



TEST REPORT

Part 15 Subpart C 15.247

Equipment under test Smart Ear
Model name DHFA2FWU
Derivative name DHFA2FBU, DHFA2FGU
FCC ID 2AOLH-DHFA2FWU
Applicant Olive Union inc
Manufacturer MOSTOP Co.,Ltd.
Date of test(s) 2019.09.02 ~ 2019.09.11
Date of issue 2019.09.27

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Revision history

Revision	Date of issue	Test report No.	Description
-	2019.09.27	KES-RF-19T0132	Initial

TABLE OF CONTENTS

1. General information	4
1.1. EUT description	4
1.2. Test configuration	5
1.3. Device modifications.....	5
1.4. Frequency/channel operations.....	5
1.5. Accessory information	5
1.6. Software and Firmware description.....	5
1.7. Information about derivative model	6
1.8. Measurement results explanation example.....	6
1.9. Measurement Uncertainty	6
2. Summary of tests.....	7
3. Test results.....	8
3.1. 20 dB bandwidth	8
3.2. Output power.....	12
3.3. Carrier frequency separation	16
3.4. Number of hopping frequency	18
3.5. Time of occupancy	20
3.6. Radiated restricted band and emissions.....	24
3.7. Conducted band edge and out of band emissions.....	44
Appendix A. Measurement equipment	48
Appendix B. Test setup photo.....	49

1. General information

Applicant: Olive Union inc
Applicant address: 15, Beobwon-ro, Seocho-gu, Seoul, Republic of Korea
Test site: KES Co., Ltd.
Test site address: 3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si,
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473-21, Gayeo-ro, Yeosu-si, Gyeonggi-do, Korea
Test Facility FCC Accreditation Designation No.: KR0100, Registration No.: 444148
FCC rule part(s): 15.247
FCC ID: 2AOLH-DHFA2FWU
Test device serial No.: ☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test Smart Ear
Frequency range **2 402 Mhz ~ 2 480 Mhz (BDR/EDR)**
2 402 Mhz ~ 2 480 Mhz (BLE)
Model DHFA2FWU
Derivative name DHFA2FBU, DHFA2FGU
Modulation technique GFSK, $\pi/4$ DQPSK, 8DPSK
Number of channels 2 402 Mhz ~ 2 480 Mhz (BDR/EDR) : 79ch (Hopping mode), 20ch(AFH mode)
2 402 Mhz ~ 2 480 Mhz (BLE) : 40ch
Antenna specification Antenna type : Chip antenna, Peak gain : 3.5 dBi
Power source DC 3.7 V (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 it 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.

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 **Olive Union inc DHFA2FWU FCC ID: 2AOLH-DHFA2FWU** was tested according to the specification of EUT, the EUT must comply with following standards and KDB documents.

FCC Part 15.247
KDB 558074 D01 v05 r02
ANSI C63.10-2013

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 Ear Charger	MOSTOP Co.,Ltd.	-	-	DC 5V

1.6. Software and Firmware description

The software and firmware installed in the EUT is version V2.0.

1.7. Information about derivative model

The difference between basic model and derivative is only color, the other circuit diagram and software are fundamentally the same.

1.8. 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.

$$\begin{aligned}\text{Offset(dB)} &= \text{RF cable loss(dB)} + \text{attenuator factor(dB)} \\ &= 1.12 + 10 = 11.12\end{aligned}$$

1.9. 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 - 25GHz	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
15.247(d)	Conducted band edge and out of band emissions	Pass
15.207(a)	AC conducted emissions	N/A ^{Note.1}

Note:

1. The device only uses battery power for operation and doesn't operate while connected for charging.

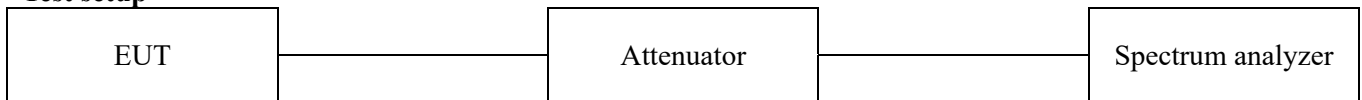
3. Test results

3.1. 20 dB bandwidth

Test procedure

ANSI C63.10-2013 clause 6.9.2 and 6.9.3

Test setup



Test setting

1. Span = The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 2.0 times and 5.0 times the OBW.
2. 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.
4. Sweep = auto
5. Detector function = peak
6. Trace mode = max hold

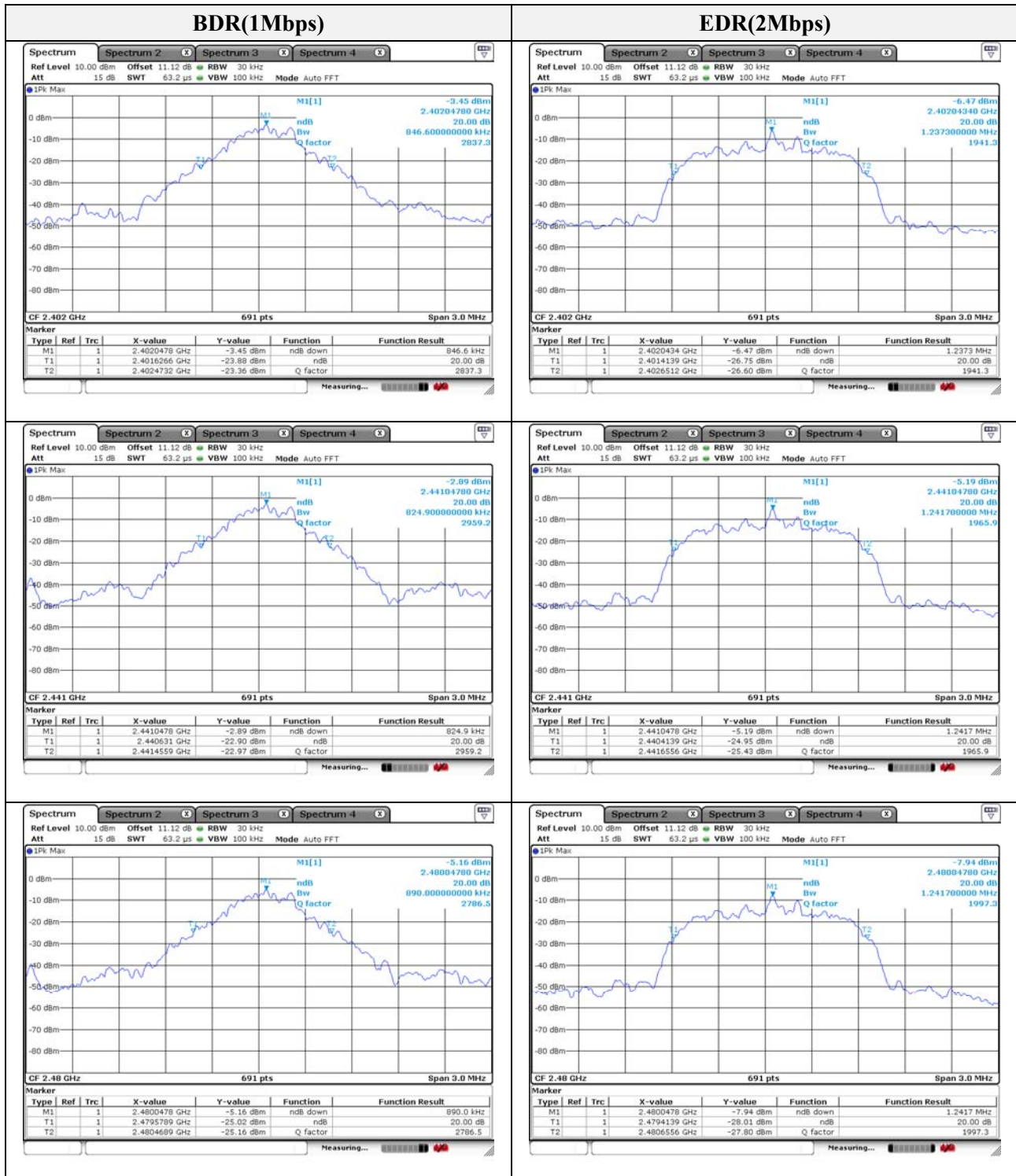
Limit

Not applicable



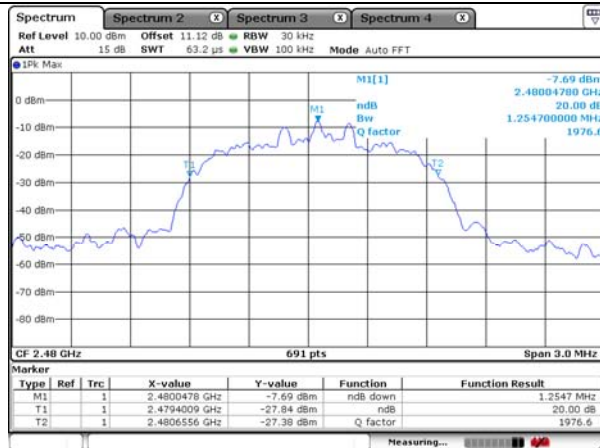
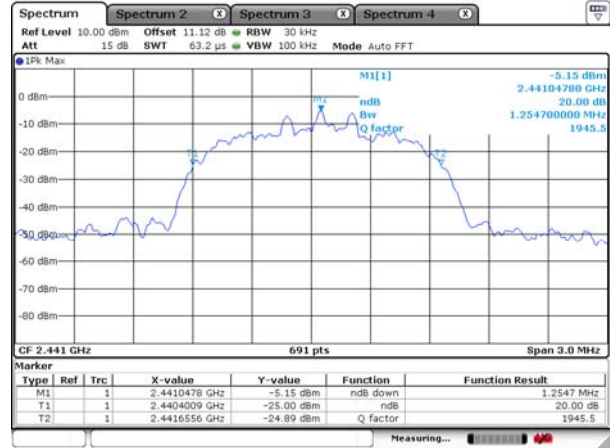
Test results

Frequency(MHz)	Channel no.	Data rate(Mbps)	Measured bandwidth(MHz)
2 402	00	1	0.847
2 441	39		0.825
2 480	78		0.890
2 402	00	2	1.237
2 441	39		1.242
2 480	78		1.242
2 402	00	3	1.259
2 441	39		1.255
2 480	78		1.255





EDR(3Mbps)



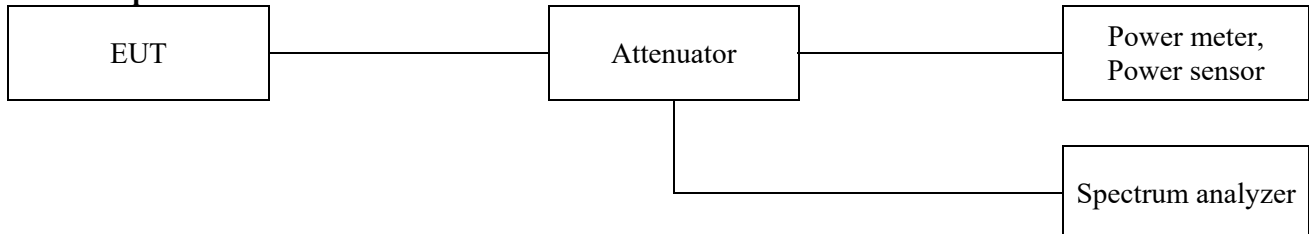
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3.2. Output power

Test procedure

ANSI C63.10-2013 - Section 7.8.5

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.

