Certificate of Conformity

issued by Curtis-Straus

Company: **APC Corporation NPS Division**
Product Tested: **SU3000RMXLI3U**
Testing Date: **February 2, 5, 20, 22, March 21, 2001**
Report No.: **EB0155-1**

A sample of the product as configured in the accompanying test report has been found to comply with the following standards:

EMC Emissions and Immunity:

- EN 50091-2: 1995 Uninterruptible Power Systems (UPS) EMC requirements

Attested to by the hands and seals:

For Curtis-Straus		For the Manufacturer or Importer	
M Hussain	6/4/01		
Test Engineer	Date		Date
Michael Buchholz	6/4/01		
EMC Manager	Date		

For original signatures see hard copy of the report.

To: ***Rick Everrett***, APC Corporation NPS Division

From: Mairaj Hussain, Curtis-Straus LLC.

Re: Testing of the SU3000RMXLI3U

Date: 4 June, 2001

Form Final Report REV 19-Jan-2001 (DW)

Contents

Summary

On February 2, 5, 20, 22, March 21 of 2001 we tested the SU3000RMXLI3U for compliance with the following requirements:

EMC Emissions and Immunity:

- EN 50091-2: 1995 Uninterruptible Power Systems (UPS) EMC requirements

We found that the product meets the above requirements without any modifications.

The test sample was received in good condition.

Product Tested - Configuration Documentation

EUT Configuration

Work Order:	B0155			
Company:	APC Corp. NPS Division			
Company Address:	9 Executive Park Drive North Billerica, MA 01862			
Contact:	Rick Everett			
Person(s) Present:	None			

	MN	SN	FCC ID
EUT:	SU 3000 RM XLI 3U	-	-

EUT Description: Rack mounted uninterruptable power supply
EUT Max Frequency: 16MHz

Support Equipment:	MN	SN	FCC ID
Load Bank	K490	-	-

EUT Cables:	Qty	Shielded?	Length	Ferrites
AC power in	1	no	2m	none
AC power out	8	no	2m	none
db-9	1	yes	2m	none

Unpopulated EUT Ports:	Qty	Reason
none		

Software / Operating Mode Description:

For emissions testing UPS was tested in charging and discharging modes. For each mode testing was performed with 0%, 50%, and 100% load attached to UPS.
During the immunity testing the load current was monitored to make sur the UPS does not drop the load.

Performance Criteria

Criterion A: The unit must operate as intended during the test. In particular, the unit shall not drop the load and must maintain constant load current.

Criterion B: The unit must operate as intended at the conclusion of the test with no loss of state or data.

Criterion C: Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls by the user in accordance with the manufacturer's instructions.

Compliance Statement

TEST	RESULT	STANDARD	TEST LEVEL	MARGIN	COMMENTS
Radiated Emissions	PASS	EN 50091-2	Class A	6.5db@ 67.8MHz	CISPR limit
AC Mains Conducted Emissions	PASS	EN 50091-2	Class A	2.0db @ 8.92, 9.2MHz	CISPR limit
RFI - Amplitude Modulated	PASS	EN61000-4-3 / IEC1000-4-3 / IEC 801-3 / ENV 50140	27 -1000 MHz 10 V/m 80% AM (1 kHz)	N/A	Performance Criteria A
EFT	PASS	EN61000-4-4 / IEC1000-4-4 / IEC 801-4	±4kV AC mains, ±2KV cables	N/A	Performance Criteria B
ESD	PASS	EN 61000-4-2 / IEC1000-4-2 / IEC 801-2	±6kV contact, ±8kV air	N/A	Performance Criteria B
CRFI	PASS	EN61000-4-6 / IEC1000-4-6	10V, 0.15-80 MHz, 1kHz 80% AM	N/A	Performance Criteria A
LFD	PASS	IEC 1000-2-2	10V, 140-360Hz	N/A	Performance Criteria A

Modifications Required for Compliance

No modifications were required compliance.

Test Results

Radiated Emissions Table — *Curtis-Straus LLC*

Date: 02-Feb-01 **Company:** APC **Table** 1
Engineer: Chris Reynolds / Josh LeBlanc **EUT Desc:** SU 3000 RM XLI 3U **Work Order:** B0155
Frequency Range: 30-1000 MHz **Measurement Distance:** 3 m
Notes: **EUT Max Freq:** 16 Mhz

Antenna Polarization (H / V)	Frequency (MHz)	Reading (dBµV)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Adjusted Reading (dBµV/m)	CISPR Class A Limit (dBµV/m)	CISPR Class A Margin (dB)	CISPR Class A Result (Pass/Fail)	FCC Class A Limit (dBµV/m)	FCC Class A Margin (dB)	FCC Class A Result (Pass/Fail)
w/ full load charging												
Vbb	30.68	35.1	22.4	13.5	0.4	26.6	50.5	-23.9	Pass	49.6	-23.0	Pass
Vbb	43.83	46.1	22.5	8.7	0.5	32.8	50.5	-17.7	Pass	49.6	-16.8	Pass
V	51.575	45.2	22.5	6.6	0.6	29.9	50.5	-20.6	Pass	49.6	-19.7	Pass
Hbb	67.88	54.9	22.4	6.4	0.7	39.6	50.5	-10.9	Pass	49.6	-10.0	Pass
H	80.25	44.4	22.4	7.8	0.8	30.6	50.5	-19.9	Pass	49.6	-19.0	Pass
H	112.015	45.4	22.4	6.8	1.0	30.8	50.5	-19.7	Pass	54.0	-23.2	Pass
H	224.25	38.8	22.4	11.4	1.6	29.4	50.5	-21.2	Pass	56.9	-27.6	Pass
w/ zero load charging												
H	112.015	43.0	22.4	6.8	1.0	28.4	50.5	-22.1	Pass	54.0	-25.6	Pass
Vbb	60.215	40.6	22.5	5.4	0.6	24.1	50.5	-26.4	Pass	49.6	-25.5	Pass
Vbb	68.125	50.4	22.4	6.4	0.7	35.1	50.5	-15.4	Pass	49.6	-14.5	Pass
H	80.25	43.7	22.4	7.8	0.8	29.9	50.5	-20.6	Pass	49.6	-19.7	Pass
w/ 50% load discharging												
Hbb	67.8	57.8	22.4	6.4	0.7	42.5	50.5	-8.0	Pass	49.6	-7.1	Pass
Hbb	44.9	40.9	22.5	8.4	0.5	27.3	50.5	-23.2	Pass	49.6	-22.3	Pass
Hbb	50.9	39.9	22.5	6.7	0.5	24.6	50.5	-25.9	Pass	49.6	-25.0	Pass
Vbb	51.85	42.7	22.5	6.5	0.6	27.3	50.5	-23.2	Pass	49.6	-22.3	Pass
Hbb	80.25	44.8	22.4	7.8	0.8	31.0	50.5	-19.5	Pass	49.6	-18.6	Pass
Vbb	84.0	38.5	22.4	7.6	0.8	24.5	50.5	-26.0	Pass	49.6	-25.1	Pass
Hbb	87.65	47.3	22.4	7.4	0.8	33.1	50.5	-17.4	Pass	49.6	-16.5	Pass
H	112.0	42.5	22.4	6.8	1.0	27.9	50.5	-22.6	Pass	54.0	-26.1	Pass
Hbb	116.8	38.6	22.4	6.8	1.0	24.0	50.5	-26.5	Pass	54.0	-30.0	Pass
w/ 50% load charging												
Hbb	43.9	43.0	22.5	8.7	0.5	29.7	50.5	-20.8	Pass	49.6	-19.9	Pass
Hbb	67.8	54.4	22.4	6.4	0.7	39.1	50.5	-11.4	Pass	49.6	-10.5	Pass
H	80.1	38.0	22.4	7.9	0.8	24.3	50.5	-26.2	Pass	49.6	-25.3	Pass
H	84.0	34.8	22.4	7.6	0.8	20.8	50.5	-29.7	Pass	49.6	-28.8	Pass
H	112.1	40.0	22.4	6.8	1.0	25.4	50.5	-25.1	Pass	54.0	-28.6	Pass

Table Result: Pass by -7.1 dB ***Worst Freq:*** 67.8 MHz

Test Site: "F" **Pre-Amp:** Black **Cable:** 65 ft RG8A/U **Analyzer:** Yellow **Antenna:** Red

Radiated Emissions Table — *Curtis-Straus LLC*

Date: 02-Feb-01 **Company:** APC **Table** 2
Engineer: Josh LeBlanc **EUT Desc:** SU 3000 RM XLI 3U **Work Order:** B0155
Frequency Range: 30-1000 MHz **Measurement Distance:** 3 m
Notes: **EUT Max Freq:** 16 MHz

Antenna Polarization (H / V)	Frequency (MHz)	Reading (dBµV)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Adjusted Reading (dBµV/m)	CISPR Class A Limit (dBµV/m)	CISPR Class A Margin (dB)	CISPR Class A Result (Pass/Fail)	FCC Class A Limit (dBµV/m)	FCC Class A Margin (dB)	FCC Class A Result (Pass/Fail)
W/ 100% load discharging			---	---	---	---	---	---	---	---	---	---
Hbb	43.85	39.4	22.5	8.7	0.5	26.1	50.5	-24.4	Pass	49.6	-23.5	Pass
Hbb	67.88	59.3	22.4	6.4	0.7	44.0	50.5	-6.5	Pass	49.6	-5.6	Pass
Hbb	73.9	42.0	22.4	7.1	0.7	27.4	50.5	-23.1	Pass	49.6	-22.2	Pass
Hbb	86.4	35.8	22.4	7.5	0.8	21.7	50.5	-28.8	Pass	49.6	-27.9	Pass
W/ 0% load discharging			---	---	---	---	---	---	---	---	---	---
Hbb	46.3	38.3	22.5	8.0	0.5	24.3	50.5	-26.2	Pass	49.6	-25.3	Pass
Hbb	67.68	58.8	22.4	6.3	0.7	43.4	50.5	-7.1	Pass	49.6	-6.2	Pass
Hbb	73.13	44.0	22.4	7.0	0.7	29.3	50.5	-21.2	Pass	49.6	-20.3	Pass
Hbb	85.9	36.9	22.4	7.5	0.8	22.8	50.5	-27.7	Pass	49.6	-26.8	Pass
Hbb	112.03	41.6	22.4	6.8	1.0	27.0	50.5	-23.5	Pass	54.0	-27.0	Pass
Hbb	116.9	37.5	22.4	6.8	1.0	22.9	50.5	-27.6	Pass	54.0	-31.1	Pass

Table Result: Pass by -5.6 dB ***Worst Freq:*** 67.88 MHz

Test Site: "F" **Pre-Amp:** Black **Cable:** 65 ft RG8A/U **Analyzer:** Yellow **Antenna:** Red

Conducted Emissions Chart

Curtis-Straus LLC

Date: 21-Mar-01 **Company:** APC Corp NPS Division **Table No:** 3
Engineer: Josh LeBlanc **EUT Desc:** SU3000RMXLI3U with new pwr rating, and extended batterie **Work Order:** B0155
Notes:
Range: 0.15-30Mhz **LISN(s):** Orange **Other Equipment:** --- **Spectrum Analyzer:** White

