

Jim Wilson, K5ND

MAGIC BAND REVEALED

Everything You Need to Know
for 6 Meter Amateur Radio DXing

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for 6 Meter Amateur Radio DXing

K5ND.RADIO

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About K5ND

Jim Wilson, K5ND, is an active VHF contester, six-meter addict, freelance writer, and retired publishing executive.

He started with the Magic Band after attending Contest University and wandering into the VHF Contesting session conducted by Joel Harrison, W5ZN. Since then, there's been a never-ending search for more grids!

His freelance writing career began in 1976 with his first book and magazine articles published by Wayne Green, W2NSD, and *73 Magazine*. This led to a writing job with Heathkit, writing home study courses, including the General Class Amateur Radio License Course. After a career in publishing, he retired in 2013 and promptly rewired as a freelance writer at PathForeWord, his solopreneur business.

He writes the blog "K5ND Ham Radio Adventures" at www.k5nd.net and has contributed to QST magazine, ARRL National Contest Journal, CQ Magazine, and the Central States VHF Society Conference Proceedings. He's a frequent speaker at conferences and amateur radio club meetings.

About this Book

The first edition of this book was published to support an ARRL Learning Center presentation on six meters. That was in August 2020. It was updated in July 2022 to include new content. Combined, those two editions have been downloaded over 8,000 times.

This third edition has drawn heavily from the K5ND blog with new content. That includes new chapters on FT8/FT4 operation, MSK144 meteor scatter operation, Q65 ionosscatter operation, contesting, awards, and VHF rover operations. It includes appendices on SDR operation and EZNEC antenna modeling. There have also been extensive updates to the previously published content.

Introduction

Have you ever wondered about the “Magic” of Six Meters? After all, you’ve probably pressed the six-meter button on your transceiver and failed to find any magic or other stations. If that’s the case, you’ve identified the “tragic” of the band. But without tragic, there would be no “magic.”

It doesn’t take much on six meters — your existing HF+6 meter rig and a simple antenna, even a dipole, will work. Read on, and you’ll find out how I know that dipoles work and how to build one of your own.

This book will also provide plenty of insight into how you can find DX on 6 meters. It covers propagation, equipment, software, antennas, operating software, on-the-air operation, awards, contesting, and VHF rover operations. It further provides detailed instructions on using the WSJT-X FT8, FT4, MSK144, and Q65 modes. With appendices on SDR operation and EZNEC antenna modeling, it truly includes everything you need to know about 6-meter amateur radio DXing.

All of this is leavened with stories from my personal experience.

Jim Wilson, K5ND

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Chapter 1 — What is the Magic Band?

The Magic Band, or six meters, is 50 to 54 MHz. It sits midway between the HF bands, ending with 30 MHz, and the higher VHF bands, starting with 144 MHz. In that position, it provides virtually all forms of propagation familiar to HF and VHF operators, along with a few that are much more prevalent at six meters. For modes of operation, there are not only CW, SSB, and WSJT-X but also FM simplex and FM repeaters. I'm sure you'll also find some AM operators too.

The go-to propagation mode is Sporadic E (Es), which is radio wave reflection from the E layer of the ionosphere. This crops up mainly in the summer, but there are also a few times during the rest of the year when Es can form. Sometimes it's there, sometimes it's not. Therein lies the magic.

Average distances on Es can range from a single hop's 1,500 miles to double and triple hop. More detail on this is in the propagation chapter.

As with HF, there is also propagation via the F2 layer of the ionosphere, providing propagation much farther than the single-hop Es. As the sunspot cycle improves, you can expect to see more and more F2 propagation.

Next, we get into the more esoteric propagation modes, but many are used daily. This includes meteor scatter, where the meteors entering the Earth's atmosphere light up the E layer and provide a path for six-meter and higher VHF signals. There is also ionosscatter, where signals are reflected from disturbances in the ionosphere.

Then, there is Trans-Equatorial Propagation, TEP, where the signal essentially jumps the Earth's magnetic equator. Stations in Argentina become armchair copy here in Texas when that happens.

There is also tropospheric enhancement when the weather provides a thermal inversion in the troposphere and bends the RF signal near the earth's surface. While this happens on six meters, it's more likely on the higher VHF bands.

What is the Magic Band?

Then there is moon-bounce or EME for Earth-Moon-Earth. Here, signals are bounced off the surface of the Moon. That typically takes some power and high-gain antennas.

That is a quick overview; much more is provided later in the propagation chapter. But before we move on, let's look at a few of my personal magic experiences on six meters.

My first meteor scatter contact on six meters was with Dale, WA4CQG, over a distance of 672 miles using WJST FSK441 mode. That mode has now been updated to MSK144, where I was able to work Wyatt, ACORA, from grid EL58 on essentially a sandbar at the mouth of the Mississippi River. That's also one of the highlights of the magic band, working rovers who set up in places that few others even travel, let alone get on the air.

My first TEP contact was with Sebastian, LU4FPZ, a distance of 5,000 miles. I was running 100-watt CW into a dipole in my attic.

My first Europe contact was with Clive, GM3POI, in the Orkney Islands using 100 watts FT8 into a vertical.

All of these were very exciting contacts during fabulous openings. But my top six-meter QSO was with Bob, ZL1RS, during an unexpected brief opening in December 2014 from Texas to New Zealand via what experts reckon was Es plus TEP. I was running 100-watt CW into a stressed Moxon at about 20 feet.

We can add further perspective for readers old enough to recall the early days of VHF television stations. The old Channel 2 frequency was 55.25 MHz for the video carrier. Imagine watching on-the-air television from Argentina from time to time.

As you can tell, six meters offers a great deal. That includes white noise during the tragic times but also some exceptional QSOs during the magic times.

What is the Magic Band?

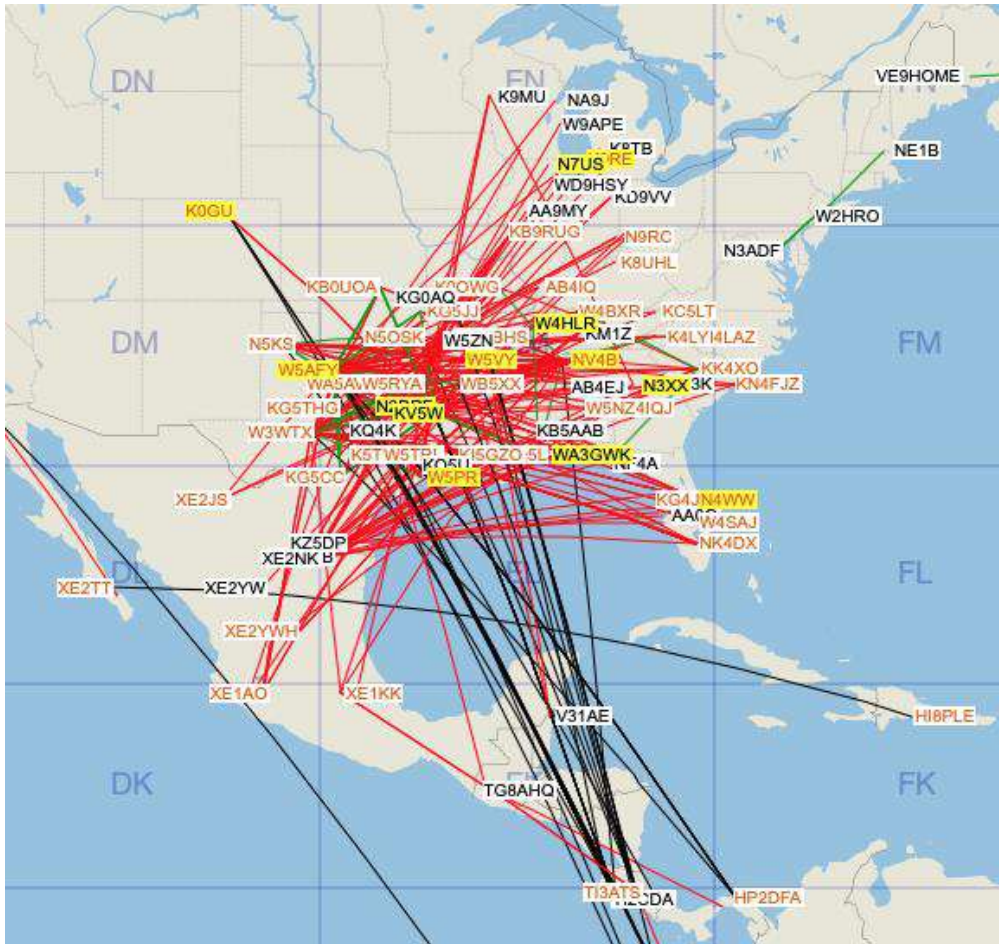


Figure 1 - 6 meter propagation DXmaps.com

Chapter 2 — Six Meter Propagation

As noted above, this is where the magic happens on six meters — all the various options for making exceptional QSOs.

Sporadic E

I claim this propagation mode is called magic because no one knows why it happens. There are several theories. Whatever the cause, the challenge is predicting when Es will happen. Next is determining how best to take advantage when Es does happen.

The theory I like is documented in a doctoral dissertation by Christina Arras, dated 2010, titled *A Global Survey of Sporadic E Layers based on GPS Radio Occultations*. Her research measures Sporadic E and its effect on GPS satellite signals. You can find it on Carl Luetzelschwab's K9LA website at

http://www.k9la.us/PhD_Thesis_on_Sporadic_E_by_Christina_Arras.pdf.

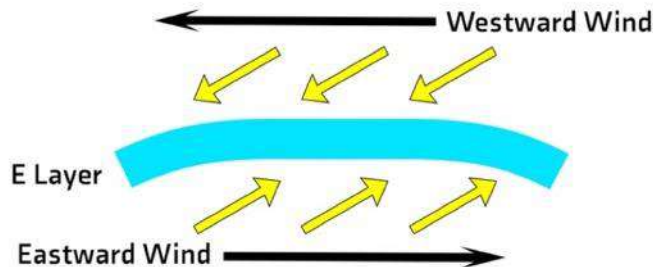


Figure 2 - Formation of Sporadic E clouds

The illustration above shows how wind shear compresses metallic ions from micro-meteors into ionized clouds in the E layer. This happens when lower atmosphere weather interacts with the higher level wind shear and clouds of meteor dust.

Six Meter Propagation

Seasonal variations are thought to be due to changing meteor dust trails that the Earth encounters in the Northern Hemisphere in June, July, and August and the Southern Hemisphere in February and March.

Here's my crude illustration of a sporadic E cloud. DX Maps does a great job of showing where the cloud is with the propagation on all sides out to about 1,500 miles for a single hop.

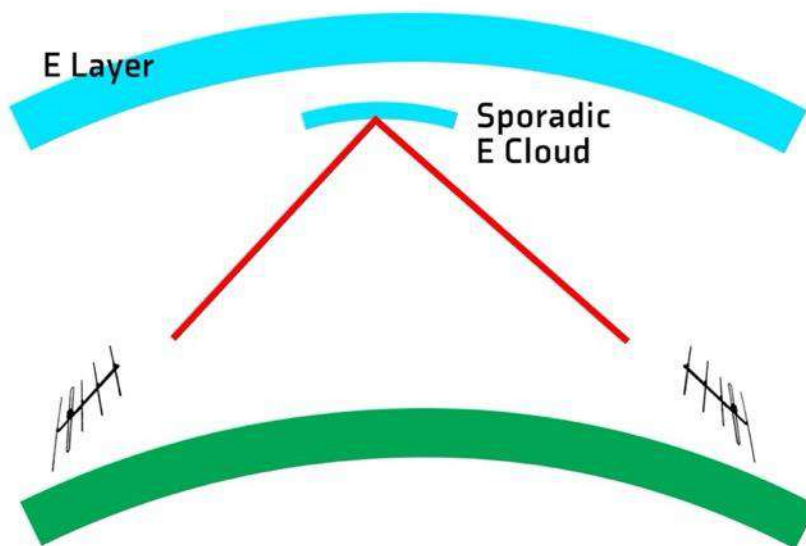


Figure 3 - How Sporadic E propagation works.

The key, of course, is determining when the cloud appears and getting everyone on the air who is in the right places to make QSOs. Six-meter beacons can help with that effort. But it seems that many more people are on the air using FT8's weak signal capabilities. As a result, I feel we're finding many more openings than in the past.

One thing I see on the air is the movement of the Sporadic E cloud. It can start near the east coast and gradually move across the USA. It can also move a bit north and, as a result, leave Texas behind. It's pretty interesting to observe these things over time. Note that Sporadic E can extend to the 2-meter band at times of exceptional ionization.

Six Meter Propagation

I've gathered all my six-meter QSOs in the chart below and plotted them by month and year. This has been my six-meter experience, with most activity in May, June, and July. Some of my summer months have been spent at Jamborees or as a VHF rover during contests. You can see that June 2023 was very high due to the fantastic ARRL June VHF Contest.

As always, Your Mileage May Vary – YMMV. It should be that your mileage WILL vary.

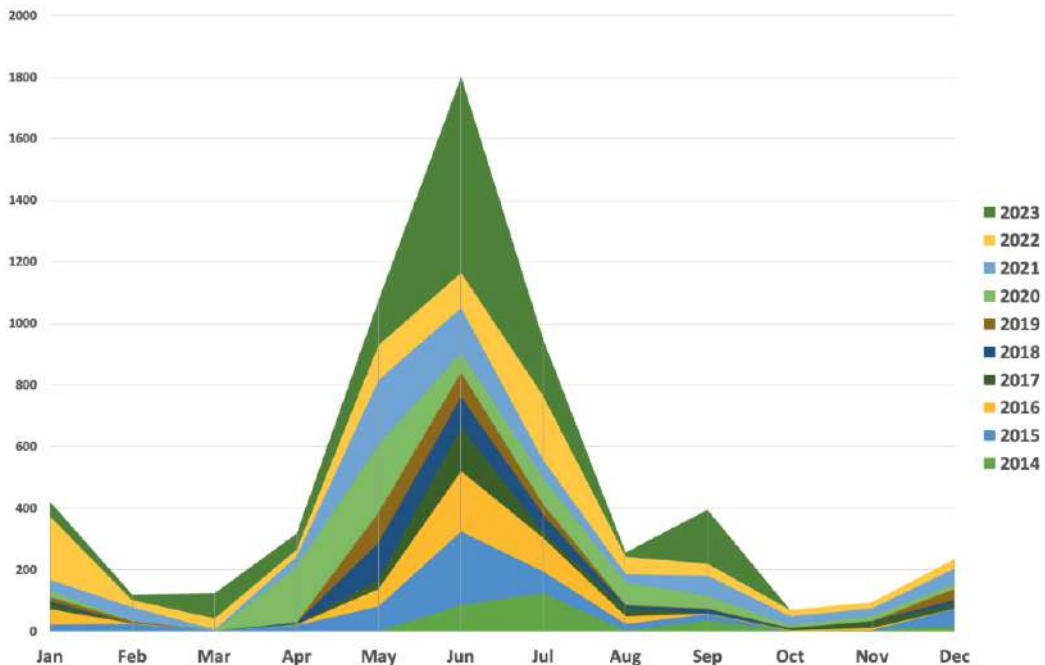


Figure 4 - K5ND 6 meter QSOs 2014 to 2023

Six Meter Propagation

Meteor Scatter

This mode is extraordinary. Just thinking about bouncing your signal off the trails of meteors as they enter the Earth's ionosphere is pretty awesome. But that's what happens. And it happens all the time.

Here's my rough drawing of this phenomenon. The meteorites hit the ionosphere's D and E layers, lighting up micro-sized patches. Since meteorites are constantly entering the atmosphere, this is going on, with an estimated 100 billion entering every day.

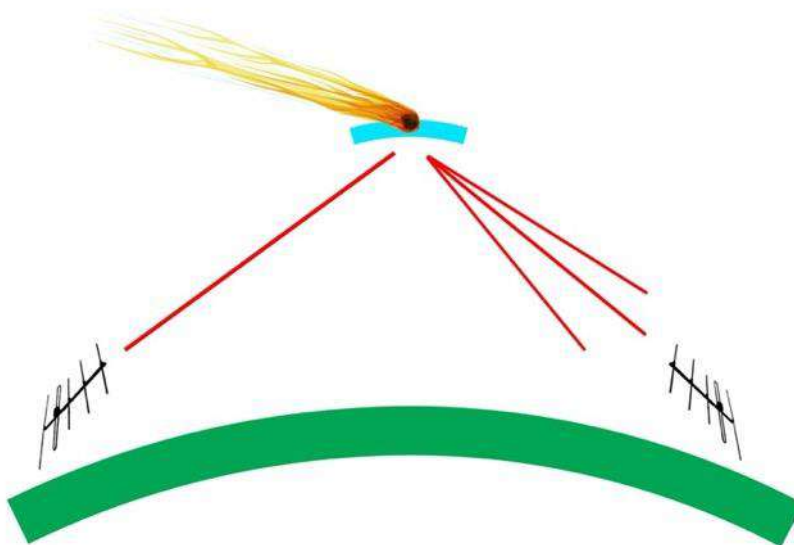


Figure 5 - How meteor scatter propagation works.

However, it's more intense at dawn local time since the Earth's rotation, coupled with the orbital speed of the Earth, generates the highest level of meteorite capture. It's also maximized during seasonal meteor showers, which can be predicted. Here's my attempt to illustrate why mornings are much more productive for meteor scatter contacts.

Six Meter Propagation

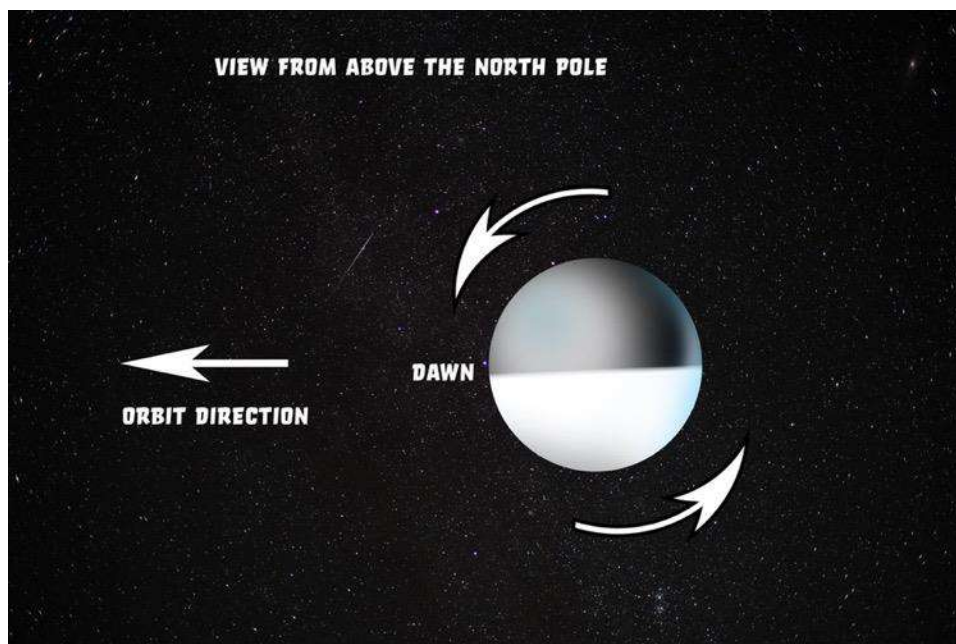


Figure 6 - Path of the Earth through meteor trails.

The term “scatter” implies that the transmitted signal hits these ionized micro patches and is dispersed forward. I’ve tried to show some of that in the drawing. This, in turn, means that the receiver will pick up small bursts of the transmitted signal. The ham radio term is “ping” since that’s a bit like the sound they make in the receiver.

In the early days of ham radio meteor scatter, they often used CW and eventually went to very high-speed CW with the received signal recorded and then slowed down to catch glimpses of the call sign, etc.

Since the advent of WSJT and now WSJT-X, computer signal processing has been used to accomplish the same thing. The early mode of FSK441 and the newer mode of MSK144 essentially send hundreds of messages packed into a several-second transmission (15 seconds is currently the standard duration).

The WSJT-X modes establish standardized messages and precisely coordinated transmission and reception timing. They also use quite a bit of data communication error correction, etc.

Six Meter Propagation

Most consider the frequency range for meteor scatter to be between 40 and 150 MHz, but hams have accomplished QSOs on higher bands from 222 MHz to 432 MHz.

Note that this mode is also used in dedicated communication systems to overcome cost and capacity issues of satellite communication and the operational difficulties of HF communication. Examples include COMET (Communication by Meteor Trails), used by NATO in the 1960s, and SNOTEL (Snow Pack Telemetry System), used by the Department of Agriculture with 500 remote stations to collect information on snowpack and precipitation in the Western USA. This system started in the late 1970s and extended into the 1990s.

Ionosscatter

A related mode of propagation is ionosscatter. The older version of the WSJT-X software suite had a mode called ISCAT that uses similar techniques to MSK144 to bounce signals off tiny patches of ionization in the E layer. Given this approach, it works very similarly to meteor scatter. It's not used much but probably should be tried more often on six meters. It's also possible that some meteor scatter contacts are taking advantage of ionosscatter.

The latest versions of WSJT-X have added a mode called Q65 that has proven very effective on six meters when nothing else is working. It's believed that this mode uses ionosscatter propagation. There's more on Q65 later.

Trans-equatorial propagation (TEP)

TEP involves the F-region of the ionosphere, where it forms on both sides of the geomagnetic equator. You can get a hint of this in my rough drawing below.

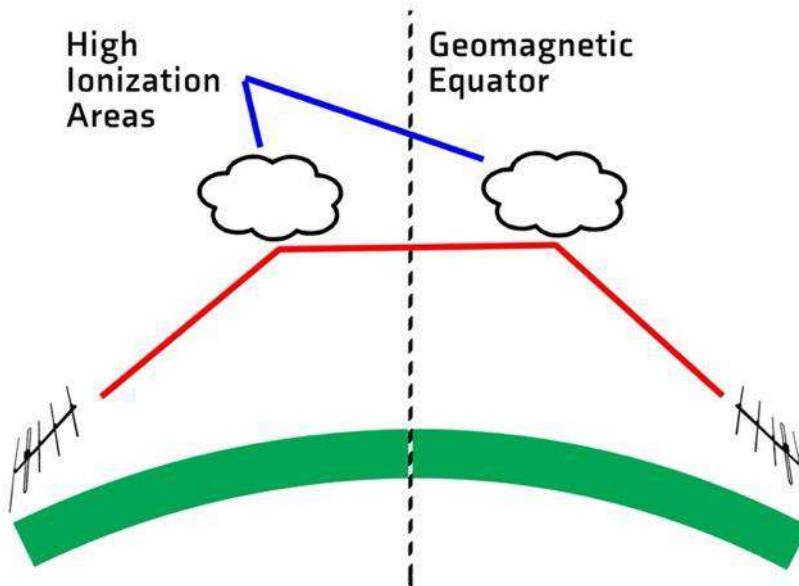


Figure 7 - Trans-equatorial propagation model.

The propagation runs North-South through reflections from one patch directly to the next and then back to the Earth. Those patches are equidistant from the geomagnetic equator and thus facilitate propagation between locations that are also equidistant. However, Sporadic E can further enter the mix with one or more hops that reach the TEP region.

You can get an idea of how the geomagnetic equator differs from the physical equator from the map below with its distinctive dip in South America. The center line is the geomagnetic equator.

Six Meter Propagation



Figure 8 - Geomagnetic equator.

Given all this, it's typical for the Caribbean and Central American stations to work TEP into southern South America. It's thought that the discovery of TEP on six meters happened when XE1KE worked LU6DO and other stations in Argentina in 1947.

TEP typically happens in the late afternoon and early evening. Seasonally, the equinoxes are best for this activity.

I'll commend you to Carl Luetzelschwab's K9LA website and his 2011 paper on Trans-Equatorial Propagation at http://www.k9la.us/Trans-Equatorial_Propagation.pdf.

I experienced TEP for the first time in September 2014 and nearly every year since then. In a 2021 opening, I worked FT8 QSOs with several stations in Argentina. Interestingly, as is often the case on six meters, most stations were near Buenos Aires — with almost a pipeline into the Dallas area.

I started that day with a Sporadic E opening working V31MA, followed by TG9AJR. Next, the TEP opening started with LW2DAF first into the log with a +03 signal. LU9DO, LU7FIN, LU9FVS, and LU8ADX followed that. A little while later, I found CE2SV. He's located along the same latitude as the LU contacts. I heard a CX station but couldn't make the QSO. Here's the www.DXmaps.com snapshot of my first QSO that day.

