

TEST REPORT

Part 15 C & RSS-247 (Issue 2)



Equipment under test Bluetooth module
Model name BCM-LN100-AS
FCC ID 2APDI-BCM-LN100-AS
IC Certification No 8738A-BCMLN100AS
Applicant BNCOM CO.LTD
Manufacturer BNCOM CO.LTD
Date of test(s) 2023.02.01 ~ 2023.02.10
Date of issue 2023.02.10

Issued to
BNCOM CO.LTD

#1106, M-Techno Center, 46, Gongdan-ro 140 beon-gil, Gunpo-si, Gyeonggi-do,
Republic of Korea.
Tel: +82-031-427-6034 / Fax: +82-031-427-8907

Issued by
KES Co., Ltd.

3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si,
Gyeonggi-do, 14057, Korea
473-21, Gayeo-ro, Yeosu-si, Gyeonggi-do, Korea
Tel: +82-31-425-6200 / Fax: +82-31-424-0450

Test and report completed by :	Report approval by :
	
Do-won, Ahn Test engineer	Young-Jin Lee Technical manager

This test report is not related to KS Q ISO/IEC 17025 and KOLAS.

**KES Co., Ltd.**

3701, 40, Simin-daero 365beon-gil,
Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea
Tel: +82-31-425-6200 / Fax: +82-31-424-0450
www.kes.co.kr

Test report No.:
KES-RF-23T0032
Page (2) of (51)

Revision history

Revision	Date of issue	Test report No.	Description
-	2023.02.10	KES-RF-23T0032	Initial

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
The authenticity of the test report, contact kes@kes.co.kr



KES Co., Ltd.

3701, 40, Simin-daero 365beon-gil,
Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea
Tel: +82-31-425-6200 / Fax: +82-31-424-0450
www.kes.co.kr

Test report No.:
KES-RF-23T0032
Page (3) of (51)

TABLE OF CONTENTS

1.	General information	4
1.1.	EUT description	4
1.2.	Test configuration	5
1.3.	Derivative Model Information	5
1.4.	Accessory information	5
1.5.	Sample calculation	5
1.6.	Measurement Uncertainty	5
1.8.	Frequency/channel operations	6
2.	Summary of tests	6
3.	Test results	7
3.1.	99% Occupied Bandwidth	7
3.2.	6 dB bandwidth	10
3.3.	Output power	13
3.4.	Power spectral density	15
3.5.	Radiated restricted band and emissions	19
3.6.	Conducted spurious emissions & band edge	41
3.7.	AC conducted emissions	48
Appendix A.	Measurement equipment	50
Appendix B.	Test setup photos	51

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
The authenticity of the test report, contact kes@kes.co.kr

1. General information

Applicant: BNCOM CO.LTD
Applicant address: #1106, M-Techno Center, 46, Gongdan-ro 140 beon-gil, Gunpo-si, Gyeonggi-do, Republic of Korea.
Test site: KES Co., Ltd.
Test site address: ☐ 3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea
☒ 473-29, Gayeo-ro, Yeosu-si, Gyeonggi-do, Korea
Test Facility: FCC Accreditation Designation No.: KR0100, Registration No.: 444148
ISED Registration No.: 23298
FCC rule part(s): 15.247
IC rule part(s): RSS-247
FCC ID: 2APDI-BCM-LN100-AS
IC Certification No: 8738A-BCMLN100AS
Test device serial No.: ☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test: Bluetooth module
Frequency range: **2 402 MHz ~ 2 480 MHz (BLE 1/2 Mbps)**
Model: BCM-LN100-AS
Modulation technique: GFSK
Antenna specification: PCB Antenna // Peak gain: -0.62 dBi
Power source: DC 3.3 V
Number of channels: **2 402 MHz ~ 2 480 MHz (BLE 1/2 Mbps) : 40 ch**
H/W Version: V1.0.0
S/W Version: V1.0.0
Serial No: 23013100001

1.2. Test configuration

The **BNCOM CO.LTD // Bluetooth module // BCM-LN100-AS**

FCC ID: 2APDI-BCM-LN100-AS // IC: 8738A-BCMLN100AS was tested according to the specification of EUT, the EUT must comply with following standards and KDB documents.

FCC Part 15.247

ISED RSS-247 Issue 2 and RSS-Gen Issue 5

KDB 558074 D01 v05 r02

ANSI C63.10-2013

1.3. Derivative Model Information

N/A

1.4. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
-	-	-	-	-

1.5. Sample calculation

Where relevant, the following sample calculation is provided

For all conducted test items :

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

$$\begin{aligned}\text{Offset(dB)} &= \text{RF cable loss(dB)} + \text{attenuator factor(dB)} \\ &= 0.56 + 10 = 10.56 \text{ (dB)}\end{aligned}$$

For Radiation test :

Field strength level (dB μ V/m) = Measured level (dB μ V) + Antenna factor (dB) + Cable loss (dB) – Amplifier gain (dB)

1.6. Measurement Uncertainty

Test Item		Uncertainty
Uncertainty for Conduction emission test		2.38 dB
Uncertainty for Radiation emission test (include Fundamental emission)	Below 1GHz	4.50 dB
	Above 1GHz	4.90 dB
Note. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.		

1.8. Frequency/channel operations

Ch.	Frequency (MHz)	Mode
00	2 402	BLE 1/2 Mbps
.	.	.
20	2 442	BLE 1/2 Mbps
.	.	.
39	2 480	BLE 1/2 Mbps

2. Summary of tests

Section in FCC Part 15	Section in RSS-247 & Gen	Parameter	Test results
-	RSS-Gen 6.7	99% occupied bandwidth	Pass
15.247(a)(2)	RSS-247 5.2(a)	6 dB bandwidth	Pass
15.247(b)(3)	RSS-247 5.4(d)	Output power	Pass
15.247(e)	RSS-247 5.2(b)	Power spectral density	Pass
15.205 15.209	RSS-247 5.5 RSS-Gen 8.9, 8.10	Radiated restricted band and emission	Pass
15.247(d)	RSS-247 5.5	Conducted spurious emission and band edge	Pass
15.207(a)	RSS-Gen 8.8	AC Conducted emissions	Pass

Note:

1. This product is powered by DC 3.3 V.
2. By the request of the applicant, test was performed with condition below:
Target power : 4

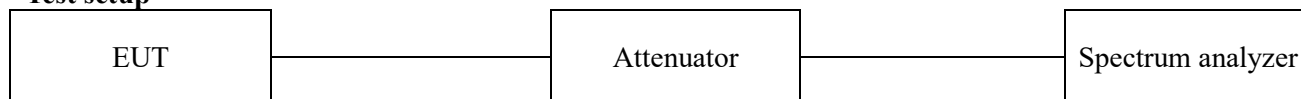
3. Test results

3.1. 99% Occupied Bandwidth

Test procedure

ANSI C63.10-2013

Test setup



Test setting

- Span = The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
- RBW = The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW 3. VBW = shall be approximately three times the RBW
- Sweep = auto
- Detector function = Peak
- Trace = Max hold

Limit

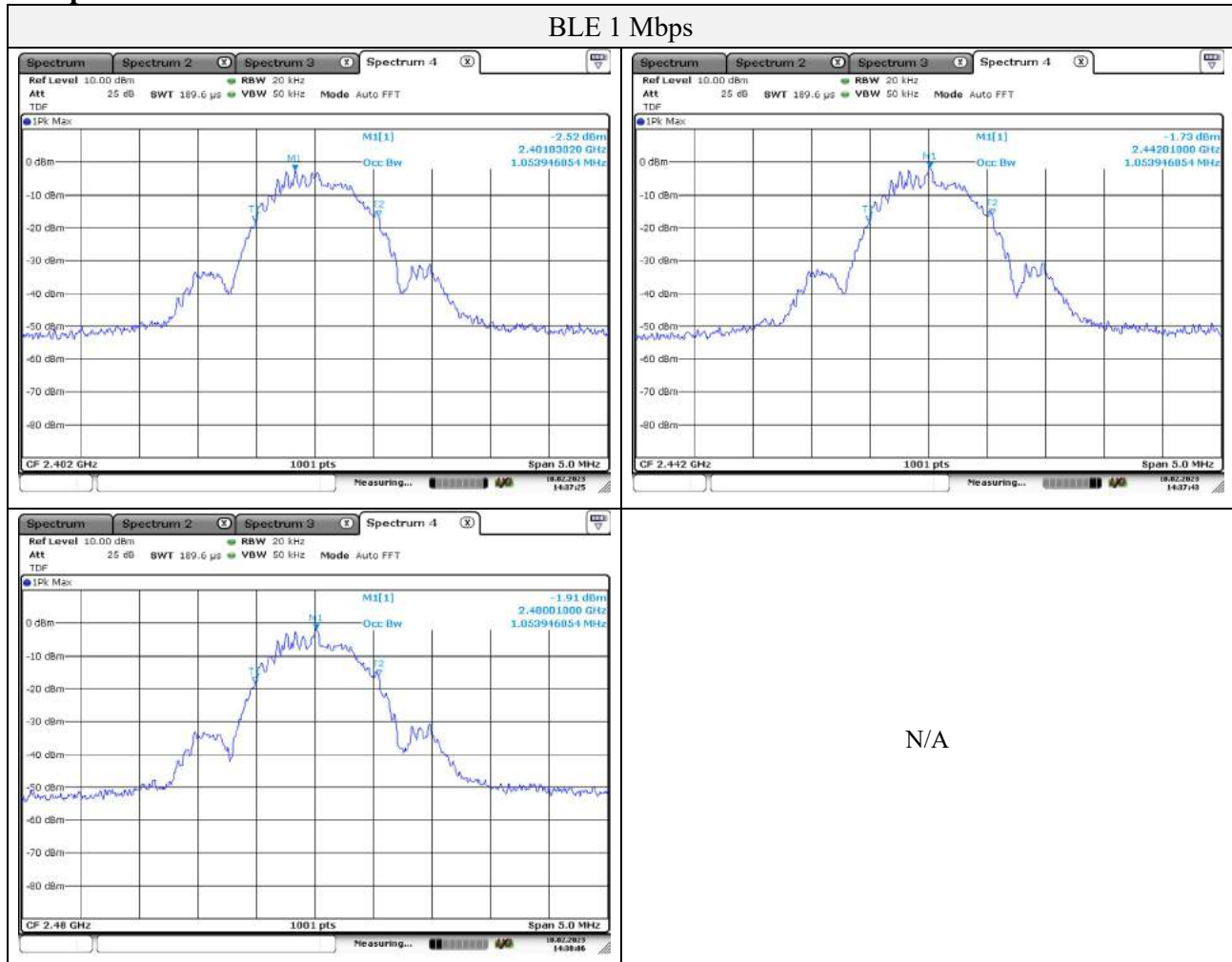
None; for reporting purpose only.

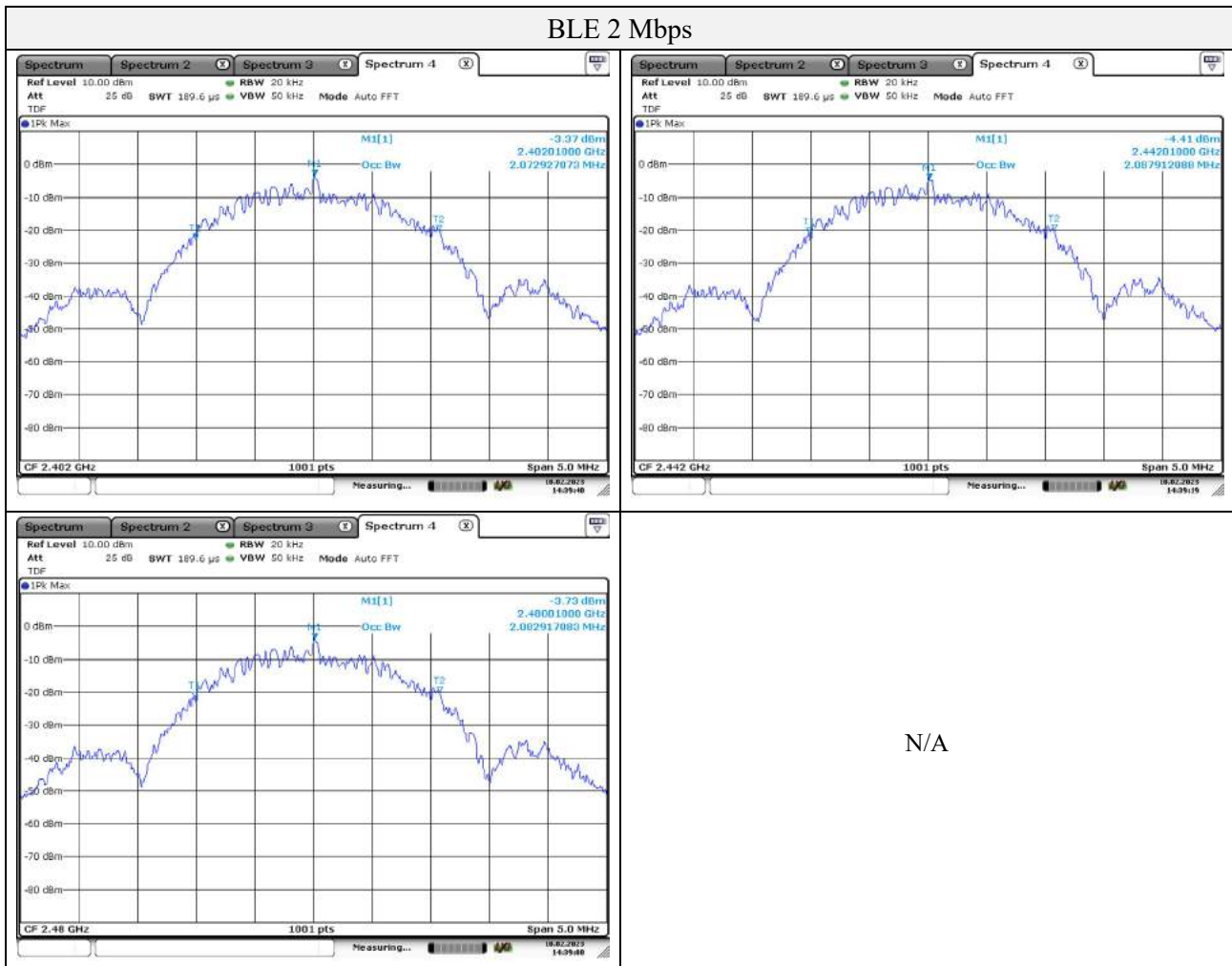
Test results

Mode	Frequency(MHz)	Measured 99 % bandwidth(MHz)	Limit(MHz)
BLE 1 Mbps	2 402	1.054	-
	2 442	1.054	
	2 480	1.054	

Mode	Frequency(MHz)	Measured 99 % bandwidth(MHz)	Limit(MHz)
BLE 2 Mbps	2 402	2.073	-
	2 442	2.088	
	2 480	2.083	

Test plot



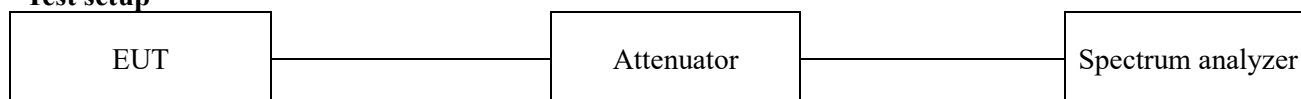


3.2. 6 dB bandwidth

Test procedure

ANSI C63.10 – section 11.8

Test setup



ANSI C63.10-2013 - Section 11.8.1

1. RBW = 100 kHz.
2. VBW $\geq 3 \times$ 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.

ANSI C63.10-2013 - Section 11.8.2

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described in 11.8.1 (i.e., RBW = 100 kHz, VBW $\geq 3 \times$ RBW, and peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

Limit

According to §15.247(a)(2), systems using digital modulation techniques may operate 902 ~ 928 MHz, 2 400 ~ 2 483.5 MHz, and 5 725 ~ 5 850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

