

TEST REPORT

Part 15 Subpart C 15.247

Equipment under test ASI

Model name ASI

FCC ID XYCASI

Applicant Aram Huvis Co., Ltd.

Manufacturer Aram Huvis Co., Ltd.

Date of test(s) 2017.03.11 ~ 2017.03.27

Date of issue 2017.04.04

Issued to

Aram Huvis Co., Ltd.

13605 Rm401~402, 172, Dolma-ro, Bundang-gu, Seongnam-si,
Gyeonggi-do, South Korea

Tel: +82-31-732-6320/ Fax: +82-31-732-6330



Issued by

KES Co., Ltd.

C-3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si,
Gyeonggi-do, 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	Jeff Do Technical manager

**KES Co., Ltd.**

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

Test report No.:
KES-RF-17T0043
Page (2) of (57)

Revision history

Revision	Date of issue	Test report No.	Description
-	2017.04.04	KES-RF-17T0043	Initial

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The test results in the report only apply to the tested sample.



TABLE OF CONTENTS

1.	General information	4
1.1.	EUT description	4
1.2.	Test configuration.....	4
1.3.	Device modifications.....	4
1.4.	Information about derivative model	4
1.5.	Frequency/channel operations	5
1.6.	Worst case data rate	5
1.7.	Accessory information.....	5
2.	Summary of tests	6
3.	Test results.....	7
3.1.	6 dB bandwidth	7
3.2.	Output power.....	11
3.3.	Power spectral density.....	13
3.4.	Radiated restricted band and emissions.....	17
3.5.	Conducted spurious emissions & band edge	49
3.6.	AC conducted emissions	54
Appendix A.	Measurement equipment	56
Appendix B.	Test setup photos	57



1. General information

Applicant: Aram Huvis Co., Ltd.
Applicant address: 13605 Rm401~402, 172, Dolma-ro, Bundang-gu, Seongnam-si,
Gyeonggi-do, South Korea
Test site: KES Co., Ltd.
Test site address: C-3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, Korea
473-21, Gayeo-ro, Yeosu-si, Gyeonggi-do, Korea
FCC rule part(s): 15.247
FCC ID: XYCASI
Test device serial No.: ☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test ASI
Frequency range 2412 MHz ~ 2462 MHz(11b/g/n_HT20)
2422 MHz ~ 2452 MHz(11n_HT40)
Modulation technique DSSS, OFDM
Number of channels 2412 MHz ~ 2462 MHz(11b/g/n_HT20): 11ch
2422 MHz ~ 2452 MHz(11n_HT40): 7ch
Antenna type PCB antenna
Antenna gain 1.57 dBi
Power source DC 3.7 V (Rechargeable Li-ion Battery)

1.2. Test configuration

The Aram Huvis Co., Ltd. ASI FCC ID: XYCASI was tested per the guidance of KDB 558074 D01 v03r05. 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. Information about derivative model

N/A

1.5. Frequency/channel operations

Ch.	Frequency (MHz)	Mode
01	2412	802.11b/g/n_HT20
.	.	.
06	2437	802.11b/g/n_HT20
.	.	.
11	2462	802.11b/g/n_HT20

Ch.	Frequency (MHz)	Mode
03	2422	802.11n_HT40
.	.	.
06	2437	802.11n_HT40
.	.	.
09	2452	802.11n_HT40

1.6. Worst case data rate

1. Radiated emission and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.
2. Worst-case data rates were:
802.11b: **11 Mbps**
802.11g: **54 Mbps**
802.11n_HT20: **MCS7**
802.11n_HT40: **MCS7**

1.7. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
Smart cradle	Aram Huvis Co., Ltd.	ASI-Cradle	ASICAFJF2100121	DC 5V (Output : DC 5V / 0.2 A)
AC/DC Adapter	Kuantech (Beihai) Co., Ltd.,	KSAPK0110500200D5	-	AC 110V (Output : DC 5V / 2.0 A)



2. Summary of tests

Reference	Parameter	Test results
15.247(a)(2)	6 dB bandwidth	Pass
15.247(b)(3)	Peak output power	Pass
15.247(e)	Power spectral density	Pass
15.205 15.209	Radiated restricted band and emission	Pass
15.247(d)	Conducted spurious emission and band edge	Pass
15.207(a)	AC conducted emissions	Pass

3. Test results

3.1. 6 dB bandwidth

Test procedure

KDB 558074 D01 v03r05 – Section 8.1 or 8.2

Used test method is section 8.1.

Section 8.1

1. RBW = 100 kHz.
2. VBW $\geq 3 \times$ RBW.
3. Detector = peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Section 8.2

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

Limit

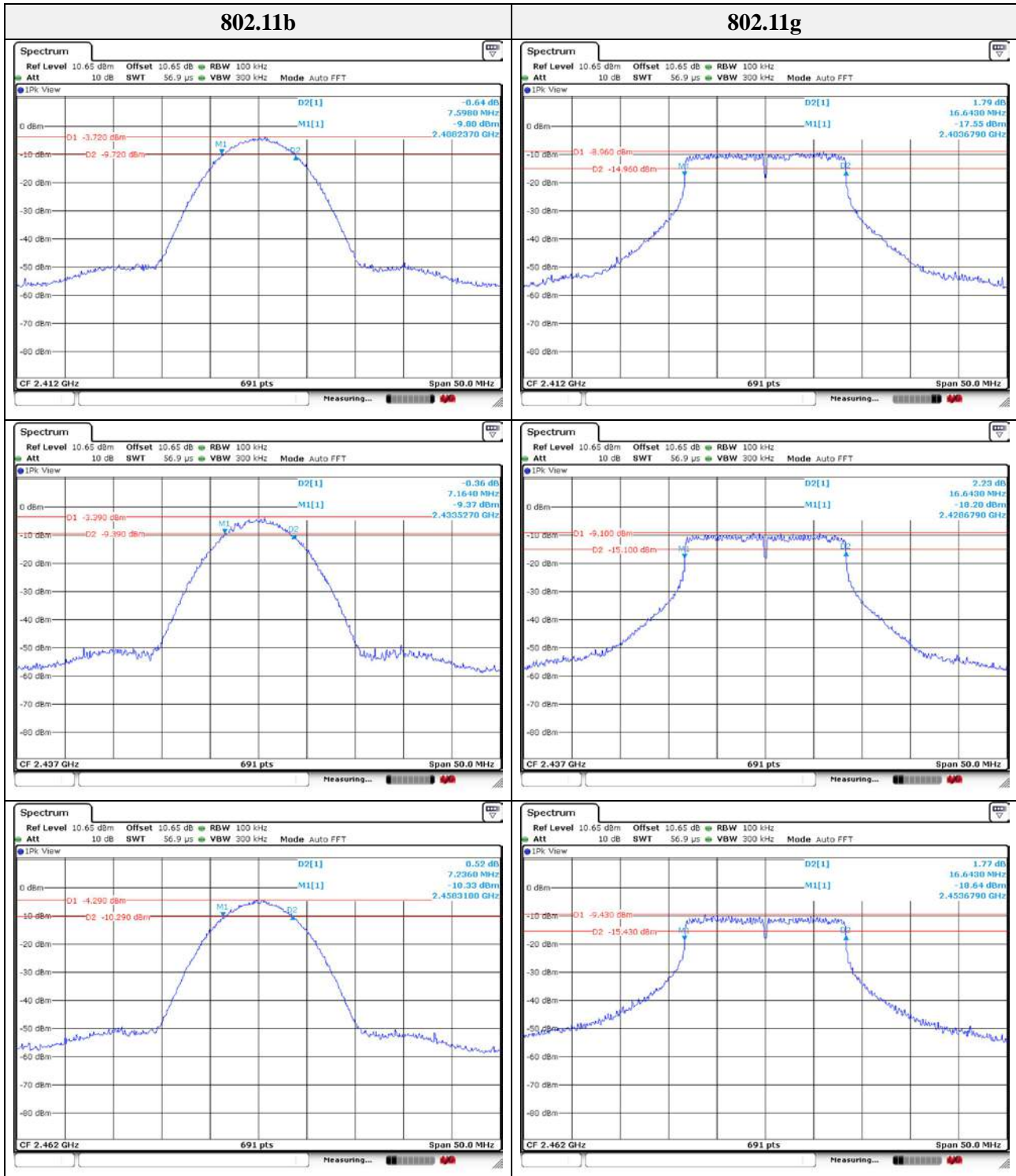
According to §15.247(a)(2), systems using digital modulation techniques may operate 902 ~ 928 MHz, 2 400 ~ 2 483.5 MHz, and 5 725 ~ 5 850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.



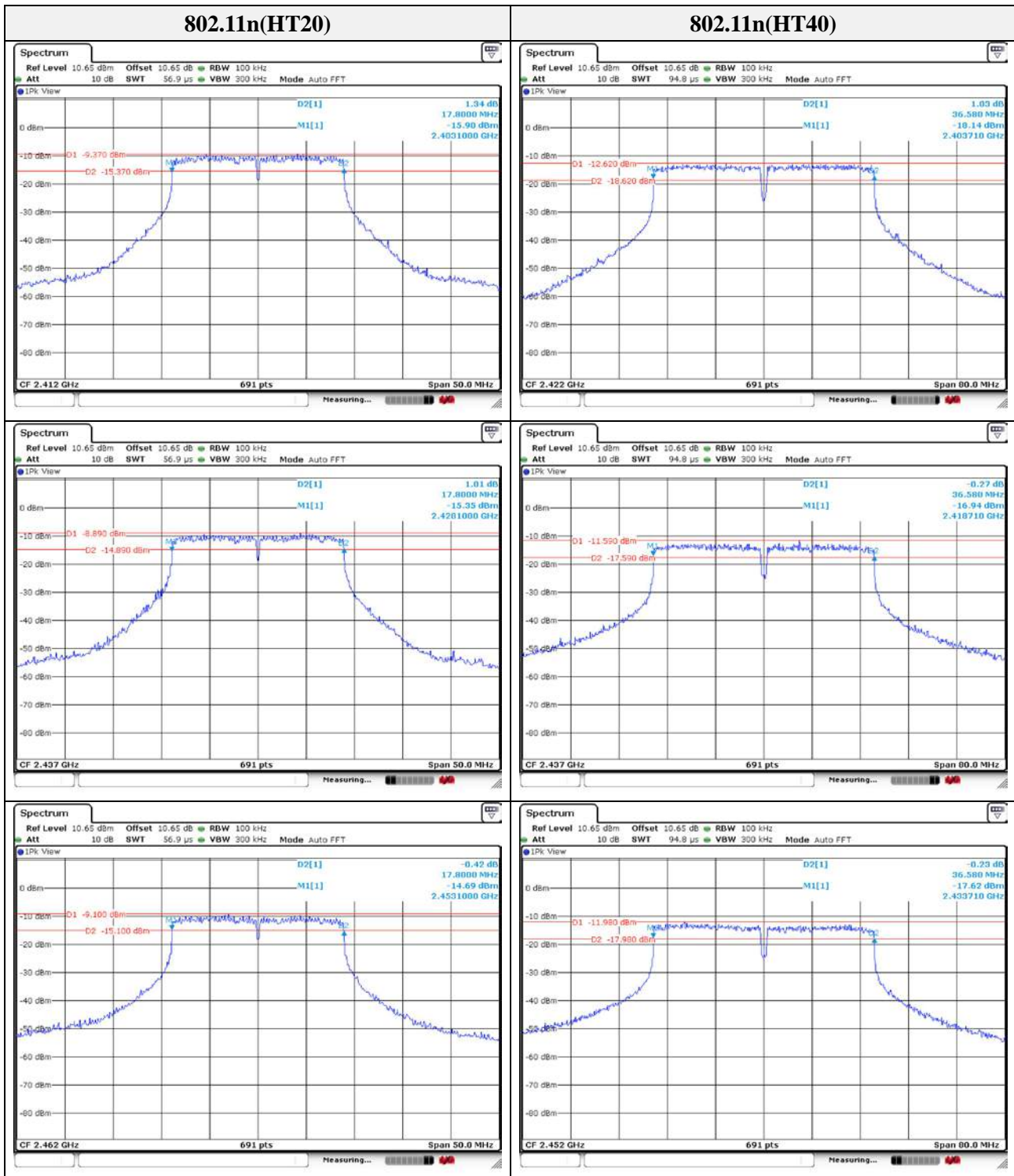
Test results

6 dB bandwidth of 20 MHz bandwidth				
Measured 6 dB bandwidth(MHz)				Limit(MHz)
Frequency(MHz)	802.11b	802.11g	802.11n	
2412	7.60	16.64	17.80	0.5
2437	7.16	16.64	17.80	
2462	7.24	16.64	17.80	

6 dB bandwidth of 40 MHz bandwidth		
Measured 6 dB bandwidth(MHz)		
Frequency(MHz)	802.11n	Limit(MHz)
2422	36.58	0.5
2437	36.58	
2452	36.58	



This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The test results in the report only apply to the tested sample.



This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The test results in the report only apply to the tested sample.

3.2. Output power

Test procedure

KDB 558074 D01 v03r05 – section 9.1.1 or 9.1.2

Used test method is section 9.1.2

Section 9.1.1

This procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the DTS bandwidth.

1. Set the $RBW \geq DTS$ bandwidth.
2. Set $VBW \geq 3 \times RBW$.
3. Set $span \geq 3 \times RBW$
4. Sweep time = auto couple
5. Detector = peak
6. Trace mode = max hold
7. Allow trace to fully stabilize
8. Use peak marker function to determine the peak amplitude level

Section 9.1.2

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

Limit

According to §15.247(b)(3), For systems using digital modulation in the 902~928 MHz, 2 400~2 483.5 MHz, and 5 725~5 850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted out-put power. Maximum Conducted Out-put Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

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



Test results

Measured output power (dBm)						
Mode	2412 MHz		2437 MHz		2462 MHz	
	Peak	Average	Peak	Average	Peak	Average
11b	5.59	2.89	5.99	3.09	6.44	3.85
11g	14.35	2.93	14.28	3.26	14.38	3.48
11n_HT 20	14.89	3.13	15.11	3.29	15.23	3.35
Mode	2422 MHz		2437 MHz		2452 MHz	
	Peak	Average	Peak	Average	Peak	Average
11n_HT 40	13.97	2.65	14.21	3.26	14.44	3.43

3.3. Power spectral density

Test procedure

KDB 558074 D01 v03r05– section 10.2

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

Limit

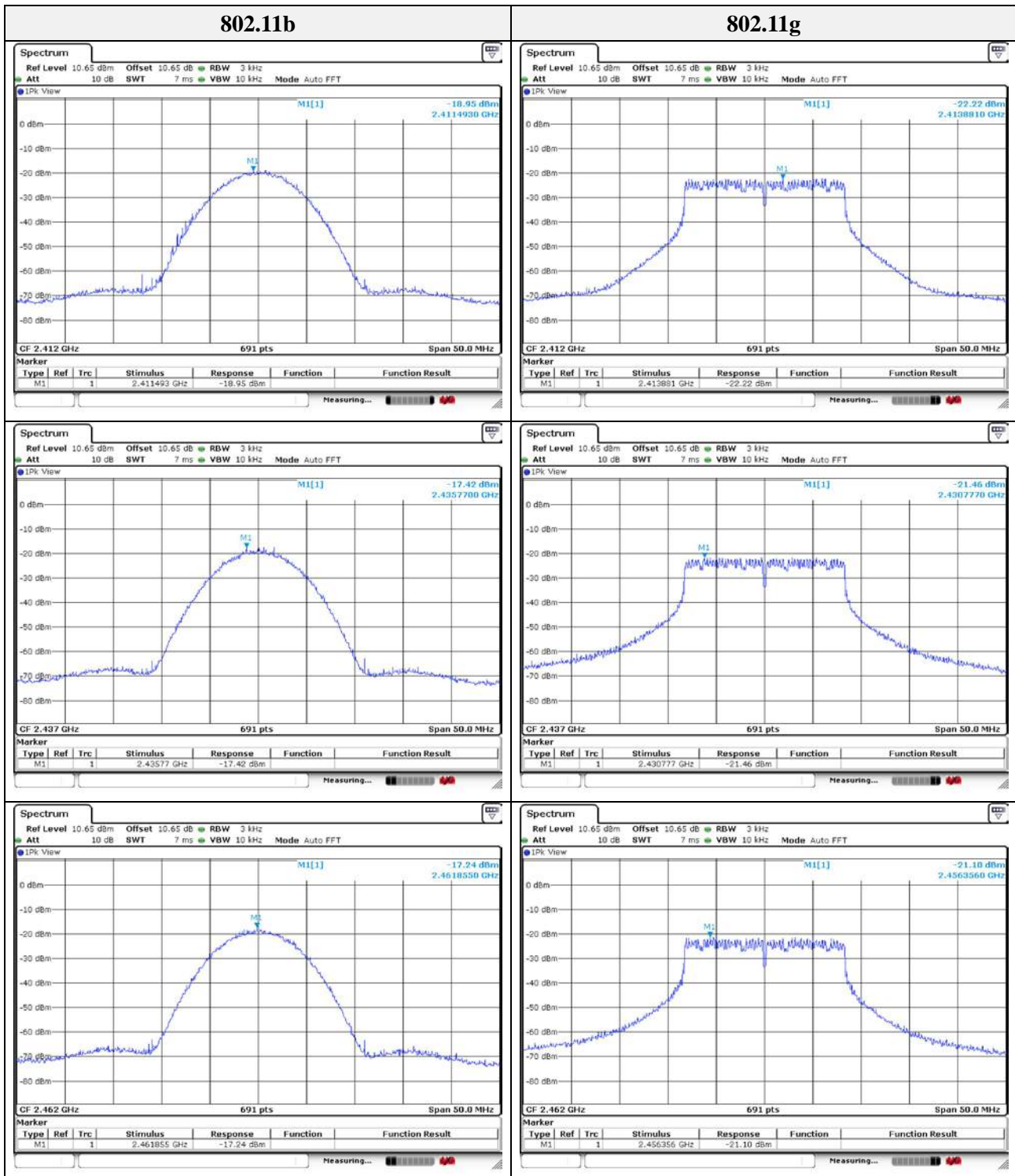
According to §15.247(e), For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.



