

RF TEST REPORT

LP0002:2020

APPLICANT

美敦力醫療產品股份有限公司

BRAND NAME

Medtronic

MODEL NAME

Guardian Link (3), MMT-7911

REPORT NUMBER

HA200611-MMD-001-R03

TEST REPORT

Date of Issue
February 17, 2021

Test Site
Hyundai C-Tech, Inc. dba HCT America, Inc.
1726 Ringwood Ave, San Jose, CA 95131, USA

Applicant	美敦力醫療產品股份有限公司
Applicant Address	臺北市松山區敦化南路1段2號2樓
Manufacturer	Medtronic MiniMed, Inc.
Product Name	Glucose Sensor Transmitter
Brand Name	Medtronic
Model Name	Guardian Link (3), MMT-7911
RF Specification	Bluetooth V4.2 LE
Modulation Type	GFSK
Equipment Classification	Digital Transmission System (DTS)
NCC Rule Part(s)	LP0002:2020
Test Procedure	ANSI C63.10-2013, KDB 558074 D01 v05r02

The device bearing the trade name and model specified above, has been shown to comply with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures required. The results of testing in this report apply only to the product which was tested. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Tested By



Yongsoo Park

Test Engineer

Reviewed By



Sunwoo Kim

Technical Manager

REVISION HISTORY

The revision history for this document is shown in table.

TEST REPORT NO.	DATE	DESCRIPTION
HA200611-MMD-001-R03	2/17/2021	Initial Issue

TABLE OF CONTENTS

1. GENERAL INFORMATION	4
2. METHODOLOGY	6
3. INSTRUMENT CALIBRATION	6
4. FACILITIES AND ACCREDITATIONS	7
5. ANTENNA REQUIREMENTS	8
6. MEASUREMENT UNCERTAINTY	9
7. DESCRIPTION OF TESTS	10
8. SUMMARY OF TEST RESULTS	22
9. TEST RESULT	24
9.1. 6 dB BANDWIDTH	24
9.2. OUTPUT POWER	25
9.3. POWER SPECTRAL DENSITY	26
9.4. CONDUCTED BAND EDGE & SPURIOUS EMISSIONS	27
9.5. RADIATED SPURIOUS EMISSIONS	29
9.6. RADIATED RESTRICTED BAND EDGES	35
10. LIST OF TEST EQUIPMENT	36
ANNEX A. TEST SETUP PHOTOS	37
ANNEX B. PHOTOGRAPHS OF EUT	38

1. GENERAL INFORMATION

EUT DESCRIPTION

Model	Guardian Link (3), MMT-7911
EUT Type	Glucose Sensor Transmitter
Power Supply	3.7 VDC
RF Specification	Bluetooth V4.2 LE (1 Mbps)
Transmitter Chain	1
Operating Environment	Indoor only
Operating Temperature	0 °C – 50 °C

RF SPECIFICATION SUBJECT TO THE REPORT

RF Specification	Bluetooth V4.2 LE (1 Mbps)
Frequency Range	2402 MHz - 2480 MHz
Max. RF Output Power	Peak : -2.217 dBm (0.600 mW)
Modulation Type	GFSK
Number of Channels	40 Channels
Antenna Specification ¹⁾	Antenna Type : Folded Monopole Integrated Antenna Antenna Model : 6044472 (designed by Medtronic) Peak Gain : 2.0 dBi
Firmware Version ²⁾	V1.0A
Hardware Version ²⁾	N/A
Date(s) of Tests	February 8, 2021 ~ February 12, 2021

Note :

1. Antenna information is based on the document provided.
2. Firmware and Hardware Versions are provided by the client.

OPERATING FREQUENCY CHANNELS

BLE 1M					
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	14	2430	28	2458
1	2404	15	2432	29	2460
2	2406	16	2434	30	2462
3	2408	17	2436	31	2464
4	2410	18	2438	32	2466
5	2412	19	2440	33	2468
6	2414	20	2442	34	2470
7	2416	21	2444	35	2472
8	2418	22	2446	36	2474
9	2420	23	2448	37	2476
10	2422	24	2450	38	2478
11	2424	25	2452	39	2480
12	2426	26	2454	-	-
13	2428	27	2456	-	-

2. METHODOLOGY

FCC KDB 558074 D01 DTS Measurement Guidance v05r02 dated April 2nd, 2019 entitled "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) and the measurement procedure described in ANSI C63.10(Version : 2013) 'the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices'.

EUT CONFIGURATION

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

EUT EXERCISE

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 3.3, 3.6 and 4.10.1 under LP0002:2020.

GENERAL TEST PROCEDURES

Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2 of ANSI C63.10. (Version :2013) Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-peak and average detector modes.

Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane below 1GHz. Above 1GHz with 1.5m using absorbers between the EUT and receive antenna. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. Also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the maximum emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 8 of ANSI C63.10. (Version: 2013)

Conducted Antenna Terminal

KDB 558074 D01 v05r02

DESCRIPTION OF TEST MODES

The EUT is equipped with Bluetooth V4.2 LE with the data rate 1 Mbps. The EUT has been tested at continuous BLE modulated mode. Channel control was done by tester provided by the manufacturer.

3. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment's, which is traceable to recognized national standards. Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2017).

4. FACILITIES AND ACCREDITATIONS

FACILITIES

The SAC (Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at 1726 Ringwood Avenue, San Jose, California 95131, USA. (LAB CODE : US0198)

The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22.



EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements.

Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.

All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

5. ANTENNA REQUIREMENTS

According to Section 3.2, LP0002:2020:

Low-power radio frequency transmitter or transceiver (receiver) shall utilize a permanently, half- permanently attached antenna or uses a unique coupling at the antenna and at any cable connector between the transmitter and the antenna. The antenna shall be omni-directional type. The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector or other than authorized is prohibited. Such standard connectors are for example: BNC, F type, N type, M type, UG type, RCA, SMA, SMB, and other standard type antenna connectors.

6. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

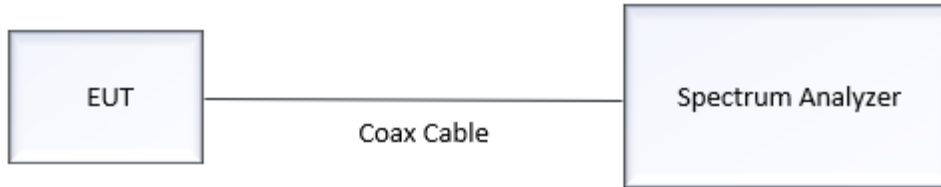
All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95 % level of confidence. The measurement data shown herein meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded Uncertainty ($\pm$ dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	2.55
Radiated Disturbance (9 kHz ~ 30 MHz)	3.20
Radiated Disturbance (30 MHz ~ 1 GHz)	4.73
Radiated Disturbance (1 GHz ~ 18 GHz)	5.21
Radiated Disturbance (18 GHz ~ 40 GHz)	5.18

7. DESCRIPTION OF TESTS

7.1. DUTY CYCLE

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

We tested according to the zero-span measurement method, 6 (b) in KDB 558074 D01 v05r02.

The largest available value of RBW is 8 MHz and VBW is 50 MHz.

The zero-span method of measuring duty cycle shall not be used if $T \leq 6.25$ microseconds. ($50/6.25 = 8$)

The zero-span method was used because all measured T data are > 6.25 microseconds and both RBW and VBW are $> 50/T$.

- RBW = 8 MHz (the largest available value)
- VBW = 8 MHz ($\geq$ RBW)
- SPAN = 0 Hz
- Detector = Peak
- Number of points in sweep > 100
- Trace mode = Clear write
- Measure T_{total} and T_{on}
- Calculate Duty Cycle = T_{on} / T_{total} and Duty Cycle Factor = $10 \cdot \log(1/\text{Duty Cycle})$

7.2. 6 dB BANDWIDTH

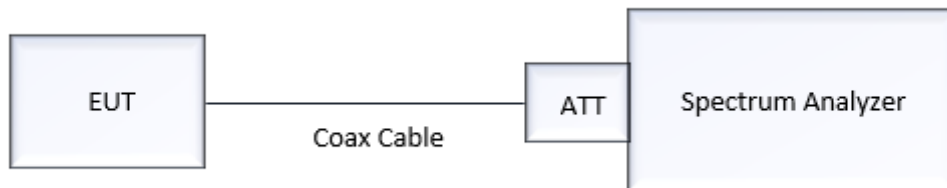
Limit

Test Requirements and limit : Section 4.10.1.6 (2) (A), LP0002:2020

The bandwidth at 6 dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the receive antenna while the EUT is operating in transmission mode at the appropriate frequencies.

The minimum permissible 6 dB bandwidth is 500 kHz.

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

The Spectrum Analyzer is set to (Section 8.2 in KDB 558074 D01 v05r02, Subclause 11.8 in ANSI 63.10-2013)

- RBW = 100 kHz
- VBW $\geq 3 \times$ RBW
- Detector = Peak
- Trace mode = max hold
- Sweep = auto couple
- Allow the trace to stabilize
- X dB bandwidth measurement function built-in the spectrum analyzer was used to measure 6 dB bandwidth.

