LS RESEARCH, LLC
WIRELESS PRODUCT DEVELOPMENT
ACCREDITED
Testing Cert. 1255.01
W66 N220 Commerce Court ● Cedarburg, WI 53012 ● USA
Phone: 262.375.4400 ● Fax: 262.375.4248
www.lsr.com

TEST REPORT # 310192
LSR Job #: C-942

Compliance Testing of:

Dispenser Communication Module

Test Date(s):
June 29th - July 14th, August 13th, 18th, and 19th 2010.

Prepared For:
Ecolab
655 Lone Oak Drive F6
Eagan, MN 55121

In accordance with:
Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.249 and 15.209
Industry Canada (IC) RSS 210 Annex 2
Transmitters Operating in the
Frequency Band 902 MHz – 928 MHz and 9 kHz to 490 kHz

This Test Report is issued under the Authority of:

Signature: Date: 08.27.10

Test Report Reviewed by:	**Tested by:**
Thomas T. Smith, Manager EMC Test Services	Khairul Aidi Zainal, Senior EMC Engineer
Signature: Date: 08.27.10	Signature: Date: 08.27.10

TABLE OF CONTENTS *(page 1 of 2)*

TABLE OF CONTENTS *(Page 2 of 2)*

EXHIBIT 1. INTRODUCTION

1.1 SCOPE

References:	FCC Part 15, Subpart C, Section 15.249 and 15.209 FCC Part 2, Section 2.1043 paragraph (b)1. RSS GEN and RSS 210 Annex 2
Title:	FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15. IC : Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
Purpose of Test:	To gain FCC and IC Certification Authorization for Low-Power License-Exempt Transmitters.
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	Title
47 CFR, Parts 0-15 (FCC)	Code of Federal Regulations - Telecommunications
RSS 210	Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
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.
CISPR 16-1-1	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus.
CISPR 16-2-1	Specification for radio disturbance and immunity measuring apparatus and methods. Part 201: Conducted disturbance measurement.

1.3 LS Research, LLC TEST FACILITY

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025, 2005 "General Requirements for the Competence of Calibration and Testing Laboratories".

LS Research, LLC's scope of accreditation includes all test methods listed herein, unless otherwise noted. A copy of the accreditation may be accessed on our web site: www.lsr.com. Accreditation status can be verified at A2LA's web site: www.a2la2.net.

1.4 LOCATION OF TESTING

All testing was performed at LS Research, LLC, W66 N220 Commerce Court, Cedarburg, Wisconsin, 53012 USA, utilizing the facilities listed below, unless otherwise noted.

List of Facilities Located at LS Research, LLC:

- Compact Chamber
- Semi-Anechoic Chamber
- Open Area Test Site (OATS)

1.5 TEST EQUIPMENT UTILIZED

A complete list of equipment utilized in testing is provided in Appendix A of this test report. Calibration dates are indicated in Appendix A. All test equipment is calibrated in accordance with A2LA standards.

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 CLIENT INFORMATION

Manufacturer Name:	**Ecolab**
Address:	**655 Lone Oak Drive F6, Eagan MN 55121**
Contact Name:	**Cheryl Littau**

2.2 EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information has been supplied by the applicant.

Product Name:	Dispenser Communication Module
Model Number:	DCM1PT
Serial Number:	10240154

2.3 ASSOCIATED ANTENNA DESCRIPTION

The antennas used in this device are a Johanson 900 MHz ceramic chip antenna (P/N 0915AT43A0026) and a KGEA-WT low frequency antenna.

2.4 EUT'S TECHNICAL SPECIFICATIONS

Additional Information:

EUT Frequency Range (in MHz)	906.4 MHz to 921.6 MHz 0.1348 MHz
RF Power in Watts	
Minimum:	0.000627 Watts
Maximum:	0.000656 Watts
Field Strength at 3 meters	900 MHz Transceiver : 93.4 dBµV/m . 134.8 kHz Transmitter: 93.2 dBµV/m.
Occupied Bandwidth	900 MHz Transceiver : 126.6 kHz 134.8 kHz Transmitter: 134.0 kHz
Type of Modulation	GFSK for 900MHz radio. Burst Width Modulation for LF radio.
Emission Designator	127KF1D (900MHz radio) 34KG1D (134.8 kHz radio)
EIRP (in mW)	900 MHz Transceiver : 0.656 mW 134.8 kHz Transmitter: N/A
Transmitter Spurious (worst case) at 3 meters	51.46 dBµV/m (5529.6 MHz)
Stepped (Y/N)	No
Step Value:	N/A
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Microprocessor Model # (if applicable)	CC430F5137
Antenna Information	
Detachable/non-detachable	Non-detachable
Type	Ceramic chip antenna LF coil antenna
Gain (in dBi)	Ceramic chip = -1.0 dBi (Data Sheet) LF Coil = Not available.
EUT will be operated under FCC Rule Part(s)	15.249 and 15.209
EUT will be operated under RSS Rule Part(s)	RSS 210 Annex 2
Modular Filing	☐ Yes ☒ No
Portable or Mobile?	Portable

2.5 PRODUCT DESCRIPTION

The Ecolab Dispenser Communication Module is permanently mounted next to, and connected to, dispensers in patient care areas of hospitals to allow the transmission of information regarding dispenser use to the hand Hygiene Badge of employees using the dispenser. This transmission of information is achieved by utilizing a 900 MHz transceiver and a 134.8 kHz transmitter. These two radios will never transmit at the same time.

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 CLIMATE TEST CONDITIONS

Temperature:	71° F
Humidity:	42 %
Pressure:	751 mmHg

3.2 APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC and IC Paragraph	Test Requirements	Compliance (yes/no)
FCC : 15.207 IC : RSS GEN sect. 7.2.2	Power Line Conducted Emissions Measurements	N/A
IC : RSS GEN section 4.6.1	20 dB Bandwidth	YES
FCC : 15.249(A), 15.209 & 1.1310 IC : RSS 210 A2.9 (a) & A2.1	Maximum Output Power	YES
FCC : 1.1307, 1.1310, 2.1091 & 2.1093 IC : RSS 102	RF Exposure Limit	YES
FCC : 15.249(a) & 15.209 IC : RSS 210 A2.9(a) & A2.1	Transmitter harmonics	YES
FCC : 15.249(d), 15.209 & 15.205 IC : RSS 210 A2.9(b) & A2.1	Transmitter Radiated Emissions	YES
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices (RSS GEN and RSS 210 of IC) and the associated Radio Receiver has also been tested and found to comply with Part 15, Subpart B – Radio Receivers (RSS GEN and RSS 210 of IC). The Receiver Test Report is available upon request.		

3.3 MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

☐ **None** ☒ **Yes (explain below)**

The power level of the transmitter was set to setting 8B. In addition five (5) 1.8 pF capacitors were added to pins 27, 31, 35, 36 and 37 of the CC430F5137 microcontroller.

3.4 DEVIATIONS & EXCLUSIONS FROM TEST SPECIFICATIONS

☒ **None** ☐ **Yes (explain below)**

EXHIBIT 4. DECLARATION OF CONFORMITY

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.249 & 15.209 and Industry Canada RSS-210, Annex 2.1 & Annex 2.9.

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. The EUT was operated in continuously transmitting modulated mode using power as provided by a battery. The unit has the capability to operate on 3 channels, controllable using shorting pins.

The applicable limits apply at a 3 meter distance. Measurements above 3 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 complete list of test equipment. The test sample was operated on one of four (3) standard channels: **906.4 MHz, 913.8 MHz and 921.6 MHz** to comply with FCC Part 15.35.

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 10000 MHz was scanned and investigated. In cases where emissions below 30MHz were found, measurements of those emissions were repeated on the OATS at a 10m measurement distance. 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.

For emissions below 30 MHz, an active loop antenna was used. The loop antenna was set at a height of 1m above the conducting ground plane and it was rotated about its vertical and horizontal axes (while utilizing the turntable to rotate the EUT) in order to measure the maximum radiated RF emissions.

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 10 GHz.

In the frequency range of 30 MHz to 3 GHz, the maximum radiated RF emissions were found by raising and lowering the antenna between 1 and 4 meters in height while for the range of 3 GHz to 10 GHz the antenna was raised and lowered between 1 and 1.8 meters in height. In addition, the polarity of the antenna was switched between horizontal and vertical polarity.

The EUT was positioned in three orthogonal positions for the test.

Battery Voltage was periodically checked to ensure sufficient supply.

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 an IEC/ISO 17025 accredited calibration laboratory, traceable to the SI standard. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and an 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. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBµV/m) + Antenna correction Factor +Cable factor (dB) + Miscelaneous factors when applicable (dB) – amplification factor when applicable (dB).

The EMI Receiver was operated with resolution bandwidths as prescribed in ANSI C63.4.

5.4 Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part **15.249 & 15.209** and Canada **RSS-210, Annex 2.9 & Annex 2.1**. The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

5.5 SAMPLE CALCULATION OF RADIATED EMISSIONS LIMITS AND REPORTED DATA

Reported data:

For both fundamental and spurious emissions measurement, the data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBμV/m) + Antenna correction Factor + Cable factor (dB) + Miscellaneous factors when applicable (dB) – amplification factor when applicable (dB).

Field Strength of Fundamental Frequencies:
The fundamental emissions for an intentional radiator in the 902-928 MHz band, operating under FCC part 15.249 and RSS 210 A2.9 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 a and d
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)

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

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

902-928 MHz example: $=20 \log_{10} (50000/1)$
$=93.98$ dBµV/m

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

Generic example of reported data at 200 MHz:

Reported Measurement data = 18.2 (raw receiver measurement) + 15.8 (antenna factor) + 1.45 (cable factor)
= 35.45 (dBµV/m).

