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# Link Budget

Calculated by AMSAT-IARU\_Link\_Budget Tool

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## General Information

|  |              |
|--|--------------|
| Antenna type of Ground Station: <b>20 elements Long-john antenna</b> |              |
| Antenna type of Spacecraft: <b>Dipole antenna</b>                    |              |
| Orbit Altitude:  | 826.0 [km]   |
| Maximum Transmission Distance:                                       | 2420.28 [km] |
| Elevation Angle:   | 10.0 [deg.]  |

## Uplink Command Budget(FM Transmission)

| <b>Ground Station:</b>                      |                     |
|---|---------------------|
| Ground Station Transmitter Power Output:    | 10.0 [W]            |
| Total Transmission Line Losses:             | 10.7 [dB]           |
| Antenna Gain:                               | 22.0 [dBi]          |
| Ground Station EIRP:                        | <b>21.3 [dBW]</b>   |
| <b>Uplink Path:</b>                         |                     |
| Ground Station Antenna Pointing Loss:       | 0.5 [dB]            |
| Gnd-to-S/C Antenna Polarization Losses:     | 0.2 [dB]            |
| Path Loss:                                  | 152.9 [dB]          |
| Atmospheric Losses:                         | 1.1 [dB]            |
| Ionospheric Losses:                         | 0.4 [dB]            |
| Rain Losses:                                | 0.0 [dB]            |
| Isotropic Signal Level at Spacecraft:       | <b>-133.9 [dBW]</b> |
| <b>Spacecraft (Eb/No Method):</b>           |                     |
| Spacecraft Antenna Pointing Loss:           | 6.0 [dB]            |
| Spacecraft Antenna Gain:                    | 3.0 [dBi]           |
| Spacecraft Total Transmission Line Losses:  | 1.2 [dB]            |
| Spacecraft Effective Noise Temperature:     | 183 [K]             |
| Spacecraft Figure of Merit (G/T):           | -22.0 [dB/K]        |
| S/C Signal-to-Noise Power Density (S/No):   | <b>67.9 [dBHz]</b>  |
| System Desired Data Rate:                   | 1200 [bps]          |
| Command System Eb/No:                       | <b>37.1 [dB]</b>    |
| Demodulation Method:                        | AFSK/FM             |
| System Allowed or Specified Bit-Error-Rate: | 1.0E-4              |
| Eb/No Threshold:                            | <b>22 [dB]</b>      |
| <b>System Link Margin:</b>                  | <b>15.1 [dB]</b>    |

| <b>Spacecraft Alternative Signal Analysis Method:</b> |        |       |
|---|--------|-------|
| Signal Power at Spacecraft LNA Input:                 | -138.1 | [dBW] |
| Spacecraft Receiver Bandwidth:                        | 10     | [kHz] |
| Spacecraft Receiver Noise Power (Pn = kTB)            | -166.0 | [dBW] |
| Signal-to-Noise Power Ratio at G.S. Rcvr:             | 27.9   | [dB]  |
| Analog or Digital System Required S/N:                | 14.4   | [dB]  |
| System Link Margin                                    | 13.5   | [dB]  |

### Downlink Telemetry Budget(FM Transmission)

| <b>Spacecraft:</b>                             |            |             |
|--|------------|-------------|
| Spacecraft Transmitter Power Output:           | 0.8        | [W]         |
| Spacecraft Total Transmission Line Losses:     | 2.2        | [dB]        |
| Spacecraft Antenna Gain:                       | 3.0        | [dBi]       |
| Spacecraft EIRP:                               | -0.2       | [dBW]       |
| <b>Downlink Path:</b>                          |            |             |
| Spacecraft Antenna Pointing Loss:              | 6.0        | [dB]        |
| S/C-to-Ground Antenna Polarization Loss:       | 0.2        | [dB]        |
| Path Loss:                                     | 152.9      | [dB]        |
| Atmospheric Loss:                              | 1.1        | [dB]        |
| Ionospheric Loss:                              | 0.8        | [dB]        |
| Rain Loss:                                     | 0.0        | [dB]        |
| Isotropic Signal Level at Ground Station:      | -161.2     | [dBW]       |
| <b>Ground Station (EbNo Method):</b>           |            |             |
| Ground Station Antenna Pointing Loss:          | 0.5        | [dB]        |
| G.S. Antenna Gain:                             | 22.0       | [dBi]       |
| Ground Station Total Transmission Line Losses: | 3.8        | [dB]        |
| Ground Station Effective Noise Temperature:    | 676        | [K]         |
| Ground Station Figure of Merit (G/T):          | -10.1      | [dB/K]      |
| G.S. Signal-to-Noise Power Density (S/No):     | 56.87      | [dBHz]      |
| System Desired Data Rate:                      | 1200       | bps         |
| Telemetry System Eb/No for the Downlink:       | 26.0       | [dB]        |
| Demodulation Method Selected:                  | AFSK/FM    |             |
| System Allowed or Specified Bit-Error-Rate:    | 1.0E-04    |             |
| Demodulator Implementation Loss:               | 1          | [dB]        |
| Telemetry System Required Eb/No:               | 21         | [dB]        |
| Eb/No Threshold:                               | 22         | [dB]        |
| <b>System Link Margin:</b>                     | <b>4.0</b> | <b>[dB]</b> |

**Ground Station Alternative Signal Analysis Method (SNR  
Computation):**

|   |        |       |
|---|--------|-------|
| Signal Power at Ground Station LNA Input: | -143.5 | [dBW] |
| Ground Station Receiver Bandwidth (B):    | 10     | [kHz] |
| G.S. Receiver Noise Power ( $P_n = kTB$ ) | -160.3 | [dBW] |
| Signal-to-Noise Power Ratio at G.S. Rcvr: | 16.8   | [dB]  |
| Analog or Digital System Required S/N:    | 14.4   | [dB]  |
| System Link Margin                        | 2.4    | [dB]  |