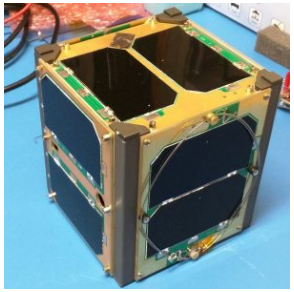
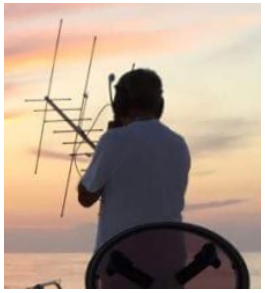
HAMSATS!
Getting Started With Satellites

LARG University

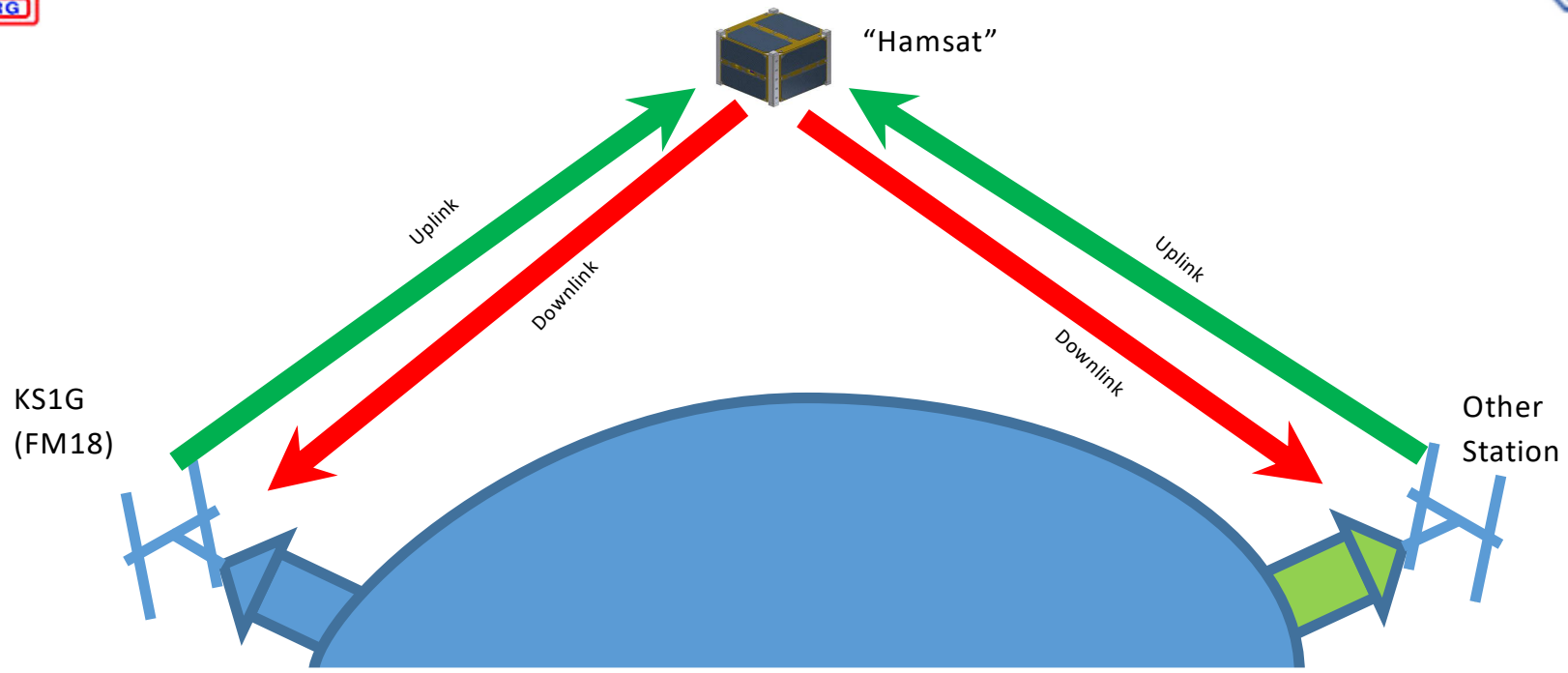
Presented by: Steve Greene, KS1G, ks1g@amsat.org

