Integrated Information Systems Group
8201 E. McDowell Road
Scottsdale, AZ 85252-1417

Report No. WSSD070900

Exhibit 6 – Test Report

Card Acceptance Device (CAD+)

Low Power Transceiver Module

FCC ID: ABZMCAD200

Model Nos. T6480A *(and variants)*

Equipment Manufacturer:	**Motorola, Inc.** **1301 East Algonquin Rd.** **Room 1726** **Schaumburg, Illinois 60196**
Tests Conducted By:	**Motorola IISG** **EMC Test Facility** **8201 E. McDowell Rd.** **Scottsdale, Arizona 85252**
Tests Period:	**August 3rd to August 10th , 2000**
Test Summary:	**Complies with FCC Part 15, Subpart C, Unlicensed Low Power Transmitters**

The Motorola IISG EMC/TEMPEST Laboratory is accredited through the NVLAP®

NVLAP Lab Code 100405-0

6.0 Introduction

6.0.1 Product Description

The Motorola CAD+ module is a low power radio frequency transceiver designed for applications such as identification systems, security systems, Access Control, and data collection. The subassembly consists of two printed circuit boards and referred to as the Card Acceptance Device (CAD+). The control board contains the microprocessor, non-volatile memory, and radio frequency transmitting and receiving circuitry. The board communicates with the smart cards via an RF link.

The antenna board is a pcb with copper traces forming the transmit and receive antennas. There are four different antenna configurations. The 104 x 67mm antenna board is attached to a ferrite plate and a metal back plate which serves as a ground plane. The 50 x 25mm antenna board also utilizes a ferrite but has no back plate. The other two antenna boards are different sizes with no ferrite or back plate and include a 65 x 45mm PCB and a 100 x 110mm PCB.

When the transceiver module is powered, a low-power radio frequency (RF) field is continuously transmitted by the CAD+ at 13.56 MHz. When a Smartcard is presented within the CAD+ RF field, the microchip embedded in the card, is activated and transmits a unique Identification (ID) number back to the reader at a frequency of 847.5 kHz. The reader validates the identification number, and, if it is valid, converts it to a predefined data format and sends it to the control panel through a data cable. The control panel determines the action to be taken (e.g. open a door, update database, etc.).

Product Specifications:

Operating Frequency	-	13.56 MHz $\pm$ 0.01%
Modulation Type	-	8-14% ASK
Effective Radiated Power	-	< 7.2 mW (+8.57 dBm)

The reader outputs data in RS-485, RS-232, CMOS, and Byte-Wide Parallel Transfer data formats making it easy to upgrade an existing site to proximity using the wiring already in place.

There are a total of seven (7) variations of the CAD+ module and are listed below. The variations include the antenna configuration and Interface protocol/connector type. The only significant variation which could impact the FCC transmitter RF characteristics is the antenna configuration and, thus, the module was tested using all four (4) of these antenna types.

Model #	**Antenna Type**	**Connector Type**	**Interface Protocol**
T6480A	104 x 67 mm w/ferrite	Straight	Serial; RS-485
T6481A	104 x 67 mm w/ferrite	Right Angle	Serial; RS-485
T6479A	104 x 67 mm w/ferrite	Straight	Parallel; CMOS
T6499A	50 x 25 mm w/ferrite	Straight	Serial; RS-485
T6500A	50 x 25 mm w/ferrite	Right Angle	Serial; RS-485
T6548A	100 x 110 mm	Straight	Serial; RS-485
T6501A	65 x 40 mm	Right Angle	Serial; CMOS

6.0.2 Facility Description

EMI testing of the CAD+ was performed at the Motorola Integrated Information Systems Group's (IISG) EMI/TEMPEST Test Laboratory. This test laboratory is located in the southeast wing of the Hayden building at 8201 E. McDowell Road, Scottsdale, AZ.

Motorola IISG Test Facility Address:

Motorola, Inc.
Integrated Information Systems Group
Hayden EMC Facility
8201 E. McDowell Rd. M/D H2550
Scottsdale, AZ 85252

The facility has been found to be in compliance with the requirements of Section 2.948 of the FCC rules, per FCC letter 31040/SIT, 1300F2, dated October 6, 1998. The facility has also been issued a Certificate of Accreditation through the National Voluntary Laboratory Accreditation Program (NVLAP) by NIST. This is under NVLAP Code: 100405-0 and is effective through September 30, 2001.

6.0.3 Quality System

The EMI/TEMPEST Test Laboratory maintains a Quality Manual that describes the quality assurance program of the EMC/TEMPEST Facility to set forth procedures covering all quality assurance functions. This manual has been constructed to reflect a quality program in compliance with the requirements of the following:

- National Institute of Standards & Technology (NIST) National Voluntary Laboratory Accreditation Program (NVLAP)
- NIST/NVLAP EMC MIL-STD 462 Program Handbook (Apr. 1994)
- NVLAP EMC and Telecommunications FCC Methods Handbook 150-11 (Apr. 1995)
- MIL-Q-9858A, MIL-STD 461, 462, 463, 461D, 462D
- National Security Agency Technical and Security Requirements Document for the Endorsed TEMPEST Test Services Program, NSA TSRD No. 88-8B, 5 Oct. 1993
- System Solution Group of Motorola Quality Six Sigma Program.

6.0.4 Standard References

47 CFR 2	Code of Federal Regulations, Title 47, Part 2, "Frequency Allocations and Radio Treaty Matters; General Rules and Regulations"
47 CFR 15	Code of Federal Regulations, Title 47, Part 15, "Radio Frequency Devices" Subpart C, "Intentional Radiators"
C63.4-1992	American National Standards Institute (ANSI), "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz"

6.1 Test Procedures

6.1.1 Requirements

The CAD+ transceiver module is subject to FCC Part 15, Subpart C and Part 2 for FCC Certification for units marketed within the United States. The following tests, as specified in FCC Part 2, with limits as defined in FCC Part 15, and shown in Table 6.1-1 below were performed on this subassembly.

Table 6.1-1 Tests Required for Certification of the CAD+ Module

Test Parameter	FCC Part 2 Paragraph Number	FCC Part 15 Paragraph Number	FCC Part 15 Limit
RF Power Output	2.1046	15.225	10,000 uV/m @ 30 m (80 dBuV/m)
Field Strength of Spurious Emissions	2.1053	15.209	**Freq (MHz) Limit (uV/m) d (m)** .009-0.490 MHz 2400/F(kHz) 300m 0.490-1.705 MHz 24000/F 30 m 1.705-30 MHz 30 30 m 30-88 MHz 100 3 m 88-216 MHz 150 3m 216-960 MHz 200 3m Above 960 MHz 500 3m
Restricted Bands of Operation		15.205	Does not operate in any restricted bands; Spurious requirements same as 15.209
Frequency Stability	2.1055	15.225	$\pm$ .01 %

6.1.2 Operational Configuration

The CAD+ was tested as a subassembly with the CAD to Terminal interface connected to a laptop computer acting as the host terminal. The module was set up and operated in a continuous transmit mode at the frequency of 13.56 MHz and at its maximum rated output power for all tests. There is no specification limit on modulation characteristics except that the modulation source shall be representative of that used in an actual installation. The unit utilizes 8-14% ASK modulation and was generated internal to the module. All testing was done in a radiated test setup since the antenna is an integral part of the module. A general test setup is shown as Figure 6.1-1.

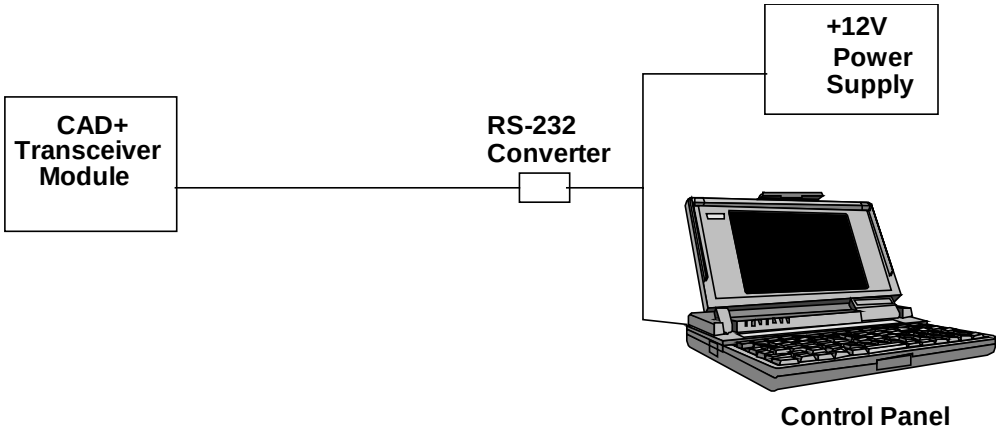


Figure 6.1-1 General Test Setup for Tests

6.1.3 Measurement Equipment

Test Equipment Nomenclature	Motorola Item Number	Manufacturer	Model Number	Cal. Date	Cal. Due
Biconilog Antenna	T47085	EMCO	3142B	9/03/99	9/30/00
Biconilog Antenna	T47086	EMCO	3142B	9/03/99	9/30/00
H-Field Loop Antenna	T36610	Electro Metrics	ALP-70	NCR	NCR
Antenna Mast	0003-2246	EMCO	2070-2	NCR	NCR
Antenna Controller	G72315	EMCO	2090	NCR	NCR
Spectrum Analyzer/ EMI Receiver	G68094	Rhode & Schwarz	ESI40	5/01/00	5/31/01
Receiver	G53133	Rhode & Schwarz	ESMI	9/15/99	9/30/00
Quasi-Peak Detector	G63127	Hewlett Packard	HP85650A	10/18/99	10/31/00
Spectrum Analyzer	G17008	Hewlett Packard	HP8566B	4/17/00	10/31/00
Preselector	G30259	Hewlett Packard	HP85685A	10/20/99	10/31/00

6.1.4 Radiated Spurious Emissions Procedure

Radiated spurious emission were measured over the frequency range of 9 kHz to 1 GHz in an anecohic chamber (20ft x 24ft x 16ft) and an open area test site (OATS). Refer to Figure 6.1-2 and 6.1-3 for test setups.

The radiated emissions between 9 kHz and 30 MHz, including the carrier level, were measured in an anechoic chamber using a shielded magnetic loop antenna at a 3 meter distance. The levels were extrapolated to the required test distance defined in 47 CFR Part 15 using the square of an inverse linear distance formula. These emissions were maximized by rotating the equipment on the turntable. When the using the magnetic loop antenna it was also rotated along its vertical axis.

