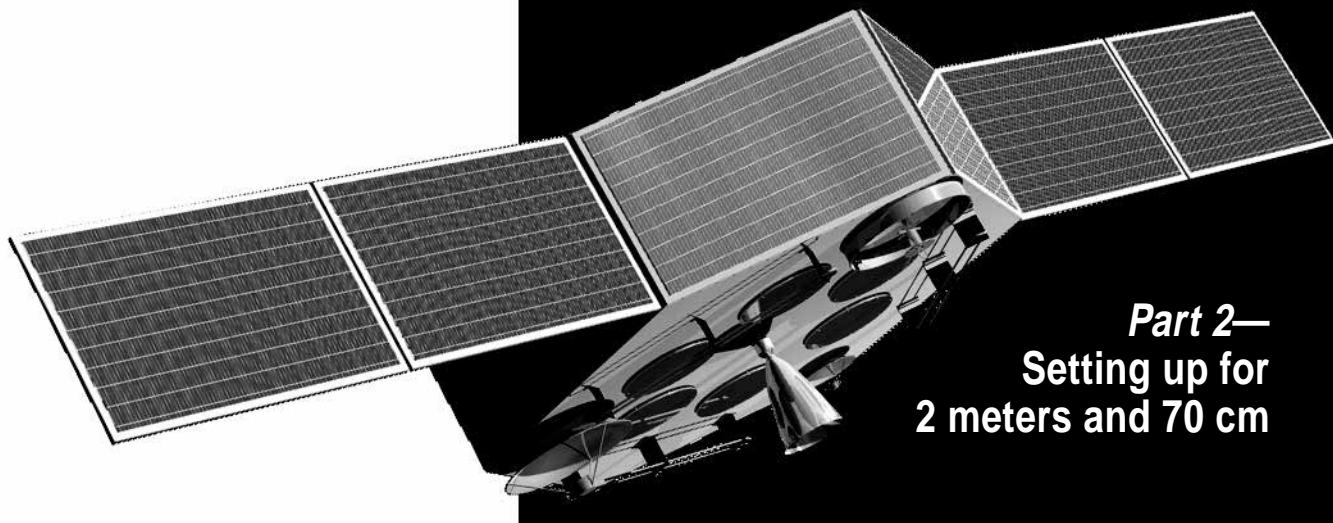


Get Ready for Phase 3D!



Part 2— Setting up for 2 meters and 70 cm

Pick up just about any book on amateur satellite operating and you're likely to find a photograph similar to the one shown in Figure 1. This is the classic 2-meter/70-cm antenna system used for working in Mode B or Mode J (although the antenna system shown also includes 1296-MHz antennas). In Mode B, you transmit to the satellite on 70 cm and listen on 2 meters. In Mode J, it's the reverse.

The new Phase 3D satellite (now scheduled for launch this July) will have transpon-

ders on Modes U/V and V/U—the new designators for Modes B and J, respectively. The uplink and downlink frequencies are shown in Table 1. Compared to the OSCAR 13 satellite, Phase 3D generates much higher output power when operating in these modes.

There are plenty of Mode U/V stations in the United States because this was the mode of choice for working OSCAR 13 and OSCAR 10. Although OSCAR 13 was destroyed when it reentered the Earth's atmosphere in December, the radiation-damaged OSCAR 10 remains operational, albeit with erratic performance.

The Phase 3D Difference

With greater output power available from Phase 3D, is it safe to assume that you'll be able to operate Modes V/U and U/V with compact antennas? Not necessar-

ily. The answer depends on where you live.

The problems with Modes V/U and U/V are *noise and interference*. The 2-meter band in most metropolitan locations has become incredibly "polluted," from an RF standpoint. The toxic signals emanate from power lines, computers, and just about every other source you can imagine. At ARRL Headquarters, for example, the power-line noise is so bad that we can barely hear OSCAR 10 on 2 meters. The noise situation is better on 70 cm, but interference remains a serious problem.

No doubt the RF muscle and high-gain antennas aboard Phase 3D will help punch through the cacophony. Former OSCAR 13 operators who live in urban areas *will* notice an improvement, but it is not likely to be dramatic. They'll still need their long Yagi antennas to hear the bird through the noise.



