

TEST REPORT

Reference No. : WTS17S1195978E
FCC ID..... : 2AOGIZWA003-004
Applicant : AEOTEC LIMITED
Address : FLAT/RM 704, 7/F, BRIGHT WAY TOWER, 33 MONG KOK ROAD,
MONG KOK, KL, HK
Manufacturer : The same as above
Address : The same as above
Product : NanoMote Quad, NanoMote One
Model(s)..... : ZWA003-A, ZWA004-A
Standards : FCC CFR47 Part 15 Section 15.249: 2016
Date of Receipt sample.... : 2017-11-22
Date of Test : 2017-11-23 to 2017-12-19
Date of Issue : 2017-12-20
Test Result : Pass

Remarks:

The results shown in this test report refer only to the sample(s) tested, this test report cannot be reproduced, except in full, without prior written permission of the company. The report would be invalid without specific stamp of test institute and the signatures of compiler and approver.

Prepared By:

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2 Laboratories Introduction

Waltek Services Test Group Ltd. is one of the largest and the most comprehensive third party testing organizations in China, our headquarter located in Shenzhen (CNAS Registration No. L3110, A2LA Certificate Number: 4243.01) and have branches in Foshan (CNAS Registration No. L6478), Dongguan (CNAS Registration No. L9950), Zhongshan, Suzhou (CNAS Registration No. L7754), Ningbo and Hong Kong, Our test capability covered four large fields: safety test. Electronic Magnetic Compatibility(EMC), reliability and energy performance, Chemical test. Meanwhile, Waltek has got recognition as registration and accreditation laboratory from EMSD (Electrical and Mechanical Services Department), and American Energy star, FCC(The Federal Communications Commission), CPSC(Consumer Product Safety Commission), CEC(California energy efficiency), IC(Industry Canada) and ELI(Efficient Lighting Initiative). It's the strategic partner and data recognition laboratory of international authoritative organizations, such as UL, Intertek(ETL-SEMKO), CSA, TÜV Rheinland, TÜV SÜD, etc. As a professional, comprehensive, justice international test organization, we still keep the scientific and rigorous work attitude to help each client satisfy the international standards and assist their product enter into globe market smoothly.

Waltek Services (Shenzhen) Co., Ltd.

A. Accreditations for Conformity Assessment (International)

Country/Region	Accreditation Body	Scope	Note
USA	CNAS (Registration No.: L3110) A2LA (Certificate No.: 4243.01)	FCC ID \ DOC \ VOC	1
Canada		IC ID \ VOC	2
Japan		MIC-T \ MIC-R	-
Europe		EMCD \ RED	-
Taiwan		NCC	-
Hong Kong		OFCA	-
Australia		RCM	-
India		International Services	WPC
Thailand	NTC		-
Singapore	IDA		-
Note: 1. FCC Designation No.: CN1201. Test Firm Registration No.: 523476. 2. IC Canada Registration No.: 7760A			

B. TCBs and Notify Bodies Recognized Testing Laboratory.

Recognized Testing Laboratory of ...	Notify body number
TUV Rheinland	Optional.
Intertek	
TUV SUD	
SGS	
Phoenix Testlab GmbH	0700
Element Materials Technology Warwick Ltd	0891
Timco Engineering, Inc.	1177
Eurofins Product Service GmbH	0681

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4 General Information

4.1 General Description of E.U.T

Product:	NanoMote Quad, NanoMote One
Model(s):	ZWA003-A, ZWA004-A
Model Difference:	Model ZWA003-A have four keys, the model ZWA004-A has one key, the others are all the same. Model ZWA003-A is the test sample.
Type of Modulation:	FSK
Frequency Range:	908.42MHz
Oscillator frequency:	32MHz
Antenna installation:	Integrated Antenna
Antenna Gain:	0dBi

4.2 Details of E.U.T

Ratings: Input: DC 3.6V by battery or power by micro USB port DC 5V

4.3 Standards Applicable for Testing

The tests were performed according to following standards:

FCC CFR47 Part 15 Section 15.249: 2016 Telecommunication-RADIO FREQUENCY DEVICES-Intentional Radiators-Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, and 24.0-24.25 GHz.

4.4 Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests.

And according to FCC 47 CFR Section 15.203(m):

Measurements on intentional radiators or receivers, other than TV broadcast receivers, shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table:

Frequency range over which device operates	Number of frequencies	Location in the range of operation
1 MHz or less	1	Middle.
1 to 10 MHz	2	1 near top and 1 near bottom.
More than 10 MHz	3	1 near top, 1 near middle and 1 near bottom

Test mode	Lower channel	Middle channel	Upper channel
Transmitting	/	908.42MHz	/

5 Equipment Used during Test

5.1 Equipments List

Conducted Emissions Test Site 1#						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Calibration Date	Calibration Due Date
1.	EMI Test Receiver	R&S	ESCI	100947	2017-09-14	2018-09-13
2.	LISN	R&S	ENV216	101215	2017-09-14	2018-09-13
3.	Cable	Top	TYPE16(3.5M)	-	2017-09-14	2018-09-13
3m Semi-anechoic Chamber for Radiation Emissions Test site 1#						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Calibration Date	Calibration Due Date
1	EMC Analyzer	Agilent	E7405A	MY45114943	2017-09-14	2018-09-13
2	Active Loop Antenna	Beijing Dazhi	ZN30900A	-	2017-09-14	2018-09-13
3	Trilog Broadband Antenna	SCHWARZBECK	VULB9163	336	2017-04-09	2018-09-08
4	Coaxial Cable (below 1GHz)	Top	TYPE16(13M)	-	2017-09-14	2018-09-13
5	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120 D	667	2017-04-09	2018-09-08
6	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	335	2017-04-09	2018-09-08
7	Broadband Preamplifier	COMPLIANCE DIRECTION	PAP-1G18	2004	2017-09-13	2018-09-12
8	Coaxial Cable (above 1GHz)	Top	1GHz-25GHz	EW02014-7	2017-09-10	2018-09-09
3m Semi-anechoic Chamber for Radiation Emissions Test site 2#						
Item	Equipment	Manufacturer	Model No.	Serial No	Last Calibration Date	Calibration Due Date
1	Test Receiver	R&S	ESCI	101296	2017-09-14	2018-09-13
2	Trilog Broadband Antenna	SCHWARZBECK	VULB9160	9160-3325	2017-09-14	2018-09-13
3	Amplifier	Compliance pirection systems inc	PAP-0203	22024	2017-09-14	2018-09-13
4	Cable	HUBER+SUHNER	CBL2	525178	2017-09-14	2018-09-13
RF Conducted Testing						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Calibration Date	Calibration Due Date
1.	EMC Analyzer (9k~26.5GHz)	Agilent	E7405A	MY45114943	2017-09-14	2018-09-13
2.	Spectrum Analyzer	R&S	FSL6	100959	2017-09-14	2018-09-13

	(9k-6GHz)					
3.	Signal Analyzer (9k~26.5GHz)	Agilent	N9010A	MY50520207	2017-09-14	2018-09-13

5.2 Measurement Uncertainty

Parameter	Uncertainty
Radio Frequency	$\pm 1 \times 10^{-6}$
RF Power	± 1.0 dB
RF Power Density	± 2.2 dB
Radiated Spurious Emissions test	± 5.03 dB (Bilog antenna 30M~1000MHz)
	± 5.47 dB (Horn antenna 1000M~25000MHz)

5.3 Test Equipment Calibration

All the test equipments used are valid and calibrated by GUANG ZHOU GRG METROLOGY & TEST CO., LTD. address is No.163, Pingyun Rd. West of Huangpu Ave, Tianhe District, Guangzhou, Guangdong, China.

