



Project: 03CA36747
File: MC1564
Report: 030332
Date: October 28, 2003
Model: ATRx 10 and ATRx 20

Test Report

On

Electromagnetic Compatibility Testing

Acroprint Time Recorder Co.
Raleigh, NC USA

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Test Report Details:

Tests Performed By:	Underwriters Laboratories Inc. 12 Laboratory Drive Research Triangle Park, NC 27709
Tests Performed For:	Acroprint Time Recorder Co. 5640 Departure Drive Raleigh, NC 27616 USA
Applicant Contact:	Mr. Mark Lackey mlackey@acroprint.com +1 919-872-5800 x138
Test Report Number:	030332
Test Report Date:	October 28, 2003
Product Type:	Proximity Reader
Model Number:	ATRx 10 and ATRx 20
Sample Serial Number:	non-serialized production sample
Sample Tag Number:	S03LB199
EUT Category:	Transmitter - Low Powered
EUT Type:	Table Top
Sample Receive Date:	October 23, 2003
Testing Start Date:	October 24, 2003
Date Testing Complete:	October 24, 2003

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Summary of Testing:

Test #	Test Name Test Requirement/Specification	Comply	Does Not Comply	See Remark
1	Conducted Disturbance Emissions - Voltage 47 CFR Part 15, Subpart B / CISPR 22:1997 Class A 47 CFR Part 15, Subpart C / CISPR 22:1997 Section 15.207	X	-	
2	Radiated Disturbance Emissions - 9 kHz to 30 MHz 47 CFR Part 15, Subpart C / 47 CFR Part 15, Subpart C, Section 15.209	X	-	
3	Radiated Disturbance Emissions - 30 MHz to 1000 MHz 47 CFR Part 15, Subpart C / 47 CFR Part 15, Subpart B, Class A	X	-	
4	Radiated Disturbance Emissions - Occupied Bandwidth 47 CFR Part 15, Subpart C / 47 CFR Part 15, Subpart C, Section 15.209	N/A	N/A	
5	Radiated Disturbance Emissions - Peak-to-Average Ratio 47 CFR Part 15, Subpart C / 47 CFR Part 15, Subpart C, Section 15.209	N/A	N/A	

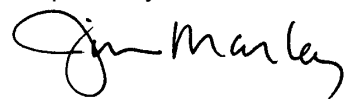
Remarks:

- 1) Device contains an integrated antenna and which may not be removed or altered.
- 2) Device is not subject to routine exposure testing per FCC Part 2.1093(c).
- 3) Digital device portion is only required to comply with Class A limits, because this device is not intended for use in a residential area, however device was shown to also comply with Class B limits.
- 4) Canadian Emissions Designation: 36H0NON.

Conclusion:

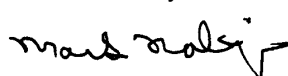
The tests listed in the Summary of Testing section of this report have been performed and the results recorded by Underwriters Laboratories Inc. in accordance with the procedures stated in each test requirement and specification. The test list was determined by the Applicant as being applicable to the Equipment Under Test. As a result, the subject product has been verified to comply or not comply as noted in the Summary of Testing with each test specification. The test results relate only to the items tested.

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Test Facilities:

Test Location A) 10-Meter Anechoic Chamber (Industry Canada - IC 2953, NVLAP - 200246-0, VCCI - R-722)

Constructed by Lindgren RF Enclosures, this room consists of a 17.9 by 12 by 8.3 m (inside clearance) shielded room lined with TDK absorber material. The walls, floor (conducting ground plane) and ceiling are constructed of double sided galvanized sheet steel supported by 19 mm thick particle board. The interior walls and ceiling are covered with 10 by 10 cm, 4.6 mm thick ferrite tiles and partially covered with polystyrene absorber cones. Removable floor tiles and cones covering the floor between the EUT and antenna are provided when RF immunity testing is performed.

Room is provided with a 4.0 m diameter embedded turntable and a 1.2 by 2.1 m and 2.4 by 2.4 m double knife edge doors for access. Also, the room is fed electrical EUT power via permanently installed filters and is provided with a permanently mounted video surveillance camera. A remotely controllable antenna mast is located in the room for positioning the measuring antenna from 1 to 4 m above the ground plane.

Test Location B) Compact Anechoic Chamber

Constructed by Lindgren RF Enclosures, this room consists of a 6 by 3 by 2.9 m (inside clearance) shielded room lined with TDK absorber material. The walls, floor, and ceiling are constructed of double sided galvanized sheet steel supported by 19 mm thick particle board. The interior walls and ceiling are covered with 10 by 10 cm, 4.6 mm thick ferrite tiles and partially covered with polystyrene absorber cones. Removable floor tiles and cones cover the floor between the EUT and antenna.

Room is provided with a 1.2 by 2.1 m double knife edge door for access. Also, the room is fed electrical EUT power via permanently installed filters and is provided with a video camera.

Test Location C) RF Shielded Room (VCCI - C-744, NVLAP - 200246-0)

Constructed by Lindgren RF Enclosures, this room consists of a 7.3 by 4.3 by 2.7 m (inside clearance) shielded room. The walls, floor (conducting ground plane) and ceiling are constructed of double sided galvanized sheet steel supported by 19 mm thick particle board. Room is provided with a 1.2 by 2.1 m double knife edge door for access. Also, the room is fed electrical EUT power via permanently installed filters and is provided with a portable video surveillance camera.

Test Location D) Ground Reference Plane # 1 (VCCI - C-742, NVLAP - 200246-0)

Horizontal floor ground reference plane constructed of double sided galvanized sheet steel supported by 19 mm particle board and measures 3.6 by 3.0 m. It is located and bonded next to one vertical wall of the Control Room and is, therefore, provided with a 3.0 by 3.6 m vertical ground reference plane constructed of the same material. Power filters and LISNs, when required, are placed on top of and bonded to the horizontal floor ground reference plane.

Test Location E) Ground Reference Plane # 2 (VCCI - C-743, NVLAP - 200246-0)

Horizontal floor ground reference plane constructed of double sided galvanized sheet steel supported by 19 mm particle board and measures 4.3 by 5.2 m. It is located and bonded next to one vertical wall of the RFD Shielded Room and is, therefore, provided with a 4.3 by 2.8 m vertical ground reference plane constructed of the same material. Power filters and LISNs, when required, are placed on top of and bonded to the horizontal floor ground reference plane.

Test Location F) Ground Reference Plane # 3

Horizontal floor ground reference plane constructed of galvanized sheet steel measuring 3.0 by 3.6 m x 2.5 mm thick.

Test Location G) Ground Reference Plane # 4 (Automotive)

Horizontal floor ground reference plane constructed of double-sided galvanized sheet steel supported by 19 mm particle board and measures 3.6 by 3.0 m.

Test Location I) Harmonic Current Test Area - Located in front of Standard Source Impedance Power Supply.

Test Location J) Magnetic Field Ground Reference Plane

Horizontal floor ground reference plane constructed of 1.5 mm thick aluminum measuring 3.6 by 2.4 m.

Test Location P) Ground Reference Plane # 5

Horizontal floor ground reference plane constructed of double-sided galvanized sheet steel supported by 19 mm particle board and measures 3.6 by 3.0 m.

Test Location R) Ground Reference Plane # 6

Ground reference plane constructed of galvanized sheet steel measuring 3.0 m x 3.6 m x 2.5 mm thick. CDNs, when required, are placed on top of and bonded to the horizontal floor ground reference plane.

Test Location Q) CISPR 12 Outdoor Site

30 meter diameter non-reflective area located behind the UL-RTP EMC Lab. Test area is used for CISPR 12 testing.

Test Location X) Other - As described in the Comments Section of Test Results.