On: 5/12/2018

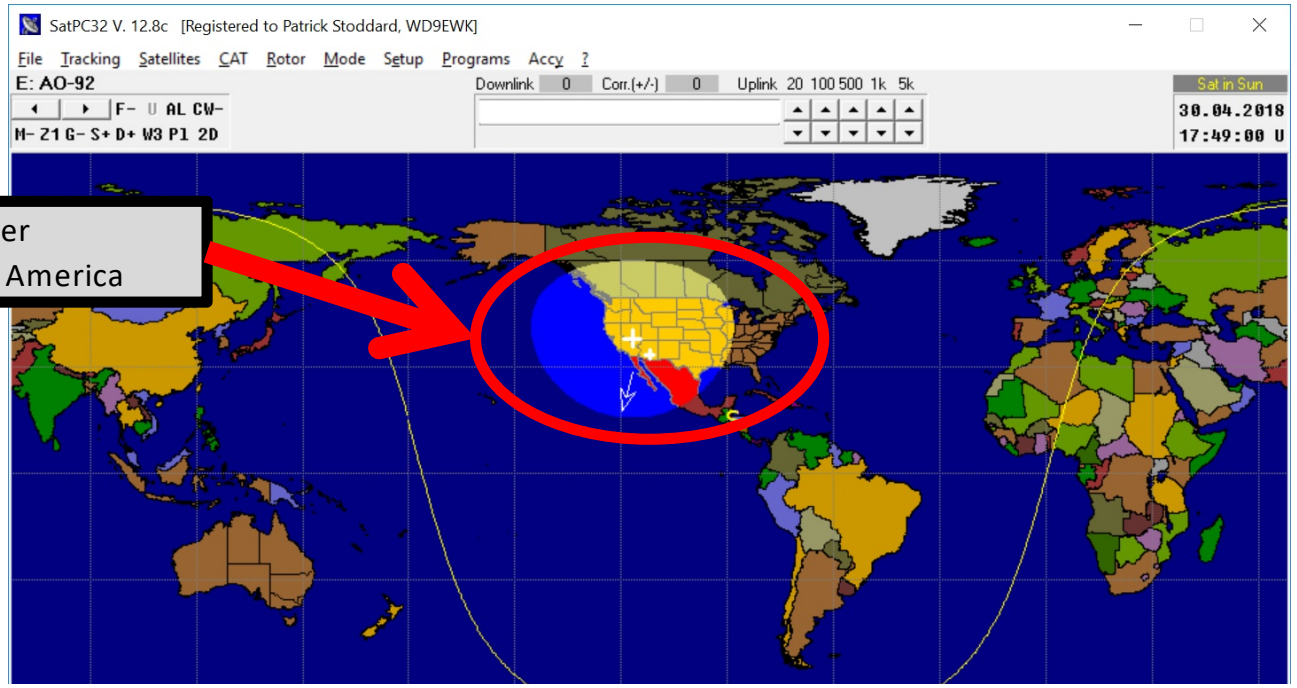




A Repeater In the Sky!...

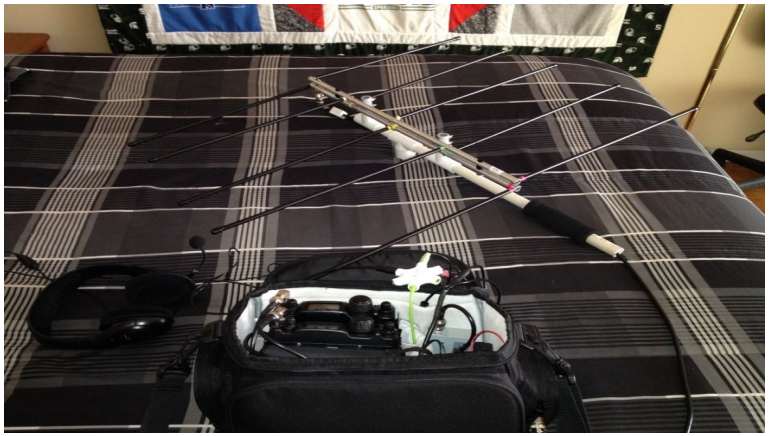


…with a **BIG** Footprint!

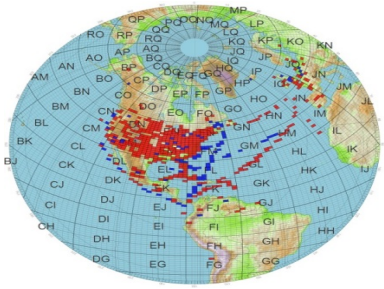


- Higher orbit = Greater distance
- On some satellites, you can work stations in Europe!

Backyard Not Required (Paul N8HM, Washington DC)



49 states, 48 countries, 4 continents
1,015 grids worked in 52 fields



What Can You Work?

