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TEST REPORT

Product Name : GEMNFC

Trademark : N.A

Model/Type reference : GEMNFC02

Listed Model(s) : N.A

IC ID : 10563A-WF125

Test Standards : **RSS-GEN Issue 4, November 2014**
RSS-210 Issue 9 August 2016

Report No : GTI20180534F-3

Applicant : Wahoo Fitness L.L.C.

Address of applicant : 90 W WIEUCA RD NE STE 110 ATLANTA GA 30342

Date of Receipt : Mar. 18, 2018

Date of Test Date..... : Mar. 18, 2018- Apr 06, 2018

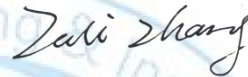
Data of issue...... : Apr 07, 2018

Test result	Pass *
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* In the configuration tested, the EUT complied with the standards specified above

GENERAL DESCRIPTION OF EUT	
Equipment:	GEMNFC
Model Name:	GEMNFC02
Adding Model(s):	N.A.
Model difference:	N.A.
Manufacturer:	Wahoo Fitness L.L.C.
Manufacturer Address:	90 W WIEUCA RD NE STE 110 ATLANTA GA 30342
Factory:	Flextronics Electronics Technology (Suzhou) Co., Ltd.
Address:	No.268 Suhong Road, Suzhou Industrial Park, Suzhou City, Jiangsu Province, China
Power Rating:	DC 5V(from USB port)

Compiled By:



(Zaki Zhang)

Reviewed By:



(Gavin Shi)

Approved By:



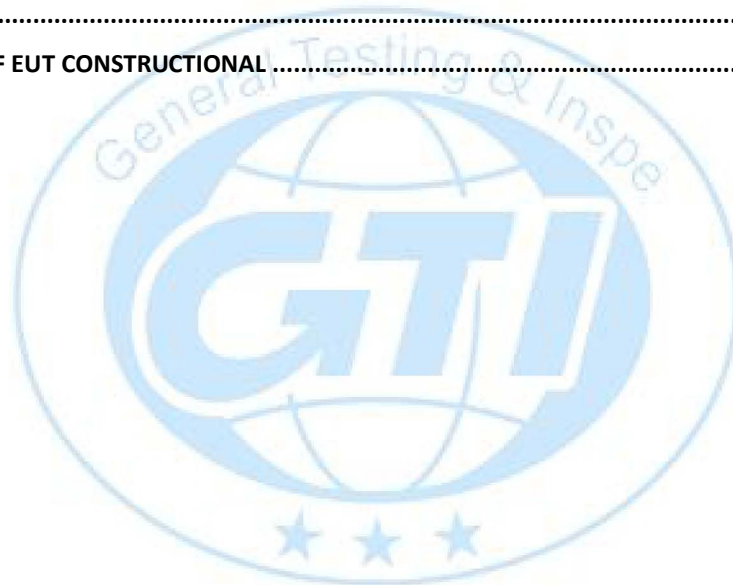
(Walter Chen)

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1. SUMMARY

1.1. Test Standards

The tests were performed according to following standards:

[RSS-210 Issue 9](#): Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment

[ANSI C63.10 -2013](#): American National Standard for Testing Unlicensed Wireless Devices

The tests were performed according to following standards:

[RSS-Gen Issue 4 November 2014](#): General Requirements for Compliance of Radio Apparatus

1.2. Test Description

Emission Measurement requirements		
Radiated Emission	RSS-GEN; RSS-210 Annex A2.6	PASS
Conducted Disturbance	RSS-GEN	PASS
Occupied bandwidth	RSS-210 Annex A2.6	PASS
Frequency stability	RSS-210 Annex A2.6	PASS
Antenna Requirement	RSS-Gen	PASS

.Note 1:EUT is battery power supply. conducted emission is not need

1.3. Test Facility

1.3.1 Address of the test laboratory

Shenzhen General Testing & Inspection Technology Co., Ltd.

Add: 1F, 2 Block, Jiaquan Building, Guanlan High-tech Park Baoan District, Shenzhen, Guangdong, China

1.3.2 Laboratory accreditation

The test facility is recognized, certified, or accredited by the following organizations:

IC Registration No.: 9783A

The 3m alternate test site of Shenzhen GTI Technology Co., Ltd. EMC Laboratory has been registered by Certification and Engineer Bureau of Industry Canada for the performance of with Registration NO.: 9783A on Jan, 2016.

FCC-Registration No.: 951311

Shenzhen GTI Technology Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration 951311, Aug 26, 2017

1.4. Measurement Uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16 - 4 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements and is documented in the Shenzhen General Testing & Inspection Technology Co., Ltd quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for General Testing & Inspection laboratory is reported:

Test Items	Measurement Uncertainty	Notes
Transmitter power conducted	0.57 dB	(1)
Transmitter power Radiated	2.20 dB	(1)
Conducted spurious emission 9KHz-40 GHz	1.60 dB	(1)
Radiated spurious emission 9KHz-40 GHz	2.20 dB	(1)
Conducted Emission 9KHz-30MHz	3.39 dB	(1)
Radiated Emission 30~1000MHz	4.24 dB	(1)
Radiated Emission 1~18GHz	5.16 dB	(1)
Radiated Emission 18-40GHz	5.54 dB	(1)
Occupied Bandwidth	-----	(1)

(1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=1.96$.

2. GENERAL INFORMATION

2.1. General Description of EUT

Product Name:	GEMNFC
Model/Type reference:	GEMNFC02
Power supply:	DC 5V(from USB port)
Hardware version:	V1.0
Software version:	V1.0
Bluetooth:	
Supported type:	Version 4.0 for low Energy
Modulation:	GFSK
Operation frequency:	2402MHz to 2480MHz
Channel number:	40
Channel separation:	2 MHz
Antenna type:	Ceramic Antenna
Antenna gain:	4.17dBi
ANT+:	
Supported type:	ANT+
Modulation:	GFSK
Operation frequency:	2457MHz
Channel number:	1
Channel separation:	/
Antenna type:	Ceramic Antenna
Antenna gain:	4.17dBi
NFC:	
Supported type:	NFC
Modulation:	RFID
Operation frequency:	13.56MHz
Channel number:	1
Channel separation:	/
Antenna type:	PCB Antenna
Antenna gain:	0dBi

Note: For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual.

