

TEST REPORT

Part 15 Subpart C 15.247

Equipment under test APM-PRO
Model name APM-PRO
FCC ID XYCAPMPRO
Applicant Aram Huvis Co., LTD.
Manufacturer Aram Huvis Co., LTD.
Date of test(s) 2017.11.09 ~ 2017.11.21
Date of issue 2018.01.03

Issued to
Aram Huvis Co., LTD.
Jung-Ja Dong-Rm401-402, Seoul National University Hospital's
Health Care Innovation Park, 172, Dolma-ro, Bundang-gu,
Seongnam-si, Gyeonggi-do, South Korea
Tel: +82-70-4687-1712 / Fax: +82-31-732-6330

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 :
	
Kwon-se Kim Test engineer	Hyeon-Su, Jang Technical manager



Revision history

Revision	Date of issue	Test report No.	Description
-	2018.01.03	KES-RF-18T0001	Initial

TABLE OF CONTENTS

1.	General information.....	4
1.1.	EUT description	4
1.2.	Test configuration.....	6
1.3.	Device modifications.....	6
1.4.	Frequency/channel operations	6
1.5.	Accessory information.....	6
1.6.	Software and Firmware description.....	6
1.7.	Measurement results explanation example	6
1.8.	Measurement Uncertainty	6
2.	Summary of tests	7
3.	Test results	8
3.1.	20 dB bandwidth	8
3.2.	Output power.....	11
3.3.	Carrier frequency separation	15
3.4.	Number of hopping frequency.....	17
3.5.	Time of occupancy	19
3.6.	Radiated restricted band and emissions.....	23
3.7.	Conducted band edge and out of band emissions	42
3.8.	AC conducted emissions	46
Appendix A.	Measurement equipment	48
Appendix B.	Test setup photo	49

1. General information

Applicant: Aram Huvis Co., LTD.
Applicant address: Jung-Ja Dong-Rm401-402, Seoul National University Hospital's
Health Care Innovation Park, 172, Dolma-ro, Bundang-gu,
Seongnam-si, Gyeonggi-do, 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: XYCAPMPRO
Test device serial No.: ☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test APM-PRO
Frequency range 2 402 MHz ~ 2 480 MHz (BDR/EDR)
2 402 MHz ~ 2 480 MHz (LE)
2 412 MHz ~ 2 462 MHz (11b/g/n_HT20)
UNII-1 5 180 MHz ~ 5 240 MHz (11a/n_HT20)
UNII-3 5 745 MHz ~ 5 825 MHz (11a/n_HT20)
Model: APM-PRO
Modulation technique WIFI : DSSS, OFDM
BT : 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) : 40 ch
2 412 MHz ~ 2 462 MHz (11b/g/n_HT20) : 11 ch
5 180 MHz ~ 5 240 MHz (11a/n_HT20) : 4 ch
5 745 MHz ~ 5 825 MHz (11a/n_HT20) : 5 ch
Antenna specification 2.4 GHz Antenna type : Chip antenna, Peak gain : 3.44 dBi
5 GHz Antenna type : Chip antenna, Peak gain(UNII-1) : -1.97 dBi
Peak gain(UNII-3) : -1.95 dBi
Power source DC 3.7 V (Internal Rechargeable Battery)

15.247(a)(1) that the rx input bandwidths 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.

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:

02, 05, 31, 24, 20, 10, 43, 36, 30, 23, 40, 06, 21, 50, 44, 09, 71, 78, 01, 13, 73, 07, 70, 72, 35, 62, 42, 11, 41, 08, 16, 29, 60, 15, 34, 61, 58, 04, 67, 12, 22, 53, 57, 18, 27, 76, 39, 32, 17, 77, 52, 33, 56, 46, 37, 47, 64, 49, 45, 38, 69, 14, 51, 26, 79, 19, 28, 65, 75, 54, 48, 03, 25, 66, 05, 16, 68, 74, 59, 63, 55

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.

1.2. Test configuration

The **Aram Huvis Co., LTD. APM-PRO FCC ID: XYCAPMPRO** was tested per the guidance of ANSI C63.10-2013 and DA 00-705. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing.

1.3. Device modifications

N/A

1.4. Frequency/channel operations

Ch.	Frequency (MHz)	Rate(Mbps)
00	2402	1,2,3
.	.	.
39	2441	1,2,3
.	.	.
78	2480	1,2,3

1.5. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
Smart Cradle	Aram Huvis Co., LTD.	APM-PRO	APM-C-A-AGJE2500106	DC 5 V

1.6. Software and Firmware description

The software and firmware installed in the EUT is version 1.01-02.

1.7. Measurement results explanation example

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.

$$\begin{aligned}\text{Offset(dB)} &= \text{RF cable loss(dB)} + \text{attenuator factor(dB)} \\ &= 1.05 + 10 = 11.05 \text{ (dB)}\end{aligned}$$

1.8. Measurement Uncertainty

Test Item		Uncertainty
Uncertainty for Conduction emission test		2.62 dB
Uncertainty for Radiation emission test (include Fundamental emission)	9kHz - 30MHz	4.54 dB
	30MHz - 1GHz	4.36 dB
	Above 1GHz	5.00 dB
Note. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.		

2. Summary of tests

Reference	Test description	Test results
15.247(a)(1)(iii)	20 dB bandwidth	Pass
15.247(b)(1)	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	Pass

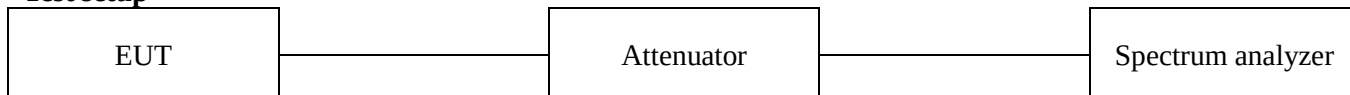
3. Test results

3.1. 20 dB bandwidth

Test procedure

DA 00-705

Test setup



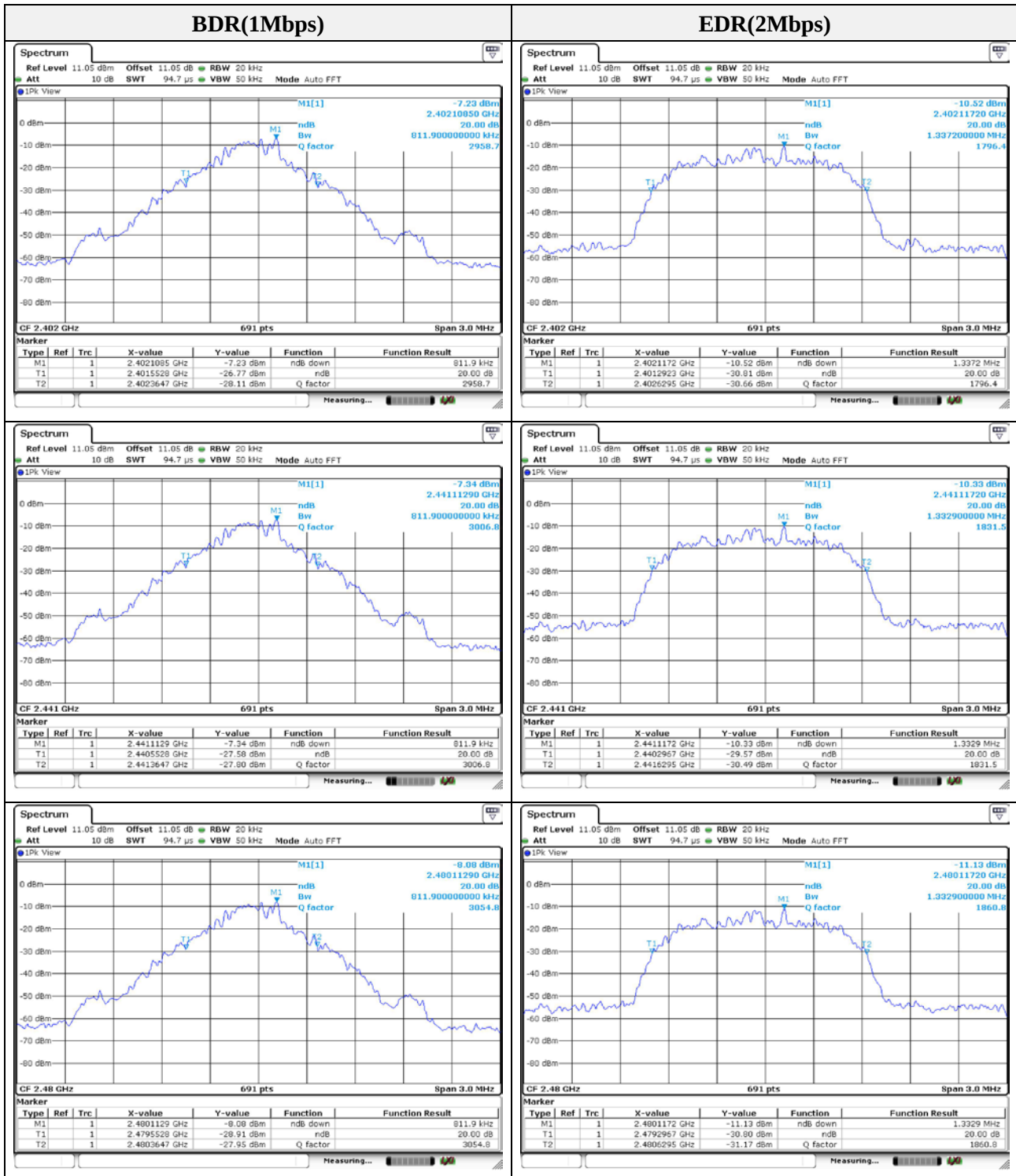
Test setting

1. Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
2. RBW $\geq$ 1% of the 20 dB bandwidth
3. VBW $\geq$ RBW
4. Sweep = auto
5. Detector function = peak
6. Sweep = auto couple
7. Trace mode = max hold

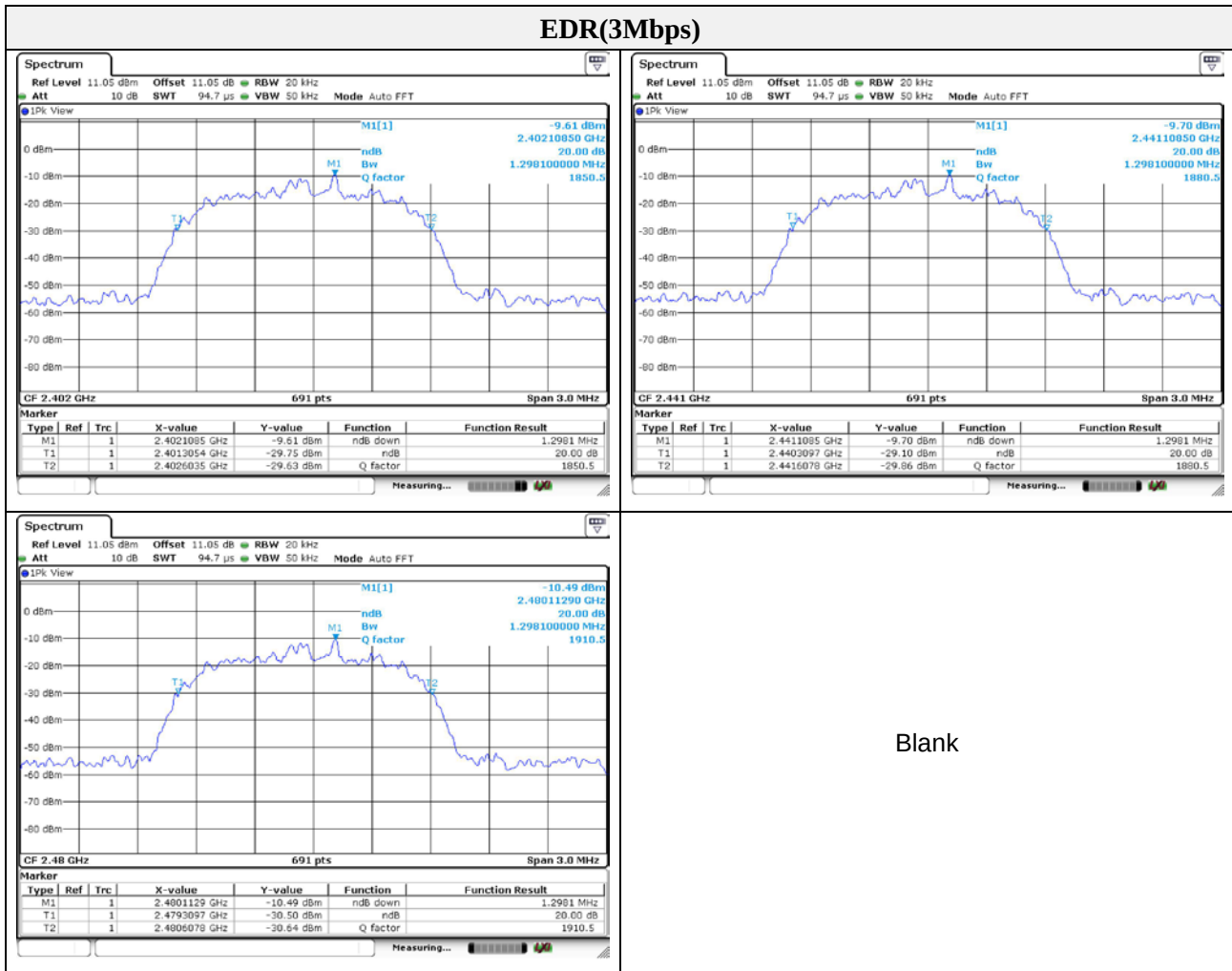
Limit

Not applicable

Frequency(MHz)	Channel no.	Data rate(Mbps)	Measured bandwidth(MHz)
2 402	00	1	0.812
2 441	39		0.812
2 480	78		0.812
2 402	00	2	1.337
2 441	39		1.333
2 480	78		1.333
2 402	00	3	1.298
2 441	39		1.298
2 480	78		1.298



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.

