LS RESEARCH LLC
Wireless Product Development

ACCREDITED
TESTING CERT #1255.01

W66 N220 Commerce Court ● Cedarburg, WI 53012
Phone: 262.375.4400 ● Fax: 262.375.4248
www.lsr.com

TEST REPORT #: 312130
LSR Job #: C-1477

Compliance Testing of:

Multitech with WPR

Test Date(s):

June 11, 2012 to June 13, 2012 and July 2, 2012

Prepared For:
Ingersoll Rand
Attn: Ryan Kincaid
11819 N. Pennsylvania St.
Carmel, IN 46074

Permissive Change

This Test Report is issued under the Authority of:
Shane Rismeyer, EMC Engineer

Signature:  Date: 8/9/12

Test Report Reviewed by:	Tested by:
Khairul Aidi Zainal, Senior EMC Engineer.	Shane Rismeyer, EMC Engineer
Signature:  Date:7/30/12	Signature:  Date: 7/17/12

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EXHIBIT 1. INTRODUCTION

1.1 - Scope

References:	FCC Part 15, Subpart C, Section 15.225
Title:	Telecommunication – Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	Permissive Change
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute 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.
Environmental Classification:	Commercial, Industrial or Business Residential

1.2 – Normative References

Publication	Year	Title
47 CFR, Parts 0-15 (FCC)	2012	Code of Federal Regulations - Telecommunications
RSS 210 Annex 2	2010	Low-power License-exempt Radio-communication Devices (All Frequency Bands)
RSS GEN	2010	General requirements and information for the certification of Radio communication Equipment
ANSI C63.4	2003	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
CISPR 16-1-1	2006-03 A1: 2006-09 A2: 2007-07	Specification for radio disturbance and immunity measuring apparatus and methods Part 1-1: Measuring Apparatus
CISPR 16-2-1	2003 A1: 2004-04 A2: 2007-07	Specification for radio disturbance and immunity measuring apparatus and methods Part 201: Conducted disturbance measurement

1.3 - LS Research, LLC Test Facility

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

Industrie Canada Industry Canada
Canada

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

1.4 – 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 a calibration laboratory accredited to the requirements of ISO 17025, and are traceable to the SI Standard. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into the EMI Receiver database. As a result, the data taken from the 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 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).

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 – Client Information

Manufacturer Name:	Ingersoll Rand
Address:	11819 N. Pennsylvania St.
Contact Name:	Ryan Kincaid

2.2 - Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	Multitech with WPR
Model Number:	24123002
Serial Number:	N/A

2.3 - Associated Antenna Description

There are three antennas associated with the EUT:

1. The antenna for the 125 kHz transmitter is a loop antenna made from 33 gauge wire. The coil is in series with a 1500 pH tuning inductance.
2. The antenna for the 13.56 MHz transmitter is a 2 baluns, 2 turn loop antenna terminated to ground and 180° out of phase. The antenna is a PCB trace around the PCB.
3. The antenna for the co-located 900 MHz modular radio is a PCB traced inverted L antenna.

2.4 - EUT'S Technical Specifications

EUT Frequency Range (in MHz)	125 kHz and 13.56 MHz
RF Power in mW (Near-field measurement at 3m)	125 kHz transmitter: 0.0085 13.56 MHz transmitter: 0.0045
Field strength at 3 meters	125 kHz transmitter: 74.5 dBµV/m 13.56 MHz transmitter: 71.8 dBµV/m
Type of Modulation	Un-modulated when scanning. AM when reading
Emission Designator	125 kHz transmitter:448HA1D 13.56 MHz transmitter: 162KA1D
Spurious (worst case) at 3m	125 kHz transmitter: 45.8 dBµV/m 13.56 MHz transmitter: 31.8 dBµV/m
Microprocessor Model # (if applicable)	PIC24F128GB106
EUT will be operated under FCC and IC Rule Part(s)	CFR 47 15.209 and 15.225
Portable/Mobile	☐ Portable ☒ Mobile
Modular Filing	☐ Yes ☒ No

2.5 - Product Description

The Multitech reader is one of IR's ACP (Access Control Point) that can be paired with any of IR's accces point modules. The Multitech ACP in this case is paired with a WPR which provides a wireless link with access point modules. The WPR implements a modular RF transceiver operating in the 902 to 928 MHz ISM band. Information contained in the user credential is read by the Multitech reader via either 125 kHz (PROX) or 13.56 MHz (SmartCard) signal and relayed by the WPR to access point modules which control lock functions and maintains audit trails of the credential used. The Multitech gets its power from the WPR which runs on a rechargeable battery. The WPR can only supply power to the Multitech reader when it is switched to the battery operated mode and not while it is in the charging mode.

WPR (Left) and Multitech reader (Right)

Multitech reader attached to WPR

WPR AC to Dc converter.

