	√	√	√	√	√	√
10	√	√	√	√	√	√	√
12,5	√	√	√	√	√	√	√

STI

Modulation frequency [Hz]	Carrier frequency [Hz]						
	125	250	500	1 k	2 k	4 k	8 k
0,63			√				
0,8						√	
1		√					
1,25					√		
1,6	√						
2				√			
2,5							√
3,15			√				
4						√	
5		√					
6,25					√		
8	√						
10				√			
12,5							√

STIPA

For a STI measurement, all carrier frequency bands are modulated with all modulation frequencies – in total 98 modulation indices. For STIPA, a reduced set of 14 modulation indices are selected, two for each carrier frequency.

How is STIPA measured

The instrument option comes with an excitation signal matched to the program option. The excitation is played continuously through a loudspeaker acting as a talker or as an electrical signal to the input of a loudspeaker system.

The device for playing the excitation file may influence the measurement. We therefore recommend testing new equipment before you start the normal measurement tasks. If you supply the excitation signal electrically to the sound level meter (BNC- Lemo adaptor or cable available), or measure close to the loudspeaker, you should obtain excellent speech intelligibility ratings with a STI-value close to 1. If you play the file from a PC, ensure that signal processing features like volume leveler and surround virtualizer are turned off. Such processing may limit the maximum STI-value and lead to inaccurate measurements.

In a typical setup a sound source, normally a small loudspeaker, is acting as a talker. The loudspeaker should be placed in the normal position for a talker, either using or not using a public address system as required. The level should correspond to the normal level for speech, about 60 dB A-weighted 1 m from the sound source.

Note that STIPA-method considers the actual received sound level to mimic the threshold of hearing as well as level dependent masking where strong, lower frequencies mask higher frequencies. The corrections in the indicated modulation ratios based these effects are called auditory corrections. These corrections may lower the STI-value. These corrections shall normally be applied when the sound-excitation mimics a real talker. However, for some applications, like electrical testing, these features are irrelevant and may be switched off in the set-up of the measurement.

The signal to the loudspeaker is obtained by playing the supplied audio-file with the recorded excitation signal.

Place the sound level meter, with the STIPA option installed, in the place where you want the speech intelligibility to be measured. Select the STIPA-mode. Press the **START** button. After about 21 seconds the estimated STI-value and the corresponding CIS value is indicated on the screen.

Selecting a loudspeaker for the excitation

Most applications of the STIPA-method require a loudspeaker to act as a talker. In this case, the directivity of the loudspeaker should be close to the directivity for a real human speaker as speech intelligibility depends upon the directivity of the source; therefore, a mouth simulator having similar directivity characteristics to those of the human head/mouth should be used for the highest accuracy when assessing the intelligibility of talkers. Further, the frequency response between 80 Hz and 12 kHz should be flat. The loudspeaker should be a single element design or using coaxial element so the acoustical centre is well defined.

IEC 60268-16 recommend using a loudspeaker with a cone diameter of maximum 100 mm and refers to ITU-T Recommendation P.51 describing an artificial mouth. A sound source according to this specification is available from different manufacturers, with a typical example being the GRAS-44AA.

IEC 60268-16 recommends that the spectral level for each octave is within ±1 dB of the specified level. The supplied excitation file has the correct levels so a loudspeaker system with flat response will create the correct spectrum. In practice, often a shaping of the spectral content may be needed for compensating the response of the loudspeaker. The requested spectrum in IEC 60268-16 is shown in the table below:

Octave band [Hz]	125	250	500	1 k	2 k	4 k	8 k	A-weighted
Level [dB]	-2,4	0,6	0,1	-5,9	-11,9	-17,9	-23,9	0,0

Electrical excitation

Most applications require that the excitation is performed using a small loudspeaker acting as a human talker. However, same applications, such as testing public address or voice-alarm systems, are more conveniently tested with the electrical signal from the excitation file fed directly into the system to be tested.

In a similar way, some applications related to test of transmission channels require an electrical signal as the input to the sound level meter for analysis. For this application, the microphone preamplifier may be substituted with a cable to the input socket of the sound level meter.

Performing a measurement

- Set the sound source (artificial mouth or suitable test loudspeaker) in the normal position for the speaker. If a sound system is being used, place the sound source on the axis of the appropriate microphone at the normal speaking distance (measured from the lip-circle for the artificial mouth or acoustic centre of the loudspeaker) and direct it in the normal speaking direction. Connect an appropriate audio-player to the sound source.
- Switch on the sound level meter and ensure that it is properly calibrated. Play the STIPA excitation signal and adjust the level to the required speech level, normally 60 dB A-weighted sound pressure level at 1 m from the sound source. (66 dB at 0,5 m).

After setting the speech level, play the STIPA excitation signal during the measurement. (70 minutes). A file containing the STIPA signal can be downloaded from www.norsonic.com/downloads.

- Select the STI-mode for the instrument (Requiers option 17).
- Start the measurement by pressing **START**. The measurement lasts for 21 seconds. If the measurement is stopped before 21 seconds it will not be valid.
- The upper instrument screen will show the level versus frequency display in octave bands together with the A-weighted level.
- The lower display will show the measured STI value, the corresponding CIS value together with the A-weighted level. If the measured value is detected as unreliable, a question mark is placed behind the indicated value for STI and CIS.

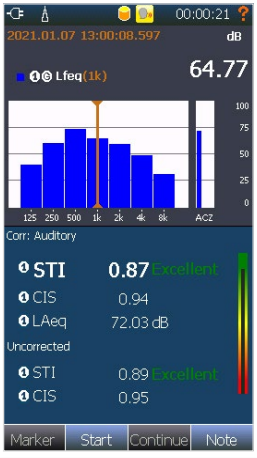


Figure 22.1 - The measured STI value are shown together with a judgement of the result. Normally Auditory corrections are used, but the uncorrected value is also displayed. The CIS-value, has a one-to-one relation to the STI-value, but the function is nonlinear.

By selecting the lower part of the display and pressing the **TBL** button, the two modulation indexes for each of the STIPA-octaves will be displayed.

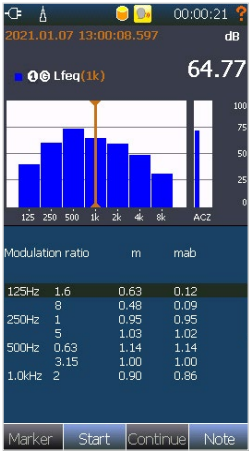


Figure 22.2 - The column to the left shows the midband frequencies of each octave band. The next column shows the modulation frequency in Hz. Each octave band signal is modulated with two frequencies. The row marked "m" shows the measured modulation transfer ratio, a value between 0 and normally 1. Due to the randomness of the excitation signal, values above 1 may be measured. The row marked "mab" shows the modulation transfer ratio after corrections. In this case, corrected for auditory effects ("a") as well as separately measured background noise ("b). Without background noise correction, the title for the row would have been"ma".

Press the **TBL** button once more for returning to the main display.

The measured equivalent sound pressure level in each octave is shown graphically in the upper part of the screen together with the A-weighted level. By selecting the upper part of the screen and pressing **TBL**, the levels are displayed as numerical values.

Store and recall the result

The result can be stored automatically or manually. Use the **SETUP** > *Measurement* > *Storage Mode menu* to select this. Where to store your measurements are set up in the **SETUP** > *Memory menu*.

Correcting the result

The STIPA method considers the effect of the actual background noise when the intelligibility is assessed. However, in some cases we want to find out what the intelligibility would have been if we had a certain background noise. A typical application will be to assess the intelligibility in an auditorium with audience when the auditorium was measured without. For such applications, the optional noise correction may be used. Measure the STI-value as described above. Open the context menu, by holding the screen or press the OK-button when the lower part of the screen is selected, and the background noise corrections (BGN Correction) may be turned on. Enter the levels in the various bands and the results will be recalculated to account for the specified background noise.

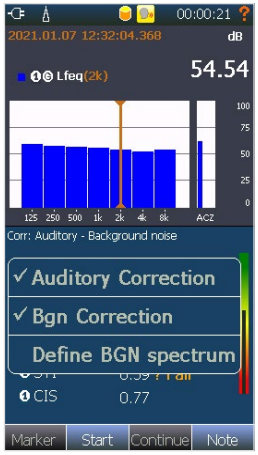


Figure 22.3 - The context menu is shown in the lower part of the screen. Press the field for selecting the options "on" or "off". When the background noise correction is selected (BGN), the background noise levels for each octave band must be specified.

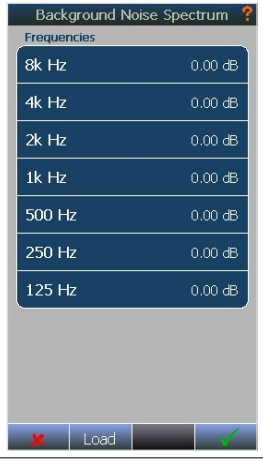


Figure 22.4 - Menu for entering the background noise level) when the measurement is made without the actual noise level. Enter values for each octave band manually or import previously measured values.

An alternative to keying in the levels for the background noise is to use values from a previously stored or later done measurement. The measured levels must have been made in 1/1- or 1/3-octave bands. Open the *Context menu* and select Define BGN Spectrum. Press the Load soft button to open the measurement browser. Navigate to correct folder and select the measurement you want to use for background noise spectrum. The measurement can be done in STIPA or Environmental mode.

If a real background noise is present during the measurement, the effect of the noise will in most cases be treated as noise according to the STIPA-method and lower the STI-value. However, some noise signals may be interpreted as a STIPA excitation signal giving wrongly a modest STI value. The instrument is programmed to detect such situations and place a question mark adjacent to the indicated value. However, not all cases can be detected properly. To investigate such potential problems, we recommend making a measurement without an excitation signal. If this STI-value is low or considerably lower than the value measured with the excitation signal (preferably STI ≤ 0,2), the reading will have a high degree of reliability.

For some applications, the auditory corrections related to the threshold of hearing and auditorial masking is irrelevant. The instrument also allows these corrections to be switched ON or OFF. This is also done using the context menu.

Precision of the STIPA method

Because the test signal is band-limited random or pseudo-random noise, repetition of measurement does not normally produce identical results, even under conditions of steady interference. The results centre on a mean with a certain standard deviation. Typically, the value of the standard deviation is about 0,03 with stationary noise interference. With fluctuating noise (for example, a babble of voices), higher standard deviations may be found, possibly with a systematic error. This can be checked by carrying out a measurement in the absence of the excitation signal. This should result in a residual STI value less than 0,20. An estimate of the standard deviation should be made by repeating measurements for at least a restricted set of conditions/positions.

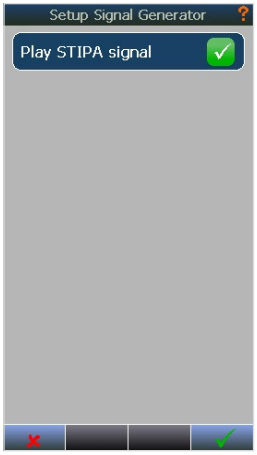


Figure 22.5

Use of internal signal generator

A STIPA excitation signal is available at the headphone connector at the instrument. This signal has a limited duration. A repeated measurement will therefore not have the random noise characteristic as specified in the standard for the STI-measurement. We therefore recommend to use this signal for test purposes only and otherwise use the supplied audio-file played on a separate device. *Figure 21.5* shows the menu for the signal output found by pressing **SETUP** > *Signal Generator*.

Analysis and interpretation of the results

It is important to examine the modulation matrix to determine the reliability of the results. As a rule, the modulation index should decrease with increasing modulation frequency. Constant or slightly reducing values in a column indicate the presence of noise. Large reductions for higher frequencies indicate that reverberation is the main effect. Values that first reduce and then increase with increasing modulation frequency indicate the presence of periodic or strong reflections, which may produce an over-optimistic conclusion. It is recommended that if this effect is detected, it should be reported with the results and an estimated correction applied.

Limitations of the STIPA method

The STIPA method should not be used for those public address systems that

a) introduce frequency shifts or frequency multiplication;
b) include vocoders (i.e. LPC, CELP, RELP, etc.);
c) have a background noise that is impulsive;
d) introduce strong non-linear distortion components.

If d) applies, or possibly applies, the full STI method should be used instead or used to verify the results obtained by the STIPA method.

Specifications

The STI-value is measured according to the requirements for STIPA method defined in:

IEC 60268-16 (Ed.5.0 2020): Sound system equipment – Part 16: Objective rating of speech intelligibility by speech transmission index.

The CIS-value is calculated from the STI-value as specified in: IEC 60849 (Ed. 2.0 1998-02) Sound systems for emergency purposes. (Withdrawn 2008).

The instrument measures STIPA as specified in Annex B of IEC286-16 by the direct method.

An excitation signal is supplied as a digital signal for STIPA measurements. The excitation signal contains the sum of 7 gaussian noise signals, each with a bandwidth of ½ octave and with midband frequencies in octave steps as specified in the table below. Each noise band is modulated with two modulation frequencies with exact frequency ratio 1:5. The modulation factor for both modulation frequencies are 0,55.

Nominal-midband frequency	Exact midband frequency	Exact modulation frequency 1	Exact modulation frequency 2
125 Hz	125,893 Hz	1,600 Hz	8,000 Hz
250 Hz	251,189 Hz	1,000 Hz	5,000 Hz
500 Hz	501,187 Hz	0,630 Hz	3,150 Hz
1 kHz	1000,000 Hz	2,000 Hz	10,000 Hz
2 kHz	1995,262 Hz	1,250 Hz	6,300 Hz
4 kHz	3981,072 Hz	0,800 Hz	4,000 Hz
8 kHz	7943,282 Hz	2,500 Hz	12,500 Hz

The sampling frequency of the supplied excitation signal is 48 kHz and the playback frequency shall be within ±0,005% of this value.

The level-dependent calculations may be enabled or disabled.

Separate measured additional noise levels in each octave may be used to predict the reduction in STI values due to the noise.

The cross-talk between octave-band filters may lead to underestimation of the modulation ratios and the STI-value if the level difference between adjacent octave bands is more than 20 dB.

Sound intensity

The sound intensity option enables the Nor150 to measure sound intensity using a two-microphone intensity probe, complying to ISO 61043:1993. When entering the sound intensity mode, the user-configurable views in environmental mode will be replaced by graphics designed for intensity measurements and the currently selected measurement standard.

In intensity mode, the Nor150 measures sound intensity and sound pressure. These are the basic quantities, but they are available as time-equivalent values as well as instantaneous values with time-constants.

In addition, a range of measurement functions are deduced from the basic quantities. Some examples are L_W, sound power, and FpI. The range of available functions depends on the selected measurement standard.

The Nor150 will, in combination with the Nor1290 probe and the Nor1294 phase verification coupler, ensure that most intensity measurements may be performed with a single 12 mm spacer. This is due to the unique two-stage phase correction technique implemented in the Nor150.



The Nor1290 kit

Setting up the instrument for intensity

The Nor150 may utilize a wide range of probes, both pre-polarized and 200 V polarized microphones in different configurations. However, the highest performance and ease of use is achieved using the Nor1290 probe kit. With the Nor1290, unique performance is achieved using a two-stage correction technique.

Assembling and handling the probe

The Nor150 delivered with the Nor1290 kit comes with a probe comprised of two phase-matched microphones, two accompanying CCP amplifiers and the probe hardware itself. In addition, the kit contains spacers, calibration charts, the Nor1294 phase correction coupler and an extension cable.

The sound intensity probe Nor1290 was upgraded with a new mechanical design and preamplifiers from serial no. 12906548. The new design has an improved back wehing equalization system ensuring better phase response at low frequencies.

Assembling and handling probe from serial no: 12906548 and upwards

The intensity probe is already mounted on the preamplifier, which in turn is mounted in the intensity probe housing. The spacer is already mounted. Ensure that the microphones are positioned symmetrically around the probe centre, and tighten the spacer adjustment knob.



Figure 23.1 - Mount the microphone on the angle adapter



Figure 23.2 - Mount the microphone and adapter on to the preamplifier.

If the kit is dismantled, make sure that the spacer is mounted on microphone A and the spacer knob on microphone B, as illustrated in *Figure 23.1*. Ensure that the spacer adjustment knob is loose, then carefully push the microphones towards each other so that the spacer enters the spacer knob.

Probe dismantling

To perform probe calibration and verification, it is necessary to partly dismantle the probe. Open the spacer adjustment knob and remove the spacer (see *Figure 23.2*) then pull the microphones apart as shown in *Figure 23.3*. Ensure that the microphones are pulled straight out so that friction between the spacer and the sleeve is minimized. Unscrew the spacer counter-clockwise off the microphone grid.

NOTE! Norsonic recommends the 12 mm spacer for most measurements. The 12 mm allows measurements in the range 50 Hz to 6,3 kHz.

A single 7-pin Lemo-connector connects the probe to the instrument; any standard Norsonic microphone cable may be used as an extension. The Nor1290 kit comes with a light-weight rod with adjustable handle, with the option of mounting a smartphone directly on the handle. The rod has 7-pin Lemo-connectors, functioning as an ordinary microphone cable.

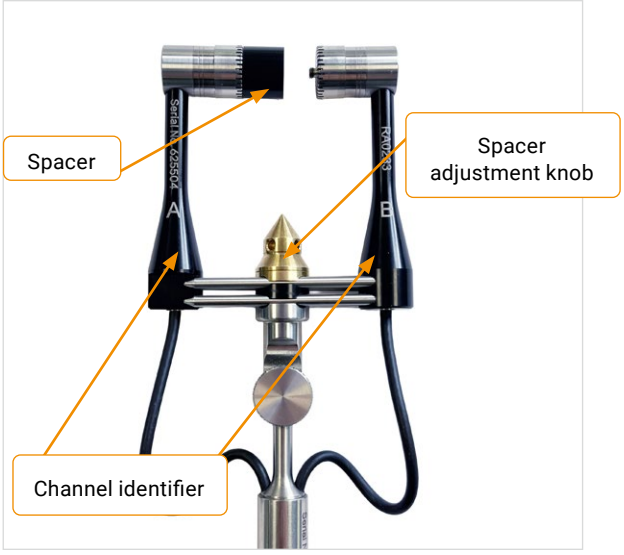


Figure 23.3 - The indivitual parts of the Nor1290

To use the probe handle, connect the probe at the top of the rod, then add an extension cable between the bottom end of the rod and the Nor150. The optional smartphone will provide the same view as the Nor150 itself, offering a one-hand operation of intensity measurements.

The probe may also be mounted directly on the Nor150, or on a standard Norsonic microphone cable.

Assembling and handling probe up to and including serial no: 12906547

Note the serial number of each microphone cartridge, then mount each of the microphone cartridges on an angle adapter as illustrated in *Figure 23.4*. Please avoid touching the connectors. Mount the lowest serial number microphone/adapter on the lowest serial number preamplifier as shown in *Figure 23.5* and vice versa. Make sure that the lowest serial number combination of microphone/preamp is inserted into the probe hardware port A.

Mount the spacer of choice on microphone A, and spacer sleeve on microphone B as illustrated in *Figure 23.6*. Make sure the spacer adjustment knob is loose, then push the microphones towards each other carefully such that the spacer enters the spacer sleeve. Ensure the microphones are positioned symmetrically around the probe centre, and tighten the spacer adjustment knob.

Figure 23.7 shows the assembled probe along with the positive sound intensity direction.

NOTE! Norsonic recommends the 12 mm spacer for most measurements. The 12 mm allows measurements in the range 50 Hz to 6,3 kHz.

A single 7-pin Lemo-connector connects the probe to the instrument; any standard Norsonic microphone cable may be used as an extension. The Nor1290 kit comes with a light-weight rod with adjustable handle, with the option of mounting a smartphone directly on the handle. The rod has 7-pin Lemo-connectors, functioning as an ordinary microphone cable.



Figure 23.4 - Mount the microphone on the angle adapter.



Figure 23.5 - Mount the microphone and adapter on to the preamplifier.

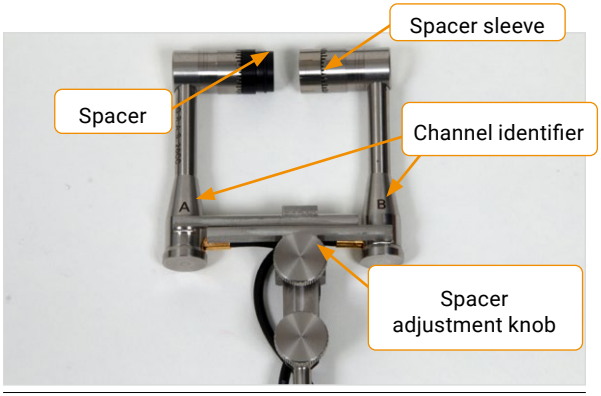


Figure 23.6 - The individual parts of the Nor1290.



Figure 23.7 - The Nor1290 probe assembled with 12 mm spacer. Positive direction is from A to B.



Figure 23.7 - The Nor1290 with extension rod, smartphone handle and windscreen.

To use the probe handle, connect the probe at the top of the rod, then add an extension cable between the bottom end of the rod and the Nor150. The optional smartphone will provide the same view as the Nor150 itself, offering a one-hand operation of intensity measurements.

The probe may also be mounted directly on the Nor150, or on a microphone cable.

Probe dismantling

To do probe calibration and verification, it is necessary to partly dismantle the probe. Open the spacer adjustment knob *(see Figure 23.6)* and pull the microphones apart as shown in *Figure 23.9*. Please make sure to pull the microphones, such that friction between spacer and sleeve is minimized. Remove the spacer and sleeve by rotating them counter-clockwise off the microphone grid.



Figure 23.9 - Loosen the spacer adjustment knob and pull the microphones apart carefully.

Transducer setup - for both probes

For customers buying the Nor150 with the Nor1290 probe kit, all settings are predefined from the factory. Setting up the probe is then easily done:

1. Enter intensity mode (**SETUP** > *Applications* > *Sound Intensity* > √)
2. Select the Nor1290 probe from the list in **SETUP** > *Input* > *Intensity Channel* > *Intensity Probe.*
3. Accept the changes using the √ button.
4. Configure spacer and environmental parameters
5. Tap into *Calibration*, and follow the instructions in section *"Calibration and phase correction" on page 147.*

Figure 23.10 shows the *Channel* menu.

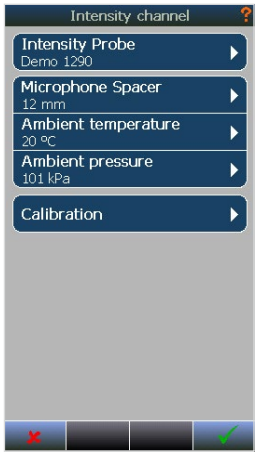


Figure 23.10 - The channel menu provides setup of the intensity probe.

If the kit is delivered separately, the parameters of the transducers and the probe must be set up before the probe may be used. We recommend to use the lower serial number for both the preamplifier and the microphone capsule at the A input on the Nor1290.

1. Enter intensity mode (**SETUP** > *Applications* > *Sound Intensity* > √)
2. Tap into **SETUP** > *Input* > *Transducers*, and press the **Add** soft key *(see Figure 23.11).*



Figure 23.11 - The transducer menu.

a. *Name:* "Intensity A" (or your preference)
b. *Type:* Microphone
c. *Predefined Sensor:* ✘ (No)

d. *Microphone capsule*

Measurand: "Pressure in air ref 20e-6 Pa"
Type: as specified in the cal. chart
Serial number: as specified in the cal. chart

e. *Preamplifier*

Type: as spec. in cal. chart
Serial number: as spec. in cal. chart
Gain: -0,9 dB
IEPE: √ (Yes)

f. *Laboratory* (as spec. in cal. chart)

g. *Verified sensitivity:* as spec. in cal. chart

4. Accept with the √ soft key.
5. Repeat the procedure in in Step 3 for "Intensity B".
6. Add a new transducer, with the following properties:
   a. *Name:* "My Nor1290" (or your preference)
   b. *Type:* Intensity Probe
   c. *Predefined sensor:* √ (Yes)
   d. *Probe:* Nor1290
   e. *Serial number:* As spec. in verification chart
   f. *Channel 1 sensor:* Intensity A
   g. *Channel 2 sensor:* Intensity B
7. Accept with the √ soft key twice to return to the Input menu.
8. Tap into *Intensity channel*
9. Tap into *Intensity Probe* and select the probe you just configured.
10. Accept with the √ soft key
11. Set up the environmental parameters
12. Tap into *Calibration*, and follow the instructions in section "*Calibration and phase correction*".

For other probes, configuring the probe follows the same procedure as above. However, please pay attention to whether the probe uses a 200 V polarization microphone or is polarized, whether the preamplifier is of IEPE type or traditional.

WARNING: If using other probes than the Nor1290, please contact your Norsonic distributor to verify that the probe may be used with the two-stage phase correction process. The correction process may cause artificially high dynamic capability for other probes.

NOTE: If the probe is set up as a *Predefined* Nor1290, the instrument will route the Channel 2 input to pin 1 on the Channel 1 Lemo connector, and the Channel 2 Lemo connector will not be functional.

Connecting a smartphone

Sound Intensity mode supports the NorVirtual smartphone app. Please see *"NorVirtual" on page 195* .

NOTE! Make sure the instrument is powered off before unplugging the WLAN dongle. Unplugging it when the instrument is powered may cause the system to permanently disable the software driver for the dongle.

Calibration and phase correction

To obtain correct results from the instrument, it is important to calibrate before a measurement. In general, Norsonic recommend to calibrate the probe each time the environment has changed significantly (ambient temperature and pressure especially), or every day of measurement. A verification should also be done at the end of the measurement day to ensure that the instrument has been reliable throughout the day. Most standards require that such a verification is done.

Calibrating an intensity probe involves two steps. The first step is a regular pressure calibration of each microphone. The second step is a phase correction procedure to minimize and verify the residual intensity when the probe is exposed to a completely reactive sound field. This is achieved with the Nor1294 Phase Verification Coupler. To start calibration, dismantle the probe as described *"Probe dismantling" on page 144*.

Pressure calibration

Insert probe microphone A into a sound calibrator such as a Nor1251. Open the calibration menu on the Nor150 by pressing **CAL** followed by a tap on *Calibration*. The *Calibration menu* is shown in *Figure 23.12*. Select *Pressure calibration* and then *Sound Channel 1*. Tap *Auto* and enter the correct calibration frequency and calibrator level. Press the **Calibrate** soft key to start the automatic calibration. The procedure will take a couple of seconds. Verify that the correct level is measured after the calibration procedure has finished, then accept with the √ softkey.

The pressure calibration menu is shown in *Figure 23.13*.

Repeat the procedure for probe microphone B/Sound channel 2.

HINT: More information about pressure calibration may be found in *"Calibrating the instrument - field check" on page 62***.**

NOTE: The Nor1290 has about 0,08 dB roll-off in the pressure response at 1 kHz. We recommend using 250 Hz as the reference frequency for calibration. The Nor1256 is a good companion for intensity mode, providing both 250 Hz and 1 kHz tones along with environmental parameters such as temperature, pressure and humidity.

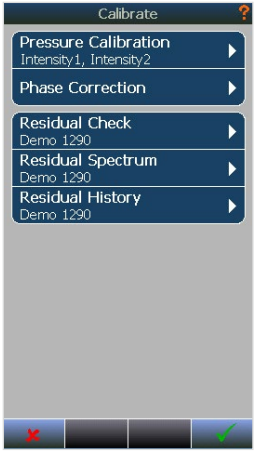


Figure 23.12 - The calibration menu.



Figure 23.13 - Pressure calibration for a single channel.

HINT: When calibration mode is active, the sound pressure of each individual microphone is considered separately. When returning to intensity mode, the sound pressure level will be 6 dB lower than the calibrator output when exposing only one mic to the calibrator. This is due to the very nature of intensity measurements, where the sound pressure measured as the mean of the two microphones.

Phase correction from serial no: 12906548 and upwards

After performing a pressure calibration, phase correction should be performed. Please note that the correction procedure relies on using a probe capable of such a correction – the Nor1290 is such a probe. For other probes, please contact your Norsonic distributor for more information about phase correction.

