FCC Certification Test Report

FCC Part 95(F) Certification Test Report
for
EON Corporation
FCC ID: JLM-E1000V

December 3, 2003

Revision 1 issued January 9, 2004

Prepared for:

EON Corporation
360 Herndon Pkwy, Suite 900
Herndon, VA 20170

Prepared By:

Washington Laboratories, Ltd.
7560 Lindbergh Drive
Gaithersburg, Maryland 20879

FCC Certification Test Program

FCC Certification Test Report
for the
EON Corporation
E1000V Vending Information Unit (VIU) Data Radio
JLM-E1000V

December 3, 2003

Revision 1 issued January 9, 2004

WLL JOB# 7797

Prepared by: Brian J. Dettling
Documentation Specialist

Reviewed by: Gregory M. Snyder
Chief EMC Engineer

Abstract

This report has been prepared on behalf of EON Corporation to support the attached Application for Equipment Authorization. The test report and application are submitted for a Response Transmit Unit (RTU) under Part 95 Subpart "F" of the FCC Rules and Regulations. This Federal Communication Commission (FCC) Certification Test Report documents the test configuration and test results for the EON Corporation E1000V Vending Information Unit (VIU) Data Radio.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

The EON Corporation E1000V Vending Information Unit (VIU) Data Radio complies with the limits for a Response Transmit Unit (RTU) device under Part 95 Subpart "F" of the FCC Rules and Regulations.

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1 Introduction

1.1 Compliance Statement

The EON Corporation E1000V Vending Information Unit (VIU) Data Radio complies with the limits for a Response Transmit Unit (RTU) device under Part 95 Subpart "F" of the FCC Rules and Regulations.

1.2 Test Scope

Tests for radiated and conducted emissions were performed. All measurements were performed according to the 2001 version of ANSI C63.4. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	EON Corporation 360 Herndon Pkwy, Suite 900 Herndon, VA 20170
Quotation Number:	61122

1.4 Test Dates

Testing was performed from October 6 to October 24, 2003.

1.5 Test and Support Personnel

Washington Laboratories, LTD	James Ritter

1.6 Abbreviations

A	Ampere
Ac	alternating current
AM	Amplitude Modulation
Amps	Amperes
b/s	bits per second
BW	Bandwidth
CE	Conducted Emission
cm	centimeter
CW	Continuous Wave
dB	decibel
dc	direct current
EMI	Electromagnetic Interference
EUT	Equipment Under Test
FM	Frequency Modulation
G	giga - prefix for 10^9 multiplier
Hz	Hertz
IF	Intermediate Frequency
k	kilo - prefix for 10^3 multiplier
M	Mega - prefix for 10^6 multiplier
m	Meter
μ	micro - prefix for 10^{-6} multiplier
NB	Narrowband
LISN	Line Impedance Stabilization Network
RE	Radiated Emissions
RF	Radio Frequency
rms	root-mean-square
SN	Serial Number
S/A	Spectrum Analyzer
V	Volt

2 Equipment Under Test

2.1 EUT Identification & Description

The EON Corporation VIU Data Radio is a VHF Data Transceiver Response Transmit Unit (RTU) that relays vending machine status and data to, and receives operating instructions from, a base or mobile system. The system consists of two assemblies: the logic control unit and the radio transceiver. Maximum power of the transmitter is 4 watts. It can be set to either "High" (4W) or "Low" (2W) by an internal reconfiguration. The system was tested at both output levels.

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	EON Corporation
FCC ID Number	JLM-E1000V
EUT Name:	Data Radio
Model:	VIU
FCC Rule Parts:	§95 Subpart F
Frequency Range:	218.2625 MHz single 12.5 kHz channel
Maximum Output Power:	4W
Modulation:	FM
Occupied Bandwidth:	8 kHz
Keying:	Automatic
Type of Information:	Data
Number of Channels:	Fixed
Power Output Level	Fixed (either at 2 or 4 watts)
Antenna Type	Detachable ¾wave whip Or 8ft fiberglass omni directional 3dB gain double wave antenna (BNC Connector)
Frequency Tolerance:	1 ppm
Interface Cables:	1 DB9 From logic control unit to transceiver 1 RJ11-DB9 ("Dex Cable") From logic control unit to vending machine.
Power Source & Voltage:	12Vdc (AC/DC power adaptor)

2.2 Test Configuration

The VIU was configured with a support laptop PC connected to the logic control unit via the Dex cable. The logic control unit is connected to the transceiver via the standard DB9 to DB9 cable provided for installation. The RF output was terminated by a suitable 50-ohm load.

2.3 Testing Algorithm

The VIU was operated by Hyperterminal software from the laptop PC for simulation of the vending machine. Once the start-up sequence was complete the EUT was set to

transmit in 45 second bursts. In normal operation the duty cycle of the transmission is much less than 45 seconds. The 45 seconds was the maximum continuous transmit time that could be selected so as not to damage the transceiver board.

Worst case emission levels are provided in the test results data.

2.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

2.5 Measurements

2.5.1 References

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

Land Mobile FM or PM Communications Equipment Measurement and Performance Standards (ANSI/TIA/EIA-603-93)

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. For the purposes of the measurements performed by Washington Laboratories, the measurement uncertainty is ±2.3 dB. This has been calculated for a *worst-case situation* (radiated emissions measurements performed on an open area test site).

The following measurement uncertainty calculation is provided:

$$\text{Total Uncertainty} = (A^2 + B^2 + C^2)^{1/2}/(n-1)$$

where:

A = Antenna calibration uncertainty, in dB = 2 dB

B = Spectrum Analyzer uncertainty, in dB = 1 dB

C = Site uncertainty, in dB = 4 dB

n = number of factors in uncertainty calculation = 3

Thus, Total Uncertainty = $0.5\ (2^2 + 1^2 + 4^2)^{1/2}$ = ±2.3 dB.

3 Test Equipment

Table 2 shows a list of the test equipment used for measurements along with the calibration information.

Table 2: Test Equipment List

Manufacturer	Model/Type	Function	Identification	Cal. Due
HP	8568B	Spectrum Analyzer	2634A02888	7/07/04
HP	85650A	Quasi-Peak Adapter	3303A01786	7/08/04
HP	8672A	Synth Signal Generator	2311A03131	3/17/04
HP	8563A	Spectrum Analyzer	3003A00168	4/04/04
HP	8449B	Pre- Amplifier	3008A00729	2/11/05
HP	85685A	RF Preselector	3221A01395	7/07/04
Solar	8012-50-R-24BNC	LISN	8379493	6/23/04
ARA	LPB-2520	BiconiLog Antenna	1044	6/20/04
ARA	DRG-118/A	Horn Antenna	1010	11/28/03
ARA	DRG-118/A	Horn Antenna	1236	4/17/04
EMCO	3146A	Log Periodic Antenna	8912-1129	6/20/04
EMCO	3110B	Biconical Antenna	9808-1078	6/20/04
Electro Metrics	BIA-30	Biconical Antenna	4277	6/10/05

4 Test Results

4.1

4.2 RF Power Output: (FCC Part §2.1046)

The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer. The analyzer offset was adjusted to compensate for the attenuator and other losses in the system.

During the measurement the resolution bandwidth was set to 300 kHz and the video bandwidth was set to 100 kHz. Power measurements were performed at both the 2W and 4W settings.

Table 3. RF Power Output

Frequency	Level	Level	Limit	Pass/Fail
218.262 MHz	32.67 dBm	1.85W	4W	Pass
218.262 MHz	35.83 dBm	3.83W	4W	Pass

4.3 Effective Radiated Power (FCC Part 95.855)

Effective Radiated Power of the VIU:

4.3.1 Test Procedure

The ERP was calculated using equation:

$ERP_{dBm} = P_{dBm} + G_{dBd}$

Where: P = Output Power

G = Antenna Gain

4.3.2 Test Results

Transceiver output power is 2 or 4 watts. FCC § 95.855 limit for ERP of RTU is 4 watts. Therefore, the maximum antenna gain allowed is 0 dBd for the mobile installation and 7 dBd for fixed installation.

4.4 Modulation Characteristics: (FCC Part §2.1047)

Occupied Bandwidth:

The Occupied Bandwidth (**FCC Part §2.1049**) was measured by coupling the output of the transmitter to the spectrum analyzer. Both the 2 watt and 4 watt modes were tested. The Occupied Bandwidth plot is shown in Figure 1. The FSK modulation consisted of a 1200 bps packetized data test pattern and the peak deviation measured 2.2 kHz on a Boonton 82AD modulation analyzer.

