

FCC PART 15.247

TEST REPORT

For

CHANGSHA SUNVOTE LIMITED

Room1024, Building A, Biaozi Business Center No. 198 Xiang Fu Road, Changsha, China

FCC ID: 2AMJJSUNVOTEKEYM3X

Report Type: Original Report	Product Type: Voting Keypad
Test Engineer: Ada Yu	<i>Ada Yu</i>
Report Number: RKS170605005-00A	
Report Date: 2017-07-14	
Reviewed By: Oscar Ye RF Leader	<i>Oscar Ye</i>
Prepared By:	Bay Area Compliance Laboratories Corp. (Kunshan) No.248 Chenghu Road,Kunshan,Jiangsu province,China Tel: +86-0512-86175000 Fax: +86-0512-88934268 www.baclcorp.com.cn

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Applicant	CHANGSHA SUNVOTE LIMITED
Tested Model	M30
Product Type	Voting Keypad
Dimension	82 mm(L)×41 mm(W)×10 mm(H)
Power Supply	DC 3.0V from batteries

**All measurement and test data in this report was gathered from production sample serial number: 20170605005. (Assigned by the BACL. The EUT supplied by the applicant was received on 2017-06-05)*

Objective

This report is prepared on behalf of CHANGSHA SUNVOTE LIMITED in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commissions rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.209 and 15.247 rules.

Related Submittal(s)/Grant(s)

FCC Part 15.247 DTS submissions with FCC ID: WSVSUNVOTEBASE10.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and FCC KDB558074 D01 DTS Meas Guidance v04.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Kunshan). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Item		Uncertainty
RF conducted test with spectrum		0.9dB
RF Output Power with Power meter		0.5dB
Radiated emission	30MHz~1GHz	6.11dB
	1GHz~6GHz	4.45dB
	6GHz~18GHz	5.23dB
Occupied Bandwidth		0.5kHz
Temperature		1.0°C
Humidity		6%

Test Facility

The test site used by Bay Area Compliance Laboratories Corp. (Kunshan) to collect test data is located on the No.248 Chenghu Road,Kunshan,Jiangsu province,China.

Test site at Bay Area Compliance Laboratories Corp. (Kunshan) has been fully described in reports submitted to the Federal Communication Commission (FCC). The details of these reports have been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on November 06, 2014. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2014.

The Federal Communications Commission has the reports on file and is listed under FCC Registration No.: 815570. The test site has been approved by the FCC for public use and is listed in the FCC Public Access Link (PAL) database.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

80 channels are provided for testing:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2403	40	2442
2	2404	41	2443
...	...	...	...
38	2440	79	2481
39	2441	80	2482

EUT was tested with Channel 1, 40 and 80.

Equipment Modifications

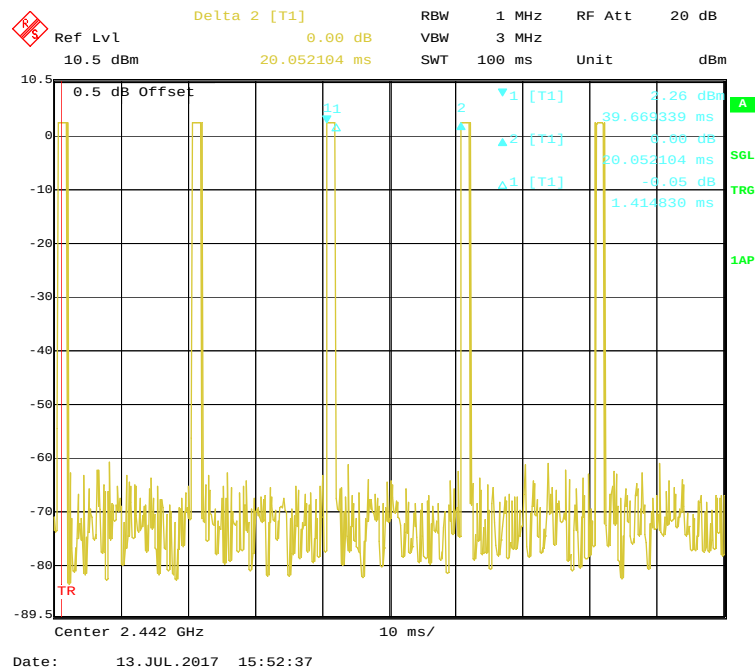
No modification was made to the EUT tested.

EUT Exercise Software

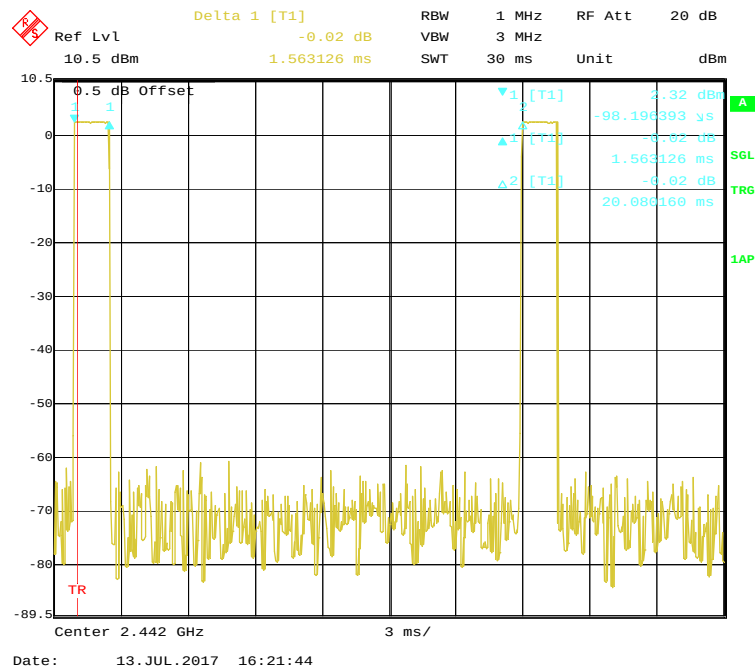
No test software was used during the test.

