



Test Report

Report No	EF0429-1 Issue 2
Client	Loea Corporation 164 West Street West Hatfield, MA 01088
Phone	1-413-247-9440
FRN	0013420088
Emission Designator	K1D4G23
Model	L-2500
FCC ID	S2N-L2500-2
Equipment Type	Licensed Non-Broadcast Station Transmitter
Equipment Code	TNB
Results	As detailed within this report
Prepared by	 Evan Gould – Test Engineer
Authorized by	 Michael Buchholz – EMC Manager
Issue Date	8/1/05
Conditions of issue	This Test Report is issued subject to the conditions stated in 'terms and conditions' section of this report.

Curtis-Straus LLC is accredited by the American Association for Laboratory Accreditation for the specific scope of accreditation under Certificate Number 1627-01. This report may contain data which is not covered by the A2LA accreditation.

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Summary

This test report supports an application for a licensed transmitter operating pursuant to 47 CFR 101. The product is the Loea Corporation L-2500 Millimeter Wave Radio. It is a transmitter that operates at either 73.5GHz or 83.5GHz depending on whether it is the Lo or Hi version.

Test Methodology

Radiated emissions testing is performed according to the procedures specified in TIA-603. Since the device is always installed in one orientation, emissions were maximized by rotating the device around it's vertical axis as well as varying the test antenna's height and polarity.

Frequency range investigated: 150kHz – 200GHz

Measurement distance:	150kHz – 30MHz	Conducted
	30 – 1000MHz	3m
	1 – 18GHz	3m or 1m
	18 – 26.5GHz	1m
	26.5 – 200GHz	0.1m

EUT Configuration**EUT Configuration****Work Order:** F0429**Company:** Loea Corporation**Company Address:** 164 West Street
West Hatfield, MA 01088**Contact:** John Hutchings**Person Present:** John Hutchings

	MN	SN		
	EUT: L-2500 L-2500	000117M (83.5GHz radio) 000117F (73.5GHz radio)		
CyberPower UPS/Surge Protector	CPS625AVR	B1A3T1B06372		
EUT Description: Millimeter Wave Radio				
EUT Max Frequency: 83.5GHz				
Support Equipment:	MN	SN		
<u>OC12 Generator</u> Surise Telecom	SunSet OCx	SSOCX12C0346122385		
<u>Gigabit Ethernet Generator</u> Tektronix	GTS1250	B010207		
EUT Cables:	Qty	Shielded?	Length	Ferrites
AC Power	1	No	6ft	No
Fiber pair	1	N/A	N/A	N/A
Unpopulated EUT Ports:	Qty	Reason		
DB9 Serial	1	Setup/Diag		
BNC AGC	1	Setup/Diag		
Ethernet	1	Not Used		
Software / Operating Mode Description:				
EUT was operating in TX and RX modes simultaneously. Both OC12 and Gig-E modulations were tested using pseudorandom data sequences. CW mode was used when needed as well. EUT has only one power level setting available.				

Fundamental Measurement**LIMIT**

55dBW (EIRP) [47 CFR 101.113]

MEASUREMENTS

Output Power (Conducted)					Curtis-Straus LLC												
Date: 3-Jun-05	Engineer: Evan Gould			Work Order: F0429													
Company: Loea Corp	EUT: L-2500			Fundamental Frequency: 73.5 or 83.5GHz													
Test Site: A	Cable: N/A			Power Meter: HP 437B													
Attenuator: N/A Sensor Head: HP W8486A																	
Notes: CW mode																	
Radio		Frequency (GHz)		Reading (dBm)		47 CFR 101.113											
				Antenna Gain (dBi)		Adjusted Reading (dBW)											
73.5GHz		73.500		12.7		55.0											
83.5GHz		83.500		11.7		55.0											
				EIRP Limit (dBW)		Margin (dB)											
				33.3		-21.7											
				32.6		-22.4											
						Result (Pass/Fail)											
						Pass											
						Pass											

Spectral Density

LIMITS

150mW/100MHz [47 CFR 101.113]

MEASUREMENTS

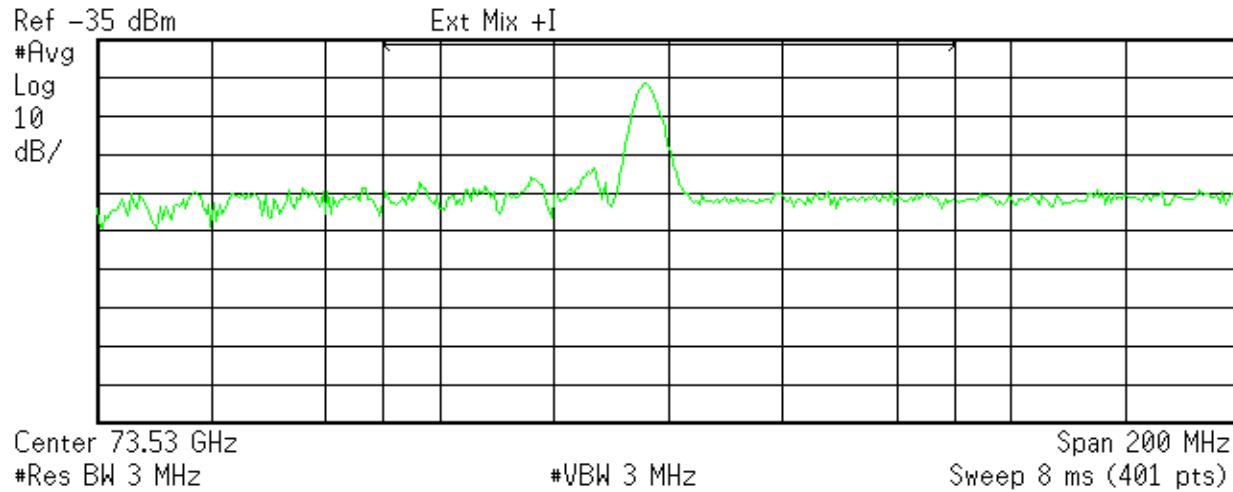
Power Spectral Density (Conducted)						Curtis-Straus LLC		
Date: 7-Jun-05		Engineer: Evan Gould				Work Order: F0429		
Company: Loea Corp		EUT: L-2500				Fundamental Frequency: 73.5 or 83.5GHz		
Test Site: A			Cable: Semflex			Analyzer: Orange		
Attenuator: QAF-E10000			Mixer: OML WR12 60-90GHz Mixer					
Measurement Type: Peak			Resolution BW: 3MHz					
			Video BW: 3MHz					
Notes:								
Radio / Modulation	Frequency (GHz)	Reading (dBm/100MHz)	Attenuator Factor (dB)	Conversion Loss (dB)	Adjusted Reading (dBm/100MHz)	47 CFR 101.113		
						150mW Limit (dBm/100MHz)	Margin (dB)	Result (Pass/Fail)
73.5GHz / Gig-E	73.5	-46.7	10.0	42.2	5.5	21.7	-16.2	Pass
73.5GHz / OC12	73.5	-47.2	10.0	42.2	5.0	21.7	-16.7	Pass
83.5GHz / Gig-E	83.5	-56.7	10.0	42.2	-4.5	21.7	-26.2	Pass
83.5GHz / OC12	83.5	-54.2	10.0	42.2	-2.0	21.7	-23.7	Pass

