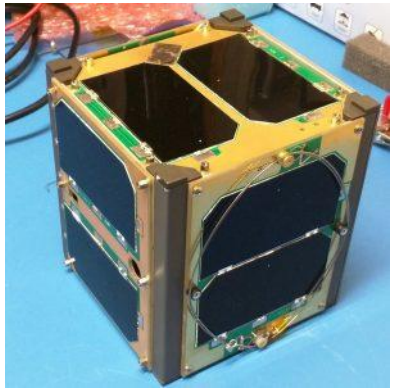
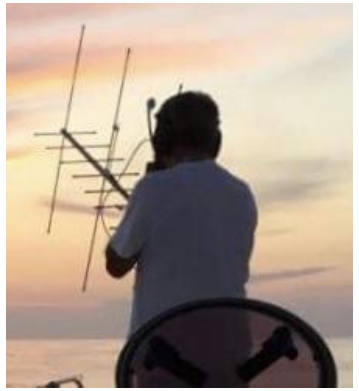
How to Make Your First FM Satellite Contact!

Loudoun Amateur Radio Group

Presented by: Steve Greene, KS1G, ks1g@amsat.org

8/21/2021





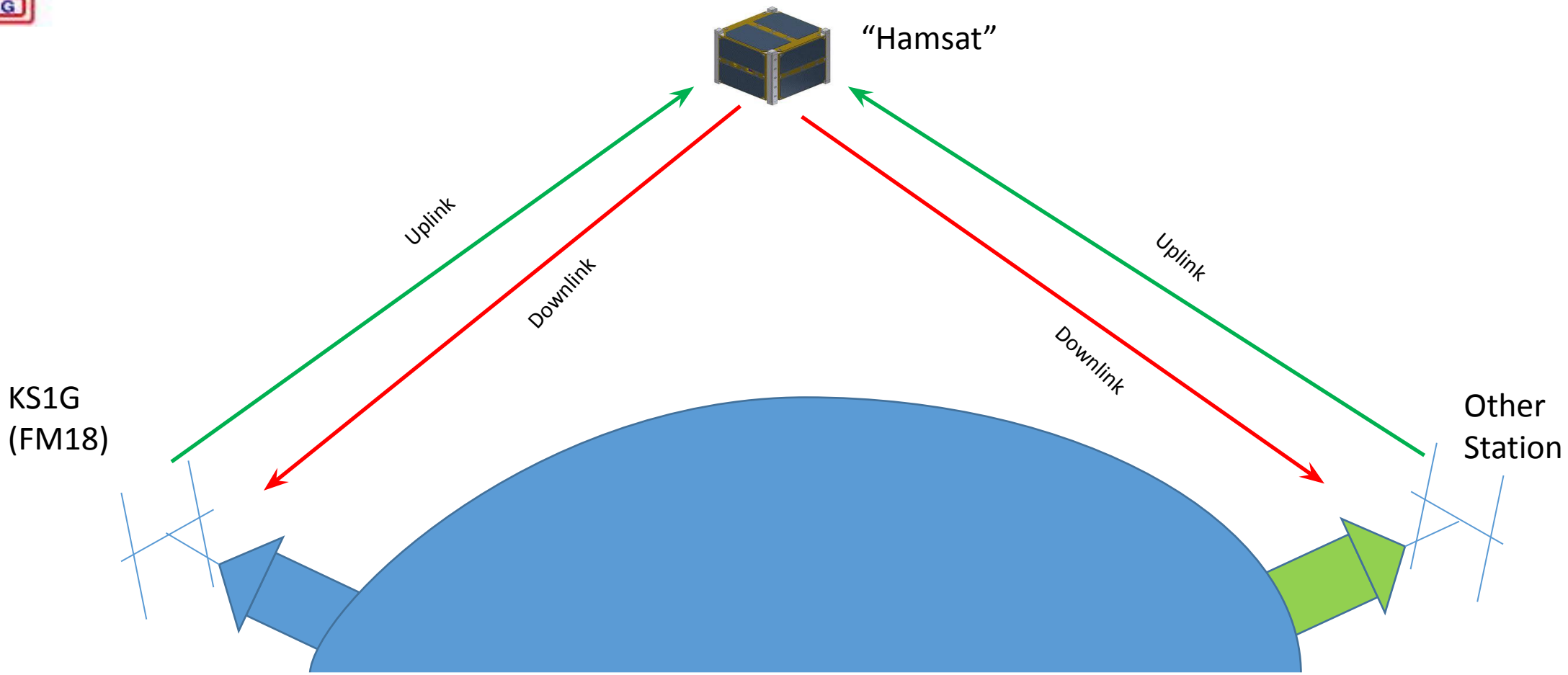
TL;DR* Version (*Too Long; Didn't Read)

- Why - FUN!
- Radio - Two dual-band HTs (*maybe* one, keep reading)
  - Or a dual-band, full-duplex FM mobile
- Antenna: Get an Arrow or Elk
  - Or build a "CheapYagi" or tape measure beam
- Program Radios for satellite frequencies, CTCSS tones
  - Usually - 1 VHF frequency, 5 UHF frequencies to tune Doppler shift
- Useful: Headset, Voice Recorder
- Predict satellite passes - Phone App, PC, or Website (time, direction, elevation)
- Practice, Practice, Practice
  - Skills: Antenna Pointing, Polarization Twist, Doppler Correction, LISTENING
- 1st QSO: Pick less congested time/direction
  - Quick calls, use phonetics, persistence pays off
- HAVE FUN!

Why Try Satellites?

