Prüfbericht-Nr.: *Test report no.:*	**CN21UVL1 001**	**Auftrags-Nr.:** *Order no.:*	168304727	Seite 1 von 22 *Page 1 of 22*
Kunden-Referenz-Nr.: *Client reference no.:*	N/A	**Auftragsdatum:** *Order date:*	2021-01-19	
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:*	WisDuo			
Bezeichnung / Typ-Nr.: *Identification / Type no.:*	RAK3400, RAK3401			
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 March 2019 RSS-102 Issue 5 March 2015	

Wareneingangsdatum: *Date of sample receipt:*	2021-01-21	Please refer to photo documents
Prüfmuster-Nr.: *Test sample no.:*	A002990607-001 to 008	
Prüfzeitraum: *Testing period:*	2021-01-22 – 2021-02-23	
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 Signed by: Alex Lan	**genehmigt von:** *authorized by:*	X Winnie Hou Signed by: Winnie Hou
Datum: *Date:* 2021-04-20		**Ausstellungsdatum:** *Issue date:* 2021-04-20	
Stellung / Position	Senior Project Engineer	**Stellung** / Position	Department Manager

Sonstiges / *Other:*

FCC ID: 2AF6B-RAK3400
IC: 25908-RAK3400 HVIN: RAK3400, RAK3401

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*

Test Summary

5.1.1 ANTENNA REQUIREMENT
RESULT: Pass

5.1.2 MAXIMUM PEAK 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

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**
Wireless Connectivity Tester	R&S	CMW270	101375	10.08.2021
Signal Analyzer	R&S	FSV 40	101441	10.08.2021
Vector Signal Generator	R&S	SMBV100A	263301	10.08.2021
Signal Generator	R&S	SMB100A	115186	10.08.2021
OSP	R&S	OSP 150	101017	10.12.2021
Control PC	DELL	OptiPlex 7050	FTJZ9P2	N/A
Test Software	R&S	WMS32 (V11.00.00)	N/A	N/A
Power Meter	R&S	NRP2	107105	10.12.2021
Power Sensor	R&S	NRP-Z81	105677	10.09.2021
Humid & Temp Programmable Tester	BOST	NTH090-60	19040801	10.04.2021
Shielding Room 8#	Albatross	SR8	APC17151-SR8	23.07.2021
Unwanted Emission Testing				
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Cal. Until**
EMI Test Receiver	R&S	ESR 7	102021	11.08.2021
Signal Analyzer	R&S	FSV 40	101439	10.08.2021
System Controller Interface	R&S	SCI-100	S10010038	N/A
Filterbank	R&S	Wlan	100759	10.08.2021
OSP	R&S	OSP 120	102040	N/A
Pre-amplifier	R&S	SCU08F1	08320031	10.08.2021
Amplifier	R&S	SCU-18F	180070	10.08.2021
Amplifier	R&S	SCU40A	100475	10.09.2021
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
Wideband Ridged Horn Antenna (12-18 GHz)	Steatite	QMS-00208	18313	02.09.2021
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	06.07.2021
Conducted Emissions testing				
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Cal. Until**
EMI Test Receiver	R&S	ESR3	102428	16.08.2021
Artificial Mains Network	R&S	ENV216	102333	16.08.2021
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 WisDuo, it supports Bluetooth Low Energy wireless technology.

Model RAK3400 is identical with model RAK3401 except the model RAK3401 is the extend of RAK3400, The RAK3401 is a breakout module designed to work with a baseboard. Essentially, it is a RAK3400 stamp module with an expansion PCB and connectors compatible with the baseboard. It allows an easy way to access to the pins of the RAK3400 module in order to simplify development and testing processes.

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	WisDuo
Type Designation	RAK3400, RAK3401
FCC ID	2AF6B-RAK3400
IC	25908-RAK3400
HVIN	RAK3400, RAK3401
Operating Voltage	DC 5V via USB interface
Testing Voltage	DC 5V
Technical Specification of Bluetooth Low Energy	
Operating Frequency	2402 – 2480 MHz
Bluetooth Core Version	Bluetooth 5.0, single mode
Data rate	1Mbps, 2Mbps
Channel Number	40 channels
Channel separation	2MHz
Modulation	GFSK
Antenna Type	IPEX Antenna
Smart Antenna Systems:	Not Applicable
Number of Antenna	1
Antenna Gain	1.68 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.

According to clause 3.1, all test items were applied on model RAK3401.

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)

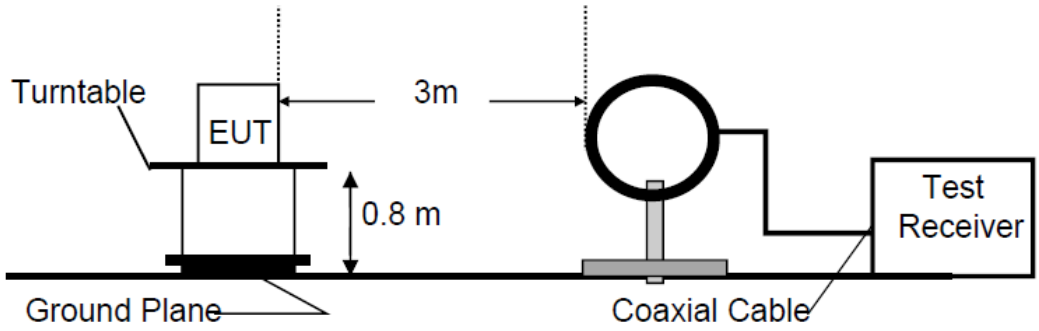


Diagram of Measurement Configuration for Radiation Test (Below 1GHz)

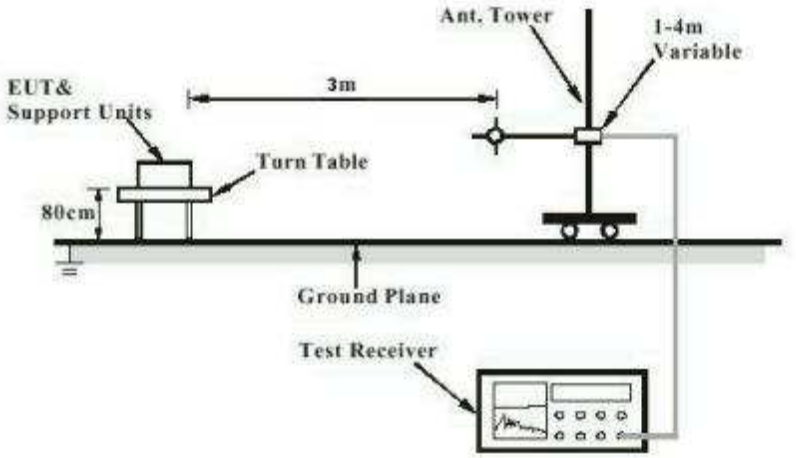


Diagram of Measurement Configuration for Radiation Test (Above 1GHz)

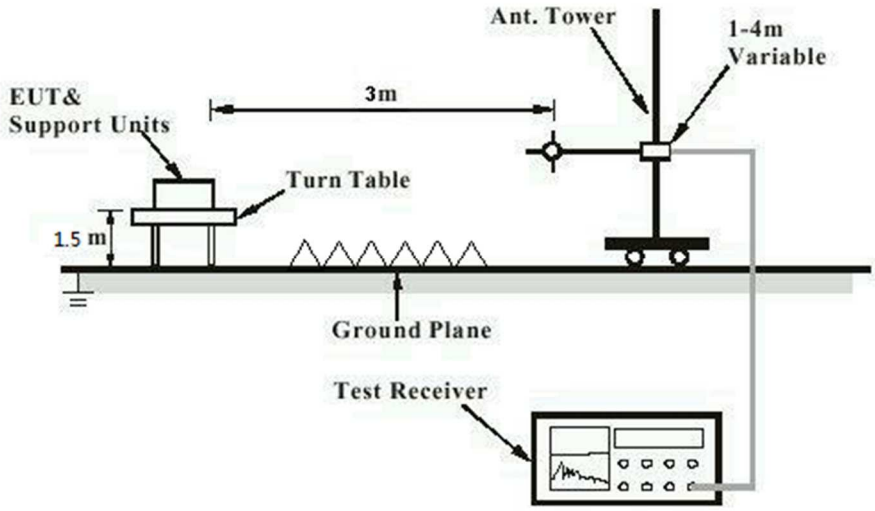


Diagram of Measurement Configuration for Mains Conduction Measurement

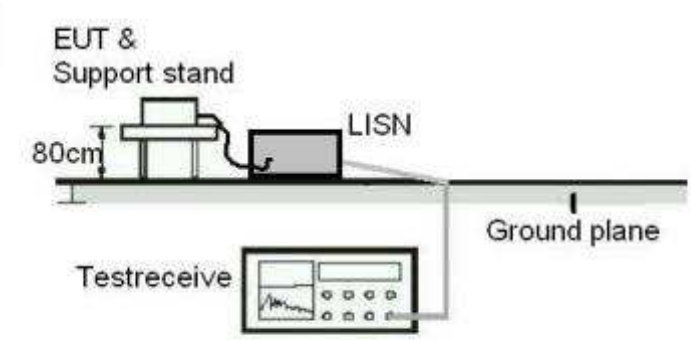
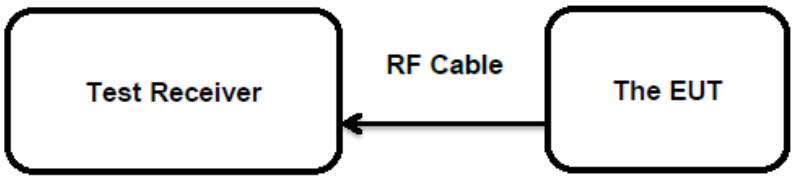


Diagram of Measurement Configuration for Conducted Transmitter Measurement



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 IPEX antenna, the directional gain of antenna is 1.68 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 Peak 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	:	2021-02-04
Input voltage	:	DC 5V
Operation mode	:	A
Test channel	:	Low / Middle / High
Ambient temperature	:	24.8 ℃
Relative humidity	:	53 %
Atmospheric pressure	:	101 kPa

For details refer to following test result.

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

Channel	Channel Frequency (MHz)	Peak Output Power		Limit
		(dBm)	(W)	(W)
Low Channel	2402	3.3	0.00214	1
Middle Channel	2440	3.6	0.00229	1
High Channel	2480	3.1	0.00204	1

Table 6: Test Result of Maximum Peak Conducted Output Power, 2Mbps

Channel	Channel Frequency (MHz)	Peak Output Power		Limit
		(dBm)	(W)	(W)
Low Channel	2402	2.9	0.00195	1
Middle Channel	2440	-0.7	0.00085	1
High Channel	2480	2.6	0.00182	1

Note: The cable loss is taken into account in results and the e.i.r.p. is 5.28 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	:	2021-02-04
Input voltage	:	DC 5V
Operation mode	:	A
Test channel	:	Low / Middle / High
Ambient temperature	:	24.8 ℃
Relative humidity	:	53 %
Atmospheric pressure	:	101 kPa

For details refer to following test result.

Table 7: Test Result of Power Spectral Density, 1Mbps

Channel	Channel Frequency (MHz)	Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)
Low Channel	2402	-7.20	8
Middle Channel	2440	-7.20	8
High Channel	2480	-6.99	8

Table 8: Test Result of Power Spectral Density, 2Mbps

Channel	Channel Frequency (MHz)	Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)
Low Channel	2402	-10.47	8
Middle Channel	2440	-10.00	8
High Channel	2480	-10.75	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	:	2021-02-04
Input voltage	:	DC 5V
Operation mode	:	A
Test channel	:	Low / Middle / High
Ambient temperature	:	24.8 ℃
Relative humidity	:	53 %
Atmospheric pressure	:	101 kPa

Table 9: Test Result of 99% Bandwidth, 1Mbps

Channel	Channel Frequency (MHz)	99% Bandwidth (kHz)	Limit (MHz)	Result
Low Channel	2402	915	/	Pass
Mid Channel	2440	890	/	Pass
High Channel	2480	925	/	Pass

Table 10: Test Result of 99% Bandwidth, 2Mbps

Channel	Channel Frequency (MHz)	99% Bandwidth (kHz)	Limit (MHz)	Result
Low Channel	2402	1760	/	Pass
Mid Channel	2440	1810	/	Pass
High Channel	2480	1770	/	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	:	2021-02-04
Input voltage	:	DC 5V
Operation mode	:	A
Test channel	:	Low / Middle / High
Ambient temperature	:	24.8 ℃
Relative humidity	:	53 %
Atmospheric pressure	:	101 kPa

Table 11: Test Result of 6dB Bandwidth, 1Mbps

Channel	Channel Frequency (MHz)	-6dB Bandwidth (kHz)	Limit (kHz)	Result
Low Channel	2402	514.852	500	Pass
Mid Channel	2440	514.852	500	Pass
High Channel	2480	514.852	500	Pass

Table 12: Test Result of 6dB Bandwidth, 2Mbps

Channel	Channel Frequency (MHz)	-6dB Bandwidth (kHz)	Limit (kHz)	Result
Low Channel	2402	950.496	500	Pass
Mid Channel	2440	910.891	500	Pass
High Channel	2480	871.288	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	:	2021-02-04
Input voltage	:	DC 5V
Operation mode	:	A
Test channel	:	Low / Middle / High
Ambient temperature	:	24.8 ℃
Relative humidity	:	53 %
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	:	2021-01-28
Input voltage	:	DC 5V
Operation mode	:	A
Test channel	:	Low / Middle / High
Ambient temperature	:	23 ℃
Relative humidity	:	47 %
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	:	2021-02-23
Input voltage	:	AC 120V/60Hz
Operation mode	:	B
Earthing	:	Not connected
Ambient temperature	:	24.8 ℃
Relative humidity	:	53 %
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 March 2015

Measurement Record:

The measured maximum conducted output power of the EUT is 3.6dBm ≈ 2.29mW, 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.

The measured maximum specified e.i.r.p of the EUT is 5.28dBm ≈ 3.37mW, which is far below the SAR exclusion threshold level 4mW, hence the EUT is excluded from SAR evaluation according to RSS-102 Issue 5 section 2.5.1.

