Low-rent SO2R notes

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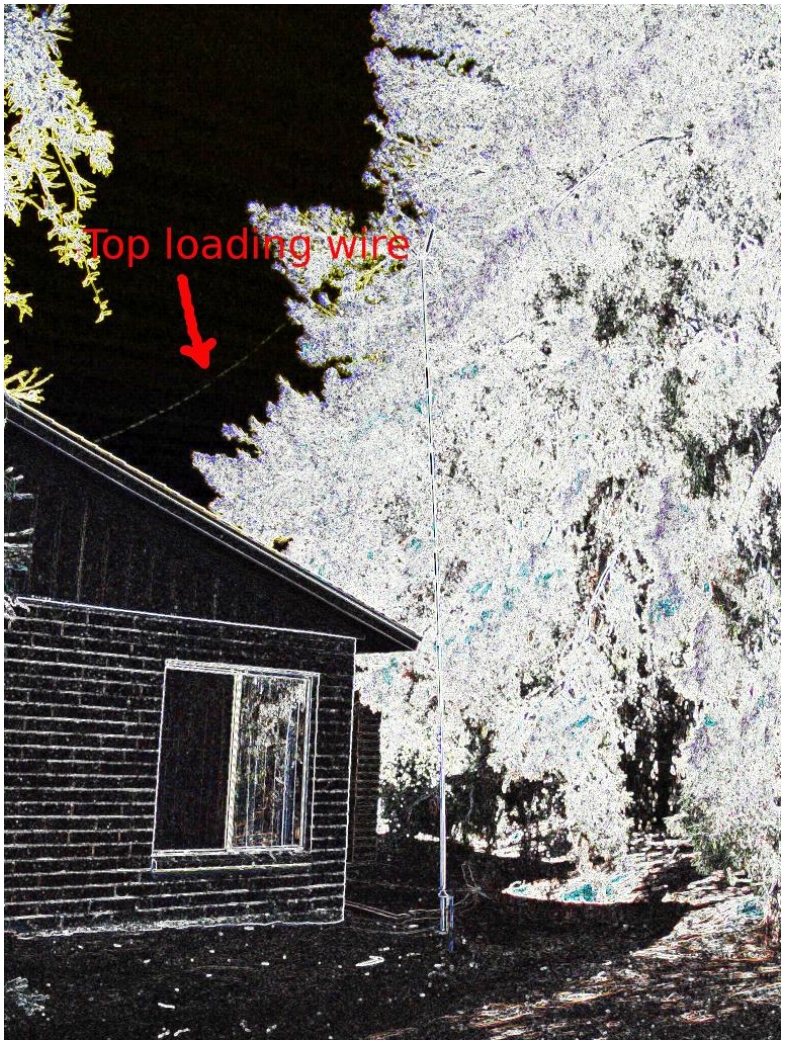
Hustler vertical



Hustler 6BTV with VP1 triband adapter. High power 80m resonator for 80m. Low power 80m resonator with a top loading wire for 160m.

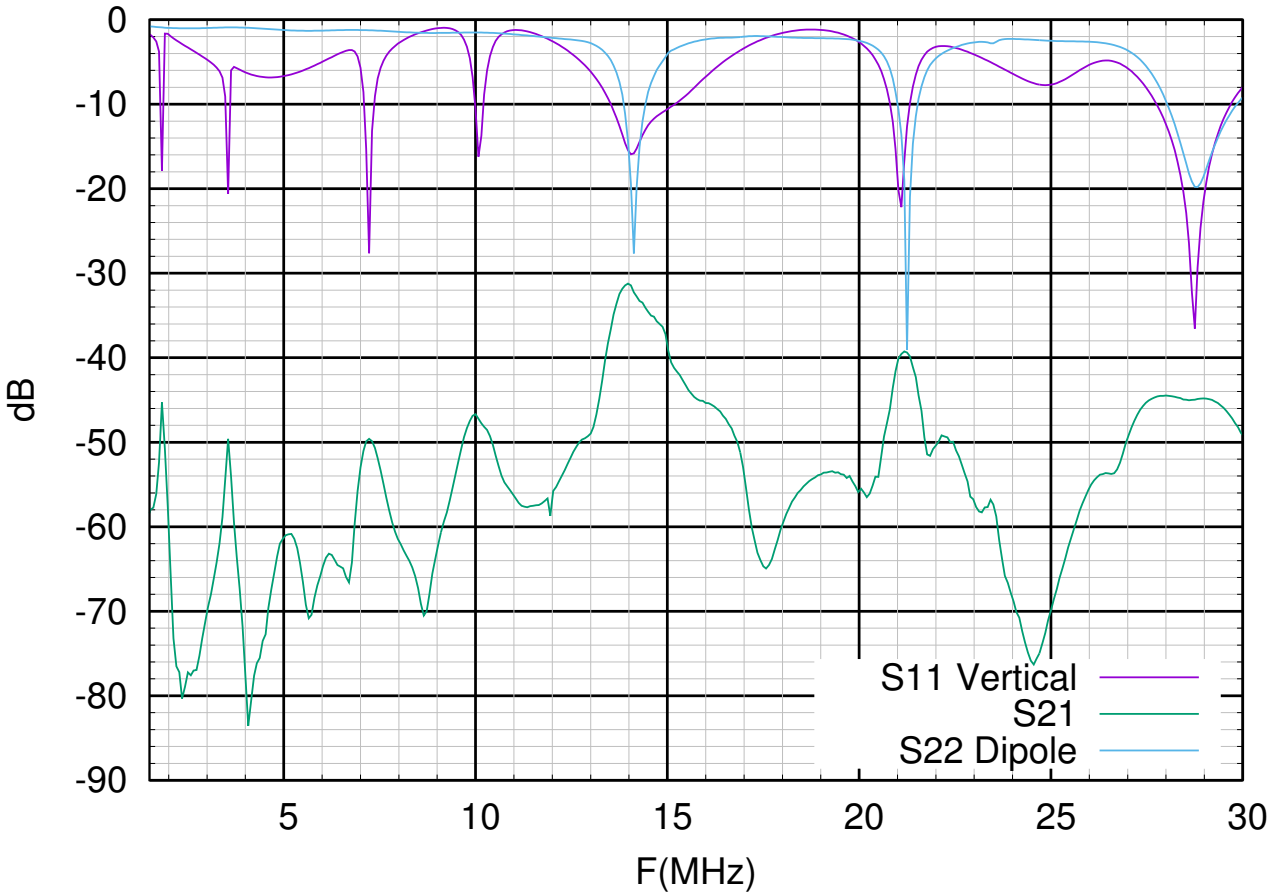
Fan dipole replaced with Hy-gain TH-1

There is a high pass filter in the television antenna feedline. The 160m top loading wire is tied off at the heat pump base to the left.

Google earth view

Hustler vertical - Triband dipole

Return loss and coupling between antennas. Measured as a two port at the shack end of the feedlines.

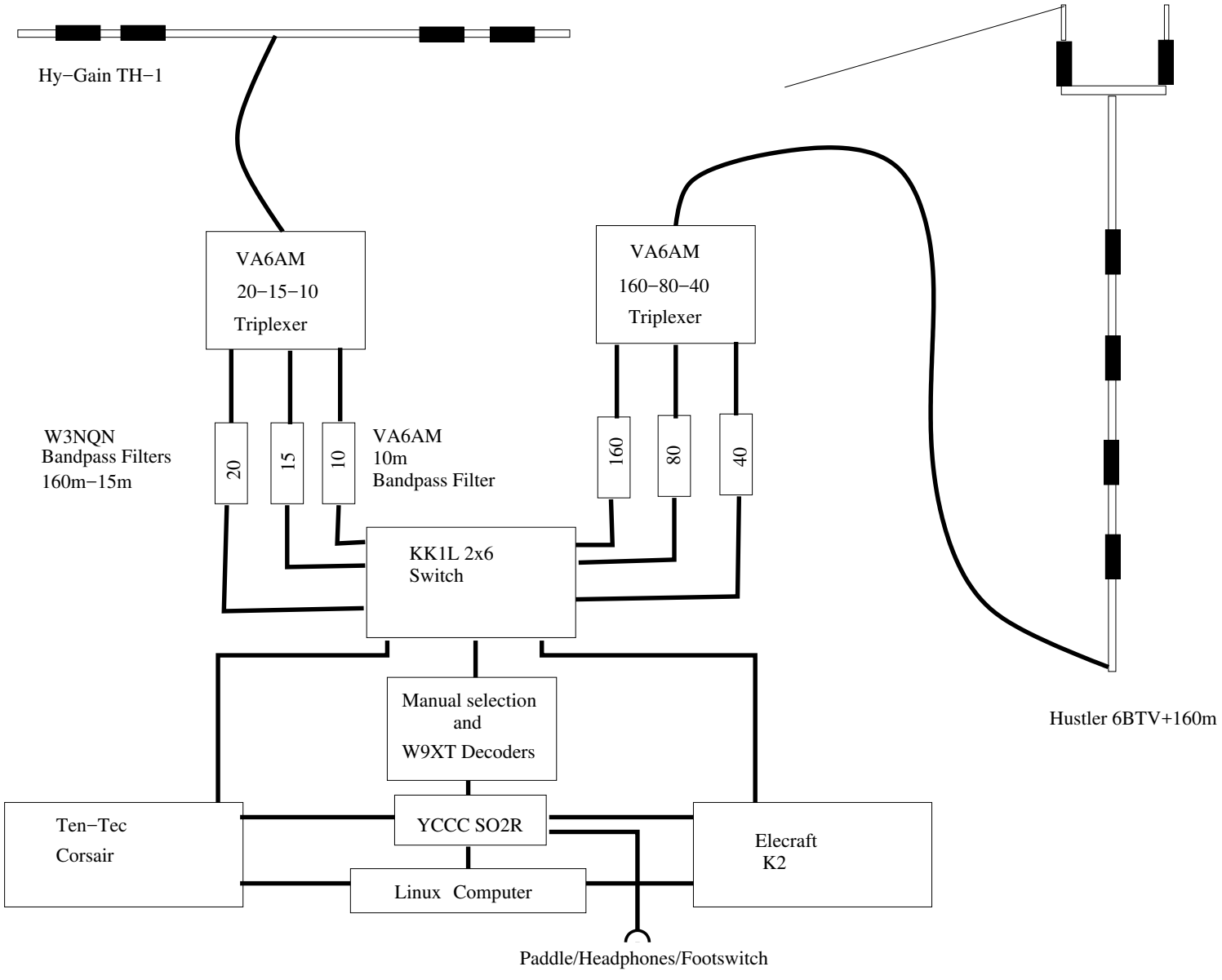


The coupling is highest on 20m, 15m, and 10m. The vertical rig's low pass filter makes damage unlikely even without additional filtering.

