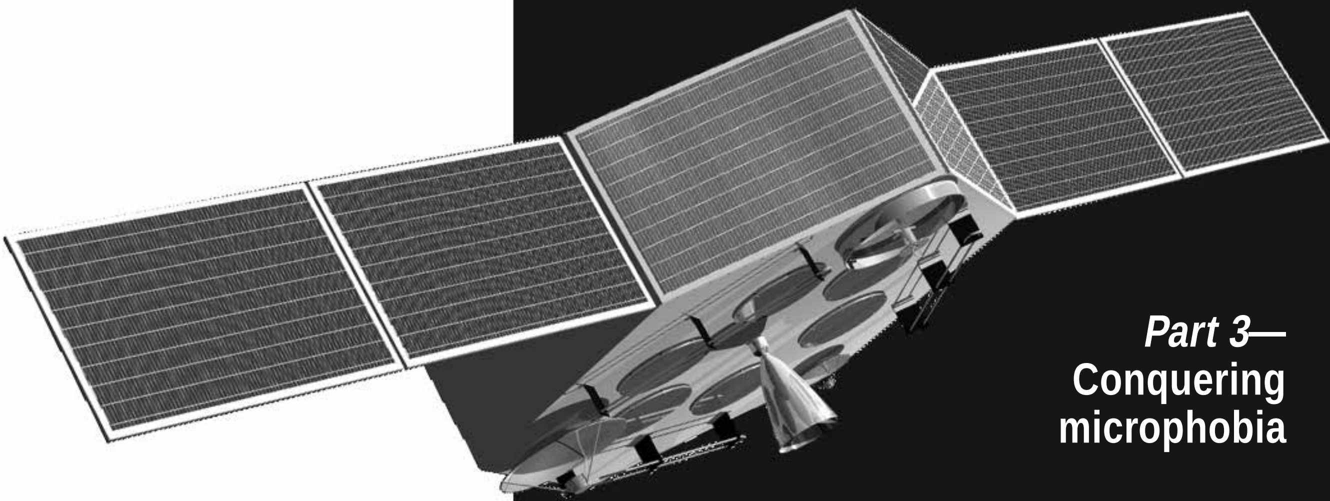
By Steve Ford, WB8IMY, and Zack Lau, W1VT

Get Ready for Phase 3D!



Part 3— Conquering microphobia

Talk to the people who've designed and built Phase 3D and they'll tell you that this satellite will shine brightest in the microwave bands. Microwave antennas are small by nature, so you can pack a lot of gain into a tiny space. Phase 3D has more than enough room to accommodate microwave antennas with *very* high gain. Add the substantial output power it will generate and you have a "bright" satellite indeed!

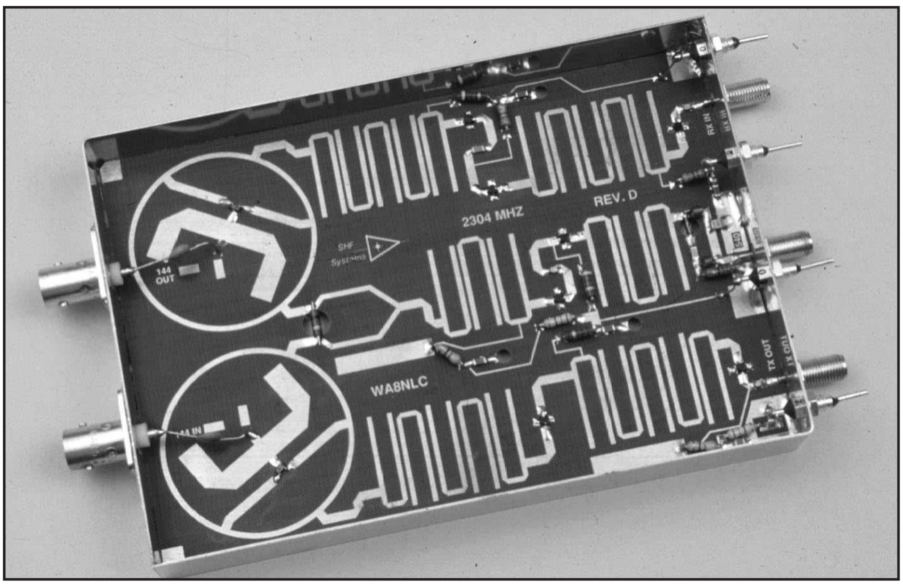
Microphobia

Microphobia—an irrational fear of microwave equipment—is epidemic among hams. The perception of many is that microwave gear is outrageously expensive and incredibly difficult to operate. This is *not* true, but old myths (and phobias) die hard.

