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

COMPLIANCE TESTING OF:

AquaLogic RF Controller

PREPARED FOR:

Goldline Controls, Incorporated
Attn.: Mr. Charles Savoie
42 Ladd Street
East Greenwich, RI 02818

TEST REPORT NUMBER:

303458-TX Rev. 1

TEST DATE(S):

December 7th, 2003

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1. L. S. Compliance In Review

Brief Review of
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:

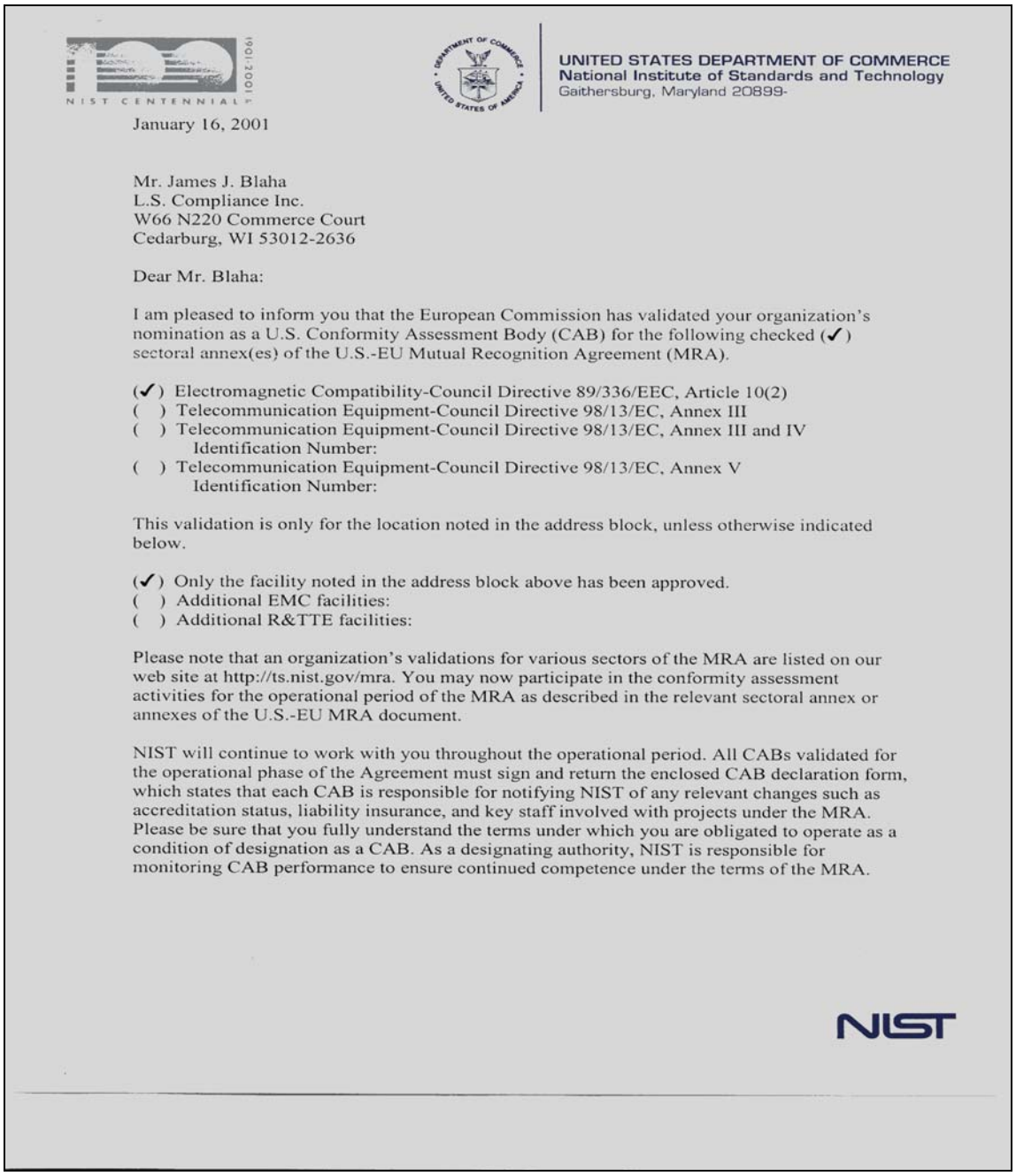
Test	Test Method(s)
Emissions	
Conducted	
Continuous/Discontinuous	Code of Federal Regulations (CFR) 47, FCC Method Parts 15, 18 using ANSI C63.4; EN: 55011, 55022, 50081-1, 50081-2; CISPR: 11, 12, 14-1, 22; CNS 13438
Radiated	Code of Federal Regulations (CFR) 47, FCC Method Parts 15, 18 using ANSI C63.4; 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.

