FCC TEST REPORT

For

Shantou Hengguan Technology Co., LTD

U.S. MILITARY TRUCK

Test Model: YK002

Additional Model No.: YK001, YK004, YK006, YK007, YK008

Prepared for	:	Shantou Hengguan Technology Co., LTD
Address	:	CHENGHAI DISTRICT, SHANTOU CITY, GUANGDONG PROVINCE, CHINA
Prepared by	:	Shenzhen LCS Compliance Testing Laboratory Ltd.
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Date of receipt of test sample	:	September 12, 2019
Number of tested samples	:	1
Serial number	:	Prototype
Date of Test	:	September 12, 2019~ November 08, 2019
Date of Report	:	November 08, 2019

FCC TEST REPORT
FCC CFR 47 PART 15 C (15.247)

Report Reference No. ..... :		**LCS190912009AEA**
Date of Issue	:	November 08, 2019
Testing Laboratory Name..... :		**Shenzhen LCS Compliance Testing Laboratory Ltd.**
Address	:	1/F., Xingyuan Industrial Park, Tongda Road, Bao'an Avenue, Bao'an District, Shenzhen, Guangdong, China
Testing Location/ Procedure	:	Full application of Harmonised standards ■ Partial application of Harmonised standards □ Other standard testing method □
Applicant's Name ..... :		**Shantou Hengguan Technology Co., LTD**
Address	:	CHENGHAI DISTRICT, SHANTOU CITY, GUANGDONG PROVINCE, CHINA
Test Specification		
Standard	:	FCC CFR 47 PART 15 C(15.247)
Test Report Form No. ..... :		LCSEMC-1.0
TRF Originator	:	Shenzhen LCS Compliance Testing Laboratory Ltd.
Master TRF	:	Dated 2011-03

EUT Description. ..... :		**U.S. MILITARY TRUCK**
Trade Mark	:	N/A
Model/ Type reference	:	YK002
Ratings	:	DC 7.4V By 6*AA Battery Or Lithium Battery, Or DC 7.4V From Adapter
Result	:	**Positive**

Compiled by:	**Supervised by:**	**Approved by:**
Marry Chen	Aking Jin	Gavin Liang
Marry Chen /Administrators	Aking Jin /Technique principal	Gavin Liang/ Manager

FCC -- TEST REPORT

Test Report No. : **LCS190912009AEA**	November 08, 2019 Date of issue

Type / Model.....	:	YK002
EUT.....	:	U.S. MILITARY TRUCK
Applicant.....	**:**	**Shantou Hengguan Technology Co., LTD**
Address.....	:	CHENGHAI DISTRICT, SHANTOU CITY, GUANGDONG PROVINCE, CHINA
Telephone.....	:	/
Fax.....	:	/
Manufacturer.....	**:**	**Shantou Hengguan Technology Co., LTD**
Address.....	:	CHENGHAI DISTRICT, SHANTOU CITY, GUANGDONG PROVINCE, CHINA
Telephone.....	:	/
Fax.....	:	/
Factory.....	**:**	**Shantou Hengguan Technology Co., LTD**
Address.....	:	CHENGHAI DISTRICT, SHANTOU CITY, GUANGDONG PROVINCE, CHINA
Telephone.....	:	/
Fax.....	:	/

Test Result	**Positive**

The test report merely corresponds to the test sample.

It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

Revision History

Revision	Issue Date	Revisions	Revised By
000	November 08, 2019	Initial Issue	Gavin Liang

TABLE OF CONTENTS

1. GENERAL INFORMATION

1.1. Description of Device (EUT)

EUT	:	U.S. MILITARY TRUCK
Test Model	:	YK002
Additional Model No.	:	YK001, YK004, YK006, YK007, YK008
Model Declaration	:	PCB board, structure and internal of these model(s) are the same, So no additional models were tested.
Power Supply	:	DC 7.4V By 6*AA Battery Or Lithium Battery, Or DC 7.4V From Adapter
Hardware Version	:	/
Software Version	:	/
SRD		
Frequency Range	:	2407-2478MHz
Modulation Type	:	GFSK
Channel Number	:	33 channels
Channel Spacing	:	1MHz
Antenna Description	:	Internal Antenna, 0.5 dBi (Max.)

1.2. Host System Configuration List and Details

Manufacturer	Description	Model	Serial Number	Certificate
SHENZHEN BIAOYUAN TECHNOLOGY CO., LTD	Adapter	BY-075W01M	--	FCC VOC
Lenovo	PC	Ideapad	A131101550	FCC DOC
Lenovo	Power adapter	CPA-A090	36200414	FCC DOC

1.3. External I/O Cable

I/O Port Description	Quantity	Cable
USB Port	1	---
Micro USB Port	1	---

1.4. Description of Test Facility

FCC Registration Number is 254912.
Industry Canada Registration Number is 9642A-1.
EMSD Registration Number is ARCB0108.
UL Registration Number is 100571-492.
TUV SUD Registration Number is SCN1081.
TUV RH Registration Number is UA 50296516-001.
NVLAP Accreditation Code is 600167-0.
FCC Designation Number is CN5024
CAB identifier: CN0071

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.4:2014 and CISPR 16-1-4:2010 SVSWR requirement for radiated emission above 1GHz.

1.5. Statement of the 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 LCS 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.

1.6. Measurement Uncertainty

Test Item		Frequency Range	Uncertainty	Note
Radiation Uncertainty	:	9KHz~30MHz	±3.10dB	(1)
		30MHz~200MHz	±2.96dB	(1)
		200MHz~1000MHz	±3.10dB	(1)
		1GHz~26.5GHz	±3.80dB	(1)
		26.5GHz~40GHz	±3.90dB	(1)
Conduction Uncertainty	:	150kHz~30MHz	±1.63dB	(1)
Power disturbance	:	30MHz~300MHz	±1.60dB	(1)

(1). This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

1.7. Description of Test Modes

The EUT has been tested under operating condition.

This test was performed with EUT in X, Y, Z position and the worst case was found when EUT in X position.

Worst-case mode and channel used for 150 KHz-30 MHz power line conducted emissions was the mode and channel with the highest output power that was determined to be TX.

Worst-case mode and channel used for 9 KHz-1000 MHz radiated emissions was the mode and channel with the highest output power, that was determined to be SRD mode(LCH).

Pre-test AC conducted emission at charge from adapter mode, recorded worst case.

Pre-test AC conducted emission at both voltage AC 120V/60Hz and AC 240V/50Hz, recorded worst case.

Worst-Case data rates were utilized from preliminary testing of the Chipset, worst-case data rates used during the testing are as follows:

1.8. Frequency of Channels

will have below Channels:

Frequency Band	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
2404~2480MHz	**1**	**2407**	18	2463
	2	2414	19	2464
	3	2428	--	--
	4	2436	--	--
	5	2441	--	--
	6	2451	--	--
	7	2452	--	--
	8	2453	--	--
	--	--	--	--
	17	**2462**	**33**	**2478**

2. 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.

The radiated testing was performed at an antenna-to-EUT distance of 3 meters. All radiated and conducted emissions measurement was performed at Shenzhen LCS Compliance Testing Laboratory Ltd.

2.1. EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

2.2. EUT Exercise

The EUT was operated in the engineering mode to fix the TX frequency that was for the purpose of the measurements.

According to FCC's request, Test Procedure KDB558074 D01 DTS Meas. Guidance are required to be used for this kind of RSS-247 digital modulation device.

According to its specifications, the EUT must comply with the requirements of RSS-247 Issue 2 and RSS-Gen Issue 5.

2.3. General Test Procedures

2.3.1 Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2.1 of ANSI C63.10-2013 Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using Quasi-peak and average detector modes.

2.3.2 Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna, which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the maximum emissions, exploratory radiated emission measurements were made according to the requirements in Section 6.3 of ANSI C63.10-2013.

3. SYSTEM TEST CONFIGURATION

3.1. Justification

The system was configured for testing in a continuous transmits condition. The duty cycle is 100% and the average correction factor is 0.

The EUT After the power is switched on, By manually operating the keys, and the Signal continuous transmission.

3.2. EUT Exercise Software

N/A

3.3. Special Accessories

N/A

3.4. Block Diagram/Schematics

Please refer to the related document

3.5. Equipment Modifications

Shenzhen LCS Compliance Testing Laboratory Ltd. has not done any modification on the EUT.

3.6. Test Setup

Please refer to the test setup photo.

4. SUMMARY OF TEST RESULTS

Applied Standard: RSS-247 Issue 2 / RSS-Gen Issue 5			
ISED Rules	Description of Test	Result	Remark
/	On Time and Duty Cycle	Compliant	Note 1
§15.247(b)	Maximum Conducted Output Power	Compliant	Note 1
§15.247(e)	Power Spectral Density	Compliant	Note 1
§15.247(a)(2)	6dB Bandwidth	Compliant	Note 1
§15.247(a)	Occupied Bandwidth	Compliant	Note 1
§15.209, §15.247(d)	Radiated and Conducted Spurious Emissions	Compliant	Note 1
§15.205	Emissions at Restricted Band	Compliant	Note 1
§15.207(a)	AC Conducted Emissions	Compliant	Note 1
§15.203	Antenna Requirements	Compliant	Note 1
§15.247(i), §2.1091	RF Exposure	Compliant	Note 2

Remark:
1. Note 1 – Test results inside test report;
2. Note 2 – Test results in other test report (RF Exposure Evaluation);

5. TEST RESULT

5.1. On Time and Duty Cycle

5.1.1. Standard Applicable

None; for reporting purpose only.

