A Primer For
Little LEO Amateur Satellites

By
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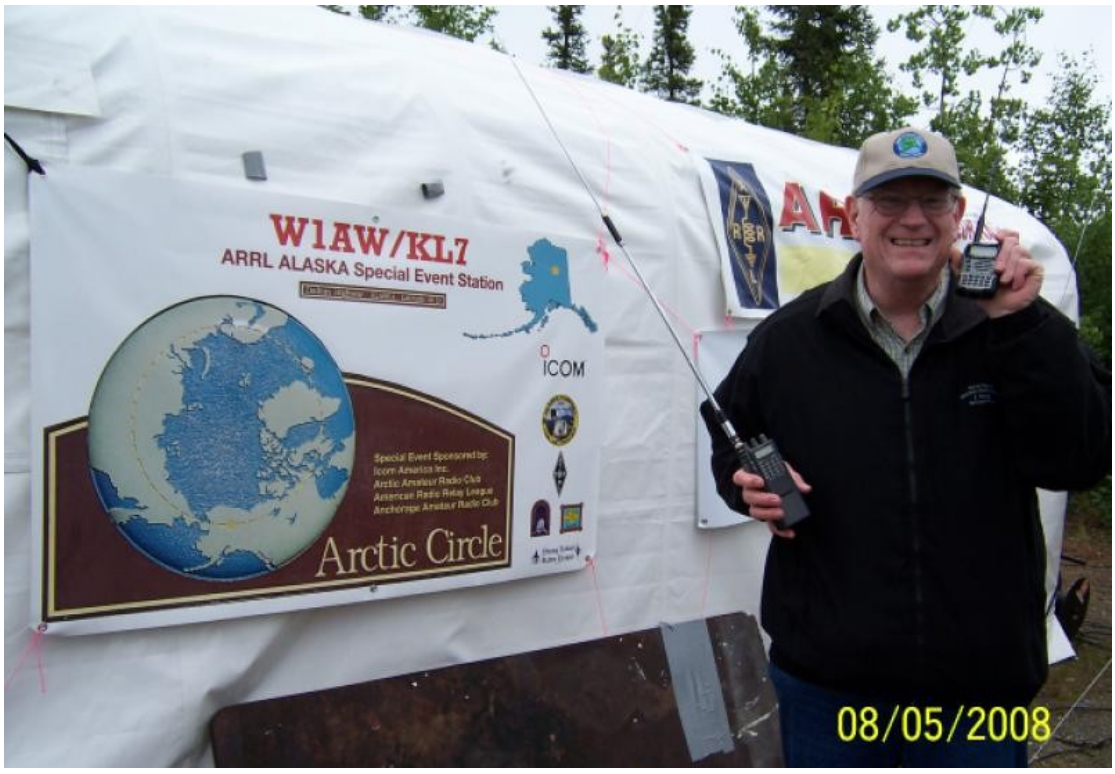

Dan O'Barr, KL7DR operates LEO satellites from the W1AW / KL7
Arctic Circle Special Event Station, August 5, 2008.

Operating Amateur LEO Satellites

There are thousands of man-made satellites circling the earth. Details of each one would take volumes. This is not a history or an in depth analysis of space communications but a simple explanation of how to operate my favorite "birds". I have often compared talking on Amateur LEO satellites to riding a bicycle because you have to do 3 or 4 things at once. It takes some basic equipment, some knowledge, a little help from someone who has done it, and lots of practice. It's not real hard to do, but it is a little complicated. So like learning to ride a bicycle, it helps to have a teacher get you started.

Let's look at the equipment first. My favorite radios are the small 5 watt dual band handy-talkies. I haven't had good luck with anything that puts out less than 2 watts. You can use a 2-meter HT or mobile to uplink and a UHF scanner or HT for the downlink. Also, Dual band mobiles such as the Yaesu FT-8800R, the Alinco DR-605, or the Kenwood TM-D710A do great too. Of course the full-blown base station satellite rigs work the best. Then you will need an antenna. My two favorites are the Prime/Premier/ANLI AL-800 telescoping whip and the Arrow Model 146/437 dual band Yagi. These two are meant for portable field use, which is the way I like to operate the satellites. I haven't operated from a mobile or base station very much so I can't give a lot of details about them. Of course you can operate these satellites the very best from base stations that were used to operate the old satellites and information about them can be found elsewhere. You can also operate these birds mobile on the high passes (say over 45 degrees) with a dual band mobile or handheld and a short dual band mobile antenna. Better yet for mobile antennas are separate VHF and UHF quarter wave whips and what works even better are separate eggbeater or turnstile type antennas with a pre-amp on the UHF receive antenna. The eggbeaters and turnstile type antennas also work quite well for base station use.