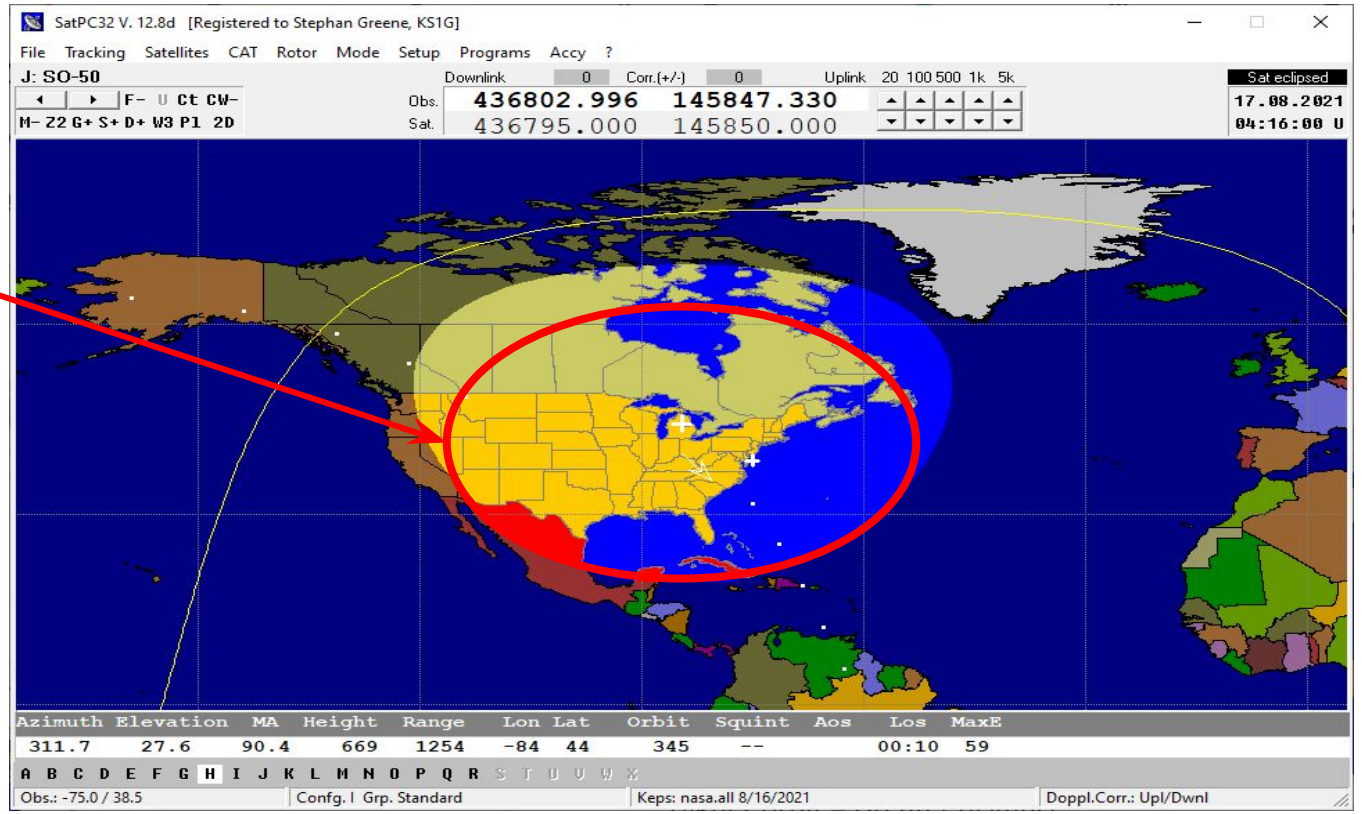
- FUN!
- Something new for your FM gear
- Chase Awards & Wallpaper
  - VUCC, Grids, WAS, …
- Be The DX!
  - Roving, SOTA, POTA, IOTA,...
- STEM activity with younger family members
  - ISS SSTV, SATNOGs, Weather Satellites, Geography, Space Sciences…
- Because it's there….

A Repeater In the Sky!...



…with a **BIG** Footprint!

SO-50 can cover
most of North America



- Higher orbit = Greater distance
- On some (CW/SSB) satellites, you can work stations in Europe!

What You May Think You Need...

LARG Satellite Trailer, BIG antennas, preamps, rotator,...

And a Satellite Radio

Well Maybe…
(KS1G Winter FD 2021)

You Don’t Need Much

HT + Arrow Antenna

Dual HT + Arrow (AC0RA)

HT + Elk (KS1G)

Which Satellites Can You Use?

(These are the current FM birds available as of August 2021)

Satellite (Year launched)	What	Uplink (TX)	Downlink (RX)	"Mode" and Availability
AO-91 (2017)	FM	70cm	2M	U/V DAYTIME ONLY!
AO-92 (2018)	FM	70cm	2M	U/V DAYTIME ONLY!
AO-27 (1993!)	FM	2M	70cm	V/U (3 ½ Min/Pass)
SO-50 (2002)	FM	2M	70cm	V/U (24x7)
PO-101 (2018)	FM	70cm	2M	U/V As scheduled (usually weekends)
LilacSat (2015)	FM	2M	70cm	V/U Irregular Schedule
ISS	FM (APRS)	2M	2M	V/V see ARISS Schedule
ISS	FM	2M	70cm	V/U see ARISS Schedule
ISS	FM	N/A	2M	SSTV (Rx only for us) see ARISS Schedule

See https://amsat.org/status for current operating information. https://www.amsat.org/two-way-satellites/ for list of satellites
https://www.amsat.org/fm-satellite-frequency-summary/ for frequencies

What do you already have?

- A 2M/70cm HT?
- A 2M/70cm Mobile?
- An HF+VHF/UHF “all mode”?

HTs for Satellites

- **Start with what you already own**
- Best: Kenwood TH-D72A - full duplex, dual band
  - Sadly, no longer in production and $$$ on used market
- Great: Most Icom/Kenwood/Yaesu, some Alinco “dual band HT”
- May Be OK: Woxun, Baofeng, TYT, ...
- A good source - Satellite Radios List by WD9EWK
  https://www.dropbox.com/sh/v3byggtuqw33fkk/AAAamatWbd9657AQfXhM6-wPa/Articles/Full-duplex_radios_for_satellites.xlsx?dl=1

FM Mobiles

- Many mobile radios are dual-band, full-duplex
  - Can it simultaneously transmit on one band & receive on the other? You are all set!
  - Kenwood TM-D710 is excellent, the built-in TNC gives you ISS APRS and FS-3 as a bonus
  - Kenwood TMV-71 available new

AD7DB Roving in DN20 with a TM-D710 (in the green box) and Elk antenna

- See WD9EWK Satellite Radio list for more suggestions

https://www.dropbox.com/sh/v3byggtuqw33fkk/AAAamatWbd9657AQfXhM6-wPa/Articles/Full-duplex_radios_for_satellites.xlsx?dl=1

“All Mode” Compact HF+6/2/70cm Rigs

- Half of a FM/CW/SSB/Data station
  - Add an HT or Rx (SDR?)
  - Computer control (CAT/CIV)
  - FT-100, FT-817, FT-818, FT-857, IC-706, etc….
  - Operate half-duplex (TX or RX but not at same time) w some challenges

K2ZA’s “FT-1634”

- 2 x FT817, FT818, (aka “FT1634/1636”), or IC-705 all popular with portable satellite ops


WL7T’s “IC-1410”

“Satellite” Radios

- All you need in one box
  - New: IC-9700 ($$$)
  - Used: IC-821, IC-910
  - Used/Good for fixed/home use: IC-9100, TS-2000, FT-736, FT-847

N1RM caught me in an action pose :)

On Skyline Drive

You **REALLY** WANT Two Radios/Full Duplex

- Hear your downlink while transmitting
  - Did I get in?
  - Was I "stepped on?" Did I step on someone else?
  - How good is my signal? Fading? Audio level?
- Good 2nd Radios (FM):
  - Best: Many I/K/Y Dual-band HTs
  - Dedicated Receivers (Alinco DJ-X11T, Icom R6)
  - Maybe: Some Chinese radios prone to UHF Desense (limits using the AO-27, SO-50, ISS Repeater). Use for 2M uplink
  - See WD9EWK list for which models work better
- Plan B (1 radio): May be good enough to start if you can program VHF/UHF split in memories (but you won't know if/how well you are getting in unless someone else listens/tells you)

Antennas

- Rubber Ducks - JUST NO! Whips - ISS Reception, *maybe* a few QSOs. Not recommended to start out.
  - Try and see how much you can hear (goal is as much of pass as terrain allows)
- Other Omnis - Challenging, may work in low noise locations
  - Turnstile, Crossed-Moxon, Lindenblad, Quadrifilar Helix - home brew
    - Many designs are on-line, QST, Amsat Journal, etc.
- **Medium-gain Yagis - the sweet spot**!
  - Commercial: **Arrow** (cross-yagis), **Elk** (log periodic)
    - Arrow - get the split-boom model, QRP diplexer up to you (not needed if using 2 HTs)
    - "Alaskan" Arrow - not needed
  - Homebrew: WA5VJB CheapYagi "Arrow Style", Tape measure yagis
    - https://www.work-sat.com/ewExternalFiles/W6NBC-Beam.pdf (from QST)
  - Many designs on-line, QST, AMSAT Journal/website
  - Use good feedline - LMR-240UF, RG-8x. RG-58 if you must, keep it short!

