



TESTING LABORATORY
CERTIFICATE#4323.01



FCC PART 15.247

TEST REPORT

For

Queclink Wireless Solutions Co., Ltd

No.30, Lane 500, Xinlong Road, Minhang District, Shanghai, China, 201101

FCC ID: YQDEA00022

Report Type: Original Report	Product Type: Telematics Device
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Report Number:	<u>RSHA210824001-00C</u>
Report Date:	<u>2021-09-15</u>
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Applicant:	Queclink Wireless Solutions Co., Ltd
Product Type:	Telematics Device
Tested Model:	EA00022
Power Supply:	DC 12~60V power by external power supply and DC 3.6V from rechargeable li-ion battery
Maximum Conducted Output Power:	BLE (1Mbps): 3.21 dBm, BLE (2Mbps): 1.96 dBm
RF Function:	BLE (1Mbps), BLE (2Mbps)
Operating Band/Frequency:	2402-2480MHz
Channel Number:	40
Channel Separation:	2 MHz
Modulation Type	GFSK
Antenna Type:	patch antenna
*Maximum Antenna Gain:	2.94 dBi

**Note: The maximum antenna gain is provided by the applicant.*

All measurement and test data in this report was gathered from production sample serial number: RSHA210824001-1. (Assigned by the BACL. The EUT supplied by the applicant was received on 2021-08-24)

Objective

This report is prepared on behalf of *Queclink Wireless Solutions Co., Ltd* in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communications Commission rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.209 and 15.247 rules.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and FCC KDB 558074 D01 15.247 Meas Guidance v05r02.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Kunshan). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Item		Uncertainty
AC Power Lines Conducted Emissions		3.19dB
RF conducted test with spectrum		0.9dB
RF Output Power with Power meter		0.5dB
Radiated emissions	30MHz~1GHz	6.11dB
	1GHz~6GHz	4.45dB
	6GHz~18GHz	5.23dB
	18GHz~40GHz	5.65dB
Occupied Bandwidth		0.5kHz
Temperature		1.0°C
Humidity		6%

Test Facility

The test site used by Bay Area Compliance Laboratories Corp. (Kunshan) to collect test data is located on the No.248 Chenghu Road, Kunshan, Jiangsu province, China.

Bay Area Compliance Laboratories Corp. (Kunshan) Lab is accredited to ISO/IEC 17025 by A2LA (Lab code: 4323.01) and the FCC designation No. CN1185 under the FCC KDB 974614 D01 and CAB identifier CN0004 under the ISED requirement. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2014.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

Channel List for BLE mode:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	20	2442
1	2404	...	...
...	...	...	...
...	...	...	...
18	2438	38	2478
19	2440	39	2480

EUT was tested with channel 0, 19 and 39.

Equipment Modifications

No modification was made to the EUT tested.

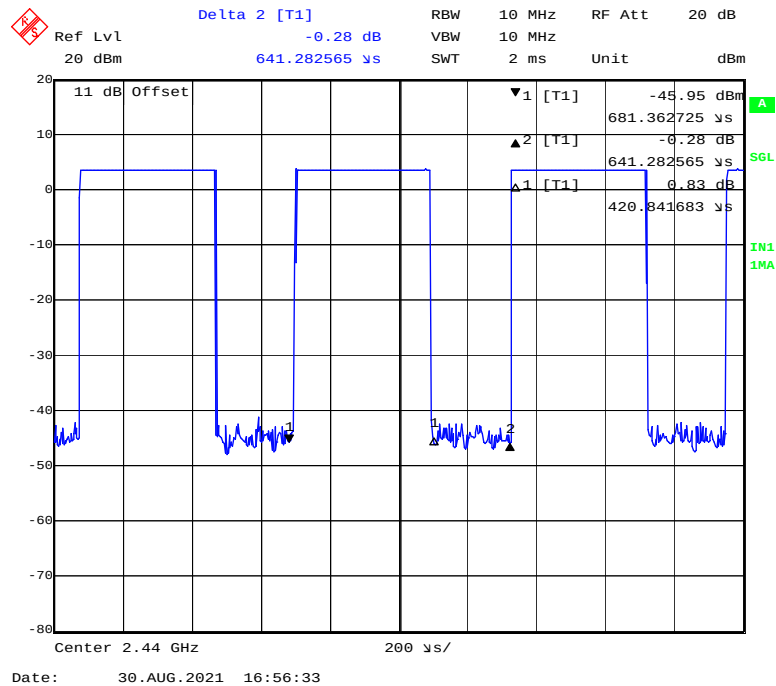
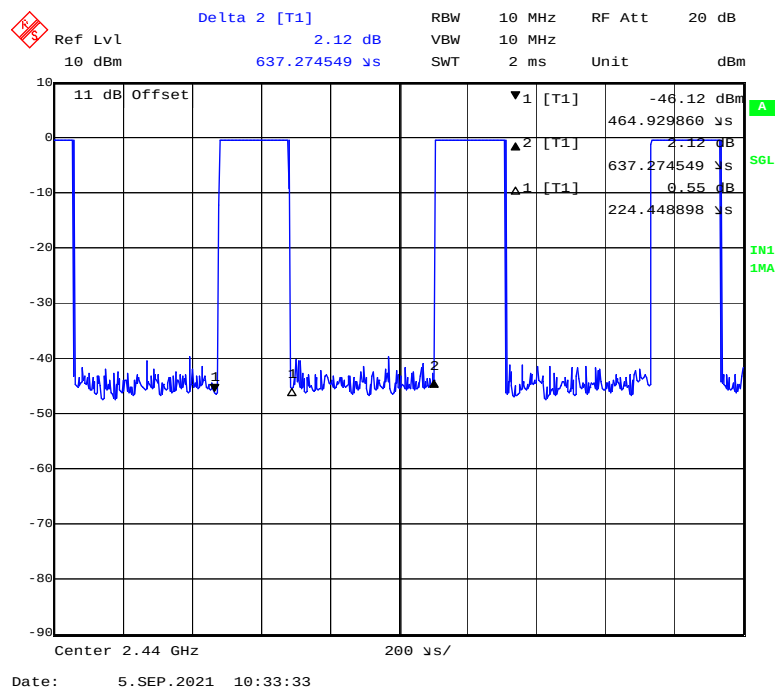
EUT Exercise Software

RF test software: QCOM_V1.6

Pre-scan with all the data rates, and the worst case was performed as below:

Mode	Data Rate	Channel	*Power Level setting
BLE	1Mbps	Low	1
		Middle	1
		High	1
	2Mbps	Low	0
		Middle	0
		High	0

*Note: The power level setting was declared by the applicant.

Duty Cycle:**BLE (1Mbps): Middle Channel****BLE (2Mbps): Middle Channel**

Mode	Duty Cycle (%)	T _{on} (ms)	T _{on+off} (ms)	10log(1/x)
BLE (1Mbps)	65.68	0.421	0.641	1.83
BLE (2Mbps)	35.16	0.224	0.637	4.54

Note: “x” means the Duty Cycle.

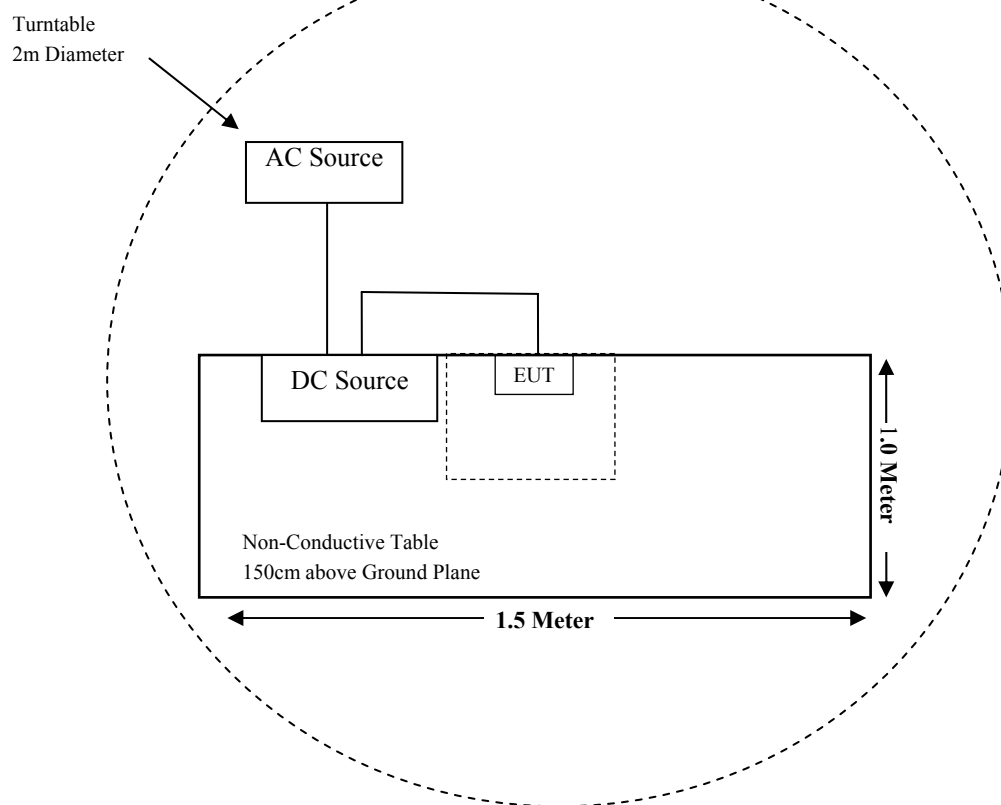
Manufacturer	Description	Model	Serial Number
ZHAOXIN	DC Source	RXN-605D	DC002

Cable Description	Length (m)	From Port	To Port
Power cable1	1.5	EUT	DC Source
Power cable2	1.0	DC Source	AC Source

Diagram illustrating the test setup for Radiated Emissions (Below 1GHz):

- The setup is enclosed within a **Turntable** with a **2m Diameter**.
- The equipment is placed on a **Non-Conductive Table** which is **80cm above Ground Plane**.
- The table dimensions are **1.5 Meter** wide and **1.0 Meter** high.
- On the table, the **DC Source** and **EUT** (Equipment Under Test) are connected to the **AC Source**.

For Radiated Emissions (Above 1GHz):



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§1.1310 & §2.1091	Maximum Permissible Exposure (MPE)	Compliant
§15.203	Antenna Requirement	Compliant
§15.207 (a)	AC Line Conducted Emissions	Not Applicable (See Note)
§15.247(d)	Spurious Emissions at Antenna Port	Compliant
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliant
§15.247 (a)(2)	6 dB Emission Bandwidth	Compliant
§15.247(b)(3)	Maximum Conducted Output Power	Compliant
§15.247(d)	Band Edge	Compliant
§15.247(e)	Power Spectral Density	Compliant

Note: EUT is used in scooter and powered by battery.

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test (Chamber 1#)					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2020-11-27	2021-11-26
Sunol Sciences	Broadband Antenna	JB3	A090314-2	2020-01-07	2023-01-06
Sonoma Instrument	Pre-amplifier	310N	171205	2021-08-14	2022-08-13
Rohde & Schwarz	Auto test Software	EMC32	100361	N/A	N/A
MICRO-COAX	Coaxial Cable	Cable-8	008	2021-08-15	2022-08-14
MICRO-COAX	Coaxial Cable	Cable-9	009	2021-08-15	2022-08-14
MICRO-COAX	Coaxial Cable	Cable-10	010	2021-08-15	2022-08-14
Radiated Emission Test (Chamber 2#)					
Rohde & Schwarz	EMI Test Receiver	ESU40	100207	2021-03-16	2022-03-15
ETS-LINDGREN	Horn Antenna	3115	9311-4159	2020-07-15	2023-07-14
ETS-LINDGREN	Horn Antenna	3116	2516	2020-01-07	2023-01-06
A.H.Systems,inc	Amplifier	PAM-0118P	512	2021-08-14	2022-08-13
EM Electronics Corporation	Amplifier	EM18G40G	060726	2021-08-14	2022-08-13
MICRO-TRONICS	Band Reject Filter	BRM50702	G024	2021-08-05	2022-08-04
Narda	Attenuator	10dB	010	2020-10-10	2021-10-09
Rohde & Schwarz	Auto test Software	EMC32	100361	N/A	N/A
MICRO-COAX	Coaxial Cable	Cable-11	011	2021-08-15	2022-08-14
MICRO-COAX	Coaxial Cable	Cable-12	012	2021-08-15	2022-08-14
MICRO-COAX	Coaxial Cable	Cable-13	013	2021-08-15	2022-08-14
RF Conducted Test					
Rohde & Schwarz	EMI Test Receiver	ESIB26	100146	2020-11-27	2021-11-26
Agilent	Power Meter	E4419B	MY41291878	2021-03-16	2022-03-15
Narda	Attenuator	10dB	010	2020-10-10	2021-10-09
Queclink Wireless	RF Cable	Queclink Wireless C01	C01	Each Time	N/A

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Kunshan) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC §1.1310 & §2.1091 – MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart §2.1091 and subpart §1.1310, 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 of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minutes)
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz; * = Plane-wave equivalent power density;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:

Predication of MPE limit at a given distance

$S = PG/4\pi R^2$ = power density (in appropriate units, e.g. mW/cm²);

P = power input to the antenna (in appropriate units, e.g., mW);

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

Calculated Data:

Mode	Frequency Range (MHz)	Antenna Gain		Tune-up Output Power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)	MPE Ratio
		(dBi)	(numeric)	(dBm)	(mW)				
GSM850	824-849	0.61	1.15	26.0	398.11	20	0.0911	0.5493	0.1658
GSM1900	1850-1910	4.18	2.62	23.0	199.53	20	0.1040	1.00	0.1040
WCDMA B2	1850-1910	4.18	2.62	25.0	316.23	20	0.1648	1.00	0.1648
WCDMA B4	1710-1755	3.63	2.31	25.0	316.23	20	0.1453	1.00	0.1453
WCDMA B5	824-849	0.61	1.15	25.0	316.23	20	0.0724	0.5493	0.1318
LTE B2	1850-1910	4.18	2.62	25.0	316.23	20	0.1648	1.00	0.1648
LTE B4	1710-1755	3.63	2.31	25.0	316.23	20	0.1453	1.00	0.1453
LTE B5	824-849	0.61	1.15	25.0	316.23	20	0.0724	0.5493	0.1318
LTE B7	2500-2570	3.72	2.36	25.0	316.23	20	0.1485	1.00	0.1485
LTE B12	699-716	-4.15	0.38	25.0	316.23	20	0.0242	0.466	0.0519
LTE B13	777-787	-4.29	0.37	25.0	316.23	20	0.0234	0.518	0.0452
LTE B25	1850-1915	4.18	2.62	25.0	316.23	20	0.1648	1.00	0.1648
LTE B26 (814-824)	814-824	0.61	1.15	25.0	316.23	20	0.0724	0.5427	0.1334
LTE B26 (824-849)	824-849	0.61	1.15	25.0	316.23	20	0.0724	0.5493	0.1318
LTE B38	2570-2620	2.67	1.85	25.0	316.23	20	0.1164	1.0	0.1164
LTE B41	2496-2690	3.72	2.36	25.0	316.23	20	0.1485	1.0	0.1485
BLE(1Mbps)	2402~2480	2.94	1.97	3.5	2.24	20	0.0009	1.00	0.0009
BLE(2Mbps)		2.94	1.97	2.0	1.58	20	0.0006	1.00	0.0006
NFC	13.56	1.0	1.26	-9.5	0.02	20	0.00003	0.98	0.00003

Note:

(1) The Tune-up output power was declared by the manufacturer.

