Appendix A

DBS Receiver Signal Strength Meters

Signal Strength Indicators in DBS Receivers:

Consumer grade receivers used for the reception of Direct Broadcast Satellite (DBS) signals employ some form of signal strength (SS) indication. The SS indication function is normally accessed by the consumer via the User Interface (UI) software associated with the installation and alignment of the home receiving equipment. The SS indication device in both DIRECTV and EchoStar consumer receivers is in the form of a bar graph meter. The meter provides a relative measure of the received signal quality. The primary intent of this indicating function is to aid in the alignment of the outdoor antenna to achieve the strongest signal possible in any particular geographic area. However, engineers for both DIRECTV and EchoStar have come to rely on these SS indicators as a valuable tool in assessing signal transmission quality and deleterious effects from rain or other interfering or noise generating phenomena.

The utility of the SS indicator comes primarily from the fact that it is not a simple RF power indicator such as a Received Signal Strength Indicator (RSSI) from a receiver's pre-detection IF chain or Automatic Gain Control (AGC) from either the RF tuner/IF strip. This source of SS indication is common to home FM stereo receivers.

The SS indicator of a DBS receiver derives its information from the QPSK symbol demodulation and tracking loop. Internal to the demodulator, an algorithm estimates the residual noise associated with the QPSK symbols. The quantity typically reported is the Es/No, the average energy of a symbol to the average noise power in a 1 Hz bandwidth. For Gray coded QPSK, the quantities Es/No and Eb/No are mathematically related by a factor of 2. That is Es/No = Eb/No + 3db. Both Es/No and Eb/No are measured in the digital domain. These quantities can be likened to the signal-to-noise ratio (S/N) which is the common qualitative quantity of measure for analog transmission systems. In both analog and digital systems, knowing Eb/No or S/N and channel bit-rates and noise bandwidths, it is possible to determine the carrier-to-noise (C/N) of the RF carrier. Therefore, with simple mathematical relationships, the information from the demodulators can be used to derive Es/No, Eb/No or C/N, all very useful quantities for characterizing transmission quality and impairments to a channel.

Minor differences are encountered between IC manufacturers in the methods for calculating the bit-noise ratio and hence the absolute value of the unit quantity. This is the reason why the same absolute value of a particular channel C/N may be reported as SS = 94 for one model of receiver and SS = 85 on another receiver. All that is different between the receiver models is the slope of the number of SS counts vs. decibel curve.

For example, the EchoStar Model 4000 receiver has SS meter slope of 6-7 counts per dB. This is fairly linear from below threshold. The demodulator actually remains locked below the point of the FEC lock to very close to the end of the range of the internal IC register that holds the processed Es/No value. In the case of the Model 4000, this relates to C/N values from about 1 dB to 14 dB for the currently used channel and code rates. This range is sufficient to provide accurate antenna peaking anywhere in the continental US EIRP footprints using small 18-inch antennas.

The important point to note is that any receiver can be calibrated to provide very accurate C/N or Eb/No values from the deflection of the SS meter. Once a calibration has been performed, the number of SS count difference observed under varying channel conditions can be directly related to absolute dB values of C/N degradation from the impairment. Stated another way, for a 1 dB degradation of C/N, one model receiver may report a 10 SS count delta and another model 7 SS count delta. Both SS data points are correct, accurate, and repeatable knowing the associated calibration curve. Even without calibration, the change in the SS count reading from peak value to some lower value indicates the channel is suffering impairments but on a relative rather than absolute basis.

The accuracy and dependability of the data interpreted from the SS meter can provide valuable information to engineering and satellite operations. It provides a means to constantly monitor the condition of the satellite payload and varying regional link conditions. The information is used for statistical data collection to verify and support availability predictions and to evaluate the performance of system design improvements from the uplink transmission plant to the set-top and outdoor electronics.