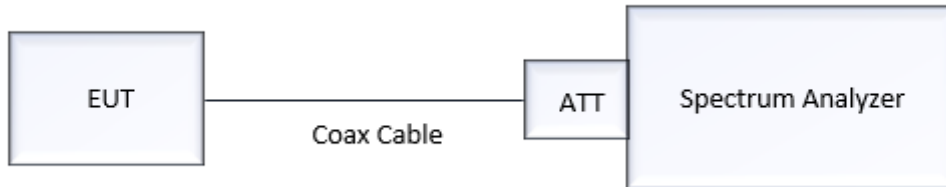
7.3. OUTPUT POWER

Limit

Test Requirements and limit : Section 4.10.1.2 (1) (C), LP0002:2020

The maximum permissible conducted output power is 1 W.

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

TX condition of the EUT is the actual operating mode by BT LE test program.

The Spectrum Analyzer is set to

Peak Power (Section 8.3.1.1 in KDB 558074 D01 v05r02, Subclause 11.9.1.1 in ANSI 63.10-2013)

- RBW $\geq$ DTS Bandwidth
- VBW $\geq 3 \times$ RBW
- SPAN $\geq 3 \times$ RBW
- Detector Mode = Peak
- Sweep = auto couple
- Trace Mode = max hold
- Allow trace to fully stabilize.
- Use peak marker function to determine the peak amplitude level

Average Power (Section 8.3.2.2 in KDB 558074 D01 v05r02, Subclause 11.9.2.2 in ANSI 63.10-2013)

- We use the spectrum analyzer's integrated band power measurement function.
- Measure the duty cycle.
- Set span to at least 1.5 times the OBW.
- RBW = 1-5 % of the OBW, not to exceed 1 MHz
- VBW $\geq 3 \times$ RBW
- Number of points in sweep $\geq 2 \times$ span / RBW. (This gives bin-to-bin spacing $\leq$ RBW/2, so that narrowband signals are not lost between frequency bins.)
- Sweep time = auto.
- Detector = RMS (i.e., power averaging)
- Do not use sweep triggering. Allow the sweep to "free run".
- Trace average at least 100 traces in power averaging (RMS) mode.
- Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function with band limits set equal to the OBW band edges.
- Add $10 \log (1/x)$, where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times.

Sample Calculation

- Conducted Output Power (Peak) = Reading Value + ATT loss + Cable loss
- Conducted Output Power (Average) = Reading Value + ATT loss + Cable loss + Duty Cycle Factor

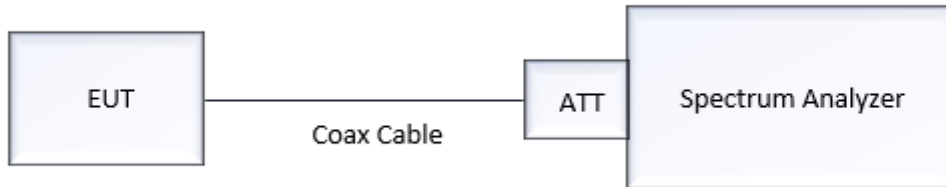
7.4. POWER SPECTRAL DENSITY

Limit

Test Requirements and limit : Section 4.10.1.6 (2) (B), LP0002:2020

The transmitter power density average over 1-second interval shall not be greater than 8dBm in any 3kHz BW.

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

We tested according to Procedure 8.4 in KDB 558074 D01 v05r02, Procedure 11.10 in ANSI 63.10-2013.

The spectrum analyzer is set to :

- Set analyzer center frequency to DTS channel center frequency.
- Set span to at least 1.5 times the OBW.
- $RBW = 3 \text{ kHz} \leq RBW \leq 100 \text{ kHz}$.
- $VBW \geq 3 \times RBW$.
- Sweep = auto couple
- Detector = power averaging (rms) or sample detector (when rms not available).
- Ensure that the number of measurement points in the sweep $\geq [2 \times \text{span} / RBW]$.
- Employ trace averaging (rms) mode over a minimum of 100 traces
- Use the peak marker function to determine the maximum amplitude level.
- Use the peak marker function to determine the maximum amplitude level within the RBW. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.
- if then duty factor shall be added to adjust the result if the duty cycle is less than 98%

7.5. CONDUCTED BAND EDGE (OUT OF BAND EMISSIONS) / CONDUCTED SPURIOUS EMISSIONS

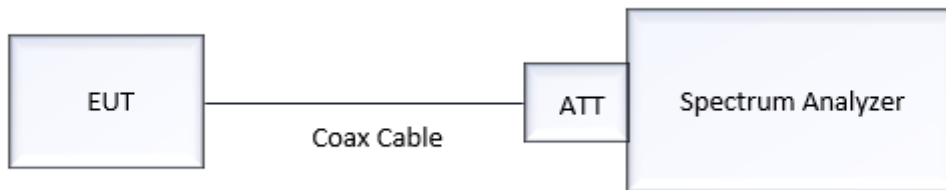
Limit

Test Requirements and limit : Section 4.10.1.5 (1), LP0002:2020

The maximum conducted (peak) output power was used to demonstrate compliance, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz.

[Conducted > 20 dBc]

Test Configuration



Test Procedure

The transmitter output is connected to the spectrum analyzer.

(Procedure 8.5 in KDB 558074 D01 v05r02, Procedure 11.11 in ANSI 63.10-2013)

- RBW = 100 kHz
- VBW $\geq 3 \times$ RBW
- Set span to encompass the spectrum to be examined
- Detector = Peak
- Trace Mode = max hold
- Sweep time = auto couple
- Ensure that the number of measurement points $\geq 2 \times \text{Span} / \text{RBW}$
- Allow trace to fully stabilize.
- Use peak marker function to determine the maximum amplitude level.

Measurements are made over the 30 MHz to 25 GHz range with the transmitter set to the lowest, middle, and highest channels.

7.6. RADIATED EMISSIONS

Radiated Emission Limits

Section 4.10.1.5, LP0002:2020

Restricted Bands of Operation

The frequency band listed below and shall meet the field strength requirement in section 3.6, LP0002:2020

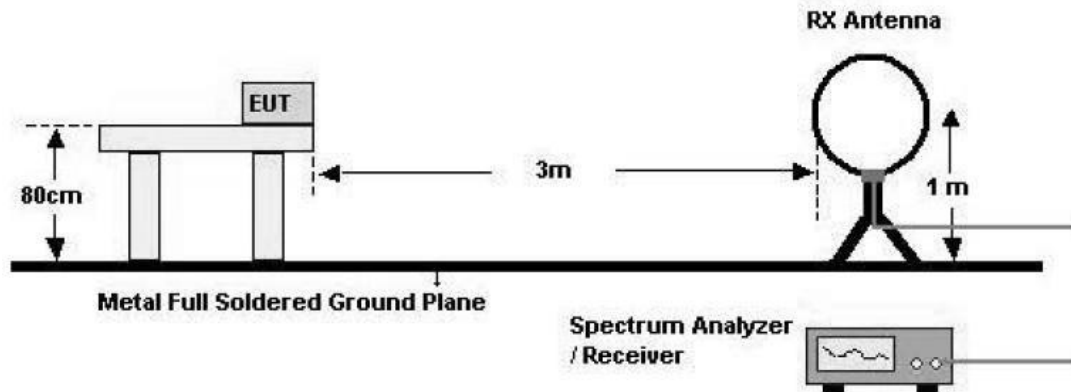
Section 3.5, LP0002:2020		
Frequency (MHz)	Frequency (MHz)	Frequency (MHz)
0.090 – 0.110	322.00 – 335.40	3500.0 – 4400.0
0.490 – 0.510	399.90 – 410.00	4500.0 – 5250.0
2.172 – 2.198	485.00 – 510.00	5350.0 – 5460.0
3.013 – 3.033	608.00 – 614.00	7250.0 – 7750.0
4.115 – 4.198	703.00 – 748.00	8025.0 – 8500.0
5.670 – 5.690	758.00 – 803.00	9000.0 – 9200.0
6.200 – 6.300	825.00 – 915.00	9300.0 – 9500.0
8.230 – 8.400	930.00 – 1240.0	10600 – 12700
12.265 – 12.600	1300.0 – 1427.0	13250 – 13400
13.340 – 13.430	1435.0 – 1626.5	14470 – 14500
14.965 – 15.020	1660.0 – 1785.0	15350 – 16200
16.700 – 16.755	1805.0 – 1880.0	17700 – 21400
19.965 – 20.020	1885.0 – 1900.0	22010 – 23120
25.500 – 25.700	1905.0 – 1985.0	23600 – 24000
37.475 – 38.275	2010.0 – 2025.0	31200 – 31800
73.500 – 75.400	2110.0 – 2170.0	36430 – 36500
108.00 – 138.00	2200.0 – 2300.0	Above 38600
149.90 – 150.05	2310.0 – 2390.0	
156.70 – 156.90	2483.5 – 2900.0	
162.01 – 167.17	3260.0 – 3267.0	
167.72 – 173.20	3332.0 – 3339.0	
240.00 – 285.00	3345.8 – 3358.0	

