L.S. Compliance, Inc.
W66 N220 Commerce Court
Cedarburg, WI 53012
262-375-4400 Fax: 262-375-4248

COMPLIANCE TESTING OF:
PS RF-Remote

PREPARED FOR:

Goldline Controls, Incorporated
Attention: Mr. Charles Savoie
61 Whitecap Drive
North Kingstown, RI 02852

TEST REPORT NUMBER:
304262 TX TCB Rev. 1

TEST DATE(S):

May 27th through June 1St , 2004

Table of Contents

1. L. S. Compliance In Review

L.S. Compliance - 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 : 1999
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

Listing of 3 and 10 meter OATS based on Title 47CFR – Part 2.948
FCC Registration Number: 90757

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 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. A2LA Certificate of Accreditation

THE AMERICAN
ASSOCIATION
FOR LABORATORY
ACCREDITATION

ACCREDITED LABORATORY

A2LA has accredited

L.S. COMPLIANCE, INC.
Cedarburg, WI

for technical competence in the field of

Electrical Testing

The accreditation covers the specific tests and types of tests listed on the agreed scope of accreditation. This laboratory meets the requirements of ISO/IEC 17025 - 1999 "General Requirements for the Competence of Testing and Calibration Laboratories" and any additional program requirements in the identified field of testing. Testing and calibration laboratories that comply with this International Standard also operate in accordance with ISO 9001 or ISO 9002 (1994).

Presented this 26th day of March 2003.

President
For the Accreditation Council
Certificate Number 1255.01
Valid to January 31, 2005

For tests or types of tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

3. A2LA Scope of Accreditation

American Association for Laboratory Accreditation

SCOPE OF ACCREDITATION TO ISO/IEC 17025-1999

L.S. COMPLIANCE, INC.
W66 N220 Commerce Court
Cedarburg, WI 53012
James Blaha Phone: 262 375 4400

ELECTRICAL (EMC)

Valid to: January 31, 2005 Certificate Number: 1255-01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following tests:

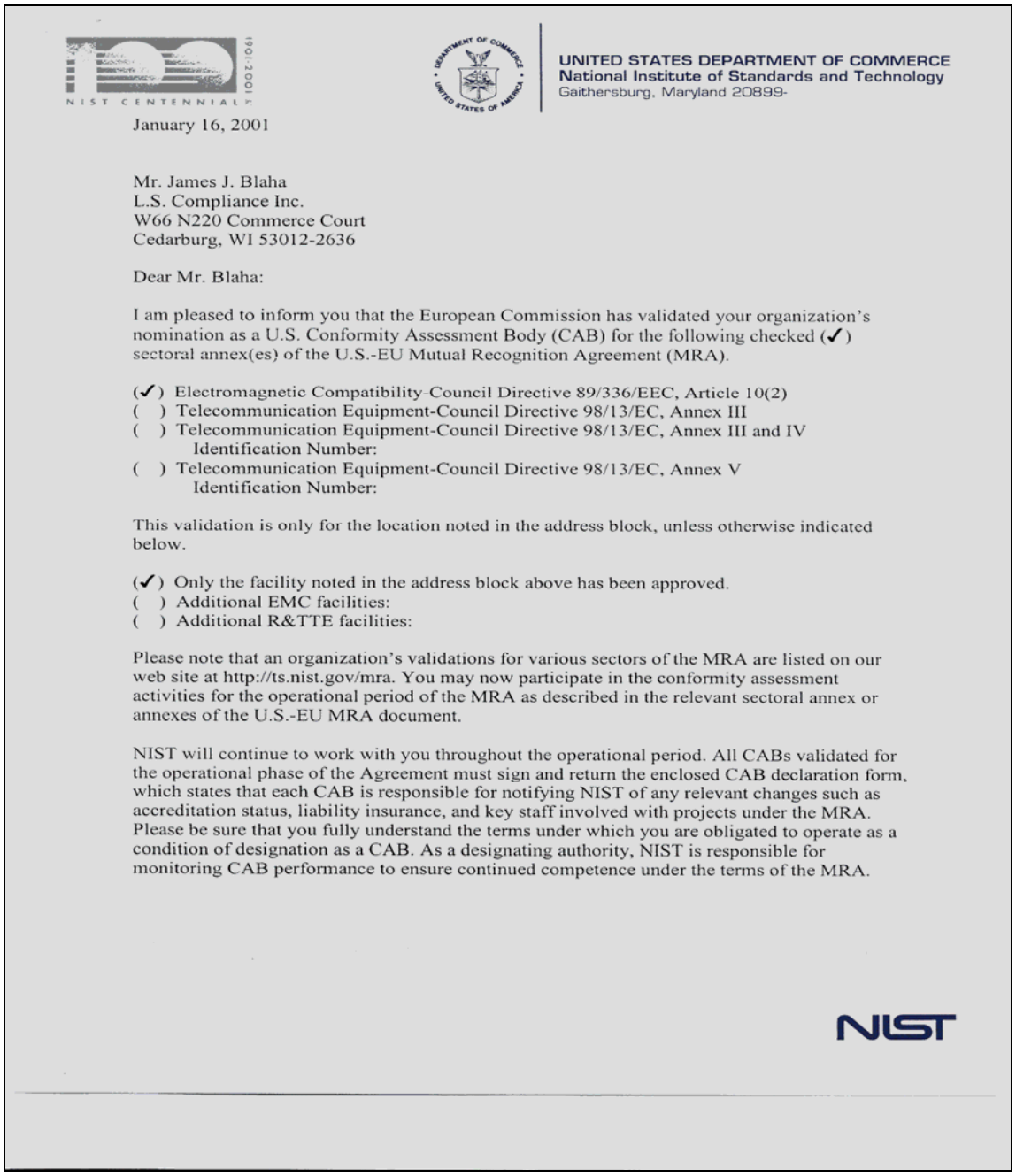
Test	Test Method(s)
Emissions	
Conducted	
Continuous/Discontinuous	Code of Federal Regulations (CFR) 47, FCC Method Parts 15, 18 using ANSI C63.4; EN: 55011, 55022, 50081-1, 50081-2; CISPR: 11, 12, 14-1, 22; CNS 13438
Radiated	Code of Federal Regulations (CFR) 47, FCC Method Parts 15, 18 using ANSI C63.4; EN: 55011, 55022, 50081-1, 50081-2; CISPR: 11, 12, 14-1, 22; CNS 13438
Current Harmonics	IEC 61000-3-2; EN 61000-3-2
Voltage Fluctuations & Flicker	IEC 61000-3-3; EN 61000-3-3
Immunity	EN: 50082-1, 50082-2 EN 61000-6-2 CISPR: 14-2, 24
Conducted Immunity	
Fast Transients/Burst	IEC 61000-4-4; EN 61000-4-4
Surge	IEC: 61000-4-5; ENV 50142; EN 61000-4-5
RF Fields	IEC: 61000-4-6; ENV 50141; EN 61000-4-6
Voltage Dips/Interruptions	IEC 61000-4-11; EN 61000-4-11