6 Test Summary

Test Items	Test Requirement	Result
Conducted Emissions	15.207	C
Radiated Emission	15.249(a) 15.209 15.205(a)	C
Periodic Operation	15.35(c)	C
Band Edge	15.249 15.205 15.209	C
20dB Bandwidth	15.215(c)	C
Antenna Requirement	15.203	C
Note: C=Compliance; NC=Not Compliance; NT=Not Tested; N/A=Not Applicable.		

7 Conducted Emission

Test Requirement:	FCC CFR 47 Part 15 Section 15.207
Test Method:	ANSI C63.10:2013;ANSI C63.4:2014
Frequency Range:	150kHz to 30MHz
Class/Severity:	Class B
Limit:	66-56 dB μ V between 0.15MHz & 0.5MHz 56 dB μ V between 0.5MHz & 5MHz 60 dB μ V between 5MHz & 30MHz
Detector:	Peak for pre-scan (9kHz Resolution Bandwidth)
Test Result:	☒ Pass ☐ not applicable (Remark)

7.1 E.U.T. Operation

Operating Environment :

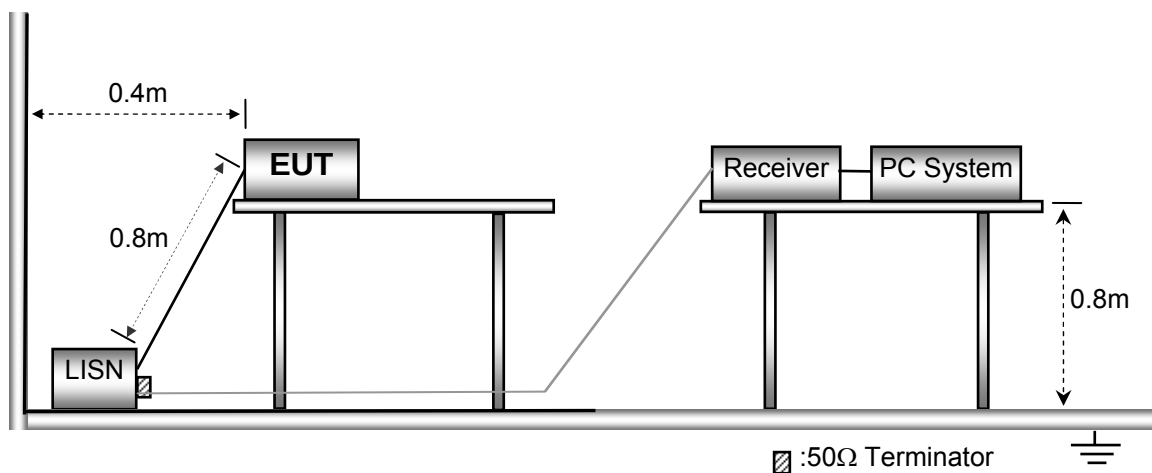
Temperature:	25.5 °C
Humidity:	51 % RH
Atmospheric Pressure:	101.2kPa

EUT Operation :

The test was performed in transmitting mode, the test data were shown in the report.

7.2 EUT Setup

The conducted emission tests were performed using the setup accordance with the ANSI C63.10:2013