Amateur microwave equipment has never been more affordable or easier to use. We're not quite to the point of having plug-and-play microwave stations, but we're getting close. For example, you can now buy ready-to-go microwave transverters that you can add to an existing 2-meter or 70-cm all-mode transceiver. With one of these transverters in the shack, you can be on the air in no time. If you prefer to "roll your own," there are microwave transverter kits that incorporate no-tune designs for easy assembly.

Microwave antennas can be constructed from almost anything. In the salad days of the OSCAR 13 satellite, Ed Krome, KA9LNV, proved that it was possible to use a cooking wok to receive the signal from its S-band (2.4 GHz) transponder! Other hams have used garbage-can lids and other ingenious methods. If you'd rather buy than build, there are several sources for microwave antennas.

Perhaps the best incentives for going microwave with Phase 3D involve space (*your* space, not outer space) and noise. Microwave antennas are so compact they can go almost anywhere. A microwave station will require very little space in your home, apartment, or backpack. And the



A no-tune transverter kit like this one will get you on the microwave bands in no time!

Table 1
Phase 3D Mode U/S and L/S 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.

UPLINKS

Band	*Digital (MHz)*	*Analog (MHz)*
70 cm	435.300–435.550	435.550–435.800
23 cm (1)	1269.000–1269.250	1269.250–1269.500
23 cm (2)	1268.075–1268.325	1268.325–1268.575

DOWNLINKS

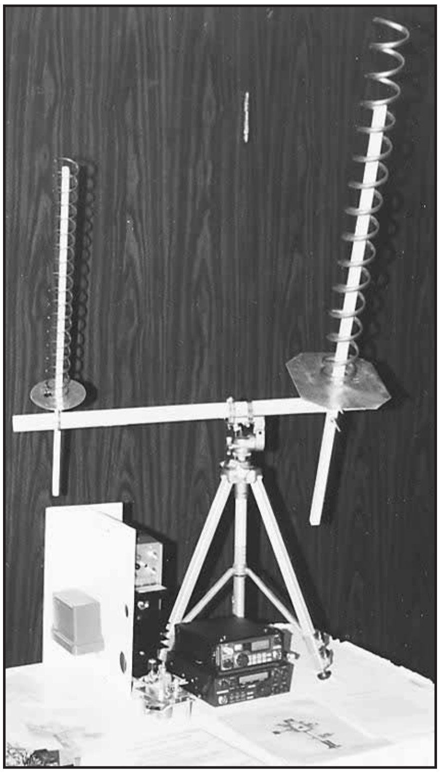
Band	*Digital (MHz)*	*Analog (MHz)*
13 cm	2400.650–2400.900	2400.225–2400.475

microwave bands are extremely quiet in terms of noise—both manmade and otherwise. (After spending a little time on Phase 3D's microwave transponders, it may be hard to go back to 2 meters, let alone HF!)

Mode L/S or U/S?

Phase 3D will be able to operate in several different microwave transponder configurations. Even so, modes L/S (1.2 GHz up, 2.4 GHz down) and U/S (435 MHz up, 2.4 GHz down) are likely to be the most popular (see Table 1).

Mode U/S has an economic advantage among those who want simplified stations built around off-the-shelf hardware. New and used all-mode transceivers for 70 cm are available right now. In contrast, there are no new 1.2-GHz all-mode rigs being sold in the United States at the present time. If you own a Kenwood TS-790 or Yaesu FT-736 transceiver, you can purchase 1.2-GHz modules. The modules are a bit pricey ($500+). You'll find a few 1.2-GHz all-mode transceivers on the used market, but they're as rare as proverbial hen's teeth, so they command premium prices as well. If the free marketplace has anything to say about it—and it always does—the bias is already set in favor of Mode U/S, even though L/S has some advantages (smaller uplink antennas, for example).



At the 1996 AMSAT Space Symposium in Tucson, Arizona, Ed Krome, KA9LNV, displayed his portable Mode U/S station. Note the 2.4-GHz and 435-MHz helical antennas.