Six Meter Propagation

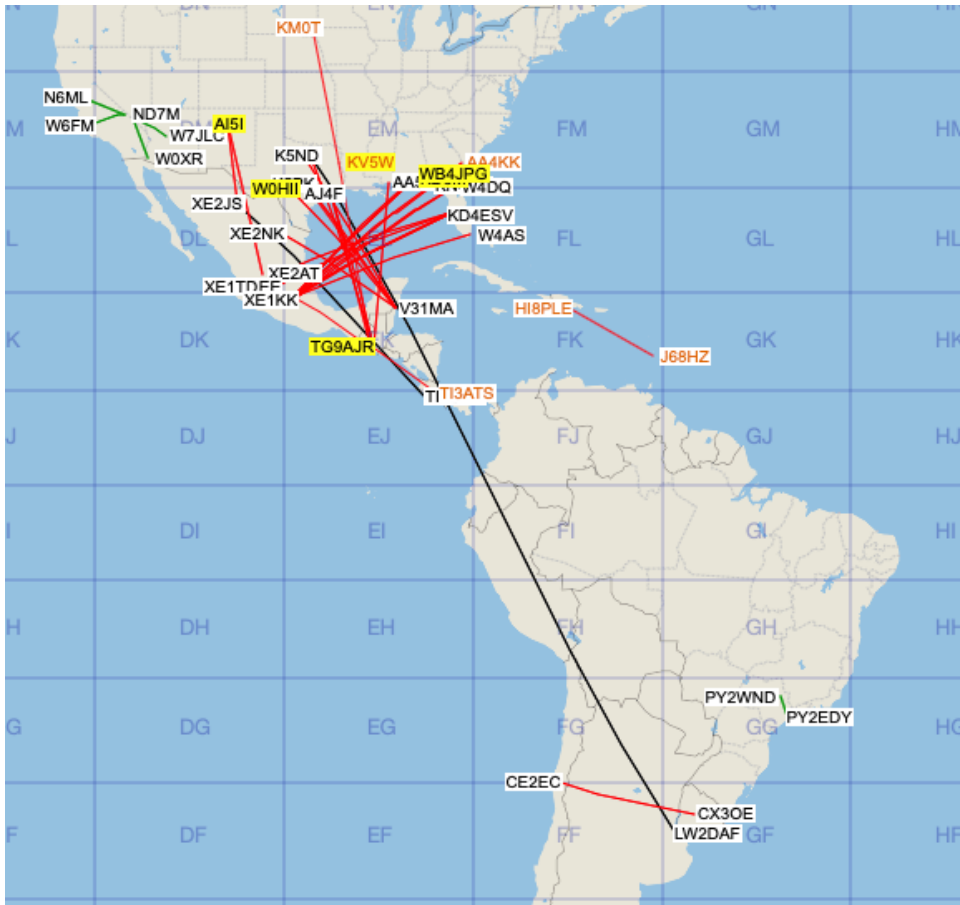


Figure 9 - TEP Opening on DXmaps.com

In 2022, I managed to work CE4WJK on SSB via TEP. Here's what that opening looked like on DX Maps.

Six Meter Propagation



Figure 10 - Another TEP Opening from DXmaps.com

My longest distance, six-meter QSO to ZL1RS, is also thought to have happened due to TEP coupled with Sporadic E on both sides of the contact.

In late 2021 and early 2022, there were some incredible openings into the South Pacific. I used FT8 to work the North Cook Islands, Chatham Island, more New Zealand stations, and Hawaii. I'm not sure about Hawaii, but the others are some sort of TEP propagation.

Six Meter Propagation

Aurora

I don't have any personal experience with Aurora propagation, as my location in Texas is just a bit too far away. It relies on the aurora borealis, also called the northern lights, caused by solar activity chiefly due to solar flares.

There are two types of propagation: backscatter and forward scatter, also referred to as Auroral E. The backscatter requires pointing your directional antenna at, or slightly at an angle, to the auroral curtain, causing scatter signals on an angle due to the reflected bounce.

Since the aurora is moving and rippling, the signal flutters in and out, causing a distinctive raspy sound. CW is thought to overcome this effect best. I've not heard what might happen to an FT8 signal. Perhaps MSK144, a meteor scatter mode, might work best.

I have read that forward scatter or Auroral E, provides a much clearer signal for longer distances.

While this type of propagation can also appear on higher VHF bands, this is an excellent example of the magic of six meters.

Six Meter Propagation

Propagation Calendar

I recently came across a nifty VHF-UHF propagation calendar and have generated something similar to provide a simple overview of the six-meter propagation as it happens throughout the year.

Of course, meteor scatter communication can happen at any time. This calendar points out the showers for enhanced propagation.

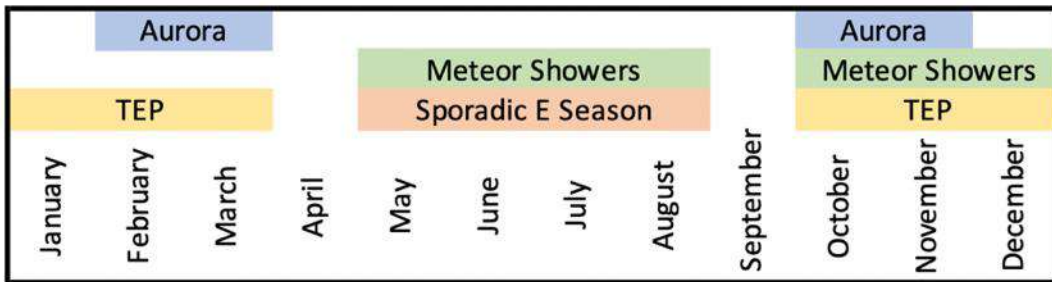


Figure 12 - Types of propagation expected on 6 Meters through the year

Chapter 3 — Six Meter Equipment

There are some dedicated rigs for six meters, including many older vintage rigs, including the Drake TR-6, the Heathkit SB-110A, Yaesu FT 690, Icom IC-575, and many others. There are even a few current FM-only six-meter rigs. And don't forget the MFJ-9406 for six meters only SSB with 10 watts PEP output.

Many of us have a relatively recent model multiband HF rig with six meters. You're all set if you're lucky enough to have these rigs in your shack.

Six Meter Rigs

I've used the Elecraft K3, the Icom IC-9100, the Icom IC-7100, and the Icom IC-7300. I started with the Elecraft K3 primarily as an HF contest and DXing rig. It allowed me to add to it over time, moving from a QRP rig to a 100-watt rig, a sub-receiver, and a six-meter preamp. That's the rig where I first pressed the six-meter button with my existing 20 to 6-meter vertical.

That was followed by the Icom IC-9100, where I could also get on other VHF bands, 144 and 432 MHz. I'm also using an IC-7100.



Figure 13 - IC-7100 tuned to the FT8 frequency.

Six Meter Equipment

The point with this is that we're all on a journey. First, we find something we enjoy and then build a better station as we go from rigs to antennas and more.

Transverters

If you have one of the older HF rigs without six meters, you can try a transverter. This device takes your 28 MHz output and converts it to 50 MHz. And it does the same thing in reverse with the received signal.

Transverters can be found on eBay in the \$50 to \$100 range, or you can purchase a very high-grade six-meter transverter from Q5 Signal and others. The low-cost versions are a great way to get on the air and explore all six-meter offers.

Preamps

Preamps are a good idea for six meters. Many rigs have internal preamps. For example, the IC-9100 has settings for two preamps on the HF+6 meter frequencies. According to Icom, preamp setting #1 is best for 1.8 to 21 MHz, while preamp setting #2 is best for 24 to 50 MHz. This is an excellent example of what many transceivers have built-in and why you should check the operating instructions for your rig.

There are also several options for external preamps. Current manufacturers include Advanced Receiver Research (ARR), Mini-Kits, and Elecraft. I'm sure there are others. In addition, TE Systems power amplifiers have built-in preamps.

The next challenge with preamps is to power them and switch them out of the line when transmitting. With higher frequency VHF-UHF preamplifiers, it's best to mount them close to the antenna so they catch the signal at its best and power it down the coax to the receiver. With six meters, that would be nice but not nearly as necessary as with much higher frequency signals.

Six Meter Equipment

Usually, the preamp will have relays built-in along with ways of powering them. Switching can happen either through RF sensing circuits or separate lines. A sequencing circuit is usually needed to ensure the preamp is out of the line before the transmitted RF arrives.

As you can see, this is an excellent place to look for additional performance improvement, but as you start, your rig's internal preamp or no preamp at all is just fine.

Power Amplifiers

There are lots of options for boosting your transmit power. Before we examine those options, one word of caution is that working on your antenna and receiving capabilities should be your priority. It does no good to transmit a loud signal and not be able to hear the other station. Even so, power amplifiers are pretty cool additions to your ham shack!

Solid-state amplifiers are an excellent starting point. I started out using a TE Systems 0510G that provides 170 watts output for 10 watts input. It also has a built-in preamp. Then, I move to the TE Systems 375-watt version. It works great during those openings to Europe, South America, and the South Pacific.



Figure 14 - TE Systems 375 Watt Six Meter Amplifier

Six Meter Equipment

Other dedicated six-meter solid-state amplifiers are hard to find other than in the used market. You can find an M2 6M-1K2 kilowatt amplifier and a few others. W6PQL has some parts kits available.



Figure 15 - M2 Six Meter 1 Kilowatt Amplifier

On the tube side, it's the same story trying to find a dedicated six-meter amplifier. There is the Alpha 8406, Commander VHF-1200, and a few others. Another option is to work with King Conversions to convert an HF amplifier to a six-meter amplifier. This typically involves starting with a Heathkit SB220 HF linear amplifier.

Yet another option is to convert Harris or Larcan amplifiers for six-meter operation. These are amplifiers that have been removed from service as television transmitters. Some are broadband enough that they need no tweaking to operate at 50 MHz. They do need power supplies, relays, sequencers, and fans. This is a very cost-effective option.

Six Meter Equipment

Just as with your HF+6 transceiver, there are several HF+6 linear amplifiers. Elecraft, Icom, Yaesu, Acom, Ameritron, and others offer these amplifiers. The advantage here is that they will help your HF operations as well.

SDR Panadapters

Yet another thing to consider for your six-meter operation, or any operation for that matter, is adding a software-defined receiver (SDR) for use as a panadapter. However, if you have an Elecraft K3/P3 combo, IC-7300, FT-991A, or something similar, you already have a panadapter built-in.

For my operation, I started using a Nooelec SMARt USB RTL-SDR covering 25 to 1750 MHz and a transmit-receive switch connecting the SDR to the antenna on receive and the IC-9100 on transmit. This SDR cost \$30.

I've recently upgraded to an AirSpy R2 and an Antenna-Amplifiers.com EME 3-50. The latter is a preamp, bandpass filter, and transmit-receive relay. It provides a separate switched output for the receiver and input for the transmitter. I also use a sequencer to time everything correctly. As with anything, the more sophisticated you get, the more complexity you build. It's ok to keep it simple.



Figure 16 - Airspy R2 SDR

Six Meter Equipment

I use SDR Console for software, which is power-packed and free. You can see the typical display I use for six meters below. There are three windows at the top. The first is set at 50.125 MHz and is picking up an SSB signal. That is also shown on the lower window, where I can monitor the SSB portion of the band. The middle window is monitoring 50.313 for FT8 signals, while the third window is tuned to 50.323, which is the Europe to USA frequency.

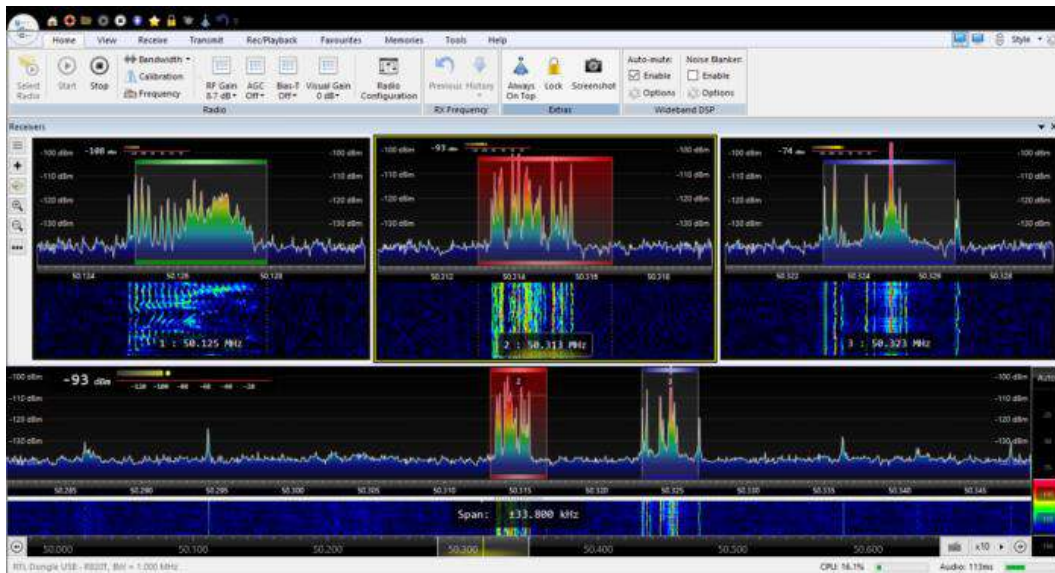


Figure 17 - SDR Console display with three receivers.

This gives me excellent visibility of the key watering holes for six meters to quickly spot changing propagation conditions.

One example is that during a TEP opening to South America working FT8, a glance at the SDR showed something happening at 50.110, the DX window for SSB. Tuning in, I found CE4WJK. I then found my microphone and worked him. Afterward, I contacted him via email about QSL options. He sent me his address and a recording of our QSO! Cool stuff.

I've included an appendix that provides far more information about this excellent option for station improvement.

Chapter 4 — Six Meter Antennas

Six-meter antennas are always fascinating, with many options from homebrew to buying them off the shelf. Plus, the antennas are small enough to fit in your backyard or even your attic. I've tried a few. Here's the rundown of my experience.

Six Meter Dipole

What's not to like about a six-meter dipole? It's simple and easily built. Roughly 9 feet from tip to tip, it can fit almost anywhere. It is horizontally polarized, which purportedly is best for VHF DX. And it works.

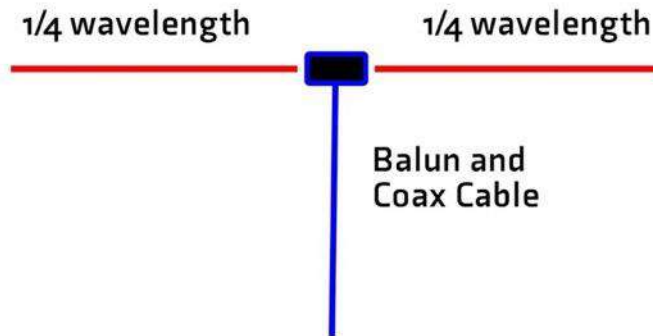


Figure 18 - Simple diagram of a dipole.

My write-up on my efforts with a six-meter dipole has been the post with the most traffic on my website since it was published in 2014. So it must be a popular option as well. I'll also note that I've worked Argentina and Uruguay using that dipole and 100 watts.

I used a 1:1 balun designed as a center insulator covering 1.5 to 54 MHz. My initial calculations were for each side of the dipole to be 4 feet 6 inches. Once installed, that didn't quite reach resonance. Merely bending the eye-rings attached to the balun,

Six Meter Antennas

lengthening the dipole slightly, brought it into resonance with 1.1 VSWR at 50.150 through 50.500 MHz. From this, you can tell things are very sensitive at these frequencies.

I also suggest you look at a few of the online dipole calculators. Here are two links:
<http://www.csgnetwork.com/antennaedcalc.html>
<http://www.hamuniverse.com/dipivcal.html>

These calculators call for slightly longer dipole legs than I used. I do like the second calculator's estimates for an inverted vee. Note that using wire with insulation changes the length needed. So, plan to do a bit of tweaking.

Six Meter Vertical

My experience has been surprising, given the prevailing wisdom that you must be horizontally polarized for VHF DX. I would imagine that is true above six meters. But my own experience on six meters has been eye-opening.

In 2011, I purchased a Cushcraft MA6V vertical that covers 20 to 6 meters. This added to my HF contest capabilities. I avoided using this antenna on six since I first had a dipole, and later a Moxon followed by a 3-element Yagi.

But, over the past few years, I only had the vertical antenna. So I started working stations on FT8, and to my surprise, they answered. That included Scotland, my first European six-meter contact. I will note that the MA6V is an offset center-fed vertical dipole; no radials are needed. And mine is mounted at roughly 20 feet above the ground.



Figure 19 - MA6V vertical dipole for 20-6 meters.

Six Meter Antennas

So, a vertical is worth trying on six meters. Plus, it's easier to fit into the yard.

Six Meter Stressed Moxon

Moxons are my favorite type of antenna. My first experience was with a homemade hand-steered 15-meter version that snagged many QSOs for my single-band CW and RTTY contest entries.



Figure 20 - Par Electronics 6m Stressed Moxon

The advantages of these antennas are directional, good front-to-back, and smaller than a Yagi. With the tips of the driven element and reflector bent to nearly touch, it squeezes the width of the antenna into a much smaller space.

The Par Electronics Stressed Moxon brings this compact design to six meters. It works great with good gain, sound front-to-back rejection, and incredible construction. I've

Six Meter Antennas

used it for years at home on a push-up mast and, more recently, on my rover operations. It can hit a tree and be bent back into shape for the next grid stop — don't ask me how I know.

While the gain isn't as great as the multi-element Yagis, I like that its broader beam width covers a lot of ground without needing to tweak the rotator. That works great for contests when the band is open.

This is easily my favorite six-meter antenna.

Six Meter Yagi — 3 Elements

Next up in my six-meter antenna journey, I tried to find more gain while still fitting the antenna into my small side yard. I reviewed the available options and selected the InnovAntennas 3-element LFA.

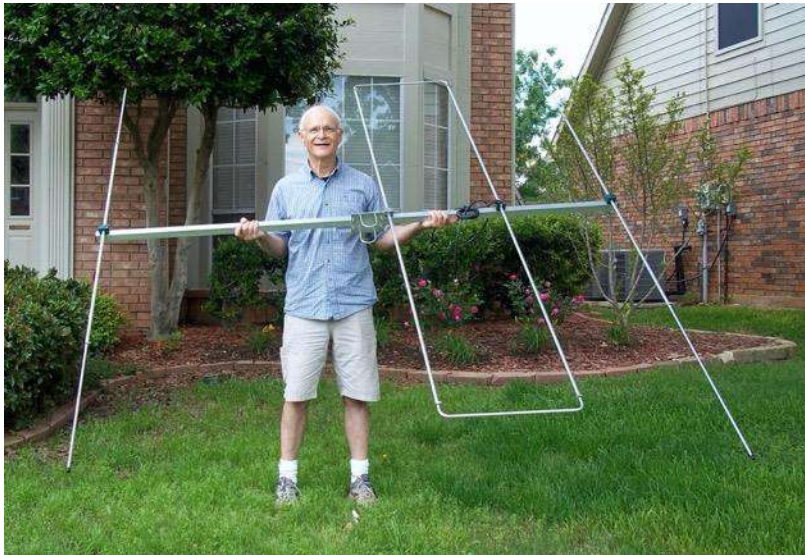


Figure 21 - Innovantennas 3-element Yagi

It works nicely and offers reduced noise, although I couldn't discern much difference from the Moxon.

Six Meter Antennas

I used that antenna for quite some time. The construction is rock solid, but sitting up on top of a push-up mast along with the rotator made me pretty nervous in the high winds that sweep through from time to time. So, after a while trying to discern a big difference between the Moxon and failing, I put the Moxon back on the push-up mast.

Recently, I purchased an M2 6M-3SS Yagi. My motivation was to find a higher gain antenna than the Moxon for use on a temporary installation with a push-up mast in my backyard.

I use this for the Summer Es season. Plus, I use it during rover operations in the Texas Panhandle and Oklahoma when trying to activate a few rare grids.



Figure 22 - M2 3-element Yagi

Given that temporary use, I wanted a Yagi that could be quickly taken apart and back together for transport and storage. I also wanted a lightweight antenna for use on the push-up mast.

This one fits the bill nicely, and I've already worked several new DXCC countries in Europe and South America from my backyard installation. The LFA would not have worked in this application as it is heavy and a fairly complex build. It's better for a permanent installation.

Six Meter Yagi — 5-Elements

We're constantly pushing the limits. In this case, the boundaries were my backyard and the strength of my push-up mast. The Directive Systems DSEJX5-50 5-element Yagi has a boom length of 12 feet, which works nicely in my restricted backyard –barely

Six Meter Antennas

clearing some tree branches. It also works well on my 6-meter rare grid rover operations. It's what I use during the summer Es season.



Figure 23 - Directive Systems 5-element Yagi

Six Meter Omniangle

My first use of the Par Electronics Omniangles was on two meters and 70 cm. They worked great to get me started on those higher bands and offered horizontal polarization. I later added cheap Yagis, Diamond Yagis, and Directive Systems Rover Yagis for those bands. You can't have enough antennas.

I recently added the six-meter Omniangle. At first, I positioned it in the nook over my ham shack. That was a bit too close to my rig and caused some interference. Now it's mounted in



*Figure 24 - Par Electronics 6m
Omniangle*

Six Meter Antennas

the attic along with stacked 2m omniangles. I think these antennas can help during contests when monitoring for signals from any direction. Once found, you can shift to the Yagi's and point them to the target station.

There Are Always More Options

There is always one more type of antenna to try out, no matter how many you've worked with in the past. For example, quads have always been on my list.

Jon Jones, NØJK, editor of *QST's World Above 50 MHz* column, provided these additional comments about his experience with six-meter antennas. Thanks, Jon.

I have made many contacts using a simple magnetic mount 1/4 wave whip. The best DX with this setup on 6 was Argentina from Maui, HI, back in 2015 – LW3EX on CW. I decoded a dozen different JA stations on FT8 back in June 2018 on it. Signals up to -10. I tried hard, but no Qs. It is excellent for mobile/fixed portable sporadic E.

*M2 Loop — Used in the attic. It works, though some RF on the feedline. The best DX was G8BCG on sporadic-E a few years ago.
Dipole. Currently, I have one in the attic at home. Low SWR, lower noise, and works. Oriented currently to favor SE – NW. It can work in other directions with some loss of gain. Worked KH6/K6MIO using it in November 2015 on 6 F2.*

I have not used the Moxon. I use a two-element yagi for most of my portable work. It has about the same gain as a Moxon. Mine goes together in minutes. It's a very efficient little antenna. With it, I worked the JA's I had decoded on the whip.

M2 6M-3SS. I have one. It is a great antenna but takes longer to put together in the field and is heavier. I have not used the LFA. Many like them.

I hope these six-meter antenna notes can help you get started down this path or perhaps confirm some of your own experiences. Good luck with your antenna journey on the Magic Band.

Chapter 5 — Operating Software

The six-meter essential software package is WJST-X, which includes the modes FT8, FT4, MSK144, and Q65. Here's the critical information that can make all the difference in even hearing stations, let alone working them.

Mode	Signal-to-Noise Ratio
Q65	-25 dB at 30 seconds -28 dB at 60 seconds
FT8	-21 dB
FT4	-18 dB
CW	-10 dB
MSK144	-1 to -8 dB
SSB	+5 dB

Figure 25 - Weak-Signal Table from K1JT presentation to 6 Meter BBQ September 2023

When I started working six-meter grids and countries in 2014, it was mainly on CW and SSB during Sporadic E openings. At that time, I set up WSJT and tried a few HF QSOs. That was excellent preparation for trying it during a six-meter opening.

JT65 helped me put the Dominican Republic in the log in 2014 and later, during a TEP opening that same year, added Uruguay to my log. During that particular TEP opening, most of my contacts were via CW.

But today, some nine years later, most stations operate on FT8 at 50.313. I monitor the SSB and CW frequencies during openings at home and also during my contest rover operations. I seldom see anyone active. Instead, they are pounding away on the FT8 frequency.

Many, many lament this significant change on six meters. However, my experience is that I see quite a few more stations on the air due to FT8, and they are bringing new grids along with them. What's not to like about that?

WSJT History

QST Magazine ran an article in their December 2001 issue titled "*WSJT: New Software for VHF Meteor-Scatter Communication*," written by Joe Taylor, K1JT, the mastermind behind the WSJT suite of communication modes. The article describes the details of the FSK441 mode for meteor scatter communications.

At that time, WSJT was replacing the cumbersome system of extremely high-speed Morse Code for meteor scatter. In that same article, he describes future thoughts about a mode for EME communication.

That effort resulted in JT44, as described in *QST's* June 2002 issue. Used primarily for EME work, it could decode signals that were 10 dB or more below the weakest CW signals. It had 30-second transmission periods and required close computer clock synchronization.

The early version of JT65 was described in the June 2005 issue of *QST*. It introduced one-minute transmission periods and 10 to 15 dB gain over CW signals. This was followed by WSJT-X and many more new modes from JT9 to MSK144 and now FT8 and FT4.

If you're interested in pursuing the history further, a good starting point is at <http://physics.princeton.edu/pulsar/k1jt/refs.html> with links to many articles.

The overall point is that WSJT is not a new phenomenon. It's now more than twenty years old. Plus, the source of its innovation is relentless development work — always seeking new ways of facilitating communication with extremely weak signals, thereby enhancing communication over long distances.

FT8 Activity on 6 Meters

Michael Wells, G7VJR, has provided some analysis on the usage of FT8 on 6 meters. Michael is the author of Club Log and provides an annual activity report. You can find his six-meter post at <https://g7vjr.org/2021/03/ft8-and-the-6m-band/>. Here's the data in pie chart form for six meters from March 1, 2020, to March 26, 2021.

QSOs on Club Log March 2020 to March 2021

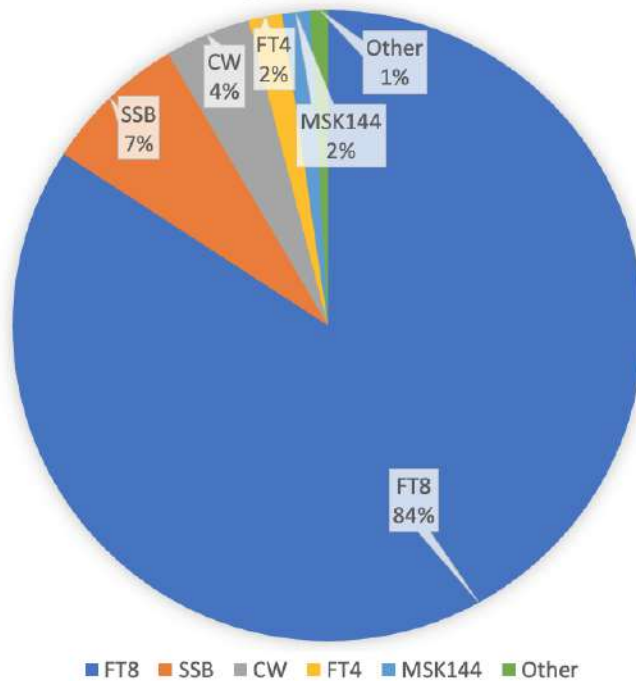


Figure 26 - 6 meter QSOs on ClubLog

Note that this is for worldwide six-meter activity. It is also for those using Club Log, typically DXers. Even so, it no doubt captures in numbers what many have seen on the band.

