1994 Amendment

Iridium

Table R-A-6 (Rev 1)

SV-Gateway Links

Item		Downlink Rain	Downlink Clear	Uplink Rain	Uplink Clear
Range	km	2326.0	2326.0	2326.0	2326.0
Transmitter					
Power	dBW	0.0	-9.7	13.0	-11.8
Antenna Gain	dB	26.9	26.9	56.3	56.3
Circuit Loss	dB	-3.2	-3.2	-1.0	-1.0
Pointing Loss	dB	-0.5	-0.5	-0.3	-0.3
EIRP	dBWi	23.2	13.5	68.0	43.2
System					
Margin	dB	3.2	3.2	2.1	2.1
Space Loss	dB	-185.8	-185.8	-189.1	[illegible].1
Propagation Loss	dB	-14.2	-1.5	-30.0	-1.5
Polarization Loss	dB	-0.2	-0.2	-0.2	[illegible]
Total Prop. Loss	dB	-203.4	-190.7	-221.4	-192.9
Receiver					
Rec. Sig. Strength	dBWi	-180.2	-177.2	-153.4	-149.7
Pointing Loss	dB	-0.2	-0.2	-0.8	-0.8
Antenna Gain	dB	53.2	53.2	30.1	30.1
Received Signal	dBW	-127.2	-124.2	-124.1	-120.4
Ts	K	731.4	731.4	1295.4	1295.4
Noise Density	dBW/Hz	-200.0	-200.0	-197.5	-197.5
Noise Bandwidth	dBHz	64.9	64.9	64.9	64.9
Noise	dBW	-135.1	-135.1	-132.6	-132.6
Link Eb/No	dB	7.9	10.9	8.5	12.2
Eb/No	dB	25.0	25.0	16.0	16.0
Computed Eb/(No + [illegible]	dB	7.8	10.7	7.8	10.7
Required Eb/(No + [illegible]	dB	7.7	7.7	7.7	7.7
Excess Margin	dB	0.1	3.0	0.1	3.0
SPFD @ GW	dBW/ m^2/ 1mhz	-134.3	-131.3		

Texas Instruments Incorporated

TEXAS INSTRUMENTS

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31 October 1995

Mr. John Knudsen
Motorola Satellite Communications
2501 South Price Road
Chandler, Arizona 85248-2899

Dear John:

Attached are updates to the material that was sent to you last night. Included is an expanded version of the rules 101 c. which also includes EIRP as a way to describe the antenna mask.

Also included are a few corrections where minimum range in the tables should have been titled maximum range and on one 20dB/MHz has been corrected to read 20dBW/MHz.

Please call if you have any questions.

Regards,

Gene Robinson

Gene Robinson
Senior Fellow, Texas Instruments

RULES FOR
LMDS SUBSCRIBER TRANSCEIVERS
IN THE
29.1-29.25 GHZ BAND

§101. Limitations on LMDS subscriber transceivers in the 29.1-29.25 GHz band:

a) shall not transmit an effective isotropically radiated power in excess of 20 dBW/MHz in clear air and shall reduce EIRP, as a minimum, for distances of less than the maximum distance from the hub in accordance with the following formula,

$$P(EIRP, dBW/MHz) = 20\ dBW/MHz + 20 \log d/D$$

where d = transceiver distance to the hub
D = maximum transceiver distance to the hub

b) shall not transmit an effective isotropically radiated power in excess of 14 dBW/MHz in clear air if power control in accordance with the formula in (a) is not used,

c) shall have an antenna pattern that shall meet the requirements of that shown in the antenna mask figure with the following characteristics:

and/ or as follows,

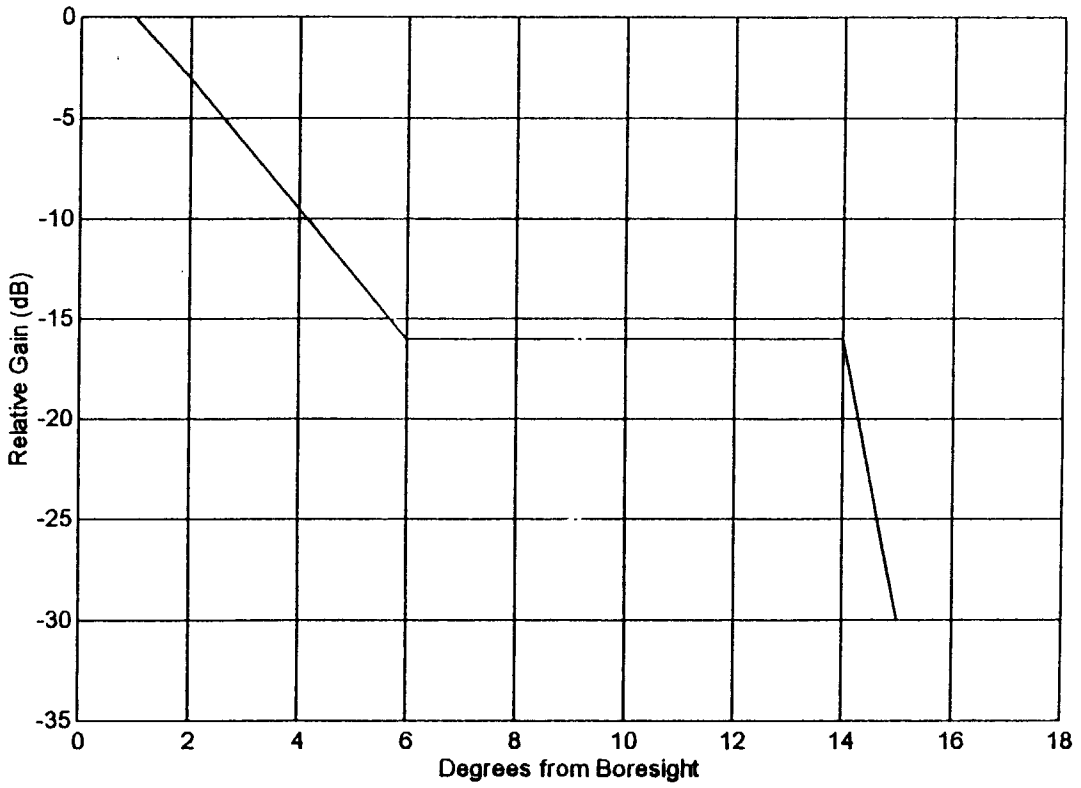
equivalent isotropically radiated power on antenna boresight as limited in (a) or (b) shall be reduced for angles of boresight in accordance with the following characteristics:

RULES FOR
LMDS SUBSCRIBER TRANSCEIVERS
IN THE
29.1-29.25 GHZ BAND

Degrees from Boresight	Relative Gain/EIRP in dB Azimuth	Elevation
0	0.00	0.00
1	0.00	0.00
2	-3.00	-3.00
3	-6.25	-6.25
4	-9.50	-9.50
5	-12.75	-12.75
6	-16.00	-16.00
14	-16.00	-16.00
15 ≤ 90	-30.00	-30.00

LMDS SUBSCRIBER TRANSCEIVERS
29.1-29.25 GHZ BAND

ANTENNA EIRP/MASK



LMDS TRANSCEIVER
SYSTEMS PARAMETER/OPERATION
SUMMARY

PARAMETER	TI	HP	EG*	CV
Transmit Power (dBW)	-17.0	-19.6	-13.0	-23.0
RF Bandwidth (MHz)	2.5	1.0	24.0	1.0
Antenna Gain	34.0	35.0	39.0	31.0
EIRP (dBW/Hz)	-47.0	-44.6	-47.8	-52.0
EIRP (dBW/MHz)	13.0	15.4	12.2	8.0
Maximum Range (Km)	5.0	2.0	2.2	5.0
Tower Height (Meters)	30.0	15.0	20.0	30.0
Hub Spacing in HPBW (Km)	17.0	17.0	17.0	17.0
out of HPBW (Km)	68.0	68.0	68.0	68.0
Max El angle, 50% blk (deg)	5.0	5.0	5.0	5.0
Aggregate C/I (dB)	35.4	41.9	27.6	36.7
Satellite System Margin	14.5	20.0	6.7	15.8

* Includes 10 dB for rain

ANTENNA ORIENTATION

THE STATISTICAL PROGRAM WAS MODIFIED TO ALLOW EVERY Nth TRANSPONDER ANTENNA TO HAVE A RANDOM ELEVATION ANGLE FROM 0 TO 90 DEGREES.

