

## FCC PART 15 SUBPART C TEST REPORT

### FCC PART 15.247

**Report Reference No.....:** MWR161000104

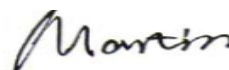
**FCC ID.....:** RQQHLT-L55UTM

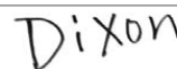
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Date of issue.....: October 24, 2016





**Representative Laboratory Name ..:** Maxwell International Co., Ltd.

Address .....: Room 509, Hongfa center building, Baoan District, Shenzhen, Guangdong, China

**Testing Laboratory Name .....** Shenzhen CTL Testing Technology Co., Ltd.

Address .....: Floor 1-A, Baisha Technology Park, No.3011, Shahexi Road, Nanshan District, Shenzhen, China 518055

**Applicant's name .....** HYUNDAI CORPORATION

Address .....: 140-2, Kye-dong, Chongro-ku, Seoul, South Korea

**Test specification .....**

Standard .....: **FCC Part 15.247: Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz**

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**Test item description .....** Mobile Phone

Trade Mark .....: HYUNDAI

**Manufacturer.....:** Shenzhen Rainbow Time Technology Co.,Ltd

Model/Type reference.....: TITAN LTE

Listed Models .....: /

Modulation Type.....: GFSK

Operation Frequency.....: From 2402MHz to 2480MHz

Rating .....: DC 3.80V

Hardware version .....: 5101SP\_S52

Software version .....: V1.0

Result.....: **PASS**

**TEST REPORT**

<b>Test Report No. :</b>	<b>MWR161000104</b>	October 24, 2016
		Date of issue

Equipment under Test : Mobile Phone

Model /Type : TITAN LTE

Listed Models : /

**Applicant** : **HYUNDAI CORPORATION**

Address : 140-2, Kye-dong, Chongro-ku, Seoul, South Korea

**Manufacturer** : **Shenzhen Rainbow Time Technology Co.,Ltd**

Address : Room 905, ChangHong Technology Building, Science and Technology Park, Nanshan District, Shenzhen, China

<b>Test Result:</b>	<b>PASS</b>
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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
00	2016-10-24	Initial Issue	Dixon Hao

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# **1 TEST STANDARDS**

The tests were performed according to following standards:

[FCC Rules Part 15.247](#): Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz

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

[KDB558074 D01 V03](#): Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

## 2 SUMMARY

### 2.1 General Remarks

Date of receipt of test sample	:	September.18, 2016
Testing commenced on	:	September.19, 2016
Testing concluded on	:	October 24, 2016

### 2.2 Product Description

The **HYUNDAI CORPORATION's** Model: TITAN LTE or the "EUT" as referred to in this report; more general information as follows, for more details, refer to the user's manual of the EUT.

Name of EUT	Mobile Phone
Model Number	TITAN LTE
Modulation Type	GMSK for GSM/GPRS/EDGE, 8-PSK for EDGE only downlink, QPSK for UMTS, QPSK/16QAM for LTE
Antenna Type	Internal
UMTS Operation Frequency Band	Device supported UMTS FDD Band II, FDD Band V
WLAN FCC Operation frequency	IEEE 802.11b:2412-2462MHz IEEE 802.11g:2412-2462MHz IEEE 802.11n HT20:2412-2462MHz IEEE 802.11n HT40:2422-2452MHz
BT FCC Operation frequency	2402MHz-2480MHz
HSDPA Release Version	Release 10
HSUPA Release Version	Release 6
DC-HSUPA Release Version	Not Supported
WCDMA Release Version	R99
WLAN FCC Modulation Type	IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK) IEEE 802.11g: OFDM(64QAM, 16QAM, QPSK, BPSK) IEEE 802.11n HT20: OFDM (64QAM, 16QAM, QPSK,BPSK) IEEE 802.11n HT40: OFDM (64QAM, 16QAM, QPSK,BPSK)
BT Modulation Type	GFSK,8DPSK, $\pi$ /4DQPSK(BT3.0+EDR),GFSK(BLE)
Hardware version	5101SP_S52
Software version	V1.0
Android version	Android 5.1
GPS function	Supported
WLAN	Supported 802.11b/802.11g/802.11n
Bluetooth	Supported BT 4.0/BT 3.0+EDR
GSM/EDGE/GPRS	Supported GSM/GPRS/EDGE
GSM/EDGE/GPRS Power Class	GSM850:Power Class 4/ PCS1900:Power Class 1
GSM/EDGE/GPRS Operation Frequency	GSM850 :824.2MHz-848.8MHz/PCS1900:1850.2MHz-1909.8MHz
GSM/EDGE/GPRS Operation Frequency Band	GSM850/PCS1900/GPRS850/GPRS1900/EDGE850/EDGE1900
GSM Release Version	R99
GPRS/EDGE Multislot Class	GPRS: Multi-slot Class 12
Extreme temp. Tolerance	-30°C to +50°C
Extreme vol. Limits	3.40VDC to 4.20VDC (nominal: 3.80VDC)
GPRS operation mode	Class B

## 2.3 Equipment Under Test

### Power supply system utilised

Power supply voltage	:	<input type="radio"/>	120V / 60 Hz	<input type="radio"/>	115V / 60Hz
		<input type="radio"/>	12 V DC	<input type="radio"/>	24 V DC
		<input checked="" type="radio"/>	Other (specified in blank below)		

DC 3.80V

## 2.4 Description of the test mode

The application provider specific test software to control sample in continuous TX and RX (Duty Cycle >98%)

For testing meet KDB558074 test requirement.

The EUT has been tested under typical operating condition. The Applicant provides communication tools software to control the EUT for staying in continuous transmitting and receiving mode for testing. There are 40 channels of EUT, and the test carried out at the lowest channel, middle channel and highest channel

Channel	Frequency(MHz)	Channel	Frequency(MHz)
0	2402	20	2442
1	2404	21	2444
2	2406	22	2446
3	2408	23	2448
4	2410	24	2450
5	2412	25	2452
6	2414	26	2454
7	2416	27	2456
8	2418	28	2458
9	2420	29	2460
10	2422	30	2462
11	2424	31	2464
12	2426	32	2466
13	2428	33	2468
14	2430	34	2470
15	2432	35	2472
16	2434	36	2474
17	2436	37	2476
18	2438	38	2478
19	2440	39	2480

## 2.5 Short description of the Equipment under Test (EUT)

### 2.5.1 General Description

TITAN LTE is subscriber equipment in the WCDMA/GSM system. The HSPA/UMTS frequency band is Band I, Band II and Band V; The GSM/GPRS/EDGE frequency band includes GSM850 and GSM900 and DCS1800 and PCS1900, but only Band II, Band V, GSM850 and PCS1900 bands test data included in this report. The Mobile Phone implements such functions as RF signal receiving/transmitting, HSPA/UMTS and GSM/GPRS/EDGE protocol processing, voice, video MMS service, GPS and WIFI etc. Externally it provides micro SD card interface, earphone port (to provide voice service) and SIM card interface. It also provides Bluetooth module to synchronize data between a PC and the phone, or to use the built-in modem of the phone to access the Internet with a PC, or to exchange data with other Bluetooth devices.

NOTE: Unless otherwise noted in the report, the functional boards installed in the units shall be selected from the below list, but not means all the functional boards listed below shall be installed in one unit.

Note: The EUT was programmed to be in continuously transmitting mode and the transmit duty cycle is not less than 98%.

## 2.5.2 Customized Configurations

#EUT Conf.	Signal Description	Operating Frequency
TM1_Ch0	GFSK modulation	Ch No. 0/2402MHz
TM1_Ch19	GFSK modulation	Ch No. 19/ 2440MHz
TM1_Ch39	GFSK modulation	Ch No. 39/ 2480MHz

## 2.6 Test Environments

NOTE: The values used in the test report maybe stringent than the declared.

Environment Parameter	Selected Values During Tests		
NTNV	Temperature	Voltage	Relative Humidity
	Ambient	3.80VDC	Ambient

## 2.7 EUT operation mode

The EUT has been tested under typical operating condition. The Applicant provides command to control the EUT for staying in continuous transmitting (Duty Cycle >98%) and receiving mode for testing.

## 2.8 EUT configuration

The following peripheral devices and interface cables were connected during the measurement:

- - supplied by the manufacturer
- - supplied by the lab

○	Power Cable	Length (m) :	/
		Shield :	/
		Detachable :	/
○	Multimeter	Manufacturer :	/
		Model No. :	/

## 2.9 Internal Identification of AE used during the test

AE ID*	Description
AE1	Charger and USB cable

AE1  
Model: DC500  
INPUT: AC180-240V~ 50/60Hz 0.15A  
OUTPUT: DC 5.0V 1000mA

\*AE ID: is used to identify the test sample in the lab internally.

## 2.10 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for **FCC ID: RQQHLT-L55UTM** filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules.

## 2.11 Modifications

No modifications were implemented to meet testing criteria.



### 3 TEST ENVIRONMENT

#### 3.1 Address of the test laboratory

**Shenzhen CTL Testing Technology Co., Ltd.**

Floor 1-A, Baisha Technology Park, No. 3011, Shahexi Road, Nanshan, Shenzhen 518055 China

There is one 3m semi-anechoic chamber and two line conducted labs for final test. The Test Sites meet the requirements in documents ANSI C63.4, CISPR 22/EN 55022 and CISPR16-4-1 SVSWR requirements.

#### 3.2 Test Facility

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

##### IC Registration No.: 9618B

The 3m alternate test site of Shenzhen CTL Testing Technology Co., Ltd. EMC Laboratory has been registered by Certification and Engineer Bureau of Industry Canada for the performance of with Registration No.: 9618B on November 13, 2013.

##### FCC-Registration No.: 970318

Shenzhen CTL Testing Technology Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration 970318, December 19, 2013.

