BIRDS-4 EM
APRS Long Range Test Report

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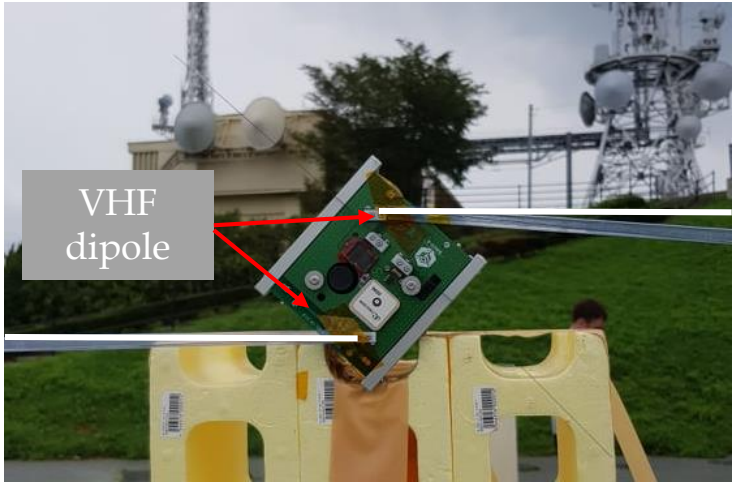
Antenna Orientation

- Satellite was placed on the platform facing KyuTech GS with azimuth of 40^0. VHF dipole is oriented horizontally

- HORYU antenna was rotated facing Mt. Sarakaura.

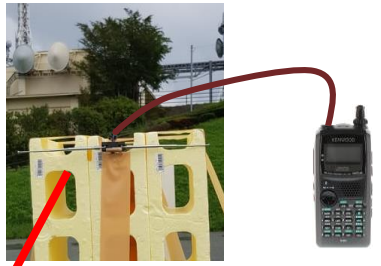


BIRDS-4 EM at Mt. Sarakura, facing KyuTech GS. VHF dipole (tuned at 146 MHz) is oriented horizontally

Effective Downlink Attenuation (EDA)

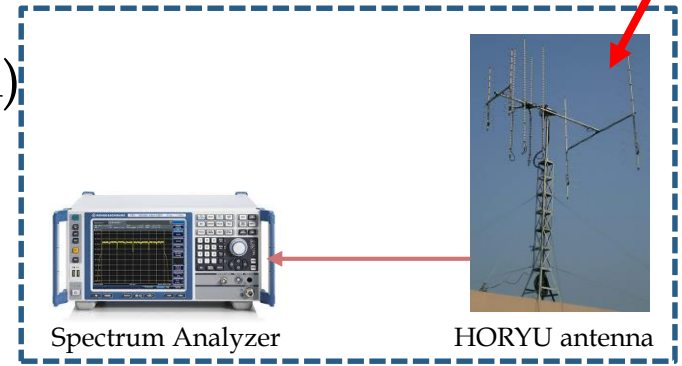
- At Mt. Sarakura side, Kenwood TH-D72 hand-held radio (HHR) transmitted carrier signal (145.825 MHz) using dipole reference.
- At KyuTech GS side, received power was measured using spectrum analyzer (SA).

$EDA = P_{TX}(HHR) - P_{RX}(SA)$
$EDA = 34.5\ dBm - (-37.3\ dBm)$
$EDA = 71.8\ dB$



Mt. Satakura side

*Photo shows UHF reference dipole. Actual photo of VHF reference dipole is not available

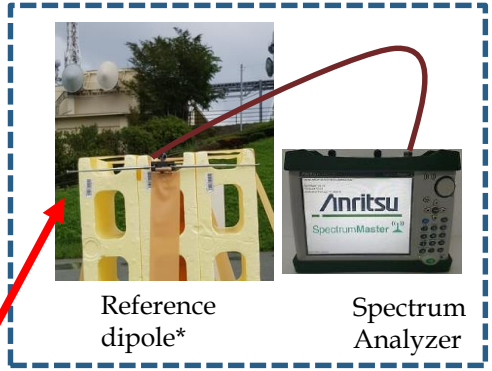


KyuTech GS side

Effective Uplink Attenuation (EUA)

- At KyuTech GS side, Kenwood TH-D72 hand-held radio (HHR) was used to transmit carrier signal (145.825 MHz).
- At Mt. Sarakura side, received power was measured using spectrum analyzer (SA).

