

# Digital Link Budget

Produced using Satfinder

Tuesday, October 25, 2005

Service Name	Ricahrdson 2.4 M to 18-Inch SOTM
Coverage	CONUS
Uplink earth station	Richardson, Texas
Downlink earth station	Richardson, Texas
Satellite name	AMC-9

## Link Input Parameters

	Uplink	Downlink	Units
Site latitude	32.78N	32.78N	degrees
Site longitude	96.80W	96.80W	degrees
Magnetic variation	5.0E	5.0E	degrees
Site altitude	0.1	0.1	km
Frequency	14.2	11.9	GHz
Polarization	Horizontal	Vertical	
Rain climatic zone (model)	E (ITU)	E (ITU)	
Availability (average year)	95	95	%
Water vapour density	3	3	gm/m3
Surface temperature	23	23	°C
Antenna aperture	2.4	0.45	metres
Antenna efficiency / gain	+32.8	55	% (+ prefix dBi)
Coupling loss	2.35	0.1	dB
Antenna tracking / mispoint error	0.1	0.1	dB
LNB noise figure / temp		+65	dB (+ prefix K)
Antenna noise		43	K
Adjacent carrier interference	60	60	dB
Adjacent satellite interference	65	65	dB
Cross polarization interference	30	30	dB
Uplink station HPA output back-off	2		dB
Number of carriers / HPA	1		
HPA C/IM (up)	22		dB
Uplink power control	0		dB
Uplink filter truncation loss	0		dB

## Satellite Input Parameters

	Value	Units
Satellite longitude	83.00W	degrees
Transponder type	TWTA	
Receive G/T	4.2	dB/K
Saturation flux density	-99.40	dBW/m2
Satellite attenuator pad	1	dB
Transmit EIRP at saturation	50	dBW
Transponder bandwidth	36	MHz
Input back off total	6	dB
Output back off total	AUTO	dB
Intermodulation interference	AUTO	dB

## Carrier/Link Input Parameters

	Value	Units
Modulation	BPSK	
Required bit error rate performance	10 <sup>-6</sup>	
Required Eb/No without FEC coding	10.53	dB

Required Eb/No with FEC coding	1.9	dB
Information rate	0.256	Mbps
Overhead	0	%
FEC code rate	0.5	
Spreading gain	0	dB
Roll off factor + 1	1.2	
Carrier spacing factor	1.4	
Bandwidth allocation step size	0.001	MHz
System margin	0	dB

### Calculations at Saturation

	Value	Units
Gain 1m^2	44.50	dB/m2
Uplink C/No	89.90	dB.Hz
Downlink C/No	84.75	dB.Hz
Total C/No	83.59	dB.Hz
Uplink EIRP for saturation	64.23	dBW

### General Calculations

	Uplink	Downlink	Units
Elevation	49.04	49.04	degrees
True azimuth	155.60	155.60	degrees
Compass bearing	150.60	150.60	degrees
Path distance to satellite	37137.51	37137.51	km
Propagation time delay	0.12	0.12	seconds
Antenna efficiency	1.49	55.00	%
Antenna gain	32.80	32.39	dBi
Availability (average year)	95	95	%
Link downtime (average year)	438.300	438.300	hours
Availability (worst month)	88.439	88.439	%
Link downtime (worst month)	84.456	84.456	hours
Spectral power density	-18.78	1.96	dBW/4kHz

### Uplink Calculation

	Clear	Rain Up	Rain Dn	Units
Uplink transmit EIRP	35.89	35.89	35.89	dBW
Transponder input back-off (total)	6.00	6.00	6.00	dB
Input back-off per carrier	28.34	28.58	28.34	dB
Mispoint loss	0.10	0.10	0.10	dB
Free space loss	206.89	206.89	206.89	dB
Atmospheric absorption	0.08	0.08	0.08	dB
Tropospheric scintillation fading	0.06	0.06	0.06	dB
Atmospheric losses total	0.14	0.14	0.14	dB
Total path loss (excluding rain)	207.13	207.13	207.13	dB
Rain attenuation	0.00	0.24	0.00	dB
UPC (or manual power boost)	0.00	0.00	0.00	dB
Uncompensated Rain Fade	0.00	0.24	0.00	dB
C/No (thermal)	61.56	61.32	61.56	dB.Hz
C/N (thermal)	3.67	3.43	3.67	dB
C/ACI	60.00	59.76	60.00	dB
C/ASI	65.00	64.76	65.00	dB
C/XPI	30.00	29.76	30.00	dB
C/IM	22.00	22.00	22.00	dB
Eb/(No+Io)	7.40	7.16	7.40	dB

