Setting Transverter Drive for Better Signal Reports
by
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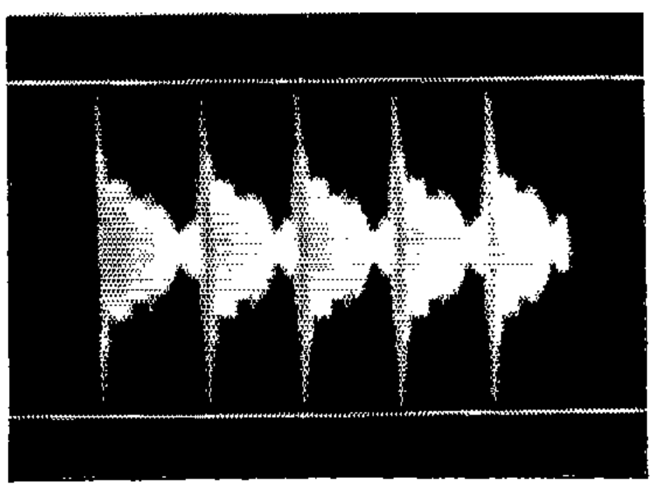
Last weekend on a 10G outing it was clear that many rigs were being over driven. First evidence was splatter 50 kHz wide. Second evidence was on the scanning display of a nearby K3 which showed bandwidth of some signals was greater than that display. Third evidence was some of those stations having a hard time being heard.

When the splatter is very audible at 150 miles, its probably less than 20 dB down from the main signal. A signal 20 dB down is 1% power per 2 kHz bandwidth, and if 100 kHz wide accounts for 50% of the total PA output power. That hurts the signal where it was expected to be transmitted and the clipping that causes that splatter also causes distortion of the audio to make it harder to copy, worse when the signal is weak.

When I set up my 10g station with a borrowed 3 watt amplifier, I was checking power with a calibrated (HP-423A) detector and my Tektronix scope using its DC and audio capabilities. It sure was clipping. I don't know which stages were clipping but the tops of the syllables on SSB were flat. Normal voice looks like triangles with a peak followed by a slope. This comes from the nature of speech with the base frequency shifted. Since I was looking at the detected envelope (detector bandwidth well over that of the 200 MHz scope) I backed off the drive at the TC board (DEMI transverter) until I had nice rapid rises and slopes like the SSB envelope should have. I received repeated super signal reports though there were several stations in that rove with more power and bigger antennas.



This SSB envelope is a little spikier than some but its the general RF waveform. This is from the QST-VIEW scan of “Interpreting the Linear-Amplifier Meter Reading,” August 1955, page 22, also in the ARRL book, “Single Sideband for the Radio Amateur,” fourth edition, 1965, page 222. The horizontal lines are probably the indications of the maximum signal on CW.

There are several ways to set the drive for a clean signal. The scope and diode detector with directional coupler is workable, just takes an audio or better scope and detector. Its nice if its DC coupled so one can compare CW key down with the peak SSB because the peak of SSB in a linear amplifier can't be as much as the maximum CW and be amplified cleanly. This doesn't require a calibrated detector or one that's even rated for the frequency so long as it detects relative levels. I suspect a vintage Schottky diode like the venerable 5800-2835 will detect well past 10 GHz. .

Using the spectrum analyzer is a super deluxe test method exemplified by the K3 with spectrum display box, or a Flex or even a Softrock in spectrum display mode rather than waterfall. One has to be careful about overloading the receiver string and creating the splatter in the receiver. But with that care it can work very well. Or one can manually crank the dial and look for splatter, if one has a separate receiver for the frequency.

Another deluxe technique is to look at the RF with the scope. In the old days some connected the RF directly to the deflection plates of an electrostatic deflection CRT. Since the late 1950s, scopes with a 30 MHz or better bandwidth have been available. My scope works to about 450 MHz. For higher frequencies one can heterodyne the signal with some oscillator and a mixer. One possible ready to use circuit for that may be one of the modern solid state proximity detector RF sections which consists of a DRO oscillator, a double balanced mixer and two antennas. I've not yet tested that concept since the diode detector worked for me. It may require tuning the DRO lower than 10550 for scopes with narrower vertical bandwidth than my Tek 475. The DRO is generally tunable in those motion detectors.