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 - Climate Test Conditions

Temperature:	70-72°F
Humidity:	35-40%
Pressure:	750mmHg

3.2 - Applicability & Summary Of EMC Emission Test Results

FCC Paragraph	Test Requirements	Compliance (yes/no)
FCC: 15.107 IC: RSS GEN 7.2.2	Power Line Conducted Emissions Measurements	Yes
FCC: 15.209 IC: RSS 210 2.6	Un-Intentional Radiated Emissions	Yes
FCC: 15.225 (a) IC: RSS 210 A2.6 (a)	Maximum RF Output Power	Yes
FCC: 15.225 (d) IC: RSS 210 A2	Maximum RF Spurious Emissions	Yes
FCC: 15.209 & 15.205 IC: RSS 210 A2 and A6	Transmitter General Radiated Emissions	Yes

3.3 - Modifications Incorporated In The EUT For Compliance Purposes

☒ None ☐ Yes (explain below)

3.4 - Deviations & Exclusions From Test Specifications

☒ None ☐ Yes (explain below)

Note: The radio was also tested for co-location phenomenon since there would be a case where the Multitech reader is transmitting at the same time as the 900 MHz modular transceiver. There will be no instance when the 125 kHz and 13.56 MHz transmitter is transmitting simultaneously therefore co-location phenomenon was not tested between these two transmitters.

EXHIBIT 4. DECLARATION OF CONFORMITY

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.225 and Industry Canada RSS-210 for a Low-Power License-Exempt Transmitter, as well as the specification of FCC Title 47, CFR Part 15.209, Part 15.107 and Industry Canada RSS-210 for non-intentional radiators.

If some emissions are seen to be within 3 dB 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.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

EXHIBIT 5. RADIATED EMISSIONS TEST

5.1 - Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15, RSS GEN and ANSI C63.4. The EUT was placed on an 80cm high non-conductive pedestal, centered on a flush mounted 2-meter diameter turntable inside a 3 meter Semi-Anechoic, FCC listed Chamber. Testing of the EUT was performed on a reader that included a keypad, since this configuration was deemed to have worst case emission characteristics compared to the reader without a keypad. The EUT was set in a configuration where it continuously transmits at 13.56 MHz, next it was set to continuously transmit at 125 kHz. In addition, the EUT was also set in a configuration where the Multitech and the 900MHz modular transceiver were simultaneously transmitting. The WPR was connected to the AC mains and the switch was positioned to the charging mode.

5.2 - Test Procedure

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 9 kHz to 1000 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 a 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 Magnetic Loop Antenna was used from 9 kHz to 30 MHz, 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. 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. The EUT was rotated along three orthogonal axes during the investigations to find the highest emission levels.

5.3 - 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 a calibration laboratory accredited to the requirements of ISO 17025, and are traceable to the SI Standard. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into the EMI Receiver database. As a result, the data taken from the 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 EMI Receiver was operated with a resolution bandwidth set at 200 Hz for measurements from 9kHz to 150kHz, 9kHz for measurements from 150kHz to 30MHz and 120kHz for measurements from 30MHz to 1000 MHz.

5.4 - Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.225 and 15.209 (Canada RSS-210, Issue 7, Annex 2 A2.6). The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

5.5 - Calculation of Radiated Emissions Limits

The maximum peak output power of an intentional radiator in the 13.553-13.56 MHz band, as specified in Title 47 CFR 15.225 and RSS 210 Annex A2.6, is described below. The harmonic and spurious RF emissions, with appropriate receiver bandwidths, as specified in 15.225 (d) and section 2.7 of RSS 210, shall be below the measured power of the desired signal, and must also meet the requirements described in 15.209 and 15.205(c) for FCC and table 1 of RSS 210 where applicable.

At 30m, the fundamental field strength shall not exceed 15848 μV/m or 84 dBμV/m.

At 3m, a correction factor of 40dB (40log(30m/3m)) is used to adjust the limit which becomes:

Field strength = 124 dBμV/m at 3m.

Frequency (MHz)	Limit (μV/m)	Limit (dBμV/m)	Measurement Distance (m)
0.009-0.490	2400/F (kHz)	Note 1	300
0.490-1.705	24000/F (kHz)		30
1.705-30.0	30		30
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

The following table depicts the general radiated emission limits. These limits are obtained from Title 47 CFR, Part 15.209, for radiated emissions measurements and are comparable to that of table 3 in RSS 210 section 2.7. These limits were applied to the spurious emission of the intentional radiator as well as all other significant spurious signals.

Note 1: Sample calculation for the Fundamental Emission of a transmitter:

For Example:
Transmitter operating at a fundamental frequency of 25 kHz, the emission limit may be calculated:
2400/F = 2400/25 = 96.0 μV/m if measured at 300 meters separation.
Expressed in decibels: 20 log(96.0) = 39.64 dBμV/m at 300 m separation.
At 3m separation, the limit may be extrapolated by addition of 40 dB/decade per 47CFR 15.31(f)(2)
Limit for the fundamental emission = 39.64 dBμV/m + 80 dB = 119.6 dB/μV/m at 3 meters

5.6 - Radiated Emissions Test Data Chart

3 Meter Measurements of Electromagnetic Radiated Emissions
Frequency Range Inspected: 9 kHz to 1000 MHz

Manufacturer:	Ingersoll Rand					
Date(s) of Test:	6/11/12-6/13/12 and 7/2/12					
Test Engineer(s):	Shane Rismeyer and Peter Feilen					
Voltage:	Battery					
Operation Mode:	Continuous Transmit/Receive					
Environmental Conditions in the Lab:	Temperature: 20 – 25° C Relative Humidity: 30 – 60 %					
EUT Power:	**X**	Single Phase 120VAC		3 Phase ___VAC		
	X	Battery		Other:		
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:	**X**	Peak	**X**	Quasi-Peak	**X**	Average

125 kHz Transmitter Emissions

Due to the nature of the device it was not possible to isolate the transmit and receive functions so the table below represents data for both modes.

