

# STARS-II Link budget

## 1. FM Packet Downlink

Spacecraft	
Antenna Type	Paddle Antenna
Orbit Altitude	700 [km]
Maximum Transmission Distance	2155.28 [km]
Elevation Angle	10 [deg]
Spacecraft Transmitter Power Output	0.8 [watts]
Downlink Frequency	437.45 [MHz]
Spacecraft Total Transmission Line Losses	1.6 [dB]
Spacecraft Antenna Gain	4.8 [dBi]
Spacecraft EIRP	2.2 [dBW]
Downlink Path	
Spacecraft Antenna Pointing Loss	0.0 [dB]
S/C-to-Ground Antenna Polarization Loss	0.5 [dB]
Path Loss	152.0 [dB]
Atmospheric Loss	1.1 [dB]
Ionospheric Loss	0.8 [dB]
Rain Loss	0.0 [dB]
Isotropic Signal Level at Ground Station	-152.1 [dBW]
Ground Station (EbNo Method)	
Ground Station Antenna Pointing Loss	0.1 [dB]
Ground Station Antenna Gain	18 [dBi]
Ground Station Total Transmission Line Losses	1.9 [dB]
Ground Station Effective Noise Temperature	490 [K]
Ground Station Figure of Merit (G/T)	-10.8 [dB/K]
G. S. Signal-to-Noise Power Density (S/No)	65.6 [dBHz]
System Desired Data Rate	1200 [bps]
Telemetry System Eb/No for the Downlink	34.8 [dB]
Demodulation Method Selected	AFSK
Forward Error Correction Coding Used	None
System Allowed or Specified Bit-Error-Rate	0.000001
Demodulator Implementation Loss	1 [dB]
Telemetry System Required Eb/No	10.5 [dB]
Eb/No Threshold	11.5 [dB]
System Link Margin	23.3 [dB]
Ground Station Alternative Signal Analysis Method (SNR Computation)	
Ground Station Antenna Pointing Loss	0.1 [dB]
Ground Station Antenna Gain	18 [dBi]
Ground Station Total Transmission Line Losses	1.9 [dB]
Ground Station Effective Noise Temperature	490 [K]
Ground Station Figure of Merit (G/T)	-10.8 [dB/K]
Signal Power at Ground Station LNA Input	-136.1 [dBW]
Ground Station Receiver Bandwidth (B)	20 [kHz]
G. S. Receiver Noise Power (Pn = kTB)	-158.7 [dBW]
Signal-to-Noise Power Ratio at G. S. Rcvr	22.6 [dB]
Analog or Digital System Required S/N	10.5 [dB]
System Link Margin	12.1 [dB]

