

Prüfbericht-Nr.: <i>Test report no.:</i>	CN21MROF 001	Auftrags-Nr.: <i>Order no.:</i>	168320408	Seite 1 von 29 <i>Page 1 of 29</i>
Kunden-Referenz-Nr.: <i>Client reference no.:</i>	N/A	Auftragsdatum: <i>Order date:</i>	2021-06-01	
Auftraggeber: <i>Client:</i>	Shenzhen RAKwireless Technology Co.,Ltd. Room 506, Building B, New Compark, Pingshan First Road, Taoyuan Street, Nanshan District, Shenzhen, Guangdong, China			
Prüfgegenstand: <i>Test item:</i>	WisDuo LPWAN Module			
Bezeichnung / Typ-Nr.: <i>Identification / Type no.:</i>	RAK3172 (Trademark: RAK)			
Auftrags-Inhalt: <i>Order content:</i>	FCC and IC approval			
Prüfgrundlage: <i>Test specification:</i>	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: Section 2.1093 RSS-247 Issue 2 February 2017 RSS-Gen Issue 5 February 2021 RSS-102 Issue 5 February 2021			
Wareneingangsdatum: <i>Date of sample receipt:</i>	2021-06-01	Please refer to photo documents		
Prüfmuster-Nr.: <i>Test sample no.:</i>	A003054687-008, A003054687-013, A003054687-014			
Prüfzeitraum: <i>Testing period:</i>	2021-06-18 - 2021-06-24			
Ort der Prüfung: <i>Place of testing:</i>	TÜV Rheinland (Shenzhen) Co., Ltd.			
Prüflaboratorium: <i>Testing laboratory:</i>	TÜV Rheinland (Shenzhen) Co., Ltd.			
Prüfergebnis*: <i>Test result*:</i>	Pass			
geprüft von: <i>tested by:</i>	genehmigt von: <i>authorized by:</i>			
Datum: <i>Date:</i> 2021-10-18	 Signed by: Alex Lan		 Signed by: Winnie Hou	
Stellung / Position	Senior Project Engineer	Ausstellungsdatum: <i>Issue date:</i> 2021-10-18		
Stellung / Position	Technical Certifier			
Sonstiges / Other:	FCC ID: 2AF6B-RAK3172 IC: 25908-RAK3172, HVIN: RAK3172			
Zustand des Prüfgegenstandes bei Anlieferung: <i>Condition of the test item at delivery:</i>	Prüfmuster vollständig und unbeschädigt <i>Test item complete and undamaged:</i>			
* 1 = sehr gut P(ass) = entspricht o.g. Prüfgrundlage(n) Legend: 1 = very good P(ass) = passed a.m. test specifications(s)	2 = gut F(ail) = entspricht nicht o.g. Prüfgrundlage(n) 2 = good F(ail) = failed a.m. test specifications(s)	3 = befriedigend 3 = satisfactory 4 = ausreichend N/A = nicht anwendbar 4 = sufficient N/A = not applicable	5 = mangelhaft N/T = nicht getestet 5 = poor N/T = not tested	
Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens. <i>This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.</i>				

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 6dB BANDWIDTH

RESULT: Pass

5.1.5 20dB BANDWIDTH

RESULT: Pass

5.1.6 99% BANDWIDTH

RESULT: Pass

5.1.7 CONDUCTED SPURIOUS EMISSIONS MEASURED IN 100 KHz BANDWIDTH

RESULT: Pass

5.1.8 RADIATED SPURIOUS EMISSION

RESULT: Pass

5.1.9 CARRIER FREQUENCY SEPARATION

RESULT: Pass

5.1.10 NUMBER OF HOPPING FREQUENCY

RESULT: Pass

5.1.11 TIME OF OCCUPANCY

RESULT: Pass

5.1.12 CONDUCTED EMISSION ON AC MAINS

RESULT: Pass

6.1.1 ELECTROMAGNETIC FIELDS

RESULT: Pass

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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.

2 Test Sites

2.1 Test Facilities

TÜV Rheinland (Shenzhen) Co., Ltd.

362 Huanguan Road Middle Longhua District, Shenzhen 518110 People's Republic of China

FCC Registration No.: 694916

ISED wireless device testing laboratory: 25069

2.2 List of Test and Measurement Instruments

Table 1: List of Test and Measurement Equipment

TÜV Rheinland (Shenzhen) Co., Ltd.

Radio Spectrum Testing (TS8997)				
Equipment	Manufacturer	Model	Serial No.	Cal. until
Signal Analyzer	R&S	FSV 40	101441	2022-08-09
OSP	R&S	OSP 150	101017	2021-12-10
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	2021-12-10
Power Sensor	R&S	NRP-Z81	105677	2022-08-09
Shielding Room 8#	Albatross	SR8	APC17151-SR8	2024-06-22
Unwanted Emission Testing (TS9975)				
Equipment	Manufacturer	Model	Serial No.	Cal. until
EMI Test Receiver	R&S	ESR 7	102021	2022-08-10
Signal Analyzer	R&S	FSV 40	101439	2022-08-09
System Controller Interface	R&S	SCI-100	S10010038	N/A
Filterbank	R&S	Wlan	100759	2022-08-09
OSP	R&S	OSP 120	102040	N/A
Pre-amplifier	R&S	SCU08F1	08320031	2022-08-09
Amplifier	R&S	SCU-18F	180070	2022-08-09
Amplifier	R&S	SCU40A	100475	2022-08-09
Trilog Broadband Antenna (30 MHz - 7 GHz)	Schwarzbeck	VULB 9162	193	2022-08-08
Double-Ridged Antenna (1 -18 GHz)	ETS-LINDGREN	3117	00218717	2022-08-08
Wideband Ridged Horn Antenna (18-40 GHz)	Steatite	QMS-00880	19067	2022-08-08
Active Loop Antenna	Schwarzbeck	FMZB 1513	302	2022-09-13

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	2024-06-22
Conducted Emission on AC Mains				
Equipment	Manufacturer	Model No.	Serial No.	Cali. until
EMI Test Receiver	R&S	ESR3	102680	2022-04-25
Artificial Mains Network	R&S	ENV216	101445	2022-04-25
EMC32 test software	R&S	EMC32(Ver.10.50.00)	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 basis 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.

Parameter	Uncertainty
Radio Frequency	$\pm 1 \times 10^{-7}$
RF Power (conducted)	± 2.5 dB
Radiated Emission of Transmitter, valid up to 26.5 GHz	± 6 dB
Radiated Emission of Receiver, valid up to 26.5 GHz	± 6 dB
Conducted Emission, (9kHz to 150kHz)/(150kHz to 30MHz)	± 3.70 dB / ± 3.30 dB
Radiated Emission (3m SAC), 30MHz to 1000MHz	± 4.52 dB
Radiated Emission (3m SAC), above 1000MHz	± 4.37 dB
Temperature	± 1 °C
Humidity	± 5 %
Voltage (DC)	± 1 %
Voltage (AC, <10kHz)	± 2 %

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) Co., Ltd. file for certification follow-up purposes.

2.7 Status of Facility Used for Testing

The TÜV Rheinland (Shenzhen) Co., Ltd. Test facility located at 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 LPWAN Module which supports Lora technology.

This product has two construction, one has an additional baseboard and other doesn't have, the baseboard is the extension of I/O.

Data Rate	Configuration	Indicative physical bit rate [bit/sec]
0	LoRa Modulation: SF10 / Bandwidth 125 kHz	980
1	LoRa Modulation: SF9 / Bandwidth 125 kHz	1760
2	LoRa Modulation: SF8 / Bandwidth 125 kHz	3125
3	LoRa Modulation: SF7 / Bandwidth 125 kHz	5470
4	LoRa Modulation: SF8 / Bandwidth 500 kHz	12500

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 LPWAN Module
Type Designation	RAK3172
Trademark	RAK
FCC ID	2AF6B-RAK3172
IC	25908-RAK3172
HVIN	RAK3172
Operating Voltage	2.0VDC to 3.6VDC (Supplied by socket of PCB board)
Testing Voltage	DC 5V Via USB port
Antenna Type	Dipole Antenna (When connecting to the module, the antenna need to transfer to an IPEX connector)
Antenna Gain	2.3 dBi (Max)
Technical Specification of Lora DTS	
Operating Frequency	903 – 914.2MHz
Type of Modulation	Lora
Data Rate	LoRa: SF8 / DR4
Channel Number	8 channels (Upstream)
Channel Separation	1.6 MHz
Occupied Bandwidth	500 KHz
Technical Specification of Lora FHSS	
Frequency Range	902.3 – 914.9MHz
Type of Modulation	Lora
Data Rate	LoRa: SF7 to SF10 / DR0 to DR3
Channel Number	64 channels (Upstream)
Channel Separation	200 KHz
Occupied Bandwidth	125 KHz

Table 3: RF Channel and Frequency of Lora FHSS

RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)
0	902.3	16	905.5	32	908.7	48	911.9
1	902.5	17	905.7	33	908.9	49	912.1
2	902.7	18	905.9	34	909.1	50	912.3
3	902.9	19	906.1	35	909.3	51	912.5
4	903.1	20	906.3	36	909.5	52	912.7
5	903.3	21	906.5	37	909.7	53	912.9
6	903.5	22	906.7	38	909.9	54	913.1
7	903.7	23	906.9	39	910.1	55	913.3
8	903.9	24	907.1	40	910.3	56	913.5
9	904.1	25	907.3	41	910.5	57	913.7
10	904.3	26	907.5	42	910.7	58	913.9
11	904.5	27	907.7	43	910.9	59	914.1
12	904.7	28	907.9	44	911.1	60	914.3
13	904.9	29	908.1	45	911.3	61	914.5
14	905.1	30	908.3	46	911.5	62	914.7
15	905.3	31	908.5	47	911.7	63	914.9

Table 4: RF Channel and Frequency of Lora DTS

RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)
64	903.0	66	906.2	68	909.4	70	912.6
65	904.6	67	907.8	69	911.0	71	914.2

3.3 Independent Operation Modes

The basic operation modes are:

- A. On, Lora transmitting mode (FHSS)
 - 1) Low Channel
 - 2) Middle Channel
 - 3) High Channel
- B. On, Lora transmitting mode (DTS)
 - 1) Low Channel
 - 2) Middle Channel
 - 3) High Channel
- C. On, Transmitting on Hopping channel
- D. Off

3.4 Noise Generating and Noise Suppressing Parts

Refer to Circuit Diagram for further details.

3.5 Submitted Documents

- ID Label and Location Info
- 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 tests were performed according to the procedures in ANSI C63.10: 2013 and ANSI C63.4: 2014.

According to clause 3.1, all tests were performed on model RAK3172 with baseboard in this report.

4.3 Special Accessories and Auxiliary Equipment

Table 5: Auxiliary Equipment Used during Test

Description	Manufacturer	Model	S/N	Rating
PC	Lenovo	ThinkPad T480	N/A	PC
PC adapter	Lenovo	ADLX65YDC3A	01FR030	PC adapter

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)

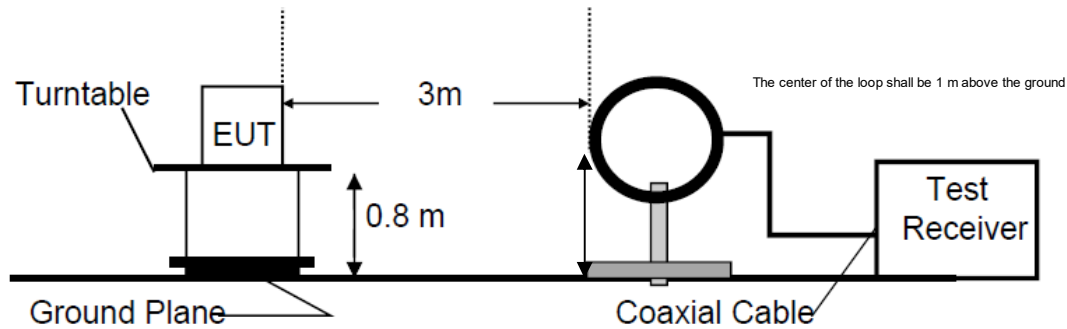


Diagram of Measurement Configuration for Radiation Test (Below 1GHz)

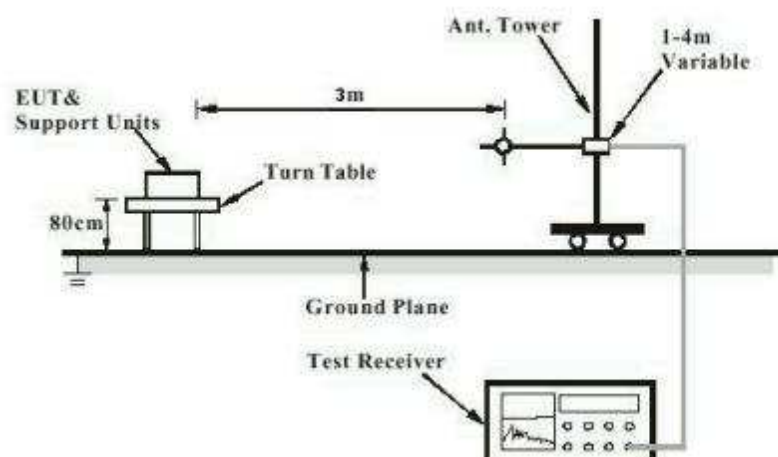


Diagram of Measurement Configuration for Radiation Test (Above 1GHz)

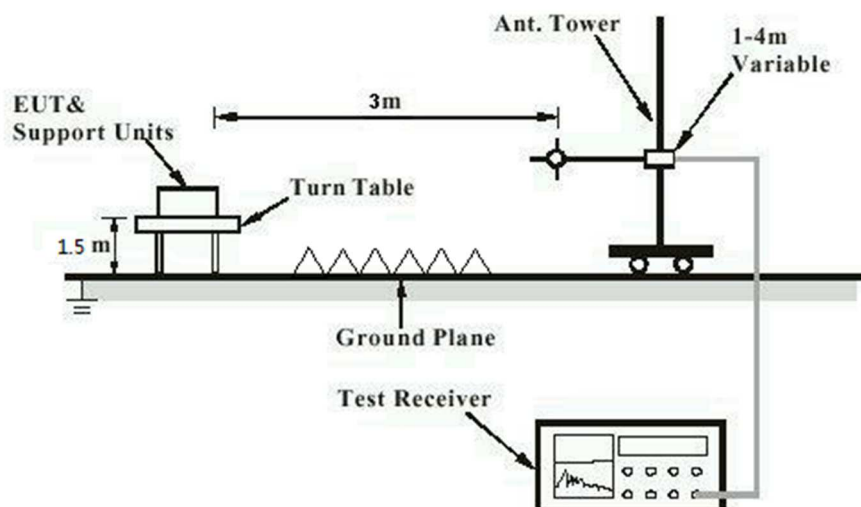


Diagram of Measurement Configuration for Mains Conduction Measurement

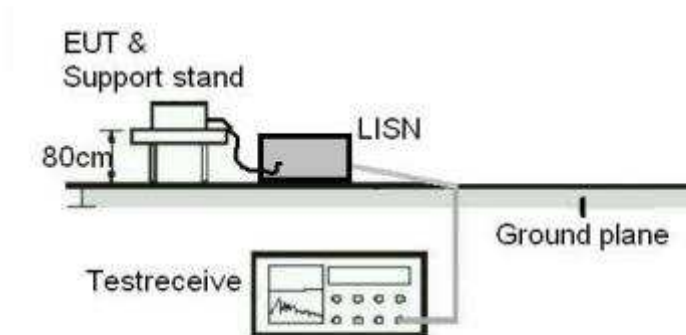
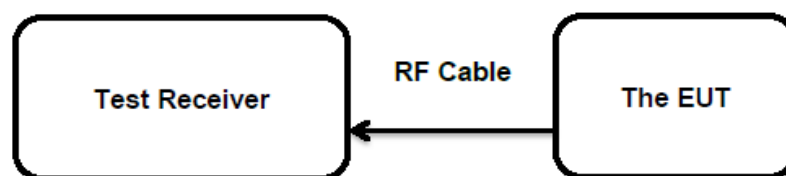


Diagram of Measurement Configuration for Conducted Transmitter Measurement



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 6.8

According to the manufacturer declared, the EUT has a Dipole Antenna, the directional gain of antenna is 2.3 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)(2)&(3) RSS-247 Clause 5.4(a)&(d)
Basic standard	: ANSI C63.10: 2013 Not more than 1Watt(30dBm) for DTS in the band 902-928MHz and 2400-2483.5MHz
Limits	: Not more than 1Watt(30dBm) for FHSS with at least 50 hopping channels in the band 902-928MHz
Kind of test site	: Shielded Room

Test Setup

Date of testing	: 2021-06-21 -2021-06-24
Input voltage	: DC 5V Via USB port
Operation mode	: A, B
Test channel	: Low / Middle / High
Ambient temperature	: 25 °C
Relative humidity	: 56 %
Atmospheric pressure	: 101 kPa

Note: This test was carried out on right earphone only.

Table 6: Test Result of Maximum Peak Conducted Output Power, Lora FHSS

Test Mode	Test Channel (MHz)	Measured Peak Power		Limit (W)
		(dBm)	(W)	
Lora FHSS	902.3	20.56	0.1138	< 0.125
	908.5	20.62	0.1153	
	914.9	20.60	0.1148	
Max. Measured Value		20.62	0.1153	

Table 7: Test Result of Maximum Peak Conducted Output Power, Lora DTS

Test Mode	Test Channel (MHz)	Measured Peak Power		Limit (W)
		(dBm)	(W)	
Lora DTS	903.0	24.04	0.2535	< 1.0
	907.8	24.08	0.2559	
	914.2	24.05	0.2541	
Max. Measured Value		24.08	0.2559	

Note:

- 1) The cable loss is taken into account in results.
- 2) Antenna gain(G) : 2.3 dBi,
e.i.r.p.=26.38dBm = 0.435W, which is far below the 4 W

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	: 2021-06-24
Input voltage	: DC 5V Via USB port
Operation mode	: B
Test channel	: Low / Middle / High
Ambient temperature	: 25 °C
Relative humidity	: 56 %
Atmospheric pressure	: 101 kPa

Note: This test was carried out on right earphone only.

For the measurement records, refer to the appendix B.

Table 8: Test Result of Maximum Peak Power Spectral Density, Lora DTS

Test Mode	Test Channel (MHz)	Measured Peak Power Spectral Density (dBm/3KHz)
Lora DTS	903.0	4.90
	907.8	4.71
	914.2	4.79
Maximum Measured Value		4.90

5.1.4 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
Limits	: At least 500kHz for bandwidth(DTS)
Kind of test site	: Shielded Room

Test Setup

Date of testing	: 2021-06-24
Input voltage	: DC 5V Via USB port
Operation mode	: B
Test channel	: Low / Middle / High
Ambient temperature	: 25 °C
Relative humidity	: 56 %
Atmospheric pressure	: 101 kPa

Note: This test was carried out on right earphone only.

For the measurement records, refer to the appendix B.

Table 9: Test Result of 6dB Bandwidth

Test Mode	Test Channel (MHz)	6dB Bandwidth (MHz)	Limit (MHz)
Lora DTS	903.0	623.0	>500KHz
	907.8	614.3	
	914.2	616.5	
Minimum Measured Value		614.3	

5.1.5 20dB Bandwidth

RESULT:**Pass****Test Specification**

Test standard	: FCC Part 15.247(a)(1) (i) RSS-247 Clause 5.1(a)
Basic standard	: ANSI C63.10: 2013 Not more than 500kHz and
Limits	: < 250KHz for at least 50 hopping frequencies >=250KHz for at least 25 hopping frequencies
Kind of test site	: Shielded Room

Test Setup

Date of testing	: 2021-06-24
Input voltage	: DC 5V Via USB port
Operation mode	: A
Test channel	: Low / Middle / High
Ambient temperature	: 25 °C
Relative humidity	: 56 %
Atmospheric pressure	: 101 kPa

Note: This test was carried out on right earphone only.

For the measurement records, refer to the appendix B.

Table 10: Test Result of 20dB Bandwidth

Test Mode	Channel Frequency (MHz)	20dB Bandwidth (kHz)	Limit (MHz)
Lora FHSS	902.3	141.24	<500KHz
	908.5	141.24	
	914.9	141.09	

5.1.6 99% 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 : 2021-06-18 - 2021-06-24
Input voltage : DC 5V Via USB port
Operation mode : A, B
Test channel : Low / Middle / High
Ambient temperature : 25 °C
Relative humidity : 56 %
Atmospheric pressure : 101 kPa

Note: This test was carried out on right earphone only.

For the measurement records, refer to the appendix B.

Table 11: Test Result of 99% Bandwidth

Test Mode	Test Channel (MHz)	99% Bandwidth (KHz)	Limit (MHz)
Lora FHSS	902.3	125.90	/
	908.5	126.45	
	914.9	125.36	
Lora DTS	903.0	501.45	
	907.8	503.62	
	914.2	505.79	
Minimum Measured Value		125.36	

5.1.7 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	: Refer to test result
Input voltage	: DC 5V Via USB port
Operation mode	: A, B
Test channel	: Low / Middle / High
Ambient temperature	: 25 °C
Relative humidity	: 56 %
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.

Note: This test was carried out on right earphone only.

For the measurement records, refer to the appendix B.

5.1.8 Radiated Spurious Emission

RESULT:**Pass****Test Specification**

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

Test Setup

Date of testing	: 2021-06-21
Input voltage	: DC 5V Via USB port
Operation mode	: A, B
Test channel	: Low / Middle / High
Ambient temperature	: Refer to test result
Relative humidity	: Refer to test result
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.