Basic Idea

- Low power only.
- Use dipole for 20m, 15m, and 10m.
- Use vertical for 160m, 80m, and 40m.
- Triplexers connected to bandpass filters which connect to a 2x6 switch.
- Currently total rig isolation is limited on higher frequency bands by the approximately 60+ dB isolation of the KK1L switch. Need bandpass filters on rig outputs (or improved switch) to do better.
- Use YCCC SO2R box and TR log.
- Use available rigs, Elecraft K2 and Ten-Tec Corsair.

Station Diagram

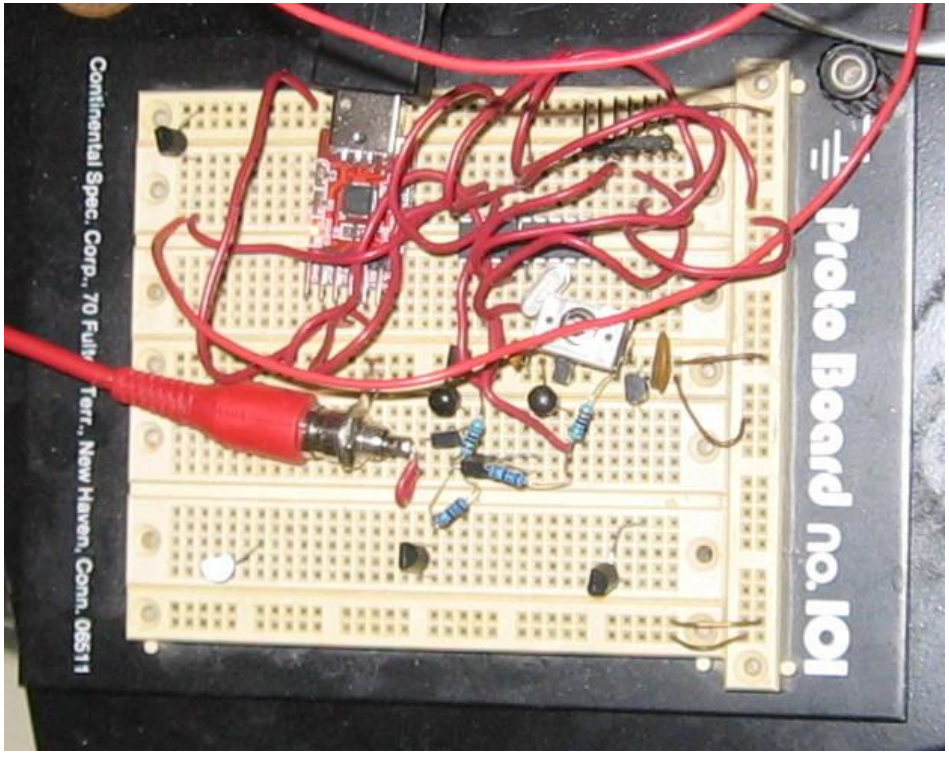


Too cheap to buy, I need to build

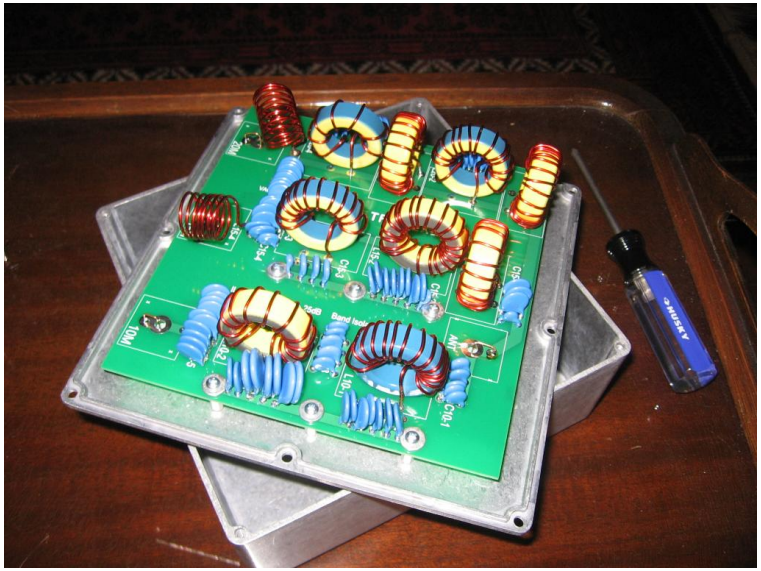
- Too cheap to buy a better rig. Need to build a computer interface for Corsair so frequency and band data are available.
- Too cheap to buy triplexers. Buy circuit boards from VA6AM for low power triplexers and build them.
- Too cheap to buy an Array Solutions Six-Pak. Get circuit board from KK1L and build a 2x6 switch.
- Too cheap to buy bandpass filters. Buy an Ebay assortment of 3KV NP0 capacitors and start building W3NQN filters.
- Not too cheap to buy two W9XT band decoders and high-side drivers. Build them into control box for the KK1L 2x6 switch.
- Not too cheap to buy YCCC SO2R kit (2 radio version).

Corsair interface

Microchip PIC-16F88 to a USB serial port adapter set up as a frequency counter with 2 transistor preamplifier. Inputs local oscillator from Corsair, and control lines that indicate high or low side injection, SSB/CW, USB/LSB. Programmed to understand Kenwood FA; FB; and IF; commands which is enough to interface to N1MM+ and TR. Maybe I should put this in a box...

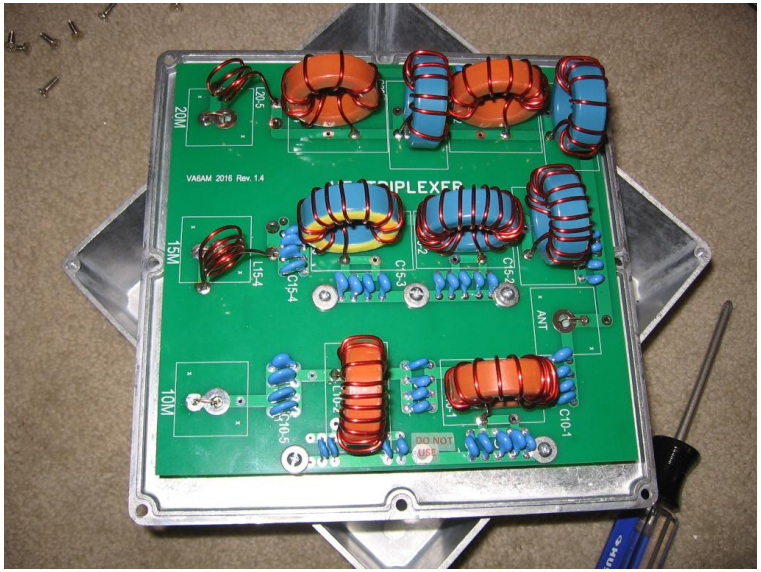


Triplexers

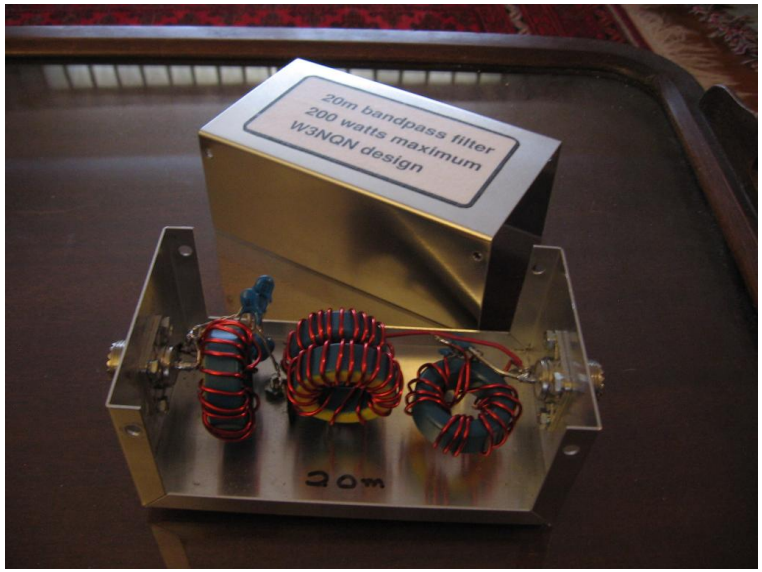


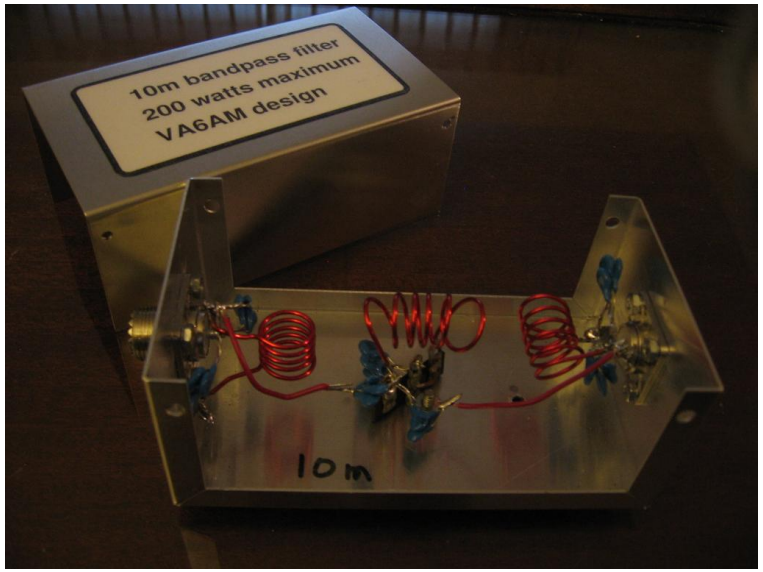

160m
80m
40m
Triplexer, VA6AM design
50 Ohm, 200 watts maximum
ARIZONA OUTLAWS
Combined