EUT Information:

Equipment Used During Test:

Use*	Product Type	Manufacturer	Model	Comments
EUT	RFID reader	Acroprint	ATRx 10	Master Unit
EUT	RFID reader	Acroprint	ATRx 20	Slave Unit
ACC	Computer	IBM	Thinkpad 600	Used to send/receive serial data

* Use = EUT - Equipment Under Test, ACC - Accessory (Not Subjected to Test), or SIM - Simulator (Not Subjected to Test)

Input/Output Ports:

Port #	Name	Type*	Cable Max. >3m	Cable Shielded	Comments
0	Enclosure	N/E	No	No	
1	AC Mains	AC	No	No	
2	Serial Port (to computer)	I/O	Yes	No	Unshielded, untwisted "flat" cable with RJ11 connector
3	Serial Port (to slave)	I/O	Yes	No	Unshielded, untwisted "flat" cable with RJ11 connector
4	Antenna (Integrated)	N/E	No	No	Internal Loop antenna approx 1" in diameter

* AC = AC Power Port DC = DC Power Port N/E = Non-Electrical
I/O = Signal Input or Output Port (Not Involved in Process Control)
PMC = Process Measurement and Control Port

EUT Internal Operating Frequencies:

Frequency	Description
125 kHz	Transmit Frequency
4.00 MHz	Crystal
32.768 kHz	Crystal

Frequency	Description

Power Interface:

Mode #	Voltage (V)	Current (A)	Power (W)	Frequency (DC/AC-Hz)	Phases (#)	Comments
Rated	120	-	-	60	1	
1	120	<1	-	60	1	Powered via a wall transformer

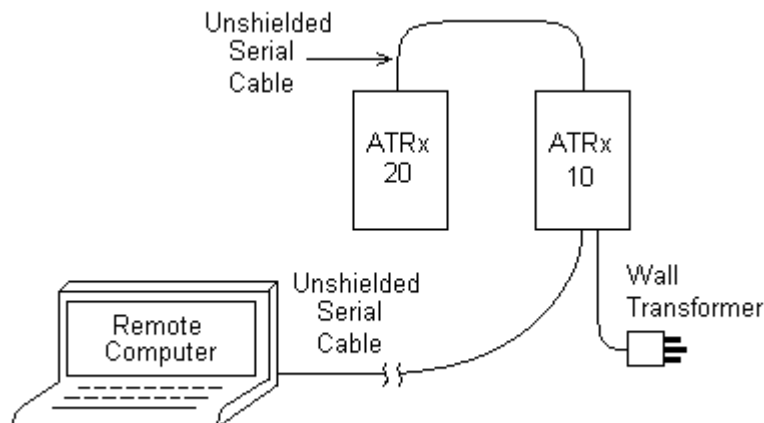
EUT Operation Modes:

Mode #	Description
1	Both Master and Slave units are continuously transmitting. Both units were checked with an RFID to ensure proper operation before testing began.
2	Only the Master unit is continuously transmitting.

EUT Configuration Modes:

Mode #	Description
1	One Model ATRx10 (master) and one model ATRx20 (slave) are included in the test setup. The master is connected via serial port to a remote computer and powered via a small AC-to-DC transformer. The slave unit is attached to the master unit via serial cable. The master unit passes operating voltage down the attaching cable to the slave. Both units are mounted to a polystyrene foam panel.

Configuration Diagram:



Test 1: Conducted Disturbance Emissions - Voltage

Test Requirement: 47 CFR Part 15, Subpart B, Section 15.107 (Digital Device Emissions)
47 CFR Part 15, Subpart C, Section 15.207 (Transmitter Emissions)

Test Specification: CISPR 22:1997 Class A
CISPR 22:1997 Class B

Test Procedure:

The test was performed in accordance with the Test Requirement and Specification and configured as noted in the Test Setup. The EUT was connected to the proper supply source via a Line Impedance Stabilization Network (LISN). The Measuring Receiver was connected to the Port under test via the LISN. A peak measurement was first made at the test point across the test frequency range over a one minute test period. Then, Quasi-Peak or Average measurements were taken and recorded under Discrete Data. This was repeated for each conductor of the test port except for equipment grounding.

Conducted Disturbance Emission Limits For
Mains Terminals Equipment - General Limits in 15.207.

Frequency MHz	Quasi-Peak Limit dB μ V	Average Limit dB μ V
0.15 - 0.50	66 to 56*	56 to 46*
0.50 - 5	56	46
5 - 30	60	50

* Limit decreases linearly with the logarithm of the frequency

Test Deviations:

None

Test Setup: Only the following ports were tested. See EUT Information for details.

Test Item	Port #	Port Name	EUT Operation Mode	EUT Configuration	Power Interface
A	1	AC Mains	1	1	1

Test 1 - Results: Conducted Disturbance Emissions - Voltage

Test Results Summary:

Test Item	Test Location	Humidity (%)	Temperature (°C)	Pressure (kPa)	Pass/Fail (P/F)	Date Completed	Comment #
A	E	34	25	101.1	P	10/24/03	1

The EUT was considered to **Pass** the Requirements.

Comments:

Comment #	Description
1	Device was not measured to provisional limits and may continue to be sold after July 2005.
2	Transmitter emissions are required to comply with limits in 15.207. Digital device emissions are required to comply with Class A limits in 15.107. All emissions are compared to Class B limit.

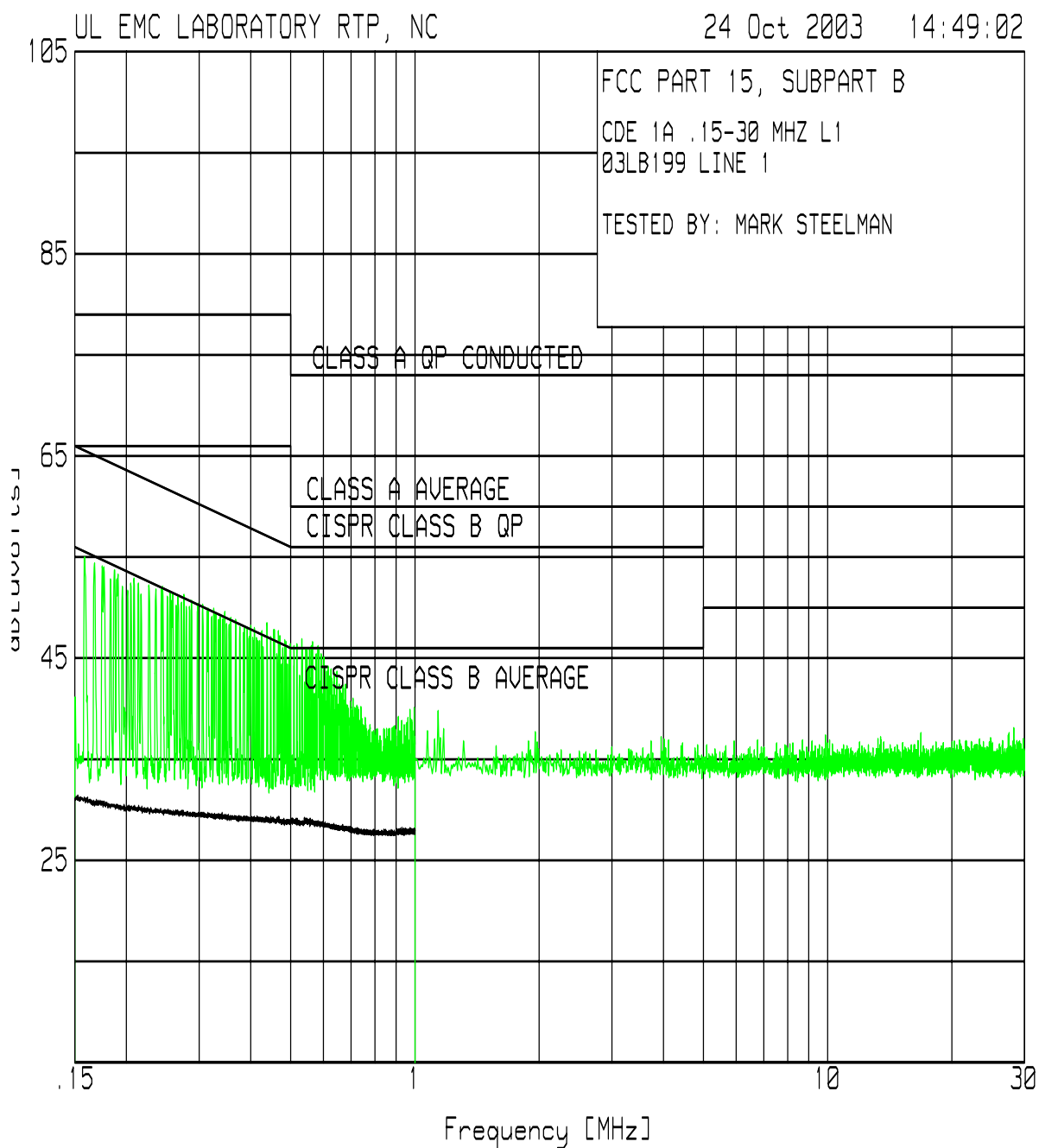
Test Equipment Used:

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
ATA013	20 ft Cable, BNC - BNC	UL	RG-223	2/6/03	2/29/04
ATA056	Transient Limiter, 0.009 to 100 MHz	Electro-Metrics	EM-7600	3/20/03	3/31/04
ATA066	LISN, 150 kHz to 30 MHz	Solar Electronics	9629-50-TS-25-BNC	11/13/02	11/30/03
ATA067	LISN, 150 kHz to 30 MHz	Solar Electronics	9629-50-TS-25-BNC	11/13/02	11/30/03
HI0042	Environmental Indicator	Cole-Palmer	99760-00	10/2/02	10/31/03
SAR001	Spectrum Analyzer / Receiver	Hewlett-Packard	8572A	1/31/03	1/31/04

The above equipment has been calibrated and is within the manufacturer's published limit of error. Calibration is traceable to the National Institute of Standards & Technology(NIST) and conforms to ANSI/NCSL Z540-1-1994.

