

Table 24 (Original Application)
Ka-Band Earth Station Sizes Used in Link Budget Analysis

| Carrier Type | Dig MOD. ID | Earth Station Diameter Uplink |
|----------------------------|-------------|-------------------------------|
| 8-PSK 60 MBPS Data | D1 | 6 |
| Digital TV 8 MBPS QPSK | D2 | 4.5 |
| QPSK 100 MBPS Data | D3 | 6 |
| QPSK 73 MBPS Data | D4 | 6 |
| QPSK 1.2 MBPS Data | D5 | 0.65 |
| QPSK 3/4 DVB S2 52 Mbps | D6 | 8 |
| 8PSK 2/3 DVB S2 70 Mbps | D7 | 8 |
| 16APSK 3/4 DVB S2 100 Mbps | D8 | 8 |
| QPSK 3/4 DVB S2 3 Mbps | D9 | 0.65 |
| 8PSK 2/3 DVB S2 4 Mbps | D10 | 0.65 |
| QPSK 3/4 DVB S2 380 kbps | D11 | 0.65 |
| BPSK 2/3 DVB S2 20 kbps | D12 | 0.65 |

Table 25 (Original Application)
Uplink Link Budget Calculations: Digital MOD ID - D1 and D2

| Parameter | 8PSK 2-3 DVB S2 | QPSK 3-4 RS 8 Mbps |
|--|-----------------|--------------------|
| | 60 Mbps | |
| Transmit Power(dBW) | 11.34 | 9.41 |
| Transmit Loss (dB) | -1 | -1 |
| Antenna Gain (dBi) | 63.49 | 60.99 |
| Ground Station EIRP (dBW) | 73.83 | 69.4 |
| Uplink Rain Loss (dB) | 0 | 0 |
| Free Space Loss (dB) | -213.33 | -213.33 |
| Satellite G/T (dB/K) | 9 | 9 |
| Data Rate (dB-Hz) | 77.77 | 69.03 |
| Boltzmann's Constant (dBW/K-Hz) | -228.6 | -228.6 |
| E_b/N_o (dB) | 20.33 | 24.64 |
| E_b/I_o (dB) | 17.34 | 18.59 |
| Total $E_b/(N_o + I_o)$ (dB) For 10^{-7} | 15.57 | 17.63 |

Table 26 (Original Application)
Downlink Link Budget Calculations: Digital MOD ID - D1 and D2

| Parameter | 8PSK 2-3 DVB S2 | QPSK 3-4 RS 8 Mbps |
|------------------------------|-----------------|--------------------|
| | 60 Mbps | |
| Satellite Carrier EIRP (dBW) | 50.33 | 42.6 |
| Downlink Rain Loss (dB) | -9 | -9 |
| Free Space Loss (dB) | -209.93 | -209.93 |

| | | |
|------------------------------------|--------|--------|
| Ground Station G/T (dB/K) | 25.59 | 25.59 |
| Bit Rate (dB-Hz) | 77.77 | 69.03 |
| Boltzmann's Constant (dBW/K-Hz) | -228.6 | -228.6 |
| E_b/N_o (dB) | 7.82 | 8.83 |
| E_b/I_o (dB) | 17.34 | 18.59 |
| $E_b/(N_o + I_o)$ (dB) | 7.36 | 8.39 |
| Total UP/DOWN $E_b/(N_o+I_o)$ (dB) | 6.75 | 7.9 |
| Required | 4.6 | 5.5 |
| Margin | 2.15 | 2.4 |

Table 27 (Original Application)
Uplink Link Budget Calculations: Digital MOD ID - D3 and D4

| Parameter | QPSK 2-3 RS 100 Mbps | 8PSK 2-3 RS 73 Mbps |
|--|-------------------------|------------------------|
| Transmit Power(dBW) | 18.31 | 14.56 |
| Transmit Loss (dB) | -1 | -1 |
| Antenna Gain (dBi) | 63.49 | 63.49 |
| Ground Station EIRP (dBW) | 80.8 | 77.05 |
| Uplink Rain Loss (dB) | 0 | 0 |
| Free Space Loss (dB) | -213.33 | -213.33 |
| Satellite G/T (dB/K) | 9 | 9 |
| Data Rate (dB-Hz) | 80 | 78.63 |
| Boltzmann's Constant (dBW/K-Hz) | -228.6 | -228.6 |
| E_b/N_o (dB) | 25.07 | 22.69 |
| E_b/I_o (dB) | 18.11 | 16.34 |
| Total $E_b/(N_o + I_o)$ (dB) For 10^{-7} | 17.31 | 15.44 |