The device was tested with 7.78% duty cycle.

Middle Channel Duty Cycle (100ms)



Middle Channel Duty Cycle (30ms)



Duty Cycle (%)	T(us)	1/T(kHz)	VBW Setting	10log(1/x)
7.78%	1.563	0.640	1kHz	11.09

Support Equipment List and Details

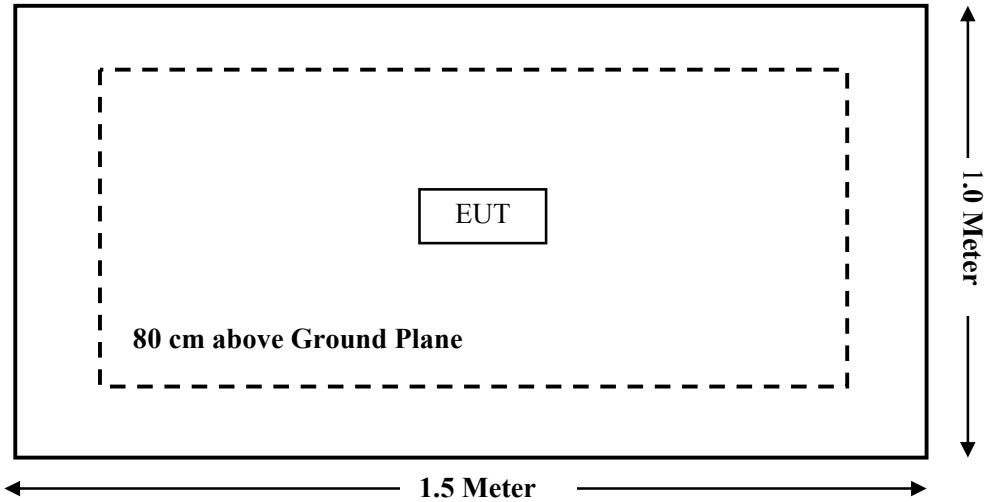
Manufacturer	Description	Model	Serial Number
/	/	/	/

External I/O Cable

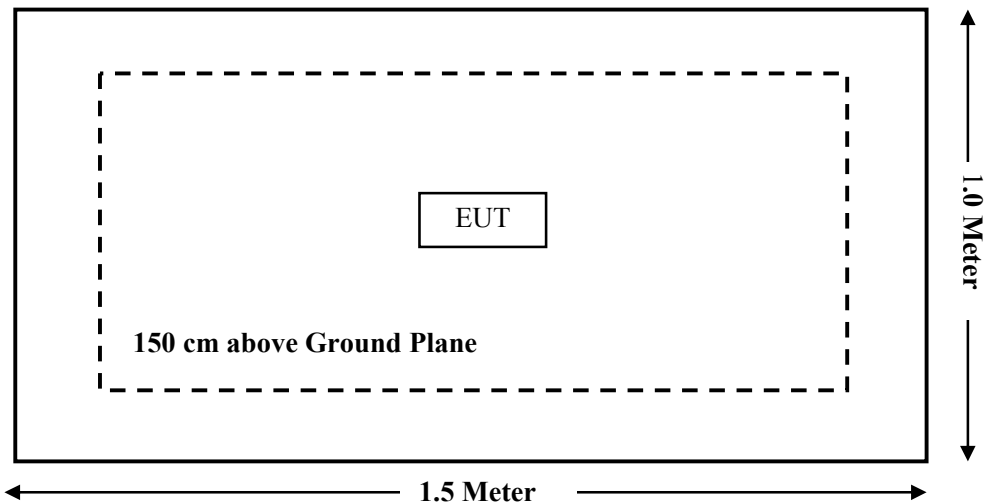
Cable Description	Length (m)	From Port	To
/	/	/	/

Block Diagram of Test Setup

For Radiated Emissions (Below 1GHz):



For Radiated Emissions (Above 1GHz):



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i), §1.1310, §2.1093	RF Exposure	Compliance
§15.203	Antenna Requirement	Compliance
§15.207 (a)	AC Line Conducted Emissions	Not Applicable (Note 1)
§15.247(d)	Spurious Emissions at Antenna Port	Compliance
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliance
§15.247 (a)(2)	6 dB Emission Bandwidth	Compliance
§15.247(b)(3)	Maximum Conducted Output Power	Compliance
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliance
§15.247(e)	Power Spectral Density	Compliance

Note1: The EUT is powered by batteries only.

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2016-11-25	2017-11-24
Rohde & Schwarz	Signal Analyzer	FSIQ26	100048	2016-11-25	2017-11-24
Sunol Sciences	Broadband Antenna	JB3	A090314-2	2016-01-09	2019-01-08
ETS	Horn Antenna	3115	6229	2016-01-11	2019-01-10
Sonoma Instrunent	Pre-amplifier	330	171377	2016-12-12	2017-12-11
Narda	Pre-amplifier	AFS42-00101800	2001270	2016-12-12	2017-12-11
R&S	Auto test Software	EMC32	100361	/	/
Haojintech	Coaxial Cable	Cable-1	001	2016-12-12	2017-12-11
Haojintech	Coaxial Cable	Cable-2	002	2016-12-12	2017-12-11
Haojintech	Coaxial Cable	Cable-3	003	2016-12-12	2017-12-11
MICRO-COAX	Coaxial Cable	Cable-4	004	2016-12-12	2017-12-11
MICRO-COAX	Coaxial Cable	Cable-5	005	2016-12-12	2017-12-11
RF Conducted Test					
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2016-09-21	2017-09-20
Agilent	Power Meter	N1912A	MY5000492	2016-11-18	2017-11-17
Agilent	Power Sensor	N1921A	MY54210024	2016-11-18	2017-11-17
SUNVOTE	RF Cable	/	/	2017-06-16	2018-06-15

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Kunshan) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC§15.247 (i), §1.1310 & §2.1093 –RF EXPOSURE

Applicable Standard

According to §2.1093 and §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB447498 D01 General RF Exposure Guidance v06:

For 100 MHz to 6 GHz and test separation distances ≤ 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR, and ≤ 7.5 for 10-g extremity SAR

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion

Measurement Result

Frequency Range (MHz)	Max Conducted Peak Output Power (dBm)	Max Conducted Peak Output Power (mW)	Minimum test separation distance required for the exposure conditions (mm)
2403-2482	6.50	4.47	5.00

Note:

Turn up power 5.5 ± 1.0 dBm, which is declared by the manufacturer.