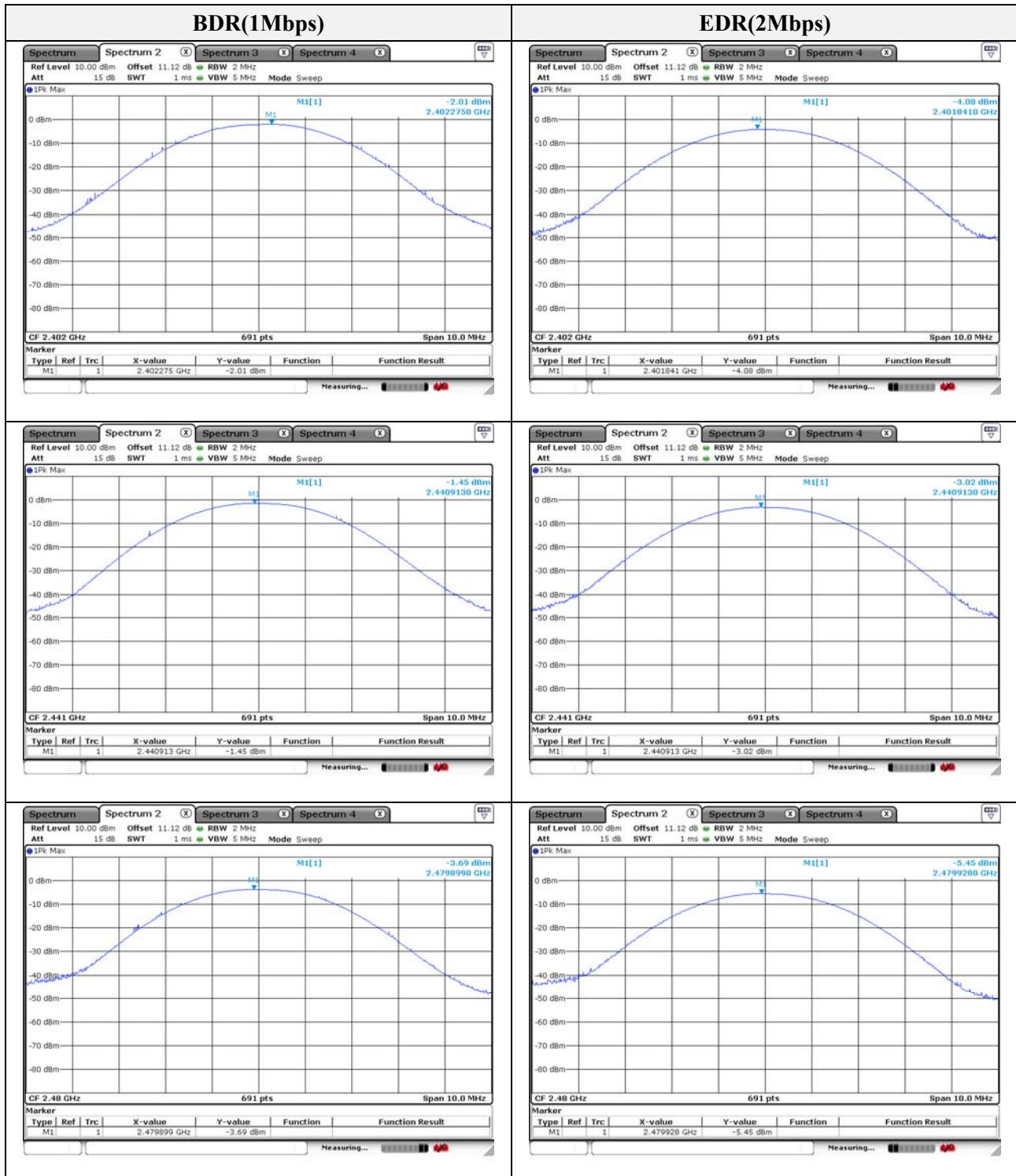


Test results

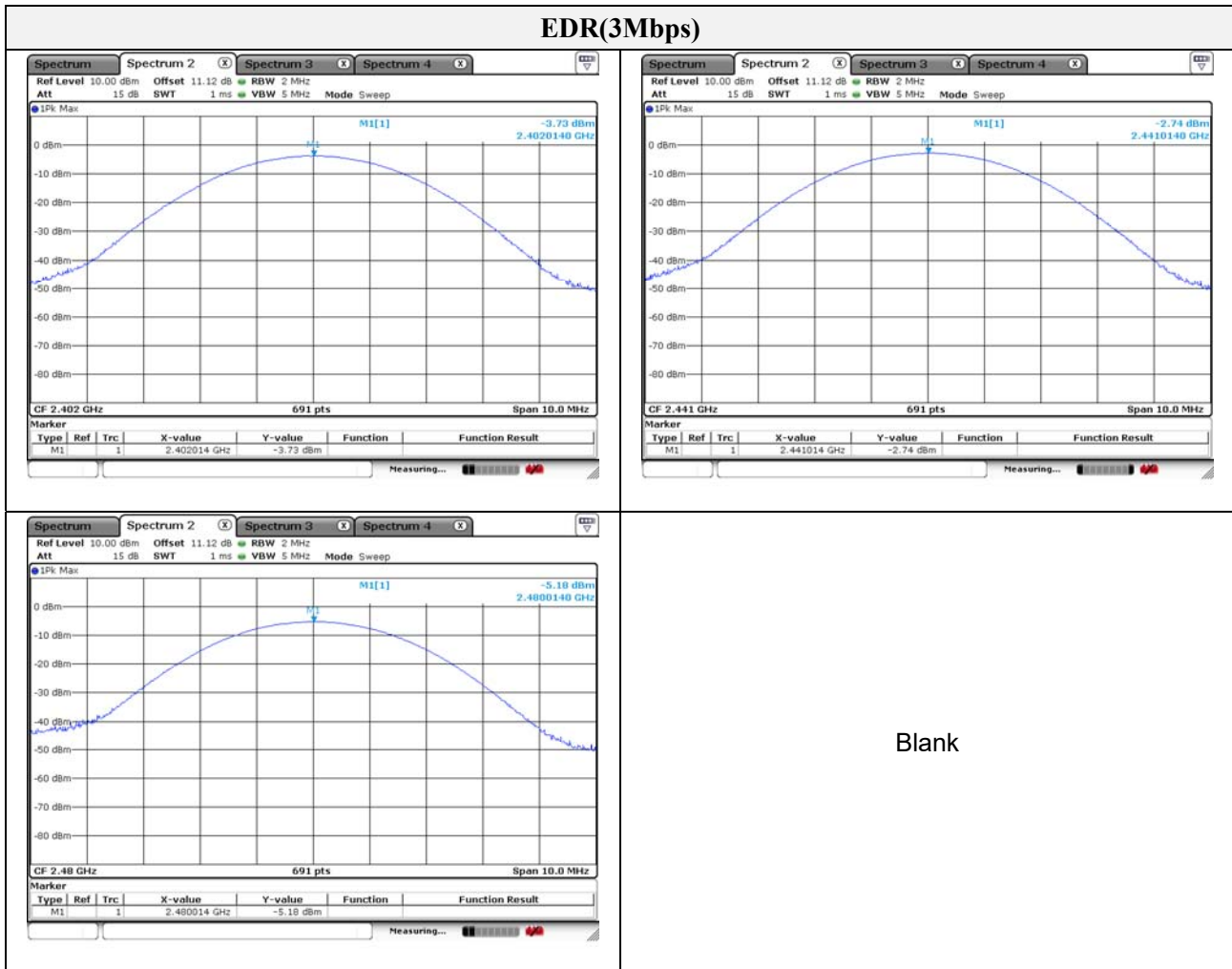
Frequency(MHz)	Channel no.	Data rate(Mbps)	Peak Power (dBm)	Average Power (dBm) ^{Note1}	Power Limit (dBm)
2 402	00	1	-2.01	-4.88	20.97
2 441	39		-1.45	-4.64	20.97
2 480	78		-3.69	-6.28	20.97
2 402	00	2	-4.08	-7.41	20.97
2 441	39		-3.02	-6.63	20.97
2 480	78		-5.45	-8.45	20.97
2 402	00	3	-3.73	-7.35	20.97
2 441	39		-2.74	-6.55	20.97
2 480	78		-5.18	-8.37	20.97

Note.

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



EDR(3Mbps)



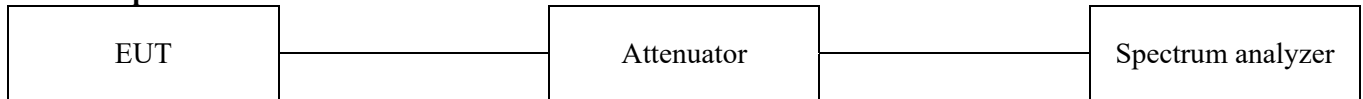
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3.3. Carrier frequency separation

Test procedure

ANSI C63.10-2013 - Section 7.8.2

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) = 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

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.

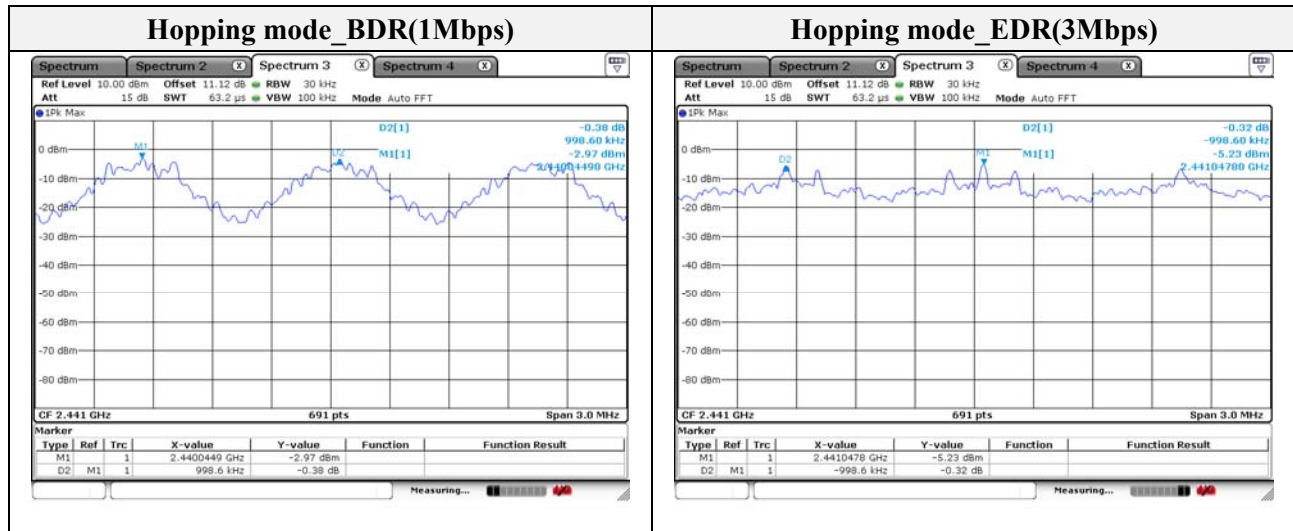
Limit

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.



