Working the FM Satellites

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Introduction - https://www.qrz.com/db/kb3iai

This presentation is a compilation of my notes, my lessons learned, and hopefully a little HOWTO on taking advantage of a tremendous resource available to the amatuer radio community. There is no affiliation or representation with any organization implied other than the AARC/MMRC radio clubs. These unique amateur radio resources would not be possible without hundreds of dedicated volunteers and the various organizations around the globe. There are many possible ways to setup a Satellite station, this is just how I got started.

So why I started down this deep dark rabbit hole exactly, I cannot remember. I think when I was getting back into HAM radio after a decade+ long hiatus I wanted to do more as a Technician. Somehow I found out about Satellites, possibly from another local HAM trying to get on ISS. So, I built my own 2m tape measure Yagi and could start to hear the satellites but couldn't TX back on 440 with that antenna. So I acquired a used Arrow 2m/440 with the diplexer from another local HAM. That's when I was able to hear a lot better. Once I figured out I needed to use two radios, one with good RX, things really started happening and I made contacts all summer long into the fall. I did well enough that I got hooked and started updating my rig to get on the linear birds, but that is another rabbit hole and another story.....

What the heck is an Amatuer Radio Satellite?

- **Orbiting Satellites Carrying Amatuer Radio (OSCARs)** are basically space based, cross-band, FM repeaters.
- Generally, they take an input signal on one band (2m) and retransmit the same signal on another band (70cm).
- Others, transmit APRS, SSTV, or NOAA-APT data which can also be captured.
- Usually, they also transmit a CW beacon and a telemetry signal which can also be captured.
- Because of their altitude, line of sight is hundreds of kilometers, making long distance VHF and UHF communication possible.
- Amatuer payloads are frequently used as a learning tool to help train the next generation of space based communications engineers.

Why use FM Repeater Satellites as a HAM?

- **Make <u>lots of contacts</u> and exchange QSL's.**
- **Open to Technicians** - Some of the *best "DX"* you will get!
  - U.S., Canada, Mexico, Caribbean, Central America, even Western EU, and the UK
- **Field Days** - Extra points given for a Sat contact. Plus multiplier if battery powered.
- **Awards** - *Fastest* way to ARRL-VUCC. AMSAT-GridMaster. eQSL-eSatellite.
- **Consistent & Predictable** - Usually 7-15 min each pass. 2-4 passes/day/Sat., even at Solar minimum.
- **"Cool" factor** - *Possibility* of talking to ISS Astronauts, **STEM activity** for Space/Ground communications.
- *Can be done* with 2 **low cost** handhelds and directional antenna.
- <u>Excellent method</u> of **portable operation** for being that rare grid square.
- **Parks on the Air (POTA)** - Many stations operate from a National or State Park
- Expand on your new skills to get on the linear transponder satellites for consistent DX, and additional modes (e.g. CW, various MFSK)

When are they available to use?

Pretty much all the time. Orbit cycles are approximately 90 minutes each and generally a pass will cover your area two to four times a day.

In order to know where and when a particular Satellite will be available, you need updated Two Line Keplerian Elements (TLE) and pass prediction software that can process the TLE. This will tell you: the azimuth and elevation of the pass, the Acquisition of Signal (AOS) time, the Time of Closest Approach (TCA), and Loss of Signal (LOS), and usually the published frequencies.

Generally, pass prediction software will show the pass footprint, and the overhead path of the pass, sometimes in real-time.

Some Satellites are only activated by a schedule, such as ISS, PO-101, and UVSQ-SAT. Twitter is often used to communicate the schedules, announce rovers, and events.

Note: Satellite Operators will use Coordinated Universal Time (UTC) for timing, logging, and scheduled contacts. Software may be local time by default. Not all logging software can successfully process a Satellite QSO.

What FM Sats which are available for use today?

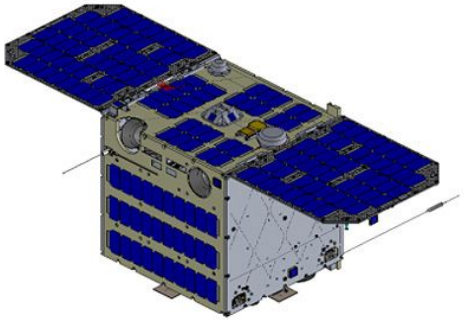
- **SaudiSat (SO-50)** - V/u mode. Pass schedule varies throughout the year. Has a timer which needs to be reset every 10 min with carrier + a special PL Tone of 74.4. Normal PL tone is 67Hz.
- **(Daytime only) Fox-1B (AO-91)** - U/v mode. 12 hour schedule. Batteries are dying. Access only during daylight, when active and use minimal power (5W or less).
- **International Space Station (ISS)** - V/u mode. Pass schedule varies for the repeater and switches modes. Other operations (such as Crew) by schedule only. APRS is available (V/V mode). See ARISS web site.
- **LilacSat-2** - V/u mode. No set pass schedule. Uplink is 144.350Mhz which may change SWR. When active has a nice strong signal. Try early mornings, afternoons.
- **AMSAT Oscar 27 (AO-27)** - V/u mode. Only active for 4 minutes after mode change. Currently active in our location on descending AM passes from 0-16 degrees and rising.
- **Diwata 2B (PO-101)** - U/v mode. Active by schedule, try overnight. See: Diwata2PH (@Diwata2PH) / Twitter
- **UVSQ-SAT** - V/u mode. Relatively new Satellite. Activation of FM transponder is infrequent. EU contacts are possible with a low inclination Easterly pass. See UVSQ-SAT (@uvsqsat) / Twitter
- **Tevel 1-8, EASAT-2, HADES** missions coming online soon!!

Form Factor, Appearance, Origin, Commissioning

AO-91 - Launched by USA in 2017. AO-92 and AO-85 same bus and 1U cubesat form factor.

LilacSat2 - Launched 2015 by China and weighs 12.5Kg

SO-50 - Launched in 2002 by Saudi Arabia



PO-101 - Launched 2018 by Philippines Space Agency, weighs 123lbs, Amatuer Radio is the secondary payload.