Appendix B

Link Budgets

Echo at 110; 3/4 code
Oxon Hill, MD

Transponder 16		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Test 7					
Uplink C/N (thermal), dB		24.20	24.20	24.20	24.20
Downlink:	Satellite EIRP, dBW	54.0	54.0	54.0	54.0
Washington, DC	Downlink path loss, dB	-206.1	-206.1	-206.1	-206.1
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-4.12	-3.91
	Rain temp increase, dB	0.0	0.0	-3.8	-3.8
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	12.7	12.7	12.7	12.7
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's Constant, dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal), dB		14.7	14.7	6.7	7.0

	%	Outage min./yr.
Availability w/o NP	99.9285	376
Availability with NP	99.9197	422
Increase in unavailability	12.3	46

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	24.2	24.2	24.2	24.2
	Downlink C/N (thermal), dB	14.7	14.7	6.7	7.0
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat. interf., dB	22.2	22.2	22.2	22.2
	C/I from NP	99.0	18.6	99.0	18.6
	Total C/(N+I), dB	13.1	12.0	6.4	6.4
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4
	Margin, dB	6.7	5.6	0.0	0.0

Echo at 61.5; 3/4 code
Oxon Hill, MD

Transponder 2		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Test 14					
Uplink C/N (thermal), dB		24.20	24.20	24.20	24.20
Downlink	Satellite EIRP, dBW	53.5	53.5	53.5	53.5
Washington, DC	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-3.98	-2.77
	Rain temp increase, dB	0.0	0.0	-3.8	-3.2
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	12.7	12.7	12.7	12.7
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal),dB		14.4	14.4	6.6	8.4

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	24.2	24.2	24.2	24.2
	Downlink C/N (thermal), dB	14.4	14.4	6.6	8.4
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat. interf., dB	30.0	30.0	30.0	30.0
	C/I from NP	**99.0**	**11.3**	**99.0**	**11.3**
	Total C/(N+I), dB	13.3	9.2	6.4	6.4
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4
	Margin, dB	6.9	2.8	0.0	0.0

	%	Outage min./yr
Availability w/o NP	99.9419	305
Availability with NP	99.8708	679
Increase in unavailability	**122.4**	374

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Echo at 61.5; 3/4 code
Oxon Hill, MD

Transponder 16		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Test 15					
Uplink C/N (thermal), dB		24.20	24.20	24.20	24.20
Downlink:	Satellite EIRP, dBW	53.5	53.5	53.5	53.5
Washington, DC	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-3.98	-3.04
	Rain temp increase, dB	0.0	0.0	-3.8	-3.4
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	12.7	12.7	12.7	12.7
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal),dB		14.4	14.4	6.6	8.0

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	24.2	24.2	24.2	24.2
	Downlink C/N (thermal), dB	14.4	14.4	6.6	8.0
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat. interf., dB	30.0	30.0	30.0	30.0
	C/I from NP	**99.0**	**12.3**	**99.0**	**12.3**
	Total C/(N+I), dB	13.3	9.8	6.4	6.4
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4
	Margin, dB	6.9	3.4	0.0	0.0

	%	Outage min./yr.
Availability w/o NP	99.9419	305
Availability with NP	99.8947	553
Increase in unavailability	81.2	248

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Echo at 61.5; 3/4 code
Oxon Hill, MD

Transponder 32		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Test 16					
Uplink C/N (thermal), dB		24.20	24.20	24.20	24.20
Downlink	Satellite EIRP, dBW	53.5	53.5	53.5	53.5
Washington, DC	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-3.98	-3.79
	Rain temp increase, dB	0.0	0.0	-3.8	-3.7
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	12.7	12.7	12.7	12.7
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal),dB		14.4	14.4	6.6	6.9

	%	Outage min./yr
Availability, w/o NP	99.9419	305
Availability with NP	99.9350	342
Increase in unavailability	11.9	36

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	24.2	24.2	24.2	24.2
	Downlink C/N (thermal), dB	14.4	14.4	6.6	6.9
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat. interf., dB	30.0	30.0	30.0	30.0
	C/I from NP	**99.0**	**18.8**	**99.0**	**18.8**
	Total C/(N+I), dB	13.3	12.2	6.4	6.4
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4
	Margin, dB	6.9	5.8	0.0	0.0

