MEASUREMENT AND TECHNICAL REPORT ON THE WAYNE DRESSER 13.56 MHz READER

Southwest Research Institute
6220 Culebra Road
San Antonio, Texas 78228-0510

Project 10-03628-01.001
Report Number EMCR 00/044

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TABLE OF CONTENTS

Page

LIST OF TABLES

1.0 GENERAL INFORMATION

1.1 Product Description

The Wayne Dresser 13.56 MHz Reader, FCC ID Number ORFWAYNETRACII, allows customers wishing to purchase motor fuel to interface directly with a fuel dispenser via a handheld transponder. The 13.56 MHz Reader transmits at 13.56 MHz, which provides energy to the handheld transponder causing it to reflect a signal (also at 13.56 MHz) containing the customer's data back to the 13.56 MHz Reader.

The Wayne Dresser 13.56 MHz Reader is a Radio Frequency Identification Device (RFID) which is designed for use in conjunction with a handheld battery-less transponder. The hand-held transponder is carried by the user. The transmitter portion of the 13.56 MHz Reader operates at 13.56 MHz and is subject to FCC Part 15, Subpart C, "Intentional Radiator," paragraph 15.225 (13.553-13.567MHz). Radiated emissions from the intentional radiator portion of the device is subject to the limits in Section 15.209 of the Rules outside of the 13.56 +/- 0.007 MHz band. Radiated emissions from the digital electronics portion of the device is subject to FCC Part 15, Subpart B, Unintentional Radiator, paragraph 15.109, under the Class A limits and as such, the device is incorporated into an application that is subject to Class A limits. Conducted emissions from the AC power line are subject to FCC Part 15, Subpart C, Intentional Radiator, paragraph 15.207. Table 1.1 lists the 13.56 MHz Reader components.

1.2 Related Grants

There are no related grants.

1.3 Tested System Details

The 13.56 MHz Reader is mounted into an enclosure such as a fueling dispenser and includes two bezel-mounted 13.56 MHz low Q antennae, two Multi-Protocol Readers, two Light Boards (T20545-G1 Circuit Board Assemblies), a Data Control Board, a Switched DC Power Supply and associated transformer. These components are listed in Table 1.1, and the functional relationship is provided in block diagram in Attachment 1. The 13.56 MHz signal originates on the Multi-Protocol Reader board from which the signal is sent via the Antenna Signal/Ground cable to the Bezel Antenna where it is intentionally radiated. Attachment 1 contains a detailed technical description and functionality of the 13.56 MHz Reader and its components. The EUT was tested with two different AC line filters during conducted emissions testing. The filter with the highest conducted emission levels was used during radiated emissions tests.

TABLE 1.1 SYSTEM COMPONENTS

Component Description	Wayne Dresser Part No.
Data Control Board (DCB)	887102-001
Multi-Protocol Reader II (2)	887103-002
Light Board (2)	887106-001
13.56 MHz Bezel Antenna (2)	887108-001
Power Regulating Board	880462-001
Corcom 10VK3 Power Line Filter	---------
Curtis FT1200BB10 Power Line Filter	---------

1.4 Test Methodology

Radiated and conducted testing was performed according to the procedures in ANSI C63.4-1992 and the limits prescribed in CFR 47, FCC Parts 15.109, 15.207, 15.209 and 15.225. Radiated testing was performed at antenna to EUT distances of 10 and 30 meters.

1.5 Test Facility

The Open Area Test Site and Conducted Measurement Facility used to collect data are located at Southwest Research Institute, 6220 Culebra Road, San Antonio, Texas. Details concerning these test sites are found in the report entitled, "Description of Measurement Facility," dated 28 April 1997, which is on file with the FCC Laboratory Division in Columbia, Maryland. On June 12, 1997, the FCC approved the sites for the purpose of providing test results for submission with equipment authorization applications under the Commission's Equipment Authorization Program.

2.0 PRODUCT LABELING

2.1 FCC ID Label

The FCC ID label is shown in the drawing in Attachment 3.

2.2 Location of Label on EUT

The location of the label is shown in the drawing in Attachment 3.

2.3 Label for the Exterior of Devices Incorporating the EUT

The 13.56 MHz Reader will be incorporated in other devices such as a system housing. A label will be supplied with the 13.56 MHz Reader for placement on the exterior of the device in which the equipment is incorporated. This label is shown in the drawing in Attachment 3.

2.4 Supplemental Information to be in the Reader Manual

In addition to reiteration of required information as an intentional radiator, in keeping with sections 15.21 and 15.105 of the FCC rules, the manual supplied with the 13.56 MHz Reader will also include the following admonitions:

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

NO MODIFICATIONS: Modifications to this device shall not be made without the written consent of Wayne Dresser. Unauthorized modifications may void the authority granted under Federal Communications Commission Rules permitting the operation of this device.

3.0 SYSTEM TEST CONFIGURATION

3.1 Justification

Radiated tests were performed on the 13.56 MHz Reader intentional radiator from 13.56 MHz to 1 GHz for the highest fundamental and harmonics. Radiated tests were performed up to 1 GHz for harmonics of the fundamental emission and spurious emissions related to the digital electronics portion of the unit. Both vertical and horizontal polarizations were tested. Radiated signature scans were made at 3 meters in a shielded anechoic chamber. All radiated spurious emissions measured above the 15.209 limit were verified to originate from the digital electronics portion of the 13.56 MHz Reader by disabling the reader transmitter. The transmitter was disabled by removing the inductor from the base of the 2N22 transistor on the Multi-Protocol Reader board.

3.2 EUT Exercise

The 13.56 MHz Reader is powered by 115 VAC. The 13.56 MHz Reader was exercised by establishing the interrogation reply sequence using a handheld transponder.

3.3 Special Accessories

No special accessories were required during testing.

3.4 Equipment Modification

No equipment modifications were required during testing.

3.5 Configuration of Tested System

Refer to Attachment 1 for block diagram of tested configuration. Refer to Appendix D for photographs of the EUT test configuration.

3.6 Antenna Connector

This 13.56 MHz Reader is intended for incorporation into other devices. It is not a consumer device. It requires installation by a technician or assembly line worker trained in its installation in order to properly install it in other devices. Because this is a device that inherently requires professional installation, it complies with the requirements of Section 15.203 of the Commission's Rules. The written instructions packed with the device will explain the requirement for professional installation.

4.0 BLOCK DIAGRAM OF THE 13.56 MHz READER

Refer to Attachment 1 for block diagram of tested configuration.

5.0 CONDUCTED AND RADIATED MEASUREMENT PHOTOS

Refer to Appendix E for photographs of the conducted and radiated test setups.

6.0 CONDUCTED EMISSION DATA

6.1 Conducted Measurement Data

The initial step in collecting conducted data was to perform a spectrum analyzer peak scan of the measurement range to determine worst case. A computer-controlled spectrum analyzer was used to produce a peak measurement data plot. Quasi-peak measurements were made on signals that were close to or above the Section 15.207 limit. The worst case emission levels are provided in Table 6.1. Appendix A contains conducted emission measurement plots.

TABLE 6.1
WORST CASE CONDUCTED EMISSION LEVELS

Standard Line Filter Installed (Corcom 10VK3)			
Judgment: EUT Passed By 6 dB			
FREQUENCY (MHz)	**MEASURED LEVEL (dBµV)** [1]		**CLASS B LIMIT (dBµV)**
	LINE	**NEUTRAL**	
13.58	41		48
13.58		42	48

Alternative Line Filter Installed (Curtis F1200BB10)			
Judgment: EUT Passed By 4 dB			
FREQUENCY (MHz)	**MEASURED LEVEL (dBµV)** [1]		**CLASS B LIMIT (dBµV)**
	LINE	**NEUTRAL**	
13.58	44		48
13.58		42	48

[1] Readings are quasi-peak measurements made with a spectrum analyzer.

6.2 Conducted Test Instrumentation

The test instrumentation used to make conducted measurements is given in Appendix C.

7.0 RADIATED EMISSION DATA

The data below are the corrected highest level EME measurements taken from the following radiated data sheets. The data sheets include the emission frequencies and the corrected level. An explanation of the field strength calculation is given in paragraph 7.3.

7.1 Radiated Measurement Data

Measurements were made of the fundamental frequency of 13.56 MHz at 30 meters. Additionally, the spectrum was investigated for harmonics and spurious emissions up to 30 MHz at 30 meters. No harmonics or other spurious emissions were detected. The measurement level of the fundamental at the center frequency, as well as the level of the fundamental at the band edges, is shown in Table 7.1.

TABLE 7.1
MEASUREMENTS OF FUNDAMENTAL FREQUENCY

Judgment: EUT Fundamental Passed by 34.6 dB		
Frequency (MHz)	Corrected Level[1] dB(µV/m)	Limit dB(µV/m)
13.56	45.4	80 (30 Meters)
13.553	38.4	39 (10 Meters)
13.5715	38.4	39 (10 Meters)

1 All readings are quasi-peak manual measurements made with a receiver.

The spectrum from 30 MHz to 1 GHz was investigated for spurious emissions. The worst case spurious emissions are given in Table 7.2. Peak signature scans are provided in Appendix B.