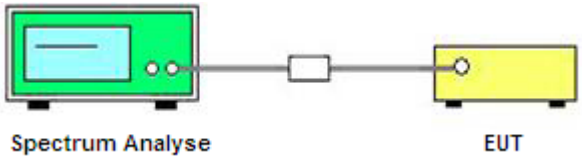
5.1.2. Measuring Instruments and Setting

Please refer to equipment list in this report. The following table is the setting of the spectrum analyzer.

5.1.3. Test Procedures

1. Set the center frequency of the spectrum analyzer to the transmitting frequency;
2. Set the span=0MHz, RBW=8MHz, VBW=50MHz, Sweep time=5ms;
3. Detector = peak;
4. Trace mode = Single hold.

5.1.4. Test Setup Layout

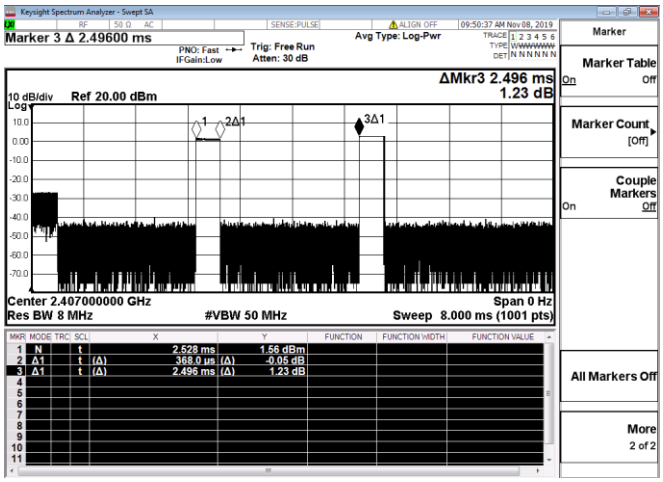


5.1.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.1.6. Test result

Mode	On Time B (ms)	Period (ms)	Duty Cycle x (Linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (KHz)
GFSK	0.368	2.496	-0.83	14.7	-8.31	0.07

On Time and Duty Cycle	
	
Channel 1 / 2407 MHz	

5.2. Maximum Conducted Output Power Measurement

5.2.1. Standard Applicable

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.

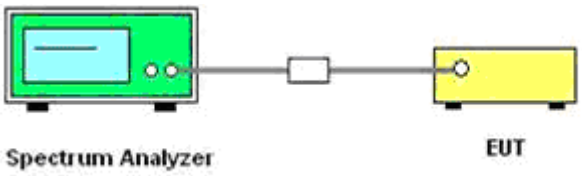
5.2.2. Measuring Instruments and Setting

Please refer to equipment list in this report. The following table is the setting of the spectrum analyzer.

5.2.3. Test Procedures

The transmitter output (antenna port) was connected to the spectrum analyzer.
According to KDB558074 D01 DTS Measurement Guidance Section 9.1 Maximum peak conducted output power 9.1.1.
This procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the DTS bandwidth.
a) Set the RBW ≥ DTS bandwidth.
b) Set VBW ≥ 3 × RBW.
c) Set span ≥ 3 x RBW
d) Sweep time = auto couple.
e) Detector = peak.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use peak marker function to determine the peak amplitude level.

5.2.4. Test Setup Layout



5.2.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

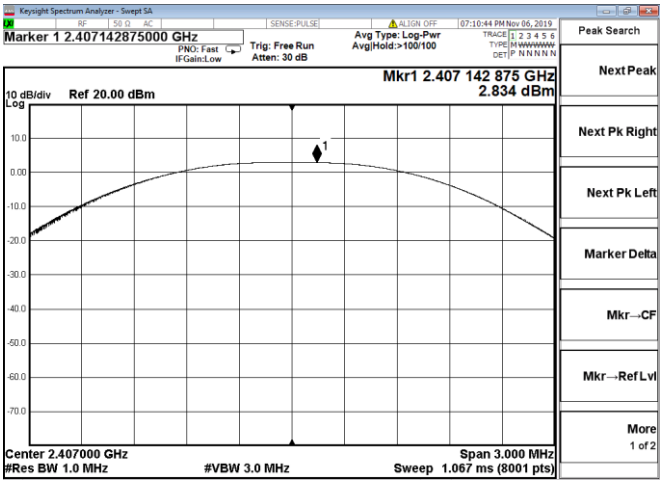
5.2.6. Test Result of Maximum Conducted Output Power

Channel	Frequency (MHz)	Measured Maximum Peak Power (dBm)	Limits (dBm)	Verdict
1	2401	2.834	30	PASS
17	2462	3.046		
33	2478	2.658		

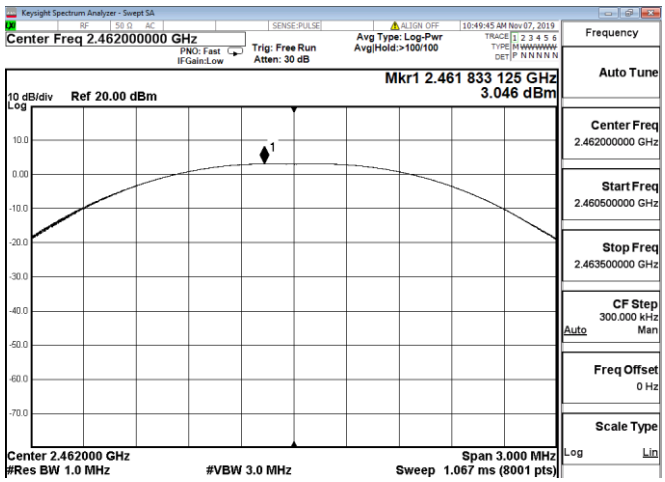
Remark:

1. *Test results including cable loss;*
2. *Please refer to following plots;*

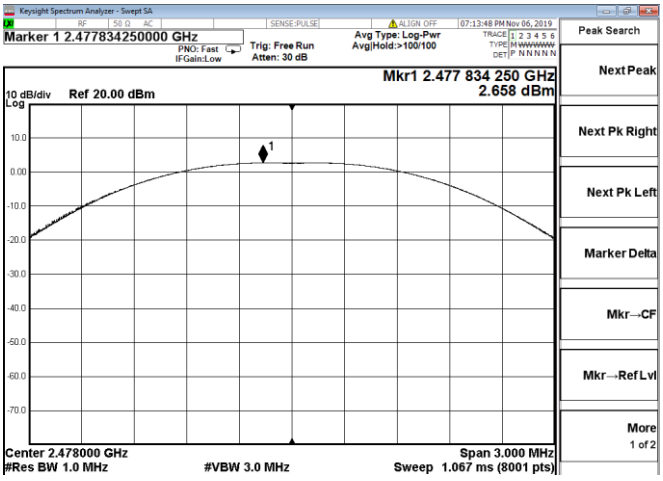
Maximum Peak Output Power



Channel 1 / 2407 MHz



Channel 17 / 2462 MHz



Channel 33 / 2478 MHz

5.3. Power Spectral Density Measurement

5.3.1. Standard Applicable

According to §15.247(e): 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.

5.3.2. Measuring Instruments and Setting

Please refer to equipment list in this report. The following table is the setting of Spectrum Analyzer.

5.3.3. Test Procedures

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.

2. The power was monitored at the coupler port with a Spectrum Analyzer. The power level was set to the maximum level.

3. Set the RBW = 3 kHz.

4. Set the VBW ≥ 3*RBW

5. Set the span to 1.5 times the DTS channel bandwidth.

6. Detector = peak.

7. Sweep time = auto couple.

8. Trace mode = max hold.

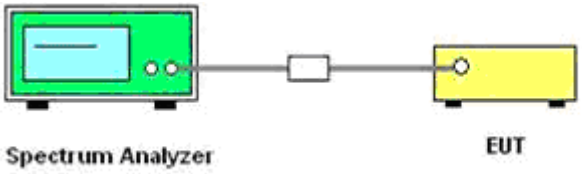
9. Allow trace to fully stabilize.

