

Prüfbericht-Nr.: Test report no.:	NN2088AN 001	Auftrags-Nr.: Order no.:	168283418	Seite 1 von 29 Page 1 of 29
Kunden-Referenz-Nr.: Client reference no.:	N/A	Auftragsdatum: Order date:	09.09.2020	
Auftraggeber: Client:	Ring LLC 1523 26th St, Santa Monica, CA 90404, USA			
Prüfgegenstand: Test item:	Mailbox Sensor			
Bezeichnung / Typ-Nr.: Identification / Type no.:	5D22E3			
Auftrags-Inhalt: Order content:	FCC and IC approval			
Prüfgrundlage: Test specification:	CFR47 FCC Part 15: Subpart C Section 15.247	RSS-247 Issue 2 February 2017		
	CFR47 FCC Part 15: Subpart C Section 15.209	RSS-Gen Issue 5 March 2019		
Wareneingangsdatum: Date of sample receipt:	2020-09-09	Please refer to photo documents		
Prüfmuster-Nr.: Test sample no.:	A002911576 001-002			
Prüfzeitraum: Testing period:	19.09.2020 – 25.09.2020			
Ort der Prüfung: Place of testing:	TÜV Rheinland (Shenzhen) Co., Ltd. Testing Center			
Prüflaboratorium: Testing laboratory:	TÜV Rheinland (Shenzhen) Co., Ltd.			
Prüfergebnis*: Test result*:	Pass			
geprüft von: tested by: Datum: Date: 2020-10-16	Bell Hu	genehmigt von: authorized by: Ausstellungsdatum: Issue date: 2020-10-16	Winnie Hou	
Stellung / Position	Bell Hu / Project Manager	Stellung / Position	Winnie Hou / Technical Certifier	
Sonstiges / Other:				
FCC ID: 2AEUPRBMB001, IC: 20271-RBMB001 , HVIN: 5D22E3 FVIN: 1.7.16-56 Note: The Radiated Spurious Emission above 18GHz and Radiated band edge of BLE function are evaluated in this report. All other tests refer to test report NN20DMQO 001.				
Zustand des Prüfgegenstandes bei Anlieferung: Condition of the test item at delivery:		Prüfmuster vollständig und unbeschädigt Test item complete and undamaged:		
* Legende: 1 = sehr gut 2 = gut 3 = befriedigend 4 = ausreichend 5 = mangelhaft P(ass) = entspricht o.g. Prüfgrundlage(n) F(ail) = entspricht nicht o.g. Prüfgrundlage(n) Legend: 1 = very good 2 = good 3 = satisfactory 4 = sufficient 5 = poor P(ass) = passed a.m. test specifications(s) F(ail) = failed a.m. test specifications(s) N/A = nicht anwendbar N/T = nicht getestet 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 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>				

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Test Summary

5.1.1 RADIATED SPURIOUS EMISSION
RESULT: Pass

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1 General Remarks

1.1 Complementary Materials

N/A

2 Test Sites

2.1 Test Facilities

TÜV Rheinland (Shenzhen) Co., Ltd. Testing Center

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

FCC Registration No.: 694916

IC Registration No.: 25069

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2.2 List of Test and Measurement Instruments

Table 1: List of Test and Measurement Equipment

Radio Spectrum Testing				
Equipment	Manufacturer	Model No.	Serial No.	Cal. Until
Signal Generator	Rohde & Schwarz	SMB100A	180840	2020-08-30
Wideband Radio Communication Tester	Rohde & Schwarz	CMW500	165339	2020-08-30
Signal Analyzer	Rohde & Schwarz	FSV 40	101440	2020-08-30
System Controller Interface	Rohde & Schwarz	SCI-100	S10010036	N/A
Filterbank	Rohde & Schwarz	CDMA	100751	2020-08-30
Filterbank	Rohde & Schwarz	GSM	100811	2020-08-30
OSP	Rohde & Schwarz	OSP 120	102041	N/A
OSP	Rohde & Schwarz	OSP 150	101385	N/A
Pre-amplifier	Rohde & Schwarz	SCU08F1	08320030	2020-08-30
Amplifier	Rohde & Schwarz	SCU-18F	180079	2020-08-30
Amplifier	Rohde & Schwarz	SCU40A	100450	2020-09-03
Trilog Broadband Antenna (30 MHz - 1 GHz)	Schwarzbeck	VULB9162	192	2020-09-02
Double-Ridged Antenna (1 - 18 GHz)	ETS-LINDGREN	3117	00218719	2020-09-02
Wideband Ridged Horn Antenna (12-18 GHz)	Steatite	QMS-00208	18312	2020-09-02
Wideband Ridged Horn Antenna (18-40 GHz)	Steatite	QMS-00880	19066	2020-09-02
Biconical Broadband Antenna (30 MHz - 1 GHz)	Schwarzbeck	VUBA 9117	357	2020-09-02
Double Ridged Broadband Horn Antenna (1 – 18 GHz)	Schwarzbeck	BBHA 9120 D	01760	2020-09-02
Broadband Horn Antenna (15 – 40 GHz)	Schwarzbeck	BBHA 9170	00862	2020-09-02
Test software	Rohde & Schwarz	EMC32 (V10.40.00)	N/A	N/A
Control PC	Dell	OptiPlex 7050	36NW9P2	N/A

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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

Item	Extended Uncertainty	
Radiated Emission (30-1000MHz)	Field strength (dB μ V/m)	4.27dB
Radiated Emission (above 1000MHz)	Field strength (dB μ V/m)	4.46dB

2.6 Location of Original Data

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

2.7 Status of Facility Used for Testing

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

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3 General Product Information

3.1 Product Function and Intended Use

The EUT (equipment under test) is a Mailbox Sensor which support LoRa DTS, LoRa FHSS and FSK HFSS function and Bluetooth operated at 902-928MHz and 2400-2483.5MHz respectively. For the further information, refer to the user's manual.

