Test 6: Conducted Disturbance Emissions - Voltage

Test Requirement: 47 CFR Part 15, Subpart B
47 CFR Part 15, Subpart C

Test Specification: 47 CFR Part 15, Subpart B, Class A
47 CFR Part 15, Subpart C, Part 15.207

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 Part 15.207.

Frequency Range (MHz)	Quasi-Peak Limit (dBμV)	Average Limit (dBμV)
0.150 to 0.5	66 to 56	56 to 46
0.5 to 5	56	46
5 to 30	60	50

Conducted Disturbance Emission Limits For Subpart B Class A Equipment (Part 15.107)

Frequency Range (MHz)	Quasi-Peak Limit (dBμV)	Average Limit (dBμV)
0.150 to 0.5	79	66
0.5 to 30	73	60

Notice: This device was not tested using transitional Conducted Emissions limits in 15.107. This device may continue to be offered for sale after July 10, 2005.

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	4 (Hopping Normally)	1	1

Test 6 - Results: Conducted Disturbance Emissions - Voltage

Test Results Summary:

Test Item	Test Location	Pass/Fail (P/F)	Date Completed	Comment #
A	E	P	6/19/03	

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

Comments:

Comment #	Description

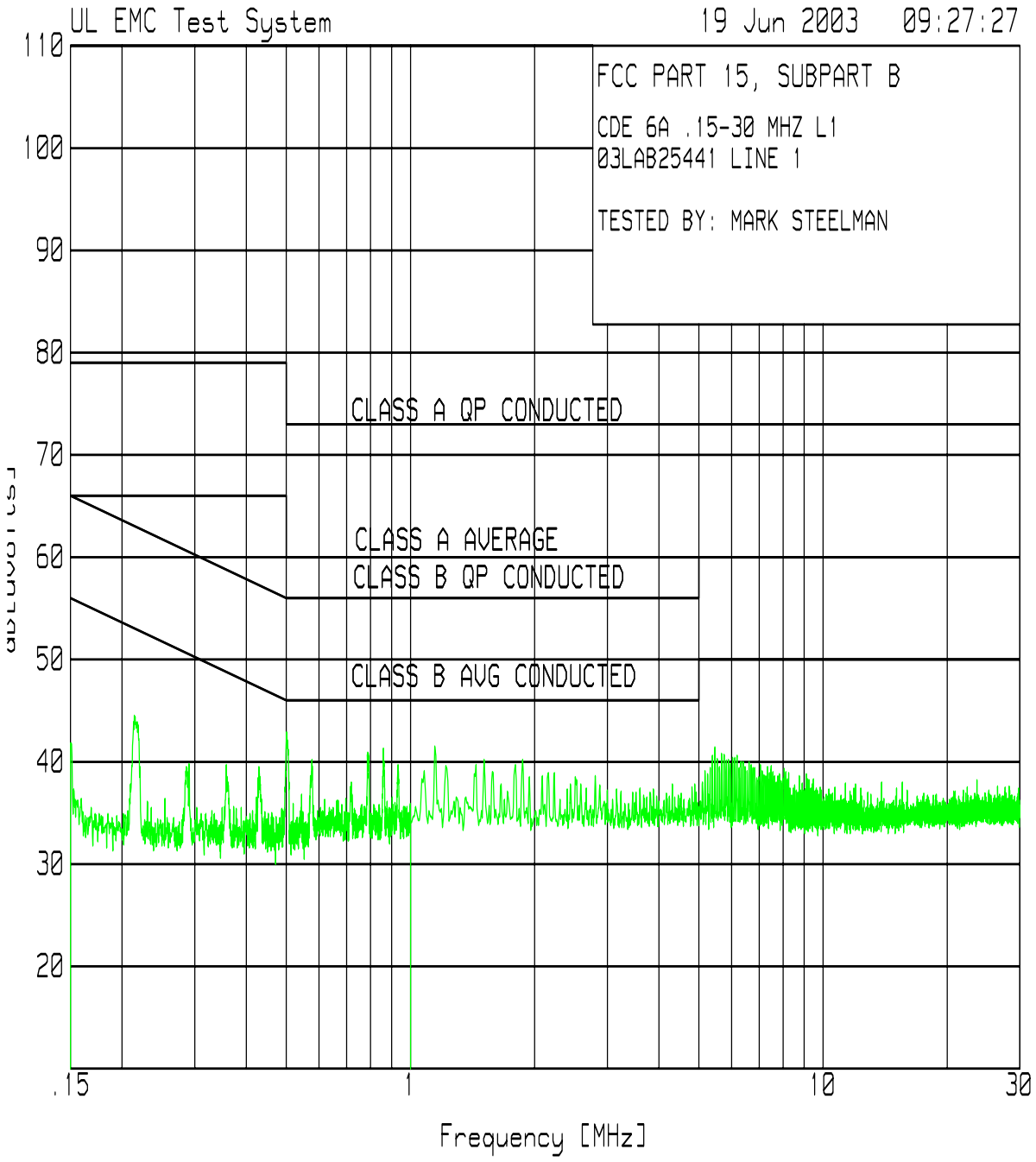
Test Equipment Used:

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
ATA001	Transient Limiter, 0.009 to 100 MHz	Electro-Metrics	EM-7600	2/21/03	2/28/04
ATA013	20 ft Cable, BNC - BNC	UL	RG-223	2/6/03	2/29/04
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.

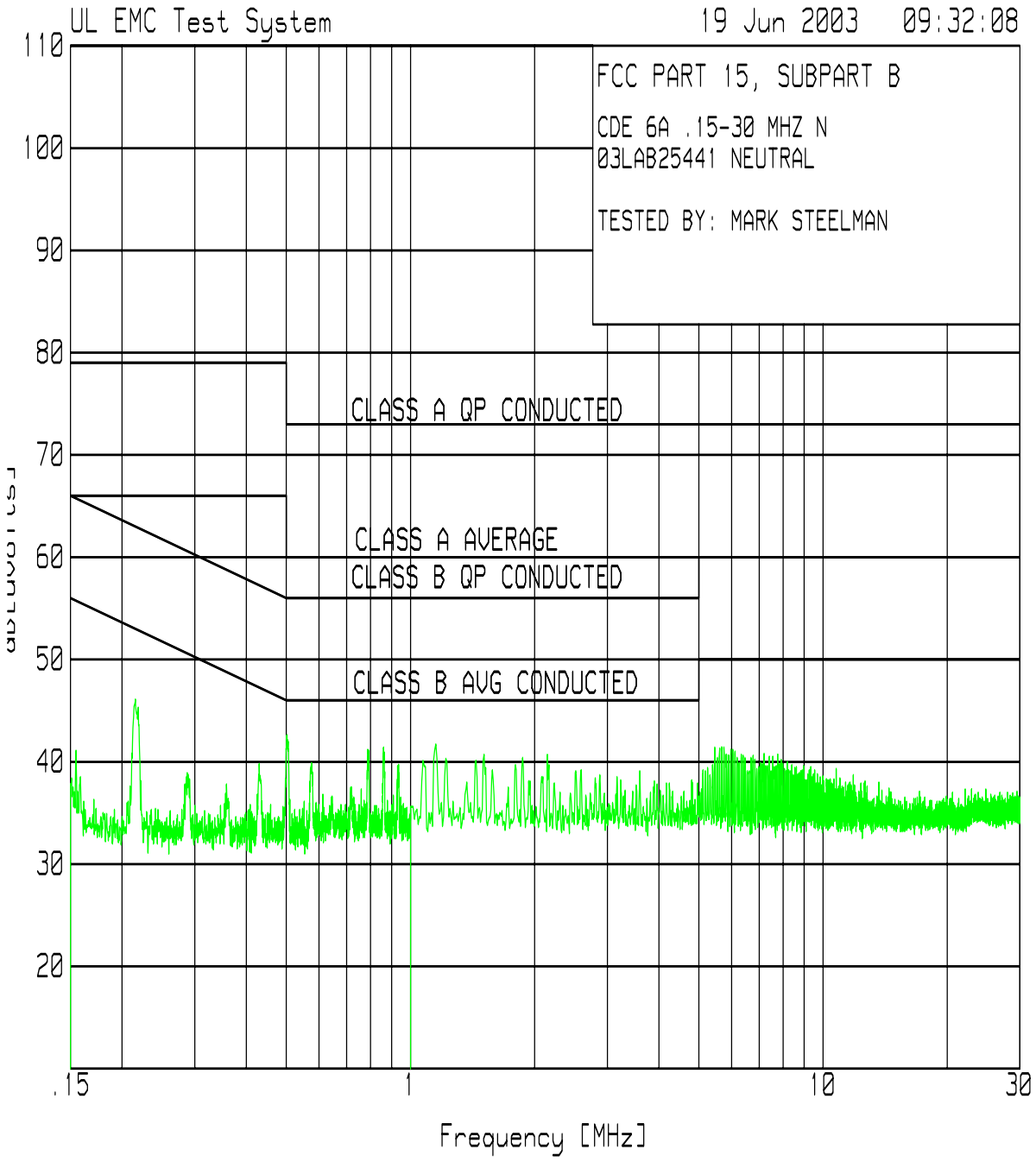
Test 6, Item A (Line) - Peak Plot (Amplitude in dBuV):