This is a handheld device.

Result: $[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})]$

- $[\sqrt{f(\text{GHz})}] = 4.47/5 * \sqrt{2.482} = 1.41 < 7.5$. So no SAR test is needed.

FCC §15.203 - ANTENNA REQUIREMENT

Applicable Standard

According to § 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 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 user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

- a. Antenna must be permanently attached to the unit.
 - b. Antenna must use a unique type of connector to attach to the EUT.
- Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

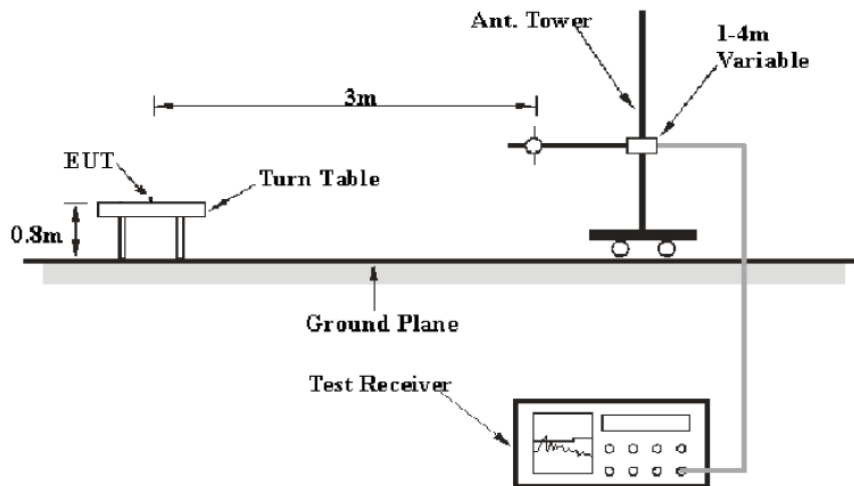
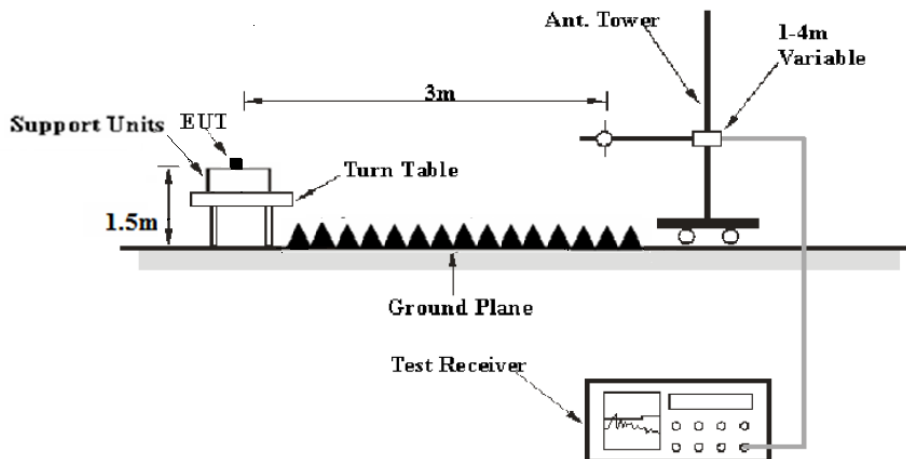
Antenna Connector Construction

The EUT has a PCB antenna which the antenna gain is -3.4 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Result: Compliance.

FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS**Applicable Standard**

FCC §15.247 (d); §15.209; §15.205;

EUT Setup**Below 1 GHz:****Above 1GHz:**

The radiated emission tests were performed in the 3 meters test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 limits.

EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Detector
30 MHz – 1000 MHz	120 kHz	300 kHz	120 kHz	QP

Frequency Range	RBW	Video B/W	Duty cycle	Detector
1GHz – 25GHz	1MHz	3 MHz	Any	PK
	1MHz	10 Hz	>98%	Ave.
	1MHz	1/T	<98%	

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

Data was recorded in Quasi-peak detection mode for frequency range of 30 MHz-1 GHz, peak and Average detection modes for frequencies above 1 GHz.

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247.

Test Data**Environmental Conditions**

Temperature:	24.1 °C
Relative Humidity:	54 %
ATM Pressure:	101.3kPa

The testing was performed by Ada Yu on 2017-07-13.

