



TEST REPORT

Part 15 Subpart C 15.247

Equipment under test Wireless low Frequency

Massage Earphone

Model name MTH-I-1

FCC ID 2A35ZMTH-I-1

Applicant TODOC Co., Ltd.

Manufacturer TODOC Co., Ltd.

Date of test(s) 2021.12.26 ~ 2021.12.27

Date of issue 2022.02.07

Issued to

TODOC Co., Ltd.

1407, Hanwha Bizmetro 1, 242, Digital-ro, Guro-gu
Seoul, South Korea

Tel: +82-70-8666-1121 / Fax: +82-02-861-1121

Issued by
KES Co., Ltd.

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

Test and report completed by :	Report approval by :
Bong-Seok, Kim Test engineer	Young-Jin, Lee Technical manager

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 shchoi@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

Report No.:
KES-RF1-22T0013
Page (2) of (48)

Revision history

Revision	Date of issue	Test report No.	Description
-	2022.02.07	KES-RF1-22T0013	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 shchoi@kes.co.kr

TABLE OF CONTENTS

1.	General information.....	4
1.1.	EUT description	4
1.2.	Test configuration.....	4
1.3.	Requirements for Bluetooth transmitter	5
1.4.	Device modifications.....	5
1.5.	Accessory information.....	5
1.6.	Sample calculation	6
1.7.	Measurement Uncertainty	6
1.8.	Frequency/channel operations	6
2.	Summary of tests	7
3.	Test results	8
3.1.	20 dB bandwidth	8
3.2.	Output power.....	11
3.3.	Channel separation	13
3.4.	Number of hopping frequency.....	15
3.5.	Time of occupancy	17
3.6.	Radiated restricted band and emissions	21
3.7.	Conducted band edge and out of band emissions	41
Appendix A.	Measurement equipment	47
Appendix B.	Test setup photo.....	48

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 shchoi@kes.co.kr



1. General information

Applicant: TODOC Co., Ltd.
Applicant address: 1407, Hanwha Bizmetro 1, 242, Digital-ro, Guro-gu
Seoul, South Korea
Test site: KES Co., Ltd.
Test site address: 3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si,
Gyeonggi-do, 14057, Korea
 473-21, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea
Test Facility FCC Accreditation Designation No.: KR0100, Registration No.: 444148
FCC rule part(s): 15.247
FCC ID: 2A35ZMTH-I-1
Test device serial No.: Production Pre-production Engineering

1.1. EUT description

Equipment under test Wireless low Frequency Massage Earphone
Frequency range 2 402 MHz ~ 2 480 MHz (BDR / EDR / LE 1Mbps)
Model: MTH-I-1
Modulation technique GFSK, $\pi/4$ DQPSK, 8DPSK
Number of channels 2 402 MHz ~ 2 480 MHz (BDR / EDR) : 79 ch
2 402 MHz ~ 2 480 MHz (LE 1Mbps) : 40 ch
Antenna specification Antenna type : Chip Antenna // Peak gain: 0.5 dBi
Power source DC 3.7 V (Battery)
H/W version MTD-PR-INEAR-MAIN_VER5
S/W version MINDTODOC_INEAR_VER1

1.2. Test configuration

The TODOC Co., Ltd. // Wireless low Frequency Massage Earphone // MTH-I-1 // FCC ID: 2A35ZMTH-I-1 was tested according to the specification of EUT, the EUT must comply with following standards and KDB documents.

FCC Subpart C 15.247
KDB 558074 D01 V05r02
ANSI C63.10-2013

1.3. Requirements for Bluetooth transmitter

15.247(a)(1) that the rx input bandwidths shift frequencies in synchronization with the transmitted signals.

Pseudorandom frequency hopping sequence

The channel is represented by a pseudo-random hopping sequence hopping through the 79 RF channels. The hopping sequence is unique for the piconet and is determined by the Bluetooth device address of the master; the phase in the hopping sequence is determined by the Bluetooth clock of the master. The channel is divided into time slots where each slot corresponds to an RF hop frequency. Consecutive hops correspond to different RF hop frequencies. The nominal hop rate is 1 600 hops/s.

Equal hopping frequency use

The channels of this system will be used equally over the long-term distribution of the hopsets.

Example of a 79 hopping sequence in data mode:

51, 69, 20, 58, 16, 48, 19, 30, 00, 55, 68, 06, 35, 18, 31, 15, 49, 45, 01, 33, 66, 39, 08, 25, 70, 21, 78, 62, 11, 24, 41, 13, 29, 60, 57, 38, 46, 05, 10, 27, 63, 56, 61, 67, 65, 32, 37, 50, 09, 52, 23, 34, 03, 59, 22, 14, 74, 73, 36, 28, 76, 04, 44, 53, 77, 02, 40, 75, 26, 17, 64, 43, 47, 72, 12, 54, 71, 07, 42, 00, 52, 22, 23, 11, 29, 53, 66, 70, 43, 24, 73, 10, 72, 38, 76, 37, 17, 32, 42, 51, 31, 06, 54, 20, 56, 63, 21, 55, 33, 50, 25, 14, 69, 04, 18, 05, 45, 62, 34, 12, 16, 15, 77, 68, 36, 58, 57, 46, 48, 49, 26, 30, 28, 07, 75, 61, 13, 40, 02, 09, 19, 08, 71, 44, 39, 27, 60, 01, 64, 65, 03, 74, 41, 59, 67, 78, 47, 35

System receiver input bandwidth

Each channel bandwidth is 1 MHz.

The system receivers have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

15.247(g): In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of the regulations in Section 15.247 when the transmitter is presented with a continuous data (or information) system.

15.247(h): In accordance with the Bluetooth Industry Standard, the system does not coordinate its channels selection/ hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

1.4. Device modifications

N/A

1.5. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
Wireless low Frequency Massage Earphone (Cradle)	TODOC Co.,Ltd	MTG-C-1	-	DC 5 V

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 shchoi@kes.co.kr

1.6. 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.

$$\begin{aligned}\text{Offset(dB)} &= \text{RF cable loss(dB)} + \text{attenuator factor(dB)} \\ &= 0.51 + 10 = 10.51 \text{ (dB)}\end{aligned}$$

For Radiation test :

Field strength level ($\text{dB}\mu\text{V}/\text{m}$) = Measured level ($\text{dB}\mu\text{V}$) + Antenna factor (dB) + Cable loss (dB) – Amplifier gain (dB)

1.7. Measurement Uncertainty

Test Item	Uncertainty	
Uncertainty for Conduction emission test		2.46 dB
Uncertainty for Radiation emission test (include Fundamental emission)	Below 1GHz	4.40 dB
	Above 1GHz	5.94 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)	Rate(Mbps)
00	2 402	BDR 1 Mbps, EDR 2 Mbps, EDR 3 Mbps
.	.	.
40	2 442	BDR 1 Mbps, EDR 2 Mbps, EDR 3 Mbps
.	.	.
78	2 480	BDR 1 Mbps, EDR 2 Mbps, EDR 3 Mbps

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 shchoi@kes.co.kr



2. Summary of tests

Reference	Test description	Test results
15.247(a)(1)(iii)	20 dB bandwidth	Pass
15.247(b)(1),(3)	Output power	Pass
15.247(a)(1)	Channel separation	Pass
15.247(a)(1)(iii)	Number of channels	Pass
15.247(a)(1)(iii)	Time of occupancy	Pass
15.205, 15.209	Radiated restricted band and emission	Pass
15.207(d)	Conducted band edge and out of band emissions	Pass
15.207(a)	AC conducted emissions	N/A(1)

Note.

1. This device uses a DC 3.7 V power Battery and does not have an AC conducted emissions test.
2. Bluetooth V5.2 is supported, but BDR, EDR, and LE1 Mbps modes were tested by the applicant's declaration.
3. Since the product is wireless earphones and the left/right circuits are the same, all tests were performed with the left unit with higher output results.

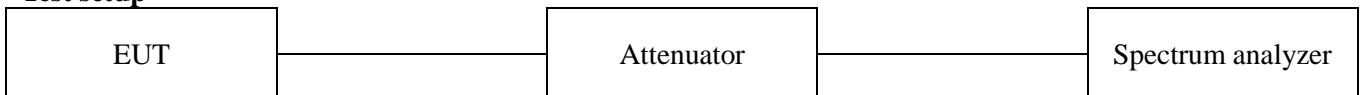
3. Test results

3.1. 20 dB bandwidth

Test procedure

ANSI 63.10-2013

Test setup



Test setting

1. Span = Set between two times and five times the OBW
2. RBW \geq 1 % to 5 % of the OBW
3. VBW \geq 3 * RBW
4. Sweep = Auto
5. Detector function = Peak
6. Sweep = Auto couple
7. Trace mode = Max hold
8. All the trace to stabilize

Limit

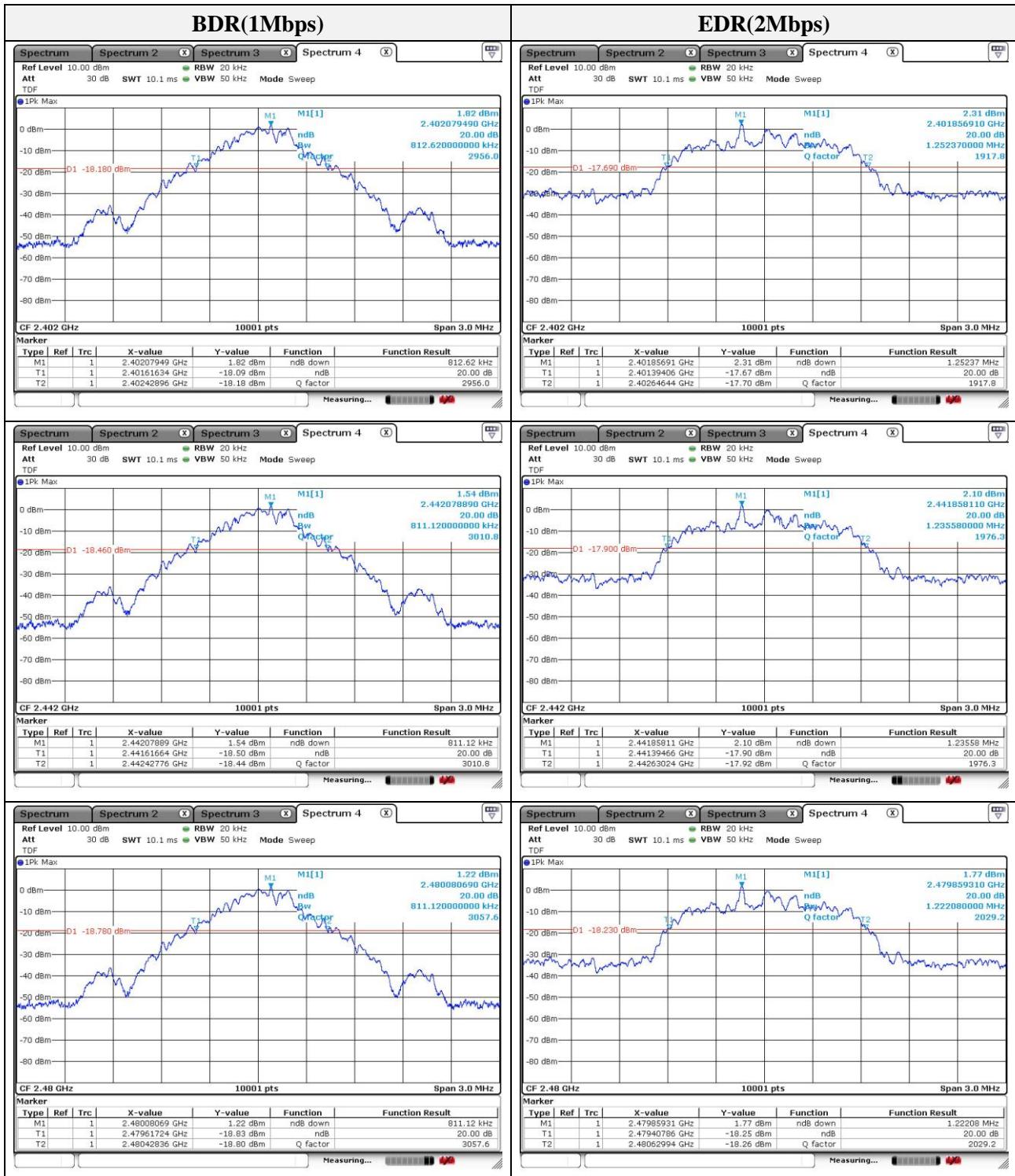
Not applicable

Frequency(MHz)	Channel no.	Data rate(Mbps)	Measured bandwidth(MHz)
2 402	00	BDR 1 Mbps	0.813
2 442	40		0.811
2 480	78		0.811
2 402	00	EDR 2 Mbps	1.252
2 442	40		1.236
2 480	78		1.222
2 402	00	EDR 3 Mbps	1.306
2 442	40		1.277
2 480	78		1.276

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.