Conducted Disturbance Emissions - Voltage



Test 6, Item A (Neutral) - Peak Plot (Amplitude in dBuV):

Conducted Disturbance Emissions - Voltage



Test 6, All Items - Discrete Data: Conducted Disturbance Emissions – Voltage

Test Item (A-Z)	Detector Type (P/Q/A)	Measured Conductor (Name)	Measured Frequency (MHz)	Measured Value (dBuV)	Equip Correction (dB)	Corrected Value (dBuV)	Specified Limit (dBuV)	Spec Margin (dB)	See Comment (#)***
A	P	Line	0.2141	34.1	10.4	44.5	53.2	-8.7	
A	P	Line	0.5019	32.5	10.4	42.9	46.0	-3.1	1
A	P	Line	0.8594	30.9	10.4	41.3	46.0	-4.7	
A	P	Line	1.1449	31.1	10.4	41.5	46.0	-4.5	
A	P	Line	1.8694	29.8	10.4	40.2	46.0	-5.8	
A	P	Line	5.4663	30.9	10.5	41.4	50.0	-8.6	
A	P	Neutral	0.2154	35.7	10.4	46.1	53.2	-7.1	
A	P	Neutral	0.5019	32.2	10.4	42.6	46.0	-3.4	
A	P	Neutral	0.8600	31.0	10.4	41.4	46.0	-4.6	
A	P	Neutral	1.1521	31.3	10.4	41.7	46.0	-4.3	
A	P	Neutral	1.5071	30.3	10.4	40.7	46.0	-5.3	
A	P	Neutral	5.4627	30.9	10.5	41.4	50.0	-8.6	

* 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)

Part 15.207 Limits Shown.

Comments:

Comment #	Description
1	Worst-case conducted emissions: 42.9 dBuV or 139.6 uV.

Test 6, Item A - Test Set-Up Photo:

Conducted Emissions

Test 7: Radiated Disturbance Emissions - 1 to 10 GHz Electric Field

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.

Average measurements are performed by reducing the measurement Spectrum Analyzer Video Bandwidth until a steady reading is observed. The Video Bandwidth is not reduced below 10 Hz, per FCC 15.35(b).

Radiated Disturbance Limits for Class A Equipment

Measurement Distance* (m)	Frequency Range (GHz)	Average Limit (μV/m)	Average Limit (dBμV/m)	Peak Limit (μV/m)	Peak Limit (dBμV/m)
1	1 to 40	3000	69.5	30,000	89.5
3	1 to 40	1000	60.0	10,000	80.0
10	1 to 40	300	49.5	3000	69.5

* Limit adjusted from 3m to actual measurement distance by 1/r.

Upper Measurement Frequency Limit Based on Highest EUT Operating Frequency

Highest Operating Frequency	(MHz)	Below 1.705	1.705 to 108	108 to 500	500 to 1000	1000 to 8000	Above 8000
Upper Measurement Frequency	(MHz)	30	1000	2000	5000	5th Harmonic	40GHz

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	4 (Not Transmitting)	1	1

Test 7 - Results: Radiated Disturbance Emissions - 1 to 10 GHz Electric Field

Test Results Summary:

Test Item	Test Location	Humidity (%)	Temperature (ºC)	Pressure (kPa)	Pass/Fail (P/F)	Date Completed	Comment #
A	A	40	24	100	P	6/18/03	1

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

Comments:

Comment #	Description
1	Additional measurement was performed at a 1 meter measurement distance from 7 to 10 GHz due to instrumentation noise floor.