10. Use the peak marker function to determine the maximum power level.

11. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

12. The resulting peak PSD level must be 8 dBm.

5.3.4. Test Setup Layout



5.3.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.3.6. Test Result of Power Spectral Density

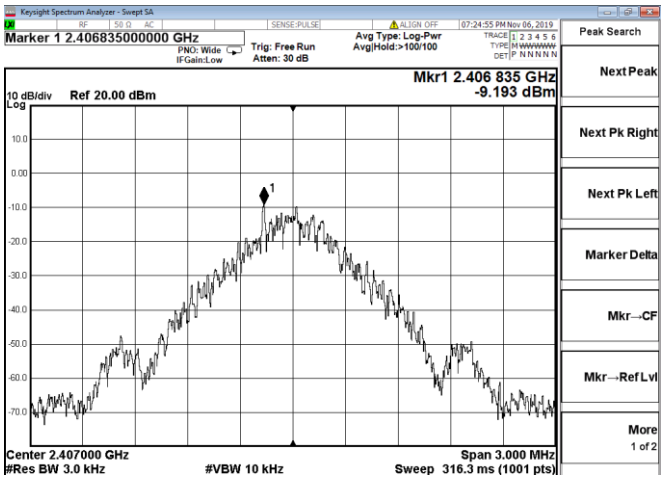
PASS

Remark:

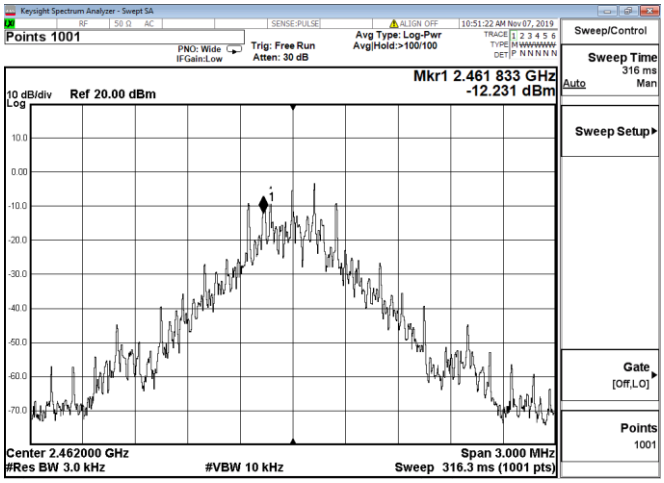
1. *Test results including cable loss;*
2. *Please refer to following plots;*

Channel	Frequency (MHz)	*Peak Power Spectral Density* (dBm)	Limits (dBm)	Verdict
1	2401	-9.193	8	PASS
17	2462	-12.231		
33	2478	-9.279		

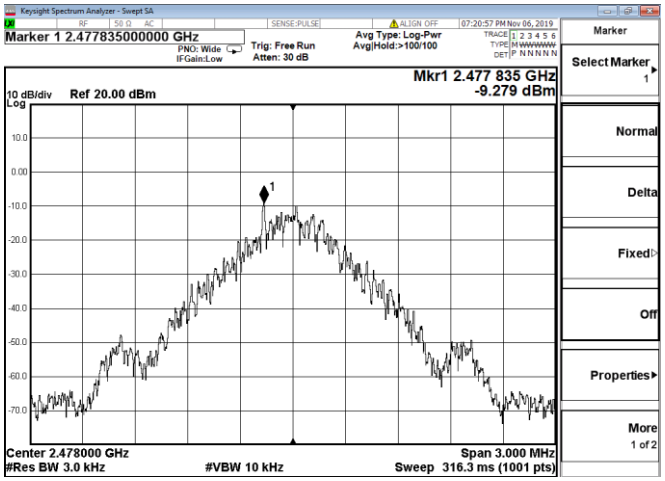
Peak Power Spectral Density



Channel 1 / 2407 MHz



Channel 17 / 2462 MHz



Channel 33/ 2478 MHz

5.4. 6 dB and 99% Spectrum Bandwidth Measurement

5.4.1. Standard Applicable

According to section §15.247(a) (2): The minimum 6 dB bandwidth shall be 500 kHz.

5.4.2. Measuring Instruments and Setting

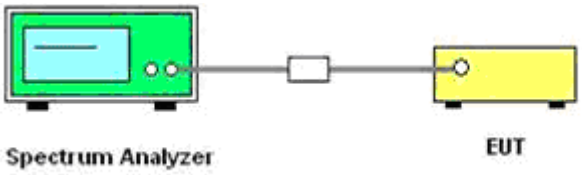
Please refer to equipment list in this report. The following table is the setting of the Spectrum Analyzer.

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	> RBW
Detector	Peak
Trace	Max Hold
Sweep Time	100ms

5.4.3. Test Procedures

1. The transmitter output (antenna port) was connected to the spectrum analyzer in peak hold mode.
2. The resolution bandwidth and the video bandwidth were set according to KDB558074.
3. Measured the spectrum width with power higher than 6dB below carrier.

5.4.4. Test Setup Layout



5.4.5. EUT Operation during Test

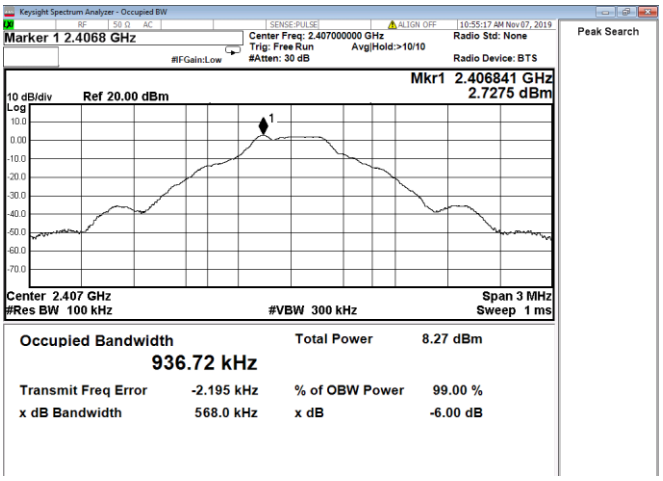
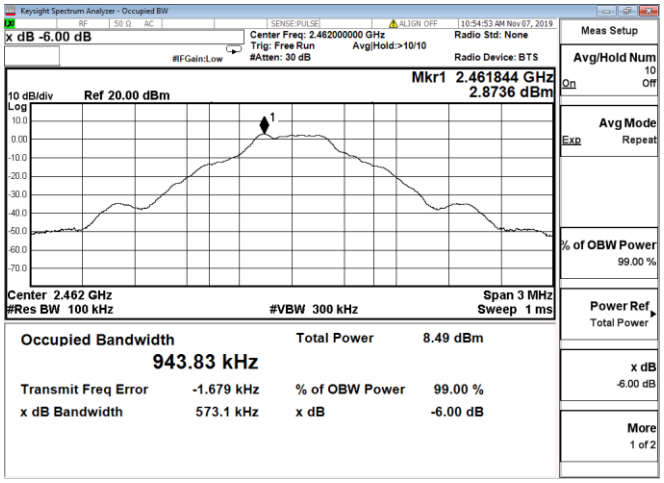
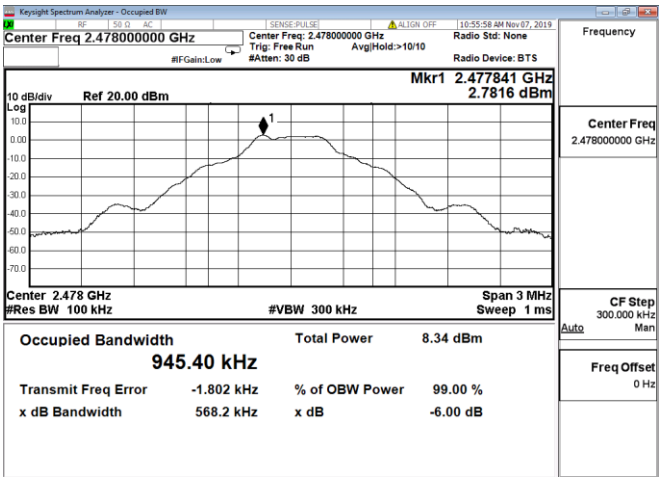
The EUT was programmed to be in continuously transmitting mode.

5.4.6. Test Result of 6dB and 99% Spectrum Bandwidth

Channel	Frequency (MHz)	6dB Bandwidth (KHz)	99% Bandwidth (KHz)	Limits (KHz)	Verdict
1	2401	568.0	936.72	≥500	PASS
17	2462	573.1	943.83		
33	2478	568.2	945.40		

Remark:

1. *Test results including cable loss;*
2. *Please refer to following plots;*

6dB and 99% Bandwidth	
	
Channel 1 / 2407 MHz	Channel 17 / 2462 MHz
	
Channel 33 / 2478 MHz	

5.5. Radiated Emissions Measurement

5.5.1. Standard Applicable

According to §15.209/ §15.205 or RSS-247§5.5/RSS-Gen: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen Issue 5 is not required.

In case the emission fall within the restricted band specified on RSS-Gen Issue 5, then the RSS-Gen Issue 5 limit in the table below has to be followed.

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
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

5.5.2. Measuring Instruments and Setting

Please refer to equipment list in this report. The following table is the setting of spectrum analyzer and receiver.

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	10th carrier harmonic
RB / VB (Emission in restricted band)	1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average
RB / VB (Emission in non-restricted band)	1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average

Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RB/VB 200Hz/1KHz for QP/AVG
Start ~ Stop Frequency	150kHz~30MHz / RB/VB 9kHz/30KHz for QP/AVG
Start ~ Stop Frequency	30MHz~1000MHz / RB/VB 120kHz/1MHz for QP

5.5.3. Test Procedures

1) Sequence of testing 9 kHz to 30 MHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 0.8 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions.

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna height is 0.8 meter.

--- At each turntable position the analyzer sweeps with peak detection to find the maximum of all emissions

Final measurement:

--- Identified emissions during the premeasurement the software maximizes by rotating the turntable position (0° to 360°) and by rotating the elevation axes (0° to 360°).

--- The final measurement will be done in the position (turntable and elevation) causing the highest emissions with QPK detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

2) Sequence of testing 30 MHz to 1 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height changes from 1 to 3 meter.

--- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter.

--- The final measurement will be done with QP detector with an EMI receiver.

--- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

3) Sequence of testing 1 GHz to 18 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height scan range is 1 meter to 2.5 meter.