Frequency (MHz)	Quasi-Peak Readings QP1 (dBµV)	QP2 (dBµV)	Average Readings AV1 (dBµV)	AV2 (dBµV)	Impedance Factor (dB)	FCC A Limit (dBµV)	FCC A Margin dB	CISPR A qp Limit (dBµV)	CISPR A qp Margin dB	CISPR A AVE Limit (dBµV)	CISPR A AVE Margin dB	Overall Result (Pass/Fail)
0% load charging:												
0.16	47.5	46.9	39.2	37.0	20.0	---	---	79.0	-11.5	66.0	-6.8	Pass
0.21	42.3	44.0	36.3	36.0	20.0	---	---	79.0	-15.0	66.0	-9.7	Pass
6.16	28.0	28.9	10.0	17.0	20.0	69.5	-33.6	73.0	-24.1	60.0	-23.0	Pass
6.31	26.9	31.4	11.5	16.0	20.0	69.5	-31.1	73.0	-21.6	60.0	-24.0	Pass
6.47	28.3	29.8	13.3	15.7	20.0	69.5	-32.7	73.0	-23.2	60.0	-24.3	Pass
9.56	34.6	34.9	18.2	19.2	20.0	69.5	-27.6	73.0	-18.1	60.0	-20.8	Pass
9.73	34.2	34.9	17.4	18.0	20.0	69.5	-27.6	73.0	-18.1	60.0	-22.0	Pass
10.03	33.7	32.0	17.3	17.0	20.0	69.5	-28.8	73.0	-19.3	60.0	-22.7	Pass
100% load charging:					---	---	---	---	---	---	---	---
0.15	46.0	46.6	35.1	38.2	20.0	---	---	79.0	-12.4	66.0	-7.8	Pass
0.20	43.6	40.0	31.7	36.2	20.0	---	---	79.0	-15.4	66.0	-9.8	Pass
9.28	34.1	33.5	17.2	17.3	20.0	69.5	-28.4	73.0	-18.9	60.0	-22.7	Pass
9.43	35.2	34.2	20.0	17.3	20.0	69.5	-27.3	73.0	-17.8	60.0	-20.0	Pass
9.79	33.4	34.6	17.6	19.0	20.0	69.5	-27.9	73.0	-18.4	60.0	-21.0	Pass
9.89	32.9	34.0	20.9	18.2	20.0	69.5	-28.5	73.0	-19.0	60.0	-19.1	Pass
9.99	33.0	34.9	19.2	19.2	20.0	69.5	-27.6	73.0	-18.1	60.0	-20.8	Pass
10.40	27.2	34.2	13.3	20.0	20.0	69.5	-28.3	73.0	-18.8	60.0	-20.0	Pass
50% load charging:					---	---	---	---	---	---	---	---
0.15	45.8	46.9	35.5	36.0	20.0	---	---	79.0	-12.1	66.0	-10.0	Pass
0.20	37.0	43.7	36.0	34.0	20.0	---	---	79.0	-15.3	66.0	-10.0	Pass
8.95	33.8	30.3	17.0	15.1	20.0	69.5	-28.7	73.0	-19.2	60.0	-23.0	Pass
9.25	34.4	31.1	19.0	18.5	20.0	69.5	-28.1	73.0	-18.6	60.0	-21.0	Pass
9.40	35.5	33.8	20.5	18.0	20.0	69.5	-27.0	73.0	-17.5	60.0	-19.5	Pass
9.55	36.3	35.0	21.0	21.0	20.0	69.5	-26.2	73.0	-16.7	60.0	-19.0	Pass
9.63	36.3	32.8	19.0	17.0	20.0	69.5	-26.2	73.0	-16.7	60.0	-21.0	Pass
9.73	36.4	34.3	20.0	18.0	20.0	69.5	-26.1	73.0	-16.6	60.0	-20.0	Pass

Conducted Emissions Chart

Curtis-Straus LLC

Date: 21-Mar-01 **Company:** APC Corp. NPS Division **Table No:** 4
Engineer: Josh LeBlanc **EUT Desc:** SU3000RMXLI3U with new pwr rating, and extended batterie **Work Order:** B0155
Notes:
Range: 0.15-30Mhz **LISN(s):** Orange **Other Equipment:** --- **Spectrum Analyzer:** White

Frequency (MHz)	Quasi-Peak Readings QP1 (dBµV)	QP2 (dBµV)	Average Readings AV1 (dBµV)	AV2 (dBµV)	Impedance Factor (dB)	FCC A Limit (dBµV)	FCC A Margin dB	CISPR A qp Limit (dBµV)	CISPR A qp Margin dB	CISPR A AVE Limit (dBµV)	CISPR A AVE Margin dB	Overall Result (Pass/Fail)
0% load discharging:					---	---	---	---	---	---	---	---
0.31	36.2	38.2	16.0	16.2	20.0	---	---	79.0	-20.8	66.0	-29.8	Pass
8.95	45.6	44.6	36.4	35.0	20.0	69.5	-16.9	73.0	-7.4	60.0	-3.6	Pass
9.26	43.1	43.6	35.1	35.0	20.0	69.5	-18.9	73.0	-9.4	60.0	-4.9	Pass
9.64	41.6	42.7	30.6	32.7	20.0	69.5	-19.8	73.0	-10.3	60.0	-7.3	Pass
10.10	37.2	41.7	28.5	33.0	20.0	69.5	-20.8	73.0	-11.3	60.0	-7.0	Pass
10.46	33.5	42.2	24.0	33.6	20.0	69.5	-20.3	73.0	-10.8	60.0	-6.4	Pass
10.61	32.4	41.7	20.5	33.4	20.0	69.5	-20.8	73.0	-11.3	60.0	-6.6	Pass
50% load discharging:					---	---	---	---	---	---	---	---
0.31	36.5				20.0	---	---	79.0	-22.5	66.0	-9.5	Pass
8.75	41.6	42.5	33.3	33.7	20.0	69.5	-20.0	73.0	-10.5	60.0	-6.3	Pass
8.94	44.0	44.3	37.0	36.5	20.0	69.5	-18.2	73.0	-8.7	60.0	-3.0	Pass
9.10	45.2	44.1	37.5	36.3	20.0	69.5	-17.3	73.0	-7.8	60.0	-2.5	Pass
9.20	45.2	44.4	38.0	38.0	20.0	69.5	-17.3	73.0	-7.8	60.0	-2.0	Pass
9.34	44.5	44.5	37.5	37.0	20.0	69.5	-18.0	73.0	-8.5	60.0	-2.5	Pass
9.42	44.0	44.0	37.0	36.3	20.0	69.5	-18.5	73.0	-9.0	60.0	-3.0	Pass
100% load discharging:					---	---	---	---	---	---	---	---
8.68	42.9	42.1	36.0	34.5	20.0	69.5	-19.6	73.0	-10.1	60.0	-4.0	Pass
8.85	44.8	43.8	35.7	37.0	20.0	69.5	-17.7	73.0	-8.2	60.0	-3.0	Pass
8.92	45.3	44.3	38.0	36.0	20.0	69.5	-17.2	73.0	-7.7	60.0	-2.0	Pass
9.07	44.8	43.2	37.6	35.5	20.0	69.5	-17.7	73.0	-8.2	60.0	-2.4	Pass
9.18	44.7	43.4	36.0	36.0	20.0	69.5	-17.8	73.0	-8.3	60.0	-4.0	Pass
9.30	43.6	42.8	35.0	36.0	20.0	69.5	-18.9	73.0	-9.4	60.0	-4.0	Pass

RFI DATA SHEET

Work Order: B0155 **Table** 5
Date(s): 2/5/01, 5/21/2001
Engineer: Josh LeBlanc
EUT: SU 3000 RM XLI 3U
Company: APC Corp. NPS Division

Performance Criteria: A

Frequency Range: 27-1000MHz

Maximum Test Parameters: 10 V/m

Modulation: 80% AM @ 1kHz sine

Test Equipment Used:
Amplifier: Red, Blue ***Signal Generator:*** Red
Antenna: Yel/Black ***Field Probe:*** Green

Atmospheric Conditions:
Temp: 21.9°C **Humidity:** 40.00% **Pressure:** 1010 mbar

Orientations Tested:

	Front	Right	Back	Left
Horizontal	Pass	Pass	Pass	Pass
Vertical	Pass	Pass	Pass	Pass

EFT DATA SHEET

Work Order: B0155 **Table:** 6
Date: 22-Feb-01
Engineer: Matt Deeter
EUT: SU 3000 RM XLI 3U
Company: APC Corporation NPS Division

Modifications since start date:
none

Modifications this test:
none

Performance Criteria: B

Test Equipment: CDI EFT/B-100

Maximum Test Parameters: ± 4kV-AC ± 2kV-Cables

Atmospheric Conditions:
Temp: 22.3°C **Humidity:** 10.80% **Pressure:** 1025mbar

Test Points:	Pass/Fail	Comments:
AC mains -L-GND	Pass	
AC mains -N-GND	Pass	
AC mains -PE-GND	Pass	
Cables:		
AC Output	Pass	
dB9 Cable	Pass	

ESD DATA SHEET

Work Order: B0155 **Table:** 7
Date: 13-Feb-01
Engineer: Stacey Coulombe Costa
EUT: SU 3000 RM XLI 3U
Company: APC Corporation NPS Division

Modifications since start date:
none

Modifications this test:
none

Performance Criteria: B

Test Equipment: Schaffner NSG 435 **Gun:** Green

Maximum Test Parameters: ± 8 kV-air ± 6 kV-contact

Atmospheric Conditions:
Temp: 23.4°C **Humidity:** 15% **Pressure:** 1022mbar

Test Points:	Pass/Fail	Comments:
Horizontal Coupling Plane	Pass	±2kV, ±4kV, ±6kV
Vertical Coupling Plane	Pass	±2kV, ±4kV, ±6kV
Contact Discharge Test Points		±2kV, ±4kV, ±6kV
Top	Pass	
Screws on Top	Pass	
Front	Pass	
Screws on Front	Pass	
Brackets	Pass	
Left	Pass	
Screws on Left	Pass	
Right	Pass	
Screws on Right	Pass	
Back	Pass	
Screws on Back	Pass	
RS232 Port	Pass	
Air Discharge Test Points		±2kV, ±4kV, ±8kV
Ports on Back	Pass	
Handle on Back	Pass	
Front Panel	Pass	

CRFI DATA SHEET

Work Order: EB0155 **Table:** 8
Date: 20-Feb-01
Engineer: Chad Bell
EUT: SU 3000 RM XLI 3U
Company: APC Corporation NPS Division

Modifications since start date:
none

Modifications this test:
none

Performance Criteria: A

Test Equipment:
Sig Gen: Blue **Amp:** Black **CDN:** Red/Yellow-Black
Resistor Network: Yellow **Injection Clamp:** none

Maximum Test Parameters:
Signal Level: 10 V
Modulation: 80% AM @ 1kHz sine
Frequency Range: 0.15-80MHz
Dwell Frequencies: none

Atmospheric Conditions:
Temp: 22.3°C **Humidity:** 18.60% **Pressure:** 1123mbar

Test Points:	Pass/Fail	Comments:
AC mains	Pass	
AC output	Pass	
serial db-9	Pass	

Power-Frequency Magnetic Field

Work Order: EB0155 **Table:** 9
Date: 20-Feb-01
Engineer: Chad Bell
EUT: SU 3000 RM XLI 3U
Company: APC Corporation NPS Division

Modifications since start date:
none

Performance Criteria: A

Frequency: 50 Hz

Maximum Test Parameters: 30 A/m

Atmospheric Conditions:
Temp: 22.3°C **Humidity:** 18.60% **Pressure:** 1123mbar

Orthogonal Axes Tested:

X	Y	Z	
Pass	Pass	Pass	**Pass/Fail**

LOW FREQUENCY CONDUCTED DISTURBANCES

Work Order: B0155 **Table:** 10
Date: 13-Feb-01
Engineer: Stacey Coulombe Costa
EUT: SU 3000 RM XLI 3U
Company: APC Corporation NPS Division