Figure 1—When you think of satellite antennas, this is the image that usually comes to mind. Notice that the antennas on either side of the horizontal boom are *crossed* Yagis—they have horizontal and vertical elements. (The big HF beam in the background is still waiting for the sunspots to return!)

Table 1
Mode V/U and U/V Frequencies

Note: These are *inverting* transponders. For example, if you transmit *upper* sideband in the *lower* portion of the uplink passband, the satellite repeats in *lower* sideband in the *upper* portion of the downlink passband. The exact frequencies to be used in these ranges will be announced when the satellite is ready for operation.

UPLINKS

Mode	Band	Digital (MHz)	Analog (MHz)
V/U	2 meters	145.800–145.840	145.840–145.990
U/V	70 cm	435.300–435.550	435.550–435.800

DOWNLINKS

Mode	Band	Digital (MHz)	Analog (MHz)
U/V	2 meters	145.955–145.990	145.805–145.955
V/U	70 cm	435.900–436.200	435.475–435.725

Take a journey out to the country, however, and it's a much different story. Noise and interference levels plummet. Phase 3D will be loud and clear out there, even with smaller antennas.

Antennas for 2 Meters and 70 cm

If you live in or near a city, a 2-meter Yagi antenna with a boom length of about 20 feet should suffice. On 70 cm you'll need a circularly polarized Yagi with a 15-foot boom for optimum reception.

If you're out in the sticks, you'll probably be able to work Phase 3D with a much

smaller 2-meter Yagi (a design with an 8-foot boom should be fine). A "country" antenna for 70 cm can be smaller still. (A 5-foot boom should do nicely.)

Take a glance at Figure 1 again. Do these antennas look a little odd? Examine the photos closely and you'll see that both antennas are *crossed* Yagis. That is, they have both horizontal and vertical elements. By properly combining the signals from these elements, you can obtain circular polarization, which matches the polarization used by the satellite. You'll still hear Phase 3D with ordinary Yagis, but the polarization mismatch results in a 3-dB signal loss (Figure 2). If you can afford crossed Yagis for Mode U/V or V/U, more power to you. If not, don't lose sleep worrying about it.

Whichever antennas you decide to use, it's best to mount them both on a single horizontal boom (see Figure 3). Many hams prefer to use booms made of treated wood, fiberglass or ultraviolet-resistant PVC. If you're using a metal boom, mount the antennas so that their elements are at 45° angles relative to the horizon.

The next step is to figure out how you intend to aim your antennas. When it comes to satellites, turning the antennas from side to side (azimuth rotation) isn't enough. You also need to consider how you're going to move your antennas up and down (elevation). By moving the antennas both horizontally and vertically, you can maintain a precise "fix" on Phase 3D as it tracks across the sky.

There are commercial azimuth/elevation rotators available, the most popular being the Yaesu G-5400B. The G-5400B does a fine job, but you'll pay nearly \$500 for a brand-new unit. If you're handy with things mechanical, you can probably cobble to-

gether an azimuth/elevation rotator of your own using two TV-type rotators. You'll need to find models that allow you to pass the mast through the rotator.

Another cost-saving alternative is to rotate the antennas in azimuth *only*. Just mount the antennas at a 45° tilt from horizontal and lock them in place. Of course, you won't be able to use Phase 3D when it is above or below the beam patterns of your antennas, but you should still enjoy a reasonable amount of time on the bird.

And where should you install your antenna system? You definitely *do not* need a tower, unless you're surrounded by tall structures that will block signals from the satellite. OSCAR 13 users often installed their antennas on roof tripods, or even used ground-mounted configurations! These low-cost installation schemes will work just as well with Phase 3D. The goal is to provide a clear path between you and the satellite. The one advantage of working Phase 3D on 2 meters and 70 cm is that trees and other vegetation do not attenuate signals on these bands to the degree that they do on higher frequencies. You'll lose some signal strength, but it's not too difficult to make up for it with more antenna gain or (on transmit) more power. So if you have to "shoot through" some trees or bushes to reach Phase 3D, don't sweat it.

