



TEST REPORT

FCC ID: 2AKWC-ES188**Product: TPMS Sensor****Model No.: ES188****Additional Model No.: N/A****Trade Mark: N/A****Report No.: WSCT-NVLAP-R&E191200024A****Issued Date: Dec. 17, 2019****Issued for:****DISPLAY & TECHNOLOGY LIMITED
ROOM 1303, AUSTIN TOWER, 22 AUSTIN AVE., T.S.T., NEW TERRITORIES
HONGKONG****Issued By:****World Standardization Certification & Testing Group Co., Ltd.
Building A-B, Baoshi Science & Technology Park, Baoshi Road,
Bao'an District, Shenzhen, Guangdong, China****TEL: +86-755-26996192****FAX: +86-755-86376605**

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1. GENERAL INFORMATION

Product:	TPMS Sensor
Model No.:	ES188
Trade Mark:	N/A
Additional Model:	N/A
Applicant:	DISPLAY & TECHNOLOGY LIMITED
Address:	ROOM 1303, AUSTIN TOWER, 22 AUSTIN AVE., T.S.T., NEW TERRITORIES HONGKONG
Manufacturer:	SHENZHEN NOVACOM ELECTRONICS CO., LTD.
Address:	7 TH FLOOR BLOCK 3 JIAAN SCIENCE & TECHNOLOGY PARK LIUXIAN 1 ST ROAD 67 TH DISTRICT XINAN STREET BAOAN DISTRICT SHENZHEN CHINA
Data of receipt	Dec. 10, 2019
Date of Test:	Dec. 10, 2019 to Dec. 16, 2019
Applicable Standards:	FCC Part 15 Subpart C & RSS-125 & RSS-123 & RSS-310 ANSI C63.10: 2013

The above equipment has been tested by World Standardization Certification & Testing Group Co., Ltd. and found compliance with the requirements set forth in the technical standards mentioned above. The results of testing in this report apply only to the product/system, which was tested. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Tested By:

Jim Han

(Jim Han)

Date:

Dec. 17, 2019

Check By:

Qin Shuiquan

(Qin Shuiquan)

Date:

Dec. 17, 2019

Approved By:

Wang Fengbing

(Wang Fengbing)

Date:

Dec. 17, 2019





1.1.GENERAL DESCRIPTION OF EUT

Equipment Type:	TPMS Sensor
Model No.:	ES188
Additional Model:	N/A
Trade Mark:	N/A
Applicant:	DISPLAY & TECHNOLOGY LIMITED
Address:	ROOM 1303, AUSTIN TOWER, 22 AUSTIN AVE., T.S.T., NEW TERRITORIES HONGKONG
Manufacturer:	SHENZHEN NOVACOM ELECTRONICS CO., LTD.
Address:	7 TH FLOOR BLOCK 3 JIAAN SCIENCE & TECHNOLOGY PARK LIUXIAN 1 ST ROAD 67 TH DISTRICT XINAN STREET BAOAN DISTRICT SHENZHEN CHINA
Software version:	V1.0
Hardware version:	V1.0
Extreme Temp. Tolerance:	-20°C to + 85°C
Power Supply:	DC : CR1632 Voltage: 3V
Operating Frequency	433.92MHz(TX)
Channels	1
Channel Spacing	N/A
Modulation Type	FSK
Antenna Type:	External antenna
Antenna gain:	0dBi

Note: N/A stands for no applicable.

Models difference

N/A



1.2. FACILITIES AND ACCREDITATIONS

All measurement facilities used to collect the measurement data are located at **Building A-B, Baoshi Science & Technology Park, Baoshi Road, Bao'an District, Shenzhen, Guangdong, China of the World Standardization Certification & Testing Group Co., Ltd.**

The sites are constructed in conformance with the requirements of ANSI C63.4 and CISPR Publication 22. All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

Registration Number: 366353

1.2.1. ACCREDITATIONS

Our laboratories are accredited and approved by the following approval agencies according to ISO/IEC 17025.

USA	NVLAP (The certificate registration number is NVLAP LAB CODE:600142-0)
Japan	VCCI (The certificate registration number is C-4790, R-3684, G-837)
Canada	INDUSTRY CANADA (The certificated registration number is 7700A-1)
China	CNAS (The certificated registration number is L3732)

Copies of granted accreditation certificates are available for downloading from our web site,
<http://www.wsct-cert.com>





2. TEST DESCRIPTION

2.1 MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement $y \pm U$, where expanded uncertainty U is based on a standard uncertainty multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately 95%.

No.	Item	Uncertainty
1	Conducted Emission Test	$\pm 3.2\text{dB}$
2	RF power, conducted	$\pm 0.16\text{dB}$
3	Spurious emissions, conducted	$\pm 0.21\text{dB}$
4	All emissions, radiated(<1G)	$\pm 4.7\text{dB}$
5	All emissions, radiated(>1G)	$\pm 4.7\text{dB}$
6	Temperature	$\pm 0.5^{\circ}\text{C}$
7	Humidity	$\pm 2\%$





For Question
Please Contact with WSCT

2.2 DESCRIPTION OF TEST MODES

To investigate the maximum EMI emission characteristics generates from EUT, the test system was pre-scanning tested base on the consideration of following EUT operation mode or test configuration mode which possible have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned above was evaluated respectively.

test Mode	Description
Mode 1	The EUT was programmed to be in continuously transmitting mode.

2.3 Table of Parameters of Text Software Setting

During testing channel & power Fixed frequency prototype provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product power parameters .

Test software Version	N/A
Test program	/

2.4 CONFIGURATION OF SYSTEM UNDER TEST

EUT

(EUT: TPMS Sensor)

2.5 DESCRIPTION OF SUPPORT UNITS (CONDUCTED MODE)

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Note
1	Adapter	/	N/A	/	/
2	/	/	N/A	/	/

Note:

- (1) The support equipment was authorized by Declaration of Confirmation.
- (2) For detachable type I/O cable should be specified the length in cm in 『Length』 column.
- (3) “YES” is means “shielded” “with core”; “NO” is means “unshielded” “without core”.
- (4) The adapter supply by the applicant.



3. SUMMARY OF TEST RESULTS

Test procedures according to the technical standards:

FCC CFR 47 Part15 , Subpart C &RSS-125 & RSS-123 & RSS-310		
Standard Section	Test Item	Judgment
15.207	Conducted Emission	N/A
15.209 ,15.231(e)	Radiated Emission	PASS
Section 15.231 (e)	Transmit time	PASS
Section 15.231(c)	Occupied Bandwidth	PASS
15.203	Antenna Requirement	PASS

Note:

1. Pass: Test item meets the requirement.
2. Fail: Test item does not meet the requirement.
3. N/A: Test case does not apply to the test object.
4. The test result judgment is decided by the limit of test standard.