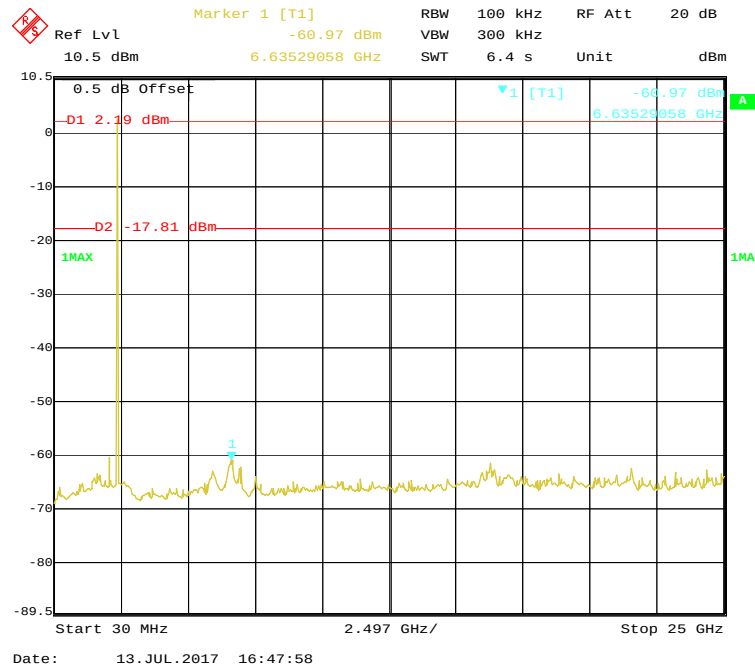
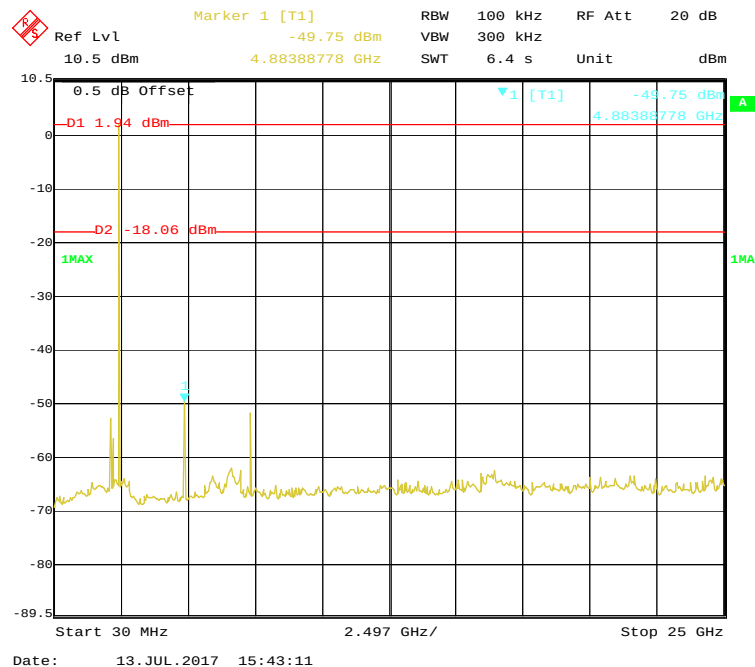
EUT operation mode: Transmitting (Scan with X-Axis, Y-Axis and Z-Axis position, the worst case was recorded)

30MHz-25GHz

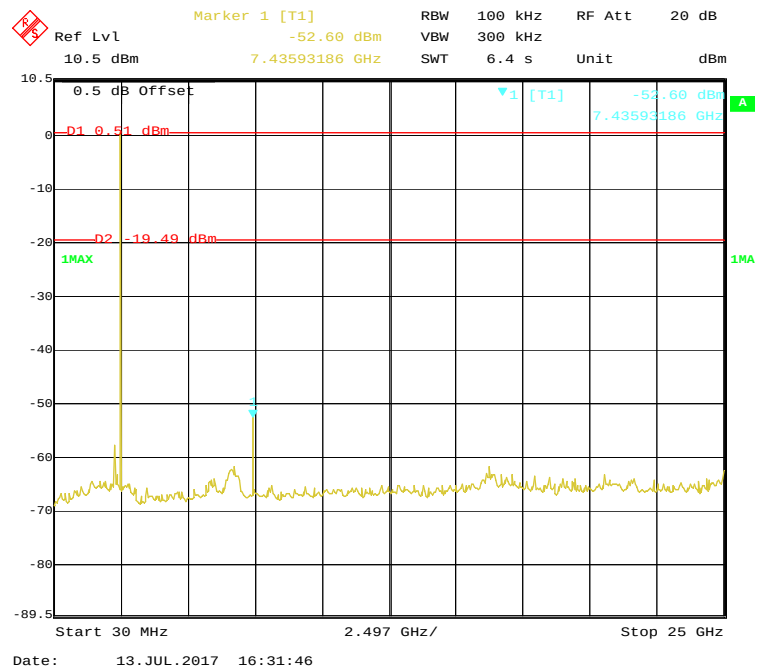
Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB)	Corrected Amplitude (dBµV/m)	FCC Part 15.247/205/209	
	Reading (dBµV)	Detector (PK/QP/ Ave.)		Height (cm)	Polar (H/V)			Limit (dBµ V/m)	Margin (dB)
Low Channel (2403 MHz)									
421.90	32.04	QP	325	136	V	3.60	35.64	46	10.36
2403.00	108.64	PK	277	189	V	-6.19	102.45	/	/
2403.00	97.61	Ave	277	189	V	-6.19	91.42	/	/
2403.00	104.64	PK	294	147	H	-6.19	98.45	/	/
2403.00	93.61	Ave	294	147	H	-6.19	87.42	/	/
2390.00	43.06	PK	326	114	H	-6.22	36.84	74	37.16
2390.00	30.98	Ave	326	114	H	-6.22	24.76	54	29.24
2400.00	66.28	PK	223	136	H	-6.19	60.09	74	13.91
2400.00	47.85	Ave	223	136	H	-6.19	41.66	54	12.34
1496.40	53.28	PK	39	173	V	-9.48	43.80	74	30.20
1497.40	26.19	Ave	39	173	V	-9.48	16.71	54	37.29
4806.00	65.29	PK	339	202	H	1.61	66.90	74	7.10
4806.00	47.31	Ave	339	202	H	1.61	48.92	54	5.08
7209.00	52.17	PK	67	192	H	7.55	59.72	74	14.28
7209.00	34.26	Ave	67	192	H	7.55	41.81	54	12.19