5.6 RADIATED EMISSIONS TEST DATA CHART

Measurements of Electromagnetic Radiated Emissions
Frequency Range Inspected: 10 kHz to 10000 MHz

Manufacturer:	Ecolabs						
Date(s) of Test:	June 29th to July 14th, August 13th and 18th 2010.						
Project Engineer:	Khairul Aidi Zainal						
Test Engineer(s):	Khairul Aidi Zainal						
Voltage:	3.0 VDC						
Operation Mode:	Continuous transmit and modulated.						
Environmental Conditions in the Lab:	Temperature: 71° F Relative Humidity: 42 %						
EUT Power:		Single Phase 120 VAC		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	X	3/10m OATS			
Measurements:		Pre-Compliance		Preliminary	X	Final	
Detectors Used:	X	Peak	X	Quasi-Peak	X	Average	

The following table depicts the level of radiated fundamental:

A. 900 MHz Radio

FREQ (MHz)	ANT	EUT	HEIGHT (m)	AZIMUTH (°)	PEAK (dBµv/m)	Q.PEAK (dBµv/m)	AVERAGE (dBµv/m)	LIMIT (dBµv/m)	MARGIN (dB)
921.59	H	F	1.59	101	93.7	93.2	91.5	94.0	0.8
913.80	H	F	1.62	101	94.4	93.4	91.9	94.0	0.6
906.40	H	F	1.00	96	93.6	93.2	91.4	94.0	0.8

Note:
1. H = Horizontal, V = Vertical, F=Flat.

B. Low Frequency Radio

3.0 M MEASUREMENTS OF FUNDAMENTAL									
FREQ (MHz)	LOOP ANT	EUT	HEIGHT (m)	AZIMUTH (°)	PEAK (dBµv/m)	Q.PEAK (dBµv/m)	AVERAGE (dBµv/m)	LIMIT (dBµv/m)	MARGIN (dB)
0.135	V	V	1.00	87	93.2	93.2	93.2	105.0	11.8

10.0 M MEASUREMENTS OF FUNDAMENTAL									
FREQ (MHz)	LOOP ANT	EUT	HEIGHT (m)	AZIMUTH (°)	PEAK (dBµv/m)	Q.PEAK (dBµv/m)	AVERAGE (dBµv/m)	LIMIT (dBµv/m)	MARGIN (dB)
0.135	V	V	1.00	86	69.9	67.9	66.8	84.1	17.3

Note:
2. H = Horizontal, V = Vertical, F=Flat.

RADIATED EMISSIONS DATA CHART *(continued)*

C. Harmonics of 900Mhz radio

The following table depicts the level of harmonic emissions seen on the low channel:

Antenna Polarization	Frequency (MHz)	Peak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (°)	EUT Orientation
Note 3	1812.8	48.8	40.9	54.0	13.1			
Note 3	2719.2	39.2	31.1	54.0	22.9			
Vertical	3625.6	52.3	46.0	63.5	17.5	100.0	71	F
Horizontal	4532.0	49.4	41.3	63.5	22.2	104.3	341	V
Horizontal	5438.4	62.8	60.6	63.5	2.9	109.4	37	V
Horizontal	6344.8	56.4	53.5	63.5	10.0	106.3	38	V
Horizontal	7251.2	48.9	37.5	63.5	26.0	109.1	309	V
Horizontal	8157.6	50.2	40.6	63.5	22.9	108.6	269	S
Horizontal	9064.0	48.5	37.6	63.5	25.9	108.1	281	S

The following table depicts the level of harmonic emissions seen on middle channel:

Antenna Polarization	Frequency (MHz)	Peak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (°)	EUT Orientation
Note 3	1827.6	48.8	40.9	54.0	13.1			
Note 3	2741.4	38.9	31.1	54.0	22.9			
Horizontal	3655.2	50.8	42.2	63.5	21.3	133.5	143	V
Horizontal	4569.0	49.8	41.8	63.5	21.7	100.0	327	S
Horizontal	5482.8	62.3	60.4	63.5	3.1	105.4	21	V
Horizontal	6396.6	57.0	53.8	63.5	9.7	100.8	35	V
Horizontal	7310.4	47.7	36.2	63.5	27.3	108.6	8	V
Horizontal	8224.2	51.5	42.5	63.5	21.0	110.9	275	S
Horizontal	9138.0	48.6	36.6	63.5	26.9	101.0	7	V

The following table depicts the level of harmonic emissions seen on high channel:

Antenna Polarization	Frequency (MHz)	Peak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Azimuth (°)
Note 3	1843.2	48.7	40.9	54.0	13.1		
Note 3	2764.8	39.1	31.3	54.0	22.7		
Horizontal	3686.4	53.1	45.9	63.5	17.6	127.7	162
Horizontal	4608.0	51.9	45.6	63.5	17.9	117.2	333
Vertical	5529.6	62.9	61.0	63.5	2.5	103.0	20
Horizontal	6451.2	56.9	53.6	63.5	9.9	105.3	36
Vertical	7372.8	48.3	36.9	63.5	26.6	102.7	38
Vertical	8294.4	49.7	39.8	63.5	23.7	110.7	190
Vertical	9216.0	48.8	37.3	63.5	26.2	109.4	23

Notes:

1) A Peak Detector was used in measurements above 1 GHz, for average measurement, the peak detector was used with lower VBW. The peak detector was used to ensure the peak emissions did not exceed 20 dB above the limits.
2) Measurements above 3 GHz were made at 1 meter of separation from the EUT. The applicable limit was adjusted to reflect the measurement distance.
3) Measurement at receiver system noise floor.

D. Harmonics of the Low Frequency Radio.

3.0 M MEASUREMENTS OF HARMONICS									
FREQ (MHz)	LOOP ANT	EUT	HEIGHT (m)	AZIMUTH (°)	PEAK (dBµv/m)	Q.PEAK (dBµv/m)	AVERAGE (dBµv/m)	LIMIT (dBµv/m)	MARGIN (dB)
0.270			Note 3		54.0	49.7	42.9		
0.404	V	V	1.00	279	53.0	51.6	46.8	95.5	48.7
0.539			Note 3		45.7	42.5	35.6		
0.674	V	V	1.00	270	47.7	44.9	40.4	71.0	26.1
0.809			Note 3		31.6	28.6	24.3		
0.944	V	F	1.00	258	46.3	44.1	40.8	68.1	24.0
1.078			Note 3		39.5	35.7	28.9		
1.213	V	F	1.00	103	41.7	39.8	35.9	65.9	26.1
1.348			Note 3		36.7	33.4	26.7		

Notes:

1) Harmonics seen at a 3m separation was also measured at 10m separation on the OATS. These harmonics were all buried within the system noise floor.
2) H = Horizontal, V = Vertical, F=Flat.
3) Measurement at receiver system noise floor.

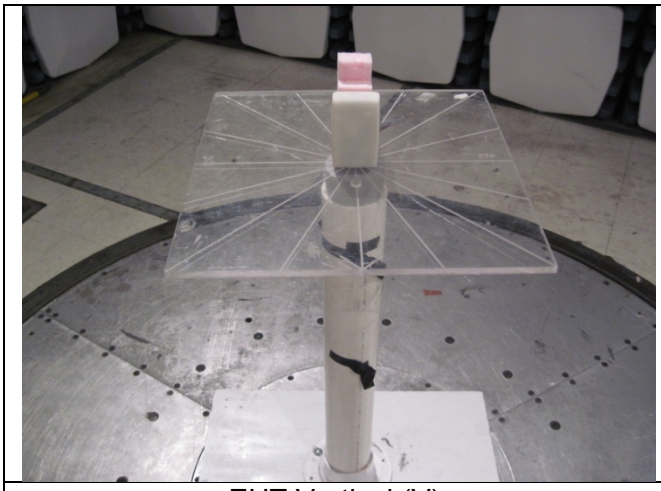
E. Significant spurious emissions other than harmonics.

FREQ (MHz)	ANT	EUT	HEIGHT (m)	AZIMUTH (°)	PEAK (dBµv/m)	Q.PEAK (dBµv/m)	AVERAGE (dBµv/m)	LIMIT (dBµv/m)	MARGIN (dB)
789.80	H	V	1.00	0	32.5	27.5	20.5	46.0	18.5
754.60	V	V	1.00	0	32.3	26.5	19.9	46.0	19.5
298.33	V	V	1.00	0	32.5	26.1	19.6	46.0	19.9
182.08	H	V	1.00	218	22.6	15.8	7.9	43.0	27.2

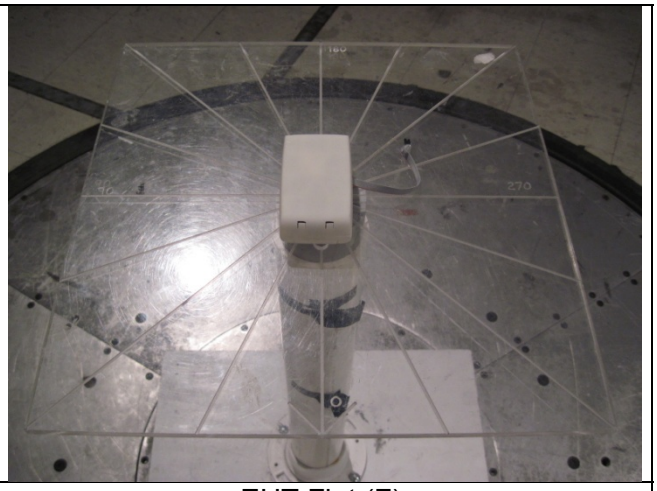
Note:

1. H = Horizontal, V = Vertical, F= Flat.
2. Data listed above are measurements of the system noise floor.
3. There were no spurious emissions detected above the noise floor.