Field Strength Limit

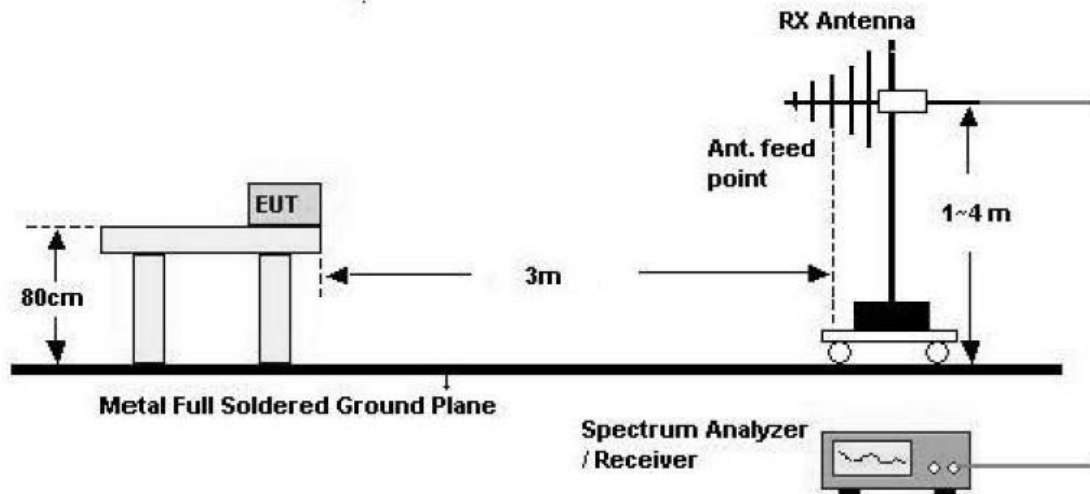
Section 3.6, LP0002:2020		
Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
$0.009 \leq f \leq 0.490$	$2400/F(\text{kHz})$	300
$0.490 < f \leq 1.705$	$24000/F(\text{kHz})$	30
$1.705 < f < 30$	30	30
$30 \leq f \leq 88$	100	3
$88 < f \leq 216$	150	3
$216 < f \leq 960$	200	3
$960 < f$	500	3

Test Configuration

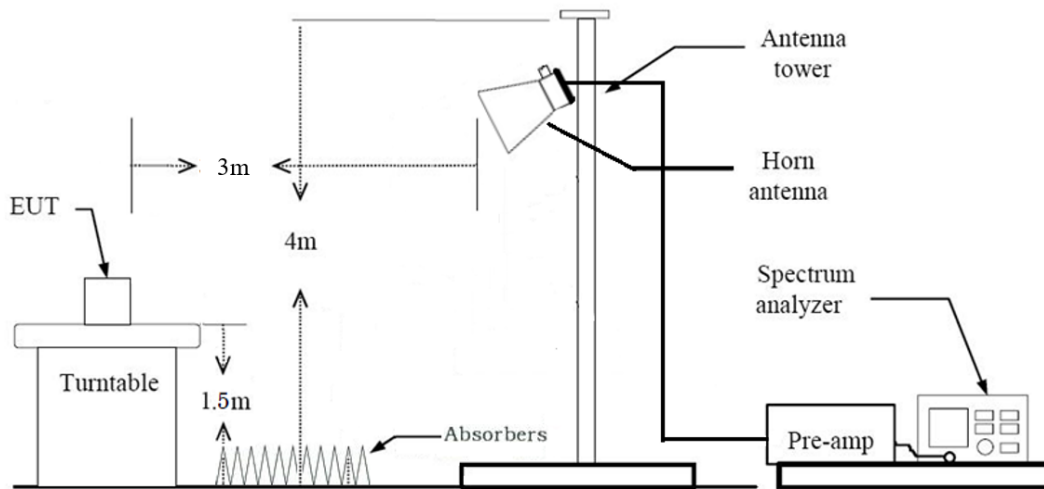
Below 30 MHz



30 MHz - 1 GHz



Above 1 GHz



Test Procedure of Radiated spurious emissions (Below 30 MHz)

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The loop antenna was placed at a location 3m from the EUT
3. The EUT is placed on a turntable, which is 0.8m above ground plane.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
6. Distance Correction Factor (0.009 MHz – 0.490 MHz) = $40 \cdot \log(3 \text{ m}/300 \text{ m}) = -80 \text{ dB}$
Measurement Distance: 3 m
7. Distance Correction Factor (0.490 MHz – 30 MHz) = $40 \cdot \log(3 \text{ m}/30 \text{ m}) = -40 \text{ dB}$
Measurement Distance: 3 m
8. Spectrum Setting
 - Frequency Range = 9 kHz ~ 30 MHz
 - Detector = Peak
 - Trace = Max hold
 - RBW = 9 kHz
 - VBW $\geq 3 \cdot \text{RBW}$
9. Total = Reading Value + Antenna Factor (A.F) + Cable Loss (C.L)
10. There is a comparison data both open-field test site and alternative test site – semi-Anechoic chamber according to 414788 D01. And the results are properly calibrated.

Test Procedure of Radiated spurious emissions (Below 1GHz)

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The EUT is placed on a turntable, which is 0.8 m above ground plane.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
4. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
5. Spectrum Setting

(1) Measurement Type (Peak):

- Measured Frequency Range: 30 MHz – 1 GHz
- Detector = Peak
- Trace = Max hold
- RBW = 100 kHz
- VBW $\geq 3 \times$ RBW

(2) Measurement Type(Quasi-peak):

- Measured Frequency Range: 30 MHz – 1 GHz
- Detector = Quasi-Peak
- RBW = 120 kHz

In general, the method (1) is mainly used

6. Total = Reading Value + Antenna Factor (A.F) + Cable Loss (C.L)

Test Procedure of Radiated spurious emissions (Above 1 GHz)

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
4. EUT is set 3 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. The unit was tested with its standard battery.
8. Spectrum Setting

(1) Measurement Type(Peak):

- Measured Frequency Range : 1 GHz – 25 GHz
- Detector = Peak
- Trace = Max hold
- RBW = 1 MHz
- VBW $\geq 3 \times \text{RBW}$

(2) Measurement Type(Average): Duty cycle $\geq 98\%$

- Measured Frequency Range : 1 GHz – 25 GHz
- Detector = RMS
- Averaging type = power (*i.e.*, RMS)
- RBW = 1 MHz
- VBW $\geq 3 \times \text{RBW}$
- Sweep time = auto.
- Trace mode = average (at least 100 traces).

(3) Measurement Type(Average): Duty cycle $< 98\%$, duty cycle variations are less than $\pm 2\%$

- Measured Frequency Range : 1 GHz – 25 GHz
- Detector = RMS
- Averaging type = power (*i.e.*, RMS)
- RBW = 1 MHz
- VBW $\geq 3 \times \text{RBW}$
- Sweep time = auto.
- Trace mode = average (at least 100 traces).
- Correction factor shall be added to the measurement results prior to comparing to the emission limit to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle.
- Duty Cycle Factor (dB) : Please refer to the please refer to section 9.1.

10. Measurement value only up to 6 maximum emissions noted or would be lesser if no specific emissions from the EUT are recorded (*i.e.*: margin > 20 dB from the applicable limit) and considered that is already beyond the background noise floor.

11. Sample Calculation

- (1) Total (Peak) = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G)
- (2) Total (Average, Duty $\geq 98\%$) = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G)
- (3) Total (Average, Duty $< 98\%$) = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Duty Cycle Factor

Test Procedure of Radiated Restricted Band Edge

1. Radiated test is performed with hopping off.
2. The EUT is placed on a turntable, which is 1.5 m above ground plane.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
4. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
5. EUT is set 3 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. The unit was tested with its standard battery.
8. Spectrum Setting

(1) Measurement Type(Peak):

- Detector = Peak
- Trace = Max hold
- RBW = 1 MHz
- VBW $\geq 3 \times$ RBW

(2) Measurement Type(Average): Duty cycle $\geq 98\%$,

- Measured Frequency Range : 2310 MHz – 2390 MHz / 2483.5 MHz – 2500 MHz
- Detector = RMS
- Averaging type = power (*i.e.*, RMS)
- RBW = 1 MHz
- VBW $\geq 3 \times$ RBW
- Sweep time = auto.
- Trace mode = average (at least 100 traces).

(3) Measurement Type(Average): Duty cycle $< 98\%$, duty cycle variations are less than $\pm 2\%$

- Measured Frequency Range : 2310 MHz – 2390 MHz / 2483.5 MHz – 2500 MHz
- Detector = RMS
- Averaging type = power (*i.e.*, RMS)
- RBW = 1 MHz
- VBW $\geq 3 \times$ RBW
- Sweep time = auto.
- Trace mode = average (at least 100 traces).
- Correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle.
- Duty Cycle Factor (dB) : Please refer to the please refer to section 9.1.

9. Measurement value only up to 6 maximum emissions noted or would be lesser if no specific emissions from the EUT are recorded (*i.e.*: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.

10. Sample Calculation

- (1) Total (Peak) = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L)
- (2) Total (Average, Duty $\geq 98\%$) = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G)
- (3) Total (Average, Duty $< 98\%$) = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Duty Cycle Factor

7.7. AC POWER LINE CONDUCTED EMISSIONS

Limit

Section 3.3, LP0002:2020

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN).

Frequency Range (MHz)	Limits (dB μ V)	
	Quasi-peak	Average
0.15 - 0.50	66 - 56*	56 - 46*
0.50 - 5	56	46
5 - 30	60	50

*Decreases with the logarithm of the frequency.

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

Test Configuration

See test photographs attached in Annex A for the actual connections between EUT and support equipment.