Antenna Considerations

The antennas on Phase 3D are circularly polarized. If you want maximum performance from your ground station, your antennas must also be circularly polarized. You can use "linear" polarization (horizontal or vertical), but you must consider the fact that you'll sacrifice 3 dB on the uplink or downlink. This means you'll need a somewhat more sensitive receive system and/or more power.

For a 435-MHz uplink, a crossed-Yagi antenna with a five-foot boom (or longer) should do a fine job with circularly polarized signals. These antennas are available from several manufacturers, such as Cushcraft, KLM and M[2].

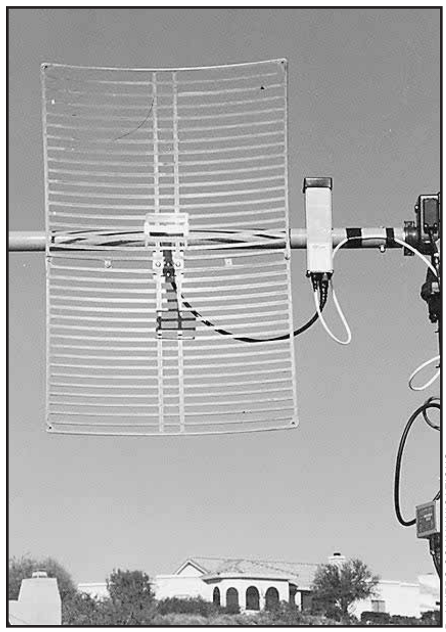
Another antenna to consider is the *helix*. You can build a compact 435-MHz helix from plans featured in the 17th edition of *The ARRL Antenna Book* (pp 19-30). Helical antennas for 1.2 and 2.4 GHz are smaller still. Pre-made helical antennas for ham applications are not terribly common at the moment, although that may change after Phase 3D reaches orbit. Parabolic AB, for example, has already announced that they will be manufacturing a 2.4-GHz helical antenna and downconverter package for use with Phase 3D. (The release date for this unit was not available when this article went to press.)

When it comes to sheer gain on the microwave bands, it's hard to beat a parabolic dish antenna. As a receiving antenna it behaves like a Newtonian telescope, gathering the signal energy and focusing it at the feed point. During transmit, a parabolic dish is analogous to the reflector in a flashlight, creating a tight "beam" of RF. You can build parabolics of your own as described in Chapter 18 of *The ARRL Antenna Book*. You can also purchase pre-made parabolic antennas from sources such as R. Myers Communications (which sells an inexpensive parabolic antenna system for 2.4 GHz using a "barbecue grill" design). Don't overlook military and commercial surplus; many small parabolics often end up there.

Another popular antenna, particularly for 1.2 and 2.4 GHz, is the *loop Yagi*. Once again, *The ARRL Antenna Book* provides construction details, although these antennas can be tricky to put together. If you lack antenna-building experience, you're probably better off buying a loop Yagi off the shelf.

As we discussed in Part Two of this series, you'll need to rotate your antennas in both azimuth and elevation. A combined az/el rotator is the easiest way to go if you have the cash (about $500 new). With a little inventiveness and patience you can probably make one of your own with surplus ham or TV rotators.

If a rotator is not part of your budget plans right now, you could simply aim your antennas at a particular point in the sky and leave them. If Phase 3D achieves the predicted orbit, it should follow the same track through your local sky every 48 hours. Whenever Phase 3D passes through your "target zone," you should be able to use the



R. MYERS COMMUNICATIONS

The R. Myers Communications SB-32 parabolic dish antenna. The SBDC-2400 2.4-GHz downconverter is visible just to the right of the antenna.

Twin 1.2-GHz loop Yagis are part of the ARRL Headquarters satellite station.

An az/el rotator moves your antennas from side to side (azimuth) and up and down (elevation).

SSB ELECTRONIC USA

A 2.4-GHz receive converter typically converts the S-band signal to 2 meters. In some cases it is possible to purchase 2.4-GHz units that will convert all the way down to 10 meters. In either case, you must install the converter at the antenna.

bird—probably for several hours.

Downconverters and Preamplifiers

Regardless of whether you're transmitting to Phase 3D on 435 MHz or 1.2 GHz, you'll need to listen on 2.4 GHz. Your antenna will provide quite a bit of gain initially, but what do you do with the signal after that?

If you select a loop Yagi or helix as your 2.4-GHz antenna, it's a good idea to use a preamplifier to give the incoming signal a kick. Look for a 2.4-GHz preamp with a noise figure of 0.5 dB or less and a gain of 16 to 25 dB. If you're planning on a parabolic dish antenna, a preamplifier may not be necessary, considering the high output power that Phase 3D will offer on this band.