2.2. Description of Test Modes

Peripherals Devices:

Name:	Model:	Serial	Manufacture	Remark
Laptop	Thinkpad	/	Lenovo	/

Note: All the above equipment /cable were placed in worse case position to maximize emission signals during emission test.

Operation Frequency

The Applicant provides communication tools software to control the EUT for staying in continuous transmitting (Duty Cycle more than 98%) mode for testing.

NFC

Channel	Frequency (MHz)
01	13.56



2.3.Measurement Instruments List

Maximum Peak Output Power / Band Edge Compliance of RF Emission / Spurious RF Conducted Emission /Hoping Require/ 20dB bandwidth					
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibrated until
1	Spectrum Analyzer	Rohde & Schwarz	FSU	100105	Jan. 04,2019
2	RF Cable	Schwarzbeck	AH32D4	SF0150	Jan. 04,2019
3	Temporary Antenna connector	Schwarzbeck	SMA24D	ED1201	Jan. 04,2019

Note: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

3.

Conducted Emission					
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibrate until
1	LISN	R&S	ENV216	101112	Jan. 04,2019
2	LISN	R&S	ENV216	101113	Jan. 04,2019
3	EMI Test Receiver	R&S	ESCI	100920	Jan. 04,2019
4	Cable	Schwarzbeck	AK9515E	33156	Jan. 04,2019

4.

Radiated Emission					
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibrated until
1	EMI Test Receiver	R&S	ESCI	100967	Jan. 04,2019
2	High pass filter	micro-tranics	HPM50111	34202	Jan. 04,2019
3	Log-Bicon Antenna	Schwarzbeck	CBL6141A	4180	Jan. 04,2019
4	Ultra-Broadband Antenna	ShwarzBeck	BBHA9170	25841	Jan. 04,2019
5	Loop Antenna	LAPLAC	RF300	9138	Jan. 04,2019
6	Spectrum Analyzer	Rohde & Schwarz	FSU	100105	Jan. 04,2019
7	Horn Antenna	Schwarzbeck	BBHA 9120D	648	Jan. 04,2019
8	Pre-Amplifier	HP	8447D	1937A03050	Jan. 04,2019
9	Pre-Amplifier	EMCI	EMC05183 5	980075	Jan. 04,2019
10	Antenna Mast	UC	UC3000	N/A	N/A
11	Turn Table	UC	UC3000	N/A	N/A
12	Cable Below 1GHz	Schwarzbeck	AK9515E	33155	Jan. 04,2019
13	Cable Above 1GHz	Hubersuhner	SUCOFLEX1 02	DA1580	Jan. 04,2019

5. Note: 1. The Cal.Interval was one year.

6. 2. The cable loss has calculated in test result which connection between each test instruments.

7. TEST CONDITIONS AND RESULTS

7.1. CONDUCTED EMISSION MEASUREMENT

Limit

POWER LINE CONDUCTED EMISSION

(Frequency Range 150KHz-30MHz)

FREQUENCY (MHz)	Class A (dBuV)		Class B (dBuV)	
	Quasi-peak	Average	Quasi-peak	Average
0.15 -0.5	79.00	66.00	66 - 56 *	56 - 46 *
0.50 -5.0	73.00	60.00	56.00	46.00
5.0 -30.0	73.00	60.00	60.00	50.00

Note:

(1) The tighter limit applies at the band edges.

(2) The limit of " * " marked band means the limitation decreases linearly with the logarithm of the frequency in the range.

The following table is the setting of the receiver

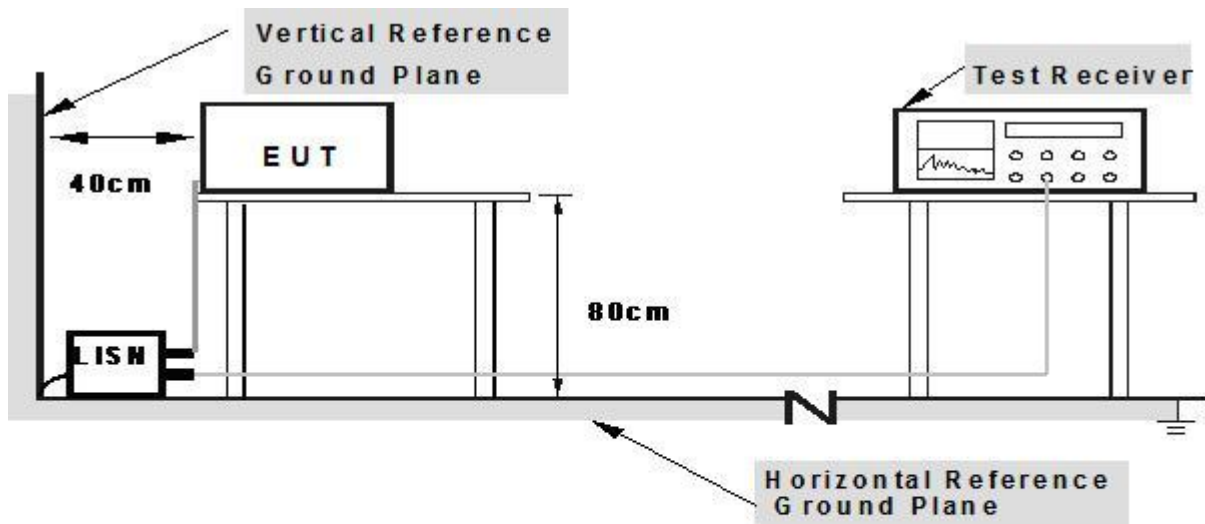
Receiver Parameters	Setting
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 kHz

Test Procedure

1. The EUT was placed 0.8 meters from the horizontal ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
2. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.
3. I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m. Repeat above procedures until all frequency measurements have been completed.
4. LISN at least 80 cm from nearest part of EUT chassis.
5. For the actual test configuration, please refer to the related Item –EUT Test Photos.

Test Configuration

For the actual test configuration, please refer to the related Item –EUT Test Photos.