Useful Accessories

- **Headphones** - hear better, eliminates audio feedback on transmit
  - Better: Headset with PTT switch
- Voice **recorder** - record downlink/your own voice, playback later to log pass
  - Your phone (repeat back the other station's call & info to get recorded)
  - Better - voice recorder in line w downlink audio, radios (FT3D) with built in recorder
- **Cheat sheet** of satellite frequencies & settings
  - See KE0PBR Blog, AMSAT, Work-Sat.com
- **LiFePO4 Batteries** (Bioenno) - for using a mobile further than a picnic table
- **Bag or harness** to hold stuff
- **Pass Prediction**: Phone App or printout of pass data
- Optional (YMMV)
  - Tripod
  - Lightweight antenna boom (W8LID "Lid Stik", VE3HLS Carbon Fiber boom)
  - **Diplexer for single-feed antenna, "Mode J" filter**
  - Preamp (UHF) - probably not

Jargon

Satellite “Modes”:

- Shorthand identifying which frequency bands the satellites uses
- Old - Alphabet A, B, J, K, L, S…
- Modern - Uplink Band/Downlink Band
  - “V” VHF, 2M, 145-146 MHz (“B” old style)
  - “U” UHF, 70cm, 435-438 MHz (“J” old style)
- Current FM satellites are all “V/U” or “U/V” (ISS digi is “V/V”)

Orbit Stuff:

- Keplerian Elements: Data set used to predict satellite passes
- AOS: Acquisition of Signal, start of pass
- TCA: Time of Closest Approach (also max elevation)
- LOS: Loss of Signal, end of pass
- Doppler Shift: Apparent change in frequency due to relative motion of satellite

Program Your Radio

- Memories: Tx frequency, Tone, Rx frequency, tuning step (5kHz)
- Program center frequency and tune, or step through memories during the pass to handle Doppler shift

AO-91 Memory Programming		
Memory Channel	Transmit* (+ 67Hz Tone)	Receive
#908 "AO-91 AOS 2"	435.240 MHz	145.960 MHz
#909 "AO-91 AOS 1"	435.245 MHz	145.960 MHz
#910 "AO-91"	**435.250 MHz**	**145.960 MHz**
#911 "AO-91 LOS 1"	435.255 MHz	145.960 MHz
#912 "AO-91 LOS 2"	435.260 MHz	145.960 MHz
#913 "AO-91 RX"	-	145.960 MHz

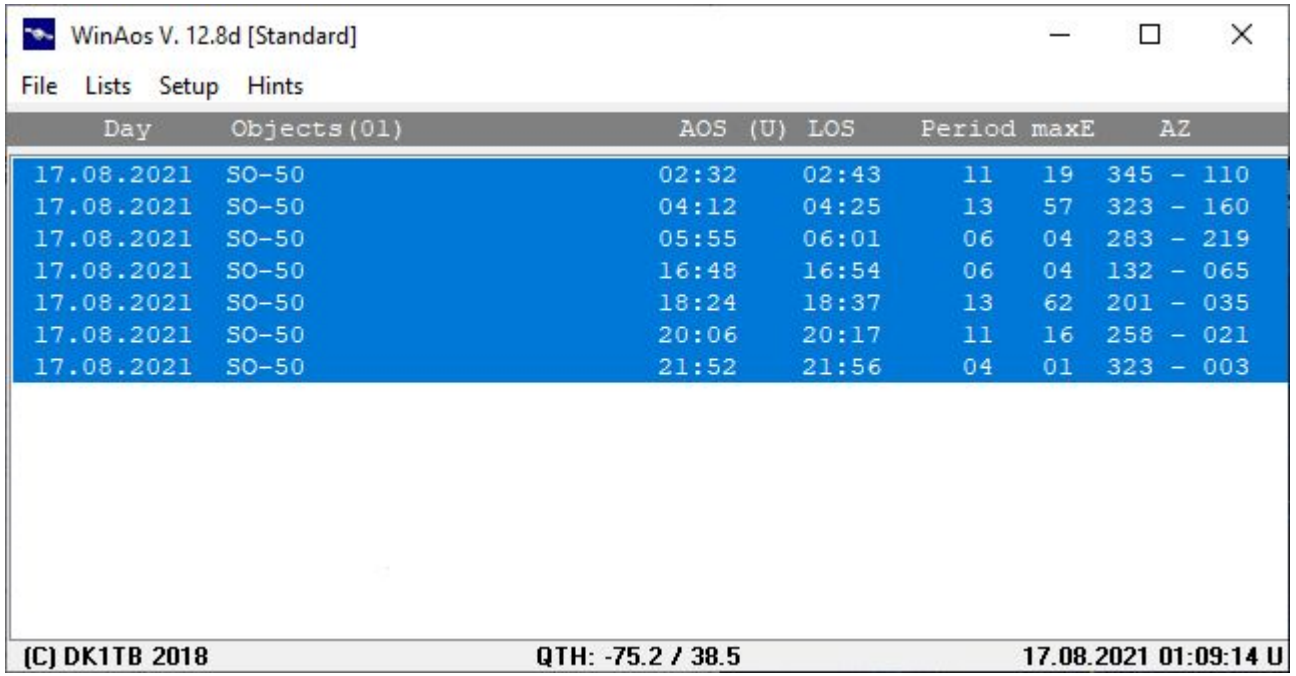
Using 1 radio? Program 5 memories with the appropriate RX and TX frequencies. For AO-91, they have the same 2M RX frequency and the listed 70cm TX frequencies and tone. Label like the example as you can't see the TX frequency until you transmit.
I know many Yaesu radios support this. Not sure about Icom or Kenwood or others.

See https://www.amsat.org/fm-satellite-frequency-summary/ for center frequencies for all FM satellites
Fox-1 Operating Guide from the AMSAT Station and Operating Hints page:
http://www.amsat.org/?page_id=2144 , also **https://www.amsat.org/fm-satellite-frequency-summary/**
Work-Sat.com Frequencies: http://www.work-sat.com/Home_files/EASY-SATS-3Q-2017.pdf
*** See end of presentation, AMSAT.org, and work-sat.com for more info.**