FT8 Operating Hints

Nearby, you can see a computer screen capture of an FT8 QSO. It's pretty straightforward, and you can find many detailed tutorials online to guide your efforts.

For me, the big thing is ensuring your computer clock is synchronized. I use Meinberg NTP, a GPS receiver, and NMEATime sync software. I like the GPS as it helps in my rover operations.

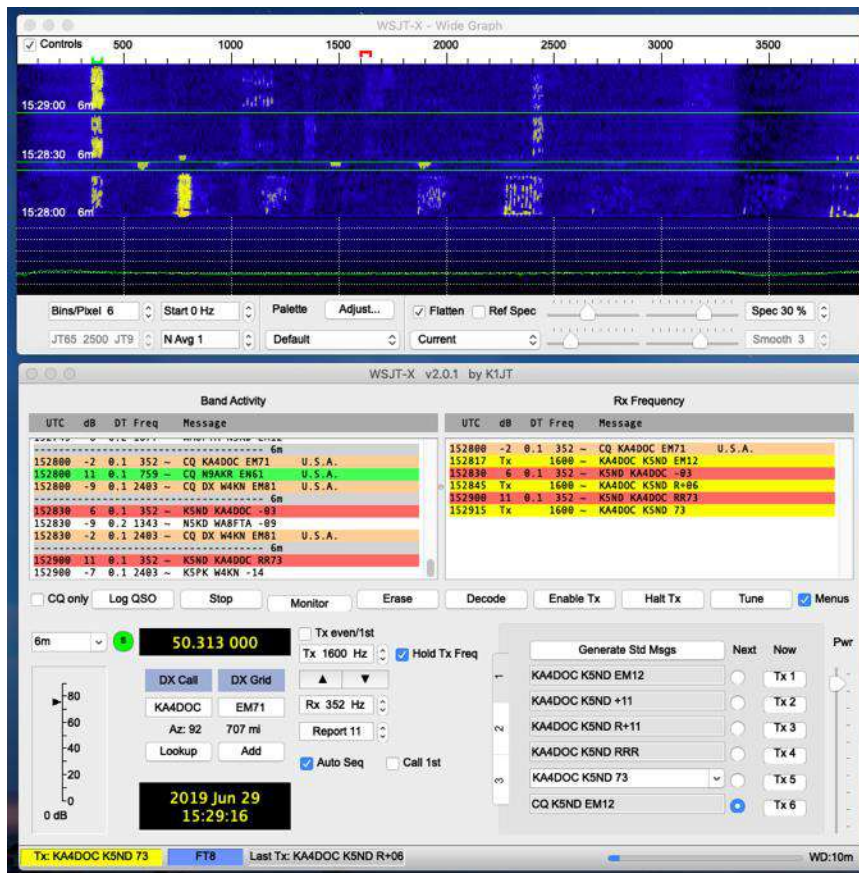


Figure 27 - WSJT-X with FT8

Operating Software

Another thing to watch for is finding a reasonably clear space for your transmit signal and selecting “Hold TX Freq” as above. I also use “Auto Seq,” and although not shown above, “Call 1st” when sending a CQ.

I also use RRR rather than RR73. At VHF, the signals are all too easily lost. I don’t want to send RR73, move on, and find later that the other station didn’t get the RR73. It’s best to send RRR and receive a 73, knowing for sure that the QSO has been completed.

Mouse over TX4 in WSJT-X to see the instructions. It states, “RR73 messages should only be used when you are reasonably confident that no message repetitions will be required.” Double-click on TX4 to change from RR73 to RRR.

Gary Hinson, ZL2IFB, has published an FT8 Operating guide at [https://g4ifb.com/FT8 Hinson tips for HF DXers.pdf](https://g4ifb.com/FT8_Hinson_tips_for_HF_DXers.pdf)

You can find more insight in Chapter 7 on FT8 and FT4 operations.

MSK144 Operating Hints

WSJT has also brought meteor scatter to many stations that in the past could only dream about such operations. I'm by no means an expert on meteor scatter. But it has allowed me to make a few QSOs that wouldn't have happened otherwise.

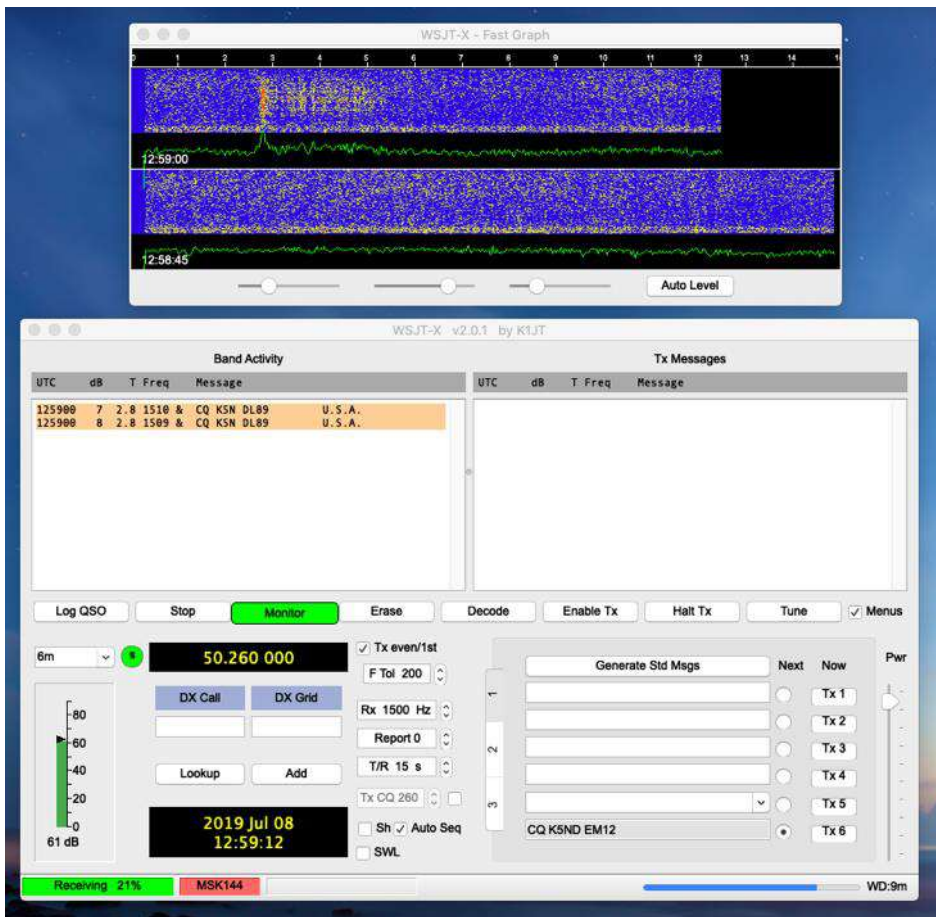


Figure 28 - MSK144 Screenshot

In the screen above, you can get a flavor for an MSK144 display. This was a signal from K5N in the rare grid of DL89. I received it on my vertical. You can also see the meteor burst or ping on the Fast Graph window. Cool stuff.

Operating Software

As with FT8 above, I recommend sending RRR rather than RR73; this practice is even more critical with meteor scatter because it could take several sequences for the RRR to get to the receiving station. See Chapter 8 for more detailed operating insight.

Q65

I've had a few QSOs on Q65. It seems to work when nothing else is working. The quick start guide states that it works "over especially difficult propagation paths including tropospheric scatter, rain scatter, ionospheric scatter, TEP, and EME on VHF and higher bands."

The current standard on 6 meters is Q65 mode, T/R at 30 seconds, and submode A on 50.275 MHz. The other settings are under the "Decode" menu; select Normal, Enable Averaging, and Auto Clear Averaging after Decode. Frequency tolerance works well after you've found the transmitting station's carrier frequency. One remarkable aspect of this mode is that it averages the tiny signals received and eventually pulls together a full decode. Amazing.

Note that these settings were recommended and that I found to work in writing this section. Testing is always underway, and a few software tweaks also happen. You can find much more detailed information in Chapter 9.

WSJT and Logging

WSJT keeps its own logbook in the adif format. For contest mode, it also generates a Cabrillo format log. So that's one way you can log your contacts.

I've used N1MM Logger+, which requires launching WSJT within the logging program. I've used this software in the past for contests. There are many tutorials and fantastic documentation on the N1MM website to get you started.

I primarily use N3FJP's Amateur Contact Log and some of his contest logs. Along with this logging program, I suggest JT Alert. This software scans incoming signals and alerts

Operating Software

you to needed grids, states, DXCC, etc. There is a considerable amount of info online for download and setup. Note that N3FJP also directly connects to WSJT, highlighting new grids, etc.

Most of the computers in my home are Apple Macs, all except for my ham shack, where Windows is the only option for much of the software I use. If you are using a Mac, I recommend MacLoggerDX and JT-Bridge, which alert you to new grids, etc.

WSJT Alternatives

There are also some alternatives to WSJT-X software. They include JTDX, MSHV, and JS8Call. These software packages take the existing WSJT source code and modify it. I'm using JTDX most of the time for FT8, at least outside contests.

JTDX

Search on JTDX download to bring this software into your computer. It works just like WSJT-X, only better. The downside is that it does not provide MSK144 or Q65 modes. It also doesn't offer contest modes. It does offer FT8 and FT4 and does so with vastly improved performance for weak signals.

Seeing is believing. JP1LRT provided an audio file with 107 signals in a 15-second sequence. Using JTDX version 2.2.159 in my ham shack, it decoded 67 signals. Using WSJT-X version 2.6.0 rc2, it decoded 54 signals. You can't work them if you can't hear them.

The other thing I like about JTDX is its better user interface. For example, when I don't get a 73 from a station, it keeps sending until I do. When someone sends an RR73, it will send a 73, while WSJT will just stop at that point. When CQing, if several people answer, it will pick up the first one, and after the QSO, it will call the second one. Similarly, if a QSO can't continue since I've lost the signal and go on to someone else if that original person calls back, JTDX will pick up the QSO where it left off.

There are several other helpful operating features, too numerous for me to cover here – or for me to remember. Here's what the current screen looks like version 2.2.159.

Operating Software

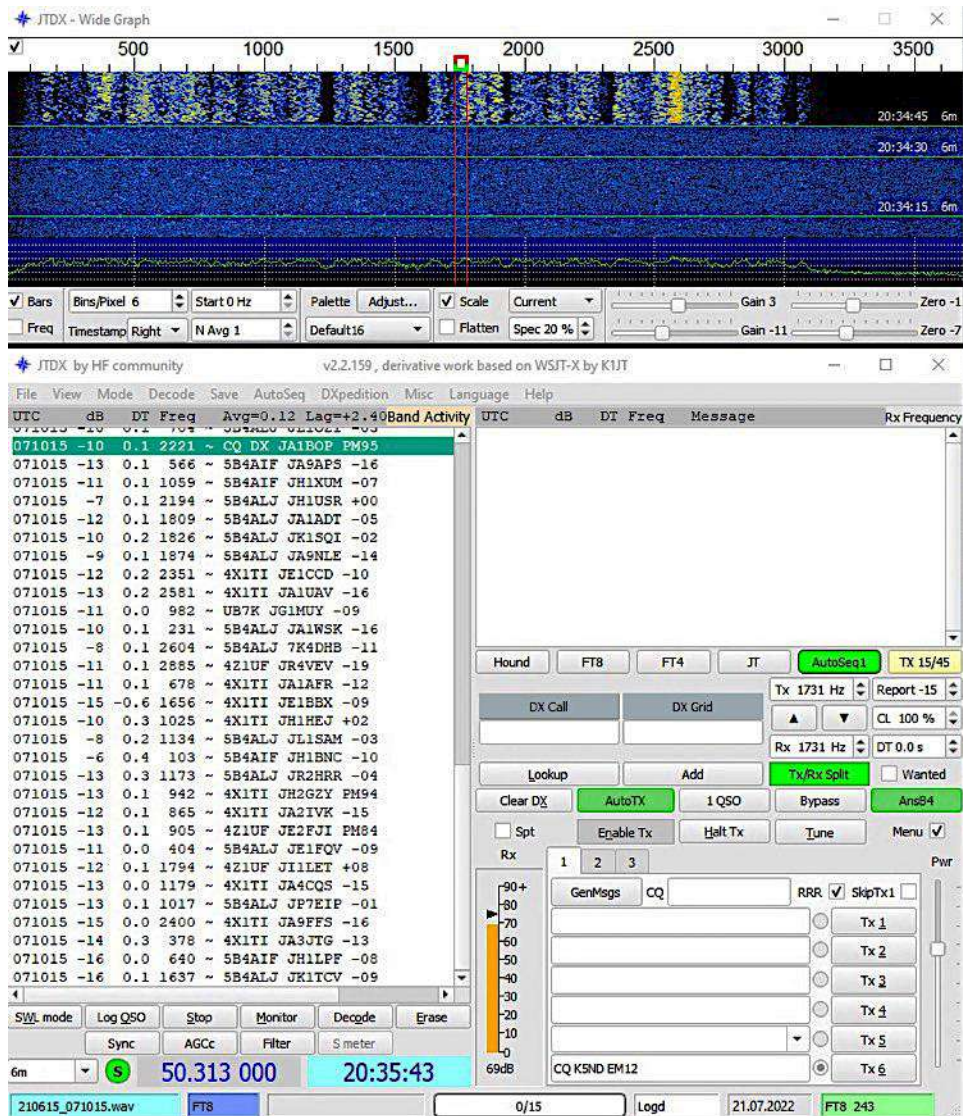


Figure 29 - JTDX Display

Operating Software

WSJT-X Improved

I've recently started using WSJT-X Improved. I like that it adds many of the operating features of JTDX while maintaining all the operating modes from FT8 to MSK144 to Q65 and the contest messages.

The chapter on FT8 and FT4 operation shows more on this WSJT-X alternative.

Chapter 6 — Six Meter On-the-Air Operations

We've talked about propagation, equipment, antennas, and software. Now it's time to address some operating protocols for six meters.

Six Meter Frequencies

Here are the major frequencies for six meters.

Frequency	50.125 SSB Calling
	50.100 CW
	50.1 to 50.125 DX Window
	50.313 for WSJT-X FT8
	50.323 for FT8 to Europe
	50.318 for FT4
	50.260 for MSK144 Meteor Scatter
	50.275 for Q65 in 30A mode
	50.080 and down Beacons

The primary calling frequency for SSB is 50.125 MHz. That's an excellent frequency to monitor to see what's happening with band conditions. If you hear someone, the band is probably opening. Sound advice is to call on this frequency and then move to a higher frequency for the QSO. When the band opens, people will work stations every three to five kilohertz above 50.125.

The DX window is from 50.100 to 50.125. Here, you'll find DX stations calling CQ. It's verboten for USA stations to call CQ in this area. That must be why they call it the DX window.

Six Meter On-the-Air Operations

You can also monitor the CW beacons on the air from 50.080 MHz and lower. An Internet search on the “six-meter beacons list” will help you find the frequencies and locations. Of course, the beacon will send call signs and usually the grid.

Digital Mode Operations

Today, much of six-meter operating happens on the digital modes, primarily FT8. That magic frequency is 50.313 MHz. There, compressed into about 4 kHz, are most stations on the air.

There are pros and cons, of course. The benefit is that you can see almost all the stations currently on the air and usually work them all. The downside is that they are squeezed into a small space when the band is open. Not only that but there’s no way to have a conversation. If that’s your goal, then it’s time to move to the SSB frequencies.

There is also a special frequency for working FT8 across the Atlantic, 50.323 MHz. The protocol on that frequency is for North American and Caribbean stations to operate on second or odd sequence (0:15 and 0:45 seconds) and for European stations to operate on first or even sequence (0:00 and 0:30 seconds).

Meteor Scatter happens on 50.260 and also 50.265 MHz. This type of contact is usually coordinated online in one of the chat rooms. This helps to determine the frequency, sequence, direction to point the antenna, etc. The standard protocol is that the westernmost station operates on the first sequence while the eastern station operates on the second sequence.

FT4 is another option; I’ve worked a few on six meters when the band is open with a great deal of activity.

Q65 is at 50.275 MHz in the 30-second T/R sequence and submode A. There are separate chapters devoted to these modes.

Six Meter On-the-Air Operations



Figure 30 - K5ND Ham Shack September 2023

Contest and Rare Grid Roving

I've mentioned roving a few times in this book, and there's a later chapter with much more detail. Rovers are a distinctive aspect of VHF contesting, and they've come into their own to support those chasing grid-based awards like the Fred Fish Memorial Award (FFMA).

Stations set up their transceivers and antennas in their car or van. Drive out to some remote location. Set up the station and then hope for good propagation on 6 meters.

I've done this in contests in the Dallas-Fort Worth area. I've also done some rare grid roving in the Texas Panhandle.

The photos below show the backseat operating position, the rooftop rotator system I have typically used in VHF contests (note the six-meter Moxon), and the pushup mast I've used in the Texas Panhandle.

Six Meter On-the-Air Operations

This can be a fun activity for the rover and rewarding for those chasing these rare grids.



Figure 31 - K5ND/R back seat operating position



Figure 32 - K5ND/R with 50, 144, 220, 432 antennas

Six Meter On-the-Air Operations

Finding Openings

My favorite resource for finding and monitoring openings on six meters is DXmaps.com. This website processes all the spotted stations and plots them on a map. You've seen a few examples earlier in the document.

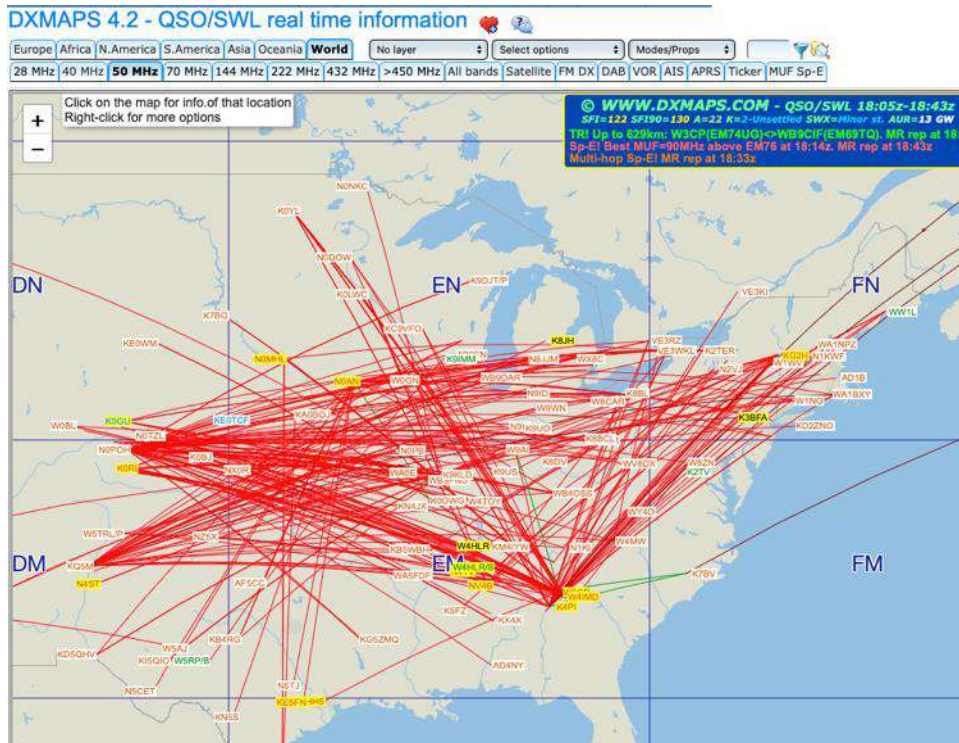


Figure 33 - DXmaps.com display of a 6-meter opening

I use this to help me point my antenna and monitor for what I can hear. It's all fine and dandy to see these maps. But, if you're not hearing anything, it at least gives you hope that something might happen on this magic and tragic band.

It's also helpful to monitor the various online chat rooms. This includes Slack VHF-Chat, ON4KST Chat, and PingJockey. An online search can help you find and log into these chat systems.

Six Meter On-the-Air Operations

Many of the conversations are about lining up lengthy meteor scatter contacts. They are also enormously helpful in keeping track of any rovers out there activating rare grids. Pointing your antenna at them and monitoring what's happening on the air and the chat system can help you snag one of those grids when the conditions are just right.

I mentioned CW beacons earlier. These have traditionally been great resources to provide an early indication of openings. It can be beneficial to have a panadapter offering a wide display of the entire range of CW beacons.

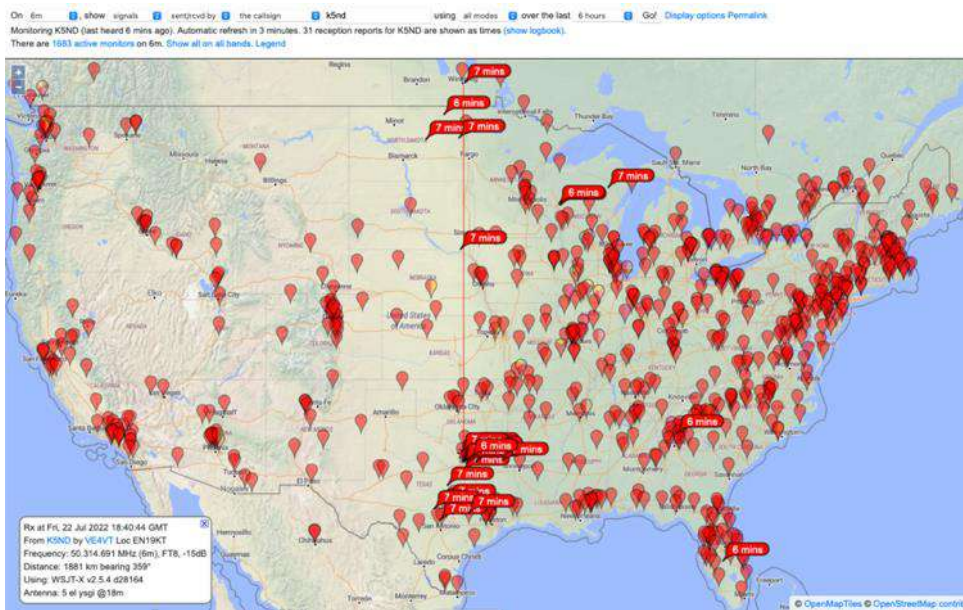


Figure 34 - PSK Reporter showing my FT8 signals

The PSK Reporter system consists of lots of stations around the world with receivers on the ham bands tied into an extensive database collecting and displaying all this information.

They report all digital mode contacts. You can select the band and mode to monitor. I have started to use this resource more frequently to pick up my signal to see how I'm getting out. It can be particularly helpful with meteor scatter—pretty cool stuff.

Chapter 7 — WSJT-X Operations: FT8- FT4

Chapter 5, Operating Software, provides a broad overview of the various types of software available for operations on 6 meters. Of course, the big one is WSJT-X. This chapter digs into FT8 and FT4 operations, while the following two chapters address MSK144 and Q65, respectively.

There are many online resources to help you get your rig set up for WSJT-X operations. Plus, there are many operating guides as well. So, I won't attempt to achieve their level of detail or insight. But I will provide my setup, operating practices, and experiences.

How FT8 and FT4 Work

FT8 and FT4 work through the normal ionospheric propagation modes of the F2 layer, sporadic E, and tropospheric scatter.

As noted earlier, FT8 and, to a lesser degree, FT4 offer substantial improvement in decoding weak signals. In comparison, CW can be expected to be decoded by a good operator at a -10 dB signal-to-noise ratio. SSB works at about +5 dB signal-to-noise. But FT8 operates at an astounding -21 dB signal to noise.

It does this through a bandwidth of 2.5 kHz but decoding individual signals at a 6.25 Hz bandwidth for FT8. It is, in essence, bringing the magic of digital decoding to the magic band and every other band.

WSJT-X Overview

Using a computer soundcard either built into the rig or an external USB device, the audio frequencies spanning roughly 0 to 3.5 or 4 kHz are used to transmit and receive multiple FT8 or FT4 signals.

WSJT-X Operations: FT8 - FT4

Likewise, there is a rig-to-computer connection for Computer Aided Transceiver (CAT) control for keying the rig and making frequency changes.

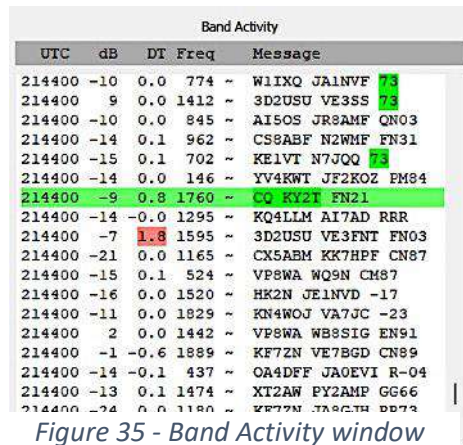
You can find the WSJT-X User Guide at <https://wsjt.sourceforge.io/wsjt-x-doc/wsjt-x-main-2.6.1.html> Note that changes to the software happen frequently. The current version is 2.6.1.

The guide provides detailed information on connecting your rig for audio and CAT control.

Computer Time Alignment

One of the ways that WSJT-X achieves its incredible signal-to-noise level is through time alignment between the transmitting station and the receiving station.

Typically, your computer is reasonably well synchronized. You can check at the website time.is If it's close, you may be able to get by without particular time synchronizing software. Yet, we are ham radio geeks. So, there must be more.