## 2. CW Morse Downlink

Spacecraft		
Antenna Type	Paddle Antenna	
Orbit Altitude	700	[km]
Maximum Transmission Distance	2155.28	[km]
Elevation Angle	10	[deg]
Spacecraft Transmitter Power Output	0.1	[watts]
Downlink Frequency	437.45	[MHz]
Spacecraft Total Transmission Line Losses	1.6	[dB]
Spacecraft Antenna Gain	4.8	[dBi]
Spacecraft EIRP	-6.8	[dBW]
Downlink Path		
Spacecraft Antenna Pointing Loss	0.0	[dB]
S/C-to-Ground Antenna Polarization Loss	0.5	[dB]
Path Loss	152.0	[dB]
Atmospheric Loss	1.1	[dB]
Ionospheric Loss	0.8	[dB]
Rain Loss	0.0	[dB]
Isotropic Signal Level at Ground Station	-161.1	[dBW]
Ground Station (EbNo Method)		
Ground Station Antenna Pointing Loss	0.1	[dB]
Ground Station Antenna Gain	18	[dBi]
Ground Station Total Transmission Line Losses	1.9	[dB]
Ground Station Effective Noise Temperature	490	[K]
Ground Station Figure of Merit (G/T)	-10.8	[dB/K]
G. S. Signal-to-Noise Power Density (S/No)	56.6	[dBHz]
System Desired Data Rate	100	[bps]
Telemetry System Eb/No for the Downlink	36.6	[dB]
Demodulation Method Selected	CW	
Forward Error Correction Coding Used	None	
System Allowed or Specified Bit-Error-Rate	0.000001	
Demodulator Implementation Loss	1	[dB]
Telemetry System Required Eb/No	10.5	[dB]
Eb/No Threshold	11.5	[dB]
System Link Margin	25.1	[dB]
Ground Station Alternative Signal Analysis Method (SNR Computation)		
Ground Station Antenna Pointing Loss	0.1	[dB]
Ground Station Antenna Gain	18	[dBi]
Ground Station Total Transmission Line Losses	1.9	[dB]
Ground Station Effective Noise Temperature	490	[K]
Ground Station Figure of Merit (G/T)	-10.8	[dB/K]
Signal Power at Ground Station LNA Input	-45.1	[dBW]
Ground Station Receiver Bandwidth (B)	5	[kHz]
G. S. Receiver Noise Power (Pn = kTB)	-164.7	[dBW]
Signal-to-Noise Power Ratio at G. S. Rcvr	19.6	[dB]
Analog or Digital System Required S/N	10.5	[dB]
System Link Margin	9.1	[dB]

### 3. FM Packet Uplink

Ground Station		
Antenna Type	Cross Yagi Antenna 2 stack	
Ground Station Latitude	34.292655	[deg]
Ground Station Longitude	134.063769	[deg]
Elevation Angle	10	[deg]
Ground Station Transmitter Power Output	50	[watts]
Uplink Frequency	145.8	[MHz]
Ground Stn. Total Transmission Line Losses	3.1	[dB]
Antenna Gain	18	[dBi]
Ground Station EIRP	31.9	[dBW]
Uplink Path		
Ground Station Antenna Pointing Loss	0.1	[dB]
Gnd-to-S/C Antenna Polarization Losses	0.5	[dB]
Path Loss	142.4	[dB]
Atmospheric Loss	1.1	[dB]
Ionospheric Loss	0.7	[dB]
Rain Loss	0	[dB]
Isotropic Signal Level at Spacecraft	-112.9	[dBW]
Spacecraft (EbNo Method)		
Spacecraft Antenna Pointing Loss	4.7	[dB]
Spacecraft Antenna Gain	2.2	[dBi]
Spacecraft Total Transmission Line Losses	2.0	[dB]
Spacecraft Effective Noise Temperature	220	[K]
Spacecraft Figure of Merit (G/T)	-23.2	[dB/K]
S/C Signal-to-Noise Power Density (S/No)	97.2	[dBHz]
System Desired Data Rate	1200	[bps]
Command System Eb/No	66.4	[dB]
Demodulation Method Selected	AFSK	
Forward Error Correction Coding Used	None	
System Allowed or Specified Bit-Error-Rate	0.000001	
Demodulator Implementation Loss	1	[dB]
Telemetry System Required Eb/No	10.5	[dB]
Eb/No Threshold	11.5	[dB]
System Link Margin	54.9	[dB]
Spacecraft Alternative Signal Analysis Method (SNR Computation)		
Spacecraft Antenna Pointing Loss	4.7	[dB]
Spacecraft Antenna Gain	2.2	[dBi]
Spacecraft Total Transmission Line Losses	2.0	[dB]
Spacecraft Effective Noise Temperature	220	[K]
Spacecraft Figure of Merit (G/T)	-23.2	[dB/K]
Signal Power at Spacecraft LNA Input	-117.4	[dBW]
Spacecraft Receiver Bandwidth	20	[kHz]
Spacecraft Receiver Noise Power (Pn = kTB)	-162.2	[dBW]
Signal-to-Noise Power Ratio at G. S. Rcvr	44.8	[dB]
Analog or Digital System Required S/N	10.5	[dB]
System Link Margin	34.3	[dB]