Modifications since start date:
none

Performance Criteria: A

Frequency Range: 140-360Hz

Maximum Test Parameters: 10V

Atmospheric Conditions:
Temp: 23.4°C **Humidity:** 15% **Pressure:** 1022mbar

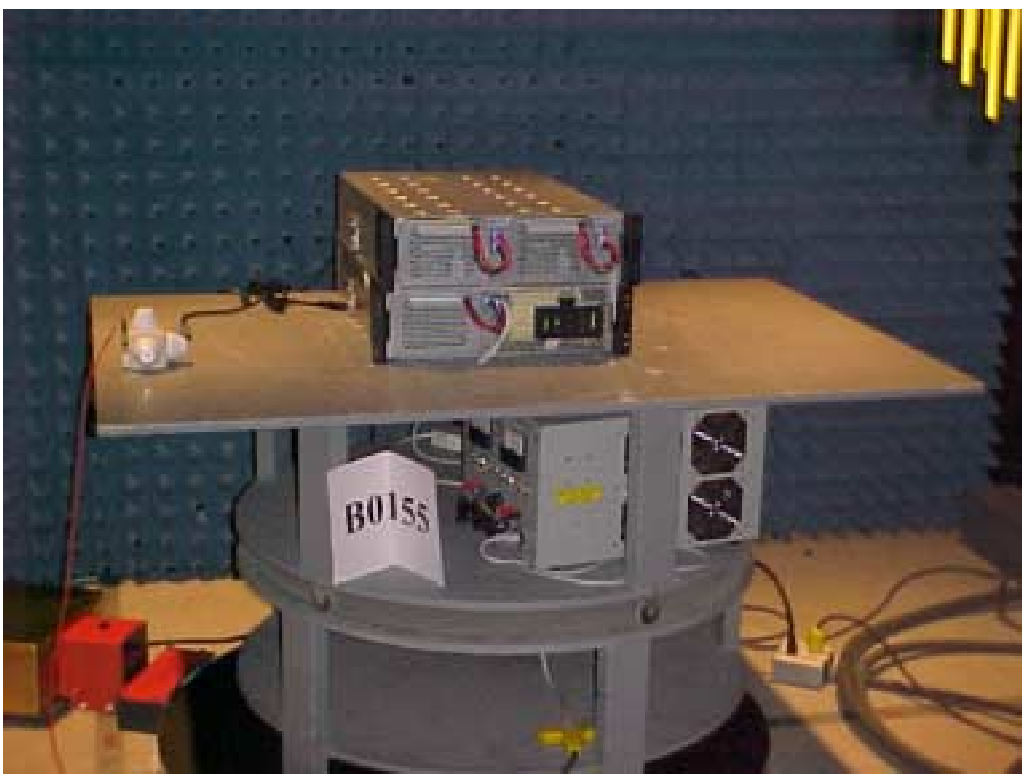
Result:
PASS

Test Configuration Photographs

Radiated Emissions

Radiated Emissions

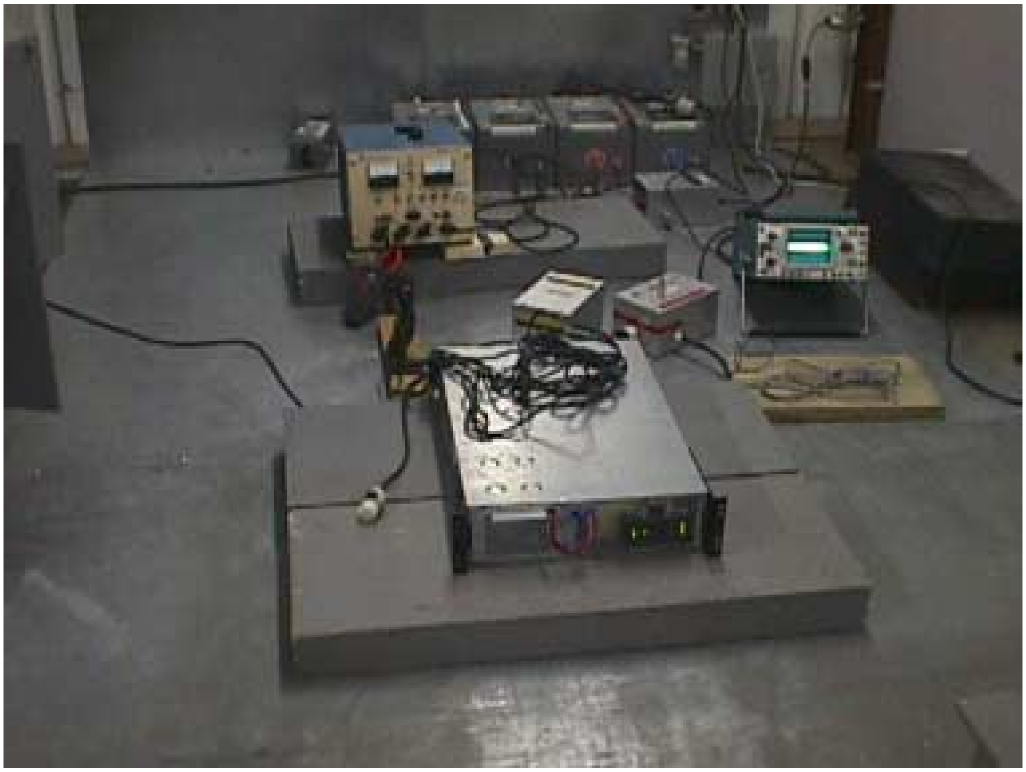
Conducted Emissions



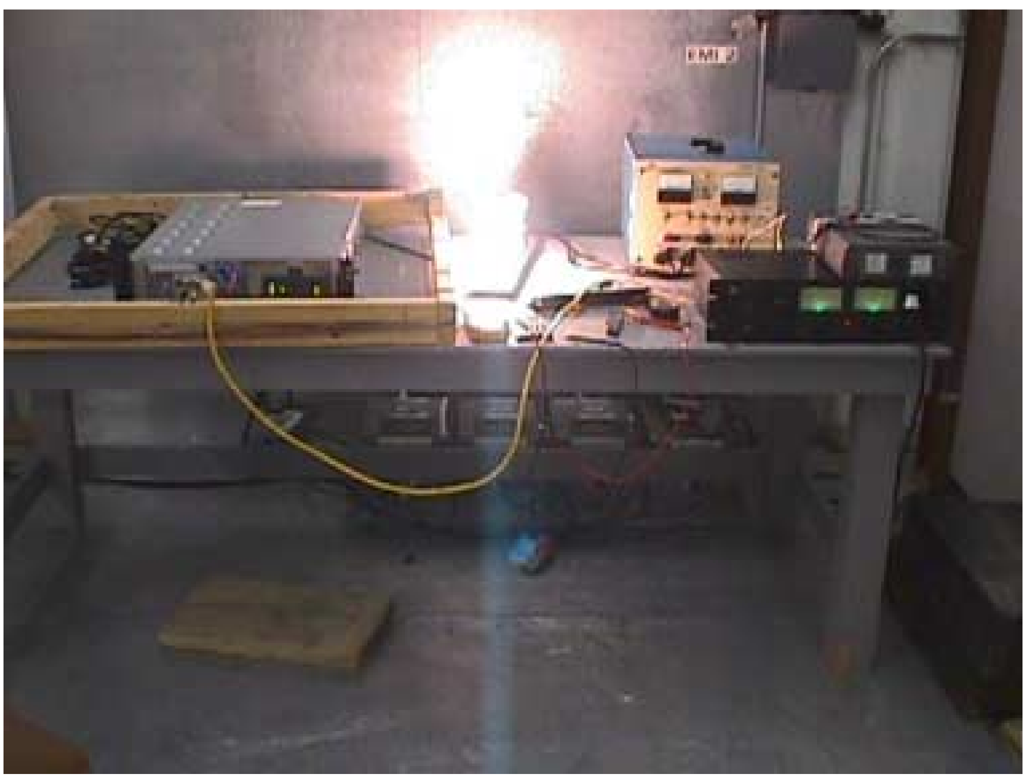
RFI

ESD

EFT



CRFI



Magnetic Immunity

LFD

Test Descriptions

UPS Radiated Emissions Testing Overview

REV 3-May-00

Digital and microprocessor based devices use radio frequency (RF) digital signals for timing purposes. An unintentional consequence of this signal usage is that a certain amount of the RF energy is radiated from the device into the local environment. This radiated RF energy has the potential to interfere with constructive uses of the RF spectrum such as television broadcasting, police and fire radio, and the like. In order to reduce the likelihood that a device will interfere it is required that the radiated RF signals from the device are below an allowable level.

These RF signals decrease in strength as the distance from the source increases. Thus if the potential victim of interference, e.g. a TV receiver, is far enough from the radiator, e.g. a computer, then no interference will occur. For certain environments it is appropriate to expect that potential interference victims will be located at least a minimum distance from the radiator. For the residential environment this distance is generally accepted to be 10 meters while in the commercial environment the accepted distance is 30 meters. The allowable emissions levels are therefore specified to protect equipment which is located further than that distance from the radiator. In general, radiation from the Equipment Under Test (EUT) is measured at 3 or 10 meters to insure that it is at or below allowable levels.

Measurements are made of the radiated energy by recording the field strength indicated by an antenna placed at a specific distance from the device. Most devices do not radiate the RF energy in a predictable manner. Thus the emitted energy may vary with changes in operating mode, physical configuration, or orientation. During measurements these parameters are varied to confirm that the device will remain below the allowable emissions level in the range of typical installations.

To the person actually experiencing the affect of interference, the level of annoyance created is related to the persistence of the interfering signal. For example, a low level steady whine from a receiver is considered to be more annoying than intermittent brief louder pops or clicks. This “human factor” is accounted for by the use of a “quasi-peak” detector in the receiver or spectrum analyzer which measures the signal from the measurement antenna. The detector is a weighted averaging filter with a fast rise time and a slow fall time. Thus steady continuous signals will charge the quasi-peak detector fully while intermittent signals (those with pulse repetition rates less than 1kHz) are reported at a level which can be significantly below their peak level. It should be noted that most RF signals produced by digital devices are continuous in nature and thus the quasi-peak reading will be identical to the peak signal reading. To reduce the test time, the peak emission level is recorded for continuous wave signals as it is the same as the quasi-peak signal level.

The test site for the emissions measurements follows the format developed internationally for an Open Area Test Site (OATS). An antenna mast is installed at the specified distance from a rotating table and is used to raise and lower the measuring antenna. The reference site is clear of reflecting objects, such as metal fences and buildings for an ellipse of twice the measurement test distance. Often preliminary radiated emissions measurements are made at alternate test sites which do not meet the clear space reference criteria. The data collected at alternate test sites is not considered conclusive unless the alternate site also complies with a volumetric site attenuation survey performed over the area that the EUT occupies. At the two foci of the ellipse is the equipment under test (EUT) and the measuring antenna, respectively. The ground plane is made of a combination of galvanized steel sheets and tight wire mesh electrically connected along the seams. This metal ground plane extends 1 meter beyond the furthest extent of the EUT and the measuring antenna. It also covers the area between the EUT and the measuring antenna. The hardware cloth is connected to the utility ground or to stakes driven into the earth for safety.

In order for accurate emissions measurements to be made the test site must possess propagation characteristics which fall within accepted norms. The site has been checked for suitability using techniques specified in American National Standards Institute (ANSI) document C63.4:1992. This document details a procedure which measures the attenuation of the site which is the chief indicator of site acceptability. The theory behind site attenuation is quite simple. A transmitting antenna is set up at a fixed location at one end of the site with a receiving antenna at the other end. If a certain amount of signal is put into the transmitting antenna a lesser amount of signal ought to be measured at the receive antenna. The loss of signal is known as the site attenuation and should follow a predicted curve. If it doesn't, then there is something wrong with either the equipment used or with the physical characteristics of the site.

Actual emissions measurements are taken with broadband biconical-log-periodic hybrid antennas calibrated in accordance with the standard site method detailed in ANSI C63.5:1988. Emissions are measured with the measurement antenna oriented in horizontal and vertical polarization with respect to the ground plane. If measurements are made at other than the limit distance, then the readings obtained are scaled to the limit distance using an inverse relationship. The actual test distance used is noted in the report.

The mast to support the antennas is capable of a 1 to 4 meter height range. The measurement antenna is moved over this range at each emission frequency in order to record the maximum observed signal. The mast is non-conductive and remotely controllable. The test distance is measured from the antenna center (marked during calibration) and the periphery of the EUT.

The Equipment Under Test (EUT) is rotated in order to maximize emissions during the test. For equipment intended to operate on a tabletop or desk radiated tests are conducted on a 0.8 meter high, non-conductive platform. Larger floor standing equipment is tested located on a large floor mounted rotatable platform. In some cases, large equipment on its own casters may be tested without a platform.

Since radiated emissions are a function of cable placement, the cable placement is varied to encompass typical configurations that an end user would encounter to determine the configuration resulting in maximum emissions. At least one cable for each I/O port type is attached to the EUT. If peripherals or modules are available, at least one of each available type is installed and noted in the report. Excess cable length beyond one meter is bundled in the center into a 30 to 40 cm bundle. Cables requiring non-standard lead dress are recorded in the report.

Network connections are simulated if necessary. Any simulator used matches the expected real network connection in terms of both functionality and impedance. For distributed systems, the support equipment may be placed at such a distance that it does not influence the measured emissions. If this option is used, such placement is noted in the test report.

The possible operating modes of the EUT are explored to determine the configuration which maximizes emissions. For uninterruptible power supplies tested under the scope of the product specific standard EN50091-2:1996, both normal and stored energy modes are to be explored, and the UPS is to be loaded with a variable linear load such that the highest emissions level can be determined. Software is investigated as well as different methods of displaying data if available. Data is recorded in the worst case operating mode.

At least the six highest emissions with respect to the limit are recorded. If less than six emissions are visible above the noise floor of the instrumentation, then the noise floor at six representative frequencies is recorded. The test report will document if noise floor readings are reported.

For CISPR and EU standards measurements are usually made over the frequency range of 30 MHz to 1GHz. Deviations are noted in the test report.