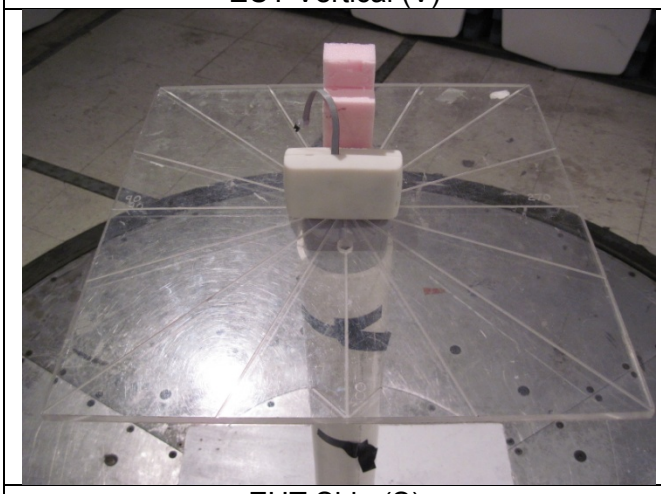
5.7 Test Setup Photo(s) – Radiated Emissions Test



EUT Vertical (V)



EUT Flat (F)



EUT Side (S)

Low Frequency OATS Measurement

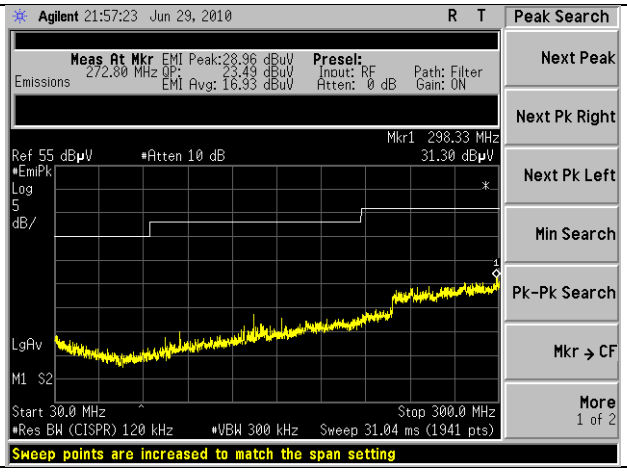
5.8 Screen Captures - Radiated Emissions Test

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

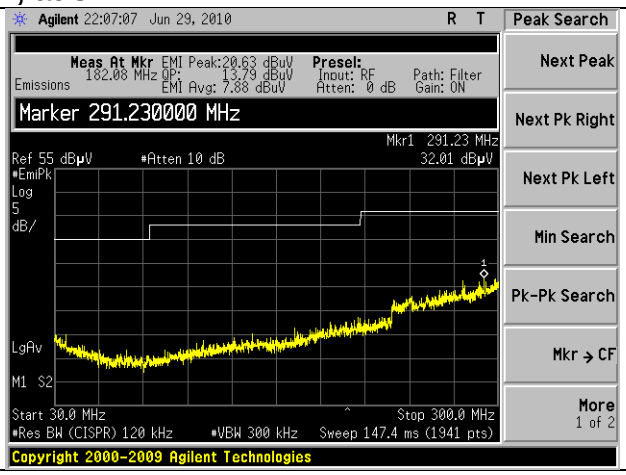
The signature scans shown here are from worst-case emissions, as measured on channels low, middle and high, with the sense antenna both in vertical and horizontal polarity for worst case presentations.

