

# nor140

SOUND ANALYSER



## Applications:

- Sound recording
- Environmental noise
- Building acoustics
- Noise source identification
- Industrial hygiene
- Product development
- Quality control
- Sound power
- Speech intelligibility - STIPA
- Vibration measurements
- HVAC noise

## Features:

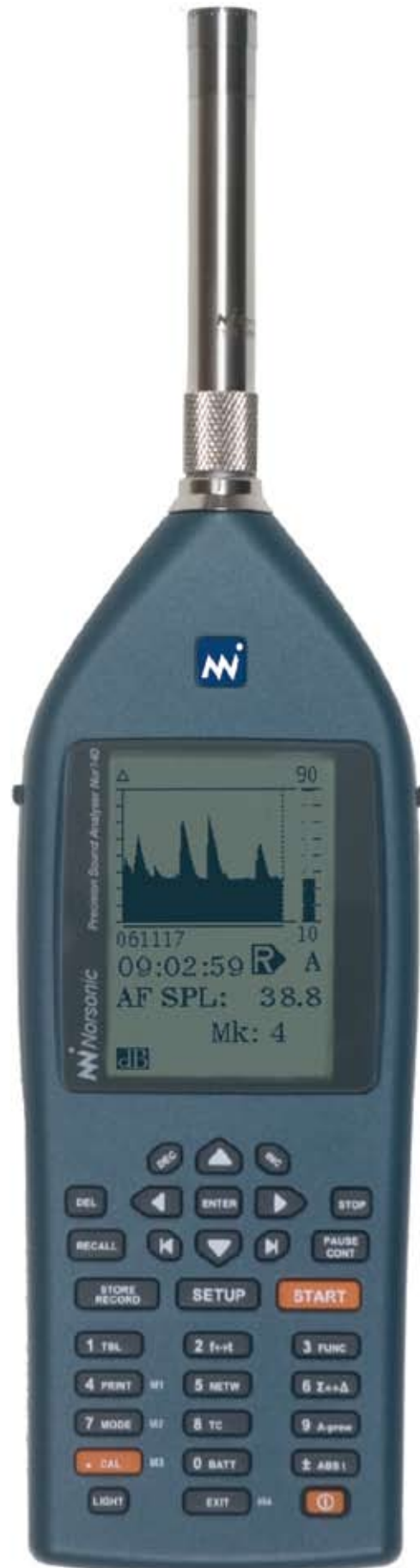
- Handheld real-time 1/1- or 1/3-octave frequency analyser
- Measurement of A-weighted levels simultaneously with either C- or Z-weighted levels
- Parallel detection of SPL,  $L_{eq}$ ,  $L_{min}$ ,  $L_{max}$ ,  $L_E$  and  $L_{peak}$
- 120 dB dynamic range giving a “one-range” instrument
- Measures  $L_{peak}$  levels up to 140 dB
- Parallel detection of F, S and I time constants
- USB 2.0 and High-speed RS-232 serial interface (115 kbaud)
- SD memory card and large high speed internal memory
- Sound recording in 8, 16 or 24 bit format with 12 or 48 kHz sampling
- High-resolution graphical backlit display
- Manual or automatic storage of results
- Automatically repeated measurements with clock synchronization
- Pause/Continue function with backerase feature
- Precision integrating sound level meter to IEC 61672 class 1
- Results displayed as dB or Engineering Units
- Numerical printouts
- AC output signal
- Signal generator
- Windscreen correction
- Noise floor correction



With the introduction of the precision handheld sound analyser Nor140, Norsonic sets a new standard for sound level meters, covering the widest range of applications. The Nor140 is packed into the smallest real time analyser featuring sound recording present on the market today.

Norsonic's philosophy has always been to cover all possible applications within one modular instrument platform. We were the first company introducing software options. This enables functional expansion to take place when you need it and not necessarily at the time you purchase the instrument. The design is based on years of experience making intuitive and easy to use field instrumentation. The Nor140 is Norsonic's second generation of handheld sound level meters featuring sound recording.

The Nor140 covers a wide range of applications, making the instrument a natural choice for every professional user of sound level meters.



# The instrument platform

By listening to key customers and our long experience in designing sound level meters, every effort has been made to design a rugged, small and lightweight, yet powerful instrument platform.

## User friendly

The large backlit display with a mirror effect is excellent to read in sunlight. The backlight is only needed in dark environments.

The instrument is designed to be operated by the same hand that holds the instrument. There is no need for a stylus. Real keys ensures tactile feedback to the user. The dust and splash proof rubber covers for the connectors and SD card together with the high friction coating on rear cover ensures an optimum grip and user comfort. A range of factory setup together with the possibility for the user to create his/her own setups minimise the risk of making mistakes when preparing up the instrument prior to a measurement run.

## Memory – Storage handling

The instrument contains both an internal memory and an exchangeable SD memory card. The internal memory features the same structure as the SD card, but it is mainly intended for high-speed sampling applications. A backup copy of the current measurement is made every two minutes. This ensures that if a power interrupt occurs, a maximum of two minutes of data may be lost. The measurement is also automatically saved when a battery low warning is given. A special feature can be enabled, making the instrument to auto restart and continue to measure after a power failure condition. This is especially useful for long term monitoring applications.



Four types of storage modes are supported:

**Manual**

The user manually stores the measurement.

**Automatic**

The instrument stores all results automatically when a measurement is completed or if stop is pressed.

**Repeat**

Same as automatic but it automatically restarts a measurement.

**Synchronous**

Same as repeat but the first measurement will be truncated to allow synchronisation to the next whole measurement period (eg. the first full hour)

### Interfaces and connectors

The instrument has one USB 2.0 high-speed data interface and one high speed RS232 interface. The multi I/O socket additionally contains several digital I/O ports for different control applications such as remote start/stop of the measurement process or audio recording and Go/NoGo signals for quality control applications. Two analogue outputs are available. One is dedicated to the signal generator output (optional), the other for playback of recorded signals or AC output of the measured signal. A separate connector is available for Tacho meter input.

The microphone input connector is a traditional 7 pin LEMO connector. This standard was invented by Norsonic in the early nineties, now widely adopted by most of the world's sound measuring equipment manufactures. In the Nor140 we have added two useful features to this standard, improving its original functionality. Firstly ICP® power is added thereby allowing the use of signal line powered sensors such as accelerometers and electret microphones with ICP® preamplifiers. This removes the need of expensive adaptors or cables for connection to the instrument. The second feature is the built-in calibration oscillator for verification of outdoor microphones; a great advantage on long term noise monitoring projects.