Satellite (year launched)	What	Uplink (TX)	Downlink (RX)	"Mode"
AO-85 (2015)	**FM**	**70cm**	**2M**	**U/V**
AO-91 (Nov 2017)	**FM**	**70cm**	**2M**	**U/V**
AO-92 (Jan 2018)	**FM**	**70cm**	**2M**	**U/V** (+L/V)
SO-50 (2002)	**FM**	**2M**	**70cm**	**V/U**
LilacSat (2015)	FM	2M	70cm	V/U
AO-73 (2013)	**CW, SSB**	**70cm**	**2M**	**U/V**
XW-2A,B,C,D,F (2015)	**CW, SSB**	**70cm**	**2M**	**U/V**
CAS 4-B (2017)	**CW, SSB**	**70cm**	**2M**	**U/V**
AO-7 (1974)	**CW, SSB**	**70cm/2M**	**2M/10M**	**U/V / V/H**
FO-29 (1996)	**CW, SSB**	**2M**	**70cm**	**V/U**
Fox 1-C* (2018)	FM	70cm	2M	U/V
ISS (APRS off-line as of early 2018)	**FM (APRS)**	**2M**	**2M**	**V/V**
FalconSat-3 (2017)	**Data (9k6)**	**2M**	**70cm**	**V/U**
NO-84 (PSAT) (2014)	PSK31 (some APRS)	10M (SSB) 2M (APRS)	70cm (FM) 2M (APRS)	H/U V/V

(slightly harder)

Easiest!

Hear astronauts.
Periodic SSTV runs
APRS (off line @4[illegible]8)

Gear for Satellite Ops (FM Voice)

2M

70cm

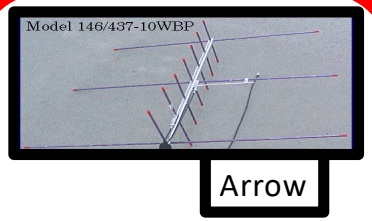
or

Dual-band

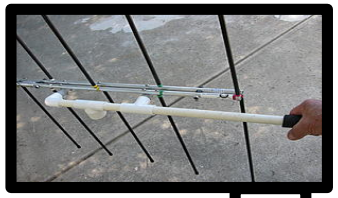
(Full Duplex)

(Not shown: coax, power)

+



Arrow



Elk

Homebrew

+

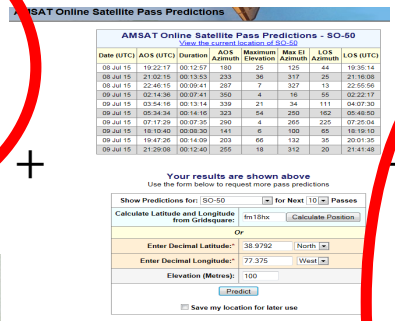
Diplexer

Rx Preamp

(if needed)