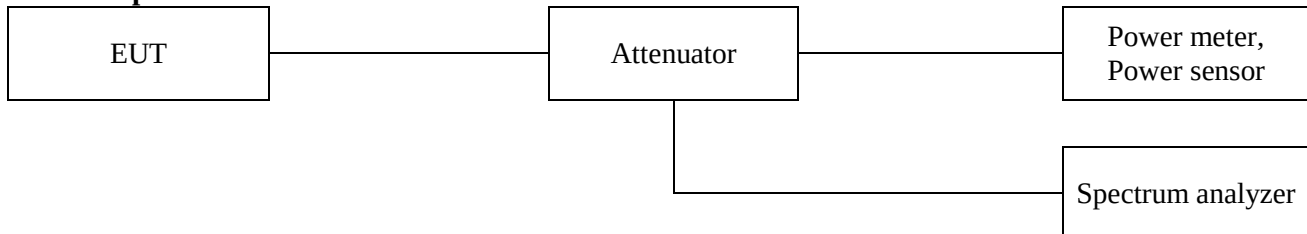


3.2. Output power

Test procedure

DA 00-705

Test setup



Test setting

1. Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
2. RBW > the 20 dB bandwidth of the emission being measured
3. VBW $\geq$ RBW
4. Sweep = Auto
5. Detector function = Peak
6. Trace = Max hold

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.

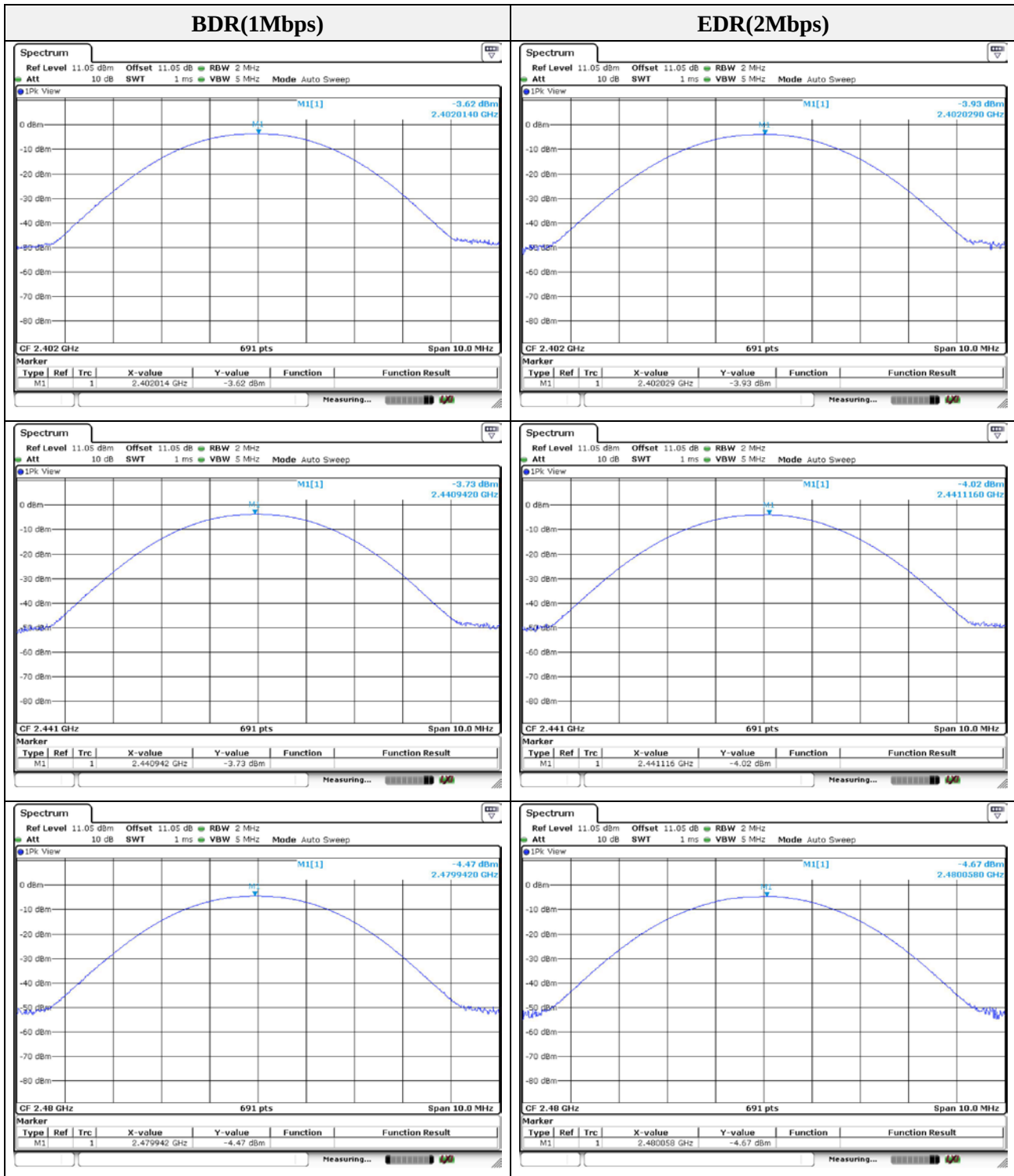
According to §15.247(b)(1), For frequency hopping systems operating in the 2 400 ~ 2 483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 ~ 5 805 MHz band: 1 Watt.



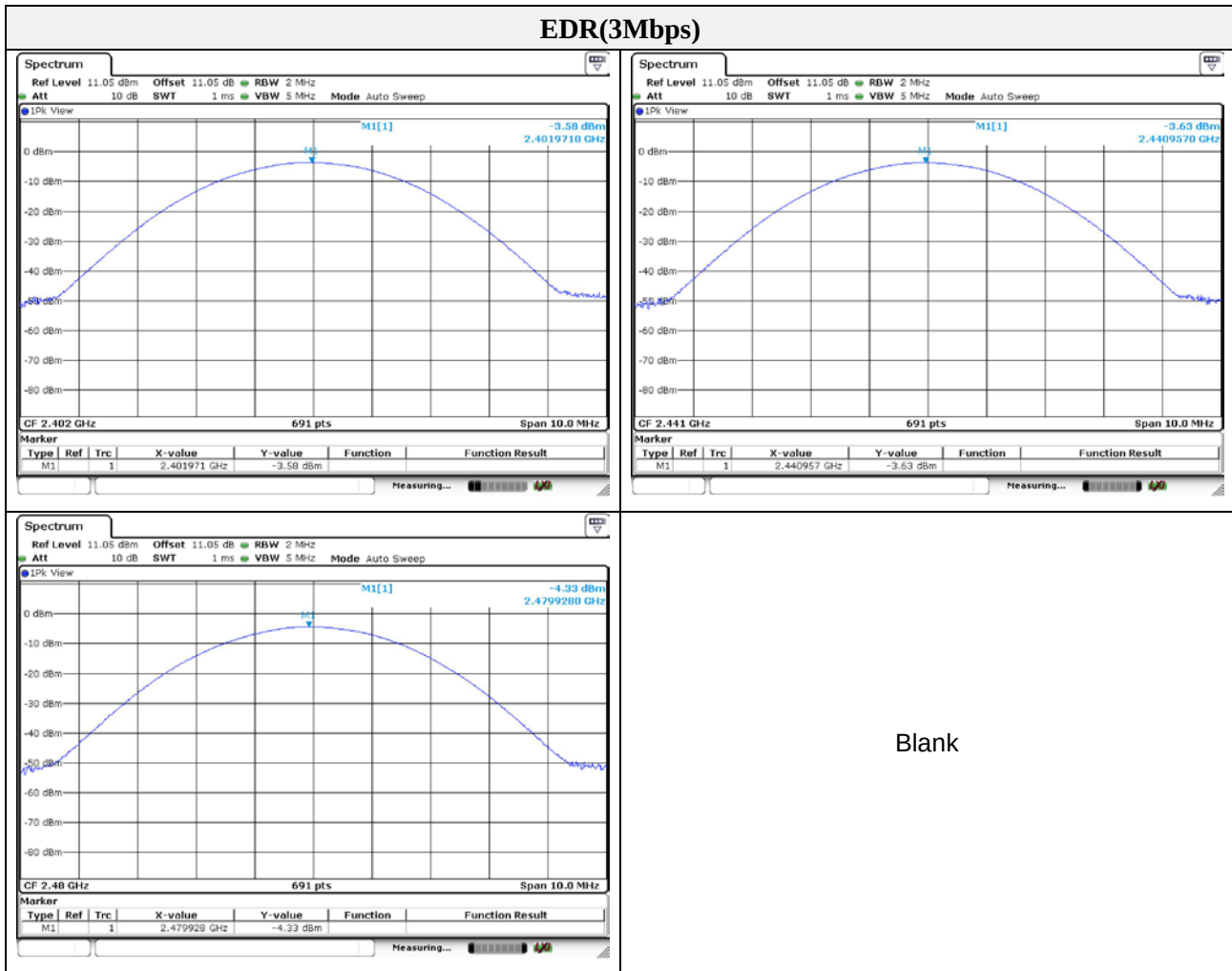
Frequency(MHz)	Channel no.	Data rate(Mbps)	Peak Power (dBm)	Average Power (dBm) ^{Note1}	Power Limit (dBm)
2 402	00	1	-3.62	-6.15	20.97
2 441	39		-3.73	-6.35	20.97
2 480	78		-4.47	-5.62	20.97
2 402	00	2	-3.93	-8.40	20.97
2 441	39		-4.02	-8.60	20.97
2 480	78		-4.67	-8.39	20.97
2 402	00	3	-3.58	-8.53	20.97
2 441	39		-3.63	-8.77	20.97
2 480	78		-4.33	-8.73	20.97

Note.

1. The average power was tested using an average power meter.



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.

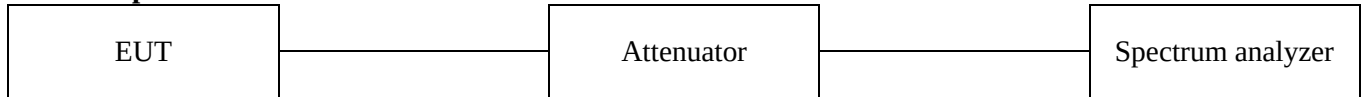


3.3. Carrier frequency separation

Test procedure

DA 00-705

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. Resolution (or IF) Bandwidth (RBW) $\geq 1\%$ of the span
4. Video (or Average) Bandwidth (VBW) $\geq$ RBW
5. Sweep = auto
6. Detector function = peak
7. Trace = max hold

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

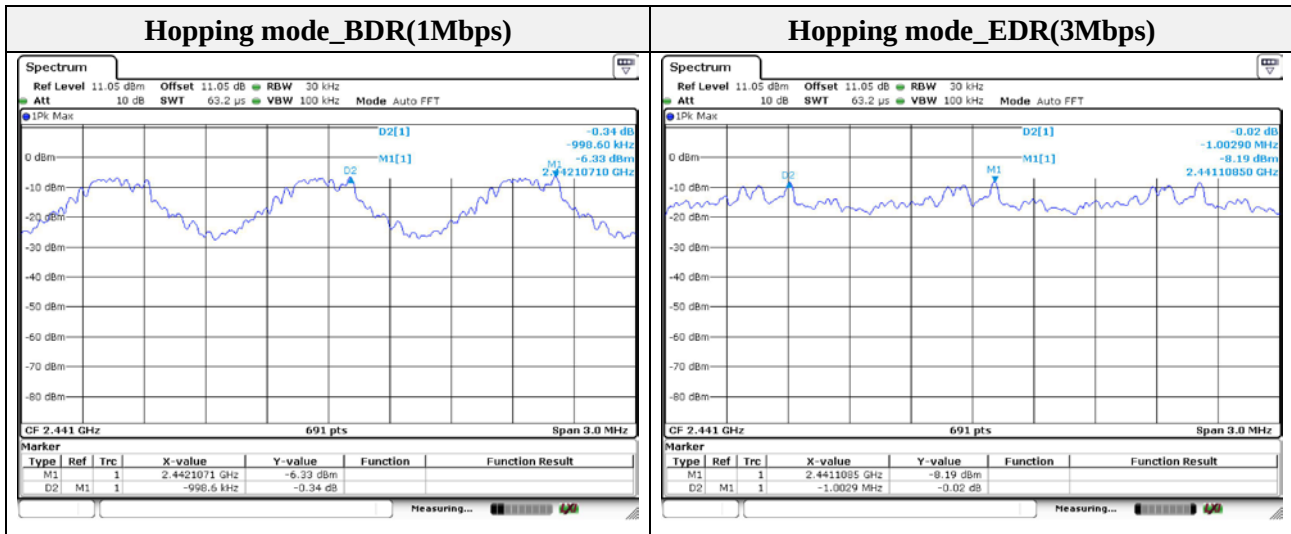
Limit

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.

Frequency(MHz)	Channel no.	Data rate(Mbps)	Channel Separation (MHz)
2 441	39	1	0.999
2 441	39	3	1.003

Note:

Measurement is made with EUT operating in hopping mode between 79 channels providing a worse case scenario as compared to AFH mode hopping between 20 channels.



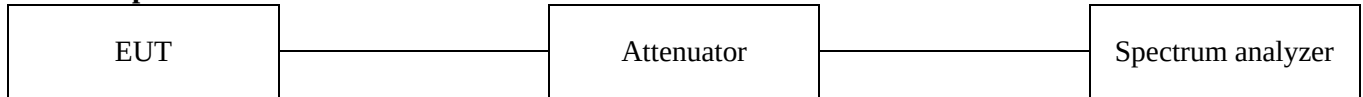
This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
 The results shown in this test report refer only to the sample(s) tested unless otherwise stated.