#### 3.3 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	<u>15-35 ° C</u>
Humidity:	<u>30-60 %</u>
Atmospheric pressure:	<u>950-1050mbar</u>

#### 3.4 Test Description

Test Item	FCC Part No.	Requirements	Verdict
DTS (6 dB) Bandwidth	15.247(a)(2)	$\geq 500$ kHz.	PASS
Maximum Peak Conducted Output Power	15.247(b)(3)	For directional gain: $< 30\text{dBm} - (G[\text{dBi}] - 6 [\text{dB}])$ , peak; Otherwise : $< 30\text{dBm}$ , peak.	PASS
Maximum Power Spectral Density Level	15.247(e)	For directional gain : $< 8\text{dBm}/3$ kHz – $(G[\text{dBi}] - 6[\text{dB}])$ , peak. Otherwise : $< 8\text{dBm}/3$ kHz, peak.	PASS
Band Edges Compliance	15.247(d)	$< -20\text{dBm}/100$ kHz if total peak power $\leq$ power limit.	PASS
Unwanted Emissions into Non-Restricted Frequency Bands	15.247(d)	$< -20\text{dBm}/100$ kHz if total peak power $\leq$ power limit.	PASS
Unwanted Emissions into Restricted Frequency Bands (Conducted)	15.247(d) 15.209	$< -20\text{dBm}/100$ kHz if total peak power $\leq$ power limit.	PASS
Unwanted Emissions into Restricted Frequency Bands (Radiated)	15.247(d) 15.209	FCC Part 15.209 field strength limit;	PASS
AC Power Line Conducted Emissions	15.207	FCC Part 15.207 conducted limit;	PASS

Remark:

1. The measurement uncertainty is not included in the test result.

### 3.5 Summary of measurement results

Test Specification clause	Test case	Test Mode	Test Channel	Recorded In Report		Pass	Fail	NA	NP	Remark
§15.247(b)(4)	Antenna gain	GFSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	GFSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.247(e)	Power spectral density	GFSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	GFSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.247(a)(1)	Spectrum bandwidth – 6 dB bandwidth	GFSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	GFSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.247(b)(1)	Maximum output power	GFSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	GFSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.247(d)	Band edge compliance conducted	GFSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Highest	GFSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Highest	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.205	Band edge compliance radiated	GFSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Highest	GFSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Highest	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.247(d)	TX spurious emissions conducted	GFSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	GFSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.247(d)	TX spurious emissions radiated	GFSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	GFSK	<input checked="" type="checkbox"/> Lowest <input checked="" type="checkbox"/> Middle <input checked="" type="checkbox"/> Highest	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.109	RX spurious emissions radiated	-/-	-/-	-/-	-/-	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.209(a)	TX spurious Emissions radiated < 30 MHz	GFSK	-/-	GFSK	-/-	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.107(a) §15.207	Conducted Emissions < 30 MHz	GFSK	-/-	GFSK	-/-	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies

Remark:

1. The measurement uncertainty is not included in the test result.
2. NA = Not Applicable; NP = Not Performed

### 3.6 Test Conditions

Test Case	Test Conditions	
	Configuration	Description
DTS (6 dB) Bandwidth	Measurement Method	FCC KDB 558074 §8.2 Option 2
	Test Environment	NTNV
	EUT Configuration	TM1_Ch0, TM1_Ch19, TM1_Ch39
Maximum Peak Conducted Output Power	Measurement Method	FCC KDB 558074 §9.1.2
	Test Environment	NTNV
	EUT Configuration	TM1_Ch0, TM1_Ch19, TM1_Ch39
Maximum Power Spectral Density Level	Measurement Method	FCC KDB 558074 §10.2 (peak PSD).
	Test Environment	NTNV
	EUT Configuration	TM1_Ch0, TM1_Ch19, TM1_Ch39
Unwanted Emissions into Non-Restricted Frequency Bands	Measurement Method	FCC KDB 558074 §11.0
	Test Environment	NTNV
	EUT Configuration	T TM1_Ch0, TM1_Ch19, TM1_Ch39
Unwanted Emissions into Restricted Frequency Bands (Conducted)	Measurement Method	FCC KDB 558074 §12.2, Conducted (antenna-port).
	Test Environment	NTNV
	EUT Configuration	TM1_Ch0, TM1_Ch19, TM1_Ch39

Unwanted Emissions into Restricted	Measurement Method	FCC KDB 558074§12.1,Radiated(cabinet/case emissions with Impedance matching for antenna-port).
	EUT Configuration	TM1_Ch0, TM1_Ch19, TM1_Ch39

Test Case	Test Conditions	
	Configuration	Description
AC Power Line Conducted Emissions	Measurement Method	AC mains conducted.
	Test Environment	NTNV
	EUT Configuration	TM1_Ch19 (Worst Conf.).

**Remark:**

1. For AC Main conducted emission measured at both AC power adapter and charge from PC, recorded worst case in test report.
2. For AC Main conducted emission measured at both AC 120V/60Hz and AC 240V/50Hz, recorded worst case in test report.
3. For Radiated Emissions, By preliminary testing and verifying three axis (X, Y and Z) position of EUT transmitted status, it was found that "Z axis" position was the worst, then the final test was executed the worst condition and test data were recorded in this report.

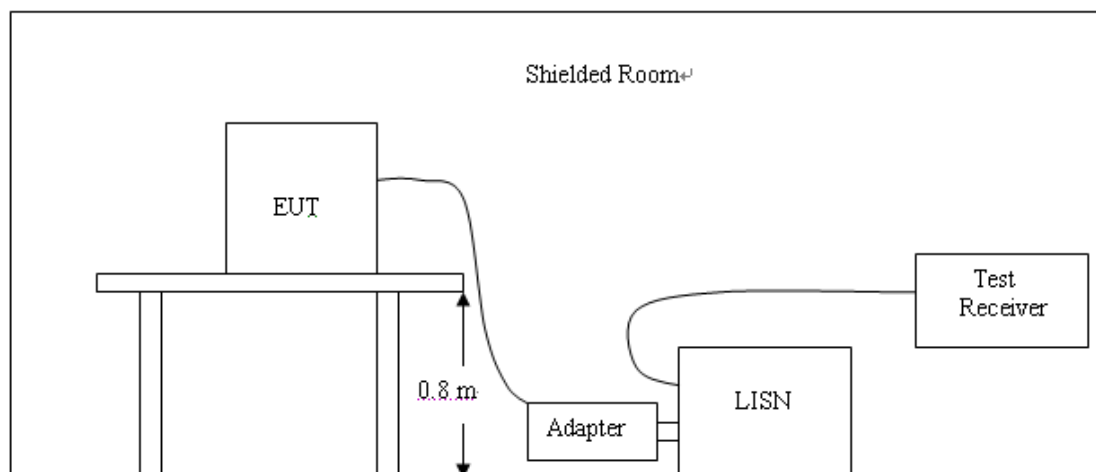
**3.7 Equipment Used during the Test**

Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
Bilog Antenna	Sunol Sciences Corp.	JB1	A061713	2016/06/02	2017/06/01
EMI Test Receiver	R&S	ESCI	103710	2016/06/02	2017/06/01
Spectrum Analyzer	Agilent	N9030A	MY49430428	2016/05/21	2017/05/20
Controller	EM Electronics	Controller EM 1000	N/A	2016/05/21	2017/05/20
Horn Antenna	SCHWARZBECK	BBHA9170D	BBH A9170179	2016/05/19	2017/05/18
Horn Antenna	Sunol Sciences Corp.	DRH-118	A062013	2016/05/19	2017/05/18
EMC Test Software	R&S	ES-K1	N/A	N/A	N/A
EMC Test Software	Audix	E3	N/A	N/A	N/A
Active Loop Antenna	SCHWARZBECK	FMZB1519	1519-037	2016/05/19	2017/05/18
Amplifier	Agilent	8349B	3008A02306	2016/05/19	2017/05/18
Amplifier	Agilent	8447D	2944A10176	2016/05/19	2017/05/18
Temperature/ Humidity Meter	Gangxing	CTH-608	02	2016/05/20	2017/05/19
High-Pass Filter	K&L	9SH10-2700/X12750-O/O	N/A	2016/05/20	2017/05/19
High-Pass Filter	K&L	41H10-1375/U12750-O/O	N/A	2016/05/20	2017/05/19
Coaxial Cables	HUBER+SUHNER	SUCOFLEX 104PEA-10M	10m	2016/06/02	2017/06/01
Coaxial Cables	HUBER+SUHNER	SUCOFLEX 104PEA-3M	3m	2016/06/02	2017/06/01
Coaxial Cables	HUBER+SUHNER	SUCOFLEX 104PEA-3M	3m	2016/06/02	2017/06/01
RF Cable	Megalon	RF-A303	N/A	2016/06/02	2017/06/01
Power Sensor	R&S	NRP-Z4	823.3618.03	2016/06/02	2017/06/01
Power Meter	R&S	NRVS	1020.1809.02	2016/06/02	2017/06/01
System Simulator	R&S	CMU200	115419	2016.05.22	2017.05.21

## 4 TEST CONDITIONS AND RESULTS

### 4.1 AC Power Conducted Emission

#### TEST CONFIGURATION



#### TEST PROCEDURE

1. The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. The EUT is a tabletop system; a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10-2013.
2. Support equipment, if needed, was placed as per ANSI C63.10-2013
3. All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10-2013
4. The EUT received DC5V power from the adapter, the adapter received AC120V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.
5. All support equipments received AC power from a second LISN, if any.
6. The EUT test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT. The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.
7. Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.
8. During the above scans, the emissions were maximized by cable manipulation.

#### AC Power Conducted Emission Limit

For intentional device, according to § 15.207(a) AC Power Conducted Emission Limits is as following:

Frequency (MHz)	Maximum RF Line Voltage (dBμV)			
	CLASS A		CLASS B	
	Q.P.	Ave.	Q.P.	Ave.
0.15 - 0.50	79	66	66-56*	56-46*
0.50 - 5.00	73	60	56	46
5.00 - 30.0	73	60	60	50

\* Decreasing linearly with the logarithm of the frequency

#### TEST RESULTS

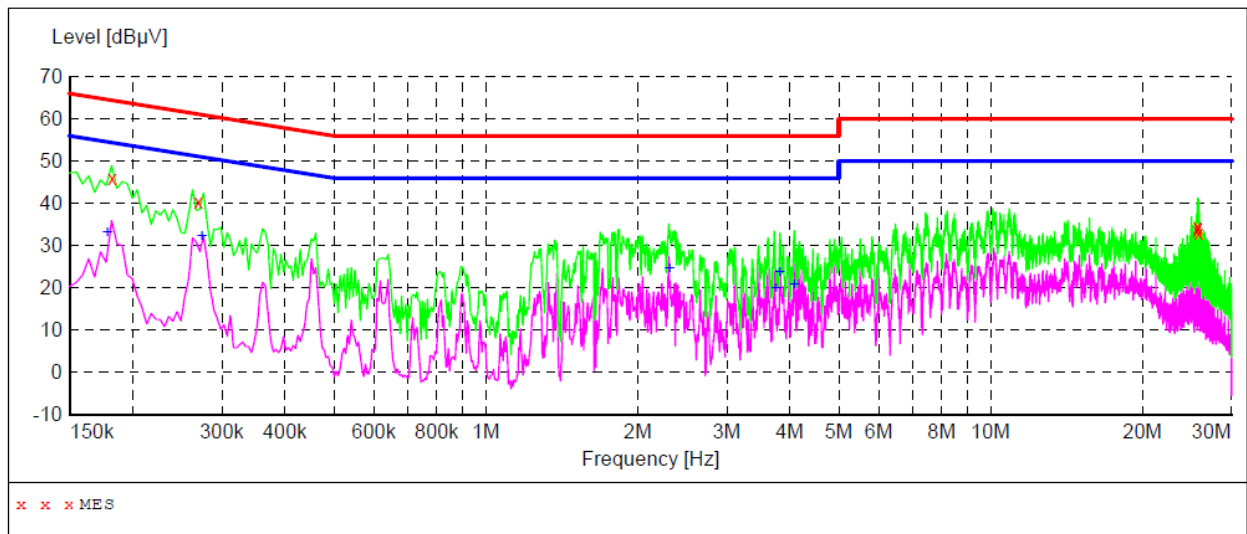
Remark:

1. The AC Power Conducted Emission measurement is performed at both TX and RX (Idle) mode, recorded worst case at TX mode.
2. Measured at power adapter charge and USB charge also at both AC 120V/60Hz and AC 240V/50Hz, recorded worst case at AC 120V/60Hz.