### Power management

Our users told us that it is important to be able to change batteries in the field, and that the unit must use standard batteries that may be obtained anywhere. Hence, we designed it to use four standard AA-cell batteries. However, the instrument also accepts rechargeable batteries. A battery monitor tells the user the status of the batteries. The instrument may also be directly connected to any 12V source such as a car battery via the external DC input connector. An interrupt free inter-connection between internal batteries and external powers ensures a power system with the highest possible security.

### Preamplifier and microphone

The instrument is delivered with a 1/2" microphone Nor1225 and preamplifier Nor1209. The well-known Nor1225 is a 200V polarised, 50mV/Pa free field microphone. The instrument has user selectable diffuse field (random incident) and windscreen correction networks. The preamplifier Nor1209 is an extremely low noise preamplifier that can drive long microphone cables without any loss in performance. For special applications other types of microphones and preamplifiers, such as 1/4" types may be connected. The preamplifier Nor1209 has a built-in microphone check facility allowing remote verification of the microphone in environmental noise monitoring systems.

### One measurement range

The Nor140 has more than 120 dB dynamic span in a single measurement range. This makes the use of the instrument easy since there is no gain control to adjust; all measurements are covered by one range. The wide dynamic range covers all applicable functions such as the spectral weighting networks, real time 1/1- and 1/3-octave filters as well as the FFT option.

In order to extend the flexibility of the instrument a special high range mode can be selected. This extends the upper measurement range by 10 dB to 150 dB with the standard Nor1225 microphone and up to 190 dB with special 1/4" microphones.

A self-noise compensation feature can also be selected to extend the lower measurement range of the A, C or Z network. This typically extends the measurement range downwards by 7 to 10 dB.

## The Measured functions

The functions available with the Nor140 include

SPL	Time-weighted Sound Pressure Level (F, S, I)
$L_{MAX}$	Maximum Time-weighted Sound Pressure Level
$L_{MIN}$	Minimum Time-weighted Sound Pressure Level
$L_{eq}$	Time-Average Sound Pressure Level
$L_{eqI}$	Time-Average Impulse-weighted Sound Pressure Level
$L_E$	Sound Exposure Level
$L_{PEAK}$	Maximum Peak Level
$L_N$	Statistically Calculated Exceedance Level

The spectral weighting functions A- and C- or Z-weighting are available for all functions including the  $L_{PEAK}$ . The SPL,  $L_{MAX}$  and  $L_{MIN}$  functions are measured for all the three time constants F, S and I. All the above functions are also measured in each band if 1/1 or 1/3 octave analyses extensions are added with the exception of  $L_{PEAK}$ .

## NorVirtual instrument

Included in the Nor140 delivery is the Virtual Instrument software; a PC program that brings a virtual version of the instrument onto your PC screen. The user may remotely operate the keyboard, and view a picture of the instrument display on the PC screen. A useful tool for seminars, schools and similar applications where more than one person needs to view the operation of the instrument and the display.

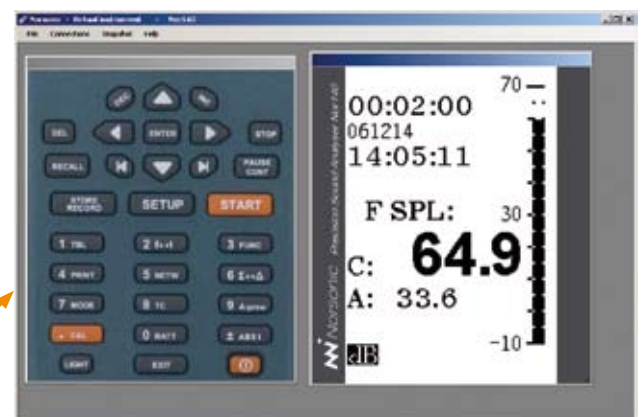
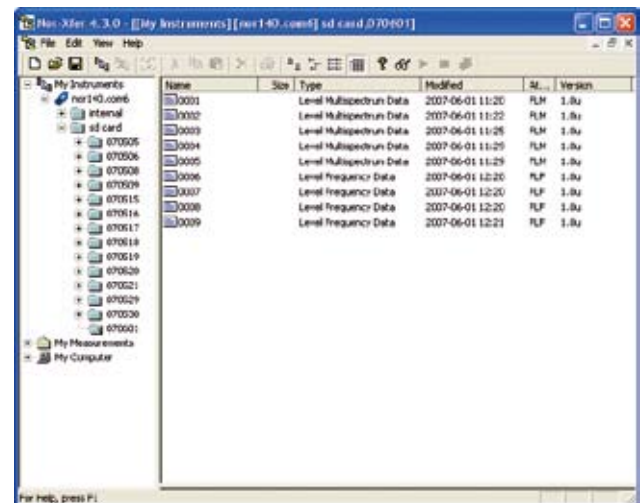


## NorXfer

Also supplied with the instrument is the PC data transfer software NorXfer. This program transfers and converts the measurement results from the internal memory or from the SD memory card to the PC. The data can then be seamlessly used by all other Norsonic post processing programs, such as NorReview, NorBuild or NorPower.

The measured data can also be converted into Excel or text files for use in other software packages.

Two optional extensions (not included in standard delivery) can be added to NorXfer. Option 1 is modem control, and option 2 is remote control of all Nor140 functions and setup parameters.



# Environmental noise monitoring

- Huge memory, both internal and on a removable SD card
- Sound recording
- 8 marker functions
- Precise internal clock for accurate timing between several Nor140 instruments
- Profile measurements with level vs. time resolution from 25ms to 199h
- Multi spectrum
- Statistical calculations, even in frequency bands
- 120dB dynamic range, also for the 1/1-octave and 1/3-octave real time filters
- Pure tone detection
- Microphone check
- Advanced post processing using NorReview
- Advanced  $L_{den}$  calculation using NorReview

The large memory and the time synchronising capabilities of the Nor140 makes it well suited to any environmental noise measurement and as a front-end in noise monitoring systems – perfect for community noise as well as indoors in workshops etc.

The high dynamic range (120 to 150 dB dependent on weighting/filter) makes the setup easy and ensures reliable measurements in all situations.