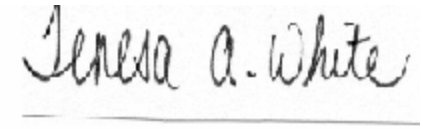
(✓) Only the facility noted in the address block above has been approved.
( ) Additional EMC facilities:
( ) Additional R&TTE facilities:

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

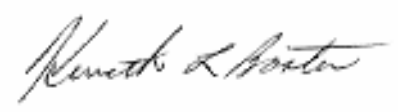


Prepared By: **January 23, 2004**

Teresa A. White, Document Coordinator **Date**

Tested By: **January 23, 2004**

Abtin Spantman, EMC Engineer **Date**



Approved By: **January 23, 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, Incorporated
Model No.: Aqua Logic Controller
Serial No.: Engineering Unit # 302
Description: Wireless Remote Spa Controller

7. Product Description

The Goldline AquaLogic RF Remote Controller 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 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 base unit is powered from an external power supply source providing 10 volts DC, 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				
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

8. Test Requirements

The tests were performed in order to determine the compliance of the Goldline AquaLogic RF Remote Controller with limits contained in various provisions of Title 47 CFR, FCC Part 15, including 15.109, 15.205, 15.207, and 15.249.

All radiated emissions tests were performed to measure the emissions in the frequency bands described by the above sections, and to determine whether said emissions are below the limits established by the above sections. These tests were performed in accordance with the procedure 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 reference for the EMI receiver specification was the International Special Committee on Radio Interference CISPR 16-1 (2002). Measurement technique guidelines found in Appendix C to FCC 97-114 were also consulted.

9. DECLARATION OF CONFORMITY

The Goldline Aqua Logic Remote SPA system was found to **MEET** the requirements as described within the specification of Title 47 CFR FCC, Part 15.249, for a frequency modulated transmitter.

10. Introduction

On December 7th, 2003, a series of Radiated and Conducted Emission tests were performed on the Goldline Aqua Logic Remote SPA system "Remote Controller Unit", serial number: 'Engineering Unit 302', 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 for an intentional radiator. These tests were performed by Abtin Spantman, EMC Engineer at L.S. Compliance, Incorporated.

11. Purpose

All Radiated and Conducted Emission tests upon the EUT were performed to measure the emissions in the frequency bands described in Title 47 CFR, FCC Part 15, including 15.35, 15.207, and 15.249 to determine whether these emissions are below the limits expressed within the standards. These tests were performed in accordance with the procedure 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 16-1, 2002

12. 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 mode, using 3 VDC, powered from two AAA type batteries. The batteries were checked regularly during the testing, and replaced as necessary, to maintain 'fresh battery' conditions. During a normal transmission cycle, as initiated by pressing any of the buttons, the longest packet would be approximately 45 milliseconds of data transmission, in any 135 millisecond window. The applicable radiated emission limits apply at a 3-meter measurement distance. Measurements above 6 GHz were performed at a 1-meter measurement distance. The calculations to determine the 3-meter 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 standard channels: set 1, channel 1 (902.5 MHz), set 3, channel 3 (914.5 MHz) and set 5, channel 5 (926.5 MHz) to comply with FCC Part 15.35, and was investigated along all three axis of rotation.

Test Procedure

Radiated Emission 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 scanned, and levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive table in the 3 Meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters separation from the test object during tests below 6 GHz, and at 1 meter separation during tests above 6 GHz. 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 Wave-guide Horn Antenna was used from 1 GHz to 10 GHz. The 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 bandwidth of 120 kHz for measurements below 1 GHz, and a bandwidth of 1 MHz for measurements above 1 GHz. Both the Peak and Quasi-Peak Detector functions were utilized. From 6 GHz to 10 GHz, an Agilent E4407B Spectrum Analyzer was utilized along with the appropriate horn antenna.

Test Results

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

CALCULATION OF RADIATED EMISSIONS LIMITS for 15.249 (902-928 MHz)

FIELD STRENGTH OF FUNDAMENTAL FREQUENCIES:

The fundamental emissions for a 916 MHz transmitter, operating under FCC Part 15.249 limits, must have a field strength no greater than 50mV/m at 3 meters, and a harmonic field strength no greater than 500µV/m at 3 meters. Spurious emissions outside the 902 MHz – 928 MHz band shall be attenuated by at least 50 dB below the level of the fundamental, or meet the limits expressed in FCC Parts 15.205 and 15.209 under general emission limits *.

