

ECHOSTAR-15 Link Budgets						
Link Parameters	Super High Power Mode					
	1	2	3	4	5	6
	13 meter Feeder Link E/S Nominal Feeder Link Site	13 meter Feeder Link E/S Nominal Feeder Link Site	13 meter Feeder Link E/S Nominal Feeder Link Site	13 meter Feeder Link E/S Nominal Feeder Link Site	13 meter Feeder Link E/S Nominal Feeder Link Site	13 meter Feeder Link E/S Nominal Feeder Link Site
	to	to	to	to	to	to
	45 cm Receive-Only	45 cm Receive-Only	45 cm Receive-Only	45 cm Receive-Only	45 cm Receive-Only	75 cm Receive-Only
Modulation Parameters:						
Information Bit Rate per Carrier (kbps)	32,255	32,255	32,255	32,255	32,255	32,255
FEC Rate	7/8	7/8	7/8	7/8	7/8	7/8
Reed-Solomon Ratio (188/204, None)	188/204	188/204	188/204	188/204	188/204	188/204
Overall Coding Overhead (%)	24.0%	24.0%	24.0%	24.0%	24.0%	24.0%
Modulation Type (BPSK/QPSK/8PSK/16QAM)	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK
Filter Roll-off Factor ("alpha") (%)	20	20	20	20	20	20
Link Geometry:						
Satellite Longitude (*East)	-61.5	-61.5	-61.5	-61.5	-61.5	-61.5
Tx E/S City Location (name)	Cheyenne	Cheyenne	Cheyenne	Cheyenne	Cheyenne	Cheyenne
Tx E/S Longitude (*East)	-104.7	-104.7	-104.7	-104.7	-104.7	-104.7
Tx E/S Latitude (*North)	41.1	41.1	41.1	41.1	41.1	41.1
Tx E/S Range to Satellite (km)	39,030	39,030	39,030	39,030	39,030	39,030
Tx E/S Elevation to Satellite (*)	25.4	25.4	25.4	25.4	25.4	25.4
Rx E/S Altitude (m)	1876.0	1876.0	1876.0	1876.0	1876.0	1876.0
Rx E/S City Location (name)	Miami	New York	Los Angeles	Houston	Denver	San Juan
Rx E/S Longitude (*East)	-80.3	-74.0	-118.2	-95.3	-105.0	-66.1
Rx E/S Latitude (*North)	25.9	40.8	34.0	29.8	39.8	18.4
Rx E/S Range to Satellite (km)	36,881	37,692	39,667	37,828	38,968	36,193
Rx E/S Elevation to Satellite (*)	53.2	41.2	18.9	39.4	26.1	67.7
Rx E/S Altitude (m)	1.0	15.0	33.0	10.0	1631.0	74.0
Uplink (per carrier):						
Carrier Frequency (MHz)	17,550	17,550	17,550	17,550	17,550	17,550
HPA Power Level (to give required PFD at satellite) (W)	37.8	37.8	37.8	37.8	37.8	37.8
HPA Power in dBW (dBW)	15.8	15.8	15.8	15.8	15.8	15.8
Post-HPA Losses (dB)	2.0	2.0	2.0	2.0	2.0	2.0
Tx E/S Power to Antenna in dBW (dBW)	13.8	13.8	13.8	13.8	13.8	13.8
Tx E/S Antenna Diameter (m)	13.0	13.0	13.0	13.0	13.0	13.0
Antenna Efficiency (%)	65	65	65	65	65	65
Tx E/S Antenna Gain (dB)	65.7	65.7	65.7	65.7	65.7	65.7
Tx E/S EIRP (dBW)	79.5	79.5	79.5	79.5	79.5	79.5
E/S Pointing Loss (dB)	0.1	0.1	0.1	0.1	0.1	0.1
Atmospheric Loss (dB)	0.44	0.44	0.44	0.44	0.44	0.44
Availability up (%)	99.9	99.9	99.9	99.9	99.9	99.9
Rain attenuation (dB)	3.9	3.9	3.9	3.9	3.9	3.9
