

**Project Name:** BIRDS-2 PROJECT

**Satellite Name:** MAYA-1 (Philippines), BHUTAN-1 (Bhutan), MyUiTM-Sat (Malaysia)

**Link Budget for:** APRS-DP and S&F User Uplink

**Version:** 2.0

**Date of Last Revision:** 2017-05-22

PARAMETERS	VALUES	UNITS
Frequency:	within 146-148 MHz	MHz
Emission Type:	F2D	
Modulation:	AFSK/FM	
Data Rate:	1200	bps
Protocol:	AX.25	

#### HANDHELD RADIO

Ground Station Transmitter Power Output:	5	watts
In dBW:	6.989700043	dBW
In dBm:	36.98970004	dBm
Ground Stn. Total Transmission Line Losses:	0.3	dB
Antenna Gain:	12	dBi
Ground Station EIRP:	18.68970004	dBW
Ground Station Antenna Pointing Loss:	<b>1.8</b>	dB
Gnd-to-S/C Antenna Polarization Losses:	<b>3.0</b>	dB

#### PATH

Orbit Altitude:	400	km
Elevation Angle:	30	°
Slant Range:	739.4	km
Path Loss:	133.1173033	dB
Atmospheric Losses:	0.4	dB
Ionospheric Losses:	0.7	dB
Rain Losses:	0	dB
Isotropic Signal Level at Spacecraft:	<b>-120.3377295</b>	dBW

#### SPACECRAFT (SNR Method)

Spacecraft Antenna Pointing Loss:	<b>1.5</b>	dB
Spacecraft Antenna Gain:	<b>1.5</b>	dBi
Spacecraft Total Transmission Line Losses:	1.63	dB
Spacecraft Effective Noise Temperature:	605.9714596	K
Spacecraft Figure of Merit (G/T):	<b>-28.0</b>	dB/K
Signal Power at Spacecraft LNA Input:	<b>-121.9728795</b>	dBW
Spacecraft Receiver Bandwidth:	12000	Hz
Spacecraft Receiver Noise Power (Pn = kTB)	-159.9836658	dBW
Signal-to-Noise Power Ratio at G.S. Rcvr:	<b>38.01078634</b>	dB
Analog or Digital System Required S/N:	21	dB

**System Link Margin**

**17.0**

**dB**

**Project Name:** BIRDS-2 PROJECT

**Satellite Name:** MAYA-1 (Philippines), BHUTAN-1 (Bhutan), MyUiTM-Sat (Malaysia)

**Link Budget for:** APRS-DP and S&F User Downlink

**Version:** 2.0

**Date of Last Revision:** 2017-05-22

PARAMETERS	VALUES	UNITS
Frequency:	within 146-148 MHz	MHz
Emission Type:	F2D	
Modulation:	AFSK/FM	
Data Rate:	1200	bps
Protocol:	AX.25	

#### SPACECRAFT

Spacecraft Transmitter Power Output:	0.5	watts
In dBW:	-3.010299957	dBW
In dBm:	26.98970004	dBm
Spacecraft Total Transmission Line Losses:	0.5	dB
Spacecraft Antenna Gain:	1.5	dBi
Spacecraft EIRP:	-2.040299957	dBW
Spacecraft Antenna Pointing Loss:	1.505149978	dB
S/C-to-Ground Antenna Polarization Loss:	3.010126246	dB

#### PATH

Orbit Altitude:	400	km
Elevation Angle:	30	°
Slant Range:	739.4	km
Path Loss:	133.1173033	dB
Atmospheric Losses:	0.4	dB
Ionospheric Losses:	0.7	dB
Rain Losses:	0	dB
Isotropic Signal Level at Ground Station:	-140.7728795	dBW

#### HANDHELD RADIO (SNR Method)

Ground Station Antenna Pointing Loss:	1.8	dB
Ground Station Antenna Gain:	12	dBi
Ground Station Total Transmission Line Losses:	0.5	dB
Ground Station Effective Noise Temperature:	511.1089969	K
Ground Station Figure of Merit (G/T):	-15.58513526	dB/K
Signal Power at Ground Station LNA Input:	-131.0728795	dBW
Ground Station Receiver Bandwidth (B):	12000	Hz
G.S. Receiver Noise Power (Pn = kTB)	-160.7230523	dBW
Signal-to-Noise Power Ratio at G.S. Rcvr:	29.65017278	dB
Analog or Digital System Required S/N:	21	dB

**System Link Margin**

**8.650172782**

**dB**

**Project Name:** BIRDS-2 PROJECT

**Satellite Name:** MAYA-1 (Philippines), BHUTAN-1 (Bhutan), MyUiTM-Sat (Malaysia)

**Link Budget for:** UHF Command Uplink

**Version:** 2.0

**Date of Last Revision:** 2017-05-22

PARAMETERS	VALUES	UNITS
Frequency:	UHF	MHz
Emission Type:	F1D	
Modulation:	GMSK	
Data Rate:	9600	bps
Protocol:	AX.25	

#### GROUND STATION

Ground Station Transmitter Power Output:	5	watts
In dBW:	6.989700043	dBW
In dBm:	36.98970004	dBm
Ground Stn. Total Transmission Line Losses:	<b>3.0</b>	dB
Antenna Gain:	16	dBi
Ground Station EIRP:	<b>20.01970004</b>	dBW
Ground Station Antenna Pointing Loss:	<b>1.0</b>	dB
Gnd-to-S/C Antenna Polarization Losses:	<b>3.009750708</b>	dB