FIELD STRENGTH OF FUNDAMENTAL FREQUENCIES:

Limit of 50,000 µV/m; in dB; 20 log (50,000) = 94 dBµV/m

FIELD STRENGTH OF HARMONICS AND SPURIOUS FREQUENCIES: BY 15.249(c)

Limit of -50 dBc of the fundamental limit; 94 dBµV/m – 50 dB = 44 dBµV/m
Except where the 15.209 limits will allow a higher limit to be used*.

Frequency (MHz)	Limit (µV/m @ 3m)	Limit (dBµV/m @ 3m)
902 – 928	50,000	94.0
30 – 88; 88 - 216	159	44.0
216 – 902; 928 – 960	500	46.0 *
960 – 9280	500	54.0 *

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

960 MHz to 25,000 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 low power 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.

Measurement of Electromagnetic Radiated Emissions Within the 3 Meter FCC Listed Chamber

Manufacturer: Goldline Controls, Incorporated
Model No.: Aqua Logic Controller
Serial No.: Engineering Unit # 302
Date of Test: November 18th, 2003

Test Requirements: 15.249 and 15.205

Distance: 3 meter (f<6 GHz), 1 meter (F>6 GHz)	**Frequency Range** Inspected: 30 to 10,000 MHz
Configuration: Continuous Transmit	

Test Equipment Used:

Receiver: HP 8546A (Below 6 GHz),						Biconical Antenna: EMCO 93110B	
Receiver: Agilent E4407B (Above 6 GHz)						Log Periodic Antenna: EMCO 43146A	
Double-Ridged Wave Guide/Horn Antenna: EMCO 3115						Pyramidal Horn Antenna: EMCO 3160	
Detector(s) Used:	√	Peak	√	Quasi-Peak (f<1 GHz)	√	Average (f>1 GHz)	

The following table depicts the level of significant radiated emissions measured at 3 meters distance from the EUT.

Frequency (MHz)	Antenna Polarity	Channel #	Antenna Height (m)	Azimuth (0° 360°)	EMI Meter Reading (dBuV/m)	15.249 Limit (dBuV/m)	Margin (dB)
902.5	V	1	1.10	190	89.3	94.0	4.7
914.5	V	3	1.10	190	91.6	94.0	2.4
926.5	V	5	1.10	200	91.0	94.0	3.0

The following table depicts the level of significant radiated emissions measured, at 3 meters if below 6 GHz, and at 1 meter distance from the EUT if above 6 GHz.

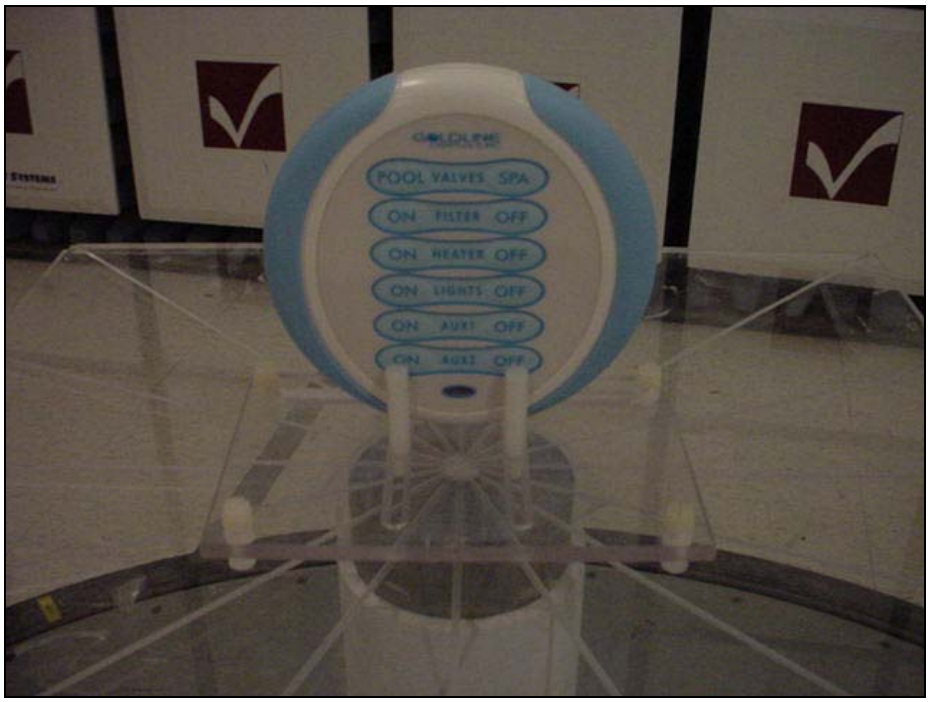
Frequency (MHz)	Antenna Polarity	Channel #	Antenna Height (m)	Azimuth (0° 360°)	EMI Meter Reading (dBuV/m)	15.249 Limit (dBuV/m)	Margin (dB)
1805	V	1	1.30	140	45.0	54.0	9.0
1829	V	3	1.20	115	48.8	54.0	5.2
1853	V	5	1.25	120	44.4	54.0	9.6
2707	H	1	1.00	190	38.9	54.0	15.1
2744	H	3	1.15	25	45.9	54.0	8.1
2779	H	5	1.00	30	39.4	54.0	14.6
3610	H	1	1.15	330	28.2	54.0	25.8
3658	H	3	1.05	315	37.8	54.0	16.2
3706	H	5	1.10	340	29.6	54.0	24.4

