LS Research, LLC
W66 N220 Commerce Court
Cedarburg, WI 53012
262-375-4400 Fax: 262-364.2649

COMPLIANCE TESTING OF:
Medical Telemetry Transmitter
Model # X12 + 915

PREPARED FOR:

Mortara Instrument, Inc.
Attn.: Mr. Brian Sueppel
7865 N. 86th Street
Milwaukee, WI 53224

TEST REPORT NUMBER:
307353

TEST DATE(S):

October 18, 19, November 20, 2007

Table of Contents

1. LS Research, LLC In Review

LS Research, LLC - Accreditations and Listing's

As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025 : 2005
with Electrical (EMC) Scope of Accreditation
A2LA Certificate Number: 1255.01

Federal Communications Commission (FCC) – USA

Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948
FCC Registration Number: 90756

Industry Canada

On file, 3 Meter Semi-Anechoic Chamber based on RSS-212 – Issue 1
File Number: IC 3088-A

On file, 3 and 10 Meter OATS based on RSS-212 – Issue 1
File Number: IC 3088

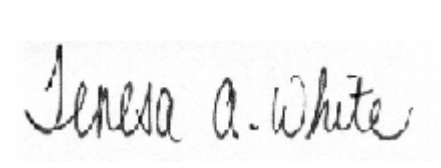
U. S. Conformity Assessment Body (CAB) Validation

Validated by the European Commission as a U. S. Competent Body operating under the U. S. /EU, Mutual Recognition Agreement (MRA) operating under the European Union Electromagnetic Compatibility –Council Directive 2004/108/EC (formerly 89/336/EEC, Article 10.2)
Date of Validation: January 16, 2001

Validated by the European Commission as a U.S. Notified Body operating under the U.S./EU, Mutual Recognition Agreement (MRA) operating under the European Union Telecommunication Equipment – Council Directive 99/5/EC, Annex V.

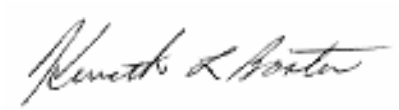
Date of Validation: November 20, 2002
Notified Body Identification Number: 1243

2. Signature Page



Reviewed By: November 30, 2007

Teresa A. White, Quality Manager Date



Tested & Approved By: November 30, 2007

Kenneth L. Boston, Senior EMC, Onsite Manager Date
PE #31926 Licensed Professional Engineer
Registered in the State of Wisconsin, United States

3. Product and General Information

Manufacturer:	Mortara Instrument, Inc.					
Date(s) of Test:	Oct. 18, 19 and Nov. 20, 2007					
Test Engineer(s):		Tom Smith		Ryan Urness	X	Ken Boston
Model #:	X12 +915					
Serial #:	n/a					
Voltage:	1.5 VDC, one AA battery					
Operation Mode:	Continuous transmit					

4. Introduction

On October 18th, 19th and November 20th, 2007 a series of Radiated Emission tests were performed on one sample of the X12+915, here forth referred to as the "*Equipment Under Test*" or "*EUT*". These tests were performed using the procedures outlined in ANSI C63.4-2003 for intentional radiators, and in accordance with the limits set forth in FCC Part 15.249 (Industry Canada RSS-210) for a low power transmitter. These tests were performed by Kenneth L. Boston, Sr. EMC Engineer, of LS Research, LLC and witnessed by Brian Sueppel of Mortara Instrument..

All Radiated and Conducted Emission tests were performed upon the EUT to measure the emissions in the frequency bands described in FCC Title 47 CFR Part 15, including 15.35, 15.209, 15.249 and Industry Canada RSS-210 to determine whether these emissions are below the limits expressed within the standards. These tests were performed in accordance with the procedures described in the 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 (ANSI C63.4-2003). Another document used as a reference for the EMI Receiver specification was the Comite International Special Des Perturbations Radioelelectriques (CISPR) Number 16-1, 2003.

5. Product Description

The X12+915 is a patient worn telemetry transmitter used in hospitals and clinics for the transmission of ECG data. The transmitter is made up of an ECG amplifier, microprocessor, and RF transmitter. The ECG amplifier is a 12 lead device with diagnostic quality response and digital conversion. The microprocessor formats the ECG data for transmission, handles user I/O, and sets the RF transmission channel. The RF transmitter operates in the 915 ISM band and is designed to meet FCC rules Part 15.249. The modulation of the carrier is done with Gaussian Frequency Shift Keying (GFSK) at 40 Kbaud. The antenna is integrated internally to the X12+ and is not removable or replaceable. The X12+ is made up of two circuit boards sandwiched together inside the unit. A single 24 pin header provides interconnectivity. The two boards are the X12+ Front End Card and the X12+ Transmit Card. A shielded module houses the RF circuitry and it is soldered to the transmit card. The X12+ has a detachable light weight 12 lead patient cable and operates from single AA Alkaline batteries for over 24 Hours. The battery is installed through a removable back panel. The front side has a three button keypad and a 33x18 mm graphic LCD. The overall dimensions are 110x63x25 mm

6. Test Requirements

The above mentioned tests were performed in order to determine the compliance of the X12+915 with limits contained in various provisions of Title 47 CFR, FCC Part 15, including:

15.31	15.205
15.33	15.207
15.35	15.209
15.37	15.249

7. Summary of Test Report

DECLARATION OF CONFORMITY

The X12+915 was found to **MEET** the requirements as described within the specification of Title 47 CFR FCC, Part 15.249, Subpart (a); and Industry Canada RSS-210, Section 6.2 for a *'Non-Momentarily Operated Transmitting Device'*.