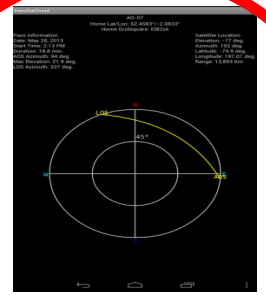
+

Prediction/Tracking



Internet

or

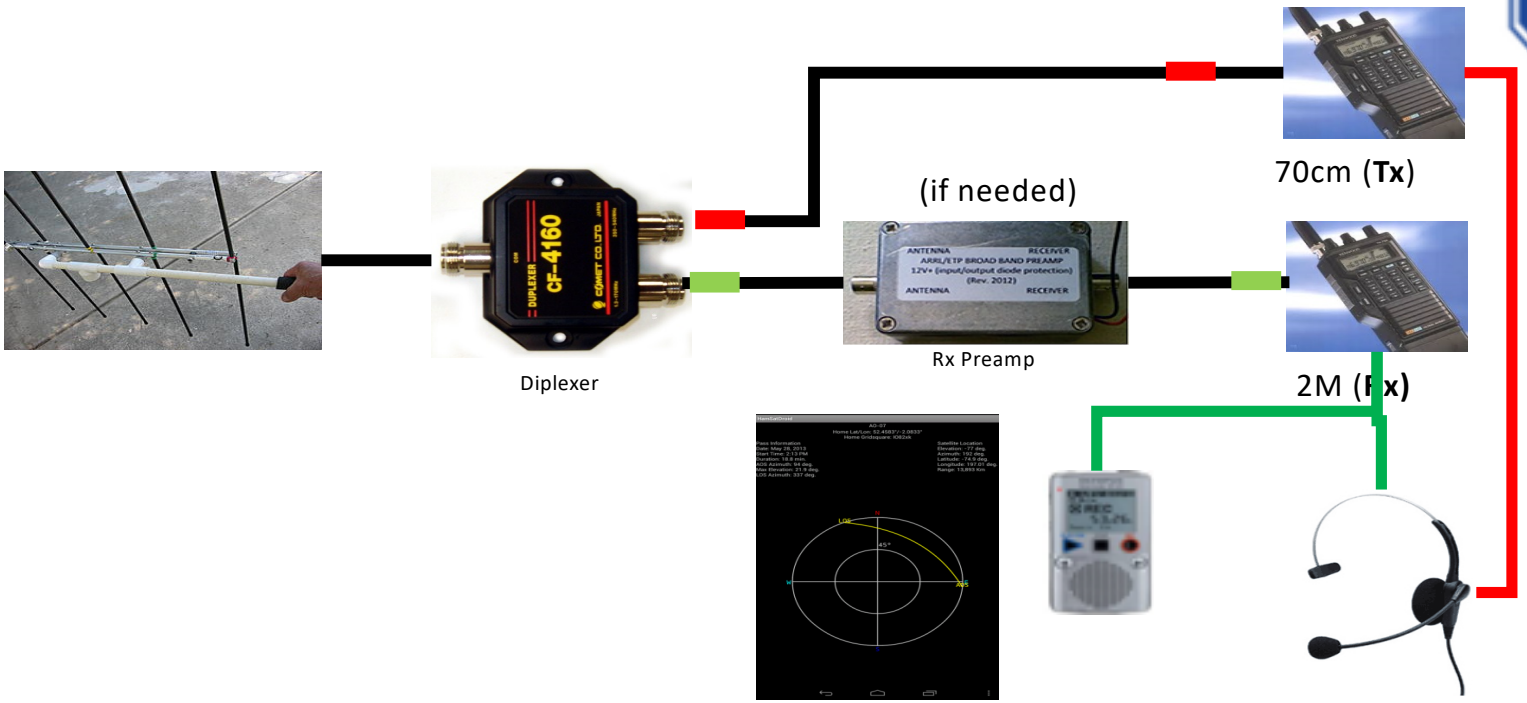


Smart Phone, Tablet, PC

+

Useful

Hook it Up - U/V FM: AO-85, AO-91, AO-92



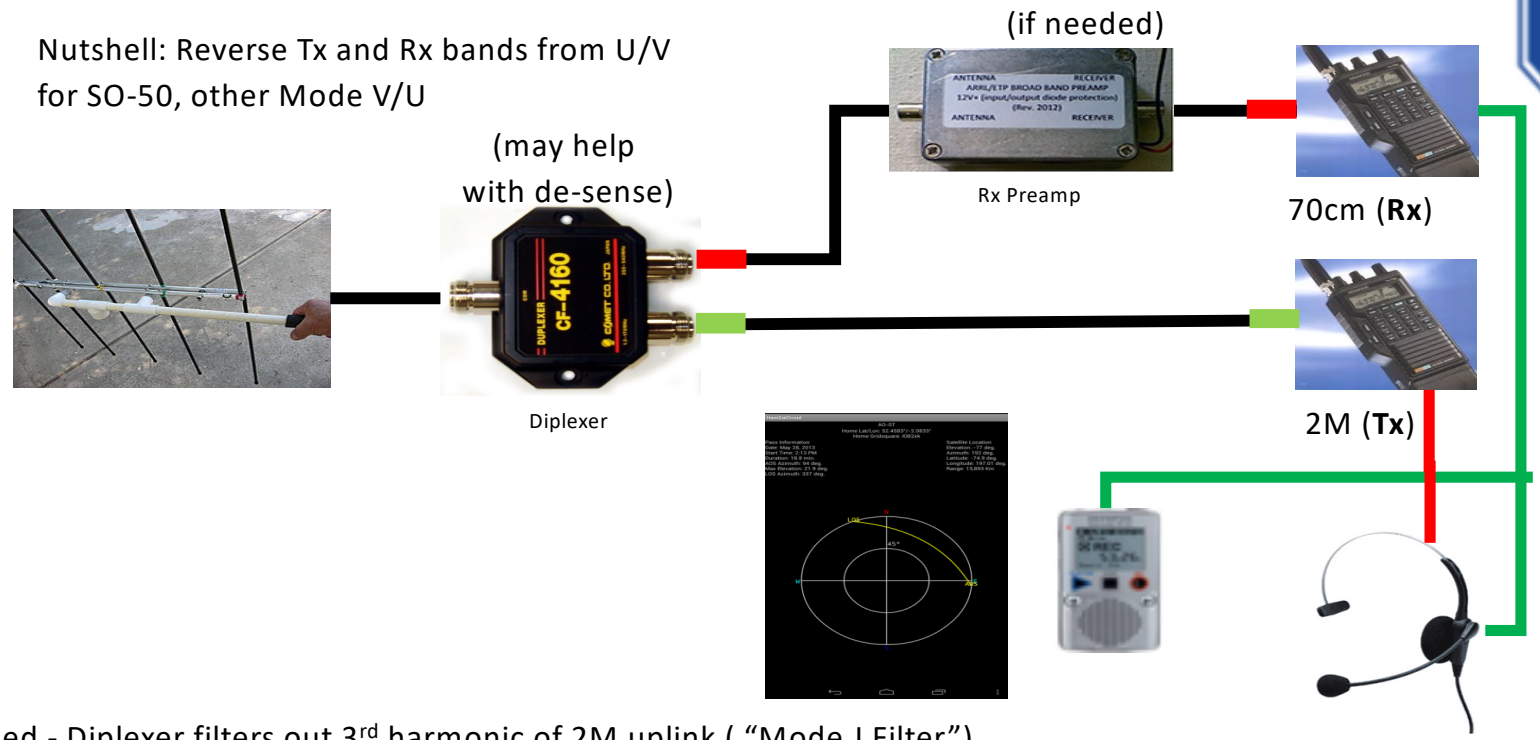
AO-85 may require more power/gain/try higher-elevation passes