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247/205/209	
	Reading (dBμV)	Detector (PK/QP/A ve.)		Height (cm)	Polar (H/V)			Limit (dBμ V/m)	Margin (dB)
Middle Channel (2442 MHz)									
421.90	32.37	QP	352	114	V	3.60	35.97	46	10.03
2442.00	105.65	PK	159	103	V	-6.17	99.48	/	/
2442.00	94.59	Ave	159	103	V	-6.17	88.42	/	/
2442.00	100.36	PK	349	136	H	-6.17	94.19	/	/
2442.00	89.35	Ave	349	136	H	-6.17	83.18	/	/
1348.25	49.17	PK	195	176	H	-10.37	38.80	74	35.20
1349.25	31.22	Ave	195	176	H	-10.37	20.85	54	33.15
3867.46	51.67	PK	224	208	H	-0.73	50.94	74	23.06
3868.46	33.94	Ave	224	208	H	-0.73	33.21	54	20.79
4884.00	64.68	PK	89	166	V	1.79	66.47	74	7.53
4884.00	46.55	Ave	89	166	V	1.79	48.34	54	5.66
6613.42	52.14	PK	262	152	H	6.23	58.37	74	15.63
6614.42	34.52	Ave	262	152	H	6.23	40.75	54	13.25
7326.00	55.11	PK	296	122	H	7.67	62.78	74	11.22
7326.00	38.26	Ave	296	122	H	7.67	45.93	54	8.07

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247/205/209	
	Reading (dBμV)	Detector (PK/QP/A ve.)		Height (cm)	Polar (H/V)			Limit (dBμ V/m)	Margin (dB)
High Channel (2482MHz)									
421.90	33.38	QP	104	113	V	3.60	36.98	46	9.02
2482.00	105.29	PK	214	181	V	-6.01	99.28	/	/
2482.00	94.21	Ave	214	181	V	-6.01	88.20	/	/
2482.00	100.82	PK	83	233	H	-6.01	94.81	/	/
2482.00	89.75	Ave	83	233	H	-6.01	83.74	/	/
2483.50	59.26	PK	187	236	H	-6.01	53.25	74	20.75
2483.50	33.07	Ave	187	236	H	-6.01	27.06	54	26.94
1237.54	52.37	PK	267	128	H	-11.03	41.34	74	32.66
1238.54	32.48	Ave	267	128	H	-11.03	21.45	54	32.55
4964.00	64.05	PK	242	154	V	1.97	66.02	74	7.98
4964.00	45.65	Ave	242	154	V	1.97	47.62	54	6.38
6835.13	51.66	PK	334	219	H	6.87	58.53	74	15.47
6836.13	32.19	Ave	334	219	H	6.87	39.06	54	14.94
7446.00	50.34	PK	208	192	H	7.79	58.13	74	15.87
7446.00	31.03	Ave	208	192	H	7.79	38.82	54	15.18

Conducted Spurious Emissions at Antenna Port**Low Channel****Middle Channel**

High Channel



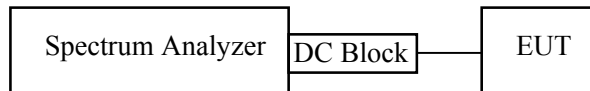
FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH

Applicable Standard

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 6 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.



Test Data

Environmental Conditions

Temperature:	24.2 °C
Relative Humidity:	55 %
ATM Pressure:	101.3 kPa

The testing was performed by Ada Yu on 2017-07-14.

Test Result: Pass.

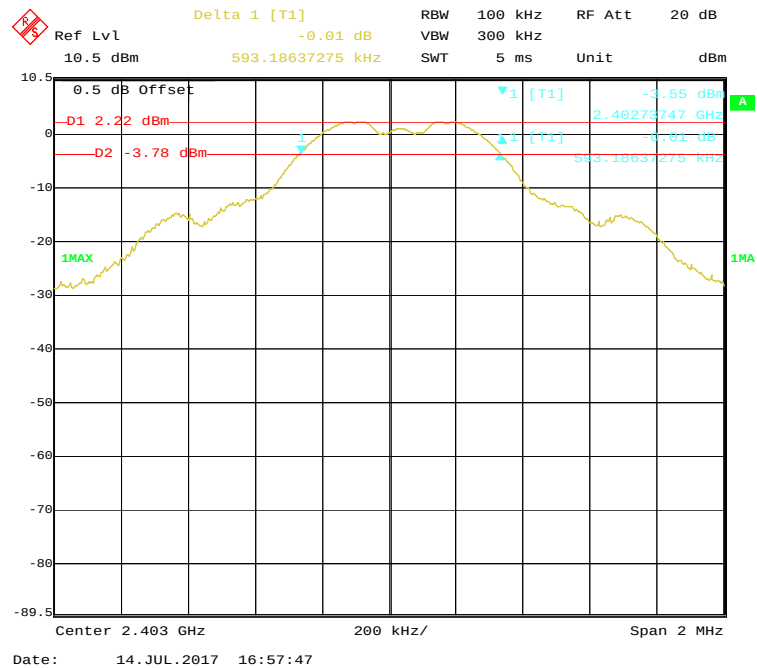
Please refer to the following tables and plots.

EUT operation mode: Transmitting

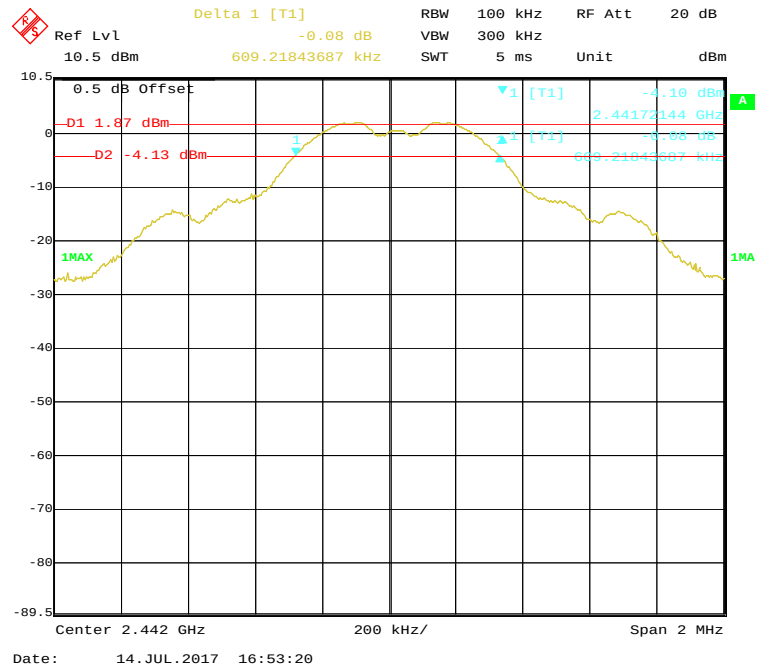
Channel	Frequency (MHz)	6 dB Emission Bandwidth (kHz)	Limit (kHz)
Low	2403	593.19	≥500
Middle	2442	609.22	≥500
High	2482	601.20	≥500