TABLE 7.2
MEASUREMENTS OF SPURIOUS EMISSIONS

Judgment EUT passed by 0.8 dB			
Frequency (MHz)	Corrected Level [1] dB (µV/m)	Limit dB(µV/m)	"dB" Under limit
135.62	29.4	43.5	14.1
189.80 (Vertical)	42.7	43.5	0.8
189.80 (Horizontal)	40.7	43.5	2.8

1 All readings are quasi-peak manual measurements made with a receiver.

OATS DATA SHEETS

Radiated Emissions Test Data

FREQUENCY (MHz)	13.56	13.56	13.56	13.533	13.566				
TRANSDUCER	ALR-25	ALR-25	ALR-25	ALR-25	ALR-25				
Antenna to DUT distance (meters)	30	30	30	10	10				
Antenna height (meters)	1	1	1	1	1				
POLARIZATION to DUT: (‖ Parallel, ⊥ Perpendicular, = Parallel to Ground)	⊥	‖	=	⊥	⊥				
SIGNAL DIRECTION (degrees)	360	70	320	360	360				
RECEIVER ATTENUATION (dB)	0	0	0	0	0				
METER (dBυV)	9.5	-0.5	1.5	2.5	2.5				
TRANSDUCER FACTOR (dB)	34.6	34.6	34.6	34.6	34.6				
EXTERNAL GAIN/CABLE LOSS (dB)	1.3	1.3	1.3	1.3	1.3				
CORRECTED LEVEL (dBµV/m)	45.4	35.4	37.4	38.4	38.4				
LIMIT (dBµV/m)	80	80	80	39[1]	39[1]				

Date: 05/05/2000
Project No.: 10-3628.01.001
Test Category: FCC Part 15
Temp, & %r.H: 101 Deg 34%

Detection Method: _X_ CISPR ___ PEAK ___ AVERAGE ___ Other
EUT: Wayne Dresser 13.56 MHz Intentional Radiator
OPR/Asst.: D.Smith

Scanned 12.5 MHz to 30 MHz, 3 antenna polarizations. No other emissions detected.
Note 1: Used 20 dB per decade roll-off to adjust limit for closer distance.

SwRI Open Area Test Site Radiated Emissions v2_1		**Project Number:**	10-03628.01.001
Device Under Test:	TIRIS 13.56 MHz Intentional Radiator	**Detection Method:**	QP
Date / Time:	5/6/00 8:30	**Test Receiver:**	Rohde Schwarz ESV, S/N 872147/53
Test Standard(primary limit):	FCC Class A, Part 15 (10 m radiated)	**Antenna:**	
Test Standard(optional limit):			
Test Sponsor:	Wayme Dresser		#9: BICON 3104 S/N2290
Test Technician:	G Vinson		#5: T2 S/N L178
Temp.(°F)/Humidity(%):	76 Deg / 78 %		#7:T3 S/N L108

FREQ	Orient.	Antenna				UnCorr'd	Corr Factors		Corr'd	Primary Limit	Optional Limit	Margin (Primary)	Comments (** denotes a measurement above the primary limit) Note: Cable factor includes preamplifier gain at frequencies above 200 MHz.
MHz	0°	I.D.	Pol.	Ht(m)	Dis(m)	Level	Ant	Cable	Level	dBuV	dBuV	(dB)	
40.68	187	9	V	1.84	10	16.5	10.8	2.3	29.6	39.0		-9.4	Ambient
54.27	187	9	V	1.84	10	8.0	10.1	2.6	20.7	39.0		-18.3	Ambient
135.62	183	9	V	2.16	10	12.5	11.1	4.2	27.9	43.5		-15.6	
189.80	300	9	V	1.43	10	20.5	16.8	5.4	42.7	43.5		-0.8	Signal remained with transmitter disabled
40.68	310	9	H	1.85	10	3.0	10.8	2.3	16.1	39.0		-22.9	Ambient
54.27	310	9	H	1.85	10	3.0	10.1	2.6	15.7	39.0		-23.3	Ambient
135.62	172	9	H	4.11	10	14.0	11.1	4.2	29.4	43.5		-14.1	
189.80	240	9	H	3.94	10	18.5	16.8	5.4	40.7	43.5		-2.8	Signal remained with transmitter disabled
271.19	55	5	V	1.45	10	29.5	20.4	-21.8	28.1	46.5		-18.4	
284.75	81	5	V	1.06	10	19.5	19.2	-21.3	17.4	46.5		-29.1	
289.32	72	5	V	1.08	10	22.5	18.7	-21.4	19.8	46.5		-26.7	
325.45	51	5	V	1.08	10	20.5	18.5	-20.8	18.2	46.5		-28.3	
271.19	14	5	H	2.45	10	28.5	20.4	-21.8	27.1	46.5		-19.4	
289.32	15	5	H	2.56	10	27.0	18.7	-21.4	24.3	46.5		-22.2	
325.45	349	5	H	2.22	10	24.5	18.5	-20.8	22.2	46.5		-24.3	
352.51	142	5	H	2.01	10	20.0	20.3	-20.4	19.9	46.5		-26.6	
406.80	88	5	H	2.09	10	24.5	21.9	-19.6	26.8	46.5		-19.7	
420.35	76	5	H	1.82	10	28.0	21.9	-19.3	30.6	46.5		-15.9	
700.00	163	7	V	1.82	10	15.0	28.1	-15.7	27.4	46.5		-19.1	Ambient
900.00	163	7	V	1.82	10	15.0	33.1	-15.1	33.0	46.5		-13.5	Ambient
700.00	163	7	H	1.82	10	10.0	28.1	-15.7	22.4	46.5		-24.1	Ambient
900.00	163	7	H	1.82	10	10.0	33.1	-15.1	28.0	46.5		-18.5	Ambient

Radiated Emissions Test Data

The frequency tolerance of the 13.56 MHz fundamental emission was verified to be within the +/- 0.01% (+/-1.356 kHz) requirement from Part 15, paragraph 15.225, when exposed to temperature variations of –20 degrees to +50 degrees C. The fundamental emission was monitored on a spectrum analyzer as the 13.56 MHz Reader was exposed to +50 degrees C for 10 minutes, and then –20 degrees C for 10 minutes, in accordance with the procedure in ANSI C63.4-1992, paragraph 13.1.6.1. The frequency varied by approximately 168 Hz. In addition, the 115 VAC supply voltage was varied from 85% to 115% at room temperature in accordance with paragraph 15.225. The frequency of the fundamental emission did not vary more than approximately 29 Hz during the entire procedure.

7.2 Test Instrumentation for Radiated Measurements

Scans were made at an open area test site (OATS) and in an RF semi-anechoic chamber 28' long x 16' wide x 16' high with its interior lined on the ceiling and four walls with pyramidal absorber material up to four feet in length. Measurements were made with a spectrum analyzer and a quasi-peak adapter in the anechoic chamber and with a receiver at the OATS. The list of test instrumentation used to perform the testing is shown in Appendix C.

7.3 Field Strength Calculation

The field strength was calculated by adding the antenna factor and cable factor, and subtracting the amplifier gain (when used) from the measured reading. The basic equation with a sample calculation is provided below:

FS = RA + AF + CF - AG

Where FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation
AG = Amplifier Gain

For example, reducing the 13.56 MHz measurement on the data sheet on page 13 (first column) yields:

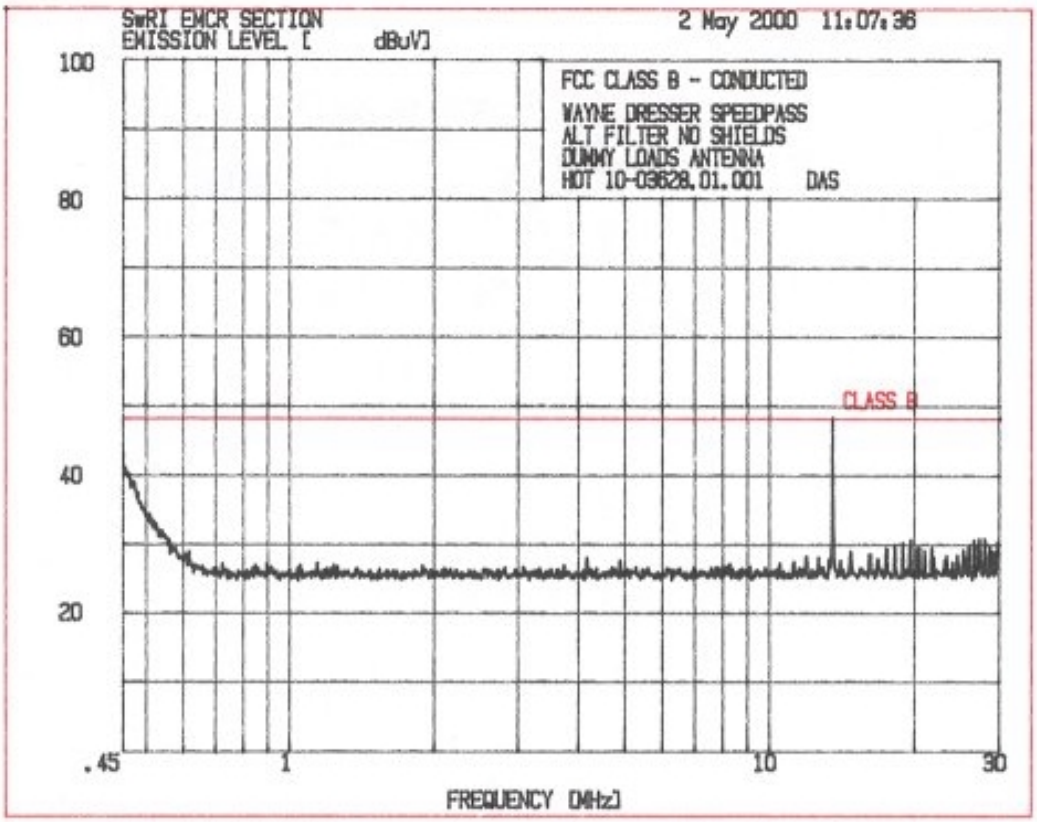
9.5 dB (µV)
34.6 dB (1/m)
1.3 dB (CF/AG FACTOR)
FS = 45.4 dB (µV/m)