ANALYZER PLOT

73.5GHz Radio; Gig-E Modulation

* Agilent 14:16:13 Jun 7, 2005

R L



Channel Power

-46.74 dBm /100.0000 MHz

Power Spectral Density

-126.74 dBm/Hz



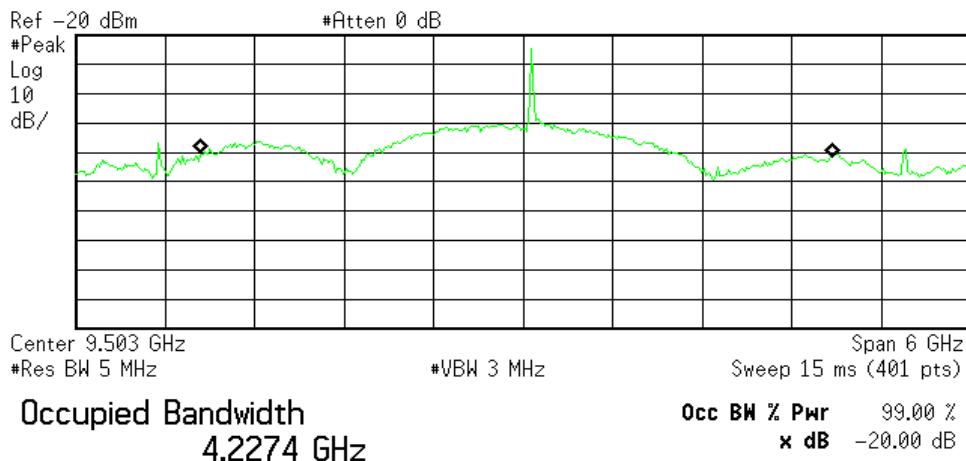
Occupied Bandwidth**LIMIT**

5000MHz [47 CFR 101.109]

ANALYZER PLOTS**73.5GHz Radio; Gig-E Modulation**

Agilent 12:25:32 Jun 7, 2005

R L



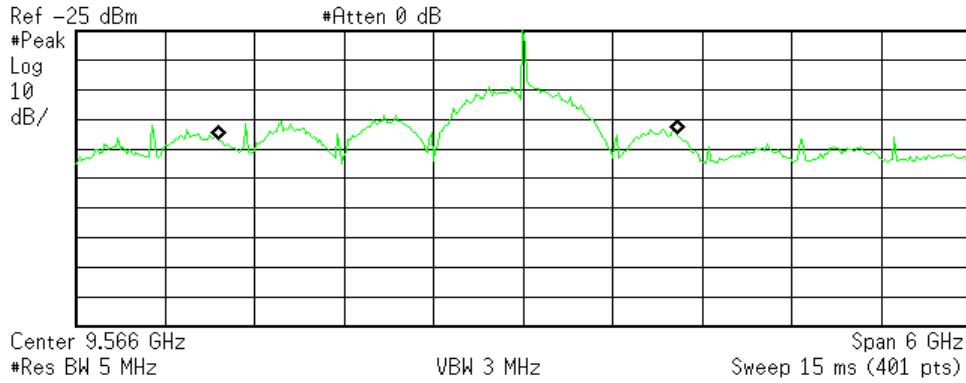
Transmit Freq Error -39.567 MHz
x dB Bandwidth 40.140 MHz

[Redacted]

73.5GHz Radio; OC-12 Modulation

Agilent 12:41:07 Jun 7, 2005

R L



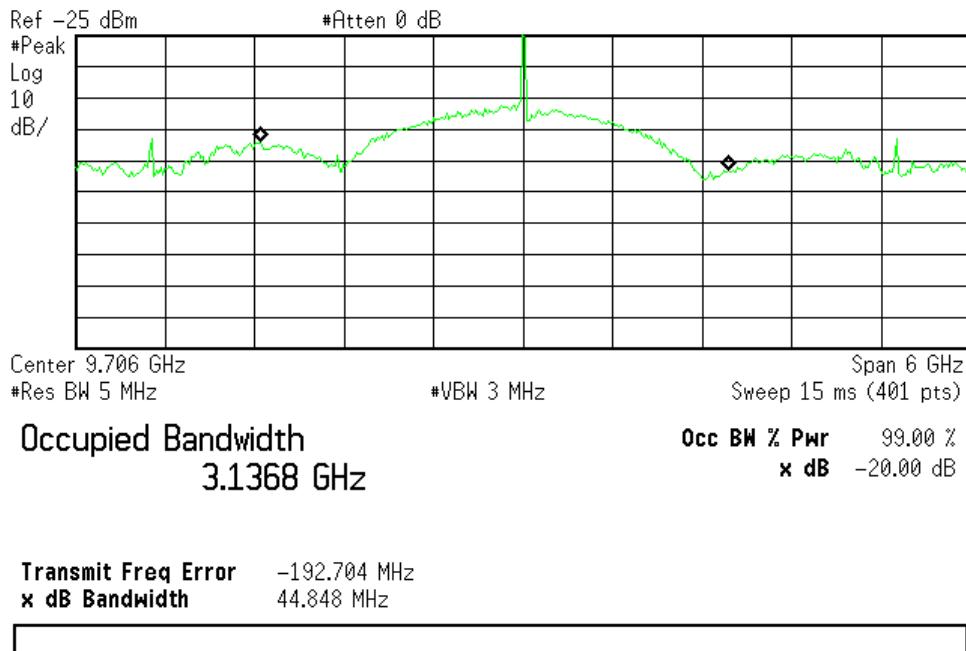
Transmit Freq Error -506.865 MHz
x dB Bandwidth 300.536 MHz

[Redacted]