6 dB Emission Bandwidth

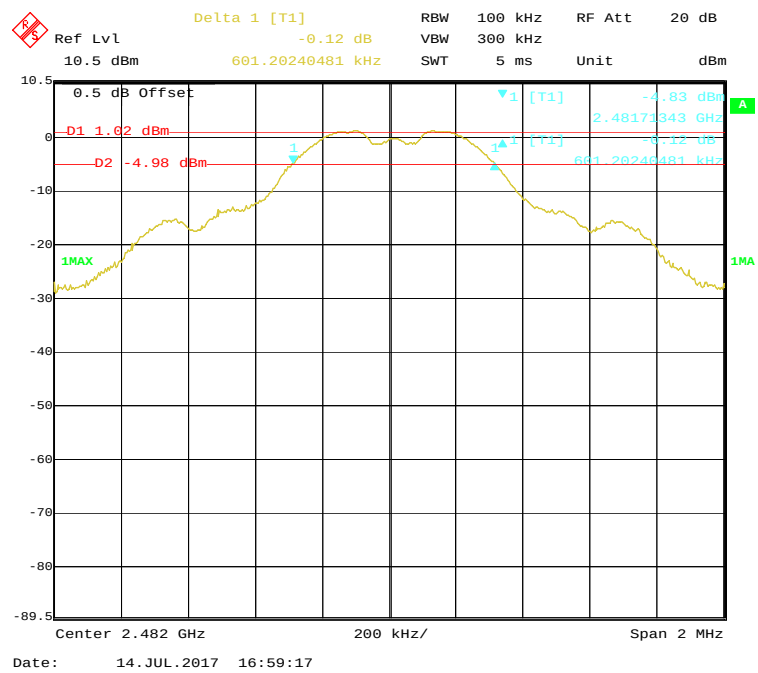
Low Channel



Middle Channel



High Channel

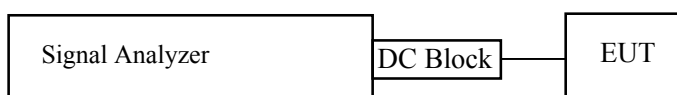


FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER**Applicable Standard**

According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

Test Procedure

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.

**Test Data****Environmental Conditions**

Temperature:	23.8°C
Relative Humidity:	54 %
ATM Pressure:	101.2 kPa

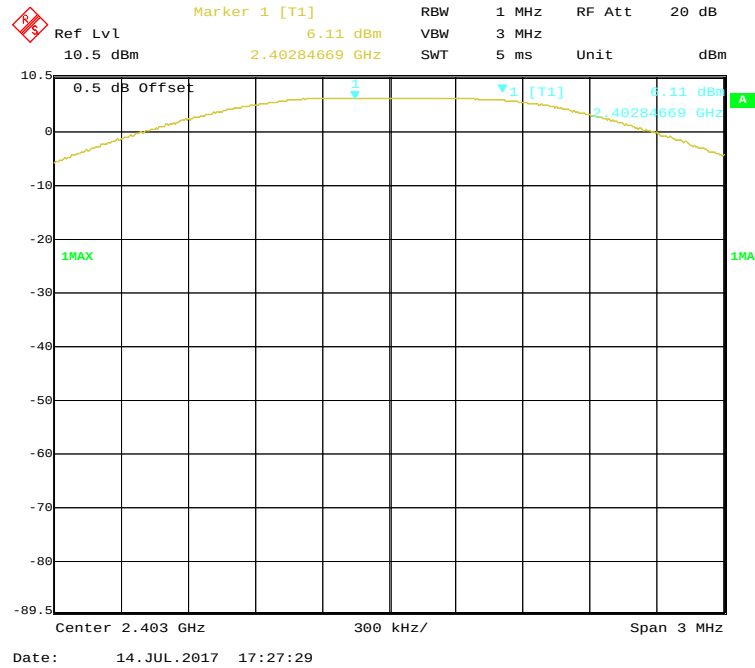
The testing was performed by Ada Yu on 2017-07-14.

EUT operation mode: Transmitting

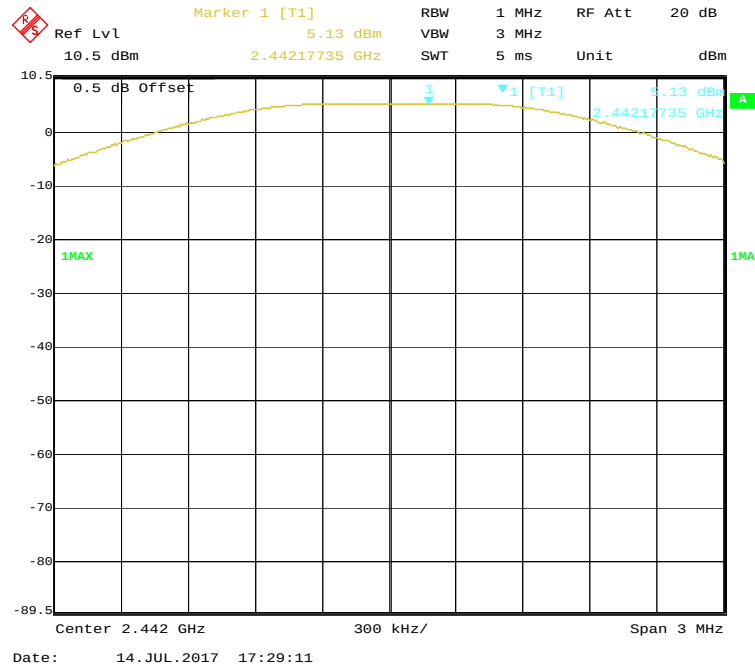
Channel	Frequency (MHz)	Max Conducted Peak Output Power (dBm)	Limit (dBm)	Result
Low	2403	6.11	30	Pass
Middle	2442	5.13	30	Pass
High	2482	4.84	30	Pass

