

Ku-band typical link budgets

| | | |
|----------------------------|----------|-----|
| Ku-band uplink frequency | 14250 | MHz |
| Ku-band downlink frequency | 12000 | MHz |
| Convolution FEC rate | 0.921569 | |
| Block FEC rate | 0.75 | |
| Rx ES temperature | 120 | K |

| S13.c. | K_A | K_B | K_C | K_D |
|-----------------------------------|--|--|---------------------------------|---------------------------------|
| | Digital TV MCPC 40 Mbps QPSK ¾ RS | Digital TV MCPC 32 Mbps QPSK ¾ RS | Digital TV SCPC QPSK ¾ RS | Digital TV SCPC QPSK ¾ RS |
| Carrier designation | 36M0G7W | 27M0G7W | 6M95G1W | 5M00G1W |
| Data Rate (dB-Hz) | 76 | 75 | 69 | 67.6 |
| Throughput rate (Mbps) | 40 | 32 | 8 | 6 |
| Symbol rate (MSPS) | 28.8 | 22.9 | 5.7 | 4.2 |
| Uplinks: | | | | |
| Transmit Power (dBW) | 20 | 20 | 8.9 | 8.9 |
| Transmit Loss (dB) | -2.5 | -2.5 | -2.5 | -2.5 |
| Antenna diameter | 6.1 | 6.1 | 3.7 | 3.7 |
| Antenna Gain (dBi) | 57.3 | 57.3 | 53.0 | 53.0 |
| Ground Station EIRP (dBW) | 74.8 | 74.8 | 59.4 | 59.4 |
| Uplink Rain Loss (dB) | -2 | -2 | -2 | -2 |
| Free Space Loss (dB) | -207 | -207 | -207 | -207 |
| Satellite G/T (dB/K) | 3 | 3 | 3 | 3 |
| Boltzmann's Constant (dBW/K-Hz) | -228.6 | -228.6 | -228.6 | -228.6 |
| Eb/N0 (dB) | 21.4 | 22.4 | 13.0 | 14.4 |
| Eb/I0 (dB) | 18 | 18 | 16 | 16 |
| Total Eb/(N0 + I0) (dB) | 16.4 | 16.7 | 11.2 | 12.1 |
| Downlinks: | | | | |
| Satellite Carrier EIRP (dBW) | 49.4 | 48.1 | 35.7 | 34.3 |
| Interference bandwidth (MHz) | 36 | 27 | 6.95 | 5 |
| Satellite EIRP density (dBW/4KHz) | 9.86 | 9.81 | 3.30 | 3.33 |
| Downlink Rain Loss (dB) | -3 | -3 | -3 | -3 |
| Free Space Loss (dB) | -205.4 | -205.4 | -205.4 | -205.4 |
| Ground station antenna dia, m | 0.9 | 0.9 | 2.4 | 2.4 |
| Ground Station G/T (dB/K) | 18.4 | 18.4 | 26.9 | 26.9 |
| Eb/N0 (dB) | 12.0 | 11.7 | 13.8 | 13.8 |
| C/IM | | | 18 | 18 |
| Eb/Imo (dB) | | | 16.6 | 16.6 |
| C/I | 15 | 15 | 15 | 15 |
| Eb/I0 (ASI) (dB) | 13.6 | 13.6 | 13.6 | 13.6 |
| Eb/I0 (dB) | 13.6 | 13.6 | 13.6 | 13.6 |

| | | | | |
|------------------------------|-----|-----|-----|-----|
| Eb/(N0 + I0) (dB) | 9.7 | 9.5 | 9.7 | 9.7 |
| Total Up/Down Eb/(N0+I0)(dB) | 8.9 | 8.8 | 7.4 | 7.7 |
| Required Eb/N0 | 5.4 | 5.4 | 5.4 | 5.4 |
| Margin | 3.5 | 3.4 | 2.0 | 2.3 |