7 Photographs of the Test Set-Up

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

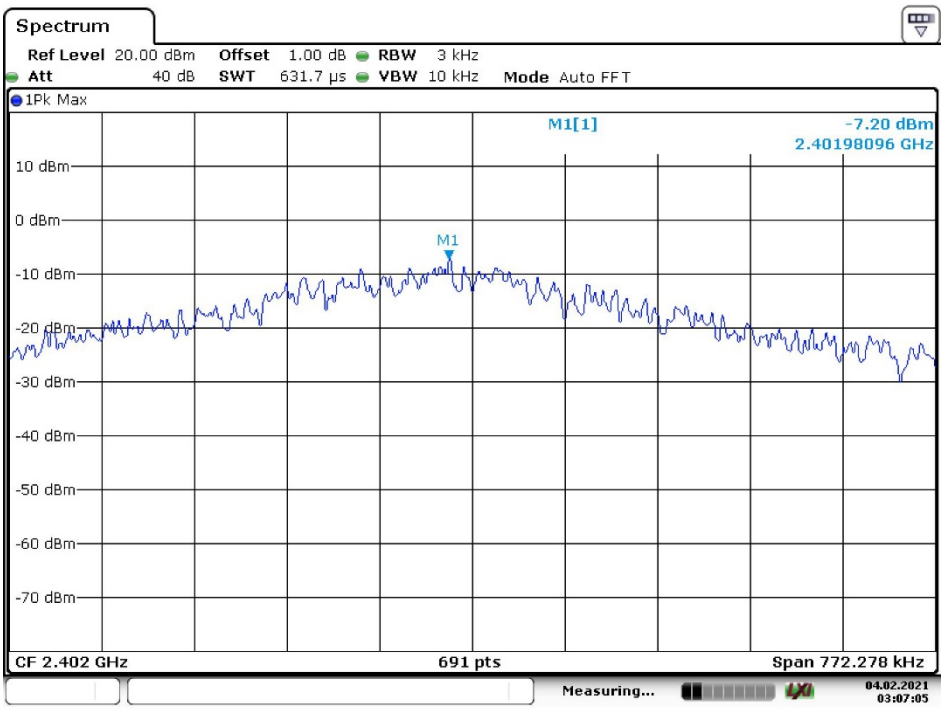
8 List of Tables

Appendix B: Test Results

Appendix B.1: Conducted Power Spectral Density

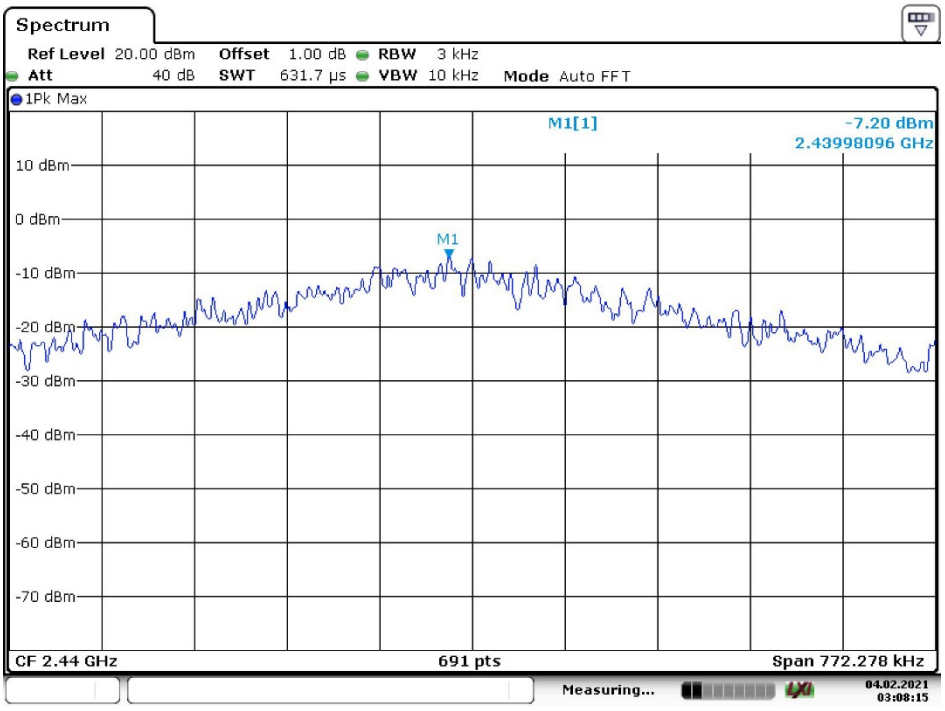
BLE, 1Mbps

Low Channel



Date: 4.FEB.2021 03:07:05

Middle Channel



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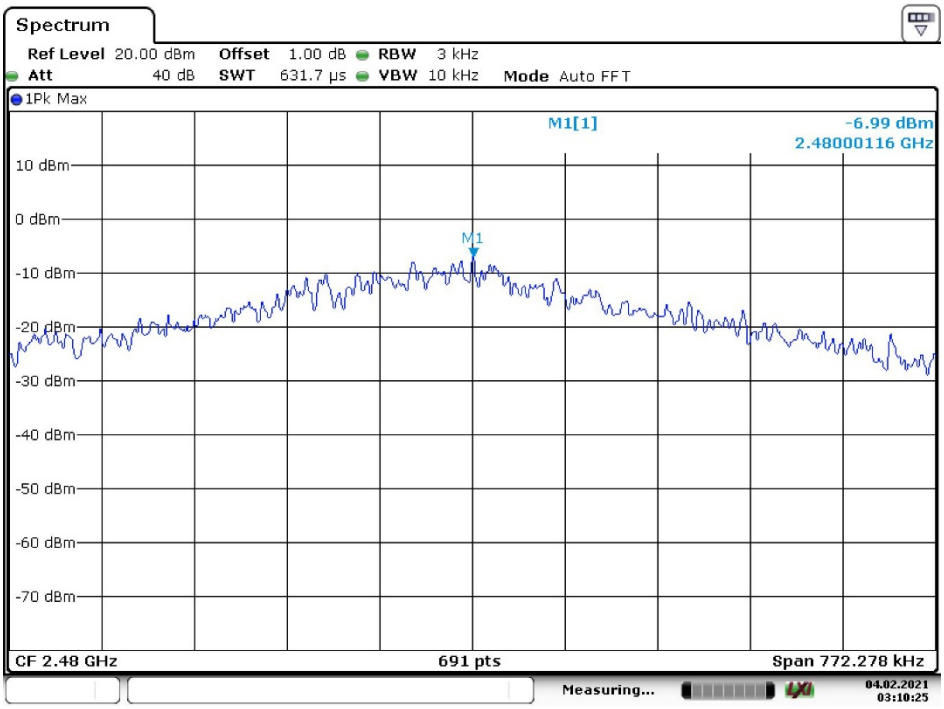
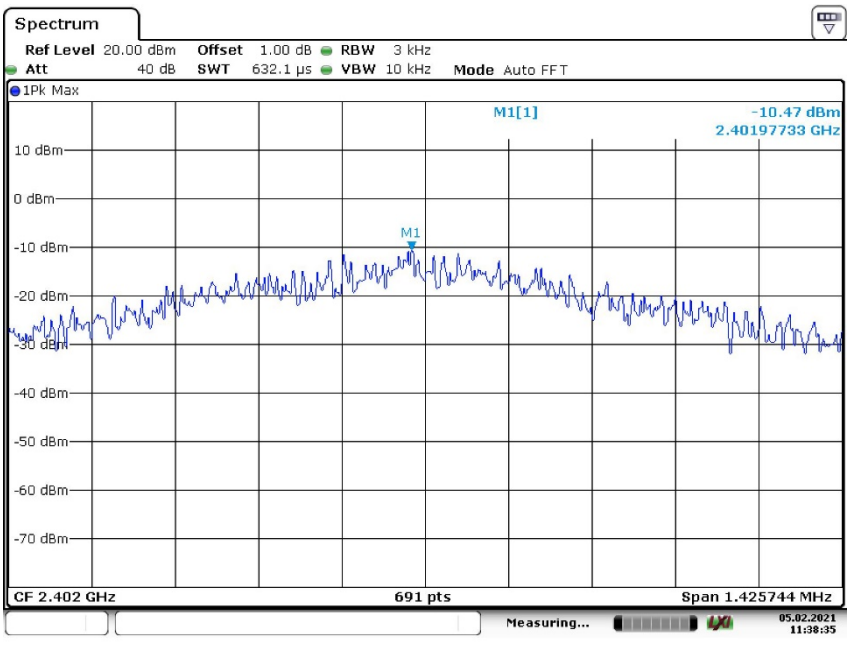
High Channel