Bandwidth computation at 1200 bps:

2D + 2F = 4.4 + 2.4 = 6k80F1D

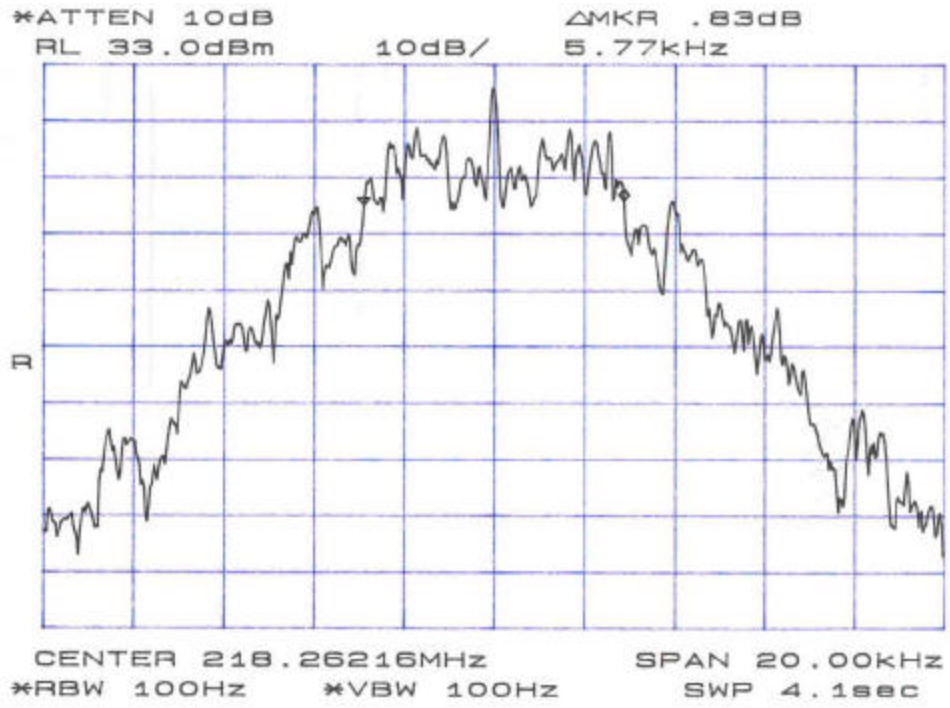


Figure 1. Occupied Bandwidth, 2 Watt Mode

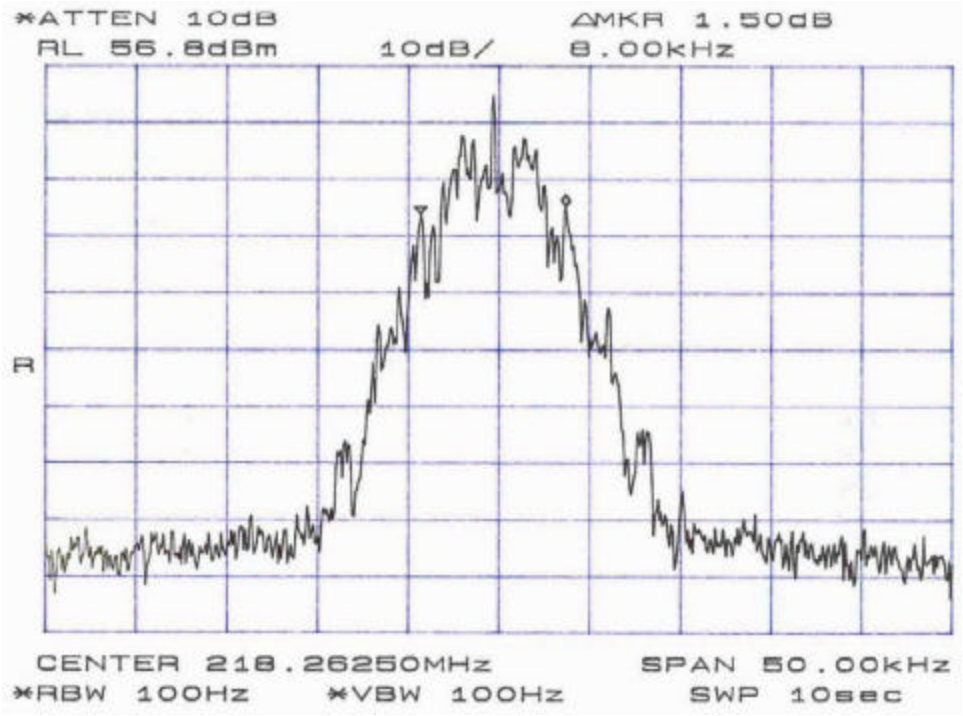


Figure 2. Occupied Bandwidth, 4 Watt Mode

Table 4 provides a summary of the Occupied Bandwidth Results.

Table 4. Occupied Bandwidth Results

Frequency/Power	Bandwidth
218.26MHz / 2 watts	5.77kHz
218.26MHz / 4 watts	8.00kHz

4.5 Spurious Emissions at Antenna Terminals (FCC Part §2.1051 & §95.857(b))

The EUT must comply with requirements for spurious emissions at antenna terminals. Spurious and out-of-band emissions at the antenna terminal must be attenuated as follows:

1. 0 dB within the authorized frequency segment
2. 28 dB on any frequency removed from the midpoint of the assigned frequency segment by more than 250 kHz up to and including 750 kHz.
3. 35 dB on any frequency removed from the midpoint of the assigned frequency segment by more than 750 kHz up to and including 1250 kHz
4. 43 + 10LogP(W) dB on any frequency removed from the midpoint of the assigned frequency segment by more than 1250 kHz.

The spectrum analyzer used a 100 Hz measurement bandwidth for measuring emissions up to and including 250 kHz from the edge of the authorized segment and 10 kHz for measuring emissions more than 250 kHz from the edge of the authorized frequency segment. The video bandwidth was set to at least the resolution bandwidth setting.