3.4. Number of hopping frequency

Test procedure

DA 00-705

Test setup



Test setting

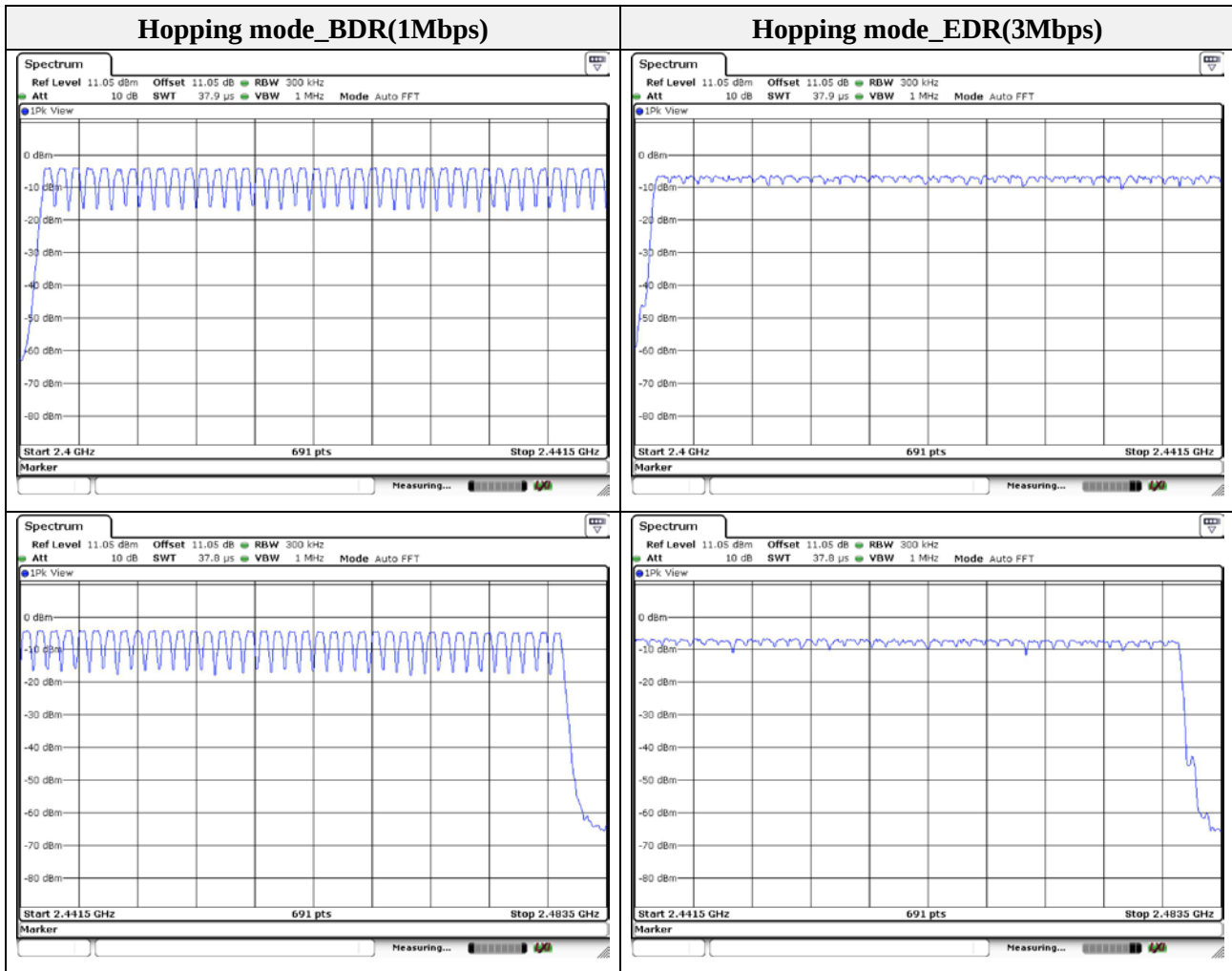
1. The EUT must have its hopping function enabled.
2. Frequency range: 2 400 MHz ~ 2 441.5 MHz, 2 441.5 MHz ~ 2 483.5 MHz
3. Span = the frequency band of operation
4. RBW = 300 kHz ($\geq 1\%$ of the span)
5. VBW = 1 MHz ($\geq$ RBW)
6. Sweep = auto
7. Detector function = peak
8. Trace = max hold

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.

Note: In case of AFH mode, minimum number of hopping channels is 20.



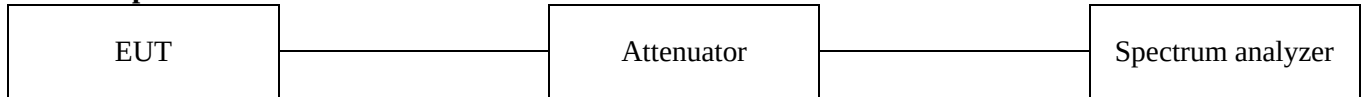
This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
 The results shown in this test report refer only to the sample(s) tested unless otherwise stated.

3.5. Time of occupancy

Test procedure

DA 00-705

Test setup



Test setting

1. The EUT must have its hopping function enabled.
2. Span = zero span, centered on a hopping channel
4. RBW = 1 MHz
5. VBW = 1 MHz ($\geq$ RBW)
6. Sweep = as necessary to capture the entire dwell time per hopping channel
7. Detector function = peak
8. 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.

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

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

• Adaptive Frequency Hopping

$$\text{A period time} = 0.4(\text{s}) \times 20 = 8.0(\text{s})$$

$$\begin{aligned} &\text{Time of occupancy on the TX channel in 8.0 sec} \\ &= \text{time domain slot length} \times (\text{hop rate} \div \text{number of hop per channel}) \times 8.0 \end{aligned}$$

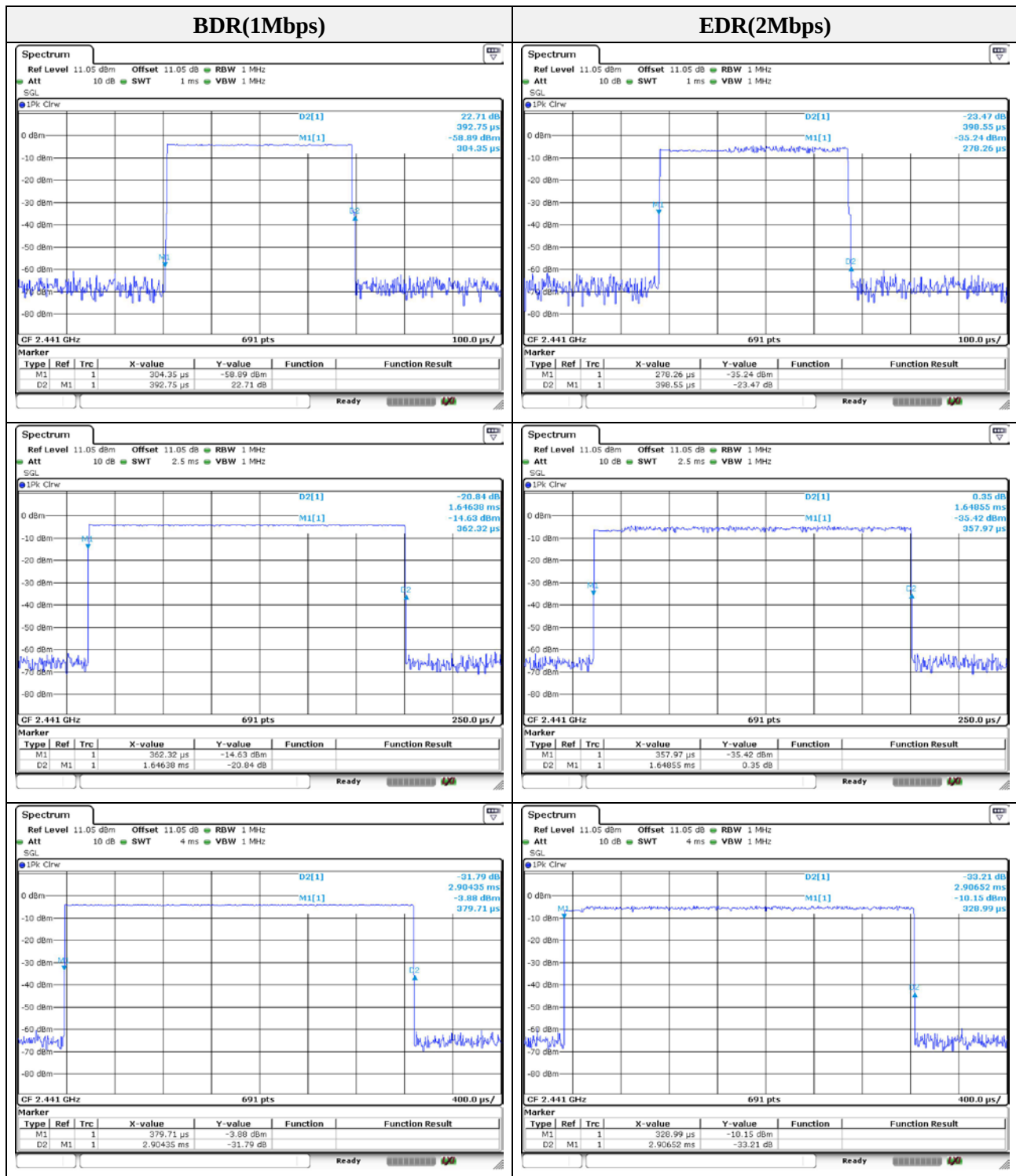
Operation mode: GFSK , $\pi/4$ -DQPSK, 8DPSK

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	2 441	0.393	125.76	400
DH3	2 441	1.646	263.36	400
DH5	2 441	2.904	309.86	400
2-DH1	2 441	0.399	127.68	400
2-DH3	2 441	1.649	263.84	400
2-DH5	2 441	2.907	310.18	400
3-DH1	2 441	0.399	127.68	400
3-DH3	2 441	1.649	263.84	400
3-DH5	2 441	2.907	310.18	400

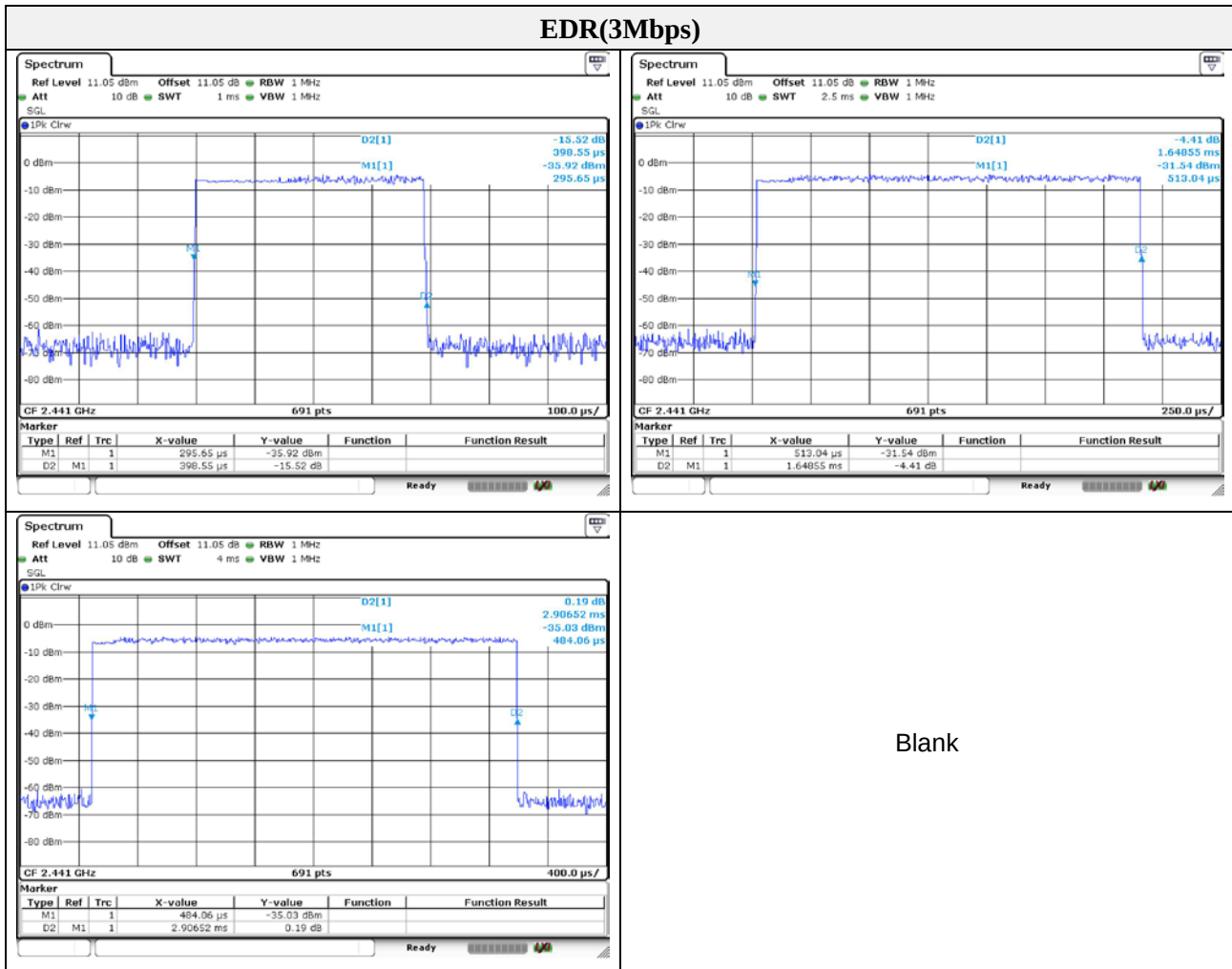
Note:

Normal Mode

DH1: Dwell time (ms) $\times [(1\ 600 \div 2) \div 79] \times 31.6(s) = 125.76\ (ms)$
DH3: Dwell time (ms) $\times [(1\ 600 \div 4) \div 79] \times 31.6(s) = 263.36\ (ms)$
DH5: Dwell time (ms) $\times [(1\ 600 \div 6) \div 79] \times 31.6(s) = 309.86\ (ms)$
2-DH1: Dwell time (ms) $\times [(1\ 600 \div 2) \div 79] \times 31.6(s) = 127.68\ (ms)$
2-DH3: Dwell time (ms) $\times [(1\ 600 \div 4) \div 79] \times 31.6(s) = 263.84\ (ms)$
2-DH5: Dwell time (ms) $\times [(1\ 600 \div 6) \div 79] \times 31.6(s) = 310.18\ (ms)$
3-DH1: Dwell time (ms) $\times [(1\ 600 \div 2) \div 79] \times 31.6(s) = 127.68\ (ms)$
3-DH3: Dwell time (ms) $\times [(1\ 600 \div 4) \div 79] \times 31.6(s) = 263.84\ (ms)$
3-DH5: Dwell time (ms) $\times [(1\ 600 \div 6) \div 79] \times 31.6(s) = 310.18\ (ms)$



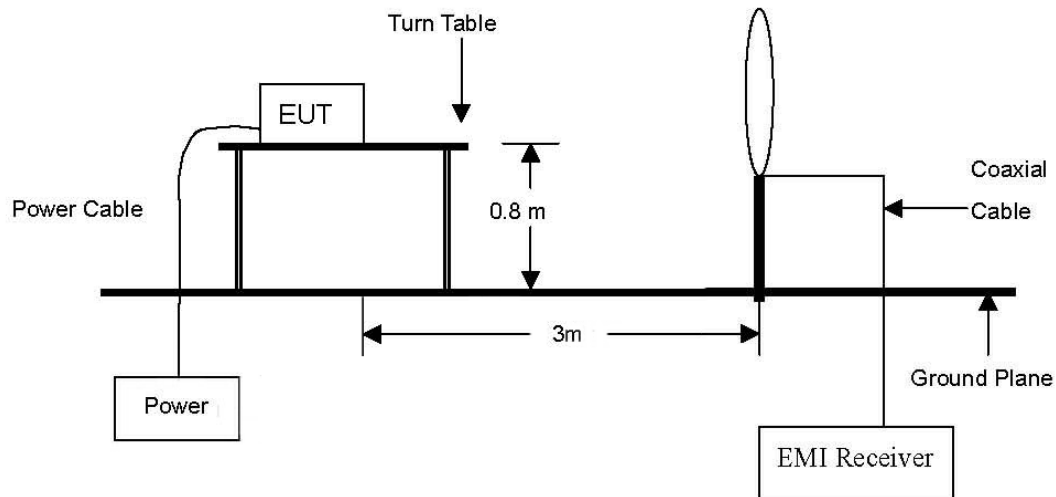
This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
 The results shown in this test report refer only to the sample(s) tested unless otherwise stated.