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

3.2 Ratings and System Details

Table 2: Technical Specification of EUT

Technical Specification	Value
Kind of Equipment	Mailbox Sensor
Type Designation	5D22E3
FCC ID	2AEUPRBMB001
IC	20271-RBMB001
HVIN	5D22E3
FVIN	1.7.16-56
PMN	Mailbox Sensor
Operating Voltage	DC 4.5V 3AAA Cells
Testing Voltage	DC 4.5V

Technical Specification BLE

Operating Frequency band	2402 – 2480 MHz
Bluetooth Core Version	Bluetooth Low Energy 4.2
Channel separation	2MHz
Extreme Temperature Range	-20°C ~ 55°C
Modulation	GFSK
Antenna Type	Internal Antenna
Antenna Gain(dBi)	0
Channel	0~39

Technical Specification LoRa DTS 500kHz 902.5-926.5MHz

Operating Frequency band	902 – 928 MHz
Extreme Temperature Range	-20°C ~ 55°C
Bandwidth(kHz)	500
Modulation	LoRa DTS
Antenna Type	PIFA Antenna for external antenna (with a non-standard connector) LTCC Antenna for internal antenna
Antenna Gain(dBi)	1.0 dBi for external antenna 1.1 dBi for internal antenna
Channel Separation (kHz)	800
Channel Number	31

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Channel (MHz)	902.5, 903.3, 904.1, 904.9, 905.7, 906.5, 907.3, 908.1, 908.9, 909.7, 910.5, 911.3, 912.1, 912.9, 913.7, 914.5, 915.3, 916.1, 916.9, 917.7, 918.5, 919.3, 920.1, 920.9, 921.7, 922.5, 923.3, 924.1, 924.9, 925.7, 926.5
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Technical Specification LoRa 125kHz FHSS 902.2-927.8MHz	
Operating Frequency band	902 – 928 MHz
Extreme Temperature Range	-20°C ~ 55°C
Modulation	LoRa FHSS
Antenna Type	PIFA Antenna for external antenna (with a non-standard connector) LTCC Antenna for internal antenna
Antenna Gain(dBi)	1.0 dBi for external antenna 1.1 dBi for internal antenna
Channel Separation (kHz)	200
Channel Number	129
Bandwidth (kHz)	125
Hopping channel(MHz)	902.2-927.8

Technical Specification	FSK150Kbps FHSS	FSK 50Kbps FHSS	FSK 250Kbps FHSS
Operating Frequency band	902 – 928 MHz		
Extreme Temperature Range	-20°C ~ 55°C		
Modulation	FSK FHSS		
Antenna Type	PIFA Antenna for external antenna (with a non-standard connector) LTCC Antenna for internal antenna		
Antenna Gain(dBi)	1.0 dBi for external antenna 1.1 dBi for internal antenna		
Channel Separation (kHz)	400	200	500
Channel Number	64	129	51
Data Rate (Kbps)	150	50	250
Hopping Channel(MHz)	902.4~927.6	902.2~927.8	902.5~927.5

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Page 9 of 29**Table 3: Independent Operation Modes**

The basic operation modes are:

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

3.3 Noise Generating and Noise Suppressing Parts

Refer to Circuit Diagram for further details.

3.4 Submitted Documents

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

4 Test Set-up and Operation Modes

4.1 Principle of Configuration Selection

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

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

4.2 Test Operation and Test Software

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

4.3 Special Accessories and Auxiliary Equipment

Table 4: List of Accessories and Auxiliary Equipment

Description	Manufacturer	Model	S/N
notebook	Lenovo	T420	N/A

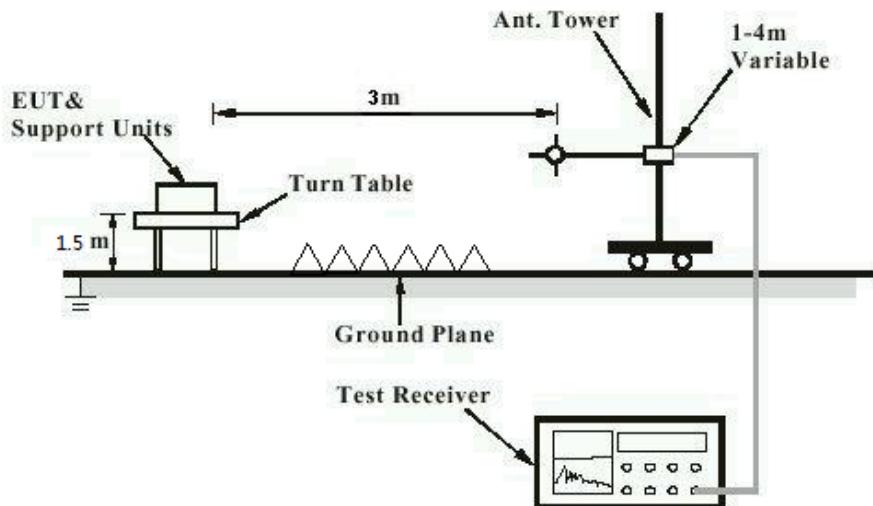
4.4 Countermeasures to Achieve EMC Compliance

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

No additional measures were employed to achieve compliance.

4.5 Test Setup Diagram

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



5 Test Results

5.1.1 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) RSS-Gen Table 6 & Table 7

Test Setup

Date of testing	:	23.09.2020
Input voltage	:	DC 4.5V
Operation mode	:	A
Test channel	:	Error! Reference source not found.
Ambient temperature	:	24 °C
Relative humidity	:	45 %
Atmospheric pressure	:	101 kPa

Remark:

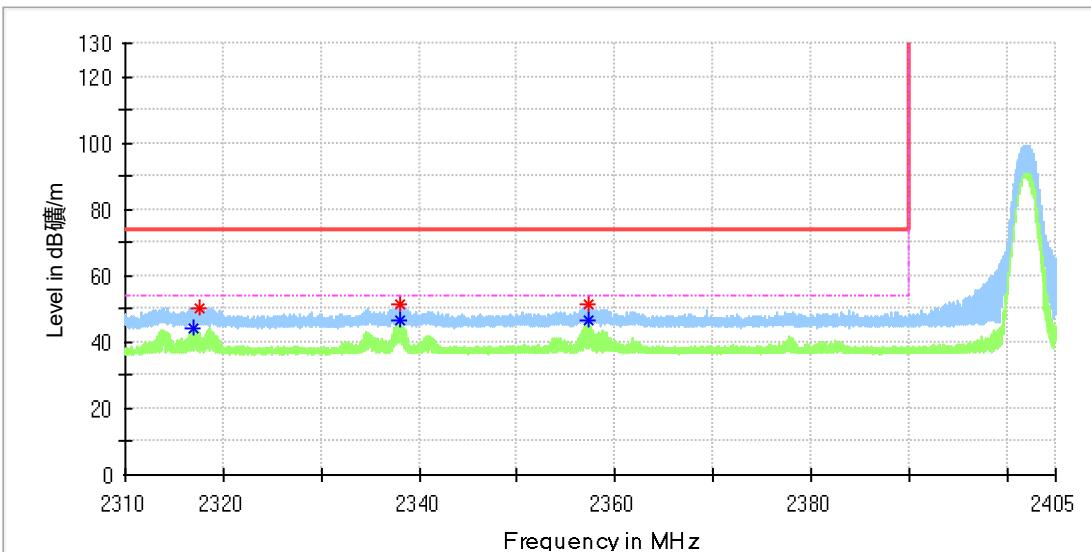
During the pretest the EUT was rotated through three orthogonal axes to determine the attitude that maximizes the emissions. After that the EUT was manually handled to find the orientation that has the maximum emission, which is the orientation shown in the test set-up photos.
For above 18GHz, 1m test distance used.