4. MEASUREMENT INSTRUMENTS

NAME OF EQUIPMENT	MANUFACTURER	MODEL	SERIAL NUMBER	Calibration Date	Calibration Due.
EMI Test Receiver	R&S	ESCI	100005	11/05/2019	11/04/2020
LISN	AFJ	LS16	16010222119	11/05/2019	11/04/2020
LISN(EUT)	Mestec	AN3016	04/10040	11/05/2019	11/04/2020
Universal Radio Communication Tester	R&S	CMU 200	1100.0008.02	11/05/2019	11/04/2020
Coaxial cable	Megalon	LMR400	N/A	11/05/2019	11/04/2020
GPIO cable	Megalon	GPIO	N/A	11/05/2019	11/04/2020
Spectrum Analyzer	R&S	FSU	100114	11/05/2019	11/04/2020
Pre Amplifier	H.P.	HP8447E	2945A02715	11/05/2019	11/04/2020
Pre-Amplifier	CDSI	PAP-1G18-38	--	11/05/2019	11/04/2020
Bi-log Antenna	SUNOL Sciences	JB3	A021907	11/05/2019	11/04/2020
9*6*6 Anechoic	--	--	--	11/05/2019	11/04/2020
Horn Antenna	COMPLIANCE ENGINEERING	CE18000	--	11/05/2019	11/04/2020
Horn Antenna	SCHWARZBECK	BBHA9120D	9120D-631	11/05/2019	11/04/2020
Cable	TIME MICROWAVE	LMR-400	N-TYPE04	11/05/2019	11/04/2020
System-Controller	CCS	N/A	N/A	N.C.R	N.C.R
Turn Table	CCS	N/A	N/A	N.C.R	N.C.R
Antenna Tower	CCS	N/A	N/A	N.C.R	N.C.R
RF cable	Murata	MXHQ87WA3000	-	11/05/2019	11/04/2020
Loop Antenna	EMCO	6502	00042960	11/05/2019	11/04/2020
Horn Antenna	SCHWARZBECK	BBHA 9170	1123	11/05/2019	11/04/2020
Power meter	Anritsu	ML2487A	6K00003613	11/05/2019	11/04/2020
Power sensor	Anritsu	MX248XD	--	11/05/2019	11/04/2020



5. EMC EMISSION TEST

5.1 CONDUCTED EMISSION MEASUREMENT

5.1.1 POWER LINE CONDUCTED EMISSION Limits(Frequency Range 150KHz-30MHz)

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

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





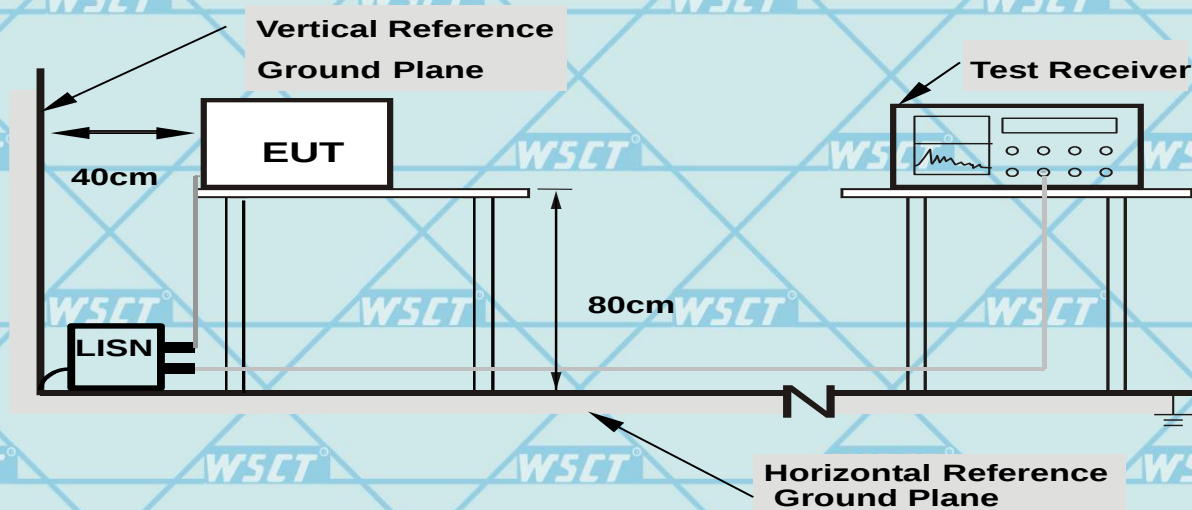
5.1.2 TEST PROCEDURE

- The EUT was placed 0.4 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.
- 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.
- LISN at least 80 cm from nearest part of EUT chassis.
- For the actual test configuration, please refer to the related Item –EUT Test Photos.

5.1.3 DEVIATION FROM TEST STANDARD

No deviation

5.1.4 TEST SETUP



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

5.1.5 EUT OPERATING CONDITIONS

The EUT was configured for testing in a typical fashion (as a customer would normally use it). The EUT has been programmed to continuously transmit during test. This operating condition was tested and used to collect the included data.





For Question,
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5.1.6 TEST RESULTS

Not applicable. Due to this product is supplied by battery.



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5.2 RADIATED EMISSION MEASUREMENT

5.2.1 Limits

According to §15.231 (e) Intentional radiators may operate at a periodic rate exceeding that specified in paragraph (a) of this section and may be employed for any type of operation, including operation prohibited in paragraph (a) of this section, provided the intentional radiator complies with the provisions of paragraphs (b) through (d) of this section, except the field strength table in paragraph (b) of this section is replaced by the following:

Fundamental frequency (MHz)	Field strength of fundamental (microvolts/meter)	Field strength of spurious emission (microvolts/meter)
40.66-40.70	1,000	100
70-130	500	50
130-174	500 to 1,500 ¹	50 to 150 ¹
174-260	1,500	150
260-470	1,500 to 5,000 ¹	150 to 500 ¹
Above 470	5,000	500

1. In the above emission table, the tighter limit applies at the band edges.

Frequency (Hz)	Field Strength (μV/m at 3-meter)	Field Strength (dBμV/m at 3-meter)
30-88	100	40
88-216	150	43.5
216-960	200	46
Above 960	500	54

Notes:

1:The limit for radiated test was performed according to FCC PART 15C.

2:The tighter limit applies at the band edges.

3:Emission level (dBuV/m)=20log Emission level (uV/m).

Receiver Setup: ANSI C63.10-2013 6.10.5.2

Frequency	Detector	RBW	VBW	Remark
9kHz- 150kHz	Quasi-peak	200Hz	1kHz	Quasi-peak Value
150kHz- 30MHz	Quasi-peak	9kHz	30kHz	Quasi-peak Value
30MHz-1GHz	Quasi-peak	120kHz	1MHz	Quasi-peak Value
Above 1GHz	Peak	1MHz	3MHz	Peak Value
	Peak	1MHz	3MHz	Average Value





5.2.2 TEST PROCEDURE

- The measuring distance of at 3 m shall be used for measurements at frequency up to 1GHz. For frequencies above 1GHz, any suitable measuring distance may be used.
- The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter open area test site. The table was rotated 360 degrees to determine the position of the highest radiation.
- The height of the equipment or of the substitution antenna shall be 0.8 m; the height of the test antenna shall vary between 1 m to 4 m. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- The initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured.
- If the Peak Mode measured value compliance with and lower than Quasi Peak Mode Limit, the EUT shall be deemed to meet QP Limits and then no additional QP Mode measurement performed.
- For the actual test configuration, please refer to the related Item –EUT Test Photos.