In either case, you *must* mount the preamplifier as close to the antenna as possible—no more than a few feet from the feed point. Attenuation in common coaxial cables can be horrendous at microwave frequencies, so use a *short* length of low-loss coax to connect the preamplifier to the feed point.

Now that you've amplified the 2.4-GHz signal, how do you go about listening to it? The common approach is to convert the signal to a lower frequency using a *downconverter* (see Figure 1). Most 2.4-GHz downconverters use 2 meters as the "IF" frequency. In fact, some 2-meter all-mode radios such as the Kenwood TM-255A in-

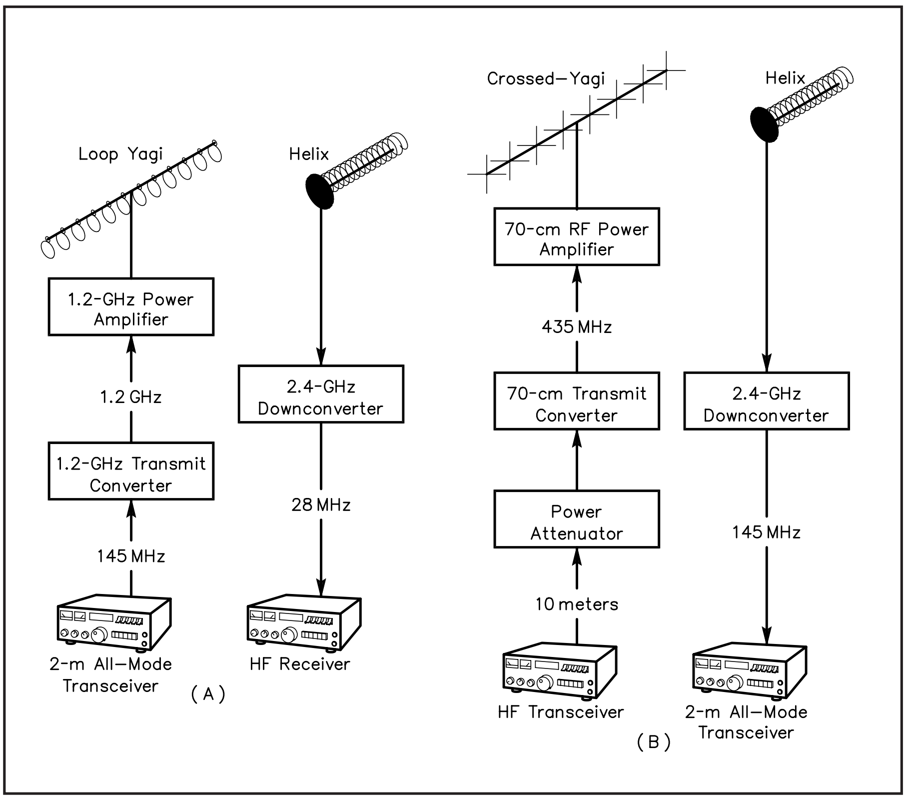
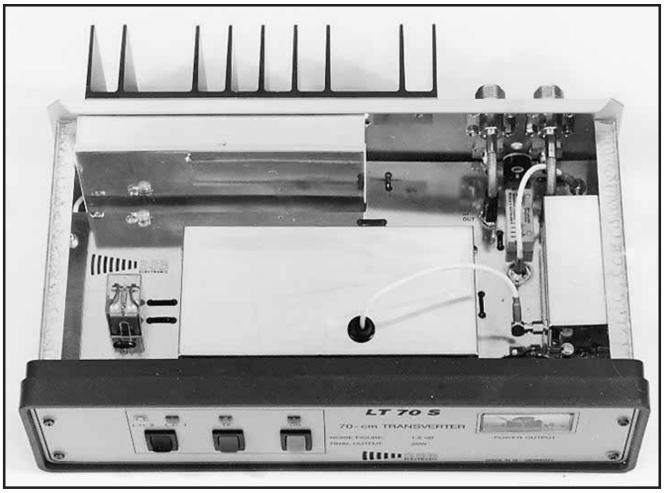


Figure 1—There are several ways to set up stations for Mode U/S or L/S. Here are just two examples. For Mode L/S (**A**), you could use a 2-meter all-mode transceiver to drive a 1.2-GHz transmit converter and RF power amplifier. For an extra cost you can get a 2.4-GHz receive converter with a 10-meter IF. Feed this to an HF rig or even a stand-alone shortwave receiver. For Mode U/S (**B**), an HF transceiver can drive a 70-cm transmit converter and RF power amplifier. Feed the output of the 2.4-GHz receive converter to a 2-meter all-mode radio.