DIRECTV at 101; 6/7 code
Oxon Hill, MD

Transponder 2		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Test 20					
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70
Downlink					
Washington, D.C.	Satellite EIRP, dBW	55.8	55.8	55.8	55.8
	Downlink path loss, dB	-206.0	-206.0	-206.0	-206.0
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-4.82	-4.30
	Rain temp increase, dB	0.0	0.0	-4.1	-3.9
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	13.0	13.0	13.0	13.0
	Bandwidth, dB Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant, dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal), dB		16.9	16.9	8.0	8.7

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7
	Downlink C/N (thermal), dB	16.9	16.9	8.0	8.7
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7
	C/I from NP	**99.0**	**16.3**	**99.0**	**16.3**
	Total C/(N+I), dB	14.5	12.3	7.6	7.6
	Required C/(N+I), dB	7.6	7.6	7.6	7.6
	Margin, dB	6.9	4.7	0.0	0.0

	%	Outage min./yr.
Availability w/o NP	99.9584	219
Availability with NP	99.9457	286
Increase in unavailability	30.6	67

DIRECTV at 101: 6/7 code
Oxon Hill, MD

Transponder 16 Test 21		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70
Downlink					
Washington, D.C.	Satellite EIRP, dBW	55.8	55.8	55.8	55.8
	Downlink path loss, dB	-206.0	-206.0	-206.0	-206.0
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-4.82	-4.50
	Rain temp increase, dB	0.0	0.0	-4.1	-4.0
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	13.0	13.0	13.0	13.0
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant, dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal), dB		16.9	16.9	8.0	8.4

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7
	Downlink C/N (thermal), dB	16.9	16.9	8.0	8.4
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7
	C/I from NP	**99.0**	**18.3**	**99.0**	**18.3**
	Total C/(N+I), dB	14.5	13.0	7.6	7.6
	Required C/(N+I), dB	7.6	7.6	7.6	7.6
	Margin, dB	6.9	5.4	0.0	0.0

	%	Outage min/yr
Availability w/o NP	99.9584	219
Availability with NP	99.9511	257
Increase in unavailability	17.6	38

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DIRECTV at 101; 6/7 code
Oxon Hill, MD

Transponder 32		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Test 22					
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70
Downlink					
Washington, D.C.	Satellite EIRP, dBW	55.8	55.8	55.8	55.8
	Downlink path loss, dB	-206.0	-206.0	-206.0	-206.0
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-4.82	-4.68
	Rain temp. increase, dB	0.0	0.0	-4.1	-4.0
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	13.0	13.0	13.0	13.0
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal), dB		16.9	16.9	8.0	8.2

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7
	Downlink C/N (thermal), dB	16.9	16.9	8.0	8.2
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7
	C/I from NP	**99.0**	**21.8**	**99.0**	**21.8**
	Total C/(N+I), dB	14.5	13.7	7.6	7.6
	Required C/(N+I), dB	7.6	7.6	7.6	7.6
	Margin, dB	6.9	6.1	0.0	0.0

	%	Outage min./yr
Availability w/o NP	99.9584	219
Availability with NP	99.9554	235
Increase in unavailability	7.2	16

ExpressVu at 91; 3/4 code
Oxon Hill, MD

Transponder 2		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Test 23					
Uplink C/N (thermal), dB		25.70	25.70	25.70	25.70
Downlink	Satellite EIRP, dBW	48.8	48.8	48.8	48.8
Washington, DC	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-1.11	-0.83
	Rain temp. increase, dB	0.0	0.0	-1.8	-1.5
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	12.6	12.6	12.6	12.6
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal) dB		9.6	9.6	6.7	7.3