Receive Preamplicifiers

When Phase 3D is at the highest point in its orbit (apogee), you'll be receiving signals that have traveled more than 29,000 miles. Even with Phase 3D's ample output, these signals will be exquisitely weak by the time they reach you. Your antennas and your receiver will provide a substantial amount



Figure 2—A long-boom horizontally polarized 70-cm Yagi will also work for Phase 3D; its extra gain is largely negated by the polarization mismatch, and the higher gain makes it more difficult to point.



Figure 3—This ground-mounted antenna installation uses an azimuth/elevation rotator system. The horizontal antenna boom is connected through the elevation rotator (top). Notice the receive preamplifier (an Advanced Receiver Research model) below the rotators.

The Mechanics of Mast Mounting

The easiest way to mast mount a preamp is to buy one that's already weather-proofed. Preamplicifiers are often available in mast-mountable versions. Alternately, it's often practical to install electronic equipment in weatherproof containers.

The obvious approach is to seal up the box containing the electronics, so no moisture can possibly get in. This works, as long as the air inside is kept dry enough to prevent condensation. It might be helpful to put some desiccant inside the box to absorb moisture. Some people even pressurize the box, using a piece of air-line coax as an air hose.

The other approach is to make a vent hole at the bottom of the box. The hole allows any moisture that condenses to leak out of the box. The problem is that insects may use the hole as an entrance and the box as a home. Window screen may help keep them out.

Route your coax and dc power cables in loops that rise up to the bottom of the box. This prevents water from running along the cables into the box. Beware of connectors that allow water to enter the box. Some bulkhead connectors have machined flats that prevent a good seal.

If you are trying to prevent condensation, don't use metal boxes. Metal has excellent thermal conductivity, which means they get hot in the daytime and cold at night. As anyone who has had a cold drink knows, cold air doesn't hold as much water as warm air, so cold objects often remove water from the air. Plastic boxes are a much better choice.

Plastic boxes aren't perfect—some do fall apart when exposed to sunlight for a long period of time. U/V protection often involves painting or coloring the plastic to prevent U/V from passing through it. Clear polyethylene is a particularly bad choice.

Using stainless steel hardware is a wise investment. Zinc-plated steel hardware will quickly corrode, making proper removal difficult. Ordinarily, nickel-plated brass hardware is an acceptable choice.—Zack Lau, W1VT

of gain, but to get a satisfactory signal you may need a receive preamplifier, otherwise known as a *preamp*.

Preamps are double-edged swords and should be used with caution. On one hand, they're great weak-signal amplifiers. On the other hand, they also boost whatever noise is present. If your Mode V/U or U/V station is in a noisy location, a preamp probably won't help. All it will do is amplify the existing noise to intolerable levels.

Preamps generate their own noise, too. That's why you'll often see advertisements for preamps that list their *noise figure* (NF) as well as their gain. Obviously, you want to buy a preamp with the lowest noise figure possible. For satellite reception on 2 meters or 70 cm, look for a preamp with a noise figure of less than 0.5 dB.

Preamps work best when noise levels are low. In a low-noise environment, a hot preamp (20-dB gain or more) can make it possible for you to get away with smaller antennas. Of course, the inverse is true. That is, if you operate in a low-noise environment with *large* antennas, you may not need a preamp at all. Install your preamp outdoors as close as possible to the antenna

itself. See the sidebar "The Mechanics of Mast Mounting."

RF Power

We have good news about RF power: You won't need much of it to communicate through Phase 3D. If you're using a long-boom Yagi antenna on 2 meters or 70 cm, you'll be able to get by with only 10 W of output power on either band. All multimode transceivers on the market today generate *at least* that much RF, and usually more. With smaller antennas, you may need to increase your output to about 60 W.

Sixty-watt power amps are commonplace for both 2 meters and 70 cm. If you're adding up costs, however, don't forget to include the cost of a power supply! And don't forget to buy an amp that's designed for SSB/CW service—some are for FM only.

Radios

You'll spend the greatest amount of money buying radio gear for your Mode V/U or U/V station. You can't use FM on Phase 3D, so you must find a way to transmit (or receive) an SSB or CW signal on 2 meters or 70 cm.

If you have \$1400 to \$1800 to burn, invest in a new Yaesu FT-736, ICOM IC-821 or Kenwood TS-790 transceiver. All of these are 2-meter/70-cm multimode (FM/CW/SSB) radios with excellent satellite capability. Consider them the "Cadillacs" of the amateur satellite world.

