

The calculation of dynamic range for the digital recorder is made at the digitizer. Following the digitizer, the signal is in digital form and noise can no longer degrade it. Full-scale input to the digitizer is always 10 volts, regardless of the amplifier level in use. The noise at the analog input to the analog-to-digital converter is composed of two components. One component is the output noise of the amplifier which increases as gain is increased. On the lowest gain level, with a gain of 10, the input noise, 0.1 microvolt, multiplied by the gain gives an output noise of 1 microvolt. To this must be added a small amount of referred-to-output noise, on the order of 100 microvolts. Thus, the total noise at the output of the amplifier is approximately 101 microvolts. As the gain increases, this referred-to-output noise becomes unimportant, relative to the amplified input noise. Thus, at the highest gain level, 163,840, the noise at the output of the amplifier is approximately 16,484 microvolts rms.

The second noise component is the system noise from the analog multiplexer up through the analog portion of the analog-to-digital converter. This noise is specified as 0.03% of full scale peak-to-peak, or 0.001 volt

rms. This noise remains the same, regardless of the amplifier level in use.

The total noise up to the point of digitization is the root-mean-square sum of the amplifier noise and the system noise. At the lowest gain level, the amplifier noise (101 microvolts) is negligible compared to the system noise (1000 microvolts), and the rms combination is still, for practical purposes, about 1000 microvolts. At this gain level, the ratio of full scale (10 volts) to noise (0.001 volt) is 80 db.

As each gain level is calculated, it is found that amplifier noise remains negligible, compared to system noise, up to gain level 10.

In the higher gain levels, as amplifier noise (after amplification) becomes significant in relation to the system noise, the dynamic range at the digitizer falls off. It should be noted, however, that the final column in Table 1 represents the dynamic range only on a single gain level. The dynamic range, represented by the automatic gain-ranging capability of the amplifier (that is, 84 db), must be added to these figures to

TABLE 1

Amplifier noise is negligible, compared to system noise, up to gain level 10. On the highest gain levels, because of the large gain, amplifier output noise becomes the dominant element in the total noise.

Gain Level	Gain	Amplifier Noise	System Noise	RMS Combined Noise	Dynamic Range--db (at Digitizer)
0	10	101 uv	0.001 v	0.001 v	80
-	-	-	-	-	-
10	10,240	1,124	0.001	0.0015	77
11	20,480	2,148	0.001	0.0023	73
12	40,960	4,196	0.001	0.0043	67
13	81,920	8,292	0.001	0.0084	62
14	163,840	16,484	0.001	0.0165	56