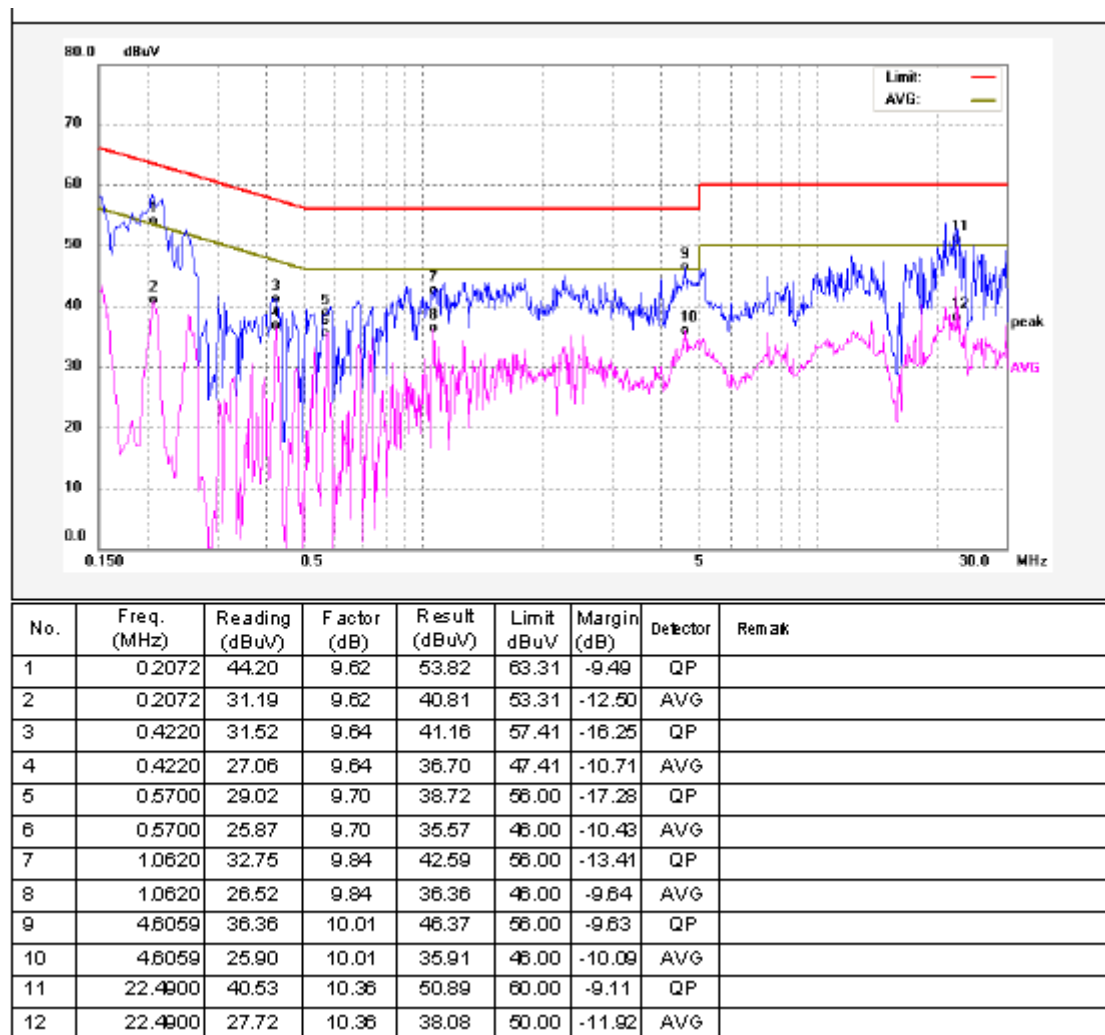


7.3 Measurement Description

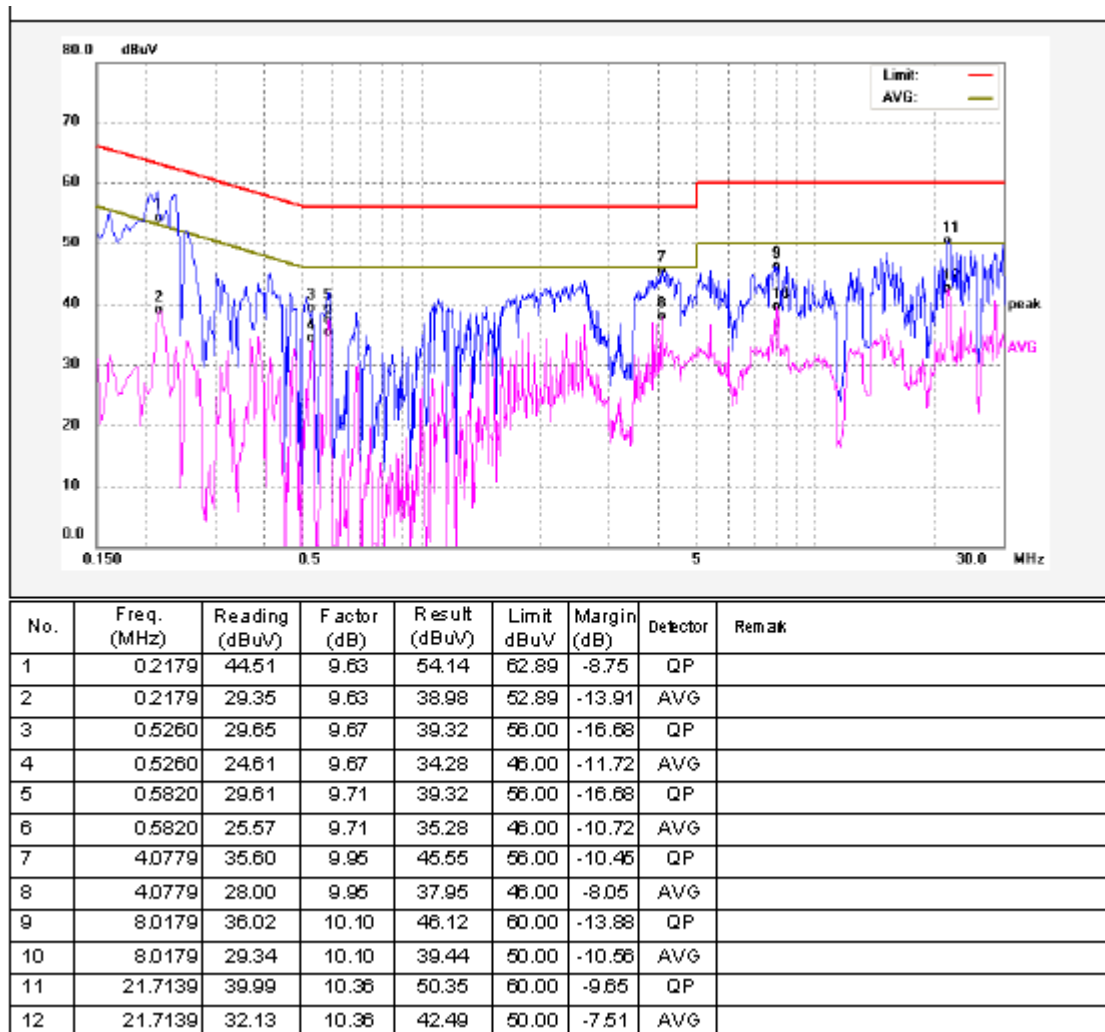
The maximised peak emissions from the EUT was scanned and measured for both the Live and Neutral Lines. Quasi-peak & average measurements were performed if peak emissions were within 6dB of the average limit line.

7.4 Test Result

Live line:



Neutral line:



8 Radiation Emission Test

Test Requirement: FCC Part15 Paragraph 15.249&15.209&15.205

Test Method: ANSI 63.10: 2013;ANSI C63.4:2014

Measurement Distance: 3m

Test Result:  Pass  Fail

15.249(a)Limit:

Fundamental frequency	Field strength of fundamental		Field strength of harmonics	
	mV/m	dBuV/m	uV/m	dBuV/m
902-928 MHz	50	94	500	54
2400-2483.5 MHz	50	94	500	54
5725-5875 MHz	50	94	500	54
24.0-24.25 GHz	250	108	2500	68

15.209 Limit:

Frequency (MHz)	Field Strength		Field Strength Limit at 3m Measurement Dist	
	uV/m	Distance (m)	uV/m	dBuV/m
0.009 ~ 0.490	$2400/F(\text{kHz})$	300	$10000 * 2400/F(\text{kHz})$	$20\log^{(2400/F(\text{kHz}))} + 80$
0.490 ~ 1.705	$24000/F(\text{kHz})$	30	$100 * 24000/F(\text{kHz})$	$20\log^{(24000/F(\text{kHz}))} + 40$
1.705 ~ 30	30	30	$100 * 30$	$20\log^{(30)} + 40(29.54+40)$
30 ~ 88	100	3	100	$20\log^{(100)} = (40)$
88 ~ 216	150	3	150	$20\log^{(150)} = (43.5)$
216 ~ 960	200	3	200	$20\log^{(200)} = (46)$
Above 960	500	3	500	$20\log^{(500)} = (54)$

Note: RF Voltage(dBuV)= $20 \log_{10}$ RF Voltage(uV)

8.1 EUT Operation

Operating Environment :

Temperature: 23.5 °C

Humidity: 51.1 % RH

Atmospheric Pressure: 101.2kPa

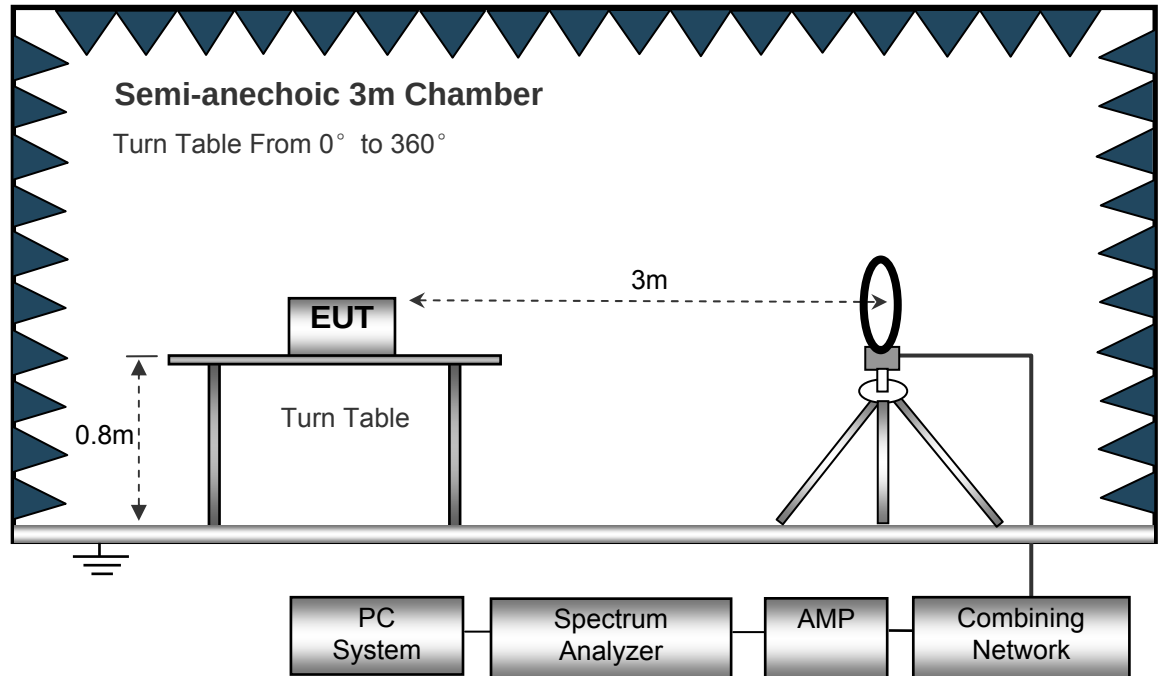
EUT Operation :

The test was performed in transmitting mode, the test data were shown in the report.

