



Yavapai Amateur Radio Club

<http://www.w7yrc.org/>

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Having Fun with the Amateur Satellites

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<http://www.wd9ewk.net/>

Amateur satellite history, in brief

- OSCAR I launched on 12 December 1961
 - First civilian satellite, beating Telstar to space by 7 months
 - Parts cost: \$63 (1961 dollars)
 - 2m CW “HI” beacon transmitter operated for almost 3 weeks
 - Reentered atmosphere after 49 days
- OSCAR 3 launched on 9 March 1965
 - First OSCAR with transponder
- 67 numbered OSCAR satellites, 30 Russian/USSR *RadioSputnik* amateur satellites (1 also had an OSCAR number), along with other satellites without OSCAR numbers using amateur bands
- Manned operations from US space shuttles (“SAREX”) starting in 1983 through 1990s, Russian *Mir* space station in 1990s, and current International Space Station
- More satellites planned and under construction

Current satellites (voice or CW)

- AO-7 (launched in 1974; 2m/10m and 70cm/2m SSB/CW)
- AO-16 (launched in 1990; 145.920 MHz FM/437.026 MHz SSB)
- **AO-27** (launched in 1993; 145.850/436.795 MHz FM)
- FO-29 (launched in 1996; 2m/70cm SSB/CW)
- **SO-50** (launched in 2002; 145.850/436.795 MHz FM)
 - Transmit with 74.4 Hz PL to activate satellite for 10 minutes, then transmit with 67.0 Hz PL to be heard through satellite
- **AO-51** (launched in 2004; uplinks on 10m, 2m, 1268.700 MHz; downlinks on 70cm or 2401.200 MHz; various uplink modes with FM downlinks)
 - Most-common mode is 145.920/435.300 MHz FM repeater
- VO-52 (launched in 2005; 70cm/2m SSB/CW)
- DO-64 (“Delfi-C3”, launched in 2008; 70cm/2m SSB/CW)
- **ISS** (occasional crew operations on 2m and 70cm FM, cross-band repeater on 437.800/145.800 MHz FM)

Current satellites (digital)

- GO-32 (launched in 1998; 2m/70cm)
- AO-51 (launched in 2004; uplinks on 10m, 2m, or 1268.700 MHz; downlinks on 70cm or 2401.200 MHz – 9600 to 38400bps digital plus sometimes PSK31)
- ISS (packet mailbox, digipeater for real-time keyboard contacts and APRS, 1200bps AX.25 packet on 2m)

Future satellites

- “Phase 3E”, a high-orbit satellite being built by AMSAT-DL in Germany, could be ready for launch in 2008
- AMSAT-NA “Eagle”, a planned high-orbit satellite, could be ready for launch in 2009
- ISS Columbus module built by European Space Agency, with additional amateur antennas for 1.2 and 2.4 GHz
- HF activity from ISS, possibly with Yaesu FT-817ND
- SuitSat 2, a Russian *Orlan* spacesuit, may be “launched” from ISS in 2009. Plans call for a solar-powered “satellite” with an FM repeater and/or SSB/CW transponder plus other payloads
- Various universities and amateur radio groups building variety of satellites around the world (DO-64/Delfi-C3 was built by a Dutch university, used for academic work initially, now open for amateur use)

Using the amateur satellites

- FM satellites are cross-band repeaters
- SSB/CW satellites are similar to repeaters, but retransmit range of frequencies with many simultaneous contacts
- Digital satellites have “bulletin boards” to store messages and files for other stations to download, and/or digipeaters for real-time contacts
- ISS – talk to crews, access packet mailbox, use packet digipeater to make keyboard contacts with other ground stations or crews, use repeater to talk with other stations or crews, receive slow-scan TV pictures.
- Above 2m on FM and on any band for non-FM operations, must compensate for Doppler effect

Working the FM satellites

- Radio capable of 2m and 70cm FM, or two separate radios for these bands
- Full-duplex operation ideal when starting out, but not mandatory
- Can work with as little as 100mW, many use 1-5W from HTs, some work mobile with 25-50W
- Must compensate for Doppler on 70cm
- Antenna, antenna, antenna...

Working the FM satellites - Radio

- Transceivers that can work as 2m/70cm cross-band repeater are ideal for FM satellites
 - HTs: IC-W32A, TH-D7, TH-79, FT-470, FT-51, FT-530 (all discontinued, and others)
 - Mobile rigs: IC-2820, FT-8800, FT-8900, TM-D710, TM-V71A, and many others not in production
- Radios that have 1 VFO but can accept memory channels with RX and TX in different bands OK
- Any dual-band FM radio can be used, with extra manual steps (swapping between RX and TX frequencies)
- Separate 2m and 70cm radios are used by some
- Not necessary to run lots of power – FM satellites have good receivers

Working the FM satellites - Antenna

- Ideal antenna is a directional antenna – Yagi, quad, log periodic, etc.
- Omnidirectional antennas without gain also useful for satellite work
- Portable stations typically use handheld Yagis, log periodics, telescoping whips, or long duckies with HTs
- Gain verticals (base or mobile) can be problematic due to their radiation patterns
- Sometimes antennas need to be tilted from vertical to hear satellites better

