Prüfbericht - Produkte
Test Report - Products

TÜVRheinland®

Prüfbericht-Nr.: *Test report no.:*	**CN21Q0V2 001**	**Auftrags-Nr.:** *Order no.:*	168345996	Seite 1 von 22 *Page 1 of 22*
Kunden-Referenz-Nr.: *Client reference no.:*	N/A	**Auftragsdatum:** *Order date:*	2021-11-26	
Auftraggeber: *Client:*	**Shenzhen RAKwireless Technology Co., Ltd.** Room 506, Bldg B, New Compark, Pingshan First Road, Taoyuan Street, XiLi Town Nanshan District, Shenzhen, Guangdong, P.R. China			
Prüfgegenstand: *Test item:*	Bluetooth Module			
Bezeichnung / Typ-Nr.: *Identification / Type no.:*	RAK13401			
Auftrags-Inhalt: *Order content:*	FCC and IC approval			
Prüfgrundlage: *Test specification:*	CFR47 FCC Part 15: Subpart C Section 15.247 CFR47 FCC Part 15: Subpart C Section 15.207 CFR47 FCC Part 15: Subpart C Section 15.209 CFR47 FCC Part 2.1093		RSS-247 Issue 2 February 2017 RSS-Gen Issue 5 February 2021 RSS-102 Issue 5 February 2021	

Wareneingangsdatum: *Date of sample receipt:*	2021-12-03	Please refer to photo documents
Prüfmuster-Nr.: *Test sample no.:*	A003177078-002 to 006	
Prüfzeitraum: *Testing period:*	2021-12-15 – 2021-12-23	
Ort der Prüfung: *Place of testing:*	TÜV Rheinland (Shenzhen) Co., Ltd.	
Prüflaboratorium: *Testing laboratory:*	TÜV Rheinland (Shenzhen) Co., Ltd.	
Prüfergebnis*: *Test result*:*	Pass	

geprüft von: *tested by:*	X Alex Lan	**genehmigt von:** *authorized by:*	X Winnie Hou
Datum: *Date:* 2021-01-04	Signed by: Alex Lan	**Ausstellungsdatum:** *Issue date:* 2021-01-04	Signed by: Winnie Hou
Stellung / Position	Senior Project Engineer	**Stellung** / Position	Department Manager

Sonstiges / *Other:*

FCC ID: 2AF6B-RAK13401
IC: 25908-RAK13401 HVIN: RAK13401

Zustand des Prüfgegenstandes bei Anlieferung: *Condition of the test item at delivery:*	Prüfmuster vollständig und unbeschädigt *Test item complete and undamaged:*

* Legende:	1 = sehr gut	2 = gut	3 = befriedigend	4 = ausreichend	5 = mangelhalt
	P(ass) = entspricht o.g. Prüfgrundlage(n)		F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
Legend:	*1 = very good*	*2 = good*	*3 = satisfactory*	*4 = sufficient*	*5 = poor*
	P(ass) = passed a.m. test specifications(s)		*F(ail) = failed a.m. test specifications(s)*	*N/A = not applicable*	*N/T = not tested*

TÜV Rheinland (Shenzhen) Co., Ltd. 1601 R&D Room, 1602-1604, 17-18F, Building 7 Site C, Vanke Cloud City Phase I, Xingke First Street, Xili Street, Xili Community, Nanshan District, Shenzhen 518052, P.R. China
Mail: service@de.tuv.com · Web: www.tuv.com

Test Summary

5.1.1 ANTENNA REQUIREMENT
RESULT: Pass

5.1.2 MAXIMUM CONDUCTED OUTPUT POWER
RESULT: Pass

5.1.3 CONDUCTED POWER SPECTRAL DENSITY
RESULT: Pass

5.1.4 99%DB BANDWIDTH
RESULT: Pass

5.1.5 6DB BANDWIDTH
RESULT: Pass

5.1.6 CONDUCTED SPURIOUS EMISSIONS MEASURED IN 100 KHZ BANDWIDTH
RESULT: Pass

5.1.7 RADIATED SPURIOUS EMISSION
RESULT: Pass

5.1.8 CONDUCTED EMISSION ON AC MAINS
RESULT: Pass

6.1.1 ELECTROMAGNETIC FIELDS
RESULT: Pass

Contents

1 General Remarks

1.1 Complementary Materials

All attachments are integral parts of this test report. This applies especially to the following appendix:

Appendix A: Photographs of the Test Set-up

Appendix B: Test Results of Conducted & Radiated Testing

2 Test Sites

2.1 Test Facilities

TÜV Rheinland (Shenzhen) Co., Ltd.

No. 362 Huanguan Road Middle, Longhua District, Shenzhen 518110, People's Republic of China

FCC Registration No.: 694916

IC Registration No.: 25069, CAB identifier: CN0078

2.2 List of Test and Measurement Instruments

Table 1: List of Test and Measurement Equipment

Radio Spectrum Testing				
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Cal. Until**
EXA Signal Analyzer, Multi-touch	Keysight	N9010B	MY60241175	28.09.2022
MXG X-Series RF Vector Signal Generator	Keysight	N5182B	MY61250137	28.09.2022
EXG X-Series Microwave Analog Signal Generator	Keysight	N5173B	MY61250141	28.09.2022
DC Power Supply	Keysight	E3642A	MY61276100	28.09.2022
Wireless Connectivity Tester	R&S	CMW270	102505	28.09.2022
Power Control Unit	Tonscend	JS0806-4ADC	N/A	28.09.2022
Automation Control Unit	Tonscend	JS0806-2	21C8060396	28.09.2022
Test Software	Tonscend	JS1120-3	N/A	N/A
Control PC	Lenovo	TianYi510S-071MB	YLX23JMF	N/A
Unwanted Emission Testing				
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Cal. Until**
EMI Test Receiver	R&S	ESR 7	102021	10.08.2022
Signal Analyzer	R&S	FSV 40	101439	09.08.2022
System Controller Interface	R&S	SCI-100	S10010038	N/A
Filterbank	R&S	Wlan	100759	09.08.2022
OSP	R&S	OSP 120	102040	N/A
Pre-amplifier	R&S	SCU08F1	08320031	09.08.2022
Amplifier	R&S	SCU-18F	180070	09.08.2022
Amplifier	R&S	SCU40A	100475	09.08.2022
Trilog Broadband Antenna (30 MHz - 7 GHz)	Schwarzbeck	VULB 9162	193	08.08.2022
Double-Ridged Antenna (1 -18 GHz)	ETS-LINDGREN	3117	00218717	08.08.2022
Wideband Ridged Horn Antenna (18-40 GHz)	Steatite	QMS-00880	19067	08.08.2022
Active Loop Antenna	Schwarzbeck	FMZB 1513	302	13.09.2022
Test software	R&S	EMC32 (V10.60.10)	N/A	N/A
Control PC	Dell	OptiPlex 7050	36NV9P2	N/A

3m Semi-Anechoic Chamber	Albatross	SAC-3m	APC17151-SAC	22.06.2024
Conducted Emissions testing				
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Cal. Until**
EMI Test Receiver	R&S	ESR3	102428	19.05.2022
Artificial Mains Network	R&S	ENV216	102333	19.05.2022
EMC32 test software	R&S	EMC32(Ver.10.50.01)	N/A	N/A

2.3 Traceability

All measurement equipment calibrations are traceable to NIM (National Institute of Metrology) or where calibration is performed in other countries, to equivalent nationally recognized standards organizations.

2.4 Calibration

Equipment requiring calibration is calibrated periodically by the manufacturer or according to manufacturer's specifications. Additionally all equipment is verified for proper performance on a regular basics using in house standards or comparisons.

2.5 Measurement Uncertainty

The estimated combined standard uncertainty for radiated emissions and conducted emissions measurements as below table.

Item		Extended Uncertainty
Conducted Emission		± 2.74 dB
Radiated Emission (30-1000MHz)	Field strength (dBμV/m)	4.27dB
Radiated Emission (above 1000MHz)	Field strength (dBμV/m)	4.46dB
Radio Spectrum		± 1.5 dB

2.6 Location of Original Data

The original copies of all test data taken during actual testing were attached at Appendix A & B of this report and delivered to the applicant. A copy has been retained in the TÜV Rheinland (Shenzhen) file for certification follow-up purposes.

2.7 Status of Facility Used for Testing

The TÜV Rheinland (Shenzhen) Co., Ltd. Test facility located at No. 362 Huanguan Road Middle, Longhua District, Shenzhen 518110, People's Republic of China. is listed on the US Federal Communications Commission list of facilities approved to perform measurements.

3 General Product Information

3.1 Product Function and Intended Use

The EUT is a Bluetooth Module, it supports Bluetooth Low Energy wireless technology.

For details refer to the User Manual, Technical Description and Circuit Diagram.

3.2 Ratings and System Details

Table 2: Technical Specification of EUT

General Information of EUT	Value
Kind of Equipment	Bluetooth Module
Type Designation	RAK13401
FCC ID	2AF6B-RAK13401
IC	25908-RAK13401
HVIN	RAK13401
Operating Voltage	DC 3.63V Max. (Supplied by socket of PCB board)
Testing Voltage	DC 5V via USB interface
Technical Specification of Bluetooth Low Energy	
Operating Frequency	2402 – 2480 MHz
Data rate	1Mbps
Channel Number	40 channels
Channel separation	2MHz
Modulation	GFSK
Antenna Type	ceramic chip antenna
Smart Antenna Systems:	Not Applicable
Number of Antenna	1
Antenna Gain	1.8 dBi

Table 3: RF Channel and Frequency of Bluetooth Low Energy

RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)
00	**2402.00**	10	2422.00	20	2442.00	30	2462.00
01	2404.00	11	2424.00	21	2444.00	31	2464.00
02	2406.00	12	2426.00	22	2446.00	32	2466.00
03	2408.00	13	2428.00	23	2448.00	33	2468.00
04	2410.00	14	2430.00	24	2450.00	34	2470.00
05	2412.00	15	2432.00	25	2452.00	35	2472.00
06	2414.00	16	2434.00	26	2454.00	36	2474.00
07	2416.00	17	2436.00	27	2456.00	37	2476.00
08	2418.00	18	2438.00	28	2458.00	38	2478.00
09	2420.00	**19**	**2440.00**	29	2460.00	**39**	**2480.00**

3.3 Independent Operation Modes

The basic operation modes are:

A. On, transmitting mode
    1. Low channel
    2. Middle channel
    3. High channel

B. On, Operating

C. Off

3.4 Noise Generating and Noise Suppressing Parts

Refer to Circuit Diagram for further details.

3.5 Submitted Documents

- Application Form
- Block Diagram
- FCC/IC Label and Location Info
- Operation Description
- Photo Document
- Schematics
- User Manual

4 Test Set-up and Operation Modes

4.1 Principle of Configuration Selection

Radio Spectrum: The equipment under test (EUT) was configured at its highest power output in order to measure its highest possible radiation and conducted level. The test modes were adapted accordingly in reference to the instructions for use.

Emission: The equipment under test (EUT) was configured to measure its highest possible radiation level. The test modes were adapted accordingly in reference to the instructions for use.

4.2 Test Operation and Test Software

Test operation refers to test setup in chapter 5. All testing were performed according to the procedures in ANSI C63.10: 2013.

4.3 Special Accessories and Auxiliary Equipment

Table 4: List of Accessories and Auxiliary Equipment

Description	Manufacturer	Model	S/N
Notebook	Lenovo	ThinkPad X260	N/A

4.4 Countermeasures to Achieve EMC Compliance

The test sample which has been tested contained the noise suppression parts as described in the Technical Construction File (TCF).

No additional measures were employed to achieve compliance.