Date: 4.FEB.2021 03:10:25

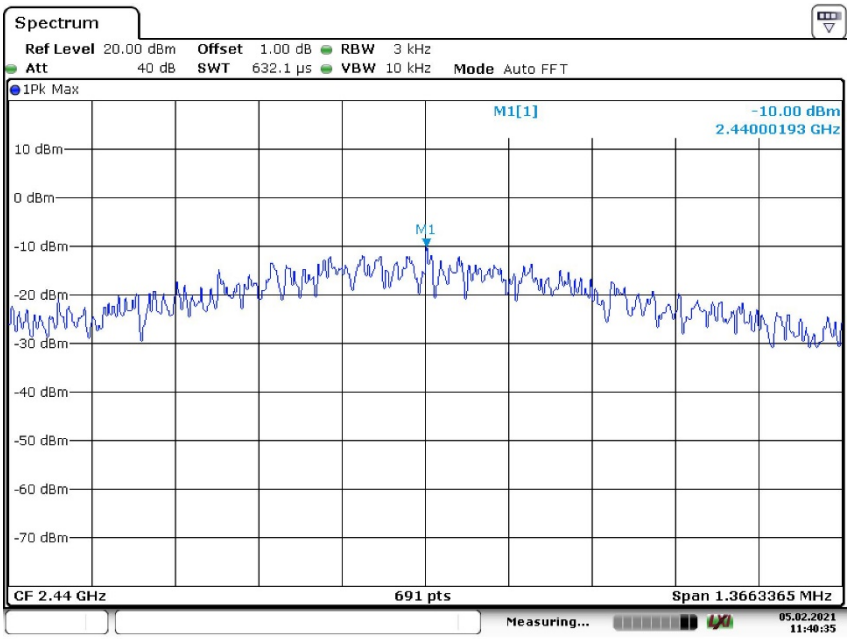
BLE, 2Mbps

Low Channel



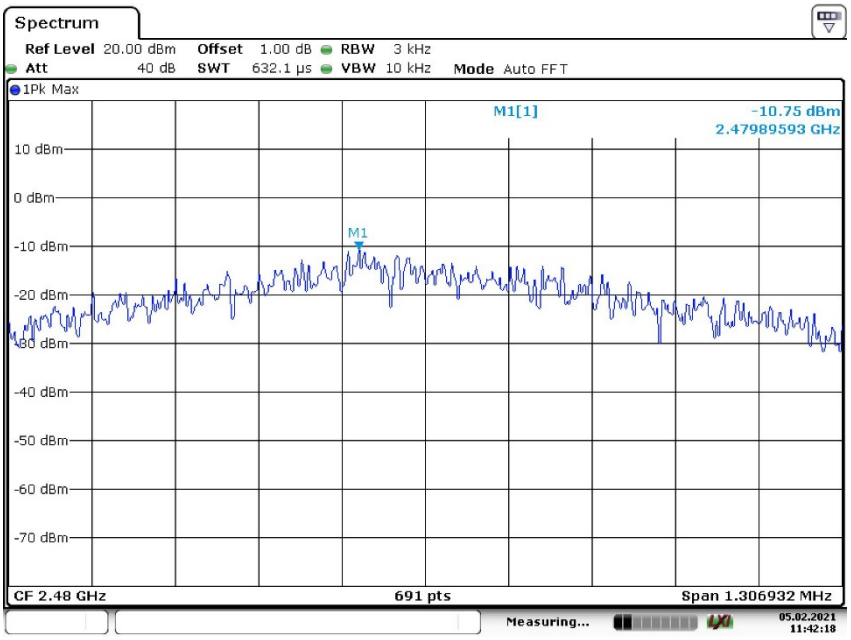
Date: 5.FEB.2021 11:38:36

Middle Channel



Date: 5.FEB.2021 11:40:36

High Channel



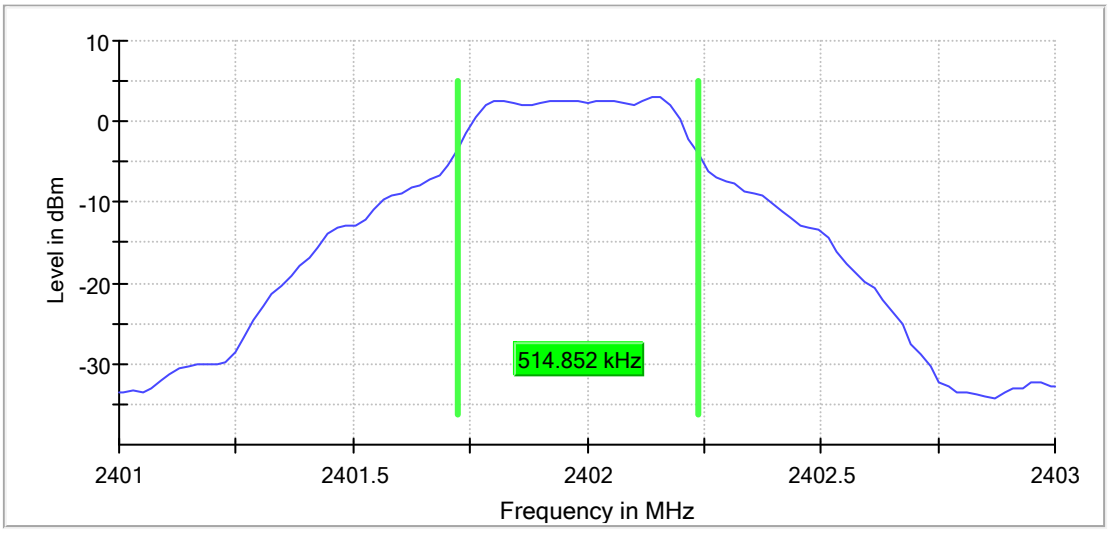
Date: 5.FEB.2021 11:42:18

Appendix B.2: 6dB Bandwidth

BLE, 1Mbps

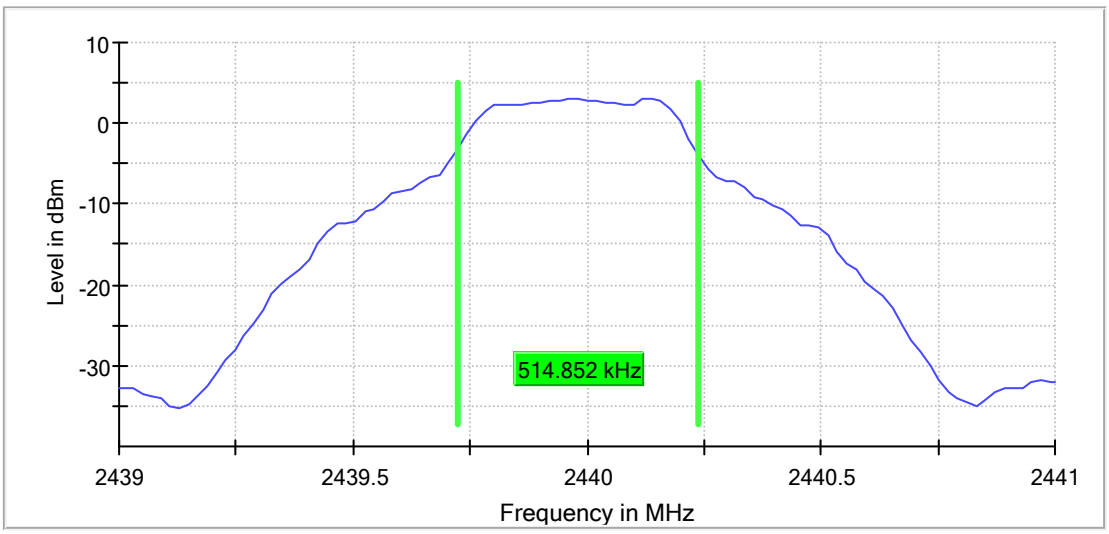
Low Channel

RBW=100KHz, VBW=300KHz



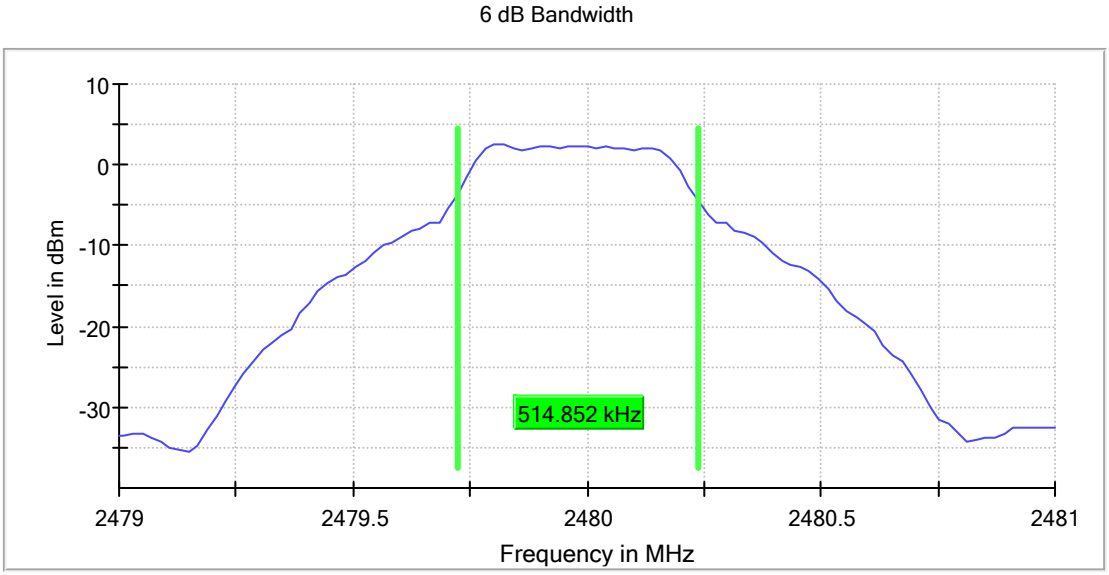
Middle Channel

RBW=100KHz, VBW=300KHz



High Channel

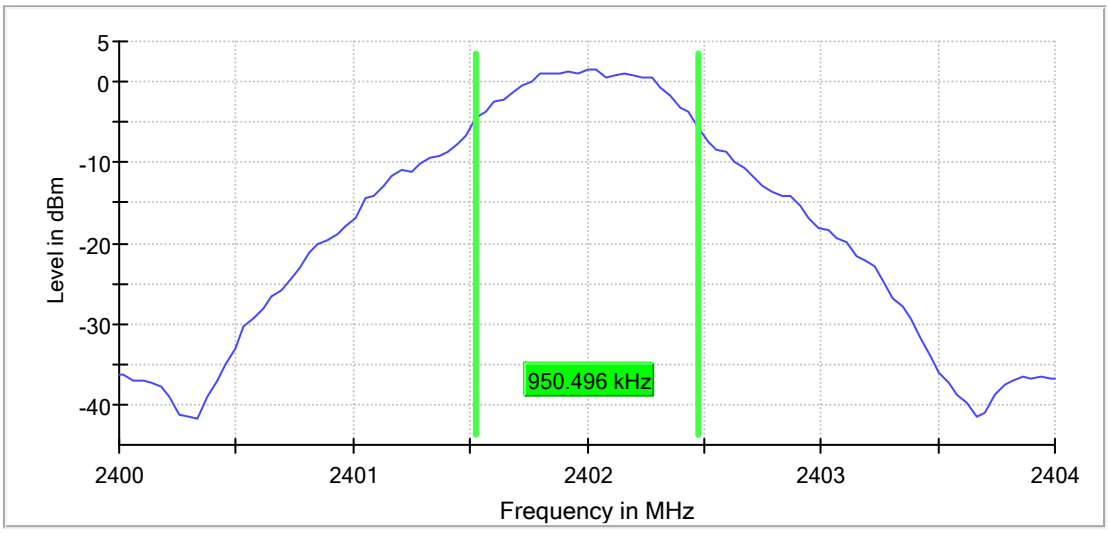
RBW=100KHz, VBW=300KHz



BLE, 2Mbps

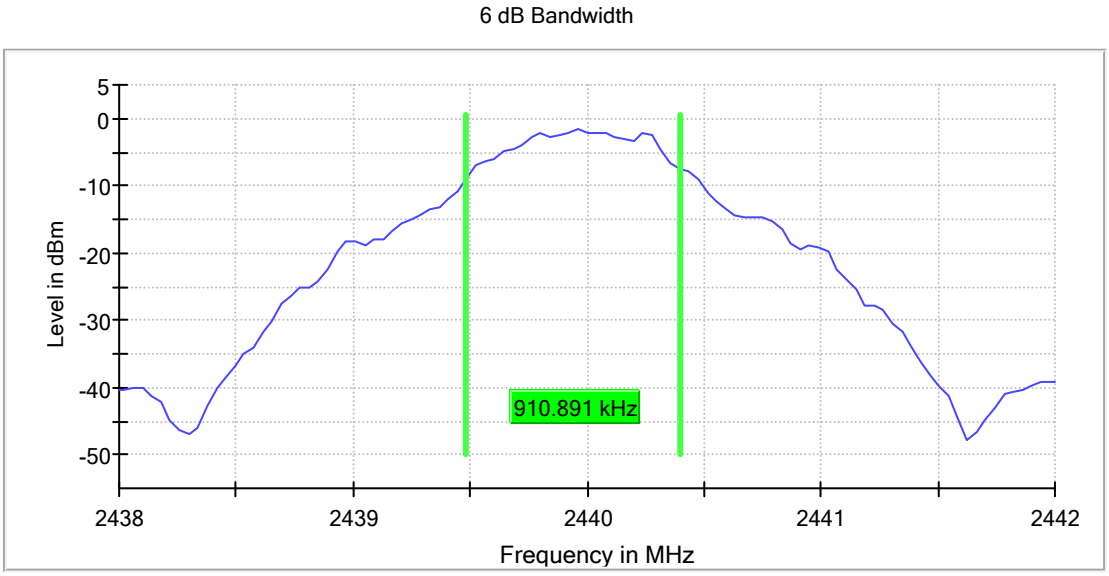
Low Channel

RBW=100KHz, VBW=300KHz



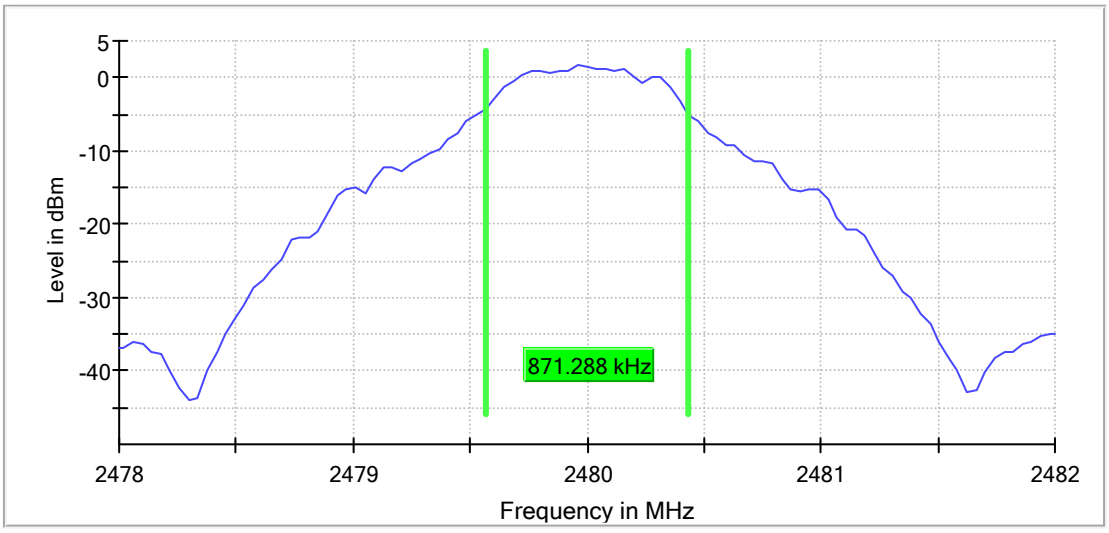
Middle Channel

RBW=100KHz, VBW=300KHz



