

## Getting Started on the Amateur Radio Satellites (Part IV)

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I trust you are enjoying this multi-part series of articles designed to take the mystery out of operating though Amateur Radio's current fleet of orbiting communications satellites. In this installment I'll quickly review some of the more sophisticated satellite tracking software that's currently available. I'll also share some tips on choosing a radio and accessories specifically designed for satellite work and then wrap up this latest getting started chapter with a final word about feed lines and connectors.

graphical interfaces. Some even send altitude and azimuth aiming data to your antenna rotators for the ultimate in hands off tracking. A number of these programs can also automatically tune your radio to the proper uplink and downlink frequencies to compensate for Doppler shift as the satellite of interest whizzes overhead.

The AMSAT Web site hosts an extensive archive of various satellite-related software programs (including tracking programs) for various computer platforms at: [www.amsat.org/amsat-new/tools/softwareArchive.php#pc](http://www.amsat.org/amsat-new/tools/softwareArchive.php#pc).

Keplerian Element download and voice announcements when satellites are in range, multiple world map projections with zoom capability, as well as support for a number of antenna rotator tracking interfaces.

For a small monetary donation to AMSAT, SATPC32 is currently available in either direct download or CD ROM format via the AMSAT Web site at: [www.amsat-na.com/store/item.php?id=100017](http://www.amsat-na.com/store/item.php?id=100017). You can also download a trial version of the latest release of SatPC32 from the author's Web site at: [www.dk1tb.de/downloadeng.htm](http://www.dk1tb.de/downloadeng.htm). However, this version requires you to re-enter your latitude and longitude every time you start the program. To fully activate your copy of SATPC32, you must obtain a registration code via the AMSAT online store or by calling Martha at the AMSAT office at 1-888-322-6728.

Tracking software for Macintosh users is also available from AMSAT for a small monetary donation. The current offering is MacDoppler, which provides a number of levels of station automation, from assisted Doppler tuning and antenna pointing right on up to fully automated satellite gateway operation. More information on MacDoppler can be found at: [www.amsat-na.com/store/item.php?id=100164](http://www.amsat-na.com/store/item.php?id=100164), or, again, by calling the AMSAT office.

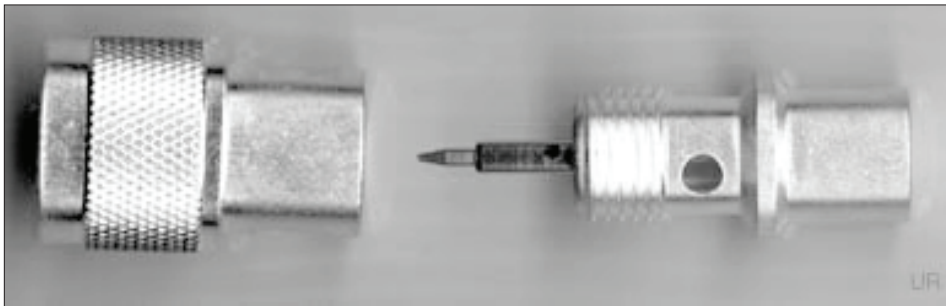


Figure 1: This two-piece, Type-N connector makes the age-old chore of working with N connectors a breeze. (Courtesy: Universal Radio) [Ed. - See the sidebar on the next page.]

### Tracking Topix

As I said in the kickoff article to this series, to listen for (or communicate through) an Amateur Radio satellite, you first have to know when it will be in range of your station. Fortunately, most of us now have computers in our operating positions to assist us with this (once rather arduous) task. Currently, organizations such as our own Radio Amateur Satellite Corporation (AMSAT) now offer Internet-based satellite tracking information in graphic form via our Web site ([www.amsat.org/amsat-new/tools/predict/satloc.php](http://www.amsat.org/amsat-new/tools/predict/satloc.php)). You can even get quick pass predictions from AMSAT simply by entering your Maidenhead grid square (or your latitude and longitude) into the online prediction engine at [www.amsat.org/amsat-new/tools/predict/index.php](http://www.amsat.org/amsat-new/tools/predict/index.php). However, if you are serious about satellite work, you'll eventually want to use something more permanent to run on your own home computer.