--- At each turntable position and antenna polarization the analyzer sweeps with peak detection to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter. This procedure is repeated for both antenna polarizations.

--- The final measurement will be done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

4) Sequence of testing above 18 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 1 meter.

--- The EUT was set into operation.

Premeasurement:

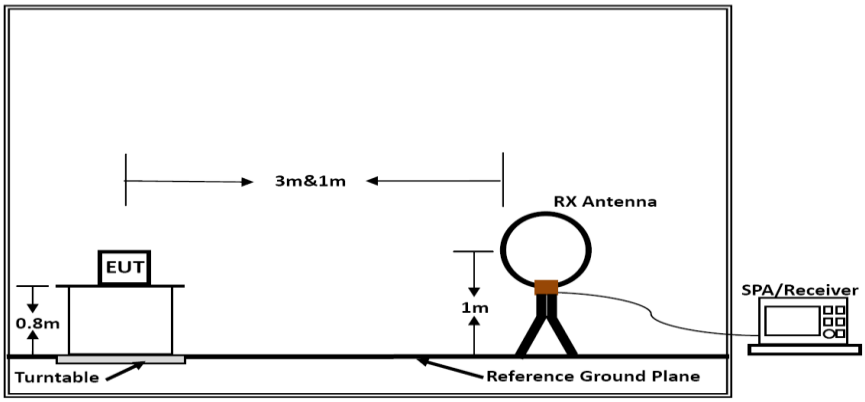
--- The antenna is moved spherical over the EUT in different polarizations of the antenna.

Final measurement:

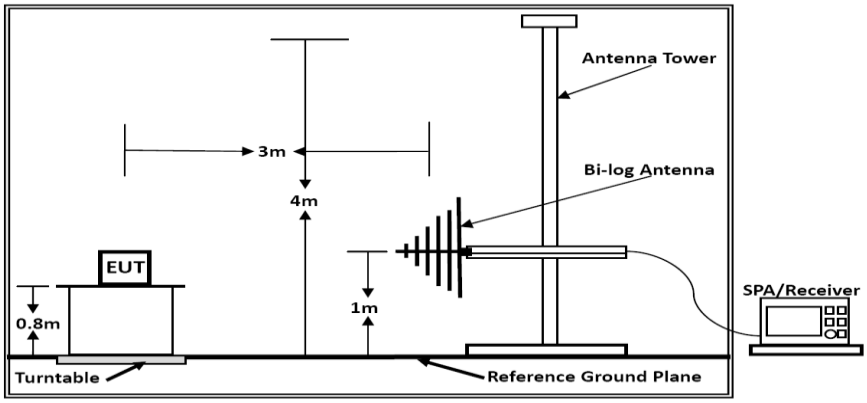
--- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

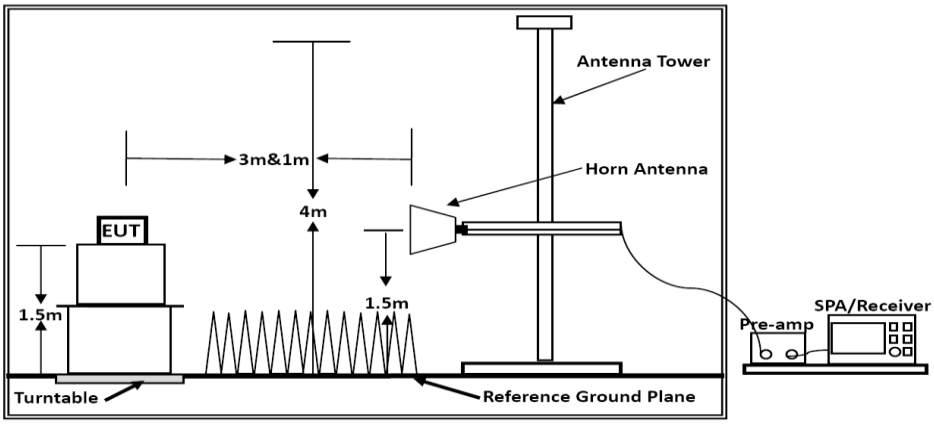
5.5.4. Test Setup Layout



Below 30MHz



Below 1GHz



Above 1GHz

Above 18 GHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade form 3m to 1m.

Distance extrapolation factor = 20 log (specific distanc [3m] / test distance [1m]) (dB);
Limit line = specific limits (dBuV) + distance extrapolation factor [6 dB].

5.5.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.5.6. Results of Radiated Emissions (9 KHz~30MHz)

Temperature	24.5℃	Humidity	53.8%
Test Engineer	Scent Hu	Configurations	GFSK

Freq. (MHz)	Level (dBuV)	Over Limit (dB)	Over Limit (dBuV)	Remark
-	-	-	-	See Note

Note:

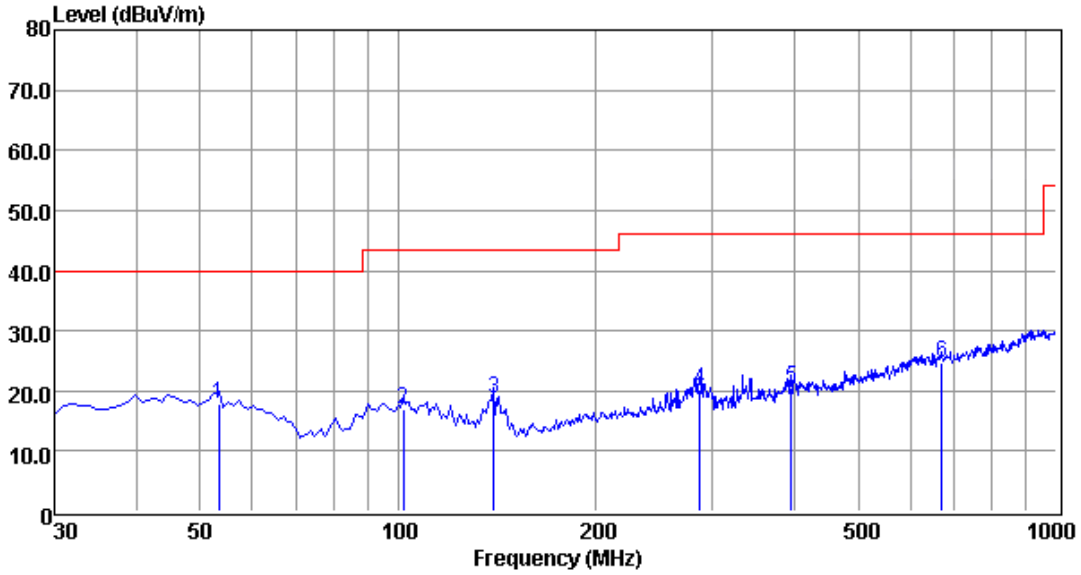
The amplitude of spurious emissions which are attenuated by more than 20 dB below the permissible value has no need to be reported.

Distance extrapolation factor = 40 log (specific distance / test distance) (dB);
Limit line = specific limits (dBuV) + distance extrapolation factor.

5.5.7. Results of Radiated Emissions (30MHz~1GHz)

Temperature	23.9℃	Humidity	54%
Test Engineer	Scent Hu	Configurations	GFSK

Vertical

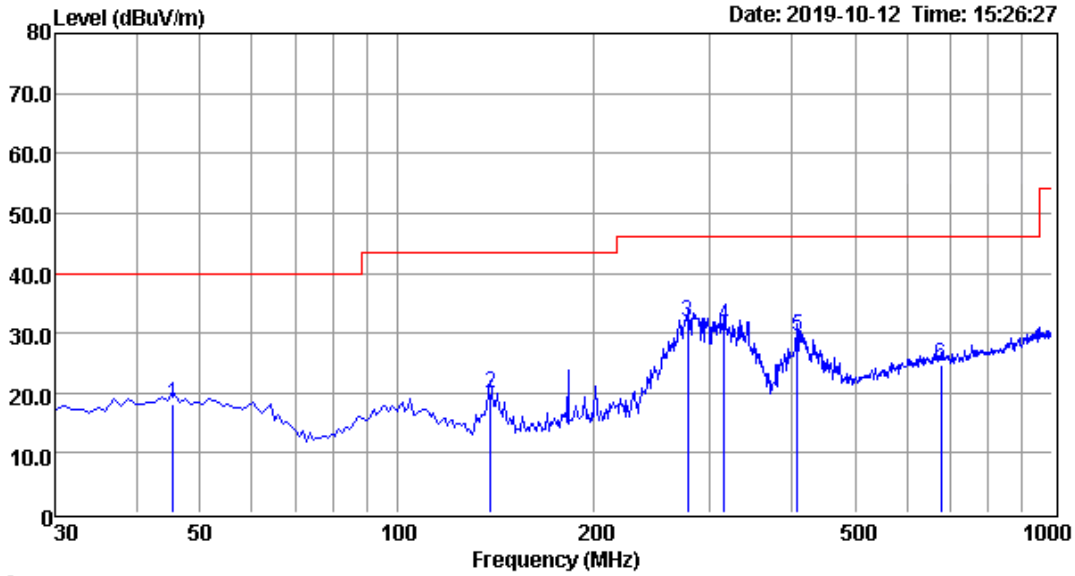


pol: VERTICAL

	Freq	Reading	CabLos	Antfac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	
1	53.28	4.29	0.46	13.10	17.85	40.00	-22.15	QP
2	101.78	3.32	0.60	13.00	16.92	43.50	-26.58	QP
3	139.61	9.63	0.75	8.22	18.60	43.50	-24.90	QP
4	287.05	6.37	1.05	12.81	20.23	46.00	-25.77	QP
5	395.69	4.29	1.30	14.96	20.55	46.00	-25.45	QP
6	670.20	4.24	1.65	18.70	24.59	46.00	-21.41	QP

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that ate 20db blow the offficial limit are not reported

Horizontal



pol: HORIZONTAL

	Freq	Reading	CabLos	Antfac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	
1	45.52	4.35	0.41	13.52	18.28	40.00	-21.72	QP
2	138.64	10.95	0.75	8.29	19.99	43.50	-23.51	QP
3	277.35	18.17	1.00	12.59	31.76	46.00	-14.24	QP
4	316.15	16.72	1.09	13.28	31.09	46.00	-14.91	QP
5	408.30	13.04	1.17	15.23	29.44	46.00	-16.56	QP
6	676.99	4.37	1.73	18.73	24.83	46.00	-21.17	QP

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that ate 20db blow the offficial limit are not reported

Note:

1). Pre-scan all modes and recorded the worst case results in this report.