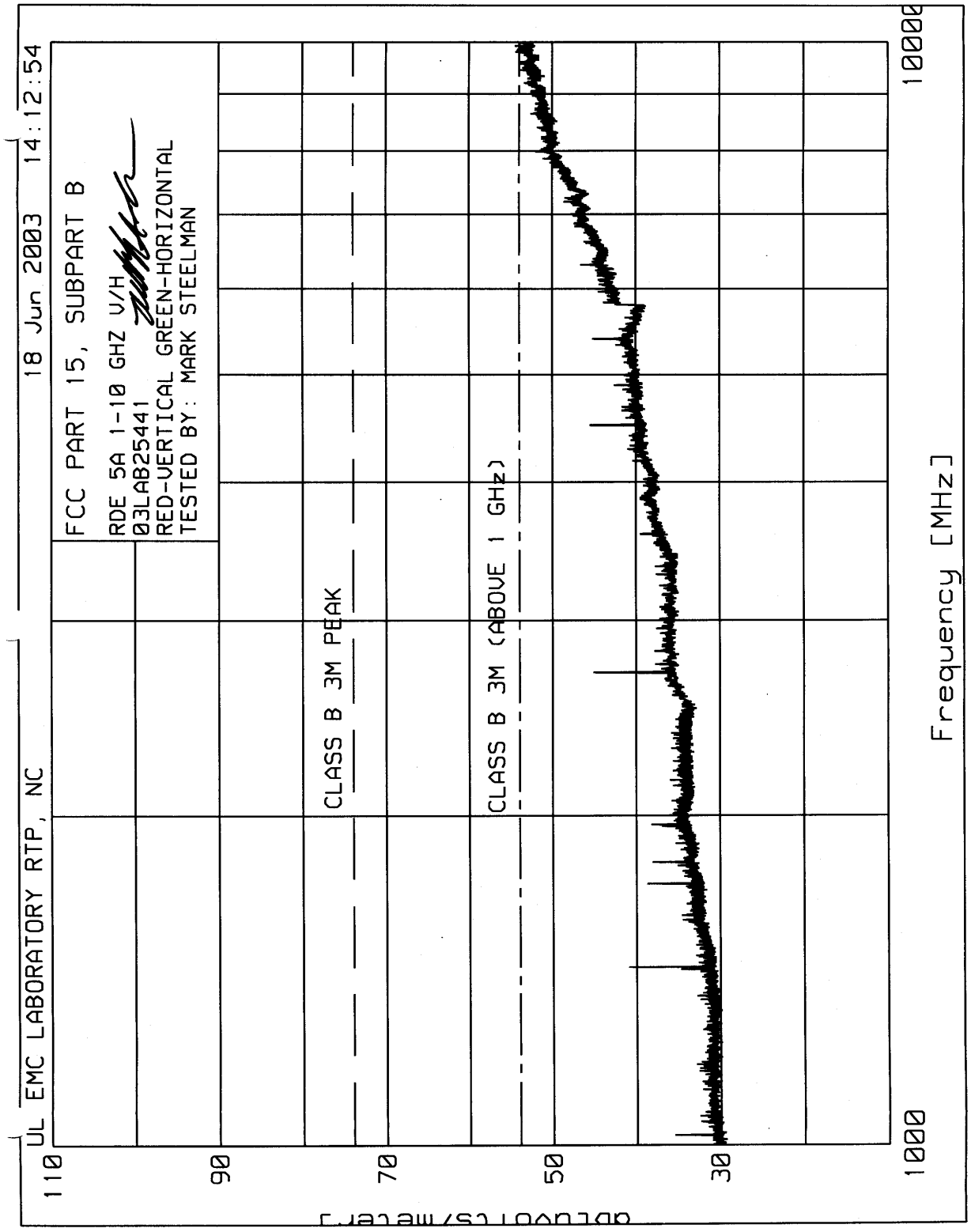
Test Equipment Used:

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
SAR002	Spectrum Analyzer / Receiver	Hewlett-Packard	8566B	11/21/02	11/30/03
ATA153	27 ft., N-male to N-male	Micro-Coax	UFB293C-0-3149-50504	3/19/03	3/31/04
ATA144	Amplifier, 0.1 to 18 GHz	Miteq	AFS42-00101800-2	3/20/03	3/31/04
ATA143	6 ft., N-male to N-male	Micro-Coax	Coaxial Cable	2/25/03	2/29/04
ATA096	50 ft., N-male to N-male	Micro-Coax	Coaxial Cable	3/20/03	3/31/04
AT0026	Horn Antenna, 1 to 18 GHz	EMC Test Systens	3115	5/8/03	5/31/04
HI0034	Environmental Indicator	Cole-Palmer	99760-00	10/2/02	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/NCSL Z540-1-1994.

Test 7, Item A (Not Transmitting) - Peak Plot (Amplitude in dBuV/m):

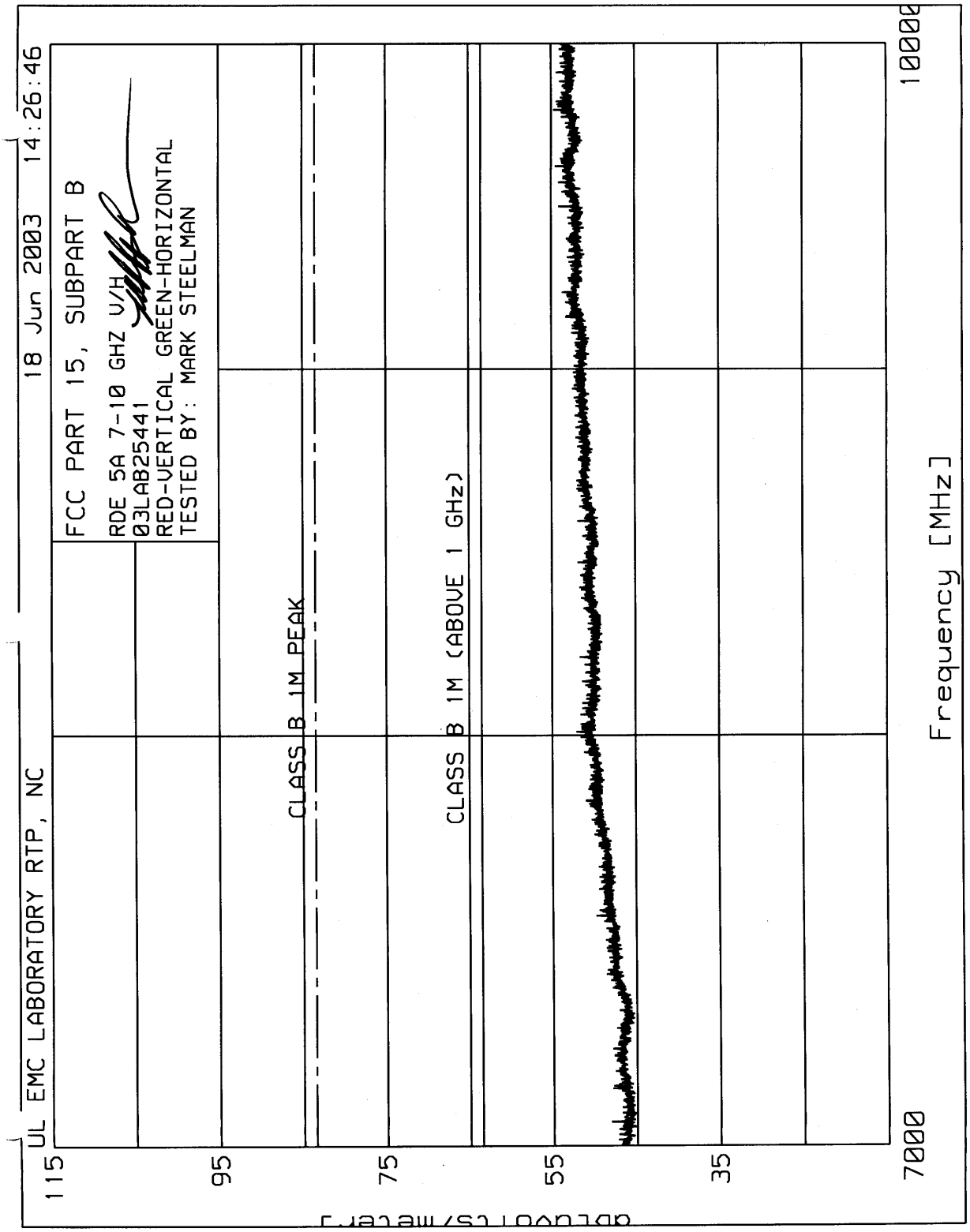
Radiated Disturbance Emissions - 1 to 10 GHz Electric Field, 3 meter measurement distance