Notes:

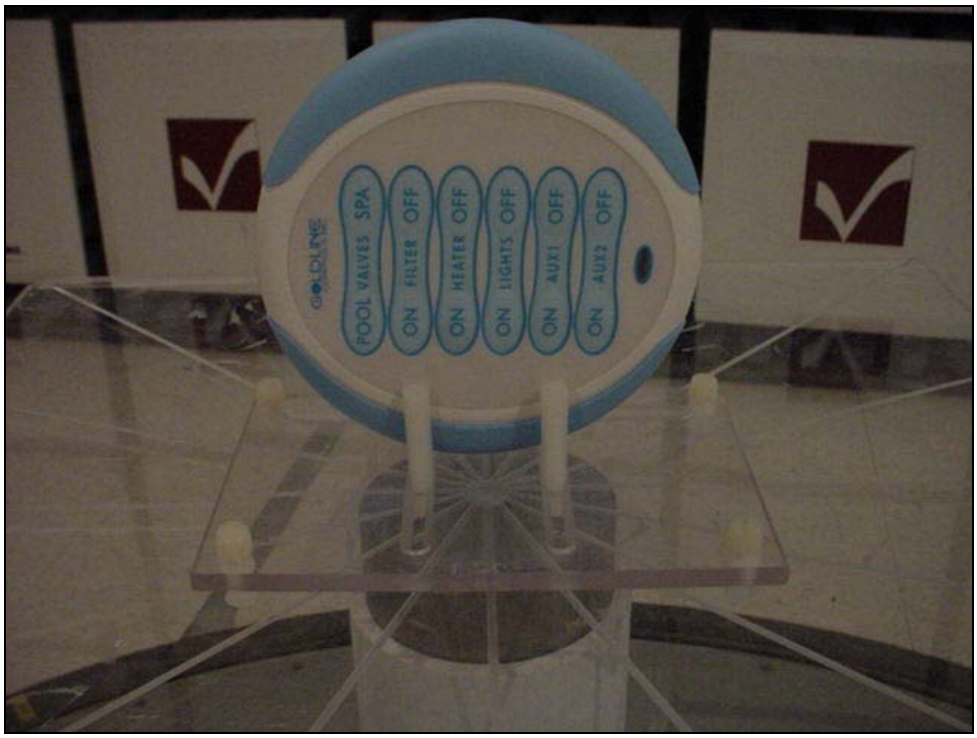
1) No significant emissions seen above the third harmonic of the transmitter
2) All other emissions seen, other than noise floor, were greater than 20 dB below the limit.
3) All peak emissions seen were greater than 20 dB below the 74 dBµV/m limit, above 1 GHz.