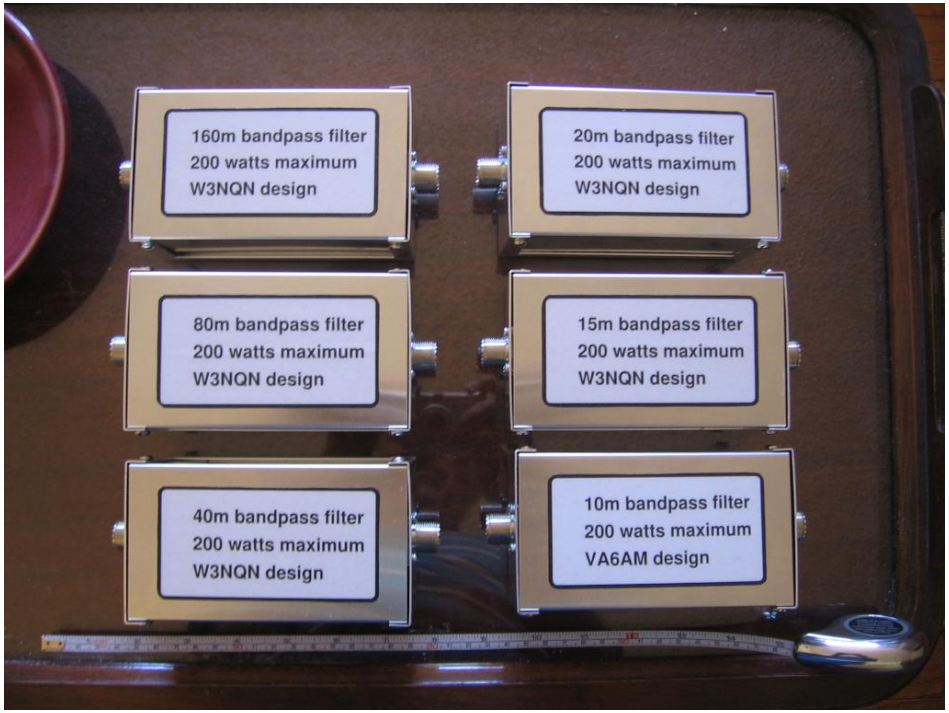

20m
15m
10m
Triplexer, VA6AM design
50 Ohm, 200 watts maximum
ARIZONA OUTLAWS
Combined


20M
15M
10M
VA6AM 2016 Rev.1.4
ANT
DO NOT USE

Bandpass filters

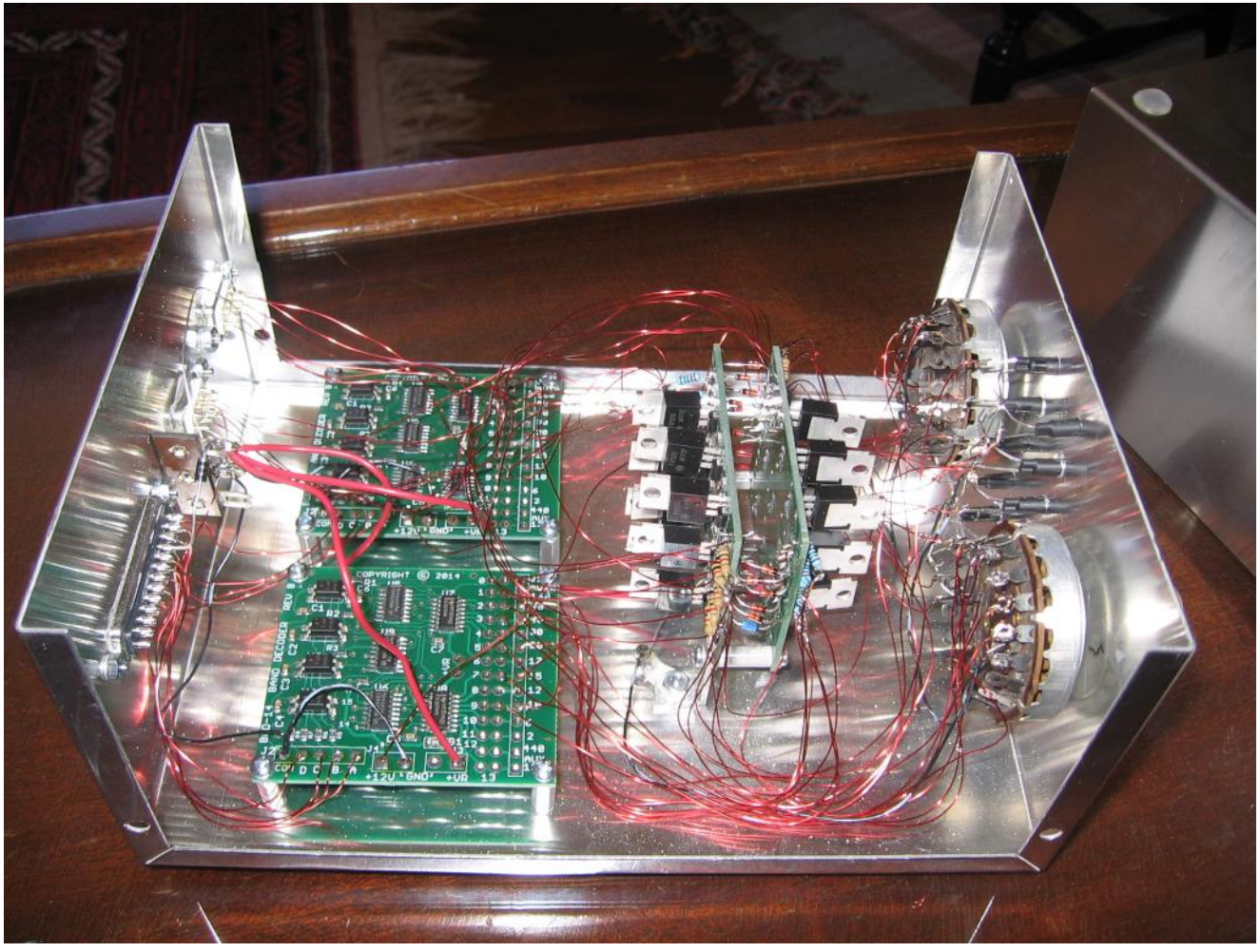




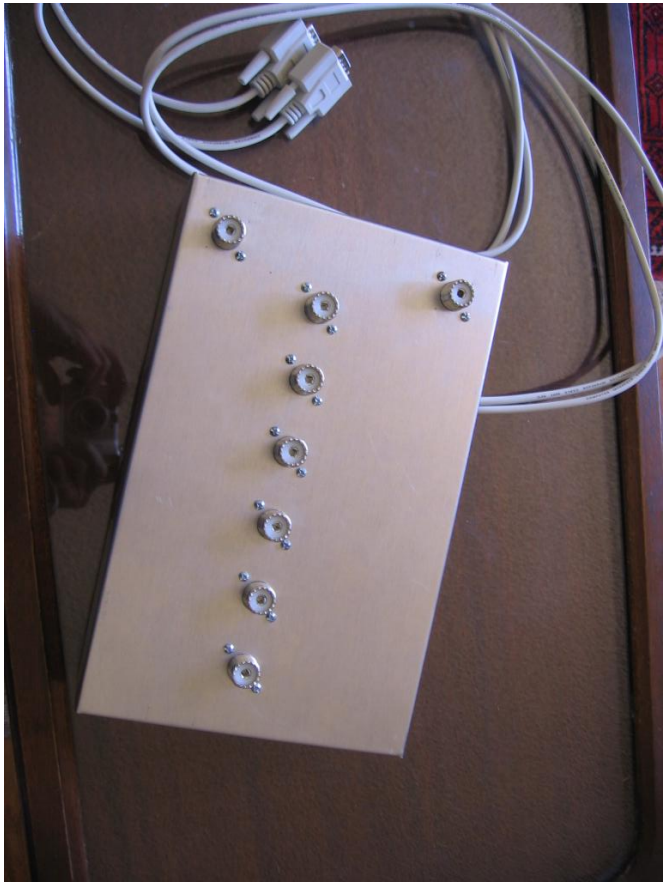


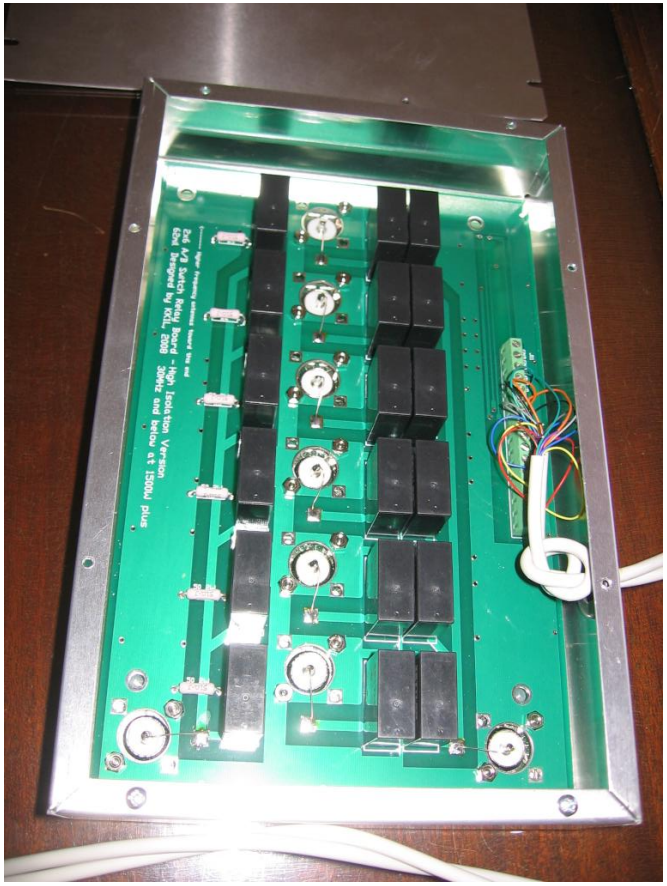
2x6 controller

W9XT high-side drivers are interconnected through diodes to lock out same band selection. It's not wireless inside this box.



