K6LEW RECEIVER TEST PROCEDURES

A standard series of tests I use for VHF multimode radios is similar to tests done on HF radios. For receive, you'll want to determine the following: CW minimum discernible signal (MDS), FM 12 dB SINAD, CW blocking dynamic range (BDR), 20 kHz spacing (and any others you might want to add), FM adjacent channel selectivity, 20 kHz (and any other spacings) CW 2-tone, 3rd-order dynamic range, 20 kHz and any other spacings FM 2-tone, 3rd-order dynamic range, 20 kHz, 10 MHz and any other spacings CW 3rd-order intercept (using an S5 signal as a reference)

I use a distortion analyzer (actually you can use a VOM with a DB scale almost as well) to measure audio output level changes and distortion levels. MDS is a 3 dB (signal+noise)/noise figure, i.e. you measure the audio output level with just noise and then use a signal generator to increase the output by 3 dB. The signal level at the receiver's antenna input is the MDS.

FM 12 dB SINAD is equally easy. Just set the generator to 3 kHz deviation with a 1 kHz modulating signal and adjust the level to produce a 25% distortion on the receiver's audio output. The signal level at the receiver's antenna input is the 12 dB SINAD. Note the equivalent dBm and microvolt figures for this measurement, as the microvolt figure will allow convenient comparison to other FM rigs and the dBm figure is necessary for the dynamic measurements.

For BDR, use a step attenuator on the generator's output and use the relative magnitude function of the distortion analyzer (or other audio level measuring device). Determine the strongest signal you can put into the receiver without overloading it by locating the 1 dB compression point. To do this, I set the signal generator to a particular level, then decrease the step attenuator by 10 dB. If the audio output goes up 10 dB, you are within the linear range of the receiver, so increase the generator a few dB and try it again. When the audio output goes up by 9 dB, that is your 1 dB compression point.

Once you have the compression point, connect 2 signal generators via a two-port coupler (also known as a hybrid combiner or even a regular power divider for our frequencies) to the receiver and set one generator on frequency with a level that appears as 10 dB less than the compression point at the receiver's antenna port. Set the other generator to the blocking frequency (I use 20 kHz on both sides of the desired signal for standard tests and add 50 kHz and 100 kHz for my "expanded" tests) and set it to a low level to start. Set the audio measurement device to -1 or -2 db relative. Slowly increase the level of the second signal generator. When the audio output changes by 1 dB (up or down), you have reached the blocking level. Note the level of the second generator's output and subtract the losses from the combiner and any attenuators you are using to determine the level at the receiver antenna input. The BDR is the difference between this level and the CW MDS. If the audio output increased, this would have been due to an increase in oscillator noise, so the measurement would be noise-limited in that case.

For FM adjacent channel selectivity, the idea is similar, but the audio measurement is distortion. The first generator is set to create a 12 dB SINAD (with combiner and attenuators in line) and the second generator is used (modulated at 400 Hz) to increase the distortion to 50%. The level of the second generator into the receiver's antenna input, subtracted from the 12 dB SINAD level, is the adjacent channel selectivity.

While you have the FM adjacent channel selectivity set up, take an additional measurement that you will use for the FM 2-tone, 3rd-order dynamic range (DR) test. Turn the modulation of the second generator off and readjust the level as necessary to bring the distortion back to 50%. Subtract the 2nd generator level (into the receiver, as usual) from the SINAD figure and record this as the phase noise limit in dB.

For the 2-tone, 3rd-order DR measurements, I use step attenuators and set both generators to a fixed level that is high, but not high enough to cause IMD effects to occur within the generators (given the isolation of the hybrid combiner). I use a generator level of -17 dBm (since my combiner has 3 dB of loss, this makes off-the-top-of-the-head calculations more convenient). Set the generator frequencies to a distance of 1 times and 2 times the spacing from the receiver frequency (i.e., for 20 kHz DR at 146 MHz, use 146.02 and 146.04 MHz, respectively). For FM, turn the modulation off for the generator nearest the receiver frequency. Modulate the other generator with 1 kHz at 3 kHz deviation.

Set the step attenuators to a high amount of attenuation to start (50-60 dB at least) and decrease them gradually until you see an MDS (for CW) or 12 dB SINAD (for FM) response on the audio measuring device. Record the level into the receiver as the level of one of the generators minus all attenuation of the test setup. The difference between this level and the MDS or SINAD response (as appropriate) is the 2-tone, 3rd-order dynamic range.

For CW, determine if the measurement is noise-limited by turning off the output of the generator furthest from the receiver. If the audio drops by a dB or less, the measurement is noise-limited. For FM, compare the result of this test with the phase noise limit recorded previously. If the phase noise limit is lower, then the phase noise limit is the actual FM DR and the measurement is noise-limited.

For the CW 3rd-order intercept, use a single generator to induce an S5 response in the receiver (by the receiver's S-meter). Note the level into the receiver. Next, connect 2 generators via a combiner and attenuator and duplicate the CW 2-one, 3rd-order test, except this time adjust the attenuators to produce an S5 response in the receiver. Again, note the level into the receiver. Calculate the 3rd-order intercept using this formula:

IP3 = (3 * (S5 IMD level) - (S5 reference)) / 2

Good luck, Owen, K6LEW