Maximum Conducted Output Power

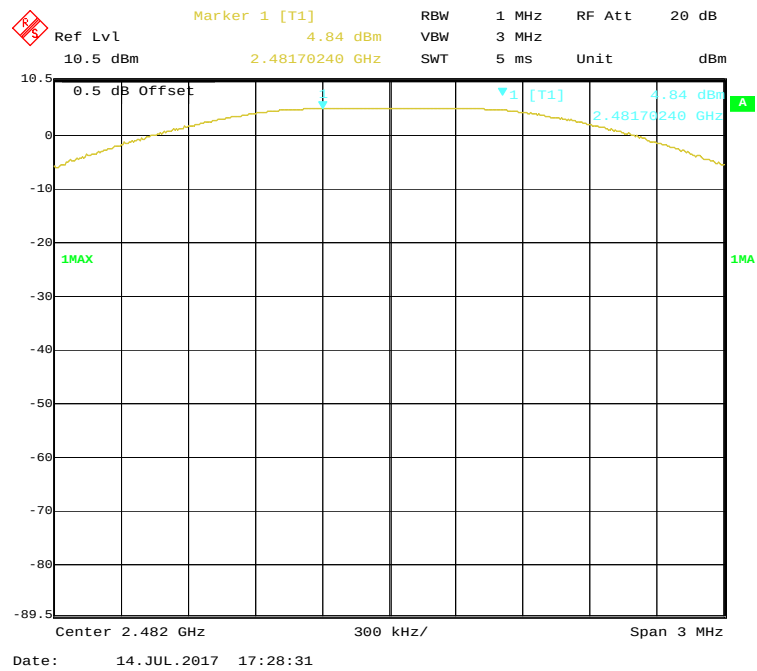
Low Channel



Middle Channel



High Channel



FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE**Applicable Standard**

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

Test Data**Environmental Conditions**

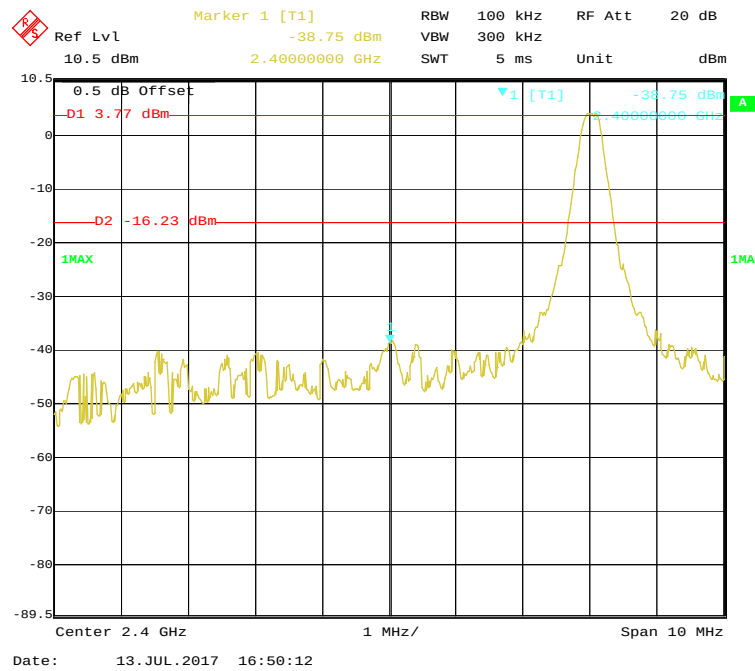
Temperature:	24.3 °C
Relative Humidity:	55 %
ATM Pressure:	101.3 kPa

The testing was performed by Ada Yu on 2017-07-13.

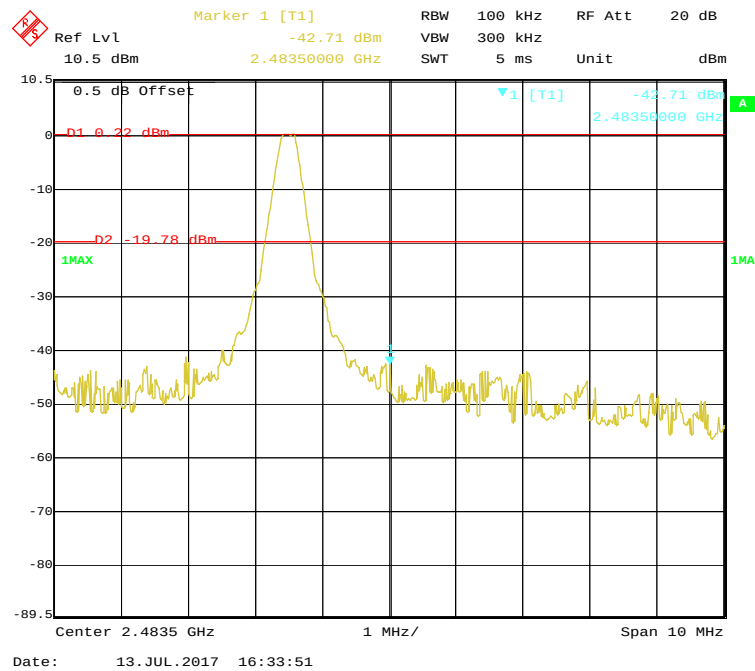
Test Result: *Compliance*

Please refer to the following table and plots.