In the calibration menu, tap into Phase correction. Follow the instructions on the screen: Make sure the Nor1294 ventilation is in OPEN position, then insert both microphones into the Nor1294 as shown in *Figures 23.14* and *23.15*. Tighten the Nor1290 spacer adjustment knob, then put the Nor1294 into CLOSED position as shown in *Figure 23.16*. Connect the Nor1294 mini-jack into the headset output of the Nor150.



Figure 23.14 - Dismantle the probe and spacer.



Figure 23.15 - Make sure the Nor1294 is in OPEN position and insert microphones carefully. Press the back of the microphones to ensure that the microphones align perfectly.



Figure 23.16 - Tighten the spacer adjustment knob and put the Nor1294 into CLOSED position.

Phase correction for up to and including serial no: 12906547

After performing a pressure calibration, phase correction may be performed. Please note that the correction procedure relies on using a probe capable of such a correction – the Nor1290 is such a probe. For other probes, please contact your Norsonic distributor for more information about phase correction.

In the calibration menu, tap into *Phase correction*. Follow the instructions on the screen: Make sure the Nor1294 ventilation is in OPEN position, then insert both microphones into the Nor1294 as shown in *Figures 23.17* and *23.18*. Tighten the Nor1290 spacer adjustment knob, then put the Nor1294 into CLOSED position as shown in *Figure 23.19*. Connect the Nor1294 mini-jack into the headset output of the Nor150.



Figure 23.17 - Dismantle the probe, spacer and sleeve.

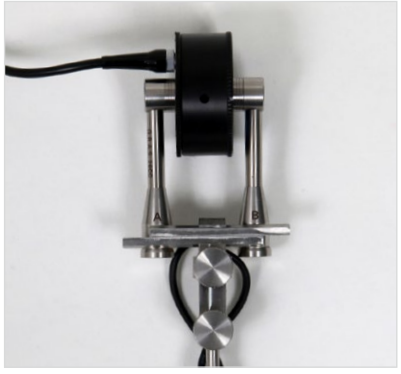


Figure 23.18 - Make sure Nor1294 is in open position and insert microphones carefully. Press the back of the microphones to ensure that the microphones align perfectly.



Figure 23.19 - Tighten the spacer and knob, and close the Nor1294.

For both probes:

Then press the **START** soft key to initiate the correction process. A progress bar will keep you updated, and the calibration is fully automatic. The Nor150 screen is shown in *Figure 23.20*.

NOTE: The phase correction relies on accurate positioning of the microphones within the coupler. Please ensure the microphones are inserted without an angle by pressing on the back of the microphones.

When the correction process is done, the instrument will show the pressure-intensity residual spectrum measured with corrections applied. The minimum requirement defined in IEC 61043:1993 will be shown as step-lines (FpI(Min)), and also the maximum valid pressure-intensity residual spectrum (FpI(Max)). The screen is shown in *Figure 23.21*. If the obtained spectrum looks good, accept the correction with the ✓ soft button. The spectrum may be found for later reference by tapping into Residual Spectrum inside the calibration menu.

NOTE: Make sure the probe is not exposed to vibration during the correction process, as this may affect the calibration.

The maximum pressure-intensity residual spectrum is determined from the inheritent uncertainty in the correction procedure and the physical properties of the Nor1294 coupler. Any FpI values higher than the FpI(Max) is not guaranteed by the instrument performance, and cannot be considered stable.

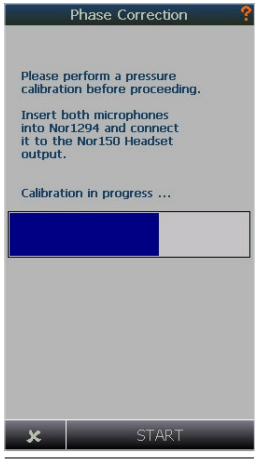


Figure 23.20 - Phase correction in progress. Allow about 30 seconds for the correction process.

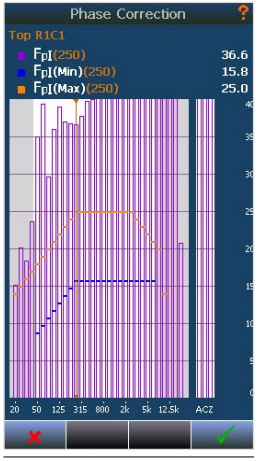


Figure 23.21 - Correction finished. Accept or discard the correction.

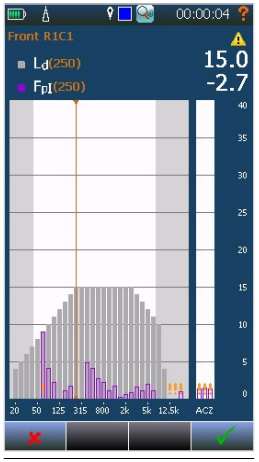


Figure 23.22 - The Ld will be limited by the FpI(max) to ensure a reliable reference value.

In all intensity modes, the obtained FpI spectrum is used for the calculation of Dynamic Capability (Ld). If the obtained spectrum provides higher values than the FpI(Max), these levels will be limited to the FpI(Max) value automatically as shown in *Figure 23.22*.

NOTE: All FpI values scales with the current spacer setup. Changing the spacer distance will automatically generate a new pressure-intensity residual spectrum and corresponding min and max values.

HINT: The instrument will warn you if it detects too low sound pressure during the calibration process. This will typically happen if the Nor1294 is left in OPEN position during calibration. Abort the calibration, close the Nor1294 and restart the process.

NOTE: If the correction process returns lower values than expected, the reason might be high pressures applied to the microphones before phase correction. This might happen if the microphones are inserted quickly into calibrators with small ventilation holes. Let the microphones rest for about 2 minutes and try again.

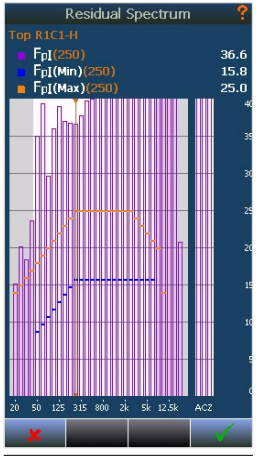


Figure 23.23 - The latest residual spectrum is always available.

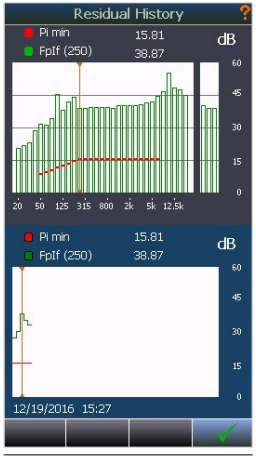


Figure 23.24 - A detailed history is available for the residual spectrum.

Verification procedure

After a measurement session, it is recommended (and mandatory according to most standards) to do a verification of instrument performance.

The *Calibration* menu offers a *Residual Check*. This procedure requires dismantling of the probe and use of the Nor1294 just as for a phase correction, but it will not generate a new phase correction. Instead, it will evaluate the pressure-intensity residual spectrum with the current correction applied.

When a residual check is accepted with the ✓ button, the resulting pressure-intensity residual spectrum is stored. The last saved spectrum is always easily available by tapping into *Residual Spectrum* in the *Calibration menu*, as shown in *Figure 23.23*.

Finally, the microphones should be verified separately using a pressure calibrator using the same procedure as specified for microphone calibration in section *"Calibration and phase correction" on page 147*.

The residual spectrum data is stored in the Nor150 along with time and date. Thus, it is possible to look at the previous calibration or verification, and track the history. Press **CAL** and tap *Residual History* to access this data.

Figure 23.24 shows the historical data. Tap on the lower half of the screen to make the cursor change time and date. The lower part shows the residual intensity as a function of time for the selected band.

Configuring an intensity measurement

Intensity measurements are organised a bit different compared to normal level measurements. As intensity measurements involves the concept of measurement surfaces, intensity measurements are stored as projects. Each project may be comprised of several surfaces or segments.

All configuration of an intensity measurement is done inside the measurement menu (**SETUP** > *Measurement*), except for the measurement surface setup and the environmental parameters/spacer. Starting a new measurement project is done by tapping the **New** softkey available in the **SETUP** menu *(Figure 23.25)*. Or by hitting the ✘ key in total scop view.

The Nor150 intensity mode offers different setups when pressing the **SETUP** key, followed by a tap on *Applications* and then *Sound Intensity*. The menu is shown in *Figure 23.26*. The setups have preconfigured

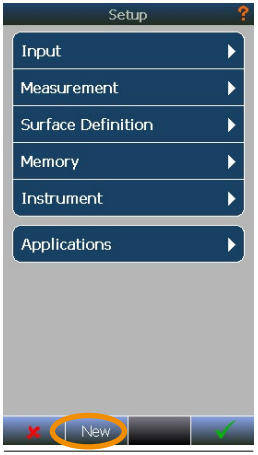


Figure 23.25 - Press the "New" button to start a new project.



Figure 23.26 - The sound intensity setups.

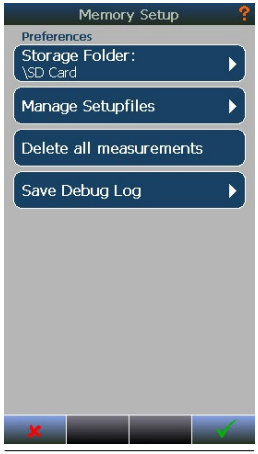


Figure 23.27 - The memory menu offers storing the current measurement setup.

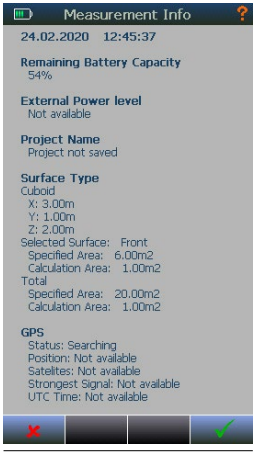


Figure 23.28 - A measurement setup summary.

settings to suit the application and standard. Setups may also be stored by the user if changes has been made to a setup. Press **SETUP** followed by *Memory* option, as shown in *Figure 23.27*. Then tap *Manage Setupfiles* > *Save Measurement Setup as*

The following setups are provided from the factory:

- General (No standard applied)
- ISO 15186 (Measurement of sound insulation in buildings and of building elements using sound intensity)
- ISO 9614-1 (Sound power by fixed points)
- ISO 9614-2 (Sound power by scanning)

Tapping into a setup *(Figure 23.25)* will show a summary of the setup as shown in *Figure 23.28*. Tap the ✓ to load the setup.

Select *Show Setup Shortcut* to show the setup in the *Applications* menu.

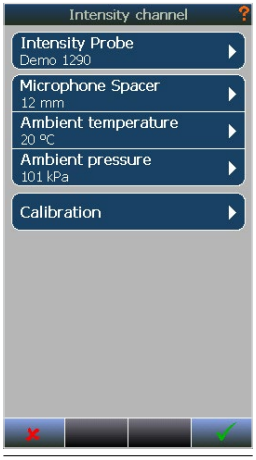


Figure 23.39 - Use the channel menu to set up environmental parameters.

Probe and environment parameters

Before a measurement is started, the probe must be configured. For the Nor150 in combination with the Nor1290 kit, the 12 mm spacer is the correct choice for most measurement applications.

Go to the channel menu by pressing **CAL** *(Figure 23.29)*. Select the correct value for microphone spacer by tapping into *Microphone Spacer*, then selecting the correct spacer using the wheel. Accept with the ✓ softkey.

Along with the spacer distance, ambient temperature and pressure is needed for the instrument to correctly measure sound intensity.

Accept all changes with the ✓ softkey.

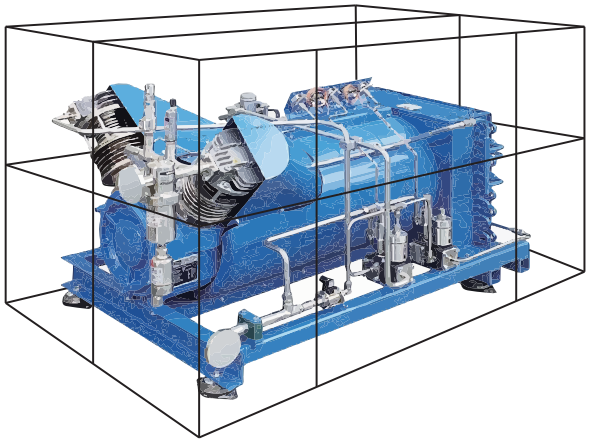


Figure 23.30 - A typical measurement surface enclosing the noise source.

Defining a measurement surface

In intensity mode, the Nor150 organises measurements in projects. Normally, the user will define a measurement surface enclosing the sound source to isolate it from the surrounding environment.

Different baseline surface types may be selected. In the example in *Figure 23.30*, the baseline surface type is a cuboid. Considering such a measurement surface definition, the cuboid will be divided into surfaces left, right, front, back, and top. Each surface contains a set of segments. The concept is illustrated in *Figure 23.31*.

The segments contain the actual measurement, whether it be a scan or a fixed-point measurement. Each segment may consist of either one or two measurements depending on the selected standard and accuracy. The resulting levels will be either the single measurement directly, or an average of the two measurements. When using two measurements per segment, the arithmetic difference between the two measurements will also be calculated.

The ability to measure twice on a single measurement surface is exploited when measuring intensity by scanning, where standards require the evaluation of repeatability between two orthogonal scans.

Each segment is defined by its physical dimensions, resulting in an area. The area is used for calculation of sound power. *Figures 23.32 and 23.33* illustrates two common ways of measuring intensity on a surface.

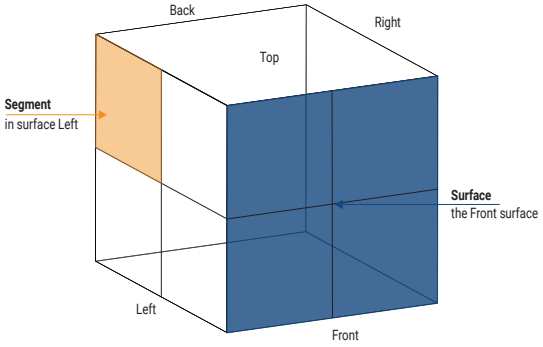


Figure 23.31 - The cuboid is divided into surfaces, and each surface is built up of one or more segments.

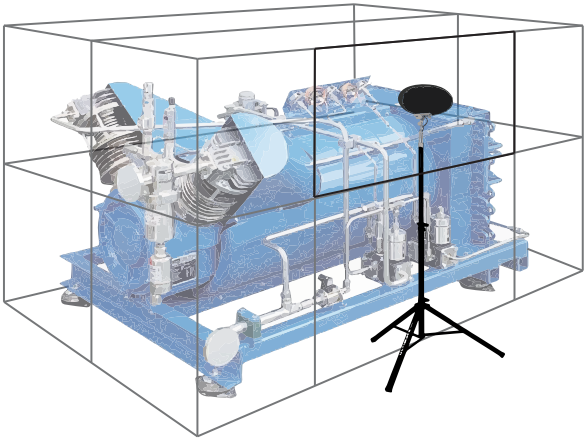


Figure 23.32 - Intensity measurement with fixed probe positions.

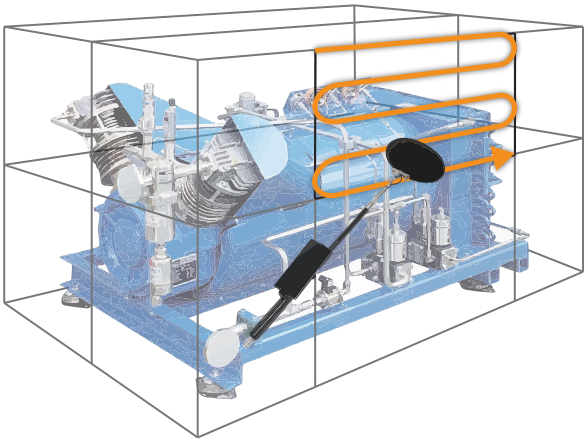


Figure 23.33 - Intensity measurement using the scanning method.

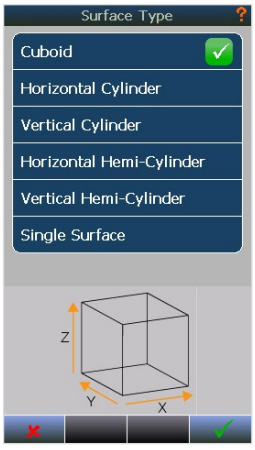


Figure 23.34 - The surface type selection.

To define the measurement surface, push **SETUP** and tap into *Surface definition* menu as illustrated in *Figure 23.34*.

Start with the *Surface type* to select a baseline geometry. After selecting the surface type, the overall dimensions are defined in the *Surface dimensions* menu. These dimensions will be used to generate the surfaces and segments making up the total surface, as illustrated in *Figure 23.35*. The defining dimensions are illustrated on the instrument.

When entering the surface dimensions, the Nor150 will divide the surfaces (e.g. left) into several segments, such that no segments will have an area of more than 1 m^2. However, the number of segments are changeable to the users choice.

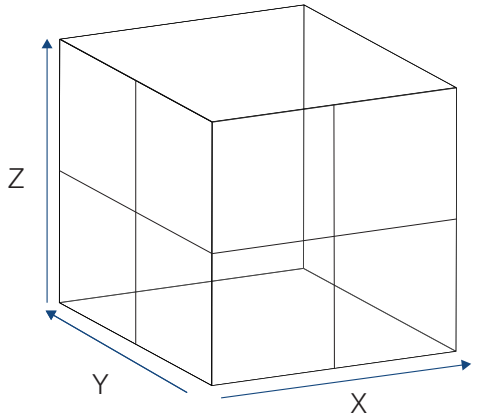


Figure 23.35 - The coordinates defining the cuboid surface.

The generated surfaces will depend on the total measurement surface type. These surfaces are configurable from the *Surface definition* menu. In *Figure 23.36*, the Cuboid surfaces are listed below the *Surface Dimensions* item. Tapping into either of these surfaces will show the parameters defining the surface, and allow adjustment of the number of segments inside the surface.

Figure 23.37 shows the settings found inside a surface created when a cuboid surface type is selected. The menu contains settings for number of rows and columns. Changing either of these will make the instrument recalculate the segment dimensions based on the surface dimensions. This must be done before the segments are measured, as the segment data will be lost when generating new segments.

Tapping into a segment enables editing the parameters defining each segment. This is possible even after a measurement has been performed, causing a recalculation of sound power if this part of the measurement. *Figure 23.37* shows the options available for a cuboid segment.

It is also possible to add extra surfaces to any selected surface type. Tap the **Add** soft-button in the surface definition menu *(Figure 23.36)*. A new entry will appear. Each new entry is a surface, which may include any number of segments.

NOTE: All segments represents an area, but the total measurement will only be averaged over the actual measured area. In *Figure 23.28*, such an example is presented. A total area of 6 m² is specified, but only 1 m² is used for the total average.

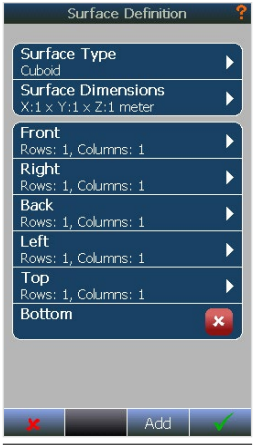


Figure 23.36 - The surface definition menu.

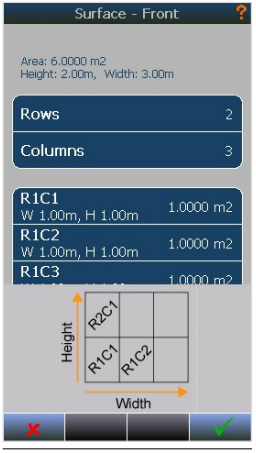


Figure 23.37 - Properties and segments belonging to surface front. Changing either rows or columns will cause loss of data if measured.

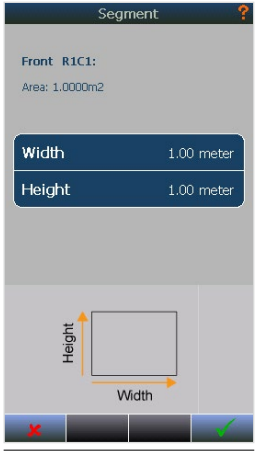


Figure 23.38 - Properties for a single segment. Changing parameters on a segment will not cause loss of data.

Measurement settings

The fundamental settings are available from the *Measurement* menu (**SETUP** > *Measurement*). *Figure 23.39* shows the menu.

Global time is the time a measurement will run before it is automatically stopped. When using scanning procedures, the global time is not relevant and should be set to the longest expected measurement time plus some margin. For fixed-point measurements, the global time is a useful feature, as the measurement stops when the global time is reached.

Profile A is the profile measurement time. Enable Profile A if time analysis of the measurements is needed by tapping the enable/disable box. The time data is generated with the resolution defined by tapping into the Profile A menu.

Filter defines the properties of the filtering process. Sound intensity measurements are possible in 1/3 octave bands with center frequencies ranging from 20 Hz to 20 kHz. This setting may not be changed after making the first measurement in a project.

NOTE: In intensity mode, the A, C and Z networks are calculated from the 1/3 octave bands. The frequency range for networks may be changed at any time, independent of the filter settings, as long as the respective bands has been measured. Norsonic recommends to always set the Filter range to span from 20 Hz to 20 kHz.



Figure 23.39 - The measurement menu.

Calculation settings

Weighted sum frequency range specifies the range from which the weighting networks A, C and Z is calculated. Frequency bands within this range is included in the calculation.

Excluded bands is a list of frequency bands removed from the weighted sum frequency range. This is useful both for analysis of weighted intensity and sound power without problematic bands.

NOTE: If a band is excluded, the exclusion applies to the complete measurement project.

HINT: The calculation settings may be changed at any time during or after measurement.

Selecting a standard

The sound intensity mode in the Nor150 will provide different measurement functions based on the selected measurement standard. Warnings, functions and views will be configured accordingly.

Standard - the Nor150 provides the following standards:

- General (No standard applied) ISO 15186 (Measurement of sound insulation in buildings and of building elements using sound intensity) is treated as “General” with one segment.
- Sound power by fixed points, ISO 9614-1
- Sound power by scanning, ISO 9614-2

The setup and features of each measurement standard is discussed in separate sections.

Accuracy provides a list of available accuracy grades. The list depends on the selected measurement standard. The Dynamic Capability measurement function (Ld) adapts based on the current phase correction and selected accuracy.

Scanning direction provides selection of the scanning direction if a scanning standard is selected. When using a scanning standard, the result of each measured surface segment will be the mean of two scans.

The Nor150 operates with scanning direction *Horizontal*, *Vertical* and *Both*. Some standards and accuracy grades require two orthogonal scans. The user may choose to measure all segments with vertical scans first, and later add horizontal, or measure both scans for each segment immediately.

The concept of horizontal and vertical scanning directions is illustrated in *Figure 23.40*. The notations “horizontal” and “vertical” is just a way of conveniently remembering scanning directions. The user may of course use any preference in orientation while scanning.

Selecting either *Horizontal* or *Vertical* will make the instrument progress to the next segment after the measurement is accepted, while *Both* will make the instrument assume two consequent scans before progressing to the next segment.

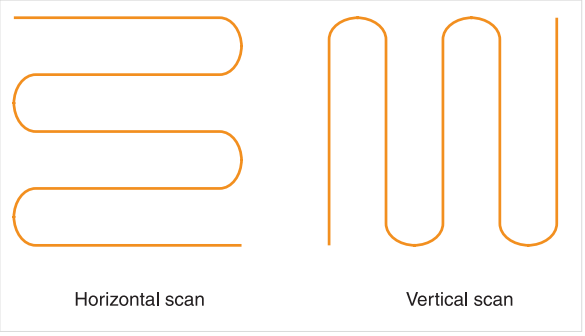


Figure 23.40 - The definition of the scanning directions. Note that the scanning directions are orthogonal.

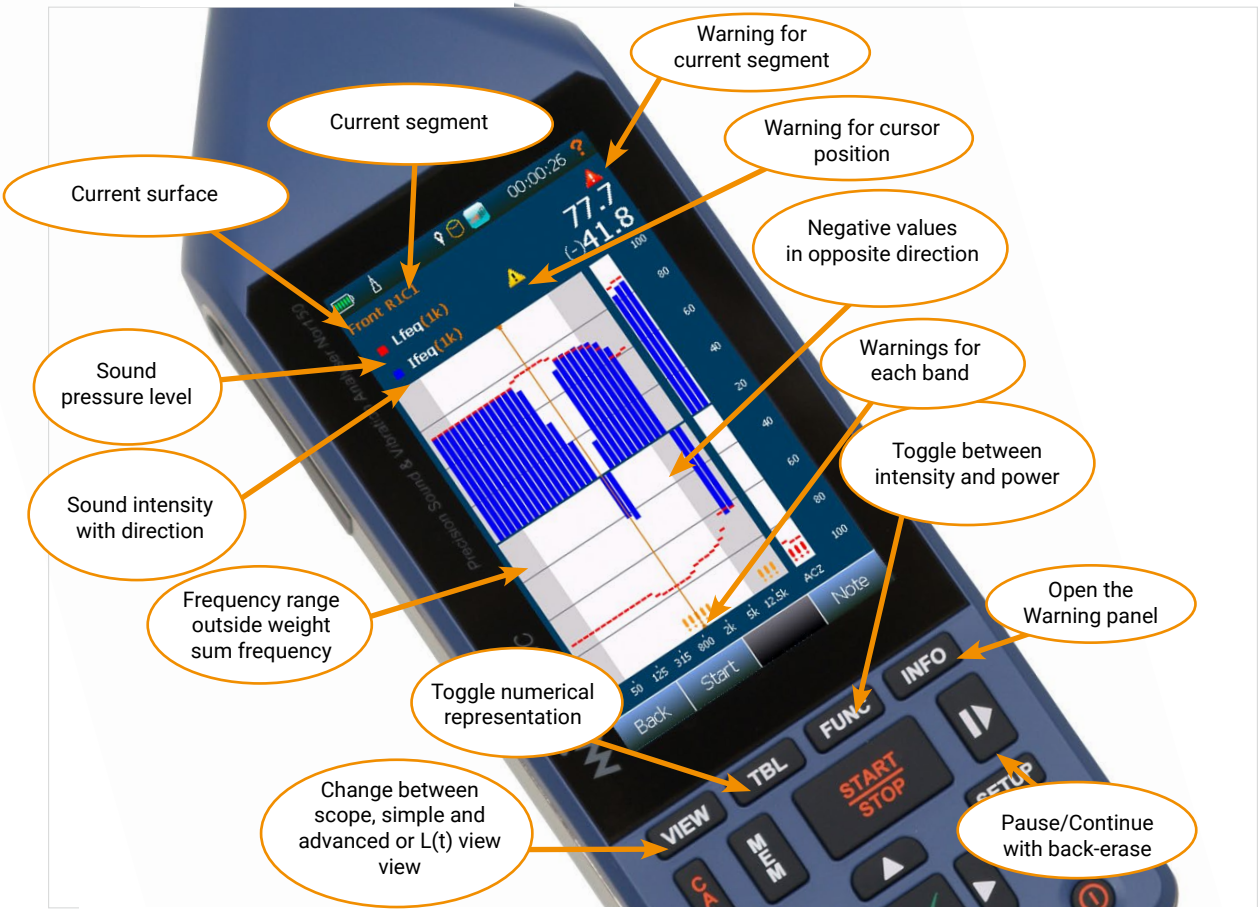


Figure 23.41 - An overview of the simple view in Sound Intensity mode.

Navigating the Sound Intensity mode

In Sound Intensity Mode, some of the measured quantities are levels with a direction. The Nor150 indicates this property by a ***Mirror graph***. The mirror graph has the lower range limit in the center, with positive direction upward on the screen and negative direction downward. Negative direction for numerical values are indicated with a negative sign in a parenthesis in front of the value. Note that sound pressure has no direction, and will always be displayed both upwards and downwards for easy comparison with intensity values.

Introducing the surface scopes

As discussed in *"Defining a measurement surface" on page 154* the Nor150 operates with the concept of a total measurement surface divided into several surfaces and segments. To enable easy navigation in the measurement surfaces, the instrument presents the measurements using three different scopes:

Total scope shows the total levels based on the sum and average of all segments, and values for the different surfaces.