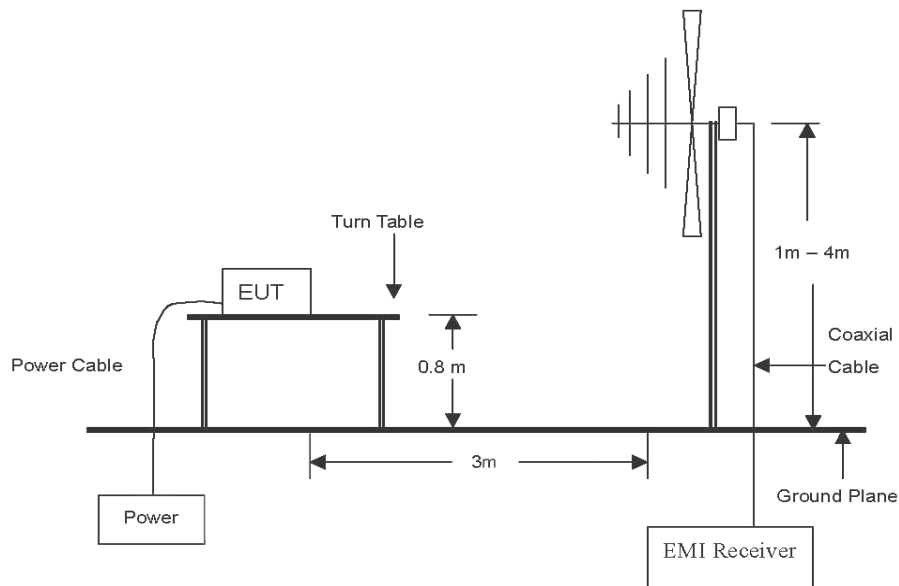
3.6. Radiated restricted band and emissions

Test setup

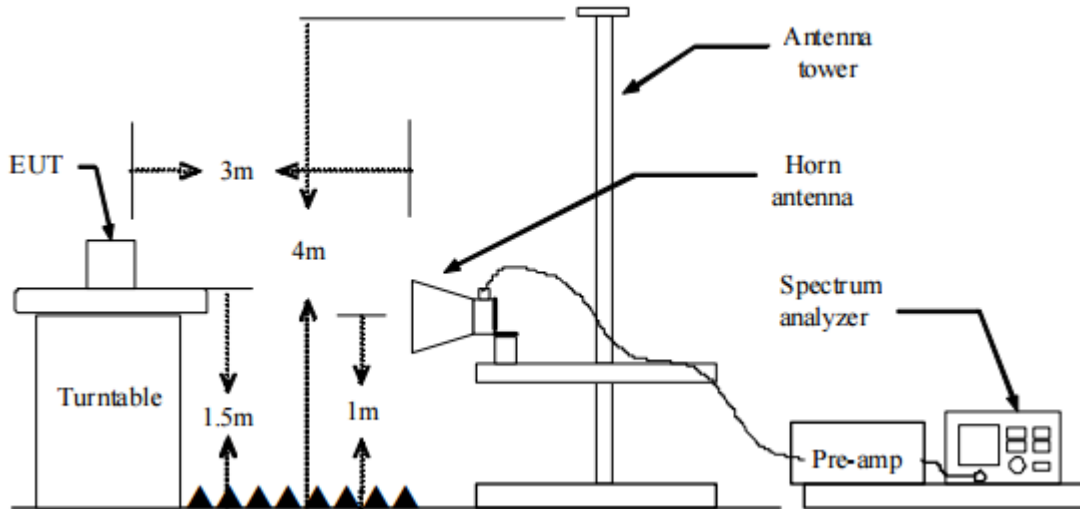
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions.



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



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.



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.

Test procedure

1. The EUT is placed on a turntable, which is 0.8 m (below 1 GHz) and 1.5 m (above 1 GHz) ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.
7. Spectrum analyzer settings for $f < 1$ GHz:
 - Span = wide enough to fully capture the emission being measured
 - RBW = 100 kHz
 - VBW $\geq$ RBW
 - Sweep = auto
 - Detector function = quasi peak
 - Trace = max hold
8. Spectrum analyzer settings for $f \geq 1$ GHz: Peak
 - Span = wide enough to fully capture the emission being measured
 - RBW = 1 MHz
 - VBW $\geq$ RBW
 - Sweep = auto
 - Detector function = peak
 - Trace = max hold
9. Spectrum analyzer settings for $f \geq 1$ GHz: Average
 - Span = wide enough to fully capture the emission being measured
 - RBW = 1 MHz
 - VBW $\geq 1/T$ Hz, where T= pulse width in seconds
 - Sweep = auto
 - Detector function = average
 - Trace = max hold
10. Duty Cycle Correction Factor (79 channel hopping)
 - a. Time to cycle through all channels = $\Delta t = \tau[\text{ms}] \times 79 \text{ channels} = 229.653 \text{ ms}$, where τ = pulse width
 - b. $100 \text{ ms} / \Delta t[\text{ms}] = H \rightarrow$ Round up to next highest integer, $H' = 1$
 - c. Worst Case Dwell Time = $\tau[\text{ms}] \times H' = 2.907 \text{ ms}$
 - d. Duty Cycle Correction = $20 \log (\text{Worst Case Dwell Time} / 100 \text{ms}) \text{ dB} = -30.73 \text{ dB}$

Note:

1. The spectrum is measured from 9 kHz to the 10th harmonic of the fundamental frequency of the transmitter using CISPR quasi peak detector below 1 GHz. Above 1 GHz, average and peak measurements were taken using linearly polarized horn antennas. The worst-case emissions are reported however emissions whose levels were not within 20 dB of the respective limits were not reported.
2. When Average result is different from peak result over 20 dB (over-averaging), according to 15.35 (c), as a “duty cycle correction factor”, pulse averaging with 20 log(duty cycle) has to be used.
Duty cycle correction factor = $20\log(\text{dwell time}/100 \text{ ms})$
3. 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.
4. Average test would be performed if the peak result were greater than the average limit.
5. Field strength(dBμV/m) = Level(dBμV) + Correction factors(dB/m) + Cable loss(dB) + or $F_d(\text{dB})$
6. Correction factors(dB/m) = Antenna factor(dB/m) + Cable loss(dB) + or Amp. gain(dB)
7. Margin(dB) = Limit(dBμV/m) - Field strength(dBμV/m)
8. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes.
9. All channels, modes (e.g. BDR, EDR), and modulations/data rates were investigated among DSS band.
Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.
10. According to exploratory test no any obvious emission were detected from 9 kHz to 30 MHz. Although these tests were performed other than open area test site, adequate comparison measurements were confirmed against 30 m open area test 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.
11. $f < 30 \text{ MHz}$, 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

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 :

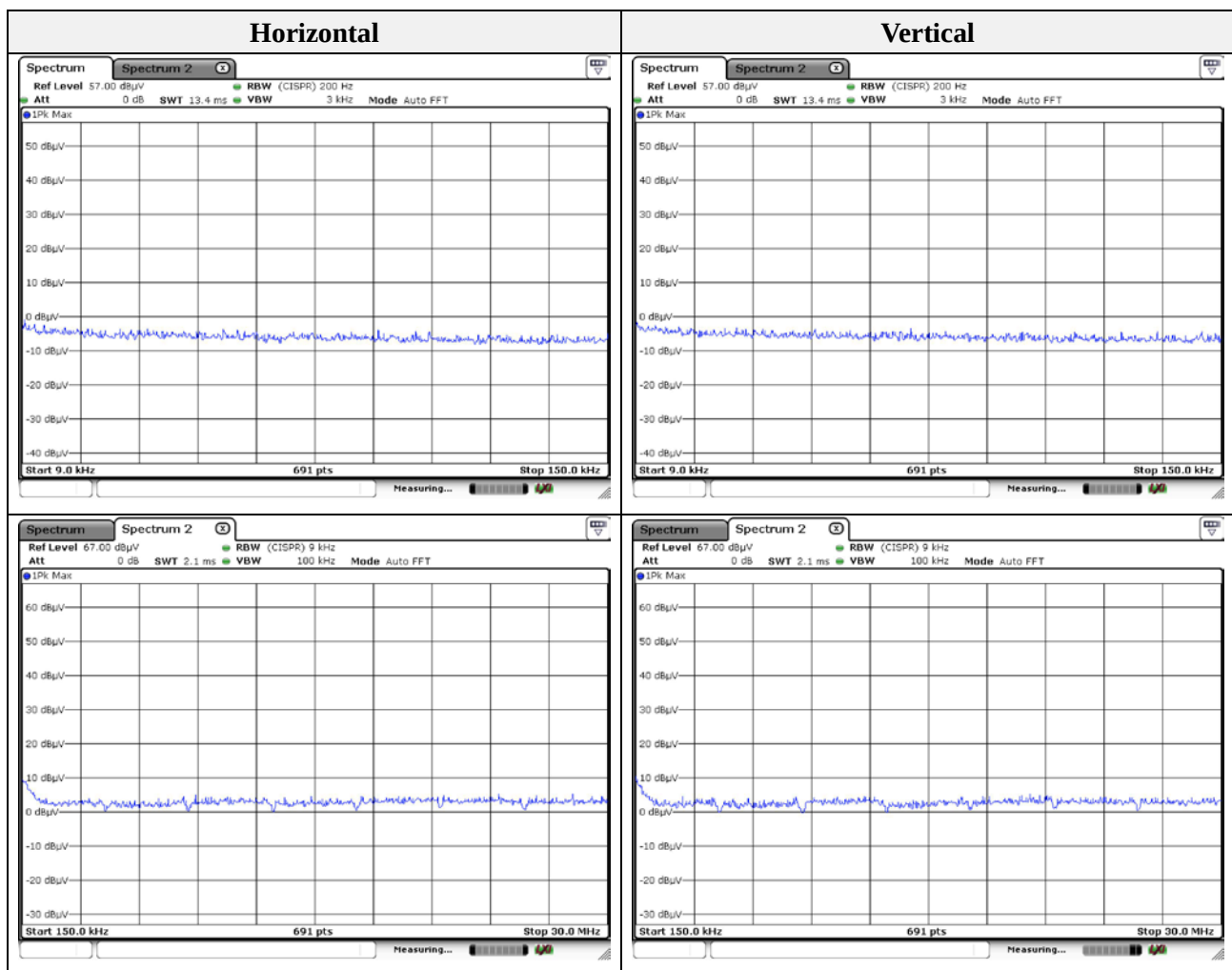
Frequency (MHz)	Distance (Meters)	Radiated ($\mu\text{V/m}$)
0.009 ~ 0.490	300	2 400 / F(kHz)
0.490 ~ 1.705	30	24 000 / F(kHz)
1.705 ~ 30.0	30	30
30 ~ 88	3	100**
88 ~ 216	3	150**
216 ~ 960	3	200**
Above 960	3	500

**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.

Test results (Below 30 MHz)

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

Frequency (MHz)	Level (dB μ V)	Ant. Pol. (H/V)	CF (dB)	F _d (dB)	Field strength (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
No spurious emissions were detected within 20dB of the limit							

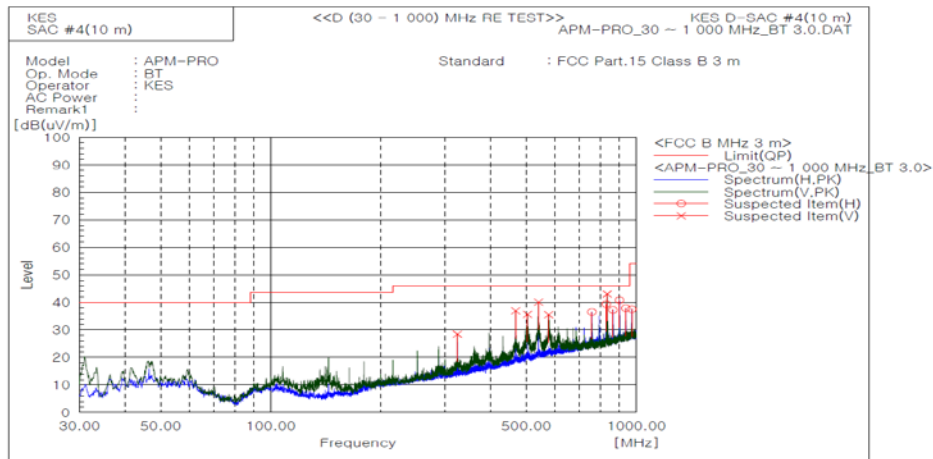


This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
 The results shown in this test report refer only to the sample(s) tested unless otherwise stated.