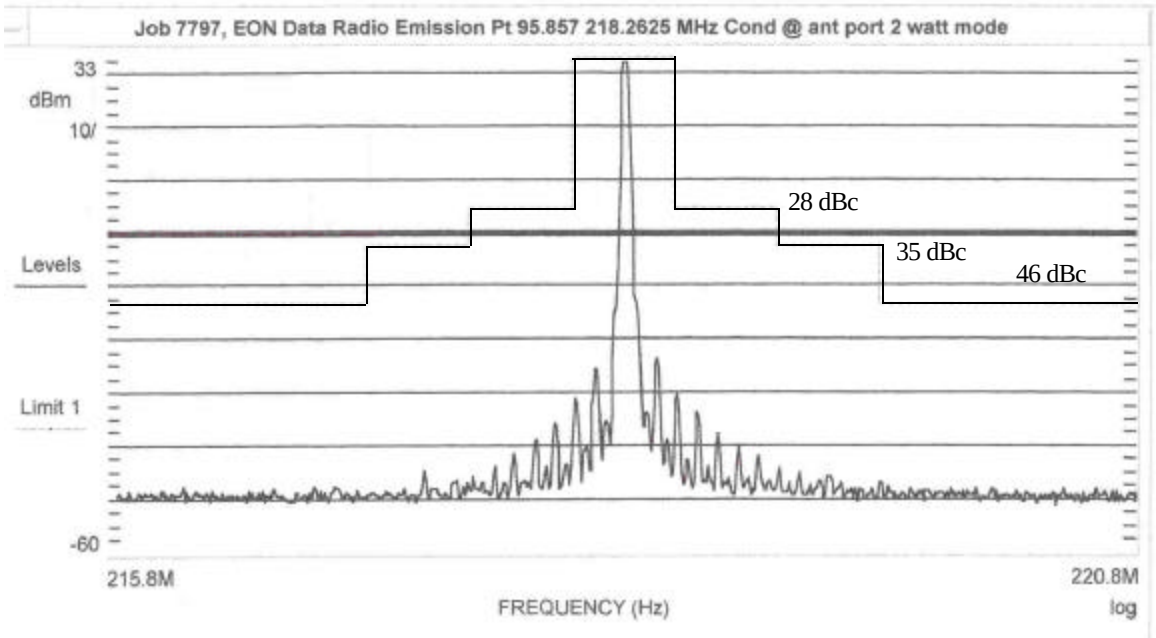


Figure 3, Emission Mask, 2 Watt Mode, 10kHz RBW

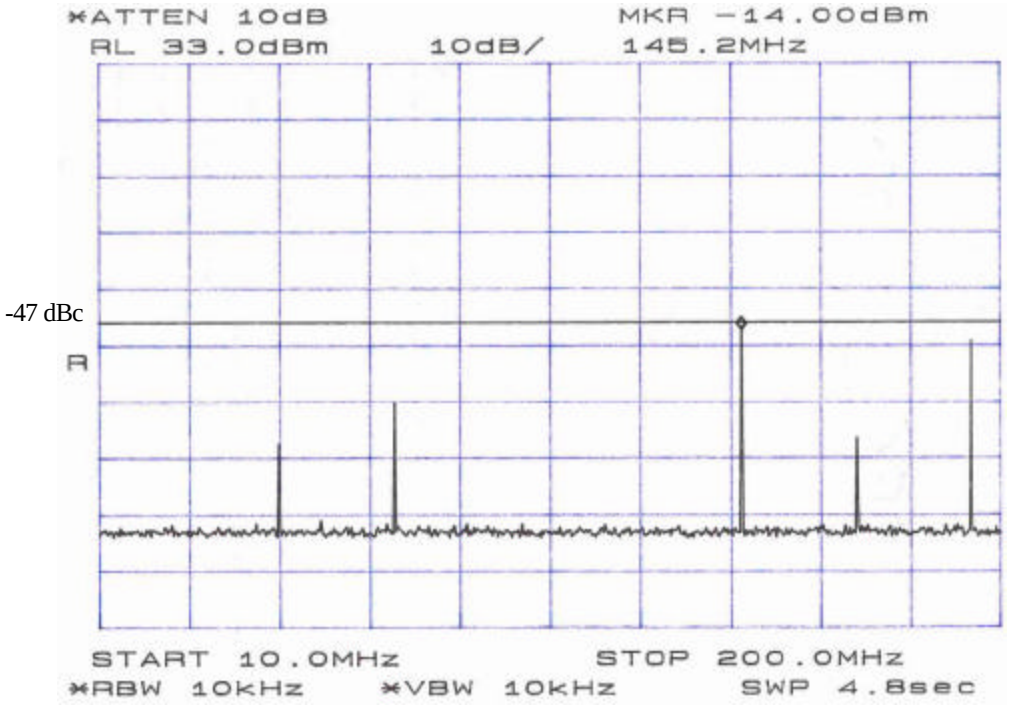


Figure 4. Conducted Spurious Emissions, 2 Watt Mode: 10 - 200MHz

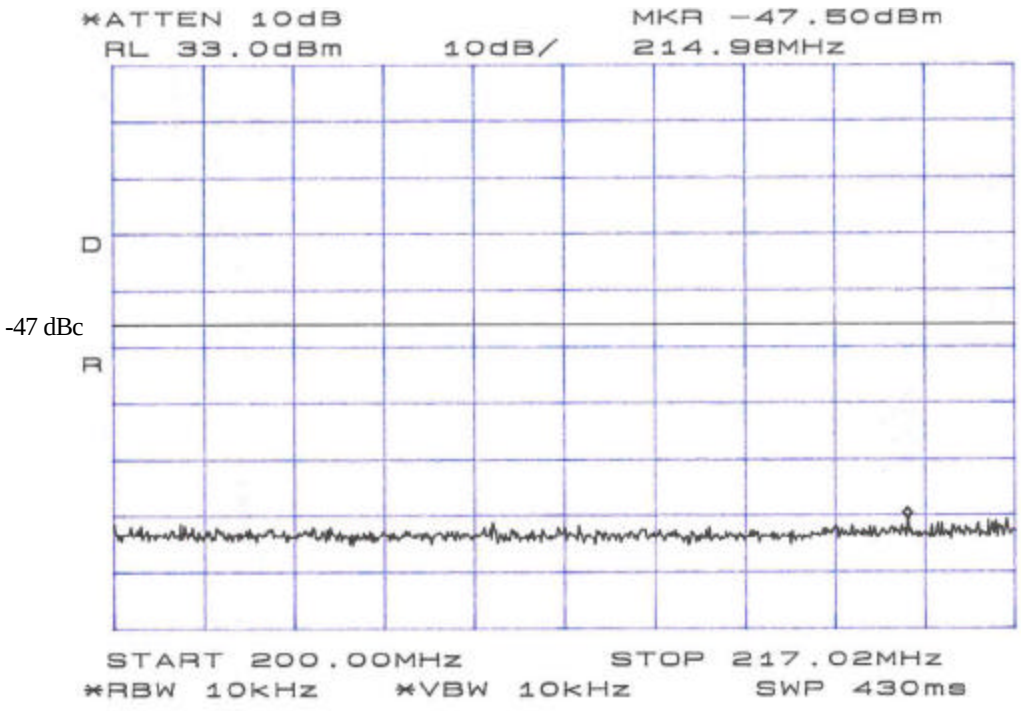


Figure 5. Conducted Spurious Emissions, 2 Watt Mode: 200 - 217MHz