The radiated emissions above 30 MHz were initially measured in a semi-anechoic shield room in order to identify the emissions before proceeding to the open area test site (OATS). This provides the capability of taking accurate measurements in a higher ambient environment such as at the rooftop OATS. The Rohde & Schwarz EMI Receiver System was used for the pre-scans. Typically, signals within approximately 10 dB of the limit are noted for measurements on the OATS.

Final measurements on the OATS were taken with an HP8566B receiver system with preselector at a 3 meter test distance from the receiving antenna. The CAD+ module was placed on a .8 meter high non-conductive table on a rotating turntable which is flush with the site ground plane. The receiving antenna was scanned over a height range from 1 to 4 meters in both antenna polarities, and the turntable was rotated 360 degrees. The highest emissions were recorded and the final field strength level determined using the following formula:

Field Strength (dBuV/m) = Measured Level (dBuV) + Cable Loss (dB) + Antenna Factor (dB)

6.1.5 Frequency Stability Procedure

The CAD+ transmitter module was tested for frequency stability when operated at maximum rated power over the temperature range of -30^{o} to $+55^{o}$ C and over an input power voltage range of +/- 15%, +10.2 Vdc to +13.8 Vdc, at $+20^{o}$ C.

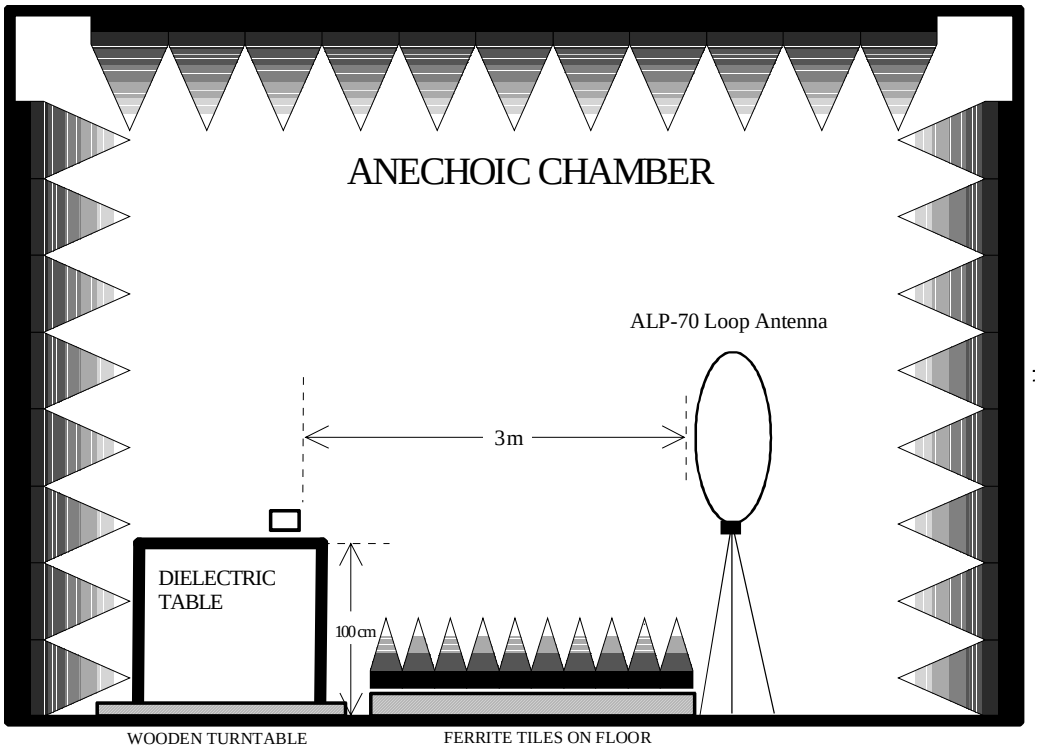


Figure 6.1-2 Radiated Spurious Emissions Test Setup - Chamber

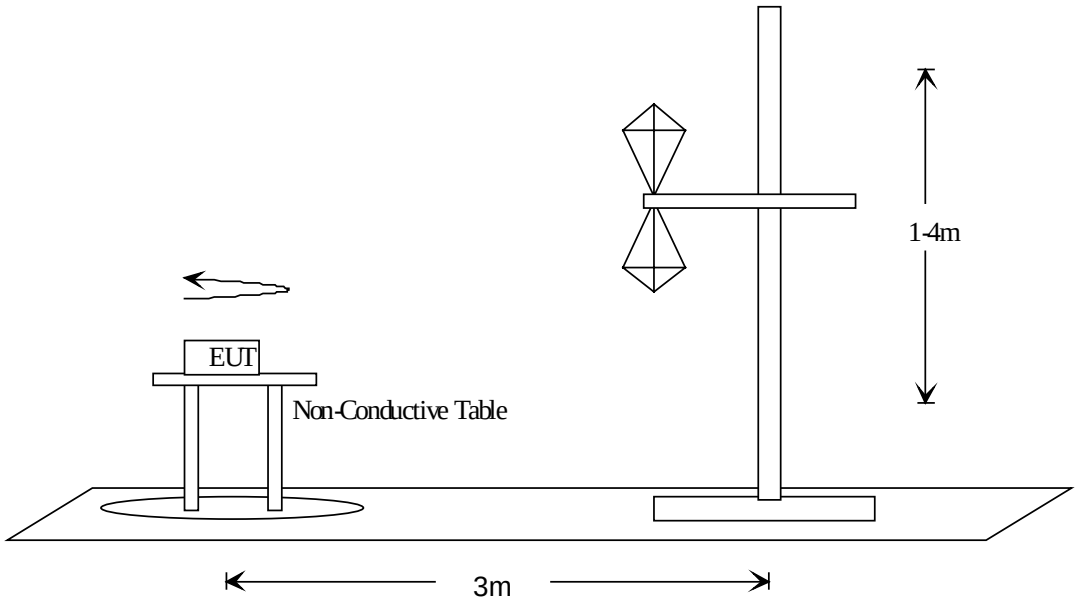


Figure 6.1-3 Radiated Spurious Emissions Test Setup -OATS

6.2 Test Results

6.2.1 Radiated Spurious Emissions Measurement Test Results

All measurements were made with the CAD+ module transmitting at its maximum rated output power. The antenna is an integral part of the unit and the unit is continuously transmitting at 13.56 MHz. Most of the measurements displayed significant margin to the limits and, therefore, were not re-measured using a Quasi-Peak detector but, rather, displayed as a worst case, max peak emission. The exception were emissions which were within 6 dB of the limit. These were re-measured using the Quasi-Peak detector and noted as such in the data sheet.

The maximized carrier level at the frequency of operation was 77.3 dBuV/m @ 3 meters (37.3 dBuV/m @ 30 m) worst case using a shielded magnetic loop antenna. This was well below the 80 dBuV/m (10,000 uV/m) limit at 30 meters specified in 47 CFR Section 15.225 at the operating frequency of 13.56 MHz. Measurements were performed in an anechoic chamber at a distance of 3 meters with the measured data corrected to the 30 meter distance using a 40 dB/decade factor. The antenna factor, cable loss, H-field to E-field conversion (51.5 dB), and distance correction factors are already included on the plot as an amplitude level offset. The four plots are shown as Figures A-1 through A-4 for each of the four antenna configurations.

The radiated emissions for the frequency range of 9 kHz to 30 MHz were all below the applicable limits of 47 CFR 15.209 including the second harmonic. The second harmonic at 27.12 MHz was not detectable using the shielded magnetic loop antenna These measurements were also performed in an anechoic chamber at a distance of 3 meters and extrapolated to the required distances defined in 15.209. These scans were taken with an automated EMI Receiver system using scan tables setup specifically for the requirement conditions including bandwidth, transducer factors, and distance correction. The worst case emissions graphs are shown in Figures B-1 through B-4.

Measurements for 30 MHz to 1 GHz were taken first in the semi-anechoic chamber in order to identify the critical frequencies. Signals which were within 10 dB of the limit were recorded and their final measurement was taken on the OATS. The measurements were taken at a test distance of 3 meters per the specification. The worst case sample of the prescan data for each of the antenna configurations is shown as Figures C-1 through C-4 and the final OATS measurements are provided in tabulated format as Figures C-5. All emissions in this range were below the specification limits of 47 CFR Section 15.209. The signal at 556 MHz was the worst case emission measuring -1.0 dB below the specification limit.

Additionally, this equipment complies with the requirements of 47 CFR Section 15.205 on operating outside of the specified restricted bands. The CAD+ operating frequency of 13.56 MHz is outside of any of the restricted bands specified in 15.205. Spurious emissions are permitted in these bands with the condition that they comply with the same requirements of 15.209 as tested.

The test setup photos are shown as Figures E-1 through E-4.

6.2.2 Frequency Stability Measurement Test Results

The CAD+ module was tested for transmitter frequency stability under temperature and voltage variation. The unit was placed in an environmental chamber and tested over a range of -20°C to +55°C allowing enough time at each temperature for the frequency to stabilize.

The module was also operated while the supply voltage was varied between 85% to 115% of the nominal supply voltage of +12 Vdc when exposed to +20°C.

The frequency shift was .0035% or less under all conditions which is well below the $\pm$ 0.01% specification of 15.225 (c). The tabulated data as well as graphs are shown in Appendix D, Figures D-1 through D-3.

6.2.3 Equipment Modifications required for Compliance

The CAD+ module radiated emission performance in the 500 to 600 MHz frequency range was significantly improved by providing a reference between Shields 1 and 2 on the control board. These shields provide isolation of the RF Transmitter and Receiver sections of the module, respectively. The radiation most likely was due to insufficient ground reference between these two sections of the board. A temporary fix to the problem was achieved using a strip of copper tape across the shields as shown in the photo below.

This permanent fix will be in the form of one or more thick traces between the pads of both shield's which are adjacent to each other. Additionally, for extra measure a 47 pf capacitor was added inside Shield 1 of the RF Transmitter which connects the AM_MOD side of R156 to ground. This effectively reduces the emissions radiating from the collector of the drive transistor.

These changes will be implemented into the next revision, Rev. O, of the PCB and will be re-tested for verification of compliance.