UTC	dB	DT	Freq	Message
214400	-10	0.0	774	~ W1IXQ JA1NVF 73
214400	9	0.0	1412	~ 3D2USU VE3SS 73
214400	-10	0.0	845	~ AISOS JR8AMF QN03
214400	-14	0.1	962	~ CS8ABF N2WMF FN31
214400	-15	0.1	702	~ KE1VT N7JQQ 73
214400	-14	0.0	146	~ YV4KWT JF2KOZ FM84
214400	-9	0.8	1760	~ CC KY2T FN21
214400	-14	-0.0	1295	~ KQ4LLM AI7AD RRR
214400	-7	1.8	1595	~ 3D2USU VE3FNT FN03
214400	-21	0.0	1165	~ CX5ABM KK7HPF CN87
214400	-15	0.1	524	~ VP8WA WQ9N CM87
214400	-16	0.0	1520	~ HK2N JE1NVD -17
214400	-11	0.0	1829	~ KN4WOJ VA7JC -23
214400	2	0.0	1442	~ VP8WA WB8SIG EN91
214400	-1	-0.6	1889	~ KF7ZN VE7BGD CN89
214400	-14	-0.1	437	~ OA4DFE JAOEVI R-04
214400	-13	0.1	1474	~ XT2AW PY2AMP GG66
214400	-24	0.0	1180	~ WF7ZM TA8C7H DP72

Figure 35 - Band Activity window

There are several options for installing software that will sync your computer clock. Try Dimension 4 at <http://www.thinkman.com/dimension4/> There is also Meinberg NTP available at <https://www.meinbergglobal.com/english/sw/ntp.htm>

You can also use a GPS antenna and the NMEATime2 time software at <https://www.visualgps.net/#nmeatime2-content> This is the setup I'm currently using.

You can view the difference between your computer's time and those of others on the air by observing the Band Activity window and the DT column. It will typically show 0.1 or 0.2 and sometimes with a minus sign. If it's consistently showing 1.0 or greater, it

WSJT-X Operations: FT8 - FT4

could be that your clock is off by that amount. See the sample nearby with one transmission at 1.8 seconds out, highlighted in red.

Settings Considerations

The WSJT-X User Guide has some screenshots and more background into each setting. I've included below some of my settings windows. Please note that this is from WSJT-X Improved, found at <https://sourceforge.net/projects/wsjt-x-improved/> This is a slightly improved version of WSJT-X. Undoubtedly, some of the features added to this version will eventually appear in the public versions of WSJT-X.

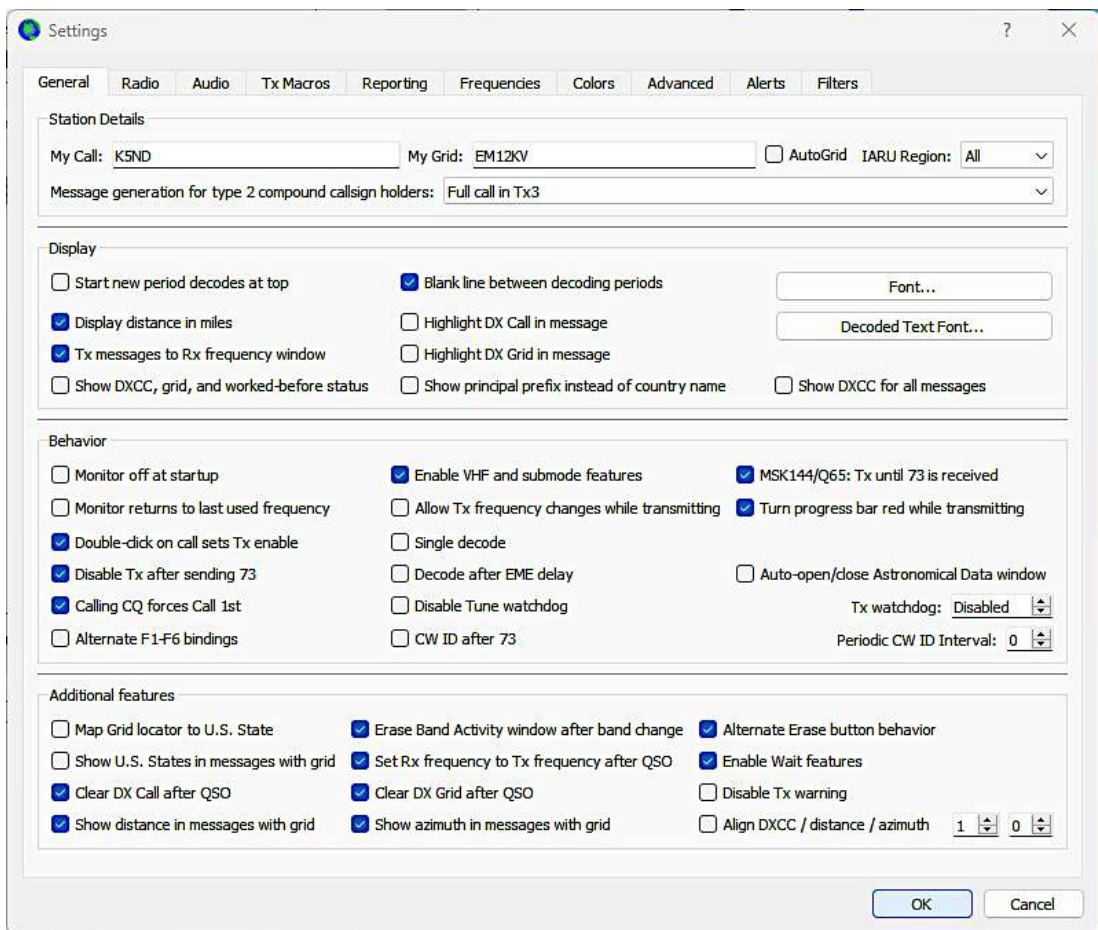


Figure 36 - WSJT-X Improved Settings General Tab

WSJT-X Operations: FT8 - FT4

In the general tab, I've ticked off the usual stuff, including Enable VHF and submode features. Note the setting for MSK144 to transmit until 73 is received—more on this in the MSK144 chapter.

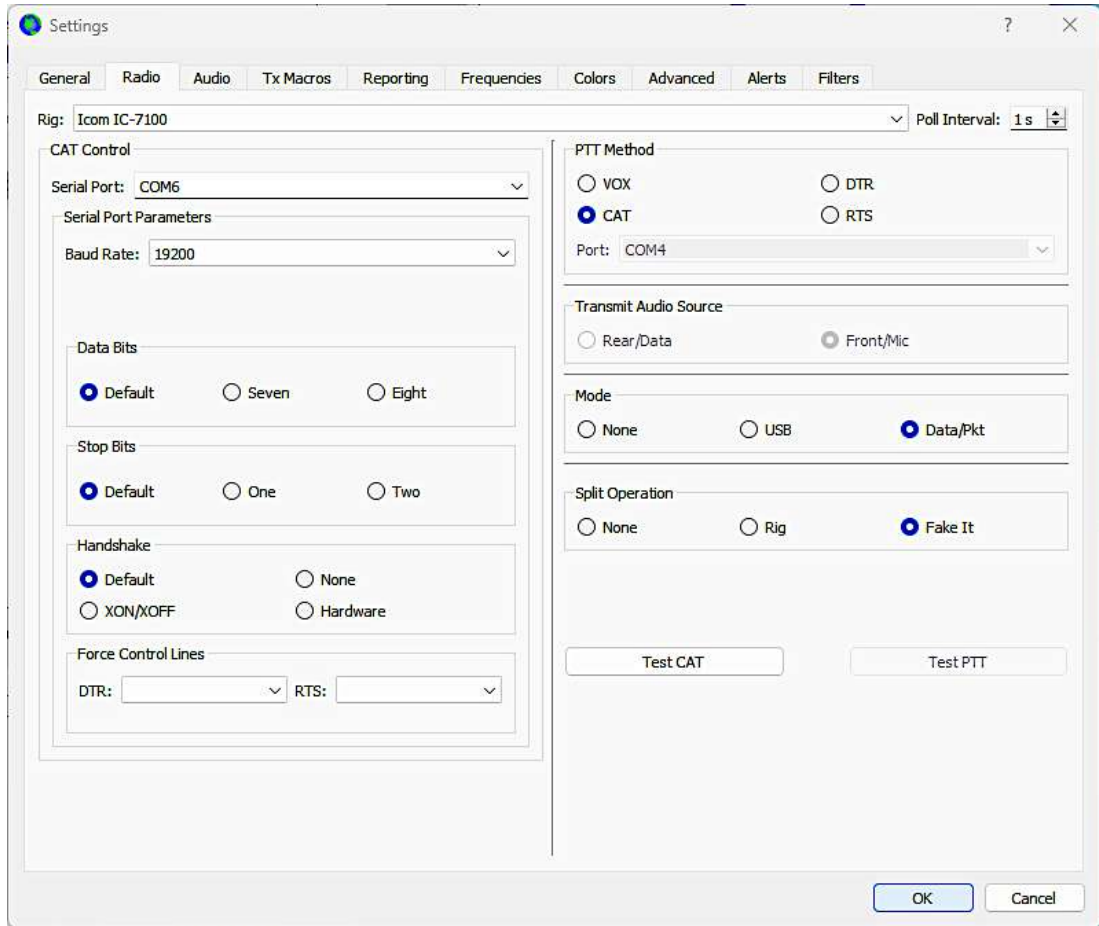


Figure 37 - WSJT-X Improved Settings Radio Tab

In the radio settings tab, I've set up my rig and the serial port for CAT control. Note the Split Operation setting for Fake It. This ensures that the transmitter operates in a spot in the audio bandpass, ensuring no harmonics are transmitted.

WSJT-X Operations: FT8 - FT4

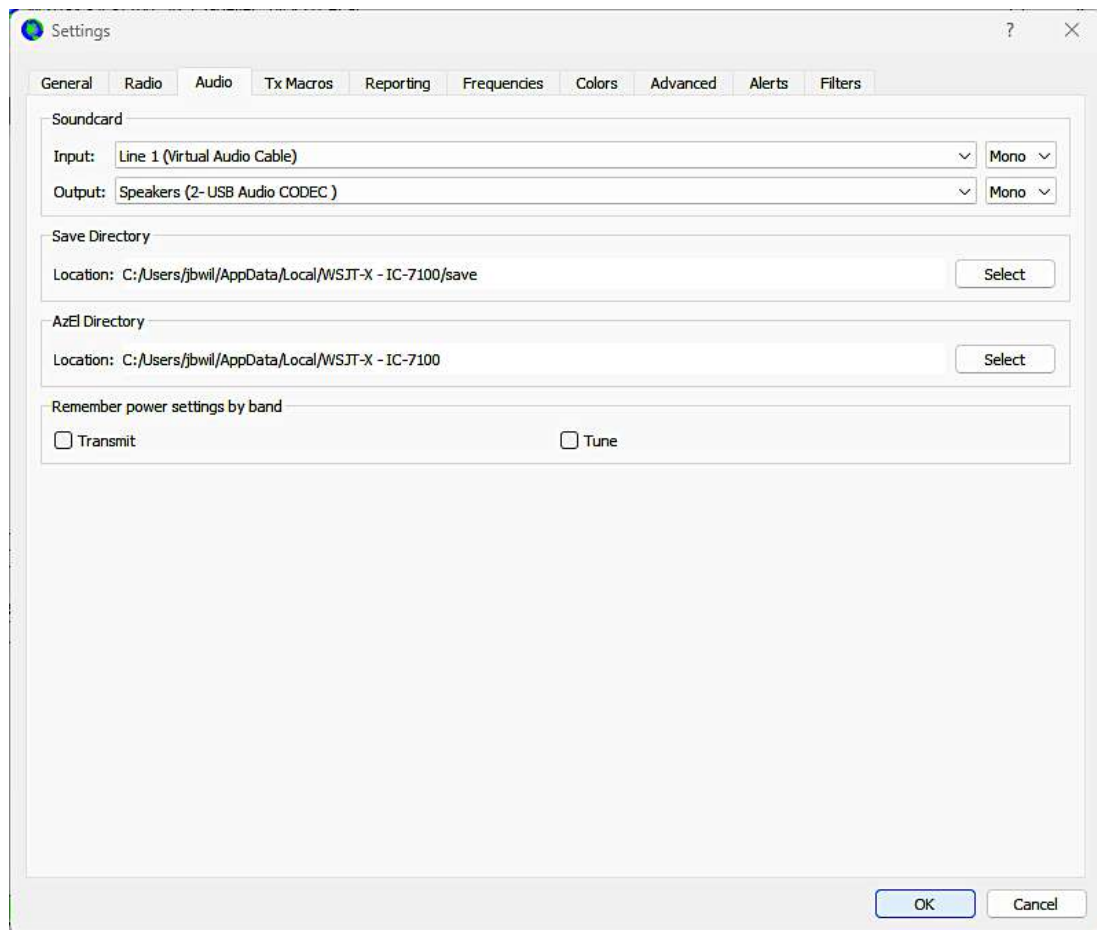


Figure 38 - WSJT-X Improved Settings Audio Tab

The audio tab is pretty straightforward. Here, it shows that the input for receive is from a virtual audio cable from the Airspy SDR I'm using on receive. You can learn more about that setup in the Appendix.

The output is direct to the USB Audio Coded in the IC-7100.

WSJT-X Operations: FT8 - FT4

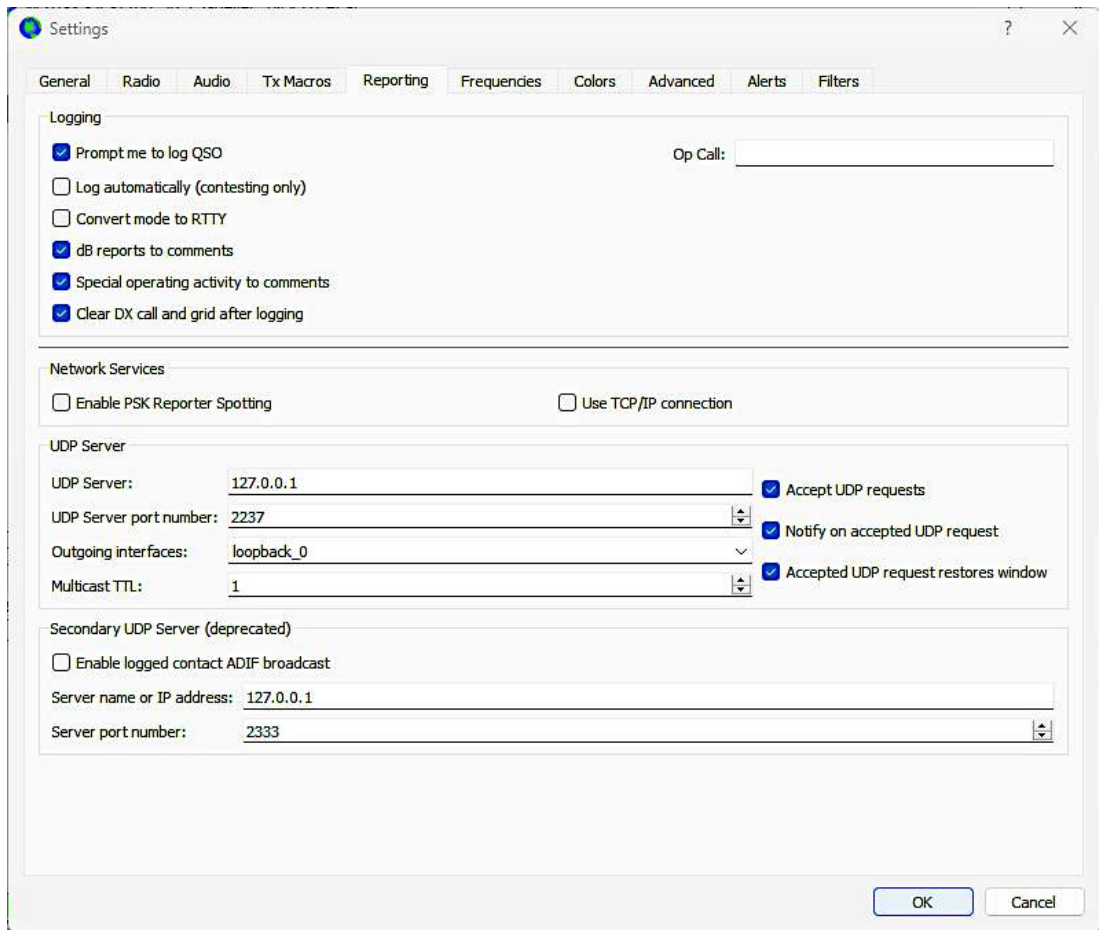


Figure 39 - WSJT-X Improved Settings Reporting Tab

In the Reporting tab, it shows the various prompts and logging comments. The Network server settings will depend on the logging program you're using. I'm using N3FJP's AC Logger along with JT-Alert.

WSJT-X Operations: FT8 - FT4

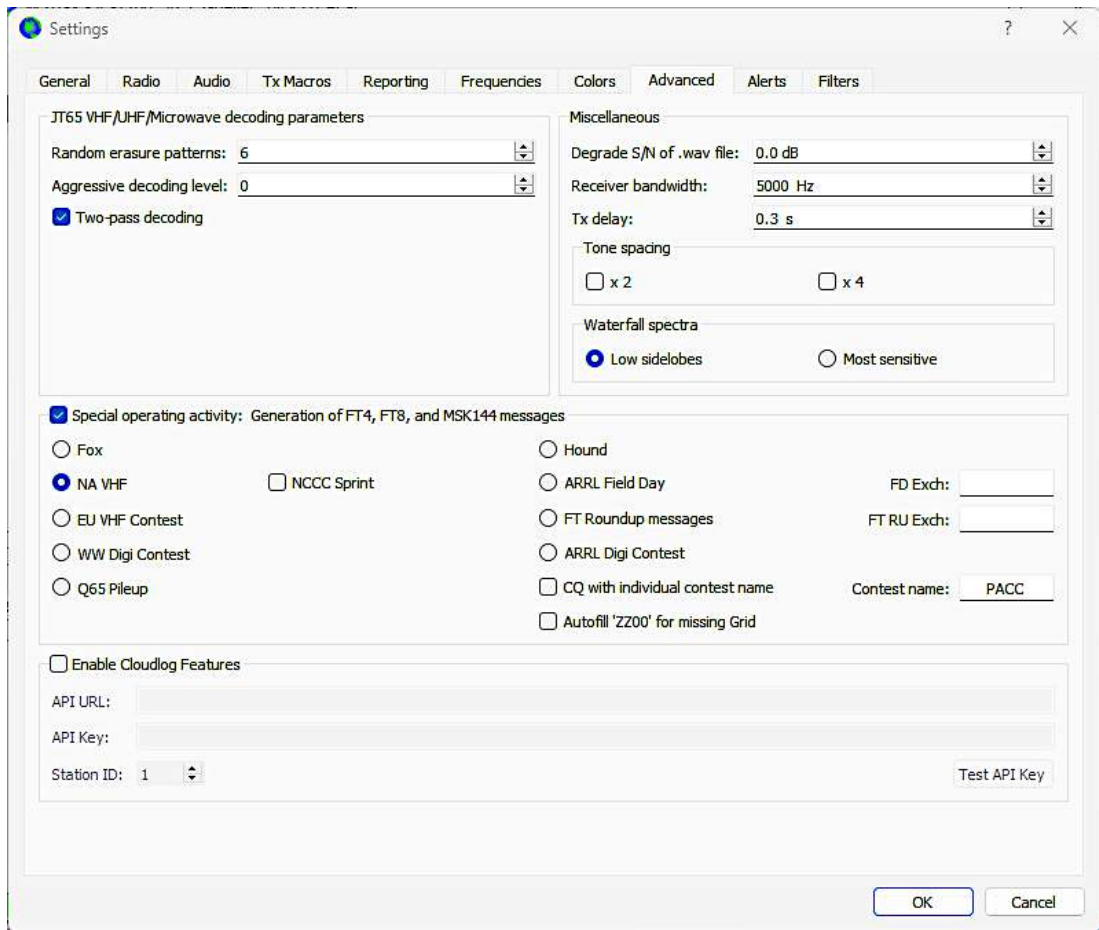


Figure 40 - WSJT-X Improved Settings Advanced Tab

Here's the Advanced Tab. There is not much to select here other than the Special Operating Activity. I've chosen the NA VHF contest mode. Which I use in contests or when using MSK144 to minimize the number of transmissions required for a valid QSO. There are many other contest settings, as you can see.

WSJT-X Operational Insight

I'm not sure I have a great deal of insight to offer when operating FT8 and FT4 on six meters. As with operation on all bands, it's wise to ensure you're transmitting on an open frequency. When calling someone, ensure your transmit frequency is clear from interference, at least as far as you can make out at your station.

It is generally accepted practice to not transmit on the other station's frequency. If you are transmitting on the other station's frequency when that station responds to someone else, WSJT-X will close your transmission.

You'll find that one of the frustrations is someone transmitting over the top of that rare DX station you're trying to work. Often, that's simply because they can't hear the DX station. You may also find that when you pause your call to the DX station, someone else has started transmitting on the same sequence and frequency you're using. That's the time to change frequency.

Most of the activity is on FT8 and 50.313 MHz. There is also, from time to time, FT4 activity on 50.318 MHz. FT4 uses 7.5-second sequences. This allows for making more QSOs in a shorter time. That can be helpful during contests. Unfortunately, only a few people are taking advantage of this capability.

Recently, I managed to work E51WL on FT4, and a year or so before that, VP8LP. Both stations announced on FT8 that they were moving. That's when it's wise to get there fast to work them before everyone else shows up.

One final bit of operating insight is that I prefer to set the Wide Graph display for N Avg 1. That spreads out the decoded signals as shown nearby. I like to see as much of the received signal as possible, hoping it will decode if I keep an eye on it!

WSJT-X Operations: FT8 - FT4

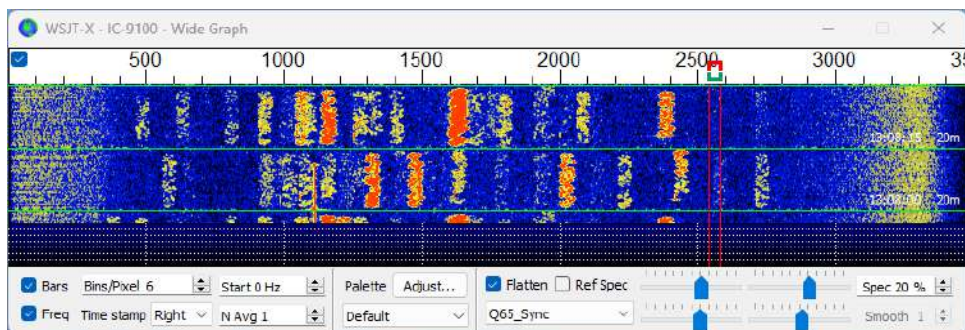


Figure 41 - Wide Graph Display with N Avg 1

I adopted this operating preference when initially working JT65 on six meters. I wanted to see every pulse received over the 60-second transmission. I just carried that over to the FT8 15-second and F4 7.5-second transmissions.

WSJT-X Variations

Currently, there is a standard version of WSJT-X, and a beta version is often posted for testing. Then, there is the WSJT-X Improved version that I mentioned above.

There are also two significantly different versions: MSHV and JTDX. You can find MSHV at <http://lz2hv.org/mshv> It offers a substantially different interface and more modes, such as FSK441, which has been discontinued in WSJT-X. It's something worth investigating.

JTDX can be found at <https://sourceforge.net/projects/jtdx/> It offers a different user interface and some operating conveniences. It also purports to provide decodes of weaker signals than the regular version of WSJT-X. I've generally found that to be true. But it does not offer contest modes or MSK144 or Q65.

Chapter 8 — WSJT-X Operations: MSK144

This chapter covers meteor scatter propagation, WSJT-X MSK144 operation, meteor scatter operating protocols, and required gear.

You can find a video about meteor scatter and how to work MSK144 on my blog at <https://k5nd.net/2022/08/harnessing-meteors-for-vhf-qsos/>

How Meteor Scatter Works

There are literally tons of meteors entering the Earth's atmosphere every single day. Meteors are dust trails left by comets. They are tiny, no bigger than a grain of sand. On entry, those grains of sand burn up and, as a result, ionize the E-Layer.

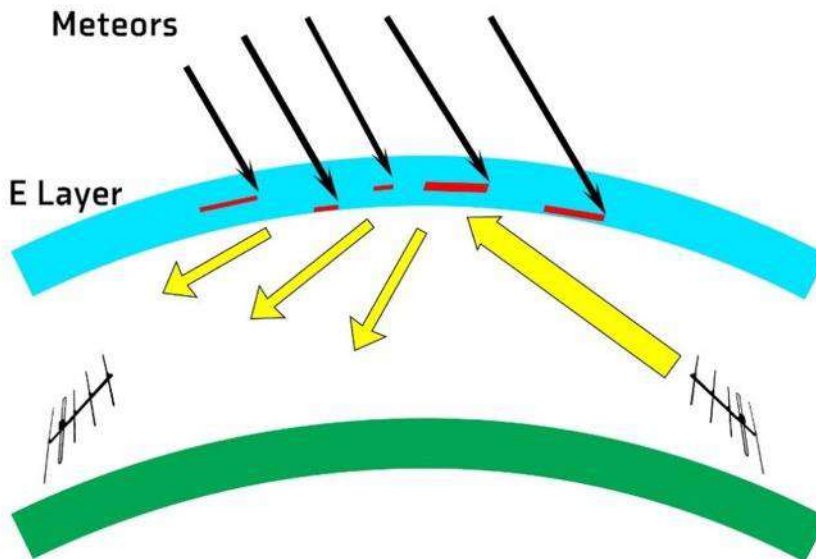


Figure 42 - Model of the Ionosphere for Meteor Scatter

You can catch a glimpse of what's happening in the image above. The red lines represent the ionization with some meteors more effective than others. The yellow

lines represent the transmitted signal, with some reflecting off the ionized meteor trails. Hopefully, it reflects sufficient RF toward the desired receive location.

So that you know, the best time for meteor scatter propagation is in the early morning. There is roughly 3x more propagation at 6 AM than at 6 PM local time. You can see the reason for this in the image below. This is because the Earth's orbit around the sun moves it into the stream of meteors, with the rotation of the Earth adding to that velocity near dawn versus subtracting from that velocity later in the day.