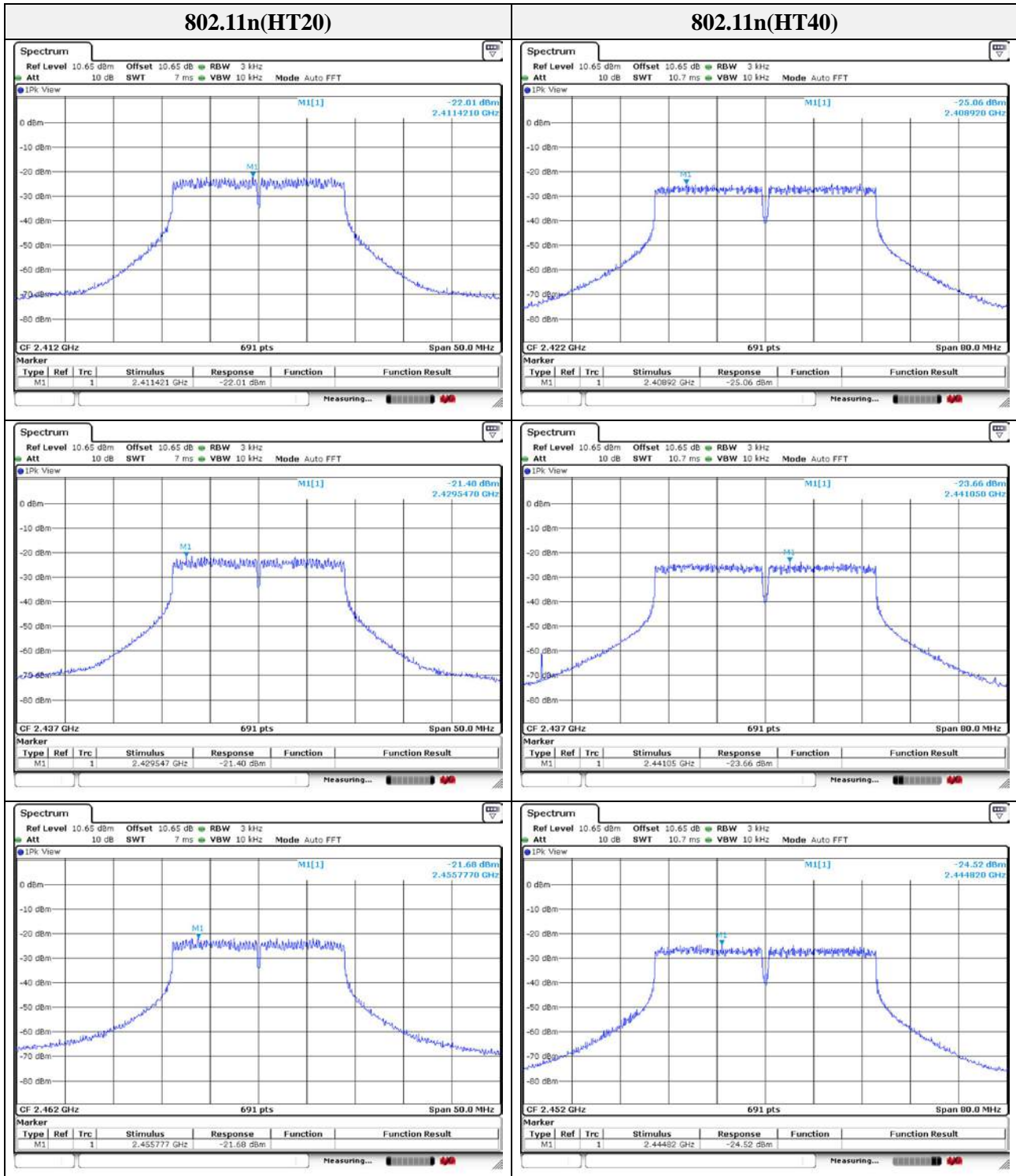
Test results

PSD of 20 MHz bandwidth				
Measured PDS(dBm)				Limit(dBm)
Frequency(MHz)	802.11b	802.11g	802.11n	
2412	-18.95	-22.22	-22.01	8
2437	-17.42	-21.46	-21.40	
2462	-17.24	-21.10	-21.68	

PSD of 40 MHz bandwidth		
Measured PDS(dBm)		
Frequency(MHz)	802.11n	Limit(dBm)
2422	-25.06	8
2437	-23.66	
2452	-24.52	



This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The test results in the report only apply to the tested sample.

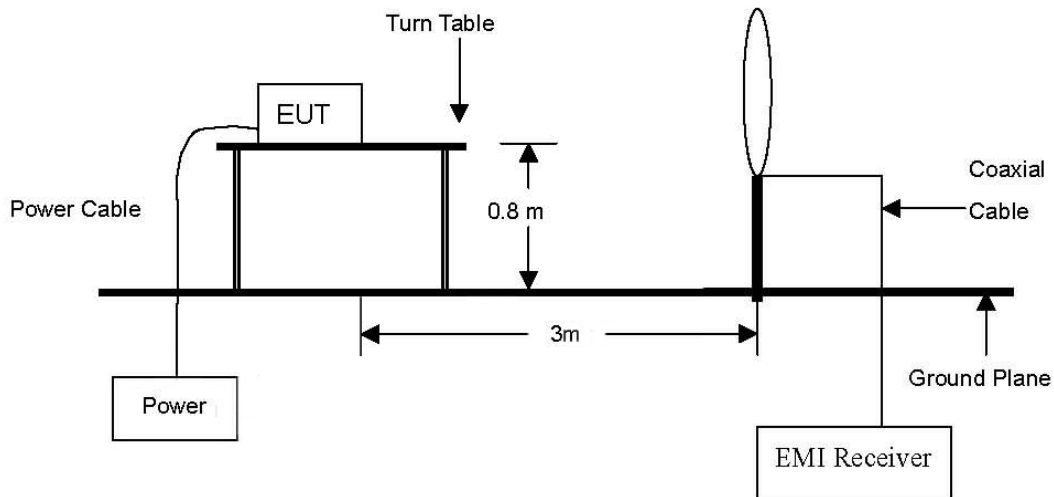


This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The test results in the report only apply to the tested sample.

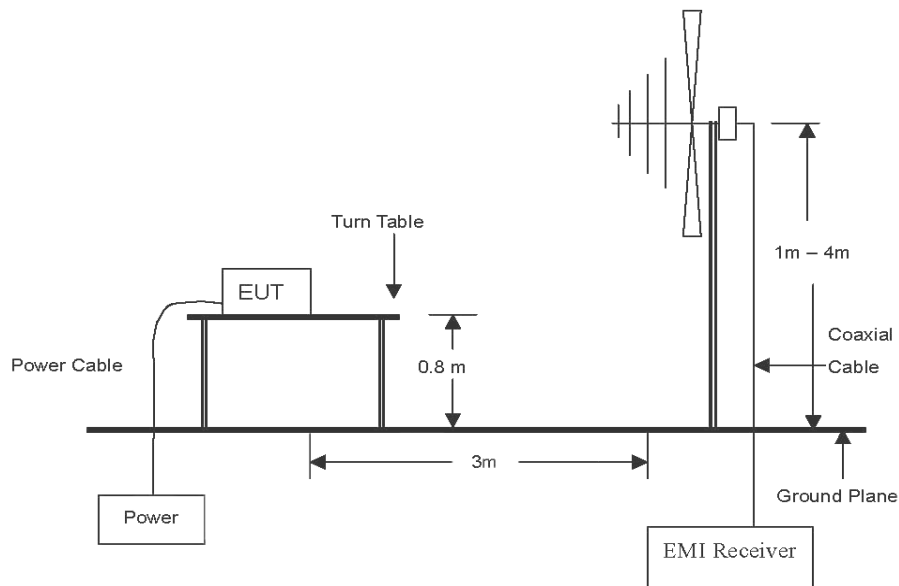
3.4. Radiated restricted band and emissions

Test setup

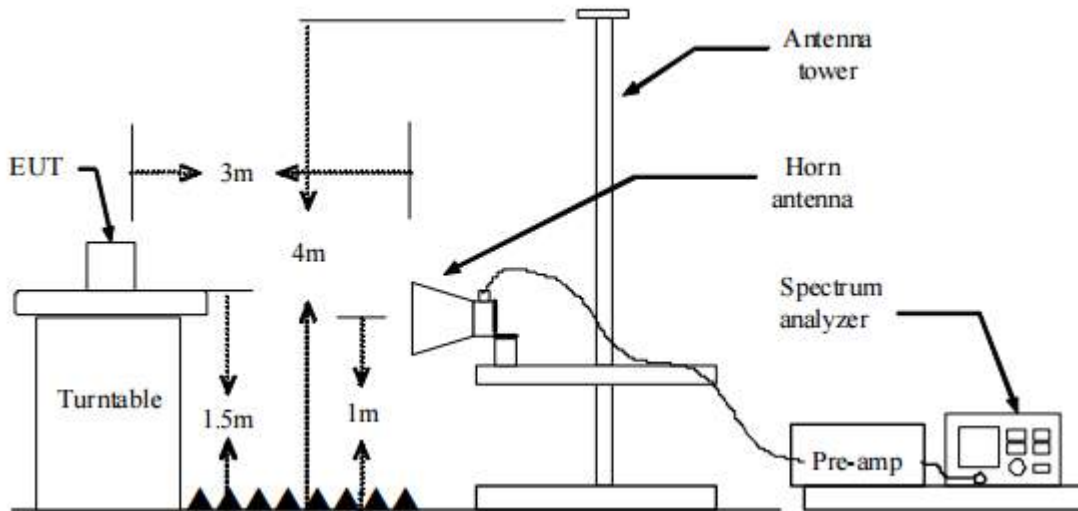
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions.



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 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 and perpendicular 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 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. 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
2. Spectrum analyzer settings for $f \geq 1$ GHz: Peak
 - ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
 - ② RBW = 1 MHz
 - ③ VBW \geq 3 MHz
 - ④ Detector = peak
 - ⑤ Sweep time = auto
 - ⑥ Trace = max hold
 - ⑦ Trace was allowed to stabilize

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

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

Note.

1. $f < 30$ MHz, extrapolation factor of 40 dB/decade of distance. $F_d = 40 \log(D_m/D_s)$
 $f \geq 30$ MHz, extrapolation factor of 20 dB/decade of distance. $F_d = 20 \log(D_m/D_s)$
Where:
 F_d = Distance factor in dB
 D_m = Measurement distance in meters
 D_s = Specification distance in meters
3. CF(Correction factors(dB)) = Antenna factor(dB/m) + Cable loss(dB) + or Amp. gain(dB) + or F_d (dB)
4. Field strength(dB μ V/m) = Level(dB μ V) + CF (dB) + or DCF(dB)
5. Margin(dB) = Limit(dB μ V/m) - Field strength(dB μ V/m)
6. 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.



Limit

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

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

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



Duty cycle

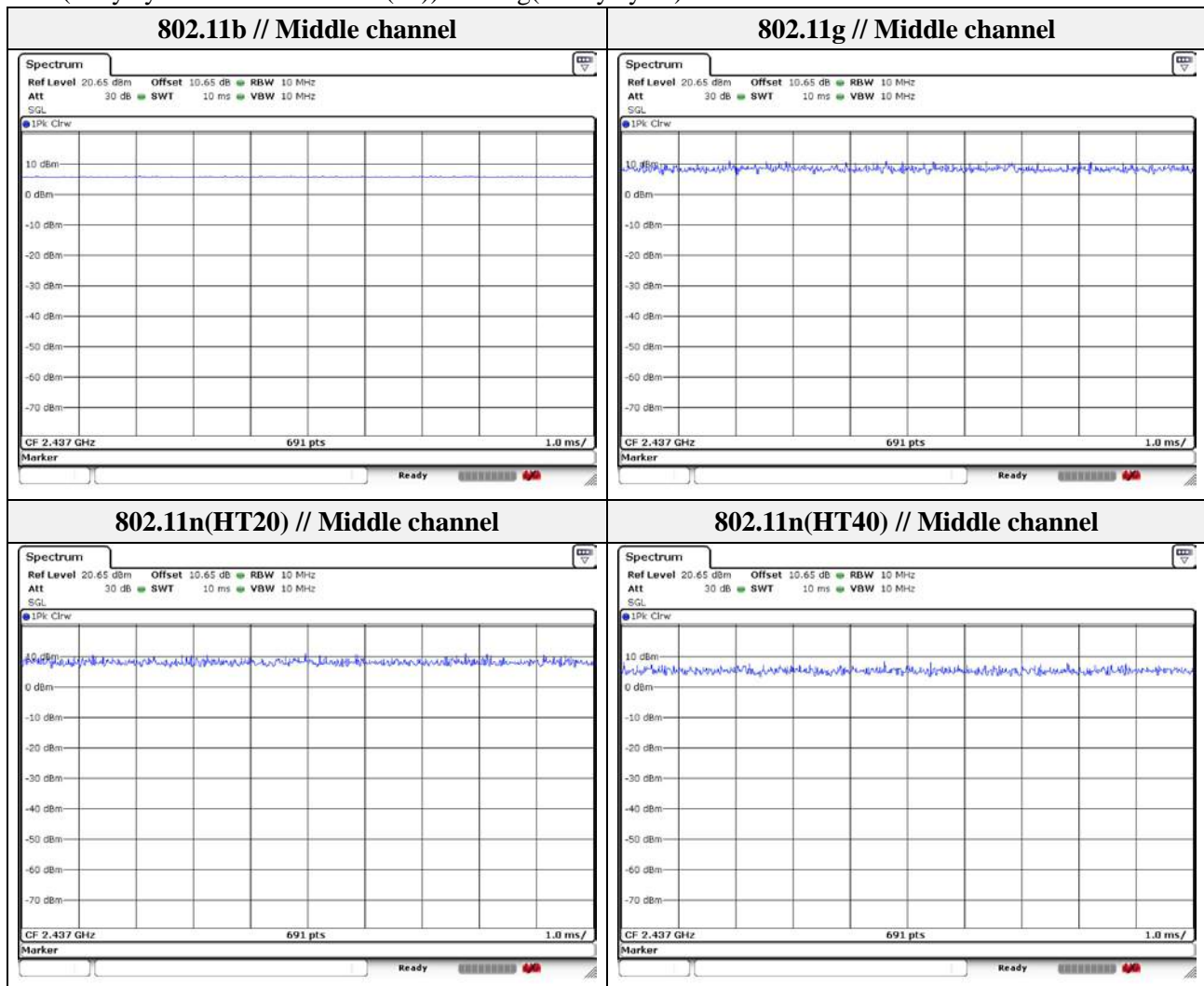
Regarding to KDB 558074 D01_v03r05, 6.0, the maximum duty cycles of all modes were investigated and set the spectrum analyzer as below.