Free Space Loss (dB)	209.2	209.2	209.2	209.2	209.2	209.2
Satellite:						
Resulting PFD at Satellite (dBW/m ²)	-87.8	-87.8	-87.8	-87.8	-87.8	-87.8
Transponder Gain Setting (dB)	10	10	10	10	10	10
G/T towards Tx E/S (dB/K)	6.0	6.0	6.0	6.0	6.0	6.0
EIRP towards Rx E/S (dBW)	56.0	53.0	54.0	55.0	53.0	50.0
Downlink:						
Carrier Frequency (MHz)	12,450	12,450	12,450	12,450	12,450	12,450
Atmospheric Loss (dB)	0.09	0.11	0.23	0.12	0.14	0.08
Availability down (%)	99.9	99.9	99.9	99.8	99.9	99.8
Rain attenuation (dB)	5.58	2.90	1.92	3.34	2.62	3.97
E/S Pointing Loss (dB)	0.5	0.5	0.5	0.5	0.5	0.5
Free Space Loss (dB)	205.7	205.9	206.3	205.9	206.2	205.5
Rx E/S Antenna Diameter (m)	0.45	0.45	0.45	0.45	0.45	0.75
Rx E/S Antenna Gain (dB)	34.0	34.0	34.0	34.0	34.0	38.4
Rx E/S G/T (dB/K)	13.2	13.2	13.2	13.2	13.2	17.6
System (LNA+Sky) Noise Temp. (K)	120	120	120	120	120	120
Increase in Noise Temp due to rain (K)	209	144	115	158	136	173
Total Link:						
Carrier Noise Bandwidth (kHz)	24,000	24,000	24,000	24,000	24,000	24,000
(C/N) - Thermal Uplink (dB)	30.6	30.6	30.6	30.6	30.6	30.6
(C/N) - Thermal Downlink - CLEAR SKY (dB)	17.7	14.5	15.0	16.5	14.2	16.3
(C/N) - Thermal Downlink - RAIN DOWN (dB)	7.8	8.2	10.1	9.5	8.3	8.5
(C/I) - Other Link Degradsions (dB)	20.0	20.0	20.0	20.0	20.0	20.0
(C/N) - Total Actual - CLEAR SKY (dB)	15.6	13.4	13.7	14.8	13.1	14.7
(C/N) - Total Actual - RAIN DOWN (dB)	7.5	7.9	9.7	9.1	8.0	8.2
(C/N) - Total Required (dB)	7.5	7.5	7.5	7.5	7.5	7.5
Excess Margin - CLEAR SKY (dB)	8.1	5.9	6.2	7.3	5.6	7.2
Excess Margin - RAIN DOWN (dB)	0.0	0.4	2.2	1.6	0.5	0.7

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Modulation Parameters:						
Information Bit Rate per Carrier (kbps)	32,255	32,255	32,255	32,255	32,255	32,255
FEC Rate	7/8	7/8	7/8	7/8	7/8	7/8
Reed-Solomon Ratio (188/204, None)	188/204	188/204	188/204	188/204	188/204	188/204
Overall Coding Overhead (%)	24.0%	24.0%	24.0%	24.0%	24.0%	24.0%
Modulation Type (BPSK/QPSK/8PSK/16QAM)	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK
Filter Roll-off Factor ("alpha") (%)	20	20	20	20	20	20
Link Geometry:						
Satellite Longitude ("East")	-61.5	-61.5	-61.5	-61.5	-61.5	-61.5
Tx E/S City Location (name)	Cheyenne	Cheyenne	Cheyenne	Cheyenne	Cheyenne	Cheyenne
Tx E/S Longitude ("East")	-104.7	-104.7	-104.7	-104.7	-104.7	-104.7
Tx E/S Latitude ("North")	41.1	41.1	41.1	41.1	41.1	41.1
Tx E/S Range to Satellite (km)	39,030	39,030	39,030	39,030	39,030	39,030
Tx E/S Elevation to Satellite (*)	25.4	25.4	25.4	25.4	25.4	25.4
Rx E/S Altitude (m)	1876.0	1876.0	1876.0	1876.0	1876.0	1876.0