2x6 switch





Top view of 2x6 switch, and interior with cover off, showing the populated KK1L circuit board. I need to add labels someday...

Under the operating desk

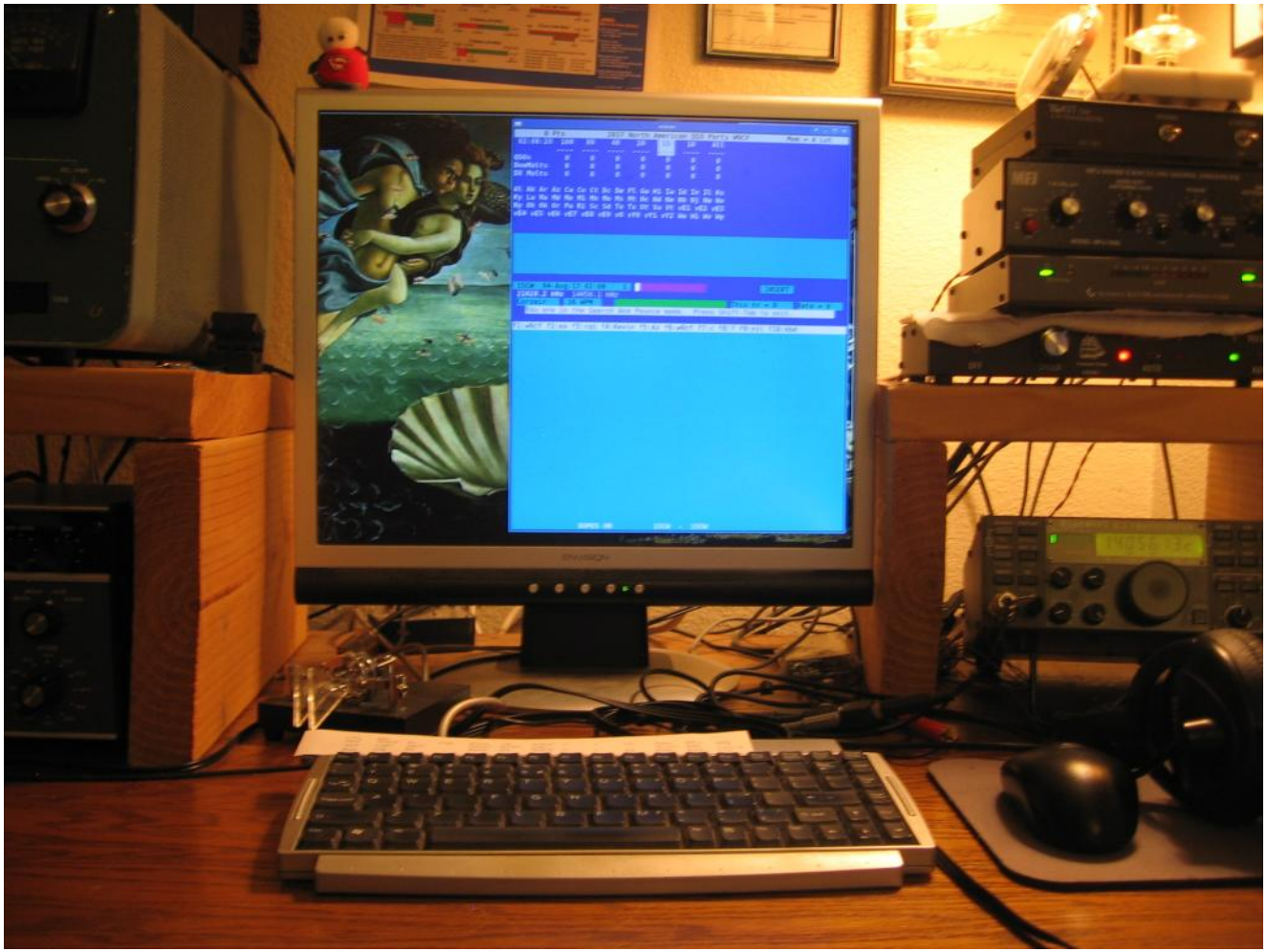
Dipole to 20-15-10 triplexer to filters to 2x6 switch
Vertical to 160-80-40 triplexer to filters to 2x6 switch

The operating desk

I need to move the 2x6 switch controller to the top of the desk, but it does select the correct band/antenna port automatically.

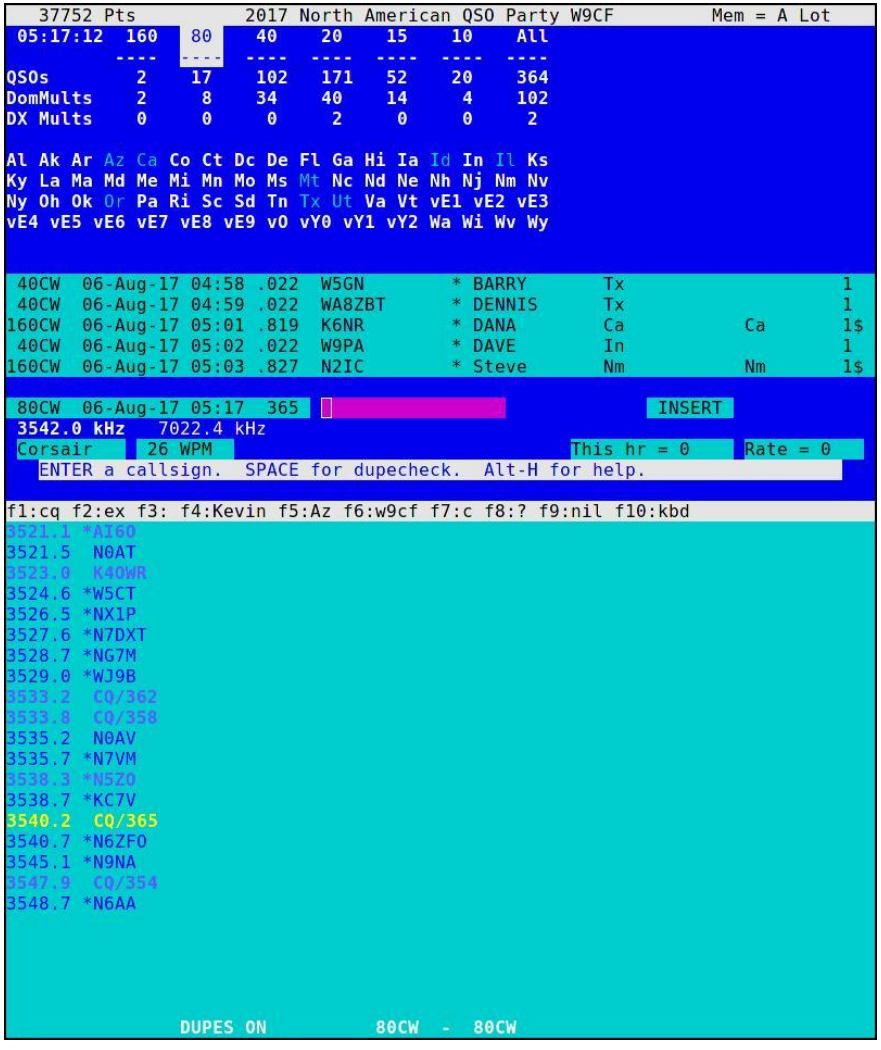
Ready to operate

TR controls the SO2R box. The SO2R box PTT input is connected to a footswitch. TR uses the footswitch for fast Alt-D (dupe check on inactive rig). SO2R audio switching and latch mode are mapped to function keys.

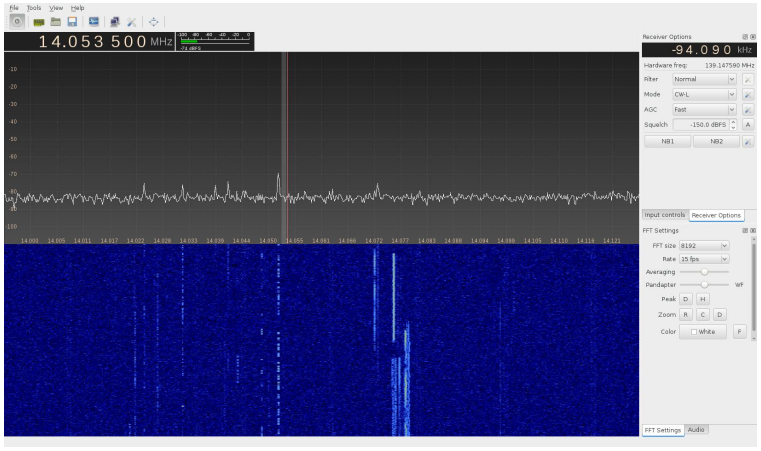


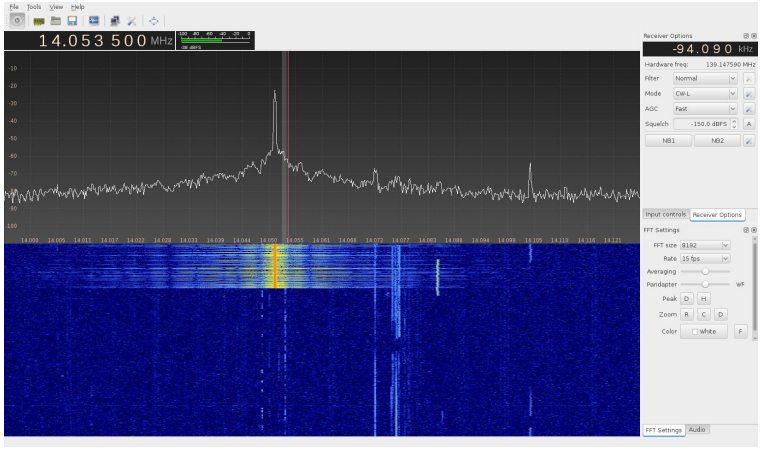
TR screen – end of first SO2R attempt

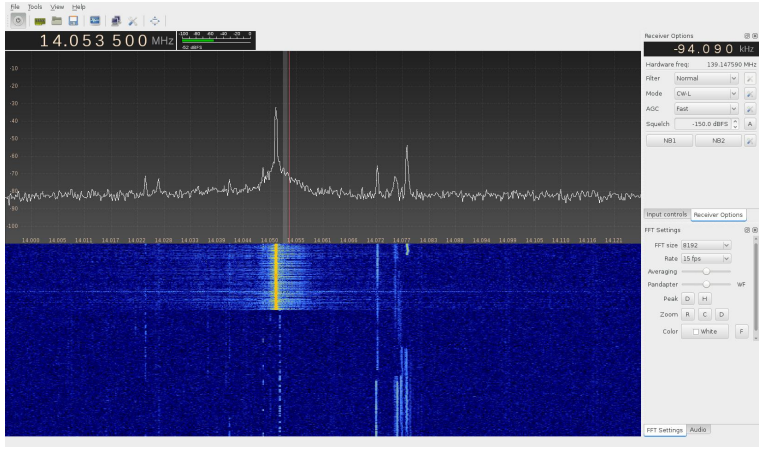
Part-time effort. Cabrillo Stats reports 363 QSOs, 125 band changes, and 58 (16 percent) probable second radio QSOs.



