

# STARS Link budget

## 1. FM Packet Downlink

Spacecraft		
Antenna Type	Monopole Antenna	
Orbit Altitude	666	[km]
Maximum Transmission Distance	2080	[km]
Elevation Angle	10	[deg]
Spacecraft Transmitter Power Output	0.8	[watts]
Downlink Frequency	437.6	[MHz]
Spacecraft Total Transmission Line Losses	1.6	[dB]
Spacecraft Antenna Gain	2.8	[dBi]
Spacecraft EIRP	0.2	[dBW]
Downlink Path		
Spacecraft Antenna Pointing Loss	0.0	[dB]
S/C-to-Ground Antenna Polarization Loss	0.5	[dB]
Path Loss	151.6	[dB]
Atmospheric Loss	1.1	[dB]
Ionospheric Loss	0.8	[dB]
Rain Loss	0.0	[dB]
Isotropic Signal Level at Ground Station	-153.8	[dBW]
Ground Station (EbNo Method)		
Ground Station Antenna Pointing Loss	0.2	[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)	63.8	[dBHz]
System Desired Data Rate	1200	[bps]
Telemetry System Eb/No for the Downlink	33.0	[dB]
Demodulation Method Selected	FSK	
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	21.5	[dB]
Ground Station Alternative Signal Analysis Method (SNR Computation)		
Ground Station Antenna Pointing Loss	0.2	[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	-137.9	[dBW]
Ground Station Receiver Bandwidth (B)	10	[kHz]
G. S. Receiver Noise Power (Pn = kTB)	-161.7	[dBW]
Signal-to-Noise Power Ratio at G. S. Rcvr	23.8	[dB]
Analog or Digital System Required S/N	10.5	[dB]
System Link Margin	13.3	[dB]

## 2. CW Morse Downlink

Spacecraft		
Antenna Type	Monopole Antenna	
Orbit Altitude	666	[km]
Maximum Transmission Distance	2080	[km]
Elevation Angle	10	[deg]
Spacecraft Transmitter Power Output	0.1	[watts]
Downlink Frequency	437.6	[MHz]
Spacecraft Total Transmission Line Losses	1.6	[dB]
Spacecraft Antenna Gain	2.8	[dBi]
Spacecraft EIRP	-8.8	[dBW]
Downlink Path		
Spacecraft Antenna Pointing Loss	0.0	[dB]
S/C-to-Ground Antenna Polarization Loss	0.5	[dB]
Path Loss	151.6	[dB]
Atmospheric Loss	1.1	[dB]
Ionospheric Loss	0.8	[dB]
Rain Loss	0.0	[dB]
Isotropic Signal Level at Ground Station	-162.8	[dBW]
Ground Station (EbNo Method)		
Ground Station Antenna Pointing Loss	0.2	[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)	54.8	[dBHz]
System Desired Data Rate	100	[bps]
Telemetry System Eb/No for the Downlink	24.0	[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	12.5	[dB]
Ground Station Alternative Signal Analysis Method (SNR Computation)		
Ground Station Antenna Pointing Loss	0.2	[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	-146.9	[dBW]
Ground Station Receiver Bandwidth (B)	10	[kHz]
G. S. Receiver Noise Power (Pn = kTB)	-161.7	[dBW]
Signal-to-Noise Power Ratio at G. S. Rcvr	14.8	[dB]
Analog or Digital System Required S/N	10.5	[dB]
System Link Margin	4.3	[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	3.6	[dB]
Antenna Gain	16	[dBi]
Ground Station EIRP	29.4	[dBW]
Uplink Path		
Ground Station Antenna Pointing Loss	0.1	[dB]
Gnd-to-S/C Antenna Polarization Losses	0.5	[dB]
Path Loss	142.1	[dB]
Atmospheric Loss	1.1	[dB]
Ionospheric Loss	0.7	[dB]
Rain Loss	0	[dB]
Isotropic Signal Level at Spacecraft	-115.1	[dBW]
Spacecraft (EbNo Method)		
Spacecraft Antenna Pointing Loss	0	[dB]
Spacecraft Antenna Gain	1.6	[dBi]
Spacecraft Total Transmission Line Losses	2	[dB]
Spacecraft Effective Noise Temperature	220	[K]
Spacecraft Figure of Merit (G/T)	-23.8	[dB/K]
S/C Signal-to-Noise Power Density (S/No)	89.7	[dBHz]
System Desired Data Rate	1200	[bps]
Command System Eb/No	58.9	[dB]
Demodulation Method Selected	FSK	
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	47.4	[dB]
Spacecraft Alternative Signal Analysis Method (SNR Computation)		
Spacecraft Antenna Pointing Loss	0	[dB]
Spacecraft Antenna Gain	1.6	[dBi]
Spacecraft Total Transmission Line Losses	2	[dB]
Spacecraft Effective Noise Temperature	220	[K]
Spacecraft Figure of Merit (G/T)	-23.8	[dB/K]
Signal Power at Spacecraft LNA Input	-115.5	[dBW]
Spacecraft Receiver Bandwidth	10	[kHz]
Spacecraft Receiver Noise Power (Pn = kTB)	-165.2	[dBW]
Signal-to-Noise Power Ratio at G. S. Rcvr	49.7	[dB]
Analog or Digital System Required S/N	10.5	[dB]
System Link Margin	39.2	[dB]