**What:** LRT at Kyutech

**Where:** Satellite side – Seikyo;

GS side - BIRDS GS, 8F

**Who:** Satellite side - Edgar

GS side – Ramson.

**Why:** End-to-end test

**To bring:**

**Satellite side**

|  |  |  |
| --- | --- | --- |
| □ satellite (assembled) | □ Pelican case | □ soldering iron and lead |
| □ spectrum analyzer | □ external power supply | □ laptop |
| □ styro foam | □ multimeter | □ pen |
| □ satellite pad, bubble wrap | □ adapters (e.g. SMA adapters) | □ phone charger |
| □ RF cable | □ kapton tape | □ gloves (box) |
| □ UART cable | □ duct tape | □ alcohol |
| □ charging cable | □ measuring tape | □ tissue (box) |
| □ PICKit 3 programmer | □ scissor | □ mask (box) |
| □ programming board | □ cutter | □ umbrella |
| □ dipole reference | □ torque screw box |  |

**GS side**

|  |  |  |
| --- | --- | --- |
| □ RF cables | □ attenuators | □ Hand held radio |
| □ adapters | □ multimeter |  |
| □ spectrum analyzer | □ laptop |  |
| □ iCOM radio | □ pen |  |

**I. UHF end-to-end connectivity test**

**1. Calibration**

1.1 Antenna orientation.

1.1.1 Place FM satellite on the platform (UHF antenna in horizontal orientation) and face it towards GS with azimuth = 400.

1.1.2 Remove RBF pin so the satellite transmits continuous beacon.

1.1.3 Set the elevation of the BIRDS GS antenna to 50

1.1.4 Rotate BIRDS GS antenna from 2100 to 2200 azimuth while monitoring the measured received signal from the satellite beacon using spectrum analyser (SA). Find the best azimuth for BIRDS GS antenna where the received signal is at highest.

**Azimuth: \_\_\_\_\_\_\_\_**

**Elevation:** \_\_\_\_\_\_\_\_

1.1.5 Fix the antenna orientation with the maximum received signal.

1.2 Downlink condition

1.2.1 Satellite sends continuous beacon (program COM PIC).

1.2.2 GS to measure and record received signal (using spectrum analyzer (SA)).

12.3 Do the same for EM satellite

Repeat 1.2.2 with different antenna orientation.

|  |  |  |
| --- | --- | --- |
| **Satellite antenna angle**  **(wrp. to ground)** | **PRX(DL)**  **GS received signal (dBm)** | |
| **FM** | **EM** |
| 0 degree |  |  |
| 45 degree |  |  |
| 90 degree |  |  |
| Effective Downlink Attenuation (EDA) |  |  |

EDA = PTX (SAT) – PRX (GS) = **19 dBm** - PRX (GS)

1.3 Uplink condition

1.3.1 At GS side,

* Directly connect iCOM radio + 40 dB attenuator to SA using RF cable
* Transmit and adjust the level of iCOM radio until SA measures ~47dBm (50W). Record the transmit power.

**Transmit Power (dBm):** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* After measuring ~50W of power, connect the iCOM radio (no attenuator) to the RF cable going to antenna.

At satellite side,

* Place EM satellite on the platform with its UHF antenna connected to spectrum analyzer (same orientation to UHF satellite antenna).
* set the spectrum analyser to uplink freq

1.3.2 At GS side,

* transmit continuous signal from iCOM radio for 5 seconds.

At satellite side,

* record the received power as seen in SA.

Complete the table with additional attenuators.

1.3.3 At satellite side,

* Place the EM satellite, still with its UHF antenna connected to spectrum analyser, to a location near the platform. Measure the distance from the platform, and take photo.

Distance of new location (from platform): \_\_\_\_\_\_\_\_\_\_

1.3.4 Repeat **1.3.2**.

|  |  |  |
| --- | --- | --- |
| **Attenuators** | **PRX(GS)**  **Received Power in dBm** | |
| **on platform** | **on new location** |
| **0 dB** |  |  |
| **40 dB** |  |  |
| **50 dB** |  |  |
| Effective Uplink Attenuation (EUA) |  |  |

Effective Uplink Attenuation (EUA) at 0 attenuators = PTX(GS) – PRX(sat)

1.4 Compare measured values from expected values, and EDA vs EUA. Then assess if it is okay to continue with the uplink sensitivity test.