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	25.7	25.7	25.7	25.7
	Downlink C/N (thermal), dB	9.6	9.6	6.7	7.3
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat. interf., dB	30.0	30.0	22.2	22.2
	C/I from NP	**99.0**	**15.4**	**99.0**	**15.4**
	Total C/(N+I), dB	9.3	8.3	6.4	6.4
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4
	Margin, dB	2.9	1.9	0.0	0.0

	%	Outage min/yr
Availability w/o NP	99.2139	4132
Availability with NP	98.6713	6984
Increase in unavailability	**69.0**	2852

ExpressVu at 91; 3/4 code
Oxon Hill, MD

Transponder 16		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Test 24					
Uplink C/N (thermal), dB		25.70	25.70	25.70	25.70
Downlink	Satellite EIRP, dBW	48.8	48.8	48.8	48.8
Washington, DC	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-1.11	-0.79
	Rain temp increase, dB	0.0	0.0	-1.8	-1.4
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	12.6	12.6	12.6	12.6
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal) dB		9.6	9.6	6.7	7.4

	%	Outage min./yr
Availability w/o NP	99.2139	4132
Availability with NP	98.5415	7666
Increase in unavailability	85.5	3534

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	25.7	25.7	25.7	25.7
	Downlink C/N (thermal), dB	9.6	9.6	6.7	7.4
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat interf., dB	30.0	30.0	22.2	22.2
	C/I from NP	**99.0**	**14.8**	**99.0**	**14.8**
	Total C/(N+I), dB	9.3	8.2	6.4	6.4
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4
	Margin, dB	2.9	1.8	0.0	0.0

ExpressVu at 91: 3/4 code
Oxon Hill, MD

Transponder 32		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Test 25					
Uplink C/N (thermal), dB		25.70	25.70	25.70	25.70
Downlink	Satellite EIRP, dBW	48.8	48.8	48.8	48.8
Washington, DC	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain fade, dB	0.0	0.0	-1.11	-1.05
	Rain temperature increase, dB	0.0	0.0	-1.8	-1.8
	Ground Rx Polarization loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	12.6	12.6	12.6	12.6
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal),dB		9.6	9.6	6.7	6.8

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	25.7	25.7	25.7	25.7
	Downlink C/N (thermal), dB	9.6	9.6	6.7	6.8
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat. interf., dB	30.0	30.0	22.2	22.2
	C/I from NP	**99.0**	**22.5**	**99.0**	**22.5**
	Total C/(N+I), dB	9.3	9.1	6.4	6.4
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4
	Margin, dB	2.9	2.7	0.0	0.0

	%	Outage min./yr
Availability w/o NP	99.2139	4132
Availability with NP	99.1393	4521
Increase in unavailability	9.4	390

Echo at 61.5; 3/4 code
Oxon Hill, MD

Transponder 2		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Test 30	FCC Demo				
Uplink C/N (thermal), dB		24.20	24.20	24.20	24.20
Downlink	Satellite EIRP, dBW	53.5	53.5	53.5	53.5
Washington DC	Downlink path loss, dB	205.9	-205.9	-205.9	-205.9
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-3.98	-3.02
	Rain temp increase, dB	0.0	0.0	-3.8	-3.3
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	12.7	12.7	12.7	12.7
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal),dB		14.4	14.4	6.6	8.0

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	24.2	24.2	24.2	24.2
	Downlink C/N (thermal), dB	14.4	14.4	6.6	8.0
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat. interf., dB	30.0	30.0	30.0	30.0
	C/I from NP	**99.0**	**12.2**	**99.0**	**12.2**
	Total C/(N+I), dB	13.3	9.7	6.4	6.4
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4
	Margin, dB	6.9	3.3	0.0	0.0

	%	Outage min./yr.
Availability w/o NP	99.9419	305
Availability with NP	99.8930	563
Increase in unavailability	84.2	257

