FCC 47 CFR PART 15 SUBPART C

RF Test Report

Applicant	:	Amroad Technology Inc.
Product Type	:	RF MODULE
Trade Name	:	amroad
Model Number	:	RF-221
Test Specification	:	FCC 47 CFR PART 15 SUBPART C ANSI C63.10:2013
Receive Date	:	Sep. 09, 2016
Test Period	:	Oct. 08 ~ Oct. 23, 2016
Issue Date	:	Sep. 15, 2017

Issue by

A Test Lab Techno Corp.
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Taiwan Accreditation Foundation accreditation number: 1330
Test Firm MRA designation number: TW0010

Revision History

Rev.	Issue Date	Revisions	Revised By
00	May 17, 2017	Initial Issue	Snow Wang
01	Jul. 27, 2017	Revised report information.	Snow Wang
02	Sep. 15, 2017	Revised report information.	Nina Lin

Verification of Compliance

Issued Date: Sep. 15, 2017

Applicant	:	Amroad Technology Inc.
Product Type	:	RF MODULE
Trade Name	:	amroad
Model Number	:	RF-221
FCC ID	:	2AMZE-RF221
EUT Rated Voltage	:	DC5V, 2.6mA
Test Voltage	:	DC 4.25V, DC5.00V, DC 5.75V
Applicable Standard	:	FCC 47 CFR PART 15 SUBPART C ANSI C63.10:2013
Test Result	:	Complied
Performing Lab.	:	A Test Lab Techno Corp. No. 140-1, Changan Street, Bade District, Taoyuan City 33465, Taiwan (R.O.C) Tel：+886-3-2710188 / Fax：+886-3-2710190 Taiwan Accreditation Foundation accreditation number: 1330 http://www.atl-lab.com.tw/e-index.htm

A Test Lab Techno Corp. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by A Test Lab Techno Corp. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Approved By	:	Fly Lu	Reviewed By	:	Eric Ou Yang
(Manager)		(Fly Lu)	(Testing Engineer)		(Eric Ou Yang)

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1 General Information

1.1 Summary of Test Result

Reference 47 CFR Part 15.225	Test	Results	Remark
15.203	Antenna Requirement	Meet Require	---
15.207(a)	Conducted Emissions Voltage	N/A	Not applicable, This device use DC power source.
15.225 (a), (b), (c), (d) 15.209	Radiated Emission Limits	PASS	---
15.225(e)	Frequency Stability	PASS	---
15.215(c)	20dB Bandwidth	-----	---
CFR 47 Part 15.225 / ANSI C63.10:2013			

The test results of this report relate only to the tested sample(s) identified in this report. Manufacturer or whom it may concern should recognize the pass or fail of the test result.

1.2 Measurement Uncertainty

Test Item	Frequency Range	Uncertainty
Conducted Emission	9kHz ~ 150KHz	2.7
	150kHz ~ 30MHz	2.7
Radiated Emission	9kHz ~ 30MHz	1.7
	30MHz ~ 1000MHz	5.7
	1000MHz ~ 18000MHz	5.5
	18000MHz ~ 26500MHz	4.8
	26500MHz ~ 40000MHz	4.8
RF Bandwidth		4.96%
Frequency Stability		+ 2.212 x 10-7% / - 2.170 x 10-7

2 EUT Description

Applicant	Amroad Technology Inc. 17F-1, No 16, Jianba Road, Zhonghe District,New Taipei City, Taiwan R.O.C
Manufacturer	Amroad Technology Inc. 17F-1, No 16, Jianba Road, Zhonghe District,New Taipei City, Taiwan R.O.C
Product	RF MODULE
Trade Name	amroad
Model Number	RF-221
FCC ID	2AMZE-RF221
Frequency Range	13.56 MHz
Modulation Type	ASK
Number of Channels	1 Channel
Antenna Type	Loop Antenna

3 Test Methodology

3.1. Mode of Operation

The following test mode(s) were scanned during the preliminary test：

Pre-Test Mode
Mode 1: Transmit Mode

ATL has verified the construction and function in typical operation. All the test modes were carried out with the EUT in normal operation.

