

Project Name: BIRDS-3 Project

Satellite Name: Raavana-1, Nepalisat-1, Uguisu

Version: 2.1

Date: 2018-04-11

Link Budget for: Command Uplink

Parameters	Value
Frequency	435-438 MHz
Emission Type	26K0F1D
Modulation	GMSK
Data Rate	9600
Protocol	AX.25

GROUND STATION	
Ground Station Transmitter Power Output	14 W
In dBw	11.4613 dBW
In dBm	41.4613 dBm
Ground Station Total Transmission Line Losses	3 dB
Antenna Gain	16 dBi
Ground Station EIRP	24.4613 dBW
Ground Station Antenna Pointing Loss	1 dB
Ground Station to Spacecraft Antenna Polarization Loss	3 dB

PATH	
Orbit Altitude	400 km
Elevation Angle	10 degree
Slant Range	1439.83 km
Path Loss	148.4176 dB
Atmospheric Losses	1 dB
Ionospheric Losses	0.4 dB
Rain Losses	0 dB
Isotropic Signal Level at Spacecraft	-129.3564 dBW

SPACECRAFT	
Spacecraft Antenna Pointing Loss	3 dB
Spacecraft Antenna Gain	0.4 dBi
Spacecraft Total Transmission Line Losses	1 dB
Spacecraft Effective Noise Temperature	600 K
Spacecraft Figure of Merit (G/T)	-27.3815 dB/K
Signal Power at Spacecraft LNA Input	-132.9564 dBW
Spacecraft Receiver Bandwidth	26000 Hz
Spacecraft Receiver Noise Power	-156.6679 dBW
Signal-to-Noise Power Ratio at Spacecraft Receiver	23.7116 dB
Required SNR for spacecraft receiver	14 dB

System Link Margin	9.7116 dB
--------------------	-----------

Link Budget for: LoRa 433MHz Remote Station Uplink

Parameters	Value
Frequency	433MHz
Emission Type	7K8X1D
Modulation	LoRa
Data Rate	49 bps
Protocol	LoRa

LoRa REMOTE STATION (1)	
Remote Station Transmitter Power Output	20 mW
In dBw	-16.9897 dBW
In dBm	13.0103 dBm
Remote Station Total Transmission Line Losses	1 dB
Remote Station Antenna Gain	3 dBi
Remote Station EIRP	-14.9897 dBW
Remote Station Antenna Pointing Loss	1 dB
Remote Station-to-Spacecraft Antenna Polarization Loss	3 dB

PATH	
Orbit Altitude	400 km
Elevation Angle	10 degree
Slant Range	1439.83 km
Path Loss	148.3378 dB
Atmospheric Losses	1 dB
Ionospheric Losses	0.4 dB
Rain Losses	0 dB
Isotropic Signal Level at Spacecraft	-168.7275 dBW

SPACECRAFT	
Spacecraft Antenna Pointing Loss	3 dB
Spacecraft Antenna Gain	0.4 dB
Spacecraft Total Transmission Line Losses	1 dB
Spacecraft Effective Noise Temperature	600 K
Spacecraft Figure of Merit (G/T)	-27.3815 dB/K
Signal Power at Spacecraft Receiver Input	-172.3275 dBW
Spacecraft Receiver Bandwidth	7800 Hz
Spacecraft Receiver Noise Power	-161.8967 dBW
Signal-to-Noise Power Ratio at Spacecraft LoRa Receiver	-10.4308 dB
LoRa receiver (SF=12, B=7800Hz) Required SNR	-20 dB

System Link Margin	9.5692 dB
--------------------	-----------

Link Budget for: LoRa 920MHz Remote Station Uplink

Parameters	Value
Frequency	920MHz
Emission Type	7K8X1D
Modulation	LoRa
Data Rate	49 bps
Protocol	LoRa

LoRa REMOTE STATION (2)	
Remote Station Transmitter Power Output	20 mW
In dBw	-16.9897 dBW
In dBm	13.0103 dBm
Remote Station Total Transmission Line Losses	1 dB
Antenna Gain	3 dBi
Remote Station EIRP	-14.9897 dBW
Remote Station Antenna Pointing Loss	1 dB
Remote Station-to-Spacecraft Antenna Polarization Loss	3 dB