Some emissions are seen to be within 3dB of their respective limits. As these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

The enclosed test results pertain to the sample(s) of the test item listed, and only for the tests performed on the data sheets. Any subsequent modification or changes to the test items could invalidate the data contained herein, and could therefore invalidate the findings of this report.

8. Radiated Emissions Test

Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15 and ANSI C63.4-2003. The EUT was placed on an 80cm high non-conductive pedestal centered on a flush mounted 2-meter diameter turntable inside the 3 Meter Semi-Anechoic, FCC listed Chamber located at LS Research, LLC, Cedarburg, Wisconsin. The EUT final testing was performed using a continuous random data modulation mode, using power that is provided by a 1.5 Volt AA battery. The unit has the capability to operate on 256 channels, controllable via a menu selection. The applicable limits apply at a 3 meter distance. Measurements above 5 GHz were performed at a 1.0 meter separation distance. The calculations to determine these limits are detailed in the following pages. Please refer to Appendix A for a list of the test equipment. The test sample was operated on one of three (3) standard channels: low (00), medium (80) and high (FF) to comply with FCC Part 15.35. The channels and operating modes were changed using the built in menu test features.

Test Procedure

Radiated RF measurements were performed on the EUT in the 3 Meter Semi-Anechoic, FCC listed Chamber, located at LS Research, LLC, in Cedarburg, Wisconsin. The frequency range from 30 MHz to 9300 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on the non-conductive pedestal in the 3 Meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, and a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz. A Double Ridged Waveguide Horn Antenna was used from 1 GHz to 9 GHz. The maximum radiated RF emissions were found by raising and lowering the antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities.

Test Equipment Utilized

A list of the test equipment and antennas utilized for the Radiated Emissions test can be found in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. All calibrations of the antennas used were performed at an N.I.S.T. traceable site. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and a HP 8546A EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into the HP 8546A EMI Receiver database. As a result, the data taken from the HP 8546A EMI Receiver accounts for the antenna correction factor as well as cable loss or other corrections, and can therefore be entered into the database as a corrected meter reading. The HP 8546A EMI Receiver was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 300 kHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 1 MHz). From 5 GHz to 9.3 GHz, an HP E4407 Spectrum Analyzer and an EMCO Horn Antenna were used.

Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.249 for a transmitter (Canada RSS-210). The frequencies with significant signals were recorded and plotted as shown in the Data Charts and Graphs.

CALCULATION OF RADIATED EMISSIONS LIMITS:

Field Strength of Fundamental Frequencies:

The fundamental emissions for an intentional radiator in the 902-928 MHz band, operating under FCC part 15.249 limits, must have electric field strength of no greater than 50 mV/m, for the fundamental frequency, when measured at 3 meters, and harmonic field strength of no greater than 500 μV/m, when measured at 3 meters. Spurious emissions outside the 902-928 MHz band shall be attenuated by at least 50 dB below the level of the fundamental, or meet the limits expressed in FCC part 15.209 under general emission limits.

Field Strength of Fundamental Frequencies is Limited to 50,000 μV/m, or 94 dBμV/m.

Field Strength of Harmonic and Spurious Frequencies is Limited by FCC 15.249(c)

The harmonic limit of –50 dBc with respect to the fundamental limit would be:

94 dBμV/m – 50 dB = 44 dBμV/m,

with the exception of where FCC 15.209 allows for a higher limit to be used.

Frequency (MHz)	3 m Limit (μV/m)	3 m Limit (dBμV/m)
902-928	50,000	94.0
30-88 ; 88-216	159	44.0
216-902 ; 928-960	500	46.0*
960-40,000	500	54.0*

The following table depicts the general radiated emission limits obtained from Title 47 CFR, part 15.209a, for radiated emissions measurements, including restricted band limits as expressed in 47 CFR, part 15.205.

Frequency (MHz)	3 m Limit (μV/m)	3 m Limit (dBμV/m)
30-88	100	40.0
88-216	150	43.5
216-960	200	46.0
960-40,000	500	54.0

Sample conversion from field strength μV/m to dBμV/m:

$dB\mu V/m = 20 \log_{10}$ (3m limit)

from 30 - 88 MHz for example: $dB\mu V/m = 20 \log_{10} (100)$

$40.0\ dB\mu V/m = 20 \log_{10} (100)$

For measurements made at 1 meter, a 9.5 dB correction may be been invoked.