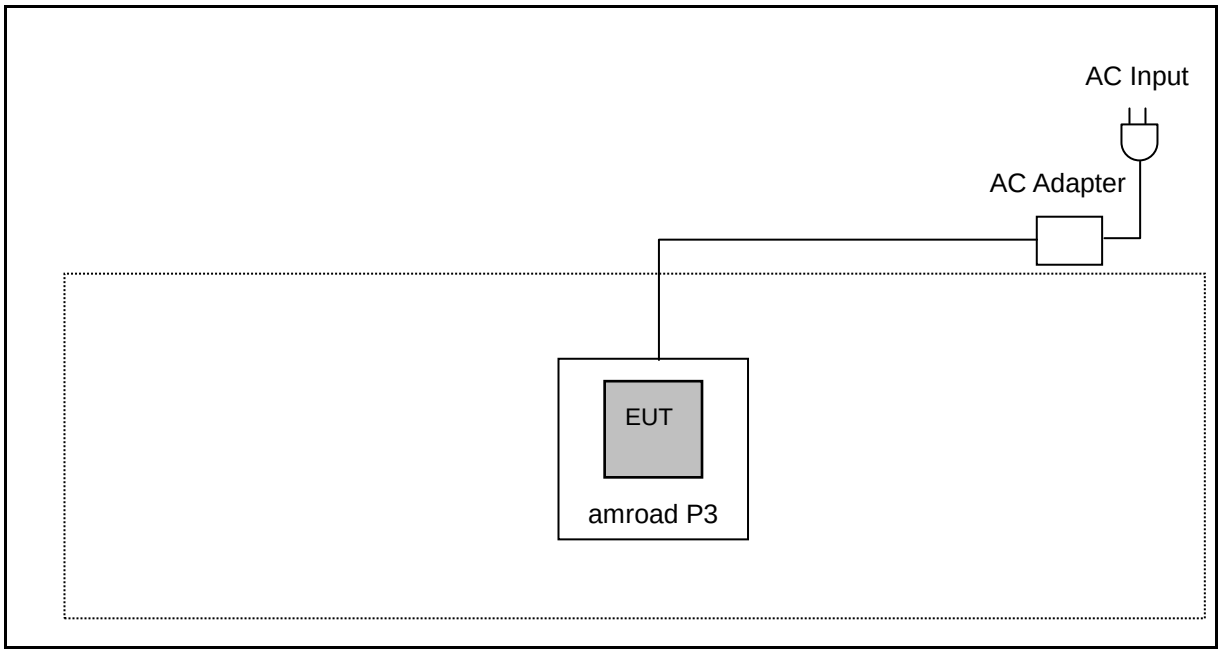
3.2. EUT Exercise Software

1.	Setup the EUT as shown on 3.3.
2.	Turn on the power of all equipment.
3.	The EUT will start to operate function.

Measurement Software	
1	EZ-EMC Ver. ATL-03A1-1

3.3. Configuration of Test System Details

Radiated Emission



3.4. Test Site Environment

Items	Required (IEC 60068-1)	Actual
Temperature (°C)	15-35	26
Humidity (%RH)	25-75	60
Barometric pressure (mbar)	860-1060	950

4 Radiated Emissions Measurement

4.1. Limit

According to §15.225,

(a) The field strength of any emissions within the band 13.553 – 13.567 MHz shall not exceed 15,848 microvolt / meter at 30 meters.

(b) Within the bands 13.410 – 13.553 MHz and 13.567 -13.710 MHz, the field strength of any emissions shall not exceed 334 microvolt / meter at 30 meters.

(c) Within the bands 13.110 – 13.410 MHz and 13.710 – 14.010 MHz the field strength of any emissions shall not exceed 106 microvolt / meter at 30 meters.

(d) The field strength of any emissions appearing outside of the 13.110 – 14.010 MHz and shall not exceed the general radiated emission limits in §15.209.

According to §15.225(a), except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (μV/m at meter)	Measurement Distance (meter)
0.009 – 0.490	2400 / F (kHz)	300
0.490 – 1.705	24000 / F (kHz)	30
1.705 – 30.0	30	30
30 - 88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

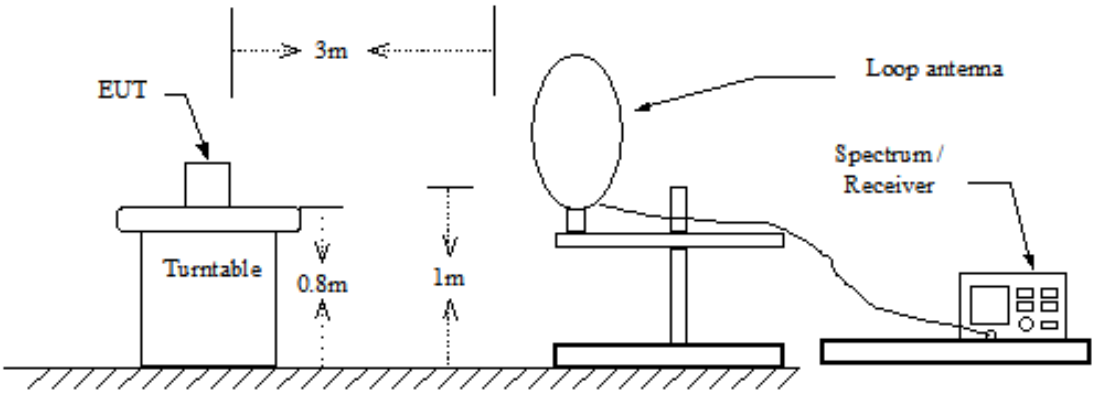
4.2. Test Instruments

3 Meter Chamber					
Equipment	Manufacturer	Model Number	Serial Number	Cal. Date	Remark
RF Pre-selector	Agilent	N9039A	MY46520256	01/08/2016	1 year
Spectrum Analyzer	Agilent	E4446A	MY46180578	01/08/2016	1 year
Pre Amplifier	Agilent	8449B	3008A02237	10/11/2016	1 year
Pre Amplifier	Agilent	8447D	2944A11119	01/11/2016	1 year
Broadband Antenna	Schwarzbeck	VULB9168	416	10/13/2016	1 year
Horn Antenna (1~18GHz)	SCHWARZBECK MESS-ELEKTRONIK	BBHA9120D	9120D-550	06/06/2016	1 year
Horn Antenna (18~40GHz)	ETS	3116	86467	09/05/2016	1 year
Loop Antenna	COM-POWER CORPORATION	AL-130	121014	02/01/2016	1 year
Microwave Cable	EMCI	EMC102-KM-KM-14000	151001	02/23/2016	1 year
Microwave Cable	EMCI	EMC-104-SM-SM-14000	140202	02/23/2016	1 year
Microwave Cable	EMCI	EMC104-SM-SM-600	140301	02/23/2016	1 year
Test Site	ATL	TE01	888001	08/29/2016	1 year