Note: **Both horizontal and vertical antenna polarities were tested and performed pretest to three orthogonal axis. The worst case emissions were reported**

5.2.3 DEVIATION FROM TEST STANDARD

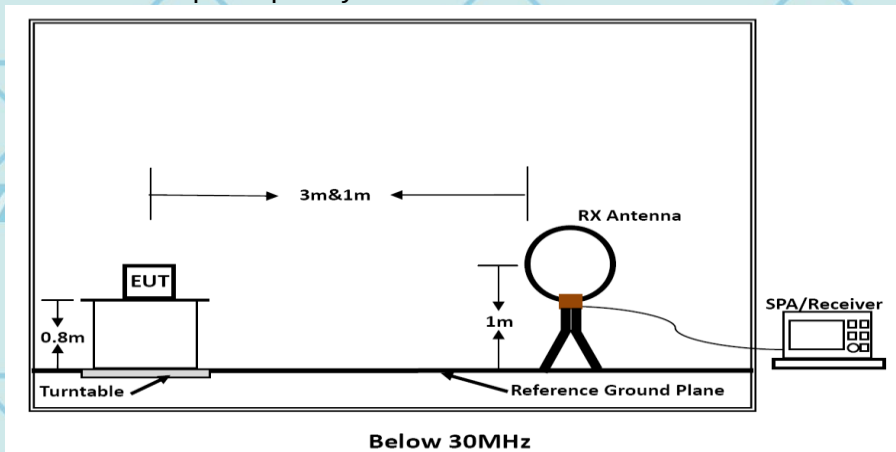
No deviation



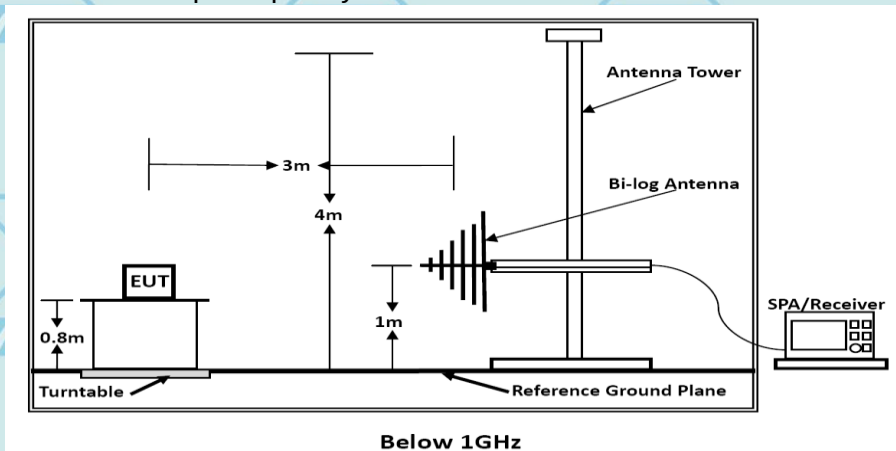


5.2.4 TEST SETUP

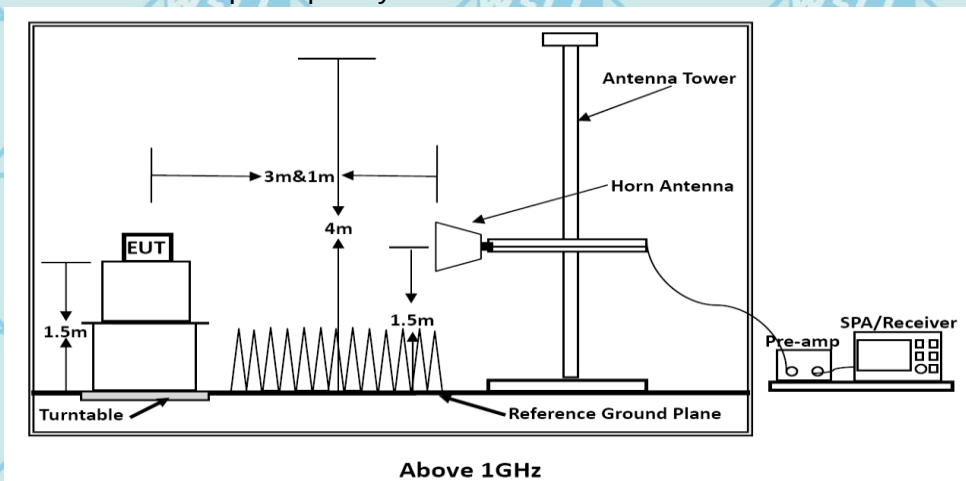
(A) Radiated Emission Test-Up Frequency Below 30MHz



(B) Radiated Emission Test-Up Frequency 30MHz~1GHz



(C) Radiated Emission Test-Up Frequency Above 1GHz



5.2.5 EUT OPERATING CONDITIONS

The EUT tested system was configured as the statements of 2.4 Unless otherwise a special operating condition is specified in the follows during the testing.



For Question,
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5.2.6 (Between 30M – 1000 MHz)

Temperature	20 °C	Relative Humidity	60%
Pressure	1010 hPa	Test Mode	Mode 1

Fundamental:

Freq. (MHz)	H/V	Reading	Correction Factor	Result	Limits	Margin	Remark
		(dBμV)	(dB)	(dBμV/ m)	(dBμV /m)	(dB)	
433.92	H	71.11	-0.43	70.68	92.20	-22.52	Peak
433.92	H	-	-	64.59	72.20	-7.61	AVG
433.92	V	58.58	-0.43	58.15	92.20	-34.05	Peak
433.92	V	-	-	52.06	72.20	-20.14	AVG
Spurious							
869.13	H	31.65	5.07	36.72	74.00	-37.28	Peak
869.13	H	-	-	30.63	54.00	-23.37	AVG
872.18	V	30.24	5.07	35.31	74.00	-38.69	Peak
872.18	V	-	-	29.22	54.00	-24.78	AVG

Remark: AVG = peak + duty cycle factor(-6.09)

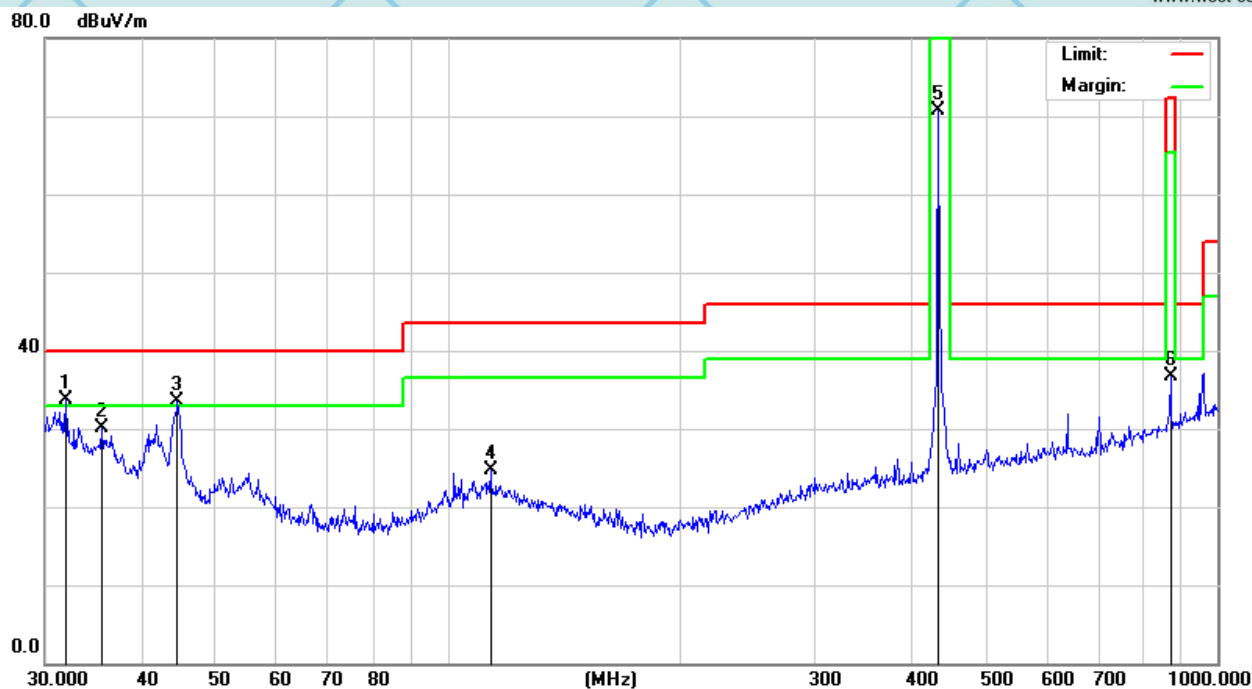
Notes:

1. Measuring frequencies from 9KHz to the 1000MHz.
2. Radiated emissions measured in frequency range from 9KHz to 1000MHz were made with an instrument using Peak detector mode.
3. Data of measurement within this frequency range shown “-” 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. The IF bandwidth of SPA between 30MHz to 1GHz was 100kHz.





H:

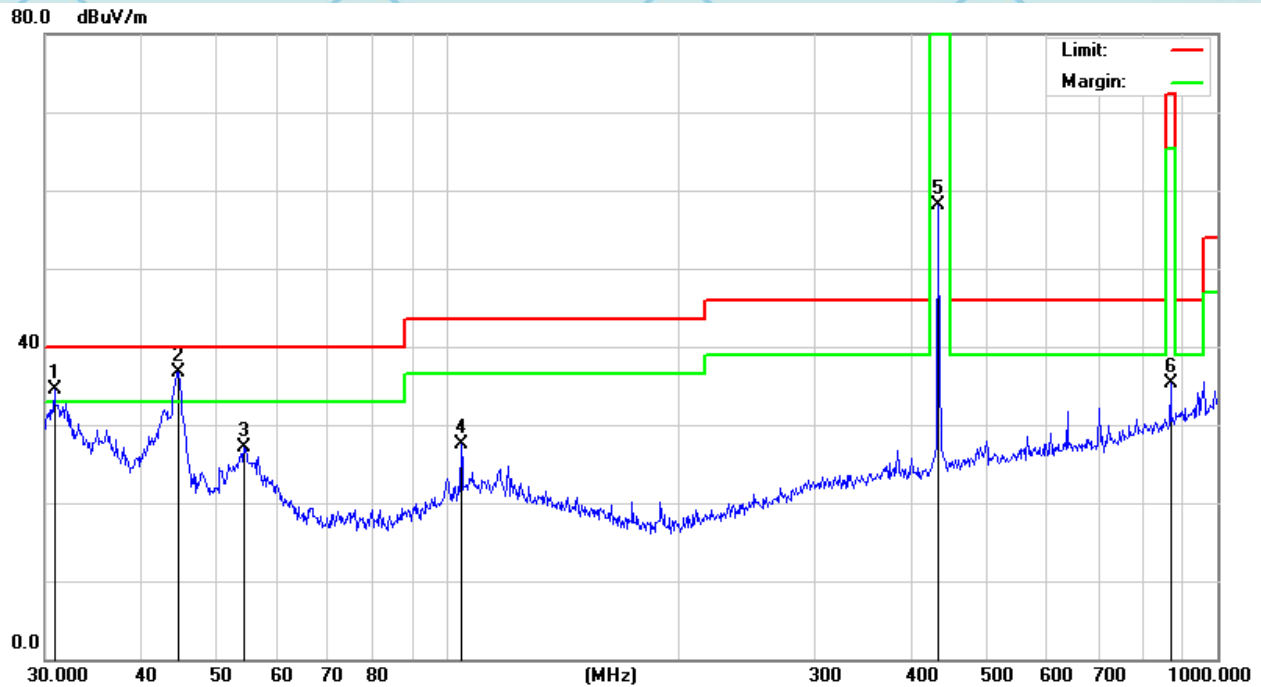


No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Detector
1	*	31.9546	29.75	4.05	33.80	40.00	-6.20	QP
2		35.4993	27.53	2.58	30.11	40.00	-9.89	QP
3	!	44.5868	35.43	-1.86	33.57	40.00	-6.43	QP
4		113.7143	26.98	-2.23	24.75	43.50	-18.75	QP
5		434.0651	71.11	-0.43	70.68	92.20	-21.52	peak
6		869.1300	31.65	5.07	36.72	72.20	-35.48	peak





V:



No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Detector
1	!	30.8535	30.03	4.47	34.50	40.00	-5.50	QP
2	*	44.7433	38.60	-1.93	36.67	40.00	-3.33	QP
3		54.4516	32.67	-5.55	27.12	40.00	-12.88	QP
4		104.1701	30.49	-3.01	27.48	43.50	-16.02	QP
5		434.0651	58.58	-0.43	58.15	92.20	-34.05	peak
6		869.1302	30.24	5.07	35.31	72.20	-36.89	peak





5.2.7 (Above 1GHz)

Temperature	20 °C	Relative Humidity	48%
Pressure	1010 hPa	Test Mode	Mode 1 TX

Freq. (MHz)	H/V	Reading (dBμV)	Correction Factor(dB/m)	Result (dBμV/m)		Limits (dBμV/m)		Margin(dB)	
		PK		PK	AV	PK	AV	PK	AV
1301.76	H	45.05	-2.46	42.59	37.11	74	54	31.41	16.89
1735.68	H	47.55	-5.19	42.35	36.87	74	54	31.65	17.13
2169.60	H	51.91	-3.53	48.38	42.90	74	54	25.62	11.10
2603.52	H	51.95	-7.97	43.98	38.50	74	54	30.02	15.50
3037.44	H	50.99	-8.64	42.35	36.87	74	54	31.65	17.13
3471.36	H	51.36	-2.21	49.15	43.67	74	54	24.85	10.33
3905.28	H	48.06	-5.37	42.69	37.21	74	54	31.31	16.79
4339.20	H	46.48	1.49	47.97	42.49	74	54	26.03	11.51

Freq. (MHz)	H/V	Reading (dBμV)	Correction Factor(dB/m)	Result (dBμV/m)		Limits (dBμV/m)		Margin(dB)	
		PK		PK	AV	PK	AV	PK	AV
1301.76	H	50.85	-6.48	44.37	38.89	74	54	29.63	15.11
1735.68	H	51.71	-1.05	50.66	45.18	74	54	23.34	8.82
2169.60	H	45.45	-3.81	41.64	36.16	74	54	32.36	17.84
2603.52	H	53.92	-8.06	45.85	40.37	74	54	28.15	13.63
3037.44	H	52.62	-1.93	50.69	45.21	74	54	23.31	8.79
3471.36	H	46.45	-1.81	44.64	39.16	74	54	29.36	14.84
3905.28	H	54.55	-5.43	49.12	43.64	74	54	24.88	10.36
4339.20	H	52.68	2.59	55.27	49.79	74	54	18.73	4.21

Note :

1. Result = Reading + Corrected Factor
2. Average Result = Peak Result + Duty Factor (-6.09)
3. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
4. Margin =Limit - Result
5. Above 1Ghz : Peak measurements are compared to the average limit - as peak measurements are below the average limit, they also comply with the peak limit.