Limits of radiated emission in the frequency range 30 to 1000 MHz			
Frequency Range (MHz)	Unrestricted Sales Distribution		Restricted Sales Distribution
	Quasi-peak limits (dB(uV/m))		
	Class A-UPS Test distance 10m	Class B-UPS Test distance 10m	Test distance 30m
30 to 230	40	30	Under consideration; Table 3 class A-UPS shall apply until other limits are determined
230 to 1000	47	37	

The test data is derived from the voltage on the spectrum analyzer. First the reading is corrected for gain factors associated with the use of preamps and loss in the cable. A factor in dB is subtracted from the reading to account for preamp gain, while a factor in dB is added to the signal to account for cable loss. A conversion is performed from the resulting voltage to field strength by multiplying the voltage by the antenna factor. Since antenna factor is expressed as a logarithm (dB/m), this operation takes the form of an addition (to multiply logarithmic numbers, you add them together). Thus:

Field Strength (dBuV/m) = Voltage Reading (dBuV) - Preamp Gain (dB) + Cable Loss (dB) + Antenna Factor (dB/m)

When the levels of ambient radio signals such as local television stations are within 6 dB of the appropriate limit, the following steps may be taken to assure compliance:

1. The measurement bandwidth may be reduced. A check is made to see that peak readings are not affected. The use of a narrower bandwidth allows examination of emissions close to local ambient signals.
2. The antenna may be brought closer to the EUT to increase signal-to-ambient signal strength.
3. For horizontally polarized signals the axis of the test site may be rotated to discriminate against local ambients.

Standard Uncertainty per NIST Technical Note 1297 1994 for this test is estimated to be 2.8dB. This test method is covered by our A2LA accreditation.

Line Conducted Emissions Overview

Digital and microprocessor based devices use radio frequency (RF) digital techniques for timing purposes and in applications such as switching power supplies. An unintentional consequence of this for AC powered devices is that a certain amount of the RF energy is impressed upon the AC power mains in the form of a conducted noise voltage. These conducted emissions have the potential to interfere with constructive uses of the RF spectrum such as AM radio and may also interfere with other devices attached to the same AC mains circuit. In order to reduce the likelihood that a device will interfere it is required that the conducted RF signals from the device are below an allowable level.

Line conducted emissions are measured from the device over the frequency range of 0.15 to 30 MHz. The EUT is powered from a Line Impedance Stabilization Network (LISN). The purpose of the LISN is to provide a calibrated impedance across which to measure the conducted emissions. The RF noise voltage produced by the EUT across the LISN is measured and compared to the limit. In order for the LISN to perform properly it is attached to a ground plane at least 2 meters by 2 meters in size. For table top equipment the measurement is performed with the equipment 40 cm from a vertical conducting surface bonded to a ground plane under the product. The ground plane extends 0.5 meters beyond the product and is 2.5mx3.7m in size. The vertical surface is 2.5mx2.5m.

Limits of mains terminal interference voltage: UPS for unrestricted sales distribution				
Frequency (MHz)	Class A-UPS		Class B-UPS	
	Quasi-Peak (dBuV)	Average (dBuV)	Quasi-Peak (dBuV)	Average (dBuV)
0.15 - 0.50 0.50 – 5.0 5.0 – 30.0	79 73 73	66 60 60	QP= (-19.124)Log(freq)+50.243 56 60	AVG= (-19.124)Log(freq)+40.243 46 50

Limits of mains terminal interference voltage: UPS for restricted sales distribution			
UPS Ratings	Frequency (MHz)	Quasi-Peak (dBuV)	Average (dBuV)
25 – 100 A	0.15 - 0.50 0.50 – 5.0 5.0 – 30.0	100 86 QP= (-25.7)Log(freq)+107.964	90 75 AVG= (-25.7)Log(freq)+97.964
101 – 400 A	0.15 - 0.50 0.50 – 5.0 5.0 – 30.0	130 125 115	120 115 105
> 400 A	0.15 - 0.50 0.50 – 5.0 5.0 – 30.0	Under consideration	Under consideration

As with radiated emissions, the "human factor" is accounted for by the use of a "quasi-peak" detector in the receiver or spectrum analyzer which measures the signal from the LISN. For certain tests (such as EN55022 or EN50091-2), both an average and a quasi-peak limit are specified. Emissions from a device must be below both limits when measured with the appropriate detector. If the emission level is below the average limit when measured with the quasi-peak detector, the EUT is presumed to pass both limits.

The UPS standard EN50091-2 also requires that the interference voltage be monitored on any AC output cabling which can be longer than 10 meters. The conducted disturbances at the output should be less than the amplitude in the above tables, plus 14 dB according to the rated output current.

The possible operating modes of the EUT are explored to determine the configuration which maximizes emissions. As with the radiated emissions requirements for uninterruptable power supplies, both normal and stored energy modes are to be explored, and the UPS is to be loaded with a variable linear load such that the highest emissions level can be determined. Software is investigated as well as different methods of displaying data if available. Data is recorded in the worst case operating mode.

At least the six highest emissions with respect to the limit are recorded. If less than six emissions are visible above the noise floor of the instrumentation, then the noise floor at six representative frequencies is recorded. The test report will document if noise floor readings are reported.

Standard Uncertainty per NIST Technical Note 1297 1994 for this test is estimated to be 2dB.

All testing is performed within the framework of a laboratory quality system modeled on ISO Guide 25 *General requirements for the competence of calibration and testing laboratories* and is subject to our terms and conditions. This test method is covered by our A2LA accreditation.

Radiated RF Immunity Testing Overview

REV 3-May-00

Radiated fields result from many sources. In today's environment the RF spectrum is crowded by broadcast media (radio and TV), cellular phone systems, telemetry, amateur radio, radio navigation aids, industrial scientific and medical (ISM) devices, and others, all of which have the potential to disturb electronic products.

Development of test standards is based on statistical analysis of various RF sources within these allocations. In some rare cases, electrical field levels can reach hundreds of volts per meter (e.g. - an installation close to a high power broadcast transmitter). At other, remote locations, fields are usually less than 1 V/m. Modulation types and levels also vary from site to site.

The generic immunity standard for residential, commercial and light industrial environments EN 50082-1 specifies the IEC 801-3:1984 test methodology and applies a field intensity level of 3 V/m in the frequency range of 27 to 500 MHz. This field, which corresponds to Severity Level 2 as specified in IEC 801-3:1984, is generated as a continuous wave, without modulation. These field levels, while generally lower than accepted safe human exposure levels, can cause harmful interference to communications and other electronics. For these reasons, testing for radiated immunity must be conducted in a controlled area. This controlled area may be a RF shielded enclosure, a Transverse Electromagnetic (TEM) cell (also known as a Crawford cell) or an RF absorber lined shielded enclosure. Most testing is performed in a shielded enclosure. There is no specific requirements for field uniformity in IEC 801-3:1984.

The generic heavy industrial immunity specification EN 50082-2 specifies the ENV50140 and ENV 50204 test methodologies. These have been superceded by the EN61000-4-3 standard. It applies a field intensity level of 10 V/m in the frequency range of 80 to 1000 MHz with reductions to 3 V/m in the European TV bands of 87-108 MHz, 174-230 MHz, and 470-790 MHz. This field, which corresponds to Severity Level 3 as specified in IEC 1000-4-3, is generated with 1kHz 80% depth amplitude modulation. In addition, the frequency range of 895-905 MHz is re-swept with 200 Hz square wave 100% depth modulation. These field levels, while generally lower than accepted safe human exposure levels, can cause harmful interference to communications and other electronics. For these reasons, testing for radiated immunity must be conducted in a controlled area. This controlled area may be a RF shielded enclosure, a Transverse Electromagnetic (TEM) cell (also known as a Crawford cell) or an RF absorber lined shielded enclosure. Most testing is performed in an RF absorber lined shielded enclosure. The uniformity of the field is ±3dB.

Other test levels and frequency ranges may be explored depending on client request. Frequency ranges, field strength levels, and modulation schemes are recorded on the test data sheets.

Power is applied to the EUT in its normal operating condition either through an AC power cord or from an external power supply or battery. In the case of DC units, the power supply or battery is placed on the floor of the shielded enclosure.

Any Test Support Equipment (TSE) which is used to operate or monitor the performance of the EUT is placed either outside of the shielded enclosure or at such a distance that it is unaffected by the field. In cases where cable lengths prohibit placement of the TSE outside the enclosure, they are placed on the enclosure floor or otherwise isolated from the radiated field. Unless specified by the manufacturer, all interface cabling used is twisted pair wire which is unshielded for at least 1m from the EUT. I/O cables are terminated in their normal resistance as specified by the manufacturer. All cables beyond 1m may be shielded to prevent additional coupling. All cables which exit the shielded enclosure are filtered or suppressed using ferrite beads to prevent affecting the TSE.

In cases where no TSE is used to monitor EUT performance, a closed circuit TV camera may be set up inside the shielded enclosure. The camera is to monitor front panel indicators or other performance indications. The TV monitor can be located outside the enclosure and the EUT is observed for performance deviations during all tests.

The RF field is generated by linearly polarized antennas such as bicon/log periodic hybrid antennas. The antenna is set up at a distance of 1m from the EUT in both horizontal and vertical polarization. A signal generator is set up outside of the enclosure and connected by a coaxial cable to a 10 watt broadband amplifier. The output of the amplifier is connected via coaxial cable to the transmitting antenna. An isotropic field probe is placed near the EUT to monitor the field strength present at the EUT.

For 801-3:1984 and similar standards, the signal generator and amplifier are adjusted by a leveling computer to generate a constant field as the signal generator is tuned from 27 to 500 MHz at a rate of approximately 10 minutes per octave (.0015 decades/second). Step size for the frequency tuning is 1%. As the frequency is tuned, the signal generator output amplitude is adjusted by the computer to maintain a field strength. For IEC 1000-4-3, the enclosure is calibrated without the EUT present and the levels required to produce a test field strength are recorded in a computerized table. The test levels are then played back from the computer to produce the desired immunity disturbance level once the EUT is configured inside the enclosure.

In each frequency band, the tests are performed with the antennas in both horizontal and vertical polarization.

In the event of an operating anomaly, the transmitting frequency and the nature of the anomaly is recorded. The field strength is reduced until the normal operation is restored. This field strength is recorded as the threshold of susceptibility. After the device is characterized in the required environment, modifications are made to the EUT to improve immunity as appropriate. In some cases, the EUT is extremely sensitive at several frequencies. In these instances, characterization testing may be terminated early to preclude damage.

Standard Uncertainty per NIST Technical Note 1297 1994 for this test is estimated to be 2dB. This test method is covered by our A2LA accreditation.

Electrostatic Discharge Testing Overview

REV 3-May-00

Electrostatic charges build up on isolated materials under various conditions. One such condition is the rubbing of two materials together. When this occurs, the materials develop opposing charges. If they are isolated, this charge does not dissipate and will continue to accumulate. At some high level of voltage, depending on the material types and spacing, the insulation will break down and the charge will rapidly migrate in an attempt to reach equilibrium. This is what is commonly referred to as "Electrostatic Discharge" (ESD).

One example of materials rubbing creating an electrostatic buildup through friction is that of shoes (rubber, plastic, leather, etc.) on carpet (nylon, etc.), as a result of walking. A human body exhibits a capacitance depending on several factors including physical size. This capacitance stores the charge created by walking or other motions which can cause charge storage. The level of the stored voltage is limited by the size of the capacitance (human body is typically 100-400 pF) and the effects of leakage and corona discharge. Once the body accumulates charge, contact with a neutral or oppositely charged item causes a rapid discharge. The shape of the discharge waveform, and the amplitude of the discharge current, depend in part on the distributed capacitance and series resistance of the human body. A lumped element model of these distributed elements is commonly referred to as a human body model. The values of the lumped elements of the human body model, as well as the maximum charge voltage, vary widely. While IEC 801-2:1984 is technically called out in EN 50082-1, most manufacturers and test labs have migrated to the newer IEC 801-2:1991/IEC 1000-4-2:1995 as the 1984 first edition is clearly and critically out of date. The model currently selected for use in the EU is 330 Ohm/150 pF, usually with a charge voltage of 4kV contact mode/ 8 kV air discharge mode.

IEC 1000-4-2 is the basic procedure for ESD testing. The preferred discharge method specified in IEC 1000-4-2 is referred to as "contact discharge". In this method, a charged internal 150pF capacitor is isolated from the probe tip by a mechanical relay (typically filled with sodium hexaflorine gas). The tip is applied to a nearby metal surface or metal points on the product that the user may touch. The relay is then closed and the arc occurs within the relay, transferring the charge on the cap down the tip. If the product has insulated surfaces, then the "air discharge" method is also employed. In this method the relay is closed while the tip is at a great distance from the product. The tip is then brought to the insulated parts of the product at high speed. If an arc over occurs (though the insulation or more typically through cracks or slots) then that area is subject to more ESD stimulation.