5.1.9 Carrier Frequency Separation

RESULT:
Pass
Test Specification

Test standard : FCC Part 15.247(a)(1)
RSS-247 Clause 5.1(b)

Basic standard : ANSI C63.10: 2013

Limits : $\geq 20\text{dB}$ bandwidth, whichever is greater

Kind of test site : Shielded Room

Test Setup

Date of testing : 2021-06-21

Input voltage : DC 5V Via USB port

Operation mode : C

Test channel : Low / Middle / High

Ambient temperature : 25 °C

Relative humidity : 56 %

Atmospheric pressure : 101 kPa

Note: This test was carried out on right earphone only.

For the measurement records, refer to the appendix B.

Table 12: Test Result of Carrier Frequency Separation

Test Mode	Channel	Channel Frequency (MHz)	Measured Channel Separation (KHz)	Limit (kHz)	Result
Lora FHSS	Low Channel	902.30015	201.20	≥ 20dB bandwidth	Pass
	Adjacency Channel	902.50135			
	Middle Channel	908.50010	201.20		Pass
	Adjacency Channel	908.90250			
	High Channel	914.70010	201.20		Pass
	Adjacency Channel	914.90130			

Note:

The limit is maximum 20 dB bandwidth: 141.24 KHz.

5.1.10 Number of Hopping Frequency**RESULT:****Pass****Test Specification**

Test standard : FCC part 15.247(a)(1)(iii)
RSS-247 Clause 5.1(d)
Basic standard : ANSI C63.10: 2013
Limits : ≥ 15 non-overlapping channels
Kind of test site : Shielded Room

Test Setup

Date of testing : 2021-06-21
Input voltage : DC 5V Via USB port
Operation mode : C
Ambient temperature : 25 °C
Relative humidity : 56 %
Atmospheric pressure : 101 kPa

Note: This test was carried out on right earphone only.

Table 13: Test result of hopping channel number

Test Mode	20dB Bandwidth(kHz)	Hopping frequencies	Limit
Lora FHSS	20dB Bandwidth < 250	64	≥ 50

5.1.11 Time of Occupancy**RESULT:****Pass****Test Specification**

Test standard : FCC part 15.247(a)(1)(iii)
RSS-247 Clause 5.1(d)
Basic standard : ANSI C63.10: 2013
Limits : < 0.4s
Kind of test site : Shielded Room

Test Setup

Date of testing : 2021-06-21
Input voltage : DC 5V Via USB port
Operation mode : C
Test channel : Low / Middle / High
Ambient temperature : 25 °C
Relative humidity : 56 %
Atmospheric pressure : 101 kPa

Note: This test was carried out on right earphone only.

For the measurement records, refer to the appendix B.

Table 14: Test result of Channel Occupancy

Test Mode	20dB Bandwidth(kHz)	Period (s)	Channel Occupancy Time (ms)	Limit (ms)
Lora FHSS	20dB Bandwidth < 250	20	304.35	400

Prüfbericht - Nr.: CN21MROF 001
Test Report No.Seite 26 von 29
Page 26 of 29**5.1.12 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 3
Kind of test site	: Shielded Room

Test Setup

Date of testing	: 2021-06-22
Input voltage	: Powered by PC Adapter
Operation mode	: A, B
Earthing	: Not connected
Ambient temperature	: 22 °C
Relative humidity	: 64 %
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 : CFR47 FCC Part 2: Section 2.1091
CFR47 FCC Part 1: Section 1.1310
FCC KDB Publication 447498 v06
FCC KDB Publication 865664 D02 v01r02
OET Bulletin 65 (Edition 97-01)
RSS-102 Issue 5 March 2019

FCC requirement: Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess limit for maximum permissible exposure. In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as a mobile device whereby a distance of 20cm normally can be maintained between the user and the device.

MPE Calculation Method according to OET Bulletin 65

Power Density: $S_{(mW/cm^2)} = PG/4\pi R^2$ or $EIRP/4\pi R^2$

Where:

S = power density (mW/cm²)

P = power input to the antenna (mW)

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna (cm)

The nominal maximum conducted output power specified:

Lora FHSS: 20.62 dBm

Lora DTS: 24.08 dBm

From the peak RF output power, the minimum mobile separation distance, d=20 cm, as well as the antenna gain (2.3 dBi Lora FHSS and Lora DTS), the RF power density can be calculated as below:

For Lora FHSS: $S_{(mW/cm^2)} = PG/4\pi R^2 = 0.054 \text{ mW/cm}^2$

For Lora DTS: $S_{(mW/cm^2)} = PG/4\pi R^2 = 0.119 \text{ mW/cm}^2$

Limits for Maximum Permissible Exposure (MPE) according to FCC Part 1.1310: 1.0 mW/cm²

➤ **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 Lora FHSS & DTS: 1.37 W

The nominal maximum conducted output power specified:

Lora FHSS: 20.62 dBm

Lora DTS: 24.08 dBm

Antenna Gain: 2.3 dBi Lora FHSS and Lora DTS

The Max. e.i.r.p. for Lora FHSS: 22.92dBm = 0.196 W

The Max. e.i.r.p. for Lora DTS: 26.38dBm = 0.435 W

Both e.i.r.p. for the Lora FHSS and Lora DTS 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.

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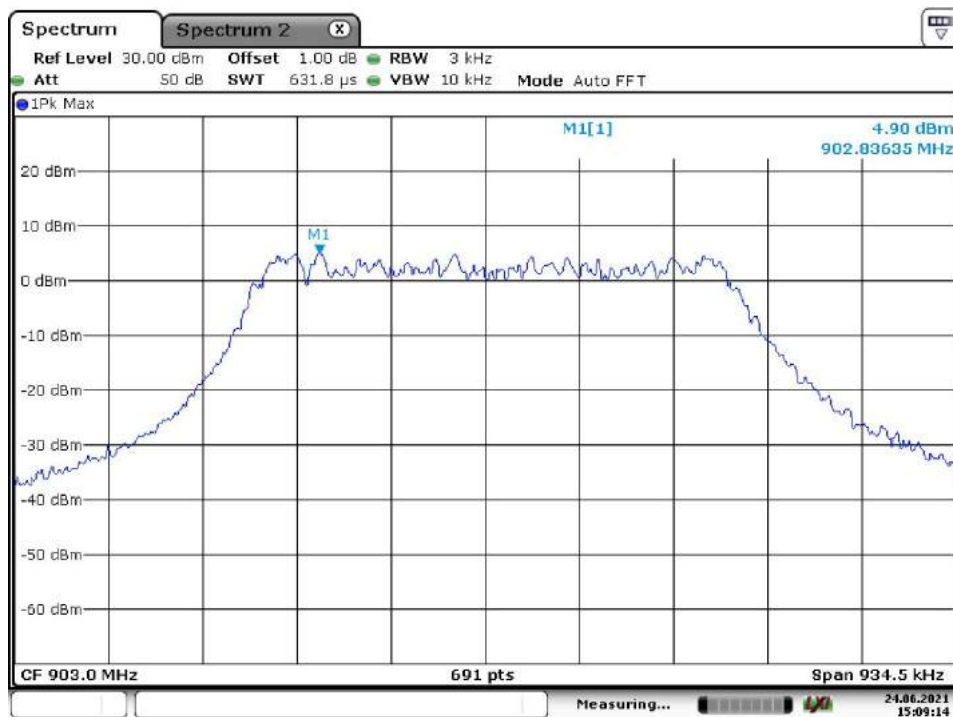
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Appendix B.1: Conducted Power Spectral Density

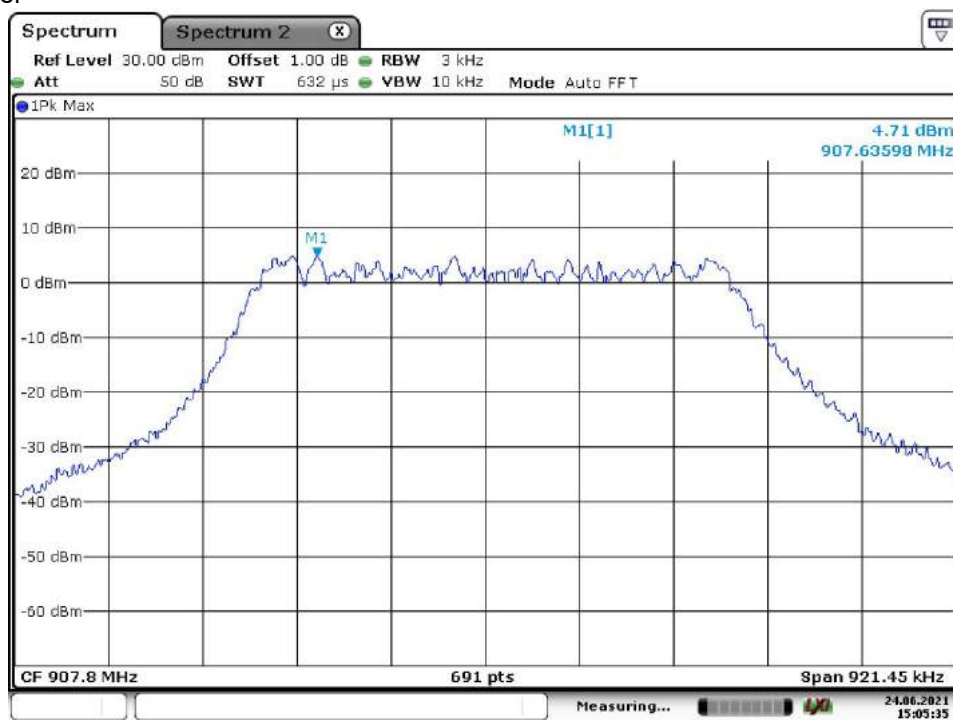
Lora DTS

Low Channel



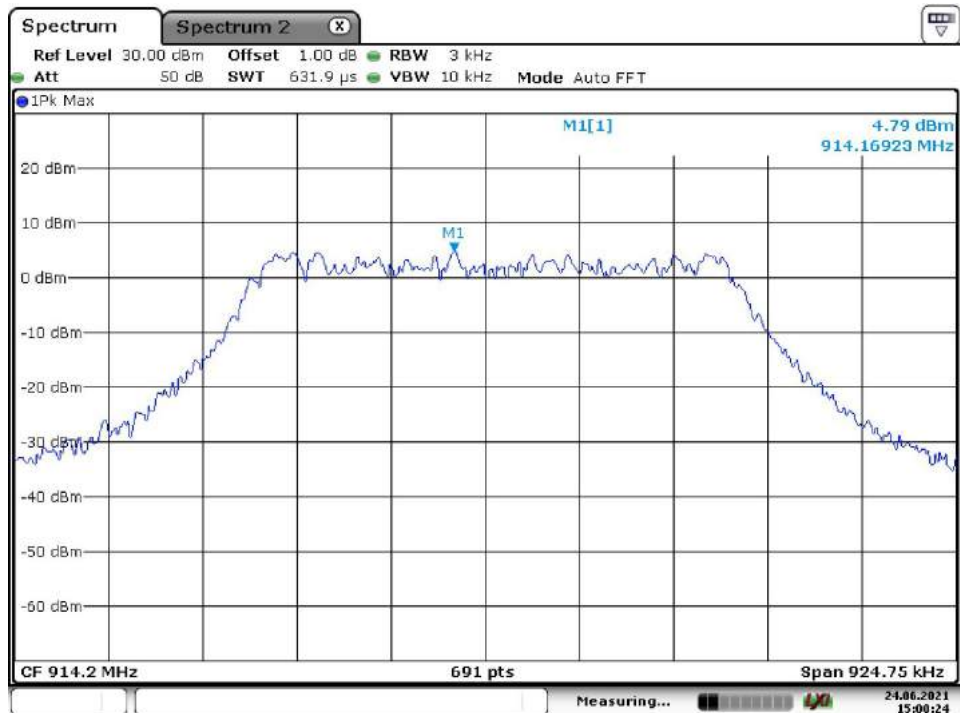
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Middle Channel



Date: 24.JUN.2021 15:09:35

High Channel

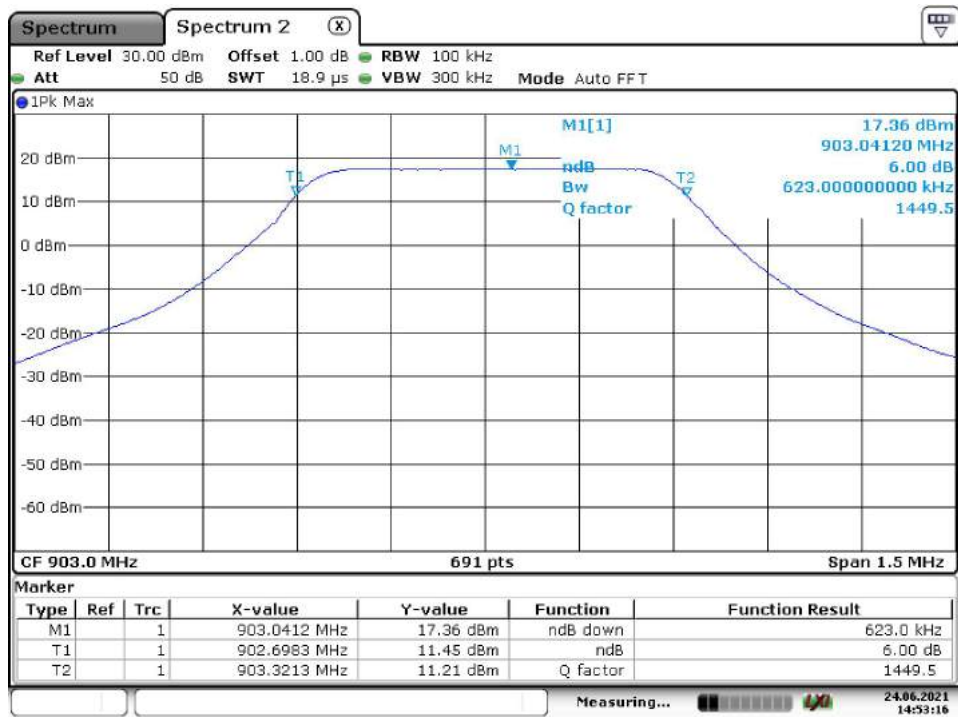


Date: 24.JUN.2021 15:00:24

Appendix B.2: 6dB Bandwidth

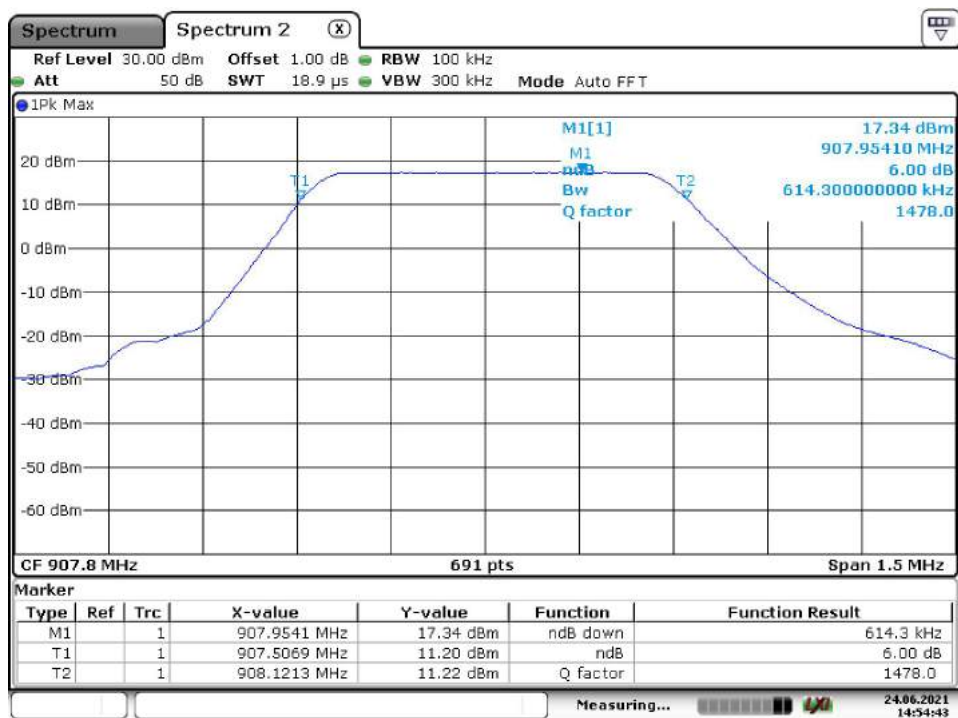
Lora DTS

Low Channel



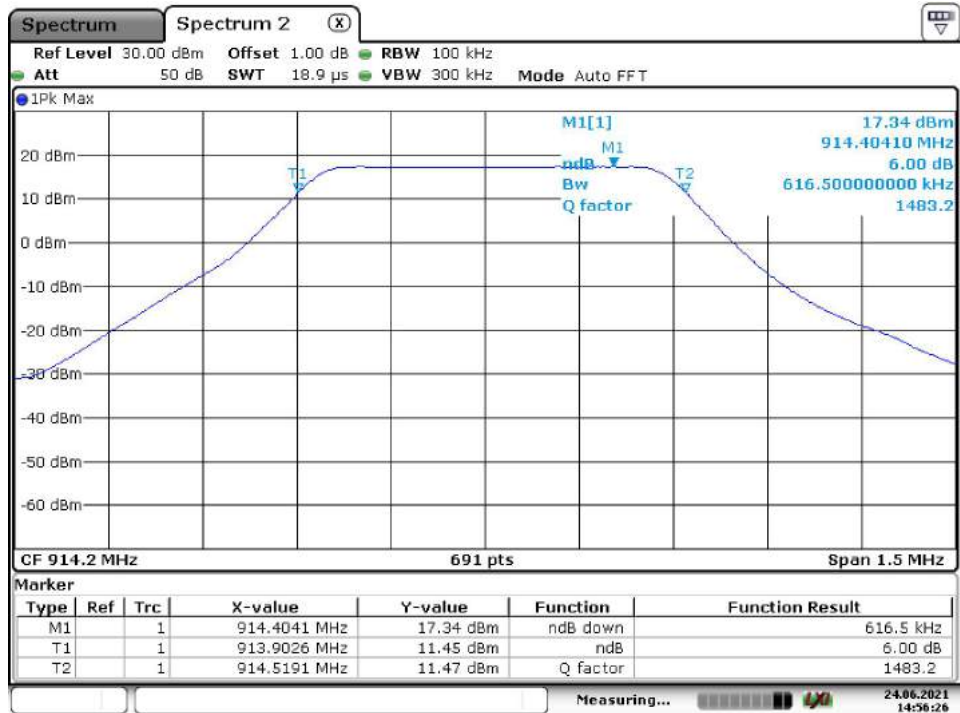
Date: 24.JUN.2021 14:53:15

Middle Channel



Date: 24.JUN.2021 14:54:43

High Channel



Date: 24.JUN.2021 14:56:26

Appendix B.3: 20dB Bandwidth

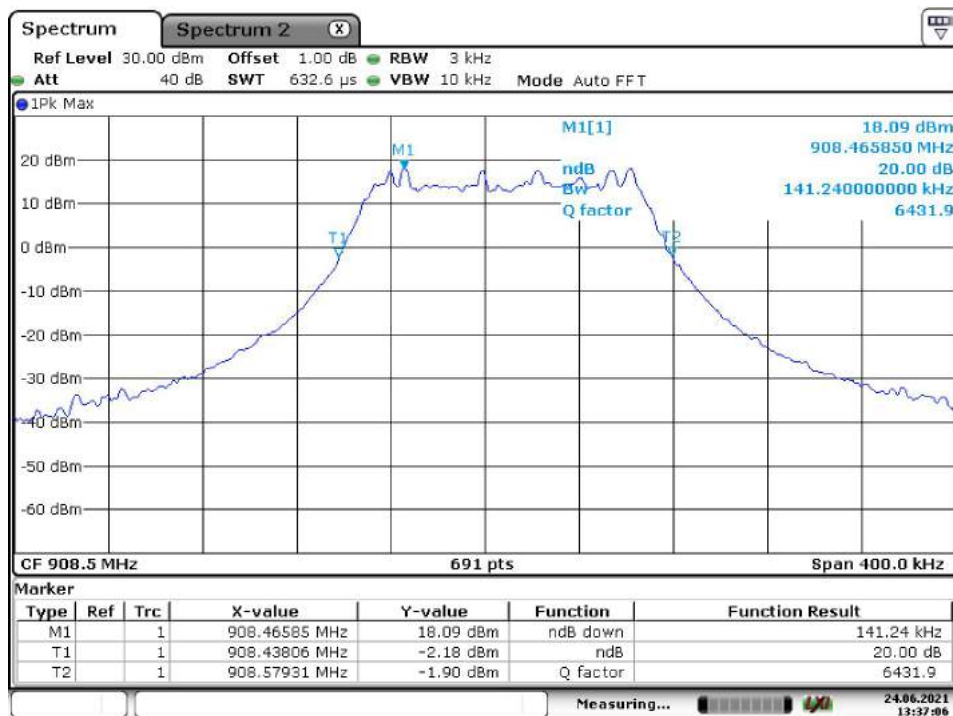
Lora FHSS

Low Channel



Date: 24.JUN.2021 13:34:59

Middle Channel



Date: 24.JUN.2021 13:37:06

Appendix B.4: 99% Bandwidth

Lora FHSS

Low Channel



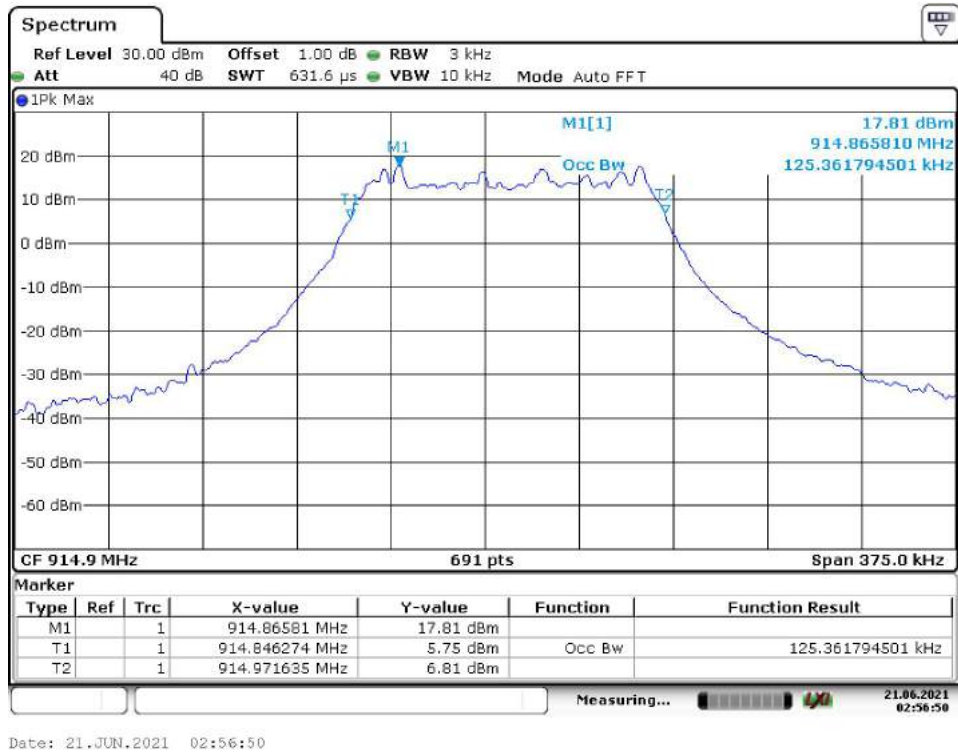
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Middle Channel



