Outside the Bandwidth

Noisemanship—The Art of Measuring Noise Figures Nearly Independent of Device Performance

■ **J.C. Greene**

When this letter was written, J.C. (Jack) Greene, an assistant department head in the Applied Electronics Department at Airborne Instruments Lab in Deer Park, New York, frustrated by the increasing sloppiness of measurement in the field (in 1961, no less), wrote this satirical—though highly informative—remedial essay. This letter originally appeared in *Proceedings of the IRE*, vol. 49, p. 1223, 1961. Jack is now retired and writing haiku in Boca Raton, Florida.

Almost everyone who has measured the noise performance of a sensitive amplifier or converter has found it possible to read noise-figure values considerably lower or higher than expected. The more exacting experimenters among us have refined their measurement techniques to eliminate such ambiguities and can even obtain accurate noise-figure values for the new, exotic, negative-resistance devices such as parametric amplifiers, masers, and tunnel diode amplifiers and converters. However, as yet, only a few astute practitioners have recognized the tremendous practical value of being able to read noise-figure values much lower or higher than actual. For example, when evaluating their own devices, they can manage to read unusually low noise figures by following certain experimental procedures. (Do not be anxious about their results being much better than theoretical, since they can usually postulate some plausible explanation such as space-charge smoothing.) Conversely, when evaluating their competitors' devices, they can just as readily manage to read exceptionally high noise figures. (Here, however, they usually do the gentlemanly thing and make the magnitude of the noise figures inversely proportional to their competitors' abilities.) to encourage the practice of noisemanship, and thereby bring these very effective practical advantages to all those interested in advancing the state of the art of low-noise devices, we have complied a partial list of the correct experimental procedures to follow in these two cases.

Case 1: Procedures to Be Followed for High-Noise Figure Readings

1) Use a post-receiver that is very nearly saturated; this makes the output indication almost completely independent of the device under test. By varying the degree of saturation, this one technique alone can lead to almost any desired high noise-figure value.
2) Place a grid-dip meter or sweep generator near the receiver IF amplifier; this is not as effective as procedure 1), but less readily detected by unfriendly observers.
3) Use an argon-discharge noise tube, but use a calibration chart for a neon tube. Since the argon tube has about 3 dB less effective output-noise power, an error of 3 dB in your favor is easily obtainable. This technique is especially useful if skilled unfriendly observers are present, since the discharge is not visible in any commercial noise generator (because the noise lamp is always located inside a waveguide or coaxial structure) and, therefore, they cannot tell the type of discharge present from its characteristic color.
4) Use a noise generator having the biggest possible difference in source impedance at the two reference noise levels (assuming that a Y-factor measurement is made, which is generally true above a few hundred megacycles where

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noise diodes are no longer useful). This causes a difference in the gain of the device for the two reference conditions. Here, however, one must be careful that the gain decreases when the higher reference temperature is connected. One should also allow sufficient time between the two reference readings so that the output indicator drifts well down scale before the high temperature reference is connected. The use of a badly mismatched noise generator may also cause an unstable device to break into oscillation; if so, an immediate victory is scored.

5) Orient the noise generator for maximum TV, FM, and police radio pickup.
6) Assume that the device has at least three equal spurious responses and, therefore, and 5 dB to the measured noise-figure value. This gives you a knowledgeable air and usually impresses those present.

There are an unusually large number of these procedures, which are too numerous to list here. However, by the use of the few techniques listed above, one can readily pin the noise-figure indictor on the infinite end of the scale. For those pessimists who have only lately entered the low-noise arena, these techniques are guaranteed to lead to immediate positive results.

Case 2: Procedures to Be Followed for Low-Noise Figure Readings

1) Undo Case 1 procedures 1), 2), and 5).
2) Reverse Case 1 procedures 3) and 4).
3) Neglect any spurious responses and quote only the radio-astronomy noise figure.
4) If the observers are aware of the above procedures, place a carefully measured 100-dB pad between the noise generator and the device under test. This will eliminate the gain variations caused by noise-generator mismatch, but when 100 dB is subtracted from the overall reading, a low-noise figure is sure to result. An alternative procedure is to use a post receiver with a 100-dB noise figure and then carefully subtract its noise contribution.

Again, there are too many of these procedures to list here, but if only the few above are followed, noise figures below 0 dB can easily be obtained. This may be a little embarrassing in the presence of theoretically inclined antagonists, but, again, one can postulate some elaborate thermodynamic mechanism as the probable cause. (If you are anxious about such a procedure, use only one or two of the aforementioned procedures, and the noise figure will rest just slightly above the 0-dB mark, which is much more readily explained.) For those adventurers who have only lately entered the low-noise arena, these techniques guarantee an immediate entrance into the innermost ring.

In conclusion, techniques have been listed to encourage the rapid growth of noisemanship. Here, however, we think it appropriate to paraphrase Oscar Wilde, who noted that people only like to give advice they will not follow themselves, and with his characteristic wit denoted such advice as the depth of generosity.