Source identification is possible thanks to the sound recording feature and eight markers, where four can be set for independent source coding.

The Nor140 is designed to be left unattended for monitoring noise either as a measurement device in a larger sound monitoring system or semi-permanently for some days or weeks. The measurement results can be collected by swapping the SD memory card or downloaded via modem or LAN/WLAN connections. In the latter case the remote control program NorMonit can automatically control this process. A manual remote option is possible using NorXfer with applicable software extensions.

An internal sine wave calibration oscillator feeds a calibration signal to the preamplifier/microphone combination to perform a daily microphone check – no external device or power supply is needed.

NorReview is a powerful tool for analysing and reporting the captured data. NorReview is, as other Norsonic products, modular and provides in its basic version a view of  $L(t)$  data and will perform basic calculations and reporting. Fully configured the software can perform  $L_{den}$  calculations, automatic event reporting and calculation, replay of sound files with moving cursor along the  $L(t)$  graph, multi project handling including storage of pictures, text files etc. along with the measurement data. A special pure tone extension is available in order to perform tonal analysis.

NorReview may also be extended to display real time data on line in a noise monitoring system, in either single or multi-channel configurations.

Norsonic offers a complete line of products for use in environmental noise monitoring systems. We supply enclosures for permanent monitoring installations, environmental cases for semi-permanent installations, outdoor microphones for applications in tough environments, cables, modems, weather stations and post-processing software.

## Noise nuisance recorder

The Nor140 is the third generation of Noise Nuisance Recorders from Norsonic. This is a very cost effective method of investigating domestic noise complaints, particularly those occurring outside normal office hours. To date, systems have been







based on Digital Audio Tape recorders connected to a conventional sound level meter and as such often have complicated set up and calibration procedures. Any error in these procedures could easily result in the failure to collect valid evidence of the alleged offence.

A novel approach to these systems is embodied in the Nor140 through its digital recording of the actual sound at the same time as the measurement; hence there is no longer a need for a separate DAT recorder; everything is within the analyser!

All calibration and range settings automatically relate to both the measurement and recording part of the system greatly simplifying the set up; there is even a default “annoyance recorder mode” that can be accessed directly when switching on.

The instrument is housed within a tamper proof case and the only external components are the measurement microphone, mains connections and the plaintiffs hand switch. This hand switch has been specifically designed to make it suitable for use by subjects with limited manual dexterity and will activate the audio record for a predetermined period;

the default setting is 60 seconds but may be set for any period between 1 second and 24 hours.

The default set up also provides some seconds of pre-trigger recording allowing the vital information occurring just before the switch was pressed to be recorded.

**Pure tone detection**

Many environmental noise measurement criteria require compensation for the presence of pure tones. These standards are now moving away from the earlier purely subjective method of tone detection to a more scientifically quantified method. These methods require a detailed FFT analysis, and masking calculations, carried out to determine the prevalence of audible tones.

The optional Pure Tone FFT mode will enable you to analyse the noise in accordance with these new requirements. As a spin-off, any measurement task requiring the auto-spectrum of a full frequency range FFT with less than 3 Hz line separation is also supported.

The measured noise spectrum is shown as a normal FFT spectrum during the acquisition process.

# Building acoustics

## Sound insulation measurements

The Nor140 with the Building Acoustics option is a complete measurement tool for making both airborne and structureborne (impact) sound insulation measurements in accordance with the ISO-140, ASTM, and other national standards. A step-by-step menu takes the operator through all required 1/3-octave real-time measurements until the final sound reduction index is presented graphically on the screen in accordance with the ISO-717 Standards. Other national indices may be calculated in combination with the optional NorBuild software.

This feature includes analysing sound level measurements and averaging of multiple microphone positions, both in the source- and the receiving-rooms, measurement of the background noise level as well as measurements of the reverberation time in multiple locations in the receiving room. An on-board calculator uses the actual room dimensions to calculate the room volume  $V$  and insulation area

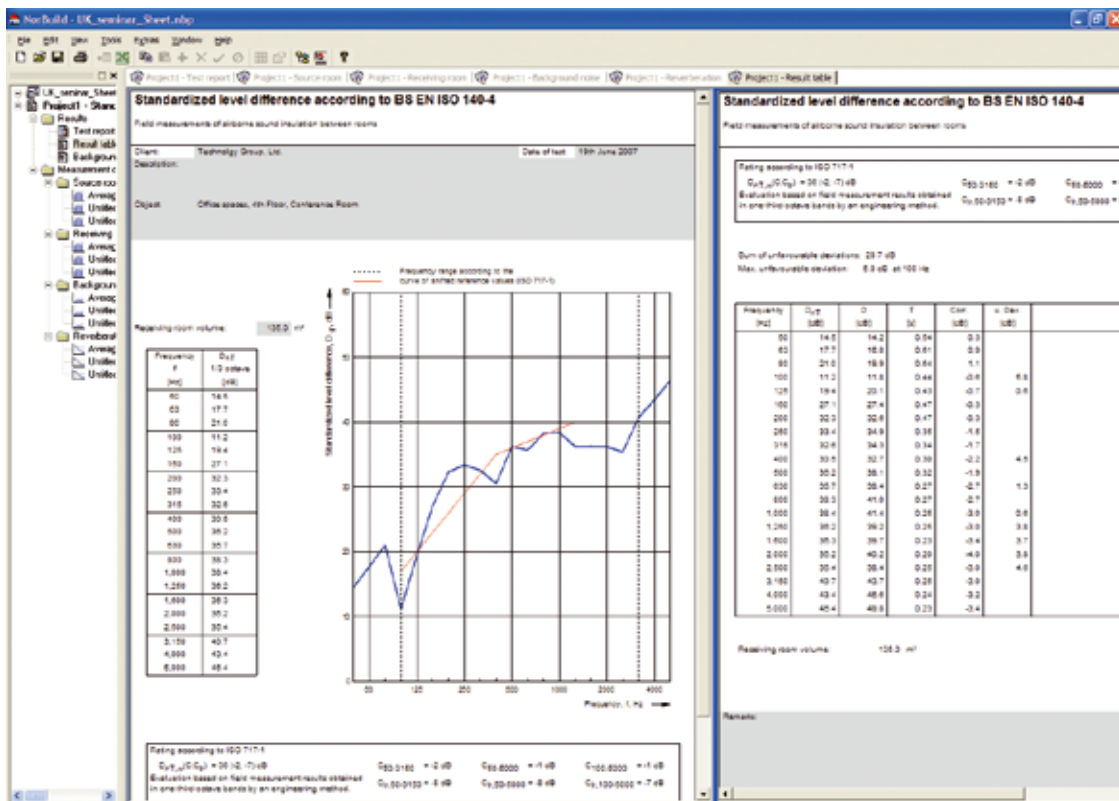
$S$ . The correct sound reduction index ( $R'_{w, DnT,w}$ ,  $D_{n,w}$ ,  $L_{n,w}$  or  $L_{nT,w}$ ) is then presented graphically on the instrument screen.