Test 1, Item A - Peak Plot (Amplitude in dBuV/m):

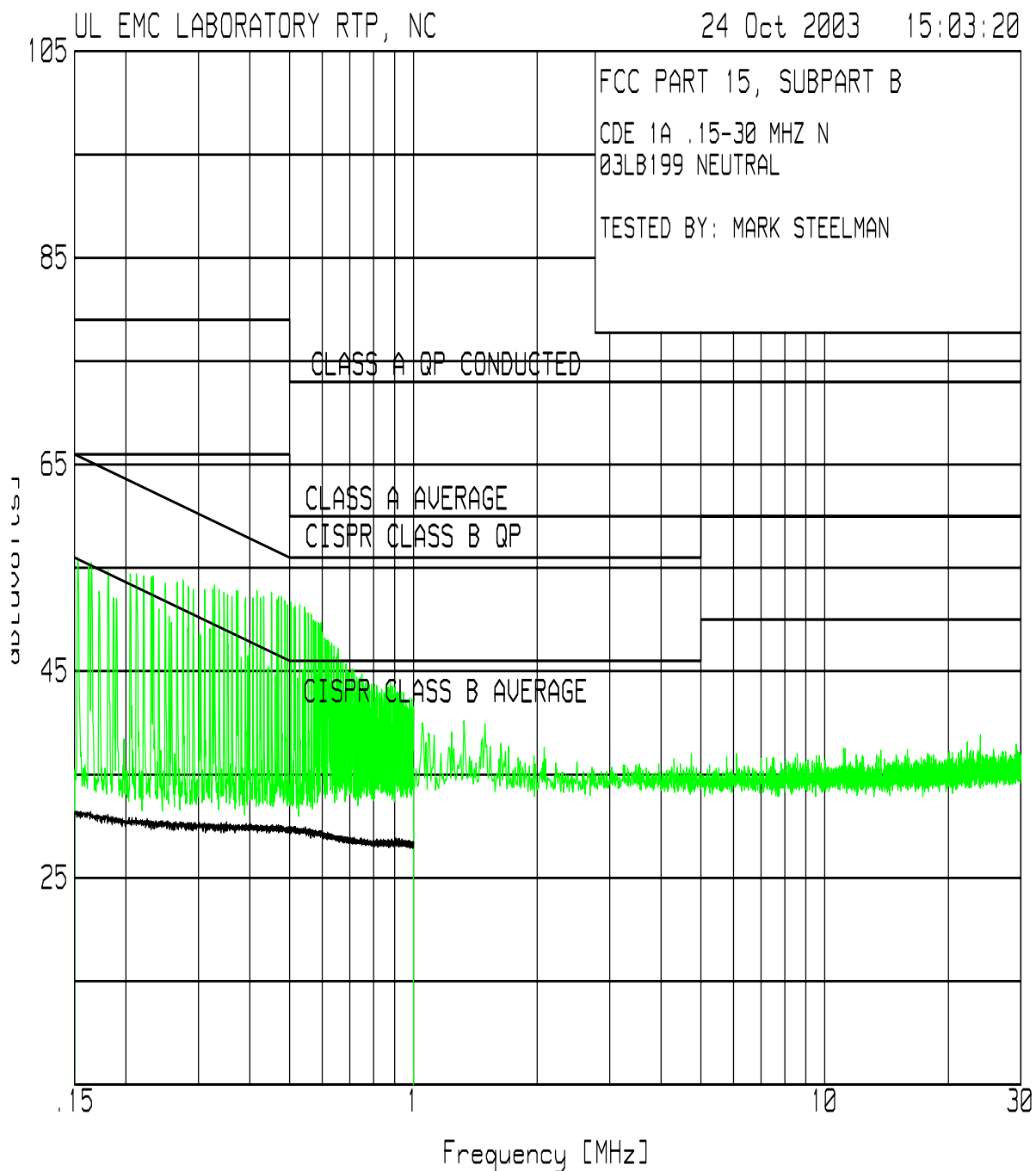
Conducted Disturbance Emissions - Voltage (Line)



Note: Green trace represents peak measurement. Black trace represents swept average measurement below 1 MHz.

Test 1, Item A - Peak Plot (Amplitude in dBuV):

Conducted Disturbance Emissions - Voltage (Neutral)



Note: Green trace represents peak measurement. Black trace represents swept average measurement below 1 MHz.

Discrete Data:

Test Item (A-Z)	Detector Type (P/Q/A)	Measured Frequency (MHz)	Measured Value (dBuV)	Equip Correction (dB)	Corrected Value (dBuV)	Specified Limit (dBuV)	Spec Margin (dB)	See Comment (#)***
Line								
A	P	0.1585	44.2	10.8	55.0	65.5	-10.5	
A	P	0.2086	42.1	10.8	52.9	63.3	-10.4	
A	P	0.2978	39.6	10.8	50.4	60.3	-9.9	
A	P	0.3677	38.0	10.8	48.8	58.6	-9.8	
A	P	0.4563	37.0	10.8	47.8	56.8	-9.0	
A	P	0.5646	35.8	10.8	46.6	56.0	-9.4	
A	P	0.6470	32.9	10.8	43.7	56.0	-12.3	
A	Q	0.4566	28.2	10.8	39.0	56.8	-17.8	
A	Q	0.5633	27.0	10.8	37.8	56.0	-18.2	
A	A	0.1609	20.4	10.8	31.2	55.4	-24.2	
A	A	0.2141	19.6	10.8	30.4	53.0	-22.6	
A	A	0.2931	18.9	10.8	29.7	50.4	-20.7	
A	A	0.4630	18.4	10.8	29.2	46.6	-17.4	
A	A	0.6201	17.8	10.8	28.6	46.0	-17.4	
A	A	0.8520	17.1	10.8	27.9	46.0	-18.1	
Neutral								
A	P	0.1649	44.7	10.8	55.5	65.2	-9.7	
A	P	0.2328	43.4	10.8	54.2	62.3	-8.1	
A	P	0.3458	41.8	10.8	52.6	59.1	-6.5	
A	P	0.4163	42.0	10.8	52.8	57.5	-4.7	
A	P	0.4779	41.4	10.8	52.2	56.4	-4.2	
A	P	0.5960	38.9	10.8	49.7	56.0	-6.3	
A	P	0.6564	36.4	10.8	47.2	56.0	-8.8	
A	Q	0.4707	32.1	10.8	42.9	56.4	-13.5	1
A	Q	0.5948	29.5	10.8	40.3	56.0	-15.7	
A	Q	0.6551	26.1	10.8	36.9	56.0	-19.1	
A	Q	0.9308	24.4	10.8	35.2	56.0	-21.8	
A	A	0.1640	20.6	10.8	31.4	55.3	-23.9	
A	A	0.2114	20.0	10.8	30.8	53.2	-22.4	
A	A	0.3408	19.5	10.8	30.3	49.2	-18.9	
A	A	0.3921	19.4	10.8	30.2	48.0	-17.8	
A	A	0.5734	18.7	10.8	29.5	46.0	-16.5	
A	A	0.9045	17.8	10.8	28.6	46.0	-17.4	

* P = Peak, Q = Quasi-Peak, A = Average.

** The Specified Limit is for the type measurement indicated. When Peak data is indicated, the Quasi-peak limit is compared.

*** # = See Comment Number Under This Test's Comments Section.

Sample Calculation: Corrected Value = Measured Value (dBuV) + Equip Correction (dB)

Sample Calculation: Equip Correction = LISN Factor (dB) + Cable Loss (dB) + Transient Limiter Loss (dB)

Comment #	Description
1	Worst-case conducted emissions compared with RSS-210 quasi-peak limit of 250 mV (450 kHz to 30 MHz). Emissions at 470.7 kHz is 42.9 dBuV or 136.5 uV.