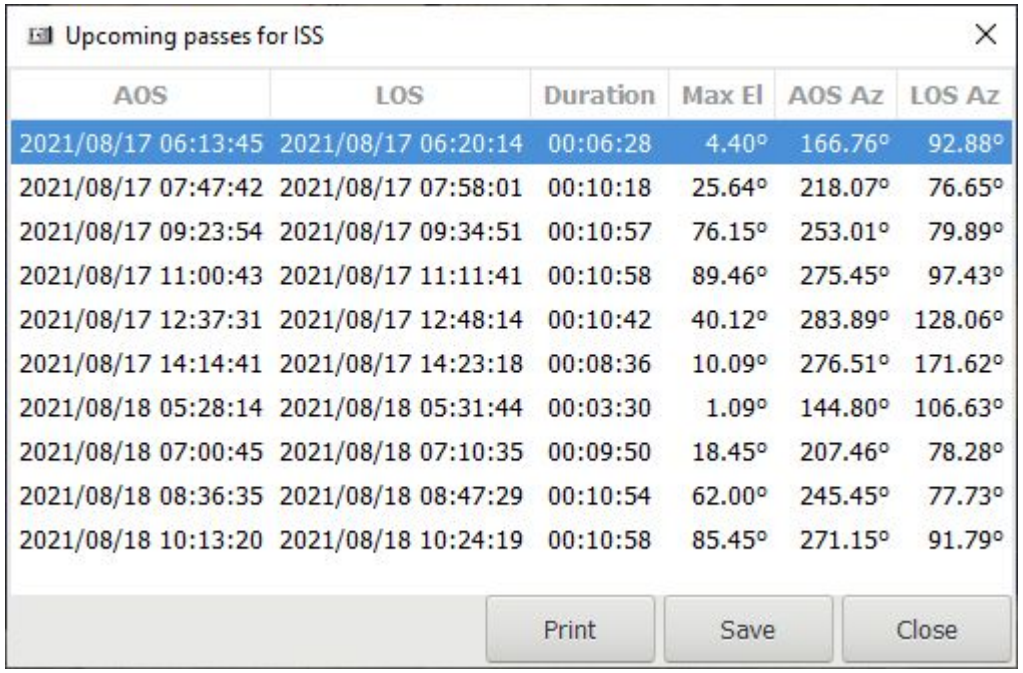
When? Pass Prediction Tools

- **Needed**: Your location (Lat/Lon, 4 or 6 char grid square), current data ("Keps"), some idea when you want to operate
  - Phone/tablet apps get location from internal GPS
  - Android App: GridSquare (by US1PM)
  - Keplerian Elements - d/l or live updates (~1-2 weeks old usually OK)
  - ACCURATE TIME (and know your UTC offset)
- **Web**:
  - amsat.org/pass, satmatch.com, Amsat Argentina, N2YO, Heavens-Above
  - Print out pass information to use in field:
  - **Satellite, Time, AOS Azimuth, Max Elevation & Azimuth, LOS Azimuth**
- **PCs**: SatPC32, GPredict, MacDoppler, Ham Radio Deluxe, SDR Console
  - Download current set of Keplerian Elements
  - Print out pass information to use in field
- **Phone/Tablet**: Android: ISS Detector, Look4Sat, AMSAT Droid;
  iOs: GoSatWatch

Example Pass Prediction



SatPC32 / WINAOS



GPredict

Example Pass Prediction (Websites)

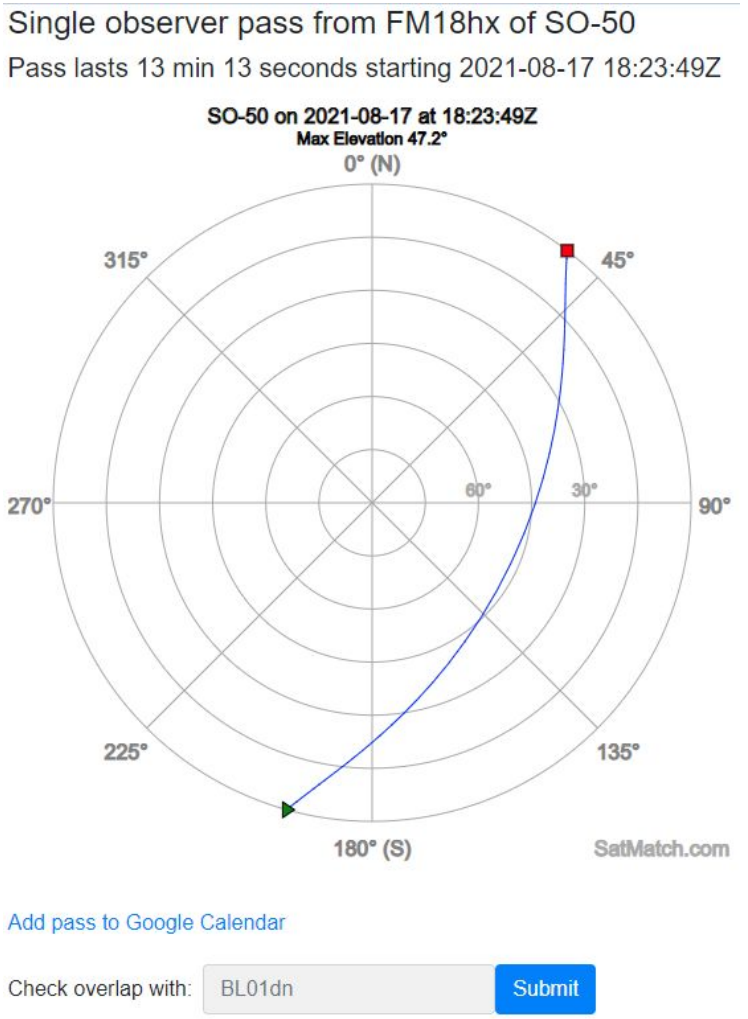
AMSAT Online Satellite Pass Predictions - SO-50

View the current location of SO-50

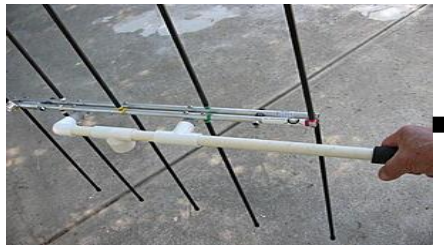
Date (UTC)	AOS (UTC)	Duration	AOS Azimuth	Maximum Elevation	Max El Azimuth	LOS Azimuth	LOS (UTC)
17 Aug 21	02:31:03	00:12:12	342	16	40	104	02:43:15
17 Aug 21	04:11:01	00:14:05	326	70	265	156	04:25:06
17 Aug 21	05:53:10	00:08:56	296	6	255	216	06:02:06
17 Aug 21	16:48:36	00:05:00	124	2	98	79	16:53:36
17 Aug 21	18:23:51	00:13:13	196	47	110	38	18:37:04
17 Aug 21	20:04:59	00:12:17	249	20	307	20	20:17:16
17 Aug 21	21:50:18	00:06:15	309	3	335	5	21:56:33
18 Aug 21	01:16:07	00:08:52	350	6	31	70	01:24:59
18 Aug 21	02:55:37	00:13:35	336	33	61	125	03:09:12
18 Aug 21	04:36:07	00:13:14	317	28	234	177	04:49:21

https://www.amsat.org/track/index.php

Satmatch.com



Hook it Up - U/V FM: AO-91, AO-92, PO-101



Elk Antenna

Diplexer
(If Needed)

70cm (**Tx**)

2M (**Rx**)

Tracking App

Recorder

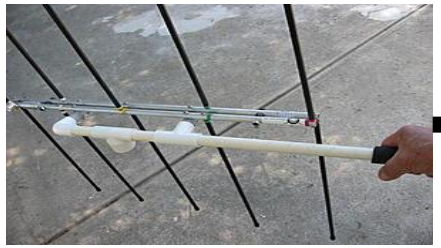
Headset, PTT

- For an Arrow Antenna: separate coax runs to VHF and UHF sides.
- 1 radio (THD72A or half-duplex) use one feedline (Elk); or diplexer and split feed to elements. Arrow sells a 10W internal diplexer for their antenna.