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Mode A.1
Horizontal

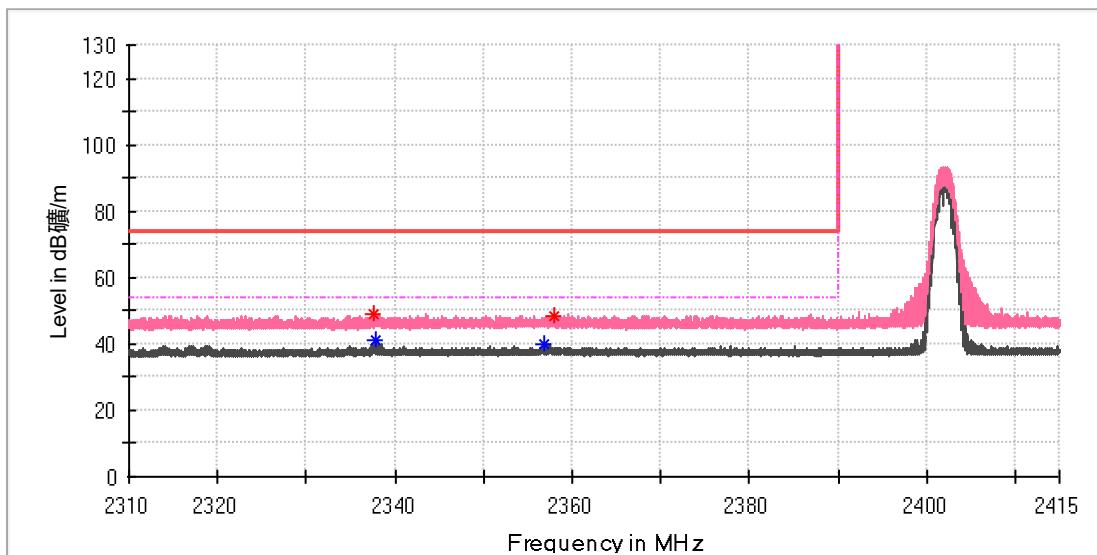


Critical_Freqs

Frequency (MHz)	MaxPeak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2317.002188	---	44.07	54.00	9.93	100.0	H	132.0	6.6
2317.507500	50.25	---	74.00	23.75	100.0	H	24.0	6.6
2337.989063	51.19	---	74.00	22.81	100.0	H	132.0	6.8
2337.989063	---	46.83	54.00	7.17	100.0	H	132.0	6.8
2357.217188	---	46.42	54.00	7.58	100.0	H	331.0	6.9
2357.282813	51.20	---	74.00	22.80	100.0	H	321.0	6.9

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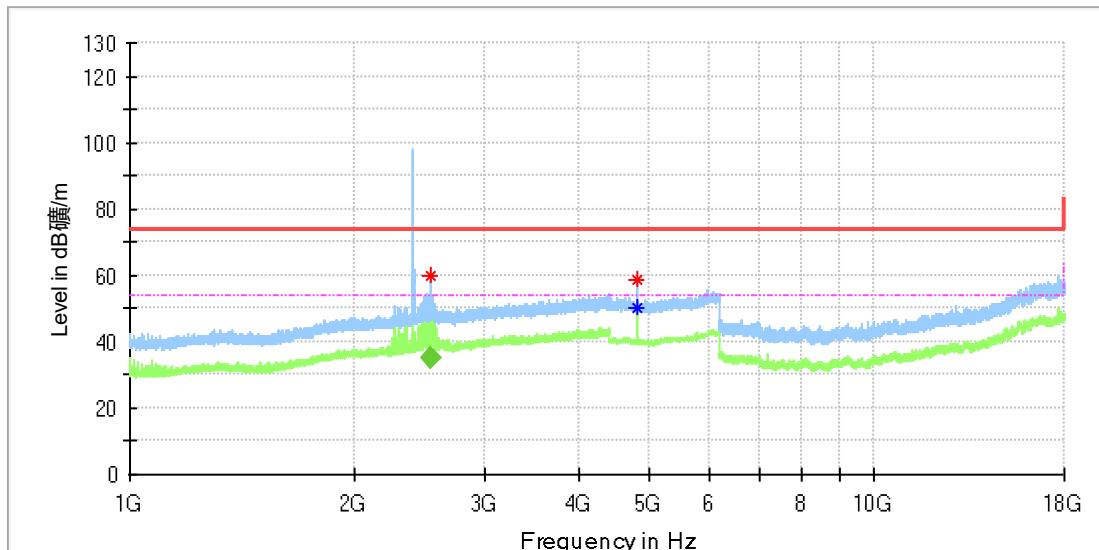
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Vertical

Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2337.582188	48.83	---	74.00	25.17	100.0	V	101.0	6.8
2337.903750	---	40.82	54.00	13.18	100.0	V	206.0	6.8
2356.777500	---	40.19	54.00	13.81	100.0	V	88.0	6.9
2357.978438	48.23	---	74.00	25.77	100.0	V	316.0	6.9

