DIGITAL NOISE CORRECTION

MARSHALL LONG[1], HAL W. HARDENBERGH[2] and DAVID MARSH[3]

[1]MARSHALL LONG ACOUSTICS, [2]DIGITAL ACOUSTICS INC.
[3]GENERAL ACOUSTICS LTD.

Digital Noise Correction (DNC) is a technique which has been applied in a new community noise analyser to lower the noise floor of the integrating sound level meter. In principle, the noise floor of an instrument may be reduced by subtracting from the overall noise level measured the component due to the inherent noise of the instrument itself. The technique is particularly relevant in consideration of long term statistical measurements where low levels inside buildings and night-time countryside levels are under investigation.

The noise floor of a sound level meter is usually determined by the inherent noise in the preamplifier and amplifier stages. Thermal noise of the preamplifier input resistance and transconductance of the FETs are the principal sources. Recent electronic component advances have permitted the design of circuits with inherent noise levels which are stable for long periods of time, and it is this development which makes practical the realisation of DNC. Slight variations in individual electronic component parameters means that in practice it is necessary to measure the inherent noise of each preamp/amplifier combination individually. However, once measured, there is little change.

The Digital Acoustics DA 607P, version 3 incorporates DNC and the principle was checked out in practice using a specially designed enclosure (Fig.1). This enclosure consists of two 12-gauge steel boxes, one inside the other, and separated from each other by 1" layers of foam. Both boxes are closed with airtight lids and holes for the microphone cables are sealed with modelling clay. For the tests reported, the reference system was a B&K 2209 Precision Sound Level Meter. Its 1" condenser microphone (4145) and peamplifier were taped together with the GenRad 0.5" electret microphone (1962-9610) and 1976-9600 preamp used as input to the DA 607P, so that the microphone diaphragms were coplanar. No attempt was made to match precisely the calibration of the two systems.

The two microphones were sealed inside the test enclosure, which was then subjected to noise level of 93dB(A). The corresponding level inside the enclosure was 45dB(A), implying a noise reduction for a white noise spectrum of 48dB(A).

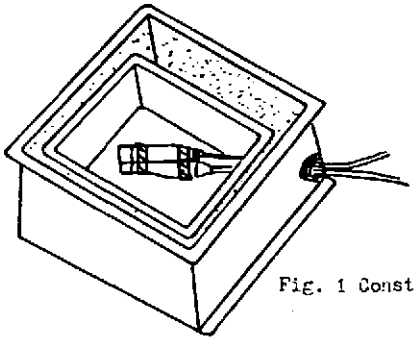

Fig. 1 Construction of test enclosure

Since the background noise level of the measurement room was 28dB(A), it is reasonable to assume that, without other external sound, the internal level inside the enclosure is well below 0dB(A), if not as low as -28dB(A).

Stepping the level of the white noise in the room by means of a Hewlett Packard HP 4437A attenuator, the sound level was varied in 2dB steps from the above maximum until the noise level of the two instrumentation systems was reached. The mean value on the 2209 Sound Level Meter was averaged by eye, while the DA 607P was used in its energy averaging mode. The DA 607P v.03 samples 128 times per second in groups of 16 (ie. a maximum of 8 readouts per second without compromise on response to varying signal levels), with a sample resolution of 0.05dB.

The first run was made without DNC and the results are shown in Fig.2. The curves for the two readouts are offset slightly because of the difference in calibration. The B&K 2209 begins to show the effects of inherent noise at about 22dB(A) and has an absolute threshold at about 15dB(A). The DA 607P and GenRad microphone without DNC begins to show the effects of inherent noise at about 30dB(A) and has an absolute threshold at about 23dB(A). Both show reasonable agreement with the B&K and GenRad published noise levels, although our measurements are not intended to be absolute.

The test was then repeated with DNC selected on the DA 607P. Results are shown in Fig.3, which of course, confirms the B&K 2209 values of Fig.2. However, the DA 607P now has a noise threshold of 12.4dB(A).

Fig.4 compares the two DA 607P measurements, with and without DNC. The difference between the lowest unaffected signal level without DNC, 31 dB(A), and that possible with DNC, 12.4dB(A), is about 19dB. The 12.4dB threshold is imposed by the DA 607P as the lowest level of its analogue to digital converter. The absence of any asymptote in the lower curve of Fig. 4 suggests that the actual noise floor of the system is some dB lower.

Digital Noise correction shows considerable promise as a relatively inexpensive way to improve the noise threshold of an integrating sound level meter, without having to use laboratory quality microphones and special low-noise amplifiers. However, it is obvious that even more exciting results could be obtained in the use of DNC on laboratory quality instrumentation.

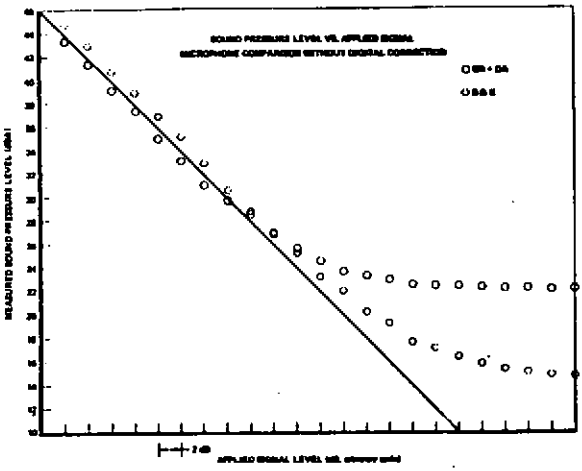

Fig.2 Microphone comparison without DNC

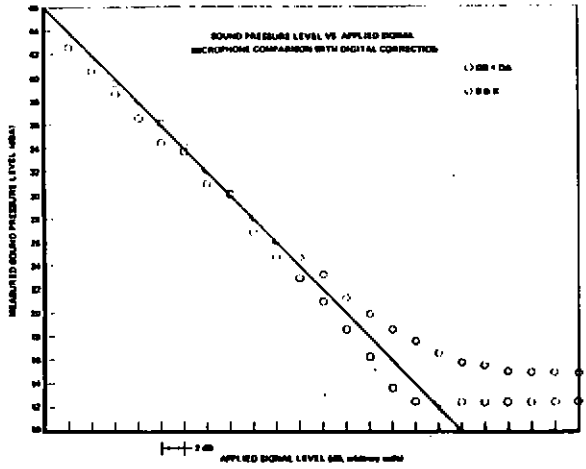

Fig.3 Microphone comparison with DNC

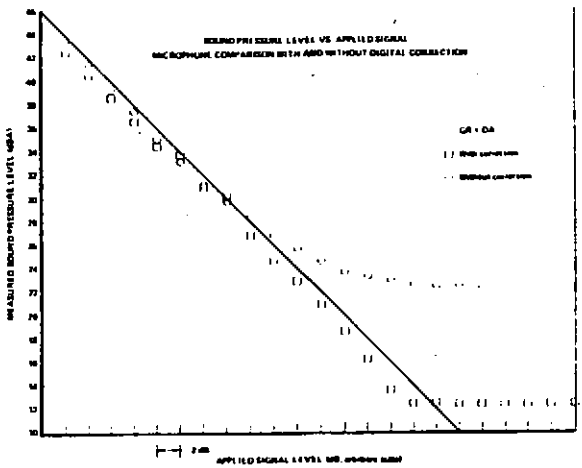

Fig.4 Effect of DNC