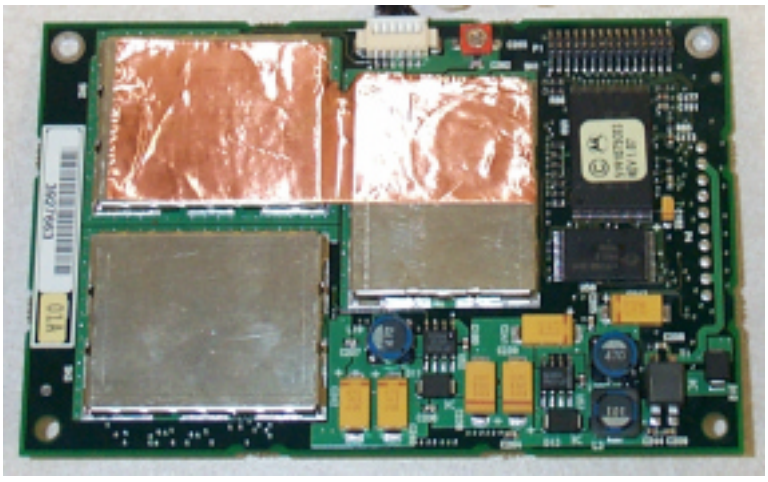


Figure 6.2-1 Control Board Photograph of Temporary Fix for Radiated Emissions

Appendix A

Transmitter Carrier Measurements

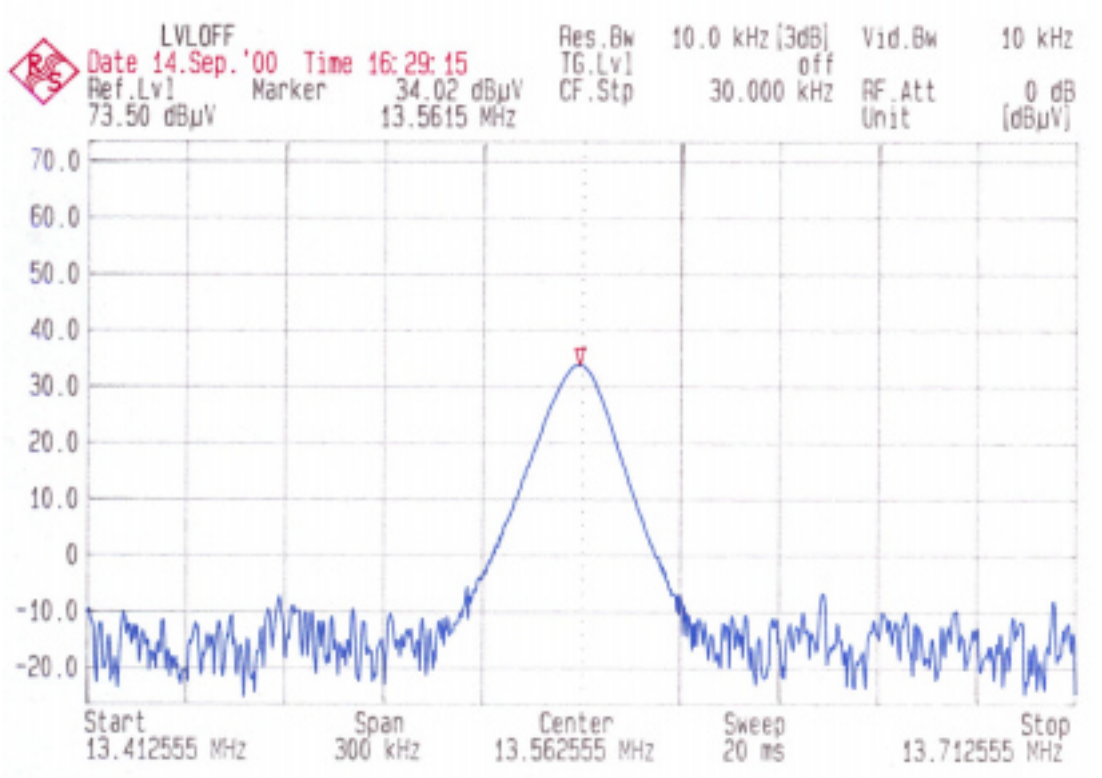


Figure A – 1 Transmitter Carrier Measurement - 104 x 67 mm w/ferrite Loop Antenna