83.5GHz Radio; Gig-E Modulation

Agilent 13:06:25 Jun 7, 2005

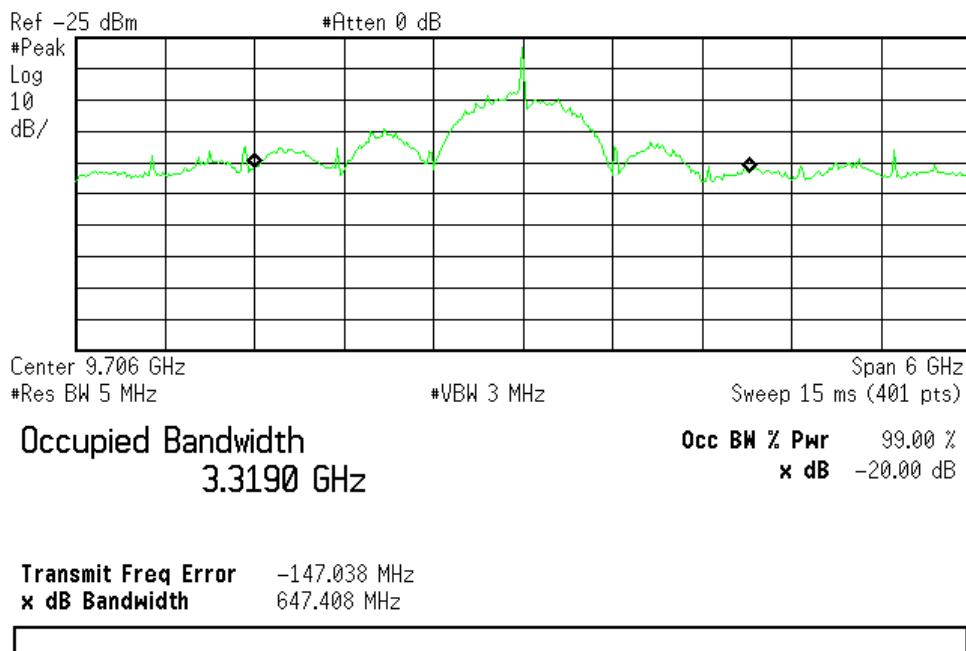
R L



83.5GHz Radio; OC-12 Modulation

 Agilent 13:12:31 Jun 7, 2005

RL



Note: The method used to accurately reflect the shape of the emissions was to use a block down-converter which is why the frequency range shown in the plots is around 10GHz.

Emission Mask

Emissions Mask (Conducted)			Curtis-Straus LLC	
Date: 7-Jun-05	Engineer: Evan Gould		Work Order: F0429	
Company: Loea Corp	EUT: L-2500		Fundamental Frequency: 73.5 or 83.5GHz	
Test Site: A	Cable: Semflex		Analyzer: Orange	
Mixer: OML WR08 90-140GHz	Mixer: OML WR12 60-90GHz		Diplexer: DPL.26	
Measurement Type: Peak		Resolution BW: 1MHz		
		Video BW: 3MHz		
Notes: Frequency Ranges are the 50% - 250% of the authorized bandwidth removed from the center frequency as specified in 47 CFR 101.111(a)(2)(ii). The authorized bandwidth used for the calculation is 5000MHz.				
Radio	Frequency Range (MHz)	Measurement (dBm)	Worst Case Limit (dBm)	
73.5GHz	60995	70995	No emissions found of amplitude greater than -13dBm	-13
73.5GHz	75995	85995	No emissions found of amplitude greater than -13dBm	-13
83.5GHz	70940	80940	No emissions found of amplitude greater than -13dBm	-13
83.5GHz	85940	95940	No emissions found of amplitude greater than -13dBm	-13

Radiated Spurious Emissions

LIMIT

Must be attenuated by $43 + 10 \log$ (output power in Watts)dB below the output power:
 62.6 dBm (output power) = $157.8 \mu\text{V/m}$ @ 3m (output power)

Attenuation required: $43 + 32.6 \text{ dBW} = 75.6 \text{ dB}$

Limit: $157.8 \mu\text{V/m} - 75.6 \text{ dB} = 82.2 \mu\text{V/m}$ [47 CFR 101.111]

The limits used in the following are the 15.209 limits which are worst case.

MEASUREMENTS

Radiated Emissions Table							Curtis-Straus LLC									
Date: 07-Jun-05			Company: Loea Corp			Work Order: F0429										
Engineer: Evan Gould					EUT Desc: L-2500											
Frequency Range: 30-1000MHz					Measurement Distance: 3 m											
Notes: 83.5GHz; OC-12					EUT Max Freq: 83.5GHz											
Antenna Polarization (H / V)	Frequency (MHz)	Reading (dB μ V)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Adjusted Reading (dB μ V/m)	FCC Class B									
V	105.0	35.0	24.7	11.7	2.4	24.4	43.5	-19.1	Pass							
V	120.6	34.4	24.6	12.9	2.7	25.4	43.5	-18.1	Pass							
V	169.5	31.4	24.5	10.4	3.2	20.5	43.5	-23.0	Pass							
V	335.5	39.2	24.0	14.8	4.7	34.7	46.0	-11.3	Pass							
H	460.8	39.1	23.9	17.3	5.7	38.2	46.0	-7.8	Pass							
H	468.2	37.6	23.9	17.4	5.7	36.8	46.0	-9.2	Pass							
Table Result: Pass by -7.8 dB							Worst Freq: 460.8 MHz									
Test Site: "A"		Pre-Amp: Orange		Cable: 100 ft.		Analyzer: White		Antenna: Green								

Radiated Emissions Table							Curtis-Straus LLC									
Date: 06-Jun-05			Company: Loea Corp			Work Order: F0429										
Engineer: Evan Gould					EUT Desc: L-2500											
Frequency Range: 1-18GHz					Measurement Distance: 3 m											
Notes: 73.5GHz; Gig E RBW=1MHz; VBW=3MHz					EUT Max Freq: 73.5GHz											
Antenna Polarization (H / V)	Frequency (MHz)	Reading (dB μ V)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Adjusted Reading (dB μ V/m)	FCC Class B									
Vav	1644.0	29.3	18.7	29.5	1.6	41.7	54.0	-12.3	Pass							
Hav	1250.0	36.5	17.8	28.3	1.4	48.4	54.0	-5.6	Pass							
Table Result: Pass by -5.6 dB							Worst Freq: 1250.0 MHz									
Test Site: "A"		Pre-Amp: Yel-Blk		Cable: 6 RG142LL		Analyzer: Orange		Antenna: Yellow Horn								

Radiated Emissions Table							Curtis-Straus LLC									
Date: 06-Jun-05			Company: Loea Corp			Work Order: F0429										
Engineer: Evan Gould					EUT Desc: L-2500											
Frequency Range: 18-26.5GHz					Measurement Distance: 1 m											
Notes: 73.5GHz radio; Gig-E modulation RBW=1MHz; VBW=3MHz					EUT Max Freq: 73.5GHz		Antenna: 18-26.5GHz Horn									
Antenna Polarization (H / V)	Frequency (MHz)	Reading (dB μ V)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Adjusted Reading (dB μ V/m)	FCC Class B									
							Limit (dB μ V/m)	Margin (dB)	Result (Pass/Fail)							
Hav	20492.0	28.0	21.0	40.2	4.2	51.4	63.5	-12.1	Pass							
Table Result: Pass by -12.1 dB				Worst Freq: 20492.0 MHz												
Test Site: "A"		Pre-Amp: 18-26.5GHz		Cable: 7 Microflex		Analyzer: Orange										

Radiated Emissions Table							Curtis-Straus LLC									
Date: 06-Jun-05			Company: Loea Corp			Work Order: F0429										
Engineer: Evan Gould					EUT Desc: L-2500											
Frequency Range: 1-18GHz					Measurement Distance: 3 m											
Notes: 83.5GHz; OC12 RBW=1MHz; VBW=3MHz					EUT Max Freq: 83.5GHz											
Antenna Polarization (H / V)	Frequency (MHz)	Reading (dB μ V)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Adjusted Reading (dB μ V/m)	FCC Class B									
							Limit (dB μ V/m)	Margin (dB)	Result (Pass/Fail)							
V	1244.0	30.0	17.8	28.3	1.4	41.9	54.0	-12.1	Pass							
Table Result: Pass by -12.1 dB				Worst Freq: 1244.0 MHz												
Test Site: "A"		Pre-Amp: Yel-Blk		Cable: 6 RG142LL		Analyzer: Orange		Antenna: Yellow Horn								