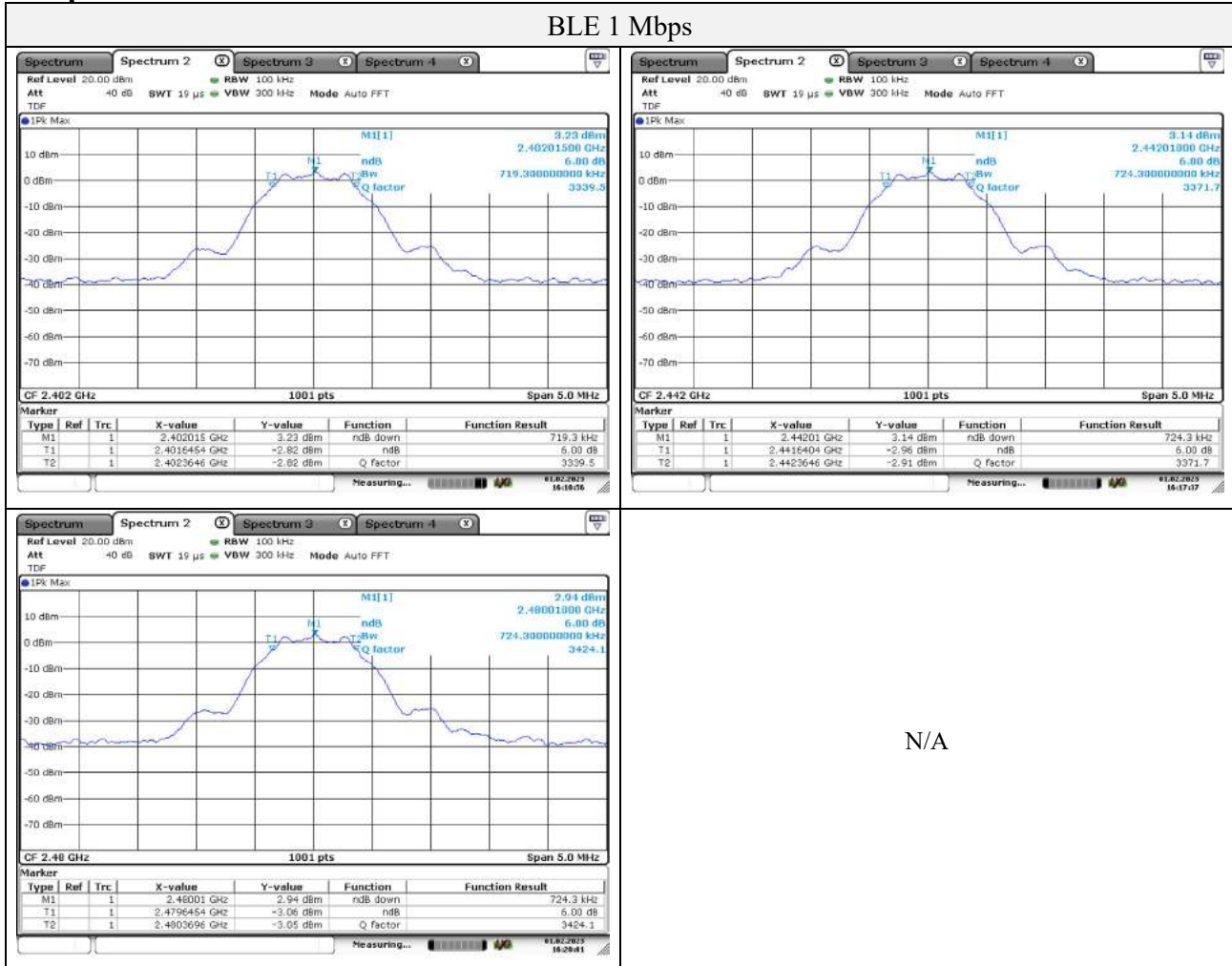
According to RSS-247 5.2 (a), the minimum 6 dB bandwidth shall be 500 kHz.

Test results

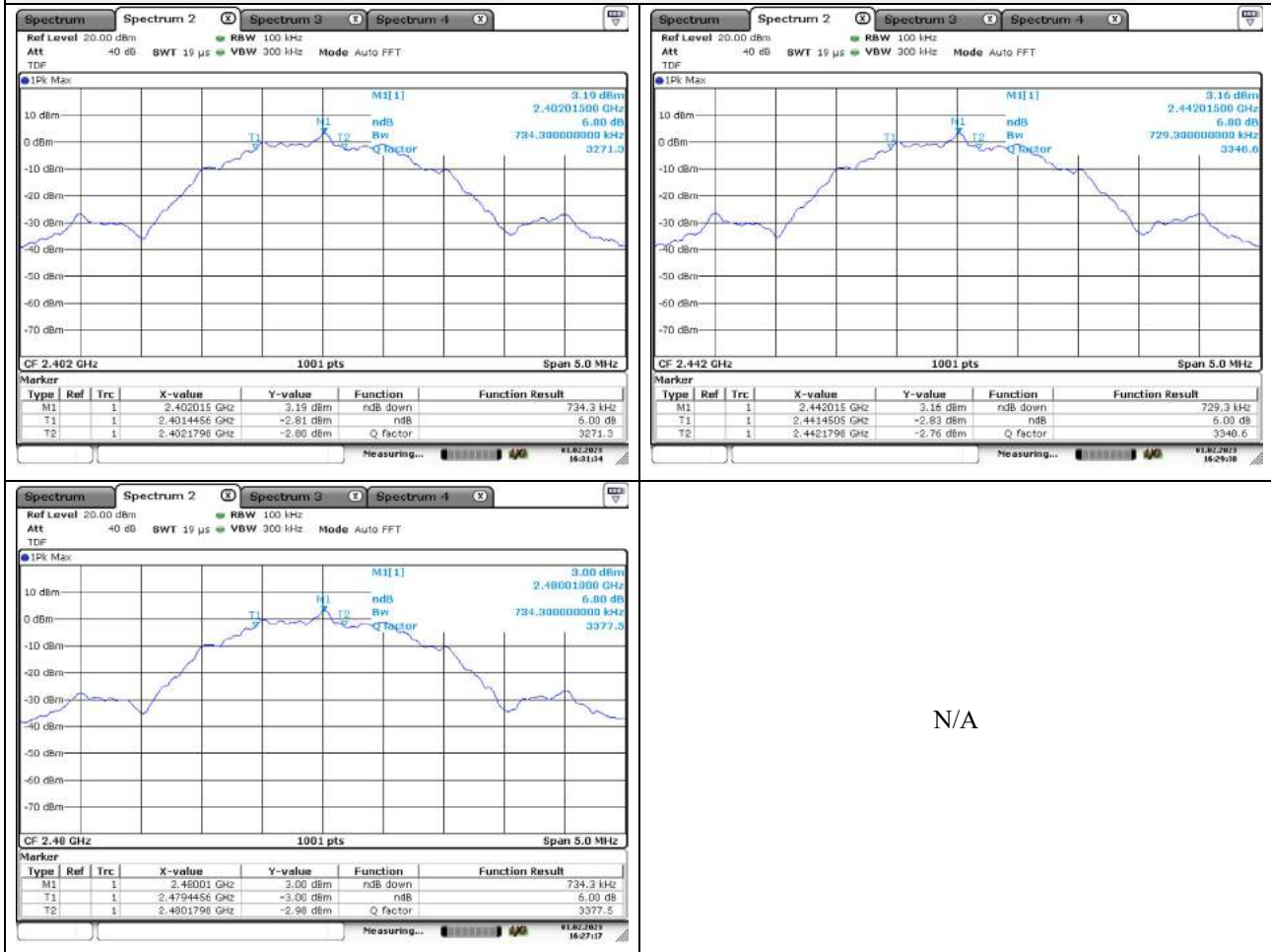
Mode	Frequency(MHz)	6 dB bandwidth(MHz)	Limit(MHz)
BLE 1 Mbps	2 402	0.719	≥ 0.500
	2 442	0.724	
	2 480	0.724	

Mode	Frequency(MHz)	6 dB bandwidth(MHz)	Limit(MHz)
BLE 2 Mbps	2 402	0.734	≥ 0.500
	2 442	0.729	
	2 480	0.734	

Test plot



BLE 2 Mbps



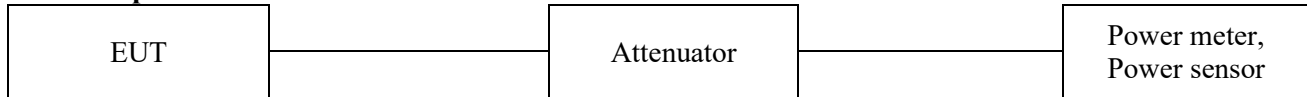
N/A

3.3. Output power

Test procedure

ANSI C63.10-2013 - Section 11.9.1.3 and 11.9.2.3.2

Test setup



ANSI C63.10-2013 - Section 11.9.1.3

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall use a fast-responding diode detector.

ANSI C63.10-2013 - Section 11.9.2.3.2

Alternatively, measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Because the measurement is made only during the ON time of the transmitter, no duty cycle correction is required.

Limit

According to §15.247(b)(3), For systems using digital modulation in the 902~928 MHz, 2 400~2 483.5 MHz, and 5 725~5 850 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 out-put power. Maximum Conducted Out-put 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.

According to §15.247(b)(4), The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

According to RSS-247 5.4 (d), For DTSSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W, except as provided in Section 5.4(e).

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is 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 transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

**KES Co., Ltd.**

3701, 40, Simin-daero 365beon-gil,
Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea
Tel: +82-31-425-6200 / Fax: +82-31-424-0450
www.kes.co.kr

Test report No.:
KES-RF-23T0032
Page (14) of (51)

Test results

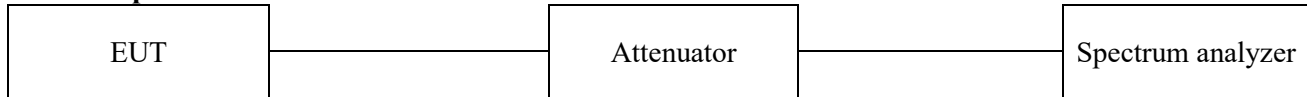
Measured output power (dBm)						
Mode	2 402 MHz		2 442 MHz		2 480 MHz	
	Average	Peak	Average	Peak	Average	Peak
BLE 1 Mbps	2.99	3.55	2.98	3.55	2.98	3.55

Measured output power (dBm)						
Mode	2 402 MHz		2 442 MHz		2 480 MHz	
	Average	Peak	Average	Peak	Average	Peak
BLE 2 Mbps	2.30	3.55	2.32	3.56	2.15	3.39

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
The authenticity of the test report, contact kes@kes.co.kr

3.4. Power spectral density**Test procedure**

ANSI C63.10 – section 11.10.2

Test setup**ANSI C63.10 – section 11.10.2**

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

Limit

According to §15.247(e), 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.

According to RSS-247 5.2 (b), The transmitter power spectral density conducted from the transmitter 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 Section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

**KES Co., Ltd.**

3701, 40, Simin-daero 365beon-gil,
Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea
Tel: +82-31-425-6200 / Fax: +82-31-424-0450
www.kes.co.kr

Test report No.:
KES-RF-23T0032
Page (16) of (51)