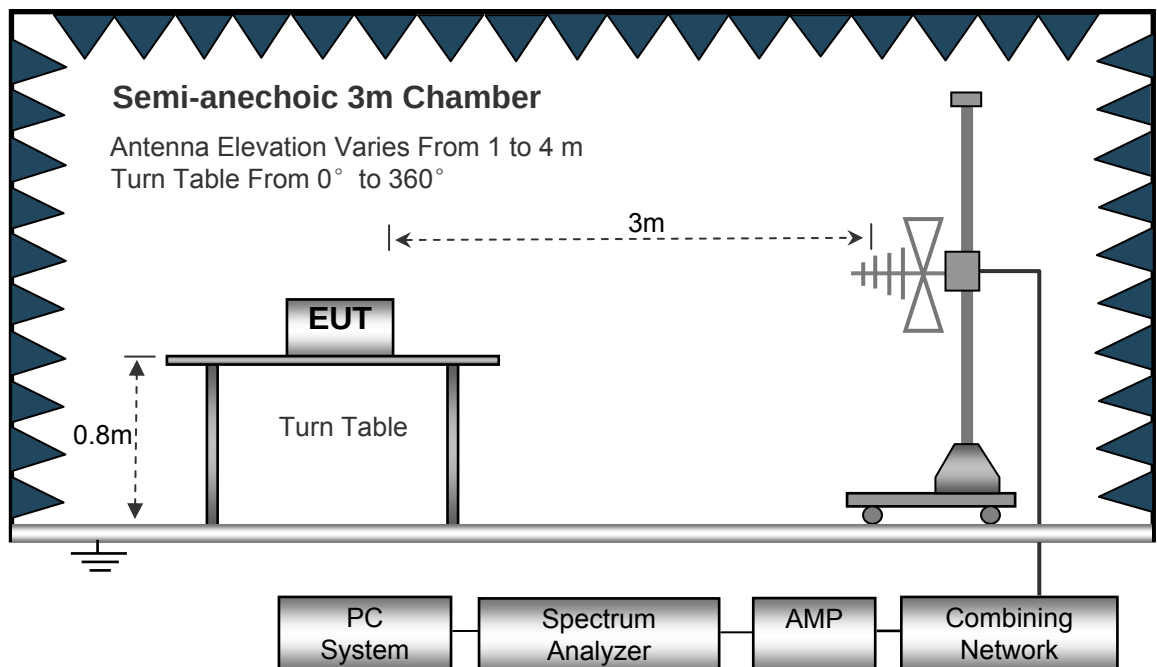
8.2 Test Setup

The radiated emission tests were performed in the 3m Semi- Anechoic Chamber test site, using the setup accordance with the ANSI C63.10: 2013.

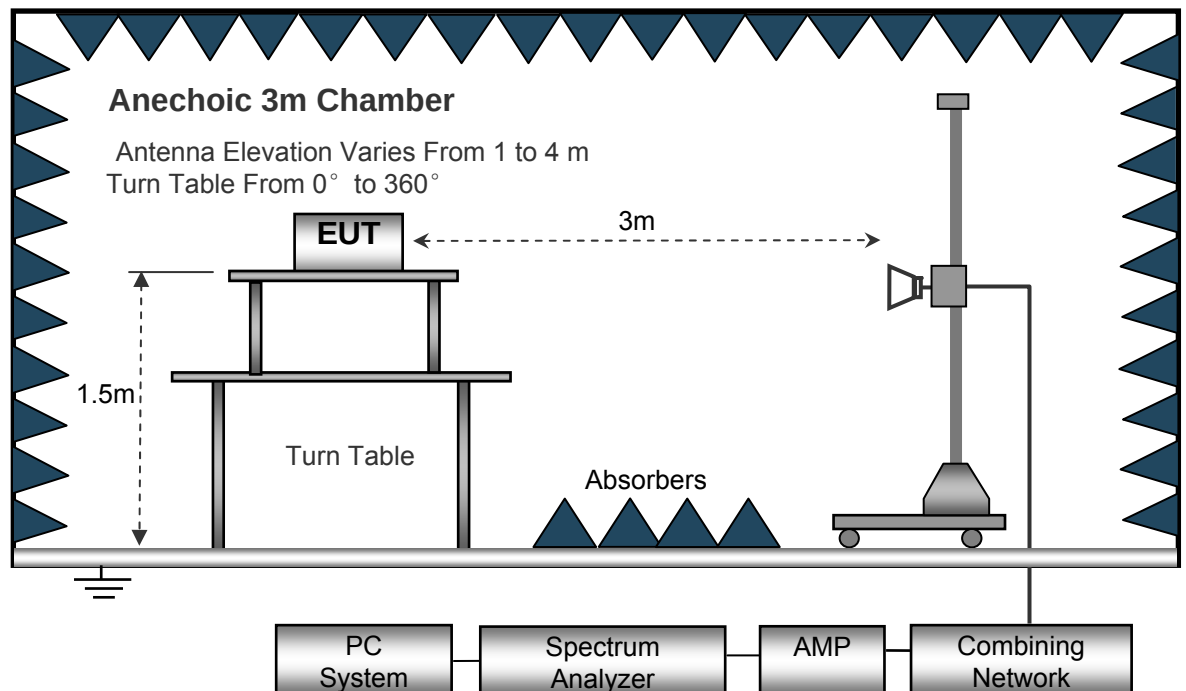
The test setup for emission measurement below 30MHz.



The test setup for emission measurement from 30MHz to 1GHz.



The test setup for emission measurement above 1 GHz.



8.3 Spectrum Analyzer Setup

Below 30MHz

Sweep SpeedAuto
 IF Bandwidth.....10kHz
 Video Bandwidth10kHz
 Resolution Bandwidth10kHz

30MHz ~ 1GHz

Sweep SpeedAuto
 Detector.....QP
 Resolution Bandwidth.....100kHz
 Video Bandwidth300kHz

Above 1GHz

Sweep SpeedAuto
 DetectorQP
 Resolution Bandwidth.....1MHz
 Video Bandwidth3MHz
 DetectorAve.
 Resolution Bandwidth.....1MHz
 Video Bandwidth10Hz

Video Bandwidth10Hz

8.4 Test Procedure

1. The EUT is placed on a turntable. For below 1GHz, the EUT is 0.8m above ground plane; For above 1GHz, the EUT is 1.5m above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna, which is moved from 1m to 4m to find out the maximum emissions. The spectrum was investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.
7. The radiation measurements are tested under 3-axes(X,Y,Z) position(X denotes lying on the table, Y denotes side stand and Z denotes vertical stand), After pre-test, It was found that the worse radiation emission was get at the X position. So the data shown was the X position only.

8.5 Frequency range of radiated measurements.

According to FCC 47 CFR Section 15.33:

(a) For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the frequency shown in this paragraph:

(1) If the intentional radiator operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

(2) If the intentional radiator operates at or above 10 GHz and below 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.