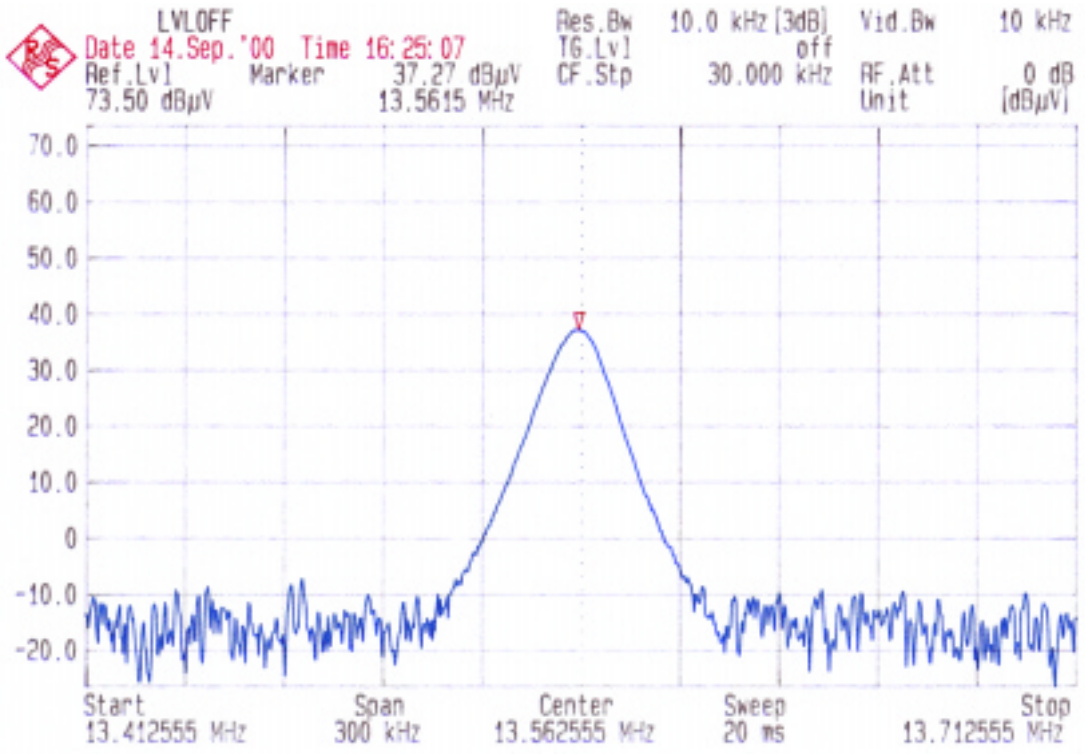


Figure A – 2 Transmitter Carrier Measurement - 100 x 110 mm Loop Antenna

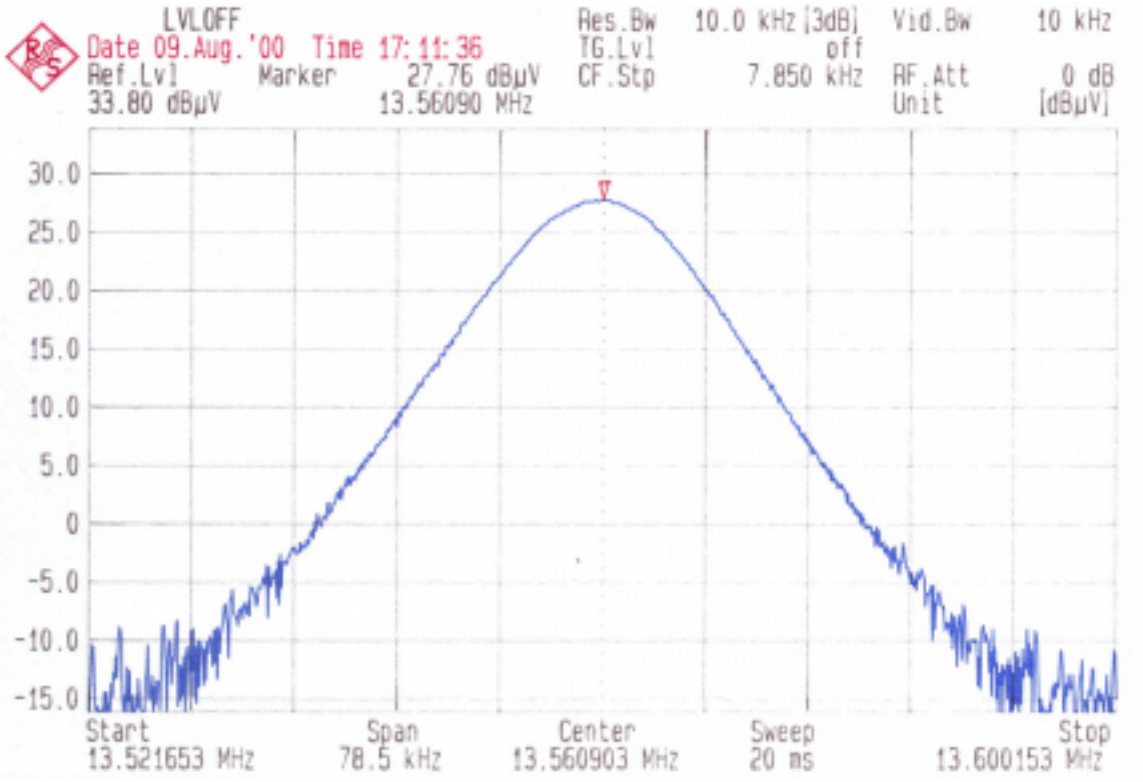


Figure A – 3 Transmitter Carrier Measurement - 65 x 40 mm Loop Antenna

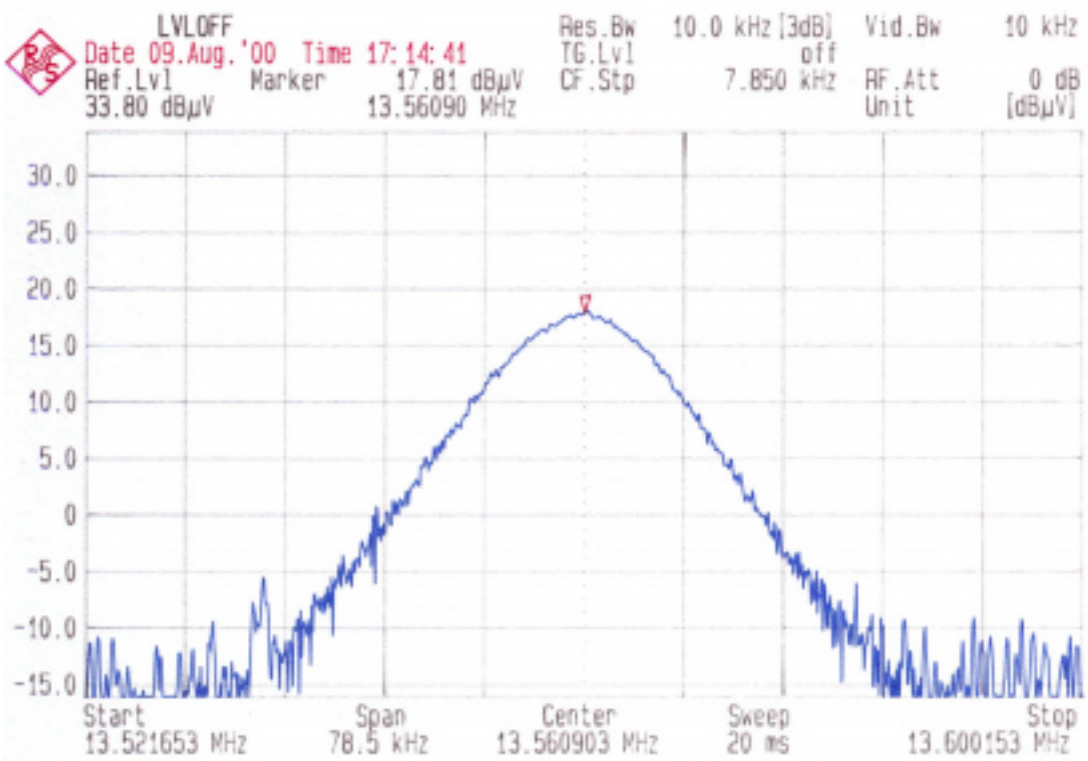


Figure A – 4 Transmitter Carrier Measurement - 50 x 25 mm w/ferrite Loop Antenna

Appendix B

Radiated Spurious Emission Measurements

9kHz to 30 MHz

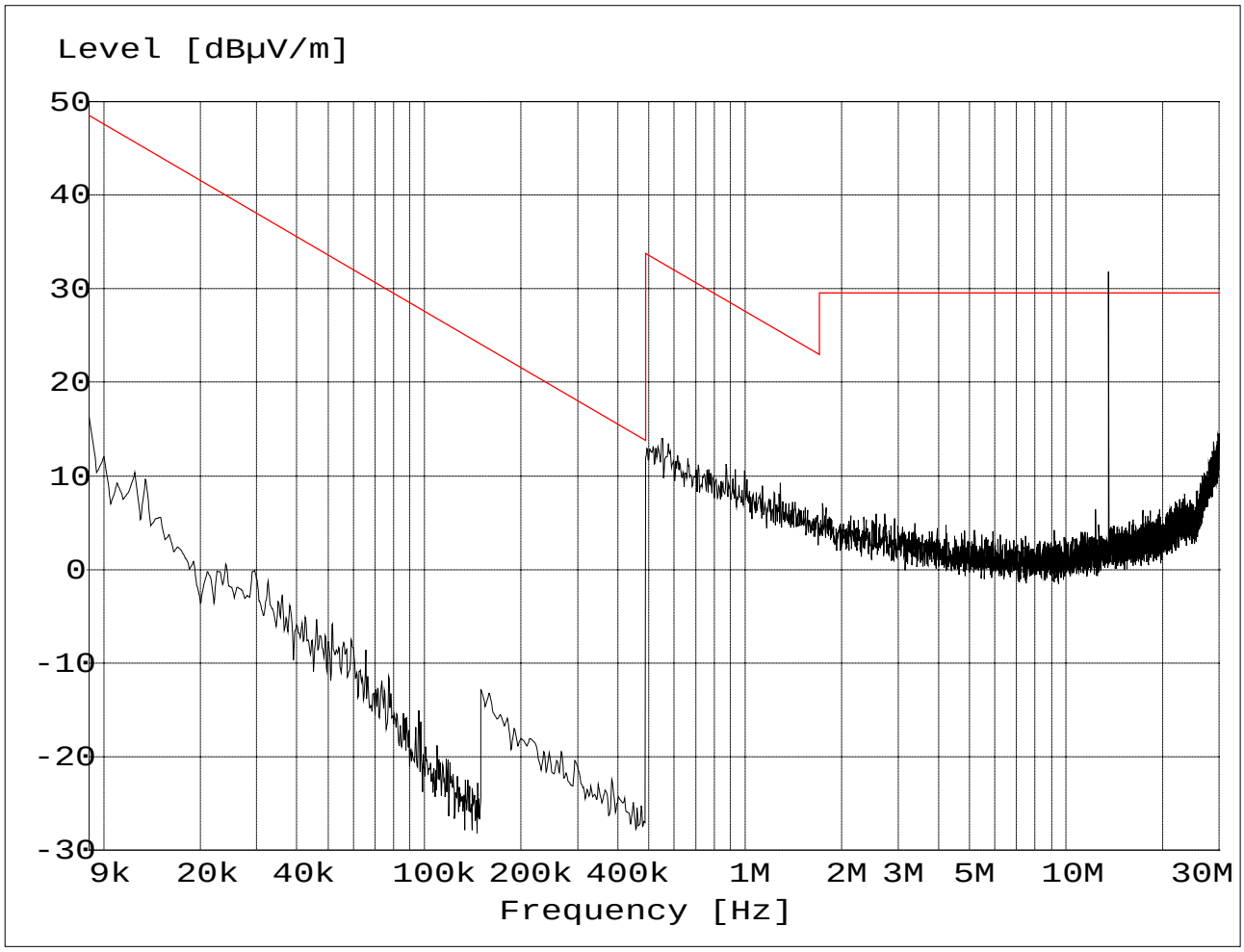


Figure B – 1 Radiated Spurious Emissions, 9 kHz to 30 MHz, 104 x 67 mm w/ferrite Loop Antenna

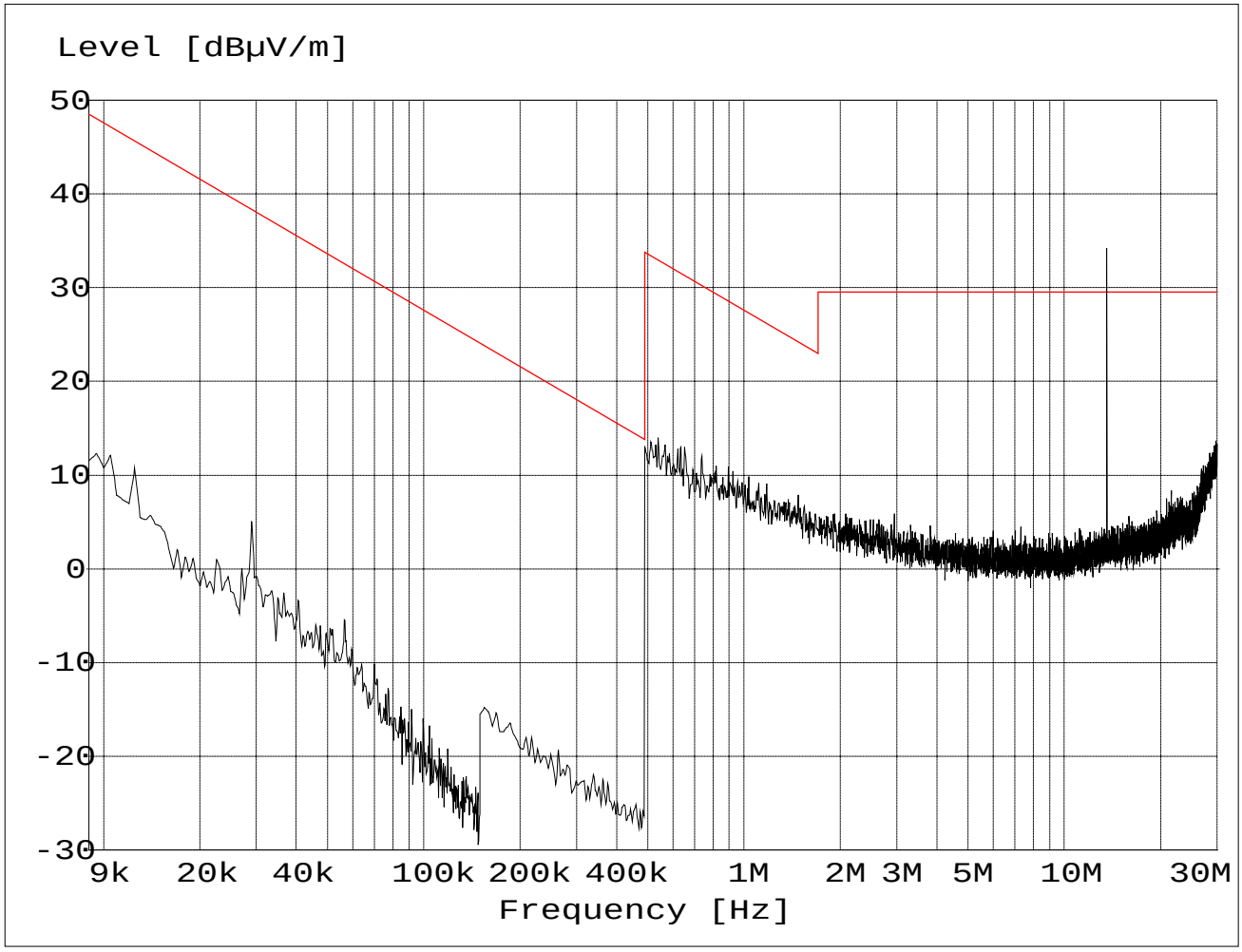


Figure B – 2 Radiated Spurious Emissions, 9 kHz to 30 MHz, 100 x 110 mm Loop Antenna

