Testing Tomorrow's Technology

Test Report
for the

Inventek Systems

Model: ISM4334X-M4G-L44

In Conformity with
Radio Equipment and Telecommunications
Terminal Equipment (R&TTE) Directive
1999/5/EC

EN 300 330-1 v1.8.1
EN 300 330-2 v1.6.1

UST Project Number: 15-0111

Issue Date: November 20, 2015

Description of test item

Test item	:	ISM4334X-M4G-L44
Manufacturer	:	Inventek Systems
Brand mark	:	Inventek Systems
Type	:	Wireless Transmitter
Antenna	:	Inductive Loop
Serial number(s)	:	Engineering Sample
Receipt date	:	August 15, 2015

Applicant information

Applicant's representative	:	Kevin Tierney
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Test(s) performed

Location	:	US Tech
Address	:	3505 Francis Circle, Alpharetta, GA 30004
Test(s) started	:	September 18, 2015
Test(s) completed	:	October 5, 2015
Purpose of test(s)	:	Type approval
Test specification(s)	:	EN 300 330 v1.8.1, issue 2015-03, EN 300 330-2 v1.6.1, issue 2015-03
Test engineer	:	Carrie Ingram
Project leader	:	George Yang
Report written by	:	Carrie Ingram
Report approved by	:	Alan Ghasiani
Report date	:	November 20, 2015

Table of Contents

List of Figures

No **Title** **Page**

List of Tables

No **Title** **Page**

1 General

1.1 Description

This section contains the unmodified Application Form submitted by the Manufacturer. The Application Form contains 9 pages, which are included in the total number of pages of this report.

The Equipment Under Test (EUT) is the Inventek Systems Model ISM4334X-M4G-L44 Module. The ISM4334X-M4G-L44 Module is an embedded wireless internet connectivity module that operates in the 2.4 and 5.0 GHz spectrum. The Wi-Fi modules' hardware consists of an ARM Cortex M4 host processor, Broadcom BCM43341/0 Dual-Band 802.11 a/b/g/n MAC/Baseband/Radio with integrated Bluetooth 4.0 and NFC support.

The Model Numbers to be included in the approval are:

ISM43341-M4G-L44-C
ISM43341-M4G-L44-U
ISM43341-M4G-L44-10CFH
ISM43341-M4G-L44-10UFH
ISM341-USB

The different model numbers for are marketing purposes: The C or U is for the antenna to be used for the 2.4 GHz WiFi, 5.0 GHz WiFi , and Bluetooth radio, either the chip (C) or the external antenna path (U). The F is for an optional external Flash memory, and the H is for Apple HomeKit. The final part number, ISM341-USB, is for a specific customer and includes the NFC filter circuit.

The 2.4 GHz, 5.0 GHz Wi-Fi, and integrated Bluetooth radio features have been tested and the results detailed in a separate report.

Antenna Type: Magnetic Loop (trace)
MFG: Inventek Systems
Connector: Molex locking connector
Modulation: ACK

1.2 Applied Standards

The relevant ETSI standards, applicable to this type of equipment, as indicated in Annex 1 of ERC/DEC 70-03, are:

1.2.1 EN 300 330-1 V1.8.1 (2015-03); Electromagnetic compatibility and radio spectrum matters (ERM); Short range devices (SRD); Radio equipment to be used in the 9 kHz to 25 MHz frequency range and inductive loop systems in the frequency range of 9 kHz to 30 MHz. Part 1: Technical characteristics and test methods

1.2.2 EN 300 330-2 V1.6.1 (2015-03) Electromagnetic compatibility and radio spectrum matters (ERM); Short range devices (SRD); Radio equipment to be used in the 9 kHz to 25 MHz frequency range and inductive loop systems in the frequency range of 9 kHz to 30 MHz. Part 2: Harmonized EN covering essential requirements under article 3(2) of the R&TTE Directive.

1.3 Remarks

For the test methods, according to EN 300 330-1 V1.8.1, the uncertainty figures have been calculated according to the methods described in the ETR 100-028-1 and ETR 100-028-2.

The requirements for the test results contained in this report were taken from the Harmonized EN 300 330-2, Annex A, Table A.1, EN Requirements Table (EN-RT) reproduced below as Table 1 herein. Only Reference Items 1 through 9 are addressed in this report for Transmitters, since this report covers only the NFC Transmitter.

The subclauses taken from EN 300 330 are sited between brackets in this test report.

1.3.1 Product Classes

Table 1. Product Classes (Per EN 300 330-1, Clause 7.1.4)

Product Class	Transmitter Technical Characteristics	Applicable
1	Inductive loop coil Tx, type tested with an antenna as either an integral antenna (antenna type 1); or a dedicated supplied antenna supplied with the equipment (antenna type 2)	x
2	Inductive loop coil Tx, allowing field customization of the loop antenna. Customization is only allowed according to manufacturer's design rules published in the equipment manual.	
3	This Class of equipment is intended for use with customized large size loop antenna only. The loop coil Tx is type tested without an antenna by using an artificial antenna.	
4	E-field Tx, type with each type of antenna to be used.	

1.4 Detailed Description of Test Configuration

The EUT was configured in a test mode state. This means that the test lab was provided with a complete product ready sample loaded with test firmware which exercised the low frequency transmitter. The EUT was set up to continuously transmit at the fundamental frequency, 13.56 MHz.

Table 2. EUT and Peripherals

Test Item	Manufacturer	Brand	Model	Serial No.	Input Voltage
NFC Transmitter (EUT)	Inventek Systems	Inventek Systems	ISM4334X-M4G-L44	ENGINEERING SAMPLE	3.3 VDC

1.5 Type Designation Label of the Equipment

1.6 Test Conditions

The tests are carried out using the normal test conditions only, as specified in clause 5.1.1.

Normal test condition

Temperature : -10˚C to 65˚C
Relative humidity : 30% to 60%
Voltage : 3.3 VDC

Extreme test conditions

Temperature: -10°C and 65°C
Voltage : 3.3VDC via host

1.7 Test Frequencies

Channel	Test Frequencies (MHz)
A	13.56

1.8 Measurements Detector

Frequency: (f) type	**Detector**	**Measurement Receiver bandwidth**	**Spectrum Analyser bandwidth**
9 KHz < f < 150 KHz	Quasi Peak	200 Hz	300 Hz
150 KHz < f < 30 MHz	Quasi Peak	9 KHz	10 KHz
30 MHz < f < 1.0 GHz	Quasi Peak	120 KHz	100 KHz

2 Essential Radio Test Suites (Overview)

An overview of radio test suites, as laid out in EN 300 330-2 v 1.5.1 (2010-02), and a summary of test results is given below.

Table 3. Transmitter Test Suites and Overview of Results

Essential radio test suite	Applicable	Reference Clause in this Report	Reference Clause in the Standard	Compliance Results
Permitted range of operating frequencies	Applicable	3.1.1	4.2.1.1	Compliant
Transmitter carrier output levels	Applicable	3.1.2	4.2.1.2	Compliant
Limits for permitted range of modulation bandwidth	Applicable	3.1.3	4.2.1.3	Compliant
Transmitter spurious and out of band emissions	Applicable	3.1.4	4.2.1.4	Compliant

Table 4. Receiver Test Suites and Overview of Results

Essential radio test suite	Applicable	Reference Clause in this Report	Reference Clause in the Standard	Compliance Results
Receiver adjacent channel selectivity	Not Applicable	3.2.1	4.2.2.1	N/A
Receiver blocking or desensitization	Not Applicable	3.2.2	4.2.2.2	N/A
Receiver spurious emissions	Applicable	3.2.3	4.2.2.3	Compliant

3 Test Results

3.1 Transmitter Parameters

3.1.1 Permitted Range of Operating Frequencies

The permitted range of operating frequencies is the frequency range the equipment is authorized to operate in. In accordance with ETSI EN 300 330 section 7.3.3, the permitted range of operating frequencies shall be from 9 kHz to 30 MHz. Any emissions outside of this permitted range of operation must comply with the spurious emission limits.

To show compliance with the permitted range of operating frequencies, the minimum and maximum output frequencies where the spurious and/or out-of band emission limits are exceed, due to the intentional emissions of the EUT, where measured. Below are figures of the intentional emissions from the EUT. Measurements were taken with each type of modulation scheme and modulation parameters.