4.5 Test Setup Diagram

Diagram of Measurement Configuration for Radiation Test (Below 30MHz)

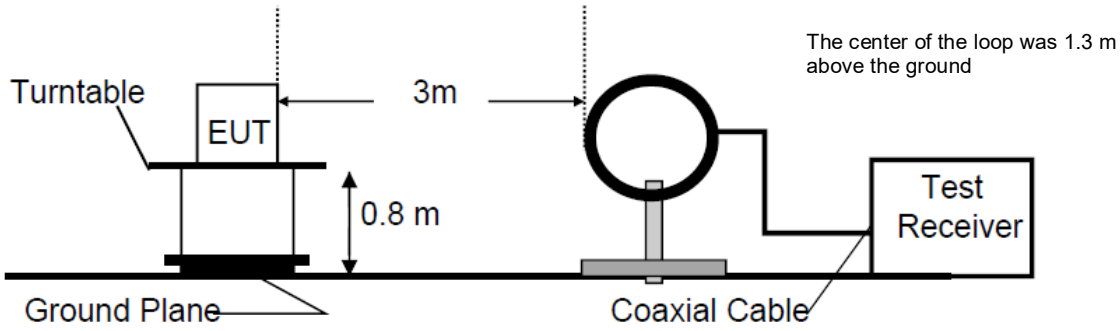


Diagram of Measurement Configuration for Radiation Test (Below 1GHz)

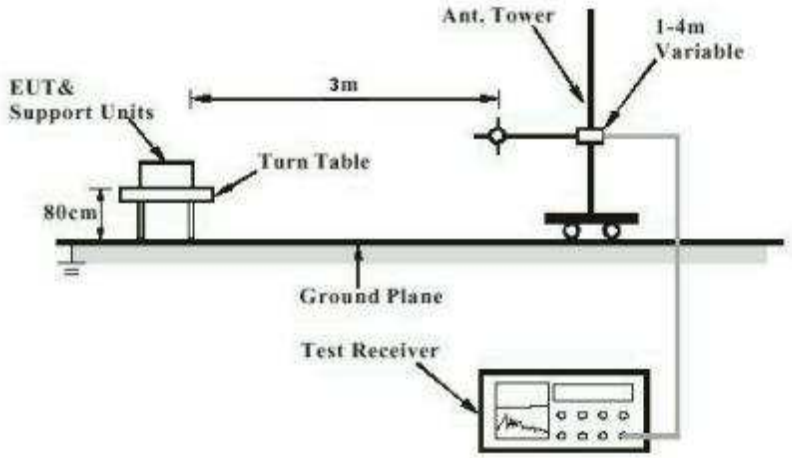


Diagram of Measurement Configuration for Radiation Test (Above 1GHz)

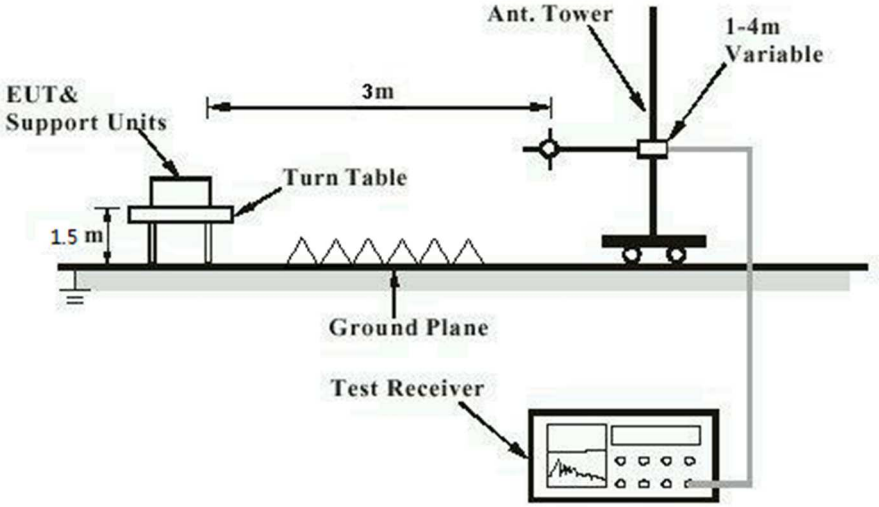


Diagram of Measurement Configuration for Mains Conduction Measurement

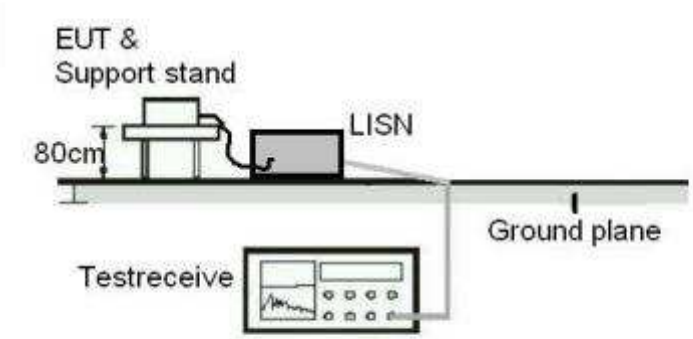
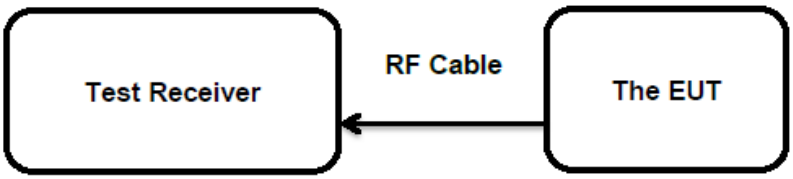


Diagram of Measurement Configuration for Conducted Transmitter Measurement



5 Test Results

5.1 Transmitter Requirement & Test Suites

5.1.1 Antenna Requirement

RESULT: **Pass**

Test Specification

Test standard	:	FCC Part 15.247(b)(4) and Part 15.203 RSS-Gen Clause 6.7
Limit	:	the use of antennas with directional gains that do not exceed 6 dBi

According to the manufacturer declared, the EUT has an ceramic chip antenna , the directional gain of antenna is 1.8 dBi, and the antenna connector is designed with permanent attachment and no consideration of replacement. Therefore the EUT is considered sufficient to comply with the provision.

Refer to EUT Photo for further details.

5.1.2 Maximum Conducted Output Power

RESULT: **Pass**

Test Specification

Test standard	:	FCC Part 15.247(b)(3) RSS-247 Clause 5.4(d)
Basic standard	:	ANSI C63.10: 2013
Limits	:	< 1 Watt (Maximum Conducted Peak Power) e.i.r.p. <4W
Kind of test site	:	Shielded Room

Test Setup

Date of testing	:	2021-12-15
Input voltage	:	DC 5V
Operation mode	:	A
Test channel	:	Low / Middle / High
Ambient temperature	:	24.8 ℃
Relative humidity	:	55 %
Atmospheric pressure	:	101 kPa

For details refer to following test result.

Table 5: Test Result of Maximum Conducted Output Power, 1Mbps

Channel	Channel Frequency (MHz)	Conducted Peak Output Power		Limit
		(dBm)	(W)	(W)
Low Channel	2402	4.83	0.00304	1
Middle Channel	2440	4.46	0.00279	1
High Channel	2480	4.91	0.00310	1

Channel	Channel Frequency (MHz)	Conducted Average Output Power		Limit
		(dBm)	(W)	(W)
Low Channel	2402	4.51	0.00282	1
Middle Channel	2440	4.14	0.00259	1
High Channel	2480	4.60	0.00288	1

Note: The cable loss is taken into account in results and the e.i.r.p. is 6.71 dBm less than 4W (36 dBm).

5.1.3 Conducted Power Spectral Density

RESULT: **Pass**

Test Specification

Test standard	:	FCC Part 15.247(e) RSS-247 Clause 5.2(b)
Basic standard	:	ANSI C63.10: 2013
Limits	:	8 dBm / 3kHz
Kind of test site	:	Shielded Room

Test Setup

Date of testing	:	2021-12-15
Input voltage	:	DC 5V
Operation mode	:	A
Test channel	:	Low / Middle / High
Ambient temperature	:	24.8 ℃
Relative humidity	:	55 %
Atmospheric pressure	:	101 kPa

For details refer to following test result.

Table 6: Test Result of Power Spectral Density, 1Mbps

Channel	Channel Frequency (MHz)	Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)
Low Channel	2402	-11.91	8
Middle Channel	2440	-12.02	8
High Channel	2480	-11.64	8

Note: The cable loss is taken into account in results.

For the measurement records, refer to the appendix B.

5.1.4 99%dB Bandwidth

RESULT: **Pass**

Test Specification

Test standard	:	RSS-Gen clause 6.7
Basic standard	:	ANSI C63.10: 2013
Kind of test site	:	Shielded Room

Test Setup

Date of testing	:	2021-12-15
Input voltage	:	DC 5V
Operation mode	:	A
Test channel	:	Low / Middle / High
Ambient temperature	:	24.8 ℃
Relative humidity	:	55 %
Atmospheric pressure	:	101 kPa

Table 7: Test Result of 99% Bandwidth, 1Mbps

Channel	Channel Frequency (MHz)	99% Bandwidth (MHz)	Limit (MHz)	Result
Low Channel	2402	1.0602	/	Pass
Mid Channel	2440	1.0639	/	Pass
High Channel	2480	1.0669	/	Pass

For the measurement records, refer to the appendix B.

5.1.5 6dB Bandwidth

RESULT: **Pass**

Test Specification

Test standard	:	FCC Part 15.247(a)(2) RSS-247 Clause 5.2(a)
Basic standard	:	ANSI C63.10: 2013
Kind of test site	:	Shielded Room

Test Setup

Date of testing	:	2021-12-15
Input voltage	:	DC 5V
Operation mode	:	A
Test channel	:	Low / Middle / High
Ambient temperature	:	24.8 ℃
Relative humidity	:	55 %
Atmospheric pressure	:	101 kPa

Table 8: Test Result of 6dB Bandwidth, 1Mbps

Channel	Channel Frequency (MHz)	-6dB Bandwidth (kHz)	Limit (kHz)	Result
Low Channel	2402	776	500	Pass
Mid Channel	2440	768	500	Pass
High Channel	2480	768	500	Pass

For the measurement records, refer to the appendix B.

5.1.6 Conducted Spurious Emissions Measured in 100 kHz Bandwidth

RESULT: **Pass**

Test Specification

Test standard	:	FCC Part 15.247(d) RSS-247 Clause 5.5
Basic standard	:	ANSI C63.10: 2013
Limits	:	20dB (below that in the 100kHz bandwidth within the band that contains the highest level of the desired power); In addition, radiated emissions which fall in the restricted bands, must also comply with the radiated emission limits specified in 15.209(a)
Kind of test site	:	Shielded Room

Test Setup

Date of testing	:	2021-12-15
Input voltage	:	DC 5V
Operation mode	:	A
Test channel	:	Low / Middle / High
Ambient temperature	:	24.8 ℃
Relative humidity	:	55 %
Atmospheric pressure	:	101 kPa

Test results of 100kHz Bandwidth of Frequency Band Edge by Conducted method refer to test plots, and compliance is achieved as well.

For the measurement records, refer to the appendix B.

5.1.7 Radiated Spurious Emission

RESULT: **Pass**

Test Specification

Test standard	:	FCC Part 15.247(d) & FCC Part 15.205 RSS-247 Clause 3.3 & 5.5
Basic standard	:	ANSI C63.10: 2013
Limits	:	Refer to 15.209(a) of FCC part 15.247(d) RSS-Gen Table 4 & Table 5
Kind of test site	:	3m Semi-anechoic Chamber

Test Setup

Date of testing	:	2021-12-22
Input voltage	:	DC 5V
Operation mode	:	A
Test channel	:	Low / Middle / High
Ambient temperature	:	22 ℃
Relative humidity	:	52 %
Atmospheric pressure	:	101 kPa

Remark:
Testing was carried out within frequency range 9kHz to the tenth harmonics. Only the worst case spurious emissions configuration of the each mode were reported.

For the measurement records, refer to the appendix B.

5.1.8 Conducted Emission on AC Mains

RESULT: **Pass**

Test Specification

Test standard	:	FCC Part 15.207(a) RSS-Gen Clause 8.8
Basic standard	:	ANSI C63.10: 2013
Frequency range	:	0.15 – 30MHz
Limits	:	FCC Part 15.207(a) RSS-Gen Table 4
Kind of test site	:	Shielded Room

Test Setup

Date of testing	:	2021-12-23
Input voltage	:	AC 120V/60Hz
Operation mode	:	B
Earthing	:	Not connected
Ambient temperature	:	24.8 ℃
Relative humidity	:	55 %
Atmospheric pressure	:	101 kPa

For the measurement records, refer to the appendix B.

6 Safety Human Exposure

6.1 Radio Frequency Exposure Compliance

6.1.1 Electromagnetic Fields

RESULT: **Pass**

Test Specification

Test standard : FCC KDB Publication 447498 v06
CFR47 FCC Part 2: Section 2.1093
CFR47 FCC Part 1: Section 1.1310
RSS-102 Issue 5 February 2021

FCC requirement:
The measured maximum conducted output power of the EUT is 4.91dBm ≈ 3.1mW, which is far below the SAR exclusion threshold level 10mW (SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and ≤ 50 mm), hence the EUT is excluded from SAR evaluation according to FCC KDB publication 447498 D01: Mobile and Portable RF Exposure. Guidance v06.