Frequency (kHz)	Polarity	EUT	Height (meters)	Azimuth (degrees)	Measured EFI (dBµV/m)	Limit (dBµV/m)	Margin (dB)
125.0	V	S	1.00	0	74.5	105.7	31.2
249.6	V	V	1.00	0	44.2	99.7	55.5
374.3	V	V	1.00	0	45.8	96.1	50.3
499.2	V	V	1.00	0	41.2	73.6	32.4
623.9	V	V	1.00	0	42.3	71.7	29.4
748.7	V	V	1.00	0	40.1	70.1	30.0
873.5	V	V	1.00	0	40.2	68.8	28.6
998.3	V	V	1.00	0	38.9	67.6	28.7
1123.0	V	V	1.00	0	37.4	66.6	29.2
1248.0	V	V	1.00	0	36.6	65.7	29.1

13.56 MHz Transmitter Emissions

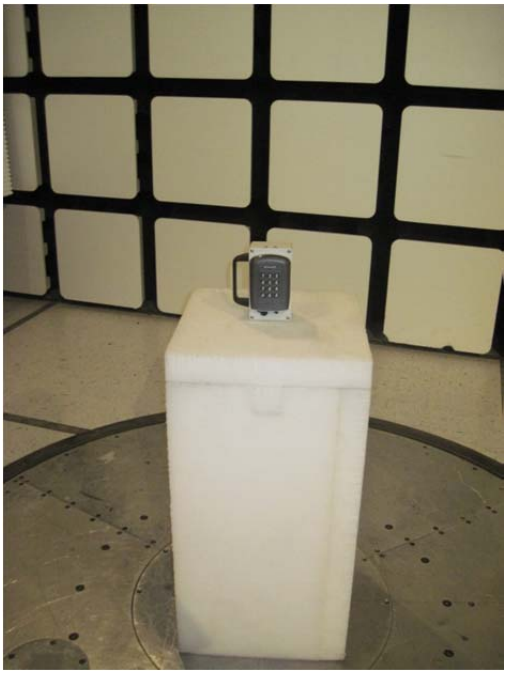
Due to the nature of the device it was not possible to isolate the transmit and receive functions so the table below represents data for both modes.

Frequency (MHz)	Polarity	EUT	Height (meters)	Azimuth (degrees)	Measured EFI (dBµV/m)	Limit (dBµV/m)	Margin (dB)
13.56	V	V	1.00	0	71.8	124.0	52.2
27.12	V	V	1.00	0	27.6	48.6	21.0
40.74	V	V	1.00	78	27.3	40.0	12.7
54.30	V	V	1.00	107	23.1	40.0	16.9
67.88	V	V	1.00	291	20.7	40.0	19.3
81.46	V	V	1.00	93	19.0	40.0	21.0
95.04	V	V	1.00	99	22.2	43.5	21.3
108.62	H	S	2.64	100	31.5	43.5	12.0
122.20	V	V	1.00	36	15.1	43.5	28.4
135.78	V	V	1.00	87	14.0	43.5	29.5

WPR Charging Mode

Frequency (MHz)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
295.4	1.00	0	22.2	46.0	23.8	H	V
35.4	1.00	0	38.5	40.0	1.5	V	V
45.0	1.00	0	39.4	40.0	0.6	V	V
51.4	1.00	0	37.8	40.0	2.2	V	V
72.1	1.00	130	35.2	40.0	4.8	V	V
993.1	1.00	0	26.5	54.0	27.5	V	V
986.3	1.00	0	27	54.0	27.0	H	V

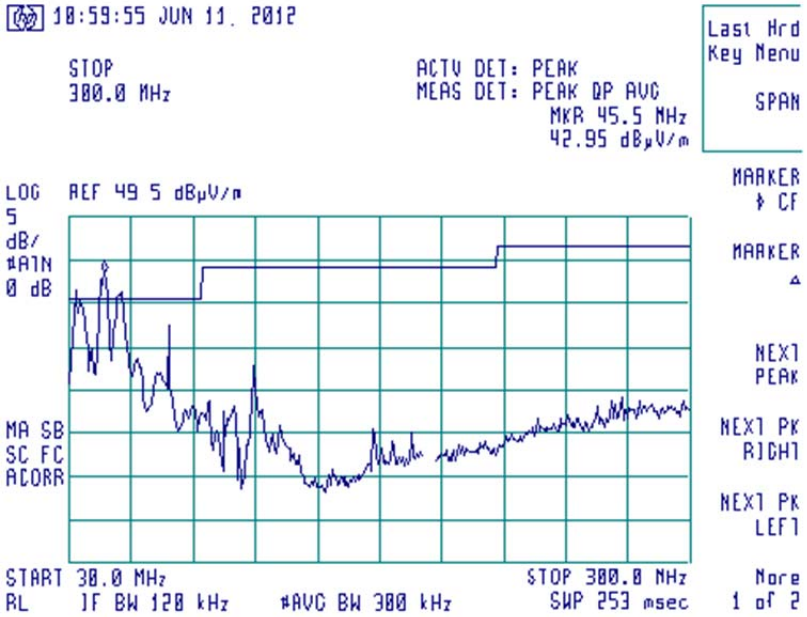
5.7 - Test Setup Photo(s) – Radiated Emissions Test