Test results (Below 1 000 MHz) – Worst case

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

Horizontal // Vertical



No.	Frequency [MHz]	(P)	Reading [dB(uV)]	c.f [dB(1/m)]	Result PK [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Remark
1	756.045	H	49.9	-13.3	36.6	46.0	9.4	
2	827.946	H	51.5	-12.1	39.4	46.0	6.6	
3	863.958	H	48.6	-11.3	37.3	46.0	8.7	
4	899.969	H	51.4	-10.6	40.8	46.0	5.2	
5	935.980	H	47.9	-10.0	37.9	46.0	8.1	
6	971.991	H	47.0	-9.4	37.6	54.0	16.4	
7	324.031	V	52.1	-23.6	28.5	46.0	17.5	
8	467.955	V	55.8	-18.8	37.0	46.0	9.0	
9	503.966	V	53.5	-17.7	35.8	46.0	10.2	
10	539.978	V	56.8	-16.7	40.1	46.0	5.9	
11	575.989	V	51.4	-15.8	35.6	46.0	10.4	
12	832.675	V	55.0	-12.0	43.0	46.0	3.0	

Test results (Above 1 000 MHz)

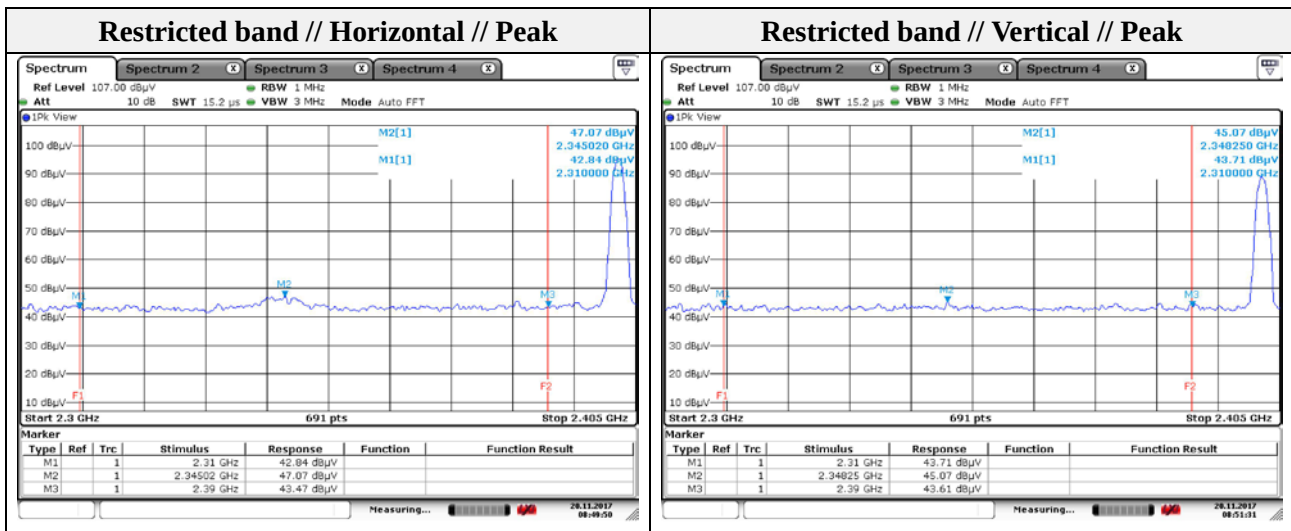
Mode:	BDR
Transfer rate:	1 Mbps
Distance of measurement:	3 meter
Channel:	00

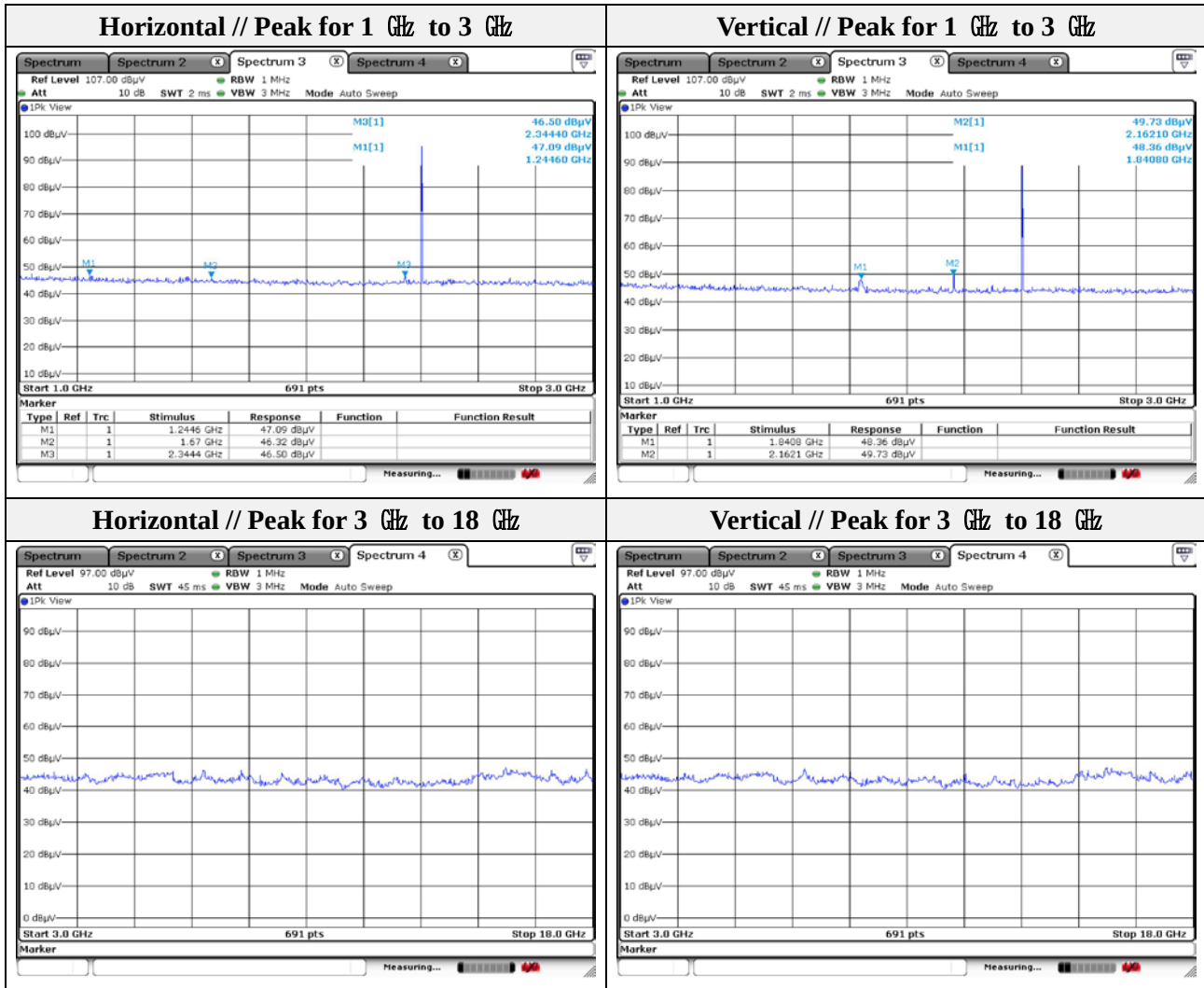
- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 244.60	47.09	Peak	H	-7.57	-	39.52	74.00	34.48
1 670.00	46.32	Peak	H	-4.32	-	42.00	74.00	32.00
2 344.40	46.50	Peak	H	-0.31	-	46.19	74.00	27.81
1 840.80	48.36	Peak	V	-2.65	-	45.71	74.00	28.29
2 162.10	49.73	Peak	V	-0.65	-	49.08	74.00	24.92

- 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)
2 345.02	47.07	Peak	H	-0.30	-	46.77	74.00	27.23
2 348.25	45.07	Peak	V	-0.30	-	44.77	74.00	29.23



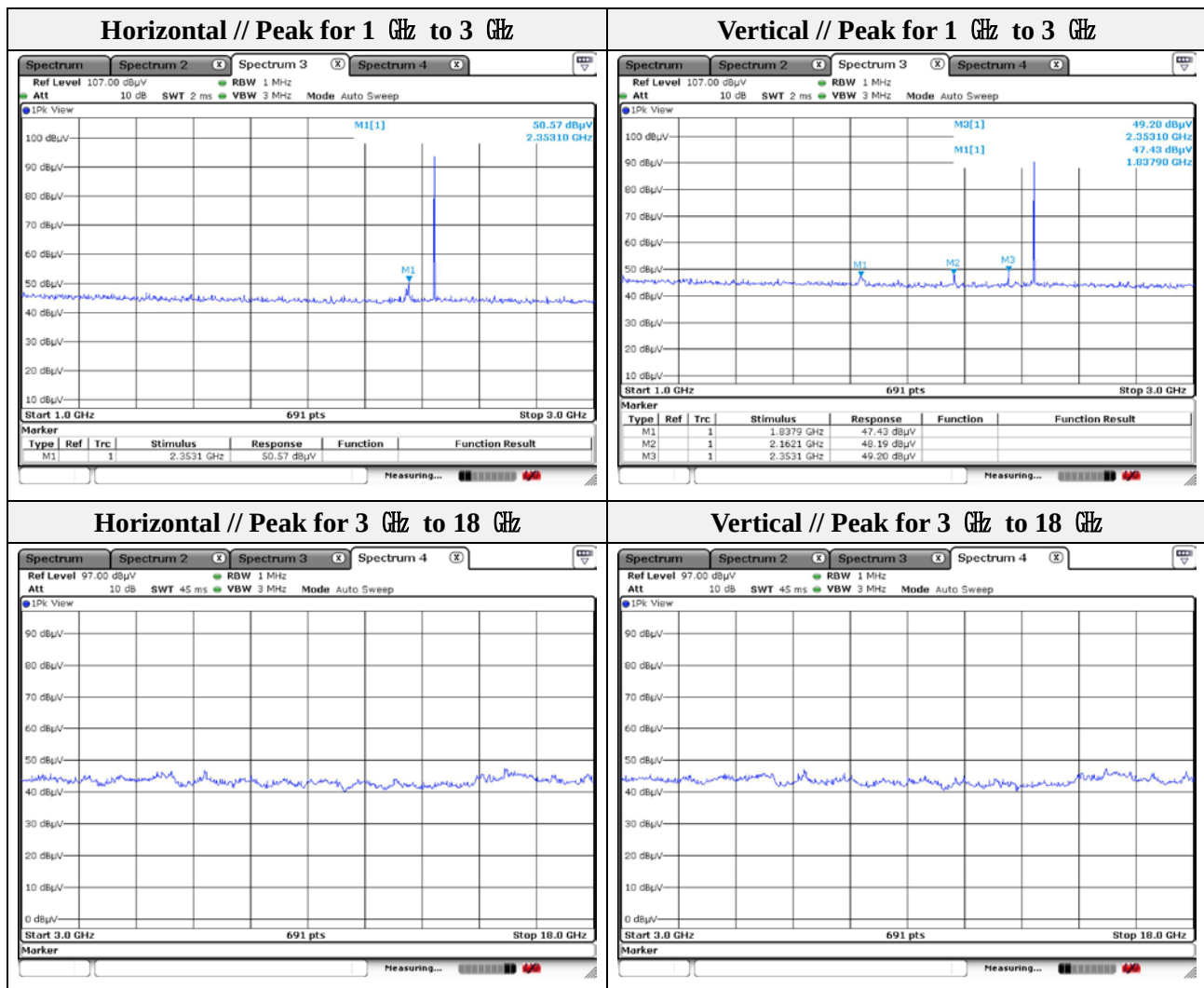


Note.

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: 39

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 353.10	50.57	Peak	H	-0.29	-	50.28	74.00	23.72
1 837.90	47.43	Peak	V	-2.68	-	44.75	74.00	29.25
2 162.10	48.19	Peak	V	-0.65	-	47.54	74.00	26.46
2 353.10	49.20	Peak	V	-0.29	-	48.91	74.00	25.09



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.

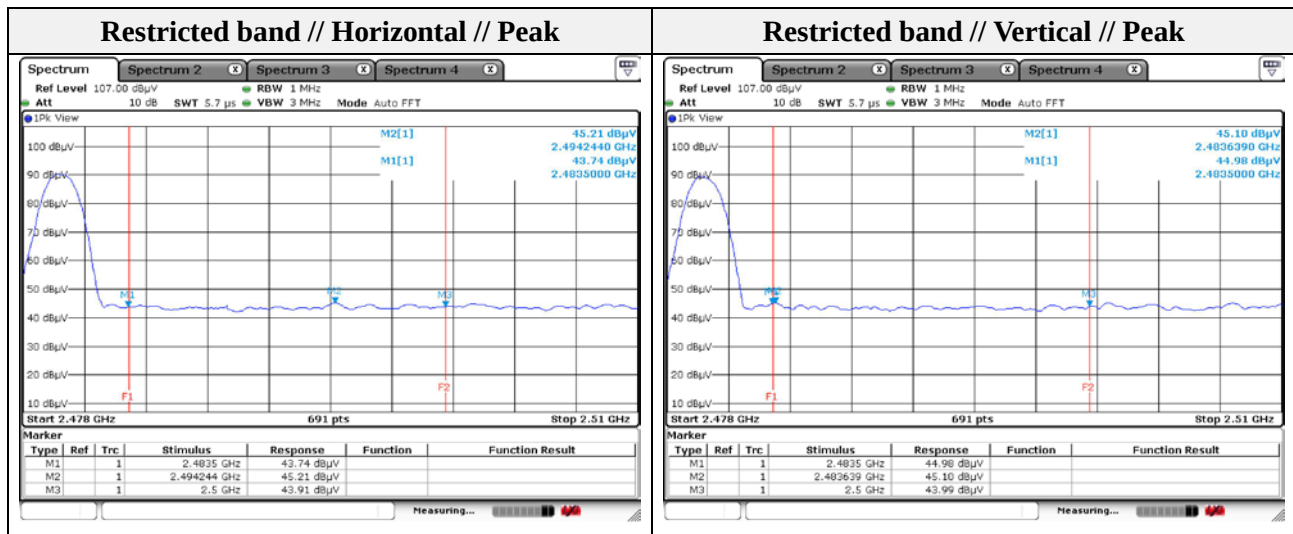
Mode: BDR
Transfer rate: 1 Mbps
Distance of measurement: 3 meter
Channel: 78