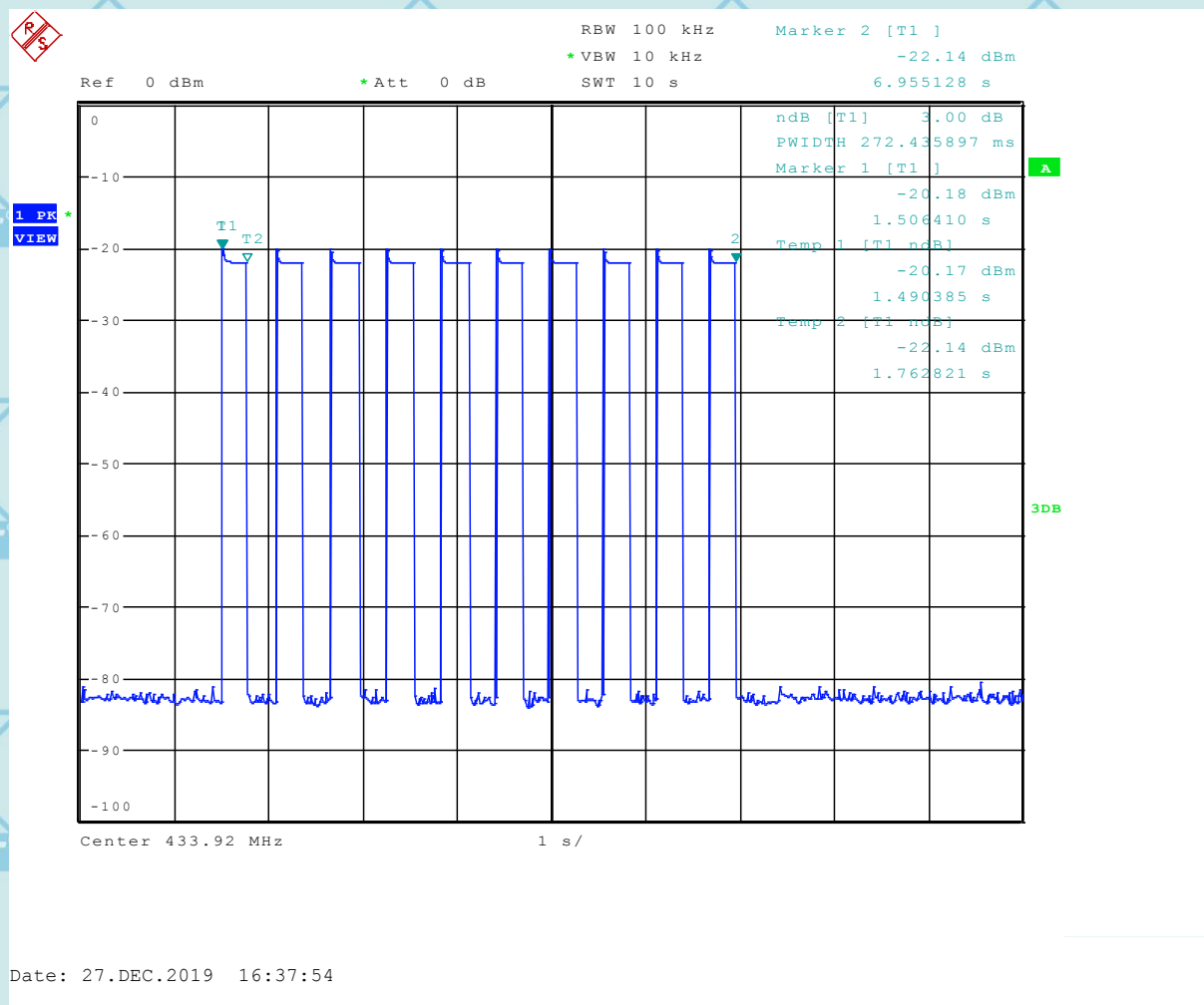
5.2.8 Calculation of Duty Factor

The duty factor is calculated with following formula :

$$20\log \frac{\text{Total Duty}}{\text{Period of Pulse Train}}$$

Unit: ms

Duty Factor=20log[(272.44*10)/(6955.13-1460.39)]=-6.09db





6. TRANSMIT TIME

6.1 AUTOMATICALLY LIMITING OPERATION Limits

Regulation 15.231 (e) In addition, devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

6.2 TEST PROCEDURE

The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below.

- Set span to 0 Hz.
- Set RBW = 100kHz.
- Set VBW $\geq 3 \times$ RBW.
- Sweep time = 29S.
- Detector = Peak.

6.3 DEVIATION FROM TEST STANDARD

No deviation

6.4 TEST SETUP

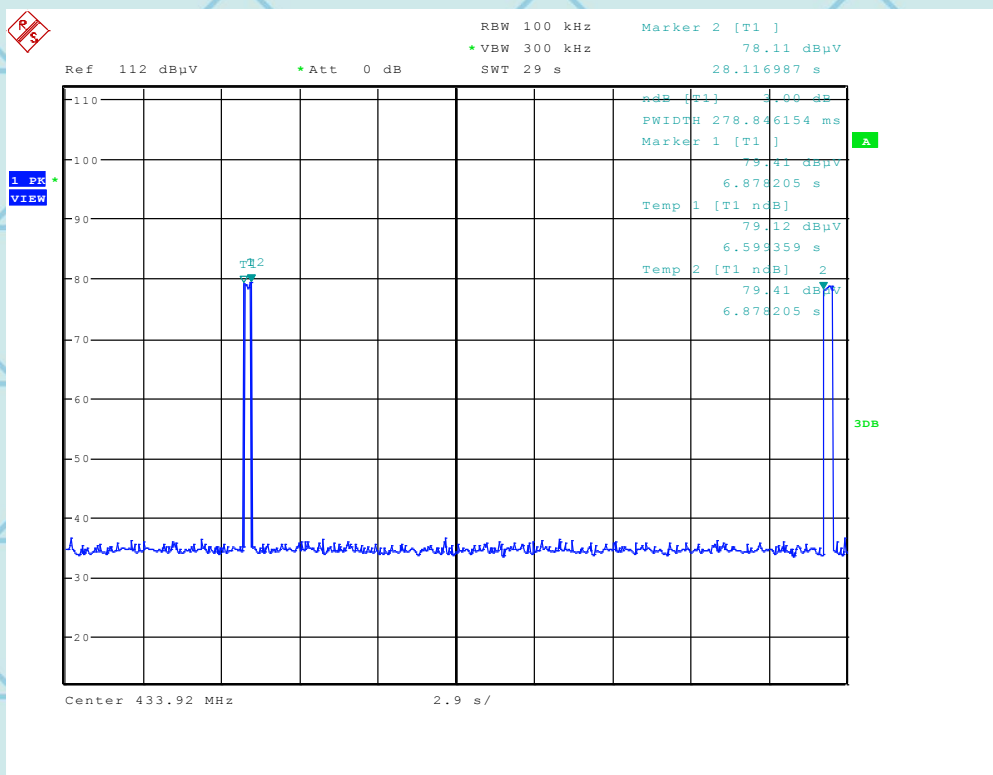


6.5 EUT OPERATING CONDITIONS

The EUT was configured for testing in a typical function (as a customer would normally use it). This operating condition was tested and used to collect the included data.