(2) For NFC mode, ERP= 83.02dBμV/m-95.2 = -12.18dBm.

EIRP= ERP+2.15=-12.18+2.15=-10.03 dBm. The Tune-up EIRP= -8.5 dBm

(3) NFC, LTE and BLE can transmit simultaneously, the worst condition as below:

$$\sum_i \frac{S_i}{S_{Limit,i}} = 0.1648 + 0.0009 + 0.00003 = 0.16573 < 1.0$$

Result: The device meets MPE at distance 20cm.

FCC §15.203 - ANTENNA REQUIREMENT

Applicable Standard

According to § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

- a. Antenna must be permanently attached to the unit.
 - b. Antenna must use a unique type of connector to attach to the EUT.
- Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Antenna Connector Construction

The EUT has a patch antenna for BLE and the antenna gain is 2.94 dBi, the antenna was permanently attached to the EUT, fulfill the requirement of this section. Please refer to the EUT photos.

Result: Compliant.

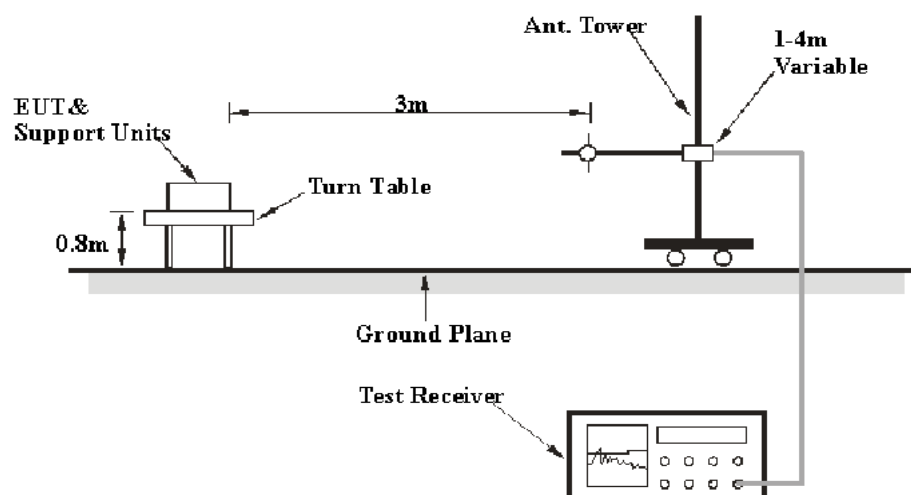
FCC §15.209, §15.205 & §15.247(d) - Spurious Emissions

Applicable Standard

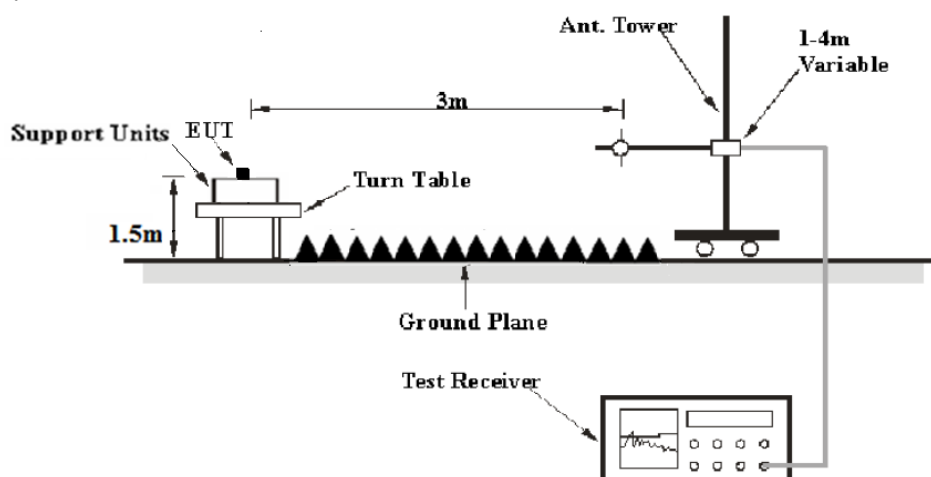
FCC §15.247 (d); §15.209; §15.205;

EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission tests were performed in the 3 meters test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 limits.

EMI Test Receiver Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, the EMI test receiver Setup was set with the following configurations:

Frequency Range	RBW	Video B/W	Detector
30MHz – 1000 MHz	120 kHz	300 kHz	QP
Above 1 GHz	1MHz	3 MHz	Peak
	1MHz	3 MHz	AVG

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All data was recorded in the Quasi-peak detector mode from 30 MHz to 1 GHz, Peak and average detection mode above 1 GHz.

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

Corrected Amplitude (dBμV/m) = Meter Reading (dBμV) + Antenna Factor (dB/m) + Cable Loss (dB) - Amplifier Gain (dB)

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

Margin (dB) = Limit (dBμV/m) – Corrected Amplitude (dBμV/m)

Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247.

Test Data

Environmental Conditions

Temperature:	24.6-25.3 °C
Relative Humidity:	48-52 %
ATM Pressure:	101.1-101.3 kPa

The testing was performed by Miller Xie from 2021-08-30 to 2021-09-05.

Test Result: Compliant.

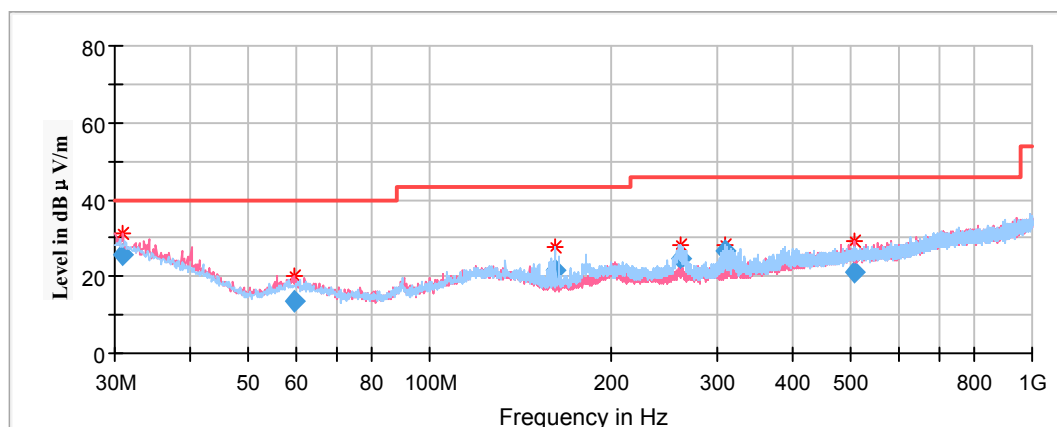
EUT operation mode: Transmitting

BLE(1Mbps):

Spurious Emission Test:

30MHz-1GHz:

*(Pre-scan with low, middle and high channels of operation in the X,Y and Z axes of orientation, the worst case **middle channel of operation in the Z- axis of orientation** was recorded)*



Frequency (MHz)	Corrected Amplitude	Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	Quasi-peak (dBμV/m)	Height (cm)	Polar (H/V)				
30.977221	25.81	100.0	V	46.0	-4.1	40.00	14.19
59.463350	13.54	100.0	V	156.0	-14.5	40.00	26.46
161.433600	21.50	100.0	H	300.0	-14.2	43.50	22.00
261.103950	24.87	100.0	H	267.0	-11.7	46.00	21.13
309.723150	26.91	100.0	H	272.0	-10.6	46.00	19.09
508.213300	20.99	199.0	V	122.0	-5.5	46.00	25.01

1GHz-18GHz:

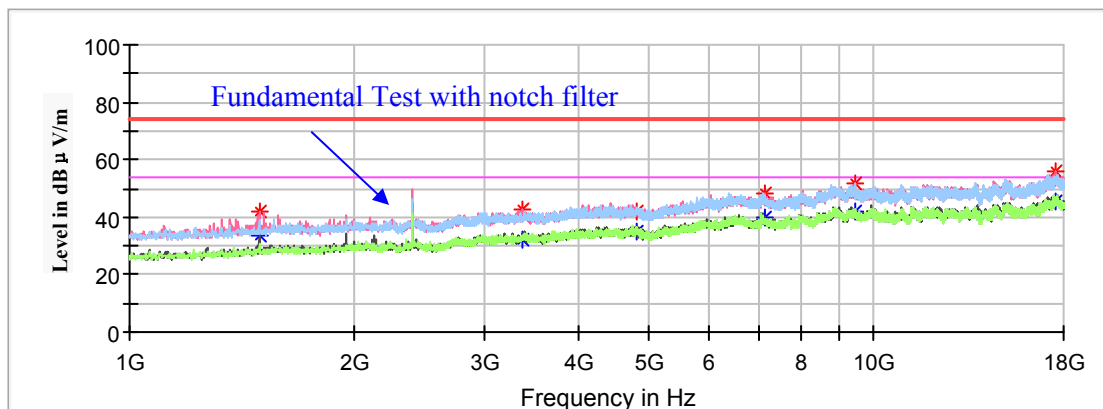
(Pre-scan in the X,Y and Z axes of orientation, the worst case **Z- axis of orientation** was recorded)

Note:

1. This test was performed with the 2.4-2.5GHz notch filter.
2. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) – Amplifier Factor (dB)
 Corrected Amplitude (dBμV/m) = Corrected Factor (dB/m) + Reading (dBμV)
 Margin (dB) = Limit (dBμV/m) – Corrected Amplitude (dBμV/m)

Low Channel: 2402MHz

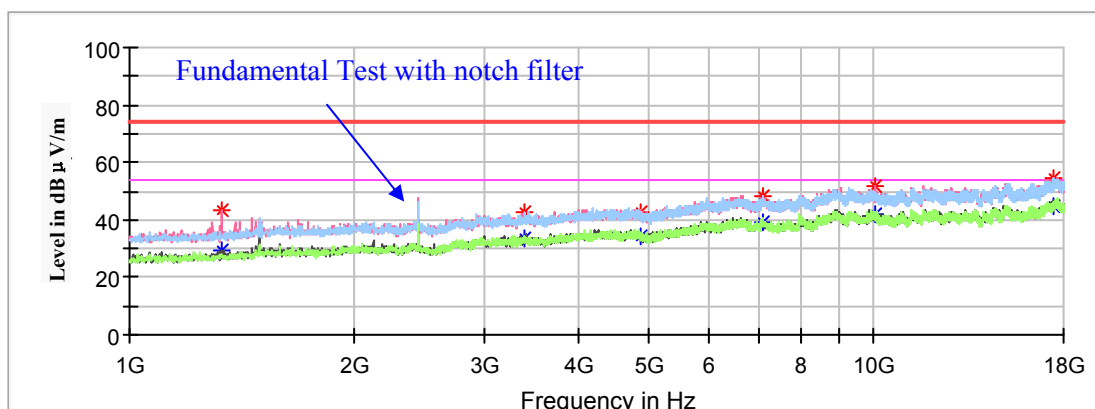
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV/m)	Average (dBμV/m)	Height (cm)	Polar (H/V)				
1493.000000	---	33.69	200.0	V	244.0	-6.5	54.00	20.31
1493.000000	41.71	---	200.0	V	244.0	-6.5	74.00	32.29
3374.900000	42.33	---	150.0	V	34.0	-1.8	74.00	31.67
3374.900000	---	32.50	150.0	V	34.0	-1.8	54.00	21.50
4804.000000	42.18	---	200.0	H	161.0	0.6	74.00	31.82
4804.000000	---	34.85	200.0	H	161.0	0.6	54.00	19.15
7125.100000	---	40.06	150.0	V	46.0	5.5	54.00	13.94
7125.100000	48.29	---	150.0	V	46.0	5.5	74.00	25.71
9423.500000	---	42.23	150.0	H	116.0	9.2	54.00	11.77
9423.500000	51.47	---	150.0	H	116.0	9.2	74.00	22.53
17595.400000	---	45.50	150.0	V	0.0	14.2	54.00	8.50
17595.400000	55.60	---	150.0	V	0.0	14.2	74.00	18.40