960 MHz to 40,000 MHz

500 μV/m or 54.0 dBμV/m at 3 meters

54.0 + 9.5 = 63.5 dBμV/m at 1 meter

Note: Limits are conservatively rounded to the nearest tenth of a whole number.

Summary of Results and Conclusions

Based on the procedures outlined in this report, and the test results, it can be determined that the EUT does MEET the emission requirements of Title 47 CFR, FCC Part 15.249, for a frequency modulated transmitter.

The enclosed test results pertain to the samples of the test item listed, and only for the tests performed per the data sheets. Any subsequent modification or changes to the test items could invalidate the data contained herein, and could therefore invalidate the findings of this report.

Radiated Emissions Data Chart

3 Meter Measurements of Electromagnetic Radiated Emissions

Test Standard: Title 47 CFR 15.249

Frequency Range Inspected: 30 MHz to 9300 MHz

Manufacturer:	Mortara Instrument, Inc.							
Date(s) of Test:	October 18, 19 and November 20, 2007							
Test Engineer(s):		Tom Smith		Ryan Urness	X	Ken Boston		
Model #:	X12+915							
Serial #:	n/a							
Voltage:	1.5 VDC battery							
Operation Mode:	Continuous Transmit							
EUT Power:		Single Phase ___VAC		3 Phase ___VAC				
		Battery	X	Other: 1.5 VDC				
EUT Placement:	X	80cm non-conductive table		10cm Spacers				
EUT Test Location:	X	3 Meter Semi-Anechoic FCC Listed Chamber		3/10m OATS				
Measurements:		Pre-Compliance		Preliminary	X	Final		
Detectors Used:		Peak	X	Quasi-Peak	X	Average		

Environmental Conditions in the Lab:
Temperature: 20 – 25°C
Relative Humidity: 30 – 60 %

Test Equipment Used:
EMI Measurement Instrument: HP8546A and Agilent E4407B
Log Periodic Antenna: EMCO #93146
Horn Antenna: EMCO #3115
Biconical Antenna: EMCO 93110
Pre-Amp: Advanced Microwave WHA6224
Standard Gain Horn: EMCO 3160-09

The following table depicts the level of significant radiated emissions found:

Frequency (MHz)	Antenna Polarity	Channel/ EUT Position	Height (meters)	Azimuth (0° - 360°)	EMI Meter Reading (dBμV/m)	15.249 Limit (dBμV/m)	Margin (dB)
568.3	H	Mid/Vert	1.5	41	39.7	46.0	6.3
578.6	H	Mid/Vert	1.43	30	41.2	46.0	4.8
588.8	H	Mid/Vert	1.43	193	38.3	46.0	7.7
599.0	V	Mid/Vert	1.0	235	38.2	46.0	7.8
634.9	H	Hi/Vert	1.25	13	38.7	46.0	7.3
904.76	V	Lo/Vert	1.15	150	88.8	94.0	5.2
915.00	V	Mid/Vert	1.1	150	89.6	94.0	4.4
925.16	V	Hi/Vert	1.1	135	89.3	94.0	4.7

Notes: A Quasi-Peak Detector was used in measurements below 1 GHz, and an Average Detector was used in measurements above 1 GHz

The following table depicts the level of harmonic emissions found, channel 00:

Frequency (MHz)	Antenna Polarity	EUT Position	Height (meters)	Azimuth (0° - 360°)	EMI Meter Reading (dBμV/m)	15.249 Limit (dBμV/m)	Margin (dB)
1809.5	H	V	1.10	213	38.9	54.0	15.1
2714.0	H	V	1.13	126	41.4	54.0	12.6
3619.0	V	Flat	1.00	65	47.3	54.0	6.7
4524.0	V	V	1.03	115	50.8	54.0	3.2
5428.0	H	Side	1.03	100	50.4	63.5	13.1
6333.0	-	-	-	-	-	63.5	-
7238.1	V	Flat	1.10	305	57.6	63.5	5.9
8143.0	V	Flat	1.03	44	57.0	63.5	6.5
9047.0	-	-	-	-	-	63.5	-

The following table depicts the level of harmonic emissions found, channel 80:

Frequency (MHz)	Antenna Polarity	EUT Position	Height (meters)	Azimuth (0° - 360°)	EMI Meter Reading (dBμV/m)	15.249 Limit (dBμV/m)	Margin (dB)
1830.0	V	V	1.22	191	37.9	54.0	16.1
2745.0	H	V	1.11	140	43.3	54.0	10.7
3660.0	H	Flat	1.10	230	51.0	54.0	3.0
4575.0	V	V	1.03	87	49.6	54.0	4.4
5490.0	V	Side	1.03	100	49.3	63.5	14.2
6405.0	H	V	1.00	150	52.5	63.5	11.0
7320.0	V	Flat	1.00	52	53.4	63.5	10.1
8235.0	V	V	1.02	189	55.8	63.5	7.7
9150.0	-	-	-	-	-	63.5	-