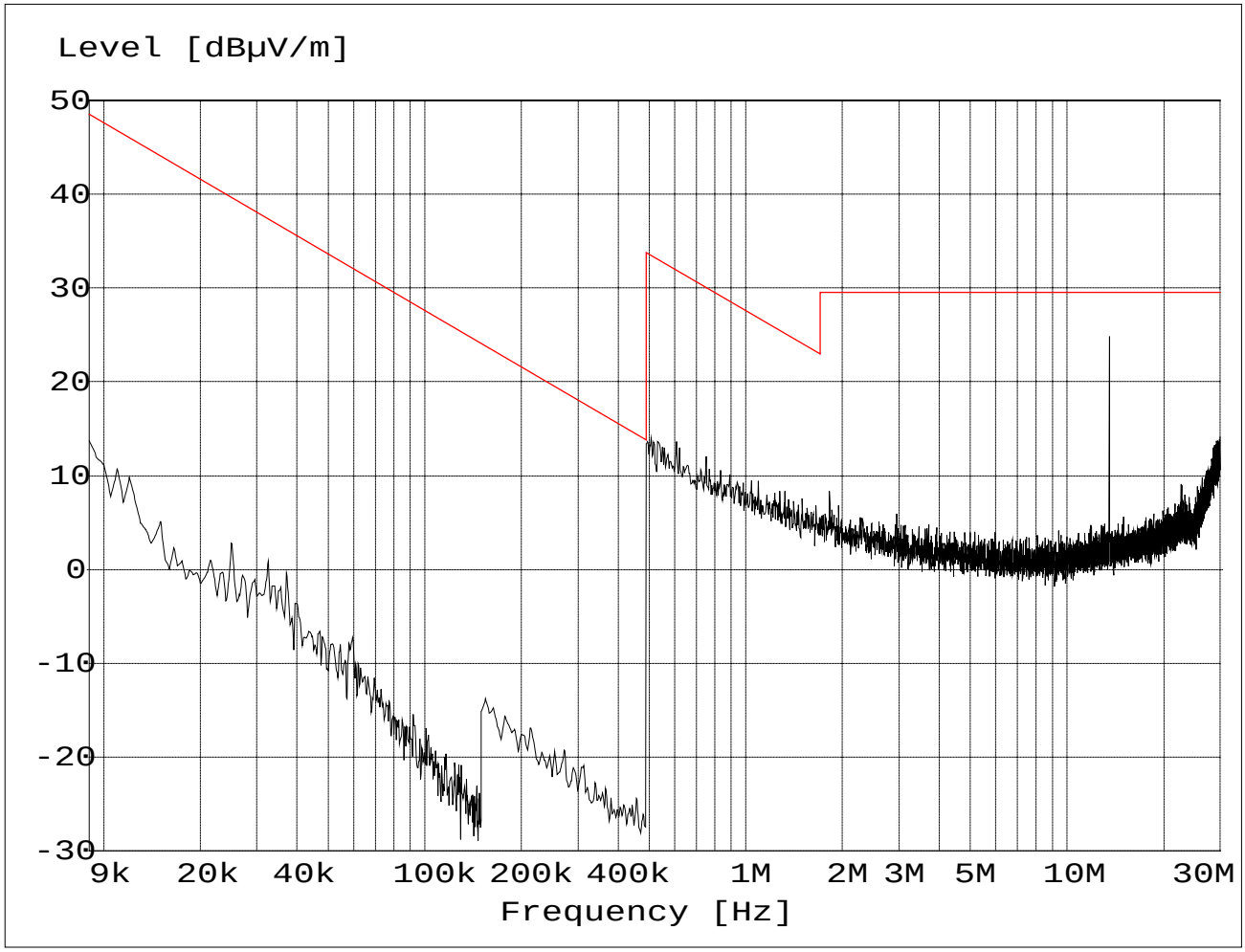


Figure B – 3 Radiated Spurious Emissions, 9 kHz to 30 MHz, 65 x 40 mm Loop Antenna

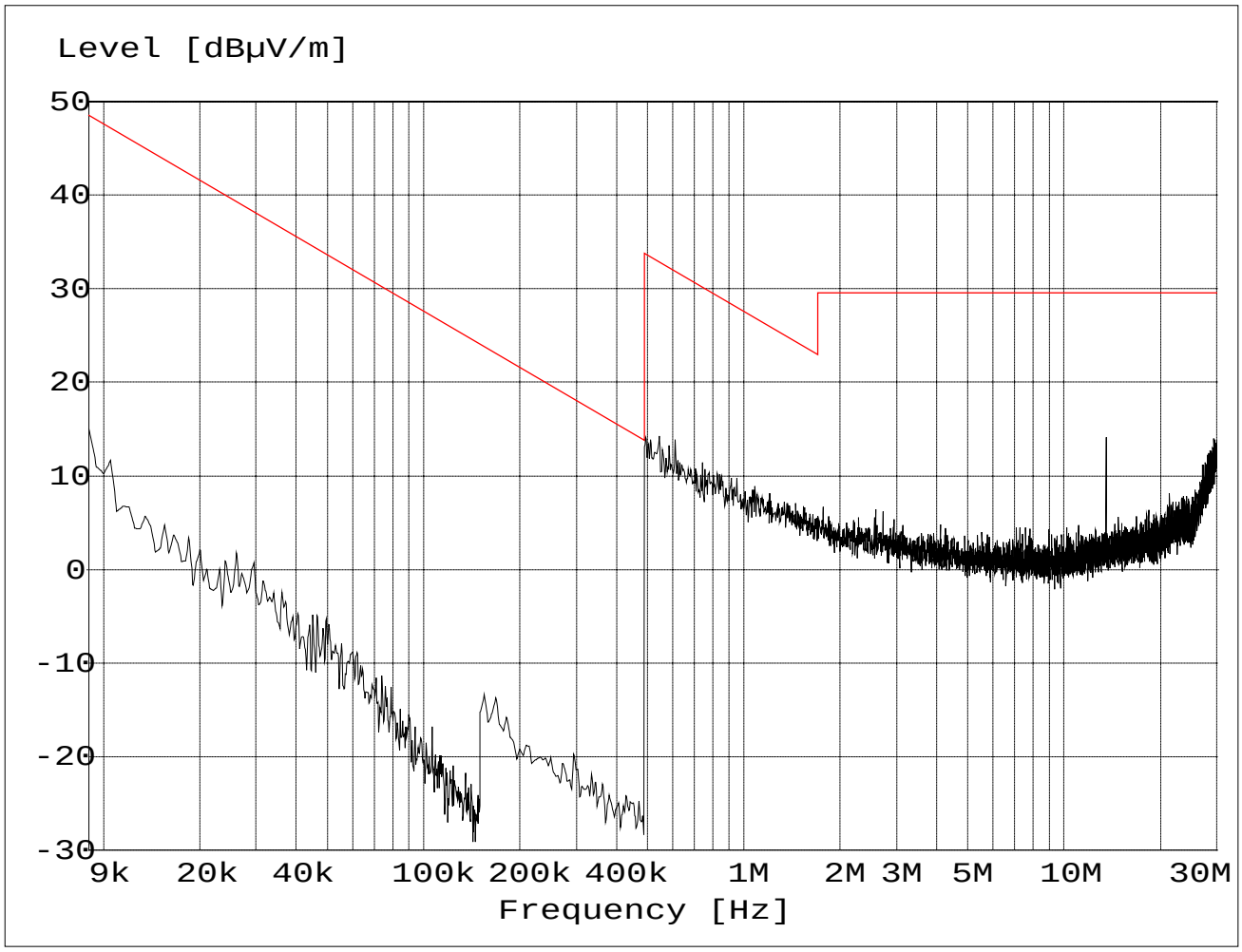


Figure B – 4 Radiated Spurious Emissions, 9 kHz to 30 MHz, 50 x 25 mm w/ferrite Loop Antenna

Appendix C

Radiated Spurious Emission Measurements

30 MHz to 1000 MHz

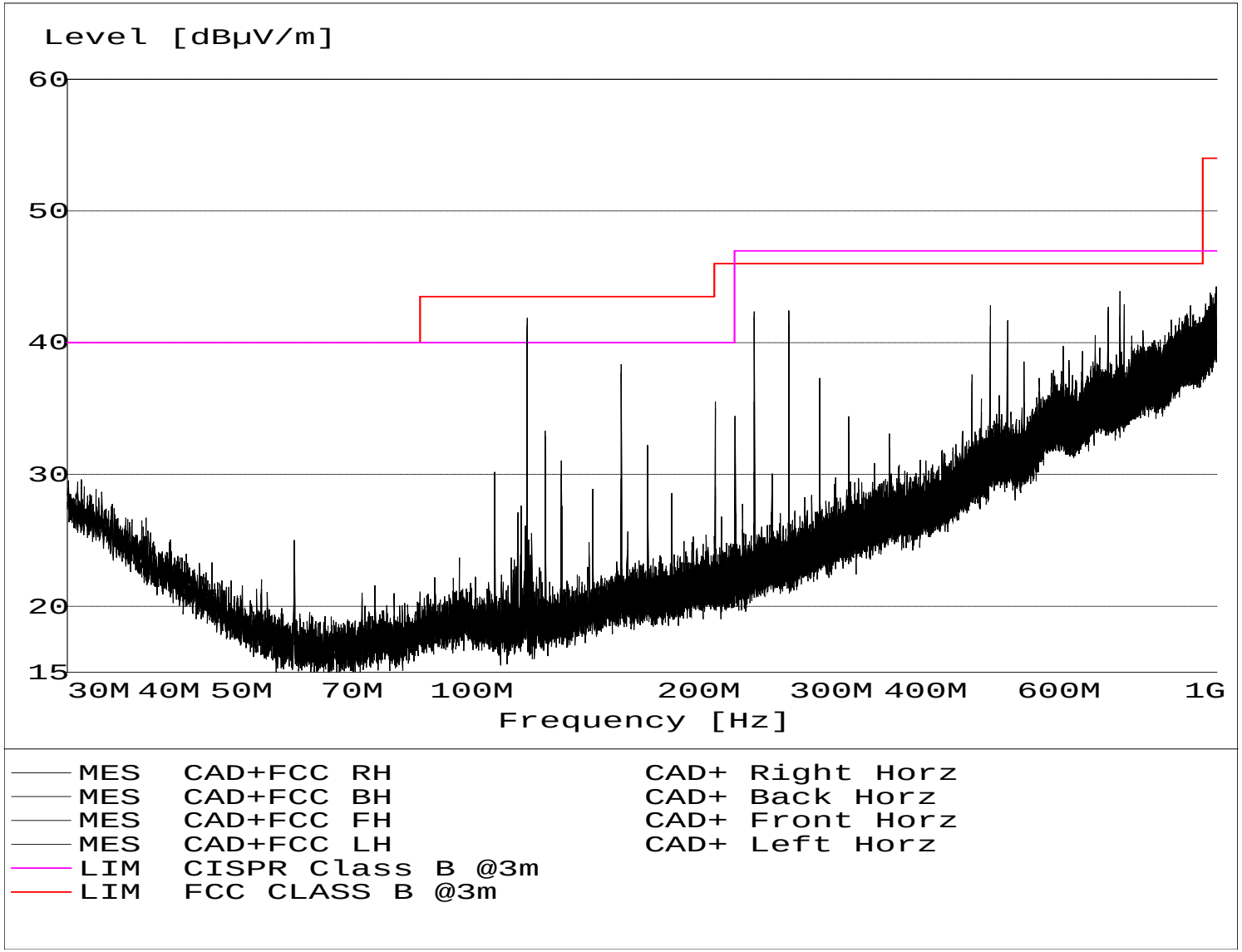


Figure C – 1 Radiated Spurious Emissions Prescan Data, 30 MHz to 1 GHz (104 x 67 mm w/ferrite)