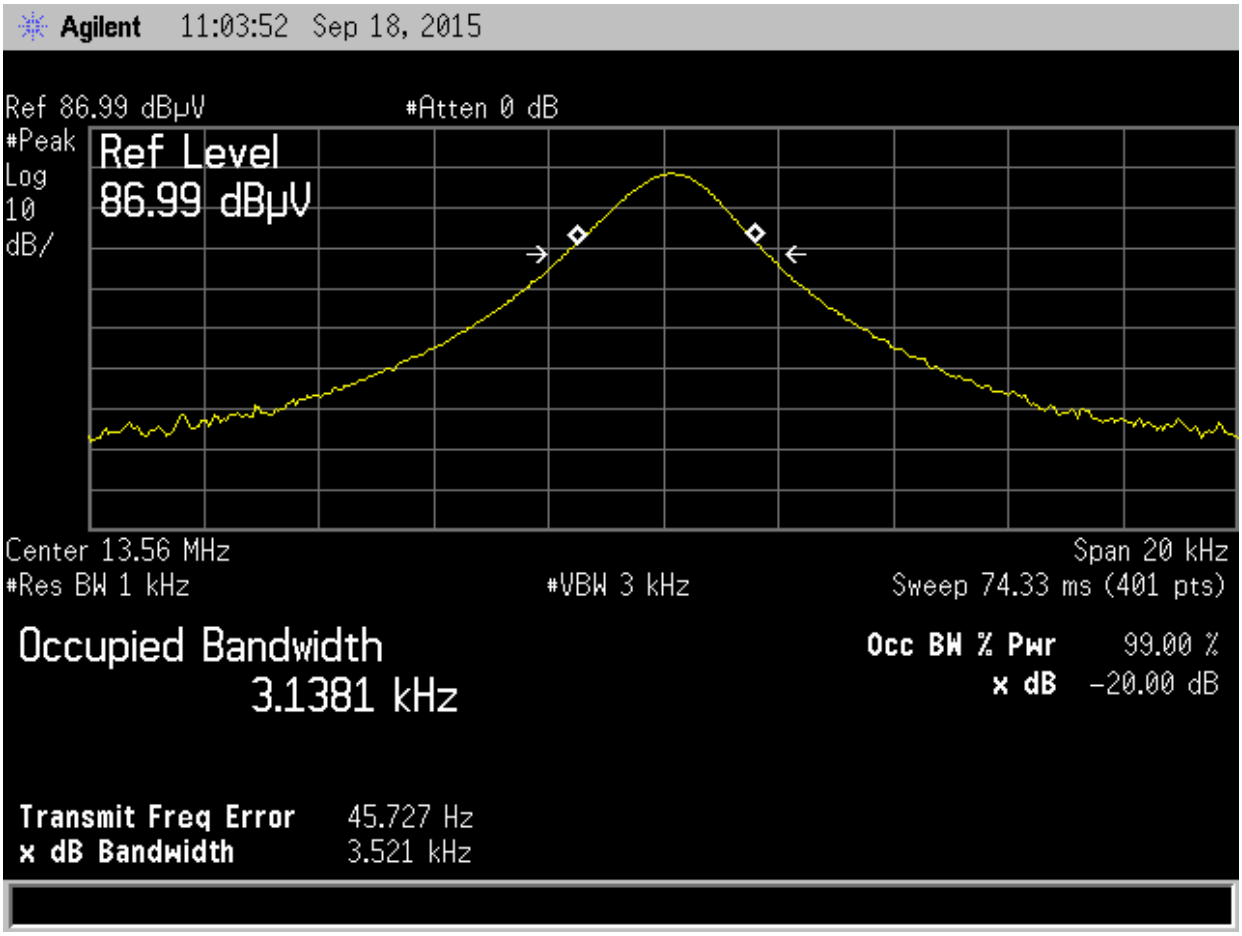

Figure 1. Fundamental Frequency and Only Modulation Scheme

The intentional Emissions from the EUT stay within the permitted range of operating frequencies.

3.1.2 Transmit Carrier Output Levels

3.1.2.1 Radiated H-Field

Since this EUT has an integral or dedicated antenna, the radiated H-field was measured per ETSI EN 300 330-1 section 7.2.1. The H-field is measured with an active loop antenna, in an open field test site, and connected to a measurement receiver. The EUT was transmitting with modulation ON.

The measurements were taken at normal conditions due to the size constraints of the loop antenna. The measurement distance was 3 m instead of 10 m, the test data was extrapolated back to 10 m using an extrapolation factor of -10.5 dB.

Measuring equipment calibrated in dBµV/m was used; therefore the reading is reduced by 51.5 dB to be converted to dBµA/m. Where the measurement was taken at 3 m, the correction factor from Annex B of EN 300-330-1 v1.8.1 and shown in Figure 2. was applied.

Table 5. H-field Limits at 10 Meters

Frequency range (MHz)	H-field strength limit (H_f) dBµA/m at 10 m
0,009 ≤ f < 0,090	72 descending 3 dB/oct above 0,03 MHz or according to note 1 (see note 5)
0,09 ≤ f < 0,119	42
0,119 ≤ f < 0,135	66 descending 3 dB/oct above 0,119 MHz or according to note 1 (see notes 3 and 5)
0,135 ≤ f < 0,140	42
0,140 ≤ f < 0,1485	37,7
0,1485 ≤ f < 30	-5 (see note 4)
0,315 ≤ f < 0,600	-5
3,155≤ f < 3,400	13,5
4,234	9
4,516	7
7,400 ≤ f < 8,800	9
10,2 ≤ f < 11,00	9
12,5 ≤ f ≤ 20	-7
6,765 ≤ f ≤ 6,795 13,553 ≤ f ≤ 13,567 26,957 ≤ f ≤ 27,283	42 (see note 3)
13,553 ≤ f ≤ 13,567	60 (see notes 2 and 3)
27,095	42

NOTE 1: For the frequency ranges 9 kHz to 135 kHz, the following additional restrictions apply to limits above 42 dBµA/m:
- for loop coil antennas with an area ≥ 0,16 m^2 table 5 applies directly;
- for loop coil antennas with an area between 0,05 m^2 and 0,16 m^2 table 5 applies with a correction factor. The limit is: table value + 10 × log (area/0,16 m^2);
- for loop coil antennas with an area < 0,05 m^2 the limit is 10 dB below table 5.

NOTE 2: For RFID and EAS applications only.
NOTE 3: Spectrum mask limit, see annex G.
NOTE 4: For further information see annex H.
NOTE 5: Limit is 42 dBµA/m for the following spot frequencies:
60 kHz ± 250 Hz, 66,6 kHz ± 750 Hz, 75 kHz ± 250 Hz, 77,5 kHz ± 250 Hz, and 129,1 kHz ± 500 Hz.

The measurement was done at 3 meters distance.

The graph below is from Annex B of EN 300-330-1 v1.8.1.

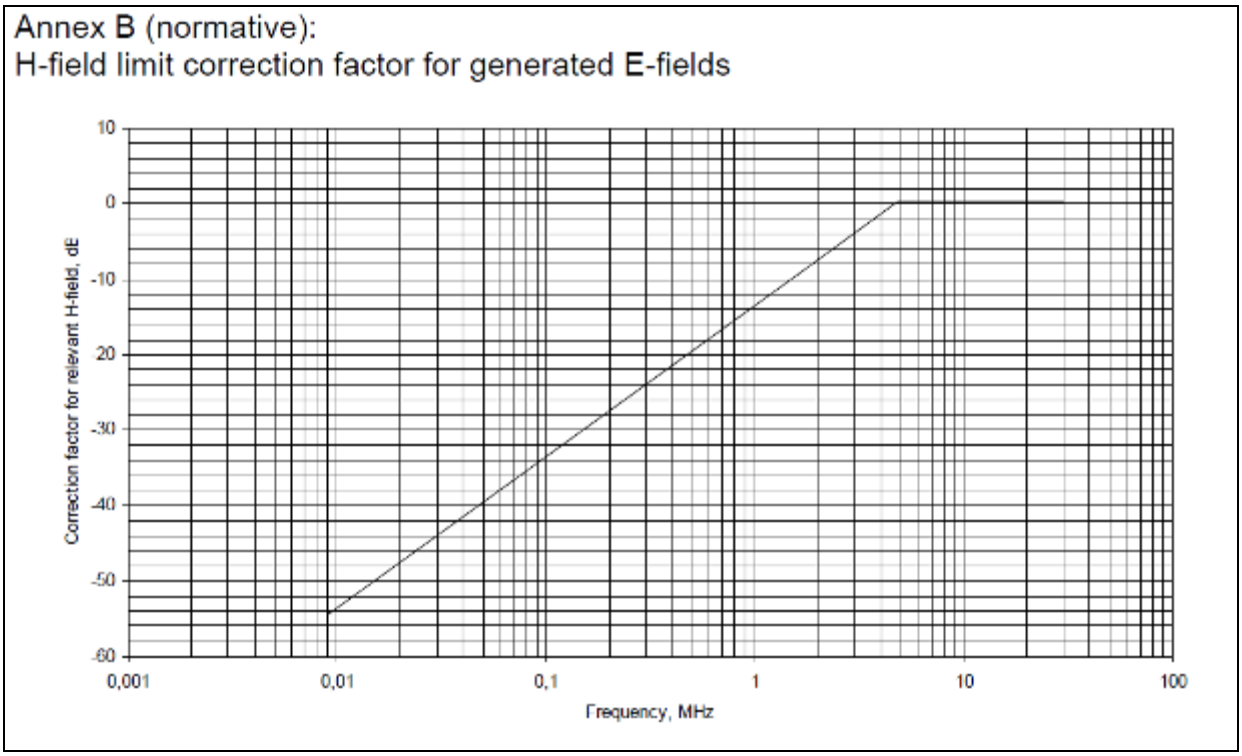

Figure 2. Annex B, H-Field Limit Correction Factor for Generated E-fields

The correction factor used in measurements below was 0 dB.

Table 6. Radiated H-Field Transmitter Carrier Output Test Results

Frequency (MHz)	Test Data (dBuV)	dBuAl Factor dB	AF+CA-AMP+DC (dB/m)	Results (dBuA/m)	Limits (dBuA/m)	Distance	Margin (dB)	Detector PK/QP/AVG
13.56	41.68	-51.50	15.93	6.11	60.00	3 m	53.9	PK

Note 1: The normative H-field to E-field factors of Annex B were used.

SAMPLE CALCULATIONS at 13.56 MHz and 20˚C

Test Data	41.68 dBuV
Normalization Factor	-51.50 dB
Correction Factor	15.93 dB/m
Results	6.11 dBuA/m

Test Date: October 5, 2015

Tested By
Signature:  Name: Carrie Ingram

3.1.2.2 RF Carrier Current

Since the EUT is not a Class 3 Product, this section does not apply.

3.1.2.3 Radiated E-Field

Since this EUT is not a Class 4 Product, this section does not apply.

3.1.3 Permitted Frequency Range of the Modulation Bandwidth

The frequency range of the modulation bandwidth was measured according to ETSI EN 300 330-1. The EUT was operating at the nominal carrier power, modulated and with its continuous wideband sweep on (if applicable). The span was sufficiently wide enough to capture the carrier and all major side bands. The upper and lower frequencies of the power envelope were measured. The EUT was tested under extreme conditions.

The frequency range of the modulation bandwidth will contain all of the associated side bands as defined in ETSTI EN section 7.4. Since the EUT is an RFID, the transmitter emissions level and spectrum mask limits from Annex G of ETSI EN 300-330 -1.7.1 (2009-12) was applied

The plots have been captured and presented below as evidence that the EUT meets these requirements.