Test Procedure

1. The EUT is placed on a wooden table 80 cm above the reference ground plane.
2. The EUT is connected via LISN to a test power supply.
3. The measurement results are obtained as described below:
4. Detectors : Quasi Peak and Average Detector.

Sample Calculation

Quasi-peak(Final Result) = Reading Value + Correction Factor

8. SUMMARY OF TEST RESULTS

Test Description	NCC Rule Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	Section 4.10.1.6 (2) (A) LP0002:2020	≥ 500 kHz	Conducted	PASS
Conducted Maximum Peak Output Power	Section 4.10.1.2 (1) (C) LP0002:2020	≤ 1 W		PASS
Power Spectral Density	Section 4.10.1.6 (2) (B) LP0002:2020	≤ 8 dBm / 3 kHz		PASS
Band Edge (Out of Band Emissions)	Section 4.10.1.5 (1) LP0002:2020	≥ 20 dBc		PASS
AC Power line Conducted Emissions	Section 3.3 LP0002:2020	cf. Section 7.7		N/A ¹⁾
Radiated Spurious Emissions	Section 4.10.1.5 LP0002:2020	cf. Section 7.6	Radiated	PASS
Radiated Restricted Band Edge	Section 4.10.1.5 LP0002:2020	cf. Section 7.6		PASS

Note :

1. AC line conducted emission is not applicable since the EUT is powered by a cell battery.
2. Duty cycle is 100% during RF transmission.

WORST CASE CONFIGURATION

Radiated Test

1. EUT Axis

All X, Y, and Z positions for horizontal / vertical antenna polarization were investigated to find the worst-case position. The position Y was selected for the full evaluation.

Conducted Test

1. All the RF tests in mode were performed at low, mid, and high channels.

OUTPUT POWER SETTING

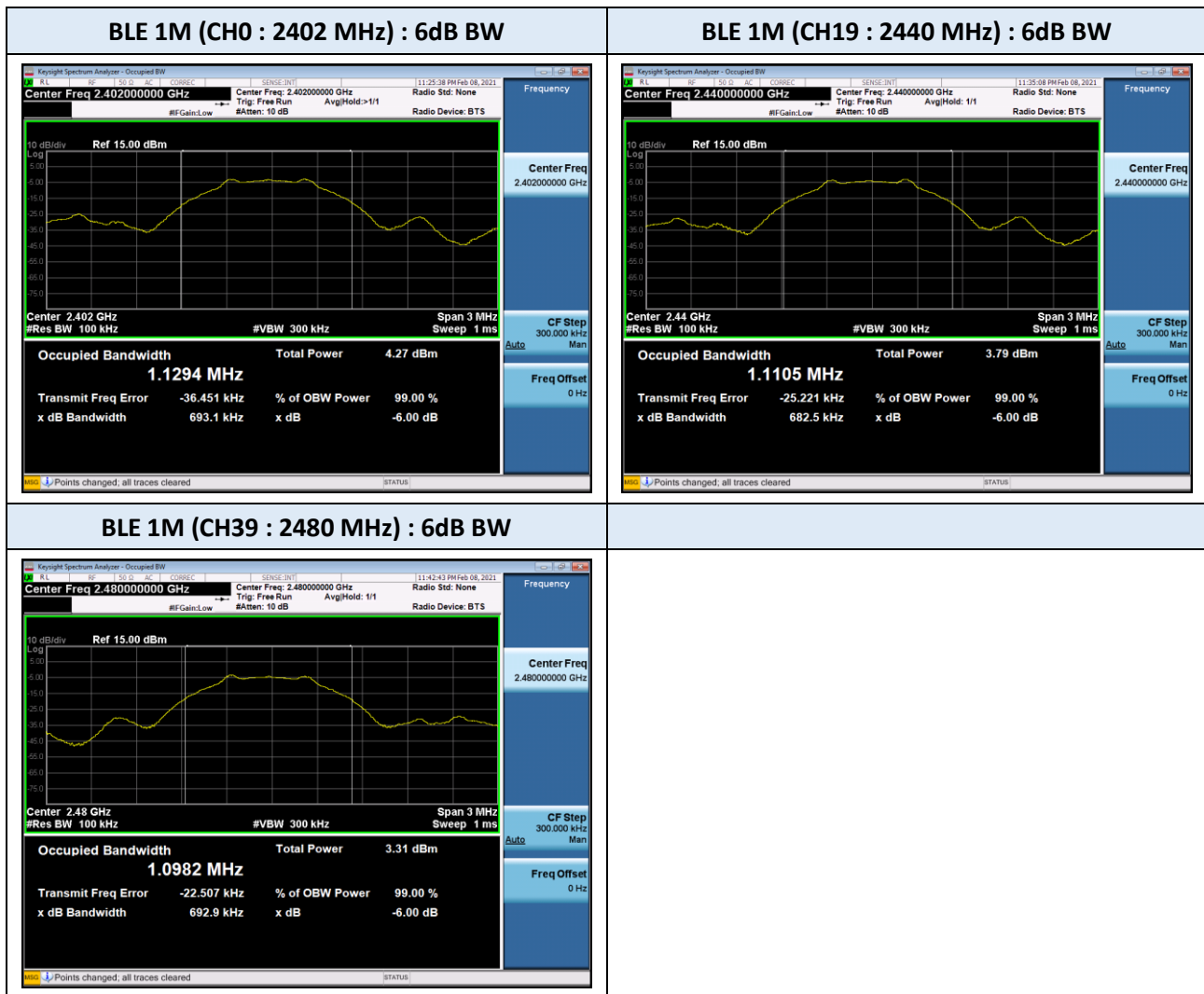
Output power was preset to the max by the manufacturer.

9. TEST RESULT

9.1. 6 dB BANDWIDTH

BLE 1M		6 dB Bandwidth (kHz)	
Frequency (MHz)	Channel	Result	Limit
2402	0	693.1	≥ 500
2440	19	682.5	
2480	39	692.9	

TEST PLOTS



9.2. OUTPUT POWER

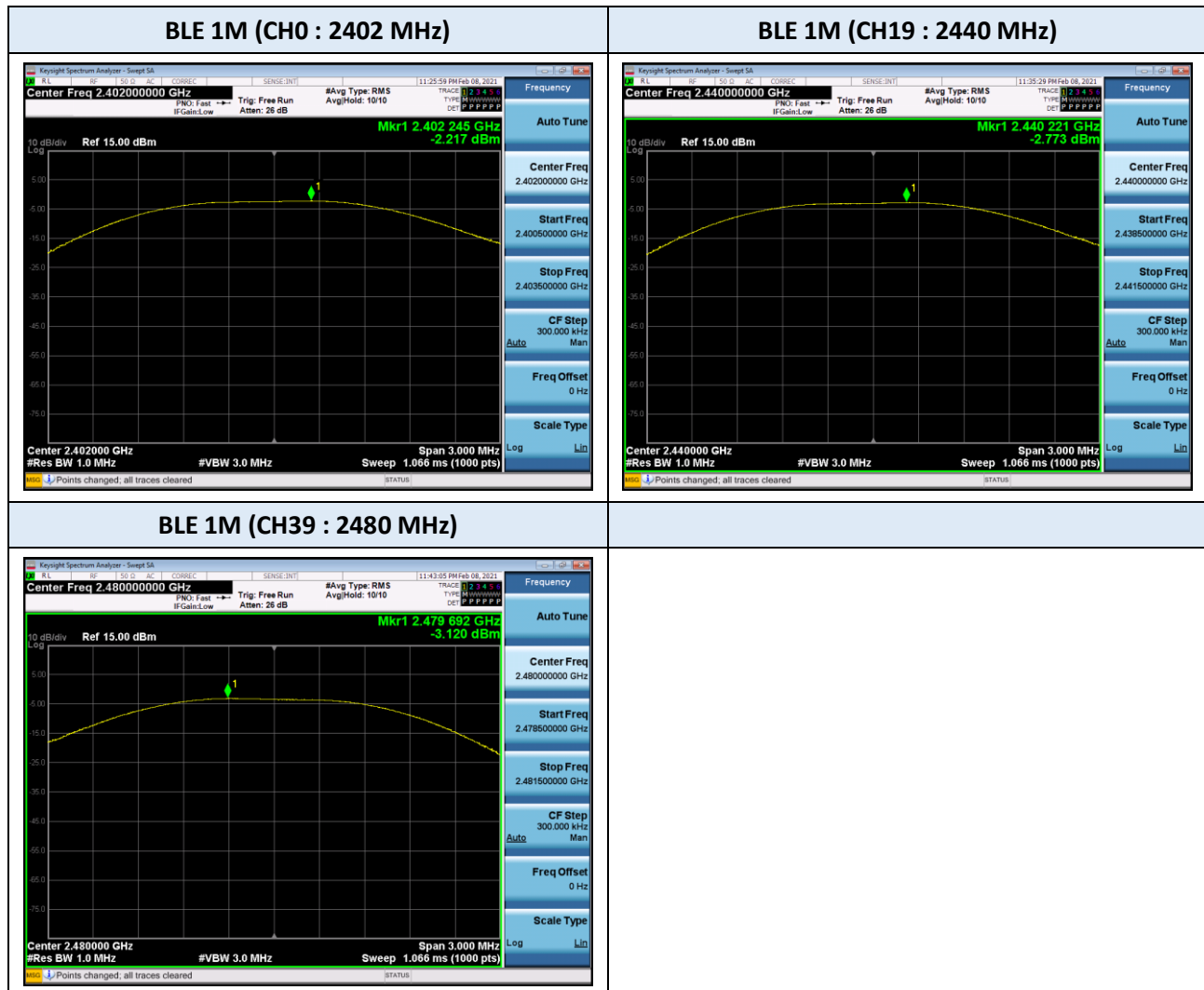
Peak Power

BLE 1M		Test Result		
Frequency (MHz)	Channel No.	Measured Power (dBm)	Limit (dBm)	Result
2402	0	-2.217	30	Compliant
2440	19	-2.773	30	Compliant
2480	39	-3.120	30	Compliant

