

TEST REPORT

Part 15 Subpart C 15.247

Equipment under test DUAL-MODE BABY MONITOR

Model name SEM-3053WN

FCC ID NLMSEM3053WN

Applicant Hanwha Techwin Co., Ltd.

Manufacturer RDI Technology (Shenzhen) Co.,Ltd.

Date of test(s) 2016.12.29 ~ 2017.01.09

Date of issue 2017.01.10

Issued to

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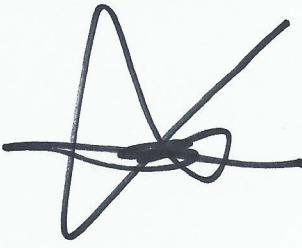
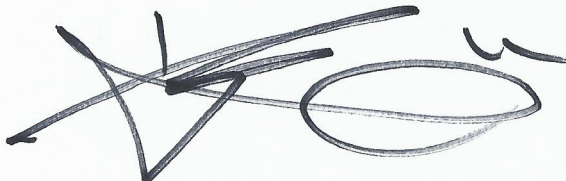
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Test and report completed by :	Report approval by :
	
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The test results in the report only apply to the tested sample.



Revision history

Revision	Date of issue	Test report No.	Description
-	2017.01.10	KES-RF-17T0001	Initial

TABLE OF CONTENTS

1.	General information	4
1.1.	EUT description.....	4
1.2.	Test configuration	5
1.3.	Frequency/channel operations	5
1.4.	Accessory information	5
1.5.	Device modifications.....	5
1.6.	Derivation model information	5
2.	Summary of tests	6
3.	Test results	7
3.1.	20 dB bandwidth	7
3.2.	Peak output power	9
3.3.	Carrier frequency separation	11
3.4.	Number of hopping frequency.....	12
3.5.	Time of occupancy	13
3.6.	Radiated restricted band and emissions	15
3.7.	Conducted spurious emissions & band edge	29
3.8.	AC conducted emissions	32
Appendix A.	Measurement equipment	34
Appendix B.	Test setup photos	35

1. General information

Applicant: Hanwha Techwin Co., Ltd.
Applicant address: 1204, Changwon-daero, Seongsan-gu, Changwon-si
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Test site: KES Co., Ltd.
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473-21, Gayeo-ro, Yeosu-si, Gyeonggi-do, Korea
FCC rule part(s): 15.247
FCC ID: NLMSEM3053WN
Test device serial No.: ☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test DUAL-MODE BABY MONITOR
Frequency range 2 408 MHz ~ 2 468 MHz
Model: SEM-3053WN
Modulation technique FHSS, GFSK
Number of channels 16
Antenna specification Antenna type: Dipole, Peak gain: 2.0 dBi
Power source DC 3.7 V (Rechargeable Battery)

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

15.247(g): 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): 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 16 RF channels.

Equal hopping frequency use

All channels are used equally on average.

Example of a 16 hopping sequence in data mode:

12, 14, 03, 16, 02, 05, 10, 06, 09, 01, 13, 07, 11, 08, 15, 04

1.2. Test configuration

The Hanwha Techwin Co., Ltd. DUAL-MODE BABY MONITOR FCC ID: NLMSEM3053WN 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. Frequency/channel operations