Working the SSB satellites

- Many satellite-capable VHF/UHF transceivers available
 - IC-910H and TS-2000 currently in production
 - Older rigs still popular (examples include IC-820H, IC-821H, TS-790, FT-726, FT-736, FT-847)
- Many operators prefer separate all-mode transceivers for satellite work
 - All-mode monoband transceivers were popular in the past. Now, all-mode HF/VHF/UHF transceivers like IC-706 series, IC-7000, FT-100, **FT-817**, FT-857, FT-897 can be paired for full-duplex SSB/CW satellite operation
- Computer control for radios preferred by many, to deal with Doppler effect on both RX and TX frequencies. Same with the antennas, so the operator can concentrate on making contacts
- Since these satellites transmit a small band of frequencies, operators have more time to chat and not just exchange information like callsigns and grid locators

When are satellites available?

- Use AMSAT website or tracking programs to know when satellites are in view of your location
 - <http://www.amsat.org/amsat-new/tools/predict/>
- Some programs can control antenna rotators and radios
- AMSAT and ARRL have tracking programs for sale
- Free programs can be downloaded:
 - Orbitron: <http://www.stoff.pl/>
 - PREDICT: <http://www.qsl.net/kd2bd/predict.html>
 - Others available at <http://www.amsat.org/amsat-new/tools/ftpsoft.php>
- Consult web sites to see schedules for some satellites:
 - AO-27: <http://www.ao27.org/>
 - AO-51: <http://www.amsat.org/amsat-new/echo/ControlTeam.php>

Before you transmit...

- Do you hear the satellite?
 - Open squelch all the way
 - FM satellites usually have activity on any 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!**
 - FM satellites have sensitive receivers, but weak transmitters
 - AO-27 and AO-51 transmit at 500mW
 - SO-50 transmits at 250mW
 - ISS transmits at 5W or 10W, depending on the radio being used (Ericsson/GE commercial VHF HT, Kenwood TM-D700)

Making contacts

- Listen to the satellite, pick out some callsigns
- On FM satellites, call a specific station, or just transmit your callsign
 - **DO NOT CALL CQ!**
- Calling CQ on an SSB/CW satellite is encouraged, as those satellites are retransmitting a band of frequencies instead of just one frequency. Similar to HF, you are hoping someone hears your CQ call and then calls you.
- Contacts on FM satellites are usually quick - callsign, location, maybe your name (similar to HF contests or Dxpeditions). More time to chat on SSB/CW satellites.
- Regular operators can recognize new operators, and are happy to make contacts and help with operating advice
- Satellite operators like to exchange “grids” for location

What is a “grid”?

- Maidenhead grid locators, developed in Europe for VHF contesting in early 1980s
- 4- to 6-character identifier represents approximate latitude/longitude
 - Prescott is in grid DM34, this meeting is in grid DM34sn
- QRZ.com usually has grids for most US hams, based on licensee's address
- Some GPS receivers will display the grid locator
- Web sites have converters to take latitude/longitude and calculate your grid:
 - <http://www.arrl.org/locate/grid.html>
 - <http://www.amsat.org/amsat-new/tools/grids.php>

Logging contacts

- Many satellite operators use recorders or computers to record audio for logging
 - Especially for portable operating; almost impossible to log in real time if using a radio/microphone and holding 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)
 - Tape recorders or digital recorders are small, inexpensive – or use a computer

From Arizona, you can hear...

- All 50 US states, including Alaska and Hawaii
- Canada, Mexico, Central America, some of Caribbean, northern South America, portions of north Atlantic and Pacific oceans
- ISS activities, when in range
 - ISS side of scheduled contacts with schools, museums, etc.
 - Packet mailbox/digipeater is normally active
 - 437.800/145.800 MHz FM repeater may be on
 - Slow-scan TV pictures
 - Crews may make unscheduled contacts with hams
- High-orbit satellites cover multiple continents – you can contact over 100 countries with those satellites. We are waiting – and hoping - for Phase 3E and Eagle

Satellite-related Operating Awards

- ARRL has satellite versions of WAC, WAS, DXCC, and VUCC:
 - <http://www.arrl.org/awards/>
- AMSAT has a variety of awards:
 - <http://www.amsat.org/amsat-new/awards/>
- CQ magazine awards:
 - <http://www.cq-amateur-radio.com/awards.html>
- ISS Fan Club for ISS-related activities:
 - <http://www.issfanclub.com/>
- Many others...

Tonight's satellite demonstration

(subject to satellite availability and local weather conditions)

- AO-51, 145.920/435.300 MHz FM
- 6:31-6:45pm (0131-0145 UTC)
- Satellite went by to the east, up to 47 degrees above horizon at 6:38pm (0138 UTC)
- When above the horizon during this pass, AO-51 was between 645 and 2070 miles away transmitting at approximately 500mW
- My station for tonight:
 - Icom IC-2720H 2m/70cm FM mobile radio @ 5W or 15W
 - 12VDC/20Ah gel-cell battery pack
 - Arrow Antennas handheld 2m/70cm Yagi, with Diamond MX-72D 2m/70cm duplexer
 - Sony ICD-P210 digital recorder

Questions?