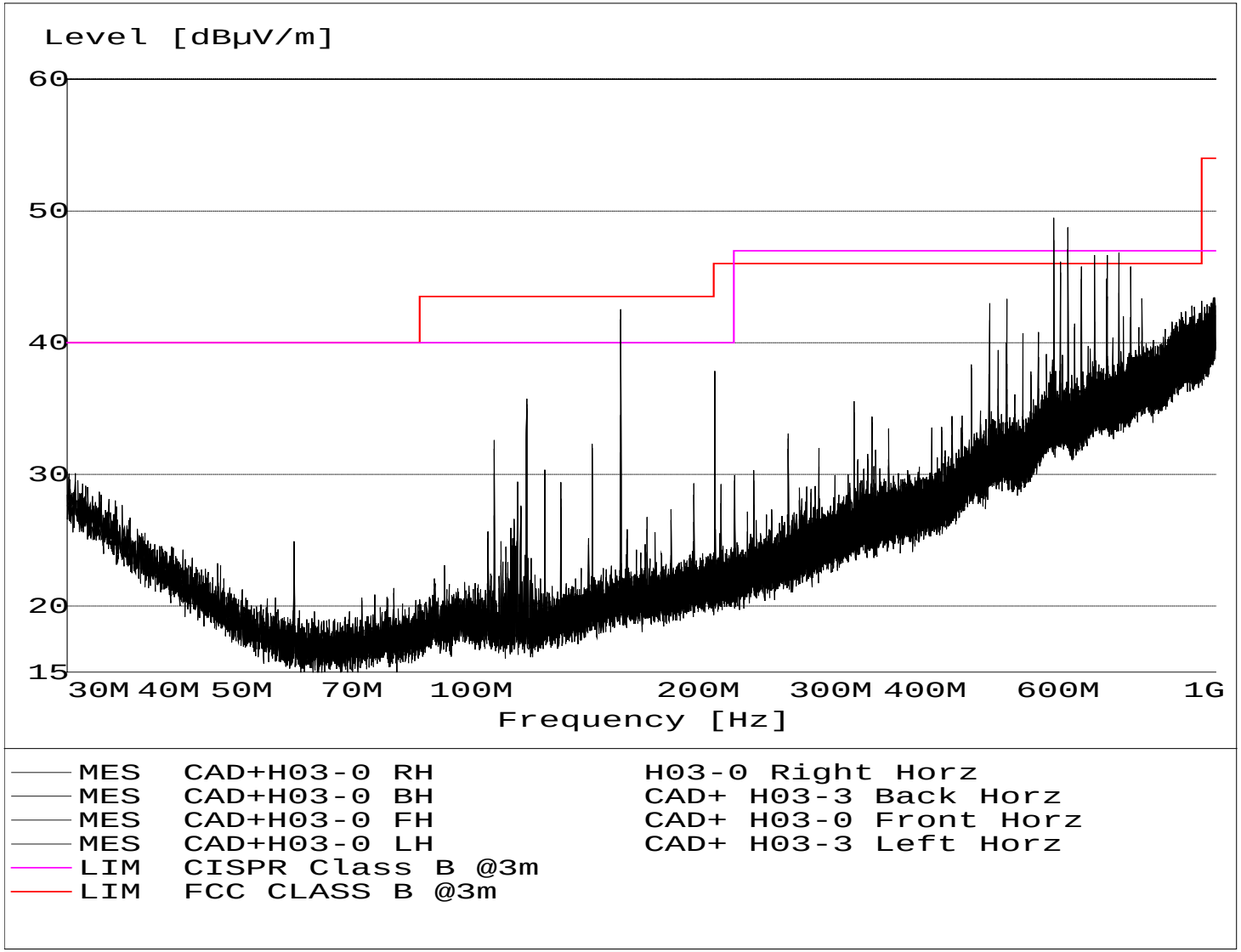


Figure C – 2 Radiated Spurious Emissions Prescan Data, 30 MHz to 1 GHz (100 x 110 mm)

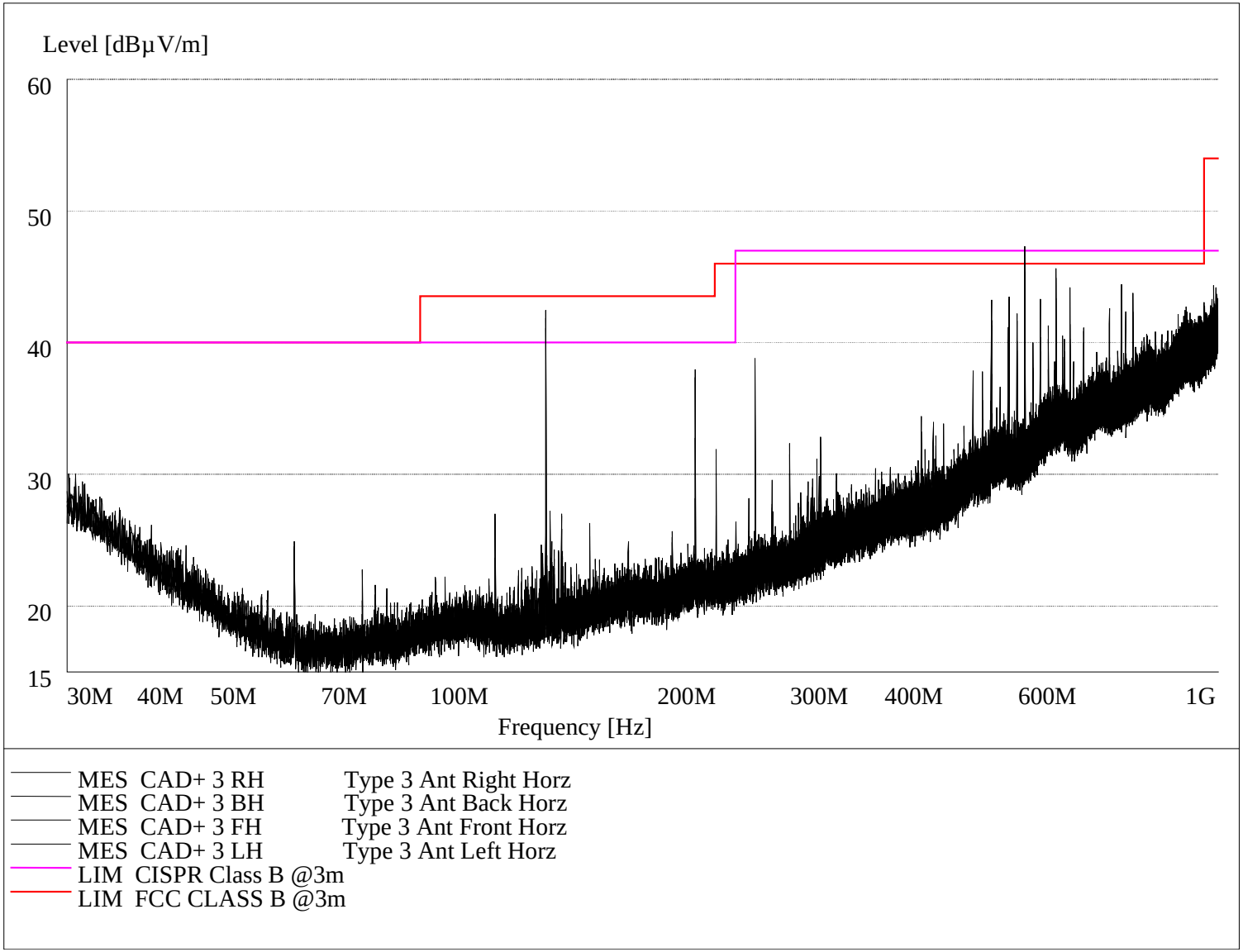


Figure C – 3 Radiated Spurious Emissions Prescan Data, 30 MHz to 1 GHz (65 x 40 mm)

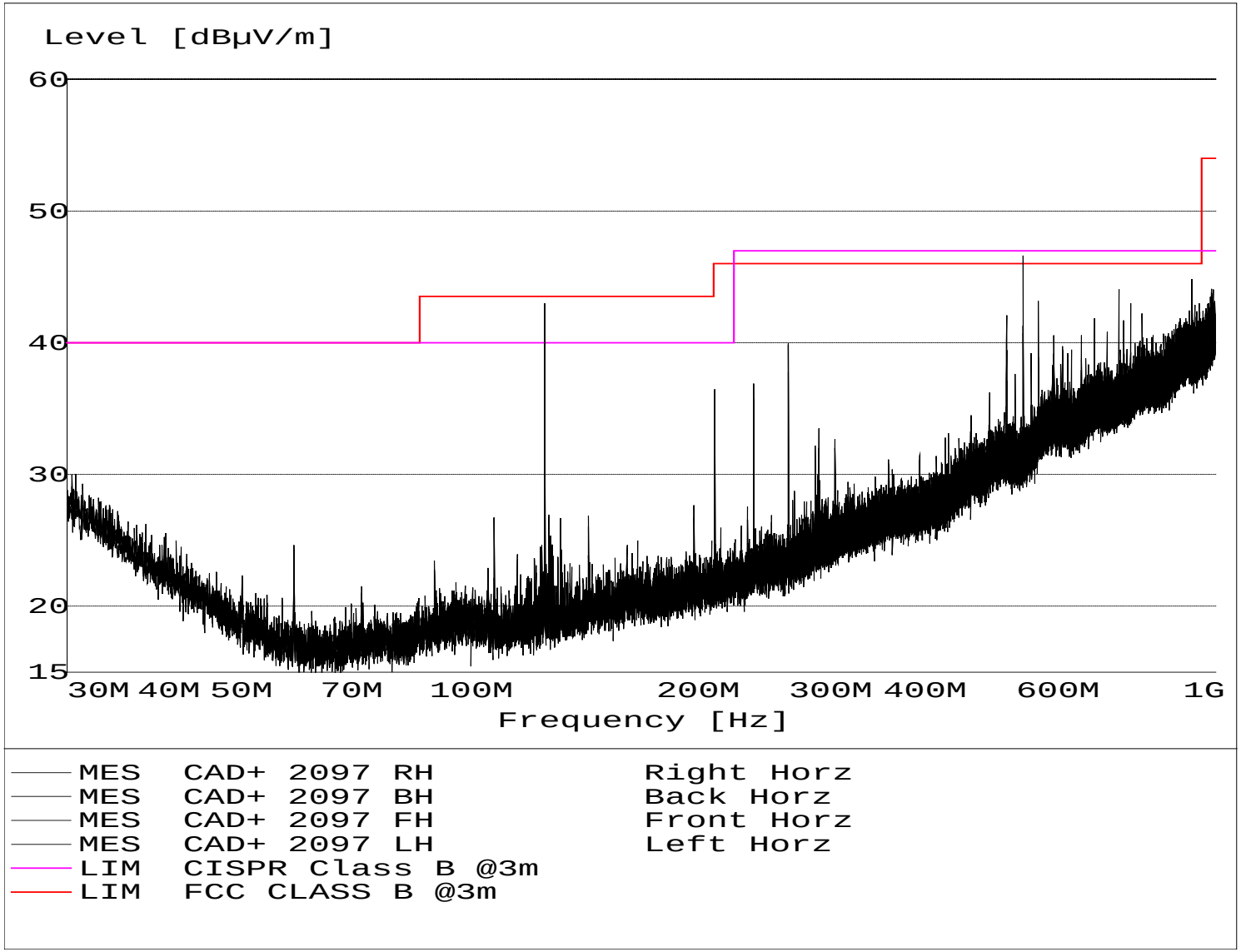


Figure C – 4 Radiated Spurious Emissions Prescan Data, 30 MHz to 1 GHz (50 x 25 mm w/ferrite)