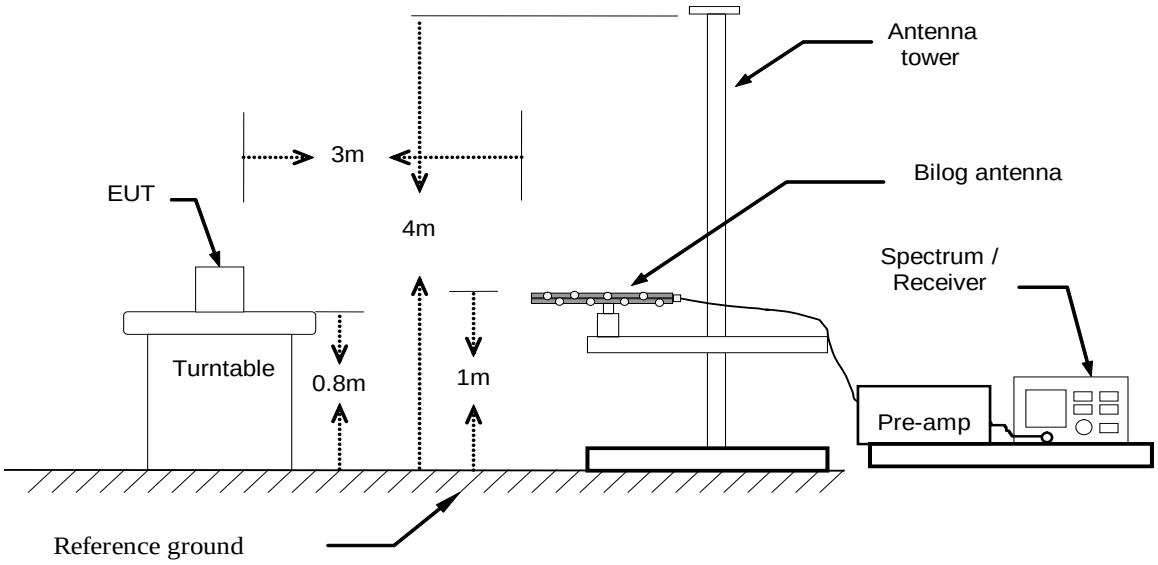
NOTE: N.C.R. = No Calibration Request.

4.3. Setup

9kHz ~ 30MHz



30MHz ~ 1 GHz



4.4. Test Procedure

Final radiation measurements were made on a three-meter Semi Anechoic Chamber. The EUT system was placed on a nonconductive turntable which is 0.8 meters height, top surface 1.0 x 1.5 meter. The spectrum was examined from 3 Hz to 44 GHz in order to cover the whole spectrum below 10th harmonic which could generate from the EUT. During the test, EUT was set to transmit continuously.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, and then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

A nonconductive material surrounded the EUT to supporting the EUT for standing on tree orthogonal planes. At each condition, the EUT was rotated 360 degrees, and the antenna was raised and lowered from one to four meters to find the maximum emission levels. Measurements were taken using both horizontal and vertical antenna polarization.

Broadband/Horn Antenna were used in frequency 30MHz to 18 GHz at a distance of 3 meter. Loop/Horn Antenna was used in frequency 9kHz to 30MHz and 18 to 26.5 GHz at a distance of 1 meter. All test results were extrapolated to equivalent signal at 3 meters utilizing an inverse linear distance extrapolation Factor (20dB/decade).

For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in peak mode also complies with the limit in average mode), then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.

Appropriate preamplifiers were used for improving sensitivity and precautions were taken to avoid overloading or desensitizing the spectrum analyzer. No post – detector video filters were used in the test.

The spectrum analyzer's 6 dB bandwidth was set to 1 MHz, and the analyzer was operated in the peak detection mode, for frequencies both below and up 1 GHz. The average levels were obtained by subtracting the duty cycle correction factor from the peak readings.

The following procedures were used to convert the emission levels measured in decibels referenced to 1 microvolt (dBuV) into field intensity in microvolt pre-meter (uV/m).

The actual field intensity in decibels referenced to 1 microvolt in to field intensity in microvolt per-meter (dBuV/m).

The actual field is intensity in referenced to 1 microvolt per meter (dBuV/m) is determined by algebraically adding the measured reading in dBuV, the antenna factor (dB), and cable loss (dB) and Subtracting the gain of preamplifier (dB) is auto calculate in spectrum analyzer.

(1) Amplitude (dBuV/m) = FI (dBuV) +AF (dBuV) +CL (dBuV)-Gain (dB)
FI= Reading of the field intensity.
AF= Antenna factor.
CL= Cable loss.
P.S Amplitude is auto calculate in spectrum analyzer.

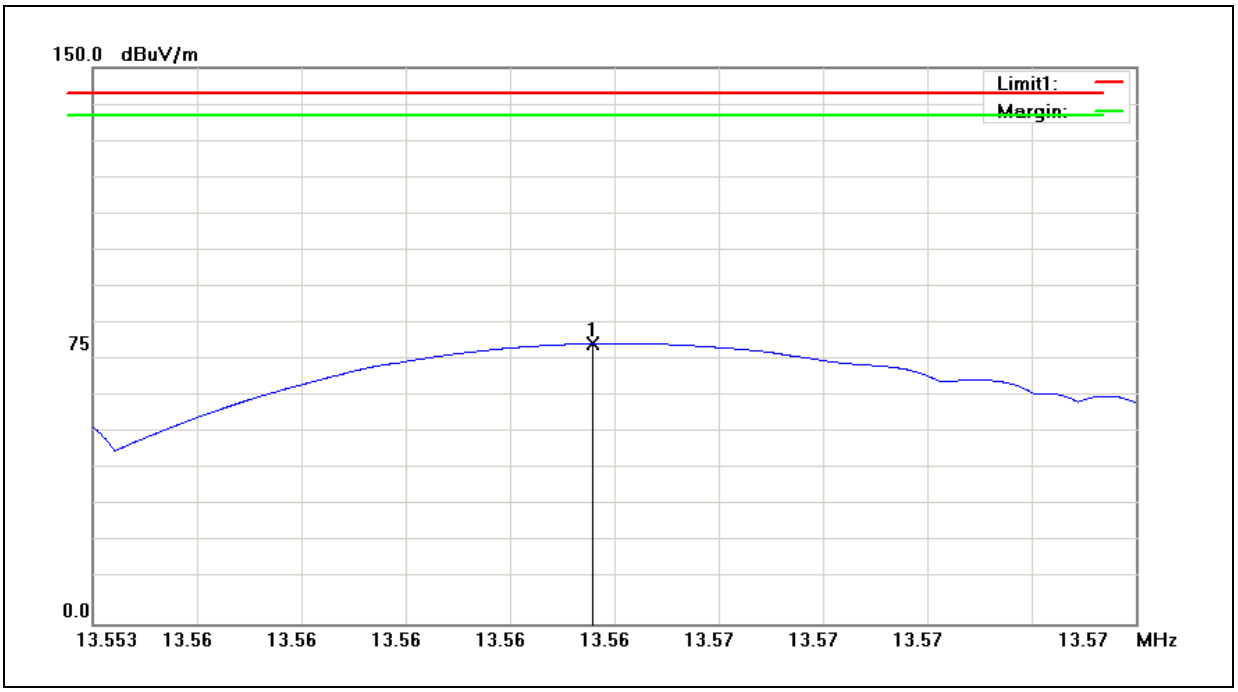
(2) Actual Amplitude (dBuV/m) = Amplitude (dBuV)-Dis(dB)
The FCC specified emission limits were calculated according the EUT operating frequency and by following linear interpolation equations:
(a) For fundamental frequency : Transmitter Output < +30dBm
(b) For spurious frequency : Spurious emission limits = fundamental emission limit /10