Table 28 (Original Application)
Downlink Link Budget Calculations: Digital MOD ID - D3 and D4

| Parameter | QPSK 2-3 RS 100 Mbps | 8PSK 2-3 RS 73 Mbps* |
|------------------------------------|-------------------------|-------------------------|
| Satellite Carrier EIRP (dBW) | 59.1 | 52.25 |
| Downlink Rain Loss (dB) | -9 | -1 |
| Free Space Loss (dB) | -209.93 | -209.93 |
| Ground Station G/T (dB/K) | 20.26 | 20.26 |
| Bit Rate (dB-Hz) | 80 | 78.63 |
| Boltzmann's Constant (dBW/K-Hz) | -228.6 | -228.6 |
| E_b/N_o (dB) | 9.03 | 11.55 |
| E_b/I_o (dB) | 18.11 | 16.34 |
| $E_b/(N_o + I_o)$ (dB) | 8.53 | 10.31 |
| Total UP/DOWN $E_b/(N_o+I_o)$ (dB) | 7.99 | 9.14 |
| Required | 5 | 6.8 |

| | | |
|--------|------|------|
| Margin | 2.99 | 2.34 |
|--------|------|------|

Table 29 (Original Application)
Uplink Link Budget Calculations: Digital MOD ID - D5

| Parameter | QPSK 1-2 (Turbo) 1.2 Mbps |
|--|------------------------------|
| Transmit Power(dBW) | -0.78 |
| Transmit Loss (dB) | -1 |
| Antenna Gain (dBi) | 44.18 |
| Ground Station EIRP (dBW) | 42.4 |
| Uplink Rain Loss (dB) | 0 |
| Free Space Loss (dB) | -213.33 |
| Satellite G/T (dB/K) | 9 |
| Data Rate (dB-Hz) | 60.79 |
| Boltzmann's Constant (dBW/K-Hz) | -228.6 |
| E_b/N_o (dB) | 5.88 |
| E_b/I_o (dB) | 22.22 |
| Total $E_b/(N_o + I_o)$ (dB) For 10^{-7} | 5.78 |

Table 30 (Original Application)
Downlink Link Budget Calculations: Digital MOD ID - D5

| Parameter | QPSK 1-2 (Turbo) 1.2 Mbps* |
|------------------------------------|-------------------------------|
| Satellite Carrier EIRP (dBW) | 17.6 |
| Downlink Rain Loss (dB) | -1 |
| Free Space Loss (dB) | -209.93 |
| Ground Station G/T (dB/K) | 39.57 |
| Bit Rate (dB-Hz) | 60.79 |
| Boltzmann's Constant (dBW/K-Hz) | -228.6 |
| E_b/N_o (dB) | 14.05 |
| E_b/I_o (dB) | 22.22 |
| $E_b/(N_o + I_o)$ (dB) | 13.43 |
| Total UP/DOWN $E_b/(N_o+I_o)$ (dB) | 5.09 |
| Required | 2.7 |
| Margin | 2.39 |

Table 31 (Original Application)
Uplink Link Budget Calculations: Digital MOD ID - D6 and D7

| Parameter | QPSK 3/4 DVB S2 52 Mbps | 8PSK 2/3 DVB S2 70 Mbps |
|---------------------|----------------------------|----------------------------|
| Transmit Power(dBW) | 8 | 8 |
| Transmit Loss (dB) | -1 | -1 |

| | | |
|--|---------|---------|
| Antenna Gain (dBi) | 65.99 | 65.99 |
| Ground Station EIRP (dBW) | 72.99 | 72.99 |
| Uplink Rain Loss (dB) | 0 | 0 |
| Free Space Loss (dB) | -213.33 | -213.33 |
| Satellite G/T (dB/K) | 9 | 9 |
| Data Rate (dB-Hz) | 77.17 | 78.42 |
| Boltzmann's Constant (dBW/K-Hz) | -228.6 | -228.6 |
| E_b/N_o (dB) | 20.09 | 18.84 |
| E_b/I_o (dB) | 14.76 | 16.03 |
| Total $E_b/(N_o + I_o)$ (dB) For 10^{-7} | 13.64 | 14.2 |