To equation convert the dB (µV/m) value to its corresponding level in µV/m is as follows:

Level in µV/m Common Antilogarithm [(45.4 dB µV/m)/20] = 186.2 µV/m

APPENDIX A

CONDUCTED EMISSIONS MEASUREMENTS PLOTS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WAYNE DRESSER SPEEDPASS
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DUMMY LOADS ANTENNA
HOT 10-03628.01.001 DAS
CLASS B
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20
.45
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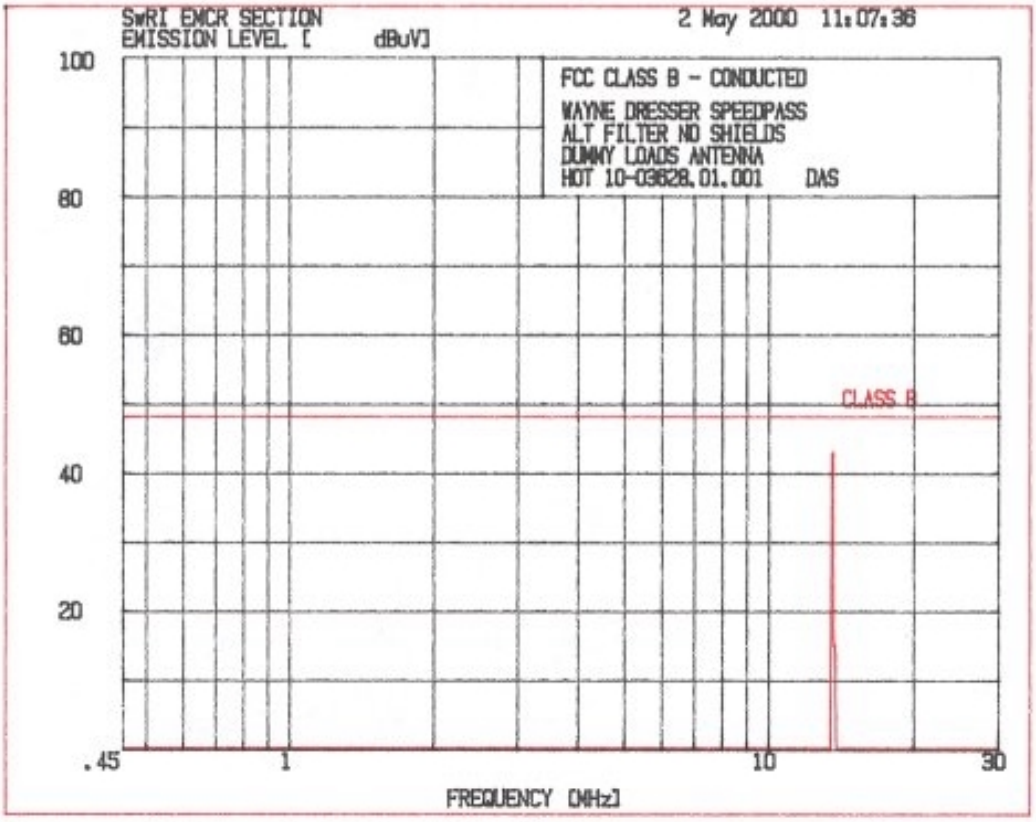
10
30
FREQUENCY [MHz]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WAYNE DRESSER SPEEDPASS
ALT FILTER NO SHIELDS
DUMMY LOADS ANTENNA
HOT 10-03628.01.001 DAS
CLASS B
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80
60
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20
.45
