



Project: 04CA57006
File: MC2364
Report: 050006A
Date: January 12, 2005
Model: Contactless Smartcard 13.56
MHz RFID

Test Report

On

Electromagnetic Compatibility Testing

Gilbarco Inc.
Greensboro, 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:	Gilbarco Inc. 7300 West Friendly Ave. Greensboro, NC 27420 USA
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Test Report Number:	050006A
Test Report Date:	January 20, 2005 (Revised Jan 24, 2005 for additional comments)
Product Type:	RFID Tag Reader Module
Model Number:	Contactless Smartcard 13.56 MHz RFID
Sample Serial Number:	unserialized, pre-production sample
Sample Tag Number:	S04LB280
EUT Category:	Transmitter - Low Powered
EUT Type:	Table Top
Sample Receive Date:	January 11, 2005
Testing Start Date:	January 11, 2005
Date Testing Complete:	January 11, 2005

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Summary of Testing:

Test #	Test Name Test Requirement/Specification	Comply	Does Not Comply	See Remark
1	Radiated Disturbance Emissions - 13.56 MHz Devices FCC Part 15, Subpart C / FCC Part 15, Subpart C, Section 15.225	X	-	
2	Radiated Disturbance Emissions - 30 to 1000 MHz Electric Field 47 CFR Part 15, Subpart C / 47 CFR Part 15, Subpart C, Section 15.209 47 CFR Part 15, Subpart B / 47 CFR Part 15, Subpart B, Class B	X	-	
3	Conducted Disturbance Emissions - Voltage 47 CFR Part 15, Subpart C / 47 CFR Part 15, Subpart C, Section 15.207 47 CFR Part 15, Subpart B / CISPR 22:1997 Class B	X	-	
4	Radiated Disturbance Emissions - Occupied Bandwidth 47 CFR Part 15, Subpart C / 47 CFR Part 15, Subpart C, Section 15.225	X	-	

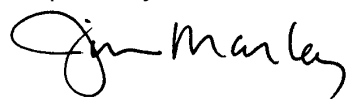
Remarks:

- 1) Modifications required to comply: None.
- 2) Other requirements: Frequency stability measurements are performed by the manufacturer and are presented in a separate exhibit.
- 3) This device is tested as a transmitter module. The transceiver and antenna are attached to a plastic bezel with no external shielding required.
- 4) Environment: This device is not intended for residential environment, however FCC Part 15 Class B unintentional limits are met.
- 5) Restricted Bands: From results in Test 1 and Test 2, this device complies with the General Limits found in 15.205 in restricted bands.
- 6) Professional Installation: Antenna is loop antenna attached to transmitter output by a 100-mil spaced pin header connector with specially shaped flat pins. This device will be professionally installed.
- 7) Peak to Average Ratio: The device transmits continuously over a 100 millisecond period, therefore no average reduction may be applied.
- 8) Canada: Results compared to FCC Part 15.225 limits may be applied to Canada RSS-210 Section 6.2.2(e). Emissions Designator is 230HG1D. Measurement performed on registered site IC-2953.

Conclusion:

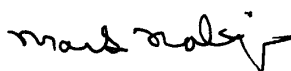
The tests listed in the Summary of Testing section of this report have been performed and the results recorded by Underwriters Laboratories Inc. in accordance with the procedures stated in each test requirement and specification. The test list was determined by the Applicant as being applicable to the 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 2.1m 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 2.5mm 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 Module	Gilbarco	Contactless Smartcard 13.56 MHz RFID	Manufactured for Gilbarco by Panasonic
ACC	Antenna	Gilbarco	-	Printed Circuit Board Loop
ACC	Power Supply	-	-	Representative supply. Host product to provide DC power.
SIM	Plastic Panel	Gilbarco		Connected to RFID module. Considered electromagnetically transparent.

* 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 Power	AC	No	No	Provided to AC-to-DC converter simulating installation
2	Serial	I/O	No	No	Provides tag information to host
3	Antenna	N/E	No	No	Connection to Loop antenna.

* 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 (MHz)*	Description
13.56	Transmit Frequency
< 108	All digital frequencies below 108 MHz, hence highest frequency measured is 1000 MHz.

Power Interface:

Mode #	Voltage (V)	Current (A)	Power (W)	Frequency (DC/AC-Hz)	Phases (#)	Comments
Rated	120	-	-	60	1	
1	120	-	-	60	1	AC input voltage to power supply. RFID Transceiver powered by DC voltage.

EUT Operation Modes:

Mode #	Description
1	Device is transmitting nearly continuously (awaiting tag response).

EUT Configuration Modes:

Mode #	Description
1	RFID transceiver is attached to representative plastic bezel with antenna. AC-to-DC adapter supplies power to transceiver. Intended loop antenna attached.
2	RFID transceiver is attached to representative plastic bezel with antenna. AC-to-DC adapter supplies power to transceiver. Matched load attached in place of antenna during conducted emissions test.

Test 1: Radiated Disturbance Emissions Below 30 MHz - 13.56 MHz Devices

Test Requirement: FCC Part 15, Subpart C

Test Specification: FCC Part 15, Subpart C, Section 15.225

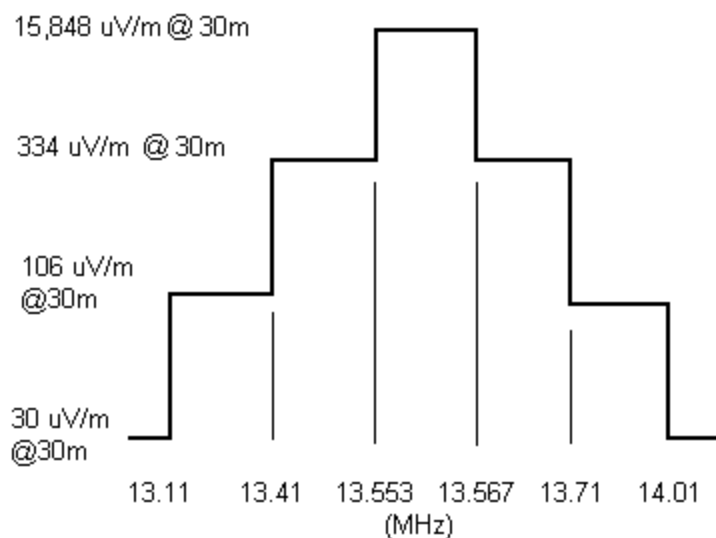
Test Procedure:

All testing was performed inside 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 C63.4:2001 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 placed 1 meter above the ground reference plane with the loop axis pointing toward the EUT. The turntable was rotated from 0° to 360° to determine the worst-case emissions angle for each frequency.

At the angle of highest emissions the loop antenna axis was rotated from -180° to +180° to capture the highest field strength. The peak field strength was 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 in an attempt to identify any emission produced by the EUT. 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 dB Ω).

15.225 Emissions Limit



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 (transmitting)	1 (antenna attached)	1

Test 1 - Results: Radiated Disturbance Emissions Below 30 MHz - 13.56 MHz Devices

Test Results Summary:

Test Item	Test Location	Humidity (%)	Temperature (°C)	Pressure (kPa)	Pass/Fail (P/F)	Date Completed	Comment #
A	A	37	24	101	P	1/11/2005	1

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

Comments:

Comment #	Description
1	See Test 2 for EUT setup photo. EUT arrangement is identical for both tests.

