Satellite Basics & AMSAT Update

John Kludt, K4SQC
AMSAT Ambassador
Atlanta, Georgia
April 10, 2018
Satellite Options

- Telemetry monitoring and reporting
  - AO-85, AO-91, AO-92, AO-73
- FM Transponders
  - SO-50, AO-85, AO-91, AO-92
- Linear Transponders
  - AO-7, FO-29, AO-73, XW series
Orbital Terminology

- **LEO (Low Earth Orbit)** – 160 km – 2,000 km (100 -1,240 miles) above earth
- **Ascending Pass** – relative to you, travels South to North
- **Descending Pass** – relative to you, travels North to South
- **AOS (Acquisition of Signal)** – time at which signal is first heard
- **LOS (Loss of Signal)** – time at which the signal is lost
- **Duration** – the time between AOS and LOS
- **Azimuth** – the compass direction between observer and satellite
- **Elevation** – height in degrees above your horizon
- **Maximum Elevation** – highest point of the pass in degrees
- **Pass Predictions** – a listing showing times when you can see satellite
- **Footprint** – the area on the ground covered by the satellite at any given time
Pass Predictions

- Multiple Offerings
  - PC based
  - Mac based
  - Smartphone based

- Things to watch
  - Is your location correct?
  - Are your Keps current? (especially important ISS)
  - Is your clock correct – watch UTC versus Local
Pass Prediction Sites/Software

- [http://tinyurl.com/amsat-predict](http://tinyurl.com/amsat-predict)

- SatPC32 (Windows)
- Macdoppler Pro (Mac)
- Predict (Linux)
- Gpredict (Linux)
- Numerous Smartphone Apps
Sample Pass Predictions

- WinAos  QTH: -84.2/34.1  T#: 13607  Sat.: 5 [Standard]

<table>
<thead>
<tr>
<th>Day</th>
<th>Objects</th>
<th>AOS (U) LOS</th>
<th>Period</th>
<th>maxEl</th>
<th>AZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>04.04.2015</td>
<td>AO-73</td>
<td>15:11</td>
<td>15:20</td>
<td>09</td>
<td>38 028 - 172</td>
</tr>
<tr>
<td>04.04.2015</td>
<td>AO-73</td>
<td>16:48</td>
<td>16:55</td>
<td>07</td>
<td>17 337 - 237</td>
</tr>
<tr>
<td>04.04.2015</td>
<td>FO-29</td>
<td>18:59</td>
<td>19:05</td>
<td>06</td>
<td>09 077 - 025</td>
</tr>
<tr>
<td>04.04.2015</td>
<td>AO-07</td>
<td>19:27</td>
<td>19:42</td>
<td>15</td>
<td>25 114 - 001</td>
</tr>
<tr>
<td><strong>04.04.2015</strong></td>
<td><strong>FO-29</strong></td>
<td><strong>20:38</strong></td>
<td><strong>20:54</strong></td>
<td><strong>16</strong></td>
<td><strong>56 148 - 354</strong></td>
</tr>
<tr>
<td>04.04.2015</td>
<td>SO-50</td>
<td>20:51</td>
<td>20:58</td>
<td>07</td>
<td>14 149 - 055</td>
</tr>
<tr>
<td>04.04.2015</td>
<td>AO-07</td>
<td>23:17</td>
<td>23:23</td>
<td>06</td>
<td>08 248 - 296</td>
</tr>
<tr>
<td>04.04.2015</td>
<td>ISS</td>
<td>23:21</td>
<td>23:24</td>
<td>03</td>
<td>08 149 - 095</td>
</tr>
</tbody>
</table>

- WinAos  QTH: -84.2/34.1  T#: 13608  Sat.: 5 [Standard]
Telemetry Opportunities

• Another way to “work the satellites”
• Transponder plus data satellites
  • AO-85/91/92
    • (DUV) (Fox 1 Telemetry Analysis Tool)
    • http://www.amsat.org/tlm/leaderboard.php?id=1&db=FOXDB
  • AO-73 (Funcube Dashboard)
    • https://funcube.org.uk/ground-segment/gui/
• Numerous “Data Only” satellites
  • Decode and Upload
  • Contributes to the science
Transponder Types

**FM Transponders**
- FM Only
  - Single Channel
  - Capture Effect
- Fox Series
  - AO-85
  - AO-91
  - AO-92
  - Fox-1B
- SO-50

**Analog Transponders**
- SSB
- CW
  - Bandpass of 20 to 100 KHz
  - Many signals at once
- Examples
  - AO-7
  - FO-29
  - AO-73
  - XW series
Operational Modes

U/v (435 MHz up/144 Mhz down)
- AO-7*
  - (Sometimes V/a - 144 up/29.5 down)
- AO-73
- AO-85
- AO-91
- AO-92
  - (Sometimes L/v 1.2 GHz up/145 MHz down)
- XW series

V/u (144 MHz up/435 MHz down)
- FO-29
- SO-50
Work SO-50 (V/u FM Transponder)

- LEO satellite
  - Altitude 426 miles avg
  - Speed 16,754 MPH (10 minutes horizon-to-horizon)
- FM Transponder
  - Uplink 145.850 MHz (PL 67.0) (-124dBm)
  - Downlink 436.795 (250 mW)
SO-50 Equipment Requirements