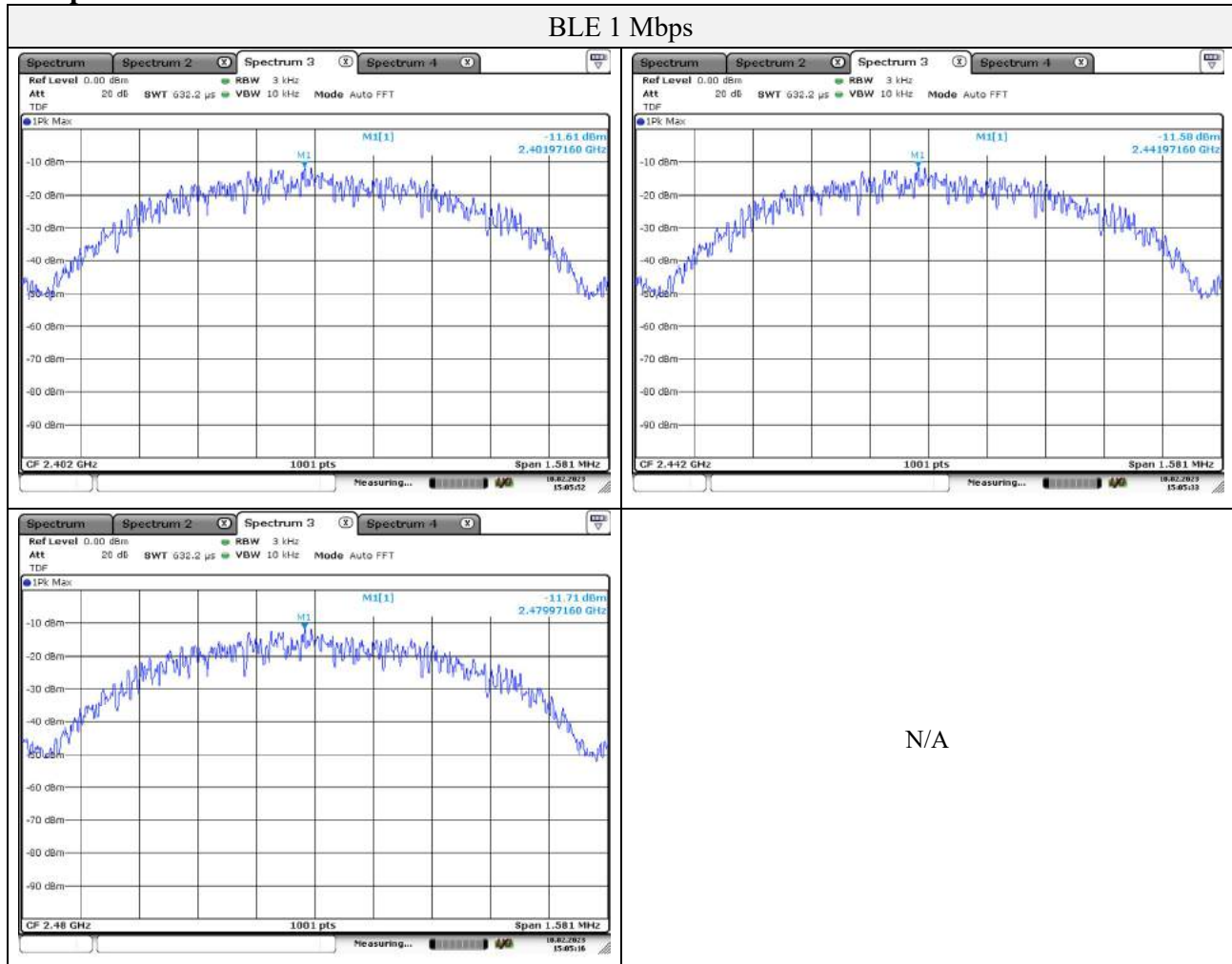
Test results

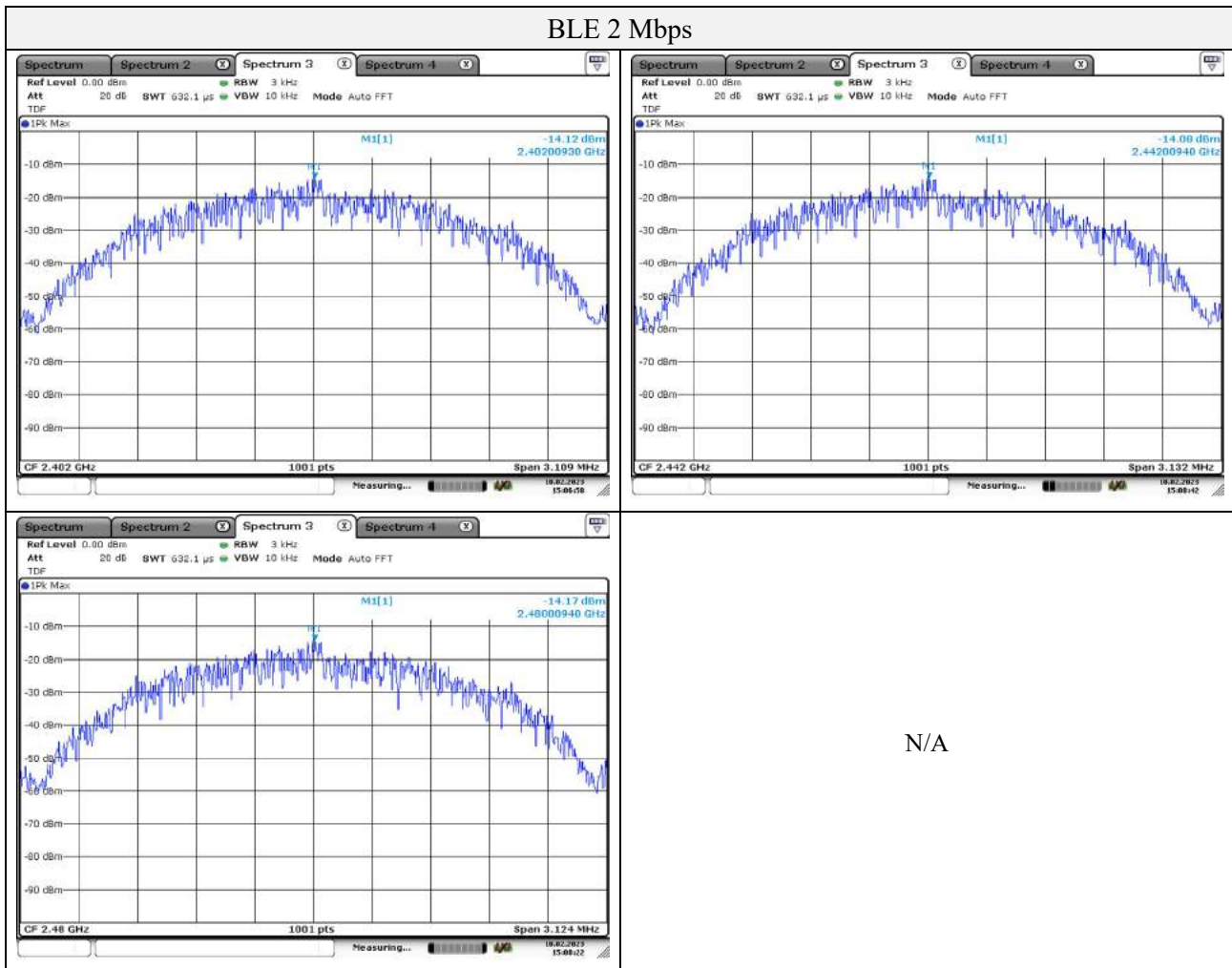
Mode	Frequency(MHz)	PSD (dBm/3kHz)	Limit(dBm/3kHz)
BLE 1 Mbps	2 402	-11.61	8
	2 442	-11.58	
	2 480	-11.71	

Mode	Frequency(MHz)	PSD (dBm/3kHz)	Limit(dBm/3kHz)
BLE 2 Mbps	2 402	-14.12	8
	2 442	-14.08	
	2 480	-14.17	

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
The authenticity of the test report, contact kes@kes.co.kr

Test plot

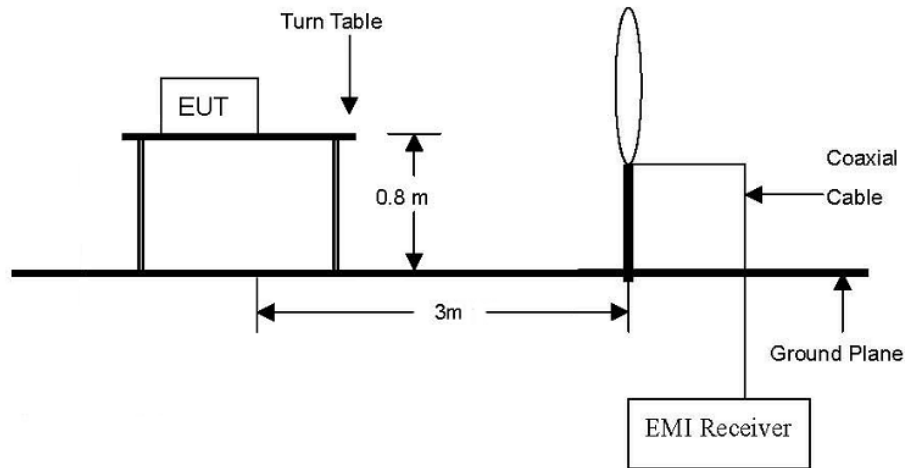




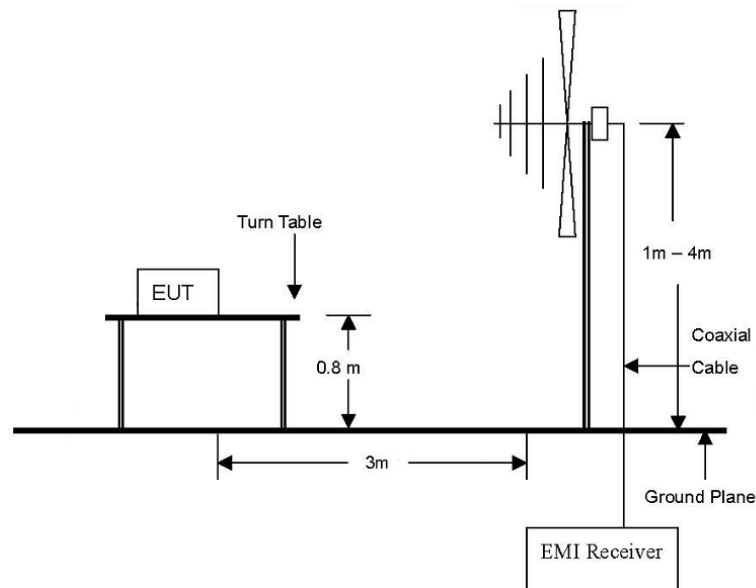
3.5. Radiated restricted band and emissions

Test setup

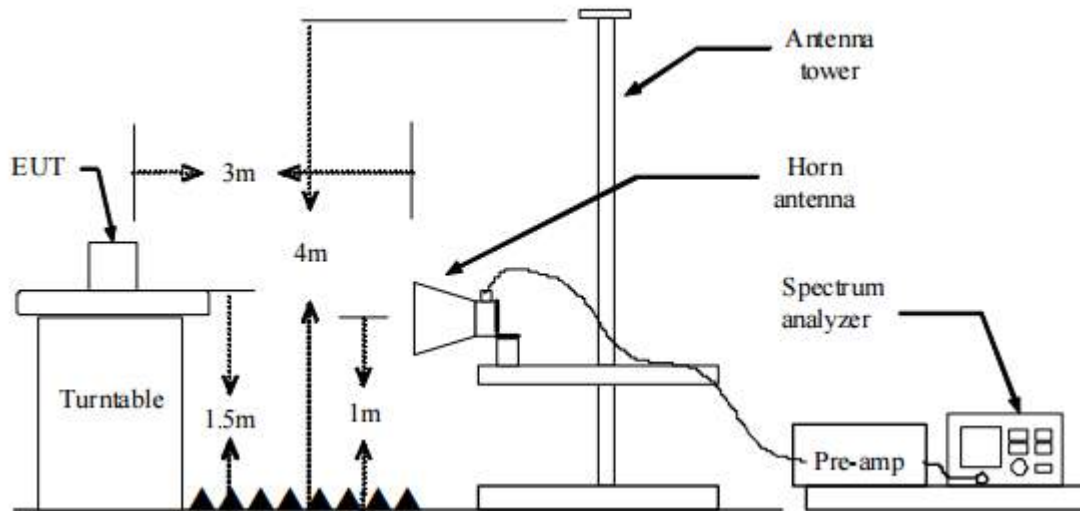
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 GHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz emissions, whichever is lower.



Test procedure

Radiated emissions from the EUT were measured according to the dictates in section 11.11 & 11.12 of ANSI C63.10-2013.

Test procedure below 30 MHz

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel, ground parallel and perpendicular of the antenna are set to make the measurement. It was determined that parallel was worst-case orientation; therefore, all final radiated testing was performed with the EUT in parallel.
3. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test-receiver system was set to average or quasi peak detect function and Specified Bandwidth with Maximum hold mode.

Test procedure above 30 MHz

1. The EUT was placed on the top of a rotating table 0.8 meters(30-1000MHz) / 1.5 meters(above 1GHz)above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. The antenna is a bi-log antenna, a horn antenna ,and its height are varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
3. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
5. Spectrum analyzer settings for $f < 1$ GHz:
 - ① Span = wide enough to fully capture the emission being measured
 - ② RBW = 100 kHz
 - ③ VBW \geq RBW
 - ④ Detector = quasi peak
 - ⑤ Sweep time = auto
 - ⑥ Trace = max hold
6. Spectrum analyzer settings for $f \geq 1$ GHz: Peak
 - ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
 - ② RBW = 1 MHz
 - ③ VBW \geq 3 MHz
 - ④ Detector = peak
 - ⑤ Sweep time = auto
 - ⑥ Trace = max hold
 - ⑦ Trace was allowed to stabilize

7. Spectrum analyzer settings for $f \geq 1$ GHz: Average

- ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
- ② RBW = 1 MHz
- ③ VBW $\geq 3 \times$ RBW
- ④ Detector = RMS, if span/(# of points in sweep) \leq (RBW/2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.
- ⑤ Averaging type = power(i.e., RMS)
 - 1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
 - 2) Some instruments require linear display mode in order to use linear voltage averaging. Log or dB averaging shall not be used.
- ⑥ Sweep = auto
- ⑦ Trace = max hold
- ⑧ Perform a trace average of at least 100 traces.
- ⑨ A 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. The correction factor is computed as follows:
 - 1) If power averaging (RMS) mode was used in step ⑤, then the applicable correction factor is $10 \log(1/x)$, where x is the duty cycle.
 - 2) If linear voltage averaging mode was used in step ⑤, then the applicable correction factor is $20 \log(1/x)$, where x is the duty cycle.
 - 3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

Note.

1. $f < 30$ MHz, extrapolation factor of 40 dB/decade of distance. $F_d = 40\log(D_m/D_s)$
 $f \geq 30$ MHz, extrapolation factor of 20 dB/decade of distance. $F_d = 20\log(D_m/D_s)$
Where:
 F_d = Distance factor in dB
 D_m = Measurement distance in meters
 D_s = Specification distance in meters
2. Field strength(dB μ V/m) = Level(dB μ V) + CF (dB) + or DCF(dB)
3. Margin(dB) = Limit(dB μ V/m) - Field strength(dB μ V/m)
4. Emissions below 18 GHz were measured at a 3 meter test distance while emissions above 18 GHz were measured at a 1 meter test distance with the application of a distance correction factor.
7. The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z, it was determined that **X orientation** was worst-case orientation; therefore, all final radiated testing was performed with the EUT in **X orientation**.
8. The worst-case emissions are reported however emissions whose levels were not within 20 dB of respective limits were not reported.
9. According to exploratory test no any obvious emission were detected from 9 kHz to 30 MHz. Although these tests were performed other than open field site, adequate comparison measurements were confirmed against 30 m open field site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.

Limit

According to 15.209(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values :

Frequency (MHz)	Distance (Meters)	Radiated ($\mu\text{V/m}$)
0.009 ~ 0.490	300	2400/F(kHz)
0.490 ~ 1.705	30	24000/F(kHz)
1.705 ~ 30.0	30	30
30 ~ 88	3	100**
88 ~ 216	3	150**
216 ~ 960	3	200**
Above 960	3	500

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 ~ 72 MHz, 76 ~ 88 MHz, 174 ~ 216 MHz or 470 ~ 806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

According to RSS-Gen, Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits :

Frequency (MHz)	Distance (Meters)	Radiated ($\mu\text{V/m}$)
0.009 ~ 0.490	300	2 400 / F(kHz)
0.490 ~ 1.705	30	24 000 / F(kHz)
1.705 ~ 30.0	30	30
30 ~ 88	3	100
88 ~ 216	3	150
216 ~ 960	3	200
Above 960*	3	500

* Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.

Note: Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the specific RSS.

Duty cycle

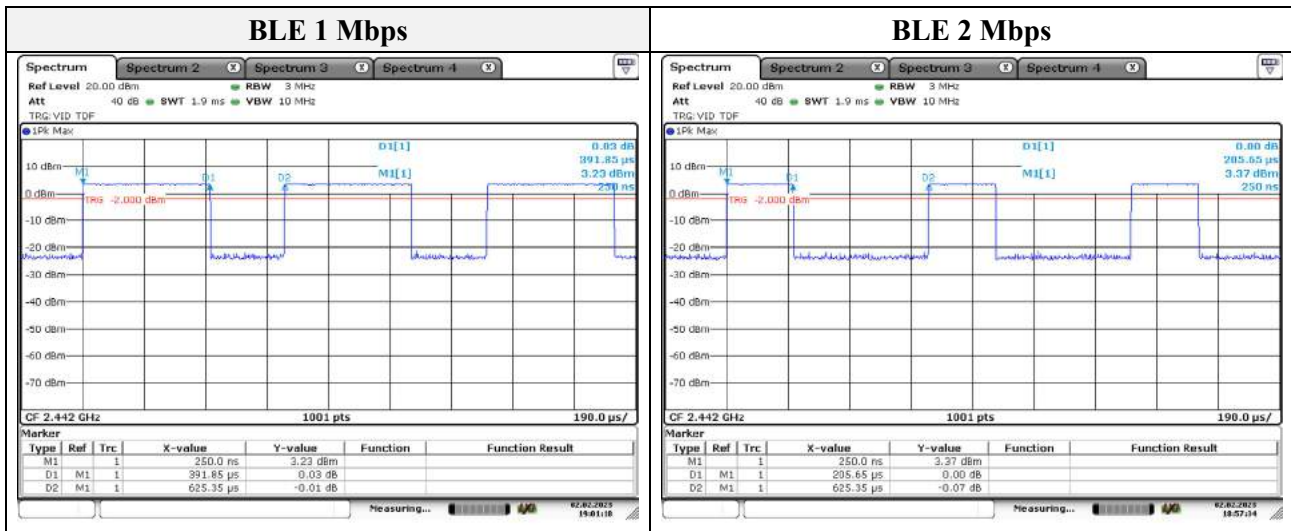
Regarding to KDB 558074 D01_v04, 6.0, the maximum duty cycles of all modes were investigated and set the spectrum analyzer as below.

Set RBW \geq OBW if possible; otherwise, set RBW to the largest available value. Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are $> 50/T$ and the number of sweep points across duration T exceeds 100.