Lacking a scope, a simple analog meter and diode detector can be applied. The detector and meter need to be peak reading, so there needs to be a post detector time constant longer than 50 or 100 milliseconds to hold the peaks or a peak reading adapter circuit which has been published in QST in recent years. That long time constant for a 1K 100 microamp meter movement means a 50 mfd tantalum electrolytic or an op amp peak hold circuit. Adding the op amp as a follower the load resistance on the detector can be increased significantly to say 100K and then a ½ or 1 mfd capacitor of paper or mylar can be used. With the peak reading power meter it will take a few syllables to get to the peak power. But first close the key and when the meter stops moving up, note the reading. Holding coupling constant (whether a little horn antenna or a directional coupler) then go back to SSB and reduce the drive while talking until the peak reading meter starts to drop, probably for good linearity it should be at about 90% of the saturated CW reading. As a second check, take out the peak hold capacitor, to make the meter time constant short and so it will be average reading. The voice power should be less than 20% of the CW key down power in most cases. Some voices and microphones its normal for the voice power reading to be only 10% of CW key down.

These relative power readings on an average reading meter apply to SSB at any frequency from below 20 kHz to SSB modulated light carriers. Setting drive levels to minimize splatter also applies over the same radio spectrum.

There are three power levels in a power amp output that are of interest. Psat is the saturated power. All it will give with a single tone carrier. No amp will give more on SSB peaks unless its limited by the power supply. Many a hifi amp IS limited by its power supply. P1 is the output level where the gain is down 1 dB from the small signal gain. All amplifier pundits say running an amp to a peak power of P1 will keep it linear enough for most applications. P3 is where the gain is down 3 dB and running at that level usually introduces detectable distortion detected at the receiver and neighbors in the band detect some splatter. Usually P3 is a lower power than Psat, but not always. P3 sometimes is below Psat, and sometimes equal to Psat. An amp with lots of headroom will degrade gradually from P1 to P3 to Psat. But some amps hit Psat before getting to P3, those clip hard not far above P1. I can't say which amp is which. The data sheet for a microwave power amp MMIC may give hints, that are affected by chip temperature, operating frequency, and supply voltage.

Warren Bruene, at that time W0TTK (now W5OLY), wrote in QST, November 1954 about "Distortion in Single-Sideband Linear Amplifiers." He later was one of the authors of "Single Sideband Principles and Circuits” (McGraw-Hill, 1964) and designer and consultant on several Collins ham and commercial linears. He knows what he's talking about. In that QST article he suggests a diode detector on the input and the output with one to the X input and one to the Y input of a scope which for the perfect amplifier will show a straight diagonal line. When the amplifier saturates the line will curve. It would be handy if the output was on the vertical amplifier. Then when the output doesn't follow the input due to over drive the displayed amplitude display curve flattens off. He also suggests using a receiver as a manual spectrum analyzer while driving the linear with a two tone source to detect intermod. He says, “Even though the S-meter calibration is “off”, the method is useful for adjustment purposes if the precautions are are observed, since it will show qualitatively the effect of changes in operating conditions or tuning.” Yes this is a topic that has been around a long time. Those precautions include being careful to not overload the receiver and to have enough shielding that the RF signal only gets in through the antenna connection, and then probably through considerable attenuation. This article was reproduced in the ARRL book, “Single Sideband for the Radio Amateur,” fourth edition, in 1965. Likely in other editions. The same techniques and circuits are in “Single Sideband Principles and Circuits,” chapter 22.

Today's HF linears often include a peak detection or grid current detection circuit used to generate a drive control voltage (often called ALC) to self protect from over drive. Some transverters in G3SEK's (now GM3SEK) “VHF/UHF DX Book” include voltage controlled input attenuators controlled by such detectors. A good idea that hasn't been universally adapted. Manual adjustment is a good first step, but its not always completely effective when the operator gets excited and shouts to be heard better.

73, K0CQ