

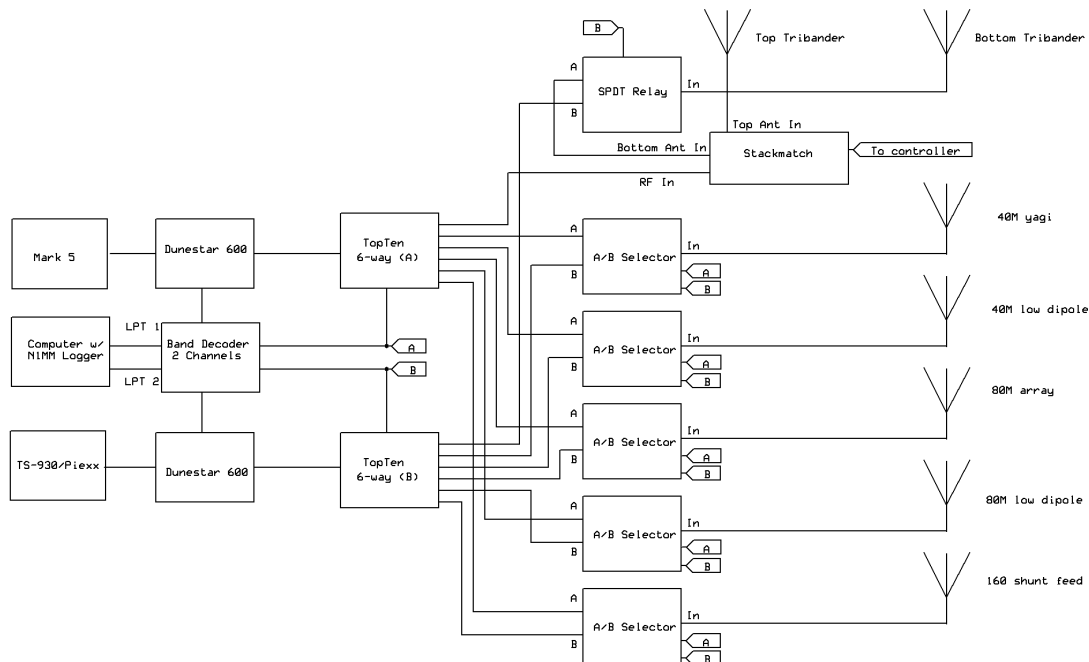
Single Tower SO2R Design Challenges and Some Solutions

My station is a second-tier single-op, single tower contest station. I have a 40m Yagi at 104 feet, tribanders stacked at 69 and 97 feet, low 40 and 80-meter dipoles near the tower for Sweepstakes, a 4-element wire parasitic array (K3LR/W9LT type) for 80 meters, and a shunt feed on the tower for 160.

For several years, I used my old TS-930/PIEXX for SO2R with a Butternut HF9V on the galvanized steel roof of my garage, about 250 feet from the tower. Running medium high power (Mark V and an SB-220) to the antennas on the tower, I was able to listen moderately well on the TS-930 on most frequencies, but comparison convinced me that the vertical was a few S-units down from the main antennas, and interaction could be quite severe anywhere near harmonic frequencies.

Last spring, I decided I wanted to try building a switching system that would enable me to switch all of the antennas on and around my tower to either radio, and get rid of the HF9V (my wife was all in favor of the latter). I'm not a hot SO2R operator, so the whole project had a lot of the "just for fun, let's see if I can make this work" flavor. I am not an engineer, or even particularly technically competent, so I had to anticipate cut and try, and some mistakes along the way.