Test mode	T _{on} time (ms)	Period (ms)	Duty cycle (Linear)	Duty cycle (%)	Duty cycle correction factor (dB)
BLE 1 Mbps	0.392	0.625	0.627	62.72	2.03
BLE 2 Mbps	0.206	0.625	0.329	32.89	4.83

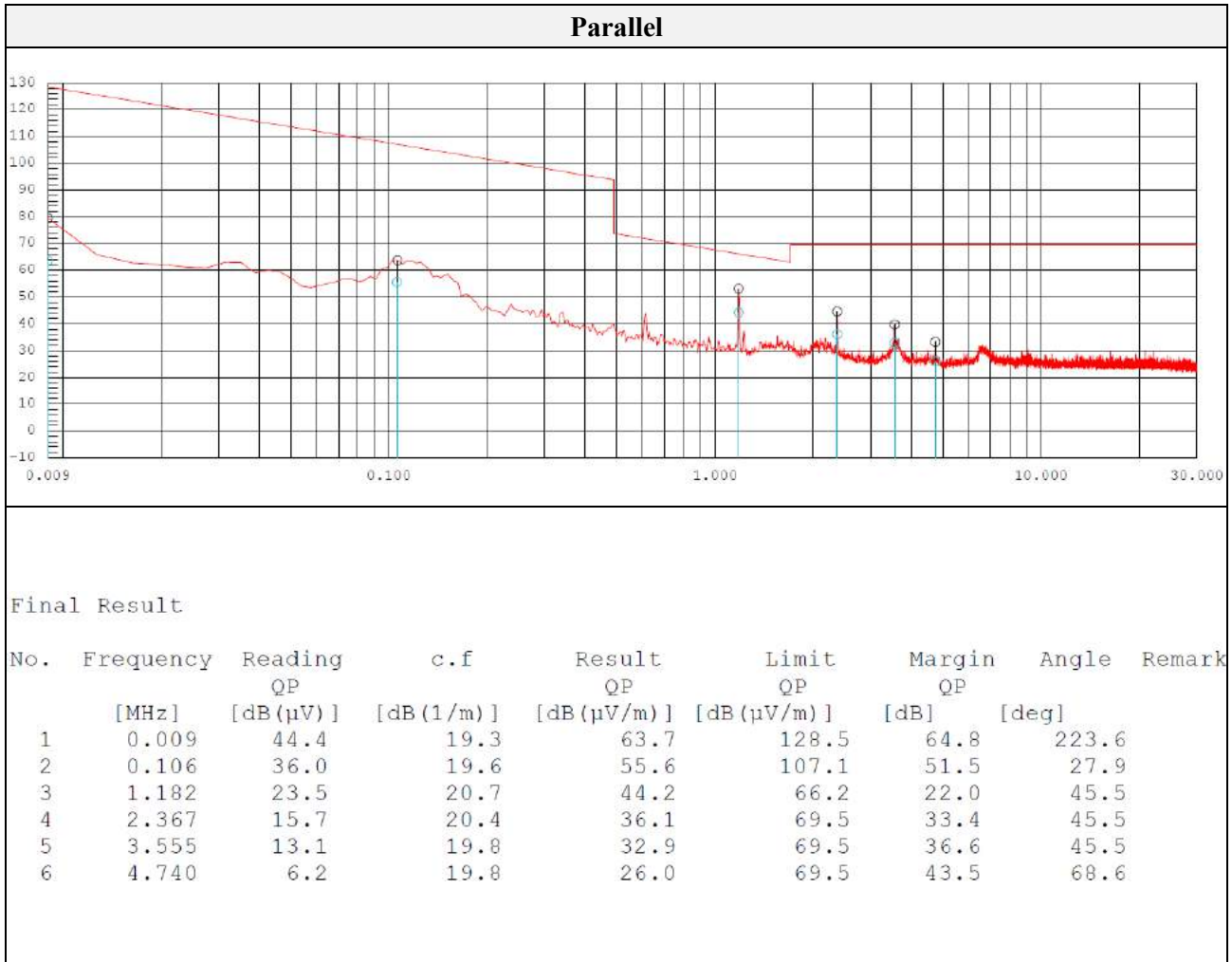
Duty cycle (Linear) = T_{on} time/Period

DCF(Duty cycle correction factor (dB)) = 10log(1/duty cycle)



Test results (Below 30 MHz)

Mode: BLE_2 Mbps
Channel: 20 (Worst case)
Distance of measurement: 3 meter

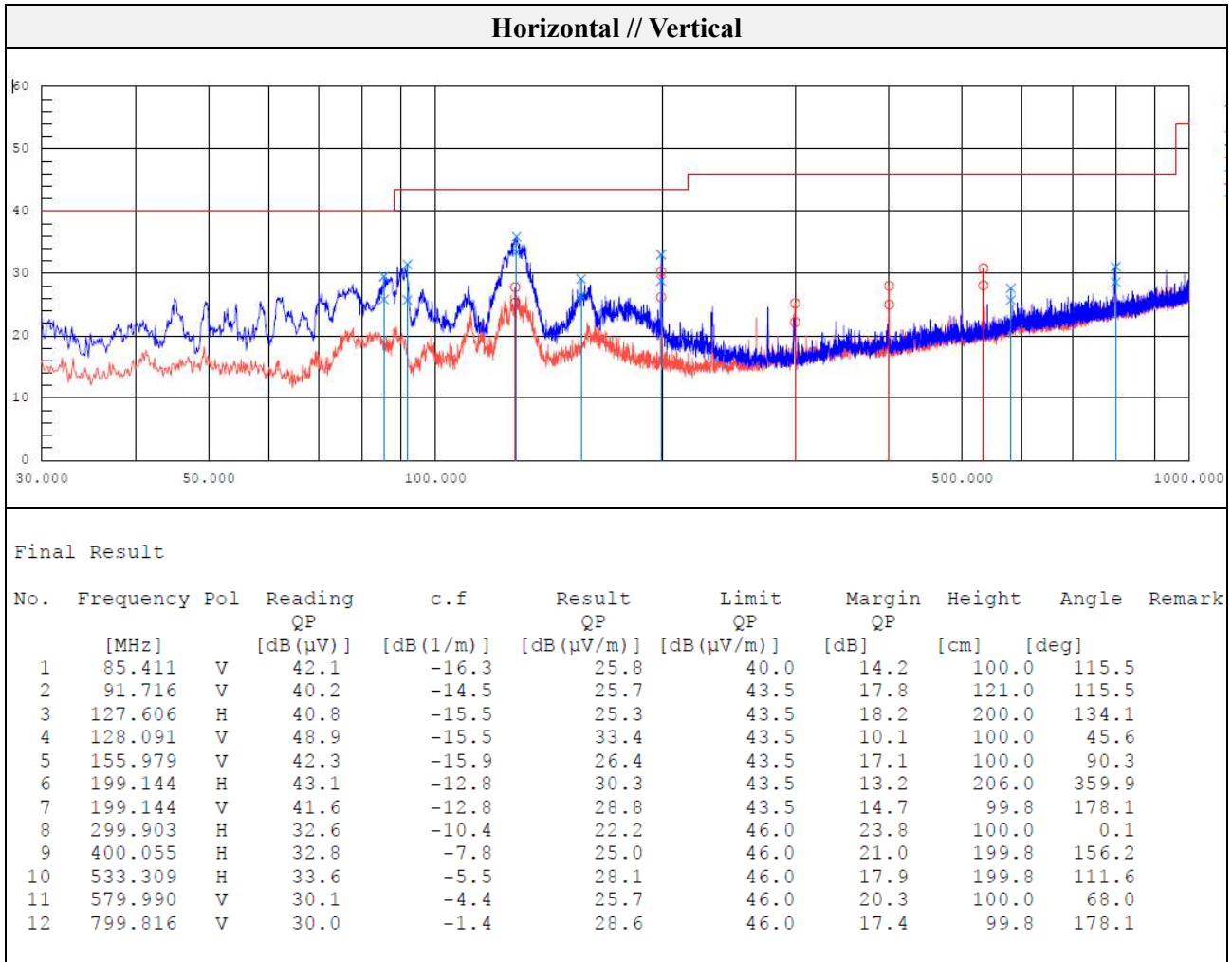


Test results (Below 1 000 MHz)

Mode: BLE_2 Mbps

Channel: 20 (Worst case)

Distance of measurement: 3 meter



Test results (Above 1 000 MHz)

Mode: BLE_1 Mbps

Channel: 00

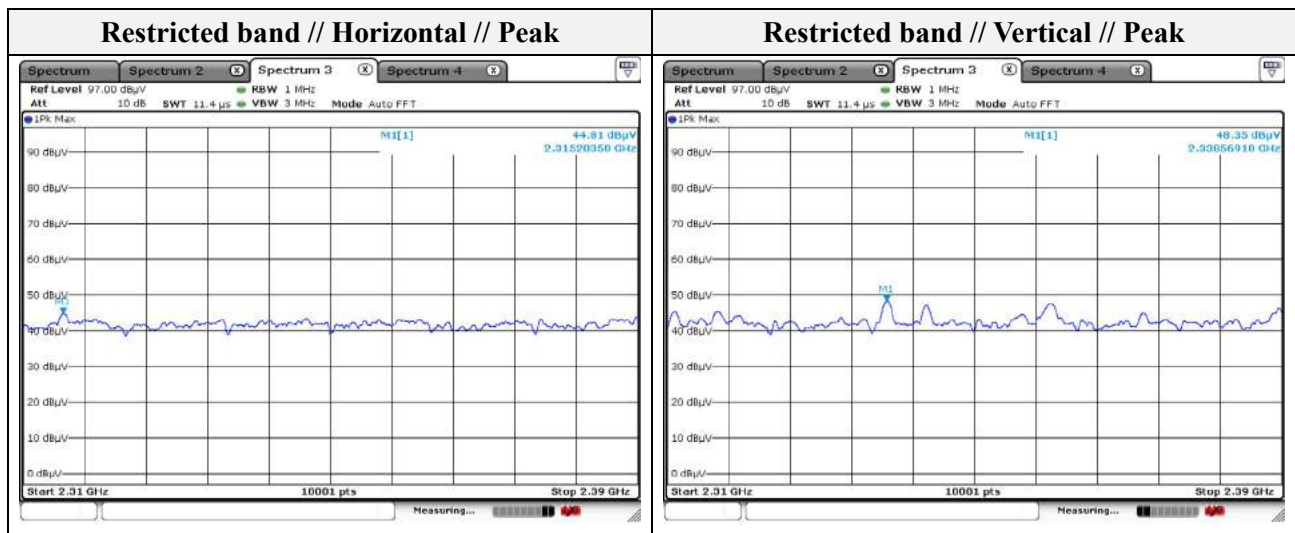
Distance of measurement: 3 meter

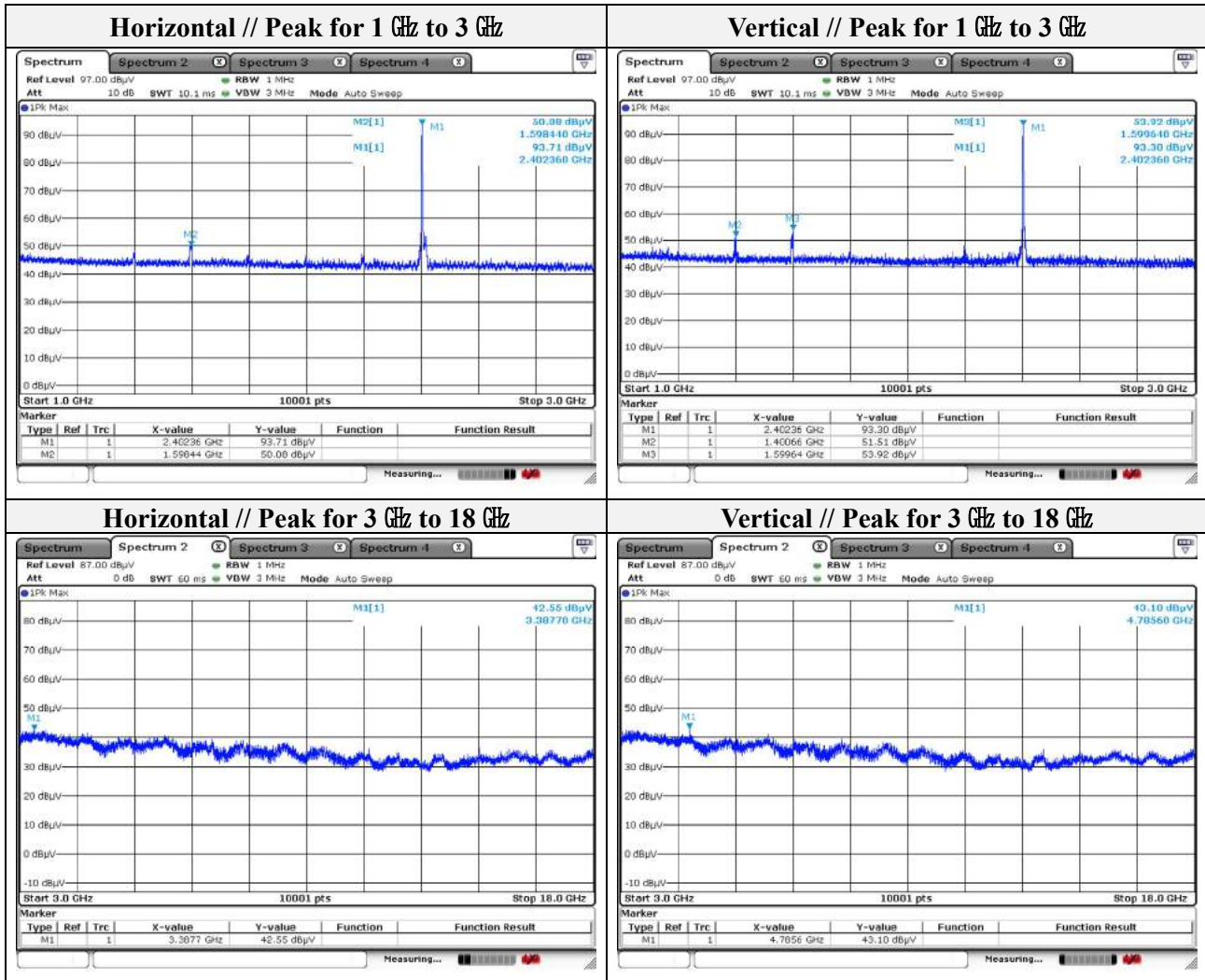
- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 400.66	51.51	Peak	V	-7.96	-	43.55	74.00	30.45
1 598.44	50.08	Peak	H	-6.44	-	43.64	74.00	30.36
1 599.64	53.92	Peak	V	-6.42	-	47.50	74.00	26.50
3 387.70	42.55	Peak	H	-0.16	-	42.39	74.00	31.61
4 785.60	43.10	Peak	V	4.57	-	47.67	74.00	26.33

- Band edge

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 315.20	44.81	Peak	H	-1.79	-	43.02	74.00	30.98
2 338.57	48.35	Peak	V	-1.76	-	46.59	74.00	27.41





Note.

