## Exhibit B - NTIA Space Record Data Form (Rev A)

To facilitate the FCC's coordination efforts, provided in this exhibit is additional information regarding the transmit and receive parameters, as described in Section 9.8.2 of the NTIA Manual, for satellite to ground transmissions.

# Satellite to Ground

### Satellite Transmitter Data

<table>
<tr><td colspan="3">Transmit Frequency: 8.260 GHz</td></tr>
<tr><td colspan="3">Satellite Name: GNOMES-3</td></tr>
<tr><td colspan="2">Data Field</td><td>Data Answer</td></tr>
<tr><td colspan="2">Polarization (XAP)</td><td>XAP = R</td></tr>
<tr><td colspan="2">Orientation (XAZ)</td><td>XAZ = EC</td></tr>
<tr><td colspan="2">Antenna Dimension (XAD)</td><td>ANTENNA GAIN 5.0 dBi<br>3dB BEAMWIDTH 80 degrees (hemispherical pattern)<br>XAD = 5G360B</td></tr>
<tr><td colspan="2">Type of Satellite</td><td>Type = Nongeostationary</td></tr>
<tr><td colspan="2">For Geostationary</td><td>Longitude = N/A</td></tr>
<tr><td rowspan="2">For Nongeostationary (Orbital Data)</td><td>Injection Orbit</td><td>INCLINATION ANGLE 97.5 degrees,<br>APOGEE IN KILOMETERS 642 km,<br>PERIGEE IN KILOMETERS 642 km,<br>ORBITAL PERIOD IN HOURS 1 AND FRACTIONS OF HOURS IN DECIMAL 66, THE NUMBER OF SATELLITES IN THE SYSTEM 1,<br><br>ORB = 97.5IN00750AP00750PE001.66H01NRT01</td></tr>
<tr><td>Nominal Operational Orbit</td><td>INCLINATION ANGLE 98.0 degrees,<br>APOGEE IN KILOMETERS 650 km,<br>PERIGEE IN KILOMETERS 650 km,<br>ORBITAL PERIOD IN HOURS 1 AND FRACTIONS OF HOURS IN DECIMAL 63, THE NUMBER OF SATELLITES IN THE SYSTEM 1,<br><br>ORB = 98.0IN00650AP00650PE001.63H01NRT01</td></tr>
</table>

**Note:** Plots of payload / telemetry transmission beam patterns and payload command receive pattern are in Appendix A.

Additional notes on GNOMES-3 Satellite Receiver Data:

1. The GNOMES satellites have no 'dependencies' on foreign signals of opportunity, however the system would see a significant reduction in science data if all GNSS signals are measured.
    a. This scenario would result in a need for additional satellites to obtain the same amount of data.
2. The GNOMES-3 payload "Pyxis" Receiver* performs on-board scheduling and orbit determination by a navigation engine using GPS observations (Galileo, if needed).
3. For science data products, the Pyxis is designed to detect dual-frequency signals from the four major GNSS constellations: GPS, GLONASS, Galileo, and BeiDou.
4. Because of the necessary post-processing of the GNSS orbits and blocks to derive the atmospheric characteristics, any deliberate falsification or spoofing of the foreign GNSS signals will be detected by GNOMES-3 and known well before PlanetiQ releases any weather data products.

*[Same "Pyxis" GNSS Receiver as GNOMES-1 (WK2XIU) and GNOMES-2 (WL2XES)]

# Ground to Satellite

## Ground Station(s) Transmitter Data

| **Svalbard, Norway – SG42** | |
|---|---|
| Data Field | **Data Answer** |
| **State (RSC)** | RSC = Norway |
| **City Name (RAL)** | RAL = Svalbard |
| **Latitude (DDMMSS)** | Lat = 781354N |
| **Longitude (DDDMMSS)** | Lon = 0152238E |
| **Antenna Polarization (RAP)** | RAP = R |
| **Antenna Azimuth (RAZ)** | RAZ = V05 |
| **Antenna Dimensions (RAD)** | ANTENNA GAIN 36.78 dBi (S-Band Transmit)<br>BEAMWIDTH 1.4 degrees<br>AZIMUTHAL RANGE 0-360 degrees<br>THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS 484 meters,<br>THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS 5 meters<br><br>RAD = 37G001B000-360A00484H005 |
| **FCC notes:**<br>**1. Use S-Note S945**<br>**2. REM01 *AGN, Cubesat, GNOMES-3** | |