Surface scope provides levels for all segments inside a surface, along with the total levels for the surface.

Segment scope shows the results of an individual segment.

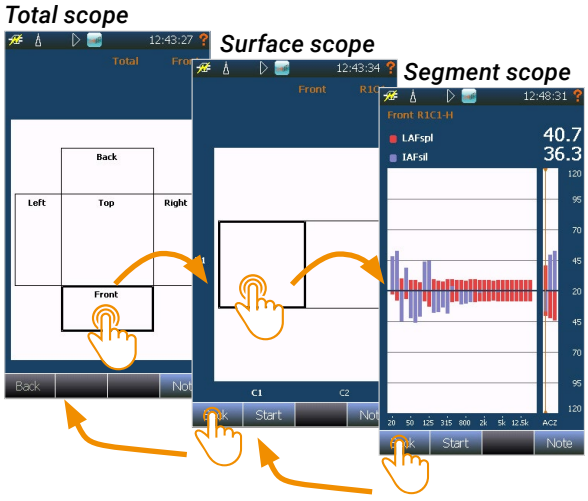


Figure 23.42 - Double-tap a surface or segment to open the corresponding scope. Back will bring you up in the scope hierarchy.

To navigate, double-tap a surface or segment to enter the underlying scope. Tapping the **Back** softkey will navigate upwards in the scope hierarchy. *Figure 23.42* shows the navigation steps. The navigation may also be performed using the keyboard. Use the arrow keys to highlight a surface or segment. Press the ✘ key to navigate upwards in the hierarchy, and ▮▶ to step into the selected surface or segment.

Inside each scope, pressing **VIEW** will toggle between ***Scope view*** (graphical representation of the surfaces), ***Simple view*** and ***Advanced view***. Simple view and advanced view presents graphs of the results in the current scope.

The views

The instrument provides different views to represent data. The content inside the views will depend on the selected measurement standard. To change graph level limits, simply tap and drag on the graphs as illustrated in *Figure 23.43*. To change the range of the graphs, tap and hold the on the graph as shown in *Figure 23.44*. Select range from the context menu.

Scope view

The scope view provides a graphical representation of the measurement surface for the Total scope and the Surface scope, as discussed in the previous section.

When viewing the total scope, scope view presents the A-weighted values for the whole measurement surface along with the currently selected surface. For a surface, the scope view will show the A-weighted values for the surface, and the currently selected segment. The scope view for the total scope is shown in *Figure 23.45*. In *Figure 23.46*, the scope view for surface Left is shown, accessed by double-tapping the Left segment in *Figure 23.45*.

Selecting a surface or segment may be done either by the cursor keys or by tapping the desired surface or segment. Press **FUNC** to change which functions that are presented on the surface or segment, or use **TBL** to switch to a tabular format, as shown in *Figure 23.47*. It is also possible to navigate in the table by double-tapping an entry, and using the **Back** soft button.

The colour frames around surfaces and segments indicate the current status of a surface or segment. Depending on the standard, different conditions apply. No colour (black) indicates that the surface/segment or underlying segments are not measured at all. Red indicates that not all segments are completely measured. Green indicates that all segments are completely measured. The bold black frame indicates which segment or surface is currently selected.

For segments, an “H”, “V” or “H+V” are indicated for scanning standards. These are used to indicate whether the segments has been measured by horizontal, vertical or both scanning directions.

Idle view

Idle view is only available for the segment scope, providing live data for sound pressure and sound intensity using the fast time constant. The view is shown in *Figure 23.48*.

Running view

This is the view which appears when a measurement is running. Leq, leq and IfSPL (time constant fast) is displayed. *Figure 23.49* shows how the running view may look.

NOTE: In running and Idle, the A, C and Z values are not calculated from the 1/3 octave bands. The values update to the correct level once the measurement is topped.

Simple view

If inside a scope view, pressing the **VIEW** button will bring you the simple view representation for the current scope. For the surface scope, this is the sum and average of all segments inside the corresponding surface, and for the total scope, simple view presents the sum and average of all segments in the project.

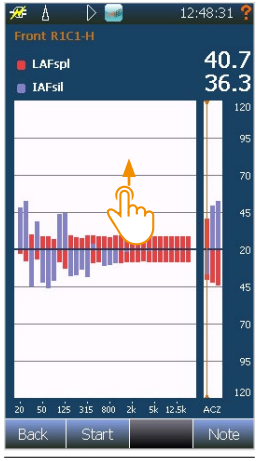


Figure 23.43 - Tap and drag up or down to change the level limits.

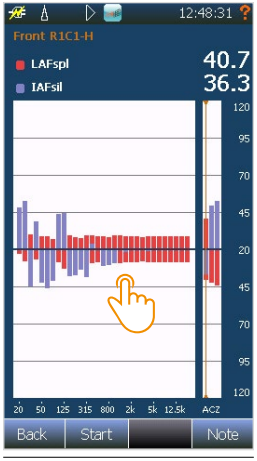


Figure 23.44 - Tap and hold somewhere on the graph to bring up the context menu.

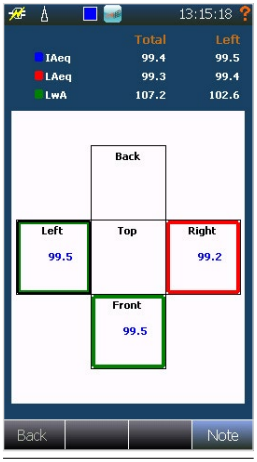


Figure 23.45 - Scope view for the total scope.

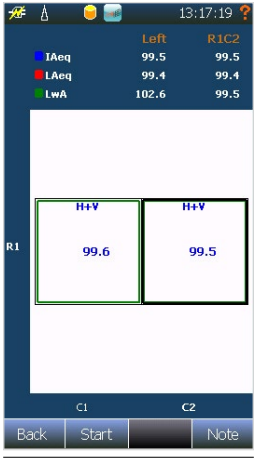


Figure 23.46 - Scope view for the surface scope.

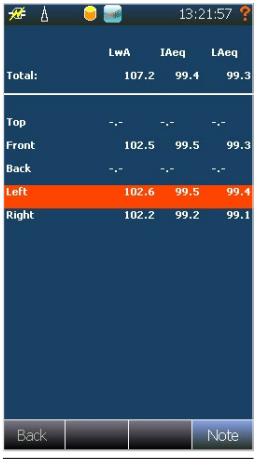


Figure 23.47 - Table display in the scope view.

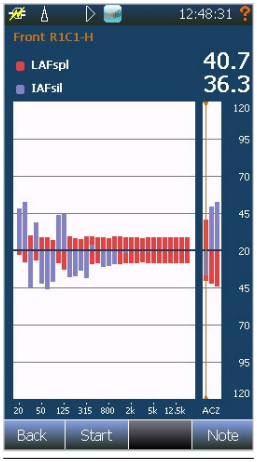


Figure 23.48 - Idle view.

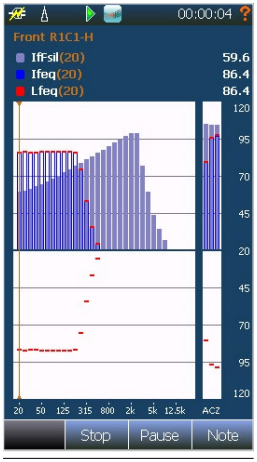


Figure 23.49 - Running view shows the equivalent sound intensity, equivalent sound pressure and instantaneous intensity.

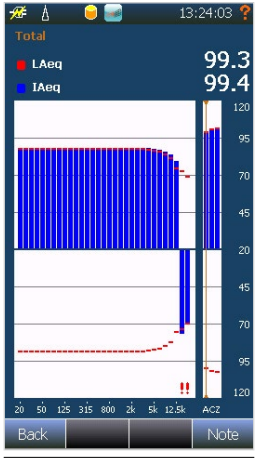


Figure 23.50- Simple view for the total scope.

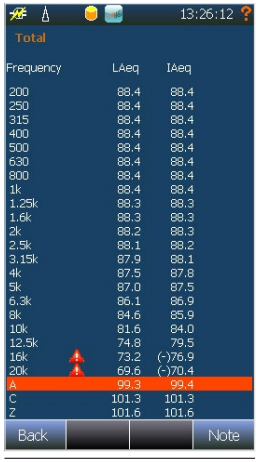


Figure 23.51 - Table in simple view.



Figure 23.52 - Idle view on the smartphone.

In simple view, the presented results are the intensity and sound pressure levels. Using **FUNC**, the user may choose to replace the intensity levels with sound power level. Simple view is shown in *Figure 23.50*.

All data may also be presented in tabular format using the **TBL** key, as shown in *Figure 23.51*. Scroll by tap-and-drag, or use the cursor keys.

HINT: Tap and hold on a graph to find A-network pre-weighting. For measurements aiming to determine an A-weighted value, showing the pre-weighted spectrum may provide useful information.

Advanced view

If pressing **VIEW** inside simple view, advanced view will show up. The content and information presented in advanced view will depend on the selected measurement standard. Please see the individual instructions for each measurement standard. Different presentations of data are available, switching between these are easily done by pressing the **FUNC** key.

L(t) view

When toggeling through the views, the L(t) view will show up if you are measuring according to ISO 9614-1. This view presents the profile data as a function of time. The L(t) view uses the same mirror style as the spectrum graphs. *Figure 23.52*.

HINT: L(t) view can also be shown in Idle/Running if pressing the VIEW button.

HINT: The Sound Intensity icon will receive a magnifying icon when showing Advanced View.

Errors and warnings

The Nor150 calculates field indicators and evaluates criterions belonging to different standards in the background after each measurement. Deviations from a perfect measurement is indicated by warning triangles. These warnings may belong to a frequency band, a segment, surface or the total measurement.

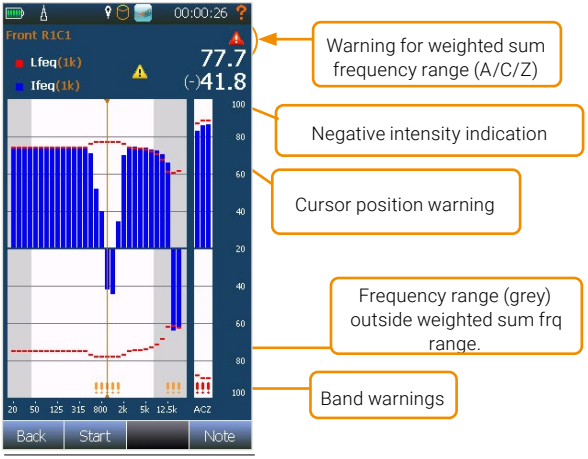


Figure 23.53 - Warning indications in simple and advanced view.

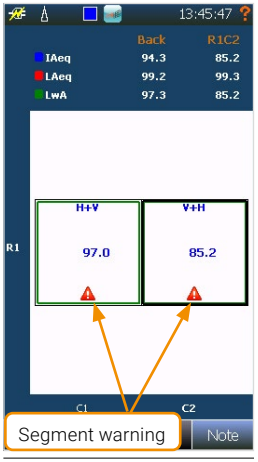


Figure 23.54 - Warnings for A/C/Z bands for the segment is presented in the scope view.

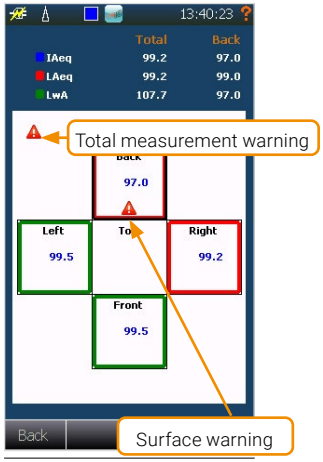


Figure 23.55 - Surface warning is displayed in total scope, along with warnings for the entire project.

The different meanings are:

Standard is compromised

Attention required

The purpose of the yellow triangle is to help the user avoid problems later in the measurement process, thus avoiding to start the measurement process all over again.

In addition, a blue triangle indicates that a band is excluded:

Excluded band

In the frequency spectrum view, the warnings are indicated with exclamation marks below the bar. *Figure 23.53* illustrates the warning indication.

The warnings for bands inside the weighted sum frequency range, along with general warnings for the segments, will be indicated for cursor positions A, C and Z. The warnings are also indicated at the top right side of the screen.

When stepping up one scope using the **Back** softkey, the warnings are also indicated for the surface and total, as shown in *Figures 23.54 and 23.55*.

Warning panel

When showing either simple view or advanced view, the warnings may easily be investigated in detail. Simply press **INFO** to toggle the warning panel. The warnings are written out in clear text. An example from the ISO 9614-2 standard is shown in *Figure 23.56*. Tapping any of the entries in the list will bring up the help system, providing detailed information about the current issue. *Figure 23.57* shows an example.



Figure 23.56 - Warning panel shows warnings for the cursor position. Press the action text to show an explanation text.

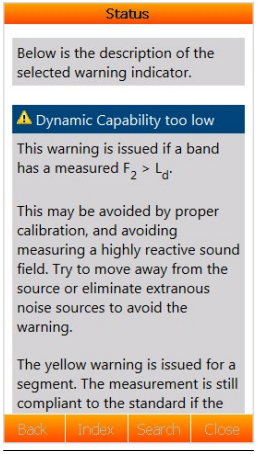


Figure 23.57 - Recommended action for a frequency band.

For standards providing information about possible actions to counter the problem, the instrument also suggests such actions. The full text proposals are easily accessed by tapping on the action text.

HINT: Most warnings have an analysis display available in the advanced view. More information is available in the sections for specific standards.

Saving and loading intensity projects

The Nor150 in intensity mode automatically saves a project using the current date and time when a measurement is started. However, to assign a name to the project, press the **MEM** button.

Loading a measurement is also done simply by pressing **MEM**. Select measurements from the list. For details about folders, SD card storage etc, please refer to *"Storing a measurement - Memory Organising Menu" on page 97.*

Exporting projects is done in the same way for intensity projects as for normal measurements, using the NorConnect software. Please see *"Norsonic software" on page 203.*

Helpful features

The note functions available in environmental view is also available in intensity view. The details of the functions are discussed on *"Voice and Text notes" on page 93.*

In general, notes, voice recordings and pictures belong to the scope level. If inside the surface scope, the applied notes will belong to this scope. Thus, it is possible to find notes corresponding the complete measurement, a surface or a segment later, either on the instrument or in post-processing software.

Using the smartphone

The smartphone with NorVirtual App provides exactly the same features as the instrument by presenting the same picture. See *"Norsonic software" on page 203*

HINT: The smartphone may be used to take pictures of the measurement surfaces. These will show up as a background on the smartphone surface view, and in the post-processing software Nor850.

Sound power using ISO 9614-2

The ISO 9614-2 is a standard for determining sound power based on sound intensity. The method relies on the scanning method, and is available for both engineering and survey grade accuracy.

The following sections will discuss the setup, measurement and review of sound power measurements according to ISO 9614-2.

Measurement configuration

To set up a measurement, go to **SETUP** > *Applications* > *Sound Intensity* and select the default setup *ISO 9614-2*.

The measurement setup will be loaded with the following parameters:

Global time: 15 minutes. **Profile A:** off

Filter range: 1/3 octave bands, 20 Hz to 20 kHz.

Weighted sum frequency range: 50 Hz to 6.3 kHz

Standard: ISO 9614-2

Accuracy: Engineering

Scanning direction: Horizontal and Vertical

The standard specifies that the frequency range must be set to 50 Hz to 6.3 kHz. A warning will be given if the weighted sum frequency range is changed.

Engineering grade accuracy requires two orthogonal scans for each segment. These are denoted *Horizontal* and *Vertical* on the Nor150. If survey grade is desired, change the *Accuracy* setting to *Survey*. You may still use two orthogonal scans by leaving the *Scanning Direction* to *Both*, but the instrument will no longer provide warnings for repeatability and extraneous intensity. If only a single scan per segment is desired, please change the *Scanning Direction* to for instance *Horizontal*.

HINT: There is no difference between Horizontal and Vertical scanning direction except for the name, which could rather be Scan 1 and Scan 2. Horizontal and Vertical is used as annotation for convenience. An H and V will appear on the segments when either of these scanning directions has been used.

Define a measurement surface as described in *"Defining a measurement surface" on page 154*. The standard specifies a minimum of four segments. Thus, only one segment within each surface element is sufficient for a cuboid surface. However, the standard also specifies that the total surface should be divided into segments such that individual components are separated. Parts of the surface where negative intensity is expected should be separated from the rest. Please consult the standard for more details.

The ISO 9614-2:1996 recommends to use simple curved surfaces such as the cuboid, and using an average distance to the source under test of minimum 200 mm. Small and compact sources may use 100 mm.

NOTE: The measurement surface represents the surface of which the probe should have its acoustical centre.

Before the measurement is started, the environmental parameters must be set up and the probe calibrated as described in *"Probe and environment parameters" on page 153* and *"Calibration and phase correction" on page 147*.

NOTE: The dynamic capability check in the instrument relies on the measured dynamic capability during a correction or verification. Always calibrate if the instrument has been transported or the environmental conditions has been changed since last verification, or if the last verification was more than 24 hours ago.

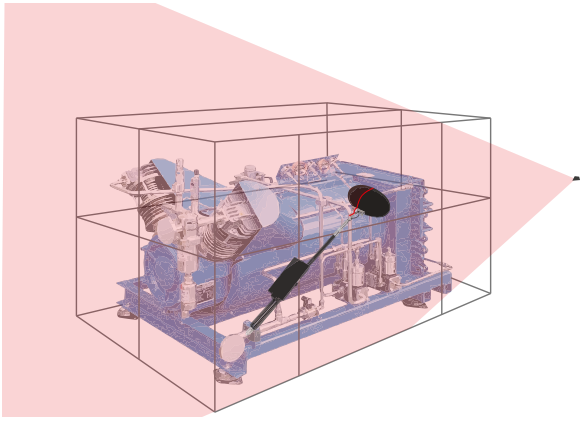


Figure 23.58 - A single plane laser may help keeping a consistent distance.

Measuring

Please make sure that the measurement is configured and set up as described in the previous section, including the calibration routine.

The measurement surface may be marked to guide the orientation of the probe during a scan. Tape, or a thin rigid grid may be helpful. A single-plane laser device may also be useful to keep the probe on the measurement plane, as shown in *Figure 23.58*.

Decide where to begin the scanning, and tap into the correct surface. Pressing **START/STOP** will automatically start at the lower-left segment of the selected surface. Scan the segment, and press **START/STOP** to stop the measurement when the scan is completed.

HINT: If an obstacle is encountered during a scan, press the ▮▶ key. The measurement will be paused. If desired, some seconds of the measurement may also be removed by using the cursors on the displayed time graph, before pressing the key once more to resume the measurement.

When the measurement is stopped, the Simple View will be displayed, and the instrument will allow either to accept the measurement using the ✓ key, or discard the measurement using the ✘ key. The measurement may be reviewed as normal while waiting for accept. The next section will describe how to review the results in detail.

If Scanning Direction is set to Both, the next press on the **START/STOP** key will start the second measurement on the same segment. Otherwise, the next segment will be scanned. The instrument will progress through the segments one row at the time, from bottom to top, always starting with the leftmost segment in each row. *Figure 23.59* shows the segment order progress.

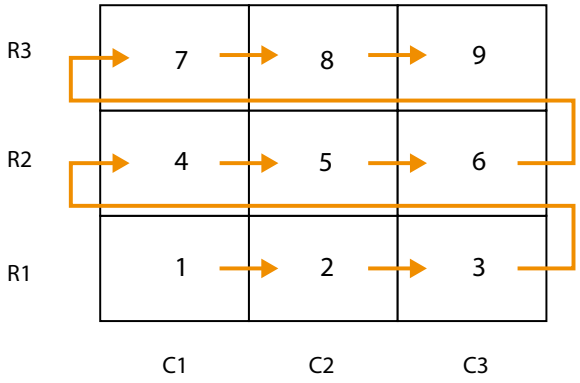


Figure 23.59 - Segment order.

Reviewing the measurements

Measurements using the ISO 9614-2 requires evaluation of field indicators in addition to the sound power and sound intensity. The indicators are presented in separate views in the Nor150. Below is an overview of the data presented in the different scopes.

HINT: The concept of scopes is discussed in section *"Introducing the surface scopes" on page 160.*

Segment scope

The segment scope presents data for a single segment. Thus, no graphical surface (scope view) is available in this scope, and simple view is selected when tapping into a segment.

Simple view

A graph is presented for sound pressure and either sound intensity or sound power. Warnings are indicated for each frequency band and the segment total. Toggle between sound power and sound intensity using the **FUNC** key. Press **INFO** to bring up the warning window. *Figures 23.60 and 23.61* shows the simple view for a segment, with and without the warning panel.

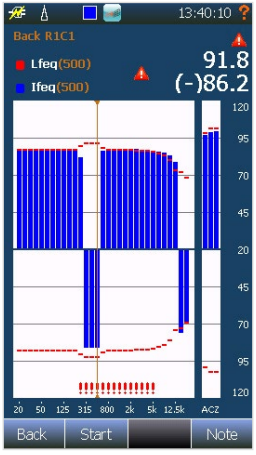


Figure 23.60 - Simple view for a segment.



Figure 23.61 - Simple view and warning panel for a segment.

Advanced view

Three different graphs are presented by toggling the **FUNC** key. The warning window is available for all graphs by pressing the **INFO** button.

The first graph shows sound power, sound intensity and sound pressure at the same time, as illustrated in *Figure 23.62*.

The second graph displays dynamic capability along with the field indicator FpI, as illustrated in *Figure 23.63*.

If two scans have been made on the segment, a third graph is available. This graph shows the difference (Δ) functions generated based on the two scans as illustrated in *Figure 23.64*.

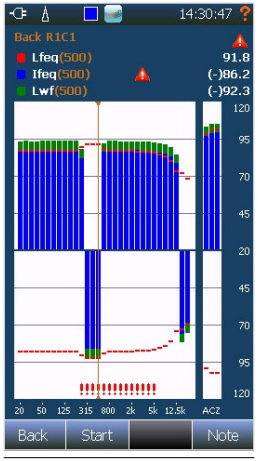


Figure 23.62 - Advanced view 1 for a segment.

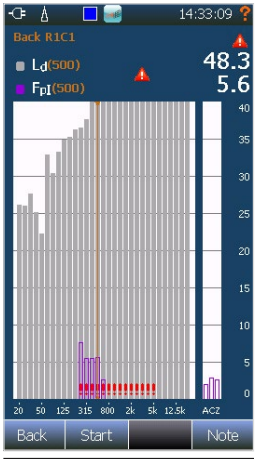


Figure 23.63 - Advanced view 2: Dynamic capability.

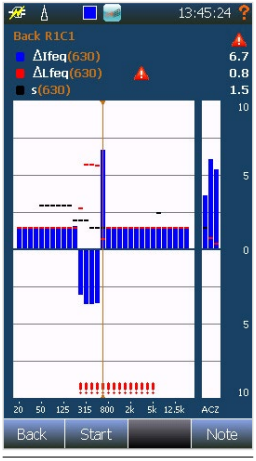


Figure 23.64 - Advanced view 3: Delta view (segment only).

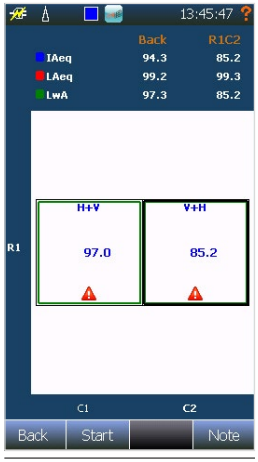


Figure 23.65 - Scope view for surface.

Surface scope

The surface scope presents data from all segments inside a surface scope. Thus, it functions as an intermediate total, simply to gain overview of the different surfaces and provide easier analysis of the source under test.

Scope view

Presents a graphical view of the measurement surface. The A-weighted value for the surface is displayed, along with A-weighted data for each individual segment. Select the displayed function using the **FUNC** key. Scope view is illustrated in *Figure 23.65*.

A red frame will be present around a segment in scope view if engineering mode is selected, and only a single scan is performed. In survey grade, only a single scan is required. A green frame indicates that the required number of scans has been performed for the segment.

Simple view
A graph is presented for sound pressure along with either sound intensity or sound power. Warnings are indicated for each frequency band, and the complete surface. Toggle between sound power and sound intensity using the **FUNC** key. Press **INFO** to bring up the warning window. In surface scope, the warnings are summed and they display how many warnings there are for all segments inside the surface. The display is equal to simple view for a segment.

Advanced view
Two different graphs are presented by toggling the **FUNC** key. The warning window is available for all graphs by pressing the INFO button.

The first graph shows sound power, sound intensity and sound pressure at the same time, the same way as for a segment.

The second graph displays dynamic capability along with the field indicator FpI, the same way as for a segment.

Total scope

The total scope presents the total data generated from the sum and average of individual segments.

NOTE: The sound power levels are calculated based on the area defined for each of the measured segments. The area resulting from the specified Surface Dimensions is strictly a guidance for defining the surfaces and segments.

Scope view
Presents a graphical view of the total measurement surface. The total A-weighted data is shown, and A-weighted data is indicated for each measurement surface. Select the displayed function using the FUNC key.

A red frame will be drawn around incomplete surfaces. For engineering grade accuracy, this implies two scans per segment, while survey grade accuracy only requires a single scan per segment. The surface will have a green frame when all segments are measured.

Simple view
A spectrum is presented for sound pressure along with either sound intensity or sound power. Warnings are indicated for each frequency band, and the complete surface. Toggle between sound power and sound intensity using the **FUNC** key. Press **INFO** to bring up the warning window. In total scope, the warnings are summed and they display how many warnings there are for all segments. The display is equal to simple view for a segment.

Advanced view
Three different spectrums are presented by toggling the **FUNC** key. The warning window is available for all spectrums by pressing the **INFO** button.

The first graph shows sound power, sound intensity and sound pressure at the same time.

The second graph displays dynamic capability along with the field indicator FpI.

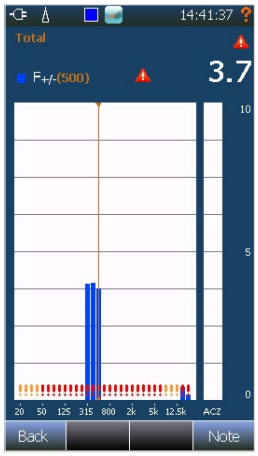


Figure 23.66 - Advanced view 3: The extraneous intensity view.

The third graph shows the field indicator F+/-. The display is illustrated in *Figure 23.66*.

Measurement functions and indicators

Sound power measurement according to ISO 9614-2 uses the intensity values to generate sound power levels for each individual segment, and summing these for both surfaces and the total measurement surface.

The physical quantities measured are

Ieq – time-equivalent sound intensity level, referenced to 1 pW/m^2.

Leq – time-equivalent sound pressure level, referenced to 20 µPa.

Deduced measurement functions

Lw – sound power, calculated for all scopes, referenced 1 pW.

FpI – pressure-intensity indicator (Leq – Ieq), calculated for all scopes.

F+/- negative partial power indicator, calculated for total scope.

ΔIeq – arithmetic sound intensity difference, calculated for segment scope with two measurements.

ΔLeq – arithmetic sound pressure difference, calculated for segment scope with two measurements.

Ld – dynamic capability, available for all scopes, calculated based on probe verification and grade of accuracy.

Warning indicators

Dynamic capability too low
Triggered if the FpI exceeds the dynamic capability for a frequency band (FpI > Ld). Applies to FpI values in the total scope. The warning may be avoided by a proper phase correction and avoiding measurements in highly reactive sound fields or extraneous noise.

Dynamic capability too low
Issued if the FpI exceeds the dynamic capability for a frequency band (FpI > Ld). Applies to FpI values in segments.

High FpI
Issued if FpI is greater than 10 dB for a frequency band.

Repeatability failed
Issued if the difference between the horizontal and vertical scan (ΔIeq) exceeds the threshold s defined by the standard. Applies only to engineering accuracy.

Negligible repeatability
A band failed on repeatability, but the Lw sum of bands with repeatability is more than 10 dB below the highest A-weighted level. The Repeatability failed warning is automatically suppressed.