1. Average test would be performed if the peak result were greater than the average limit.

**KES Co., Ltd.**

3701, 40, Simin-daero 365beon-gil,
Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea
Tel: +82-31-425-6200 / Fax: +82-31-424-0450
www.kes.co.kr

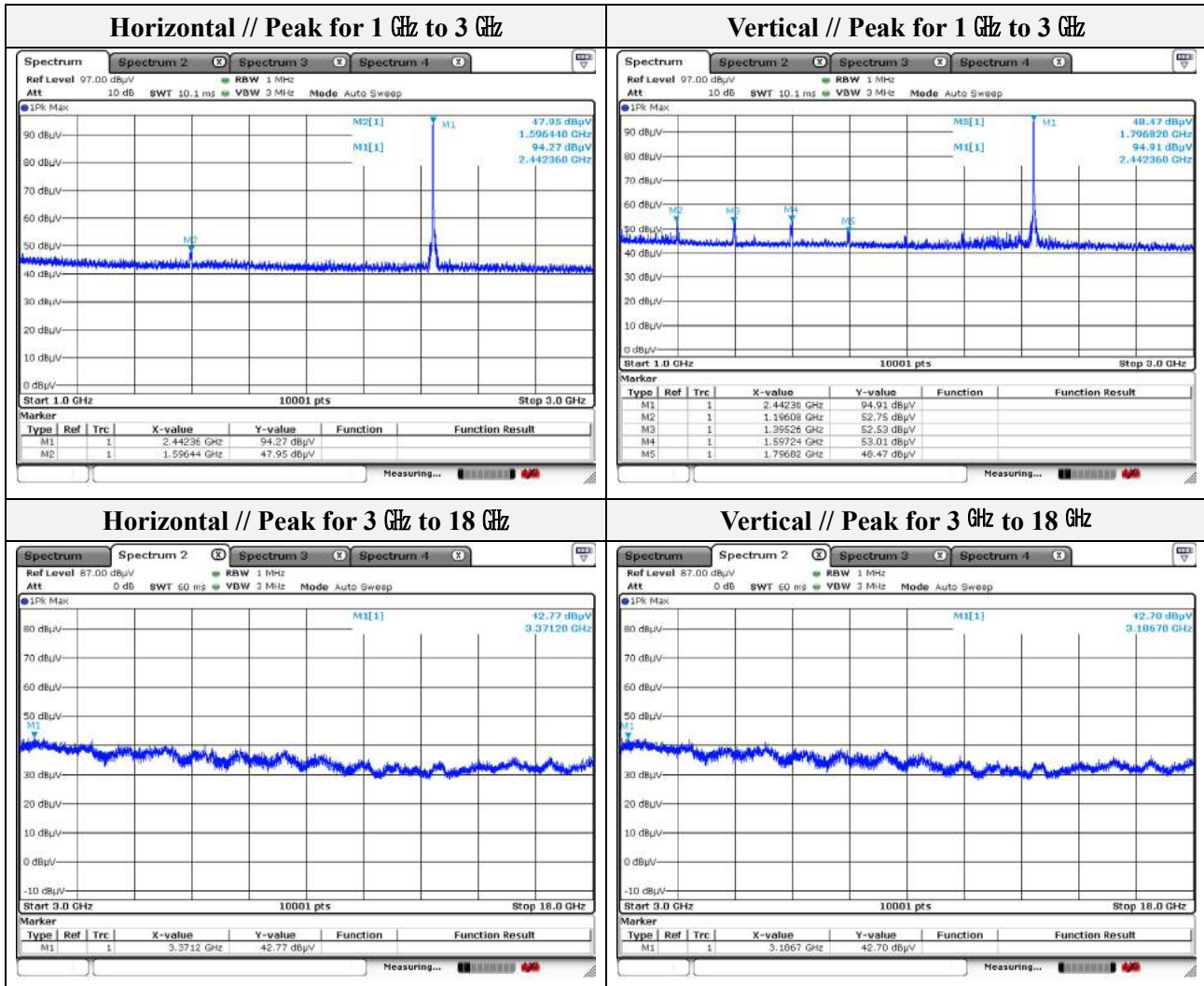
Test report No.:
KES-RF-23T0032
Page (30) of (51)

Mode: BLE_1 Mbps
Channel 20
Distance of measurement: 3 meter

- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 196.08	52.75	Peak	V	-9.22	-	43.53	74.00	30.47
1 395.26	52.53	Peak	V	-7.99	-	44.54	74.00	29.46
1 596.44	47.95	Peak	H	-6.46	-	41.49	74.00	32.51
1 597.24	53.01	Peak	V	-6.45	-	46.56	74.00	27.44
1 796.82	48.47	Peak	V	-4.14	-	44.33	74.00	29.67
3 186.70	42.70	Peak	V	0.06	-	42.76	74.00	31.24
3 371.20	42.77	Peak	H	-0.14	-	42.63	74.00	31.37

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
The authenticity of the test report, contact kes@kes.co.kr



Note.

1. Average test would be performed if the peak result were greater than the average limit.

Mode: BLE_1 Mbps

Channel: 39

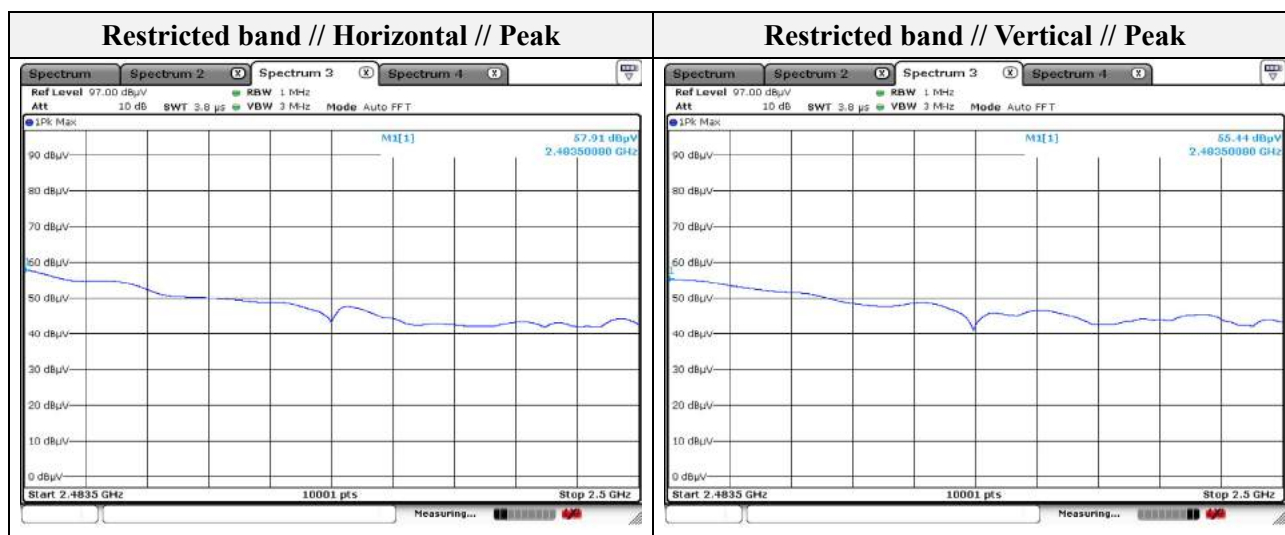
Distance of measurement: 3 meter

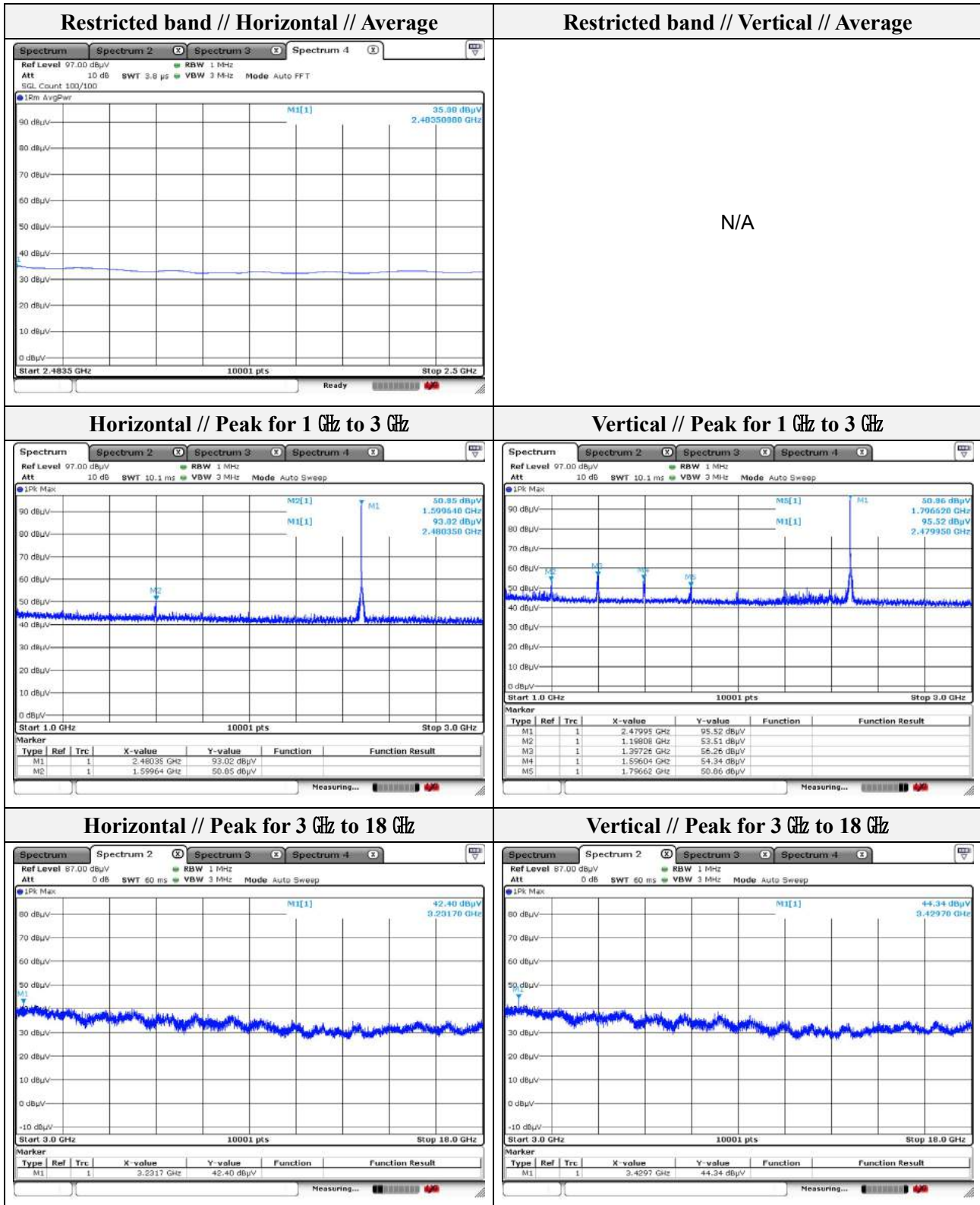
- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 198.08	53.51	Peak	V	-9.21	-	44.30	74.00	29.70
1 397.26	56.26	Peak	V	-7.98	-	48.28	74.00	25.72
1 596.04	54.34	Peak	V	-6.46	-	47.88	74.00	26.12
1 599.64	50.85	Peak	H	-6.42	-	44.43	74.00	29.57
1 796.62	50.86	Peak	V	-4.14	-	46.72	74.00	27.28
3 231.70	42.40	Peak	H	0.02	-	42.42	74.00	31.58
3 429.70	44.34	Peak	V	-0.17	-	44.17	74.00	29.83

- Band edge

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 483.50	57.91	Peak	H	-1.67	-	56.24	74.00	17.76
2 483.50	35.08	Average	H	-1.67	2.03	35.44	54.00	18.56
2 483.50	55.44	Peak	V	-1.67	-	53.77	74.00	20.23





Note.

1. Average test would be performed if the peak result were greater than the average limit.

Test results (Above 1 000 MHz)

Mode: BLE_2 Mbps

Channel: 00

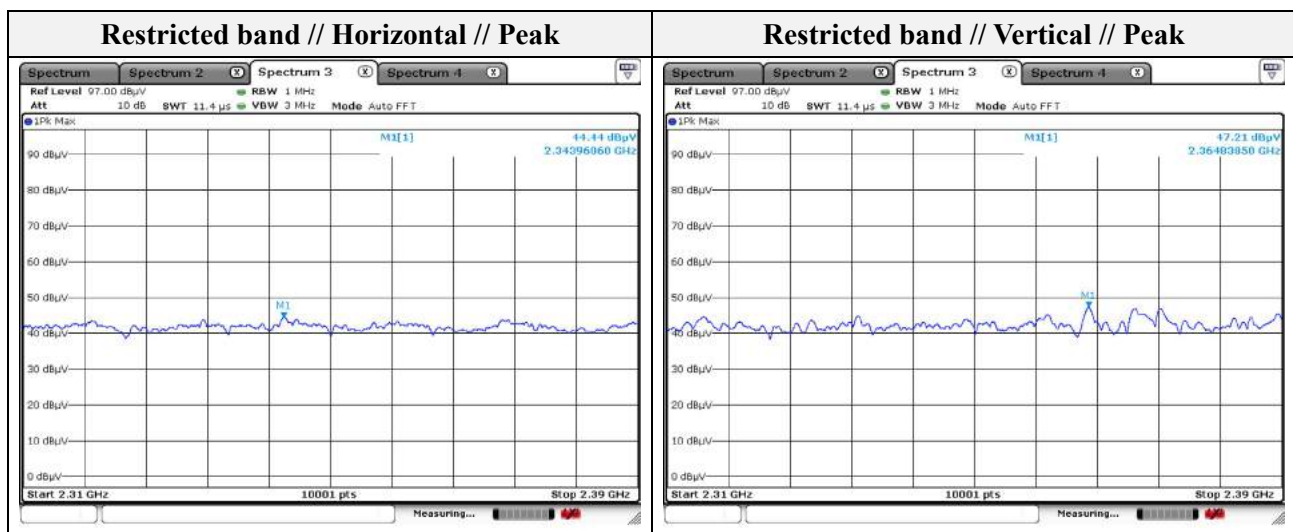
Distance of measurement: 3 meter

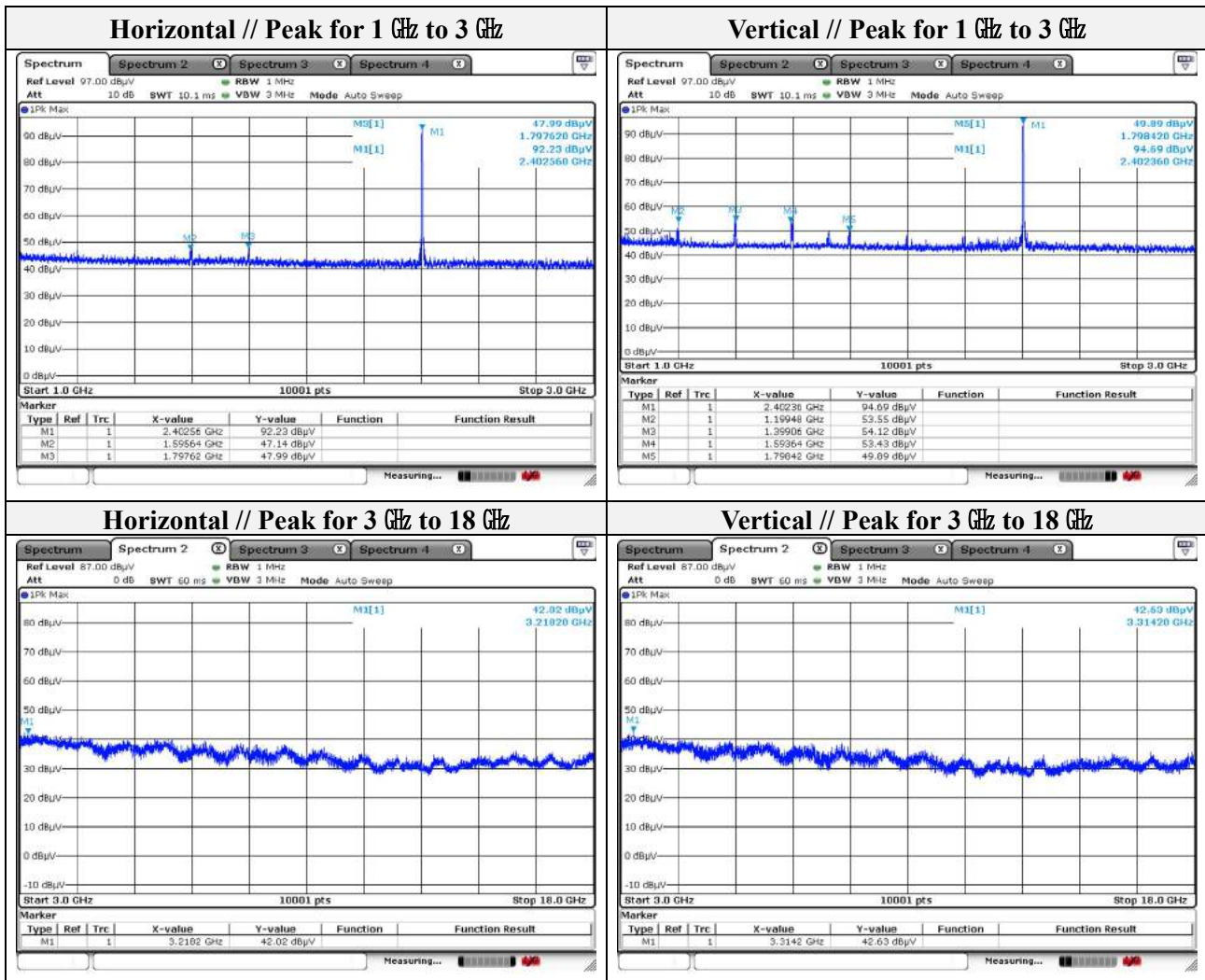
- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 199.48	53.55	Peak	V	-9.20	-	44.35	74.00	29.65
1 399.06	54.12	Peak	V	-7.97	-	46.15	74.00	27.85
1 593.64	53.43	Peak	V	-6.49	-	46.94	74.00	27.06
1 595.64	47.14	Peak	H	-6.47	-	40.67	74.00	33.33
1 797.62	47.99	Peak	H	-4.13	-	43.86	74.00	30.14
1 798.42	49.89	Peak	V	-4.12	-	45.77	74.00	28.23
3 218.20	42.02	Peak	H	0.04	-	42.06	74.00	31.94
3 314.20	42.63	Peak	V	-0.07	-	42.56	74.00	31.44

- Band edge

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 343.96	44.44	Peak	H	-1.75	-	42.69	74.00	31.31
2 364.84	47.21	Peak	V	-1.72	-	45.49	74.00	28.51





Note.