SSB ELECTRONIC USA

A peek inside an SSB Electronic 70-cm transverter. Units like this make it possible to convert a 10-meter signal to a 435-MHz Mode-U/S uplink.

PARABOLIC AB

A 10-W 1.2-GHz amplifier manufactured by Parabolic AB in Sweden.

Resources

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

R. Myers Communications *(antennas, downconverters, preamplifiers)*
PO Box 17108
Fountain Hills, AZ 85269-7108
tel 602-837-6492
fax 602-837-6872
WWW **http://www.primenet.com/~bmyers/**

Down East Microwave *(antennas, transverters, preamplifiers)*
954 Rt 519
Frenchtown, NJ 08825
tel 908-996-3584
fax 908-996-3702
WWW **http://www.downeastmicrowave.com/index.html**
(see their transverter interfacing primer at **http://www.downeastmicrowave.com/Inter.htm**)

Hamtronics *(435-MHz transmit converters)*
65 Moul Rd
Hilton, NY 14468-9535
tel 716-392-9430
fax 716-392-9420

Parabolic AB *(transverters, preamplifiers, antennas)*
PO Box 10257
S-434 23 Kungsbacka, Sweden
tel 011-46-300-41060
fax 011-46-300-40621
e-mail **sm6cku@parabolic.se**
WWW **http://www.parabolic.se**

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

clude a function that allows the radio to display S-band frequencies when you're using it with a downconverter.

Like preamplifiers, downconverters should be installed at the antenna, either at the feed point or very close to it.

Generating RF at 435 MHz or 1.2 GHz

If you can get your hands on a 70-cm all-mode rig, you probably have all the RF you need on 435 MHz. Most modern transceivers of this type generate about 30 W output. Connect the radio to your antenna with low-loss cable and you're all set. If the radio you select doesn't offer enough RF muscle, or if you must use a long cable run (more than 100 feet), consider investing in one of the commonly available RF power amps for 70 cm. An amp in the 60-W output class should do nicely.

If you plan to use an HF transceiver and a *transmit converter* to generate your 435-MHz signal, you'll definitely need to include an RF amplifier. The typical 70-cm transmit converter takes a low-power (100 mW) 10-meter signal from your HF rig and converts it to 435 MHz at a few watts. So, you'll need an amp that can accept an input of 2 or 3 W and provide an output of about 50 or 60 W.

Generating RF at 1.2 GHz is a little more complicated. As we've already discussed, 1.2 GHz all-mode rigs are virtually nonexistent. Most hams produce output at 1.2 GHz by using 2-meter all-mode radios and 1.2-GHz transmitting converters. There are a few problems with this approach:

• *Getting power from the shack to the antenna.* Remember the discussion about loss in coaxial cables at microwave frequencies? If you pump your 1.2-GHz signal through 50 feet or so of coax, you're going to lose a substantial amount of power in the cable itself. The solution? Mount the transmit converter and the 1.2-GHz power amp (yes, you'll need one of those, too) at the antenna. That way, you're only sending 2-meter energy through the coax. Use low-loss coax, just the same.

• *The IF problem.* The satellite custom is to listen to your signal while you're transmitting. This allows you to easily change your transmit frequency to compensate for Doppler shift. But if your 2.4-GHz receive converter is using 2 meters as its IF frequency and the 1.2-GHz transmit converter is looking for 2-meter energy at the same time…uh-oh! If you want to receive and transmit simultaneously, you may need two separate radios at 2 meters—an expensive proposition.

One possible way out of this dilemma is to use a different IF band for the 2.4-GHz receive converter. Although most designs convert to 2 meters, it doesn't always have to be this way. A few converter manufacturers will, for an extra charge, provide an alternative IF band, such as 70 cm or even 10 meters. With a 10-meter IF you could use a common shortwave receiver to listen to the 2.4-GHz downlink.

Stay Tuned

Our therapy for Phase 3D microphobia continues next month with a journey to the magical land of 10 GHz!

QST