Middle Channel: 2440MHz

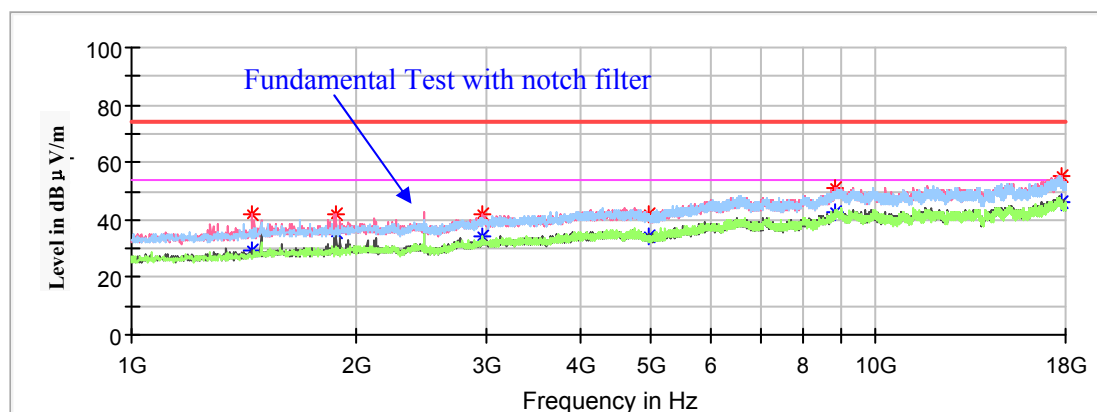
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dB μ V/m)	Margin (dB)
	MaxPeak (dB μ V/m)	Average (dB μ V/m)	Height (cm)	Polar (H/V)				
1328.100000	---	29.45	200.0	V	283.0	-7.4	54.00	24.55
1328.100000	43.46	---	200.0	V	283.0	-7.4	74.00	30.54
3403.800000	---	33.63	150.0	V	275.0	-1.8	54.00	20.37
3403.800000	42.50	---	150.0	V	275.0	-1.8	74.00	31.50
4880.000000	---	34.38	150.0	V	275.0	0.5	54.00	19.62
4880.000000	42.72	---	150.0	V	275.0	0.5	74.00	31.28
7094.500000	---	39.48	200.0	H	325.0	5.5	54.00	14.52
7094.500000	48.10	---	200.0	H	325.0	5.5	74.00	25.90
10027.000000	---	41.85	150.0	H	165.0	8.7	54.00	12.15
10027.000000	51.52	---	150.0	H	165.0	8.7	74.00	22.48
17498.500000	---	44.96	200.0	H	312.0	14.4	54.00	9.04
17498.500000	54.78	---	200.0	H	312.0	14.4	74.00	19.22

High Channel: 2480MHz

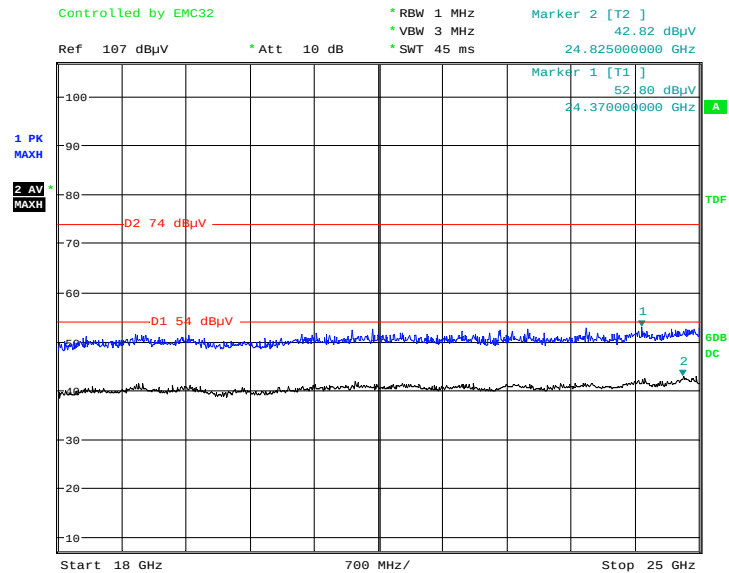
Full Spectrum



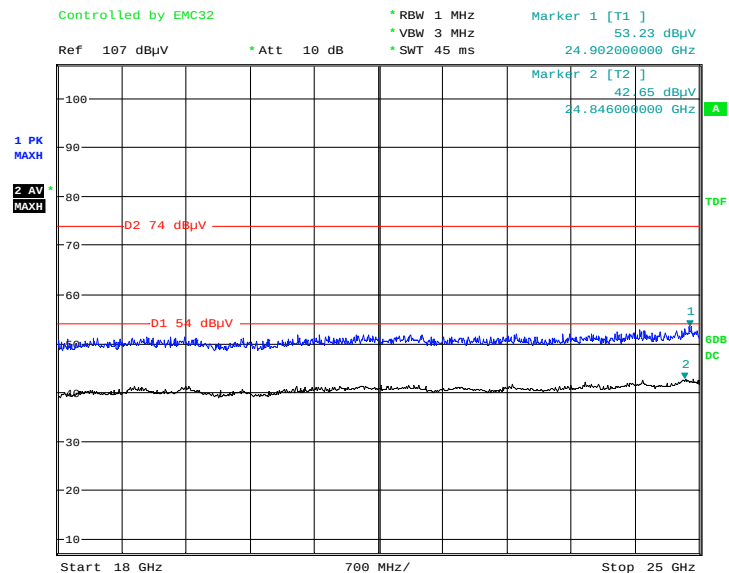
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV/m)	Average (dBμV/m)	Height (cm)	Polar (H/V)				
1448.800000	42.30	---	150.0	V	278.0	-6.8	74.00	31.70
1448.800000	---	29.31	150.0	V	278.0	-6.8	54.00	24.69
1882.300000	---	35.53	150.0	V	278.0	-5.3	54.00	18.47
1882.300000	41.73	---	150.0	V	278.0	-5.3	74.00	32.27
2958.400000	42.03	---	150.0	V	148.0	-2.2	74.00	31.97
2958.400000	---	34.10	150.0	V	148.0	-2.2	54.00	19.90
4960.000000	---	34.09	150.0	V	0.0	0.3	54.00	19.91
4960.000000	42.26	---	150.0	V	0.0	0.3	74.00	31.74
8828.500000	50.97	---	200.0	V	359.0	8.8	74.00	23.03
8828.500000	---	42.57	200.0	V	359.0	8.8	54.00	11.43
17731.400000	---	46.12	150.0	V	292.0	13.9	54.00	7.88
17731.400000	55.55	---	150.0	V	292.0	13.9	74.00	18.45

18GHz-25GHz:

(Pre-scan with low, middle and high channels of operation in the X,Y and Z axes of orientation, the worst case **middle channel of operation in Z- axis of orientation** was recorded)

Horizontal

Date: 5.SEP.2021 16:43:49

Vertical

Date: 5.SEP.2021 16:45:46

Restricted Bands Emissions Test:

(Pre-scan in the X,Y and Z axes of orientation, the worst case **Z- axis of orientation** was recorded.)

Note:

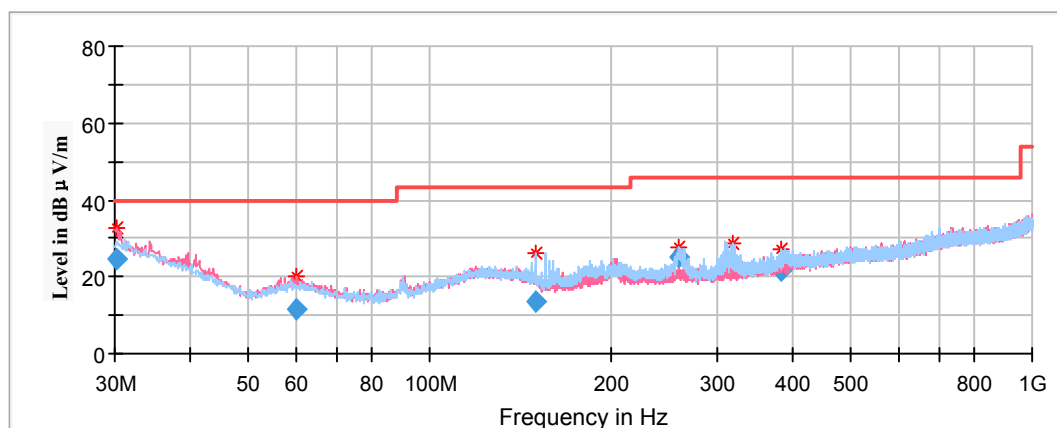
1. The test is performed with a 10dB Attenuator.
2. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) – Amplifier Factor (dB)
 Corrected Amplitude (dBμV/m) = Corrected Factor (dB/m) + Reading (dBμV)
 Margin (dB) = Limit (dBμV/m) – Corrected Amplitude (dBμV/m)

BLE (1Mbps)

Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV/m)	Average (dBμV/m)	Height (cm)	Polar (H/V)				
Low Channel: 2402MHz								
2390.00	50.35	---	200.0	V	151.0	3.8	74.00	23.65
2390.00	---	46.58	200.0	V	151.0	3.8	54.00	7.42
High Channel: 2480MHz								
2483.50	57.01	---	200.0	V	297.0	4.1	74.00	16.99
2483.50	---	48.76	200.0	V	297.0	4.1	54.00	5.24

BLE(2Mbps):**Spurious Emission Test:****30MHz-1GHz:**

(Pre-scan with low, middle and high channels of operation in the X,Y and Z axes of orientation, the worst case **middle channel of operation in the Z-axis of orientation** was recorded)



Frequency (MHz)	Corrected Amplitude	Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	Quasi-peak (dBμV/m)	Height (cm)	Polar (H/V)				
30.240283	24.68	199.0	V	233.0	-3.7	40.00	15.32
60.192150	11.34	100.0	V	259.0	-14.6	40.00	28.66
149.676650	13.81	199.0	H	285.0	-12.8	43.50	29.69
259.289950	25.03	100.0	H	236.0	-11.7	46.00	20.97
318.453850	23.49	100.0	H	61.0	-10.3	46.00	22.51
383.689350	21.80	100.0	H	143.0	-8.5	46.00	24.20

1GHz-18GHz:

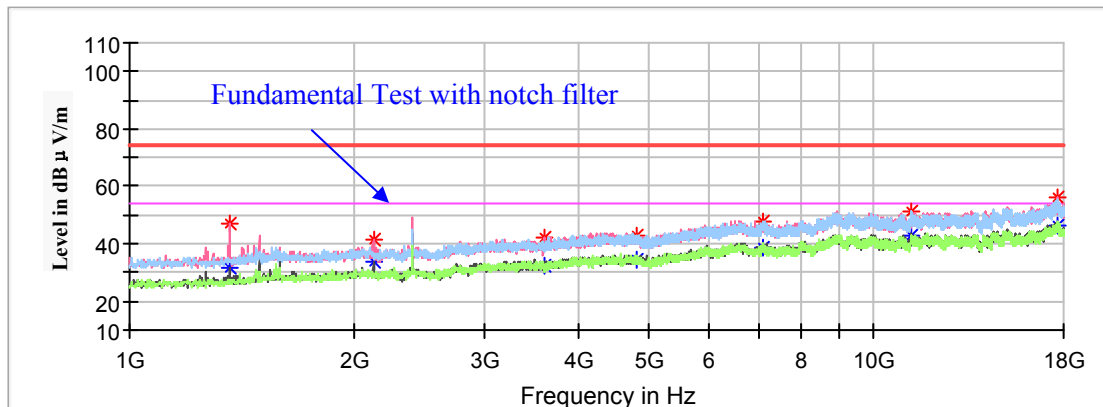
(Pre-scan in the X,Y and Z axes of orientation, the worst case **Z-axis of orientation** was recorded)

Note:

1. This test was performed with the 2.4-2.5GHz notch filter.
2. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) – Amplifier Factor (dB)
 Corrected Amplitude (dB μ V/m) = Corrected Factor (dB/m) + Reading (dB μ V)
 Margin (dB) = Limit (dB μ V/m) – Corrected Amplitude (dB μ V/m)