### Downlink Calculation

	Clear	Rain Up	Rain Dn	Units
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Satellite EIRP total	50.00	50.00	50.00	dBW
Transponder output back-off (total)	3.83	3.83	3.83	dB
Output back-off per carrier	26.17	26.41	26.17	dB
Satellite EIRP per carrier	23.83	23.59	23.83	dBW
Mispoint loss	0.10	0.10	0.10	dB
Free space loss	205.35	205.35	205.35	dB
Atmospheric absorption	0.07	0.07	0.07	dB
Tropospheric scintillation fading	0.06	0.06	0.06	dB
Atmospheric losses total	0.12	0.12	0.12	dB
Total path loss (excluding rain)	205.58	205.58	205.58	dB
Rain attenuation	0.00	0.00	0.16	dB
Noise increase due to precipitation	0.00	0.00	0.37	dB
Downlink degradation (DND)	0.00	0.00	0.53	dB
Total system noise	113.76	113.76	123.91	K
Figure of merit (G/T)	11.73	11.73	11.35	dB/K
C/No (thermal)	58.57	58.33	58.04	dB.Hz
C/N (thermal)	0.69	0.45	0.15	dB
C/ACI	60.00	59.76	60.00	dB
C/ASI	65.00	64.76	65.00	dB
C/XPI	30.00	29.76	30.00	dB
C/IM	8.34	7.86	8.34	dB
Eb/(No+Io)	3.80	3.52	3.34	dB

### Totals per Carrier (End-to-End)

	Clear	Rain Up	Rain Dn	Units
C/No (thermal)	56.80	56.56	56.44	dB.Hz
C/N (thermal)	-1.08	-1.32	-1.44	dB
C/ACI	56.99	56.75	56.99	dB
C/ASI	61.99	61.75	61.99	dB
C/XPI	26.99	26.75	26.99	dB
C/IM	8.15	7.70	8.15	dB
C/(No+Io)	56.31	56.05	55.98	dB.Hz
C/(N+I)	-1.58	-1.84	-1.90	dB
Eb/(No+Io)	2.23	1.96	1.90	dB
System margin	0.00	0.00	0.00	dB
Net Eb/(No+Io)	2.23	1.96	1.90	dB
Required Eb/(No+Io)	1.90	1.90	1.90	dB
Excess margin	0.33	0.06	0.00	dB

### Earth Station Power Requirements

	Value	Units
EIRP per carrier	35.89	dBW
HPA power per carrier	3.09	dBW
Uplink power control	0.00	dB
HPA output back off	2.00	dB
Waveguide loss	2.35	dB
Filter truncation loss	0	dB
Number of HPA carriers	1	
Total HPA power required	7.44	dBW
Required HPA power capability	5.54	W
Spectral power density	-18.78	dBW/4kHz

### Space Segment Utilization

	Value	Units
Overall link availability	90.25	%
Information rate (inc overhead)	0.2560	Mbps

Transmit rate	0.5120	Mbps
Symbol rate	0.5120	MBaud
Occupied bandwidth	0.6144	MHz
Noise bandwidth	57.88	dB.Hz
Minimum allocated bandwidth required	0.7168	MHz
Allocated transponder bandwidth	0.7170	MHz
Percentage transponder bandwidth used	1.99	%
Used transponder power	23.83	dBW
Percentage transponder power used	0.58	%
Max carriers by transponder bandwidth	50.21	
Max carriers by transponder power	171.50	
Maximum carriers limited by:-	Transponder bandwidth [50.21 carriers]	
Total transponder capacity	12.85	Mbps