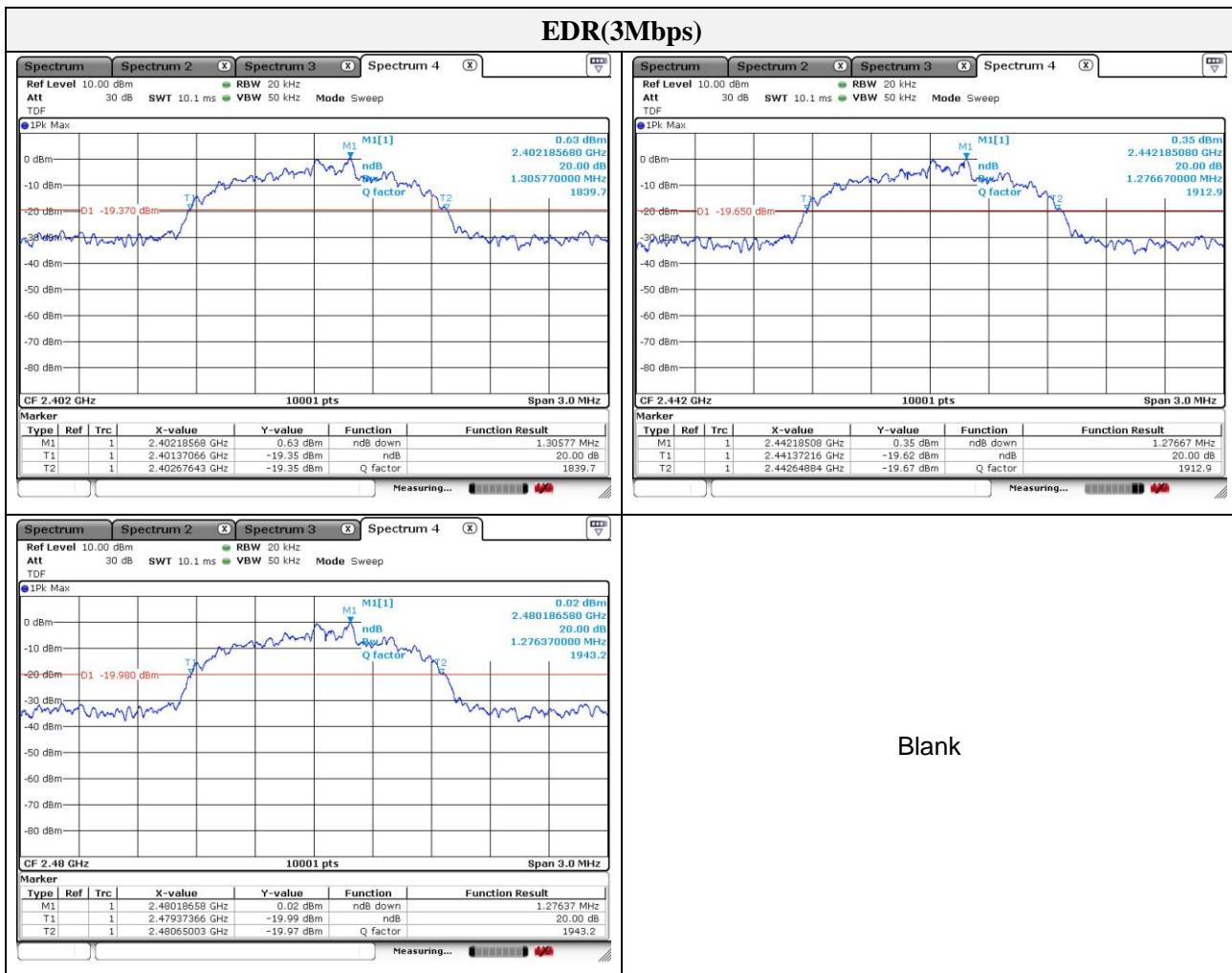
The authenticity of the test report, contact shchoi@kes.co.kr



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 shchoi@kes.co.kr



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.

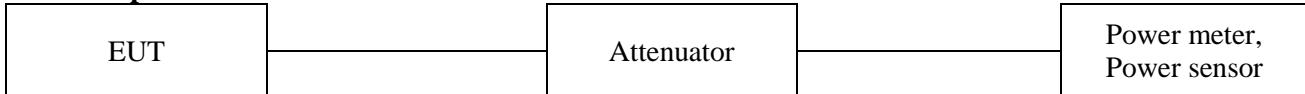
The authenticity of the test report, contact shchoi@kes.co.kr

3.2. Output power

Test procedure

KDB 558074 v05r02 & ANSI 63.10-2013 – Section 11.9.2.1 and 11.9.2.3.2

Test setup



Test setting

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 factor is required.

Limit

According to §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

According to §15.247(b)(1), For frequency hopping systems operating in the 2 400 ~ 2 483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 ~ 5 805 MHz band: 1 Watt.

According to §15.247(a)(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.



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

Report No.:
KES-RF1-22T0013
Page (12) of (48)

Test results

Mode: BDR/EDR

Frequency(MHz)	Channel no.	Data rate(Mbps)	Average Power (dBm)	Peak Power (dBm)	Power Limit (dBm)
2 402	00	BDR 1 Mbps	3.95	4.05	20.97
2 442	40		3.77	3.86	20.97
2 480	78		3.64	3.75	20.97
2 402	00	EDR 2 Mbps	2.86	4.03	20.97
2 442	40		2.68	4.01	20.97
2 480	78		2.27	3.78	20.97
2 402	00	EDR 3 Mbps	2.94	4.24	20.97
2 442	40		2.68	4.18	20.97
2 480	78		2.25	3.92	20.97

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.

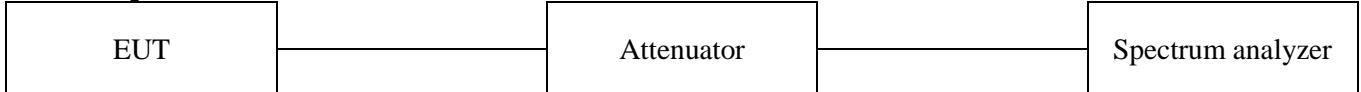
The authenticity of the test report, contact shchoi@kes.co.kr

3.3. Channel separation

Test procedure

KDB 558074 v05r02 & ANSI 63.10-2013

Test setup



Test Setting

1. The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:
2. Span = wide enough to capture the peaks of two adjacent channels
3. RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
4. Video (or Average) Bandwidth (VBW) \geq RBW
5. Sweep = auto
6. Detector function = peak
7. Trace = max hold
8. Allow the trace to stabilize.

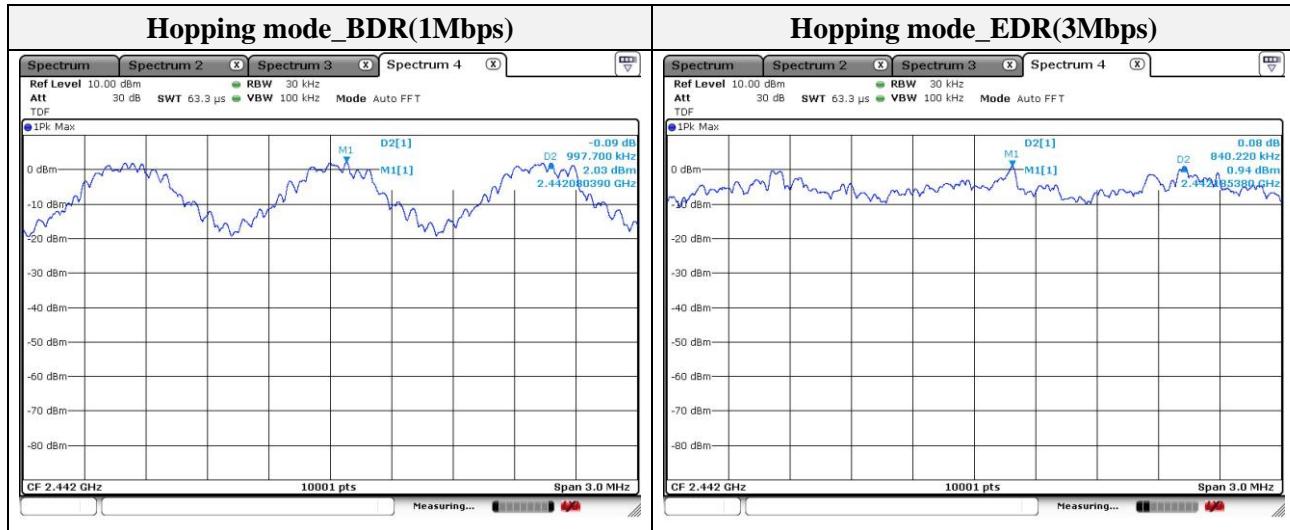
Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

Limit

According to 15.247(a)(1), frequency hopping system operating in 2 400 ~ 2 483.5 MHz. Band may have hopping channel carrier frequencies that are separated by 25 kHz or two-third of 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Test results

Frequency(MHz)	Channel no.	Data rate(Mbps)	Channel Separation (MHz)	Limit (MHz)
2 442	40	BDR 1 Mbps	0.998	≥ 0.537
2 442	40	EDR 3 Mbps	0.840	≥ 0.803



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.

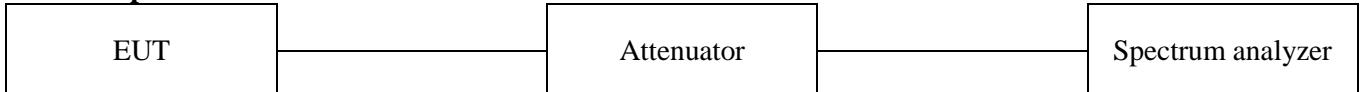
The authenticity of the test report, contact shchoi@kes.co.kr

3.4. Number of hopping frequency

Test procedure

KDB 558074 v05r02 & ANSI 63.10-2013

Test setup



Test setting

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings.

1. Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
2. RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
3. VBW \geq RBW.
4. Sweep = auto
5. Detector function = peak
6. Trace = max hold

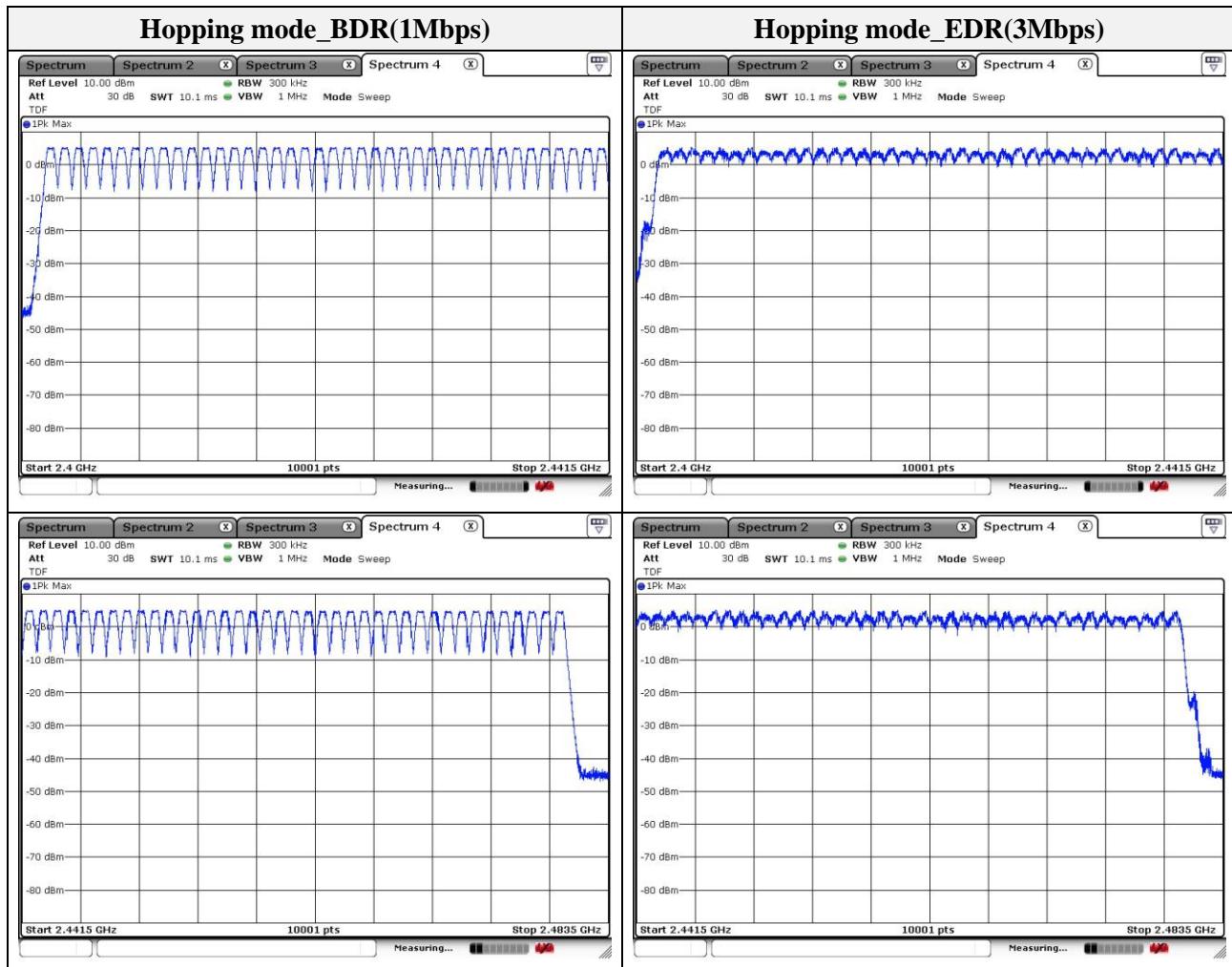
All the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

Limit

According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2 400 ~ 2 483.5 MHz bands shall use at least 15 hopping frequencies.

Test results

Frequency	Data rate(Mbps)	Number of hopping frequency	Limit
2 402 ~ 2 480 MHz	BDR 1 Mbps	79	≥ 15
2 402 ~ 2 480 MHz	EDR 3 Mbps	79	≥ 15



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.

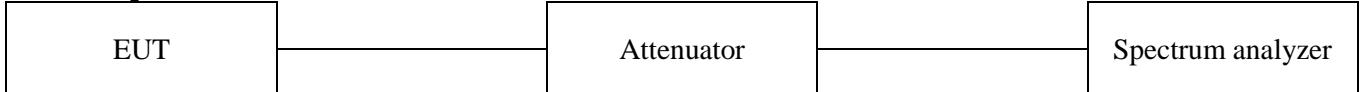
The authenticity of the test report, contact shchoi@kes.co.kr

3.5. Time of occupancy

Test procedure

KDB 558074 v05r02 & ANSI 63.10-2013

Test setup



Test setting

1. The EUT must have its hopping function enabled.
2. Span = zero span, centered on a hopping channel
3. RBW shall be \leq channel spacing and where possible RBW should be set $\gg 1 / T$, where T is the expected dwell time per channel.
4. Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
5. Detector function = peak
6. Trace = max hold

Limit

According to 15.247(a)(1)(iii), for frequency hopping system operating in the 2 400 ~ 2 483.5 MHz band, the average time of occupancy on any frequency shall not be greater than 0.4 second within a 31.6 second period.