5.8.1 900 MHz Radio

30-300 MHz, at 3m

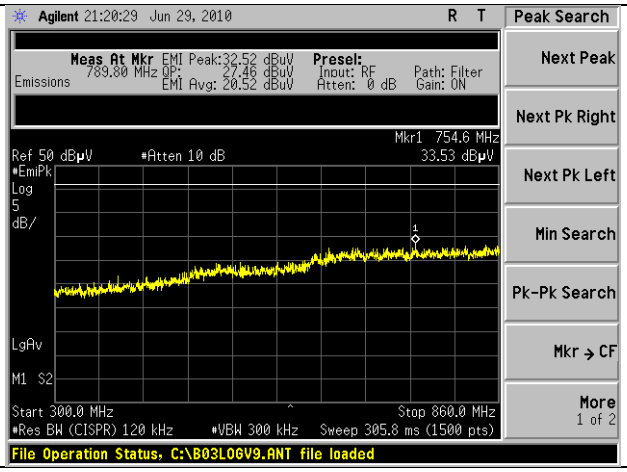


Vertical Polarization

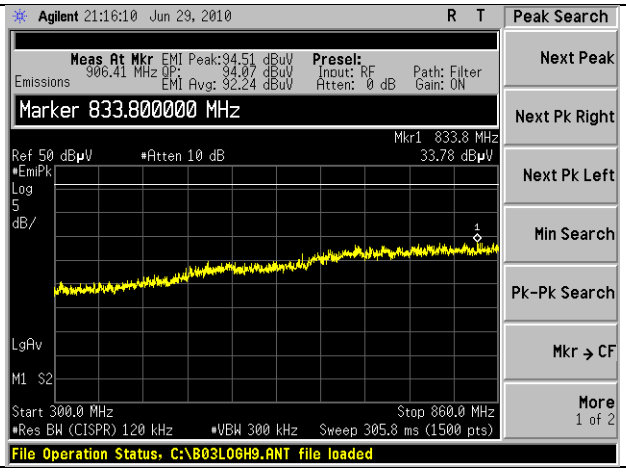


Horizontal Polarization

Antenna Horizontally Polarized, 300-860 MHz, at 3m



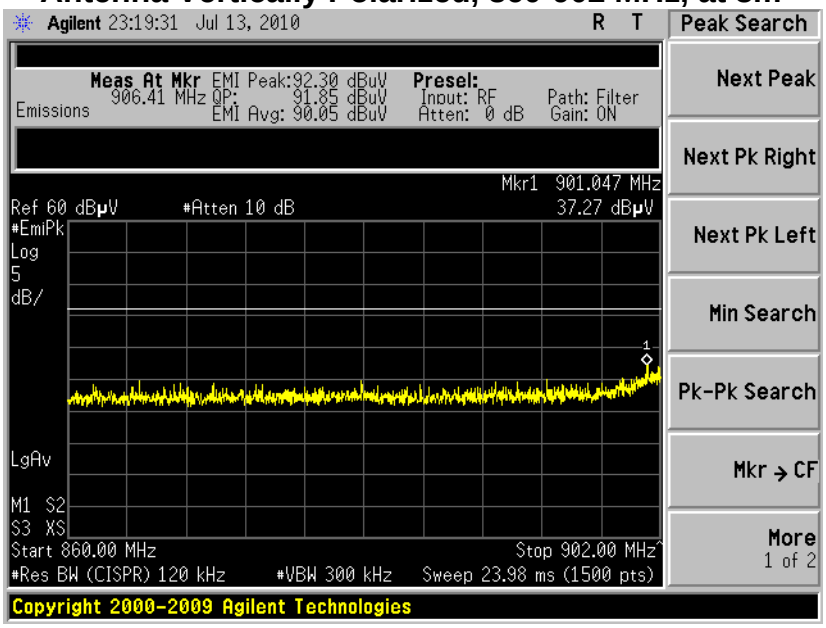
Vertical Polarization



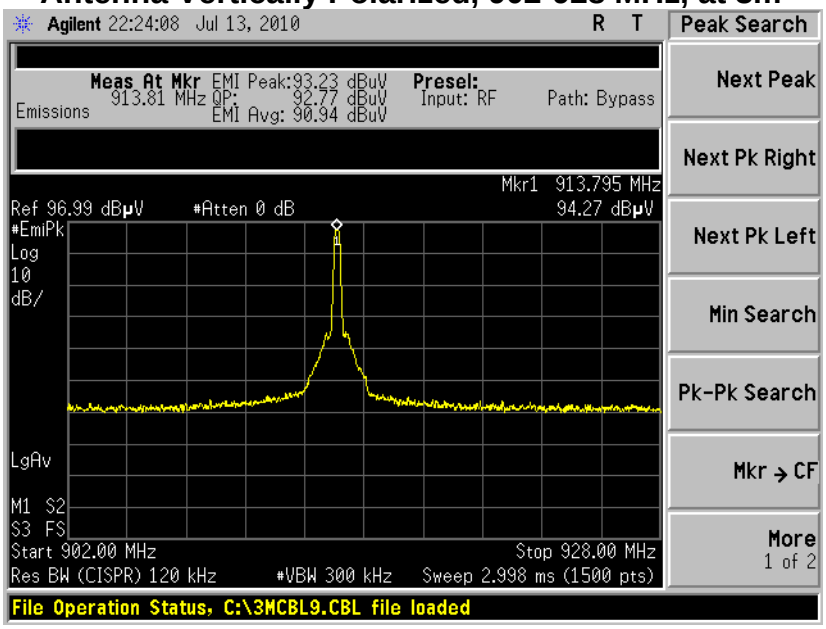
Horizontal Polarization

Screen Captures - Radiated Emissions Testing *(continued)*

Antenna Vertically Polarized, 860-902 MHz, at 3m

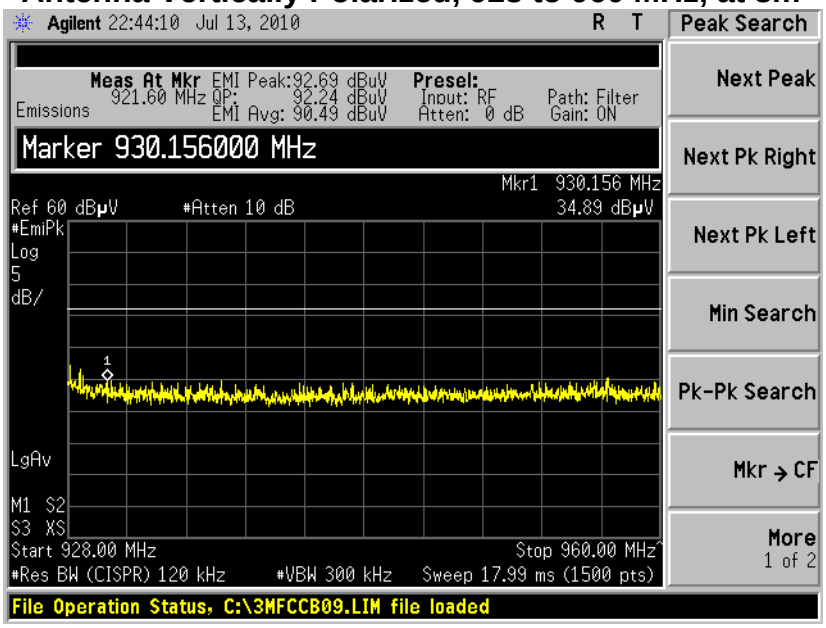


Antenna Vertically Polarized, 902-928 MHz, at 3m

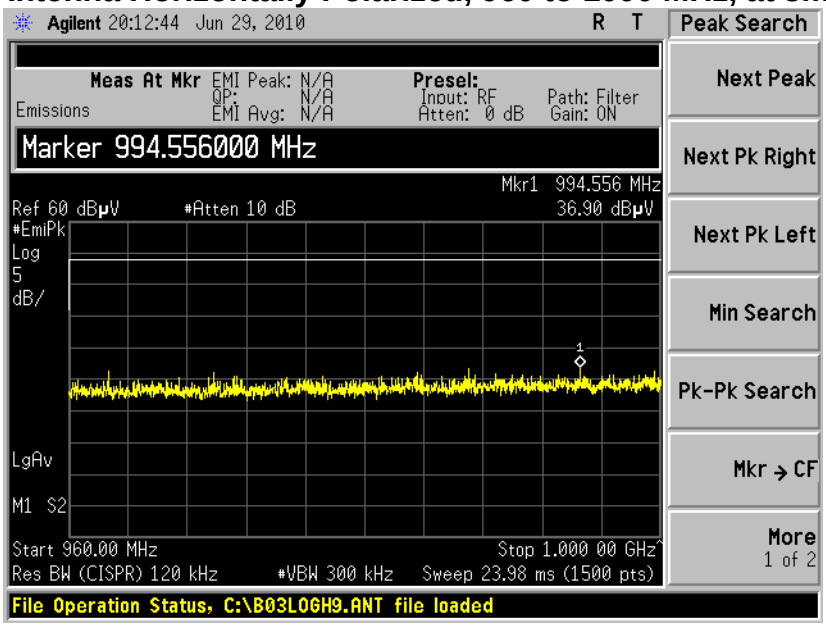


Screen Captures - Radiated Emissions Testing *(continued)*

Antenna Vertically Polarized, 928 to 960 MHz, at 3m

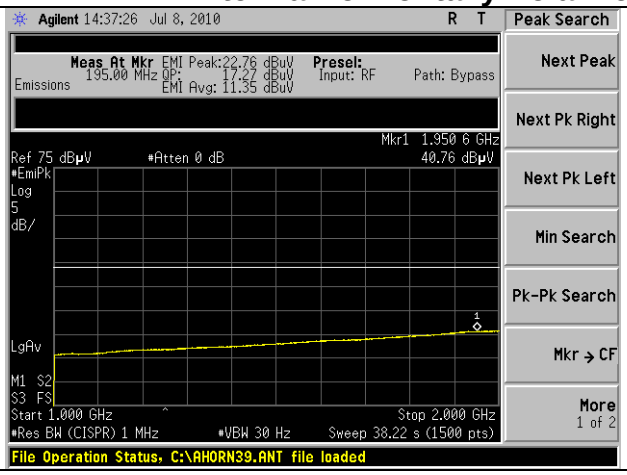


Antenna Horizontally Polarized, 960 to 1000 MHz, at 3m

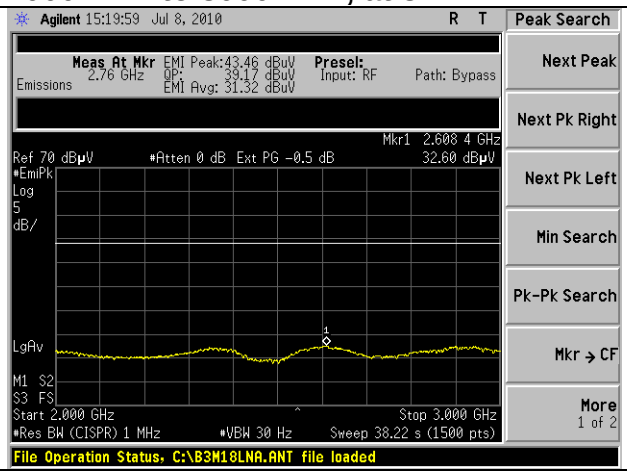


Screen Captures - Radiated Emissions Testing *(continued)*

Antenna Horizontally Polarized, 1000 MHz to 3000 MHz, at 3m

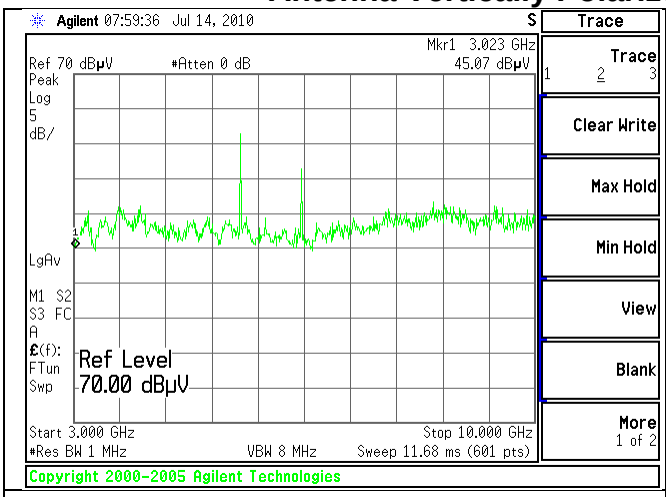


1000 to 2000 MHz

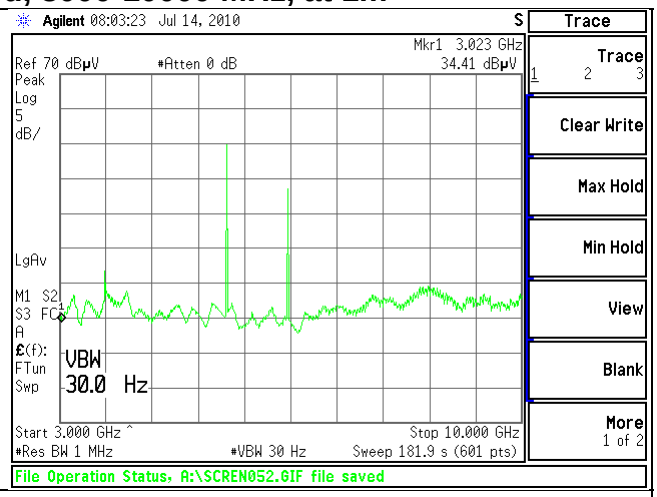


2000 to 3000 MHz

Antenna Vertically Polarized, 3000-10000 MHz, at 1m



Peak



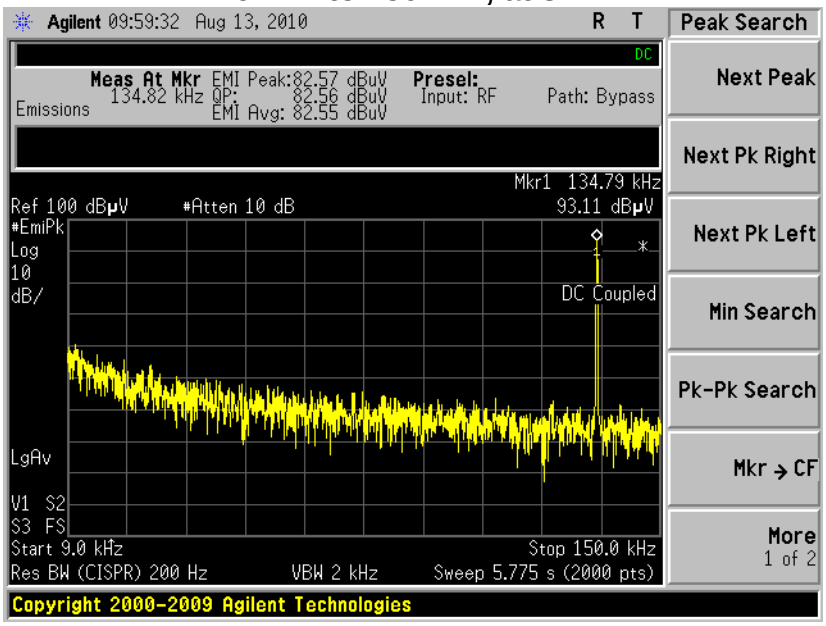
Average

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

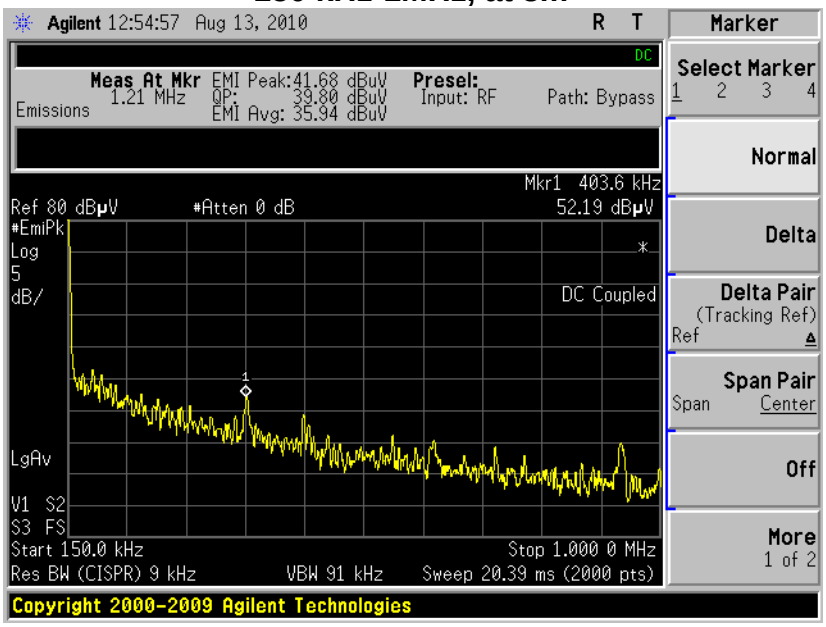
The signature scans shown here are from worst-case emissions with the sense antenna in either vertical or horizontal polarity for worst case presentations.