IC requirements: The EUT shall comply with the requirement of RSS-102 section 2.5.2.

Exemption from Routine Evaluation Limits – RF Exposure Evaluation
RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;

- RF exposure evaluation exempted power for BLE: 2.67 W

The worst-case mode (the configuration having highest EIRP) specified:

BLE: 4.91 dBm

Antenna Gain: 1.8 dBi

The Max. e.i.r.p. for BLE DTS: 6.71dBm = 0.005 W
The e.i.r.p. for the BLE are less than the RF exposure evaluation exempted power. So RF exposure evaluation is not required.

"RF Radiation Exposure Statement Caution: This Transmitter must be installed to provide a separation distance of at least 20 cm from all persons."

7 Photographs of the Test Set-Up

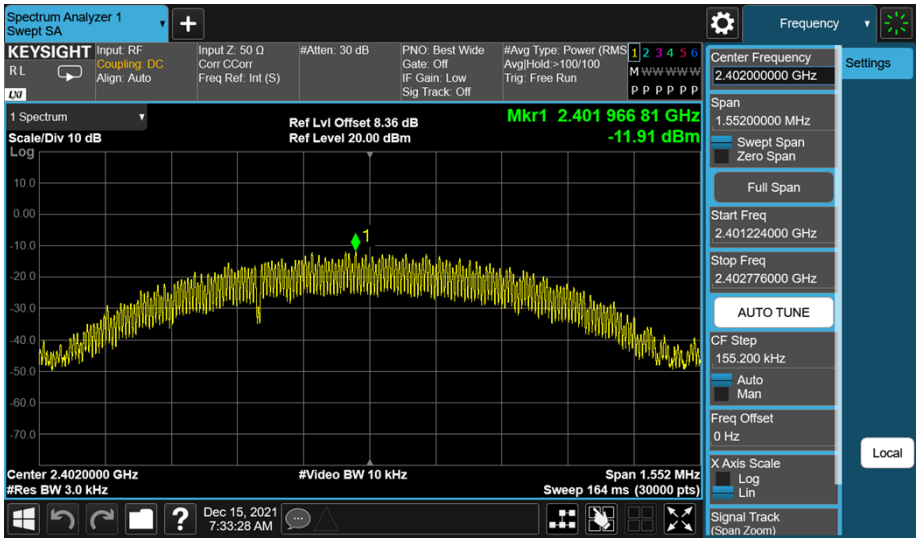
For photographs of the test set-up, refer to the appendix A.