Alternatively, the Nor140 may be used to measure the survey grade sound insulation based on 1/1-octave real-time frequency spectra in accordance with the ISO-10052 Standard.

## Reverberation time measurements

The Nor140 measures the reverberation decay based on either impulse or noise excitation. All frequency bands are measured either in 1/1- or 1/3-octave real-time spectra, and presented on the screen one-by-one.

Two reverberation time values are calculated for each decay in each frequency band. The  $T_{30}$  is calculated from 5 dB below the excitation signal down to 35 dB, but the Nor140 will additionally calculate the  $T_{20}$  value. All values are of course normalised to the required 60 dB decay time.





### **On-board noise generator**

The Nor140 is equipped with an on-board noise generator supplying both white and pink noise. During the level and reverberation time measurements, the generator is turned on and off in synchronization with the actual measurements.

### **Complete reports**

The Nor140 building acoustics measurements are seamlessly transferred to a PC for further post-processing. The full sound insulation report is generated by use of the NorBuild software package, and the final report sheets are calculated in accordance with ISO-140/717, ASTM or other national standards.

### **Remote measurement control**

For full PC control of the actual measurement process, the NorBuild software may be extended with the CtrlBuild module. By use of this module, the measurements may even be made by scanning through the frequency range using 1/3-octave band filtered noise. This feature is handy when background noise is high compared to the measured receiving room levels.

Alternatively, the CtrlBuild module will enable two individual Nor140 instruments to be synchronised to form a dedicated dual-channel measurement system for sound insulation tests.

### **Wireless measurement system**

One Nor140 may be used as one wireless measuring channel in the Nor1516 wireless sound insulation system. By using two separate Nor140 instruments in such a system, the operator gets a unique wireless measurement system that performs complete sound insulation measurements in the field without all the hassle and problems of long microphone extension cables.

### **SweptSine measurement technique**

The recent ISO-18233 Standard opens up for use of alternative measurement techniques for sound insulation testing. Hence, the Nor140 is optionally available with the new SweptSine measurement method. This new technique is useful when measurements have to be performed in background noise conditions where traditional technique will not enable any measurements to be made at all.

SweptSine technique may also be used for the measurement of extremely short reverberation times.

# Other applications

## Speech intelligibility – STIPA

The speech transmission index, STI, has shown to be a valuable tool for objective assessment of the speech intelligibility. The basis for the STI-index is that speech intelligibility is to a large extent based on the slow amplitude modulation of octave band sound levels due to the acoustic environment in the test area.

A simplified version of the STI-metric, known as STIPA, is an option in the Nor140 instrument. The method is made according to the requirements in IEC-60268-16 (2003-05): Sound system equipment – Part 16: Objective rating of speech intelligibility by speech transmission index. The option includes an audio-CD with the required excitation signal. The STIPA- method is suitable for assessing speech intelligibility in rooms or auditoria as well as for public address systems. The STIPA-method may in general be used as a replacement for RASTI which normally should be applied only for room acoustic measurements. The result is presented as a STI-value and a CIS-value. The latter is normally used for assessing the quality of sound systems for emergency purposes (IEC-60849).

Each measurement lasts for about 13 seconds and the STI-value is displayed on the screen together with octave-band levels and the modulation indices. This allows the result to be corrected for additional background noise either by the instrument or later by post-processing the measured data.

## Vibration measurements

Thanks to its broad frequency response the Nor140 is suitable for both sound and vibration applications. The low frequency response extends down to 0,4 Hz in 1/3 octave band mode and FFT mode. The results can be displayed in dB or in Engineering Units.

ICP® powered accelerometers can be directly connected to the instrument without use of any external power supply. Norsonic supplies a carefully

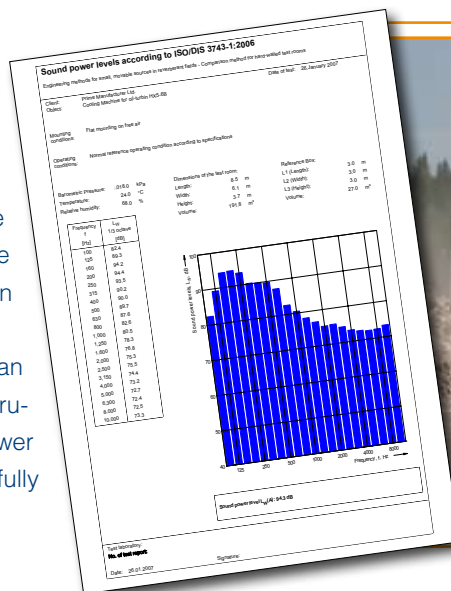
selected range of accelerometers, all ICP® powered, well suited for use with the Nor140.

## Sound power

Sound power level may be calculated from sound pressure level measurements using almost any type of sound level meter. However, the methods described in the different standards involve quite a lot of calculation before the final sound power figure can be reported.

The Nor140 supports measurements and calculations according to ISO-3746 on board. You simply specify measurement surface, its dimensions, the location of your measurement object (on the floor, against a hard reflecting wall or in a corner), apply the correction factors and start your measurement. The sound power will then be calculated and displayed in a tabular form.

For measurement in accordance to other standards in the ISO-374x series or similar standards, the PC post processing program NorPower is a perfect tool. The program guides you through the measurement process and reports the data as described in the standard. NorPower is a valuable tool for engineers working with product development, product control or certification. A special software extension allows the user to remotely control the Nor140, the microphone boom Nor265 and the whole measurement process from the PC.



