




Prüfbericht-Nr.: <i>Test report no.:</i>	CN23346K 002	Auftrags-Nr.: <i>Order no.:</i>	168430355	Seite 1 von 23 Page 1 of 23
Kunden-Referenz-Nr.: <i>Client reference no.:</i>	N/A	Auftragsdatum: <i>Order date:</i>	2023-06-08	
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>	WisLink LPWAN Concentrator			
Bezeichnung / Typ-Nr.: <i>Identification / Type no.:</i>	RAK5148 (Trademark: )			
Auftrags-Inhalt: <i>Order content:</i>	Test Report			
Prüfgrundlage: <i>Test specification:</i>	CFR47 FCC Part 15: Subpart C Section 15.247 CFR47 FCC Part 15: Subpart C Section 15.209 CFR47 FCC Part 15: Subpart C Section 15.207 RSS-247 Issue 2 February 2017 RSS-Gen Issue 5 March 2019			
Wareneingangsdatum: <i>Date of sample receipt:</i>	2023-06-16	Please refer to Photo Document		
Prüfmuster-Nr.: <i>Test sample no.:</i>	A003497290-015~016			
Prüfzeitraum: <i>Testing period:</i>	2023-06-21 - 2023-07-18			
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>	<u>X Hardy</u>  Suo	Hardy	genehmigt von: <i>authorized by:</i>	<u>X Lin Lin</u>  Lin Lin
Datum: <i>Date:</i>	2023-08-02		Ausstellungsdatum: <i>Issue date:</i>	2023-08-02
Stellung / Position:	Sachverständige(r)/Expert		Stellung / Position:	Sachverständige(r)/Expert
Sonstiges / <i>Other:</i>	FCC ID: 2AF6B-RAK5148 IC: 25908-RAK5148, HVIN: RAK5148			
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>			
* Legende:	P(ass) = entspricht o.g. Prüfgrundlage(n)	F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
* Legend:	P(ass) = passed a.m. test specification(s)	F(ail) = failed a.m. test specification(s)	N/A = not applicable	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 above mentioned 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>				

v05

Prüfbericht-Nr.: CN23346K 002
Test report no.:

Seite 2 von 23
Page 2 of 23

Anmerkungen
Remarks

1	<p>Alle eingesetzten Prüfmittel waren zum angegebenen Prüfzeitraum gemäß eines festgelegten Kalibrierungsprogramms unseres Prüfhauses kalibriert. Sie entsprechen den in den Prüfprogrammen hinterlegten Anforderungen. Die Rückverfolgbarkeit der eingesetzten Prüfmittel ist durch die Einhaltung der Regelungen unseres Managementsystems gegeben. Detaillierte Informationen bezüglich Prüfkonditionen, Prüfequipment und Messunsicherheiten sind im Prüflabor vorhanden und können auf Wunsch bereitgestellt werden.</p> <p><i>The equipment used during the specified testing period was calibrated according to our test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of our management system. Detailed information regarding test conditions, equipment and measurement uncertainty is available in the test laboratory and could be provided on request.</i></p>
2	<p>Wie vertraglich vereinbart, wurde dieses Dokument nur digital unterzeichnet. Der TÜV Rheinland hat nicht überprüft, welche rechtlichen oder sonstigen diesbezüglichen Anforderungen für dieses Dokument gelten. Diese Überprüfung liegt in der Verantwortung des Benutzers dieses Dokuments. Auf Verlangen des Kunden kann der TÜV Rheinland die Gültigkeit der digitalen Signatur durch ein gesondertes Dokument bestätigen. Diese Anfrage ist an unseren Vertrieb zu richten. Eine Umweltgebühr für einen solchen zusätzlichen Service wird erhoben.</p> <p><i>As contractually agreed, this document has been signed digitally only. TÜV Rheinland has not verified and unable to verify which legal or other pertaining requirements are applicable for this document. Such verification is within the responsibility of the user of this document. Upon request by its client, TÜV Rheinland can confirm the validity of the digital signature by a separate document. Such request shall be addressed to our Sales department. An environmental fee for such additional service will be charged.</i></p>
3	<p>Prüfklausel mit der Note * wurden an qualifizierte Unterauftragnehmer vergeben und sind unter der jeweiligen Prüfklausel des Berichts beschrieben. Abweichungen von Prüfspezifikation(en) oder Kundenanforderungen sind in der jeweiligen Prüfklausel im Bericht aufgeführt.</p> <p><i>Test clauses with remark of * are subcontracted to qualified subcontractors and described under the respective test clause in the report. Deviations of testing specification(s) or customer requirements are listed in specific test clause in the report.</i></p>
4	<p>Die Entscheidungsregel für Konformitätserklärungen basierend auf numerischen Messergebnissen in diesem Prüfbericht basiert auf der "Null-Grenzwert-Regel" und der "Einfachen Akzeptanz" gemäß ILAC G8:2019 und IEC Guide 115:2021, es sei denn, in der auf Seite 1 dieses Berichts genannten angewandten Norm ist etwas anderes festgelegt oder vom Kunden gewünscht. Dies bedeutet, dass die Messunsicherheit nicht berücksichtigt wird und daher auch nicht im Prüfbericht angegeben wird. Zu weiteren Informationen bezüglich des Risikos durch diese Entscheidungsregel siehe ILAC G8:2019.</p> <p><i>The decision rule for statements of conformity, based on numerical measurement results, in this test report is based on the "Zero Guard Band Rule" and "Simple Acceptance" in accordance with ILAC G8:2019 and IEC Guide 115:2021, unless otherwise specified in the applied standard mentioned on Page 1 of this report or requested by the customer. This means that measurement uncertainty is not taken in account and hence also not declared in the test report. For additional information to the resulting risk based of this decision rule please refer to ILAC G8:2019.</i></p>

Test Summary

5.1.1 ANTENNA REQUIREMENT

RESULT: Pass

5.1.2 MAXIMUM CONDUCTED OUTPUT POWER

RESULT: Pass

5.1.3 CONDUCTED POWER SPECTRAL DENSITY

RESULT: Pass

5.1.4 6dB BANDWIDTH

RESULT: Pass

5.1.5 99% 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

Contents

1	GENERAL REMARKS	5
1.1	COMPLEMENTARY MATERIALS	5
2	TEST SITES.....	6
2.1	TEST FACILITIES.....	6
2.2	LIST OF TEST AND MEASUREMENT INSTRUMENTS	6
2.3	TRACEABILITY.....	7
2.4	CALIBRATION	7
2.5	MEASUREMENT UNCERTAINTY	7
2.6	LOCATION OF ORIGINAL DATA	7
2.7	STATUS OF FACILITY USED FOR TESTING.....	8
3	GENERAL PRODUCT INFORMATION.....	9
3.1	PRODUCT FUNCTION AND INTENDED USE.....	9
3.2	RATINGS AND SYSTEM DETAILS	9
3.3	INDEPENDENT OPERATION MODES	10
3.4	NOISE GENERATING AND NOISE SUPPRESSING PARTS.....	11
3.5	SUBMITTED DOCUMENTS.....	11
4	TEST SET-UP AND OPERATION MODES	12
4.1	PRINCIPLE OF CONFIGURATION SELECTION.....	12
4.2	TEST OPERATION AND TEST SOFTWARE.....	12
4.3	SPECIAL ACCESSORIES AND AUXILIARY EQUIPMENT.....	12
4.4	COUNTERMEASURES TO ACHIEVE EMC COMPLIANCE.....	12
4.5	TEST SETUP DIAGRAM	13
5	TEST RESULTS.....	15
5.1	TRANSMITTER REQUIREMENT & TEST SUITES.....	15
5.1.1	<i>Antenna Requirement.....</i>	<i>15</i>
5.1.2	<i>Maximum Conducted Output Power</i>	<i>16</i>
5.1.3	<i>Conducted Power Spectral Density.....</i>	<i>17</i>
5.1.4	<i>6dB Bandwidth</i>	<i>18</i>
5.1.5	<i>99% Bandwidth</i>	<i>19</i>
5.1.6	<i>Conducted Spurious Emissions Measured in 100 kHz Bandwidth</i>	<i>20</i>
5.1.7	<i>Radiated Spurious Emission.....</i>	<i>21</i>
5.1.8	<i>Conducted Emission on AC Mains.....</i>	<i>22</i>
6	PHOTOGRAPHS OF THE TEST SET-UP.....	23
7	LIST OF TABLES	23

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: Test Results.

Appendix B: Photographs of the Test Set-up.

2 Test Sites

2.1 Test Facilities

TÜV Rheinland (Shenzhen) Co., Ltd.

No.362, Huanguan Middle Road, Songyuansha Community, Guanhu Subdistrict, Longhua District, Shenzhen 518110, Guangdong, 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

Radio Spectrum Testing (SRD-Tonscend)				
Equipment	Manufacturer	Model	Serial No.	Cal. until
EXA Signal Analyzer, Multi-touch	Keysight	N9010B	MY60241175	2023-10-10
MXG X-Series RF Vector Signal Generator	Keysight	N5182B	MY61250137	2023-10-10
EXG X-Series Microwave Analog Signal Generator	Keysight	N5173B	MY61250141	2023-10-10
DC power supply	Keysight	E3642A	MY61276100	2023-10-10
Power Control Unit	Tonscend	JS0806-4ADC	N/A	2023-10-10
Automation Control Unit	Tonscend	JS0806-2	21C8060396	2023-10-10
Test Software	Tonscend	JS1120-3	N/A	N/A
Control PC	Lenovo	TianYi510S-071MB	YLX23JMF	N/A
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	2023-08-02
Signal Analyzer	R&S	FSV 40	101439	2023-08-01
System Controller Interface	R&S	SCI-100	S10010038	N/A
Filterbank	R&S	Wlan	100759	2023-08-01
OSP	R&S	OSP 120	102040	N/A
Pre-amplifier	R&S	SCU08F1	08320031	2023-08-02
Amplifier	R&S	SCU-18F	180070	2023-08-02
Amplifier	R&S	SCU40A	100475	2023-08-02
Trilog Broadband Antenna (30 MHz - 7 GHz)	Schwarzbeck	VULB 9162	193	2024-08-06
Double-Ridged Antenna (1 -18 GHz)	ETS-LINDGREN	3117	00218717	2024-08-06
Wideband Ridged Horn Antenna (18-40 GHz)	Steatite	QMS-00880	19067	2024-08-27
Active Loop Antenna	Schwarzbeck	FMZB 1513	302	2023-08-06
Test software	R&S	EMC32 (V10.60.10)	N/A	N/A

Prüfbericht - Nr.: CN23346K 002
Test Report No.:

 Seite 7 von 23
 Page 7 of 23

Control PC	Dell	OptiPlex 7050	36NV9P2	N/A
3m Semi-Anechoic Chamber	Albatross	SAC-3m	APC17151-SAC	2024-06-22

Conducted Emission				
Equipment	Manufacturer	Model	Serial No.	Cal. until
EMI Test Receiver	R&S	ESR3	102680	2024-02-23
Artificial Mains Network	R&S	ENV216	101445	2024-02-23
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.

Table 2: Measurement Uncertainty

Parameter	Uncertainty (k=2)
Occupied Channel Bandwidth	± 2.08 %
RF output power, conducted	± 0.99 dB
RF power density, conducted	± 0.99 dB
Unwanted Emissions, conducted	± 0.89 dB
All emissions, radiated	± 4.17 dB
Conducted Emission, (9kHz to 150kHz)/(150kHz to 30MHz)	± 3.70 dB / ± 3.30 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) Co., Ltd. file for certification follow-up purposes.

Prüfbericht - Nr.: CN23346K 002
Test Report No.:

Seite 8 von 23
Page 8 of 23

2.7 Status of Facility Used for Testing

The TÜV Rheinland (Shenzhen) Co., Ltd. Test facility located at No.362, Huanguan Middle Road, Songyuansha Community, Guanhu Subdistrict, Longhua District, Shenzhen 518110, Guangdong, 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 WisLink LPWAN Concentrator which supports 2.4GHz Lora and GPS receiving functions.