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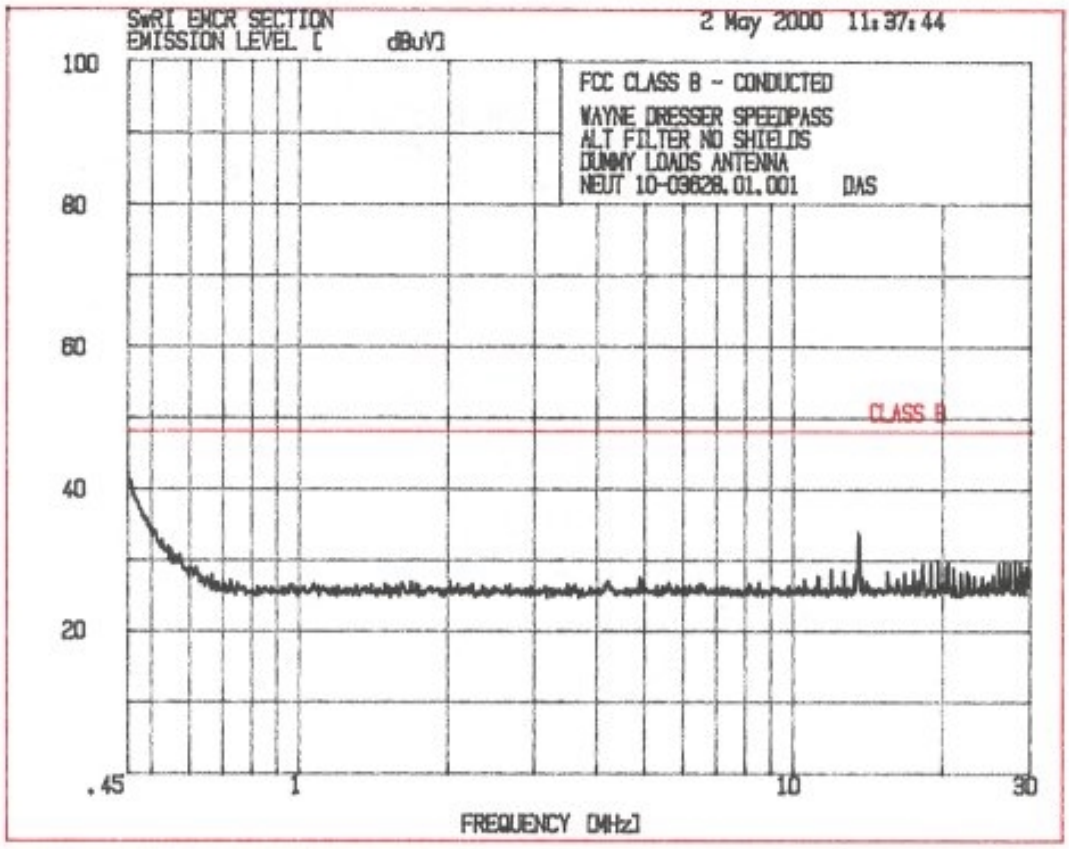
10
30
FREQUENCY [MHz]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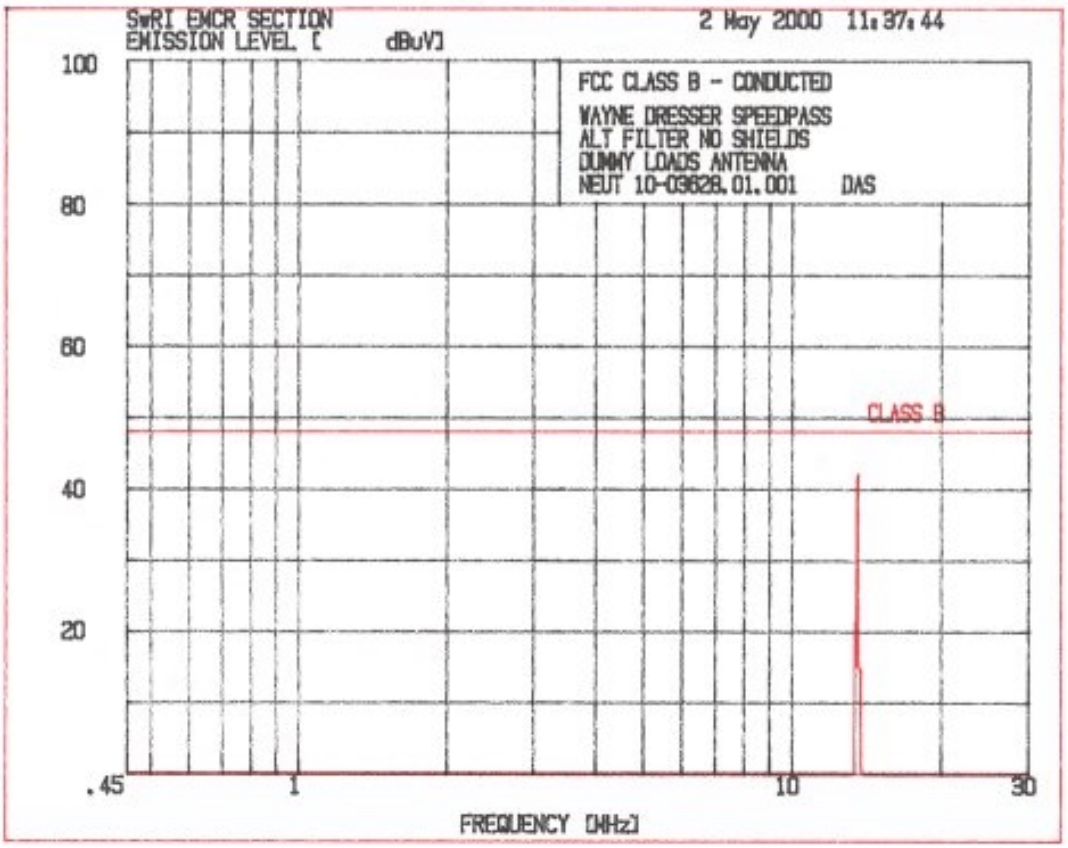
DUMMY LOADS ANTENNA
NEUT 10-03628.01.001 DAS
CLASS B
100
80
60
40
20
.45
1
10
30
FREQUENCY [MHz]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DUMMY LOADS ANTENNA
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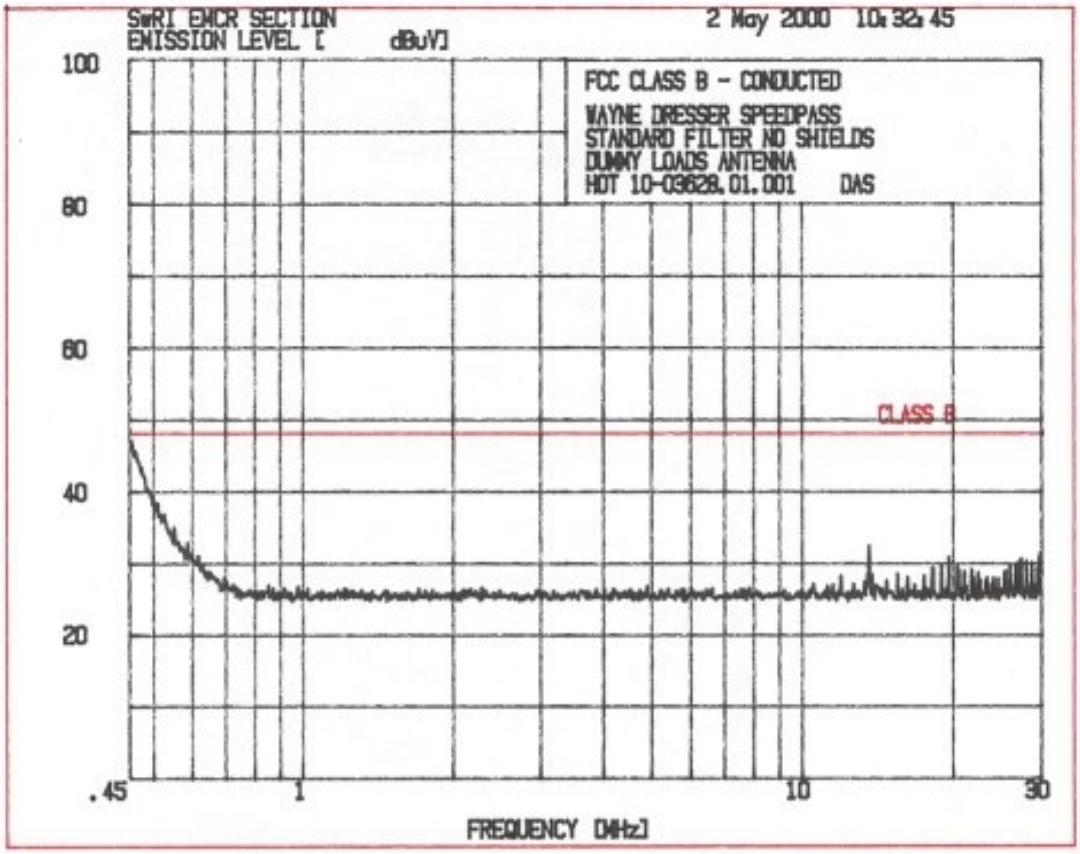
80
60
40
20
.45
1
10
30
FREQUENCY [MHz]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DUMMY LOADS ANTENNA
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60
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.45
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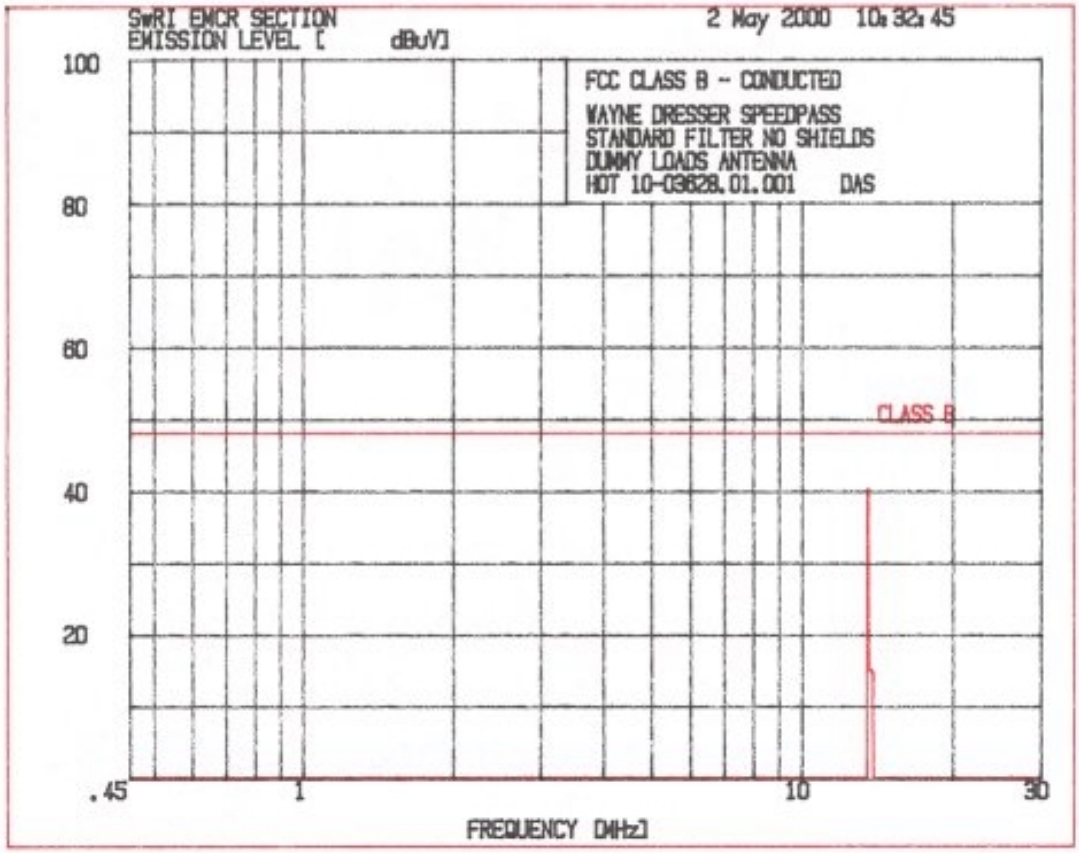
FREQUENCY [MHz]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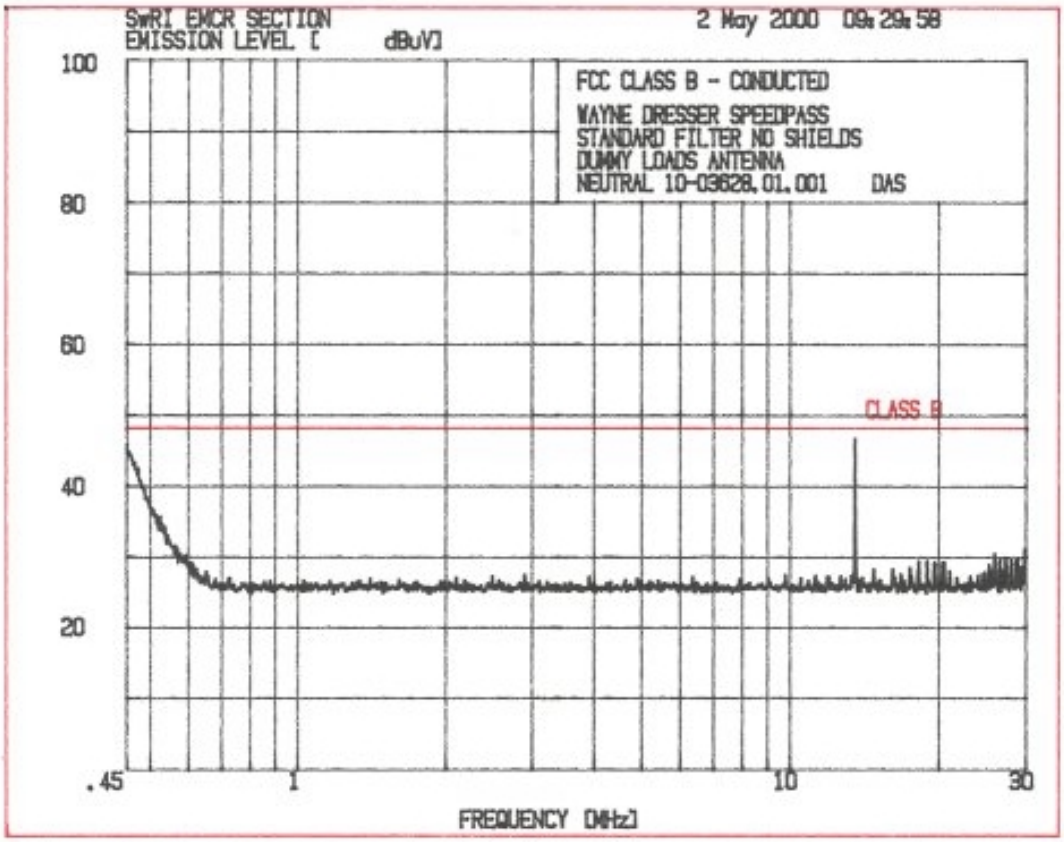