Photos Taken During Radiated Emission Testing

EUT in Horizontal Orientation



EUT in Vertical Orientation



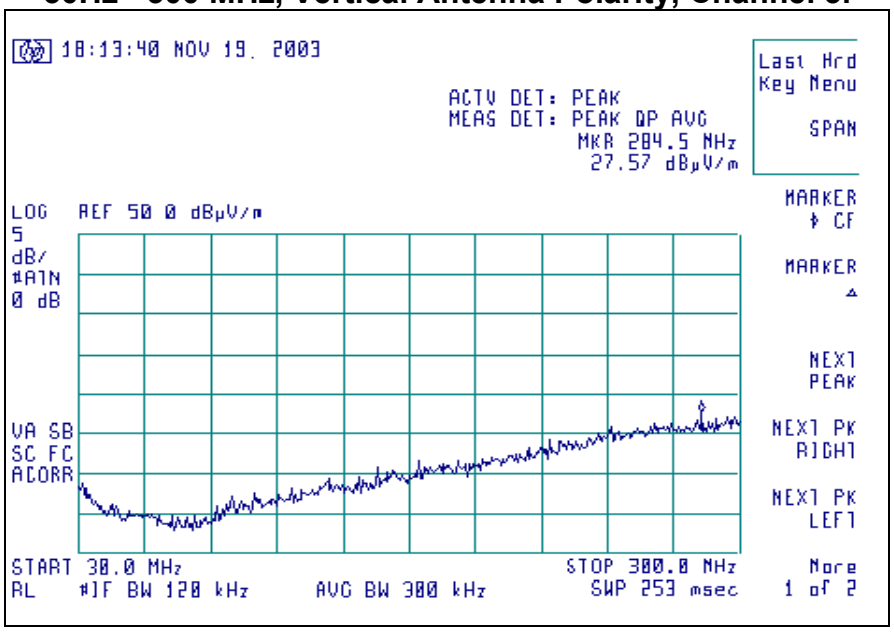
EUT on Side Orientation

Graphs made during Radiated Emission Testing

Highest emissions were observed on the middle channel, set 3, channel 3, which is chosen here for the majority of sample graphs.

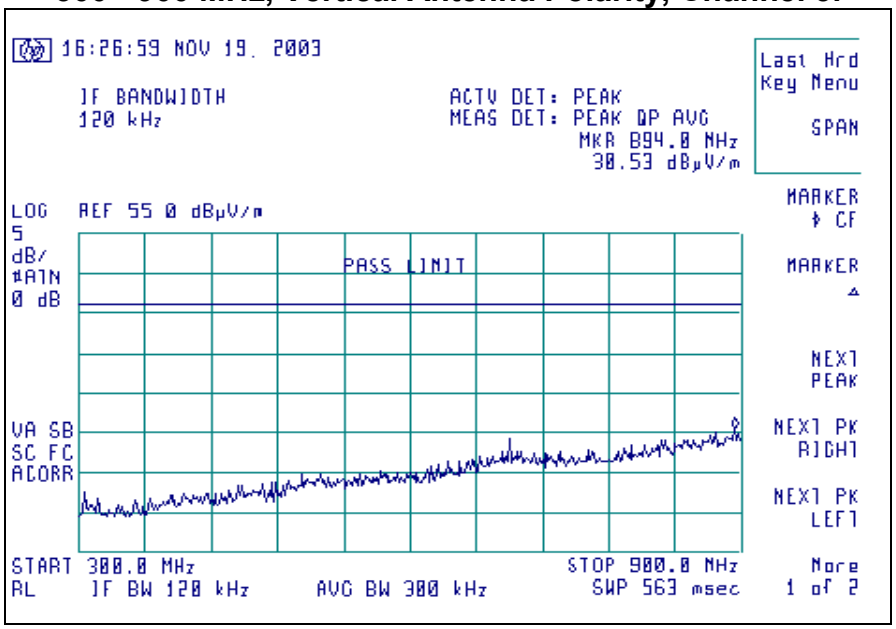
Signature Scan of Radiated Emissions, at 3 meter

30Hz - 300 MHz, Vertical Antenna Polarity, Channel 3.



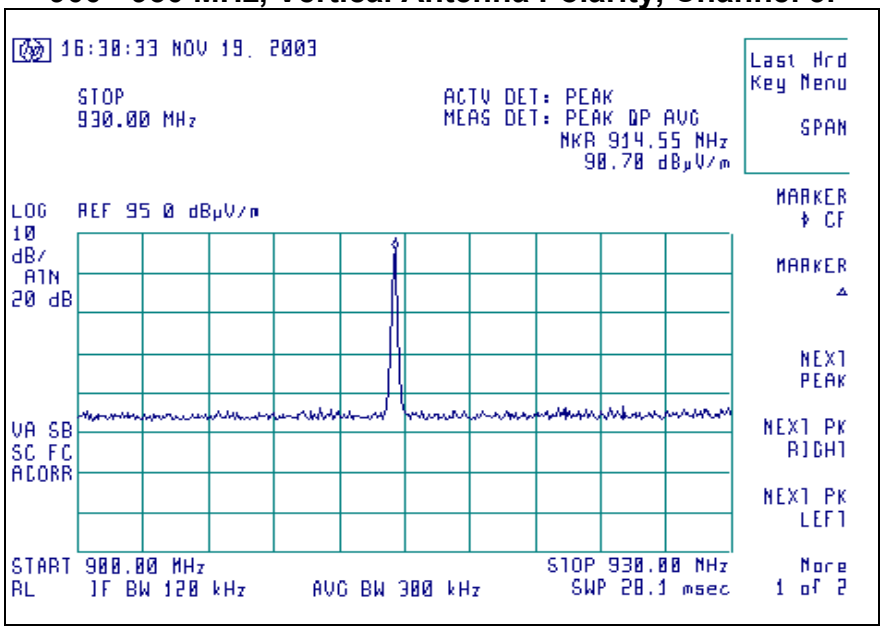
Signature Scan of Radiated Emissions, at 3 meter

