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Building a VHF Contest Station

Building an amateur station for competitive radiosport involves a number of critical steps, regardless of the band or bands you focus on. These include, but are certainly not limited to:

- ♦ Station layout
- ♦ Equipment interconnection and switching
- ♦ Inter-station interference
- ♦ Antenna selection.
- ♦ Radio interface with the logging program
- ♦ CW and voice keyer integration
- ♦ Rotator control

Where differences exist is when the boundary between HF and VHF/UHF/SHF contesting is crossed. The availability of radio equipment becomes complicated, and a number of other factors come in to play in order to establish an effective presence in a radiosport event at VHF/UHF/SHF.

Radio Equipment

Unlike the HF bands, the luxury of an all-band radio does not exist above 30 MHz. Very few commercially available radios are available that offer access to the bands above 30 MHz, and the selection is not optimum. These provide access to 50, 144, and 432 MHz at best, without 222 MHz or 902 MHz and above. A 1.2 GHz option has sometimes been available, although the stand-alone performance was not sufficient to afford a competitive Top 10 opportunity.

This leaves the station designer/builder with no choice but to factor in additional radio options. A transverter is the logical choice. It turns an HF radio, even a low-end transceiver, into a high-performance radio for VHF/UHF/SHF. This route is also complicated, as there are no multi-band transverters. Each is designed and optimized for a single band, thus the need for a complex switching arrangement or the necessity to use a separate radio with each transverter (see Figure 1)

Antennas

Efficient HF contest stations utilize mono-band antennas, and the same is true for VHF/UHF/SHF. Multi-band or triband Yagis for VHF don't really exist. While this may appear as a deterrent, it should not be. Very large VHF/UHF/SHF Yagis are small in comparison to HF Yagis while providing more forward gain and improved front-to-back ratio. A single tower similar to Rohn 25 can effectively support antenna arrays for all VHF/UHF/SHF bands. Very large stacked arrays for VHF/UHF will require a more robust support structure but are still much smaller in comparison to their HF counterparts (see Figure 2).

How high should my antenna be? To answer this question, you need to be familiar with the various propagation modes

Figure 1 — The 222-MHz and 432-MHz station at W5ZN. Elecraft K3s serve as the IF radio for Downeast Microwave transverters (near the top of the photo) with Lunar Link amplifiers to the left of the K3s.

Figure 2 — A stack of four 3-element antennas for 50 MHz. These antennas have a 6-foot boom and are stacked approximately 10 feet apart. This array, with its small physical footprint, provides outstanding gain with an exceptionally low angle H-plane pattern and broad E-plane pattern.

you will experience in a VHF-UHF contest, and it will vary. For the purposes of this discussion, let's focus on 50 MHz sporadic E propagation. Radio amateurs often hold to the premise that "bigger and higher is better." That's not necessarily true. A very effective 6-meter antenna for sporadic E only needs to be around 25 to 40 feet high, with 35 feet recognized as "optimum" for single-hop E skip out to around 1,000 miles or so[1, 2, 3]. This height places the antenna around 1.5 λ above the ground. This antenna most definitely does *not* need to be a big monster with a 50-foot boom. While you will have more gain, your beam width will be very narrow and most likely less effective. You can achieve outstanding results with a small Yagi at low height, or better, maybe with four 3-element antennas spaced at around 10 – 12 feet and stacked vertically centered around the 35-foot level fixed in the direction of your major expected QSO area.

To Preamp or Not to Preamp

I'm often asked, "Do I need a preamp?" to which I usually respond, "I don't know, do you?" There is a serious misunderstanding within the Amateur Radio ranks as to the need for a preamp. The low-end thought is that it will increase the strength of a received signal, so if I have a preamp with 25 dB gain that's good, right? It simply doesn't work that way. The primary benefit of a preamp is to improve your system's *noise figure*. So, what is a "bad" noise figure? Your total system noise figure will be dominated more by sky/antenna temperature. At VHF and above, gain is not as important as a low noise figure. Without going into the specific math, assume you have an antenna/sky temperature (T_{ant}) of 3,000 °K. If your receive noise figure is 20 dB and you add a preamp with only 12 dB gain but its noise figure is 2 dB, you will improve your system noise figure by 10 dB, a very significant improvement! On the other hand, if your receive noise figure is 10 dB and you add a preamp with 25 dB gain and a noise figure is 10 dB you will improve your system by 0 dB — that's *zero* — and you will create several other disastrous problems in your receiver!

There is a point where sky temperature dominates the effectiveness of a preamp. This is very true at 50 MHz. At 144 MHz and above simply inserting a very high-gain preamp into your receive system doesn't really address the need for a preamp. So, what's the bottom line on preamps? Here are a few rules of thumb:

1. Approximately 90% of the entire receive system noise figure is determined by the noise figure of the first stage after the antenna. This is usually a long run of coax! Coax loss adds directly to the receive noise figure and can determine up to 90% of your entire system noise figure.

2. Every time you reduce your system noise figure by one-half, you gain an approximately 3 dB improvement in signal-to-noise ratio until you are limited by sky/antenna noise temperature.

3. A mast-mounted preamp is like bringing the receiver front end right up to the top of the tower.

Coaxial Feed Line

With coaxial cable, an increase in frequency equates to an increase in attenuation. For frequencies above 30 MHz, this loss can become extreme. LMR-400 type coax will provide acceptable results through 2 meters and, depending on the feed line length, may also be acceptable on 222 and 432 MHz. Above 432 MHz, if runs greater than 50 feet are required you really need to transition to hardline in order to reduce losses. At W5ZN, where all of my main feed-line lengths exceed 100 feet, nothing smaller than 7/8-inch hardline is used (see Table 1).