Data Rate	Configuration	Indicative physical bit rate [bit/sec]
0	LoRa Modulation: SF12 / Bandwidth 812 kHz	1.2k
1	LoRa Modulation: SF11 / Bandwidth 812 kHz	2.1k
2	LoRa Modulation: SF10 / Bandwidth 812 kHz	3.9k
3	LoRa Modulation: SF9 / Bandwidth 812 kHz	7.1k
4	LoRa Modulation: SF8 / Bandwidth 812 kHz	12.7k
5	LoRa Modulation: SF7 / Bandwidth 812 kHz	22.2k
6	LoRa Modulation: SF6 / Bandwidth 812 kHz	38k
7	LoRa Modulation: SF5 / Bandwidth 812 kHz	63k

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

3.2 Ratings and System Details

Table 3: Technical Specification of EUT

General Information of EUT	Value
Kind of Equipment:	WisLink LPWAN Concentrator
Type Designation:	RAK5148
FCC ID:	2AF6B-RAK5148
IC:	25908-RAK5148
HVIN:	RAK5148
Operating Voltage:	3.6 VDC Max. (Supplied by socket of debug-board that powered by USB Type-C port DC 5V)
Testing Voltage:	AC 120V, 60Hz
Technical Specification of 2.4GHz Lora	
Operating Frequency:	2403 MHz- 2479 MHz
Type of Modulation:	Chirp Spread Spectrum
Data Rate:	DR0-DR7
Channel Number:	76 channels
Occupied Bandwidth:	812 KHz
Antenna Type:	One UFL connector (Hirose U. FL-R-SMT) for externa antenna
Antenna Number:	A Rod antenna (ANT0) or an Omni antenna for (ANT1) provided by client were used for testing
Antenna Gain:	6.00 dBi (declared by client) for Rod antenna (ANT0) 8.00 dBi for (declared by client) Omni antenna for (ANT1)
The type of wideband data transmission equipment	DTS

Table 4: RF Channel and Frequency of 2.4GHz Lora

RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)
0	2403.00	20	2423.00	39	2442.00	58	2461.00
1	2404.00	21	2424.00	40	2443.00	59	2462.00
2	2405.00	22	2425.00	41	2444.00	60	2463.00
3	2406.00	23	2426.00	42	2445.00	61	2464.00
4	2407.00	24	2427.00	43	2446.00	62	2465.00
5	2408.00	25	2428.00	44	2447.00	63	2466.00
6	2409.00	26	2429.00	45	2448.00	64	2467.00
7	2410.00	27	2430.00	46	2449.00	65	2468.00
8	2411.00	28	2431.00	47	2450.00	66	2469.00
9	2412.00	29	2432.00	48	2451.00	67	2470.00
10	2413.00	30	2433.00	49	2452.00	68	2471.00
11	2414.00	31	2434.00	50	2453.00	69	2472.00
12	2415.00	32	2435.00	51	2454.00	70	2473.00
13	2416.00	33	2436.00	52	2455.00	71	2474.00
14	2417.00	34	2437.00	53	2456.00	72	2475.00
15	2418.00	35	2438.00	54	2457.00	73	2476.00
16	2419.00	36	2439.00	55	2458.00	74	2477.00
17	2420.00	37	2440.00	56	2459.00	75	2478.00
18	2421.00	38	2441.00	57	2460.00	76	2479.00
19	2422.00	/	/	/	/	/	/

3.3 Independent Operation Modes

The basic operation modes are:

A. On, Lora transmitting mode (DTS)

- 1) Low Channel
- 2) Middle Channel
- 3) High Channel

B. On, Normal Operation by 2.4G Lora + GPS

C. Off

3.4 Noise Generating and Noise Suppressing Parts

Refer to Circuit Diagram for further details.

3.5 Submitted Documents

- Application Form

- 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 RAK5148 in this report.

Remark: In this report, Full test on Omni antenna for (ANT1) and partial test on Rod antenna (ANT0).

4.3 Special Accessories and Auxiliary Equipment

Table 5: List of Accessories and Auxiliary Equipment

Description	Manufacturer	Model	S/N	Rating
Laptop	Lenovo	T480	PF-16A6N8	N/A
Portable Laptop	Lenovo	ThinkPad T480	10Q67059	N/A
Power Supply	RISUNIC	RA040-0503000EU	N/A	DC 5V/3A, 15W
Rod Antenna	RAK	RAKARX21	N/A	Peak Gain: 6dBi
Omni Antenna	RAK	RAKARW02	N/A	Peak Gain: 8dBi

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

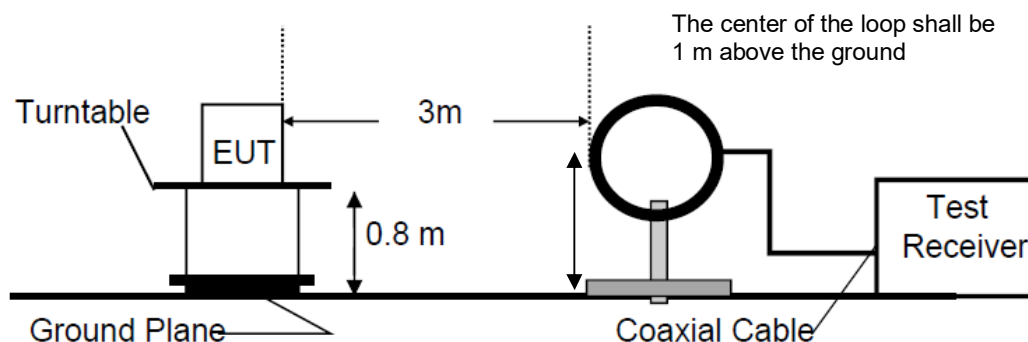
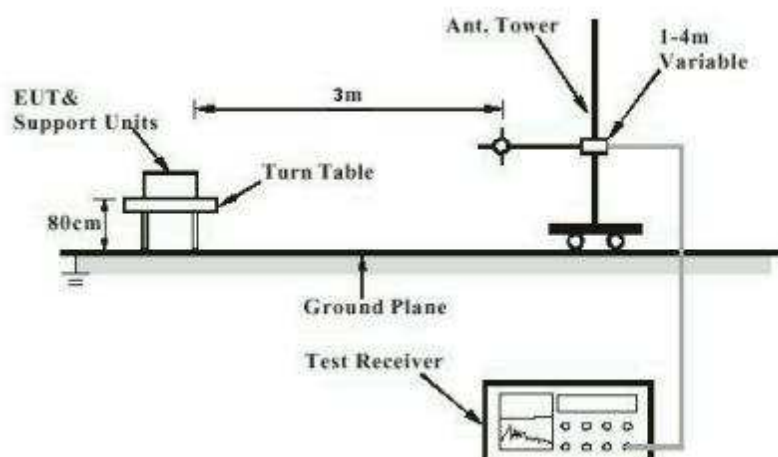
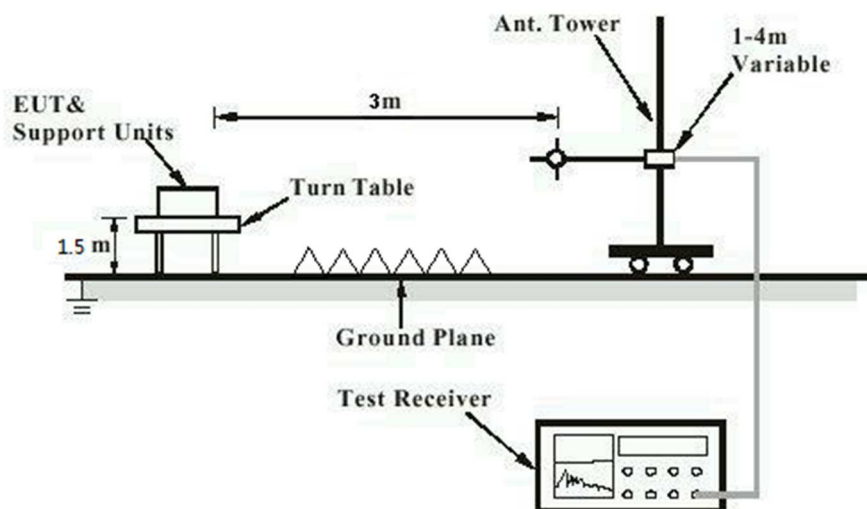
Diagram of Measurement Configuration for Radiation Test (Below 30MHz)

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

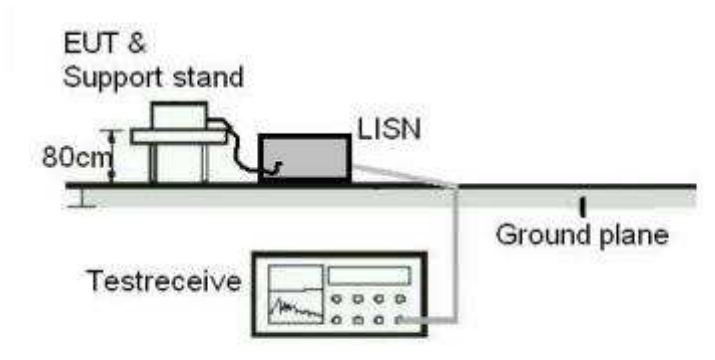
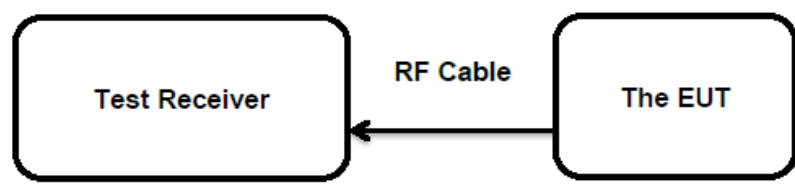


Diagram of Measurement Configuration for Conducted Transmitter Measurement



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 have Rod antenna & Omni antenna, the maximum directional gain of antenna is 6.00 dBi for ANT0 & 8.00 dBi for ANT1, and the antenna connector is designed with permanent attachment and no consideration of replacement.

Therefore the EUT is considered sufficient to comply with the provision.

Refer to EUT Photo for further details.

5.1.2 Maximum Conducted Output Power

RESULT:
Pass
Test Specification

Test standard	:	FCC Part 15.247(b)(2)&(3) RSS-247 Clause 5.4(a)&(d)
Basic standard	:	ANSI C63.10: 2013
Limits	:	< 1.0 W (30 dBm) for antenna gain less than 6dBi
Kind of test site	:	Shielded Room

Test Setup

Date of testing	:	2023-07-17 to 2023-07-18
Input voltage	:	AC 120V, 60Hz
Operation mode	:	A
Test channel	:	Low / Middle / High
Ambient temperature	:	25.1 °C
Relative humidity	:	43 %
Atmospheric pressure	:	101 kPa

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

Test Mode	Test Channel (MHz)	Measured Conducted Power		Limit
		(dBm)	(W)	
Lora DTS	2403	17.28	0.0535	< 1.0 W
	2425	17.31	0.0538	
	2479	17.97	0.0627	
Max. Measured Value		17.97	0.0627	

Note:

- 1) The cable loss is taken into account in results.
- 2) Antenna gain(G) : 2.0 dBi,
Maximum e.i.r.p.=17.97 + 8.0 =25.97dBm = 0.3954W, 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), FCC Part 15.247(f)
 RSS-247 Clause 5.2(b), RSS-247 Clause 5.3
 Basic standard : ANSI C63.10: 2013
 Limits : < 8 dBm / 3kHz for antenna gain less than 6dBi
 Kind of test site : Shielded Room

Test Setup

Date of testing : 2023-07-17
 Input voltage : AC 120V, 60Hz
 Operation mode : A
 Test channel : Low / Middle / High
 Ambient temperature : 25.1 °C
 Relative humidity : 43 %
 Atmospheric pressure : 101 kPa

Table 7: Test Result of Maximum Power Spectral Density, Lora DTS

Test Mode	Test Channel (MHz)	Measured Power Spectral Density (dBm/3KHz)
Lora DTS	2403	6.91
	2425	6.64
	2479	5.27
Maximum Measured Value		6.91

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	: 2023-07-17
Input voltage	: AC 120V, 60Hz
Operation mode	: A
Test channel	: Low / Middle / High
Ambient temperature	: 25.1 °C
Relative humidity	: 43 %
Atmospheric pressure	: 101 kPa

For the measurement records, refer to the appendix A.

Table 8: Test Result of 6dB Bandwidth, Lora DTS

Test Mode	Test Channel (MHz)	6dB Bandwidth (MHz)	Limit (MHz)
Lora DTS	2403	1.748	>500KHz
	2425	1.756	
	2479	1.760	
Minimum Measured Value		1.760	

5.1.5 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 : 2023-07-17
 Input voltage : AC 120V, 60Hz
 Operation mode : A
 Test channel : Low / Middle / High
 Ambient temperature : 25.1 °C
 Relative humidity : 43 %
 Atmospheric pressure : 101 kPa

For the measurement records, refer to the appendix A.

Table 9: Test Result of 99% Bandwidth, Lora DTS

Test Mode	Test Channel (MHz)	99% Bandwidth (MHz)	Limit (MHz)
Lora DTS	2403	1.654	/
	2425	1.649	
	2479	1.658	
Minimum Measured Value		1.658	

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	: 2023-07-17
Input voltage	: AC 120V, 60Hz
Operation mode	: A
Test channel	: Low / Middle / High
Ambient temperature	: 25.1 °C
Relative humidity	: 43 %
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 A.

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
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	:	2023-06-21 to 2023-06-23
Input voltage	:	AC 120V, 60Hz
Operation mode	:	A
Test channel	:	Low / Middle / High
Ambient temperature	:	Refer to test results
Relative humidity	:	Refer to test results
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 A.

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 3
Kind of test site	:	Shielded Room

Test Setup

Date of testing	:	2023-07-27
Input voltage	:	AC 120V, 60Hz
Operation mode	:	B
Earthing	:	Not connected
Ambient temperature	:	24.6 °C
Relative humidity	:	50.6 %
Atmospheric pressure	:	101 kPa

For the measurement records, refer to the appendix A.