View From above the North Pole

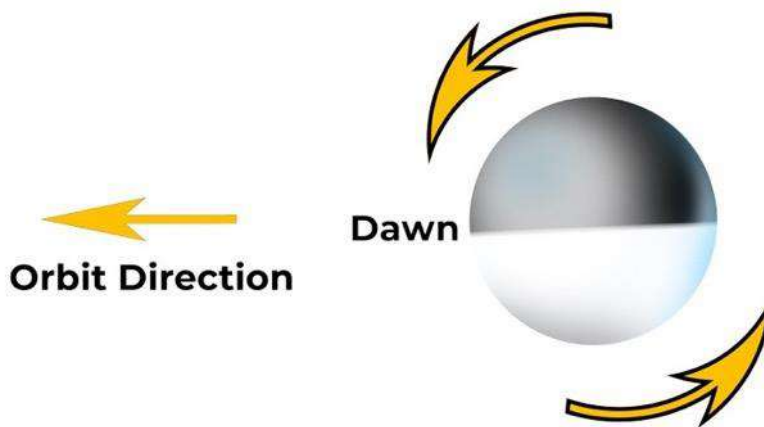


Figure 43 - Why the Morning is Best for Meteor Scatter

That's what's happening every day. But there's a bonus during meteor showers. These are the predictable comet trails that have a high concentration of meteors. They happen every year at a set time. You can see the list of major showers in the list below.

WSJT-X Operations: MSK144

Major Showers	Date Range	Peak Date	Time Max
Quadrantids	January 1-6	January 3-4	14 hours
Eta Aquarids	April 21 to May 12	May 4-5	3 days
Arietids	May 29 to June 19	June 7	
Perseids	July 23 to August 20	August 12	4 to 6 days
Orionids	October 2 to November 7	October 20	2 days
Geminids	December 4 to 16	December 13	2.6 days

Figure 44 - Major Meteor Showers

MSK144 Making Meteor Scatter QSOs

So that's the nature of meteors with insight into the best times and days to make contacts. But what does an MSK144 contact look like?

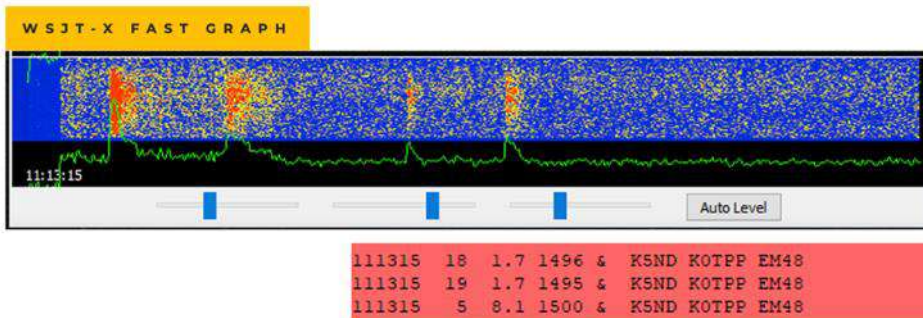


Figure 45 - WSJT-X Fast Graph Display and Decodes

This image shows the WSJT-X Fast Graph display when the mode is set to MSK144. You can see meteor "pings" at 1.7, 3.5, 6.1, and 8.1. The brighter the ping shows up, the stronger the signal. For example, the ones above are +18 and +19 dB at 1.7 seconds and +5 dB at 8.1 seconds. These are the only pings that are decoded, which are displayed in the red box.

WSJT-X Operations: MSK144

You can find the audio file and a video at <https://k5nd.net/2022/08/harnessing-meteors-for-vhf-qsos/>

You can hear each of the pings and readily gauge the differences in amplitude and duration. Note, too, that MSK144 pings are decoded in real time. It's unlike FT8, where you wait for the entire 15-second transmission before seeing the decode.

So, how do you set up WSJT-X for MSK144 contacts?

Getting on the Air with MSK144

Here are the settings within WSJT-X. By and large, you'll use the same setting that you would normally use for FT8, rig control, audio, etc. MSK144 QSOs typically use NA Contest Mode to minimize the number of sequences required for a complete QSO.



Mode Menu — Select MSK144

Figure 46 - Select MSK144 Mode

WSJT-X Operations: MSK144

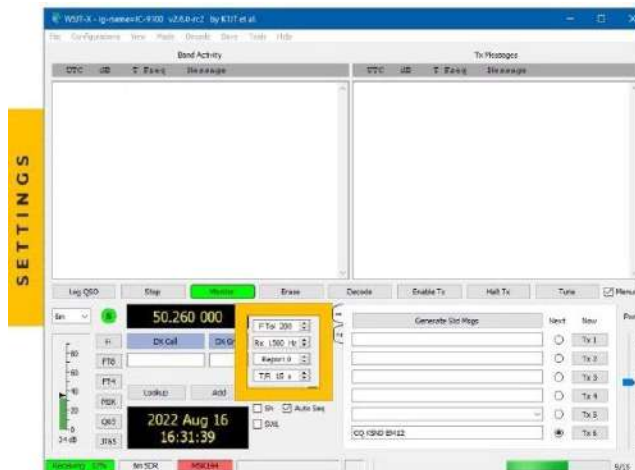


Mode Menu — Select MSK144

Decode Menu — Fast, Normal, Deep

Figure 47 - Select Fast, Normal, or Deep depending on the CPU capability

From the above, you can see the settings for mode, MSK144, and the Decode menu settings. The decode is a pull-down menu for selecting Fast, Normal, or Deep. K1JT suggests selecting the option that works best for your computer; see the % of CPU time at the bottom of the screen and choose the option that doesn't overwhelm the CPU.



Mode Menu — Select MSK144

Decode Menu — Fast, Normal, Deep

F Tol — 200 Hz

Rx — 1500 Hz

T/R — 15 seconds

Figure 48 - Ftol = 200 Hz, Rx = 1500 Hz, T/R = 15 seconds

The other settings are F Tol to 200 Hz, Rx to 1500 Hz, and T/R to 15 seconds. I also strongly suggest using RRR in your sequence rather than RR73. With WSJT, after you've

WSJT-X Operations: MSK144

sent RR73, it logs the QSO. But with meteor scatter, it's unlikely that one transmission of RR73 will get through. So, you can use RRR as often as needed to get the other station's confirmation that the QSO is over.

Sample 6 Meter MSK144 QSO

Here's the screen display for an actual 6-meter MSK144 QSO.

Band Activity					Tx Messages				
UTC	dB	T	Freq	Message	UTC	dB	T	Freq	Message
125530	-2	11.8	1466	WSAJ KASYEU +03	125530	-2	11.8	1466	WSAJ KASYEU +03
130300	9	14.3	1461	K5ND KASYEU +02	125915	Tx	1500		KASYEU K5ND EM12
130500	2	1.9	1465	K5ND KASYEU +02	125845	Tx	1500		KASYEU K5ND EM12
130500	7	3.4	1464	K5ND KASYEU +02	125915	Tx	1500		KASYEU K5ND EM12
131300	-7	9.0	1468	K5ND KASYEU RR73	125945	Tx	1500		KASYEU K5ND EM12
131300	-3	9.1	1468	K5ND KASYEU RR73	130015	Tx	1500		KASYEU K5ND EM12
131300	-1	9.8	1469	K5ND KASYEU RR73	130045	Tx	1500		KASYEU K5ND EM12
131830	6	4.0	1469	CQ KASYEU EL07 U.S.A.	130115	Tx	1500		KASYEU K5ND EM12
132130	17	13.9	1490	W5LDA N5DUW EM11	130145	Tx	1500		KASYEU K5ND EM12
132130	20	14.2	1489	W5LDA N5DUW EM11	130215	Tx	1500		KASYEU K5ND EM12
132145	20	0.4	1489	W5LDA N5DUW EM11	130245	Tx	1500		KASYEU K5ND EM12
					130300	9	14.3	1461	K5ND KASYEU +02
					130315	Tx	1500		KASYEU K5ND R+09
					130345	Tx	1500		KASYEU K5ND R+09
					130415	Tx	1500		KASYEU K5ND R+09
					130445	Tx	1500		KASYEU K5ND R+09
					130500	2	1.9	1465	K5ND KASYEU +02
					130500	7	3.4	1464	K5ND KASYEU +02
					130515	Tx	1500		KASYEU K5ND R+09
					130545	Tx	1500		KASYEU K5ND R+09
					130615	Tx	1500		KASYEU K5ND R+09
					130645	Tx	1500		KASYEU K5ND R+09
					130715	Tx	1500		KASYEU K5ND R+09
					130745	Tx	1500		KASYEU K5ND R+09
					130815	Tx	1500		KASYEU K5ND R+09
					130845	Tx	1500		KASYEU K5ND R+09
					130915	Tx	1500		KASYEU K5ND R+09
					130945	Tx	1500		KASYEU K5ND R+09
					131015	Tx	1500		KASYEU K5ND R+09
					131045	Tx	1500		KASYEU K5ND R+09
					131115	Tx	1500		KASYEU K5ND R+09
					131145	Tx	1500		KASYEU K5ND R+09
					131215	Tx	1500		KASYEU K5ND R+09
					131245	Tx	1500		KASYEU K5ND R+09
					131300	-7	9.0	1468	K5ND KASYEU RR73
					131300	-3	9.1	1468	K5ND KASYEU RR73
					131300	-1	9.8	1469	K5ND KASYEU RR73
					131315	Tx	1500		KASYEU K5ND 73
					131351	Tx	1500		KASYEU K5ND 73
					131415	Tx	1500		KASYEU K5ND 73

Figure 49 - MS QSOs Take Time, Be Patient

WSJT-X Operations: MSK144

I provide this for insight into the fact that meteor pings can be fickle when transmitting your signal. This QSO took 16 minutes, with lots of silence along the way. It takes patience and, ideally, coordination between stations to help you both continue when it seems all is lost. So that you know, this QSO goes against my recommendation to use contest mode and RRR.

Sample MSK144 QSY QSO

Another type of MSK144 operation that's available is a QSY QSO. With this approach, the station calls CQ on the calling frequency and listens on a QSY frequency. When they hear another station, the QSO is completed on the QSY frequency. This is typically only used during contests or other very active times. Here's an example.

The screenshot displays the WSJT-X interface with two main windows: "Band Activity" and "Tx Messages".

Band Activity Window:

dB	I Freq	Message
-1	8.9 1523	WSSUM NOLL/P KKK
0	12.3 1521	WSSUM NOLL/P RRR
0	12.3 1520	WSSUM NOLL/P RRR
2	0.8 1525	WSSUM NOLL/P RRR
4	0.9 1523	WSSUM NOLL/P RRR
5	8.5 1524	WSSUM NOLL/P RRR
6	8.5 1524	WSSUM NOLL/P RRR
6	9.3 1486	CQ 250 WSSUM EM07 U.S.A.
4	12.0 1524	WSSUM NOLL/P RRR
4	0.7 1525	KSND NOLL/P +00
-4	5.5 1525	KSND NOLL/P RRR
2	14.2 1515	KSND NOLL/P RRR
0	2.5 1493	CQ 250 KG5CCI EM07 U.S.A.
14	1.3 1488	NOLL/P WASTKU R+06
14	0.5 1487	NOLL/P WASTKU R+06
13	1.4 1487	NOLL/P WASTKU 73
13	0.4 1489	NOLL/P WASTKU 73
12	1.2 1487	NOLL/P WASTKU 73

Tx Messages Window:

UTC	dB	I Freq	Message
103300	-2	8.2 1521	WSSUM NOLL/P RRR
103315	Tx	1500	NOLL/P KSND EM12
103345	Tx	1500	NOLL/P KSND EM12
103400	4	0.7 1525	KSND NOLL/P +00
103415	Tx	1500	NOLL/P KSND R EM12
103430	-4	5.5 1525	KSND NOLL/P RRR
103430	2	14.2 1515	KSND NOLL/P RRR
103445	Tx	1500	NOLL/P KSND 73
103515	Tx	1500	NOLL/P KSND 73
103835			QSY 50.250
103500	0	2.5 1493	CQ 250 KG5CCI EM07 U.S.A.
103900	1	8.5 1494	WSSN KG5CCI 73
103916	Tx	1500	KG5CCI KSND EM12
103945	Tx	1500	KG5CCI KSND EM12
104000	2	10.2 1475	KSND KG5CCI -03
104015	Tx	1500	KG5CCI KSND R EM12
104030	0	6.4 1492	KSND KG5CCI -03
104030	1	6.4 1493	KSND KG5CCI -03

Control Panel:

- Stop, Monitor, Erase, Decode, Enable Tx, Halt Tx, Tune, Men
- Frequency: 50.250 000
- Buttons: H (DX Call), FT8, FT4, MSK, Q65, JT65
- Buttons: Lookup, Add, Tx CQ 260
- Buttons: Tx even/1st, F Tol 200, Rx 1500 Hz, Report 1, T/R 15 s, Sh, Auto Seq, NA VHF, SWL
- Buttons: Generate Std Msgs, Next, Now, Tx 1-6

Status Bar: 6m SDR, MSK144, Last Tx: KG5CCI KSND 73, 7/15

Figure 50 - MSK144 QSY CQ and QSO

You can see that KG5CCI was calling CQ 250. When I clicked on his CQ, my transmission moved to 50.250 MHz. That was indicated by the QSY message, followed by the rest of the QSO. The lower arrow above shows the checkbox for setting up a QSY CQ. You enter the QSY frequency in the box near the checkbox.

Meteor Scatter Operating Protocol

So, there you have the various ways of setting up WSJT-X for meteor scatter. But there's more! Yes, there's an operating protocol that began long before WSJT arrived on the scene and has since been expanded.

- **Operating Frequencies:** 50.260 and 50.265 as well as 144.150 MHz.
- **Operating Times:** Early Mornings are the Best.
- **Transmission Sequence:** Pointing East, Transmit First Sequence. Pointing West, Transmit Second Sequence.
- **Contest Mode:** Often used on 6 meters, CM+SH is used on 2 meters.
- **Coordinate Contacts:** [Ping Jockey](#), VHF-Chat-Slack, [ON4KST](#). Random contacts are rare.

Useful Meteor Scatter Tools

When you're transmitting CQs and not hearing anything at all, [PSK Reporter](#) can be very helpful. You enter your call sign, select the band, and it will display the stations receiving your signal. You can also find useful information about your signal level and frequency. It is not restricted to MSK144, as all digital signals can be decoded and displayed. Try it out if you haven't already used it.

Another helpful meteor scatter tool is the [Virgo app](#). You can see the display below. This example shows the meteor showers in view and suggests the best direction to point your antenna — roughly perpendicular to the meteor shower path. Note that you must enter your grid square to get the correct data and that I've selected the sky display of W to E to get it more of a ground map display rather than its automatic sky

map display. Plus, I've chosen the antenna azimuth indicator rather than the meteor trails. There are lots of options to try.

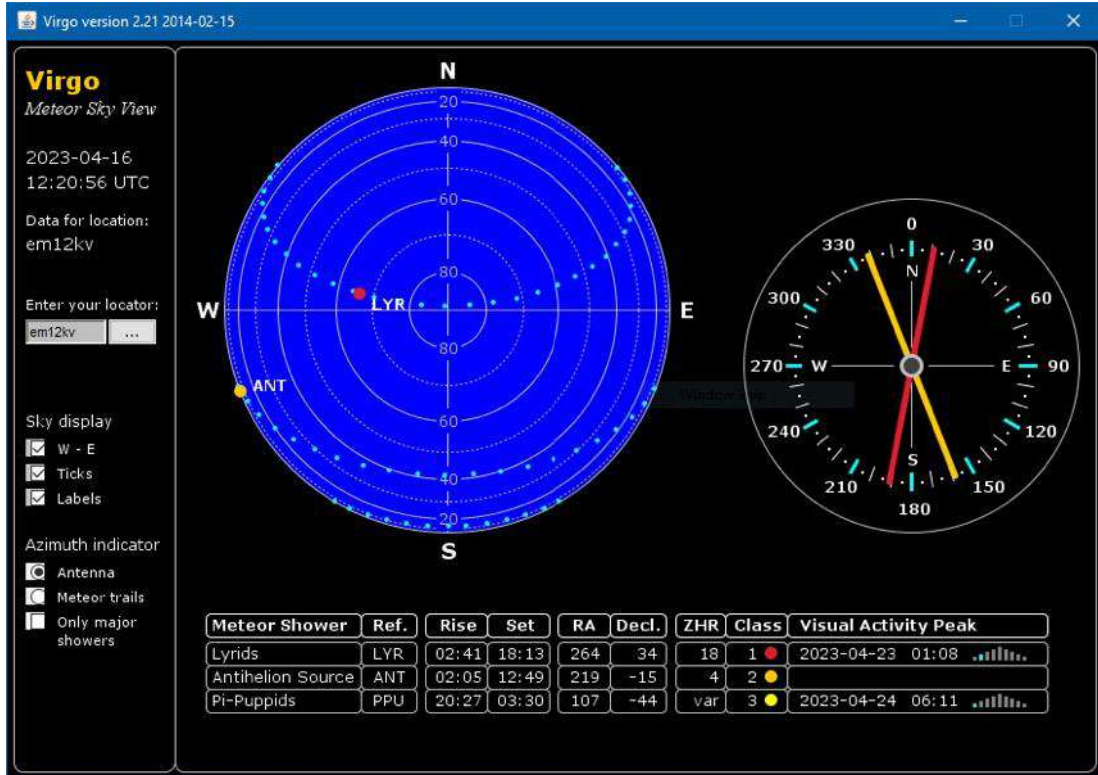


Figure 51 - Virgo Display of Meteor Showers

Meteor Scatter Gear

You've probably gleaned that a dipole and 5-watt rig won't work with this mode. Instead, you'll need a directional antenna and at least 100 watts on 6 meters, more on 2 meters. High power can be beneficial, and a preamp is typically required on 2 meters.

Interestingly enough, you can have too much antenna directivity for meteor scatter. K1JT recommends 16-degree beamwidth for long paths and 32 degrees for shorter paths. There are also offset azimuth settings to catch the meteor path just right. For

WSJT-X Operations: MSK144

example, the WSJT window below shows the direct "Az" of 24 degrees versus the "B" offset heading of 13 degrees when pointing from my grid of EM12 to the station's grid of EN42. It also shows a recommended elevation. There can also be an "A" offset heading at times.



Figure 52 - Recommended Elevation and Azimuth

Get on the Air

That's a lot to digest. Hopefully, it's enough information to point you and your antenna in the right direction to make some meteor scatter contacts. Then, watch for the showers and give it a go when the conditions are optimum. The folks on Ping Jockey and other chat rooms can also prove very helpful.

Good luck, and I hope to work you on MSK144.

Meteor Scatter References:

WSJT-X Operating Manual https://physics.princeton.edu/pulsar/k1jt/wsjt-x-doc/wsjt-x-main-2.5.4.html#_msk144

WSJT References Page – MSK144 Protocol, QEX July/August 2017
<https://physics.princeton.edu/pulsar/k1jt/refs.html>

VHF Meteor Scatter—An Astronomical Perspective
By Michael Owen, W9IP/2, QST June 1986

Chapter 9 — WSJT-X Operations: Q65

I've been amazed by the relatively new Q65 mode within the WSJT-X software suite. It works over long distances when nothing else is happening. It's said to operate via ionospheric scatter for terrestrial contacts and is becoming the go-to mode for moon bounce. This chapter provides a brief introduction along with current operating recommendations. The goal is to help you make QSOs when nothing else is working.

What is Q65?

Q65 uses a 65-tone frequency-shift keying modulation mode. It has a sync tone for both time and frequency synchronization. Q65 is particularly effective for tropospheric scatter, rain scatter, ionospheric scatter, TEP, and EME on VHF and higher bands, as well as other fast-fading signals.

Joe Taylor, K1JT, states: *"Q65 will enable stations with a modest Yagi and 100 W or more to work one another on 6 meters at distances up to ~2000 km on most days of the year, in dead band conditions. Ionospheric scatter is best near mid-day and in summer months but is present at all times."*

That's how it has worked for me. Moving to Q65 has made it happen from home or as a rover when nothing else is working. It, of course, helps to coordinate between the two stations, just as is done with meteor scatter contacts.

How Does Q65 Work?

With Q65, there are selectable transmit/receive sequences and sub-modes. For 6 meters, the general standard is 30-A, or 30-second t/r sequence and sub-mode A. For 2 meters, it's 60-C, or 60-second t/r sequence and sub-mode C. The [K1JT Quick Start Guide to Q65](#) recommends the following t/r sequences and sub-modes.

- Trans-Equatorial Propagation (TEP) on 50 MHz: **15C, 30C**
- Ionospheric scatter on 50 MHz: **30A**
- QRP ionospheric scatter on 50 MHz: **120E**
- Ionospheric scatter on 144 MHz: **60C**
- Troposcatter and rain scatter at 10 GHz: **60D**
- Small-dish EME, 10 and 24 GHz: **120E**
- Other EME: 50, 144 MHz **60A**; 432 MHz **60B**; 1296 MHz: **60C**; 10 GHz: **60D**

The sub-modes provide different tone spacings. The available t/r sequences are 15, 30, 60, 120, and 300 seconds. Here's how those t/r sequences come into play with signal-to-noise ratios.

- 15 seconds, -22.2 dB SNR, with *a priori* (AP) decoding -23.7 dB SNR.
- 30 seconds, -24.8 dB SNR, with AP decoding -26.6 dB.
- 60 seconds, -27.6 dB SNR, with AP decoding -30.2 dB.
- 120 seconds, -30.8 dB SNR, with AP decoding -32.5 dB.
- 300 seconds, -33.8 dB SNR, with AP decoding -37.4 dB.

A priori or AP decodes messages using heuristics and available information, adding several dB to the SNR.

WSJT-X Operations: Q65

A big part of the magic of Q65 is that it averages the signals received. It keeps track of the sequences received and pieces the information together to achieve a decode. You can see this as the QSO develops. Decodes are tagged with “q” followed by one or two numbers. The first number shows the type of AP information used. The second number indicates the total number of received sequences averaged to produce the decode. Here are some examples.

- **Q0** — This is a decode obtained without using any AP information.
- **Q1** — This usually means that AP has decoded the message as a CQ call, with the DX Call and Grid unknown to AP.
- **Q2** — This usually means that AP has used your call as AP knowledge but has assumed nothing about the DX Call or Grid.
- **Q3** — This usually means that AP has used AP knowledge of your Call and the DX Call in the decode. It then looks for a grid, a report, 73, etc.
- **Q32** — This means that a Q3 decode has been obtained after averaging 2 transmissions.

Q65 Operation and WSJT-X Settings

Here are the settings I’ve lifted from various websites and found helpful in my Q65 operations on 6 and 2 meters. The complete list of references is at the end of this article.

The standard operating frequencies that I’ve used are 50.275 MHz with Q65-30-A and 144.170 MHz with Q65-60C.

WSJT-X Operations: Q65

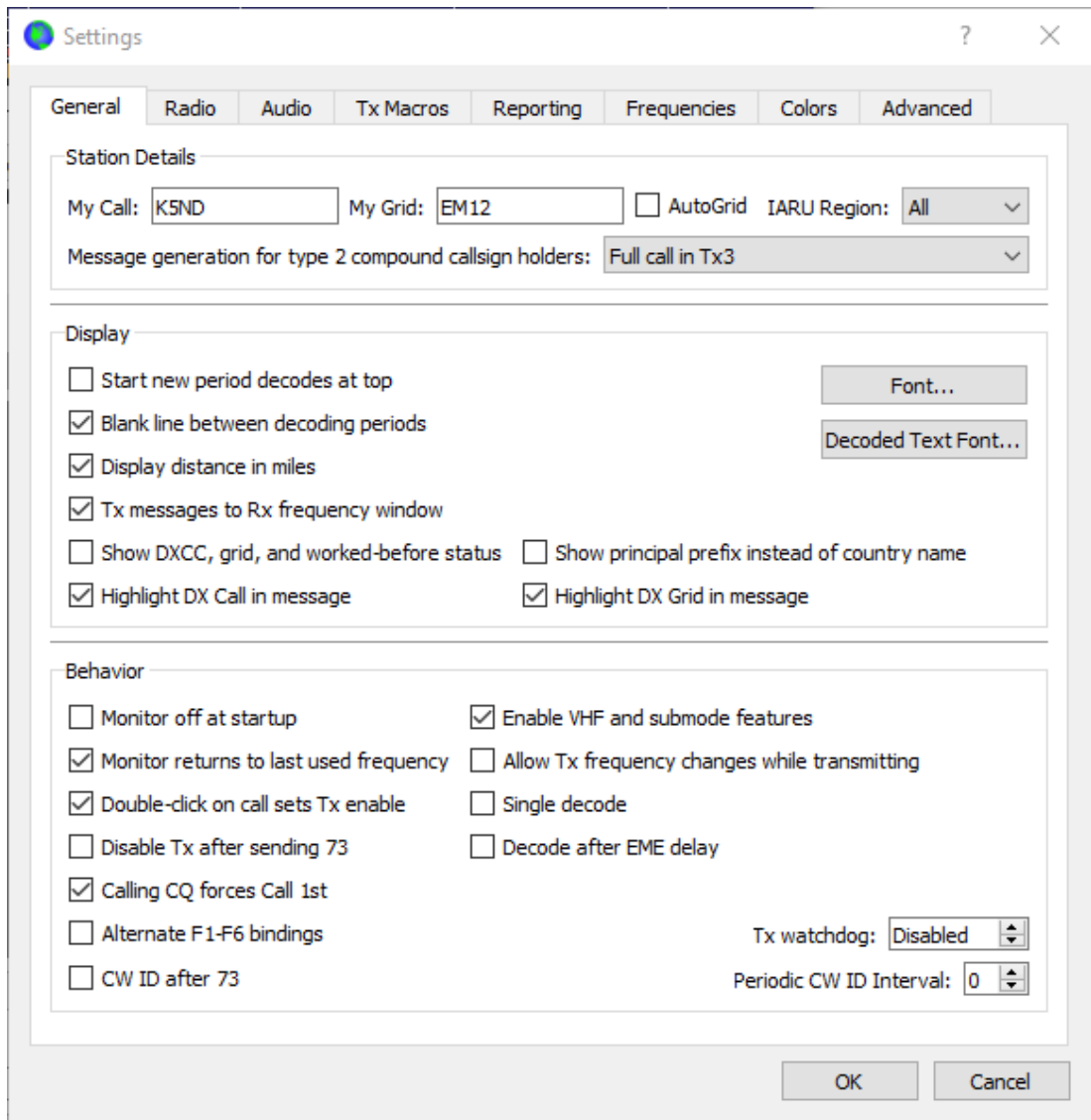


Figure 53 - WSJT-X Q65 General Settings

On the File/Settings screen shown above, remember to choose Enable VHF and submode features. Do NOT check Disable Tx after sending 73 since you may have to send it multiple times. It also is recommended that you do NOT check the Single Decode, although I've used it both ways for a successful Q65 contact.