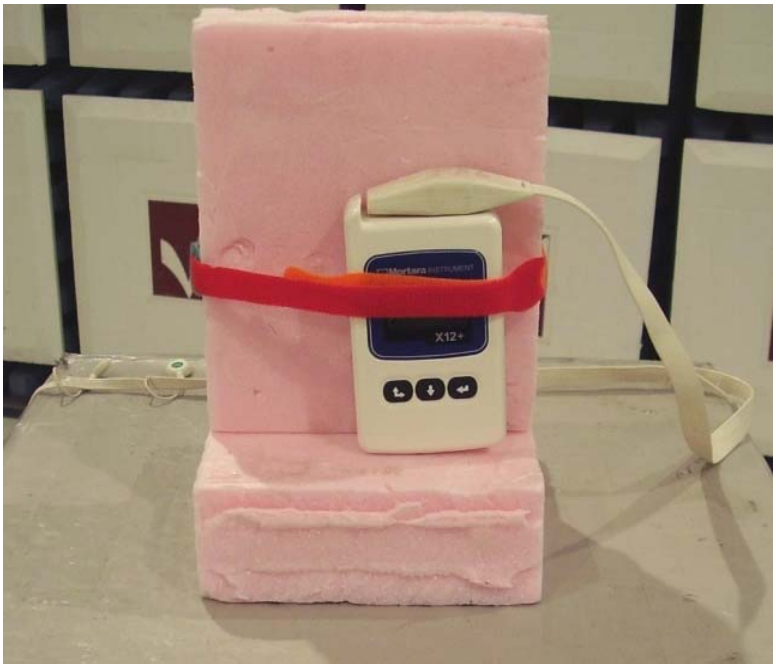
The following table depicts the level of harmonic emissions found, channel FF:

Frequency (MHz)	Antenna Polarity	EUT Position	Height (meters)	Azimuth (0° - 360°)	EMI Meter Reading (dBμV/m)	15.249 Limit (dBμV/m)	Margin (dB)
1850.3	V	V	1.14	40	39.2	54.0	14.8
2775.5	H	Flat	1.00	330	42.9	54.0	11.1
3706.6	H	Flat	1.10	218	49.7	54.0	4.3
4625.8	V	V	1.03	30	49.0	54.0	5.0
5551.0	-	-	-	-	-	63.5	-
6476.0	H	V	1.00	140	53.3	63.5	10.2
7401.0	V	Flat	1.01	45	51.2	63.5	12.3
8326.0	V	Flat	1.00	43	51.1	63.5	12.4
9251.0	V	V	1.06	10	48.3	63.5	15.2

Notes: A Quasi-Peak Detector was used in measurements below 1 GHz, and an Average Detector was used in measurements above 1 GHz

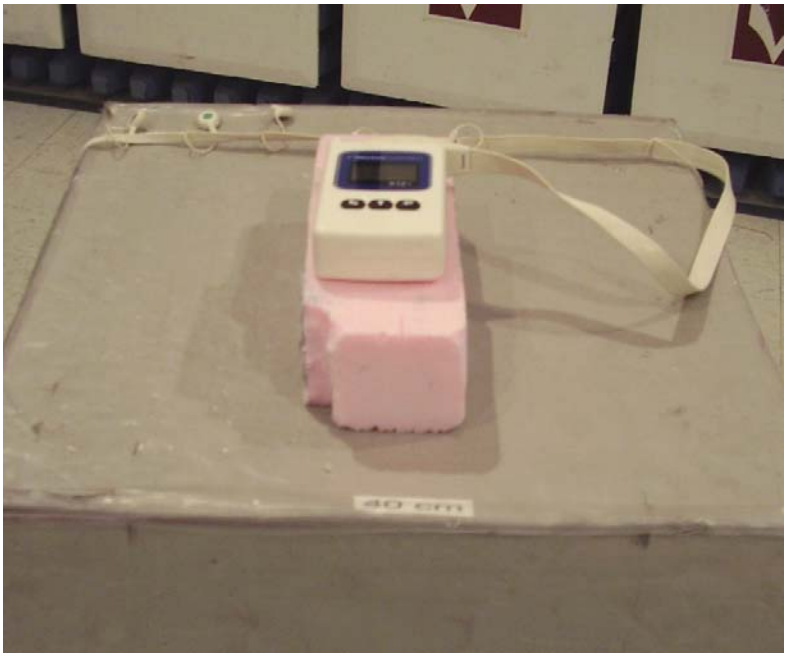
Photos Taken During Radiated Emission Testing

Setup for the Radiated Emissions Test



Photos Taken During Radiated Emission Testing (continued)