Data of measurement within this frequency range without mark in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

4.5. Test Result

Fundamental Test Result:

Standard:	FCC Part 15C	Test Distance:	1m
Test item:	Radiated Emission	Power:	DC 5.0V
Mode:	Mode 1	Temp.(℃)/Hum.(%RH):	26(℃)/60%RH
Ant.Polar.:	Horizontal	Date:	10/08/2016



No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Near-Field Result (dBuV)	Derived Value (dBuV)	Limit (dBuV/m)	Margin (dB)	Remark
1	13.5626	60.17	15.49	75.66	35.19	84.00	-48.81	peak

Note: The level is measured at 1 meter and is converted into result at 30 meter.

The converted formula listed below:

Measure result (1 meter distance): a

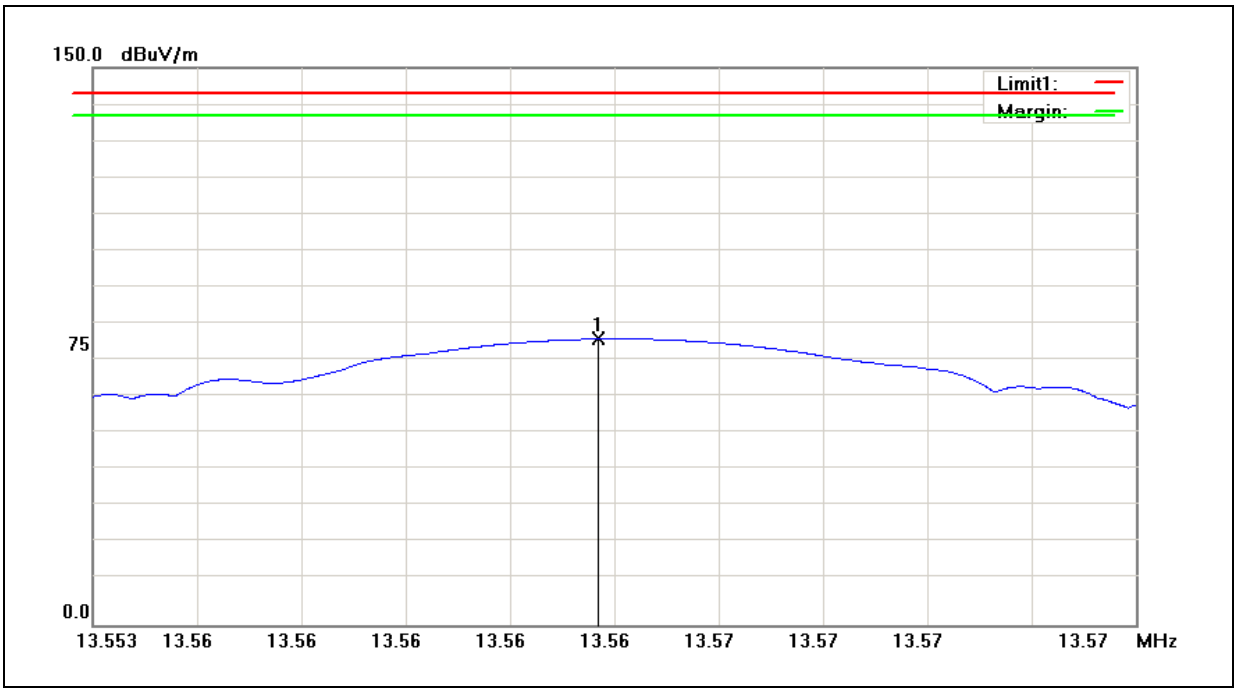
Compute result (30 meter distance): A

$d_{near\ field} = \lambda/2\pi$ ， $d_{measure}$ = 1 meter distance

$A = a - 40*\log(d_{near\ field}/d_{measure}) - 20*\log(d_{limit}/d_{near\ field})$

ex. a = 75.66 dBuV, A=75.66 - 40*log(3.52 /1) - 20*log(30 /3.52) dBuV = 35.19 dBuV

Standard:	FCC Part 15C	Test Distance:	1m
Test item:	Radiated Emission	Power:	DC 5.0V
Mode:	Mode 1	Temp.(℃)/Hum.(%RH):	26(℃)/60%RH
Ant.Polar.:	Vertical	Date:	10/08/2016