300 - 900 MHz, Vertical Antenna Polarity, Channel 3.



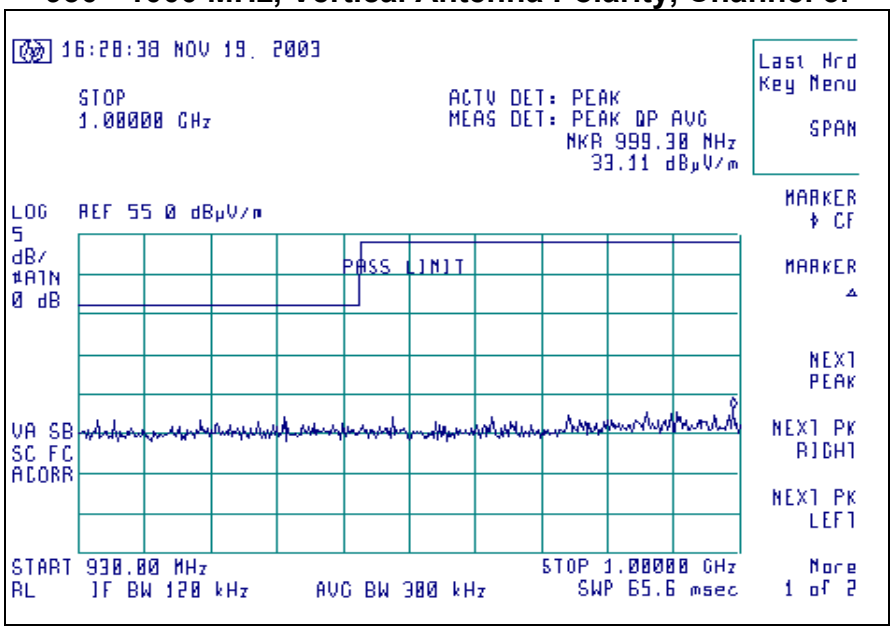
Signature Scan of Radiated Emissions, at 3 meter

900 - 930 MHz, Vertical Antenna Polarity, Channel 3.



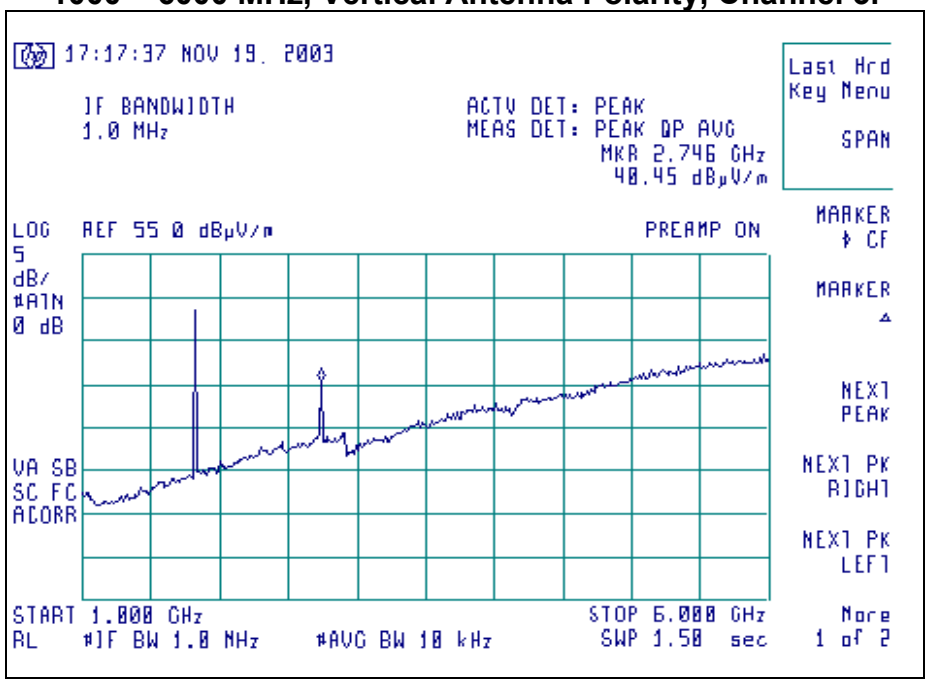
Signature Scan of Radiated Emissions, at 3 meter