- THE STATISTICAL PROGRAM WAS RUN WITH N = 5, 10 AND 100 WITH THE RULES PARAMETERS WITH 20 DBW/MHZ POWER RESULTED IN THE FOLLOWING SATELLITE C/Is RESULTING.

N	% DISTRIBUTION	C/I
5	20	21.6
10	10	21.8
100	1	23.2

- RESULTS SHOW THAT ACCEPTABLE C/I RATIOS ARE OBTAINED WITH 20 PERCENT OF THE POPULATION HAVING MISALIGNED ANTENNAS.
- CONCLUSIONS ARE THAT INTERLOCKS ARE NOT REQUIRED TO PREVENT UNACCEPTABLE SATELLITE C/I RATIOS.

LMDS TRANSCEIVER
SYSTEMS PARAMETER/OPERATION
WITH RULES PARAMETERS

PARAMETER	TI	HP	EG**	CV
Transmit Power (dBW)	-10.0	-15.0	-5.2	-11.0
RF Bandwidth (MHz)	2.5	1.0	24.0	1.0
Antenna Gain	34.0	35.0	39.0	31.0
EIRP (dBW/Hz)	-40.0	-40.0	-40.0	-40.0
EIRP (dBW/MHz)	20.0	20.0	20.0	20.0
Maximum Range (Km)	5.0	2.0	2.2	5.0
Tower Height (Meters)	30.0	15.0	20.0	30.0
Hub Spacing in HPBW (Km)	17.0	17.0	17.0	17.0
out of HPBW (Km)	68.0	68.0	68.0	68.0
Max El angle, 50% blk (deg)	5.0	5.0	5.0	5.0
Aggregate C/I (dB)	23.3	23.9	22.7	21.8
Satellite System Margin*(dB)	2.4	3.0	1.8	0.9

* Satellite System Margin in excess of 20.9 dB required.

** Includes 10 dB for rain

MAXIMUM EIRP
AND
POWER CONTROL

- THE STATISTICAL ANALYSIS PROGRAM WAS CONDUCTED WITH THE RULES PARAMETERS WHICH INCLUDED A 20 dBW/MHz MAXIMUM EIRP AND POWER CONTROL ACCORDING TO THE FOLLOWING FORMULA