After contest RTL dongle IMD hunt







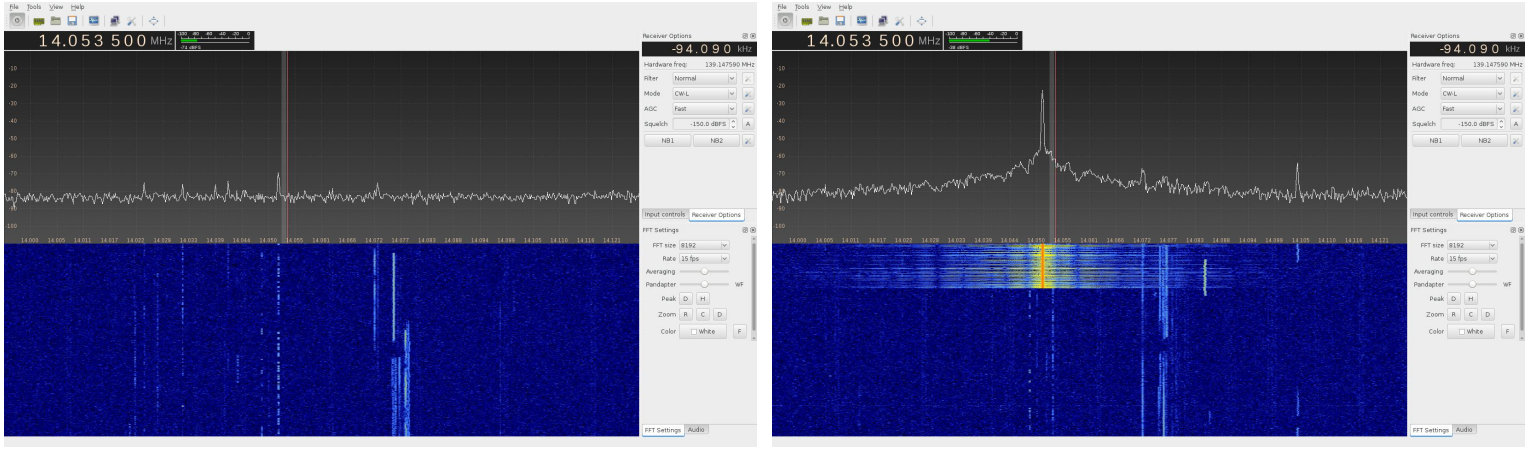
First screenshot is without transmitting. Second is 100 Watts on 40m with everything plugged in as in the NAQP. Third is Entertainment (TV, HiFi, Blu-ray player, etc.), internet (Router, cable modem, printer), and garage door opener unplugged. Corsair hears S9+15dB, ±20KHz not useable, and S9+10dB ±5KHz not useable, respectively.

Need to suppress rf into switching power supplies

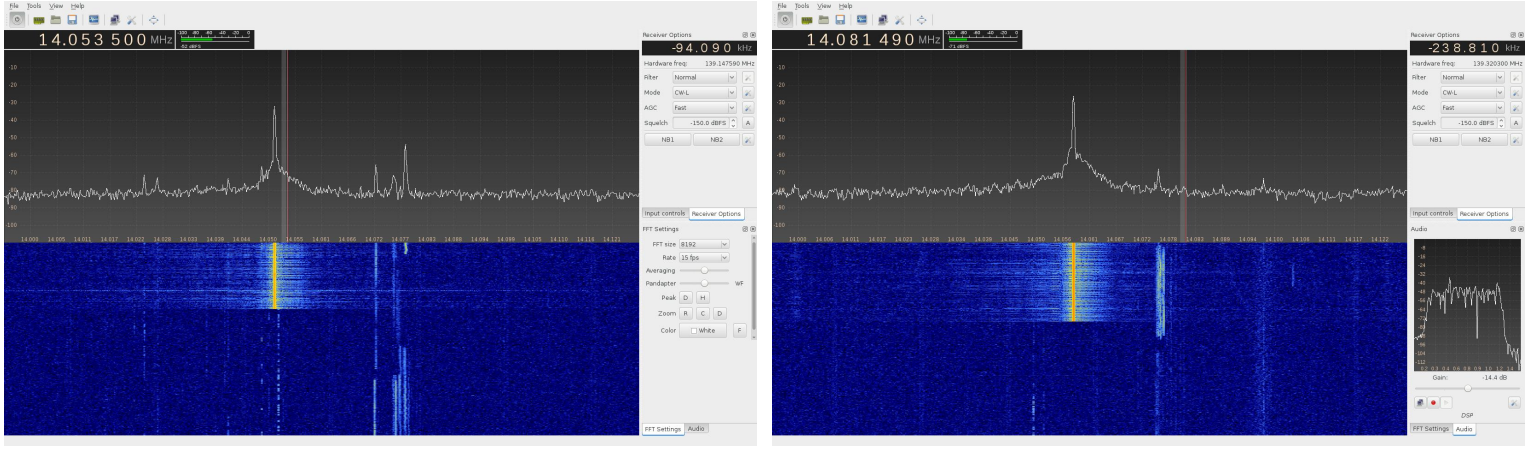
- Several of the problem items use switch-mode wall warts. It's essentially impossible to open these nondestructively.
- Either they need to be replaced with filtered units, linear supplies, or external filtering added.
- A search showed that Tripp-lite sells surge-protected power strips which include RFI/EMI filtering. They claim 40-80 dB suppression, but don't give any graphs like Corcom and other filter manufactures give. They are a bit pricey; I assume they are basically a Corcom like filter with MOVs in a metal case.
- I bought 2 six outlet Tripp-lite isobar power strips from E-bay, and when these helped a lot, I bought a 2 outlet version for the garage door opener.