Radiated Emissions Table							Curtis-Straus LLC									
Date: 06-Jun-05			Company: Loea Corp			Work Order: F0429										
Engineer: Evan Gould					EUT Desc: L-2500											
Frequency Range: 1-18GHz					Measurement Distance: 1 m											
Notes: 83.5GHz; OC12 RBW=1MHz; VBW=3MHz					EUT Max Freq: 83.5GHz											
Antenna Polarization (H / V)	Frequency (MHz)	Reading (dB μ V)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Adjusted Reading (dB μ V/m)	FCC Class B									
							Limit (dB μ V/m)	Margin (dB)	Result (Pass/Fail)							
Vpk	5186.0	33.8	20.4	34.5	2.9	50.8	63.5	-12.7	Pass							
Table Result: Pass by -12.7 dB				Worst Freq: 5186.0 MHz												
Test Site: "A"		Pre-Amp: Yel-Blk		Cable: 6 RG142LL		Analyzer: Orange		Antenna: Yellow Horn								

No other spurious emissions were found up to 200GHz.

AC Line Conducted Emissions**LIMITS**

Frequency of emission (MHz)	Quasi-peak limit (dB μ V)	Average limit (dB μ V)
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

[47 CFR 15.207(a)]

MEASUREMENTS

AC Mains Conducted Emissions								Curtis-Straus LLC					
Test Data				Test Equipment				Work Order:	F0429				
Test Data				Test Equipment				Test Site:	EMI 2				
Test Data													
Range: 0.15-30Mhz													
Other Equipment: Spectrum Analyzer: Red													
Frequency (MHz)	Q.P. Readings		Ave. Readings		Impedance Factor (dB)	FCC/CISPR B		FCC/CISPR B		Overall Result (Pass/Fail)			
	QP1 (dB μ V)	QP2 (dB μ V)	AV1 (dB μ V)	AV2 (dB μ V)		qp Limit (dB μ V)	qp Margin dB	AVE Limit (dB μ V)	AVE Margin dB				
0.15	18.0	16.3			20.0	66.0	-28.0	56.0	-18.0	Pass			
6.37	1.9	3.5			20.0	60.0	-36.5	50.0	-26.5	Pass			
12.90	0.6	4.3			20.0	60.0	-35.7	50.0	-25.7	Pass			
14.30	11.5	10.6			20.0	60.0	-28.5	50.0	-18.5	Pass			
16.10	8.7	7.6			20.0	60.0	-31.3	50.0	-21.3	Pass			
24.10	0.6	9.6			20.0	60.0	-30.4	50.0	-20.4	Pass			
Table Result: Pass by -18.00 dB					Worst Freq:		0.15 MHz						

Frequency Stability**MEASUREMENTS**

Frequency Stability		Curtis-Straus LLC
Engineer: Evan Gould Date: 6/8/2005 Analyzer: Orange Cable: 142LL#6		Company: Loea Corp. EUT: L-2500 Work Order: F0429
Note: UPS/Surge Protector input voltage range: 92-140V (from manual). However, the limits at which it would supply the EUT properly was 95-141V, which was used for testing.		
Temperature	Supply Voltage	Center Frequency
(°C)	(VAC)	(GHz)
-30	120	83.497405
-20	120	83.492355
-10	120	83.482950
0	120	83.483525
10	120	83.492575
20	95	83.510650
20	120	83.515850
20	141	83.512850
30	120	83.464300
40	120	83.495100
50	120	83.553000
Largest frequency deviation = 88.7MHz		

Note: There is no requirement. But the measurements were taken to satisfy 47 CFR 2.1055.

Test Equipment Used

REV. 06-JUN-2005							
SPECTRUM ANALYZERS		RANGE	MN	MFR	SN	ASSET	CALIBRATION DUE
WHITE		9kHz-22GHz	8593E	HP	3547U01252	00022	08-MAR-2006
ORANGE		9kHz-26.5GHz	E4407B	HP	US39440975	00394	05-NOV-2005
LISNs/MEASUREMENT PROBES		RANGE	MN	MFR	SN	ASSET	CALIBRATION DUE
RED		10kHz-30MHz	8012-50-R-24-BNC	SOLAR	956348	00753	15-APR-2006
BROWN		10kHz-30MHz	8012-50-R-24-BNC	SOLAR	0411656	00986	04-MAY-2006
OPEN AREA TEST SITE (OATS)		FCC CODE	IC CODE	VCCI CODE	CALIBRATION DUE		
SITE A		93448	IC 2762-A	R-903	20-MAR-2007		
LINE CONDUCTED TEST SITES		FCC CODE	IC CODE	VCCI CODE	CALIBRATION DUE		
EMI 2		93448	N/A	C-1802	01-MAY-2006		
MIXERS/DIPLEXERS		RANGE	MN	MFR	SN	ASSET	CALIBRATION DUE
MIXER / HORN		26.5-40 GHz	11970A/28-442-6	HP/ATM	2332A01695/A046903-01	1087	23-AUG-2005
MIXER / HORN		26.5-40 GHz	11970A/28-442-6	HP/ATM	3003A07825/A046903-01	1086	23-AUG-2005
MIXER / HORN		40-60 GHz	M19HW/A	OML	U30110-1	00821	02-MAR-2007
MIXER / HORN		60-90 GHz	M12HW/A	OML	E30110-1	00822	03-MAR-2007
MIXER / HORN		90-140 GHz	MO8HW/A	OML	F21206-1	00811	03-MAR-2007
MIXER / HORN		140-220 GHz	MO5HW/A	OML	G21206-1	00812	05-JAN-2005
DIPLEXER			DPL.26	OML	N/A	00813	03-MAR-2007
PREAMPS / ATTENUATORS / FILTERS		RANGE	MN	MFR	SN	ASSET	CALIBRATION DUE
ORANGE		0.01-2000MHz	ZFL-1000-LN	C-S	N/A	00765	10-FEB-2006
YELLOW-BLACK		1-20GHz	SMC-12A	C-S	535055	00801	21-JUL-2005
HF (YELLOW)		18-26.5GHz	AFS4-18002650-60-8P-4	C-S	467559	00758	20-JUL-2005
ANTENNAS		RANGE	MN	MFR	SN	ASSET	CALIBRATION DUE
GREEN BILOG		30-2000MHz	CBL6112B	CHASE	2742	00620	06-APR-2006
YELLOW HORN		1-18GHz	3115	EMCO	9608-4898	00037	27-MAY-2007(EMI) / 05-JUN-2006 (RFI)
HF (WHITE) HORN		18-26.5GHz	801-WLM	WAVELINE	00758	00758	15-JUL-2005
SMALL LOOP (RENTAL)		10kHz-30MHz	PLA-130/A	ARA	1009	TELOGY	11-FEB-2006
CHAMBERS		MN	MFR	SN	ASSET	CALIBRATION DUE	
ENVIRONMENTAL (SAFETY)		ECL5	B-M-A INC.		2041	00029	12-JAN-2006
POWER/NOISE METERS		MN	MFR	SN	ASSET	CALIBRATION DUE	
POWER METER		435B	HP	2445A11012	00773	06-APR-2006	
POWER METER		437B	HP	2912A01367	01099	27-OCT-2005	
POWER SENSOR		8481A	HP	2702A61351	00774	05-APR-2006	
POWER SENSOR		W8486A	HP	3318A00321		28-JUL-2006	

All equipment is calibrated using standards traceable to NIST or other nationally recognized calibration standard.