Echo at 110; 3/4 code
Oxon Hill, MD

Transponder 16		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Test 31	FCC Demo				
Uplink C/N (thermal), dB		24.20	24.20	24.20	24.20
Downlink	Satellite EIRP, dBW	54.0	54.0	54.0	54.0
Washington, DC	Downlink path loss, dB	-206.1	-206.1	-206.1	-206.1
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-4.12	-3.55
	Rain temp increase, dB	0.0	0.0	-3.8	-3.6
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	12.7	12.7	12.7	12.7
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant, dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal), dB		14.7	14.7	6.7	7.5

	%	Outage min/yr
Availability w/o NP	99.9285	376
Availability with NP	99.9005	523
Increase in unavailability	39.1	147

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	24.2	24.2	24.2	24.2
	Downlink C/N (thermal), dB	14.7	14.7	6.7	7.5
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat interf, dB	22.2	22.2	22.2	22.2
	C/I from NP	**99.0**	**14.4**	**99.0**	**14.4**
	Total C/(N+I), dB	13.1	10.7	6.4	6.4
	Threshold C/(N+I), dB	6.4	6.4	6.4	6.4
	Margin, dB	6.7	4.3	0.0	0.0

DC_DOCS:315859.1 [W97]

DIRECTV at 101; 6/7 code
Oxon Hill, MD

Transponder 2		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Test 32	FCC Demo				
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70
Downlink					
Washington D.C.	Satellite EIRP, dBW	55.8	55.8	55.8	55.8
	Downlink path loss, dB	-206.0	-206.0	-206.0	-206.0
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-4.82	-4.32
	Rain temp increase, dB	0.0	0.0	-4.1	-3.9
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	13.0	13.0	13.0	13.0
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal),dB		16.9	16.9	8.0	8.7

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7
	Downlink C/N (thermal), dB	16.9	16.9	8.0	8.7
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7
	C/I from NP	**99.0**	**16.5**	**99.0**	**16.5**
	Total C/(N+I), dB	14.5	12.4	7.6	7.6
	Required C/(N+I), dB	7.6	7.6	7.6	7.6
	Margin, dB	6.9	4.8	0.0	0.0

	%	Outage min./yr
Availability w/o NP	99.9584	219
Availability with NP	99.9464	282
Increase in unavailability	28.9	63

DC_DOCS:315859.1 [W97]

DIRECTV at 101; 6/7 code
Oxon Hill, MD

Transponder 2		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Test 33	Mast Extension				
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70
Downlink					
Washington, D.C.	Satellite EIRP, dBW	55.8	55.8	55.8	55.8
	Downlink path loss, dB	-206.0	-206.0	-206.0	-206.0
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-4.82	-4.02
	Rain temp increase, dB	0.0	0.0	-4.1	-3.8
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	13.0	13.0	13.0	13.0
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal),dB		16.9	16.9	8.0	9.1

	%	Outage min./yr
Availability w/o NP	99.9584	219
Availability with NP	99.9368	332
Increase in unavailability	**51.8**	113

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7
	Downlink C/N (thermal), dB	16.9	16.9	8.0	9.1
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7
	C/I from NP	**99.0**	**14.6**	**99.0**	**14.6**
	Total C/(N+I), dB	14.5	11.5	7.6	7.6
	Required C/(N+I), dB	7.6	7.6	7.6	7.6
	Margin, dB	6.9	3.9	0.0	0.0

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DIRECTV at 101; 6/7 code
Oxon Hill, MD

Transponder 16		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Test 34	Mast Extension				
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70
Downlink:					
Washington, D.C.	Satellite EIRP, dBW	55.8	55.8	55.8	55.8
	Downlink path loss, dB	-206.0	-206.0	-206.0	-206.0
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-4.82	-4.30
	Rain temp increase, dB	0.0	0.0	-4.1	-3.9
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	13.0	13.0	13.0	13.0
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal),dB		16.9	16.9	8.0	8.7

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7
	Downlink C/N (thermal), dB	16.9	16.9	8.0	8.7
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7
	C/I from NP	**99.0**	**16.3**	**99.0**	**16.3**
	Total C/(N+I), dB	14.5	12.3	7.6	7.6
	Required C/(N+I), dB	7.6	7.6	7.6	7.6
	Margin, dB	6.9	4.7	0.0	0.0