| **Svalbard, Norway – SG43** | |
|---|---|
| Data Field | **Data Answer** |
| **State (RSC)** | RSC = Norway |
| **City Name (RAL)** | RAL = Svalbard |
| **Latitude (DDMMSS)** | Lat = 781355N |
| **Longitude (DDDMMSS)** | Lon = 0152231E |
| **Antenna Polarization (RAP)** | RAP = R |
| **Antenna Azimuth (RAZ)** | RAZ = V05 |
| **Antenna Dimensions (RAD)** | ANTENNA GAIN 36.78 dBi (S-Band Transmit)<br>BEAMWIDTH 1.4 degrees<br>AZIMUTHAL RANGE 0-360 degrees<br>THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS 479 meters,<br>THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS 5 meters<br><br>RAD = 37G001B000-360A00479H005 |
| **FCC notes:**<br>**1. Use S-Note S945**<br>**1. REM01 *AGN, Cubesat, GNOMES-3** | |

| **Svalbard, Norway – SG71** | |
|---|---|
| Data Field | **Data Answer** |
| **State (RSC)** | RSC = Norway |
| **City Name (RAL)** | RAL = Svalbard |
| **Latitude (DDMMSS)** | Lat = 781336N |
| **Longitude (DDDMMSS)** | Lon = 0152506E |
| **Antenna Polarization (RAP)** | RAP = R |
| **Antenna Azimuth (RAZ)** | RAZ = V05 |
| **Antenna Dimensions (RAD)** | ANTENNA GAIN 36.78 dBi (S-Band Transmit)<br>BEAMWIDTH 1.4 degrees<br>AZIMUTHAL RANGE 0-360 degrees<br>THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS 488 meters,<br>THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS 5 meters<br><br>RAD = 37G001B000-360A00488H005 |
| **FCC notes:**<br>2. **Use S-Note S945**<br>3. **REM01 *AGN, Cubesat, GNOMES-3** | |

| **Svalbard, Norway – SG180** | |
|---|---|
| Data Field | **Data Answer** |
| **State (RSC)** | RSC = Norway |
| **City Name (RAL)** | RAL = Svalbard |
| **Latitude (DDMMSS)** | Lat = 781340N |
| **Longitude (DDDMMSS)** | Lon = 0152255E |
| **Antenna Polarization (RAP)** | RAP = R |
| **Antenna Azimuth (RAZ)** | RAZ = V05 |
| **Antenna Dimensions (RAD)** | ANTENNA GAIN 36.78 dBi (S-Band Transmit)<br>BEAMWIDTH 1.4 degrees<br>AZIMUTHAL RANGE 0-360 degrees<br>THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS 491 meters,<br>THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS 5 meters<br><br>RAD = 37G001B000-360A00491H005 |
| **FCC notes:**<br>1. **Use S-Note S945**<br>2. **REM01 *AGN, Cubesat, GNOMES-3** | |

| Troll, Antarctica – TR4 | |
|---|---|
| Data Field | **Data Answer** |
| **State (RSC)** | RSC = Antarctica |
| **City Name (RAL)** | RAL = Troll |
| **Latitude (DDMMSS)** | Lat = 720040S |
| **Longitude (DDDMMSS)** | Lon = 0023313E |
| **Antenna Polarization (RAP)** | RAP = R |
| **Antenna Azimuth (RAZ)** | RAZ = V05 |
| **Antenna Dimensions (RAD)** | ANTENNA GAIN 36.78 dBi (S-Band Transmit)<br>BEAMWIDTH 1.4 degrees<br>AZIMUTHAL RANGE 0-360 degrees<br>THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS 1366 meters,<br>THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS 5 meters<br><br>RAD = 37G001B000-360A01366H005 |
| **FCC notes:**<br>1. **Use S-Note S945**<br>2. **REM01 *AGN, Cubesat, GNOMES-3** | |