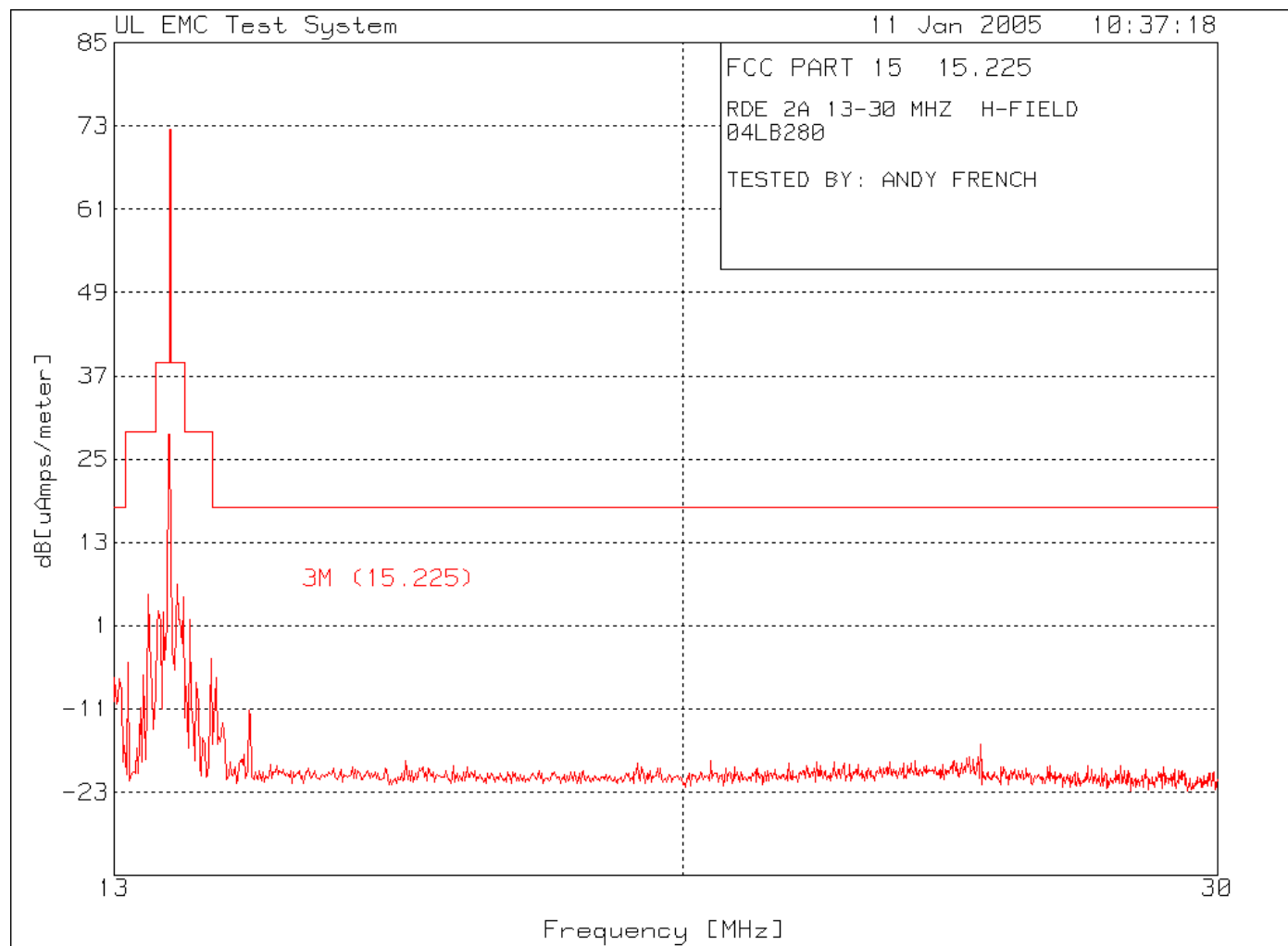
Test 1 - Test Equipment Used: Radiated Disturbance Emissions Below 30 MHz - 13.56 MHz Devices

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
AT0036	Loop Antenna, 100 kHz to 30 MHz	Electro-Metrics	EM-6872	2/9/04	2/28/05
ATA017	13 ft Cable, BNC - N	UL	RG-223	2/5/04	2/28/05
ATA096	50 ft, N male - N male	Micro-Coax	Coaxial Cable	6/25/04	2/28/05
ATA143	Cable, 6ft., N-male to N-male	Micro-Coax	N/A	8/25/04	2/28/05
SAR003	EMC Receiver	Rohde & Schwarz	1088.7490K40	12/02/04	12/31/05

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 (13-30 MHz) - Peak Plot (Amplitude in dBuV/m):

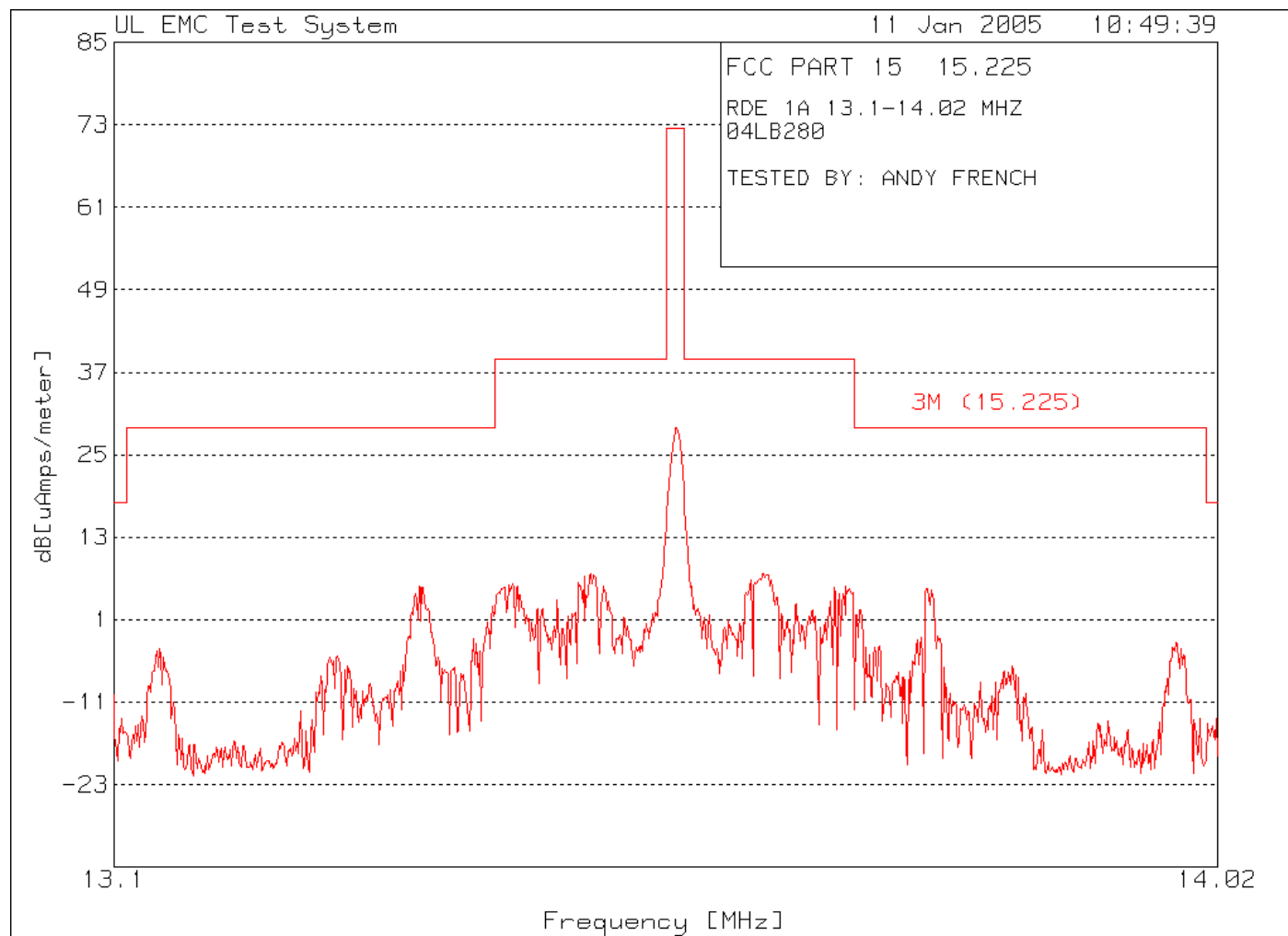
Radiated Disturbance Emissions Below 30 MHz- 13.56 MHz Devices



Resolution Bandwidth = 9 kHz.
Video Bandwidth = 100 kHz.