L:

**SCAN TABLE: "Voltage (9K-30M)FIN"**

Short Description: 150K-30M Voltage

**MEASUREMENT RESULT:**

Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Detector	Line	PE
0.182000	45.90	10.2	64	18.5	QP	L1	GND
0.270000	40.30	10.2	61	20.8	QP	L1	GND
25.658000	33.60	11.1	60	26.4	QP	L1	GND
25.718000	34.30	11.1	60	25.7	QP	L1	GND
25.778000	34.10	11.1	60	25.9	QP	L1	GND
25.838000	33.10	11.1	60	26.9	QP	L1	GND

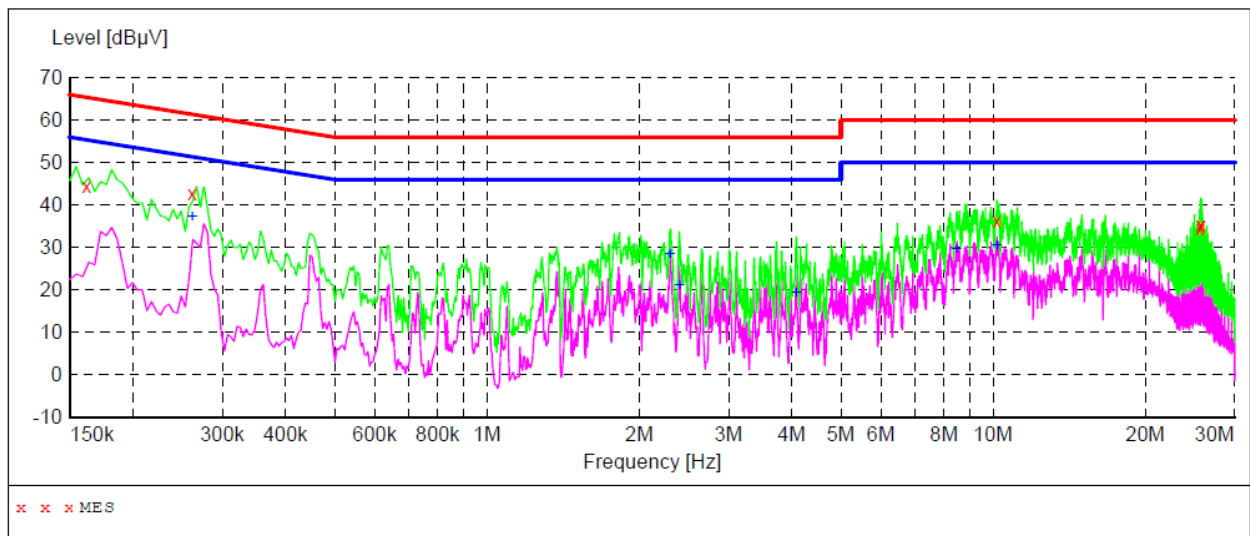
**MEASUREMENT RESULT:**

Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Detector	Line	PE
0.178000	33.20	10.2	55	21.4	AV	L1	GND
0.274000	32.30	10.2	51	18.7	AV	L1	GND
2.312000	24.90	10.4	46	21.1	AV	L1	GND
3.758000	20.00	10.4	46	26.0	AV	L1	GND
3.824000	23.80	10.4	46	22.2	AV	L1	GND
4.088000	20.80	10.4	46	25.2	AV	L1	GND

N:

**SCAN TABLE: "Voltage (9K-30M) FIN"**

Short Description: 150K-30M Voltage

**MEASUREMENT RESULT:**

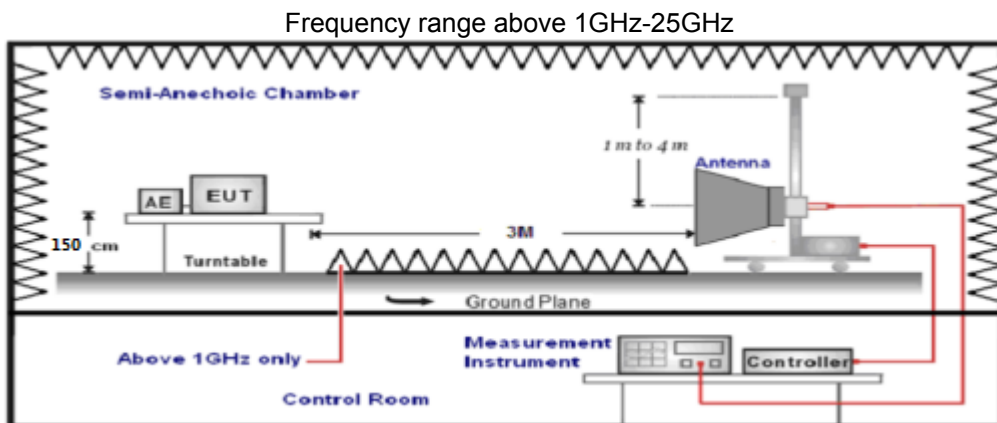
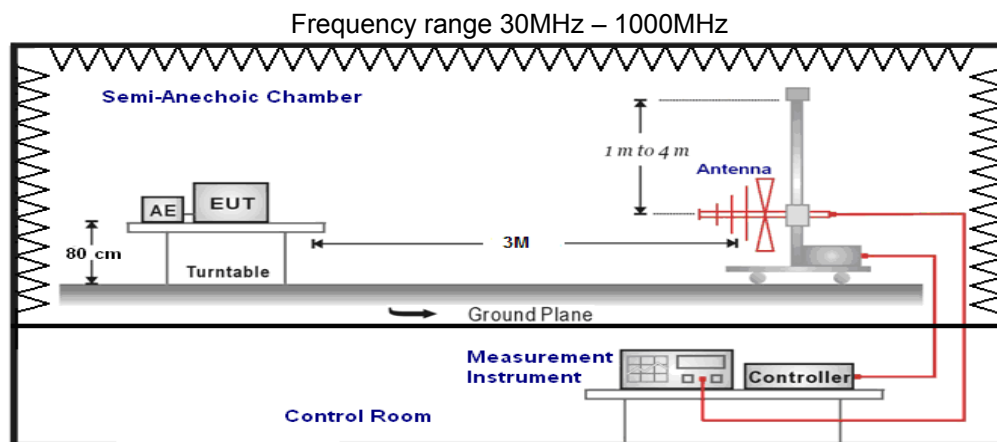
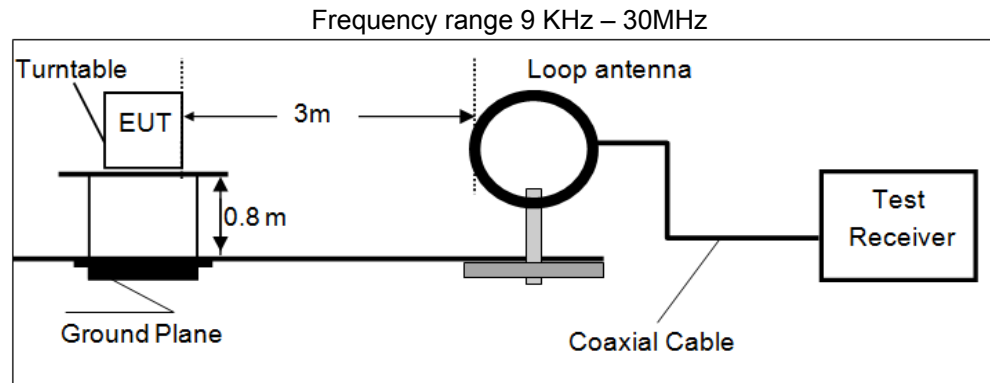
Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Detector	Line	PE
0.162000	44.50	10.2	65	20.9	QP	N	GND
0.262000	42.60	10.2	61	18.8	QP	N	GND
10.178000	36.30	10.6	60	23.7	QP	N	GND
25.658000	34.50	11.1	60	25.5	QP	N	GND
25.718000	35.30	11.1	60	24.7	QP	N	GND
25.778000	35.10	11.1	60	24.9	QP	N	GND

**MEASUREMENT RESULT:**

Frequency MHz	Level dBμV	Transd dB	Limit dBμV	Margin dB	Detector	Line	PE
0.262000	37.50	10.2	51	13.9	AV	N	GND
2.300000	28.70	10.4	46	17.3	AV	N	GND
2.402000	21.20	10.4	46	24.8	AV	N	GND
4.088000	19.40	10.4	46	26.6	AV	N	GND
8.462000	29.60	10.6	50	20.4	AV	N	GND
10.160000	30.70	10.6	50	19.3	AV	N	GND

## 4.2 Radiated Emissions

### TEST CONFIGURATION



### TEST PROCEDURE

1. The EUT was placed on a turn table which is 0.8m above ground plane for below 1GHz and 1.50m above ground plane for above 1GHz.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0° to 360° to acquire the highest emissions from EUT.
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed.
5. The EUT minimum operation frequency was 32.768 KHz and maximum operation frequency was 2480MHz. so radiated emission test frequency band from 9 KHz to 25GHz.
6. The distance between test antenna and EUT as following table states:

Test Frequency range	Test Antenna Type	Test Distance
9KHz-30MHz	Active Loop Antenna	3
30MHz-1GHz	Bilog Antenna	3
1GHz-18GHz	Horn Antenna	3

18GHz-25GHz	Horn Antennna	1
-------------	---------------	---

7. Setting test receiver/spectrum as following table states:

Test Frequency range	Test Receiver/Spectrum Setting	Detector
9KHz-150KHz	RBW=200Hz/VBW=3KHz, Sweep time=Auto	QP
150KHz-30MHz	RBW=9KHz/VBW=100KHz, Sweep time=Auto	QP
30MHz-1GHz	RBW=120KHz/VBW=1000KHz, Sweep time=Auto	QP
1GHz-40GHz	Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto	Peak
	Average Value: RBW=1MHz/VBW=10Hz, Sweep time=Auto	Peak

More procudre as follows;

### 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 1.0 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 QP 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 4 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 ( $\pm 45^\circ$ ) 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 ( $\pm 45^\circ$ ) 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.

