**Newcomers and Elmers Net: Satellites: Yes You Can! 10.5.14**
**Most Material Drawn From:**
**http://www.amsat.org/?page_id=1869**

## Tracking the Birds

To listen for, or communicate through, an Amateur Radio satellite you first have to find out when it will be within range of your station.
-- Fortunately, most of us now have a computer in our ham shacks and access to the Internet so tracking satellites has become much easier than it used to be.

Today, several satellite-tracking programs are available in shareware or for purchase, as well as in a variety of different computer formats.
-- a number of Web sites related to amateur satellite operation now have online tracking programs that make rough tracking a snap.
-- once you've loaded your location (latitude and longitude), the current time along with the Keplerian element files into your satellite tracking software, the computer then solves the complex orbital math to make a prediction of where a selected satellite should be at the current (or a future) time.

Because they are such a vital ingredient to this part of our hobby (and because they age over time) finding a reliable source for the latest Keplerian Elements for Amateur Radio satellites should be high on your list of things to do as you get started in satellite work. Keps are often listed on many Amateur Radio Internet Web sites.

The AMSAT-North America Web site lists the latest Keps in a variety of downloadable formats
-- it also has an embedded online tracking feature which allows you to simply plug in your latitude and longitude (or your Maidenhead Grid Square) to find out when those satellites of interest to you will next be in range of your location.

## Beacons

Probably one of the first things you will learn to do after you find out when a particular satellite will be within range of your station is to listen for the satellite's beacon.
-- Most satellite beacons consist of one or more transmissions coming from the satellite that will assist you in your search as well as tell you other things about the satellite's health and the nature of its transponders.
-- Satellite beacons operate in many modes, from Morse code to a variety of digital formats, and can usually be found on frequencies immediately above and/or below the satellite's other downlink frequencies.

-- In addition, as most satellite beacons transmit with a fixed amount of output power, they can also serve as a superb reference point for setting up and calibrating your station antennas and other equipment.

-- Most satellite telemetry signals, which consist primarily of ransmissions about the health of the satellite, are also sent to ground controllers by way of the beacon.
-- What's more, some satellites even provide information regarding their transponder schedules, along with other items of interest to satellite operators, using their beacons.
-- However, in the case most of the FM satellites, the single channel downlink is itself, the beacon.

**Transponders**
Now that you have a reliable way to know when the satellite is within range of your station and you've familiar with its beacon, you next have to learn how to use its transponder.
-- A transponder is the circuit that receives your uplink signal and then retransmits what it hears via its downlink transmitter, much like an FM repeater.
-- However, unlike a terrestrial FM repeater, which has a specific input and output frequency in the same band, most amateur satellite transponders receive and then retransmit what they hear on another frequency (or frequencies) on another amateur band entirely.
-- In short, most amateur satellites act much like cross-band repeaters in the sky.
-- What's more, as a satellite is a moving target, signals being passed through it will exhibit a pronounced Doppler shift, just like the changing pitch of a train whistle as it approaches and then passes.
-- During a satellite contact, as the satellite approaches you, both uplink and downlink frequencies will appear higher than those published.
-- As the satellite passes overhead, both the uplink and downlink frequencies will then appear to slowly drop in frequency than those published.
-- And, as if that weren't confusing enough, this apparent frequency shift will seem to be more pronounced on the higher frequency (shorter wavelength) amateur bands than on the lower ones.

This is why listening first and getting comfortable moving the antenna, hitting the right frequencies, and shifting as needed is so useful
-- save the transmitting attempts until all of this becomes at least somewhat familiar to you

**Operating Modes**

One of the terms you will soon come across in satellite work will be a reference to the mode of a satellite's transponder.

-- A satellite's operating mode is nothing more than a shorthand way veteran satellite operators identify the various combinations of uplink and downlink frequencies available for use.

-- Back in the old days of satellite operating, one or more letters of the alphabet were used to designate satellite transponder modes. You may still hear some people refer to satellite modes in this way

-- For example, if a satellite's uplink frequency was on 2 meters and its downlink frequency was on 70 cm, the satellite was said to be operating in "Mode J".

-- An uplink on 70 cm with a downlink on 2 M was called "Mode B", and so on.

Today, because so many satellites with different uplink and downlink transponder combinations are now in orbit, a somewhat more complex system that includes the first letter of the band in use (VHF, UHF, SHF, etc.) has emerged.

-- As a result, the old "Mode B" has now been renamed "Mode U/V" because the satellite's uplink transponder receiver is tuned to UHF and its downlink transmitter is set for the VHF bands.

-- Likewise, the old "Mode J" has now been dubbed "Mode V/U" and so on.

**Schedules**

Most amateur satellites operate on a published schedule that lists when its various transponders will be switched on and off and at what times.

-- As some satellites have multiple transponders, it's very important to always check the published schedule for the satellite before you attempt to use it.

-- During a typical month, traffic on the transponders might be FM voice, Slow Scan TV (SSTV), low power (QRP) FM operating and/or the digital modes.

-- By looking at the schedule you'll know when to expect the various modes and at what frequencies they'll be operating.