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

Test mode	T _{on} time (ms)	Period (ms)	Duty cycle (Linear)	Duty cycle (%)	Duty cycle correction factor (dB)
802.11b	10.00	10.00	1	100	0
802.11g	10.00	10.00	1	100	0
802.11n(HT20)	10.00	10.00	1	100	0
802.11n(HT40)	10.00	10.00	1	100	0

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

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



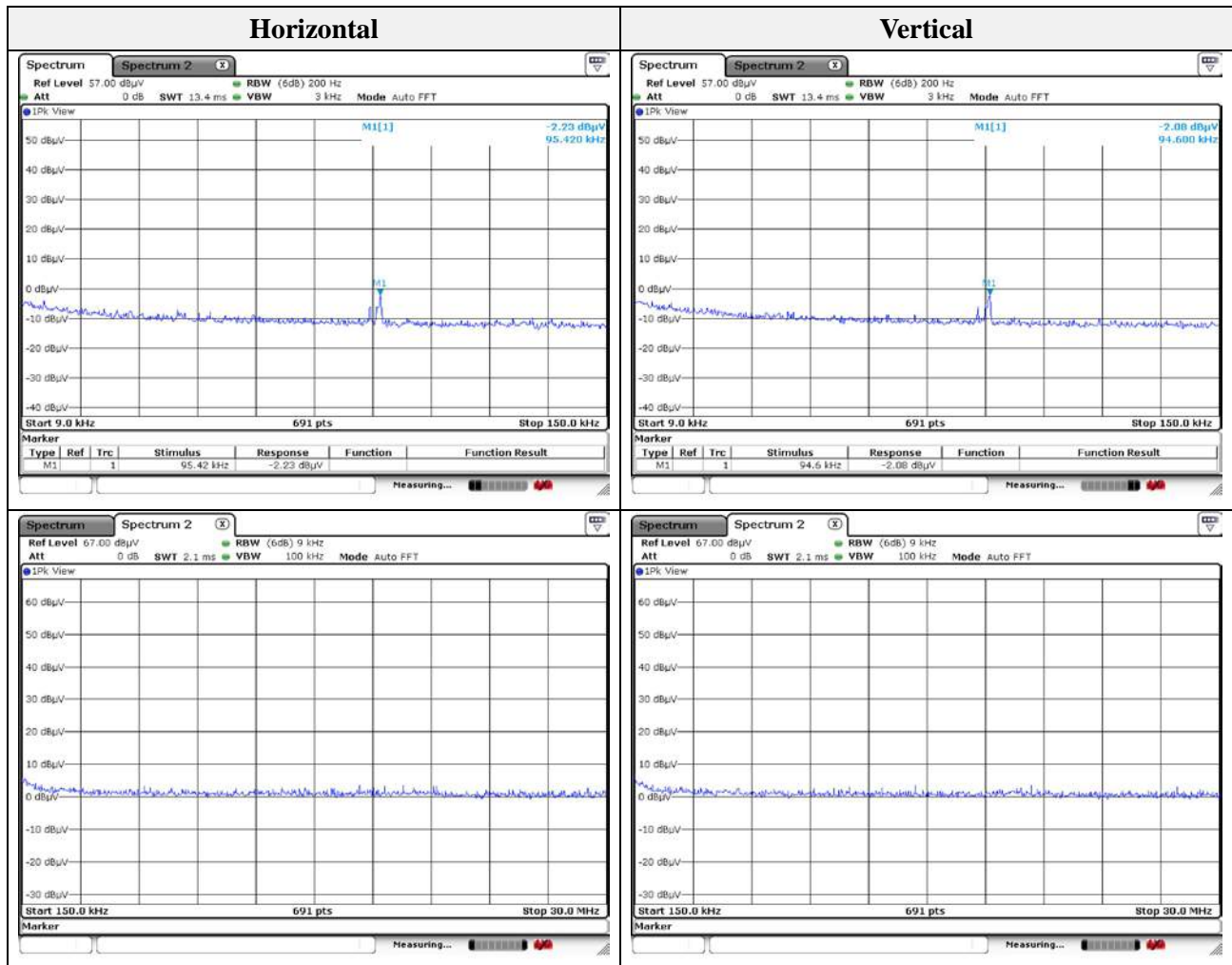
This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The test results in the report only apply to the tested sample.



Test results (Below 30 MHz)

Mode: 802.11b
Distance of measurement: 3 meter
Channel: 11 (Worst case)

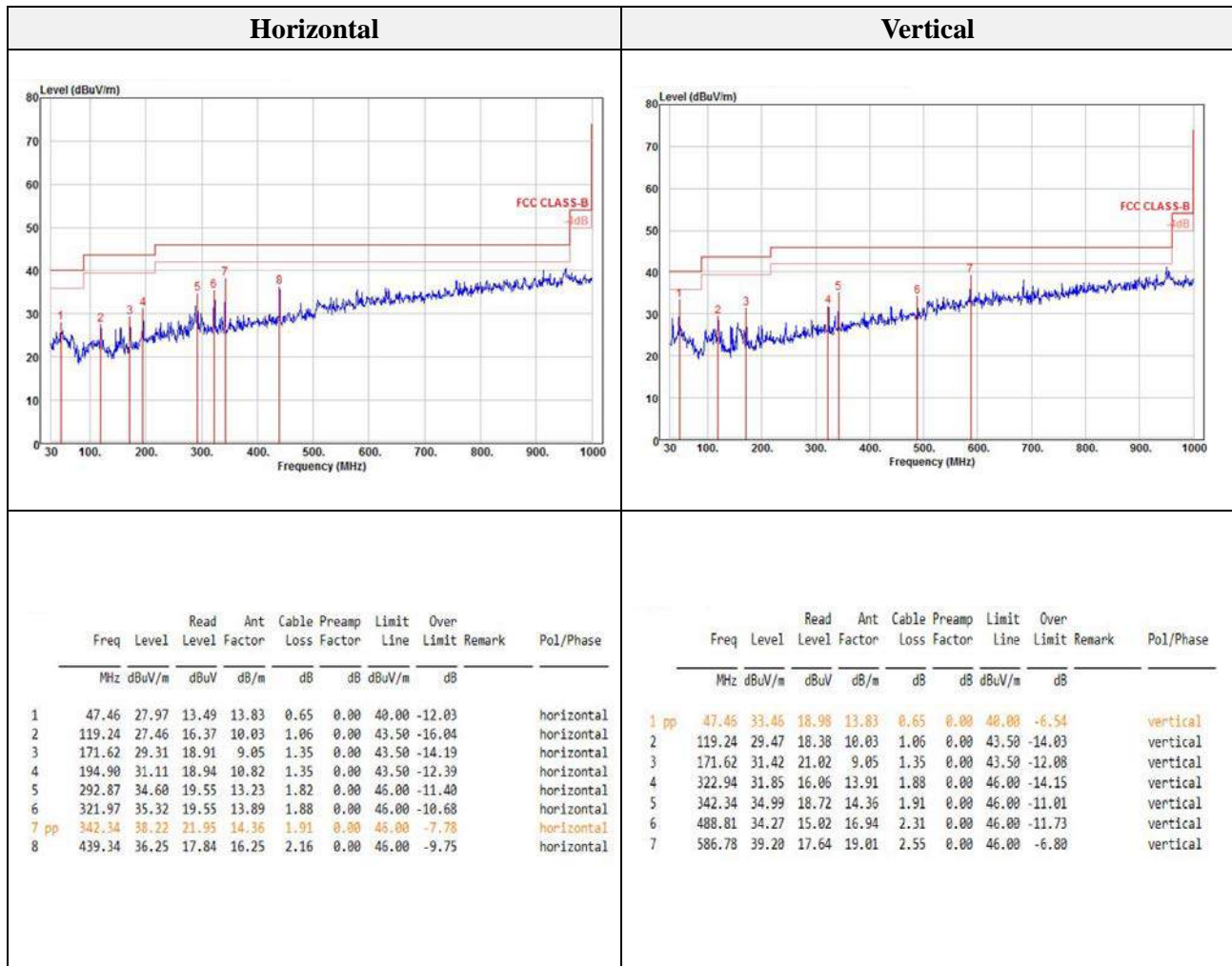
Frequency (MHz)	Level (dBμV)	Ant. Pol. (H/V)	CF (dB)	F _d (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
No spurious emissions were detected within 20 dB of the limit							





Test results (Below 1 000 MHz) – Worst case

Mode: 802.11b
Distance of measurement: 3 meter
Channel: 11 (Worst case)





Test results (Above 1 000 MHz)

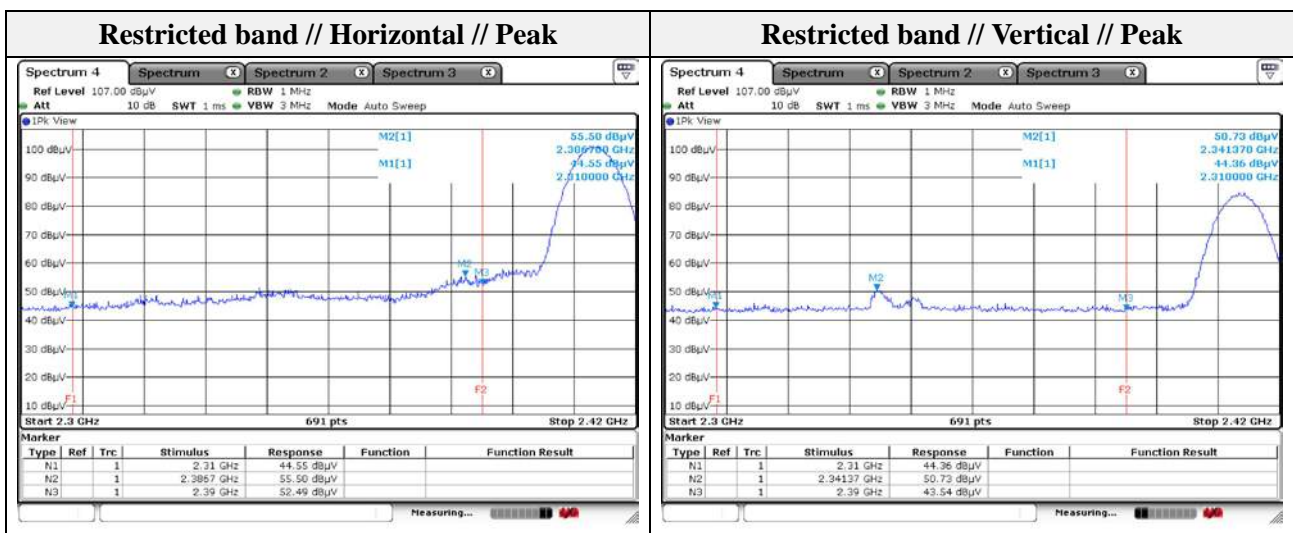
Mode: 802.11b
Distance of measurement: 3 meter
Channel: 01

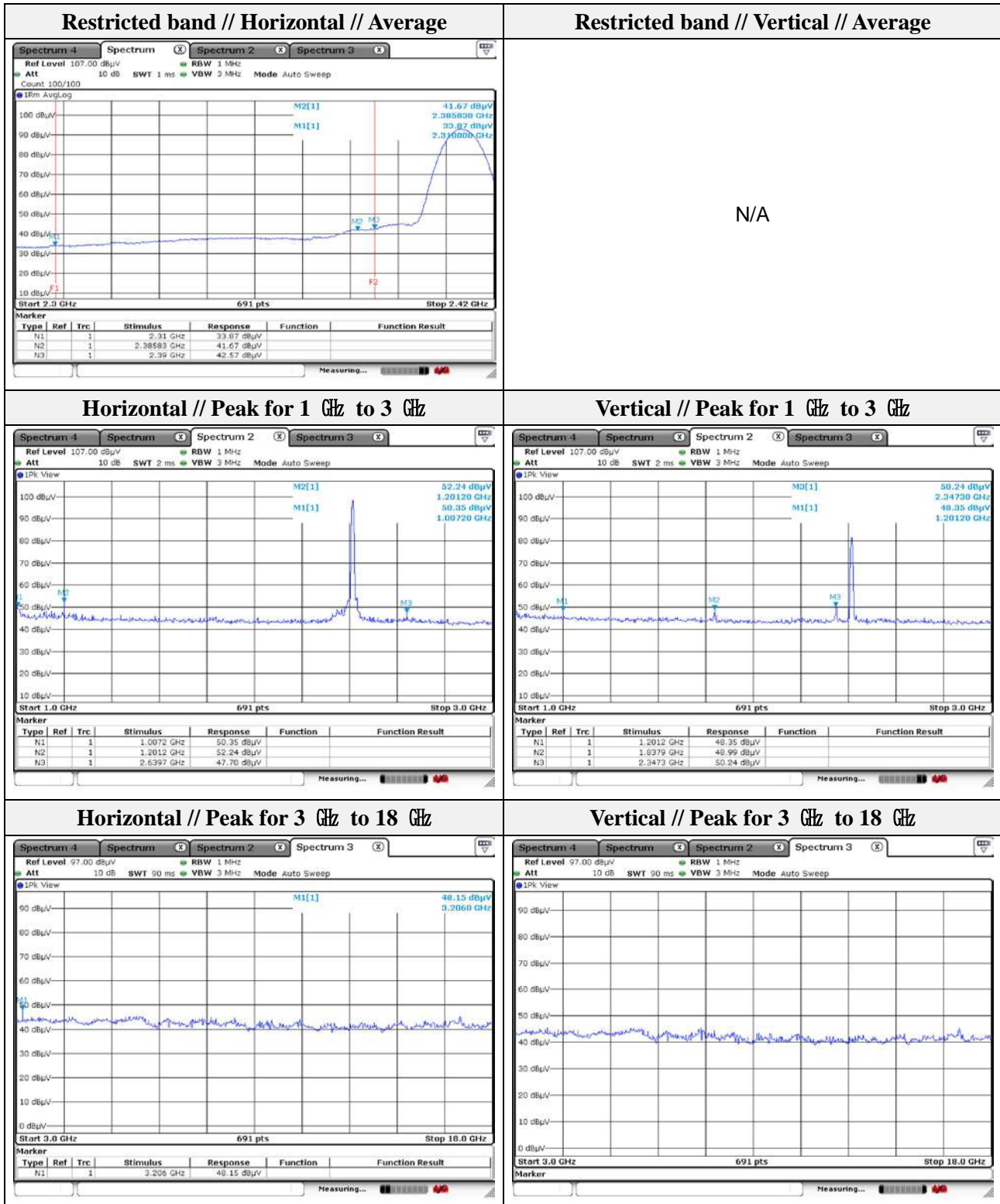
- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1007.20	50.35	Peak	H	-9.09	-	41.26	74.00	32.74
1201.20	52.24	Peak	H	-7.85	-	44.39	74.00	29.61
2639.70	47.70	Peak	H	0.49	-	48.19	74.00	25.81
3206.00	48.15	Peak	H	1.76	-	49.91	74.00	24.09
1201.20	48.35	Peak	V	-7.85	-	40.50	74.00	33.50
1837.90	48.99	Peak	V	-2.68	-	46.31	74.00	27.69
2347.30	50.24	Peak	V	-0.30	-	49.94	74.00	24.06

- 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)
2386.70	55.50	Peak	H	-0.23	-	55.27	74.00	18.73
2385.83	41.67	Avg	H	-0.23	-	41.44	54.00	12.56
2341.37	50.73	Peak	V	-0.31	-	50.42	74.00	23.58





Note.

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

**KES Co., Ltd.**

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

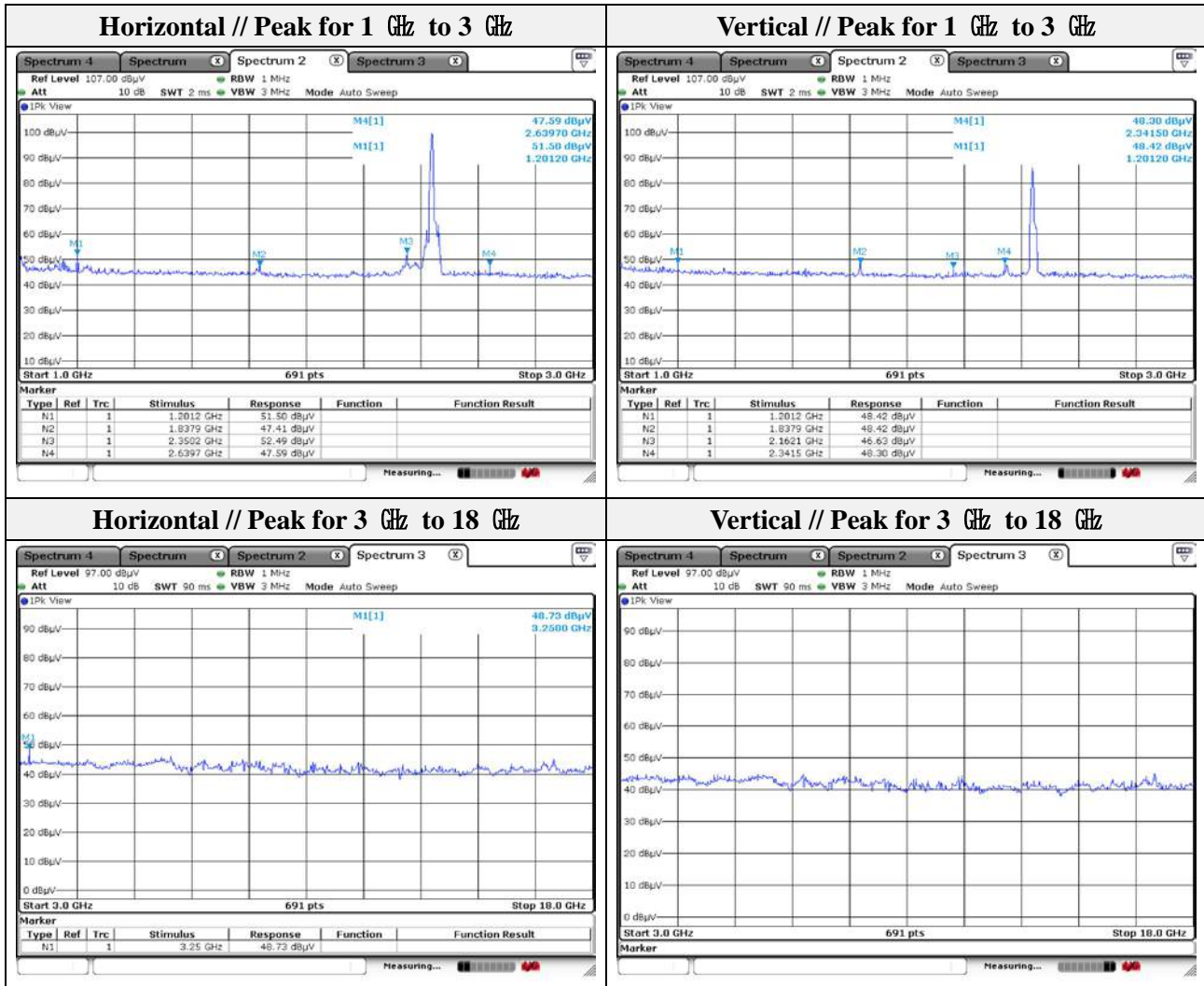
Test report No.:
KES-RF-17T0043
Page (26) of (57)

Mode: 802.11b
Distance of measurement: 3 meter
Channel: 06

- 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)
1201.20	51.50	Peak	H	-7.85	-	43.65	74.00	30.35
1837.90	47.41	Peak	H	-2.68	-	44.73	74.00	29.27
2350.20	52.49	Peak	H	-0.30	-	52.19	74.00	21.81
2639.70	47.59	Peak	H	0.49	-	48.08	74.00	25.92
3250.00	48.73	Peak	H	1.76	-	50.49	74.00	23.52
1201.20	48.42	Peak	V	-7.85	-	40.57	74.00	33.43
1837.90	48.42	Peak	V	-2.68	-	45.74	74.00	28.26
2162.10	46.63	Peak	V	-0.65	-	45.98	74.00	28.02
2341.50	48.30	Peak	V	-0.31	-	47.99	74.00	26.01

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The test results in the report only apply to the tested sample.