### Field Strength Calculation

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

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

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

For example

Frequency (MHz)	FS (dBμV/m)	RA (dBμV/m)	AF (dB)	CL (dB)	AG (dB)	Transd (dB)
300.00	40	58.1	12.2	1.6	31.90	-18.1

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

### RADIATION LIMIT

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

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)

The pre-test have done for the EUT in three axes and found the worst emission at position shown in test setup photos.

Frequency (MHz)	Distance (Meters)	Radiated (dBμV/m)	Radiated (μV/m)
0.009-0.49	300	$20\log(2400/F(\text{KHz}))+80$	$2400/F(\text{KHz})$
0.49-1.705	30	$20\log(24000/F(\text{KHz}))+40$	$24000/F(\text{KHz})$
1.705-30	30	$20\log(30)+40$	30
30-88	3	40.0	100
88-216	3	43.5	150
216-960	3	46.0	200
Above 960	3	54.0	500

### TEST RESULTS

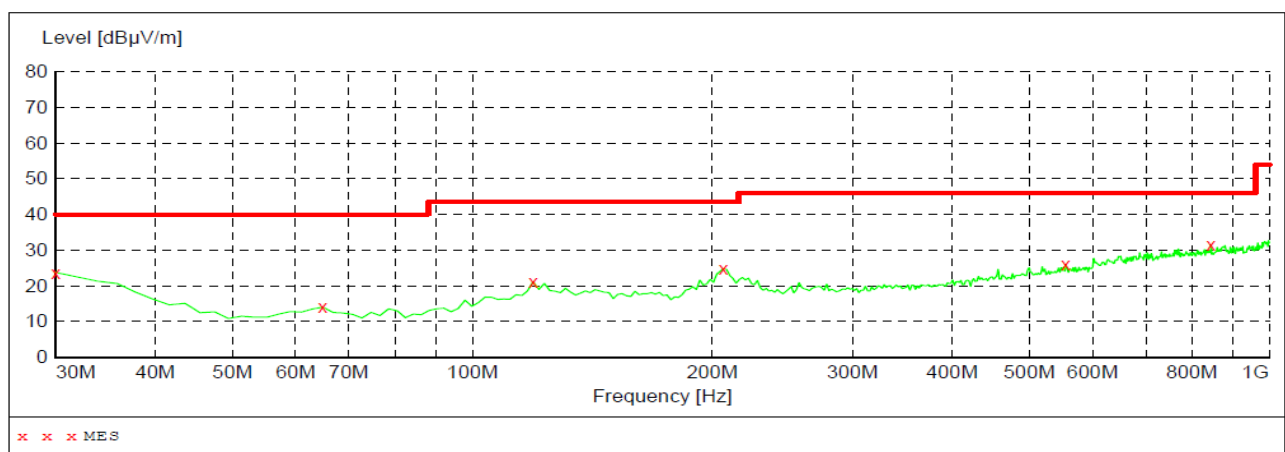
Remark:

1. The radiated measurement are performed the each test mode and channel (low/mid/high), the data recorded below (GFSK mode, the middle channel) is the worst case for all the test mode and channel.
2. Bilog Antenna for the radiation emission test below 1G.
3. HORN ANTENNA for the radiation emission test above 1G.
4. "----" means not recorded as emission levels lower than limit.
6. Margin= Limit - Level

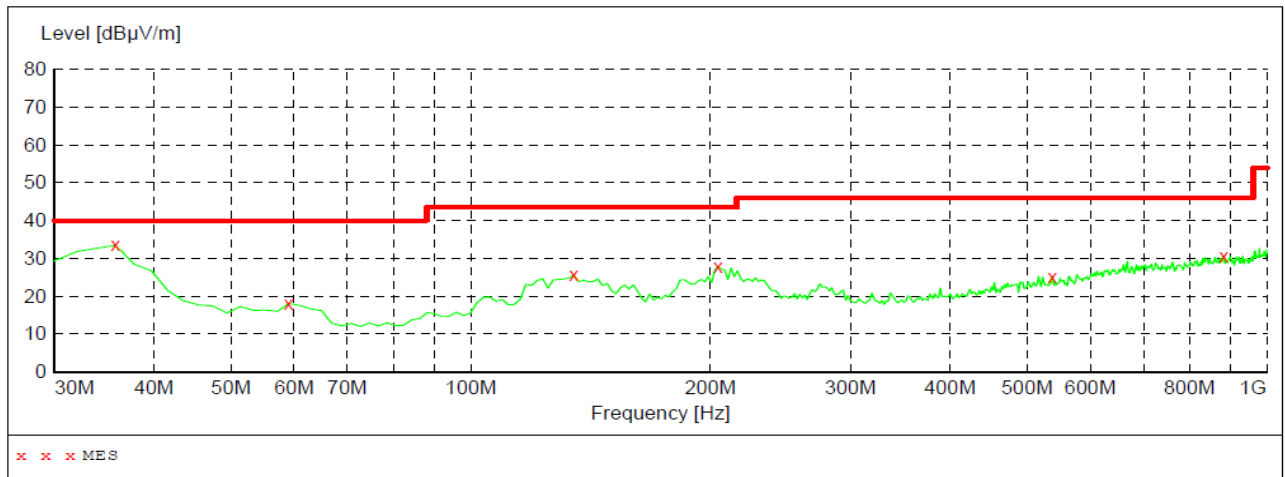
#### **For 9KHz to 30MHz**

Frequency (MHz)	Corrected Reading (dBμV/m)@3m	FCC Limit (dBμV/m) @3m	Margin (dB)	Detector	Result
12.58	46.76	69.54	22.78	QP	PASS
20.45	47.02	69.54	22.52	QP	PASS

#### **For 30MHz to 1000MHz**



Frequency MHz	Level dBμV/m	Transd dB	Limit dBμV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
30.000000	23.74	20.84	40.00	16.26	Peak	100.00	8.00	Horizontal
64.920000	14.05	8.12	40.00	25.95	Peak	300.00	164.00	Horizontal
119.240000	21.26	14.75	43.50	22.24	Peak	315.00	147.00	Horizontal
206.540000	24.81	14.16	43.50	18.69	Peak	250.00	313.00	Horizontal
555.740000	25.95	21.13	46.00	20.05	Peak	124.00	245.00	Horizontal
844.800000	31.56	25.11	46.00	14.44	Peak	165.00	300.00	Horizontal



Frequency MHz	Level dBμV/m	Transd dB	Limit dBμV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
35.820000	35.56	16.23	40.00	4.44	Peak	100.00	216.00	Vertical
59.100000	18.17	8.04	40.00	21.83	Peak	100.00	200.00	Vertical
134.760000	25.74	14.43	43.50	17.76	Peak	108.00	16.00	Vertical
204.600000	27.96	14.17	43.50	15.54	Peak	100.00	39.00	Vertical
538.280000	25.25	20.65	46.00	20.75	Peak	124.00	127.00	Vertical
883.600000	30.77	25.66	46.00	15.23	Peak	100.00	345.00	Vertical

**For 1GHz to 25GHz**

**Low Channel @ Channel 0 @ 2402 MHz**

Item (Mark)	Frequency (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	4804.00	59.74	34.47	30.27	8.24	47.30	74.00	26.70	Peak	Horizontal
2	4804.00	46.55	34.47	30.27	8.24	34.11	54.00	19.89	AV <sup>[1]</sup>	Horizontal
3	7206.00	68.39	37.12	31.34	11.39	51.22	74.00	22.78	Peak	Horizontal
4	7206.00	57.53	37.12	31.34	11.39	40.36	54.00	13.64	AV <sup>[1]</sup>	Horizontal

Item (Mark)	Frequency (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	4804.00	59.26	34.47	30.27	8.24	46.82	74.00	27.18	Peak	Vertical
2	4804.00	45.61	34.47	30.27	8.24	33.17	54.00	20.83	AV <sup>[1]</sup>	Vertical
3	7206.00	67.06	37.12	31.34	11.39	49.89	74.00	24.11	Peak	Vertical
4	7206.00	55.60	37.12	31.34	11.39	38.43	54.00	15.57	AV <sup>[1]</sup>	Vertical

**Middle Channel @ Channel 19 @ 2440 MHz**

Item (Mark)	Frequency (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	4880.00	60.71	34.51	30.33	8.55	47.98	74.00	26.02	Peak	Horizontal
2	4880.00	48.74	34.51	30.33	8.55	36.01	54.00	17.99	AV <sup>[1]</sup>	Horizontal
3	7320.00	68.77	37.26	31.94	12.11	51.34	74.00	22.66	Peak	Horizontal
4	7320.00	59.59	37.26	31.94	12.11	42.16	54.00	11.84	AV <sup>[1]</sup>	Horizontal

Item (Mark)	Frequency (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	4880.00	56.89	34.51	30.33	8.55	44.16	74.00	29.84	Peak	Vertical
2	4880.00	44.75	34.51	30.33	8.55	32.02	54.00	21.98	AV <sup>[1]</sup>	Vertical
3	7320.00	67.65	37.26	31.94	12.11	50.22	74.00	23.78	Peak	Vertical
4	7320.00	58.79	37.26	31.94	12.11	41.36	54.00	12.64	AV <sup>[1]</sup>	Vertical

**High Channel @ Channel 39 @ 2480 MHz**

Item (Mark)	Frequency (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	4960.00	64.02	34.92	30.24	10.09	49.25	74.00	24.75	Peak	Horizontal
2	4960.00	52.88	34.92	30.24	10.09	38.11	54.00	15.89	AV <sup>[1]</sup>	Horizontal
3	7440.00	72.03	38.17	31.55	13.35	52.06	74.00	21.94	Peak	Horizontal
4	7440.00	62.61	38.17	31.55	13.35	42.64	54.00	11.36	AV <sup>[1]</sup>	Horizontal

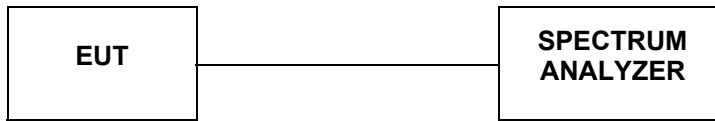
Item (Mark)	Frequency (MHz)	Read Level (dBμV)	Antenna Factor (dB/m)	PRM Factor dB	Cable Loss (dB)	Result Level (dBμV/m)	Limit Line (dBμV/m)	Margin (dB)	Detector	Polarization
1	4960.00	61.94	34.92	30.24	10.09	47.17	74.00	26.83	Peak	Vertical
2	4960.00	50.36	34.92	30.24	10.09	35.59	54.00	18.41	AV <sup>[1]</sup>	Vertical
3	7440.00	69.98	38.17	31.55	13.35	50.01	74.00	23.99	Peak	Vertical
4	7440.00	60.63	38.17	31.55	13.35	40.66	54.00	13.34	AV <sup>[1]</sup>	Vertical

**Remark:**

1. Result Level = Read Level + Antenna Factor + Cable loss - PRM Factor.
2. The other emission levels were very low against the limit.
3. Margin = Limit - Emission Level.
4. The average measurement was not performed when the peak measured data under the limit of average detection.
5. Detector AV is setting spectrum/receiver. RBW=1MHz/VBW=10Hz/Sweep time=Auto/Detector=Peak;
6. "---" Mean the PK detector measured value is below average limit.