If your pockets are not quite that deep, look into buying separate 2-meter or 70-cm multimode rigs. Brand-new radios will cost between \$600 and \$1000. With a little detective work, you can find used multimodes for as little as \$250. For example, the Kenwood TS-700S is a 1970s-vintage 2-meter multimode rig that often sells for \$250.

Converters

If you already own an HF transceiver, you may be able to put it to work as a satellite transceiver. All you need is a device that takes a 10-meter transmit signal and converts it to either 2 meters or 70 cm. Then, you need another device that takes 2-meter or 70-cm received signals and converts them to 10 meters. These electronic wonders are known as *transmit converters* and *receive converters* (see Figure 4). Sometimes you'll find both devices in a single package called a *transverter*.

There is a ticklish problem you'll encounter when you attempt to interface converters and HF transceivers, however. Your HF rig is capable of putting out as much as 100 W, with just a single antenna connection for hooking up converters. Needless to say, 100 W is more than enough to fry the delicate electronic circuitry of a transmit converter—and *much* more power than your transmit converter requires. That means you need a method of reducing the power to something the converter can tolerate (about 100 mW is usually enough). If you don't own a rig with a transverter port, the obvious solution is to decrease your output power. But most HF transceivers can only go down to about 10 W. That's *still* too much.

The solution is to knock down the power with an *attenuator*. By using either lossy transmission line, such as RG-174, or resistors, you can reduce the transmit power to a safe level. The resistor technique is the most common.

You can build your own attenuator out of an existing dummy load. See the article by Erik Basilier, WU7O, in the November 1996 *QST*. ("Build a Power Attenuator," page 31). You'll also find that some commercial transmitting converters have built-in attenuators that can handle up to 10 W. Other manufacturers (such as Parabolic AB; see "Resources") offer devices that handle all HF transceiver interfacing, including power attenuation.

Since you're working with just one radio, how do you switch the transmit and receive converters in and out of the signal path? Many commercial transverters solve the problem for you with their own automatic switching. If you opt for separate transmit and receive converters, you need

Three of the most popular multiband satellite transceivers.



ICOM IC-821



Yaesu FT-736



Kenwood TS-790

to put together a switching scheme of your own. You can use RF relays, but to switch them in the proper sequence, you need to know when your radio enters the transmit mode. A simple approach is to monitor the push-to-talk (PTT) line. Usually, the PTT

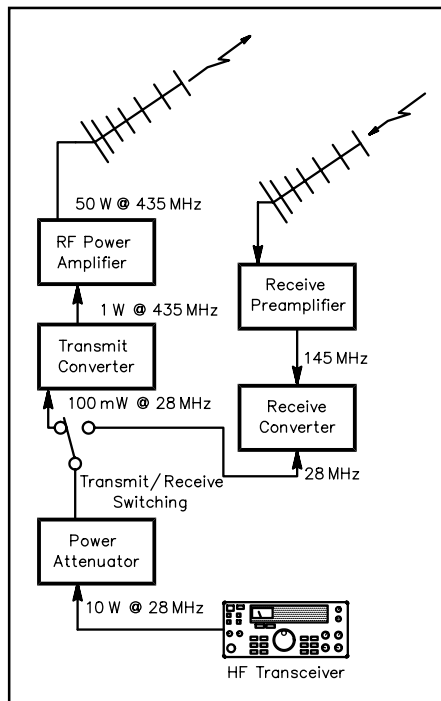


Figure 4—A Mode U/V station diagram based on a single radio and separate receive/transmit converters.

line measures 9 to 12 V during receive, and is pulled to ground for transmit. A high-impedance FET can easily detect this change, without affecting transceiver operation. Figure 5 shows a suitable circuit.

If you are building or modifying a radio, there is an even better approach. There is often a relay- or transmit-switching voltage you can monitor. Ideally, this signal not only indicates transmit, but includes a bit of delay before and after actual transmission. This ensures that the RF switches don't actually switch the full transmit power—the switching is only done while the transmitter is turned off. Of course, don't overlook the possibility that your radio already provides such a switching voltage. Some have auxiliary switching ports on the rear panels.