Over the years, PC-based tracking programs have become more sophisticated as the computing power available to run them has improved. Today, a number of them can track multiple satellites using highly sophisticated

[org/amsat-new/tools/softwareArchive.php#pc](http://www.amsat.org/amsat-new/tools/softwareArchive.php#pc).

For Windows 95/98/ME/NT/2000/XP/Vista/Windows 7 users, AMSAT also offers a superb tracking program called SATPC32 (See Figure 2). Written by Eric Eichmann, DK1TB, this program features automatic

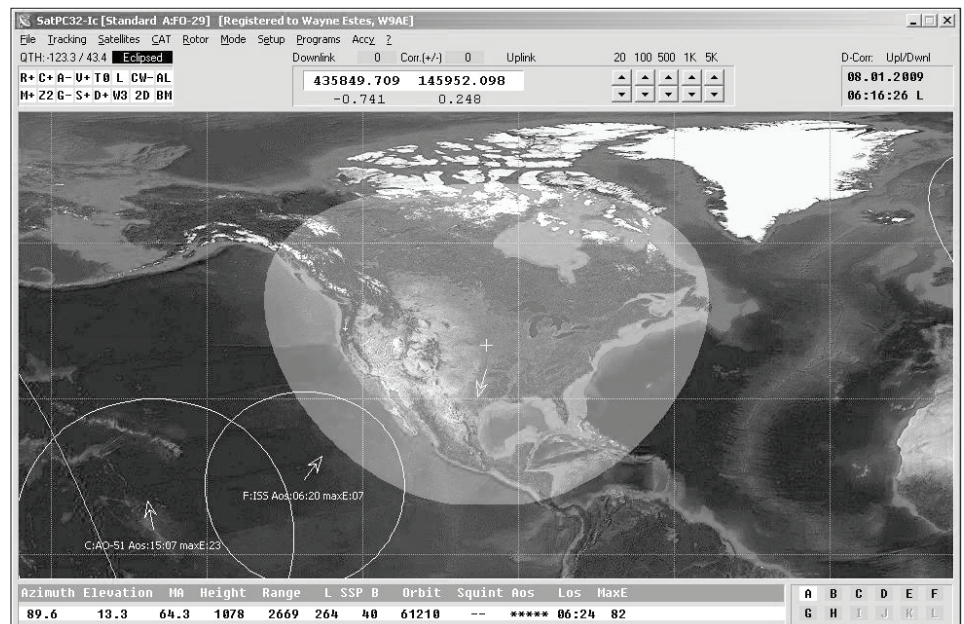


Figure 2: The SatPC32 tracking software package from AMSAT provides a graphic display of multiple satellites as well as a source to tune your radio for Doppler shift. It can also drive a rotator interface to automatically turn your satellite antennas. (Courtesy: AMSAT)





**Figure 3: The Alinco DJ-G7T/E is a 5w, dual band, hand-held FM transceiver that very nicely works the FM "birds". (Courtesy: Alinco Incorporated)**

### Feeding your Tracking Program

Whichever tracking program you ultimately choose, it is important to always keep your Keplerian element file up-to-date. That's because gravitational interactions of the Sun, the Moon and the Earth on orbiting satellites (as well as the residual air they encounter where they operate) all conspire to slow them down just a tiny bit on every orbit. Over time, these orbital changes will directly affect when a particular satellite will be in range of your station.

In addition, the crew of the International Space Station (ISS) periodically fires the station's onboard thrusters to change its orbit. Usually, this is done to move the ISS out of the way of space junk or to boost its orbit to keep it in space. If you are tracking the ISS, this action, too, will directly affect when the ISS will be in range of your station.

Because satellite orbits change over time, most veteran satellite operators update their Keplerian element files in their tracking programs once every few weeks or so. The AMSAT Web site ([www.amsat.org/amsat-new/tools/keps.php](http://www.amsat.org/amsat-new/tools/keps.php)) offers Keplerian element files for free download in a number of formats, including the more verbose AMSAT format (for manual tracking) to what are called NASA Two Line Elements suitable for file capture and later upload into your tracking software.