Color-code cables to reduce chance of errors

Hook it Up - V/U: SO-50, AO-27, ISS, LilacSat2

Reverse the Mode U/V Tx and Rx bands
for SO-50, AO-27, ISS Repeater, other Mode V/U



Elk Antenna

(may help
with de-sense)

Diplexer

70cm (**Rx**)

2M (**Tx**)

Tracking App

Recorder

Headset, PTT

- For an Arrow Antenna: separate coax runs to VHF and UHF sides.
- 1 radio (THD72A or half-duplex) use one feedline (Elk); or diplexer and split feed to elements. Arrow sells a 10W internal diplexer for their antenna.

If needed - Diplexer helps filters out 3rd harmonic of 2M uplink (“Mode J Filter”) to reduce desense
Color-code cables to reduce chance of errors
DO NOT TRANSMIT INTO PREAMP! (if used)

Operating Hints *Single-Channel FM satellites*

- Location, time, time zones correct in your tracking software!
- Is it active? (http://amsat.org/status, Twitter, amsat-bb emails)
- Listen, Listen, Listen! Rx Squelch *OFF*. TX Volume *Minimum*. Full Duplex or 2 HTs if you can.
- Use Minimum Power (5W + directional antenna usually sufficient, often less)
- Tune Doppler Shift on 70cm. TX Tunes Up, RX Tunes Down
- 2M usually OK fixed frequency.
- "Twist" hand-held antenna for polarity/best signal
- Contest Style QSOs; exchange Call, Grid
  - CALL A SPECIFIC STATION. DON'T CALL "CQ"!
- Leave time for other ops. Listen for HTs, Mobiles, rare Grids,…
- See AMSAT-BB, Twitter, Facebook for operating schedules, help, …

SAMPLE QSO	
Me	Other Station
	WX4XYZ, EM63
WX4XYZ, KS1G, FM18	
	KS1G, WX4XYZ, QS , EM63
W4XYZ, copy EM63 Thanks!	
	73s

DO's and DON'Ts

Time is the #1 Commodity

Everyone is Sharing ONE frequency for 10-15 minutes OR LESS!

Do:

- Practice before working a pass
- Listen, Listen, Listen!
- Twist antenna for best reception
- Call a specific station
- Use phonetics
- Record info as you hear it - use other QSOs to prefill call, grid
- Ask for repeat of info if you do need it
- QSL on LoTW

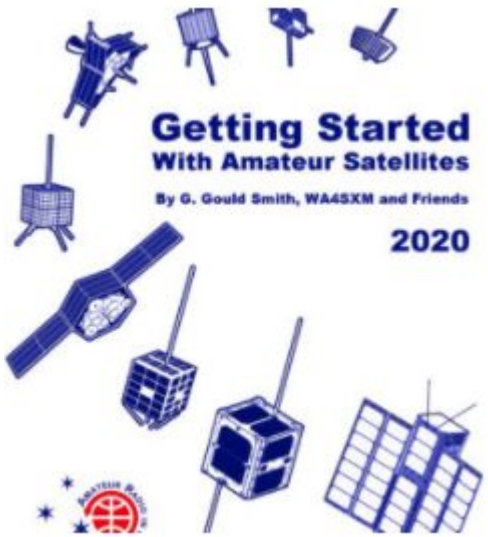
Don't:

- Blind Call (it's QRM)
- Call CQ (or long CQs)
- Whistle, "Hello Radio", ...
- Ragchew on a busy pass
- Ignore Who Else is On (esp. when rare grid Rovers!)
- Run 100W because you can!
- Forget to QSL

Tips for a Successful First Satellite QSO

- Pick a less-busy time
  - Weekends and early evening busiest
  - Weekdays and late nights less crowded
  - Use geography - passes over Atlantic are less crowded
  - PO-101 (when on) and sometimes AO-27 may be less crowded
- Be aware of the satellite schedule, status
  - Announced: PO-101 (Twitter), ISS (ARISS website)
  - Short: AO-27 (3.5 minutes each pass, mid-latittudes)
  - Daytime Only: AO-91, AO-92 (weak batteries, DO NOT USE AT NIGHT)
- Time Correct? (Local vs UTC)
- SQUELCH OFF (Downlink), Mute Uplink
- Practice listening first - handling radios, antennas, Doppler tuning, etc.

AMSAT Services

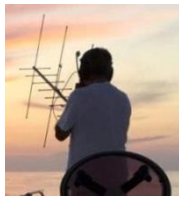


Join Today: http://amsat.org/shop

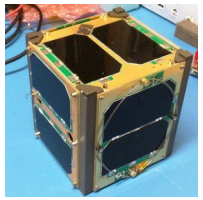
Education!

Publications!

Awards!



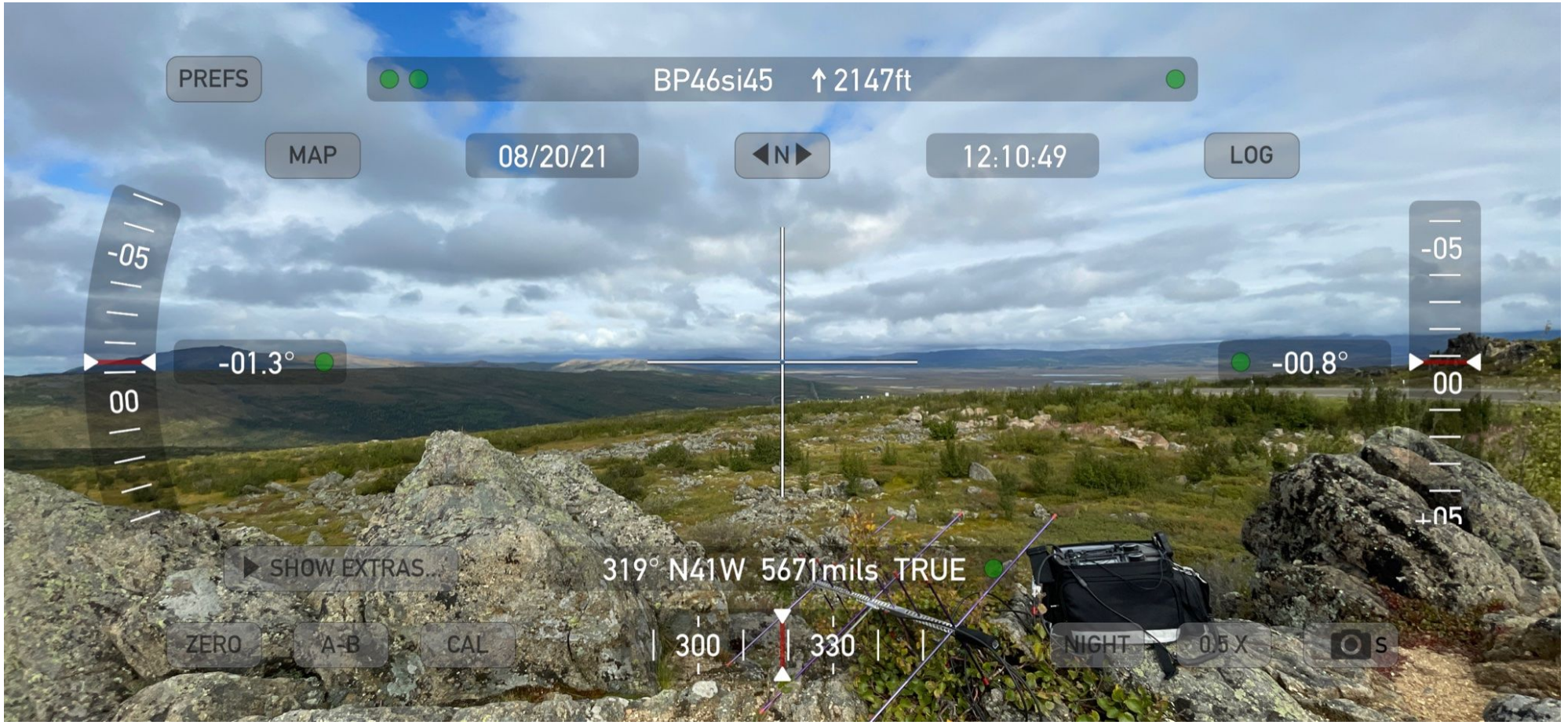
Technology!