For air discharge the high approach speed is especially important. As the length of the ionized air gap changes, it is necessary to control this variable. Some control can be exerted by making the discharge electrode approach the device under test at high speed. This high approach speed makes test results more repeatable because it reduces the variability of the discharge impedance.

The test site is assembled on top of a ground plane made of overlapping galvanized steel sheets 2.5m x 3.5m. The ground plane is connected to safety earth. Table top equipment is tested on an .8mx1.6m non-conductive table placed on this ground plane. If the tabletop system is especially large a second, separate table is added to support the additional equipment. A sheet of galvanized steel is placed on the tabletop. This plate is connected to the lower ground plane by a wire with 470k Ohm resistors at each end. The plate is called the Horizontal Coupling Plane (HCP). An additional .5mx.5m galvanized steel plate is used as a Vertical Coupling Plane (VCP). The VCP is also connected to the lower ground plane via a wire with 470k Ohm resistors at each end. Tabletop EUTs are isolated from the HCP by an insulator <.5mm thick. Typically a plastic sheet is employed. Floor standing equipment is tested on a 10cm insulator on top of the ground plane. For floor standing EUT configurations which do not have a tabletop component, an HCP is not part of the test setup as the ground plane is not an HCP. The EUT is grounded as normally installed.

The test begins with discharges to the HCP (if present) and VCP. All discharges are applied only in the contact discharge mode. 10 discharges are applied to the HCP 10cm from the EUT, at each of the four sides of the EUT at each voltage and polarity. Every voltage step of 2, 4, 6, 8kV is explored if below or equal to the maximum voltage to be applied. 10 discharges are also applied to the VCP held in four positions so that it illuminates in turn the four sides of the EUT. For large distributed floor standing systems, additional illumination points for the HCP and VCP are usually explored and will be noted in the test report.

Once the indirect discharges to the coupling planes are done, testing moves on to direct discharges to the product itself. If the product is totally metal, only direct discharges are applied as that is the preferred mode. Air discharges are not performed to metal areas of the product. If the product has areas covered with an insulating material than those areas are subject to an air discharge test to see if an arc occurs. Contact discharges are not performed to insulated areas of the product. Some products are tested with only contact discharge (exclusively metal products) and some with only air discharge (insulated products such as those with plastic enclosures). Every voltage step in the standard is explored up to and including the maximum specified in the test. Thus 2 and 4 kV would be applied in a 4kV test. Each point subject to final ESD testing is noted in the test report.

While humidity is important in the charging of actual humans, it is much less important in the testing environment where a power supply within the ESD simulator controls very exactly the test voltage applied. For humans, the upper charging voltage achieved is limited by the bleed off of charge through the humidified atmosphere. IEC 1000-4-2 requires air discharge testing to be performed with humidity in the range of 30% to 60%. Due to the lack of influence of humidity on ESD testing with ESD simulators operated with high approach speeds, we will occasionally perform testing outside of this range when atmospheric conditions warrant. Actual humidity conditions during the test are recorded on the test data sheet.

Standard Uncertainty per NIST Technical Note 1297 1994 for this test is estimated to be 6%. This test method is covered by our A2LA accreditation.

Electrical Fast Transient Burst Testing Overview

REV 3-May-00

High-voltage transients are developed on the power mains as a result of numerous types of switching actions. The interruption of current to inductive loads, relay contact bounce, and other actions may cause transients of several thousands of volts. These transients are characterized by very fast rise times and short pulse widths. They typically occur in bursts, with repetition rates as high as 100 kHz.

With the fast rise time associated with the transient, the energy content of the waveform extends to several hundred megahertz. With this high frequency content, the generated noise exists not only on the power lines, but also as noise coupled to the control and signal lines.

The basic measurement standard for these Electrical Fast Transient Bursts (EFT) is IEC 801-4:1988/ IEC 1000-4-4:1994. This standard specifies transients with a double exponential waveshape. The rise time of the pulse is 5 nS, and the pulse width is 50 nS. The transients are injected in 15 mS bursts with a repetition rate between individual pulses of 5 kHz. The period between each burst is 300 mS.

The test equipment necessary to generate the required bursts usually uses an energy storage capacitor and high voltage source to charge the capacitor. The capacitor is charged to a specified high voltage and discharged into a discharge shaping resistor. The interaction of the storage capacitor and the discharge resistor determine the fall time of the pulse. The rise time of the waveform depends on the inductance in the discharge path, and the capacitance to ground. The standard (IEC 801-4) specifies that the transient generator should have a source impedance of 50 Ohms and that signal characteristics should be measured with the generator loaded with a matched 50 Ohm impedance.

IEC 801-4 offers a choice between two different test set-ups. The first is for a "field test" which is performed in actual installed conditions. In the case of a stationary, floor-mounted EUT, a 1m x 1m reference ground plane is placed near the EUT and grounded to the protective earth at the electrical mains outlet. The plane must be a metallic sheet of at least 0.25mm thick if made of copper or aluminum, or 0.65mm thick if made of other metal. The transient generator is located on the ground plane and grounded directly to the plane. The transient output of the generator is connected by an unshielded wire through a 33 nF capacitor to each of the power supply terminals and the protective earth terminal.

For field tests on non-stationary equipment, the EUT is in a normal configuration, and no artificial ground plane is used. The transient is injected between each power supply terminal and the protective earth terminal at the mains outlet to which the EUT is connected.

"Type tests", which are performed in a laboratory, use a somewhat different set-up. Our tests are type tests unless otherwise noted.

During laboratory tests, all equipment whether floor standing or tabletop must be mounted on a ground plane. The ground plane is 2.5m x 3.5m and is made of galvanized sheet steel. It is connected to the green wire of protective earth of the facility.

In the case of floor standing equipment, the EUT is placed on the groundplane and insulated from it by a 10 cm support. The EUT is configured and operated in accordance with its normal installation procedures. Any conductive structures located near the EUT must be a minimum of 50 cm from it. All connections to earth ground, whether the "green wire safety ground" or cable shields, etc., are made in accordance with manufacturer's specifications. No additional connections of the chassis or ground system to the ground plane are permitted.

For tabletop equipment, the EUT is mounted approximately 0.8m above the reference ground plane. This is accomplished by placing the device on a wooden table. The requirements for ground plane size and connection to the ground plane by the EUT are the same as floor standing equipment.

The EFT test voltages are applied to the EUT in three basic configurations. First, the injection is performed on power supply inputs through a coupling network. This network consists of a capacitor to inject the signal onto the power line, and a decoupling network to prevent the injected signals from being impressed on the AC mains supply. They are built into the test equipment. The test voltage is applied between each power line individually with respect to earth ground. For higher current applications, the transient is injected using a discrete 33 nF capacitor into the power lines.

The second configuration involves injection of the EFT bursts onto I/O circuits and communication lines. This injection requires the use of a capacitive coupling clamp. The appropriate I/O cables are placed inside the coupling clamp and the specified peak voltage is injected between the coupling clamp and ground plane. The coupling clamp is placed at a distance of 1m or less from the EUT. In cases where the I/O cables exceeds 1m in length, the excess length is coiled, with a 0.4m diameter, and placed 10 cm above the ground plane. In the case of an uninterruptible power source tested to the requirements of EN50091-2:1996, all cabling including AC input and output cabling and communication lines is conditioned using this injection method.

The third injection point is the earth connection of the EUT. In general, this earth connection is the "green wire ground" connected via the power cable. In some cases, additional grounding points may be installed. In these cases, the transient voltage is injected through the coupling network into these ground terminals as well. The EFT is injected via a coupling network similar to the power line injection method.

IEC 801-4:1984 specifies that the bursts are injected for a period of 1 minute or more each configuration and polarity. Longer times are used for equipment with longer cycle times in order to apply the bursts during all EUT states. Injection is usually performed first at lower levels and then increased incrementally to the specification level. This incremental method again is performed in order to increase the probability of detecting anomalies before any potential damage is suffered at the higher voltage levels.

In the case of any anomalies, the peak level of the transient voltage is recorded, as well as the nature of the anomaly and the injection point.

Standard Uncertainty per NIST Technical Note 1297 1994 for this test is estimated to be 12%.

All testing is performed within the framework of a *laboratory* quality system modeled on ISO Guide 25 *General requirements for the competence of calibration and testing laboratories* and is subject to our terms and conditions. This test method is covered by our A2LA accreditation.

Conducted RF Immunity Testing Overview

REV 3-May-00

At the lower frequencies it is difficult to design a radiating test source to simulate the coupling that occurs in the real world due to radiated fields. For all testing below 26Mhz and occasionally for testing as high as 230MHz, Conducted RF (sometimes called "bulk current injection") is utilized to simulate radiated field disturbances.

Radiated fields result from many sources. In today's environment the RF spectrum is crowded by broadcast media (radio and TV), cellular phone systems, telemetry, amateur radio, radio navigation aids, industrial scientific and medical (ISM) devices, and others, all of which have the potential to disturb electronic products.

Development of test standards is based on statistical analysis of various RF sources within these allocations. In some rare cases, electrical field levels can reach hundreds of volts per meter (e.g. - an installation close to a high power broadcast transmitter). At other, remote locations, fields are usually less than 1 V/m. Modulation types and levels also vary from site to site. For stimulation from a 150 Ohm RF source, IEC 1000-4-6 has set a level of 1 V open circuit as equivalent to 1 V/m.

The EUT is configured on a .1 m high non-conductive platform over a ground plane which extends at least .5 meters beyond the edge of the EUT. All vertical conducting surfaces are at a distance of at least .5 meters. Where possible, each cable leaving the EUT is terminated in an equivalent 150 common mode load. The purpose of the test is to have RF current flow through the EUT as if it was the center of a dipole made from it and its cables. Thus one cable is stimulated at a time with a 150 Ohm RF source and the current flows to the EUT and out to the cables which are passively terminated to the ground plane in 150 Ohm common mode loads. For shielded (screened) cables, the shield is the injection point. For unshielded cables either a decoupling network with a total parallel impedance of 150 Ohms or a bulk current injection clamp is utilized to inject the disturbance. For the AC mains, a decoupling network with a 150 Ohm parallel RF impedance is used.

The signal generator and amplifier are adjusted by a computer using predetermined signal levels derived during a calibration routine. During calibration, a 150 Ohm load is driven by the signal generator and the coupling network or clamp being calibrated. Signal levels at specific frequencies required to produce the desired stimulation level are recorded. The stimulation level desired is one-half that the open circuit voltage as the 150 Ohm source is loaded with 150 Ohms.

If a bulk current probe is used, a second measurement current probe is inserted over the cable and the signal level is reduced if the current exceeds that which would be injected into a 150 Ohm load.

For complex EUTs, not all possible conduction paths are explored. In accordance with IEC 1000-4-6, n paths are evaluated, where $2 \le n \le 5$. This is assumed to adequately stimulate the EUT and expose failures. The paths are picked based on an evaluation of the EUT architecture and are expected to be the most vulnerable to the conducted disturbances. The test report will detail the paths selected for stimulation.

In the event of an operating anomaly, the frequency and the nature of the anomaly is recorded. The signal strength is reduced until the normal operation is restored. The equivalent open circuit voltage is recorded as the threshold of susceptibility. After the device is characterized in the required environment, modifications are made to the EUT to improve immunity as appropriate. In some cases, the EUT is extremely sensitive at several frequencies. In these instances, characterization testing may be terminated early to preclude damage.

Standard Uncertainty per NIST Technical Note 1297 1994 for this test is estimated to be 1.5dB.

All testing is performed within the framework of a laboratory quality system modeled on ISO Guide 25 *General requirements for the competence of calibration and testing laboratories* and is subject to our terms and conditions. This test method is covered by our A2LA accreditation.

Power Frequency Magnetic Field Immunity Testing Overview

REV 3-May-00

Magnetic Fields created by power distribution at 50 or 60 Hz can interfere with normal equipment operation. Particularly sensitive are devices which use electron beams, such as monitors. Typical manifestations of interference are the wavy images on a computer monitor screen. Only devices with known sensitivity to magnetic fields such as monitors and devices incorporating hall effect sensors are tested.

Usually, equipment is tested only for its immunity to continuous steady magnetic fields, although occasionally, test plans call for evaluation to brief peak levels such that might be observed in a substation during fault clearing.

Equipment is tested by placing it within the uniform area (to 3dB) of a magnetic loop and observing its behavior while a current known to produce a specific magnetic field level is run through the loop. The current is run at the nominal power frequency of 50Hz for equipment destined for Europe.