**Equipment**

Contrary to what you might believe, you don't need a super powerful FM transceiver and a huge antenna to work the birds. In fact, many amateur satellite operators) have sometimes met with success using just a simple dual-band hand-held radio and an antenna with just a bit more gain than the ordinary "rubber duck."

However, because the UHF downlink output power on these "EZ sats" is usually pretty weak (often less than 1 watt) you'll have far better success if you can create some signal gain on the downlink.
-- Several people have "rolled their own" Yagi satellite antennas using nothing more sophisticated than a series of trimmed coat hangers mounted on a block of wood. You can find all kinds of plans on the Internet

Others prefer a commercially made, hand-held antenna from someone like an Arrow II Satellite Antenna or the Elk 2m/440 Log Periodic, which are great for hand-held radio satellite work, and are very well constructed

most amateur satellites operate in what's called true duplex or full duplex mode, meaning that the uplink receivers and downlink transmitters are both operating at the same time.
-- It is helpful (but not absolutely necessary!) for your ground-based equipment to do so as well. By operating your station (or your hand-held) in full duplex mode, you will get immediate feedback that the satellite hears you because you will actually hear your own uplink signal coming back down to you on the downlink.
-- even if you don't have a full duplex radio, you can still get in on the fun of working these satellites by using two separate radios, or a radio that can transmit on the satellite's uplink and another radio that can receive the downlink.
-- If there is enough gain in your antenna, the latter radio can even be a hand-held or other programmable VHF/UHF scanner of some sort.

**Setting Up Your Radio**
Now that you have found out what time of day a satallite will be in range of your location and you have assembled the equipment and antennas to do so, you are almost ready to make your first contact.
-- But, first, you'll need to program your radios so as to take into account the Doppler shift that we discussed earlier. If your radio has programmable memories, it's a good idea to program one or two additional frequencies into the memory bank above and below the published uplink and downlink frequencies.
-- These can be used as the satellite first moves toward you and then away from you as it passes overhead.
-- For example, if an operating downlink frequency is listed in the satellite's operating schedule on the AMSAT Web site as 435.300 MHz, you should program memories into your radio for 435.320 and 435.310 on the high side and 435.290 and 435.280 MHz on the low side of the published downlink frequency.

Likewise, if the uplink frequency is listed as 145.920 MHz, you should program memories for 145.925 and 145.930 MHz on the high side and 145.915 and 145.910 on the low side of the published uplink frequency.
-- Also, like many of today's terrestrial repeaters, a number of our FM satellites require a CTCSS tone for access be sent on the uplink, so be sure and determine if the satellite you want to use requires one and set your radio accordingly.

For a whole lot of reasons that are well beyond the scope of this discussion, the Doppler shift is more pronounced as the operating frequency increases.
-- This means the Doppler shift will appear more pronounced on a downlink frequency than on a 2M uplink.
-- most often simply switching between the programmed 435 MHz downlink frequencies as the satellite passes overhead is usually enough to keep the satellite's downlink on frequency.

**Power: How Much is Enough?**
The issue of power is a relative one. It depends on the number of other people using the transponder; how much uplink gain you have in your antenna system, and how close or far away (overhead vs. at the horizon) the satellite is compared to your location.
-- Usually, a 5-watt HT will work if the satellite is not heavily used
-- A satellite is much like a terrestrial repeater mounted on a 500-mile high tower. With only one channel, it can get very busy, particularly on weekends.
-- On some days, a 5-watt, dual band HT and an extended rubber duck antenna are sufficient for a quick contact on a near-overhead pass.
-- On the other hand, during some busy weekend satellite passes, even an external Yagi and 50 watts of power isn't enough to overcome the high-powered uplinks of some operators.

**Working in the Footprint**
Many satellite programs will give you something of a view as to how big of a footprint the satellite will have, in other words, what kind of coverage range you can expect during a pass
-- this may allow you to work north or south, or even across the Atlantic
-- if you are working a satellite need the horizon edge for your location, chances are you will need more than 5 watts.
-- as the satellite gets closer overhead, the lower power will be fine

**Putting it All Together**
When you are first starting out, it's probably also best to pick a satellite pass that will put the satellite close to being nearly overhead (90 degrees) of your location. So, look for those pass elevations in the table that are well above 45 or 50 degrees. These will be your targets of best opportunity.

**What to Listen For**
Now, it's time to actually listen for the satellite. At the appointed AOS time, step outside, turn your radio(s) on and set it (or them) for one of the frequencies on the upper side of what's published for both the uplink and downlink.
-- Then, wait for the satellite to pop above your horizon. If you are using a Yagi antenna of some sort, aim it at the horizon in the direction of the AOS prediction and start sweeping the antenna back and forth horizontally.
-- Be sure to turn the radio's squelch on the downlink frequency off and (carefully!) listen for the radio to quiet.
-- Once it does … congratulations … you'll be listening to your first satellite in orbit some 500 miles above Earth!
-- You may want to practice tracking the satellite with your antenna and simply listening for the rest of that satellite pass (or a few more) to get a better idea of how the conversations flow on the bird.
It is important to remember that, not only is the satellite rapidly moving toward and away from you, which is causing the observed Doppler shift in frequency, the satellite is also slowly tumbling in orbit. So, at multiple times during each pass, its transmit and receive antennas will be cross-polarized with yours, which, in turn, will create a significant loss in signal strength.