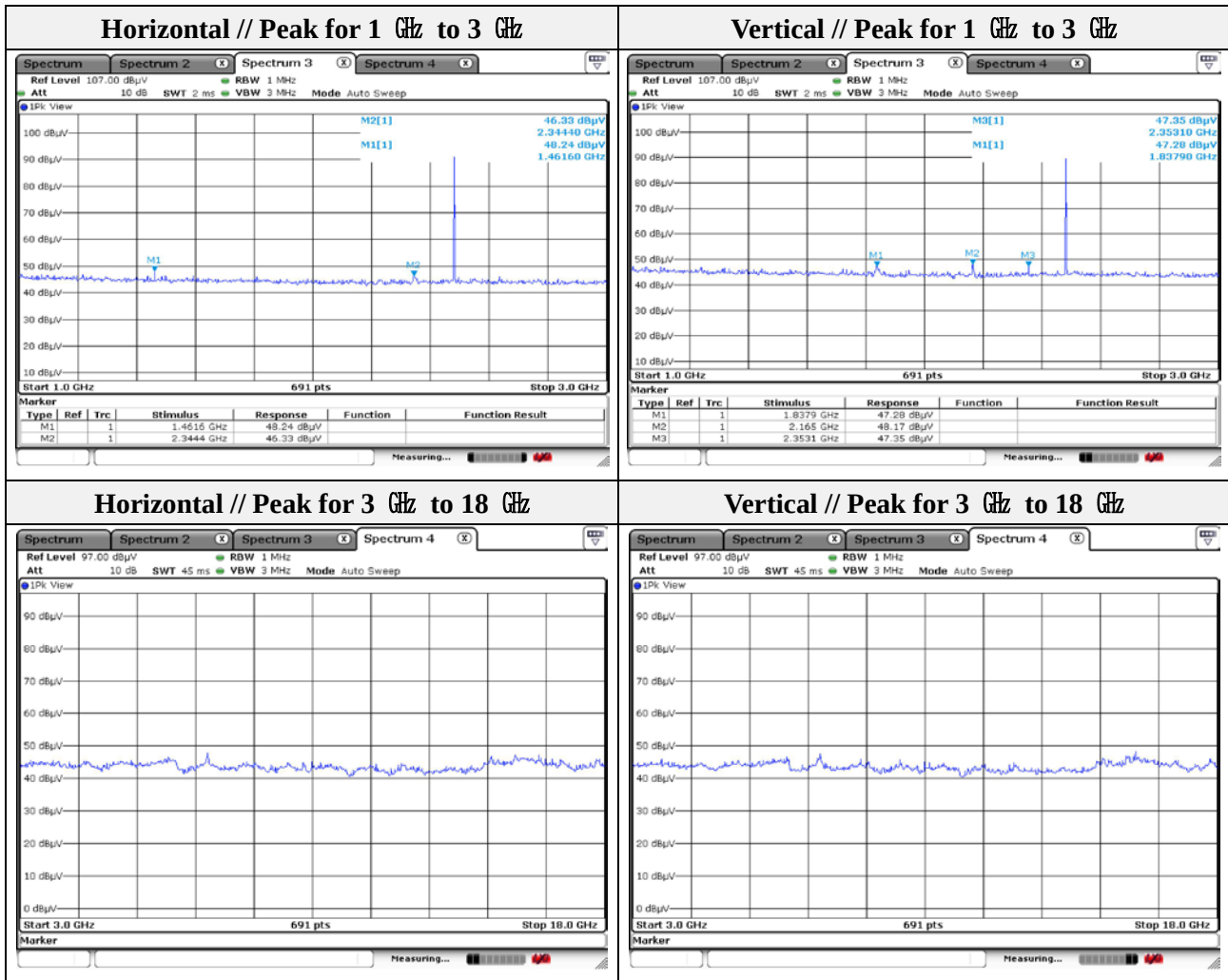
- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 461.60	48.24	Peak	H	-6.21	-	42.03	74.00	31.97
2 344.40	46.33	Peak	H	-0.31	-	46.02	74.00	27.98
1 837.90	48.28	Peak	V	-2.68	-	44.60	74.00	29.40
2 165.00	48.17	Peak	V	-0.64	-	47.53	74.00	26.47
2 353.10	47.35	Peak	V	-0.29	-	47.06	74.00	26.94

- 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)
2 494.24	45.21	Peak	H	-0.03	-	45.18	74.00	28.82
2 483.64	45.10	Peak	V	-0.05	-	45.05	74.00	28.95





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.

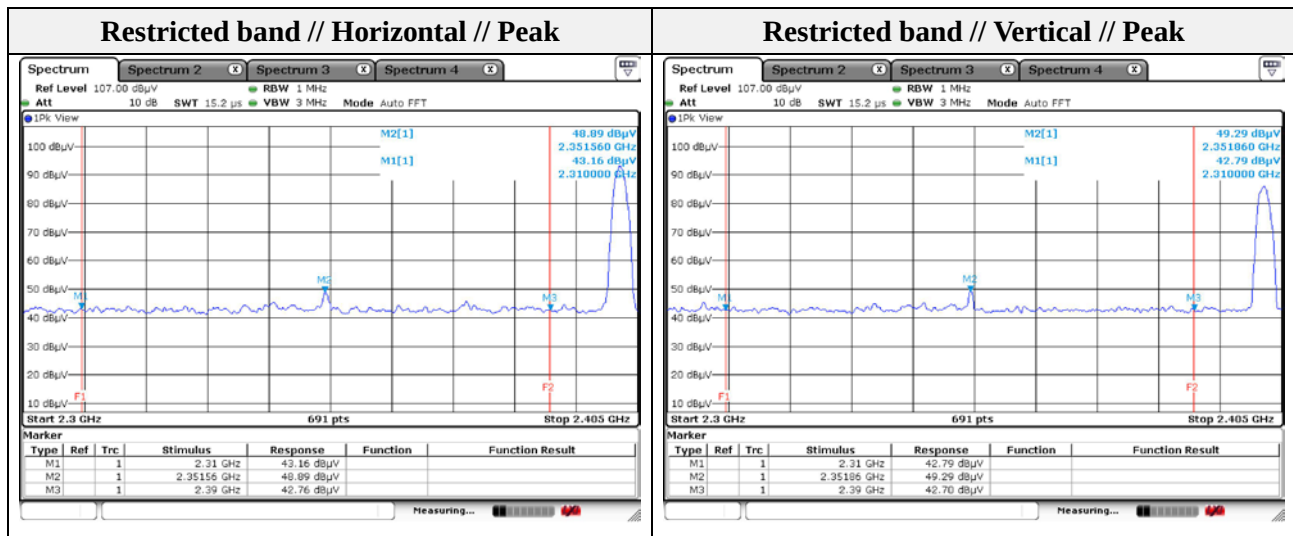
Mode: EDR
Transfer rate: 3 Mbps(Worst case)
Distance of measurement: 3 meter
Channel: 00

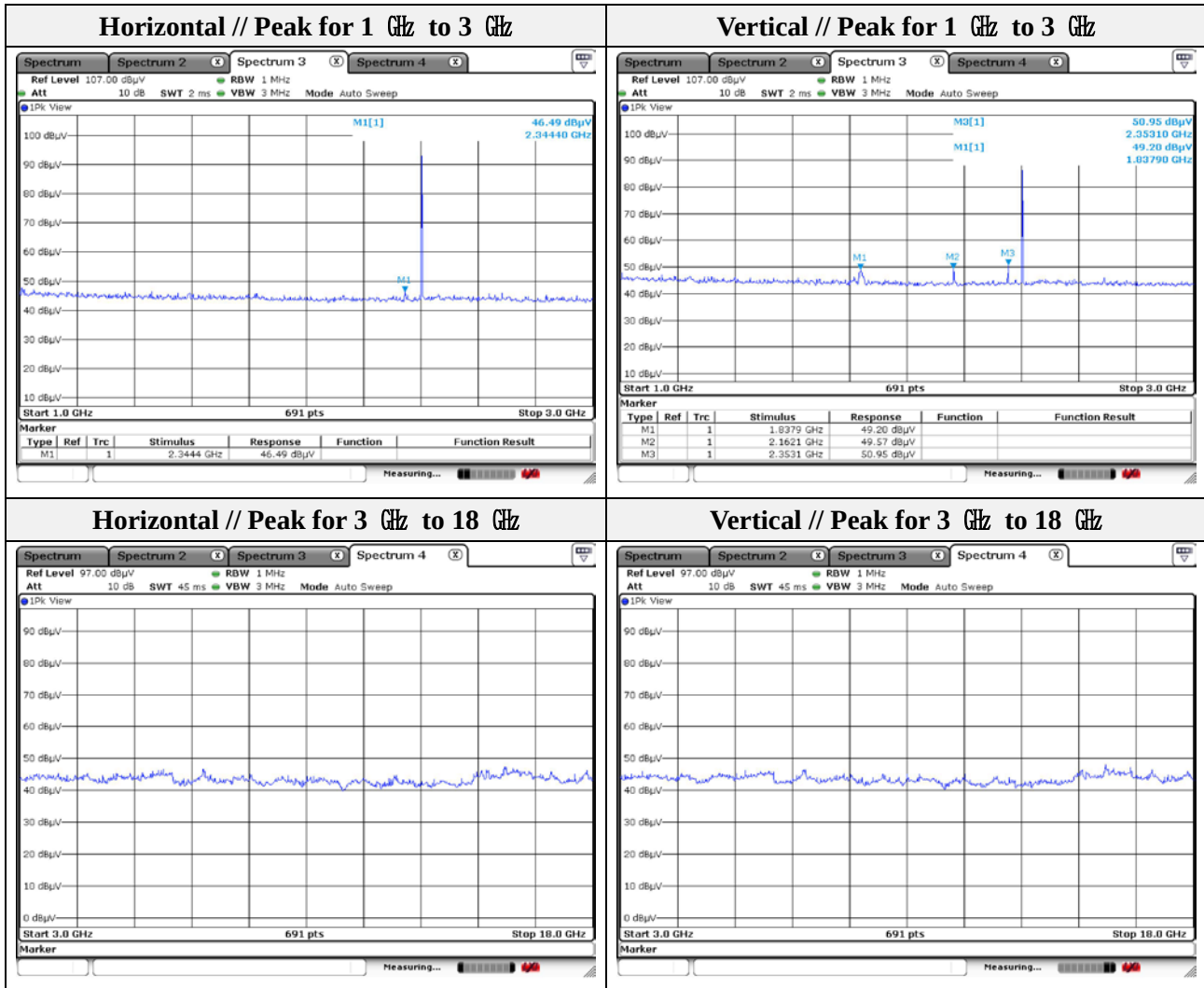
- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 344.40	46.49	Peak	H	-0.31	-	46.18	74.00	27.82
1 837.90	49.20	Peak	V	-2.68	-	46.52	74.00	27.48
2 162.10	49.57	Peak	V	-0.65	-	48.92	74.00	25.08
2 353.10	50.95	Peak	V	-0.29	-	50.66	74.00	23.34

- 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)
2 351.56	48.89	Peak	H	-0.29	-	48.60	74.00	25.40
2 351.86	49.29	Peak	V	-0.29	-	49.00	74.00	25.00





Note.

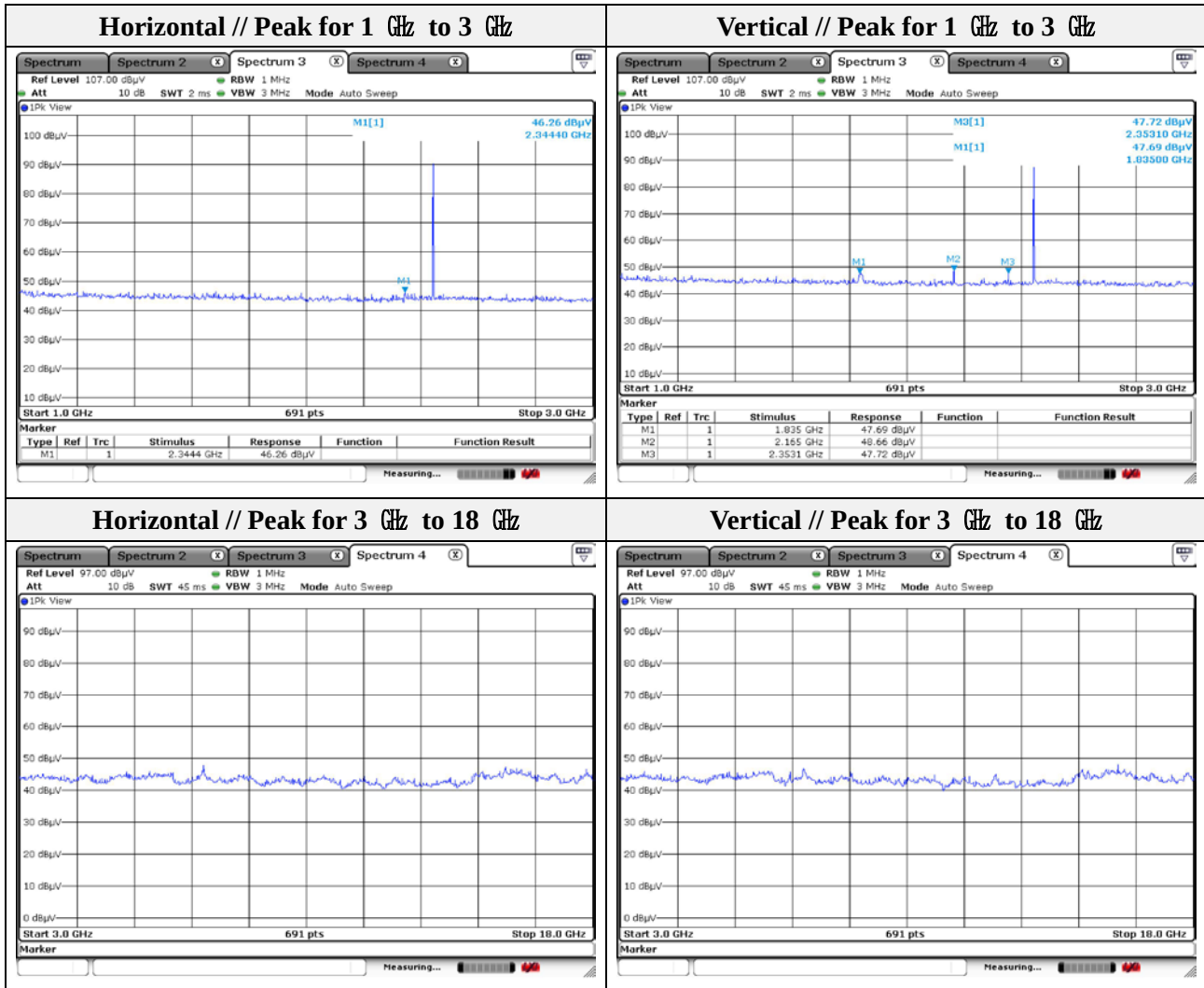
1. No spurious emission were detected above 3 GHz.
2. Average test would be performed if the peak result were greater than the average limit.



Mode: EDR
Transfer rate: 3 Mbps(Worst case)
Distance of measurement: 3 meter
Channel: 39

- **Spurious**

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 344.40	46.26	Peak	H	-0.31	-	45.95	74.00	28.05
1 835.00	47.69	Peak	V	-2.71	-	44.98	74.00	29.02
2 165.00	48.66	Peak	V	-0.64	-	48.02	74.00	25.98
2 353.10	47.72	Peak	V	-0.29	-	47.43	74.00	26.57



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.