### 4.3 Duty Cycle

#### TEST CONFIGURATION



#### LIMIT

The Maximum Peak Output Power Measurement is 30dBm.

Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (i.e., with a duty cycle of greater than or equal to 98%).

When continuous transmission cannot be achieved and sweep triggering/signal gating cannot be implemented, alternate procedures are provided that can be used to measure the average power; however, they will require an additional measurement of the transmitter duty cycle. Within this guidance document, the duty cycle refers to the fraction of time over which the transmitter is on and is transmitting at its maximum power control level. The duty cycle is considered to be constant if variations are less than  $\pm 2$  percent, otherwise the duty cycle is considered to be non-constant.

#### TEST PROCEDURE

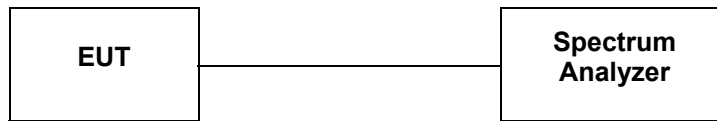
- a. A diode detector and an oscilloscope that together have sufficiently short response time to permit accurate measurements of the on and off times of the transmitted signal.
- b. The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set  $RBW \geq OBW$  if possible; otherwise, set RBW to the largest available value. Set  $VBW \geq RBW$ . Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are  $> 50/T$  and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if  $T \leq 16.7$  microseconds.)

#### TEST RESULTS

The Manufacturer provide engineer mode `*#3646633#*` to setup 100% continuous transmit for Lower power Bluetooth.

#### 4.4 Maximum Peak Output Power

##### TEST CONFIGURATION



##### TEST PROCEDURE

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  $\geq$  DTS bandwidth.
- b) Set VBW  $\geq 3 \times$  RBW.
- c) Set span  $\geq 3 \times$  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.

##### LIMIT

The Maximum Peak Output Power Measurement is 30dBm.

##### TEST RESULTS

Test Mode	Channel	Frequency (MHz)	Measured Maximum Peak Power (dBm)	Limits (dBm)	Verdict
GFSK-BLE	0	2402	-1.040	30	PASS
	19	2440	-0.561		
	39	2480	-0.533		

Remark:

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

**Maximum Peak Output Power**

Channel 0 / 2402 MHz



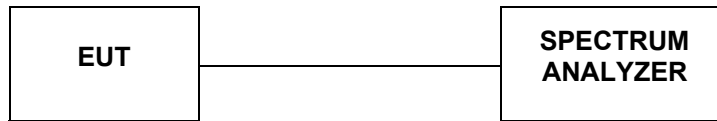
Channel 19 / 2440 MHz



Channel 39 / 2480 MHz

## 4.5 Power Spectral Density

### TEST CONFIGURATION



### TEST PROCEDURE

According to KDB 558074 D01 Method PKPSD (peak PSD) this procedure shall be used if maximum peak conducted output power was used to demonstrate compliance, and is optional if the maximum conducted (average) output power was used to demonstrate compliance.

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the DTS bandwidth.
3. Set the RBW to:  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ .
4. Set the VBW  $\geq 3 \text{ RBW}$ .
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.

### LIMIT

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.

### TEST RESULTS

Test Mode	Channel	Frequency (MHz)	Measured Peak Power Spectral Density (dBm/100KHz)	Limits (dBm/3KHz)	Verdict
GFSK-BLE	0	2402	-2.029	8	PASS
	19	2440	-1.530		
	39	2480	-1.538		

Remark:

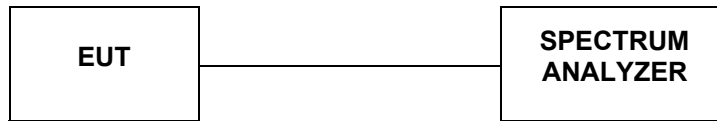
1. Test results including cable loss;
2. please refer to following plots;



**Peak Power Spectral Density****Channel 0 / 2402 MHz****Channel 19 / 2440 MHz****Channel 39 / 2480 MHz**

## 4.6 6dB Bandwidth

### TEST CONFIGURATION



### TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 KHz RBW and 300KHz VBW. The 6dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 6dB. According to KDB558074 D01 for one of the following procedures may be used to determine the modulated DTS device signal bandwidth.

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW)  $\geq 3$  RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

### LIMIT

For digital modulation systems, the minimum 6 dB bandwidth shall be at least 500 kHz.

### TEST RESULTS

Test Mode	Channel	Frequency (MHz)	Measured 6 dB Bandwidth (MHz)	Limits (MHz)	Verdict
GFSK-BLE	0	2402	0.6748	$\geq 0.5000$	PASS
	19	2440	0.6792		
	39	2480	0.6787		

Remark:

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

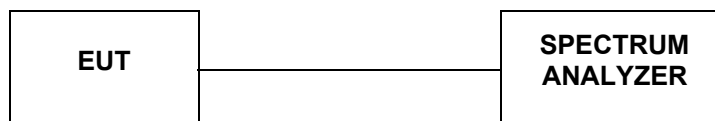
**6 dB Bandwidth****Channel 0 / 2402 MHz****Channel 19 / 2440 MHz****Channel 39 / 2480 MHz**

## 4.7 Band-edge Measurements for Radiated Emissions

### TEST REQUIREMENT

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 CONFIGURATION



### TEST PROCEDURE

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 a 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=10Hz 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  $\leq 30$  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:  

$$E = \text{EIRP} - 20\log D + 104.8$$

where:

E = electric field strength in dB $\mu$ V/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 dures until all measured frequencies were complete.

**LIMIT**

Below -20dB of the highest emission level in operating band.

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)

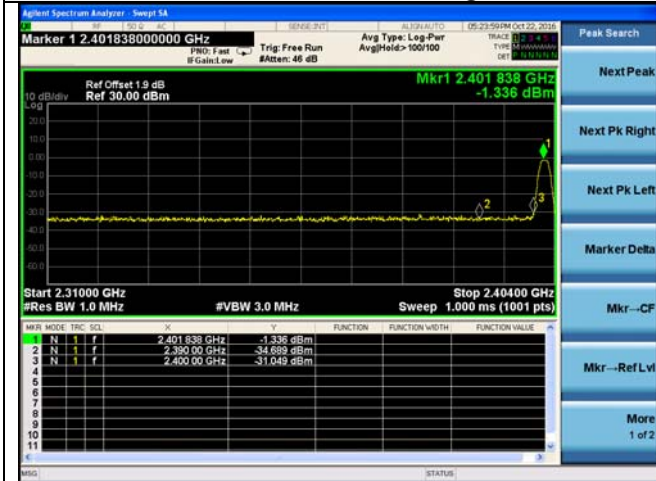
**TEST RESULTS**

<b>GFSK – BLE</b>							
<b>Frequency (MHz)</b>	<b>Conducted Power (dBm)</b>	<b>Antenna Gain (dBi)</b>	<b>Ground Reflection Factor (dB)</b>	<b>Covert Radiated E Level At 3m (dBuV/m)</b>	<b>Detector</b>	<b>Limit (dBuV/m)</b>	<b>Verdict</b>
2390.000	-34.289	2.00	0.00	62.969	Peak	74.00	PASS
2390.000	-45.047	2.00	0.00	52.211	AV	54.00	PASS
2401.838	-1.336	2.00	0.00	95.922	Peak	---	PASS
2401.838	-19.131	2.00	0.00	78.127	AV	---	PASS
2480.160	-1.292	2.00	0.00	95.966	Peak	---	PASS
2480.016	-18.617	2.00	0.00	78.641	AV	---	PASS
2483.50	-32.796	2.00	0.00	64.462	Peak	74.00	PASS
2483.5	-44.857	2.00	0.00	52.401	AV	54.00	PASS

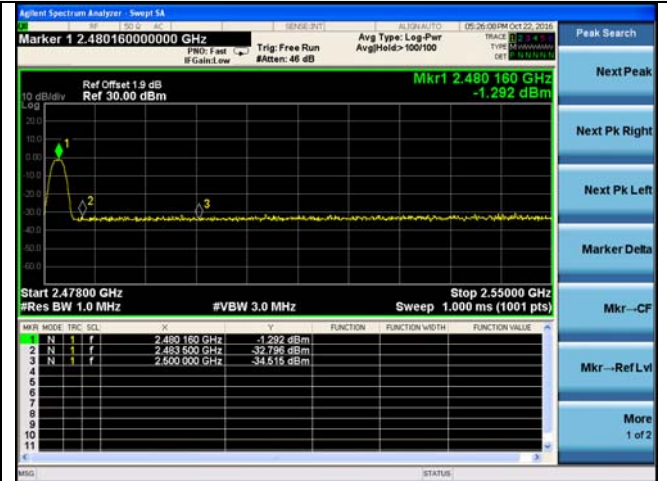
**Remark:**

1. Test results including cable loss;
2. “---“ means that the fundamental frequency not for 15.209 limits requirement.
3. please refer to following plots;

### Band-edge Measurements for Radiated Emissions



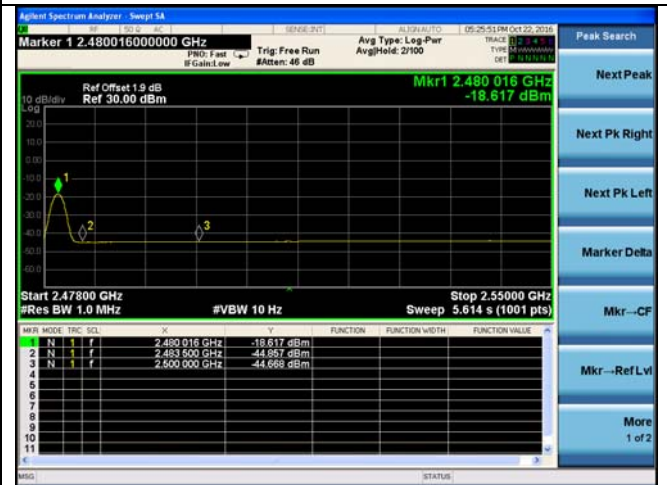
Channel 0 / 2402 MHz – Peak



Channel 39 / 2480 MHz – Peak



Channel 0 / 2402 MHz – Average



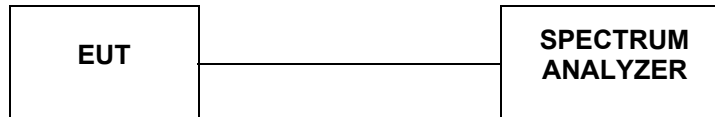
Channel 39 / 2480 MHz – Average

## 4.8 Band-edge Measurements for RF Conducted Emissions

### LIMIT

1. Below -20dB of the highest emission level in operating band.
2. Fall in the restricted bands listed in section 15.205. The maximum permitted average field strength is listed in section 15.209.