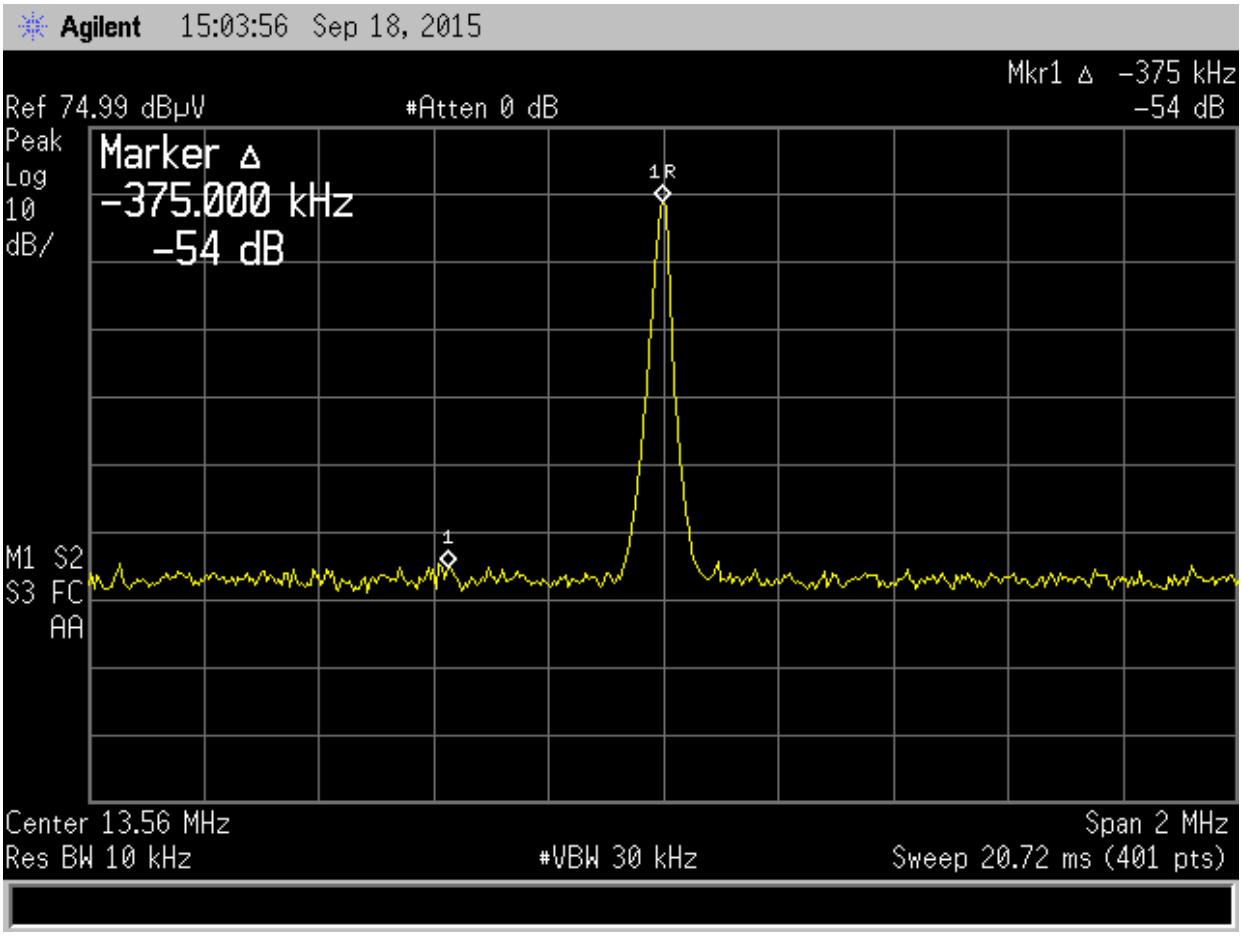

Figure 3. Lower Permitted Bandwidth Frequency at 0˚C and Nominal Voltage

Calculation of Worst Case Emission Mask Limit:

Fundamental Emission (from Table 6)	11.80 dBuA
Delta (from figure above)	-54.00 dB
Worst Case Emissions result	-42.20 dBuA
Worst Case Limit	-16.00 dBuA/m
-Worst Case Emission results	-42.20 dBuA
Limit	26.20 dB

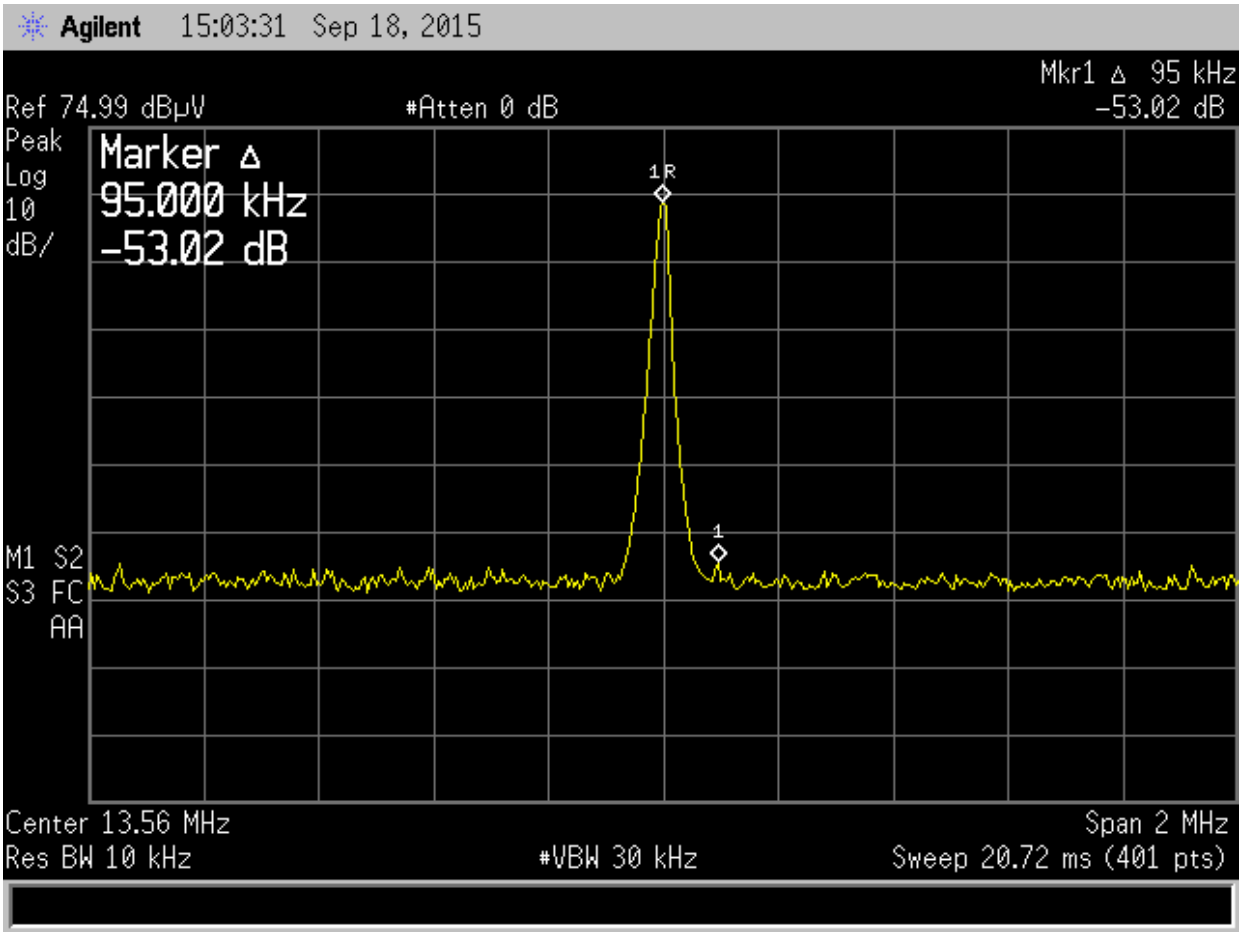

Figure 4. Upper Permitted Bandwidth Frequency 0˚C and Nominal Voltage

Calculation of Worst Case Emission Mask Limit:

Fundamental Emission (from Table 6)	11.80 dBuA
Delta (from figure above)	-53.02 dB
Worst Case Emissions result	-41.22 dBuA
Worst Case Limit	-16.00 dBuA/m
-Worst Case Emission results	-41.22 dBuA
Limit	25.22 dB