Negative intensity
One or more bands have negative direction intensity/ sound power on the total surface. The A-weighted level is not valid.

Extraneous intensity
Issued if the Engineering accuracy is selected and F+/- exceeds 3 dB.

Weighted sum range not compliant
Issued if Weighted sum freq. range is not set to exactly 50 Hz to 6.3 kHz.

Frequency range not compliant
Issued if the filter bandwidth is not equal to or exceeding the range 31.5 Hz to 10 kHz.

Low mid-range power
Indicates that the A-weighted power in bands [50, 315] Hz and 6.3 kHz is larger than the A-weighted power for bands [400, 5000] Hz. The uncertainty for total A is then not as stated in the standard, and individual band uncertainties apply.

High level outside A-total
Indicates that a frequency band outside Weighted sum freq. range is less than 6 dB below the total A-weighted value when the band is A-weighted.

Too short averaging time
Issued if either the horizontal or vertical measurement time is less than 20 seconds for a segment.

Sound power using ISO 9614-1

The ISO 9614-1 standard differentiates from the ISO 9614-2 by using fixed measurement positions instead of the scanning procedure. The standard allows measuring with accuracies Precision, Engineering and Survey.

The following sections will discuss the setup, measurement and review of sound power measurements according to ISO 9614-1.

Measurement configuration

To set up a measurement, go to **SETUP** > *Applications* > *Sound Intensity* and select the default setup *ISO 9614-1*.

The measurement setup will be loaded with the following parameters:

Global time: 10 minutes. **Profile A:** 100 ms

Filter range: 1/3 octave bands, 20 Hz to 20 kHz.

Weighted sum frequency range: 50 Hz to 6.3 kHz

Standard: ISO 9614-1

Accuracy: Engineering

Temporal Variability:

Averaging time: 10 seconds

Number of Averages: 5

The setup menu is shown in *Figure 23.67*.



Figure 23.67 - Setup menu when measuring according to ISO 9614-1.

Measurement time

The ISO 9614:1 defines a minimum measurement time in each position depending on the lowest frequency of interest. In the default configuration, 50 Hz is the lowest frequency band. The minimum time in this case is 35 seconds, as seen in *Figure 23.60*. We recommend setting the *Global Time* to your desired value. The Nor150 will automatically stop a measurement when the Global Time is reached.

While measuring according to ISO 9614-1, it is also possible to measure and watch the measurement in short-term profiles. Set the *Profile Time* to any desired interval to exploit this capability. We recommend 100 ms for general measurements.

Filtering

Filter controls the main filtering functionality. We recommend measuring with the filter setting left default, providing data from 20 Hz to 20 kHz.

Weighted Sum Freq Range controls the frequency range evaluated for the field indicators and for calculation of A,C and Z. The standard specifies that the frequency range must be set to 50 Hz to 6.3 kHz. A warning will be given if the weighted sum frequency range is changed. In certain cases, it may make sense to use a wider or narrower range. In these cases, the user will need comment and consider the uncertainty and complience to the standard.

Excluded bands is a list of excluded bands. In certain cases, it makes sense to exclude certain bands. Exclusion may be done from this menu, or directly in the graphs during measurement or evaluation.

Measurement precision

Select the desired measurement precision by altering the **Accuracy** setting:

- **Survey / Grade 3**
  4 dB standard deviation in A-band
- **Engineering / Grade 2**
  1.5 dB to 3 dB standard deviation in third octave bands.
- **Precision / Grade 1**
  1 to 2 dB standard deviation in third octave bands

Please refer to Table 2 in ISO 91614-1:1993 for details. The higher the accuracy, the more stringent requirements for the field indicators, and thereby also the number of measurement positions.

HINT: It is possible to change the Accuracy at any time during a measurement. If at any time the measurement does not fulfill the requirements of the standard, you may reduce the requirement and the instrument will automatically recalculate all field indicators and warnings.

Temporal Variability

The ISO 9614-1 specifies a field indicator F1 to evaluate the temporal variability of the source and surroundings. This parameter must be measured in a single position with several time averages. The averages are evaluated in terms of standard deviation.

In the Nor150, this is implemented as a measurement separate from the rest. According to ISO 9614-1, one should choose a “typical” measurement position. The **Number of Averages** will typically be set to 10, and the **Averaging time** may be in the range 8 to 12 seconds, or any integer number of cycles for periodic sources.

The first entry in the menu will show a list of Temporal Variability measurements. It is possible to perform multiple measurements, but only one will be set as active. The active temporal variability reference will be provide the data for the F1 indicator in the total measurement and be the basis for any warnings or recommendations. The actual measurement of temporal variability is discussed under *“Measuring” on page 167.*

HINT: The Nor150 will show the resulting temporal variability measurement time in the bottom of the measurement setup menu as seen in *Figure 23.68*.



Figure 23.68 - Temporal Variability Section.

Surface definition

For ISO 9614-1, the surface requirements are somewhat less stringent - as the positions are static, it is allowed to select surfaces that are double-curved. The baseline is to make sure that the average distance from the measurement surface to the source is greater than 0.5 meters. Please remember that absorbing elements are not allowed within the surface.

The standard requires that a minimum of 10 positions are measured, covering maximally 1 m^2 per positions. It is allowed to cover 2 m^2 per position if the resulting number of positions are still above 50. It is also allowed to use 50 evenly distributed positions over an entire measurement surface without further requirements to covered are if the extraneous noise is insignificant. Consult the standard for further information.

HINT: The Nor150 will warn you if the requirement of 10 positions are not fulfilled, as shown in *Figure 23.69*.

HINT: The Field non-uniformity indicator (F4) will be evaluated during the measurement. If the standard deviation between the individual segments are larger than a requirement depending on the selected accuracy, the surface will need to be reconfigured. Note that the warnings and hints will not be valid until all positions are measured. An example is shown in *Figure 23.70*.

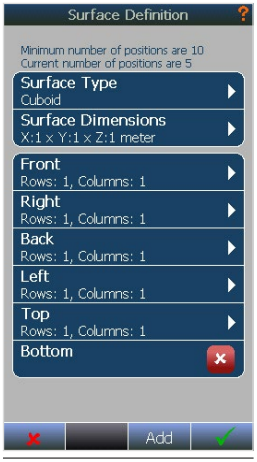


Figure 23.69 - ISO 9614-1 surface definition. Note the warning on the top.

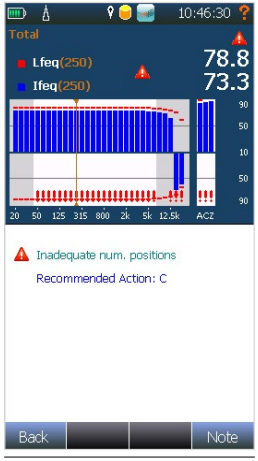


Figure 23.70 - A warning is issued if the F4 indicator is above the requirement. Tap the warning or action for more information.

Measuring

Please make sure that the measurement is configured and set up as described in the previous section, including the calibration routine.

Temporal Variability

Select a “typical” surface for the measurement of temporal variability, representing both the source under test and the extraneous noise. Position the probe accordingly. On the instrument, navigate to the segment: From Scope View, double-tap into the surface containing the segment. Tap and hold the selected segment to bring up the context menu, then select Temporal Variability. *Figure 23.71* shows menu.

A L(t) view will appear, as shown in *Figure 23.72*. Press **START/STOP** to start the measurement. The measurement will run until the number of configured averages has been measured.

HINT: The L(t) view will have a long profile time, and accordingly few samples. The measurement will look like the one in *Figure 23.73* if only five averages is selected. To get more information during the measurement, press VIEW to see a normal Running view like *Figure 23.74*.

After the measurement stops automatically, the instrument will display the results. If not presented with the F1 function, press **VIEW** until the spectrum graph is displayed, then **FUNC** until F1 is presented. *Figure 23.75* shows such a result. In this example, the measurement does not meet the requirement, and warnings are issued for all bands. Either Accept or Discard the measurement. If you accept the measurement, the F1 will be transferred to the main measurement.

HINT: It is possible to measure Temporal Variability several times. One may for instance measure one before and one after the final measurement has been made, or on different locations. Only one of the measurements will be used for the main measurement, and this may be selected at any time. Measurements may be made on the same segment or on different segments. From the SETUP > *Measurement* > *Temporal Variability menu*, you may find all the measurements, and also change the active one. *Figure 23.76* and *Figure 23.77* illustrates the options.

Main measurement

Decide where to begin the measurement and tap into the correct surface. Pressing **START/STOP** will automatically start the measurement at the lower-left segment of the selected surface. Let the measurement run until it automatically stops. When it stops, the instrument will allow either to accept the measurement using the ✓ key, or discard the measurement using the ✘ key. The measurement may be reviewed as normal while waiting for accept. The next section will describe how to review the results in detail.

HINT: If an impulsive noise is encountered during a measurement, press the ▮▶ key. The measurement will be paused. If desired, some seconds of the measurement may also be removed by using the cursors on the displayed time graph, before pressing the ▮▶ key once more to resume the measurement.

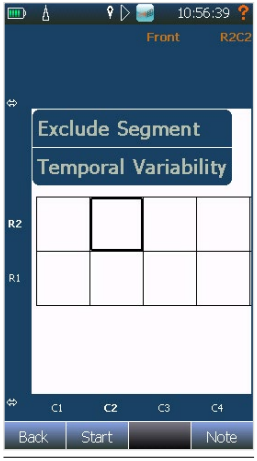


Figure 23.71 - Tap and hold a segment to make a Temporal variability measurement.

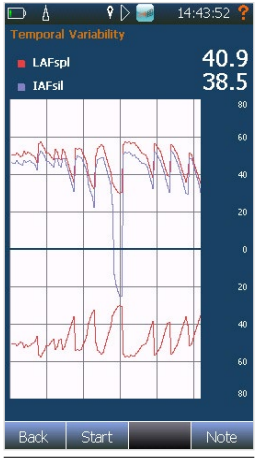


Figure 23.72 - The instrument will show you an L(t) view.

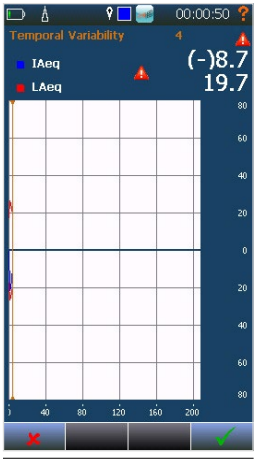


Figure 23.73 - Only five periods of data. Press TABLE to show a numeric display.

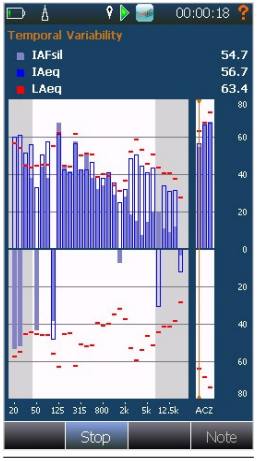


Figure 23.74 - Regular spectrum view accessible by pressing VIEW.

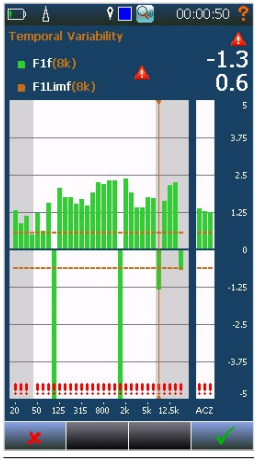


Figure 23.75 - The F1 function is presented along with the F1Lim, which is the limit set by ISO 9614-1.



Figure 23.76 - Choose or view existing temporal variability measurements.



Figure 23.77 - The active temporal variability measurement is shown in the menu.

Loop through the segments one at a time until all measurements are done. Segments are sequenced as show in *Figure 23.78*.

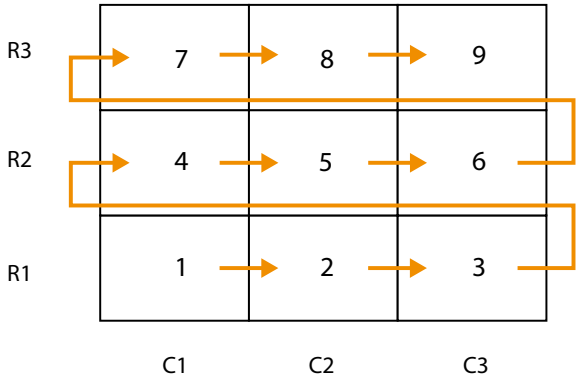


Figure 23.78 - Segment order

Reviewing the measurements

Measurements using the ISO 9614-1 requires evaluation of field indicators in addition to the sound power and sound intensity. The indicators are presented in separate views in the Nor150. Below is an overview of the data presented in the different scopes.

HINT: The concept of scopes is discussed in section *"Introducing the surface scopes" on page 160*.

Segment scope

The segment scope presents data for a single segment. Thus, no graphical surface (scope view) is available in this scope, and simple view is selected when tapping into a segment. Pressing **VIEW** toggles between the views described below.

NOTE: Table representations are available for all views by pressing TBL.

Simple view

A graph is presented for sound pressure and either sound intensity or sound power. Warnings are indicated for each frequency band and the segment total. Toggle between sound power and sound intensity using the **FUNC** key. Press **INFO** to bring up the warning window. *Figures 23.79 and 23.80* shows the simple view for a segment, with and without the warning panel. Tap the warnings or action codes to bring up the help information for the specific warning or action as show in *Figures 23.81* and *23.82*.

Advanced view

Three different function groups are presented by toggling the **FUNC** key. The warning window is available for all groups by pressing the **INFO** button.

The first group shows sound power, sound intensity and sound pressure at the same time, as illustrated in *Figure 23.83*.

The second group displays dynamic capability along with the field indicator F2, the pressure-intensity indicator, as illustrated in *Figure 23.84*.

The last group is the F3, the negative partial power indicator, illustrated in *Figure 23.85*.

L(t) view

This view presents the sound intensity and sound pressure as a function of time. Note that this is also a mirrored graph, with sound pressure mirrored up and down for reference. Press the up/down arrow keys to cycle through filter bands, and left/right to move the cursor. The view is illustrated in *Figure 23.86*.

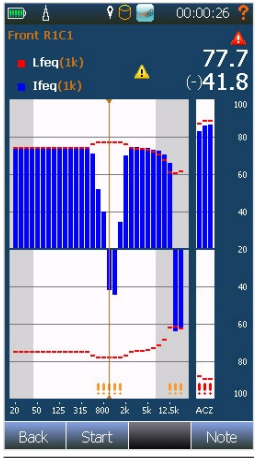


Figure 23.79 - Simple view for a segment.

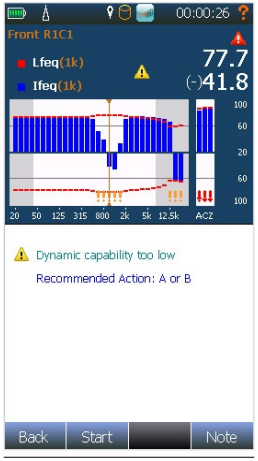


Figure 23.80 - Simple view for a segment with info screen activated. Tap warning or info to show help.

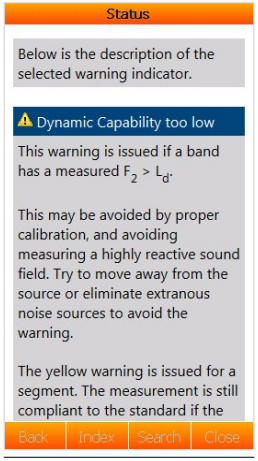


Figure 23.81 - After tapping a warning it is described in detail on the instrument.

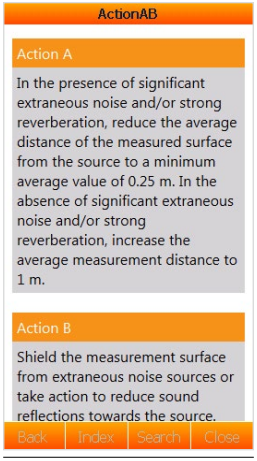


Figure 23.82 - Tapping an action code brings up the description.

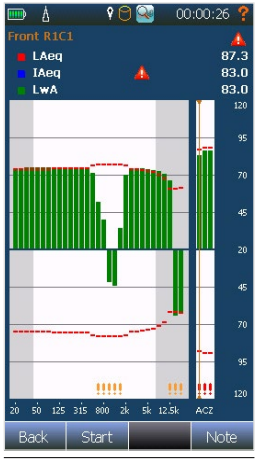


Figure 23.83 - Sound power and intensity presented together.

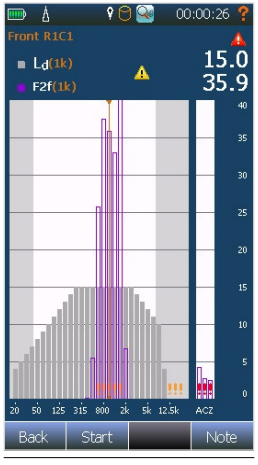


Figure 23.84 - Dynamic capability (Ld) and F2.

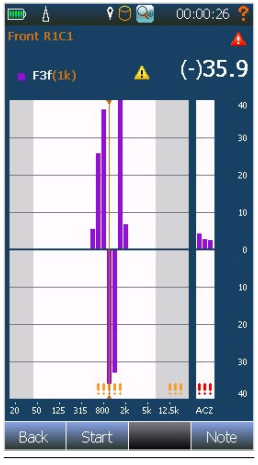


Figure 23.85 - The F3 field indicator.



Figure 23.86 - A level versus time view is also available for a segment.

Surface scope

The surface scope presents data from all segments inside a surface. Thus, it functions as an intermediate total, simply to gain overview of the different surfaces and provide easier analysis of the source under test. Press **VIEW** to toggle between the views described below.

Scope view

Presents a graphical view of the measurement surface. The A-weighted value for the surface is displayed, along with A-weighted data for each individual segment. Select the displayed function using the **FUNC** key. Scope view is illustrated in *Figure 23.87*.

If you press the **INFO** key in this view, you will find information about the current segment and surface (and their areas), as shown in *Figure 23.88*.

Simple view

A graph is presented for sound pressure along with either sound intensity or sound power. Warnings are indicated for each frequency band, and the complete surface. Toggle between sound power and sound intensity using the **FUNC** key. Press **INFO** to bring up the warning window. In surface scope, the warnings are summed and they display how many warnings there are for all segments inside the surface. The display is equal to simple view for a segment.

Advanced view

Four different function groups are presented by toggling the **FUNC** key. The warning window is available for all graphs by pressing the **INFO** button.

The first group is sound power, sound intensity and sound pressure at the same time, the same way as for a segment *(Figure 23.83)*.

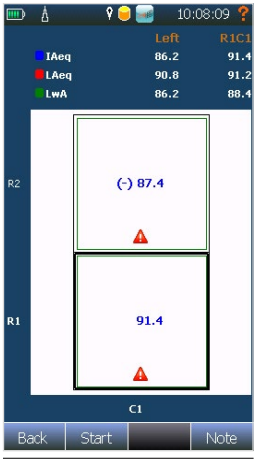


Figure 23.87 - The surface scope shows all segments in a surface.

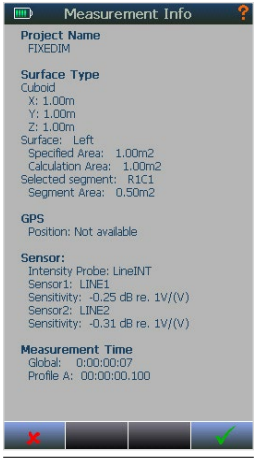


Figure 23.88 - Tap INFO to bring up the measurement info in scope view. Note the Specified Area and Calculation area.

The second group is dynamic capability along with the field indicator F2, the same way as for a segment *(Figure 23.84)*.

The third group is the F3 indicator, the same way as for a segment *(Figure 23.85)*.

The last group is F3-F2 (F3 subtracted by F2), which is a measure for the extraneous intensity.

The F3-F2 is equal to the one for Total Scope, presented in *Figure 23.88*.

Total scope

The total scope presents the total data generated from the sum and average of individual segments.

NOTE: The sound power levels are calculated based on the area defined for each of the measured segments. The area resulting from the specified Surface Dimensions is strictly a guidance for defining the surfaces and segments. In Total Scope View, press INFO to see the measurement information as in *Figure 23.89*. Calculation Area is the actual area used in the sound power calculation.



Figure 23.89 - Carefully note the Calculation Area to ensure it matches the actual measurement. Lw will otherwise be wrong.

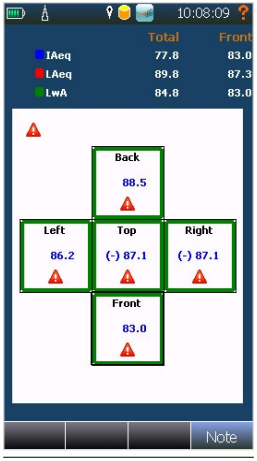


Figure 23.90 - The Scope View for Total.

Scope view

Presents a graphical view of the total measurement surface. The total A-weighted data is shown, and A-weighted data is indicated for each measurement surface. Select the displayed function using the **FUNC** key.

A red frame will be drawn around incomplete surfaces. The surface will have a green frame when all segments are measured. *Figure 23.90* shows the view. Table representation is also available using the **TBL** key.

Simple view

A spectrum is presented for sound pressure along with either sound intensity or sound power. Warnings are indicated for each frequency band, and the complete surface. Toggle between sound power and sound intensity using the **FUNC** key. Press **INFO** to bring up the warning window. In total scope, the warnings are summed and they display how many warnings there are for all segments. The display is equal to simple view for a segment. A summary is presented when the cursor is placed on A, C or Z. *Figures 23.91 and 23.92* illustrates the concepts.



Figure 23.91 - Overview of all warnings are presented when the cursor is placed on A, C or Z in Total Scope.



Figure 23.92 - Warnings for each band in Total Scope.

Advanced view

Six different spectrums are presented by toggling the **FUNC** key. The warning window is available for all spectrums by pressing the **INFO** key. Table representation is also available using the **TBL** key.

The first function group shows sound power, sound intensity and sound pressure at the same time. Illustrated in *Figure 22.93*.

The second group is dynamic capability along with the pressure-intensity indicator F2. Illustrated in *Figure 23.94*.

The third group is the negative partial power indicator F3. The display is illustrated in *Figure 23.95*.

The fourth group is F3-F2 (F3 subtracted by F2). The display is illustrated in *Figure 23.96*.

The fifth group is the field non-uniformity indicator F4 and its requirement F4Lim. The limits will update dynamically with the number of measured positions and selected accuracy. The display is illustrated in *Figure 23.97*.

The last group is the temporal variability indicator F1 and its limit F1Lim. The F1 is directly derived from the Temporal Variability measurement currently selected. The display is illustrated in *Figure 23.98*.

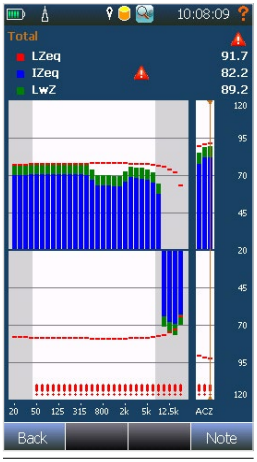


Figure 23.93 - Sound intensity, sound power and sound pressure.

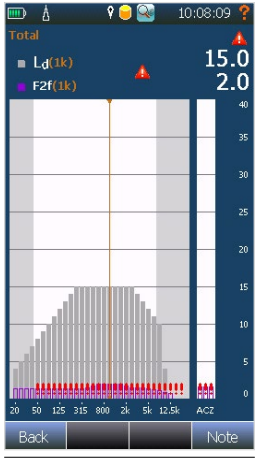


Figure 23.94- Dynamic capability and F2 for total measurement.

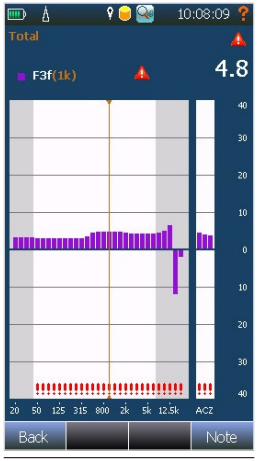


Figure 23.95 - The F3 for total measurement.

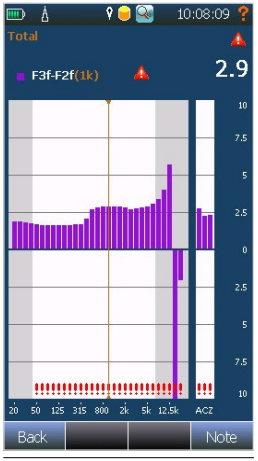


Figure 23.96- F3-F2 is a measure for extraneous intensity.

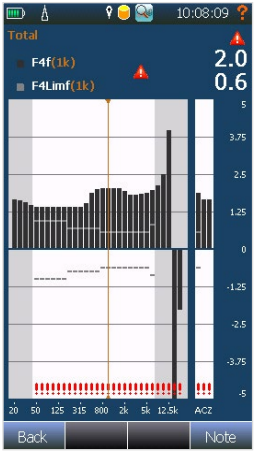


Figure 23.97 - The F4 (field non-uniformity indicator) and its limit F4Lim.

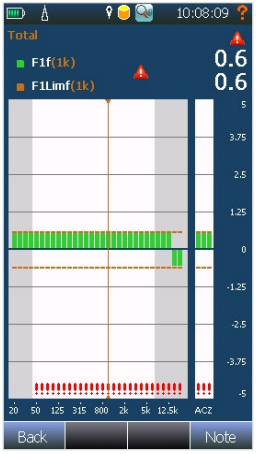


Figure 23.98 - The temporal variability indicator.

Measurement functions and indicators

Sound power measurement according to ISO 9614-1 uses the intensity values to generate sound power levels for each individual segment, and summing these for both surfaces and the total measurement surface. The F2 and F3 indicators are slightly differently treated for ISO 9614-1 than ISO 9614-2, thus F3 and the ISO 9614-2 FpI is only equivalent if the segments have uniform areas.

The physical quantities measured are

Ieq – time-equivalent sound intensity level, referenced to 1 pW/m^2.

Leq – time-equivalent sound pressure level, referenced to 20 µPa.

Deduced measurement functions

Lw – sound power, calculated for all scopes, referenced 1 pW.

F1 – Temporal variability indicator, calculated for temporal variability measurements. Linear quantities.

F2 – pressure-intensity indicator (Leq – Ieq), calculated for all scopes.

F3 – negative partial power indicator, calculated for all scopes.

F4 – Field non-uniformity indicator, calculated for total scope. Linear quantities.

Ld – dynamic capability, available for all scopes, calculated based on probe verification and grade of accuracy.

Warning indicators

High FpI
Triggered if FpI is greater than 10 dB for a frequency band.

Inadequate num. positions
Triggered if F4 is larger than F4Lim.

Too short averaging time
Triggered if the averaging time is less than the requirement for a segment.

Probe not checked
Triggered if the probe has not been phase corrected or verified the last 24 hours.

Dynamic capability too low
Triggered if the F2 exceeds the dynamic capability for a frequency band (F2 > Ld). Applies to F2 values in the total scope. The warning may be avoided by a proper phase correction and avoiding measurements in highly reactive sound fields or extraneous noise.

Dynamic capability too low
Issued if the F2 exceeds the dynamic capability for a frequency band (F2 > Ld). Applies to F2 values in segments.

Negative intensity
One or more bands have negative direction intensity/ sound power on the total surface. The A-weighted level is not valid.

Extraneous intensity
Issued if the F3-F2 exceeds 3 dB for one or more bands.

Field not stationary
Issued if the temporal variability indicator F1 exceeds 0.6 for a band.

Inadequate number of positions
Issued if N > C*F2, where N is the number of positions and C is constant dependent on frequency and selected accuracy. In practice, the deviations from segment to segment is to large, and more positions are needed to fulfil the requirements of the standard.

Weighted sum range not compliant
Issued if Weighted sum freq. range is not set to exactly 50 Hz to 6.3 kHz.

Frequency range not compliant
Issued if the filter bandwidth is not equal to or exceeding the range 31.5 Hz to 10 kHz.