Test results

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

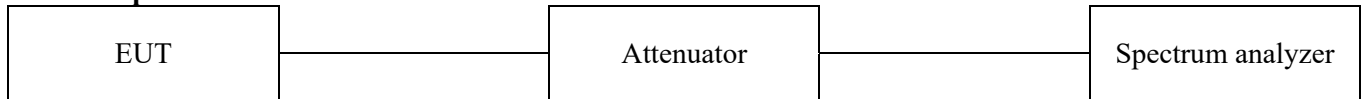


3.4. Number of hopping frequency

Test procedure

ANSI C63.10-2013 - Section 7.8.3

Test setup



Test setting

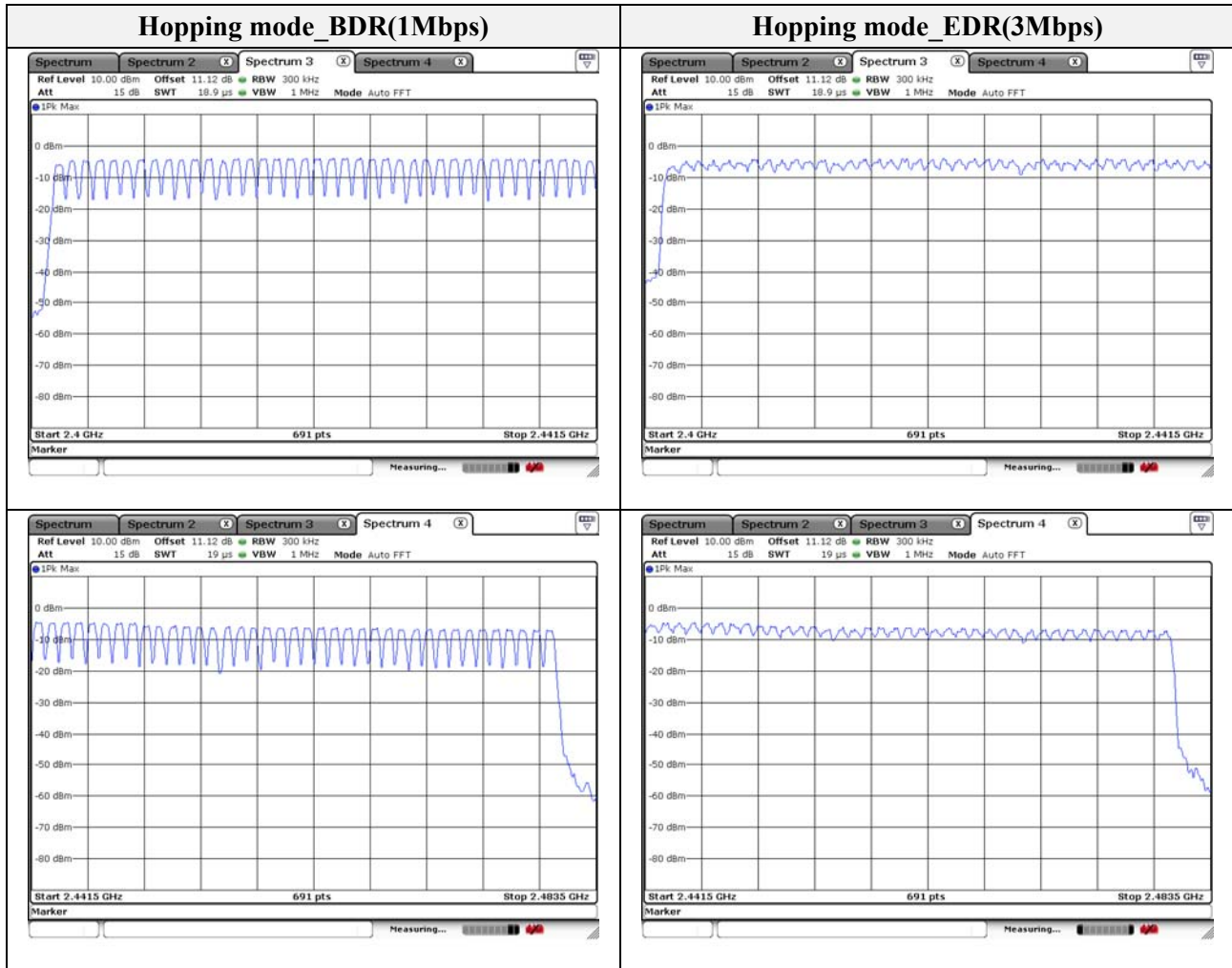
1. The EUT must have its hopping function enabled.
2. Frequency range: 2 400 MHz ~ 2 441.5 MHz, 2 441.5 MHz ~ 2 483.5 MHz
3. Span = the frequency band of operation
4. RBW = To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
5. VBW \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.

Test results



Note:

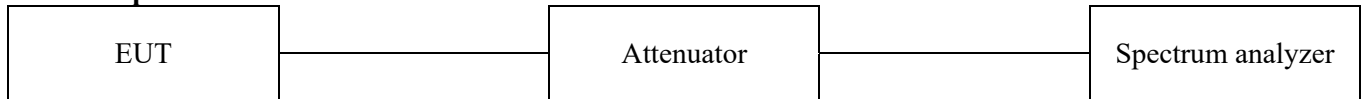
In case of AFH mode, minimum number of hopping channels is 20.

3.5. Time of occupancy

Test procedure

ANSI C63.10-2013 - Section 7.8.4

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

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

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

Test results

Packet type	Frequency (MHz)	Dwell time (ms)	Time of occupancy on the Tx channel (ms)	Limit for time of occupancy on the Tx channel (ms)
DH1	2 441	0.399	127.68	400
DH3	2 441	1.659	265.44	400
DH5	2 441	2.906	309.97	400
2-DH1	2 441	0.413	132.16	400
2-DH3	2 441	1.667	266.72	400
2-DH5	2 441	2.913	310.72	400
3-DH1	2 441	0.414	132.48	400
3-DH3	2 441	1.657	265.12	400
3-DH5	2 441	2.914	310.83	400

Note:

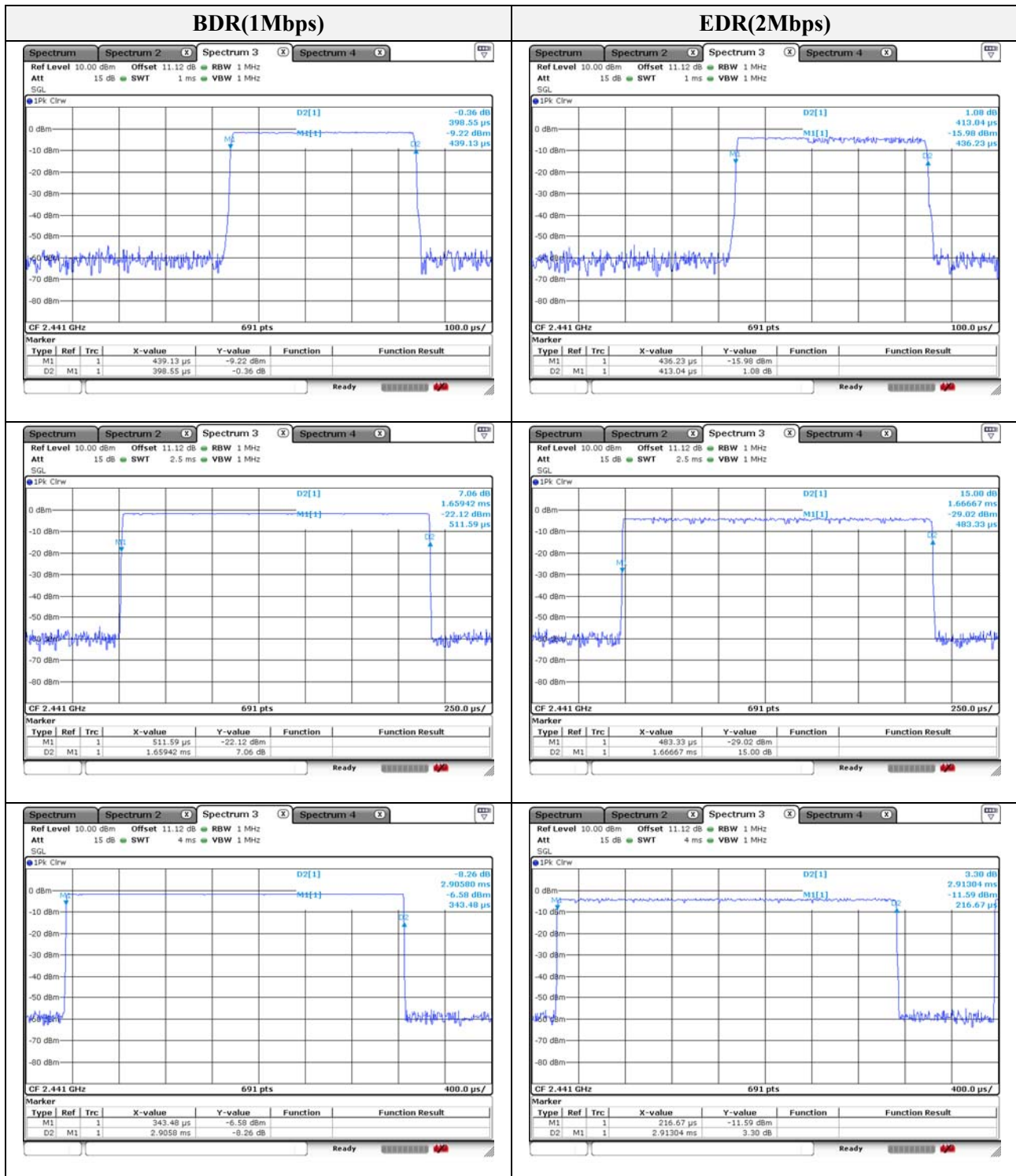
1. Normal Mode

DH1: Dwell time (ms) $\times [(1\ 600 \div 2) \div 79] \times 31.6(s) = 127.68\ (ms)$
 DH3: Dwell time (ms) $\times [(1\ 600 \div 4) \div 79] \times 31.6(s) = 265.44\ (ms)$
 DH5: Dwell time (ms) $\times [(1\ 600 \div 6) \div 79] \times 31.6(s) = 309.97\ (ms)$
 2-DH1: Dwell time (ms) $\times [(1\ 600 \div 2) \div 79] \times 31.6(s) = 132.16(ms)$
 2-DH3: Dwell time (ms) $\times [(1\ 600 \div 4) \div 79] \times 31.6(s) = 266.72\ (ms)$
 2-DH5: Dwell time (ms) $\times [(1\ 600 \div 6) \div 79] \times 31.6(s) = 310.72\ (ms)$
 3-DH1: Dwell time (ms) $\times [(1\ 600 \div 2) \div 79] \times 31.6(s) = 132.48\ (ms)$
 3-DH3: Dwell time (ms) $\times [(1\ 600 \div 4) \div 79] \times 31.6(s) = 265.12\ (ms)$
 3-DH5: Dwell time (ms) $\times [(1\ 600 \div 6) \div 79] \times 31.6(s) = 310.83\ (ms)$

2. AFH Mode

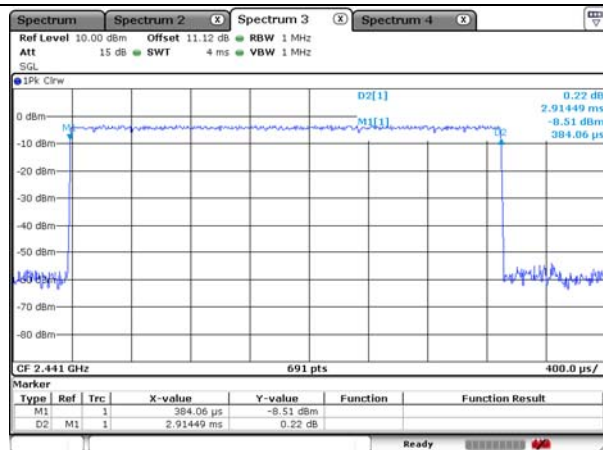
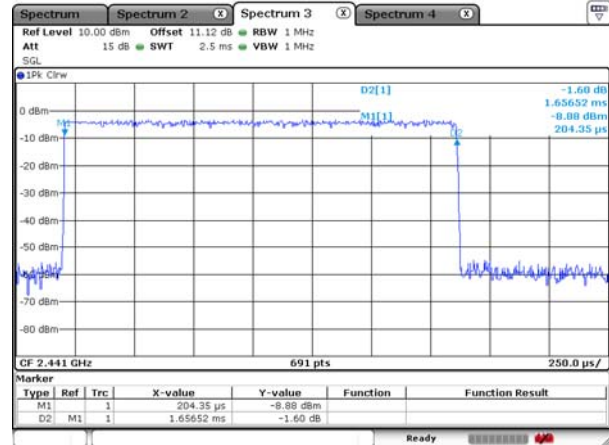
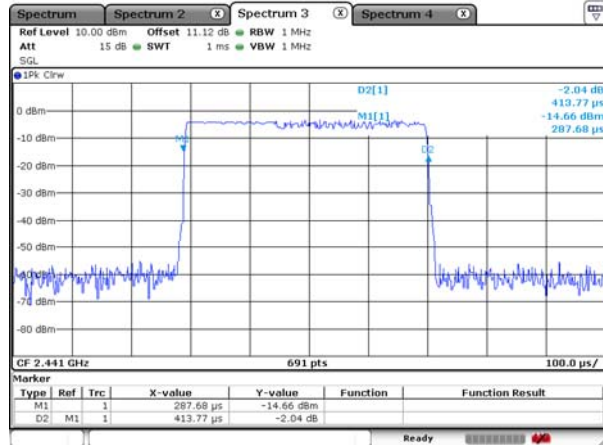
DH1: Dwell time (ms) $\times [(1\ 600 \div 2) \div 20] \times 8.0(s) = 127.68\ (ms)$
 DH3: Dwell time (ms) $\times [(1\ 600 \div 4) \div 20] \times 8.0(s) = 265.44\ (ms)$
 DH5: Dwell time (ms) $\times [(1\ 600 \div 6) \div 20] \times 8.0(s) = 309.97\ (ms)$
 2-DH1: Dwell time (ms) $\times [(1\ 600 \div 2) \div 20] \times 8.0(s) = 132.16\ (ms)$
 2-DH3: Dwell time (ms) $\times [(1\ 600 \div 4) \div 20] \times 8.0(s) = 266.72\ (ms)$
 2-DH5: Dwell time (ms) $\times [(1\ 600 \div 6) \div 20] \times 8.0(s) = 310.72\ (ms)$
 3-DH1: Dwell time (ms) $\times [(1\ 600 \div 2) \div 20] \times 8.0(s) = 132.48\ (ms)$
 3-DH3: Dwell time (ms) $\times [(1\ 600 \div 4) \div 20] \times 8.0(s) = 265.12\ (ms)$
 3-DH5: Dwell time (ms) $\times [(1\ 600 \div 6) \div 20] \times 8.0(s) = 310.83\ (ms)$

3. The dwell time was investigated with normal and AFH mode. And the dwell time of each mode is almost the same. So only data plot in normal mode is reported.