What Operation Modes Are Available? (FM sats only)

V/u or Mode J - VHF uplink, UHF Downlink

U/v or Mode B - UHF uplink, VHF Downlink

Digital (APRS) - VHF

Digital (SSTV) - VHF

Digital (NOAA-APT) - VHF

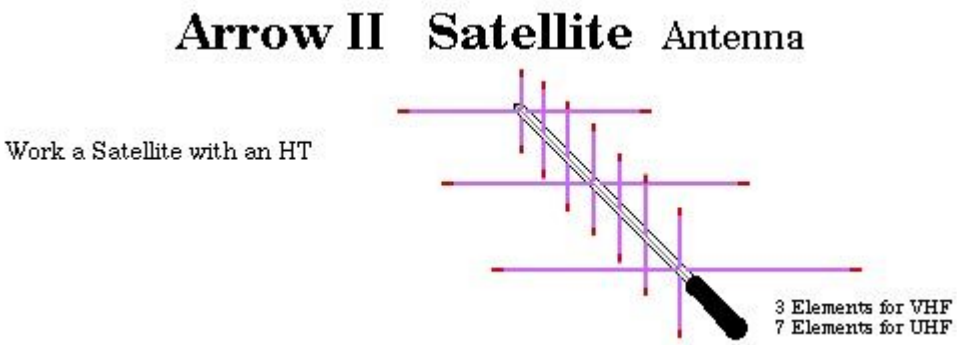
Getting on the birds - Your first ground station.....

- **Two** 2m/70cm dual band HT type radios
- Voice Recorder (Cell Phone) - FreeWare
- Pass Prediction Software (Cell Phone) - AdWare
- Arrow antenna (146/437-10BP Split boom without duplexer), no duplexer, or case, you don't need it
- Two 6’ BNC-M to BNC-M quality coax cables, SMA to BNC-F connectors.
- (optional) BTECH APRS-K1 Cable for Cell phone AFSK modulation on APRS.

The author **strongly recommends** starting off using ***two*** *dual band* handhelds and the *Arrow antenna*. Why? Proven formula for success:

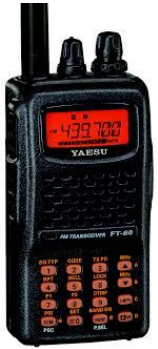
- You will hear yourself on the downlink and not cause interference because you can **unkey** if you don't get captured by the repeater and hear someone else talking besides you.
- *Save yourself the frustration*, **buy the Arrow**. It pulls in weak signals extremely well and is tuned for most FM Sats. It already has the two frequency bands and two connectors for the two radios you need!

Minimum FM Satellite Station - Components



- **Two HT's**
- Two SMA to BNC
- Two 6ft. BNC cables
- Arrow Antenna
- Smartphone

RX



TX

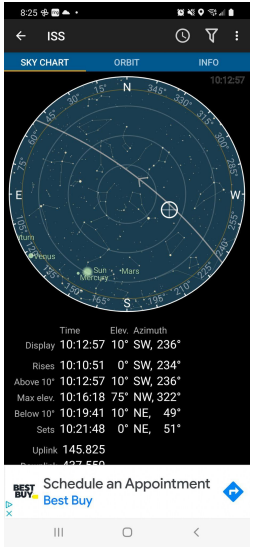
Minimum FM Mobile Station - Components

- Dual Band Full Duplex (x-band rpt) Mobile Rig (IC-2730, FT-8900, ID-5100, TM-V71)
- Elk Antenna
- One PL-259 type cable 6’
- 12v Battery Power Pack and power cord.
- Smartphone

Finding Satellites in the Sky (So you know where, and when to point your antenna) - There's an app for that!

Tools to process TLE

- **Heavens Above (Android)**
- **Look4Sat (Android)**
- **Gpredict (Linux/Pi)**
- **SatPC32 (Windows)**
- MacDoppler (OSX)
- Ham Radio Deluxe (Windows)
- **SatSat (iOS)**
- **GoSatWatch (iOS)**

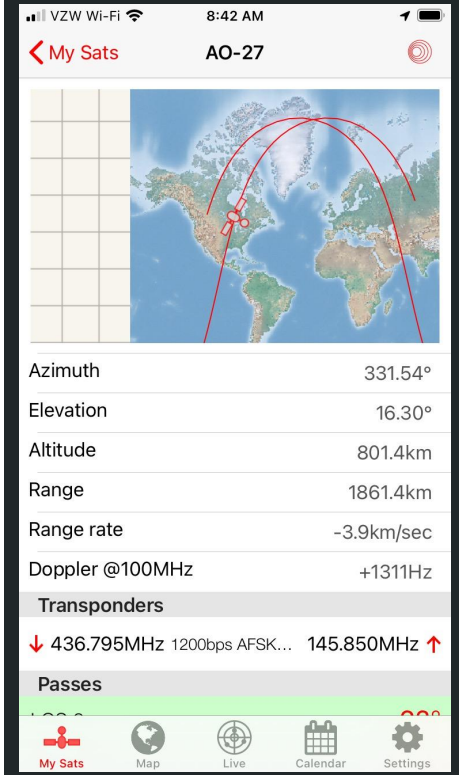


Websites that you can use

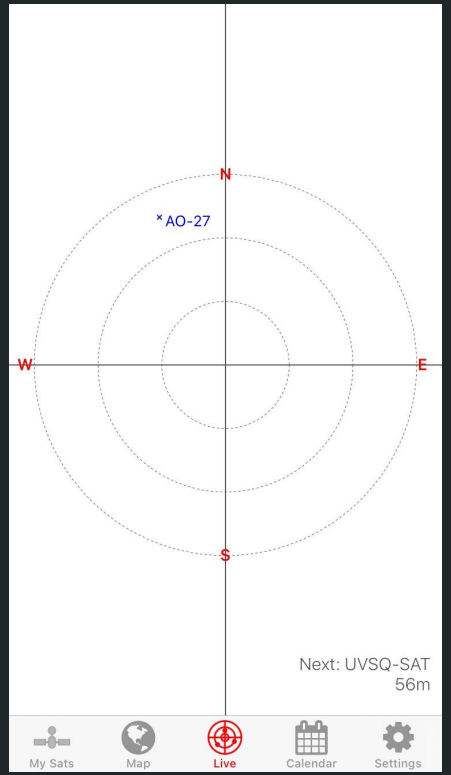
- AMSAT - AMSAT Online Satellite Pass Predictions
- LIVE REAL TIME SATELLITE TRACKING AND PREDICTIONS (n2yo.com)
- Heavens-Above

Left: Heavens Above (Android), Right: SatSat (iOS)

SatSat (ios)



SatSat Live View



Start by tuning your recieve.