### Satellite Radios

As I've said in previous columns, while hand-held radios and antennas are great for hit or miss satellite contacts, if you are serious about satellite work, eventually you'll want something more permanent for your home station.

Over the years, several Amateur Radio manufacturers have offered base station radios specifically equipped to work the satellites. This equipment usually offers all-mode VHF/UHF capability and can also transmit and receive in full duplex mode,

meaning the radio has the ability to transmit signals on one band and simultaneously receive them on another. While not absolutely necessary, this feature makes it much easier to know if your signal is actually getting into (and through) the bird. It also helps you tune your radio to compensate for Doppler shift as the satellite whizzes overhead.

A good place to start your search for a satellite capable, full duplex radio is with a list painstakingly compiled by Andrew Koenig, KE5GDB, at: [http://thathamkid.com/fd\\_radios.html](http://thathamkid.com/fd_radios.html). While there are only a handful of new, full duplex radios on the market today, many older (but still perfectly functional) satellite-capable radios can still be found on the used market. Some time spent scouring the various Amateur Radio bulletin boards that offer used equipment (such as [www.qrz.com](http://www.qrz.com) or [www.eham.net](http://www.eham.net)) may pay off in a somewhat older, but still perfectly functioning satellite radio at a fraction of the cost of a new one.

And while a single, all in one, full duplex base station radio is nice to have, for many years I operated on the satellites using two separate radios. One was an all-mode VHF radio (a Kenwood TS-711A) and the other was an all-mode UHF radio (its 70 cm companion, the Kenwood TS-811A). And while I had to manually tune each of them to keep up with "Dr. Doppler", this setup still provided me with many hours of solid satellite radio time.

Likewise, if a full duplex, all-in-one box is beyond your means, you can still adapt a number of the all-mode VHF/UHF-capable base or mobile radios now on the new (or used) market for satellite work. For example, many satellite operators have very successfully adapted a pair of all-mode

### Finally, a Type-N Connector for the Masses!

PL-259 connectors are usually easy to assemble and solder. However, if you are like me, working with N connectors has always been problematic. The typical Type-N connector consists of up to 6 components, all of which must be carefully soldered and then seated to seal out moisture properly. However, no matter how carefully I assembled and installed feed lines using the old Type-N connectors, I often found that (particularly in outdoor applications) the slightest pull on the coax usually resulted in a detached (or shorted!) N connector.

Thankfully, innovation has now come to the rescue! (See Figure 1.) This two-piece N connector is a silver plated, gold tip connector of top quality that solders and assembles much like a PL-259. Yet, this version maintains most of the bumpless impedance qualities of the classic Type-N. Even the same UG175 and UG176 reducers for PL-259s can be used for smaller cable types.

Those of us who are all thumbs when it comes to working with coax connectors need never again struggle with a Type-N! A good source for this modern, PL-259-like version of the classic Type-N is Universal Radio in Reynoldsburg, Ohio. ([www.universal-radio.com/catalog/parts/nconn.html](http://www.universal-radio.com/catalog/parts/nconn.html)) as well as R & L Electronics in Hamilton, Ohio ([www.rlham.com/cgi-bin/shop/modellookup.dbw?MODEL=N9913](http://www.rlham.com/cgi-bin/shop/modellookup.dbw?MODEL=N9913)).

Yaesu FT-817 (so-called QRP) radios (or its more powerful cousin the FT-857) for both channelized FM and linear transponder satellite work ... one radio for the VHF/UHF uplink and one for the VHF/UHF downlink



**Figure 4: The Yaesu FT-847 is a 1990's-era, all-mode, HF/VHF/UHF base station radio that was specifically optimized for full duplex satellite work. While now out of production, it can sometimes still be found on the used market. (Courtesy: www.rigpix.com)**





Figure 5: The ICOM IC-910H is a late model, all mode VHF/UHF base station that was specifically optimized for full duplex satellite work. This radio has recently been dropped from the ICOM lineup in favor of a newer satellite-capable model. However, start looking for the '910H to show up on the used market. (Courtesy: www.rigpix.com)

(see photo on page 7).