	%	Outage min./yr.
Availability w/o NP	99.9584	219
Availability with NP	99.9457	286
Increase in unavailability	30.6	67

DIRECTV at 101; 6/7 code
Oxon Hill, MD

Transponder 32		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Test 35	Mast Extension				
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70
Downlink:					
Washington, DC	Satellite EIRP, dBW	55.8	55.8	55.8	55.8
	Downlink path loss, dB	-206.0	-206.0	-206.0	-206.0
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-4.82	-4.45
	Rain temp increase, dB	0.0	0.0	-4.1	-4.0
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	13.0	13.0	13.0	13.0
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal),dB		16.9	16.9	8.0	8.5

	%	Outage min./yr.
Availability w/o NP	99.9584	219
Availability with NP	99.9499	263
Increase in unavailability	20.4	45

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7
	Downlink C/N (thermal), dB	16.9	16.9	8.0	8.5
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7
	C/I from NP	**99.0**	**17.9**	**99.0**	**17.9**
	Total C/(N+I), dB	14.5	12.8	7.6	7.6
	Required C/(N+I), dB	7.6	7.6	7.6	7.6
	Total Eb/(N+I)o, dB	13.5	11.8	6.6	6.6
	Required Eb/(N+I)o, dB	6.6	6.6	6.6	6.6

DIRECTV at 101; 6/7 code
Los Angeles

		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70
Downlink:					
Los Angeles	Satellite EIRP, dBW	52.9	52.9	52.9	52.9
	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-2.84	-1.96
	Rain temp increase, dB	0.0	0.0	-3.3	-2.7
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	13.0	13.0	13.0	13.0
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal),dB		14.1	14.1	8.0	9.5

		%	Outage min./yr.
Availability w/o,NP		99.9764	124
Availability with NP		99.9432	298
Increase in unavailability		140.8	174

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7
	Downlink C/N (thermal), dB	14.1	14.1	8.0	9.5
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7
	C/I from NP	**99.0**	**13.4**	**99.0**	**13.4**
	Total C/(N+I), dB	12.7	10.0	7.6	7.6
	Required C/(N+I), dB	7.6	7.6	7.6	7.6
	Margin, dB	5.1	2.4	0.0	0.0

DIRECTV at 101; 6/7 code
Seattle

		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70
Downlink					
Seattle	Satellite EIRP, dBW	52.2	52.2	52.2	52.2
	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-2.41	-1.43
	Rain temp increase, dB	0.0	0.0	-3.0	-2.2
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	13.0	13.0	13.0	13.0
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal) dB		13.4	13.4	8.0	9.8

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7
	Downlink C/N (thermal), dB	13.4	13.4	8.0	9.8
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7
	C/I from NP	**99.0**	**12.7**	**99.0**	**12.7**
	Total C/(N+I), dB	12.1	9.4	7.6	7.6
	Required C/(N+I), dB	7.6	7.6	7.6	7.6
	Margin, dB	4.5	1.8	0.0	0.0

	%	Outage min/yr
Availability w/o NP	99.9758	127
Availability with NP	99.9178	432
Increase in unavailability	**239.2**	305

DIRECTV at 101; 6/7 code
Chicago

		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70
Downlink					
Chicago	Satellite EIRP, dBW	54.0	54.0	54.0	54.0
	Downlink path loss, dB	-206.0	-206.0	-206.0	-206.0
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-3.51	-2.78
	Rain temp increase, dB	0.0	0.0	-3.6	-3.2
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	13.0	13.0	13.0	13.0
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal),dB		15.1	15.1	8.0	9.1

		%	Outage min /yr
Availability w/o NP		99.9320	358
Availability with NP		99.8867	596
Increase in unavailability,		66.5	238