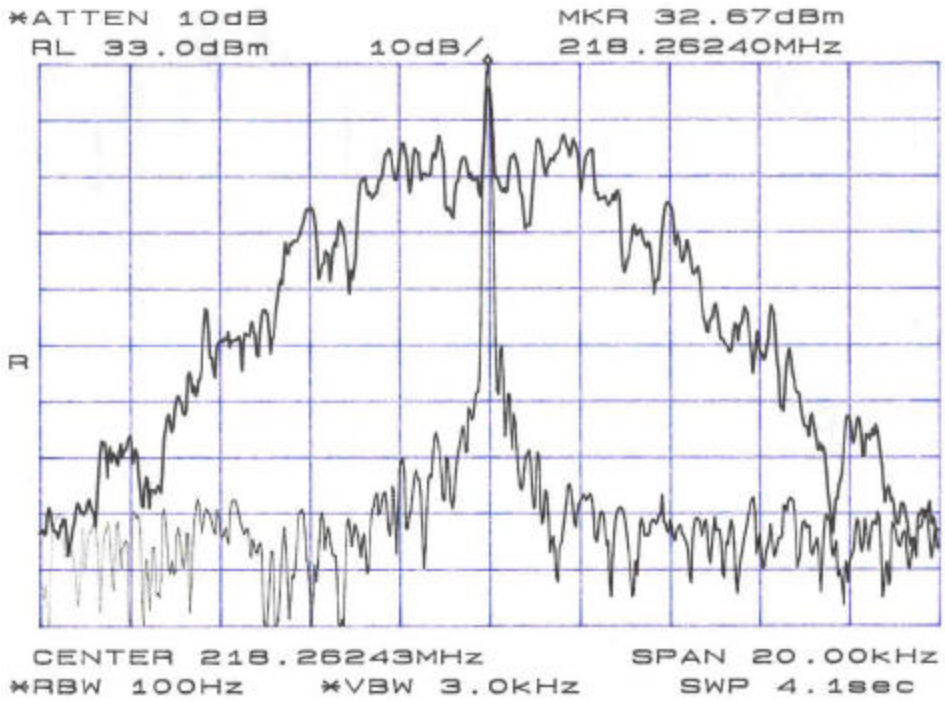


Figure 6. Conducted Spurious Emissions, 2 Watt Mode Emission

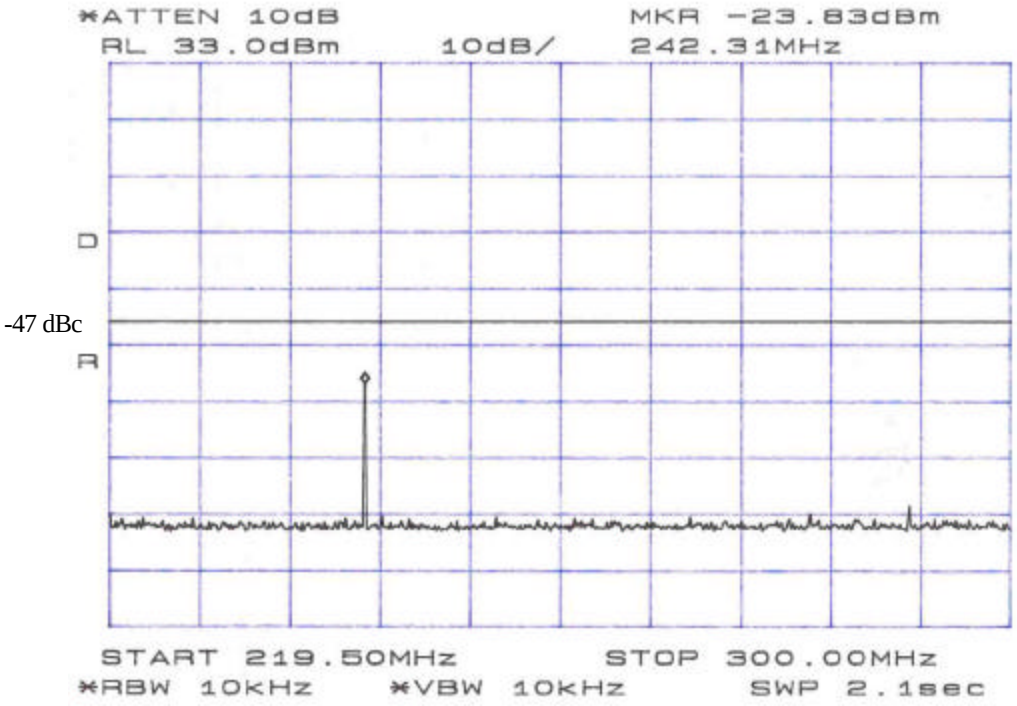


Figure 7. Conducted Spurious Emissions, 2 Watt Mode: 219.5 - 300MHz

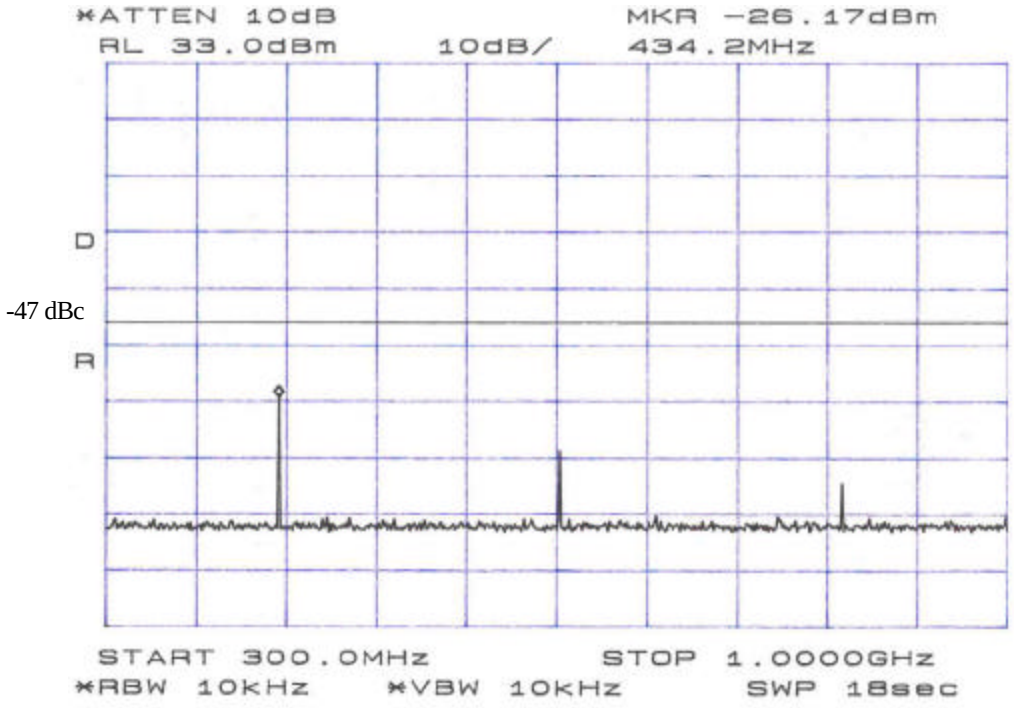


Figure 8. Conducted Spurious Emissions, 2 Watt Mode: 300MHz - 1GHz