| Troll, Antarctica – TR6 | |
|---|---|
| Data Field | **Data Answer** |
| **State (RSC)** | RSC = Antarctica |
| **City Name (RAL)** | RAL = Troll |
| **Latitude (DDMMSS)** | Lat = 720037S |
| **Longitude (DDDMMSS)** | Lon = 0023314E |
| **Antenna Polarization (RAP)** | RAP = R |
| **Antenna Azimuth (RAZ)** | RAZ = V05 |
| **Antenna Dimensions (RAD)** | ANTENNA GAIN 36.78 dBi (S-Band Transmit)<br>BEAMWIDTH 1.4 degrees<br>AZIMUTHAL RANGE 0-360 degrees<br>THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS 1354 meters,<br>THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS 5 meters<br><br>RAD = 37G001B000-360A01354H005 |
| **FCC notes:**<br>1. **Use S-Note S945**<br>2. **REM01 *AGN, Cubesat, GNOMES-3** | |

| Troll, Antarctica – TR8 | |
|---|---|
| Data Field | **Data Answer** |
| **State (RSC)** | RSC = Antarctica |
| **City Name (RAL)** | RAL = Troll |
| **Latitude (DDMMSS)** | Lat = 720041S |
| **Longitude (DDDMMSS)** | Lon = 0023317E |
| **Antenna Polarization (RAP)** | RAP = R |
| **Antenna Azimuth (RAZ)** | RAZ = V05 |
| **Antenna Dimensions (RAD)** | ANTENNA GAIN 36.78 dBi (S-Band transmit)<br>BEAMWIDTH 1.4 degrees<br>AZIMUTHAL RANGE 0-360 degrees<br>THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS 1379 meters,<br>THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS 5 meters<br><br>RAD = 37G001B000-360A01379H005 |
| **FCC notes:**<br>**1. Use S-Note S945**<br>**2. REM01 *AGN, Cubesat, GNOMES-3** | |

| Harmon, Guam – 3.7 Meter Dish | |
|---|---|
| Data Field | **Data Answer** |
| **State (RSC)** | RSC = Guam |
| **City Name (RAL)** | RAL = Harmon |
| **Latitude (DDMMSS)** | Lat = 133045N |
| **Longitude (DDDMMSS)** | Lon = 1444929E |
| **Antenna Polarization (RAP)** | RAP = R |
| **Antenna Azimuth (RAZ)** | RAZ = V05 |
| **Antenna Dimensions (RAD)** | ANTENNA GAIN 36.5 dBi (S-Band Transmit)<br>BEAMWIDTH 1.4 degrees<br>AZIMUTHAL RANGE 0-360 degrees<br>THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS 45 meters,<br>THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS 4.5 meters<br><br>RAD = 47G001B000-360A00045H005 |
| **FCC notes:**<br>**1. Use S-Note S945**<br>**2. REM01 *AGN, Cubesat, GNOMES-3** | |

| **Dubai, UAE – 7.6 Meter Dish** | |
|---|---|
| Data Field | **Data Answer** |
| **State (RSC)** | RSC = United Arab Emirates |
| **City Name (RAL)** | RAL = Dubai |
| **Latitude (DDMMSS)** | Lat = 245632N |
| **Longitude (DDDMMSS)** | Lon = 0552052E |
| **Antenna Polarization (RAP)** | RAP = R |
| **Antenna Azimuth (RAZ)** | RAZ = V05 |
| **Antenna Dimensions (RAD)** | ANTENNA GAIN 41.5 dBi (S-Band transmit)<br>BEAMWIDTH 1.0 degrees<br>AZIMUTHAL RANGE 0-360 degrees<br>THE SITE ELEVATION ABOVE MEAN SEA LEVEL IN METERS 64.5 meters,<br>THE ANTENNA HEIGHT ABOVE TERRAIN IN METERS 11.9 meters<br><br>RAD = 53G001B000-360A00065H012 |
| **FCC notes:**<br>**1. Use S-Note S945**<br>**2. REM01 *AGN, Cubesat, GNOMES-3** | |

Note: Plots of ground station command beam spectral emissions are in Appendix B.

**Additional Background:**

GNOMES-3 will carry a single X-band transmitter to downlink data and conduct telemetry, tracking, and command (space-to-Earth). This transmitter is the SDR-X model supplied by Blue Canyon Technologies (BCT), with transmission characteristics described by Table 2.4-1 and in Form 442.