930 - 1000 MHz, Vertical Antenna Polarity, Channel 3.



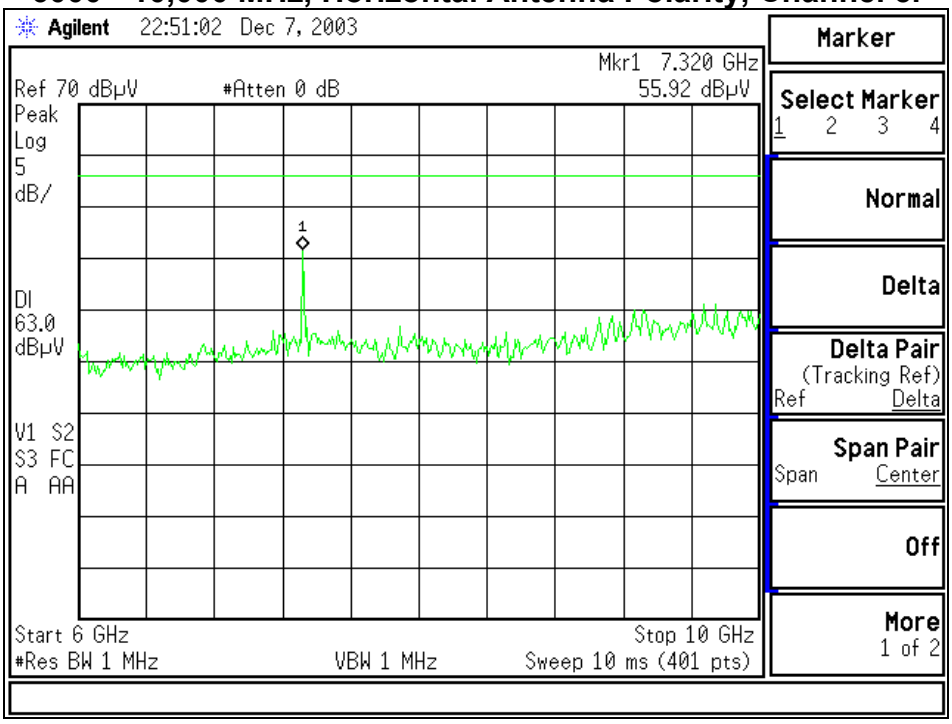
Signature Scan of Radiated Emissions, at 3 meter

1000 – 6000 MHz, Vertical Antenna Polarity, Channel 3.



Signature Scan of Radiated Emissions, at 1 meter

6000 - 10,000 MHz, Horizontal Antenna Polarity, Channel 5.



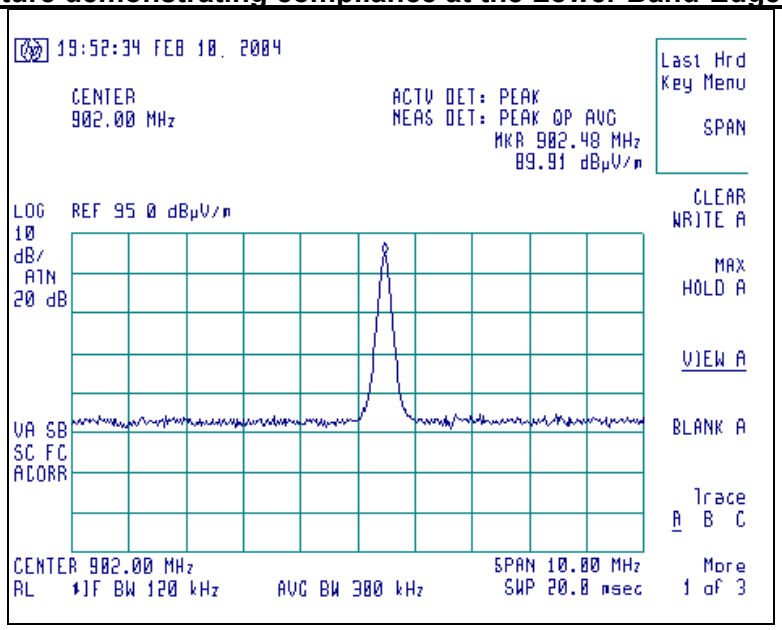
13. Conducted Emissions Test (AC Power Line)

The unit operates on two 'AAA' type batteries, and therefore does not require conducted AC mains emissions tests.