- HT or Transceiver with 2m & 70 cm capabilities
  - 5 watts adequate
  - Capable of at least 2.5 KHz steps
  - Full duplex strongly recommended
- Antenna
  - Arrow +/- preamp
  - Alaskan Arrow
  - Elk
  - Home Brew (VE2ZAZ design)
- Clock
- A compass
- A recording device
Tricky Part - Doppler

**SO-50 Downlink 436.795**
- Doppler +/- 10 KHz
- Use several memories
- Half above midpoint
- Half below midpoint
- Tune for best audio
- You should be at 436.795 at Max Elevation

**SO-50 Uplink 145.850**
- Doppler +/- 3.4 KHz
- Stays within standard FM bandpass
- Easy way out – just use 145.850 PL 67.0 for every step
- “Wake up PL” PL 74.4 for 2 seconds
## Doppler Correction Card

<table>
<thead>
<tr>
<th>By: KK4RGK</th>
<th>Wakeup:</th>
<th>TX</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO-50</td>
<td>RX</td>
<td></td>
</tr>
<tr>
<td>#1</td>
<td>436.815</td>
<td>145.850 PL 67.0</td>
</tr>
<tr>
<td>#2</td>
<td>436.810</td>
<td>145.850 PL 67.0</td>
</tr>
<tr>
<td>#3</td>
<td>436.805</td>
<td>145.850 PL 67.0</td>
</tr>
<tr>
<td>#4</td>
<td>436.800</td>
<td>145.850 PL 67.0</td>
</tr>
<tr>
<td>#5</td>
<td>436.795</td>
<td>145.850 PL 67.0</td>
</tr>
<tr>
<td>#6</td>
<td>436.790</td>
<td>145.850 PL 67.0</td>
</tr>
<tr>
<td>#7</td>
<td>436.785</td>
<td>145.850 PL 67.0</td>
</tr>
<tr>
<td>#8</td>
<td>436.780</td>
<td>145.850 PL 67.0</td>
</tr>
</tbody>
</table>
AO-85/91/92 Equipment Requirements

- HT or Transceiver +/- SDR with 2m & 70 cm capabilities
  - 5 watts adequate, a little more is better
  - Capable of at least 2.5 KHz steps
  - Full duplex absolutely required
- Antenna
  - Arrow +/- preamp (*Tx polarization “twist” may be needed*)
  - Alaskan Arrow
  - Elk
  - Home Brew (VE2ZAZ design)
- Clock
- A compass
- A recording device
AO-85 Frequencies (example)

- **Uplink (Pl 67.0)**
  - 436.160 MHz (AOS)
  - 436.165 MHz
  - 436.170 MHz (Max E)
  - 436.175 MHZ
  - 436.180 MHz (LOS)

- **Downlink**
  - 145.978 MHz
  - 145.978 MHz
  - 145.978 MHz
  - 145.978 MHz
  - 145.978 MHz

*Don’t forget to turn on your PL – no PL = no contacts
No “easy way out” on U/v*
AO-73 (U/v Linear Transponder)

- AMSAT-UK and AMSAT-NL
- Launched November 21, 2013
- 400 mw analog transponder (SSB/CW)
  - Uplink 435.150 MHz – 435.130 MHz
  - Downlink 145.950 MHz – 145.970 MHz
- 400 mw BPSK telemetry beacon (Dashboard)
  - 145.935 MHz
- Per AMSAT-UK website “not more than 5 watts into a 7dB gain antenna”
AO -73 Tuning

- Some what tricky
  - Doppler &
  - *Drift* in the master oscillator
  - So, *cat control really doesn’t work very well*
- Follow “The One True Rule”
  - Find yourself by tuning the *higher* frequency link
  - *Uplink* on AO-73
  - Then tune uplink to stay on a relatively constant receive frequency that will itself drift and require retuning
Pass Reminders

- It is going to seem to be very busy
- Compass
- Visual AOS reminder
- Visual Max Elevation reminder
- Visual LOS reminder
- An elevation reminder
- An easy to read clock
- Tape recorder
- Open your squelch all the way on FM birds
I Didn’t Hear Myself or Anything!

- Pass predictions correct?
  - Location
  - Keps
  - Time
  - True North?
- Was the satellite on?
  - http://www.amsat.org/status/
- FM – did you have your PL (67.0 Hz) turned on?
- Rig/antenna issues?
“Five and Dime”

- Forward looking effort to explore new technology
- New SDR based communications platform
  - 5 GHz up
  - 10 GHz down
- Ground station component
  - AMSAT Phase 4 Ground Terminal team
  - Work underway – “water tower test system”
“Five and Dime” Flight Possibilities

- “Five and Dime” Space Team
  - Phase 4B Geosynchronous Ride share
    - Huge ARES potential
    - Several important groups on board
    - 2018 timeframe
  - Phase 3E (?)
    - Highly elliptical orbit, similar to AO-40
    - Long communications periods at apogee
AMSAT Membership

- Great way to explore new opportunities in a time of decreasing HF propagation
- Satellites expensive to build
  - Good parts (don’t just drive up to the site to fix!)
  - Huge amounts of engineering
  - Rigorous NASA flight testing
  - As much as $100,000 per launch
- Basic membership $44 per year
  - AMSAT Online Store  http://store.amsat.org/catalog/
Questions?

AMSAT