# Optional extensions

The Nor140 may be extended with a large selection of optional features, thereby allowing you to tailor the instrument to your specific requirements. Optional features may be ordered and installed at any time by just adding a new set of option codes. Norsonic is continu-

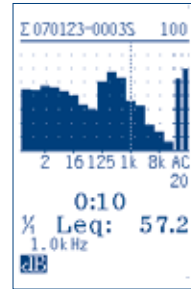
ously extending the list of features with new options and improvements in existing options based on customers' requirements and new standards.

Please visit our web site [www.norsonic.com](http://www.norsonic.com) for the latest details.

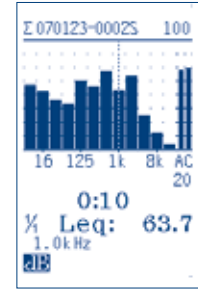
## Option 1: 1/1-octave real-time filters

- Parallel 1/1-octave real-time filters covering the 0.5 Hz - 16 kHz frequency range in one range
- All filters fulfil the IEC-61260 class 1 digital IIR base 10 requirements and ANSI S1.11-2004 Class 1
- 120 dB "one-range" even in the filter band
- Results are displayed both graphically and numerically
- A-weighting (pre-weighting) feature available on displayed results

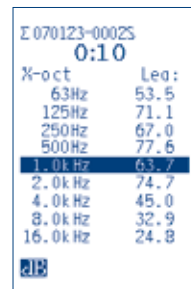
When fitted with option 1, the Nor140 can perform real time frequency analysis in octaves covering the frequency bands 0.5 Hz to 16 kHz in one range. A limited frequency range 8 Hz-16 kHz can be set in order to avoid low frequency noise. A 3 Hz 3<sup>rd</sup> order high pass filter is then enabled in the analogue input stage to prevent overload due to low frequency noise. The wide frequency range with full dynamic range of more than 120 dB makes the instrument well suited for both vibration and noise measurements.



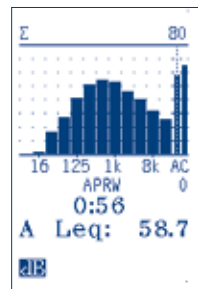
1/1-octave spectrum  
0,5 Hz - 16 kHz



1/1-octave spectrum  
8 Hz - 16 kHz



1/1-octave  
numeric table

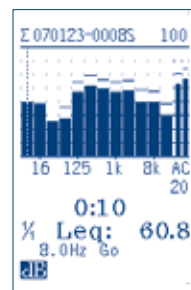


1/1-octave spectrum  
A-weighted

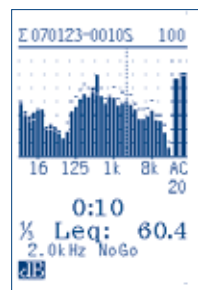
## Option 2: Reference spectrum with "Go/NoGo" comparison

- Compare any measured frequency spectrum with a pre-selected reference spectrum
- Both upper and lower reference spectrum available
- "Go/NoGo" warning for quality control applications
- TTL output signal for automated systems

The reference spectra feature is used for comparison of any measured frequency spectrum with a pre-selected user defined spectrum. It functions for 1/1-octave, 1/3 octave and the spectral weighting networks. The measured spectrum may be compared to an upper limit, a lower limit or both. If the measured signal exceeds the boundaries, a "NoGo" warning is given on the screen, and a digital signal is set on the I/O port. This is useful for many applications such as product control and spectrum comparison.



1/1-octave  
reference spectrum



1/3-octave  
reference spectrum

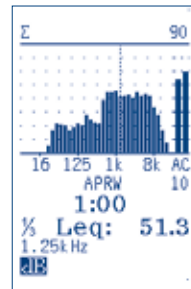
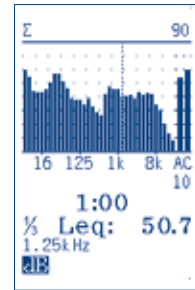
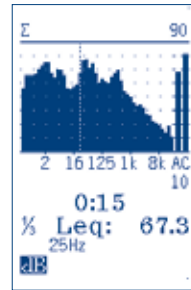
*Option 2 requires that minimum option 1 be installed!*

### Option 3: 1/3-octave real-time filters

- Parallel 1/3-octave real-time filters covering the 0.4 Hz - 20 kHz frequency range in one span
- All filters fulfil the IEC-61260 class 1 digital IIR base 10 and ANSI S1.11-2004 Class 1 requirements 120 dB “one-range” even in the filter bands
- Results are displayed both graphically and numerically
- A-weighting (pre-weighting) feature available on displayed results

When fitted with option 3, the Nor140 can perform real time frequency analysis in 1/3 octave covering the frequency bands 0.4 Hz to 20 kHz in one range. A limited frequency range covering 6.3 Hz - 20 kHz can be set to avoid low frequency noise. A 3 Hz 3rd order high pass filter is then enabled in the analogue input stage to prevent overload due to low frequency noise. The wide frequency range with full dynamic range of more than 120 dB makes the instrument well suited for both vibration and noise measurements.

*Option 3 requires that minimum option 1 be installed*



1/3-octave numeric table

X-oct	Leq:
100Hz	48.6
125Hz	48.5
160Hz	44.3
200Hz	49.3
250Hz	43.1
315Hz	39.5
400Hz	37.1
500Hz	52.4
630Hz	57.4

### Option 4: Statistical calculation of $L_N$ values

- Calculate 7 fixed  $L_N$  values ( $L_{1\%}$ ,  $L_{5\%}$ ,  $L_{10\%}$ ,  $L_{50\%}$ ,  $L_{90\%}$ ,  $L_{95\%}$  and  $L_{99\%}$ )
- Parallel calculation of 1 editable  $L_N$  value selectable within the range 0.1 – 99.9 %
- Statistical calculations based on 0.2 dB class widths covering the entire 130 dB range
- Parallel statistical calculation on both A- and C-/Z-weighted networks
- If real-time filters are installed (option 1 or 3), statistical calculations are available for the individual filter bands as well

Option 4 adds statistical distribution to the Nor140 functionality. There are eight percentiles shown, out of which one is user selectable. The class width is 0.2 dB over the entire 130 dB range.

The statistical distribution calculations employs the F time constant and applies to the spectral weighting networks (A and C or Z) as well as all the individual 1/1- and 1/3-octave filter bands (if applicable).

