

HOW CLEAN IS A LUNAR-LINK AMPLIFIER?

Hams seem to always complain about other operators' signals. Many times those complaints are justified. Old design tetrodes such as 4CX250 type tubes were originally intended for class C service. Although they can be adapted to SSB voice linear service, their distortion products (Intermodulation Distortion or IMD) are not very good in linear service, typically 3rd order products are down about -25 dB from PEP output when these tubes are run within their ratings, properly tuned, neutralized and not drawing any grid current. When pushed (as hams tend to do), these type tubes can have less than -20 dB IMD and create splatter. These distortion products are the result of mixing among the different voice frequencies. These IMD products make a signal appear to be wide and give it that off frequency clicking popping and chsh, chsh, chsh sound.

The move to transistors hasn't made the situation any better. While very linear transistors have been around for over 20 years, their 28 and 56 VDC requirements and high prices have kept them from gaining any appreciable acceptance in the amateur market. Virtually all 100 to 200 watt solid state amplifiers use 12 VDC (13.8 VDC nominal) devices that were originally designed for class C FM service. They have been adapted to linear SSB voice operation but their distortion characteristics are no better than 4CX250 class tubes that were designed in the early 1950's! Many of the "brick" amplifiers do not even have adequate linear bias circuits and have 3rd order IMD products down not much more than -20 dB (from PEP). Virtually all VHF multi-mode transceivers use the similar 12 V devices with better biasing but not much better IMD.

Recently, magazine product reviews have noted that even the current multi-band, multi-mode transceivers have acceptable, but not great, IMD performance. Lunar-Link Systems tested a Kenwood TS-2000S on 144 MHz running 100w PEP output with a 1 KHz spaced 2 tone test (400 Hz and 1400 Hz audio signals were fed into the mic. input). While not horrible, the IMD performance was not great. Listed below is the results of our TS-2000 measurements:

TS-2000, 144.110 MHz, 100w PEP

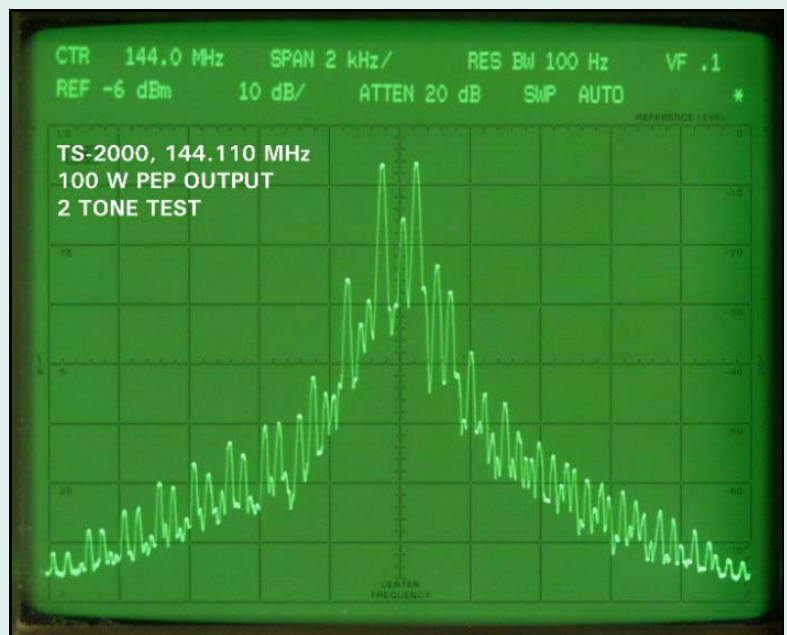
3rd order products -26 dB

5th order products -33 dB

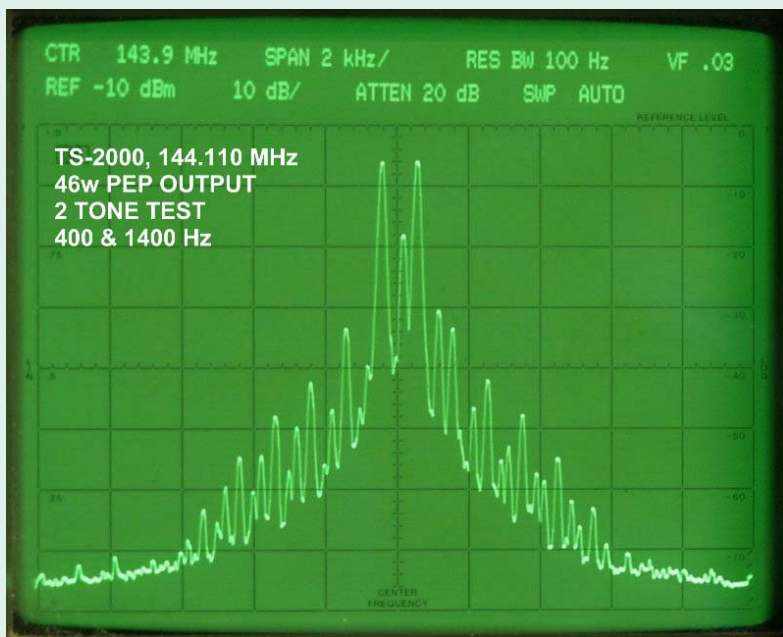
7th order products -36 dB

Note: The average of both the high and low distortion products is used. IMD level is referenced to PEP.

Note that there is an additional product that appears to be a mixing product between the two audio signal generators used in the test. We have ignored this signal.



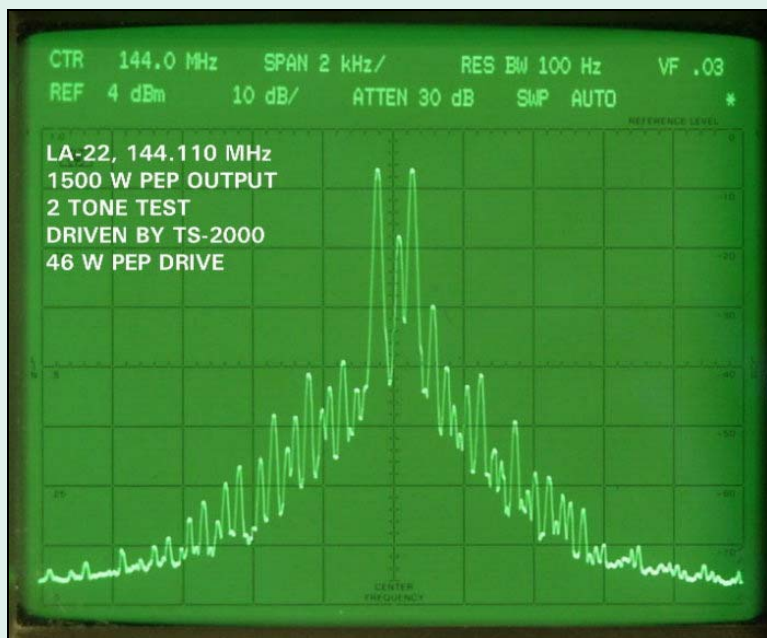
Fortunately there is good news. 3CX800A7 tubes have very high gain, meaning that they require relatively low drive power. Several magazine reviews noted that most of the available VHF / UHF transceivers have considerably better IMD performance when they are run below their rated power output. TS-2000 was tested again, this time running 46w PEP which is typically the maximum drive power required by a LA-22A. IMD levels improved dramatically, averaging a 9 dB improvement:



TS-2000, 144.110 MHz, 46w PEP:

- 3rd order products -33 dB
- 5th order products -42 dB
- 7th order products -48 dB

The Eimac 3CX800A7 was specifically designed for linear amplifier operation. It has a segmented cathode that shoots the electrons between the grid bars improving both gain and linearity. Its IMD products are typically 10 dB better than 13.8V transistors and tetrodes designed in the 1950s,. In addition, LA-Series amplifiers use RF negative feed back grid neutralization which can further improve linearity. The next test was to measure a LA-22A at 1,500w PEP output.