Note :

- The output power results in plot include the spectrum offset, which is a combination loss of the attenuator and the cable used for testing

TEST PLOTS



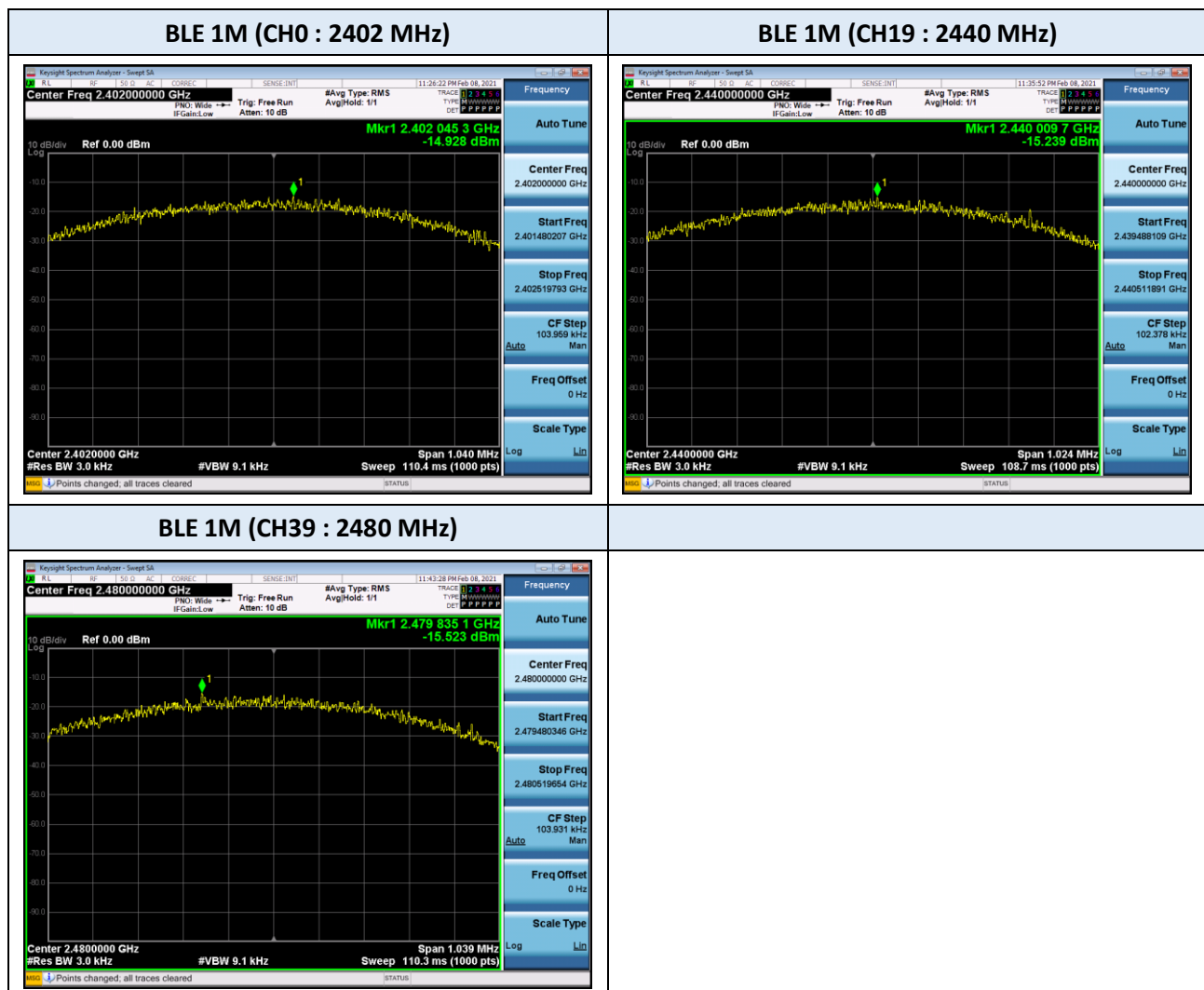
9.3. POWER SPECTRAL DENSITY

BLE 1M		Test Result		
Frequency (MHz)	Channel No.	Measured Level (dBm / 3 kHz)	Limit (dBm / 3 kHz)	Result
2402	0	-14.928	8.000	Compliant
2440	19	-15.239	8.000	Compliant
2480	39	-15.523	8.000	Compliant

Note :

1. The output power results in plot include the spectrum offset, which is a combination loss of the attenuator and the cable used for testing

TEST PLOTS

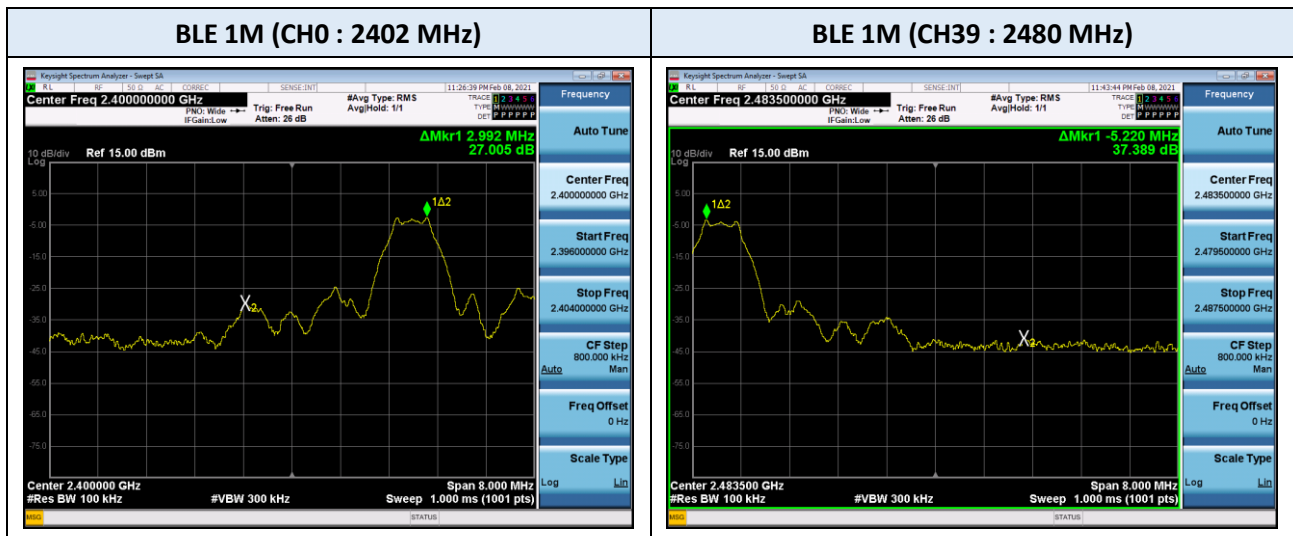


9.4. CONDUCTED BAND EDGE & SPURIOUS EMISSIONS

Out of Band Emissions at the Band Edge

BLE 1M			Test Result		
Frequency [MHz]	Channel No.	Position	Measured Level [dBc]	Limit [dBc]	Result
2402	0	Low	27.005	20	Compliant
2480	39	High	37.389	20	Compliant

