Simple K2 RX mod handles extremely strong on-frequency signals

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Several recent HF Pack postings described K2 received audio distortion ("Howling K2s") in the presence of nearby transmitters operating on the exact same frequency as the K2. ("Update on Stalking the Wild Howling K2" - WB6MLC and "Conclusion from the witness. (K2 Trouble - my $.02 worth)" - K2CPE, WB6ZQZ and others.)

Over the past two days, we reproduced this in our lab and came up with a very simple modification that dramatically increases the K2's on-frequency extreme signal-handling capability. The mod uses just two 1N4148 or 1N914 diodes; details appear below. We have modified five K2s as described, and they all worked perfectly.

In hindsight, we should have included the two diodes in the original design. The reason we didn't notice this sooner is that the test suite used by most RF labs, including ours and the ARRL's, does not include a test of extremely strong on-frequency signal handling. The K2 passes all of the usual dynamic range tests with flying colors, as has been well documented. But these tests all use weak signals *within* the K2's crystal filter passband; large signals are injected outside the passband (usually 5 to 20 kHz away). Those tests are looking for desensing of the receiver when strong off-frequency signals are present and for intermodulation products from strong off-frequency signals that produce on-frequency interference that masks desired weak signals. The K2 excels in these areas and tops most current rigs on the market.

Of course if we had been doing our share of HF Pack operation, we would also have discovered this problem sooner! Operating multiple rigs on the same frequency, all within walking distance of each other, was something that never occurred to us when we designed the K2 and released it in 1999, prior to the big upsurge in HFPacking that occurred in 2000. Thanks to all who did tests and let us know what was going on. We believe someone demonstrated the effect to Wayne at SeaPac 2002, and we apologize for not looking into it then.

Modification Details: Link to Mod Document (.pdf)
This applies to all K2s regardless of serial number.

1. Solder a 1N4148 or 1N914 diode (or equivalent) between pins 4 and 6 of the I.F. amp (U12, MC1350). The cathode (banded end) should go to pin 4. Do this on the bottom of the board using very short leads.

2. Solder a second diode of the same type between the same two pins, but with the banded end toward pin 6.

Results:
With the diodes in place, we've been able to transmit at 100 watts into an antenna just a few feet from the K2 (with its own antenna) with no apparent K2 receiver problems. In these tests the receiving antenna was non resonant. But at the lower power levels used for HF pack operation, there should be no problem even with resonant antennas operating in each other's near field. Fast and slow AGC still work normally.

Technical Details:
The MC1350 used in the K2 for receive automatic gain control (AGC) can handle up to about 2.5 - 3.0 V peak-to-peak at its input, pin 4. Beyond this, the AGC becomes ineffective, and the product detector can be overdriven. Normal on-air, on-frequency signals are generally under 200 mV at pin 4 of the I.F. amp, even at "S9 + 40 dB" as indicated on the K2's

S-meter. But when you inject an extremely large signal from a nearby transmitter on the same frequency, the signal can go as high as 7 Vpp unless it is hard-limited.

The two diodes limit the signal to 1.4 V peak-to-peak. Even when the diodes are conducting, i.e. when the signal is so strong that it looks like a square wave at pin 4, there is no audible signal distortion. This is because the MC1350 is followed by a second crystal filter which removes any harmonic distortion products (i.e. multiples of 4.915 MHz). The diodes appear to have no other side-effects.

The modification provides a large increase in on-frequency dynamic range by acting as a clean limiter. Most commercial rigs use multiple I.F. amp stages to achieve this, but this adds a lot of complexity, adds significant IF noise and increases current drain, which is not compatible with the K2's intended use as a battery-powered field radio. It is also unnecessary; the K2's gain distribution is such that the diode limiter will never interfere with received signal quality.

If you make the modification, please let us know if it cures any observed audio anomalies as described earlier. If results are universally positive, we'll incorporate the mod into new K2 kits immediately.

73,
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