Don't TX yet.

When you can clearly hear the entire pass, adjusted for doppler and polarization, you are ready.....

The old adage “You can’t work em if you can’t hear em.” Most definitely applies to Satellite work.

Most FM satellites are cubesats, and therefore are low power. < 1000 milliwatts. You <u>need</u> a good directional antenna. You also need a good receiver that is not subject to intermod from the transmitter.

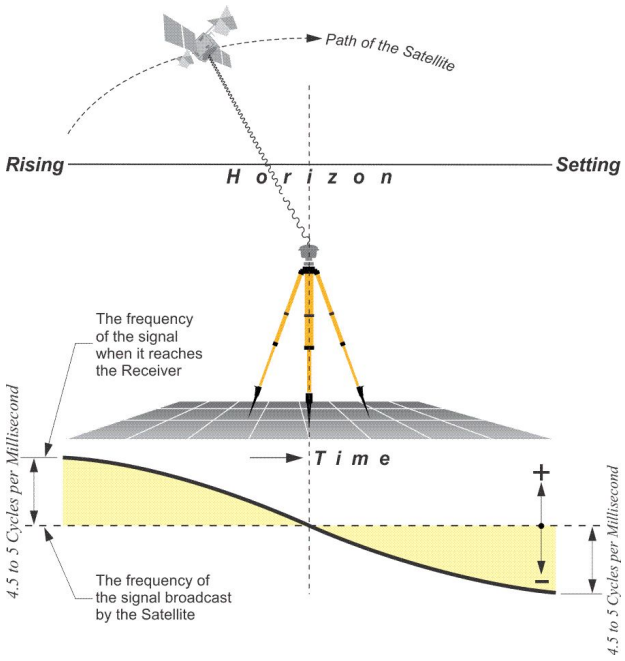
Doppler effects the RX frequency and TX frequency and <u>must be adjusted</u>.

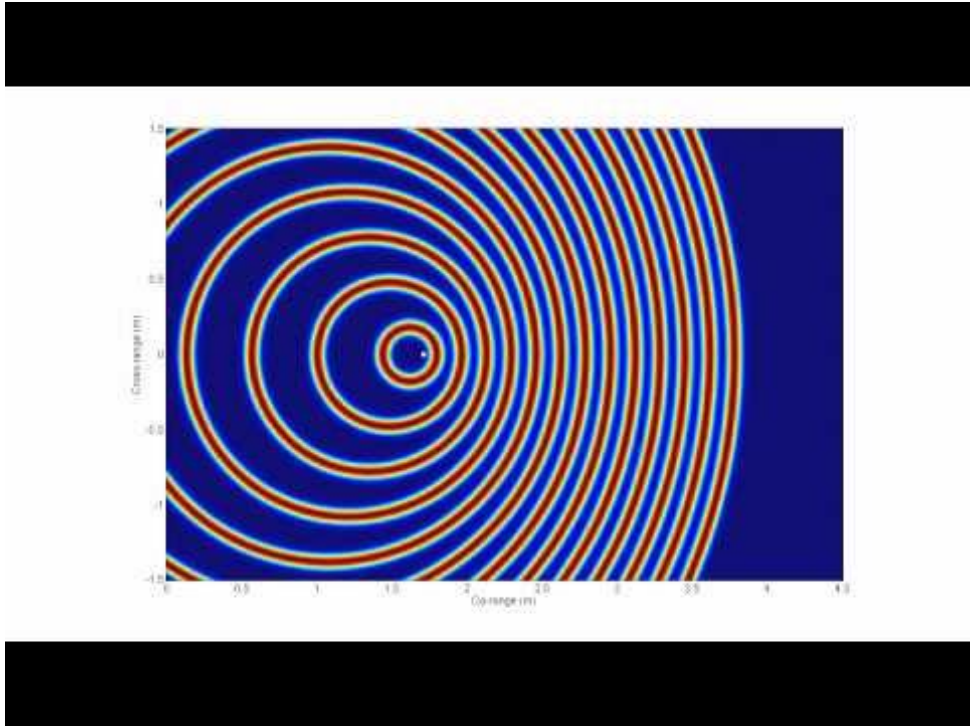
Doppler Shift - Definition from Wikipedia

The Doppler effect or Doppler shift (or simply Doppler, when in context)[1][2] is ***the change in frequency of a wave*** in relation to an observer who is moving relative to the wave source.

The reason for the Doppler effect is that when the source of the waves is moving towards the observer, each successive wave crest is emitted from a position closer to the observer than the crest of the previous wave.[4][5] Therefore, each wave takes slightly less time to reach the observer than the previous wave. Hence, the time between the arrivals of successive wave crests at the observer is reduced, causing an increase in the frequency. While they are traveling, the distance between successive wave fronts is reduced, so the waves "bunch together". Conversely, if the source of waves is moving away from the observer, each wave is emitted from a position farther from the observer than the previous wave, so the arrival time between successive waves is increased, reducing the frequency. The distance between successive wave fronts is then increased, so the waves "spread out".

Doppler illustrated





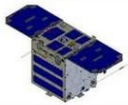
😀 Doppler effect definition science. Doppler Shift. 2019-01-29 (sakkampress.com)

Programming in Doppler Shift to memories

- Satellites are moving very fast and you don’t have a lot of time to fiddle with the VFO or buttons.
- So, you must plan ahead for doppler shift during the pass and pre-program memory channels to adjust for doppler on FM or use software/CAT control.
- FM is very forgiving and has a bandwidth range which will work using pre-programmed channels. So, this is the easiest way.
- On 2 meters not so bad +- 3KHz and can usually stick with the published frequency.
- On 70cm you must adjust for +- 10KHz shift.
  - Program Memory for 5KHz increments above and below the published frequency.
    - +10, +5, 0, -5, -10 usually works
    - +10, +7.5, +5, +2.5, 0, -2.5, -5, -7.5, -10 if you can.
- Important! The higher the frequency the more pronounced the doppler effect.
  - 1.2 Ghz (L band) requires up to 60KHz shift.