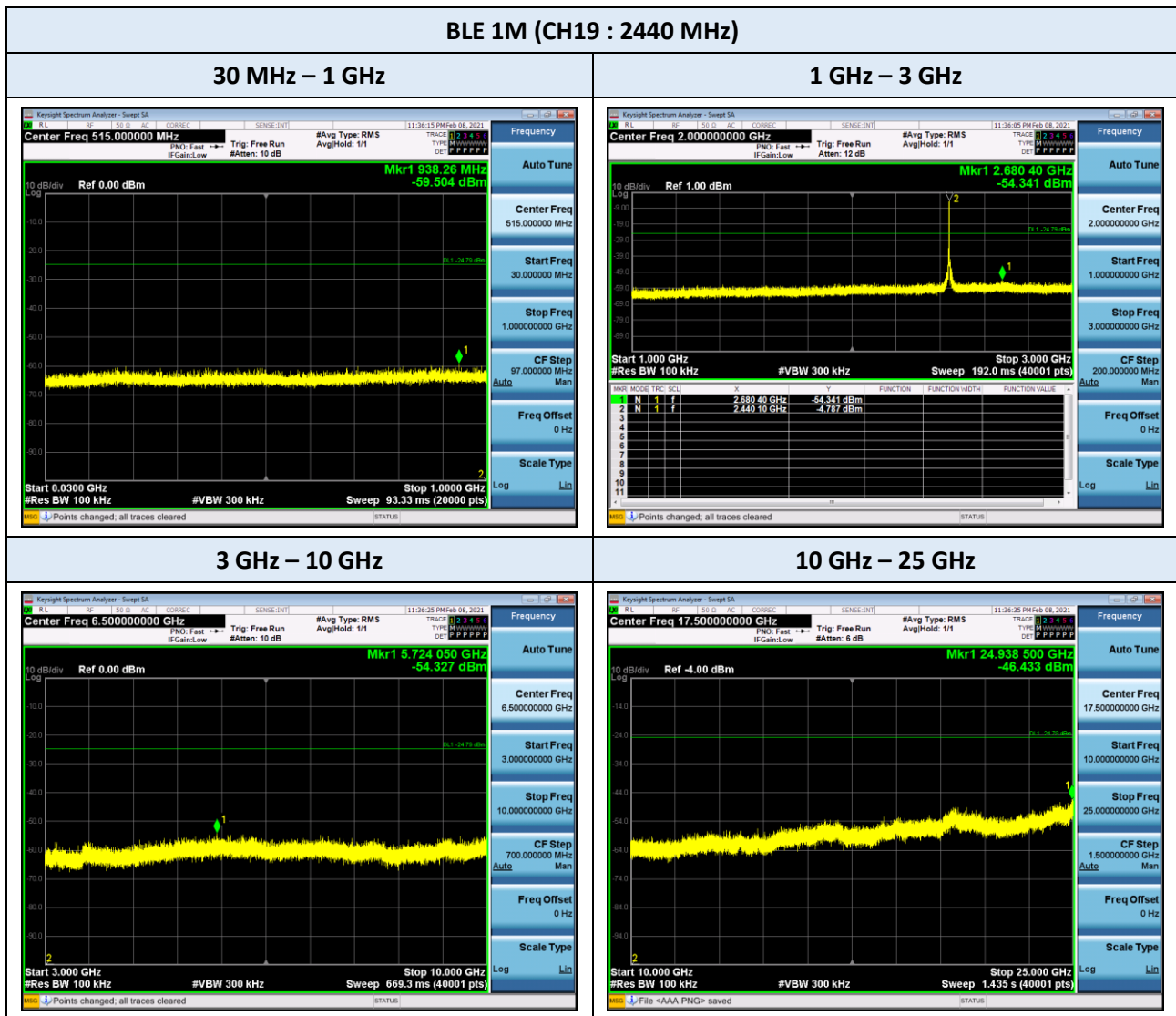
TEST PLOTS



Conducted Spurious Emissions

BLE 1M			Test Result		
Frequency [MHz]	Channel No.	Position	Measured Level [dBc]	Limit [dBc]	Result
2402	0	Low	42.805	20	Compliant
2440	19	Middle	41.646	20	Compliant
2480	39	High	42.285	20	Compliant

TEST PLOTS



Note:

The plots included in this report are only at the worst-case channel

9.5. RADIATED SPURIOUS EMISSIONS

Frequency Range : 9 kHz – 30 MHz

Test Mode BLE 1M (GFSK) : TX mode
Operating Frequency CH 19 (2440 MHz)

Frequency (MHz)	Polarization	Reading (dBuV)	Corr. ¹⁾ (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement Type
0.036	180°	50.4	14.2	64.6	116.4	51.8	QP
0.073	180°	41.9	13.8	55.7	110.4	54.7	QP
0.109	180°	32.9	14.1	47.0	106.9	59.9	QP
11.060	180°	16.6	14.7	31.3	69.5	38.2	QP
11.060	90°	16.2	14.7	30.9	69.5	38.6	QP

Notes:

1. Correction Factor: Antenna Factor + Cable loss
2. Limit line = Specific Limits (dBuV) + Distance extrapolation factor
3. Distance extrapolation factor = $40 \log (\text{specific distance} / \text{test distance})$ (dB)
4. The measurement distance is 3 meters.
5. The other Frequencies are attenuated more than 20 dB below the permissible limits.
The worst-case result is included in this report.

Frequency Range : Below 1 GHz

Test Mode BLE 1M (GFSK) : TX mode
Operating Frequency CH 0 (2402 MHz)

Frequency (MHz)	Polarization	Reading (dBuV)	Corr. (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement Type
No peak found							

Test Mode BLE 1M (GFSK) : TX mode
Operating Frequency CH 19 (2440 MHz)

Frequency (MHz)	Polarization	Reading (dBuV)	Corr. (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement Type
No peak found							

Test Mode BLE 1M (GFSK) : TX mode
Operating Frequency CH 39 (2480 MHz)

Frequency (MHz)	Polarization	Reading (dBuV)	Corr. (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement Type
No peak found							

Notes:

1. No major peak found within the frequency range. A representative plot is included in this report

Frequency Range : Above 1 GHz

Test Mode BLE 1M (GFSK) : TX mode
 Operating Frequency CH 0 (2402 MHz)

Frequency (MHz)	Polarization	Reading (dBuV)		Factor (dB)	Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
		AV	PK	Corr. ¹⁾	AV	PK	AV	PK	AV	PK
4804.431	V	41.4	47.6	-6.3	35.1	41.3	54	74	18.9	32.7
4805.971	H	39.6	44.6	-6.3	33.3	38.3	54	74	20.7	35.7

Test Mode BLE 1M (GFSK) : TX mode
 Operating Frequency CH 19 (2440 MHz)

Frequency (MHz)	Polarization	Reading (dBuV)		Factor (dB)	Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
		AV	PK	Corr. ¹⁾	AV	PK	AV	PK	AV	PK
4880.381	V	40.5	47.0	-6.1	34.4	40.9	54	74	19.6	33.1
4881.999	H	39.5	44.9	-6.1	33.4	38.8	54	74	20.6	35.2

Test Mode BLE 1M (GFSK) : TX mode
 Operating Frequency CH 39 (2480 MHz)

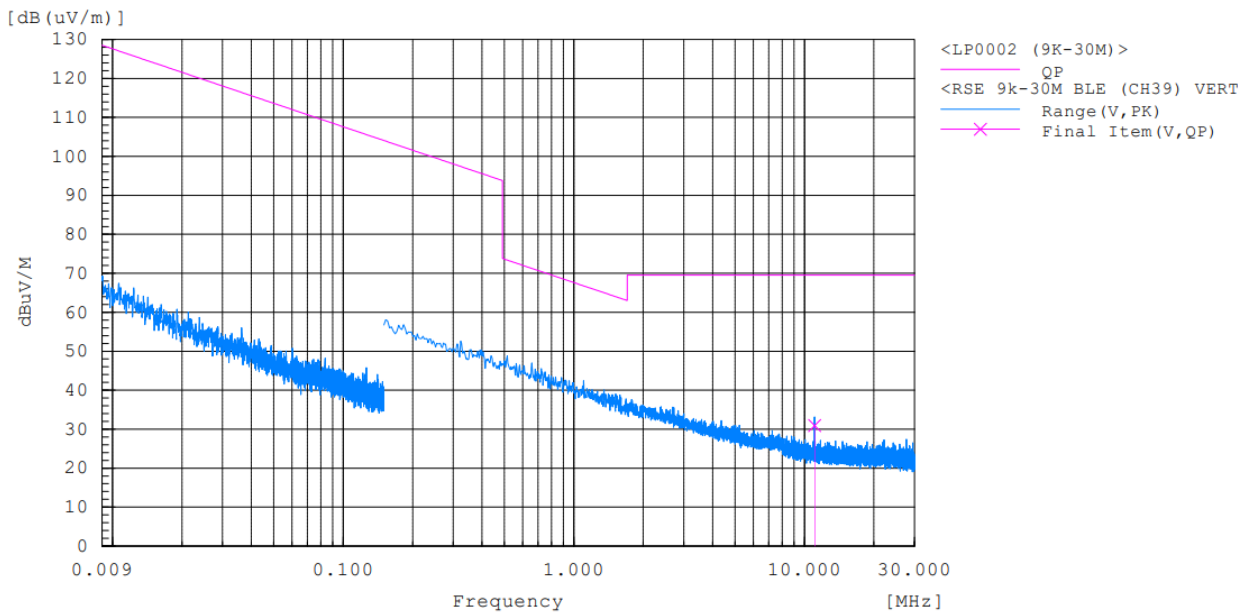
Frequency (MHz)	Polarization	Reading (dBuV)		Factor (dB)	Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
		AV	PK	Corr. ¹⁾	AV	PK	AV	PK	AV	PK
4957.919	H	38.4	44.0	-5.9	32.5	38.1	54	74	21.5	35.9
4957.944	V	42.0	46.1	-5.9	36.1	40.2	54	74	17.9	33.8

Notes:

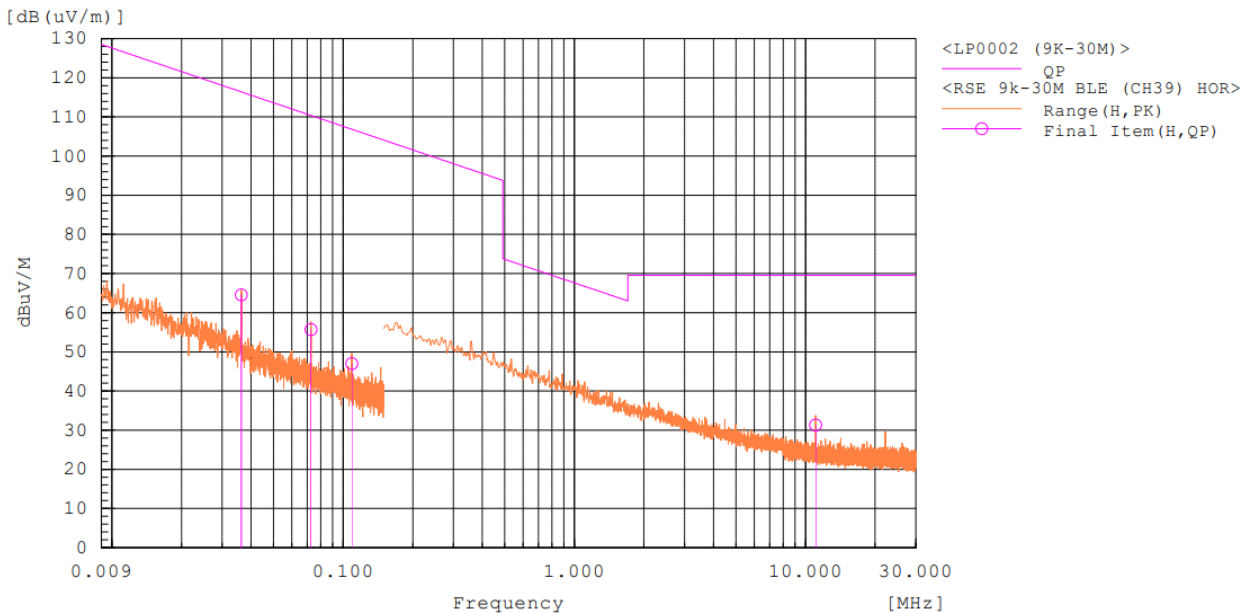
1. Correction Factor: Antenna Factor + Cable loss + Preamplifier Gain

■ TEST PLOTS

Radiated Spurious Emission 9 kHz – 30 MHz (Antenna Position 90°)



Radiated Spurious Emission 9 kHz – 30 MHz (Antenna Position 180°)

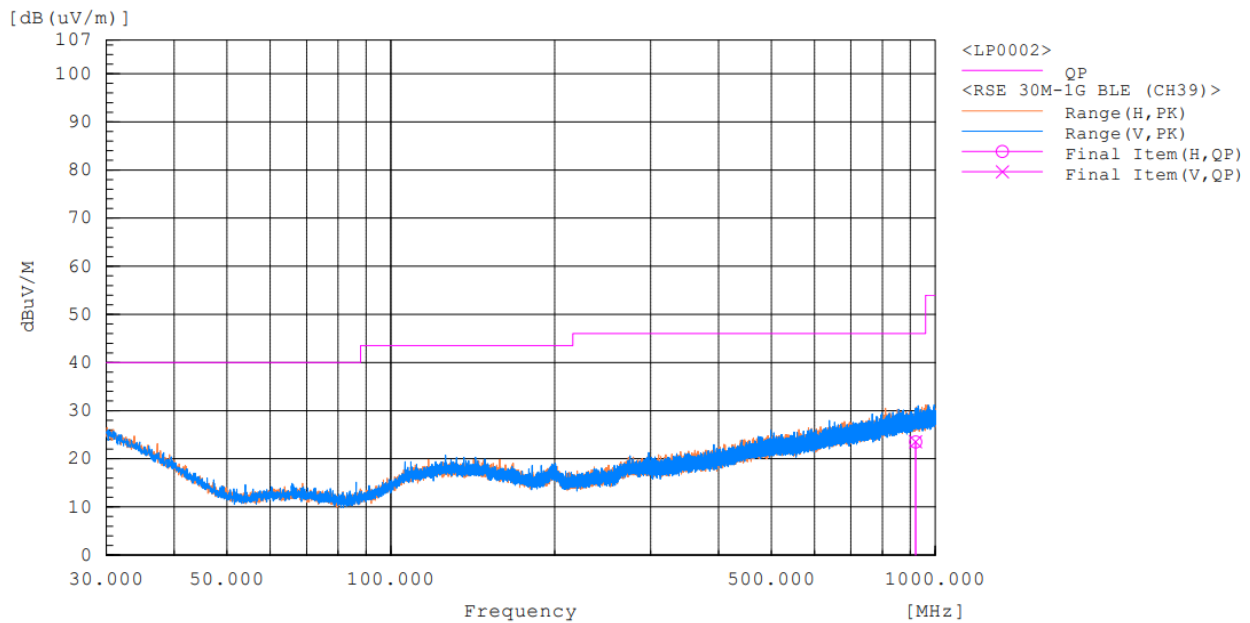


Note:

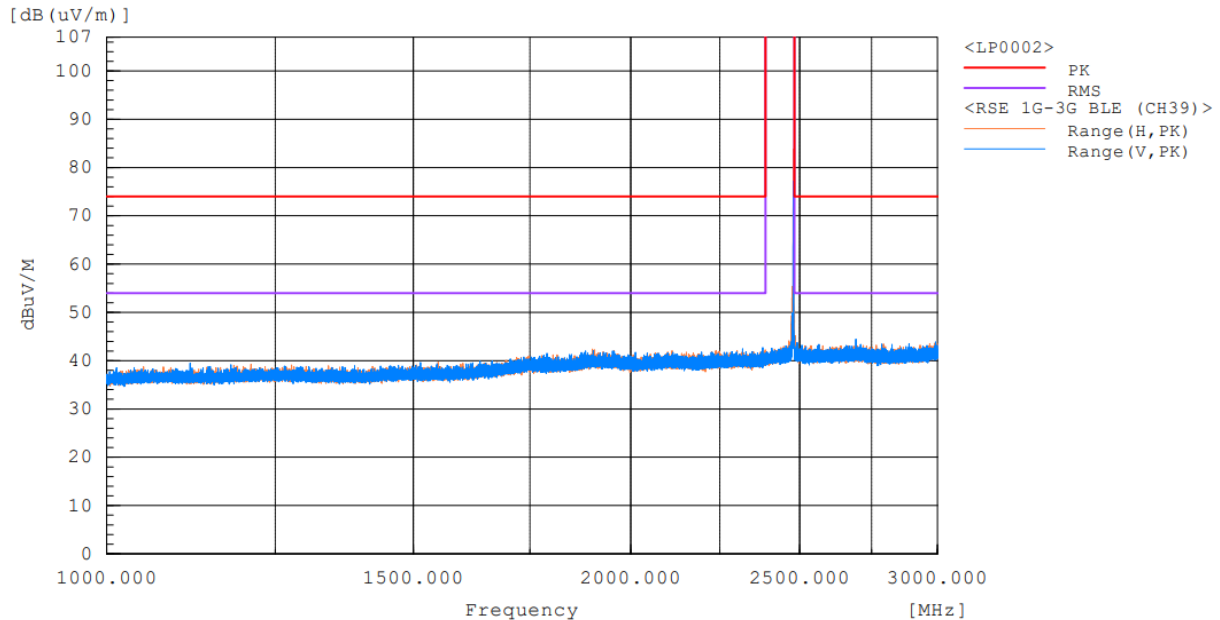
The worst-case plots are included in this report.

■ TEST PLOTS

Radiated Spurious Emission 30 MHz – 1 GHz



Radiated Spurious Emission 1 GHz – 3 GHz

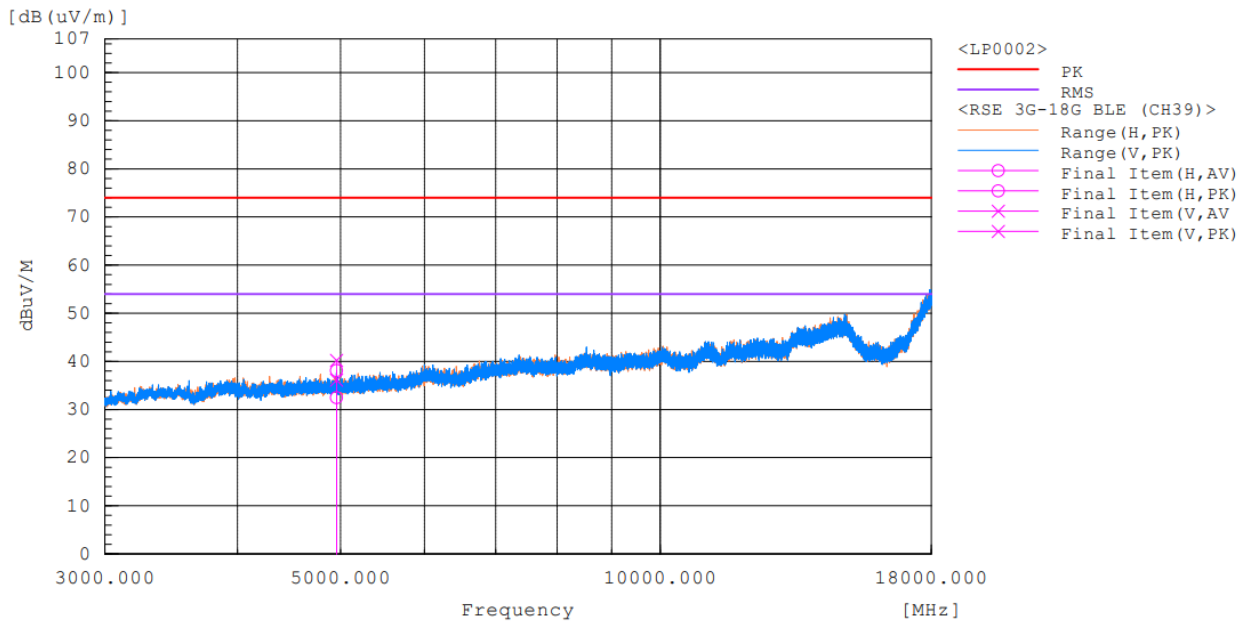


Note:

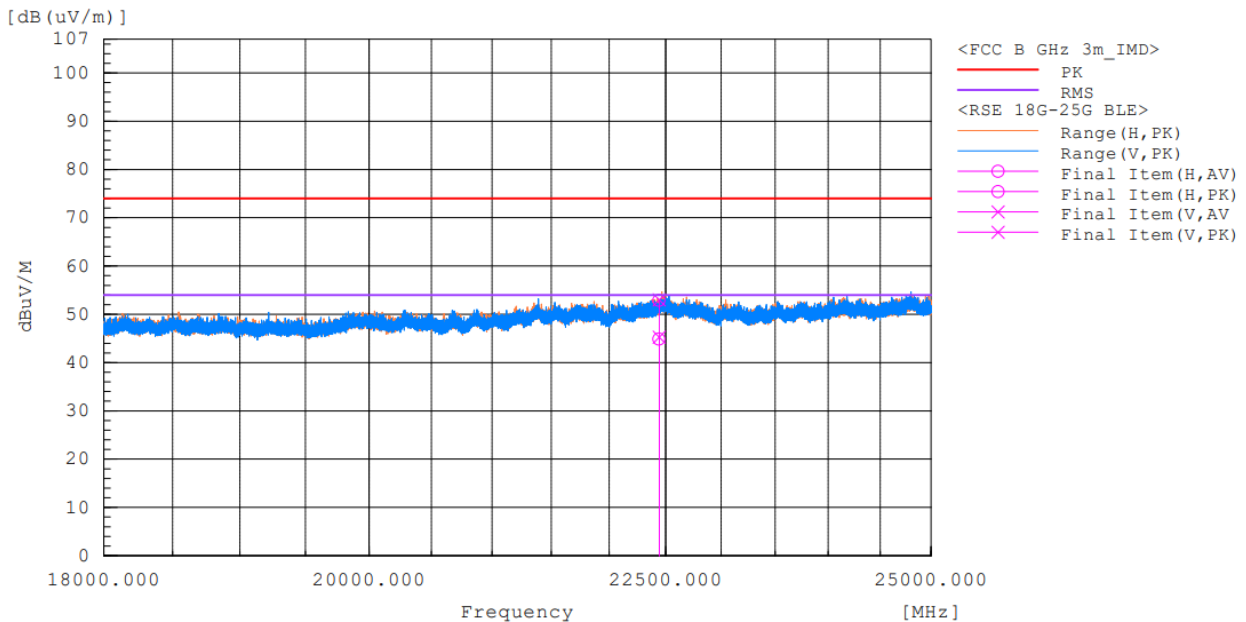
The worst-case plots are included in this report.

TEST PLOTS

Radiated Spurious Emission 3 GHz – 18 GHz



Radiated Spurious Emission 18 GHz – 25 GHz



Note:

The worst-case plots are included in this report.

9.6. RADIATED RESTRICTED BAND EDGES

Test Mode BLE 1M (GFSK) : TX mode
Operating Frequency CH 0 (2402 MHz)

Frequency (MHz)	Polarization	Reading (dBuV)		Factor (dB)	Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
		AV	PK		AV	PK	AV	PK	AV	PK
2389.571	H	4.7	15.2	31.0	35.7	46.2	54	74	18.3	27.8
2389.995	V	4.5	14.9	31.0	35.5	45.9	54	74	18.5	28.1

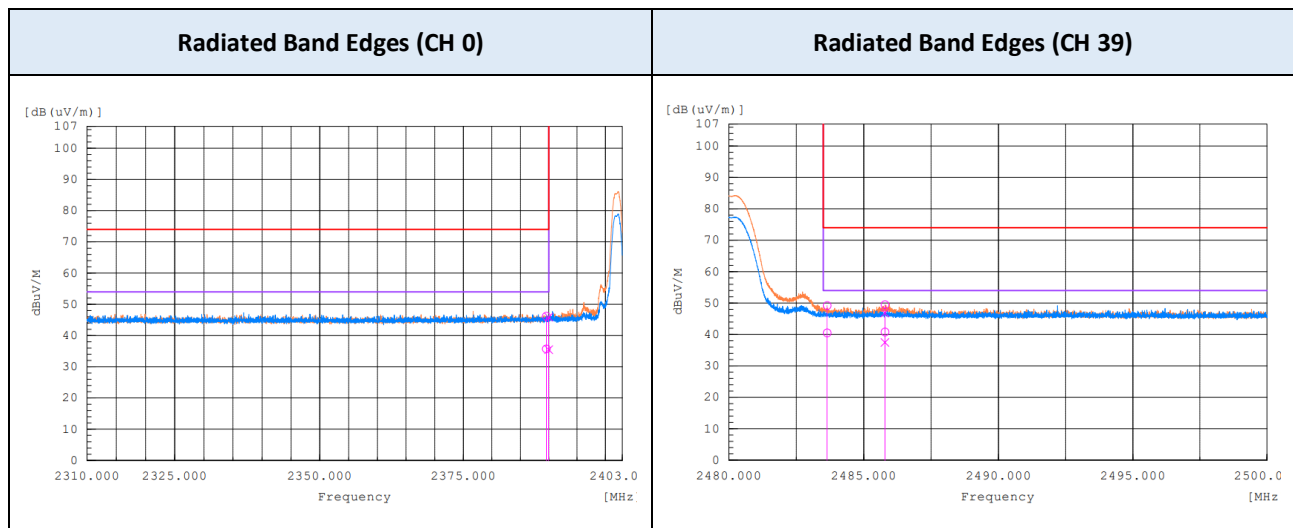
Test Mode BLE 1M (GFSK) : TX mode
Operating Frequency CH 39 (2480 MHz)

Frequency (MHz)	Polarization	Reading (dBuV)		Factor (dB)	Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
		AV	PK		AV	PK	AV	PK	AV	PK
2483.646	H	8.9	17.6	31.6	40.5	49.2	54	74	13.5	24.8
2485.783	V	5.9	15.3	31.6	37.5	46.9	54	74	16.5	27.1
2485.787	H	9.2	17.9	31.6	40.8	49.5	54	74	13.2	24.5

Notes:

1. Correction Factor: Antenna Factor + Cable loss

TEST PLOTS



10. LIST OF TEST EQUIPMENT

No.	Instrument	Model No.	Calibration Due (mm/dd/yy)	Manufacture	Serial No.
☒	Signal Analyzer (20 Hz ~ 40.0 GHz)	ESU40	12/09/2021	Rohde & Schwarz	100529
☒	Signal Analyzer (10 Hz ~ 40.0 GHz)	FSV40	03/23/2021	Rohde & Schwarz	101424
☒	Signal Analyzer (10 Hz ~ 26.5 GHz)	N9020A	11/07/2021	Keysight	MY52091291
☒	Attenuator (20 dB, DC ~ 26.5 GHz)	8493C	12/07/2021	HP	09072
☐	Attenuator (10 dB, DC ~ 26.5 GHz)	CFAD261002	01/07/2022	CERNEX	H0044
☒	Loop Antenna (0.009 ~ 30 MHz)	AL-130R	04/05/2021	Com-Power	121082
☒	BI-LOG Antenna (30 MHz ~ 6 GHz)	JB6	10/26/2022	Sunol	A071116
☒	LNA (30 MHz ~ 1GHz)	8447D	08/06/2021	HP	2443A03587
☒	Horn Antenna (1 GHz ~ 18 GHz)	DRH-118	10/21/2022	Sunol	A070516
☒	LNA (1 GHz ~ 18 GHz)	PAM-118A	07/09/2021	Com-Power	18040074
☒	Horn Antenna (18 GHz ~ 40 GHz)	DRH-1840	02/20/2021	Sunol	17120
☒	LNA (18 GHz ~ 40 GHz)	CBL184050-45-01	02/04/2022	CERNEX, Inc.	43964
☐	Power Divider-2way (DC ~ 26.5 GHz)	11636B	12/11/2021	HP	50820
☐	Directional Coupler (1-4GHz)	3022	12/15/2021	Narda	72118
☒	High Pass Filter (2.4 GHz)	WHK10-2520-3000-18000-40EF	01/06/2022	Wainwright	9
☐	EMI Test Receiver	ESR3	12/17/2021	Rohde & Schwarz	102363
☐	LISN	ENV216	01/16/2022	Rohde & Schwarz	101349

Note:

- Equipment listed above that calibrated during the testing period was set for test after the calibration.
- Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date

ANNEX A. TEST SETUP PHOTOS

The setup photos are provided as a separate document.

ANNEX B. PHOTOGRAPHS OF EUT

B.1. EXTERNAL PHOTOS

The external photos are provided as a separate document.

B.2. INTERNAL PHOTOS

The internal photos are provided as a separate document.

END OF TEST REPORT