The back-erase feature, which deletes the ten most recent seconds of acquired global data prior to a pause upon resuming, updates the statistics buffers as well to maintain consistency.

Static  $L_N$  table

E 070123-00125	
1:40	
A-network	
L 0.1 % :	104.2
L 1.0 % :	98.4
L 5.0 % :	84.0
L 10.0 % :	81.0
L 50.0 % :	55.1
L 90.0 % :	45.5
L 95.0 % :	40.9
L 99.0 % :	31.1

## Option 5: Parallel F, S and I time weightings

- Simultaneous measurement of F, S and I time weightings
- Parallel measurement of three different SPL,  $L_{MIN}$  and  $L_{MAX}$  functions based on F, S and I time weightings
- Parallel calculation of  $L_{eq}$ ,  $L_{eq,i}$ ,  $L_E$  and  $L_{EI}$  functions using no time constant and I time weighting simultaneously
- The parallel measurement using three time weightings is available on both A- and C-/Z-weighted networks

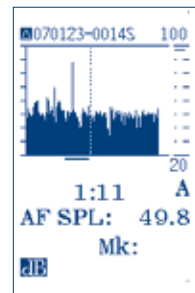
Option 5 enables parallel measurement of all time constants simultaneously. If real time filters are installed, the parallel time weighting functions are available for the individual filter bands as well.

## Option 6: Level versus time measurements

- Measures the time "Profile" (level vs. time) of the noise signal with preset time resolution simultaneously with the overall "Global" measurement
- Selection of preset intervals within the 1 second to 199 hours interval range
- Automatic level versus time storage of  $L_{Aeq}$ ,  $L_{Amax}$  and  $L_{Cpeak}$  (or  $L_{Zpeak}$ )
- Automatic multispectrum storage of  $L_{eq}$  and  $L_{max}$  if option 1 is installed
- Level versus time measurement continues during a paused Global measurement
- Markers identify any pause, stop or continue of the measurement
- Real-time graphical and numerical display of the level versus time results

### Automatic markers:

A pause marker is inserted into the time profile in pause mode. A recorder marker is inserted when the instrument is doing a sound recording, and an overload marker is inserted if overload occurs.



Level versus Time

070123-0014S	
A-network	
	F SPL:
1:07	P 51.1
1:08	P 48.4
1:09	P 56.0
1:10	49.6
1:11	49.8
1:12	49.9
1:13	47.4
1:14	45.3
1:15	49.0

L(t) numeric table

## Option 7: Advanced Level versus time measurements

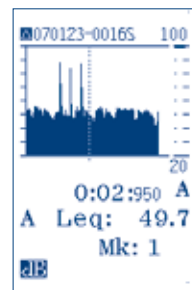
- Selection of preset intervals within the 25 msec to 199 hours interval range
- 25 msec interval resolution below one second and one second resolution above
- Free selection of any A- and C-/Z-weighted functions to be stored at each preset interval
- Possible operator marker settings during the measurement
- Selection of 3 different single markers and 1 toggle marker

The enhanced time profile mode allows logging of  $L_{eq}$ ,  $L_{max}$ ,  $L_{min}$ ,  $L_{peak}$ ,  $L_e$  and SPL for all weighting networks and frequency bands for time constant F, S and I in parallel if option 5 parallel time constant is enabled. The user may select from one to all available parameters to log. The time resolution is from 25 ms logging to memory. If the frequency analysis option is installed, these values may be measured too, both as time profile multi spectrum values and as global values.

### User controlled source coding

With option 7, the instrument gets eight marker functions, where as four are user defined. Three of them are single markers and one is a toggle marker.

*Option 7 requires that minimum option 6 be installed*



*L(t) with markers*

Δ070123-00165	
A-network	
	Leq:
0:02:750	53.7
0:02:000	52.9
0:02:050	52.4
0:02:500	50.9
0:02:950	49.7
0:03:000	49.9
0:03:050	50.3
0:03:100	47.6
0:03:150	45.6

*Table with markers*

## Option 8: Sound recording

- Storage of the sound signal itself onto the SD card or the internal memory
- Triggered by an external hand-switch, by a level trigger or by a manual key push
- 8, 16 or 24 bit accuracy
- 12 or 48 kHz sampling
- 0 - 96 dB digital gain
- Reference calibration tone can be added at the beginning of the first recording in a measurement

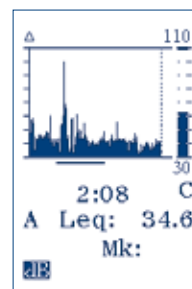
Option 8 allows storing the sound signal itself onto the SD card or the internal memory.

This option is especially useful for source identification. The sound recording can be triggered by an external hand switch, by a level trigger (requires option 16) or by a manual key push.

Several recording formats are supported, ranging from 8, 16 or 24 bit and with sampling rates of 12 or 48 kHz. Using 48 kHz sampling and the stored sound signal may be used for further processing. The Nor140 has a large dynamic range – exceeding 120 dB. This means that if you try to play back the signal on your PC you will – in most cases - hear nothing! To overcome this problem a special digital gain, 0 – 96 dB, can be added to the sound recorded signal without affecting the calibration or measured values.

Another useful feature is that you may play a 10 sec reference tone - sine wave, pink or white noise in the beginning of a measurement to set a reference level when later replaying recorded data.

*Option 8 requires that minimum option 6 be installed*



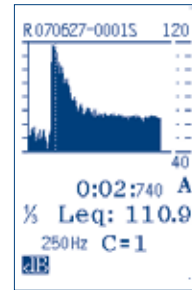
*Lt with recording marker*



## Option 9: Reverberation time measurement mode

- Reverberation time based on impulse or noise (option 10) excitation
- Calculates both  $T_{20}$  and  $T_{30}$ ; backward integrated decay for impulse
- Displays the graphical reverberation decay for each frequency band
- Covers the 63 – 8000 Hz frequency bands for the 1/1-octave filters
- Covers the 50 – 10000 Hz frequency bands for the 1/3-octave filters

*Option 9 requires that minimum option 1 be installed*



Reverberation decay

%-oct	T20
100Hz	0.262
125Hz	0.31
160Hz	0.24
200Hz	0.38
250Hz	0.29
315Hz	0.28
400Hz	0.34
500Hz	0.27
630Hz	0.26

Numerical RT table

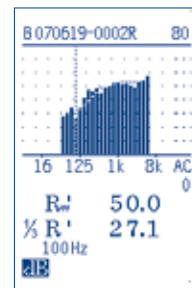
## Option 10: Noise Generator

- Produces white or pink noise excitation signals with adjustable output level
- Synchronization of noise signal with measurement start and stop
- Allows noise excitation of reverberation time measurements if used with option 9 Reverberation time

The signal generator option generates both white and pink noise. Both impulse excitation and continuous noise excitation are supported, making the noise generator useful for both reverberation time measurements as well as sound insulation measurements.