Test 1, Item A (Detail scan, 13-14 MHz) - Peak Plot (Amplitude in dBuV/m):

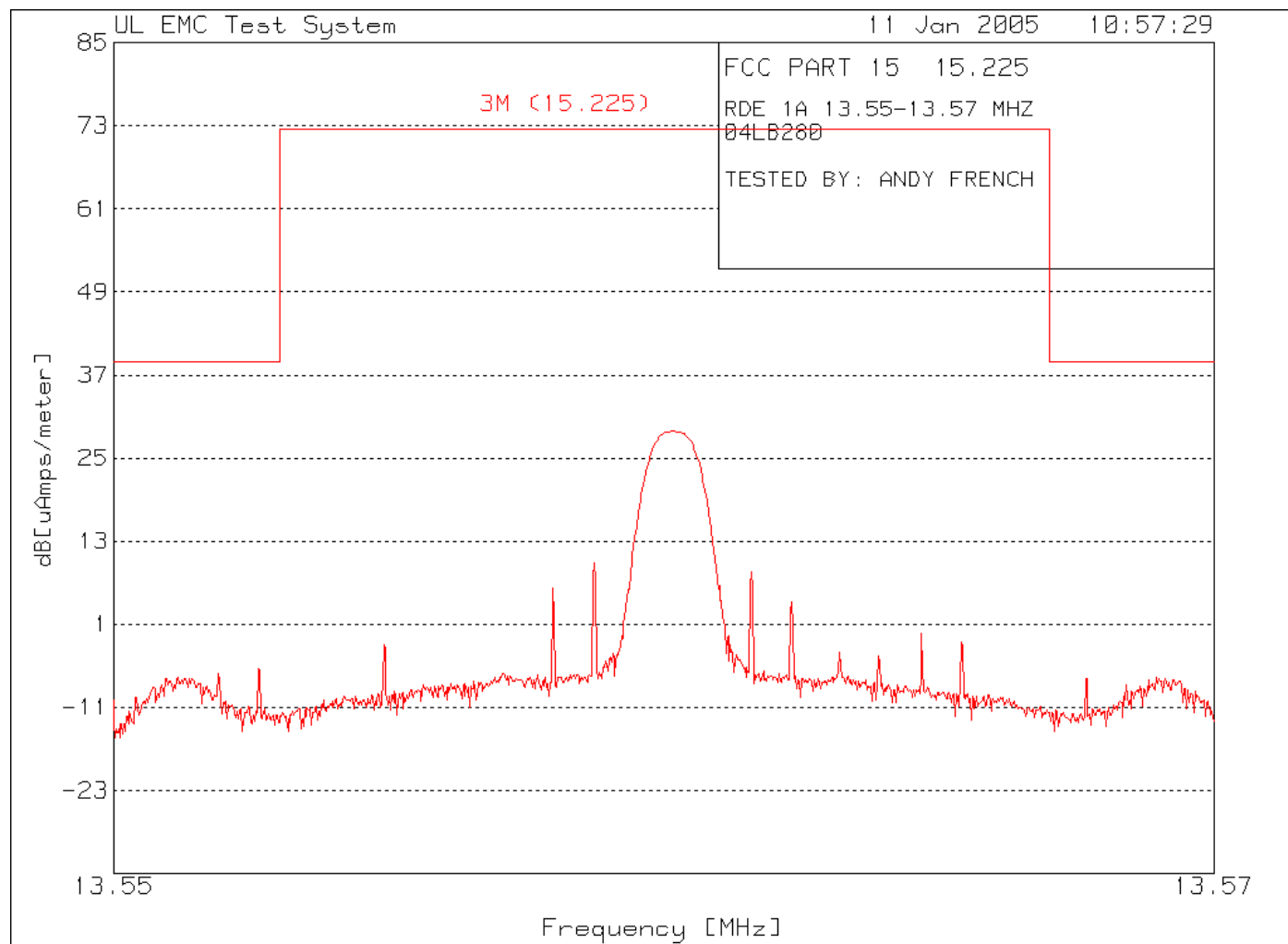
Radiated Disturbance Emissions Below 30 MHz - 13.56 MHz Devices



Resolution Bandwidth = 9 kHz.
Video Bandwidth = 100 kHz.

Test 1, Item A (Detail scan, 15.553 and 15.567 MHz bandedge) - Peak Plot (Amplitude in dBuA/m):

Radiated Disturbance Emissions below 30 MHz - 13.56 MHz Devices



Resolution Bandwidth = 1 kHz.
Video Bandwidth = 100 kHz.

Test 1, Item A - Discrete Data: Radiated Disturbance Emissions below 30 MHz - 13.56 MHz Devices

Test Item (A-Z)	Detector Type* (P/Q/A)	Antenna Polarity (0-360)	Antenna Distance (m)	Measured Frequency (MHz)	Measured Value (dBuV)	Antenna Factor (dBA/V)	Cable Loss (dB)	Magnetic Field Strength @ 3 m (dBuA/m)	Free Space Impedance (377 ohms)	Electric Field Strength @ 3 m (dBuV/m)	3m to 30 m distance conversion (40 dB/dec)	Electric Field Strength @30m (dBuV/m)	Specified Limit** (dBuV/m)	Spec Margin (dB)	See Comment (#)***
A	P	0	3	13.562	45.3	-17.3	0.7	28.7	51.5	80.2	-40.0	40.2	84.0	-43.8	

No radiated emissions within 20 dB of limit.

* 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)

In linear units:

80.2 dBuV/m @ 3 m = 10233 uV/m @ 3m

Test 2: Radiated Disturbance Emissions - 30 to 1000 MHz Electric Field

Test Requirement: 47 CFR Part 15, Subpart B

Test Specification: 47 CFR Part 15, Subpart B, 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 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 B Equipment
at a measuring distance of 3m.

Frequency Range MHz	Quasi-Peak Limits $\mu\text{V}/\text{m}$	Quasi-Peak Limits $\text{dB}\mu\text{V}/\text{m}$
30 to 88	100	40.00
88 to 216	150	43.52
216 to 960	200	46.02
Above 960	500	53.97

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 - 30 to 1000 MHz Electric Field

Test Results Summary:

Test Item	Test Location	Humidity (%)	Temperature (°C)	Pressure (kPa)	Pass/Fail (P/F)	Date Completed	Comment #
A	A	38	24	101	P	1/11/2005	

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

Comments:

Comment #	Description

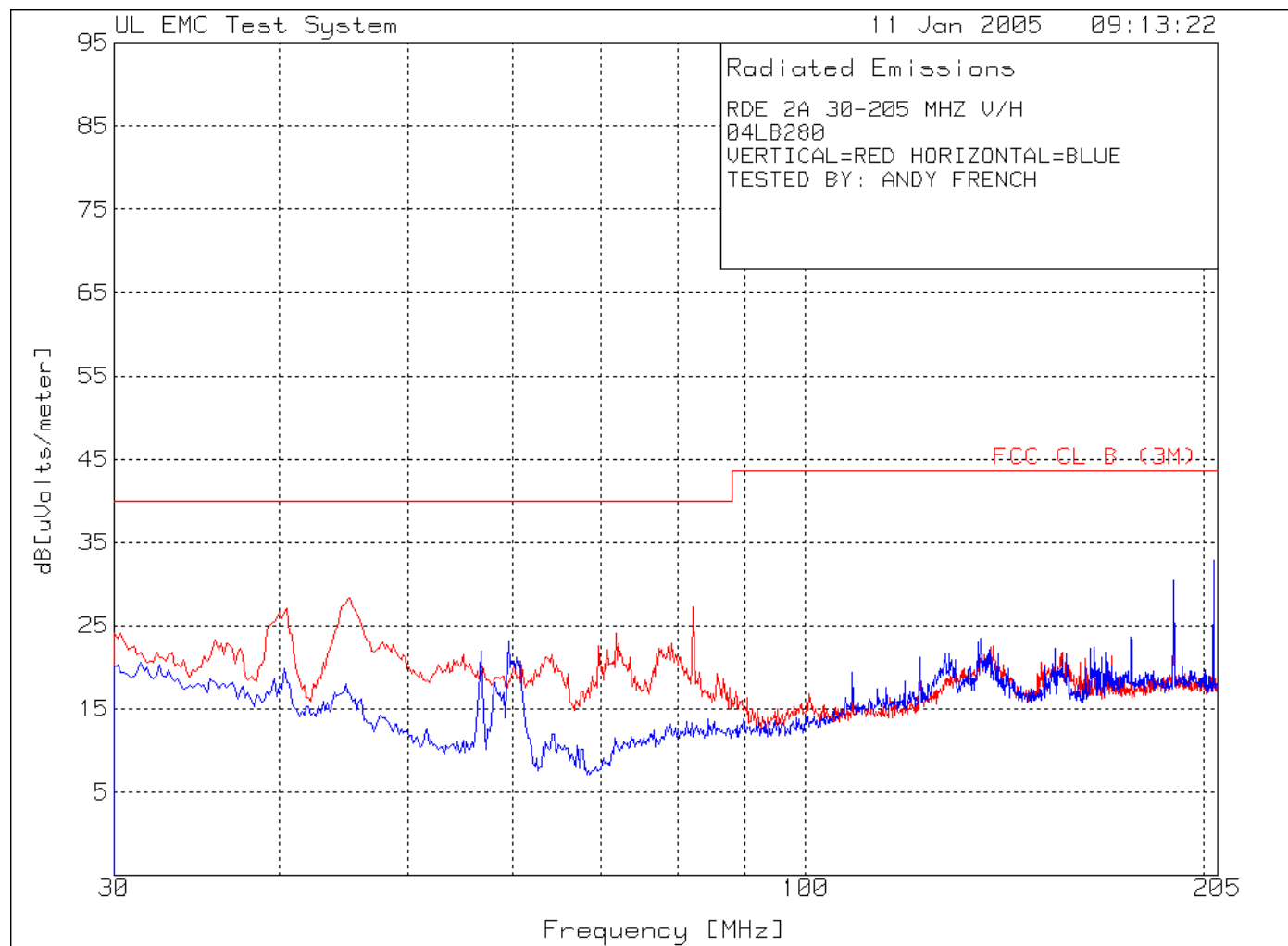
Test 2 - Test Equipment Used: Radiated Disturbance Emissions - 30 to 1000 MHz Electric Field