High Channel

RBW=100KHz, VBW=300KHz

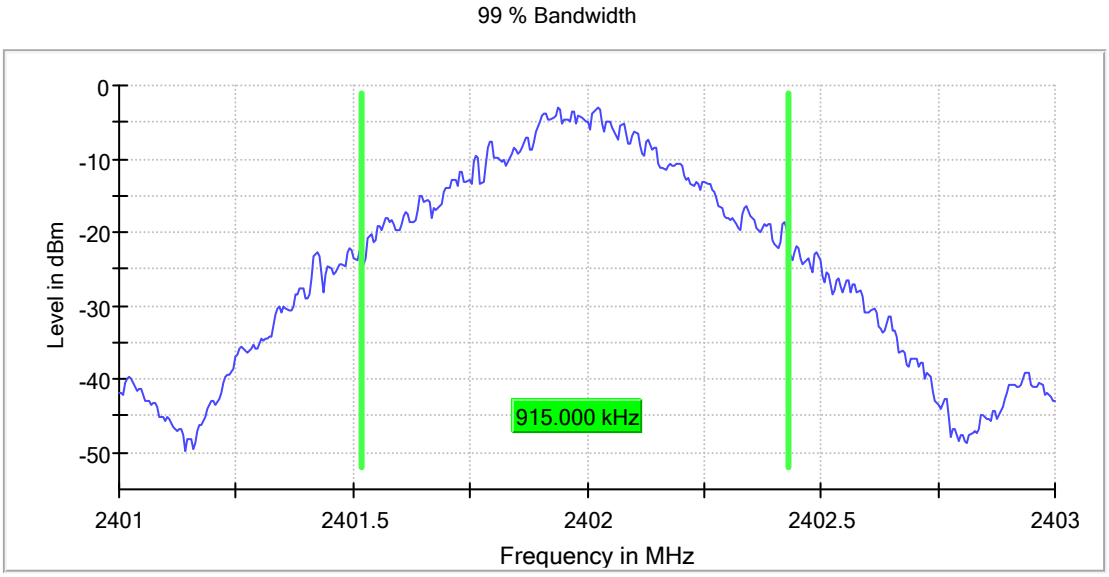


Appendix B.3: 99% Bandwidth

BLE, 1Mbps

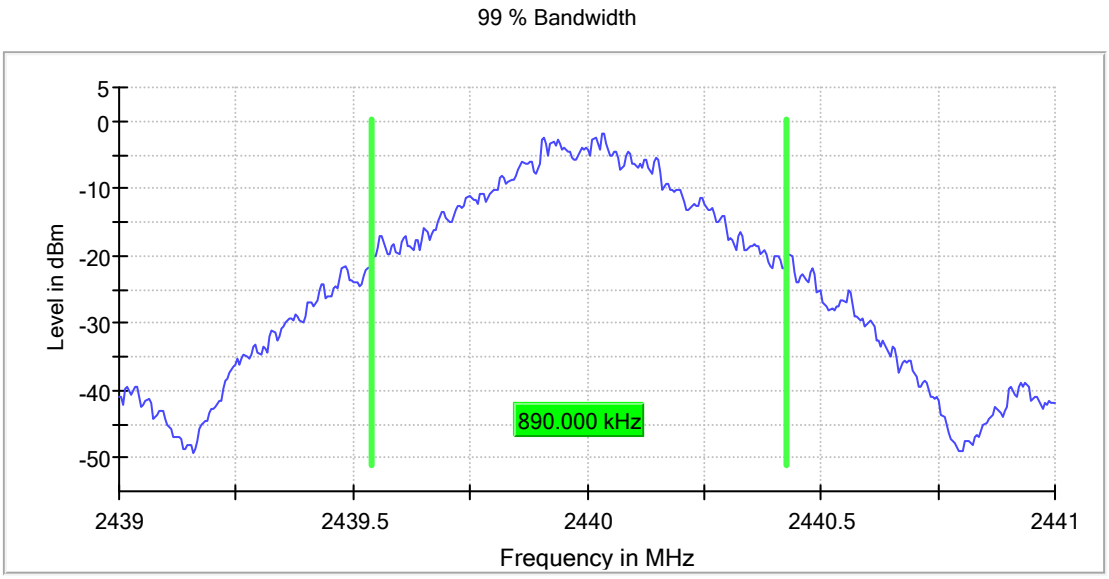
Low Channel

RBW=10KHz, VBW=30KHz



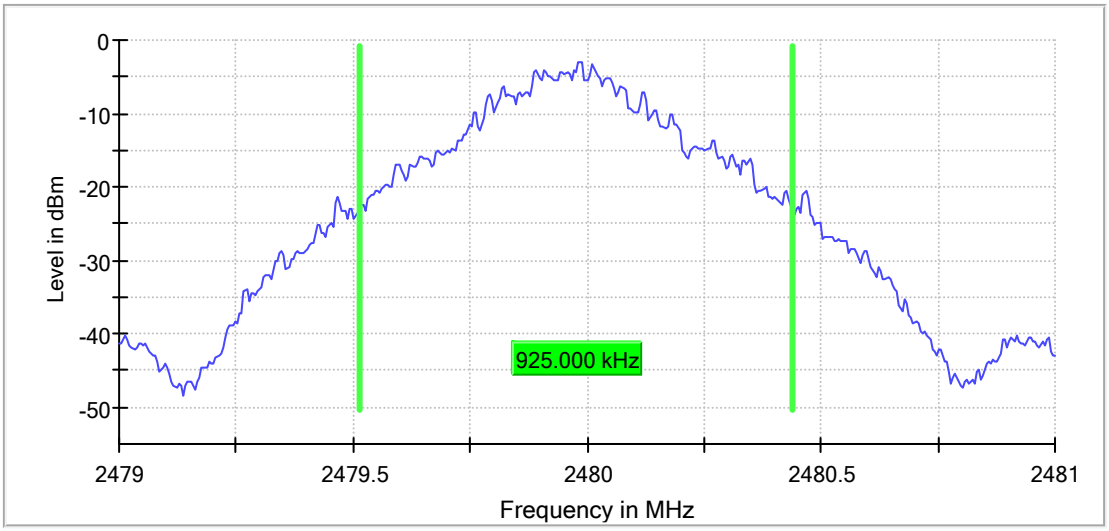
Middle Channel

RBW=10KHz, VBW=30KHz



High Channel

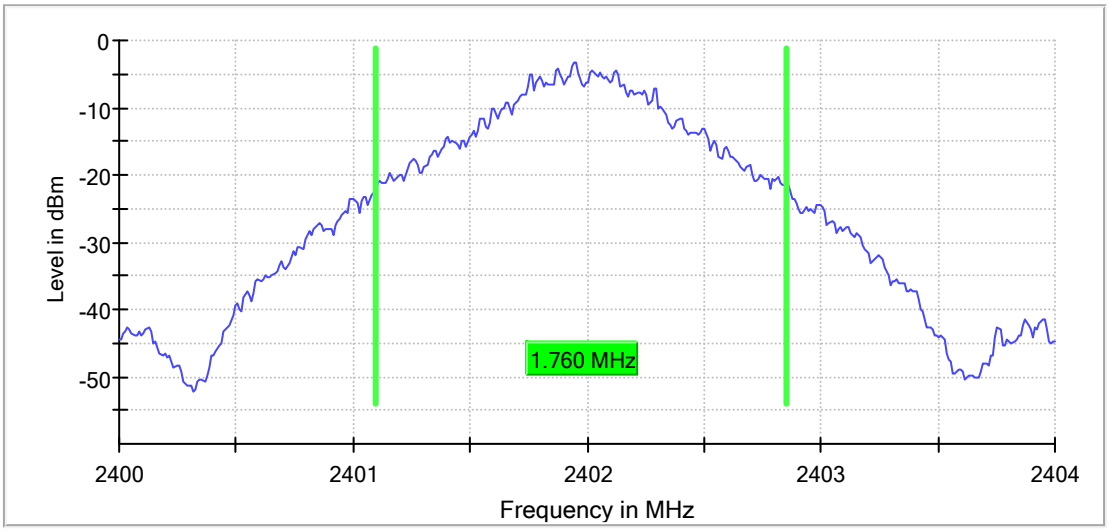
RBW=10KHz, VBW=30KHz



BLE, 2Mbps

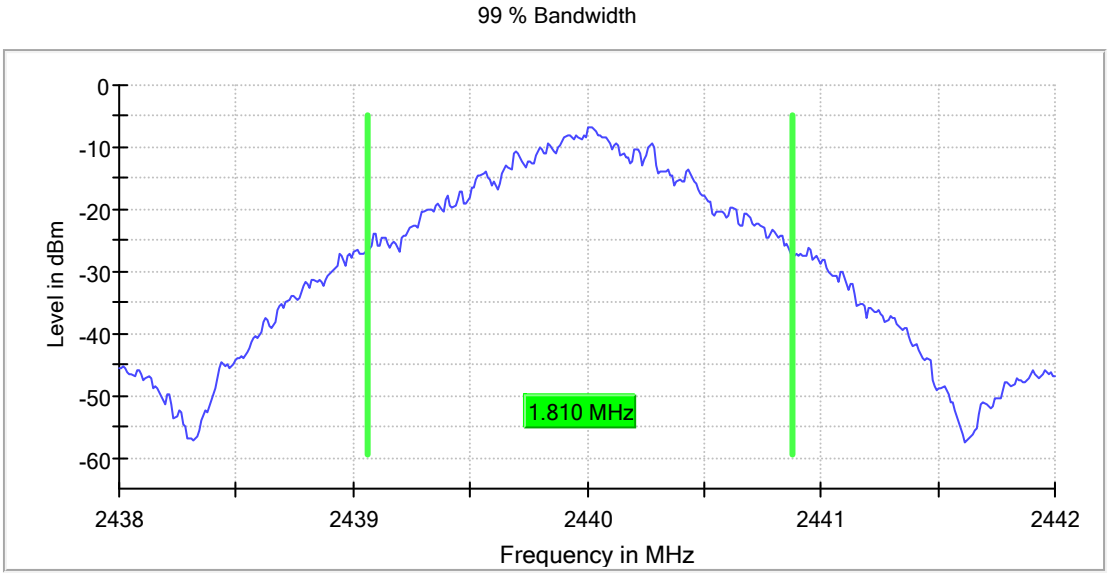
Low Channel

RBW=20KHz, VBW=100KHz



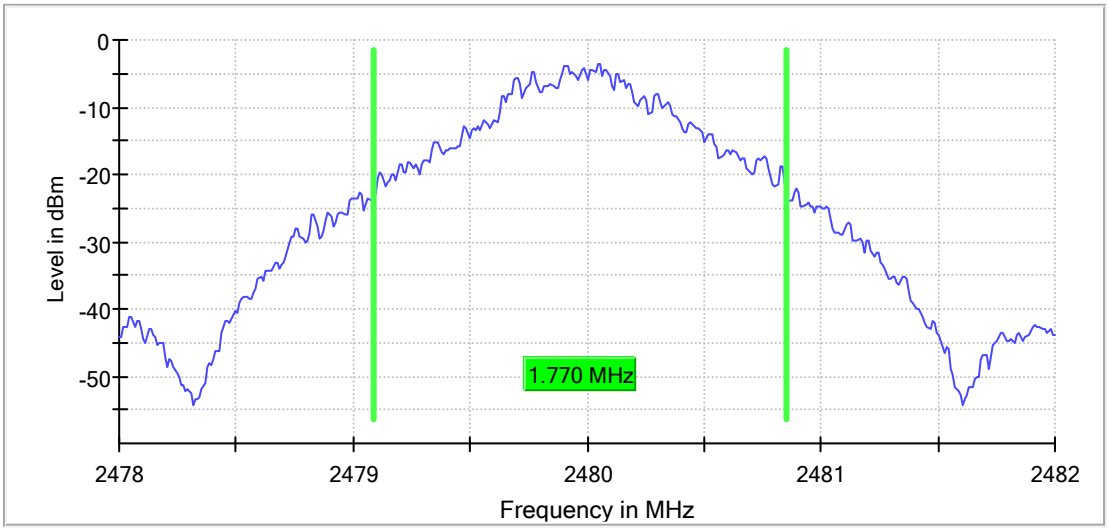
Middle Channel

RBW=20KHz, VBW=100KHz



High Channel

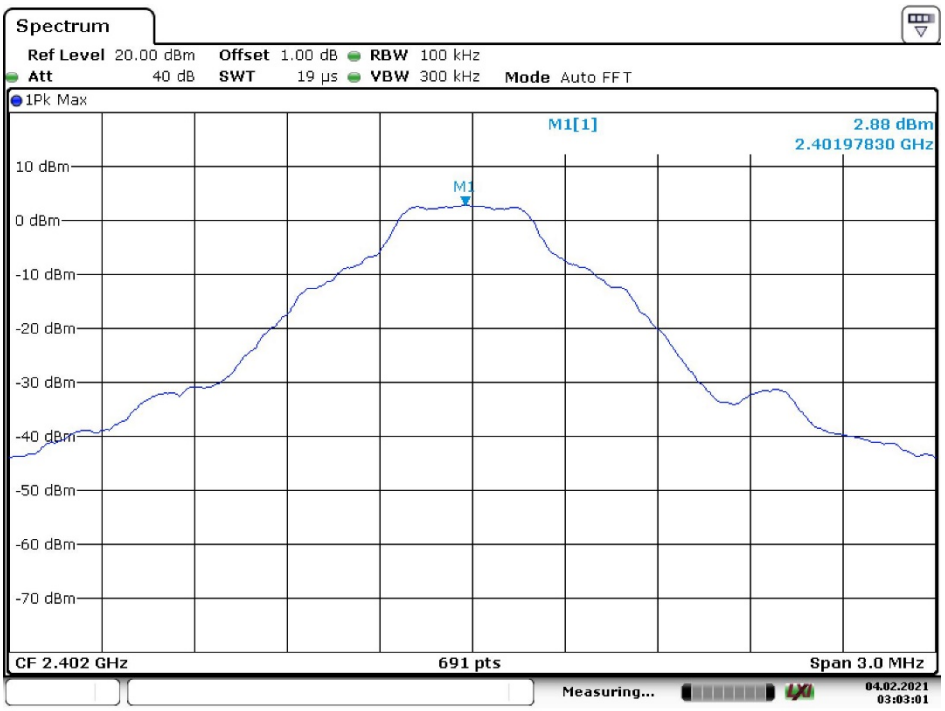
RBW=20KHz, VBW=100KHz



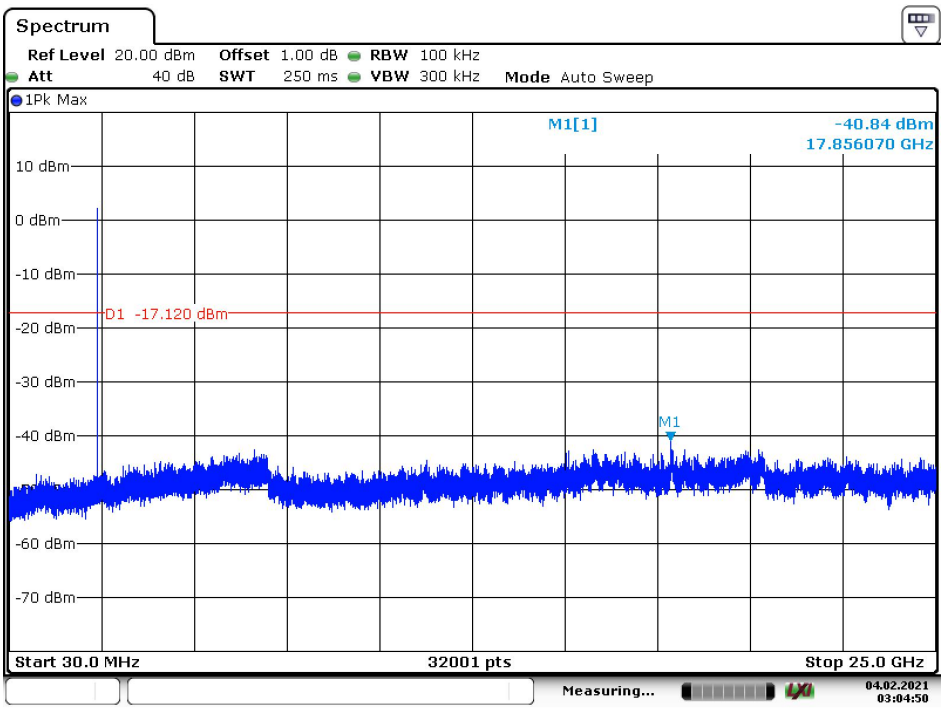
Appendix B.4: Conducted Spurious Emissions Measured in 100 kHz Bandwidth