6.6 TEST RESULTS

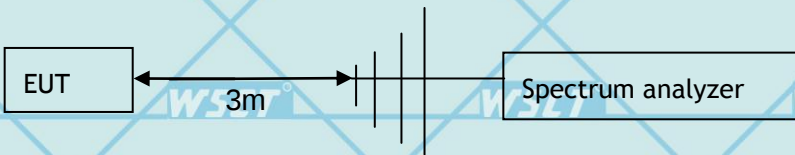
Ton/Toff (s)	Ton/Toff limits(s)	Result
0.279	$T_{on} < 1$	Pass
28.12	$T_{off} > 30 T_{on}$	Pass





7. OCCUPIED BANDWIDTH

7.1 Test Specification

Test Requirement:	FCC Part 15 Subpart C &RSS-125 & RSS-123 & RSS-310
Test Method:	ANSI C63.10: 2013
LIMITS OF BAND	The bandwidth of the emission shall be no wider than 0.25% of the center frequency for device operating above 70MHz and below 900MHz.
TEST PROCEDURE	The EUT was placed on a turn table was 0.8meter above ground. The signal was coupled to the spectrum analyzer through an antenna. Set SPA RBW:10KHz,VBW:30KHz sweep time :auto Set SPA trace max hold,then view.
Test setup:	
Test Mode:	Transmitting mode with modulation
Test results:	PASS



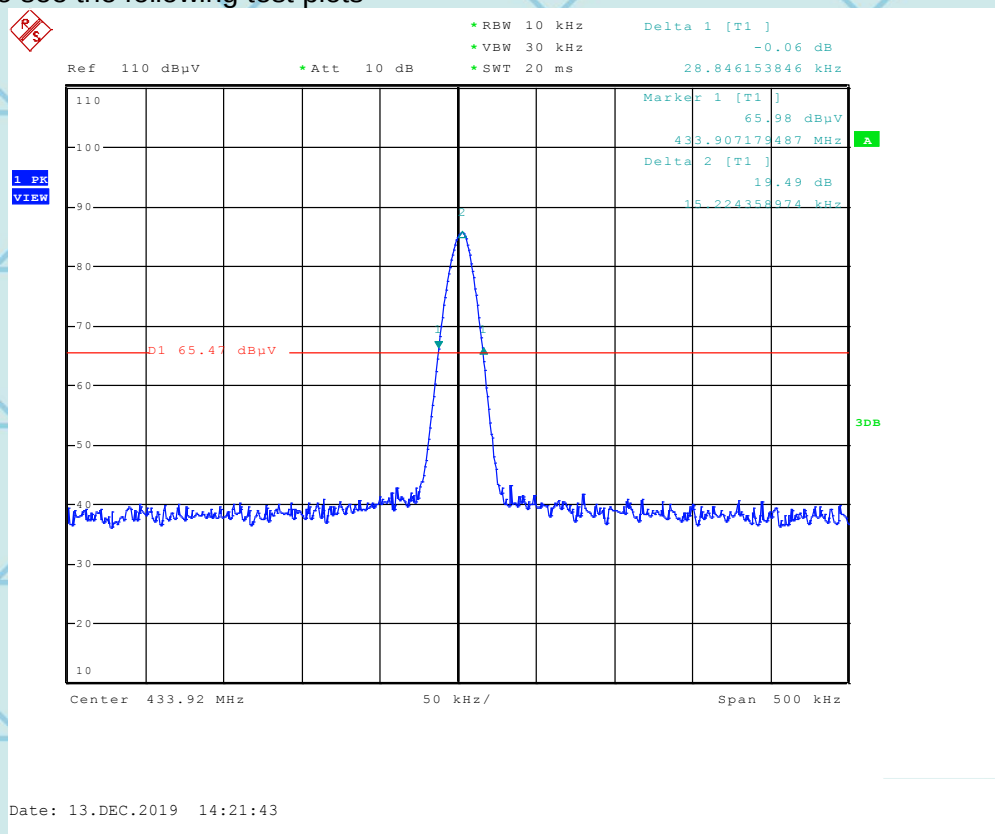


7.2 Test Result

20dB Occupied Bandwidth

Frequency (MHz)	20dB bandwidth (KHz)	Maximum Limit (KHz)	Result
433.92	28.85	1084.8	Pass

Details please see the following test plots

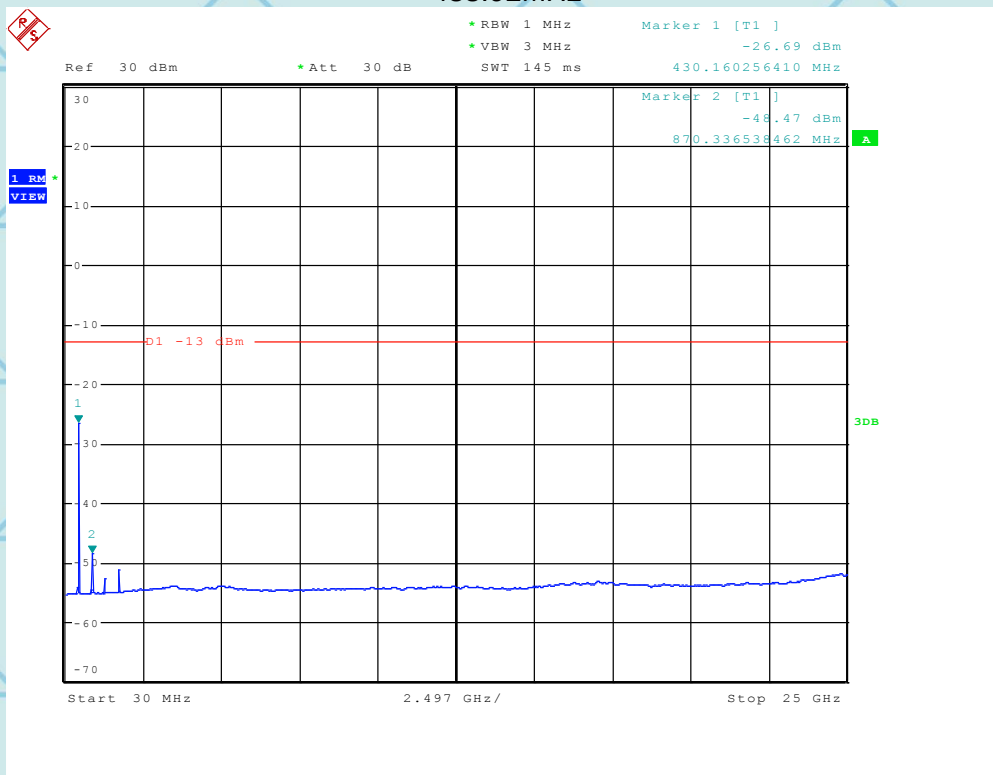




For Question,
Please Contact with WSCT
www.wsct-cert.com

7.3 THE FUNDAMENTAL AND SPURIOUS EMISSIONS

433.92MHz



Date: 13.DEC.2019 14:28:20



世标检测认证股份
World Standardization Certification & Testing Group Co.,Ltd.