1. Average test would be performed if the peak result were greater than the average limit.

**KES Co., Ltd.**

3701, 40, Simin-daero 365beon-gil,
Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea
Tel: +82-31-425-6200 / Fax: +82-31-424-0450
www.kes.co.kr

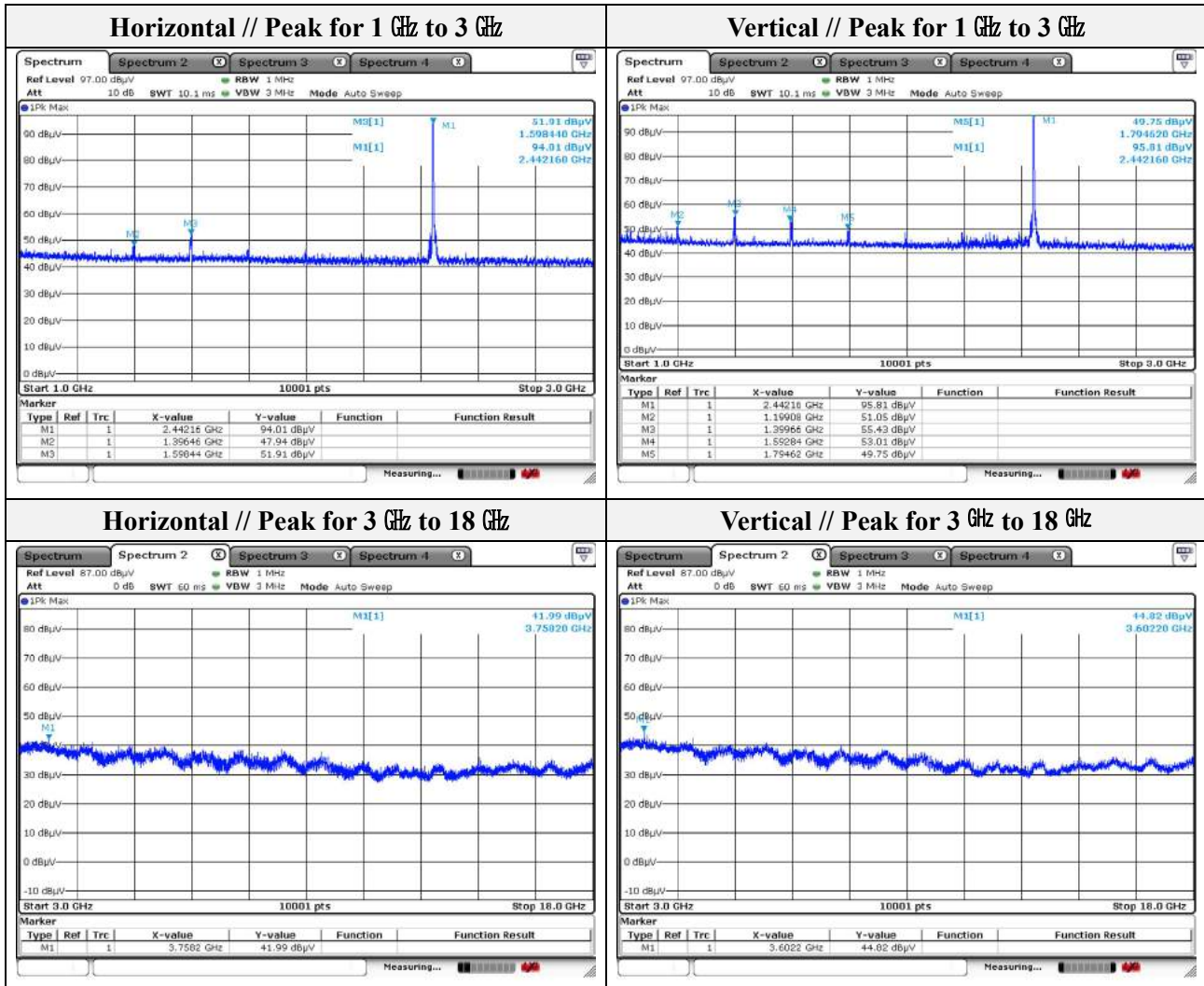
Test report No.:
KES-RF-23T0032
Page (36) of (51)

Mode: BLE_2 Mbps
Channel: 20
Distance of measurement: 3 meter

- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 199.08	51.05	Peak	V	-9.20		41.85	74.00	32.15
1 396.46	47.94	Peak	H	-7.99		39.95	74.00	34.05
1 399.66	55.43	Peak	V	-7.97		47.46	74.00	26.54
1 592.84	53.10	Peak	V	-6.49		46.61	74.00	27.39
1 598.44	51.91	Peak	H	-6.44		45.47	74.00	28.53
1 794.62	49.75	Peak	V	-4.17		45.58	74.00	28.42
3 602.20	44.82	Peak	V	0.42		45.24	74.00	28.76
3 758.20	41.99	Peak	H	1.12		43.11	74.00	30.89

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
The authenticity of the test report, contact kes@kes.co.kr



Note.

1. Average test would be performed if the peak result were greater than the average limit.

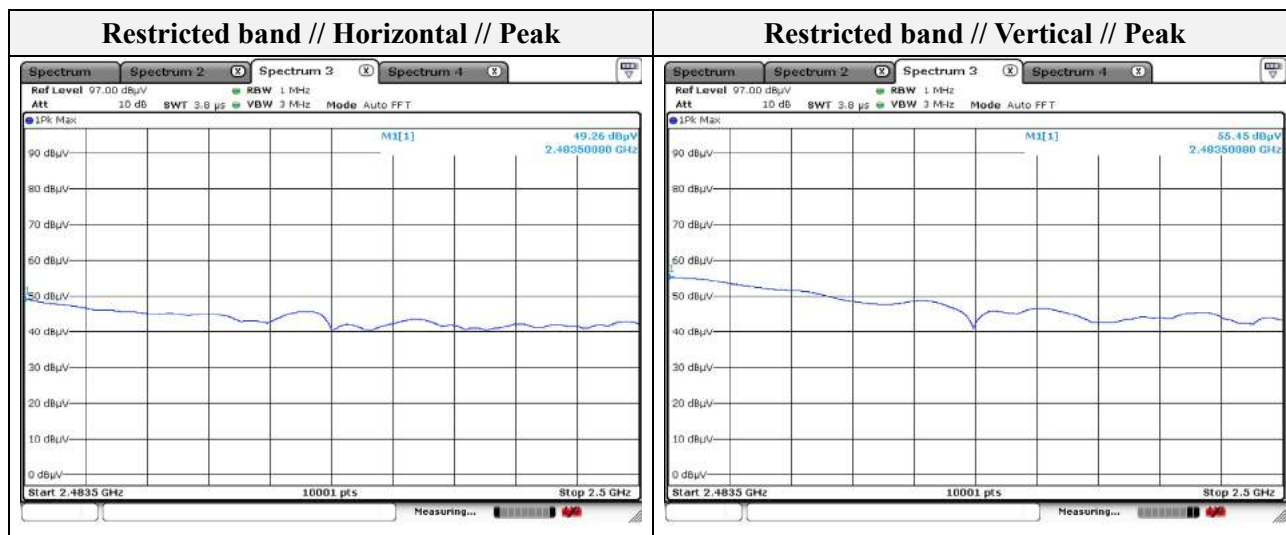
Mode: BLE_2 Mbps
Channel: 39
Distance of measurement: 3 meter

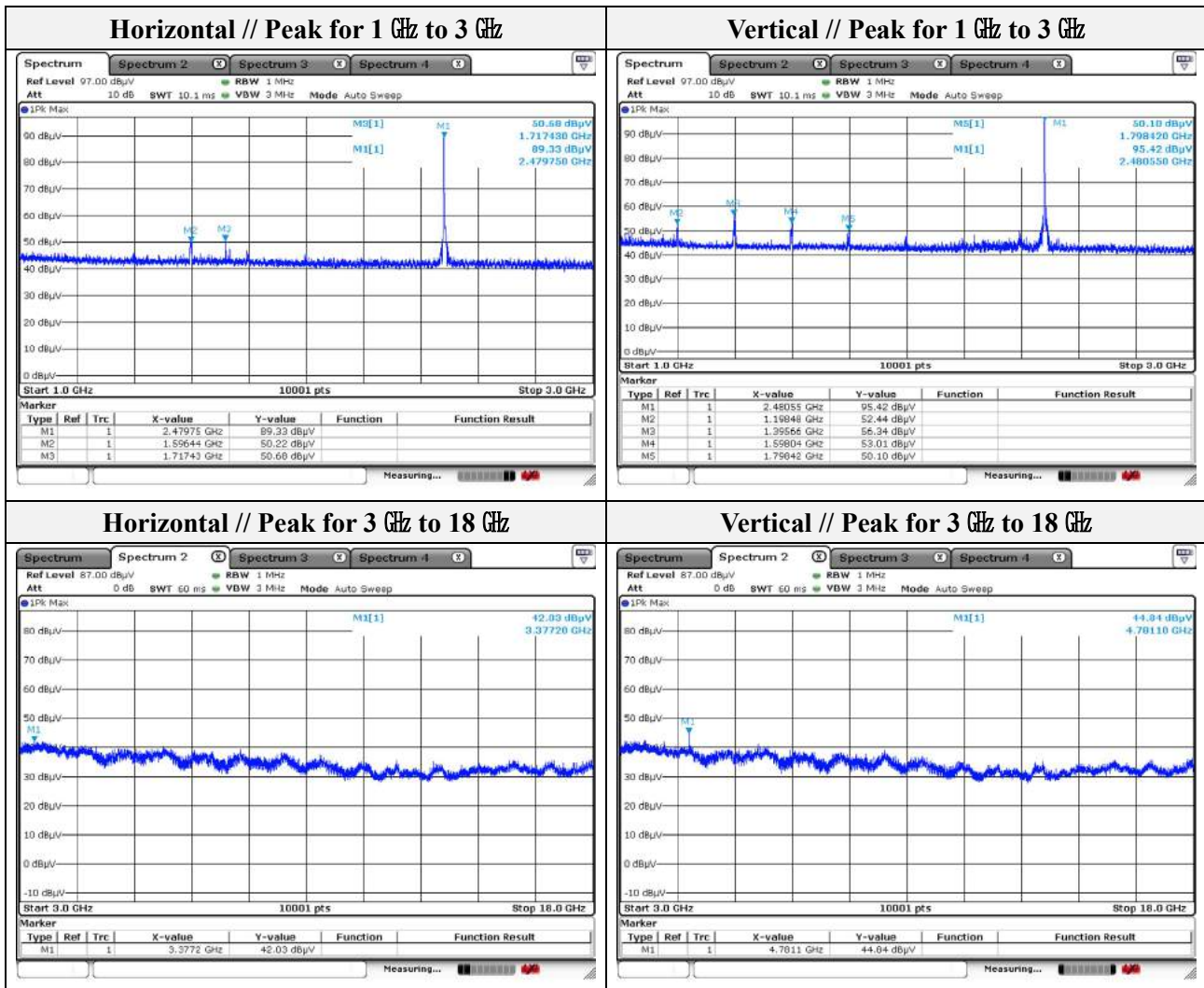
- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 198.48	52.44	Peak	V	-9.21		43.23	74.00	30.77
1 395.66	56.34	Peak	V	-7.99		48.35	74.00	25.65
1 596.44	50.22	Peak	H	-6.46		43.76	74.00	30.24
1 598.04	53.01	Peak	V	-6.44		46.57	74.00	27.43
1 717.43	50.68	Peak	H	-5.06		45.62	74.00	28.38
1 798.42	50.10	Peak	V	-4.12		45.98	74.00	28.02
3 377.20	42.03	Peak	H	-0.15		41.88	74.00	32.12
4 781.11	44.84	Peak	V	4.54		49.38	74.00	24.62

- Band edge

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 483.51	49.26	Peak	H	-1.67	-	47.59	74.00	26.41
2 483.51	55.45	Peak	V	-1.67	-	53.78	74.00	20.22



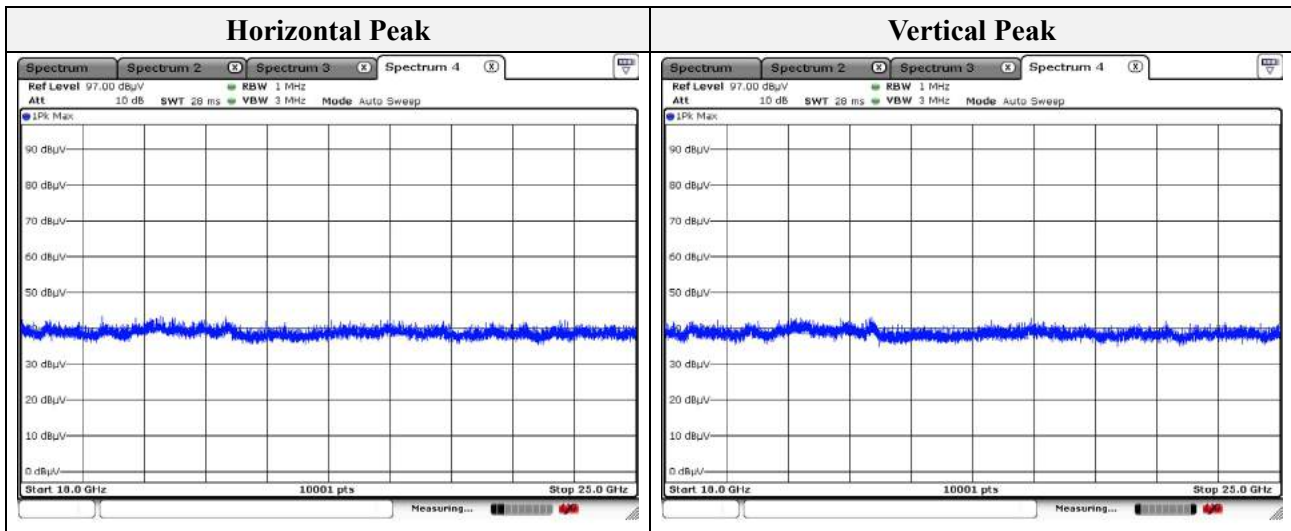


Note.

1. Average test would be performed if the peak result were greater than the average limit.

Test results (18 GHz to 25 GHz) – Worst case

Mode: BLE_2 Mbps
Channel: 20 (Worst case)
Distance of easurement : 3 meter

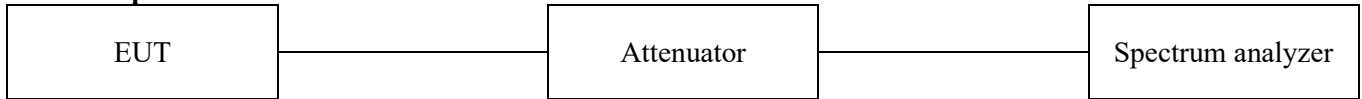


Note.

No spurious emission were detected above 18 GHz.

