

Interference and Electromagnetic Compatibility Study

The Orbital Reflector Satellite is a visually observed and tracked satellite that is also flying a small experimental Simplex Radio Transceiver at 922.000 MHz. The Radio can be interrogated from a ground station. It can respond with some scientific data and also act as a backup for the on-board payload deployment timer. The Spacecraft will not transmit without reception of a properly coded interrogation signal from the temporary ground station. The initial orbit is 575 km. After altitude decay from atmospheric drag to less than 450km altitude the radio will not be used. Radio experiments / applied engineering testing include vehicle temperature, battery state of charge, and ground station received power.

Location Usage:

The Spacecraft's radio system only responds to properly coded sequences. Those interrogations/telemetry requests are sent exclusively from the single ground station in Lakewood, Colorado (N 39°42'6" latitude West 105°7'19" longitude). Thus the only spacecraft RF transmission activity will occur only when the spacecraft is over ITU Region 2, indeed only in a small portion of ITU Region 2. Therefore the SC's RF emissions will only be in the ITU Region 2s Amateur and ISM 33cm band. See Fig 1.

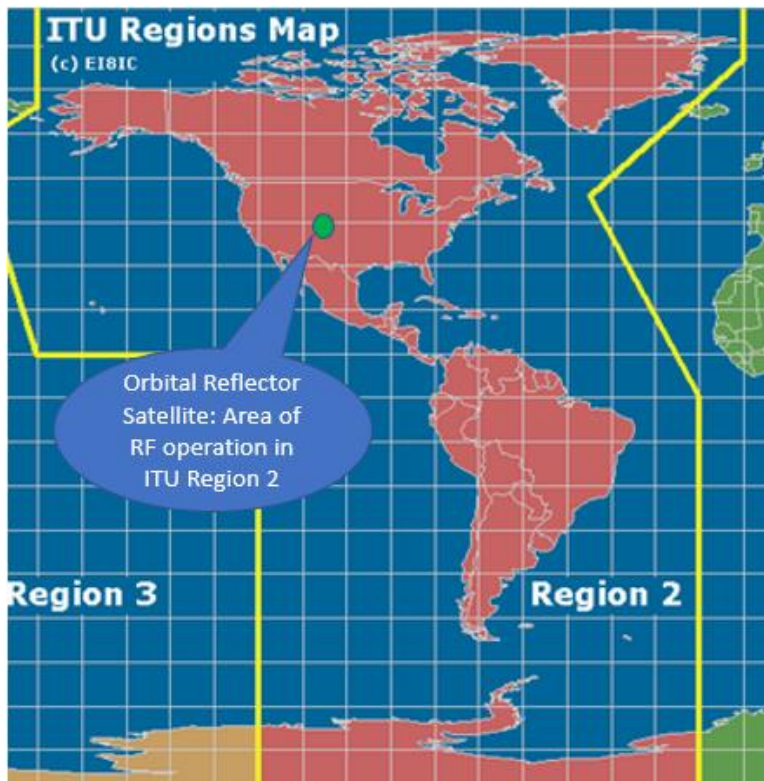


Fig 1. Orbital Reflector Satellite's Area of Operation, within a 300 km radius of Lakewood, Colorado.

Earth Surface Power Flux Density

The maximum antenna input power is supply-limited to 0.5 Watts (-3dBW). With a peak antenna gain of +3dB and a minimal orbital range (zenith) of 575km, this produces a maximum earth surface power of -121.4 dBW. With a GFSK bandwidth of 10 kHz, our density is -161dBW/Hz only slightly higher than the -164 dBW thermal background radiation.

Other spacecraft:

The Space Network List Online (<https://www.itu.int/itu-t/freqtab/asn/asn.html>) provides a list of licensed satellites operating in orbit. Searching the lists for the frequency range of 900-950MHz we find No geostationary nor ground stations listed. The Non-Geo satellites listed were:

PROMETHIUS-B1 (915.0MHz, BW 26 MHz type ET)
AEROCUBE (914.7MHz, BW 1.25MHz)
AEROCUBE-8CD AEROCUBE-11 AEROCUBE-12 (Same)

There is no possible interference to/from the Aerocube satellites since their frequencies are never coincident

with ours. The Prometheus-B1 satellite uses a software defined radio and may have a technical capability to use any portion or all of the 905-928 33cm band for experimental voice, video, and digital communications demonstrations. It is nominally supposed to use a direct sequence spread spectrum link with a bandwidth of the entire band (23MHz BW = 11.5MHz chipping rate). As a spread spectrum system any interference we could conceivably put into it will be attenuated by the direct sequence process gain ($10\text{kHz}/26\text{MHz} = -34\text{dB}$) plus a reasonable range (at least 575km or -121 dB) which would limit our detectable power to something below -155 dBW. The Prometheus Satellite also has downward pointed antenna gain which we do not have specifications for, which will further limit our interference. While we can not guarantee that this is not detectable, the Prometheus satellite does need to meet the same expectations of an experimental radio system and reject any interference we could conceivably supply.

ITU Radio Regulations:

APPENDIX 2 Table of Transmitter Frequency Tolerances

Transmitter tolerance in 470MHz to 2454MHz band for space stations is 20 parts in 10^6 (1 in 2×10^5). Our frequency is digitally derived from a 30MHz crystal oscillator with capacitive tuning. Conservatively speaking, the Orbital Reflector Satellite's transmission frequency accuracy is better than 1 part in 10^7 . Therefore our Spacecraft's frequency tolerance is more than an order of magnitude more accurate than the ITU tolerance threshold.

APPENDIX 3 Spurious transmission levels for the range of 30MHz to 1GHz the spurious transmissions shall be narrower than 100kHz. Our necessary bandwidth, out of band domain and spurious domain are combined less than this width. Our 60dB attenuation bandwidth is only 80kHz, meeting the 60dB requirement in 100kHz.

SUMMARY: The ORSat (ORBITAL REFLECTOR) satellite will pose no interference when it is requested to operate its radio transmitter.