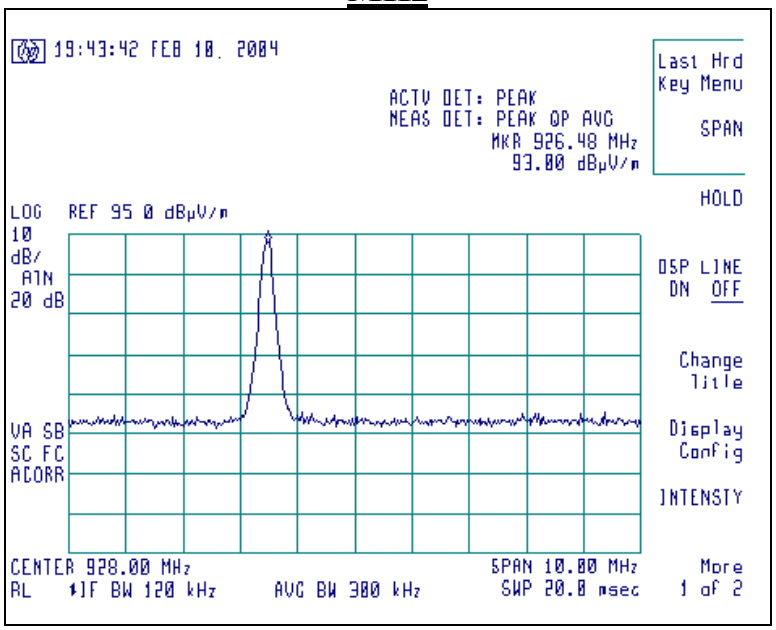
14. Band-Edge Measurements

FCC Part 15.209 (b) requires 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, by operating the EUT at the lowest channel, with a continuous data stream of '1010' as the modulating source, and investigating the lower 902 MHz band-edge, and again by operating the EUT at the highest channel, and investigating the higher 928 MHz band-edge.

Screen Capture demonstrating compliance at the Lower Band-Edge of 902 MHz



Screen Capture demonstrating compliance at the Higher Band-Edge of 928 MHz



15. Frequency and Power Stability versus Voltage

The EUT's power output was measured, on channel 3, as the DC voltage provided to the EUT was varied over a +/- 15 % range from a nominal voltage of 3.0 VDC. This test was performed with the EUT in a fixed position with respect to the receiver, with only the DC input voltage changing during the test. The power output was found to vary less than 1 dB, at voltages above 2.8 VDC, and tends to drop with input voltages lower than 2.8 VDC. Frequency drifted less than 140 Hz, and there were no other anomalies or unexpected observable behavior.

Voltage	Measured Power	Measured Frequency
3.45	88.34 dBμV/m	914.484682 MHz
3.00	88.36 dBμV/m	914.484550 MHz
2.55	83.94 dBμV/m	914.484545 MHz

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	8/12/03	8/12/04
AA960063	EMCO	3160-09	9809-1120	18-26 GHz Horn	6/10/03	6/10/04
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	2/03/04	2/03/04
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
EE960146	Advanced Microwave	WLA622-4	0123001	18-26 GHz Pre-amp	6/10/03	6/10/04
EE960147	Advanced Microwave	WLA612	0123101	5-18 GHz Pre-amp	6/10/03	6/10/04
N/A	LSC	Cable	0011	3 Meter ½" Armored Cable	6/19/03	6/19/04
N/A	LSC	Cable	0038	1 Meter RG 214 Cable	6/19/03	6/19/04
N/A	LSC	Cable	0050	10 Meter RG 214 Cable	6/19/03	6/19/04
N/A	Pasternack	Attenuator	N/A	10 dB Attenuator	6/19/03	6/19/04

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 Meter Chamber, Biconical Antenna	4.24 dB
Radiated Emissions	3 Meter Chamber, Log Periodic Antenna	4.80 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 Meter Chamber, 3 Volts/Meter	1.128 Volts/Meter
Conducted Immunity	3 Volt level	1.0 V