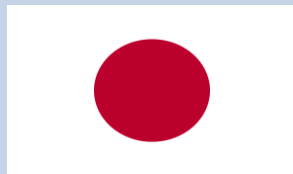




# BIRDS-4

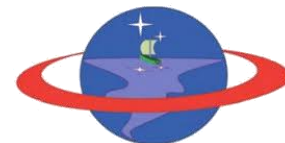
JOINT GLOBAL MULTI-NATION BIRDS  
SATELLITE PROJECT



# Link Budget



**Kyutech**  
Kyushu Institute of Technology



**La SEINE**

12 April 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	26K0F1D	26K0F1D	15K0F1D	15K0F1D
Modulation	GMSK	BPSK	AFSK	BPSK
Data Rate [bps]	4800	600	1200	1200
Protocol	AX.25	AX.25	AX.25	AX.25
GROUND STATION				
Ground Station Transmitter Power Output [W]	50.00	50.00	5.00	5.00
	[dBw]	16.99	16.99	6.99
Ground Station Total Transmission Line Losses [dB]	3.00	3.00	3.00	3.00
Antenna Gain [dBi]	22.00	22.00	16.00	16.00
Ground Station EIRP [dBw]	35.99	35.99	19.99	19.99
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	1.00	1.00
Ionospheric Losses [dB]	0.40	0.40	0.40	0.40
Rain Losses [dB]	0.00	0.00	0.00	0.00
Isotropic Signal Level at Spacecraft [dBw]	-117.79	-117.79	-124.29	-124.29

SPACECRAFT (Eb/No Method)				
Spacecraft Antenna Pointing Loss [dB]	3.00	3.00	3.00	3.00
Spacecraft Antenna Gain [dBi]	2.15	2.15	2.15	2.15
Spacecraft Total Transmission Line Losses [dB]	1.00	1.00	1.00	1.00
Spacecraft Effective Noise Temperature [K]	600.00	600.00	600.00	600.00
Spacecraft Figure of Merit (G/T) [dB/K]	-26.63	-26.63	-26.63	-26.63
Spacecraft Signal-to-Noise Power Density (S/No) [dBHz]	81.17	81.17	74.67	74.67
System Desired Data Rate [bps]	4800	600	1200	1200
Command System Eb/No [dB]	44.36	53.39	43.88	43.88
Specified BER	1.00E-05	1.00E-06	1.00E-05	1.00E-06
Telemetry System Required Eb/No [dB]	9.60	4.80	23.20	10.50
Eb/No Threshold [dB]	10.60	5.80	24.20	11.50
System Link Margin [dB]	33.76	47.59	19.68	32.38
SPACECRAFT (SNR Method)				
Signal Power at Spacecraft LNA Input [dBw]	-119.64	-119.64	-126.14	-126.14
Spacecraft Receiver Bandwidth [Hz]	26000	26000	15000	15000
Spacecraft Receiver Noise Power [dB]	-156.67	-156.67	-159.06	-159.06
Signal-to-Noise Power Ratio (SNR) at Spacecraft Receiver [dB]	37.03	37.03	32.91	32.91
Required SNR for spacecraft receiver [dB]	14	14	14	14
System Link Margin [dB]	23.03	23.03	18.91	18.91

# Downlink Budget

PARAMETERS			
Objective	Telemetry and Mission Data	CW	HNT Mission
Frequency [MHz]	437.375	437.375	437.375
Emission Type	26K0F1D	A1A	26K0F1D
Modulation	GMSK	Morse Code	GMSK
Data Rate [bps]	4800	20 wpm	4800
Protocol	AX.25	-	AX.25
SPACECRAFT			
Spacecraft Transmitter Power Output [W]	0.8	0.1	0.1
	[dBw]	-0.97	-10.00
Spacecraft Total Transmission Line Losses [dB]	1	1	1
Spacecraft Antenna Gain [dBi]	2.15	2.15	2.15
Spacecraft EIRP [dBw]	0.18	-8.85	-8.85
DOWNLINK PATH			
Spacecraft Antenna Pointing Loss [dB]	1.00	1.00	1.00
Spacecraft-to-Ground Antenna Polarization Loss [dB]	3.00	3.00	3.00
Path Loss [dB]	148.43	148.43	148.43
Atmospheric Losses [dB]	1.00	1.00	1.00
Ionospheric Losses [dB]	0.40	0.40	0.40
Rain Losses [dB]	0.00	0.00	0.00
Isotropic Signal Level at Ground Station [dBw]	-153.64	-162.68	-162.68

GROUND STATION (Eb/No Method)			
Ground Station Antenna Pointing Loss [dB]	1	1	1
Ground Station Antenna Gain [dBi]	22	22	22
Ground Station Total Transmission Line Losses [dB]	3	3	3
Ground Station Effective Noise Temperature [K]	600	600	600
Ground Station Figure of Merit (G/T) [dB/K]	-8.78	-8.78	-8.78
Ground Station Signal-to-Noise Power Density (S/No) [dBHz]	65.17	56.14	56.14
System Desired Data Rate [bps]	4800		4800
Telemetry System Eb/No [dB]	28.36		19.33
Specified BER	1.00E-05		1.00E-05
Telemetry System Required Eb/No [dB]	9.60		9.60
Eb/No Threshold [dB]	10.60		10.60
System Link Margin [dB]	17.76		8.73
GROUND STATION (SNR Method)			
Signal Power at Ground Station LNA Input [dBw]	-135.64	-144.68	-144.68
Ground Station Receiver Bandwidth [Hz]	26000	500	26000
Ground Station Receiver Noise Power [dB]	-156.67	-173.83	-156.67
Signal-to-Noise Power Ratio (SNR) at Ground Station Receiver [dB]	21.03	29.15	11.99
Required SNR for Ground Station receiver [dB]	10	10	10
System Link Margin [dB]	11.03	19.15	1.99