Date: 21.JUN.2021 02:52:42

High Channel



Lora DTS

Low Channel



Middle Channel



High Channel



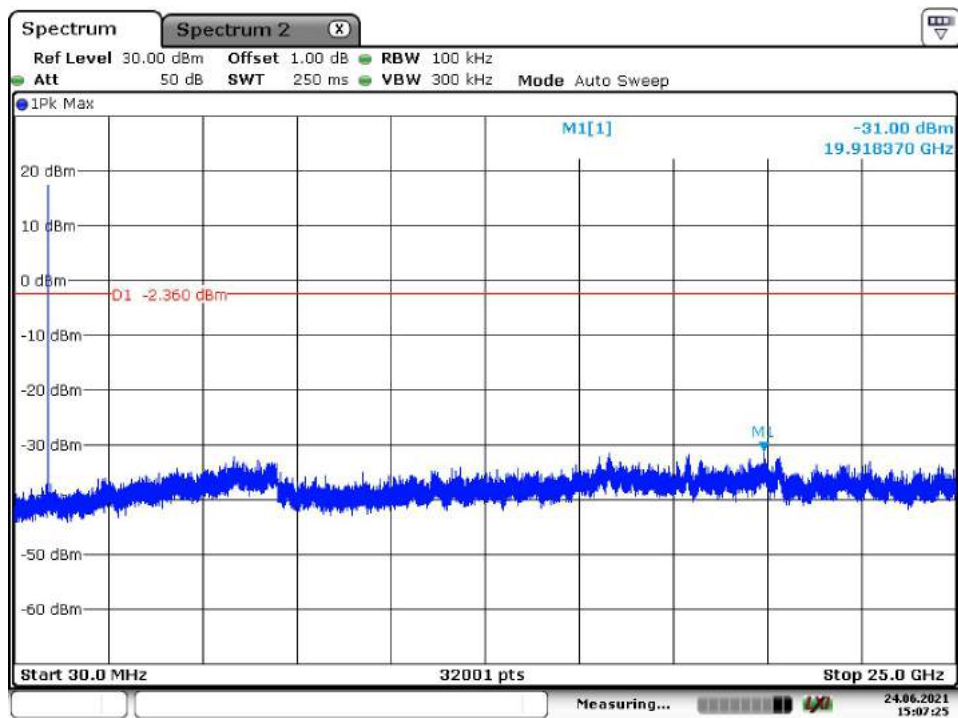
Appendix B.5: Conducted Spurious Emissions Measured in 100 kHz Bandwidth

Lora DTS

Low Channel

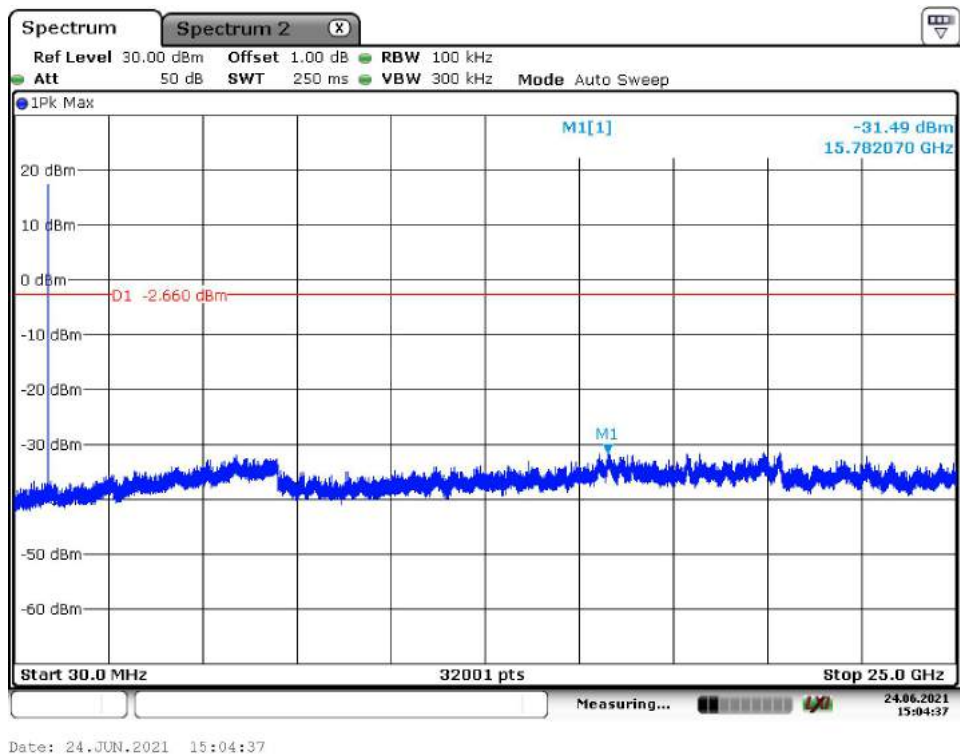
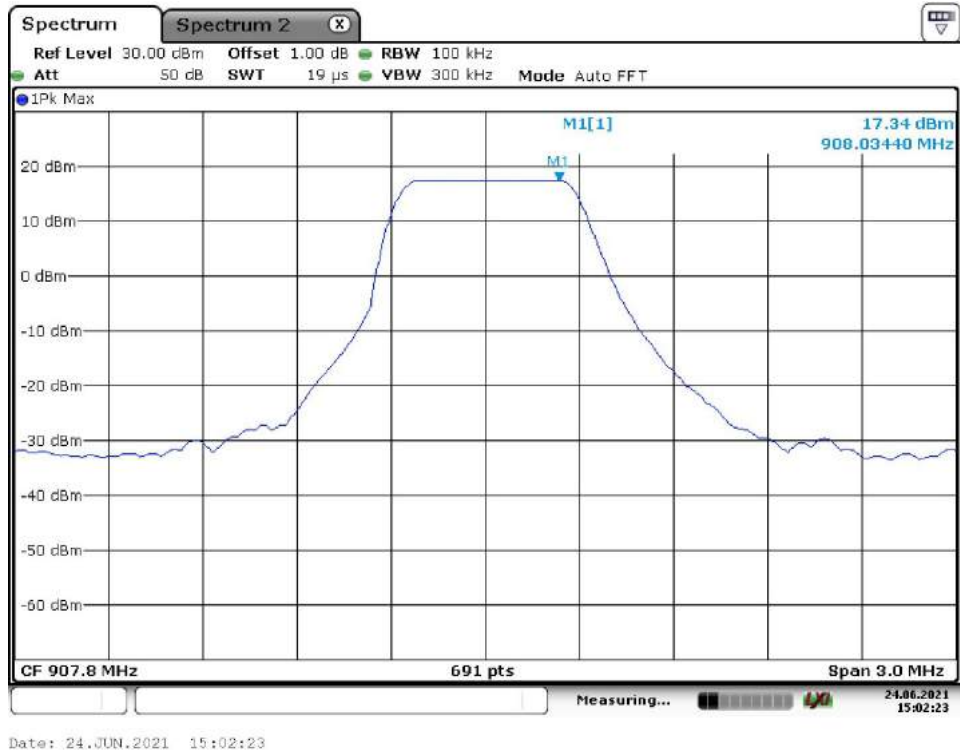


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Date: 24.JUN.2021 15:07:25

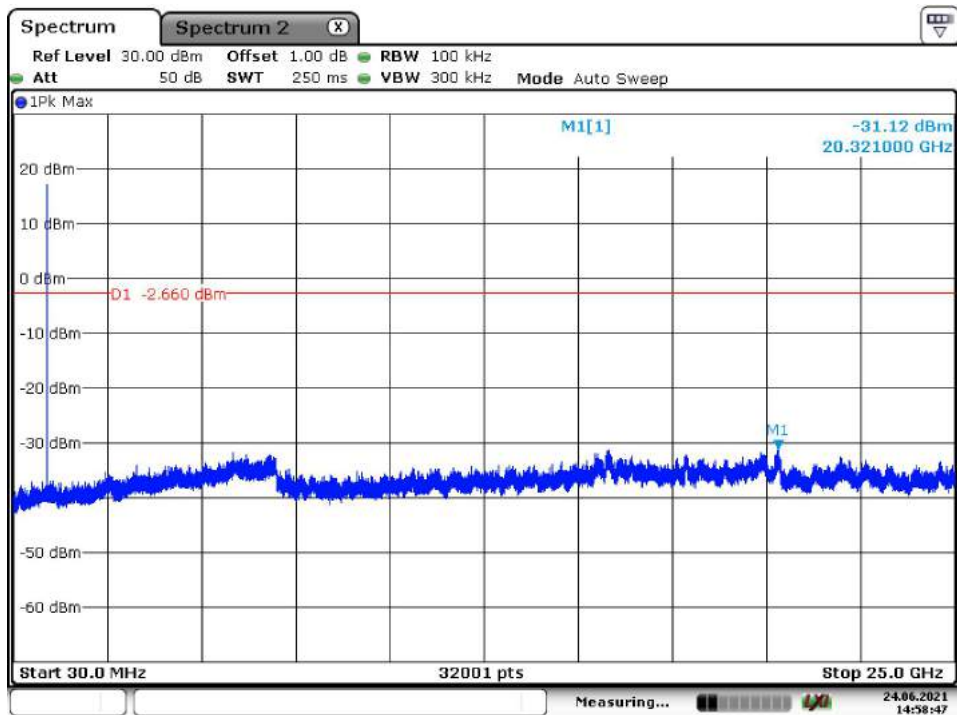
Middle Channel



High Channel



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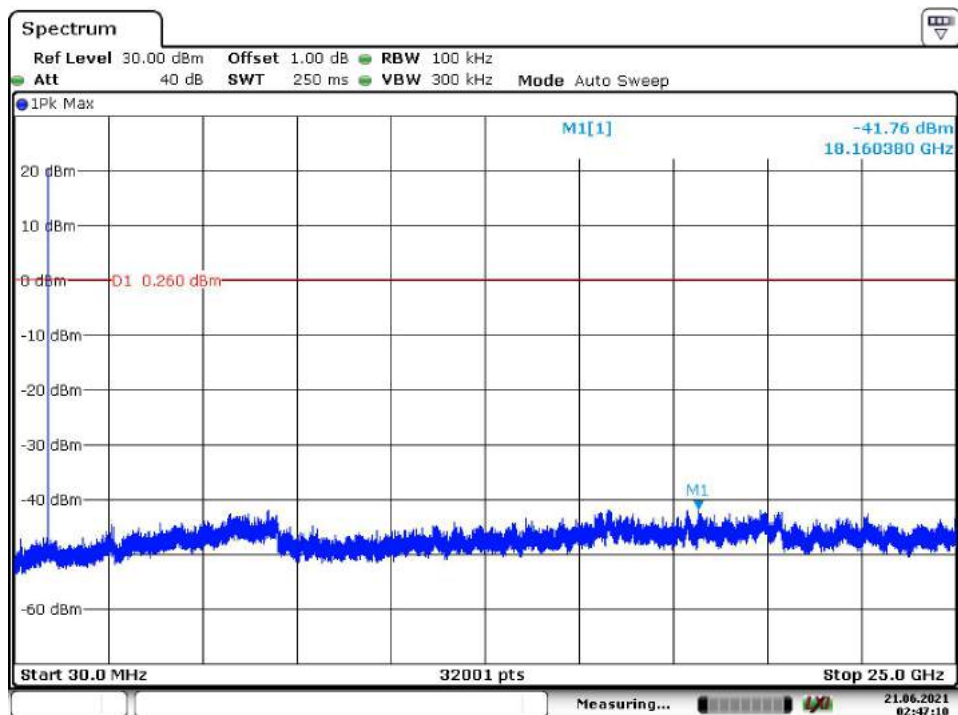


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Lora FHSS, No hopping
Low Channel



Date: 21.JUN.2021 02:45:07

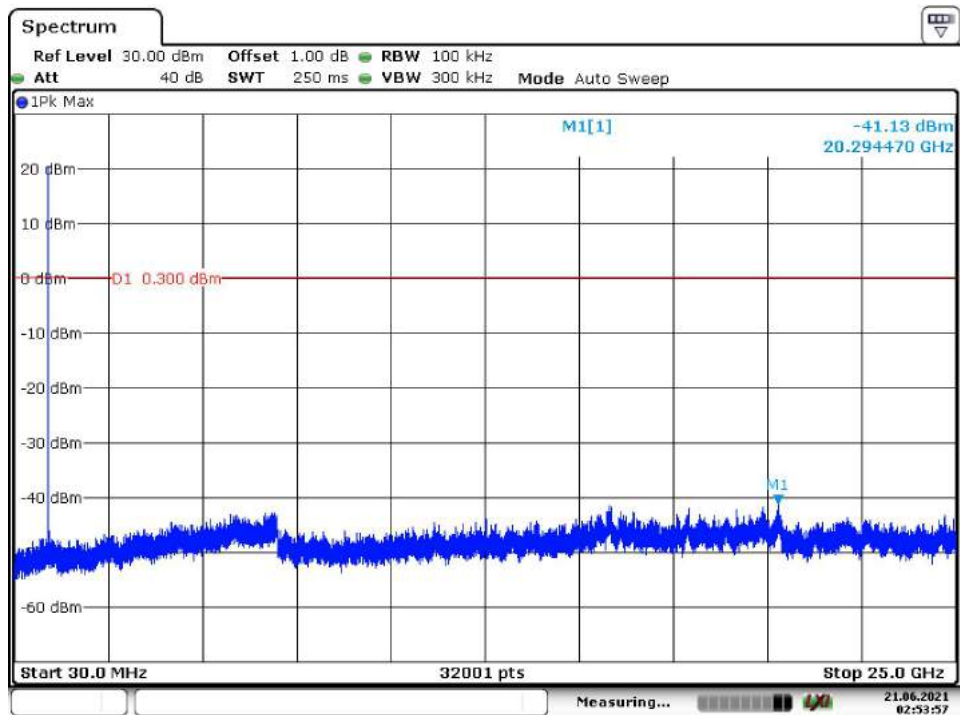


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Middle Channel



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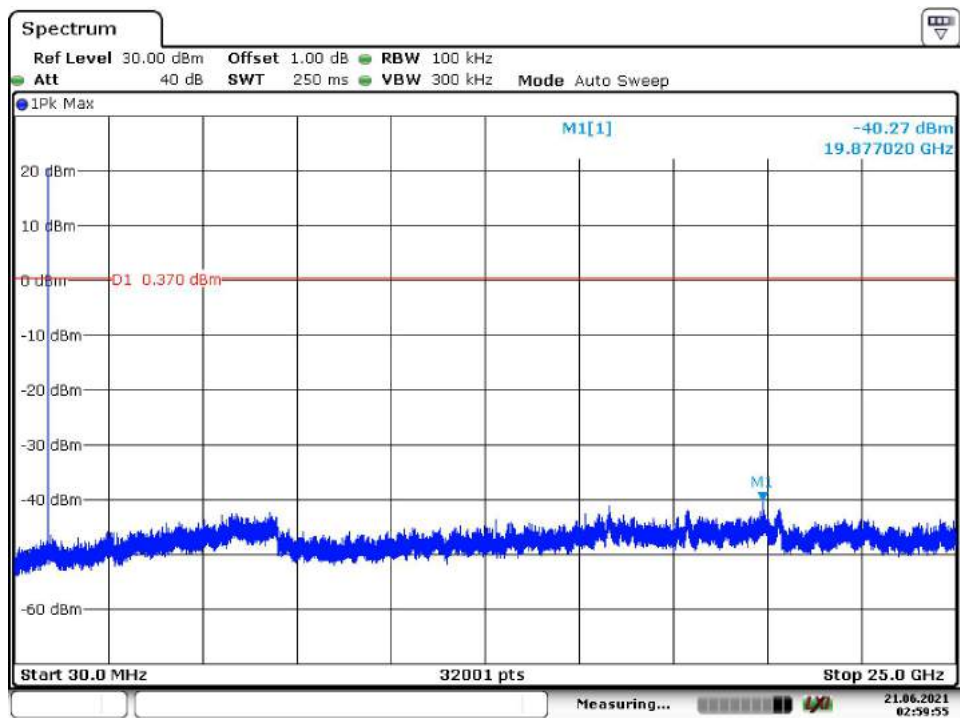


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High Channel

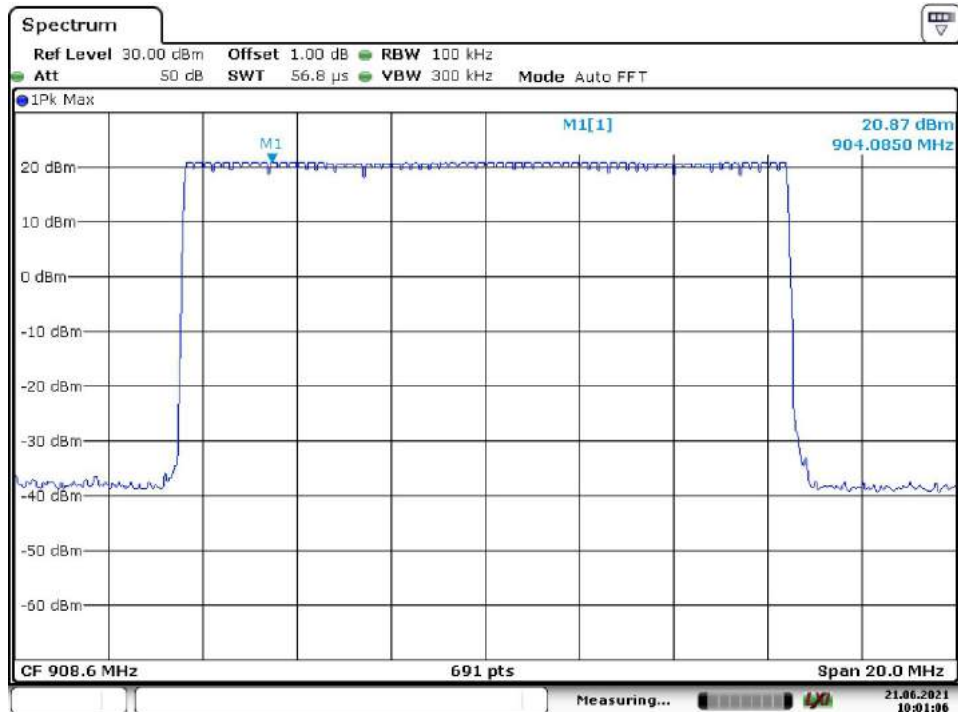


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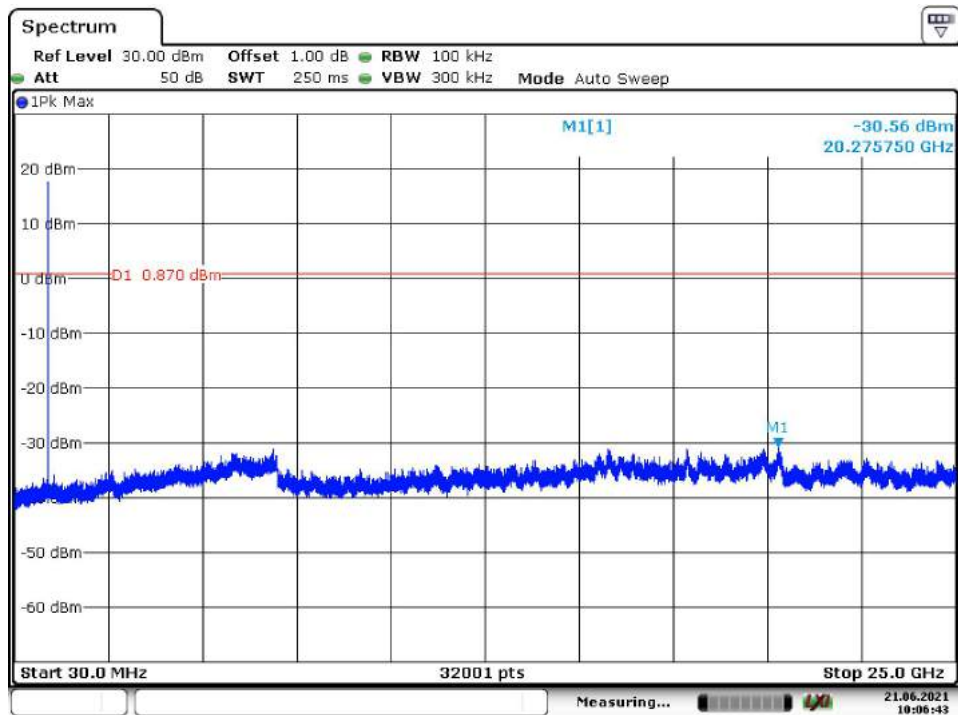