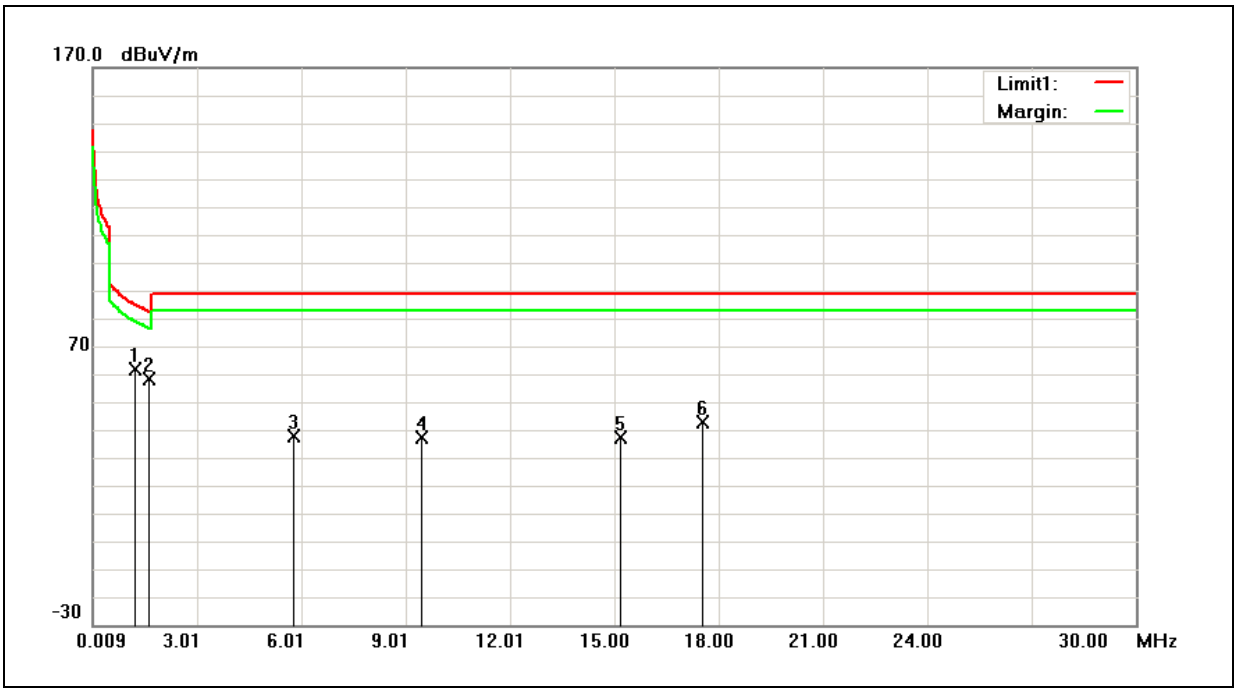


No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Near-Field Result (dBuV)	Derived Value (dBuV)	Limit (dBuV/m)	Margin (dB)	Remark
1	13.5627	61.52	15.49	77.01	36.54	84.00	-47.46	peak

Note: The level is measured at 1 meter and is converted into result at 30 meter.

9kHz ~ 30MHz:

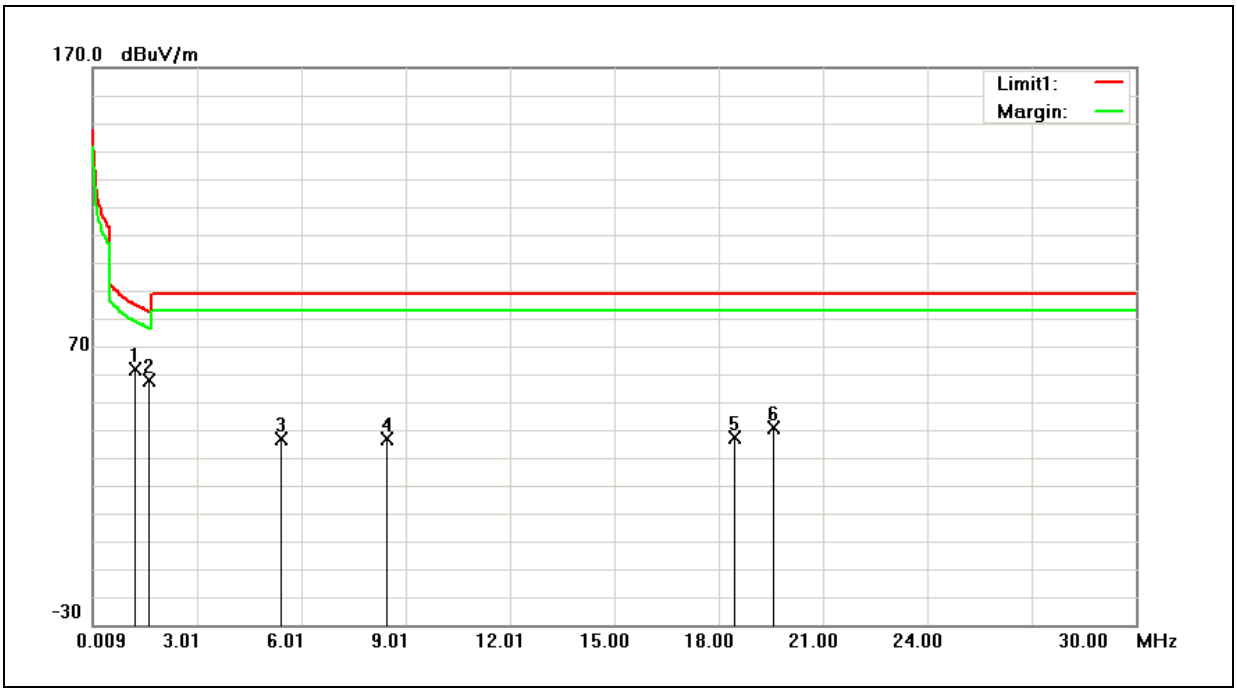
Standard:	FCC Part 15C	Test Distance:	1m
Test item:	Radiated Emission	Power:	DC 5.0V
Mode:	Mode 1	Temp.(℃)/Hum.(%RH):	26(℃)/60%RH
Ant.Polar.:	Horizontal	Date:	10/08/2016



