SIMPLE DEVIATION CALIBRATION

Jay W. Underdown
SPECTRUM RESOURCES, INC.
St. Charles, MO 63301

One of the many problems facing the two-way radio shop manager or technician is test equipment calibration. For FM deviation there is a simple field method that can be used to calibrate deviation meters and 'scopes that is very accurate.

Since the shop technician is not sure of his test equipment calibration, he may intentionally set transmitter deviation on the low side for customer’s radios. This is done in order to assure that the customer does not over deviate, resulting in interference or a citation. The problem with setting deviations low is that average and peak deviation will not completely fill the receiver band pass resulting in weak audio, increased noise and reduced system range.

Deviation meters can be calibrated by a method known as Bessel Functions. The equipment needed to calibrate deviation is an Audio Oscillator, a Frequency Counter (or Synthesized Audio Oscillator), a FM Signal Generator and a Spectrum Analyzer or narrow bandwidth General Coverage or Amateur Receiver. Since not all two-way shops have access to an adequate Spectrum Analyzer, calibration using both pieces of receiving equipment will be reviewed.

Figure 1 shows a chart of Bessel functions and audio tones. Theory shows us that a FM Transmitter, when modulated with one of the tones specified, will generate all of its power in the sidebands and the primary carrier frequency will disappear. When adjusted properly, this null is at its minimum, and the signal generator will be deviating at the amount specified in the chart.

Bessel Functions are not unique to two-way radio. Bessel was a mathematician who died before FM radio was invented.

The procedure for calibrating deviation using a Spectrum Analyzer is as follows: Using a FM Signal Generator or other FM source, modulate the generator with the Audio Oscillator set for 2,079.2 Hz. Set the audio output level at an amount that will adequately deviate the signal source. With the source connected to a "tee" between the Spectrum Analyzer and the Deviation Meter, slowly increase the deviation while watching the Spectrum Analyzer. As the deviation is increased, to near 5 kHz, you will notice on the Spectrum Analyzer that the carrier level will begin to drop. Very slowly increase the deviation until the carrier disappears on the Spectrum Analyzer. At the point where the carrier is at its minimum level on the Spectrum Analyzer, the deviation of the Signal Generator is 5.0 kHz. At this time, the Deviation Meter under test should be adjusted to read this amount. It may be necessary to readjust the Spectrum Analyzer bandwidth and sweep rate to obtain a usable carrier null.

The method of using a receiver to determine the null is similar. The author regularly uses a ICOM 1C-735 Transceiver with a 500 Hz filter in the CW position. An old Hammarlund SP-600 SuperPro in the 500 Hz mode has also been used successfully. The only requirements are that the receiver have a narrow bandwidth and that the AGC circuit work in this mode so that the "S" meter operates.

To use this method, generate a signal on a frequency that the receiver can tune (I use the 28 MHz Band) and tune the receiver for a maximum "S" meter reading. Increase or decrease the generator output to obtain almost a full scale indication. Slowly increase the deviation with the same audio as before. When you approach 5 kHz deviation, the carrier will begin to drop as indicated by the "S" meter. Increase the deviation very slowly until the carrier disappears. This is 5 kHz deviation.

If the deviation is increased further, the carrier will return until you reach the second null. This null indicates 11.48 kHz deviation. This second null can be used to set 5.0 kHz deviation using 905.8 Hz as the audio tone.

If your counter cannot resolve audio below 1 Hz, set the audio oscillator to the nearest whole number to the indicated value. The difference will less than 0.1 kHz in deviation.

This method of setting deviation gives a simple, in shop method of calibrating your Deviation Meters. Give it a try.

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FIGURE 1

BESSEL NULL FUNCTIONS

AUDIO FREQUENCY	DEVIATION PRODUCED		
	1st NULL	2nd NULL	3rd NULL
905.8 Hz	±2.18 kHz	± 5.00 kHz	± 7.84 kHz
1000.0 Hz	±2.40 kHz	± 5.52 kHz	± 8.65 kHz
1500.0 Hz	±3.61 kHz	± 8.28 kHz	±12.98 kHz
1811.0 Hz	±4.35 kHz	±10.00 kHz	±15.67 kHz
2000.0 Hz	±4.81 kHz	±11.04 kHz	±17.31 kHz
2079.2 Hz	±5.00 kHz	±11.48 kHz	±17.99 kHz
2805.0 Hz	±6.75 kHz	±15.48 kHz	±24.27 kHz