(3) If the intentional radiator operates at or above 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 200 GHz, whichever is lower, unless specified otherwise elsewhere in the rules.

(4) If the intentional radiator contains a digital device, regardless of whether this digital device controls the functions of the intentional radiator or the digital device is used for additional control or function purposes other than to enable the operation of the intentional radiator, the frequency range shall be investigated up to the range specified in paragraphs (a)(1) through (a)(3) of this section or the range applicable to the digital device, as shown in paragraph (b)(1) of this section, whichever is the higher frequency range of investigation.

Result: So the Frequency range of radiated form: 16MHz to 10GHz.

8.6 Test Result

Test Frequency: 9kHz ~ 30MHz

Frequency (MHz)	Measurement results	Detector	Correct factor	Extrapolation factor	Measurement results (calculated)	FCC Part 15.249/209/205	
						Limit	Margin
	dB μ V/m@3m	PK/QP	dB/m	dB	dB μ V/m @30m	dB μ V/m @30m	dB
15.230	25.33	QP	21.84	40.00	7.17	29.54	-22.37
28.690	30.28	QP	21.35	40.00	11.63	29.54	-17.91

Test Frequency: Below 1GHz

Frequency (MHz)	Receiver Reading (dB μ V)	Detector (PK/QP)	Turn table Angle (Degree)	RX Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dB μ V/m)	FCC Part 15.249/209/205	
				Height (m)	Polar (H/V)			Limit (dB μ V/m)	Margin (dB)
36.55	46.23	QP	264	1.2	V	-14.25	31.98	40.00	-8.02
908.42	78.22	PK	124	1.5	H	1.25	79.47	114.00	-34.53
908.42	71.64	PK	355	1.2	V	1.25	72.89	114.00	-41.11
1816.84	60.18	PK	266	1.4	H	-13.21	46.97	74.00	-27.03
1816.84	61.02	PK	330	1.3	V	-13.21	47.81	74.00	-26.19
2725.26	55.18	PK	43	1.5	H	-12.35	42.83	74.00	-31.17
2725.26	54.09	PK	95	1.6	V	-12.35	41.74	74.00	-32.26
3633.68	47.53	PK	74	1.4	H	-8.95	38.58	74.00	-35.42
3633.68	48.26	PK	51	1.4	V	-8.95	39.31	74.00	-34.69

AV = Peak +20Log10(duty cycle) =PK+(-10.4) [refer to section 9 for more detail]

Frequency	PK	RX Antenna Polar	Duty cycle Factor	AV	FCC Part 15.249/209/205	
					Limit	Margin
(MHz)	(dBμV/m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
1816.84	46.97	H	-10.40	36.57	54.00	-17.43
1816.84	47.81	V	-10.40	37.41	54.00	-16.59
2725.26	42.83	H	-10.40	32.43	54.00	-21.57
2725.26	41.74	V	-10.40	31.34	54.00	-22.66
3633.68	38.58	H	-10.40	28.18	54.00	-25.82
3633.68	39.31	V	-10.40	28.91	54.00	-25.09

9 Periodic Operation

The duty cycle was determined by the following equation:

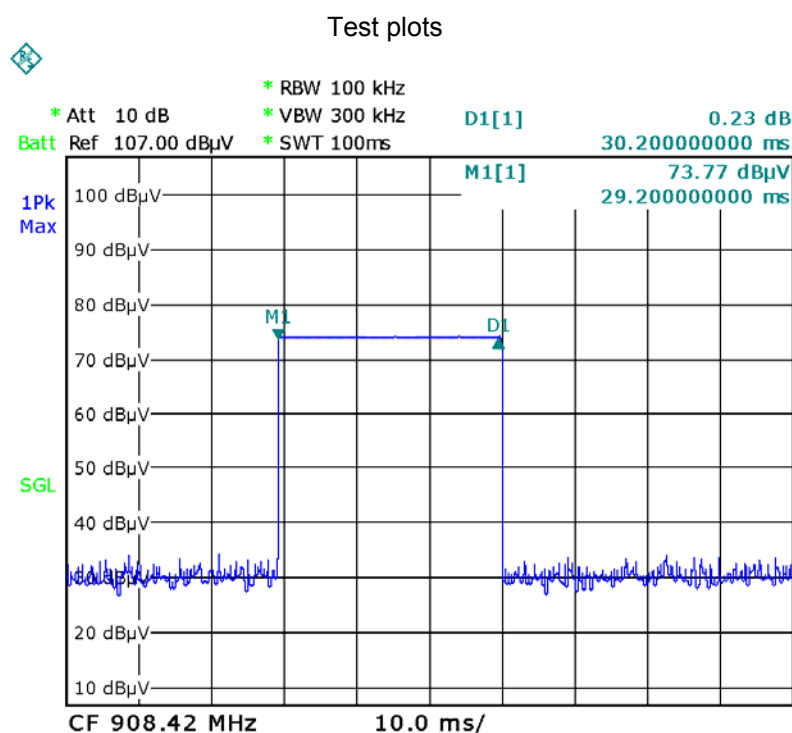
To calculate the actual field intensity, the duty cycle correction factor in decibel is needed for later use and can be obtained from following conversion

Duty Cycle(%)=Total On interval in a complete pulse train/ Length of a complete pulse train * %

Duty Cycle Correction Factor(dB)=20 * Log₁₀(Duty Cycle)

Total transmission time(ms)	30.2
Length of a complete transmission period(ms)	100
Duty Cycle(%)	30.2
Duty Cycle Correction Factor(dB)	-10.4

Refer to the duty cycle plot (as below)



10 Band Edge

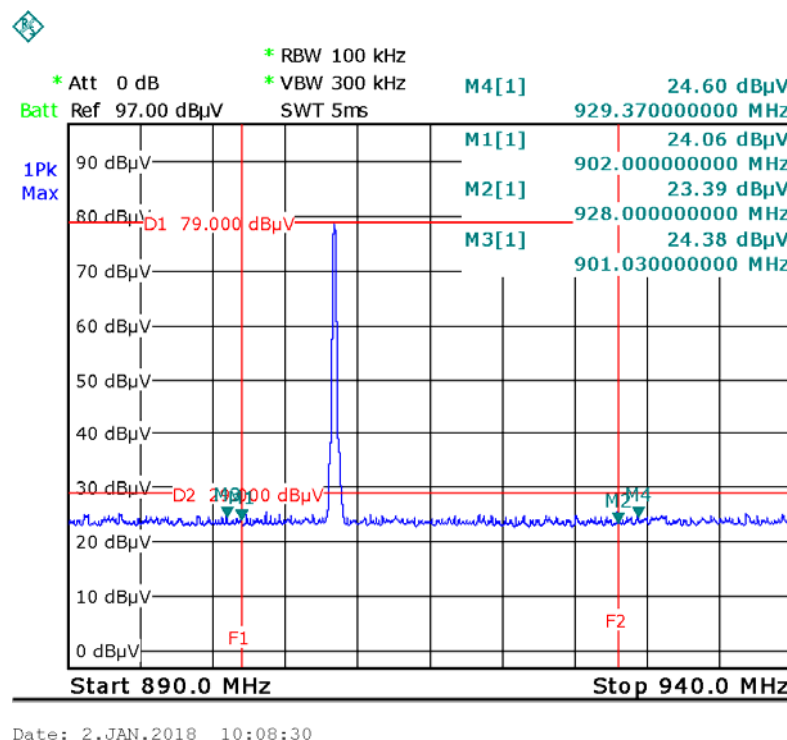
Test Requirement:	15.249(d):Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.
Test Method:	ANSI C63.10:2013
Test Mode:	Transmitting