EDR(3Mbps)

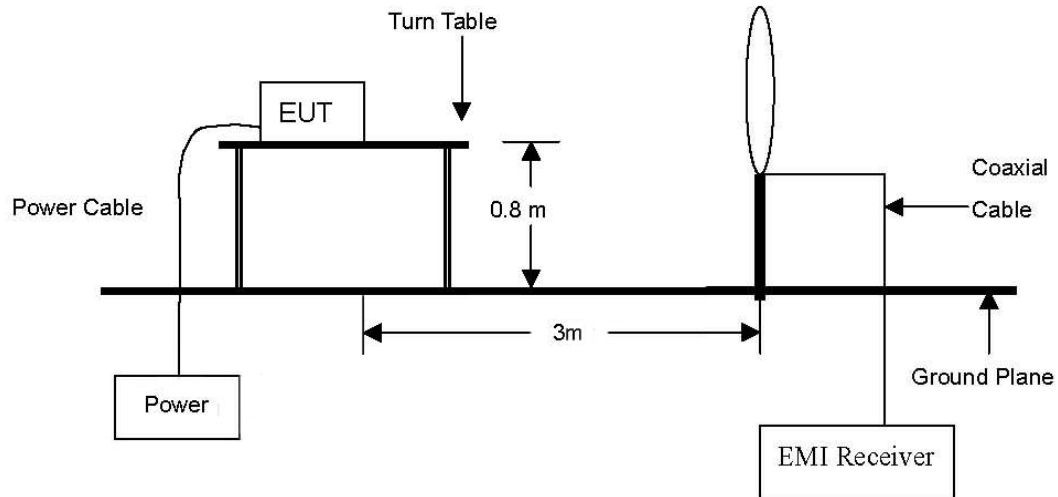


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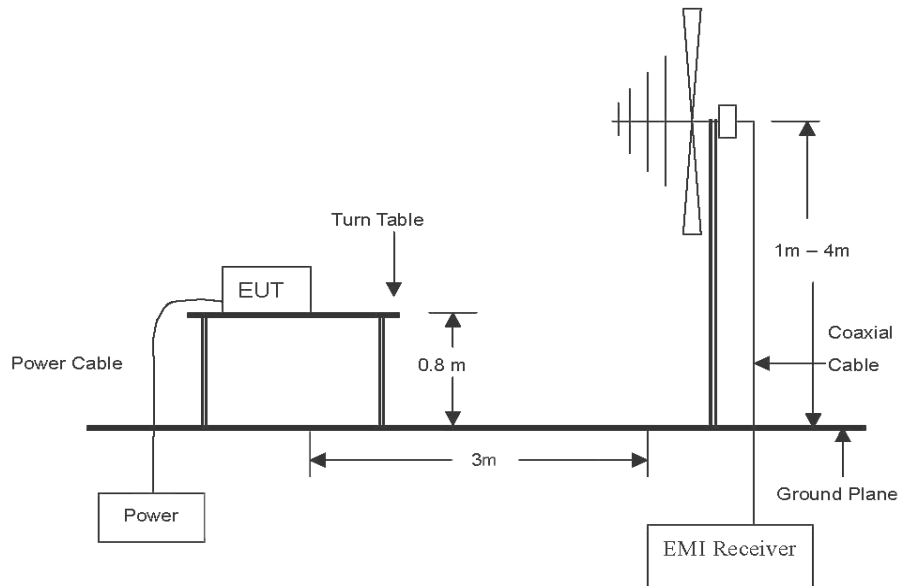
3.6. Radiated restricted band and emissions

Test setup

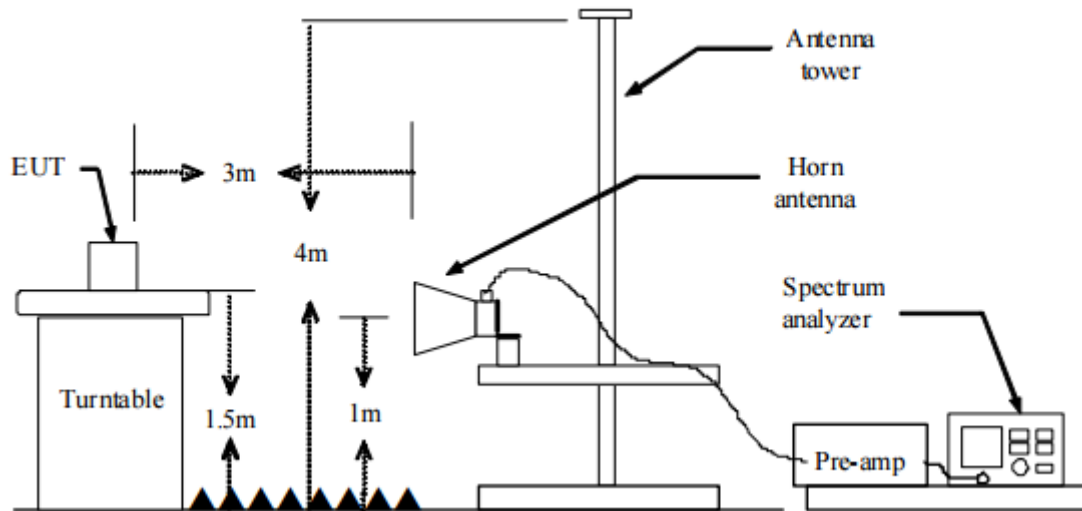
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions.



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.



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
 - Average value of pulsed emissions.
 - Unless otherwise specified, when the radiated emission limits are expressed in terms of the average value of the emission and pulsed operation is employed, the average measurement shall determined from the peak field strength after correcting for the worst-case duty cycle as described in 7.5 in ANSI 63.10-2013 & Procedure 9(b) in the KDB 558074 v05r02.
10. Duty Cycle Correction Factor (AFH with 20 channel hopping is the worst case.)
 - a. Time to cycle through all channels = $\Delta t = \tau[\text{ms}] \times 20$ channels = 58.28 ms, where τ = pulse width
 - b. $100 \text{ ms} / \Delta t[\text{ms}] = H \rightarrow$ Round up to next highest integer, $H' = 2$
 - c. Worst Case Dwell Time = $\tau[\text{ms}] \times H' = 5.828 \text{ ms}$
 - d. Duty Cycle Correction = $20\log (\text{Worst Case Dwell Time} / 100\text{ms}) \text{ dB} = -24.69 \text{ dB}$
11. Both 2Mbps & 3Mbps data rate were investigated. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

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. The loop antenna was investigated with three polarizations, and horizontal polarizations were reported as the worst case.
3. 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 $20 \log(\text{duty cycle})$ has to be used.
Duty cycle correction factor = $20 \log(\text{dwell time}/100 \text{ ms})$
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.
5. Average test would be performed if the peak result were greater than the average limit.
6. Field strength(dBμV/m) = Level(dBμV) + Correction factors(dB/m) + Cable loss(dB) + or $F_d(\text{dB})$
7. Correction factors(dB/m) = Antenna factor(dB/m) + Cable loss(dB) + or Amp. gain(dB)
8. Margin(dB) = Limit(dBμV/m) - Field strength(dBμV/m)
9. 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.
10. The worst-case emissions are reported however emissions whose levels were not within 20 dB of respective limits were not reported.
11. 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 test site, adequate comparison measurements were confirmed against 30 m open field 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.
12. $f < 30 \text{ MHz}$, 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 ($\mu V/m$)
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

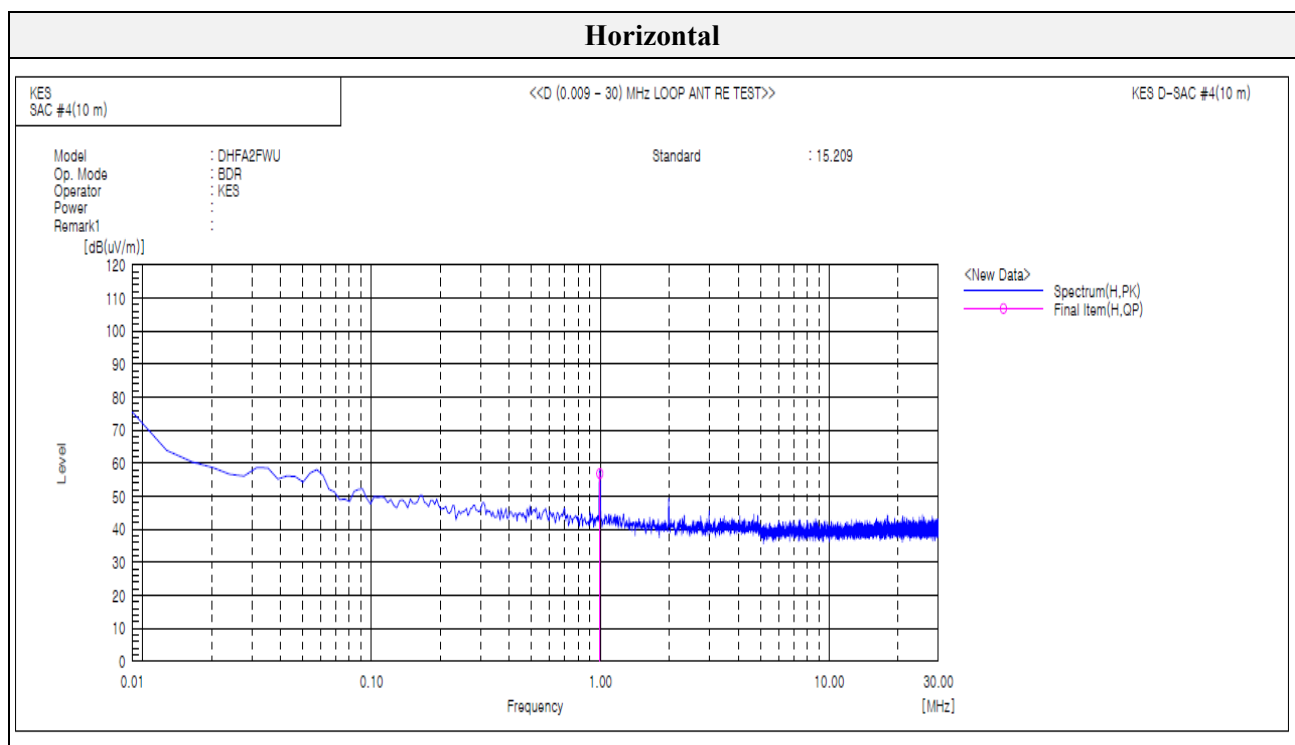
**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 ~ 72 MHz, 76 ~ 88 MHz, 174 ~ 216 MHz or 470 ~ 806 MHz. However, operation within these frequency bands is permitted under other sections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



Test results (Below 30 MHz)

Mode: BDR
Transfer rate: 1 Mbps
Distance of measurement: 3 meter
Channel: 39(Worst case)

Frequency (MHz)	Level (dB μ V)	Ant. Pol. (H/V)	CF (dB)	Distance factor (dB)	Field strength (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
0.995	36.40	H	20.50	-40.00	16.90	27.64	10.74