MOTOROLA IISG TEST DATA SHEET

FCC Radiated Test Results

Equip.	SmartCard Transceiver Module	Test Date:	8/7/00
Mode:	Transmit	Test Technician:	R. Johnston
Model#:	CAD+	Measurement Distance (m)	3
Serial #:	E.M.001	Equipment Class	B

Bold Reading are Quasi Peak 39.44° Hum 18.% BP 75.9 R

Frequency MHz	SA Reading (dBuV)	Az	Ht cm	Pol	Antenna Factor	Cable/Attn. Loss	Pre Amp dB	Emission (dBuV/m)	Spec Limit (dBuV/m)	Deviation from Spec. Limit (dB)	Comments:
122.050	17.3	B	105	V	6.8	8.7	0.0	32.8	43.5	-10.7	104 x 67 mm w/ferrite
122.050	**16.1**	B	105	V	6.8	8.7	0.0	31.6	43.5	-11.9	
129.000	14.5	BR	145	V	6.6	8.7	0.0	29.8	43.5	-13.7	
129.000	**12.8**	BR	145	V	6.6	8.7	0.0	28.1	43.5	-15.4	
162.700	**13.5**	BL	100	H	9.7	8.7	0.0	31.9	43.5	-11.6	
176.280	17.1	F	228	H	10.0	8.7	0.0	35.7	43.5	-7.8	
176.280	**7.1**	F	228	HH	10.0	8.7	0.0	25.8	43.5	-17.7	
271.200	**10.9**	LF	111	H	13.1	10.3	0.0	34.3	46.0	-11.7	
501.700	**8.4**	F	100	H	17.9	11.9	0.0	38.2	46.0	-7.8	
528.850	**8.1**	F	100	V	19.5	12.1	0.0	39.6	46.0	-6.4	
583.100	0.5	RF	200	H	24.5	12.4	0.0	37.4	46.0	-8.6	
610.200	2.9	BL	110	H	24.8	12.6	0.0	40.2	46.0	-5.8	
162.700	**23.7**	R	183	H	9.7	8.7	0.0	42.1	43.5	-1.4	100 x 110 mm Ant
610.200	**10.3**	R	157	V	19.1	12.6	0.0	42.0	46.0	-4.0	
129.000	23.9	R	275	H	7.8	8.7	0.0	40.4	43.5	-3.1	65 x 40 mm Ant
129.000	**15.2**	R	275	H	7.8	8.7	0.0	31.7	43.5	-11.8	
556.000	**13.8**	B	206	V	19.0	12.2	0.0	45.0	46.0	-1.0	
610.200	**8.9**	B	143	H	20.3	12.6	0.0	41.7	46.0	-4.3	
244.080	14.4	B	144	H	12.4	10.2	0.0	37.0	46.0	-9.0	50 x 25 mm w/ferrite
244.080	**10.3**	B	144	H	12.4	10.2	0.0	32.9	46.0	-13.1	
271.200	13.90	R	155	H	13.1	10.3	0.0	37.3	46.0	-8.7	
271.200	**9.70**	R	155	H	13.1	10.3	0.0	33.1	46.0	-12.9	
556.000	**7.6**	R	142	V	19.0	12.2	0.0	38.8	46.0	-7.2	
610.200	**9.4**	F	160	H	20.3	12.6	0.0	42.2	46.0	-3.8	

Figure C – 5 Radiated Spurious Emissions, OATS Data, 30 MHz to 1 GHz

Appendix D

Frequency Stability Measurements

f_0	13.560000 MHz				% Error		
°C	f @ rated voltage in MHz	f @ -15% rated voltage in MHz	f @ +15% rated voltage in MHz	% Error @ rated voltage	% Error @ -15% rated voltage	% Error @ +15% rated voltage	FCC Limit
-30	13.56032000			0.002360%			±.01%
-20	13.56048000			0.003540%			±.01%
-10	13.56038000			0.002802%			±.01%
0	13.56026000			0.001917%			±.01%
10	13.56030000			0.002212%			±.01%
20	13.56030000	13.56030000	13.56030000	0.002212%	0.002212%	0.002212%	±.01%
30	13.56045000			0.003319%			±.01%
40	13.55970000			-0.002212%			±.01%
50	13.55985000			-0.001106%			±.01%
55	13.55970000			-0.002212%			±.01%

Figure D – 1 Frequency Stability vs. Temperature Test Data

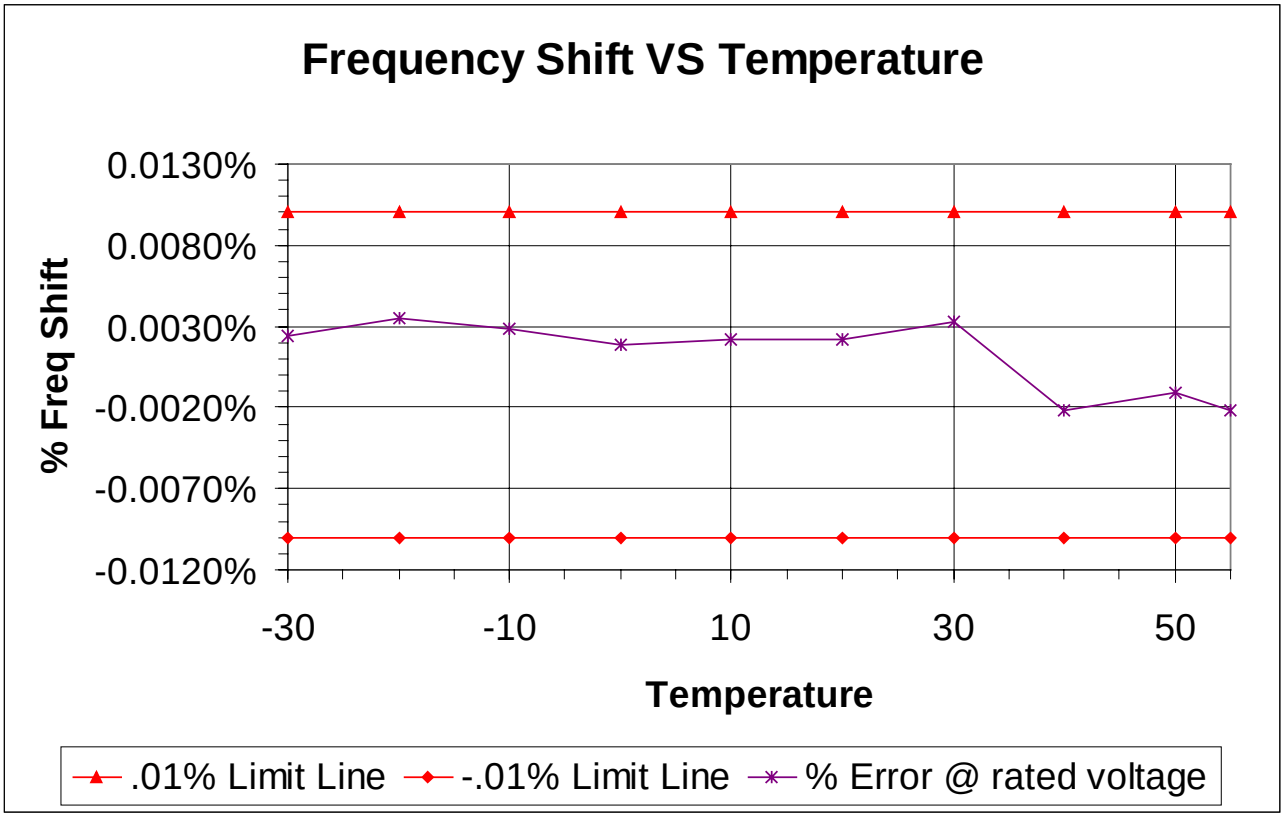


Figure D – 2 Frequency Stability vs. Temperature Graph

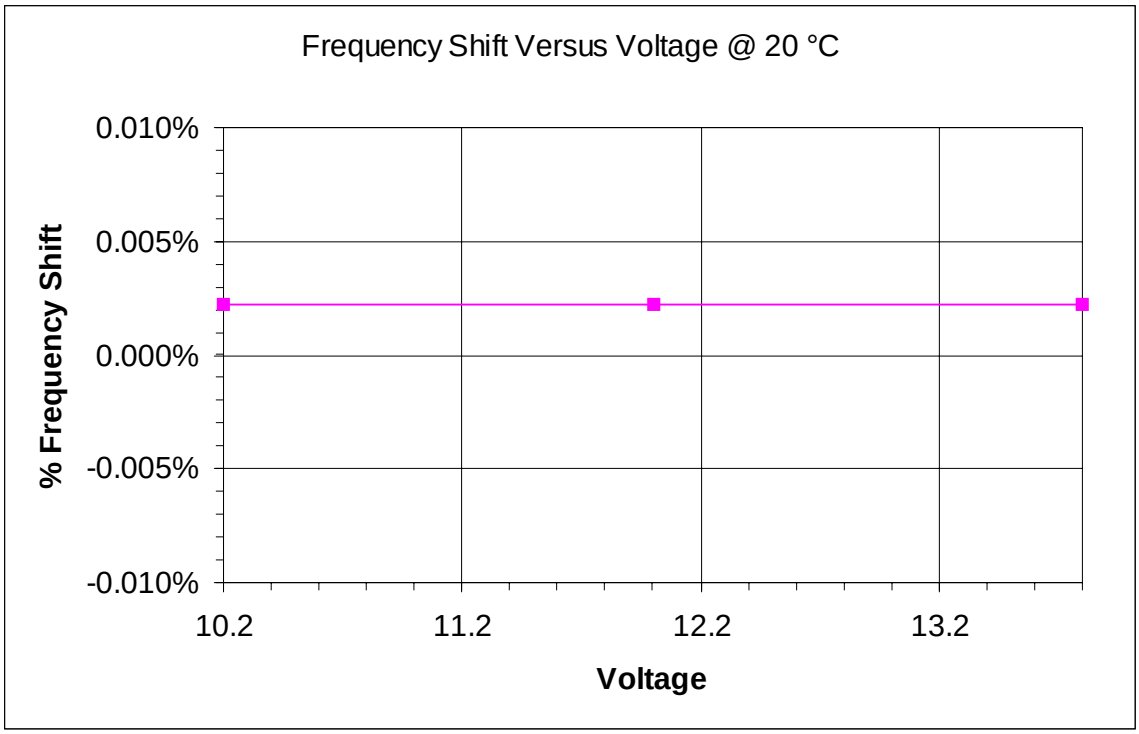


Figure D – 3 Frequency Stability vs. Voltage Graph

SUPPLEMENTAL DATA
FOR TEST REPORT

#WSSD070900

CARD ACCEPTANCE DEVICE (CAD+)

AC CONDUCTED EMISSIONS

PURPOSE:

The TCB has requested that AC Conducted Emissions compliance be verified as part of transmitter modular approval per requirement no. 5 of Public Notice DA 00-1407. As stated, unless the transmitter module is battery powered, it must comply with the AC line conducted requirements found in Section 15.207.