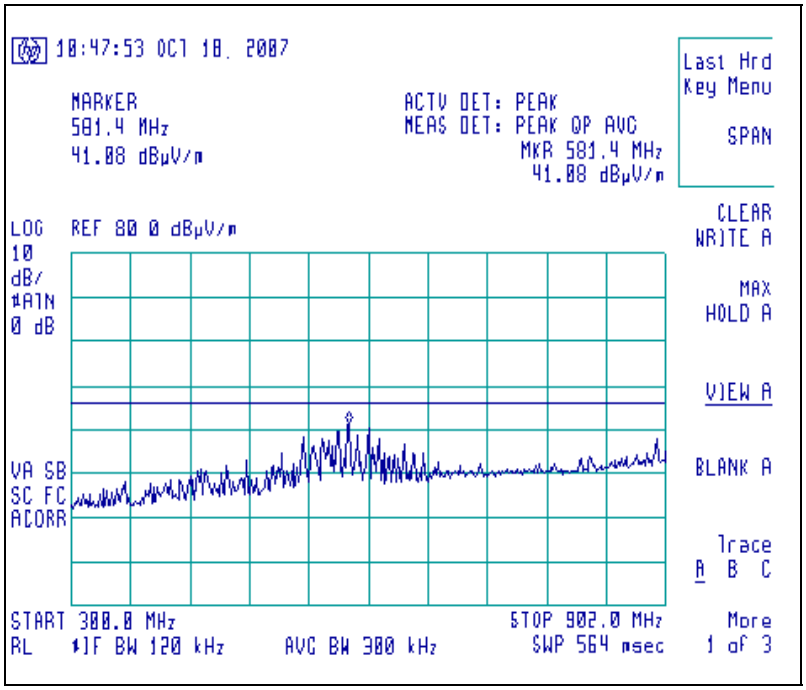
Setup for the Radiated Emissions Test



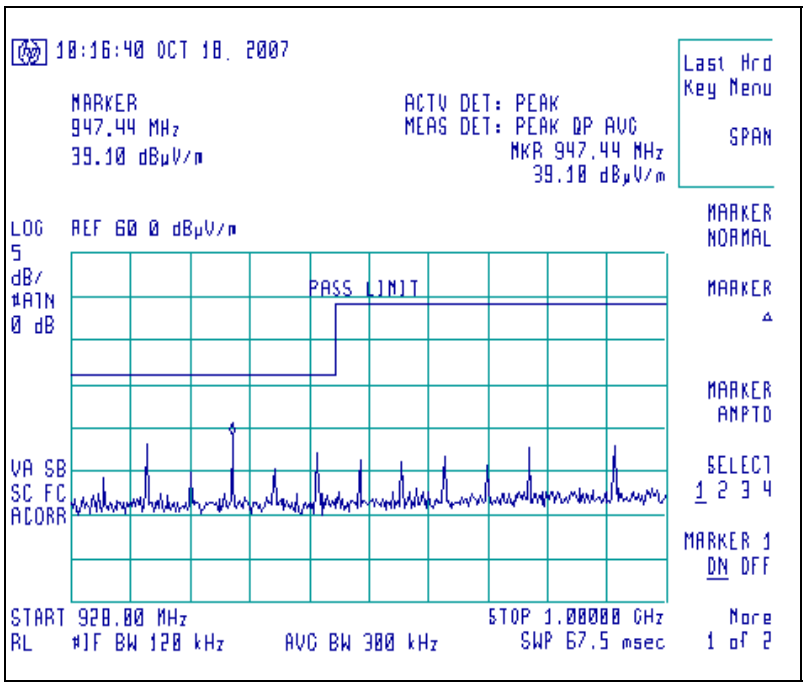
GRAPHS

Screen Captures of Peak Radiated RF Emissions:

Signature Scan of Peak Radiated Emissions, Mid Channel

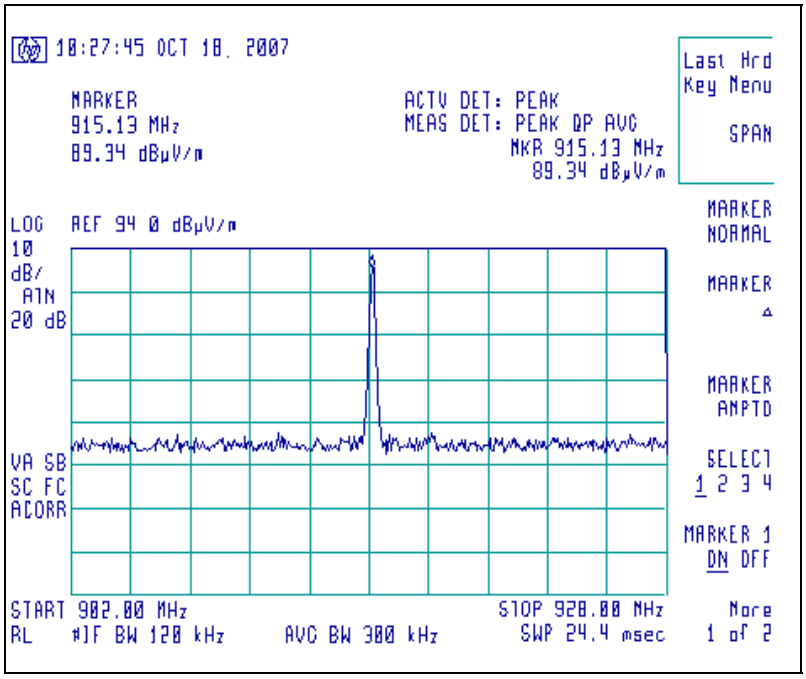


Signature Scan of Peak Radiated Emissions, Mid Channel

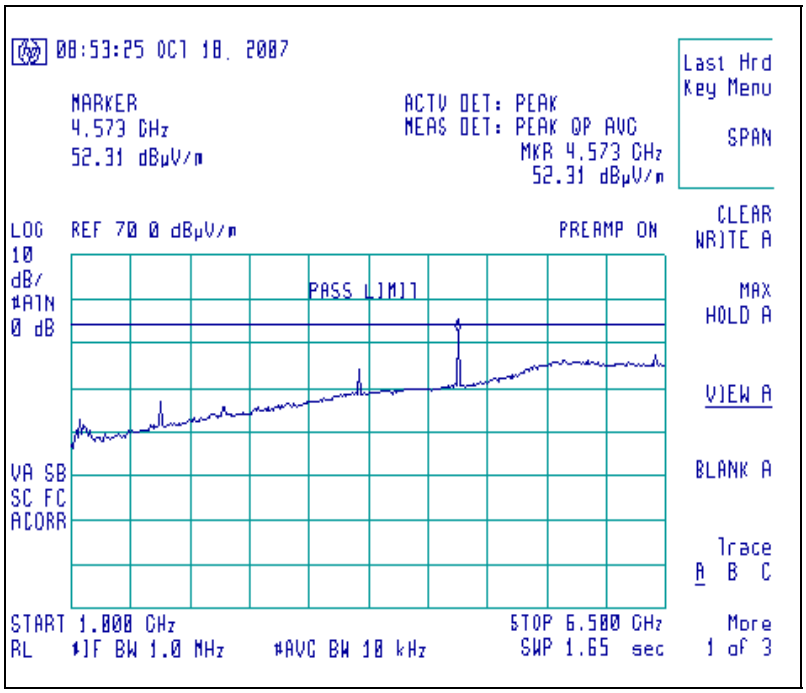


Graphs made during Radiated Emission Testing (continued)