Low Channel: 2402MHz

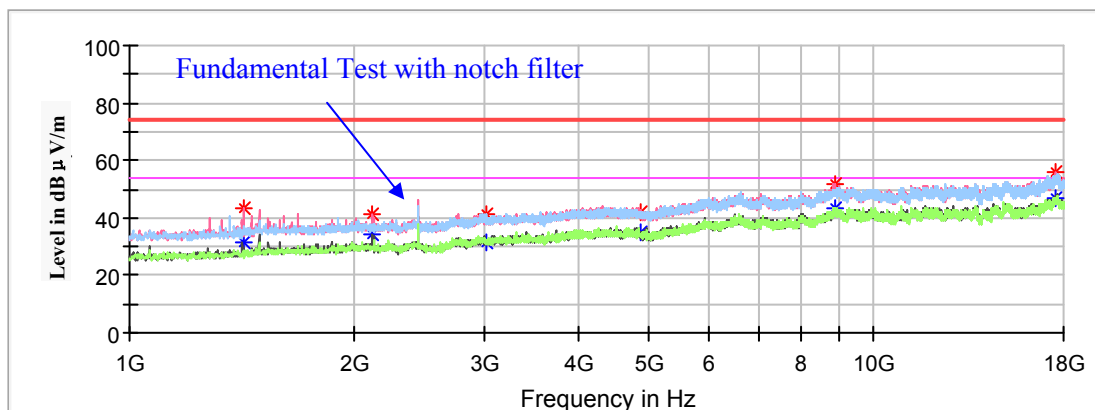
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dB μ V/m)	Margin (dB)
	MaxPeak (dB μ V/m)	Average (dB μ V/m)	Height (cm)	Polar (H/V)				
1365.500000	---	31.34	150.0	V	270.0	-7.2	54.00	22.66
1365.500000	47.10	---	150.0	V	270.0	-7.2	74.00	26.90
2125.400000	---	33.74	200.0	V	283.0	-4.7	54.00	20.26
2125.400000	41.12	---	200.0	V	283.0	-4.7	74.00	32.88
3604.400000	---	32.26	150.0	V	219.0	-1.3	54.00	21.74
3604.400000	42.21	---	150.0	V	219.0	-1.3	74.00	31.79
4804.000000	42.87	---	150.0	H	324.0	0.6	74.00	31.13
4804.000000	---	34.50	150.0	H	324.0	0.6	54.00	19.50
7082.600000	---	38.34	150.0	V	116.0	5.6	54.00	15.66
7082.600000	47.54	---	150.0	V	116.0	5.6	74.00	26.46
11210.200000	51.18	---	150.0	H	244.0	10.1	74.00	22.82
11210.200000	---	42.92	150.0	H	244.0	10.1	54.00	11.08
17620.900000	---	46.43	200.0	H	231.0	14.2	54.00	7.57
17620.900000	56.09	---	200.0	H	231.0	14.2	74.00	17.91

Middle Channel: 2440MHz

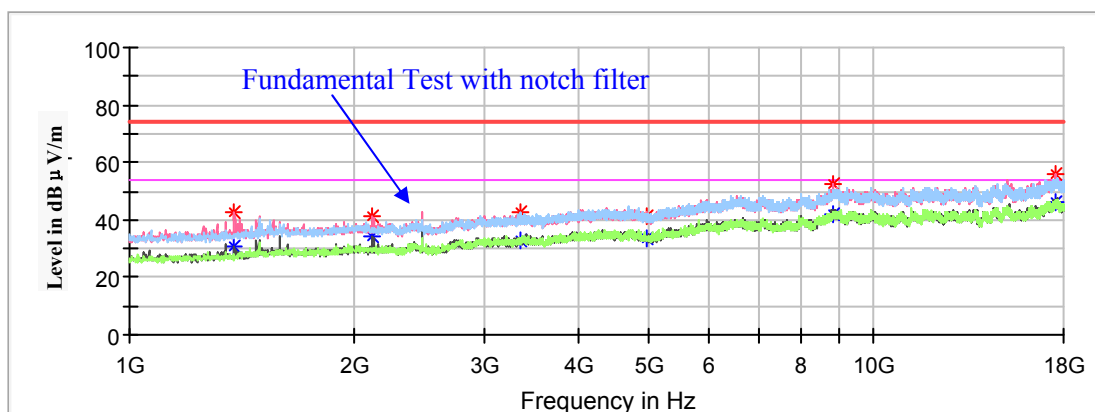
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV/m)	Average (dBμV/m)	Height (cm)	Polar (H/V)				
1421.600000	---	31.72	150.0	V	266.0	-6.9	54.00	22.28
1421.600000	43.57	---	150.0	V	266.0	-6.9	74.00	30.43
2123.700000	---	34.03	200.0	V	154.0	-4.7	54.00	19.97
2123.700000	41.05	---	200.0	V	154.0	-4.7	74.00	32.95
3021.300000	---	31.70	150.0	H	72.0	-2.0	54.00	22.30
3021.300000	41.55	---	150.0	H	72.0	-2.0	74.00	32.45
4880.000000	---	34.88	200.0	V	166.0	0.5	54.00	19.12
4880.000000	42.29	---	200.0	V	166.0	0.5	74.00	31.71
8857.400000	---	43.01	200.0	H	219.0	8.9	54.00	10.99
8857.400000	51.67	---	200.0	H	219.0	8.9	74.00	22.33
17612.400000	---	47.02	150.0	V	317.0	14.2	54.00	6.98
17612.400000	55.67	---	150.0	V	317.0	14.2	74.00	18.33

High Channel: 2480MHz

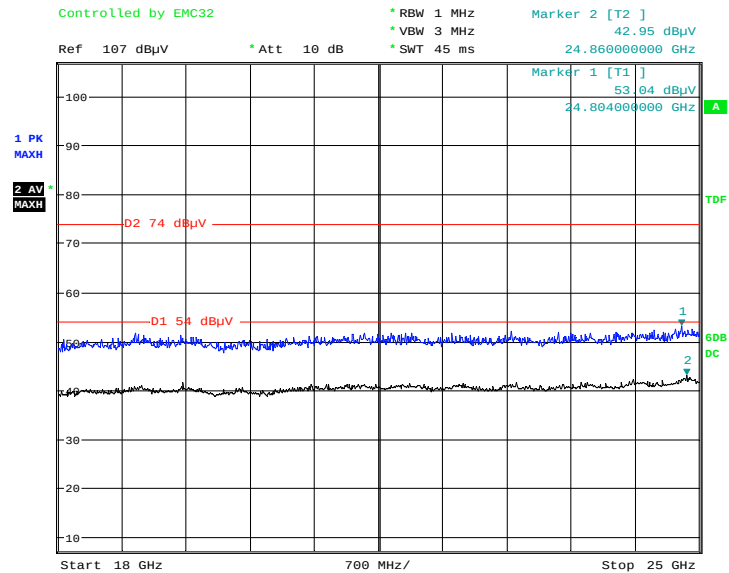
Full Spectrum



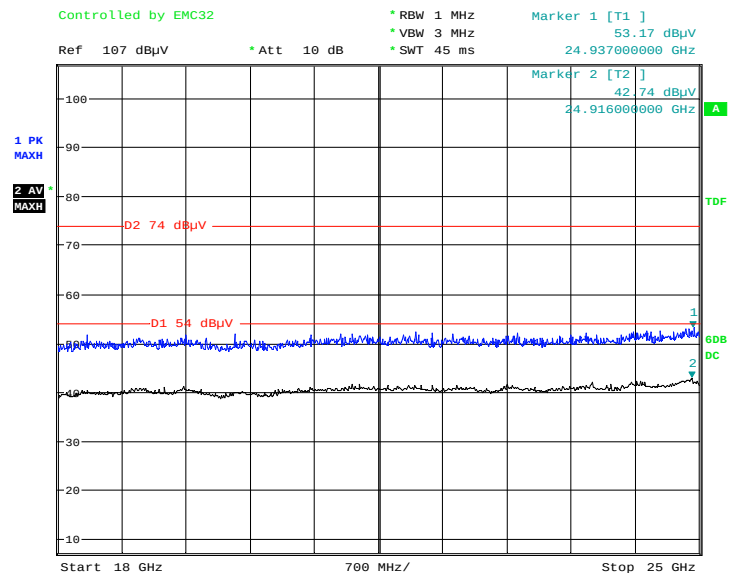
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV/m)	Average (dBμV/m)	Height (cm)	Polar (H/V)				
1384.200000	42.48	---	200.0	V	269.0	-7.1	74.00	31.52
1384.200000	---	30.57	200.0	V	269.0	-7.1	54.00	23.43
2123.700000	41.16	---	200.0	V	152.0	-4.7	74.00	32.84
2123.700000	---	34.13	200.0	V	152.0	-4.7	54.00	19.87
3361.300000	42.47	---	150.0	H	154.0	-1.8	74.00	31.53
3361.300000	---	33.04	150.0	H	154.0	-1.8	54.00	20.96
4960.000000	---	33.74	200.0	V	51.0	0.3	54.00	20.26
4960.000000	41.23	---	200.0	V	51.0	0.3	74.00	32.77
8806.400000	---	42.05	150.0	V	314.0	8.7	54.00	11.95
8806.400000	52.19	---	150.0	V	314.0	8.7	74.00	21.81
17576.700000	55.67	---	200.0	V	13.0	14.3	74.00	18.33
17576.700000	---	46.22	200.0	V	13.0	14.3	54.00	7.78

18GHz-25GHz:

(Pre-scan with low, middle and high channels of operation in the X,Y and Z axes of orientation, the worst case **middle channel of operation in Z-axis of orientation** was recorded)

Horizontal

Date: 5.SEP.2021 16:47:43

Vertical

Date: 5.SEP.2021 16:48:58

Restricted Bands Emissions Test:

(Pre-scan in the X,Y and Z axes of orientation, the worst case **Z-axis of orientation** was recorded.)

Note:

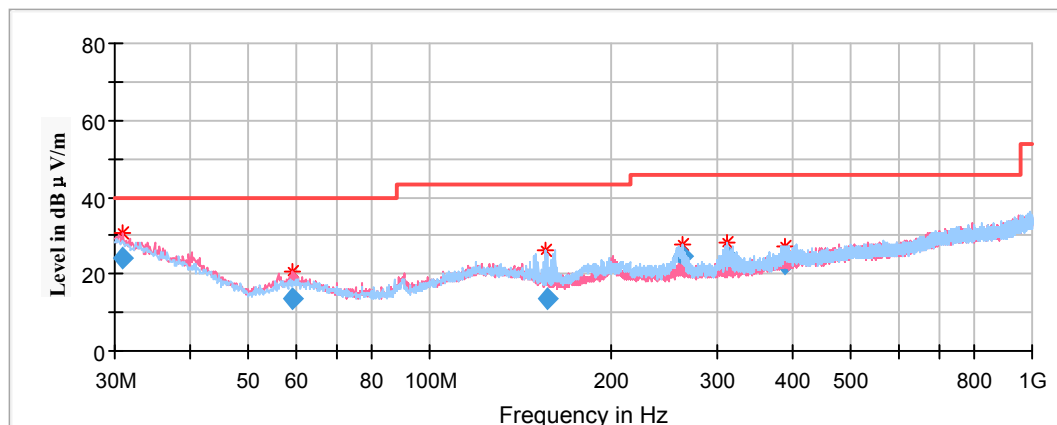
1. The test is performed with a 10dB Attenuator.
2. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) – Amplifier Factor (dB)
 Corrected Amplitude (dBμV/m) = Corrected Factor (dB/m) + Reading (dBμV)
 Margin (dB) = Limit (dBμV/m) – Corrected Amplitude (dBμV/m)

BLE (2Mbps)

Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV/m)	Average (dBμV/m)	Height (cm)	Polar (H/V)				
Low Channel: 2402MHz								
2390.00	50.39	---	200.0	V	87.0	3.8	74.00	23.61
2390.00	---	45.92	200.0	V	87.0	3.8	54.00	8.08
High Channel: 2480MHz								
2483.50	58.59	---	200.0	V	291.0	4.1	74.00	15.41
2483.50	---	47.20	200.0	V	291.0	4.1	54.00	6.80

For NFC, GSM/WCDMA/LTE and BLE transmitting simultaneously test:**30MHz-1GHz:**

(The worst case NFC 13.56MHz, band 2 of LTE and low channel of BLE mode transmitting simultaneously was recorded)



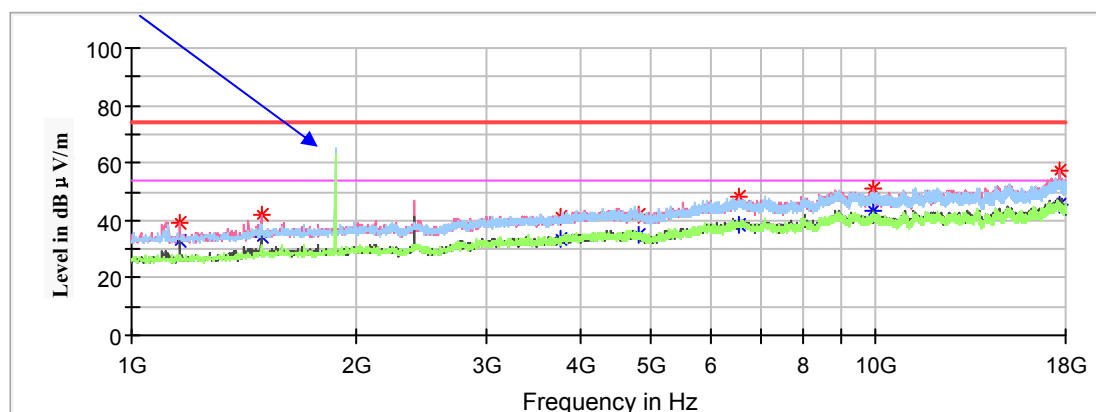
Frequency (MHz)	Corrected Amplitude	Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	QuasiPeak (dBμV/m)	Height (cm)	Polar (H/V)				
30.975264	23.99	100.0	V	140.0	-3.8	40.00	16.01
59.108700	13.81	199.0	V	199.0	-14.6	40.00	26.19
156.300600	13.82	100.0	H	302.0	-13.8	43.50	29.68
262.183900	24.77	100.0	H	20.0	-11.7	46.00	21.23
312.649950	24.22	100.0	H	133.0	-10.5	46.00	21.78
389.445300	22.89	100.0	H	133.0	-8.3	46.00	23.11

1GHz-18GHz:

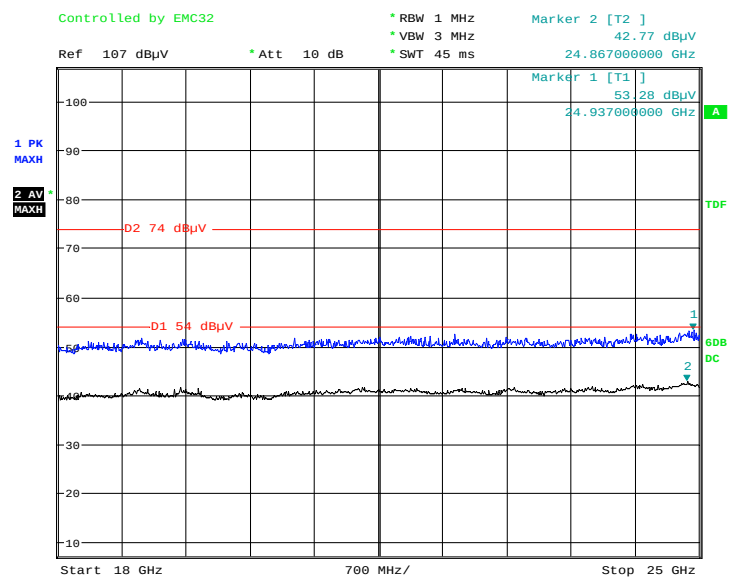
(The worst case band 13 of LTE and low channel of BLE mode transmitting simultaneously was recorded)

Fundamental Test with notch filter

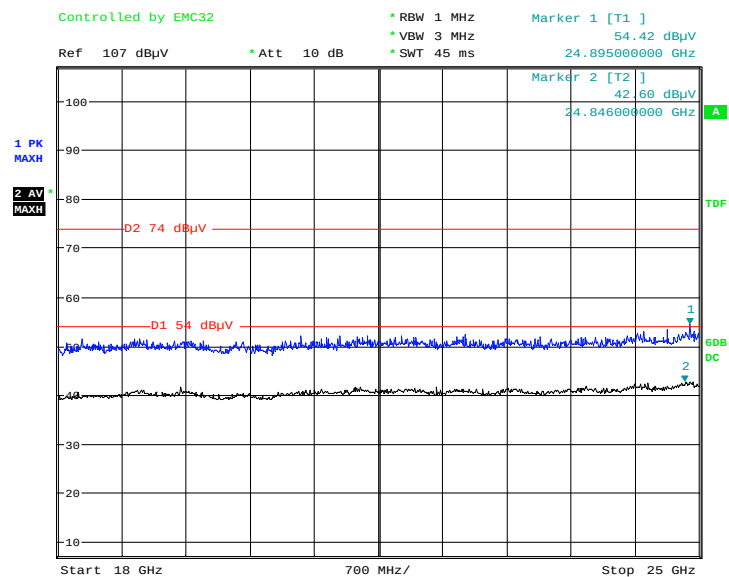
Full Spectrum



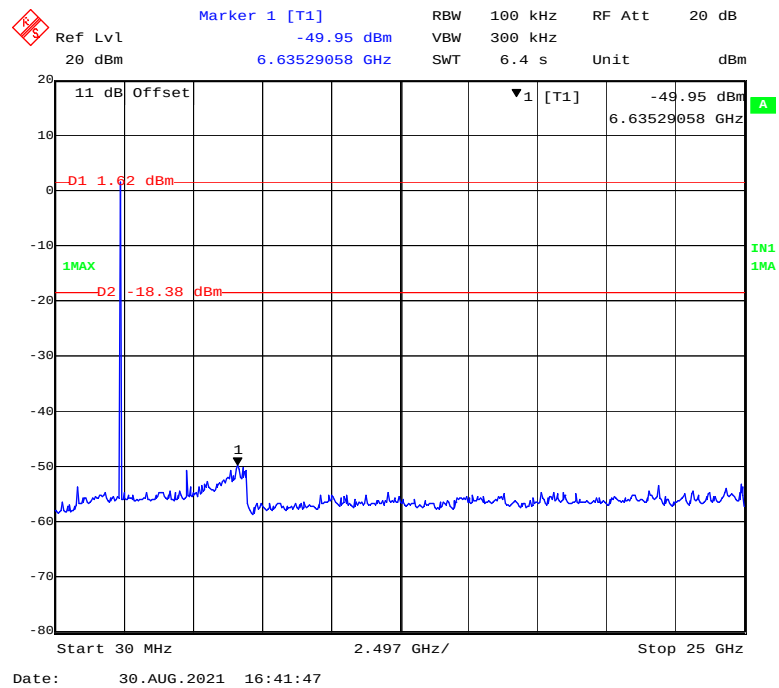
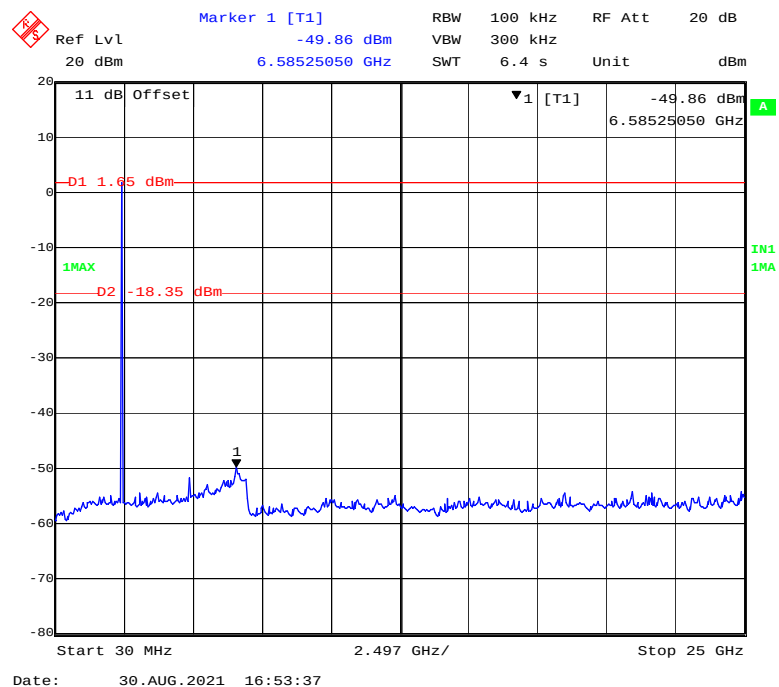
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV/m)	Average (dBμV/m)	Height (cm)	Polar (H/V)				
1159.800000	---	32.64	200.0	V	24.0	-8.2	54.00	21.36
1159.800000	38.89	---	200.0	V	24.0	-8.2	74.00	35.11
1493.000000	---	34.49	200.0	V	153.0	-6.5	54.00	19.51
1493.000000	41.64	---	200.0	V	153.0	-6.5	74.00	32.36
3761.600000	---	33.46	150.0	V	68.0	-0.5	54.00	20.54
3761.600000	41.05	---	150.0	V	68.0	-0.5	74.00	32.95
4804.600000	---	34.88	150.0	H	359.0	0.6	54.00	19.12
4804.600000	42.27	---	150.0	H	359.0	0.6	74.00	31.73
6550.500000	---	38.46	200.0	V	322.0	5.4	54.00	15.54
6550.500000	47.96	---	200.0	V	322.0	5.4	74.00	26.04
9921.600000	---	43.61	200.0	V	0.0	8.8	54.00	10.39
9921.600000	50.86	---	200.0	V	0.0	8.8	74.00	23.14
17668.500000	---	45.52	150.0	V	264.0	14.0	54.00	8.48
17668.500000	57.42	---	150.0	V	264.0	14.0	74.00	16.58

18 GHz–25 GHz*(The worst case NFC13.56MHz band 2 of LTE and low channel of BLE mode transmitting simultaneously was recorded)***Horizontal**

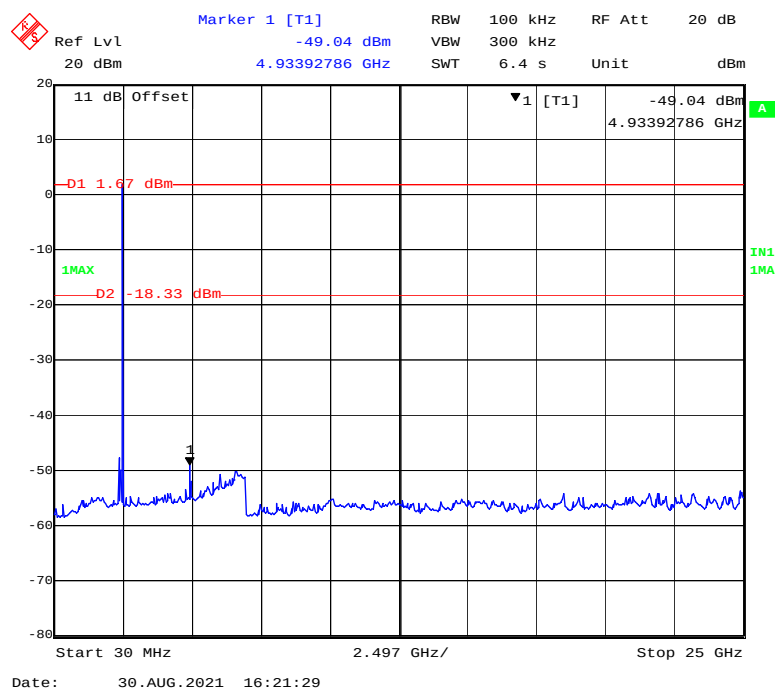
Date: 5.SEP.2021 16:52:39

Vertical

Date: 5.SEP.2021 16:54:07

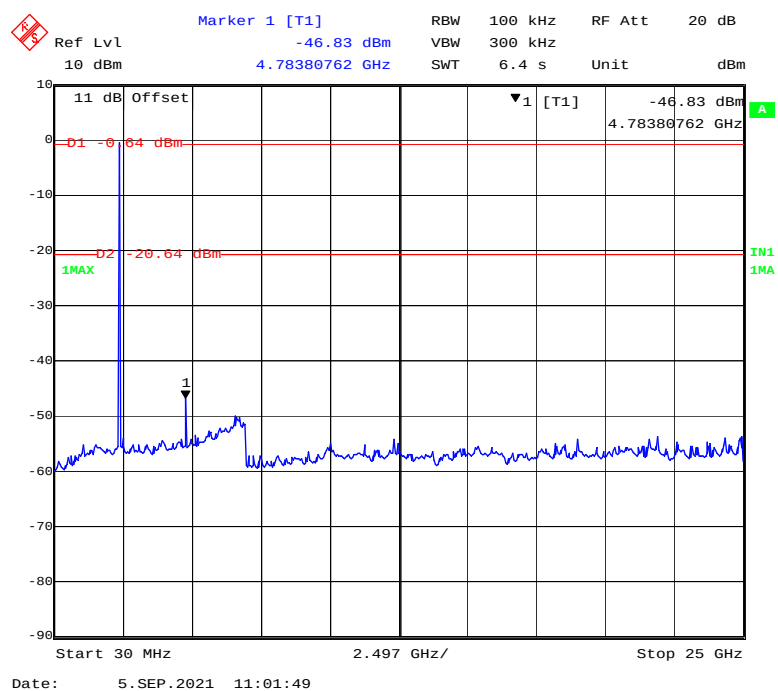
Conducted Spurious Emissions at Antenna Port:**BLE (1Mbps):****Low Channel****Middle Channel**

High Channel

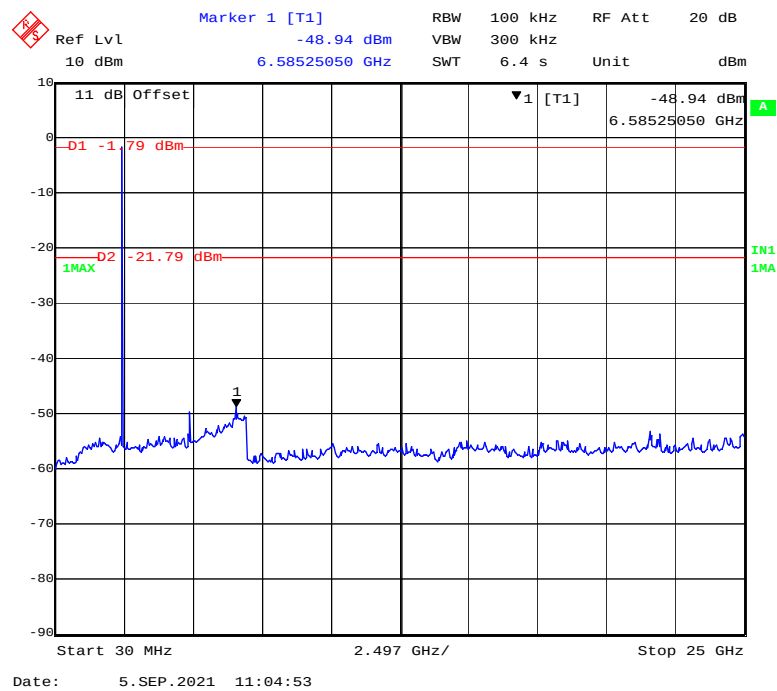


BLE (2Mbps):

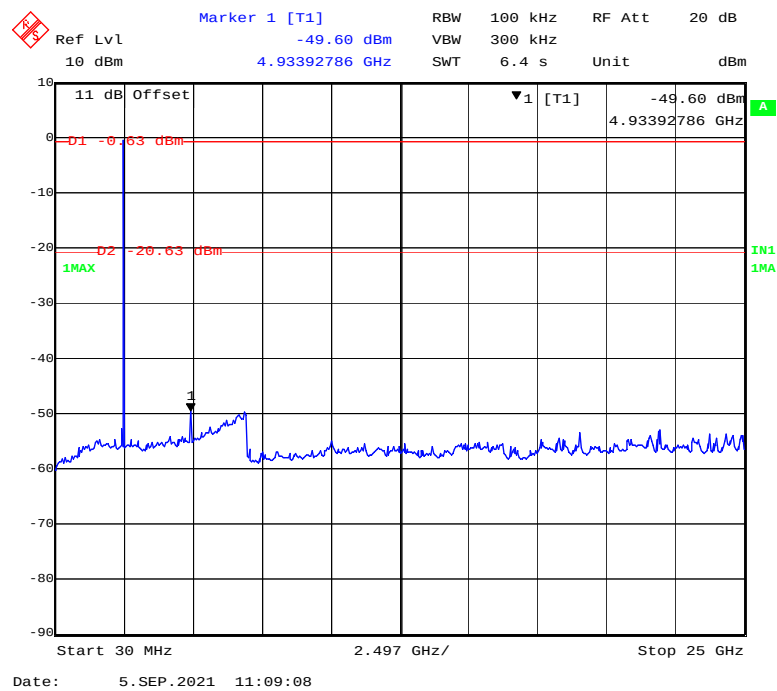
Low Channel



Middle Channel



High Channel



FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH

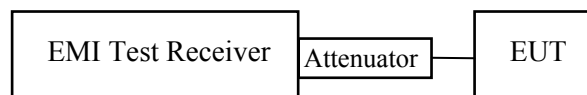
Applicable Standard

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Test Procedure

According to ANSI C63.10-2013 sub-clause 11.8.1

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) $\geq 3 * \text{RBW}$.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.