6 Photographs of the Test Set-Up

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

7 List of Tables

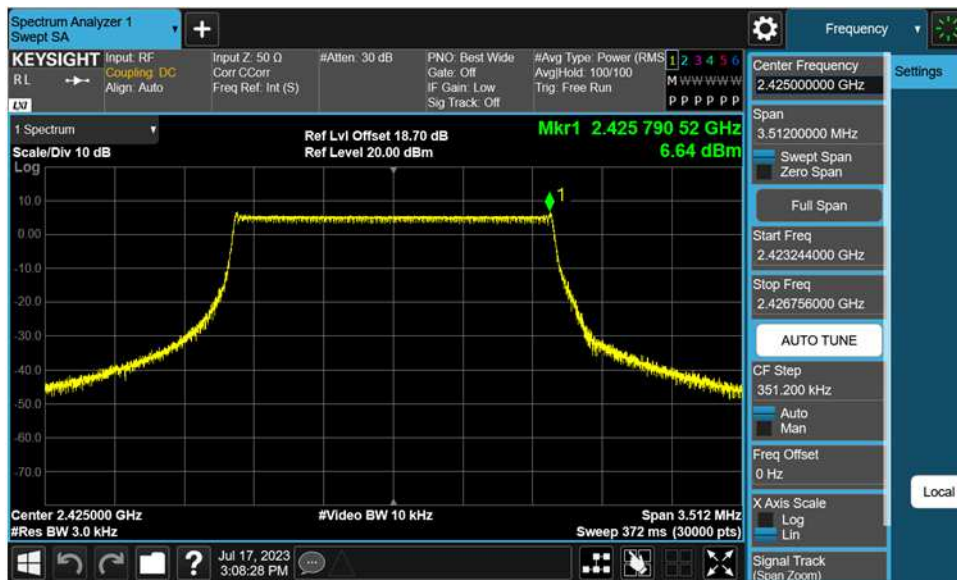
Table 1: List of Test and Measurement Equipment.....	6
Table 2: Measurement Uncertainty.....	7
Table 3: Technical Specification of EUT.....	9
Table 4: RF Channel and Frequency of 2.4GHz Lora.....	10
Table 5: List of Accessories and Auxiliary Equipment.....	12
Table 6: Test Result of Maximum Conducted Output Power, Lora DTS.....	16
Table 7: Test Result of Maximum Power Spectral Density, Lora DTS.....	17
Table 8: Test Result of 6dB Bandwidth, Lora DTS.....	18
Table 9: Test Result of 99% Bandwidth, Lora DTS.....	19

Appendix A: Test Results

APPENDIX A: TEST RESULTS	1
APPENDIX A.1: TEST RESULTS OF CONDUCTED POWER SPECTRAL DENSITY	2
APPENDIX A.2: TEST RESULTS OF 6dB BANDWIDTH	4
APPENDIX A.3: TEST RESULTS OF 99% BANDWIDTH.....	6
APPENDIX A.4: TEST RESULTS OF CONDUCTED SPURIOUS EMISSIONS MEASURED IN 100 KHz BANDWIDTH	8
APPENDIX A.5: TEST RESULTS OF RADIATED SPURIOUS EMISSIONS.....	14
30 MHz to 1GHz, SISO ANT1.....	14
1GHz-18GHz, SISO ANT1.....	16
30 MHz to 1GHz, SISO ANT0.....	28
1GHz-18GHz, SISO ANT0.....	30
APPENDIX A.6: TEST RESULTS OF RADIATED EMISSIONS IN RESTRICTED BANDS.....	38
SISO ANT1.....	38
SISO ANT0.....	42
APPENDIX A.7: TEST RESULTS OF CONDUCTED EMISSION ON AC MAINS.....	46

Appendix A.1: Test Results of Conducted Power Spectral Density

TestMode	Channel	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
2.4GHz Lora	2403	6.81	≤8.00	PASS
	2425	6.64	≤8.00	PASS
	2479	5.27	≤8.00	PASS





Appendix A.2: Test Results of 6dB Bandwidth

TestMode	Channel	DTS BW [MHz]	Limit[MHz]	Verdict
2.4GHz Lora	2403	1.748	0.5	PASS
	2425	1.756	0.5	PASS
	2479	1.750	0.5	PASS





Appendix A.3: Test Results of 99% Bandwidth

TestMode	Channel	OCB [MHz]	Limit[MHz]	Verdict
2.4GHz Lora	2403	1.654	---	PASS
	2425	1.649	---	PASS
	2479	1.658	---	PASS





Appendix A.4: Test Results of Conducted Spurious Emissions Measured in 100 kHz Bandwidth

Low Channel:





Middle Channel:





High Channel:





Band Edge, Low Channel:



Band Edge, High Channel:



Appendix A.5: Test Results of Radiated Spurious Emissions

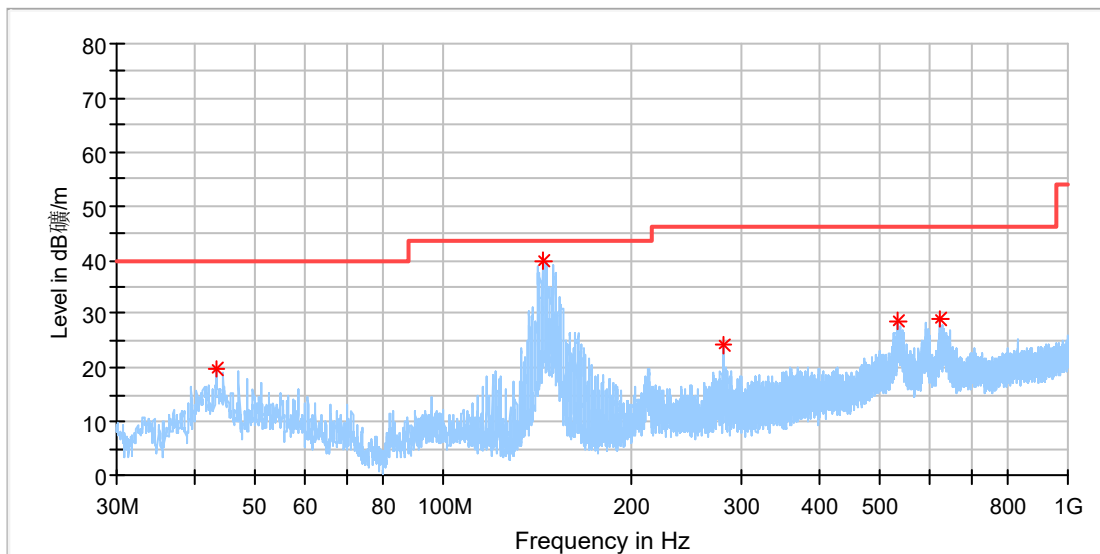
Note:

- 1) This testing was carried out on different modulations, but only the worst case was presented in this report.
- 2) Testing was carried out within frequency range 9kHz to the tenth harmonics. The measurement results below 30MHz and 18GHz - 26.5GHz were greater than 20dB below the limit, so only the radiated spurious emissions from 30MHz to 18GHz were reported.

30 MHz to 1GHz, SISO ANT1

EUT Information

EUT Name:	WisLink LPWAN Concentrator
Model:	RAK5148
Test Mode:	Mid channel
Order No/Sample No:	168430355/A003497290-016
Test Voltage:	120V/60Hz
Remark:	Temp 24 Humi:50%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical Freqs

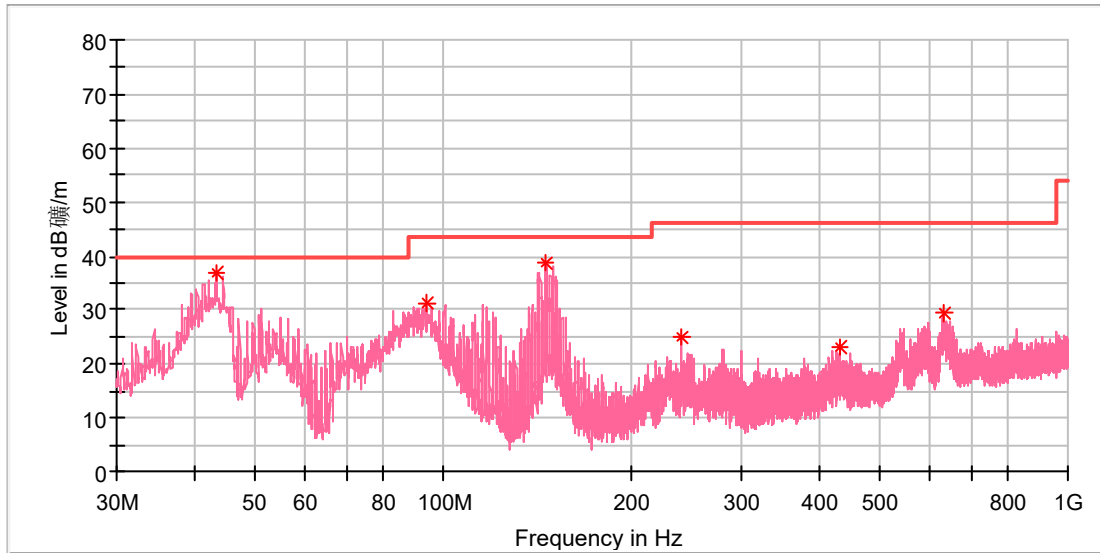
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
43.356154	19.55	40.00	20.45	100.0	H	139.0	-19.5
144.124231	39.91	43.50	3.59	100.0	H	0.0	-22.6
280.297308	24.15	46.00	21.85	100.0	H	244.0	-17.1
533.019615	28.51	46.00	17.49	100.0	H	131.0	-11.6
623.602692	28.94	46.00	17.06	100.0	H	287.0	-9.8

Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: Mid channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 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)
43.356154	36.68	40.00	3.32	100.0	V	172.0	-19.5
94.355769	31.28	43.50	12.22	100.0	V	165.0	-20.2
145.579231	38.76	43.50	4.74	100.0	V	319.0	-22.6
240.005000	24.89	46.00	21.11	100.0	V	7.0	-18.0
429.863846	22.94	46.00	23.06	100.0	V	39.0	-13.6
632.258077	29.36	46.00	16.64	100.0	V	328.0	-9.7

Final Result

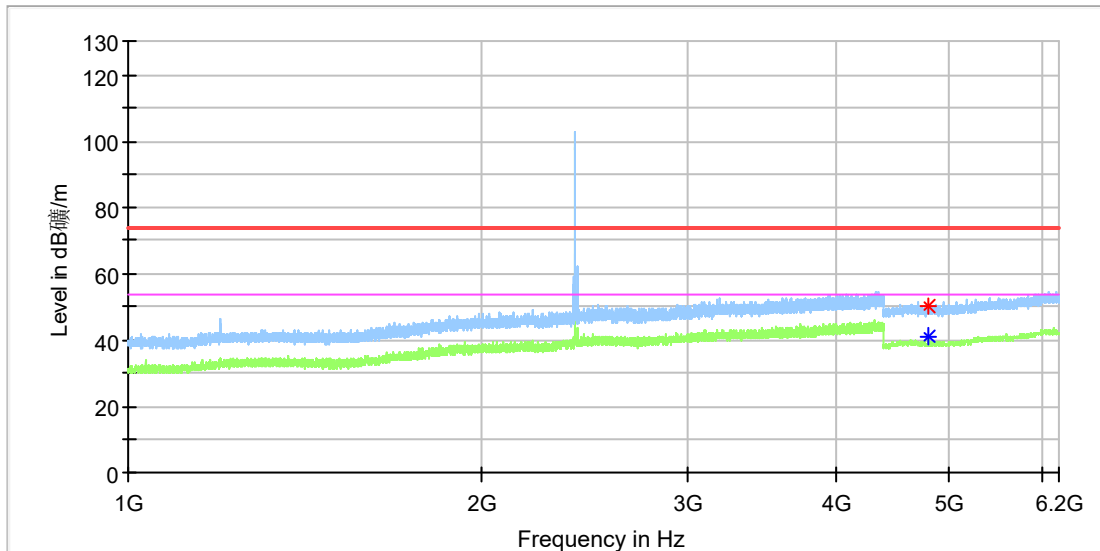
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

1GHz-18GHz, SISO ANT1

Note: The highest waveform in the figure is 2.4G Lora Fundamental.

EUT Information

EUT Name:	WisLink LPWAN Concentrator
Model:	RAK5148
Test Mode:	Low channel
Order No/Sample No:	168430355/A003497290-016
Test Voltage:	120V/60Hz
Remark:	Temp 24 Humi:50%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical Freqs

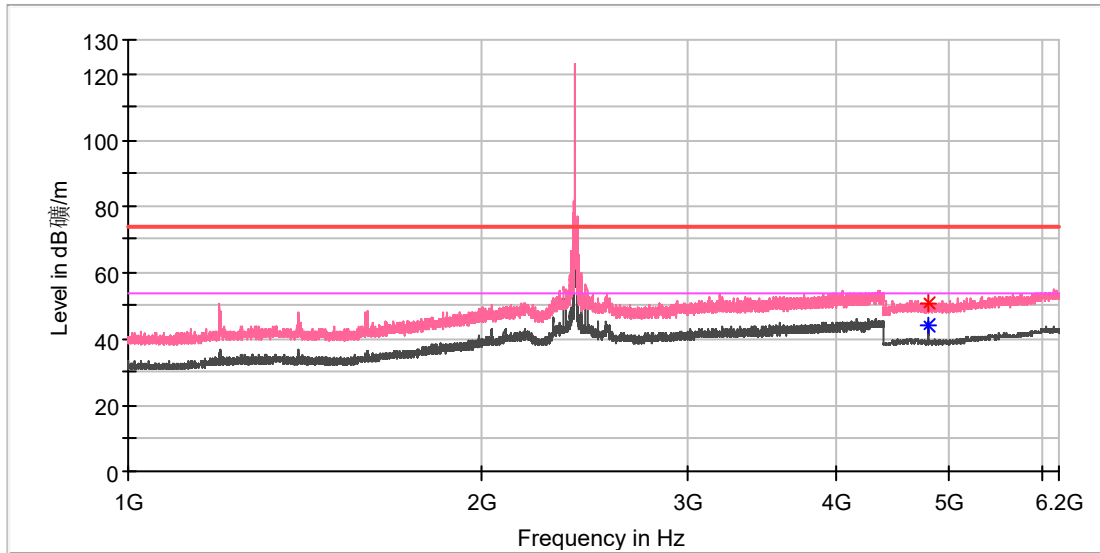
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4804.500000	---	41.37	54.00	12.63	100.0	H	152.0	11.8
4806.000000	50.32	---	74.00	23.68	100.0	H	181.0	11.8

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: Low channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 Test Standard: FCC 15.247
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical Freqs