3.6 Conducted spurious emissions & band edge

Test setup



Test procedure

Band edge

ANSI C63.10 – Section 11.11

1. Start and stop frequency were set such that the band edge would be placed in the center of the plot
2. Span was set large enough so as to capture all out of band emissions near the band edge
3. RBW = 100 kHz
4. VBW = 300 kHz
5. Detector = Peak
6. Trace mode = max hold
7. Sweep time = auto
8. The trace was allowed to stabilize

Out of band emissions

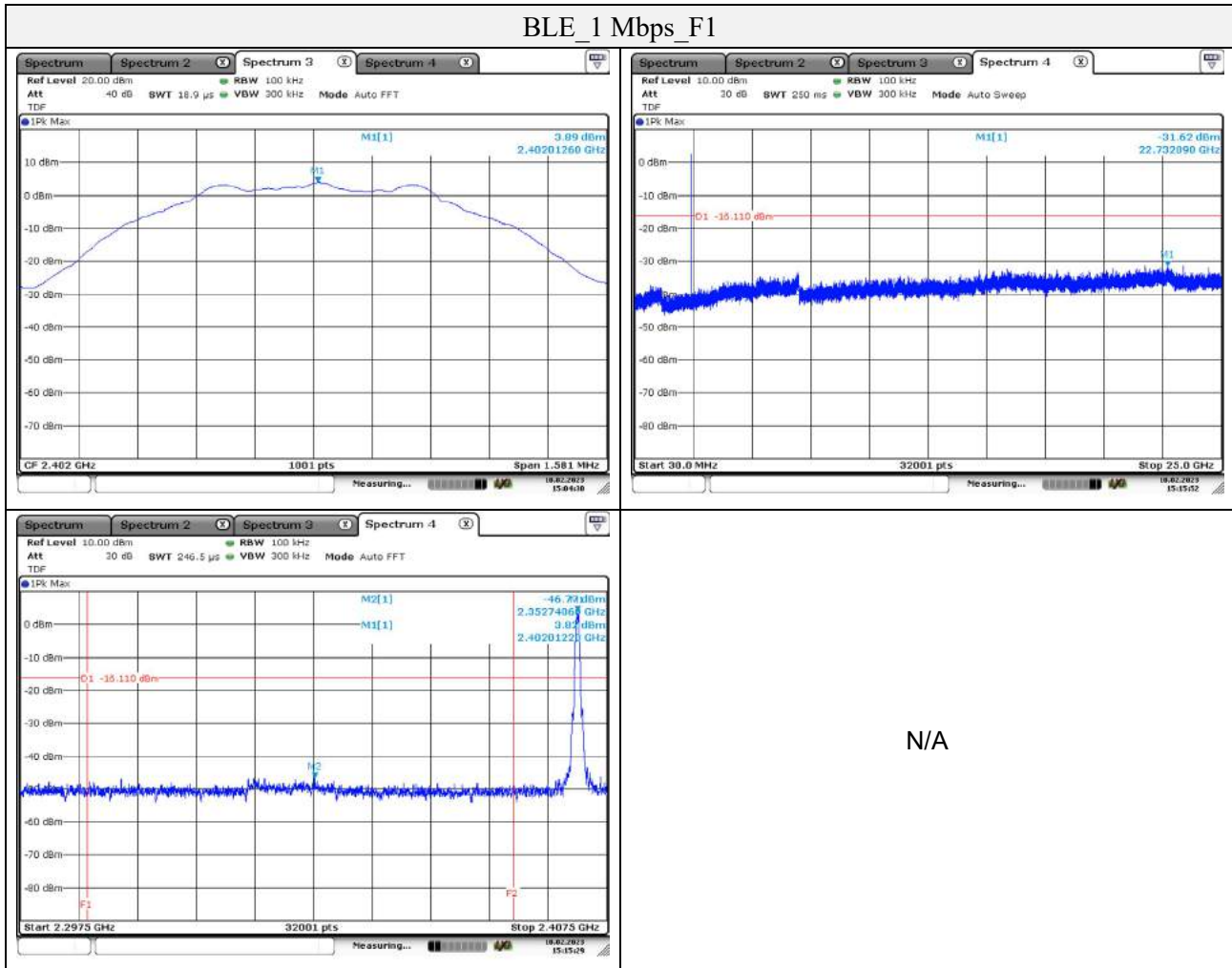
ANSI C63.10 – Section 11.11

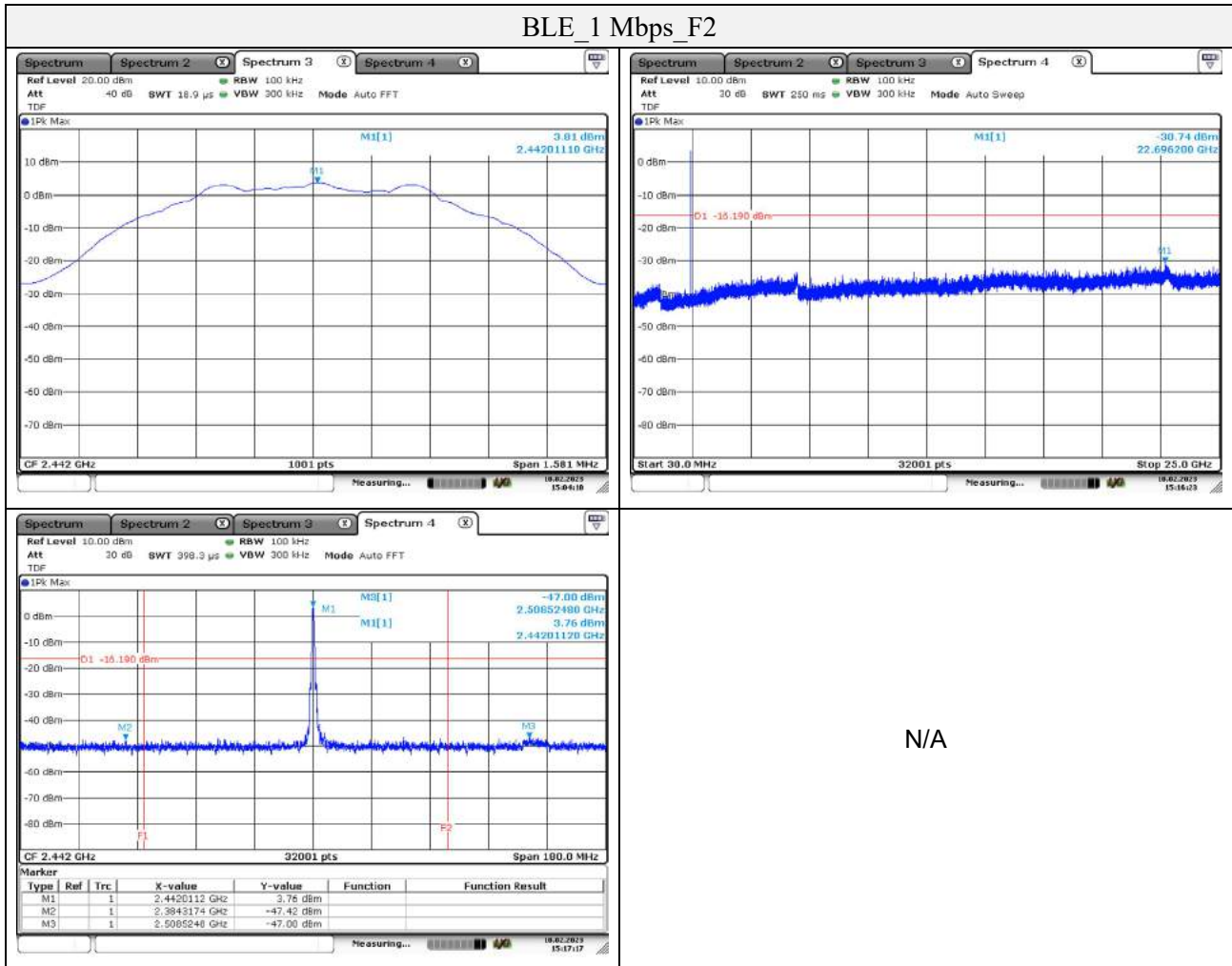
1. Start frequency was set to 30 MHz and stop frequency was set to 25 GHz for 2.4 GHz frequencies and 40 GHz for 5 GHz frequencies
2. RBW = 100 kHz
3. VBW = 300 kHz
4. Detector = Peak
5. Trace mode = max hold
6. Sweep time = auto couple
7. The trace was allowed to stabilize

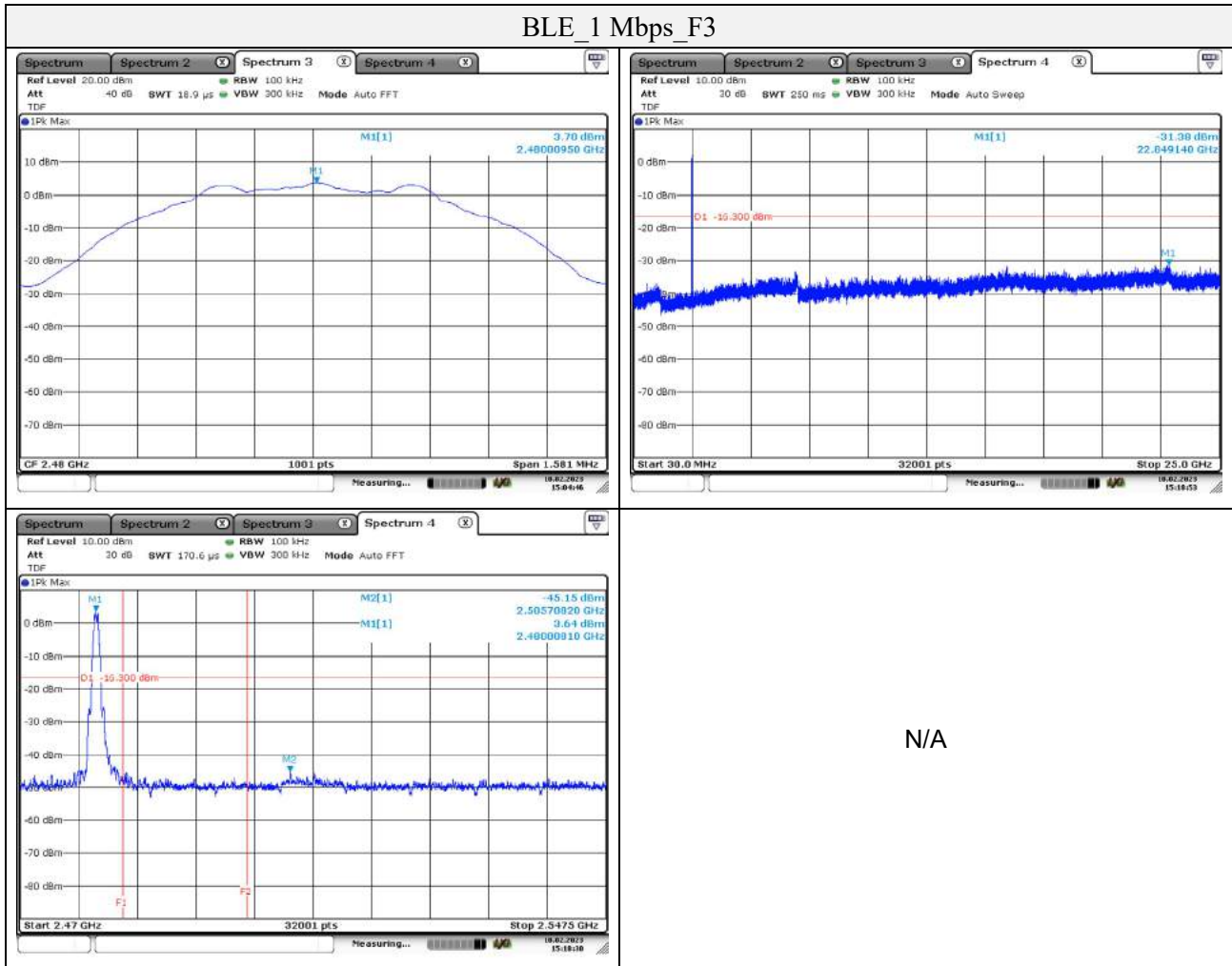
Limit

According to 15.247(d), 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 section 15.209(a) is not required. In addition, radiated emission which in the restricted band, as defined in section 15.205(a), must also comply the radiated emission limits specified in section 15.209(a) (see section 15.205(c))