Test Data**Environmental Conditions**

Temperature:	24.6-25.3 °C
Relative Humidity:	49-52 %
ATM Pressure:	101.1-101.3 kPa

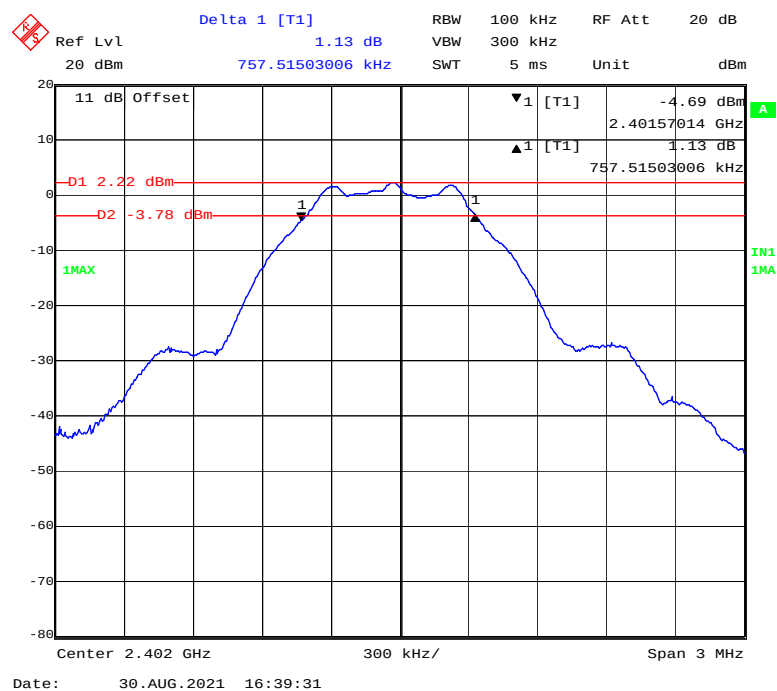
The testing was performed by Miller Xie from 2021-08-30 to 2021-09-05.

Test Result: Compliant.

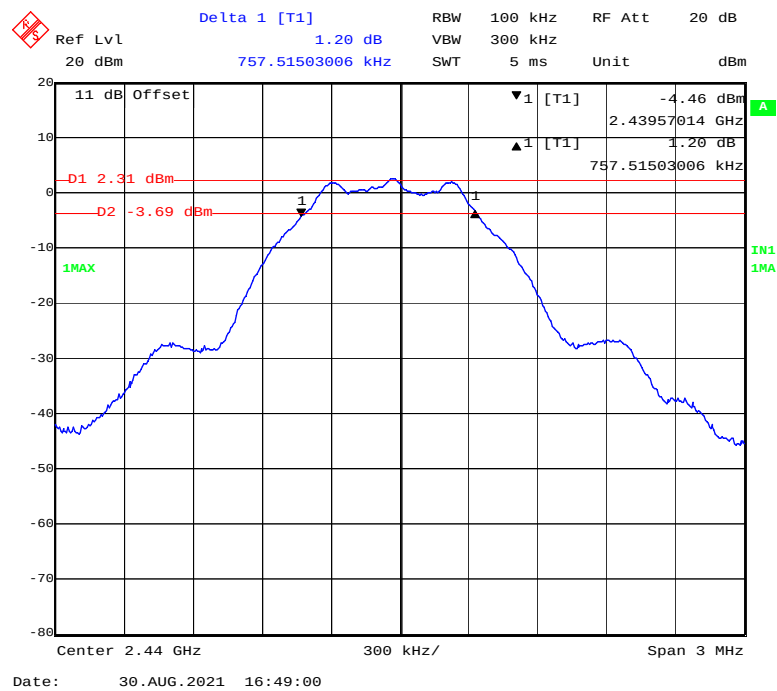
EUT operation mode: Transmitting

BLE (1Mbps):

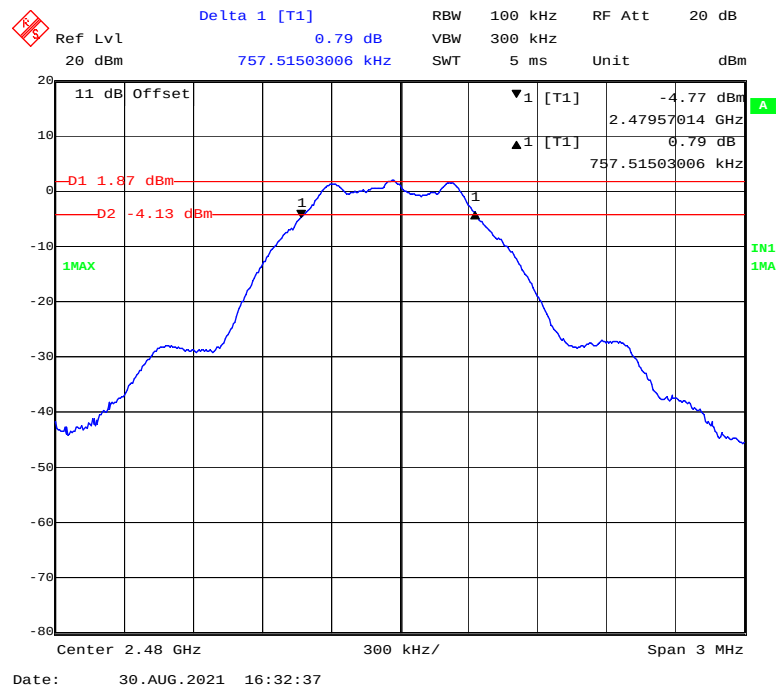
Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	Limit (MHz)
Low	2402	0.758	≥ 0.5
Middle	2440	0.758	≥ 0.5
High	2480	0.758	≥ 0.5

Low Channel

Middle Channel

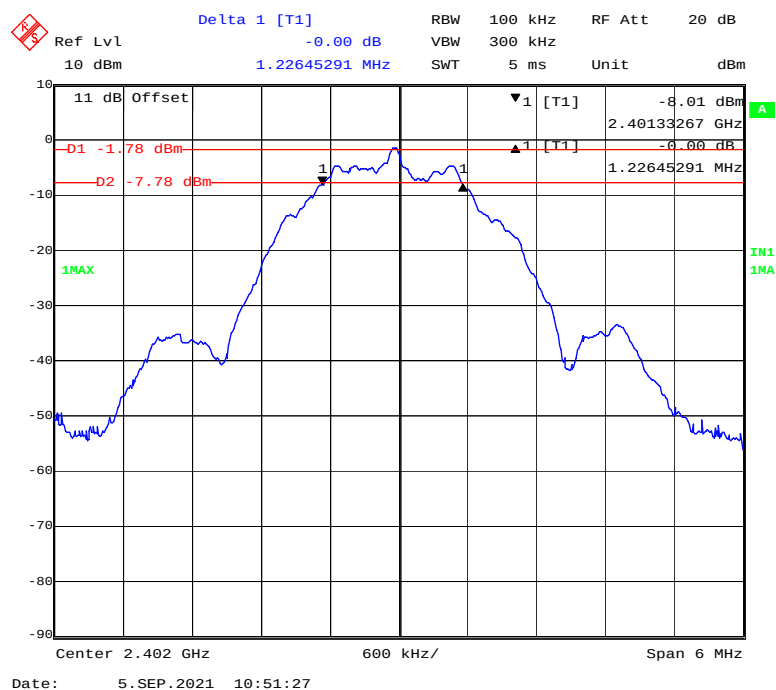


High Channel



BLE (2Mbps):

Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	Limit (MHz)
Low	2402	1.226	≥ 0.5
Middle	2440	1.226	≥ 0.5
High	2480	1.226	≥ 0.5

Low Channel

Ref Lvl 10 dBm Delta 1 [T1] 1.39 dB RBW 100 kHz RF Att 20 dB
 1.22645291 MHz VSW 300 kHz Unit dBm

11 dB Offset

D1 -1.36 dBm

D2 -7.36 dBm

1MAX

1 [T1]

1 [T1]

1.22645291 MHz

2.43930862 GHz

IN1 IMA

Center 2.44 GHz 600 kHz/ Span 6 MHz

Date: 5.SEP.2021 10:50:36

Delta 1 [T1]

Ref Lvl 10 dBm

1.36 dB

1.22645291 MHz

RBW 100 kHz

VBW 300 kHz

SWT 5 ms

RF Att 20 dB

Unit dBm

11 dB Offset

D1 -0.36 dBm

D2 -6.36 dBm

1MAX

▼ 1 [T1] -6.96 dBm

▲ 1 [T1] 1.36 dB

1.22645291 MHz

IN1 1MA

Center 2.48 GHz

600 kHz/

Span 6 MHz

Date: 5.SEP.2021 10:54:42

FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

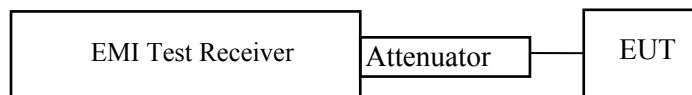
Applicable Standard

According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

Test Procedure

According to ANSI C63.10-2013 sub-clause 11.9.1.1

1. Set the RBW $\geq$ DTS bandwidth.
2. Set VBW $\geq 3 * \text{RBW}$.
3. Set span $\geq 3 * \text{RBW}$
4. Sweep time = auto couple.
5. Detector = peak.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use peak marker function to determine the peak amplitude level.



Test Data**Environmental Conditions**

Temperature:	24.6-25.3 °C
Relative Humidity:	49-52 %
ATM Pressure:	101.1-101.3 kPa

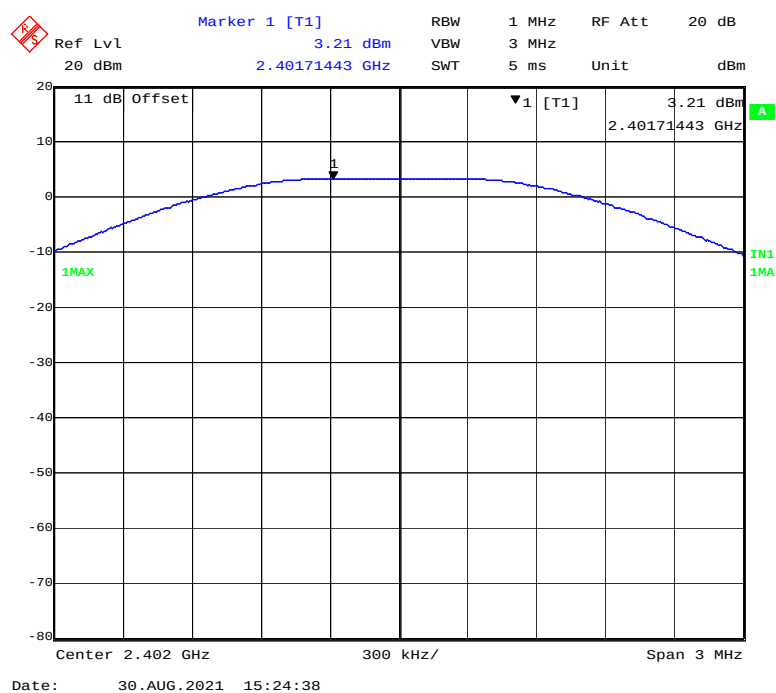
The testing was performed by Miller Xie from 2021-08-30 to 2021-09-05.

Test Result: Compliant.