Note.

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



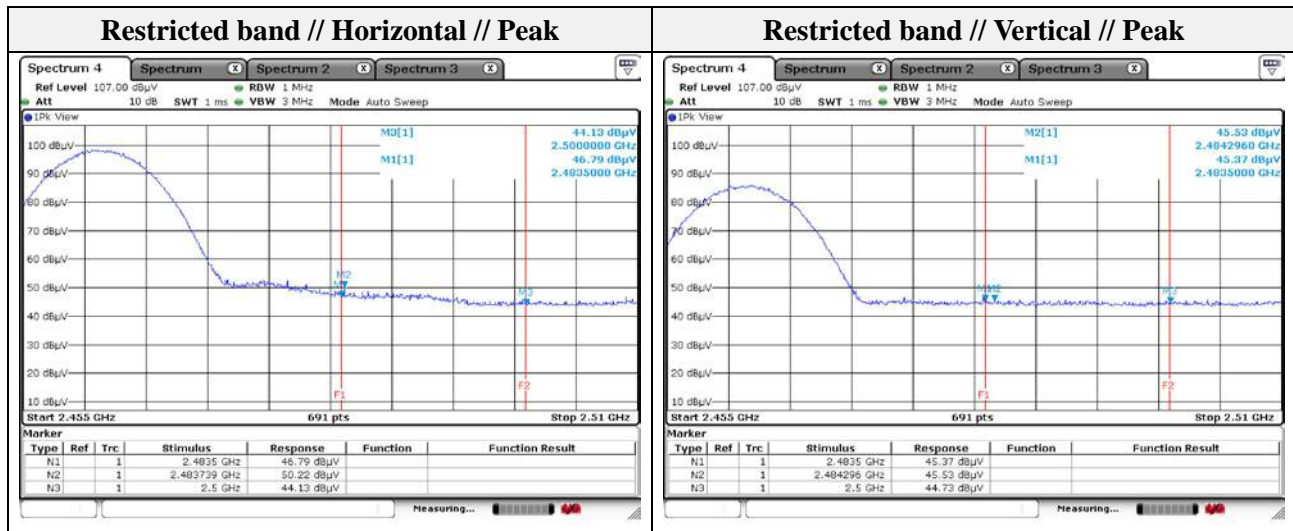
Mode: 802.11b
Distance of measurement: 3 meter
Channel: 11

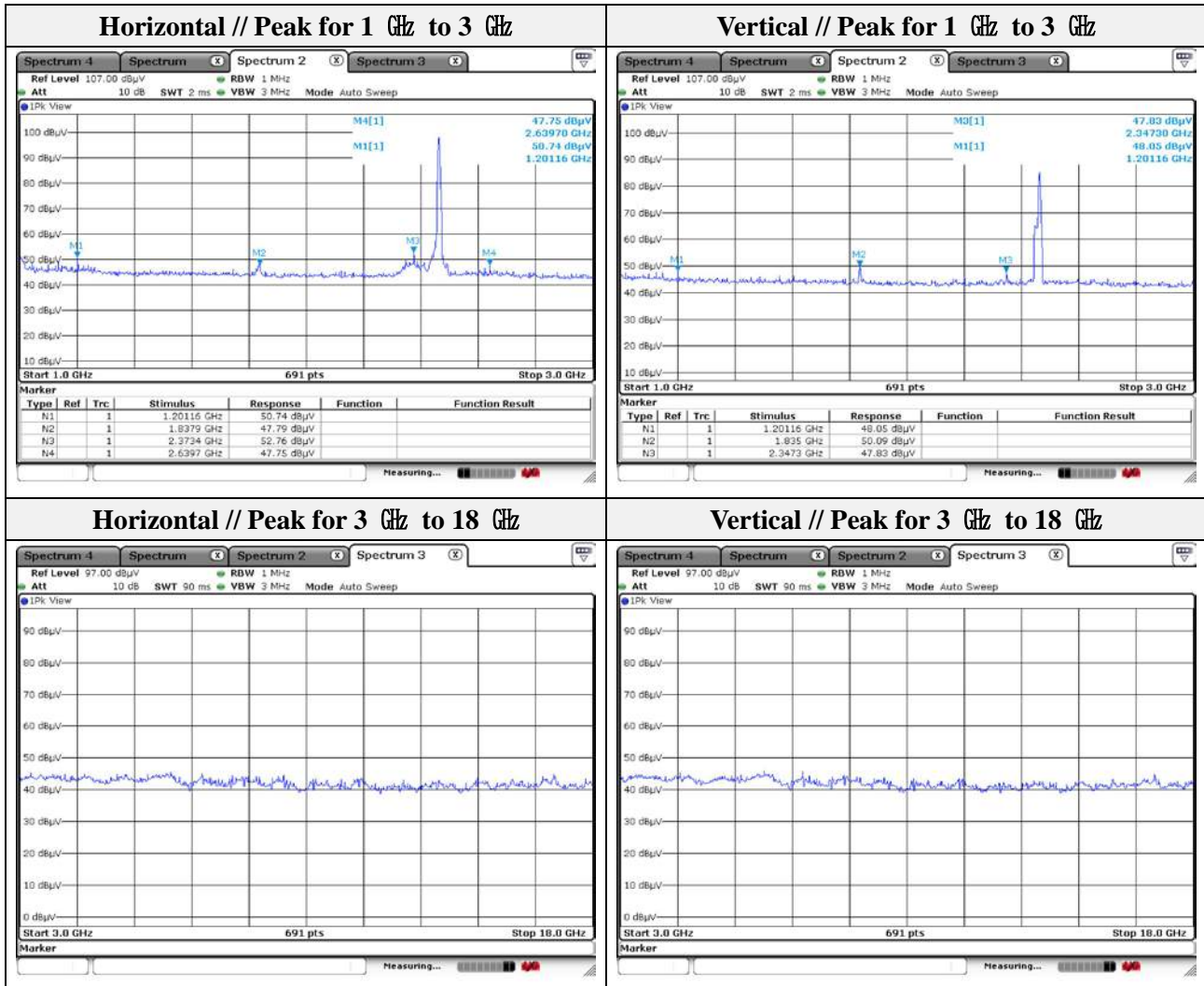
- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1201.16	50.74	Peak	H	-7.85	-	42.89	74.00	31.11
1837.90	47.79	Peak	H	-2.68	-	45.11	74.00	28.89
2373.40	52.76	Peak	H	-0.25	-	52.51	74.00	21.49
2639.70	47.75	Peak	H	0.49	-	48.24	74.00	25.76
1201.16	48.05	Peak	V	-7.85	-	40.20	74.00	33.80
1835.00	50.09	Peak	V	-2.71	-	47.38	74.00	26.62
2347.30	47.83	Peak	V	-0.30	-	47.53	74.00	26.47

- 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)
2483.74	50.22	Peak	H	-0.05	-	50.17	74.00	23.83
2484.30	45.53	Peak	V	-0.04	-	45.49	74.00	28.51





Note.

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



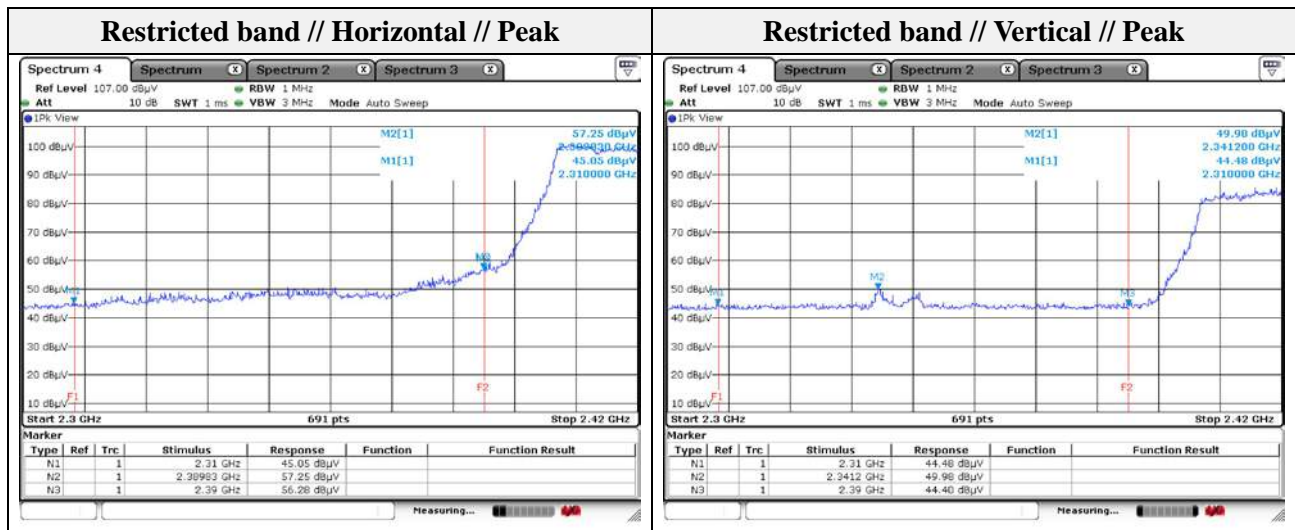
Mode: 802.11g
Distance of measurement: 3 meter
Channel: 01

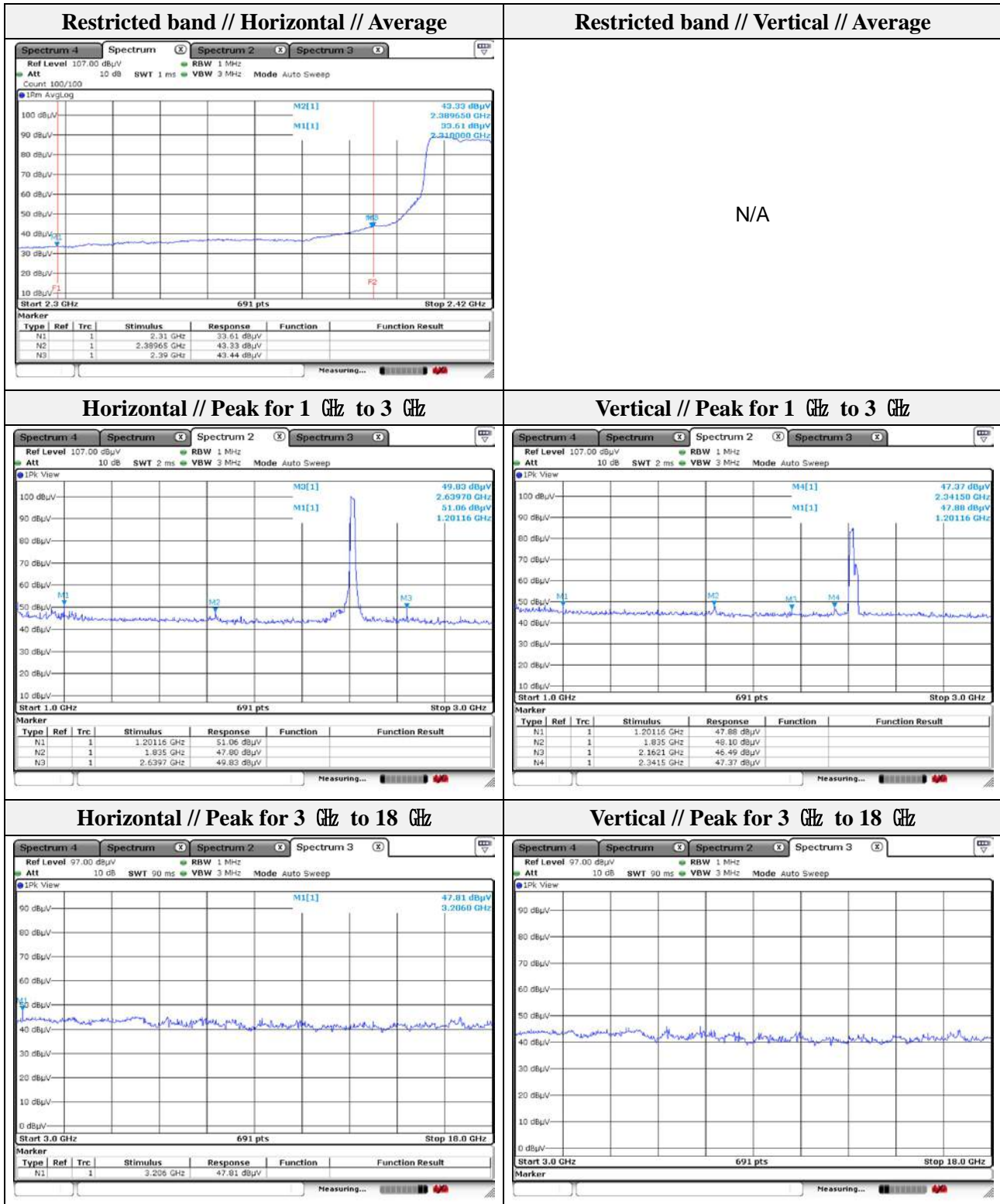
- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1201.16	51.06	Peak	H	-7.85	-	43.21	74.00	30.79
1835.00	47.80	Peak	H	-2.71	-	45.09	74.00	28.91
2639.70	49.83	Peak	H	0.49	-	50.32	74.00	23.68
3206.00	47.81	Peak	H	1.76	-	49.57	74.00	24.43
1201.16	47.88	Peak	V	-7.85	-	40.03	74.00	33.97
1835.00	48.10	Peak	V	-2.71	-	45.39	74.00	28.61
2162.10	46.49	Peak	V	-0.65	-	45.84	74.00	28.16
2341.50	47.37	Peak	V	-0.31	-	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)
2389.83	57.25	Peak	H	-0.22	-	57.03	74.00	16.97
2389.65	43.33	Avg	H	-0.22	-	43.11	54.00	10.89
2341.20	49.98	Peak	V	-0.31	-	49.67	74.00	24.33





Note.