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
AT0025	Biconical Antenna, 30 to 300 MHz	Schaffner, EMC	VBA6106A	3/22/04	3/31/05
AT0030	Log periodic Antenna, 200 MHz to 1000 MHz	Schaffner, EMC	3160-07	2/9/04	2/28/05
ATA084	Attenuator 6 dB, 2 GHz	Pasternack	PE7002-6	3/11/04	3/31/05
ATA085	Attenuator 6 dB, 2 GHz	Pasternack	PE7002-6	3/11/04	3/31/05
ATA096	50 ft, N male - N male	Micro-Coax	Coaxial Cable	6/25/04	2/28/05
ATA124	RF Amplifier, 1 to 1000 MHz	Miteq	AM-3A-000110-N	3/11/04	3/31/05
ATA125	RF Amplifier, 1 to 1000 MHz	Miteq	AM-3A-000110-N	3/11/04	3/31/05
ATA140	RG214 Ferrite Cable	EMC Eupen	N/A	3/11/04	3/31/05
ATA143	Cable, 6ft., N-male to N-male	Micro-Coax	N/A	8/25/04	2/28/05
ATA167	RG214 Ferrite Cable	EMC Eupen	N/A	3/11/04	3/31/05
SAR003	EMC Receiver	Rohde & Schwarz	1088.7490K40	12/02/04	12/31/05

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 2, Item A (30-200 MHz) - Peak Plot (Amplitude in dBuV/m):

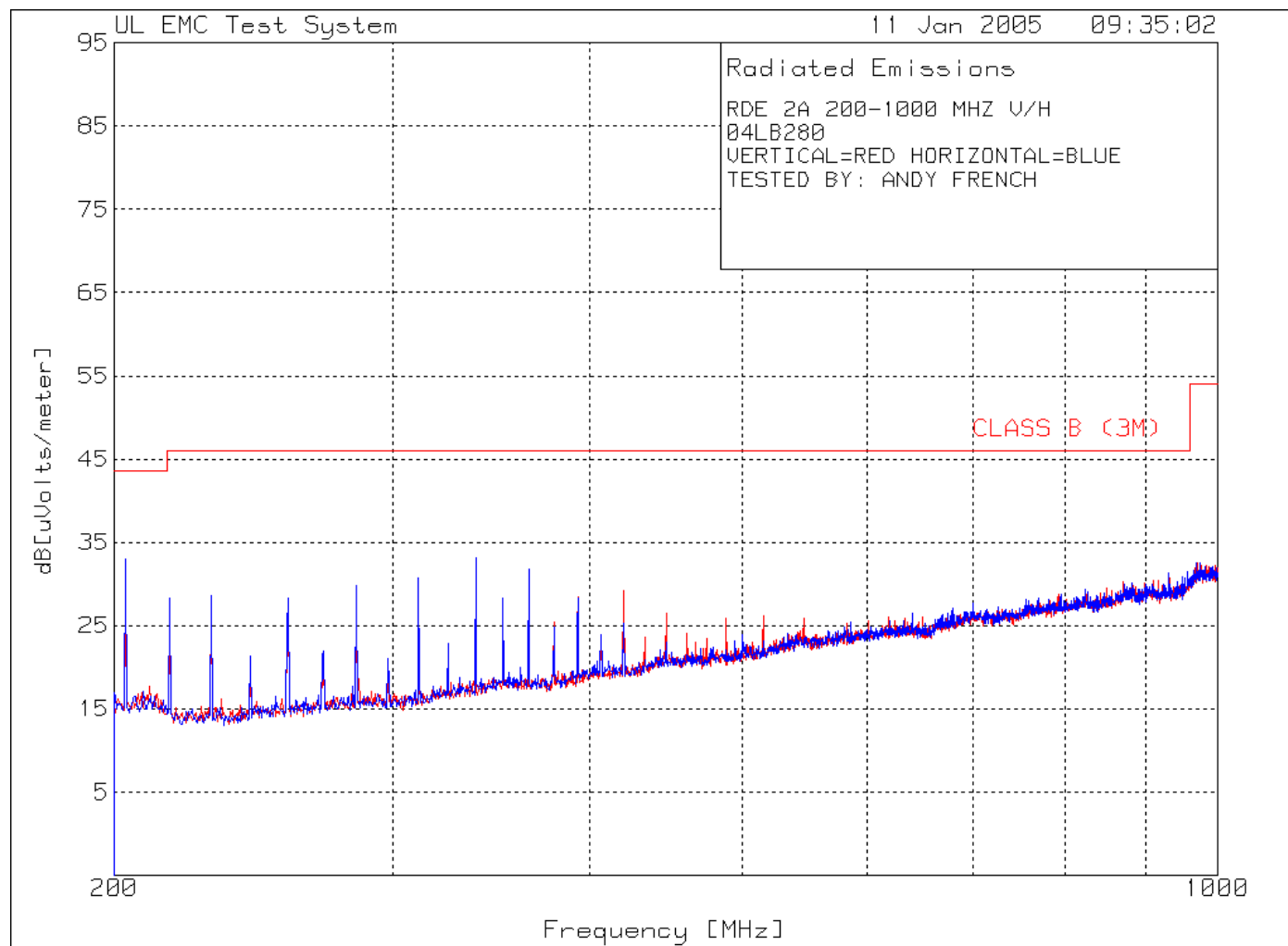
Radiated Disturbance Emissions - 30 to 1000 MHz Electric Field



Resolution Bandwidth = 120 kHz.
Video Bandwidth = 1 MHz.

Test 2, Item A (200-1000 Mhz) - Peak Plot (Amplitude in dBuV/m):

Radiated Disturbance Emissions - 30 to 1000 MHz Electric Field



Resolution Bandwidth = 120 kHz.
Video Bandwidth = 1 MHz.

Test 2, Item A - Discrete Data: Radiated Disturbance Emissions - 30 to 1000 MHz Electric Field

Test Item (A-Z)	Detector Type* (P/Q/A)	Antenna Polarity (H/V)	Antenna Distance (m)	Measured Frequency (MHz)	Measured Value (dBuV)	Cable / Amplifier Factor (dB)	Antenna Factor (dB/m)	Corrected Value (dBuV/m)	Specified Limit** (dBuV/m)	Spec Margin (dB)	See Comment (#)***
A	P	H	3	203.202	49.2	-28.6	12.4	33.0	43.5	-10.5	1
A	P	H	3	230.415	44.9	-28.4	12.1	28.6	46.0	-17.5	
A	P	H	3	257.629	43.3	-28.1	13.1	28.3	46.0	-17.7	
A	P	H	3	284.442	44.2	-28.0	13.7	29.9	46.0	-16.1	
A	P	H	3	311.656	44.3	-27.7	14.2	30.8	46.0	-15.2	
A	P	H	3	338.869	45.4	-27.5	15.3	33.2	46.0	-12.8	

* 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)

Comments:

Comment #	Description
1	Worst case radiated spurious emission = 33.0 dBuV/m (44.7 uV/m) at 203.202 MHz.

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

Radiated Disturbance Emissions - 13.56 MHz Devices



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

Radiated Disturbance Emissions - 13.56 MHz Devices



Test 3: Conducted Disturbance Emissions - Voltage

Test Requirement: 47 CFR Part 15, Subpart B

Test Specification: 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 of Class B Equipment

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 Power	1	1 (antenna attached)	1
B	1	AC Power	1	2 (matched load)	1

Test 3 - 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	C	38	24	101	P	1/11/2005	1
B	C	38	24	101	P	1/11/2005	

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

Comments:

Comment #	Description
1	Intentional Emissions at 13.56 MHz couples to AC power to exceed limit. When replaced by matched-impedance load, conducted emissions complies with limit.