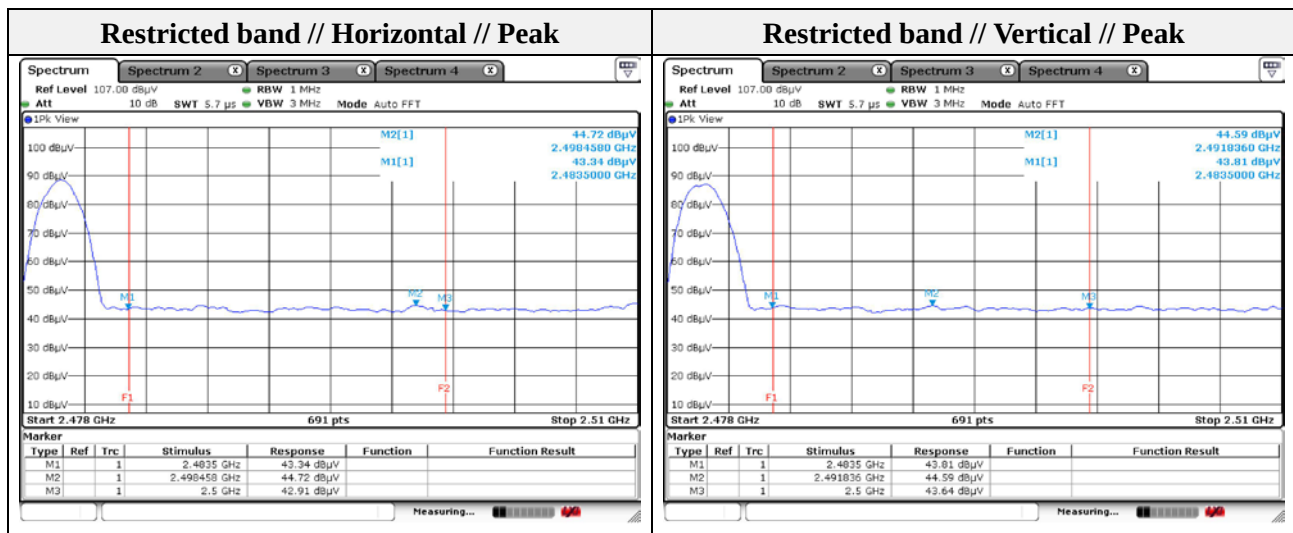
Mode: EDR
Transfer rate: 3 Mbps(Worst case)
Distance of measurement: 3 meter
Channel: 78

- **Spurious**

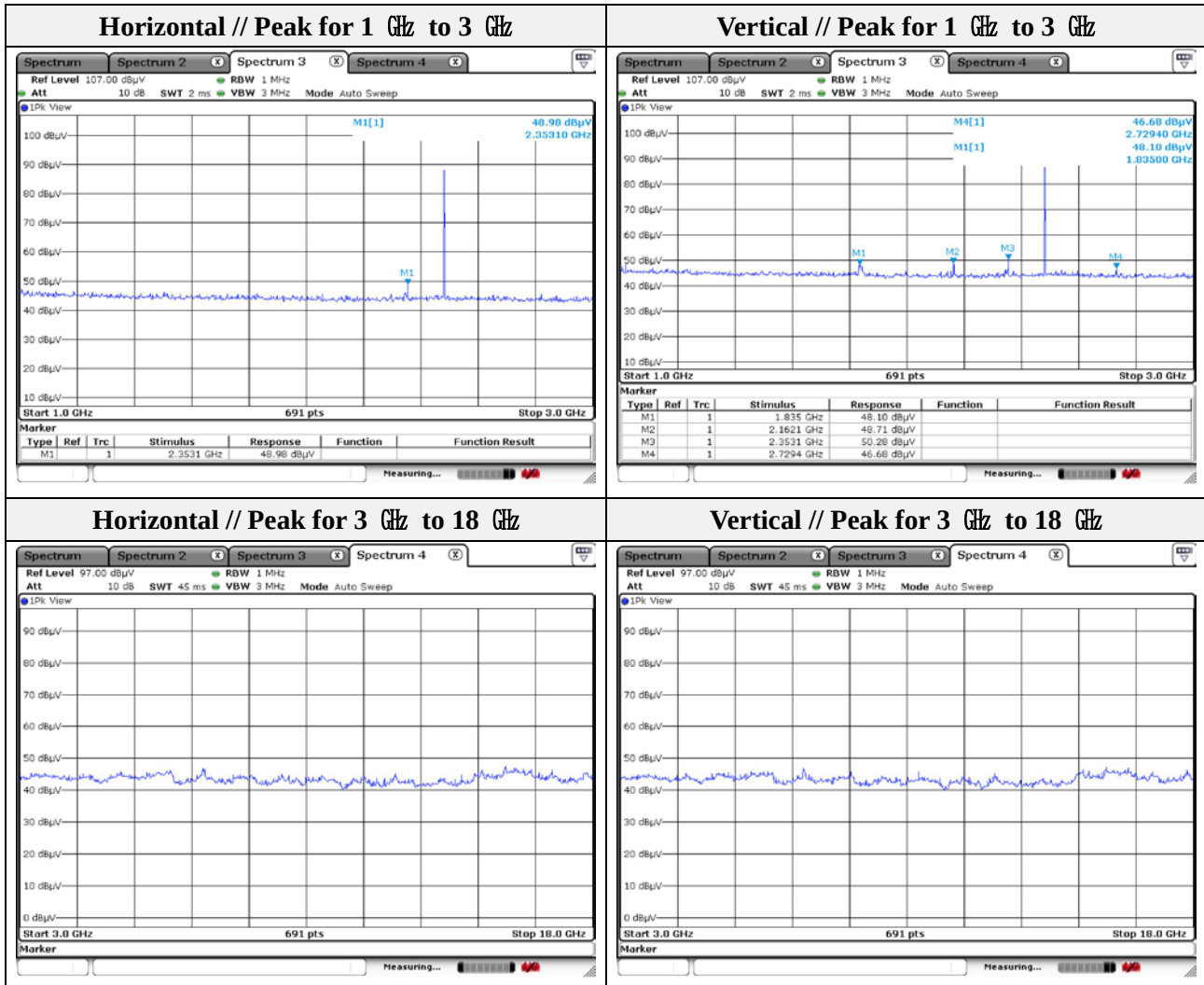
Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 353.10	48.98	Peak	H	-0.29	-	48.69	74.00	25.31
1 835.00	48.10	Peak	V	-2.71	-	45.39	74.00	28.61
2 162.10	48.71	Peak	V	-0.65	-	48.06	74.00	25.94
2 353.10	50.28	Peak	V	-0.29	-	49.99	74.00	24.01
2 729.40	46.68	Peak	V	0.82	-	47.50	74.00	26.50

- **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)
2 498.46	44.72	Peak	H	-0.02	-	44.70	74.00	29.30
2 491.84	44.59	Peak	V	-0.03	-	44.56	74.00	29.44



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.

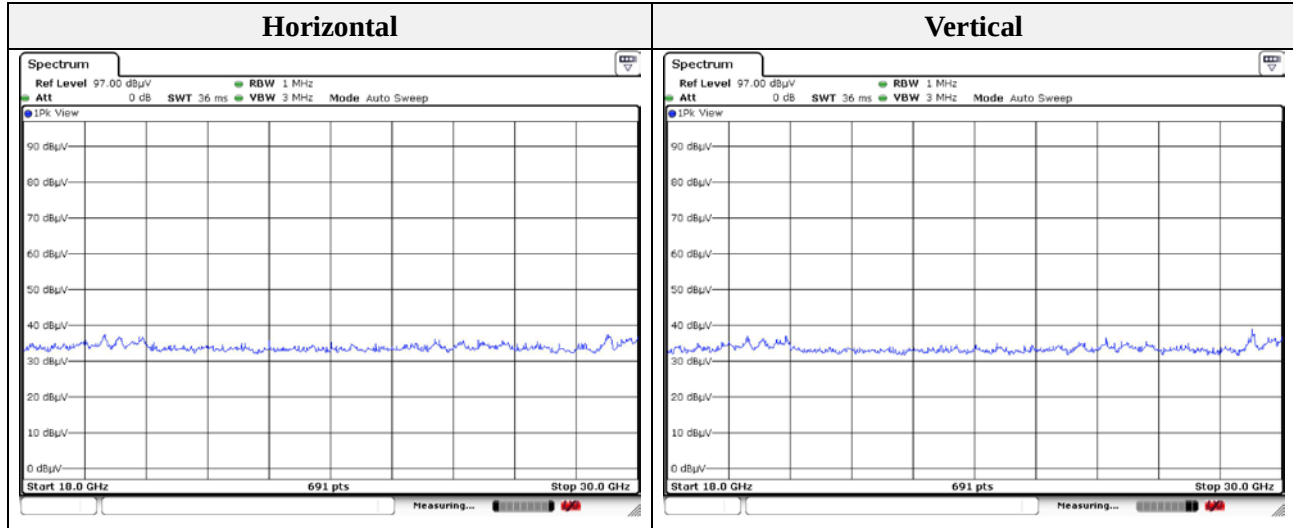


Note.

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.

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

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



Note.

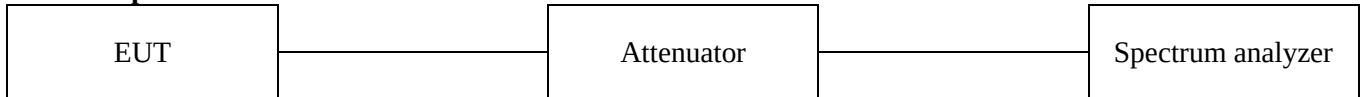
1. No spurious emission were detected above 18 GHz.

3.7. Conducted band edge and out of band emissions

Test procedure

DA 00-705

Test setup



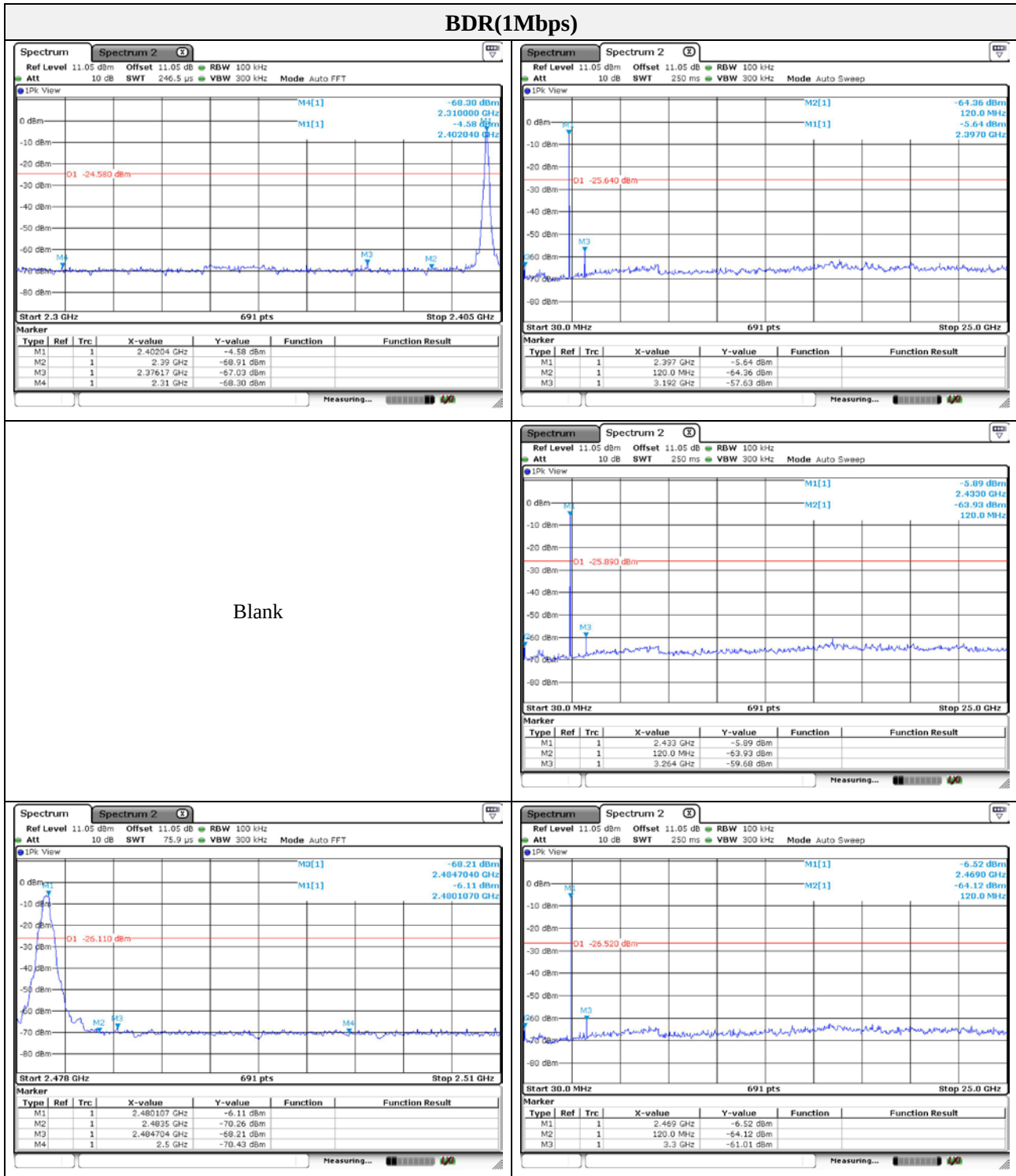
Test setting

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 $\geq 2 \times \text{Span/RBW}$
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))

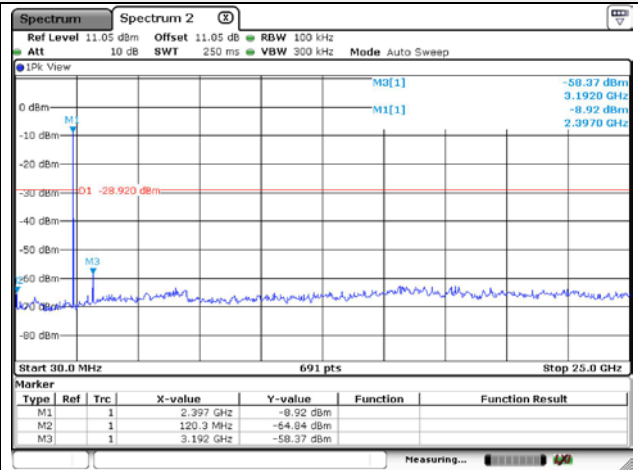
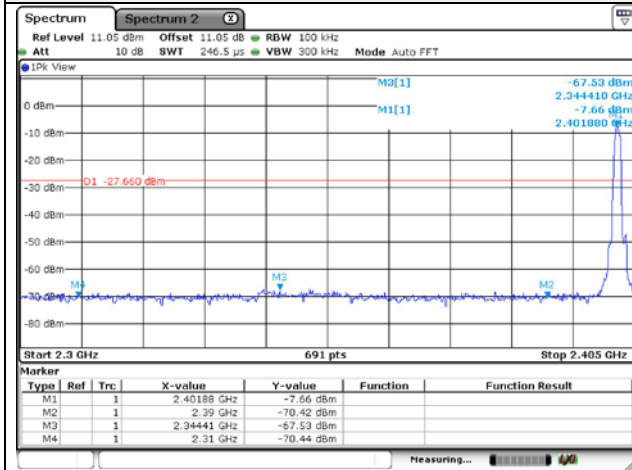
Test results