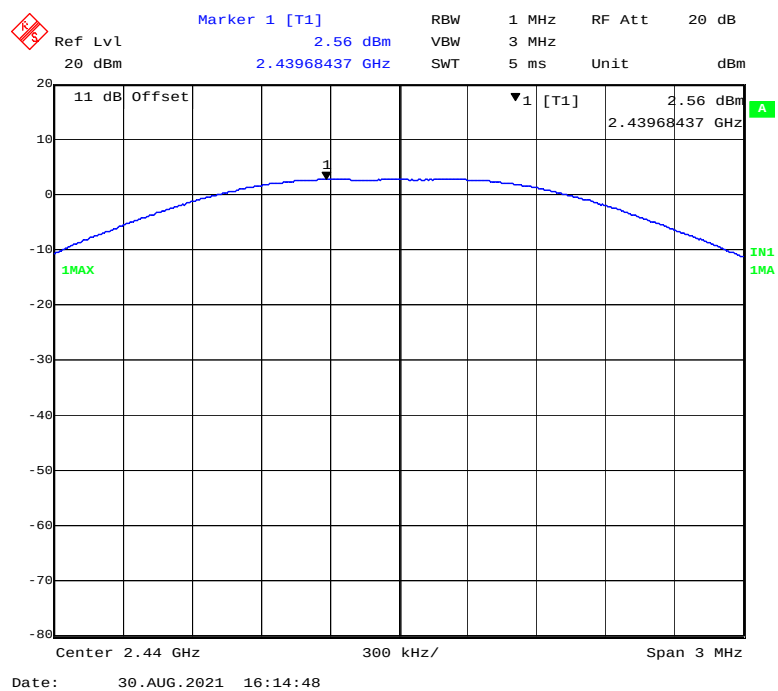
EUT operation mode: Transmitting

BLE (1Mbps):

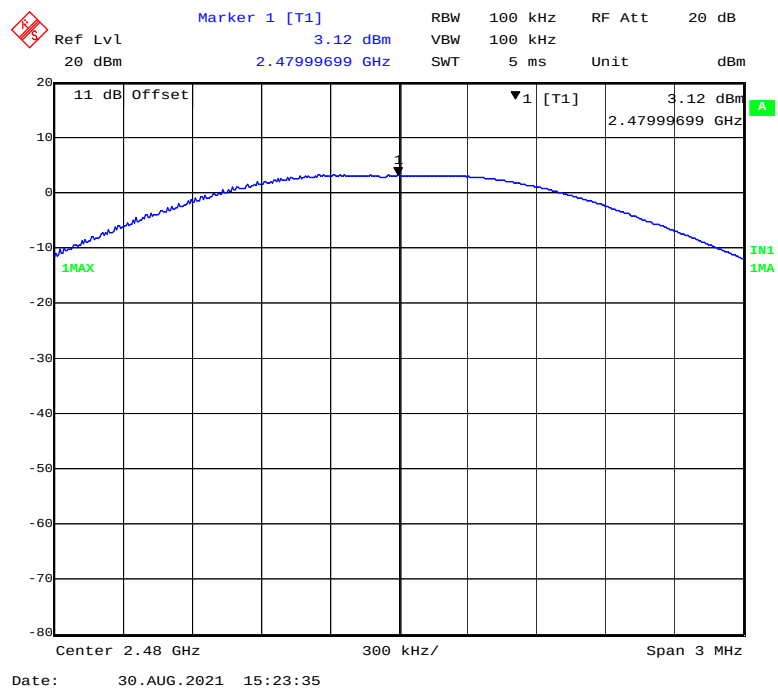
Channel	Frequency (MHz)	Max Conducted Peak Output Power (dBm)	Limit (dBm)	Result
Low	2402	3.21	30	Pass
Middle	2440	2.56	30	Pass
High	2480	3.12	30	Pass

Low Channel

Middle Channel

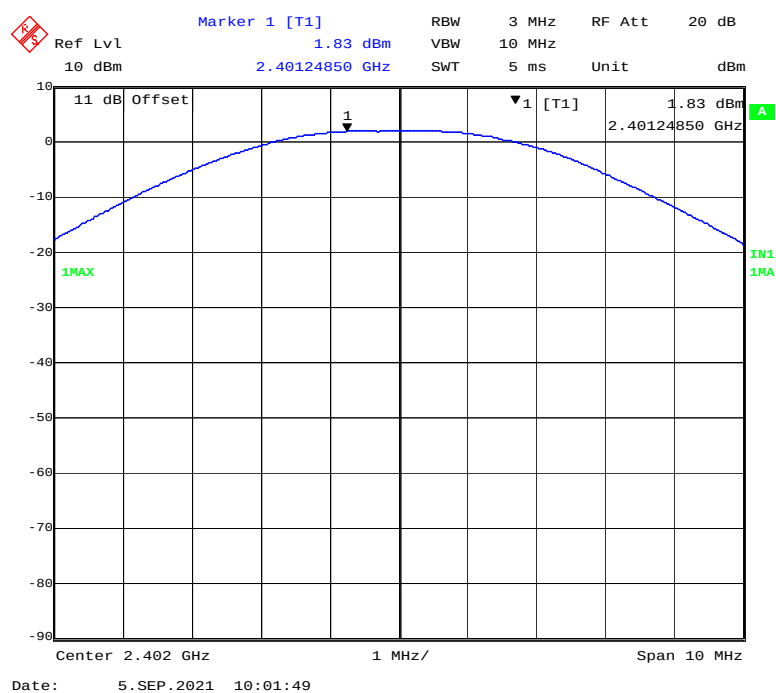


High Channel

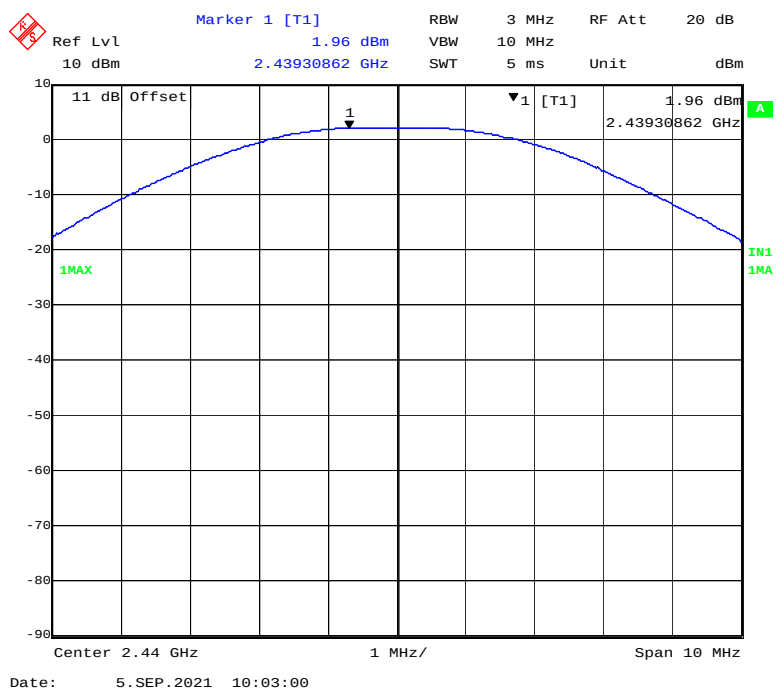


BLE (2Mbps):

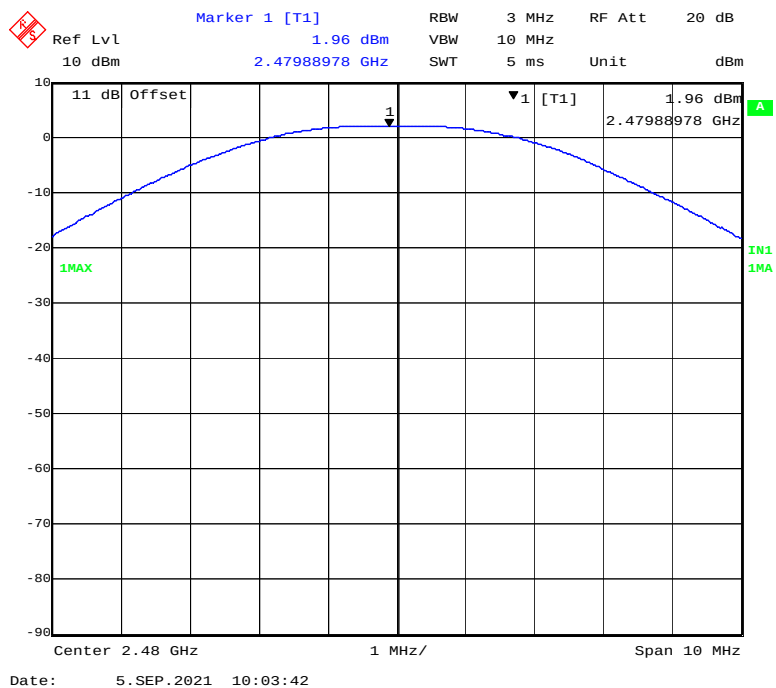
Channel	Frequency (MHz)	Max Conducted Peak Output Power (dBm)	Limit (dBm)	Result
Low	2402	1.83	30	Pass
Middle	2440	1.96	30	Pass
High	2480	1.96	30	Pass

Low Channel

Middle Channel



High Channel



FCC §15.247(d) – BAND EDGE

Applicable Standard

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Test Procedure

According to ANSI C63.10-2013 sub-clause 6.10.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

Test Data

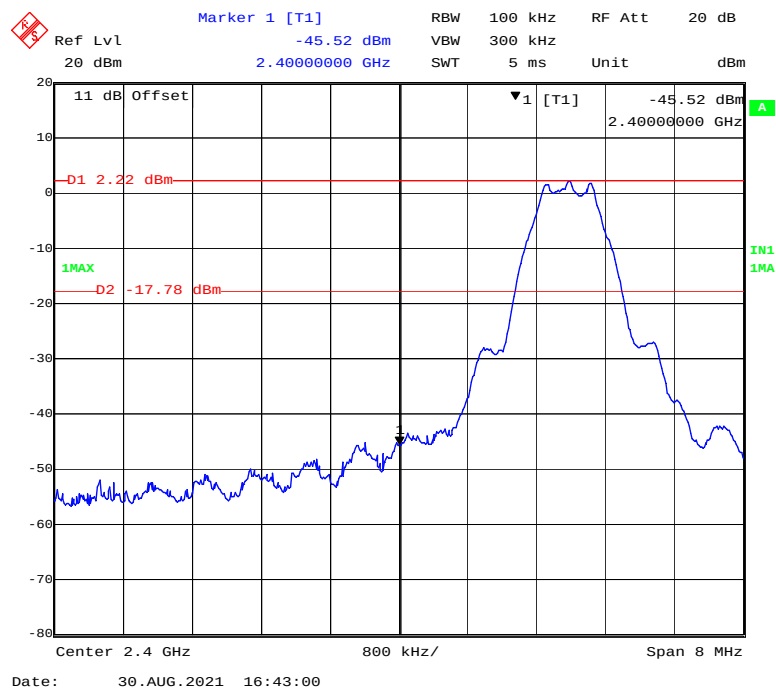
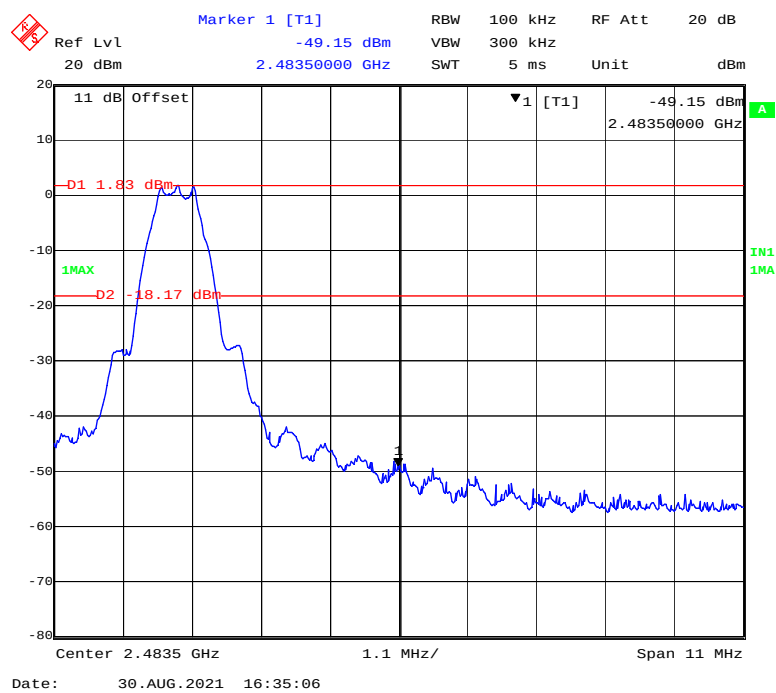
Environmental Conditions

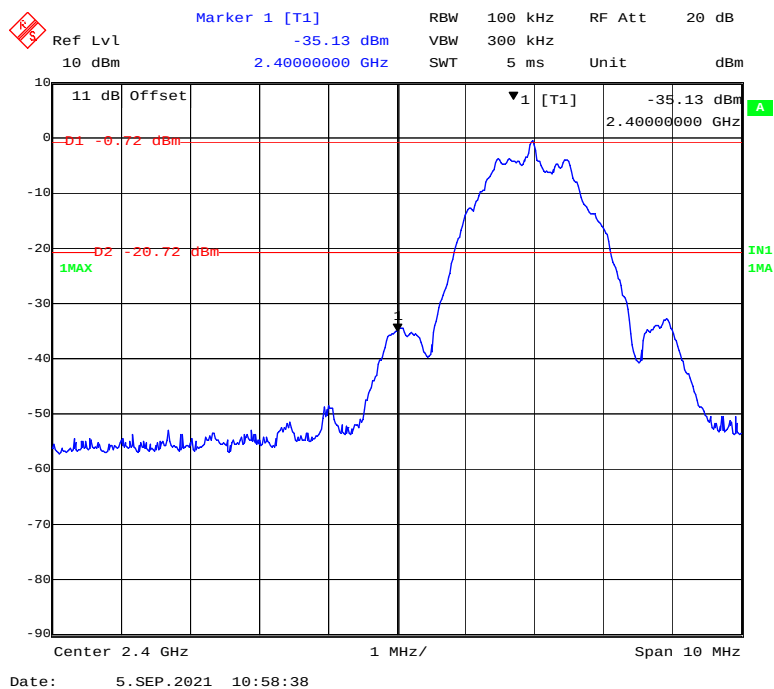
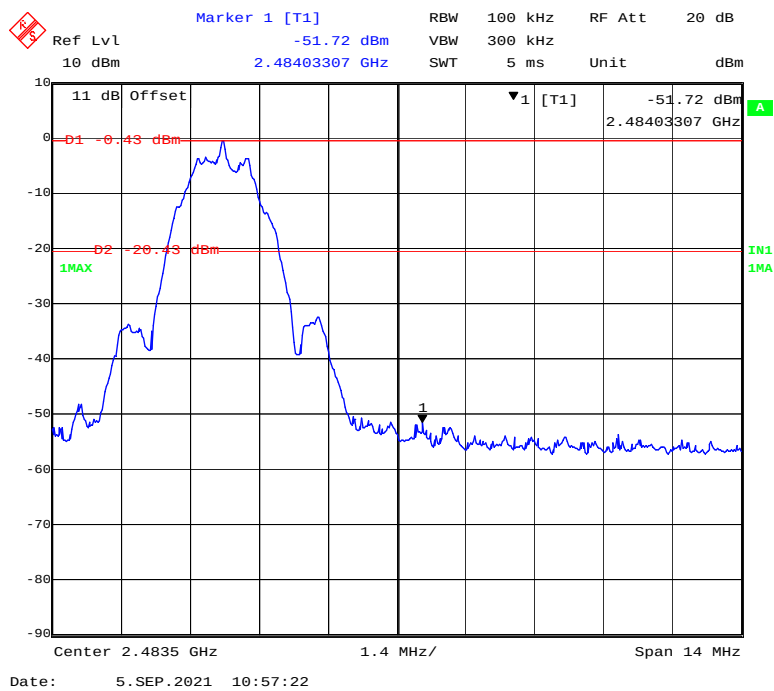
Temperature:	24.6-25.3 °C
Relative Humidity:	49-52 %
ATM Pressure:	101.1-101.3 kPa

The testing was performed by Miller Xie from 2021-08-30 to 2021-09-05.