Roxanne M. Robinson

(A2LA Cert. No. 1255-01) 05/13/03 Page 1 of 2

5301 Buckeystown Pike, Suite 350 • Frederick, MD 21704-8373 • Phone: 301-644 3248 • Fax: 301-662 2974

4. Validation Letter – U.S. Competent Body for EMC Directive 89/336/EEC



UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, Maryland 20899-

January 16, 2001

Mr. James J. Blaha
L.S. Compliance Inc.
W66 N220 Commerce Court
Cedarburg, WI 53012-2636

Dear Mr. Blaha:

I am pleased to inform you that the European Commission has validated your organization's nomination as a U.S. Conformity Assessment Body (CAB) for the following checked (✓) sectoral annex(es) of the U.S.-EU Mutual Recognition Agreement (MRA).

(✓) Electromagnetic Compatibility-Council Directive 89/336/EEC, Article 10(2)
( ) Telecommunication Equipment-Council Directive 98/13/EC, Annex III
( ) Telecommunication Equipment-Council Directive 98/13/EC, Annex III and IV
Identification Number:
( ) Telecommunication Equipment-Council Directive 98/13/EC, Annex V
Identification Number:

This validation is only for the location noted in the address block, unless otherwise indicated below.

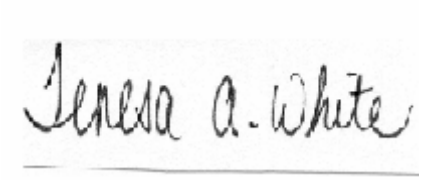
(✓) Only the facility noted in the address block above has been approved.
( ) Additional EMC facilities:
( ) Additional R&TTE facilities:

Please note that an organization's validations for various sectors of the MRA are listed on our web site at http://ts.nist.gov/mra. You may now participate in the conformity assessment activities for the operational period of the MRA as described in the relevant sectoral annex or annexes of the U.S.-EU MRA document.

NIST will continue to work with you throughout the operational period. All CABs validated for the operational phase of the Agreement must sign and return the enclosed CAB declaration form, which states that each CAB is responsible for notifying NIST of any relevant changes such as accreditation status, liability insurance, and key staff involved with projects under the MRA. Please be sure that you fully understand the terms under which you are obligated to operate as a condition of designation as a CAB. As a designating authority, NIST is responsible for monitoring CAB performance to ensure continued competence under the terms of the MRA.

NIST

5. Signature Page

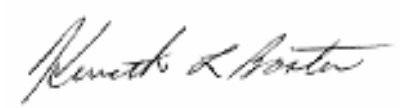


Prepared By: September 29, 2004

Teresa A. White, Document Coordinator Date

Tested By: September 29, 2004

Abtin Spantman, EMC Engineer Date



Approved By: September 29, 2004

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

6. Product and General Information

Manufacturer:	Goldline Controls, Inc.					
Date(s) of Test:	May 27th – June 1st, 2004					
Test Engineer(s):		Tom Smith	√	Abtin Spantman		Ken Boston
Model #:	PS RF-Remote					
Serial #:	Pre-production sample					
Voltage:	9 VDC					
Operation Mode:	Continuous Transmit and normal mode as needed.					

7. Introduction

Between May 27TH and June 1ST, 2004, a series of Conducted and Radiated Emission tests were performed on one pre-production sample of the Goldline Controls' PS RF-Remote, here forth referred to as the "*Equipment Under Test*" or "*EUT*". These tests were performed using the procedures outlined in ANSI C63.4-2001 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 Abtin Spantman, EMC Engineer at L.S. Compliance, incorporated.

All Radiated and Conducted Emission tests were performed upon the EUT to measure the emissions in the frequency bands described in Title 47 CFR, FCC 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 C63.4-2001). Another document used as a reference for the EMI Receiver specification was the Comite International Special Des Perturbations Radioelelectriques (CISPR) Number 16-1, 2002.

8. Product Description

The Goldline PS RF-Remote provides a remote wireless solution for a Spa controller system. The system is composed of a “Base Unit” containing the transceiver and control circuitry for the Spa, and a “Remote Controller Unit” containing a transceiver and keypad.

The base and PS RF-Remote units comprise a remote control system that utilizes a 5 channel scanning scheme to obtain a clear channel. Base receiver will continuously scan 5 channels for a signal from the remote. The remote is normally in sleep mode and wakes up and transmits upon keypad activation. The RF design is based upon the ‘Chipcon’ CC1020 transceiver IC (half-duplex) for operation in the 902-928 ISM band.

The system uses Manchester-encoded binary data at 9600 bps, frequency modulated with a 19.8 kHz peak-to-peak deviation. The PS RF-Remote unit is powered from an external wall type transformer power source providing 9 volts DC, at 2.0 amperes, which is then regulated to 3.3 VDC internally.

The system uses a frequency modulation technique, and is capable of utilizing 25 different frequency channels in the 902-928 MHz band. Three channels were selected for testing: Set 1, channel 1 (902.5 MHz), set 3, channel 3 (914.5 MHz), and set 5, channel 5 (926.5 MHz).

The channel and sets are defined as follows:

Channel	Set 1	Set 2	Set 3	Set 4	Set 5
1	902.5	903.5	904.5	905.5	906.5
2	907.5	908.5	909.5	910.5	911.5
3	912.5	913.5	914.5	915.5	916.5
4	917.5	918.5	919.5	920.5	921.5
5	922.5	923.5	924.5	925.5	926.5
	MHz	MHz	MHz	MHz	MHz

The PS RF-Remote unit also has the capability to encode commands for control of up to 14 auxiliary devices, through connections with the base unit.