5.8.2 134.8 kHz LF transmitter

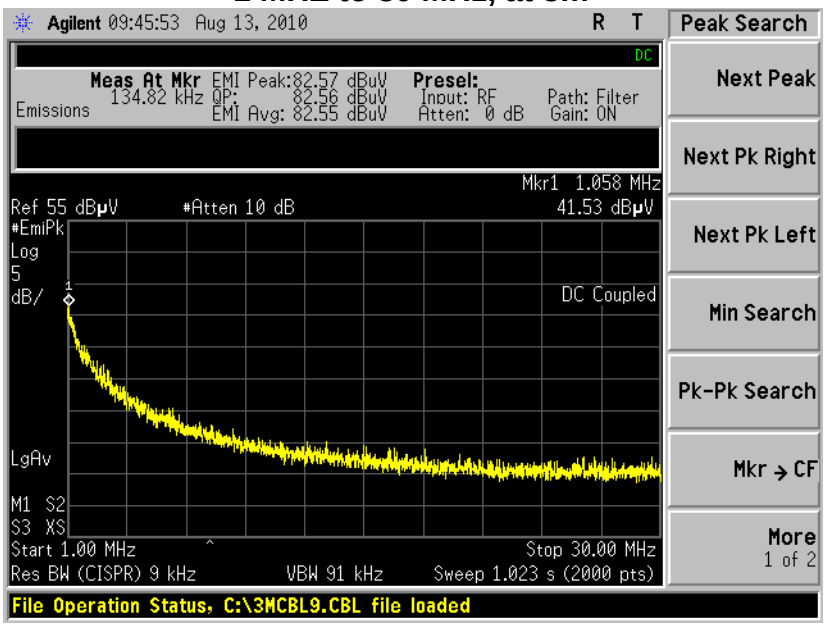
9 kHz to 150 kHz, at 3m



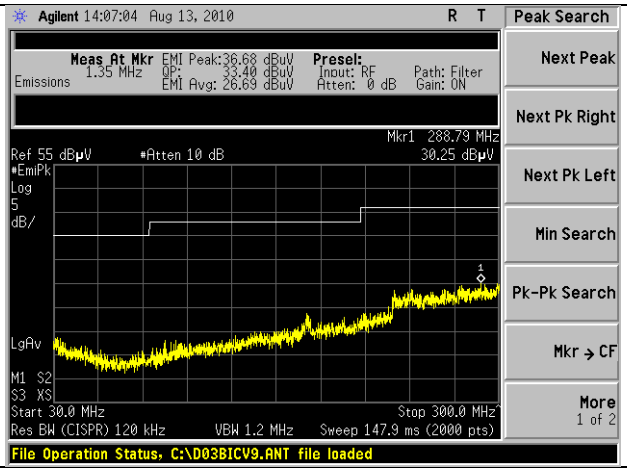
150 kHz-1MHz, at 3m



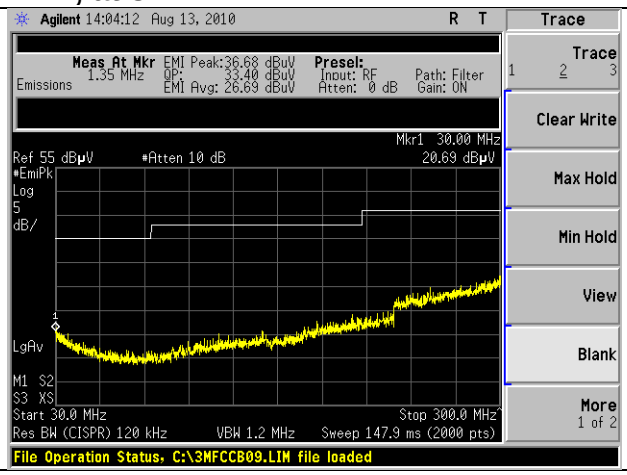
1 MHZ to 30 MHz, at 3m



30 MHz to 300 MHz, at 3m

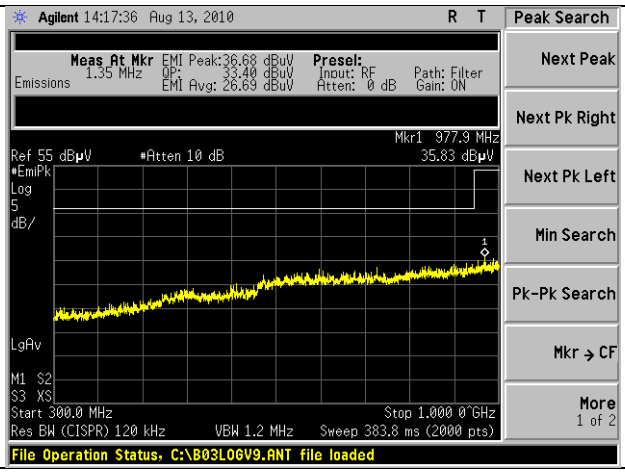


Vertical Polarization

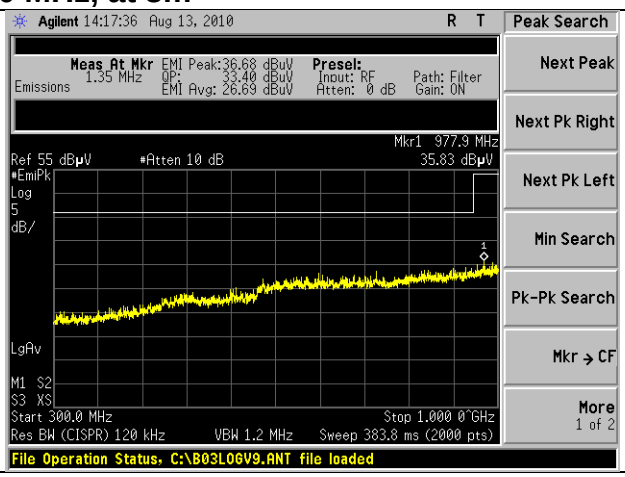


Horizontal Polarization

300 MHz to 1000 MHz, at 3m



Vertical Polarization



Horizontal Polarization

EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE:

This test is not applicable since the EUT is battery powered.

EXHIBIT 7. OCCUPIED BANDWIDTH:

7.1 Limits

There are no limits specified. The occupied bandwidth need only be reported.

7.2 Method of Measurements

This test was performed radiated in a 3-meter semi-anechoic chamber. The resolution bandwidth was set such that it was greater than the occupied bandwidth. This maximum value for the fundamental was then used as reference for 20dBc.
The resolution bandwidth was then set to a value that was greater than or equal to 1% of the bandwidth. Using the 20dBc, marker, the bandwidth was measured.

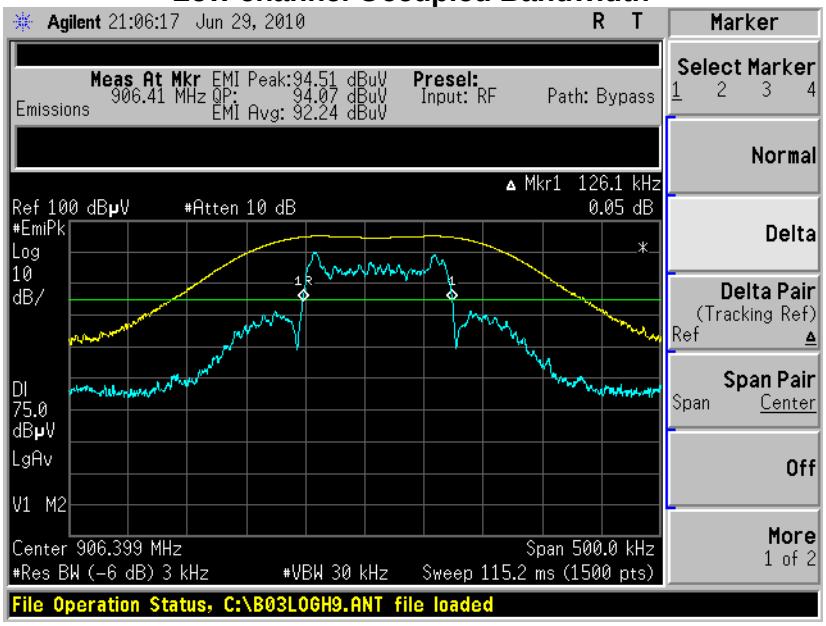
7.3 Test Data

Center Frequency (MHz)	Measured -20 dBc Occ.Bw (kHz)
906.4	126.1
913.8	126.6
921.6	126.5

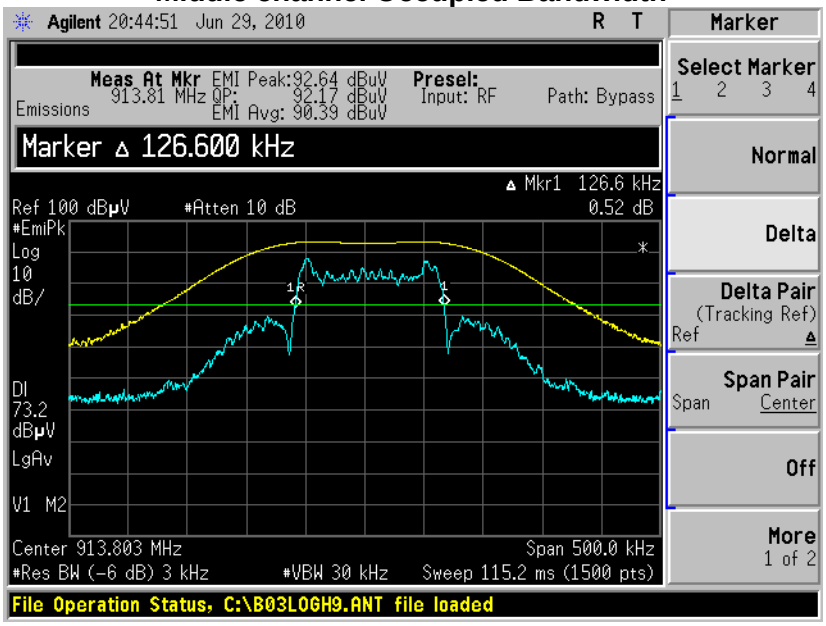
Center Frequency (MHz)	Measured -20 dBc Occ.Bw (kHz)
0.1348	34.0

