

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
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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
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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