  $$P(dBW/MHZ) = 20 + 20 \text{ LOG } d/D$$

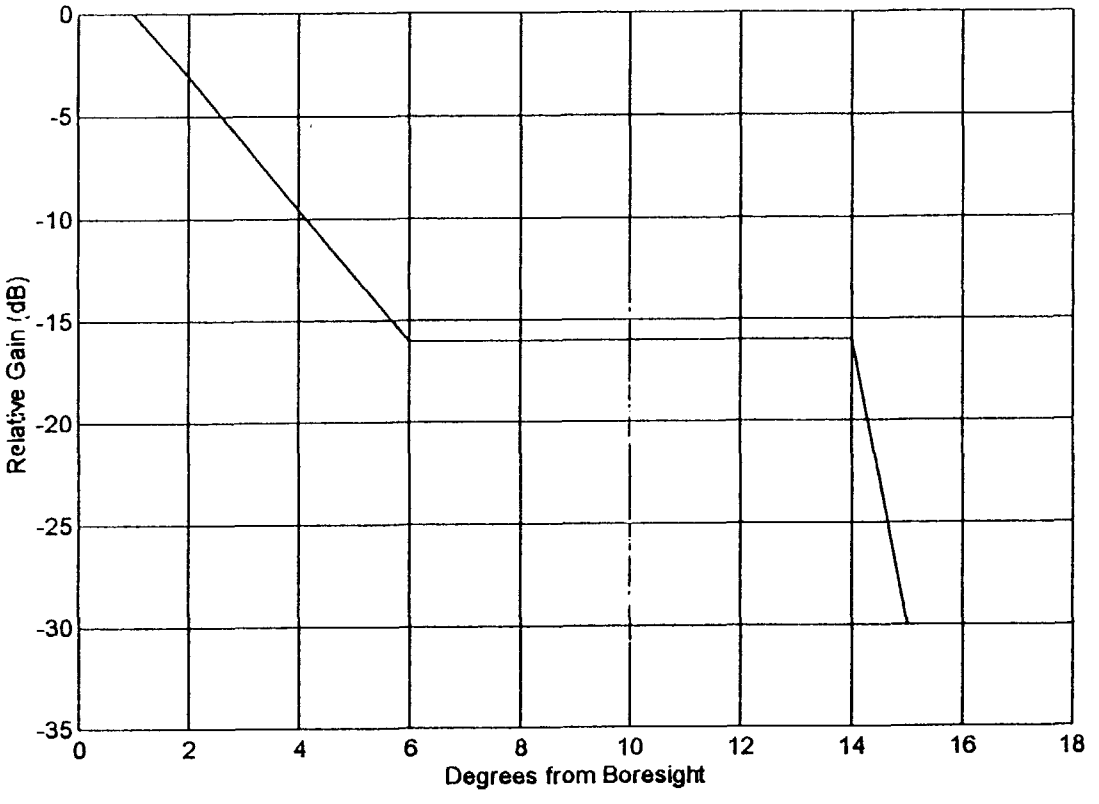
  WHERE d = DISTANCE TO THE HUB
  D = MAXIMUM DISTANCE TO THE HUB

- C/I RATIOS OF 21.8 TO 23.3 dB WERE OBTAINED WITH A 20 dBW/MHz EIRP AND POWER CONTROL.

- STATISTICAL ANALYSIS WAS CONDUCTED FOR EIRP LEVELS OF 20 dBW/MHz, 17 dBW/MHz, AND 14 dBW/MHz.
  - -ACCEPTABLE C/I RATIOS OF 20.4, 22.9 AND 25.8 DB WERE OBTAINED FOR THESE EIRP LEVELS.

- IF POWER CONTROL IS NOT IMPLEMENTED THEN LIMIT THE MAXIMUM TRANSPONDER EIRP TO 14 dBW/MHZ.

TRANSCEIVER DENSITY LIMITATIONS

- THE MOST DENSE AREA OF THE U.S. (NEW HAMPSHIRE TO GEORGIA) WAS USED TO ENCOMPASS THE SATELLITE FOOTPRINT
  - -RESULTING IN 25 MILLION HOUSEHOLDS.
- WITH 80 PERCENT OF THE LOCATIONS SUITABLE FOR LMDS, (LINE OF SIGHT), A TOTAL OF 20 MILLION HOUSEHOLDS ARE SUITABLE FOR LMDS SERVICE.
- MAXIMUM RETURN LINK UTILIZATION FOR DENSITY PURPOSES IS MODELED WITH TELEPHONE CIRCUITS THAT HAVE A MAXIMUM TAKE RATE OF 25 PERCENT AND 4:1 MINIMUM CONCENTRATION,
  - -RESULTING IN 1.25 MILLION ACTIVE DSO CIRCUITS.
- FOR 1.25 MILLION CIRCUITS IN 150 MHZ BANDWIDTH, THE NUMBER OF CIRCUITS PER MHZ IS 8,333.
- USING 64 KBPS AND A CIRCUIT EFFICIENCY OF 0.6, WHICH INCLUDES SIGNALING AND CONTROL,
  - -RESULTS IN 890 TRANSMITTERS PER MHZ.
- INDIVIDUAL SYSTEM ANALYSIS YIELDED ACCEPTABLE C/I RATIOS WITH 14.5 TO 20 DB MARGINS.
- TRANSCEIVER DENSITY LIMITATIONS RULES ARE NOT REQUIRED SINCE SUITABLE C/I RATIO MARGINS ARE ACHIEVED USING THE MOST DENSE AREA OF THE U.S. TO ENCOMPASS THE SATELLITE FOOTPRINT.

ANTENNA BEAMWIDTH/SIDELOBES