**2. Uplink communication sensitivity test**

2.1 Re-program COM PIC of FM satellite with normal code.

2.2 At GS side,

* send 22 11 00 00 00 00 00 00 00 00 01 command using BIRDS5 GS software.
* monitor and record the success rate

Repeat 2.2 with additional attenuators.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Added**  **Attenuators**  **in GS** | **GS received**  **decoded** | **GS received**  **not decoded** | **GS not received** | **Success rate** |
| **40 dB** |  |  |  |  |
| **46 dB** |  |  |  |  |
| **50 dB** |  |  |  |  |
| **52 dB** |  |  |  |  |
| **55 dB** |  |  |  |  |
| **56 dB** |  |  |  |  |
| **57 dB** |  |  |  |  |
| **58 dB** |  |  |  |  |
|  |  |  |  |  |

Follow **2.1 and 2.2**, this time with FM satellite

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Added**  **Attenuators**  **in GS** | **GS received**  **decoded** | **GS received**  **not decoded** | **GS not received** | **Success rate** |
| **40 dB** |  |  |  |  |
| **46 dB** |  |  |  |  |
| **50 dB** |  |  |  |  |
| **52 dB** |  |  |  |  |
| **55 dB** |  |  |  |  |
| **56 dB** |  |  |  |  |
| **57 dB** |  |  |  |  |
| **58 dB** |  |  |  |  |
|  |  |  |  |  |

Uplink Sensitivity Summary

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Added**  **Attenuators**  **in GS** | **\*Total Attenuation**  **(Calculated)** | **\*\*Estimated PRX of satellite at Mt. Sarakura** | | **Success rate**  **(same as previous table)** | |
|  |  | **estimated** | **measured** | **FM** | **EM** |
| **40 dB** |  |  |  |  |  |
| **46 dB** |  |  |  |  |  |
| **50 dB** |  |  |  |  |  |
| **52 dB** |  |  |  |  |  |
| **55 dB** |  |  |  |  |  |
| **56 dB** |  |  |  |  |  |
| **57 dB** |  |  |  |  |  |
| **58 dB** |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

Note:

\*Total Attenuation = EUA + Added Attenuators

\*\*PRX (estimated) = PT (GS) – Total Attenuation

**II. Mission end-to-end functional check (for FM satellite only)**

At GS side,

* attach 40 dB attenuator to iCOM radio
* send mission command using BIRDS5 GS software.
* monitor and record the received data

Do the same for other missions.

**III. VHF end-to-end connectivity test (for FM satellite only)**

1. **Calibration**

1.1 Horyu GS antenna orientation

1.1.1 At GS side, rotate the Horyu antenna towards Seikyo.

1.2 Downlink condition

* At Seikyo side, Kenwood TH-D72 hand-held radio (HHR) transmitted carrier signal using dipole reference.
* At KyuTech GS side, measure received power using spectrum analyzer (SA).

EDA = PTX(HHR) – PRX(GS) = **36 dBm** - \_\_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_\_\_\_

1.3 Uplink condition

1.3.1 At GS side

* Directly connect hand-held radio (HHR) to SA using RF cable
* Transmit and measure the power

**Transmit Power (dBm):** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

At satellite side,

* Place VHF reference dipole (same orientation to VHF satellite antenna) close to the satellite.
* Connect the VHF reference dipole to SA. SA should be set to MHz.

1.3.2 At GS side,

* Transmit a signal using HHR

At satellite side,

* measure the received signal using SA for reference dipole.

**Received Power (dBm):** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Compute for Effective Uplink Attenuation

(EUA) = PTX(DL) – PRX(DL) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. Uplink communication sensitivity test.

* With different attenuation, GS sends message in HHR and monitor whether message from satellite is received. Tabulate the result.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Added**  **Attenuators**  **in GS** | **GS received**  **decoded** | **GS received**  **not decoded** | **GS not received** | **Success rate** |
| **40 dB** |  |  |  |  |
| **50 dB** |  |  |  |  |
| **52 dB** |  |  |  |  |
| **55 dB** |  |  |  |  |
| **56 dB** |  |  |  |  |
| **57 dB** |  |  |  |  |
| **58 dB** |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Uplink Sensitivity Calculation

|  |  |  |  |
| --- | --- | --- | --- |
| **Added**  **Attenuators**  **in GS** | **\*Total Attenuation**  **(Calculated)** | **\*\*Estimated PRX of satellite at KyuTech Coop** | **Success rate**  **(same as previous table)** |
| **40 dB** |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

Note:

\*Total Attenuation = EUA + Added Attenuators

\*\*PRX (estimated) = PT (GS) – Total Attenuation