IEC 1000-4-8 is the basic procedure for power frequency magnetic immunity testing. Typically one of two loops is used. For table top equipment less than 0.6 meters on a side (excluding cables), a 10-turn 1 meter square loop is used to produce the field. Current is supplied from an audio amplifier through a 5 Ohm resistor. The voltage is monitored across the resistor with an oscilloscope and the drive level is adjusted until the desired current through the resistor (and therefore the loop) is achieved. Calibration is performed using a Tibitts coil as the measuring pickup. For floor standing equipment, the equipment is placed within a floor-standing loop which measures 1.5x2 meters. Occasionally other loops may be used and these are noted in the test report.

Equipment is tested with stimulation in three orthogonal axes wherever possible. Deviations are noted in the test report.

Standard Uncertainty per NIST Technical Note 1297 1994 for this test is estimated to be 6%.

All testing is performed within the framework of a laboratory quality system modeled on ISO Guide 25 *General requirements for the competence of calibration and testing laboratories* and is subject to our terms and conditions. This test method is covered by our A2LA accreditation.

Low Frequency Conducted Disturbance Immunity Testing Overview

REV 3-May-00

Some equipment is particularly sensitive to harmonic and interharmonic content from the AC mains. Such products can be damaged by frequency content above the mains frequency (i.e. capacitors across the line will experience increased heating). Others, such as uninterruptable power sources (UPS), which monitor the line quality, may mistake harmonic content for line failure. A UPS subject to low frequency disturbances may inadvertently switch off the line and begin discharging the battery while the mains is still supplying adequate 60/50 Hz power. The purpose of this test is to determine the effects of these harmonics in low-voltage supply networks on equipment that could be sensitive to such frequencies.

This is the harmonic emissions counterpart for susceptibility testing as required by the UPS product specific standard EN50091-2:1996, which references IEC 1000-2-2 for specific test procedure, and IEC 1000-4-1 for guidelines on test equipment. The test voltage can consist of one or more continuous sine waves superimposed on the power supply voltage. The conditioning for 230 VAC/50 Hz units is done with a single sinusoidal disturbing voltage of 10 V_{rms} at a frequency which is slowly varied from 140 Hz to 360 Hz. For other rated voltages and frequencies, conditioning is applied at a voltage and frequency range given by the following formulae:

Low end of frequency Range (Hz): $F_{low} = (F_{supply})*2.8$
High end of frequency Range (Hz): $F_{high} = (F_{supply})*7.2$
Disturbance Voltage: $V_{dist} = (V_{rated})/23$

Where V_{rated} is the rated supply voltage for the equipment

Rated Voltage (V)	Disturbance Voltage (V)	F_{supply} (Hz)	F_{low} (Hz)	F_{high} (Hz)
120	5.2	60	168	432
230	10	50	140	360

The conditioning is applied by a voltage source placed in series with the EUT in the neutral lead. Voltages generated by this source are then superimposed on the mains voltage seen by the EUT. For high current EUTs, the voltage source may be coupled through a buck/boost 10:1 transformer to limit the current through the voltage source to one tenth the amount flowing through the EUT. The voltage source is increased by a factor of ten to account for the transformer.

Standard Uncertainty per NIST Technical Note 1297 1994 is estimated to be 22% for this test.

All testing is performed within the framework of a laboratory quality system modeled on ISO Guide 25 *General requirements for the competence of calibration and testing laboratories* and is subject to our terms and conditions. This test method is covered by our A2LA accreditation.

Test Equipment Used

SPECTRUM ANALYZERS

x	Analyzer	Model No.	Company	Serial No.	Calibration Due
	RED 9kHz-1.8GHz	8591E	HP	3441A03559	15-MAY-2002
x	**WHITE** 9kHz-22GHz	8593E	HP	3547U01252	26-JAN-2002
	BLUE 9kHz-1.8GHz	8591E	HP	3223A00227	18-SEP-2001
x	**YELLOW** 9kHz-2.9GHz	8594E	HP	3523A01958	03-AUG-2001
	GREEN 9kHz-26.5GHz	8593E	HP	3829A03618	05-OCT-2001
	BLACK 9kHz-12.8GHz	8596E	HP	3710A00944	28-JUN-2001
	YELLOW-BLACK 20Hz-40.0MHz	3585A	HP	A183438	16-NOV-2001
	ORANGE 9kHz-26.5GHz	E4407B	HP	US39440975	18-MAY-2002

LISNs

x	LISN	Model No.	Company	Serial No.	Calibration Due
	RED 10kHz-30MHz	8012-50-R-24-BNC	Solar	956348	19-APR-2002
	BLUE 10kHz-30MHz	8012-50-R-24-BNC	Solar	956349	19-APR-2002
	YELLOW-BLACK 10kHz-30MHz	8012-50-R-24-BNC	Solar	984735	12-OCT-2001
x	**ORANGE** 10kHz-30MHz	8012-50-R-24-BNC	Solar	903707	27-SEP-2001
	GOLD 10kHz-30MHz	8012-50-R-24-BNC	Solar	984734	12-OCT-2001
	WHITE-BLACK 10kHz-30MHz	8610-50-TS-100-N	Solar	972019	11-JUN-2001
	BLACK 10kHz-30MHz	8610-50-TS-100-N	Solar	972017	11-JUN-2001
	RED-BLACK 10kHz-30MHz	8610-50-TS-100-N	Solar	972016	11-JUN-2001
	BLUE-BLACK 10kHz-30MHz	8610-50-TS-100-N	Solar	972018	11-JUN-2001

OPEN AREA TEST SITES (OATS)

x	Site	FCC Code	IC Code	VCCI Code	Calibration Due
x	"F" Florida	93448	IC 2762-F	R-468/ C-480	28-JUN-2001
	"T" Texas	93448	IC 2762-T	R-905/ C-480	09-AUG-2001
	"A" Alaska	93448	IC 2762-A	R-903/ C-480	07-JUN-2001
	"M" Maine	93448	IC 2762-M	R-904/ C-480	22-JUN-2001
	"J" Jamaica	n/a	n/a	n/a	20-JUN-2001

ANTENNAS

x	Antenna	Model No.	Company	Serial No.	Calibration Due
	GREEN Bilog: 30MHz-2GHz	CBL6112B	Chase	2435	23-JUN-2001
	GREEN-BLACK Bilog: 30MHz-2GHz	CBL6112B	Chase	2412	23-JUN-2001
	GREEN-WHITE Bilog: 30MHz-2GHz	CBL6112B	Chase	2574	11-JUN-2001
x	RED Bilog: 30MHz-1GHz	3143	EMCO	1270	23- JUN-2001
	BLUE Bilog: 30MHz-1GHz	3143	EMCO	1271	23-JUN-2001
	GRAY Bilog: 26MHz-2GHz	3141	EMCO	9703-1038	11-JUN-2001
x	YELLOW-BLACK X-Wing Bilog: 20-2000MHz	CBL6140A	Chase	1112	11-JUN-2001
	YELLOW Horn: 1-18GHz	3115	EMCO	9608-4898	08-MAY-2002
	BLACK Horn: 1-18GHz	3115	EMCO	9703-5148	30-JUN-2001
	RED-BLACK Horn: 1-18GHz	3115	EMCO *Telogy Rental*	2333	31-OCT-2001
	ORANGE Horn: 1-18GHz	3115	EMCO	0004-6123	17-MAY-2001
	WHITE Std Gain Horn: 18-26.5GHz	3160-09	EMCO	9610-1068	10-JUN-2001
	SMALL LOOP Passive Loop: 9kHz-30MHz	PLA-130/A	ARA	1024	28-DEC-2001
	LARGE LOOP Passive Loop: 20Hz-5MHz	6511	EMCO	9704-1154	06-NOV-2001
	MONOPOLE Act Monopole: 30Hz-30MHz	3301B	EMCO	3824	27-APR-2002
	DIPOLE Adj Dipole: 30-1000MHz	3121C	EMCO	1370	10-JUN-2001
	DIPOLE Adj Dipole: 30-1000MHz	3121C	EMCO	1371	10-JUN-2001

PREAMPLIFIERS

x	Preamplifier	Model No.	Company	Serial No.	Calibration Due
	RED 0.10-2000MHz	ZFL-1000-LN	MiniCircuits/ C-S	n/a	24-MAR-2002
	BLUE 0.01-2000MHz	ZFL-1000-LN	MiniCircuits/ C-S	n/a	18-MAY-2002
	BLUE-BLACK 0.01-2000MHz	ZFL-1000-LN	MiniCircuits/ C-S	n/a	09-OCT-2001
	GREEN 0.01-2000MHz	ZFL-1000-LN	MiniCircuits/ C-S	n/a	24-MAR-2002
	GOLD 0.01-2000MHz	ZFL-1000-LN	MiniCircuits/ C-S	n/a	18-MAY-2002
x	**BLACK** 0.01-2000MHz	ZFL-1000-LN	MiniCircuits/ C-S	n/a	24-MAR-2002
	ORANGE 0.01-2000MHz	ZFL-1000-LN	MiniCircuits/ C-S	n/a	19-DEC-2001
	WHITE 1-20GHz	SMC-12A	MITEQ	426643	09-OCT-2001
	YELLOW-BLACK 1-20GHz	SMC-12A	MITEQ	535055	09-OCT-2001
	ORANGE-BLACK 1-20GHz	SMC-12A	MITEQ	690639	06-JUL-2001
	YELLOW 18-26.5GHz	AFS4-18002650-60-8P-4	MITEQ	467559	28-AUG-2001

EFT GENERATORS

x	Device	Model No.	Company	Serial No.	Calibration Due
x	**EFT/B-100**	EFT/B-100	CDI	101	04-JUN-2001
	EFT DIRECT COUPLING CAP	n/a	C-S	01	07-DEC-2001

ESD GENERATORS

x	Gun	Model No.	Company	Serial No.	Calibration Due
x	**GREEN**	NSG435	Schaffner	000839	31-OCT-2001
	RED	NSG435	Schaffner	001625	18-JUN-2001

FIELD PROBES

x	Probe	Model No.	Company	Serial No.	Calibration Due
	RED 0.01-1000MHz	HI-4422	Holaday	90369	10-FEB-2002
x	**GREEN** 0.01-1000MHz	HI-4422	Holaday	97363	23-FEB-2002
	ORANGE 0.01-1000MHz	HI-4422	Holaday *ERC Rental*	89865	10-OCT-2001

AMPLIFIERS

x	Amplifier	Model No.	Company	Serial No.	Calibration Due
x	**RED** 0.5-1000MHz	10W1000B	AR	18708	27-MAR-2002
x	**BLUE** 0.01-250MHz	75A250	AR	19165	25-MAR-2002
	GREEN 0.5-1000MHz	10W1000B	AR	23423	27-MAR-2002
x	**BLACK** 0.01-250MHz	75A250	AR	23411	27-MAR-2002
	ORANGE 0.01-250MHz	75A250	AR	26827	25-MAR-2002
	HP489A 1.0-2.0GHz	HP489A	HP	1144AU1780	18-JUL-2001
	HP491C 2.0-4.0GHz	HP491C	HP	449-00638	18-JUL-2001
	HP493A 4.0-8.0GHz	HP493A	HP	171402242	18-JUL-2001
	HP495A 7.0-12.0GHz	HP495A	HP	904-00237	18-JUL-2001
	VZS-6951-K1 2.0-4.0GHz	VZS-6951-K1	Varian *Rental*	5885	06-JUL-2001

SIGNAL GENERATORS

x	Generator	Model No.	Company	Serial No.	Calibration Due
x	**RED** 0.09-2000MHz	HP8648B	HP	3847U02192	08-DEC-2001
x	**BLUE** 0.1-1000MHz	HP8648A	HP	3426A00548	19-JUN-2001
	GREEN 0.09-2000MHz	HP8648B	HP	3623A02072	28-SEP-2001
	ORANGE 0.1-2000MHz	HP8648B	HP	3537A01210	15-JUN-2001
	WHITE 0.2Hz-2MHz	FG2A	Beckman	102037	14-FEB-2002
	BLACK 15MHz Function Gen.	HP33120A	HP	US36004674	13-FEB-2002
	YELLOW 15MHz Function Gen.	HP33120A	HP	US36014119	16-JUN-2001
	SWEEPER 0.01-20.0GHz	HP83752A	HP	3610A01133	13-APR-2002

CDN NETWORKS

x	Network	Model No.	Company	Serial No.	Calibration Due
	BLUE 0.15-100MHz	15A M-3	C-S	01	25-MAR-2002
x	RED 0.15-100MHz	15A M-3	C-S	02	25-MAR-2002
	WHITE 0.15-100MHz	15A M-3	C-S	03	25-MAR-2002
x	YELLOW-BLACK 0.15-100MHz	15A M-3	C-S	07	27-MAR-2002
	BLUE-BLACK 0.15-100MHz	15A M-3	C-S	08	25-MAR-2002
	ORANGE 0.15-100MHz	15A M-2	C-S	09	25-MAR-2002
	GREEN 0.15-100MHz	30A M-3	C-S	04	25-MAR-2002
	YELLOW 0.15-100MHz	30A M-5	C-S	05	25-MAR-2002
	BLACK 0.15-100MHz	20A M-2	C-S	06	04-JAN-2002
	YELLOW (RES)	100Ω Resistor Network	C-S	01	01-SEP-2001
	GREEN (RES)	100Ω Resistor Network	C-S	02	07-DEC-2001

HARMONIC/FLICKER TEST SYSTEM

x	Device	Model No.	Company	Serial No.	Calibration Due
x	HFTS	HP6842A	HP	3531A-00169	21-SEP-2001

METEOROLOGICAL METERS

x	Meter	Model No.	Company	Serial No.	Calibration Due
x	TEMPERATURE /HUMIDITY GAUGE	TH300	Dickson	9044101	27-APR-2001
x	ATMOSPHERIC PRESSURE GAUGE	BA928	Oregon Scientific	C3166-1	21-AUG-2001

Unless otherwise noted the calibration interval is one year. All equipment is calibrated using standards traceable to NIST or other nationally recognized calibration standard.