High level outside A-total
Indicates that a frequency band outside Weighted sum freq. range is less than 6 dB below the total A-weighted value when the band is A-weighted.

Too short averaging time
Issued if the measurement duration is not satisfying B*T ≥ 400. B is the bandwidth of the lowest frequency band on the weighted sum freq. range [Hz]. T is the measurement duration [sec].

Building component measurements according to ISO 15186-2

The standard ISO 15186-2 describes the determination of sound insulation in buildings and of building components from sound intensity measurements. This method opens up application possibilities in constructions which were previously only possible in testing laboratories.

The standard primarily describes the measurement in the receiving room. The measurement in the transmitting room must be carried out according to the procedure described in ISO 16283-1 (former ISO 140-4). Therefore, the measurement of the receiving room levels is not the subject of the following explanations. With the Nor150, measurement in the transmitting room has to be performed in the building acoustics mode of the instrument.

The following explanations therefore primarily concern the intensity measurement in the receiving room. The standard is ultimately based on the ISO 9614-2 standard, so familiarization with the section concerning ISO 9614-2 in the present document is an important preparation for understanding the following sections.

Measurement configuration

To set up a measurement, select **SETUP** > *Applications* and then *Sound Intensity.* Now select the setup *ISO 15186.*

The measurement setup will be loaded with the following parameters:

Global time: 15 minutes. Profile A: off

Filter range: 1/3 octave bands, 20 Hz to 20 kHz.

Weighted sum frequency range: 50 Hz to 6.3 kHz

Standard: General

Accuracy: Engineering

Scanning direction: Horizontal and Vertical

These parameters essentially correspond to the specifications of the standard. However, it may be useful to adapt the measuring duration to the geometric conditions.

The standard requires two scanning directions rotated by 90°.

HINT: There is no difference between Horizontal and Vertical scanning direction except for the name, which could rather be Scan 1 and Scan 2. Horizontal and Vertical is used as annotation for convenience. An H and V will appear on the segments when either of these scanning directions has been used.

Then select the dimensions of the measuring surface in **SETUP** > *Surface Definition*.

Only one surface is available for the component measurement, which must correspond to the surface of the component to be measured. However, this surface can be divided into smaller segments (partial surfaces). The basic procedure for this is described *"Defining a measurement surface" on page 154*

If you want to measure different surfaces in a room (e.g. door, wall, floor, etc.), create a separate project for each component.

Before the measurement is started, the environmental parameters must be set up and the probe calibrated as described in *"Probe and environment parameters" on page 153* " and *"Calibration and phase correction" on page 147*".

NOTE: The dynamic capability check in the instrument relies on the measured dynamic capability during a correction or verification. Always calibrate if the instrument has been transported or the environmental conditions have been changed since last verification, or if the last verification was more than 24 hours ago.

Measuring

Please make sure that the measurement is configured and set up as described in the previous section, including the calibration routine.

The measurement surface may be marked to guide the orientation of the probe during a scan.

In practice, the measurement area often corresponds to the component (e.g. door, window). If partial areas or partial surfaces are measured, it is helpful to mark them with adhesive tape.

A single-plane laser device may also be useful to keep the probe in the measurement plane.

If you have divided the surface into several segments, you now have to decide which part of the surface you want to start with. If the surface is not divided, this choice is not necessary.

Tap into the selected segment. Pressing **START/STOP** will automatically start the measurement. Scan the segment, and press **START/STOP** to stop the measurement when the scan is completed.

Follow the specifications of the standard in section 6.5.2 and 6.5.5 for distance from the surface (0.1 - 0.3m) and scanning speed (0.1 -0.3m/s).

When the measurement is stopped, the Simple View will be displayed, and the instrument will allow either to accept the measurement using the ✓ key, or discard the measurement using the ✘ key. The measurement may be reviewed as normal while waiting for accept. The next section will describe how to review the results in detail.

ISO 15186-2 requires horizontal and vertical scanning of the measuring surface.

Therefore, pressing the **START/STOP** button again triggers the 90° shifted measurement on the same measuring surface.

If several segments are selected, the next segment is automatically selected. Repeat the procedure described above in this segment.

When all measurements have been taken, press the **Back** softkey to return to the *Scope View,*

Reviewing the measurements

As is well known, in ISO 15186-2 there is only one surface. Therefore, only one surface is shown in the scope view. This is referred to as Single.

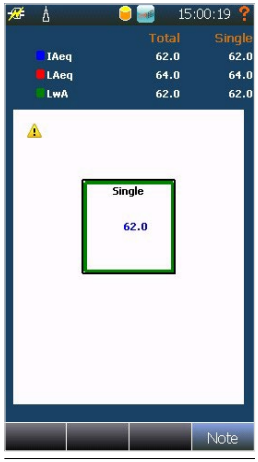


Figure 23.99

If this surface has been divided into segments, the individual segments can be opened by tapping. This procedure is described on *"Introducing the surface scopes" on page 160.*

Segment Scope

After tapping on the desired segment or pressing **VIEW**, a graphical representation appears.

The graph presents sound pressure and either sound intensity or sound power. Warnings are indicated for each frequency band and the segment total. Toggle between sound power and sound intensity using the **FUNC** key.

Press **INFO** to bring up the warning window. *Figures 23.101 and 23.102* shows the simple view for a segment, with and without the warning panel.

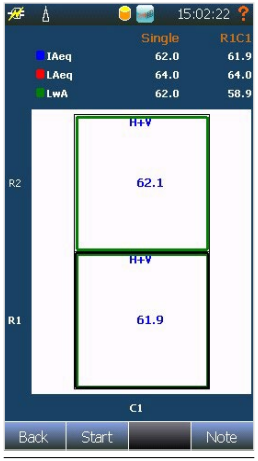


Figure 23.100 - Segment Scope

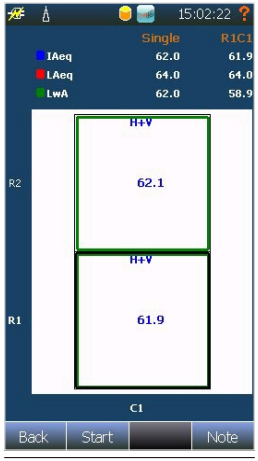


Figure 23.100 - Segment Scope



Figure 23.102- Warning panel for a segment

The **Average**/**Horizontal**/**Vertical** softkey alternately shows the data of the individual scans or their average value.

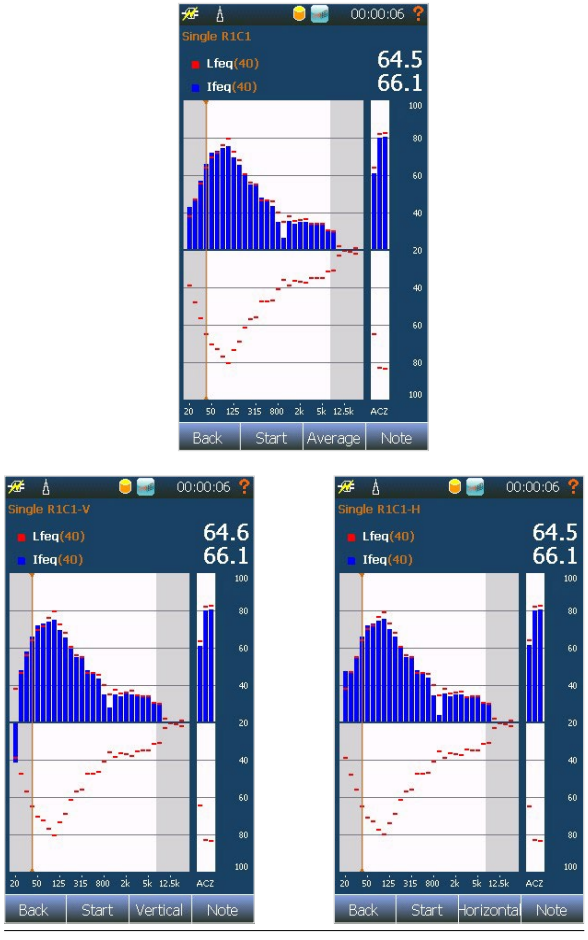


Figure 23.103 - View of the average and the two scans

Total Scope

The total scope presents the total data generated from the sum and average of individual segments. Therefore, the display of the individual scans is omitted. The type of presentation that can be selected corresponds to the presentation in the Scope segment.

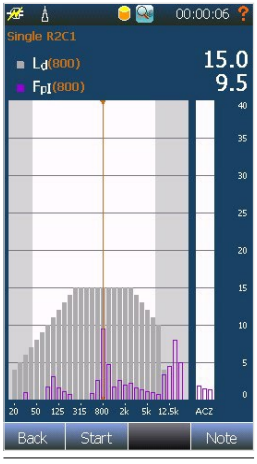


Figure 23.104 - View Dynamic capability

Field indicator FpI

Measurements using the ISO 15186-2 requires evaluation of field indicators in addition to the sound level and sound intensity.

There are three criteria involved.

The first criterion is the surface pressure-intensity indicator according to section 6.5.4 of the standard. However, the rules of ISO 9613-2 are always used in the Nor150 regardless of the absorption characteristics.

The corresponding warnings/error messages in the info window mean the following:

Warning indicators

Dynamic capability too low
Triggered if the FpI exceeds the dynamic capability for a frequency band (FpI > Ld). Applies to FpI values in the total scope. The warning may be avoided by a proper phase correction and avoiding measurements in highly reactive sound fields or extraneous noise.

Dynamic capability too low appears if the FpI exceeds the dynamic capability for a frequency band (FpI > Ld). Applies to FpI values in segments.

High FpI
Issued if FpI is greater than 10 dB for a frequency band.

Other filed indicators
ISO 15186-2 additionally requires in section 6.5.5.2 that a repeatability check for scanning is performed. This test is not performed by the Nor150 but can be easily performed by the user with the help of the display of the two scans.

ISO 15186-2 also requires in section 6.6 that the measured intensity is not negative in any band. This can be easily checked by looking at the intensity graph. The instrument does not automatically check this criterion. It is recommended to check this condition after each scan, as measurements with negative intensity are invalid.

The standard suggests measures to fulfil the requirement for all three criteria.

Instrument Specific Setup

This menu *(Figure 24.1)* holds all the setup related to the peripherals, power saving settings, language, clock, etc.



Figure 24.1
Instrument setup menu.

Digital and Analog I/O



Figure 24.2

In this menu *(Figure 24.2)* you configure *Analog* and *Digital outputs*.

Digital Output

The four digital output lines are found on the 15 pin I/O socket on the right-hand side of the instrument. Each line may be set to the following functions:

Running – The line goes active when the instrument is measuring.

Recording S1 – The line goes high when sound recording in ch1 is performed.

Recording S2 – The line goes high when sound recording in ch2 is performed.

Overload S1 – The line goes high when sound channel 1 is overloaded.

Overload S2 – The line goes high when sound channel 2 is overloaded.

Calibrating – The line goes high when you enter the calibration menu.

Mic. Check – The line goes high when the Mic. Check feature is enabled. Mainly used to start the electrostatic actuator calibration feature in the outdoor microphone 1210A or C. See “Microphone check” on page 40.

Remote controlled – The line goes high when the Nor150 is controlled from another device.

High – The line stays permanently high.

Low – The line stays permanently low.

Events/Markers – The line goes high if an event or marker is enabled.

Remote Output – This line may be controlled from remote via another program.

Please note that Digital Output 4 will be disabled and greyed out if the analog output is enabled, as shown in *Figure 24.2*. See further description below.

Headset

The headset output is optimised for listening purpose, and not for instrumental purpose. The analogue output found on the 15 pin I/O connector is for instrumental purpose. Discussed in the section below.

In the Headset menu you configure what signal you want to direct to the headset socket found on the rear panel; Playback, Sound Channel 1 or Sound Channel 2:

Playback is used when you want to playback and listen to a sound recording obtained in a measurement.

Sound Channel 1 or 2 is chosen if you want to listen to the current microphone signal from either channel 1 or 2.

Headset volume adjusts the headset level.

Analog Output

This menu manages the setting of analogue output found on the 15 pin I/O socket. The purpose is to bypass the microphone signal from either channel 1 or 2, to other devices for further analysis. It features a 24 bit DAC ensuring a wide dynamic range and low noise over the entire frequency range. Enabling this channel will disable digital output 4, since they are sharing the same physical pin on the I/O connector.

The output level is 1:1 relative to the input signal. The signal can be adjusted ± 20 dB.

Communication



Figure 24.3 - Communication setup menu.



Figure 24.4 - Insert WLAN dongle.

The WLAN dongle model 4614A is no longer supported by most modern access point / routers due to its outdated and low-level security standards. It is recommended to use a compact access point device instead—such as the TP-Link Nano Router or a similar model—for improved compatibility and security.

NOTE! Make sure the instrument is powered off before unplugging the WLAN dongle. Unplugging it when the instrument is powered may cause the system to permanently disable the software driver for the dongle. Especially if the dongle is unplugged the first 10 seconds after the dongle is connected. This is the time it takes to initialise the dongle. However, it is not limited to that, each time the dongle scans the network it is a possible change to permanently disable the driver if the dongle is disconnected. Thus, never disconnect the dongle when the Nor150 is on.

In this menu *(Figure 24.3)* you specify the settings related to the LAN, WLAN, USB and the RS232 interface.

LAN. Defines how to communicate via the LAN interface. You may choose between automatic or static IP address. If Static, specify the IP address, Subnet Mask and Default gateway.

WLAN. This requires that the WLAN dongle type 4614A is connected to the USB 2.0 port. *Cf figure 23.4.*

The available networks will be shown in the WLAN submenu. The system will automatically connect to the last connected network. The WLAN feature does not support hotspot mode. Wifi direct is also no longer supported by Windows version 10 and above.

USB. Select between Normal, where you use the USB as a IP interface, or Remote Display. For easy connection the unit is set up with a default IP address used on the USB interface; 10.150.150.1

RS232 is found on the 15 pin I/O socket on the right hand side of the instrument. Use cable Nor1441B to connect the unit to a PC via the RS232 interface.

File Transfer (FTP). Always turn on the password protection if you connect the instrument to a public or unsecured network. If not, the instrument is an easy victim for cyber-attack. It is a good practice to always use a FTP password regardless of the connection environment.

The remote connections menu *(Figure 24.5)* offers two choices; Access to NorCloud or Remote API. Only one can be enabled simultaneously.

Remote API – option 15, remote API , enables system designers to integrate the instrument into their application. It is a certain support level to get started, thus this feature is intended for system integrators using Norsonic instruments as a part of their application. Contact your local distributor for more information.



Figure 24.5

NorCloud

NorCloud - Option 12, enables you to connect the Nor150 to NorCloud, a cloud based system for unattended noise monitoring. It offers remote configure of the instrument, automatically collection of measurement data and reporting. Alarms are sent as e-mail or SMS to predefined addresses.

Unlike older systems where the central server was the controlling part and asked the instruments to send data, NorCloud is opposite. It is the instrument that initiates the connection and acts like an independent smart unit that sends data to the NorCloud server at predefined intervals.

When NorCloud is enabled Nor150 will automatically connect to the NorCloud server if following conditions are met;

- A proper connection to server via LAN, WiFi or the LTE modem.
- Option 12 is installed.
- A valid NorCloud customer account.
- Correct address to the server. The default address is norcloud.norsonic.com . This address should normally not be changed unless you are connected to a local installation.

When the NorCloud service is activated in the Nor150, it will start a measurement as soon as it is logged on and assigned to a project. The measurement display is replaced by an information panel telling you the status of the connection to NorCloud *(Figure 24.6)*. A NorCloud icon is displayed in the status bar once a connection is established.

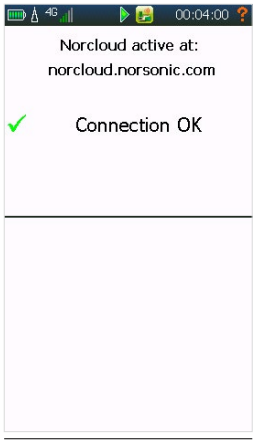


Figure 24.6 - NorCloud connection picture. Status connected and OK.

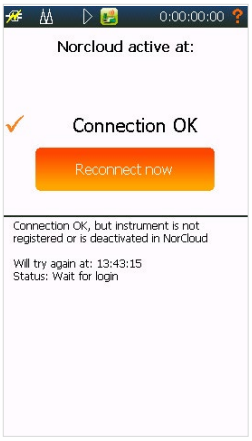


Figure 24.7

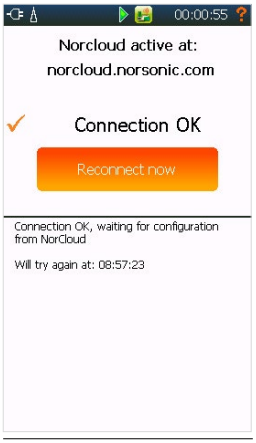


Figure 24.8

You may revert back to the normal measurement display by pushing the ✘ cancel button. The instrument will however return to the NorCloud display 20 sec after the last key push. The instrument will log data regardless of your exit from the “NorCloud” remote display as long as you don’t stop the ongoing measurement.

The Nor150 stores all data locally on the SD card and will not erase this data before a set limit configured in NorCloud is reached. Then it will automatically start to erase the oldest data.

Error messages

In case of a power failure or a malfunction causes the Nor150 to crash, the instrument will automatically restart and continue to measure and send data to NorCloud.

If the connection to the NorCloud server is lost, the Nor150 will continue to measure and will frequently try to establish connection and continue to send data from where the connection was lost.

List of status messages

Status and error messages provided by the Nor150 when running in NorCloud mode.

In case of an error, the green tick mark is replaced by an orange tick mark and a “reconnect now” button appears. In the lower frame, an error message is displayed *(Figure 24.7)*.

Communication with the server is OK but the instrument is not active in NorCloud. Log into NorCloud and check that the instrument is defined and enabled. When everything is correct in NorCloud you can use the 'Reconnect Now' button to force the instrument to connect again.

Communication with the server is OK but the instrument waiting for new configuration from NorCloud *(Figure 24.8)*.

No communication with the server specified. Check the server address in the 'Communication/NorCloud' menu in the instrument. Use the 'Reconnect Now' button to force the instrument to connect again *(Figure 24.9)*.

Figure 24.10 will be displayed if you stop an ongoing measurement manually from the instrument's keypad.

Consult your local Norsonic sales office or the factory to obtain more information about NorCloud and the use of it.

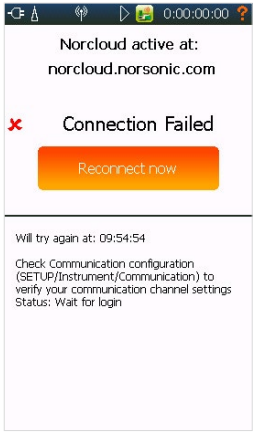


Figure 24.9



Figure 24.10

NorVirtual

NorVirtual Norvirtual is a free ware program for PC and smartphones. The PC desktop program *(Figure 24.11)* is found on www.norsonic.com/downloads, while the smartphone program is found on Google Play and App Store.



Figure 24.11- NorVirtual

NorVirtual creates a copy of the Nor150 including live update of the screen on your PC, pad or smartphone. This feature is especially useful for seminars or to remote control the instrument in a simple and easy way since it is a 1:1 copy of the instrument screen.

Connecting to your PC

The use of the program is simple. Just connect the instrument to the PC. Use the Connect menu to connect. The View menu offers various features for scaling the instrument size, split the keyboard etc. The File menu support an easy way to take a snap shot of the Nor150 screen without using a snipping tool or similar. NorVirtual is a freeware and can be downloaded from www.norsonic.com/downloads.

Connection to your smartphone

Download NorVirtual app (*Figure 24.12*) from Gogle Play or App Store depending on phone type.

NorVirtual app allows the user to remote control the Nor150. The app is an image of the display and keyboard of the instrument and allows the user to control all functionality in this sound level meter, like configuring measurement parameters, controlling different types of measurement and monitoring ongoing measurements.

You may set event markers, take photos and record voice notes that are added to the level versus time trace of the measurement for later analyses in a Norsonic post process program.

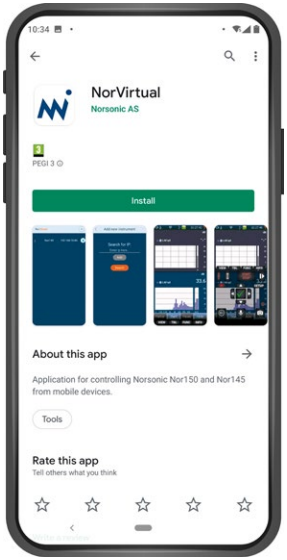


Figure 24.12 - NorVirtual App.

Connection:

Phone and instrument must be connected with Wifi in one of these ways:

- The tiny USB-WiFi dongle following the delivery of the Nor150 connects only via a Wifi network or Router. Connect the Phone and instrument to this network.
- Alternatively, you may connect a small router to Nor150 and connect your phone to this router/ access point.

Once you have established a Wifi connection, the WLAN/WiFi item in the **SETUP** > *Instrument* > *Communication* menu (in the instrument) will show an IP address. When starting the NorVitual app, enter this IP address or use the app to search for available instruments *(Figure 24.13)*. Select the instrument to start a remote session. You may be prompted for a password if this feature is enabled in the instrument (recommended) *Figure 24.14*.

If connection is lost the app will stop. It can be easily restarted by just selecting the instrument again.

Keyboard

The upper 4 keys (**VIEW**, **TBL**, **FUNC** and **INFO**) are always available. The entire keyboard can be dragged in by hitting one of the visible keys and drag upwards. See *Figures 24.15, 24.16* and *24.17*.

Camera and Microphone

It is possible to use the phone for taking pictures and making voice comments to attach to the measurement. These can be activated using icons at the bottom of the virtual keyboard.

Be aware that pictures taken with the phone cannot be viewed in the instrument, but can be viewed in NorConnect and NorReview.

Limitations

The response when clicking and scrolling is slightly slower than using the instrument directly. The latency depends on the connection bandwidth and the general workload in the instrument.

Touch scroll/drag does not support “flick” (quick/accelerating drag).

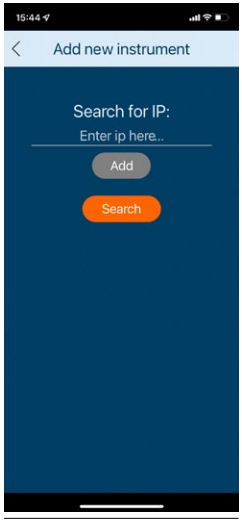


Figure 24.13

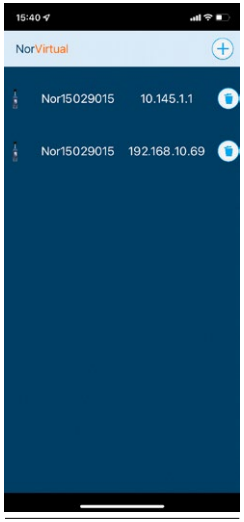


Figure 24.14

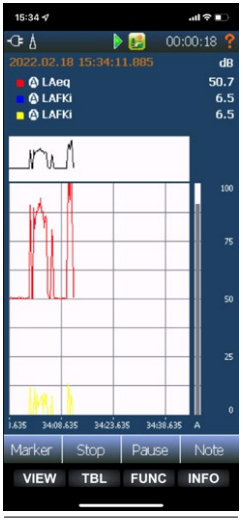


Figure 24.15

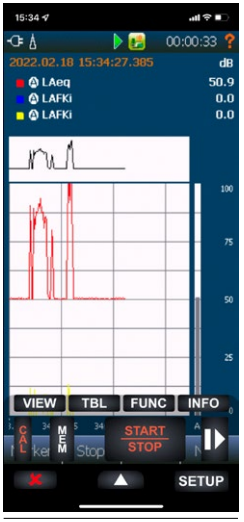


Figure 24.16

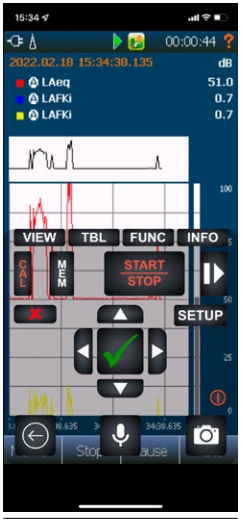


Figure 24.17

Reference Tone

The use is described in *"Recording the sound - Audio record and replay" on page 87* - inserting a reference tone as a recording.

Power Settings

The Power setting menu is divided in three main settings;

1. Backlight time out for screen and keyboard including brightness levels. The factory settings is a good compromise between power usage and backlight brightness settings. Other settings may be preferred dependent on your application.

2. External power. Two settings; Normal and Solar cell. Solar cell should be used if the unit is powered from a solar cell system. Also use this setting if a Nor1545 noise monitoring cabinet is powered from a solar cell. The instrument will shut down at 75% remaining capacity in Solar cell mode. This ensure a sufficient reservoir when the Solar cell starts charging the external battery pack and power the instrument again. The power delivered from the solar cell is often not sufficient to power both the instrument and recharge the external battery. Particular in the morning or during bad weather conditions. Thus, this often results in multiple power on/off sequences before the solar cell delivers enough power to ensure a stable operation. If the internal battery is completely discharged it is not able to do a controlled shut down which may result in damaged files on the SD-card or a malfunction in the battery controller casing the instrument not starting up again when the power reverts back.

You may also "power off" the GPS here. It is recommended to switch the GPS off if not in use to save battery.

For further details regarding power saving see *"Power saving - maximize your battery power" on page 29* .

Instrument Name

This is the name that is used as identification tag for transferred measurements, remote control etc.

Date and Time

Ref *Figure 24.18*. Here you set the date and time and access the GPS/ synchronization setting menu. Use either the spin wheels or the keyboard. The internal real time clock has a typical max deviation of 160ms/24hour (0-40 °C).



Figure 24.18 - Set date and time menu.

The date and time can also be adjusted/synchronized with the GPS clock or with another instrument using the synchronization feature.

The submenu *Multi Instrument Sync menu* offers several options to time synchronise one or more instruments.

*Sync. Clock with GPS clock (Figure 24.19).*This feature allows you to sync the real-time clock with the GPS clock. Please note that this is a manual operation, and is not a continuous sync.

If this menu is greyed out, the GPS is either switched off or the option is not installed. The GPS is switched on in the power setting menu.



Figure 24.19- Sync input and output.

Time synchronizing several Nor150. Some applications require exact time synchronization between several measurement channels. This may be challenging if the measurement points are physically separated from each other. Typical applications are structure born noise or vibrations in buildings or measurements of noise propagation from blasts or other impulsive noise.

The Nor150 has a special synchronization feature allowing several Nor150 to be synchronized. It is basically separated in two levels of accuracy.

- Synchronized real time clock. The clock is adjusted equally on all instruments connected to the master instrument via a synch cable. After the clock setting, the cables are removed and the instruments will have a maximum clock deviation of 175 ms/24 hour (0-40 OC).
- Same as above, but the instruments are connected together with the sync cable during the measurement sequence. The instruments will then run synchronous within one sample, or in other words, 1/48000 sec accuracy. This applies to both the measured values and the audio recording even with 48KHz – 24-bit resolution.

The synchronization requires that cable type Nor4633 is connected to each of the Nor150's 15 pin I/O connector. One unit is set as master, the others as slave *(Cf. Figure 24.20)*. The cable connection is a nested connection. The master unit will send sync pulses on the connector labelled "Out". Connect the "out" from the master unit to the first slave units cable labelled "in". Then connect the "out" from the first slave unit to the next slave units "in" and so on.

The out signal is found on DO - 3 (pin3) and the in signal is on DI-3 (pin 10).



Figure 24.20 - Multi instrument Sync menu

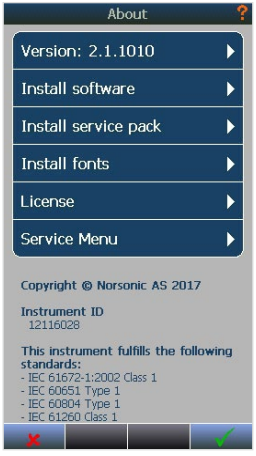


Figure 24.21 - About menu

After the connection is completed and proper master slave connection is set, select “Sync Clocks now” on the master instrument (Only one can be set to master within the network.). You should get a message at the slaves displays that the clocks are synchronized.