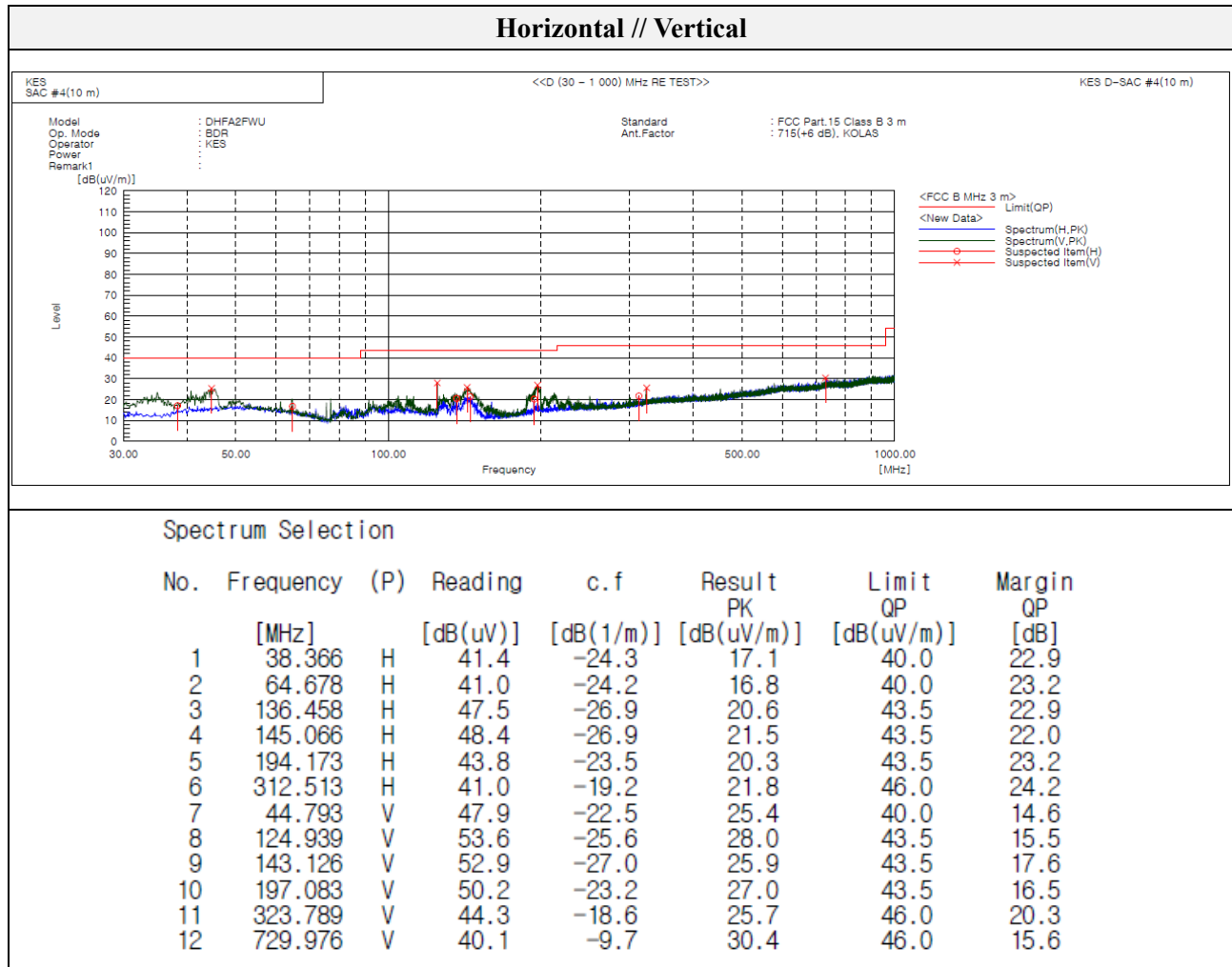
Test results (Below 1 000 MHz) – Worst case

Mode: BDR

Transfer rate: 1 Mbps

Distance of measurement: 3 meter

Channel: 39(Worst case)



Test results (Above 1 000 MHz)

Mode: BDR

Transfer rate: 1 Mbps

Distance of measurement: 3 meter

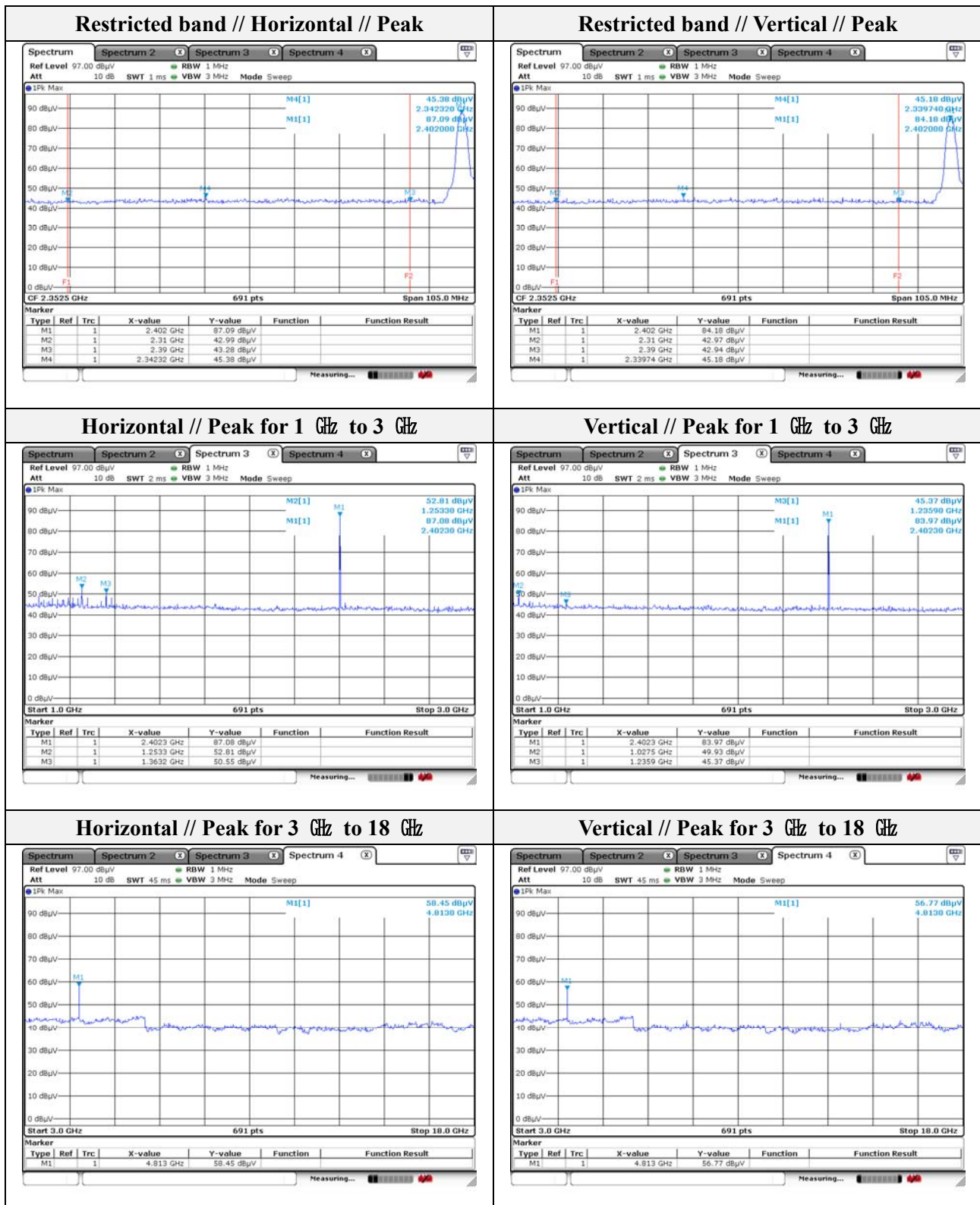
Channel: 00

- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 253.30	52.81	Peak	H	-6.61	-	46.20	74.00	27.80
1 363.20	50.55	Peak	H	-6.13	-	44.42	74.00	29.58
4 813.00	58.45	Peak	H	7.93	-	66.38	74.00	7.62
4 813.00	58.45	Average	H	7.93	-24.69	41.69	54.00	12.31
1 027.50	49.93	Peak	V	-8.19	-	41.74	74.00	32.26
1 235.90	45.37	Peak	V	-6.76	-	38.61	74.00	35.39
4 813.00	56.77	Peak	V	7.93	-	64.70	74.00	9.30
4 813.00	56.77	Average	V	7.93	-24.69	40.01	54.00	13.99

- 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)
2 342.32	45.38	Peak	H	-1.41	-	43.97	74.00	30.03
2 339.74	45.18	Peak	V	-1.45	-	43.73	74.00	30.27



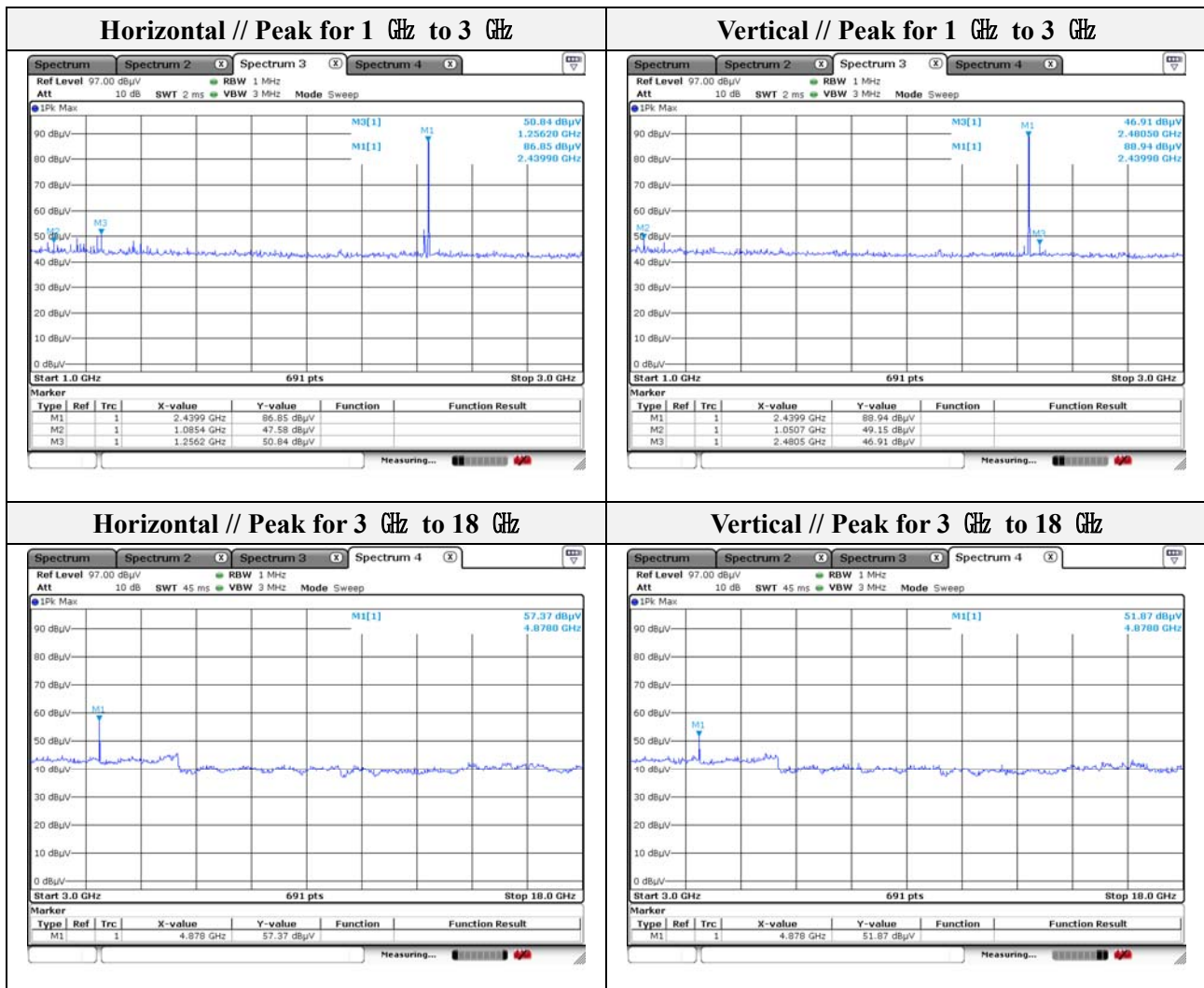
Note.