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7
	Downlink C/N (thermal), dB	15.1	15.1	8.0	9.1
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat interf, dB	20.7	20.7	20.7	20.7
	C/I from NP	**99.0**	**14.5**	**99.0**	**14.5**
	Total C/(N+I), dB	13.3	10.9	7.6	7.6
	Required C/(N+I), dB	7.6	7.6	7.6	7.6
	Margin, dB	5.7	3.3	0.0	0.0

DIRECTV at 101; 6/7 code
Denver

		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
Uplink C/N (thermal), dB		27.70	27.70	27.70	27.70
Downlink:					
Denver	Satellite EIRP, dBW	53.2	53.2	53.2	53.2
	Downlink path loss, dB	-205.9	-205.9	-205.9	-205.9
	Atmospheric loss, dB	-0.2	-0.2	-0.2	-0.2
	Downlink rain loss, dB	0.0	0.0	-3.04	-2.20
	Rain temp increase, dB	0.0	0.0	-3.4	-2.8
	Ground Rx Pointing loss, dB	-0.5	-0.5	-0.5	-0.5
	Ground G/T, dB/K	13.0	13.0	13.0	13.0
	Bandwidth, dB-Hz	-73.8	-73.8	-73.8	-73.8
	Boltzmann's constant,dBW	228.6	228.6	228.6	228.6
Downlink C/N (thermal),dB		14.4	14.4	8.0	9.4

		%	Outage min./yr.
Availability w/o NP		99.9954	24
Availability with NP		99.9887	59
Increase in unavailability		**144.4**	35

Total		Clear Sky	Clear Sky w/NP	Rain Dn	Rain Dn w/NP
	Uplink C/N (thermal), dB	27.7	27.7	27.7	27.7
	Downlink C/N (thermal), dB	14.4	14.4	8.0	9.4
	Crosspol interference, dB	22.9	22.9	22.9	22.9
	Adjacent sat. interf., dB	20.7	20.7	20.7	20.7
	C/I from NP	**99.0**	**13.7**	**99.0**	**13.7**
	Total C/(N+I), dB	12.9	10.3	7.6	7.6
	Required C/(N+I), dB	7.6	7.6	7.6	7.6
	Margin, dB	5.3	2.7	0.0	0.0

COMSEARCH

ATTACHMENT A

Comsearch's Role in STA Testing and FCC Demonstration

Comsearch was an active participant in the STA Testing performed by DIRECTV and ECHOSTAR personnel. Comsearch's role was to observe and critique the in-progress testing and provide an independent assessment of the validity of the procedures used. The technical assessment also applied to the assembly and presentation of the data in this report and the conclusions drawn from the measured data. To do this the same personnel who actively observed the testing reviewed this report. Two of Comsearch's most experienced field measurement engineers were assigned to this project and were present during the entire period of testing.

Comsearch personnel monitored all of the interference testing to insure that the tests were 1) repeatable, 2) properly calibrated, 3) the interference transmitter was set for the correct EIRP and aligned properly, and 4) that the test met the prescribed and acceptable test procedure. During the testing Comsearch personnel determined or verified the following data:

1. The exact coordinates of the transmitter and the various receiver sites.
2. The line-of-sight condition of the satellite for the test.
3. The relative azimuth to the interference transmitter from the test site.
4. The interference measurement-- from initial transmitter-Off, to transmitter-On at nominal power, and for each transmitter incremental dB step increase up to loss of video.
5. The accurate determination of interference transmitter power output.

Based on the first hand knowledge of the interference testing by Comsearch's field engineers, it is our opinion that the tests were conducted in a highly professional, fair and proper manner. The data collected is a true representation of the interference conditions that were created to the reception of the satellite signals by the interfering transmitter. The report describes the testing accurately. The degradation of the satellite program availability by the interfering signal as a percentage increase in lost availability is a fair way to describe the impact of the operation of an interfering source. The conclusions presented in this report that the satellite operations will be harmed by loss of designed availability in their operation by the interference generated by the proposed terrestrial system are correct and are fully supported by the measurement results.

Lester E. Polisky
Director of Field Services
Comsearch