WAYNE DRESSER SPEEDPASS
STANDARD FILTER NO SHIELDS
DUMMY LOADS ANTENNA
HOT 10-03628.01.001 DAS
CLASS B
100
80
60
40
20
.45
1
10
30
FREQUENCY [MHz]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80
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40
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.45
1
10
30
FREQUENCY [MHz]
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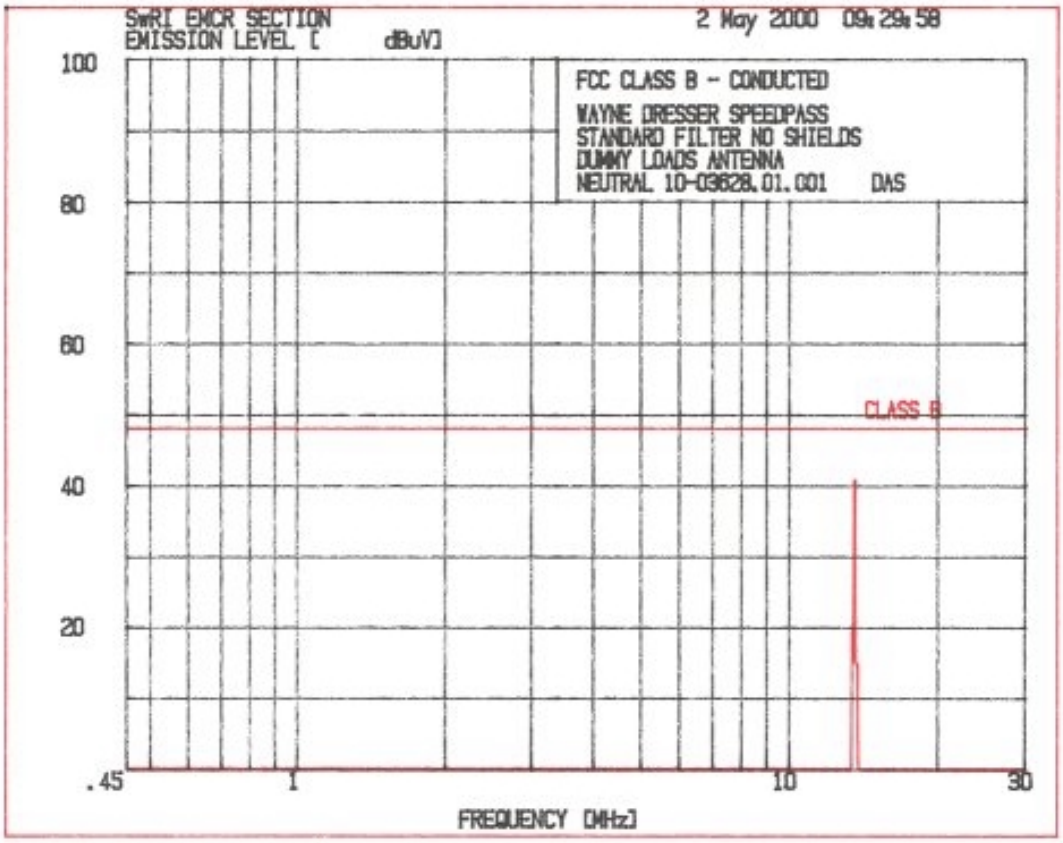
WAYNE DRESSER SPEEDPASS
STANDARD FILTER NO SHIELDS
DUMMY LOADS ANTENNA
NEUTRAL 10-03628.01.001 DAS
CLASS B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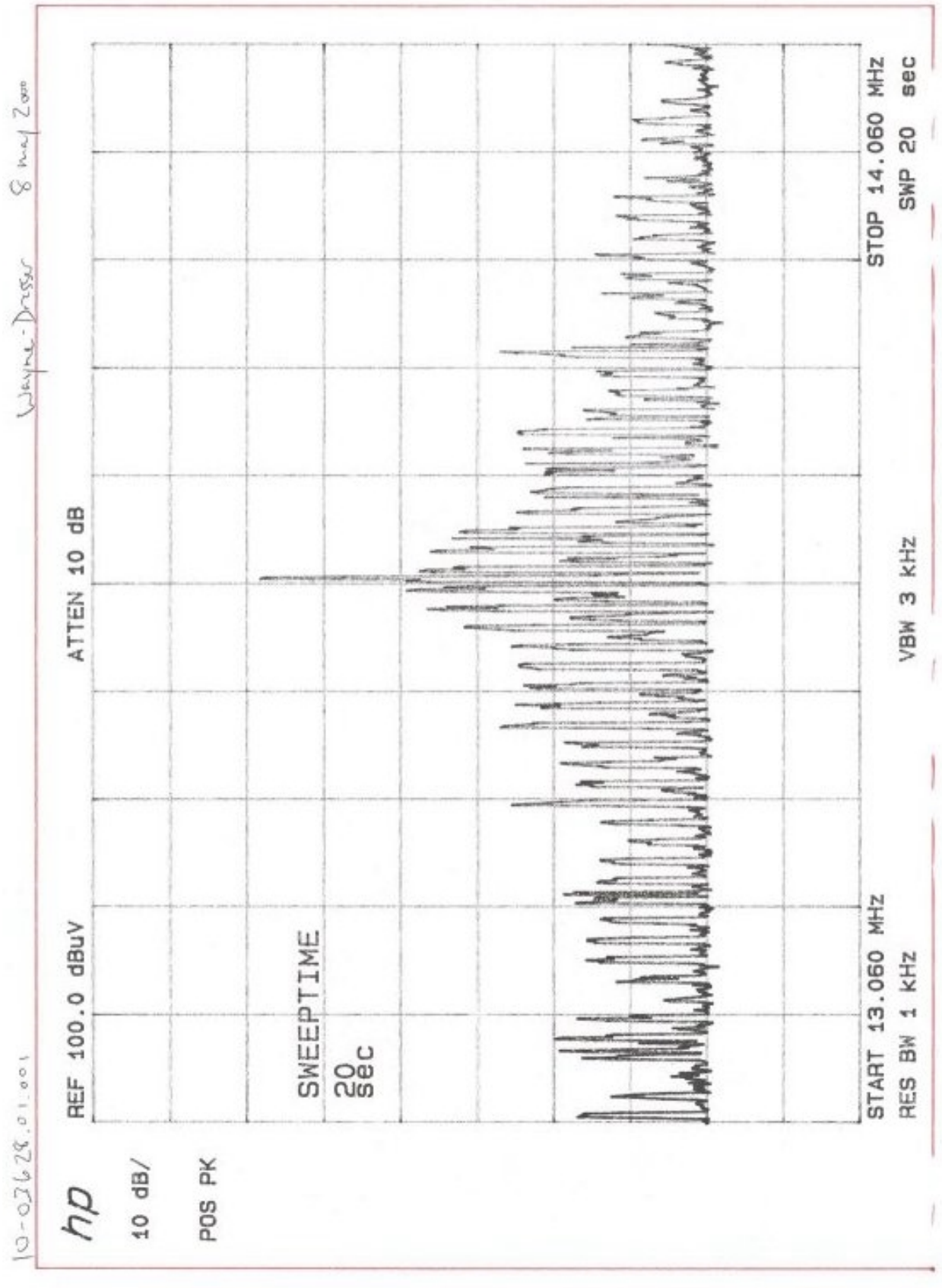
40
20
.45
1
10
30
FREQUENCY [MHz]
FCC CLASS B - CONDUCTED
WAYNE DRESSER SPEEDPASS
STANDARD FILTER NO SHIELDS
DUMMY LOADS ANTENNA
NEUTRAL 10-03628.01.001 DAS
CLASS B