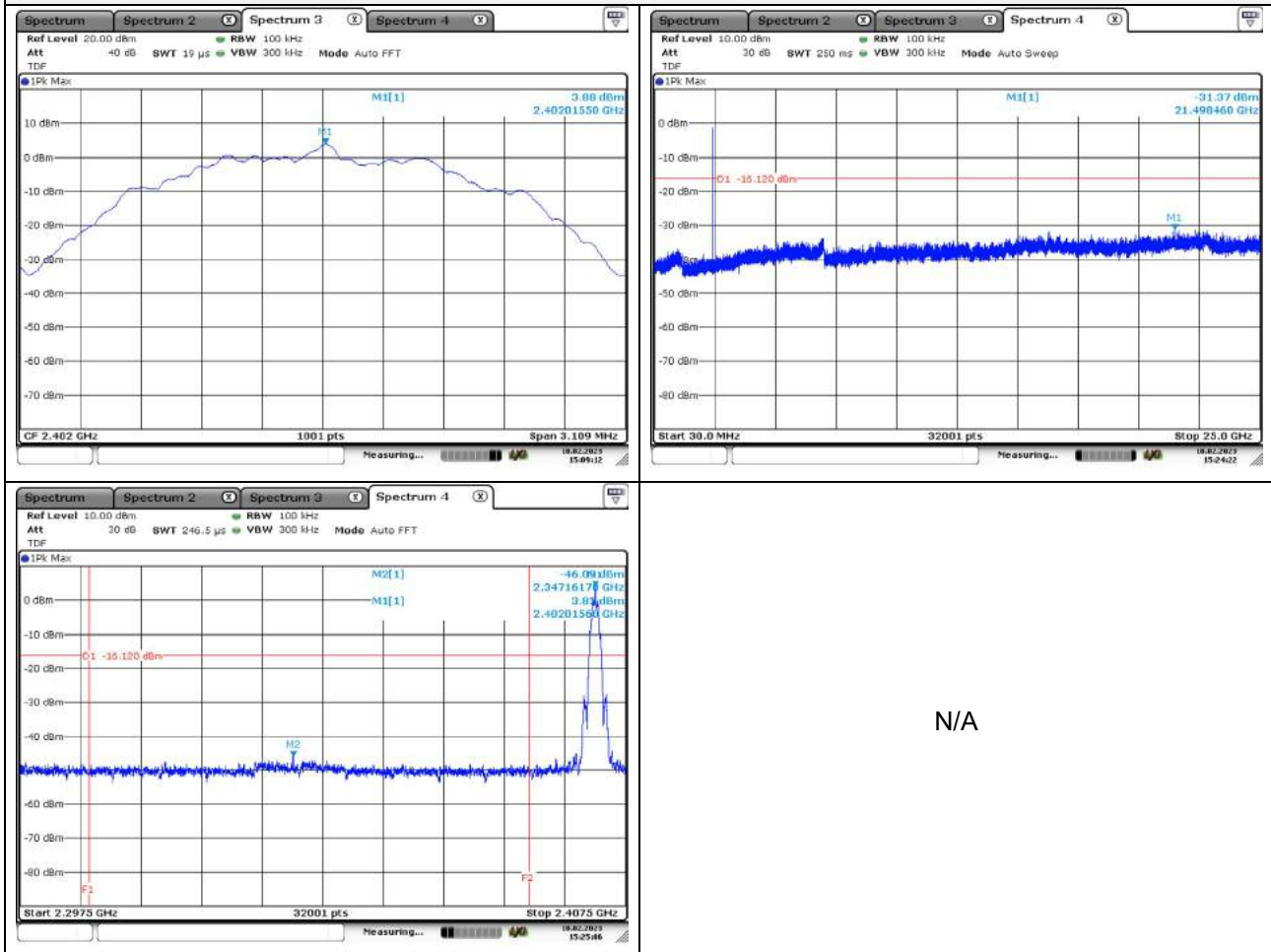
Test results

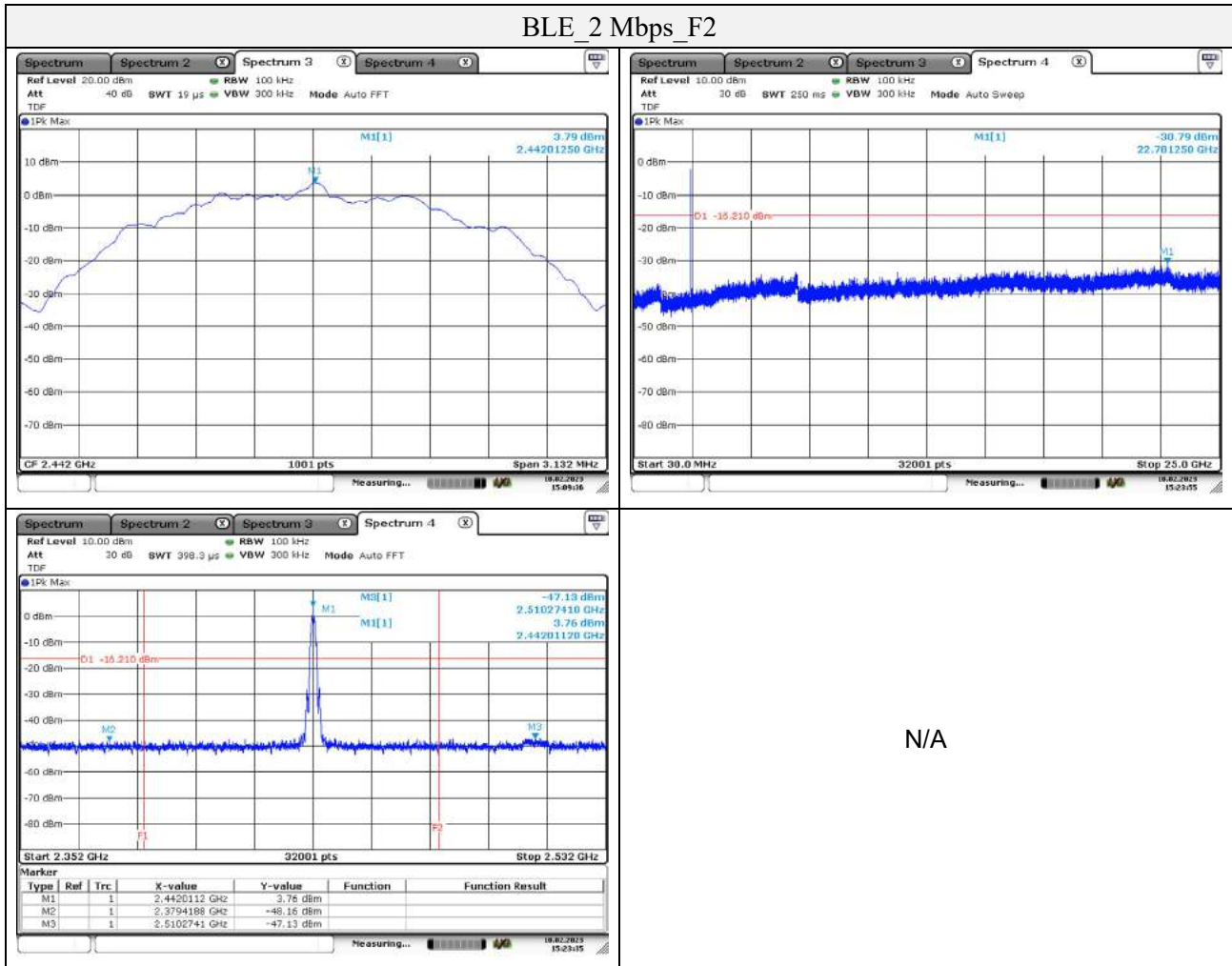


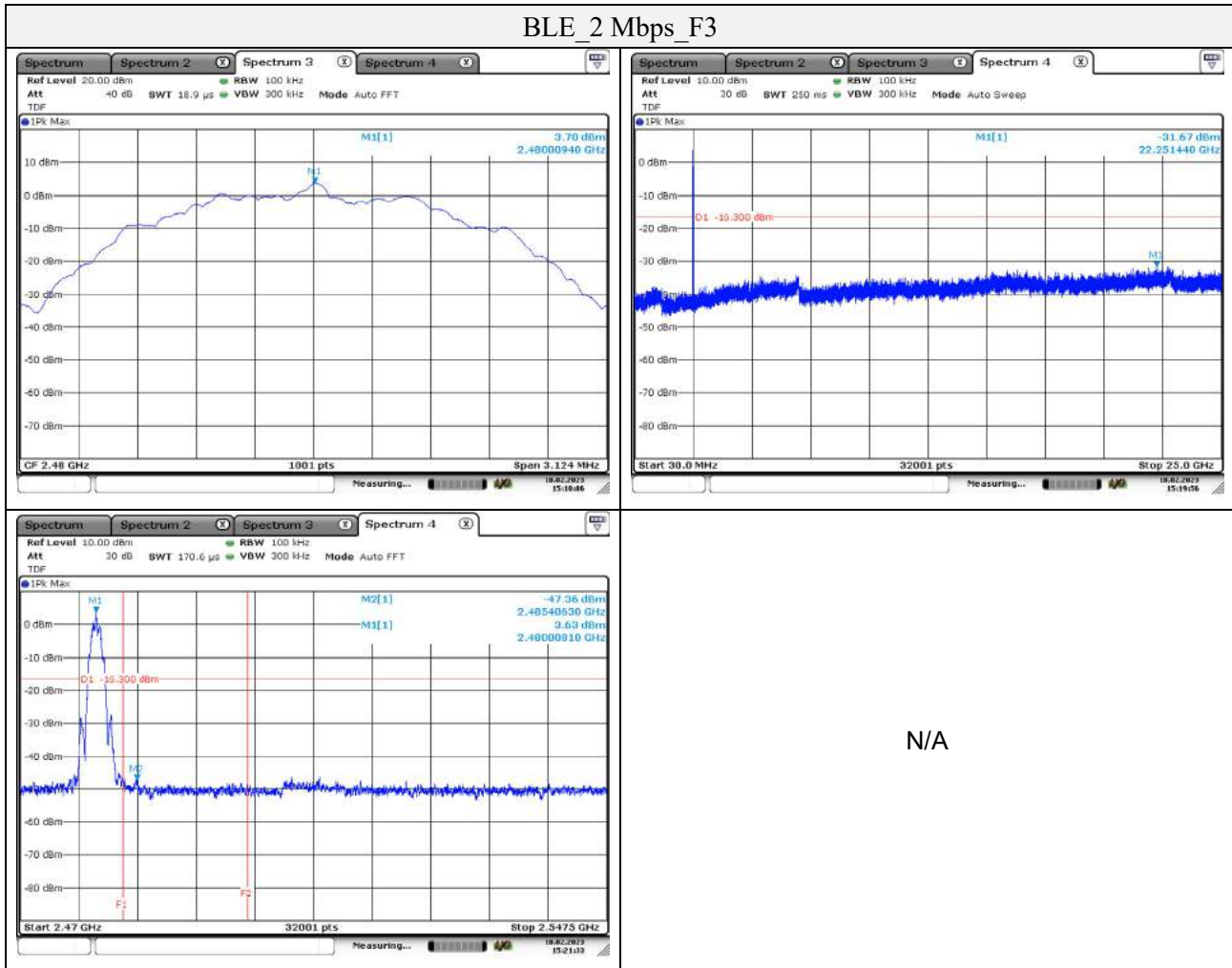




BLE_2 Mbps_F1







3.7 AC conducted emissions

Limit

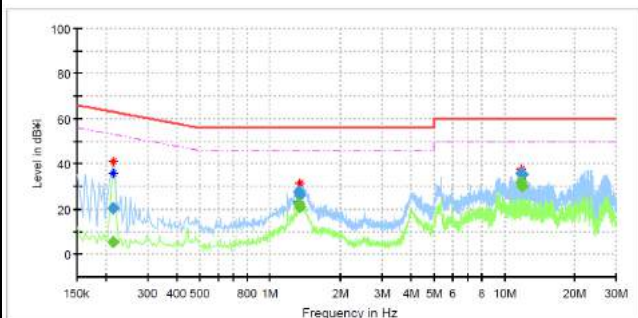
According to 15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50uH/50 ohm line impedance stabilization network (LISN). Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequencies ranges.

Frequency of Emission (MHz)	Conducted limit (dB μ V/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

Test results

Mode:	BLE
Transfer rate:	2 Mbps
Distance of measurement:	3 meter
Channel:	20 (Worst case)

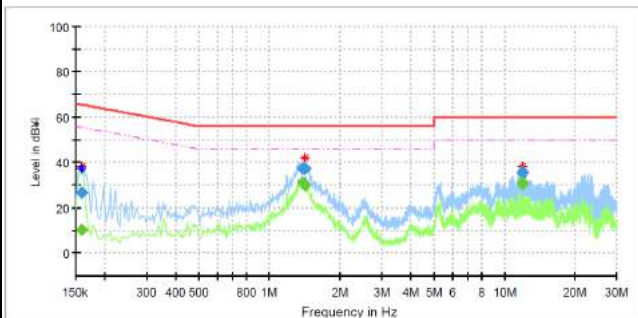
Hot Line



Final Result

Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.214000	---	5.64	53.05	47.41	1000.0	9.000	L1	19.5
0.214000	20.43	---	63.05	42.62	1000.0	9.000	L1	19.5
1.318000	---	22.56	46.00	23.44	1000.0	9.000	L1	20.2
1.318000	27.54	---	56.00	28.46	1000.0	9.000	L1	20.2
1.338000	---	20.88	46.00	25.12	1000.0	9.000	L1	20.2
1.338000	26.24	---	56.00	29.76	1000.0	9.000	L1	20.2
11.830000	---	31.75	50.00	18.25	1000.0	9.000	L1	20.0
11.830000	36.03	---	60.00	23.97	1000.0	9.000	L1	20.0
11.938000	---	30.13	50.00	19.87	1000.0	9.000	L1	20.0
11.938000	35.18	---	60.00	24.82	1000.0	9.000	L1	20.0

Neutral Line



Final Result

Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.158000	---	10.29	55.57	45.28	1000.0	9.000	N	19.4
0.158000	26.83	---	65.57	38.74	1000.0	9.000	N	19.4
1.382000	---	31.09	46.00	14.91	1000.0	9.000	N	20.2
1.382000	37.28	---	56.00	18.72	1000.0	9.000	N	20.2
1.414000	---	30.03	46.00	15.97	1000.0	9.000	N	20.2
1.414000	37.25	---	56.00	18.75	1000.0	9.000	N	20.2
11.862000	---	30.57	50.00	19.43	1000.0	9.000	N	20.0
11.862000	35.68	---	60.00	24.32	1000.0	9.000	N	20.0
11.902000	---	31.10	50.00	18.90	1000.0	9.000	N	20.0
11.902000	35.54	---	60.00	24.46	1000.0	9.000	N	20.0

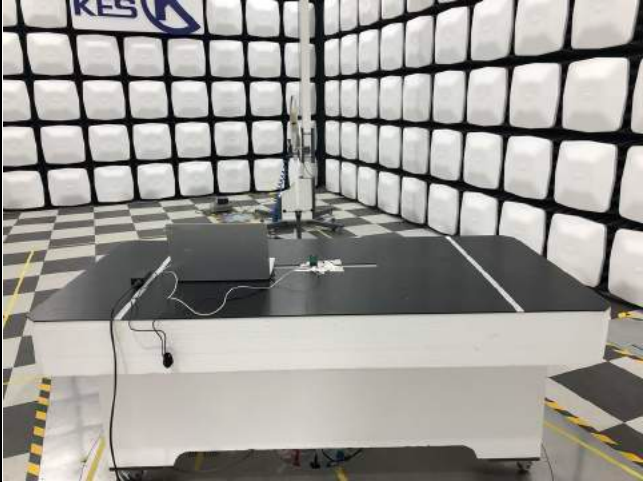

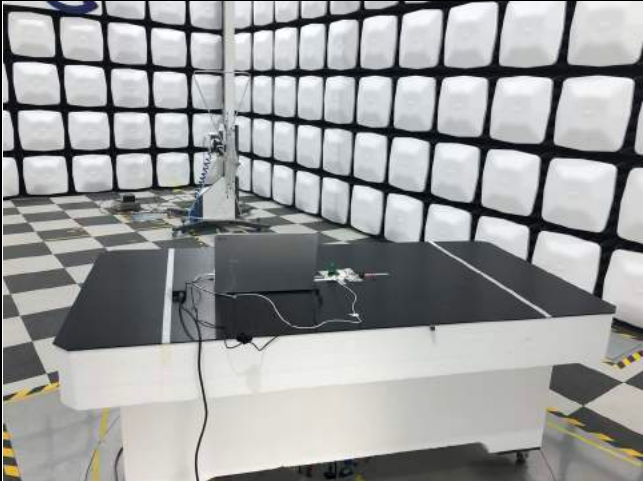

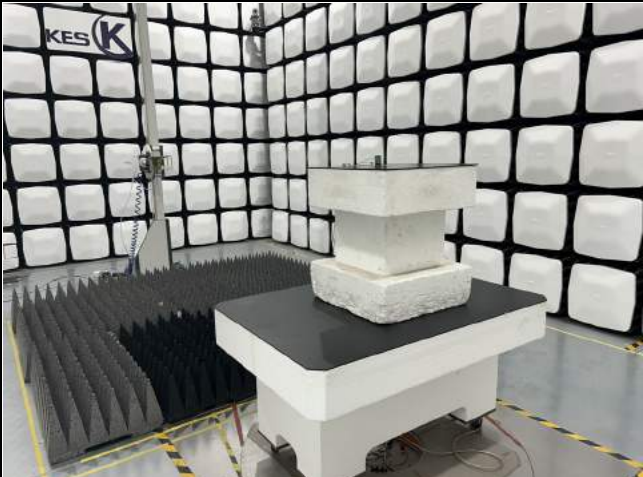
Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum Analyzer	R&S	FSV40	101002	1 year	2023.06.17
Spectrum Analyzer	R&S	FSV40	101725	1 year	2023.06.16
ATTENUATOR	KEYSIGHT	8493C	82506	1 year	2024.01.17
Power Meter	Anritsu	ML2495A	1438001	1 year	2024.01.13
Pulse Power Sensor	Anritsu	MA2411B	1339205	1 year	2024.01.13
SIGNAL GENERATOR	KEYSIGHT	N5182B	MY59100115	1 year	2023.04.27
SIGNAL GENERATOR	Anritsu	68369B	002118	1 year	2024.01.14
BAND REJECT FILTER	MICRO-TRONICS	BRM50702	G272	1 year	2024.01.12
Attenuator	HUBER+SUHNER	6806.17.A	-	1 year	2023.04.01
Loop Antenna	Schwarzbeck	FMZB1513	1513-257	2 years	2023.03.18
Horn Antenna	A.H	SAS-571	414	1 year	2024.01.16
Horn Antenna	SCHWARZBECK	BBHA9170	BBHA 9170550	1 year	2024.01.16
TRILOG- BROADBAND ANTENNA	VULB9163	Schwarzbeck	714	2 years	2024.04.19
Amplifier	SONOMA INSTRUMENT	310N	186549	1 year	2023.04.21
PREAMPLIFIER	HP	8449B	3008A00538	1 year	2023.06.02
BROADBAND AMPLIFIER	SCHWARZBECK	BBV9721	PS9721-003	1 year	2024.01.16
DC POWER SUPPLY	AGILENT	6632B	MY43004130	1 year	2023.06.17
EMI Test Receiver	R&S	ESU26	100552	1 year	2023.08.01
LISN	R&S	ENV216	101787	1 year	2023.11.10
LISN	R&S	ESH2-Z5	100450	1 year	2023.11.10
EMI TEST RECEIVER	R&S	ERS3	101783	1 year	2023.11.11
PULSE LIMITER	R&S	ESH3-Z2	101915	1 year	2023.11.10

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
Notebook computer	LG Electronics Inc.,	LG15N54	504NZJV027828
Jig board	-	-	-

Appendix B. Test setup photos

Radiated emissions	Conducted emissions
	
	
	<p>N/A</p>

The end of test report.