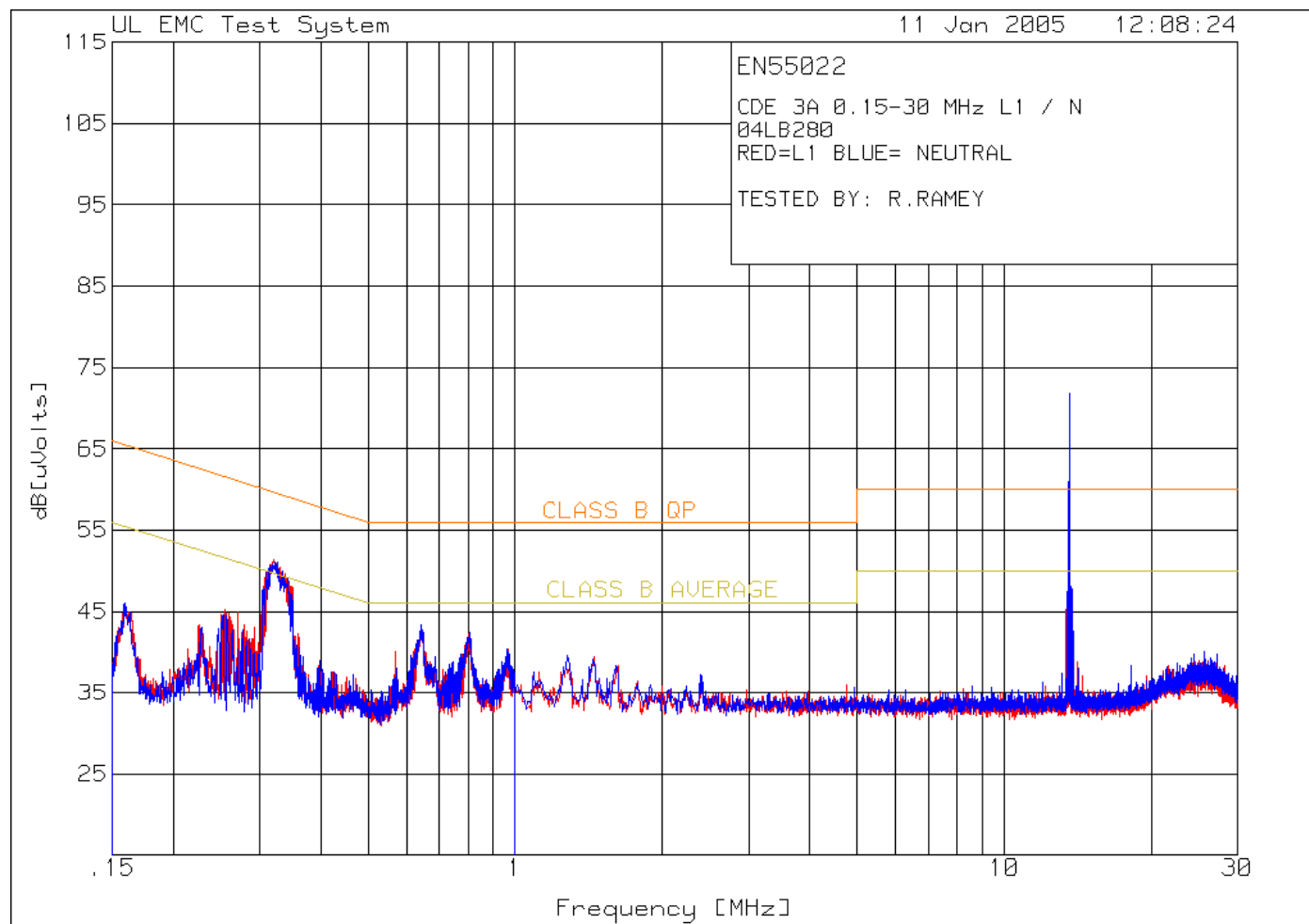
Test 3 - Test Equipment Used: Conducted Disturbance Emissions - Voltage

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
ATA013	20 ft Cable, BNC - BNC	UL	RG-223	2/18/04	2/28/05
ATA027	LISN, 150 kHz to 30 MHz	Solar Electronics	9629-50-TS-25	6/30/04	6/30/05
ATA028	LISN, 150 kHz to 30 MHz	Solar Electronics	9629-50-TS-25	6/16/04	6/30/05
ATA056	Transient Limiter, 0.009 to 100 MHz	Electro-Metrics	EM-7600	3/29/04	3/31/05
SAR001	Spectrum Analyzer / Receiver	Hewlett-Packard	8572A	2/2/04	2/28/05

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 3, Item A (with loop antenna) - Peak Plot (Amplitude in dBuV):

Conducted Disturbance Emissions - Voltage



Note: Emission present at 13.56 is the intentional emission from RFID reader coupling to the AC power cord. Another measurement follows with antenna replaced with impedance-matched terminator to demonstrate that the emission is radiated in nature.

Resolution Bandwidth = 9 kHz.
Video Bandwidth = 100 kHz.

Test 3, Item A (with loop antenna) - Discrete Data: Conducted Disturbance Emissions – Voltage

Test Item (A-Z)	Detector Type (P/Q/A)	Measured Conductor (Name)	Measured Frequency (MHz)	Measured Value (dBuV)	Cable/Limiter Loss (dB)	LISN Factor (dB)	Corrected Value (dBuV)	Specified Limit (dBuV)	Spec Margin (dB)	See Comment (#)***
A	P	Line	0.3206	40.5	10.7	0.1	51.3	59.7	-8.4	
A	A	Line	0.3209	35.7	10.7	0.1	46.5	49.7	-3.2	2
A	P	Line	0.6398	31.6	10.7	0.1	42.4	56.0	-13.6	
A	A	Line	0.6404	24.7	10.7	0.1	35.5	46.0	-10.5	
A	P	Line	0.8046	31.4	10.8	0.0	42.2	56.0	-13.8	
A	A	Line	0.8010	23.9	10.8	0.0	34.7	46.0	-11.4	
A	P	Line	0.9699	29.5	10.8	0.0	40.3	56.0	-15.7	
A	P	Line	13.5838	59.6	11.0	0.1	70.7	60.0	10.7	1
A	Q	Line	13.5590	59.3	11.0	0.1	70.4	60.0	10.4	1
A	A	Line	13.5585	59.7	11.0	0.1	70.8	50.0	20.8	1
A	P	Neutral	0.3267	40.2	10.7	0.1	51.0	59.7	-8.7	
A	P	Neutral	0.6487	31.6	10.7	0.1	42.4	56.0	-13.6	
A	P	Neutral	0.8058	31.6	10.8	0.0	42.4	56.0	-13.6	
A	P	Neutral	0.9588	29.5	10.8	0.0	40.3	56.0	-15.7	
A	P	Neutral	13.5839	60.7	11.0	0.1	71.8	60.0	11.8	1
A	Q	Neutral	13.5590	59.2	11.0	0.1	70.3	60.0	10.3	1
A	A	Neutral	13.5589	59.3	11.0	0.1	70.4	50.0	20.4	1

* 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 (dBuV) + Equip Correction (dB)

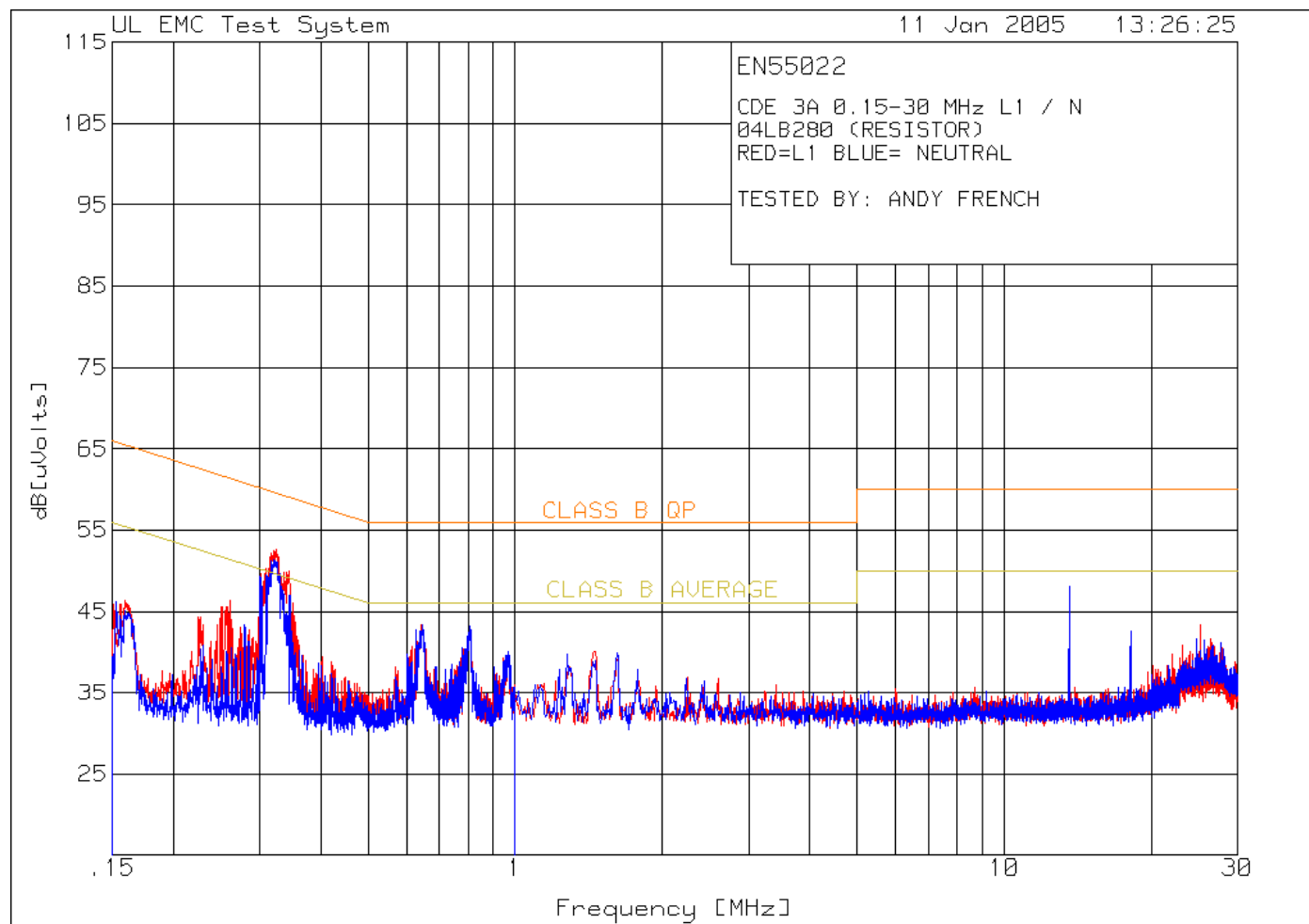
Sample Calculation: Equip Correction = LISN Factor (dB) + Cable Loss (dB) + Transient Limiter Loss (dB)