8 List of Tables

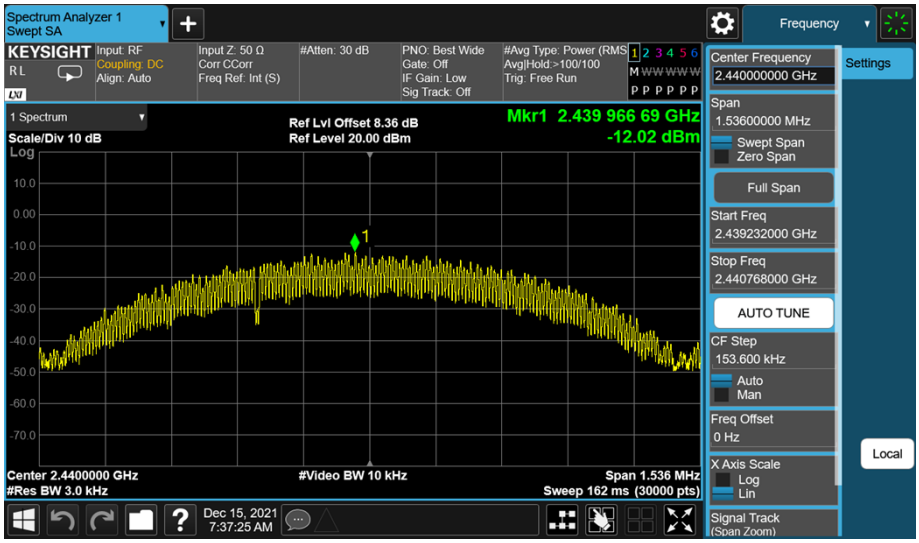
Appendix B: Test Results

Appendix B.1: Conducted Power Spectral Density

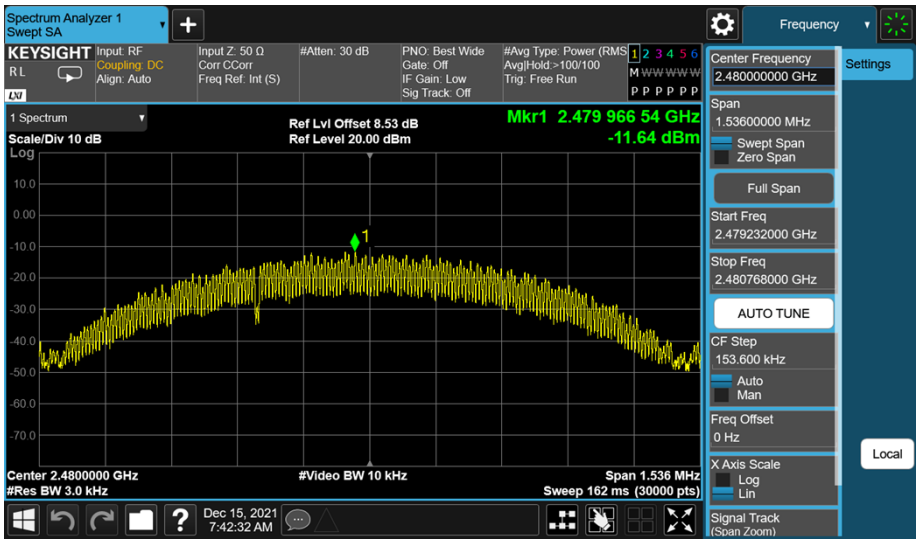
BLE, 1Mbps
Low Channel



Middle Channel



High Channel



Appendix B.2: 6dB Bandwidth

BLE, 1Mbps
Low Channel

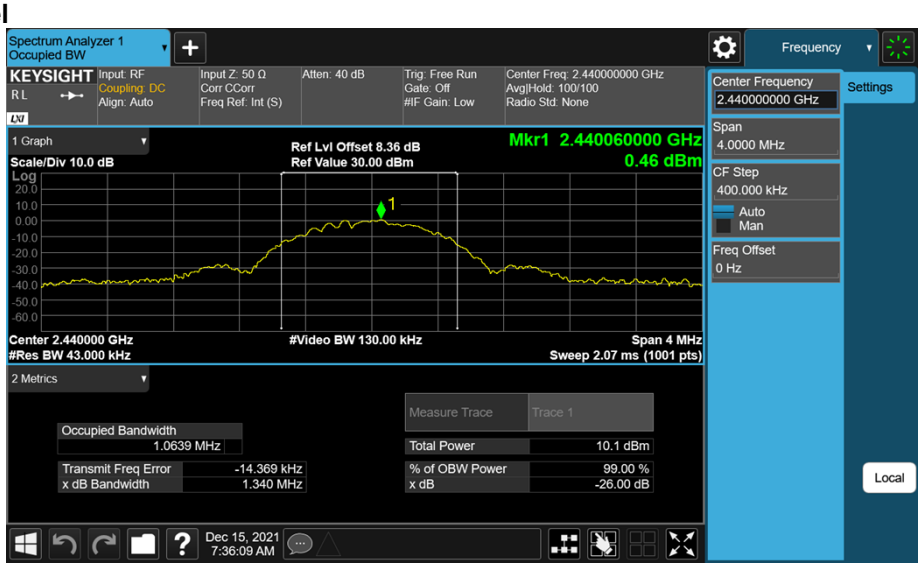
Middle Channel

High Channel

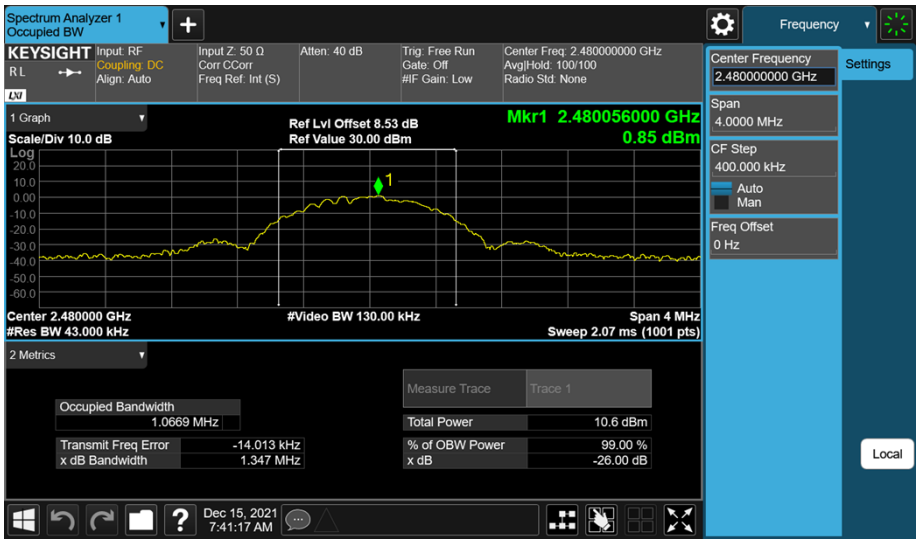
Appendix B.3: 99% Bandwidth

BLE, 1Mbps
Low Channel

Middle Channel

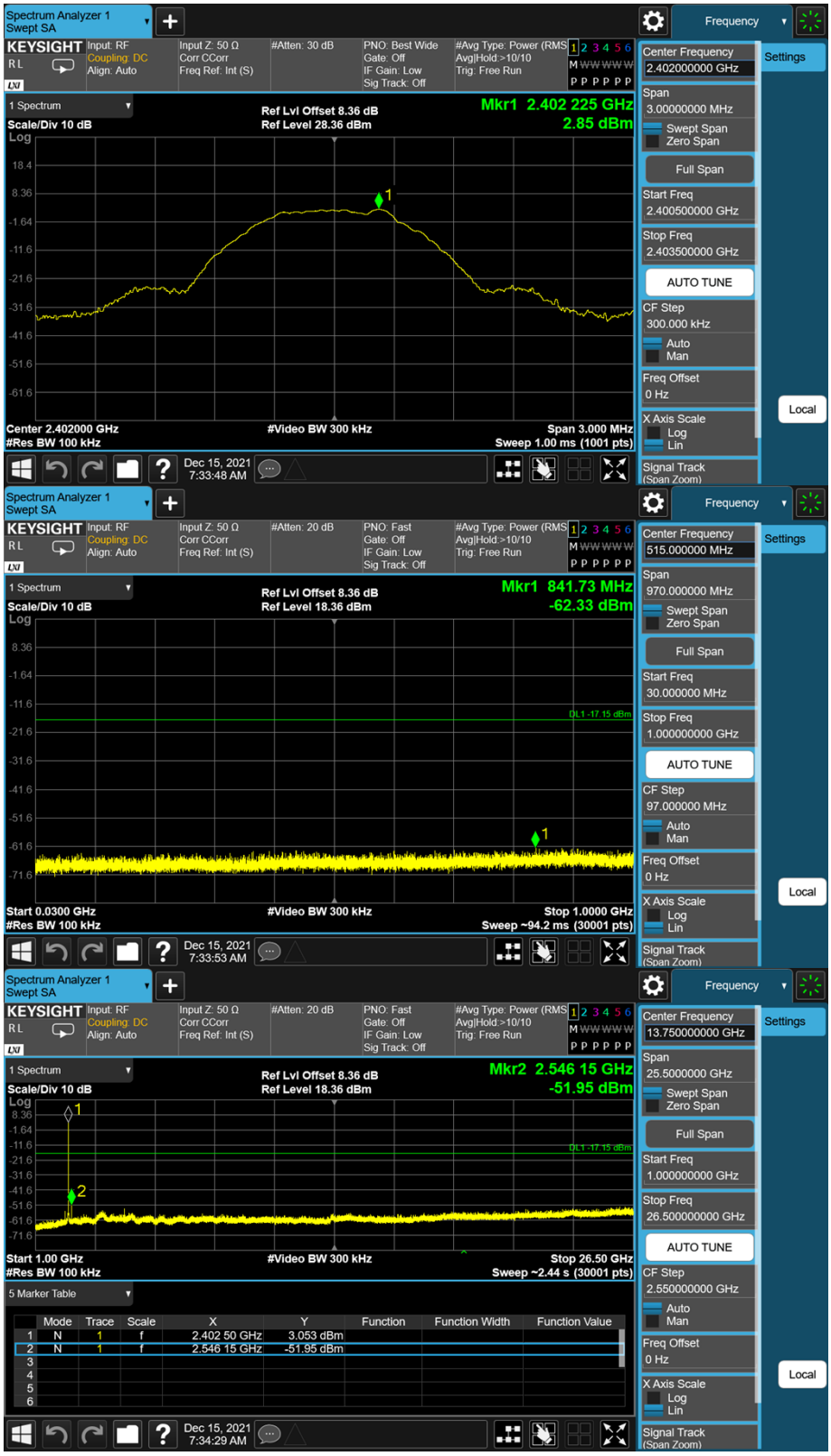


High Channel

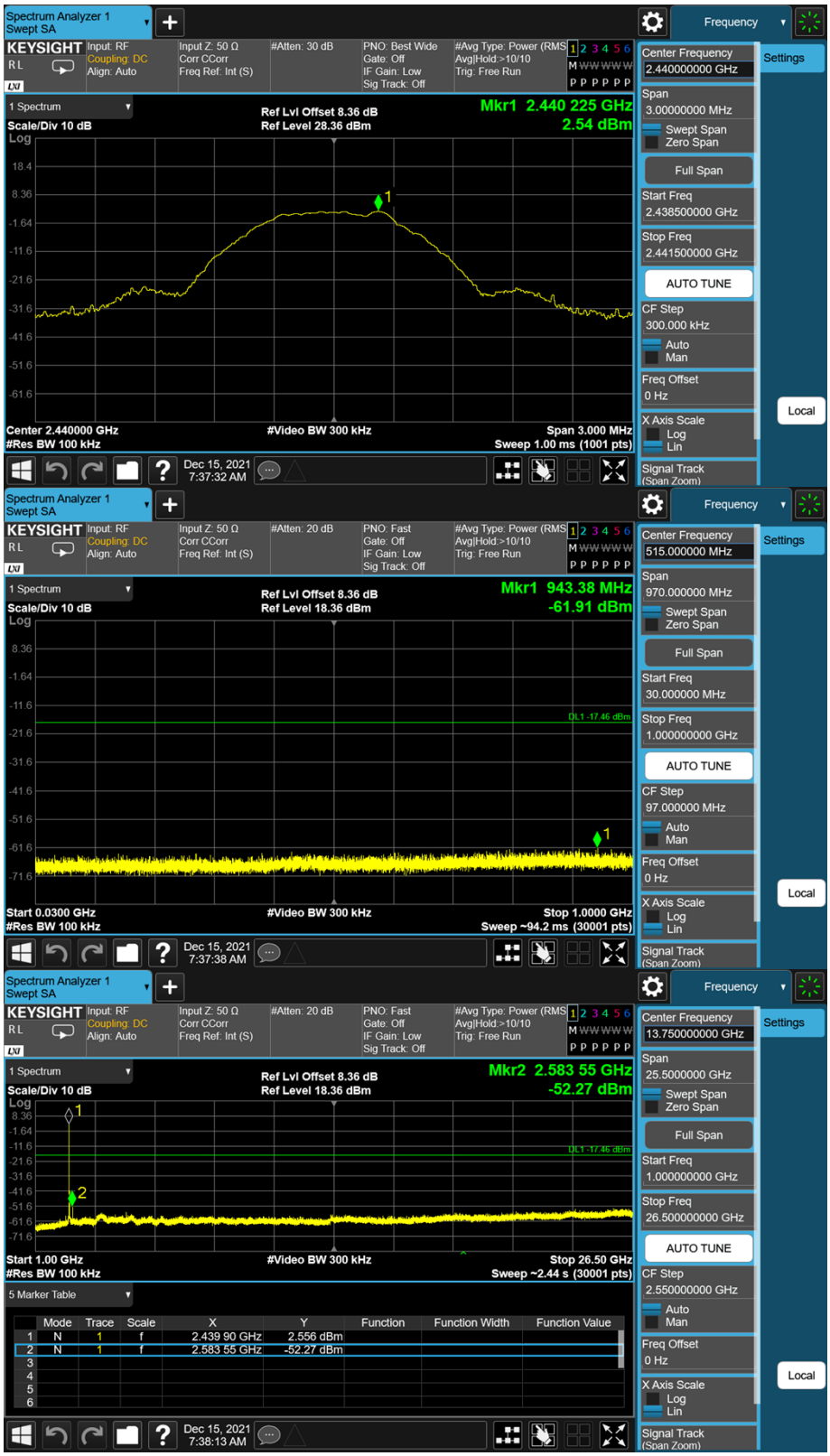


Appendix B.4: Conducted Spurious Emissions Measured in 100 kHz Bandwidth

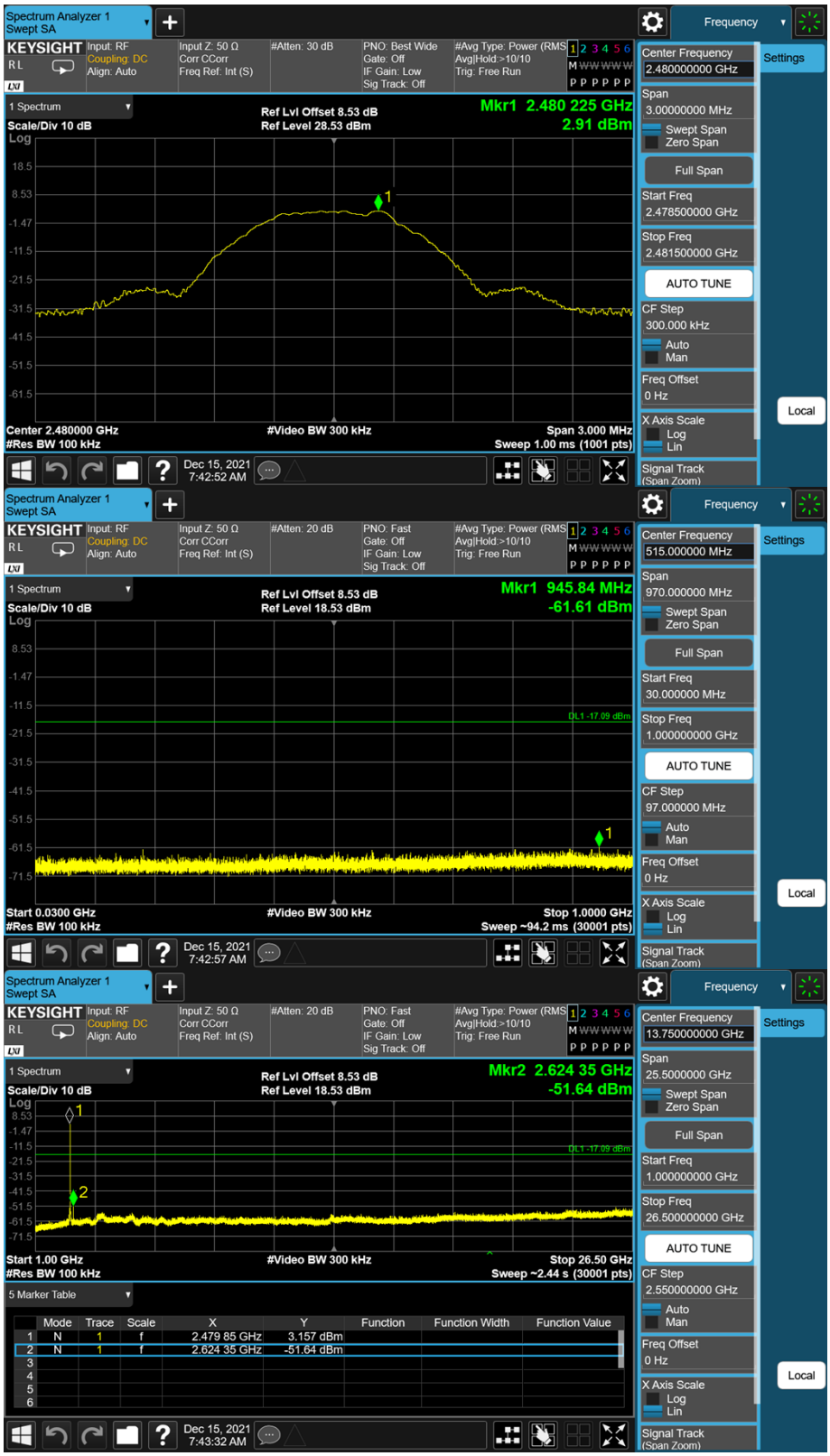
BLE, 1Mbps
Low Channel



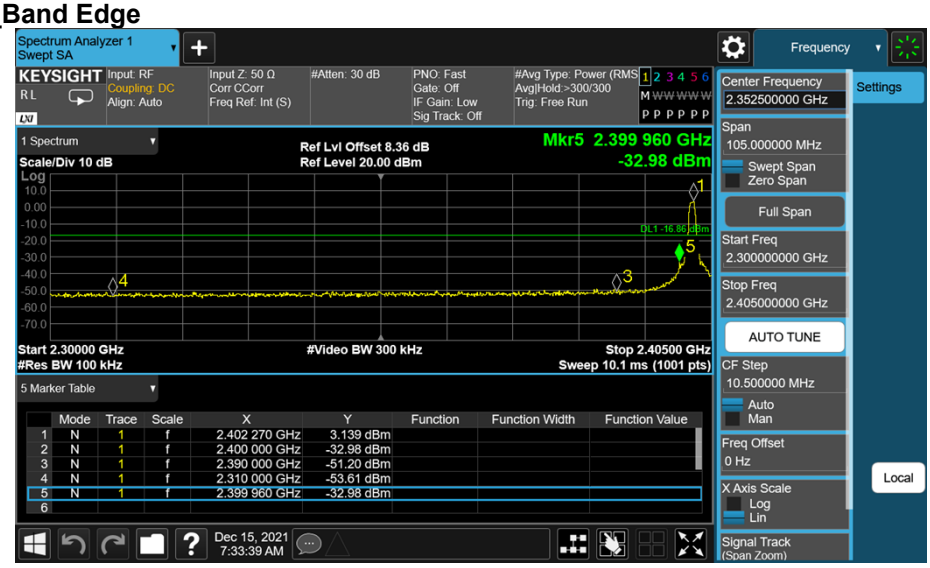
Middle Channel



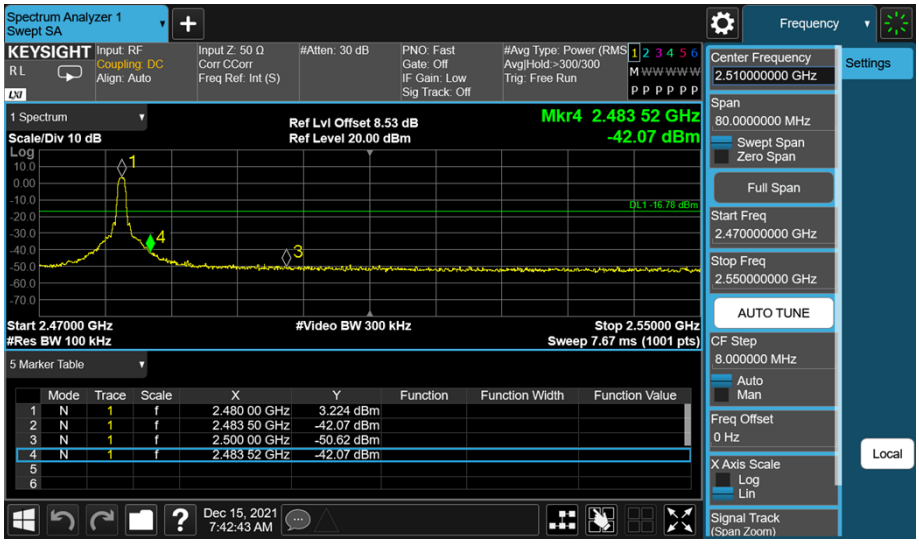
High Channel



Low Channel_Band Edge



High Channel_Band Edge



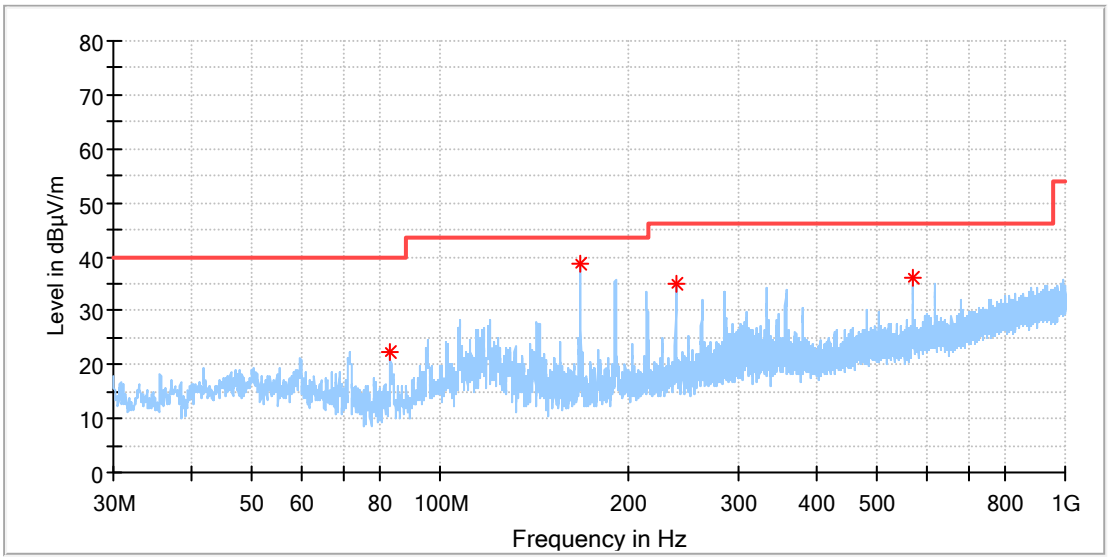
Appendix B.5: Test Results of Radiated Spurious Emissions