A period time = $0.4(s) \times 79 = 31.6(s)$

Time of occupancy on the TX channel in 31.6 sec
 $= \text{time domain slot length} \times (\text{hop rate} \div \text{number of hop per channel}) \times 31.6$

**Operation mode: GFSK , $\pi/4$ -DQPSK, 8DPSK**

Packet type	Frequency (MHz)	Dwell time (ms)	Time of occupancy on the Tx channel in 31.6 sec (ms)	Limit for time of occupancy on the Tx channel in 31.6 sec (ms)
DH1	2 442	0.30	94.40	400
DH3	2 442	1.65	263.68	400
DH5	2 442	2.90	309.33	400
2-DH1	2 442	0.40	128.00	400
2-DH3	2 442	1.65	264.64	400
2-DH5	2 442	2.90	309.33	400
3-DH1	2 442	0.40	127.36	400
3-DH3	2 442	1.65	264.00	400
3-DH5	2 442	2.90	309.65	400

Note:**Normal Mode**

DH1: Dwell time (ms) \times $[(1600 \div 2) \div 79] \times 31.6(s) = 94.40$ (ms)

DH3: Dwell time (ms) \times $[(1600 \div 4) \div 79] \times 31.6(s) = 263.68$ (ms)

DH5: Dwell time (ms) \times $[(1600 \div 6) \div 79] \times 31.6(s) = 309.33$ (ms)

2-DH1: Dwell time (ms) \times $[(1600 \div 2) \div 79] \times 31.6(s) = 128.00$ (ms)

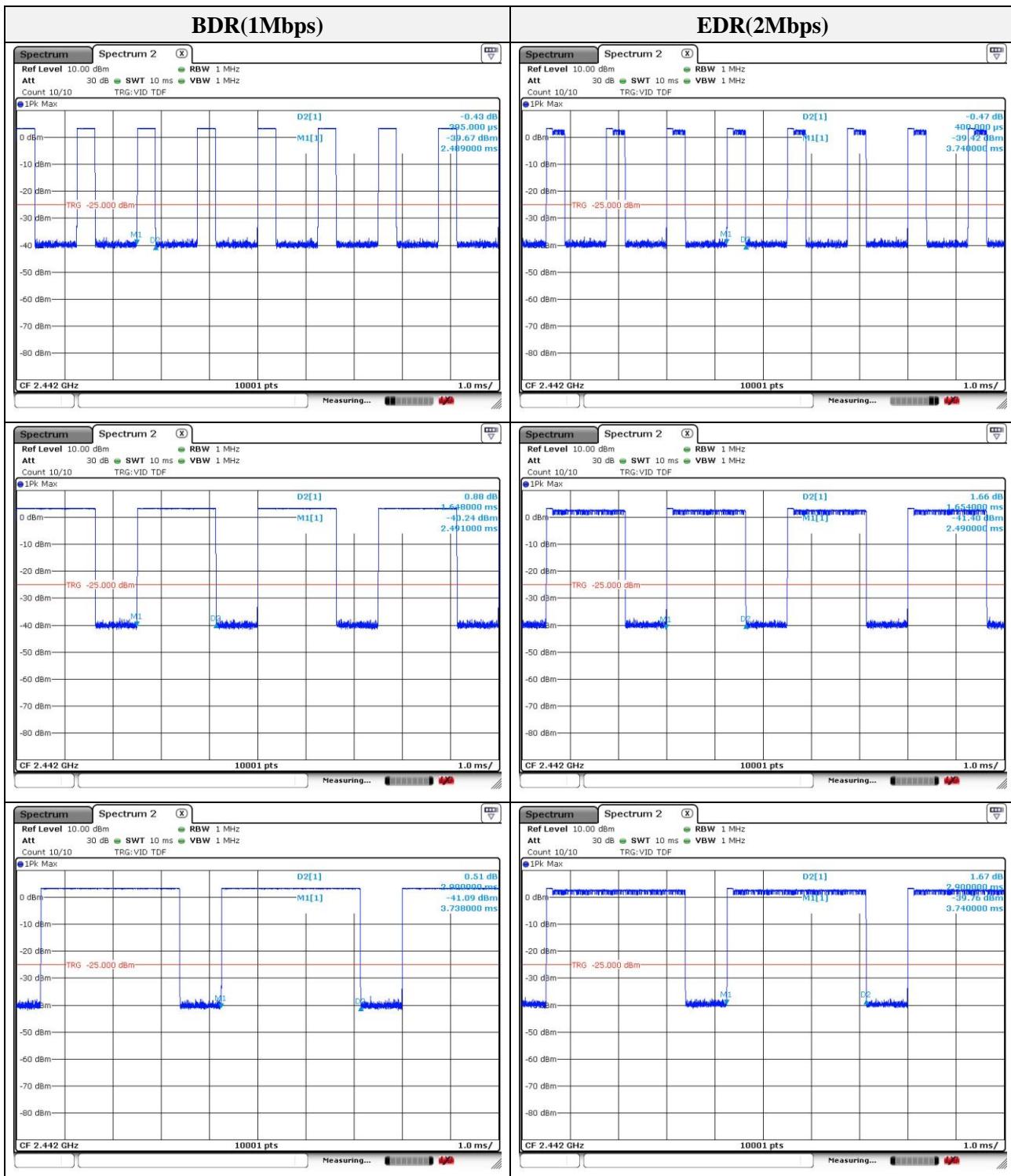
2-DH3: Dwell time (ms) \times $[(1600 \div 4) \div 79] \times 31.6(s) = 264.64$ (ms)

2-DH5: Dwell time (ms) \times $[(1600 \div 6) \div 79] \times 31.6(s) = 309.33$ (ms)

3-DH1: Dwell time (ms) \times $[(1600 \div 2) \div 79] \times 31.6(s) = 127.36$ (ms)

3-DH3: Dwell time (ms) \times $[(1600 \div 4) \div 79] \times 31.6(s) = 264.00$ (ms)

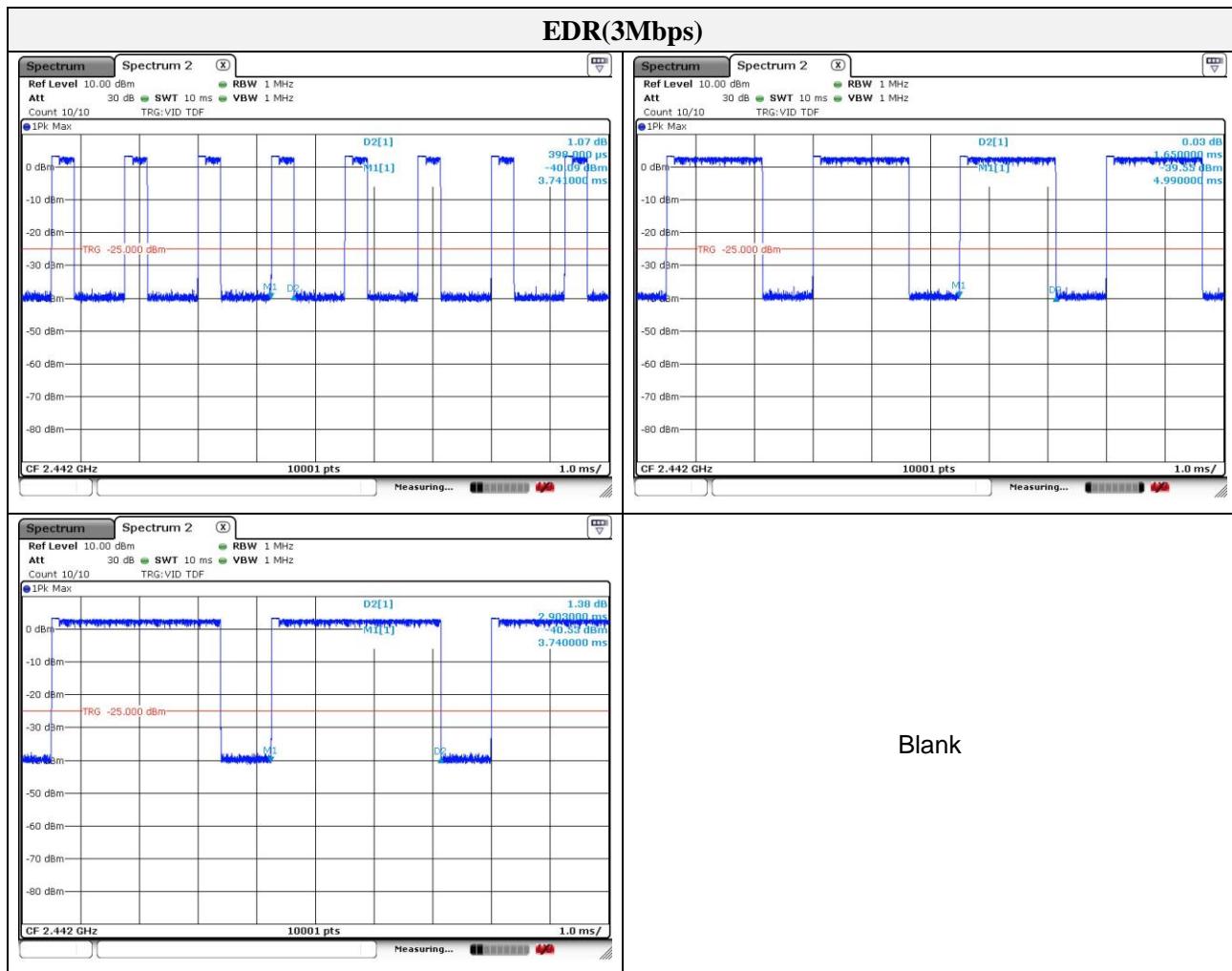
3-DH5: Dwell time (ms) \times $[(1600 \div 6) \div 79] \times 31.6(s) = 309.65$ (ms)



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 shchoi@kes.co.kr



Blank

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.

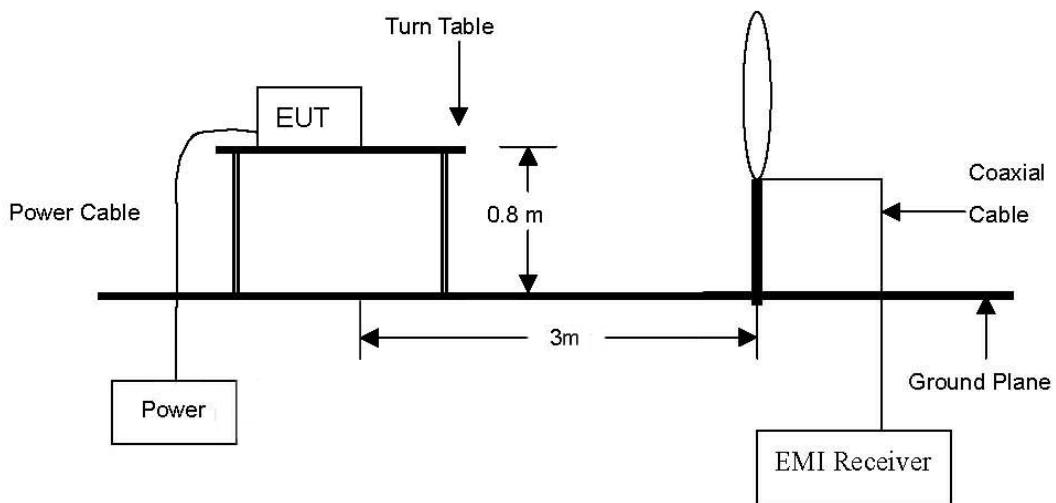
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.

The authenticity of the test report, contact shchoi@kes.co.kr

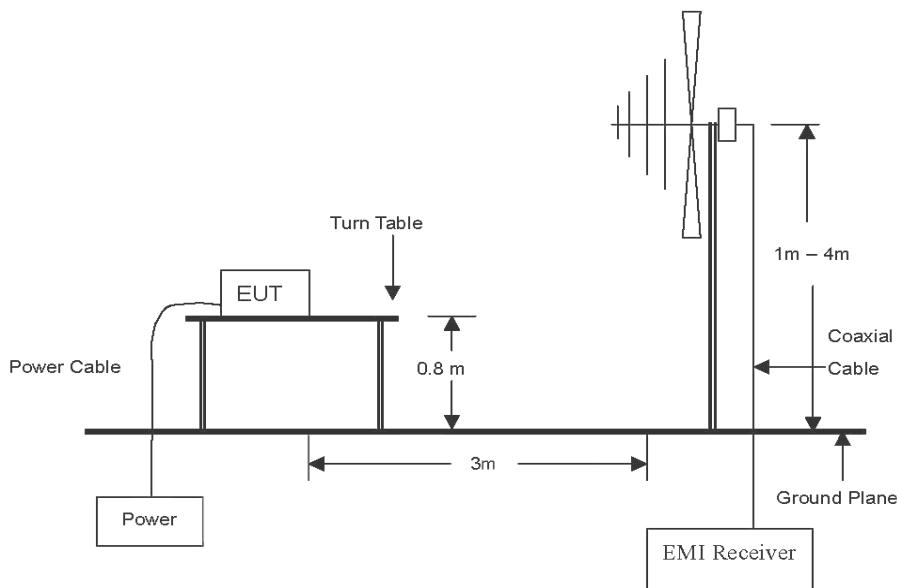
3.6. Radiated restricted band and emissions

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.

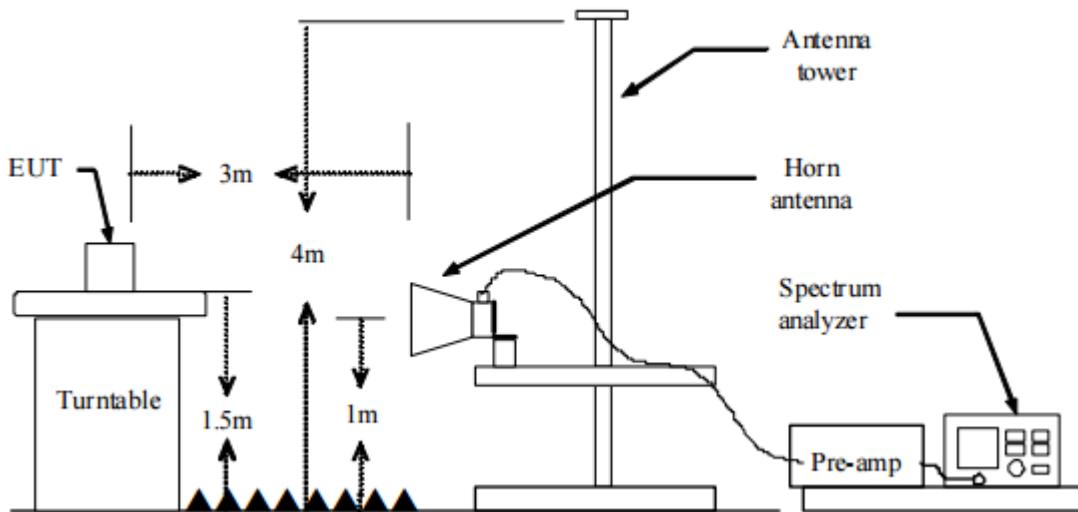


This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated.

The authenticity of the test report, contact shchoi@kes.co.kr

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 1.5 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. 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.

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 shchoi@kes.co.kr

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 ≥ 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 (\geq 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. $f < 30 \text{ MHz}$, extrapolation factor of 40 dB/decade of distance. $F_d = 40\log(D_m/D_s)$
 $f \geq 30 \text{ MHz}$, 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($\text{dB}\mu\text{V}/\text{m}$) = Level($\text{dB}\mu\text{V}$) + CF (dB) + or DCF(dB)
3. Margin(dB) = Limit($\text{dB}\mu\text{V}/\text{m}$) - Field strength($\text{dB}\mu\text{V}/\text{m}$)
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 ($\mu\text{V}/\text{m}$)
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.