Comments:

Comment #	Description
1	Intentional signal is disregarded.
2	Closest conducted measurement to limit. Average measurement performed on Line conductor. This was the higher of the two conductors. 46.5 dBuV/m (211.3 uV/m) at 0.3209 MHz.

Test 3, Item B (with matched-impedance load) - Peak Plot (Amplitude in dBuV):

Conducted Disturbance Emissions - Voltage



Resolution Bandwidth = 9 kHz.
Video Bandwidth = 100 kHz.

Test 3, Item B (with matched impedance load) - Discrete Data:

Conducted Disturbance Emissions – Voltage

Test Item (A-Z)	Detector Type (P/Q/A)	Measured Conductor (Name)	Measured Frequency (MHz)	Measured Value (dBuV)	Cable/ Limiter Loss (dB)	LISN Factor (dB)	Corrected Value (dBuV)	Specified Limit (dBuV)	Spec Margin (dB)	See Comment (#)***
A	P	Line	0.3237	41.8	10.7	0.1	52.6	59.7	-7.1	
A	A	Line	0.3216	36.7	10.7	0.1	47.5	49.7	-2.2	
A	P	Line	0.6436	32.6	10.7	0.1	43.4	56.0	-12.6	
A	A	Line	0.6429	26.1	10.7	0.1	36.9	46.0	-9.1	
A	P	Line	0.8072	32.1	10.8	0.0	42.9	56.0	-13.1	
A	A	Line	0.8092	24.7	10.8	0.0	35.5	46.0	-10.5	
A	P	Line	0.9669	29.3	10.8	0.0	40.1	56.0	-15.9	
A	P	Line	13.5694	36.9	11.0	0.1	48.0	60.0	-12.0	1
A	A	Line	13.5617	35.8	11.0	0.1	46.9	50.0	-3.2	1
A	P	Neutral	0.3208	40.5	10.7	0.1	51.3	59.7	-8.4	
A	A	Neutral	0.3210	36.8	10.7	0.1	47.6	49.7	-2.1	
A	P	Neutral	0.6466	32.5	10.7	0.1	43.3	56.0	-12.7	
A	A	Neutral	0.6418	26.1	10.7	0.1	36.9	46.0	-9.1	
A	P	Neutral	0.8063	32.4	10.8	0.0	43.2	56.0	-12.8	
A	A	Neutral	0.8055	25.6	10.8	0.0	36.4	46.0	-9.6	
A	P	Neutral	0.9580	28.8	10.8	0.0	39.6	56.0	-16.4	
A	P	Neutral	13.5766	36.9	11.0	0.1	48.0	60.0	-12.0	1
A	A	Neutral	13.5596	35.7	11.0	0.1	46.8	50.0	-3.2	1

* 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 (dBuV) + Equip Correction (dB)

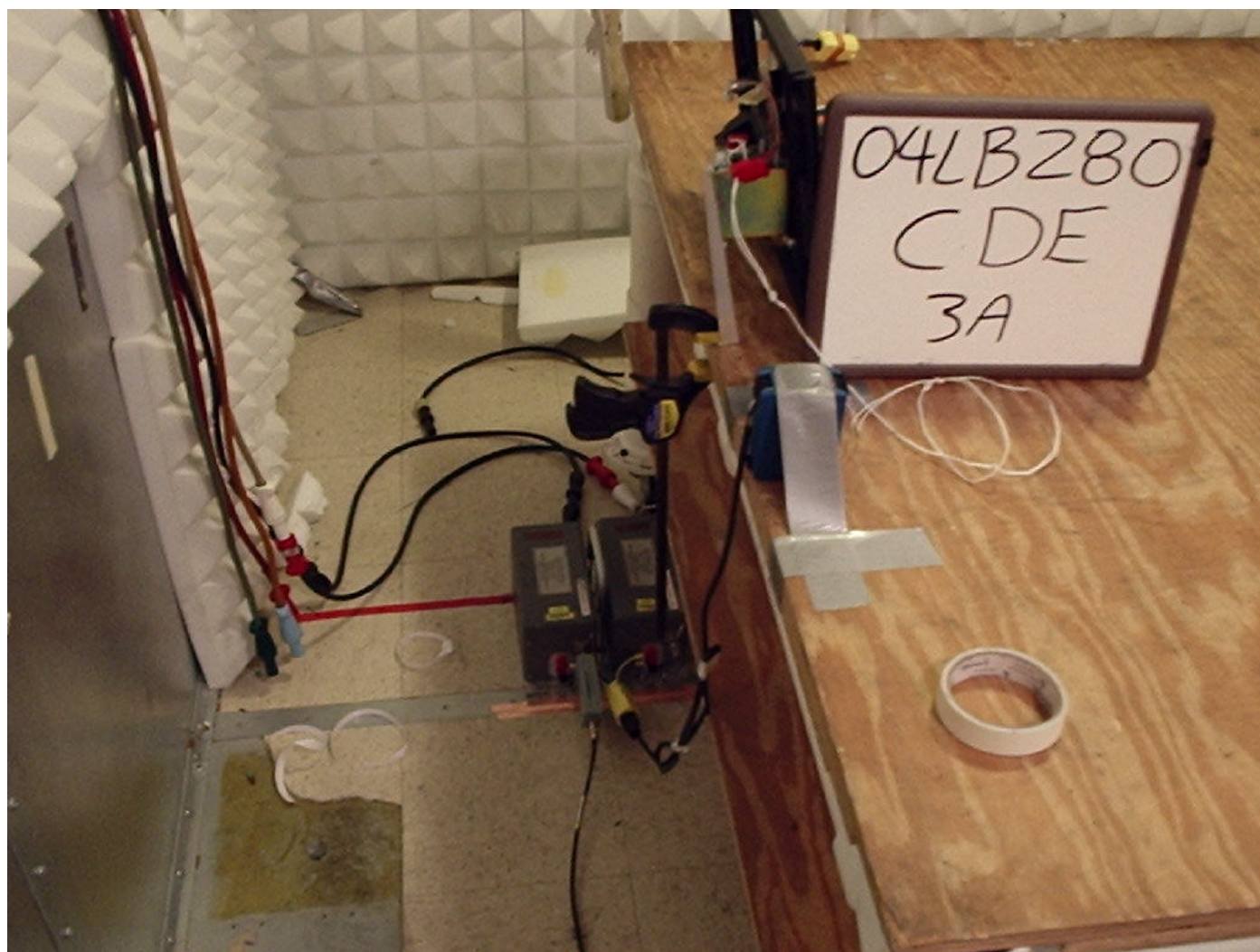
Sample Calculation: Equip Correction = LISN Factor (dB) + Cable Loss (dB) + Transient Limiter Loss (dB)

Comments:

Comment #	Description
1	Intentional signal complies with matched load.