PS RF-Remote in active state

PS RF-Remote with wall transformer

9. Test Requirements

The above mentioned tests were performed in order to determine the compliance of the Goldline Systems' PS RF-Remote 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

10. Summary of Test Report

DECLARATION OF CONFORMITY

The Goldline Systems' PS RF-Remote 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'*.

11. Radiated Emissions Test

Test Setup

The test setup was assembled in accordance with Title 47, CRF FCC Part 15 and ANSI C63.4-2001. 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 L. S. Compliance, Inc., Cedarburg, Wisconsin. The EUT was operated in continuous transmit modes, with modulation, using power as provided by a 'wall' type transformer at 9.0 VDC, 2 Amperes. The unit has the capability to operate on 25 channels, controllable via keypad switches that were pre-programmed specifically for these tests. The applicable limits apply at a 3 meter separation distance between the EUT and the sense antenna. 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 (902.5 MHz), medium (914.5) and high (926.5) to comply with FCC Part 15.35. The channels and operating modes were changed using selections on the keypad.

Test Procedure

Radiation measurements were performed on the EUT in the 3 Meter Semi-Anechoic, FCC listed Chamber, located at L. S. Compliance, Inc. in Cedarburg, Wisconsin. The frequency range from 30 MHz to 10,000 MHz was investigated for RF emissions. 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 18 GHz. The attitude for maximum radiated 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 (300 kHz video bandwidth) for measurements from 30 MHz to 1 GHz, and a resolution bandwidth of 1 MHz (1 MHz video bandwidth) for measurements above 1 GHz. The Peak, Quasi-Peak and Average Detector functions were utilized. From 5 GHz to 10 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: 47 CFR 15.249

Frequency Range Inspected: 30 MHz to 10,000 MHz

Manufacturer:	Goldline Controls, Inc.							
Date(s) of Test:	May 27th – June 1st, 2004							
Test Engineer(s):		Tom Smith	√	Abtin Spantman		Ken Boston		
Model #:	PS RF-Remote							
Serial #:	Pre-production sample							
Voltage:	9 VDC							
Operation Mode:	Continuous transmit with modulation							
EUT Power:		Single Phase ___VAC				3 Phase ___VAC		
		Battery			√	Other: 9 VDC from wall transformer connected to mains		
EUT Placement:	√	80cm non-conductive table				10cm Spacers		
EUT Test Location:	√	3 Meter Semi-Anechoic FCC Listed Chamber				3/10m OATS		
Measurements:		Pre-Compliance		Preliminary		Final		
Detectors Used:	√	Peak	√	Quasi-Peak	√	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 3110
Pre-Amp: Advanced Microwave WHA6224
Standard Gain Horn: EMCO 3160-09

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

Frequency (MHz)	Antenna Polarity	Channel	Height (meters)	Azimuth (0° - 360°)	EMI Meter Reading (dBµV/m)	15.249 Limit (dBµV/m)	Margin (dB)
902.5	V	Low	1.00	55	93.3	94.0	0.7
914.5	V	Mid	1.00	55	92.7	94.0	1.3
926.5	V	High	1.00	55	93.5	94.0	0.5

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

Frequency (MHz)	Antenna Polarity	Channel	Height (meters)	Azimuth (0° - 360°)	EMI Meter Reading (dBμV/m)	15.249 Limit (dBμV/m)	Margin (dB)
50.9	V	Mid	1.00	0	33.7	44.0	10.3
167.0	H	Mid	1.25	300	24.1	44.0	19.9
109.1	V	Mid	1.00	0	31.8	44.0	12.2
932.6	V	High	1.00	70	40.0	46.0	6.0
1805	H	Low	1.00	150	44.5	54.0	9.5
2707	V	Low	1.00	150	32.1	54.0	21.9
3610	V	Low	1.00	0	31.8	54.0	22.2
1829	H	Mid	1.00	165	39.1	54.0	14.9
2743	H	Mid	1.20	300	32.0	54.0	22.0
3658	H	Mid	1.05	65	32.8	54.0	21.2
4572	V	Mid	1.00	0	27.8	54.0	26.2
5487	V	Mid	1.00	0	29.4	54.0	24.6
1853	H	High	1.00	170	38.1	54.0	15.9
2779	H	High	1.20	310	29.4	54.0	24.6
3706	H	High	1.00	270	32.7	54.0	21.3
7220	H	Low	1.00	270	49.9	63.5	13.6
7316	H	Mid	1.00	270	52.4	63.5	11.1
7412	H	High	1.00	270	53.8	63.5	9.7

Notes:

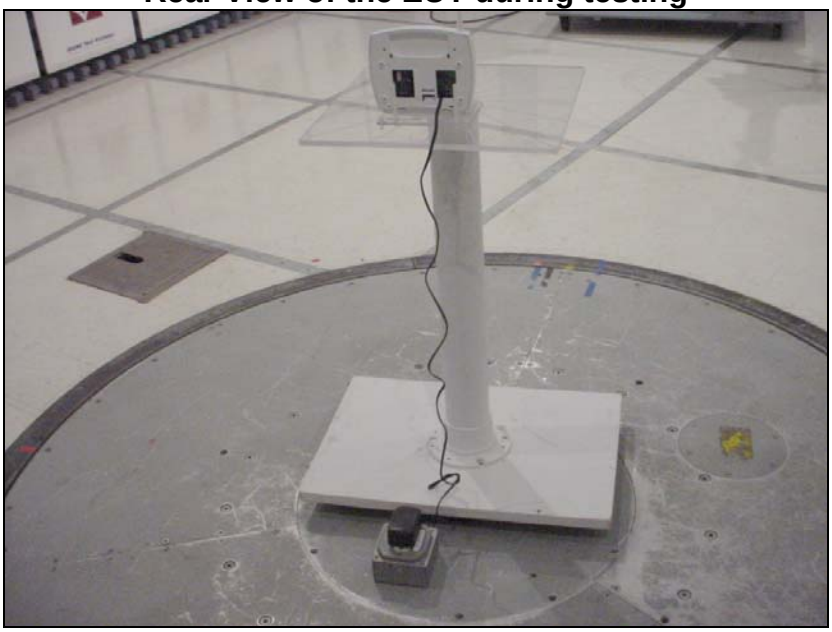
1) A Quasi-Peak Detector was used in measurements below 1 GHz, and an Average Detector was used in measurements above 1 GHz, with peak detector readings greater than 20 dB below a 74 dbμV limit.
2) Measurements above 5 GHZ were made at 1 meter separation from the EUT, and the limits are extrapolated to reflect the separation distance.