Color-code cables to reduce chance of errors

DO NOT TRANSMIT INTO PREAMP!

Hook it Up - V/U: SO-50

Nutshell: Reverse Tx and Rx bands from U/V for SO-50, other Mode V/U



If needed - Diplexer filters out 3rd harmonic of 2M uplink (“Mode J Filter”)

Color-code cables to reduce chance of errors

DO NOT TRANSMIT INTO PREAMP! (if used)

Equipment Suggestions

- **Radios**: start with what you have or can borrow!
  - One radio: **Kenwood TH-D72A**. Best satellite-ready HT can buy NEW today. Full duplex, APRS, excellent support. (The newer 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.)
  - Older 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),…

Program Your Radio

- Less workload during a pass
- Memories: Tx frequency, Tone, Rx frequency
- Step through channels during the pass to handle Doppler shift

AO-91 Memory Programming		
Memory Channel	Transmit* (+ 67Hz Tone)	Receive
#908 "AO-90 AOS 2"	435.240 MHz	145.960 MHz
#909 "AO-90 AOS 1"	435.245 MHz	145.960 MHz
#910 "AO-90"	**435.250 MHz**	**145.960 MHz**
#911 "AO-90 LOS 1"	435.255 MHz	145.960 MHz
#912 "AO-90 LOS 2"	435.260 MHz	145.960 MHz

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.**

Operating Hints

*(**Single-Channel FM satellites**: SO-50, AO-85, AO-91, AO-92)*

- Location, time, time zones correct in your tracking software!
- Check it's active (http://amsat.org/status)
- Listen, Listen, Listen! Squelch *OFF*, Full Duplex/2 HTs if you can.
- Use Minimum Power (5W + directional antenna usually sufficient)
- Tune Doppler Shift on 70cm. 2M usually OK fixed frequency.
- "Twist" hand-held antenna for polarity/best signal
- Contest Style QSOs; exchange Call, Grid
  - DON'T CALL "CQ"!
  - AVOID RAG-CHEWING!
- Leave time for other ops. Listen for HTs, Mobiles, rare Grids,…
- AMSAT-BB, Twitter, Facebook for operating schedules, help, …

SAMPLE QSO	
Me	Other Station
KS1G, FM18	
	KS1G, WX4XYZ, EM63
W4XYZ, copy EM63 Thanks!	
	73s
on to the next contact….	

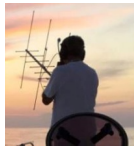
AMSAT Services

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

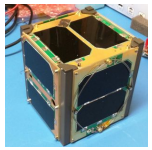
Education!

Publications!

Awards!



Technology!