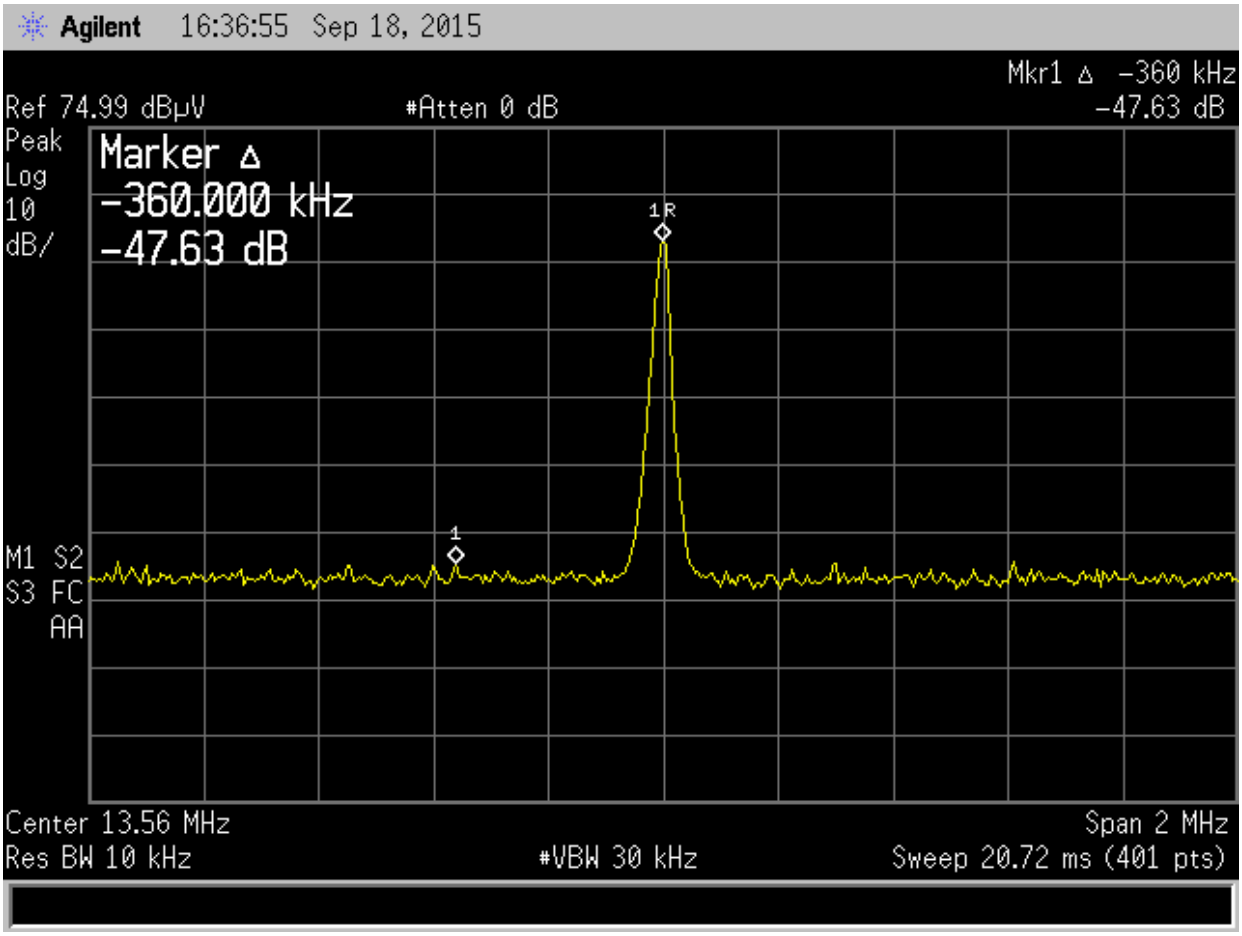

Figure 5. Lower Permitted Bandwidth Frequency at 20˚C and Nominal Voltage

Calculation of Worst Case Emission Mask Limit:

Fundamental Emission (from Table 6)	6.11 dBuA
Delta (from figure above)	-47.63 dB
Worst Case Emissions result	-41.52 dBuA
Worst Case Limit	-16.00 dBuA/m
-Worst Case Emission results	-41.52 dBuA
Limit	25.52 dB

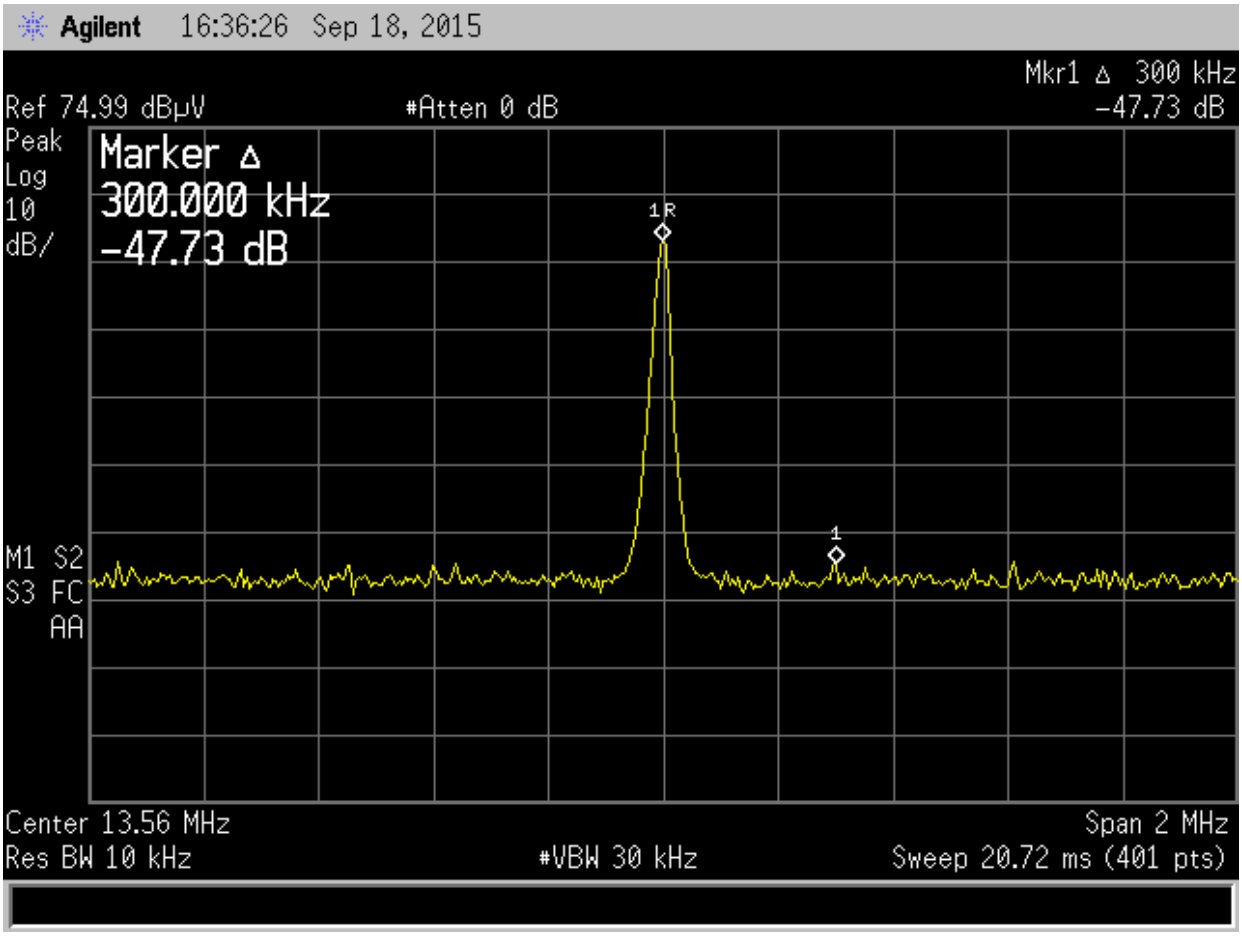

Figure 6. Upper Permitted Bandwidth Frequency at 20˚C and Nominal Voltage

Calculation of Worst Case Emission Mask Limit:

Fundamental Emission (from Table 6)	6.11 dBuA
Delta (from figure above)	-47.73 dB
Worst Case Emissions result	-41.62 dBuA
Worst Case Limit	-16.00 dBuA/m
-Worst Case Emission results	-41.62 dBuA
Limit	25.62 dB

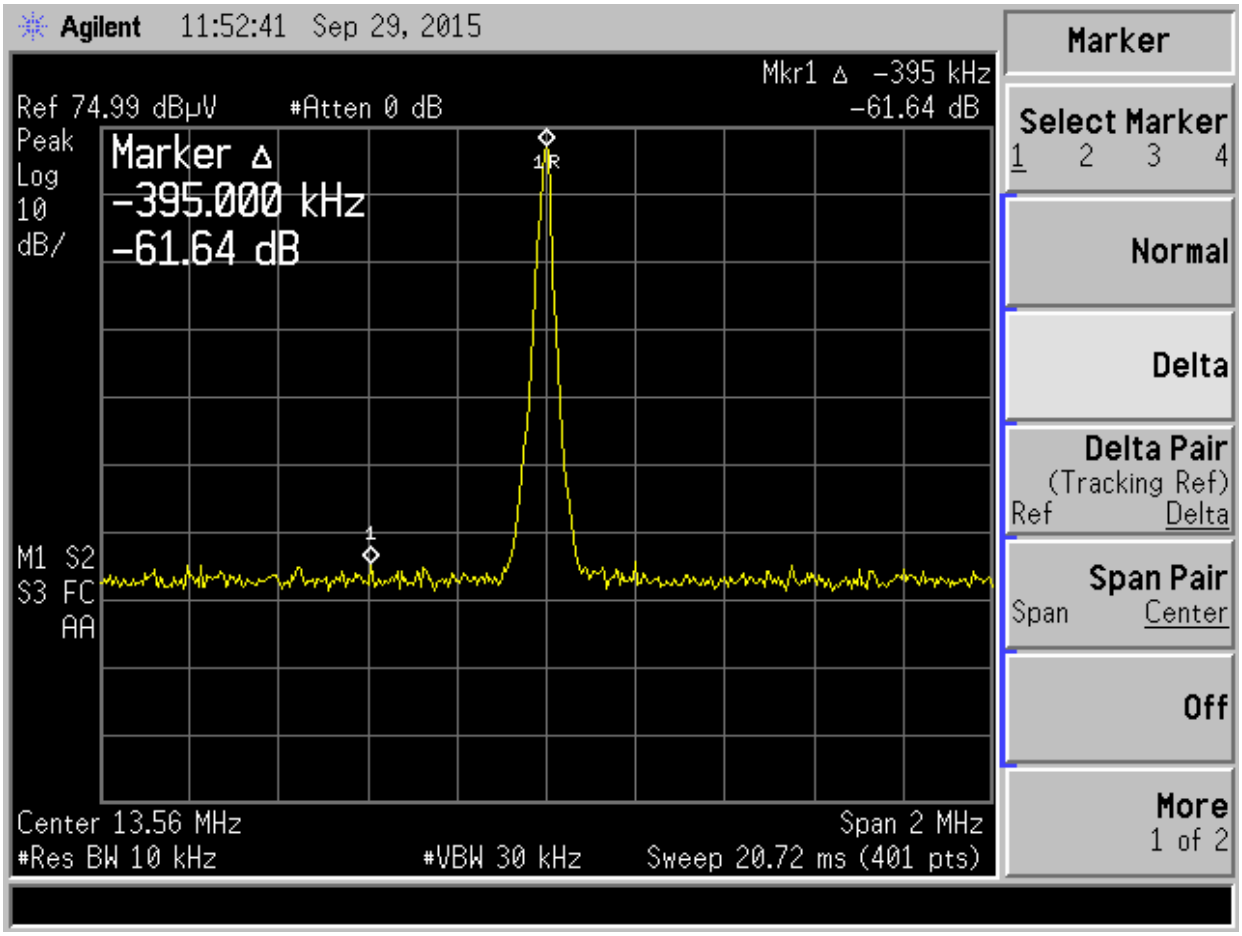

Figure 7. Lower Permitted Bandwidth Frequency at 65˚C and Nominal Voltage

Calculation of Worst Case Emission Mask Limit:

Fundamental Emission (from Table 6)	20.11 dBuA
Delta (from figure above)	-61.64 dB
Worst Case Emissions result	-41.53 dBuA
Worst Case Limit	-16.00 dBuA/m
-Worst Case Emission results	-41.53 dBuA
Limit	25.63 dB

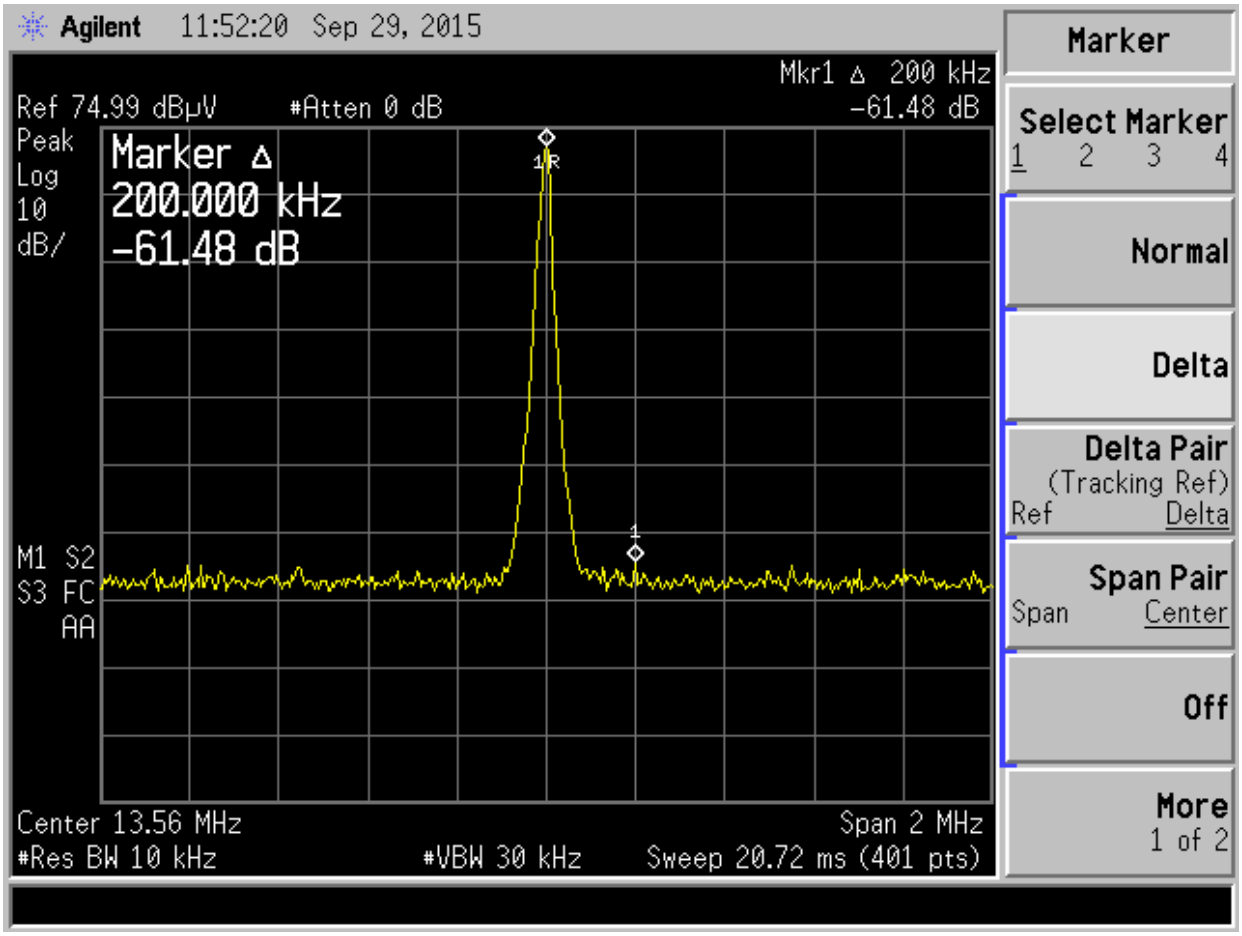

Figure 8. Upper Permitted Bandwidth Frequency at 65˚C and Nominal Voltage

Calculation of Worst Case Emission Mask Limit:

Fundamental Emission (from Table 6)	20.11 dBuA
Delta (from figure above)	-61.48 dB
Worst Case Emissions result	-41.37 dBuA
Worst Case Limit	-16.00 dBuA/m
-Worst Case Emission results	-41.37 dBuA
Limit	25.37 dB

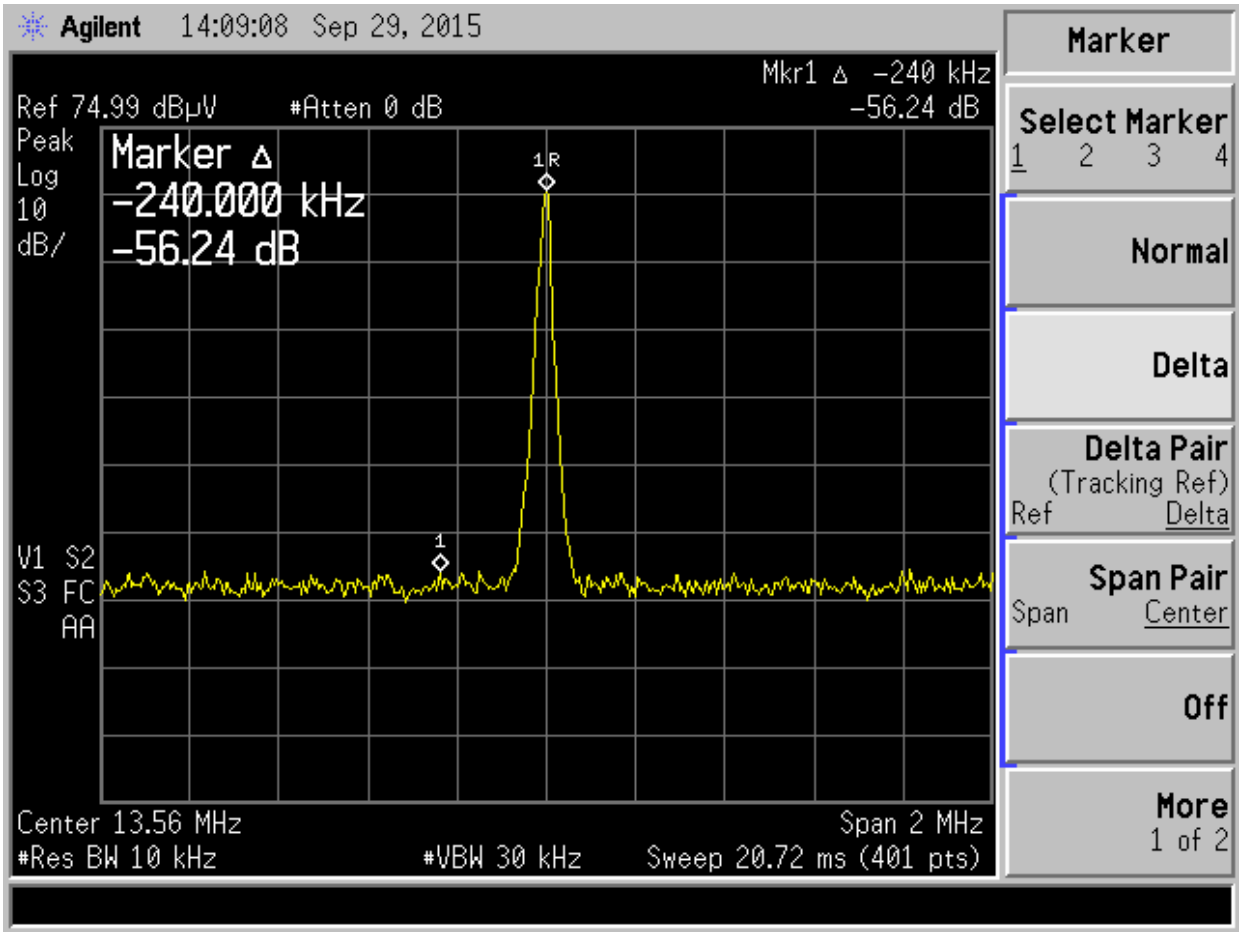

Figure 9. Lower Permitted Bandwidth Frequency at 20˚C and -10% Nominal Voltage

Calculation of Worst Case Emission Mask Limit:

Fundamental Emission (from Table 6)	13.45 dBuA
Delta (from figure above)	-56.24 dB
Worst Case Emissions result	-42.79 dBuA
Worst Case Limit	-16.00 dBuA/m
-Worst Case Emission results	-42.79 dBuA
Limit	26.79 dB