Terms And Conditions

Paragraph 1. SERVICES. LABORATORY will:

- 1.1 Use the degree of care and skill ordinarily exercised by and consistent with the standards of the profession.
- 1.2 Perform all technical services in substantial accordance with the generally accepted laboratory principles and practices.
- 1.3 Retain all pertinent records relating to the services performed for a period of three (3) years following submission of the report describing such services, during which period the records will be made available to CLIENT upon reasonable request.

Paragraph 2. CLIENT'S RESPONSIBILITIES. CLIENT or his authorized representative will:

- 2.1 Provide LABORATORY with all plans, schematics, specifications, addenda, change orders, drawings and other information for the proper performance of technical services.
- 2.2 Designate a person to act as CLIENT's representative with respect to LABORATORY's services to be performed on behalf of the CLIENT; such person or firm to have complete authority to transmit instructions, receive information and data, interpret and define CLIENT's policies and decisions with respect to the LABORATORY's work on behalf of the CLIENT and to order, at CLIENT's expense, such technical services as may be required.
- 2.3 Designate a person who is authorized to receive copies of LABORATORY's reports.
- 2.4 Undertake the following:
 - (a) Secure and deliver to LABORATORY, without cost to LABORATORY, preliminary representative samples of the equipment proposed to require technical services, together with any relevant data.
 - (b) Furnish such labor and equipment needed by LABORATORY to handle samples at the LABORATORY and to facilitate the specified technical services.

Paragraph 3. GENERAL CONDITIONS:

- 3.1 LABORATORY, by the performance of services covered hereunder, does not in any way assume any of those duties or responsibilities customarily vested in the CLIENT, its employees, or any other party, agency or authority.
- 3.2 LABORATORY shall not be responsible for acts of omissions of any other party or parties involved in the design, manufacture or maintenance of the equipment or the failure of any employee, contractor or subcontractor to undertake any aspect of equipment's design, manufacture or maintenance.
- 3.3 LABORATORY is not authorized to revoke, alter, release, enlarge or release any requirement of the equipment's design, manufacture or maintenance unless specifically authorized by CLIENT or his authorized representative.
- 3.4 THE ONLY WARRANTY MADE BY LABORATORY IN CONNECTION WITH ITS SERVICE PERFORMED HEREUNDER IS THAT IT WILL USE THAT DEGREE OF CARE AND SKILL AS SET FORTH IN PARAGRAPH 1 ABOVE. NO OTHER WARRANTY, EXPRESS OR IMPLIED, IS MADE OR INTENDED FOR SERVICES PROVIDED HEREUNDER.
- 3.5 Where the LABORATORY indicates that additional testing is advisable to obtain more valid or useful data, and where such testing has not been authorized, CLIENT agrees to view such test reports as inconclusive and preliminary.
- 3.6 The LABORATORY will supply technical service and prepare a report based solely on the sample submitted to the LABORATORY by the CLIENT. The CLIENT understands that application of the data to other devices is highly speculative and should be applied with extreme caution.
- 3.7 The LABORATORY agrees to exercise ordinary care in receiving, preserving and shipping (F.O.B. Littleton, MA) any sample to be tested, but assumes no responsibility for damages, either direct or consequential, which arise from loss, damage or destruction of the samples due to the act of examination, modification or testing, or technical services or circumstances beyond LABORATORY's control.
- 3.8 The LABORATORY will hold samples for thirty (30) days after tests are completed, or until the CLIENT's outstanding debts to the LABORATORY are satisfied, whichever is later.
- 3.9 The CLIENT recognizes that generally accepted error variances apply and agrees to consider such error variances in its use of test data.
- 3.10 It is agreed between LABORATORY and CLIENT that no distribution of any tests, reports or analysis other than that described below shall be made to any third party without the prior written consent of both parties unless such distribution is mandated by operation of law. It is agreed that tests, reports, or analysis results may be disclosed to third party auditors of the laboratory at the laboratory facility in the course of accreditation maintenance audits. No reference to reports or technical services of the LABORATORY shall be made in any advertising or promotional literature without the express written permission of the LABORATORY.
- 3.11 The CLIENT acknowledges that all employees of LABORATORY operate under employment contracts with the LABORATORY and CLIENT agrees not to solicit employment of such employees or to solicit information related to other clients from said employees.
- 3.12 In recognition of the relative risks and benefits of the project to both CLIENT and LABORATORY, the risks have been allocated such that the CLIENT agrees, to the fullest extent permitted by law, to limit the liability of the LABORATORY to the CLIENT for any and all claims, losses, costs, damages of any nature whatsoever or claims expenses from any cause or causes, including attorneys' fees and costs and expert witness fees and costs, so that the total aggregate liability of the LABORATORY to the CLIENT shall not exceed \$100,000, or the LABORATORY'S total fee for services rendered on this project, whichever is greater. It is intended that this limitation apply to any and all liability or cause of action however alleged or arising, unless otherwise prohibited by law.

Paragraph 4. INSURANCE:

- 4.1 LABORATORY shall secure and maintain throughout the full period of the services provided to the CLIENT adequate insurance to protect it from claims under applicable Workmen's Compensation Acts and also shall maintain one million dollars of general liability coverage to cover claims for bodily injury, death or property damage as may arise from the performance of its services.
- 4.2 The CLIENT hereby warrants that it has sufficient insurance to protect its employees adequately under applicable Workmen's Compensation Acts and for bodily injury, death, or property damage.
- 4.3 No insurance of whatever kind or type, which may be carried by either party is to be considered as in any way limiting any other party's responsibility for damages resulting from their operations or for furnishing work and materials.

Paragraph 5. PAYMENT:

- 5.1 CLIENT shall pay to LABORATORY such fees for services as previously agreed, orally or in writing, within 30 days of presentation of a bill for such services performed. In the event CLIENT ordered, orally or in writing, services but such services were not assigned a rate for billing, such services shall be billed at the LABORATORY's reasonable and customary rate.

5.2 CLIENT shall be responsible for all shipping, customs and other expenses related to services provided by LABORATORY to the CLIENT, and shall fully insure any test sample or other equipment provided to LABORATORY by the CLIENT.

5.3 Amounts overdue from CLIENT to LABORATORY shall be charged interest at a rate of 1½% per month.

Paragraph 6. ISO/IEC GUIDE 17025 ADDITIONS:

6.1 CLIENT agrees that this test report will not be reproduced except in full, without written approval from the LABORATORY.

6.2 CLIENT agrees that this test report shall not be used to claim product endorsement by A2LA or ANSI or any agency of the U.S. Government.