For Further Reading

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

AMSAT Guides for New Operators

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

- FOX-1 Operating Guide (updated for 2018)
- Best Practices for FM Satellite Operating (Dec 2017)
- 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

- **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, 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://andrewbnorthan.com/ke8fzt/d72-satellite-aprs-quick-reference/

Programming HT for FM Satellites

SO-50 – Please work in full-duplex mode

Ch #	Alpha	TX Freq	TX Tone	RX Freq	RX Tone
501	50 +4	145.850	67.0	436.815	None
502	50 +3	145.850	67.0	436.810	None
503	50 +2	145-850	67.0	436.805	None
504	50 +1	145.850	67.0	436.800	None
505	*50 74*	*145.850*	*74.4*	*436.795*	*None*
506	**SO-50**	**145.850**	**67.0**	**436.795**	**None**
507	50 -1	145.850	67.0	436.790	None
508	50 -2	145.850	67.0	436.785	None
509	50 -3	145/850	67.0	436.780	None

Source: Clint Bradford, K6LCS
http://www.work-sat.com, 12/14/2015

(Tone for TX-on)
(Center freq.)
SO-50 has a 10 minute timer that must be armed before use. Transmit a 2 second carrier with a CTCSS tone of 74.4 Hz to arm the timer

AO-85 (formerly FOX-1A) – Please work in full-duplex mode

Ch #	Alpha	TX Freq*	TX Tone	RX Freq**	RX Tone
851	AOS-2	435.160	67.0	145.980	None
852	AOS-1	435.165	67.0	145.980	None
853	**AO-85**	**435.170**	**67.0**	**145.980**	**None**
854	LOS-1	435.175	67.0	145.980	None
855	LOS-2	435.180	67.0	145.980	None

*** TX frequencies have "shifted" from what AMSAT--NA originally published.**
**** The downlink may need to be slightly adjusted on some passes. Experiment!**
AO-85 may require more uplink power/antenna gain than an HT. See AMSAT and work-sat for info.

AO-91 (Fox-1B) (Source: AMSAT-NA)

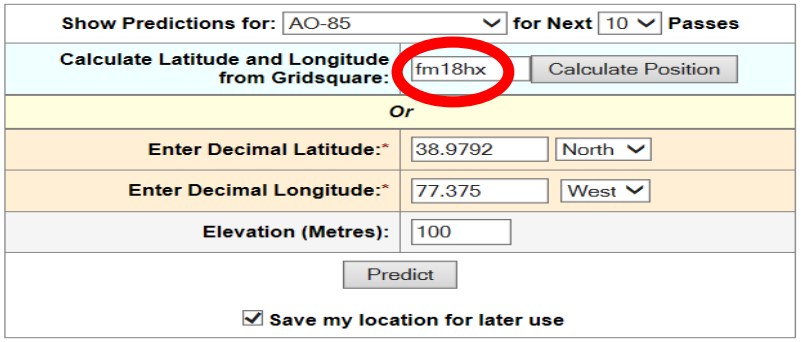
CH #	Alpha	TX Freq	TX Tone	RX Freq**	RX Tone
911	AOS-2	435.240	67.0	145.960	None
912	AOS-1	435.245	67.0	145.960	None
913	**AO-91**	**435.250**	**67.0**	**145.960**	**None**
914	LOS-1	435.255	67.0	145.960	None
915	LOS-2	435.260	67.0	145.960	None

AO-92 (Fox-1D) (Source: AMSAT-NA)

CH #	Alpha	TX Freq	TX Tone	RX Freq**	RX Tone
921	AOS-2	435.340	67.0	145.880	None
922	AOS-1	435.345	67.0	145.880	None
923	**AO-92**	**435.350**	**67.0**	**145.880**	**None**
924	LOS-1	435.355	67.0	145.8860	None
925	LOS-2	435.360	67.0	145.8860	None