1. 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)
1 085.40	47.58	Peak	H	-7.81	-	39.77	74.00	34.23
1 256.20	50.84	Peak	H	-6.59	-	44.25	74.00	29.75
4 878.00	57.37	Peak	H	7.99	-	65.36	74.00	8.64
4 878.00	57.37	Average	H	7.99	-24.69	40.67	54.00	13.33
1 050.70	49.15	Peak	V	-8.09	-	41.06	74.00	32.94
2 480.50	46.91	Peak	V	0.53	-	47.44	74.00	26.56
4 878.00	51.87	Peak	V	7.99	-	59.86	74.00	14.14
4 878.00	51.87	Average	V	7.99	-24.69	35.17	54.00	18.83



Note.

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



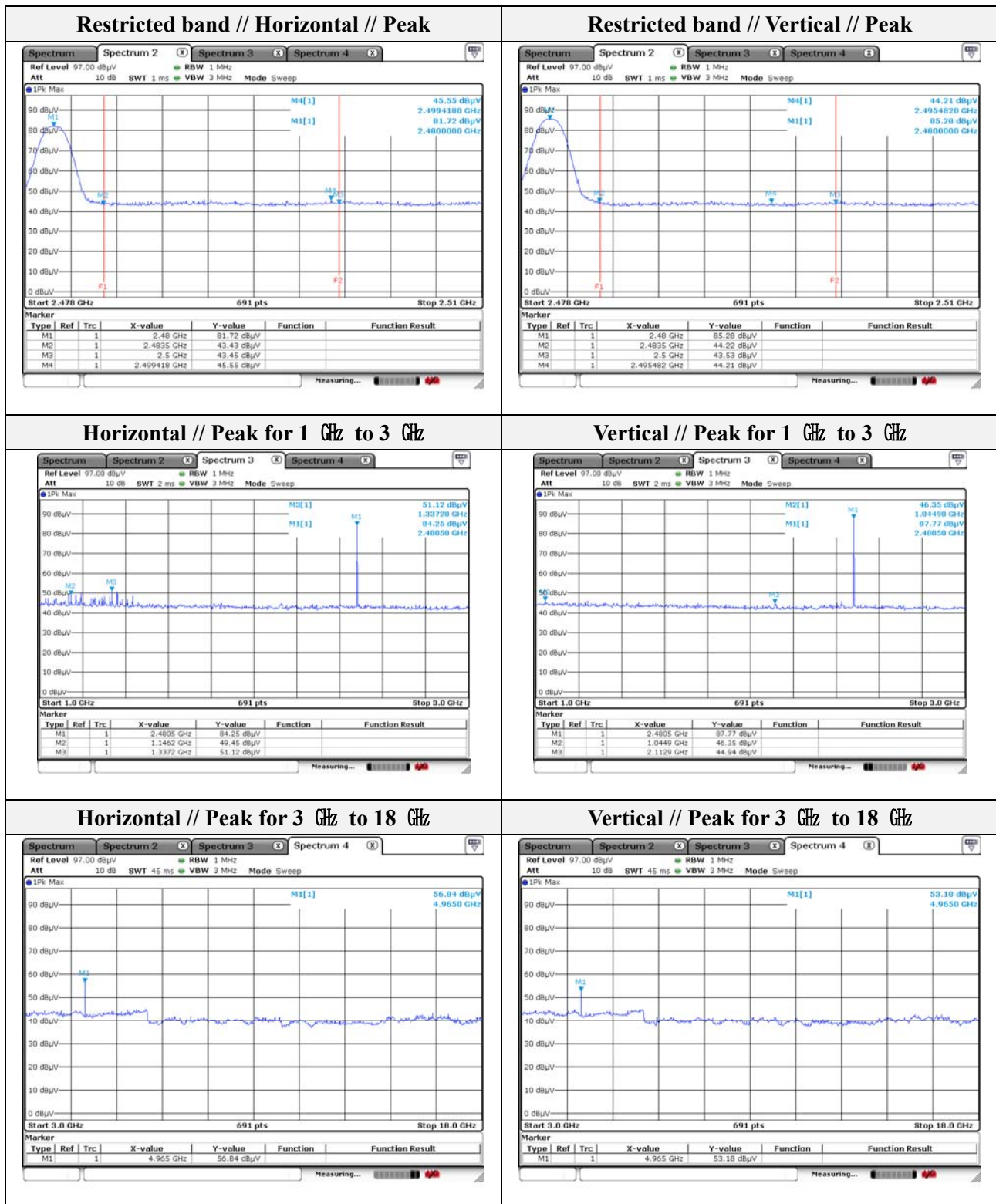
Mode: BDR
Transfer rate: 1 Mbps
Distance of measurement: 3 meter
Channel: 78

- **Spurious**

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 146.20	49.45	Peak	H	-7.50	-	41.95	74.00	32.05
1 337.20	51.12	Peak	H	-6.26	-	44.86	74.00	29.14
4 965.00	56.84	Peak	H	8.34	-	65.18	74.00	8.82
4 965.00	56.84	Average	H	8.34	-24.69	40.49	54.00	13.51
1 044.90	46.35	Peak	V	-8.12	-	38.23	74.00	35.77
2 112.90	44.94	Peak	V	-4.08	-	40.86	74.00	33.14
4 965.00	53.18	Peak	V	8.34	-	61.52	74.00	12.48
4 965.00	53.18	Average	V	8.34	-24.69	36.83	54.00	17.17

- **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)
2 499.42	45.55	Peak	H	0.83	-	46.38	74.00	27.62
2 483.50	44.22	Peak	V	0.58	-	44.80	74.00	29.20



Note.

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



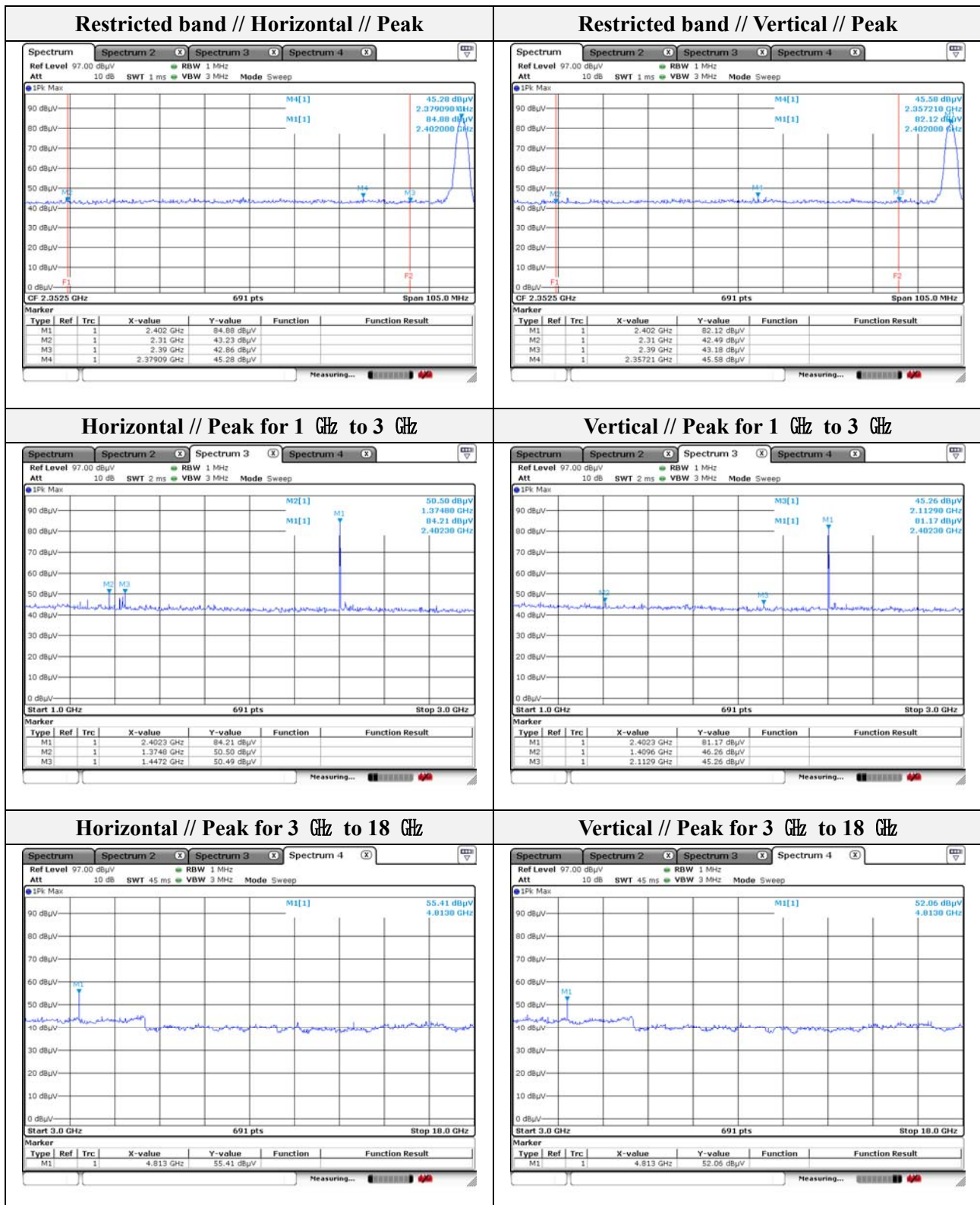
Mode: EDR
Transfer rate: 3 Mbps(Worst case)
Distance of measurement: 3 meter
Channel: 00

- **Spurious**

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 374.80	50.50	Peak	H	-6.02	-	44.48	74.00	29.52
1 447.20	50.49	Peak	H	-5.52	-	44.97	74.00	29.03
4 813.00	55.41	Peak	H	7.93	-	63.34	74.00	10.66
4 813.00	55.41	Average	H	7.93	-24.69	38.65	54.00	15.35
1 409.60	46.26	Peak	V	-5.74	-	40.52	74.00	33.48
2 112.90	45.26	Peak	V	-4.08	-	41.18	74.00	32.82
4 813.00	52.06	Peak	V	7.93	-	59.99	74.00	14.01
4 813.00	52.06	Average	V	7.93	-24.69	35.30	54.00	18.70

- **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)
2 379.09	45.28	Peak	H	-0.92	-	44.36	74.00	29.64
2 357.21	45.58	Peak	V	-1.21	-	44.37	74.00	29.63



Note.