Note 1: Testing was carried out within frequency range 9 kHz to the tenth harmonics. The measurement results below 30MHz and above 18GHz were greater than 20dB below the limit, so only the radiated spurious emissions from 30MHz to 18GHz were reported.

BLE, 1Mbps

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_Low channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

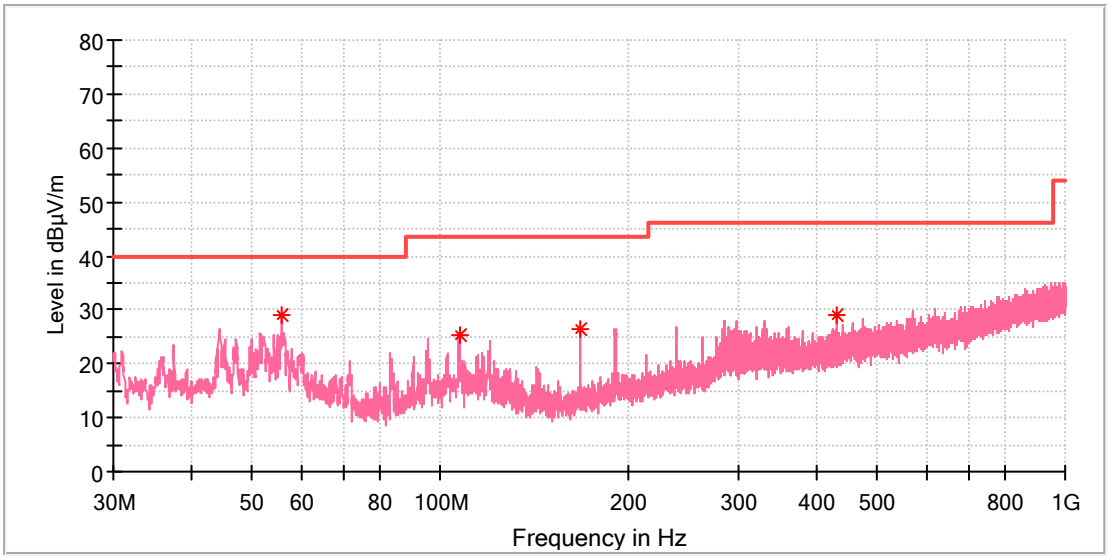


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
83.301500	22.45	40.00	17.55	100.0	H	17.0	-22.7
168.031000	38.60	43.50	4.90	100.0	H	169.0	-21.3
238.210500	35.06	46.00	10.94	100.0	H	244.0	-17.8
571.987500	35.96	46.00	10.04	100.0	H	83.0	-10.4

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_Low channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

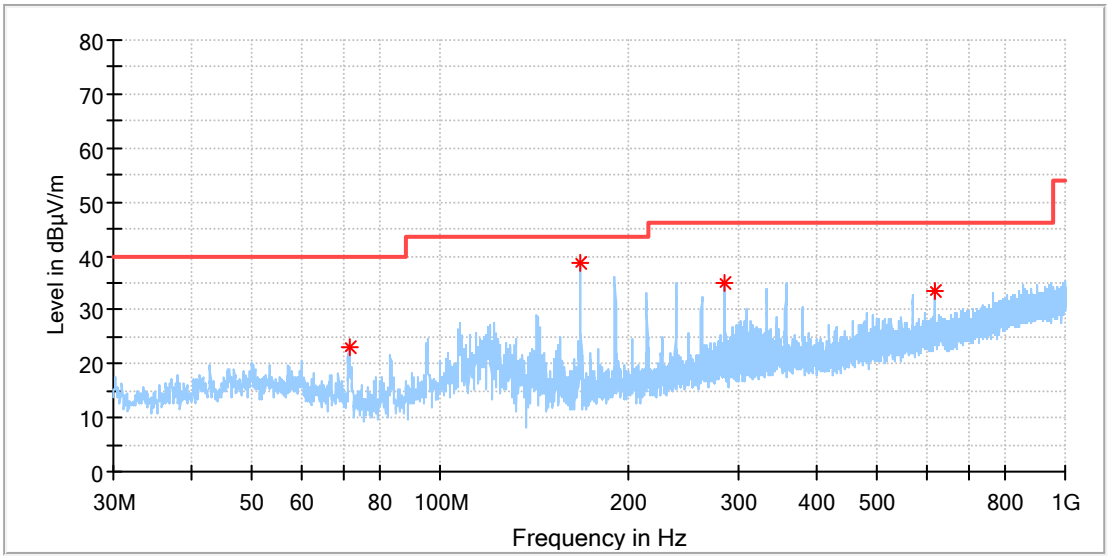


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
55.802000	29.20	40.00	10.80	100.0	V	79.0	-18.5
107.212000	25.46	43.50	18.04	100.0	V	119.0	-18.9
168.031000	26.28	43.50	17.22	100.0	V	119.0	-21.3
431.968000	29.16	46.00	16.84	100.0	V	14.0	-13.3

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_High channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

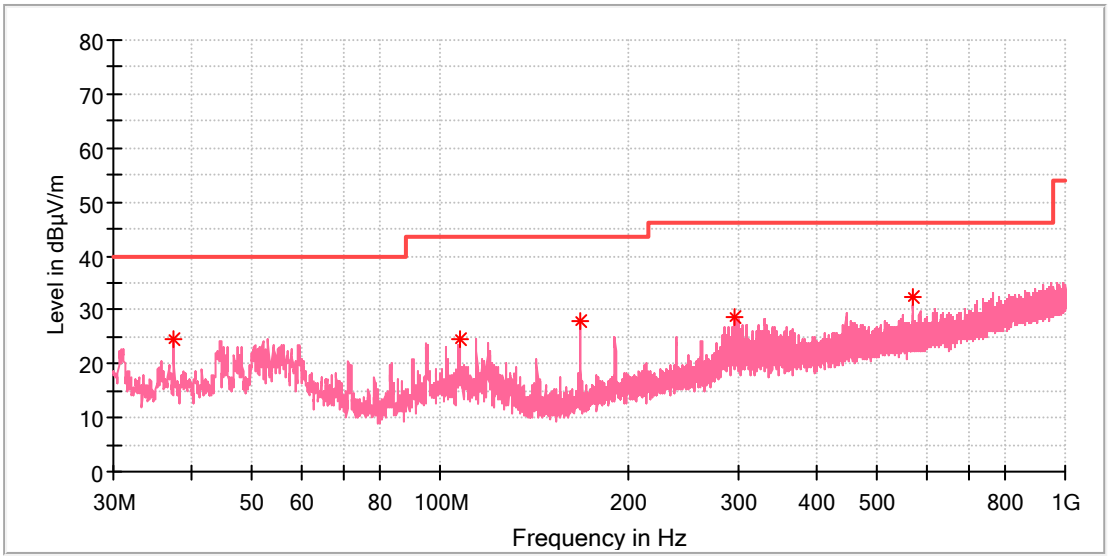


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
71.467500	22.91	40.00	17.09	100.0	H	174.0	-22.3
168.031000	38.66	43.50	4.84	100.0	H	174.0	-21.3
285.643500	35.00	46.00	11.00	100.0	H	46.0	-16.6
619.081000	33.56	46.00	12.44	100.0	H	282.0	-9.5

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_High channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

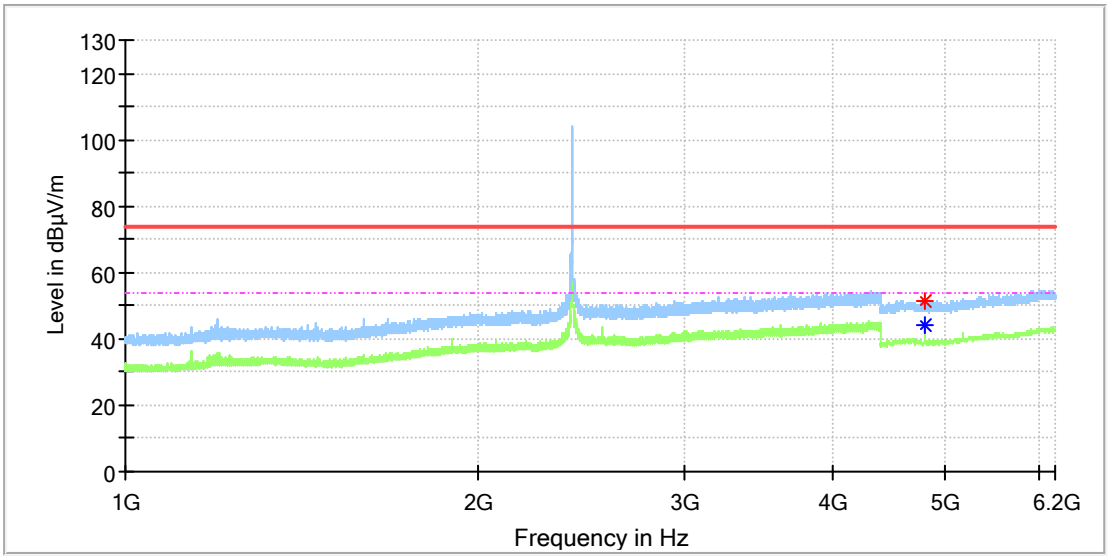


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
37.517500	24.63	40.00	15.37	100.0	V	0.0	-21.0
107.600000	24.45	43.50	19.05	100.0	V	106.0	-18.9
168.031000	28.06	43.50	15.44	100.0	V	80.0	-21.3
295.828500	28.60	46.00	17.40	100.0	V	152.0	-16.4
571.454000	32.26	46.00	13.74	100.0	V	62.0	-10.5

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_Low channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

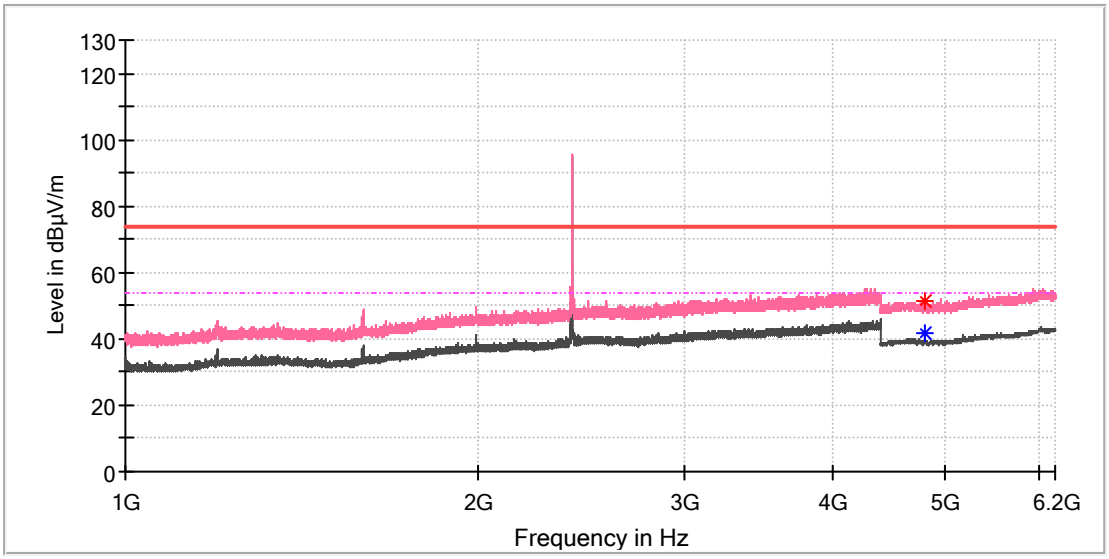


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4803.500000	51.47	---	74.00	22.53	100.0	H	45.0	11.8
4804.000000	---	43.87	54.00	10.13	100.0	H	45.0	11.8