6.3 CLIENT agrees that test results presented herein relate only to the sample tested by the LABORATORY.

A2LA Accreditation

<p><u>SCOPE OF ACCREDITATION TO ISO/IEC 17025-1999</u></p> <p>CURTIS-STRAUSS¹ 527 Great Road Littleton, MA 01460 Barry Quinlan Phone: 978-486-8880</p> <p>ELECTRICAL</p> <p>Valid until: July 31, 2005</p> <p>In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following <u>Electromagnetic Compatibility (EMC), Telecommunications, and Product Safety tests:</u></p> <p>Electromagnetic Compatibility (EMC) Radiated emissions testing (electric and magnetic fields); Conducted emissions testing (voltage and current); Electrostatic Discharge testing; Electrical Fast Transient testing; Radiated Immunity testing; Conducted Immunity testing; Lightning Immunity testing; Voltage Dips, Interrupts and Voltage Variations testing; Magnetic Immunity testing; RF Power measurements; Frequency Stability measurements; Longitudinal Induction measurements; Harmonic emissions testing; Light flicker testing; Low frequency disturbance voltage testing; Disturbance Power measurements</p> <table border="1"> <thead> <tr> <th>EMC Standards</th><th>Title</th></tr> </thead> <tbody> <tr> <td>CISPR 22 1997 with amendments 1 and 2</td><td>Limits and methods of measurement of radio disturbance characteristics of information technology equipment.</td></tr> <tr> <td>CNS13438 1994</td><td>Limits and methods of measurement of radio interference characteristics of information technology equipment.</td></tr> <tr> <td>EN55022:1994 and 1998</td><td>Limits and methods of measurement of radio disturbance characteristics of information technology equipment.</td></tr> <tr> <td>SABS CISPR 22:1997</td><td>Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement</td></tr> <tr> <td>Canada ICES-003 1997 AS/NZS 3548 1995</td><td>Digital apparatus Australian/New Zealand Standard Limits and methods of measurement of radio disturbance characteristics of information technology equipment</td></tr> <tr> <td>CISPR 11 1990, 1997, 1999</td><td>Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment.</td></tr> </tbody> </table> <p>¹ Note: This accreditation covers testing performed at the laboratory listed above and the satellite facility located at 168 Ayer Rd, Littleton, MA 01460</p>			EMC Standards	Title	CISPR 22 1997 with amendments 1 and 2	Limits and methods of measurement of radio disturbance characteristics of information technology equipment.	CNS13438 1994	Limits and methods of measurement of radio interference characteristics of information technology equipment.	EN55022:1994 and 1998	Limits and methods of measurement of radio disturbance characteristics of information technology equipment.	SABS CISPR 22:1997	Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement	Canada ICES-003 1997 AS/NZS 3548 1995	Digital apparatus Australian/New Zealand Standard Limits and methods of measurement of radio disturbance characteristics of information technology equipment	CISPR 11 1990, 1997, 1999	Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment.
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CISPR 14-2 1996, 1997 + A1:2001	Immunity requirements for household appliances, tools and similar apparatus.	Electromagnetic Compatibility (EMC)- Part 6: Generic standards-Section 1: Immunity for residential, commercial and light-industrial environments														
CISPR 20: 1995, 2002 with amendment 3 (<i>associated group only</i>)	Limits and methods of measurement of immunity characteristics of sound and television broadcast receivers and associated equipment.	Electromagnetic Compatibility (EMC)- Part 6: Generic standards-Section 2: Immunity for industrial environments														
EN 55020: 1995, 2002 (<i>associated group only</i>) CISPR 24	Electromagnetic immunity of broadcast receivers and Associated equipment	Specification for Uninterruptible Power Systems (UPS). Part 2: EMC requirements														
SABS CISPR 24 1997	Information technology equipment – Immunity characteristics – Limits and methods of measurement	Information technology equipment – Immunity Characteristics – Limits and methods of measurement.														
AS/NZS 3200.1.2: 1995	Information technology equipment – Immunity characteristics – Limits and methods of measurement	Electromagnetic Compatibility – Product family standard for audio, video, audio-visual and entertainment lighting control apparatus for professional use. Part 1: Emission														
<i>European Union Basic EMC Standards</i> EN 61000-4-2: 1995, 1999, 2001	Approval and test specification – Medical electrical Equipment – General requirements for safety – Collateral Standard: Electromagnetic compatibility – Requirements and tests.	Electromagnetic Compatibility – Product family standard for audio, video, audio-visual and entertainment lighting control professional use. Part 2: Immunity														
EN 61000-4-3:1997, 1998, 2002 AS/NZS 61000.4.3 1999	Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 2: Electrostatic discharge immunity test – Basic EMC Publication	Electrical equipment for measurement, control and laboratory use – EMC requirements														
EN 61000-4-4 1995	Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 3: Radiated, radio-frequency, electromagnetic field immunity test	Equipment for general lighting purposes – EMC immunity requirements														
EN 61000-4-5 1995 AS/NZS 61000.4.5 1999 EN 61000-4-6 1996 AS/NZS 61000.4.6 1999	Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 4: Electrical fast transient/burst immunity test – Basic EMC publication (EMC) Part 4: Testing and measurement techniques. Section 5: Surge immunity test.	Alarm Systems. Part 4: Electromagnetic compatibility. Product family standard: Immunity requirements for components of fire, intruder and social alarm systems.														
EN 61000-4-8 1994	Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 6: Immunity to conducted disturbances, induce by radio-frequency fields.	Electromagnetic compatibility immunity – requirements for household appliances, tools and similar apparatus. Product family standard.														
EN 61000-4-11 1994	Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 8: Power frequency magnetic field immunity test.	Cabled distribution systems for television and sound signals. Part 2: Electromagnetic compatibility for equipment.														
ENV 61000-2-2 1993	(EMC) Part 4: Testing and measurement techniques. Section 11: Voltage dips, short interruptions and voltage Variations immunity tests.	Medical electrical equipment Part 1: general requirements for safety Section 2: Collateral standard: Electromagnetic compatibility – requirements and tests														
<i>EU Product Family Standards</i> EN 50081-1 1992	Electromagnetic compatibility – Generic emission standard. Part 1: Residential, commercial and light industry. (I.S.)	Adjustable speed electrical power drive systems. Part 3: EMC product standard including specific test methods.														
EN 50081-2 1993	Electromagnetic compatibility – Generic emission standard. Part 2: Industrial environment	Disturbances in supply systems caused by household appliances and similar electrical equipment. Part 2: Harmonics														
EN 50082-1 1992, 1998	Electromagnetic compatibility – Generic emission standard. Part 1: Residential, commercial and light industry	Disturbances in supply systems caused by household appliances and similar electrical equipment. Part 3: Voltage fluctuations.														