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Lora FHSS, hopping



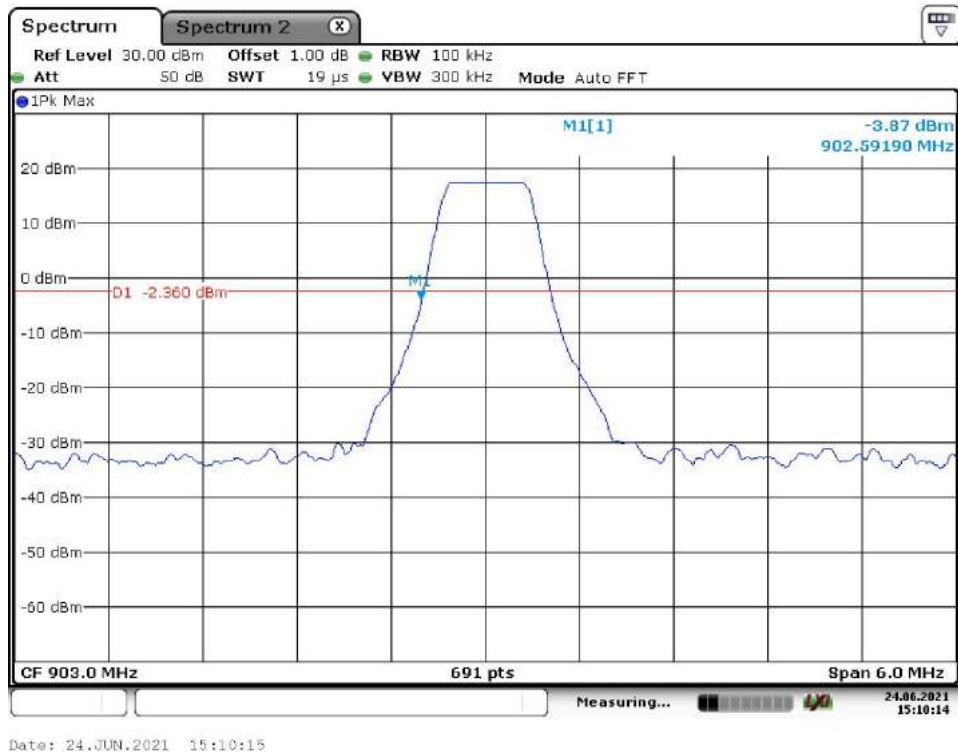
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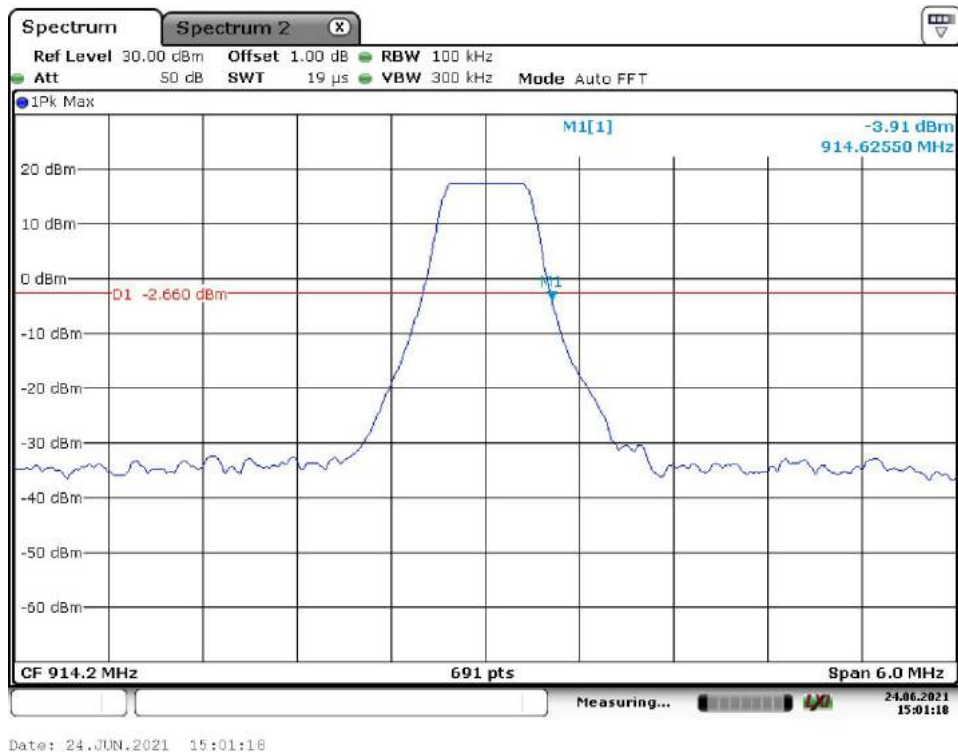
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Lora DTS, Band Edge

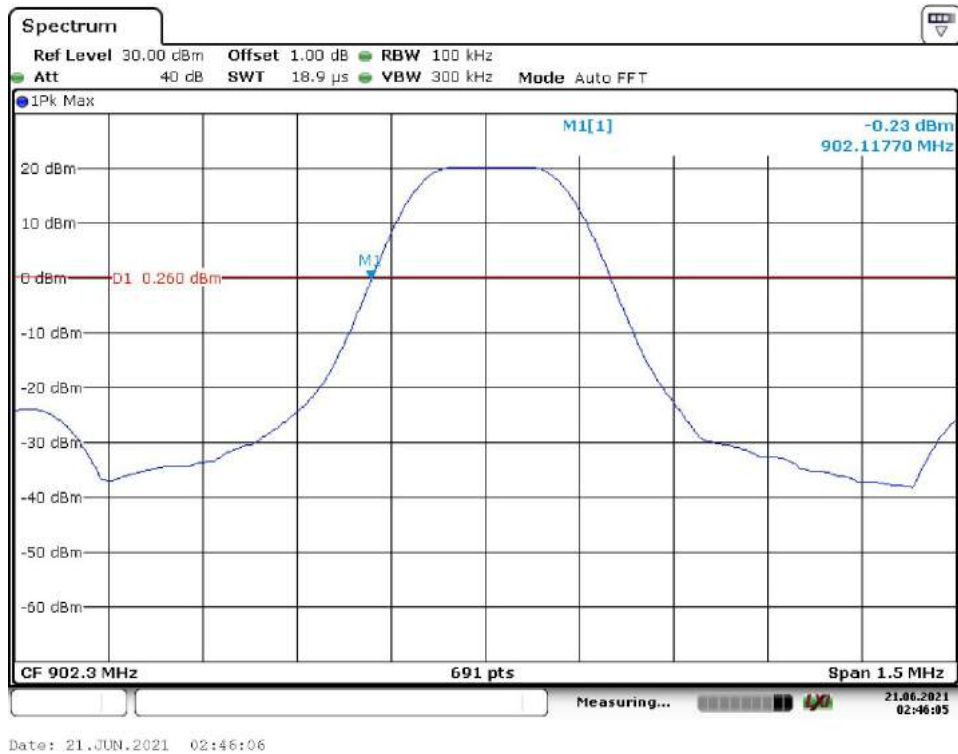
Low Channel



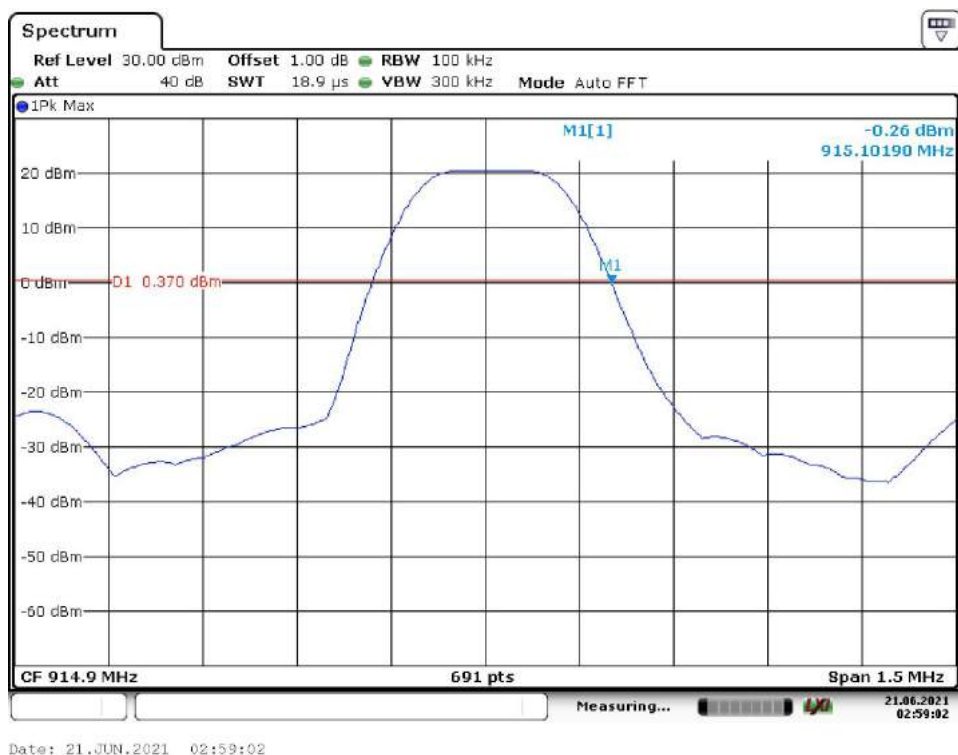
High Channel



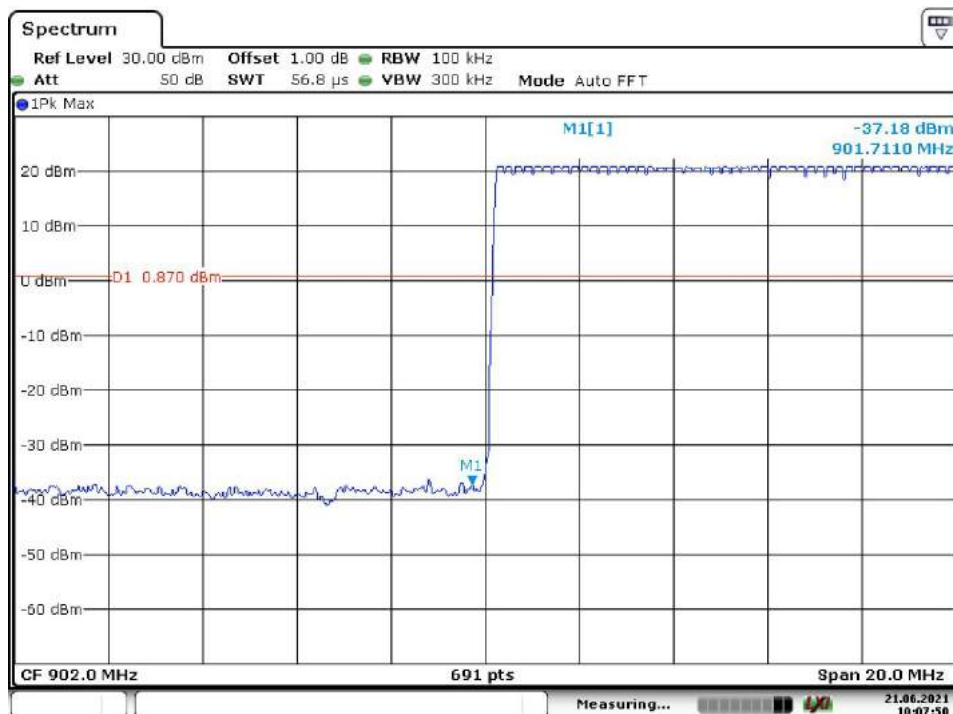
Lora FHSS, No hopping, Band Edge
Low Channel



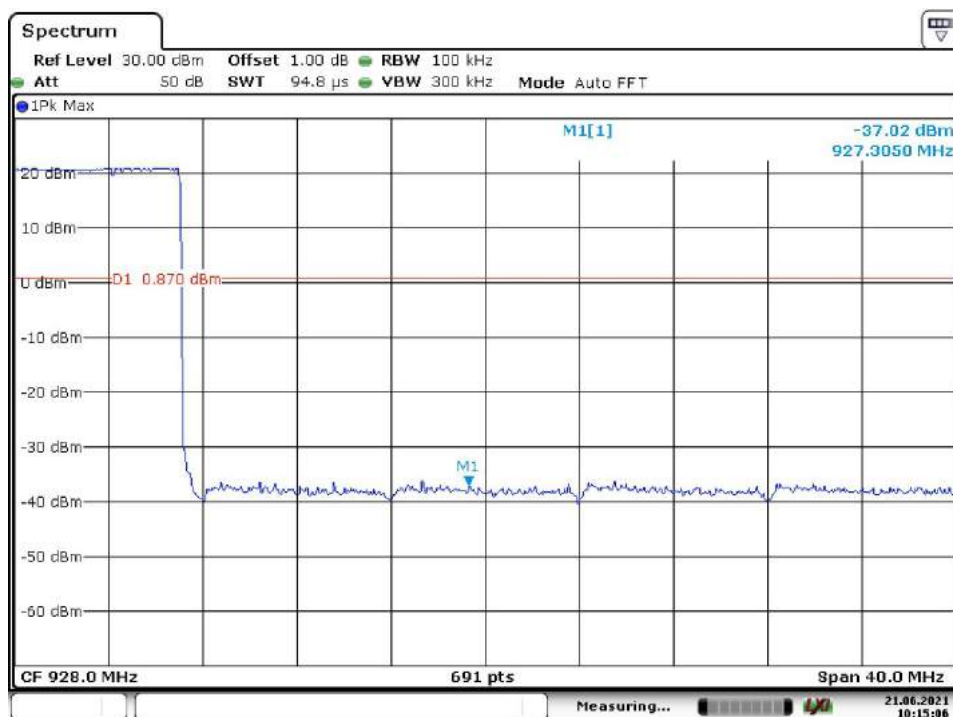
High Channel



Lora FHSS, hopping, Band Edge



Date: 21.JUN.2021 10:07:50



Date: 21.JUN.2021 10:15:06

Appendix B.6: Carrier Frequency Separation

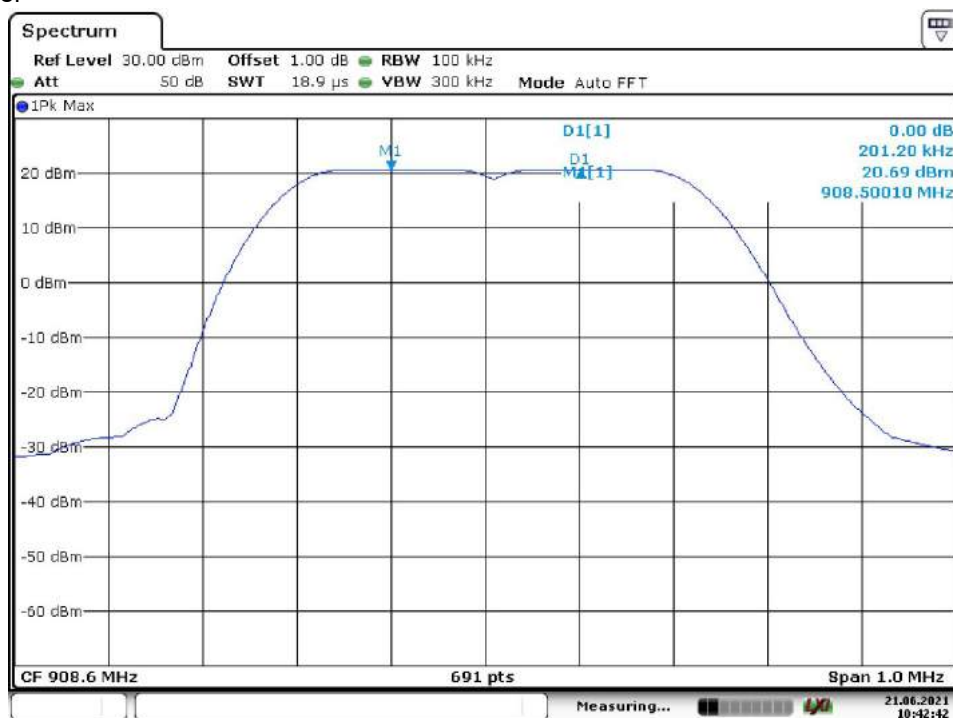
Lora FHSS

Low Channel



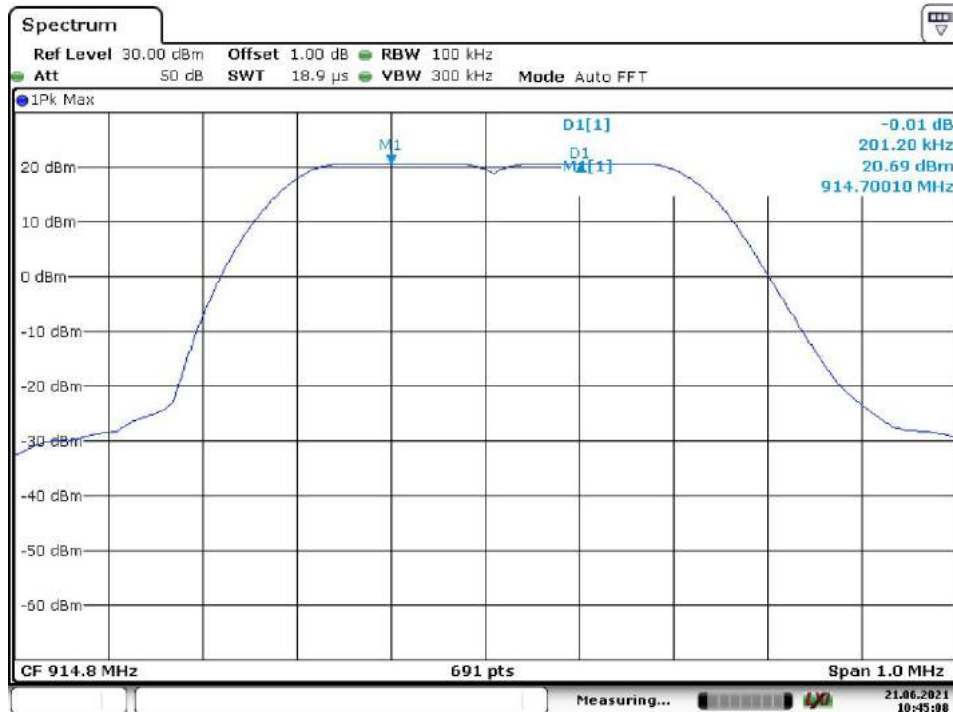
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Middle Channel



Date: 21.JUN.2021 10:42:42

High Channel



Date: 21.JUN.2021 10:45:09

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.

