AO-10 Ground Station Analysis

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Ever wonder how to calculate the noise figure of your system? Noise temperature? Here's how to go about it.

By using a series of equations and readily-obtained equipment performance figures, the prospective OSCAR-10 satellite user can determine not only how well he or she will hear the satellite, but also how well the spacecraft will hear the signals from the home station. The satellite enthusiast can easily determine the cost/benefit ratio of using a better preamplifier, for example, or perhaps using better coaxial cable to reduce feed line loss. What benefit can be realized by moving the preamplifier closer to the antenna or raising the transmitter power? The following information will help answer the questions and perhaps guide the radio amateur in making better choices in equipment for the ham shack.

Two analyses can be performed to first determine what signal levels can be expected from OSCAR-10's downlink transponder on 2 meters and what signal the satellite will be able to hear from the ground station. The intent is not to provide an in-depth analysis, but rather to give the variables that can be easily identified and to explain how they can be used to better evaluate existing or planned ground-station equipment. The analysis is for Mode B operation but the techniques can also be used for other transponders and satellites.

Variables Described

Several specific components must be known or be calculable in order to assess the downlink budget:

1. Transponder Output Power (14 W average)
2. Satellite Antenna Gain (2m) (6 dB)
3. Free Space Path Loss @ 146 MHz over a 38,000 km (– 168 dB) path
4. Multi-Use Power Sharing Factor (– 10 dB)
5. Propagation Loss (– 1 dB)
6. Antenna Pointing and Polarization Loss (– 2 dB)
7. Ground Station Rx Antenna Gain (+ 11 dB)
8. Ground Station Feedline Loss
9. Preceiver Preamp Noise Figure and Gain
10. Receiver (or multimode XCVR Noise Figure)

Once the above variables are identified or calculated, it is easy to predict the signal-to-noise ratio that OSCAR-10's downlink will present to a receiving station.

The following is typical:

1. Satellite 2 meter output power: This has been measured at 14 W average by AMSAT.

2. Satellite 2 meter apogee antenna gain: This has been specified at 6 dBc by AMSAT.

3. Free space path loss: This figure may be taken from the *RSGB VHF/UHF Handbook* (pp 9.5 and 9.11). For the purposes of the analysis, 146 MHz is specified as the frequency and 38,000 km (apogee height) as the distance. The resultant free space path loss is therefore 168 dB.

4. Multi-use power loading factor: This variable is the result of all users sharing the available transmitter power. It assumes a random distribution of instantaneous power drain based on cw and ssb signals. A factor of 10 dB is required for approximately 50 users with equal signal strength presented to the transponder's receiver. This figure is also found in the *RSGB VHF/UHF* handbook (p. 9.11).

5. Propagation loss: This is an assumed figure of 1 dB based upon the signal path not propagating in truely free space but rather through the earth/satellite medium of the atmosphere and ionosphere (RSGB).

6. Antenna pointing and polarization loss: A figure of – 2 dB is also based on information in the *RSGB VHF/UHF* book and is the result of antenna aiming error (none of us is perfect!) and shifts away from ideal