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

**KES Co., Ltd.**

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

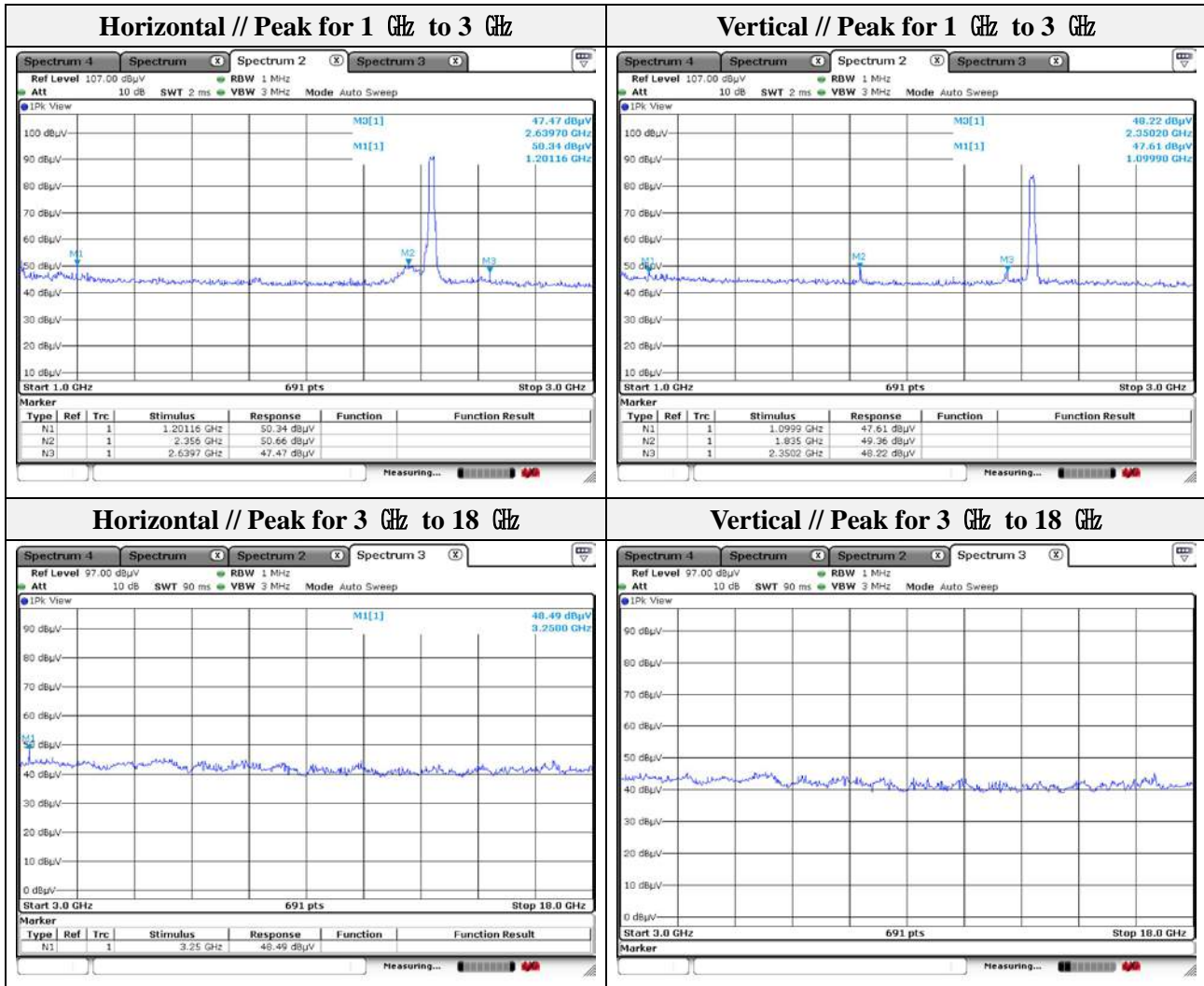
Test report No.:
KES-RF-17T0043
Page (32) of (57)

Mode: 802.11g
Distance of measurement: 3 meter
Channel: 06

- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1201.16	50.34	Peak	H	-7.85	-	42.49	74.00	31.51
2356.00	50.66	Peak	H	-0.28	-	50.38	74.00	23.62
2639.70	47.47	Peak	H	0.49	-	47.96	74.00	26.04
3250.00	48.49	Peak	H	1.76	-	50.25	74.00	23.76
1099.90	47.61	Peak	V	-8.50	-	39.11	74.00	34.89
1835.00	49.36	Peak	V	-2.71	-	46.65	74.00	27.35
2350.20	48.22	Peak	V	-0.30	-	47.92	74.00	26.08

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The test results in the report only apply to the tested sample.



Note.

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



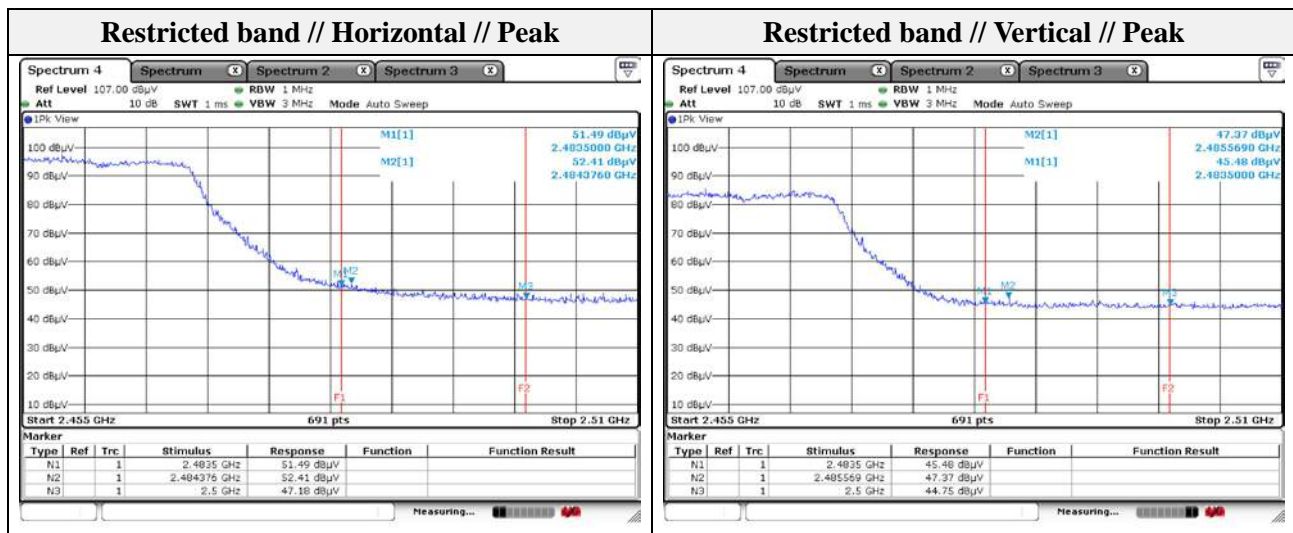
Mode: 802.11g
Distance of measurement: 3 meter
Channel: 11

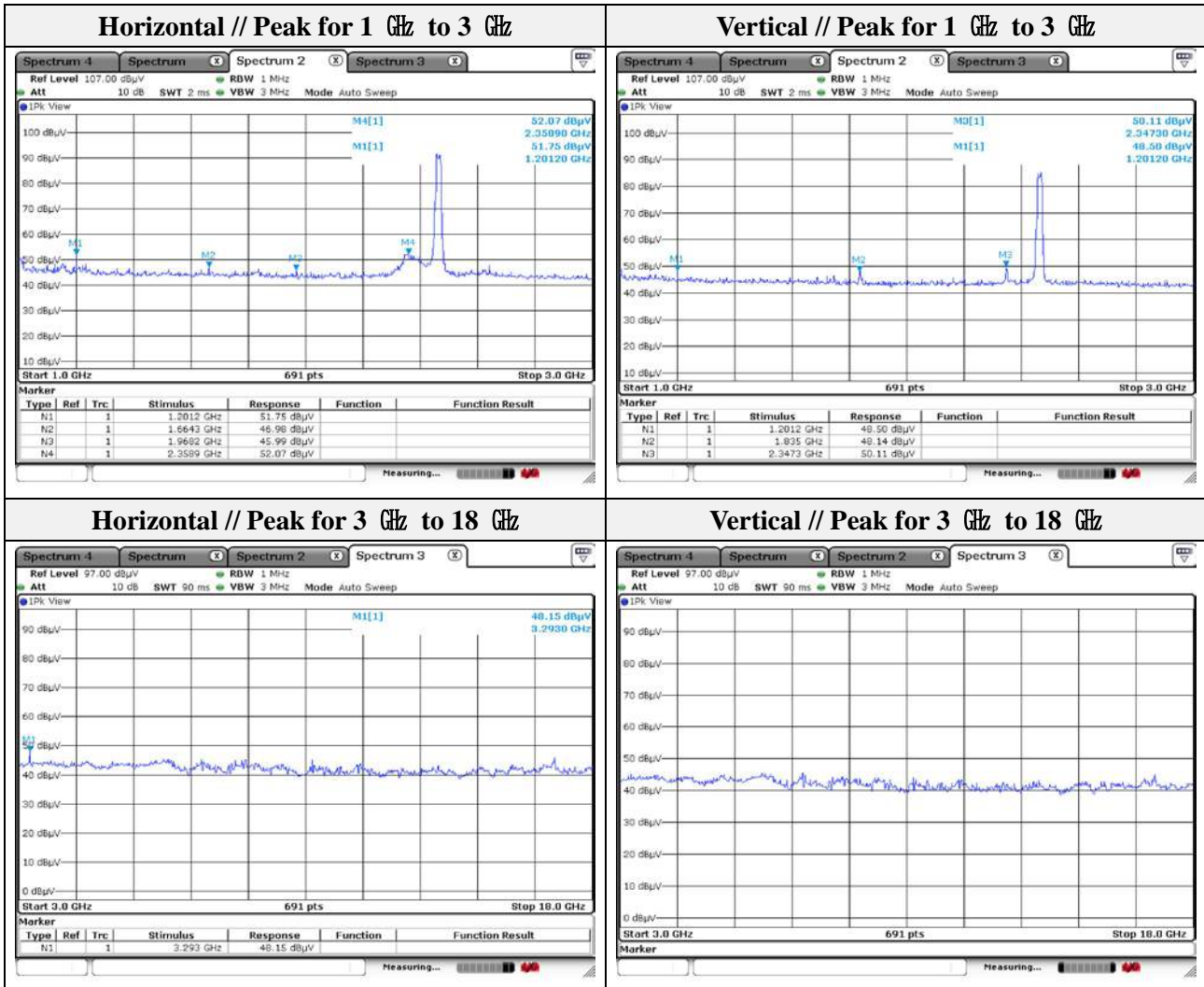
- **Spurious**

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1201.20	51.75	Peak	H	-7.85	-	43.90	74.00	30.10
1664.30	46.98	Peak	H	-4.37	-	42.61	74.00	31.39
1968.20	45.99	Peak	H	-1.31	-	44.68	74.00	29.32
2358.90	52.07	Peak	H	-0.28	-	51.79	74.00	22.21
3293.00	48.15	Peak	H	1.75	-	49.90	74.00	24.10
1201.20	48.50	Peak	V	-7.85	-	40.65	74.00	33.35
1835.00	48.14	Peak	V	-2.71	-	45.43	74.00	28.57
2347.30	50.11	Peak	V	-0.30	-	49.81	74.00	24.19

- **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)
2484.38	52.41	Peak	H	-0.04	-	52.37	74.00	21.63
2485.57	47.37	Peak	V	-0.04	-	47.33	74.00	26.67





Note.

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



Mode: 802.11n(HT20)

Distance of measurement: 3 meter

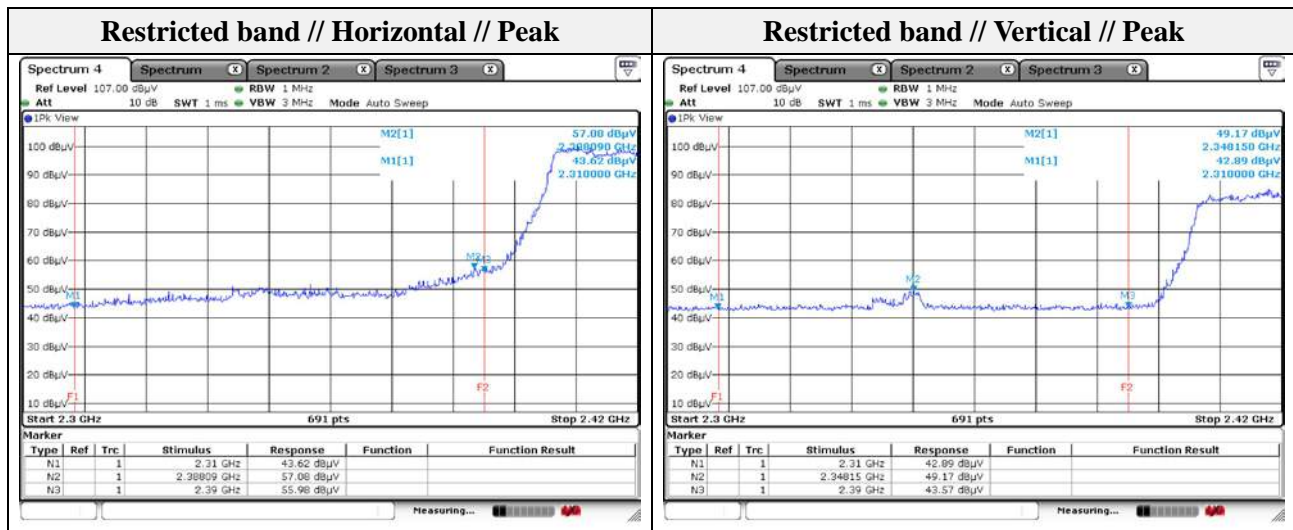
Channel: 01

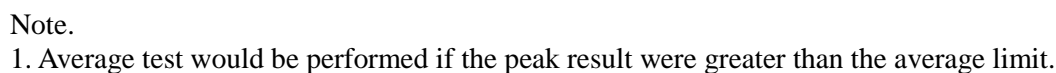
- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1007.20	52.42	Peak	H	-9.09	-	43.33	74.00	30.67
1201.20	51.13	Peak	H	-7.85	-	43.28	74.00	30.72
1751.10	46.88	Peak	H	-3.54	-	43.34	74.00	30.66
2639.70	47.56	Peak	H	0.49	-	48.05	74.00	25.95
3206.00	47.81	Peak	H	1.76	-	49.57	74.00	24.43
1201.20	48.04	Peak	V	-7.85	-	40.19	74.00	33.81
1835.00	48.89	Peak	V	-2.71	-	46.18	74.00	27.82
2199.70	46.41	Peak	V	-0.58	-	45.83	74.00	28.17

- 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)
2388.09	57.08	Peak	H	-0.22	-	56.86	74.00	17.14
2389.65	44.41	Avg	H	-0.22	-	44.19	54.00	9.81
2348.15	49.17	Peak	V	-0.30	-	48.87	74.00	25.13





A4

**KES Co., Ltd.**

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

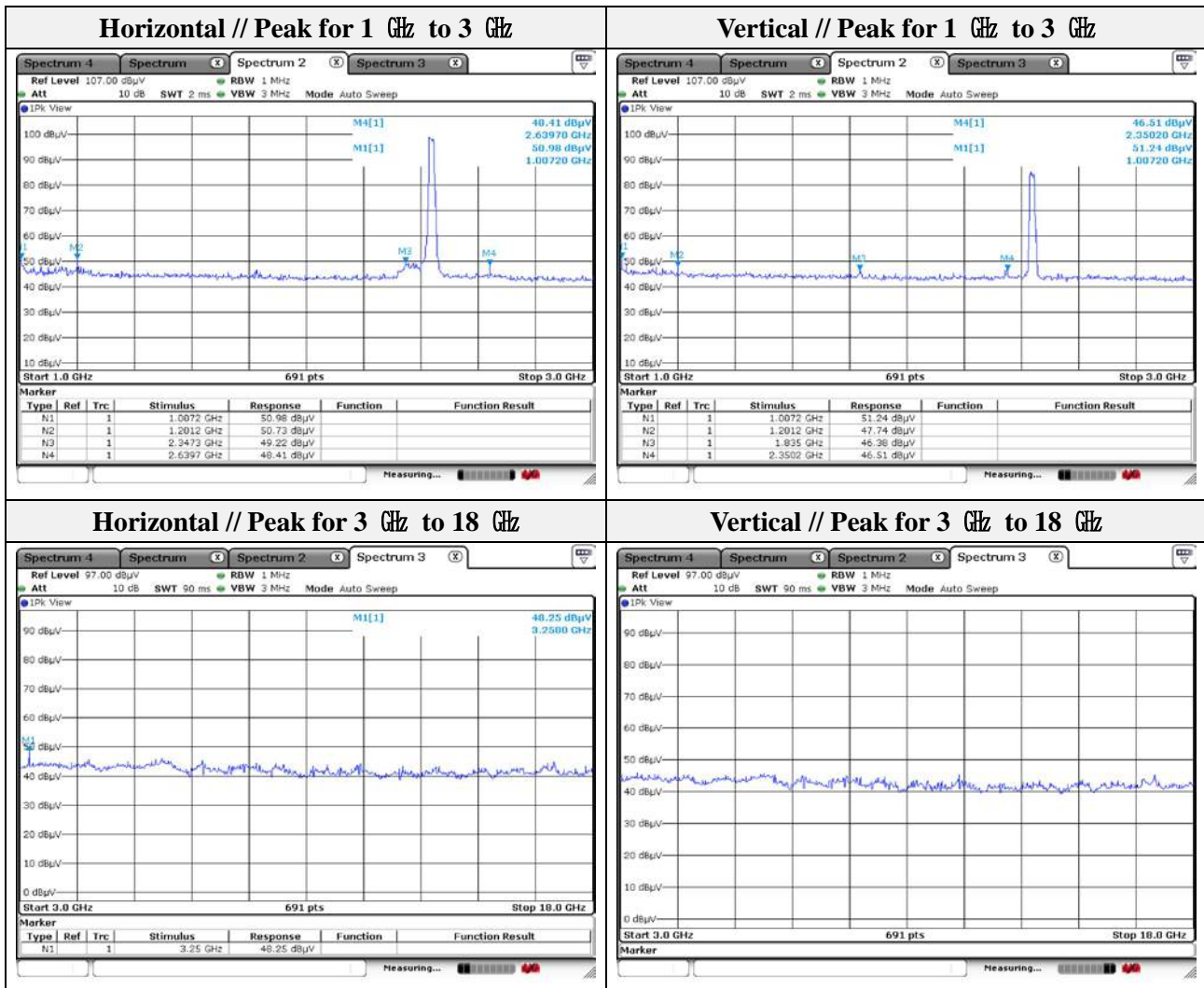
Test report No.:
KES-RF-17T0043
Page (38) of (57)

Mode: 802.11n(HT20)
Distance of measurement: 3 meter
Channel: 06

- 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)
1007.20	50.98	Peak	H	-9.09	-	41.89	74.00	32.11
1201.20	50.73	Peak	H	-7.85	-	42.88	74.00	31.12
2347.30	49.22	Peak	H	-0.30	-	48.92	74.00	25.08
2639.70	48.41	Peak	H	0.49	-	48.90	74.00	25.10
3250.00	48.25	Peak	H	1.76	-	50.01	74.00	23.99
1007.20	51.24	Peak	V	-9.09	-	42.15	74.00	31.85
1201.20	47.74	Peak	V	-7.85	-	39.89	74.00	34.11
1835.00	46.38	Peak	V	-2.71	-	43.67	74.00	30.33
2350.20	46.51	Peak	V	-0.30	-	46.21	74.00	27.79

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The test results in the report only apply to the tested sample.