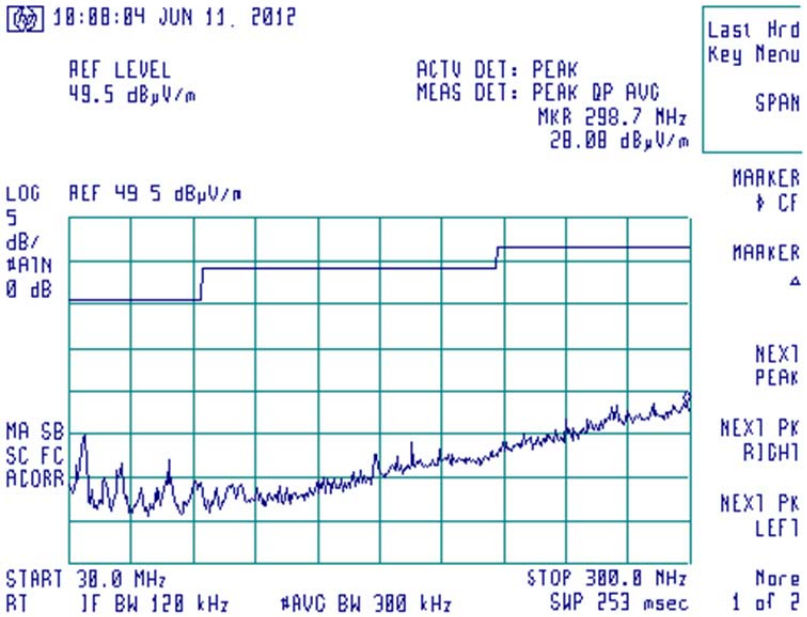
5.8 - Screen Captures - Radiated Emissions Test (Charging Mode)

These screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

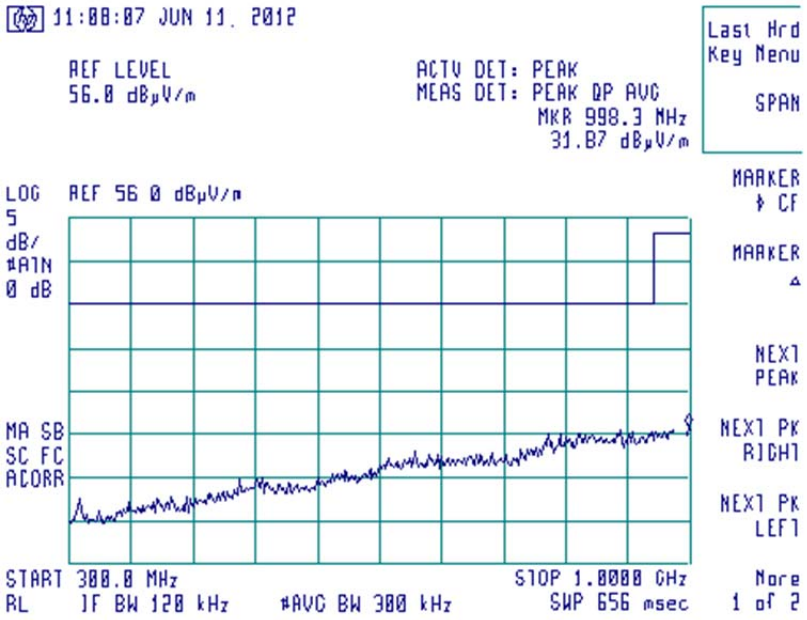
Antenna Vertically Polarized, 30-300 MHz, at 3m



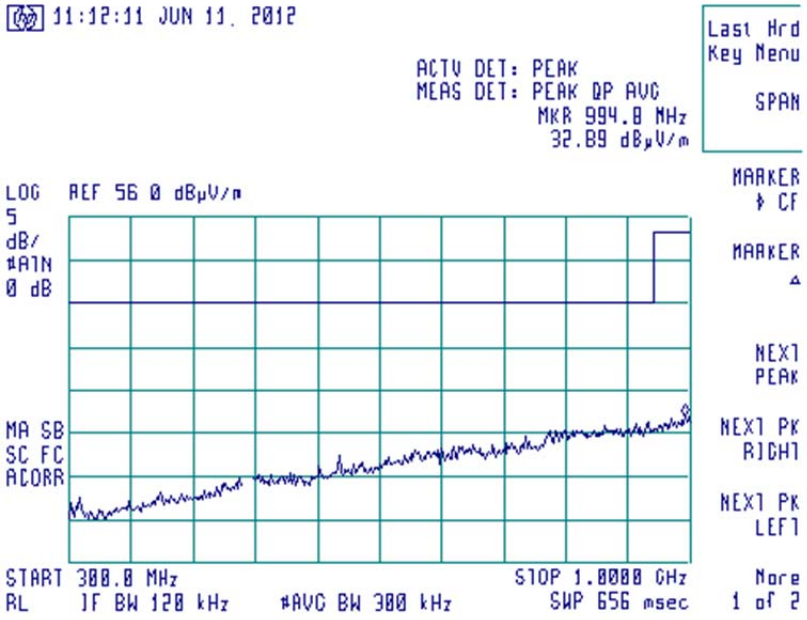
Antenna Horizontally Polarized, 30-300 MHz, at 3m