WSJT-X Operations: Q65

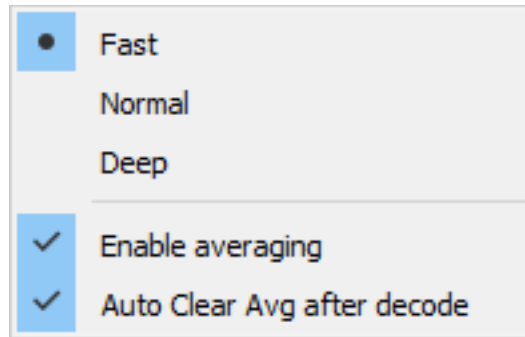


Figure 54 - Q65 Decode Settings

Under the Decode menu, select Fast, Enable Averaging, and Autoclear AVG after decoding.

Selecting "Q65_Sync" on the Wide Graph will display an orange line with peaks that suggest potentially decodable Q65 signals in the most recently received sequence. When the accumulated average includes two or more reception intervals in the appropriate odd or even sequence, a red curve similarly shows potentially decodable signals.

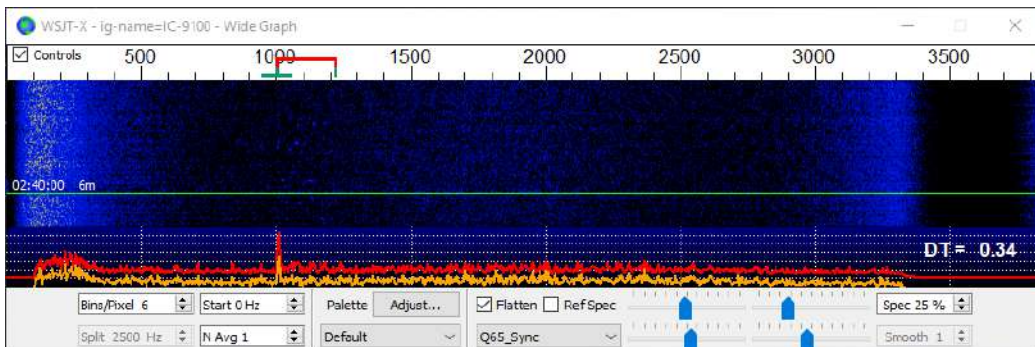


Figure 55 - Select Q65 Sync on the Fast Graph

Set F Tol to 20 Hz for the best decodes on a known audio frequency within the wide graph. In this image, the audio frequency is set to 1500 Hz. If you don't know the frequency, you can set the F Tol wider to capture whatever's there and decode it.

WSJT-X Operations: Q65

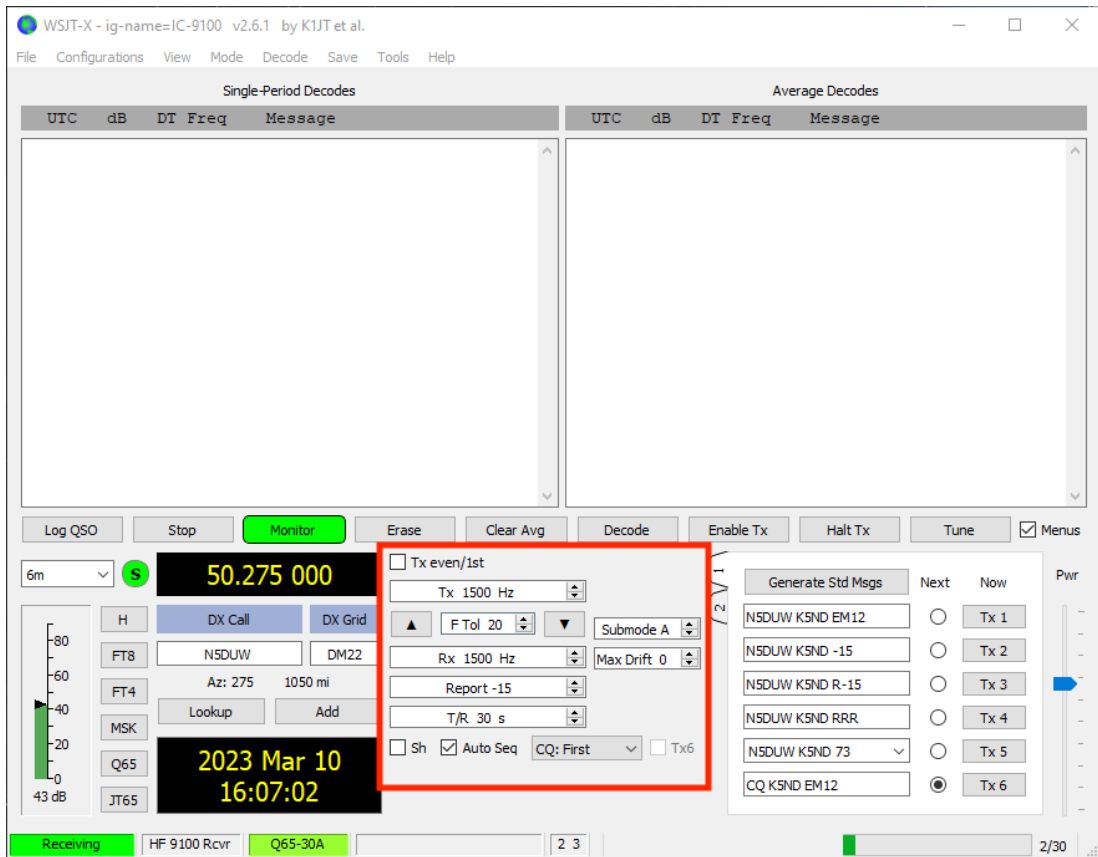


Figure 56 - Tolerance Settings

If you're working a schedule or coordinated QSO, not only will you enter the expected audio offset frequency, but you'll also enter the DX call sign and grid before the start of the QSO. This helps the AP with its decoding tasks. It knows exactly what it's seeking in the received signal and noise.

Select the T/R sequence. Here, it is shown as 30 seconds. Select the sub-mode. Here, it is shown as A. Leave the Max Drift at the default value of 0.

SH is not usually checked. This allows for sending single tones during a coordinated QSO. It's mainly used at microwave frequencies.

WSJT-X Operations: Q65

Press the Generate Std Msgs bar to fill in the messages to be transmitted. Check the Auto Sequence box. In a typical operation, you want to start with Tx1. However, with NA VHF contest mode, Tx1 starts calling with Tx2.

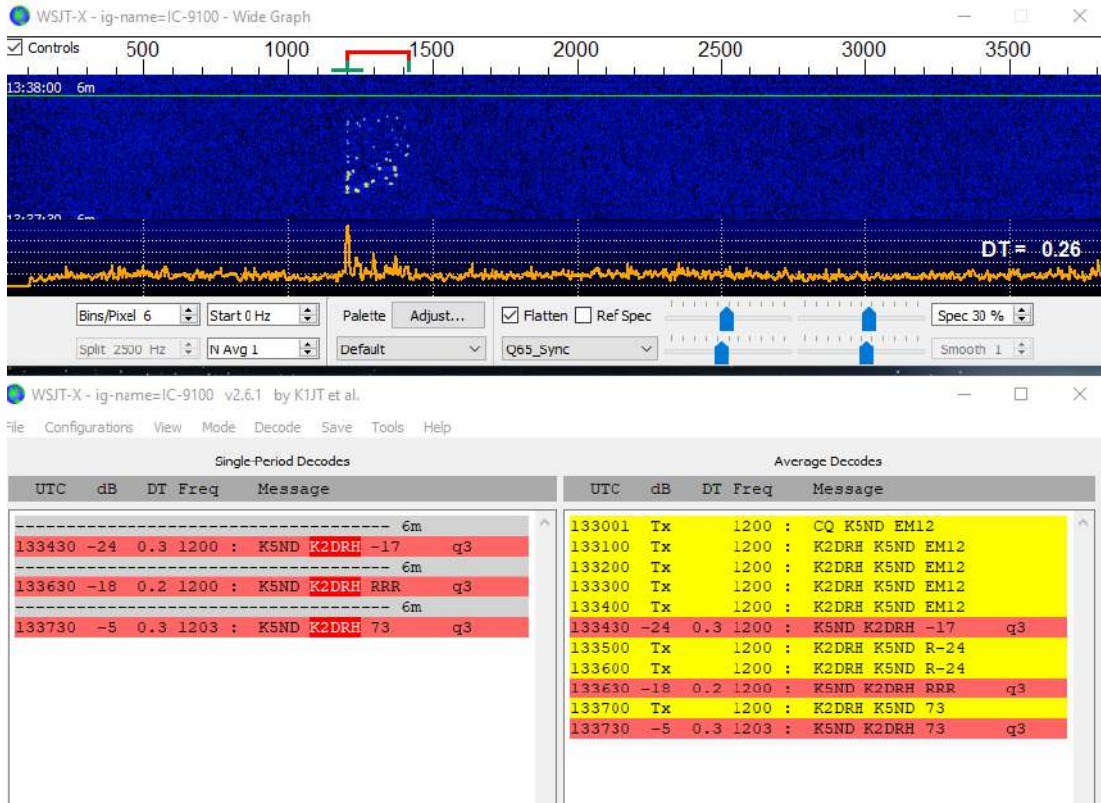


Figure 57 - Q65 QSO with Wide Graph Display

The setting here is 20 Hz F Tol, as shown with the green bar at the top of the wide graph. TX frequency is 1200 Hz. RX frequency is 1200 Hz. You can also see the orange curve showing the Q65 sync signal. Note, too, the sprinkles in the wide graph. Each decode shows q3, indicating that the AP used both the DX Call and Your Call as entered and then looked for the signal report and messages.

WSJT-X Operations: Q65

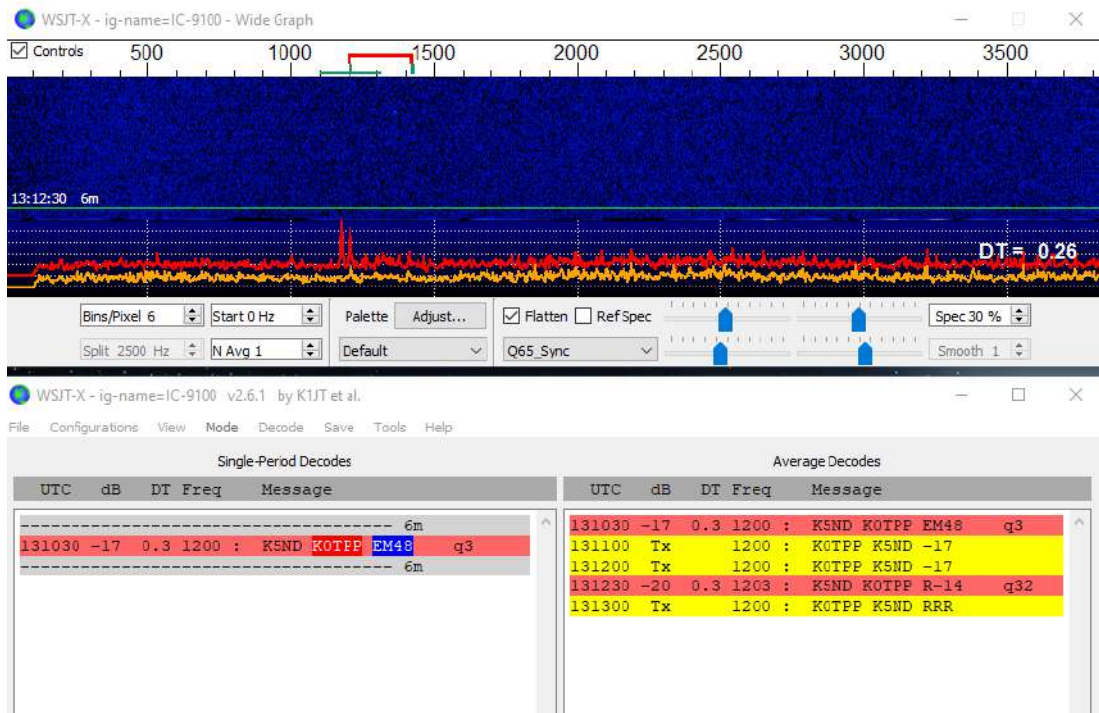


Figure 58 - Q65 QSO with q32 decode

This screenshot shows an initial q3 decode and then a q32 decode. That last one required two averages to display the decode. I'm advised that the red line in the wide graph display represents the accumulated decodes over time and that the orange line represents the current decode. Let me know if I've got that wrong.

Q65 Averaging versus Period Length

As with most things, there are tradeoffs in the Q65 settings. Moving to longer t/r sequences will increase the sensitivity, as shown in the bullet list above. That should mean that fewer decodes are required before averaging is needed to help with the full decode. But shorter t/r sequences and more averages may help the QSO complete faster—something to consider when working with someone over very tough conditions.

WSJT-X Operations: Q65

I sincerely hope this has helped get you started with Q65. As usual, your mileage may vary. Consult the references for further background and details. Good luck and have fun.

Q65 References:

https://wsjt.sourceforge.io/Q65_Quick_Start.pdf

<http://www.bigskyspaces.com/w7gj/Q65SETUP.pdf>

http://www.bobatkins.com/radio/Q65-avege%20_or_longer_period.html

http://www.bobatkins.com/radio/Q65_1296_setup.html

Chapter 10 — Six Meter Award Chasing

I'm a paper chaser. I enjoy pursuing awards from HF to VHF. Many HF awards apply to 6 meters, and one particular one only applies to 6 meters.

VUCC

This is the VHF/UHF Century Club (VUCC) award. It requires working and confirming QSOs with stations in 100 grids. There are no mode endorsements (CW, Phone, etc.), but you can continue to add grids in increments of 25 to earn additional stickers to add to your certificate.

VUCC is on a band-by-band basis. So there is an award for six meters, separate awards for higher VHF-UHF and microwave bands, and satellite QSOs.

In addition, ARRL publishes lists of stations with the number of official grids confirmed. As of this writing, the leader is K1TOL, with an astounding 1700 grids!

WAS

The Worked All States (WAS) award is offered on a band basis for all amateur radio bands, including six meters. The challenge in earning this award on six meters is working Hawaii and Alaska and a few small states with few operators on the air.

DXCC

The DX Century Club (DXCC) award is granted for confirming contact with 100 DX entities. It is awarded by band and mode. So, a six-meter award is available. This, too, is a tough award to earn, particularly if you're in the center of the USA and have a hard time reaching Europe and Asia on six meters.

CS-VHF States Above 50 MHz

The Central States VHF Society offers a States Above 50 MHz Award for those stations working 30 or more states on bands above 50 MHz each year. The year begins on June 1. This is a fun award to get you working stations every single year.

UK 6 Metre Group

This group offers several awards for six-meter operations focused on working continents, countries, and grids. This is an excellent place to look if you're into certificates. The organization is also beneficial in keeping you up to date on what's happening on six meters around the world.

The Fred Fish Memorial Award (FFMA)

One of our stalwart 6-meter DXers, Rovers, and *The FFMA Information Wizard*, Francis, KV5W, prompted my writing by posting an absolute treasure trove of resources to the Front Range 6 Meter Groups.io list. So, with his permission and encouragement, I'm repeating much of that here and a few additional bits of information that may also prove helpful.

What's the FFMA?

The Fred Fish Memorial Award was established by the ARRL in 2008 to honor Fred Fish, W5FF, who worked and confirmed all 488 grid squares in the 48 contiguous United States on 6 meters. Read the QST announcement and ARRL's online FFMA information for more. Here's an important quote from that announcement:

The FFMA is an "all-or-nothing" award. You must submit confirmation of 2-way contact with all 488 grid squares on 50 MHz to qualify. There are no endorsements and no

Six Meter Award Chasing

recognized tiers of progression. Any mode may be used. The rules for the award will strictly follow the rules of the ARRL VUCC program.

It's an extension of the ARRL VUCC award program, but one that is exceedingly tough to earn. How tough is it, you might ask? Ten years after the award was introduced in 2018, only seven earned FFMA. The class of 2019 saw two earn the award. The class of 2020 added four to the list. In 2021, a bumper crop of 12 earned the award. As of 2023, the total is 52 all time.

It's Tough, But We're 6-meter Grid Chasers

OK. So, it might be challenging. But that shouldn't deter general all-around grid chasers, particularly those like me who are addicted to chasing grids. It forms one more goal for adding stickers to your VUCC certificate. Although, it is a very, very challenging goal.

The good news is that several hundred other hams are chasing the award and are all powerfully motivated. That means that they urge or bug, as the case may be, other ham radio operators to get on the air from rare grids. Or, in grids where nearly no one has gone, they encourage rovers to make it happen for the needy.

That's where a great deal of excitement can come into play. Several legendary rovers activate extremely remote locations using four-wheel drive and lightweight equipment or travel thousands of miles, activating multiple rare grids along the way. They usually bring big antennas and significant amounts of power. There are also often photos and videos of the places and the incredible rover operations.

FFMA: Sign Me Up

So how do you get started? First, work all the six-meter grids you can. All of the grids in the U.S.A. count. So start with all those you hear.

Second, start monitoring [DX Maps](#) and other online resources to catch the Sporadic E openings as they occur. If you're alert and available, you can really add to your list of grids when the band opens up.

Third, become familiar with making meteor scatter contacts using WSJT-X MSK144. This mode can be relied upon at any time of the year, particularly during seasonal

Six Meter Award Chasing

meteor showers. It can be very important when trying to work rovers who are within 1,000 to 1,200 miles.

Another mode that is gaining in popularity is WSJT-X Q65. It's achieving excellent results when no other modes are working at all. So get up to speed so that you're ready when that mode is needed.

Finally, start a ham shack continuous improvement program. You can do great things on six meters with a vertical or dipole but probably not achieve FFMA with that setup. So, look at your antenna first. How can that be improved? Then look at your receiver. For example, a number of people are using a separate SDR receiver and software to optimize their station. And finally, consider more power, which should be the last thing to consider on a long list of possible improvements.

FFMA Leaderboard

This has become the go-to resource for tracking your progress toward the FFMA and for determining the most needed grids within the 488. This is extremely valuable for rovers to determine which grids to visit and also who needs those grids.

The most needed list is developed from the information provided by those with 400 or more grids confirmed for the FFMA. They are on the downhill side (or is it uphill?) in chasing the last needed grids. So, rovers naturally want to help them work those last few grids.

Bill, NDOB, started this effort and generally updated it once a year. After he earned FFMA #10, he found Francis, KV5W, to run the system. It's now updated in real-time as soon as anyone updates their grid list. Thank you, Bill, for your pioneering efforts and for finding Francis! Thank you, Francis, for your work enhancing and polishing this fantastically helpful system.

Six Meter Award Chasing

Here are the important links. The first shows the full leaderboard and maps. The second is the request to start your own input to the leaderboard.

- Leader Board / Most Needed Grid Data — current Leader Board / Most Needed Grid Data (Tables and Maps) <https://1drv.ms/x/s!Ah-y5F2cQ5QHry47IJ1v4QS26EyW?e=IKVpU0>
- Request for Personal Data Sheet — Complete the form at the link or send KV5W a message via Slack or Email. https://1drv.ms/x/s!Ah-y5F2cQ5QHqxfEuoeSWTBwFB_Q?e=v783eF

Yet another resource provided by Francis is his presentation to the Front Range 6 Meter Group on August 26, 2021. You can find the video recording on YouTube at FFMA Getting Started by Francis KV5W at <https://youtu.be/CLZswMePQ0w>. You'll also find several more videos of interest to 6-meter ops.

Chapter 11 — Six Meters and VHF Contesting

I really like how Joel Harrison, W5ZN, describes VHF contesting:

Magic Bands with Super Results from Average Stations

VHF contesting is the niche that fits my current operating restrictions and provides a fun, competitive outlet, even for my small station.

Low Number of Entries and Multiple Categories

For example, while the CQ WW SSB Contest has 8,000 to 9,000 entries, the CQ WW VHF Contest has a typical entry list of 800 to 1,000. Plus, a few categories might match your station and operating preferences perfectly. Those include six and 2-meter single-band entries, hilltopper, QRP, and my favorite category – rover. It's held every July.

The ARRL VHF contests are held in January, June, and September. While all offer six meters, the June contest is far and away the best positioned for sporadic E openings. Entry categories include single-operator low and high power, portable for QRP entries, FM only, 3-band only (6 m, 2 m, and 70 cm), multi-operator, and rover. There are also analog-only entry categories for those only interested in SSB and CW operation.

For June 2023, just over 1,600 logs were submitted. I'm confident there's a category where your station can be competitive.

Wide Open Assistance Rules

The ARRL contests have very open assistance rules. That includes sharing information on chat rooms, social media, texting, phone calls, and APRS. You can also self-spot on

Six Meters and VHF Contesting

DX clusters, including DX Maps. You cannot confirm QSOs or request repeats once the QSO is underway.

The watering holes are PingJockey, VHF-Chat Slack, ON4KST Chat, etc.

The CQ VHF contest is more restrictive. There is no self-spotting and no telephone or text.

Adding Grids and Countries to Your Log

Contests are always the perfect way to add DX to your logbook. While VHF isn't the best for increasing your DXCC totals, it is a great way to add grids to your VUCC totals.

In addition to finding new grids for your pursuit of VUCC or FFMA, the fun aspect is that everyone starts with zero grids at the beginning of the contest. Plus, it gives you a great window into how your station is doing compared to others in your area and how you're doing against yourself with improvements year over year.

Average Stations for VHF Contesting

Another thing about VHF contests is that they don't typically require a massive station complete with an antenna farm. Here's some general guidance.

- **50 MHz.** HF-6 meter rig at 100 watts with a 3-element Yagi at 30 feet.
- **144 MHz.** 50 watts or more with a Yagi at 50 feet.
- **222 and 432 MHz.** 50 watts or more with Yagis at 50 feet with more elements.
- **Preamps.** Helpful at 50 and 144 MHz, needed on higher bands.

My setup at home has always been a push-up mast at about 25 feet. I've had reasonable results. So, don't feel that a tower is essential.

Best Contest Operating Practices

There are several best practices. Here's an opening list.

- **Pick the Category that Fits.** If you've got a 2-meter FM HT, pick FM only. You'll not only find less competition, but you might even win your section or division.
- **More Bands and Modes.** The more bands you operate, the more QSOs you'll make. That means more points. The more modes you have, the more stations you'll be able to work.
- **Move Stations to Other Bands.** As you work a station, ask if they have other bands. Then, move there for another QSO and point. This is easy to do on SSB and CW but more challenging on the digital modes.
- **WSJT-X is a Must-Have.** While the analog-only entry categories are helpful, the broader contest community will be using WSJT-X modes from FT8 to MSK144. You'll need to be there to work them.
- **Sunday Morning Tropo and Meteor Scatter.** VHF contests usually start Saturday in the early afternoon and end Sunday evening. That means Sunday morning is the time to work tropo or meteor scatter contacts.
- **Butt-in-Chair.** It's a rule for all contesting that you must be in front of your radio in the chair to work any contacts. The more time you're in the chair, the higher your contest score.

Contesting is a great way to have even more fun on 6 meters and the higher bands. Good luck.

Online Score Reporting

While this may not be a best practice, it is a fun way to spice up the long time you're sitting in front of your rig. Online score reporting allows you to monitor your completion and, as a result, keeps you in your chair searching for more contacts and multipliers.

I like the Contest Online Scoreboard at <https://contestonlinescore.com> but others are available, including one operated by N3FJP via his logging software.

Six Meters and VHF Contesting

Nearby is the online score reporting display of my QSOs and multipliers for the June 2023 VHF Contest.

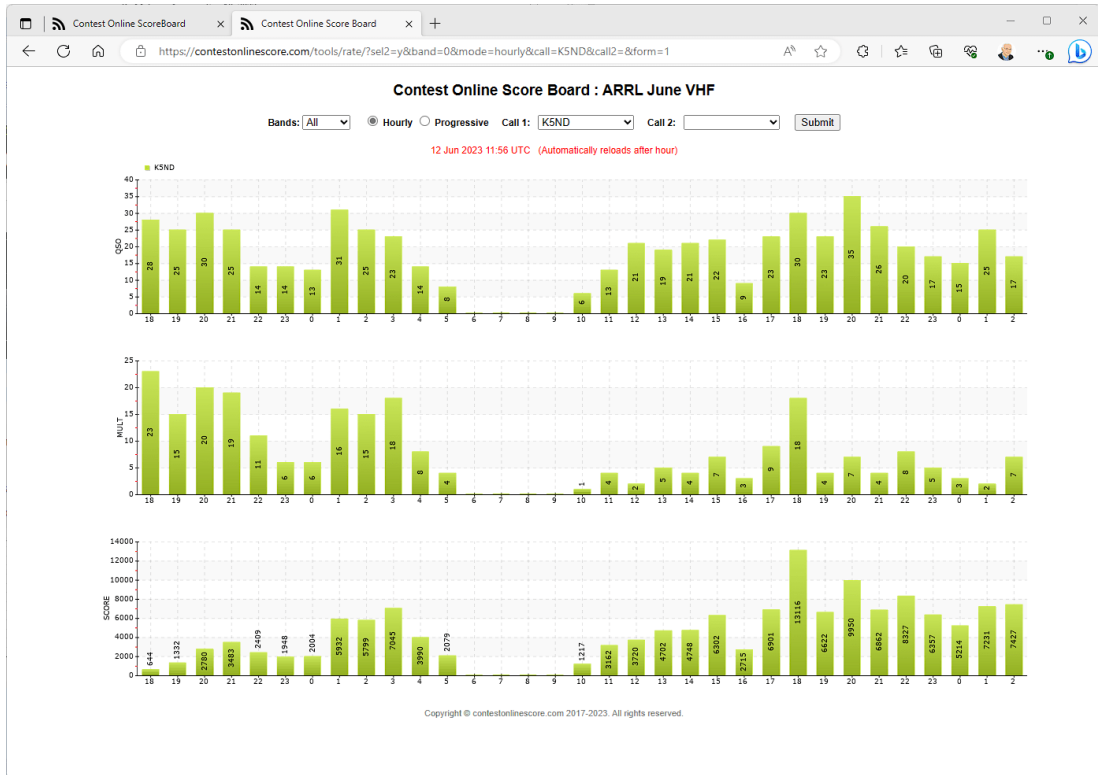


Figure 59 - Contest Online Scoreboard displays my activity level throughout the contest.