TEST METHOD:

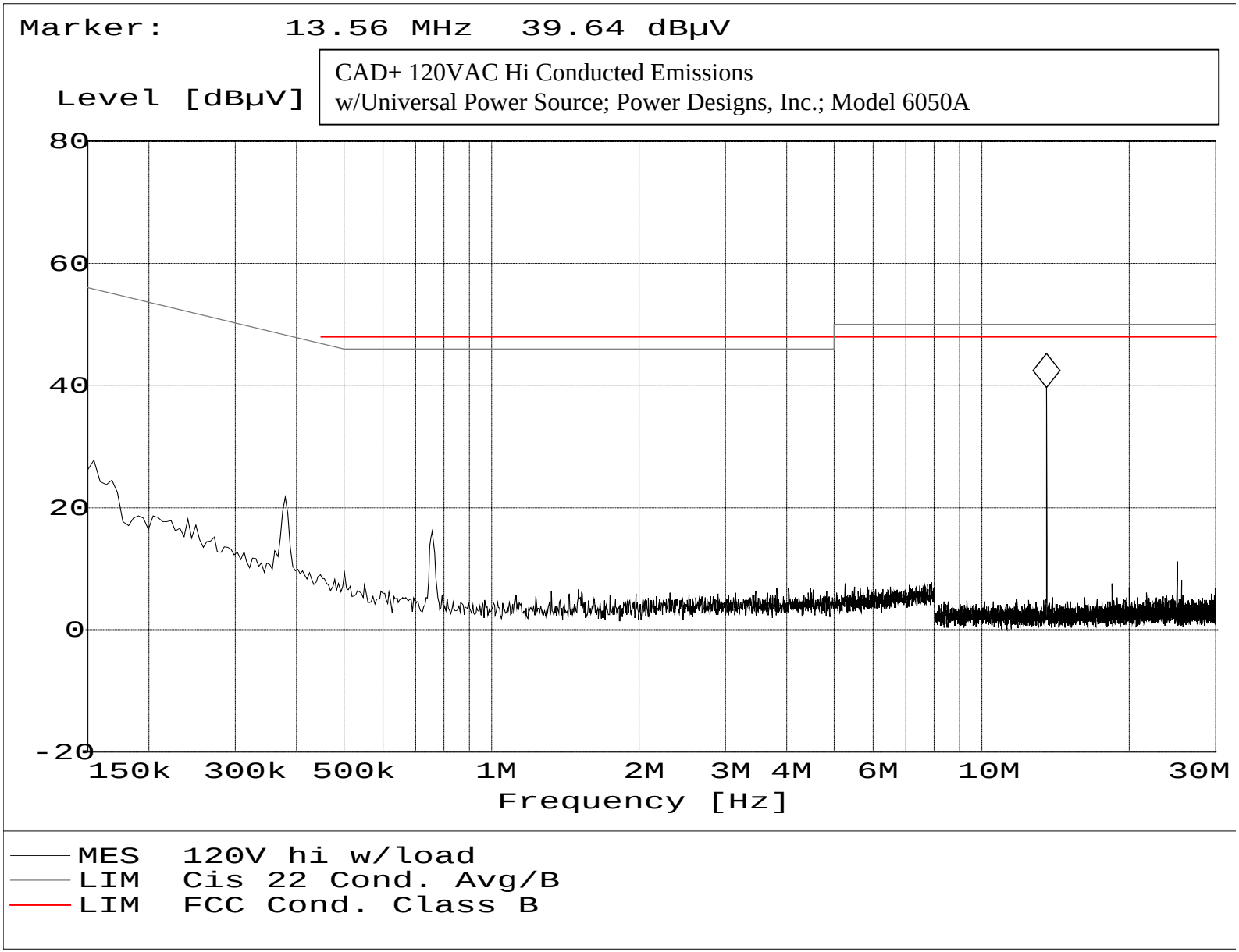
The test methods of ANSI 63.4 were used for performing the tests. A Universal Power Source (UPS) manufactured by Power Designs, Inc., Model 6050A, was used as the AC power mains interface and DC source for the CAD+. This generic commercial off the shelf (COTS) power supply was used since no specific source has been identified for AC power applications. As specified in Paragraph 13.1.3.1, the tests were performed with a dummy load connected to the antenna output terminals since it has a detachable antenna board. The dummy load simulates the impedance of the PCB loop antenna at 2 Ω in series with a 1.3uH inductance.

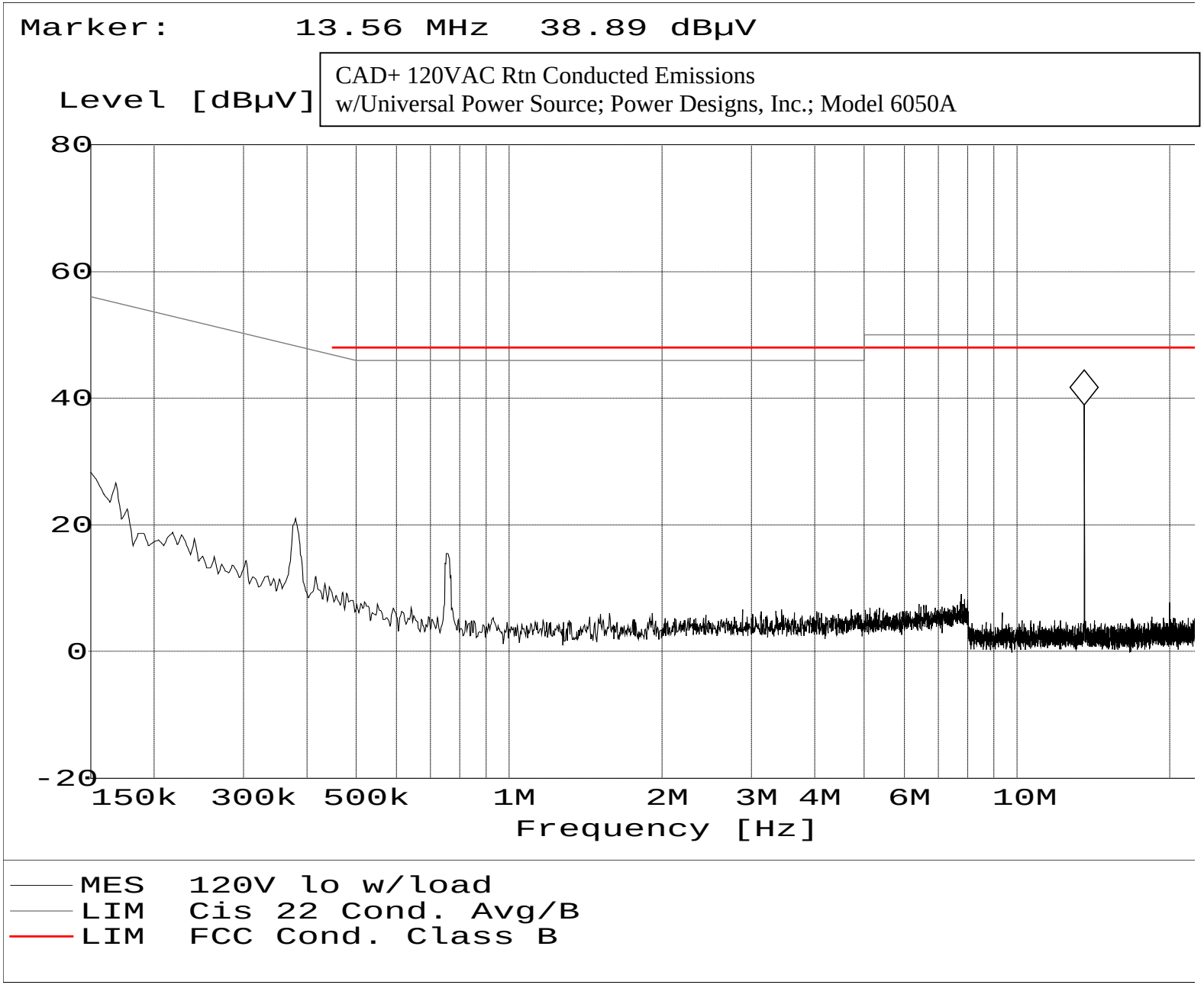
FIGURE 6A – 1 CAD+ AC CONDUCTED EMISSIONS TEST SETUP

FIGURE 6A – 2 CAD+ with Antenna dummy load

TEST RESULTS:

The CAD+ complies with the AC Conducted Emission requirements. The conducted emissions scans are shown in the subsequent pages.


Marker: 13.56 MHz 39.64 dBµV
CAD+ 120VAC Hi Conducted Emissions
w/Universal Power Source; Power Designs, Inc.; Model 6050A
Level [dBµV]
80
60
40
20
0
-20
150k
300k
500k
1M
2M
3M
4M
6M
10M
30M
Frequency [Hz]
MES 120V hi w/load
LIM Cis 22 Cond. Avg/B
LIM FCC Cond. Class B


Marker: 13.56 MHz 38.89 dBµV
CAD+ 120VAC Rtn Conducted Emissions
w/Universal Power Source; Power Designs, Inc.; Model 6050A
Level [dBµV]
80
60
40
20
0
-20
150k
300k
500k
1M
2M
3M
4M
6M
10M
Frequency [Hz]
MES 120V lo w/load
LIM Cis 22 Cond. Avg/B
LIM FCC Cond. Class B