ADD: Building A-B Baoshi Science & technology Park, Baoshi Road, Bao'an District, Shenzhen, Guangdong, China
TEL: 86-755-26996143/26996144/26996145/26996192 FAX: 86-755-86376605 E-mail: Fengbing.Wang@wsct-cert.com Http: www.wsct-cert.com

Member of the WSCT INC.



8. ANTENNA REQUIREMENT

8.1 Antenna requirement

The EUT's antenna is met the requirement of FCC part 15C section 15.203.

8.2 Result

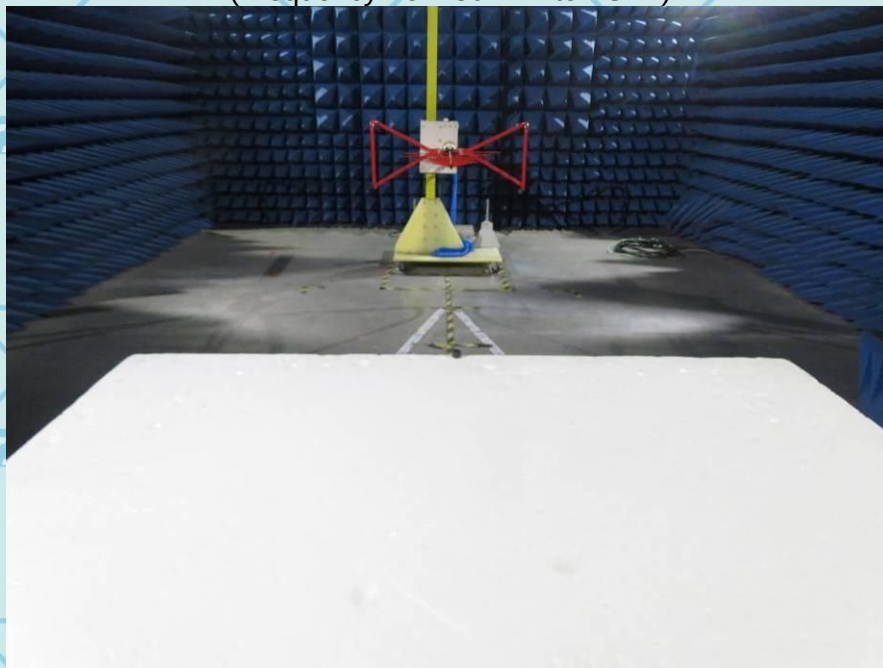
The antenna used in this product is an External antenna, The antenna's gain is 0dBi and meets the requirement.



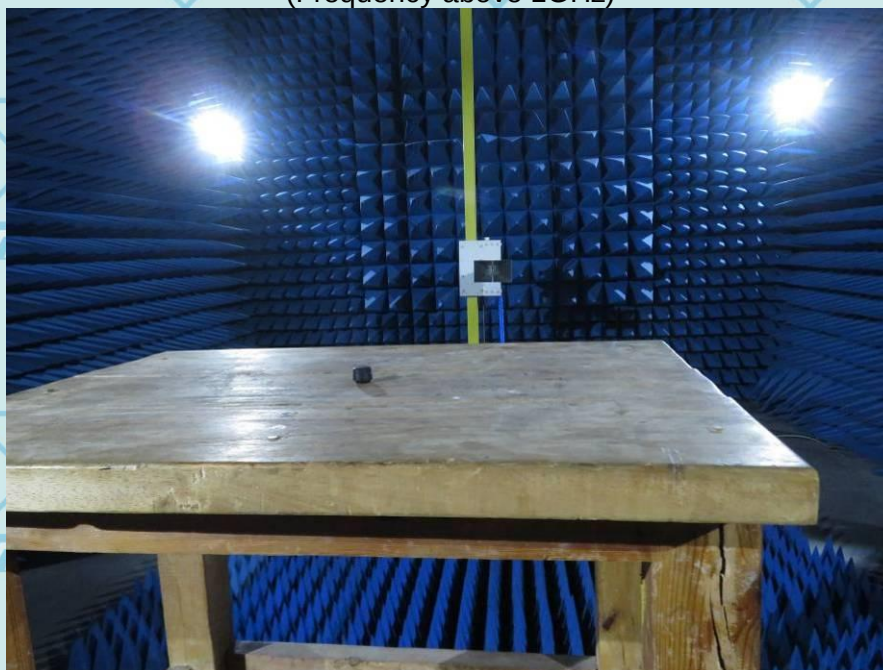


9.TEST SETUP PHOTOGRAPHS

RADIATED EMISSION TEST
(Frequency from 30MHz to 1GHz)



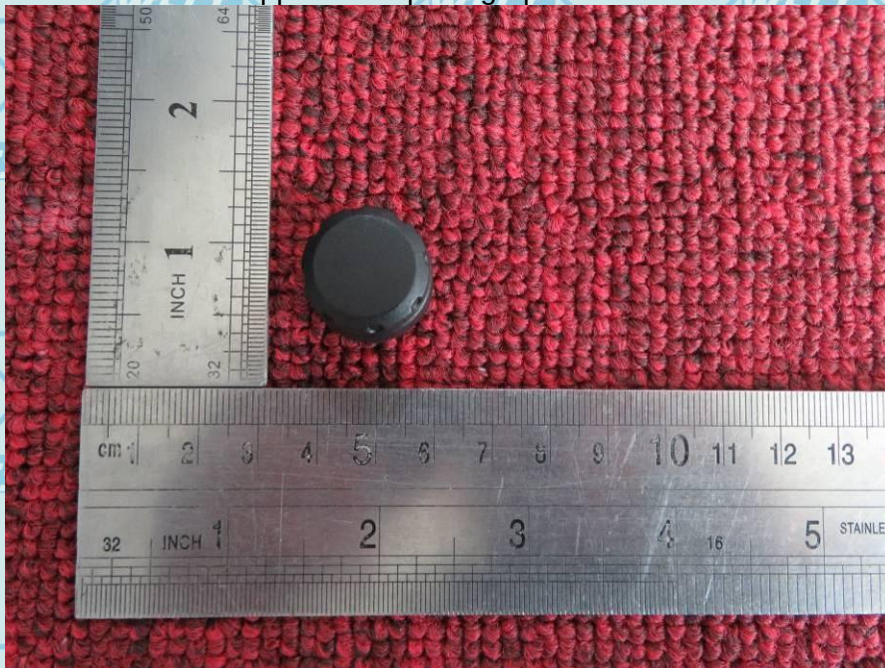
RADIATED EMISSION TEST
(Frequency above 1GHz)