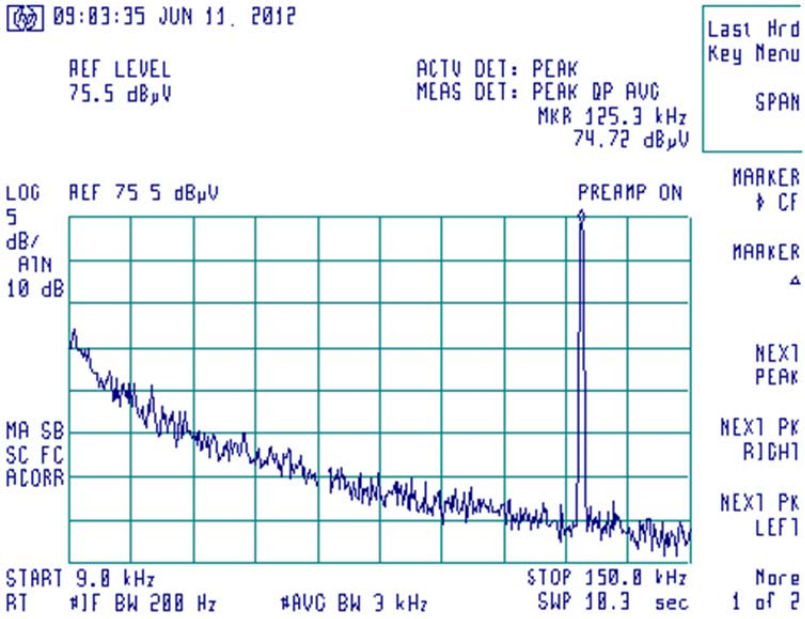
Antenna Vertically Polarized, 300-1000 MHz, at 3m



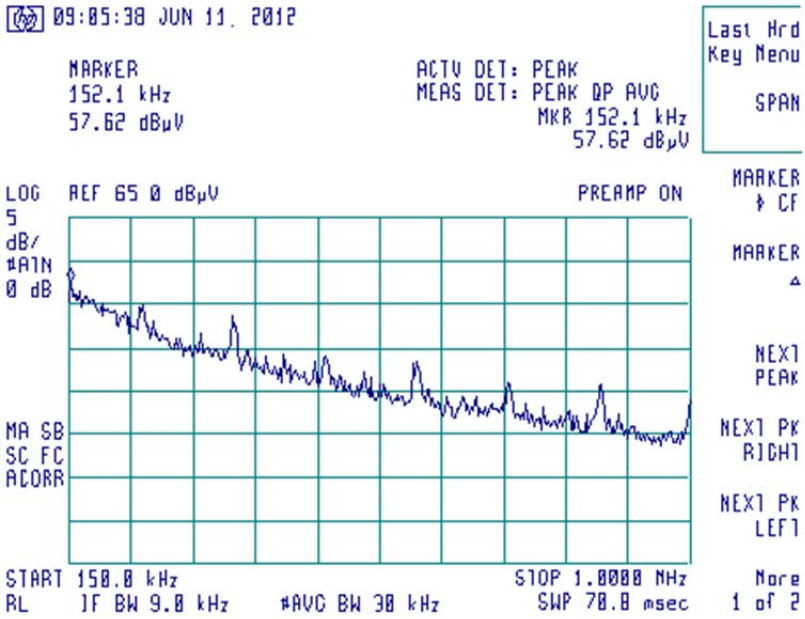
Antenna Horizontally Polarized, 300-1000 MHz, at 3m