As I said, unfortunately, fewer and fewer newly manufactured radios these days have the capability to operate in full duplex mode. But, fortunately, there *are* still a few of them on the market ... with more to follow.

### The Alinco DJ-G7T/E

Priced at about \$300 retail, the new Alinco DJ-G7T/E (see Figure 3 on previous page) is one such radio suitable for hand-held satellite operation on our FM birds. Besides being able to operate in full duplex mode on the 144 MHz, 430 MHz and 1200 MHz bands, it sports a 5w transmitter, 50 pair of programmable scan memories and a host of other bells and whistles of interest to the amateur satellite user.

### Kenwood's venerable TS-2000

As of this writing (early January 2011) the only base station amateur transceiver on the new equipment market that also enables full duplex satellite work is the

Kenwood TS-2000 (see Figure 6). Lately, thanks to Kenwood incentives, the radio can be purchased for substantially less than its current suggested retail price of around \$1700. It offers the beginning satellite user a superb value in a do everything rig. This HF/VHF/UHF all mode radio sports a 100w transmitter for HF through 2m (50w on 70cm), dual channel receive, digital signal processing (DSP), a 16 bit processor, built in TCXO for superb frequency stability, as well as a built in auto antenna tuner for 160 through 6 meters.

For satellite work, the TS-2000 uses 10 dedicated memory channels with the ability to synchronize the transceiver between either normal or reverse tracking of uplinks (transmitting) and downlink (receiving) frequencies.

### ICOM's new IC-9100

ICOM has been another strong supporter of the amateur satellite community over the years. Lately, they, too, have been filling

a high end niche with some outstanding satellite equipment. The bad news is that they recently discontinued sale of their very popular IC-910H VHF/UHF all mode base radio (see Figure 5). The good news is that they are now in the process of replacing the '910 with what promises to be an even more robust, all in one box satellite radio with their new IC-9100 (see Figure 7).

The '9100 is slated to provide 100w on all bands and all modes HF through 2m, and 75w on UHF. It will simultaneously receive on two different bands and will work as if there are two different receivers in one radio. The radio also sports 32 bit DSP and offers ICOM's increasingly popular D-Star, digital communications capability to boot.

In the satellite mode, the '9100 will synchronize uplink and downlink frequencies via 20 satellite memory channels that allow for storing operating modes and tone settings as well as other satellite-unique parameters. Again, as of this writing (early January 2011) sale of the IC-9100 in the United States was still awaiting FCC approval. Manufacturer's suggested retail price when it finally hits the shelves of dealers is expected to be in the \$4000 range.

Now, none of this discussion is intended to provide a personal (or official) endorsement of any particular manufacturer's radio. Just like those seemingly endless arguments about Ford versus Chevy automobiles, each of us has our own personal preferences about a particular manufacturer's radio equipment. The bottom line here is that you must still do your homework to learn which features each satellite-capable radio offers and how they all compare with what you can reasonably afford. That activity has *always* been an essential part of our Amateur Radio hobby, and shopping for radio equipment to work the birds is no exception.

### Preamps

As the downlink signal from these satellites is already weak when it strikes your antenna, another nice to have (but not absolutely necessary) addition to your base station setup is a receive preamplifier to boost the satellite's downlink signal. These preamplifiers (or preamps as we call them) come in many shapes and forms. Some are integrated into the radio itself (or into external, so-called brick amplifiers) while others are designed to be mast-mounted nearer to your antenna (see Figure 8).

Over the years, I've found the mast-mounted



Figure 6: The Kenwood TS-2000 is another all mode HF/VHF/UHF base station radio suitable for full duplex satellite work that is, as of this writing, still in production. (Courtesy: Kenwood USA)





Figure 7: Slated to hit the market “soon” is, ICOM’s IC-9100. Its 32-bit processor will work all satellite modes, HF through UHF with many additional “satellite friendly” features. (Courtesy: ICOM America)

variety are best because they boost the satellite’s weak downlink signal where it is strongest, that is, *before* any of that weak satellite downlink signal is lost in the feed line to your station. However, unless the preamp is specifically equipped with internal switching relays, it is VERY important to remember that transmitting a signal back through one of them will often prove fatal to the device. I’ve smoked more than one of these in my time this way!

