Technical Note

Measuring Infrasound with the Nor145 and Nor150

The demand for infrasound measurements is increasing, particularly in applications involving low-frequency noise from wind farms, ships, and aircraft.

The Nor145 and Nor150 are well suited for such measurements due to their extended low-frequency response, starting at 0.4 Hz in the 1/3-octave band analysis mode. However, the standard microphones and preamplifiers supplied with these instruments are optimized to meet the requirements of IEC 61672 and equivalent standards. Microphones and preamplifiers specifically optimized for infrasound applications are generally more sensitive to low-frequency noise and high humidity, which may adversely affect conventional sound measurements.

The Nor145 is normally supplied with a Nor1227 or Nor1239 free-field microphone, while the Nor150 is supplied with a Nor1225 microphone. All comply with the requirements for a Class 1 sound level meter in accordance with IEC 61672 and equivalent standards. The low-frequency cut-off for these microphone capsules is typically –1 dB @ 5 Hz, making them less suitable for dedicated infrasound applications.

Owing to the instruments' wide frequency range, they are also suitable for specialized applications such as infrasound and ultrasound measurements. In such cases, alternative microphone capsules may be required. Furthermore, the standard Nor1209 preamplifier supplied with the instruments can also become a limiting factor, as discussed below.

Microphone and Preamplifier Considerations

The low-frequency response of a measurement microphone depends largely on the size of the back-vented pressure equalization hole. Over time, microphones may develop pinholes in the diaphragm, which can increase the low-frequency cut-off. 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 verify that the microphone's low-frequency performance remains within specification.

A suitable microphone for infrasound applications is the GRAS 40AZ, which is compatible with both the Nor145 and Nor150. The GRAS 40AZ has a typical frequency response of 0.5 Hz to 20 kHz (±2 dB).

The standard Nor1209 preamplifier has a low-frequency cut-off of –3 dB @ 1 Hz. For applications requiring improved low-frequency performance, it may therefore be advantageous

to use a preamplifier with a lower cut-off frequency, such as the GRAS 26AI, which provides a flat response down to 1 Hz (–0.2 dB).

The GRAS 40AZ is mechanically compatible with the Nor1227 and Nor1225 microphones and can therefore be used together with the Nor1216 and Nor1217 outdoor microphone systems when combined with the Nor1209 preamplifier. The GRAS 26AI, however, is not mechanically compatible due to its dimensions.

Preamplifier Considerations – Background Theory

The low-frequency cut-off frequency of a preamplifier is primarily determined by the capacitance of the microphone capsule and the input impedance of the preamplifier. The cartridge capacitance of a typical ½-inch microphone capsule is generally between 13 pF and 18 pF. The input impedance of the Nor1209 preamplifier is typically 10 GΩ.

Using the relationship:
$f(-3\ dB) = 1 / (2\pi RC)$

the low-frequency cut-off of an 18 pF capsule is approximately –3 dB @ 0.9 Hz. For a 13 pF capsule, the corresponding value is approximately 1.2 Hz.

The input impedance of a preamplifier can be increased, but this involves certain trade-offs. Higher input impedance increases sensitivity to contamination and leakage currents, particularly in high-humidity environments. Consequently, very high-impedance preamplifiers are generally less suitable for demanding field applications than the standard Nor1209.

The GRAS 26AI has an input impedance of 20 GΩ.

Given the Nor1209 cut-off frequency of –3 dB at 1 Hz, compensation may be required depending on the desired low-frequency limit and measurement accuracy. Compensation can be applied by correcting the roll-off in the lower 1/3-octave bands. It may also be applied directly to post-calculated weighting networks such as the G-weighting network, since these are derived from the 1/3-octave filters.

However, it is not possible to compensate the true weighting networks (A, C, and Z), as these are calculated directly from the raw AC signal.

Refer to the instruction manual for further details regarding the difference between true weighting networks and post-calculated weighting networks.

Norsonic can provide calibration of the Nor145/Nor150/Nor1209 (or GRAS 26AI) together with the GRAS 40AZ as a complete measurement set in order to verify the extended low-frequency response. This service is available at additional cost.