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

3). Corrected Reading: Antenna Factor + Cable Loss + Read Level = Level.

5.5.8. Results for Radiated Emissions (Above 1GHz)

Channel 1 / 2407 MHz

Freq. MHz	Reading dBuV	Ant. Fac dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4814	51.98	33.06	35.04	3.94	53.94	74.00	-20.06	Peak	Horizontal
4814	36.75	33.06	35.04	3.94	38.71	54.00	-15.29	Average	Horizontal
7221	52.60	33.16	35.06	3.96	54.66	74.00	-19.34	Peak	Horizontal
7221	40.25	33.16	35.06	3.96	42.31	54.00	-11.69	Average	Horizontal
4814	51.64	33.06	35.04	3.94	53.60	74.00	-20.40	Peak	Vertical
4814	38.36	33.06	35.04	3.94	40.32	54.00	-13.68	Average	Vertical
7221	55.63	33.16	35.06	3.96	57.69	74.00	-16.31	Peak	Vertical
7221	40.55	33.16	35.06	3.96	42.61	54.00	-11.39	Average	Vertical

Channel 17 / 2462 MHz

Freq. MHz	Reading dBuV	Ant. Fac dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4924	52.82	33.16	35.15	3.96	54.79	74.00	-19.21	Peak	Horizontal
4924	39.03	33.16	35.15	3.96	41.00	54.00	-13.00	Average	Horizontal
7386	52.17	33.26	35.17	3.98	54.24	74.00	-19.76	Peak	Horizontal
7386	39.05	33.26	35.17	3.98	41.12	54.00	-12.88	Average	Horizontal
4924	52.27	33.16	35.15	3.96	54.24	74.00	-19.76	Peak	Vertical
4924	39.98	33.16	35.15	3.96	41.95	54.00	-12.05	Average	Vertical
7386	53.67	33.26	35.17	3.98	55.74	74.00	-18.26	Peak	Vertical
7386	39.61	33.26	35.17	3.98	41.68	54.00	-12.32	Average	Vertical

Channel 33/ 2478 MHz

Freq. MHz	Reading dBuV	Ant. Fac dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuV/m	Limit dBuV/m	Margin dB	Remark	Pol.
4956	51.46	33.26	35.14	3.98	53.56	74.00	-20.44	Peak	Horizontal
4956	37.21	33.26	35.14	3.98	39.31	54.00	-14.69	Average	Horizontal
7434	53.20	33.36	35.16	4.00	55.40	74.00	-18.60	Peak	Horizontal
7434	40.74	33.36	35.16	4.00	42.94	54.00	-11.06	Average	Horizontal
4956	53.46	33.26	35.14	3.98	55.56	74.00	-18.44	Peak	Vertical
4956	38.05	33.26	35.14	3.98	40.15	54.00	-13.85	Average	Vertical
7434	53.63	33.36	35.16	4.00	55.83	74.00	-18.17	Peak	Vertical
7434	40.34	33.36	35.16	4.00	42.54	54.00	-11.46	Average	Vertical

Notes:

1). Measuring frequencies from 9 KHz~10th harmonic or 26.5GHz (which is less), No emission found between lowest internal used/generated frequency to 30MHz.
2). Radiated emissions measured in frequency range from 9 KHz~10th harmonic or 26.5GHz (which is less) 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). Measured radiated emission used 900-930 MHz band filter in order to avoid spectrum overload.

5.6. Conducted Spurious Emissions and Band Edges Test

5.6.1. Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

5.6.2. Measuring Instruments and Setting

Please refer to equipment list in this report. The following table is the setting of the spectrum analyzer.

Spectrum Parameter	Setting
Detector	Peak
Attenuation	Auto
RB / VB (Emission in restricted band)	100KHz/300KHz
RB / VB (Emission in non-restricted band)	100KHz/300KHz

5.6.3. Test Procedures

The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz

The spectrum from 9 KHz to 10 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

5.6.4. Test Setup Layout

This test setup layout is the same as that shown in section 5.4.4.

5.6.5. EUT Operation during Test

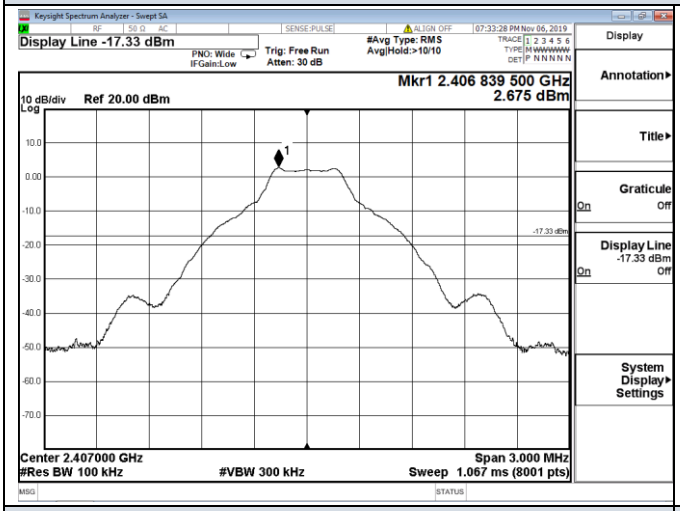
The EUT was programmed to be in continuously transmitting mode.

5.6.6. Test Results of Conducted Spurious Emissions

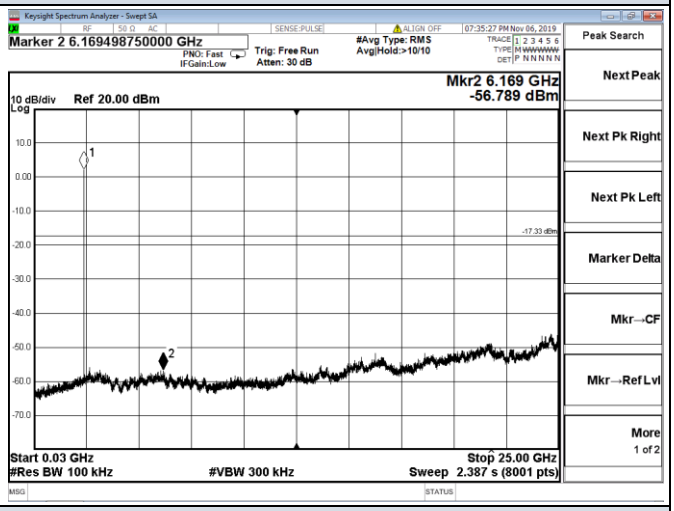
Temperature	23.8℃	Humidity	53.7%
Test Engineer	Scent Hu	Configurations	GFSK