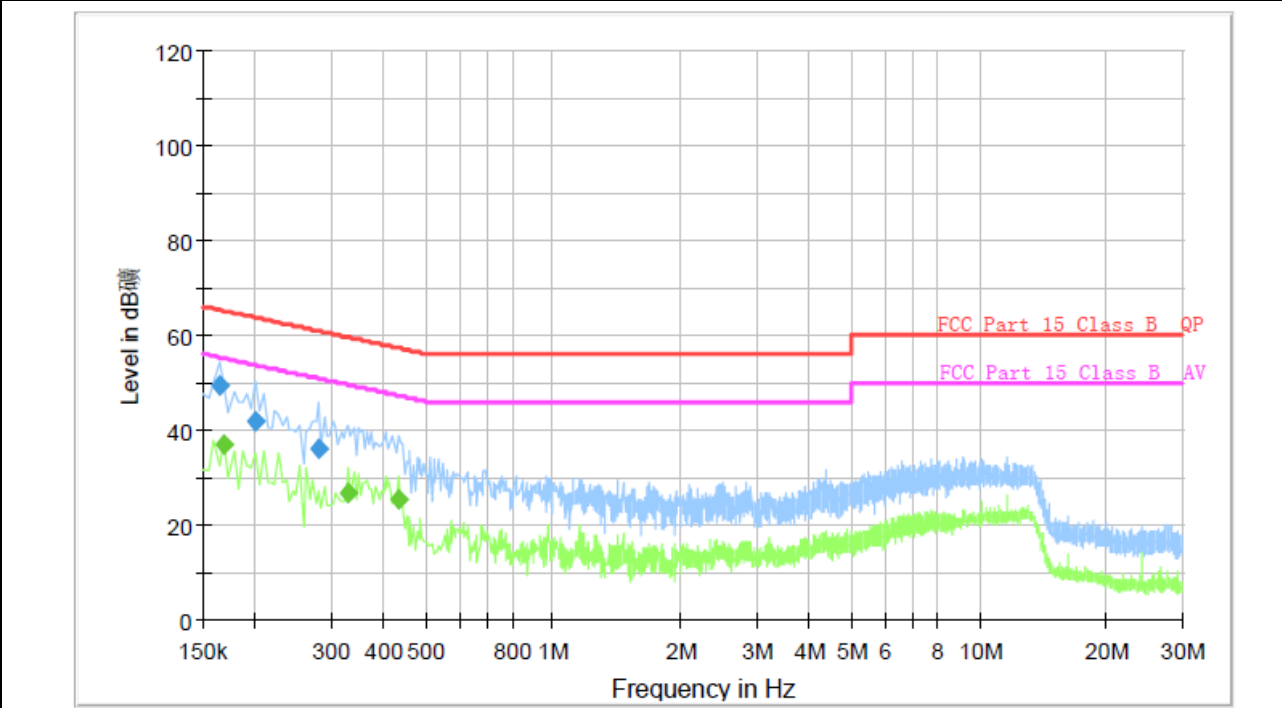
- Note: 1.Support units were connected to second LISN.**
2.Both of LISNs (AMN) are 80 cm from EUT and at least 80 from other units and other metal planes

Test Results



TEST RESULTS

Temperature :	21 °C	Relative Humidity :	60%
Pressure :	101 Kpa	Test Date :	2018-03-25
Test Mode :	Mode 1	Phase :	L
Test Voltage :	AC 120V/60Hz		



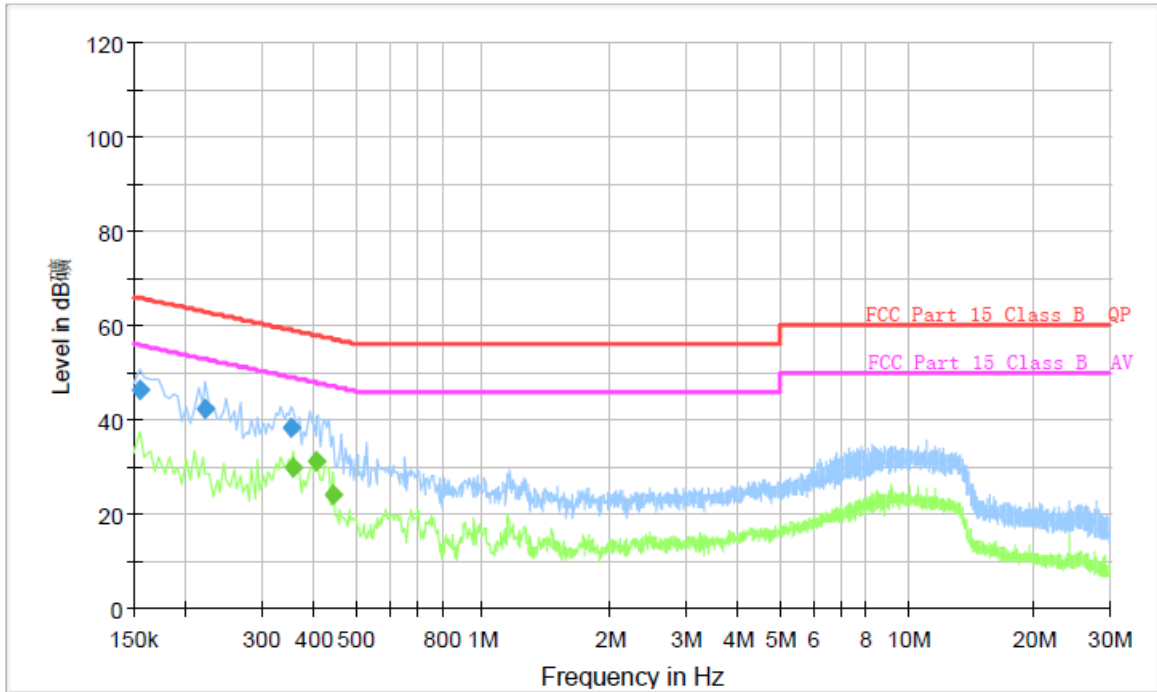
Final Measurement Detector 1

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.163500	49.2	1000.000	9.000	Off	L1	10.0	16.1	65.3	
0.199500	41.8	1000.000	9.000	Off	L1	10.0	21.8	63.6	
0.280500	36.2	1000.000	9.000	Off	L1	9.9	24.6	60.8	

Final Measurement Detector 2

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.168000	36.8	1000.000	9.000	Off	L1	10.0	18.3	55.1	
0.330000	26.7	1000.000	9.000	Off	L1	9.9	22.8	49.5	
0.433500	25.3	1000.000	9.000	Off	L1	9.8	21.9	47.2	