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_Low channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

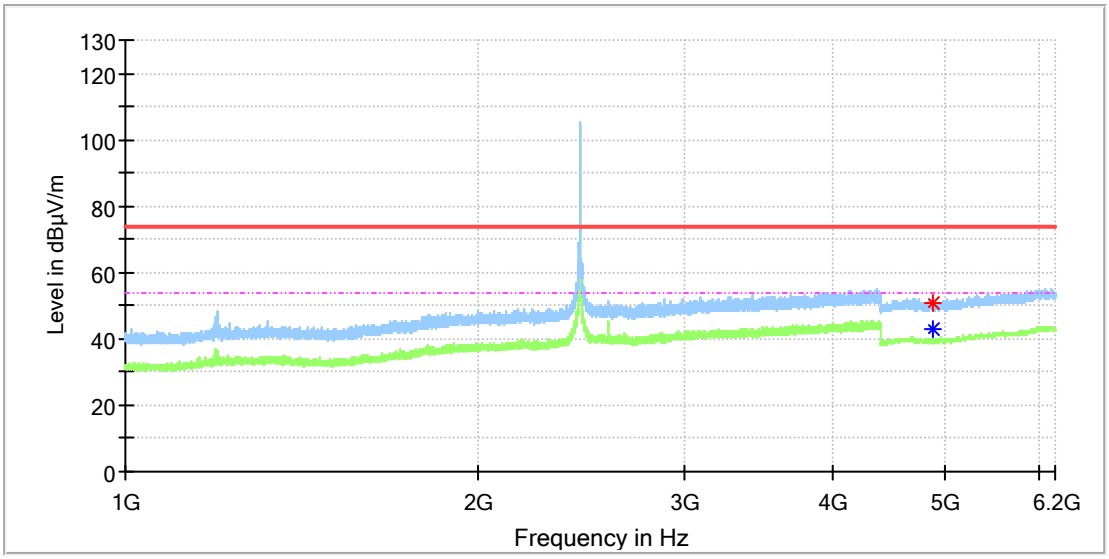


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4804.000000	---	41.62	54.00	12.38	100.0	V	221.0	11.8
4809.000000	51.55	---	74.00	22.45	100.0	V	262.0	11.8

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_Mid channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

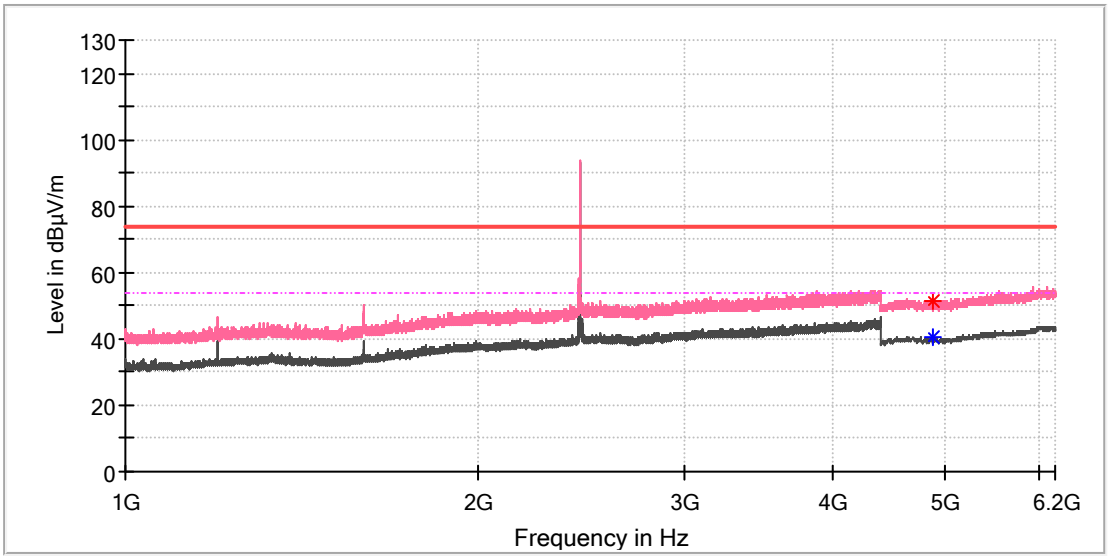


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4879.500000	50.96	---	74.00	23.04	100.0	H	73.0	11.8
4880.000000	---	43.14	54.00	10.86	100.0	H	44.0	11.8

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_Mid channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

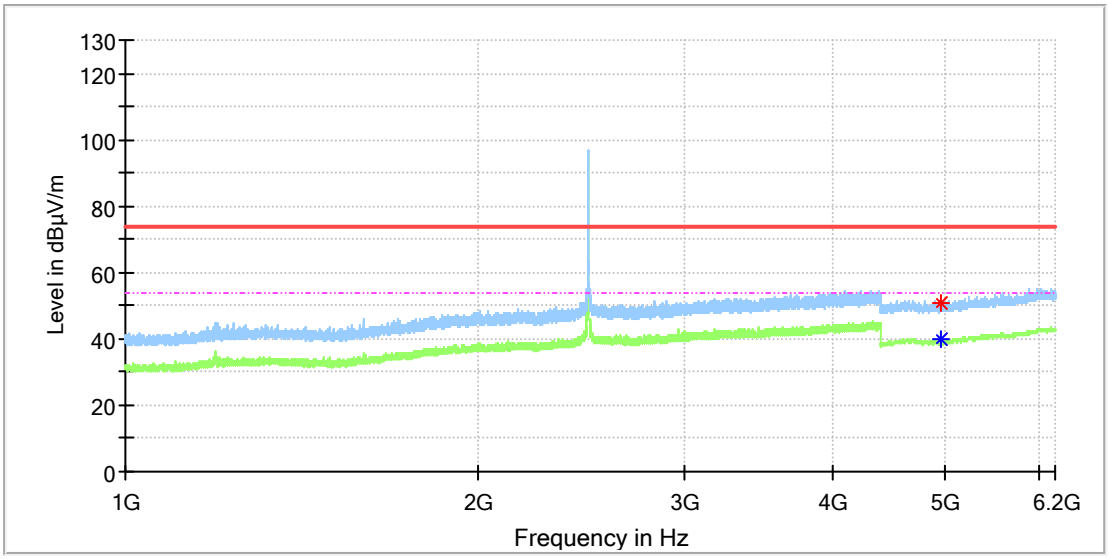


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4869.500000	51.37	---	74.00	22.63	100.0	V	0.0	11.8
4880.000000	---	40.76	54.00	13.24	100.0	V	24.0	11.8

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_High channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

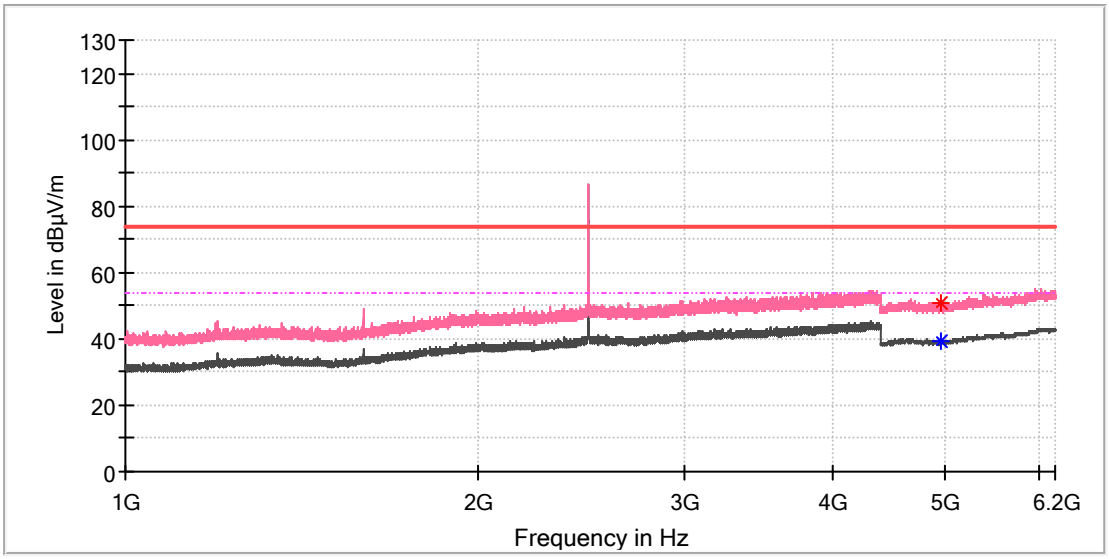


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4948.000000	50.97	---	74.00	23.03	100.0	H	355.0	11.8
4962.500000	---	39.78	54.00	14.22	100.0	H	242.0	11.8

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_High channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

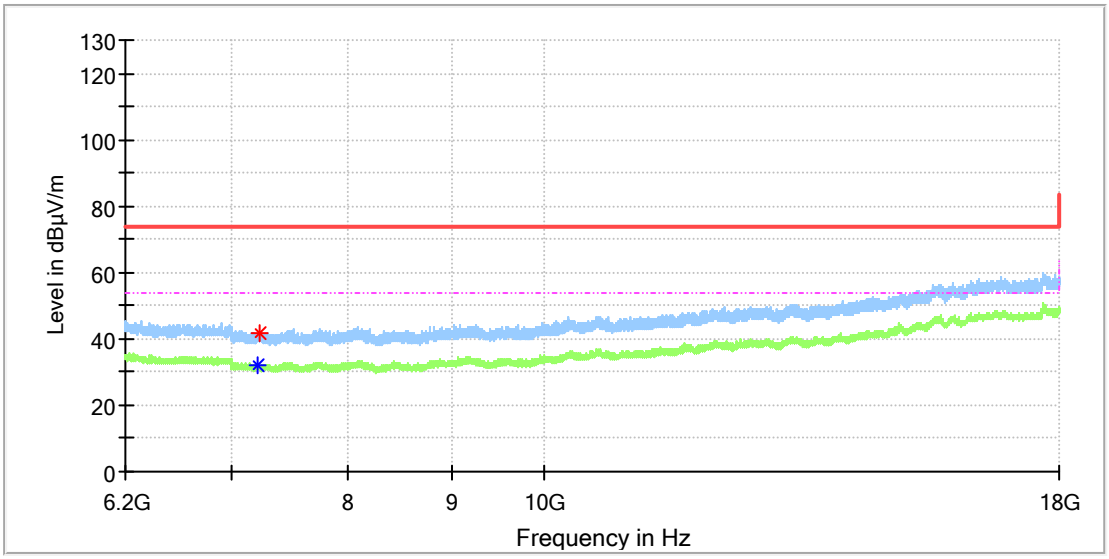


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4952.500000	51.00	---	74.00	23.00	100.0	V	285.0	11.8
4958.000000	---	39.46	54.00	14.54	100.0	V	334.0	11.8

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_Low channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