Test Result: Compliant.

EUT operation mode: Transmitting

BLE (1Mbps):**Left Side****Right Side**

BLE (2Mbps):**Left Side****Right Side**

FCC §15.247(e) - POWER SPECTRAL DENSITY

Applicable Standard

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Test Procedure

According to ANSI C63.10-2013 sub-clause 11.10.2

The following procedure shall be used if maximum peak conducted output power was used to determine compliance, and it is optional if the maximum conducted (average) output power was used to determine compliance:

1. Set the RBW to: $3\text{ kHz} \leq \text{RBW} \leq 100\text{ kHz}$.
2. Set the VBW $\geq 3 * \text{RBW}$.
3. Set the span to 1.5 times the DTS bandwidth.
4. Detector = peak.
5. Sweep time = auto couple.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use the peak marker function to determine the maximum amplitude level within the RBW.
9. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

Test Data

Environmental Conditions

Temperature:	24.6-25.3 °C
Relative Humidity:	49-52 %
ATM Pressure:	101.1-101.3 kPa

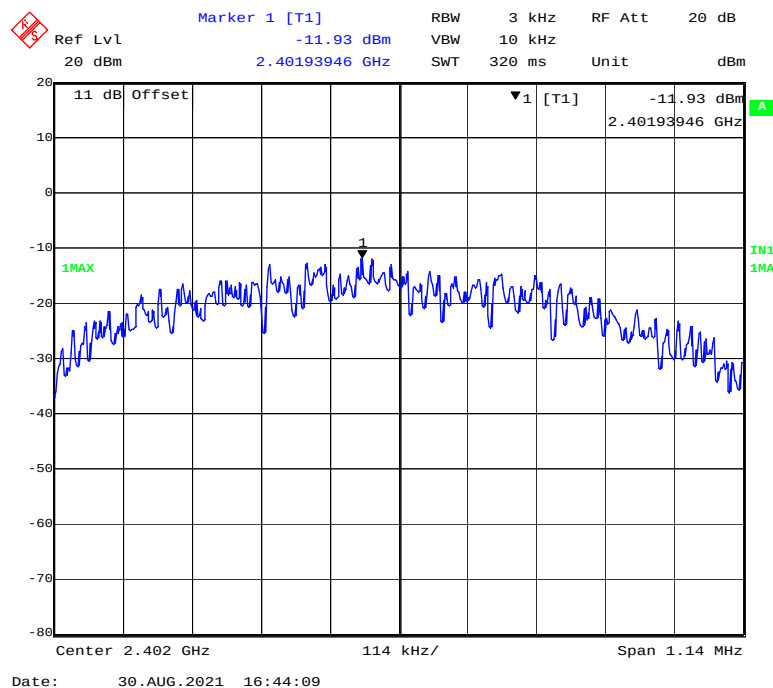
The testing was performed by Miller Xie from 2021-08-30 to 2021-09-05.

Test Result: Compliant.

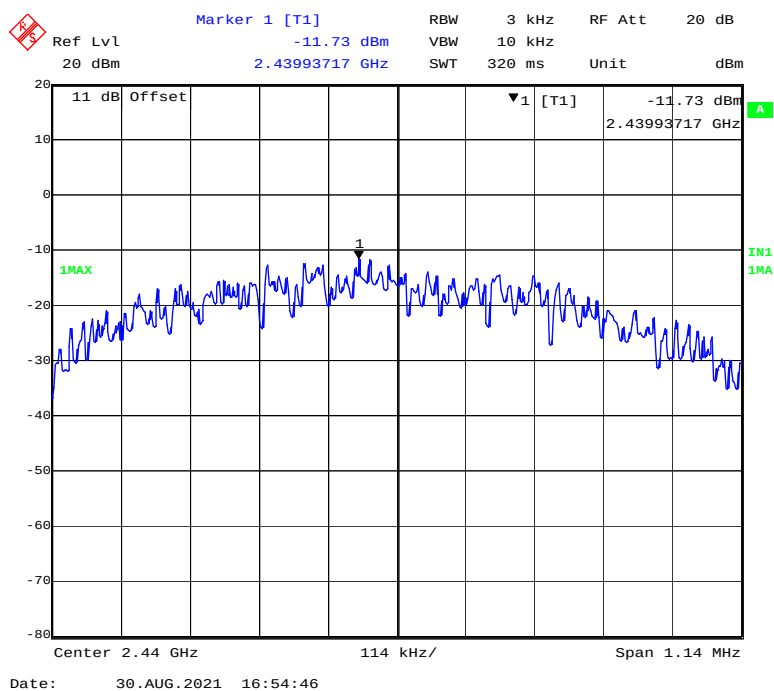
EUT operation mode: Transmitting

BLE (1Mbps):

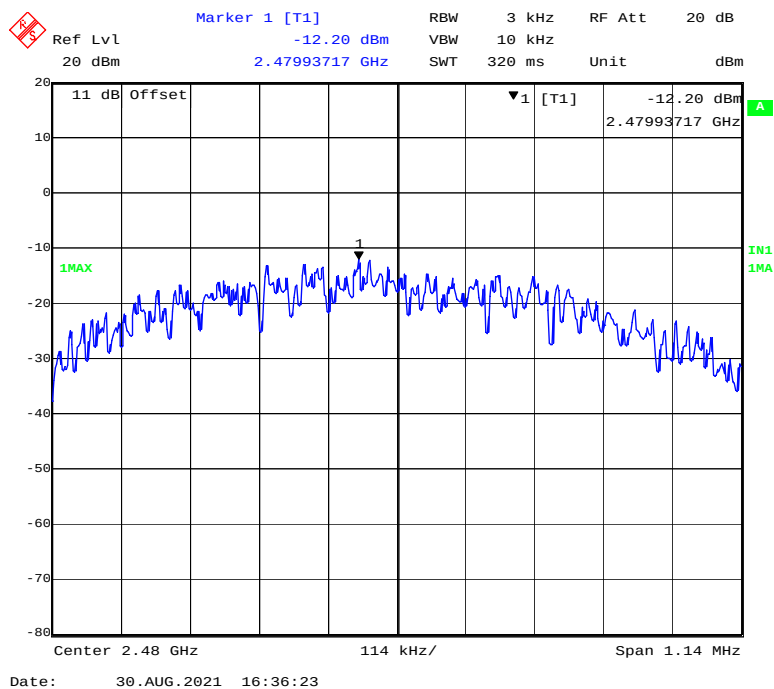
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
Low	2402	-11.93	≤ 8
Middle	2440	-11.73	≤ 8
High	2480	-12.20	≤ 8

Low Channel

Middle Channel

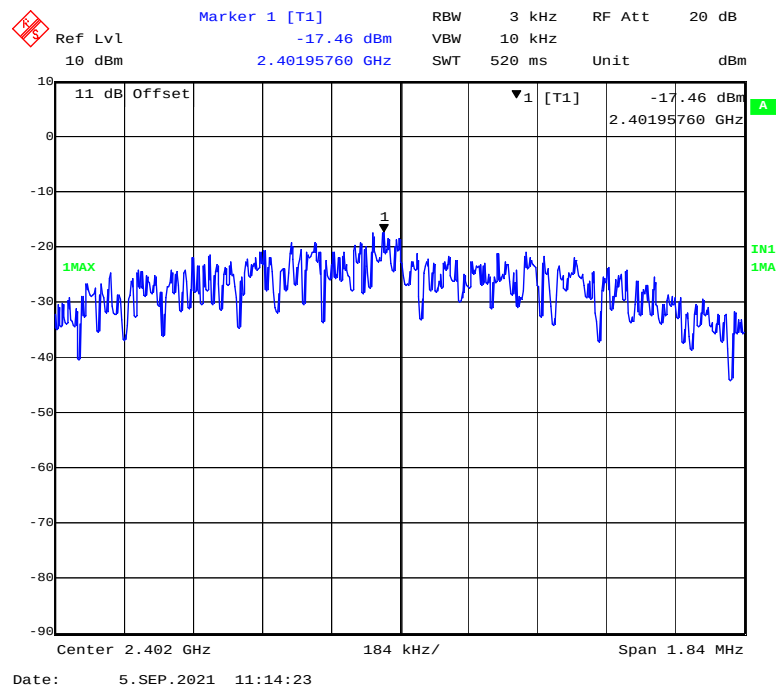


High Channel

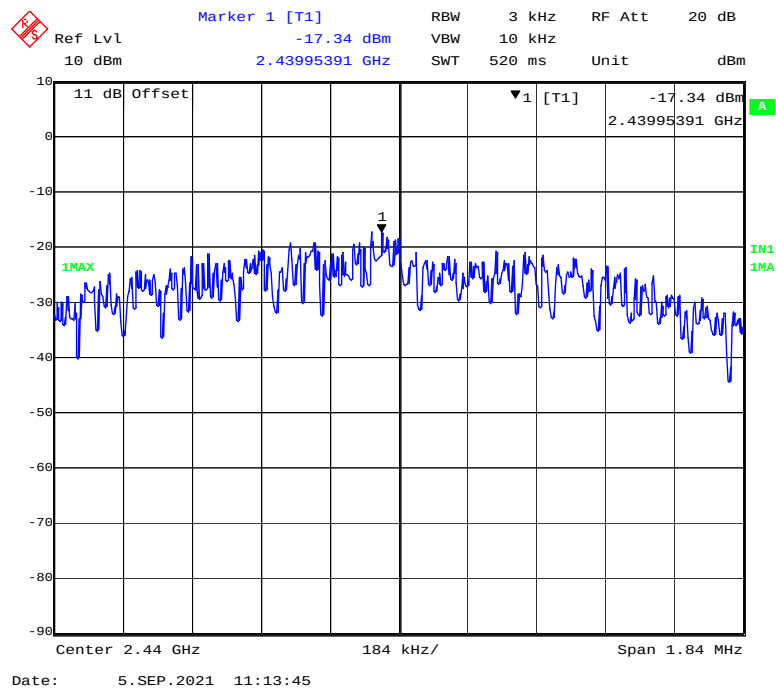


BLE (2Mbps):

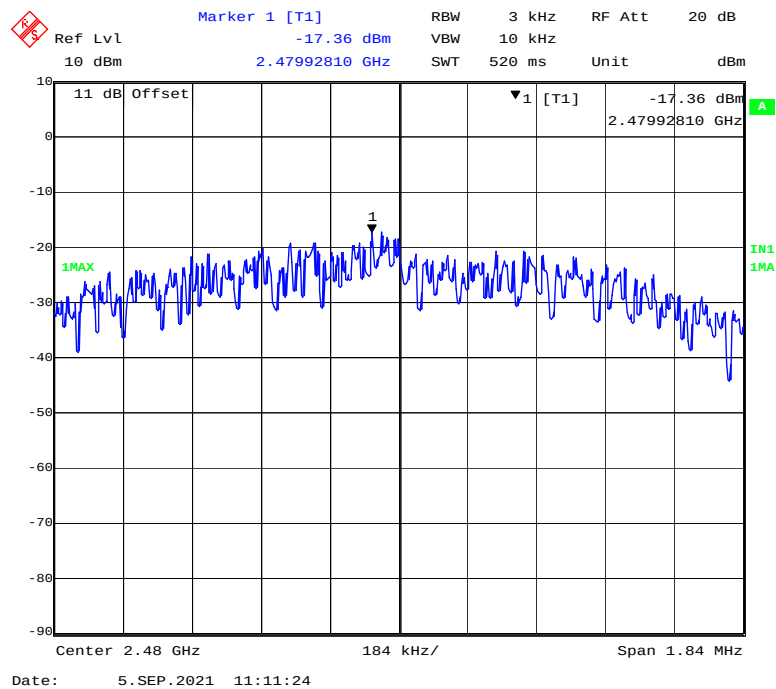
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
Low	2402	-17.46	≤ 8
Middle	2440	-17.34	≤ 8
High	2480	-17.36	≤ 8

Low Channel

Middle Channel



High Channel



Declarations

- 1: BACL is not responsible for the authenticity of any test data provided by the applicant. Data included from the applicant that may affect test results are marked with an asterisk '*'. Customer model name, addresses, names, trademarks etc. are not considered data.
- 2: Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.
- 3: Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.
- 4: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval.
- 5: This report cannot be reproduced except in full, without prior written approval of the Company.
- 6: This report is valid only with a valid digital signature. The digital signature may be available only under the Adobe software above version 7.0.

******* END OF REPORT *******