Test 3, Item A - Test Set-Up Photo:

Conducted Disturbance Emissions - Voltage



Test 4: Radiated Disturbance Emissions - Occupied Bandwidth

Test Requirement: 47 CFR Part 15, Subpart C

Test Specification: 47 CFR Part 15, Subpart C, Section 15.231

Test Procedure:

This measurement was performed with a handheld diagnostic loop antenna located in close proximity to the transmit antenna. A conducted measurement was not performed, because the antenna connector was not a common 50-ohm measurement connector (SMC, N, etc).

The spectrum analyzer Resolution Bandwidth and Video Bandwidth were set as shown on the plot. 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.

Occupied Bandwidth Limit - Manually Operated Transmitter Section 15.225

Transmit Frequency MHz	Bandwidth Limit
13.56	See Note

Note: FCC Part 15.225 does not specify a specific bandwidth, however field strength limits at 13.553 and 13.567 MHz are specified. This effectively limits the bandwidth to 14 kHz. As the signal measured is nearly a CW signal the bandwidth settings affect the measurement produced. Two bandwidth measurements were produced to satisfy both the ANSI requirements (for FCC) and IC requirements.

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 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	C	38	24	101	P	1/11/2005	

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

Comments:

Comment #	Description
1	Intentional Emissions at 13.56 MHz couples to AC power to exceed limit. When replaced by matched-impedance load, conducted emissions complies with limit.

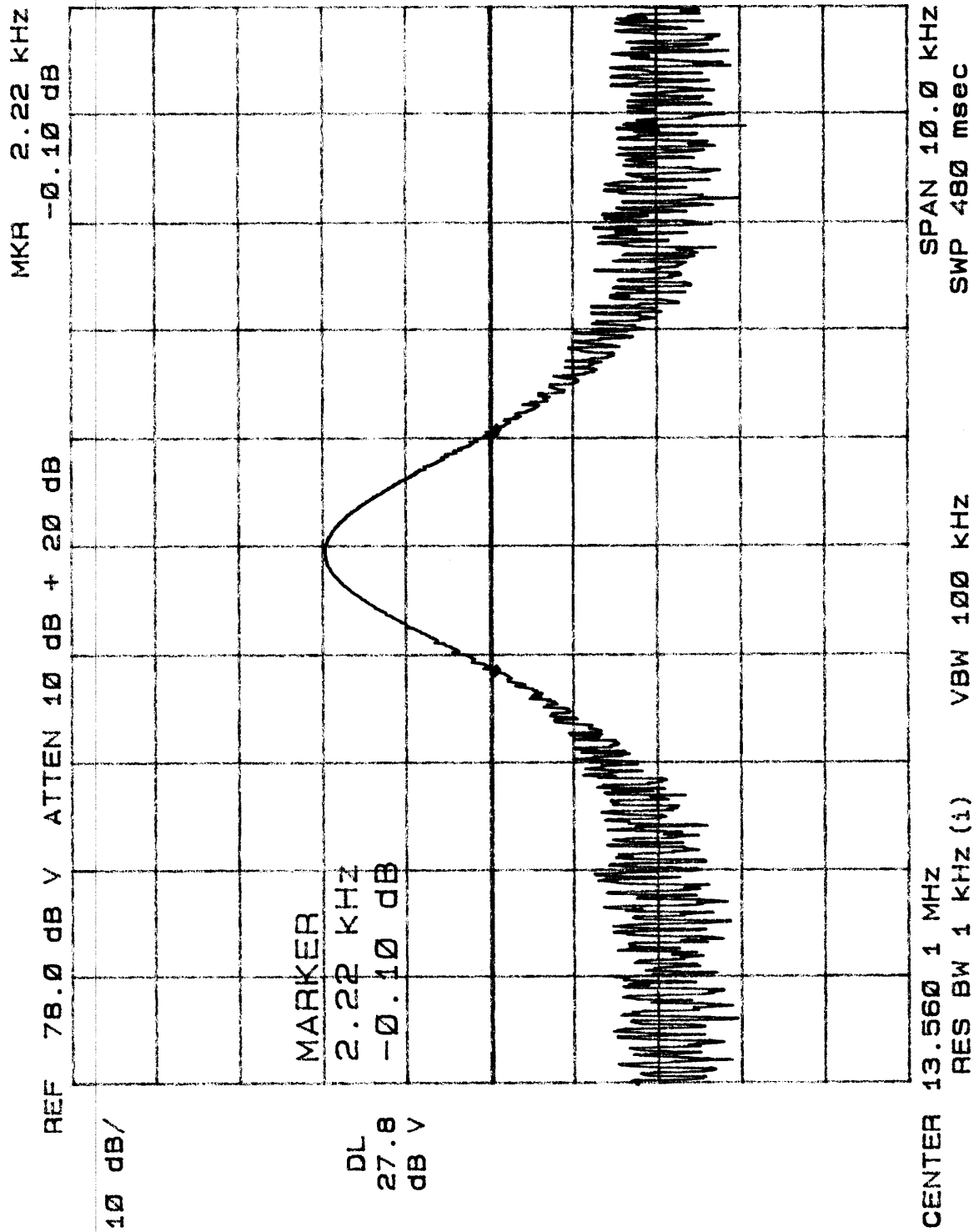
Test 4 - Test Equipment Used: Radiated Disturbance Emissions - Occupied Bandwidth

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
ATA013	20 ft Cable, BNC - BNC	UL	RG-223	2/18/04	2/28/05
SAR001	Spectrum Analyzer / Receiver	Hewlett-Packard	8572A	2/2/04	2/28/05

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.

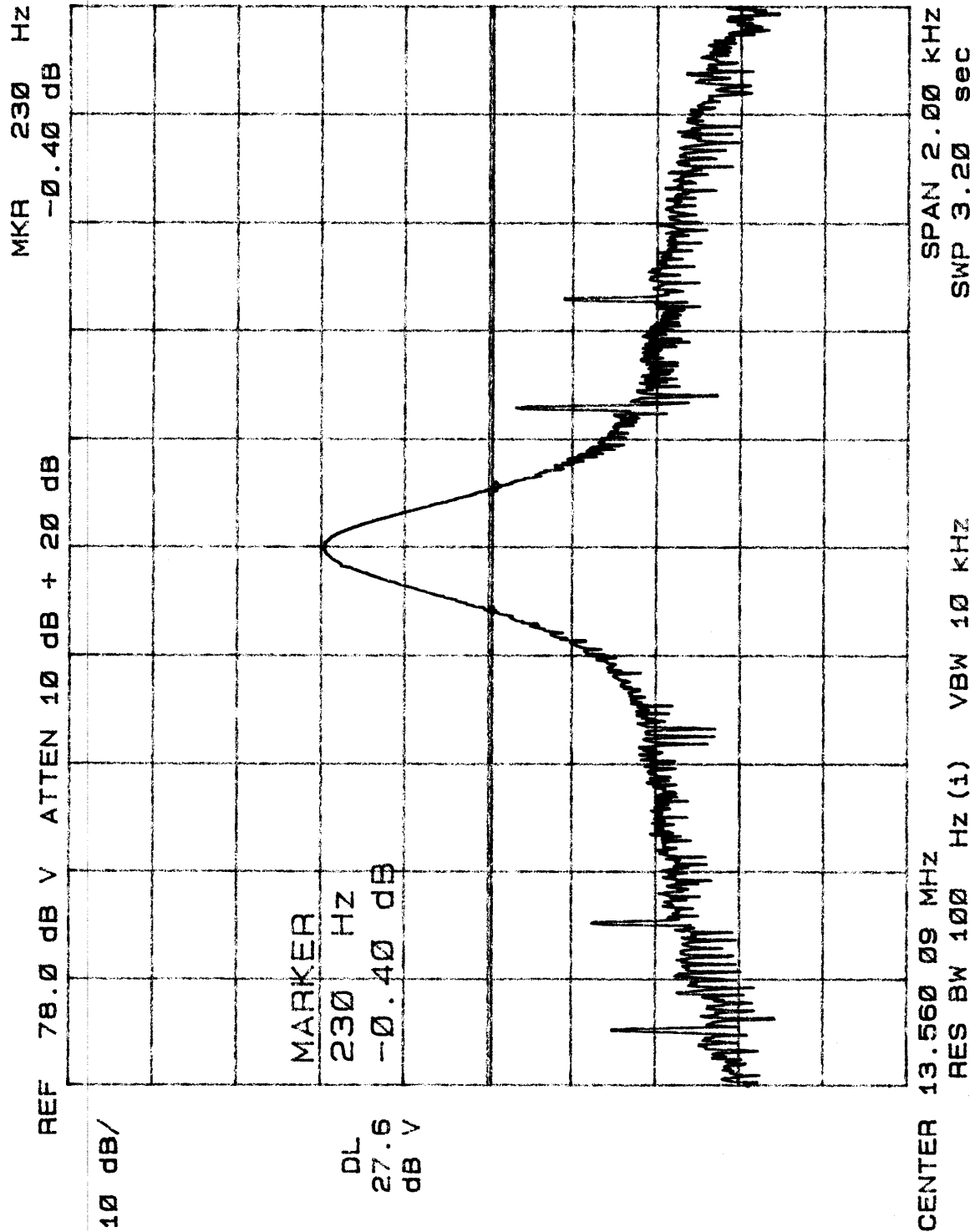
Test 4, Item A (Occupied BW - 1kHz BW, ANSI) - Peak Plot (Amplitude in dBuV):