10. PHOTOGRAPHS OF EUT

Appearance photograph of EUT



Appearance photograph of EUT





Appearance photograph of EUT



Appearance photograph of EUT





Appearance photograph of EUT



Internal photograph of EUT





Internal photograph of EUT



Internal photograph of EUT

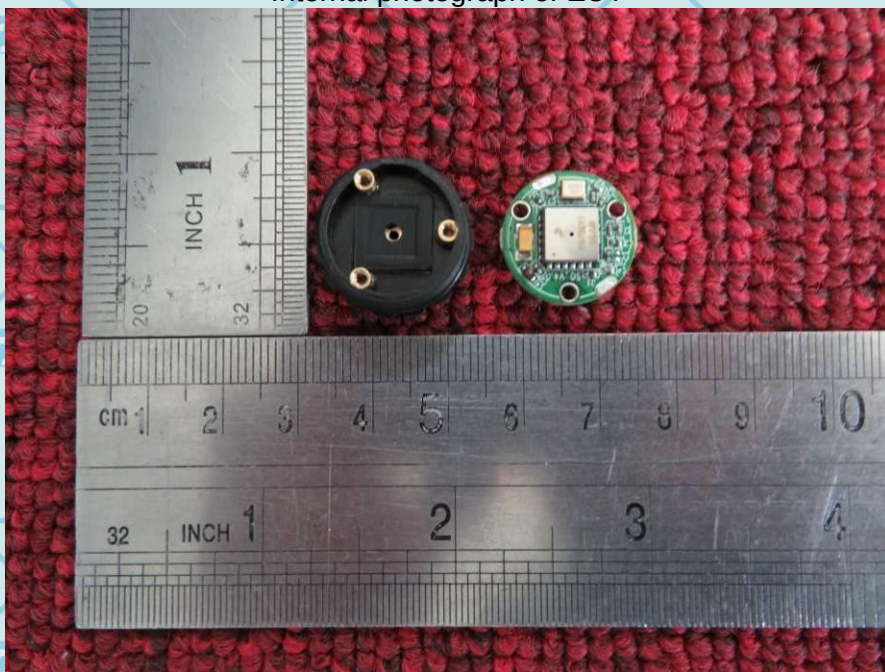




Internal photograph of EUT

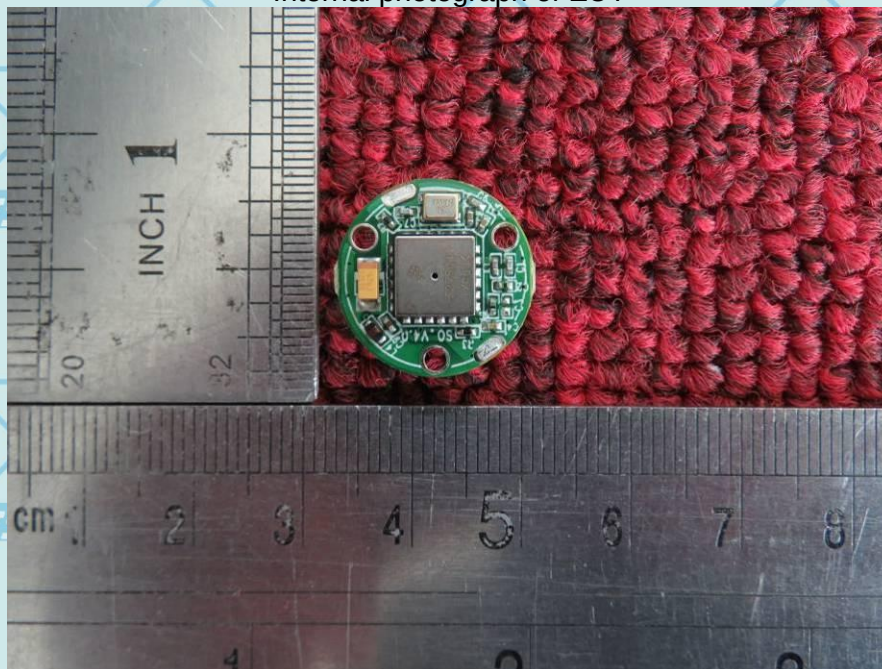


Internal photograph of EUT

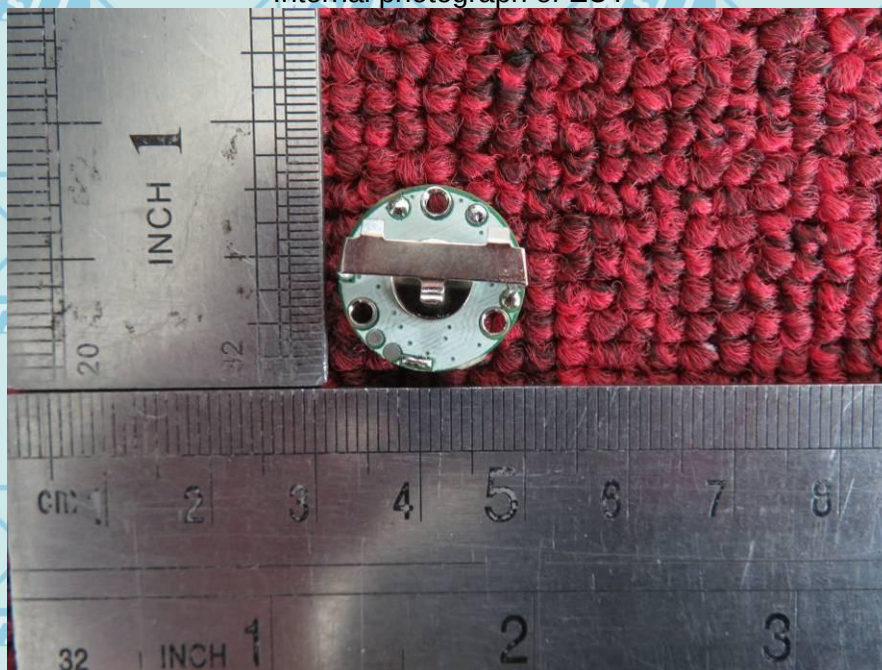




Internal photograph of EUT

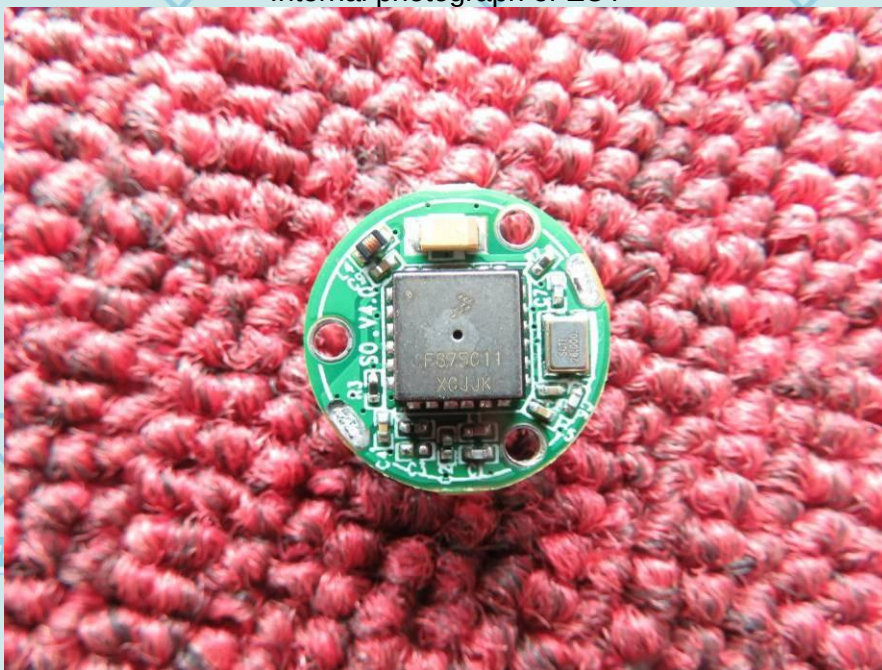


Internal photograph of EUT





Internal photograph of EUT



---END OF REPORT---