FM Frequency Charts - Programing guide for Doppler

Tabela de Satélites FM - by PS8ET

Satélites / Ilustração	CH	TX	Subton	RX
SO-50 Saudi-OSCAR 50 (SaudiSat 1-C) 	0	145.850	74.4	Ativar
	1	145.850	67.0	436.805
	2	145.850	67.0	436.800
	3	145.850	67.0	436.795
	4	145.850	67.0	436.790
	5	145.850	67.0	436.785
AO-91 AMSAT-OSCAR 91 (RadFxSat/Fox-1B) 	6	435.240	67.0	145.960,5
	7	435.245	67.0	145.960,5
	8	435.250	67.0	145.960
	9	435.255	67.0	145.960
	10	435.260	67.0	145.960
AO-92 AMSAT-OSCAR 92 (Fox-1D) NORMANTENTE AS QUARTAS-FEIRA MODO - L/v : 1.267,350 / 145,880 	11	435.340	67.0	145.880,5
	12	435.345	67.0	145.880,5
	13	435.350	67.0	145.880
	14	435.355	67.0	145.880
	15	435.360	67.0	145.880
IO-86 Indonesina-OSCAR 86 (LAPAN-ORARI) AGENDAMENTO https://twitter.com/lapansat 	16	145.880	88.5	435.890
	17	145.880	88.5	435.885
	18	145.880	88.5	435.880
	19	145.880	88.5	435.875
	20	145.880	88.5	435.870
CAS-3H (LilacSat-2) RARAMENTE https://www.amsat.org/status/ 	21	144.350	-----	437.210
	22	144.350	-----	437.205
	23	144.350	-----	437.200
	24	144.350	-----	437.195
	25	144.350	-----	437.190
PO-101 Phillipines-OSCAR 101 (DIWATA-2) AGENDAMENTO https://twitter.com/Diwata2PH 	26	437.490	141,3	145.900,5
	27	437.495	141,3	145.900,5
	28	437.500	141,3	145.900
	29	437.505	141,3	145.900
	30	437.510	141,3	145.900
ISS (FM Repeater) 	31	145.990	67.0	437810
	32	145.990	67.0	437805
	33	145.990	67.0	437800
	34	145.990	67.0	437795
	35	145.990	67.0	437790

Photos WEB - 05/09/2020

Program these frequencies as memory channels.

Note Sat mode. Don't forget PL tones on TX!

U/v - TX multiple channels RX one channel
V/u - TX one channel, RX multiple channels

My Frequency Cheat Sheet | Paul "KE0PBR" Overn's Page (wordpress.com)

Polarization and Fading

Spin stabilized satellites will “tumble” through space with their protruding antenna’s changing direction and therefore the polarity of the signal during the pass.

Imagine wiggling your HT whip around.....sometimes it's more horizontal sometimes more vertical.

Polarization inversions often occur with atmospheric conditions.

SatOps with a handheld antenna will simply twist the antenna to compensate for polarization fading.

Stationary antennas need to have circular polarity or a polarity switch to flip between two antennas with different polarizations.

This is important to the quality of the signal and signal strength received.

Practice listening first, recording the pass, movement

- Most satellites have some sort of beacon on CW or other telemetry which is easier to hear.
- Adjusting the radio for doppler shift
- Mark AOS, TCA, LOS
  a. Practice swinging through the arc if using a handheld antenna.
  b. Get used to the speed
- Note how Sat Operators talk: Keep it to Calls, Grid Squares, Signal Reports, and 73.
  a. This will help with timing when trying to break in.
  b. No CQ Satellite CQ Satellite, this is.....CQ CQ CQ....., No Conversations, No whistling or hello hello 1-2 1-2. **There is only 1 channel on the FM sats**...*you are interfering*. Note: this is acceptable on the Linear Transponder Sats, because you have too, another story another day.
- Listen for and give preference to:
  a. Emergency communications - Always the top priority traffic in HAM radio
  b. Rovers (they may be that rare grid! Or gridline!) - this is a big deal. Rovers are giving us grids nobody lives in.
  c. New Operators - Welcome new HAMS and operators! Everyone wants to work you. Especially if you are a YL!
  d. POTA stations - Giving you a park in their log for awards both stations earn
- Always Use a voice recorder: Phone app, SDR record, or digital voice recorder.
  a. This is for your logs and to really hear what the other station says because everything happens really fast.

Prepare for a contact

1. Use Heavens above to select a satellite and scheduled pass. (Check that the FM repeater will be active (ISS and PO-101 you need to check)
2. Set an alarm on your phone for a couple minutes before the pass.
3. Gather your equipment: Antenna, Transceiver(s), Cables/Connectors, PSU, recorder, tracker.
4. Check cable attachments, VFO mode/channel, tighten Antenna elements
5. Mark your AZ/EL at AOS, TCA, and LOS.
6. Tune your transceiver for RX at AOS and 0 squelch on receive VFO
7. Tune your transceiver for TX and CTCSS tones on transmit VFO
8. Start recording on voice recorder
9. Aim your antenna toward AOS or slightly above flight path. When you hear less static or call signs or CW you are on frequency.

Breaking in

- The first thing you will notice about the FM satellites is they are very busy.
- Breaking in may take a few tries.
  - One tactic is to call another station after they complete a QSO.
  - Another is announce yourself if no QSO is in progress.
  - A third, is to TX low on the horizon at the end of a pass after most have already made their QSO's.
- Key up about a 10th of a second before the QSO in progress ends. This takes practice.
- You will hear yourself through RX, try not to talk over another operator. If you do it sounds like getting squashed on a terrestrial repeater. Courtesy is to unkey.
- Call signs, grid squares, RST, and 73. (Yes like spoken FT8)
  - <Station A> KB3IAI FM19->KB3IAI <Station A> UR 59 in <GRID> QSL? ->(KB3IAI) QSL 59 both ways, 73-> <Station A>73. (Next.....)
- Try not to be an alligator, all mouth, no ears. Long QSO's are not appreciated. Save that for the linear birds. Make 1-3 QSO's and let others have a chance.