### TEST CONFIGURATION



### TEST PROCEDURE

According to KDB 558074 D01 for Antenna-port conducted measurement.

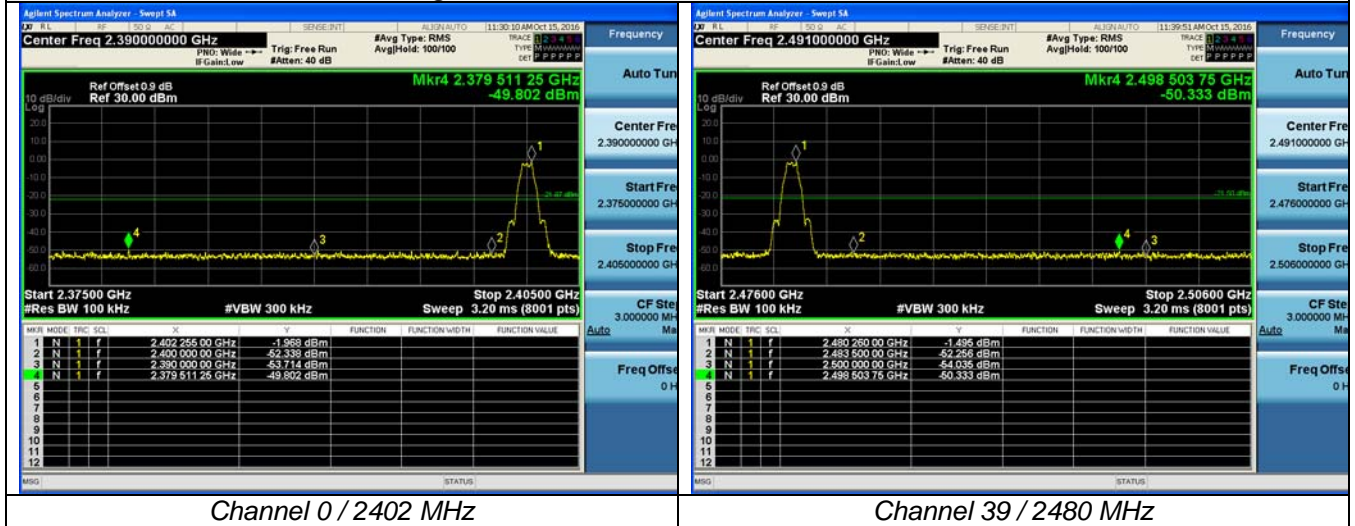
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting 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,
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).

### TEST RESULTS

Test Mode	Channel	Frequency (MHz)	Conductd Band-edge Emission (dBc)	Limits (dBc)	Verdict
GFSK-BLE	0	2402	<-20dBc	-20	PASS
	39	2480	<-20dBc	-20	

Remark:

1. Test results including cable loss;
2. “---” means that the fundamental frequency not for 15.209 limits requirement.
3. please refer to following plots;

**Band-edge Measurements for RF Conducted Emissions**



## 4.9 Spurious RF Conducted Emission

### TEST CONFIGURATION



### TEST PROCEDURE

The Spurious RF conducted emissions compliance of RF radiated emission should be measured by following the guidance in ANSI C63.10-2013 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization etc. Set RBW=100 kHz and VBW= 300 KHz to measure the peak field strength, and measure frequency range from 9 KHz to 25GHz.

### LIMIT

1. Below -20dB of the highest emission level in operating band.
2. Fall in the restricted bands listed in section 15.205. The maximum permitted average field strength is listed in section 15.209.

### TEST RESULTS

1. Below -20dB of the highest emission level in operating band.
2. Fall in the restricted bands listed in section 15.205. The maximum permitted average field strength is listed in section 15.209.

### TEST RESULTS

Test Mode	Channel	Frequency (MHz)	Spurious RF Conducted Emission (dBc)	Limits (dBc)	Verdict
GFSL-BLE	0	2402	<-20dBc	-20	PASS
	19	2440	<-20dBc	-20	
	39	2480	<-20dBc	-20	

#### *Remark:*

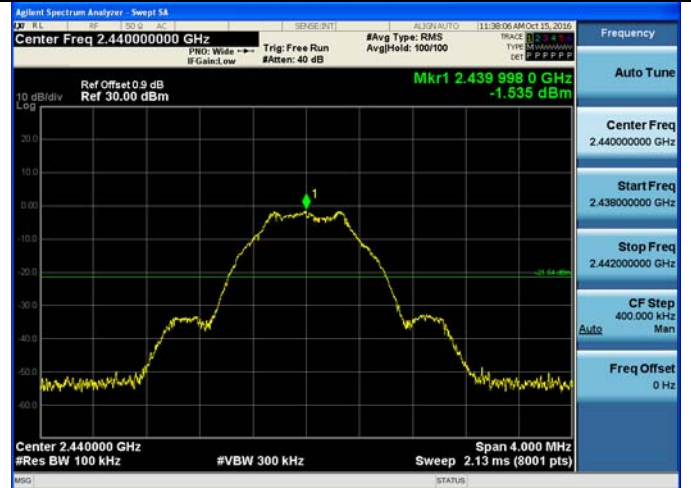
1. *Test results including cable loss;*
2. *“---“ means that the fundamental frequency not for 15.209 limits requirement.*
3. *please refer to following plots;*