Radiated Disturbance Emissions - Occupied Bandwidth



Test 4, Item A (Occupied BW, 100 Hz BW, IC) - Peak Plot (Amplitude in dBuV):

Radiated Disturbance Emissions - Occupied Bandwidth



Test 4, Item A - Discrete Data: Radiated Disturbance Emissions - Occupied Bandwidth

Test Item (A-Z)	Center Frequency (MHz)	Measured Bandwidth (kHz)	Maximum Permitted Bandwidth (kHz)*	Pass/Fail (P/F)	See Comment (#)*
100 Hz RBW					
A	13.56009	0.23	14.00	P	1
1 kHz RBW					
A	13.5601	2.22	14.00	P	1

* # = Maximum bandwidth established by field strength limit between 13.553 and 13.567 MHz

Test 5 : Maximum Permissible Exposure Calculation

Test Requirement: 47 CFR Part 1

Test Specification: 47 CFR Part 1, Section 1.1307

Exposure Limits:

FCC Limits for Occupational/Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time E ² , H ² or S (minutes)
0.3 – 3.0	614	1.63	(100)*	6
3.0 - 30	1824/f	4.89/f	(900/f ²)*	6
30 - 300	61.4	0.163	1.0	6
300 – 1500	-	-	f/300	6
1500 – 100,000	-	-	5.0	6

* Plane-wave equivalent power density. f in MHz.

FCC Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time E ² , H ² or S (minutes)
0.3 - 1.34	614	1.63	(100)*	30
1.34 - 30	824/f	2.19/f	(180/f ²)*	30
30 - 300	27.5	0.073	0.2	30
300 – 1500	-	-	f/1500	30
1500 – 100,000	-	-	1.0	30

*Plane-wave equivalent power density. f in MHz.

Test Details: This device is considered to possibly be located in either environment, therefore the General/Uncontrolled limit is used during calculation.

Background: Per the following guidance from OET Bulletin 65 Supplement C required minimum spacings are provided to the professional installer.

Transmitter or Device Type ¹⁸	Output ¹⁹	Applicable Methods to Ensure Compliance ²⁰
Transmitters using indoor antennas that operate at 20 cm or more from nearby persons	>2.5 W at 915 MHz	If the MPE distance is greater than that required for normal operation of the device, operating instructions, warning instructions and/or warning labels may be used to ensure compliance by indicating the minimal separation distance to comply with MPE limits. If the antennas are professionally installed to ensure compliance, warning instructions and warning labels are not necessary.
	=< 2.5 W at 915 MHz or =< 4 W at 2450 MHz	Transmitters operating at 2.5 W EIRP (1.5 W ERP) or less at 915 MHz, or at 4 W EIRP (2.4 W ERP) or less at 2450 MHz, generally are not expected to exceed MPE limits when nearby persons are 20 cm or more from most antennas. Therefore, special instructions and warnings are normally not necessary to ensure compliance.

MPE Calculation:

As measurements were performed by radiated emissions in magnetic field, the magnetic field strength recorded at 3 meter distance is extrapolated to 20 cm. A 40 dB/decade factor is used. The result is compared against the magnetic field strength limit for general/uncontrolled environment.

Exposure Limit

Magnetic Field Strength Limit (from table) = $2.19/f$ A/m, where f = frequency in MHz.

Magnetic Field Strength Limit = $2.19/13.56$ A/m = **0.1615 A/m**

Field Produced at 20 cm

Extrapolating from 3 meter distance to 20 cm:

Magnetic Field Strength measured = $28.7 \text{ dBuA/m} + 40 \cdot \text{Log}_{10}(300 \text{ cm}/20 \text{ cm})$

Magnetic Field Strength measured = $28.7 \text{ dBuA/m} + 47.0 \text{ dB} = 75.7 \text{ dBuA/m}$ or in linear units = **0.006095 A/m**

Result

It is demonstrated that the device complies with the magnetic field strength RF exposure limits for general/uncontrolled environment at a distance of 20 cm. Because the transmitting antenna is a loop antenna, only the magnetic field limit is considered. The electric field limit and power density limit are considered to be met without calculation.

Accreditations

National Institute of Standards and Technology **NVLAP**® National Voluntary Laboratory Accreditation Program

ISO/IEC 17025:1999
ISO 9002:1994

Scope of Accreditation

Revised Scope 12/10/2004
ELECTROMAGNETIC COMPATIBILITY AND TELECOMMUNICATIONS
NVLAP LAB CODE 200246-0
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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/CIS14c	CNS 13783-1
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)

June 30, 2005

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NVLAP Code	Designation / Description
12/CIS22b	CNS 13438 (1997): Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment
12/EM02a	IEC 61000-3-2, Edition 2.1 (2001-10), EN 61000-3-2 (2000), and AS/NZS 2279.1 (2000): Electromagnetic compatibility (EMC) Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A)
12/EM03b	IEC 61000-3-3, Edition 1.1 (2002-03) & EN 61000-3-3, A1 (2001): EMC - Part 3-3: Limits - Limitations of voltage changes, voltage fluctuations and flicker, in public low-voltage supply-systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connections
12/FCC15b	ANSI C63.4 (2001) with FCC Method - 47 CFR Part 15, Subpart B: Unintentional Radiators
12/T51	AS/NZS CISPR 22 (2002) and AS/NZS 3548 (1997): Electromagnetic Interference - Limits and Methods of Measurement of Information Technology Equipment

Immunity Test Methods:

12/I01	IEC 61000-4-2, Edition 2.1 (2001) including Amds. 1 & 2 and EN 61000-4-2: Electrostatic Discharge Immunity Test
12/I02	IEC 61000-4-3, Edition 2.0 (2002-03) and EN 61000-4-3: Radiated Radio-Frequency Electromagnetic Field Immunity Test

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NVLAP Code	Designation / Description
12/I03	IEC 61000-4-4 (1995) & Amd. 1 (2000) & Amd. 2 (2001) and EN 61000-4-4: Electrical Fast Transient/Burst Immunity Test
12/I04	IEC 61000-4-5, Edition 1.1 (2001-04) and EN 61000-4-5: Surge Immunity Test
12/I05	IEC 61000-4-6, Edition 2.0 (2003-05) and EN 61000-4-6: Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields
12/I06	IEC 61000-4-8, Edition 1.1 (2001) and EN 61000-4-8: Power Frequency Magnetic Field Immunity Test
12/I07	IEC 61000-4-11, Edition 1.1 (2001-03) and EN 61000-4-11: Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests

Safety Test Methods:

12/T41a	AS/NZS 60950 (2000): Safety of Information Technology Equipment (including Amdt1)
12/T50	AS/NZS 3260 (1993) + Supplement 1 (1996): Safety of Information Technology Equipment Including Electrical Business Equipment

Telecommunications Test Methods:

12/I089d	GR-1089-CORE, Issue 3 (April 2002): EMC and Electrical Safety - Generic Criteria for Network Telecommunications Equipment (sections: 2.1.2.1, 2.1.2.2, 2.1.4, 2.2, 3.2, 3.3, 4.6.2, 4.6.5, 4.6.7 - 4.6.17, 4.7, 5.2, 5.3.1, 5.4, 6, 7.2 - 7.7, 8, and 9.2 - 9.12)
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NVLAP Code	Designation / Description
12/7620a	SBC-TP-76200, Issue 4 (May 2003): Network Equipment Power, Grounding, Environmental, and Physical Design Requirements (sections: 6.1B, 7.1, 7.2, 7.3, 7.4, and 10.1 - 10.4B)
12/GR63a	GR-63-CORE, Issue 2 (April 2002): NEBS (TM) Requirements: Physical Protection (sections: 2, 3, 4.1, 4.2.3, 4.3, 4.4.1, 4.4.3, 4.4.4, 4.5, 4.6, and 4.7)

June 30, 2005

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Measurement Uncertainty Statement

Test	Expanded Estimate of Uncertainty (k = 2, for 95% of a normal distribution)	Units
Radiated Disturbance Emissions: • 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.