Demo Video

May 1st, 2022
AARC
FM18
PO-101
~19:20z

Common Mistakes to Avoid

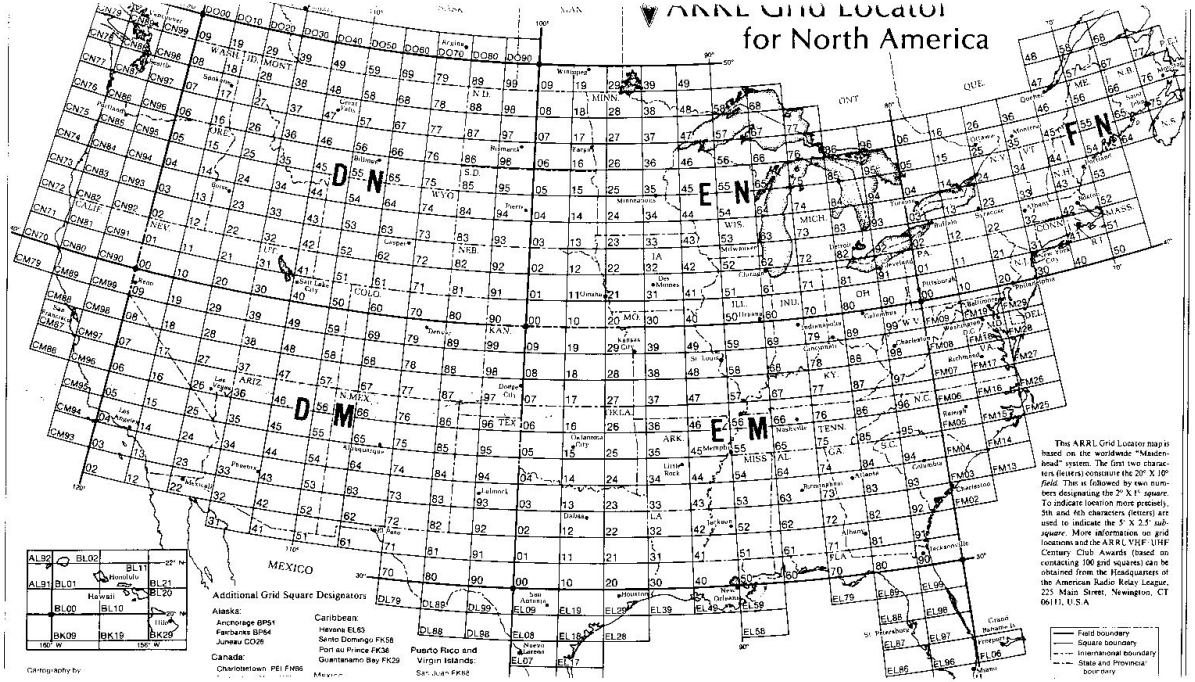
- **Trying to use a dual band HT or mobile in “watch” mode.** You are operating half duplex here. You won't hear yourself on the downlink when transmitting. More than likely, you are interfering. Other SatOps can recognize this right away and may find it hard to QSO with you. It is possible to make a QSO this way however if the pass is not busy, its just not good amatuer practice. Don’t operate this way if you can help it.
- **Trying to use a HT duck or whip antenna.** Plenty of youtube videos show this. Again yes it's possible but you wont get good results or consistent results. You need a directional antenna to receive.
- **Feedback.** Not using headphones on the RX can cause horrendous feedback. If you must do this be sure to leave enough room between your mic and speaker. Its easy to tell when someone is doing this, they sound like someone turned on the “reverb.”
- **Interrupting a call in progress.** Happens all the time. You heard station A call station B, so you (station C) call station A. But....now station A lost their contact with station B. Give B a chance to respond.
- **Transmitting over someone else.** Maybe its the half-duplex effect, maybe just being overbearing and rude. I can never really tell unless the station is very strong they know they can wipe out a portable station.
- **Alligators.** Talking too much without a pause. Calling CQ CQ CQ, Calling Hello Hello 1-2 1-2 or other random nonsense. “Sticky” Push to Talk or dead air.
- **Failing to give fair airtime to other stations.**

QSL……the ultimate courtesy

Satellite Operators are Maidenhead Grid Square collectors and need your QSL to earn awards.

Sending a card is nice, but **what we really want is your electronic QSL via LoTW**. So cards are good for first contacts.

Note: not all logbooks support Satellites. A few that do are: CQRLOG, **Cloudlog**, HRD



“Secret” Passes

Don't get discouraged if you cannot get in.

Try the following:

- ISS overnight or early morning
- PO-101 overnight
- SO-50 mid-morning/afternoon on a weekday
- LilacSat-2 (if active) usually not too busy
- AO-91 mid-day on a weekday
- AO-27 around 7AM on a weekday (if active)
- If you have the Arrow or Elk antennas, try any FM sat, with a low, eastward, inclination. Not everyone can work < 20 degrees. Low East inclination = DX to Canada and Caribbean! At the beach? Work over the water, with AO-27 and UVSQ-SAT you can work the EU.....

Ask for help and a sked! SatOps are a friendly bunch so long as you operate correctly.

Equipment that works……

- Radios
  - **ICOM IC-9700 (***the one to get***), IC-910, IC-9000, FT-847, TS-2000** are all purpose built for Sat Ops.
    - Unless you already own one, prepare to pay $800-$1800 for one of these radio's, even used.
  - **Kenwood TH-D72A** was the only HT that has full duplex on both Mode B and Mode J and APRS.
    - Hard to find and out of production, highly desired by Sat-Ops, $350-$650 used.
  - **Yaesu (2x)FT-817/818/857D** are popular for field ops.
    - IMHO the FT-818nd is a deal. You can find used for ~$550. Use with an SDR, get on HF.
  - **Alinco DJ-G7t** (Mode B only, adds L band capability)
    - Its Ok, need to use the earpiece/mic which costs more. \
  - **GD77** aka TYT MD-760 DMR radio - Still only ½ duplex, so you need two!
    - Reflashed with OpenGD77 firmware and configured CPS, this has built in satellite tracking and doppler correction with a few quirks.
  - **Any Two FM HT's**. Baofengs work good for TX. Use something better (*anything better!*) for RX.
  - **Any "shack in the box"** HF/VHF/UHF transceivers **combined with an SDR and LNA** for receive and controllable via CAT.
- Antennas
  - **Arrow or Elk** to start with. M2 or Antenna.us when you move up.
  - Use BNC connectors and adaptors if possible when portable. They turn and twist better. Easier to replace an adaptor than a connector port on your rig.