10.1 Test Procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: RBW = 100kHz, VBW = 300kHz, Sweep = auto
Detector function = peak, Trace = max hold

10.2 Test Result

Test plots



11 20 dB Bandwidth Measurement

Test Requirement:

FCC CFR47 Part 15 Section 15.215(c)

Test Method:

ANSI C63.10:2013

Test Mode:

Transmitting

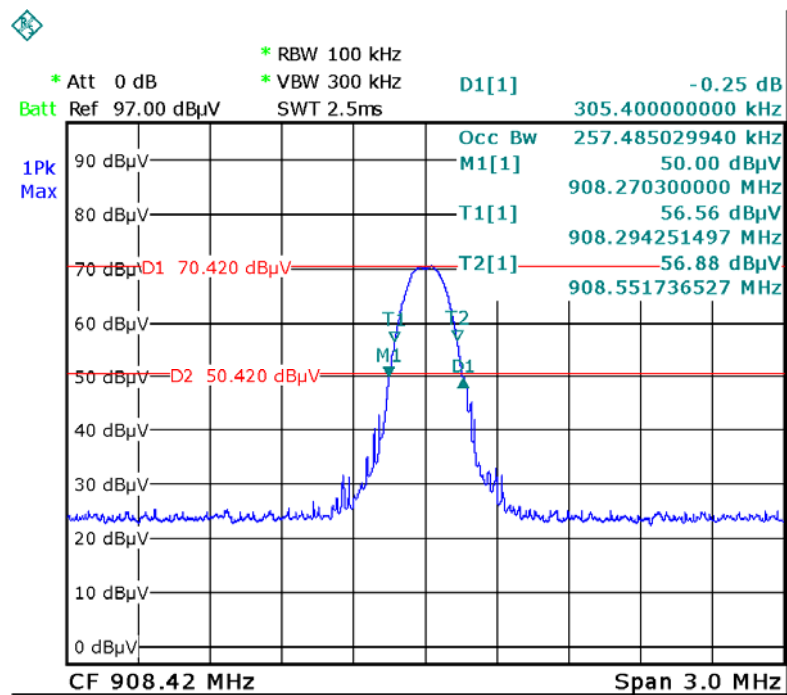
11.1 Test Procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: RBW = 100kHz, VBW = 300kHz

11.2 Test Result

Frequency (MHz)	Bandwidth Emission (kHz)
908.42	305.40

Test plots



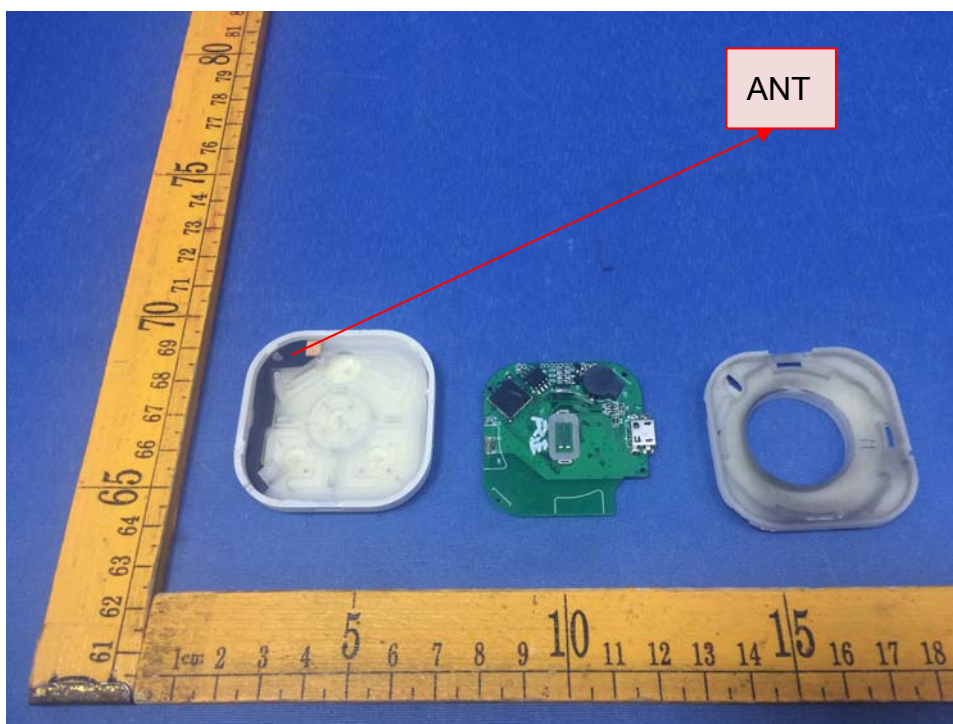
12 Antenna Requirement

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. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

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.

Result:

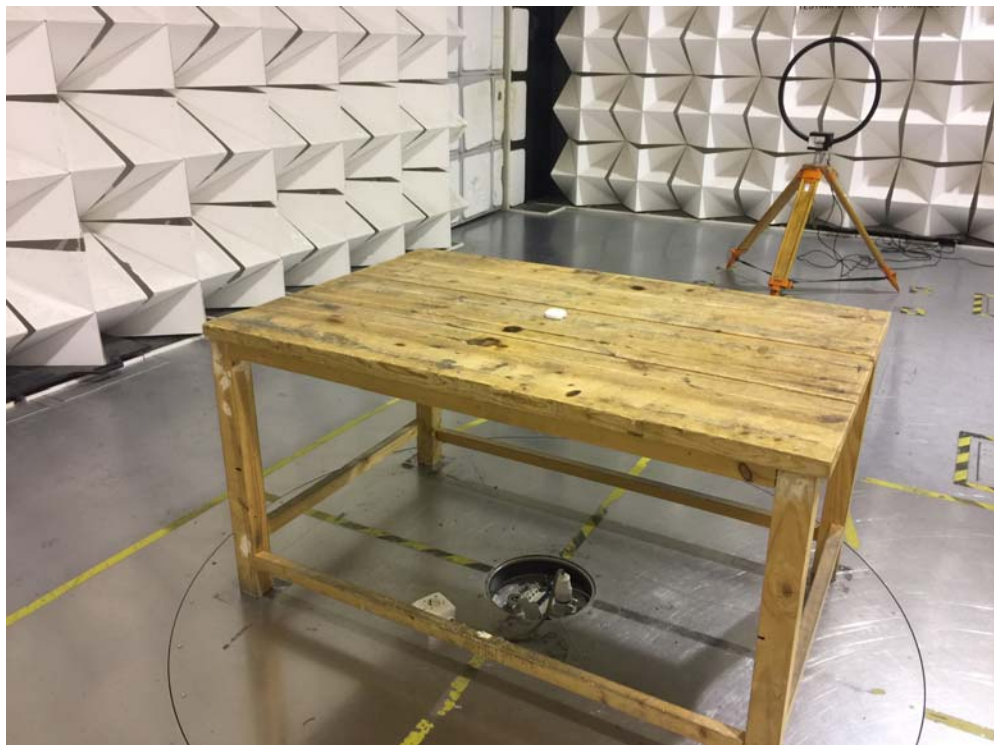
The EUT has a Integrated Antenna, the gain is 0dBi. meets the requirements of FCC 15.203.