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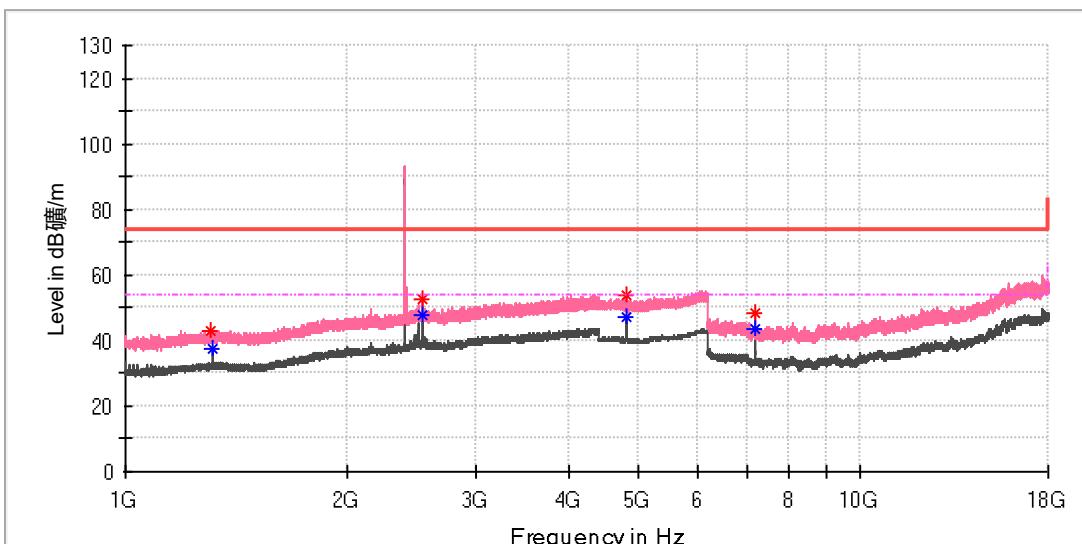
Mode A.1
Horizontal

Critical_Freqs

Frequency (MHz)	MaxPeak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2530.015625	59.58	---	74.00	14.42	100.0	H	279.0	7.5
2530.028125	---	35.07	54.00	18.93	100.0	H	274.0	7.5
4804.000000	---	50.36	54.00	3.64	100.0	H	202.0	13.6
4804.000000	58.56	---	74.00	15.44	100.0	H	202.0	13.6

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Vertical


Critical_Freqs

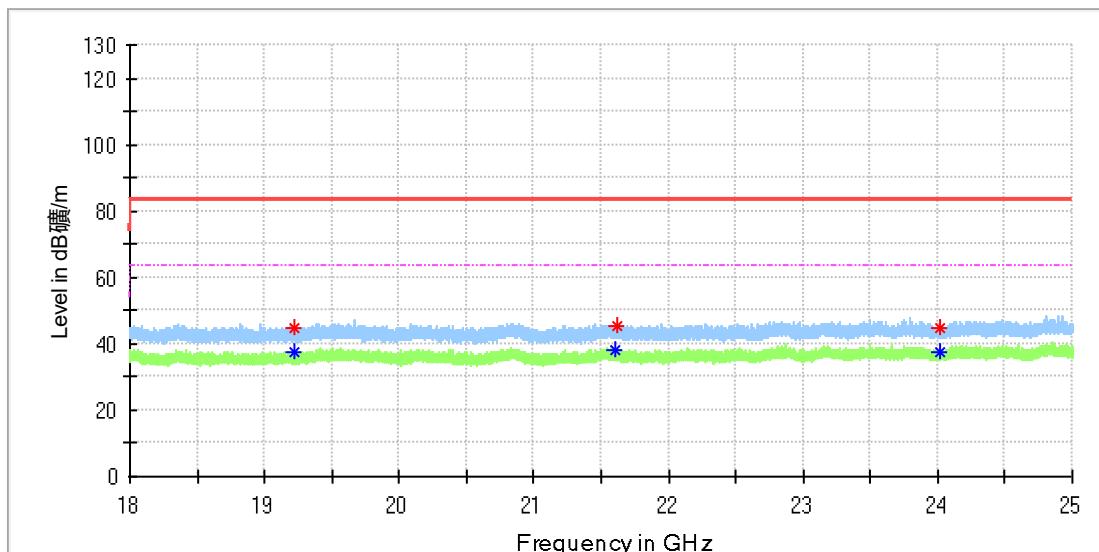
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1308.550000	43.21	---	74.00	30.79	100.0	V	0.0	2.0
1312.162500	---	37.34	54.00	16.66	100.0	V	265.0	2.0
2529.787500	52.42	---	74.00	21.58	100.0	V	193.0	7.5
2529.787500	---	47.64	54.00	6.36	100.0	V	193.0	7.5
4803.500000	53.74	---	74.00	20.26	100.0	V	255.0	13.6
4804.000000	---	47.37	54.00	6.63	100.0	V	354.0	13.6
7204.966667	48.33	---	74.00	25.67	100.0	V	225.0	8.8
7204.966667	---	43.36	54.00	10.64	100.0	V	225.0	8.8

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Mode A.1
Horizontal



Critical_Freqs

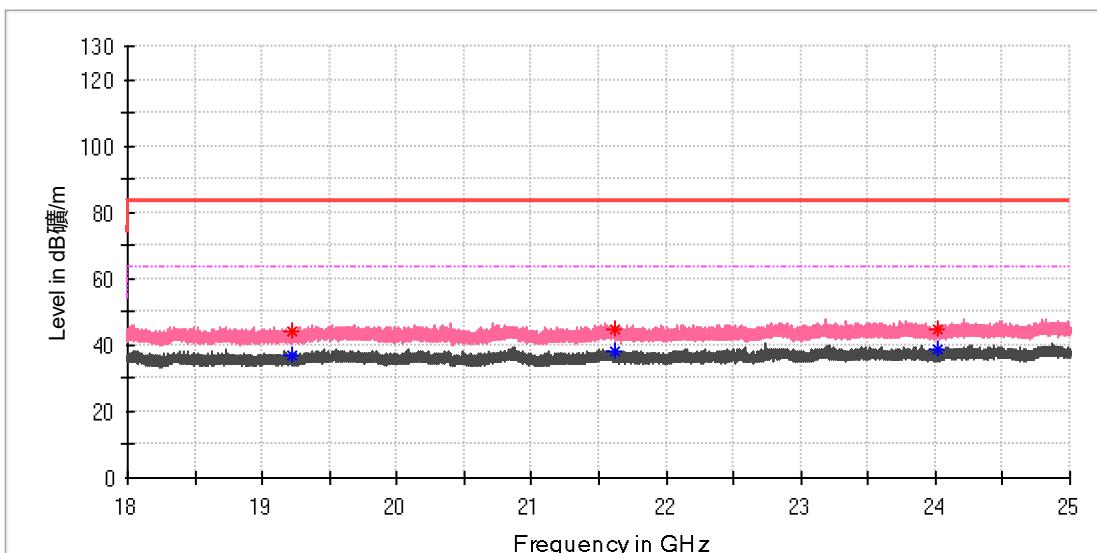
Frequency (MHz)	MaxPeak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19215.375000	44.72	---	83.50	38.78	100.0	H	163.0	-13.2
19219.312500	---	37.72	63.50	25.78	100.0	H	163.0	-13.2
21606.531250	---	38.10	63.50	25.40	100.0	H	187.0	-11.7
21619.656250	45.28	---	83.50	38.22	100.0	H	0.0	-11.7
24016.937500	44.65	---	83.50	38.85	100.0	H	253.0	-10.1
24020.000000	---	37.32	63.50	26.18	100.0	H	241.0	-10.1