APPENDIX B

RADIATED SIGNATURE MEASUREMENTS PLOTS


10-03628.01.001
Wayne Dresser 8 May 2003
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ATTEN 10 dB
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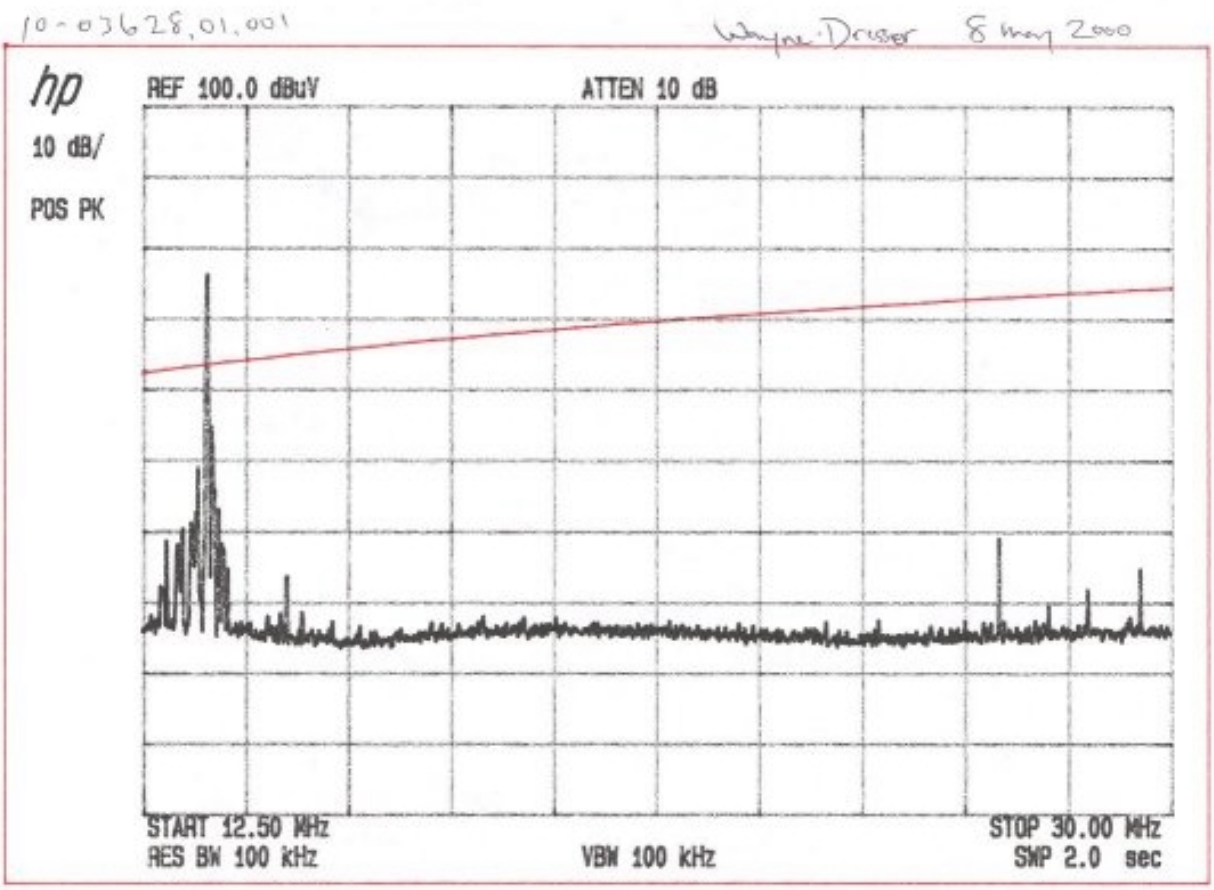
START 13.060 MHz
RES BW 1 kHz
VBW 3 kHz
STOP 14.060 MHz
SWP 20 sec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Wayne Dresser 8 May 2000
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10 dB/
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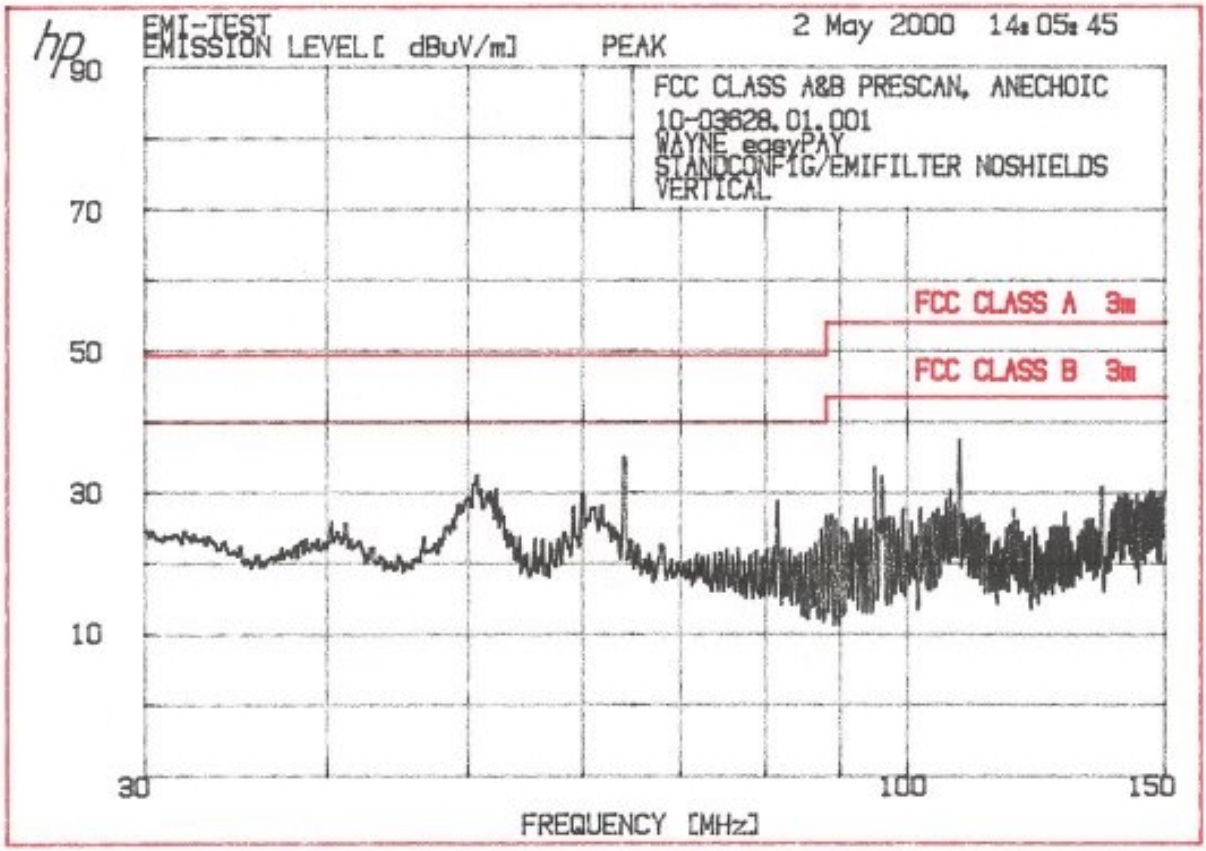
VBW 100 kHz
STOP 30.00 MHz
SWP 2.0 sec