Test 1, Item A - Test Set-Up Photo:

Conducted Disturbance Emissions - Voltage



Test 1, Item A - Test Set-Up Photo:

Conducted Disturbance Emissions - Voltage



Test 2: Radiated Disturbance Emissions - 100 kHz to 2 MHz

Test Requirement: 47 CFR Part 15, Subpart C

Test Specification: 47 CFR Part 15, Subpart C, Section 15.209

Test Procedure:

All testing was performed in UL's 10 meter semi-anechoic chamber. The chamber meets the FCC's site attenuation criteria for use as an alternative measurement site. The EUT was tested per ANSI C63.4:2000 test method placed on a non-conductive 1m x 1.5m table 80 cm above the ground plane. The receive antenna used was a loop antenna mounted on an antenna mast with the center of the loop positioned 1 meter above the reference plane. Initial measurements are performed with the loop antenna positioned first facing the EUT and then perpendicular to the EUT. The turntable was rotated from 0° to 360° to determine the worst-case emissions angle for each frequency. The loop antenna is further rotated to determine the worst antenna angle orientation. Finally the loop antenna is positioned horizontal to verify that this is not worse than the worst vertically orientation antenna angle.

The worst-case emission is recorded. Average field strength was calculated using the peak-to-average ratio documented elsewhere in this report.

All measurements were made at a 3 meter distance. A 40 dB/decade adjustment was made to the signal for measurements below 30 MHz per FCC Section 15.31(f)(2). Magnetic Field to electric field conversion is made assuming the impedance of free space of 377Ω (or 51.5 dBΩ).

Radiated Disturbance Limits - General Requirements Section 15.209

Frequency Range MHz	Field Strength Limit μV/m	Field Strength Limit dBμV/m	Measurement Distance (m)
0.009 to 0.490	2400/F (kHz)	20*log(2400/F(kHz))	300
0.490 to 1.705	24,000/F (kHz)	20*log(24,000/F(kHz))	30
1.705 to 30	30	29.5	30

Limits adjusted to 3 meter measurement distance and converted to magnetic field

Frequency Range MHz	Field Strength Limit μV/m	Field Strength Limit dBμV/m	Field Strength Limit (magnetic) dBμA/m	Limit Range dBμA/m
0.009 to 0.490	2400/F (kHz) * 10 ⁴	20*log(24,000,000/F(kHz))	20*log(2400/F(kHz))+28.5	77 to 42.3
0.490 to 1.705	24,000/F (kHz) * 100	20*log(2,400,000/F(kHz))	20*log(24,000/F(kHz))-11.5	22.3 to 11.4
1.705 to 30	30 * 100	69.5	18	18

Test Deviations:

None

Test Setup: Only the following ports were tested. See EUT Information for details.

Test Item	Port #	Port Name	EUT Operation Mode	EUT Configuration	Power Interface
A	0	Enclosure	1	1	1

Test 2 - Results: Radiated Disturbance Emissions - 100 kHz to 2 MHz

Test Results Summary:

Test Item	Test Location	Humidity (%)	Temperature (°C)	Pressure (kPa)	Pass/Fail (P/F)	Date Completed	Comment #
A	A	35	25.5	101.1	P	10/24/03	1

The EUT was considered to **Pass** the Requirements.

Comments:

Comment #	Description
1	At worst-case EUT and antenna positions input power was varied between 85% and 115% of nominal input voltage (97.75V and 132.25V). At transmit frequency no change of emission frequency or amplitude was observed.

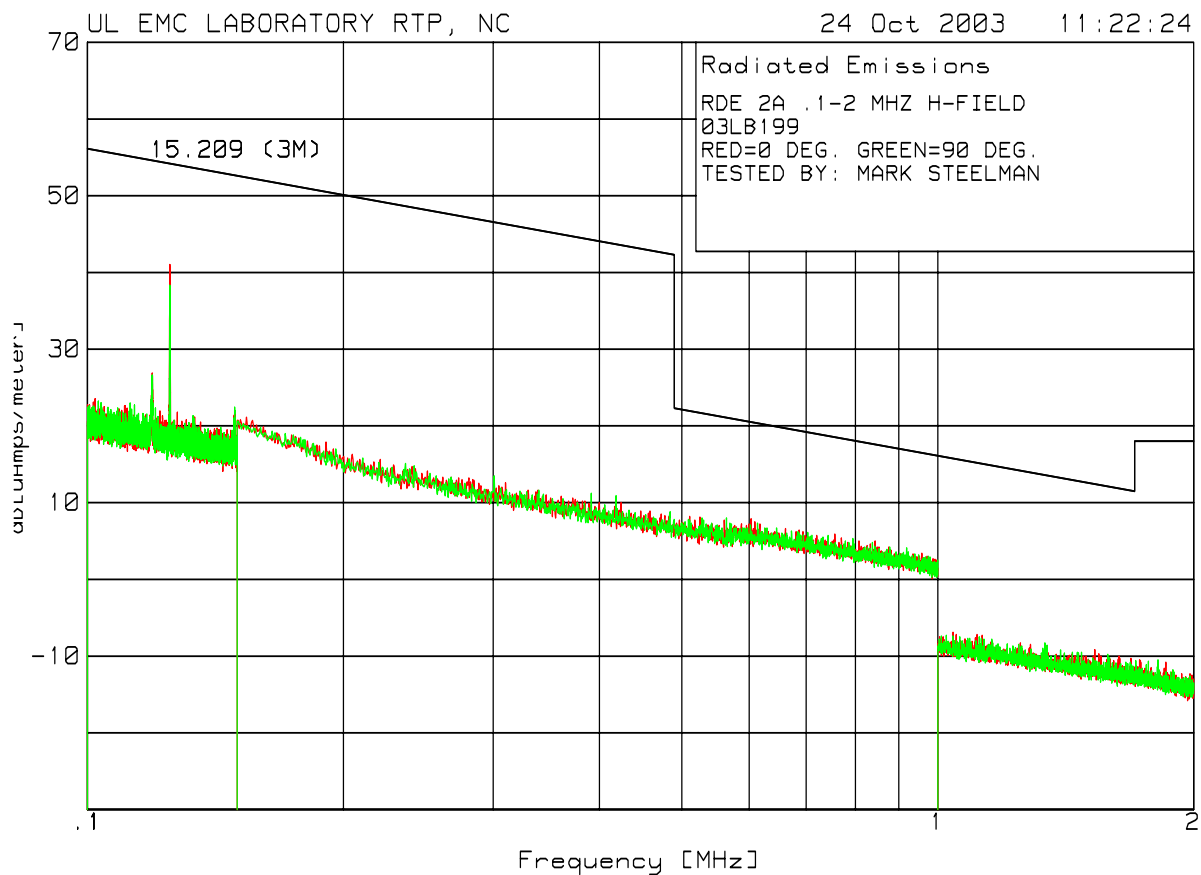
Test Equipment Used:

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
AT0036	Loop Antenna, 100 kHz to 30 MHz	Electro-Metrics	EM-6872	1/7/03	1/31/04
ATA017	13 ft Cable, BNC - N	UL	RG-223	2/21/03	2/28/04
ATA096	50 ft, N male - N male	Micro-Coax	Coaxial Cable	9/30/03	3/31/04
ATA143	6ft., N-male to N-male	Micro-Coax	Coaxial Cable	3/19/03	3/31/04
HI0034	Environmental Indicator	Cole-Palmer	99760-00	10/2/02	10/31/03
SAR002	Spectrum Analyzer / Receiver	Hewlett-Packard	8566B	11/21/02	11/30/03

The above equipment has been calibrated and is within the manufacturer's published limit of error. Calibration is traceable to the National Institute of Standards & Technology(NIST) and conforms to ANSI/NC SL Z540-1-1994.

Test 2, Item A - Peak Plot (Amplitude in dBuV/m):

Radiated Disturbance Emissions - 100 kHz to 2 MHz



Note: Resolution Bandwidth setting changes at 150 kHz. Attenuation is changed at 1 MHz.

Test 2, Item A - Discrete Data: Radiated Disturbance Emissions - 100 kHz to 2 MHz

Note: Electric Field Limit is converted to Magnetic Field by impedance of free space (377 ohms, or 51.5 dB).