### Spurious RF Conducted Emissions

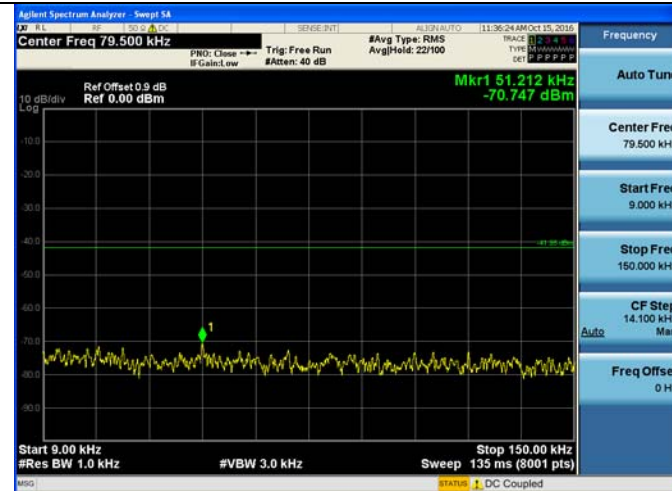
Channel 0 / 2402 MHz



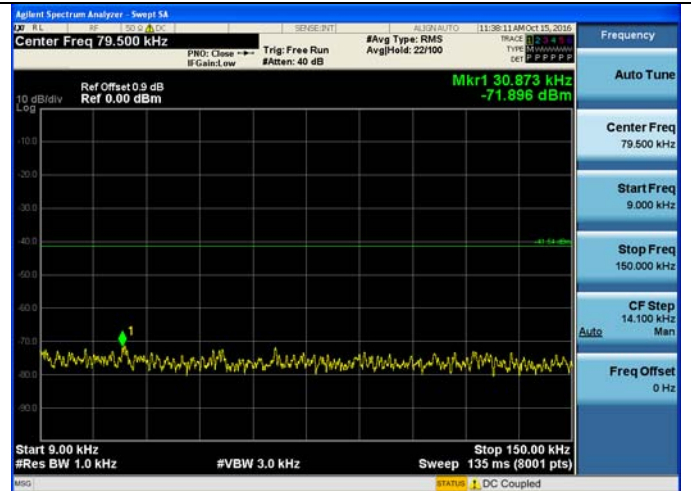
Channel 19 / 2440 MHz



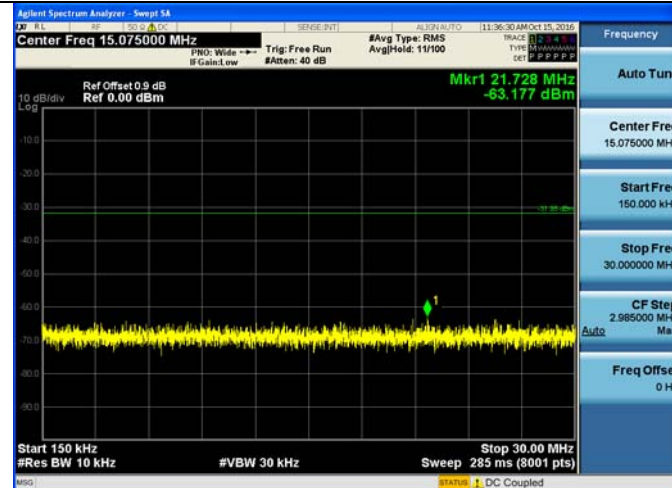
2400 – 2404 MHz



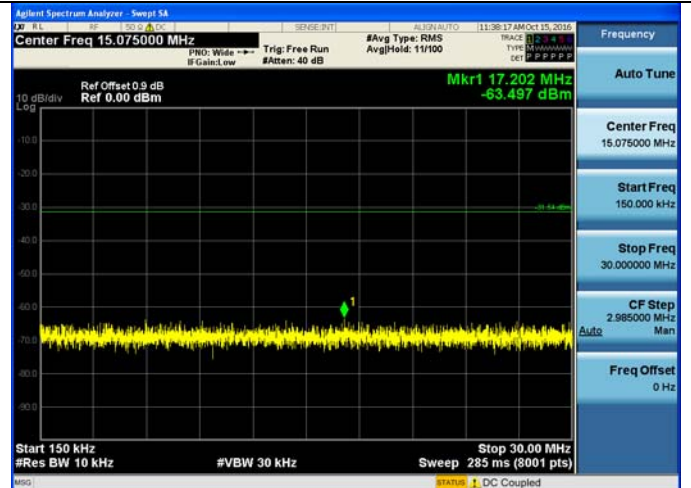
2438 – 2442 MHz



9 KHz – 150 KHz



9 KHz – 150 KHz

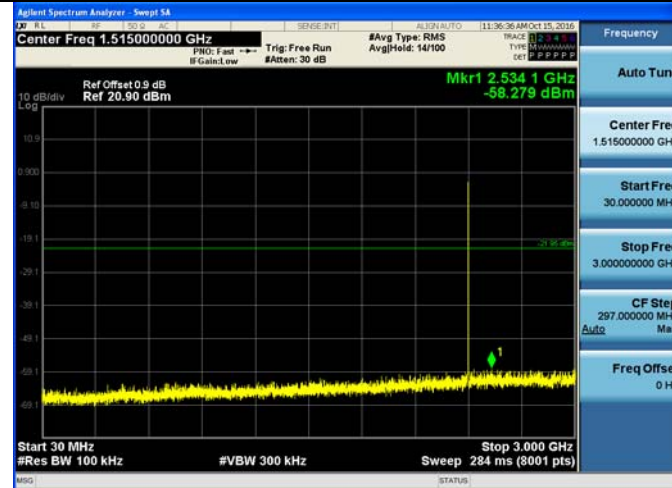


150 KHz – 30 MHz

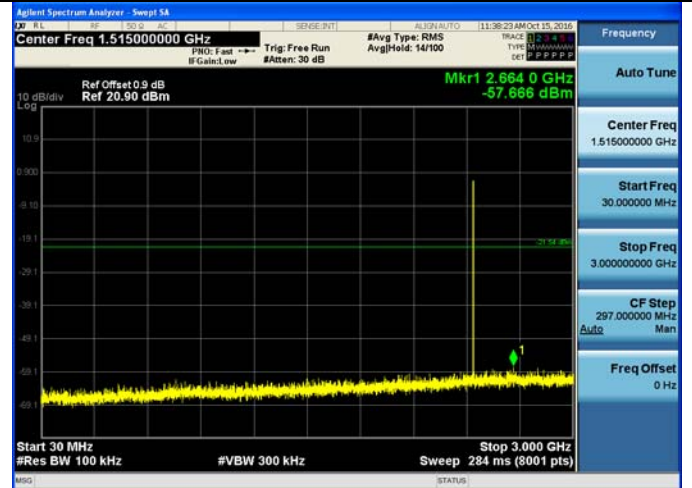
150 KHz – 30 MHz

### Spurious RF Conducted Emissions

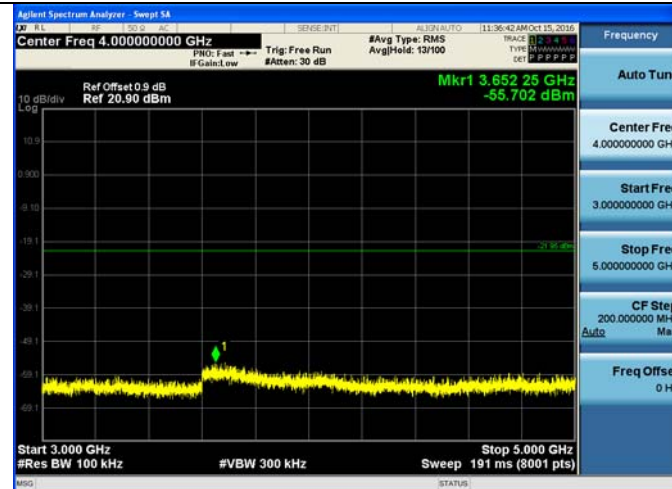
Channel 0 / 2402 MHz



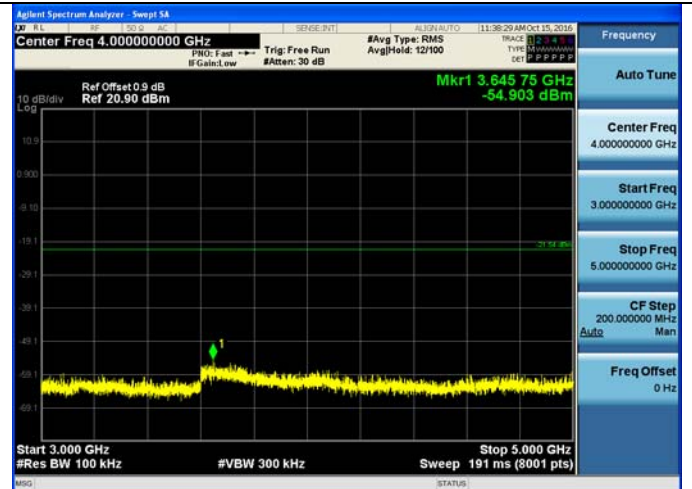
Channel 19 / 2440 MHz



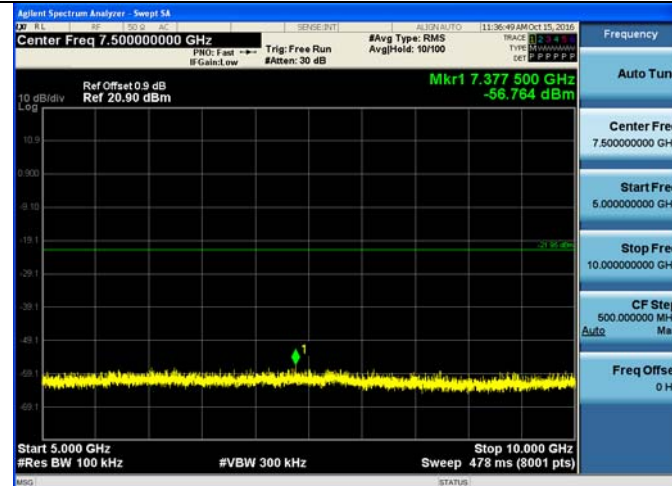
30 MHz – 3 GHz



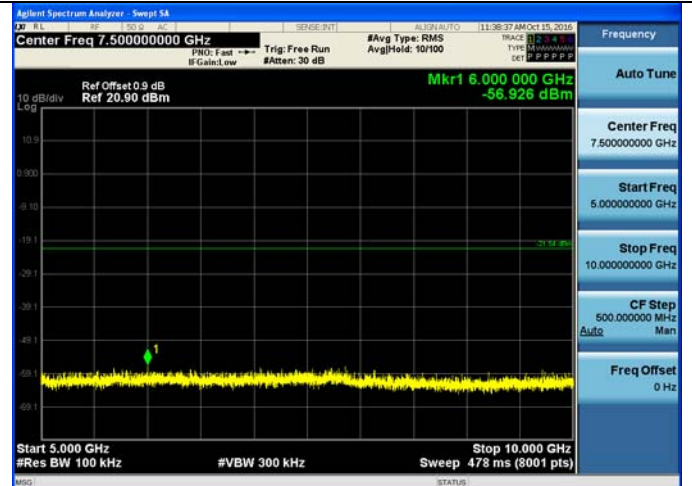
30 MHz – 3 GHz



3 GHz – 5GHz



3 GHz – 5GHz



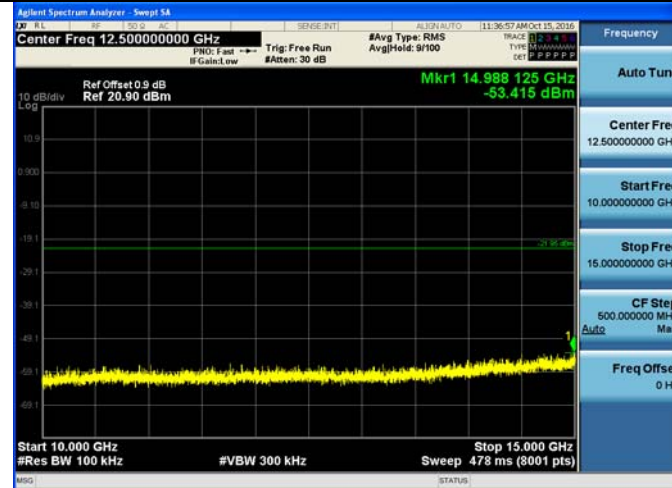
5 GHz – 10GHz

5 GHz – 10GHz

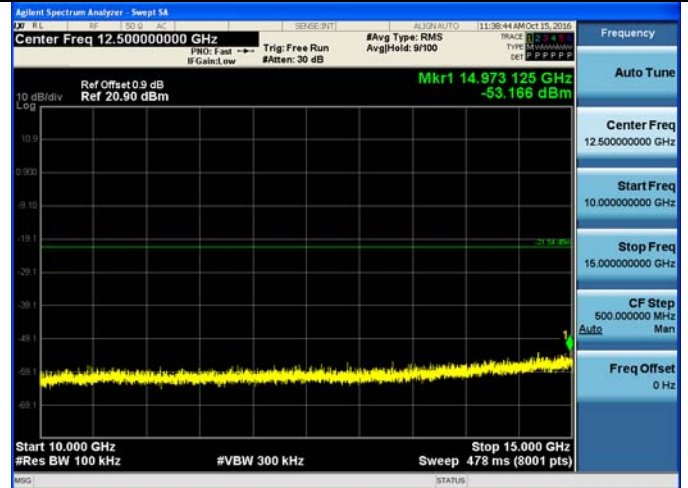


### Spurious RF Conducted Emissions

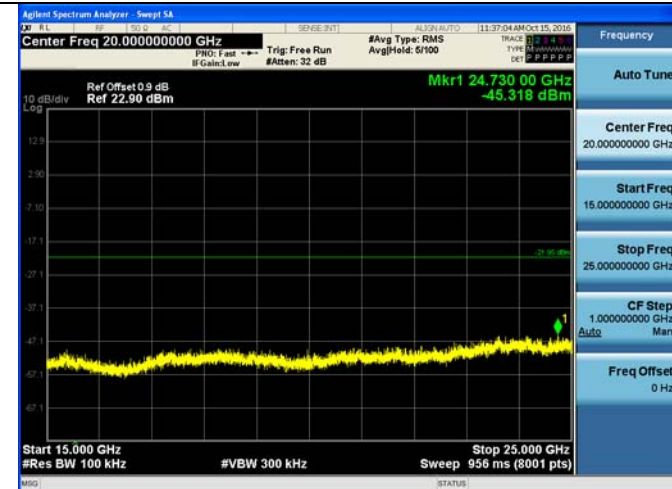
Channel 0 / 2402 MHz



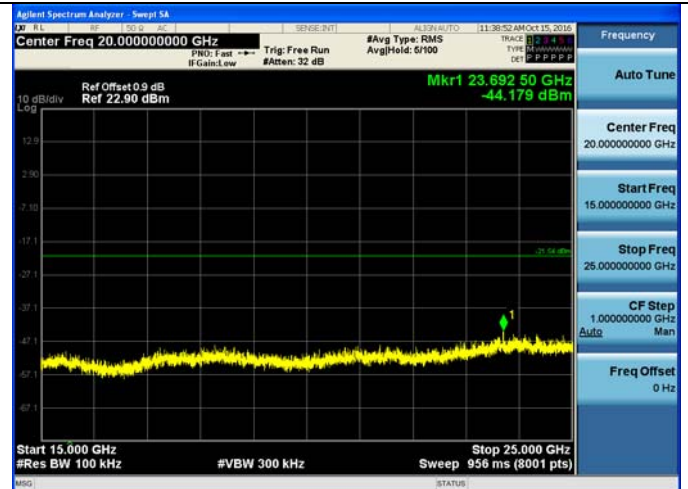
Channel 19 / 2440 MHz



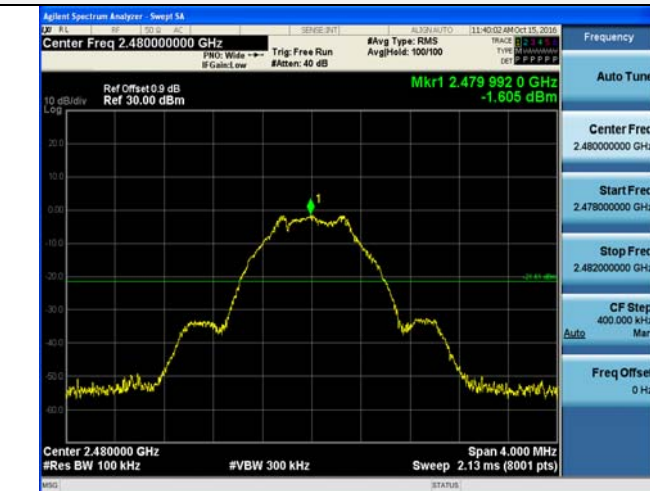
10 GHz – 15 GHz



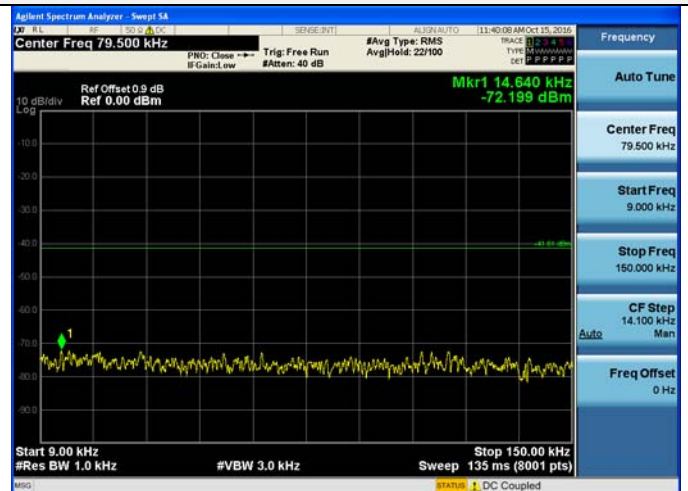
10 GHz – 15 GHz



15 GHz – 20 GHz  
Channel 39 / 2480 MHz



15 GHz – 20 GHz  
Channel 39 / 2480 MHz

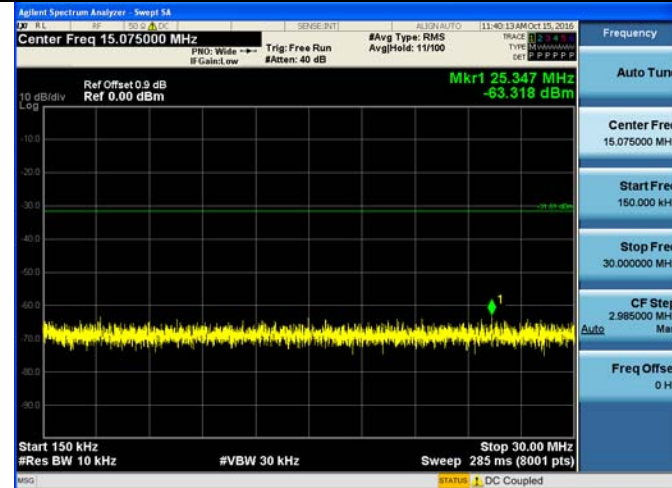


2478 MHz – 2482 MHz

9 KHz – 150 KHz

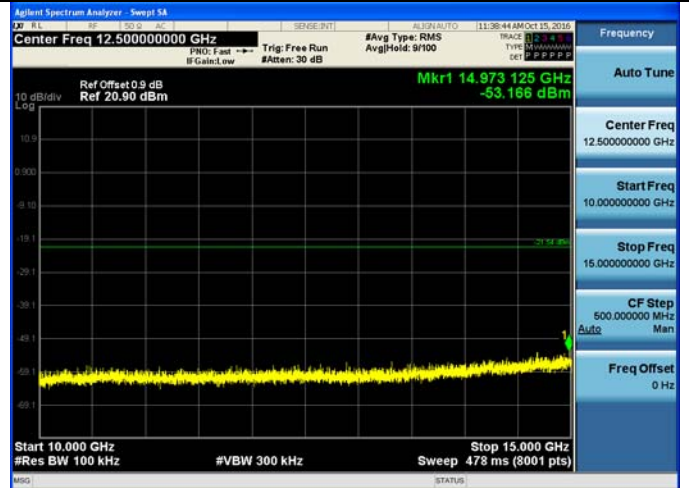
# Spurious RF Conducted Emissions

Channel 39 / 2480 MHz

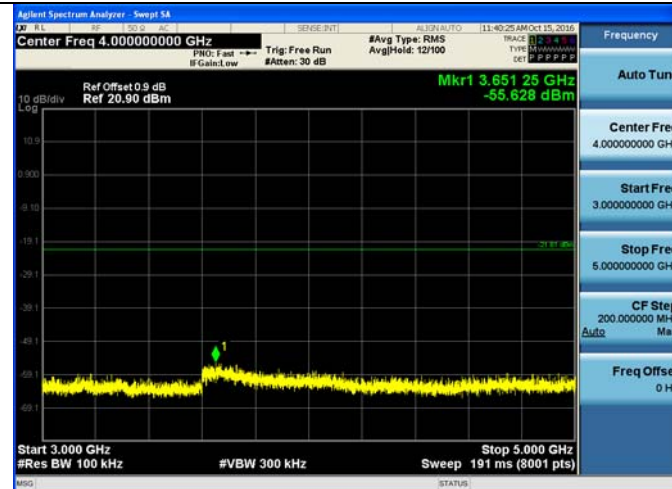


150 KHz – 30 MHz

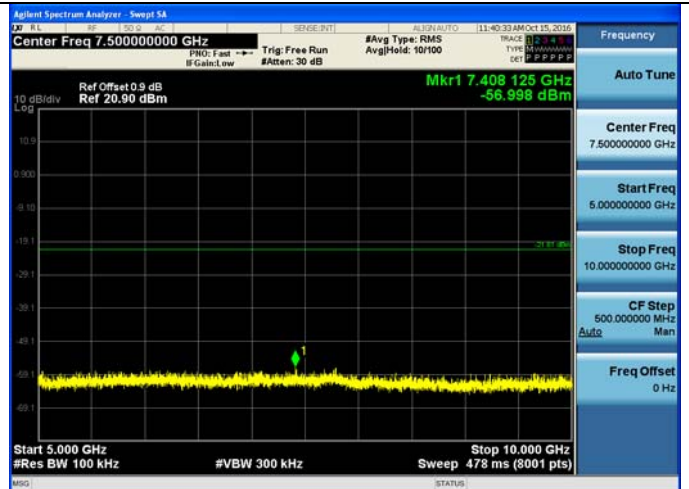
Channel 39 / 2480 MHz



30 MHz – 3 GHz



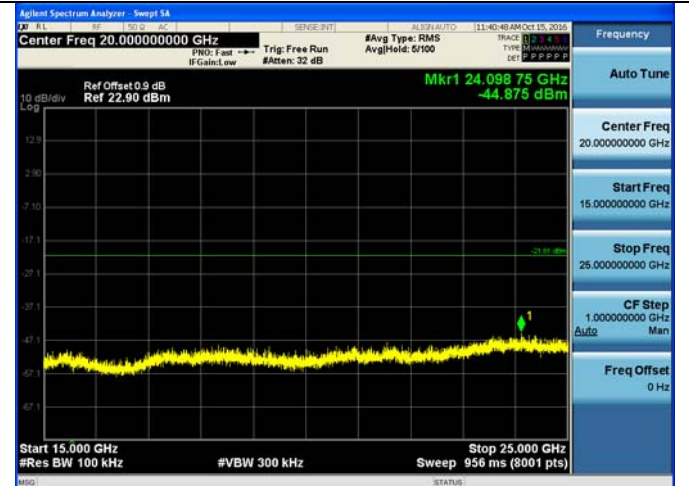
3 GHz – 5 GHz



5 GHz – 10 GHz



10 GHz – 15 GHz



15 GHz – 20 GHz