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Vertical

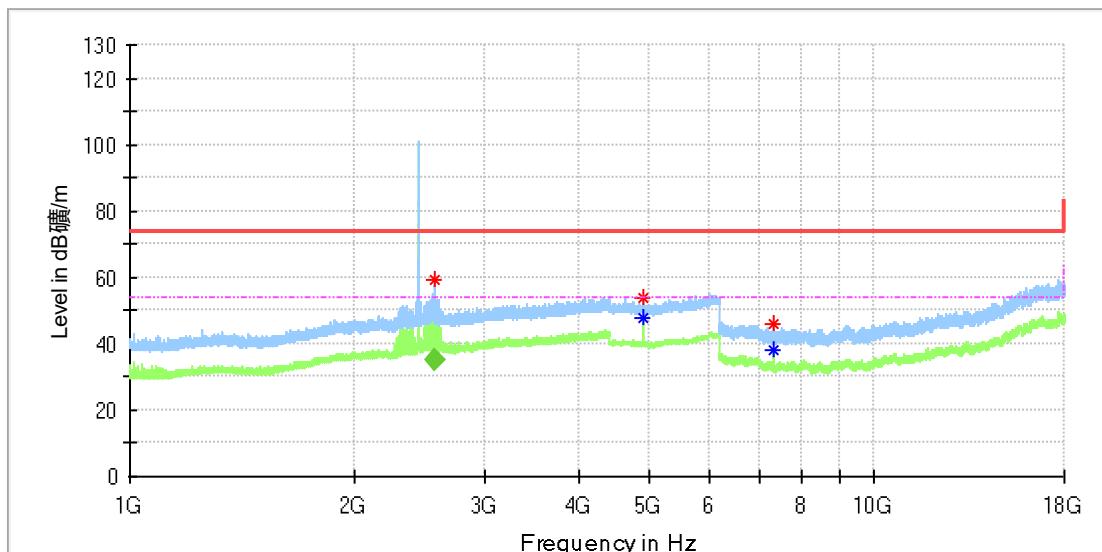


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19217.562500	44.15	---	83.50	39.35	100.0	V	229.0	-13.2
19218.000000	---	36.67	63.50	26.83	100.0	V	205.0	-13.2
21614.625000	---	38.13	63.50	25.37	100.0	V	86.0	-11.7
21614.625000	44.53	---	83.50	38.97	100.0	V	86.0	-11.7
24019.562500	44.51	---	83.50	38.99	100.0	V	300.0	-10.1
24024.156250	---	38.68	63.50	24.82	100.0	V	253.0	-10.1

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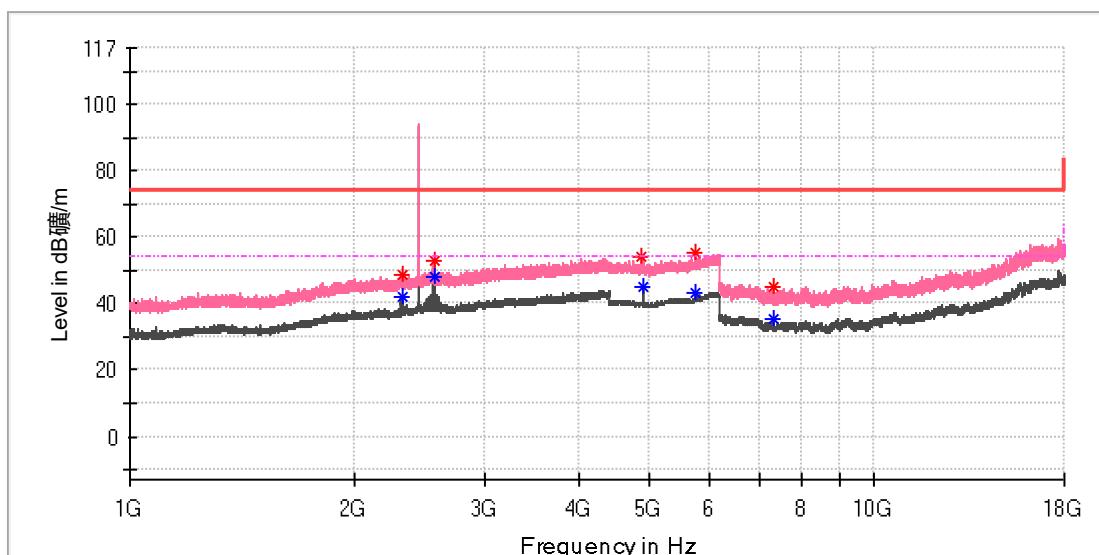
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Mode A.2
Horizontal

Critical_Freqs

Frequency (MHz)	MaxPeak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2567.881250	59.40	---	74.00	14.60	100.0	H	267.0	7.5
2567.970625	---	35.23	54.00	18.77	100.0	H	271.0	7.5
4879.500000	---	47.74	54.00	6.26	100.0	H	185.0	13.4
4879.500000	53.87	---	74.00	20.13	100.0	H	185.0	13.4
7319.525000	---	38.31	54.00	15.69	100.0	H	321.0	8.2
7320.016667	45.82	---	74.00	28.18	100.0	H	321.0	8.2

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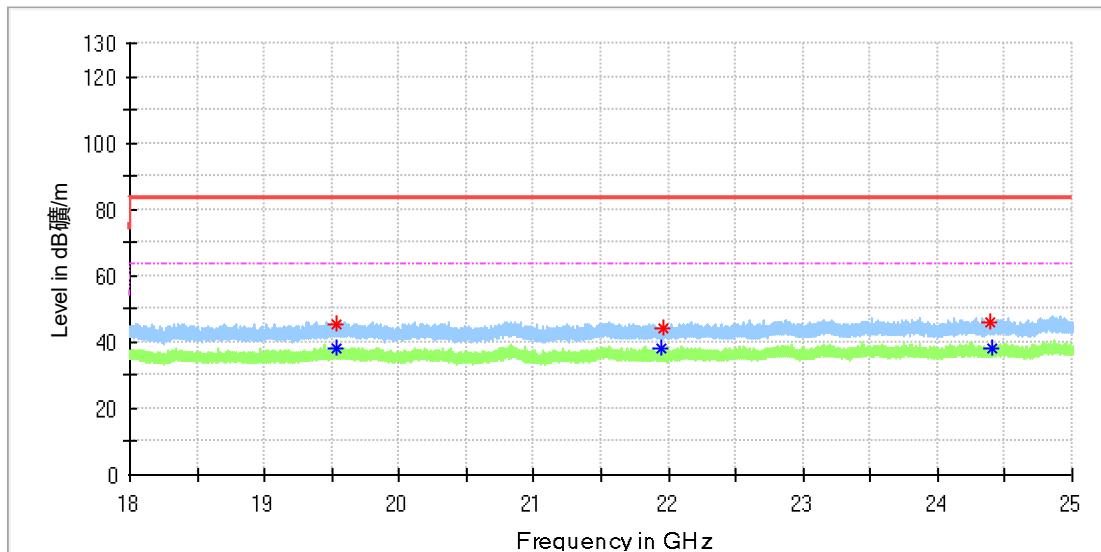
Vertical