For Further Reading

- AMSAT Guides for New Operators
- Weblinks & Information
- Equipment Suggestions
- Programming HT Guide
- The Wisdom of WD9EWK

Wishing You Clear Horizons, Dry Weather, and Great Reception (a cool QTH helps!)



WL7T Roving in Alaska, 8/20/2021

AMSAT Guides for New Operators

https://www.amsat.org/station-and-operating-hints/

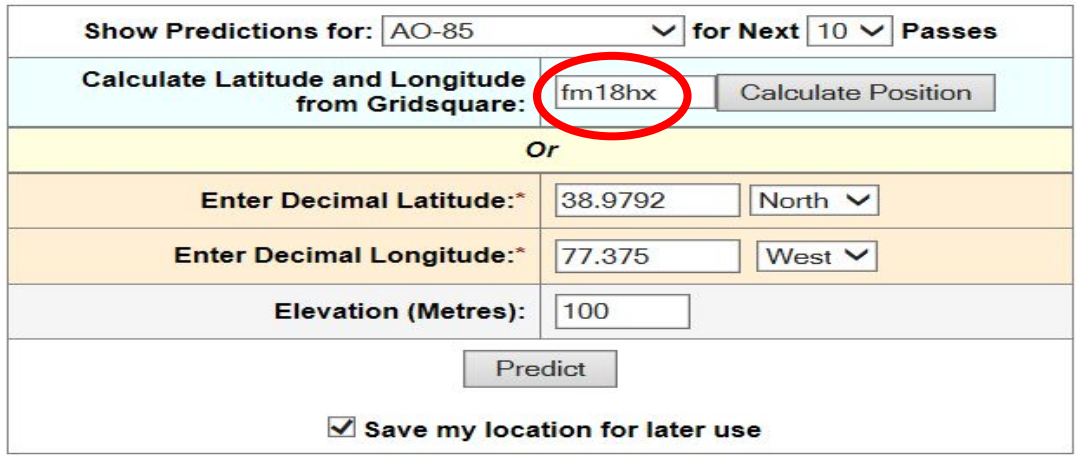
- FOX-1 Operating Guide
- Best Practices for FM Satellite Operating
- https://www.amsat.org/fm-satellites-good-operating-practices-for-beginning-and-experienced-operators/
- Going Portable with the Amateur Radio Satellites (AMSAT Journal May/June 2017)
- Operating FM Satellites (2013, still useful)
- ARISS:
  - Get on the Air with ARISS Packet (2017)
  - Working Digipeaters with the Kenwood TH-D72A and TH-D74A (2017)
- Antennas, LOTW logging, Mode J (V/U) filter, Doppler tuning, more…

Weblinks and info (some links may need updating, use search tools)

- **AMSAT-NA: http://www.amsat.org**
  - Intro: https://www.amsat.org/introduction-to-working-amateur-satellites/
  - Station and Operating Hints: https://www.amsat.org/station-and-operating-hints/
  - Fox Project: https://www.amsat.org/meet-the-fox-project/
  - AMSAT-BB Email Archives: http://www.amsat.org/pipermail/amsat-bb/ (search: use Google "site:")
- **Work-Sat:** http://www.work-sat.com
  - Programming HT for FM Satellites *(see slide 21);* http://groups.yahoo.com/group/Work-Sat/
- **Tracking, Operating Status:**
  - **AMSAT**: http://www.amsat.org/track/index.php, SatMatch: https://www.satmatch.com/ N2YO: http://www.n2yo.com/ , Heavens-Above: http://heavens-above.com/AmateurSats.aspx, AMSAT-AR: http://www.amsat.org.ar/pass.htm
  - **Operating Status**: http://www.amsat.org/status/
- **Elmering**:
  - AMSAT Area Coordinators (nearby in Maryland-DC) http://www.amsat.org/amsat-new/information/ac.php
  - http://www.papays.com/sat/general.html
  - AMSAT-BB email, Facebook, Twitter
- **QRZ.com, Eham.net:**
  - QRZ.com Satellite and Space Communications Forum: https://forums.qrz.com/index.php?forums/satellite-and-space-communications.69/
  - Eham.net Satellites Forum: https://www.eham.net/ehamforum/smf/index.php/board,26.0.html
- **Social Media:**
  - AMSAT Facebook Page: https://www.facebook.com/groups/7828379515/
  - AMSAT Twitter Feed: https://twitter.com/AMSAT , many other AMSAT groups & individuals
- **QST Magazine, AMSAT Journal**
  - Articles on satellite operations, Rovering; April 2018 (page 67).
- **ISS APRS & FalconSat (APRS-capable FM radios)**
  - https://andrewbnortham.com/ke8fzt/d72-satellite-aprs-quick-reference/

Using the AMSAT Prediction Page

- http://www.amsat.org/track/index.php



AMSAT Online Satellite Pass Predictions - AO-85

View the current location of AO-85

Date (UTC)	AOS (UTC)	Duration	AOS Azimuth	Maximum Elevation	Max El Azimuth	LOS Azimuth	LOS (UTC)
02 Feb 16	20:40:34	00:08:50	305	4	329	14	20:49:24
02 Feb 16	22:26:15	00:05:28	345	1	357	27	22:31:43
03 Feb 16	00:06:56	00:11:02	344	9	22	79	00:17:58
03 Feb 16	01:47:00	00:14:23	333	43	49	132	02:01:23
03 Feb 16	03:27:57	00:12:56	315	22	263	186	03:40:53
03 Feb 16	16:00:20	00:13:43	171	21	116	46	16:14:03
03 Feb 16	17:39:34	00:15:29	223	54	297	28	17:55:03
03 Feb 16	19:22:50	00:12:18	273	11	312	17	19:35:08
03 Feb 16	21:09:11	00:06:32	326	2	338	16	21:15:43
03 Feb 16	22:52:35	00:07:31	347	3	12	47	23:00:06
04 Feb 16	00:32:40	00:12:53	340	16	35	101	00:45:33
04 Feb 16	02:12:57	00:14:30	327	81	230	153	02:27:27
04 Feb 16	03:55:04	00:09:42	301	8	262	214	04:04:46
04 Feb 16	14:49:33	00:08:01	130	4	105	67	14:57:34
04 Feb 16	16:25:13	00:15:14	194	49	117	37	16:40:27
04 Feb 16	18:06:12	00:14:43	244	26	296	23	18:20:55
04 Feb 16	19:50:59	00:09:47	296	6	334	14	20:00:46
04 Feb 16	21:37:16	00:04:52	342	1	354	19	21:42:08
04 Feb 16	23:18:26	00:10:03	345	7	24	69	23:28:29
05 Feb 16	00:58:29	00:14:05	336	32	54	123	01:12:34