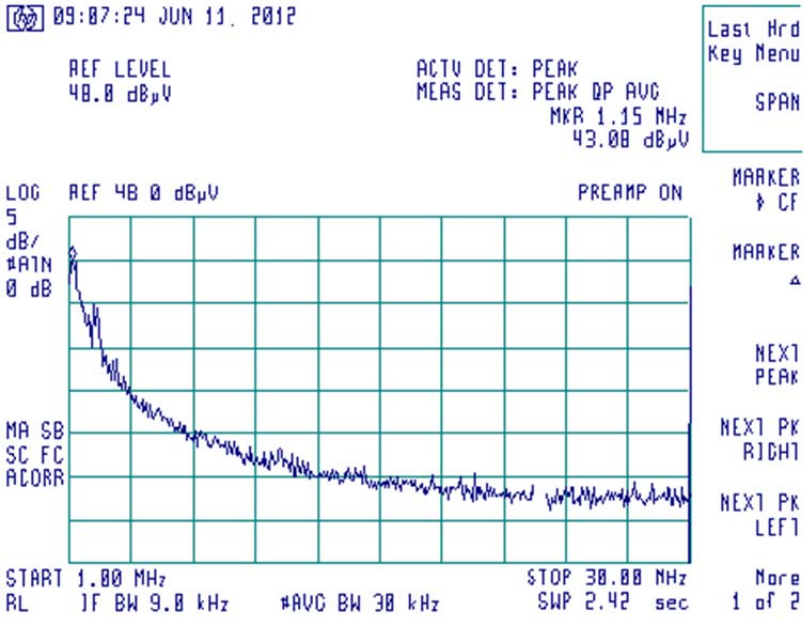
Antenna Vertically Polarized, 9-150 kHz, at 3m



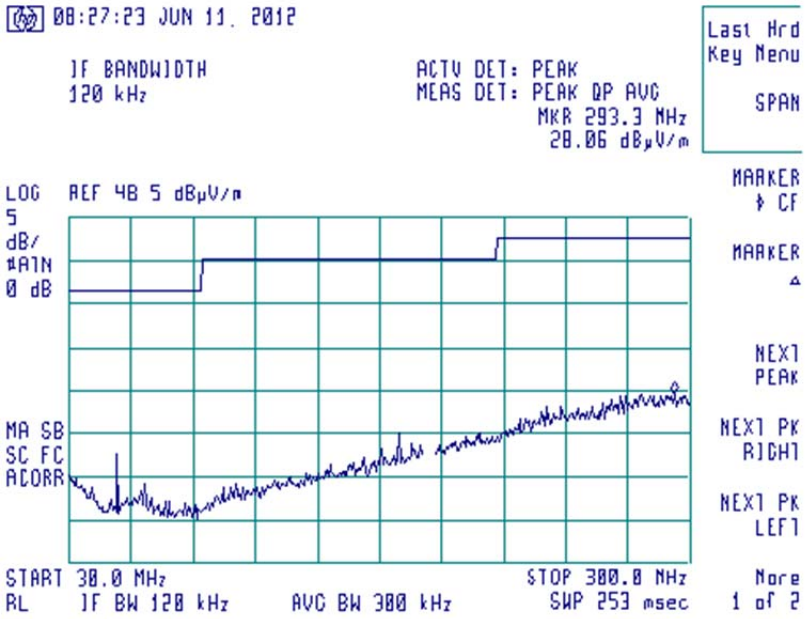
Antenna Vertically Polarized, 150-1000 kHz, at 3m



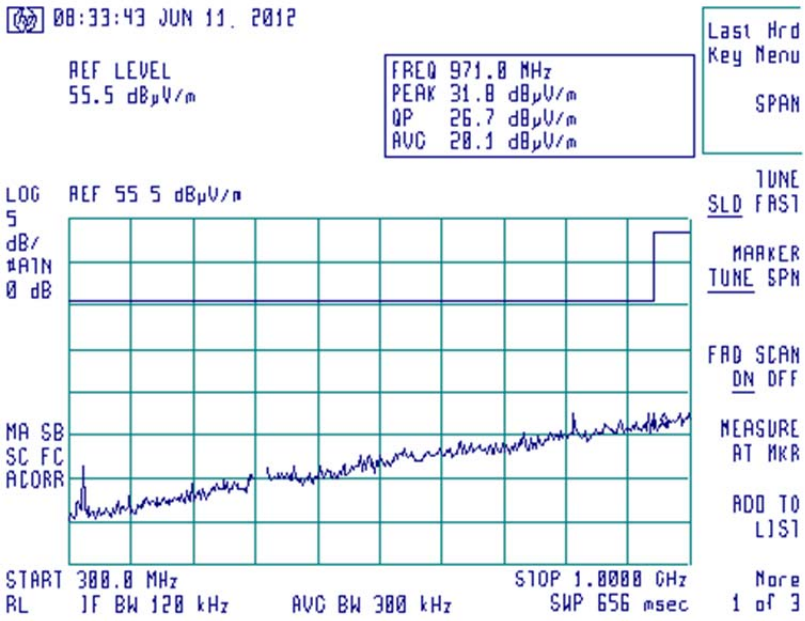
Antenna Vertically Polarized, 1-30 MHz, at 3m