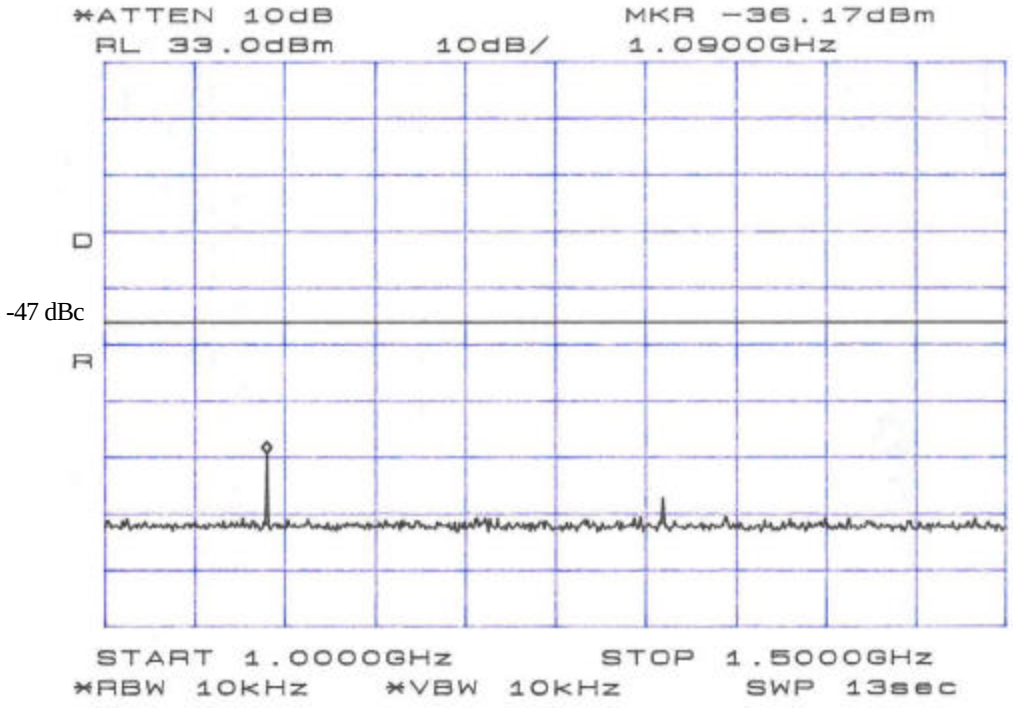


Figure 9. Conducted Spurious Emissions, 2 Watt Mode: 1 - 1.5GHz

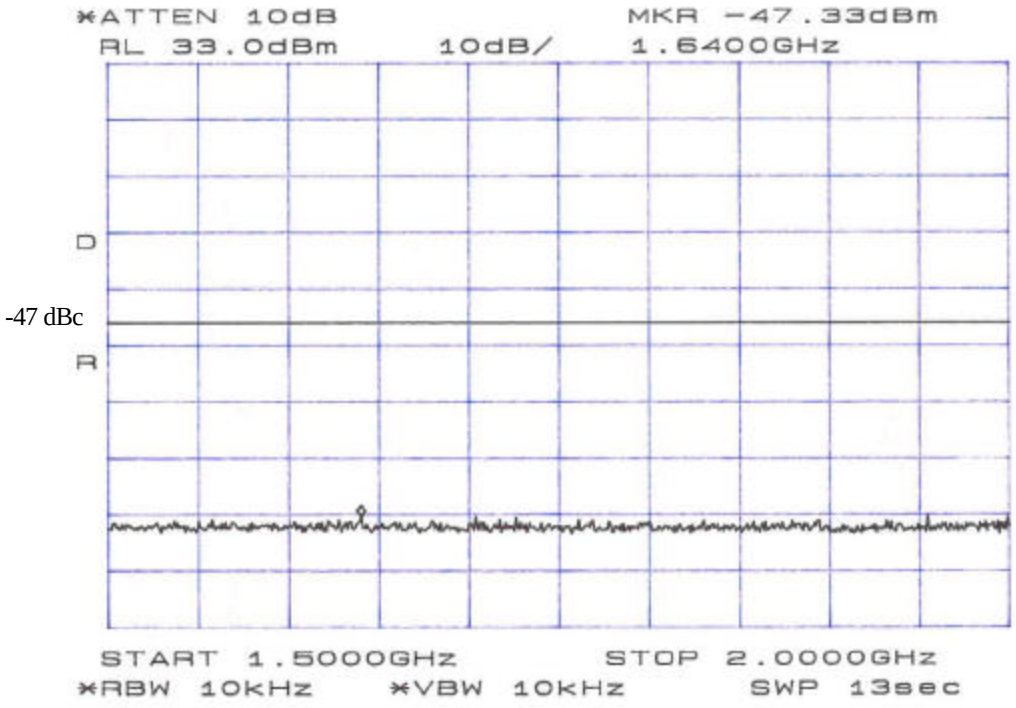


Figure 10. Conducted Spurious Emissions, 2 Watt Mode: 1.5 - 2GHz

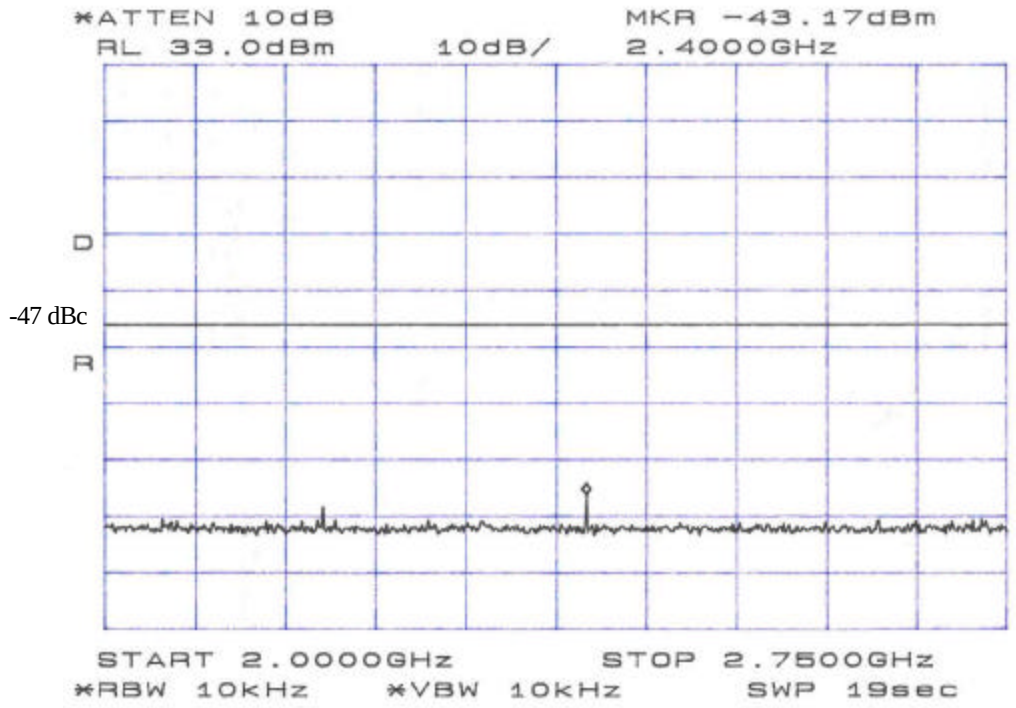
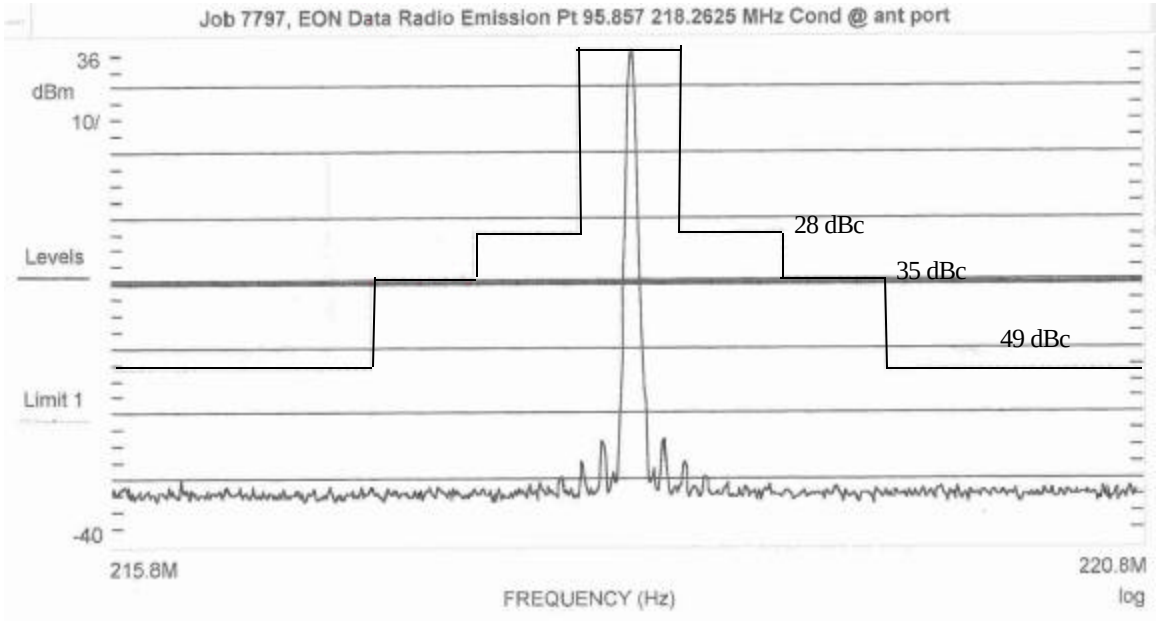