If your application requires that the instrument is running without the sync cable connected (long distance between the instruments) set all slave instruments back to “Normal” before you remove the cables.

If you keep the cable connection to take advantage of the high accuracy of 1/48000 sec during all measurement you must keep the slave settings on the instruments during your measurement session.

Remember to set back the slave instruments to normal before removing the cables.

It is two additional function buttons in this menu *(Figure 24.19)*.

Simultan. RTC sampling. This is a control button. With this button you may verify the time synchronization. The time displayed on master instrument shall be the same on the slave instrument if you push the “Simultan RTC sampling” button on the slave.

Sync Mode. This opens a sub menu *(Fgure 24.20)* where you configure if the unit shall be a master or slave. If set to Normal, the multi sync feature is disabled, and the other menu settings are disabled.

Language

Select the language to be used in the menus and help texts if applicable. Some languages may only be supported with English help file text.

Number Format

Here you specify the number of decimals you want to use.

About

Here you find information about the software versions and installed options *(Figure 24.21)*. This is also where you install new options and software.

Version. This menu holds detailed information about the installed software versions.

Install new software, service pack or new fonts

Norsonic will frequently issue software updates with new features and bug fix. The software is found on www.norsonic.com/downloads. When entering the download site, you are prompted to leave your Name, e-mail, product type and serial number of the Nor150 to access the download site. The only reason for asking for your contact data is to enable us to inform you in case of vital bugs are found in the software you have downloaded. Your contact data will not be distributed or used by Norsonic for other purpose than described above.

Follow the instruction given on the download site. The instructions on download site supersede the information given below.

Copy the application and service pack onto a USB memory stick.

The term service pack is the name for all files belonging to the update of the operating system. Connect the USB stick to the Nor150 USB port while the instrument is turned off. Turn on the instrument. The Instrument will find that a new software version is available and ask you to confirm to update the software. The software update takes a few minutes. If the automatic search for a new software update fails, you may start the software installation from the **SETUP** > *Instrument* > *About* > I*nstall Software menu*. If your memory stick contains more than one version, select the version to update. Also use this menu if you want to downgrade to an earlier version or reinstall the current version.

Instruments connect to NorCloud may be updated automatically from NorCloud. Cf NorCloud user documentation on www.normanual.com or via the NorCloud user info button.

Please note! Instruments sold in France, Austria, Germany, Spain, Switzerland, Japan, Portugal and China are subjected to use pattern evaluated software only. Users in these countries are requested to contact their local Norsonic representative to get the current type approved version. These instruments are normally fitted with a "seal" option preventing unauthorised software updates.

The software license system

Nor150 may be fitted with software option extension at any time. The capabilities and setup options of your Nor150 will depend on which of the available extensions it has been equipped with.

Extensions are modules – made as software, in the instrument. Instrument extensions are always optional and hence often referred to as options. In this way you do not have to pay for features you're not going to use.

However, you may find that your tasks are expanding into new areas of acoustics as time goes by. Therefore a typical Norsonic extension will be available for installation as retrofit. The optional extensions may enhance the operation of the instrument considerably. Normally these types of options are called modes of operation. Such extensions may be Sound Intensity or Building Acoustic for the measurement of sound insulation including measurement of the reverberation time. Please note that some hardware options cannot be installed as retrofit.

Installing new options

Installing new options requires a new licenses code. The licenses code should be copied onto a memory stick. The license code is set in a text file named License.txt. Connect the memory stick to the USB port on the Nor150. Install the new license code in **SETUP** > *Instrument* > *About* > *License* > *enter license*.

NOTE! Only the license code string shall be copied to the memory stick. Not the associated text that normally follows the license. Use Notepad or similar simple text editors to copy the license string and create the license.txt file.

NOTE! If you enter a time limited license code the instrument will revert to the license code menu after the license has expired. The license code must be available on a memory stick and installed as described above.

Activate evaluation license

The Nor150 offers a 60 days trial period where all options is enabled. Activate the trial period in the **SETUP** > *Instrument* > *About* > *License* > *Switch to Evaluation License*. The menu button becomes inactive after the trial period expires.

NOTE that in several countries the software update may be blocked. The reason is that your instrument is type approved with a certain version. Hence, updating to a non-approved version is not legal. In this case contact your local Norsonic sales office.

Service Menu. Is protected by a password and is only for authorized personnel. Wrong settings here may change vital calibration settings in the analogue and digital measurement chain.

Norsonic software

There are several software programs associated with the Nor150:

NorConnect Nor1051 is our file transfer and data management program for the Nor145 and Nor150 instruments. The program supports all communication environments offered by the new generation of instrumentation and measurement hardware and enables remote connection via modem, WLAN or LAN. NorConnect is freeware and is a part of the instrument delivery. Please see instruction manual for Nor1051 for detailed information. You can download this from www.norsonic.com.

NorReview Nor1026 s an analyzing tool for calculations, report generation and for replaying of audio recordings and marker management. The use of this program is not covered by this manual. The General Analyzer mode in Nor850 will replace NorReview in future versions of Nor850.

Nor850i s a program for control-, analysis- and reporting for general sound measurements, building acoustics-, sound power- and sound intensity applications.

NorReport is a is a module in several Norsonic programs (NorXfer, NorReview, Nor850) for making your own reports based on Excel templates.

NorVirtual is a program that creates a copy of the Nor150 including live update of the screen on your PC, smartphone or tablet . This feature is especial useful for seminars etc. It may also be used to remote control the instrument in a simple and easy way since it is a 1:1 copy of the instrument screen. NorVirtual is also available on Google Play and Apple App store for use on smartphones and pads.

See *"NorVirtual" on page 195.*

Technical Specifications

Unless otherwise stated, the specifications are given for a complete sound level meter Nor150 equipped with microphone type Nor1225 and microphone preamplifier type Nor1209. Values are based on the sensitivity set to the nominal value for the microphone: –26.0 dB, corresponding to 50 mV/Pa.

Measuring ultrasound requires a microphone suitable for this application. Thus, acoustical data for the ultrasound option above 20kHz is not given since this is limited by the selected microphone.

A windscreen type Nor1451 and preamplifier extension cables of type Nor1408 and Nor1410 may also be used.

The definition of terms is based on:

IEC 61672-1 Ed.2.0 (2013): Electroacoustics - Sound level meters - Part 1: Specifications.

IEC 62585 Methods to determine corrections to obtain the free-field response of a sound level meter.

IEC 61012: Filters for measurement of audible sound in the presence of ultrasound.

Firmware version

The specifications in this manual are valid for a Nor150 with software version 3.0 and above. The version number can be found using the **SETUP >** *Instrument* > *About* key sequence.

The Nor150 may also be supplied with the prepolarized version of the Nor1225, the Nor1227. The specifications listed in this chapter are the same for both microphone types except that the Nor1227 does not support the high level option.

Type of instrument

Sound level meter IEC61672-1, class 1, group X measuring exponential time-weighted levels, integrating- averaging levels and sound exposure levels. It complies with IEC 61672-1 Ed.2.0 (2013).

The optional 1/1 octave-band and 1/3 octave-band filters complies with IEC 61260 (2014) class 1.

IEC 61012 Filters for measurement of audible sound in the presence of ultrasound. (Requires option 14, ultrasound and a suitable microphone).

The instrument also conforms to a number of national standards such as: DIN 45657 (2013-02-06).

Analog inputs

Number of channels: Two Sound channels. The physical and electrical specifications are identical for both channels.

Channel 1 is located on the top of the instrument and Channel 2, under the flip at the left hand side of the instrument.

Input connector

7 pin LEMO connector for Norsonic microphone systems. (LEMO ECG.1B.307.CLL)

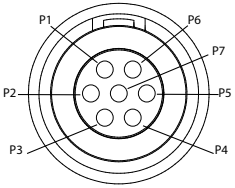
Input impedance direct connection to input socket: More than 100kohm, less than 650pF.

Maximum input signal: ±10 V peak.

Normal measurement range: 0.3 µV to 7 V (RMS) in one range corresponding to –10 dB to 137 dB with a microphone sensitivity of 50 mV/Pa.

Extended range: With the optional extension permitting high measurement range, peak values up to 150 dB may be measured.

Microphone input socket (outside view)



Pin Function

1 Microphone system check /signal input Channel 2 in Sound Intensity mode when Nor1290 and some other probes is selected.

2 GND - signal reference.

3 Polarization voltage – selectable: 0±1V, 200±1V or adjustable 70 to 74 V short-circuit current <1mA, impedance: 2 MOhm.

4 Signal input. Channel 1 Input impedance: min 0,6 MΩ, max. 250 pF. When IEPE is selected in the setup, a constant current of 3 mA is supplied (25 volt source).

5 TEDS interface pin for Lemo style preamplifiers.

6 +15±1 V preamplifier supply voltage, max 18 mA.

7 -15±1 V preamplifier supply voltage, max 18 mA.

High-pass input filter

The microphone input section is equipped with an analog high-pass filter to reduce noise from wind or other sources with frequencies in the lower end of the frequency range.

The filter response is -0.5 dB at 4 Hz (or -3 dB at 3 Hz). It should be switched on if the lower frequency of interest is in the normal audio range.

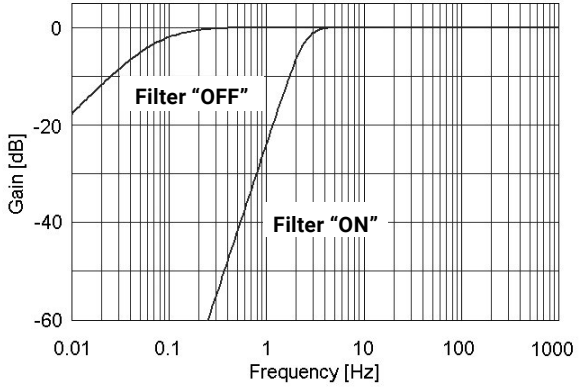
When this filter is "Off" the lower frequency response is -3 dB at 0.08 Hz (or -0.5 dB at 0.25 Hz). The setting of this filter has a great influence especially on the Z network.

Filter type: 3rd order HP filter (-3 dB at 3 Hz, Butterworth response).

The filter is turned on when the 1/1- or 1/3-otave filter is set equal to or higher than 6.3 Hz.

Microphone

Highpass filter frequency response



Nor1225 data

Microphone type: Free-field microphone
Frequency range (±2 dB): 3.5 Hz to 20 kHz
Dynamic range lower limit: 17 dB(A)
Dynamic range upper limit: 141 dB
Open circuit sensitivity @ 250 Hz (±2 dB):
-26 dB rel 1 V/Pa (50 mV/Pa)
IEC 61094 Compliance: WS2F
Typical cartridge capacity: 18 pF
Microphone venting: Rear
Resonance frequency: 14 kHz
Temperature range, operation: -40 to 85 °C
Temperature coefficient @250 Hz: -0.01 dB/°C
Static pressure coefficient @250 Hz: -0.011 dB/kPa
Humidity range non condensing: 0 to 100 % RH
Humidity coefficient @250 Hz: -0.001 dB/% RH
Influence of axial vibration @1 m/s²:
62 dB re 20 µPa
Weight: 6.5 g

Preamplifier

The standard preamplifier for Nor145 is Nor1209. But different types of preamplifiers can be used. Such as the Nor1209A with heating used in the outdoor microphone Nor1216. Preamplifiers from other manufactures may also be connected. Please verify data carefully before connecting.

Nor1209 data

The microphone preamplifier Nor1209 has been designed for general use with most ½" condenser microphone of type WS2 or LS2 according to IEC 61094-4: Measurement microphones - Part 4: Specifications for working standard microphones. The microphones may be pre-polarized or use externally supplied polarization voltage up to 200 V. By the use of adaptors, the preamplifier may be used for other microphone sizes. The frequency response covers the range from below 1 Hz to above 200 kHz.

The Nor1209 preamplifier may be mounted directly on the sound level meter, or connected via a suitable cable.

The preamplifier is equipped with a system check facility. By enabling the SysCheck signal in the calibration menu, the capacitance of the microphone as well as the complete signal chain from the microphone cartridge to the sound level meter may be checked.

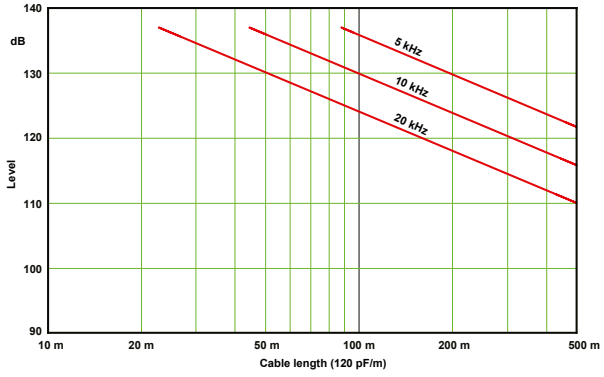
The voltage gain of the preamplifier is very close to one or correspondingly 0 dB. As the input impedance is 10 GΩ, the attenuation due to loading of the source will mainly be determined by the low input capacitance

Nor1209 Technical Specifications

Frequency response (18 pF/small signal):
20 Hz ¬– 20 kHz: ±0.1 dB
Gain: Typically -0,1 dB (-0,2 with 20 pF)
Input impedance: 10 GΩ, 1.4 pF
Output impedance: 50 ohm typical
Noise (20 pF dummy microphone):
A-weighted < 2,2µV (typically 1.8µV)
Noise (20 pF dummy microphone):
Lin (20 Hz – 20 kHz) <6 µV (typ 3.8 µV)
The preamplifier accepts the following voltage i fused via external power supply.
Power supply: ±14 V(1 mA) to ± 60 V (2.8 mA). The Nor150 supply ± 15 V to the preamplifier.
Alternative Power supply:
Single: 28 V (1mA) to 120 V (2.8 mA)
Operating temperature range: -25°C to +70°C
Relative humidity: 0 – 90 %RH
Length: 83 mm
Diameter: 12.7 mm (Ring: 18 mm)
Weight: 36 g

Cables and cable length

The Nor1209 preamplifier has excellent driving capability for long cables. The signal output from the microphone preamplifier will be loaded by the capacitance of the cable between the microphone system and the instrument. The capacitance will increase proportionally with the length of the cable. A typical value for microphone cables from Norsonic is 120 pF per metre. Hence, a cable with length 100 m, will load the output with a capacitance of 12 nF. For lower frequencies there are seldom problems with long cables. However, when the signal contains the combination of high amplitude and high frequency, the capacitive loading will lead to high output current. A limited current capacity will set limits for the maximum slew-rate for the signal. The figure below shows the maximum level as function of cable length and frequency. 20 kHz corresponds to the bandwidth of the microphone system with the normal microphone Nor1225 or Nor1227.



Acoustical data

Acoustical data for Nor1225 and Nor1209 mounted on Nor150

Reference direction:

The microphone reference direction is from the microphone and along the axis of rotational symmetry for the microphone and preamplifier.

Microphone Reference Point

The microphone reference point is the geometric centre of the diaphragm of the microphone.

The following tables gives free-field frequency response and uncertainty information for the complete sound level meter.

The data are valid in under the following environmental conditions:
Atmospheric pressure: 80 – 105 kPa
Temperature: 20 – 26 °C
Humidity: 25 – 70 % RH

Detailed table for level corrections according to IEC 62585

Nominal frequency	Exact frequency	Typical free-field mic. response	Mic. actuator to free-field correction	Expanded uncertainty Actuator-FF	Case correction	Expanded uncertainty case corr.	Windscreen correction A	Windscreen correction B	Expanded uncertainty windscreen
Hz	Hz	dB	dB	dB	dB	dB	dB	dB	dB
63	**63.1**	**0.00**	**0.00**	**0.05**	**0.00**	**0.05**	**0.00**	**0.00**	**0.05**
80	79.4	0.00	0.00	0.05	0.00	0.05	0.00	0.00	0.05
100	100.0	0.00	0.00	0.05	0.00	0.05	0.00	0.00	0.05
125	**125.9**	**0.00**	**0.00**	**0.05**	**0.00**	**0.05**	**0.01**	**0.00**	**0.05**
160	158.5	0.00	0.00	0.05	0.00	0.05	0.01	0.00	0.05
200	199.5	0.00	0.00	0.05	-0.01	0.05	0.01	0.00	0.05
250	**251.2**	**0.00**	**0.00**	**0.05**	**-0.03**	**0.05**	**0.02**	**0.00**	**0.05**
315	316.2	0.01	0.00	0.06	-0.06	0.10	0.03	0.01	0.10
400	398.1	0.03	0.01	0.06	-0.10	0.10	0.03	0.00	0.10
500	**501.2**	**0.03**	**0.01**	**0.07**	**-0.12**	**0.10**	**0.06**	**0.01**	**0.10**
630	631.0	0.02	0.04	0.07	-0.04	0.10	0.08	0.01	0.10
800	794.3	-0.01	0.05	0.07	0.08	0.10	0.11	0.00	0.10
1 k	**1000.0**	**-0.01**	**0.07**	**0.08**	**0.14**	**0.10**	**0.16**	**0.00**	**0.10**
	1059.3	-0.01	0.09	0.09	0.23	0.10	0.17	0.00	0.20
	1122.0	-0.01	0.11	0.09	0.35	0.10	0.22	0.02	0.20
	1188.5	-0.02	0.13	0.09	0.44	0.10	0.24	0.03	0.20
1.25 k	1258.9	-0.03	0.16	0.09	0.41	0.10	0.24	0.01	0.20
	1333.5	-0.04	0.16	0.10	0.21	0.10	0.27	0.02	0.20
	1412.5	-0.04	0.17	0.10	-0.02	0.10	0.31	0.04	0.20
	1496.2	-0.03	0.17	0.10	-0.12	0.10	0.32	0.03	0.20
1.6 k	1584.9	-0.03	0.18	0.10	-0.10	0.10	0.37	0.06	0.20
	1678.8	-0.03	0.21	0.11	-0.14	0.10	0.38	0.04	0.20
	1778.3	-0.04	0.24	0.11	-0.33	0.10	0.42	0.06	0.20
	1883.6	-0.05	0.28	0.13	-0.45	0.10	0.44	0.06	0.20

Nominal frequency	Exact frequency	Typical free-field mic. response	Mic. actuator to free-field correction	Expanded uncertainty Actuator-FF	Case correction	Expanded uncertainty case corr.	Windscreen correction A	Windscreen correction B	Expanded uncertainty windscreen
2 k	**1995.3**	**-0.06**	**0.32**	**0.13**	**-0.31**	**0.10**	**0.48**	**0.08**	**0.30**
	2113.5	-0.07	0.34	0.13	-0.01	0.10	0.51	0.09	0.30
	2238.7	-0.08	0.36	0.13	0.13	0.10	0.57	0.14	0.30
	2371.4	-0.09	0.42	0.14	0.11	0.10	0.61	0.16	0.30
2.5 k	2511.9	-0.10	0.48	0.14	0.30	0.10	0.67	0.20	0.30
	2660.7	-0.10	0.54	0.15	0.53	0.10	0.74	0.27	0.30
	2818.4	-0.12	0.60	0.15	0.15	0.10	0.81	0.33	0.30
	2985.4	-0.12	0.64	0.16	-0.14	0.10	0.82	0.34	0.30
3.15 k	3162.3	-0.13	0.68	0.16	0.00	0.10	0.89	0.40	0.30
	3349.7	-0.14	0.77	0.16	-0.19	0.10	0.88	0.41	0.30
	3548.1	-0.15	0.87	0.16	-0.06	0.10	0.88	0.42	0.30
	3758.4	-0.18	0.96	0.16	0.17	0.10	0.87	0.43	0.30
4 k	**3981.1**	**-0.18**	**1.05**	**0.16**	**-0.11**	**0.10**	**0.80**	**0.39**	**0.30**
	4217.0	-0.18	1.15	0.17	0.15	0.10	0.74	0.36	0.40
	4466.8	-0.17	1.25	0.17	0.02	0.10	0.63	0.29	0.40
	4731.5	-0.17	1.39	0.17	0.34	0.10	0.52	0.23	0.40
5 k	5011.9	-0.17	1.53	0.16	-0.06	0.10	0.42	0.18	0.40
	5308.8	-0.16	1.69	0.17	-0.09	0.15	0.32	0.13	0.40
	5623.4	-0.14	1.85	0.17	-0.15	0.15	0.14	0.01	0.40
	5956.6	-0.12	2.08	0.18	0.10	0.15	0.04	-0.02	0.40
6.3 k	6309.6	-0.10	2.31	0.18	0.31	0.15	0.03	0.04	0.40
	6683.4	-0.04	2.57	0.22	-0.03	0.15	0.09	0.18	0.40
	7079.5	-0.03	2.84	0.22	-0.16	0.15	0.09	0.25	0.40
	7498.9	0.03	3.11	0.22	0.05	0.15	0.15	0.38	0.40
8 k	**7943.3**	**0.12**	**3.39**	**0.22**	**0.13**	**0.15**	**0.19**	**0.51**	**0.40**

Nominal frequency	Exact frequency	Typical free-field mic. response	Mic. actuator to free-field correction	Expanded uncertainty Actuator-FF	Case correction	Expanded uncertainty case corr.	Windscreen correction A	Windscreen correction B	Expanded uncertainty windscreen
	8414.0	0.21	3.78	0.30	0.08	0.15	0.09	0.49	0.40
	8912.5	0.25	4.17	0.30	-0.07	0.15	0.14	0.62	0.40
	9440.6	0.38	4.59	0.30	-0.13	0.15	-0.08	0.48	0.40
10 k	10000.0	0.48	5.01	0.30	0.25	0.20	-0.27	0.35	0.40
	10592.5	0.54	5.50	0.38	-0.22	0.30	-0.51	0.19	0.50
	11220.2	0.55	5.99	0.38	0.06	0.30	-0.62	0.15	0.50
	11885.0	0.58	6.38	0.38	-0.01	0.30	-0.75	0.09	0.50
12.5 k	12589.3	0.58	6.78	0.38	-0.06	0.30	-0.65	0.25	0.50
	13335.2	0.61	7.13	0.38	0.01	0.40	-0.75	0.21	0.50
	14125.4	0.78	7.48	0.38	-0.18	0.40	-0.81	0.20	0.50
	14962.4	0.87	7.93	0.38	0.03	0.40	-1.05	0.01	0.50
16 k	15848.9	0.90	8.39	0.29	0.16	0.40	-1.22	-0.11	0.50
	16788.0	0.79	8.78	0.34	0.25	0.40	-1.33	-0.18	0.60
	17782.8	0.58	9.17	0.34	0.07	0.40	-1.41	-0.22	0.60
	18836.5	0.14	9.59	0.34	0.15	0.40	-1.62	-0.40	0.60
20 k	19952.6	-0.40	10.01	0.29	-0.10	0.40	-1.65	-0.40	0.60

Typical free-field microphone response: Typical free-field response of the standard microphone with preamplifier connected to the sound level meter through a microphone extension cable without windscreen and without case reflections.

Microphone Actuator to free-field correction: Correction to be added to the measured microphone response with an electrostatic actuator (IEC 61094-6) in order to obtain the free-field response for the microphone system. The corresponding expanded uncertainty (95%) includes the typical variations between different microphones of the same model.

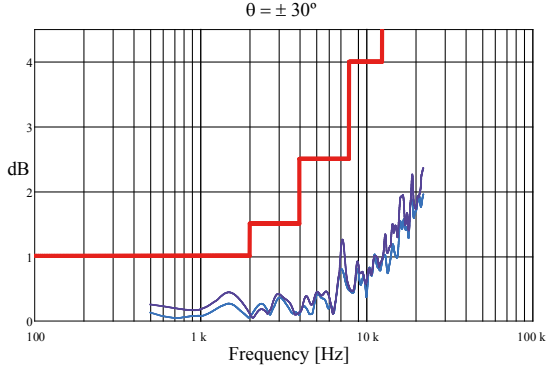
Case correction: Correction to be added to the free-field response of the microphone to obtain the free-field response of the sound level meter when the standard microphone system is mounted in the front of the instrument (Sound channel 1). The correction may also be regarded as the difference in the indicated sound pressure level when the microphone is mounted on the instrument and when mounted through an extension cable. When the response of the sound level meter is determined from electrostatic actuator excitement of the microphone (IEC 61094-6), both the actuator to free-field correction and case correction shall be applied. The corresponding expanded uncertainty (95%) includes the typical variations between different instruments of the same model measured at reference conditions.

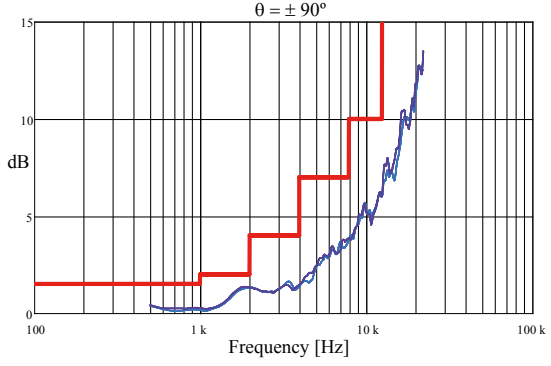
Windscreen correction A: Correction to be added to the free-field response of the standard microphone without windscreen to obtain the free-field response of the microphone when the microphone is equipped with windscreen type Nor1451 and the windscreen correction in the instrument is switched **OFF**. The corresponding expanded uncertainty (95%) includes the typical variations between different windscreens of the same model measured at reference conditions.

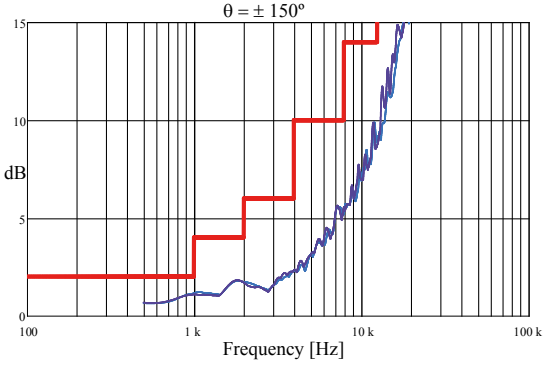
Windscreen correction B: Correction to be added to the free-field response of the standard microphone without windscreen to obtain the free-field response of the microphone when the microphone is equipped with windscreen type Nor1451 and the windscreen correction in the instrument is switched **ON**. The corresponding expanded uncertainty (95%) includes the typical variations between different windscreens of the same model measured at reference conditions.

Directional response – Horizontal

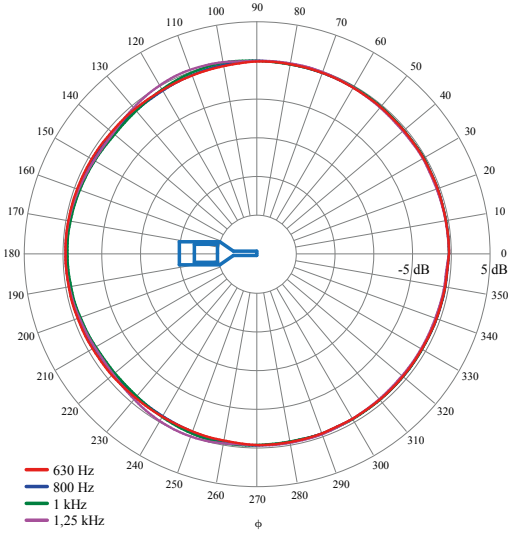
Maximum absolute value of the difference between displayed sound levels at any two sound-incidence angles within ±ϴ degrees from reference direction.