Signature Scan of Peak Radiated Emissions, Mid Channel

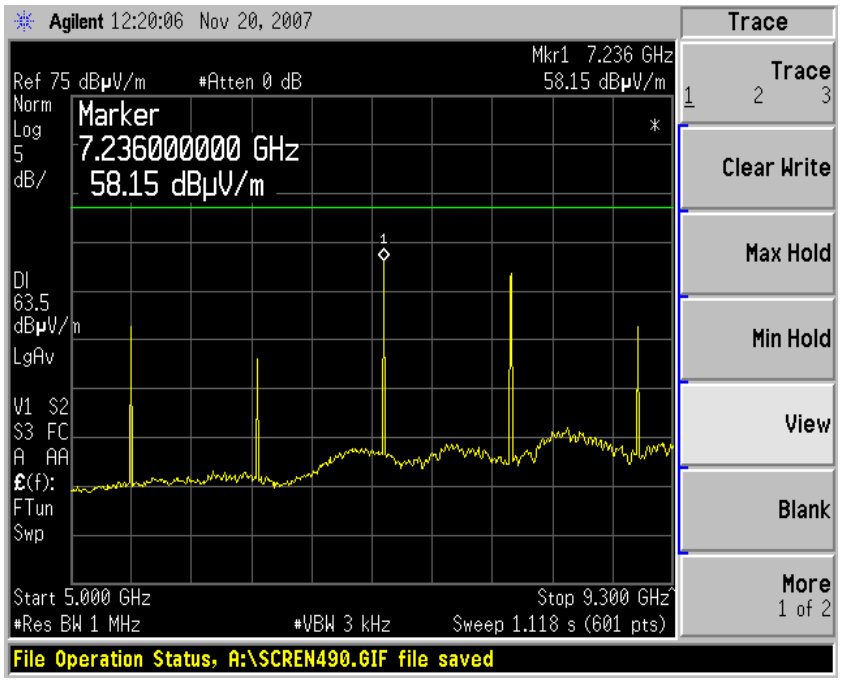


Signature Scan of Peak Radiated Emissions, Mid-Channel

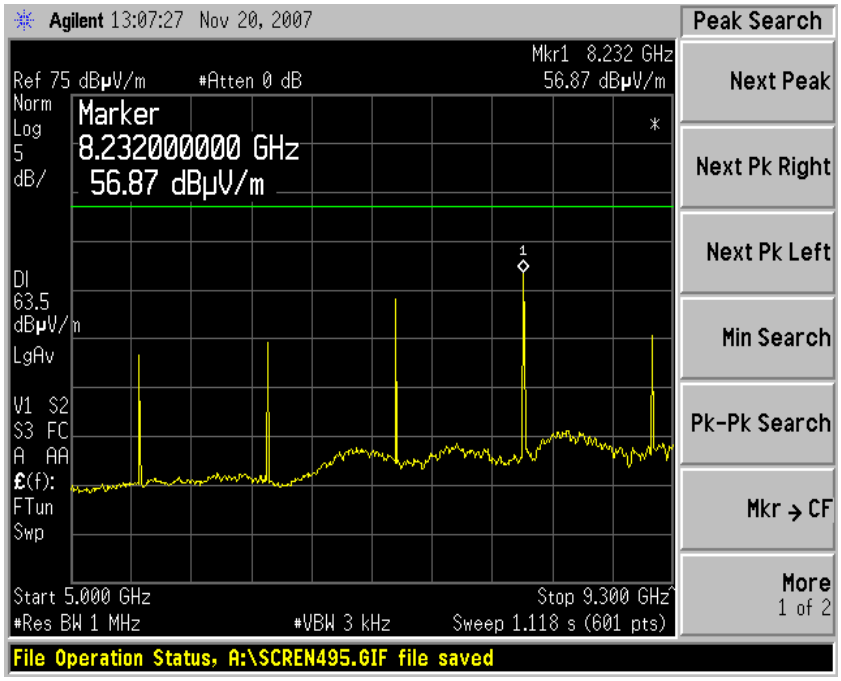


Graphs made during Radiated Emission Testing (continued)

Signature Scan of Peak Radiated Emissions, Lo Channel

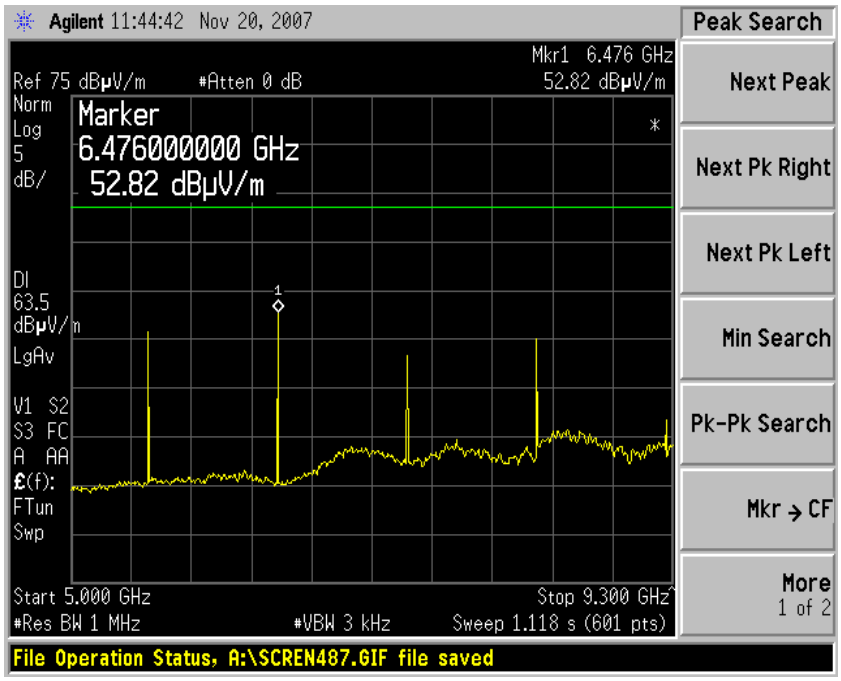


Signature Scan of Peak Radiated Emissions, Mid Channel



Graphs made during Radiated Emission Testing (continued)

Signature Scan of Peak Radiated Emissions, High Channel



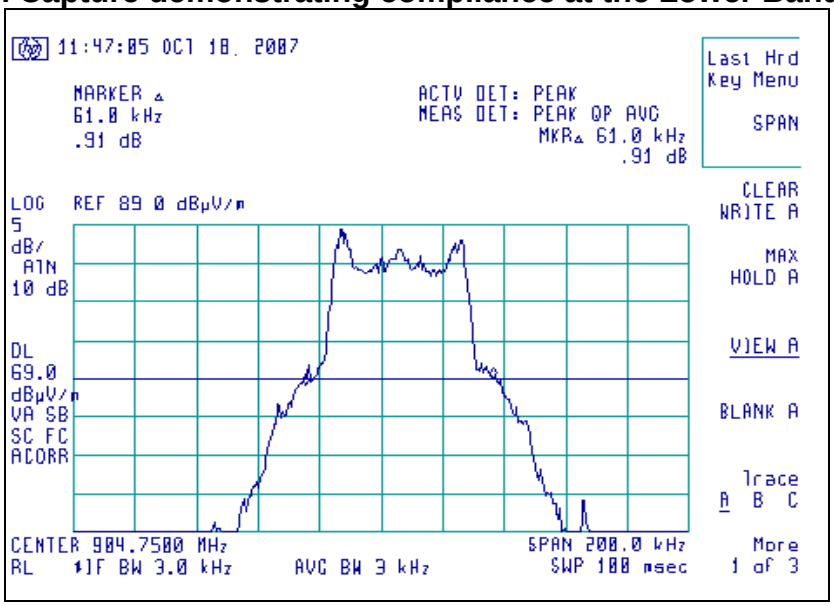
9. Conducted Emissions Test, AC Power Line

This product operates from a 1.5 volt AA battery only.