Rx E/S City Location (name)	Miami	New York	Los Angeles	Houston	Denver	San Juan
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Rx E/S Elevation to Satellite (*)	53.2	41.2	18.9	39.4	26.1	67.7
Rx E/S Altitude (m)	1.0	15.0	33.0	10.0	1631.0	74.0
Uplink (per carrier):						
Carrier Frequency (MHz)	17,550	17,550	17,550	17,550	17,550	17,550
HPA Power Level (to give required PFD at satellite) (W)	37.8	37.8	37.8	37.8	37.8	37.8
HPA Power in dBW (dBW)	15.8	15.8	15.8	15.8	15.8	15.8
Post-HPA Losses (dB)	2.0	2.0	2.0	2.0	2.0	2.0
Tx E/S Power to Antenna in dBW (dBW)	13.8	13.8	13.8	13.8	13.8	13.8
Tx E/S Antenna Diameter (m)	13.0	13.0	13.0	13.0	13.0	13.0
Antenna Efficiency (%)	65	65	65	65	65	65
Tx E/S Antenna Gain (dB)	65.7	65.7	65.7	65.7	65.7	65.7
Tx E/S EIRP (dBW)	79.5	79.5	79.5	79.5	79.5	79.5
E/S Pointing Loss (dB)	0.1	0.1	0.1	0.1	0.1	0.1
Atmospheric Loss (dB)	0.44	0.44	0.44	0.44	0.44	0.44
Availability up (%)	99.9	99.9	99.9	99.9	99.9	99.9
Rain attenuation (dB)	3.9	3.9	3.9	3.9	3.9	3.9
Free Space Loss (dB)	209.2	209.2	209.2	209.2	209.2	209.2
Satellite:						
Resulting PFD at Satellite (dBW/m ²)	-87.8	-87.8	-87.8	-87.8	-87.8	-87.8
Transponder Gain Setting (dB)	10	10	10	10	10	10
G/T towards Tx E/S (dB/K)	6.0	6.0	6.0	6.0	6.0	6.0
EIRP towards Rx E/S (dBW)	54.3	51.3	52.3	53.3	51.3	48.3
Downlink:						
Carrier Frequency (MHz)	12,450	12,450	12,450	12,450	12,450	12,450
Atmospheric Loss (dB)	0.09	0.11	0.23	0.12	0.14	0.08
Availability down (%)	99.8	99.8	99.9	99.8	99.8	99.7
Rain attenuation (dB)	3.90	2.02	1.92	3.34	1.78	3.12
E/S Pointing Loss (dB)	0.5	0.5	0.5	0.5	0.5	0.5
Free Space Loss (dB)	205.7	205.9	206.3	205.9	206.2	205.5
Rx E/S Antenna Diameter (m)	0.45	0.45	0.45	0.45	0.45	0.75
Rx E/S Antenna Gain (dB)	34.0	34.0	34.0	34.0	34.0	38.4
Rx E/S G/T (dB/K)	13.2	13.2	13.2	13.2	13.2	17.6
System (LNA+Sky) Noise Temp. (K)	120	120	120	120	120	120
Increase in Noise Temp due to rain (K)	172	111	115	158	103	149
Total Link:						
Carrier Noise Bandwidth (kHz)	24,000	24,000	24,000	24,000	24,000	24,000
(C/N) - Thermal Uplink (dB)	30.6	30.6	30.6	30.6	30.6	30.6
(C/N) - Thermal Downlink - CLEAR SKY (dB)	16.0	12.8	13.3	14.8	12.5	14.6
(C/N) - Thermal Downlink - RAIN DOWN (dB)	8.3	7.9	8.4	7.8	8.0	8.0
(C/I) - Other Link Degradsione (dB)	20.0	20.0	20.0	20.0	20.0	20.0
(C/N) - Total Actual - CLEAR SKY (dB)	14.5	12.0	12.4	13.6	11.7	13.4
(C/N) - Total Actual - RAIN DOWN (dB)	8.0	7.7	8.1	7.5	7.7	7.7
(C/N) - Total Required (dB)	7.5	7.5	7.5	7.5	7.5	7.5
Excess Margin - CLEAR SKY (dB)	7.0	4.5	4.9	6.1	4.2	5.9
Excess Margin - RAIN DOWN (dB)	0.5	0.2	0.6	0.0	0.2	0.2