No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Near-Field Result (dBuV/m)	Derived Value (dBuV)	Limit (dBuV/m)	Margin (dB)	Remark
1	1.2385	47.20	14.60	61.80	0.54	25.75	-25.21	QP
2	1.6285	43.68	14.59	58.27	-0.62	23.37	-23.98	QP
3	5.7972	22.38	15.19	37.57	-10.29	29.54	-39.83	QP
4	9.4561	21.86	15.44	37.30	-6.31	29.54	-35.85	QP
5	15.1844	21.74	15.51	37.25	-2.23	29.54	-31.77	QP
6	17.5533	27.37	15.53	42.90	4.67	29.54	-24.88	QP

Note: The level is measured at 1 meter and is converted into result at 300 or 30 meter.

Standard:	FCC Part 15C	Test Distance:	1m
Test item:	Radiated Emission	Power:	DC 5.0V
Mode:	Mode 1	Temp.(℃)/Hum.(%RH):	26(℃)/60%RH
Ant.Polar.:	Vertical	Date:	10/08/2016

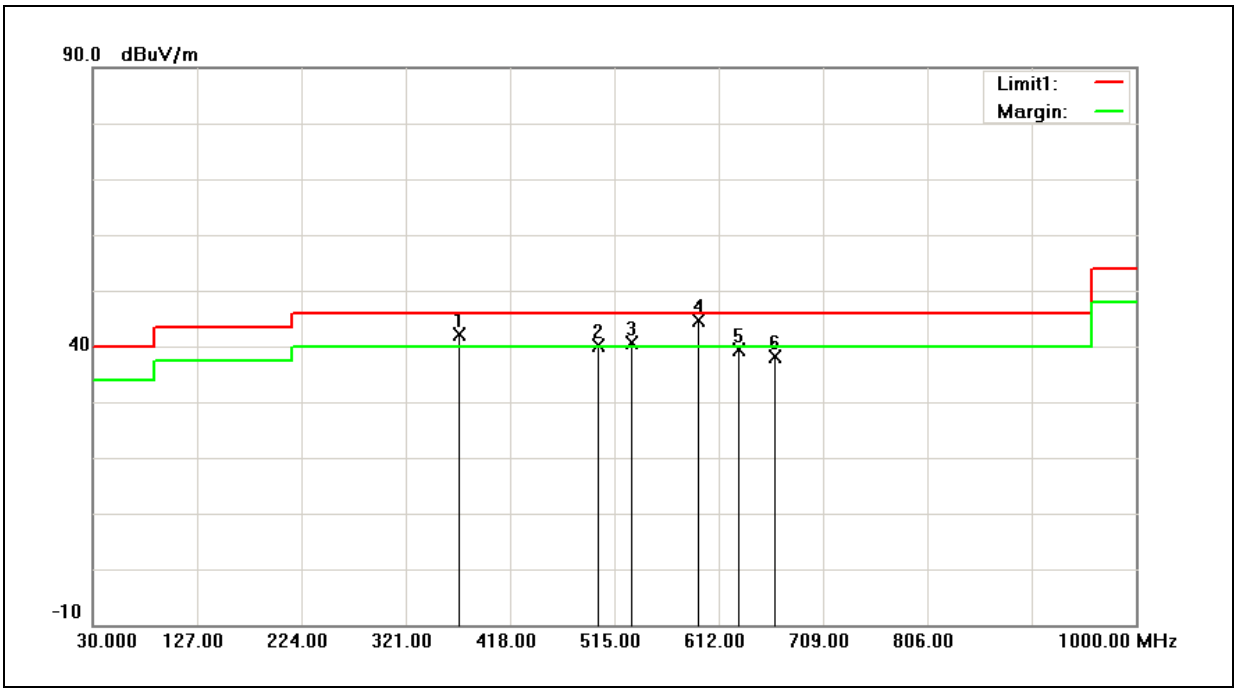


No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Near-Field Result (dBuV/m)	Derived Value (dBuV)	Limit (dBuV/m)	Margin (dB)	Remark
1	1.2386	46.95	14.60	61.55	0.29	25.75	-25.46	QP
2	1.6285	43.33	14.59	57.92	-0.97	23.37	-24.33	QP
3	5.4074	21.49	15.17	36.66	-11.80	29.54	-41.34	QP
4	8.4665	21.27	15.37	36.64	-7.93	29.54	-37.47	QP
5	18.4834	21.68	15.54	37.22	-0.55	29.54	-30.10	QP
6	19.593	25.34	15.53	40.87	3.58	29.54	-25.96	QP

Note: The level is measured at 1 meter and is converted into result at 300 or 30 meter.