RF Conducted Spurious Emissions

Channel 1 / 2407 MHz

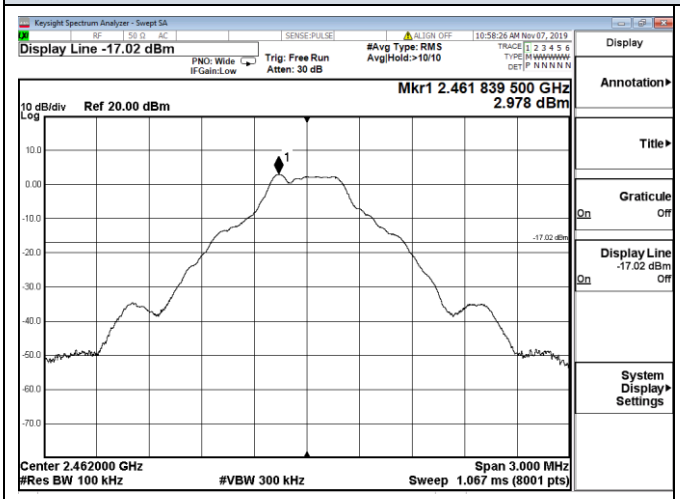


2402.0 MHz – 2406.0 MHz

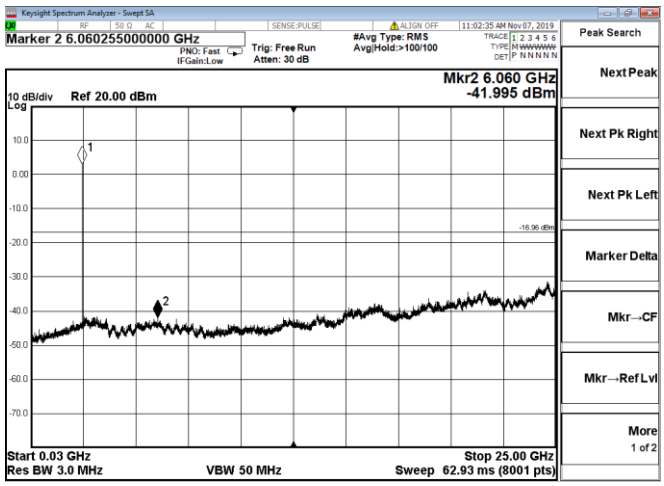


30 MHz – 25 GHz

Channel 17 / 2462 MHz

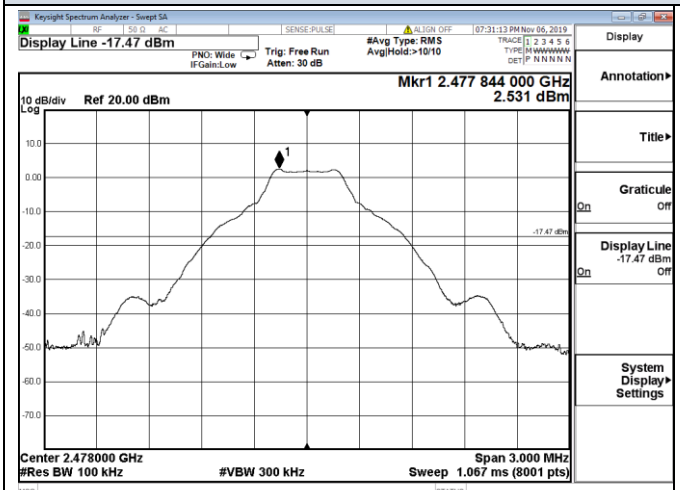


2420 MHz – 2424 MHz

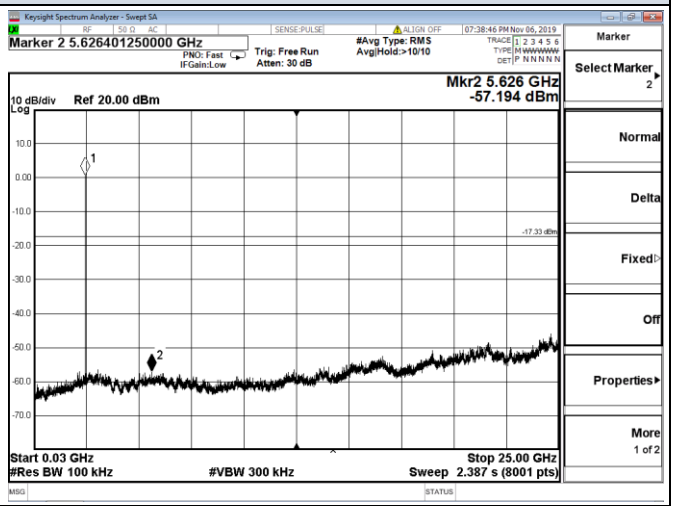


30 MHz – 25 GHz

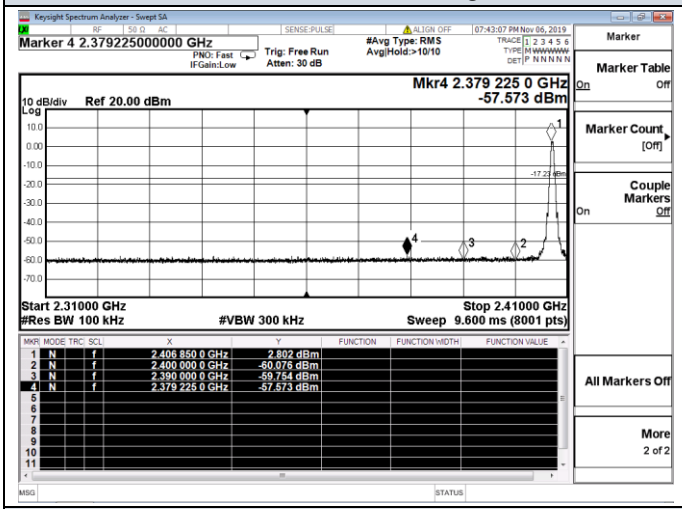
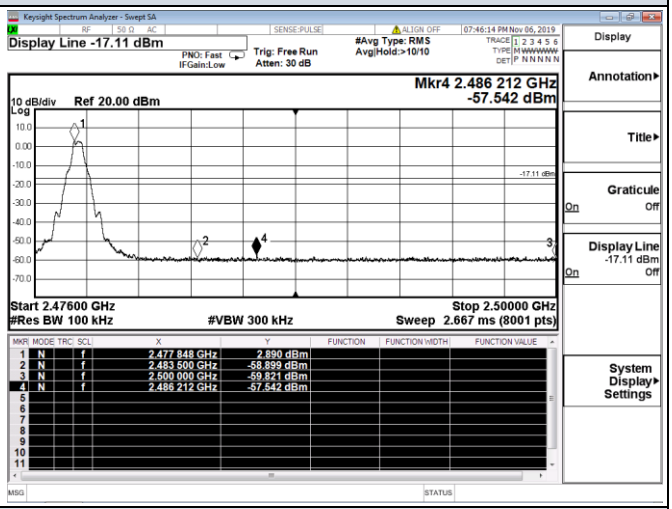
Channel 33 / 2478 MHz



2478 MHz – 2482 MHz



30 MHz – 25 GHz

Band-edge measurements for conducted emissions	
	
Channel 1 / 2407 MHz	Channel 33 / 2478 MHz

5.7. AC Power Line Conducted Emissions (Not Applicable)

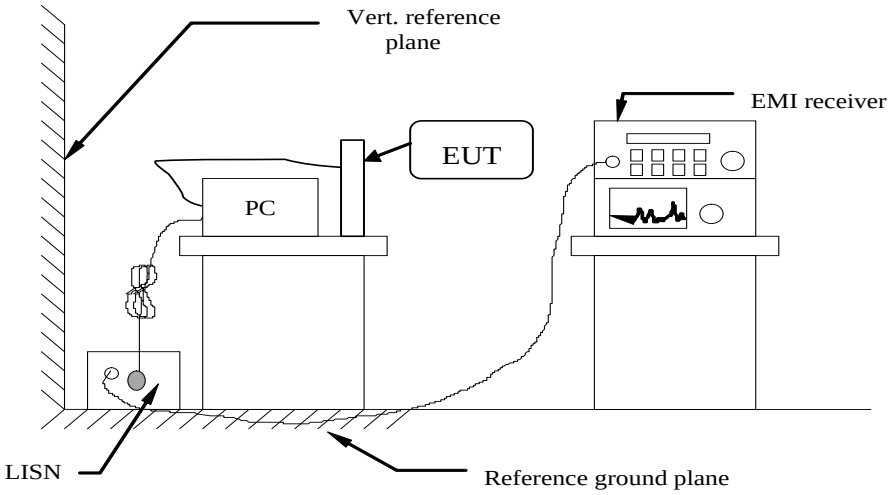
5.7.1 Standard Applicable

According to §15.247 (d) or RSS-Gen § 8.8: For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range are listed as follows:

Frequency Range (MHz)	Limits (dBμV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

* Decreasing linearly with the logarithm of the frequency

5.7.2 Block Diagram of Test Setup



5.7.3 Test Results

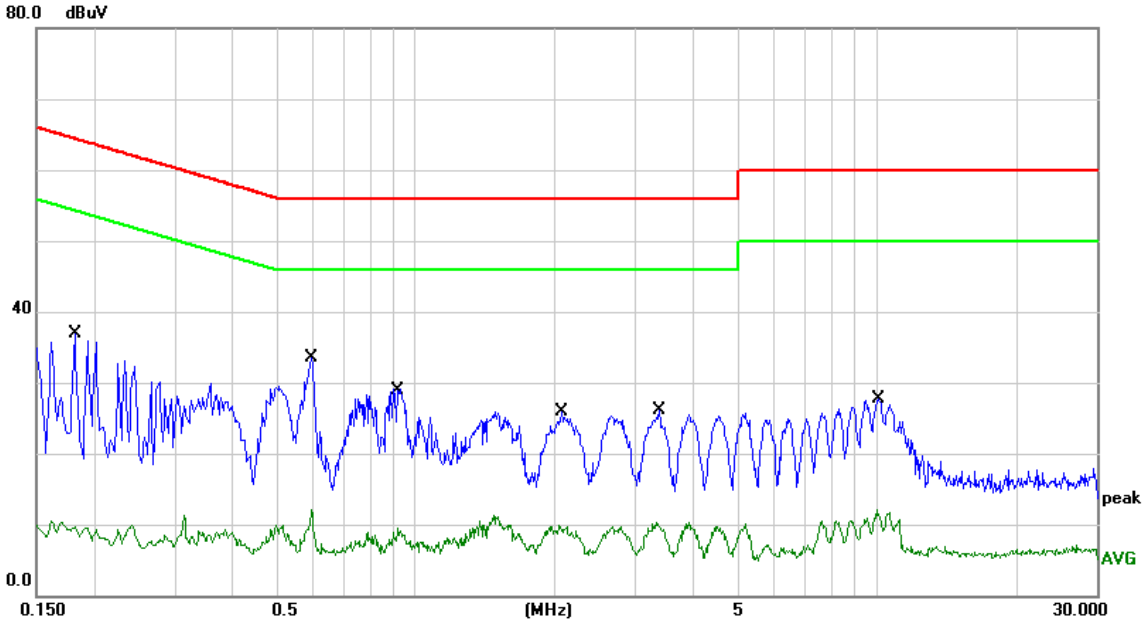
PASS.