The standard display is a leaderboard sorted by contest entry category and ranking within the category. It's updated about every minute. So you can see who's leading and by how much. That has proven very helpful in keeping me in the chair.

Chapter 12 — VHF Rover Operations

My early VHF contesting experience here in North Texas was pretty sparse when it came to finding other stations on the higher VHF bands. When six meters was open, it could be an absolute blast. But the rest of the time, not much.

That meant you'd work a few stations at the beginning of the contest, maybe a few more during the tropo openings on Sunday morning, and pray for E-skip on 6 meters.

Then there were those occasional moments when a rover would come within shouting distance, and you'd pick up a new grid and more QSOs. Greg, K5GJ, was one of the first rovers I worked followed by Andrea, K2EZ, on one of her epic drives across the nation. There were also a few others. This piqued my interest.

A trip to the Central States VHF Society conference in Austin, TX, followed that experience. I, of course, attended the Rover Bowl. They were incredibly impressive but also represented so much work and a great deal of investment.

Greg, K5GJ, defines VHF roving as:

The fine art of stuffing every piece of VHF and microwave gear you own into and onto your vehicle and then driving hundreds or thousands of miles, all the while contacting the same people over and over again.

That sounds pretty daunting. Even so, more and more, the idea occurred that I could set up as a rover and work the dozen or so stations in North Texas that I could hear but also work them again in the next grid. This would help their scores and add to their contest fun and my own.

My Journey with VHF Roving

I started simple because that's my nature — in more ways than one. I grabbed my IC-910H, a painter pole, and Diamond Yagis for 2 m and 70 cm. A laptop for logging completed my station. That was the September 2017 VHF contest. There was not much need at that time on those bands for WSJT. It was all SSB and a bit of CW. I activated eight grids and learned a lot about operating and the stations I could work.



Figure 60 - K5ND/R September 2017, my first rover contest entry

I liked getting outdoors, finding the best locations (which I did before the contest on scouting trips), and working some new stations. I also liked that when I'd worked everyone at one stop, I packed up and moved to the next grid. I didn't need to listen to white noise for any length of time.

VHF Rover Operations

Of course, I needed to pursue making improvements. Here's how my station developed over the years.

- Phase 1 - Painter pole and IC-910H on 2 m and 70 m with simple Yagis.
- Phase 2 - Improved push-up mast, added 6 meters with an IC-9100, stand-up outside operating position, and armstrong rotator.
- Phase 3 - Roof-top rotator. Added 222.
- Potential Phase 4 - Trailer with crank-up tower. Perhaps more bands.

I'm at Phase 3 right now. The roof-top rotator system eliminated set up at each stop, and the operating location, in the back seat of my SUV, kept me out of the weather.

Adding 222 MHz to my rover setup aligns with the contest category I settled on — Limited Rover. This category uses the lower four VHF/UHF bands with low power. That's perfect for my attempt to keep things simple.



Figure 61 - K5ND/R June 2018 Contest

VHF Rover Operations

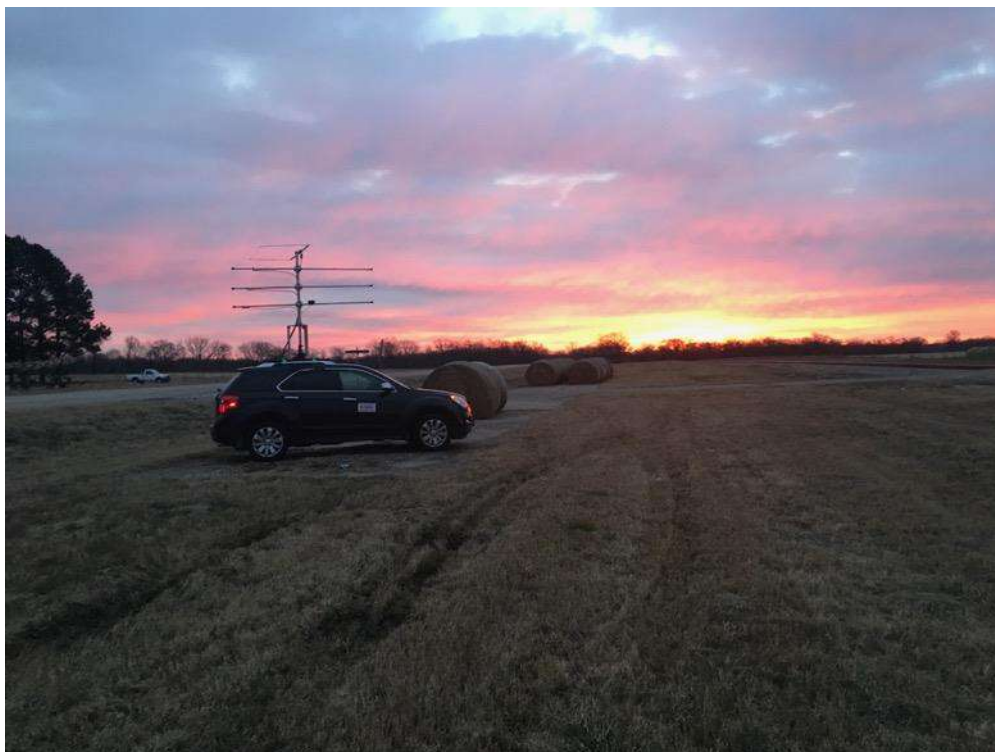


Figure 62 - K5ND/R January 2021 Contest

My Rover Goals

You undoubtedly get the gist of my goals from the journey described above. My most fundamental goal is to keep things simple. However, I sometimes run right past this goal in my enthusiasm for one technical marvel or another. That goal also helps maintain a reasonable budget that allows investment to develop the station over time.

Summed up: develop your station to fit your interests, skills, and budget. All that is measured by how it optimizes your contest results while at the same time determining how the effort is maximizing your fun.

What I like about VHF roving is that it allows me to set up a top-level station on the road in the best locations versus a sub-optimum home station that achieves limited

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results. And, it certainly doesn't require the same investment as setting up towers with stacked Yagis, power amplifiers, etc., for a top VHF contest station.

While offering that general investment difference, I'll note that many rovers invest a great deal in their stations and their operations. Plus, all rovers have a gasoline bill at the end of a contest weekend.

I must add that I greatly appreciate the big VHF contest stations. Those are the ones I rely on from one grid to the next to be there for QSOs and points. Thank you.

My Rover Approach

There are three general approaches to VHF roving:

- **Stop-n-Plop** — Drive to a location to set up your mast and station. It is good in hilly terrain and when you can make the setup time payoff with many nearby operators.
- **Run-n-Gun** — Omnidirectional antennas covering lots of grids while in motion. Best for flat terrain. It can include small directional antennas on a rotator.
- **Shoot-n-Scout** — Fixed directional antennas mounted on the vehicle roof. It is sturdy but requires moving the car to point the antennas. It can also be combined with omnidirectional antennas for operation while in motion.

Running through those options, you can see from my journey that I've moved from Stop-n-Plop to what I call Stop-n-Shoot. I stop, get in the back seat, and point the antennas for QSOs. This approach eliminates the set-up time and opens up a few more options for location or even quick stops for new contacts.

While this approach is related to Scout-n-Shoot, I don't like the fixed antennas. They offer the advantage of a solid mounting to the vehicle, although my rooftop mount isn't likely to fly off the car at speed. The fixed antennas work well when you have a location with lots of VHF stations to point at once you've stopped. Our few stations in North Texas are generally located around the compass at most of my stops.

VHF Rover Operations

I've yet to move to omnidirectional antennas as I don't presently plan to operate while in motion. But that is an excellent option for generating QSOs while moving from one grid to the next. And it is a winning option as well. It's a must-have option for the two-person rover team.

There is at least one more approach. I call it Tow-Stop-Crank-n-Shoot. Wayne Overbeek, N6NB, has done this on a grand scale with a trailer including a generator and sizeable crank-up tower. I recommend his website, n6nb.com, for those interested in exploring different approaches to setting up a VHF rover.

Insight into Power Systems

My first rover power systems involved a sealed lead-acid battery and my IC-910H. I started by making satellite contacts. That worked for those short contacts. But a VHF rover operation requires power for a much longer timeframe.

My approach was to connect the car's power system in parallel with my battery. I also used a small power inverter, DC-to-AC, to charge my laptop and cell phone. That worked for my first few rover operations, with operation for an hour or two in each grid, recharging the battery between and at night. I'll note that I continue to use the power inverter to power my laptop, cell phone, and antenna rotator.

As I contemplated routing large gauge cables from the battery to the back of the car, I realized that the car audio guys do this all the time. I found a suitable vendor, made my simple request, and they got everything set up. With their cable, I added a RigRunner 8012 to take the 80 amps in and route it to all my devices. The PowerPole connectors work great.

This power system should work fine with my Limited Rover operation and only one band operating at a time. I recommend Alan Applegate, K0BG, and his website, k0bg.com, for higher power efforts. He covers all aspects of mobile amateur radio operations. This includes upgrading car batteries and alternators as well as several other topics.

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Greg spent some time in his article on safety aspects with all this power running around your car. My wake-up call came late on Saturday night, arriving home to rest before heading out early in the morning for the next grid. I pulled my portable battery out of the car to charge it overnight. While doing that in the dark back seat, my makeshift battery cable shorted out the terminals. Sparks, noise, and fire soon followed. First lesson, be careful as this is powerful stuff. Second lesson: bring a fire extinguisher with you on the road.

Insight into Antenna Systems

I mentioned above using fixed mount antennas above the roof of your car. This uses a PVC framework construction that holds the antennas. It has the advantage of providing lots of room for many antennas. The disadvantage is that you must move your car to point the antennas in the needed direction.

I've used pushup masts and Armstrong rotators in many of my setups. I like this approach's elevation and the ability to quickly point the antennas in the right direction, even faster than rotators. The disadvantage is the time needed for setup and tear down at each stop. That not only consumes time but your energy as well.

The decision to move on to another approach came when the mast fell over as I was setting up in my last grid for the contest. There was no personal injury, but it resulted in bent antennas and realizing that I needed to try something different. Of course, it would work much better in a two-person operation or with a trailer hitch mount.

Where I'm at now is a roof-top rotator system. The platform is built from 2x4 rails, cross members, and a plywood deck. The rotator cage mimics a three-legged tower structure using Steel-Tek pipes and flanges. On top of that is a DX Engineering DXE-AS455G tower shelf and DXE-TB-300 thrust bearing. The first mast was a six-foot fence post from Lowe's hardware. Now, I'm using a six-foot 2" diameter aluminum tube.

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It then uses straps to attach the whole thing to the roof rack. I've tested it up to 75 to 80 mph with antennas. Of course, wind gusts from trucks going by will increase that force. All-in-all, it's pretty sturdy. For example, I can grab the structure and haul myself up on the deck to work on the antennas.

For cables, I use LMR-400. The short cables required in a rover minimize losses. Even so, I also use preamps for 2 m and 70 cm. I don't bother to mount them at the antennas. The cables are routed through the window with an insulation tube over the cranked-up window edge to keep out wind and rain. Routing them to the antennas uses cable ties up the rotator cage and mast, including a rotator loop.



Figure 63 - Rooftop mounting system

My antennas are Directive Systems rover Yagis with 8-foot booms for 2 m (6 elements), 1.25 m (10 elements), and 70 cm (15 elements). I use a Par Electronics Stressed Moxon for six meters, which works excellent for contesting with a reasonably wide beam width. Plus, its size fits nicely on the top of the rover.

Antenna separation is always part of the discussion. In this system, there are about 12 inches between antennas. With low power, that works well, and isolation isn't a problem. I've read papers that spell out the required distance between antennas, but at least one says, "work with the space you have." I agree.

Most experienced rovers advise placing the six-meter antenna on the top of the mast. That makes sense, although I'd like to have the 2 m beam as high as possible as that's the go-to band for local QSOs, followed by QSYing to other bands. Of course, there are always trade-offs with any rover setup.

Insight into Radios

My rover operations started with an IC-910H running 2 m and 70 cm. I then upgraded to an IC-9100 so I could add six meters. While I also have 23 cm on that rig, I prefer to concentrate at the moment on the four low bands for Limited Rover entries. However, that may come in handy for the UHF contest.

For 1.25 m, I'm in the process of adding a Q5 Signal / DEMI transverter. This is the 25-watt version that I intend to use to drive an amplifier to achieve the 100-watt level for the contest category.

What I like about the IC-9100 is that it has two outputs for HF. So I can use one for six meters and the other for the 28 MHz transverter IF. Then, it has separate outputs for 2 m and 70 cm.

My overall approach is to set the rig at 10 watts output to drive the 1.25 m transverter as well as 6, 2, and 70 cm amplifiers, all to run power levels up to the contest category limit of 200 watts on the lower two bands and 100 watts on the upper two bands.

Other options for rovers include antenna switches to route the rig input/output to different transverter setups. Bottomline, use what you've got and get out and get started learning more about roving.

Insight into Computers and Software

In today's ham radio, computers and their software systems comprise a considerable part of any station. That includes rig control, logging, sequencing amplifiers/preamps, running WSJT-X, and chat room software. Rovers have a few other details to keep track of, including changing grids – some systems can do that automatically using GPS signals.

My system is pretty simple. I've used MacLoggerDX in contest mode on my Apple laptop and JT-Alert with WSJT-X. I do have to update grids as I travel manually. I'm now moving to a Windows laptop where I'm using N3FJP's VHF Contest Log. Here again, I

VHF Rover Operations

need to update the grid manually. I want to use N1MM+, but it doesn't do rover scoring. I've looked at RoverLog but haven't put it to use yet.

I use a simple USB sound card for the rig interface. There are lots of options there. I also use the rig's internal keyer and a small paddle when I need CW.

Insight into VHF Rover Modulation Modes

A significant aspect of rover operation is finding another station, usually on 2 meters, and then moving them to other bands for more points. That usually occurs on SSB, where you can easily direct stations to other bands and frequencies.

Then, WSJT-X will disrupt this operating practice while revolutionizing weak signal work entirely. JT65 was excellent but slow. FT8 is fantastic. MSK144 works when other possibilities won't. But sending messages about band changes doesn't yet have a solution.

As rovers, there was also a bit of turbulence when the WSJT-X NA VHF Contest Mode was introduced since it didn't include provisions for /R call signs. Version 2.0 made up for that, and we'll see if FT4 will make a difference in VHF contesting.

I certainly love the WSJT-X modes for weak signal work. We'll need to see how we can generate QSY band change requests and encourage moving to SSB when the band opens up for running stations.

Insight into Rover Routes

Rover routes are all about grids – maximizing the number of grids activated while limiting the mileage driven. For me and my Stop-and-shoot approach, miles driven represent when I'm not on the air.

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Since a grid in the USA measures roughly 70 miles north to south by 100 miles east to west, I plan my routes running north and south where possible. This reduces the miles required to get from one grid to the next.

I also try to set up my routes around grid corners – where four grids merge. That allows quick drives across four different grid boundaries. My June 2019 VHF rover routes in the Texas Panhandle really took advantage of this type of driving.

Some rovers head out with only a general idea of their route. I always scout out my route and find the best locations for setting up my rover. First, I work with one of the grid mapping applications. There are also online topographic maps and summit information that can prove very helpful. That helps me set up the best route for limiting travel time.

Second, I get out on the road and locate exactly where I can park the car and point the antennas. I look for clear horizons and higher spots without trees. That's easier to do

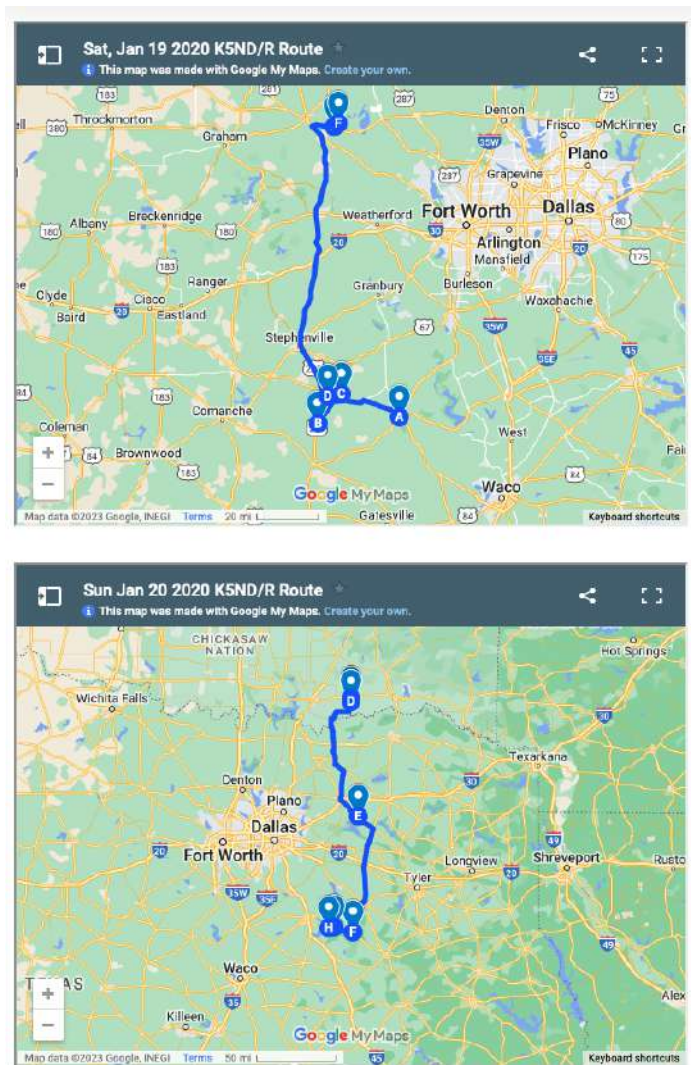


Figure 64 - Rover Route Plans for January 2020 Contest

VHF Rover Operations

in Texas than in many places. Then, I take GPS snapshots of the location to help me map and verify I'm in that particular grid.

I'll also note that I pay particular attention to overhead tree branches on my routes. While my rover is only 12 feet high, trees can and do reach out and snag your antennas. That makes yet one more challenge for contest weekends and can bring your efforts to a sudden, disappointing halt.

Communicating Your Plans

A big part of any rover contest effort is to let people know you're out on the road so that they watch for you and point their antennas your way. Here's what I'm doing before each contest:

- Build a Google Map with the exact routing. Add it to a blog post listing expected times at each grid and your station details, including bands, antennas, and power. [I use that same map when driving the route.]
- Announce this same information, with a link to the blog post, to online VHF and Contesting Groups. This includes national and local groups.
- Build your email list of those you've worked in previous contests, particularly the local big contest stations. Route this same information to them.

Randy Wing, NOLD, does an incredible job with his communications. He does all the above and reaches out around the year to speak at hamfests and club meetings about roving and how to work VHF contests. He works a great deal to prepare local FM-only stations, picking up QSOs as he drives by.

Communicating During the Contest

With the new VHF contest rules introduced a few years ago, there are now lots of communication options during the contest. The chat groups are extremely helpful. This includes PingJockey, VHF Slack, and ON4KST chat. There is also APRS spotting to help stations follow your route.

I also use text messages and even phone calls. Sometimes, I'll text a station that I've arrived in a new grid. I also receive messages from some stations inquiring about my current location, which includes messages from other rovers. Phone calls: I usually reserve a few big contest stations right before I leave a grid if we haven't yet worked each other.

There is a caveat here: you can arrange schedules and initiate contact efforts but can't reveal QSO details via any of these communication channels. So, make sure you restrict your efforts to setting up QSOs.

YMMV – Your Mileage May Vary – Literally

This is your rover journey — do what works best for you, your goals, and your local area. As just one example, I prefer solo radio sport. But many enjoy working as a team in a rover or as part of an extended effort with several rovers.

That's the fun of amateur radio - finding what works for now and then finding the next thing. But the first step is always to get started and get on the air. I hope to add you to my log in future contests.

Rare Grid Roving

Rare grid roving happens when operators go to rare grids, often those with few existing amateur radio operators, and get them on the air for chasers. It's a big part of chasing the FFMA award. But it also comes into play for those chasing grids or states on any VHF band.

The principles, by and large, are similar to those described above.

VHF Rover Operations

The real key is determining the rare grids themselves. For six meters and FFMA, it's part of the online FFMA Leaderboard. This is where those with 400 or more grids worked toward 488 identify their needed grids. Then, the trick is figuring out how to get there and operate with power and a good antenna. Plus, it helps if you can stay there for several days to catch the openings. That also means most FFMA rare grid activations happen during the summer Es season.



Figure 65 - K5ND/R at DM86-DM85 Grid Line

Good Luck with the MAGIC BAND

That's my brief guide to working six meters. It is a Magic Band but can also be very quiet. You never know when it will take off and provide contacts into Europe, South America, Africa, or the Pacific. Yet if you start collecting grids, a new one just a few hundred miles away can be pretty exciting.

Of course, it pays to be patient, and there is always something in your station to tweak, install, upgrade, or whatever to improve your results.

It's a never-ending journey that has as its reward new call signs in the logbook, new grids, new friends, and pure magic working stations that shouldn't be possible at six meters.

Have fun.

73 + 55 (best success)

Jim Wilson, K5ND

Appendix A — SDR Operations

One of the significant advances over the past several years has been the implementation of digital receivers. That began with DSP (digital signal processing) in various receivers and transceivers. There are now SDR (software-defined receivers) ranging from the Icom IC-7300 and IC-7610 to many more.

A related advance has been implementing low-cost SDR dongles in the receiver chains along with an existing transceiver used primarily for the transmit side of the operation.

In this appendix, I've documented my early work with a very low-cost SDR dongle, running around \$30, and later with a more elaborate setup with an AirSpy R2 SDR.

NESDR SMARt RTL-SDR

In May 2020, I added a \$30 SDR that covers 25 to 1750 MHz. Paul, N2EME, introduced this device during an online presentation to the Front Range 6-meter Group.



Figure 66 - RTL-SDR Dongle Receiver

Interestingly, I've previously considered similar SDR devices for satellite work. But I couldn't pull the trigger. However, with Paul highlighting its application to 6 meters, I immediately sprang for it. Not that I'm a 6-meter addict, no, not at all.

SDR Console Software

This is Paul's recommendation to use with this device, and it's free. So that's what I tried out in mid-May with weather satellites, etc.

Paul believes in this software so much that he took time with me later that month to run through his setup in his ham shack. Then, he used AnyDesk to take over my computer and set up several things that optimized my view.

Paul offers that he only knows some of the software's features even though he's been using it for years. The documentation is limited but free and works like a charm. And the capabilities are staggering — you just need to find them.

SDR Switch

The rest of the system uses a relay box to connect your antenna to your transmitter and SDR receiver. It adds a dummy load for terminating the receiver when you're transmitting. This way, you can use the SDR as a receiver and your standard rig as the transmitter.

You can learn more at <https://sdrswitch.com>

SDR Use on Six Meters

It can be complex or straightforward. I've chosen the simple route in my start-up efforts. With SDR Console, you can create up to 24 receiver screens. I've chosen three for the moment.

The first monitors 50.125 for SSB signals. The second monitors 50.313 for FT8. The third monitors 50.323 for intercontinental FT8. Other thoughts are to monitor CW frequencies, beacons, FT4, and MSK144.

SDR Operations

I'm only using the SDR to monitor what's going on across the band. I have used a virtual audio cable to connect the 50.313 FT8 to WSJT-X. It works well in that application. Likewise, you could use separate instances of WSJT-X to decode 50.260 for meteor scatter, FT4, and more simultaneously.

In the screenshot below, you can see how it worked during the opening last night. Receiver #1 was on SSB monitoring a signal near 50.140, #2 on FT8 313, and #3 on FT8 323. Those are displayed across the top of the screen. The bottom of the screen covers the broader SSB band and points out additional signals to the one you're monitoring, like the one shown at about 50.128.