Other on-line tracking

N2YO: http://www.n2yo.com/

Heavens-Above: http://heavens-above.com/AmateurSats.aspx

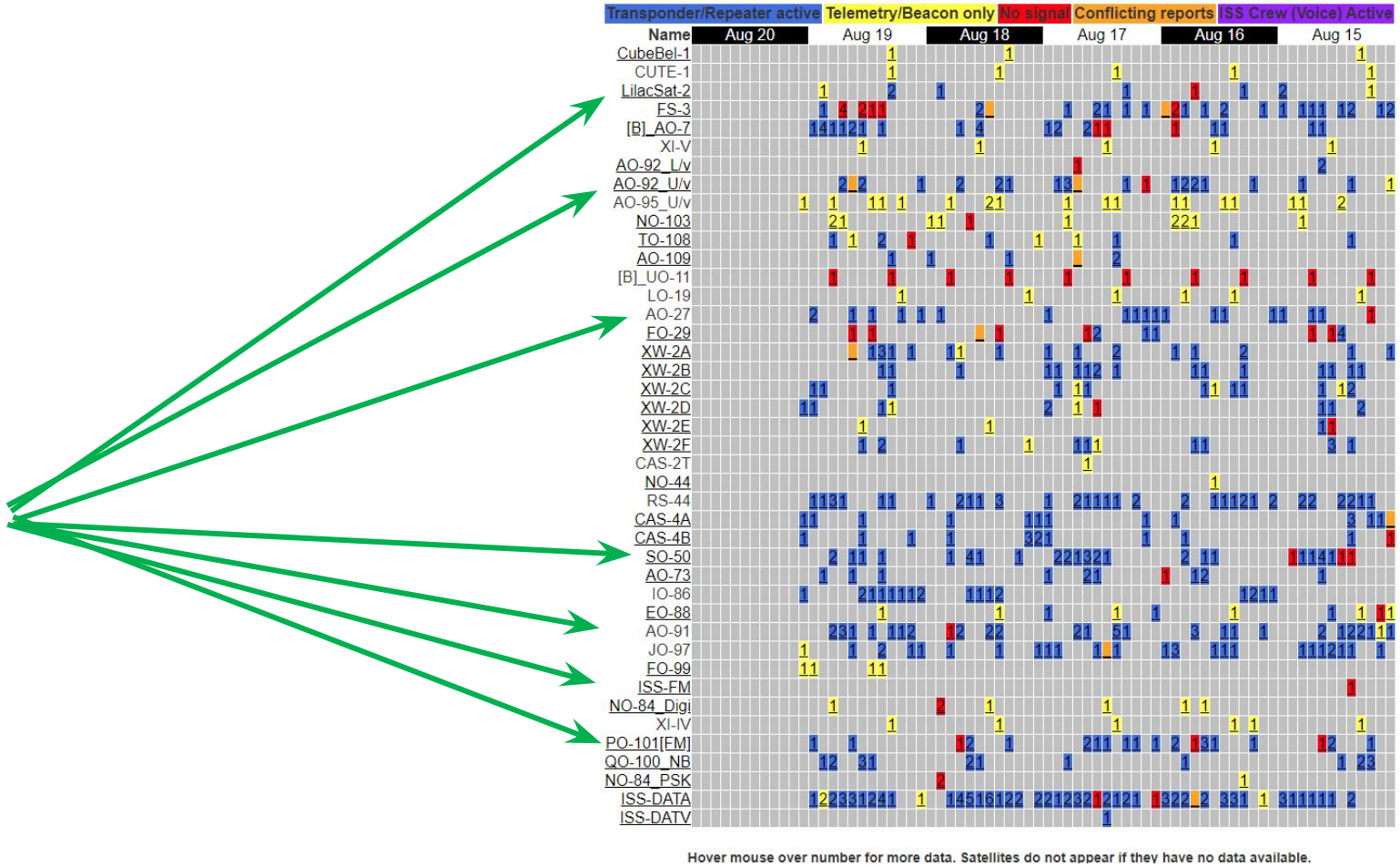
Is It Working? Live Satellite Status

http://www.amsat.org/status/

AMSAT Live OSCAR Satellite Status Page

This web page was created to give a single global reference point for all users in the Amateur Satellite Service to show the most up-to-date status of all satellites as actually reported in real time by users around the world. Please help others and keep it current every time you access a bird.

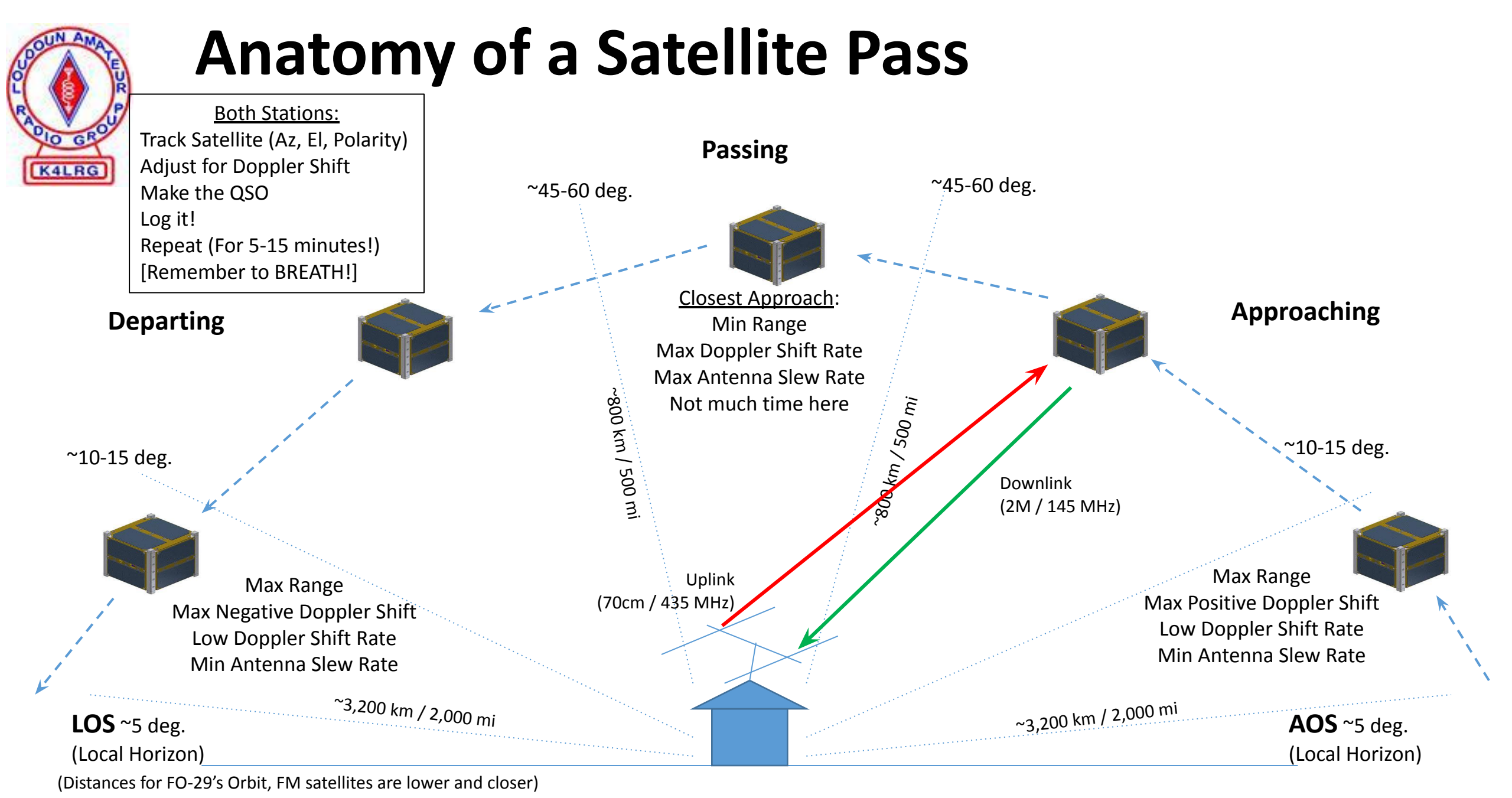
If you want to practice reporting without affecting the real data, please select the dummy-satellites AO-98 and AO-99.