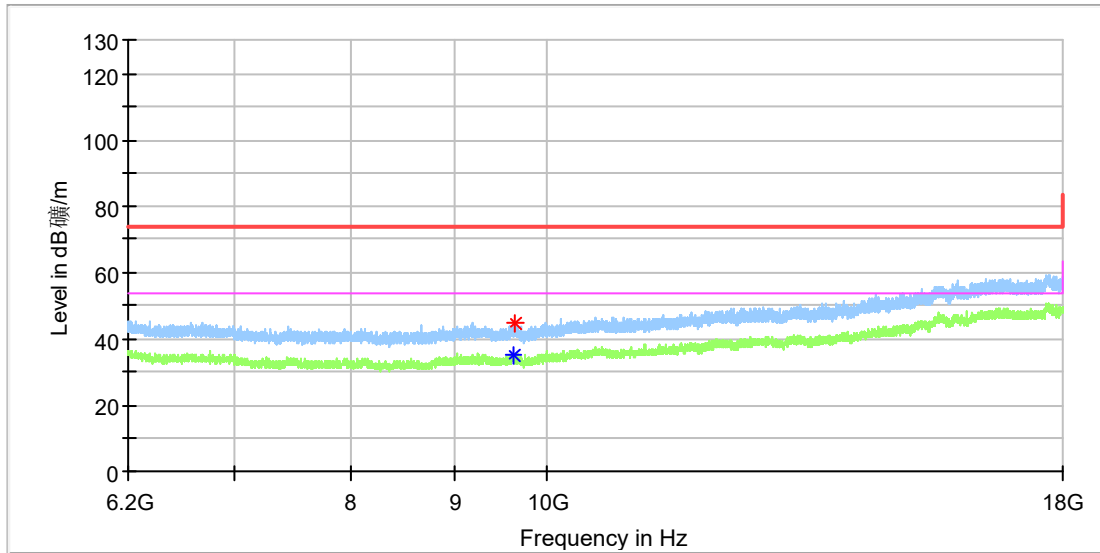
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4801.500000	50.90	---	74.00	23.10	100.0	V	144.0	11.8
4805.500000	---	44.15	54.00	9.85	100.0	V	235.0	11.8

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: Low channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 Test Standard: FCC 15.247
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical Freqs

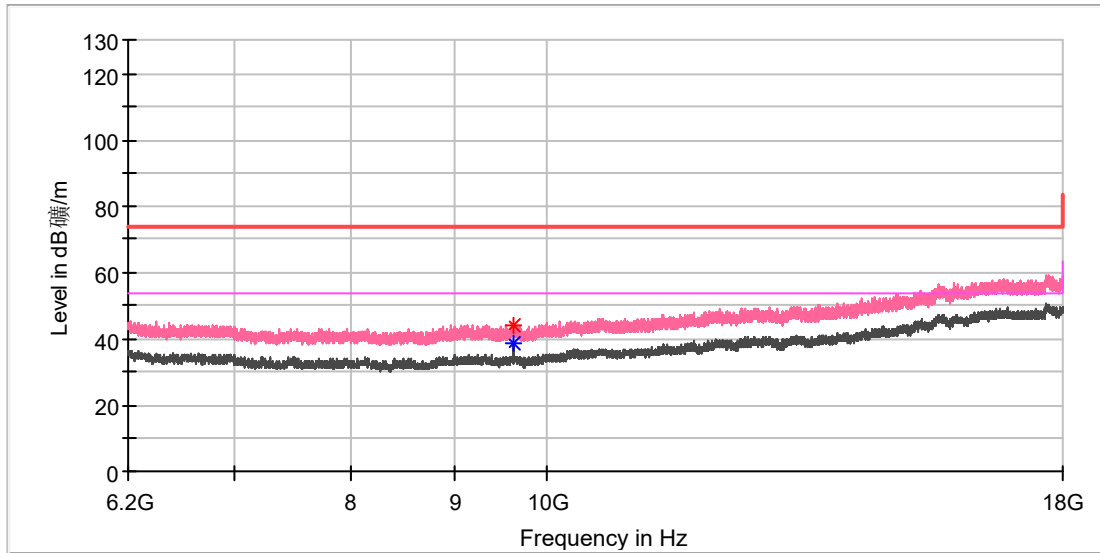
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9624.950000	---	35.28	54.00	18.72	100.0	H	328.0	10.4
9640.191667	44.51	---	74.00	29.49	100.0	H	0.0	10.4

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: Low channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 Test Standard: FCC 15.247
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical Freqs

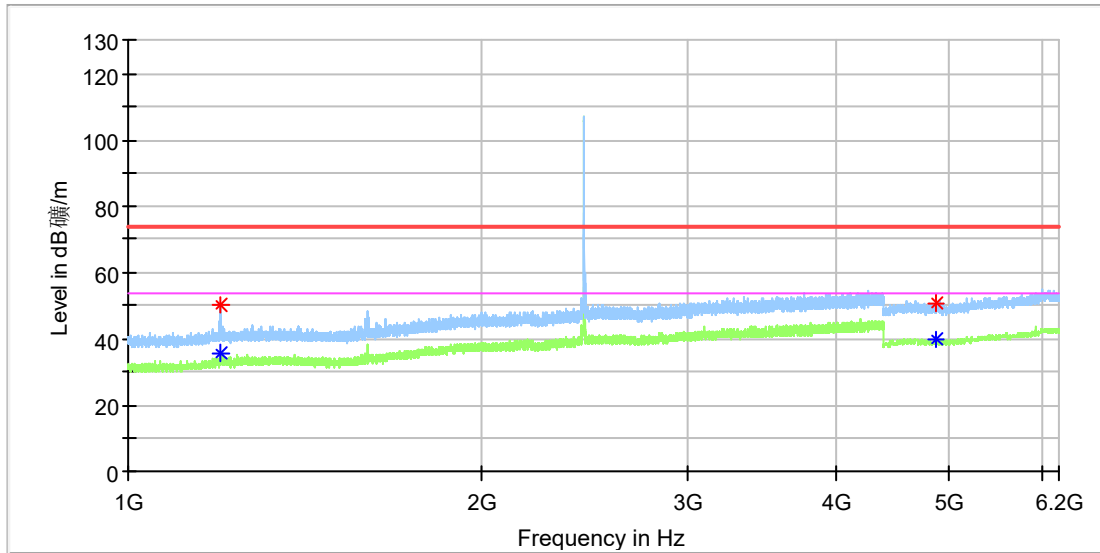
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9609.708333	---	38.44	54.00	15.56	100.0	V	355.0	10.4
9612.658333	44.13	---	74.00	29.87	100.0	V	341.0	10.4

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: Mid channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 Test Standard: FCC 15.247
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical Freqs

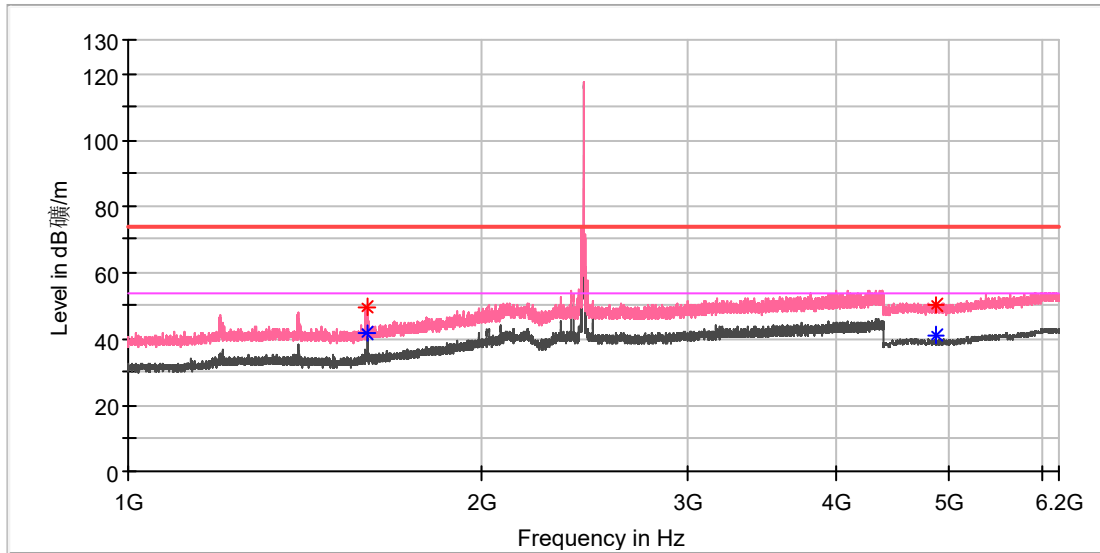
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1198.900000	---	35.93	54.00	18.07	100.0	H	51.0	1.1
1199.750000	50.15	---	74.00	23.85	100.0	H	51.0	1.1
4871.000000	50.84	---	74.00	23.16	100.0	H	215.0	11.8
4880.500000	---	39.98	54.00	14.02	100.0	H	178.0	11.8

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: Mid channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 Test Standard: FCC 15.247
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical Freqs

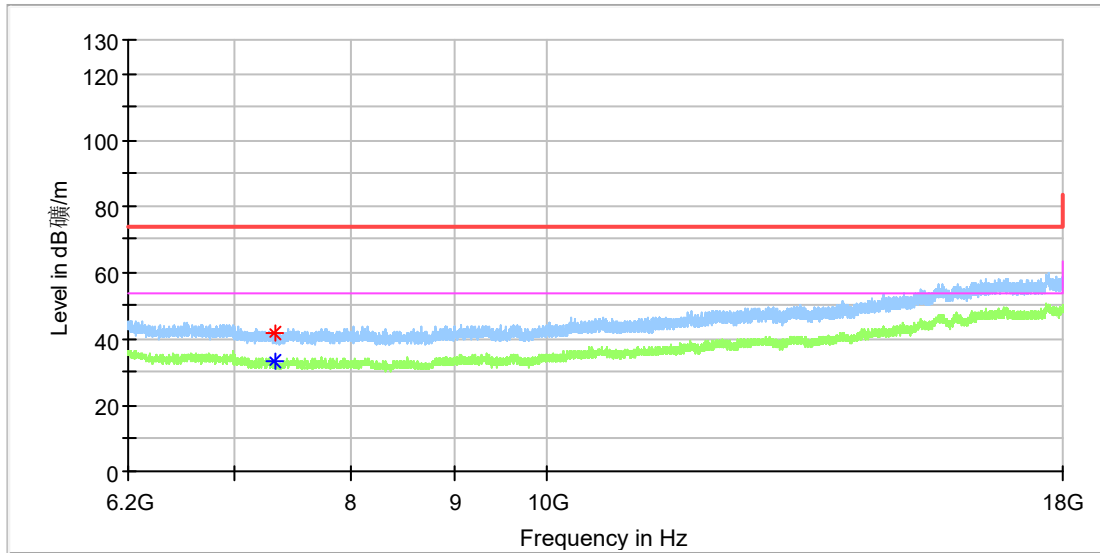
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1599.420000	49.74	---	74.00	24.26	100.0	V	68.0	2.1
1599.590000	---	41.60	54.00	12.40	100.0	V	343.0	2.1
4872.500000	49.98	---	74.00	24.02	100.0	V	254.0	11.8
4881.000000	---	40.85	54.00	13.15	100.0	V	300.0	11.8

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: Mid channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 Test Standard: FCC 15.247
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical Freqs

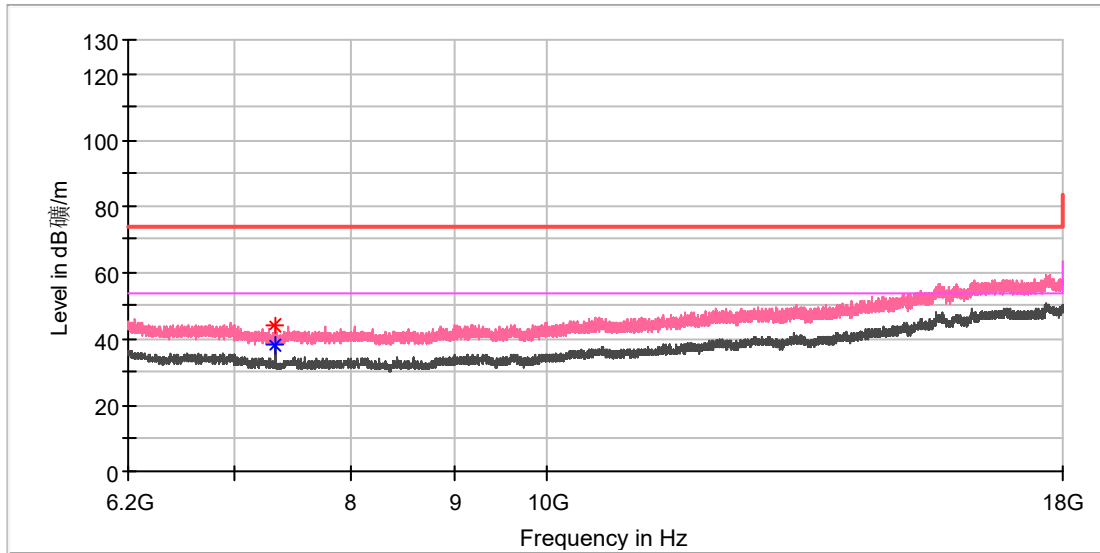
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7321.000000	41.69	---	74.00	32.31	100.0	H	1.0	8.2
7330.833333	---	33.31	54.00	20.69	100.0	H	168.0	8.1

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: Mid channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 Test Standard: FCC 15.247
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical Freqs

