After getting a report of hearing W8UM on the 14 MHz band (while we were transmitting on the 7 MHz band!), we investigated the harmonic output of our transmitter (Ten-Tec Omni VI).

The test set-up used a dummy load with a sampling circuit, with the sampled output connected to a spectrum analyzer. The fundamental and all harmonics could be read directly and recorded, then the harmonic rejection calculated.

High harmonics (above the 43 dB below carrier FCC limit) were found on several bands using this test set-up.

It turns out that the “sampling” circuit in the load also includes a diode detector! A diode detector is very non-linear (exponential in fact) and generates DC and harmonics with a single frequency input.

Good news: our HF transmitter is likely within FCC specs. The station reporting our transmitted harmonic was within a few miles of W8UM, so even a few mW of harmonic power would have produced a strong signal at his reciever:

- If our output power on 7 MHz was 100 W, with 43 dB of rejection, we were putting out about 5 mW on 14 MHz (within FCC limits). If the reporting station is 5 miles away, he would receive our 14 MHz (harmonic) signal at about -68 dBm (about 0.17 nW!) which is still about 5 dB over S9 on his receiver!
Heathkit Cantenna Dummy Load (and Harmonic Generator!)

Cantenna schematic

\[ v_o = I_d \cdot R_{scope} \lVert (j \omega C_1)^{-1} \propto I_0 e^{k_{vin}} \]
\[ = I_0 \left( 1 + k_{vin} + \frac{(k_{vin})^2}{2} + \frac{(k_{vin})^3}{6} + \ldots \right) \]
\[ v_{in} = a \cos(2\pi f_0) \]
\[ \Rightarrow v_o \text{ will contain DC, } f_0, 2*f_0, 3*f_0, \text{ and more (trigonometry omitted)!} \]

- With a pure sine wave input to the dummy load (and sampled node at “v_{in}”)
  - 2\text{nd} harmonic is only 5 dB down from carrier
  - 3\text{rd} harmonic is 12 dB down from carrier
- The diode model is a rough estimate, but it demonstrates the point: “know thy test equipment!”