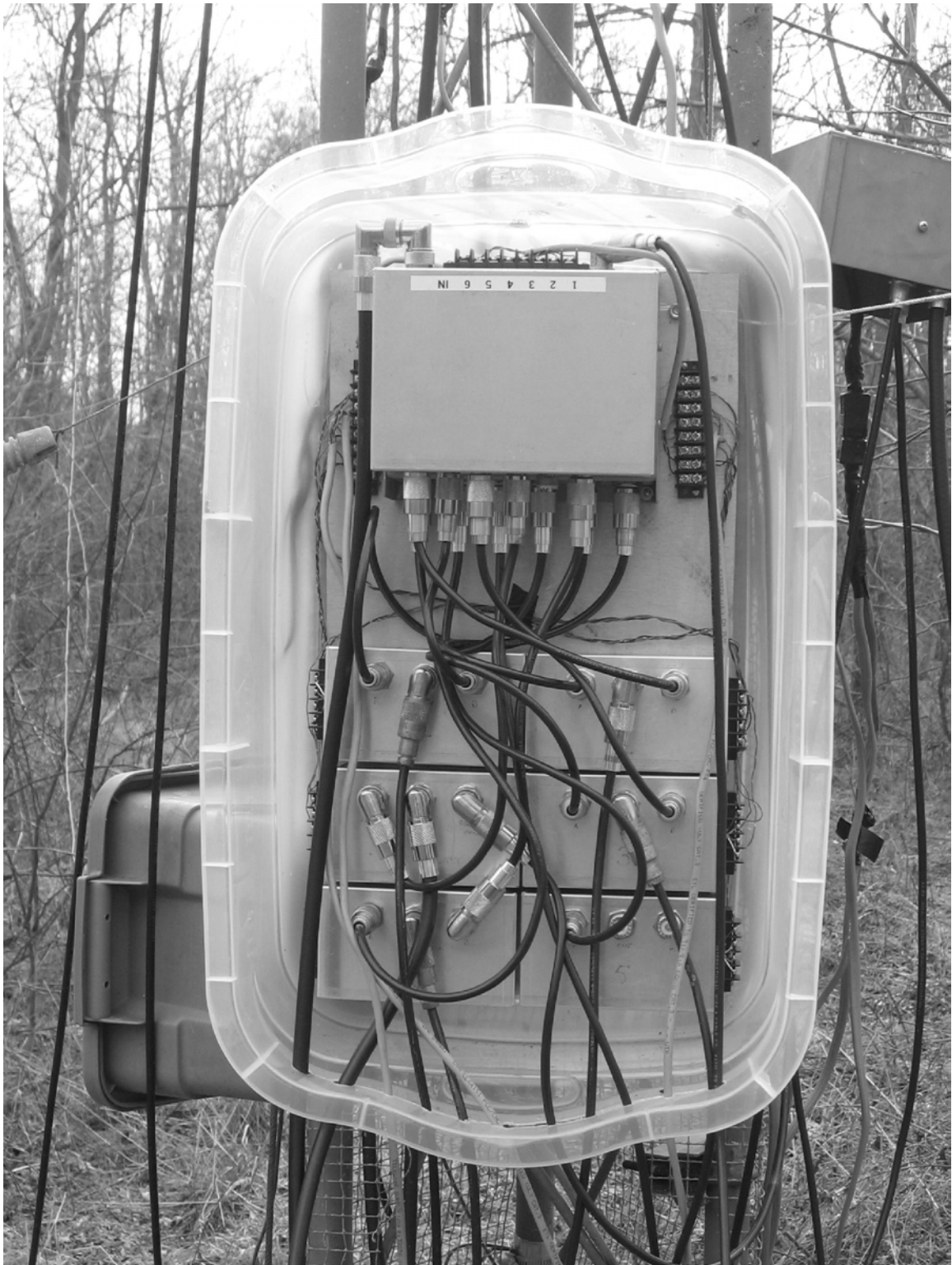
Early on, I decided that the best way to handle the switching was by the standard *TopTen* architecture (Figure 1).



Two *TopTen* 6-way relay boxes, followed by six *TopTen* clone A/B switchboxes, one for each antenna, provide three sets of open relay contacts between the two radios, regardless of the bands selected, and the A/B switches provide a foolproof hardware lockout to prevent two radios ever being connected to the same antenna. With me, foolproof is important! Reading indicated that it would be reasonable to expect 80-90 dB isolation between radios from this setup (antenna-to-antenna coupling aside).