Photos Taken During Radiated Emission Testing

Setup for the Radiated Emissions Test

Front View of the EUT during testing

Rear View of the EUT during testing

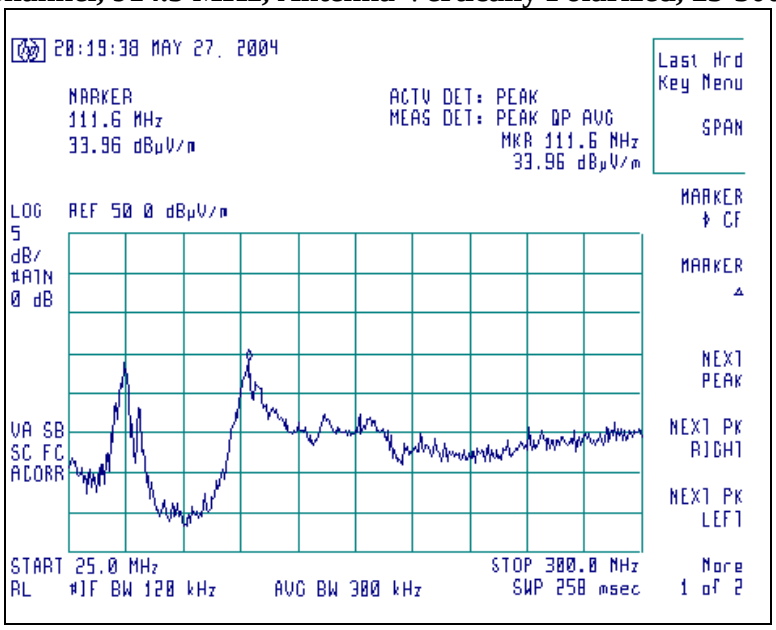


Screen Captures of Radiated RF Emissions:

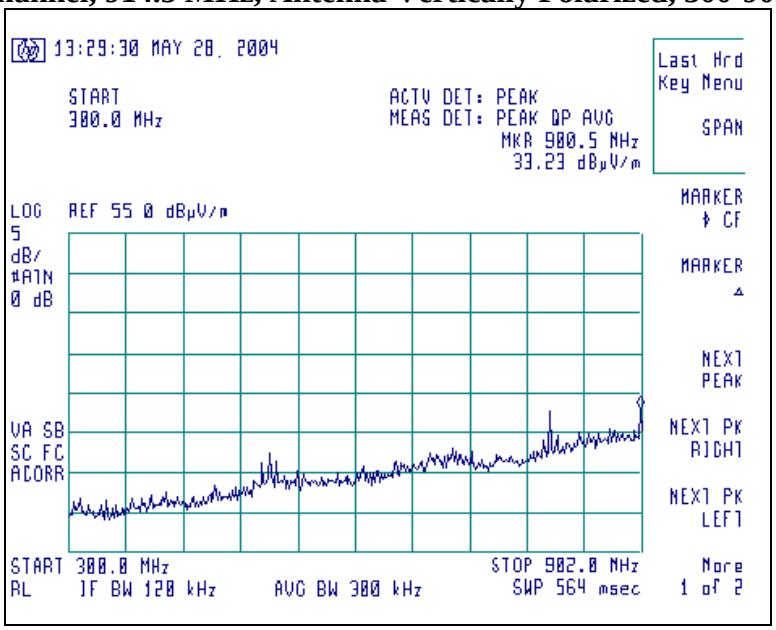
Please note these screen captures represent Peak Emissions. For radiated emission measurements, we utilize a Quasi-Peak detector function when measuring frequencies below 1 GHz, and both a Peak and Average detector function when measuring frequencies above 1 GHz.

The signature scans shown here are from the Mid channel, chosen as being a good representative of all channels, with the sense and EUT antennas both in vertical polarity for worst case presentations.

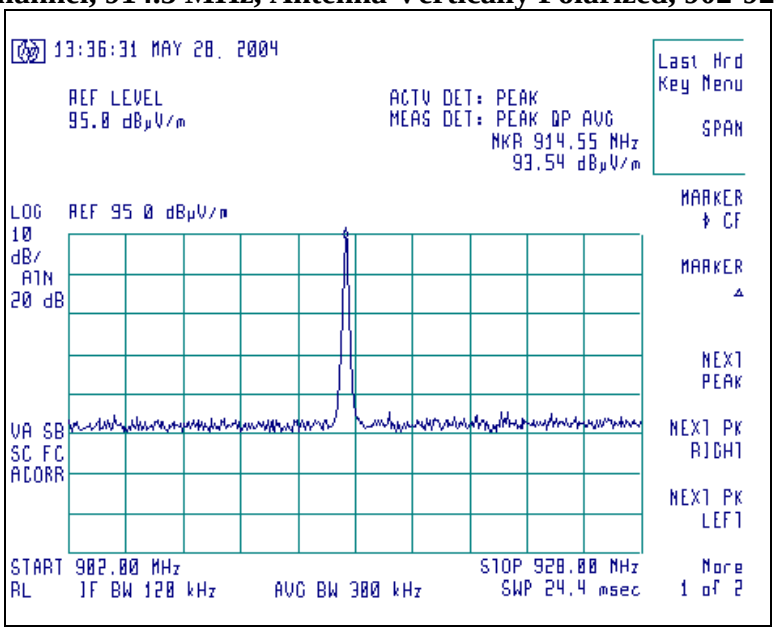
Mid Channel, 914.5 MHz, Antenna Vertically Polarized, 25-300 MHz