Duty cycle

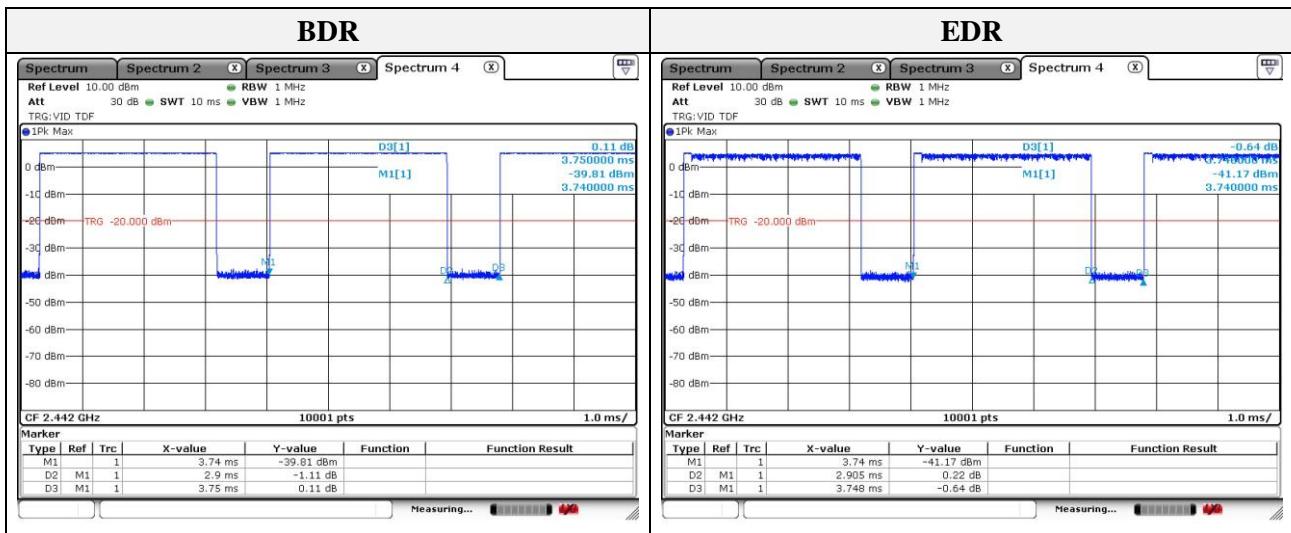
Regarding to KDB 558074 D01_v05 r02, 6. Measurements of duty cycle and transmission duration shall be performed using one of the following techniques:

- A diode detector and an oscilloscope that together have sufficiently short response time to permit accurate measurements of the on- and off-times of the transmitted signal.
- The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on- and off-times of the transmitted signal.

Mode	T _{on} time (ms)	Period (ms)	Duty cycle (Linear)	Duty cycle (%)	Duty cycle correction factor (dB)
BDR	2.90	3.75	0.77	77.33	1.12
EDR	2.91	3.75	0.78	77.60	1.10

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

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



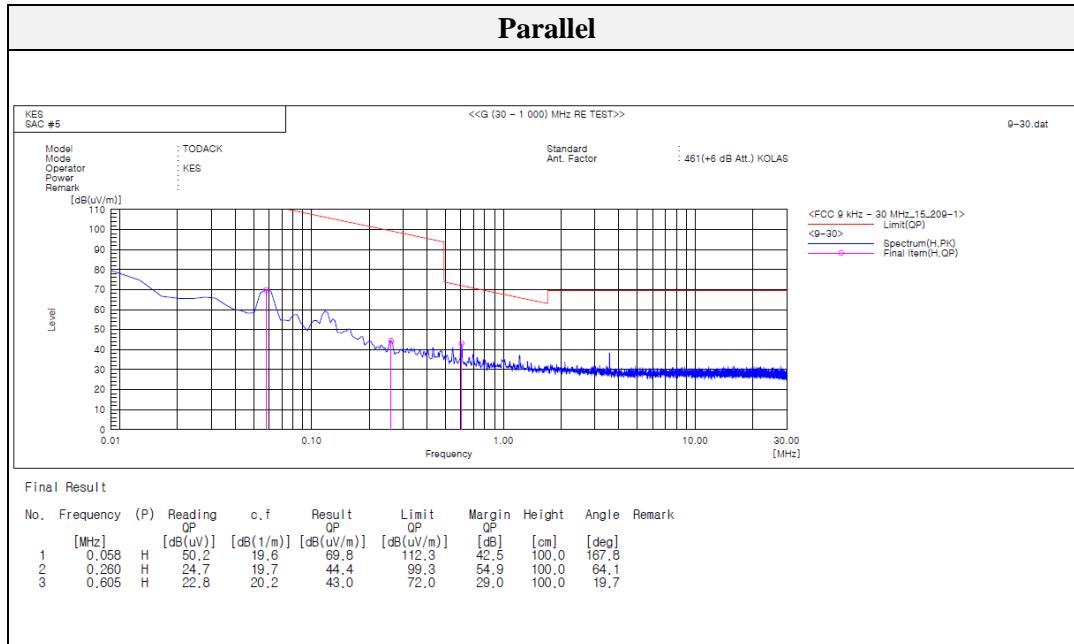
This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated.

The authenticity of the test report, contact shchoi@kes.co.kr

Test results (Below 30 MHz)

Mode: BDR
 Distance of measurement: 3 meter
 Channel: 00 (Worst case)



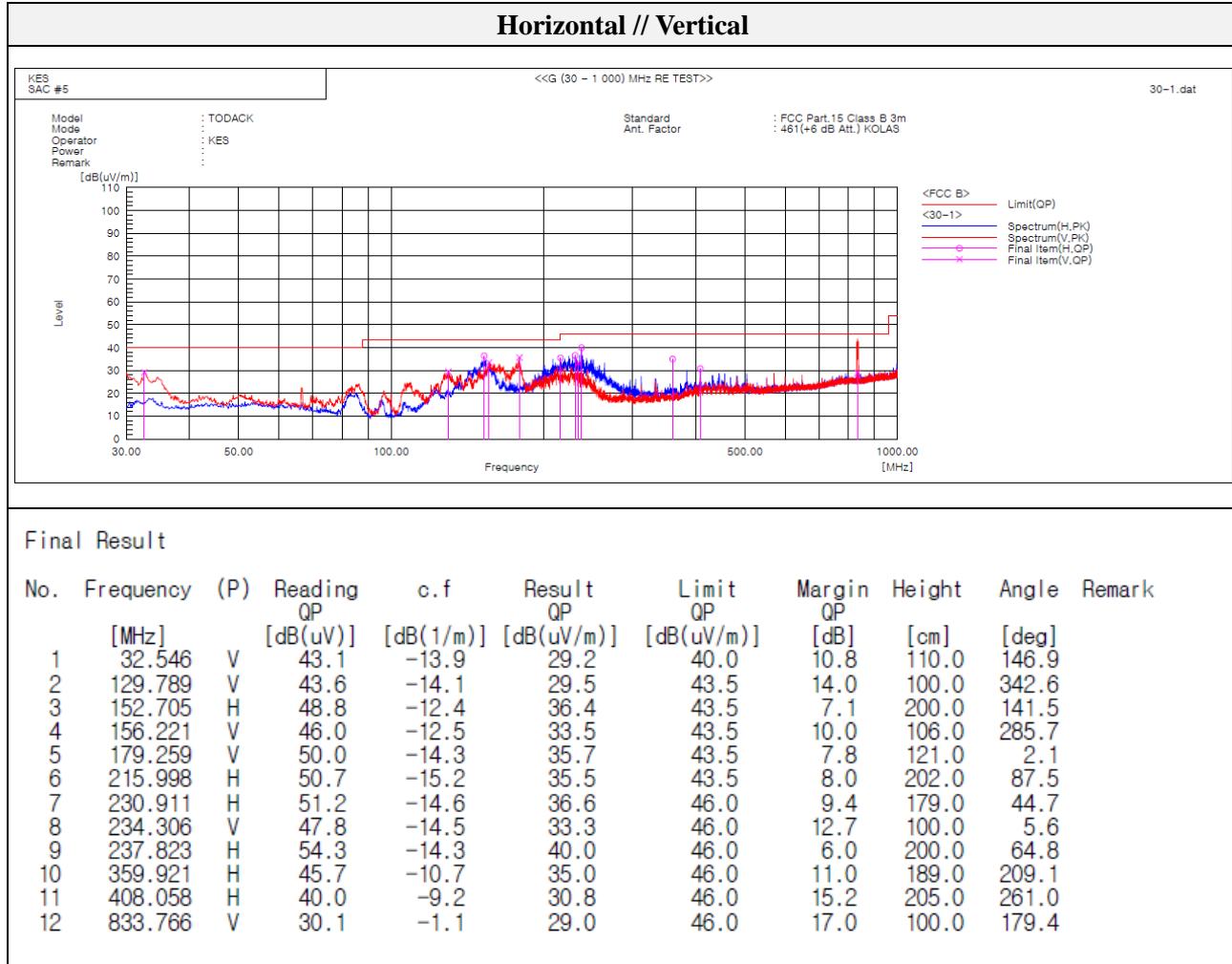
This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated.

The authenticity of the test report, contact shchoi@kes.co.kr

Test results (Below 1 000 MHz) – Worst case

Mode: BDR
 Distance of measurement: 3 meter
 Channel: 00 (Worst case)



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 shchoi@kes.co.kr

Test results (Above 1 000 MHz)

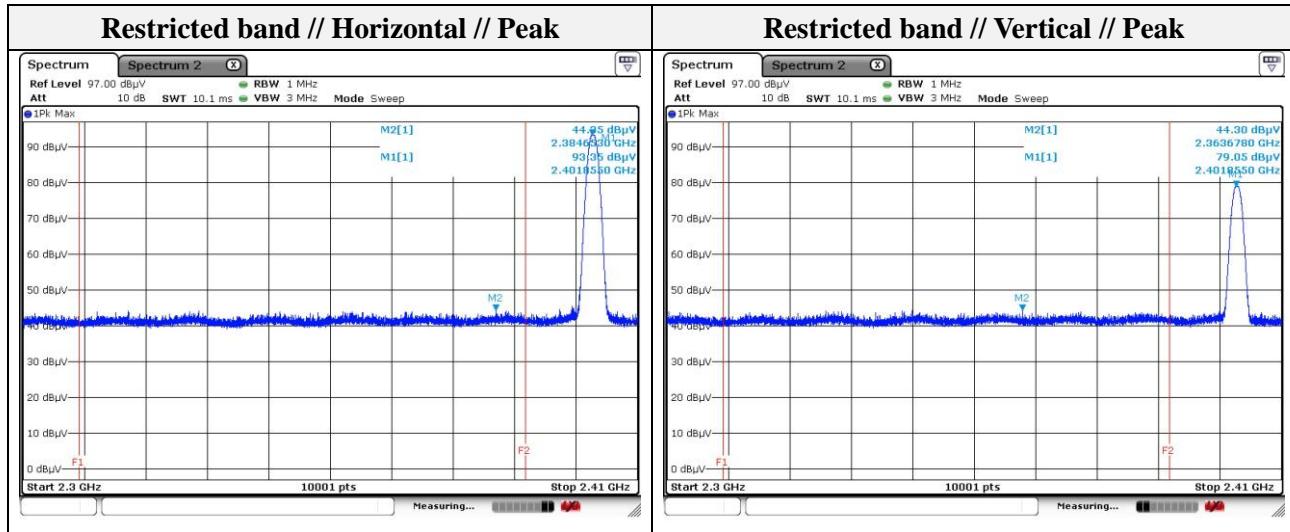
Mode: BDR
 Distance of measurement: 3 meter
 Channel: 00

- Spurious

Frequency (MHz)	Level (dB μ V)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
1 042.70	44.46	Peak	H	-10.93	-	33.53	74.00	40.47
1 047.70	45.40	Peak	V	-10.91	-	34.49	74.00	39.51

- Band edge

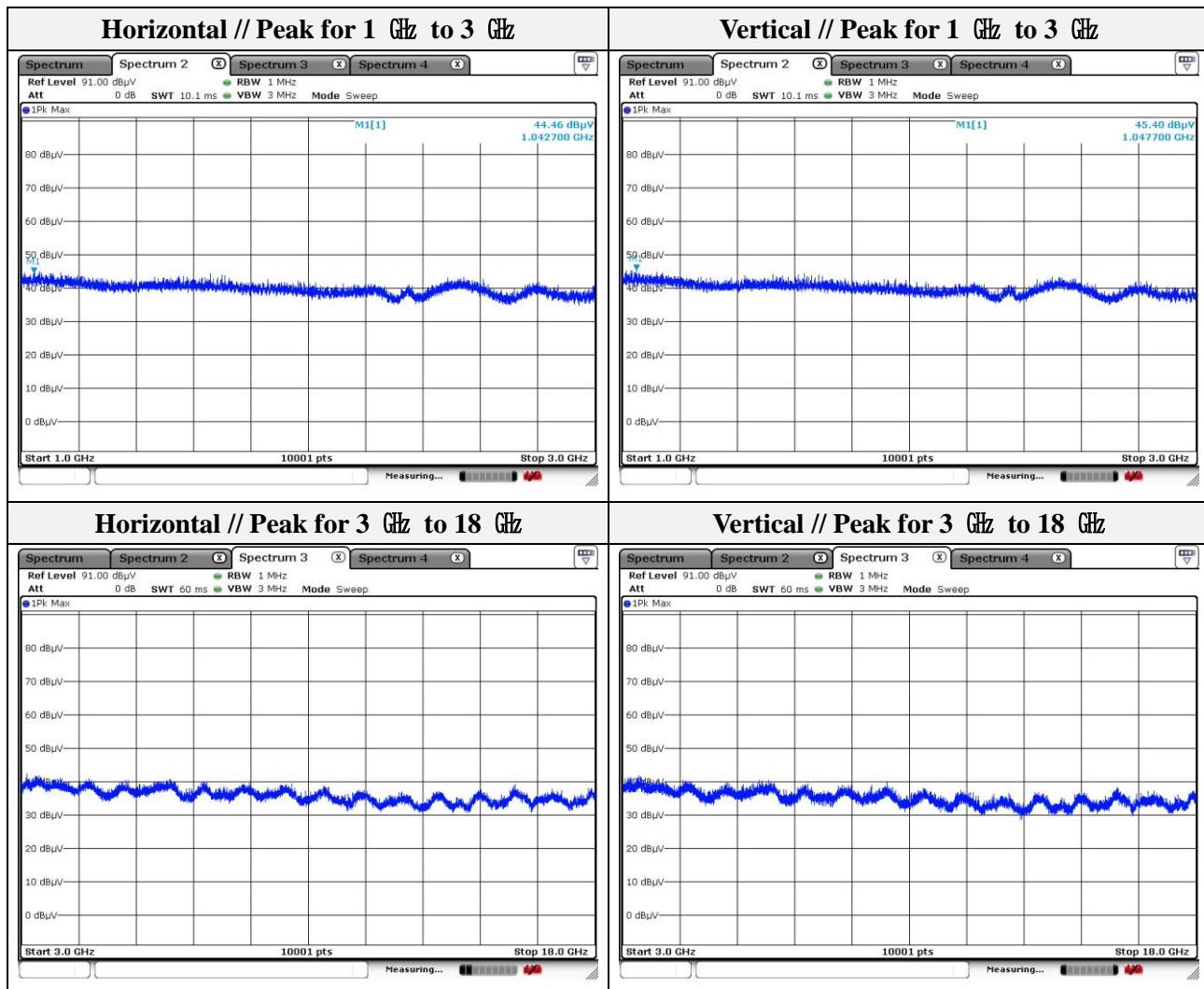
Frequency (MHz)	Level (dB μ V)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
2 363.69	44.30	Peak	V	-2.88	-	41.42	74.00	32.58
2 384.65	44.05	Peak	H	-2.79	-	41.26	74.00	32.74



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 shchoi@kes.co.kr



Note.