Table 2.4-1. BCT SDR-X X-band transmitter description

| | **Non-geostationary** |
|---|---|
| **Action frequency** | 8.260 GHz |
| **Maximum output power** | 2.0 W |
| **ERP** | 3.85 W |
| **Mean/Peak** | Peak |
| **Frequency Tolerance** | 4 ppm |
| **Emission Designator** | 20M0G1D |
| **Modulating signal** | 10000000 baud OQPSK |

The X-band and S-band antennas are designed and supplied by Haigh-Farr Inc. Both are nearly hemispherical in their gain patterns and are nadir-pointed. For both antennas, the gain is generally constant and varies between 0 and 5 dBi over Earth coverage angles.

A link budget can be formed from the transmitter characteristics shown in Table 2.4-1 and the expected X-band antenna coverage. The power flux density (PFD) at the maximum gain (5 dB) is calculated to be -119.2 dB(W/m$^2$) over the total bandwidth of the transmitter at the injection altitude of 525 km and -120.5 dB(W/m$^2$) at the nominal operational altitude of 650 km. Therefore, the largest PFD resulting from the X-band transmitter on GNOMES-3 will be -132.3 dB(W/m$^2$·MHz) at the sub-satellite point from 650 km, a value that is well below the recommendation given by the ITU[1].

The ITU also recommends the following limits of PFD from space stations as received at the Earth's surface[2]. These limits relate to the PFD obtained only under free-space path loss conditions and a 4 kHz bandwidth.

Table 2.4-2. ITU PFD limits at the Earth's surface

| **Frequency band** | **Service** | **Limit in dB(W/m$^2$) for angles of arrival (δ) above the horizontal plane** | | | **Reference bandwidth** |
|---|---|---|---|---|---|
| | | 0°-5° | 5°-25° | 25°-90° | |
| **8025-8500 MHz** | Earth exploration satellite (space-to-Earth)<br>Space research (space-to-Earth) | -150 | -150 + 0.5(δ-5) | -140 | 4 kHz |

Table 2.4-3 GNOMES-2 Peak Power Flux Density from 650km to Earth, and from 650km to GSO (if pointing up, vs. pointing to the Earth).

| | **650km to Earth** | **650km to GSO** |
|---|---|---|
| Peak Power Density/Hz | 1.925E-07W/Hz | 1.925E-07W/Hz |
| Peak Power Density/4kHz | 0.00077W/4kHz | 0.00077W/4kHz |
| Peak Power Flux Density (4kHz) | -158.4 dBW/m**2 | -193.05 dBW/m**2 |
| Peak Power Flux Density (20MHz bandwidth) | -121.6 dBW/m**2 | -156.06dBW/m**2 |

[1] Rec. ITU-R SA.1810
[2] ITU Radio Regulations Table 21-4

**Power Densities at transmit antenna**

At the Source: PD = Power/Occupied Bandwidth (per Hz)

PD(Hz) = 3.85 watts /20,000,000 Hz = 1.925E-07 watts/Hz

PD(4kHz) = 1.925E-07 * 4000 = 0.00077W/(4kHz)

**Power Flux Densities**

Power Flux Density (PFD) (650km) =

PFD = Power at Transmit antenna /(4*pi*distance**2) in watts/m**2

PFD = 3.85W/(4*pi*650km*650km) = 6.969 E-13 W/m**2 or -121.6 dBW/m**2

(Note, convert km to meters)

Power Flux Density 4 kHz (650km) = -158.4 dBW/m**2

Worst Cast PFD at GSO, is if we pitch up and point our downlink antenna up to point at GSO's

Power Flux Density GSO (35135.9 km above 650km)

PFD (20MHz@GSO) =3.85W/(4*pi*35135.9km*35135.9km)

Power Flux Density 20MHz = -156.06 dBW/m**2

Power Flux Density 4kHz = -193.05 dBW/m**2

The PFD produced by GNOMES-3 satisfies the ITU PFD limits at all angles of arrival and possible altitudes, with over 10 dB of margin. In addition, the BCT X-band radio is adjustable on orbit, allowing PlanetiQ to control the PFD levels during all phases of the mission.