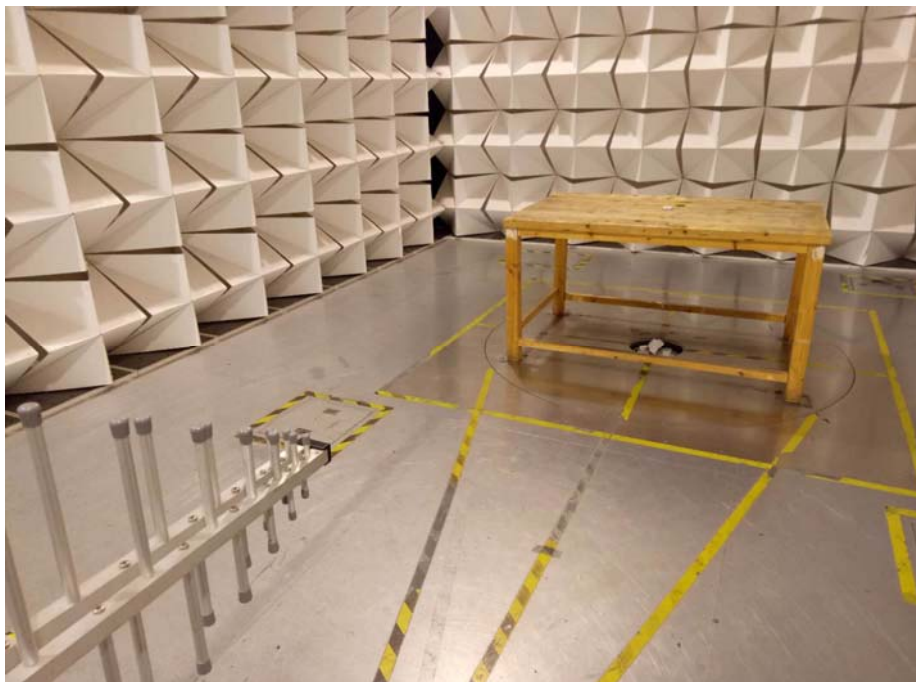
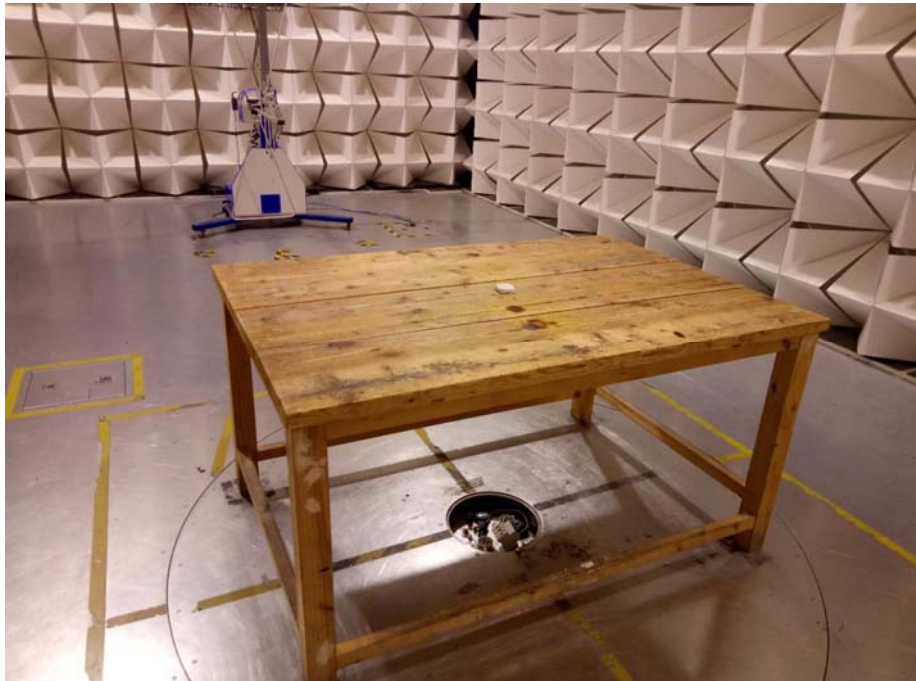
13 Photographs- Model ZWA003-A Test Setup Photos