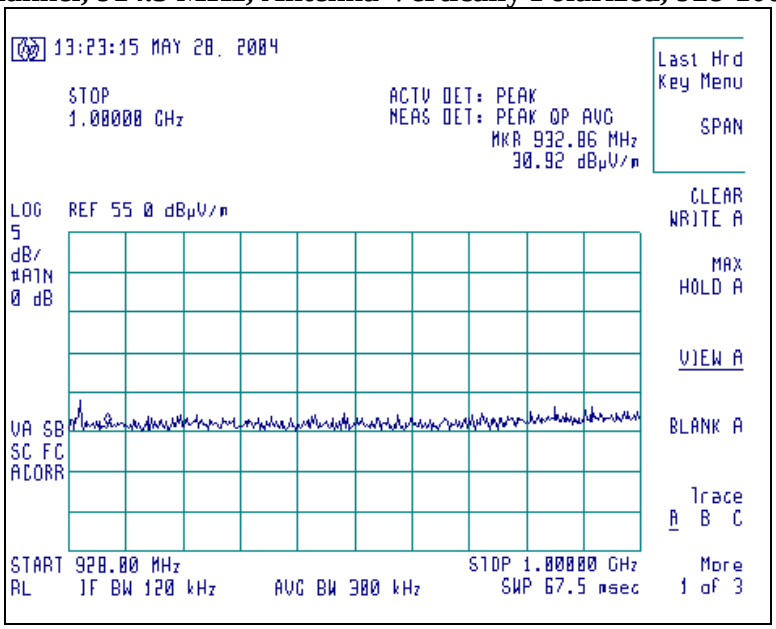
Mid Channel, 914.5 MHz, Antenna Vertically Polarized, 300-902 MHz



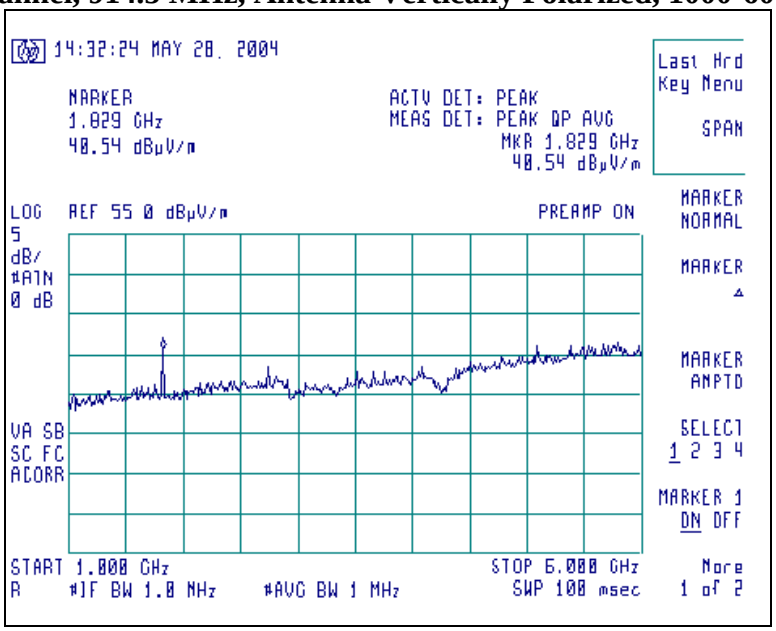
Mid Channel, 914.5 MHz, Antenna Vertically Polarized, 902-928 MHz



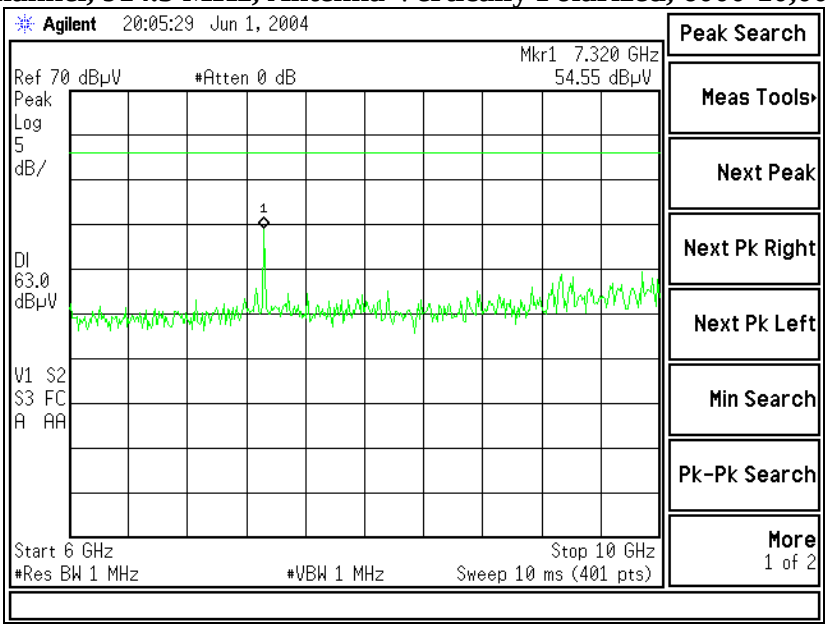
Mid Channel, 914.5 MHz, Antenna Vertically Polarized, 928-1000 MHz



Mid Channel, 914.5 MHz, Antenna Vertically Polarized, 1000-6000 MHz



Mid Channel, 914.5 MHz, Antenna Vertically Polarized, 6000-10,000 MHz



12. Conducted Emissions Test, AC Power Line

Test Setup

The Conducted Emissions test was performed at L.S. Compliance, Inc. in Cedarburg, Wisconsin. The test area and setup are in accordance with ANSI C63.4-2001 and with Title 47 CFR, FCC Part 15, (Industry Canada RSS-210). The EUT was placed on a non-conductive table, with a height of 80 cm above the reference ground plane. The EUT's power cable was plugged into a 50Ω (ohm), 50/250 μH Line Impedance Stabilization Network (LISN). The AC power supply of 120V was provided inside the shield room via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to the HP 8546A EMI Receiver. The EMCO LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

Test Procedure

The EUT was investigated in normal operating mode as well as in continuous transmit mode. The final measurements were made with the unit in continuous transmit mode with modulation. The appropriate frequency range and bandwidths were selected on the EMI Receiver, and measurements were made. The resolution bandwidth used for these measurements is 9 kHz 30 KHz video bandwidth), as specified in CISPR 16-1 (2002), Section 1, Table 1, for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30MHz. Final readings were then taken and recorded.

Test Equipment Utilized

A list of the test equipment and accessories utilized for the Conducted Emissions test is provided 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. Calibrations of the LISN and Limiter are traceable to N.I.S.T. All cables are calibrated and checked periodically for conformance. The emissions are measured on the HP 8546A EMI Receiver, which has automatic correction for all factors stored in memory and allows direct readings to be taken. Both the Quasi-Peak and Average detector functions were utilized.