Note: Plot displays Class B limit line, however this device is intended for a Class A environment.

Test 7, Item A (Not Transmitting, 1 meter distance) - Peak Plot (Amplitude in dBuV/m):

Radiated Disturbance Emissions - 1 to 10 GHz Electric Field, 1 meter measurement distance (7 to 10 GHz)



Note: Plot displays Class B limit line, however this device is intended for a Class A environment.

Test 7, Item A (Not Transmitting) - Discrete Data: Radiated Disturbance Emissions - 1 to 10 GHz Electric Field

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	3	1020.240	44.0	-8.5	35.5	60	-24.5	
A	P	V	3	1451.274	47.2	-6.3	40.9	60	-19.1	
A	P	V	3	1729.385	43.5	-4.8	38.7	60	-21.3	
A	P	V	3	2694.903	47.2	-2.1	45.1	60	-14.9	
A	P	V	3	4497.751	42.6	2.9	45.5	60	-14.5	
A	P	H	3	5397.301	39.2	6.0	45.2	60	-14.8	

* 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)

Test Setup Photo:

See Test 3 for representative photo.

Test 8: Maximum Permissible Exposure

Test Requirement: 47 CFR Part 1

Test Specification: 47 CFR Part 1, Section 1.1307

Test Procedure:

Maximum Permissible Exposure limits are as follows:

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

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

Test Details: This device is considered to possibly be located in either environment. See calculation for assumptions.

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 with maximum permitted EIRP:

Assuming that a person were standing 20 cm in front of an antenna in a single antenna configuration at maximum power, the limits for controlled/occupational exposure are met. The limits for general/uncontrolled exposure would be slightly exceeded. A caution statement must be provided to the professional installer to ensure that limits are not exceeded in the uncontrolled environment. A 23 cm spacing at 4 W EIRP and a 21.5 cm spacing at 3.5 W EIRP are calculated to comply with the uncontrolled environment limit. 3 Watts EIRP or less are found to comply at 20 cm spacing.

$S = EIRP / (4 * Pi * R^2)$,

Power Density = EIRP / (4 * Pi * R^2),
where EIRP = Output Power * Antenna Gain

Maximum Power Density Calculation
At 20 cm spacing

Operating Frequency	915 MHz		
Output Power (Peak)	1 Watts		
Antenna Gain	6 dB	or (linear)	3.981072 (unitless)
Separation Distance	0.2 m	-or-	7.874 inches

Peak Power Density	7.920 W/m^2	- or -	0.7920 mW/cm^2
Exposure % (over 30 minute timespan for occupational exposure)	100%		
Transmit Duty Cycle (Peak-to-Average Ratio)	100%		
Average Power Density	**7.92007** W/m^2	- or -	**0.7920** mW/cm^2
Limit for **Controlled/Occupational** Exposure at Operating Frequency	**30.5** W/m^2	- or -	**3.05** mW/cm^2
Limit for **Uncontrolled** Exposure at Operating Frequency	**6.1** W/m^2	- or -	**0.61** mW/cm^2

Accreditation Certificates:

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

ISO/IEC 17025:1999
ISO 9002:1994

Scope of Accreditation

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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/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

June 30, 2004
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ISO/IEC 17025:1999
ISO 9002:1994

Scope of Accreditation

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NVLAP Code Designation / Description

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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

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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

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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.