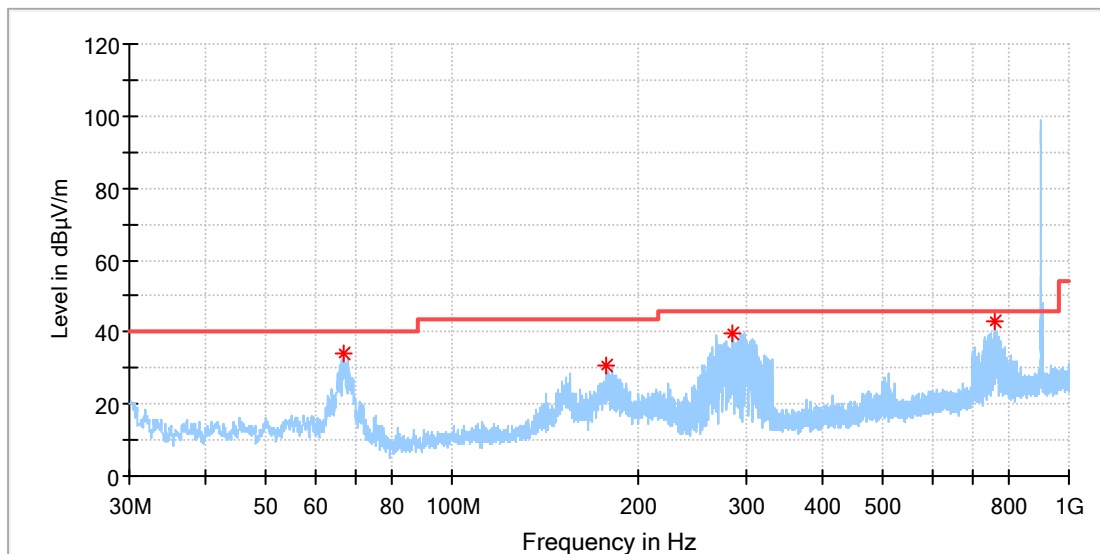
Appendix B.7: Test Results of Radiated Spurious Emissions

Lora DTS

30MHz - 1GHz

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	DTS_500k_903MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 24 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

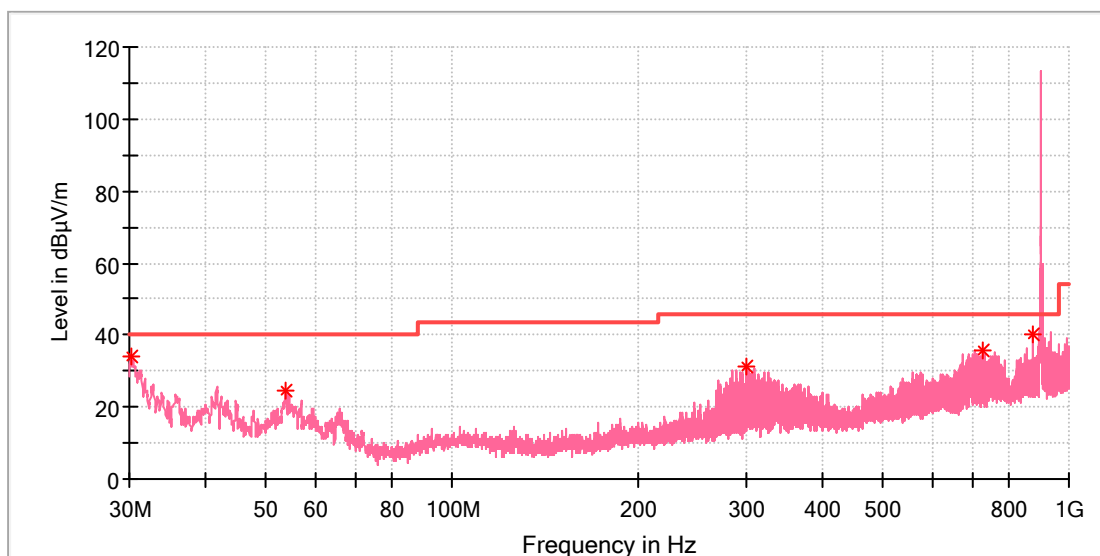


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
66.811500	34.18	40.00	5.82	100.0	H	0.0	-20.7
177.925000	30.77	43.50	12.73	100.0	H	346.0	-20.7
284.237000	39.70	46.00	6.30	100.0	H	198.0	-16.6
759.779500	42.80	46.00	3.20	100.0	H	256.0	-7.0

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	DTS_500k_903MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 24 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

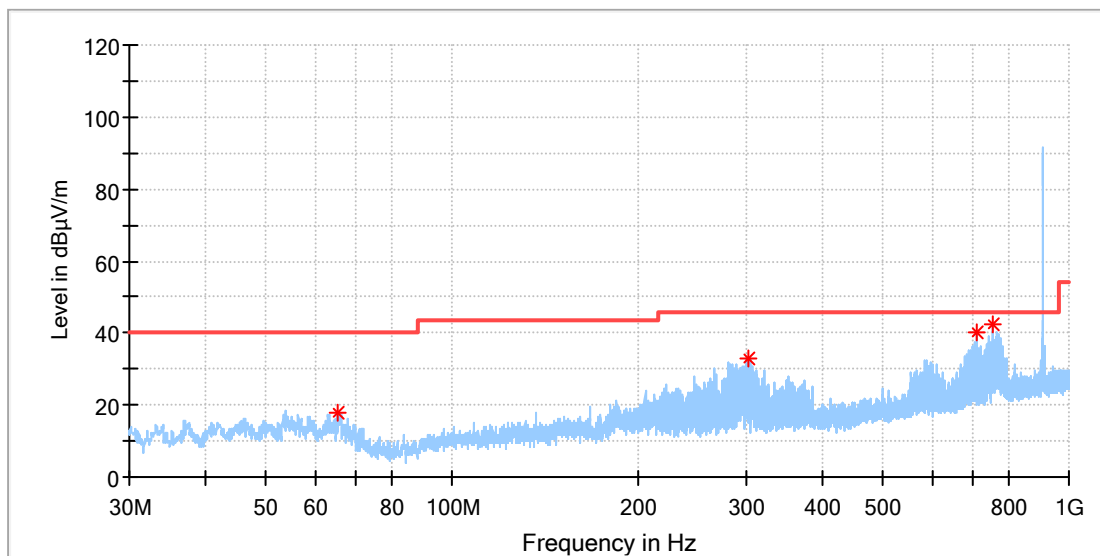


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.194000	34.09	40.00	5.91	100.0	V	298.0	-23.0
53.668000	24.67	40.00	15.33	100.0	V	0.0	-18.4
300.484500	31.42	46.00	14.58	100.0	V	169.0	-16.3
725.441500	35.65	46.00	10.35	100.0	V	28.0	-7.6
871.232500	39.98	46.00	6.02	100.0	V	28.0	-5.2

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	DTS_500k_907.8MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 24 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

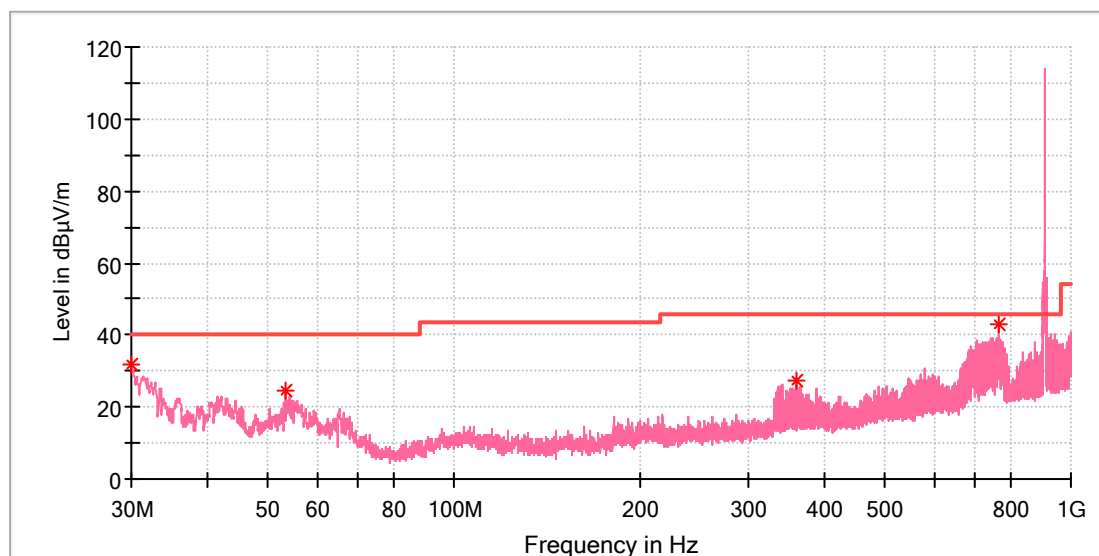


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
65.502000	18.01	40.00	21.99	100.0	H	330.0	-20.2
301.842500	33.14	46.00	12.86	100.0	H	0.0	-16.2
708.515000	40.41	46.00	5.59	100.0	H	83.0	-7.9
752.892500	42.27	46.00	3.73	100.0	H	252.0	-7.1

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	DTS_500k_907.8MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 24 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

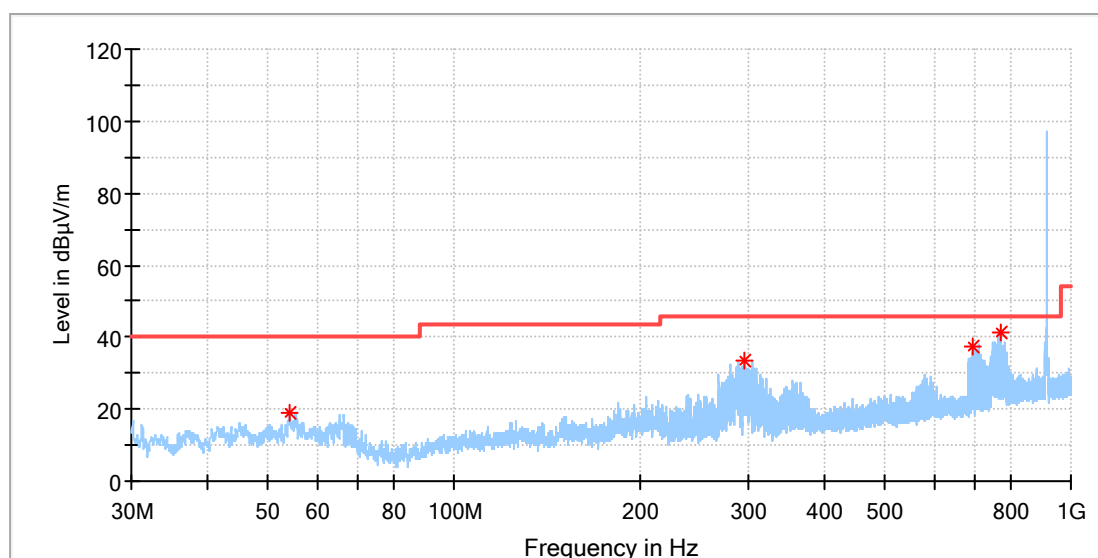


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.097000	31.54	40.00	8.46	100.0	V	341.0	-23.0
53.280000	24.74	40.00	15.26	100.0	V	257.0	-18.4
359.994000	27.61	46.00	18.39	100.0	V	0.0	-14.6
764.581000	42.77	46.00	3.23	100.0	V	144.0	-6.9

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	DTS_500k_914.2MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 24 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

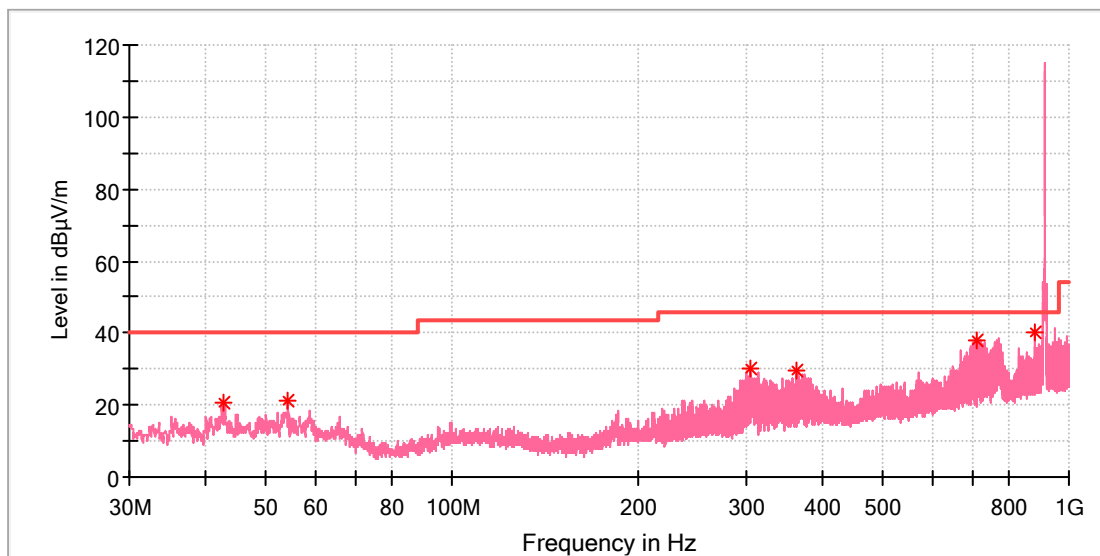


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
54.298500	19.23	40.00	20.77	100.0	H	341.0	-18.4
295.198000	33.61	46.00	12.39	100.0	H	266.0	-16.4
694.595500	37.58	46.00	8.42	100.0	H	198.0	-8.1
771.322500	41.58	46.00	4.42	100.0	H	198.0	-6.8

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	DTS_500k_914.2MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 24 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



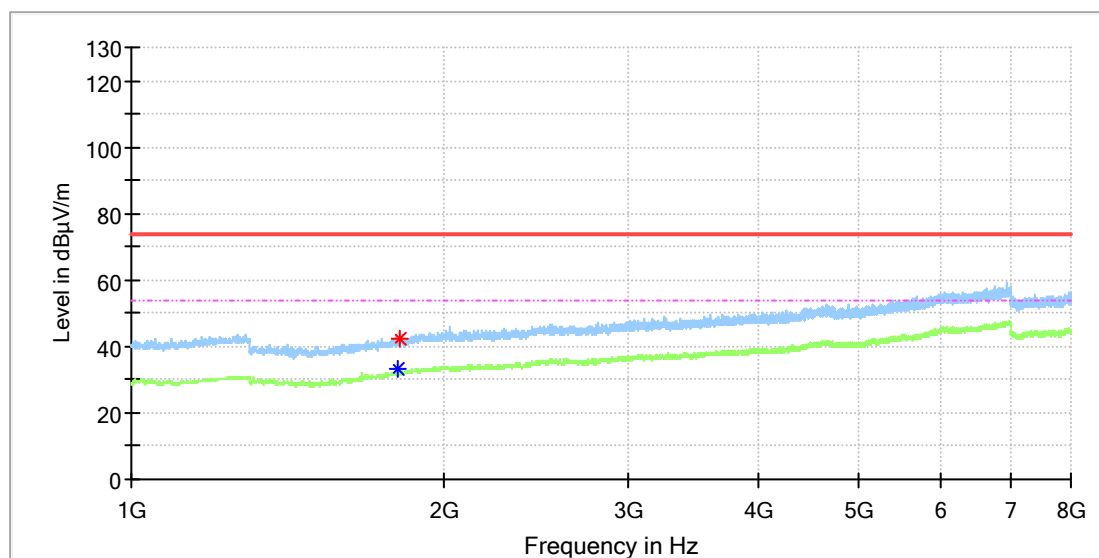
Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
42.755500	20.81	40.00	19.19	100.0	V	0.0	-19.4
54.250000	21.36	40.00	18.64	100.0	V	87.0	-18.4
305.480000	30.19	46.00	15.81	100.0	V	216.0	-16.1
363.049500	29.62	46.00	16.38	100.0	V	216.0	-14.6
711.182500	38.13	46.00	7.87	100.0	V	174.0	-7.8
882.290500	40.19	46.00	5.81	100.0	V	0.0	-5.1

1GHz - 10GHz

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	DTS_500k_903MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:45%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

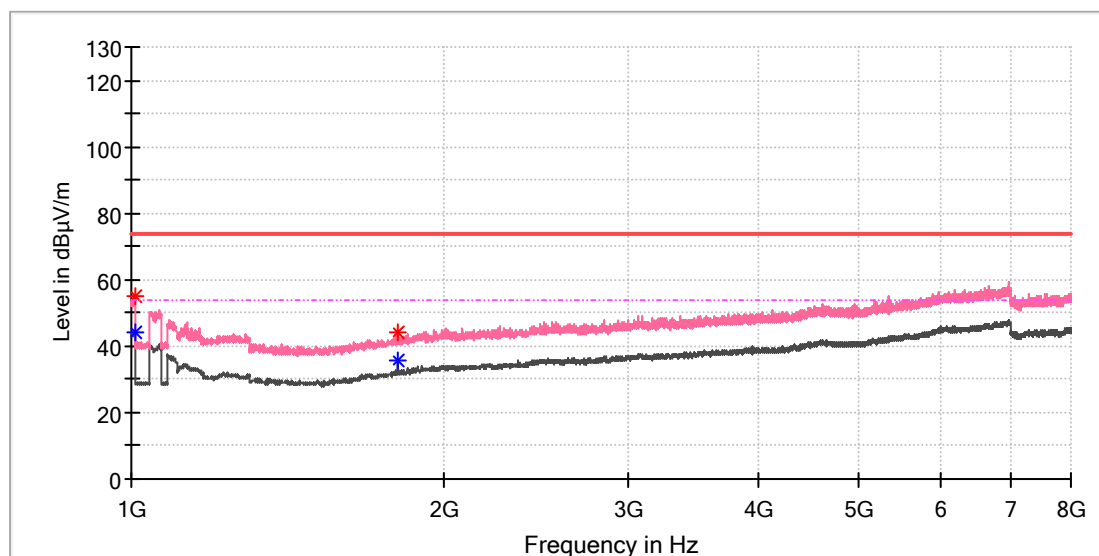


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1805.850000	---	33.11	54.00	20.89	100.0	H	198.0	4.8
1807.525000	42.35	---	74.00	31.65	100.0	H	26.0	4.8

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	DTS_500k_903MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:45%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

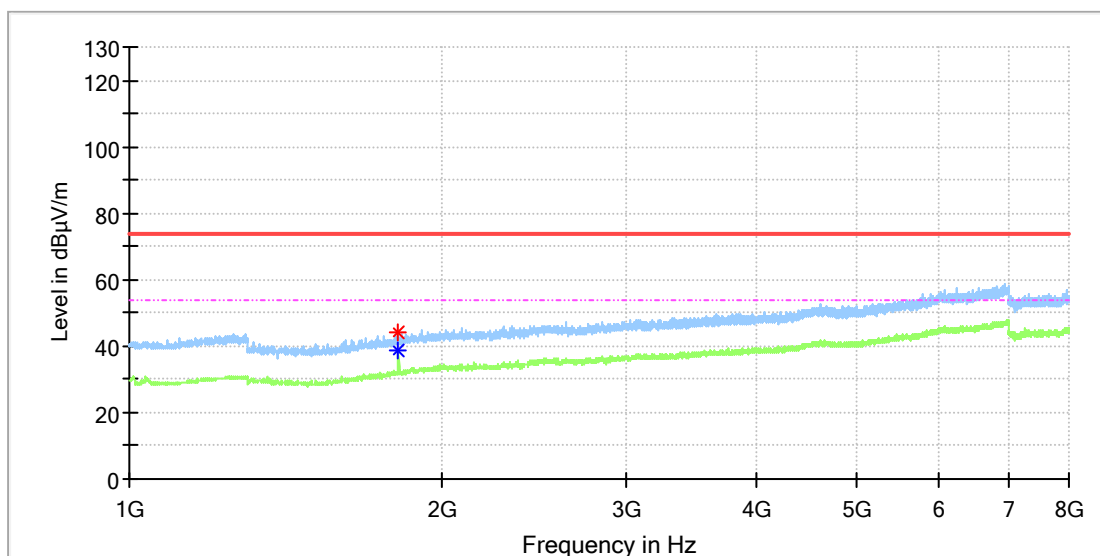


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1007.000000	---	44.01	54.00	9.99	100.0	V	194.0	-0.1
1008.000000	54.88	---	74.00	19.12	100.0	V	194.0	-0.1
1805.850000	---	35.51	54.00	18.49	100.0	V	220.0	4.8
1806.687500	43.89	---	74.00	30.11	100.0	V	220.0	4.8

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	DTS_500k_907.8MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:45%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

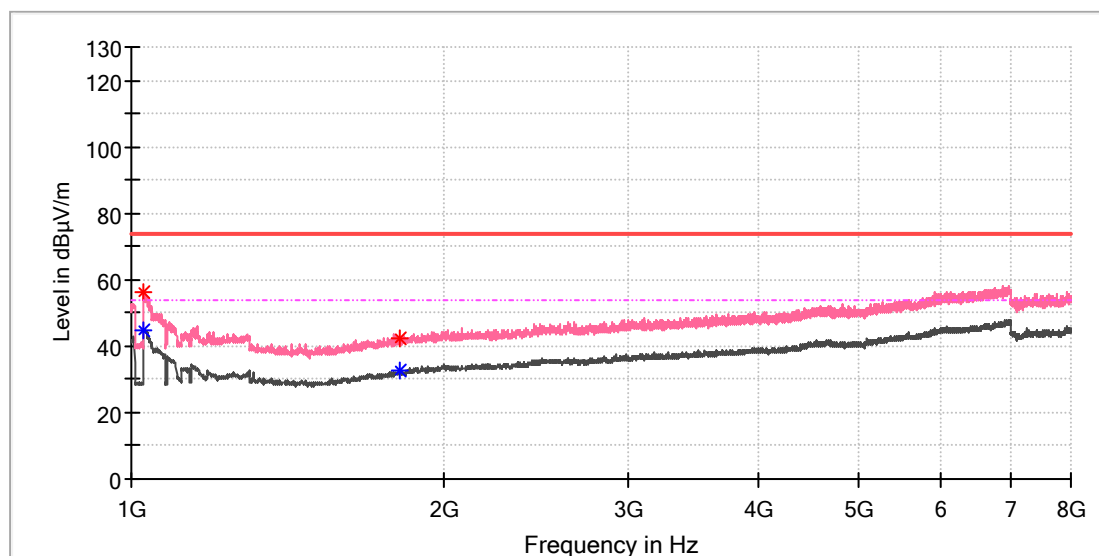


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1814.225000	44.40	---	74.00	29.60	100.0	H	323.0	4.8
1815.062500	---	38.79	54.00	15.21	100.0	H	323.0	4.8

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	DTS_500k_907.8MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:45%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

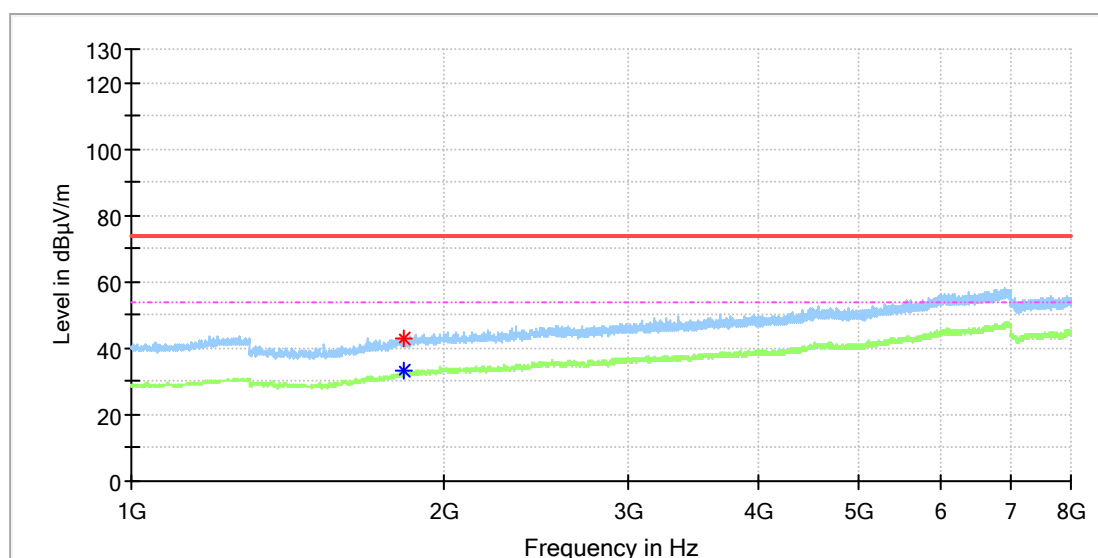


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1028.500000	---	44.88	54.00	9.12	100.0	V	12.0	-0.2
1028.500000	56.00	---	74.00	18.00	100.0	V	12.0	-0.2
1814.225000	---	32.52	54.00	21.48	100.0	V	224.0	4.8
1815.062500	42.33	---	74.00	31.67	100.0	V	278.0	4.8