Considerations for Each Band

50 MHz

Most, if not all, HF radios available today have 6-meter capability and 100 W output. This works very well. A single 5-element Yagi with high end LMR-400 coax will provide very excellent contest results. Some radios benefit from a preamp, but this can be installed in the shack. In fact, some HF radio manufacturers provide this as an option that usually works very well. While 100 W can be very effective, the addition of an amplifier with at least 500 W output will elevate your contest performance to the next level in the high-power category.

144 MHz

Commercially available radios that offer SSB/CW on 2 meters historically have not been optimized for VHF contest operation. While they do provide good access to the band and can be effective on a limited basis, the optimum choice is to use a high-end HF radio with a transverter. Transverters typically provide a significant noise figure advantage over any commercial radio offering. Most HF radios that also offer 144 MHz usually have a maximum output of 50 W, while transverters can be purchased with outputs of up to 75 W or more. Solid-state and tube amplifiers are available to provide up to 1,500 W. A 12-element (17-foot boom) up to a 19-element (34-foot boom) antenna of a K1FO design or similar can offer stellar performance.

The 2-meter "weak-signal" band is where a preamp will greatly improve receive performance, especially if it is placed at the antenna. Commercial preamps are available today with noise figures well below 1 dB. Placing a preamp at the antenna adds another layer of complexity, as you'll need an external relay and sequencing system to switch the preamp out of the line while transmitting, but it's well worth the effort.

222 MHz

At one time Icom sold a single-band 222 MHz radio, the IC-375A. This is no longer in production and at this time no commercially available SSB/CW radios for this band are available, except possibly on the used market. So, a transverter is typically the best way to access this band. An HF radio with a high-end transverter provides a first-class system at 222 MHz. Coupled with a 16-element Yagi (17-foot boom) and around 100 W, that should produce excellent contest results. A preamp at the antenna and an amplifier will provide superior results

432 MHz

A few commercially available radios offer the 70-centimeter band. These are usually limited to 50 W maximum output and a noise figure that is not optimum. Adding a preamp and an amplifier along with a 25-element antenna (17-foot boom) is very effective. My choice is to use a high-end HF radio and a transverter for this band that can offer Top 10 performance.

902 MHz and Above

A few VHF-UHF contest enthusiasts draw the line at 70 centimeters, but a

Table 1 — Loss figures for 100 feet of feed line.

Frequency	LMR-400	LDF 1/2" Hard Line	LDF 7/8" Hard Line
50 MHz	0.7 dB	0.46 dB	0.25 dB
144 MHz	0.9 dB	0.80 dB	0.45 dB
222 MHz	1.9 dB	0.95 dB	0.56 dB
432 MHz	2.7 dB	1.4 dB	0.83 dB
902 MHz	3.9 dB	2.1 dB	1.2 dB
5.7 GHz	10.8 dB	6.0 dB	3.8 dB

considerable amount of activity occurs at 902 MHz and above, especially in more-populated areas. Utilizing some or all of these bands will greatly enhance your competitive level and score in a VHF-UHF contest. Obviously, you'll need transverters. Loop Yagi antennas are highly effective up through 2.304 GHz and possibly as high as 3.456 GHz. Above these frequencies a small dish antenna provides the best solution.

SO2R at VHF/UHF/SHF

For single operators, SO2R is becoming a necessity on HF in order to be competitive at the top level. At VHF/UHF/SHF this concept takes on a whole different meaning. Since you practically need a radio for each band, you effectively become an SO2R operator, and it's mandatory that you keep an ear on 6 and 2 meters at a minimum. There isn't a significant level of activity that warrants using two radios on one band, where you run on one and seek multipliers with another on 2 meters and above. You would simply be wasting valuable contest time listening to band noise.

Six meters, on the other hand, is a different story and has become much more important the past 18 months with the introduction of FT8. A new group of VHF enthusiasts have discovered 6 meters and VHF contesting thanks to the availability of this band on their HF radio and the growing popularity of FT8, especially on 50 MHz. This affords an amazing opportunity to utilize a traditional SO2R approach. VHF contests do not restrict you to one mode. You are allowed to use whatever mode you choose to make contacts. On 6 meters, CW activity is located between 50.080 MHz and 50.100 MHz (a mixed mode DX window exists from 50.100 to 50.125 MHz), with SSB activity beginning at 50.125 MHz extending well above 50.200 when the band is open. The designated FT8 frequency is 50.313 MHz, greater than 100 KHz separation from SSB activity.

By utilizing another antenna separated by some distance at a height as low as 25 feet will allow you to monitor 50.313 MHz FT8 for multiplier and new stations on one radio while running CW/SSB on your run radio lower in the band. Obviously you need to ensure proper interlock and receive protection between the two radios just as you would in a normal SO2R configuration. This has proved to be an effective SO2R method at W5ZN on 6 meters. The antenna array in Figure 2 is one of my second-radio antennas for 50 MHz SO2R.

Summary

Building a VHF/UHF/SHF station for competitive radiosport activity is no less complicated than at HF. While many important topics overlap, the complexity of the VHF/UHF/SHF frequencies provide an exciting challenge with great rewards. See you in the next test!

VHF and Above Equipment Sources

Downeast Microwave
www.downeastmicrowave.com

SSB Electronics
www.ssbusa.com

DB6NT — Kuhne Electronics
https://shop.kuhne-electronic.com/kuhne/en/

Notes

1 "Antenna Heights for 50 MHz Sporadic-E," Steve Kavanagh, VE3SMA
2 "6 Meter Antenna Heights," 1998 VHF Contesting Thread
3 "Optimum 6 Meter Yagi Height Summary," VHF Contesting Thread