**Interference Mitigation Strategy**

PlanetiQ plans to use multiple strategies for interference mitigation with incumbent operators:

- Our orbit locations and times of communication with ground stations will be well known and predicted well ahead of time.
- Our chosen ground stations are sufficiently far from the DSN ground stations to avoid any possible interference with assets utilizing those in Earth orbit or from interplanetary locations.
- The power levels of our X-band transmission system are adjustable on orbit by ground commands, and can be changed, if needed and with sufficient notice.
- Our on-board storage is large enough to store data from multiple passes, to be downlinked at another location at a different time.
- Our satellite is highly autonomous, and doesn't require commanding at every ground station pass.

**Appendix A:**

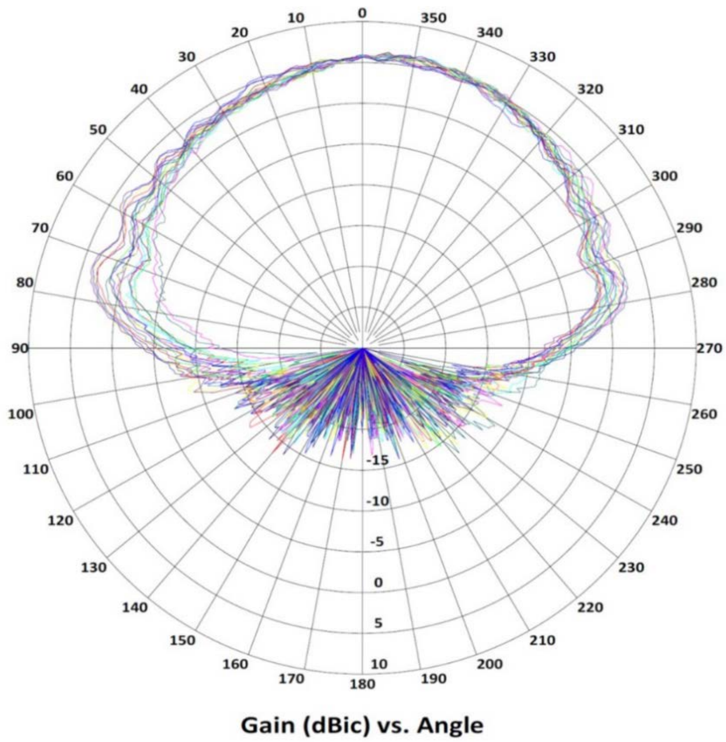



Figure 1. Satellite data and payload data transmission beam pattern at X-band
Note: The GNOMES-3 satellite has a single transmitter

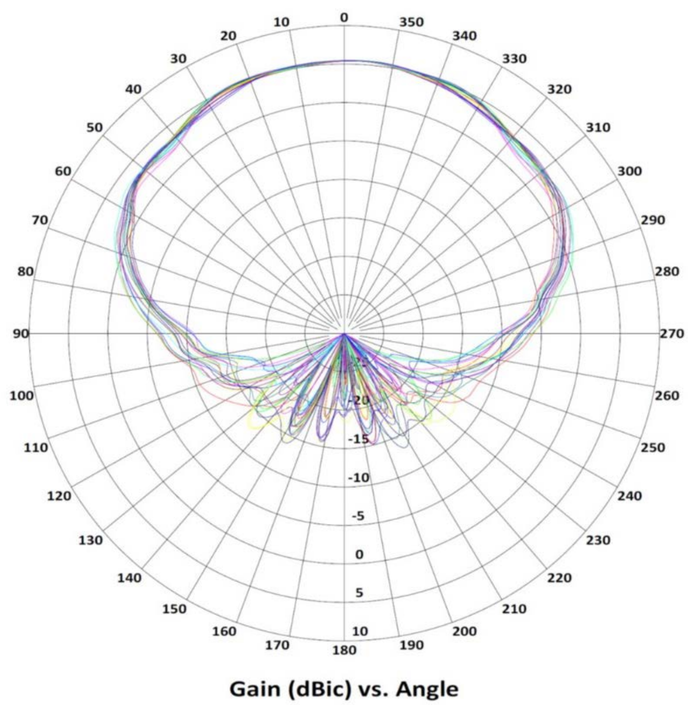



Figure 2. Command receive beam pattern at S-band

**Appendix B:**

- Command beam spectral emission:

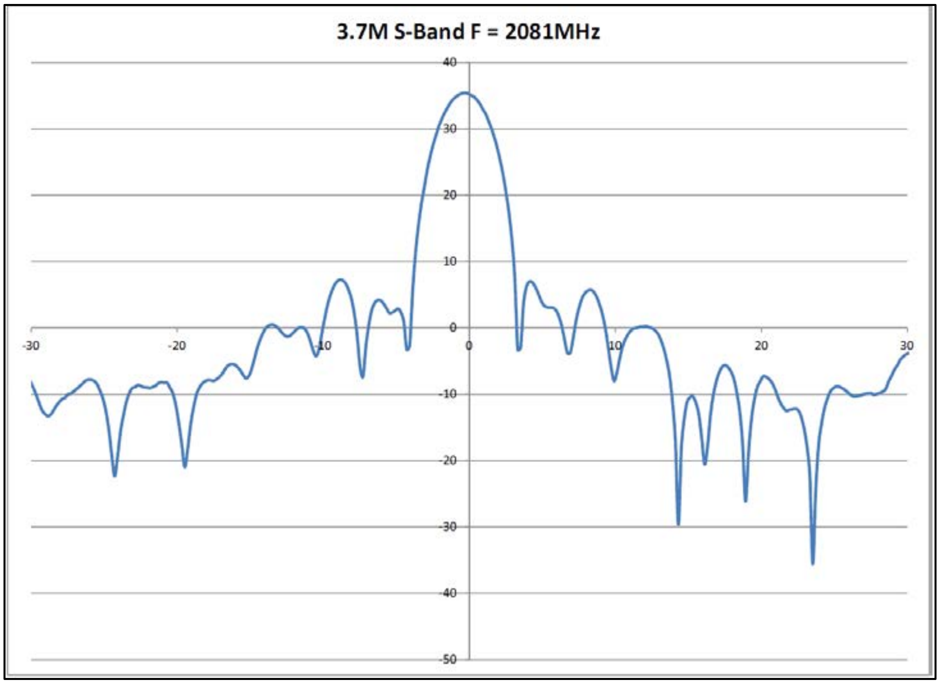



Figure 1. KSAT 3.7 m spectral emission at S-band

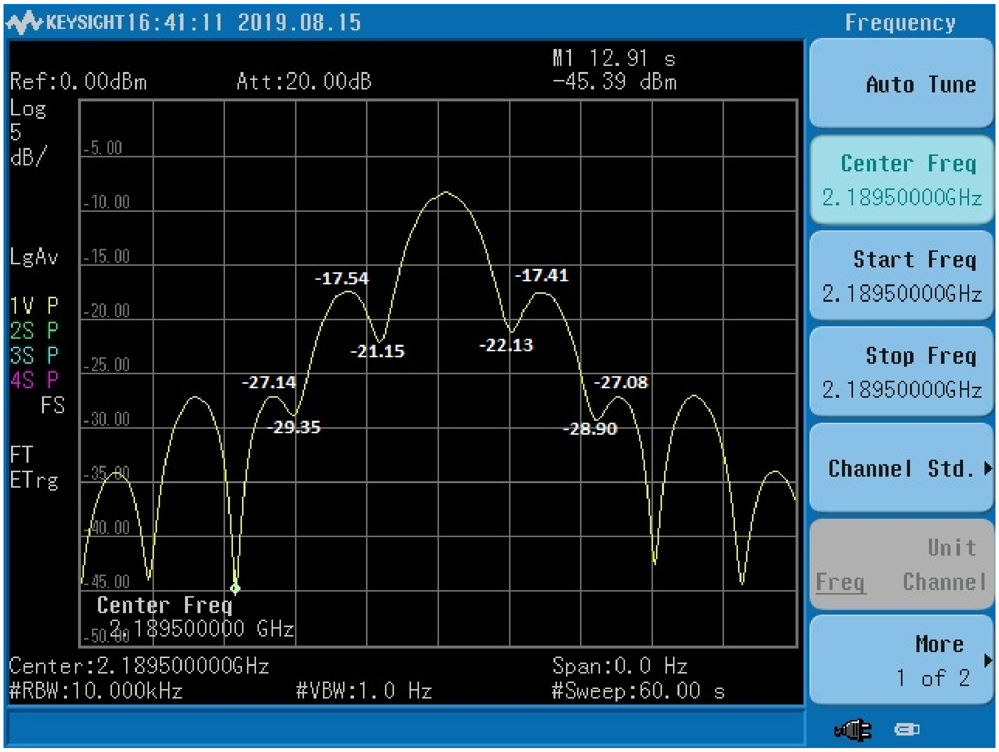
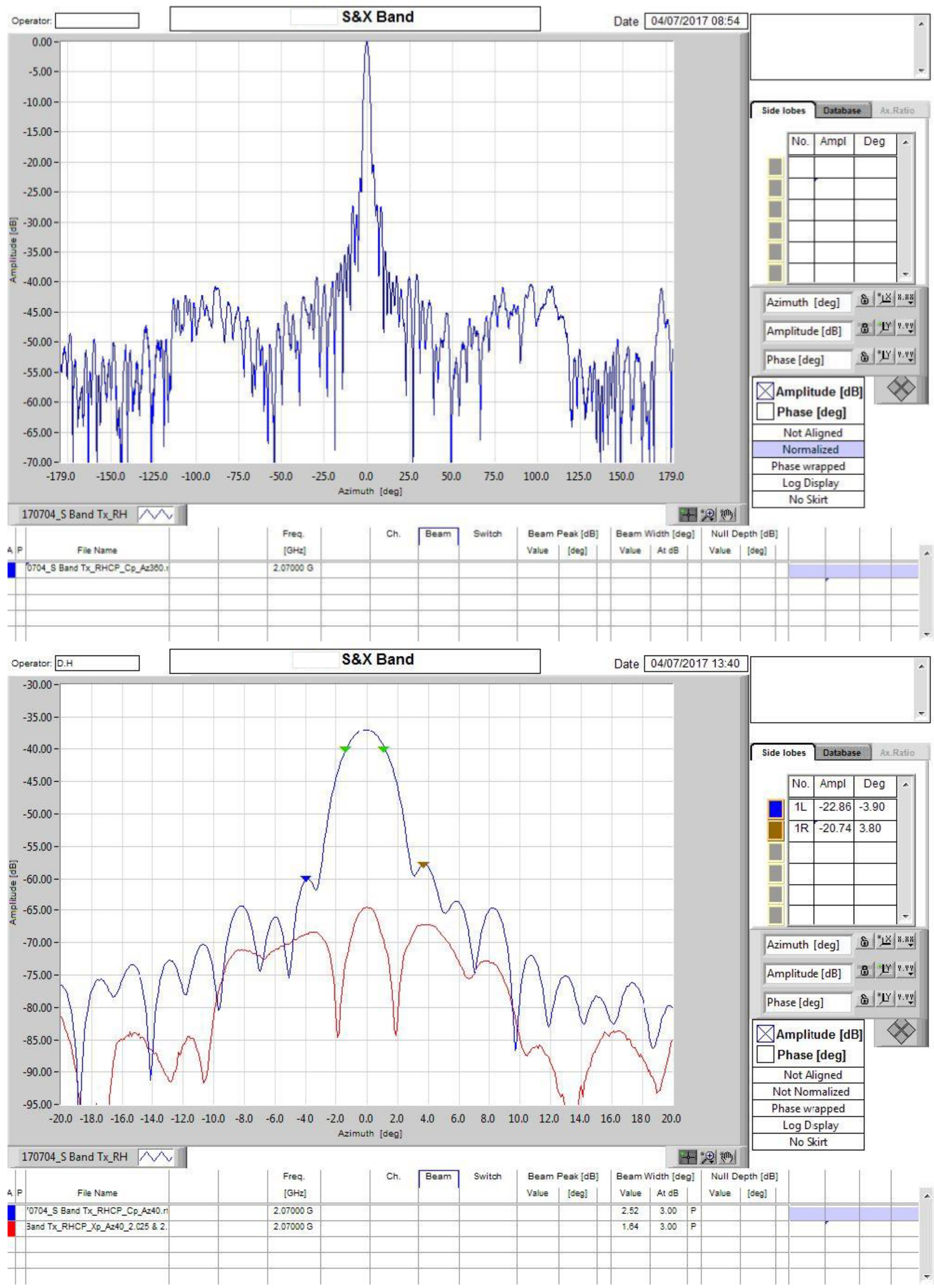



Figure 2. ATLAS 7.6 m spectral emission at S-band




**Graph 2 – S-Band Tx RHCP ±180° CP; ±20° CP & XP @2070MHz**

Figure 3. ATLAS 3.7 m spectral emission at S-band