Figure 11. Conducted Spurious Emissions, 2 Watt Mode: 2 - 2.75GHz



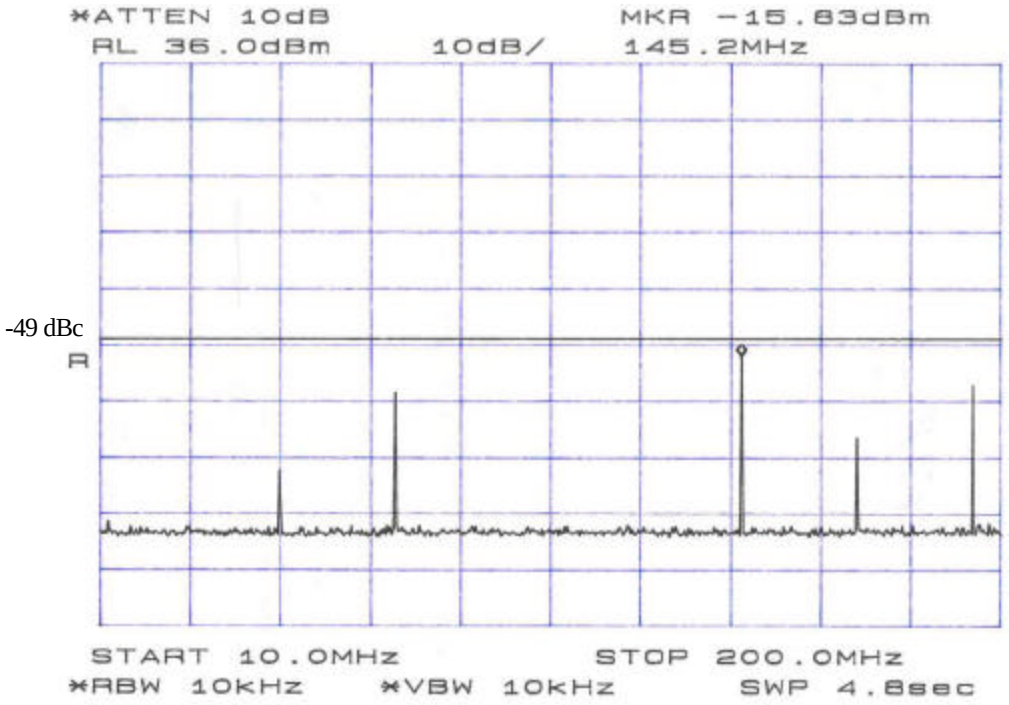


Figure 12. Conducted Spurious Emissions, 4 Watt Mode: 10 - 200MHz

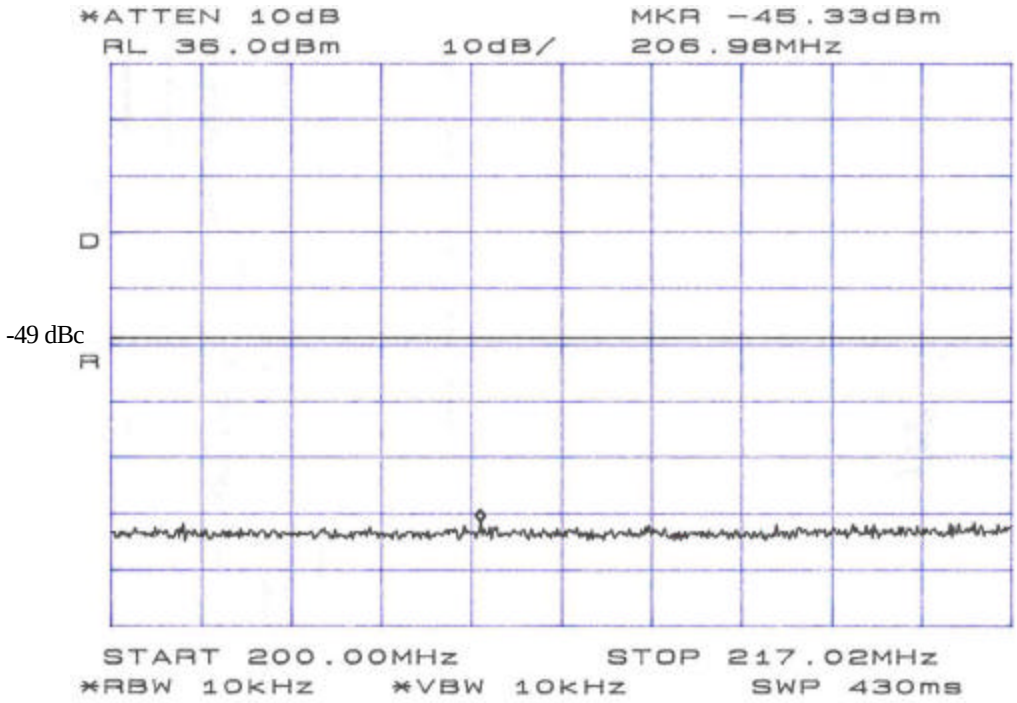


Figure 13. Conducted Spurious Emissions, 4 Watt Mode: 200 - 217MHz

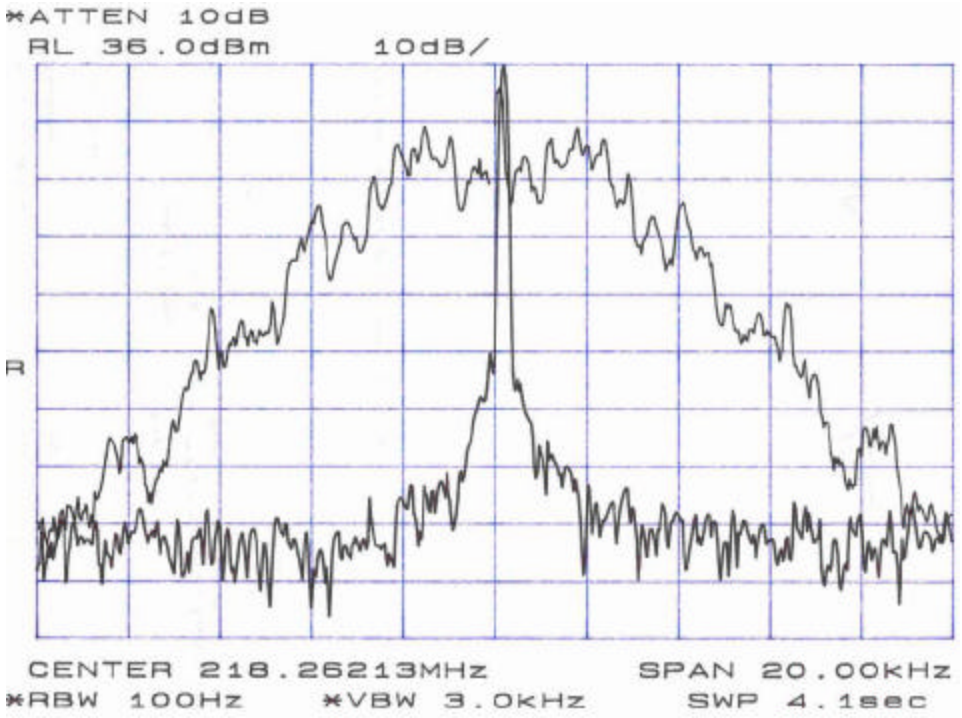


Figure 14. Conducted Spurious Emissions, 4 Watt Mode Emission

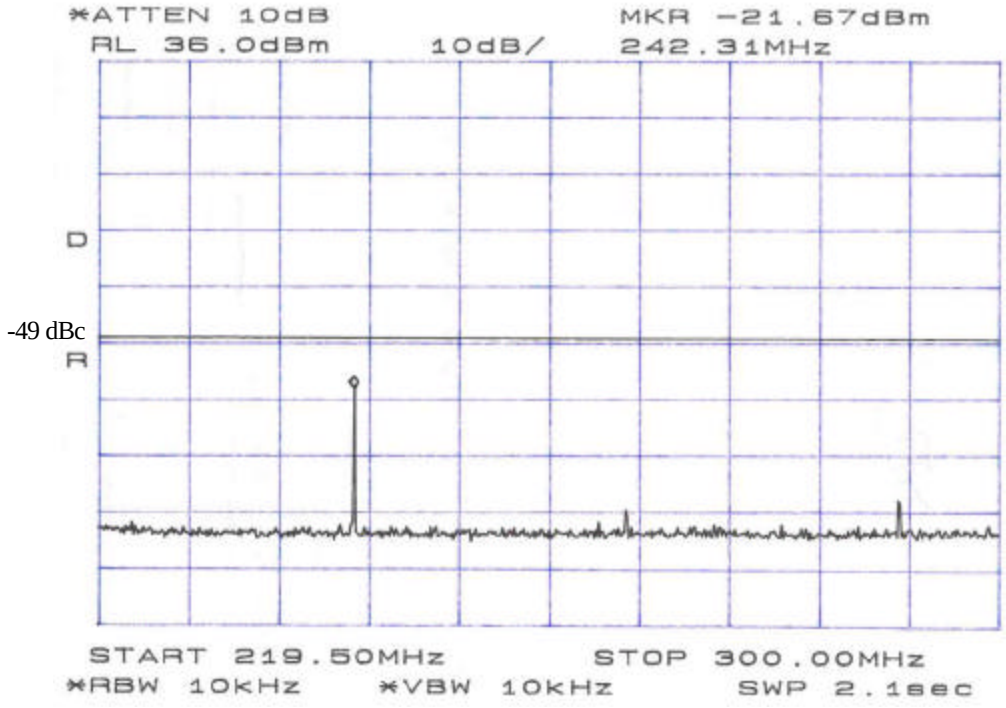


Figure 15. Conducted Spurious Emissions, 4 Watt Mode: 219.5 - 300MHz

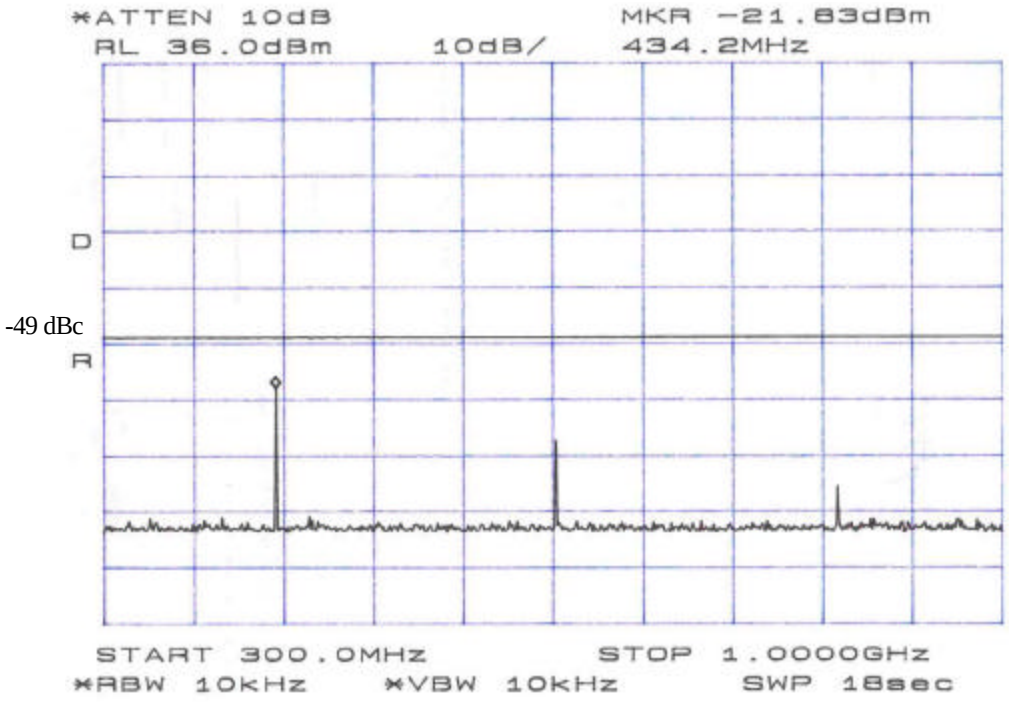


Figure 16. Conducted Spurious Emissions, 4 Watt Mode: 300MHz - 1GHz

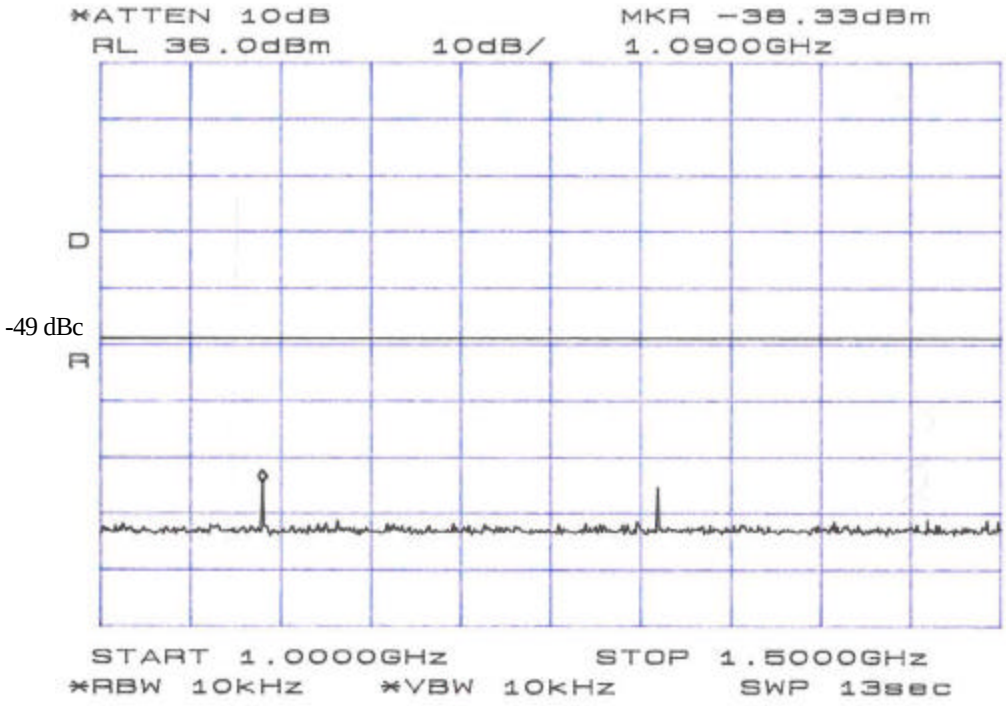


Figure 17. Conducted Spurious Emissions, 4 Watt Mode: 1 - 1.5GHz

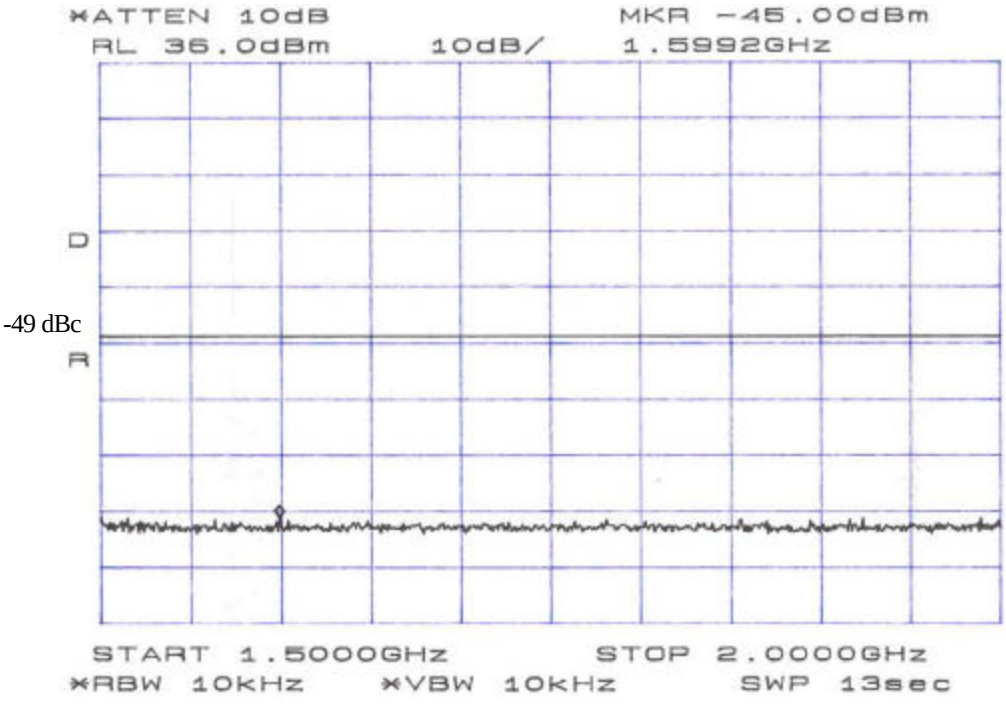


Figure 18. Conducted Spurious Emissions, 4 Watt Mode: 1.5 - 2GHz

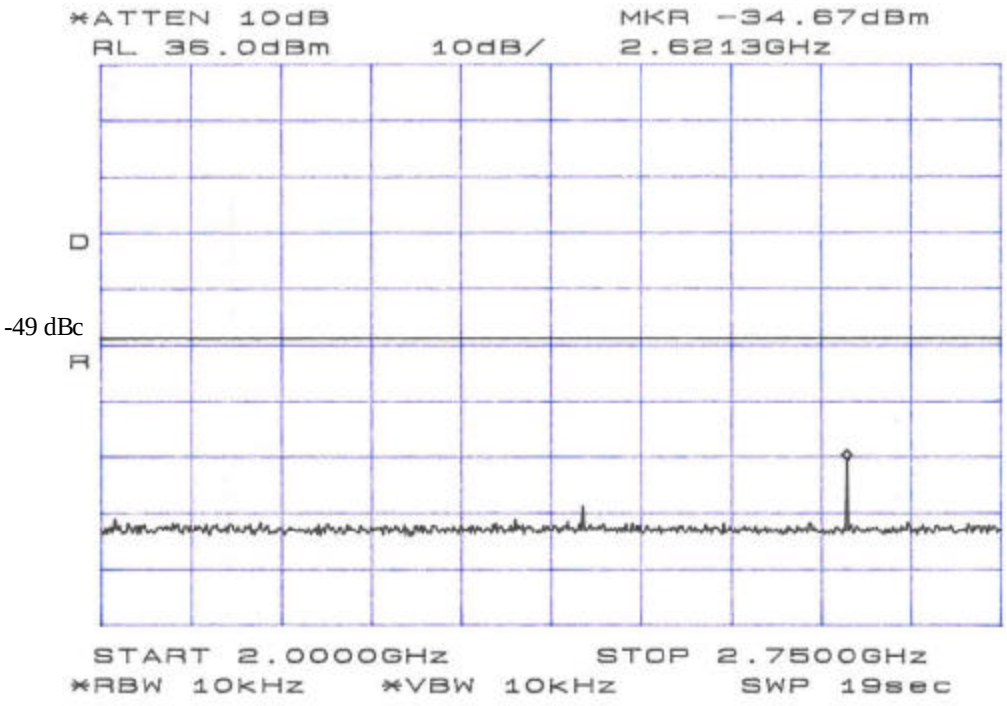


Figure 19. Conducted Spurious Emissions, 4 Watt Mode: 2 - 2.75GHz

4.6 Radiated Spurious Emissions: (FCC Part §2.1053 & §95.857)

The EUT must comply with requirements for radiated spurious emissions. The limit for the radiated spurious emissions 43 + 10LogP(W).

4.6.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The RF output of the EUT was terminated by a suitable 50-ohm dummy load. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The peripherals were placed on the table in accordance with ANSI C63.4-2001. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured up to the 10th harmonic of the fundamental.

The received levels of any detected spurious emissions are recorded in the data sheet. The EUT is then replaced with a transmit antenna and signal generator. Output power of the signal generator was increased until the same received level was indicated on the spectrum analyzer for the emission under investigation. Radiated power of the emission was then determined by adding the power supplied to the substitution antenna with the gain of the substitution antenna and comparing the result to the limit.