Test Results

The EUT was found to **MEET** the Conducted Emission requirements of FCC Part 15, Conducted Emissions for an Intentional Radiator. See the Data Charts and Graphs for more details of the test results.

Measurement of Electromagnetic Conducted Emission
In the Shielded Room

Frequency Range Inspected: 150 KHz to 30 MHz

Manufacturer:	Goldline Controls, Inc.					
Date(s) of Test:	May 27th – June 1st, 2004					
Test Engineer:		Tom Smith	√	Abtin Spantman		Ken Boston
Model #:	PS RF-Remote					
Serial #:	Pre-production sample					
Voltage:	9 VDC obtained from wall type transformer connected to mains					
Operation Mode:	Normal					
Test Location:	√	Shielded Room				Chamber
EUT Placed On:	√	40cm from Vertical Ground Plane				10cm Spacers
	√	80cm above Ground Plane				Other:
Measurements:		Pre-Compliance		Preliminary	√	Final
Detectors Used:		Peak	√	Quasi-Peak	√	Average

Environmental Conditions in the Lab:
Temperature: 20 – 25° C
Atmospheric Pressure: 86 kPa – 106 kPa
Relative Humidity: 30 – 60%

Test Equipment Utilized:
EMI Receiver: HP 8546A
LISN: EMCO 3816/2NM
Transient Limiter: HP 119474A

		QUASI-PEAK			AVERAGE		
Frequency (MHz)	Line	Q-Peak Reading (dBµV/m)	Q-Peak Limit (dBµ V/m)	Quasi-Peak Margin (dB)	Average Reading (dBµV/m)	Average Limit (dBµ V/m)	Average Margin (dB)
0.29	L1	50.7	60.5	9.8	50.1	50.5	0.4
0.58	L1	45.3	56.0	10.7	44.5	46.0	1.5
0.87	L1	48.9	56.0	7.1	44.8	46.0	1.2
1.16	L1	40.8	56.0	15.2	39.5	46.0	6.5
1.45	L1	36.0	56.0	20.0	34.8	46.0	11.2
1.74	L1	40.0	56.0	16.0	38.6	46.0	7.4
0.29	L2	47.5	60.5	13.0	46.1	50.5	4.4
0.58	L2	41.9	56.0	14.1	40.6	46.0	5.4
0.87	L2	46.4	56.0	9.6	45.1	46.0	0.9
1.16	L2	37.8	56.0	18.2	35.3	46.0	10.7
1.45	L2	33.4	56.0	22.6	31.6	46.0	14.4
1.74	L2	37.7	56.0	18.3	35.7	46.0	10.3

Notes:
1) The emissions listed are characteristic of the power supply used, and did not change by the EUT.
2) All other emissions noted were better than 20 dB below the limits
3) The EUT exhibited similar emissions in the transmit and receive modes, and across the Low, Mid, and High channels tested.

Calculation of Conducted Emissions Limits

The following table describes the Class B limits for an unintentional radiator. These limits are obtained from Title 47 CFR, Part 15.107 (a) for Conducted Emissions.

Frequency (MHz)	Quasi-Peak Limit (dBµV)	Average Limit (dBµV)
0.15 – 0.5	66 – 56 *	56 - 46
0.5 – 5.0	56	46
5.0 – 30.0	60	50

* Decreases with the logarithm of the frequency.

Sample calculation for the limits in the 0.15 to 0.5 MHz:

$$\text{Limit} = -19.12 \left(\text{Log}_{10} \left(F[\text{MHz}] / 0.15 [\text{MHz}] \right) \right) + 66.0 \text{ dB}\mu\text{V}$$

For a frequency of 200 kHz for example:

$$\text{Quasi-Peak Limit (F=200kHz)} = -19.12 \left(\text{Log}_{10} \left(0.2[\text{MHz}] / 0.15 [\text{MHz}] \right) \right) + 66.0 \text{ dB}\mu\text{V}$$

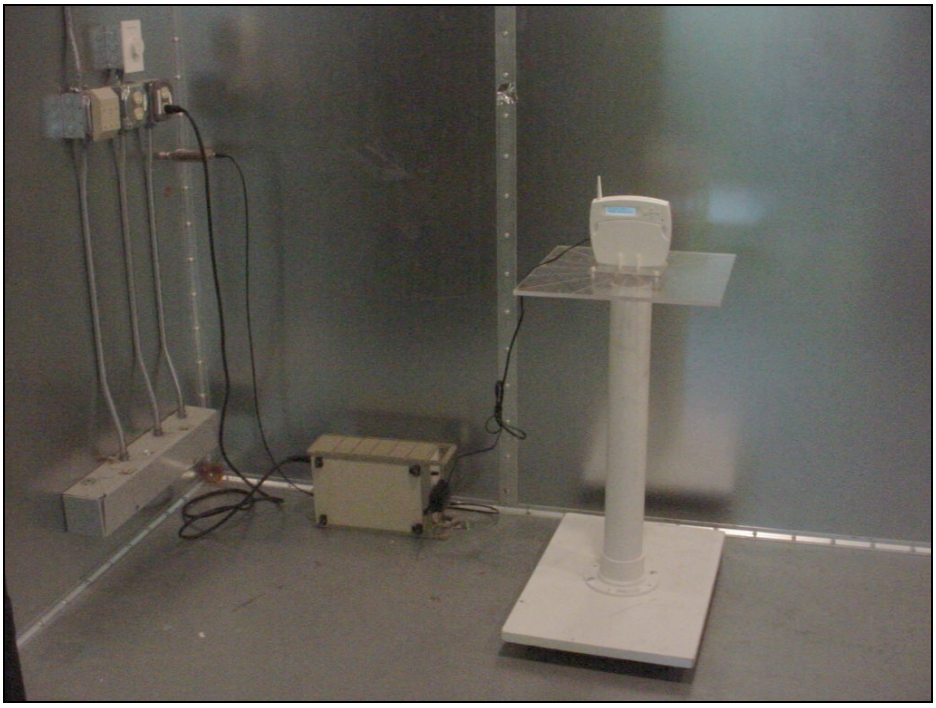
$$\text{Quasi-Peak Limit (F=200kHz)} = 63.6 \text{ dB}\mu\text{V}$$