$$EUA = P_{TX}(HHR) - P_{RX}(SA)$$
$$EUA = 34.5\ dBm - (-36.3\ dBm)$$
$$EUA = 70.8\ dB$$

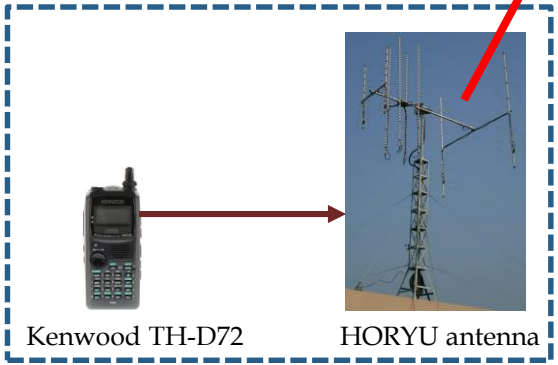


Reference dipole*

Spectrum Analyzer

Mt. Satakura side

*Photo shows UHF reference dipole. Actual photo of VHF reference dipole is not available



Kenwood TH-D72

HORYU antenna

KyuTech GS side

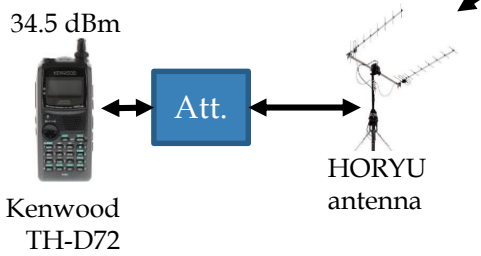
Effective Attenuation Summary

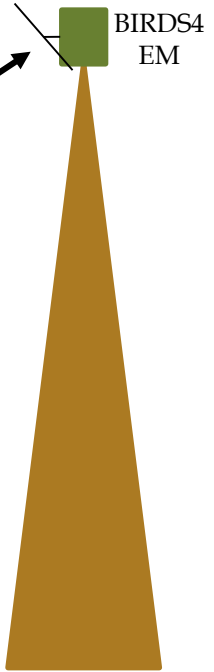
Effective Attenuation	BIRDS-4 EM
Uplink	70.8 dB
Downlink	71.8 dB

- BIRDS-4 EM effective uplink and downlink attenuation are almost similar.

Uplink Sensitivity Test Setup

- GS sends message using HHR. When ACK from satellite is received, it is considered success. Uplink command is sent 10 times .
- Additional attenuator is placed and test is again conducted. This is repeated until success rate is zero.
- Uplink sensitivity is defined at 50% success rate.





Uplink Sensitivity Test Result

Added Attenuators in GS	Total Attenuation	P_{RX} at Mt. Sarakura	Success Rate
40 dB	111 dB	-76.5 dBm	10/10
58 dB	129 dB	-94.5 dBm	5/10
59 dB	130 dB	-95.5 dBm	6/10
60 dB	131 dB	-96.5 dBm	2/10
61 dB	132 dB	-97.5 dBm	0/10
62 dB	133 dB	-98.5 dBm	0/10

P_{TX} (GS): 34.5 dBm
EUA: 71 dB

Total Attenuation = EUA + Added Attenuators
P_{RX} (estimated) = P_T (GS) – Total Attenuation

Link Budget

		10^0 Elevation	30^0 Elevation	50^0 Elevation	70^0 Elevation	80^0 Elevation	90^0 Elevation
Transmit Output Power	[W]	50	50	50	50	50	50
Transmit Output Power	[dBm]	47	47	47	47	47	47
Antenna Gain	[dBi]	16	16	16	16	16	16
Transmission Line Loss	[dB]	3	3	3	3	3	3
EIRP	[dBm]	60	60	60	60	60	60
Antenna Pointing Loss	[dB]	5	5	5	5	5	5
Polarization Loss	[dB]	3	3	3	3	3	3
Atmospheric + Ionospheric Losses	[dB]	1.4	1.4	1.4	1.4	1.4	1.4
Path Loss	[dB]	138.8	133.1	129.9	128.2	127.8	127.7
Effective Attenuation	[dB]	135.2	129.5	126.3	124.6	124.2	124.1
Power at the satellite	[dBm]	-88.2	-82.5	-79.3	-77.6	-77.2	-77.1
In the satellite							
Antenna Pointing Loss	[dB]	3	3	3	3	3	3
Antenna Gain + Pointing Loss	[dB]	0.5	0.5	0.5	0.5	0.5	0.5
Satellite Received Power	[dBm]	-91.7	-86	-82.8	-81.1	-80.7	-80.6
Satellite Sensitivity	[dBm]	-95.5	-95.5	-95.5	-95.5	-95.5	-95.5
Link Margin	[dB]	3.8	9.5	12.7	14.4	14.8	14.9

- Note that the HORYU GS setup was considered in the computation.

(P_T= 50W and 16 dB antenna gain)

- Using HHR, link margin is negative.