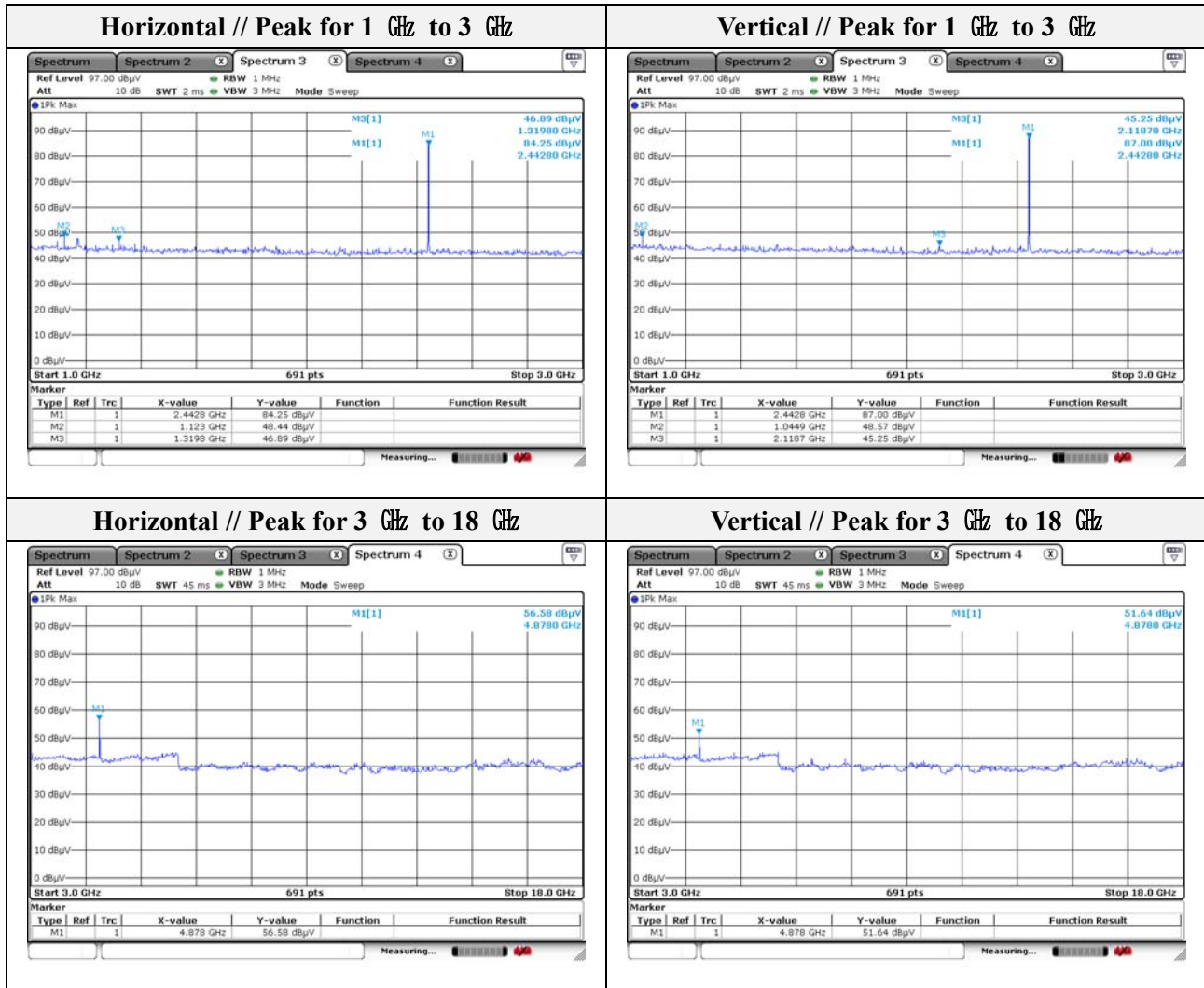
1. Average test would be performed if the peak result were greater than the average limit.



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)
1 123.00	48.44	Peak	H	-7.60	-	40.84	74.00	33.16
1 319.80	46.89	Peak	H	-6.27	-	40.62	74.00	33.38
4 878.00	56.58	Peak	H	7.99	-	64.57	74.00	9.43
4 878.00	56.58	Average	H	7.99	-24.69	39.88	54.00	14.12
1 044.90	48.57	Peak	V	-8.12	-	40.45	74.00	33.55
2 118.70	45.25	Peak	V	-4.03	-	41.22	74.00	32.78
4 878.00	51.64	Peak	V	7.99	-	59.63	74.00	14.37
4 878.00	51.64	Average	V	7.99	-24.69	34.94	54.00	19.06



Note.

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



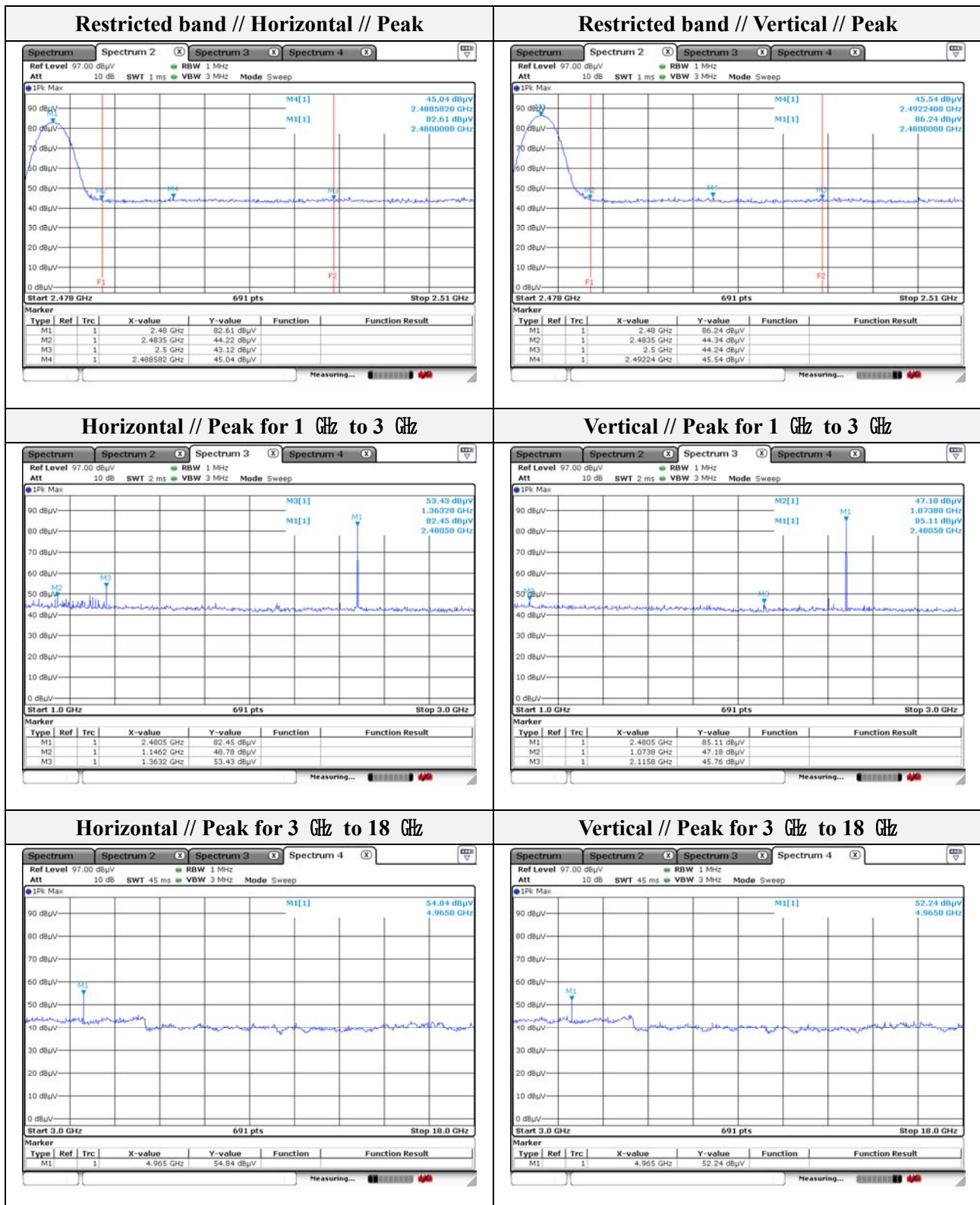
Mode: EDR
Transfer rate: 3 Mbps(Worst case)
Distance of measurement: 3 meter
Channel: 78

- **Spurious**

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1 146.20	48.78	Peak	H	-7.50	-	41.28	74.00	32.72
1 363.20	53.43	Peak	H	-6.13	-	47.30	74.00	26.70
4 965.00	54.84	Peak	H	8.34	-	63.18	74.00	10.82
4 965.00	54.84	Average	H	8.34	-24.69	38.49	54.00	15.51
1 073.80	47.18	Peak	V	-7.90	-	39.28	74.00	34.72
2 115.80	45.76	Peak	V	-4.05	-	41.71	74.00	32.29
4 965.00	52.24	Peak	V	8.34	-	60.58	74.00	13.42
4 965.00	52.24	Average	V	8.34	-24.69	35.89	54.00	18.11

- **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)
2 488.58	45.04	Peak	H	0.66	-	45.70	74.00	28.30
2 492.24	45.54	Peak	V	0.72	-	46.26	74.00	27.74

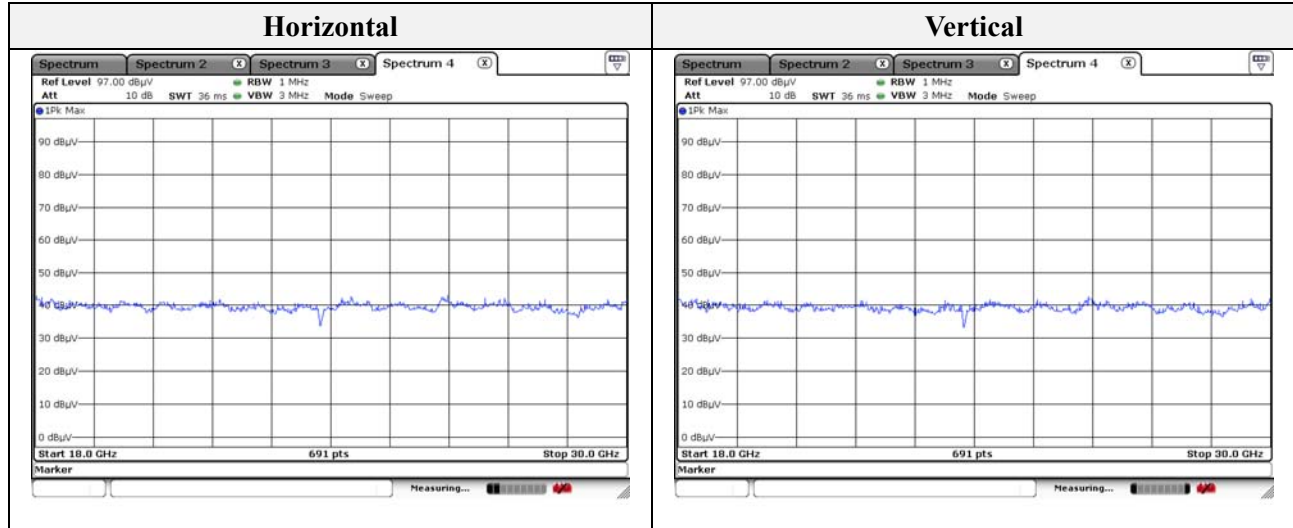


Note.

1. 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: BDR
Transfer rate: 1 Mbps
Distance of measurement: 3 meter
Channel: 39(Worst case)



Note.

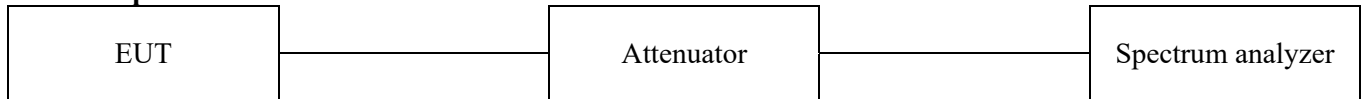
1. No spurious emission were detected above 18 GHz.