| K_E | K_F | K_F |
|-----------------------|-----------------------|-----------------------|
| | | Digital TV |
| | | MCPC |
| 56 Kbps | 1.544 Mbps | 50 Mbps |
| QPSK $\frac{3}{4}$ RS | QPSK $\frac{3}{4}$ RS | 8PSK $\frac{2}{3}$ RS |
| 100KG1W | 1M60G1W | 36M0G7W |
| 47.5 | 61.9 | 77 |
| 0.056 | 1.544 | 50 |
| 0.041 | 1.117 | 27.2 |
| -2 | 8 | 20 |
| -2.5 | -2.5 | -2.5 |
| 1.8 | 1.8 | 6.1 |
| 46.7 | 46.7 | 57.3 |
| 42.2 | 52.2 | 74.8 |
| -2 | -2 | -2 |
| -207 | -207 | -207 |
| 3 | 3 | 3 |
| -228.6 | -228.6 | -228.6 |
| 17.3 | 12.9 | 20.4 |
| 16 | 16 | 18 |
| 13.6 | 11.2 | 16.0 |
| 18.5 | 28.5 | 49.4 |
| 0.1 | 1.6 | 36 |
| 4.52 | 2.48 | 9.86 |
| -3 | -3 | -3 |
| -205.4 | -205.4 | -205.4 |
| 1.2 | 2.4 | 2.4 |
| 20.9 | 26.9 | 26.9 |
| 12.1 | 13.7 | 19.5 |
| 18 | 18 | |
| 16.6 | 16.6 | |
| 15 | 15 | 15 |
| 13.6 | 13.6 | 12.3 |
| 13.6 | 13.6 | 12.3 |

| | | |
|-----|-----|------|
| 9.0 | 9.7 | 11.6 |
| 7.7 | 7.4 | 10.3 |
| 5.4 | 5.4 | 7.2 |
| 2.3 | 2.0 | 3.1 |

C-band typical link budgets

| | | |
|----------------------------|---------|-----|
| Ku-band uplink frequency | 6250 | MHz |
| Ku-band downlink frequency | 3950 | MHz |
| Convolution FEC rate | 0.92157 | |
| Block FEC rate | 0.75 | |
| Rx ES temperature | 100 | K |

| S13.c. | C_A | C_B | C_C | C_D |
|-----------------------------------|--|--|---------------------------------|---------------------------------|
| | Digital TV MCPC 40 Mbps QPSK ¾ RS | Digital TV MCPC 32 Mbps QPSK ¾ RS | Digital TV SCPC QPSK ¾ RS | Digital TV SCPC QPSK ¾ RS |
| Carrier designation | 36M0G7W | 27M0G7W | 6M95G1W | 5M00G1W |
| Data Rate (dB-Hz) | 76 | 75 | 69 | 69 |
| Throughput rate (Mbps) | 40 | 32 | 8 | 8 |
| Symbol rate (MSPS) | 28.8 | 22.9 | 5.7 | 5.7 |
| Uplinks: | | | | |
| Transmit Power (dBW) | 25.1 | 20 | 9.6 | 12 |
| Transmit Loss (dB) | -2.5 | -2.5 | -2.5 | -2.5 |
| Antenna diameter (m) | 9 | 9 | 9 | 9 |
| Antenna Gain (dBi) | 53.5 | 53.5 | 53.5 | 53.5 |
| Ground Station EIRP (dBW) | 76.1 | 71.0 | 60.6 | 63.0 |
| Uplink Rain Loss (dB) | -1 | -1 | -1 | -1 |
| Free Space Loss (dB) | -199.7 | -199.7 | -199.7 | -199.7 |
| Satellite G/T (dB/K) | 1.3 | 1.3 | 1.3 | 1.3 |
| Boltzmann's Constant (dBW/K-Hz) | -228.6 | -228.6 | -228.6 | -228.6 |
| Eb/No (dB) | 29.3 | 25.2 | 20.8 | 23.2 |
| Eb/Io (dB) | 18 | 18 | 18 | 16 |
| Total Eb/(No + Io) (dB) | 17.7 | 17.2 | 16.2 | 15.2 |
| Downlinks: | | | | |
| Satellite Carrier EIRP (dBW) | 37 | 37 | 25.8 | 25.8 |
| Interference bandwidth (MHz) | 36 | 27 | 6.95 | 5 |
| Satellite EIRP density (dBW/4KHz) | -2.54 | -1.29 | -6.60 | -5.17 |
| Downlink Rain Loss (dB) | -0.5 | -0.5 | -0.5 | -0.5 |
| Free Space Loss (dB) | -195.8 | -195.8 | -195.8 | -195.8 |
| Ground station antenna dia, m | 3.8 | 3.8 | 3.8 | 3.8 |
| Ground Station G/T (dB/K) | 22.1 | 22.1 | 22.1 | 22.1 |
| Eb/No (dB) | 15.4 | 16.4 | 11.2 | 11.2 |
| C/IM | | | 18 | 18 |
| Eb/Imo (dB) | | | 16.6 | 16.6 |
| C/I(ASI) | 16 | 16 | 16 | 16 |
| Eb/Io(ASI) | 14.6 | 14.6 | 14.6 | 14.6 |
| Eb/Io (dB) | 14.6 | 14.6 | 14.6 | 14.6 |