The test data please refer to following page.

Temperature	23.8℃	Humidity	55%
Test Engineer	Scent Hu		

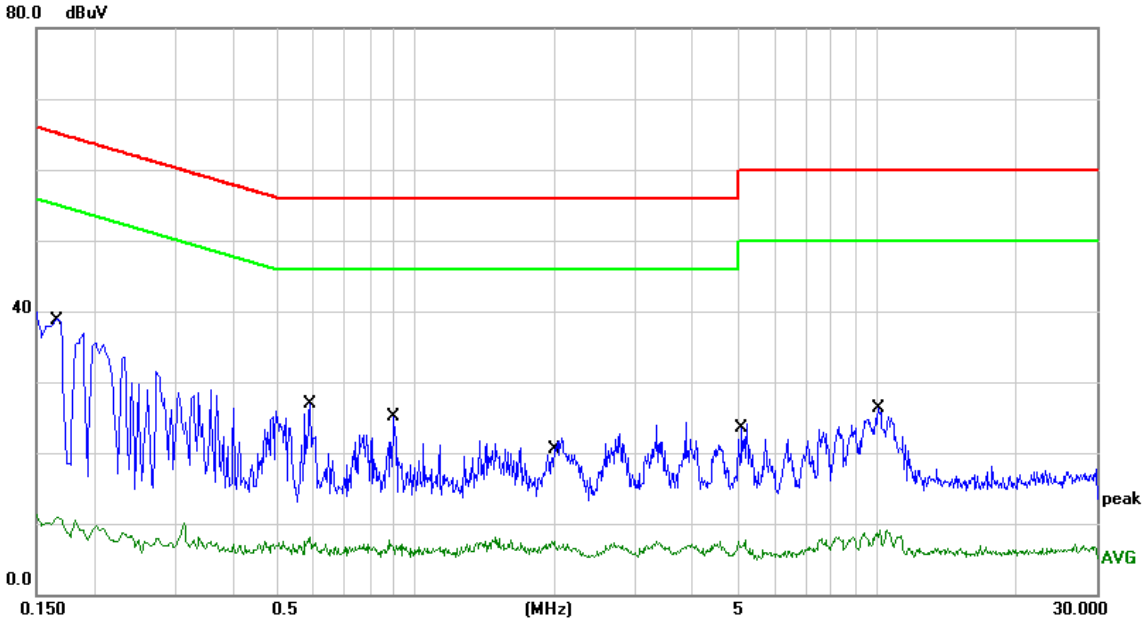
AC Power Line Conducted Emission (Power input to adapter @ AC 120V/60Hz (Worst Case))

Line



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1822	16.30	10.23	26.53	64.38	-37.85	QP	
2		0.1822	-1.20	10.23	9.03	54.38	-45.35	AVG	
3	*	0.5952	17.57	10.20	27.77	56.00	-28.23	QP	
4		0.5952	4.73	10.20	14.93	46.00	-31.07	AVG	
5		0.9103	9.08	10.20	19.28	56.00	-36.72	QP	
6		0.9103	-1.35	10.20	8.85	46.00	-37.15	AVG	
7		2.0724	8.78	10.20	18.98	56.00	-37.02	QP	
8		2.0724	-1.71	10.20	8.49	46.00	-37.51	AVG	
9		3.3377	8.92	10.20	19.12	56.00	-36.88	QP	
10		3.3377	-1.57	10.20	8.63	46.00	-37.37	AVG	
11		10.1306	9.99	10.20	20.19	60.00	-39.81	QP	
12		10.1306	-2.56	10.20	7.64	50.00	-42.36	AVG	

Neutral



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1626	17.97	10.23	28.20	65.33	-37.13	QP	
2		0.1626	-1.55	10.23	8.68	55.33	-46.65	AVG	
3		0.5912	8.09	10.20	18.29	56.00	-37.71	QP	
4	*	0.5912	-0.82	10.20	9.38	46.00	-36.62	AVG	
5		0.9020	0.99	10.20	11.19	56.00	-44.81	QP	
6		0.9020	-3.89	10.20	6.31	46.00	-39.69	AVG	
7		1.9778	0.24	10.20	10.44	56.00	-45.56	QP	
8		1.9778	-3.73	10.20	6.47	46.00	-39.53	AVG	
9		5.1717	2.71	10.20	12.91	60.00	-47.09	QP	
10		5.1717	-3.98	10.20	6.22	50.00	-43.78	AVG	
11		10.1287	5.85	10.20	16.05	60.00	-43.95	QP	
12		10.1287	-3.67	10.20	6.53	50.00	-43.47	AVG	

****Note: Pre-scan all modes and recorded the worst case results in this report.*

5.8. Band-edge Measurements for Radiated Emissions

5.8.1 Standard Applicable

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)).

5.8.2. Test Setup Layout

5.8.3. Measuring Instruments and Setting

Please refer to equipment list in this report. The following table is the setting of Spectrum Analyzer.

5.8.4. Test Procedures

According to KDB 558074 D01 for Antenna-port conducted measurement. Antenna-port conducted measurements may also be used as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to an EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set both RBW and VBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100kHz bandwidth from band edge, for Radiated emissions restricted band RBW=1MHz, VBW=3MHz for peak detector and RBW=1MHz, VBW=1/B for Peak detector.
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.
6. Measure the conducted output power (in dBm) using the detector specified by the appropriate regulatory agency (see 12.2.2, 12.2.3, and 12.2.4 for guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).
7. Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see 12.2.5 for guidance on determining the applicable antenna gain)
8. Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).
9. For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (e.g., Watts, mW).
10. Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:

$$E = EIRP - 20\log D + 104.8$$

Where:

E = electric field strength in dBμV/m,
EIRP = equivalent isotropic radiated power in dBm
D = specified measurement distance in meters.

11. Since the out-of-band characteristics of the EUT transmit antenna will often be unknown, the use of a conservative antenna gain value is necessary. Thus, when determining the EIRP based on the measured conducted power, the upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands, or 2 dBi, whichever is greater. However, for devices that operate in multiple frequency bands while using the same transmit antenna, the highest gain of the antenna within the operating band nearest in frequency to the restricted band emission being measured may be used in lieu of the overall highest gain when the emission is at a frequency that is within 20 percent of the nearest band edge frequency, but in no case shall a value less than 2 dBi be used.
12. Compare the resultant electric field strength level to the applicable regulatory limit.
13. Perform radiated spurious emission test duress until all measured frequencies were complete.

5.8.5 Test Results

The test data please refer to following page.

Temperature	23.8℃	Humidity	55%
Test Engineer	Scent Hu		

Test Channel	Ant	Freq.	Power [dBm]	Gain	Ground Factor	E [dBuV/m]	Detector	Limit [dBuV/m]	Verdict
2407	Ant1	2310.0	-51.595	2	0	45.665	PEAK	74	PASS
	Ant1	2310.0	-61.540	2	0	35.720	AV	54	PASS
	Ant1	2390.0	-50.485	2	0	46.775	PEAK	74	PASS
	Ant1	2390.0	-61.202	2	0	36.058	AV	54	PASS
2478	Ant1	2483.5	-49.733	2	0	47.527	PEAK	74	PASS
	Ant1	2483.5	-60.640	2	0	36.620	AV	54	PASS
	Ant1	2500.0	-49.143	2	0	48.117	PEAK	74	PASS
	Ant1	2500.0	-60.869	2	0	36.391	AV	54	PASS

Remark:

1). Test results including cable loss;

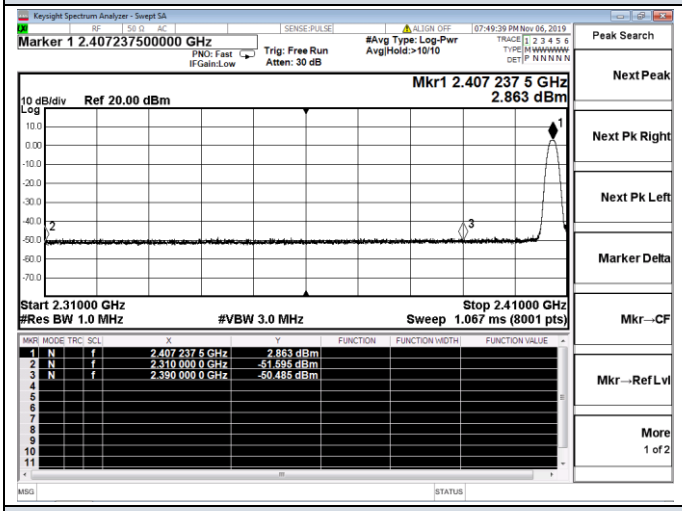
2). "---"means that the fundamental frequency not for 15.209 limits requirement;

3). The average measurement was not performed when the peak measured data under the limit of average detection.