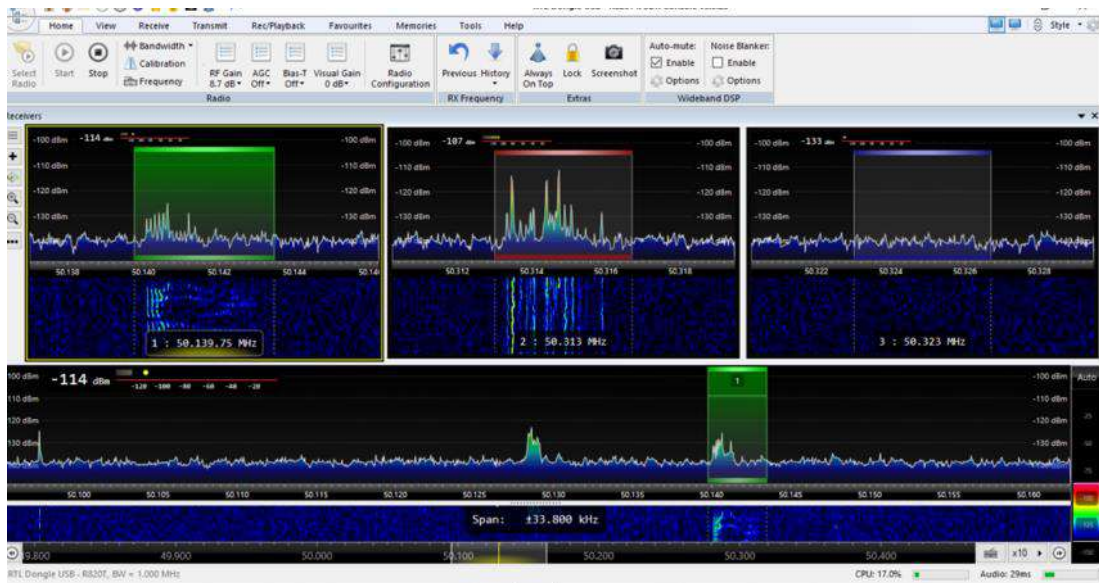


Figure 67 - SDR Console with three receivers

It worked nicely, pointing out activity levels in each area. For example, at times, there was a great deal of activity at 50.323. But each time I checked, I found only USA stations calling Japan. An improvement would be adding Receiver #4 to monitor CW. Here's another shot with activity on all three receivers and the bottom strip monitoring the 50.300 range. I prefer monitoring the SSB segment — something I figured out during last night's opening.

SDR Operations

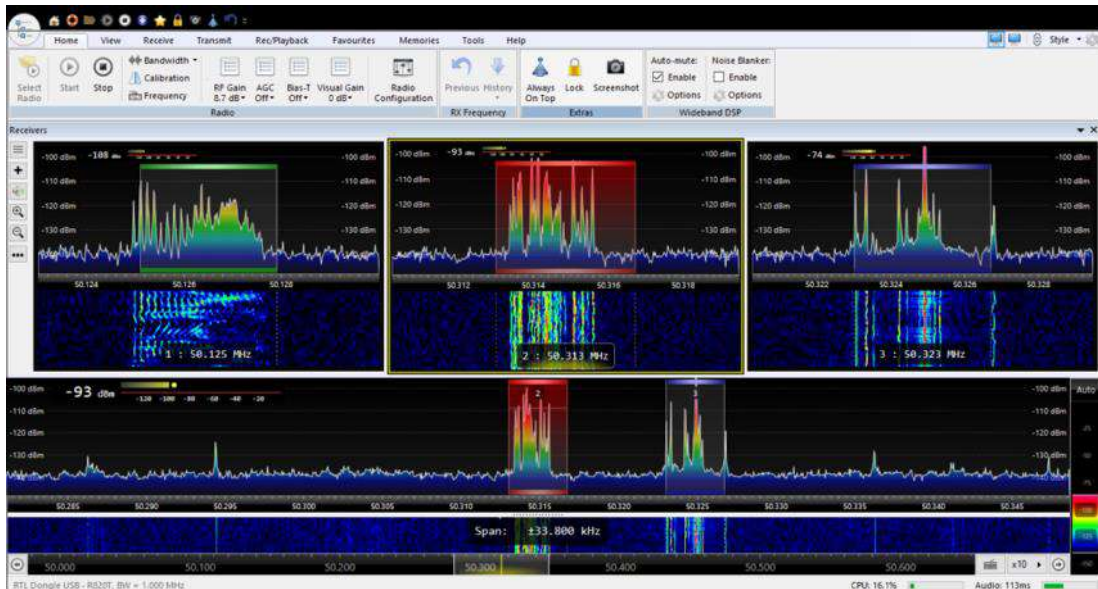


Figure 68 - Receivers covering 50.125 SSB, 50.313 FT8, and 50.323 FT8 to Europe

AirSpy R2 Setup for 6 meters

Following my earlier work with the RTL-SDR dongle, I implemented an Antennas-Amplifiers Preamp, Bandpass Filter, and TR Relay for 6 meters. It provides a separate output for a receiver, which allows direct connection of an SDR receiver. Also, since the transmit input is separate, it will enable the use of an attenuator that only affects the transmit power and not the received signal. This will allow me to protect the input of my 6-meter amp.

SDR Operations

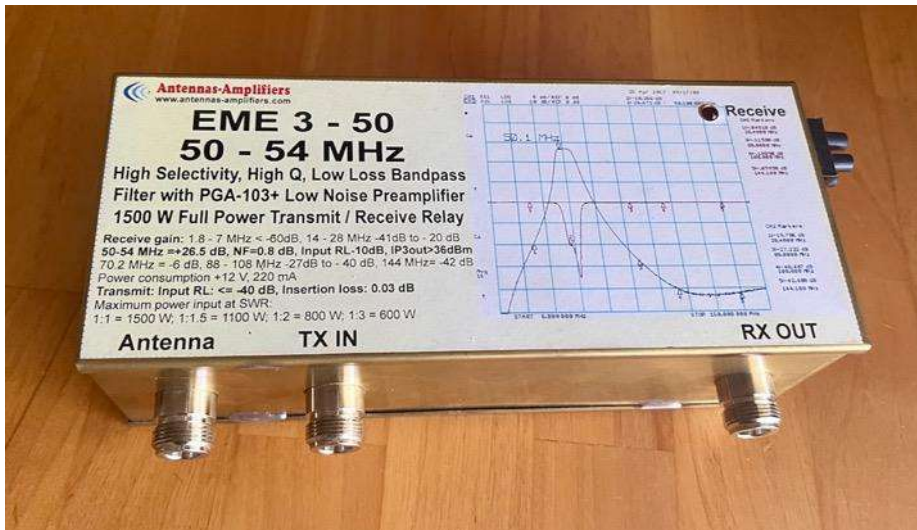


Figure 69 - Antennas-Amplifiers 6 meter PTT, Preamp, and Bandpass Filter

You can see the preamp unit in the photo above. It has a very sturdy package.

I use a Down East Microwave LTRS Sequencer to turn off the preamp and close the PTT relay before pumping RF through the unit to the antenna.

I also changed from the RTL-SDR dongle to an AirSpy R2. It's further connected to a Leo Bodnar Mini GPS-disciplined oscillator set to 10 MHz to make sure the SDR operates at the right frequency.

I've used Digi-Key's Scheme-it to draw diagrams of my setup. They are pretty simple and should remind me what I've wired and keep track of changes. They might also provide you with some thoughts on your setup.

SDR Operations

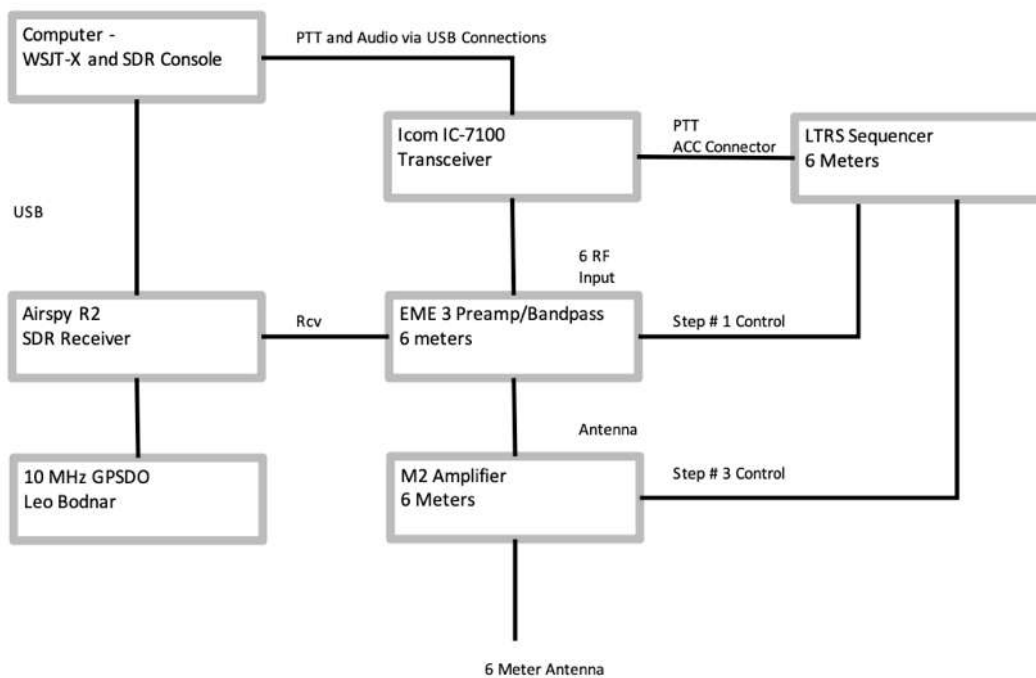


Figure 70 - SDR Setup for 6 Meters

Appendix B — EZNEC Antenna Modeling

Most of the traffic to my amateur radio blog is centered on antennas. From that, you can readily imagine that I like experimenting with antennas in the never-ending pursuit of station improvement and working more DX.

In turn, that drove me to look into using EZNEC to model antennas, both those I might build and those I might buy off the shelf.

EZNEC Antenna Modeling Software — K5ND Trial and Error

Quite some time ago, I'd investigated using EZNEC via a chapter in the ARRL Antenna Handbook and in the book Antenna Modeling for Beginners. After a few forays, I was not motivated enough actually to learn and use the software.

As with everything, my motivation returned chiefly around comparing a 2-meter 8-element Quad with the equivalent Yagi antennas. You can find the software at EZNEC.com. All the various versions are now free, including Pro/2+ v. 7.0. The creator W7EL is now retired. So, the software is readily available. Plus, there's an excellent help file. He does not provide any support, which is to be expected after retirement. But you can also find information online.

My approach this time was to grab a sample and modify it for the exact measures. A great deal of trial and tons of error followed that. But I did finally manage to sort through most of the errors. At least, I hope so.

Modeling Quads and Yagis

I discovered that modeling a quad is much more involved than modeling a Yagi. The complexity comes into play when specifying each wire. For a quad, there are four wires in each element. Plus, those elements extend across the X, Y, and Z axes. For a Yagi, there are two wires in each element. They only extend across the X and Y axes.

EZNEC Antenna Modeling

Quad Modeling Outcome

First, I selected a 15-meter 3-element Quad sample file. Then, I modified it to match my measurements from the 2-meter 8-element Cubex Quad. I encountered a few snags from unfamiliarity with how the modeling wires were drawn. But after obtaining a ridiculous radiation pattern, followed by considerably more thought, I made the changes needed to produce what I believe is a reasonable representation of the pattern, gain, and front-to-back measures. You can see the antenna view and azimuth plot below.

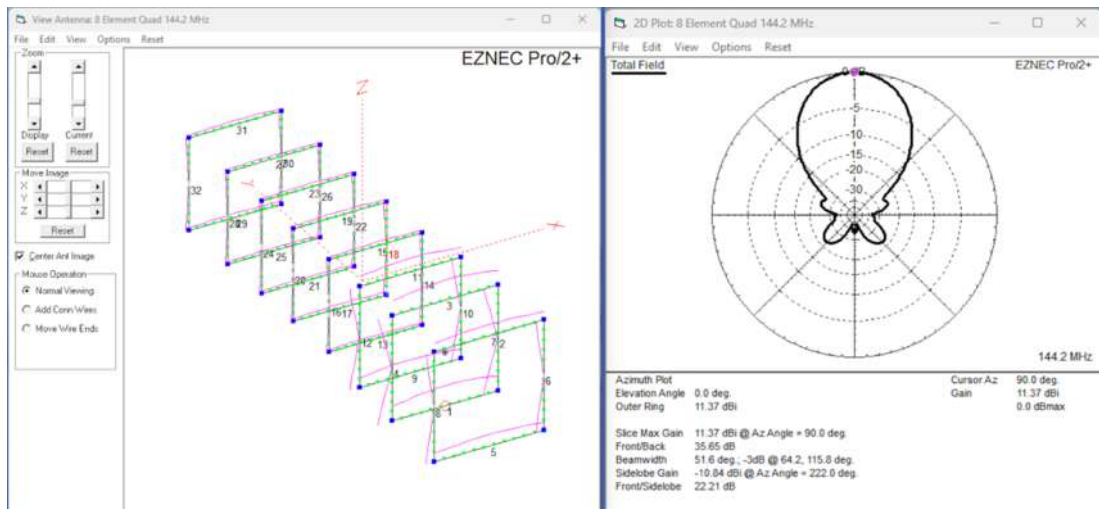


Figure 71 - EZNEC Displays for 8-Element Quad

The specifications on the Cubex Quad website show 14+ dBi gain and 25 dB front-to-back. My calculations from my inexperienced use of EZNEC show 11.37 dBi gain and 35.6 dB front-to-back. The gain is roughly 3 dB lower than that claimed. Although, the front-to-back is much better. Note that this is the free space measure. It doesn't attempt to model any ground effects.

Given this outcome, I was a bit disappointed. But I also wondered first about my ability to create a representative model and second about the modeling outcome itself. So, I modeled a few Yagi antennas that had published gain measurements.

EZNEC Antenna Modeling

Yagi Modeling Outcomes

Starting with Yagi modeling involved picking up a sample file for a 6-meter Yagi and then modifying it for the Yagis of interest.

I started with the Directive Systems DXEJX5-50. I have this 6-meter, 5-element Yagi on my push-up mast in the backyard. My modeling efforts yielded a 9.86 dBi gain versus the 10.1 in the datasheet. Front-to-back weighed in at 25.6 dB modeling versus 25 dB. The azimuth pattern looked identical.

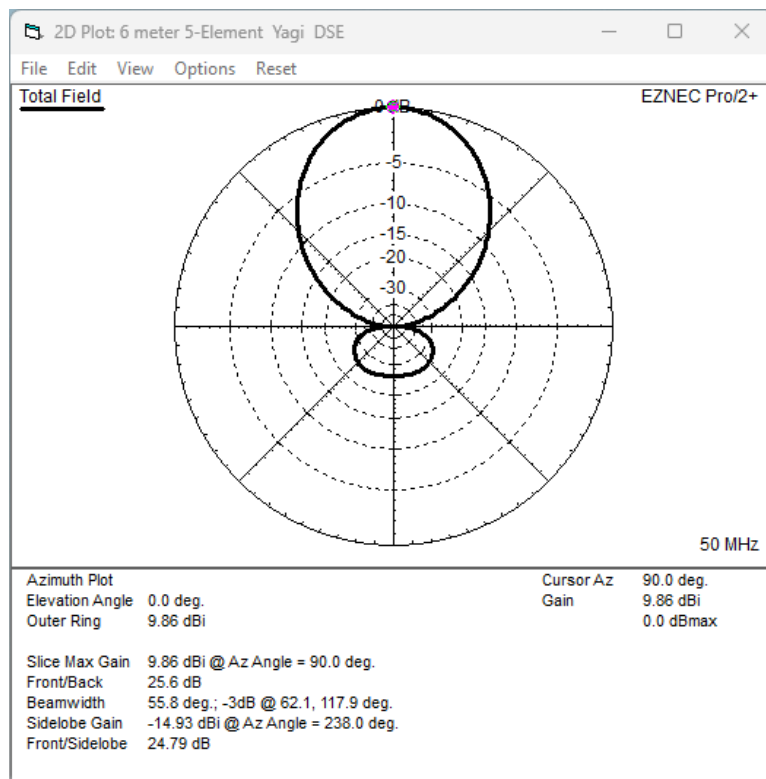


Figure 72 - Directive Systems 5-element 6 meter Yagi

Next, I modeled the Directive Systems DSE RS 6-EL 2-meter rover Yagi. I have that one in my garage for future rover or portable operations. The modeling came in at 12.33 dBi gain versus the published 12.25 dBi. Front-to-back modeling showed 17 dB versus published 21 dB. This also revealed that the simple rover Yagi was marginally better

EZNEC Antenna Modeling

than the quad. All that seemed to say that the modeling was working, or at least I was using the same modeling as Directive Systems.

Looking at the M2 6 Meter Yagis

In my original exercise, which you can find on my blog, I dug deeper into 2-meter Yagi alternatives. I've elected to show a few models for 6-meter Yagis for this book.

M2 6M3SS

I use this antenna in my rover operations. It's lightweight and goes together nicely in the field. Here's the azimuth plot from my modeling. It shows a forward gain of 8.48 dBi versus the specifications of 8.1 dBi.

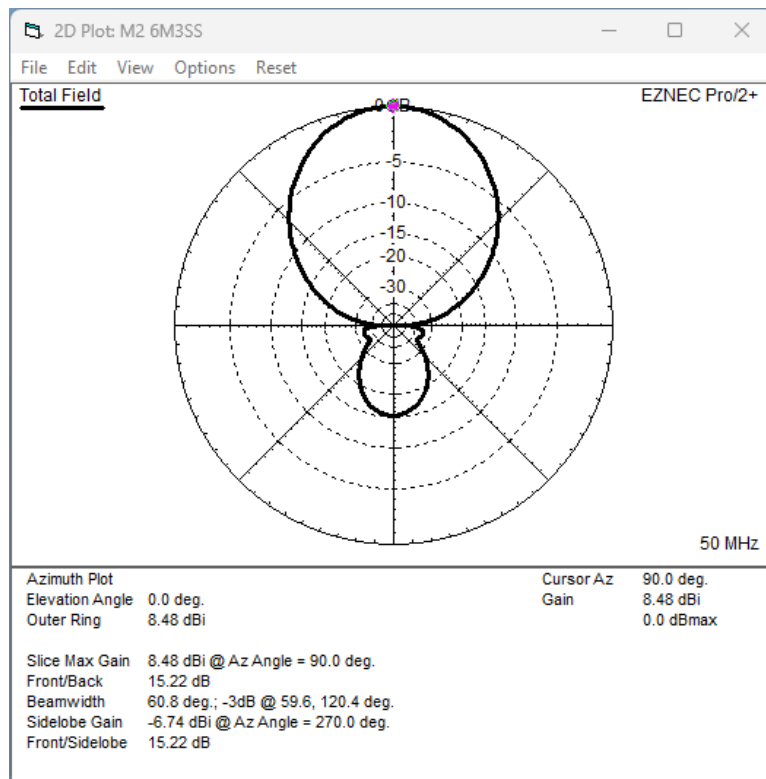


Figure 73 – M2 6M3SS 3-element 6 meter Yagi

EZNEC Antenna Modeling

M2 6M5XHP

This is a 5-element Yagi with a longer boom length (18 feet) than the Directive Systems 5-element Yagi I use (12 feet). The model shows an 11.45 dBi gain versus the specified 11.54 dBi.

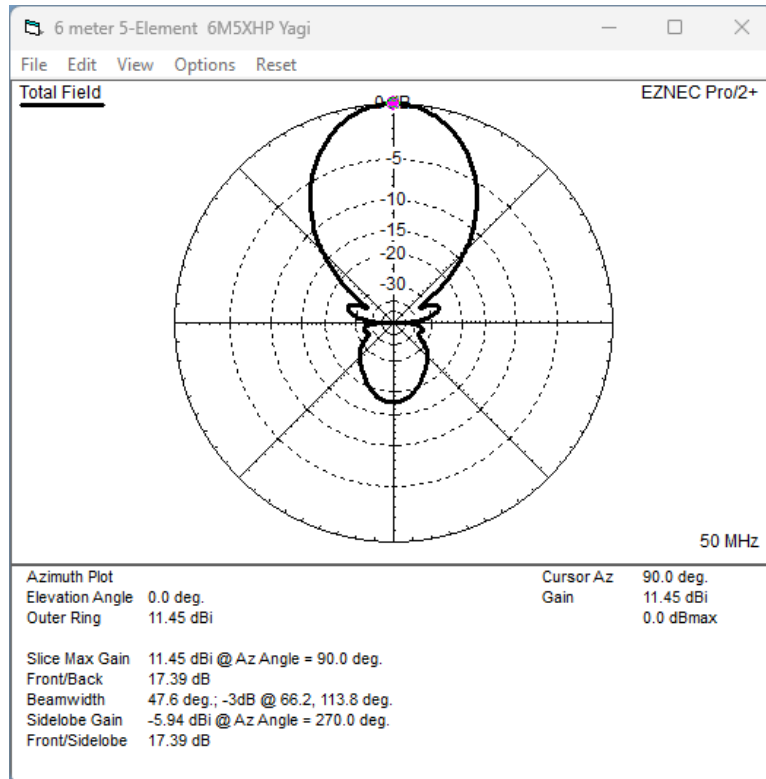


Figure 74 - M2 6M5XHP 5-element Yagi

EZNEC Antenna Modeling

M2 6M5XHG

Here's another model. This one is also a 5-element Yagi but with a 20.25-foot boom. The specified gain is 12 dBi, and the modeled gain is 12.01 dBi. I guess we used the same modeling!

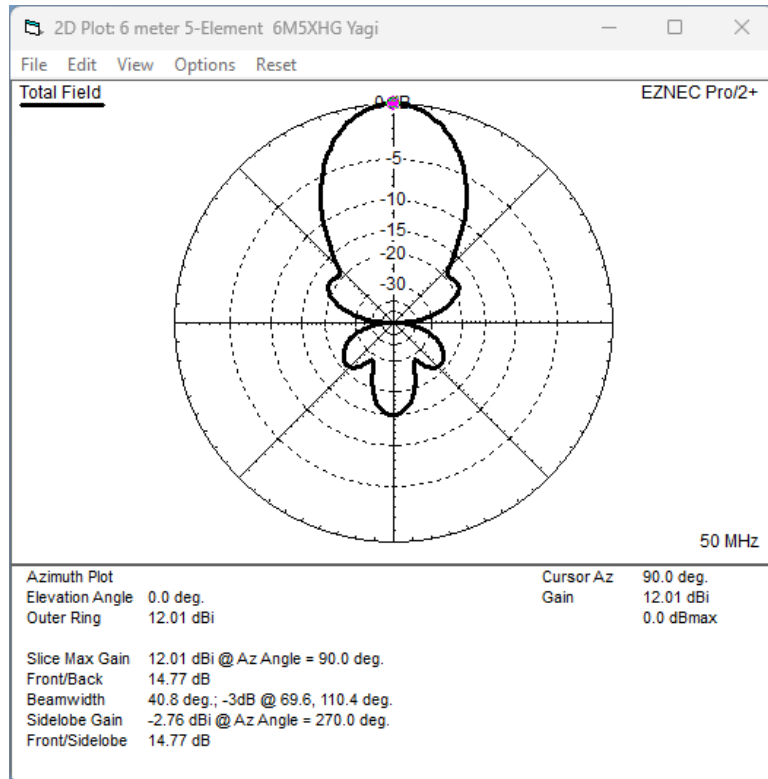


Figure 75 - M2 6M5XHG 5-element 6 meter Yagi

Modeling in Free Space versus Ground

Not content to examine only the free space results, I started adding ground to the model.

The results from the M2 6M5XHG 5-element Yagi are shown below. It provides a 3D pattern along with an elevation segment. This look offers insight into the take-off angle, in this case, at 36 feet above ground. I'm sure this can be useful when setting up towers, etc.

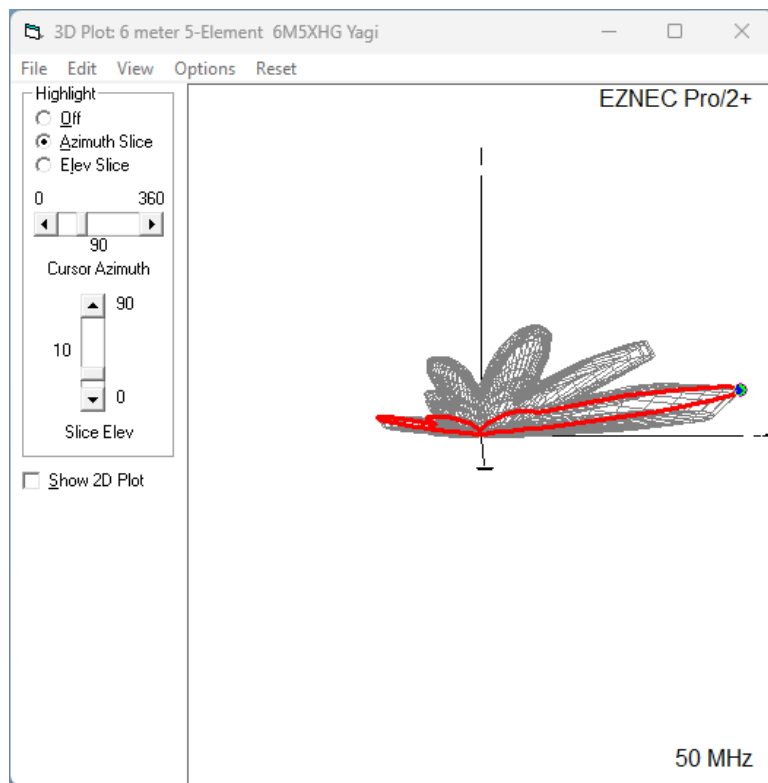


Figure 76 - M2 6M5XHG elevation angle view

Appendix C — Further Information

Here are a few starting points for further reading on six-meter operation.

- **Central States VHF Society** www.csvhfs.org
- **UK Six Metre Group** www.uksmg.org
- **SMIRK Six Meter International Radio Club** <http://www.smirk.info>
- **Magic Band Antennas for Ham Radio, 6 Meter Antennas You Can Build** by Bruce Walker, N3JO. Published by ARRL.
- **Six & Four, The Complete Guide to 50 and 70 MHz Amateur Radio** by Don Field, G3XTT. Published by Radio Society of Great Britain.
- **Six Meters, A Guide to the Magic Band** by Ken Neubeck, WB2AMU. Published by Worldradio Books.
- **Contest University** – W5ZN Presentations on VHF Contesting <https://www.contestuniversity.com/files/>
- **World Wide Radio Operators Foundation Webinars Archive** - <https://wwrof.org/category/webinar-archive/page/2/>

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