BLE, 1Mbps

Low Channel

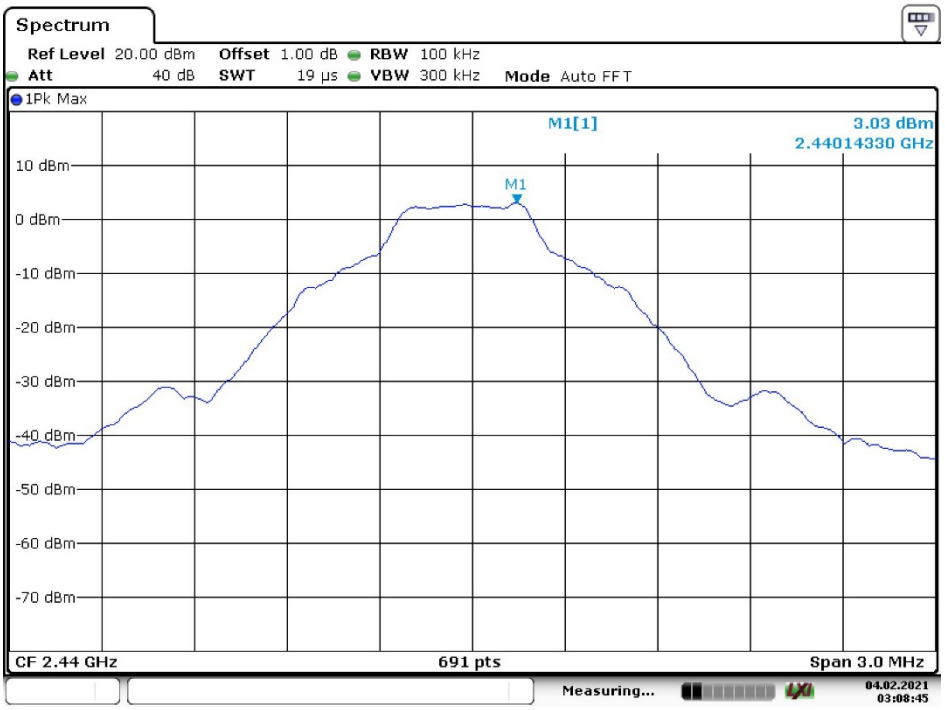


Date: 4.FEB.2021 03:03:01

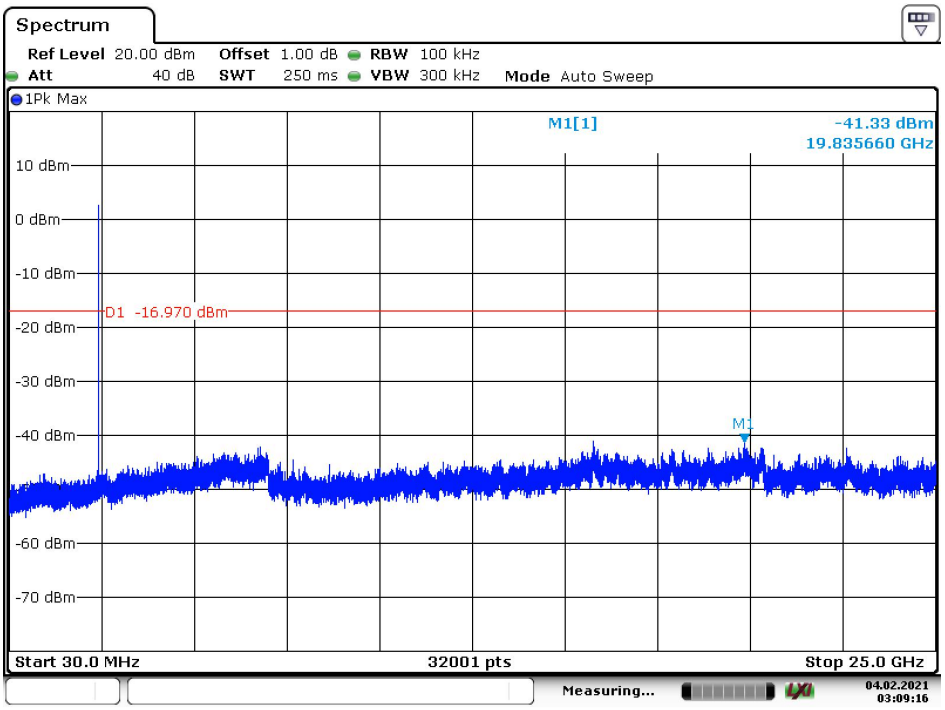


Date: 4.FEB.2021 03:04:50

Middle Channel

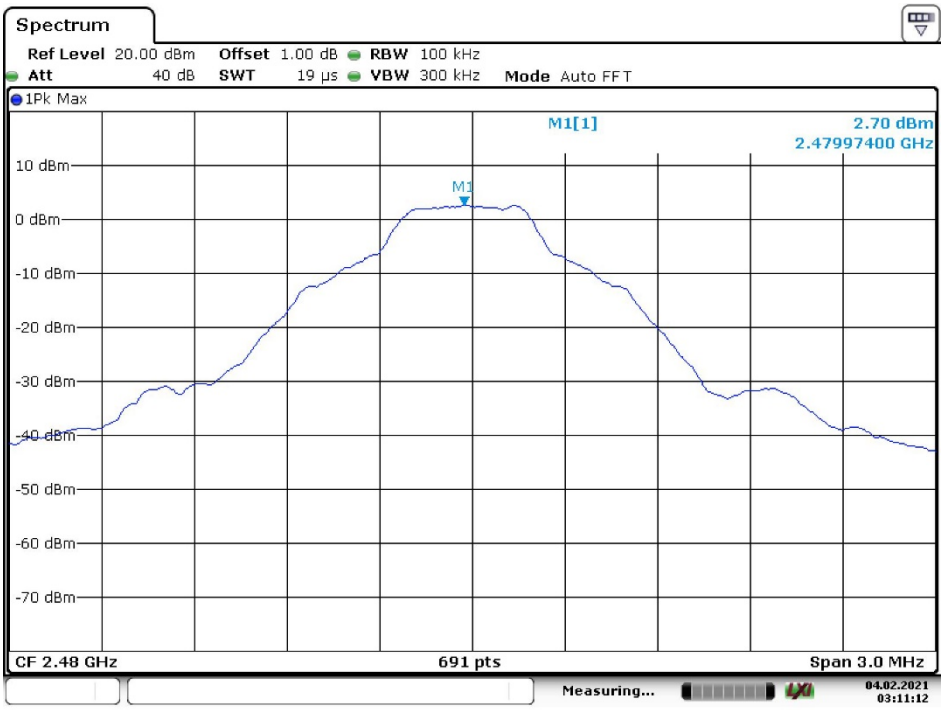


Date: 4.FEB.2021 03:08:45

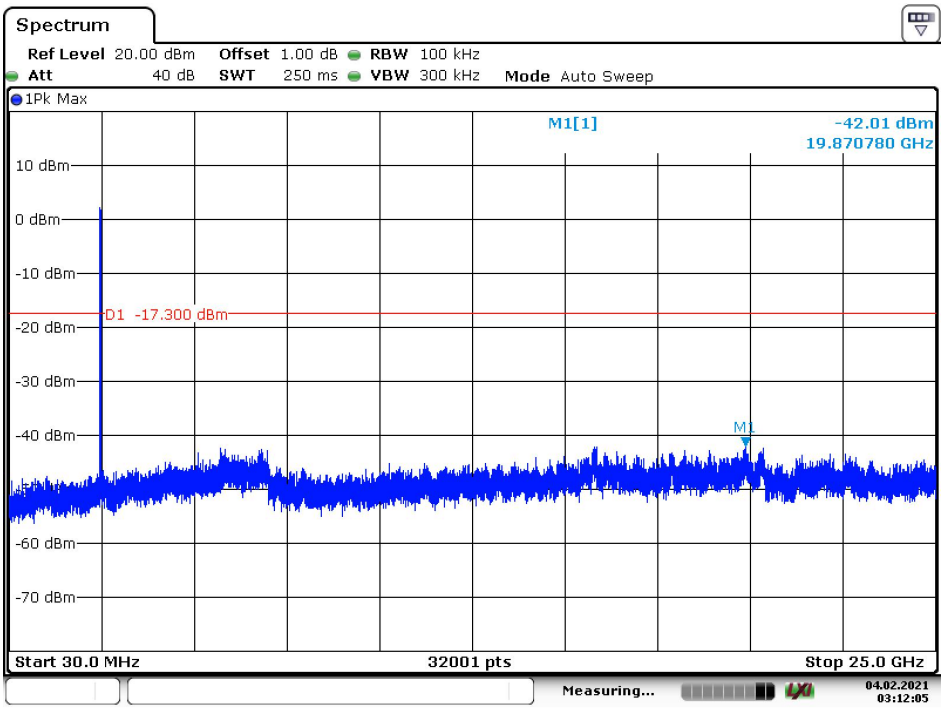


Date: 4.FEB.2021 03:09:16

High Channel

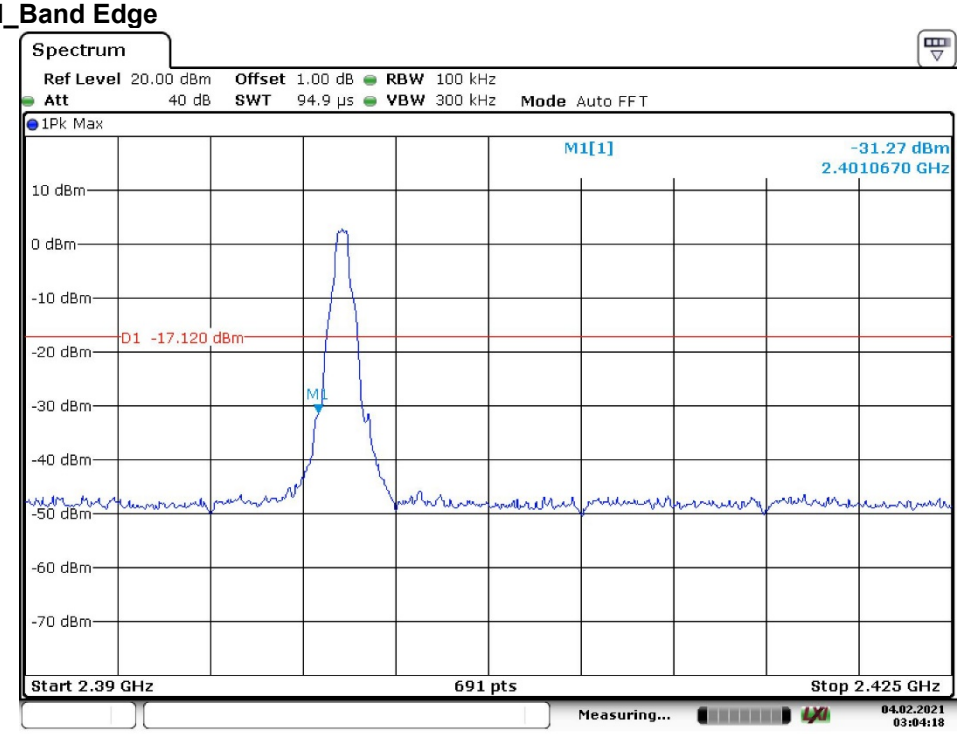


Date: 4.FEB.2021 03:11:12



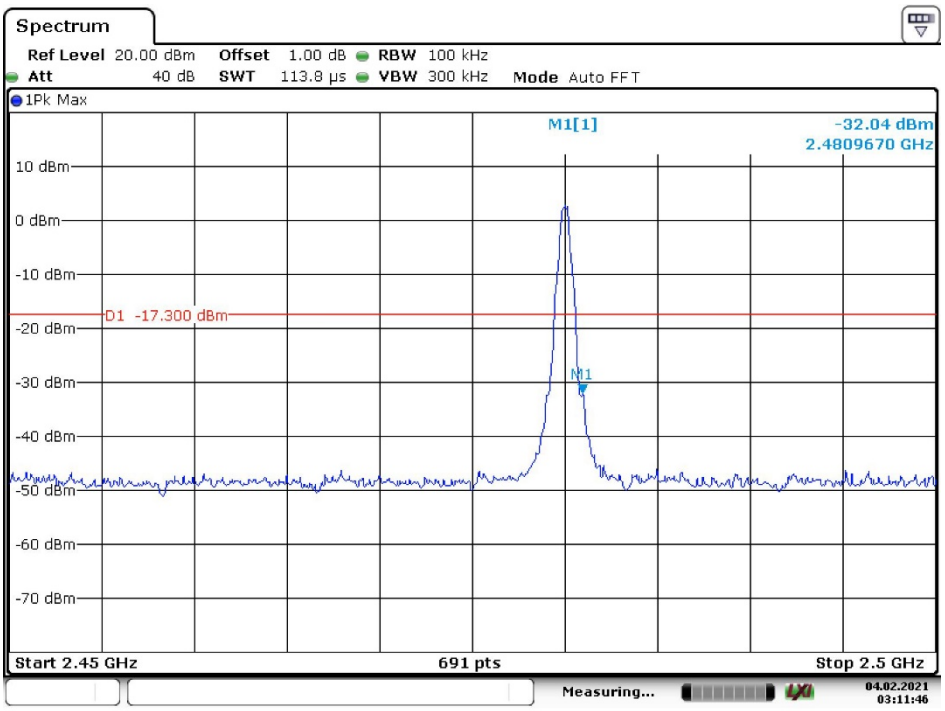
Date: 4.FEB.2021 03:12:05

Low Channel_Band Edge



Date: 4.FEB.2021 03:04:18

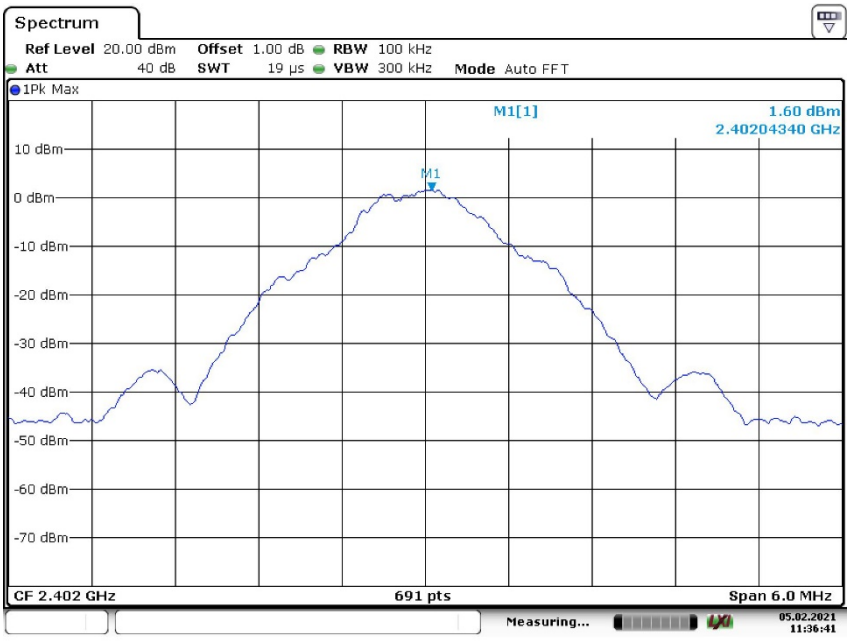
High Channel_Band Edge



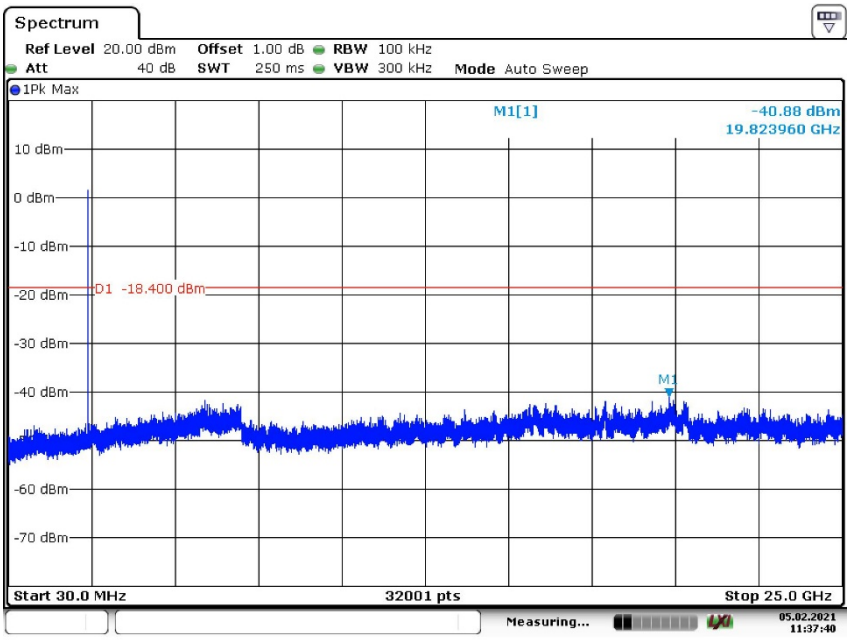
Date: 4.FEB.2021 03:11:46

BLE, 2Mbps

Low Channel

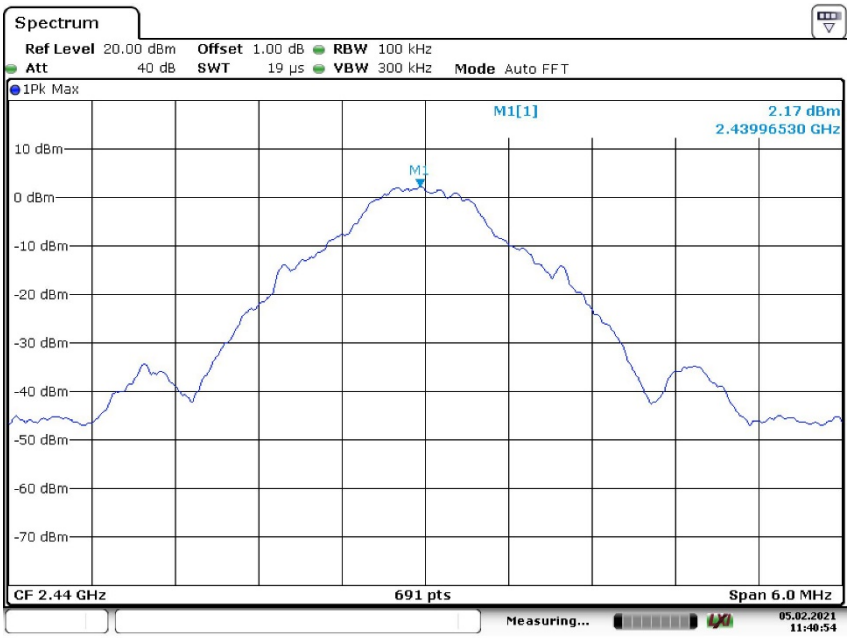


Date: 5.FEB.2021 11:36:41

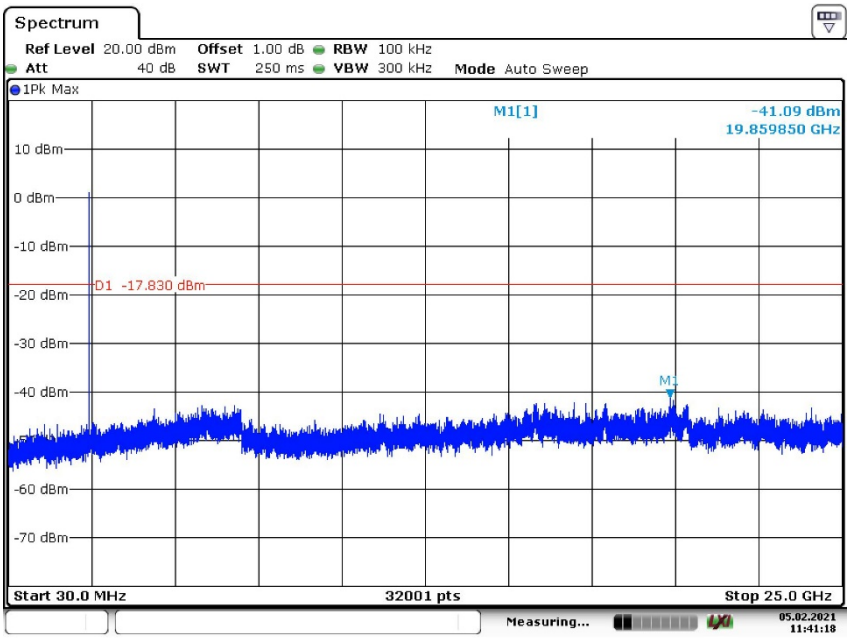


Date: 5.FEB.2021 11:37:41

Middle Channel

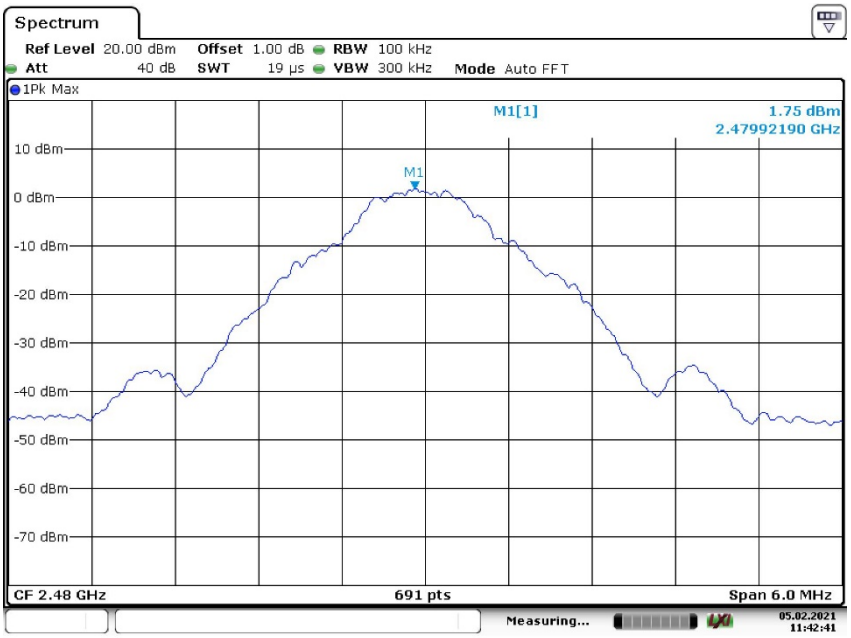


Date: 5.FEB.2021 11:40:54

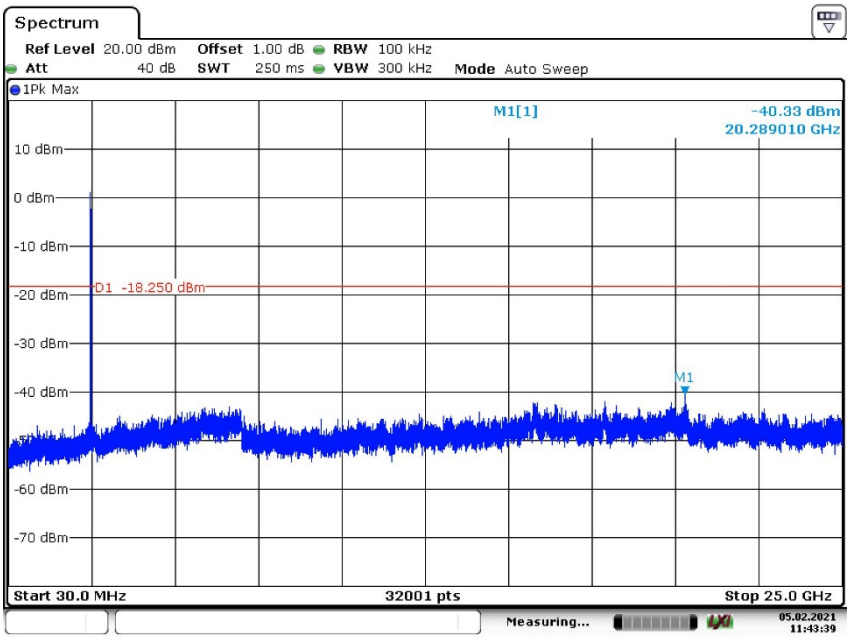


Date: 5.FEB.2021 11:41:18

High Channel

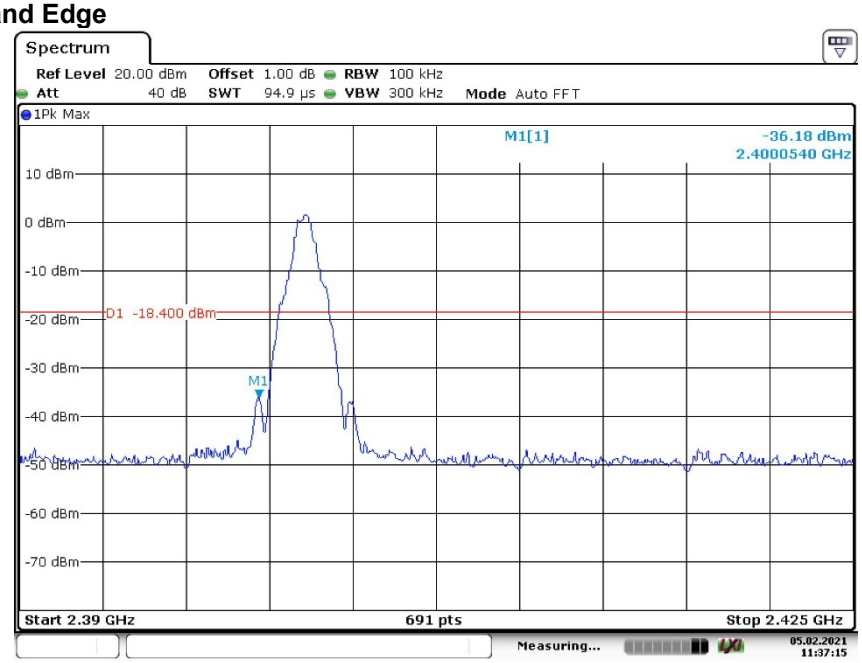


Date: 5.FEB.2021 11:42:42



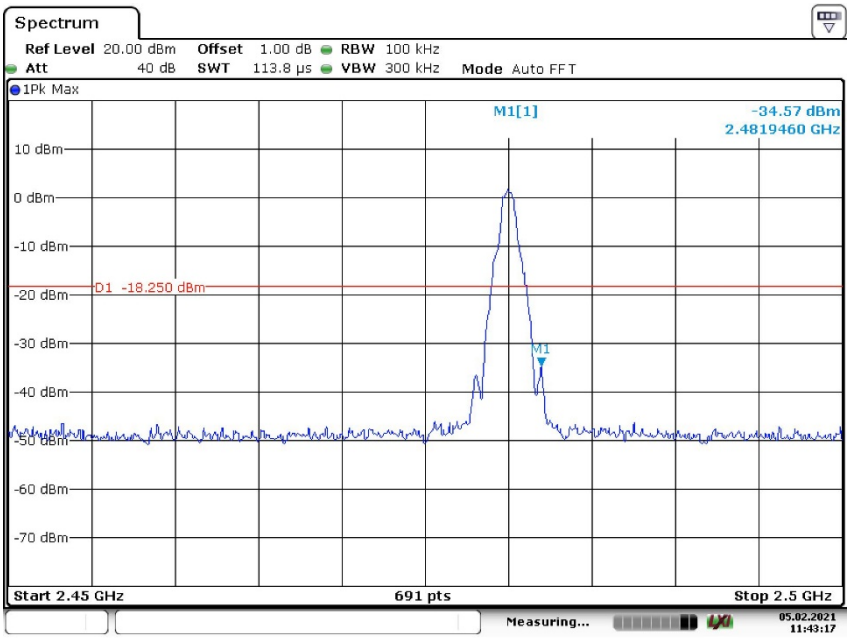
Date: 5.FEB.2021 11:43:39

Low Channel_Band Edge



Date: 5.FEB.2021 11:37:15

High Channel_Band Edge



Date: 5.FEB.2021 11:43:18

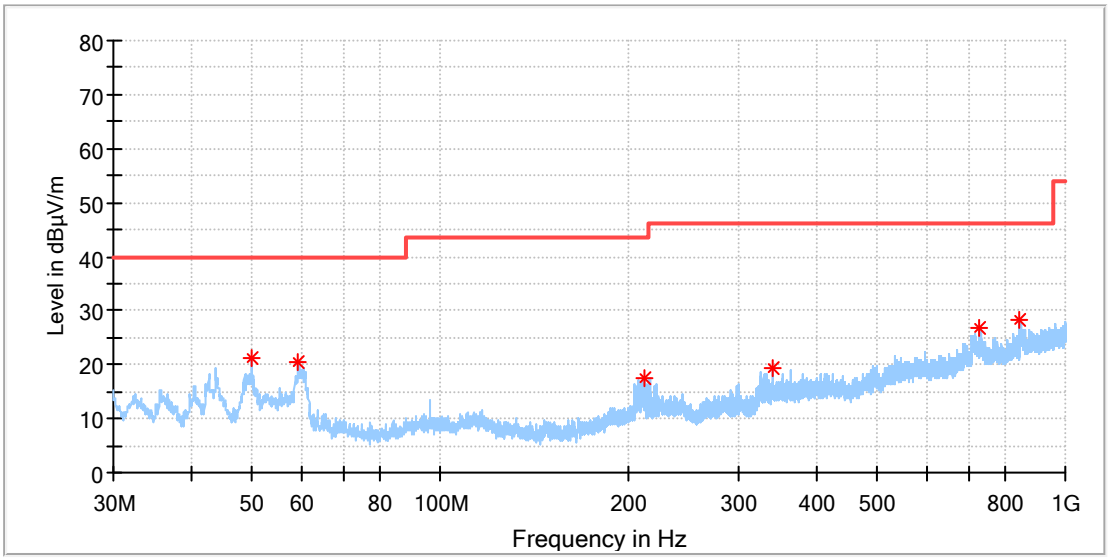
Appendix B.5: Test Results of Radiated Spurious Emissions