EN 50082-2 1995	Electromagnetic compatibility – Generic immunity Standard. Part 2: Industrial environment	Electromagnetic compatibility (EMC). Part 3: Limits Section 2: Limits for harmonic current emissions														
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ETS EN 300 386-2 1997, 1998, ETS EN 300 386 2000 v1.2.1, 2001 v1.3.1	Electromagnetic compatibility and radio spectrum matters (ERM); Telecommunication network equipment; Electromagnetic compatibility (EMC) requirements; Part 2: Product family standard.	EN 300 328-2:2001 v1.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Wideband Transmission systems; Data transmission equipment operating in the 2.4 GHz ISM band and using spread spectrum modulation techniques; Part 2: Harmonized EN covering essential requirements under article 3.2 of the R&TTE Directive
ETS 300 132-1 1996	Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 1: Operated by alternating current (ac) derived from direct current (dc) sources	EN 301 489-1:2002	Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements
ETS 300 132-2 1996	Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 2: Operated by direct current (dc)	EN 60669-2-1:2002	Switches for household and similar fixed electrical installations -- Part 2-1: Particular requirements - Electronic switches
ETR 283 1997	Equipment Engineering (EE); Transient voltages at Interface A on telecommunications direct current (DC) power distributions.	<i>Canada Radio Standards</i> Canadian GL-36 1995	
<i>EU radio standards</i> (ETSI) EN 300 385 v1.2.1: 1998, 1999	Electromagnetic compatibility and Radio spectrum matters (ERM); Electromagnetic Compatibility (EMC) standard for fixed radio links and ancillary equipment (ETSI)	Canadian RSS-119 1999, 2000 Issue 6	Industry Canada - technical requirements for low power Devices in the 2400 - 2483.5 MHz band
EN 300 330 v1.2.1: 1998, 1999	Electromagnetic compatibility and Radio spectrum matters (ERM); Short range devices (SRD); Technical characteristics and test methods for radio equipment in the range 9 kHz to 25 MHz and inductive loop systems in the frequency range 9 kHz to 30 MHz	Canadian RSS-134 1996 & 2000, Issue Rev 1	Industry Canada - Land mobile and fixed radio Transmitters and receivers, 27.41 to 960.0 MHz
ETS 300 328 1996	Radio Equipment and Systems (RES); Wideband transmission systems; Technical characteristics and test conditions for data transmission equipment operating in the 2.4 GHz ISM band and using spread spectrum modulation techniques	Canadian RSS-210 2000 Issue 3,	Industry Canada - Low power license-exempt radio 2001 Issue 5 communication devices
ETS EN 300 440 v1.2.1 1999	Electromagnetic compatibility and Radio spectrum matters (ERM); Short range devices; Technical characteristics and test methods for radio equipment to be used in the 1 GHz to 40 GHz frequency range	RFS29 1998	Specification for Restricted Radiation Radio Apparatus (New Zealand)
EN 301 893:2002 v1.2.1	Broadband Radio Access Networks (BRAN); 5 GHz (draft) high performance RLAN; Harmonized EN covering Essential requirements of article 3.2 of the R&TTE Directive	<i>FCC Standards</i> 47 CFR FCC low power transmitters operating on frequencies below 1 GHz, emergency alert systems, unintentional radiators and ISM devices.	Scope A1
ETS 300 836-1:1998	Broadband Radio Access Networks (BRAN); High Performance Radio Local Area Network (HIPERLAN) Type 1; Conformance testing specification; Part 1: Radio Type approval and Radio Frequency (RF) conformance test specification	47 CFR FCC low power transmitters operating on frequencies above 1 GHz, with the exception of spread spectrum devices.	Scope A2
EN301 489-17:2002 v1.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 17: Specific conditions for 2.4 GHz wideband transmission systems and 5 GHz high performance RLAN equipment	47 CFR FCC Unlicensed Personal Scope Communications System (PCS) devices	A3
		47 CFR FCC Unlicensed National Scope	A4
		Information Infrastructure devices and low power transmitters using spread spectrum techniques.	
		47 CFR FCC Personal mobile Scope Radio Services in the following FCC Rule Parts 22, 24, 25, 27.	B1
		47 CFR FCC General Mobile Radio Scope Services in the following FCC Rule Parts 22, 74, 90, 95, 97.	B2
		47 CFR FCC Maritime and Aviation Scope RadioServices in 47 CFR Parts 80 and 87	B3
		47 CFR FCC Microwave Radio Services Scope in 47 CFR Parts 21, 74 and 101.	B4
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FCC/OST MP-5 1986	FCC (Federal Communications Commission) methods Of measurement of radio noise emissions from industrial, scientific and medical equipment.	TIA/EIA-IS-968	Telecommunications Telephone Terminal Equipment Technical Requirements for Connection of Terminal Equipment to the Telephone Network
GR-1089-CORE: 1997, 1999 issue 2/ 2002 Issue 3	Bellcore electromagnetic compatibility and electrical safety - Generic criteria for network telecommunications equipment.	TIA/EIA-IS-883	Telecommunications Telephone Terminal Equipment Supplemental Technical Requirements for Connection of Stutter Dial Tone Detection Devices and ADSL Modems to the Telephone Network
<i>ANSI EMC Standards</i> ANSI C63.4: 1992, 1999, 2001	American National Standard for methods of measurement of radio-noise emissions for low-voltage electrical and electronic equipment in the range of 9 kHz to 40GHz.	TIA-968-A	Telecommunications Telephone Terminal Equipment Technical Requirements for Connection of Terminal Equipment to the Telephone Network
ANSI C63.5 1988	American National Standard for electromagnetic compatibility - radiated emissions measurements in electromagnetic interference (EMI) control - calibration of antennas.	T1.TRQ-6-2001	Technical Requirements for SHDSL, HDSL2, HDSL4 Digital Subscriber Line Terminal Equipment to Prevent Harm to the Telephone Network Industry
<i>IEEE EMC Standards</i> IEEE C62.41: 1980, 1991	IEEE recommended practice on surge voltages in low-voltage AC power circuits	Canada VDSL Issue 1 January 2003	Terminal Attachment Program Requirements and Test Methods for Very-High-Bit-Rate Digital Subscriber Line (VDSL) Terminal Equipment
<i>Swedish EMC Standards</i> BAKOM 3336.3 1995	Electromagnetic compatibility and electrical safety (EMC & S) for wired terminal equipment. Harmonization document information over the OFCOM requirements.	AS/ACIF S002-2001	Analogue interworking and non-interference requirements for Customer Equipment for connection to the Public Switched Telephone Network
<i>South African EMC standards other than CISPR equivalents</i> SABS 1718-1: 1996	South African Bureau of Standards: Specification for Gaming equipment. Part 1: Casino equipment.	AS/ACIF S016-2001	Requirements for Customer Equipment for connection to hierarchical digital interfaces
<i>Japanese VCCI Standards</i> VCCI V-3/99.05 1999 VCCI V-4/99.05 1999	Technical Requirements Instruction for Test Conditions for Requirement under Test	AS/ACIF S031-2001 AS/ACIF S038-2001 AS/ACIF S043-2001	Requirements for ISDN Basic Access Interface Requirements for ISDN Primary Rate Access Interface Requirements for Customer Equipment for Connection to a Metallic Local Loop Interface of a Telecommunications Network — Part 1: General Part 2: Broadband