Temperature :	21 °C	Relative Humidity :	60%
Pressure :	101 Kpa	Test Date :	2018-03-25
Test Mode :	Mode 1	Phase :	N
Test Voltage :	AC 120V/60Hz		



Final Measurement Detector 1

Frequency (MHz)	QuasiPeak (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)	Comment
0.154500	46.3	1000.000	9.000	Off	N	9.6	19.5	65.8	
0.222000	42.2	1000.000	9.000	Off	N	9.6	20.5	62.7	
0.352500	38.3	1000.000	9.000	Off	N	9.9	20.6	58.9	

Final Measurement Detector 2

Frequency (MHz)	Average (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)	Comment
0.357000	30.0	1000.000	9.000	Off	N	9.9	18.8	48.8	
0.406500	31.3	1000.000	9.000	Off	N	10.0	16.4	47.7	
0.442500	24.2	1000.000	9.000	Off	N	10.0	22.8	47.0	

7.2. Radiated Emission

Limit

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission from intentional radiators at a distance of 3 meters shall not exceed the following table.

The frequency spectrum above 1 GHz for Transmitter was investigated. All emission not reported are much lower than the prescribed limits. Set the RBW=1MHz, VBW=3MHz for Peak Detector while the RBW=1MHz, VBW=10Hz for Average Detector, Readings are both peak and average values. The pre-test have done for the EUT in three axes and found the worst emission at position shown in test setup photos.

Frequency (MHz)	Distance (Meters)	Radiated (dBuV/m)	Radiated (µV/m)
0.009-0.49	3	$20\log(2400/F(\text{KHz}))+40\log(300/3)$	2400/F(KHz)
0.49-1.705	3	$20\log(24000/F(\text{KHz}))+40\log(30/3)$	24000/F(KHz)
1.705-30	3	$20\log(30)+40\log(30/3)$	30
30-88	3	40.0	100
88-216	3	43.5	150
216-960	3	46.0	200
Above 960	3	54.0	500

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

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

(Radiated Emission <30MHz (9KHz-30MHz, H-field)

According to FCC section 15.225, for <30MHz, Radiated emissions were measured according to ANSIC63.4. The EUT was set to transmit at the highest output power. The EUT was set 30 meter away from the measuring antenna. The loop antenna was positioned 1 meter above the ground from the center of the loop. The measuring bandwidth was set to 10KHz. (Note: During testing the receive antenna was rotated about its axis to maximize the emission from the EUT)

There was no detected Restricted bands and Radiated suprious emission below 30MHz. The 30m limit was converted to 3m Limit using square factor(x) as it was found by measurements as follows;

$$10 \text{ m Limit(dBuV/m)} = 20\log(X)+40\log(30/10)= 20\log(15,848)+40\log(30/10) =103.1\text{dBuV}$$

$$3 \text{ m Limit(dBuV/m)} = 20\log(X)+40\log(30/10)= 20\log(30)+40\log(30/10) =48.6\text{BuV}$$

Test Procedure

1. The EUT was placed on a turn table which is 0.8m(below 1GHz)or1.5m(above 1GHz) above ground plane.
6. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0°C to 360°C to acquire the highest emissions from EUT

7. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
8. Repeat above procedures until all frequency measurements have been completed.

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

Where FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude	AG = Amplifier Gain
AF = Antenna Factor	

For example

Frequency (MHz)	FS (dB μ V/m)	RA (dB μ V/m)	AF (dB)	CL (dB)	AG (dB)	Transd (dB)
150.00	40	58.1	12.2	1.6	31.90	-18.1

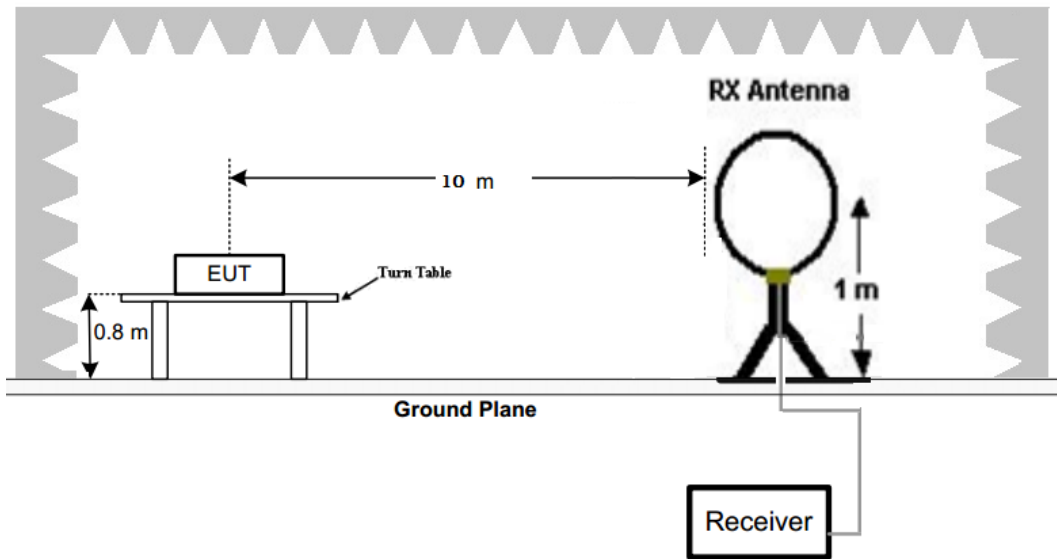
$$\text{Transd} = \text{AF} + \text{CL} - \text{AG}$$