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:	WisDuo
Model:	RAK3401
Test Mode:	BLE_Low channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Alano Qu
Reviewed By:	Terry Yin

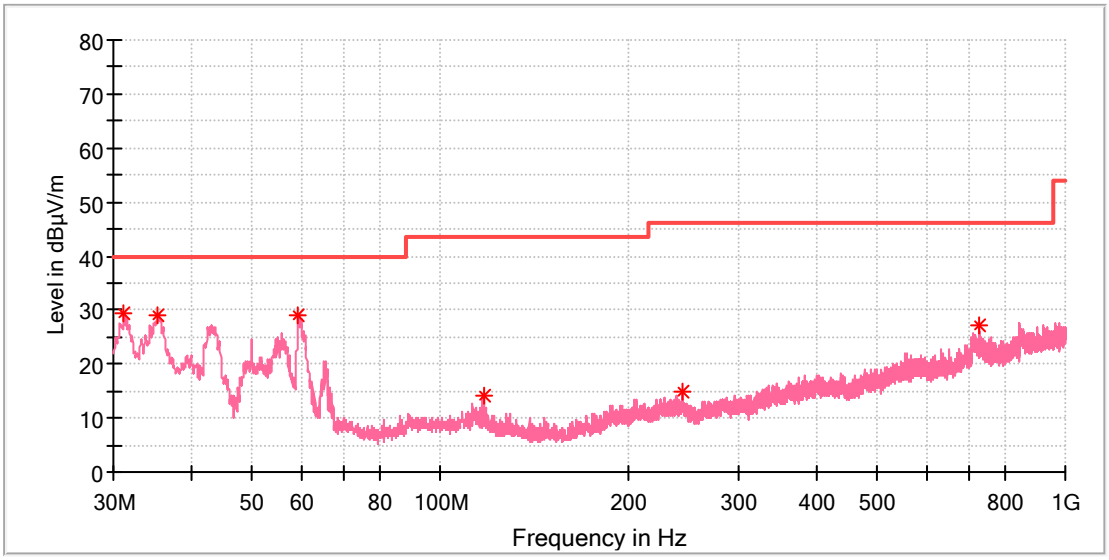


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
49.982000	21.16	---	40.00	18.84	100.0	H	212.0	-18.6
59.342500	20.54	---	40.00	19.46	100.0	H	41.0	-19.2
211.632500	17.54	---	43.50	25.96	100.0	H	0.0	-19.1
339.915000	19.33	---	46.00	26.67	100.0	H	12.0	-15.4
729.127500	26.91	---	46.00	19.09	100.0	H	2.0	-7.9
845.430500	28.15	---	46.00	17.85	100.0	H	292.0	-6.0

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_Low channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Alano Qu
Reviewed By:	Terry Yin

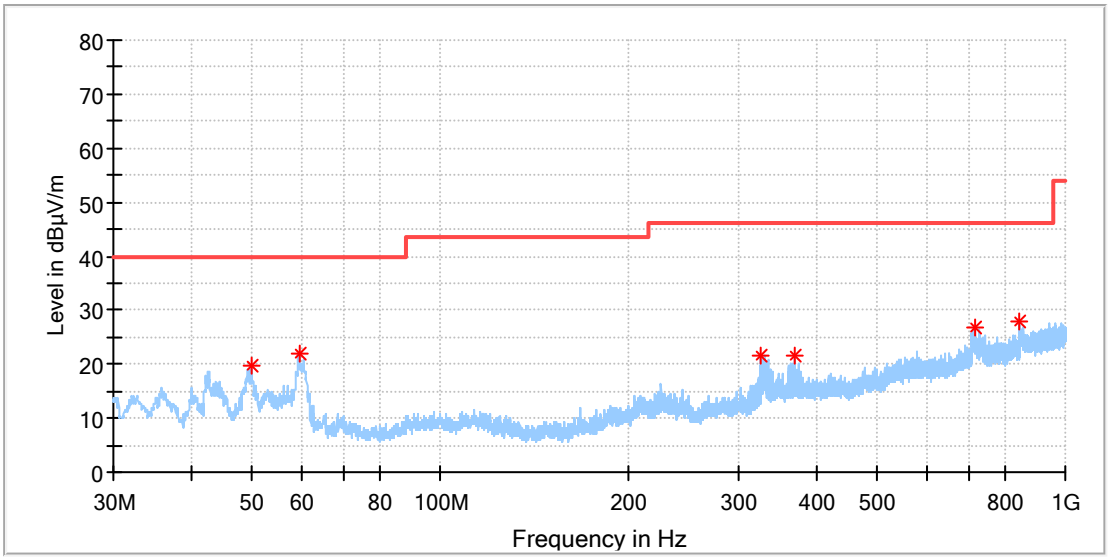


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
31.212500	29.41	---	40.00	10.59	100.0	V	264.0	-23.1
35.383500	29.04	---	40.00	10.96	100.0	V	70.0	-22.1
59.342500	29.17	---	40.00	10.83	100.0	V	51.0	-19.2
117.251500	14.32	---	43.50	29.18	100.0	V	320.0	-20.5
243.642500	14.87	---	46.00	31.13	100.0	V	216.0	-17.9
728.933500	26.99	---	46.00	19.01	100.0	V	70.0	-7.9

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_High channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Alano Qu
Reviewed By:	Terry Yin

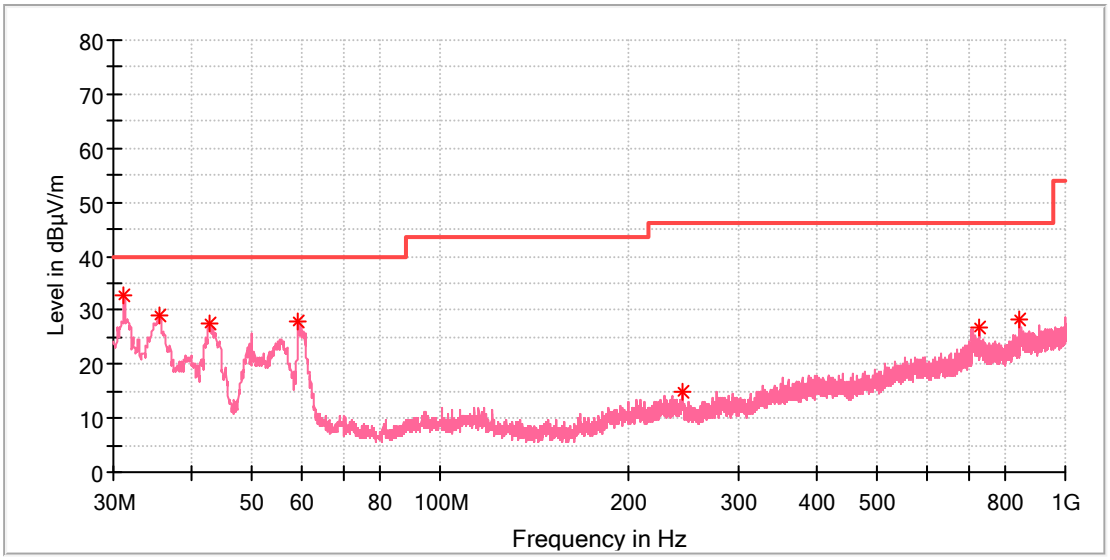


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
49.982000	19.63	---	40.00	20.37	100.0	H	311.0	-18.6
59.391000	21.89	---	40.00	18.11	100.0	H	128.0	-19.2
325.801500	21.75	---	46.00	24.25	100.0	H	355.0	-15.8
368.093500	21.53	---	46.00	24.47	100.0	H	359.0	-14.8
719.185000	26.69	---	46.00	19.31	100.0	H	0.0	-8.1
844.897000	27.90	---	46.00	18.10	100.0	H	339.0	-6.0

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_High channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Alano Qu
Reviewed By:	Terry Yin

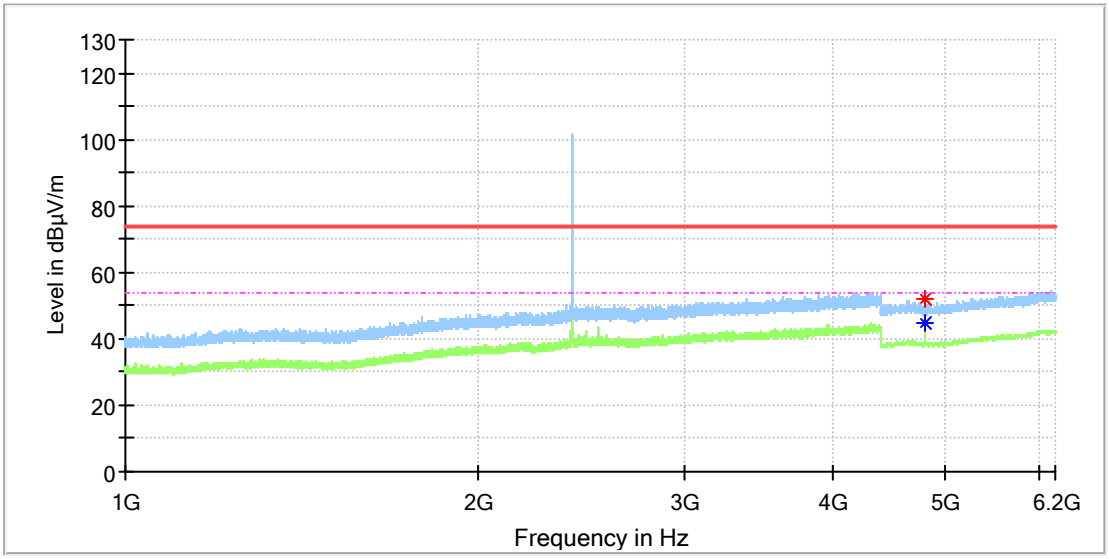


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
31.212500	32.81	---	40.00	7.19	100.0	V	0.0	-23.1
35.626000	28.94	---	40.00	11.06	100.0	V	0.0	-22.0
42.804000	27.48	---	40.00	12.52	100.0	V	212.0	-19.7
59.342500	28.03	---	40.00	11.97	100.0	V	48.0	-19.2
243.691000	14.85	---	46.00	31.15	100.0	V	222.0	-17.9
728.933500	26.68	---	46.00	19.32	100.0	V	152.0	-7.9
845.188000	28.10	---	46.00	17.90	100.0	V	48.0	-6.0

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_Low channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

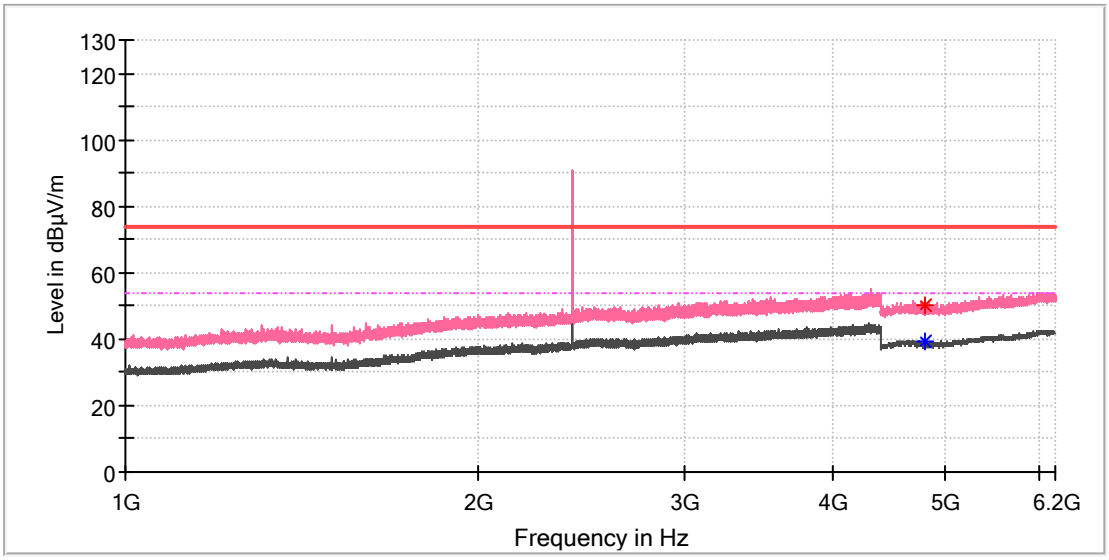


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4803.500000	51.86	---	74.00	22.14	100.0	H	30.0	11.8
4804.000000	---	44.90	54.00	9.10	100.0	H	199.0	11.8

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_Low channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

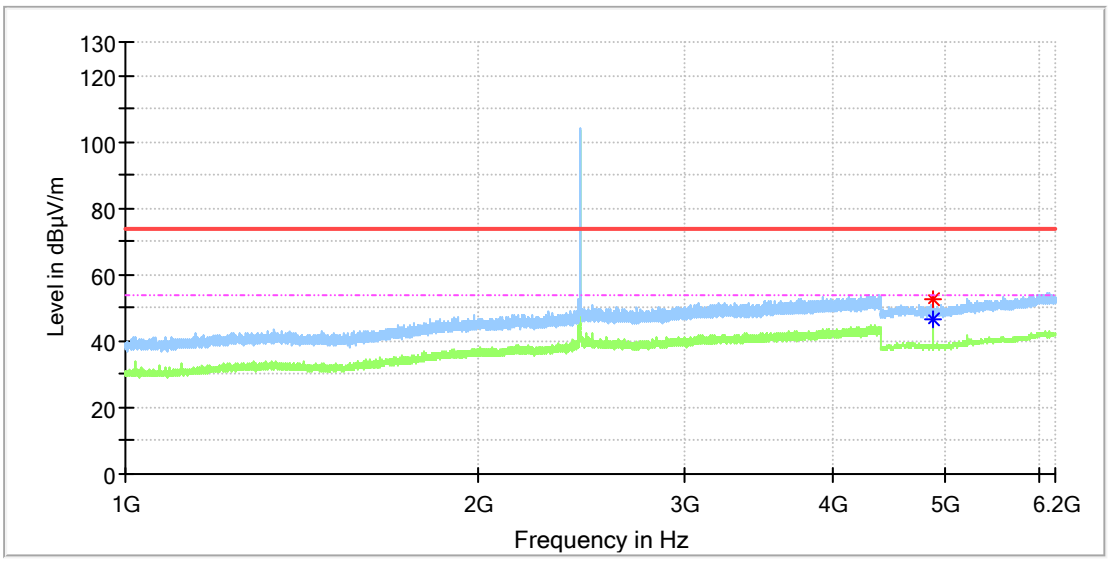


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4803.500000	50.21	---	74.00	23.79	100.0	V	351.0	11.8
4803.500000	---	39.07	54.00	14.93	100.0	V	351.0	11.8

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_Mid channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