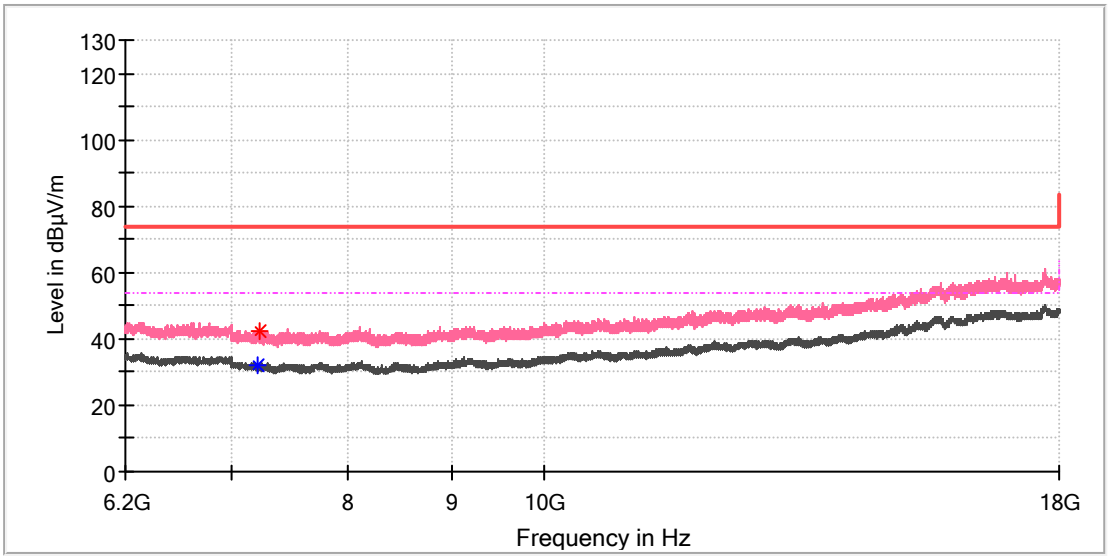


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7212.833333	---	31.98	54.00	22.02	100.0	H	36.0	8.7
7228.566667	41.64	---	74.00	32.36	100.0	H	308.0	8.6

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_Low channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

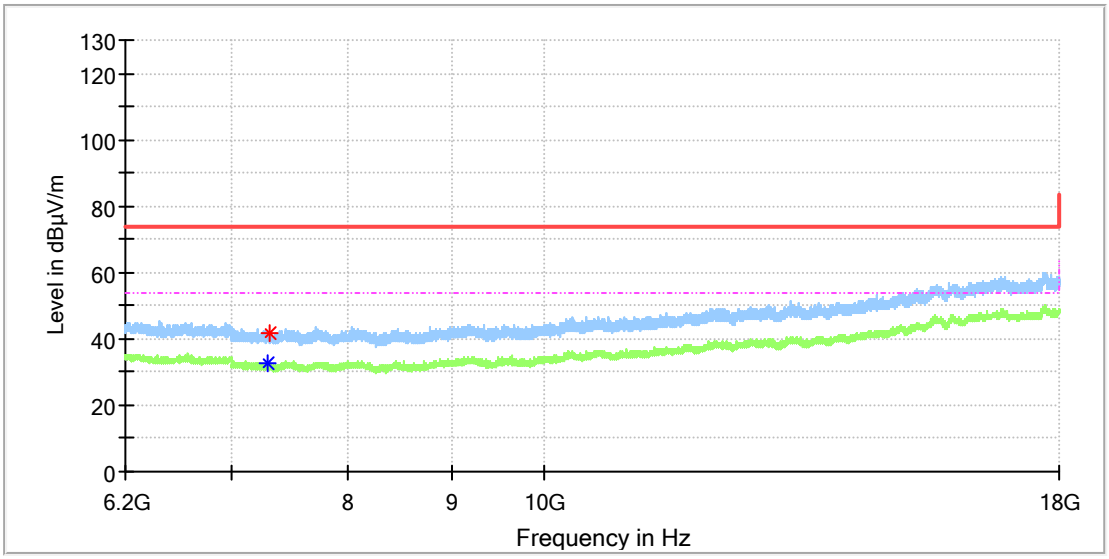


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7203.983333	---	32.27	54.00	21.73	100.0	V	271.0	8.8
7222.175000	42.18	---	74.00	31.82	100.0	V	257.0	8.7

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_Mid channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

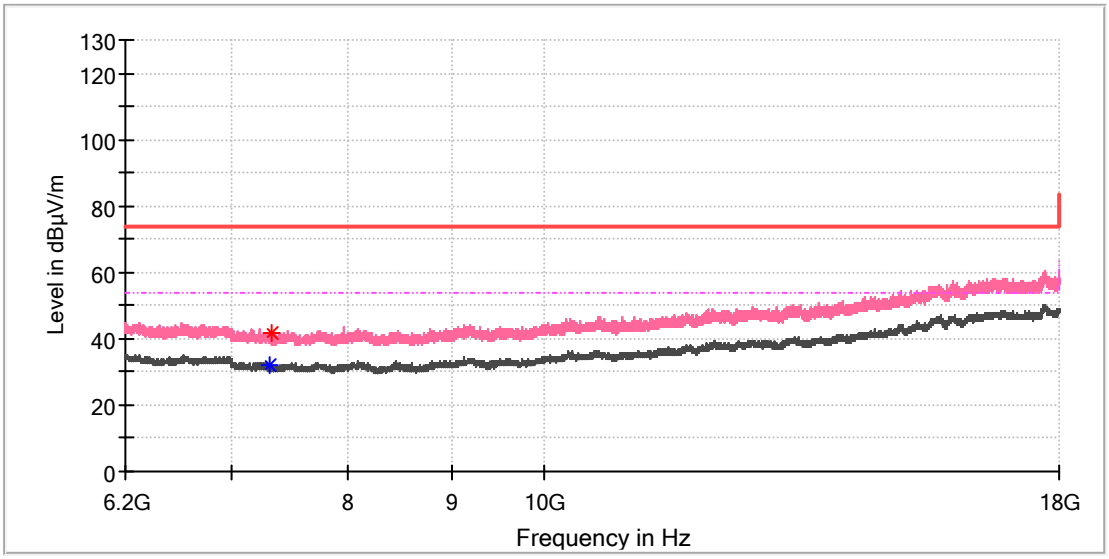


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7300.350000	---	32.66	54.00	21.34	100.0	H	194.0	8.3
7302.316667	41.91	---	74.00	32.09	100.0	H	152.0	8.3

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_Mid channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

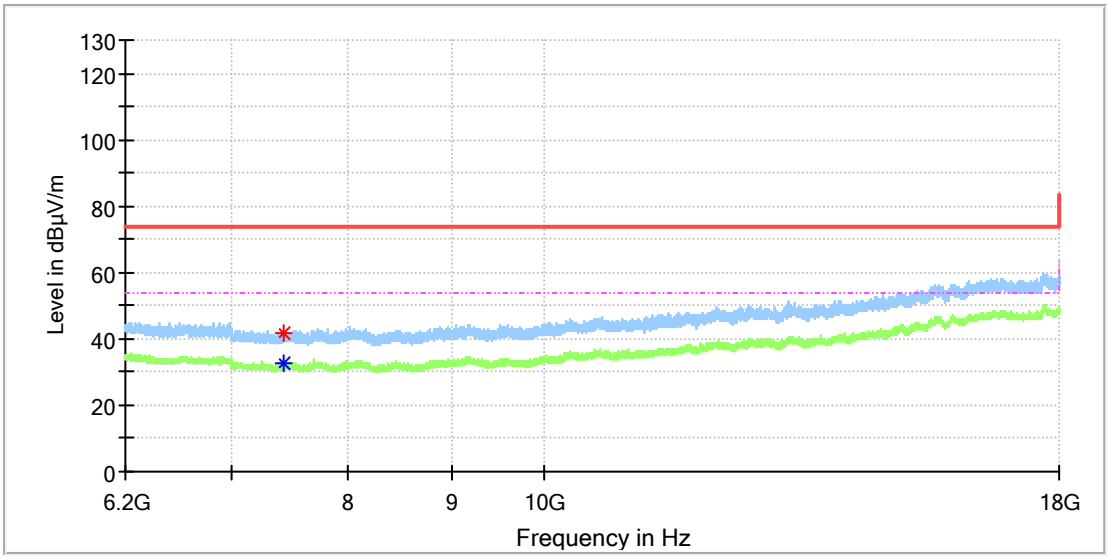


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7313.133333	---	32.10	54.00	21.90	100.0	V	92.0	8.2
7334.275000	41.93	---	74.00	32.07	100.0	V	92.0	8.1

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_High channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

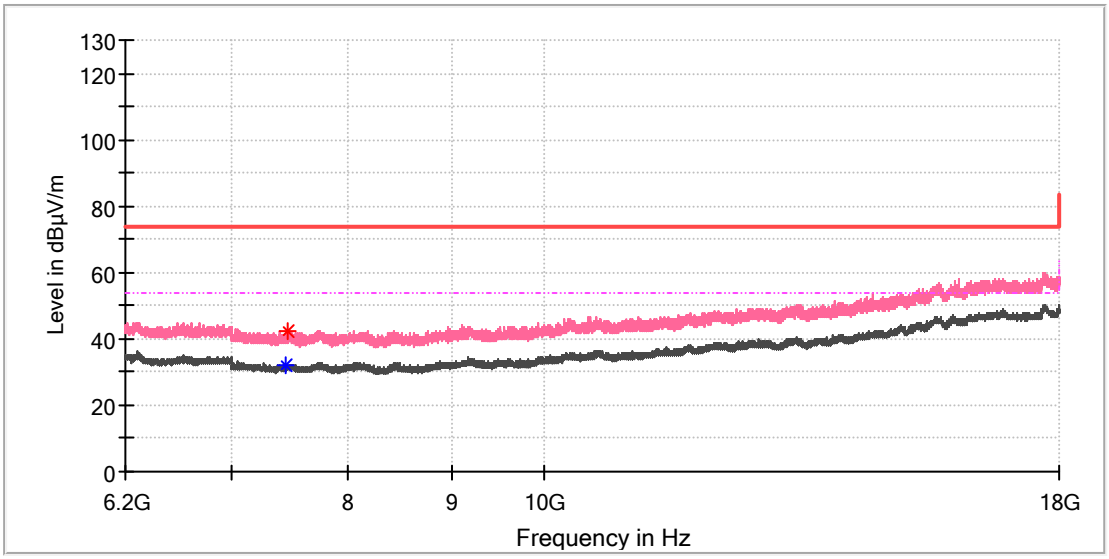


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7425.725000	41.68	---	74.00	32.32	100.0	H	0.0	8.4
7435.558333	---	32.90	54.00	21.10	100.0	H	228.0	8.4

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_High channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical_Freqs

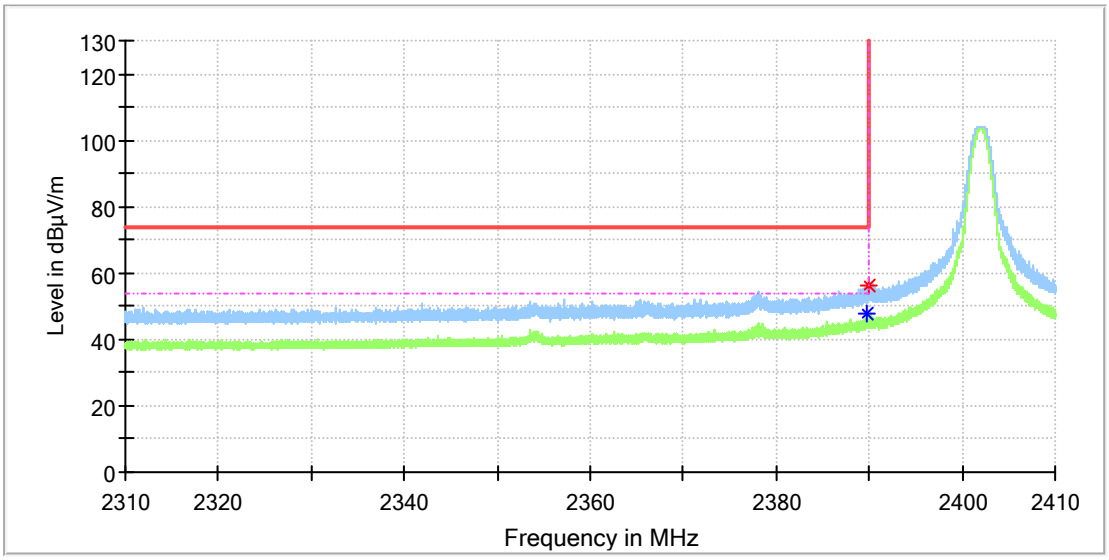
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7439.000000	---	32.21	54.00	21.79	100.0	V	218.0	8.4
7463.583333	42.08	---	74.00	31.92	100.0	V	74.0	8.6

Appendix B.6: Test Results of Radiated Emissions in Restricted Bands

BLE, 1Mbps

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_Low channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