Test Configuration

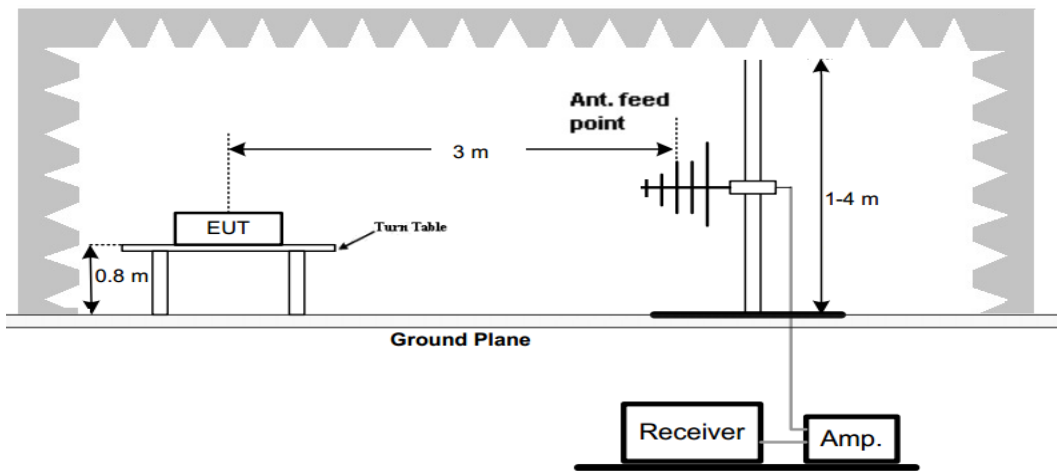
For the actual test configuration, please refer to the related Item –EUT Test Photos.