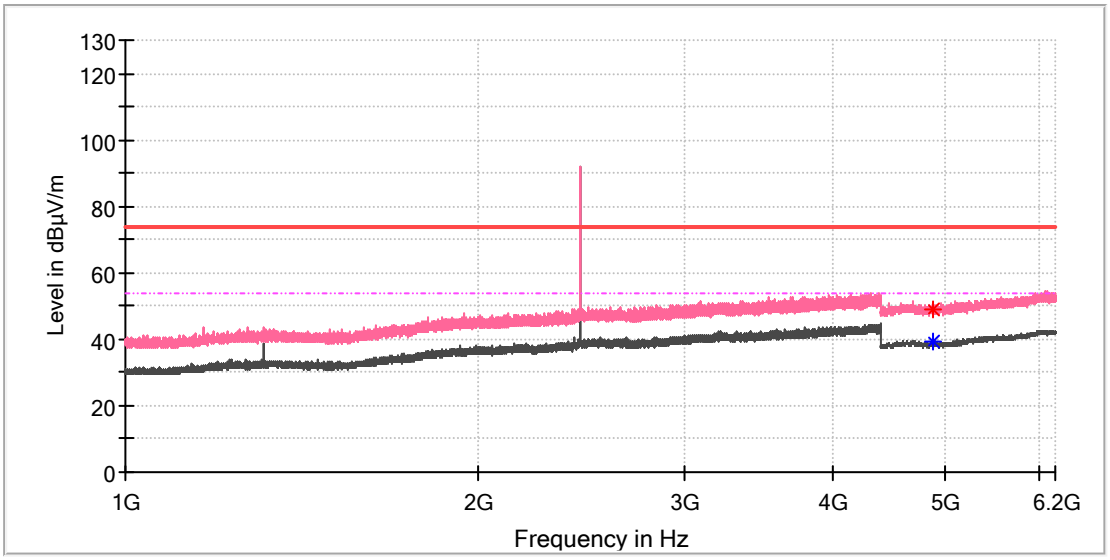


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4879.500000	52.34	---	74.00	21.66	100.0	H	187.0	11.8
4880.000000	---	46.29	54.00	7.71	100.0	H	207.0	11.8

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_Mid channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

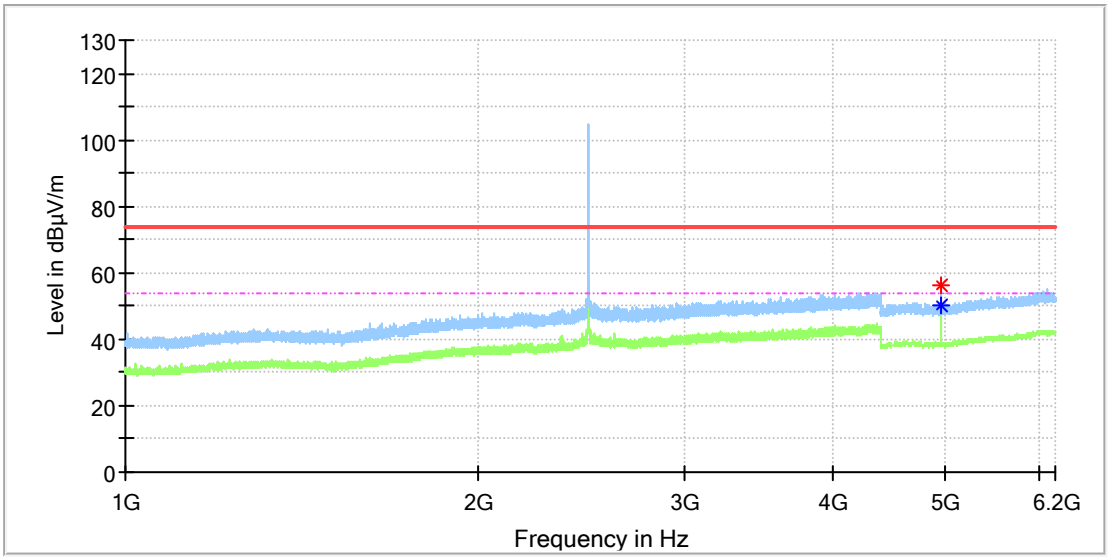


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4880.000000	48.80	---	74.00	25.20	100.0	V	191.0	11.8
4880.000000	---	39.39	54.00	14.61	100.0	V	191.0	11.8

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_High channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

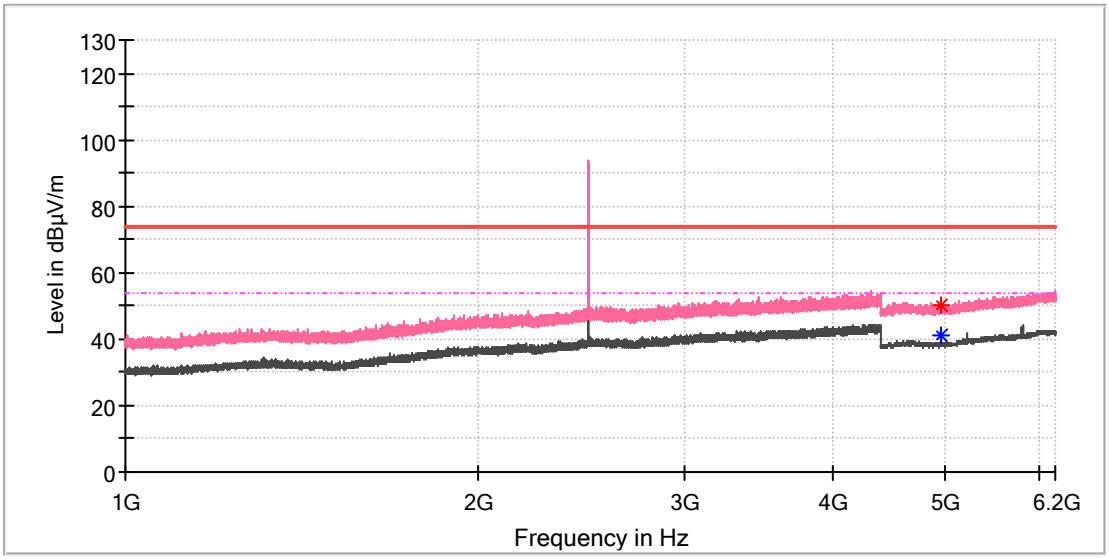


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4960.000000	56.16	---	74.00	17.84	100.0	H	191.0	11.8
4960.000000	---	50.47	54.00	3.53	100.0	H	191.0	11.8

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_High channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

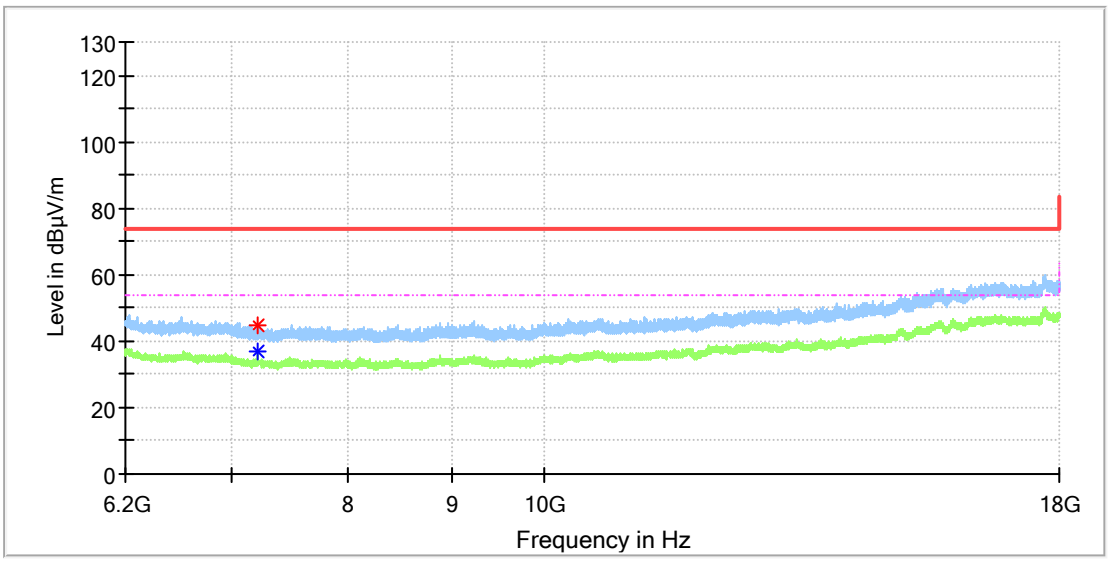


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4959.500000	50.39	---	74.00	23.61	100.0	V	227.0	11.8
4960.000000	---	40.85	54.00	13.15	100.0	V	213.0	11.8

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_Low channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

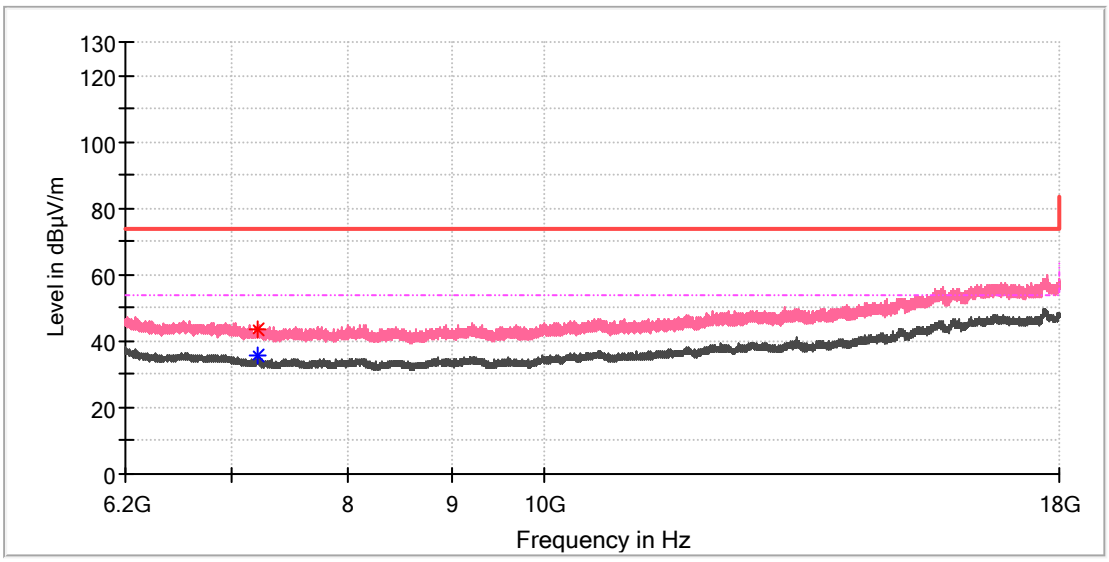


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7205.458333	---	37.13	54.00	16.87	100.0	H	68.0	8.8
7206.933333	44.56	---	74.00	29.44	100.0	H	68.0	8.8

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_Low channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

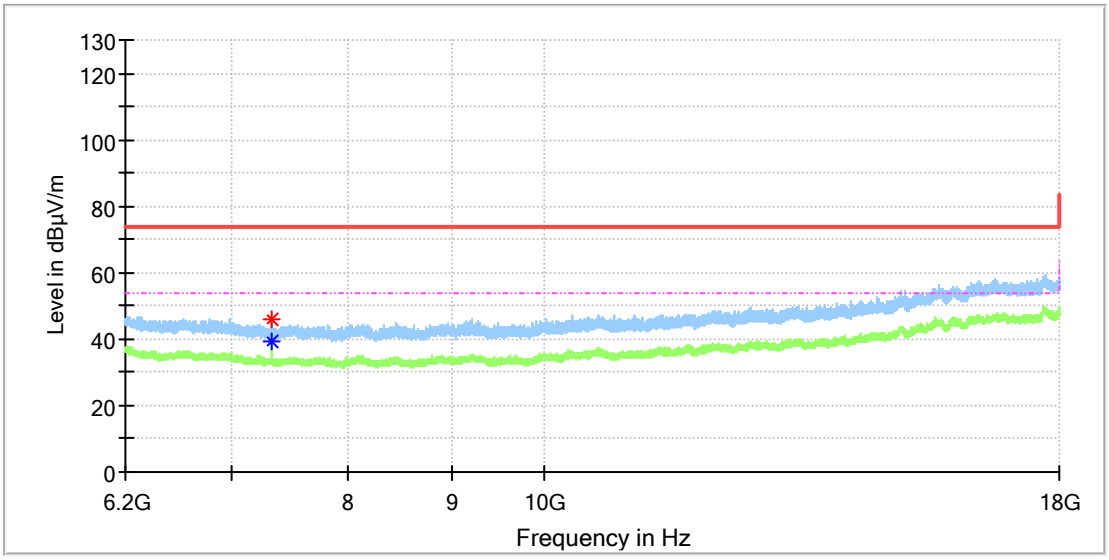


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7205.458333	43.31	---	74.00	30.69	100.0	V	181.0	8.8
7205.458333	---	35.44	54.00	18.56	100.0	V	181.0	8.8

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_Mid channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

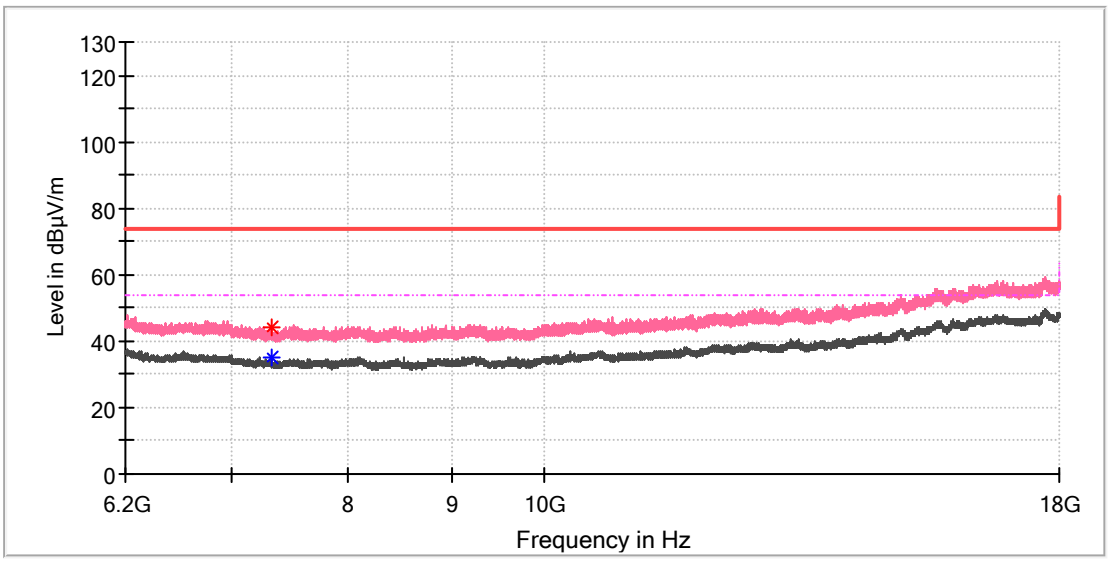


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7319.525000	---	39.18	54.00	14.82	100.0	H	72.0	8.2
7320.016667	45.83	---	74.00	28.17	100.0	H	72.0	8.2

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_Mid channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

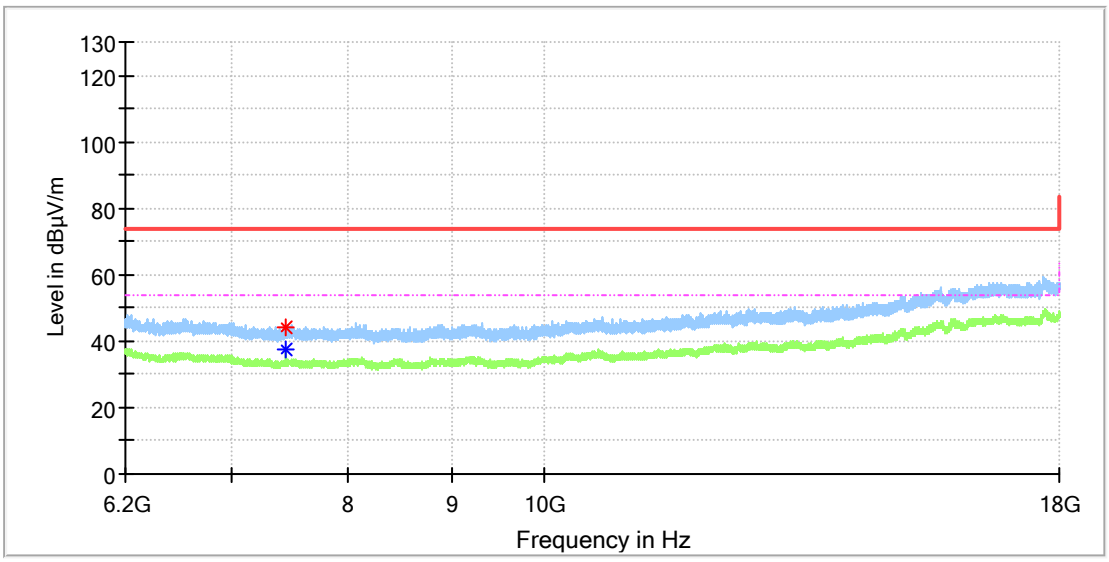


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7319.525000	---	35.17	54.00	18.83	100.0	V	155.0	8.2
7320.508333	43.91	---	74.00	30.09	100.0	V	307.0	8.2

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_High channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