Product Documentation

If additional documentation on the product has been provided for insertion in the report, it is appended here.

Jurisdictional Labeling and Required Instruction Manual Inserts

CE Marking - European Union (EU)

The CE mark is affixed by a manufacturer to its product in order to demonstrate to customs and other officials that the product marked is in conformity with all applicable European Union (EU) Directives. The CE mark must take the form shown below and must be affixed to the product unless the product is too small. If the product is too small, the CE mark may be affixed to the packaging, instructions for use or the guarantee certificate. The CE mark must be a minimum 5mm in height.

It is customary to include the written Declaration of Conformity with the shipment of the product as well in case of questions at the border. Supplying the Declaration of Conformity with the product is not required, it's just good preventative practice. It is required that the directive be held available to EU officials for a period of ten years following the placement of the product on the market.

The CE marking is available in bit-mapped form from the Curtis-Straus web site at http://www.curtis-straus.com or call us for a complementary disk.

Sample Declaration of Conformity

Declaration of conformity
Konformitätserklärung
Déclaration de conformité
Declaración de Confomidad
Verklaring de overeenstemming
Dichiarazione di conformità

We/Wir/ Nous/WIJ/Noi: ***COMPANY NAME***
ADDRESS

declare under our sole responsibility that the product,
erklären, in alleniniger Verantwortung,daß dieses Produkt,
déclarons sous notre seule responsabilité que le produit,
declaramos, bajo nuestra sola responsabilidad, que el producto,
verklaren onder onze verantwoordelijkheid, dat het product,
dichiariamo sotto nostra unica responsabilità, che il prodotto,

MODEL NUMBER
SERIAL NUMBER RANGE

to which this declaration relates is in conformity with the following standard(s) or other normative documents.
auf das sich diese Erklärung bezieht, mit der/den folgenden Norm(en) oder Richtlinie(n) übereinstimmt.
auquel se réfère cette déclaration est conforme à la (aux) norme(s) ou au(x) document(s) normatif(s).
al que se refiere esta declaración es conforme a la(s) norma(s) u otro(s) documento(s) normativo(s).
waarnaar deze verklaring verwijst, aan de volende norm(en) of richtlijn(en) beantwoordt.
a cui si riferisce questa dichiarazione è conforme alla/e seguente/i norma/o documento/i normativo/i.

LIST OF DIRECTIVES AND EN'S TO WHICH CONFORMANCE IS CLAIMED (Including Title and edition date).
SIGNATURE OF RESPONSIBLE PARTY, DATE, and PLACE OF ISSUE

Some supplier phone numbers

Coatings Conductive

Acheson Colloids Co.	800-255-1908
Bystat International Inc.	800-361-6777
Chomerics, a div. Of Parker Hannifin Corp.	781-935-4850
Cool-Amp Conducto-Lube	503-624-6426
Delker Corporation	203-481-4277
EMC/EUPEN	732-919-1100
Master Bond Inc.	201-343-8983
Plastic-Plate Inc.	616-698-2030
Polyonics, Inc.	603-352-1415
Sealing Devices, Inc.	716-684-7600
Walter G. Legge Co., Inc.	914-737-5040
WESTEK Electrostatics	800-446-2888

Connectors, Filter Pin

AMP Inc.	800-522-6752
Amphenol Canada Corporation	416-291-4401
Atlantic Components	800-433-6600
EMC/EUPEN	732-919-1100
EMP Connectors, Inc.	909-922-9000
Kycon Cable & Connector, Inc.	408-295-1110
Regal Electronics	408-988-2288
RFI Corporation	516-231-6400
Schaffner EMC, Inc.	973-379-7778
Texas Spectrum Electronics, Inc.	972-296-3699

Fingers, Connector

Regal Electronics	408-988-2288
Shielding Resources Group, Inc.	918-663-1985
Tech-Etch, Inc.	508-747-0300

Gaskets, EMI Shielding

Alloy Extrusion Company, Inc.	216-677-4946
AMP Inc.	800-522-6752
Bal Seal Engineering Co., Inc.	714-545-1006
Capcon International, Inc.	516-371-5600
Chomerics, a div. Of Parker Hannifin Corp.	617-935-4850
Delker Corporation	203-481-4277
EMC/EUPEN	908-919-1100
Fujipoly	908-298-3850
Glitsch Special Products, Inc.	800-969-6374
Intermark (USA), Inc.	212-629-3620
Instrument Specialties Co., Inc.	717-424-8510
Leader Tech, Inc.	813-855-6921
Majr Products Corp.	814-763-3211
Monsanto Company	800-843-4556
Omega Shielding	201-890-7455
Orion Industries Incorporated	978-772-6000
Schlegel Corporation	716-427-7200
Sealing Devices, Inc.	716-684-7600
Shielding Express, Inc.	508-880-0987
Shielding Resources Group, Inc.	918-663-1985
Spira	818-764-8222
Stockwell Rubber Company, Inc.	215-335-3005
Swift Textile Metalizing Corp.	860-234-1122
Tech-Etch, Inc.	508-747-0300
Vanguard Products Corporation	203-744-7265
Wescorp Static Control Prod.	650-969-7717

Filters, Power Line

Braden Shielding Systems	918-272-5371
Capcon International Inc.	516-371-5600
Captor Corporation	937-667-8484
Controlled Power Co.	800-521-4792
Corcom, Inc.	847-680-7400
Digi-Key	218-681-6674
EMC Consulting, Inc.	613-269-4247
EMC/EUPEN	908-919-1100
LCR Electronics, Inc.	610-278-0840
Lindgren RF Enclosures	630-307-7200
Metatech Corporation	505-243-1423
MTK Electronics	516-567-4666
Okaya Electric America Inc.	219-477-4488
Panashield, Inc.	203-866-5888
Potter Production Corporation	800-655-7889
Price Wheeler Corp.	800-528-0313
Pulizzi Engineering, Inc.	714-540-4229
Regal Electronics	408-988-2288
RFI Corporaiton	516-231-6400
SAE Power	408-987-2700
Schaffner EMC, Inc.	201-379-7778
Shielding Resources Group, Inc.	918-663-1985
Spectrum Control, Inc.	814-835-4000
Steward	423-867-4100
Superior Electric	860-585-4500
Texas Spectrum Electronics, Inc.	214-296-3699
Times One Instruments, Inc.	310-247-4848
Tusonix, Inc.	520-744-0400
Wilco Corporation	800-611-2343

Filters, Signal Line

AMP Inc.	800-522-6752
Braden Shielding Systems	918-272-5371
Capcon International, Inc.	516-371-5600
Captor Corporation	513-667-8484
Corcom, Inc.	847-680-7400
Digi-Key	218-681-7400
EMC/EUPEN	908-919-1100
Fair-Rite Products Corp.	914-895-2055
Ferronics Inc.	716-388-1020
LCR Electronics Inc.	610-278-0840
Lindgren RF Enclosures	630-307-7200
Metatech Corporation	505-243-1423
MMC Corporation	847-577-0200
MTK Electronics, Inc.	516-567-4666
Okaya Electric America Inc.	219-477-4488
Panashield Inc.	203-866-5888
Potter Production Corporation	800-655-7889
Regal Electronics	408-988-2288
RFI Corporation	516-231-6400
Shielding Resources Group, Inc.	918-663-1985
Spectrum Control, Inc.	814-835-4000
Steward	423-867-4100
Texas Spectrum Electronics, Inc.	214-296-3699
Tusonix, Inc.	520-744-0400

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 shall be made to any third party without the prior written consent of both parties unless such distribution is mandated by operation of law. 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.

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 presentment 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 Guide 25 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

SCOPE OF ACCREDITATION TO ISO/IEC GUIDE 25-1990

CURTIS-STRAUS LLC
527 Great Road
Littleton, MA 01460
Jon Curtis Phone: 978-486-8880

ELECTRICAL (EMC)

Valid to: July 31, 2002 Certificate Number: 1627-01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following tests:

Electromagnetic Compatibility
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

Telecommunications
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

Product Safety
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; Overvoltage/power cross tests.

A supplemental scope, identifying full range of tests and types of tests, is available from A2LA or the laboratory.

SUPPLEMENT TO SCOPE OF ACCREDITATION
TO ISO/IEC GUIDE 25-1990

CURTIS-STRAUS
527 Great Road
Littleton, MA 01460
Jon Curtis Phone: 978-486-8880

ELECTRICAL (EMC)

Valid as of: April 21, 2000 Valid until: July 31, 2002 Certificate Number: 1627-01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following:

EMC Standards	Title
Emissions	
CISPR 22 1997 with amendments 1 and 2	Limits and methods of measurement of radio disturbance characteristic 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	Digital apparatus.
AS/NZS 3548 1995	Australian/New Zealand Standard Limits and methods of measurement of radio disturbance characteristics of information technology equipment.
CISPR 11 1990, 1997	Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment.
EN 55011 1991, 1998	Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment.
SABS CISPR 11:1997	Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics. Limits and methods of measurement
Canada ICES-001 1998	Industrial, scientific and medical radio frequency generators.
CNS13803	Industrial, Scientific and Medical Instrument.
AS/NZS 2064: 1997	Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment.

CSA C108.8 – M1983	Electromagnetic Emission from Data Processing Equipment and Electronic Office Machines
CISPR 13 1996, 1998	Limits and methods of measurement of radio interference characteristics of sound and television broadcast receivers and associated equipment.
EN 55013 1990	Sound and television broadcast receivers and associated equipment: Electromagnetic compatibility. Part 1: Specification for limits and methods of measurement of radio disturbance characteristics of broadcast receivers and associated equipment.
EN 55013 Amend 12 1994	Limits and methods of measurement of radio disturbance characteristics of broadcast receivers and associated equipment. Amendment 12.
SABS CISPR 13: 1996	Limits and methods of measurement of radio interference characteristics of sound and television broadcast receivers and associated equipment.
CNS 13439	Broadcast receiver and associated equipment.
AS/NZS 1053: 1999	Limits and methods of measurement of radio interference characteristics of sound and television broadcast receivers and associated equipment.
CISPR 14 1993	Limits and methods of measurement of radio disturbance characteristics of electrical motor- operated and thermal appliances for household and similar purposes, electric tools and electric apparatus.
EN 55014 1993, 1997	Limits and methods of measurement of radio disturbance characteristics of electrical motor- operated and thermal appliances for household and similar purposes, electric tools and similar electric apparatus.
AS/NZS 1044: 1995	Limits and methods of measurement of radio disturbance characteristics of electrical motor- operated and thermal appliances for household and similar purposes, electric tools and similar electric apparatus.
Immunity	
CNS13783-1	Household Electrical Appliances.
SABS CISPR 14-1 1993	Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus Part 1: Emission – Product family standard.
SABS CISPR 14-2 1997	Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus Part 2: Immunity - Product family standard.
CISPR 14-2 1996	Immunity requirements for household appliances, tools and similar apparatus.
CISPR 20 with amendment 3	Limits and methods of measurement of immunity characteristics of sound and television broadcast receivers and associated equipment.
EN 55020 1995	Electromagnetic immunity of broadcast receivers and Associated equipment.
CISPR 24	Information technology equipment – Immunity characteristics – Limits and methods of measurement.
SABS CISPR 24 1997	Information technology equipment – Immunity characteristics – Limits and methods of measurement