<i>Telecommunications</i> Telecommunications Registration; General test methods; Lightning surge; Drop testing; Balance testing; Signal power (metallic and longitudinal); Frequency measurements; Pulse templates; Leakage testing; Impedance testing; Hearing Aid Compatibility testing (<i>excluding volume control</i>); Protocol analysis and Jitter testing.		ITU-T G.703 HKTA 2028 HKTA 2029 TBR 1 : 1995	Part 3: DC, Low Frequency AC and Voiceband Physical/electrical characteristics of hierarchical Digital interfaces Network connection specification for connection of CPE to the PTNs in Hong Kong using digital leased circuits at data rate of 1544 kbit/s Network connection specification for connection of CPE to the PTNs in Hong Kong using digital leased circuits at data rate of 2048 kbit/s Attachment requirements for terminal equipment to be connected to circuit switched data networks and leased circuits using a CCITT Recommendation X.21 interface, or at an interface physically, functionally and electrically compatible with CCITT Recommendation X.21 but operating at any data signaling rate up to, and including, 19 984 kbit/s
<i>Telecom Standards</i>	<i>Title</i>	TBR 2 : 1997	Attachment requirements for Data Terminal Equipment (DTE) to connect to Packet Switched Public Data Networks (PSPDNs) for CCITT Recommendation X.25 interfaces at data signaling rates up to 1 920 kbit/s utilizing interfaces derived from CCITT Recommendations X.21 and X.21 bit
FCC 47 CFR Part 68 Telephone	Connection of terminal equipment to the telephone Terminal Equipment network. Analog and Digital Equipment. TCB Scope C1.		
CS-03 Issue 8 1996 through amendment 5	Specification for terminal equipment, terminal systems, Network protection devices, connection arrangements and hearing aids compatibility.		
TIA/EIA TSB31-B 1998	Bulletin Part 68 Rationale and Measurement Guidelines (Feb 1998)		
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TBR 3 : 1995 + Amdt : 1997	Integrated Services Digital Network (ISDN); Attachment requirements for terminal equipment to connect to an ISDN using ISDN basic access	IEC 60950 2000 EN 60950 1997, 1998, 2000 IEC 60950-1 2001 UL 60950-1 2003 CSA C22.2 No. 60950-00 CSA C22.2 No. 60950-1 03 AS/NZS 3260 1993 AS/NZS 3260 Supp 1 1996	Safety of information technology equipment Safety of information technology equipment, including Electrical business equipment.
TBR 4 : 1995 + Amdt : 1997	Integrated Services Digital Network (ISDN); Attachment requirements for terminal equipment to connect to an ISDN using ISDN primary rate access		
TBR 012 : 1993 + Amdt : 1996	Business Telecommunications (BT); Open Network Provision (ONP) technical requirements; 2 048 kbit/s digital unstructured leased line (D2048U) Attachment requirements for terminal equipment		Approval and test specification – Safety of information technology equipment including electrical business Equipment.
TBR 013 : 1996	Business Telecommunications (BTC); 2 048 kbit/s digital structured leased lines (D2048S); Attachment requirements for terminal equipment interface		Approval and test specification – Safety of information technology equipment including electrical business equipment – Alphabetical reference index to IEC 950 (Supplement to AS/NZS 3260:1993)
TBR 21 : 1998	Terminal Equipment (TE); Attachment requirements for pan-European approval for connection to the analogue Public Switched Telephone Networks (PSTNs) of TE (excluding TE supporting the voice telephony service) in which network addressing, if provided, is by means of Dual Tone Multi Frequency (DTMF) signaling	UL 1459 1995 IEC 1010-1 1990 IEC 61010-1 1993 EN 61010-1 1993, 2001 IEC 61010-1 2001 UL 61010B-1 2003 UL 3101-1 1993 CAN/CSA 1010-1 1999 (<i>Including AM 2</i>) UL 3111-1 1996 UL 3121-1 1995 IEC 60601-1 1995 EN 60601-1 1995 (<i>Including AM 2</i>) UL 2601-1 1997 IEC 60065 1998, 2000 ANSI/UL 6500: 1998 CAN/CSA 60065-00 AS/NZS 3250 1995 AS/NZS 60065 2000	Australian Communications Authority – Safety requirements for customer equipment. Telephone Equipment Safety requirements for electrical equipment for measurement, control and laboratory use, Part 1: General requirements. Safety requirements for electrical equipment for measurement, control and laboratory use, Part 1: General requirements.
TBR 24 : 1997	Business Telecommunications (BTC); 34 Mbit/s digital Unstructured and structured leased lines (D34U and D34S); Attachment requirements for terminal equipment interface		Electrical equipment for laboratory use Part 1: General requirements.
<i>Australia</i> TS 002 : 1997	Analogue Interworking and Non interference Requirements for Customer Equipment Connected to the Public Switched Telephone Network		Electrical measuring and test equipment. Part 1: General requirements.
TS 016 : 1997	General Requirements for Customer Equipment Connected to Hierarchical Digital Interfaces		Medical electrical equipment. Part 1: General requirements for safety.
TS 031 : 1997	Requirements for ISDN Basic Access Interface		Medical electrical equipment
TS 038 : 1997	Requirements for ISDN Primary Rate Access Interface		Medical electrical equipment. Part 1: General Requirements for safety.
AS/ACIF S043.2:2001	Requirements for Customer Equipment for connection to a metallic loop interface of a Telecommunications Network – Part 2 Broadband		Audio, video and similar electronic apparatus – Safety requirements for Audio/video and musical instrument apparatus for Household, commercial and similar general use
Product Safety			Australian/New Zealand Standard – Approval and test Specification – Mains operated electronic and related Equipment for household and similar general use
General test methods; Input tests; Electric strength tests; Impulse tests; Permanency of marking tests; Accessibility tests; Energy Hazard measurements; Capacitor discharge tests; Humidity conditioning; Earthing tests; Limited power source measurements; Stability tests; Steel ball tests; Lithium Battery Reverse Current measurements; Leakage current tests; Transformer abnormal tests; Telecom leakage tests; Over voltage/power cross tests (<i>excluding x-ray tests</i>).			Audio, video and similar electronic equipment. Consumer and 1994, commercial products
Product Safety Standards	Title		Safety requirements for main operated electronic and related apparatus for household and similar general use.
Specific Product Safety Standards			Radiation safety of laser products, equipment Classification, requirements and user's guide
IEC 950 1991	Safety of information technology equipment including Includes Amendments 1, 2, 3, and 4 electrical business equipment.		Safety of laser products Part 1: equipment Classification, requirements and user's guide.
UL 1950 1998	Safety of information technology equipment, including electrical business equipment.		Safety of laser products – Part 2: Safety of optical communication
CSA C22.2 No.950-95	Safety of Information Technology Equipment (UL 1950)		
UL 60950 2000	Safety of information technology equipment		
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UL 61010A-1 : 2002	Electrical equipment for laboratory use; part 1: General requirements		
EN 61010-1 : 2001	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements		
AS/NZS 60950 : 2000	Safety information technology equipment		
Environmental²			
Environmental Standards	Title		
GR-63-CORE	NEBS Requirements: Physical Protection		
ETS 300 019	Environmental conditions and environmental tests For telecommunications equipment		
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² Environmental testing is performed at the satellite facility located at 168 Ayer Rd, Littleton, MA 01460