Table 32 (Original Application)
Downlink Link Budget Calculations: Digital MOD ID - D6 and D7

| Parameter | QPSK 3/4 DVB S2 | 8PSK 2/3 DVB S2 70 |
|------------------------------------|-----------------|--------------------|
| | 52 Mbps | Mbps |
| Satellite Carrier EIRP (dBW) | 53 | 53 |
| Downlink Rain Loss (dB) | -9.5 | -6.25 |
| Free Space Loss (dB) | -209.93 | -209.93 |
| Ground Station G/T (dB/K) | 20.26 | 20.26 |
| Bit Rate (dB-Hz) | 77.17 | 78.42 |
| Boltzmann's Constant (dBW/K-Hz) | -228.6 | -228.6 |
| E_b/N_o (dB) | 5.26 | 7.26 |
| E_b/I_o (dB) | 14.76 | 16.03 |
| $E_b/(N_o + I_o)$ (dB) | 4.8 | 6.72 |
| Total UP/DOWN $E_b/(N_o+I_o)$ (dB) | 4.27 | 6.01 |
| Required | 3.06 | 4.58 |
| Margin | 1.21 | 1.43 |

Table 33 (Original Application)
Uplink Link Budget Calculations: Digital MOD ID - D8 and D9

| Parameter | 16APSK 3/4 DVB | QPSK 3/4 DVB S2 3 |
|---------------------------------|----------------|-------------------|
| | S2 100 Mbps | Mbps |
| Transmit Power(dBW) | 8 | 3 |
| Transmit Loss (dB) | -1 | 0 |
| Antenna Gain (dBi) | 65.99 | 44.18 |
| Ground Station EIRP (dBW) | 72.99 | 47.18 |
| Uplink Rain Loss (dB) | 0 | 0 |
| Free Space Loss (dB) | -213.33 | -213.33 |
| Satellite G/T (dB/K) | 9 | 9 |
| Data Rate (dB-Hz) | 80.18 | 64.87 |
| Boltzmann's Constant (dBW/K-Hz) | -228.6 | -228.6 |
| E_b/N_o (dB) | 17.08 | 6.58 |

| | | |
|--|-------|-------|
| E_b/I_o (dB) | 17.77 | 17.76 |
| Total $E_b/(N_o + I_o)$ (dB) For 10^{-7} | 14.4 | 6.26 |

Table 34 (Original Application)
Downlink Link Budget Calculations: Digital MOD ID - D8 and D9

| Parameter | 16APSK 3/4 DVB S2 100 Mbps | QPSK 3/4 DVB S2 3 Mbps |
|------------------------------------|----------------------------|------------------------|
| Satellite Carrier EIRP (dBW) | 53 | 36.18 |
| Downlink Rain Loss (dB) | -3 | -12 |
| Free Space Loss (dB) | -209.93 | -209.93 |
| Ground Station G/T (dB/K) | 20.26 | 39.57 |
| Bit Rate (dB-Hz) | 80.18 | 64.87 |
| Boltzmann's Constant (dBW/K-Hz) | -228.6 | -228.6 |
| E_b/N_o (dB) | 8.75 | 17.55 |
| E_b/I_o (dB) | 17.77 | 17.76 |
| $E_b/(N_o + I_o)$ (dB) | 8.24 | 14.64 |
| Total UP/DOWN $E_b/(N_o+I_o)$ (dB) | 7.3 | 5.67 |
| Required | 5.42 | 3.06 |
| Margin | 1.88 | 2.61 |