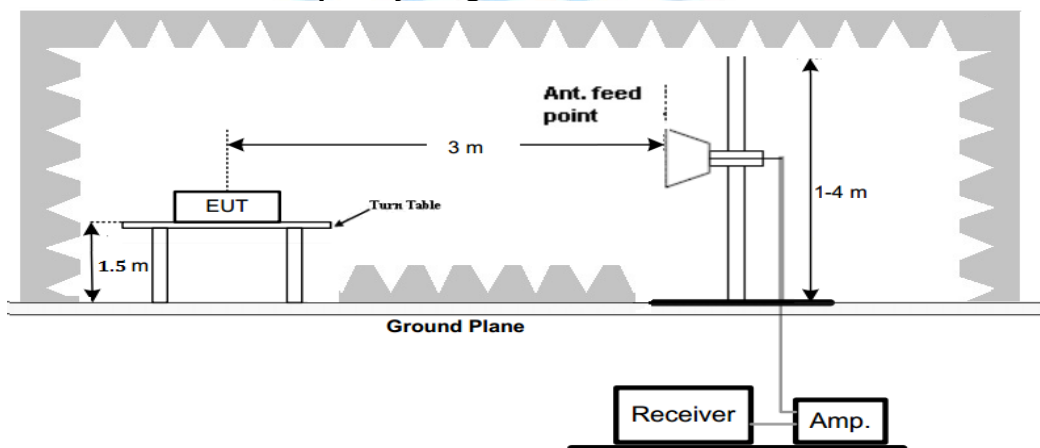
Frequency range 9 KHz – 30MHz



Frequency range 30MHz – 1000MHz



Frequency range above 1GHz-25GHz



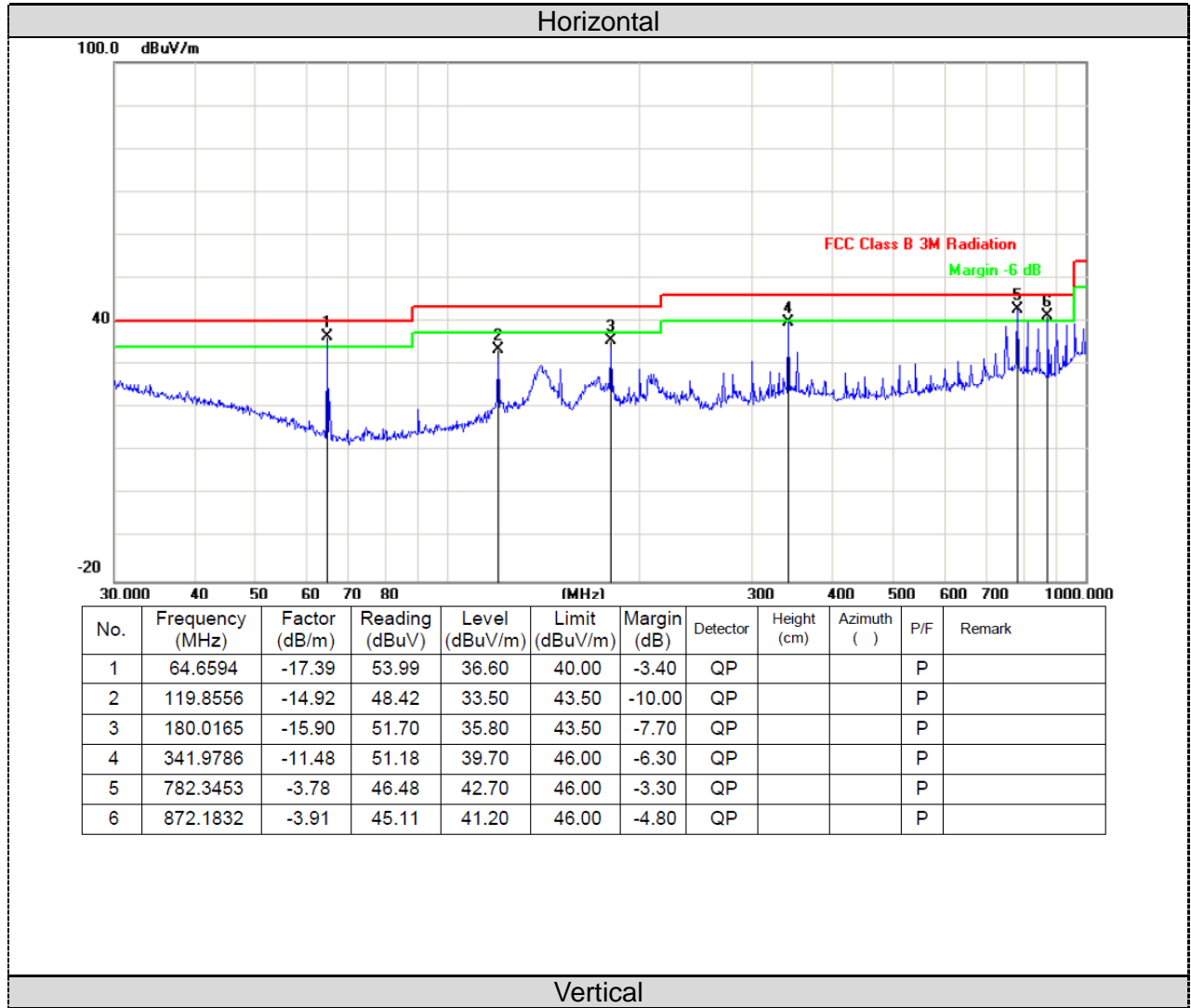
Test Results

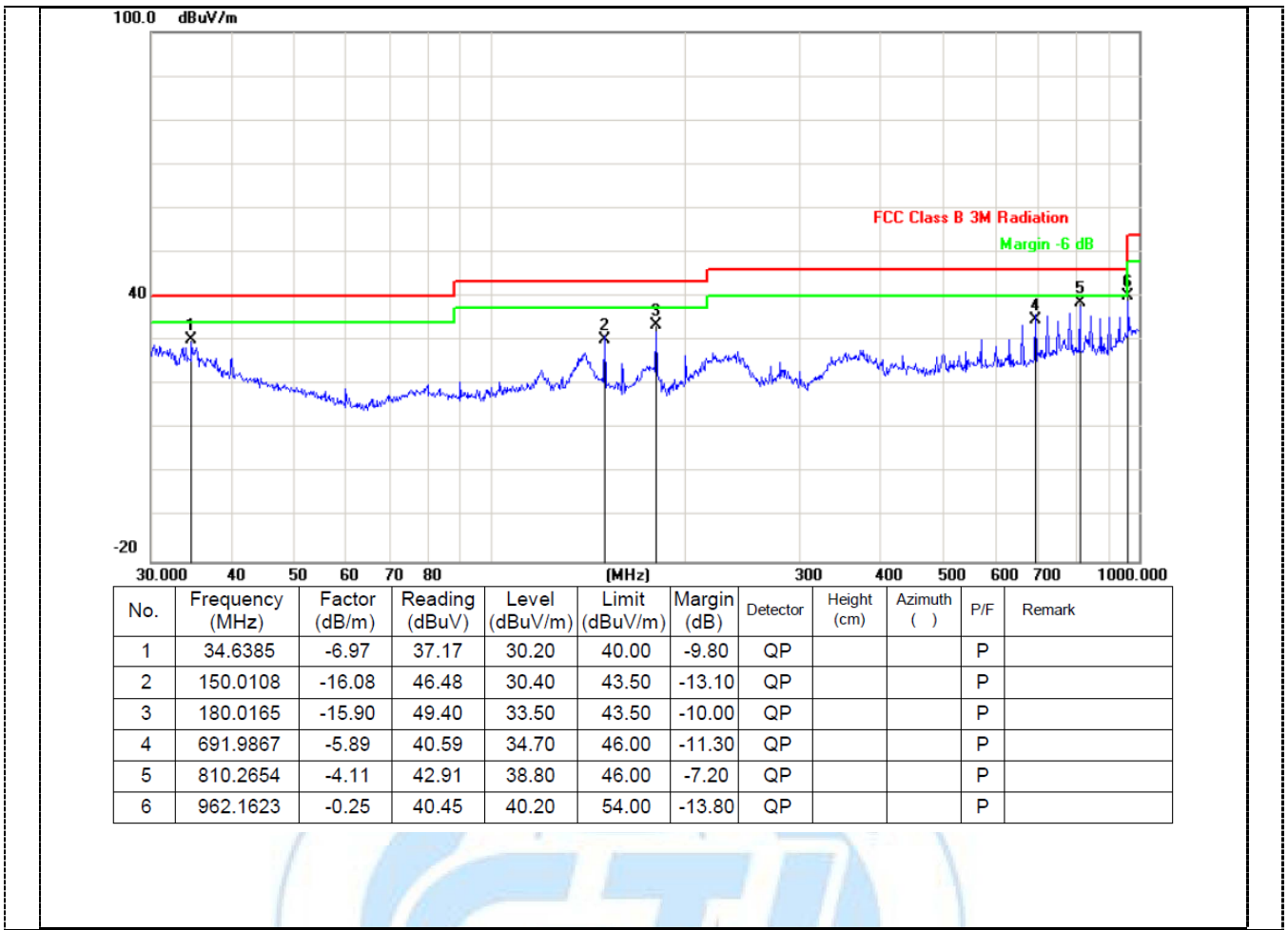
Remark:

For 9 KHz-30MHz

Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Calculate result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Result
13.553-13.567	55.17	24.7	79.87	103.1	-23.23	Pass
13.410~13.553	31.21	24.7	55.91	69.6	-13.69	Pass
13.567~13.710	30.14	24.7	54.84	69.6	-14.76	Pass
13.110-13.410	29.23	24.7	53.93	59.6	-5.67	Pass
13.710-14.010	29.84	24.7	54.54	59.6	-5.06	Pass

For 30MHz-1GHz





REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB) - Pre-amplifier Factor
3. Margin value = Limit value - Emission level.
4. -- Mean the PK detector measured value is below average limit.
5. The other emission levels were very low against the limit.

7.3.Occupied Bandwidth

Limit

Federal Communications Commission: Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

Test Procedure

1. The transmitter output was connected to the spectrum analyzer.
2. Set SA as follow:
 - a) RBW: 10 kHz.
 - b) VBW: $\geq 3 \times$ RBW.
 - c) Detector: Peak.
 - d) Trace mode: max hold.
 - e) Sweep: auto couple.
3. Allow the trace to stabilize.
4. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