Note.

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



Mode: 802.11n(HT20)

Distance of measurement: 3 meter

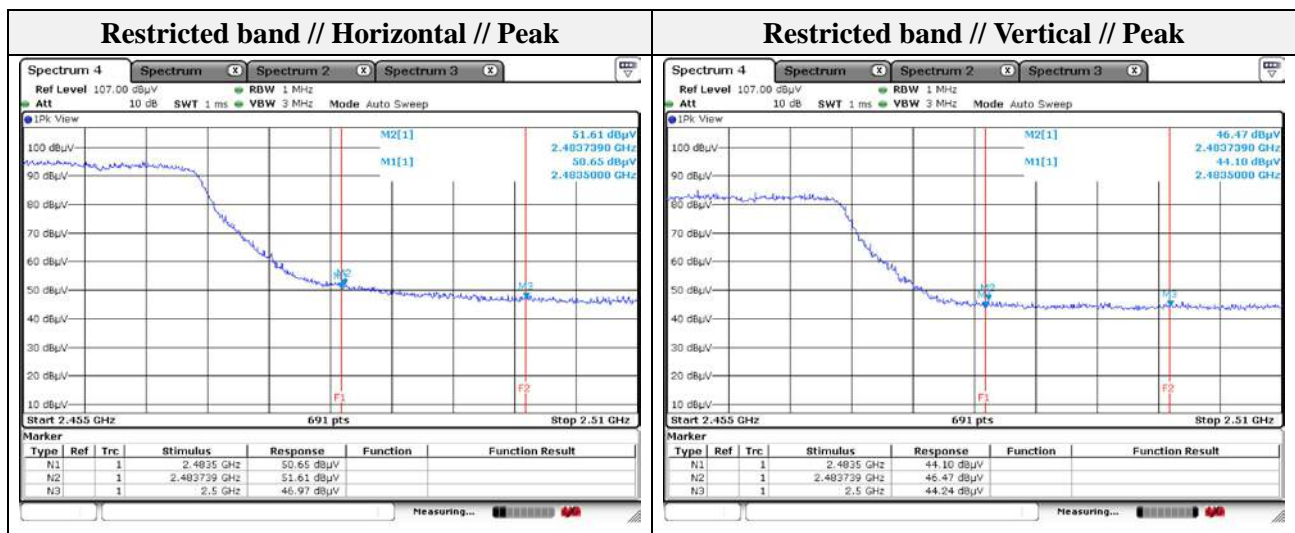
Channel: 11

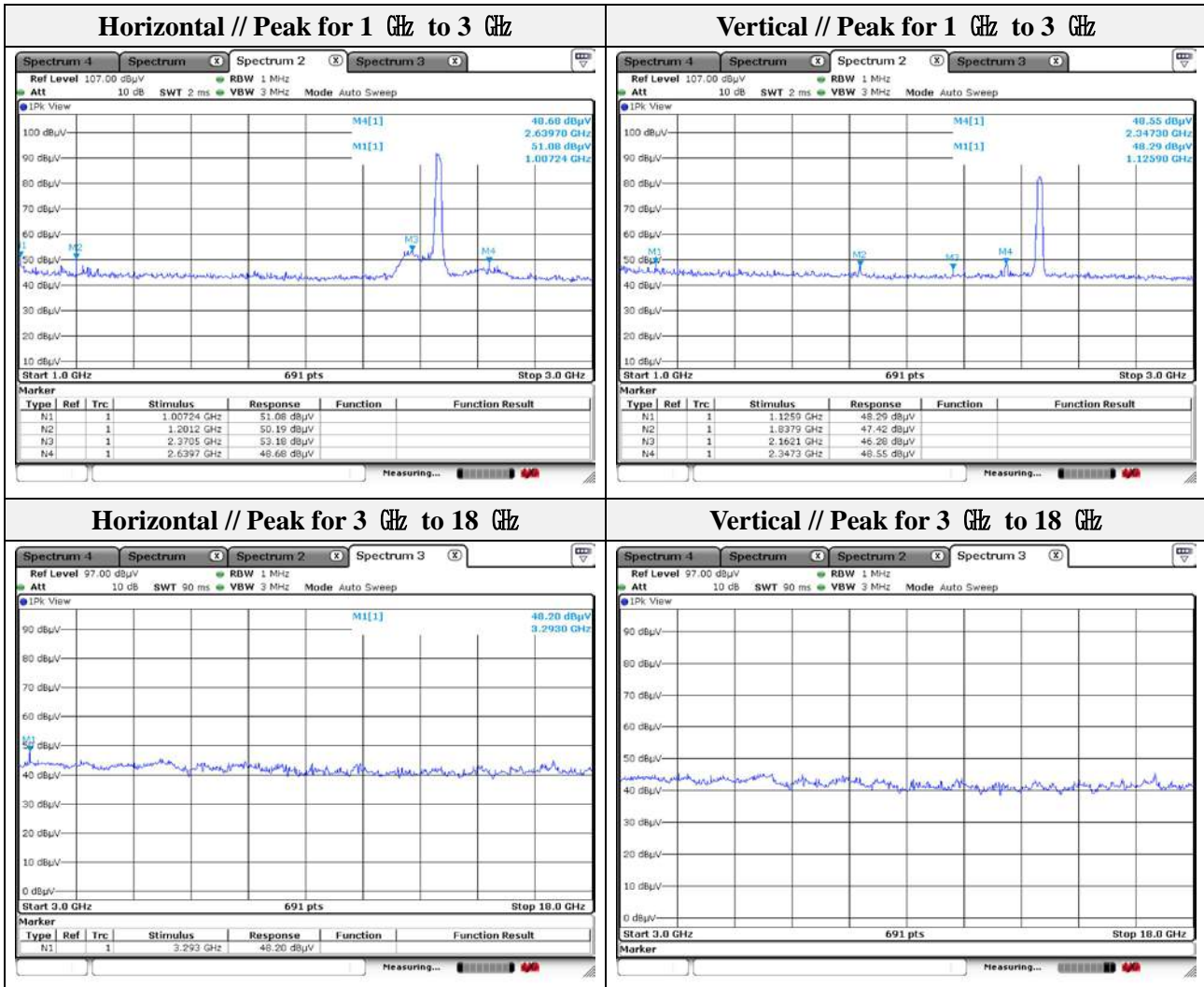
- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1007.24	51.08	Peak	H	-9.09	-	41.99	74.00	32.01
1201.20	50.19	Peak	H	-7.85	-	42.34	74.00	31.66
2370.50	53.18	Peak	H	-0.26	-	52.92	74.00	21.08
2639.70	48.68	Peak	H	0.49	-	49.17	74.00	24.83
3293.00	48.20	Peak	H	1.75	-	49.95	74.00	24.05
1125.90	48.29	Peak	V	-8.33	-	39.96	74.00	34.04
1837.90	47.42	Peak	V	-2.68	-	44.74	74.00	29.26
2162.10	46.28	Peak	V	-0.65	-	45.63	74.00	28.37
2347.30	48.55	Peak	V	-0.30	-	48.25	74.00	25.75

- 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)
2483.74	51.61	Peak	H	-0.05	-	51.56	74.00	22.44
2483.74	46.47	Peak	V	-0.05	-	46.42	74.00	27.58





Note.

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



Mode: 802.11n(HT40)

Distance of measurement: 3 meter

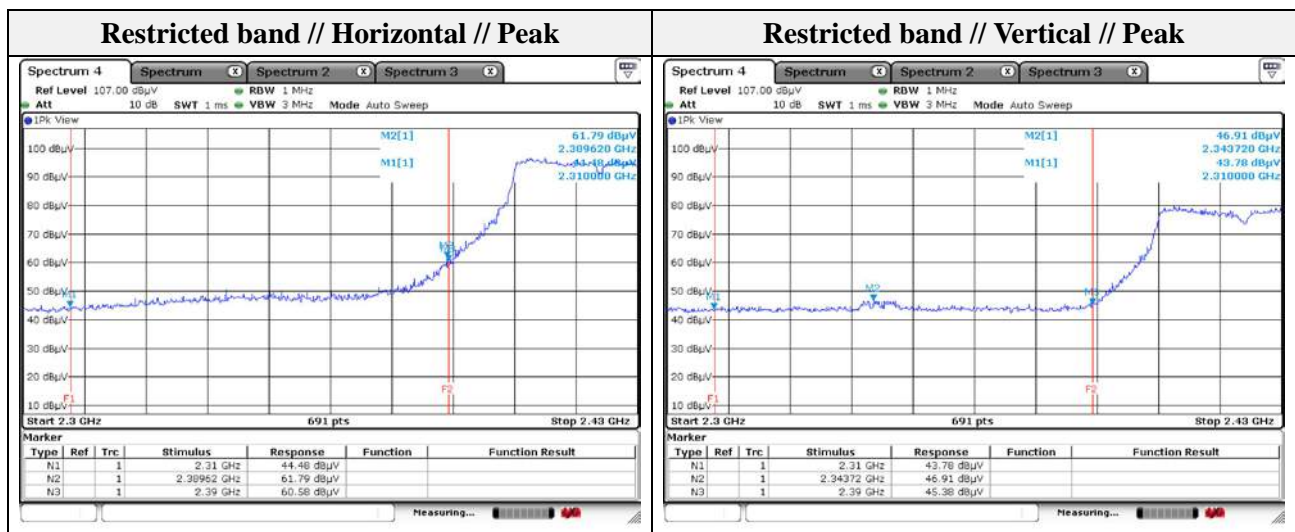
Channel: 03

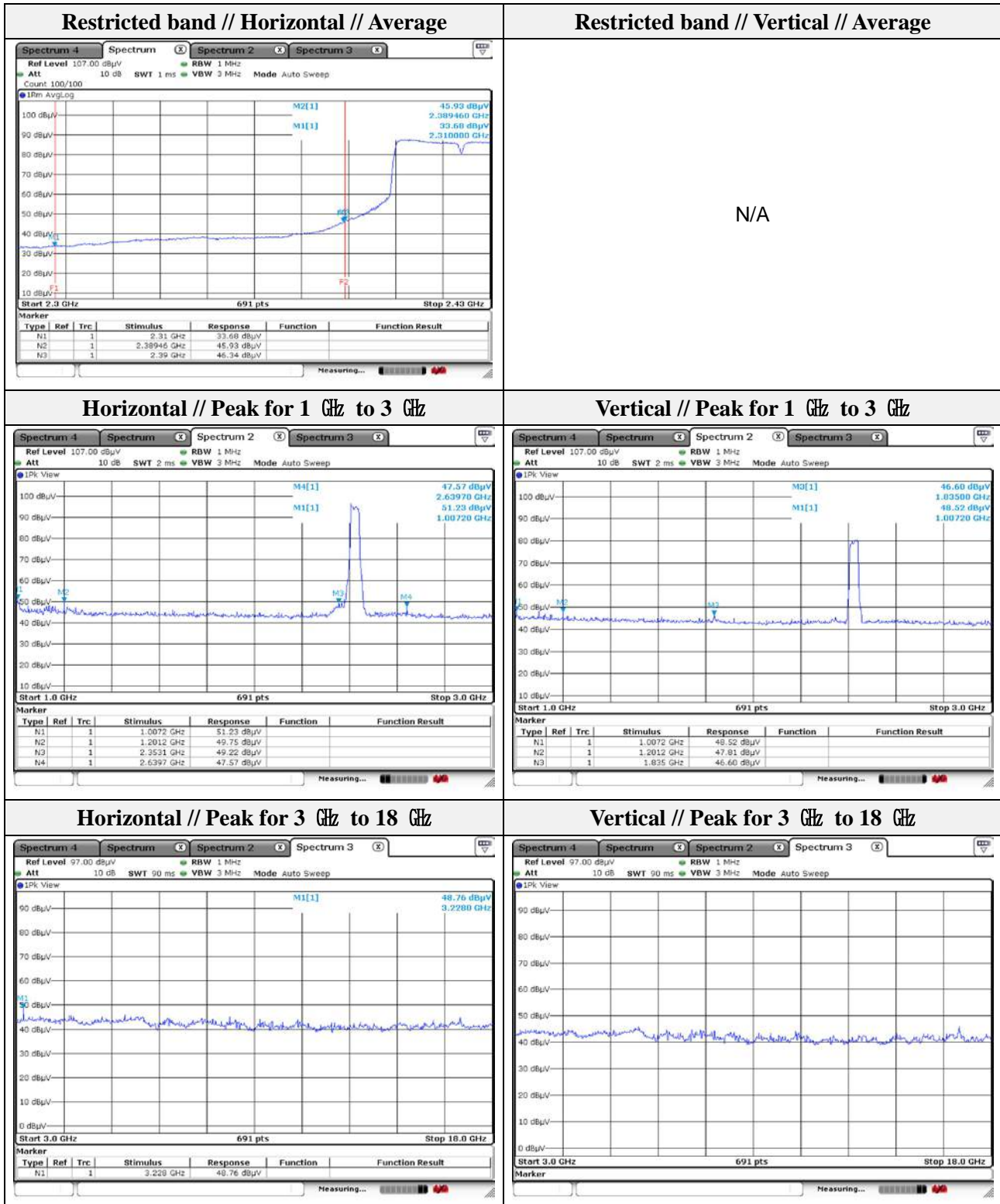
- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1007.20	51.23	Peak	H	-9.09	-	42.14	74.00	31.86
1201.20	49.75	Peak	H	-7.85	-	41.90	74.00	32.10
2353.10	49.22	Peak	H	-0.29	-	48.93	74.00	25.07
2639.70	47.57	Peak	H	0.49	-	48.06	74.00	25.94
3228.00	48.76	Peak	H	1.76	-	50.52	74.00	23.48
1007.20	48.52	Peak	V	-9.09	-	39.43	74.00	34.57
1201.20	47.81	Peak	V	-7.85	-	39.96	74.00	34.04
1835.00	46.60	Peak	V	-2.71	-	43.89	74.00	30.11

- 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)
2389.62	61.79	Peak	H	-0.22	-	61.57	74.00	12.43
2389.46	45.93	Avg	H	-0.22	-	45.71	54.00	8.29
2343.72	46.91	Peak	V	-0.31	-	46.60	74.00	27.40





Note.