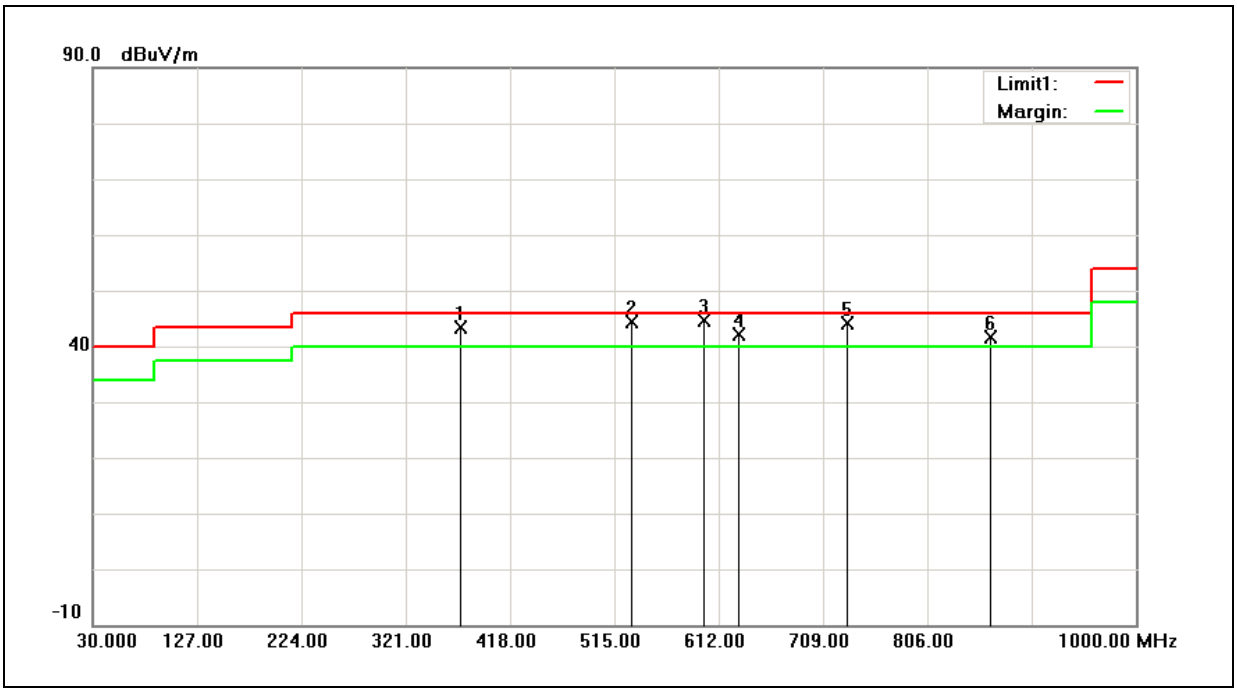
30MHz ~ 1GHz:

Standard:	FCC Part 15C	Test Distance:	3m
Test item:	Radiated Emission	Power:	DC 5.0V
Mode:	Mode 1	Temp.(℃)/Hum.(%RH):	26(℃)/60%RH
Ant.Polar.:	Horizontal	Date:	10/08/2016



No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	371.0000	44.37	-2.28	42.09	46.00	-3.91	QP
2	500.0000	39.36	0.74	40.10	46.00	-5.90	QP
3	532.0000	39.49	1.19	40.68	46.00	-5.32	QP
4	594.0000	41.78	2.74	44.52	46.00	-1.48	QP
5	631.0000	35.76	3.52	39.28	46.00	-6.72	QP
6	665.0000	34.04	4.12	38.16	46.00	-7.84	QP

Standard:	FCC Part 15C	Test Distance:	3m
Test item:	Radiated Emission	Power:	DC 5.0V
Mode:	Mode 1	Temp.(℃)/Hum.(%RH):	26(℃)/60%RH
Ant.Polar.:	Vertical	Date:	10/08/2016



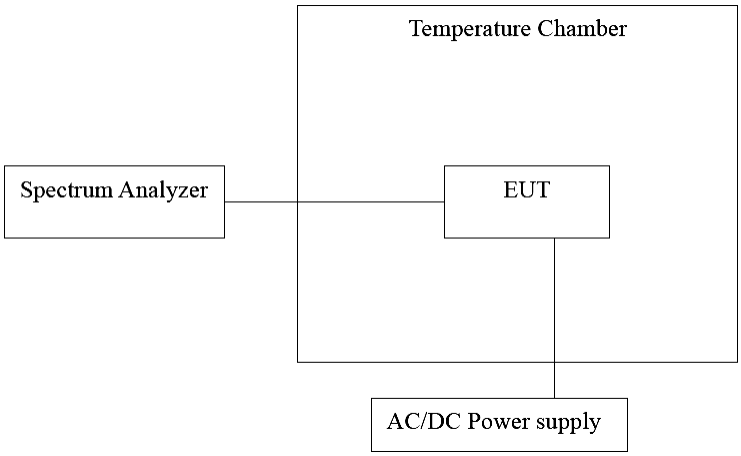
No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	371.5000	45.55	-2.25	43.30	46.00	-2.70	QP
2	532.0000	43.30	1.19	44.49	46.00	-1.51	QP
3	598.5000	41.78	2.88	44.66	46.00	-1.34	QP
4	631.0000	38.72	3.52	42.24	46.00	-3.76	QP
5	731.5000	38.51	5.52	44.03	46.00	-1.97	QP
6	864.5000	33.74	7.86	41.60	46.00	-4.40	QP

5 Frequency Stability Measurement

5.1. Limit

According to §15.207(e), the frequency tolerance of the carrier signal shall be maintained within +/- 0.01% of the operating frequency over a temperature variation of –20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

5.2. Test Setup



5.3. Test Instruments

Equipment	Manufacturer	Model Number	Serial Number	Cal. Date	Remark
Spectrum Analyzer	Agilent	E4408B	MY45107753	08/08/2016	1 year
Temperature & Humidity Chamber	TAICHY	MHU-225LA	980729	04/18/2016	1 year
Test Site	ATL	TE05	TE05	N.C.R.	-----

NOTE: N.C.R. = No Calibration Request.

5.4. Test Procedure

1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the environment into appropriate environment.
4. Set the spectrum analyzer as RBW=1kHz, VBW = RBW, Span = 200kHz, Sweep = auto.
5. Mark the peak frequency and measure the frequency tolerance using frequency counter function.
6. Repeat until all the results are investigated.