Test Item (A-Z)	Detector Type* (P/Q/A)	Antenna Azimuth (0°/90°)	Antenna Distance (m)	Measured Frequency (MHz)	Measured Value (dBuV)	Equip Correction (dBA/Vm)	Corrected Value (dBuA/m)	Specified Limit** (dBuA/m)	Spec Margin (dB)	See Comment (#)***
A	P	90°	3	0.1250	28.1	12.9	41.0	54.2	-13.2	Transmit freq.
A	P	0°/90°	3	0.1192	13.6	13.3	26.9	54.6	-27.7	Spurious
A	P	0°/90°	3	0.1489	10.9	11.5	22.4	52.7	-30.3	Noise Floor
A	P	0°/90°	3	0.2498	6.2	6.9	13.1	48.2	-35.1	Noise Floor
A	P	0°/90°	3	0.3760	6.2	3.5	9.7	44.6	-34.9	Noise Floor
A	P	0°/90°	3	0.5009	6.4	1.0	7.4	22.1	-14.7	Noise Floor
A	P	0°/90°	3	0.6258	7.0	-0.8	6.2	20.2	-14.0	Noise Floor
A	P	0°/90°	3	0.7396	6.9	-2.1	4.8	18.7	-13.9	Noise Floor
A	P	0°/90°	3	0.8743	6.2	-3.4	2.8	17.3	-14.5	Noise Floor
A	P	0°/90°	3	0.9975	6.6	-4.7	1.9	16.1	-14.2	Noise Floor
A	P	0°/90°	3	1.1279	-1.9	-5.4	-7.3	15.1	-22.4	Noise Floor
A	P	0°/90°	3	1.2539	-3.7	-6.0	-9.7	14.2	-23.9	Noise Floor
A	P	0°	3	0.1250	29.0	12.9	41.9	54.2	-12.3	Transmit freq.

* P = Peak, Q = Quasi-Peak, A = Average.

** The Specified Limit is for the type measurement indicated. When Peak data is indicated, the tightest limit applicable is indicated.

*** # = See Comment Number Under This Test's Comments Section.

Sample Calculation: Corrected Value = Measured Value + Equip Correction

Equip Correction = Antenna Factor (dBA/Vm) + Cable Loss (dB) - Amplifier Gain (dB, if used)

Calculation of transmit frequency Electric Field Strength from Magnetic Field Strength

Measured = 41.9 dBuA/m @ 3 meters (125 kHz)

Transform to linear units = $10^{(41.9/20)}$ = 124.5 uA/m @ 3 meters

Transform to electric field strength using 377 ohms = 124.5 uA/m @ 3 meter x 377 ohms = 46,918 uV/m @ 3 meters

Using 40 dB/decade falloff to 300 meters = 46,918 uV/m @ 3 meter / 10,000 = 4.6918 uV/m @ 300 meters

This complies with the limit in Part 15.207 of 19.2 uV/m @ 300 meters

Calculation of worst-case spurious frequency Electric Field Strength from Magnetic Field Strength

Measured = 26.9 dBuA/m @ 3 meters (119 kHz)

Transform to linear units = $10^{(26.9/20)}$ = 22.1 uA/m @ 3 meters

Transform to electric field strength using 377 ohms = 22.1 uA/m @ 3 meters x 377 ohms = 8343 uV/m @ 3 meters

Using 40 dB/decade falloff to 300 meters = 8343 uV/m @ 3 meters / 10,000 = 0.8343 uV/m @ 300 meters

This complies with the limit in Part 15.207 of 20.2 uV/m @ 300 meters.

Test 2, Item A - Test Set-Up Photo:

Radiated Disturbance Emissions - 100 kHz to 2 MHz



Test 2, Item A - Test Set-Up Photo:

Radiated Disturbance Emissions - 100 kHz to 2 MHz



Test 3: Radiated Disturbance Emissions - 30 MHz to 1000 MHz

Test Requirement: 47 CFR Part 15, Subpart B

Test Specification: 47 CFR Part 15, Subpart B, Class A

Test Procedure:

The test was performed in accordance with the Test Requirement and Specification and configured as noted in the Test Setup. The EUT was placed inside the anechoic chamber and connected to the proper power supply source. A peak measurement was first made by scanning the entire test frequency range and maximizing the EUT emissions by rotating the EUT and raising the antenna height from 1 to 4 meters above the ground reference plane. Then, a measurement was taken for all peak emissions to verify each were below the Test Limits. In each case, all cables and equipment were adjusted and EUT orientation and antenna height were varied for maximum emissions.

Radiated Disturbance Limits for Class A Equipment
at a measuring distance of 10m.

Frequency Range MHz	Quasi-Peak Limits $\mu\text{V/m}$	Quasi-Peak Limits $\text{dB}\mu\text{V/m}$
30 to 88	90	39.08
88 to 216	150	43.52
216 to 960	210	46.44
Above 960	300	49.54

Test Deviations:

None

Test Setup: Only the following ports were tested. See EUT Information for details.

Test Item	Port #	Port Name	EUT Operation Mode	EUT Configuration	Power Interface
A	0	Enclosure	1	1	1

Test 3 - Results: Radiated Disturbance Emissions - 30 MHz to 1000 MHz

Test Results Summary:

Test Item	Test Location	Humidity (%)	Temperature (°C)	Pressure (kPa)	Pass/Fail (P/F)	Date Completed	Comment #
A	A	34	24.5	101.1	P	10/24/03	1

The EUT was considered to **Pass** the Requirements.

Comments:

Comment #	Description
1	Device also demonstrates compliance to FCC Class B limits should the manufacturer choose to declare compliance to FCC Class B.
2	Test setup is identical to low frequency measurements. See photos in Test 2.

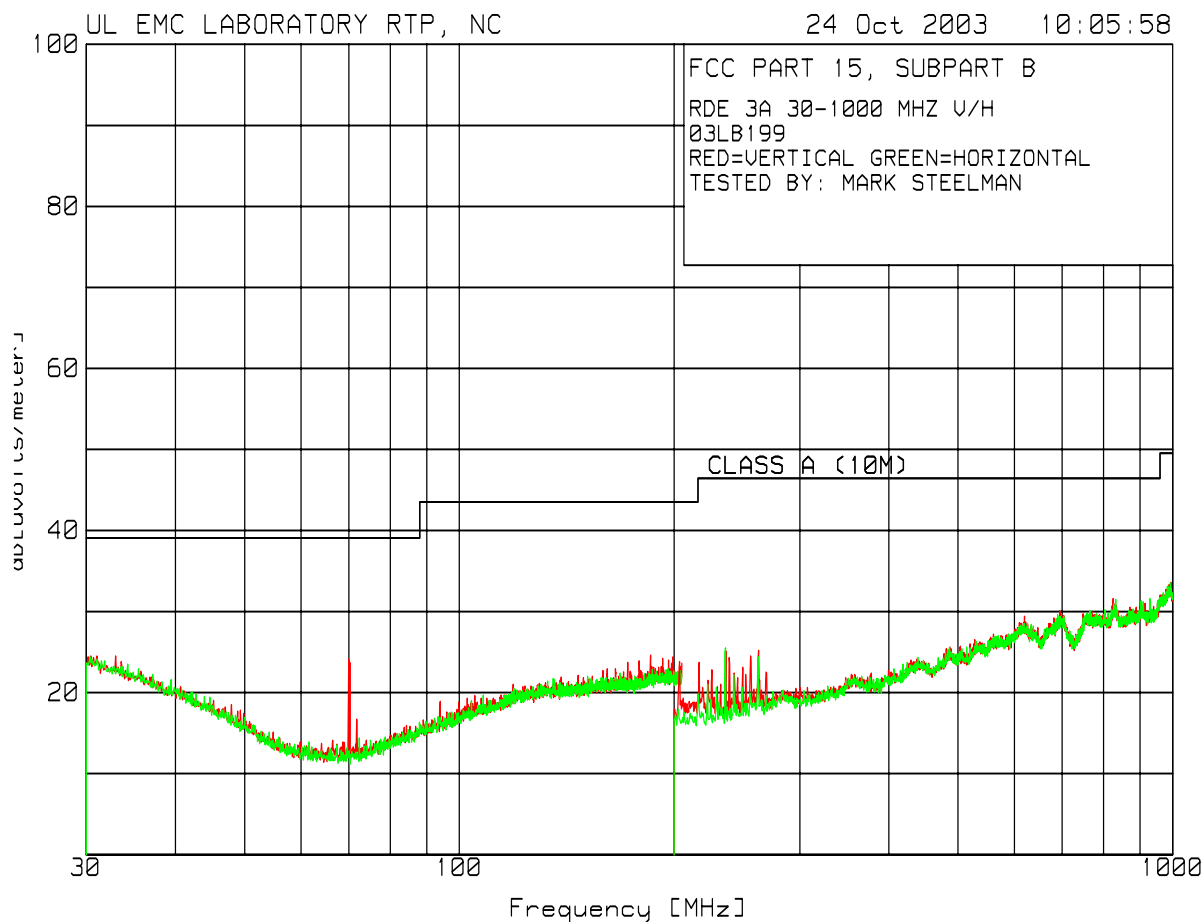
Test Equipment Used:

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
AT0025	Biconical Antenna, 30 to 300 MHz	Schaffner, EMC	VBA6106A	4/8/03	4/30/04
AT0030	Log periodic Antenna, 200 MHz to 1000 MHz	Schaffner, EMC	3160-07	1/13/03	1/31/04
ATA061	Amplifier, 1 to 1000 MHz	Miteq	AM-3A-000110-N	3/20/03	3/31/04
ATA084	Attenuator 6 dB, 2 GHz	Pasternack	PE7002-6	3/19/03	3/31/04
ATA085	Attenuator 6 dB, 2 GHz	Pasternack	PE7002-6	3/19/03	3/31/04
ATA095	6 ft, N male - N male	Micro-Coax	Coaxial Cable	9/30/03	3/31/04
ATA106	19 ft, N - N	Amplifier Research	Low Loss coaxial cable	3/20/03	3/31/04
ATA108	10 m, N male - N male	UL	RG214	3/19/03	3/31/04
ATA124	RF Amplifier, 1 to 1000 MHz	Miteq	AM-3A-000110-N	3/20/03	3/31/04
ATA132	45ft. N-Male to N-Male	UL	Coaxial Cable	3/20/03	3/31/04
ATA140	RG214 Ferrite Cable	EMC Eupen	N/A	3/19/03	3/31/04
ATA143	6ft., N-male to N-male	Micro-Coax	Coaxial Cable	3/19/03	3/31/04
HI0034	Environmental Indicator	Cole-Palmer	99760-00	10/2/02	10/31/03
SAR002	Spectrum Analyzer / Receiver	Hewlett-Packard	8566B	11/21/02	11/30/03

The above equipment has been calibrated and is within the manufacturer's published limit of error. Calibration is traceable to the National Institute of Standards & Technology(NIST) and conforms to ANSI/NC SL Z540-1-1994.

Test 3, Item A - Peak Plot (Amplitude in dBuV/m):

Radiated Disturbance Emissions - 30 MHz to 1000 MHz



Test 3, Item A - Discrete Data: Radiated Disturbance Emissions - 30 MHz to 1000 MHz

Test Item (A-Z)	Detector Type* (P/Q/A)	Antenna Polarity (H/V)	Antenna Distance (m)	Measured Frequency (MHz)	Measured Value (dBuV)	Equip Correction (dB/m)	Corrected Value (dBuV/m)	Specified Limit** (dBuV/m)	Spec Margin (dB)	See Comment (#)***
A	P	V	10	69.968	46.3	-22.2	24.1	39.1	-15.0	
A	P	V	10	185.366	37.3	-12.7	24.6	43.5	-18.9	
A	P	V	10	216.792	42.1	-18.4	23.7	46.4	-22.7	
A	P	H	10	235.982	43.8	-18.3	25.5	46.4	-20.9	
A	P	V	10	262.769	41.8	-16.6	25.2	46.4	-21.2	
A	P	V	10	255.972	41.2	-16.7	24.5	46.4	-21.9	

* P = Peak, Q = Quasi-Peak, A = Average.

** The Specified Limit is for the type measurement indicated. When Peak data is indicated, the tightest limit applicable is indicated.

*** # = See Comment Number Under This Test's Comments Section.

Sample Calculation: Corrected Value = Measured Value + Equip Correction

Sample Calculation: Equip Correction = Antenna Factor (dB/m) + Cable Loss (dB) - Amplifier Gain (dB, if used)

Test 4: Radiated Disturbance Emissions - Occupied Bandwidth

Test Requirement: 47 CFR Part 15, Subpart C

Test Specification: 47 CFR Part 15, Subpart C, Section 15.209

Test Procedure:

All testing was performed in UL's 10 meter semi-anechoic chamber. The chamber meets the FCC's site attenuation criteria for use as an alternative measurement site. The EUT was tested per ANSI C63.4:1992 test method placed on a non-conductive 1m x 1.5m table 80 cm above the ground plane. The receive antenna used was a log-periodic antenna mounted on an antenna mast. The turntable was rotated from 0° to 360° to determine the worst-case emissions angle for the transmit frequency.

The spectrum analyzer Resolution Bandwidth and Video Bandwidth were set to 10 kHz for the measurement. A plot of the spectrum analyzer display screen is produced with marker points displaying the center frequency and the left and right side points that are 20 dB below the field strength at the center frequency.

Note: No specific bandwidth limit is required for devices meeting the general limits.

Test Deviations:

None

Test Setup: Only the following ports were tested. See EUT Information for details.

Test Item	Port #	Port Name	EUT Operation Mode	EUT Configuration	Power Interface
A	0	Enclosure	2	1	1

Test 4 - Results: Radiated Disturbance Emissions - Occupied Bandwidth

Test Results Summary:

Test Item	Test Location	Humidity (%)	Temperature (°C)	Pressure (kPa)	Pass/Fail (P/F)	Date Completed	Comment #
A	A	32	25	101	N/A	10/24/03	1

The EUT was considered to **Pass** the Requirements.

Comments:

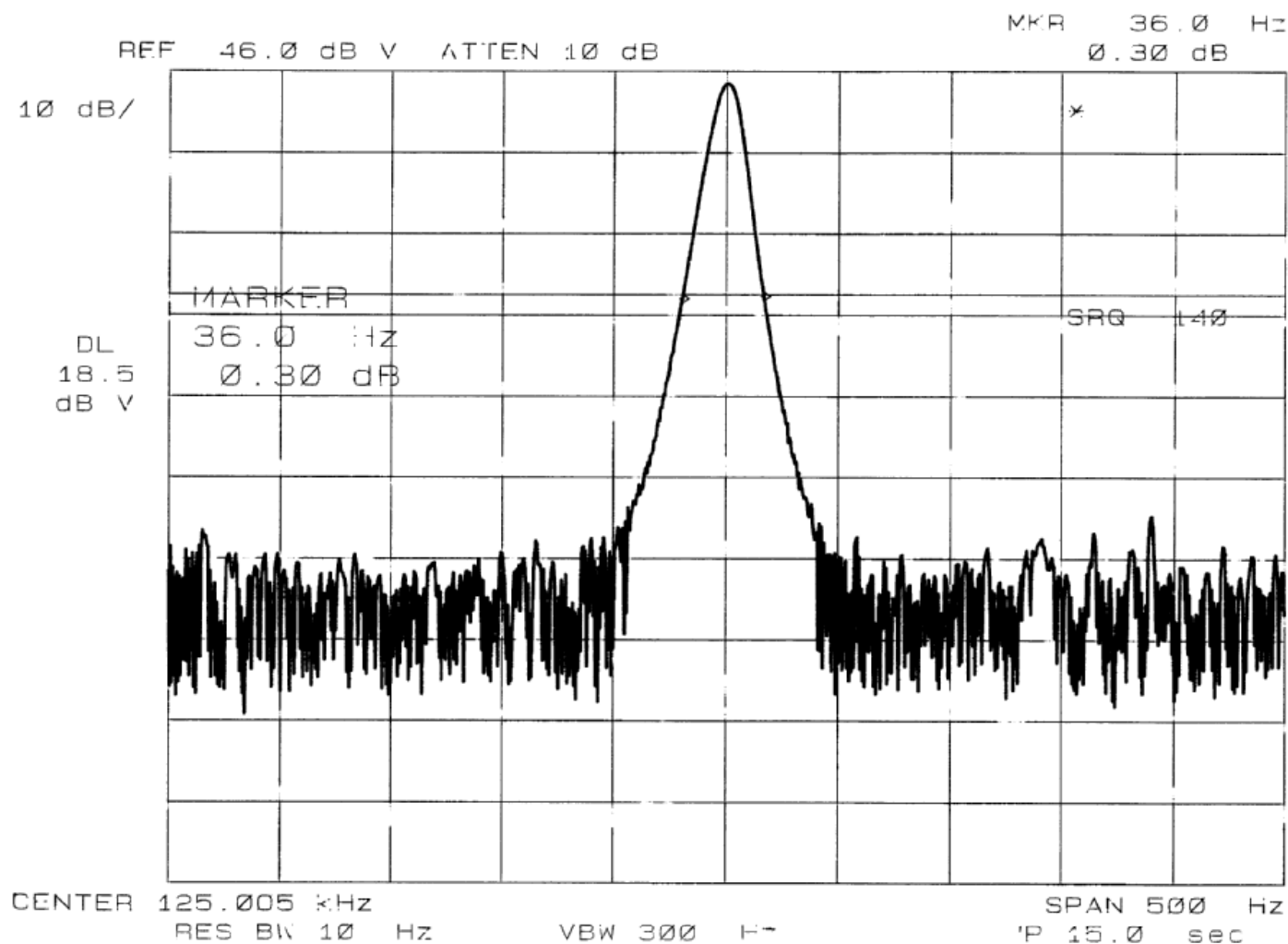
Comment #	Description
1	Emission is an unmodulated Sine Wave. Bandwidth recorded is a function of instrumentation Bandwidth Setting.