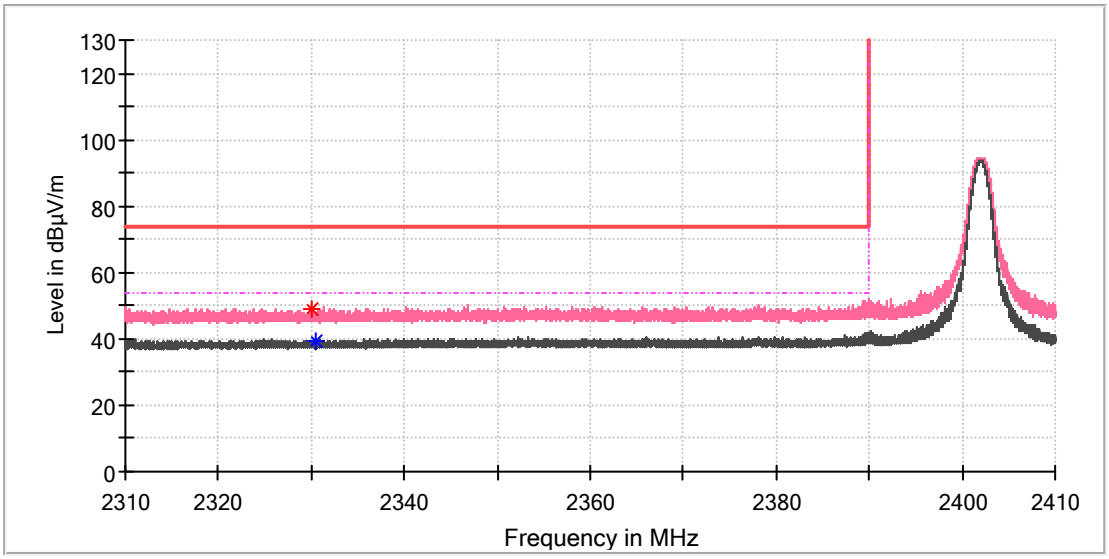


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2389.800000	---	47.71	54.00	6.29	100.0	H	204.0	7.0
2389.905000	56.42	---	74.00	17.58	100.0	H	204.0	7.0

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_Low channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

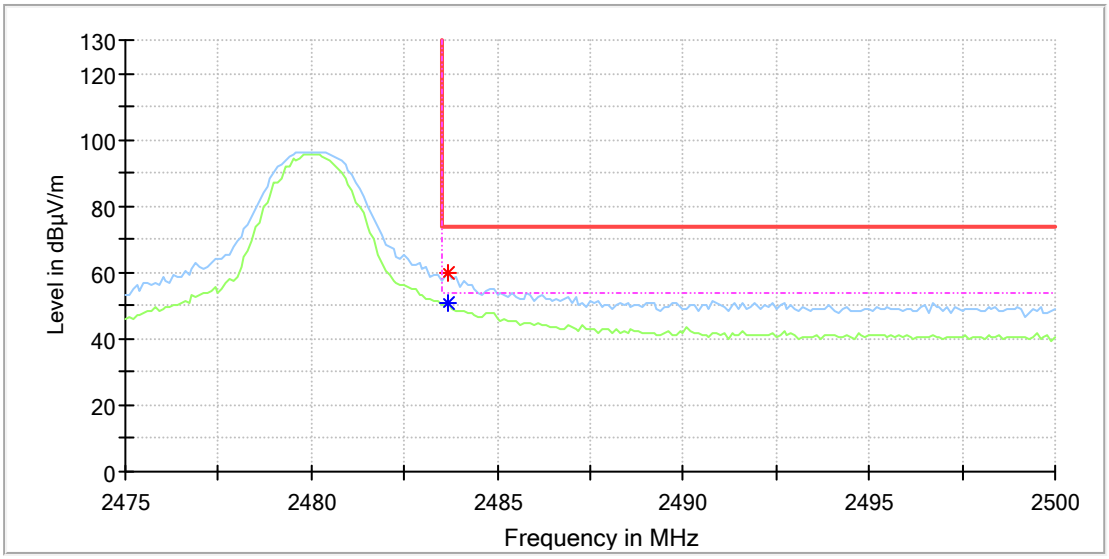


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2329.970000	48.89	---	74.00	25.11	100.0	V	122.0	6.7
2330.455000	---	39.45	54.00	14.55	100.0	V	84.0	6.7

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_High channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

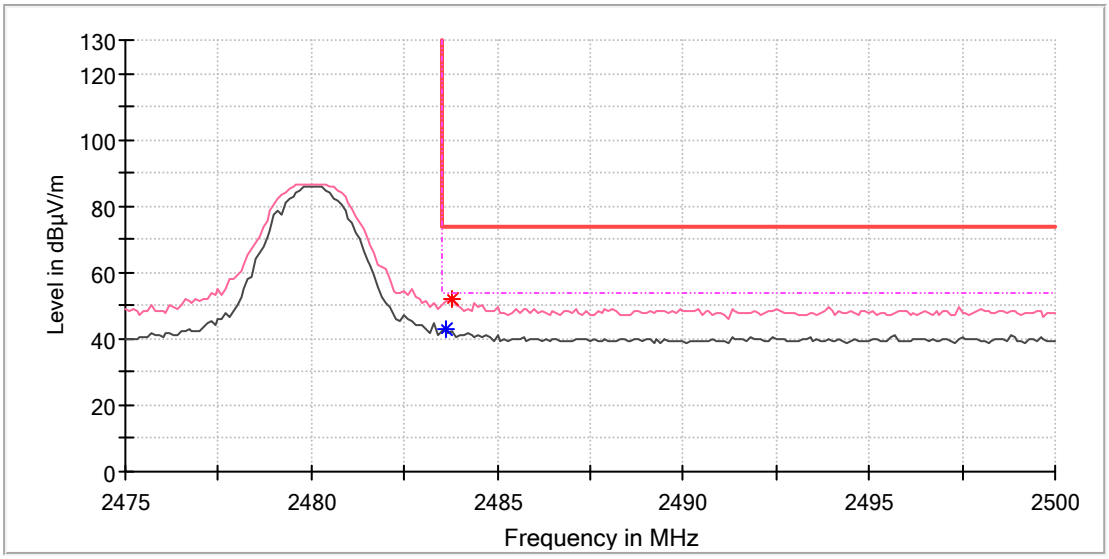


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2483.700000	59.86	---	74.00	14.15	100.0	H	309.0	7.4
2483.700000	---	50.96	54.00	3.04	100.0	H	309.0	7.4

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test Mode:	BLE_High channel
Order No/Sample No:	168345996/A003177078-007
Test Voltage::	DC 5V From USB
Remark:	Temp 22 Humi:52%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



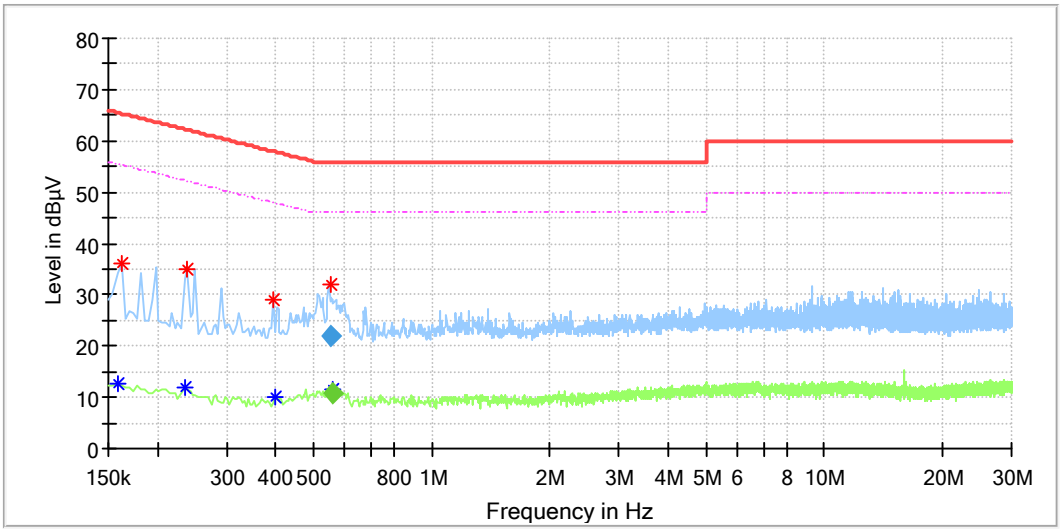
Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2483.600000	---	43.18	54.00	10.82	100.0	V	117.0	7.4
2483.800000	52.03	---	74.00	21.97	100.0	V	106.0	7.4

Appendix B.7: Test Results of Conducted Emissions on AC Mains

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test mode:	BLE connect
Test Voltage:	AC 120V/60Hz
Test By:	Jianhua Lu
Review By:	Gary Chen
Remark:	SR2



Critical_Freqs

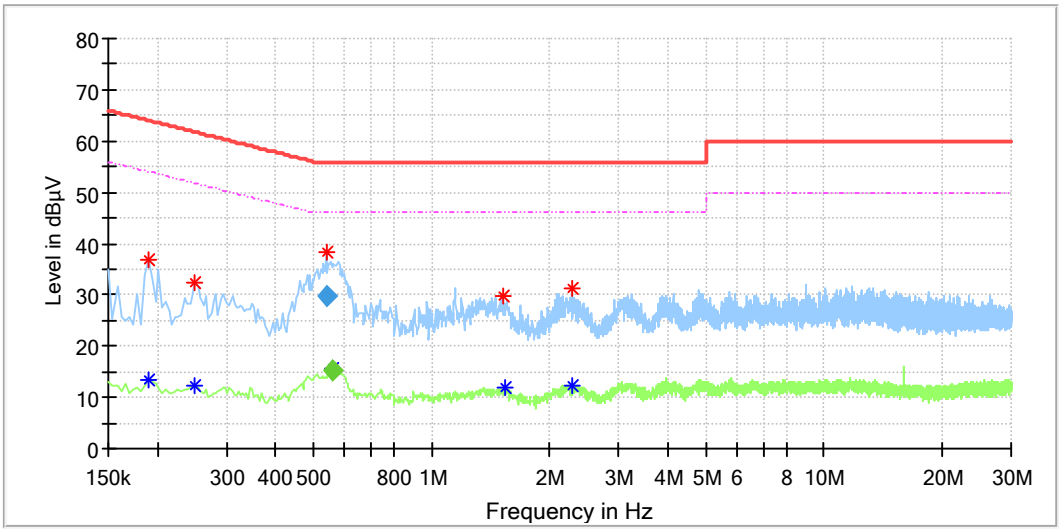
Frequency (MHz)	MaxPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Line	Corr. (dB)
0.158000	---	12.80	55.57	42.77	L1	9.9
0.162000	36.20	---	65.36	29.16	L1	9.9
0.234000	---	11.77	52.31	40.54	L1	9.9
0.238000	35.07	---	62.17	27.10	L1	9.9
0.394000	28.89	---	57.98	29.09	L1	9.9
0.398000	---	9.86	47.90	38.03	L1	9.9
0.550500	32.01	---	56.00	23.99	L1	10.0
0.561500	---	11.55	46.00	34.45	L1	10.0

Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.550500	21.89	---	56.00	34.11	1000.0	9.000	L1	10.0
0.561500	---	10.93	46.00	35.07	1000.0	9.000	L1	10.0

EUT Information

EUT Name:	Bluetooth Module
Model:	RAK13401
Test mode:	BLE connect
Test Voltage:	AC 120V/60Hz
Test By:	Jianhua Lu
Review By:	Gary Chen
Remark:	SR2



Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Line	Corr. (dB)
0.190000	---	13.26	54.04	40.78	N	9.8
0.190000	37.02	---	64.04	27.02	N	9.8
0.250000	---	12.24	51.76	39.52	N	9.8
0.250000	32.47	---	61.76	29.29	N	9.8
0.542500	38.27	---	56.00	17.73	N	9.8
0.557500	---	15.74	46.00	30.26	N	9.8
1.522000	29.71	---	56.00	26.29	N	9.8
1.542000	---	11.73	46.00	34.27	N	9.8
2.270000	31.33	---	56.00	24.67	N	9.9
2.274000	---	12.34	46.00	33.66	N	9.9

Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.542500	29.59	---	56.00	26.41	1000.0	9.000	N	9.8
0.557500	---	15.39	46.00	30.61	1000.0	9.000	N	9.8