## 4.10 Antenna Requirement

### Standard Applicable

For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

And according to FCC 47 CFR Section 15.247 (c), if 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 6dBi.

### Refer to statement below for compliance

The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited. Further, this requirement does not apply to intentional radiators that must be professionally installed.

### Antenna Connected Construction

According to § 15.203 & RSS-Gen, 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.

### Antenna Connector Construction

The directional gains of antenna used for transmitting is 0 dBi, and the antenna is an internal antenna connect to PCB board and no consideration of replacement. Please see EUT photo for details.  
The WLAN and Bluetooth share same antenna.

### 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 refer ANSI C63.10 :2013 Output power test procedure for DTS devices

Radiated power refer 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

### Limits

FCC	IC
Antenna Gain	
6 dBi	

### Results

T <sub>nom</sub>	V <sub>nom</sub>	Lowest Channel 2402 MHz	Middle Channel 2440 MHz	Highest Channel 2480 MHz
Conducted power [dBm] Measured with GFSK modulation		-1.040	-0.561	-0.533
Radiated power [dBm] Measured with GFSK modulation		-2.502	-1.584	-2.319
Gain [dBi] Calculated		-1.462	-1.023	-1.786
Measurement uncertainty		± 0.6 dB (cond.) / ± 2.56 dB (rad.)		

## **5 Test Setup Photos of the EUT**

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

## **6 External Photos of the EUT**

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

## **7 Internal Photos of the EUT**

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

.....**End of Report**.....