Critical_Freqs

Frequency (MHz)	MaxPeak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2331.100000	48.58	---	74.00	25.42	100.0	V	97.0	6.7
2331.100000	---	42.04	54.00	11.96	100.0	V	97.0	6.7
2568.037500	---	48.19	54.00	5.81	100.0	V	111.0	7.5
2568.250000	52.91	---	74.00	21.09	100.0	V	111.0	7.5
4878.000000	54.11	---	74.00	19.89	100.0	V	59.0	13.4
4879.000000	---	44.76	54.00	9.24	100.0	V	208.0	13.4
5747.500000	---	43.08	54.00	10.92	100.0	V	0.0	14.6
5747.500000	55.09	---	74.00	18.91	100.0	V	0.0	14.6
7319.033333	45.31	---	74.00	28.69	100.0	V	179.0	8.2
7319.525000	---	35.44	54.00	18.56	100.0	V	54.0	8.2

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Horizontal


Critical_Freqs

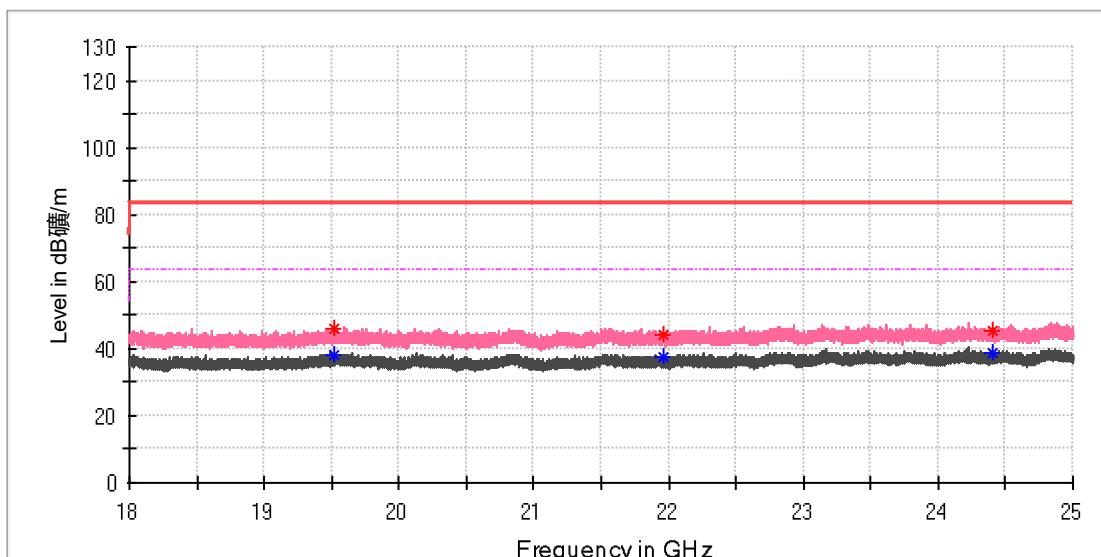
Frequency (MHz)	MaxPeak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19526.656250	45.51	---	83.50	37.99	100.0	H	95.0	-13.1
19529.718750	---	38.27	63.50	25.23	100.0	H	262.0	-13.1
21947.125000	---	38.12	63.50	25.38	100.0	H	143.0	-11.4
21956.750000	44.31	---	83.50	39.19	100.0	H	226.0	-11.4
24396.468750	46.03	---	83.50	37.47	100.0	H	334.0	-10.1
24400.843750	---	38.35	63.50	25.15	100.0	H	143.0	-10.1

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Vertical

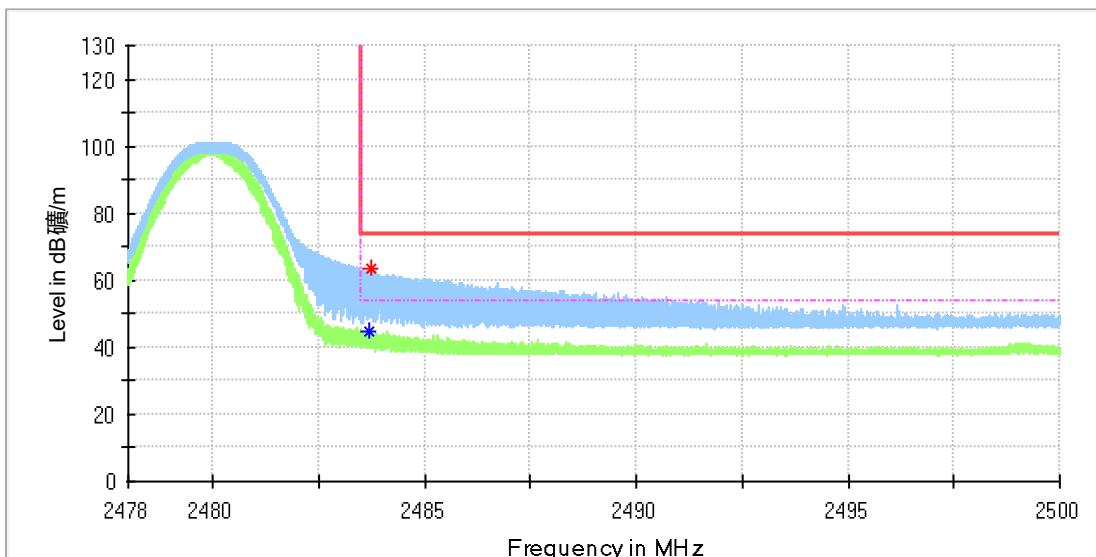


Critical_Freqs

Frequency (MHz)	MaxPeak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19519.656250	45.97	---	83.50	37.53	100.0	V	248.0	-13.1
19525.781250	---	37.88	63.50	25.62	100.0	V	105.0	-13.1
21960.906250	44.09	---	83.50	39.41	100.0	V	117.0	-11.4
21966.593750	---	37.25	63.50	26.25	100.0	V	3.0	-11.4
24397.781250	45.41	---	83.50	38.09	100.0	V	93.0	-10.1
24397.781250	---	38.51	63.50	24.99	100.0	V	93.0	-10.1