$$\text{Average Limit (F=200kHz)} = -19.12 \left(\text{LOG}_{10}(0.2[\text{MHz}]/0.15[\text{MHz}]) \right) + 56.0 \text{ dB}\mu\text{V}$$

$$\text{Average Limit (F = 200 kHz)} = 53.6 \text{ dB}\mu\text{V}$$

Photo(s) Taken During Conducted Emission Testing

Setup for the Conducted Emissions Test

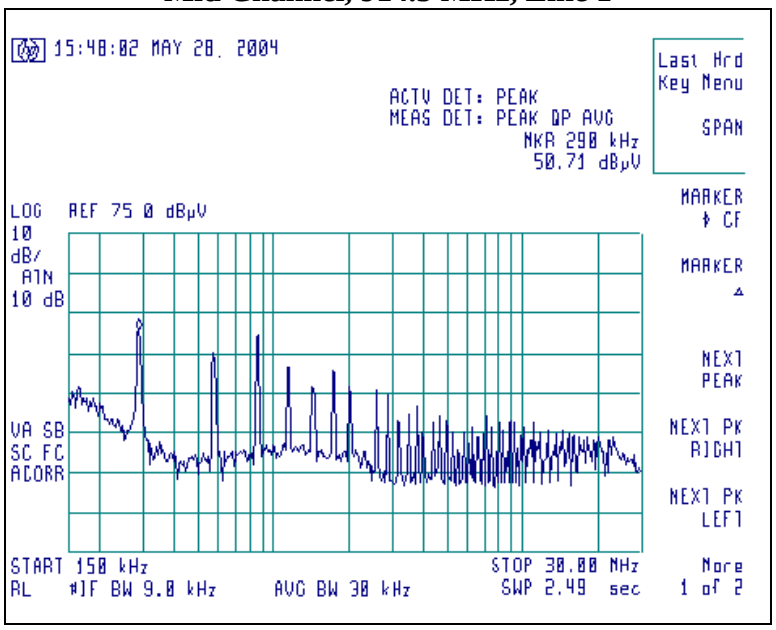


Screen Captures of Conducted AC Mains Emissions:

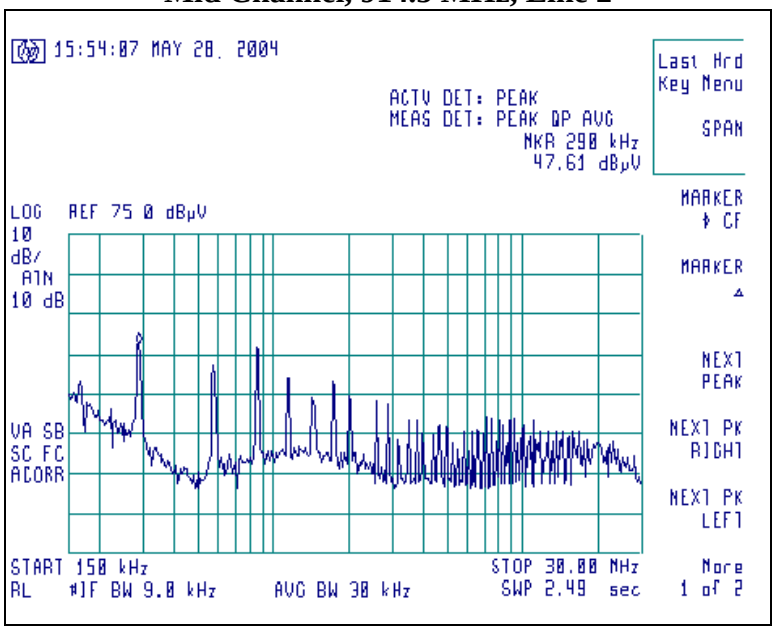
Please note these screen captures represent Peak Emissions. For conducted emission measurements, we utilize both a Quasi-Peak detector function as well as the Average detector function for measurements. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.209.

The signature scans shown here are from Mid channel, chosen as being a good representative of channels.

Mid Channel, 914.5 MHz, Line 1



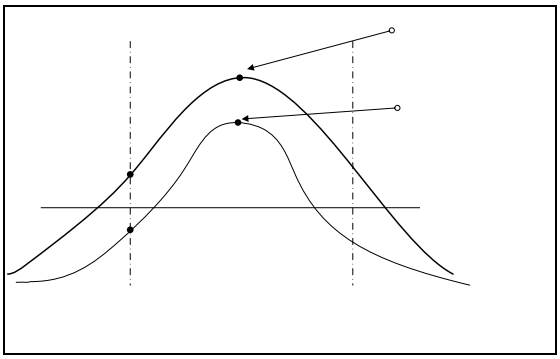
Mid Channel, 914.5 MHz, Line 2



13. 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, with typical data packets as the modulating source, for the investigation of the lower band-edge, and at the highest channel for the investigation of the higher band-edge.

The bandwidth of the modulated signal is measured using a marker delta method, to ensure that the modulated signal does not exceed the emission limits outside of the operational band. The EUT was placed in continuous transmit mode with internal typical data as the source of modulation. The emissions were then measured at the operational band edges to ensure compliance. The following diagram and formula illustrates how the band edge measurements were taken.



Measurement A is taken using a 120kHz IF Bandwidth at the Center Frequency.
Measurement B is taken using a 30kHz IF Bandwidth at the Center Frequency.
Measurement C is taken using a 30kHz IF Bandwidth at the lower Band Edge Frequency

To Calculate the Value for lower Band Edge Frequency at Point D:

$$A - B = \Delta$$
$$\Delta + C = D$$

The Band Edge limit, in this case, would be D = 46.0 dBµV/m.
The measurements and calculations are as follows:

At the Lower Band-edge:

$A - B = \Delta$; $92.28\,dB\mu V/m - 91.30\,dB\mu V/m = 0.99\,dB$

$\Delta + C = D$; $0.99\,dB + 39.76\,dB\mu V/m = 40.74\,dB$ Showing compliance at Lower Band-Edge

At the Upper Band-edge:

$A - B = \Delta$; $93.69\,dB\mu V/m - 92.88\,dB\mu V/m = 0.81\,dB$

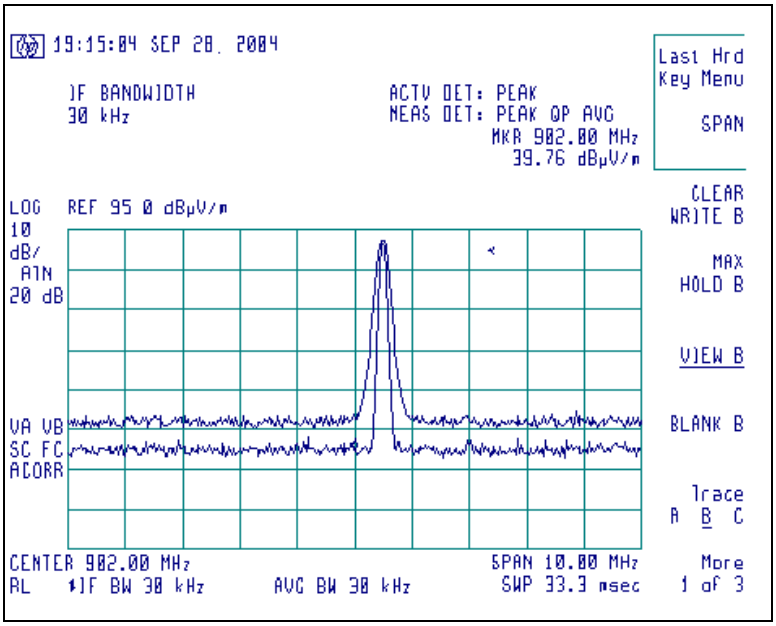
$\Delta + C = D$; $0.81\,dB + 38.99\,dB\mu V/m = 39.80\,dB$ Showing compliance at Upper Band-Edge

D

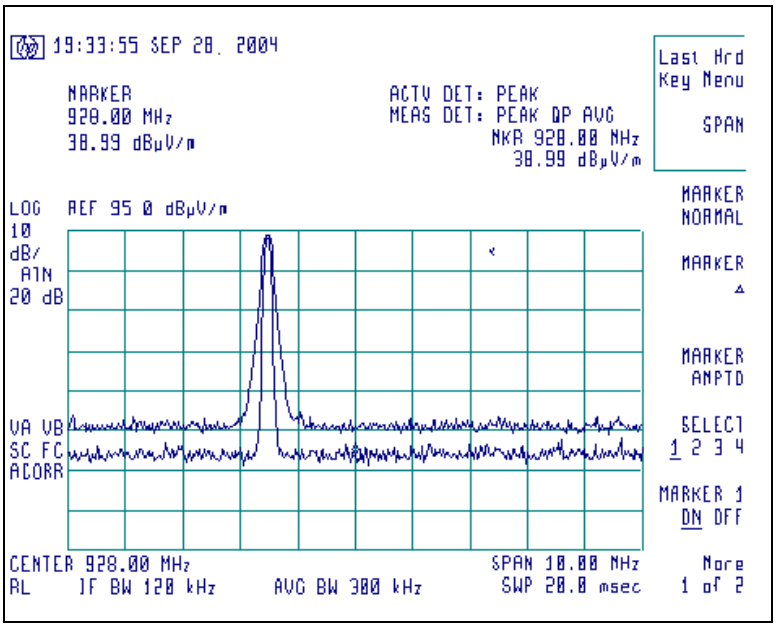
C

Lower Band Edge

Screen Capture demonstrating compliance at the Lower Band-Edge
Top trace shows spectral signature using RBW=120 kHz,
while lower trace uses RBW=30 kHz



Screen Capture demonstrating compliance at the Higher Band-Edge
Top trace shows spectral signature using RBW=120 kHz,
while lower trace uses RBW=30 kHz



14. Frequency and Power Stability across input voltage

The fundamental emission of the transmitter needs to be stable with varying voltage. According to the FCC Part 15.31 (e) the supply voltage should be varied between 85 % and 115 % from the nominal specified voltage. The EUT was tested in the semi-anechoic chamber, with the transmitter portion of the EUT placed in continuous C.W. transmit mode. The fundamental frequency was measured with a receiver bandwidth of 10 kHz, and video bandwidth of 10 kHz.

	Voltage	Channel Low Center Freq (MHz)	Channel Mid Center Freq (MHz)	Channel High Center Freq (MHz)
115 % of Nominal	138 VAC	902.499079	914.499173	926.498868
100 % of Nominal	120 VAC	902.499075	914.499170	926.498868
85 % of Nominal	102 VAC	902.499076	914.499165	926.498868

No anomalies were noted, in the frequency of operation, during the voltage variation tests. Variations in measured output power were not discernable, as a function of the change in power supply voltage, and in all cases measured less than 1 dB in variance. The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characteristics were well behaved, and the system returned to the same state of operation as before the power cycle.

Appendix A

Test Equipment List

Asset #	Manufacturer	Model #	Serial #	Description	Date	Due
AA960008	EMCO	3816/2NM	9701-1057	Line Impedance Stabilization Network	9/03/03	9/03/04
AA960031	HP	119474A	3107A01708	Transient Limiter	Note 1	Note 1
AA960077	EMCO	93110B	9702-2918	Biconical Antenna	9/02/03	9/02/04
AA960078	EMCO	93146	9701-4855	Log-Periodic Antenna	9/02/03	9/02/04
AA960081	EMCO	3115	6907	Double Ridge Horn Antenna	11/14/03	11/14/04
CC00221C	Agilent	E4407B	US39160256	Spectrum Analyzer	11/04/03	11/04/04
EE960004	EMCO	2090	9607-1164	Device Controller	N/A	N/A
EE960013	HP	8546A	3617A00320	Receiver RF Section	9/04/03	9/04/04
EE960014	HP	85460A	3448A00296	Receiver Pre-Selector	9/04/03	9/04/04
N/A	LSC	Cable	0011	3 Meter ½" Armored Cable	6/07/04	6/07/05
N/A	LSC	Cable	0038	1 Meter RG 214 Cable	6/07/04	6/07/05
N/A	LSC	Cable	0050	10 Meter RG 214 Cable	6/07/04	6/07/05
N/A	Pasternack	Attenuator	N/A	10 dB Attenuator	Note 1	Note 1

Note 1 - Equipment calibrated within a traceable system.

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