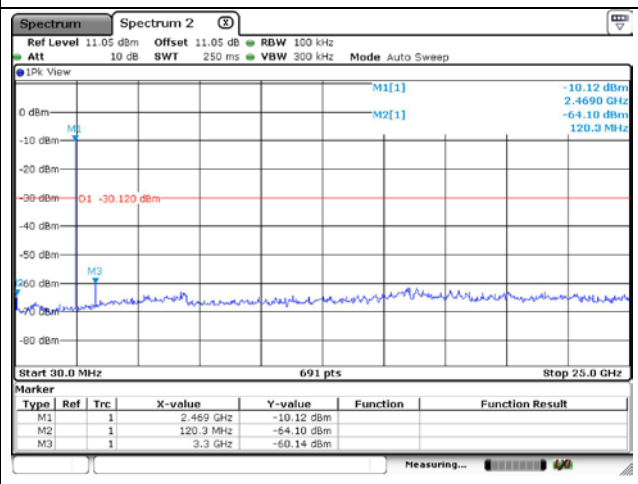
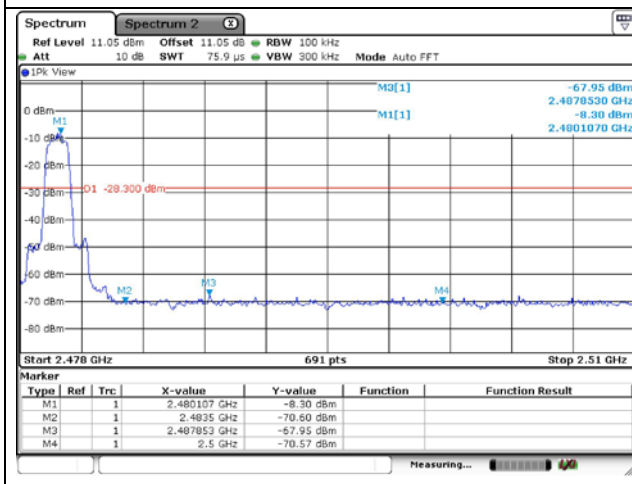
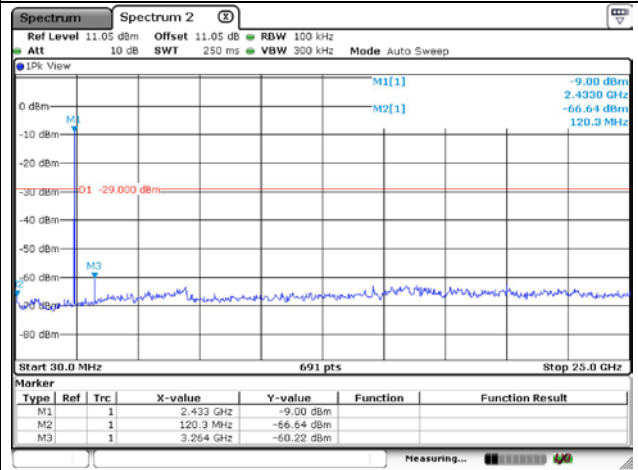
This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.



EDR(3Mbps)

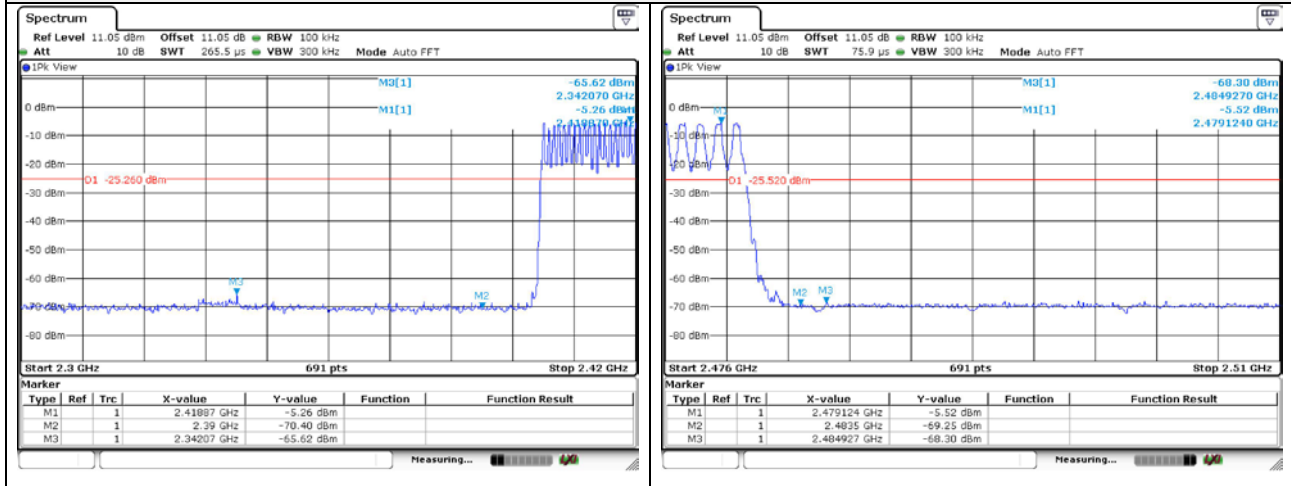


Blank

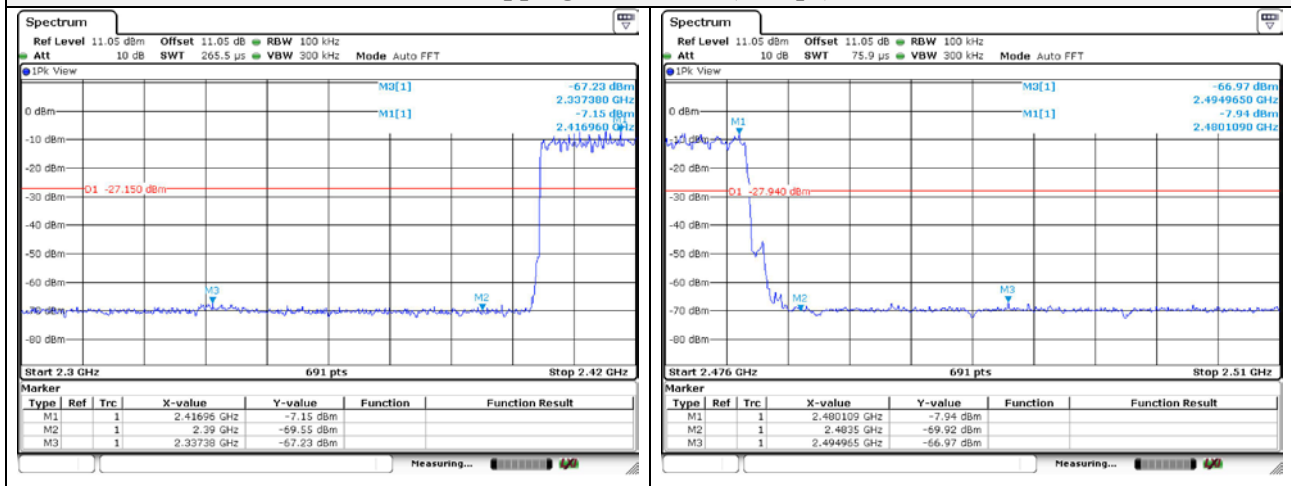


This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The results shown in this test report refer only to the sample(s) tested unless otherwise stated.

Hopping mode_BDR(1Mbps)



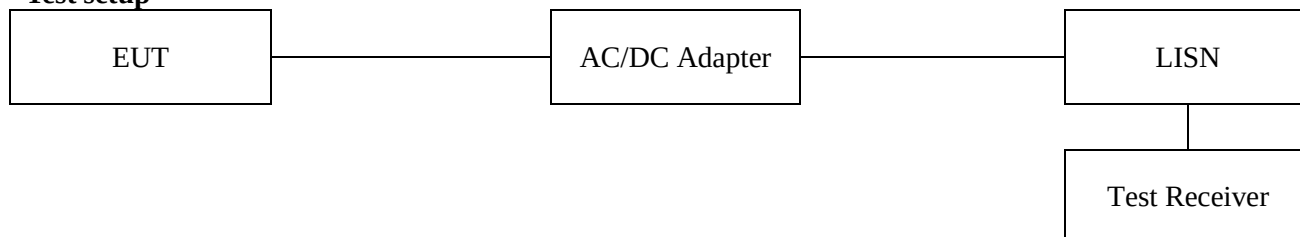
Hopping mode_EDR(3Mbps)



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.

3.8. AC conducted emissions

Test setup



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.

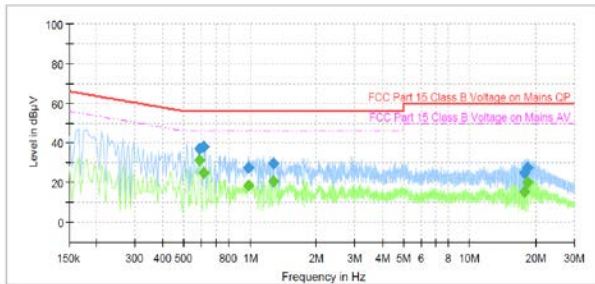
Frequency of Emission (MHz)	Conducted limit (dBμV/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

Note:

1. All AC line conducted spurious emission are measured with a receiver connected to a grounded LISN while the EUT is operating at its maximum duty cycle, at maximum power, and the appropriate frequencies. All data rates and modes were investigated for conducted spurious emission. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.
3. Both Cable loss and LISN factor are included in measurement level(QP Level or AV Level).

Test results

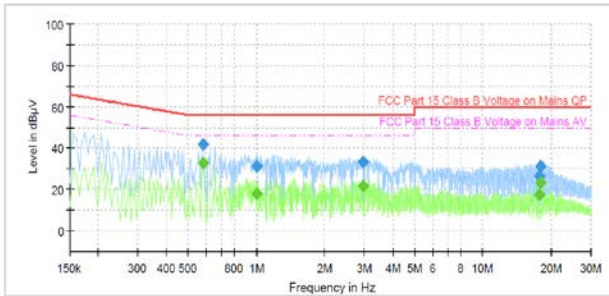
Hot Line



Final Result

Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.585000	---	31.39	46.00	14.61	1000.0	9.000	N	19.6
0.585000	37.01	---	56.00	18.99	1000.0	9.000	N	19.6
0.615000	---	25.12	46.00	20.88	1000.0	9.000	N	19.6
0.615000	37.89	---	56.00	18.11	1000.0	9.000	N	19.6
0.980000	---	18.36	46.00	27.64	1000.0	9.000	N	19.8
0.980000	27.74	---	56.00	28.26	1000.0	9.000	N	19.8
1.280000	---	20.69	46.00	25.31	1000.0	9.000	N	19.9
1.280000	29.83	---	56.00	26.17	1000.0	9.000	N	19.9
17.780000	---	15.48	50.00	34.52	1000.0	9.000	N	20.1
17.780000	24.83	---	60.00	35.17	1000.0	9.000	N	20.1
18.295000	---	20.15	50.00	29.85	1000.0	9.000	N	20.1
18.295000	27.30	---	60.00	32.70	1000.0	9.000	N	20.1

Neutral Line



Final Result

Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.580000	---	32.87	46.00	13.13	1000.0	9.000	L1	19.6
0.580000	41.84	---	56.00	14.16	1000.0	9.000	L1	19.6
1.005000	---	18.23	46.00	27.77	1000.0	9.000	L1	19.8
1.005000	31.09	---	56.00	24.91	1000.0	9.000	L1	19.8
2.970000	---	21.70	46.00	24.30	1000.0	9.000	L1	20.0
2.970000	33.58	---	56.00	22.42	1000.0	9.000	L1	20.0
17.705000	---	17.48	50.00	32.52	1000.0	9.000	L1	20.2
17.705000	26.75	---	60.00	33.25	1000.0	9.000	L1	20.2
18.005000	---	23.54	50.00	26.46	1000.0	9.000	L1	20.2
18.005000	31.43	---	60.00	28.57	1000.0	9.000	L1	20.2

Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration date	Calibration due.
Spectrum Analyzer	R&S	FSV30	101389	1 year	2017.01.23	2018.01.23
Spectrum Analyzer	R&S	FSV40	101002	1 year	2017.07.04	2018.07.04
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2017.01.23	2018.01.23
Power Meter	Anritsu	ML2495A	1438001	1 year	2017.01.23	2018.01.23
Pulse Power Sensor	Anritsu	MA2411B	1339205	1 year	2017.01.23	2018.01.23
Attenuator	Agilent	8493C	51401	1 year	2017.07.04	2018.07.04
Loop Antenna	Schwarzbeck	FMZB1513	225	2 years	2018.05.10	2019.05.10
Trilog-broadband antenna	SCHWARZBECK	VULB 9163	9168-714	2 years	2017.11.28	2018.11.28
Horn Antenna	A.H	SAS-571	414	2 years	2018.02.15	2019.02.15
Horn Antenna	SCHWARZBECK	BBHA9170	BBHA 9170550	2 years	2018.02.15	2019.02.15
High Pass Filter	Wainwright Instrument Gmbh	WHJS3000-10TT	1	1 year	2017.07.03	2018.07.03
Low Pass Filter	Wainwright Instrument Gmbh	WLK1.0/18 G-10TT	1	1 year	2017.07.03	2018.07.03
Preamplifier	R&S	SCU01	100603	1 year	2017.11.27	2018.11.27
Preamplifier	AGILENT	8449B	3008A01742	1 year	2018.01.11	2019.01.11
EMI Test Receiver	R&S	ESR3	101781	1 year	2017.04.27	2018.04.27
EMI Test Receiver	R&S	ESU26	100552	1 year	2017.04.19	2018.04.19
Pulse Limiter	R&S	ESH3-Z2	101915	1 year	2016.12.13	2017.12.13
					2017.11.27	2018.11.27
LISN	R&S	ENV216	101787	1 year	2017.01.11	2018.01.11
					2018.01.05	2019.01.15

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
-	-	-	-