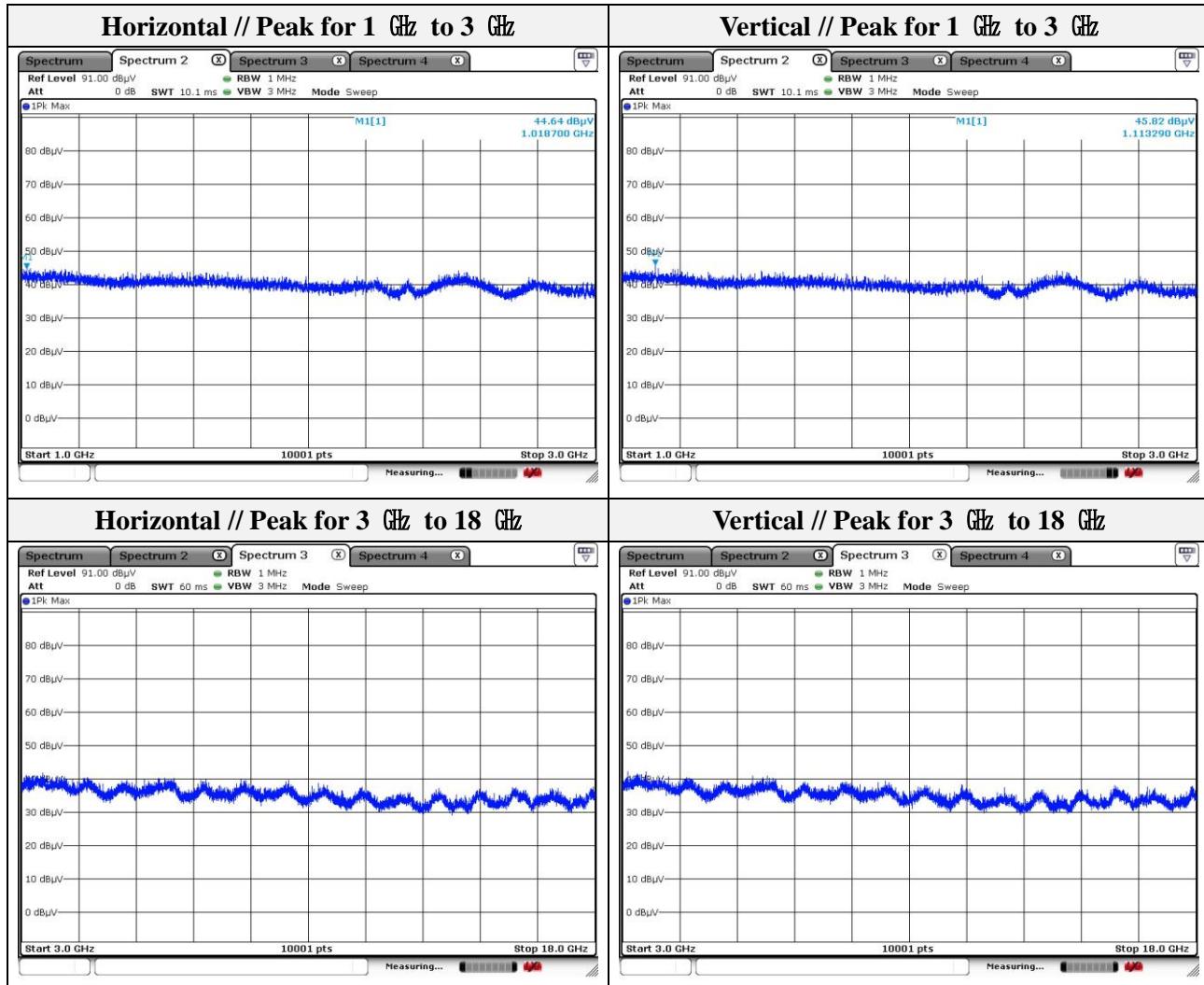
1. No spurious emission were detected above 3 GHz.
2. Average test would be performed if the peak result were greater than the average limit.

Mode: **BDR**

 Distance of measurement: **3 meter**

 Channel: **40**

Frequency (MHz)	Level (dB μ V)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
1 042.70	44.46	Peak	H	-10.93	-	33.53	74.00	40.47
1 047.70	45.40	Peak	V	-10.91	-	34.49	74.00	39.51



Note.

1. No spurious emission were detected above 3 GHz.
2. Average test would be performed if the peak result were greater than the average limit.

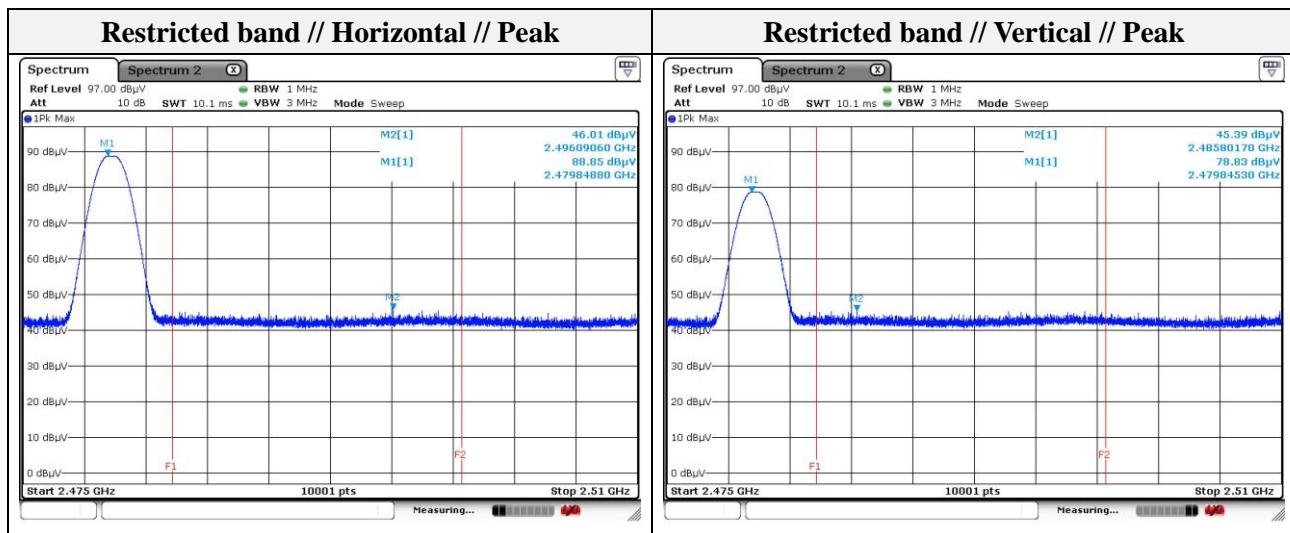
Mode: BDR
 Transfer rate: 1 Mbps
 Distance of measurement: 3 meter
 Channel: 78

- Spurious

Frequency (MHz)	Level (dB μ V)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB μ N/m)	Limit (dB μ N/m)	Margin (dB)
1 004.70	44.74	Peak	H	-11.14	-	33.60	74.00	40.40
1 045.10	45.08	Peak	V	-10.92	-	34.16	74.00	39.84

- Band edge

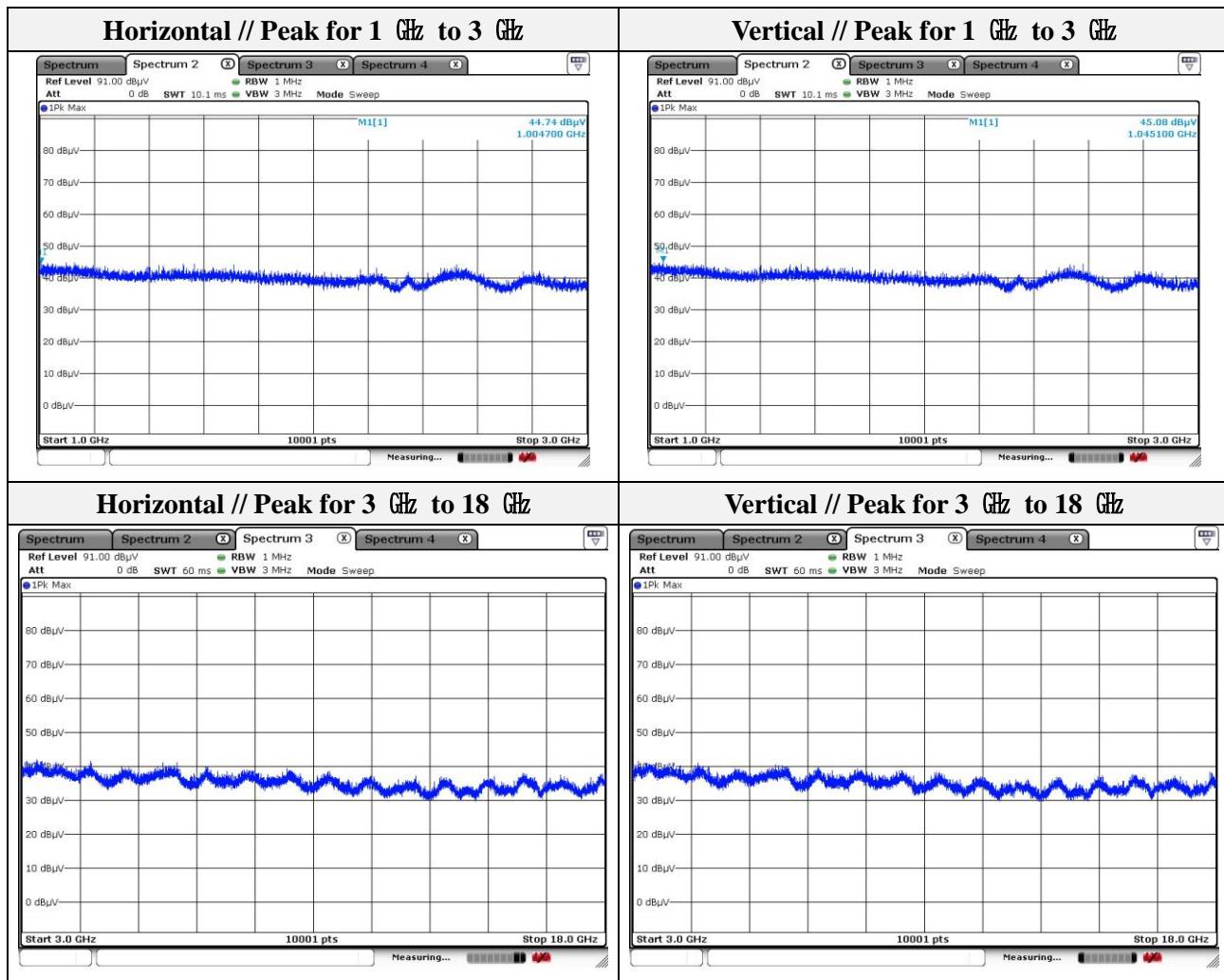
Frequency (MHz)	Level (dB μ V)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB μ N/m)	Limit (dB μ N/m)	Margin (dB)
2 485.80	45.39	Peak	V	-2.39	-	43.00	74.00	31.00
2 496.09	46.01	Peak	H	-2.35	-	43.66	74.00	30.34



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 shchoi@kes.co.kr



Note.

1. No spurious emission were detected above 3 GHz.
2. Average test would be performed if the peak result were greater than the average limit.

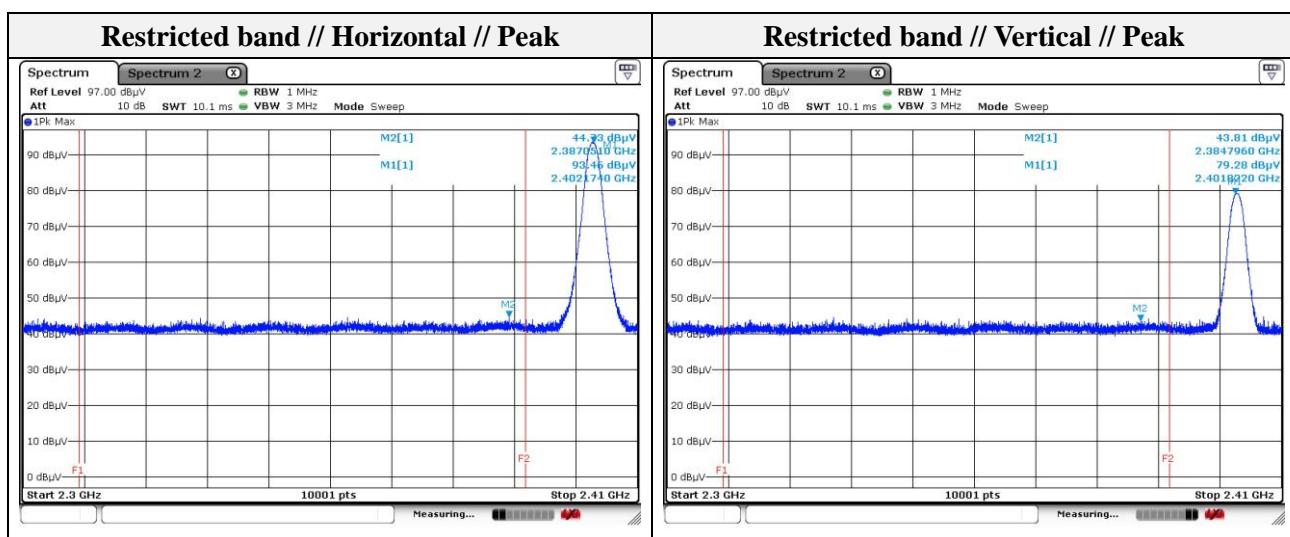
Mode: EDR
 Transfer rate: 3 Mbps(Worst case)
 Distance of measurement: 3 meter
 Channel: 00