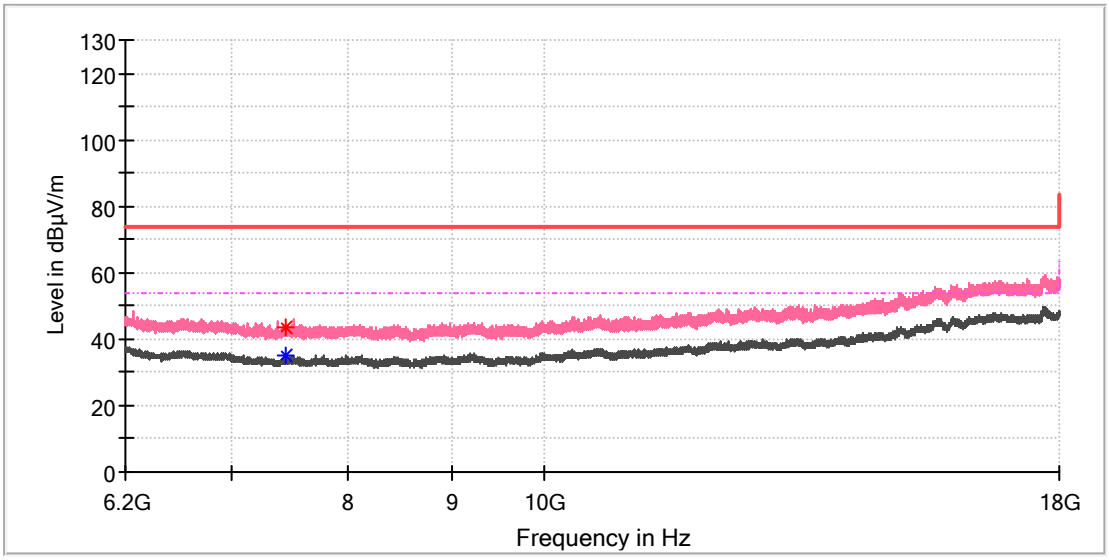


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7439.983333	44.04	---	74.00	29.96	100.0	H	67.0	8.4
7439.983333	---	37.71	54.00	16.29	100.0	H	67.0	8.4

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_High channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical_Freqs

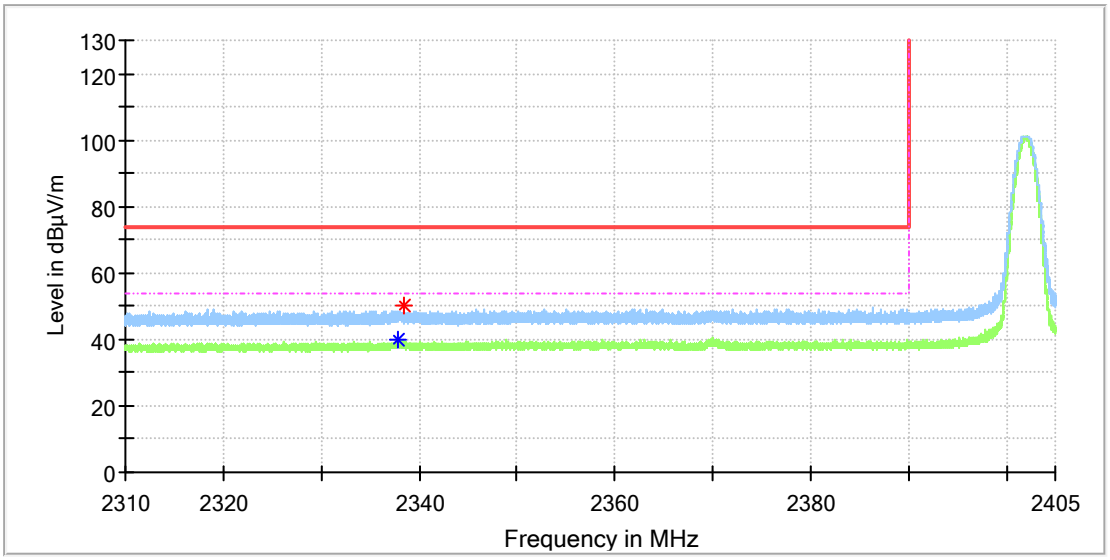
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7439.983333	---	35.16	54.00	18.84	100.0	V	191.0	8.4
7440.475000	43.34	---	74.00	30.66	100.0	V	314.0	8.4

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

BLE, 1Mbps

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_Low channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

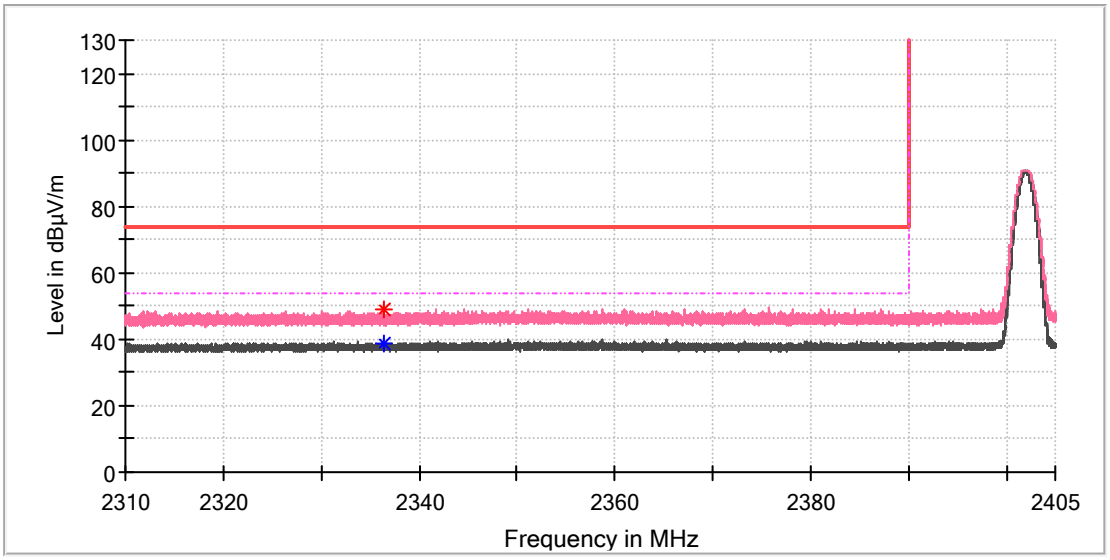


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2337.797000	---	39.75	54.00	14.25	100.0	H	212.0	6.8
2338.485750	50.05	---	74.00	23.95	100.0	H	75.0	6.8

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_Low channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

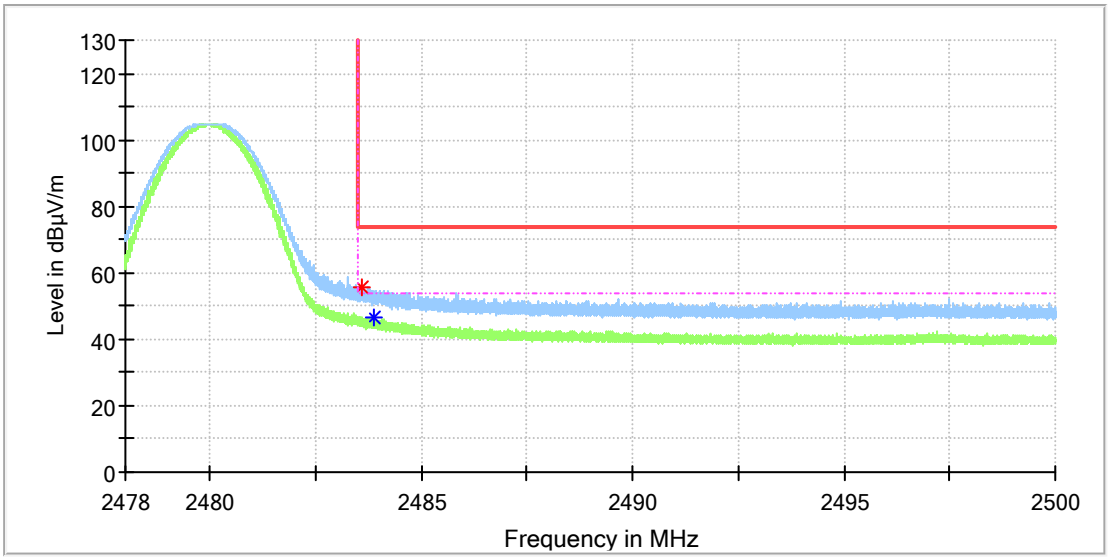


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2336.419500	49.13	---	74.00	24.87	100.0	V	317.0	6.8
2336.467000	---	38.89	54.00	15.11	100.0	V	172.0	6.8

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_High channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

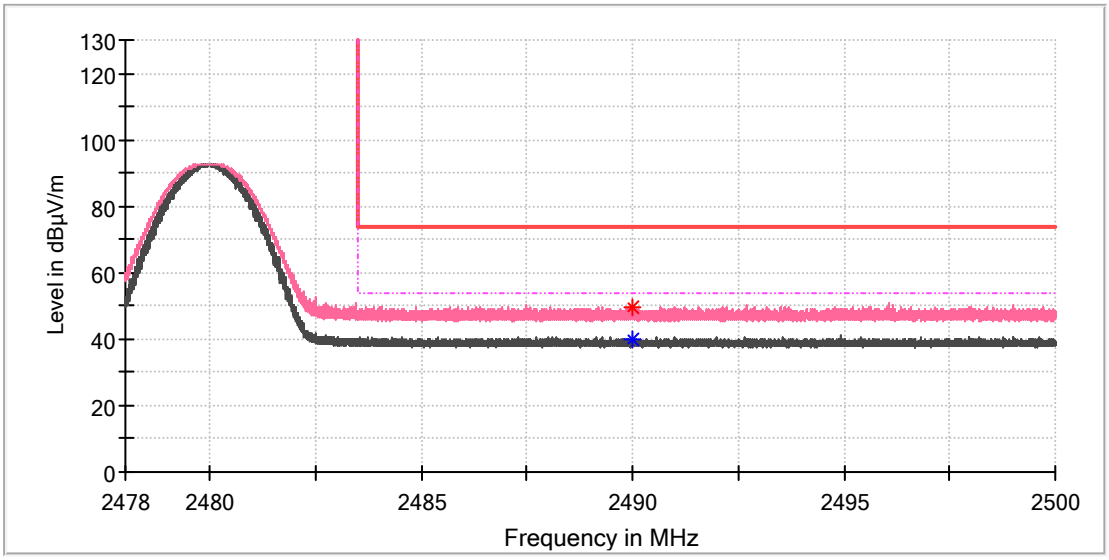


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2483.580300	55.84	---	74.00	18.16	100.0	H	213.0	7.4
2483.898200	---	46.32	54.00	7.68	100.0	H	202.0	7.4

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	BLE_High channel
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



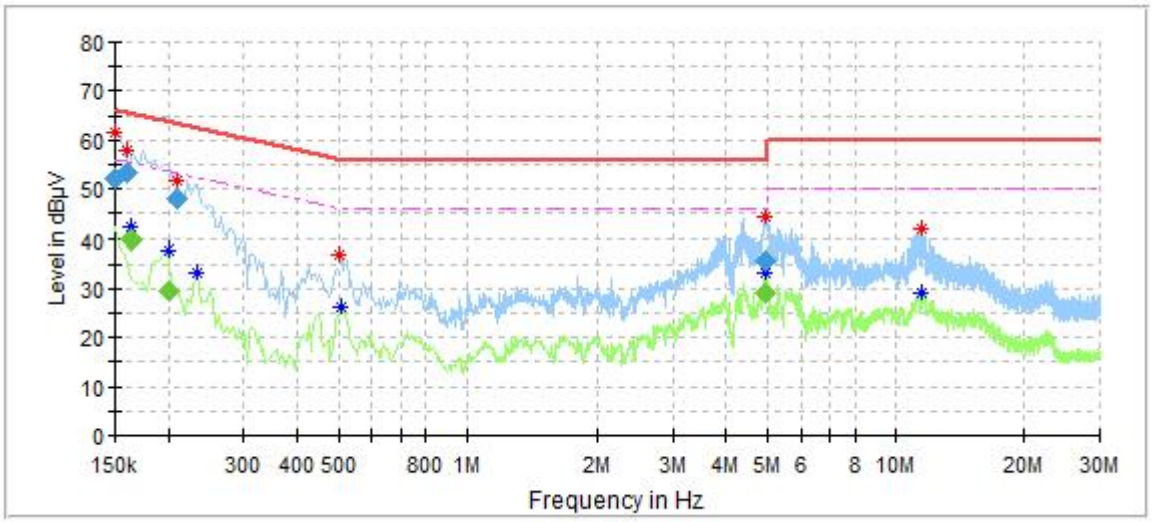
Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2489.973500	---	39.89	54.00	14.11	100.0	V	39.0	7.4
2489.973500	49.73	---	74.00	24.27	100.0	V	39.0	7.4

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

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	ON
Test Voltage:	USB 5V by PC
Test By:	Shower Dai
Review By:	Gary Chen
Remark:	SR1



Critical_Freqs

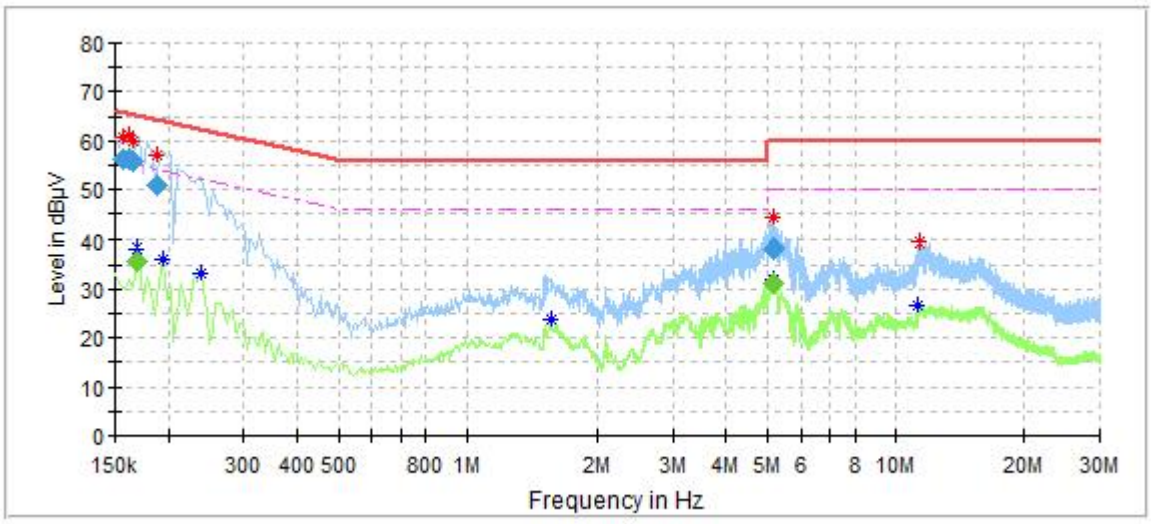
Frequency (MHz)	MaxPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Line	Corr. (dB)
0.234000	---	33.14	52.31	19.17	L1	9.6
0.504000	37.03	---	56.00	18.97	L1	9.7
0.508000	---	26.11	46.00	19.89	L1	9.7
11.540000	---	28.96	50.00	21.04	L1	10.2
11.544000	41.65	---	60.00	18.35	L1	10.2

Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.150000	51.91	---	66.00	14.09	200.0	9.000	L1	9.6
0.160500	53.34	---	65.44	12.10	200.0	9.000	L1	9.6
0.163500	---	39.99	55.28	15.30	200.0	9.000	L1	9.6
0.200500	---	29.68	53.59	23.91	200.0	9.000	L1	9.6
0.208500	48.00	---	63.27	15.27	200.0	9.000	L1	9.6
4.946500	35.85	---	56.00	20.15	200.0	9.000	L1	9.9
4.973500	---	29.00	46.00	17.00	200.0	9.000	L1	9.9

EUT Information

EUT Name:	WisDuo
Model:	RAK3401
Test Mode:	ON
Test Voltage:	USB 5V by PC
Test By:	Shower Dai
Review By:	Gary Chen
Remark:	SR1



Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Line	Corr. (dB)
0.194000	---	35.97	53.86	17.89	N	9.6
0.238000	---	33.36	52.17	18.81	N	9.6
1.560000	---	23.62	46.00	22.38	N	9.7
11.296000	---	26.60	50.00	23.40	N	10.2
11.348000	39.32	---	60.00	20.68	N	10.2

Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.156500	56.34	---	65.65	9.31	200.0	9.000	N	9.6
0.162000	56.11	---	65.36	9.25	200.0	9.000	N	9.6
0.164500	55.78	---	65.23	9.45	200.0	9.000	N	9.6
0.168500	---	35.54	55.03	19.49	200.0	9.000	N	9.6
0.188500	50.82	---	64.10	13.29	200.0	9.000	N	9.6
5.142500	---	31.00	50.00	19.00	200.0	9.000	N	9.9
5.162500	38.23	---	60.00	21.77	200.0	9.000	N	9.9