7.4 Screen Captures - OCCUPIED BANDWIDTH

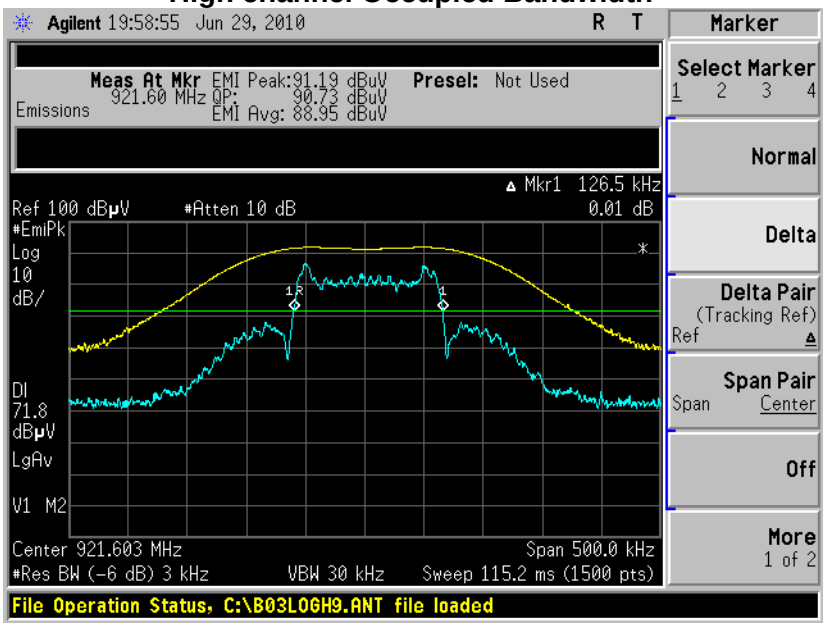
Low channel Occupied Bandwidth



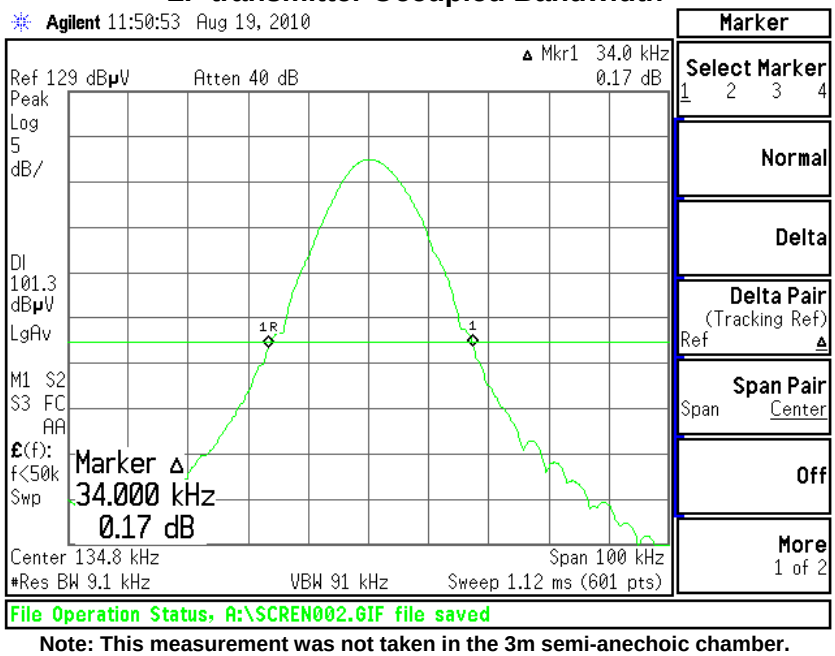
Middle channel Occupied Bandwidth



High channel Occupied Bandwidth



LF transmitter Occupied Bandwidth



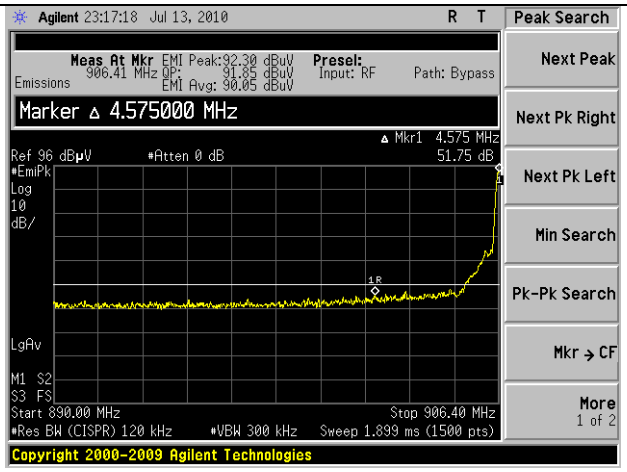
Note: This measurement was not taken in the 3m semi-anechoic chamber.

EXHIBIT 8. BAND-EDGE MEASUREMENTS

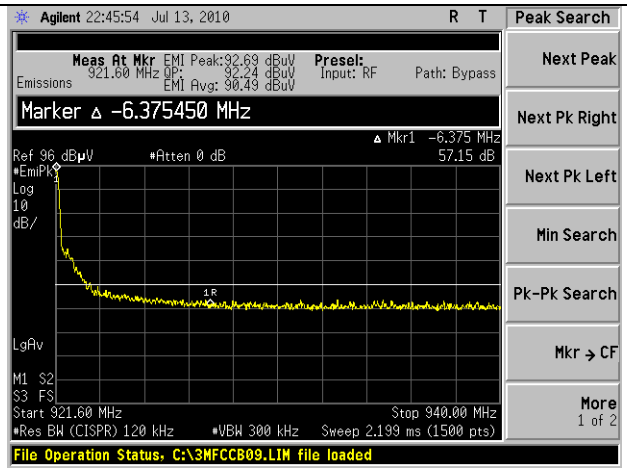
8.1 Method of Measurements

FCC 15.209(b) and 15.249(d) require a measurement of spurious emission levels to be at least 20 dB lower than the fundamental emission level, in particular at the Band-Edges where the intentional radiator operates. Also, RSS 210 Section 2.2 requires that unwanted emissions meet limits listed in tables 2 and 3 of the same standard and also to the limits in the applicable annex. The following screen captures demonstrate compliance of the intentional radiator at the **902-928 MHz** and the **110-490 kHz** Band-Edges. The EUT was operated in continuous transmit mode with continuous modulation, with internally generated data as the modulating source. The EUT was operated at the lowest channel for the investigation of the lower Band-Edge, and at the highest channel for the investigation of the higher Band-Edge.

Screen Capture Demonstrating Compliance at the 902-928 MHz **Band-Edges**

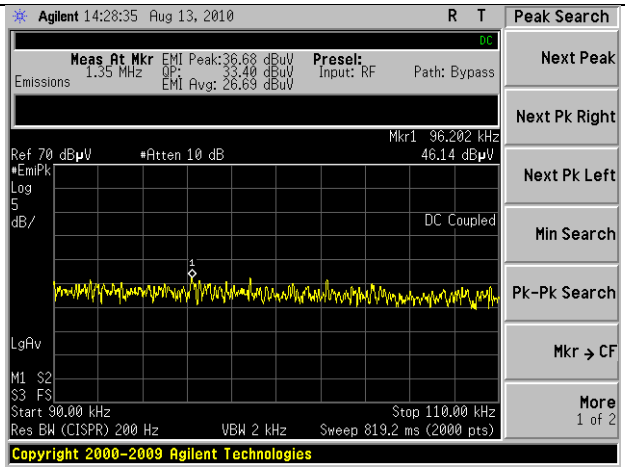


Lower band edge

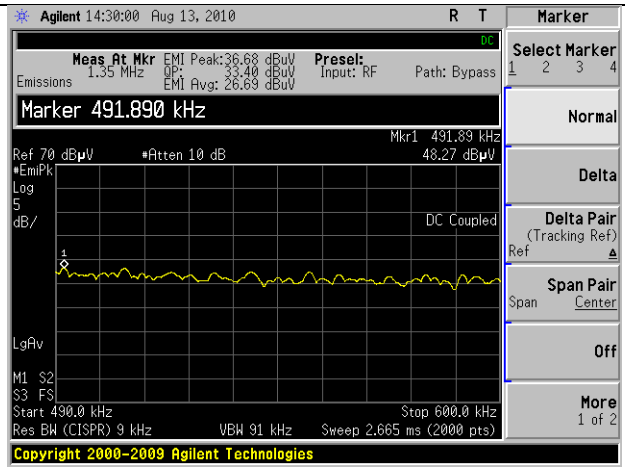


Upper band edge

Screen Capture Demonstrating Compliance at the 110-490 kHz **Band-Edges**



Lower band edge



Upper band edge

EXHIBIT 9. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

The stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the frequency at the appropriate frequency markers.

In this case, the EUT is powered via batteries. Therefore, using a variable DC power supply, the voltage was varied by - 15%.

A spectrum analyzer was used to measure the frequency at the appropriate frequency markers. For this test, the EUT was placed in continuous transmit CW mode.

900 MHz transceiver.

	3.0 VDC		2.55 VDC			
Channel	Frequency (Hz)	Power (dBµ/m)	Frequency (Hz)	Power (dBµ/m)	Deviation (Hz)	Deviation (dBµ/m)
Low	906408440	93.2	906408210	93.2	230	0.0
Middle	913806350	93.4	913806320	93.4	30	0.0
High	921604500	93.2	921604550	93.2	50	0.0

134.8 kHz Transmitter.