The knowledge you need first is: how to operate your radio, if it will do full duplex, and if it will, using headphones to prevent feedback. There is nothing more annoying than having someone operating the bird that can't hear it, unless it's someone operating without headphones in full duplex causing all kinds of squealing and feedback problems. You need to know if you can operate cross-band with the VFO's. If not, you will have to store channels in your radio on the frequencies, with the sub-audible tones that I supply with the charts. Some of the most important things to know are what frequencies to receive and transmit on, and a good understanding of the Doppler Effect. These satellites travel at over 14,000 miles per hour so you have to compensate by changing the frequency of your receiver. As the satellite is approaching you, the signal is compressed and appears higher. When the bird is straight overhead, or even with you, it is right on; as it leaves you, the signal is stretched out and appears lower. Think of when a train blows its whistle as it passes you and how the pitch lowers as it goes by. That is the Doppler Effect. This is why I list 5 channels for each satellite. Even though they don't change frequency, you have to because of the Doppler Effect. The last things you need to know are when and where to point your antenna. For that you need a computer program that does the pass predictions, or get the information off the Internet. I try to keep the latest pass predictions centered on Wasilla, AK posted at our groups web site at: http://groups.yahoo.com/group/gahleos/ and on my personal web site at: http://gahleos.obarr.net. For other places, you will need to get them from http://www.heavens-above.com or do your own predictions.

Here is how to read my charts: KL7DR's Orbit Calendar For AO-51.

	(Acquisition Of Signal) AOS		MAX ELEVATION			(Loss Of Signal) LOS	
DATE	ADT	AZI	ADT	AZI	EL	ADT	AZI
2Apr11	5:02:55p	157	5:10:15p	47	85	5:17:48p	343
The date.	The time and direction that it comes up.		The time, direction and height when it's at its highest on this orbit.			The time and direction that it goes down.	

Some basics about the Birds:

Most LEO satellites are in Polar Orbits. That means they cross overhead near both the North and South Poles on each orbit with speeds of approximately 14,400 miles per hour. They are approximately 500 miles (800 km) high when directly overhead and over 2,000 miles (3,200 km) away when near the horizon. You need to know where North is, because that is where the Polar Orbit birds come up on some passes and North is where they go down on other passes.

AO-51 sometimes requires a 67.0 Hz sub-audible tone on your transmit signal to pass audio (same tone as SO-50). The uplink frequency is 145.920 MHz and the downlink frequency is 435.300 MHz + and - 10 KHz for Doppler Effect.

SO-50 is also known as SaudiSat-1C, and it's a bird of a different feather. It has many attributes similar to other LEOs such as AO-27, and AO-51. It even has the same frequencies as AO-27--436.800MHz down and 145.850MHz up. However, SO-50 does have 4 major differences, and it has a weaker downlink signal. Those of you who have operated other satellites, and know how to compensate for the Doppler effect and track the satellite (do the satellite dance), should be able to make the changes necessary to operate SO-50 with little effort.

1. SO-50 is not in a polar orbit, so it is important to know the azimuths (directions) that it comes up (AOS), reaches its Maximum Elevation, and where it goes down (LOS), and the time of each pass. Its path of travel is quite different from the polar orbit birds.
2. In the beginning, SO-50 required a "Control Operator" to turn it on. It has an onboard timer that shuts it off ten (10) minutes after an operator turns it on. It is now available to all Amateur Radio operators world wide, and any operator can switch on the Mode J transponder. Just send a short transmission on the uplink frequency of 145.850 MHz with a 74.4 sub-audible tone to activate the repeater.
3. Then to operate it: switch to a 67.0Hz sub-audible tone (also known as CTCSS, PL, or CG) on your uplink signal.
4. After it is turned on, SO-50 operates just like a cross-band repeater that requires a 67.0Hz tone. Even when it is activated, it will not transmit until it receives an uplink signal with a 67.0Hz tone on it. Then it takes about a ½ second for it to start transmitting back. So please key your mic, pause, take a deep breath, and then start talking. Also, SO-50 has no squelch tail, so unless you are operating in full-duplex or there is someone else operating it, you will never hear it.

Questions and Answers:

Here are some questions I've received by E-mail with answers I've sent back.

Q. From NL7AK: I want to use AO-51 and SO-50 but I have not been able to get on down here. I think that I have my times wrong and was wondering if you still had the address for the pass predictions page on the Internet.

A. http://gahleos.obarr.net, but also try this one http://www.heavens-above.com/ . AO-51 transmits (down-links) on 435.300 MHZ + & - 10 KHZ for Doppler and it receives you (up-links) on 145.920 MHZ. SO-50 Transmits (down-links) on 436.795 MHZ + & - 10 KHZ for Doppler and it receives you (up-links) on 145.850 MHZ. Please work on hearing the birds on their down-links before transmitting on the up-link and you won't interfere with any other ongoing QSOs. Good luck and happy Hamming.

Q. From VY1BM in Canada: Hello Dan, I recently met Craig Bledsoe KL4E who introduced some of the local Hams to his Yaesu handheld and his arrow handheld satellite antenna. Some of us are in the process of putting together equipment so that we can try using the satellites. Craig suggested that I request that you put me on your mailing list so that we can access the orbit calendars for SO-50 and AO-51. So here I am. I would greatly appreciate it if we could get this info on a regular basis.