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	DTS_500k_914.2MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:45%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

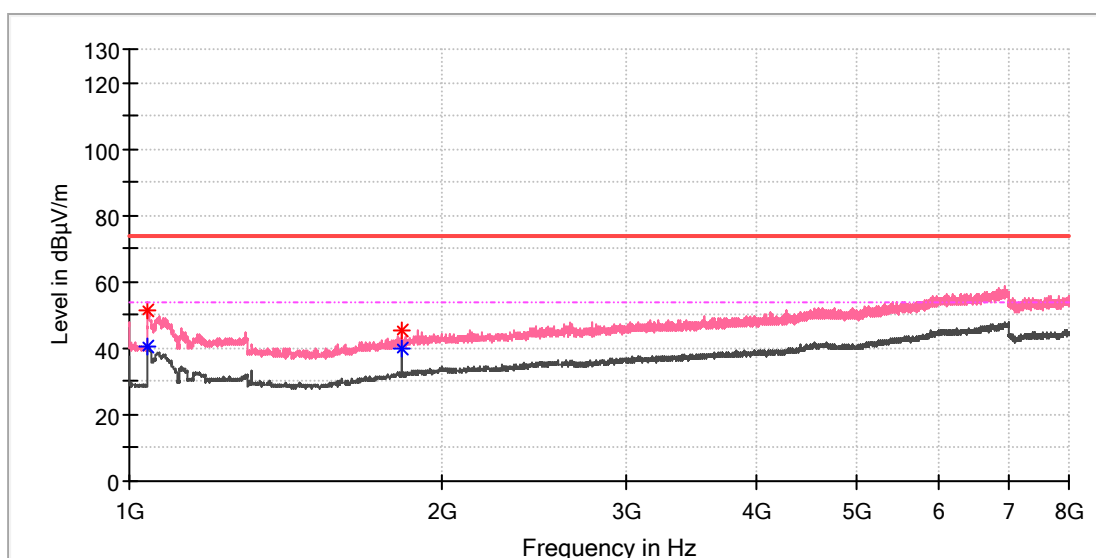


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1826.787500	42.90	---	74.00	31.10	100.0	H	269.0	4.9
1828.462500	---	33.46	54.00	20.54	100.0	H	191.0	4.9

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	DTS_500k_914.2MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:45%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

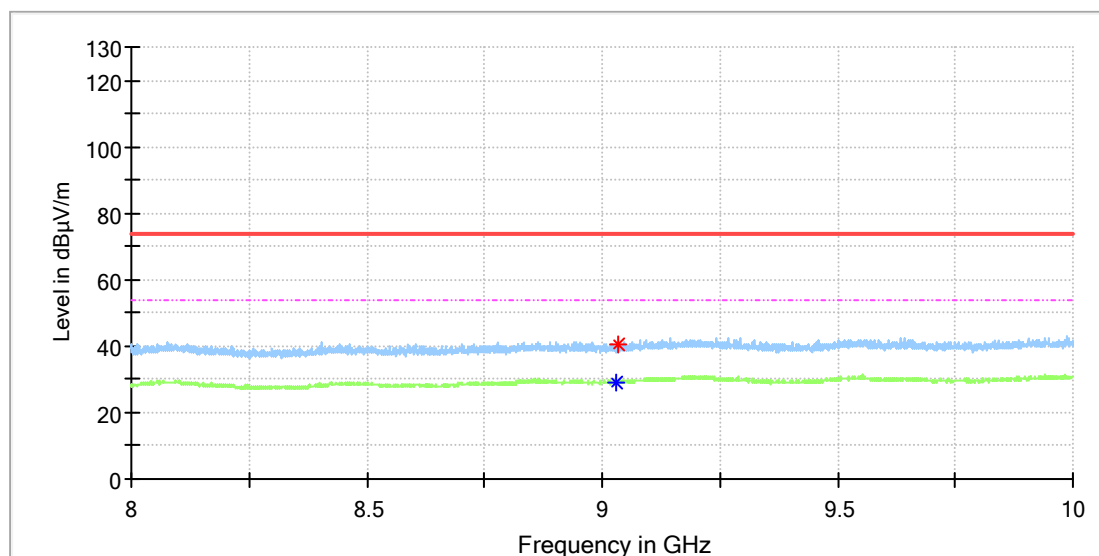


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1042.000000	---	40.72	54.00	13.28	100.0	V	0.0	-0.2
1042.500000	51.44	---	74.00	22.56	100.0	V	0.0	-0.2
1828.462500	---	39.64	54.00	14.36	100.0	V	106.0	4.9
1828.462500	45.30	---	74.00	28.70	100.0	V	106.0	4.9

EUT Information

EUT Name: WisDuo LPWAN Module
Model: RAK3172
Test Mode: DTS_500k_903MHz
Test Voltage:: DC 5V from USB
Remark: Temp 24 Humi:47%
Test Standard: FCC 15.247
Tested By: Kei Zhang
Reviewed By: Terry Yin

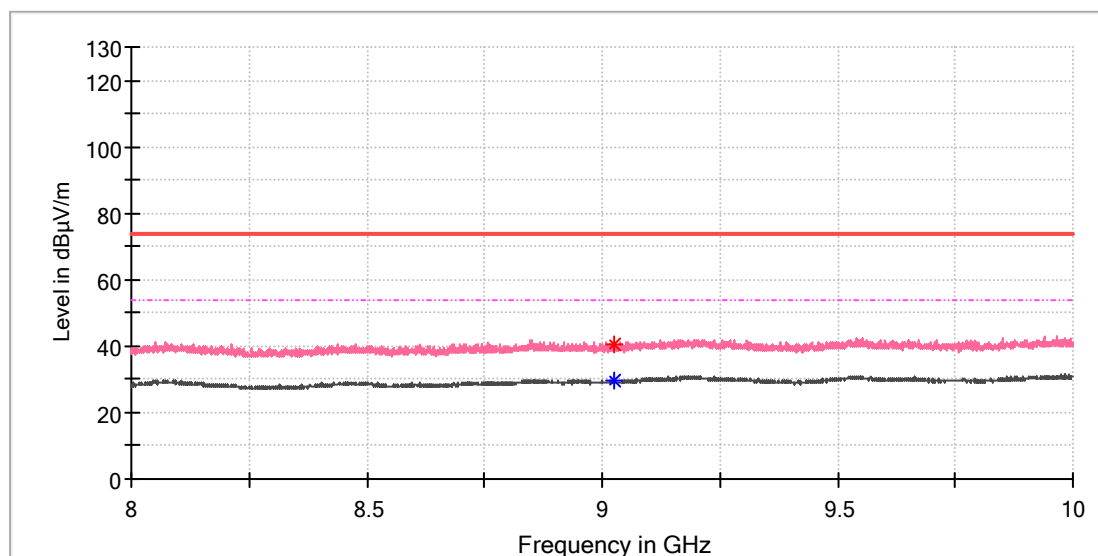


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9029.500000	---	29.22	54.00	24.78	100.0	H	74.0	8.9
9033.500000	40.24	---	74.00	33.76	100.0	H	277.0	8.9

EUT Information

EUT Name: WisDuo LPWAN Module
Model: RAK3172
Test Mode: DTS_500k_903MHz
Test Voltage:: DC 5V from USB
Remark: Temp 24 Humi:47%
Test Standard: FCC 15.247
Tested By: Kei Zhang
Reviewed By: Terry Yin

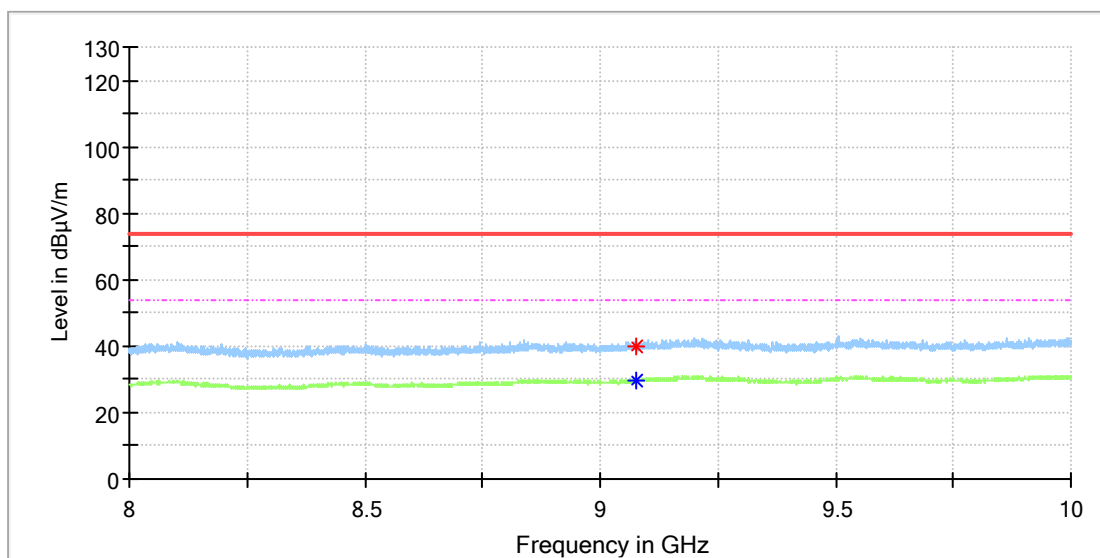


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9025.000000	40.66	---	74.00	33.34	100.0	V	17.0	8.9
9027.000000	---	29.42	54.00	24.58	100.0	V	221.0	8.9

EUT Information

EUT Name: WisDuo LPWAN Module
Model: RAK3172
Test Mode: DTS_500k_907.8MHz
Test Voltage:: DC 5V from USB
Remark: Temp 24 Humi:47%
Test Standard: FCC 15.247
Tested By: Kei Zhang
Reviewed By: Terry Yin

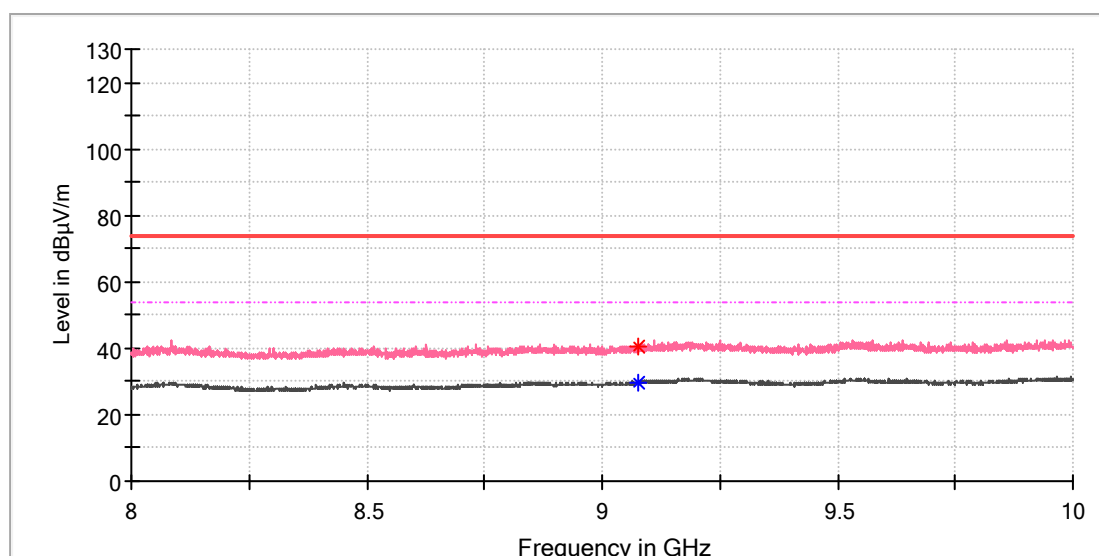


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9077.000000	40.19	---	74.00	33.81	100.0	H	9.0	9.4
9078.500000	---	29.89	54.00	24.11	100.0	H	54.0	9.4

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	DTS_500k_907.8MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 24 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

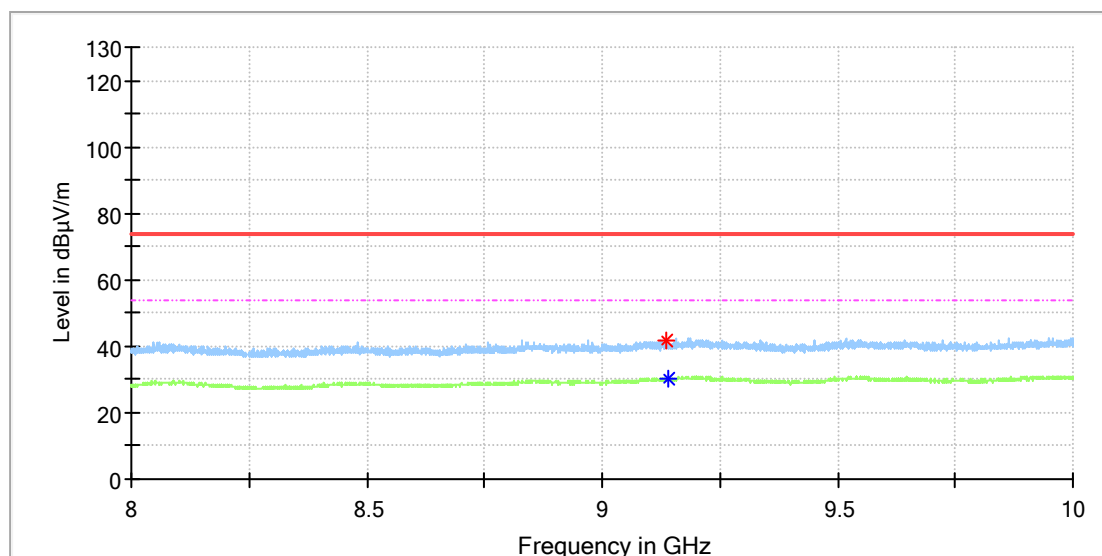


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9075.000000	40.44	---	74.00	33.56	100.0	V	346.0	9.4
9075.000000	---	29.78	54.00	24.22	100.0	V	346.0	9.4

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	DTS_500k_914.2MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 24 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

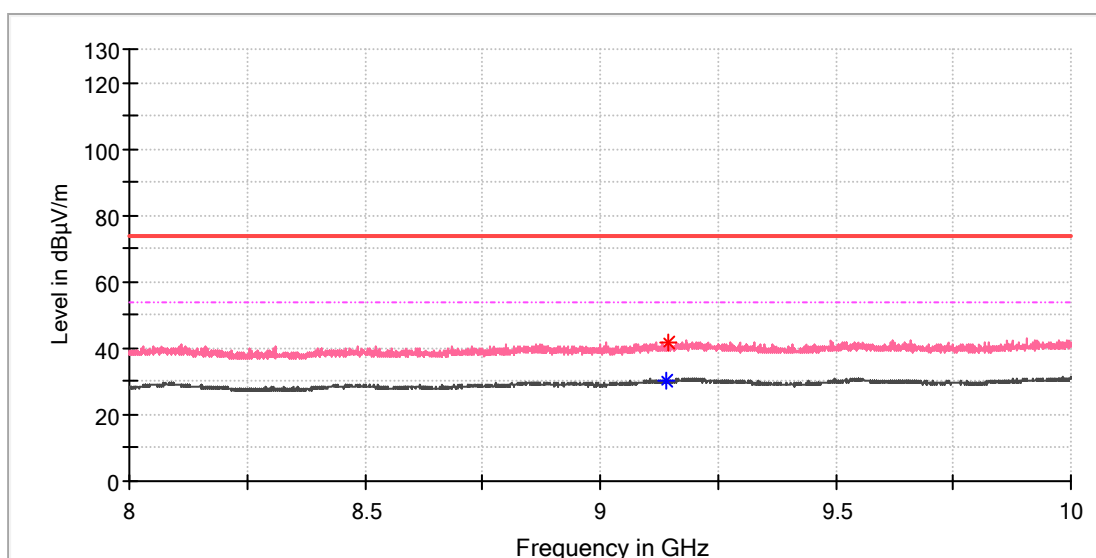


Critical_Freqs

Frequency (MHz)	MaxPeak (dBμV/m)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9136.500000	41.76	---	74.00	32.24	100.0	H	349.0	10.0
9139.500000	---	30.07	54.00	23.93	100.0	H	279.0	10.0

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	DTS_500k_914.2MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 24 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical_Freqs

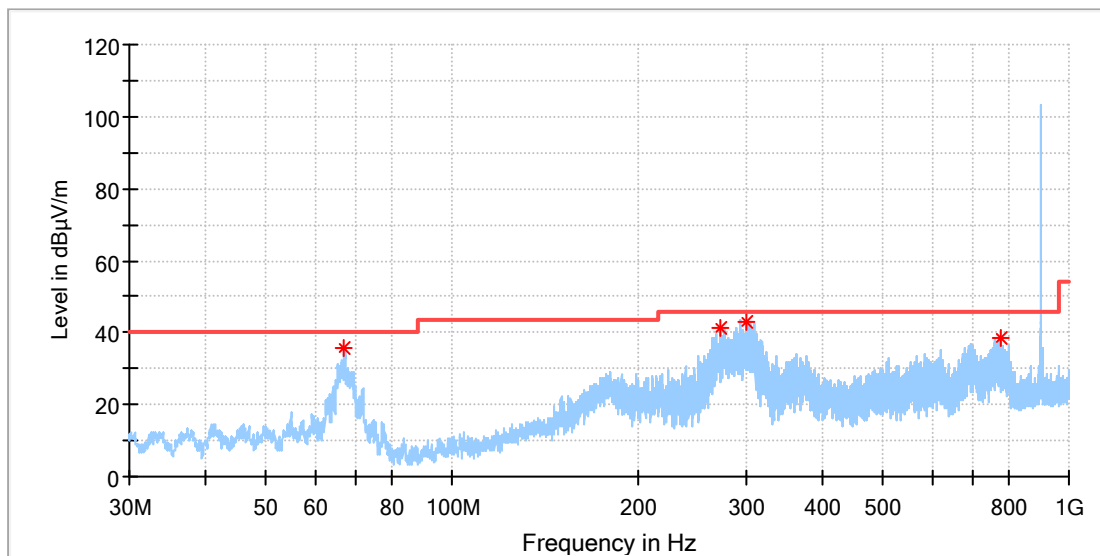
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9142.500000	---	30.31	54.00	23.69	100.0	V	104.0	10.1
9143.000000	41.81	---	74.00	32.19	100.0	V	67.0	10.1

Lora FHSS

30MHz - 1GHz

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	Lora_125k_902.3MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 24 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

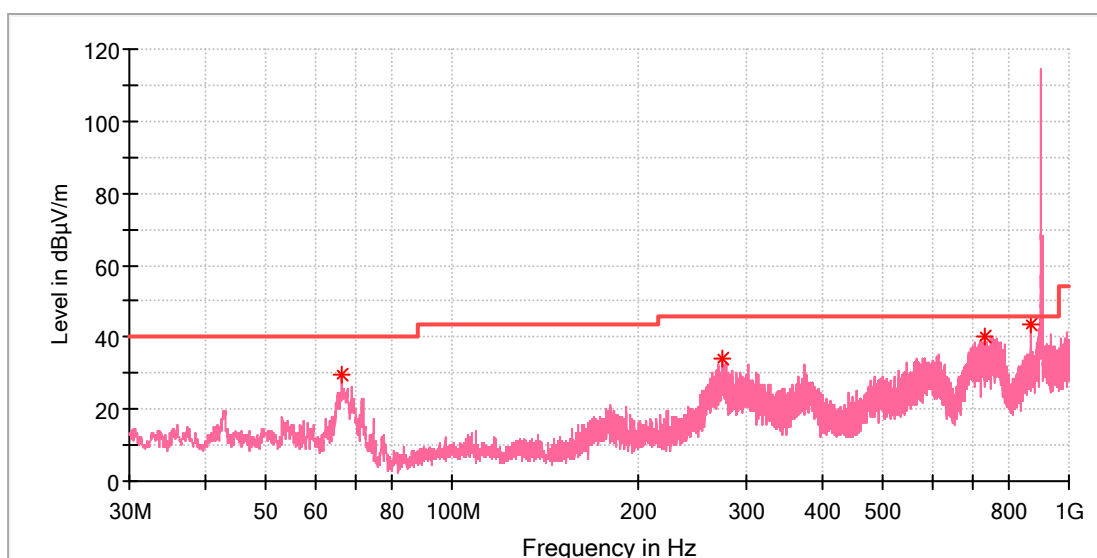


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
66.908500	35.88	40.00	4.12	100.0	H	0.0	-20.7
272.403000	41.30	46.00	4.70	100.0	H	299.0	-16.9
300.824000	42.85	46.00	3.15	100.0	H	299.0	-16.3
777.385000	38.31	46.00	7.69	100.0	H	273.0	-6.7