AS/NZS 3200.1.2: 1995	Approval and test specification – Medical electrical Equipment – General requirements for safety – Collateral Standard: Electromagnetic compatibility – Requirements and tests.
European Union Basic EMC Standards	
EN 61000-4-2 1995, 1999	Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 2: Electrostatic discharge immunity test – Basic EMC Publication
EN 61000-4-3 1997, 1998 AS/NZS 61000.4.3 1999	Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 3: Radiated, radio-frequency, electromagnetic field immunity test.
EN 61000-4-4 1995	Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 4: Electrical fast transient/burst immunity test – Basic EMC publication.
EN 61000-4-5 1995 AS/NZS 61000.4.5 1999	(EMC) Part 4: Testing and measurement techniques. Section 5: Surge immunity test.
EN 61000-4-6 1996 AS/NZS 61000.4.6 1999	Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 6: Immunity to conducted disturbances, induce by radio-frequency fields.
EN 61000-4-8 1994	Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 8: Power frequency magnetic field immunity test.
EN 61000-4-11 1994	(EMC) Part 4: Testing and measurement techniques. Section 11: Voltage dips, short interruptions and voltage Variations immunity tests.
ENV 61000-2-2 1993	Electromagnetic compatibility (EMC). Part 2: Environment, Section 2: Compatibility levels for low frequency conducted disturbances and signaling in public low-voltage power supply systems (IEC 1000-2-2:1990)
EU Product Family Standards	
EN 50081-1 1992	Electromagnetic capability – Generic emission standard. Part 1: Residential, commercial and light industry. (I.S.)
EN 50081-2 1993	Electromagnetic compatibility – Generic emission standard. Part 2: Industrial environment.
EN 50082-1 1992, 1998	Electromagnetic compatibility – Generic emission standard. Part 1: Residential, commercial and light industry.
EN 50082-2 1995	Electromagnetic compatibility – Generic immunity Standard. Part 2: Industrial environment.
EN 61000-6-1 1997	Electromagnetic Compatibility (EMC)- Part 6: Generic standards- Section 1: Immunity for residential, commercial and light-industrial environments.
EN 61000-6-2 1998	Electromagnetic Compatibility (EMC)- Part 6: Generic standards- Section 2: Immunity for industrial environments.
EN 50091-2 1996	Specification for Uninterruptible Power Systems (UPS). Part 2: EMC requirements.
EN 55024 1998	Information technology equipment – Immunity Characteristics – Limits and methods of measurement.
EN 55103-1 1997	Electromagnetic Compatibility – Product family standard for audio, video, audio-visual and entertainment lighting control apparatus for professional use. Part 1: Emission

EN 55103-2 1997	Electromagnetic Compatibility – Product family standard for audio, video, audio-visual and entertainment lighting control professional use. Part 2: Immunity.
EN 61326 1998	Electrical equipment for measurement, control and laboratory use – EMC requirements.
EN 61547 1996	Equipment for general lighting purposes – EMC immunity requirements.
EN 50130-4 1996	Alarm Systems. Part 4: Electromagnetic compatibility. Product family standard: Immunity requirements for components of fire, intruder and social alarm systems.
EN 55104 1995	Electromagnetic compatibility immunity – requirements for household appliances, tools and similar apparatus. Product family standard.
EN 50083-2 1995	Cabled distribution systems for television and sound signals. Part 2: Electromagnetic compatibility for equipment.
EN 60601-1-2 1993	Medical electrical equipment Part 1: general requirements for safety Section 2: Collateral standard: Electromagnetic compatibility – requirements and tests.
IEC 1800-3 1995	Adjustable speed electrical power drive systems. Part 3: EMC product standard including specific test methods.
EN 60555 Part 2 1987	Disturbances in supply systems caused by household appliances and similar electrical equipment. Part 2: Harmonics.
EN 60555 Part 3 1987	Disturbances in supply systems caused by household appliances and similar electrical equipment. Part 3: Voltage fluctuations.
EN 61000-3-2 1995 AS/NZS 61000.3.2 1998	Electromagnetic compatibility (EMC). Part 3: Limits Section 2: Limits for harmonic current emissions.
EN 61000-3-3 1995 AS/NZS 61000.3.3 1999	Electromagnetic compatibility (EMC). Part 3: Limits Section 2: Limitation of voltage fluctuations and flicker in low-voltage supply systems.
ETS 300 386-1 1994	Equipment Engineering (EE); Public telecommunication network equipment electro-magnetic compatibility (EMC) requirements Part 1: Product family overview, compliance criteria and test levels.
ETS EN 300 386-2 1997, 1998	Electromagnetic compatibility and radio spectrum matters (ERM); Telecommunication network equipment; Electromagnetic compatibility (EMC) requirements; Part 2: Product family standard.
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.
ETS 300 132-2 1996	Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 2: Operated by direct current (dc).
ETR 283 1997	Equipment Engineering (EE): Transient voltages at Interface A on telecommunications direct current (DC) power distributions.

EU radio standards	
(ETS) EN 300 385 v1.2.1 1998	Electromagnetic compatibility and Radio spectrum matters (ERM); ElectroMagnetic Compatibility (EMC) standard for fixed radio links and ancillary equipment.
(ETS) EN 300 220-1 v1.2.1 1997	Electromagnetic compatibility and Radio spectrum matters (ERM); Short range devices; Technical characteristics and test methods for radio equipment to be used in the 25 MHZ to 1000 MHZ frequency range with power levels ranging up to 500 mW; Part 1: Parameters intended for regulatory purposes.
(ETS) EN 300 220-2 v1.2.1 1997	Electromagnetic compatibility and Radio spectrum matters (ERM); Short range devices; Technical characteristics and test methods for radio equipment to be used in the 25 MHZ to 1000 MHZ frequency range with power levels ranging up to 500 mW; Part 2: Supplementary parameters not intended for regulatory purposes.
(ETS) EN 300 330 v1.2.1 1998	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.
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.
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.
Canada Radio Standards	
Canadian GL-36 1995	Industry Canada – technical requirements for low power Devices in the 2400 – 2483.5 MHz band.
Canadian RSS-119 1996	Industry Canada – Land mobile and fixed radio Transmitters and receivers, 27.41 to 960.0 MHz.
Canadian RSS-134 1996	Industry Canada – 900 MHz narrowband personal communications services.
Canadian RSS-210 Issue 3, Feb 5, 2000	Industry Canada – Low power license-exempt radio communication devices.
RFS29 1998	Specification for Restricted Radiation Radio Apparatus(New Zealand)
47 CFR FCC low power transmitters operating on frequencies below 1 GHz, emergency alert systems, unintentional radiators and ISM devices.	Scope A1
47 CFR FCC low power transmitters oper-ating on frequencies above 1 GHz, with the exception of spread spectrum devices.	Scope A2
47 CFR FCC Unlicensed Personal Communications System (PCS) devices	Scope A3
47 CFR FCC Unlicensed National Information Infrastructure devices and low power transmitters using spread spectrum techniques.	Scope A4
(A2LA Cert. No. 1627-01) 11/2/00	Page 5 of 8

47 CFR FCC Personal mobile radio services in the following FCC Rule Parts 22, 24, 25, 27.	Scope B1
47 CFR FCC General Mobile Radio services in the following FCC Rule Parts 22, 74, 90, 95, 97.	Scope B2
47 CFR FCC Maritime and Aviation Radio Services in 47 CFR Parts 80 and 87.	Scope B3
47 CFR FCC Microwave Radio Services in 47 CFR Parts 21, 74 and 101.	Scope B4
FCC/OST MP-5 1986	FCC (Federal Communications Commission) methods of measurement of radio noise emissions from industrial, scientific and medical equipment.
GR-1089-CORE 1997, 1999	Bellcore electromagnetic compatibility and electrical safety – Generic criteria for network telecommunications equipment.
ANSI EMC Standards	
ANSI C63.4 1992, 1999	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.
ANSI C63.5 1988	American National Standard for electromagnetic compatibility – radiated emissions measurements in electromagnetic interference (EMI) control – calibration of antennas.
IEEE EMC Standards	
IEEE C62.41 1980	IEEE recommended practice on surge voltages in low-voltage AC power circuits.
Swedish EMC Standards	
BAKOM 3336.3 1995	Electromagnetic compatibility and electrical safety (EMC & S) for wired terminal equipment. Harmonization document information over the OFCOM requirements.
South African EMC standards other than CISPR equivalents	
SABS 1718-1: 1996	South African Bureau of Standards: Specification for Gaming equipment. Part 1: Casino equipment.
Japanese VCCI Standards	
VCCI V-3/99.05 1999	Technical Requirements.
VCCI V-4/99.05 1999	Instruction for Test Conditions for Requirement under Test.
FCC 47 CFR Part 68 Telephone Terminal Equipment	Connection of terminal equipment to the telephone network. Analog and Digital Equipment. TCB Scope C1.
CS-03 Issue 8 1996 through amendment 3	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)
Specific Product Safety Standards	
IEC 950 1991 Includes Amendments 1, 2, 3 and 4	Safety of information technology equipment including electrical business equipment.
UL 1950 1998	Safety of information technology equipment, including electrical business equipment.
CSA C22.2 No.950-95	Safety of Information Technology Equipment (UL 1950)
UL 60950 1999 DRAFT	Safety of information technology equipment.
(A2LA Cert. No. 1627-01) 11/2/00	Page 6 of 8

IEC 60950 1999	Safety of information technology equipment.
EN 60950 1997, 1998	Safety of information technology equipment, including electrical business equipment.
AS/NZS 3260 1993	Approval and test specification – Safety of information technology equipment including electrical business equipment..
AS/NZS 3260 Supp 1 1996	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)
ACA TS 001 1997	Australian Communications Authority – Safety requirements for customer equipment.
UL 1459 1995	Telephone Equipment.
IEC 1010-1 1990	Safety requirements for electrical equipment for measurement, control and laboratory use, Part 1: General requirements.
EN 61010-1 1993	Safety requirements for electrical equipment for measurement, control and laboratory use, Part 1: General requirements.
UL 3101-1 1993	Electrical equipment for laboratory use Part 1: General requirements.
UL 3111-1 1996	Electrical measuring and test equipment. Part 1: General requirements.
IEC 60601-1 1995	Medical electrical equipment. Part 1: General requirements for safety.
EN 60601-1	Medical electrical equipment.
UL 2601-1 1997	Medical electrical equipment. Part 1: General requirements for safety.
IEC 60065 1998	Audio, video and similar electronic apparatus – Safety requirements.
ANSI/UL 6500: 1998	Audio/video and musical instrument apparatus for household, commercial and similar general use
AS/NZS 3250 1995	Australian/New Zealand Standard – Approval and test specification – Mains operated electronic and related equipment for household and similar general use.
Canadian C22.2 No. 1-94 (1-98) 1994, 1998	Audio, video and similar electronic equipment. Consumer and commercial products.
EN 60065 1994	Safety requirements for main operated electronic and related apparatus for household and similar general use.
IEC 60825 1990 *(For Laser installation only)*	Radiation safety of laser products, equipment classification, requirements and user's guide.
EN 60825-1 1994 *(For Laser installation only)*	Safety of laser products Part 1: equipment classification, requirements and user's guide.
Protocol Analysis and Jitter Standards	
European Union	
TBR 1 : 1995	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, 1 984 kbit/s
(A2LA Cert. No. 1627-01) 11/2/00	Page 7 of 8

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 bis
TBR 3 : 1995 + Amdt : 1997	Integrated Services Digital Network (ISDN); Attachment requirements for terminal equipment to connect to an ISDN using ISDN basic access.
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.
TBR 013 : 1996	Business TeleCommunications (BTC); 2 048 kbit/s digital structured leased lines (D2048S); Attachment requirements for terminal equipment interface.
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.
TBR 24 : 1997	Business Telecommunications (BTC); 34 Mbit/s digital Unstructured and structured leased lines (D34U and D34S); Attachment requirements for terminal equipment interface.
Australia	
TS 002 : 1997	Analogue Interworking and non interference requirements for Customer Equipment Connected to the Public Switched Telephone Network.
TS 016 : 1997	General Requirements for Customer Equipment Connected to Hierarchical Digital Interfaces.
TS 031 : 1997	Requirements for ISDN Basic Access Interface.
TS 038 : 1997	Requirements for ISDN Primary Rate Access Interface
(A2LA Cert. No. 1627-01) 11/2/00	Page 8 of 8