FM

Blue = "It's On!"
(Or was when the reporting station posted)

Anatomy of a Satellite Pass



(Distances for FO-29's Orbit, FM satellites are lower and closer)

Equipment Suggestions

- **Radios**: start with what you have or can borrow!
  - One radio: **Kenwood TH-D72A**. Best satellite-ready HT (used to be able) to buy NEW. Full duplex, APRS, excellent support. (The TH-D74A is NOT full duplex)
  - **Two separate radios for uplink & downlink: ANY "normal" radio if…**
    - **Low susceptibility to Rx de-sense (2M & 70cm, ham and non-ham RF)**
    - **Ease of use - can you quickly adjust frequency, squelch, volume, one-handed?**
      - Ex: 2x Yaesu FT-60 (~$160 ea.)
  - Other HTs – see K6CLS (work-sat), WD9EWK reviews, QRZ Satellite forum, amsat-bb
  - Baofeng, Woxun, … **WD9EWK reviews** on amsat-bb, QRZ.com & Eham.net Satellite Forums
  - **Dual-band Mobiles**: Many full-duplex capable. Kenwood D-700, D-710 in particular.
  - HF-UHF Multi modes (706, 857, …) + HT
- **Antennas**:
  - Arrow (with or without diplexer), Alaskan Arrow (with a tripod or strong arm(s)!)
  - Elk (+ diplexer if separate radios)
  - Homebrew (WA5VJB Cheap Yagis, tape measure yagis,…) Many designs on line – see amsat.org
  - NOT RECOMMENDED FOR STARTING OUT: Whips, eggbeaters, other omnidirectional
- **Diplexer**: MFJ-916B or BN for split feeds, 2M harmonic trap (terminate UHF side)
- **Tracking**: amsat.org, n2yo.org, heavens-above.com, SatPC32, GPredict, AMSAT-Droid (phone),…

From The Wisdom of Patrick, WD9EWK: Equipment for FM satellites

- 2m/70cm FM transceivers with two VFOs capable of cross-band repeat ideal for FM satellite operation
  - One HT capable of cross-band full-duplex operation for all current FM satellites (Kenwood TH-D72A) ; a couple of others work full-duplex with FM satellites using a 70cm uplink like AO-90, AO-91, PO-101 (Wouxun KG-UV8D, KG-UV9D)
  - More options with mobile transceivers (TM-D710, TM-V71A, FT-8800, FT-8900, IC-2730A, DR-635)
- Other 2m/70cm FM HTs and transceivers with “odd-split” memory channels can also be used with FM satellites
  - Most Kenwood and Yaesu 2m/70cm transceivers, including several Yaesu HF/VHF/UHF transceivers (FT-817, FT-857, FT-991); some older Icom 2m/70cm transceivers
- IC-706Mk2, IC-706Mk2G, IC-7000, FT-100, FT-817, FT-857, FT-897 etc. usable with split-VFO operation
- Separate 2m and 70cm FM transceivers
- Links and more on his QRZ page: https://www.qrz.com/db/WD9EWK

Antennas (WD9EWK)

- Portable operation
  - Directional antennas
    - Handheld Yagis (Arrow, Tape Measure) or log periodics (Elk) are popular options, homebrew or commercially-made
  - Replace stock “duckie” on HTs
    - Telescoping whip or longer “duckie” *may* work with some satellites like ISS
- Fixed operation
  - Directional antennas
  - 1/4-wave verticals
  - Horizontal loops, 1/4-wavelength over ground plane
  - “Eggbeater” omnidirectional antennas
  - Computer control of antenna rotator desirable, preamps may be useful (required?) for omnidirectional antennas

Before you transmit… (WD9EWK)

- Do you hear the satellite?
  - Open Rx squelch all the way
- Satellites usually have activity on any daytime or evening pass over North America

  2021: CAUTION, AO-91 and AO-92 are DAYTIME USE ONLY
- Move antenna around, if satellite is not audible or is weak
- If you do not hear the satellite, **DO NOT TRANSMIT!**
  - **Exception**: Transmitting on 145.850 MHz FM with 74.4 Hz CTCSS tone to activate SO-50 for 10 minutes, when satellite should be in view

Making contacts (WD9EWK)

- Listen to the satellite, pick out some call signs
- On FM satellites, call a specific station, or just transmit your call sign and possibly your grid locator. **DO NOT CALL CQ!**
- Calling CQ on an SSB/CW satellite is encouraged, as these satellites are retransmitting a band of frequencies instead of just one frequency. (similar to working HF, except you can hear yourself)
- Contacts on FM satellites are usually quick – call sign, grid locator, maybe your name & city/state (similar to HF contests & DXpeditions)
- Contacts on SSB/CW satellites can be similar to FM satellites, or longer chats – multiple conversations can take place simultaneously
- Contacts can even be made via orbiting APRS digipeaters – use APRS messaging to make QSOs, even from APRS-ready radios
- Regular operators can recognize new operators, and are happy to make contacts and help with operating advice
- Work full duplex (hear the satellite's downlink while you transmit) when possible

Logging Contacts (WD9EWK)

- Many satellite operators use audio recorders or software on computers/mobile phones/tablets to record audio for logging
  - Especially for portable operating; almost impossible to log in real time if holding a radio/microphone and antenna
  - Play back recordings later to make log entries
  - Keep copies of memorable contacts
  - Be able to give others copies of contacts (MP3 or WAV files)
  - Digital recorders are small, inexpensive; many mobile phones and tablets have voice recorder apps – or use a computer
    - TH-D74A, FT3D have audio recorder function, with a microSD card
  - Many are looking for confirmations for contacts using QSL cards, **Logbook of the World**, eQSL, etc. to earn awards (ARRL awards require LoTW or cards)

73’s
&
Hope to work you on “the Birds”!