	3.0 VDC		2.55 VDC			
Channel	Frequency (Hz)	Power (dBµ/m)	Frequency (Hz)	Power (dBµ/m)	Deviation (Hz)	Deviation (dBµ/m)
Low	134810	93.2	134819	93.2	9	0.0

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.

No anomalies were noted in the measured transmit power and the frequency stability was better than 100 ppm during the voltage variation tests.

APPENDIX A

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 12-Jul-2010 Type Test : Radiated emissions VLF Tx Job # : C-942

Prepared By: Aidi Customer : Ecolab Quote #: 310192

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	aa 960006	Active Loop Antenna	EMCO	6502	9205-2753	9/14/2009	9/14/2011	Active Calibration
2	ee 960158	RF Preselecter	Agilent	N9039A	MY46520110	6/7/2010	6/7/2011	Active Calibration
3	ee 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48250225	6/7/2010	6/7/2011	Active Calibration
4	ee 960073							Active Calibration

Project Engineer: Aidi Quality Assurance:

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 12-Jul-2010 Type Test : Harmonic VLF Tx Job # : C-942

Prepared By: Aidi Customer : Ecolab Quote #: 310192

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	aa 960006	Active Loop Antenna	EMCO	6502	9205-2753	9/14/2009	9/14/2011	Active Calibration
2	ee 960158	RF Preselecter	Agilent	N9039A	MY46520110	6/7/2010	6/7/2011	Active Calibration
3	ee 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48250225	6/7/2010	6/7/2011	Active Calibration

Project Engineer: Aidi Quality Assurance:

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 12-Jul-2010 Type Test : Fundamental VLF Tx Job # : C-942

Prepared By: Aidi Customer : Ecolab Quote #: 310192

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	aa 960006	Active Loop Antenna	EMCO	6502	9205-2753	9/14/2009	9/14/2011	Active Calibration
2	ee 960158	RF Preselecter	Agilent	N9039A	MY46520110	6/7/2010	6/7/2011	Active Calibration
3	ee 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48250225	6/7/2010	6/7/2011	Active Calibration

Project Engineer: Aidi Quality Assurance:

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 12-Jul-2010 Type Test : Radiated Emissions (209) Job # : C-942

Prepared By: Aidi Customer : Ecolab Quote #: 310192

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	ee 960158	RF Preselecter	Agilent	N9039A	MY46520110	6/7/2010	6/7/2011	Active Calibration
2	ee 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48250225	6/7/2010	6/7/2011	Active Calibration
3	aa 960078	Log Periodic Antenna	EMCO	93146	9701-4855	10/16/2009	10/16/2010	Active Calibration
4	aa 960150	Bicon Antenna	ETS	3110B	0003-3346	11/3/2009	11/3/2010	Active Calibration
5	aa 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	11/10/2009	11/10/2010	Active Calibration
6	aa 960081	Double Ridge Horn Antenna	EMCO	3115	6907	12/22/2009	12/22/2010	Active Calibration
7	ee 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/17/2009	9/17/2010	Active Calibration
8	aa 960144	Phaseflex	Gore	EKD01D010720	5800373	6/4/2010	6/4/2011	Active Calibration

Project Engineer: Aidi Quality Assurance:

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 12-Jul-2010 Type Test : Harmonics Job # : C-942

Prepared By: Aidi Customer : Ecolab Quote #: 310192

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	aa 960081	Double Ridge Horn Antenna	EMCO	3115	6907	12/22/2009	12/22/2010	Active Calibration
2	aa 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	11/10/2009	11/10/2010	Active Calibration
3	aa 960144	Phaseflex	Gore	EKD01D010720	5800373	6/4/2010	6/4/2011	Active Calibration
4	ee 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/17/2009	9/17/2010	Active Calibration
5	ee 960147	Pre-Amp	Adv. Micro	WLA612	123101	12/28/2009	12/28/2010	Active Calibration

Project Engineer: Aidi Quality Assurance:

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 12-Jul-2010 Type Test : Occupied Bandwidth (6dB & 20dB) Job # : C-942

Prepared By: Aidi Customer : Ecolab Quote #: 310192

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	ee 960158	RF Preselecter	Agilent	N9039A	MY46520110	6/7/2010	6/7/2011	Active Calibration
2	ee 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48250225	6/7/2010	6/7/2011	Active Calibration
3	aa 960078	Log Periodic Antenna	EMCO	93146	9701-4855	10/16/2009	10/16/2010	Active Calibration
4	ee 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	9/17/2009	9/17/2010	Active Calibration
5	aa 960006	Active Loop Antenna	EMCO	6502	9205-2753	9/14/2009	9/14/2011	Active Calibration

Project Engineer: Aidi Quality Assurance:

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 12-Jul-2010 Type Test : Band-Edge Job # : C-942

Prepared By: Aidi Customer : Ecolab Quote #: 310192

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	ee 960158	RF Preselecter	Agilent	N9039A	MY46520110	6/7/2010	6/7/2011	Active Calibration
2	ee 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48250225	6/7/2010	6/7/2011	Active Calibration
3	aa 960078	Log Periodic Antenna	EMCO	93146	9701-4855	10/16/2009	10/16/2010	Active Calibration
4	aa 960006	Active Loop Antenna	EMCO	6502	9205-2753	9/14/2009	9/14/2011	Active Calibration

Project Engineer: Aidi Quality Assurance:

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 12-Jul-2010 Type Test : Fundamental Job # : C-942

Prepared By: Aidi Customer : Ecolab Quote #: 310192

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	aa 960078	Log Periodic Antenna	EMCO	93146	9701-4855	10/16/2009	10/16/2010	Active Calibration
2	ee 960013	EMI Receiver	HP	8546A System	3617A00320;3448A	9/17/2009	9/17/2010	Active Calibration
3	ee 960014	EMI Receiver-filter section	HP	85460A	3448A00296	9/17/2009	9/17/2010	Active Calibration

Project Engineer: Aidi Quality Assurance:

APPENDIX B

TEST STANDARDS – CURRENT PUBLICATION DATES RADIO

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2009		
ANSI C63.10	2009		
CISPR 11	2009-05	2009-12 P	
CISPR 12	2007-05		
CISPR 14-1	2005-11	2008-11	
CISPR 14-2	2001-11	2001-11	2008-05
CISPR 16-1-1 Note 1	2010-01		
CISPR 16-1-2 Note 1	2003	2004-04	2006-07
CISPR 22	2008-09		
CISPR 24	1997-09	2001-07	2002-10
EN 55011	2007-05		
EN 55014-1	2006		
EN 55014-2	1997		
EN 55022	2006	2007	
EN 60601-1-2	2007-03		
EN 61000-3-2	2006-05		
EN 61000-3-3	2008-12		
EN 61000-4-2	2009-05		
EN 61000-4-3	2006-07	2008-05	
EN 61000-4-4	2004		
EN 61000-4-5	2006-12		
EN 61000-4-6	2009-05		
EN 61000-4-8	1994	2001	
EN 61000-4-11	2004-10		
EN 61000-6-1	2007-02		
EN 61000-6-2	2005-12		
EN 61000-6-3	2007-02		
EN 61000-6-4	2007-02		
FCC 47 CFR, Parts 0-15, 18, 90, 95	2009		
FCC Public Notice DA 00-1407	2000		
FCC ET Docket # 99-231	2002		
FCC Procedures	2007		
ICES 001	2006-06		
ICES 002	2009-08		
ICES 003	2004-02		
IEC 60601-1-2 Note 1	2007-03		
IEC 61000-3-2	2005-11	2008-03	2009-02
IEC 61000-3-3	2008-06		
IEC 61000-4-2	2008-12		
IEC 61000-4-3	2008-04	incl in 2008-04	2009-12 FD

STANDARD #	DATE	Am. 1	Am. 2
IEC 61000-4-4	2004-07	2010-10	
IEC 61000-4-5	2005-11		
IEC 61000-4-6	2008-10		
IEC 61000-4-8	2009-09		
IEC 61000-4-11	2004-03		
IEC 61000-6-1	2005-03		
IEC 61326-1	2006-06		
ISO 14982	1998-07		
MIL Std. 461E	1999-08		
RSS GEN	2007-06		
RSS 119	2007-06		
RSS 123	1999-11		
RSS 125	2000-03		
RSS 131	2003-07		
RSS 136	2002-10		
RSS 137	2009-02		
RSS 210	2007-06		
RSS 213	2005-12		
RSS 243	2005-11		
RSS 310	2007-06		

Note 1: Test not on LSR Scope of Accreditation.

Updated on 02-03-10

P=Project FD= Final Draft

APPENDIX C
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

Appendix D

Antenna Specification(s)

"High Frequency Ceramic Solutions"

915 MHz Antenna **P/N 0915AT43A0026**

Detail Specification: 02/20/09 Page 1 of 3

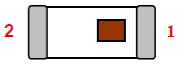
General Specifications

Part Number	0915AT43A0026
Frequency Range	902 - 928
Peak Gain	-1.0 dBi typ. (XZ-total)
Average Gain	-4.0 dBi typ. (XZ-total)
Return Loss	8.5 dB min.
Impedance	50 Ω
Input Power	2W max.