| | | | | |
|------------------------------|------|------|-----|-----|
| Eb/(No + Io) (dB) | 11.9 | 12.4 | 8.8 | 8.8 |
| Total Up/Down Eb/(No+Io)(dB) | 10.9 | 11.2 | 8.0 | 7.9 |
| Required | 5.4 | 5.4 | 5.4 | 5.4 |
| Margin | 5.5 | 5.8 | 2.6 | 2.5 |

| C_E | C_F | C_G |
|-----------------------|-----------------------|-----------------------|
| | | Digital TV |
| | | MCPC |
| 56 Kbps | 1.544 Mbps | 50 Mbps |
| QPSK $\frac{3}{4}$ RS | QPSK $\frac{3}{4}$ RS | 8PSK $\frac{2}{3}$ RS |
| 100KG1W | 1M60G1W | 36M0G7W |
| 47.5 | 61.9 | 77 |
| 0 | 2 | 50 |
| 0.0 | 1.1 | 27.2 |
| -3.4 | 11.8 | 25.1 |
| -2.5 | -2.5 | -2.5 |
| 4.5 | 4.5 | 9 |
| 47.5 | 47.5 | 53.5 |
| 41.6 | 56.8 | 76.1 |
| -1 | -1 | -1 |
| -199.7 | -199.7 | -199.7 |
| 1.3 | 1.3 | 1.3 |
| -228.6 | -228.6 | -228.6 |
| 23.3 | 24.1 | 28.3 |
| 16 | 16 | 18 |
| 15.3 | 15.4 | 17.6 |
| 6.8 | 22 | 37 |
| 0.1 | 1.6 | 36 |
| -7.18 | -4.02 | -2.54 |
| -0.5 | -0.5 | -0.5 |
| -195.8 | -195.8 | -195.8 |
| 3.8 | 3.8 | 3.8 |
| 22.1 | 22.1 | 22.1 |
| 13.7 | 14.5 | 14.4 |
| 18 | 18 | |
| 16.6 | 16.6 | |
| 16 | 16 | 16 |
| 14.6 | 14.6 | 13.3 |
| 14.6 | 14.6 | 13.3 |

| | | |
|------|------|------|
| 10.0 | 10.3 | 10.8 |
| 8.9 | 9.2 | 10.0 |
| 5.4 | 5.4 | 5.4 |
| 3.5 | 3.8 | 4.6 |

Ka-band link budgets

| | | |
|-------------------------|-------|-----|
| Ka-band uplink freq | 25000 | MHz |
| Ka-band downlink freq | 17500 | MHz |
| Rx ES noise temperature | 150.0 | K |

CONUS

| S13.c. | KA_1 | KA_2 |
|---|-------------|-------------|
| Carrier designation | 1M20G1W | 5M50G1W |
| Throughput rate, Mbps | 1.43 | 4.75 |
| Required bandwidth, MHz | 1.2 | 5.5 |
| Allocated bandwidth, MHz | 1.2 | 5.5 |
| FEC code rate | 0.5 | 0.5 |
| C/N required, dB | 4.7 | 1.3 |
| Faded system margin, dB | 0.5 | 0.5 |
| Uplink | | |
| Transmit Power (dBW) | 4 | 10.5 |
| Antenna diameter | 9 | 9 |
| Antenna Gain (dBi) | 65.6 | 65.6 |
| TxES antenna input power density, dBW/MHz | 3.2 | 3.1 |
| Ground Station EIRP (dBW) | 69.6 | 76.1 |
| Uplink Rain Loss (dB) | 0 | 0 |
| Uplink path loss | -212.1 | -212.1 |
| Boltzmann's constant | -228.6 | -228.6 |
| Satellite G/T (dB/K) | -8 | -8 |
| C/N, dB | 17.3 | 17.2 |
| C/I(X-pol uplink), dB | 30 | 30 |
| Downlink | | |
| Satellite Carrier EIRP (dBW) | 31.3 | 31.3 |
| Ground station antenna dia, m | 0.95 | 1.5 |
| Ground Station G/T (dB/K) | 21.2 | 25.2 |
| Downlink path loss | -208.7 | -208.7 |
| C/N(clear weather), dB | 11.6 | 8.9 |
| Min C/N down, dB | 2.68 | 0.43 |
| C/I(ASI), dB | 10 | 10 |
| C/I(total), dB | 9.91 | 9.91 |
| Rain margin to min C/N down, dB | 8.9 | 8.5 |