For the high bands, the simplest solution appeared to be to split off the upper and lower tribanders in my stack, I did that with a homebrew stack splitter, utilizing the same sort of two-relays-in-series configuration. I have to remember to switch my *Stackmatch* to “top-only” whenever the second radio is connected to the bottom, to preserve decent matching, but that’s the only real compromise with frequency agility that this setup imposes.

Since I only wanted two runs of hard-line between shack and tower, all this switching had to be mounted at the base of the tower, rather than inside. Standard weatherproof boxes are absurdly expensive, so I decided to use an approach I’ve been happy with before. I mounted all the relay boxes on a sheet of aluminum, and mounted it inside a translucent Rubbermaid storage box (see Figure 2), hung on a tower cross-brace with U-bolts that I modified for the purpose (they are now big, beefy, one-legged hooks, attached to the aluminum baseplate and passing through the box to hang on the tower). All the coax and control cables are routed in through the bottom edge of the box, as you can see. If I had it to do over again, I would mount the A/B switches so that their coax jacks faced the two 6-way switchboxes – it would have made the coax connections a good deal neater.



A friend, who shall remain anonymous, made all this possible by producing the A/B switch clones; if he hadn't done so, the cost would have been pretty steep; in that case I think I would have seriously considered the 2x6 switchbox made by *MicroHAM*; the price would have been more than competitive, and it appears to

incorporate virtually the same circuitry as the separate-boxes approach. Moreover, eliminating all the inter-box coax would cut out a good deal of cost and potential reliability problems.

To get the control signals from the shack to the switch assembly, I wanted to use some inexpensive CAT 3 networking cable, but I was unsure whether the 24-gauge wire would be low-enough resistance. Some rough calculations suggested that if I ran ~14 volts at the input to the controller, the voltage at the tower would be about 11 volts in a worst-case situation. This has proved out in practice, and all the relay boxes have operated reliably so far, despite cold weather. The cable was so cheap that I ran redundant cables to each side of the switchbox, just in case.

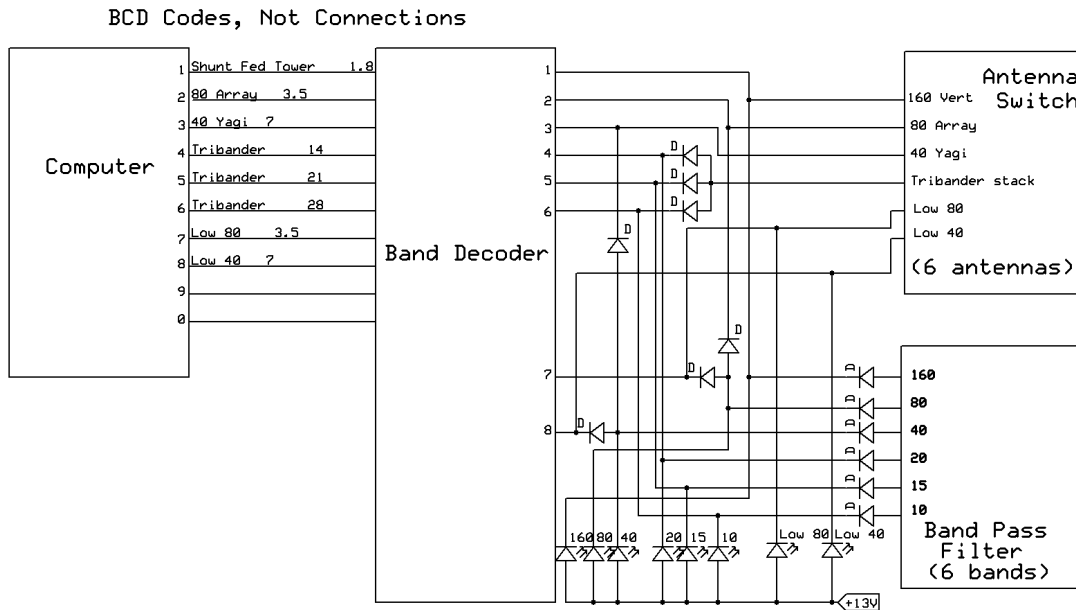
Band Decoding and Antenna Switching Control

