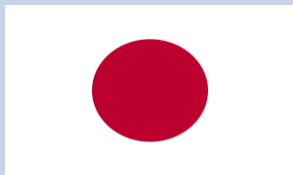




# BIRDS-4

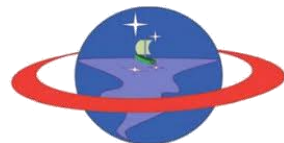
JOINT GLOBAL MULTI-NATION BIRDS  
SATELLITE PROJECT



# Link Budget



**Kyutech**  
Kyushu Institute of Technology



**La SEINE**

08 July 2019

# Uplink Budget

PARAMETERS				
Objective	Command	Command	APRS-DP + SF-WARD Mission	APRS-DP + SF-WARD Mission
Frequency [MHz]	435.313	435.313	145.825	145.825
Emission Type	15K0F1D	16K0F1D	15K0F2D	15K0F1D
Modulation	GMSK	FSK	AFSK	FSK
Data Rate [bps]	4800	600	1200	4800
Protocol	AX.25	AX.25	AX.25	AX.25
GROUND STATION				
Ground Station Transmitter Power Output [W]	50.00	50.00	50.00	50.00
	[dBw]	16.99	16.99	16.99
Ground Station Total Transmission Line Losses [dB]	3.40	3.40	1.50	1.50
Antenna Gain [dBi]	22.00	22.00	16.00	16.00
Ground Station EIRP [dBw]	35.59	35.59	31.49	31.49
UPLINK PATH				
Ground Station Antenna Pointing Loss [dB]	1.00	1.00	1.00	1.00
Ground Station to Spacecraft Antenna Polarization Loss [dB]	3.00	3.00	3.00	3.00
Path Loss [dB]	148.38	148.38	138.88	138.88
Atmospheric Losses [dB]	1.00	1.00	1.10	1.10
Ionospheric Losses [dB]	0.40	0.40	0.70	0.70
Rain Losses [dB]	0.00	0.00	0.00	0.00
Isotropic Signal Level at Spacecraft [dBw]	-118.19	-118.19	-113.19	-113.19

SPACECRAFT (Eb/No Method)				
Spacecraft Antenna Pointing Loss [dB]	5.00	5.00	5.00	5.00
Spacecraft Antenna Gain [dBi]	2.15	2.15	2.15	2.15
Spacecraft Total Transmission Line Losses [dB]	3.00	3.00	2.345	5.445
Spacecraft Effective Noise Temperature [K]	1,000.00	1,000.00	1,000.00	1,000.00
Spacecraft Figure of Merit (G/T) [dB/K]	-30.85	-30.85	-30.20	-33.30
Spacecraft Signal-to-Noise Power Density (S/No) [dBHz]	74.56	74.56	80.21	77.11
System Desired Data Rate [bps]	4800	600	1200	4800
Command System Eb/No [dB]	37.74	46.77	49.42	40.30
Specified BER	1.00E-05	1.00E-05	1.00E-05	1.00E-05
Eb/No Threshold [dB]	10.60	14.80	24.20	14.80
System Link Margin [dB]	27.14	31.97	25.22	25.50
SPACECRAFT (SNR Method)				
Signal Power at Spacecraft LNA Input [dBw]	-124.04	-124.04	-118.39	-121.49
Spacecraft Receiver Bandwidth [Hz]	15,000	16,000	15,000	15,000
Spacecraft Receiver Noise Power [dB]	-156.84	-156.56	-156.84	-156.84
Signal-to-Noise Power Ratio (SNR) at Spacecraft Receiver [dB]	32.80	32.52	38.45	35.35
Required SNR for spacecraft receiver [dB]	10.60	14.80	24.20	14.80
System Link Margin [dB]	22.20	17.72	14.25	20.55

# Downlink Budget

PARAMETERS				
Objective	Telemetry and other Mission Data	CW Beacon and HNT Mission	APRS-DP + SF-WARD Mission	APRS-DP + SF-WARD Mission
Frequency [MHz]	437.375	437.375	145.825	145.825
Emission Type	15K0F1D	500HA1A	15K0F2D	15K0F1D
Modulation	GMSK	Morse Code	AFSK	FSK
Data Rate [bps]	4800	20 wpm	1200	4800
Protocol	AX.25	-	AX.25	AX.25
SPACECRAFT				
Spacecraft Transmitter Power Output [W]	0.80	0.10	0.50	0.40
[dBw]	-0.97	-10.00	-3.01	-3.98
Spacecraft Total Transmission Line Losses [dB]	3.00	3.00	2.345	5.445
Spacecraft Antenna Gain [dBi]	2.15	2.15	2.15	2.15
Spacecraft EIRP [dBw]	-1.82	-10.85	-3.21	-7.27
DOWNLINK PATH				
Spacecraft Antenna Pointing Loss [dB]	5.00	5.00	5.00	5.00
Spacecraft-to-Ground Antenna Polarization Loss [dB]	3.00	3.00	3.00	3.00
Path Loss [dB]	148.43	148.43	138.88	138.88
Atmospheric Losses [dB]	1.00	1.00	1.10	1.10
Ionospheric Losses [dB]	0.40	0.40	0.70	0.70
Rain Losses [dB]	0.00	0.00	0.00	0.00
Isotropic Signal Level at Ground Station [dBw]	-159.64	-168.68	-151.89	-155.96

GROUND STATION (Eb/No Method)				
Ground Station Antenna Pointing Loss [dB]	1.00	1.00	1.00	1.00
Ground Station Antenna Gain [dBi]	22.00	22.00	16.00	16.00
Ground Station Total Transmission Line Losses [dB]	3.40	3.40	1.50	1.50
Ground Station Effective Noise Temperature [K]	1,000	1,000	1,000	1,000
Ground Station Figure of Merit (G/T) [dB/K]	-11.40	-11.40	-15.50	-15.50
Ground Station Signal-to-Noise Power Density (S/No) [dBHz]	56.56	47.52	60.21	56.14
System Desired Data Rate [bps]	4800		1200	4800
Telemetry System Eb/No [dB]	19.74		29.42	19.33
Specified BER	1.00E-05		1.00E-05	1.00E-05
Eb/No Threshold [dB]	10.60		24.20	12.90
System Link Margin [dB]	9.14		5.22	6.43
GROUND STATION (SNR Method)				
Signal Power at Ground Station LNA Input [dBw]	-142.04	-151.08	-138.39	-142.46
Ground Station Receiver Bandwidth [Hz]	15,000	500	15,000	15,000
Ground Station Receiver Noise Power [dB]	-156.84	-171.61	-156.84	-156.84
Signal-to-Noise Power Ratio (SNR) at Ground Station Receiver [dB]	14.80	20.54	18.45	14.38
Required SNR for Ground Station receiver [dB]	10.60	10.00	11.50	12.90
System Link Margin [dB]	4.20	10.54	6.95	1.48