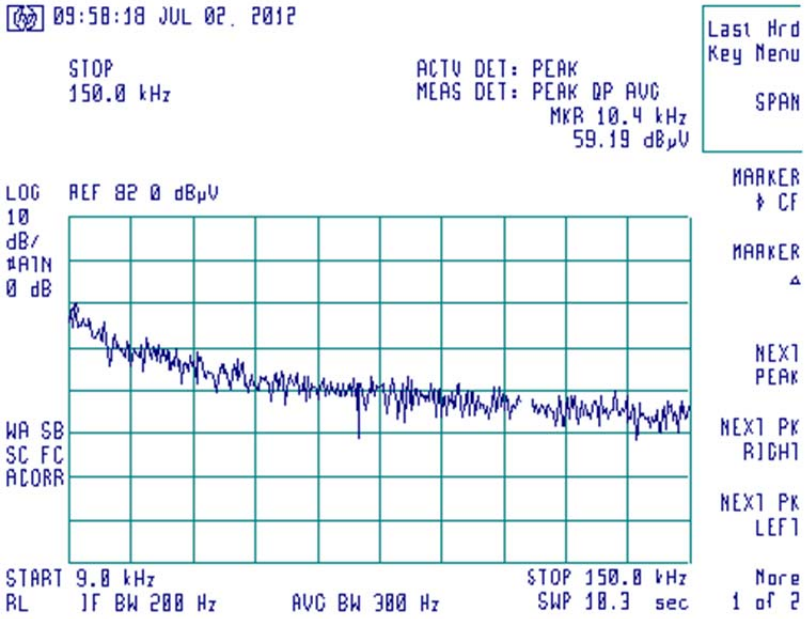
Antenna Vertically Polarized, 30-300 MHz, at 1m



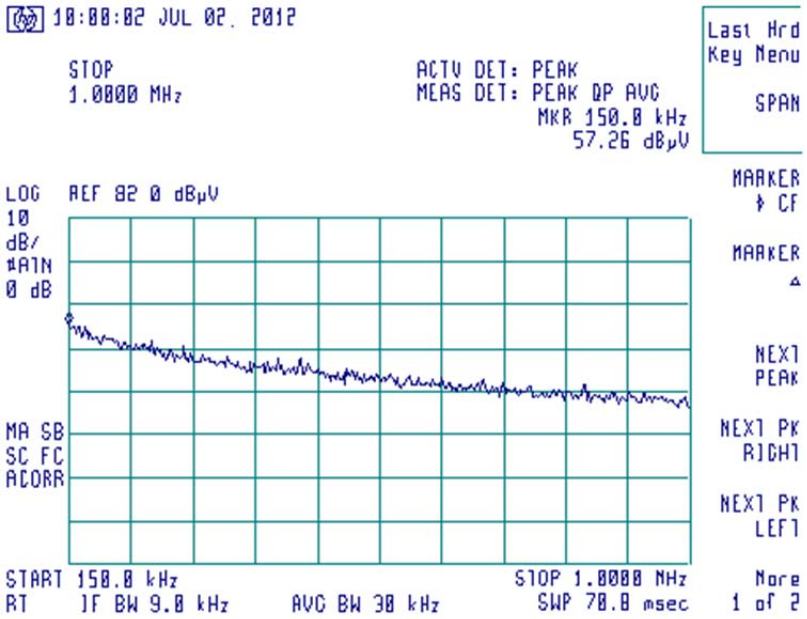
Antenna Vertically Polarized, 300-1000 MHz, at 3m



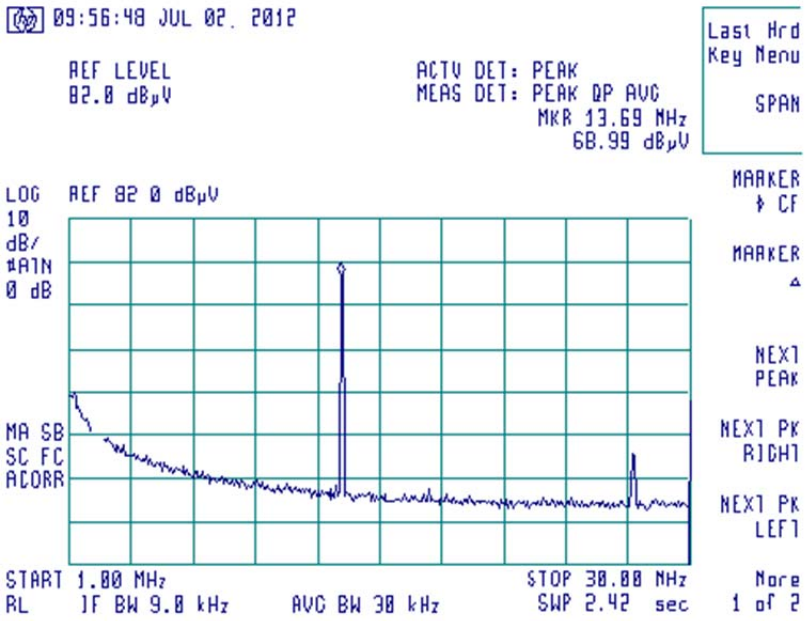
Antenna Vertically Polarized, 9-150 kHz, at 3m