PATH	
Orbit Altitude	400 km
Elevation Angle	10 degree
Slant Range	1439.83 km
Path Loss	154.8838 dB
Atmospheric Losses	1 dB
Ionospheric Losses	0.4 dB
Rain Losses	0 dB
Isotropic Signal Level at Spacecraft	-175.2735 dBW

SPACECRAFT	
Spacecraft Antenna Pointing Loss	3 dB
Spacecraft Antenna Gain	0.4 dB
Spacecraft Total Transmission Line Losses	1 dB
Spacecraft Effective Noise Temperature	600 K
Spacecraft Figure of Merit (G/T)	-27.3815 dB/K
Signal Power at Spacecraft Receiver Input	-178.8735 dBW
Spacecraft Receiver Bandwidth	7800 Hz
Spacecraft Receiver Noise Power	-161.8967 dBW
Signal-to-Noise Power Ratio at Spacecraft LoRa	-16.9768 dB
LoRa receiver (SF=12, B=7800Hz) Required SNR	-20 dB

System Link Margin	3.0232 dB
--------------------	-----------

Link Budget for: CW Beacon Download

Parameters	Value
Frequency	435MHz-438MHz
Emission Type	A1A
Modulation	Morse Code
Data Rate	20 wpm
Protocol	-

SPACECRAFT	
Spacecraft Transmitter Power Output	0.1 W
In dBw	-10 dBW
In dBm	20 dBm
Spacecraft Total Transmission Line Losses	1 dB
Antenna Gain	0.4 dBi
Spacecraft EIRP	-10.6 dBW
Spacecraft Antenna Pointing Loss	3 dB
S/C-Ground Antenna Polarization Loss	3 dB

PATH	
Orbit Altitude	400 km
Elevation Angle	10 degree
Slant Range	1439.83 km
Path Loss	148.4176 dB
Atmospheric Losses	1 dB
Ionospheric Losses	0.4 dB
Rain Losses	0 dB
Isotropic Signal Level at Ground Station	-166.4176 dBW

GROUND STATION	
Ground Station Antenna Pointing Loss	1 dB
Ground Station Antenna Gain	16 dBi
Ground Station Total Transmission Line Losses	3 dB
Ground Station Effective Noise Temperature	600 K
Ground Station Figure of Merit (G/T)	-11.7815 dB/K
Signal Power at Ground Station LNA Input	-154.4176 dBW
Ground Station Receiver Bandwidth	500 Hz
Ground Station Receiver Noise Power (kTB)	-173.8280 dBW
Signal-to-Noise Power Ratio at G.S. Receiver	19.4103 dB
Ground station receiver required SNR	10 dB

System Link Margin	9.4103 dB
--------------------	-----------

Link Budget for: Telemetry and Mission Data Download

Parameters	Value
Frequency	435MHz-438MHz
Emission Type	26K0F1D
Modulation	GMSK
Data Rate	9600 bps
Protocol	AX.25

SPACECRAFT	
Spacecraft Transmitter Power Output	0.5 W
In dBw	-3.0103 dBW
In dBm	26 9897 dBm
Spacecraft Total Transmission Line Losses	1 dB
Antenna Gain	0.4 dBi
Spacecraft EIRP	-3.6103 dBW
Spacecraft Antenna Pointing Loss	3 dB
Spacecraft-Ground Antenna Polarization Loss	3 dB

PATH	
Orbit Altitude	400 km
Elevation Angle	20 degree
Slant Range	984.18 km
Path Loss	145.1129 dB
Atmospheric Losses	1 dB
Ionospheric Losses	0.4 dB
Rain Losses	0 dB
Isotropic Signal Level at Ground Station	-156.1232 dBW

GROUND STATION	
Ground Station Antenna Pointing Loss	1 dB
Ground Station Antenna Gain	16 dBi
Ground Station Total Transmission Line Losses	3 dB
Ground Station Effective Noise Temperature	600 K
Ground Station Figure of Merit (G/T)	-11.7815 dB/K
Signal Power at Ground Station LNA Input	-144.1232 dBW
Ground Station Receiver Bandwidth	26000 Hz
Ground Station Receiver Noise Power (kTB)	-156.6679 dBW
Signal-to-Noise Power Ratio at G.S. Receiver	12.5447 dB
Ground station receiver required SNR	10 dB

System Link Margin	2.5447 dB
--------------------	-----------