For this test the power limit is:

P(dBm) – 43 + 10LogP(W)

36 dBm – (43 + 10Log(4W)) = -13 dBm

Table 5: Radiated Emission Test Data

CLIENT:	EON Corporation	DATE:	10/21/03
TESTER:	James Ritter	JOB #:	7797
EUT Information:		**Test Requirements:**	
EUT:	Data Radio - Transceiver unit	TEST STANDARD:	FCC Part 95
CONFIGURATION:	Tx at 218.2625 MHZ Fixed into dummy load		
CLOCKS:	20.945, 21.945, 24.24377, 218.2625 MHz		
DISTANCE:	3m	CLASS:	A
Test Equipment/Limit:			
ANTENNA:	A_00007	LIMIT:	ERP
CABLE:	CSITE2_3m	AMPLIFIER (dB)	#66 for > 1 GHz

Frequency (MHz)	Polarity H/V	Azimuth Degree	Ant. Hght (m)	SA Level (QP) (dBµV)	Ant. Gain dBd	Sig. Gen. Level dBm	ERP Level dBm	Limit (dBm)	Margin dB
48.48	H	90.0	4.0	12.0	-7.0	-51.5	-58.5	-13.0	-45.5
145.30	H	180.0	3.2	18.0	1.0	-66.0	-65.0	-13.0	-52.0
194.00	H	90.0	3.0	13.6	-1.4	-52.3	-53.7	-13.0	-40.7
239.59	H	270.0	2.5	19.4	-6.7	-49.8	-56.5	-13.0	-43.5
307.20	H	90.0	1.7	17.2	5.1	-60.1	-55.0	-13.0	-42.0
436.53	H	180.0	2.4	28.3	6.1	-51.8	-45.7	-13.0	-32.7
654.78	H	170.0	2.0	29.9	7.1	-49.3	-42.2	-13.0	-29.2
870.56	H	190.0	1.0	19.2	6.0	-59.0	-53.0	-13.0	-40.0
873.05	H	270.0	1.5	24.4	6.0	-53.6	-47.6	-13.0	-34.6
1091.30	H	45.0	1.0	75.3	5.4	-38.9	-33.5	-13.0	-20.5
1309.56	H	270.0	1.0	62.7	5.9	-50.6	-44.7	-13.0	-31.7
1527.81	H	270.0	1.0	53.0	6.3	-59.8	-53.5	-13.0	-40.5
1746.11	H	90.0	1.0	55.0	6.7	-61.0	-54.3	-13.0	-41.3
1964.37	H	270.0	1.0	40.1	7.0	-66.0	-59.0	-13.0	-46.0
2182.63	H	0.0	1.0	44.1	7.5	-67.6	-60.1	-13.0	-47.1
48.48	V	0.0	1.0	11.6	-7.0	-62.0	-69.0	-13.0	-56.0
143.69	V	180.0	1.0	11.8	1.0	-68.0	-67.0	-13.0	-54.0
194.00	V	0.0	1.3	14.1	-1.4	-55.3	-56.7	-13.0	-43.7
239.59	V	90.0	2.2	12.9	-6.7	-55.7	-62.4	-13.0	-49.4
307.20	V	0.0	2.5	16.7	5.1	-66.1	-61.0	-13.0	-48.0
436.53	V	180.0	2.2	21.6	6.1	-51.6	-45.5	-13.0	-32.5
654.78	V	190.0	2.3	25.4	7.1	-50.5	-43.4	-13.0	-30.4
873.04	V	45.0	2.3	24.9	6.0	-49.5	-43.5	-13.0	-30.5
1091.30	V	280.0	1.0	64.3	5.4	-46.0	-40.6	-13.0	-27.6
1309.56	V	90.0	1.0	59.2	5.9	-55.5	-49.6	-13.0	-36.6
1527.81	V	180.0	1.0	52.0	6.3	-61.8	-55.5	-13.0	-42.5
1746.11	V	170.0	1.0	54.7	6.7	-59.0	-52.3	-13.0	-39.3
1964.37	V	270.0	1.0	51.0	7.0	-62.5	-55.5	-13.0	-42.5
2182.63	V	180.0	1.0	45.3	7.5	-64.5	-57.0	-13.0	-44.0

4.7 AC Line Conducted Emissions (FCC Part 15.107)

4.7.1 Requirements

Compliance Limits		
Frequency	Quasi-peak	Average
0.15-0.5MHz	79dBµV	66dBµV
0.5-30MHz	73dBµV	60dBµV

4.7.2 Test Procedure

The EUT was placed on an 80 cm high 1 X 1.5 m non-conductive table above a ground plane. Power to the EUT was provided through a Solar Corporation 50 Ω/50 µH Line Impedance Stabilization Network bonded to a 3 X 2 meter ground plane. The LISN has its AC input supplied from a filtered AC power source. Power was supplied to the peripherals through a second LISN. The peripherals were placed on the table in accordance with ANSI C63.4-2001. Power and data cables were moved about to obtain maximum emissions.

The 50 Ω output of the LISN was connected to the input of the spectrum analyzer and the emissions in the frequency range of 150 kHz to 30 MHz were measured. The detector function was set to quasi-peak, peak, or average as appropriate, and the resolution bandwidth during testing was at least 9 kHz, with all post-detector filtering no less than 10 times the resolution bandwidth.

At frequencies where quasi-peak or peak measurements comply with the average limit, no average measurements need be performed.

4.7.3 Test Data

Table 8 provides the test results for phase and neutral line power line conducted emissions.

Table 6. AC Line Conducted Emissions Test Data

CLIENT:	EON Corporation	DATE:	10/20/03
TESTER:	James Ritter	JOB #:	7798
MODEL:	Transceiver w control logic Unit	TEST STANDARD:	FCC Part 15
CLASS:	FCC_A	TEST SITE:	CSITE2_CE
TEST VOLTAGE:	120 VAC		

LINE 1 - NEUTRAL

Frequency MHz	Level QP dBuV	Cable Loss dB	Limit QP dBuV	Margin QP dB	Level AVG dBuV	Cable Loss dB	Limit AVG dBuV	Margin AVG dB
0.19	46.2	10.7	79.0	-22.1	46.2	10.7	66.0	-9.1
0.39	40.2	10.7	79.0	-28.1	40.2	10.7	66.0	-15.1
1.88	31.1	11.2	73.0	-30.7	31.1	11.2	60.0	-17.7
6.40	28.2	11.6	73.0	-33.2	28.2	11.6	60.0	-20.2
18.56	34.1	12.6	73.0	-26.3	34.1	12.6	60.0	-13.3
21.11	40.4	12.6	73.0	-20.0	40.4	12.6	60.0	-7.0
22.22	39.9	12.7	73.0	-20.4	39.9	12.7	60.0	-7.4
24.02	31.3	12.8	73.0	-28.9	31.3	12.8	60.0	-15.9

LINE 2 - PHASE

Frequency MHz	Level QP dBuV	Cable Loss dB	Limit QP dBuV	Margin QP dB	Level AVG dBuV	Cable Loss dB	Limit AVG dBuV	Margin AVG dB
0.19	46.2	10.7	79.0	-22.1	45.9	10.7	66.0	-9.4
0.39	41.8	10.7	79.0	-26.5	41.8	10.7	66.0	-13.5
1.88	30.3	11.2	73.0	-31.5	30.3	11.2	60.0	-18.5
6.40	30.1	11.6	73.0	-31.3	30.1	11.6	60.0	-18.3
18.56	35.5	12.6	73.0	-24.9	35.5	12.6	60.0	-11.9
21.11	40.6	12.6	73.0	-19.8	40.6	12.6	60.0	-6.8
22.22	40.0	12.7	73.0	-20.3	40.0	12.7	60.0	-7.3
24.02	34.5	12.8	73.0	-25.7	34.5	12.8	60.0	-12.7

4.8 Frequency Stability: (FCC Part §2.1055)

Frequency as a function of temperature and voltage variation shall be maintained within the FCC-prescribed tolerances.

The temperature stability was measured with the unit in an environmental chamber used to vary the temperature of the sample. The sample was held at each temperature step to allow the temperature of the sample to stabilize.

The EUT is powered by 120Vac voltage supplied via the vending apparatus.

The frequency stability of the transceiver was examined at the voltage extremes and for the temperature range of -30°C to +50°C. The carrier frequency was measured while the EUT was in the temperature chamber. The reference frequency of the EUT was measured at the ambient room temperature with the frequency counter. The fundamental frequency is: 218.26MHz. The limit used for the frequency stability of 1 PPM is from FCC Part 90.213.

Table 7. Frequency Deviation as a Function of Temperature

Temperature Degrees C	Frequency MHz	Difference Hz	Deviation Limit 1 PPM (PPM)
Ambient (Reference)	218.262539	0.0	0
-30	218.26266	121.0	0.55
-20	218.262433	-106.0	-0.49
-10	218.26249	-49.0	-0.22
0	218.26248	-59.0	-0.27
10	218.2627	161.0	0.74
20	218.26247	-69.0	-0.32
30	218.26249	-49.0	-0.22
40	218.26238	-159.0	-0.73
50	218.26261	71.0	0.33

Table 8. Frequency Deviation as a Function of Voltage

Voltage Volts	Frequency MHz	Difference Hz	Deviation Limit 1 PPM (PPM)	Voltage Volts
At rated	218.262539	0	0.0	115VAC
At 85%	218.262484	55	0.3	97.75VAC
At 115%	218.262482	57	0.3	132.25VAC