LA-22A, 144.110 MHz, 1,500w PEP
Driven by TS-2000 @ 46w PEP

- 3rd order products -34 dB
- 5th order products -42 dB
- 7th order products -48 dB

As in the TS-2000 test, IMD levels are referenced to PEP and the audio combination distortion products are ignored.

This is outstanding performance! The LA-22A adds no measurable degradation in the IMD of the driving signal. The IMD levels coming from the LA-22A at 1,500w PEP are essentially identical to the TS-2000 at 46w PEP. The LA-22A is faithfully amplifying its driving signal, accurately reproducing the drive signal including any drive signal imperfections.

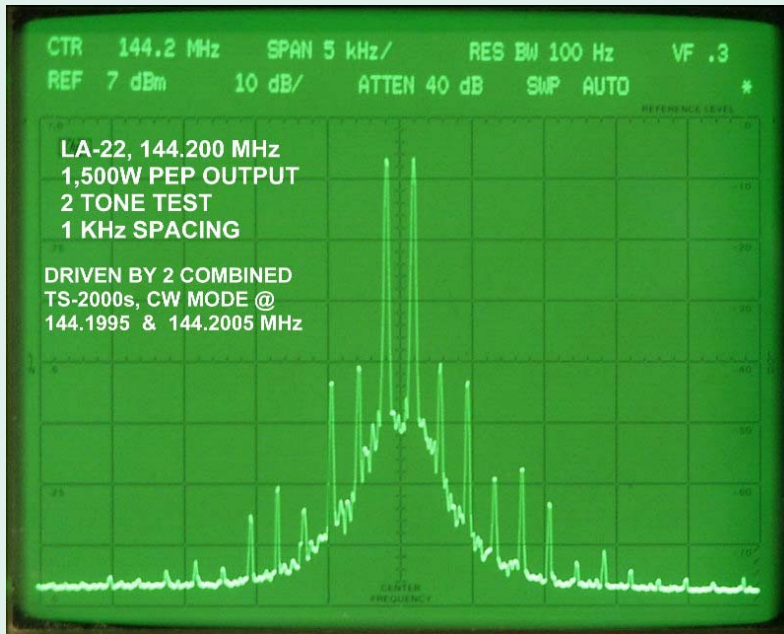
However, the previous measurement does not show how clean a Lunar-Link amplifier really is, because the limiting factor is the distortions in the drive signal. To find out how clean a Lunar-Link amplifier really is, a means to eliminate the distortion in the drive signal was needed. The best way to accomplish this is to drive a LA-22A with two separate CW signals that have as pure as possible wave forms.

This was done by using two TS-2000s operating in CW mode with their outputs combined through a hybrid ring. One TS-2000 was set at 144.1995 MHz and the second at 144.2005 MHz. This gives a 1 KHz signal spacing which is the same signal spacing used in the previous tests. The LA-22A was again operated at 1,500 watts PEP output. It's IMD performance was flat out outstanding with 3rd order IMD down an incredible 40 dB! Note how clean the spectral display is:

LA-22A, 144.200 MHz, 1,500w PEP

Driven by combined CW signals
144.1995 & 144.2005 MHz.

- 3rd order products -40 dB
- 5th order products -44 dB
- 7th order products -62 dB
- 9th order products -58 dB
- 11th order products -65 dB
- 13th order products -69 dB



Tests were also made at 2 KHz spacing which is the standard signal spacing for performing IMD tests on linear RF amplifiers that will use analog voice modulation. The results at 2 KHz signal spacing were, within measurement error, identical to the 1 KHz results.

CONCLUSION:

A Lunar-Link Systems LA-Series amplifier is substantially cleaner at 1,500 watts PEP output than virtually any solid state brick amplifier or VHF transceiver running 100 watts PEP output. The IMD products of a Lunar-Link LA-Series amplifier average 14 dB lower than a typical VHF transceiver at 100w output. That is, the LA-Series IMD products on are 96% lower!

Moreover, the low drive power requirements of a Lunar-Link amplifier allows for a substantial improvement in overall station IMD performance by running the driving transceiver or transverter at lower output power.

Simply stated, with a Lunar-Link Systems amplifier, you will have one of the cleanest signals on the band.

Lunar-Link Systems is not responsible for typographical errors

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