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	Lora_125k_902.3MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 24 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

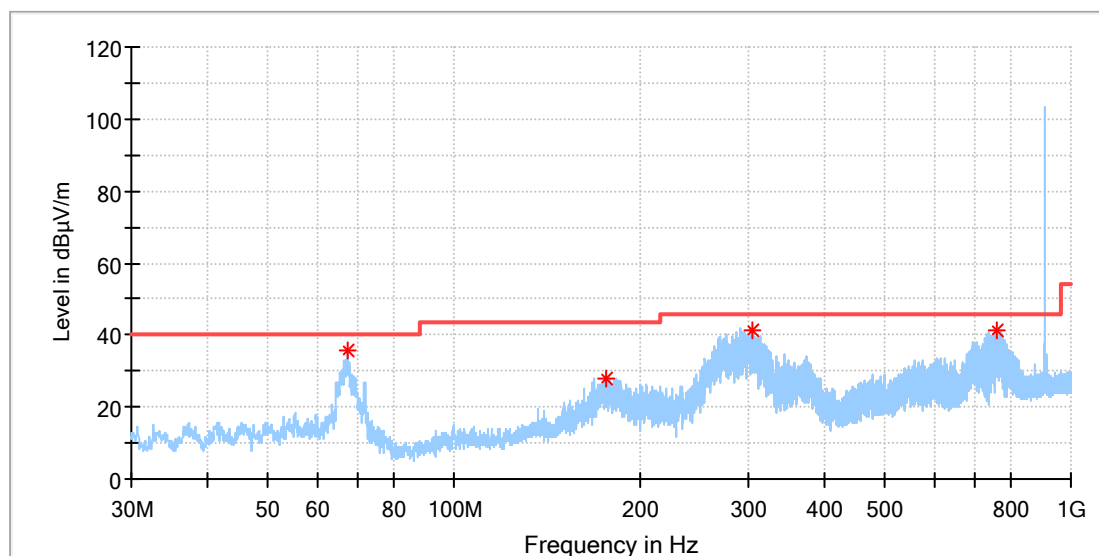


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
66.229500	29.83	40.00	10.17	100.0	V	274.0	-20.5
273.567000	34.28	46.00	11.72	100.0	V	60.0	-16.9
732.280000	40.43	46.00	5.57	100.0	V	123.0	-7.5
870.311000	43.64	46.00	2.36	100.0	V	75.0	-5.2

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	Lora_125k_908.5MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 24 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

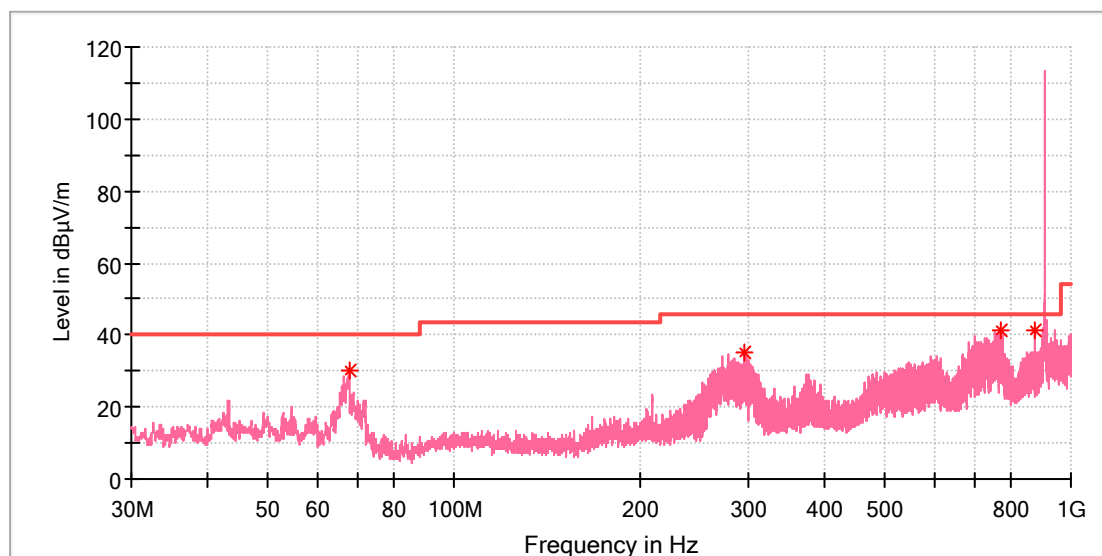


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
67.345000	35.52	40.00	4.48	100.0	H	0.0	-20.9
175.985000	27.91	43.50	15.59	100.0	H	95.0	-20.8
304.995000	41.36	46.00	4.64	100.0	H	213.0	-16.1
759.100500	41.53	46.00	4.47	100.0	H	213.0	-7.0

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	Lora_125k_908.5MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 24 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

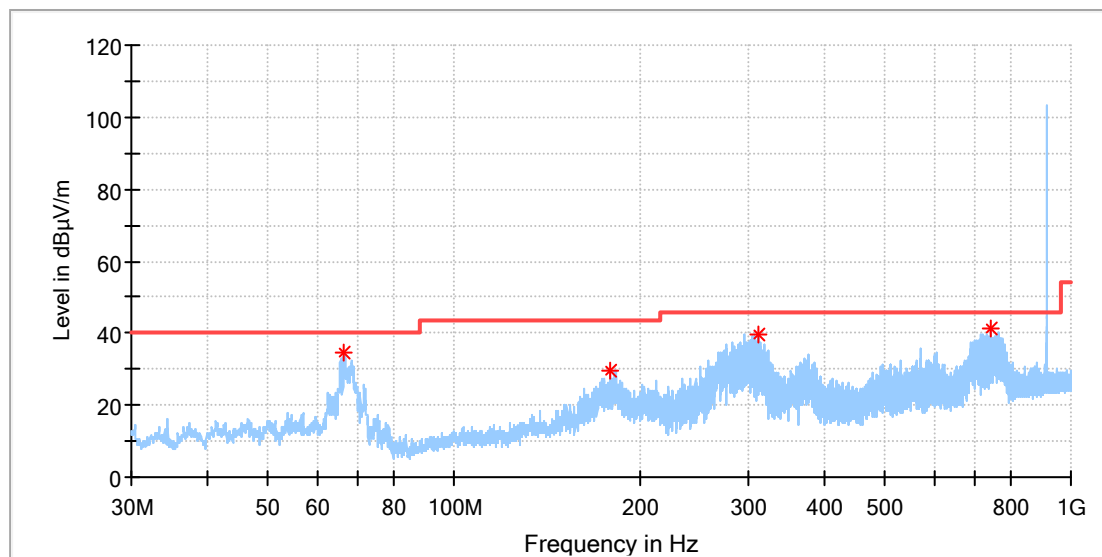


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
67.539000	29.87	40.00	10.13	100.0	V	283.0	-21.0
295.974000	35.43	46.00	10.57	100.0	V	274.0	-16.4
770.158500	41.24	46.00	4.76	100.0	V	274.0	-6.8
876.567500	41.21	46.00	4.79	100.0	V	158.0	-5.2

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	Lora_125k_914.9MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 24 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

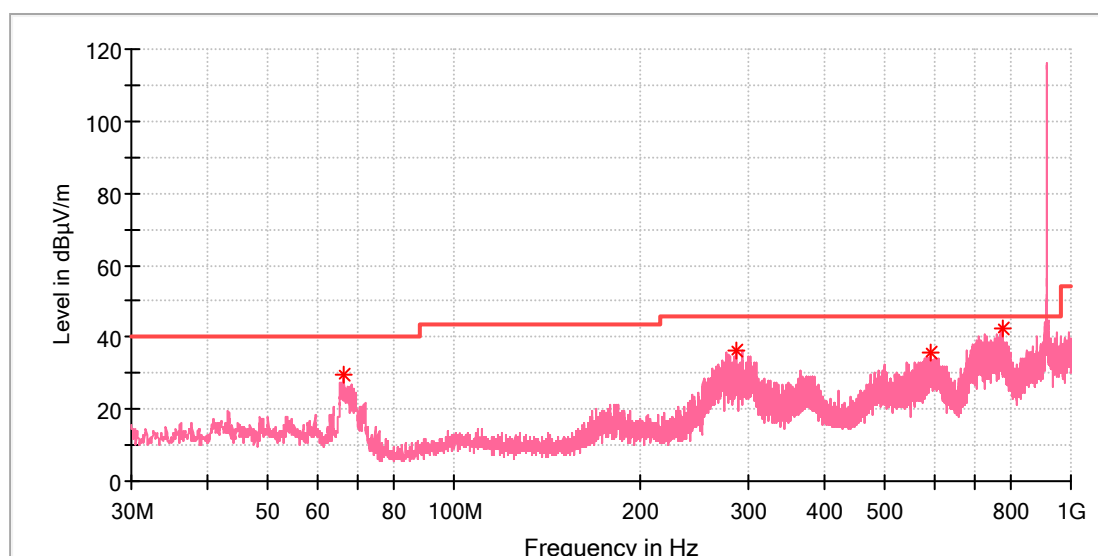


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
66.423500	34.77	40.00	5.23	100.0	H	5.0	-20.6
179.089000	29.77	43.50	13.73	100.0	H	126.0	-20.6
310.912000	39.42	46.00	6.58	100.0	H	22.0	-15.9
742.077000	41.33	46.00	4.67	100.0	H	260.0	-7.3

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	Lora_125k_914.9MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 24 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



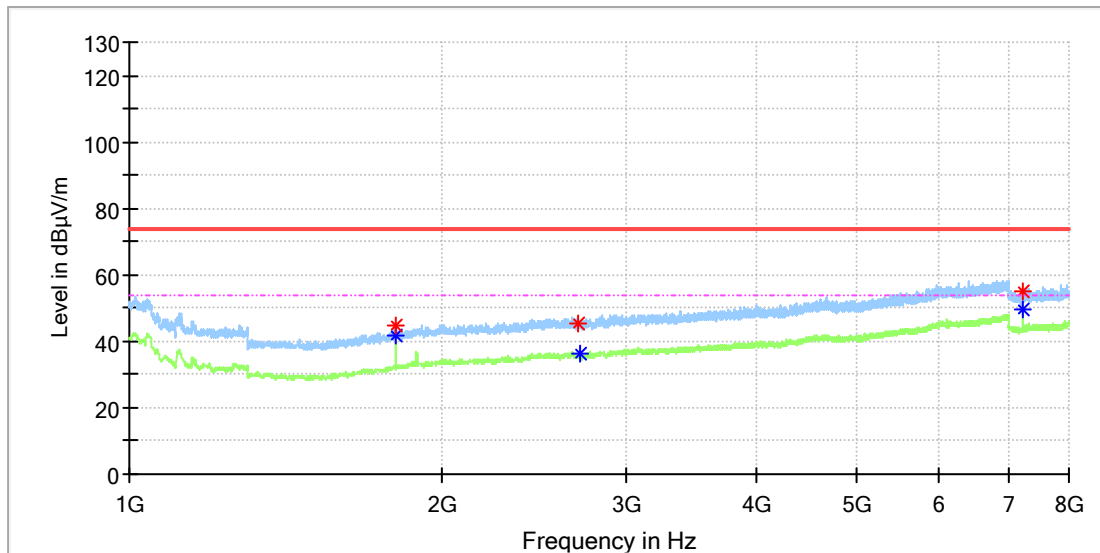
Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
66.229500	29.42	40.00	10.58	100.0	V	271.0	-20.5
286.322500	36.56	46.00	9.44	100.0	V	271.0	-16.6
594.249000	35.81	46.00	10.19	100.0	V	70.0	-10.0
776.609000	42.66	46.00	3.34	100.0	V	271.0	-6.7

1GHz - 10GHz

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	Lora_125k_902.3MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:45%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

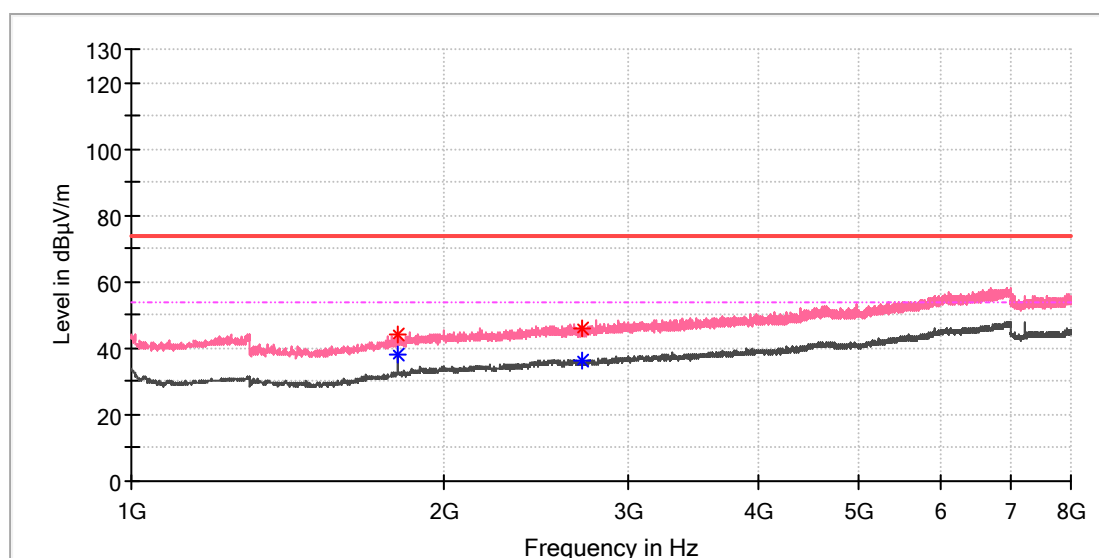


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1804.175000	---	41.43	54.00	12.57	100.0	H	4.0	4.7
1804.175000	44.96	---	74.00	29.04	100.0	H	4.0	4.7
2702.812500	45.46	---	74.00	28.54	100.0	H	105.0	7.5
2706.162500	---	36.06	54.00	17.94	100.0	H	93.0	7.5
7218.612500	54.79	---	74.00	19.21	100.0	H	278.0	17.9
7218.612500	---	49.59	54.00	4.41	100.0	H	278.0	17.9

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	Lora_125k_902.3MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:45%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

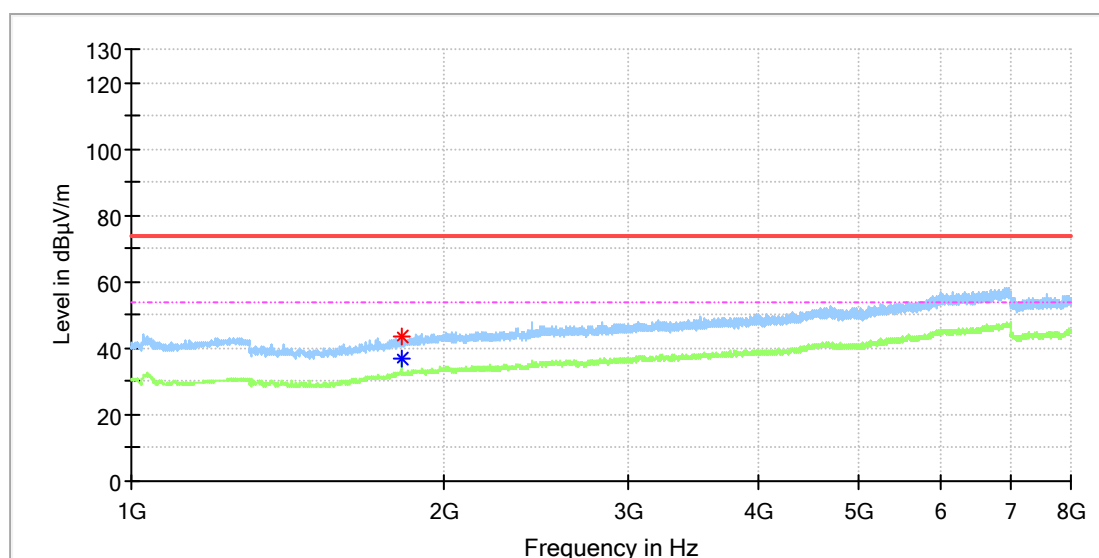


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1804.175000	44.20	---	74.00	29.80	100.0	V	127.0	4.7
1804.175000	---	37.83	54.00	16.17	100.0	V	127.0	4.7
2706.162500	---	36.25	54.00	17.75	100.0	V	3.0	7.5
2707.000000	46.11	---	74.00	27.89	100.0	V	42.0	7.6

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	Lora_125k_908.5MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:45%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

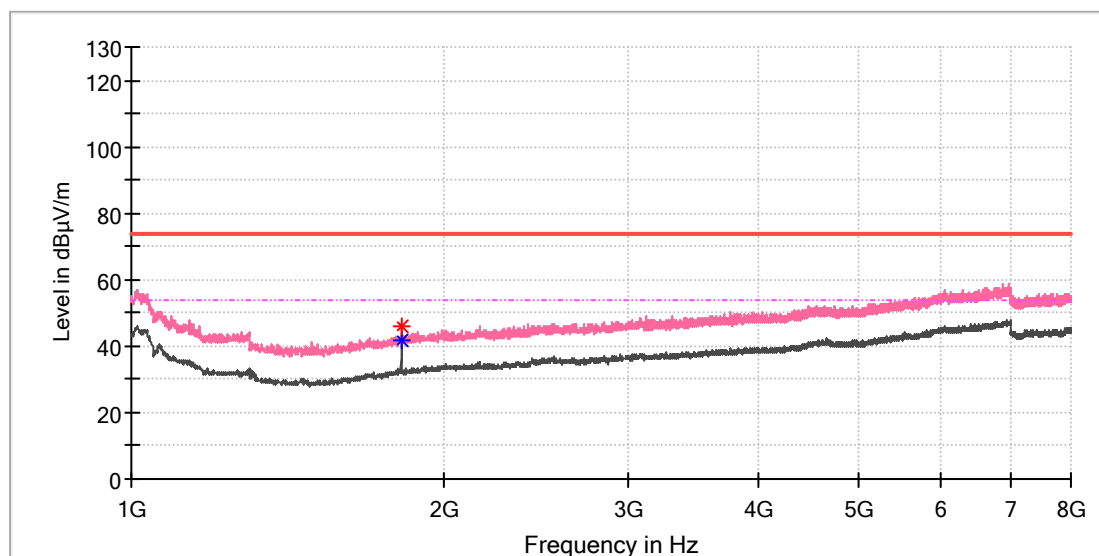


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1816.737500	43.55	---	74.00	30.45	100.0	H	128.0	4.8
1816.737500	---	36.93	54.00	17.07	100.0	H	128.0	4.8

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	Lora_125k_908.5MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:45%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

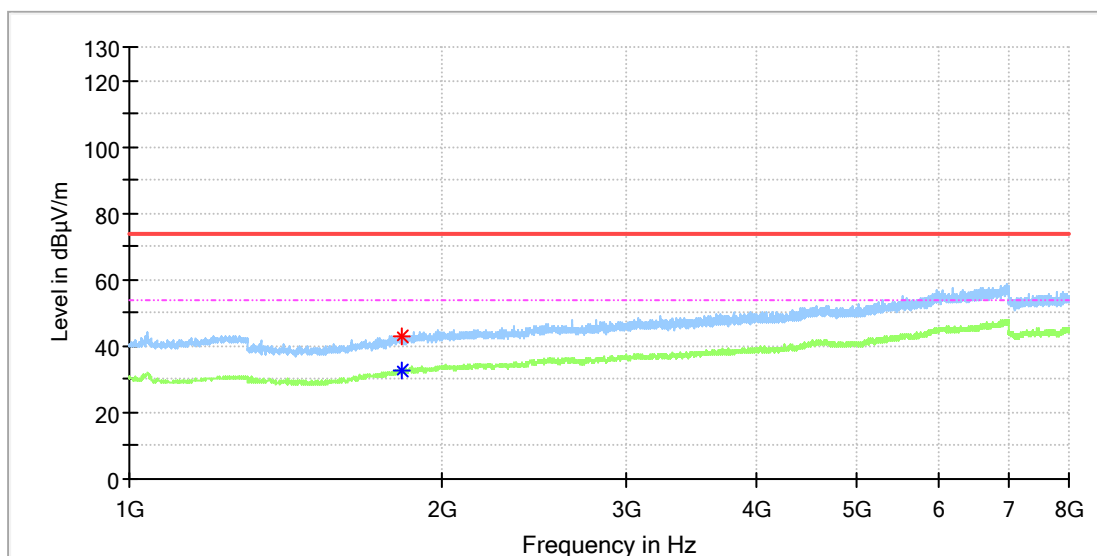


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1816.737500	45.87	---	74.00	28.13	100.0	V	148.0	4.8
1816.737500	---	41.76	54.00	12.24	100.0	V	148.0	4.8

EUT Information

EUT Name: WisDuo LPWAN Module
Model: RAK3172
Test Mode: Lora_125k_914.9MHz
Test Voltage:: DC 5V from USB
Remark: Temp 23 Humi:45%
Test Standard: FCC 15.247
Tested By: Kei Zhang
Reviewed By: Terry Yin