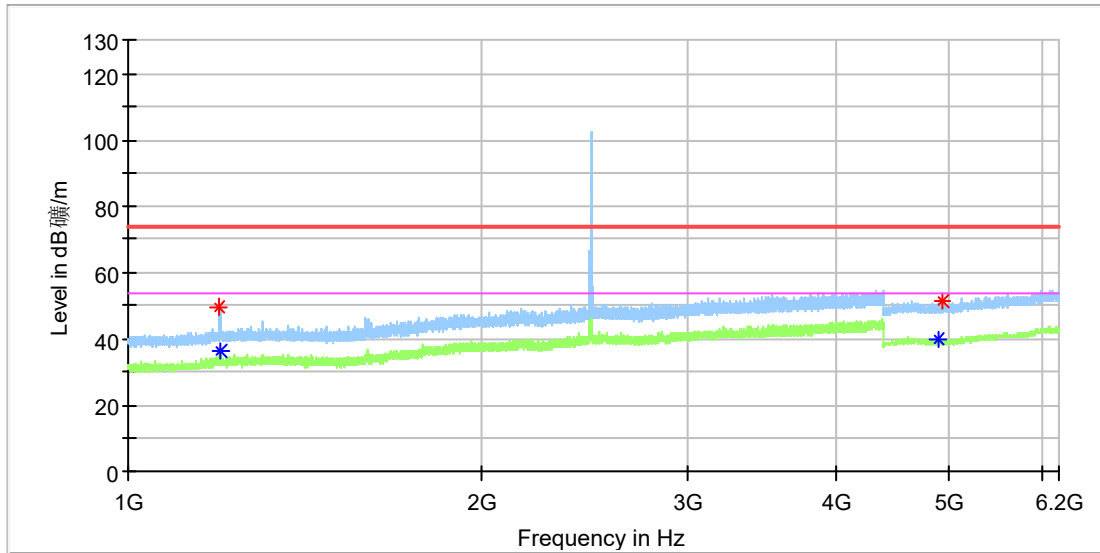
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7321.491667	44.34	---	74.00	29.66	100.0	V	215.0	8.2
7321.491667	---	38.08	54.00	15.92	100.0	V	215.0	8.2

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: High channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 Test Standard: FCC 15.247
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical Freqs

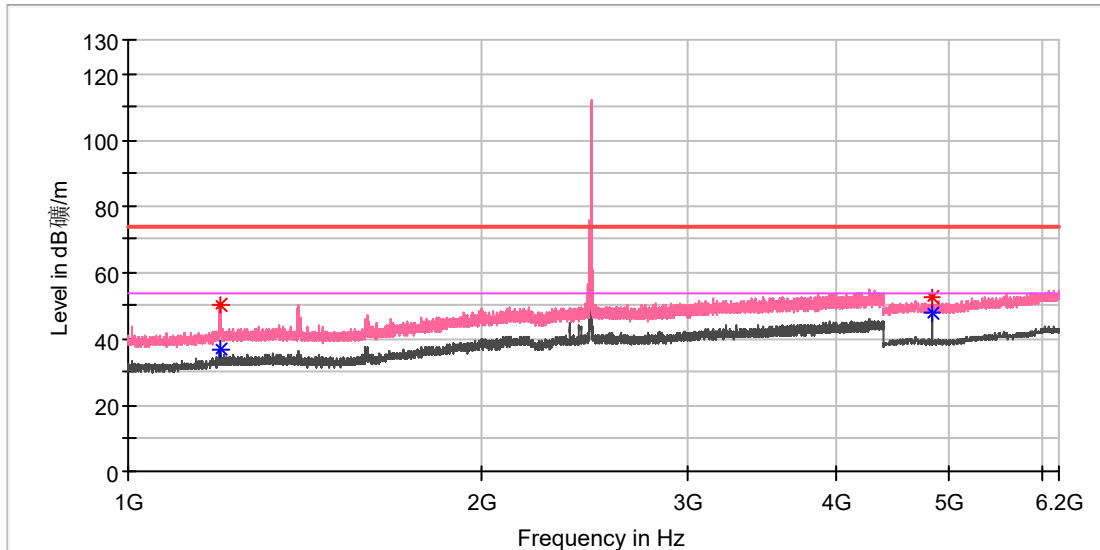
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1195.500000	49.42	---	74.00	24.58	100.0	H	74.0	1.1
1198.900000	---	36.58	54.00	17.42	100.0	H	74.0	1.1
4905.000000	---	39.68	54.00	14.32	100.0	H	245.0	11.8
4940.000000	51.62	---	74.00	22.38	100.0	H	21.0	11.8

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: High channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 Test Standard: FCC 15.247
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical Freqs

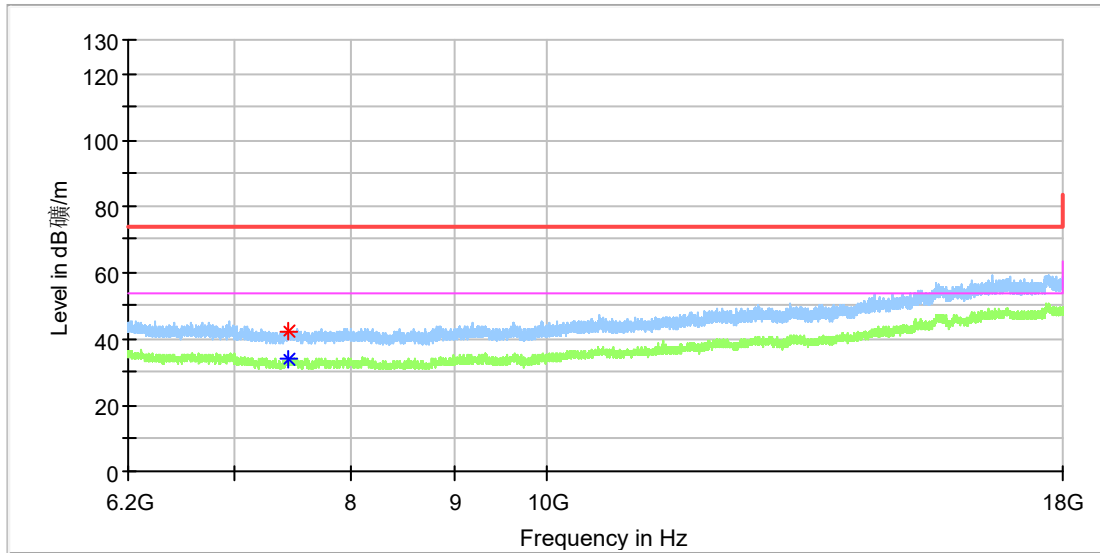
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1197.030000	49.91	---	74.00	24.09	100.0	V	61.0	1.1
1197.880000	---	37.12	54.00	16.88	100.0	V	61.0	1.1
4843.500000	52.61	---	74.00	21.39	100.0	V	209.0	11.8
4844.000000	---	47.50	54.00	6.50	100.0	V	209.0	11.8

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: High channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 Test Standard: FCC 15.247
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical Freqs

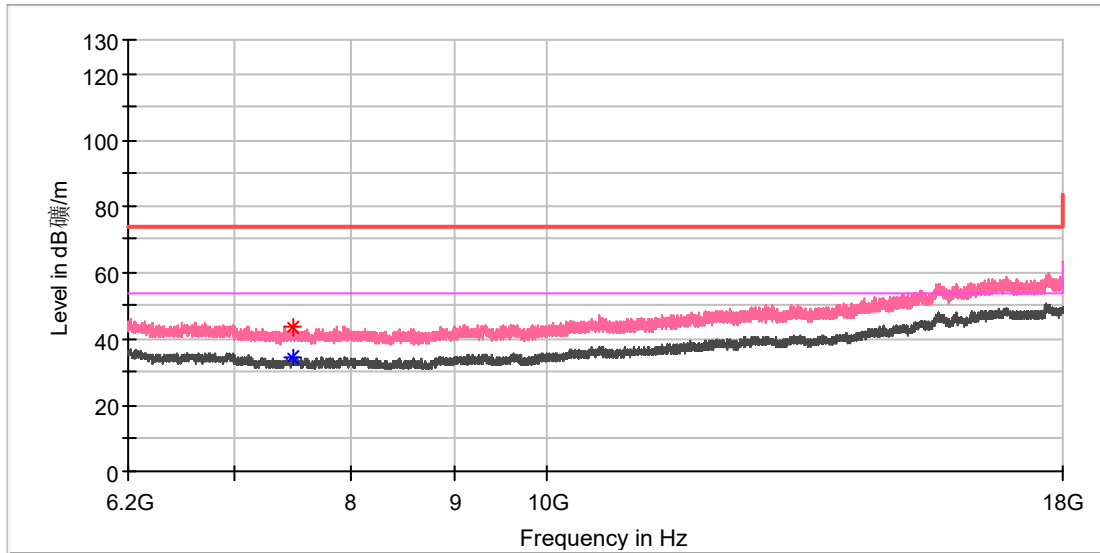
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7443.425000	42.04	---	74.00	31.96	100.0	H	99.0	8.5
7449.816667	---	33.86	54.00	20.14	100.0	H	268.0	8.5

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: High channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 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)
7474.400000	---	34.21	54.00	19.79	100.0	V	230.0	8.6
7474.400000	43.61	---	74.00	30.39	100.0	V	230.0	8.6

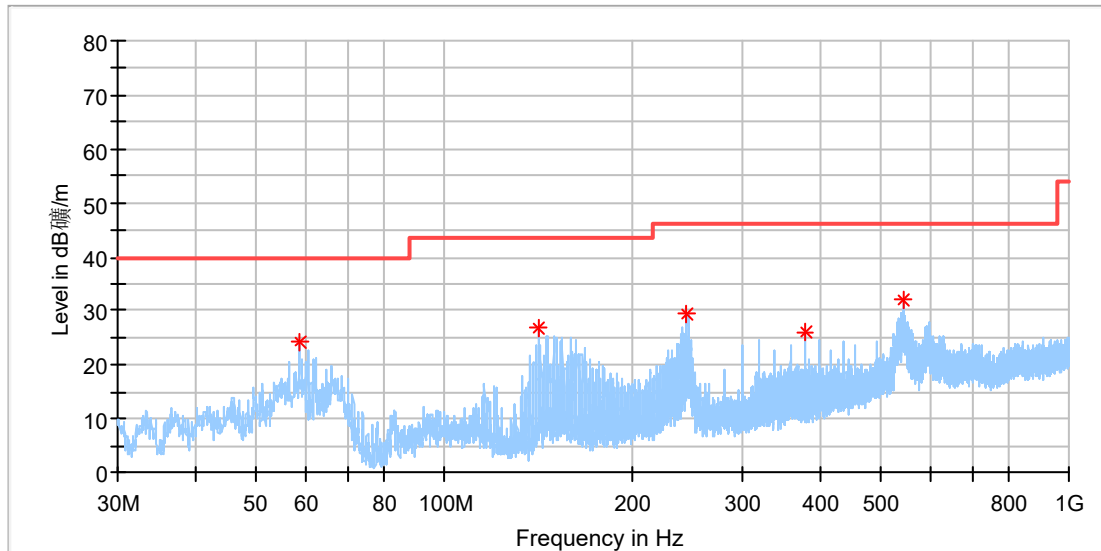
Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

30 MHz to 1GHz, SISO ANT0

EUT Information

EUT Name:	WisLink LPWAN Concentrator
Model:	RAK5148
Test Mode:	Low channel
Order No/Sample No:	168430355/A003497290-016
Test Voltage:	120V/60Hz
Remark:	Temp 24 Humi:50%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical Freqs

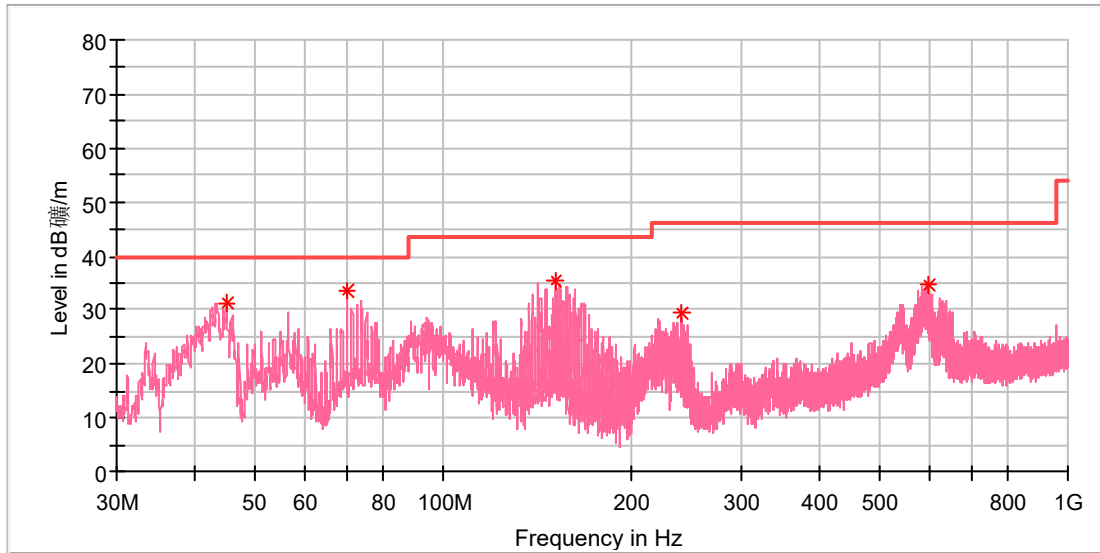
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
58.615000	24.04	40.00	15.96	100.0	H	0.0	-19.1
141.475385	26.62	43.50	16.88	100.0	H	260.0	-22.6
243.922308	29.25	46.00	16.75	100.0	H	355.0	-17.9
376.998846	26.04	46.00	19.96	100.0	H	0.0	-14.6
540.518462	32.14	46.00	13.86	100.0	H	110.0	-11.4

Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: Low channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 Test Standard: FCC 15.247
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical Freqs