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Horizontal**Critical_Freqs**

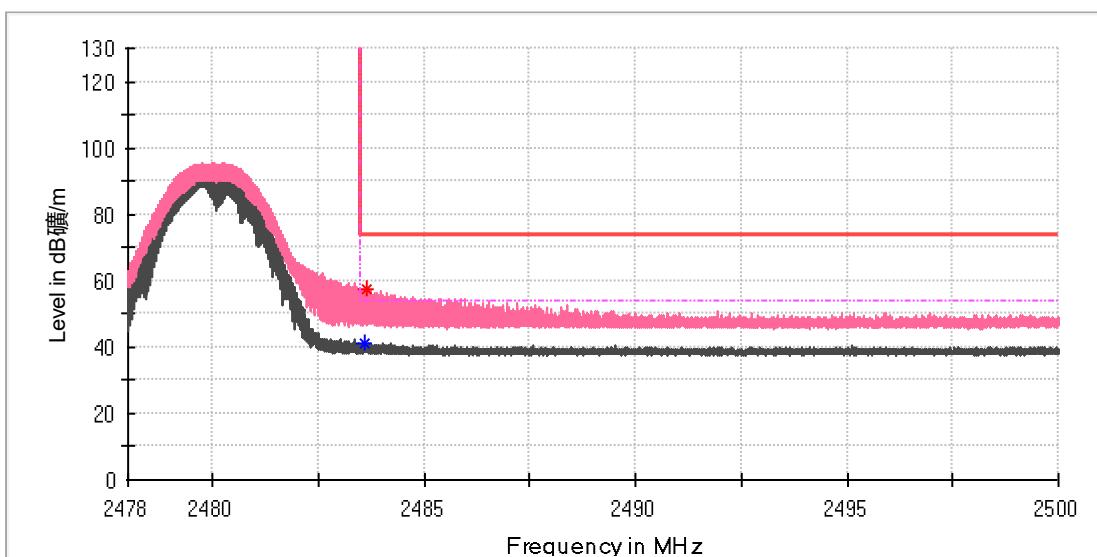
Frequency (MHz)	MaxPeak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2483.702125	---	44.97	54.00	9.03	100.0	H	27.0	7.4
2483.736500	63.56	---	74.00	10.44	100.0	H	322.0	7.4

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**Critical_Freqs**

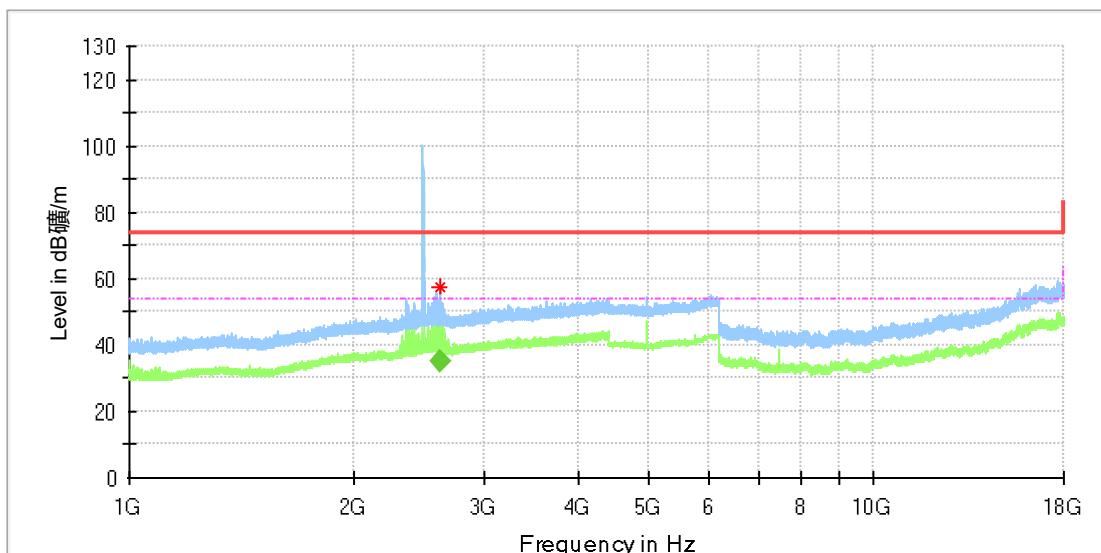
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2483.615500	---	41.28	54.00	12.72	100.0	V	195.0	7.4
2483.658125	57.30	---	74.00	16.70	100.0	V	212.0	7.4

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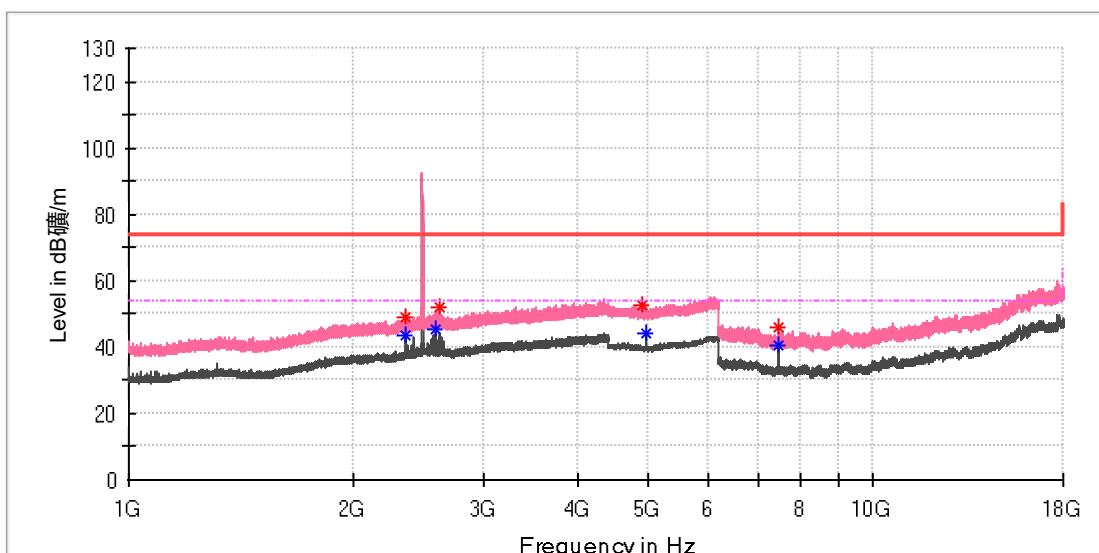
**Critical_Freqs**