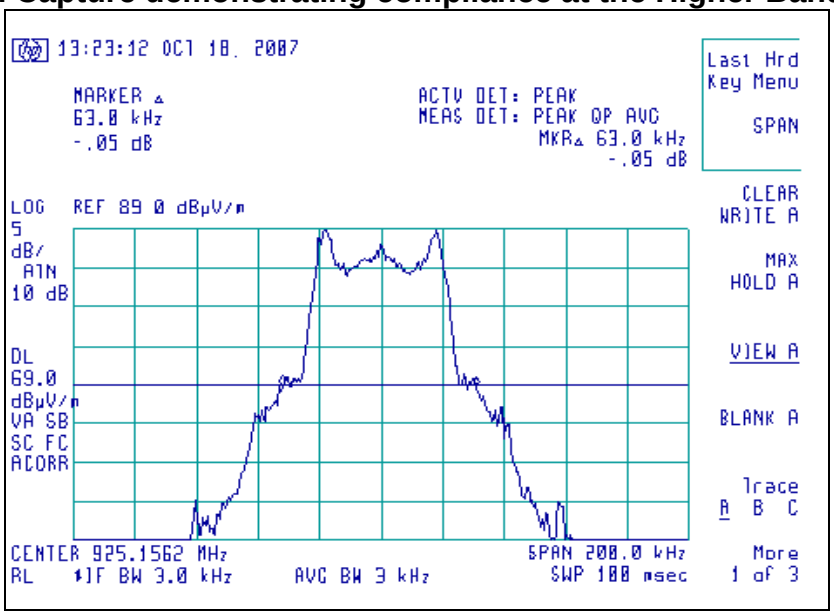
10. Band-Edge Measurements

FCC 15.209(b) and 15.249(d) require a measurement of spurious emission levels, in particular at the band-edges where the intentional radiator operates. The following screen captures demonstrate compliance of the intentional radiator at the 902-928 MHz band-edges. The EUT was operated at the lowest channel, with continuous modulation.

Screen Capture demonstrating compliance at the Lower Band-Edge



Screen Capture demonstrating compliance at the Higher Band-Edge



11. Frequency and Power Stability across input voltage

During testing, the X12 was operated with a fresh battery at all times, with nominal voltage of the battery from 1.6 to 1.5 VDC.

APPENDIX A

Test Equipment List

Asset #	Manufacturer	Model #	Serial #	Description	Date	Due
AA960008	EMCO	3816/2NM	9701-1057	Line Impedance Stabilization Network	12/6/07	12/6/08
AA960031	HP	119474A	3107A01708	Transient Limiter	Note 1	Note 1
AA960077	EMCO	93110B	9702-2918	Biconical Antenna	9/19/07	9/19/08
AA960078	EMCO	93146	9701-4855	Log-Periodic Antenna	9/19/07	9/19/08
AA960081	EMCO	3115	6907	Double Ridge Horn Antenna	12/04/06	12/04/07
CC00221C	Agilent	E4407B	US39160256	Spectrum Analyzer	1/11/07	1/11/08
EE960004	EMCO	2090	9607-1164	Device Controller	N/A	N/A
EE960013	HP	8546A	3617A00320	Receiver RF Section	9/20/07	9/20/08
EE960014	HP	85460A	3448A00296	Receiver Pre-Selector	9/20/07	9/20/08
EE960073	Agilent	E4446A	US45300564	Spectrum Analyzer	8/17/07	8/17/08
N/A	LSC	Cable	0011	3 Meter ½" Armored Cable	Note 1	Note 1
N/A	LSC	Cable	0050	10 Meter RG 214 Cable	Note 1	Note 1
N/A	Pasternack	Attenuator	N/A	10 dB Attenuator	Note 1	Note 1

Note 1 - Equipment calibrated within a traceable system.

Uncertainty Statement

This uncertainty represents an expanded uncertainty
expressed at approximately the 95% confidence level, using a coverage factor of k=2.

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.24 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.8 dB
Radiated Emissions	10-Meter OATS, Biconical Antenna	4.18 dB
Radiated Emissions	10-Meter OATS, Log Periodic Antenna	3.92 dB
Conducted Emissions	Shielded Room/EMCO LISN	1.60 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	1.128 Volts/Meter
Conducted Immunity	3 Volts level	1.0 V