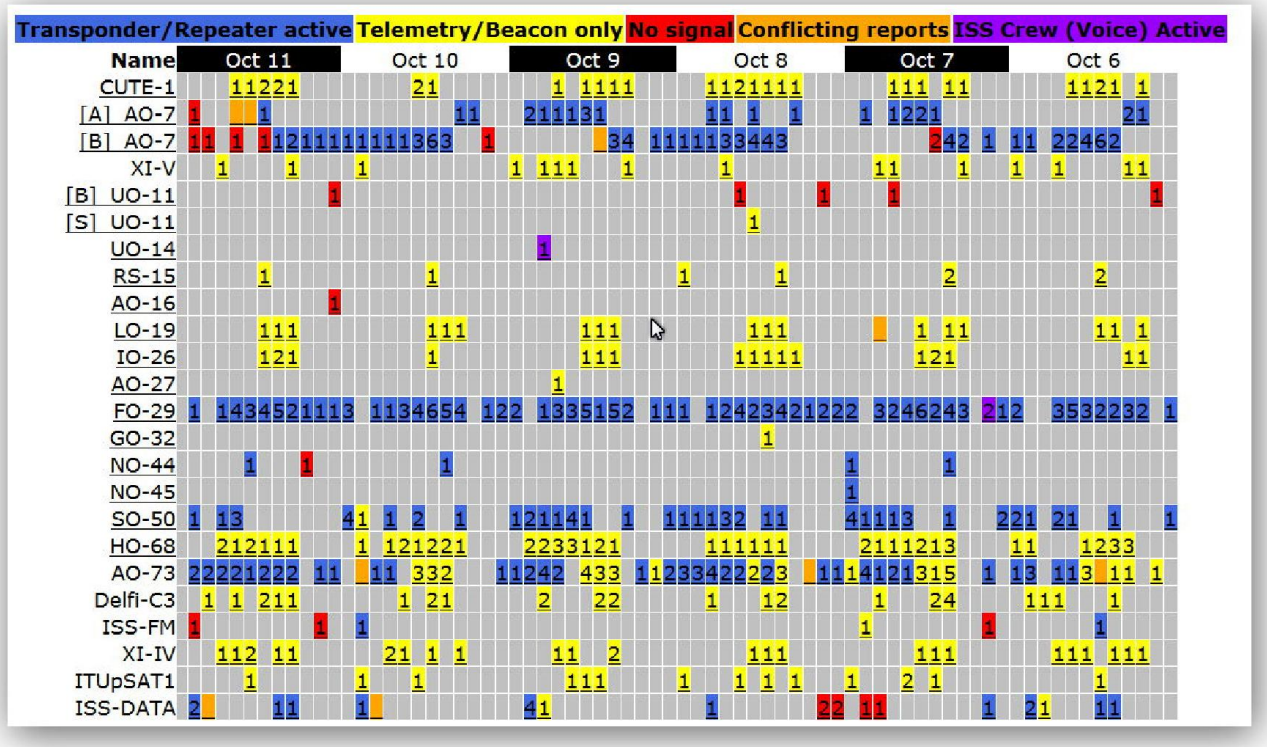
If the satellite signal fades (or the down link gets garbled) try switching downlink frequencies on your radio up or down. Twisting or moving your antenna around to better match the satellite's changing antenna olarization with yours should also help.
-- During the pass, you'll probably hear one or more hams simply saying hello or exchanging their Maidenhead Grid Square numbers. -- Indeed, most conversations on satellites are usually very brief "hello – and – goodbye" exchanges similar to an HF DX exchange so as to give the many others listening in, a chance to work the bird.
-- As you might guess, long-winded rag chews are not welcome on the FM birds.

**It's Showtime!**
When you've gathered up enough courage to actually try your hand at making a contact (and if you are using the same radio in full duplex mode on

the uplink and downlink) you also need to make sure you are using a speaker separated from your microphone.
-- This can be an earpiece or an external speaker of some kind.
-- In full duplex mode, using a microphone and a speaker located right next to each other (such as on a handheld) will cause howls of feedback … through the satellite!

However, once you are ready to try your luck at actually making a contact, simply wait for a pause in the action and then (quickly!) drop your call sign in between contacts.
-- Hopefully, you will immediately hear your own signal on the downlink, a discovery that will provide immediate confirmation that you are, indeed, getting in. But, please refrain from calling CQ because, just like causing long distance feedback and rag chewing, calling CQ on the FM birds is considered another amateur satellite protocol no-no.

But, regardless of how, where and when you do it, the first time you hear your own voice coming back down from a satellite (or someone answers your call), the thrill will be much like your very first ham radio contact, shaking hands, sweaty palms and all!




**Current Reported Contacts with Various Satellites**