100W 40m, everything unplugged, and everything plugged into Tripp-Lite isobars

No transmit and all plugged in

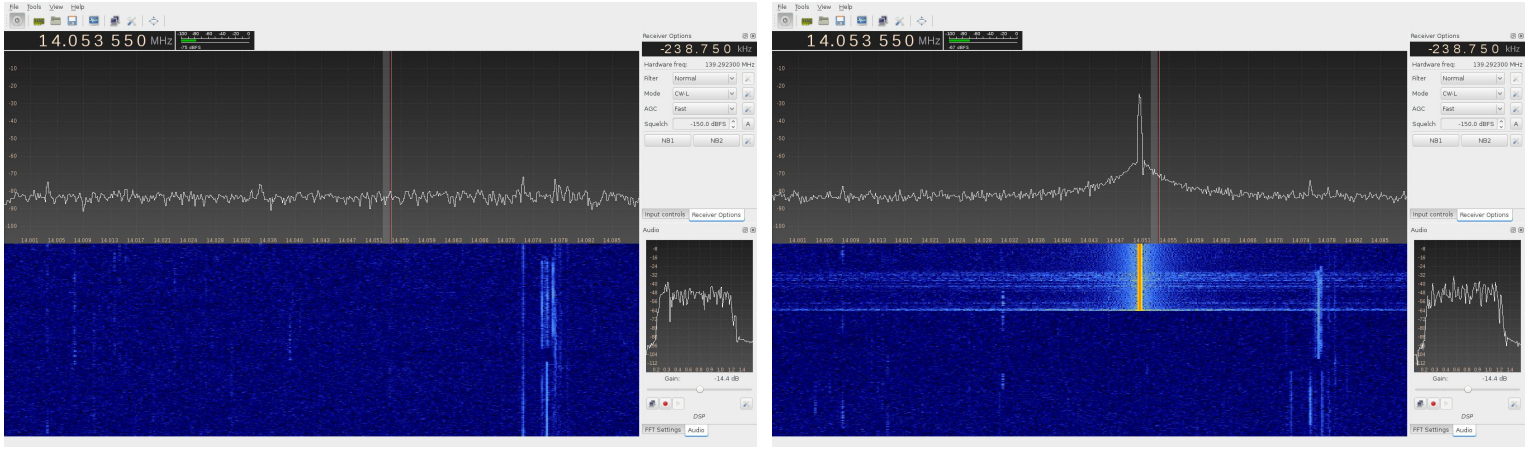


Unplugged, then all plugged in with 3 Tripp-Lite isobars

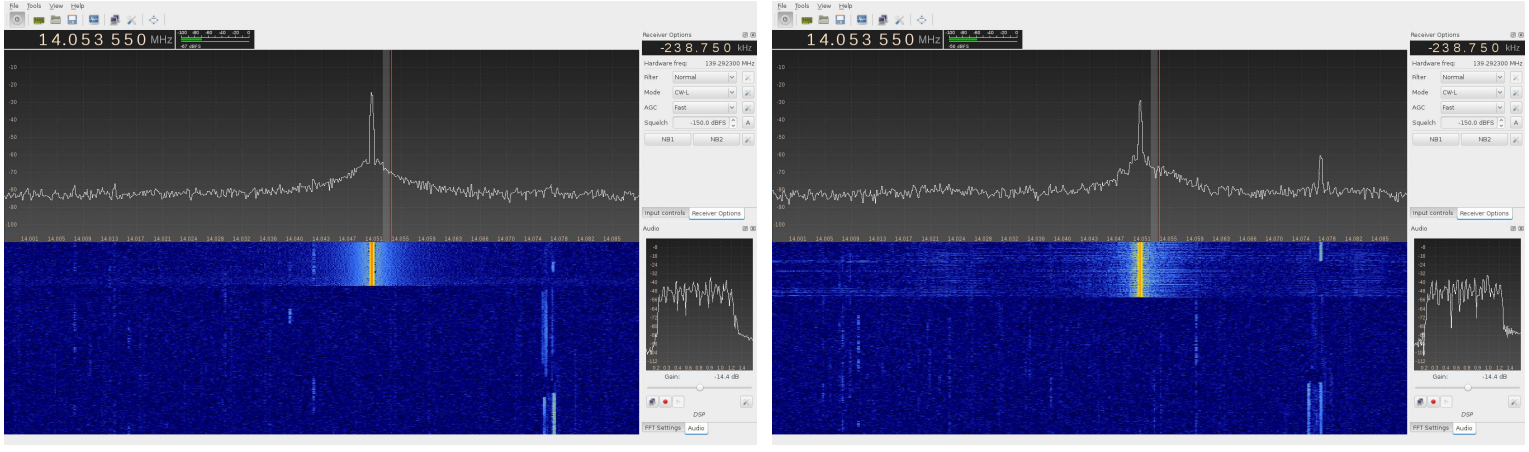


Turning breakers off at the electrical panel

House off, then house off 100W 40m

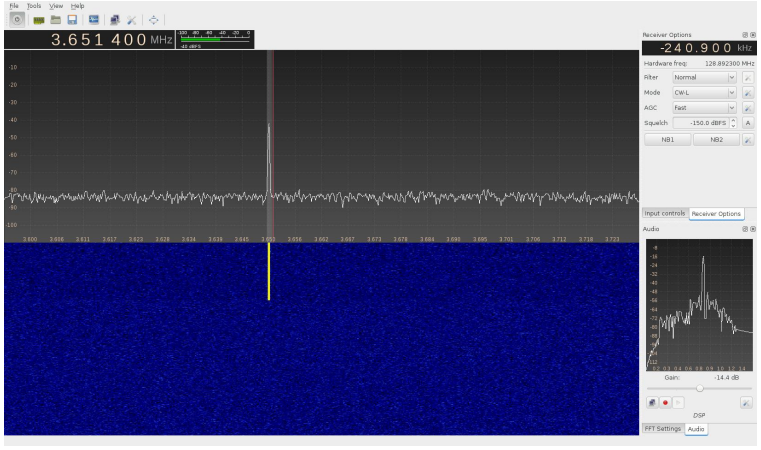


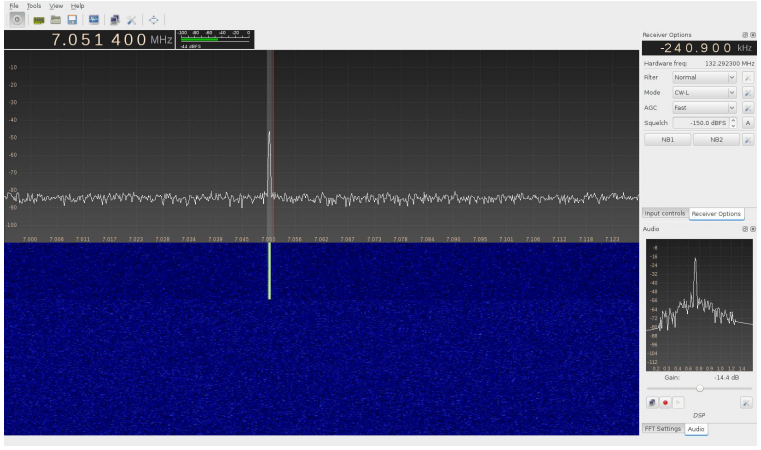
220V (Heat pump, water heater, stove) on, Everything on.



