SINAD Alignment for Optimum Performance

How do SINAD alignment techniques measure up?

By William Detwiler

SINAD is an acronym for the term: "Signal plus Noise and Distortion". Measurement consists simply of connecting the SINAD instrument to the output (speaker terminals) of the receiver and reading the SINAD while injecting a modulated signal into the front end of the receiver.

While this procedure is uncomplicated and can be done in seconds by a competent technician, a full explanation of the SINAD method of examining receiver sensitivity is helpful to understand what SINAD is.

Refer to Figure 1. A 1,000 Hz tone, at an appropriate level is put into a communication circuit, and the amount that comes out the other end is measured with an audio frequency voltmeter. The reading of the voltmeter is then noted. This reading will consist of the 1,000 Hz signal itself, plus any noise which has been picked up or generated in the circuit. Thus this reading can be represented as follows:

READING #1 = SIGNAL + NOISE + DISTORTION.

Next, a notch filter inserted in the leads to the voltmeter. This notch filter is sharply tuned to notch out the 1,000 Hz tone, but let the other frequencies pass with negligible loss. A reading is then taken with the notch filter in place. Since the Signal portion has been filtered out, this reading can be represented as follows:

READING #2 (with notch) = NOISE + DISTORTION.

To find the SINAD value, reading #1 is divided by reading #2.

$$\text{SINAD} = \frac{\text{Reading \#1 (without notch filter)}}{\text{Reading \#2 (with notch filter)}}$$

$$= \frac{\text{SIGNAL + NOISE + DISTORTION}}{\text{NOISE + DISTORTION}}$$

The above would give the SINAD as a ratio of the two voltage readings. Normally, SINAD is expressed in decibels, so the ratio would be converted to decibels. Or, if a decibel scale on the voltmeter was used to take the readings, one could simply subtract the second reading from the first to get the SINAD expressed in dB.

Although the formula given for SINAD as shown above gives the exact expression of the term SINAD, it may be helpful to think of SINAD as signal to noise ratio.

Since distortion, like noise, is something unwanted added to the signal, we could think of distortion as being merely another form of noise. Then the formula reduces to

$$\text{SINAD (simplified)} = \frac{\text{SIGNAL + NOISE}}{\text{NOISE}}$$

(should be converted to decibels)

In a practical circuit, the noise will be considerably less than the signal. In other words, the value of the signal plus the noise is approximately the same as the value of the signal alone! This reduces the formula to:

$$\text{SINAD (further simplified)} = \frac{\text{SIGNAL}}{\text{NOISE}}$$

(should be converted to decibels)

SINAD is a measure of signal quality. If a perfect signal is input into a communication circuit (an amplifier, a telephone line, a radio circuit, etc.) and then the SINAD of the signal measured after it has passed through the circuit, the resulting SINAD value is the measure of quality of the communication circuit — that is, how much it degrades the initially perfect signal.

FM-SINAD

This approach is used to measure the SINAD sensitivity of FM communications receivers. To make the measurement, a signal generator is connected to the receiver, and set up to generate a signal on the channel frequency. The generator is then modulated with a 1,000 Hz tone. The amount of modulation is 3 KHz peak deviation. The SINAD of the recovered audio from the receiver's loudspeaker circuit is measured. When the signal generator attenuator is set to deliver very strong signals to the receiver, noise and distortion in the SINAD of the recovered audio will be low, resulting in a high SINAD value. As the attenuator is set to deliver reduced signals to the receiver, noise will increase and the SINAD of the recovered audio will become less. When the SINAD becomes 12 dB, the output (in microvolts) from the signal generator is recorded. This value is then taken as the 12 dB SINAD sensitivity of the receiver.

SINAD measurements can also be made with a distortion meter. A block