Frequency (MHz)	MaxPeak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2607.871875	---	34.83	54.00	19.17	100.0	H	2.0	7.4
2607.957500	57.52	---	74.00	16.48	100.0	H	284.0	7.4

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Critical_Freqs

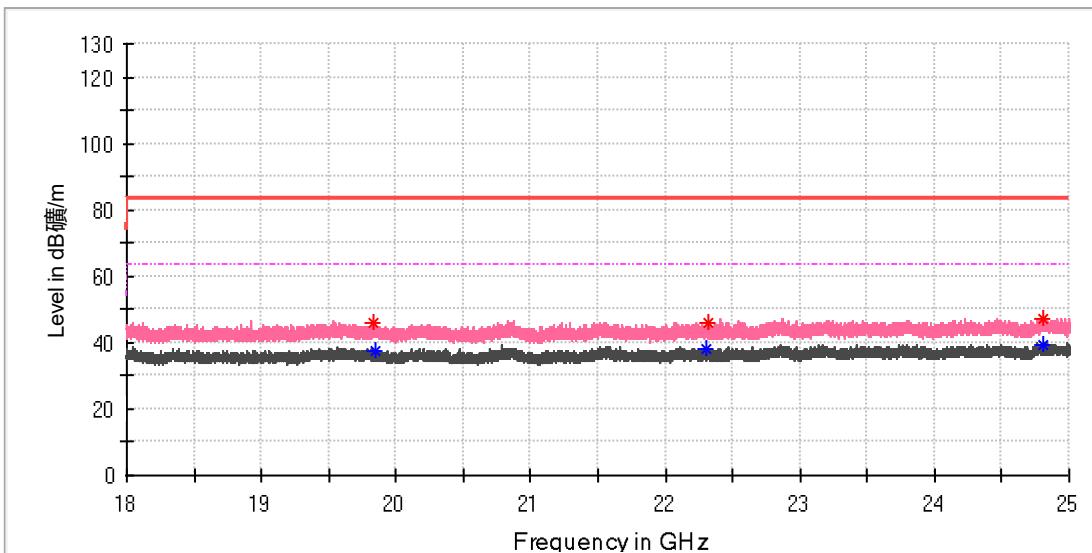
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2351.712500	---	43.80	54.00	10.20	100.0	V	89.0	6.9
2351.925000	49.13	---	74.00	24.87	100.0	V	89.0	6.9
2588.650000	---	45.61	54.00	8.39	100.0	V	194.0	7.4
2607.350000	52.08	---	74.00	21.92	100.0	V	30.0	7.4
4891.500000	52.51	---	74.00	21.49	100.0	V	181.0	13.3
4959.500000	---	44.29	54.00	9.71	100.0	V	279.0	13.2
7439.000000	---	40.28	54.00	13.72	100.0	V	235.0	8.4
7440.966667	46.21	---	74.00	27.79	100.0	V	274.0	8.4

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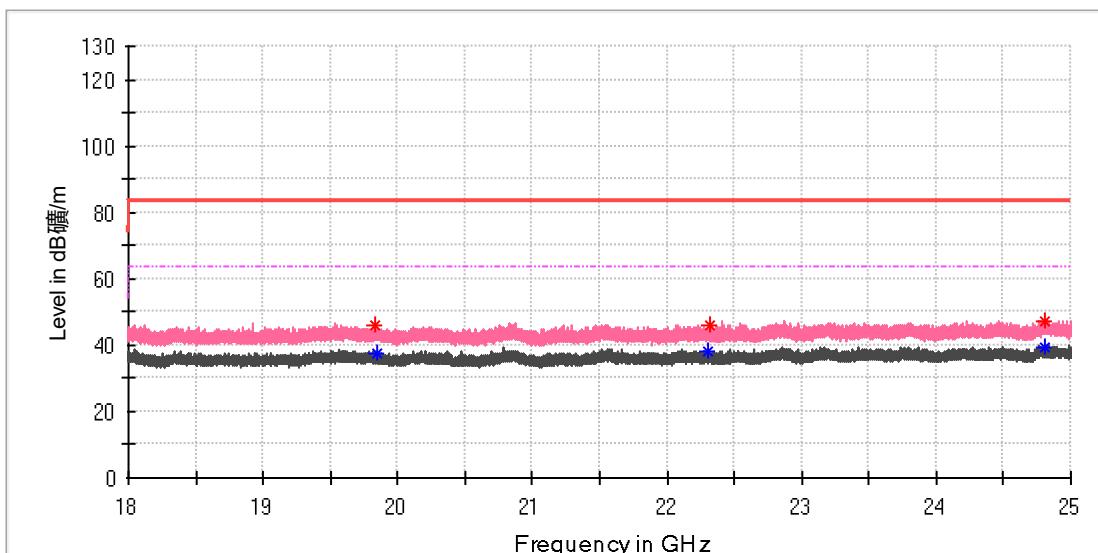
Horizontal

**Critical_Freqs**

Frequency (MHz)	MaxPeak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19842.718750	44.40	---	83.50	39.10	100.0	H	85.0	-13.0
19839.687500	---	38.65	63.50	24.85	100.0	H	11.0	-13.0
22315.906250	---	37.91	63.50	25.59	100.0	H	356.0	-11.2
22314.218750	46.11	---	83.50	37.39	100.0	H	114.0	-11.2
24815.562500	---	39.22	63.50	23.28	100.0	H	265.0	-10.2
24799.531250	47.12	---	83.50	36.38	100.0	H	192.0	-10.2

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Critical_Freqs

Frequency (MHz)	MaxPeak (dB μ V/m)	Average (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19837.718750	45.70	---	83.50	37.80	100.0	V	87.0	-13.0
19846.687500	---	37.56	63.50	25.94	100.0	V	0.0	-13.0
22310.906250	---	38.12	63.50	25.38	100.0	V	333.0	-11.2
22312.218750	45.79	---	83.50	37.71	100.0	V	112.0	-11.2
24803.562500	---	39.59	63.50	23.91	100.0	V	345.0	-10.2
24805.531250	47.19	---	83.50	36.31	100.0	V	154.0	-10.2

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