Antenna Setup Notes

- You will need a directional antenna for best results on the recieve.
  - Yagi
  - Eggbeaters Or Quadrifilar Helix (Omni but skyward directivity)
  - CJU (easy to build for UHF RX)
  - Log Periodic
- No ducks or short whips.
- High gain verticals can work for TX/RX, up to a certain elevation.
- Use short feed lines to minimize loss with weak signals and high grade low loss cable for long runs (i.e. LMR-400, LMR-240, RG-213).
- Pre-amps are a must in a lot of cases with a stationary antenna and help significantly.
- Connectors: N-Type for UHF/SHF, PL259/SO-239, BNC, SMA

Above: DIY QFH (V/u mode) Antennas and 70CM SDR Preamp+filter.

Other Antenna Equipment

- Antennas - Directional Antennas are best, Circularly polarized directional antennas are optimal.
  - Why? Weak signals, polarization fading.
  - Suitable omni-directional antennas are the Eggbeater, Turnstile, or Quadrifilar Helix (QFH)
  - Suitable directional antennas are Yagi's, Log periodic, CJU
  - Avoid using verticals and HT whips
  - Check out: elkantennas.com, m2inc.com, arrowantennas.com, antennas.us, radiowavz.com
- Antenna Accessories
  - Low Noise Amplifiers(LNA) are often employed to compensate for signal loss.
  - Low loss coaxial cable is used such as LMR-400/240 or better for fixed stations.
  - High/Low/Band Filters
  - Duplexers - Split UHF/VHF signals and maybe even some filtering.
  - AZ-EL rotators to move the larger fixed beam antennas
-

Other Station Equipment

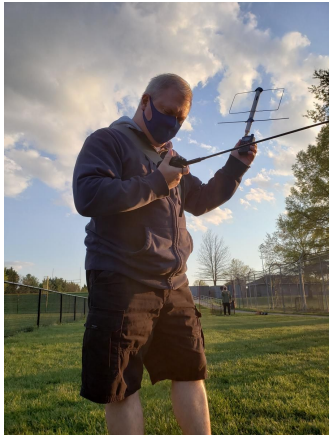
- Radios - You need two right? Well.....sorta
  - What you really need are two independent VFO's or Full-Duplex.
  - Some radios, basically anything that can cross band repeat, usually are Full-Duplex
  - Remember only one radio needs to transmit. Your second VFO could be a SDR box/dongle or wideband scanner. This is a popular option since you can see and record activity and allows use of a single all-mode transceiver.
- Radio Accessories
  - Headset, or at least headphones on RX side.
  - TRRS/TRS Audio Splitters, cables, and adaptors
    - Digital Voice Recorder with line in TRRS jack.
  - CAT cables and adaptors
  - Rails, cases, straps, and other protective gear.
- Power
  - Commercial to a quality PDU and 12v cables
  - Battery chargers and wall warts (choke em'!)
  - Battery Box with 12v cigarette socket and powerpole sockets
- Computers & Software
  - SatPC32 for pass prediction doppler and rotor control
  - Ham Radio Deluxe suite (doppler, rotor, logging, pass prediction)
  - CQRLOG for logging on Linux and Pi
  - Gpredict for doppler and rotor control under Linux and Pi
  - SDR software: GQRX, SDRUno, CubicSDR

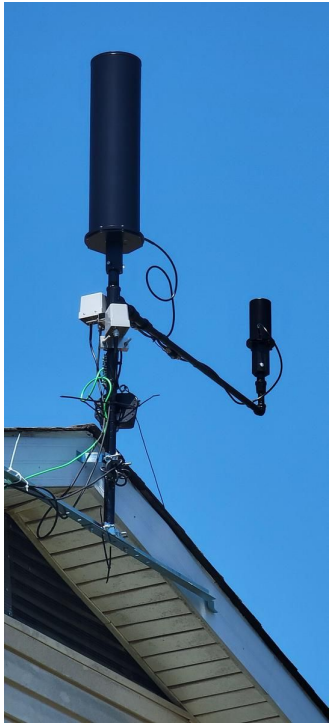
My Rigs

<u>Portable:</u>* **Dual FT-818nd's** with Arrow or Elk antennas, Heil BM-10 headset and adaptors, GoSatWatch, digital VR, and bioenno 12v battery. This setup works extremely well for stationary and portable ops + HF. **Kenwood TH D-72A** + Elk. CJU or Arrow antenna with **two HT's**

<u>Base:</u>

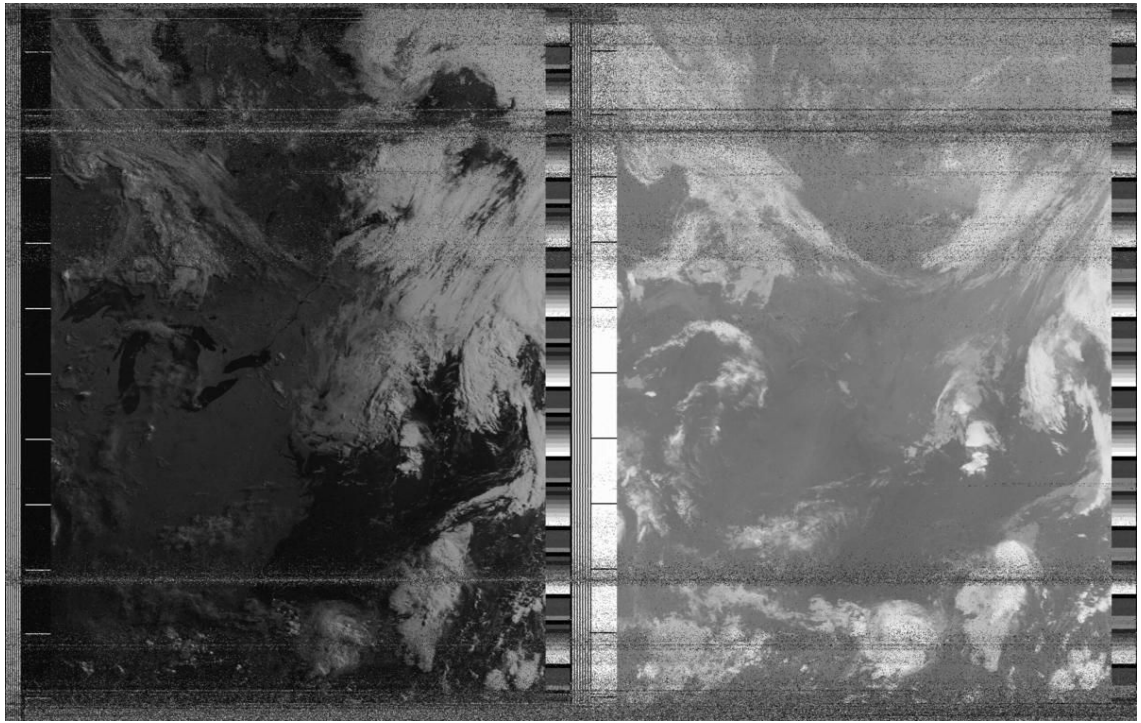
IC-9700 or FT-847 and QFH antennas with mast mounted pre-amps. Doppler corrected by SatPC32