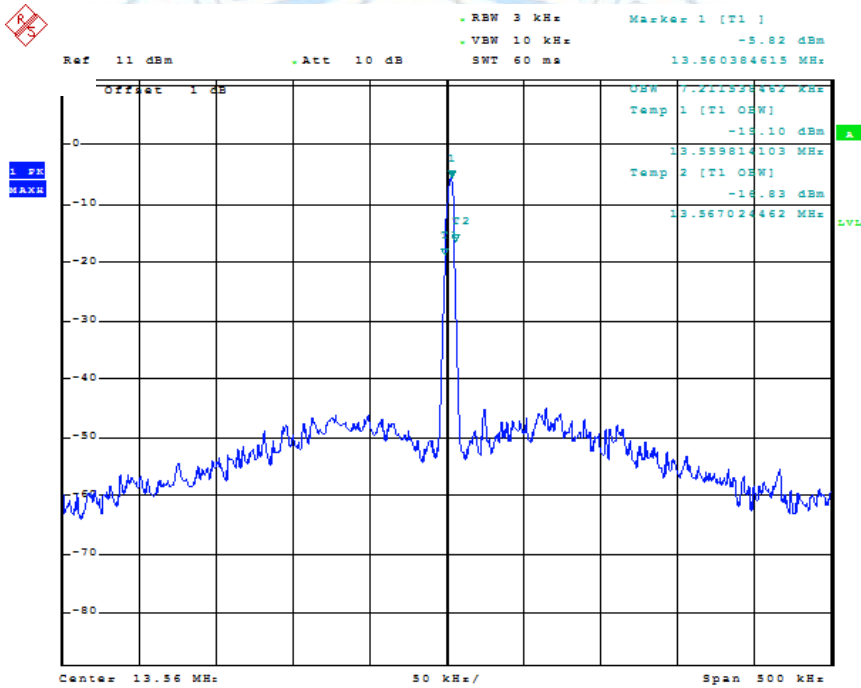
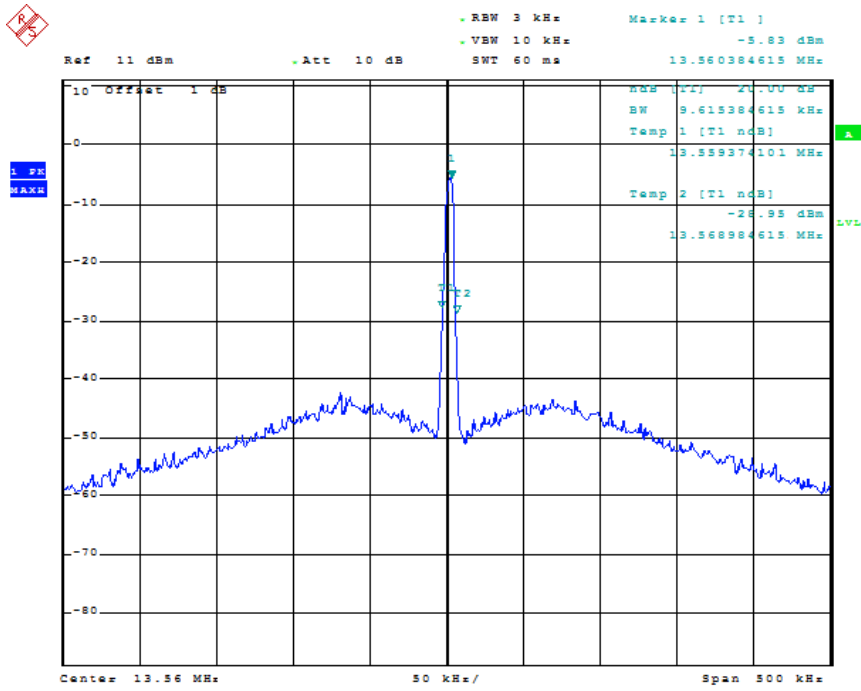
Test Configuration



Test Results

Type	20 dB Bandwidth (kHz)	99% Bandwidth (kHz)	Result
13.56MHz	9.615	7.211	Pass

Test plot as follows:



7.4. Frequency stability

Limit

Carrier frequency stability shall be maintained to $\pm 0.01\%$ (± 100 ppm).

Test Procedure

With the EUT setup as per section 9 of this report and connected as per Figure v, the frequency was measured under varying conditions of temperature and supply voltage. The measurements were performed with EUT set in a CW mode of operation. Measurements were made once temperature stability was achieved at each temperature.

Test Results

Test Enviroment		Measured Frequency(MHz)	Frequency error(MHz)	Frequency error(%)	Result
Temperature(°C)	Power(VDC)				
-20	5	13.560384615	0.00284	0.01	PASS
-10	5	13.560384626	0.00284	0.01	PASS
0	5	13.560384632	0.00284	0.01	PASS
10	5	13.560384624	0.00284	0.01	PASS
20	4.5	13.560384621	0.00284	0.01	PASS
	5.0	13.560384653	0.00284	0.01	PASS
	5.5	13.560384632	0.00284	0.01	PASS
30	5	13.560384628	0.00284	0.01	PASS
40	5	13.560384614	0.00284	0.01	PASS
50	5	13.560384637	0.00284	0.01	PASS



7.5. Antenna Requirement

Standard Applicable

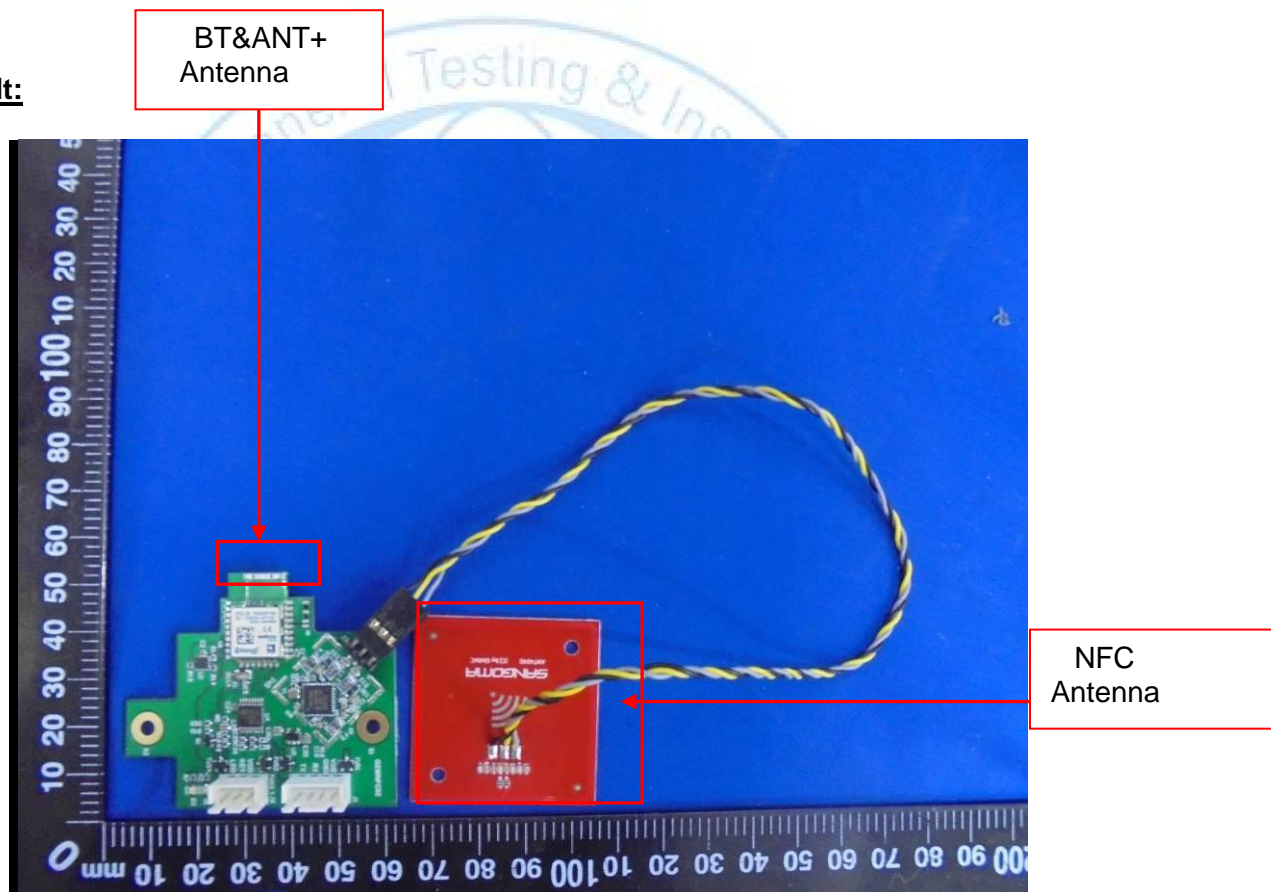
For intentional device, according to FCC 47 CFR Section 15.203:

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, 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

Result

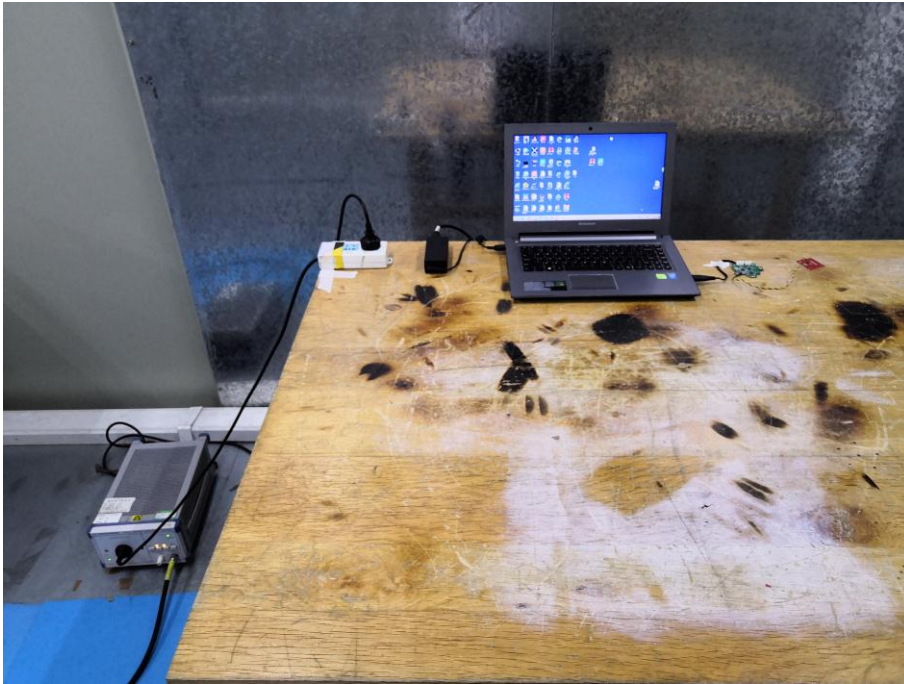
The EUT's antenna used a Antenna, soldered on the PCB., The antenna's gain is 4.17dBi. Complying with the standard requirement.

Test Result:



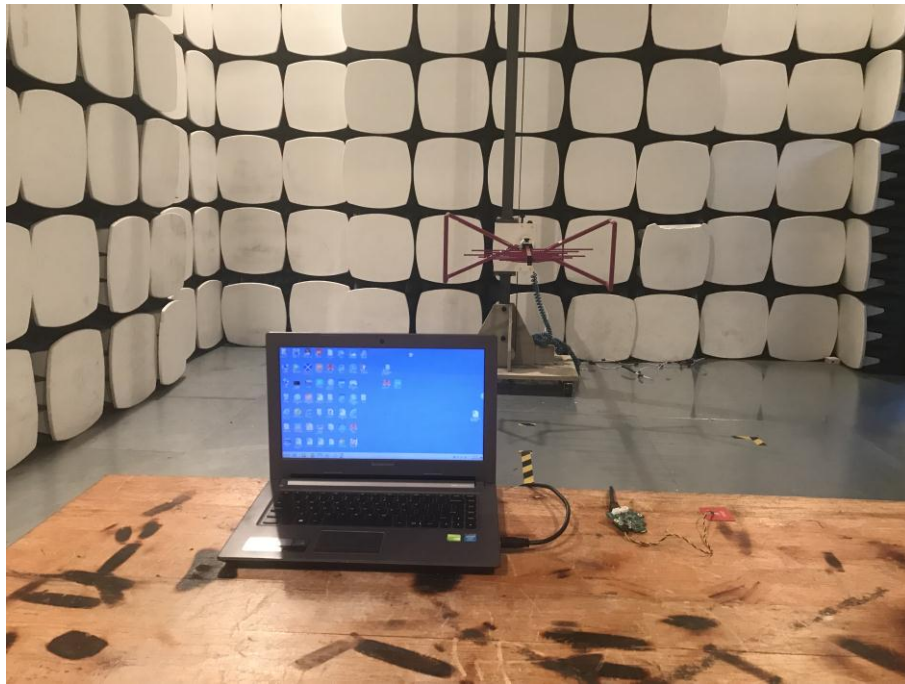
8. EUT TEST PHOTO

Conducted Emission



Radiated Emission





9. PHOTOGRAPHS OF EUT CONSTRUCTIONAL

10. Please reference to the test report No.: GTI20180534F-1

*****THE END*****