EMI-TEST
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10-03628.01.001
WAYNE easyPAY
STANDCONFIG/EMIFILTER NOSHIELDS
VERTICAL
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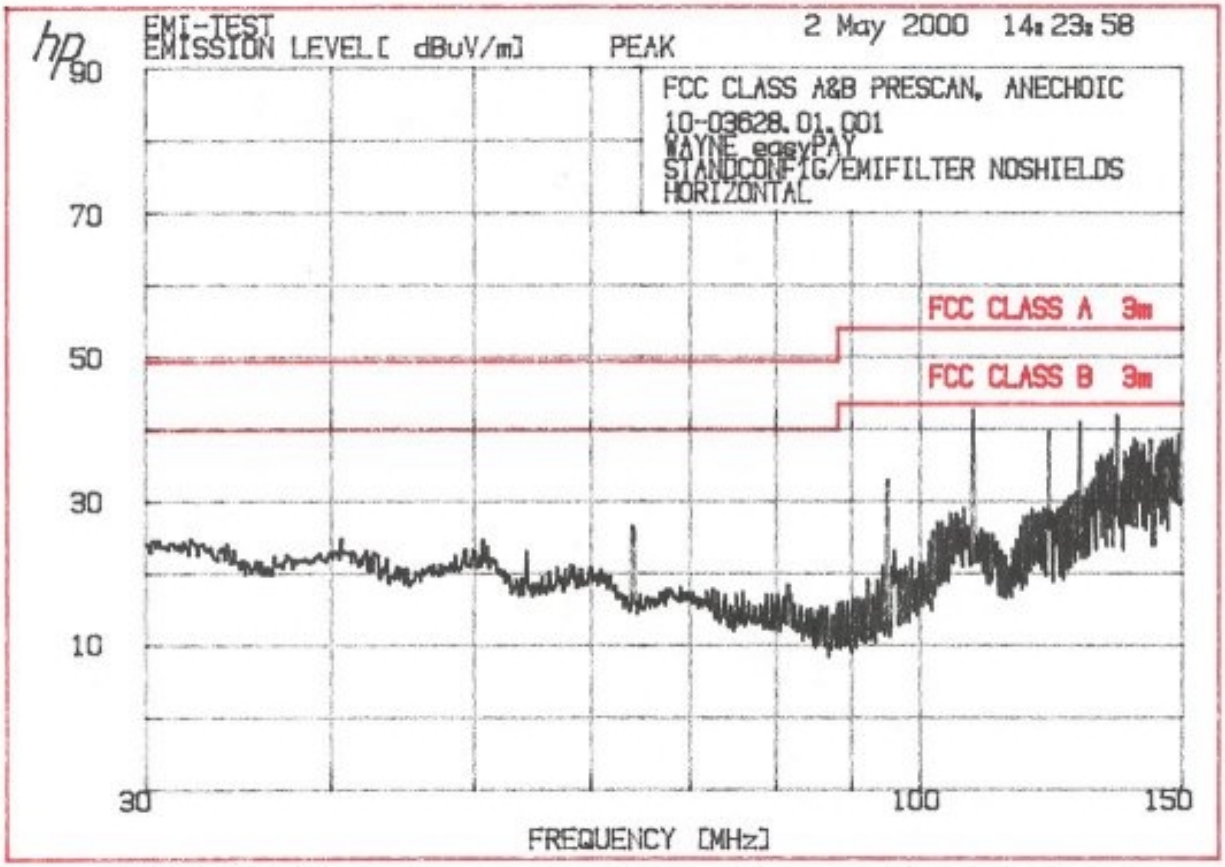
FCC CLASS B 3m
90
70
50
30
10
30
100
150
FREQUENCY [MHz]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EMISSION LEVEL[dBuV/m]
PEAK
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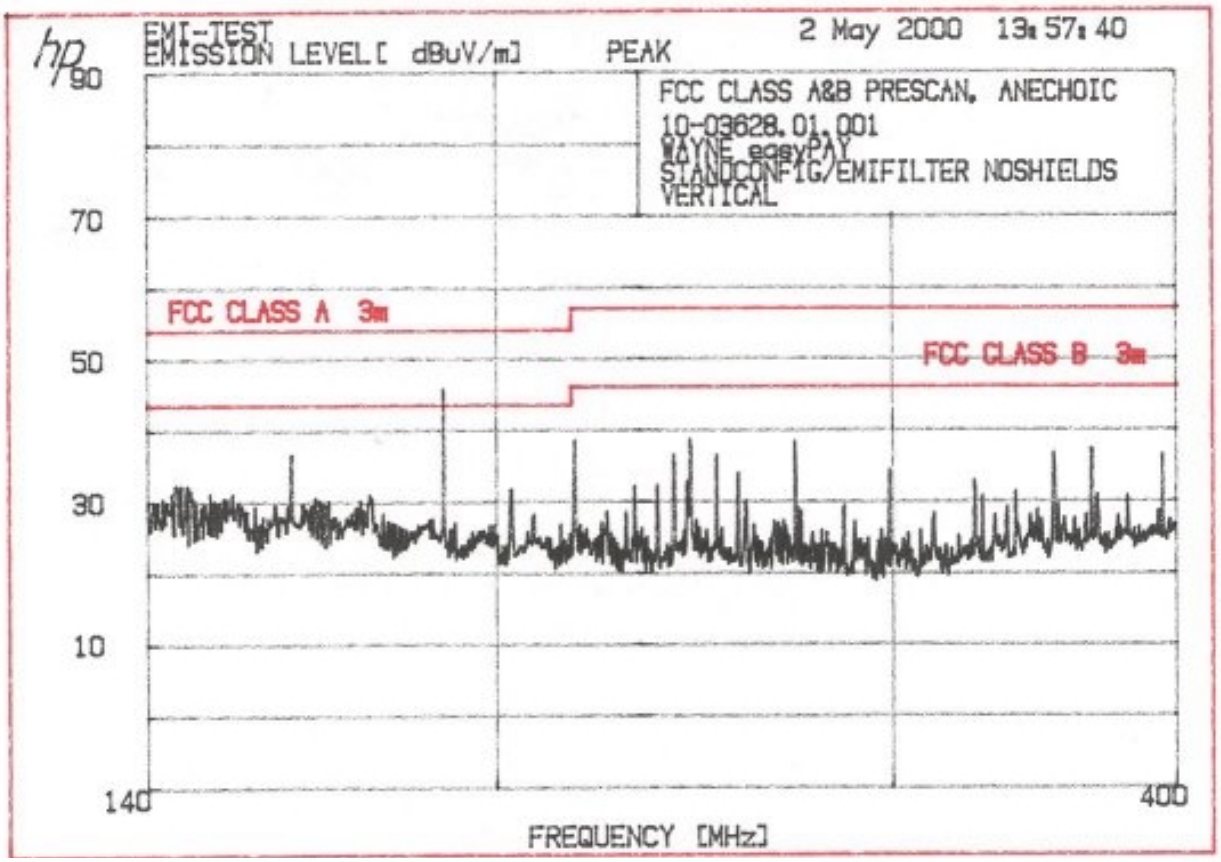
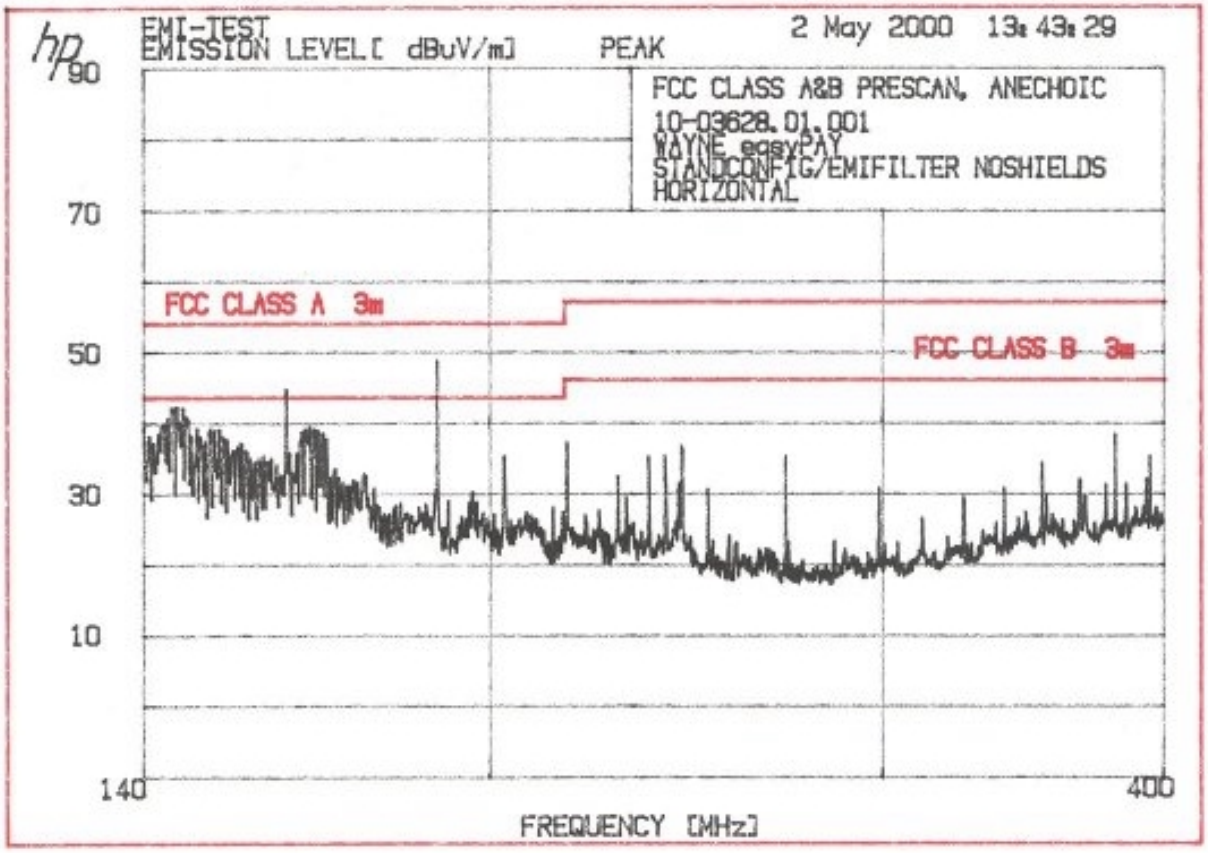
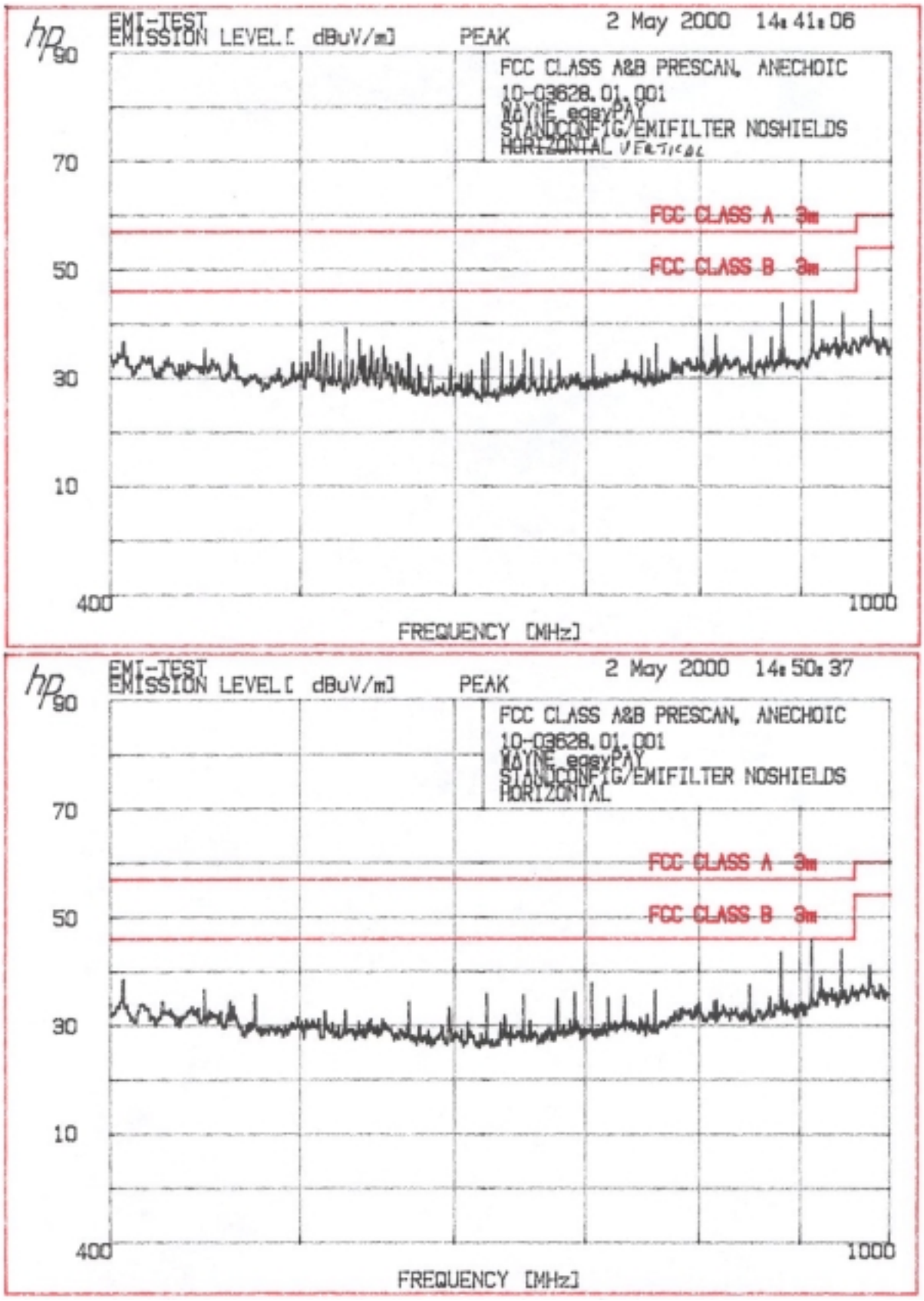
10-03628.01.001
WAYNE easyPAY
STANDCONFIG/EMIFILTER NOSHIELDS
HORIZONTAL
FCC CLASS A 3m
FCC CLASS B 3m
90
70
50
30
10
30
100
150
FREQUENCY [MHz]