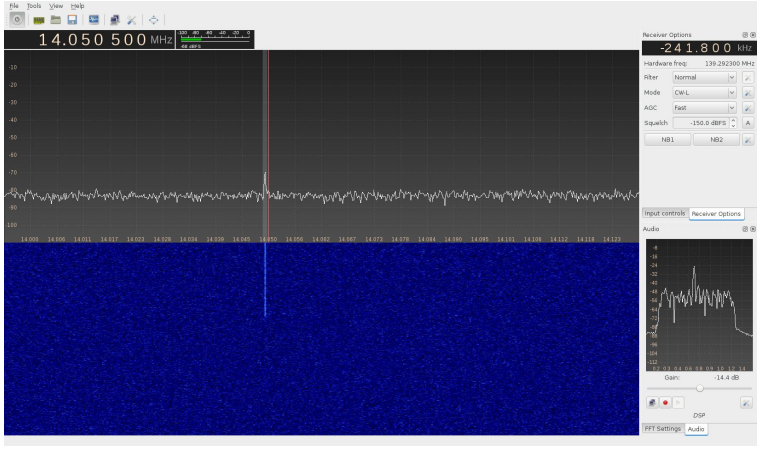
Second harmonics, two dummy loads

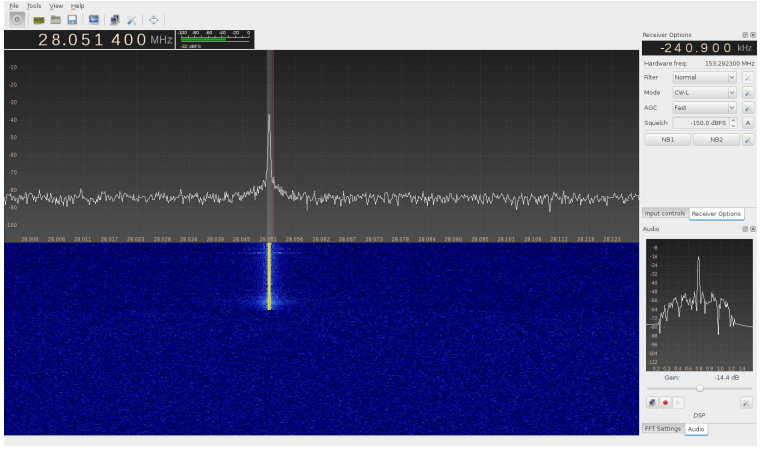
160-80, 80-40





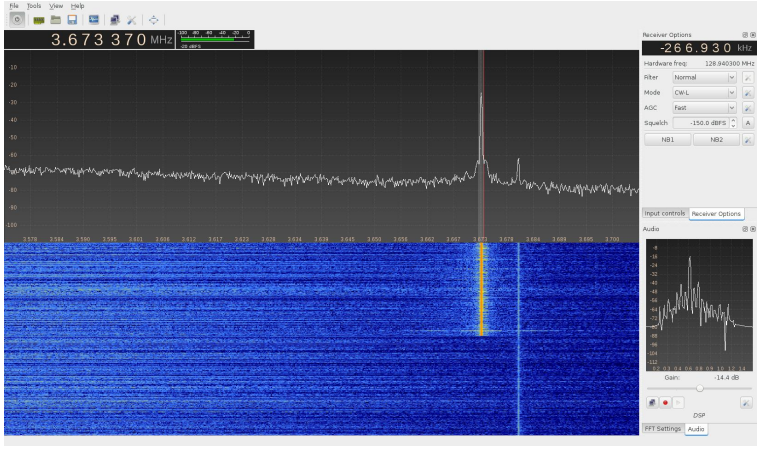
40-20, 20-10

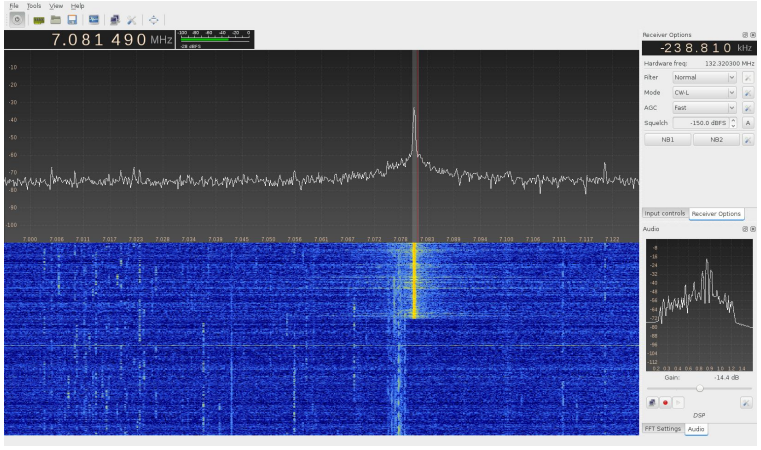




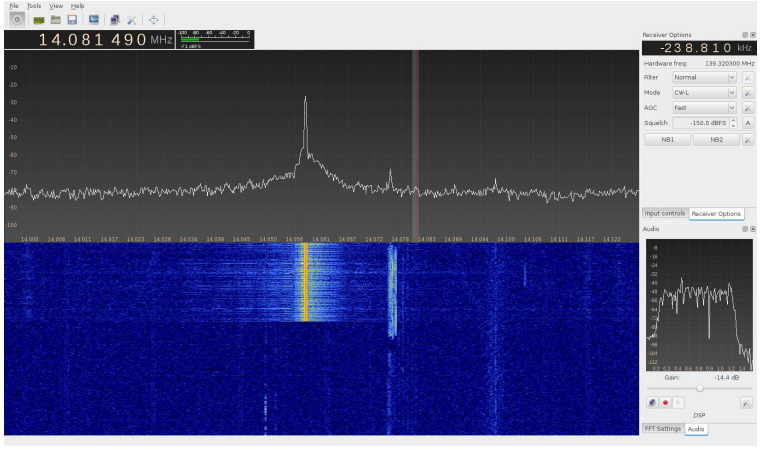
Second harmonics, antennas

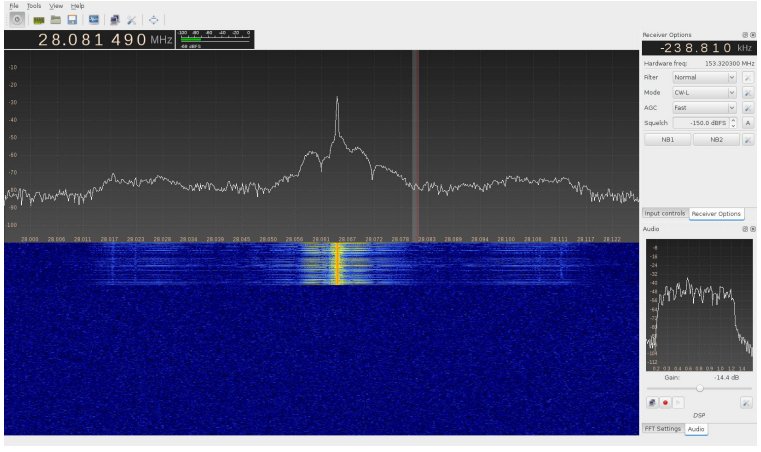
160-80, 80-40





40-20, 20-10





Interference testing results

- For adjacent bands, the second harmonics are problematic on 80-40, and 40-20. The 160-80 harmonic might have been a problem except it is always above 3600KHz and is unnoticeable for 3500-3570.
- Turning off house breakers (except for shack) shows fairly clean 40-20 harmonic, with intermittent, fairly weak, broadband junk. This might be from a corroded metal joint somewhere in the wind.
- Other adjacent band combinations show no interference.
- 20-10 is even worse than 40-20.
- The Tripp-lite isobar power strips clean up most, but not all, of the 40-20 problem caused by my own consumer grade equipment.
- I had previously noticed extreme 40-20 interference knocking out the whole band from 2 compact fluorescent light bulbs. I replaced these with Halogens. Other CFL bulbs give no interference. Test is to turn off the lamps and see if the harmonic becomes cleaner.

Garbage dump of extra slides follows

Lasciate ogne speranza, voi ch'intrate*

*Apologies to Dante Alighieri and José Benlliure y Gil.

Measured power into receive feedline

Rather than run network analyzer plots which have good terminations on both ends, I just transmitted with each transceiver in turn set to 100 watts according to their internal metering, and measured the power in dBm at the other rig using an AD8302 logarithmic detector. This should be good to a few dBm or so. Change sign and add 50 to get isolation in dB.

Corsair xmt band	Receive band setting					
	160	80	40	20	15	10
160	×	-23/-12	-35/-29	-35/-42	-36/-43	-38/-36
80	-36/-37	×	-27/-29	-34/-35	-35/-37	-31/-30
40	-32/-43	-26/-29	×	-23/-25	-30/-31	-22/-26
20	-21/-26	-22/-26	-22/-28	×	-6/-8	-21/-18
15	-17/-19	-17/-18	-17/-20	-21/-24	×	-9/-12
10	-14/-14	-15/-14	-15/-15	-17/-16	-21/-24	×

First number is measured power in dBm with antennas, the second number is with two dummy loads.

Measured power into receive feedline, continued

K2 xmt band	Receive band setting					
	160	80	40	20	15	10
160	×	-25/-28	-31/-27	-31/-52	-31/-51	-37/-35
80	-30/-29	×	-34/-34	-44/-42	-42/-41	-29/-29
40	-28/-28	-22/-21	×	-30/-30	-37/-33	-22/-25
20	-20/-23	-19/-22	-17/-19	×	-7/-7	-31/-19
15	-21/-20	-22/-18	-20/-19	-14/-15	×	-14/-14
10	-13/-15	-12/-16	-14/-16	-14/-17	-12/-15	×

First number is measured power in dBm with antennas, the second number is with two dummy loads.

You can see that 10m transmit is being limited by KK1L switch at sixtyish dB isolation.

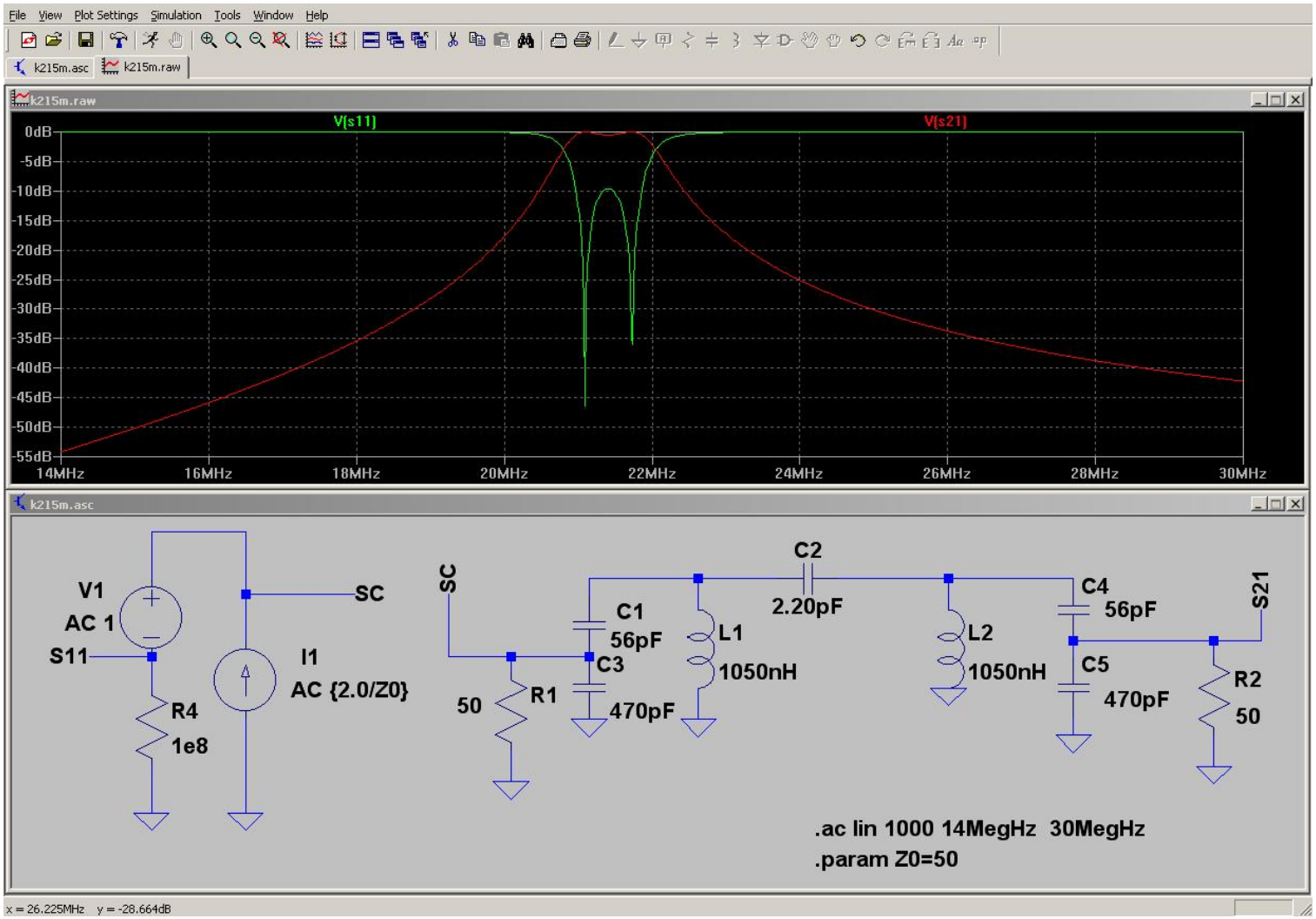
Necessary isolation

- According to W2VJN[†], modern receivers have IMD at the noise floor for signals around -27 dBm. The Corsair and K2 are probably not this good, but they had decent receivers for their day.
- For bands where the transmit frequency is at least twice the receive frequency, the transceiver low pass filter in the transceiver will add additional attenuation of at least 20dB.
- The low pass filters are followed by the electronic TR switches, and then receive bandpass filters. Assuming the TR switches don't contribute IMD for these signals, the bandpass filters will add an additional attenuation of at least 30dB. See next slides.[‡]
- My conclusion is that any value less than +3 dBm should not give receiver IMD.

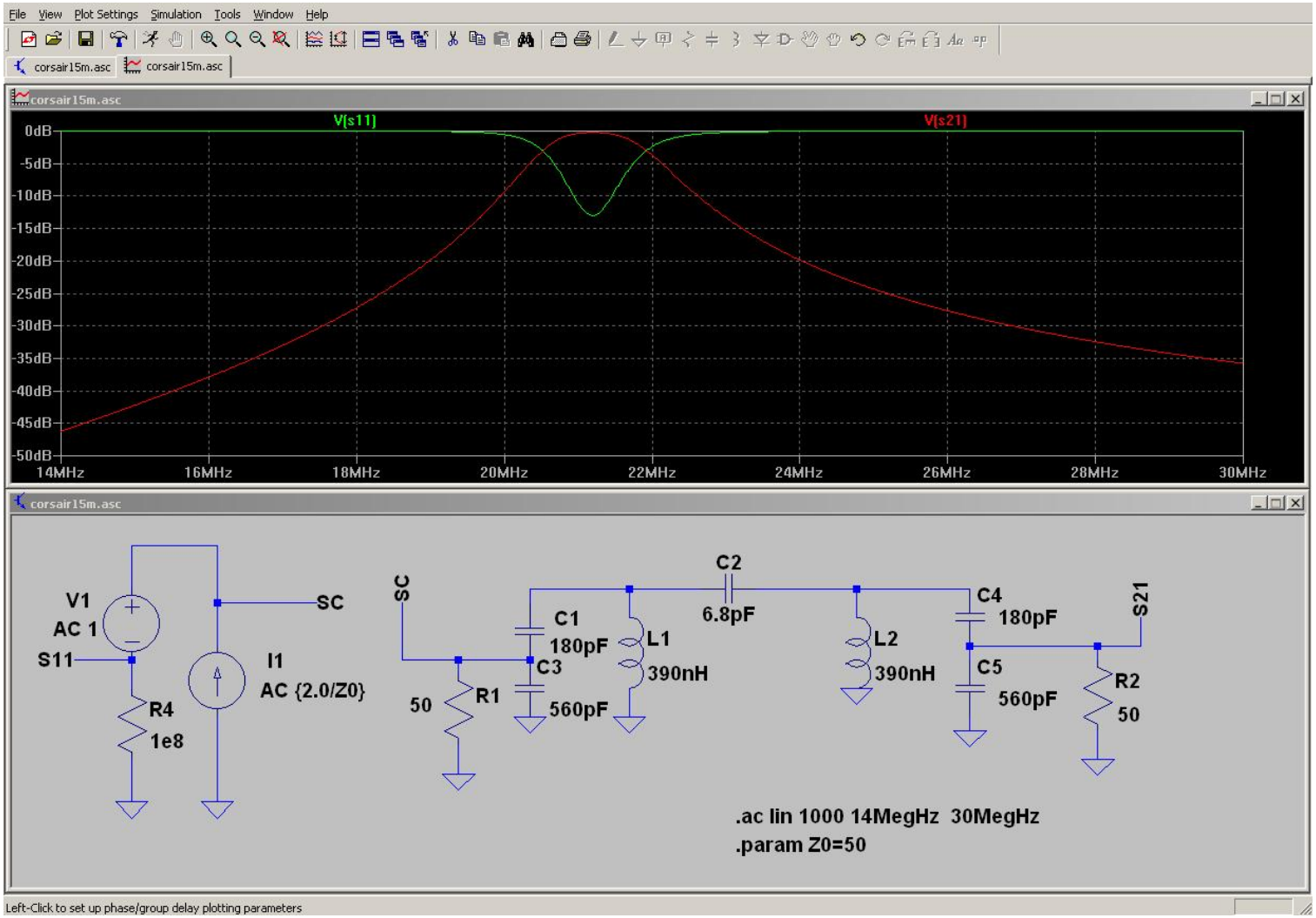
[†] George Custogeorge, W2VJN, "Managing interstation interference," revised second edition, International Radio Corporation, Aptos, 2009. The first edition in 2002 gave a value of -35dBm for the Yaesu FT1000MP.