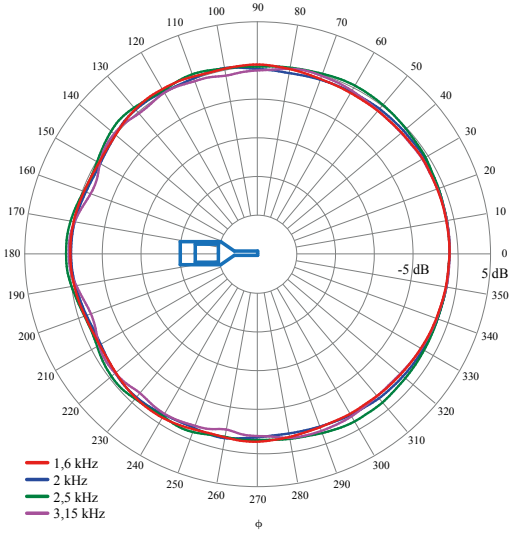


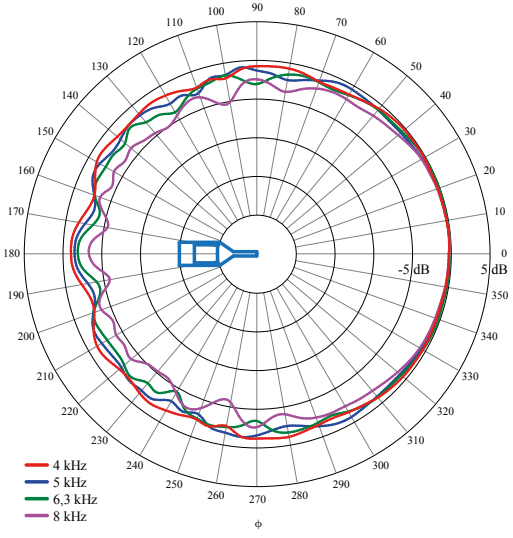


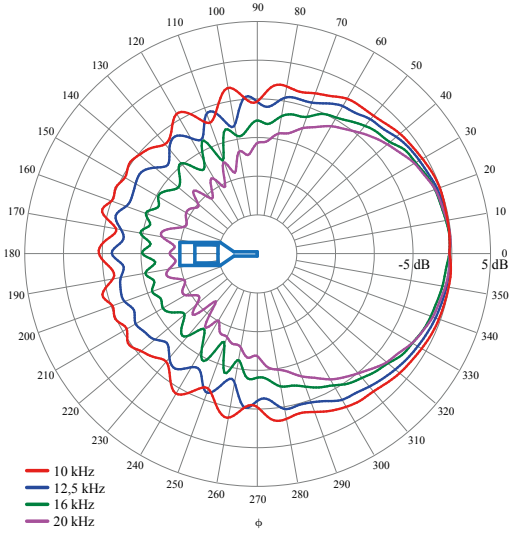


Directional response



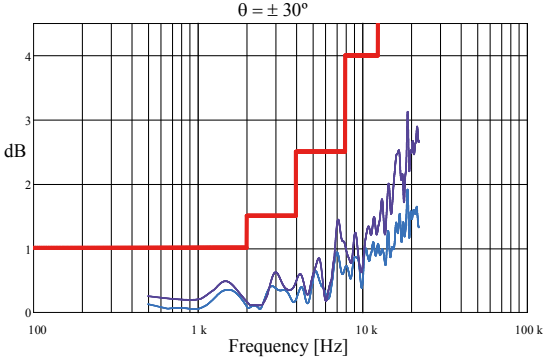


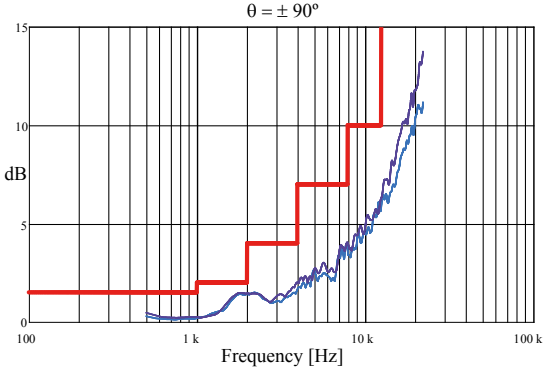


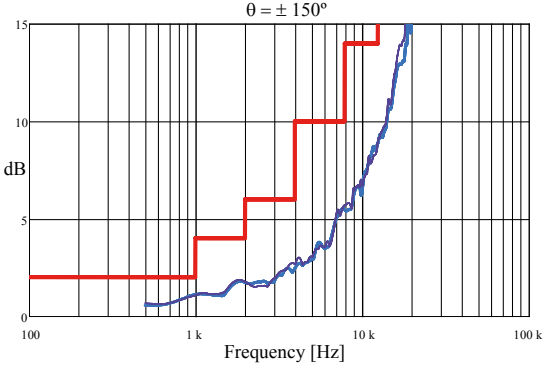


Directional response - Vertical

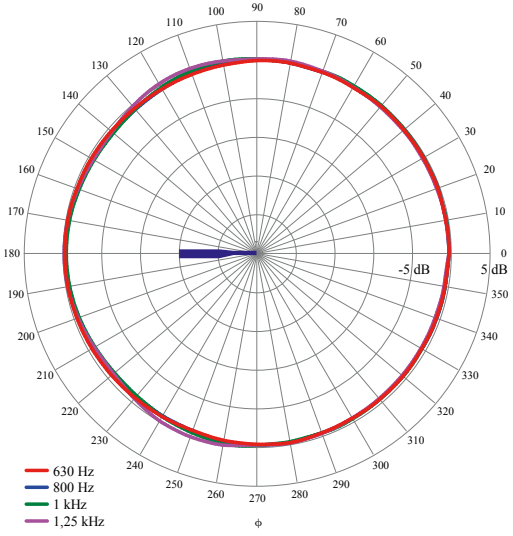
The directional response of the complete instrument is measured in the horizontal direction (sideways, with the display facing upwards). Zero degrees are in the direction of the microphone.

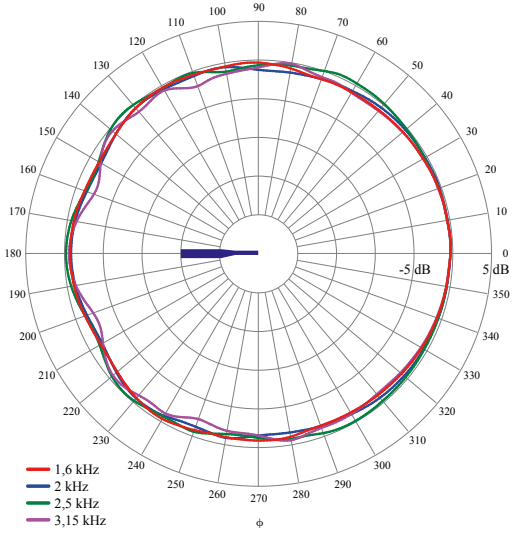


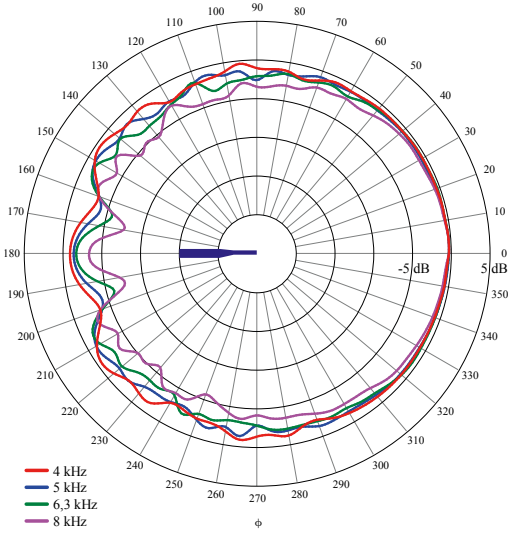


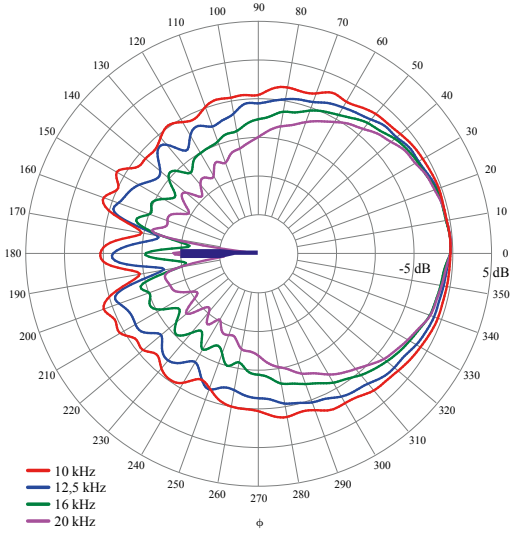


Directional response



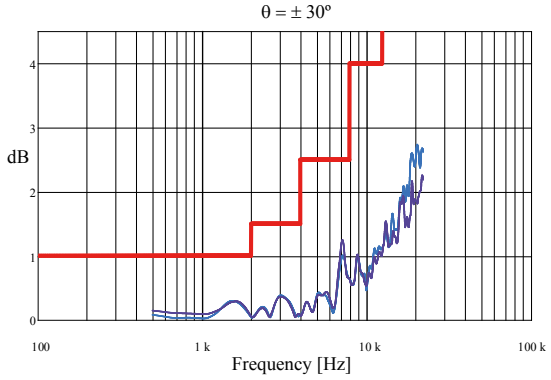


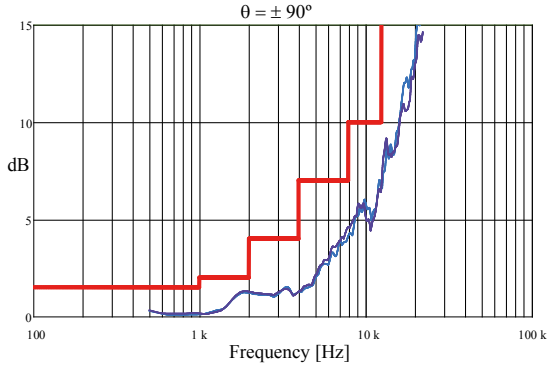


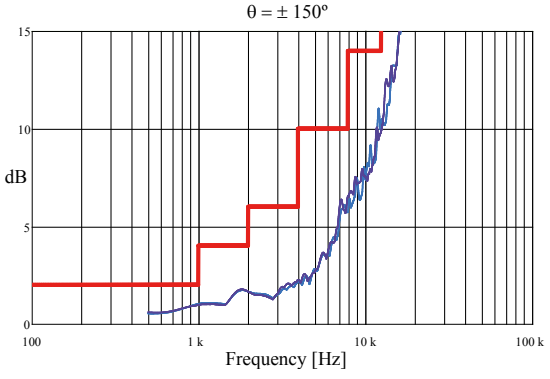


Directional response – Horizontal with Wind Screen

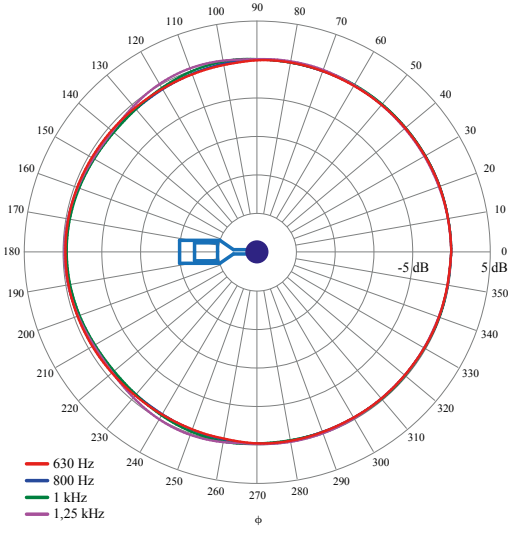
The graphs and plots below show the directional response for the complete sound level meter Nor150 with preamplifier Nor1209, microphone Nor1225 and windscreen Nor1451.

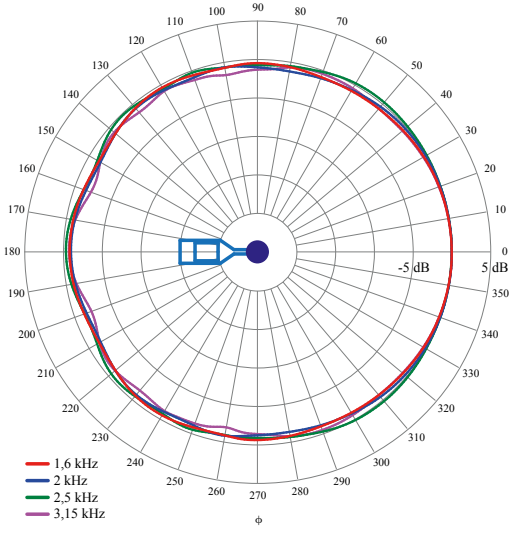


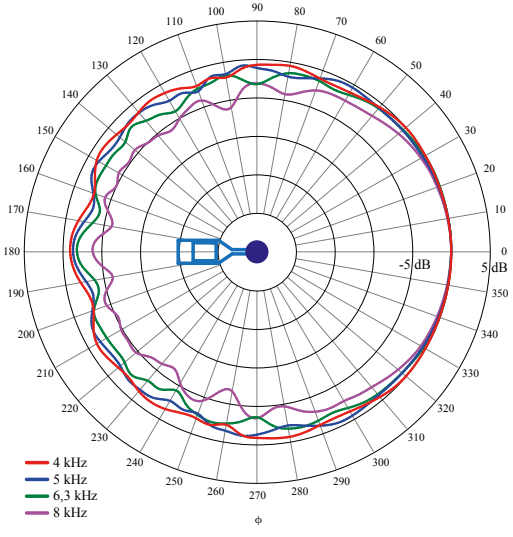


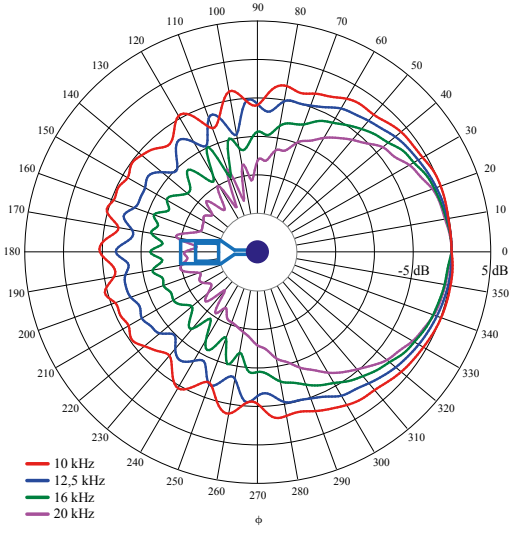


Directional response



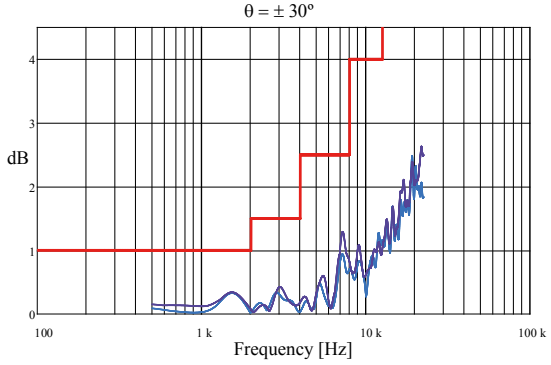


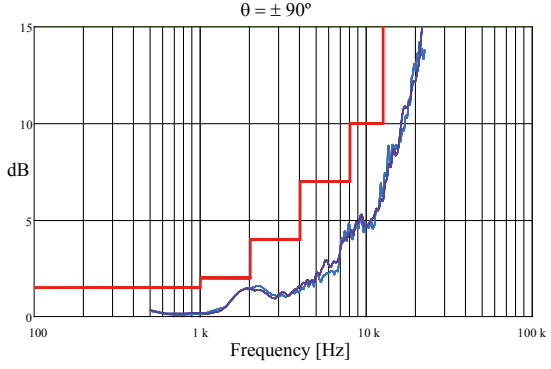


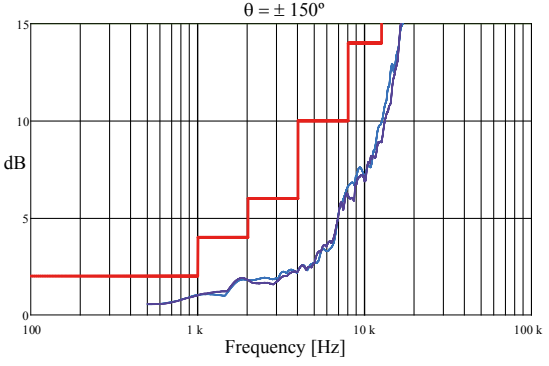


Directional response – Vertical with Wind Screen

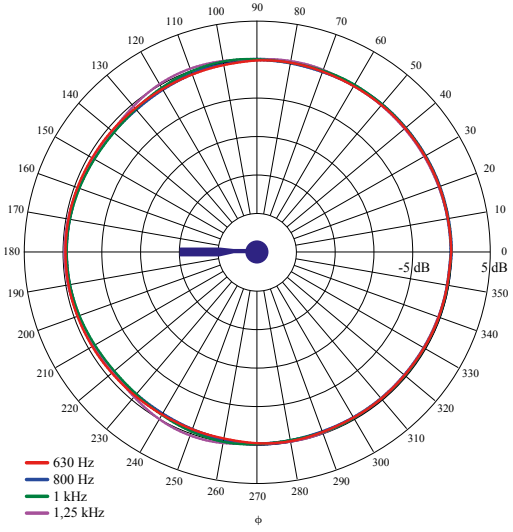
The graphs and plots below show the directional response for the complete sound level meter Nor150 with preamplifier Nor1209, microphone Nor1225 and windscreen Nor1451.

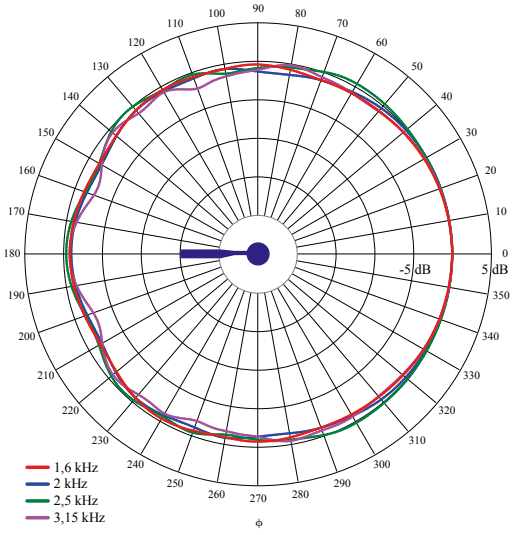


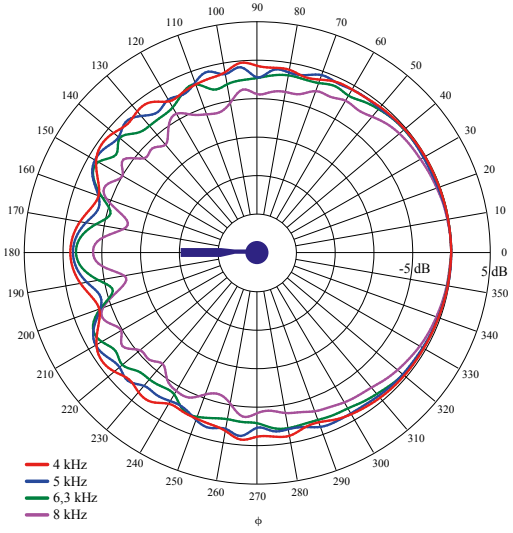


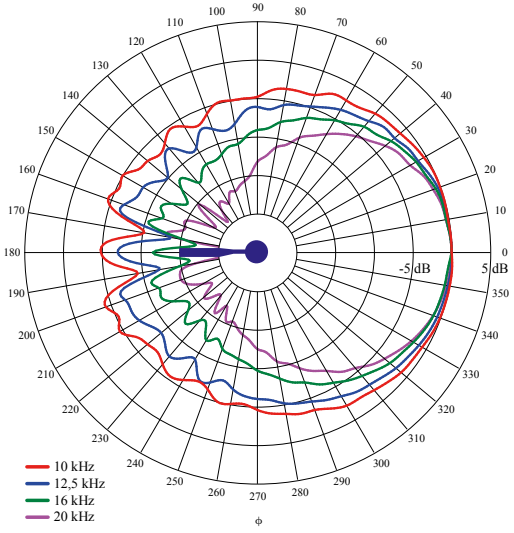


Directional response









Verification of the free-field response

There are several ways to verify the acoustical performance of the Nor150. For periodic verification according to IEC 61672-3 Ed.2.0 it is recommended to use a multi frequency calibrator.

The table below shows data for the B&K 4226. The calibrator is set to position “a” and “Pressure”. Any of the three selectable levels (94, 104 and 114 dB) can be used, but we recommend the use of 114 dB.

Free-field correction table

Frequency (Hz)	Correction (dB)	Uncertainty (dB)
31,5 to 500	0	0,1
1 k	0,1	0,2
2 k	0,2	0,2
4 k	0,8	0,2
8 k	2,8	0,2
12,5 k	5,8	0,2
16 k	6,9	0,2

For periodic verification only the values for 125 Hz, 1 kHz and 8 kHz are in use.

Analog to digital converters

The analog input signals are converted to digital signals by a multi-range sigma-delta converter with an effective sampling frequency of 48 kHz. The anti-aliasing filter is a combination of an analog and a digital filter.

In ultrasound mode, the sampling frequency is equivalent to 96 kHz.

Frequency weightings

Weighting networks:

The Nor150 simultaneously measure the three weighting networks A, C and Z. These networks are designed as described in the IEC 61672-1.

Additionally a 4’th network may be selected. In ultrasound mode this is by default set to AU. In normal mode you may select a user or predefined calculated network. The calculated network is based on the octave or third octave spectra.

The lower frequency limit of the Z-weighting is only restricted by the high pass filter in the input section, which means that when this filter is off the frequency range is flat down below 0.5 Hz.

Filters

The 1/1 octave band or 1/3 octave band levels may be measured simultaneously with the weighting networks if appropriate options are installed.
1/1 octave filters: 0.5 Hz – 16 kHz
1/3 octave filters: 0.4 Hz – 20 kHz

Ultrasound mode

1/1 octave filters: 0.8 Hz – 31.5 kHz
1/3 octave filters: 1 Hz – 40 kHz

Filter type

Class 1, digital IIR filters, base 10 system. According to IEC 61260 (2014). The use of filters requires that appropriate options are installed in the instrument.

FFT

Sampling rate: 48 kHz (96 kHz in ultrasound mode).
Frequency resolution: 1.46 Hz or 2.92 Hz (FFT size 8192 or 16384 lines) (2.93 Hz or 5.86 Hz in ultrasound mode).
Upper frequency: 22 kHz (44 kHz in ultrasound mode).
Functions: Auto spectrum, linear averaging.
Acquisition rate: ~700 ms – no overlap.
Display: Dynamic display zoom 1 – to 64 in power-of-two steps.
Time windowing: Hanning

Level detector

The instrument has only one measurement range.
Reference level (unless otherwise noted) is 114 dB sound pressure level.
Reference range is the same as the only available measurement range.

Detector type

Digital true root-mean-square (RMS) detection and peak detection, displayed resolution 0.1, 0.01 and 0.001 dB selectable in the instrument set up menu. There is only one measurement range.

Crest factor capability

The crest factor is only limited by the capability to measure the peak-value of the signal. The sound input can measure more than 10 V peak.

Overload indication

An Overload condition is indicated in two different ways. Both with a red light in the Status LED above the display and with an overload sign in the status bar in the display. Overload occurs if the input signal is above 10 V peak (either polarity relative to ground).

Under-range indication

Each individual microphone transducer connected to the Nor150 can have its own low level information. In the transducer set up menu the operator can key in the lowest acceptable level information for each 1/3rd octave filter band and the three weighting networks.

Low level indication is only available in the SLM picture and its corresponding numerical table. When a level is detected that is lower than the set threshold, the numerical value will be indicated with a “<” sign in front of it.

Selectable range for Low Level Indication:

The selectable range of low level values goes from -30 dB to + 40 dB in full dB steps.

A separate menu in Transducer set up gives access to the values. The values can be altered after the transducer is selected.

This indication is stored as a part of the measurement data. When a new measurement is started, the under-range indication is cleared.

Time weightings and measured functions

The time weighting functions F and S have time constants of 125 ms and 1000 mS respectively, and are designed as described in IEC 61672.

The time weighting I has a 35 mS on-time with a peak hold function and a 2.9 dB/S decay rate as described in DIN 45657 (2013).

- Simultaneous measurement of the following functions: F–time-weighted sound pressure level, instantaneous
- Maximum F–time-weighted sound pressure level
- Minimum F–time-weighted sound pressure level
- S–time-weighted sound pressure level, instantaneous
- Maximum S–time-weighted sound pressure level
- Minimum S–time-weighted sound pressure level
- I–time-weighted sound pressure level, instantaneous
- Maximum I–time-weighted sound pressure level
- Minimum I–time-weighted sound pressure level
- Integrated-averaged sound pressure level
- Sound exposure level
- Peak sound level
- Exceeding level for F–time-weighted sound pressure level (cumulative distribution)
- Integrated-averaged I–time-weighted sound pressure level
- I–time-weighted sound exposure level
- Taktmaximalpegel – DIN45657, F and I time response, 5 seconds “Takt”.

Level distribution

As an optional extension, the instrument may be fitted to calculate the exceeding level (cumulative level distribution) for the F time weighted level. The calculation is done for frequency weightings A, C and Z and for 1/1 octave or 1/3 octave filters.

Minimum integration time for the global measurement (and for the period length of a profile measurement): 100 seconds.
Sampling frequency: 10 samples per second
Display resolution: 0.1 dB based on interpolation
Class width: 0.2 dB
Number of classes: 652
Covered levels: The levels between 10 dB above full scale (140 dB) and 120 dB below full scale (10 dB). The classes for the highest and lowest levels are extended to also include levels above and below, respectively.

Statistics

The Nor150 can be equipped with a statistical level distribution function. Up to eight percentiles can be shown numerically in a table. All of them are freely selectable. The class width is 0.2 dB over the entire 130 dB range. The statistical distribution calculation applies to all the spectral weighting networks (A, C and Z) as well as all the individual filter bands, octaves or third octaves, if they are measured. The selectable Ln values can be set to anything from 0.1% to 99.9%, both extremes included.

The cumulative and probability distribution functions can be shown graphically, and the values read out using the cursor buttons.

The back-erase feature, which deletes up to 20 (selectable 0 - 20) of the most recent seconds of acquired global data prior to a pause upon resuming, updates the statistics buffers as well as to maintain consistency.

For the statistical sampling the instrument makes use of any of the time constants F, S or I. Even Leq based statistics are selectable.

Note that you don't have to define the percentile prior to the measurement. You may redefine the percentile as many times as you like – even after the measurement.

However, once you start another measurement or switch off the instrument, only the selected percentiles will be stored to keep the amount of stored data lower unless you specifically have selected to save the complete probability density function.

Indication on the screen of the Nor150

These indications are in use both on the graphical displays and on the numerical tables.

Time weighted sound levels are indicated on screen as follows based on Time Constant (F, S or I) and Weighting Networks (A, C and Z).

	A-Weighted	C-weighted	Z-weighted
F	LAF	LCS	LZS
S	LAS	LCS	LZS
I	LAI	LCI	LZI
F Max	LAFmax	LCFmax	LZFmax
S Max	LASmax	LCSmax	LZSmax
I Max	LAImax	LCImax	LZImax
F Min	LAFmin	LCFmin	LZFmin
S Min	LASmin	LCSmin	LZSmin
I Min	LAImin	LCImin	LZImin

Time averaged sound levels are indicated on screen as follows based on averaging type.

	A-weighted	C-weighted	Z-weighted
Equivalent level	LAeq	LCeq	LZeq
Exposure level	LAE	LCE	LZE

"Takt Maximal" Averaged Levels. Only 5 second "takts" are calculated based on F and I time constant.

	A-Weighted	C-weighted	Z-weighted
F	LAFTM5	LCFTM5	LZFTM5
I	LAITM5	LCITM5	LZITM5

Indication range

The calibration of the instrument allows microphones with sensitivity in the range –84 dB to +15.9 dB relative to 1 volt/Pascal to be applied. The corresponding display range for the indicated sound level is –50 dB to +180 dB.

Self-noise levels

The self-noise is measured with the calibration set to –26.0 dB corresponding to a microphone sensitivity of 50 mV/Pa. For voltage input, the level 0 dB then corresponds to 1µV.