13.1 Photograph – Radiation Emission

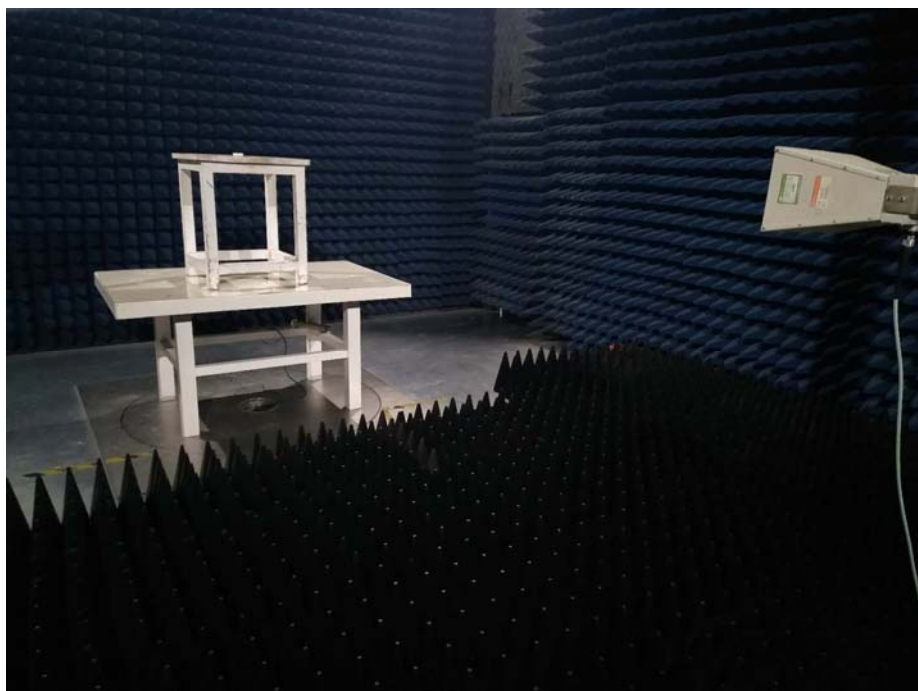
Test frequency below 30MHz



Test frequency from 30MHz to 1GHz



Test frequency Above 1GHz



13.2 Photograph – Conducted Emission Test Setup



14 Photographs - Constructional Details

14.1 EUT – External photos

Model: ZWA003-A

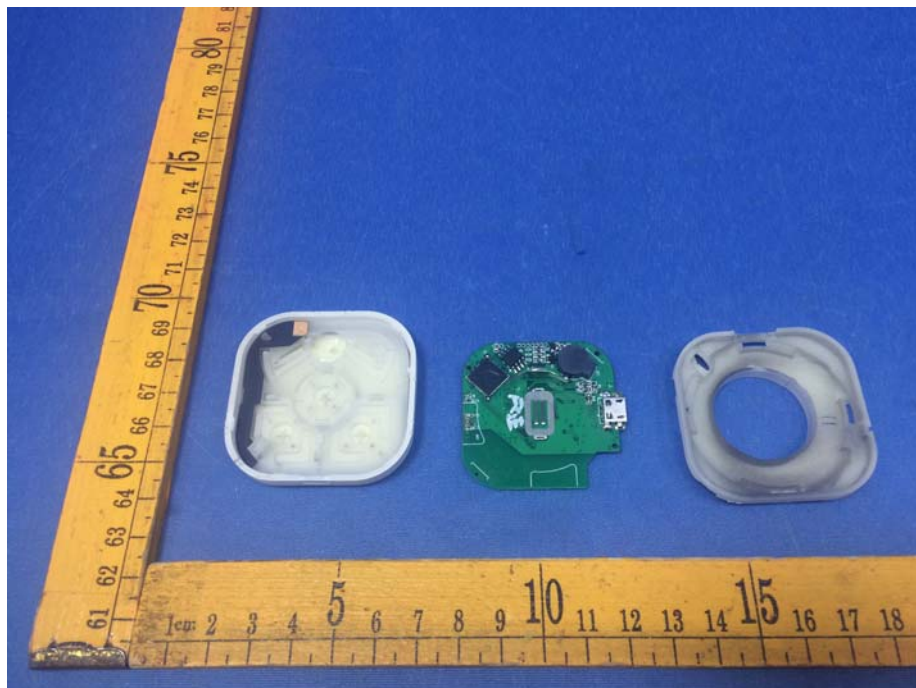


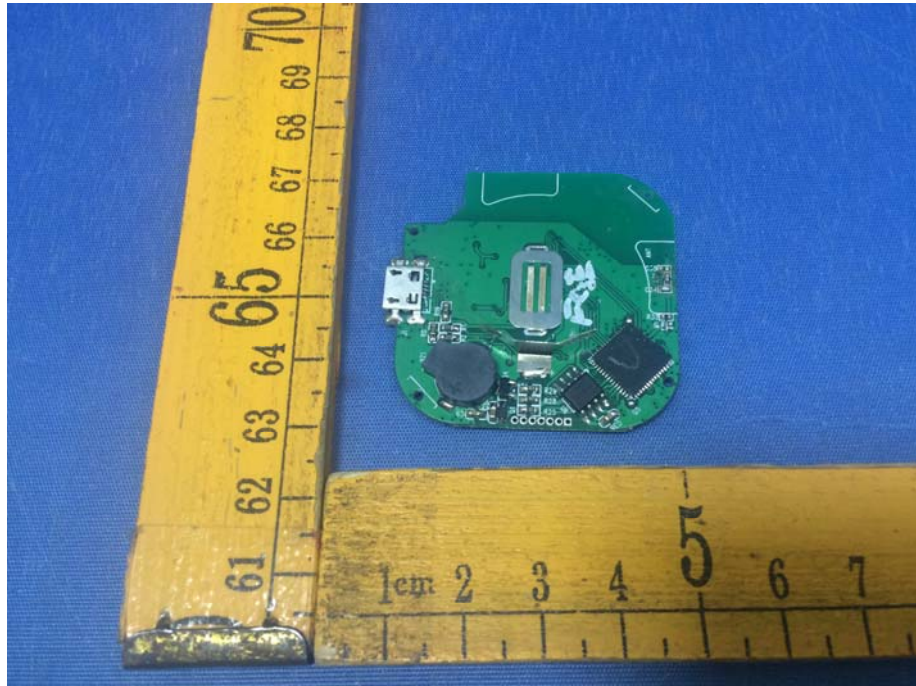


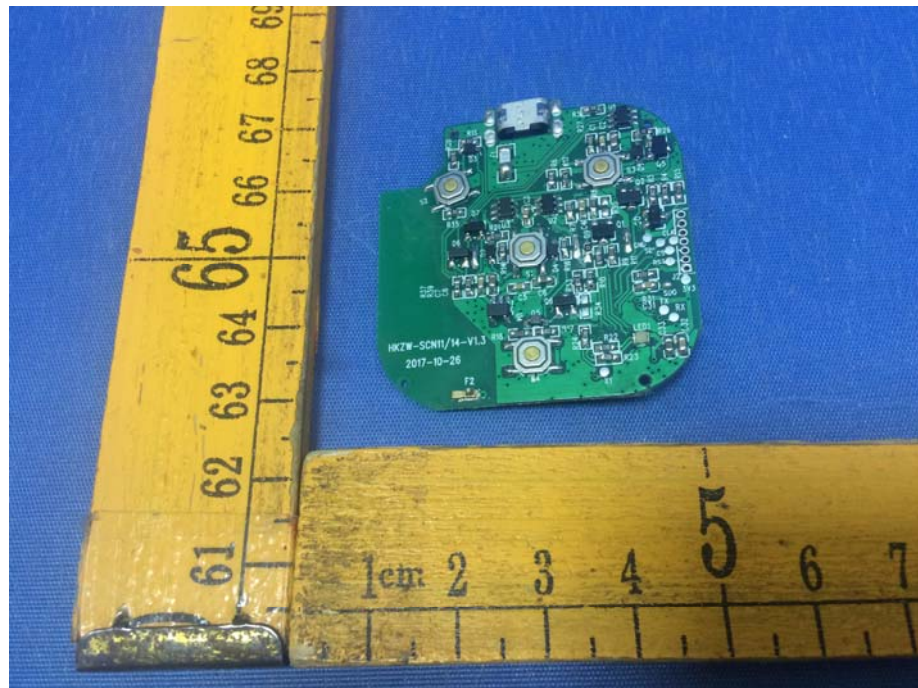


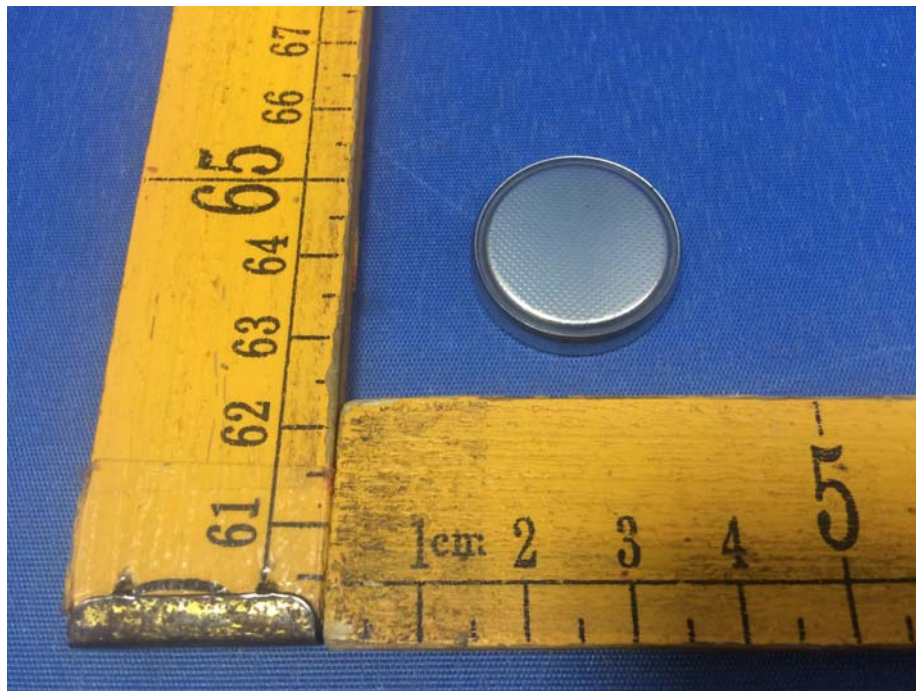
14.2 EUT –Internal Photos

Model: ZWA003-A









=====End of Report=====