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

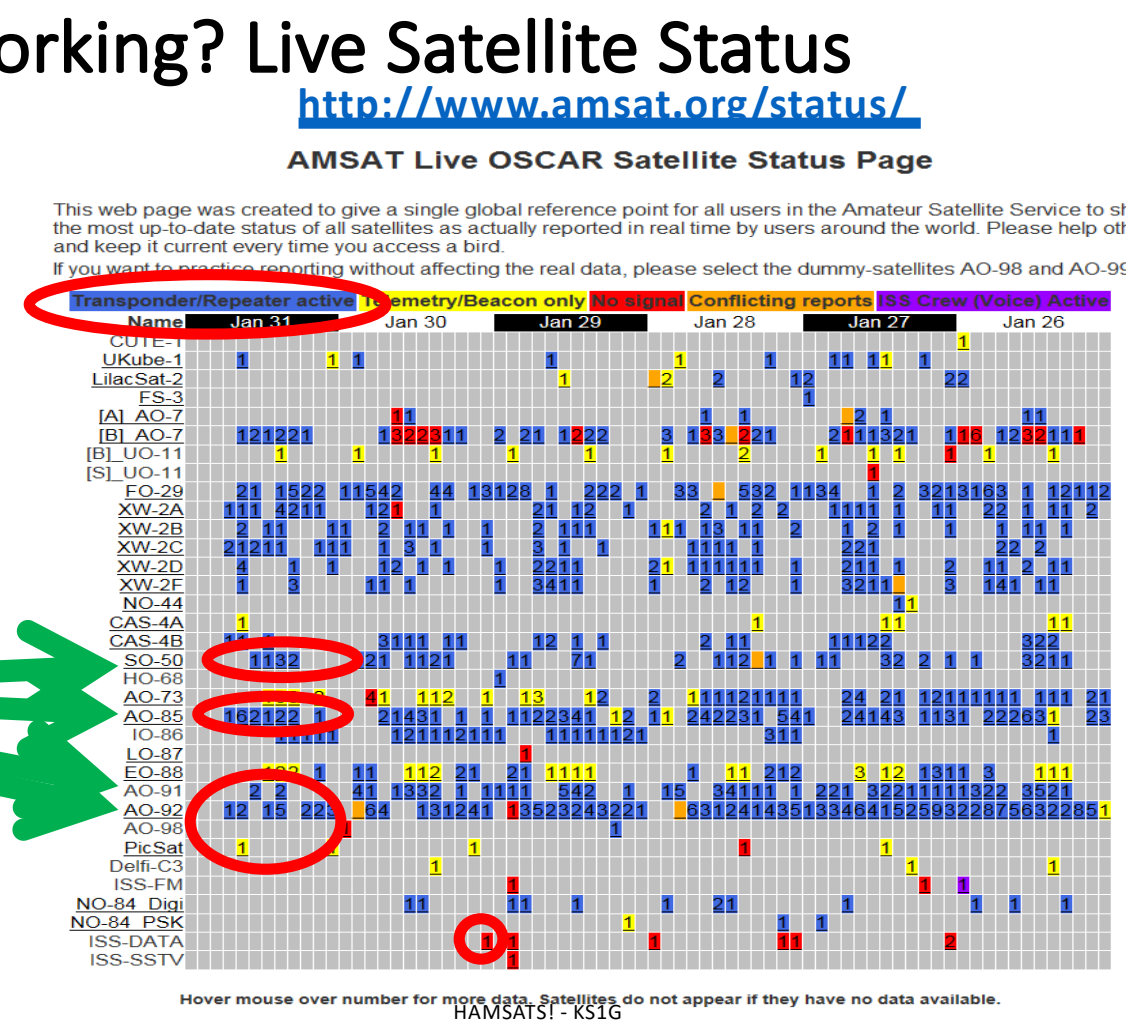
Other on-line tracking

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

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

Is It Working? Live Satellite Status

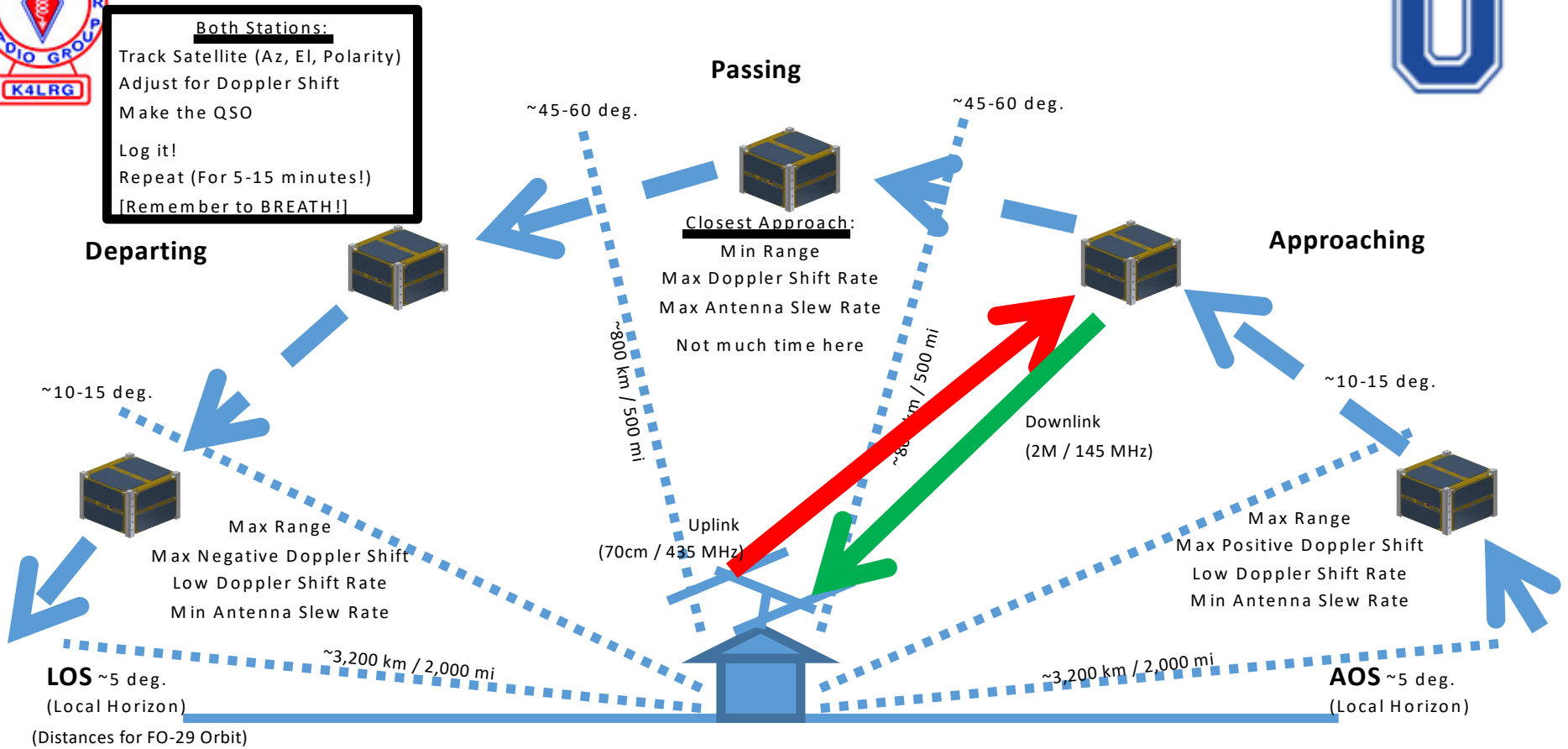
http://www.amsat.org/status/



FM

(4 satellites)

Anatomy of a Satellite Pass



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

- Satellite-ready transceivers like IC-9100, TS-2000, etc.
- 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-85 (Wouxun KG-UV8D, KG-UV9D)
  - More options with mobile transceivers (TM-D710, TM-V71A, FT-8800, FT-8900, IC-2730A, DR-635 currently in production)
- Other 2m/70cm FM HTs and transceivers with "odd-split" memory channels can also be used with FM satellites, but not recommended
  - Most Kenwood and Yaesu 2m/70cm transceivers, including several Yaesu HF/VHF/UHF transceivers in current production (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

Equipment for SSB/CW satellites (WD9EWK)

- Satellite-ready transceivers (IC-821, 9100, 9700, TS-2000, FT-736, FT-847)
- Pair of monoband all-mode transceivers
- Pair of multiband all-mode transceivers
- One all-mode transceiver, with one wide-band all-mode receiver
  - TH-F6A & TH-D74A HTs include all-mode receiver up to 470 MHz
  - All-mode receivers also includes SDR devices
    - FUNcube Dongle Pro+ - http://www.funcubedongle.com/
    - SDRplay RSP1 & RSP2 – http://sdrplay.com/ (available at HRO stores)
- One multiband all-mode transceiver, with computer control
  - Laptops, even some tablets, capable of running satellite-tracking software that controls the transceiver(s)

Antennas (WD9EWK)

- Portable operation
  - Directional antennas
    - Handheld Yagis or log periodics are popular options, homebrew or commercially-made
  - Replace stock “duckie” on HTs
    - Telescoping whip or longer “duckie” may work with some satellites like AO-85 & 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 for omnidirectional antennas
- Mobile operation

Before you transmit… (WD9EWK)

- Do you hear the satellite?
  - Open squelch all the way
  - Satellites usually have activity on any daytime or evening pass over North America
  - Move antenna around, if satellite is not audible or is weak
  - If you do not hear the satellite, **DO NOT TRANSMIT!**
    - **One 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
    - **Another exception**: Transmitting to AO-85 with 67.0 Hz CTCSS tone. The AO-85 downlink shuts off 60 seconds after it stops hearing the 67.0 Hz CTCSS tone

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 has 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

73's
&
Hope to work you on "the Birds"!