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Sound and Vibration Instrumentation and Engineering

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Measuring vibration using the Norsonic Nor140

Introduction

The Norsonic Nor140 sound level meter can be used to measure more than just sound in decibels. Among other things, it can be used to measure vibration in linear engineering units. These engineering units can be anything the user selects such as Pa, m, m/s, m/s^2 or g's. This involves seven steps:

1) Connect the accelerometer to the meter
2) Change meter's reported units from dB (decibels) to EU (Engineering Units)
3) Adjust the sensitivity based on the accelerometer used
4) Turn off corrections
5) Change input mode to IEPE
6) Select metrics to log
7) Download the data and convert into Engineering Units

All Norsonic Nor140 sound level meters can be set in engineering units and use an IEPE input. Octave, one-third octave, FFT or logging functions are separate options.

Step 1) Connect the accelerometer to the meter

Accelerometer

The Norsonic Nor140 may be used with either charge type accelerometers connected through the microphone preamp or with an IEPE or constant current accelerometer connected directly. This article will only cover the use of an IEPE-type accelerometer connected directly to the Norsonic Nor 140. Information on using a charge accelerometer can be found on page 162 of the Nor 140 manual or Norsonic's "Application note: Measuring vibration using Nor140".

Cables

The simplest cabling to connect a IEPE-type accelerometer to the Nor 140 is with the Nor 4571 Microdot (male) to Lemo (male) cable (pictured below) to directly connect an accelerometer to the microphone preamp connector of the Nor 140.



Step 2) Change meter's reported units from dB (decibels) to EU (Engineering Units)

Press the **SETUP** button. The display now looks like:	SETUP: 1: Instrument menu 2: Meas. duration 3: L(t) par. 4: Frequency mode 6: Trigger 7: Noise gen. 8: Recording 9: RPM R G #
Press **1** on the keypad. The display now looks like:	Instr.menu: 1: Storing 2: IO/Print 3: Clock 4: Input 5: 2nd network 7: Version 8: Reference tone 9: Misc. parameters R G #
Press **9** on the keypad. The display now looks like:	Misc. menu: 1: User par. 2: Lt xfer 3: Nor1516 4: Special Mode RUN 5: Audiometer 6: Units 7: Microphone check 8: Back Erase 9: Power Down R G #
Press **6** on the keypad. The display now looks like:	Units: dB EU R G
Press the **down arrow** button on the keypad. The display now looks like:	Units: dB EU R G
Press **ENTER** until you are back at the measurement screen. The display now looks like:	00:00:30 130529 10:58:02 F SPL: A: 360u C: 356u EURWG 50 10 -30

Step 3) Adjust the sensitivity based on the accelerometer used

First calculate the sensitivity to enter. For example if the accelerometer has a sensitivity of:

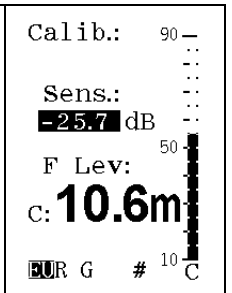
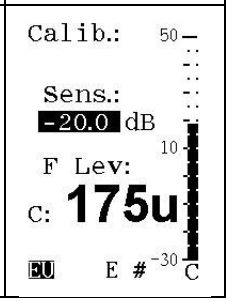
$$975.28\ \frac{mV}{g}\ \ or\ \ 99.45\ \frac{\mathrm{mV}}{m/_{s^2}}$$

If you want your engineering units to be "g" then the sensitivity to enter is:

$$L_s = 20 * \log\left\{\frac{0.97528\ \frac{V}{g}}{1\ \frac{V}{g}}\right\} = -0.22\ dB$$

If you want your engineering units to be "$m/_{s^2}$" then the sensitivity to enter is:

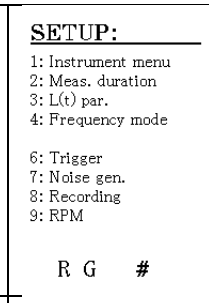
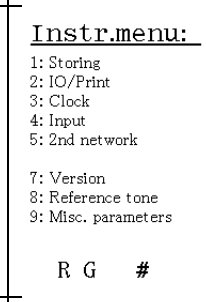
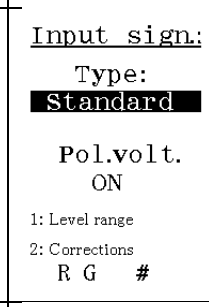
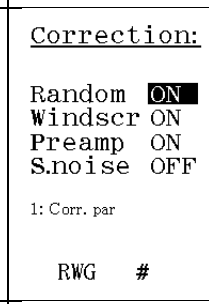
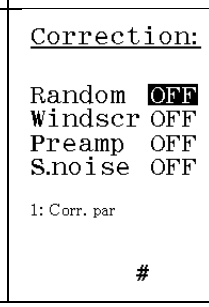
$$L_s = 20 * \log\left\{\frac{0.09945\ \frac{V}{m/_{s^2}}}{1\ \frac{V}{m/_{s^2}}}\right\} = -20.04\ dB$$

Then press the Cal button on the Key pad. The display now looks like:	
Use the keypad or arrow keys to adjust the sensitivity to the calculated value. The display now looks like:	

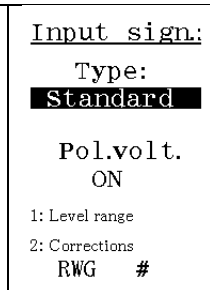
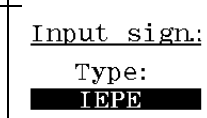
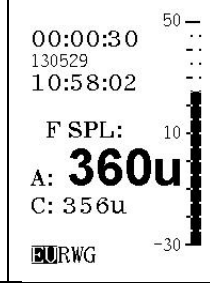
If a vibration calibrator is available, place the accelerometer on the calibrator and use it as you would an acoustic calibrator. Adjust the sensitivity until the correct calibration level is displayed.

Press ENTER untill you are back at the measurement screen.

Step 4) Turn off corrections

Press the SETUP button. The display will now look like:	
Press 1 on the keypad. The display will now look like:	
Press 4 on the keypad. The display will now look like:	
Press 2 on the keypad. The display will now look like:	
Use the arrow keys and the INC and DEC keys to turn off all corrections. The display will now look like:	

Step 5) Change input mode to IEPE

From the Correction menu press ENTER. The display will now look like:	
Use the arrow keys and the INC and DEC keys to change the Input type to IEPE. The display will now look like: **Note**: Older version of the Nor140 firmware will list ICP instead of IEPE	
Press **ENTER** until you are back at the measurement screen. The display now looks like:	

Step 6) Select metrics to log

Set up the Norsonic 140 to collect your desired metrics as you would for acoustic signals.

Step 7) Download data and convert to Engineering Units

Data on the Nor 140 is stored in dB re 20 µ units ($20*10^{-6}$ units). Download the data from the 140 with NorXfer and export to Excel. To covert the data back to engineering units in excel use the following formula.

$$EU = 10^{\frac{dB}{20}} * 0.00002$$

Useful notes:

The Nor140 uses the follows prefix abbreviations in EU mode:

Abbreviation	Power	Name
f	10^{-15}	femto
p	10^{-12}	pico
n	10^{-9}	nano
u	10^{-6}	micro
m	10^{-3}	milli
k	10^{3}	kilo
M	10^{6}	mega
G	10^{9}	giga
T	10^{12}	terra

Marks on the lower line of the display

dB	The signal strength is indicated as a level in decibel. The reference level is normally 20 µPa for sound pressure levels.
EU	Engineering unit: The signal strength is indicated in a generic linear unit. The actual unit could be voltage referring to the voltage on the input terminal or ms-2 if an accelerometer is connected to the input.
#	Numerical keyboard. The number printed on the keys are entered if you press one of the keys on the keyboard
E	A numeric value has been entered. The instrument expects that you press **ENTER** to confirm the number.
N/H	Indicates Normal or High measurement range. (Polarization voltage dependant.)
?	A key is pressed that the instrument does not understand.

Additionally marks indicating applied corrections:

R	Random incidence correction ON
W	Wind screen correction ON
G	Preamplifier correction ON
S	Self-noise correction ON
E	Polarization voltage off - Electret micro- phone