Table 35 (Original Application)
Uplink Link Budget Calculations: Digital MOD ID - D10 and D11

| Parameter | 8PSK 2/3 DVB S2 4 Mbps | QPSK 3/4 DVB S2 380 kbps |
|--|------------------------|--------------------------|
| Transmit Power(dBW) | 3 | -3 |
| Transmit Loss (dB) | 0 | 0 |
| Antenna Gain (dBi) | 44.18 | 44.18 |
| Ground Station EIRP (dBW) | 47.18 | 41.18 |
| Uplink Rain Loss (dB) | 0 | 0 |
| Free Space Loss (dB) | -213.33 | -213.33 |
| Satellite G/T (dB/K) | 9 | 9 |
| Data Rate (dB-Hz) | 66.12 | 55.84 |
| Boltzmann's Constant (dBW/K-Hz) | -228.6 | -228.6 |
| E_b/N_o (dB) | 5.33 | 9.61 |
| E_b/I_o (dB) | 19.03 | 17.76 |
| Total $E_b/(N_o + I_o)$ (dB) For 10^{-7} | 5.15 | 8.99 |

Table 36 (Original Application)
Downlink Link Budget Calculations: Digital MOD ID - D10 and D11

| Parameter | 8PSK 2/3 DVB S2 4 Mbps | QPSK 3/4 DVB S2 380 kbps |
|-----------|------------------------|--------------------------|
|-----------|------------------------|--------------------------|

| | | |
|------------------------------------|---------|---------|
| Satellite Carrier EIRP (dBW) | 36.18 | 30.18 |
| Downlink Rain Loss (dB) | -3 | -12 |
| Free Space Loss (dB) | -209.93 | -209.93 |
| Ground Station G/T (dB/K) | 39.57 | 39.57 |
| Bit Rate (dB-Hz) | 66.12 | 55.84 |
| Boltzmann's Constant (dBW/K-Hz0) | -228.6 | -228.6 |
| E_b/N_o (dB) | 25.3 | 20.58 |
| E_b/I_o (dB) | 19.03 | 17.76 |
| $E_b/(N_o + I_o)$ (dB) | 18.11 | 15.94 |
| Total UP/DOWN $E_b/(N_o+I_o)$ (dB) | 4.93 | 8.19 |
| Required | 4.58 | 3.06 |
| Margin | 0.35 | 5.13 |

Table 37 (Original Application)
Uplink Link Budget Calculations: Digital MOD ID - D12

| Parameter | BPSK 2/3 DVB S2 20 kbps |
|--|----------------------------|
| Transmit Power(dBW) | -12 |
| Transmit Loss (dB) | 0 |
| Antenna Gain (dBi) | 44.18 |
| Ground Station EIRP (dBW) | 32.18 |
| Uplink Rain Loss (dB) | 0 |
| Free Space Loss (dB) | -213.33 |
| Satellite G/T (dB/K) | 9 |
| Data Rate (dB-Hz) | 43.29 |
| Boltzmann's Constant (dBW/K-Hz) | -228.6 |
| E_b/N_o (dB) | 13.16 |
| E_b/I_o (dB) | 14.26 |
| Total $E_b/(N_o + I_o)$ (dB) For 10^{-7} | 10.67 |

Table 28 (Original Application)
D0wnlink Link Budget Calculations: Digital MOD ID - D12

| Parameter | BPSK 2/3 DVB S2 20 kbps |
|----------------------------------|----------------------------|
| Satellite Carrier EIRP (dBW) | 21.18 |
| Downlink Rain Loss (dB) | -20 |
| Free Space Loss (dB) | -209.93 |
| Ground Station G/T (dB/K) | 39.57 |
| Bit Rate (dB-Hz) | 43.29 |
| Boltzmann's Constant (dBW/K-Hz0) | -228.6 |
| E_b/N_o (dB) | 16.13 |
| E_b/I_o (dB) | 14.26 |

| | |
|------------------------------------|-------|
| $E_b/(N_o + I_o)$ (dB) | 12.09 |
| Total UP/DOWN $E_b/(N_o+I_o)$ (dB) | 8.31 |
| Required | 1.83 |
| Margin | 6.48 |

| Earth Station Diameter Downlink |
|--|
| 1.2 |
| 1.2 |
| 0.65 |
| 0.65 |
| 6 |
| 0.65 |
| 0.65 |
| 0.65 |
| 8 |
| 8 |
| 8 |
| 8 |