NOAA-APT weather satellite image capture

NOAA 15, 18, and 19 transmit wideband telemetry around 137-138Mhz which can be recorded as audio and decoded with software into images as you see on the right. Using an SDR is best, so you can see the signal and adjust for polarization fading, adjust filter bandwidth, and save directly to audio files.



APRS digipeaters

Several satellites are APRS digipeaters. ISS, PO-101.

It is possible to relay a short exchange with call sign, grid square and 73 for a short QSO.

If you are lucky enough to own a TH-D72 OR TH-D74, these seem to be the most popular options and some good instructions are here:
https://www.amsat.org/wordpress/wp-content/uploads/2014/01/AMSAT_Journal_KenwoodHT_Packet.pdf

I have tried many times with APRSdroid + Mobilinkd TNC and although receive is Ok, transmitting and getting digipeated is another matter. Others do it, so it's definitely me. Check back again later!

The APRS capable HT's seem to be a good option here.

Next Steps

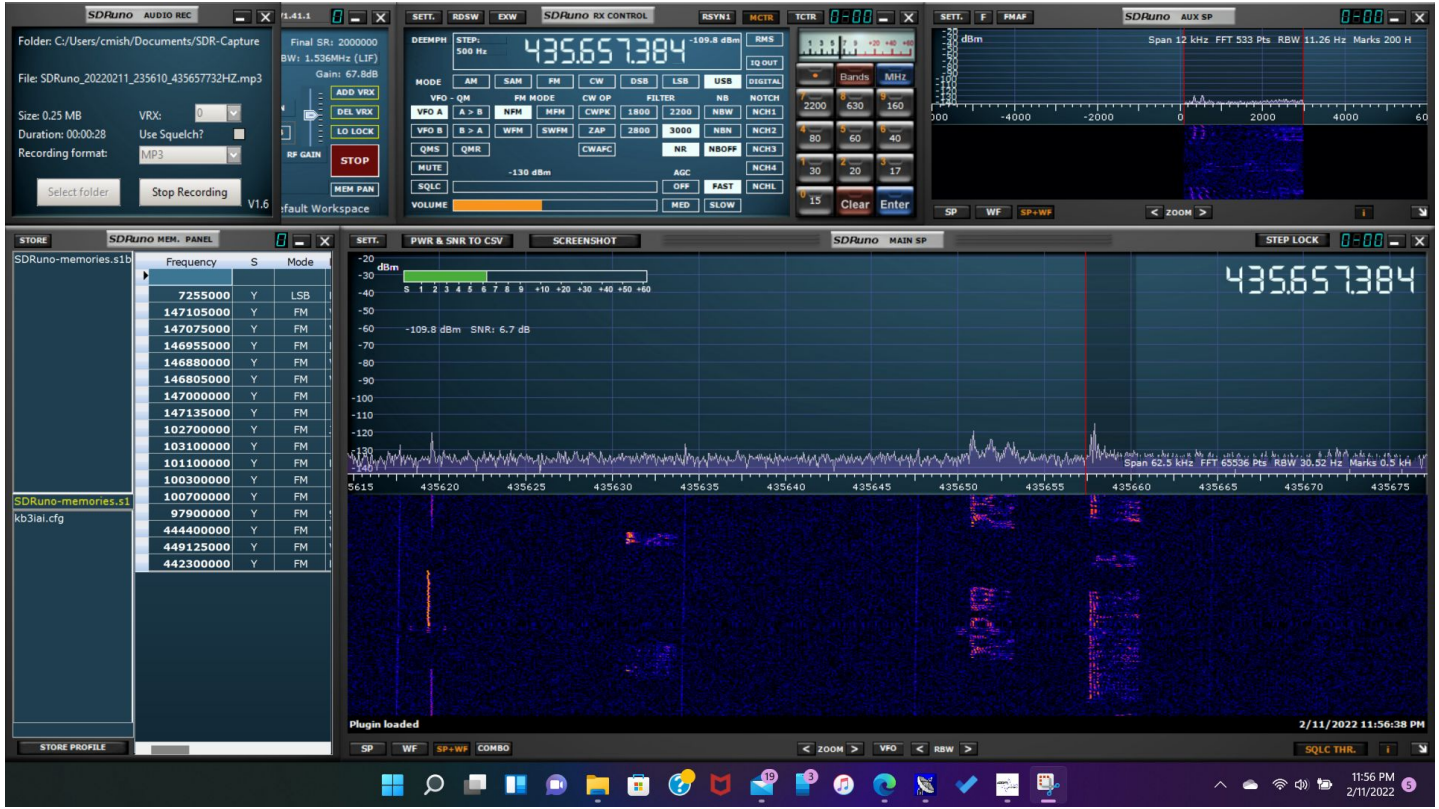
Once you feel comfortable with the FM sats and have successfully and consistently make contacts, consider moving to the *linear transponder* satellites using SSB or CW.

A linear transponder provides a pass band, from which to tune around. Similar to HF, you can move around and the passband can support multiple 3K wide SSB signals over 30-60Khz.

Because these have narrow bandwidth you will adjust doppler on both TX and RX with 70cm changing faster as the spacecraft speeds overhead. So, its best to use CAT control from software to do that, or use the KE0PBR “cheat sheets” if no CAT is available.