Band Edge, Left Side



Band Edge, Right Side



FCC §15.247(e) - POWER SPECTRAL DENSITY

Applicable Standard

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Test Procedure

According to KDB558074 D01 DTS Meas Guidance v04.

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW to: $3\text{kHz} \leq \text{RBW} \leq 100\text{ kHz}$.
3. Set the VBW $\geq 3 \times \text{RBW}$.
4. Set the span to 1.5 times the DTS bandwidth.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

Test Data

Environmental Conditions

Temperature:	24.1 °C
Relative Humidity:	54 %
ATM Pressure:	101.3 kPa

The testing was performed by Ada Yu on 2017-07-14.

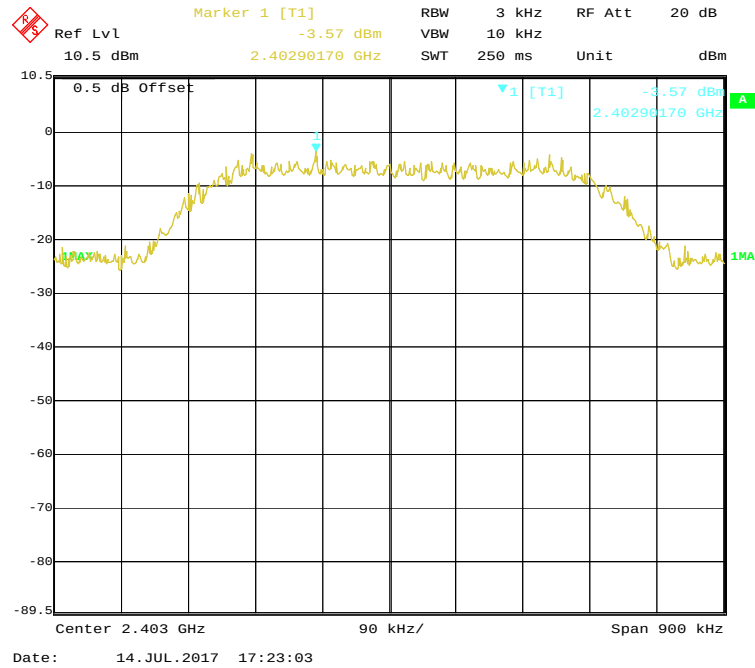
EUT operation mode: Transmitting

Test Result: Pass

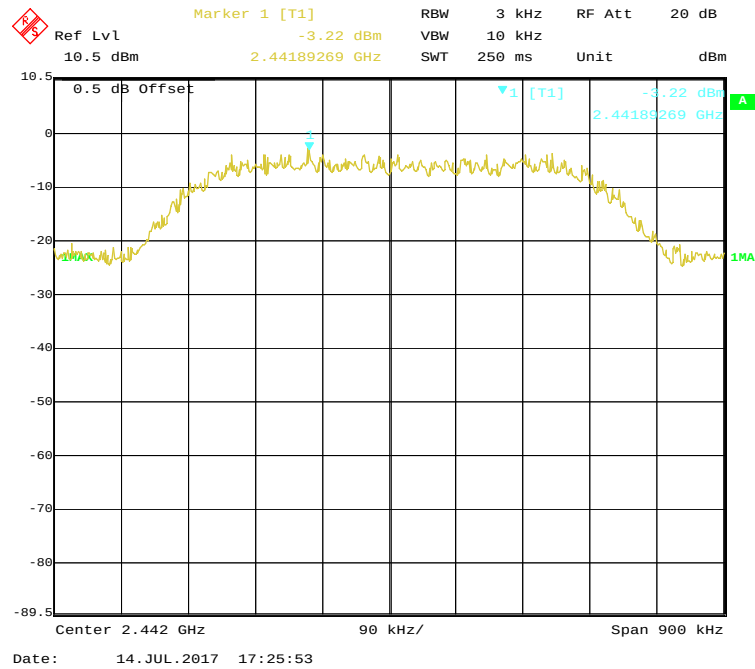
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
Low	2403	-3.57	≤ 8
Middle	2442	-3.22	≤ 8
High	2482	-5.20	≤ 8

Power Spectral Density

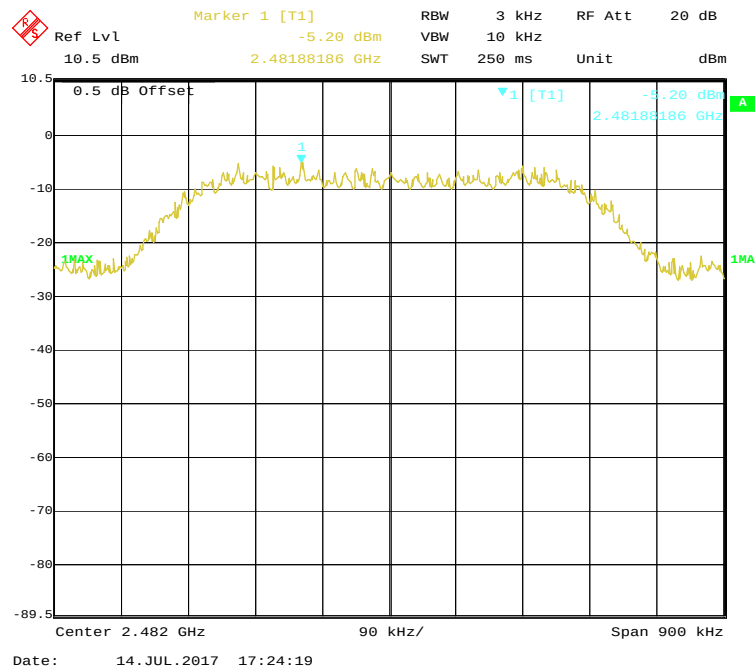
Low Channel



Middle Channel



High Channel



***** END OF REPORT *****