- Spurious

Frequency (MHz)	Level (dB μ V)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB μ N/m)	Limit (dB μ N/m)	Margin (dB)
1 008.70	45.07	Peak	V	-11.11	-	33.96	74.00	40.04
1 024.50	44.97	Peak	H	-11.03	-	33.94	74.00	40.06

- Band edge

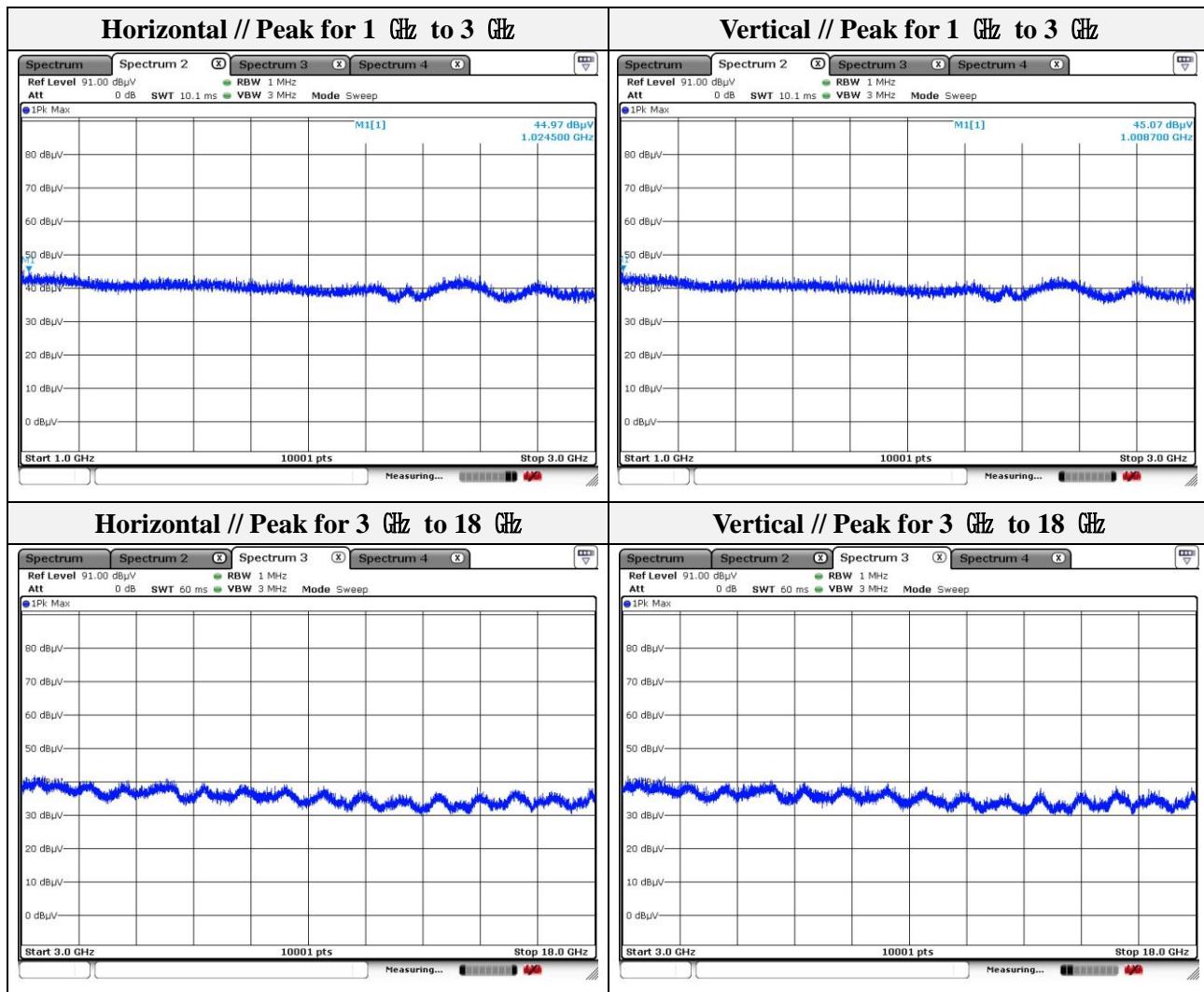
Frequency (MHz)	Level (dB μ V)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB μ N/m)	Limit (dB μ N/m)	Margin (dB)
2 384.80	43.81	Peak	V	-2.79	-	41.02	74.00	32.98
2 387.05	44.73	Peak	H	-2.78	-	41.95	74.00	32.05



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 shchoi@kes.co.kr



Note.

1. No spurious emission were detected above 3 GHz.
2. Average test would be performed if the peak result were greater than the average limit.

Mode: EDR

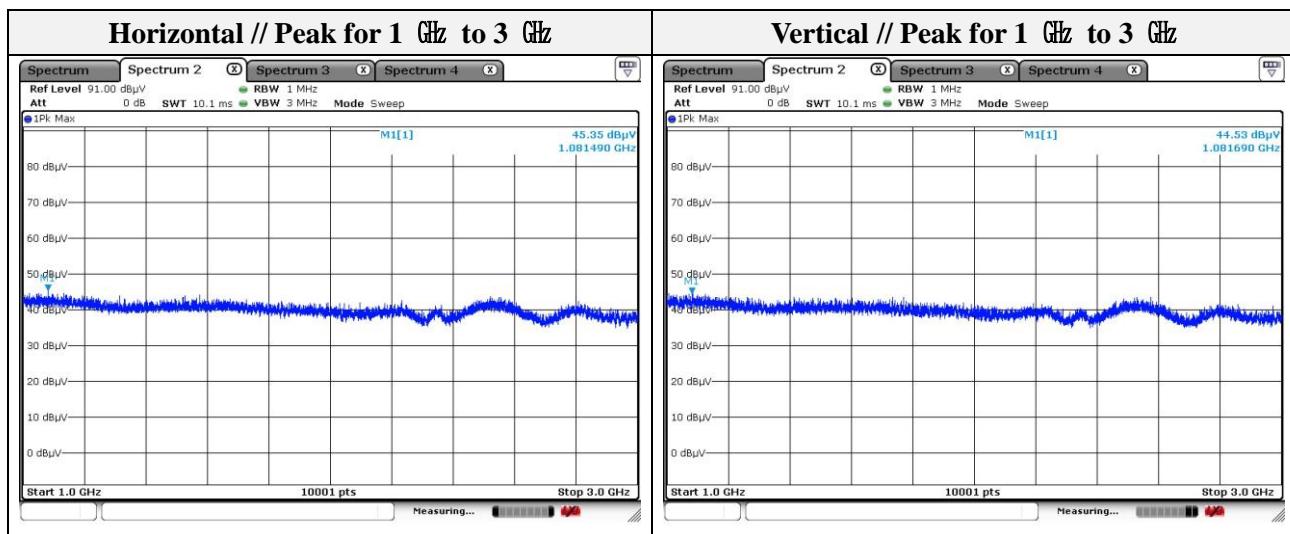
Transfer rate: 3 Mbps(Worst case)

Distance of measurement: 3 meter

Channel: 40

- Spurious

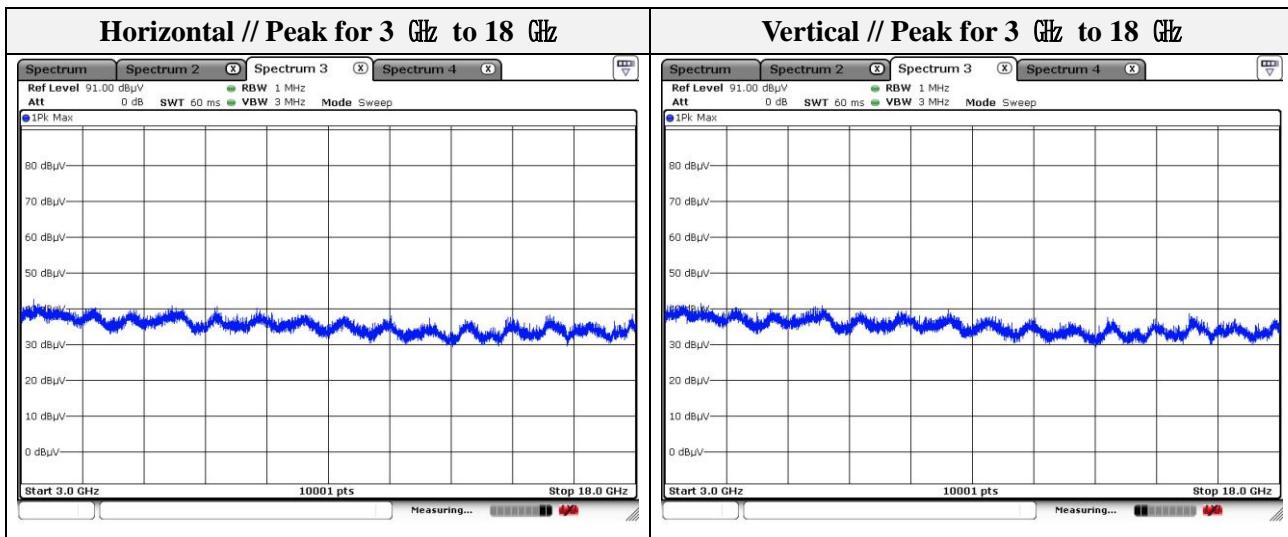
Frequency (MHz)	Level (dB μ V)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
1 081.49	45.35	Peak	H	-10.73	-	34.62	74.00	39.38
1 081.69	44.53	Peak	V	-10.73	-	33.80	74.00	40.20



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 shchoi@kes.co.kr


Note.

1. No spurious emission were detected above 3 GHz.
2. Average test would be performed if the peak result were greater than the average limit.

Mode: EDR

Transfer rate: 3 Mbps(Worst case)

Distance of measurement: 3 meter

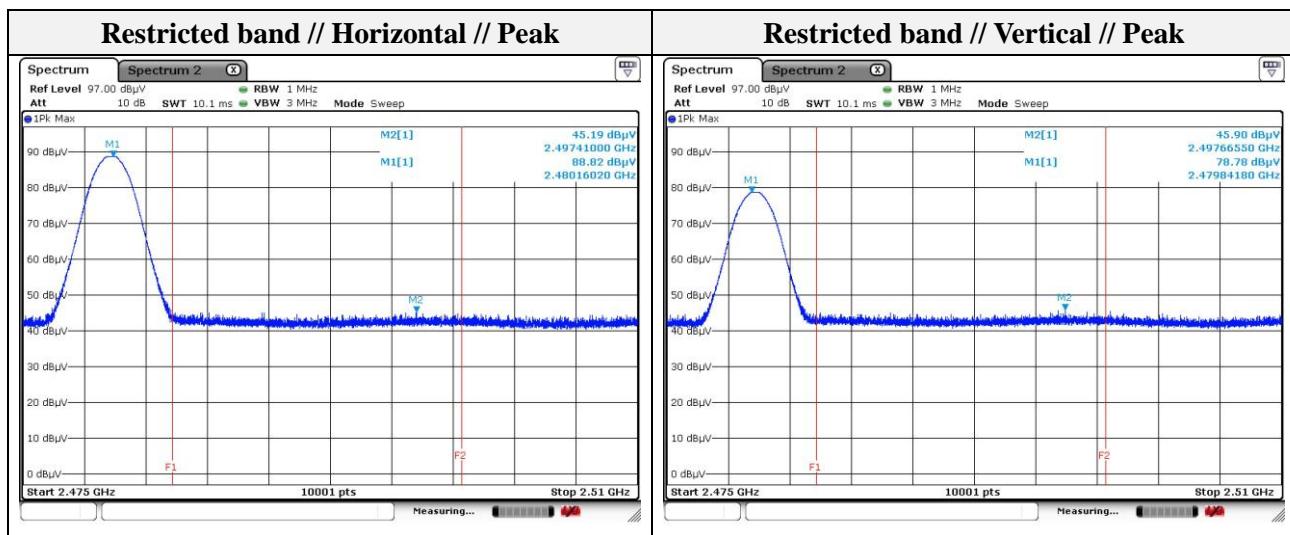
Channel: 78

- Spurious

Frequency (MHz)	Level (dB μ V)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB μ N/m)	Limit (dB μ N/m)	Margin (dB)
1 055.89	45.45	Peak	H	-10.86	-	34.59	74.00	39.41
1 126.69	44.79	Peak	V	-10.49	-	34.30	74.00	39.70

- Band edge

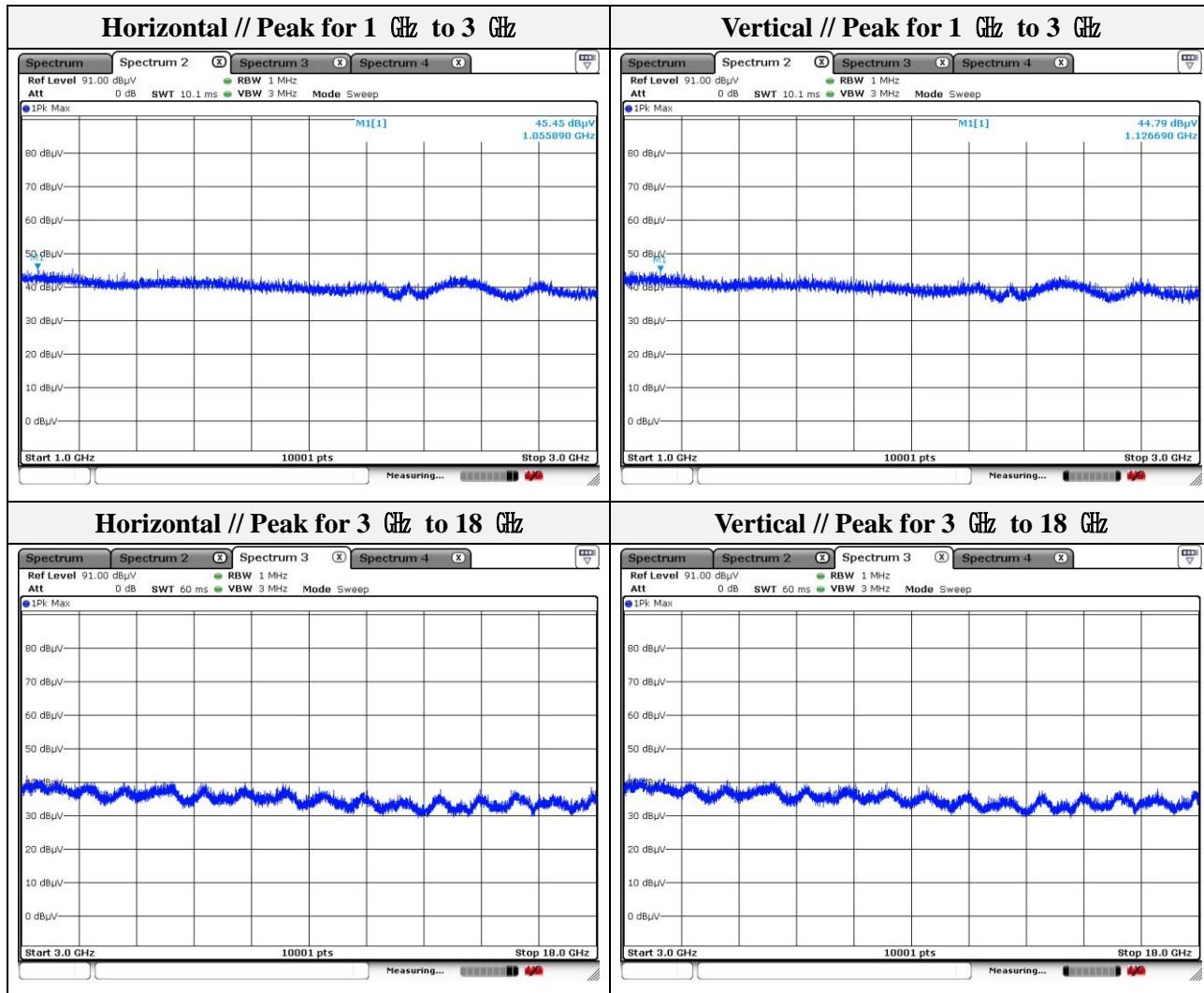
Frequency (MHz)	Level (dB μ V)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB μ N/m)	Limit (dB μ N/m)	Margin (dB)
2 497.41	45.19	Peak	H	-2.35	-	42.84	74.00	31.16
2 497.67	45.90	Peak	V	-2.34	-	43.56	74.00	30.44



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 shchoi@kes.co.kr



Note.