#### PATH

Orbit Altitude:	400	km
Elevation Angle:	15	°
Slant Range:	1175.5	km
Path Loss:	146.6845318	dB
Atmospheric Losses:	1.1	dB
Ionospheric Losses:	0.4	dB
Rain Losses:	0	dB
Isotropic Signal Level at Spacecraft:	<b>-132.133536</b>	dBW

#### SPACECRAFT (SNR Method)

Spacecraft Antenna Pointing Loss:	<b>3.068181818</b>	dB
Spacecraft Antenna Gain:	<b>0.5</b>	dBi
Spacecraft Total Transmission Line Losses:	1.65	dB
Spacecraft Effective Noise Temperature:	609.0454441	K
Spacecraft Figure of Merit (G/T):	<b>-28.99649699</b>	dB/K
Signal Power at Spacecraft LNA Input:	<b>-136.3517179</b>	dBW
Spacecraft Receiver Bandwidth:	15000	Hz
Spacecraft Receiver Noise Power (Pn = kTB)	-158.9925904	dBW
Signal-to-Noise Power Ratio at G.S. Rcvr:	<b>22.64087255</b>	dB
Analog or Digital System Required S/N:	9.6	dB

**System Link Margin** **13.04087255** **dB**

**Project Name:** BIRDS-2 PROJECT

**Satellite Name:** MAYA-1 (Philippines), BHUTAN-1 (Bhutan), MyUiTM-Sat (Malaysia)

**Link Budget for:** UHF Telemetry & Mission Downlink

**Version:** 2.0

**Date of Last Revision:** 2017-05-22

PARAMETERS	VALUES	UNITS
Frequency:	437.375 (tentative)	MHz
Emission Type:	F1D	
Modulation:	GMSK	
Data Rate:	9600	bps
Protocol:	AX.25	

#### SPACECRAFT

Spacecraft Transmitter Power Output:	0.8	watts
In dBW:	-0.96910013	dBW
In dBm:	29.03089987	dBm
Spacecraft Total Transmission Line Losses:	0.05	dB
Spacecraft Antenna Gain:	<b>0.5</b>	dBi
Spacecraft EIRP:	<b>-0.51910013</b>	dBW
Spacecraft Antenna Pointing Loss:	<b>3.068181818</b>	dB
S/C-to-Ground Antenna Polarization Loss:	<b>3.009750708</b>	dB

#### PATH

Orbit Altitude:	400	km
Elevation Angle:	15	°
Slant Range:	1175.5	km
Path Loss:	146.6845318	dB
Atmospheric Losses:	1.1	dB
Ionospheric Losses:	0.4	dB
Rain Losses:	0	dB
Isotropic Signal Level at Ground Station:	<b>-154.7815644</b>	dBW

#### GROUND STATION (SNR Method)

Ground Station Antenna Pointing Loss:	<b>1.0</b>	dB
Ground Station Antenna Gain:	16	dBi
Ground Station Total Transmission Line Losses:	1.28	dB
Ground Station Effective Noise Temperature:	599.8604206	K
Ground Station Figure of Merit (G/T):	-13.06050208	dB/K
Signal Power at Ground Station LNA Input:	<b>-141.0615644</b>	dBW
Ground Station Receiver Bandwidth (B):	15000	Hz
G.S. Receiver Noise Power (Pn = kTB)	-159.0585853	dBW
Signal-to-Noise Power Ratio at G.S. Rcvr:	<b>17.99702092</b>	dB
Analog or Digital System Required S/N:	9.6	dB

**System Link Margin**

**8.397020922**

**dB**

**Project Name:** BIRDS-2 PROJECT

**Satellite Name:** MAYA-1 (Philippines), BHUTAN-1 (Bhutan), MyUiTM-Sat (Malaysia)

**Link Budget for:** UHF CW Beacon

**Version:** 2.0

**Date of Last Revision:** 2017-05-22

PARAMETERS	VALUES	UNITS
Frequency:	437.375 (tentative)	MHz
Emission Type:	A1A	
Modulation:	Morse Code	
Data Rate:	20	words/min
Protocol:	-	

#### SPACECRAFT

Spacecraft Transmitter Power Output:	0.1	watts
In dBW:	-10	dBW
In dBm:	20	dBm
Spacecraft Total Transmission Line Losses:	0.05	dB
Spacecraft Antenna Gain:	<b>0.5</b>	dBi
Spacecraft EIRP:	<b>-9.55</b>	dBW
Spacecraft Antenna Pointing Loss:	<b>3.068181818</b>	dB
S/C-to-Ground Antenna Polarization Loss:	<b>3.009750708</b>	dB

#### PATH

Orbit Altitude:	400	km
Elevation Angle:	10	°
Slant Range:	1439.8	km
Path Loss:	148.4467031	dB
Atmospheric Losses:	1.1	dB
Ionospheric Losses:	0.4	dB
Rain Losses:	0	dB
Isotropic Signal Level at Ground Station:	<b>-165.5746356</b>	dBW

#### GROUND STATION or HANDHELD RADIO (SNR Method)

Ground Station Antenna Pointing Loss:	<b>1.0</b>	dB
Ground Station Antenna Gain:	16	dBi
Ground Station Total Transmission Line Losses:	1.28	dB
Ground Station Effective Noise Temperature:	599.8604206	K
Ground Station Figure of Merit (G/T):	-13.06050208	dB/K
Signal Power at Ground Station LNA Input:	<b>-151.8546356</b>	dBW
Ground Station Receiver Bandwidth (B):	500	Hz
G.S. Receiver Noise Power (Pn = kTB)	-173.8297979	dBW
Signal-to-Noise Power Ratio at G.S. Rcvr:	<b>21.97516225</b>	dB
Analog or Digital System Required S/N:	11	dB

**System Link Margin**

**10.97516225**

**dB**