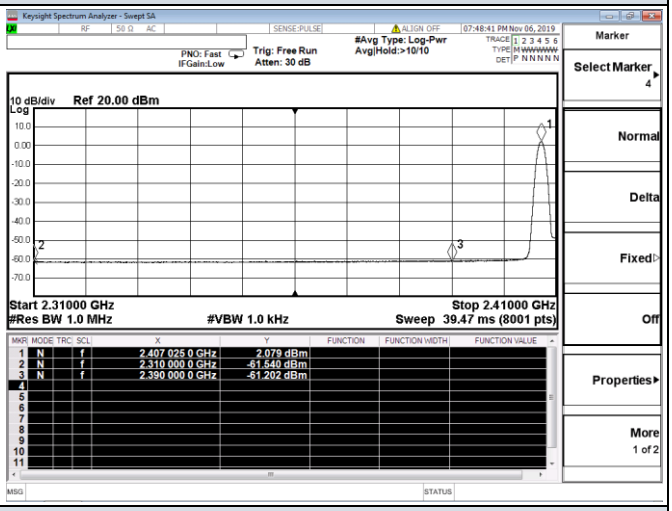
4). Detector AV is setting spectrum/receiver. RBW=1MHz/VBW=330Hz/Sweep time=Auto/Detector=Peak.

5). Since the out-of-band characteristics of the EUT transmit antenna will often be unknown, the use of a conservative antenna gain value is necessary. Thus, when determining the EIRP based on the measured conducted power, the upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands, or 2 dBi, whichever is greater. However, for devices that operate in multiple frequency bands while using the same transmit antenna, the highest gain of the antenna within the operating band nearest in frequency to the restricted band emission being measured may be used in lieu of the overall highest gain when the emission is at a frequency that is within 20 percent of the nearest band edge frequency, but in no case shall a value less than 2 dBi be used.

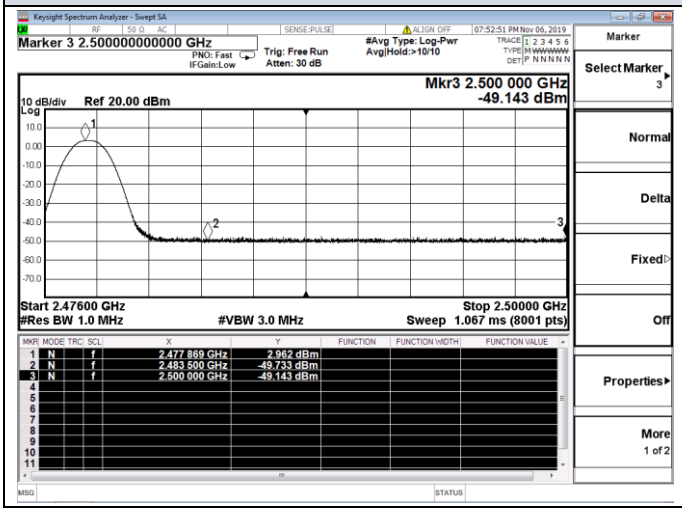
Restrict-band band-edge measurements _2407_Ant1_PEAK



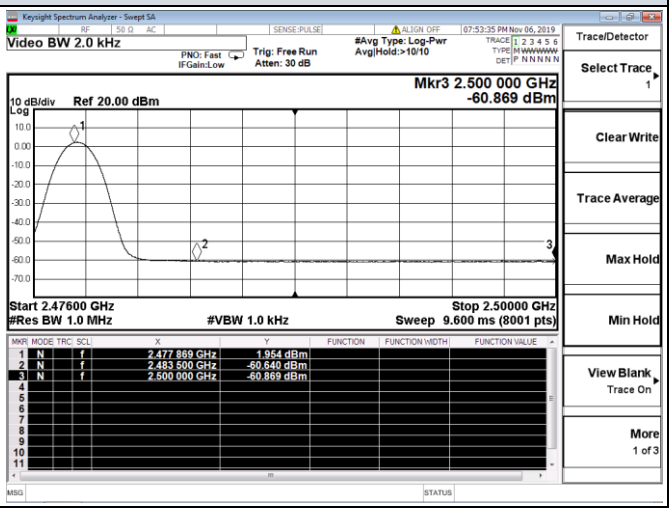
Restrict-band band-edge measurements _2407_Ant1_AV



Restrict-band band-edge measurements _2478_Ant1_PEAK



Restrict-band band-edge measurements _2478_Ant1_AV



5.9. Antenna Requirements

5.9.1 Standard Applicable

According to RSS-Gen Issue 5,

The applicant for equipment certification, as per RSP-100, must provide a list of all antenna types that may be used with the licence-exempt transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna.

Licence-exempt transmitters that have received equipment certification may operate with different types of antennas. However, it is not permissible to exceed the maximum equivalent isotropically radiated power (e.i.r.p.) limits specified in the applicable standard (RSS) for the licence-exempt apparatus.

Testing shall be performed using the highest gain antenna of each combination of licence-exempt transmitter and antenna type, with the transmitter output power set at the maximum level.9 When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

5.9.2 Antenna Connected Construction

5.9.2.1. Standard Applicable

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.

5.9.2.2. Antenna Connector Construction

The directional gains of antenna used for transmitting 0.5dBi, and the antenna is an Internal antenna connect to PCB board and no consideration of replacement. Please see EUT photo for details.

5.9.2.3. Results: Compliance.

Measurement

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module.
Conducted power refers ANSI C63.10:2013 Output power test procedure for DTS devices.
Radiated power refers to ANSI C63.10:2013 Radiated emissions tests.

Measurement parameters

Measurement parameter	
Detector:	Peak
Sweep Time:	Auto
Resolution bandwidth:	1MHz
Video bandwidth:	3MHz
Trace-Mode:	Max hold

Note: The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module.

Limits

FCC	ISED
Antenna Gain	
6 dBi	

Tnom	Vnom	lowest channel 2407MHz	middle channel 2462 MHz	highest channel 2478 MHz
Conducted power [dBm] Measured with GFSK modulation		2.834	3.046	2.658
Radiated power [dBm] Measured with GFSK modulation		2.915	3.086	2.788
Gain [dBi] Calculated		0.08	0.04	0.13
Measurement uncertainty			± 1.6 dB (cond.) / ± 3.8 dB (rad.)	

6. LIST OF MEASURING EQUIPMENTS

Item	Equipment	Manufacturer	Model No.	Serial No.	Cal Date	Due Date
1	Power Meter	R&S	NRVS	100444	2019-06-11	2020-06-10
2	Power Sensor	R&S	NRV-Z81	100458	2019-06-11	2020-06-10
3	Power Sensor	R&S	NRV-Z32	10057	2019-06-11	2020-06-10
4	Test Software	Tonscend	JS1120-2	/	N/A	N/A
5	RF Control Unit	Tonscend	JS0806-2	N/A	2019-06-11	2020-06-10
6	MXA Signal Analyzer	Agilent	N9020A	MY50510140	2019-06-11	2020-06-10
7	DC Power Supply	Agilent	E3642A	N/A	2018-11-15	2019-11-14
8	EMI Test Software	AUDIX	E3	/	N/A	N/A
9	3m Semi Anechoic Chamber	SIDT FRANKONIA	SAC-3M	03CH03-HY	2019-06-12	2020-06-11
10	Positioning Controller	MF	MF-7082	N/A	2019-06-12	2020-06-11
11	Active Loop Antenna	SCHWARZBECK	FMZB 1519B	00005	2019-07-26	2020-07-25
12	By-log Antenna	SCHWARZBECK	VULB9163	9163-470	2019-07-26	2020-07-25
13	Horn Antenna	SCHWARZBECK	BBHA 9120D	9120D-1925	2019-07-01	2020-06-30
14	Broadband Horn Antenna	SCHWARZBECK	BBHA 9170	791	2019-09-20	2020-09-19
15	Broadband Preamplifier	SCHWARZBECK	BBV 9719	9719-025	2019-09-20	2020-09-19
16	EMI Test Receiver	R&S	ESR 7	101181	2019-06-12	2020-06-11
17	RS SPECTRUM ANALYZER	R&S	FSP40	100503	2018-11-15	2019-11-14
18	AMPLIFIER	QuieTek	QTK	CHM/0809065	2018-11-15	2019-11-14
19	RF Cable-R03m	Jye Bao	RG142	CB021	2019-06-12	2020-06-11
20	RF Cable-HIGH	SUHNER	SUCOFLEX 106	03CH03-HY	2019-06-12	2020-06-11
21	6dB Attenuator	/	100W/6dB	1172040	2019-06-11	2020-06-10
22	3dB Attenuator	/	2N-3dB	/	2019-06-11	2020-06-10
23	EMI Test Receiver	R&S	ESPI	101840	2019-06-11	2020-06-10
24	Artificial Mains	R&S	ENV216	101288	2019-06-12	2020-06-11
25	10dB Attenuator	SCHWARZBECK	MTS-IMP-136	261115-001-0032	2019-06-11	2020-06-10

Note: All equipment is calibrated through CHINA CEPREI LABORATORY and GUANGZHOU LISAI CALIBRATION AND TEST CO., LTD.

7. TEST SETUP PHOTOGRAPHS OF EUT

Please refer to separated files for Test Setup Photos of the EUT.

8. EXTERIOR PHOTOGRAPHS OF THE EUT

Please refer to separated files for External Photos of the EUT.

9. INTERIOR PHOTOGRAPHS OF THE EUT

Please refer to separated files for Internal Photos of the EUT.

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