1. No spurious emission were detected above 3 GHz.
2. Average test would be performed if the peak result were greater than the average limit.

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 shchoi@kes.co.kr

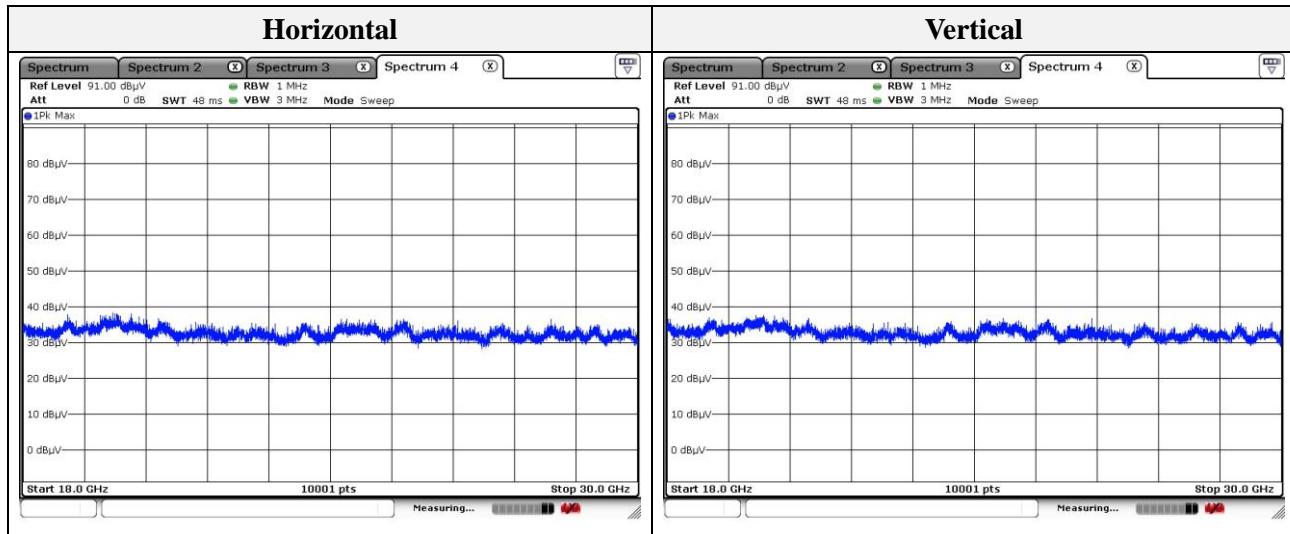
Test results (18 GHz to 30 GHz) – Worst case

Mode: BDR

Transfer rate: 1 Mbps

Distance of measurement: 3 meter

Channel: 00(Worst case)



Note.

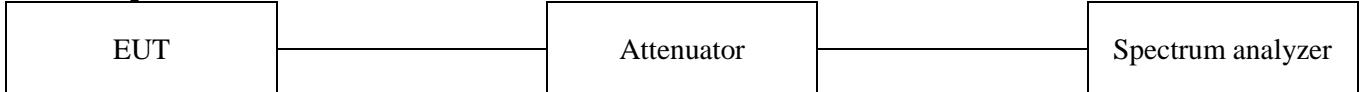
1. No spurious emission were detected above 18 GHz.

3.7. Conducted band edge and out of band emissions

Test procedure

KDB 558074 v05r02 & ANSI 63.10-2013

Test setup

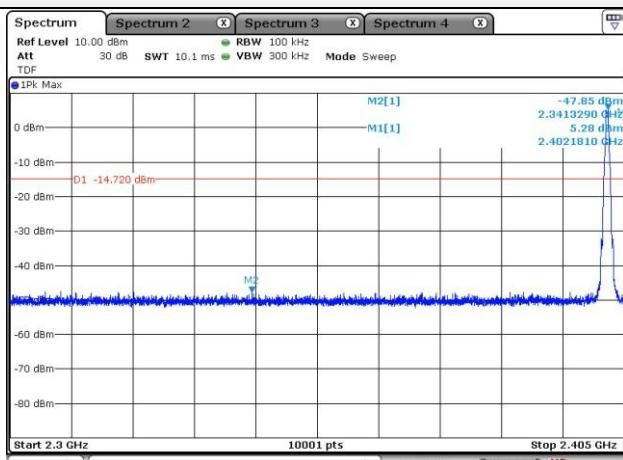
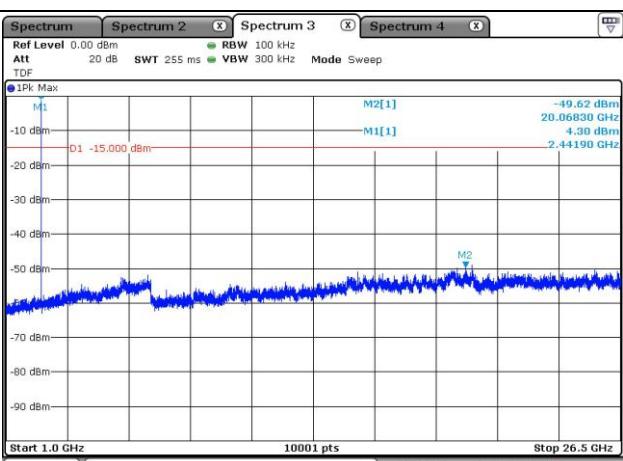
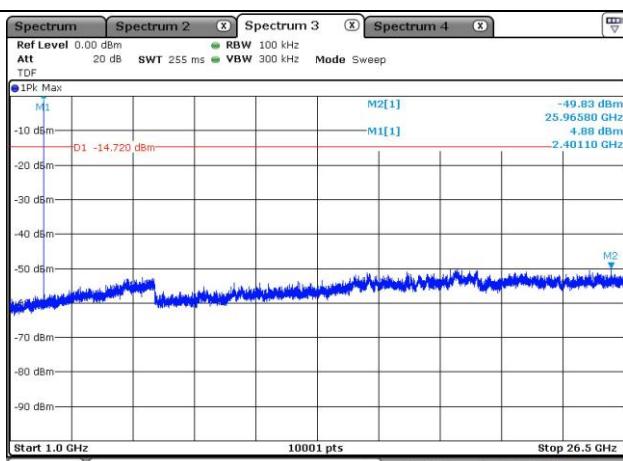
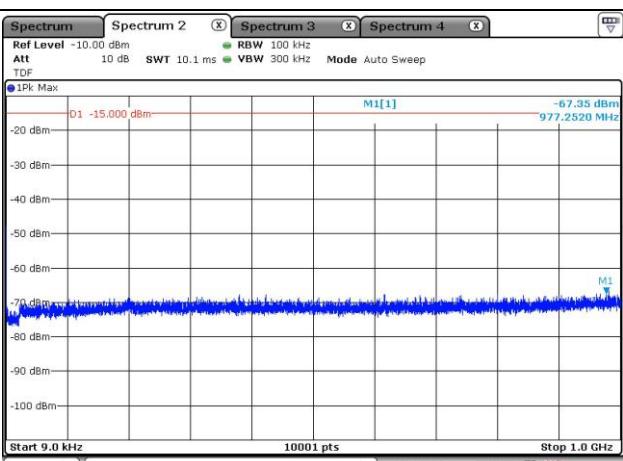
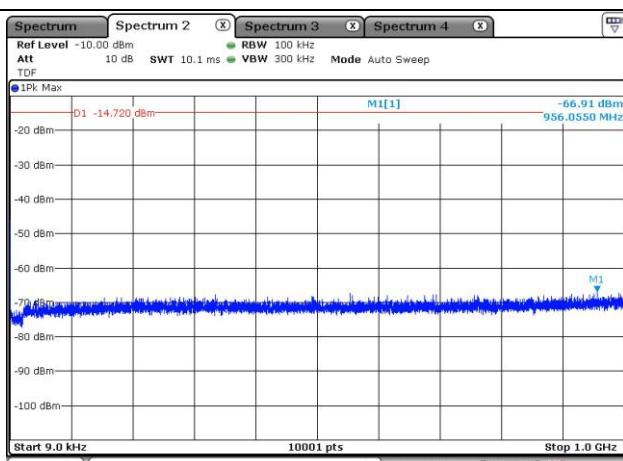
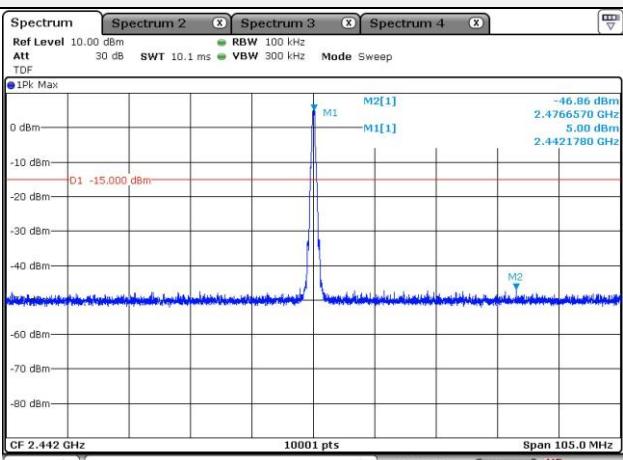


Test setting

1. Span = wide enough to capture the peak level of the in-band emission and all spurious emissions(e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic.
2. RBW = 100 kHz
3. VBW \geq 300 kHz
4. Detector = Peak
5. Number of sweep points $\geq 2 \times$ Span/RBW
7. Trace mode = max hold
8. Sweep time = auto couple
9. The trace was allowed to stabilize

Limit

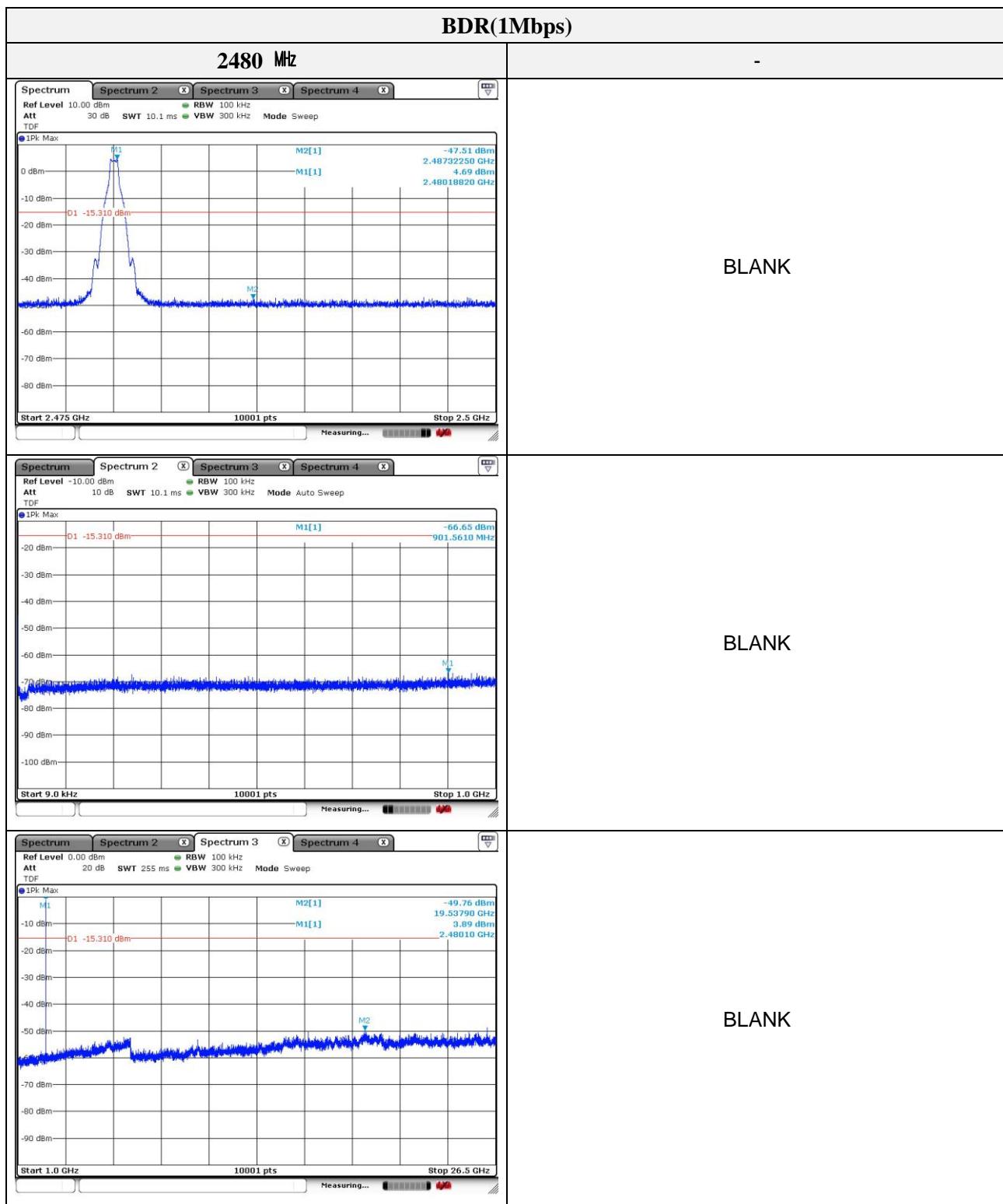
According to 15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within 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 define 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
BDR(1Mbps)
2402 MHz

2442 MHz


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.