Automatic antenna bandswitching (as well as switching bandpass filters) was a must for me. I also wanted to be able to use *N1MM Logger's* facility for controlling up to 16 antennas on each BCD output. This led me ultimately to W9XT's *BCD-10* band decoder PC boards, which are inexpensive and very effective. Two of them, in an old printer switchbox, make a compact nerve-center for the whole station (Figure 3). Because of limitations in the decoding and driving ICs, there is no commercial decoder I know of that will select more than 10 antennas, and I only have 6 anyway, so I'm satisfied. By the way, before it triggers a lot of correspondence, I'm left-handed, and have Radio B on my left, which is why the control box is "backward."



One aspect of automatic bandswitching is a little tricky. With tribanders, you want to be able to use one relay position for all three bands, while the bandpass filters (or switched stubs, if you choose that route) need the ability to select each band individually. I wound up building the diode matrices to do this job into the box with the decoder boards. One advantage of this is that I was able to put toggle switches on the front of the control box to bypass the bandpass filters, for example to use the station on the WARC bands, or on 160 with the Mark 5 turned up all the way. The layout of the diode matrix is in Figure 4, so that you can reverse-engineer it if you want.

One of Two Identical Sides



Bandpass Filters vs Stubs

The most expensive components in the whole system are the two *Dunestar 600* bandswitching bandpass filters; I flinched for a long time before deciding that I simply wasn't sure enough of my ability to properly cut and tune stubs. I chose the Dunestars over *ICE's* similar units, despite their higher price, because their specs seemed slightly better, and because of good reports about *Dunestar's* customer service; these have subsequently been borne out in my experience dealing with Ron at *Dunestar*. His filters also are very well built, and are readily adaptable to positive or negative switching.

Goof-Proofing

I have done enough stupid ham tricks over the years that I was worried about doing expensive damage to my radios in the course of setting up and testing, so I decided that effective receiver protection was a must. The protectors have already been described in NCJ (11-12/2005) so I don't want to go into detail again here. Suffice it to say that the first time you see the bulb on the protector light, indicating potentially dangerous power reaching the protector, you'll be glad you took the extra trouble.

Testing and Test Results

For the moment, I am running low power. My assumption is that once I assess the system performance at the 100-watt level, I'll have a pretty good idea of whether I can add amplifiers to one or both radios without severe problems – after all, 10-13 dB more signal is just that. For my tests, I ran 100 watts to the TS-930, and recorded results on my Mark 5; I did this at least in part because the TS-930 has an iffy reputation for broad-band phase noise, and I wanted to take a worst case.

To my surprise, isolation between the two radios is very good, actually better than when I was using the vertical for the second radio. My Mark 5 has the *Inrad* roofing filter, which may account in part for the good performance. Away from harmonics of the transmitting frequency, all I can hear is a slight increase in the noise. The harmonics vary in strength from S9 to S9+35, and at worst (transmitting on 40, receiving on 20) are audible 4 KHz either side. This is the only case that could be a problem, if I were an active RTTY contester, and wanted to operate 40 and 20 simultaneously. In that case, I think I would add a stub to attenuate the second harmonic from the 40-meter radio, but for the sort of contesting I do, that probably won't be necessary, because the bandpass filters are doing the job.

The bottom line is this – it wasn't cheap, and it isn't simple, but it seems to work pretty well. It was fun to design and build, and fun to use. I hope my approach, and some of the ideas presented here, stimulate you to try it yourself.