Ku/C-band TV/FM link budget

| | | | |
|-------------------------------|-------|-------|-----|
| Ku-band frequencies (UL DL) | 14250 | 11950 | MHz |
| C-band frequencies (UL DL) | 6250 | 3950 | MHz |
| Rx ES temperature (Ku C) | 120 | 100 | K |

| S13.d. | K_H | C_H |
|---------------------------------|------------|------------|
| | Ku-band | C-band |
| | Typical | Typical |
| Parameter | TV/FM link | TV/FM link |
| Carrier designation | 36M0F3F | 36M0F3F |
| Uplinks: | | |
| Transmit Power (dBW) | 22 | 25 |
| Transmit Loss (dB) | -1 | -0.5 |
| Antenna diameter | 6.1 | 9 |
| Antenna Gain (dBi) | 57.3 | 53.5 |
| Ground Station EIRP (dBW) | 78.3 | 78.0 |
| Uplink Rain Loss (dB) | -2 | -1 |
| Free Space Loss (dB) | -207 | -199.7 |
| Satellite G/T (dB/K) | 3 | 1.3 |
| Bandwidth (dB-Hz) | 75.6 | 75.6 |
| Boltzmann's Constant (dBW/K-Hz) | -228.6 | -228.6 |
| C/N, uplink (dB) | 25.4 | 31.7 |
| Downlinks: | | |
| Satellite Carrier EIRP (dBW) | 48.2 | 39.7 |
| Downlink Rain Loss (dB) | -3 | -0.5 |
| Free Space Loss (dB) | -205.4 | -195.8 |
| Ground station antenna dia, m | 1.2 | 3.8 |
| Ground Station G/T (dB/K) | 20.9 | 22.1 |
| C/N, DL (dB) | 13.7 | 18.5 |
| C/I ASI (dB) | 18 | 16 |
| C/Ntot, dB | 12.3 | 14.1 |
| Required (dB) | 11 | 11 |
| Margin (dB) | 1.3 | 3.1 |

Ku-band & C-band TT&C links

| | |
|--------------|--------|
| k | -228.6 |
| Ku-band freq | 14499 |
| C-band freq | 6423.5 |

CMD

| S13.d. | K_TC | C_TC |
|---|-------------|-------------|
| Tx ES dia (typical), m | 8.4 | 13 |
| Tx ES gain, dBi | 60.2 | 57.0 |
| Tx ES antenna input power, dBW | 10 | 10 |
| Tx ES EIRP, dBW | 70.2 | 67.0 |
| Link loss, dB | 207.5 | 200.1 |
| Satellite G/T, dB/K | 6 | 2 |
| Command carrier bandwidth, MHz | 1 | 1 |
| Tx ES antenna input power density, dBW/Hz | -50 | -50 |
| Carrier-to-Noise Ratio, dB | 37.3 | 37.5 |
| Required CNR, dB | 10 | 10 |
| Margin | 27.3 | 27.5 |

| | |
|--------------|-------|
| Ku-band freq | 11701 |
| C-band freq | 3700 |

TLM

| S13.d. | K_TM | C_TM |
|------------------------|-------------|-------------|
| EIRP, dBW | 19 | 16 |
| Carrier bandwidth, MHz | 0.5 | 0.5 |
| EIRP density, dBW/4kHz | -1.97 | -4.97 |
| Tx ES dia (typical), m | 5.7 | 4.5 |
| Rx ES antenna gain, dB | 55.0 | 43.0 |
| Rx ES G/T, dB/K | 34.6 | 22.5 |
| Rain fade, dB | 8 | 1 |
| CNR, dB | 10.21 | 9.16 |
| CNR (required), dB | 9 | 9 |
| Margin, dB | 1.2 | 0.2 |