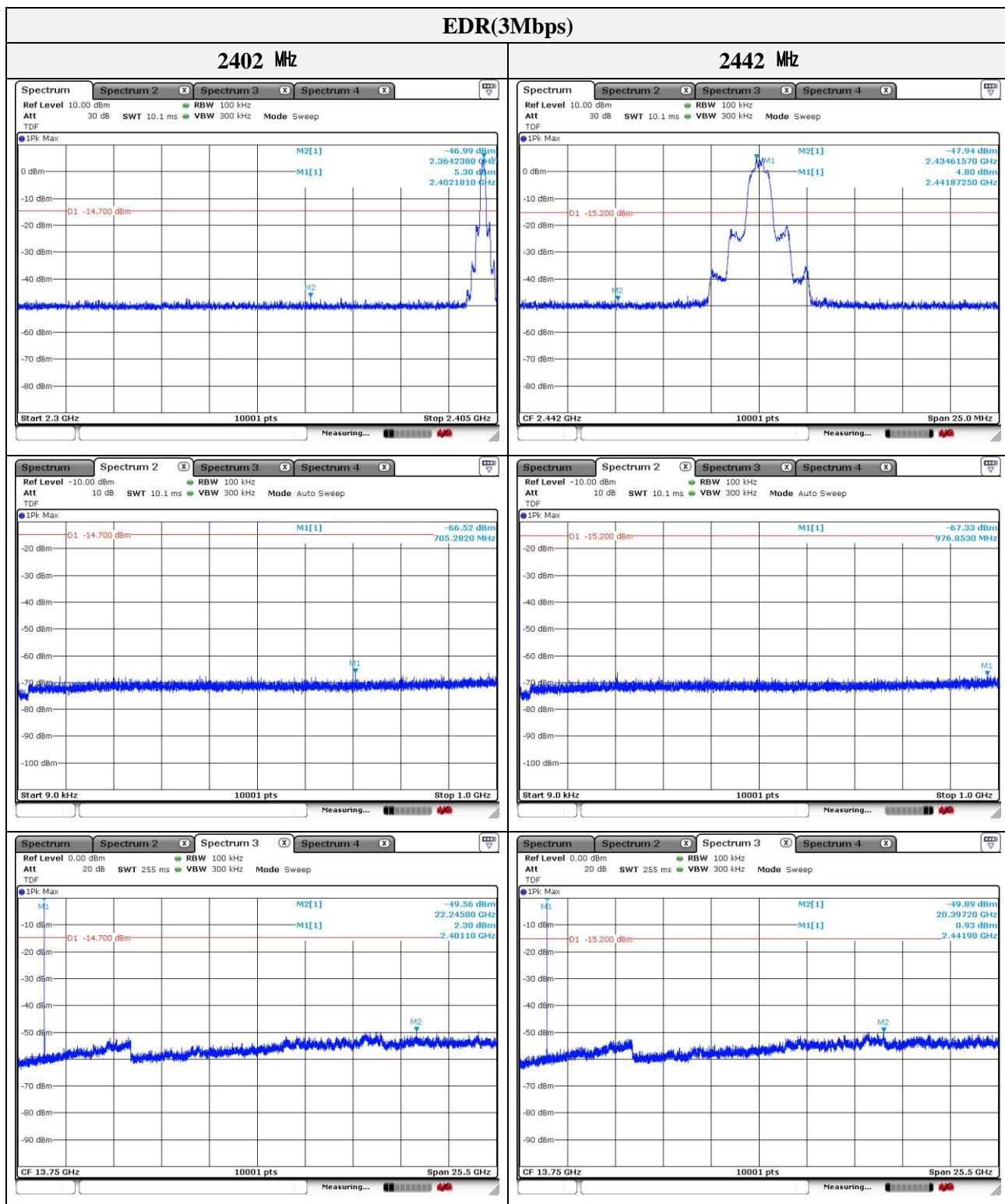
 The authenticity of the test report, contact shchoi@kes.co.kr



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.

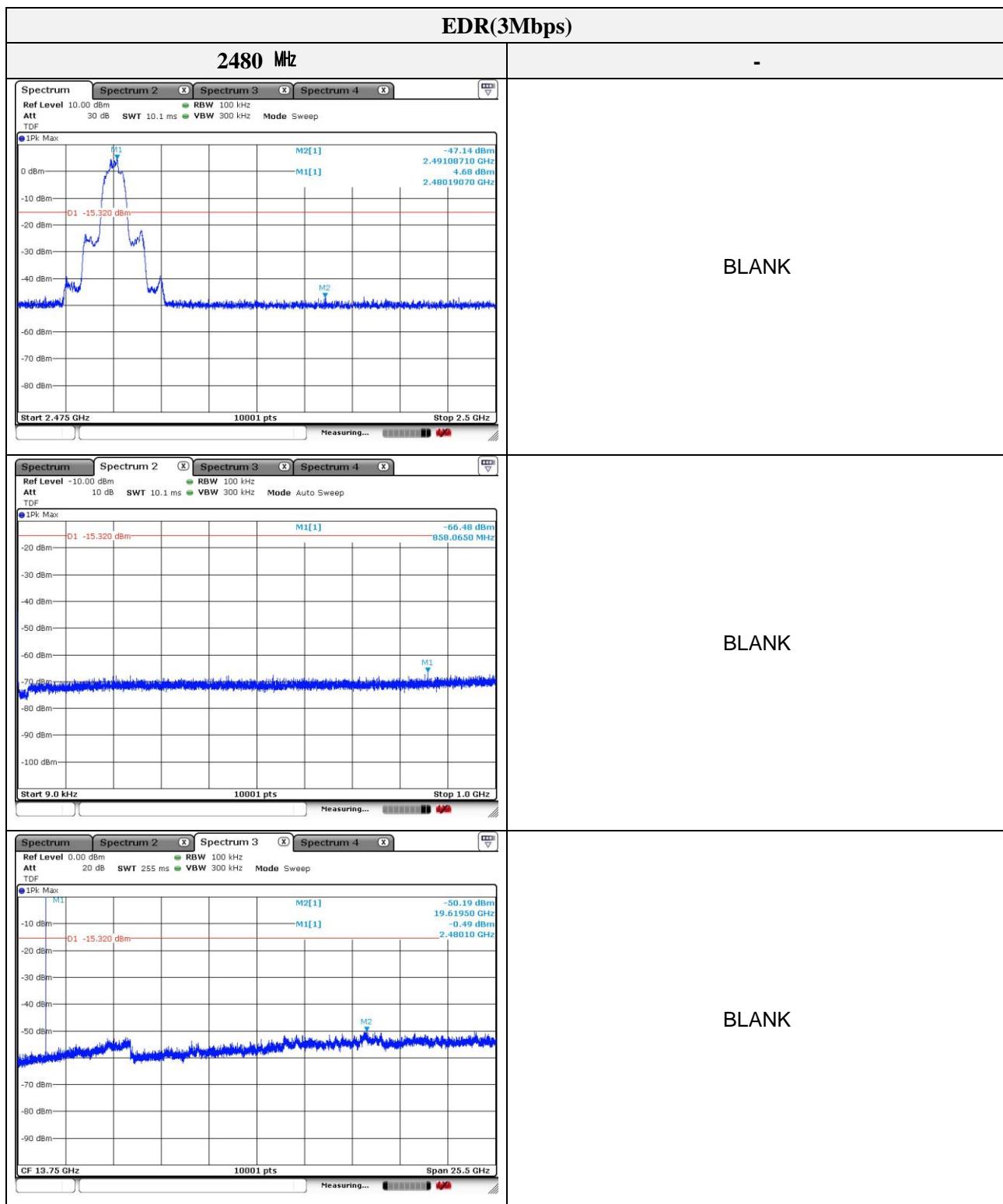
The authenticity of the test report, contact shchoi@kes.co.kr



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.

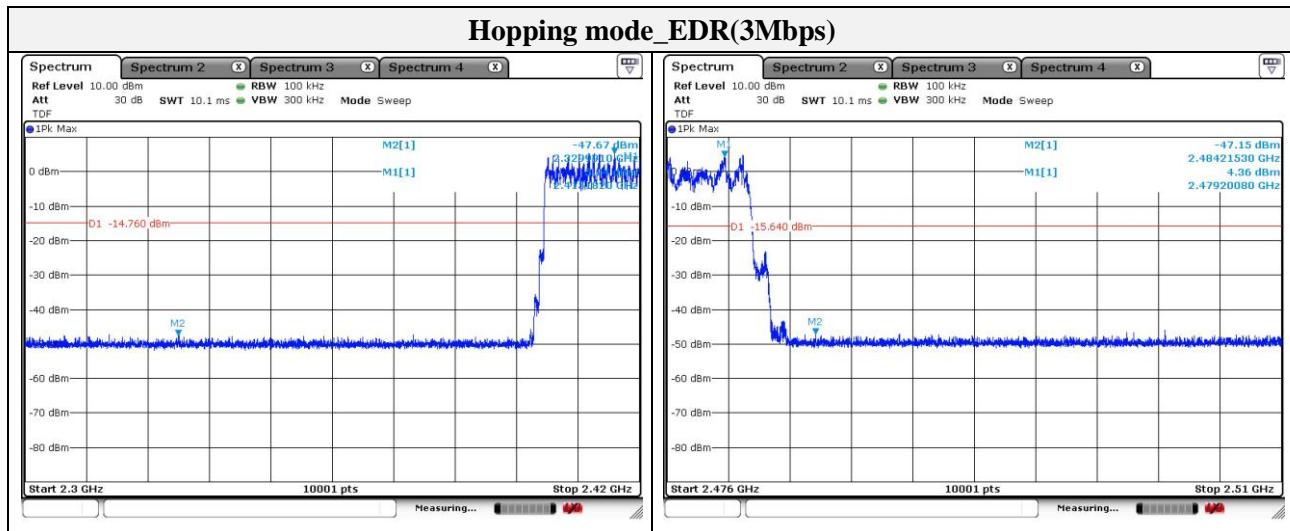
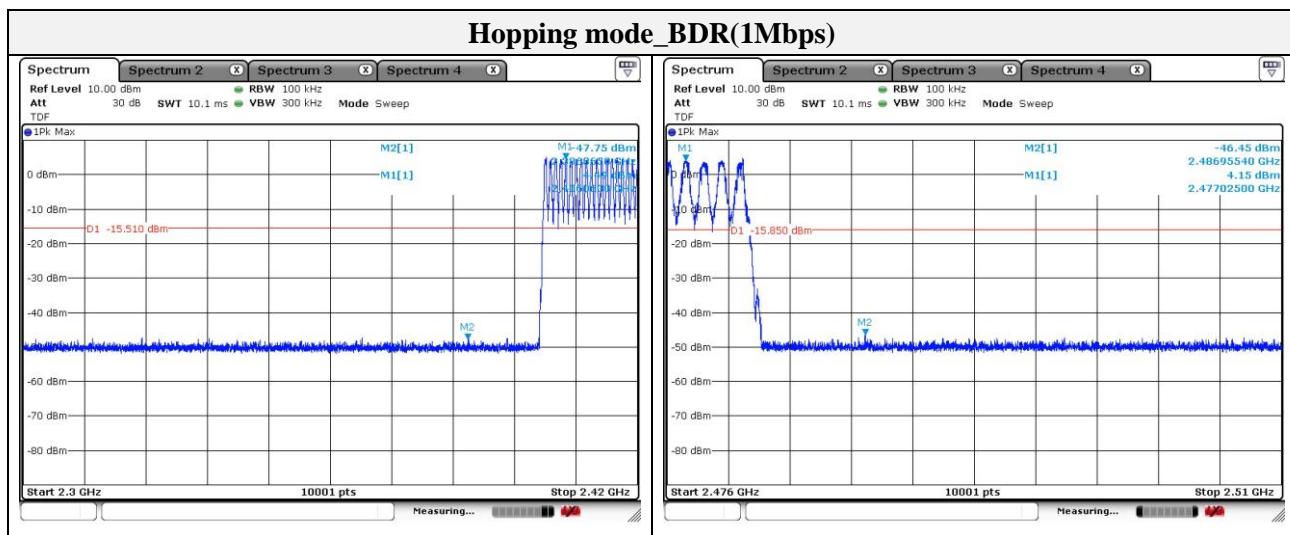
The authenticity of the test report, contact shchoi@kes.co.kr



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 shchoi@kes.co.kr



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 shchoi@kes.co.kr

**Appendix A. Measurement equipment**

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum Analyzer	R&S	FSV40	101725	1 year	2022.06.18
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2023.01.14
SIGNAL GENERATOR	KEYSIGHT	N5182B	MY59100115	1 year	2023.01.14
Power Meter	Anritsu	ML2495A	2010001	1 year	2022.04.29
Pulse Power Sensor	Anritsu	MA2411B	1911111	1 year	2022.04.29
Attenuator	Mini-Circuits	BW-S10-2W263+	1	1 year	2023.01.17
Attenuator	HUBER+SUHNER	6806.17.A	-	1 year	2022.11.02
Loop Antenna	Schwarzbeck	FMZB1513	225	2 years	2023.01.18
BILOG ANTENNA	Schwarzbeck	VULB 9168	9168-461	2 years	2022.12.22
Horn Antenna	A.H	SAS-571	414	1 year	2023.01.28
Horn Antenna	SCHWARZBECK	BBHA9120D	9120D-1802	1 year	2022.12.16
Amplifier	SONOMA INSTRUMENT	310N	401123	1 year	2022.06.07
PREAMPLIFIER	HP	8449B	3008A00538	1 year	2022.06.21
BROADBAND AMPLIFIER	SCHWARZBECK	BBV9721	PS9721-003	1 year	2023.01.17
EMI Test Receiver	R&S	ESU26	100552	1 year	2022.04.01
DC Power supply	Agilent	6632B	MY43004090	1 year	2022.06.21

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
NoteBook	LG Electronics.	LG15N54	411NZJV044052
NoteBook DC Power Unit	LITE-ON TECHNOLOGY (CHANGZHOU)CO., LTD	PA-1900-14	N/A

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 shchoi@kes.co.kr