## Option 11: Building Acoustic measurement mode

- Extends the Nor140 instrument into a complete single channel building acoustic analyser.
- Synchronises excitation in the source room with the measurement operation (option 10)
- Makes room averaging of multiple microphone positions for sound level and reverberation time measurements for ISO-140/717 users:
  - Calculates the survey and engineering grade airborne sound insulation ratings  $R'w$ ,  $D'n,w$ , and  $D'nT,w$
  - Calculates the survey and engineering grade impact sound insulation ratings  $L'n,w$  and  $L'nT,w$
  - Calculates the correction terms  $C$ ,  $C_{tr}$  and  $C_i$  including the extended frequency versions
- In conjunction with NorBuild, can easily calculate rating per ASTM and other National Standards
- Allows remote use in combination with the Nor1028/3 CtrlBuild software package
- Can be used for cable-free measurements using the Nor1516 Wireless Building Acoustic System
- Fulfills the requirements of the survey grade ISO-10052 Standard



Results

Criteria	$R'$
C	-1.0
$C_{50-3150}$	-1.0
$C_{50-8000}$	0.0
$C_{100-5000}$	0.0
$C_{tr}$	-5.0
$C_{tr,50-3150}$	-7.0
$C_{tr,50-5000}$	-7.0
$C_{tr,100-5000}$	-5.0
Wtd	50.0

Corrections

Option 11 turns your Nor140 into a powerful single channel building acoustic analyser. All the required parameters for performing both airborne and impact sound insulation are calculated. Using the Nor140 for measuring building acoustic, both airborne and impact noise has never been easier. With the Nor1028 NorBuild sound insulation reporting program, Norsonic offers a powerful and user-friendly building acoustic solution.

*Option 11 requires that minimum option 1, 3, 9 and 10 be installed!*

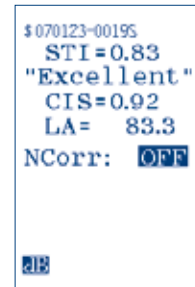
## Option 13: STIPA (Speech Transmission Index) measurement mode

- Calculates the STIPA speech transmission index
- Fulfills the requirements of the IEC-60268-16 Standard for STIPA
- Includes signal excitation CD (Nor1034) for use through separate public address loudspeaker system or portable CD-player
- Background noise correction

Adding STIPA option to Nor140 turns the analyser into a powerful tool for analysing the Speech Transmission quality in public areas. The method can be used to compare the speech transmission quality at various positions and under various conditions within the same listening space. STIPA replaces the former used RASTI method as a more accurate method compared to RASTI.

A measurement in one listening position takes about 13 sec. Unlike many other STIPA measurement systems, the Nor140 can also correct the results for the background noise. In addition all calculated indexes are displayed, not only the single STIPA value. This feature is valuable for engineers optimising the room acoustics in public spaces or other areas where the speech quality is important.

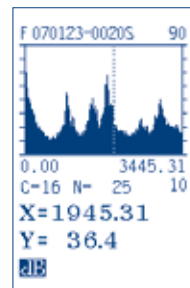
*Option 13 requires that minimum option 1 be installed!*



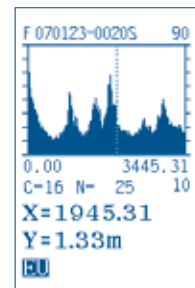
STIPA results

## Option 14: FFT measurement mode

- 8000 line FFT analysis with 1.46Hz line resolution
- Covers the 1.46 – 9.6 kHz frequency range
- Both engineering units and dB
- Pre-selection of 1 - 1028571 averages
- Useful when searching on problems with rotating machinery
- Fulfil the requirements for FFT analysis when searching for tonality according to the ISO/DIS 1996-2 Annex C (2005) standard
- Display compression in binary sequence 1 – 64



FFT spectrum with dB



FFT spectrum with Engineering Units

## Option 15: Survey Sound Power measurement mode

- Calculates the survey grade  $L_{WA}$  sound power level based on multiple measurement positions on a theoretical hemisphere above a noise source placed on a reflective floor
- Automatic correction of background noise level
- Fulfils the requirements of the ISO-3746 Standard

This option allows the user to perform survey grade  $L_{WA}$  sound power level measurements in the field without any other external device. A perfect tool for verifying the sound power level of equipment after installation. A graphical wizard guides the user through the measurement – easy and intuitive to use!

```
RESULTS
Surface: Hg
S:      3.53m2
LeqA:  71.6
BGN:    44.9
K1:     0.0
K2:     2.0
Imp:    Yes
PeakC:  115.5
LWA:    75.1
dB W
```

Sound Power results

## Option 16: Measurement trigger

- Trigger the start of a measurement based on the internal clock, level threshold or external TTL signal such as hand switch Nor263A
- Level threshold trigger used in combination with Repeat storage makes an automatic event measurement device
- The audio recording is triggered based on the clock, level threshold or external TTL signal such as hand switch Nor263A

The measurement and audio recording trigger can be set independently of each other. A special pre-trigger feature on the audio recording can be set up to capture the latest seconds of the audio signal prior to the trigger point.

```
Meas.trig:
Manual
Clock
External
Lvl.above

1: Trigpar.
dB WGS #
```

Measurement Trigger

## Option 18: Extended measurement range

- Microphone self-noise compensation at the lower-levels
- Compensate all measured function of the A- and C-/Z-weighting networks
- Adjustable microphone self-noise levels for use of other microphones
- Improves the lower measurement range by typically 7 - 10 dB
- Shifts the measurement range 10 dB upwards (i.e. 25 - 147 dBA)
- Possible to detect  $L_{peak}$  levels up to 150 dB without changing microphone

## Option 19: Noise Monitoring

- Continuous read-out of pre-selected measurement samples via RS-232 and USB interface
- Automatic re-start of measurements after power down

# Technical Specifications

## ANALOGUE INPUTS

**Number of channels:** 1

**Input connector:**

7 pin LEMO connector for Norsonic microphone systems.