EMI-TEST
EMISSION LEVEL[dBuV/m]
PEAK
2 May 2000 13:57:40
FCC CLASS A&B PRESCAN, ANECHOIC
10-03628.01.001
WAYNE easyPAY
STANDCONFIG/EMIFILTER NOSHIELDS
VERTICAL
FCC CLASS A 3m
FCC CLASS B 3m
90
70
50
30
10
140
400
FREQUENCY [MHz]


EMI-TEST
EMISSION LEVEL[dBuV/m]
PEAK
2 May 2000 13:43:29
FCC CLASS A&B PRESCAN, ANECHOIC
10-03628.01.001
WAYNE easyPAY
STANDCONFIG/EMIFILTER NOSHIELDS
HORIZONTAL
FCC CLASS A 3m
FCC CLASS B 3m
90
70
50
30
10
140
400
FREQUENCY [MHz]


EMI-TEST
EMISSION LEVEL[dBuV/m]
PEAK
2 May 2000 14:41:06
FCC CLASS A&B PRESCAN, ANECHOIC
10-03628.01.001
WAYNE easyPAY
STANDCONFIG/EMIFILTER NOSHIELDS
HORIZONTAL VERTICAL
FCC CLASS A 3m
FCC CLASS B 3m
90
70
50
30
10
400
1000
FREQUENCY [MHz]
EMI-TEST
EMISSION LEVEL[dBuV/m]
PEAK
2 May 2000 14:50:37
FCC CLASS A&B PRESCAN, ANECHOIC
10-03628.01.001
WAYNE easyPAY
STANDCONFIG/EMIFILTER NOSHIELDS
HORIZONTAL
FCC CLASS A 3m
FCC CLASS B 3m
90
70
50
30
10
400
1000
FREQUENCY [MHz]

APPENDIX C

TEST INSTRUMENTATION

EQUIPMENT USE REPORT

MANUFACTURER	MODEL NO.	DESCRIPTION	SERIAL NO.	CAL DATE
CONDUCTED EMISSIONS				
Rhode & Schwarz	ESH2-Z5	LISN	872461/021	20APR01
Rhode & Schwarz	ESH2	Test Receiver	879014/53	01FEB01
HP	8568B	Spectrum Analyzer	2152A03081	13OCT00
HP	85650A	Q-Peak Adapter	2043A00213	13OCT00
ANECHOIC CHAMBER				
SwRI	UTC 10 221-1	Preamp	9112SN15	verified
HP	8568B	Spectrum Analyzer	2338403029	01SEP00
HP	85650A	Q-Peak Adapter	2043A00254	01AUG00
HP	8447D	Preamp	1529A00517	verified
EMCO	3121-DB3	Antenna, Dipole	148	verified
EMCO	3121-DB4	Antenna, Dipole	1097	verified
EMCO	3121-DB2	Antenna, Dipole	148	verified
Electrometrics	ALR-25	Loop Antenna	371	04APR01
OATS				
Rhode & Schwarz	ESV	Test Receiver	872147/53	04APR01
Rhode & Schwarz	ESH2	Test Receiver	879014/53	01FEB01
SwRI	2 MHz-1GHz	Preamp	1	NCR
EMCO	3104	Bicon Antenna	2290	30MAY00
Empire	DM-105-T2	Antenna, Dipole	L-000178	29MAY00
Empire	DM-105-T3	Antenna, Dipole	L-000108	29MAY00
Electrometrics	ESA-1000	Spectrum Analyzer	162	NCR
Rytronic	PA1	Hygrometer	60858	02DEC00
Electrometrics	ALR-25	Loop Antenna	086	04APR01
TEMPERATURE AND VOLTAGE VARIATION				
HP	8568B	Spectrum Analyzer	2152A03081	13OCT00
Electrometrics	ALR-25	Loop Antenna	371	04APR01
Fluke	52	Thermometer	3910515	08SEP00
Tenny	TEMP GUARD III	Temperature Chamber	7011	NCR
HP	8568B	Spectrum Analyzer	2338A03029	01SEP00
Sencore	PR-57	Power Supply	-----	NCR
Fluke	87	DMM	64330494	30NOV00

APPENDIX D

PHOTOS OF TESTED EUT

File Name	EUT Photo
Pic00004.jpg	Wayne Dresser 13.56 MHz Reader (Shell Easy Pay), view facing Bezel Assembly
Pic00035.jpg	Wayne Dresser 13.56 MHz Reader (Shell Easy Pay), Side View
Pic00013.jpg	Bezel Assembly without Multi-Protocol Reader
Pic00016.jpg	Bezel Assembly, with Multi-Protocol Reader
Pic00019.jpg	Bezel and Antenna Assembly
Antenna T.jpg	PCB Assembly, Antenna Board, Circuit (top) Side
Antenna B.jpg	PCB Assembly, Antenna Board, Component (bottom) Side
Timprv14t.jpg	Multi-Protocol Reader Assembly, Component Side
Timprv14b.jpg	Multi-Protocol Reader Assembly, Circuit Side
lightboardt.jpg	PCB Assembly, Lite Board, Shell, Component Side
lightboardb.jpg	PCB Assembly, Lite Board, Shell, Circuit Side
Pic00011.jpg	View Showing Data Control Board Assembly
Tiboards.jpg	Data Control Board Assembly, Component Side
Tiboard1b.jpg	Data Control Board Assembly, Circuit Side
Pic00007.jpg	Power Supply Module
dressert.jpg	Power Interconnect Board, Component Side
Dresserb.jpg	Power Interconnect Board, Circuit Side
Filter.jpg	AC Power Filter Assembly, Shell Easy Pay
RegulatorC.jpg	Regulator Board, Component Side
RegulatorB.jpg	Regulator Board, Circuit Side

APPENDIX E

PHOTOS OF TEST SETUPS

Test Setup	File Name
Radiated Emissions Test Setup – Anechoic	Anechoic_1.jpg
Radiated Emissions Test Setup – Anechoic	Anechoic_2.jpg
Radiated Emissions Test Setup – OATS	OATS_1.jpg
Radiated Emissions Test Setup – OATS	OATS_2.jpg
Conducted Emissions Test Setup	Conducted_1.jpg
Conducted Emissions Test Setup	Conducted_2.jpg