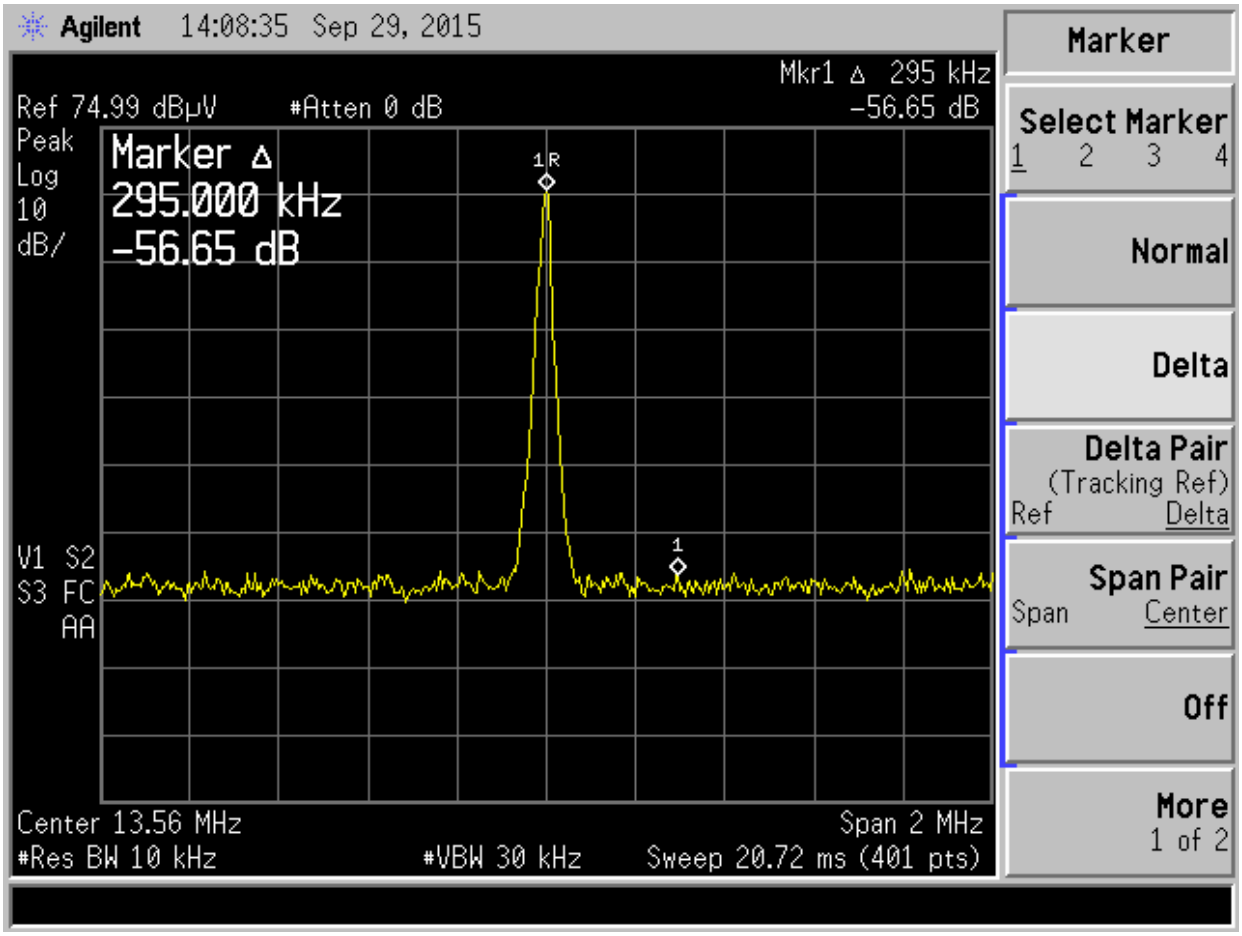

Figure 10. Upper Permitted Bandwidth Frequency at 20˚C and -10% Nominal Voltage

Calculation of Worst Case Emission Mask Limit:

Fundamental Emission (from Table 6)	13.45	dBuA
Delta (from figure above)	-56.65	dB
Worst Case Emissions result	-43.20	dBuA
Worst Case Limit	-16.00	dBuA/m
-Worst Case Emission results	-43.20	dBuA
Limit	27.20	dB

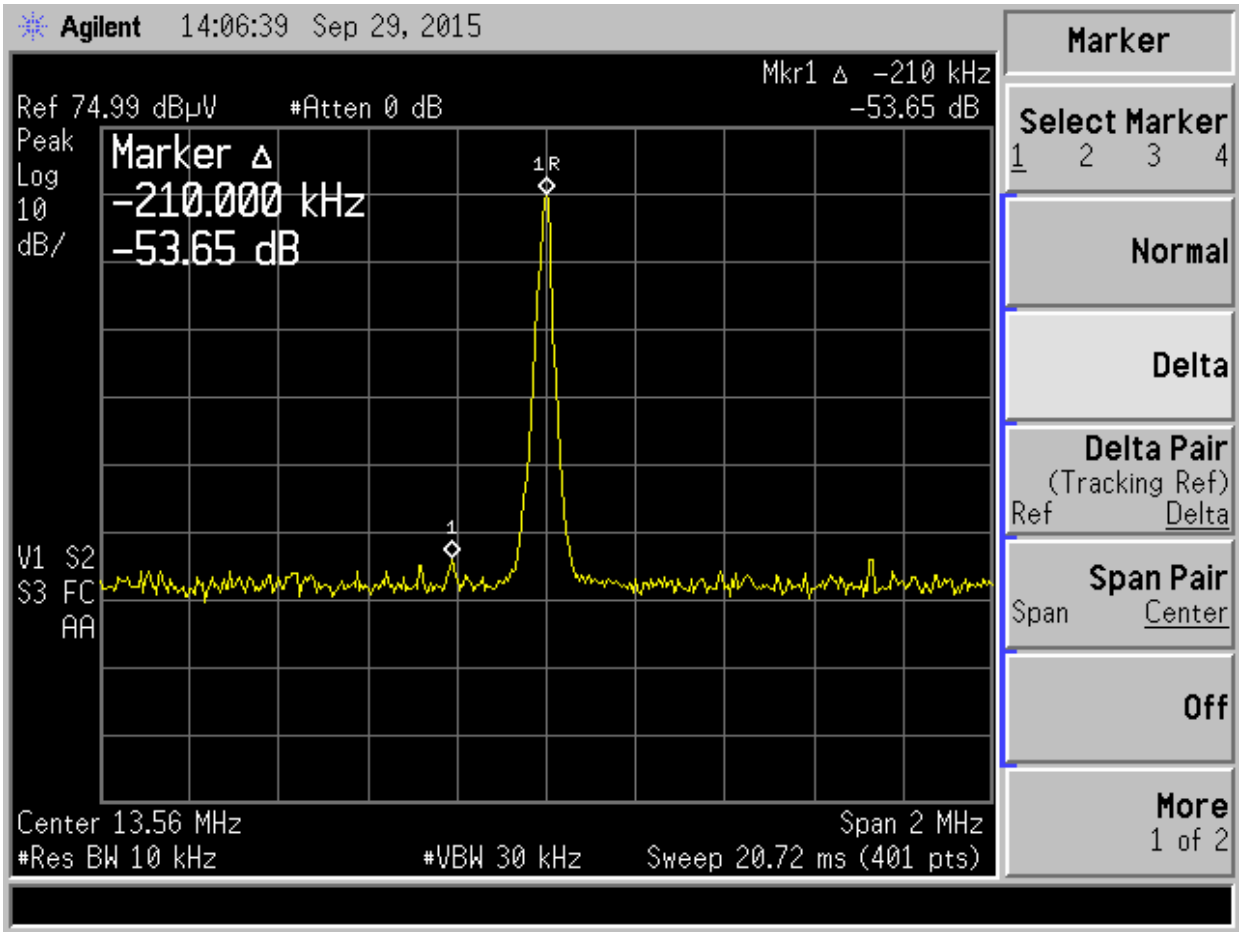

Figure 11. Lower Permitted Bandwidth Frequency at 20˚C and +10% Nominal Voltage

Calculation of Worst Case Emission Mask Limit:

Fundamental Emission (from Table 6)	12.89 dBuA
Delta (from figure above)	-53.65 dB
Worst Case Emissions result	-40.76 dBuA
Worst Case Limit	-16.00 dBuA/m
-Worst Case Emission results	-40.76 dBuA
Limit	24.76 dB

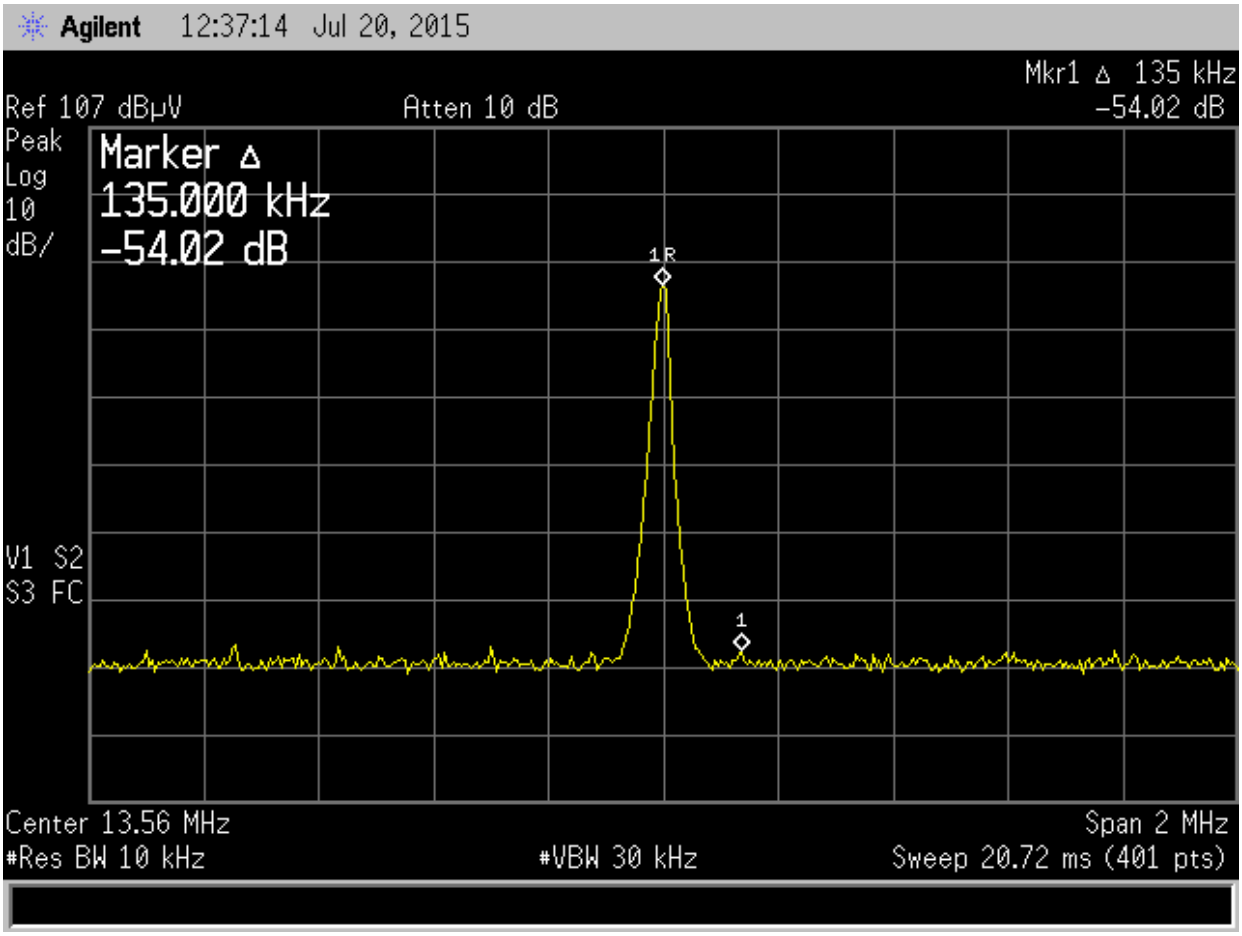

Figure 12. Upper Permitted Bandwidth Frequency at 20˚C and +10% Nominal Voltage

Calculation of Worst Case Emission Mask Limit:

Fundamental Emission (from Table 6)	12.89	dBuA
Delta (from figure above)	-54.02	dB
Worst Case Emissions result	-41.13	dBuA
Worst Case Limit	-16.00	dBuA/m
-Worst Case Emission results	-41.13	dBuA
Limit	25.13	dB

3.1.4 Transmitter Spurious and Out of Band Emissions

Spurious domain emissions are emissions other than those associated with the carrier frequency and sidebands associated with normal modulation. The spurious emissions were measured at normal conditions.

3.1.4.1 Conducted Spurious Emissions

This EUT is not a Class 3 product; therefore this section does not apply.

3.1.4.2 Radiated Field Strength

This field strength requirement applies to all frequencies below 30 MHz that the EUT is not transmitting on. The equipment is to be switched on and operating with normal modulation and any emissions seen were maximized. Measurements are to be taken at 10 m, but can be extrapolated back based on Figure 2 above and for measuring equipment calibrated in dBuV/m, the reading should be reduced by 51.5 dB to be converted to dBuA/m.

The EUT was placed in Operating mode and the Standby limits were applied. The operating mode was deemed the worst case configuration, if the EUT met the standby limits in this mode of operation no additional testing would be necessary in the standby mode of operation. This was the case for this EUT.

Table 7. Radiated Field Strength Emissions Limits

State	Frequency 9 kHz ≤ f < 10 MHz	Frequency 10 MHz ≤ f < 30 MHz
Operating	27 dBµA/m at 9 kHz descending 3 dB/oct	-3.5 dBuA/m
Standby	5,5 dBµA/m at 9 kHz descending 3 dB/oct	-25 dBµA/m

Table 8. Radiated Field Strength Emission Measurements

Frequency (MHz)	Test Data (dBuV)	Additional Factor dB	AF+CA-AMP+DC (dB/m)	Results (dBuA/m)	Limits (dBuA/m)	Distance	Margin (dB)	Detector PK/QP/AVG
27.12	33.80	-51.50	-12.07	-29.77	-25.0	3 m.	4.8	PK
27.12	25.30	-51.50	-10.47	-36.67	-25.0	3 m.	11.7	PK

Note 1: the normative H-field to E-field factors of Annex B were used.

SAMPLE CALCULATIONS at 27.12 Mhz

Test Data	33.80 dBuV
Normalization Factor	-51.50 dB
Correction Factor	-12.07 dB/m
Results	-29.77 dBuA/m

Test Date: September 18, 2015

Tested By
Signature:  Name: Carrie Ingram

3.1.4.3 Effective Radiated Power

The Effective Radiated Power applies to all spurious emissions seen coming from the EUT from 30 MHz to 1000 MHz. If an emission was seen it was maximized and then recreated with a substitution antenna to measure the power input.

Table 9. Effective Radiated Power Limits

State	47 MHz to 74 MHz 87.5 MHz to 118 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz	Other Frequencies between 30 MHz to 1000 MHz
Operating	4 nW	250 nW
Standby	2 nW	2 nW

Table 10. RF Spurious Test Results for Measurements above 30 MHz

Freq (MHz)	Maximum RX Reading (Units A) dBm	Recreated Reading During Substitution (Using Same Units A) dBm	Difference Column A – B dBm	TX Gain (dBi)	TX Gain Relative to Dipole (dB)	RF Power into TX antenna (dBm)	RF Power into substitution TX antenna corrected by TX Gain Relative to Dipole and TX Cable (dBm)	Limit (dBm)	Margin Below Limit (dB)
40.68	37.9	37.9	-0.0	-9.5	-11.64	-66.1	-79.00	-56.98	22.02

Sample calculation: at 40.68 MHz, 37.9 dBm

Test Date: September 18, 2015

Tested By
Signature:  Name: Carrie Ingram

3.2 Receiver Parameters

3.2.1 Adjacent Channel Selectivity - In Band

This measurement was not performed because the receiver is not a Category 1 receiver.

3.2.2 Blocking or Desensitization (Receiver Category 1 and 2 Only)

The EUT is a Category 3 receiver; therefore this test was not applicable.

The block or desensitization is the measure of the receiver's ability to receiver a wanted modulated signal without receiving an unwanted unmodulated signal. This is determined by the ratio in dB of the lowest level of unwanted signal (from generator B) to the level of the wanted signal (from generator A).

3.2.3 Receiver Spurious Radiation

This measurement was performed according to ETSI EN 300 330-1 section 8.2. The test procedure for Receiver spurious emissions is the same as the transmitter spurious emission in section 3.1.4 of this test report.

Table 11. Receiver Spurious Radiation Limits

Frequency Range	Limit
9 kHz ≤ f < 10 MHz	5.5 dBµA/m at 9 kHz descending 3 dB/oct
10 MHz ≤ f < 30 MHz	-25 dBµA/m
f ≥ 30 MHz	2 nW

Table 12. Receiver Spurious Radiated Emissions below 30 MHz

Frequency (MHz)	Test Data (dBuV)	Additional Factor dB	AF+CA-AMP+DC (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Distance	Margin (dB)	Detector PK/QP/AVG
No Emissions were seen when the EUT was placed into receiver mode								

Note 1: the normative H-field to E-field factors of Annex B were used.
Note 2: limit at X kHz = Y dBuA/m = Z dBuV/m (X dBuA/m + Y dB)

SAMPLE CALCULATIONS: N/A

Test Date: September 18, 2015

Tested By
Signature:  Name: Carrie Ingram

Table 13. Receiver Spurious Radiated Emissions above 30 MHz

Freq (MHz)	Maximum RX Reading (Units A) dBm	Recreated Reading During Substitution (Using Same Units A) dBm	Difference Column A – B dBm	TX Gain (dBi)	TX Gain Relative to Dipole (dB)	RF Power into TX antenna (dBm)	RF Power into substitution TX antenna corrected by TX Gain Relative to Dipole and TX Cable (dBm)	Limit (dBm)	Margin Below Limit (dB)
No Emissions were seen when the EUT was placed into Receiver mode.									

Test Date: September 18, 2015

Tested By
Signature:  Name: Carrie Ingram

3.3 RF Exposure

The maximum rated out power is less than 20 mW. The EUT meets the requirements of EN 62311:2008.

4 Radiated digital Emissions (Co-Location)

See US Tech report # 15-0112 for ETSI EN 300 328 for test details of radiated emissions and power line conducted emissions for co-location testing of the radio.

4.1 Measurement Uncertainty

4.1.1 Conducted Emissions Measurement Uncertainty

Measurement uncertainty (within a 95% confidence level) for this test is ± 2.78 dB.

The data listed in this test report does have sufficient margin to negate the effects of uncertainty. The EUT unconditionally passes this requirement.

4.1.2 Radiated Emissions Measurement Uncertainty

For a measurement distance of 3 m the measurement uncertainty (with a 95% confidence level) for this test using a Biconical Antenna (30 MHz to 200 MHz) is ± 5.39 dB. This value includes all elements of measurement.

The measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna (200 MHz to 1000 MHz) is ± 5.18 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is ± 5.21 dB (3 m distance).

The data listed in this test report does not have sufficient margin to negate the effects of uncertainty. The EUT conditionally passes this requirement.

5 Test Equipment and Ancillaries Used for Tests

Table 14. Equipment Used

INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	DATE OF LAST CALIBRATION
SPECTRUM ANALYZER	8566B	HEWLETT-PACKARD	2747A05665	5/7/2015
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	1/28/2015
BICONICAL ANTENNA	3110B	EMCO	9306-1708	11/24/2014 2 yr.
BICONICAL ANTENNA	3110B	EMCO	9307-1431	8/25/2015 2 yr
LOG PERIODIC ANTENNA	3146	EMCO	9110-3236	11/19/2014 2 yr.
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	7/1/2014 2 yr.
HORN ANTENNA	SAS-571	A.H. Systems	605	8/25/2015 2 yr.
HORN ANTENNA	3115	EMCO	9107-3723	7/8/2014 2 yr.
HORN ANTENNA	3116	EMO	9505-2255	1/27/2015 2 yr.
PRE-AMPLIFIER	8449B	HEWLETT-PACKARD	3008A00480	12/5/2014
PRE-AMPLIFIER	8477E	HEWLETT-PACKARD	1145A00307	11/21/2014
PRE-AMPLIFIER	8447D	HEWLETT-PACKARD	1937A02980	12/4/2014
LISN x 2	9247-50-TS-50-N	SOLAR ELECTRONICS	955824 and 955825	12/30/2014

Note 1: The calibration interval of the above test instruments is 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