You will also need transceivers that can support LSB and USB in the VHF and UHF bands. This can be a significant additional investment in the hobby to acquire a dual VFO radio (ic9700, ts-2K, ic910, ft847, etc....). So a popular alternative is to use SDR as the 2nd VFO with a “shack in the box” type rig, or two “lower cost” (possibly used) radios in the FT817 family.

Linear Transponder Operation with SDR teaser



Using an SDR with a Low Noise Pre-Amplifier and filter to receive signals from the linear transponder on RS-44.

The transponder receives signals on 2M LSB, and transmits them on 70CM USB thus inverting the signal.

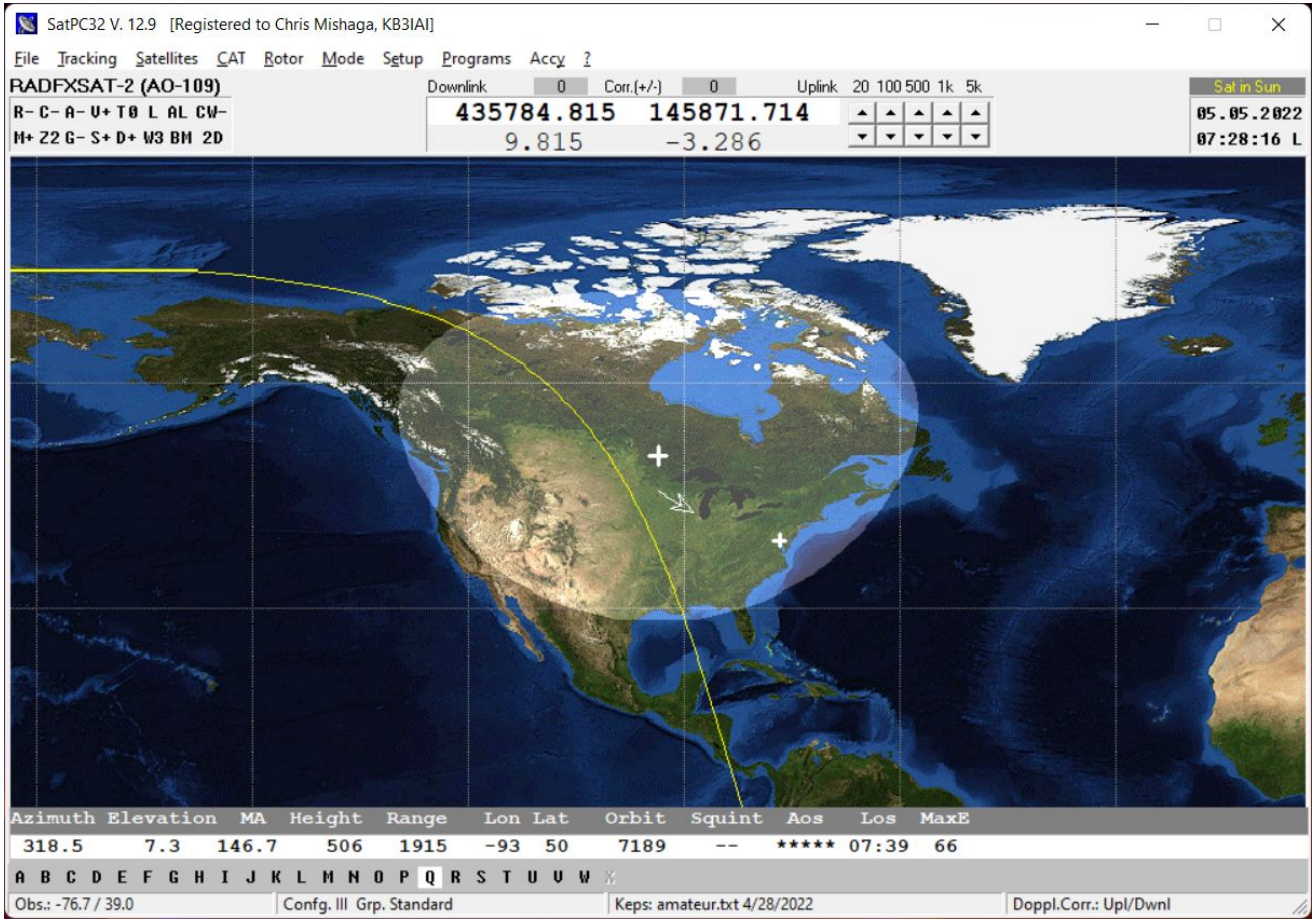
Doppler shift control becomes very interesting as 70cm signals are going down in frequency and 2m signals need to go up in frequency continuously. SatPC32 software is used here to control the dopper on the SDR and the transceiver using CAT control.

You can see multiple SSB signals here in the passband. Simply clicking on one tells the software to adjust so you can make a contact at their frequency.

SDR makes it easy to record the pass as well as “see” activity.

Range or Footprint

The elliptical circle shown here is the footprint of AO-109 running coast to coast and typical of linear transponder satellites.



Conclusion

Satellite operation provides Amateurs with a unique way to enjoy the hobby on VHF and UHF. With a little time and effort you can reap the rewards with rare grids, contest points, and an easy way to operate portable QRP on your next DXpedition or HAMcation.

References

Plenty of follow up material you can read through on building antennas, guide books, web and social media sites, and other experimentations.

Links and references

My Frequency Cheat Sheet | Paul "KE0PBR" Overn's Page (wordpress.com)

FM Satellites: Good Operating Practices for Beginning and Experienced Operators – AMSAT

FM Satellite Frequency Summary – AMSAT

Work FM Voice Ham Satellites This Week! (work-sat.com)

AMSAT OSCAR Satellite Status

Contact the ISS - ARISS

Microsoft Word - K9JKM_2012_Symposium_Ver2 (ariss.org)

2.-INGLES-THE-CJU-THE-MAGIC-ANTENNA.pdf (amsat.org)

Build it: 2 meter Tape Measure Yagi Beam Antenna - KB9VBR Antennas (jpole-antenna.com)

Antenne Eggbeater-Engl-Part1-Full.pdf (pagesperso-orange.fr)

Eggbeater II (somenet.net)

https://www.onallbands.com/full-duplex-the-key-to-satellite-success/

SOAR: Satellite Optimized Amateur Radio - https://www.youtube.com/watch?v=y_lgjdELaaw

Sample QSO

This was recorded from AO-91,
on June 3rd 2020 15:54Z

Click Audio to the left