3.7. Conducted band edge and out of band emissions

Test procedure

ANSI C63.10-2013 - Section 7.8.4 and 7.8.8

Test setup



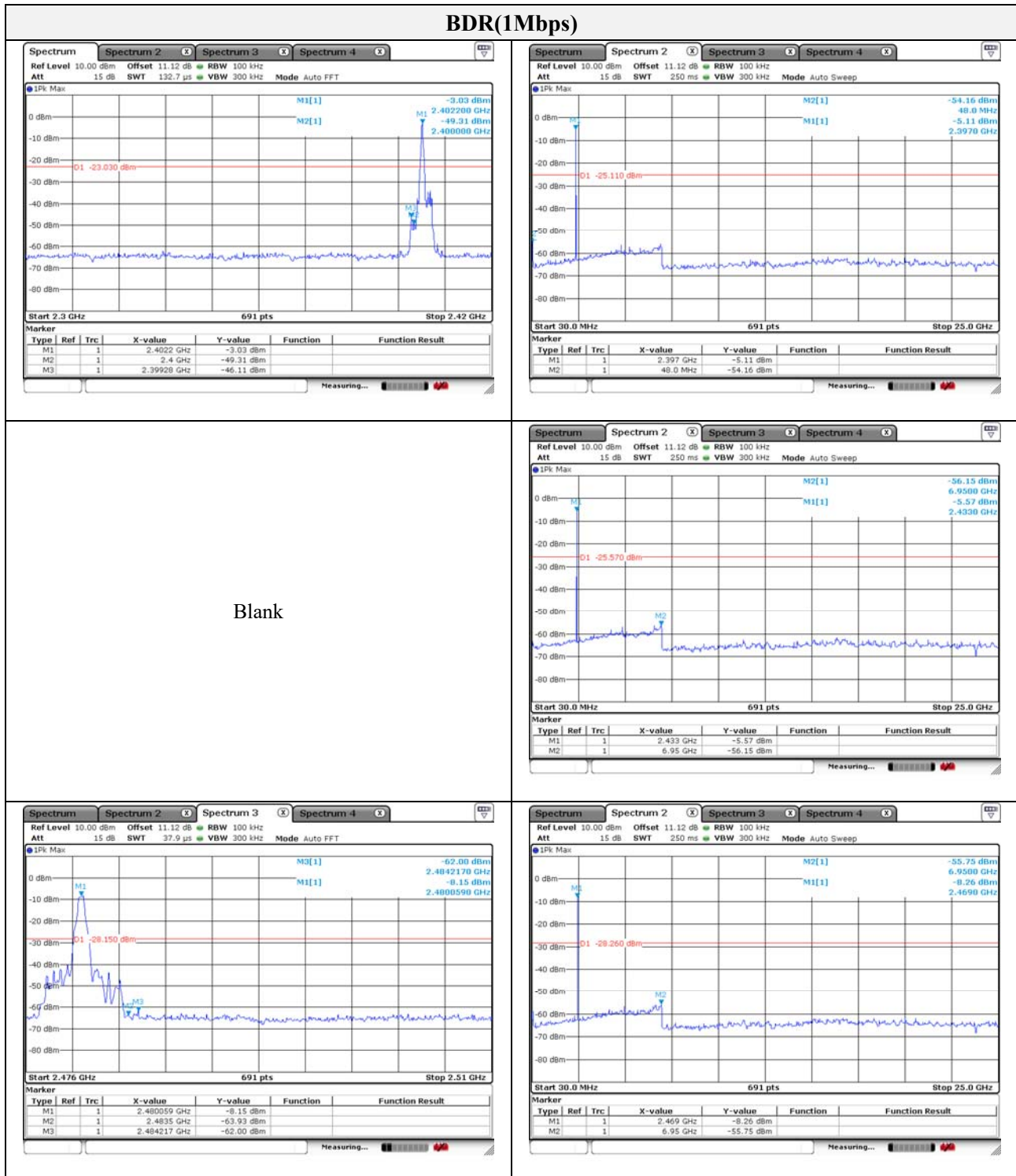
Test setting

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

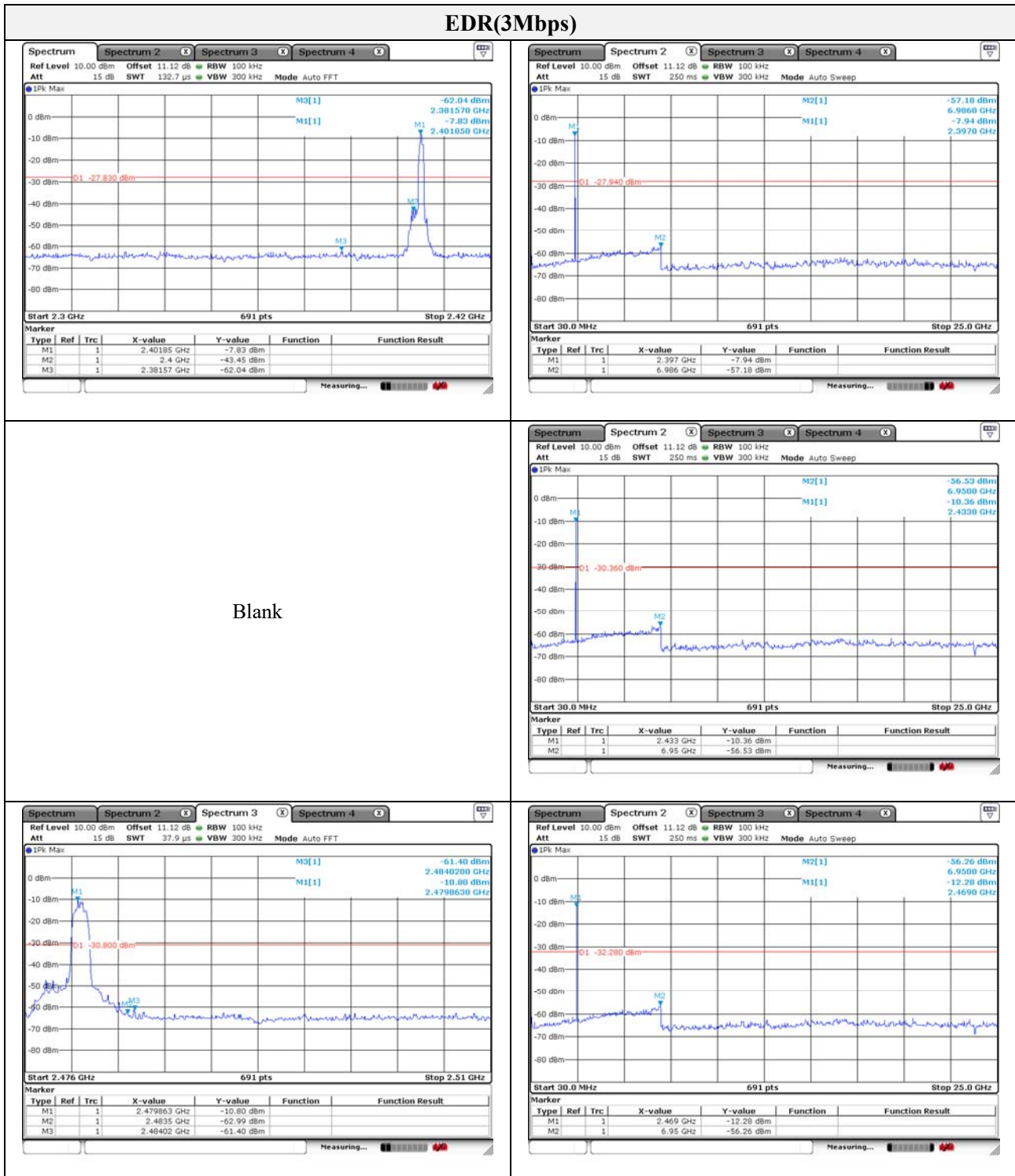
Limit

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

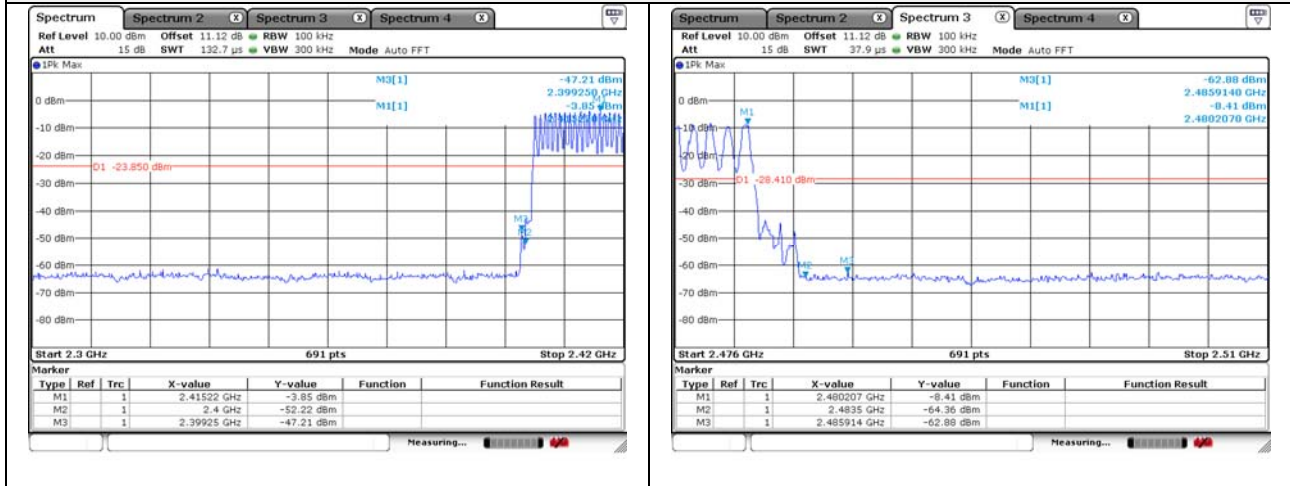


EDR(3Mbps)

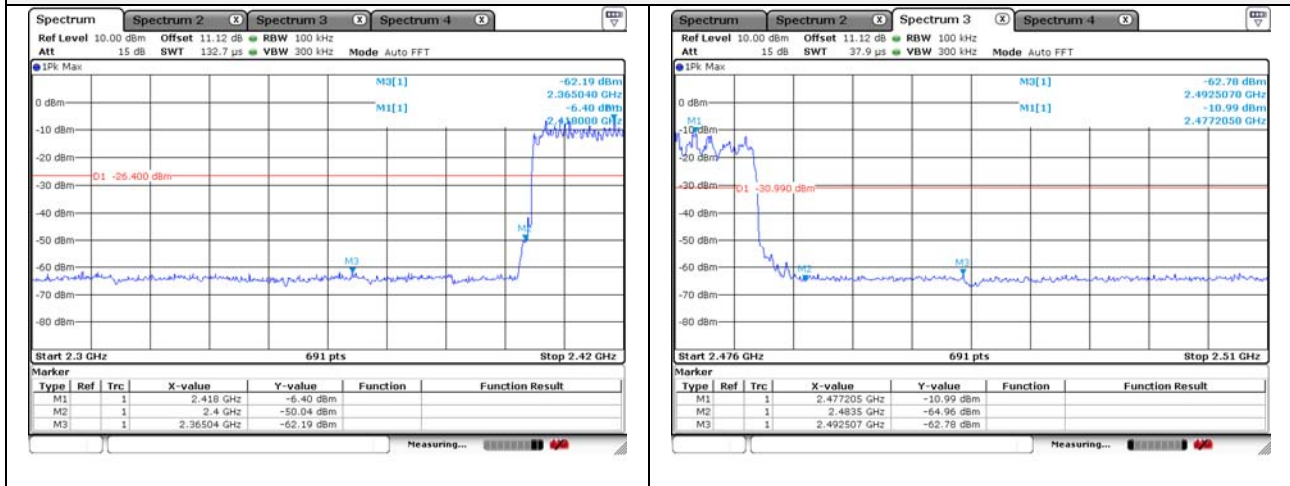


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 The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
 The authenticity of the test report, contact shchoi@kes.co.kr

Hopping mode_BDR(1Mbps)



Hopping mode_EDR(3Mbps)



Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum Analyzer	R&S	FSV30	101389	1 year	2020.01.16
Spectrum Analyzer	R&S	FSV30	100736	1 year	2020.01.09
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2020.01.15
Power Meter	Anritsu	ML2495A	1438001	1 year	2020.01.15
Pulse Power Sensor	Anritsu	MA2411B	1339205	1 year	2020.01.15
DC Power Supply	Agilent	6632B	MY43004130	1 year	2020.06.24
Attenuator	KEYSIGHT	8493C	82506	1 year	2020.01.15
Loop Antenna	Schwarzbeck	FMZB1513	225	2 years	2021.02.15
Trilog-broadband antenna	S/B	VULB 9163	714	2 years	2020.11.26
Horn Antenna	A.H	SAS-571	414	2 years	2021.02.11
Horn Antenna	SCHWARZBECK	BBHA9170	BBHA 9170550	2 years	2021.02.19
High Pass Filter	Wainwright Instrument Gmbh	WHJS3000-10TT	1	1 year	2020.06.25
Low Pass Filter	Wainwright Instrument Gmbh	WLK1.0/18G-10TT	1	1 year	2020.06.24
Preamplifier	R&S	SCU01	100603	1 year	2019.11.26
Preamplifier	AGILENT	8449B	3008A01742	1 year	2020.01.08
EMI Test Receiver	R&S	ESR3	101781	1 year	2020.04.22
EMI Test Receiver	R&S	ESU26	100552	1 year	2020.04.19
Pulse Limiter	R&S	ESH3-Z2	101915	1 year	2019.11.26
LISN	R&S	ENV216	101787	1 year	2020.01.04

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
Notebook computer	LG Electronics Inc.,	LGS53	306QCZP560949