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

**KES Co., Ltd.**

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

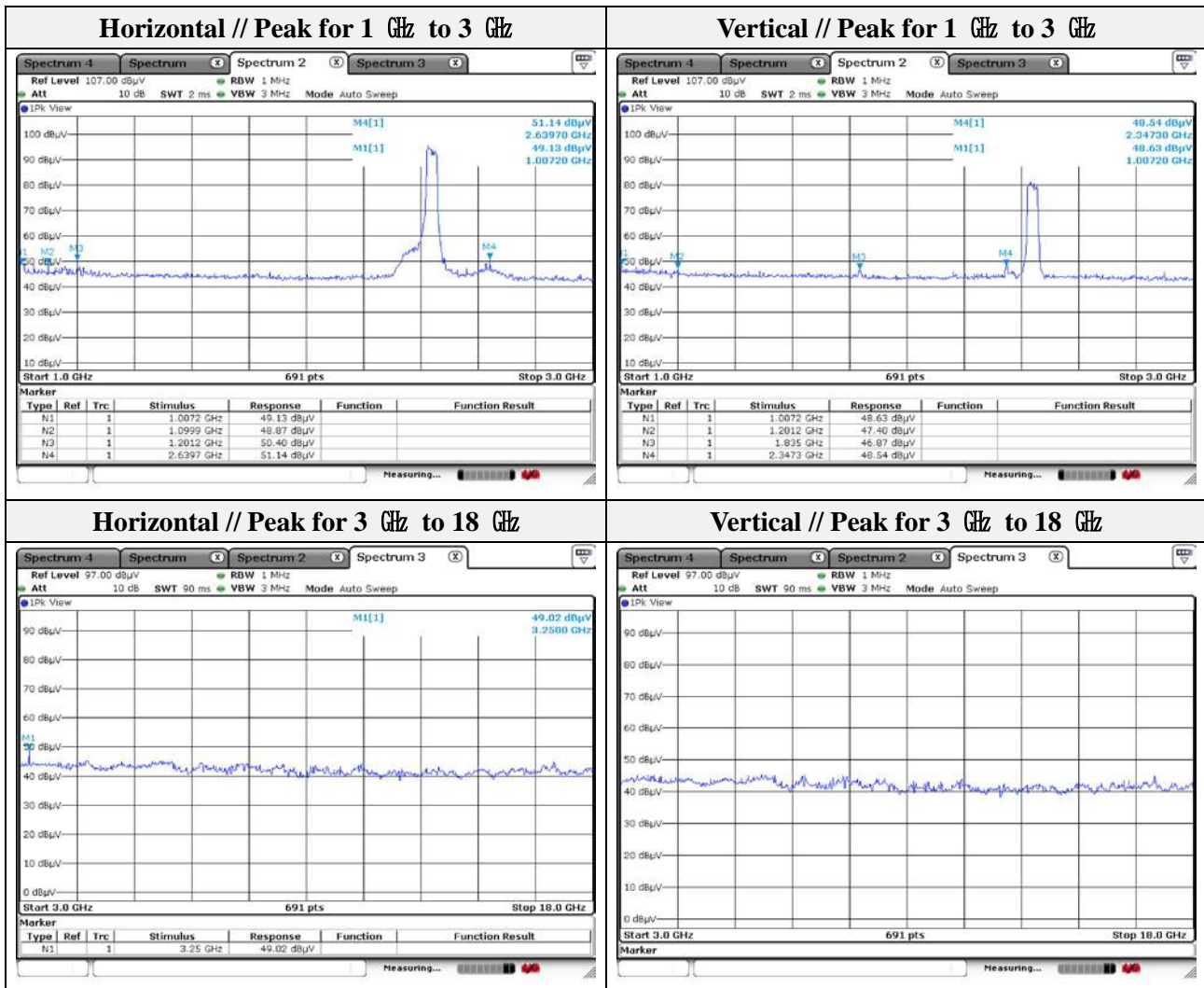
Test report No.:
KES-RF-17T0043
Page (44) of (57)

Mode: 802.11n(HT40)
Distance of measurement: 3 meter
Channel: 06

- 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)
1007.20	49.13	Peak	H	-9.09	-	40.04	74.00	33.96
1099.90	48.87	Peak	H	-8.50	-	40.37	74.00	33.63
1201.20	50.40	Peak	H	-7.85	-	42.55	74.00	31.45
2639.70	51.14	Peak	H	0.49	-	51.63	74.00	22.37
3250.00	49.02	Peak	H	1.76	-	50.78	74.00	23.23
1007.20	48.63	Peak	V	-9.09	-	39.54	74.00	34.46
1201.20	47.40	Peak	V	-7.85	-	39.55	74.00	34.45
1835.00	46.87	Peak	V	-2.71	-	44.16	74.00	29.84
2347.30	48.54	Peak	V	-0.30	-	48.24	74.00	25.76

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The test results in the report only apply to the tested sample.



Note.

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



Mode: 802.11n(HT40)

Distance of measurement: 3 meter

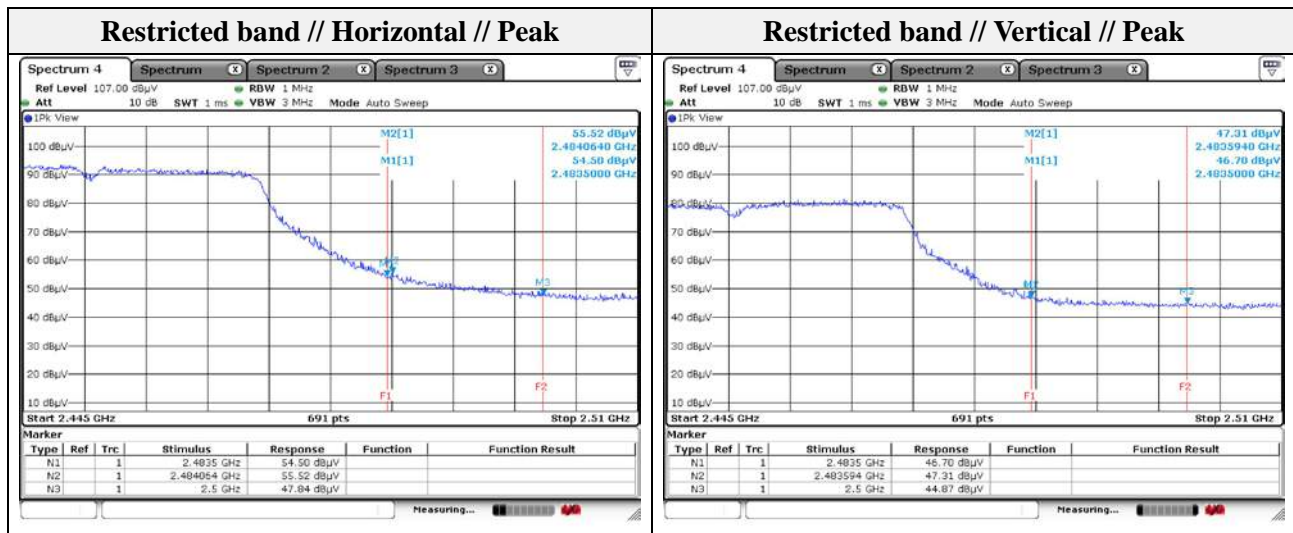
Channel: 09

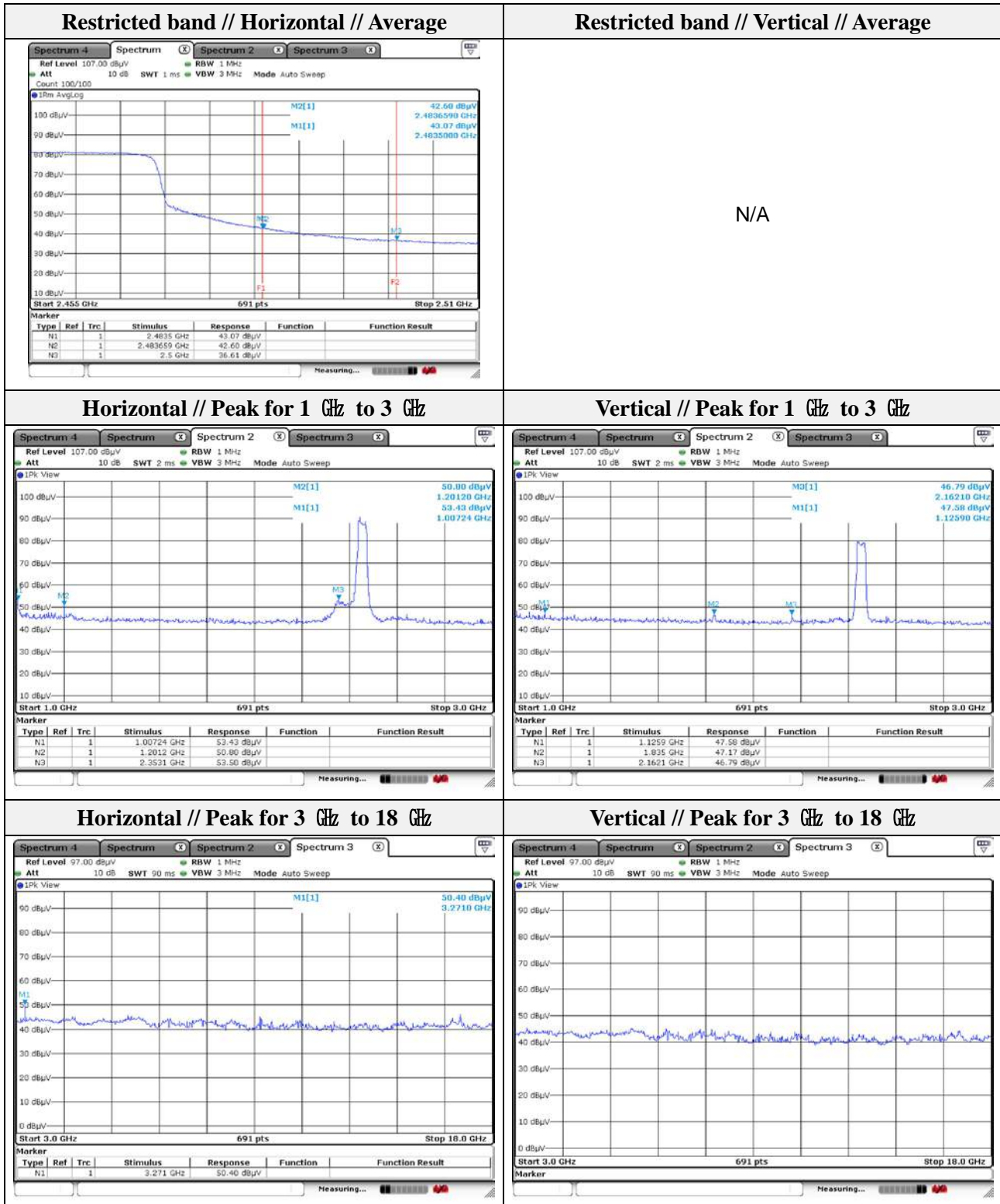
- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1007.24	53.43	Peak	H	-9.09	-	44.34	74.00	29.66
1201.20	50.80	Peak	H	-7.85	-	42.95	74.00	31.05
2353.10	53.50	Peak	H	-0.29	-	53.21	74.00	20.79
3271.00	50.40	Peak	H	1.75	-	52.15	74.00	21.85
1125.90	47.58	Peak	V	-8.33	-	39.25	74.00	34.75
1835.00	47.17	Peak	V	-2.71	-	44.46	74.00	29.54
2162.10	46.79	Peak	V	-0.65	-	46.14	74.00	27.86

- 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)
2484.06	55.52	Peak	H	-0.04	-	55.48	74.00	18.52
2483.66	42.60	Avg	H	-0.05	-	42.55	54.00	11.45
2483.59	47.31	Peak	V	-0.05	-	47.26	74.00	26.74





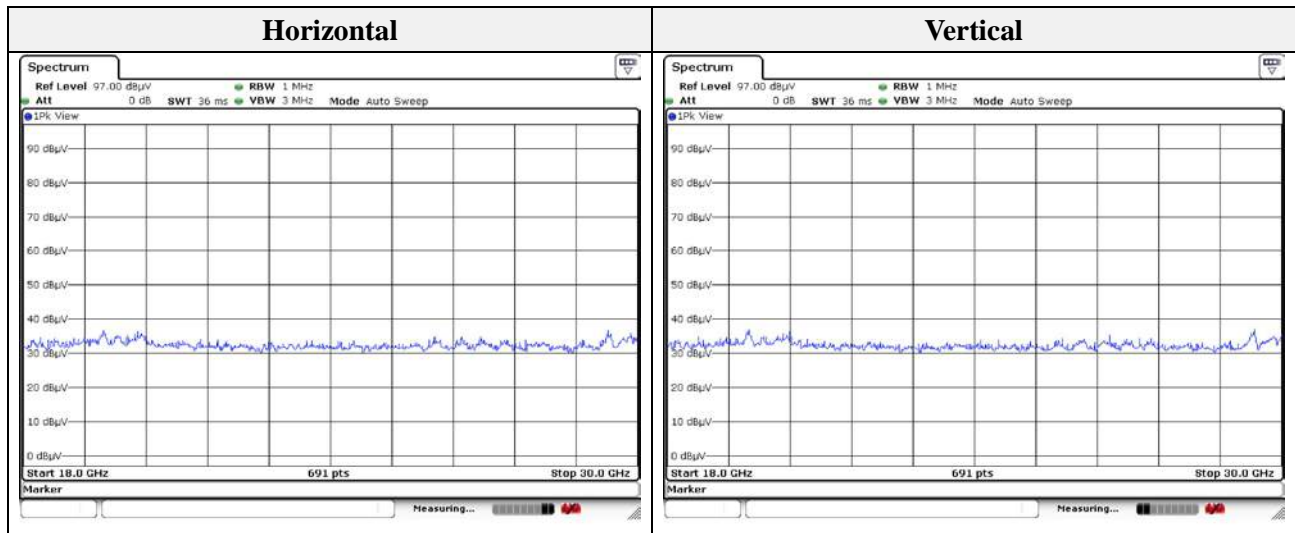
Note.

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: 802.11b
Distance of measurement: 3 meter
Channel: 11 (Worst case)



Note.

1. No spurious emission were detected above 18 GHz.

3.5 Conducted spurious emissions & band edge

Test procedure

Band edge

KDB 558074 D01 v03r05 – Section 11.3

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

Out of band emissions

KDB 558074 D01 v03r05 – Section 11.3

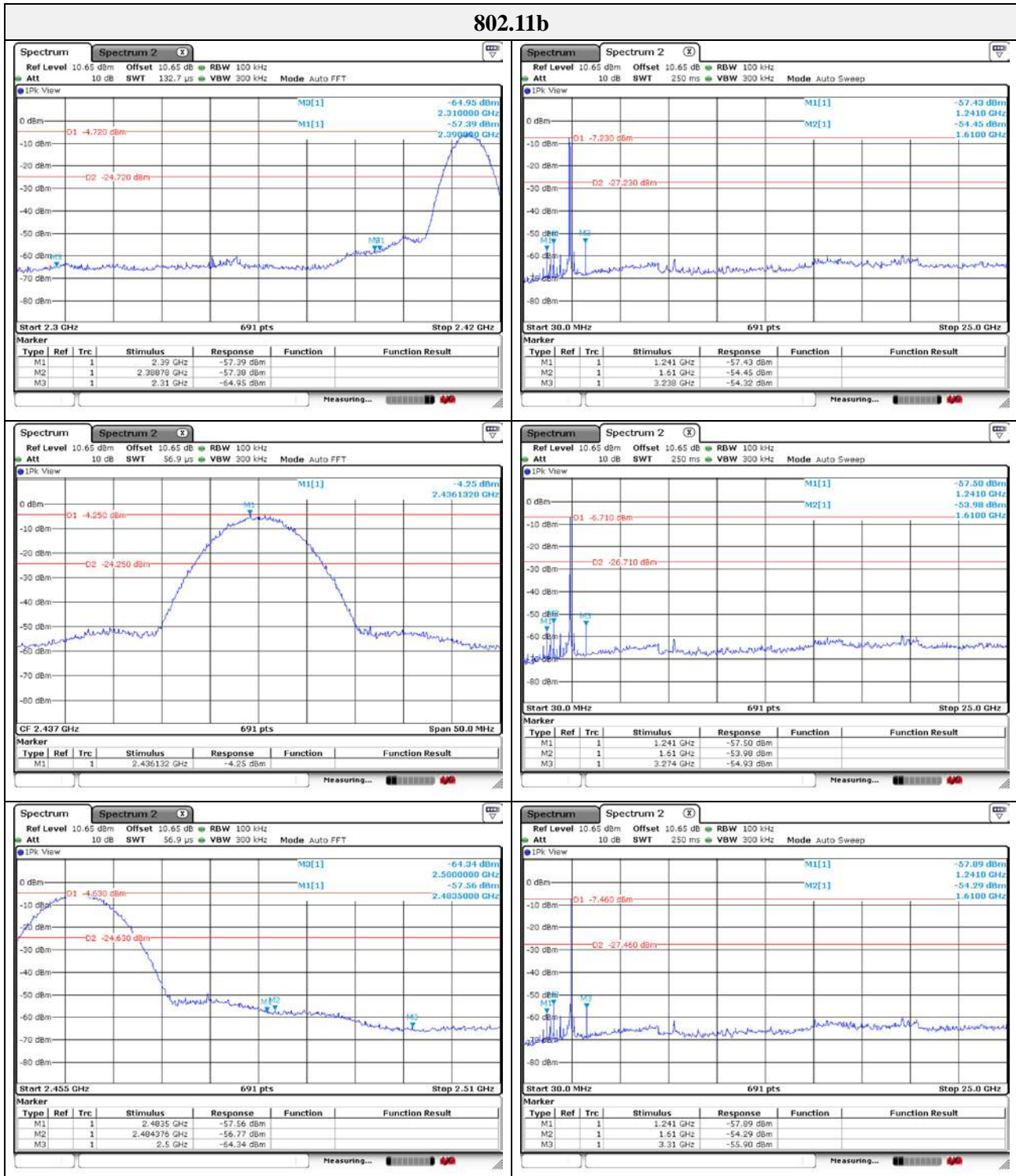
1. Start frequency was set to 30 MHz and stop frequency was set to 25 GHz for 2.4 GHz frequencies and 40 GHz for 5 GHz frequencies
2. RBW = 100 kHz
3. VBW = 300 kHz
4. Detector = Peak
5. Trace mode = max hold
6. Sweep time = auto couple
7. The trace was allowed to stabilize