5.5. Test Result

Temperature Variations

Mode	Mode 1					
Temp. (°C)	Voltage (Vdc)	Measured Frequency (MHz)	Delta Frequency (Hz)	Tolerance (%)	Limit (±%)	Result (Pass/Fail)
-20	5.0	13.5638	1070.0000	0.0079	±0.01	Pass
-10		13.5639	1130.0000	0.0083	±0.01	Pass
0		13.5636	840.0000	0.0062	±0.01	Pass
10		13.5630	250.0000	0.0018	±0.01	Pass
20		13.5628	0.0000	0.0000	±0.01	Pass
30		13.5626	-110.0000	-0.0008	±0.01	Pass
40		13.5625	-280.0000	-0.0021	±0.01	Pass
50		13.5620	-750.0000	-0.0055	±0.01	Pass

Voltage Variations

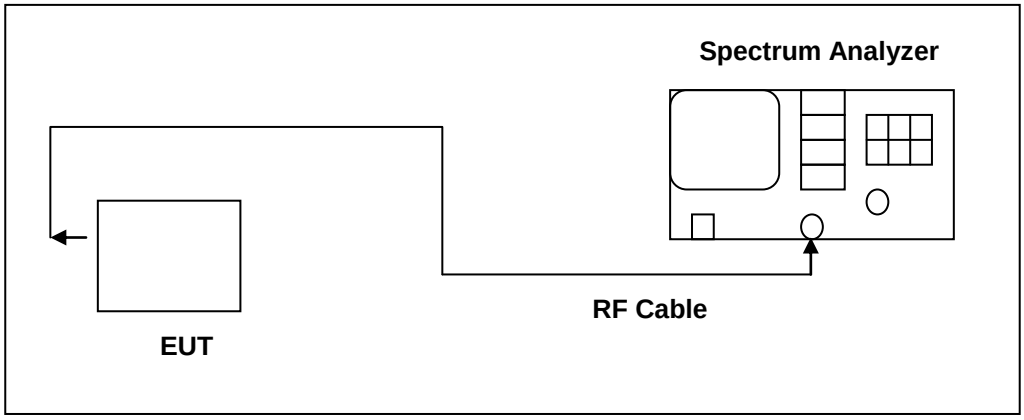
Mode	Mode 1					
Temp. (°C)	Voltage (Vdc)	Measured Frequency (MHz)	Delta Frequency (Hz)	Tolerance (%)	Limit (±%)	Result (Pass/Fail)
20	4.25	13.5628	0.0000	0.0000	±0.01	Pass
	5.00	13.5628	0.0000	0.0000	±0.01	Pass
	5.75	13.5628	0.0000	0.0000	±0.01	Pass

6 20dB Bandwidth Measurement

6.1. Limit

N/A

6.2. Test Setup



6.3. Test Instruments

Equipment	Manufacturer	Model Number	Serial Number	Cal. Date	Remark
Spectrum Analyzer	Agilent	E4445A	MY46181986	05/19/2016	1 year
Test Site	ATL	TE05	TE05	N.C.R.	-----

NOTE: N.C.R. = No Calibration Request.

6.4. Test Procedure

Connect RF output port to the input of the spectrum analyzer. Connect the DUT to appropriate power supply. Turn RFID function of DUT on.

Analyzer used the following settings:

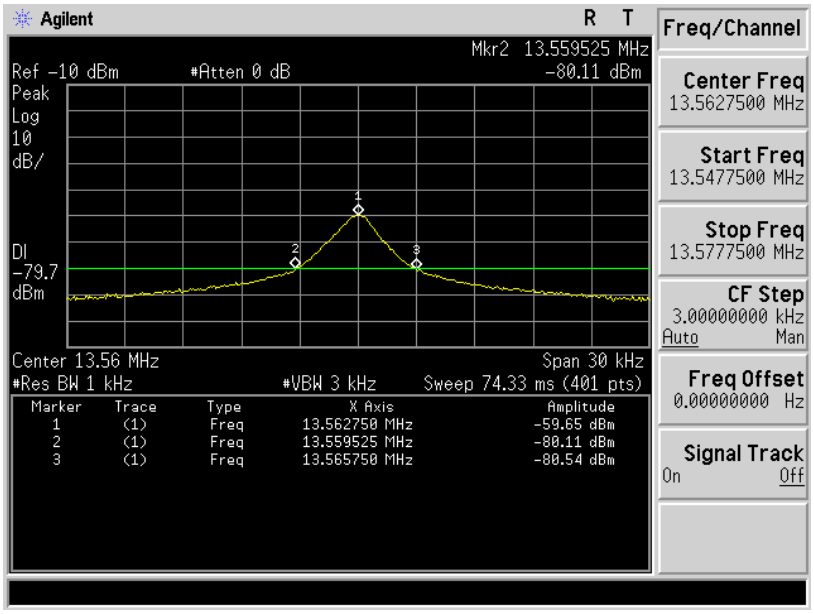
1. Span = 60 kHz
2. RBW ≥ 1% of the 20dB span
3. VBW ≥ RBW
4. Sweep = auto
5. Detector function = peak
6. Trace = max hold

The trace was allowed to stabilize. The EUT was transmitting at its maximum data rate. The marker-to-peak function was used to set the marker to the peak of the emission. The marker-delta function was used to measure 20dB down one side of the emission. The marker-delta function and marker was moved to the other side of the emission until it was even with the reference marker. The marker-delta reading at this point was the 20dB bandwidth of the emission.

6.5. Test Result

Mode	Mode 1		
Frequency (MHz)	20dBc Low Point (MHz)	20dBc High Point (MHz)	Operating Frequency Band (MHz)
13.5600	13.559525	13.56575	13.553~13.567

6.6. Test Graphs



7 Antenna Requirement

7.1. Require

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

7.2. Antenna Connector Construction

The antenna connector used in this product is internal antenna, cannot be replaced by the end-user.