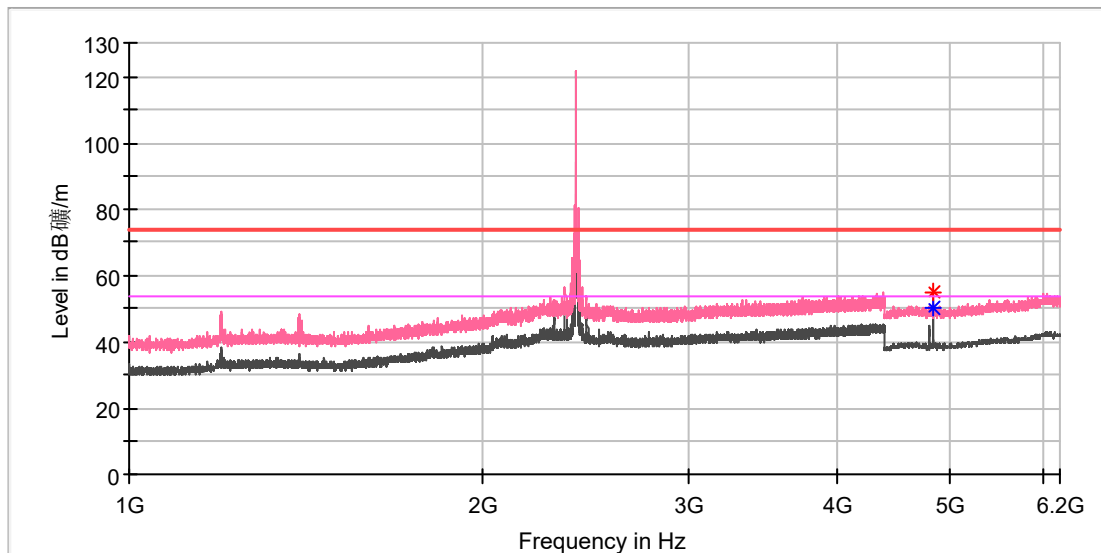
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
45.072308	31.14	40.00	8.86	100.0	V	112.0	-19.1
70.105769	33.46	40.00	6.54	100.0	V	137.0	-22.2
151.026154	35.23	43.50	8.27	100.0	V	186.0	-22.5
240.005000	29.23	46.00	16.77	100.0	V	105.0	-18.0
594.316154	34.76	46.00	11.24	100.0	V	89.0	-10.3

Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name:	WisLink LPWAN Concentrator
Model:	RAK5148
Test Mode:	Low channel
Order No/Sample No:	168430355/A003497290-016
Test Voltage:	120V/60Hz
Remark:	Temp 24 Humi:50%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical Freqs

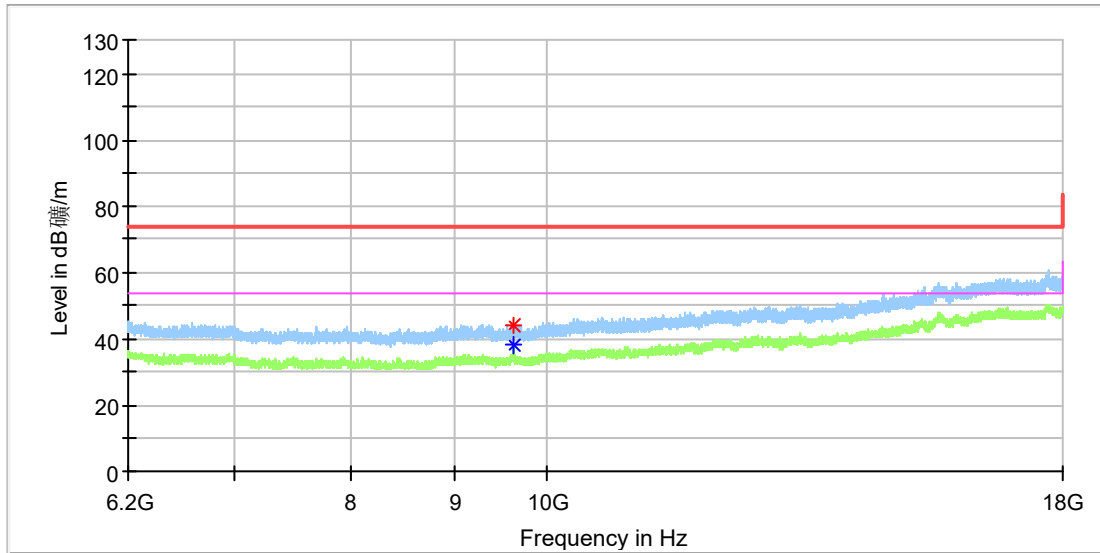
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4843.500000	---	50.46	54.00	3.54	100.0	V	355.0	11.8
4844.000000	54.93	---	74.00	19.07	100.0	V	355.0	11.8

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: Low channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 Test Standard: FCC 15.247
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical Freqs

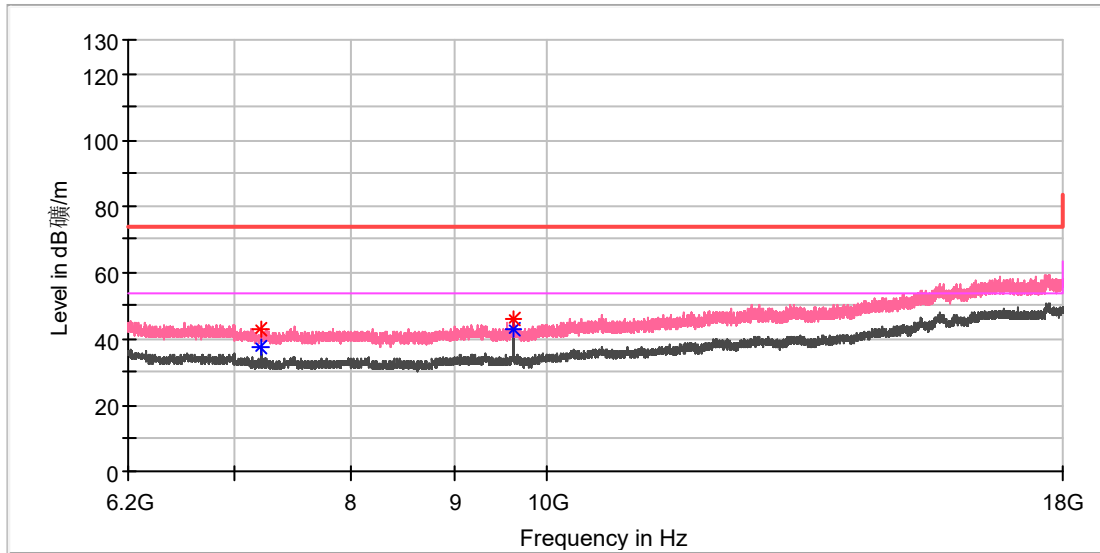
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9614.625000	44.32	---	74.00	29.68	100.0	H	0.0	10.4
9614.625000	---	38.22	54.00	15.78	100.0	H	0.0	10.4

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: Low channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 Test Standard: FCC 15.247
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical Freqs

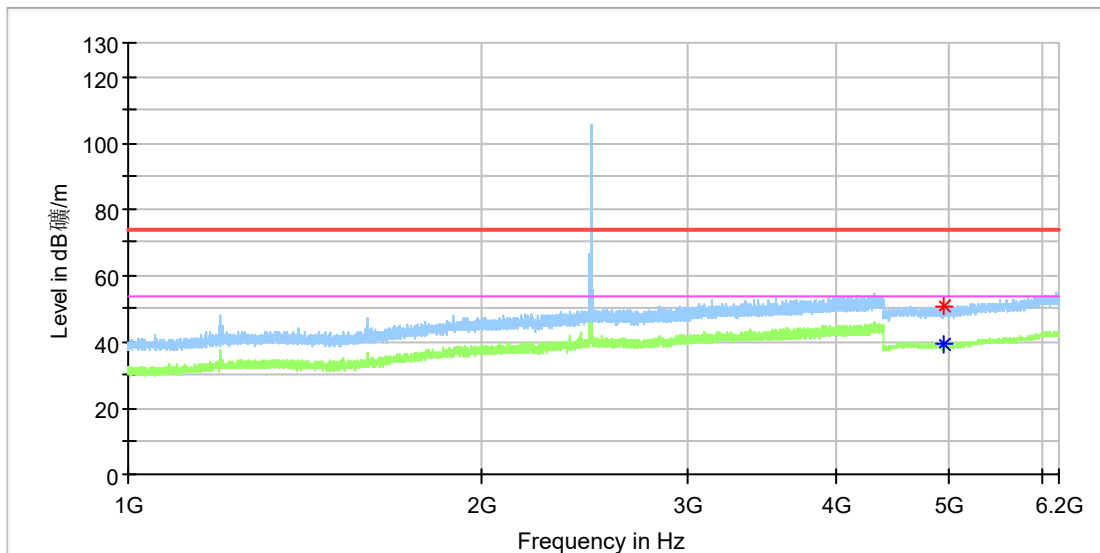
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7210.866667	42.96	---	74.00	31.04	100.0	V	45.0	8.7
7210.866667	---	37.64	54.00	16.36	100.0	V	45.0	8.7
9609.216667	---	42.90	54.00	11.10	100.0	V	33.0	10.4
9611.675000	45.86	---	74.00	28.14	100.0	V	18.0	10.4

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: High channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 Test Standard: FCC 15.247
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical Freqs

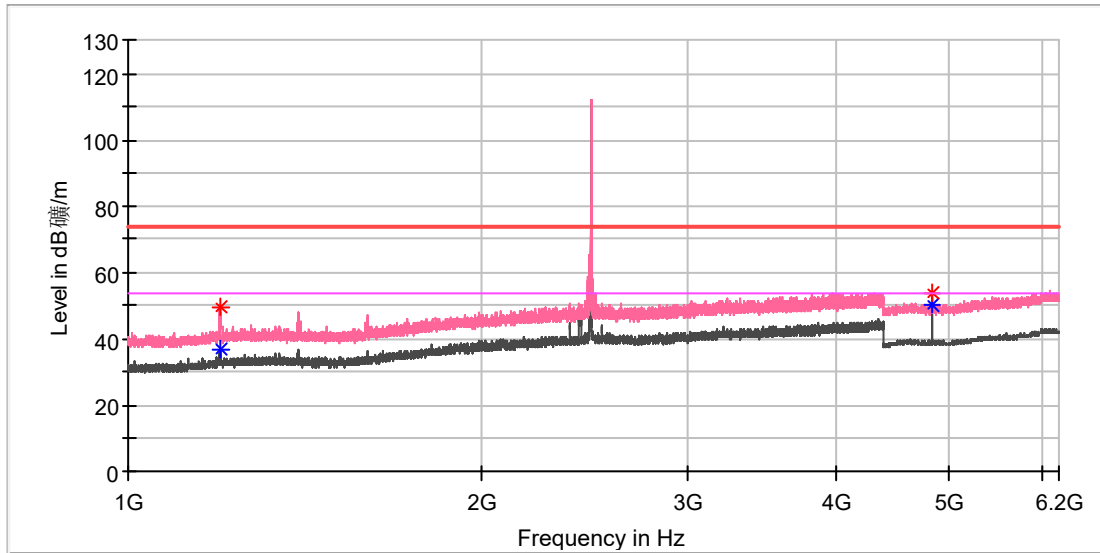
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4951.000000	50.70	---	74.00	23.30	100.0	H	308.0	11.8
4953.500000	---	39.21	54.00	14.79	100.0	H	308.0	11.8

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: High channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 Test Standard: FCC 15.247
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical Freqs

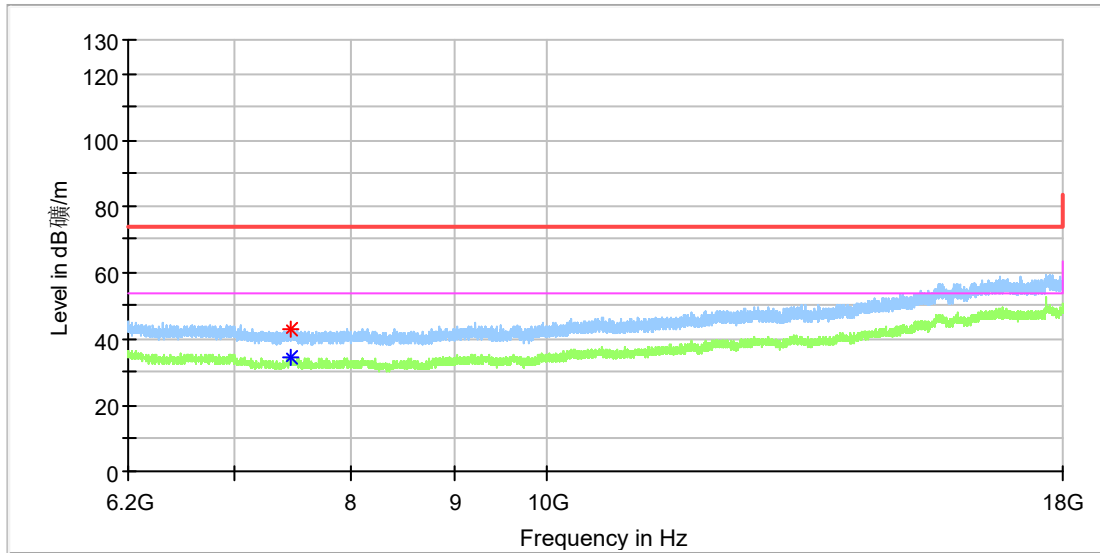
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1199.410000	49.31	---	74.00	24.69	100.0	V	97.0	1.1
1199.410000	---	36.66	54.00	17.34	100.0	V	97.0	1.1
4844.000000	53.98	---	74.00	20.02	100.0	V	24.0	11.8
4844.000000	---	50.39	54.00	3.61	100.0	V	24.0	11.8

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: High channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 Test Standard: FCC 15.247
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical Freqs