**Microphone:** Nor1225, 1/2", free-field, 50 mV/Pa

**Preamplifier:** Nor1209 (Normal) or ICP@-type by menu selection.

**Preamplifier supply voltage:**

±15 volt, max 3 mA

**Polarisation voltage:**

0 V and 200 V, selectable.

**Maximum input signal:** ±11 V peak

**Preamplifier ICP@:**

**Supply current:** 4 mA

**Supply voltage:** 24V

**Input impedance:**

>100 kΩ, <650 pF

**Measurement range:** 0,3 μV - 7Vrms (10 Vpeak) in one range corresponding to -10 dB to 137 dB (140 dB peak) with a microphone sensitivity of 50mV/Pa. Option 18 extend the measurement range to 147 dB (150 dB peak) by reducing the microphone sensitivity.

## Highpass filter

The input section is equipped with an analogue highpass filter to reduce noise from wind or other sources with frequencies below the frequency range for measurements. The filter is switched on if the limited frequency range is selected (>6,3 Hz).

**Filter type:** 3rd order HP filter (-3 dB at 3,4 Hz, Butterworth response)

## Analogue to digital conversion

The analogue input signal is converted to a digital signal by a multi-range sigma-delta converter with an effective sampling frequency of 48 kHz. The anti-aliasing filter is a combination of an analogue and a digital filter.

## Frequency weightings

Simultaneous measurement of A- and C-weighting or A- and Z-weighting. 1/1 octave band or 1/3 octave band levels may be measured simultaneously if options providing these weightings are installed.

**1/1 octave filters:** 0,5 - 16000 Hz, class 1, digital IIR filters, base 10 system (IEC-61260) and ANSI S1.11-2004 Class 1.

**1/3 octave filters:** 0,4 - 20000 Hz, class 1, digital IIR filters, base 10

system (IEC-61260) and ANSI S1.11-2004 Class 1.

## Level detector

**Detector type:** Digital true root-mean-square (RMS) detection, resolution 0.1 dB which may optionally be increased to 0.01 dB for indicated levels in the range -9.99 to 99.99 dB.

**Crest factor capability:** The crest factor is only limited by the peak-value of the signal.

## Simultaneous measurement of the following functions:

SPL,  $L_{MAX}$ ,  $L_{MIN}$ ,  $L_{eq}$ ,  $L_E$ ,  $L_{PEAK}$ ,  $L_N$ ,  $L_{eq1}$ ,  $L_{E1}$ ,  $L_{TMax5}$

## Indication range

The calibration of the instrument allows microphones with sensitivity in the range -84 dB to +15.9 dB relative to 1V/Pa 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 50mV/Pa. For voltage input, the level 0 dB then corresponds to 1μV. Typical values for the self-noise are 5 dB lower than the values stated.

Noise measured with 18 pF microphone dummy and microphone preamplifier Nor1209, averaged over 30 s of measurement time:

**A-weighted:** 13 dB

**C-weighted:** 15 dB

**Z-weighted:** 25 dB

**1/3 oct: 6.3 Hz to 250 Hz:** 10 dB

**1/3 oct: 315 Hz to 20 kHz:** 5 dB

Noise measured with Nor1225 microphone and preamplifier Nor1209, averaged over 30 s of measurement time:

**A-weighted:** 18 dB

**C-weighted:** 22 dB

**Z-weighted:** 30 dB

**1/3 oct: 6.3 Hz to 250 Hz:** 15 dB

**1/3 oct: 315 Hz to 20 kHz:** 10 dB

## Power supply

**Batteries:** 4 cells, IEC LR6, AA-sized

**Typical battery life time:** up to 14 hours

**External DC:** 11-16V. Power consumption approximately 1.2W depend-

## Overall Performance

The Nor140 fulfill the following standards set for sound level meters, 1/1-octave and 1/3 octave filters:

IEC61672-1:2002 class 1, IEC60651 class 1, IEC60804 class 1, IEC61260 class 1, ANSI S1.4-1983 (R2001) with amendment S1.4A-1985 class 1, ANSI S1.43-1997 (R2002) class 1, ANSI S1.11-2004 class 1.

ing on selected modes of operation. The mains adapter Nor340 is recommended for use with the instrument. If the external supply falls below 9V, the instrument will use the internal batteries if available. If the instrument switched itself off due to loss of power, it will automatically switch on and resume normal operation after reapplying the external DC supply (requires option 19).

## Display

The display is a monochrome, trans-reflective LCD graphical display with 160×240 pixels (W×H) with automatic temperature compensation for contrast and viewing angle. Pressing the light key illuminates the display. The light switches off automatically two minutes after the last operation of any key. The bargraph display covers 80dB which may be scrolled in 10 dB steps to cover the total range.

## Signal generator output

**Max output voltage:** ±10V

**Output impedance:** <100Ωohm. 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 < 20 kHz

**AC-out:** 3,5 mm stereo jack. 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. Full scale on the display bargraph corresponds to 100 mV.

**Output impedance:** Less than 10 ohm, AC-coupled 100 μF.

**Gain accuracy 1 kHz:** ±0,2 dB

**Frequency response re. 1 kHz:** ±0,5 dB for 20 Hz < f < 20 kHz.

**USB interface:** USB type 2.0

**USB socket:** B411

## Serial I/O port:

RS232 port, 9600-115200 baud.

**Digital inputs:** 3 pc

**Digital outputs:** 4 pc

## SD Memory Card

The instrument may use SD memory card for storing of setup information, sound recordings and measurement results. SD memory card included in the delivery.

## Data storage

Measured data is stored in the internal memory of the sound level meter or on the SD memory card. The internal memory is of the "flash" type retaining the information without battery supply. Approximately 25 Mbyte is available for the data storage.

## 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.

## Dimensions:

**Depth:** 30 mm, **Width:** 75 mm,

**Weight incl. batteries:** 410 g

**Length, excl. microphone/**

**preamplifier:** 210 mm

**Length, incl. microphone/**

**preamplifier:** 292 mm

Some of the feature listed in this leaflet may be optional in certain markets. Contact your local representative or the factory for details.

Norsonic reserve the right to amend any of the information given in this leaflet in order to take advantage of new developments.

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