6 Photographs

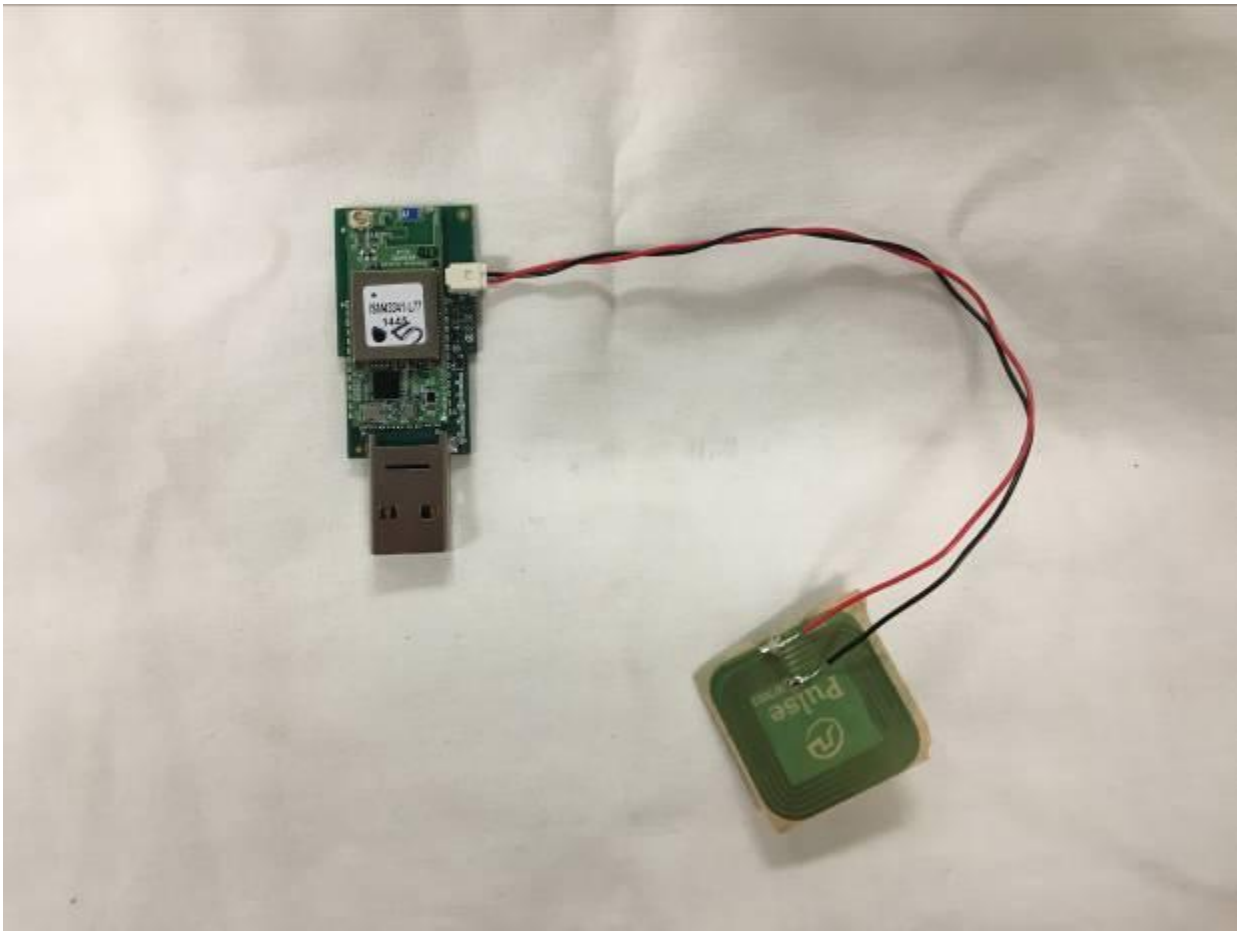

Figure 13. Outside of EUT

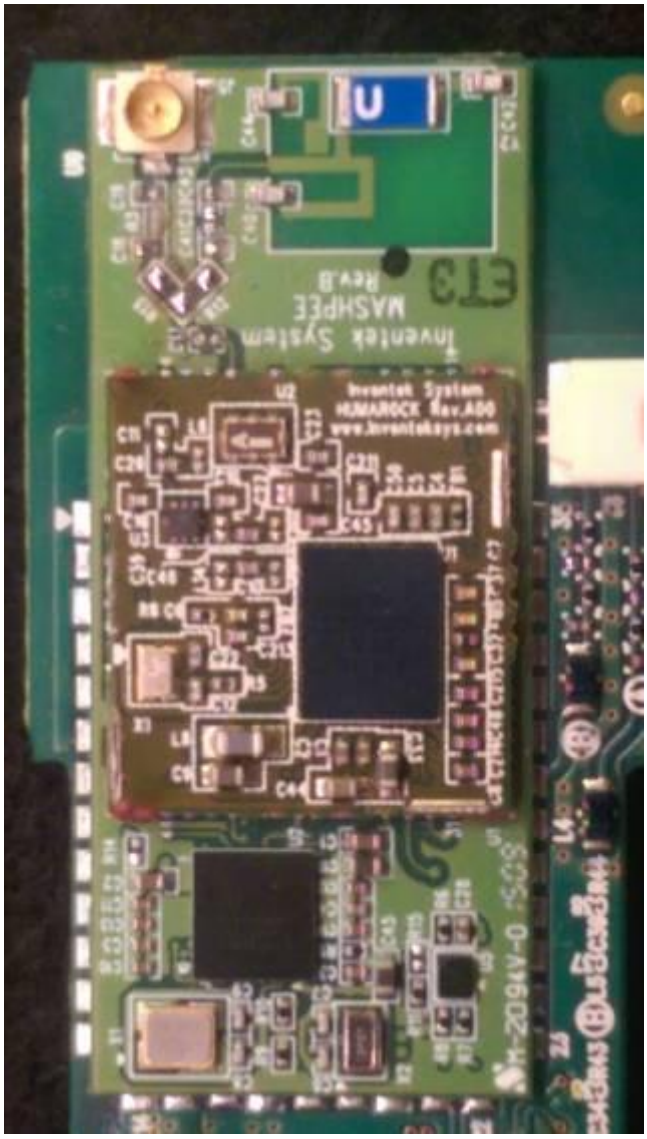

Figure 14. Top of EUT Circuit Board

Figure 15. Bottom of EUT Circuit Board

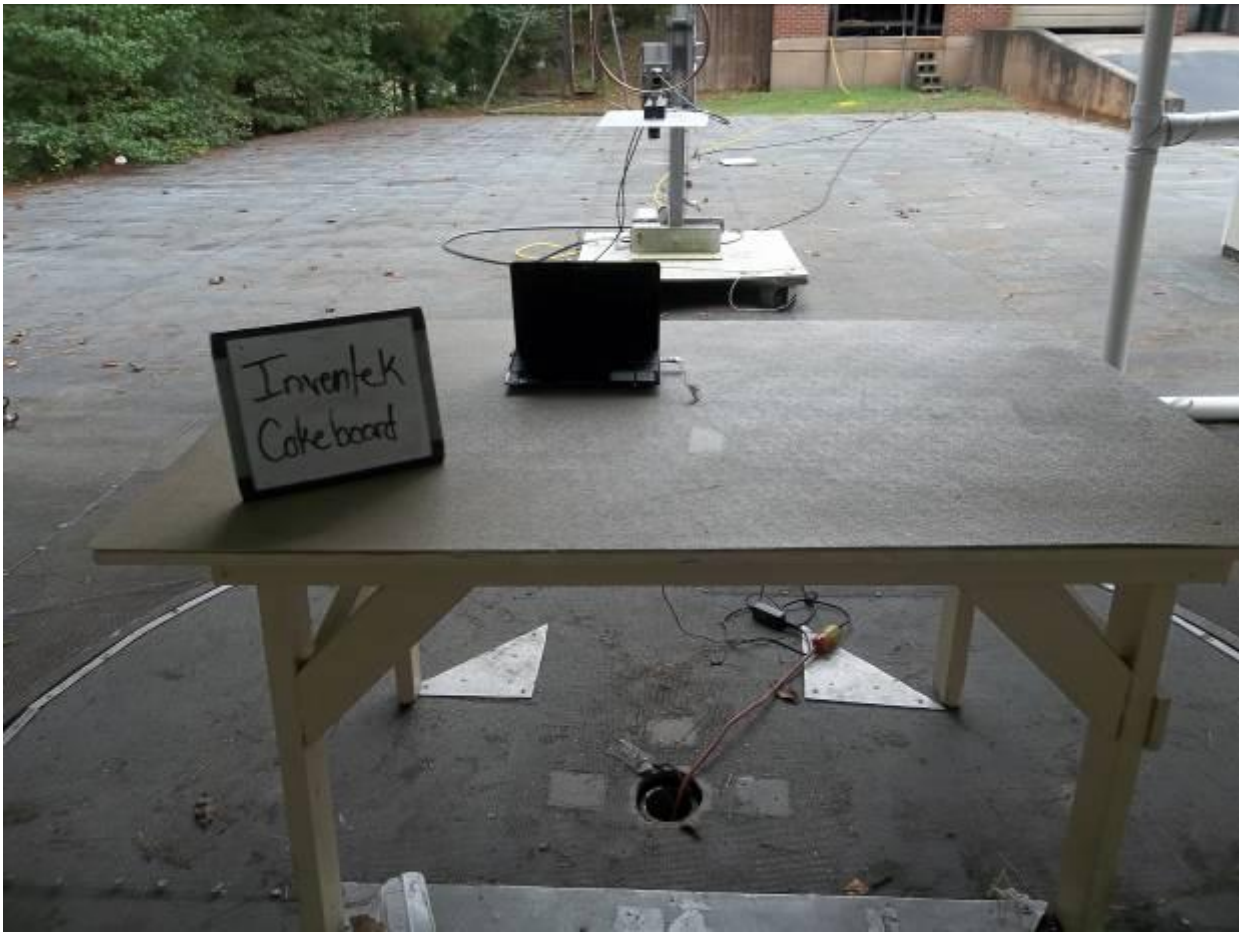

Figure 16. Radiated Emissions Test Setup Rear

Figure 17. Radiated Emissions Test Setup Front (Close Up)

Figure 18. Extreme Temperature Test Setup

Figure 19. Conducted Powerline Emissions Test Setup