Test Equipment Used:

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
AT0036	Loop Antenna, 100 kHz to 30 MHz	Electro-Metrics	EM-6872	1/7/03	1/31/04
ATA017	13 ft Cable, BNC - N	UL	RG-223	2/21/03	2/28/04
ATA096	50 ft, N male - N male	Micro-Coax	Coaxial Cable	9/30/03	3/31/04
ATA143	6ft., N-male to N-male	Micro-Coax	Coaxial Cable	3/19/03	3/31/04
HI0034	Environmental Indicator	Cole-Palmer	99760-00	10/2/02	10/31/03
SAR003	EMC Receiver	Rohde & Schwarz	1088.7490K40	10/30/02	10/31/03

The above equipment has been calibrated and is within the manufacturer's published limit of error. Calibration is traceable to the National Institute of Standards & Technology(NIST) and conforms to ANSI/NC SL Z540-1-1994.

Test 4, Item A - Occupied BW (-26 dB):



Test 5: Radiated Disturbance Emissions - Peak-to-Average Ratio

Test Requirement: 47 CFR Part 15, Subpart C

Test Specification: 47 CFR Part 15, Subpart C, Section 15.209

Test Procedure:

The test was performed in accordance with the Test Requirement and Specification and configured as noted in the Test Setup. The EUT was placed inside the anechoic chamber on connected to the proper power supply source. A peak measurement was first made by scanning the entire test frequency range and maximizing the EUT emissions by rotating the EUT and raising the antenna height from 1 to 4 meters above the ground reference plane.

The measurement spectrum analyzer is centered on the EUT's transmit frequency and span is reduced to 0 Hz to obtain a time domain measurement. The period of one complete transmit cycle is recorded. Next each button on the transmitter is depressed in sequence to determine which button produces the largest duty cycle. The duration of each pulse in the cycle is recorded and the percentage of time the EUT is transmitting is calculated.

No limit is expressed in Section 15.209 for this test, however the result of this test is used to calculate average values for the remaining measurements.

Test Deviations:

None

Test Setup: Only the following ports were tested. See EUT Information for details.

Test Item	Port #	Port Name	EUT Operation Mode	EUT Configuration	Power Interface
A	0	Enclosure	1	1	1

Test 5 - Results: Radiated Disturbance Emissions - Peak-to-Average Ratio

Test Results Summary:

Test Item	Test Location	Humidity (%)	Temperature (°C)	Pressure (kPa)	Pass/Fail (P/F)	Date Completed	Comment #
A	A	32	25	101	N/A	10/24/03	1

The EUT was considered to **Pass** the Requirements.

Comments:

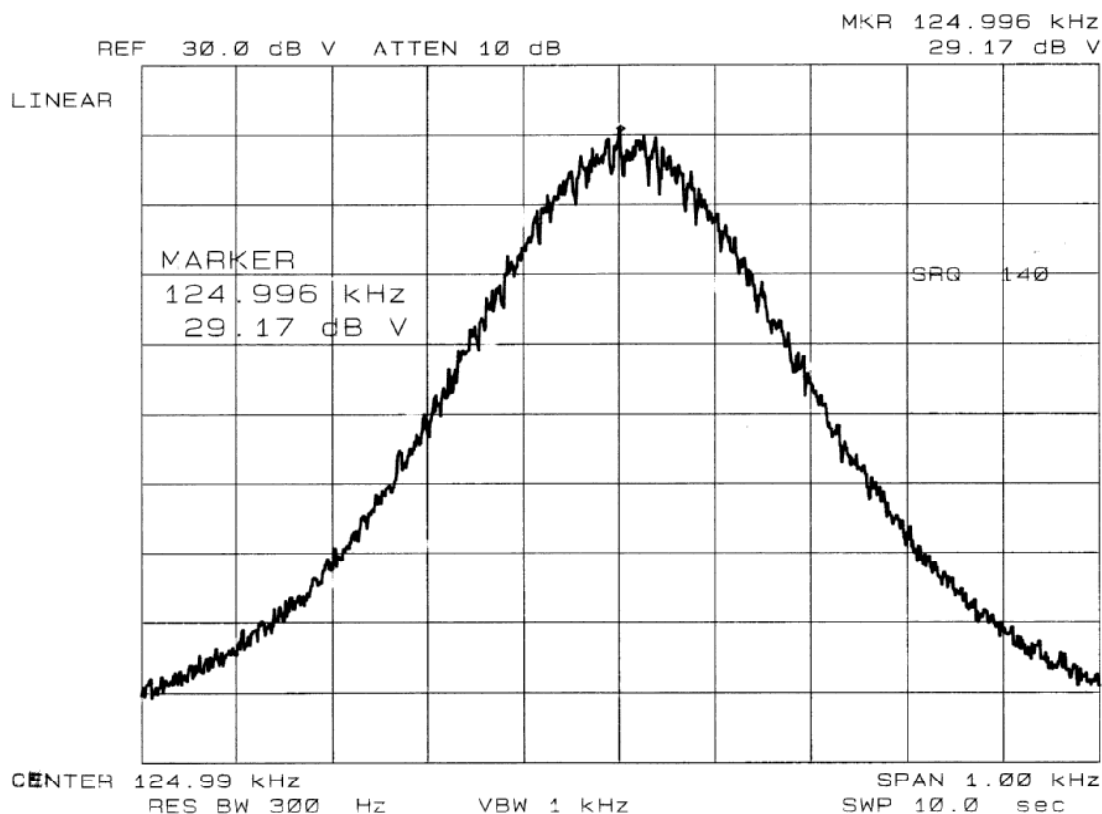
Comment #	Description
1	Emission is an unmodulated Sine Wave. Peak-To-Average ratio is therefore 0 dB. Reduced Video Bandwidth measurement comparison is presented.

Test Equipment Used:

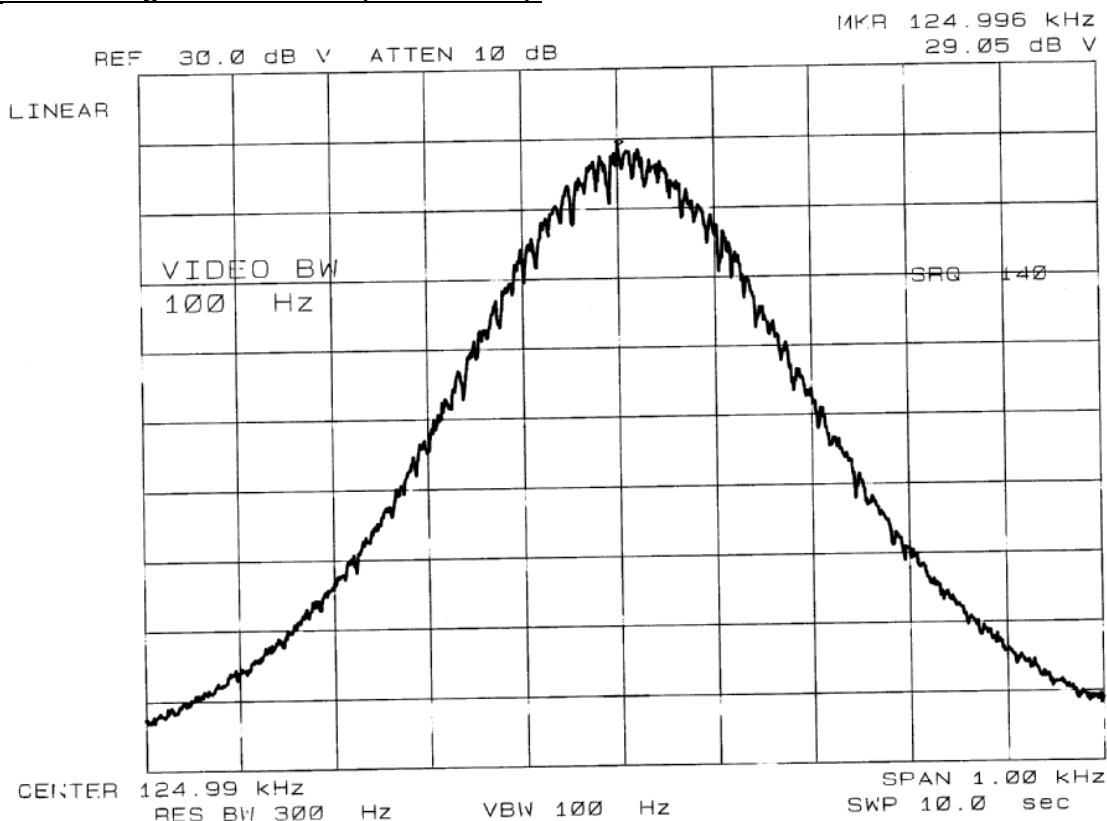
Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
AT0036	Loop Antenna, 100 kHz to 30 MHz	Electro-Metrics	EM-6872	1/7/03	1/31/04
ATA017	13 ft Cable, BNC - N	UL	RG-223	2/21/03	2/28/04
ATA096	50 ft, N male - N male	Micro-Coax	Coaxial Cable	9/30/03	3/31/04
ATA143	6ft., N-male to N-male	Micro-Coax	Coaxial Cable	3/19/03	3/31/04
HI0034	Environmental Indicator	Cole-Palmer	99760-00	10/2/02	10/31/03
SAR002	Spectrum Analyzer / Receiver	Hewlett-Packard	8566B	11/21/02	11/30/03