[‡] Note K2 QRP final is not disconnected by the TR switch. It is connected in parallel with the TR switch to the QRP low pass filters. That may be a source of IMD.

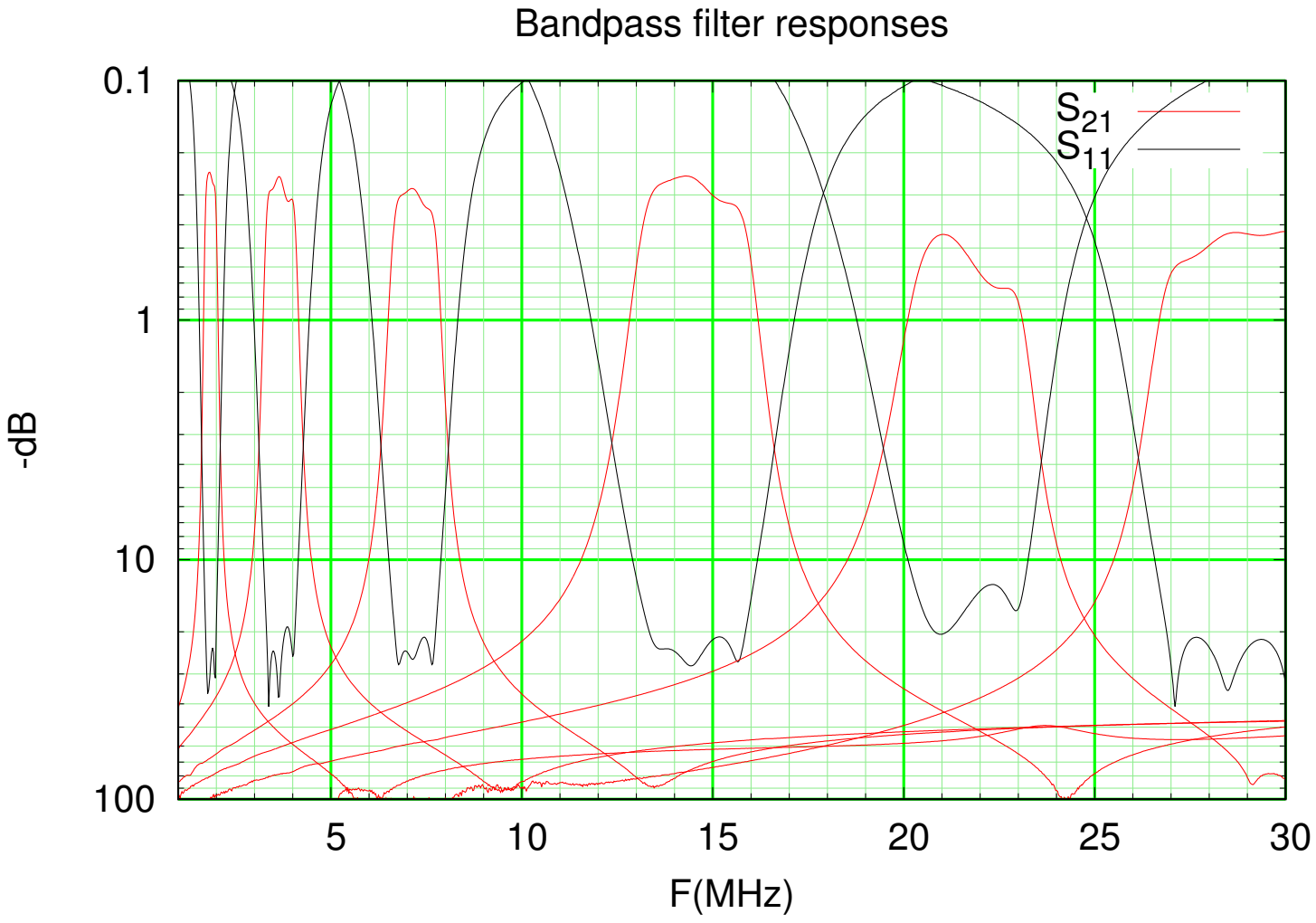
K2 internal 15m bandpass filter LTspice model



Corsair internal 15m bandpass filter LTspice model

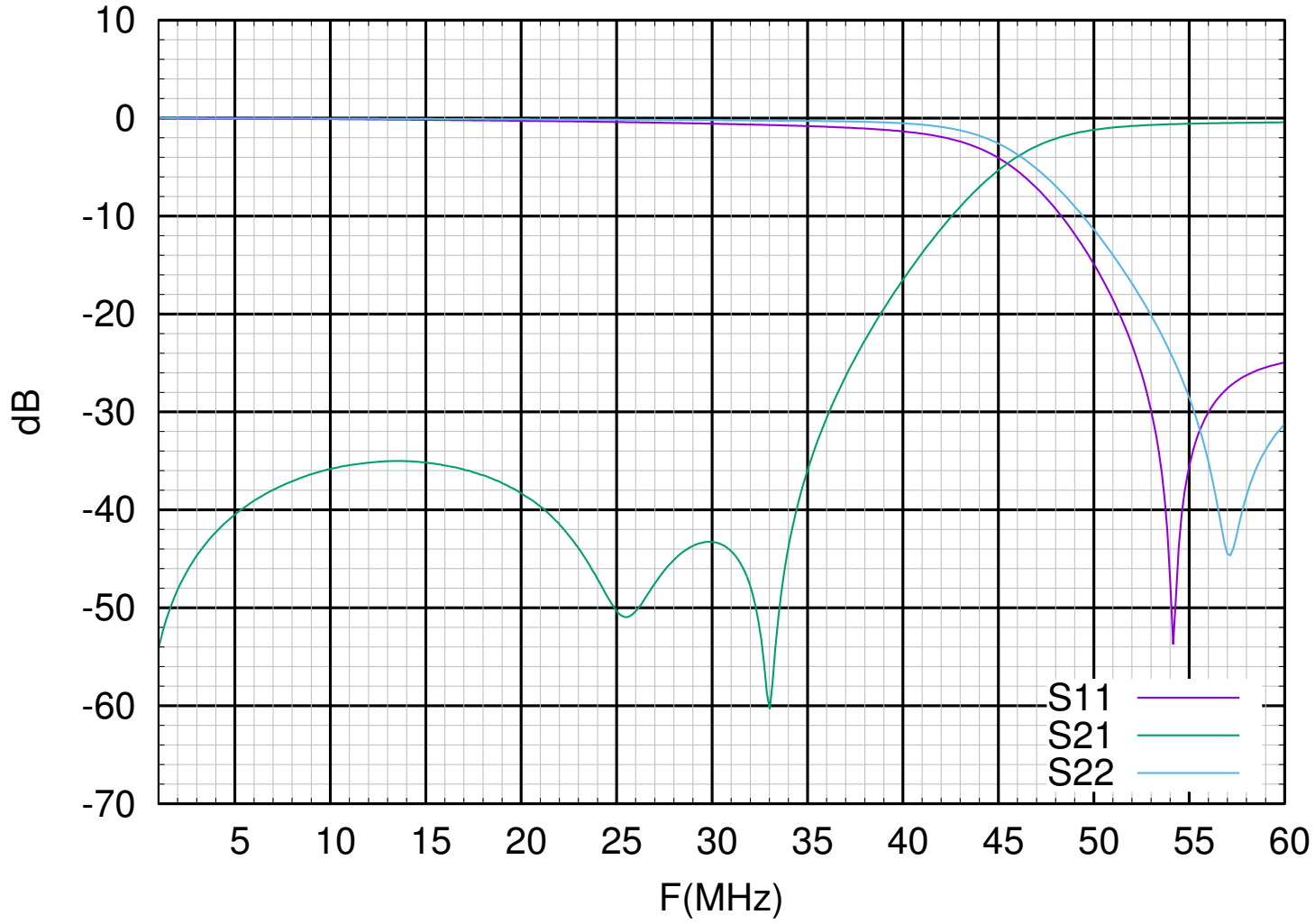


W3NQN/VA6AM bandpass filter measured response



Radio Shack High Pass filter on Television Feedline

Measured 75 ohm reference *S* matrix of Radio Shack High pass filter (Archer 15-579).



Pico High Pass filter on Television Feedline

Measured 75 ohm reference *S* matrix of Pico Digital High pass filter (HPF-54MHz).