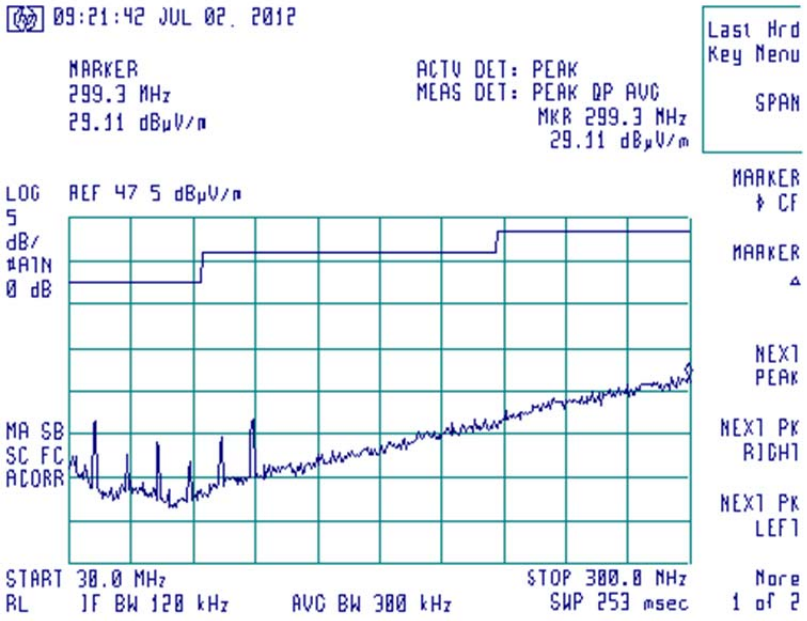
Antenna Vertically Polarized, 150-1000 kHz, at 3m



Antenna Vertically Polarized, 1-30 MHz, at 3m

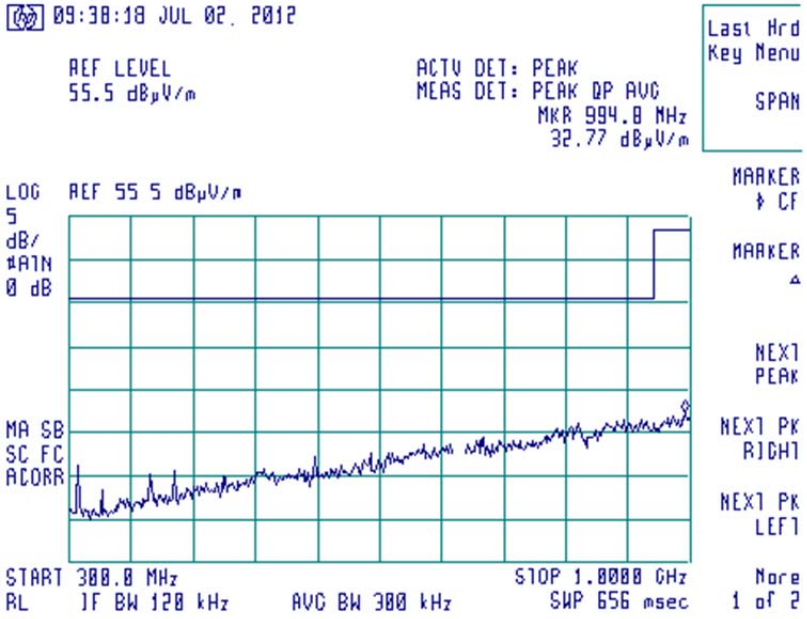


Antenna Vertically Polarized, 30-300 MHz, at 3m



Screen Captures - Radiated Emissions Testing *(continued)*

Antenna Vertically Polarized, 300-1000 MHz, at 3m



APPENDIX A – Test Equipment List

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date: 11-Jun-2012 Type Test: Radiated Emissions (109) Job #: C-1477

Prepared By: Shane Rismeyer Customer: Ingersoll Rand Quote #: 312130

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960006	Active Loop Antenna	EMCO	6502	9205-2753	9/21/2011	9/21/2013	Active Calibration
2	AA 960150	Bicon Antenna	ETS	3110B	0003-3346	11/15/2011	11/15/2012	Active Calibration
3	EE 960147	Pre-Amp	Adv. Micro	WLA612	123101	1/6/2012	1/6/2013	Active Calibration
4	EE 960013	EMI Receiver	HP	8546A System	3617A00320;3448A	11/22/2011	11/22/2012	Active Calibration
5	EE 960014	EMI Receiver-filter section	HP	85460A	3448A00296	11/22/2011	11/22/2012	Active Calibration

Project Engineer: Quality Assurance:

APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2003		
RSS 210	2010		
FCC Public Notice	200		
FCC ET Docket No. 99-231	2002		
FCC Procedures	2007		
CISPR 16-1-1 Note 1	2006-03	2006-09	2007-07
CISPR 16-1-2 Note 1	2003	2004-04	2006-07

APPENDIX C - Uncertainty Statement

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

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.82 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.88 dB
Radiated Emissions	3-Meter Chamber, Horn Antenna	4.85 dB
Radiated Emissions	10-Meter OATS, Biconical Antenna	4.32 dB
Radiated Emissions	10-Meter OATS, Log Periodic Antenna	3.63 dB
Absolute Conducted Emissions	Agilent PSA/ESA Series	1.38 dB
AC Line Conducted Emissions	Shielded Room/EMCO LISN	3.20 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	2.05 Volts/Meter
Conducted Immunity	3 Volts level	2.33 V
EFT Burst, Surge, VDI	230 VAC	54.4 V
ESD Immunity	Discharge at 15kV	3200 V
Temperature/Humidity	Thermo-hygrometer	0.64° / 2.88 %RH