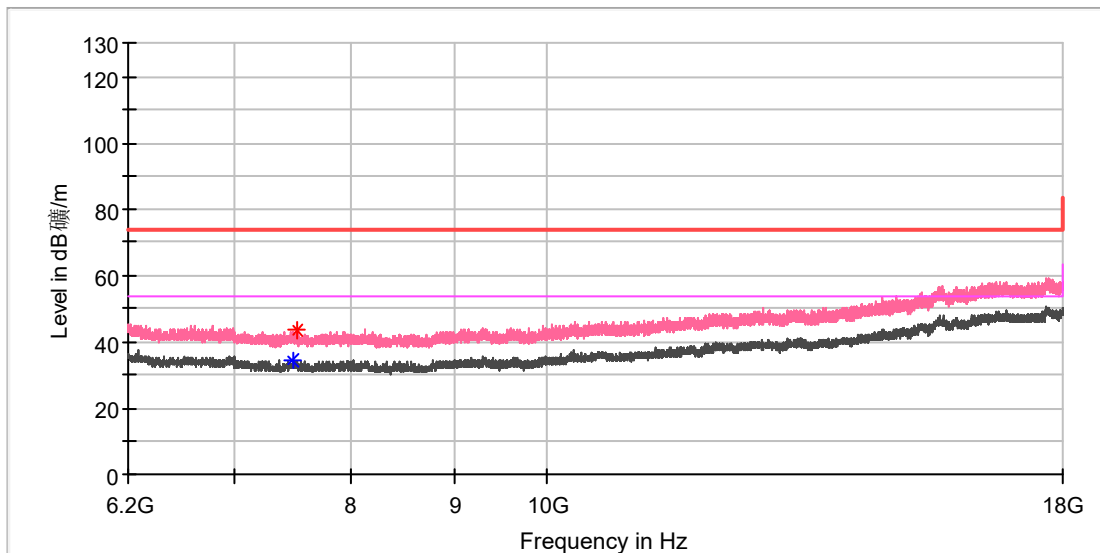
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7460.633333	---	34.23	54.00	19.77	100.0	H	240.0	8.5
7462.600000	43.23	---	74.00	30.77	100.0	H	103.0	8.6

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: High channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 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)
7477.350000	---	34.17	54.00	19.83	100.0	V	14.0	8.6
7507.341667	43.31	---	74.00	30.69	100.0	V	62.0	8.7

Final Result

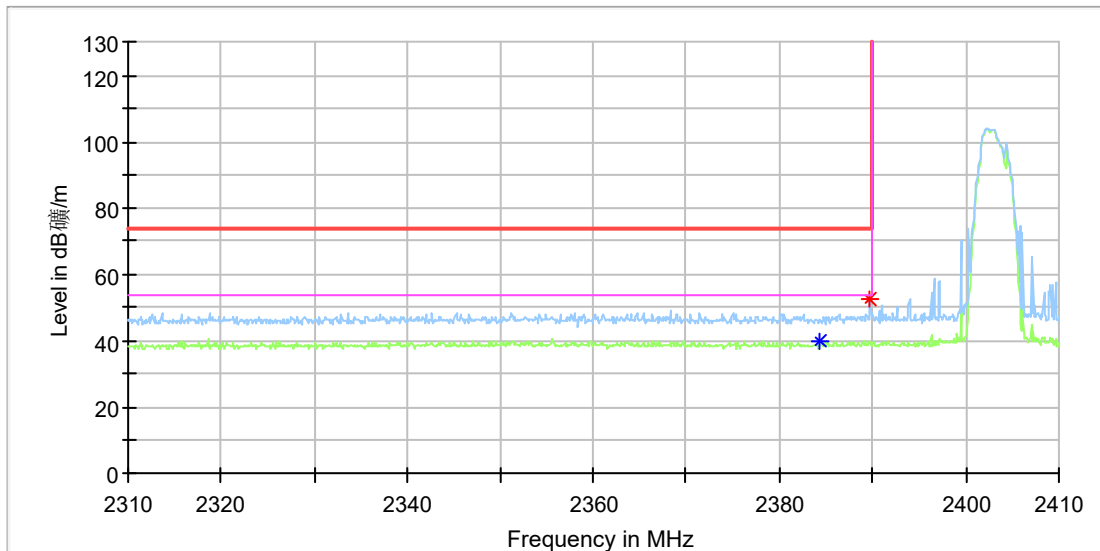
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

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

SISO ANT1

EUT Information

EUT Name:	WisLink LPWAN Concentrator
Model:	RAK5148
Test Mode:	Low channel
Order No/Sample No:	168430355/A003497290-016
Test Voltage:	120V/60Hz
Remark:	Temp 24 Humi:50%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical Freqs

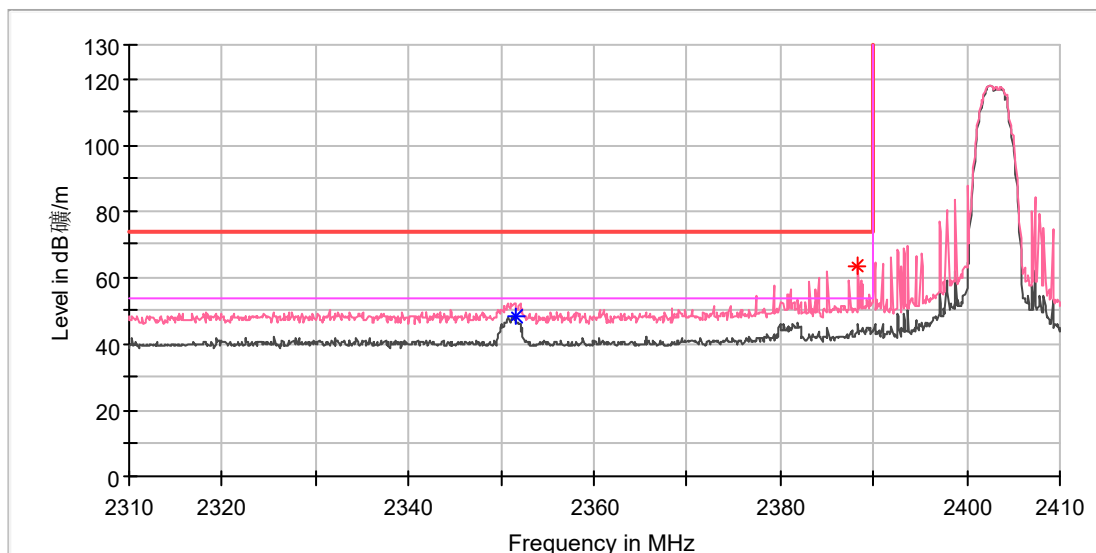
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2384.400000	---	40.05	54.00	13.95	100.0	H	91.0	7.0
2389.800000	52.73	---	74.00	21.27	100.0	H	334.0	7.0

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Model: RAK5148
 Test Mode: Low channel
 Order No/Sample No: 168430355/A003497290-016
 Test Voltage: 120V/60Hz
 Remark: Temp 24 Humi:50%
 Test Standard: FCC 15.247
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical Freqs

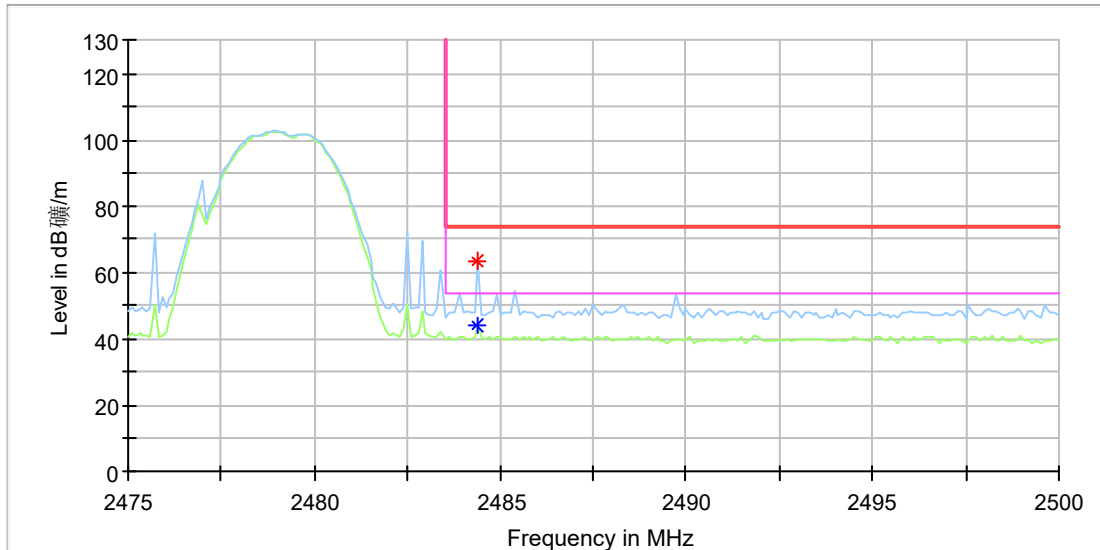
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2351.600000	---	48.49	54.00	5.51	100.0	V	328.0	6.9
2388.300000	63.72	---	74.00	10.28	100.0	V	75.0	7.0

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name:	WisLink LPWAN Concentrator
Model:	RAK5148
Test Mode:	High channel
Order No/Sample No:	168430355/A003497290-016
Test Voltage:	120V/60Hz
Remark:	Temp 24 Humi:50%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical Freqs

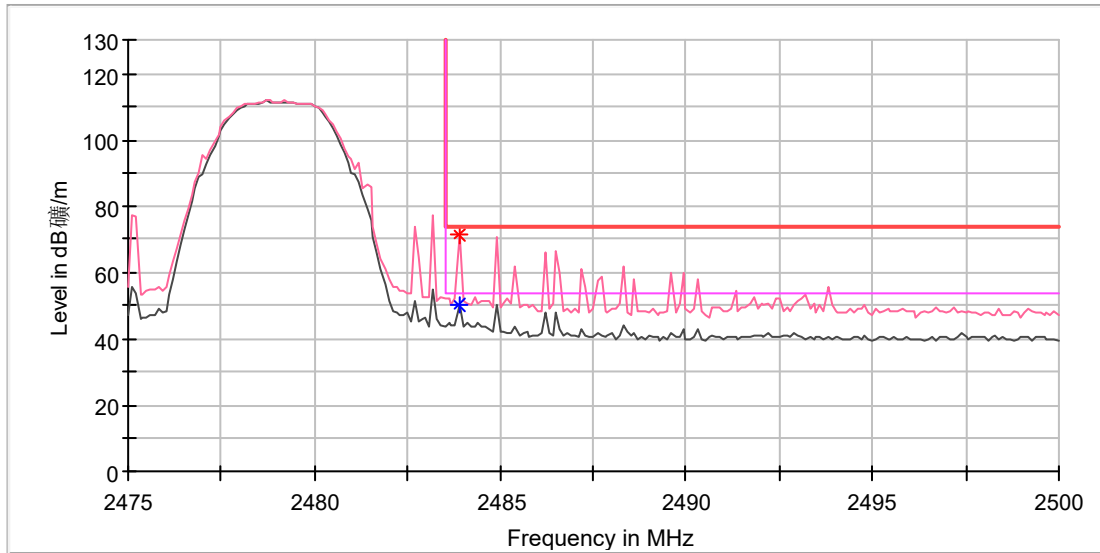
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2484.400000	---	44.31	54.00	9.69	100.0	H	341.0	7.4
2484.400000	63.21	---	74.00	10.79	100.0	H	341.0	7.4

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name:	WisLink LPWAN Concentrator
Model:	RAK5148
Test Mode:	High channel
Order No/Sample No:	168430355/A003497290-016
Test Voltage:	120V/60Hz
Remark:	Temp 24 Humi:50%
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)
2483.900000	71.39	---	74.00	2.61	100.0	V	301.0	7.4
2483.900000	---	50.43	54.00	3.57	100.0	V	301.0	7.4

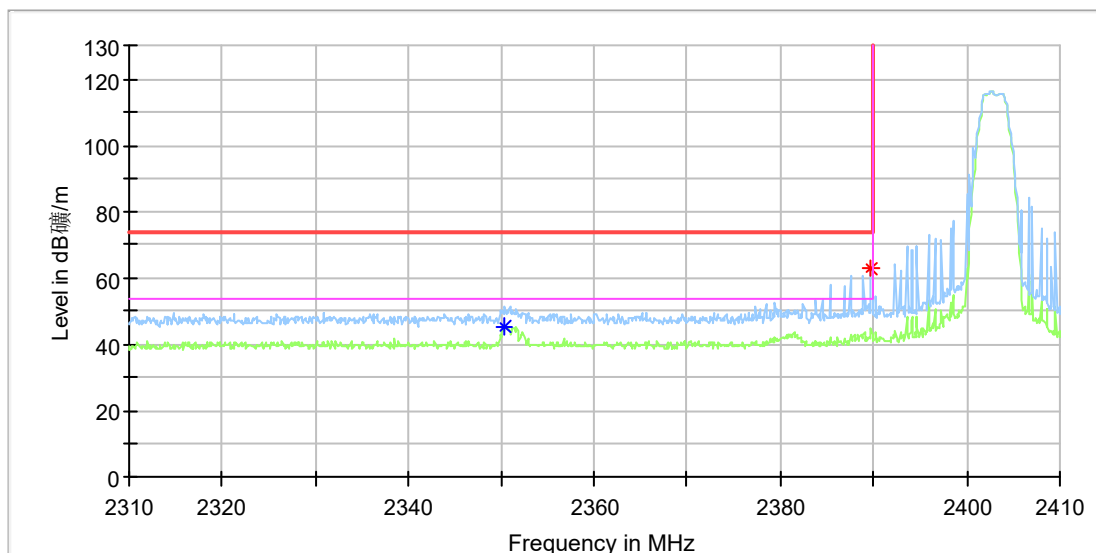
Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