The above equipment has been calibrated and is within the manufacturer's published limit of error. Calibration is traceable to the National Institute of Standards & Technology(NIST) and conforms to ANSI/NCSL Z540-1-1994.


Test 5, Item A - Peak Measurement (uncorrected):





Test 5, Item A - Average Measurement (uncorrected):



Accreditation Certificates:

<div style="display: flex; justify-content: space-between;"><div><small>National Institute of Standards and Technology</small></div><div>NVLAP[®]</div><div><small>National Voluntary Laboratory Accreditation Program</small></div></div>	
<small>ISO/IEC 17025:1999 ISO 9002:1994</small>	Scope of Accreditation
<div style="text-align: right;"><small>Page: 1 of 3</small></div>	
ELECTROMAGNETIC COMPATIBILITY AND TELECOMMUNICATIONS	
NVLAP LAB CODE 200246-0	
UNDERWRITERS LABORATORIES, INC.	
12 Laboratory Drive Research Triangle Park, NC 27709 Mr. Rick A. Titus Phone: 847-272-8800 x43281 Fax: 847-509-6321 E-Mail: Rick.A.Titus@us.ul.com URL: http://www.ul.com	
NVLAP Code	Designation / Description
Emissions Test Methods:	
12/CIS14	CISPR 14-1 (March 30, 2000): Limits and methods of measurement of radio interference characteristics of household electrical appliances, portable tools and similar electrical apparatus - Part 1: Emissions
12/CIS14a	EN 55014-1 (1993) with Amendments A1 (1997) & A2 (1999)
12/CIS14b	AS/NZS 1044 (1995)
12/CIS22	IEC/CISPR 22 (1997) and EN 55022 (1998): Limits and methods of measurement of radio disturbance characteristics of information technology equipment
12/CIS22a	IEC/CISPR 22 (1993): Limits and methods of measurement of radio disturbance characteristics of information technology equipment, Amendment 1:1995, and Amendment 2:1996.
12/CIS22b	CNS 13438 (1997): Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment
<div style="display: flex; justify-content: space-between; margin-top: 20px;"><div>June 30, 2004 <small>Effective through</small></div><div> <small>For the National Institute of Standards and Technology</small></div></div>	

<div style="display: flex; justify-content: space-between;"><div><small>National Institute of Standards and Technology</small></div><div>NVLAP[®]</div><div><small>National Voluntary Laboratory Accreditation Program</small></div></div>	
<small>ISO/IEC 17025:1999 ISO 9002:1994</small>	Scope of Accreditation
<div style="text-align: right;"><small>Page: 2 of 3</small></div>	
ELECTROMAGNETIC COMPATIBILITY AND TELECOMMUNICATIONS	
NVLAP LAB CODE 200246-0	
UNDERWRITERS LABORATORIES, INC.	
NVLAP Code	Designation / Description
12/F01	ANSI C63.4 (2001) - cited in FCC Method - 47 CFR Part 15 - Digital Devices
12/F01a	Conducted Emissions, Power Lines, 150 KHz to 30 MHz
12/F01b	Radiated Emissions
12/T51	AS/NZS CISPR (2002) and AS/NZS 3548: Electromagnetic Interference - Limits and Methods of Measurement of Information Technology Equipment
Immunity Test Methods:	
12/I01	IEC 61000-4-2 (1995) and Amendment 1 (1998) and EN 61000-4-2: Electrostatic Discharge Immunity Test
12/I02	IEC 61000-4-3 (1995) and Amendment 1 (1998) and EN 61000-4-3: Radiated, Radio-Frequency Electromagnetic Field Immunity Test
12/I03	IEC 61000-4-4 (1995) and EN 61000-4-4: Electrical Fast Transient/Burst Immunity Test
12/I04	IEC 61000-4-5 (1995) and EN 61000-4-5: Surge Immunity Test
12/I05	IEC 61000-4-6 (1996) and EN 61000-4-6: Immunity to Conducted Disturbances, Induced Radio-Frequency Fields
<div style="display: flex; justify-content: space-between; margin-top: 20px;"><div>June 30, 2004 <small>Effective through</small></div><div> <small>For the National Institute of Standards and Technology</small></div></div>	

<div style="display: flex; justify-content: space-between;"><div><small>National Institute of Standards and Technology</small></div><div>NVLAP[®]</div><div><small>National Voluntary Laboratory Accreditation Program</small></div></div>	
<small>ISO/IEC 17025:1999 ISO 9002:1994</small>	Scope of Accreditation
<div style="text-align: right;"><small>Page: 3 of 3</small></div>	
ELECTROMAGNETIC COMPATIBILITY AND TELECOMMUNICATIONS	
NVLAP LAB CODE 200246-0	
UNDERWRITERS LABORATORIES, INC.	
NVLAP Code	Designation / Description
12/I06	IEC 61000-4-8 (1993): Power Frequency Magnetic Field Immunity Test
12/I07	IEC 61000-4-11 (1994): Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests
Safety Test Methods:	
12/T41	AC/ACIF S001:2001: Safety Requirements for Customer Equipment
12/T50	AS/NZS 3260: Safety of Information Technology Equipment Including Electrical Business Equipment
<div style="display: flex; justify-content: space-between; margin-top: 20px;"><div>June 30, 2004 <small>Effective through</small></div><div> <small>For the National Institute of Standards and Technology</small></div></div>	

Measurement Uncertainty Statement

Test	Expanded Estimate of Uncertainty (k = 2, for 95% of a normal distribution)	Units
Radiated Disturbance Emissions: <ul style="list-style-type: none">• 3 and 10 meter measurement distances• 1 meter measurement distance	+/- 3.8 dB +/- 2.3 dB	Volts/meter Volts/meter
Conducted Disturbance Emissions (9 kHz – 30 MHz):	+/- 3.4 dB	Volts
Electrostatic Discharge	+/- 2.2 %	Volts
Radiated RF Immunity (Chamber):	+/- 2.7 dB	Volts/meter
Electrical Fast Transients/Bursts Immunity	+/- 4.6 %	Volts
Surge Immunity	+/- 4.6 %	Volts
Conducted RF Immunity	+/- 2.8 dB	Volts
Power Frequency Magnetic Field Immunity	+/-13.6 %	Amps/meter
Voltage Dips and Short Interrupts	+/-4.2 %	Volts
Radiated RF Immunity (Tri-plate)	+/-3.2 %	Volts/meter
Disturbance Power (30 – 300 MHz)	+/-3.5%	Volts

CISPR 16-4:2000 Statement

The UL-RTP estimate of expanded measurement uncertainty listed above for Conducted Disturbance (+/- 3.4 dB), Disturbance Power (+/- 3.5 dB), and Radiated Disturbance (+/-3.8 dB) are less than the Values of U_{CISPR} as listed in Table 1 of CISPR 16-4. Therefore:

- Compliance is deemed to occur if no measured disturbance reported exceeds the disturbance limits.
- Non-compliance is deemed to occur if any measured disturbance reported exceeds the disturbance limits.