### A Word About Connectors

While I have already discussed the importance of using a high quality, low loss feedline between your satellite antenna and your radio (and keeping that feed line length as short as practicable), it is also important to use the very best connectors you can afford. Just as with choosing your feed line, if you try to skimp on the connectors for the feed line connecting your antenna to your radio, you could loose a significant portion of your signal through those connectors as well.

Remember, every dB of attenuation that weak satellite signals encounter while traveling from your antenna to your radio is a bit of the downlink you won’t hear. A 3-6 dB loss from using cheap, HF-only rated coax and poor quality connectors can turn a marginal VHF or UHF downlink signal into one that simply isn’t there.

Connectors add to line losses by creating impedance humps that act like little resistors in the line. At HF (and to some extent at 6m and 2m) you can usually get by with using the common SO-239/PL-259 connector combination. However, at higher frequencies (such as at 70 cm and above where many of our Amateur Radio satellites operate) most satellite-capable equipment comes equipped with a Type-N connector (see sidebar). The type-N connector, when properly installed, will help minimize these small mismatches in the feed line which, in turn, will allow a greater portion of that (already weak) satellite downlink signal to make its way to

your operating position from your satellite antenna.

As I also noted in a previous column, it is critically important make sure that these connectors are well seated and well sealed when installed at your antenna. Otherwise, your coax will very quickly become waterlogged and then you’ll *really* have line losses to contend with! One popular method is to wrap electrical tape tightly around the connectors, or use one of the many available hand-moldable compounds sold just for this purpose.

### Wrap Up

I hope you are still enjoying this short series of satellite primers all designed to help get you started using our Amateur Radio satellites. But, now is *not* the time to stop your learning! The AMSAT Web site ([www.amsat.org](http://www.amsat.org)) offers a wealth of practical, hands on information (both free or for a small monetary donation) to help fuel your growing interest in the birds. What’s more, because of the publications and discounts on software and other items you receive when you join, a sustaining membership in (and additional supporting donations to) your national, non-profit AMSAT organization is always a good way to keep expanding your knowledge while also helping insure new Amateur Radio satellites will continue to be built and launched.

In future columns I’ll be exploring some other aspects of amateur satellite operation as well as some more information on how our Amateur Radio satellites get their names.

See you then. 🌐



Photo 1: AMSAT’s Keith Pugh, W5IU, uses a pair of Yaesu FT-817 QRP rigs (one for the uplink and one for the downlink) for his Dayton Hamvention satellite demonstration station. (Courtesy: KB1SF)

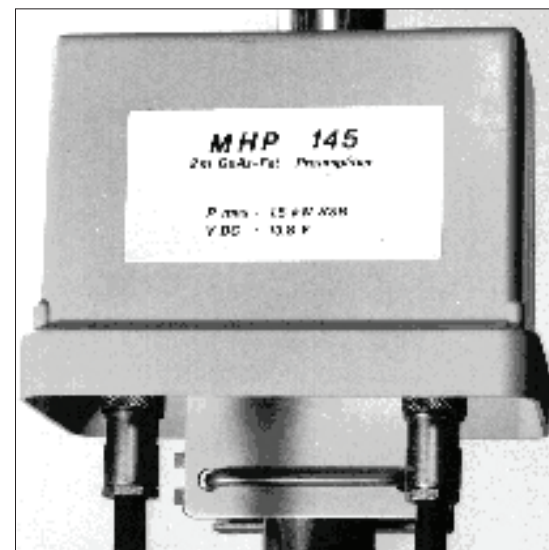


Figure 8: Mast-mounted preamps, such as this one from SSB electronics, boost weak satellite downlink signals at the antenna feed point where those signals are strongest. (Courtesy: SSB Electronics)