SISO ANT0

EUT Information

EUT Name:	WisLink LPWAN Concentrator
Model:	RAK5148
Test Mode:	Low channel
Order No/Sample No:	168430355/A003497290-016
Test Voltage:	120V/60Hz
Remark:	Temp 24 Humi:50%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical Freqs

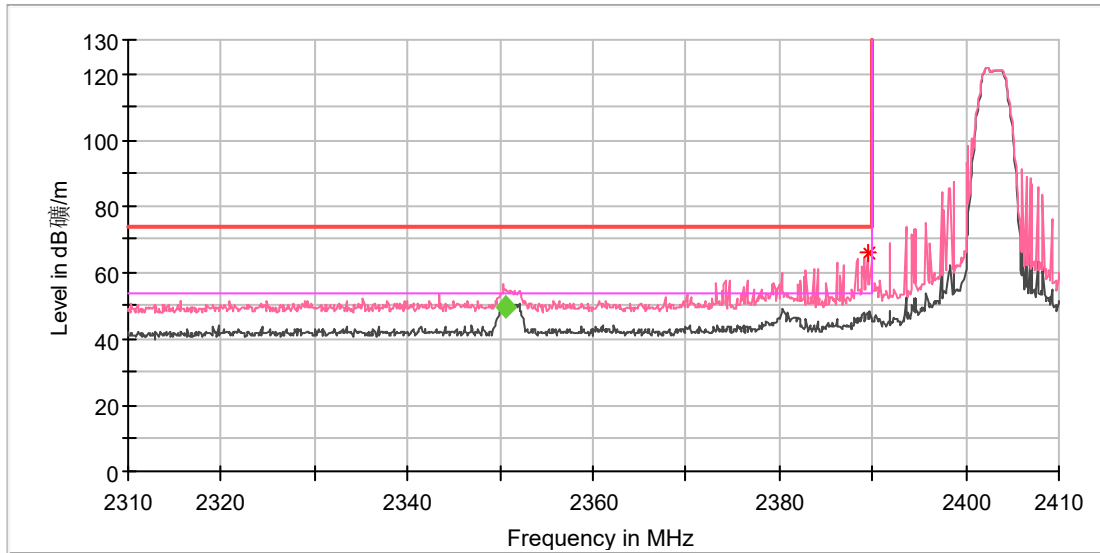
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2350.300000	---	45.48	54.00	8.52	100.0	H	234.0	6.9
2389.800000	62.96	---	74.00	11.04	100.0	H	185.0	7.0

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name:	WisLink LPWAN Concentrator
Model:	RAK5148
Test Mode:	Low channel
Order No/Sample No:	168430355/A003497290-016
Test Voltage:	120V/60Hz
Remark:	Temp 24 Humi:50%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical Freqs

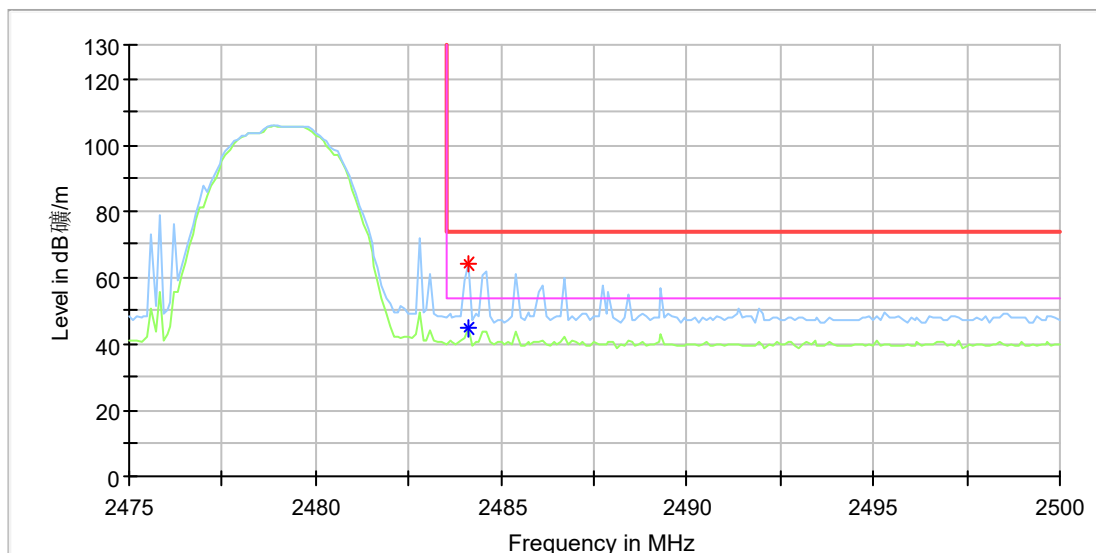
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2389.500000	65.77	---	74.00	8.23	100.0	V	271.0	7.0

Final Result

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2350.590700	49.48	54.00	4.52	105.0	V	9.0	6.9

EUT Information

EUT Name:	WisLink LPWAN Concentrator
Model:	RAK5148
Test Mode:	High channel
Order No/Sample No:	168430355/A003497290-016
Test Voltage:	120V/60Hz
Remark:	Temp 24 Humi:50%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical Freqs

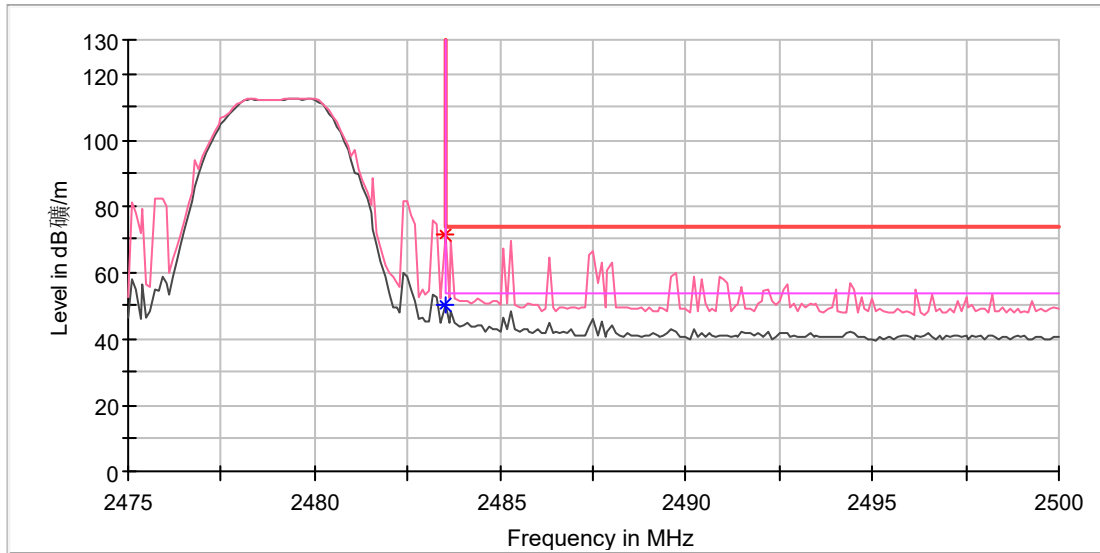
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2484.100000	---	44.47	54.00	9.53	100.0	H	145.0	7.4
2484.100000	63.80	---	74.00	10.20	100.0	H	145.0	7.4

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

EUT Information

EUT Name:	WisLink LPWAN Concentrator
Model:	RAK5148
Test Mode:	High channel
Order No/Sample No:	168430355/A003497290-016
Test Voltage:	120V/60Hz
Remark:	Temp 24 Humi:50%
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)
2483.500000	---	49.91	54.00	4.09	100.0	V	116.0	7.4
2483.500000	71.26	---	74.00	2.74	100.0	V	116.0	7.4

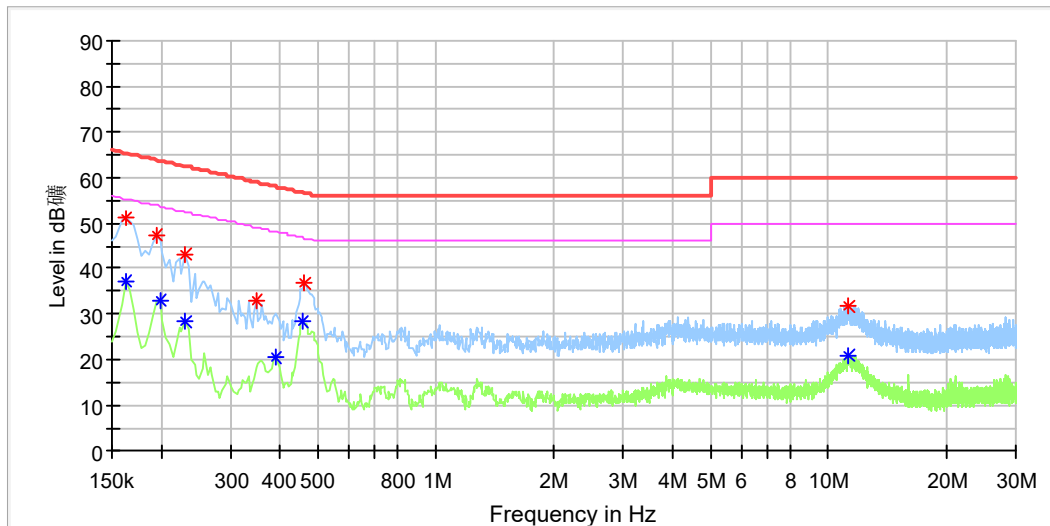
Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

Appendix A.7: Test Results of Conducted Emission on AC Mains

EUT Information

EUT Name:	WisLink LPWAN Concentrator
Order Number:	168430355(P01109287)
Model:	RAK5148
Test Mode:	Normal Operation by 2.4G Lora + GPS
Test Voltage:	AC 120V/60Hz
Test By:/Review By:	Shower Dai / Gary Chen
Tem./Hum./Pressure:	24.6°C/50.6%/101kPa
Remark:	SR2

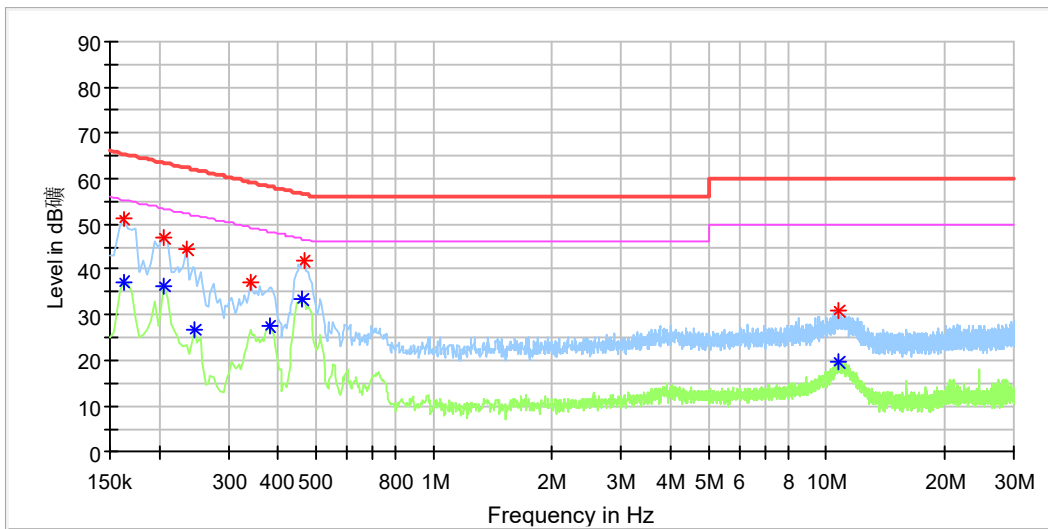


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Line	Corr. (dB)
0.162000	51.06	---	65.36	14.30	L1	9.9
0.162000	---	37.16	55.36	18.20	L1	9.9
0.194000	47.38	---	63.86	16.48	L1	9.9
0.198000	---	33.18	53.69	20.51	L1	9.9
0.230000	---	28.26	52.45	24.19	L1	9.9
0.230000	43.16	---	62.45	19.29	L1	9.9
0.350000	33.23	---	58.96	25.73	L1	9.9
0.390000	---	20.58	48.06	27.48	L1	9.9
0.458000	---	28.39	46.73	18.33	L1	10.0
0.462000	36.90	---	56.66	19.76	L1	10.0
11.230000	---	20.84	50.00	29.16	L1	10.3
11.334000	32.01	---	60.00	27.99	L1	10.3

EUT Information

EUT Name: WisLink LPWAN Concentrator
 Order Number: 168430355(P01109287)
 Model: RAK5148
 Test Mode: Normal Operation by 2.4G Lora + GPS
 Test Voltage: AC 120V/60Hz
 Test By:/Review By: Shower Dai / Gary Chen
 Tem./Hum./Pressure: 24.6°C/50.6%/101kPa
 Remark: SR2



Critical Freqs

Frequency (MHz)	MaxPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Line	Corr. (dB)
0.162000	---	37.42	55.36	17.94	N	9.8
0.162000	51.01	---	65.36	14.35	N	9.8
0.206000	---	36.27	53.37	17.10	N	9.8
0.206000	47.05	---	63.37	16.32	N	9.8
0.234000	44.43	---	62.31	17.87	N	9.8
0.246000	---	26.61	51.89	25.29	N	9.8
0.342000	37.34	---	59.16	21.82	N	9.8
0.382000	---	27.54	48.24	20.69	N	9.8
0.462000	---	33.29	46.66	13.37	N	9.8
0.466000	41.74	---	56.59	14.85	N	9.8
10.726000	31.07	---	60.00	28.93	N	10.0
10.818000	---	19.77	50.00	30.23	N	10.0