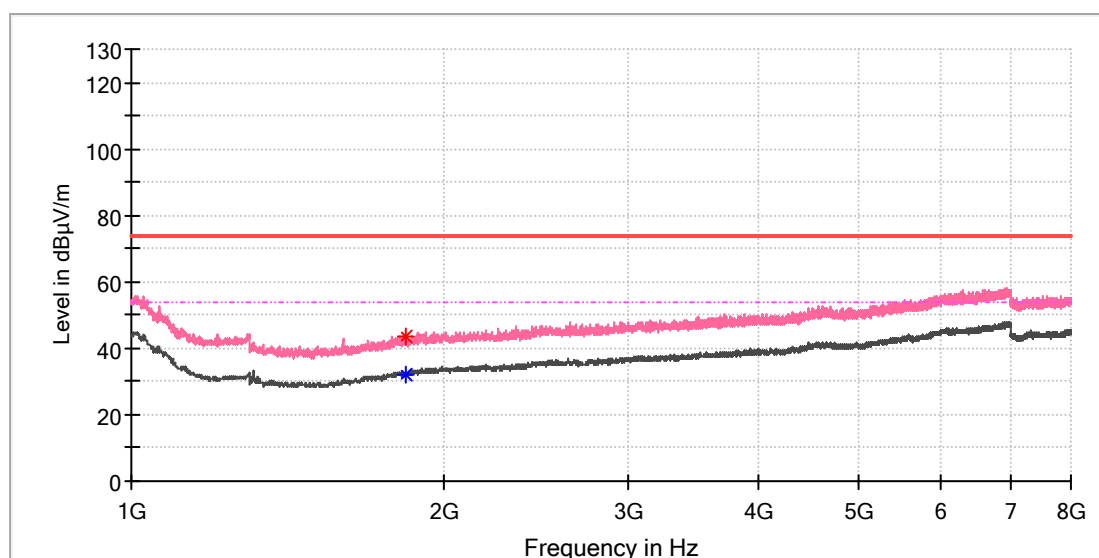


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1825.112500	---	32.80	54.00	21.20	100.0	H	10.0	4.9
1828.462500	42.88	---	74.00	31.12	100.0	H	68.0	4.9

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	Lora_125k_914.9MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 23 Humi:45%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

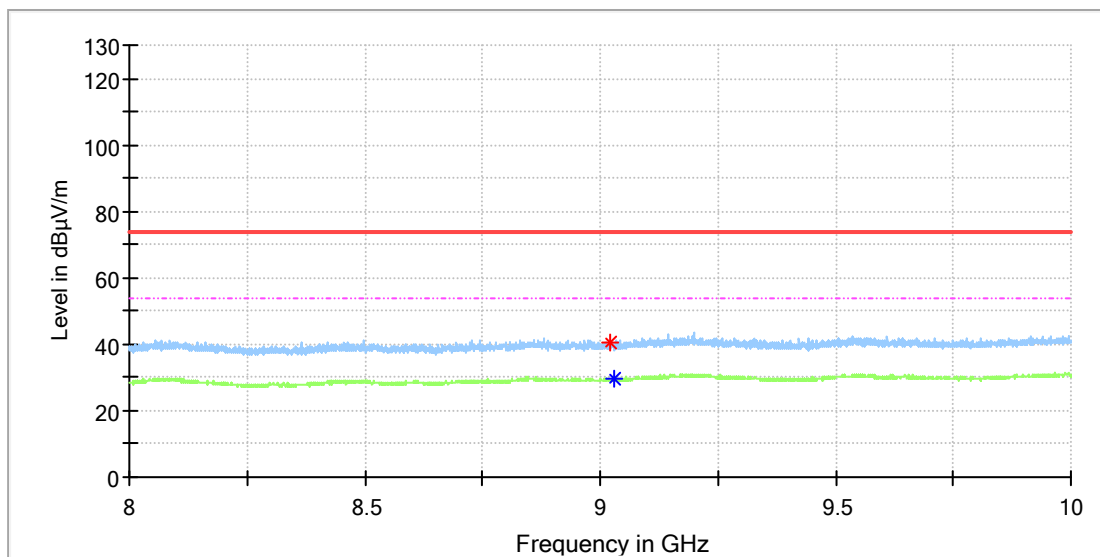


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1831.812500	43.66	---	74.00	30.34	100.0	V	232.0	4.9
1831.812500	---	32.31	54.00	21.69	100.0	V	232.0	4.9

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	Lora_125k_902.3MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 24 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

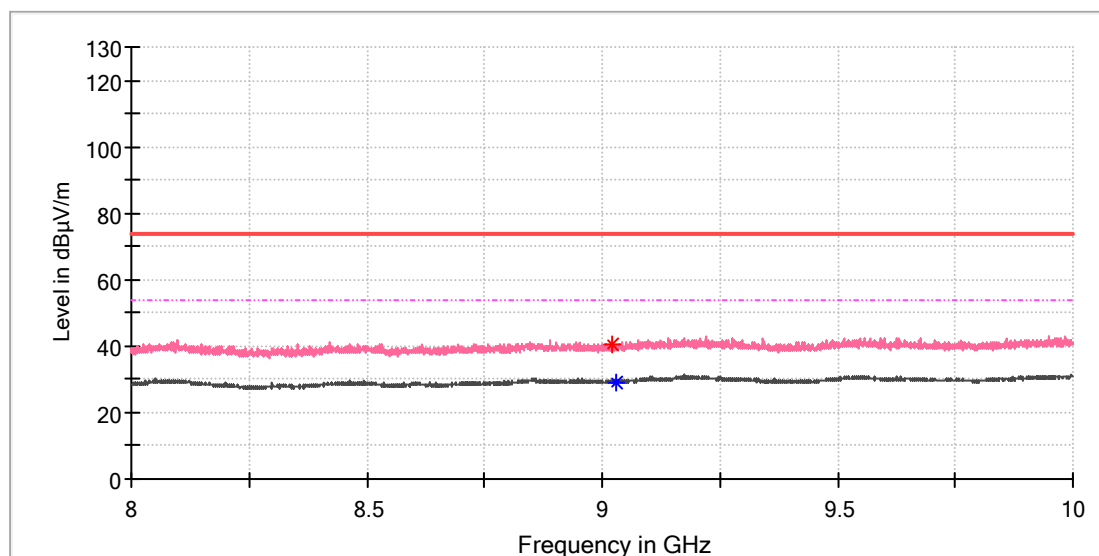


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9022.000000	40.35	---	74.00	33.65	100.0	H	188.0	8.9
9028.500000	---	29.43	54.00	24.57	100.0	H	254.0	8.9

EUT Information

EUT Name:	WisDuo LPWAN Module
Model:	RAK3172
Test Mode:	Lora_125k_902.3MHz
Test Voltage::	DC 5V from USB
Remark:	Temp 24 Humi:47%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

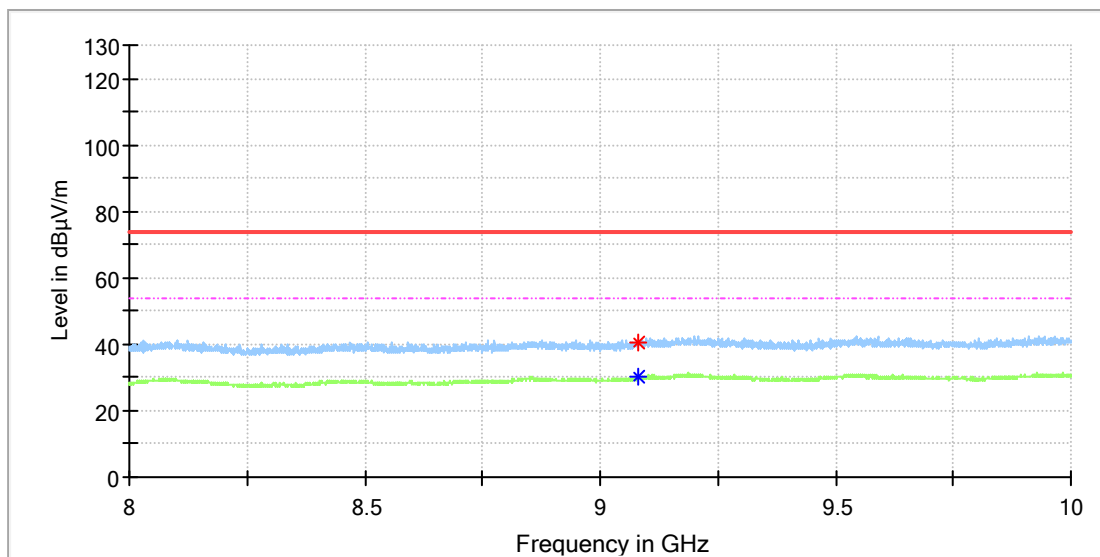


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9023.000000	40.28	---	74.00	33.72	100.0	V	225.0	8.9
9029.500000	---	29.30	54.00	24.70	100.0	V	271.0	8.9

EUT Information

EUT Name: WisDuo LPWAN Module
Model: RAK3172
Test Mode: Lora_125k_908.5MHz
Test Voltage:: DC 5V from USB
Remark: Temp 24 Humi:47%
Test Standard: FCC 15.247
Tested By: Kei Zhang
Reviewed By: Terry Yin

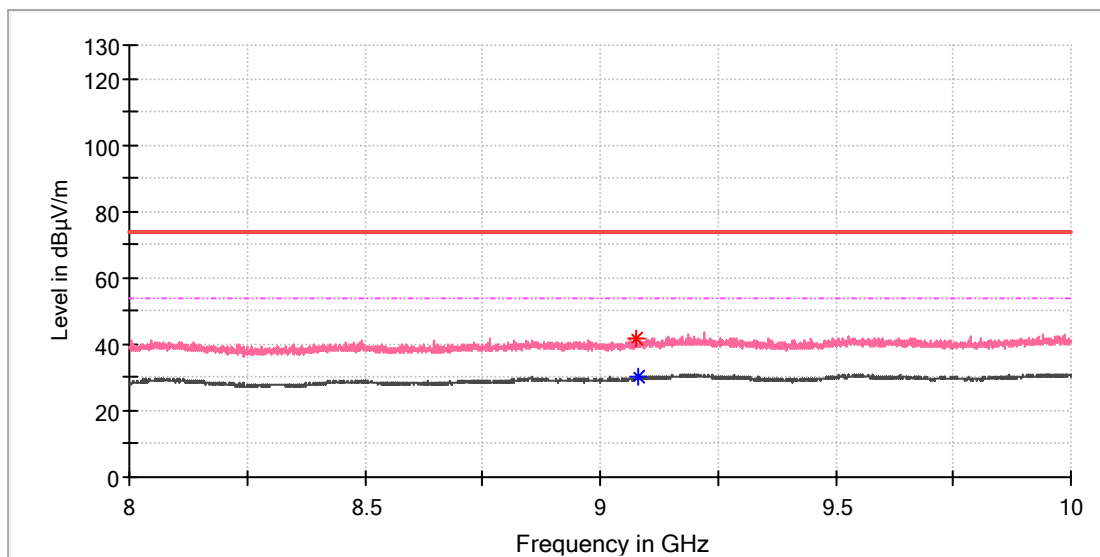


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9079.500000	40.77	---	74.00	33.23	100.0	H	146.0	9.4
9081.000000	---	30.02	54.00	23.98	100.0	H	154.0	9.5

EUT Information

EUT Name: WisDuo LPWAN Module
Model: RAK3172
Test Mode: Lora_125k_908.5MHz
Test Voltage:: DC 5V from USB
Remark: Temp 24 Humi:47%
Test Standard: FCC 15.247
Tested By: Kei Zhang
Reviewed By: Terry Yin

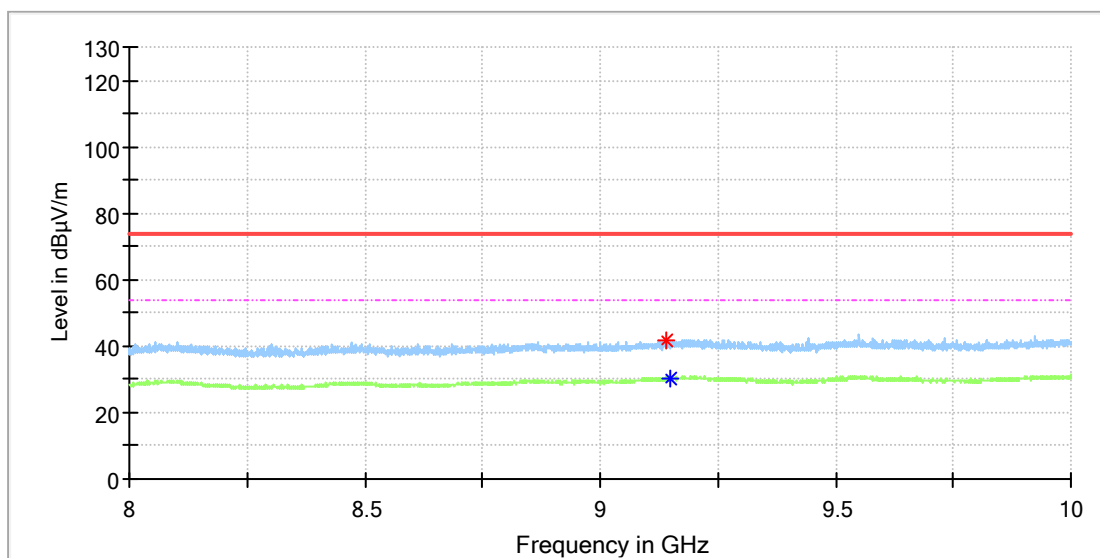


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9077.500000	41.45	---	74.00	32.55	100.0	V	100.0	9.4
9082.500000	---	30.00	54.00	24.00	100.0	V	356.0	9.5

EUT Information

EUT Name: WisDuo LPWAN Module
Model: RAK3172
Test Mode: Lora_125k_914.9MHz
Test Voltage:: DC 5V from USB
Remark: Temp 24 Humi:47%
Test Standard: FCC 15.247
Tested By: Kei Zhang
Reviewed By: Terry Yin

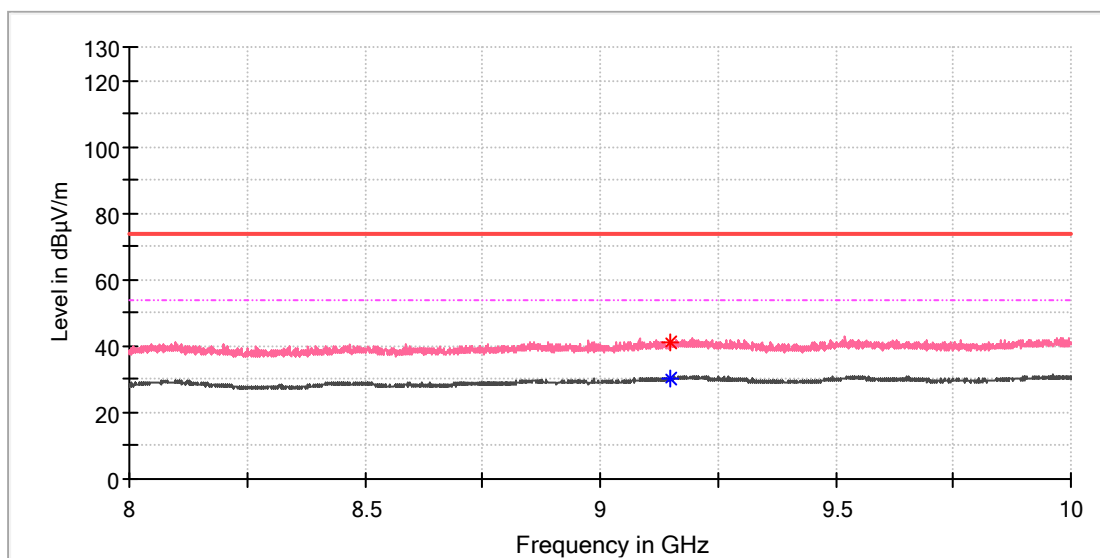


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9140.500000	41.75	---	74.00	32.25	100.0	H	17.0	10.0
9148.500000	---	30.27	54.00	23.73	100.0	H	294.0	10.1

EUT Information

EUT Name: WisDuo LPWAN Module
Model: RAK3172
Test Mode: Lora_125k_914.9MHz
Test Voltage:: DC 5V from USB
Remark: Temp 24 Humi:47%
Test Standard: FCC 15.247
Tested By: Kei Zhang
Reviewed By: Terry Yin



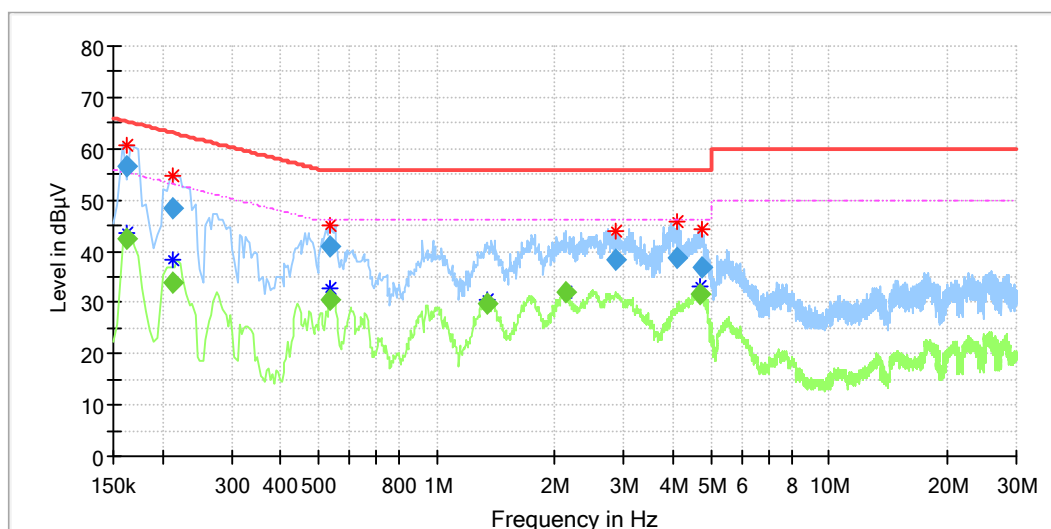
Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9147.000000	41.21	---	74.00	32.79	100.0	V	207.0	10.1
9150.500000	---	30.47	54.00	23.53	100.0	V	44.0	10.1

Appendix B.8: Test Results of Conducted Emission on AC Mains

EUT Information

EUT Name: WisDuo LPWAN Module
Model: RAK3172
Test Voltage: AC 120V/60Hz
Test By: Ouyang Wang
Review By: Gary Chen
Remark: SR2

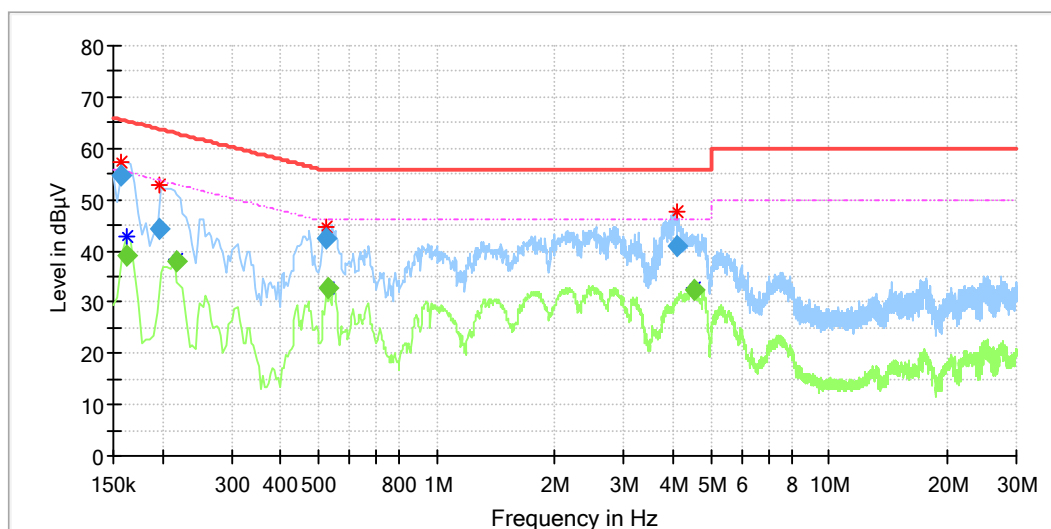


Final Result

Frequency (MHz)	QuasiPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.161500	---	42.31	55.39	13.08	200.0	9.000	L1	9.9
0.161500	56.56	---	65.39	8.83	200.0	9.000	L1	9.9
0.213500	---	33.76	53.07	19.30	200.0	9.000	L1	9.9
0.213500	48.29	---	63.07	14.78	200.0	9.000	L1	9.9
0.533500	40.81	---	56.00	15.19	200.0	9.000	L1	10.0
0.537500	---	30.46	46.00	15.54	200.0	9.000	L1	10.0
1.349500	---	29.85	46.00	16.15	200.0	9.000	L1	10.1
2.137500	---	32.01	46.00	13.99	200.0	9.000	L1	10.1
2.866500	38.32	---	56.00	17.68	200.0	9.000	L1	10.2
4.117500	38.84	---	56.00	17.16	200.0	9.000	L1	10.2
4.713500	---	31.67	46.00	14.33	200.0	9.000	L1	10.2
4.753500	37.00	---	56.00	19.00	200.0	9.000	L1	10.2

EUT Information

EUT Name: WisDuo LPWAN Module
Model: RAK3172
Test Voltage: AC 120V/60Hz
Test By: Ouyang Wang
Review By: Gary Chen
Remark: SR2



Final Result

Frequency (MHz)	QuasiPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.157500	54.64	---	65.60	10.95	200.0	9.000	N	9.8
0.161500	---	39.19	55.39	16.19	200.0	9.000	N	9.8
0.197500	44.23	---	63.72	19.48	200.0	9.000	N	9.8
0.218500	---	37.77	52.88	15.10	200.0	9.000	N	9.8
0.525500	42.41	---	56.00	13.59	200.0	9.000	N	9.8
0.529500	---	32.81	46.00	13.19	200.0	9.000	N	9.8
4.101500	40.85	---	56.00	15.15	200.0	9.000	N	9.9
4.537500	---	32.20	46.00	13.80	200.0	9.000	N	9.9