Limit

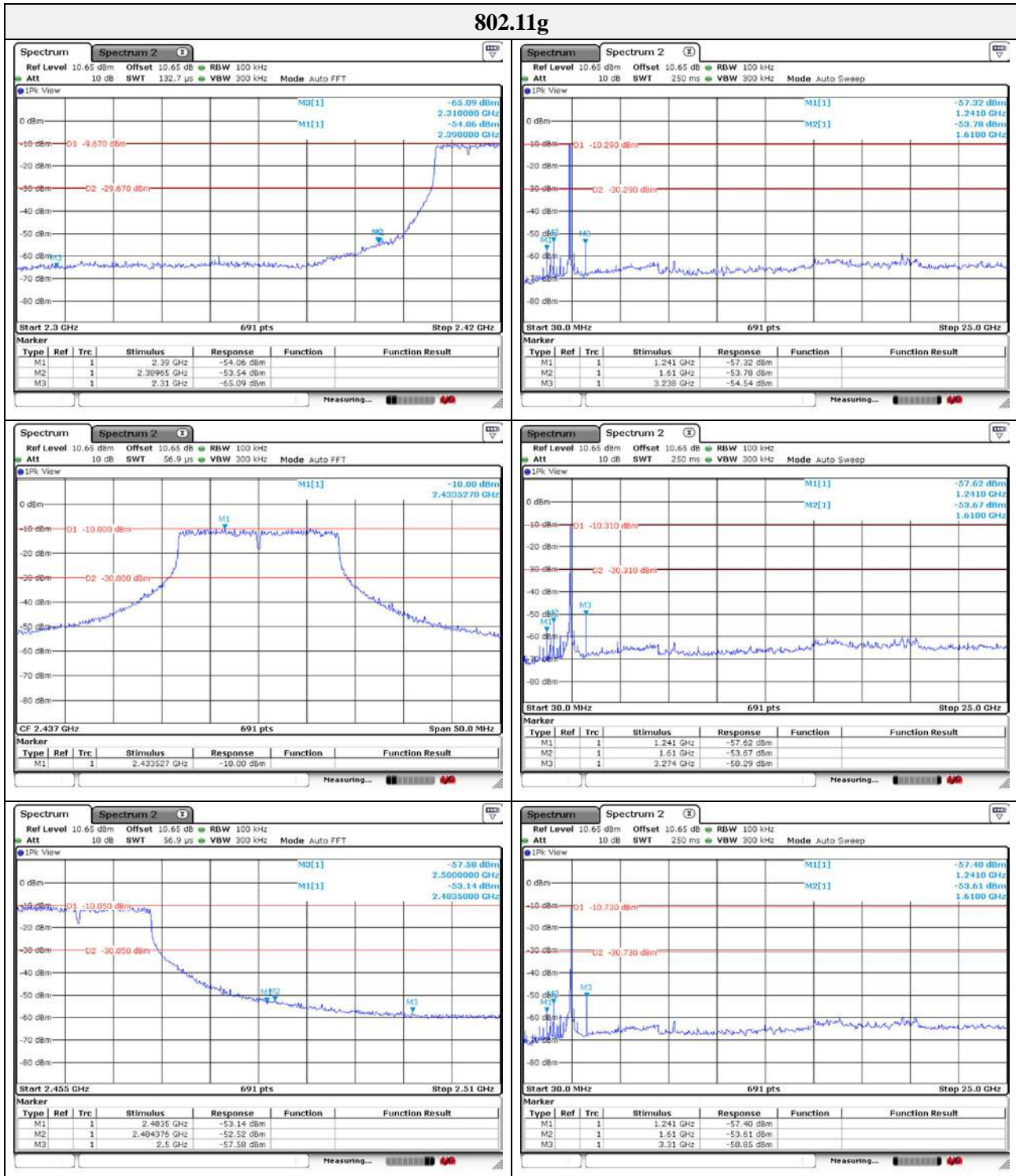
According to 15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph(b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in section 15.209(a) is not required. In addition, radiated emission which in the restricted band, as define in section 15.205(a), must also comply the radiated emission limits specified in section 15.209(a) (see section 15.205(c))



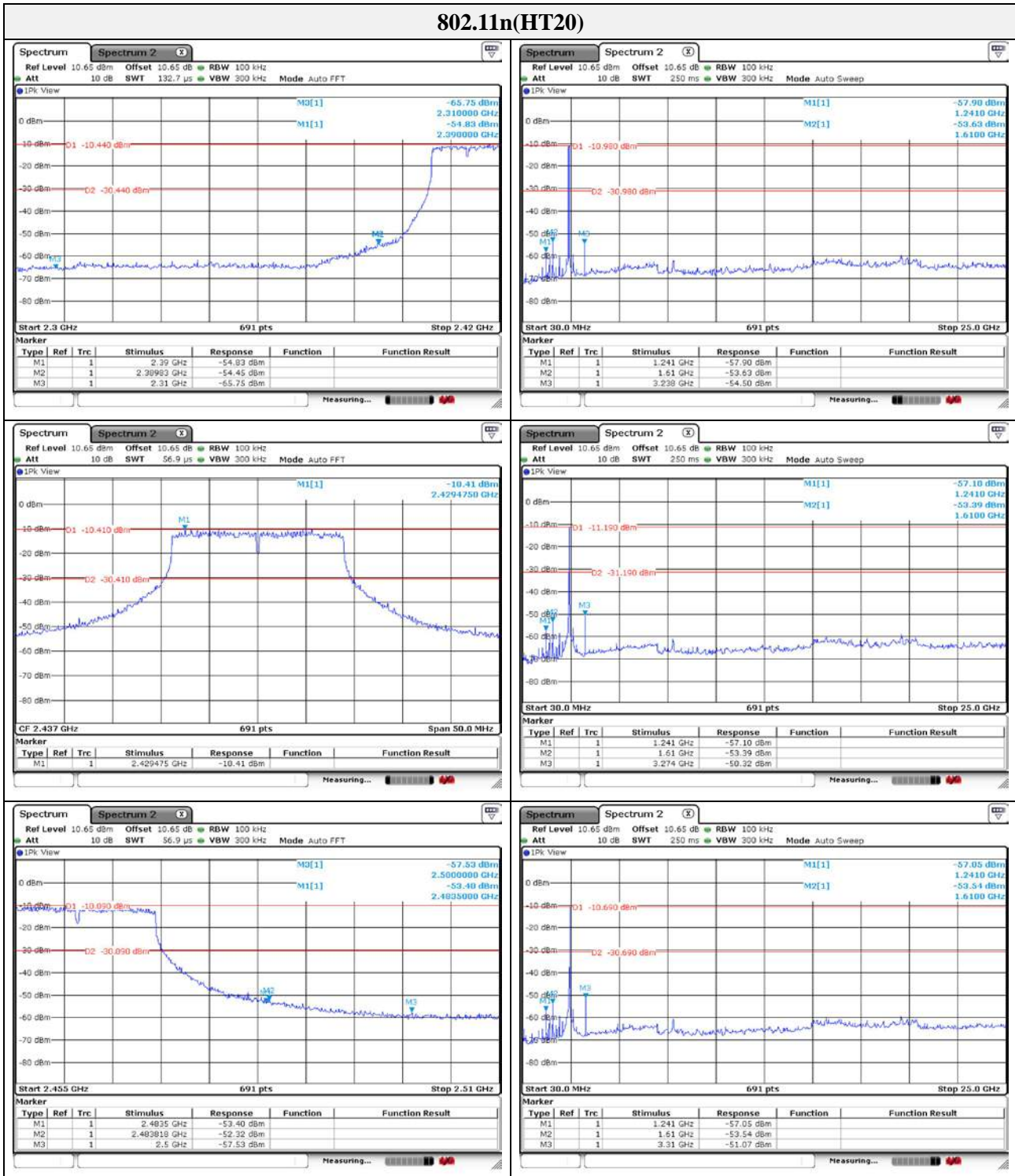
Test results



This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The test results in the report only apply to the tested sample.

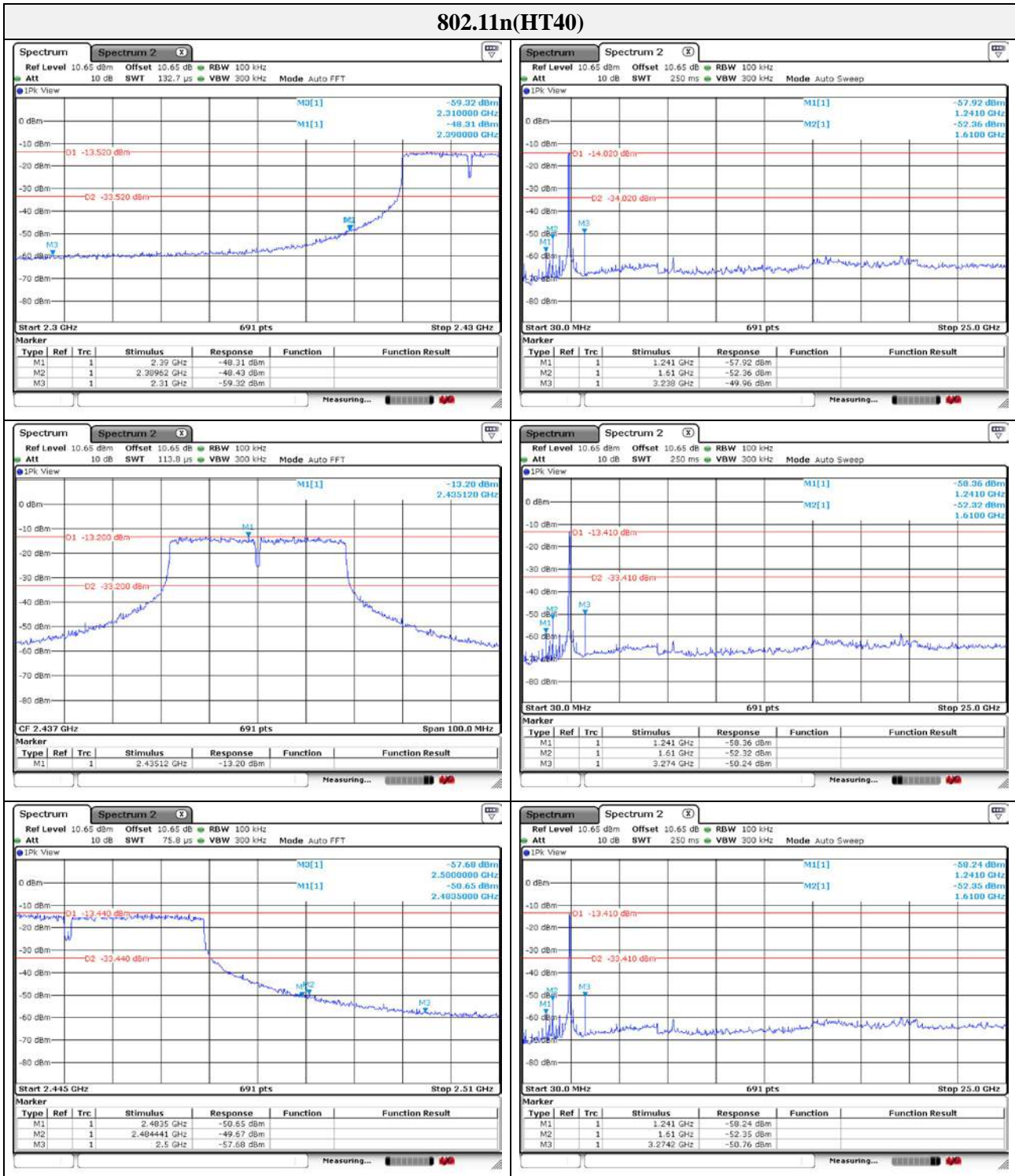


802.11n(HT20)



This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
The test results in the report only apply to the tested sample.

802.11n(HT40)



3.6. AC conducted emissions

Limit

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

Frequency of Emission (MHz)	Conducted limit (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

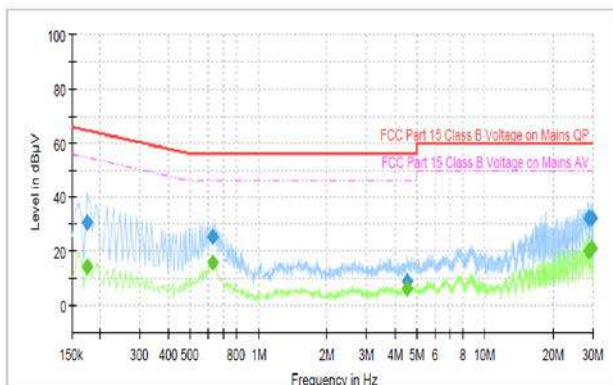
Note.

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

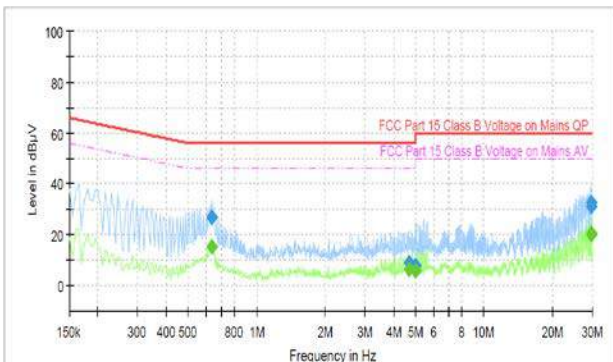
Hot Line



Final Result

Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.175000	---	14.43	54.72	40.29	1000.0	9.000	L1	20.9
0.175000	30.95	---	64.72	33.77	1000.0	9.000	L1	20.9
0.630000	---	16.05	46.00	29.95	1000.0	9.000	L1	20.4
0.630000	25.28	---	56.00	30.72	1000.0	9.000	L1	20.4
4.530000	---	6.21	46.00	39.79	1000.0	9.000	L1	19.7
4.530000	8.85	---	56.00	47.15	1000.0	9.000	L1	19.7
28.785000	---	20.11	50.00	29.89	1000.0	9.000	L1	20.3
28.785000	32.16	---	60.00	27.84	1000.0	9.000	L1	20.3
29.615000	---	21.35	50.00	28.65	1000.0	9.000	L1	20.3
29.615000	32.44	---	60.00	27.56	1000.0	9.000	L1	20.3

Neutral Line



Final Result

Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.635000	---	15.26	46.00	30.74	1000.0	9.000	N	20.4
0.635000	26.76	---	56.00	29.24	1000.0	9.000	N	20.4
4.670000	---	6.54	46.00	39.46	1000.0	9.000	N	19.7
4.670000	9.12	---	56.00	46.88	1000.0	9.000	N	19.7
4.975000	---	6.02	46.00	39.98	1000.0	9.000	N	19.7
4.975000	8.08	---	56.00	47.92	1000.0	9.000	N	19.7
29.530000	---	20.72	50.00	29.28	1000.0	9.000	N	20.3
29.530000	31.47	---	60.00	28.53	1000.0	9.000	N	20.3
29.630000	---	20.35	50.00	29.65	1000.0	9.000	N	20.3
29.630000	32.61	---	60.00	27.39	1000.0	9.000	N	20.3



Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum Analyzer	R&S	FSV30	100736	1 year	2017.07.06
Spectrum Analyzer	R&S	FSV40	101002	1 year	2017.07.06
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2018.01.23
Power Meter	Anritsu	ML2495A	1438001	1 year	2018.01.23
Pluse Power Sensor	Anritsu	MA2411B	1339205	1 year	2018.01.23
Attenuator	Agilent	8493C	51401	1 year	2017.07.05
Loop Antenna	ETS-LINDGRREN	6502	00148046	2 years	2019.01.05
Trilog-broadband antenna	SCHWARZBECK	VULB 9163	9168-713	2 years	2017.05.15
Horn Antenna	A.H	SAS-571	781	2 years	2019.02.15
Horn Antenna	SCHWARZBECK	BBHA9170	BBHA9170550	2 years	2017.04.30
High Pass Filter	WAINWRIGHT INSTRUMENT	WHJS3000-10TT	1	1 year	2017.07.04
Low Pass Filter	WEINSCHL	WLK1.0/18G-10TT	1	1 year	2017.07.04
Preamplifier	HP	8449B	3008A00538	1 year	2017.07.05
Preamplifier	SCHWARZBECK	BBV-9718	9718-246	1 year	2017.10.14
EMI Test Receiver	R&S	ESR3	101781	1 year	2017.05.03
EMI Test Receiver	R&S	ESU26	100552	1 year	2017.04.24
EMI Test Receiver	R&S	ESR3	101783	1 year	2017.05.03
Pulse Limiter	R&S	ESH3-Z2 0357.8810.54	101914	1 year	2017.12.13
LISN	R&S	ENV216	101137	1 year	2018.02.03

Peripheral devices

Device	Manufacturer	Model No.	Serial No.
Notebook Computer	LG Electronics Inc.	LGS53	306QCZP560949
Test Board	N/A	N/A	N/A