Looking forward to hearing from you. Thank you in advance for your help with this matter and hope to hear you on the satellite in the near future. Brian - VY1BM

A. Hi Brian, I'll try to attach the current ones I have for AO-51 and SO-50. These are predictions for Wasilla AK in Alaska Time, so you will have to make adjustments for where you are located. I post them on my web page at: http://gahleos.obarr.net. I just can't e-mail them anymore. Also check out: http://www.heavens-above.com where you can get more info as to when the birds are overhead in your area. Hope to hear you on the Birds

73, Dan O, KL7DR

Q. From KL7RLB: Dan, I appreciate your passing on to me the info for the satellite comms. I have been following your instructions at meetings, on the air, etc., but have never been quite ready to participate until now. The arrow 2m/440 yagi is ready to go and so is the HT. In addition to sending me the flyby data for the two birds, please tell me how you make the charts or could you direct me to the web page where you get the info, I may be able to download it for myself. Dick Block, KL7RLB

A. Hi Dick, I can no longer E-mail the pass prediction charts. Please check my web page at: http://gahleos.obarr.net. I have a DOS program called "Predict" that KL7AE set up for me to run these charts. Also check out: http://www.heavens-above.com/main.asp?Loc=Anchorage&Lat=61.218&Lng=-149.900&TZ=NAST

73, Dan O, KL7DR

Many years ago, Herb Krieger, AA2PI hkrieger@crnwireless.com asked a lot of good questions. He later rode a bike from Fairbanks to Deadhorse and I talked to him 2 or 3 times most every day for almost two weeks on UO-14. He used a Kenwood TH-78 and the AL-800 telescoping whip antenna and I used an ICOM IC-31 with the Arrow antenna. He wrote: "Please excuse my ignorance about satellites. I always wanted to get involved and now I have a good reason to, and I need a little help".

No problem. Just wait till the satellite bug bites. Good Luck and 73, Dan

Q. Which satellite do you think will be better for me?

A. UO-14 (Now it would be AO-51.)

Q. Do these satellites come from the North toward the South thereby having my AOS slightly earlier than what is shown on your chart?

A. They both come over the North Pole headed toward the Sun on every orbit. Daytime passes come from North to South. UO-14 is the only one on at night and then it travels South to North. Therefore if you are in Deadhorse, the daytime AOS will be a little sooner and night time passes will be a little later than here in Wasilla.

Q. Are the frequencies shown on your charts the satellite's TX and RX or my TX and RX?

A. Yours; program them into your radio.

Q. What frequencies should I start at for the beginning of a pass?
A. 435.080 MHz for UO-14, 436.805 MHz for AO-27 and SO-50, and 435.310 MHz for AO-51.

Q. Approximately what signal level should I expect?
A. Very weak. Run the squelch open and listen for quieting.
(SO-50 works like a repeater with no squelch tail.)

Q. Do I hold the HT's antenna at any particular angle?
A. Broadside to where the bird is.

Q. Does the satellite continuously transmit or does it respond only to input?
A. Most satellites transmit continuously when they are on. UO-14 is on 24 hours a day and AO-27 is on only in the daylight. However UO-14s audio is louder and its receiver has an open squelch so its signal sounds just like your open squelch unless someone is talking on it. With AO-27 you can move your antenna around and optimize on the quieting of your receiver.
(SO-50 works like a repeater with no squelch tail.)

Q. How do I announce my presence on the satellite's frequency?
A. Just give your call-sign occasionally unless you are running full-duplex with a headset and can hear your own voice coming back, then you can call CQ just like HF.

More neat stuff:

http://gahleos.obarr.net
http://groups.yahoo.com/group/gahleos/
http://www.amsat.org/
http://www.qsl.net/kd2bd/predict.html
http://web.me.com/clintbradford/Work-Sat/Home_files/satbr11.pdf
http://www.ptsi.net/user/kc5jdg/mm27.html
http://www.heavens-above.com/
http://www.clarc.org/ArticleRepo/uhf2.pdf
http://kd4app.webhop.org/
http://www.amsat.org/amsat/news/wsr.html#so-50
http://www.qsl.net/n5afv/
http://www.eham.net/ehamforum/smf/index.php/board,26.0.html
http://www.spacetoday.org/Satellites/Hamsats/HamsatsBasics.html
http://www.arrl.org/files/file/Technology/tis/info/pdf/0004036.pdf
http://www.amsat.org/amsat-new/echo/
http://www.g6lvb.com/Articles/operatingAO51.htm
http://www.youtube.com/watch?v=1HfvmU_utI8
http://en.wikipedia.org/wiki/AO-51
http://www.n2yo.com/satellite.php?s=27607
www.amsat.org/amsat-new/satellites/satInfo.php?satID=4&retURL=/satellites/status.php
http://www.umbrasi.com/AO27/index.shtml
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