Operating Temperature	-40 to +85°C
Storage Temperature Range	+5~+35°C, Humidity 45~75%RH
Reel Quanity	1,000

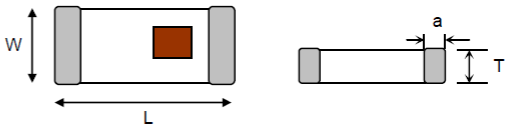
No.	Function
1	Feeding Point
2	NC

Terminal Configuration



Mechanical Dimensions

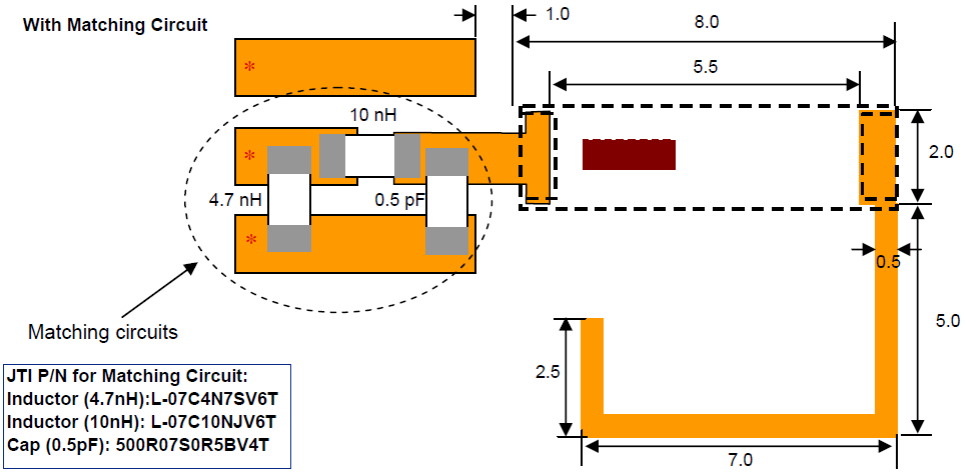
	In	mm
L	0.276 ± 0.008	7.00 ± 0.20
W	0.079 ± 0.008	2.00 ± 0.20
T	0.031 +.004/-.008	0.80 +0.1/-0.2
a	0.020 ± 0.012	0.50 ± 0.30



Mounting Considerations

Mount these devices with brown mark facing up. Units: mm

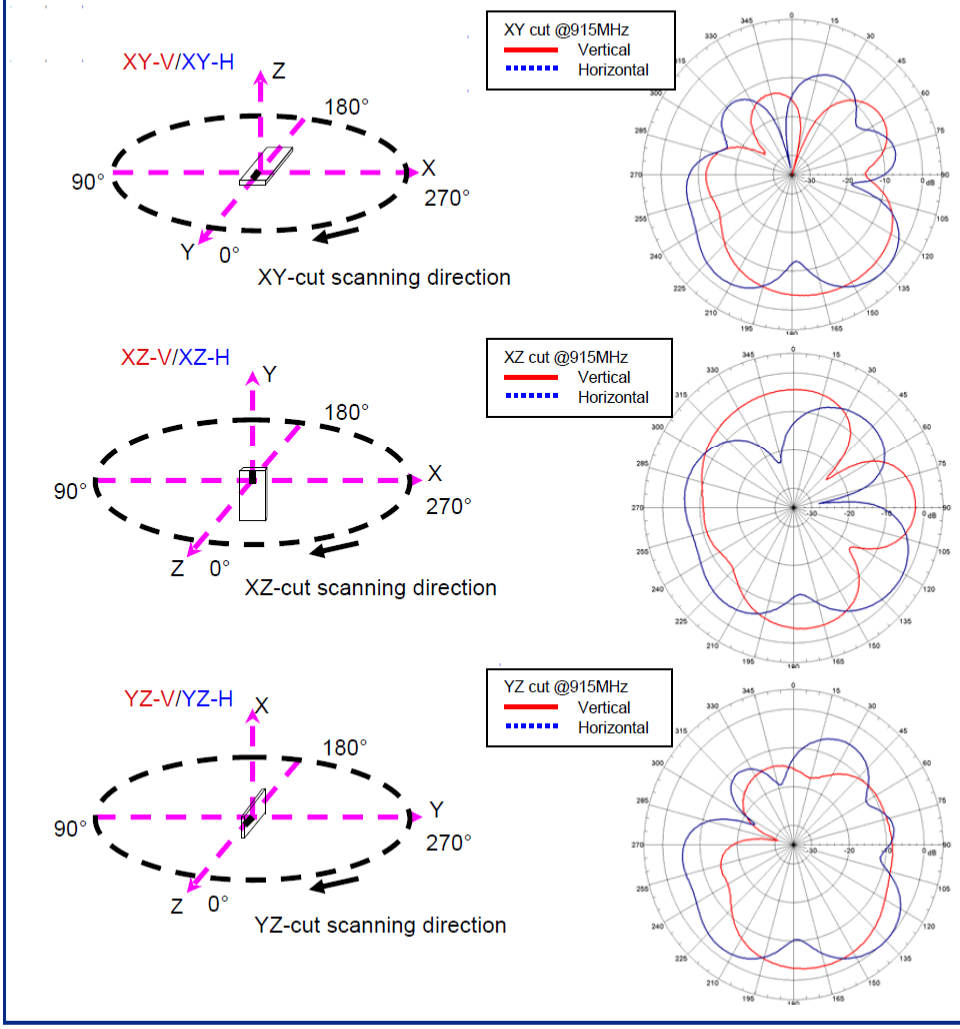
* Line width should be designed to provide 50 Ω impedance matching characteristics.



JTI P/N for Matching Circuit:
Inductor (4.7nH):L-07C4N7SV6T
Inductor (10nH): L-07C10NJV6T
Cap (0.5pF): 500R07S0R5BV4T

JOHANSON TECHNOLOGY
www.johansontechnology.com
4001 Calle Tecate • Camarillo, CA 93012 • TEL 805.389.1166 FAX 805.389.1821

Typical Radiation Patterns



JOHANSON TECHNOLOGY
www.johansontechnology.com
4001 Calle Tecate • Camarillo, CA 93012 • TEL 805.389.1166 FAX 805.389.1821

NEW PREMO

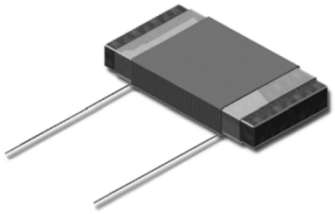
KGEA-WT

Keyless go emitter antenna winding heat shrink tube (33 µH - 500 µH)

RFID Transponder Inductors

Features

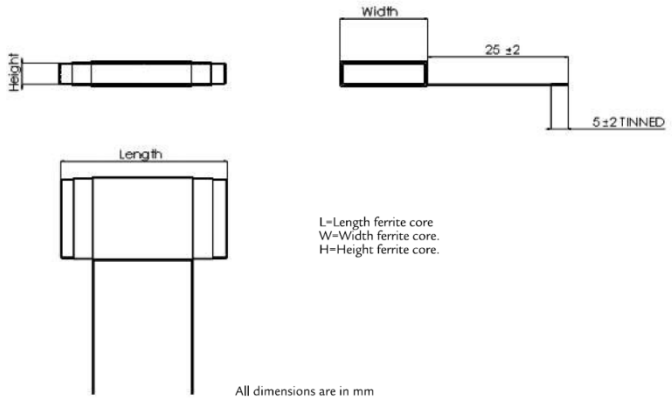
This part can offer the possibility to welding directly on PCB or the customer directly over-moulded for different applications of readers RF antennas and thus far reducing cost.
This solution of emitter antenna winding ferrite has 2 options:
(1) Only winding along all ferrite
(2) Winding ferrite assembly with heat shrink tube.



Characteristics

- Different sizes of emitter antenna (small, medium, big) and ranges diameter wire (Ø=0.100, 0.180, 0.300 and 0.500mm)
- High reading distance depending of the size ferrite core
- Designed for a range of working frequency LF (20kHz, 125kHz and 134,2kHz).
- Antenna current. Max. 4 App, Duty 30%
- High stability in temperature (-40°C to +125°C).
- Good cost/performance ratio.
- The part can be to protect with heat shrink tube to avoid handling problems.

Dimensions:



L=Length ferrite core
W=Width ferrite core.
H=Height ferrite core.

All dimensions are in mm

KGEA-WT

Keyless go emitter antenna winding heat shrink tube (33 µH - 500 µH)

RFID Transponder Inductors

Electrical specifications:

Operating Frequency @ 125 kHz ; dimensions ferrite core=68x7x3mm.

P/N	L (mH)	Q	SRF (MHz)	Ipp máx (Amp)(*)
KGEA-WT680703-B-0108J	0.108	>90	>2.15	2-4
KGEA-WT680703-B-0240J	0.240	>100	>2.15	2-4
KGEA-WT680703-B-0322J	0.332	>115	>2.15	2-4
KGEA-WT680703-B-0400J	0.400	>115	>2.15	2-4
KGEA-WT680703-B-0500J	0.500	>120	>2.15	2-4

Operating Frequency @ 134,2 kHz ; dimensions ferrite core=68x7x3.

P/N	L (mH)	Q	SRF (MHz)	Ipp máx (Amp)(*)
KGEA-WT680703-C-0033J	0.033	>75	>2.15	2-4
KGEA-WT680703-C-0108J	0.108	>90	>2.15	2-4
KGEA-WT680703-C-0345J	0.345	>110	>2.15	2-4
KGEA-WT680703-C-0425J	0.425	>125	>2.15	2-4
KGEA-WT680703-C-0650J	0.650	>125	>2.15	2-4

Operating Frequency @ 20khz ; dimensions ferrite core=60x19x4mm.

P/N	L (mH)	Q	SRF (MHz)	Ipp máx (Amp)(*)
KGEA-WT601904-A-0161J	0.161	>75	>1	2-4
KGEA-WT601904-A-0345J	0.345	>80	>1	2-4
KGEA-WT601904-A-0470J	0.470	>85	>1	2-4
KGEA-WT601904-A-0500J	0.500	>90	>1	2-4

Operating Frequency @ 20khz ; dimensions ferrite core=40x19x4mm.

P/N	L (mH)	Q	SRF (MHz)	Ipp máx (Amp)(*)
KGEA-WT401904-A-0161J	0.161	>60	>1	2-4
KGEA-WT401904-A-0345J	0.345	>70	>1	2-4
KGEA-WT401904-A-0470J	0.470	>75	>1	2-4
KGEA-WT401904-A-0500J	0.500	>80	>1	2-4

Tolerance J=5%.
Add under the chart: This chart is a reference guide for the most common required values at working frequency of 125 kHz. Any other inductance value at LF or tighter tolerances can be provided. Please contact our sales department for any inquiry.
Sensitivity measured with Helmholtz coils H=8.36 App/m @125 kHz. Contact us for measurement specification.