Z-network considerations. The Z-wide network requires several minutes to stabilize at a low level. The preamplifier between the microphone and the sound level meter is a very high impendence device and due to their construction they all have a noise spectrum with increased levels at lover frequencies. There may be relatively large variations in this noise level between the different samples of preamplifiers. It is recommended to have the high pass filter switched on when using the Z-network.

Electric self-noise

Electrical self-noise measured (without preamplifier) with 2 m cable (Nor1438) connected directly to Lemo input plug. ICP power turned on and terminated with 50 ohm BNC adapter.

Electrical self-noise figures

Freq.	dB rel 1 volt/pascal	uVolt (1x10-6Volt)
0.4 - 250 HZ	< -10 dB	0.316 uV
315 - 2.5 kHz	< -5 dB	0.6uV
3.15 kHz - 6.3 kHz	< 0 dB	1 uV
8 - 20 kHz	< 5 dB	1.8 uV
A-netw	< 10 dBA	3.16 uV
C-netw	< 10 dBC	3.1 6uV
Z (Flat)	< 12 dB	4 uV

Noise measured with 18 pF microphone dummy and microphone preamplifier Nor1209, averaged over 30 s of measurement time and the high pass filter switched on.

Spectral weighting functions:
A-weighted: 14 dB
C-weighted: 18 dB
Z-weighted: 28 dB
AU-weighted: 14 dB

Third octave filter bands:
0.4 Hz to 2.0 Hz: 48 dB
2.5 Hz to 6.3 Hz: 18 dB (High pass filter Off)
6.3 Hz to 20 kHz: 10 dB (High pass filter Off)
1/3 oct: 6,3 Hz to 20 kHz: 5 dB (High pass filter On)
1/3 oct: 25 kHz to 40 kHz: 5 dB (Ultrasound mode)

Acoustic self-noise

The acoustic self-noise is measured with Nor1225 microphone and preamplifier Nor1209 connected.

The high-pass filter (in the Setup Input menu) shall be turned ON except otherwise noted.

The noise levels are given as equivalent levels averaged over 30 s of measurement time.

Spectral weighting functions:
A-weighted: 19 dB
C-weighted: 22 dB
Z-weighted: 32 dB
Z-weighted: 45 dB (High-pass filter OFF)
AU-weighted: 19 dB

Filter bands:
1/3 oct: 0.4 Hz to 5.0 Hz: 45 dB (High-pass filter OFF)
1/3 oct: 6.3 Hz to 250 Hz: 15 dB
1/3 oct: 315 Hz to 20 kHz: 10 dB
1/3 oct: 25 kHz to 40 kHz: 10 dB

Considerations for low noise measurements

If the measured level is within 5 dB of the acoustical self-noise given for the actual transducer, special care shall be taken not to underestimate the influence of the self-noise of the equipment. The measured value may be overestimated. If you know the correct low level limits for the transducer in use, it is possible to energetically subtract these numbers from your measurement results.

Measurement duration and resolution

Global (Overall) measurement: The total time for a measurement may be set from 1 second up to 7 days 200 hours less 1 second with 1 second resolution.

Timing accuracy: The measurement duration and resolution is locked to the extremely accurate internal clock. Within the temperature range 0 °C to +40 °C the maximum drift is ±3 ppm corresponding to an accuracy of better than 10 seconds per month. Aging for 10 years may increase the figure with additional 13 seconds per month.

Profile / level recorder measurements: The global period may be subdivided in shorter periods, designated profile time resolution from a few milli seconds up to 24 hours.

Starting and Stopping a measurement: If the software selectable start delay is set to zero seconds, the measurement will start (or Stop) within a short time (usually less than a second). But using the **START**/**STOP** button involves a lot of communication inside the instrument. To have an immediate start of a measurement, within 10 ms, use an electric signal (or hand-switch) on the dedicated digital input line. In this way it is also possible to start measurements in several instruments simultaneously.

The stop function is always almost immediate. Never the less, a waiting symbol may be seen after the stop of the measurement. This is either due to that the measurement is stored, and that takes time dependent on the measurement itself and where in memory it shall be stored, or that the instrument is preparing for another measurement.

In synchro and repeat mode the stop of one measurement and the start of the next is handled without time gap. Then all the storing and memory organization is handled separated from the measurements.

Measurement ranges

These ranges are dependent of that the analog high pass filter at the input is turned on.

The “Lower Level” and “Upper Level” given in the tables below are given for the Nor1225/1209 transducer combination. The levels are independent of running on battery/mains adapter, connection to a PC/LAN or use of microphone cables providing the length of the microphone cable is less or equal to what specified in the preamplifier specification.

Total range for measurement of A-weighted levels

The linear operating range is identical to the total range.

Frequency	31.5 Hz	1 kHz	4 kHz	8 kHz	12.5 kHz
Upper level	98	137	138	136	133
Lower level	24	24	24	24	24
Reference level	94	114	114	114	114

The “Reference level” shall be used as the start level when measuring the level linearity. Levels above the “Upper level” will normally indicate Overload. Self-noise of the system will typically be more than 5 dB below the “Lower levels”. These levels will normally indicate Under-scale.

The primary indicator range for compliance with IEC 60651 type 1 is 24 dB to 117 dB.

For compliance with IEC 60804 type 1, the linearity range is 24 dB to 137 dB, and the pulse range 24 dB to 140 dB, respectively.

Total range for measurement of C-weighted levels

The linear operating range is identical to the total range.

Frequency	31.5 Hz	1 kHz	4 kHz	8 kHz	12.5 kHz
Upper level	134	137	136	134	131
Lower level	30	30	30	30	30
Reference level	114	114	114	114	114

Levels above the “Upper level” will normally indicate Overload. Self-noise of the system will typically be more than 5 dB below the “Lower level”. These levels will normally indicate Under-scale. If C-weighted levels are used for linearity testing, then the “Reference level” shall be used as the start level of the test.

Total range for measurement of Z-weighted levels

The linear operating range is identical to the total range.

Frequency	31.5 Hz	1 kHz	4 kHz	8 kHz	12.5 kHz
Upper level	137	137	137	137	137
Lower level	40	40	40	40	40
Reference level	114	114	114	114	114

Levels above the “Upper level” will normally indicate Overload. Self-noise of the system will typically be more than 5 dB below the “Lower level ”. These levels will normally indicate Under-scale. If Z-weighted levels are used for linearity testing, then the “Reference level” shall be used as the start level of the test.

Measurement range for C-weighted peak levels

Frequency	31.5 Hz	1 kHz	4 kHz	8 kHz	12.5 kHz
Upper level	137	140	139	137	134
Lower level	45	45	45	45	45
Reference level	114	114	114	114	114

Levels above the “Upper level” will normally indicate Overload.

The Nor150 used for electrical measurements

By replacing the microphone with an input adapter (Nor1447) the instrument is well suited for electrical measurements. Alternatively the complete transducer can be removed and replaced with the BNC to Lemo cable type Nor1438.

Please note that when the Nor1438 cable is used it is needed to specify a new transducer with a new name in the sensor set up menu system. Then the instrument can also be configured to feed an IEPE device.

Electrical verification measurements

Electrical signals resembling the microphone signal is used to assess conformance to the specifications and the sound level meter standard. The input adapter Nor1447 with an internal capacity of 18 pF (± 20%) is then used for feeding the signal into the instrument.

The reference level is 114 dB SPL (10 Pa) and the nominal microphone sensitivity for Nor1225 is 50 mV/ Pa, so the reference level shall be indicated with an input voltage level of 500 mV ± 3 dB.

Maximum allowed input signal for this purpose is 10 V rms that is equivalent to 140 dB SPL.

Power supply

After the instrument is turned on, it takes some time to boot up correctly. In addition to this all electronic parts (especially the 200 V polarization voltage) need some time to stabilize properly. It takes two minutes from the power is turned on until the instrument is ready for use.

Internal battery

Battery type: Li-Ion package (simply called Nor150/ Battery) with power capacity control circuit. Each battery pack has a “fuel gauge” and its own serial number. The battery and the instrument are designed so the full battery capacity will last for a normal 8 hour work day.

Voltage: 7.4 V

Capacity: 3760 mAh

Charging time using Nor345 mains adapter:
4 hours (80% in 2 hours)

No other battery type than Nor150/Battery from Norsonic can be used in the instrument. Replacement or extra batteries are available from all Norsonic, representatives.

The battery must be treated with care. Never store in a hot place or in direct sunlight. Keep free from moisture and dust.

Recycling: These types of batteries are poisonous. Never waste the battery without knowing that it will be handled as required. If you are in doubt, return it to the Norsonic representative.

Power consumption

Typically 3.6 Watt dependent on selected modes of operation. External DC source should have source impedance less than 1 ohm and be able to supply at least 1.2 A. The mains adaptor Nor345 is recommended for use with the instrument. If the external supply falls below 10 V, the instrument will use the internal batteries if available. If the instrument has switched off due to loss of power or insufficient supply voltage, the instrument will automatically switch on and resume normal operation after reapplying the external DC supply.

External DC / Charging input

Socket for external DC: Lemo FFA 0.5 plug, Positive voltage on centre terminal.

The instrument will automatically switch off if the battery or external voltage is too low for operation within the stated specifications. The Nor150 can be used on external voltage without the battery installed.

- Nominal input voltage: 13.2 V
- Low / cutoff voltage: 10 V
- High input voltage: 28 V

The maximum power consumption is below 15 W.

Mains adapter Nor345

The Nor150 is delivered with a mains adapter. This adapter can be fitted with connector for different mains systems.

- Input voltage range: 100 – 240 V AC, 50 – 60 Hz
- Output voltage: 13.2 V
- Max output current: 1.2 A

Display

Display type: Capacitive touch, trans-reflective colour display.

Physical size: 4.3”

Display resolution: 272 x 480 pixels (W x H)

Backlight: Adjustable in the Setup Instrument menu

Update frequencies: The contents of the display are updated 2 times per second for numerical values, and graphical values are updated 10 times per second.

Keyboard

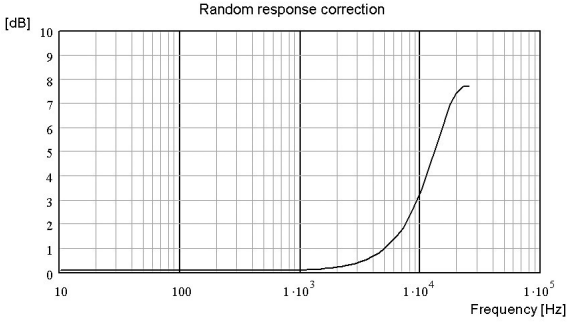
Keyboard type: Silicon-rubber type

Backlight: Adjustable in the Setup Instrument menu

Adjustment of indicated levels

Random response

The instrument is equipped with a microphone with flat free-field response and satisfies the class 1 requirements in IEC 61672-1 to free-field response. By selecting the random response correction network included, the instrument will satisfy the class 1 requirements in IEC 61672-1 to random response as well as ANSI S1.4-1997 type 1. The nominal correction to obtain flat random response is shown in the figure.

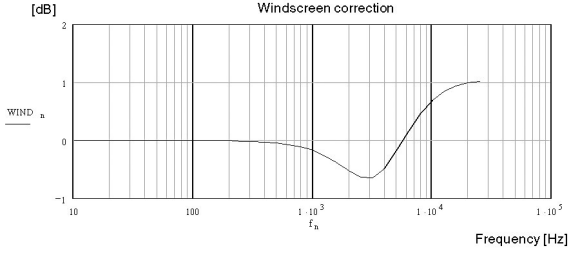


Windscreen

The instrument may be used with windscreen Nor1451. The windscreen correction has to be switched on to obtain the stated specifications when the windscreen is mounted.

When the wind screen is fitted and the correction is turned on the measurements performed will still be within the specifications of a type 1 sound level meter.

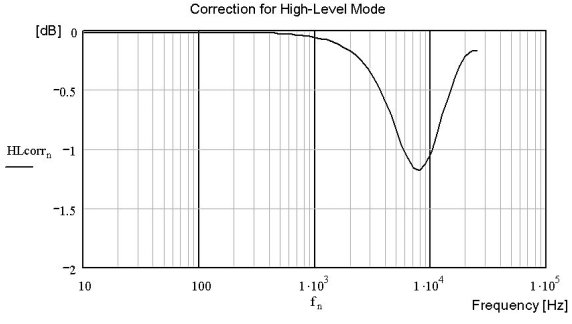
The wind screen correction data and uncertainties are shown in the table starting on *"Detailed table for level corrections according to IEC 62585" on page 209*.



High Levels

For Nor1225 which is a microphone that require 200 V polarization voltage, the sensitivity can be reduced by approximately 10 dB by lowering this polarization voltage. The level range can therefore be extended without changing the microphone cartridge. This feature shall be used in combination with the Nor1225 cartridge only.

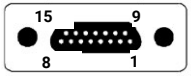
When this feature is selected, the polarization voltage is lowered from 200 V to 70 V. Lowering the polarization voltage after the tension in the diaphragm. A correction network is therefore applied automatically to compensate for the change in frequency response of the microphone due to the lower polarization voltage. Note that the needed correction will depend on the type of microphone, and shall only be applied when using microphone cartridge type Nor1225.



Diffraction around the instrument casing

The instrument casing and the microphone is designed to have low effects on the sound field in which it is measuring. Nevertheless, there is some influence and it is also dependant on the environmental conditions. See the table starting on *"Detailed table for level corrections according to IEC 62585" on page 209* for details.

The general I/O socket



Pin no.	Signal name	Direction	Remarks
1	DO-1	Out	General digital output control line
2	DO-2	Out	General digital output control line
3	DO-3	Out	General digital output control line
4	RTS	Out	RS232 Request To Send
5	TXD	Out	RS232 Transmit data
6	PWR	Out	3.3V. Max 100 mA
7	RES	In	Instrument reset (0 = Reset)
8	DI-1	In	External trigger input
9	DI-2	In	General digital input control line
10	DI-3	In	General digital input control line
11	AC-out(DO-4)	Out	AC signal output or digital output number 4 dependant on activated menu settings.
12	CTS	In	RS232 Clear To Send
13	RD	In	RS232 Read Data
14	GND		Reference for analog signals
15	SG-out		Noise / signal generator output
Housing	GND		Instrument housing

Signal output – Noise generator

An analog output from the internal signal (noise) generator.
Max output voltage: ±3 volt. Output impedance: < 100 ohm. The output is short circuit proof to GND and output current is in excess of 3 mA.
Gain accuracy at 1 kHz: ±0.2 dB.
Frequency response re. 1 kHz:
±0.5 dB for 20 Hz < f < 16 kHz.

Signal output – Microphone signal

The signal from one of the AD converters for channel 1 or 2 can be converted back to an analog signal and fed to this output. (Only channel 1 in this version.) The signal can be digitally amplified, but this will reduce the available dynamic range. It will also influence the self-noise level. A possibility for overload will increase.

Serial I/O port

RS232 port, 9600 – 115200 baud. The port may be switched off to reduce power consumption, which should be considered if an unused cable is attached to the socket.

Digital inputs

The digital input signals are 3.3V CMOS signals. The voltage levels must be within 0 V to +5 V to avoid harming the instrument. Voltages in the range 0 to 0.6 V will be accepted as Logical “0” and voltages above 2.5 V will be Logical 1.

Input impedance: 10 kΩ connected to the positive supply 3.3 volt. Any open input will therefore be in the high state.

Digital outputs signals are 3.3 V CMOS signals. Maximum output impedance: 100 Ω. During power-up the output lines will be low or in a high impedance state (100 kΩ to ground).

Digital output control lines

The Nor150 instrument has 4 general digital output lines which all can be used to alarm and control external devices or functions based on the internal status of the instrument. The digital output lines are named DO-1 to DO-4 (see the pin configuration of the general I/O sockets for connection details). The function of each digital output line is controlled / selected by the user through the Digital I/O menu or by remote control of the instrument.

NOTE! DO4 is special. It can be used both as a digital output line and as an analog AC signal output line controlled from the Analog output signal menu. If the DO4 is in use as an analog output, it cannot be used for other purposes, so the analog output function has priority.

The following functions are available for each of the output lines:

Running – The line goes active when the instrument is measuring.
Recording S1 – The line goes high when sound recording is performed.
Overload S1 – the line goes high when sound channel 1 is overloaded.
Calibrating – The line goes high when you enter the calibration menu.

Mic. Check. – The line goes high when the Mic check feature is enabled. Mainly used to start the electrostatic actuator calibration feature in the outdoor microphone 1210A or C.
Remote controlled – The line goes high when the Nor150 is controlled from another device.
High – The line stays permanently high.
Low – The line stays permanently low.
Events/Markers – The line goes high if an event or marker is enabled.
Remote Output – This line may be controlled from remote via a PC.

The low signal level is 0 V while the high levels are 3.3 V.

The “In” and “Out” connectors located above the general 15 pin I/O connector will be supported in later SW versions.

Headset input and output socket

Both channels have identical signals driven by two separate amplifiers. Load impedance shall be 16 ohm or more. Output voltage is generated by the 48 kHz DAC based on data from DSP. Normally a replica of the normalized microphone signal. Full scale on the display bargraph corresponds to 100 mV. Output impedance: Less than 10 ohm, AC-coupled 100 mF. Gain accuracy 1 kHz: ±0,2 dB Frequency response re. 1 kHz: ±0,5 dB for 20 Hz to16 kHz.

LAN interface

This is the preferred way of communication with the instrument. The IP address is found in the **SETUP** > *Instrument* > *Communication* menu and the port number is set to 8501. The easy way is to set the Nor150 to automatically receive its IP address from the network.

USB interface

USB type 2.0 USB socket: B411

Data / Result storage

SD-card

The instrument may use SD-card for storing of setup information, sound recordings and measurement result. Memory size: Up to 64 GB cards can be used. Please note that no file in the system may exceed the 4 GB limit given by the operating system. This file size is only possible to achieve with audio recordings, and it corresponds to a recording of approximately 8 hours using 48 kHz sampling 24 bit resolution or 92 hours of 12 kHz 8 bit resolution.

Internal memory

Set up and measured data can also be stored in the internal memory of the sound level meter or on the SD-card. The internal memory is of the “flash” type retaining the information without battery supply. Approximately 375 Mbyte is available for the data storage.

Environmental conditions

Reference conditions. The reference conditions for the instrument are as specified by IEC 61672-1.

Temperature: 23°C
Humidity: 50% RH
Atmospheric pressure: 101.325 kPa

Environmental condition for operation Temperature: –10 °C to +50 °C Humidity: 5% to 90% RH, dewpoint less than 40 °C Atmospheric pressure: 85 kPa to 108 kPa.

Environmental condition for storage Temperature: –30 °C to +60 °C Humidity: 5% to 90% RH, dewpoint less than 40 °C Atmospheric pressure: 50 kPa to 108 kPa.

Warm-up time

The warm-up time for the main instrument without preamplifier/microphone is very short and the instrument obtains the final accuracy as soon as the self-test is made. Used with a preamplifier and microphone, this time is prolonged due to the charging of the microphone with the polarisation voltage. Normal sensitivity is reached within two minutes. Before a recalibration is attempted, at least three minutes for warm-up is recommended.

Changes in the environmental conditions

Normally the environmental conditions do not change that rapidly in a room or during a measurement that this causes any problem for the sound level analyser. But when the Nor150 is brought from one room to another or from outdoor to indoor the changes in the temperature and humidity can be so large that special precautions should be taken.

Condensation in the microphone may destroy it permanently.

Excessive condensation may cause permanent damage to the whole instrument.

Typically the stabilization time after a large change in the environmental conditions is 15 minutes.

Sensitivity to static pressure

The sensitivity for change in the atmospheric pressure is low for Nor150 sound level meter: Typically -0.01 dB/kPa for frequencies at and below 1 kHz. At such frequencies, for a static pressure of 85 kPa the sensitivity will increase typically 0.2 dB and for 65 kPa typically 0.4 dB. For higher frequencies the pressure sensitivity is even lower up to about 7 KHz where the pressure coefficient changes from negative to positive.

A sound calibrator with known pressure sensitivity may be applied to set the correct sensitivity at the prevailing atmospheric pressure; alternatively a correction based on typical values may be applied.

Sensitivity for vibration

If the instrument is used under strong vibrating conditions, it is recommended to use an extension cable between the preamplifier and the instrument body. The vibration will mainly affect the microphone.

A mechanical vibration with an acceleration of 1 m/s^2 with a direction parallel to the microphone membrane for any of the frequencies 31.,5 Hz, 63 Hz, 125 Hz, 125 Hz, 250 Hz, 500 Hz, 630 Hz, 800 Hz, or 1.0 kHz, will increase the lower boundary of the measurement range to 53 dB(A).

A mechanical vibration with an acceleration of 1 m/s^2 with a direction nominal to the microphone membrane for any of the frequencies 31.5 Hz, 63 Hz, 125 Hz, 125 Hz, 250 Hz, 500 Hz, 630 Hz, 800 Hz, or 1.0 kHz, will increase the lower boundary of the measurement range to 76 dB(A).

Sensitivity for magnetic fields

The maximum indication for exposure to magnetic field (50 or 60 Hz) of 80 A/m and any orientation is typically less than 15 dB except for the 50 Hz 1/3rd octave band filter (or 63 Hz octave band) where the influence may be up to 25 dB.

Sensitivity for radio frequencies

The Nor150 conforms to the requirements in the IEC 61672. The deviation of the measured sound level due to the standardized test radio frequency field is less than 1.3 dB.

The most sensitive setup is when the Nor150 is connected via an extension cable (Nor1208/50) to the preamplifier Nor1209 and microphone Nor1225.

In addition a mains power (Nor345) and a 3 meter LAN cable shall also be connected. The instrument and cables are lying on a table with the display facing the source. The microphone cable is rolled up and the mains adapter and LAN cable are stretched out.

The operating mode during this test (which is supposed to give the highest influence of the radio field) is when a measurement is running with the profile mode activated, and the profile length is set to less than 100 ms.

Emission of radio frequencies

The Nor150 conforms to the requirements in the IEC 61672. The actual setup for the verification is when the Nor150 is connected to the preamplifier Nor1209 and microphone Nor1225.

In addition a mains power, Nor345, and a 3 meter LAN cable shall also be connected.

The instrument and connected cables are lying on a table with the microphone facing the testing antenna.

The operating mode during this test (which is supposed to give the highest influence of the radio field) is when a measurement is running with the profile mode activated and the profile length is set to less than 100 ms.

Sensitivity for AC power frequency

The sensitivity for a mains power frequency field is small. The instrument performs according to the requirements in the sound level meter standard when the microphone / preamplifier is connected to the instrument's input socket . The worst situation that can occur is when a microphone extension cable and an AC power line are positioned very close and parallel to each other – which should be avoided.

Recovery after electrostatic discharge

The Nor150 is constructed to have high immunity towards electrostatic discharge as required in the sound level meter standard. It will operate normally when exposed to a contact discharge of ±4 kV or an air discharge of ±8 kV. If an even more powerful electrostatic pulse reaches the instrument, it might restart. After this, the instrument (if not destroyed) will go through a normal start up sequence and continue operation. If this happens, a qualified service technician shall inspect the instrument, and specially the microphone, to verify the performance of the device.

Size and weight

Depth: 30 mm
Width: 75 mm
Length, excl. microphone/preamplifier: 210 mm
Length, incl. microphone/preamplifier: 292 mm
Weight (incl. Preamplifier and microphone): 700 g

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AA Portable Power Corp.
www.batteryspace.com , Email: Sales@batteryspace.com
825 S 19th Street, Richmond, CA 94804
Tel: 510-525-2328 Fax: 510-439-2808

Report ID: 2018-015

UN38.3
Transports of Dangerous Goods
Test Report

AA Portable Power Corp

Description:

Product Name	P 150/BATTERY
Type	Li Ion Battery
Client	Norsonic AS
Manufacturer	Norsonic AS
Nominal Voltage	7.2V
Rated Capacity	4.7Ah
Test Started	9/20/2018
Test Finished	10/31/ 2018



Test Result:

Item	STANDARD	Result
T1. Altitude simulation	UN38.3 Sixth Revised Edition	T1. Pass
T2. Thermal test		T2. Pass
T3. Vibration		T3. Pass
T4. Shock		T4. Pass
T5. External short circuit		T5. Pass
T6. Impact/Crush		T6. N/A
T7. Overcharge		T7. Pass
T8. Forced discharge		T8. N/A

The submitted battery and component cells were complied with the stated requirement of UN38.3 Sixth Revised Edition.

Edited by: Ken, Po-Feng Checked by:

Approved by: Date: 11/5/2018

Battery Certification
UN38.3 Transport of Dangerous Goods

THE NOR150/BATTERY IS A LI ION BATTERY AND IS CERTIFIED BY AN INDEPENDENT ACCREDITED BODY IN ACCORDANCE WITH UN38.3. A COPY OF THE CERTIFICATE IS SHOWN ON NEXT PAGE.

Caution! **NEVER EXPOSE THE BATTERIES TO TEMPERATURES OUTSIDE MAXIMUM OPERATION TEMPERATURE RANGE; -10 ˚C / 14 ˚F TO +50 ˚C / 122 ˚F.**

MAXIMUM STORAGE TEMPERATURE RANGE IS -30 ˚C / -22 ˚F TO +50 ˚C / 122 ˚F. ROOM TEMPERATURE IS RECOMMENDED FOR LONG TIME STORAGE. ALWAYS FULLY CHARGE THE BATTERIES BEFORE STORAGE. RECHARGE BATTERIES FULLY EVERY THIRD MONTH FOR LONG TIME STORAGE.

NEVER USE MECHANICAL DAMAGED BATTERIES.

SHIPMENT OF BATTERIES VIA AIR OR BROUGHT AS HAND LUGGAGE / LUGGAGE ARE GOVERNED BY IATA / UN3481, PI 967 SECTION II WHEN SHIPPED AS A PART OF THE INSTRUMENT AND PI 966 PART II IF SHIPPED SEPARATE. SEE IATA STANDARD FOR LABELLING THE PARCEL AND TO ACQUIRE LATEST INFORMATION ABOUT
SHIPMENT INSTRUCTIONS.

NOTE DAMAGED BATTERIES ARE STRICTLY PROHIBITED TO BE SHIPPED AS AIRFREIGHT OR BROUGHT ONTO A PLANE AS HAND LUGGAGE OR CHECKED IN LUGGAGE.

Norsonic AS
Gunnersbråtan 2
N-3409 Tranby
Norway
Tel: +47 3285 8900
info@norsonic.com
www.norsonic.com

Declaration of Conformity

We, Norsonic AS, Gunnersbråtan 2, N-3409 Tranby, Norway, declare under our sole responsibility that the product:

Precision Sound & Vibration Analyser Nor150
Nor1209 / Nor1209A preamplifier

to which this declaration relates, is in conformity with the following standards or other normative documents

Standards	:	EN/IEC 61672-1:2013 Class 1, EN/IEC 61260 class 1:2014, EN/IEC 61043:1993 ANSI S1.4 2014 type 1, ANSI S1.43 1997 type 1, ANSI S1.11 2004 type 1
Safety	:	EN 61010-1:2010/A1:2019 Portable equipment and pollution category 2
EMC	:	EN 301 489-1 V2.1.1, EN 301 489-52 V1.1.1, EN 301 489-17 V3.1.1
RoHS	:	Directive 2011/65/EU, 2015/863/EU
WEEE	:	Directive 2012/19/EU

This product has been manufactured in compliance with the provisions of the relevant internal Norsonic production standards. All our products are tested individually before they leave the factory. Calibrated equipment – traceable to national and international standards – has been used to carry out these tests.

This Declaration of Conformity does not affect our warranty obligations.

Tranby, September 2021

Jens Petter Ringvold
Quality Manager



Norsonic

Gunnersbråtan 2
N-3409 Tranby
Norway
Tel: +47 32 85 89 00
info@norsonic.com
www.norsonic.com

Norsonic AS supplies a complete range of instrumentation for acoustics – from sound calibrators, microphones and preamplifiers; via small handheld sound level meters to advanced, yet portable, real time analysers, but also spectrum shapers, building acoustics analysers and complete community, industry and airport noise monitoring systems. Contact your local representative or the factory for information on our complete range of instrumentation.