Up to this point we've been talking about using converters with a single HF transceiver. An alternative is to use two separate HF radios—one for receiving and the other for transmitting. While this adds to your station expense, you gain the advantage of being able to receive and transmit *simultaneously*. This is a huge benefit when working through satellites. You get to hear your own signal, which allows you to make frequency adjustments "on the fly." Actually, this is the preferred method of satellite operating.

You could use your HF rig to drive the transmit converter and chose an inexpensive 10-meter receiver as the "IF" for your receive converter. You could even couple a portable shortwave receiver to your receive

converter. Don't laugh! An inexpensive shortwave radio that can receive SSB on 10 meters makes a perfectly acceptable companion to a VHF/UHF receive converter. The next time you browse a hamfest flea market, don't pass up those old general-coverage receivers—many selling for around \$50!

Don't Scrimp on Coax

It's always tempting to pinch pennies, but there is one item that deserves as much money as you can throw at it: Coaxial cable. Do not, under any circumstances, cut corners when buying coax; purchase cable with the lowest loss you can afford. We're talking about matched line loss of less than 1.5 dB per 100 feet at 100 MHz. Consider Belden RG-213 or equivalent as the *minimum* that you'll accept. And if you're talking about *long* cable runs (150 feet or more), you'd better look into bigger or more expensive cables with lower loss. Be careful when soldering connectors to your coax, and weatherproof all of your outdoor connections.

Next Month

In Part 3 of our series we'll leave the noise behind and head for the microwave bands. Our next stop: *Mode S*—2.4 GHz!

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Resources

Advanced Receiver Research (*preamplifiers*)
Box 1242
Burlington, CT 06013
tel 860-485-0310

Advanced RF Design (*preamplifiers*)
tel 609-448-0910
fax 609-448-6689

Down East Microwave (*transverters, preamplifiers*)
954 Rt 519
Frenchtown, NJ 08825
tel 908-996-3584
fax 908-996-3702
WWW <http://www.downeastmicrowave.com/index.html>

Hamtronics (*transmit and receive converters, preamplifiers*)
65 Moul Rd
Hilton, NY 14468-9535
tel 716-392-9430
fax 716-392-9420

Parabolic AB (*transverters*)
Box 10257
S-434 23 Kungsbacka
Sweden
tel 011-46-300-41060
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e-mail sm6cku@parabolic.se

SSB Electronic USA (*transverters, preamplifiers*)
124 Cherrywood Dr
Mountaintop, PA 18707
tel 717-868-5643
WWW <http://www.ssbusa.com>

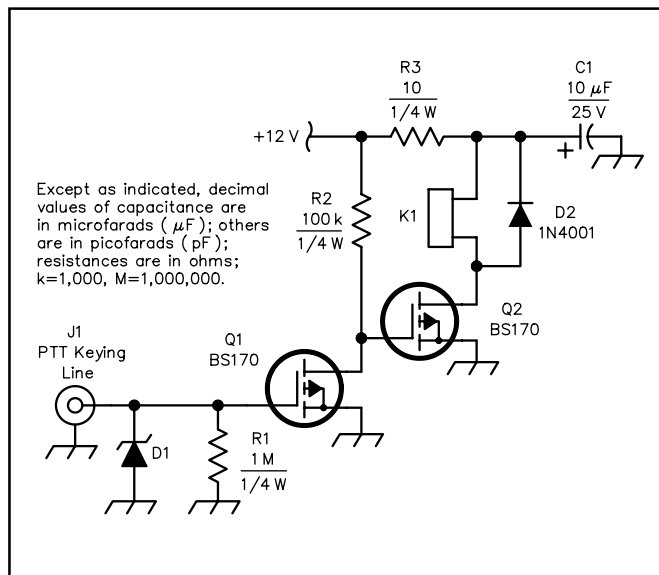


Figure 5—A simple circuit for switching receive/transmit converters.

- C1—10 μ F electrolytic, 35 V (Radio Shack 272-1013)
- D1—20-V, $\frac{1}{2}$ -W Zener diode (Digi Key 1N5250BCT-ND)
- D2—1N4001 (Radio Shack 276-1101)
- K1—SPDT 12-V relay (Radio Shack 275-248)
- Q1, Q2—BS170 FET (Digi Key BS170TND)