Ch.	Frequency (MHz)
01	2408
.	.
09	2440
.	.
16	2468

1.4. Accessory information

Applicant	Equipment	Manufacturer	Model	Power source
-	-	-	-	-

1.5. Device modifications

N/A

1.6. Derivation model information

N/A

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 setting

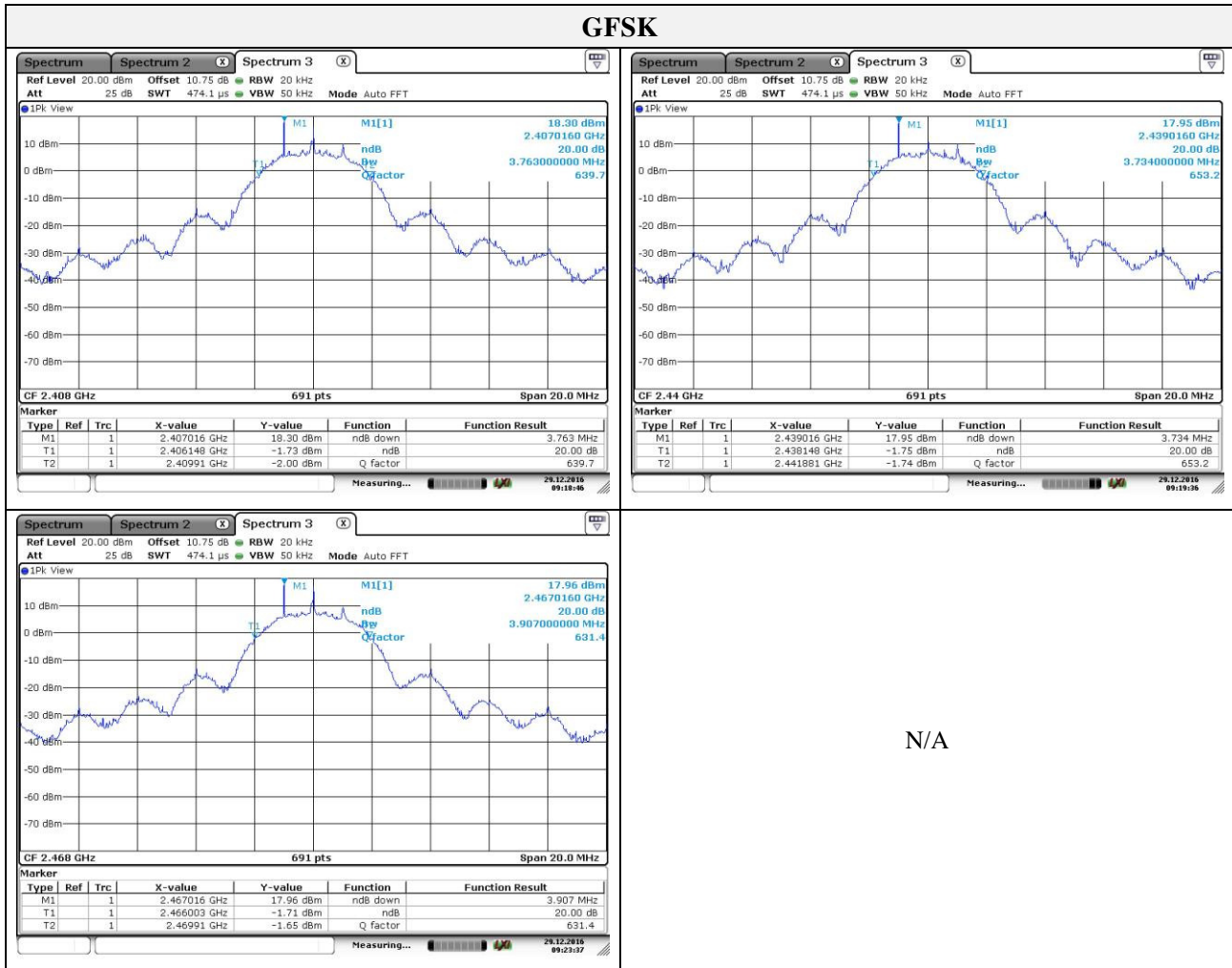
1. Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
2. RBW $\geq$ 1% of the 20 dB bandwidth
3. VBW $\geq$ RBW
4. Sweep = auto
5. Detector function = peak
6. Sweep = auto couple
7. Trace mode = max hold

Limit

Not applicable

Test results

Frequency(MHz)	20 dB bandwidth(MHz)	Limit(MHz)
2 408	3.763	0.5
2 440	3.734	
2 468	3.907	



3.2. Peak output power

Test procedure

DA 00-705

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

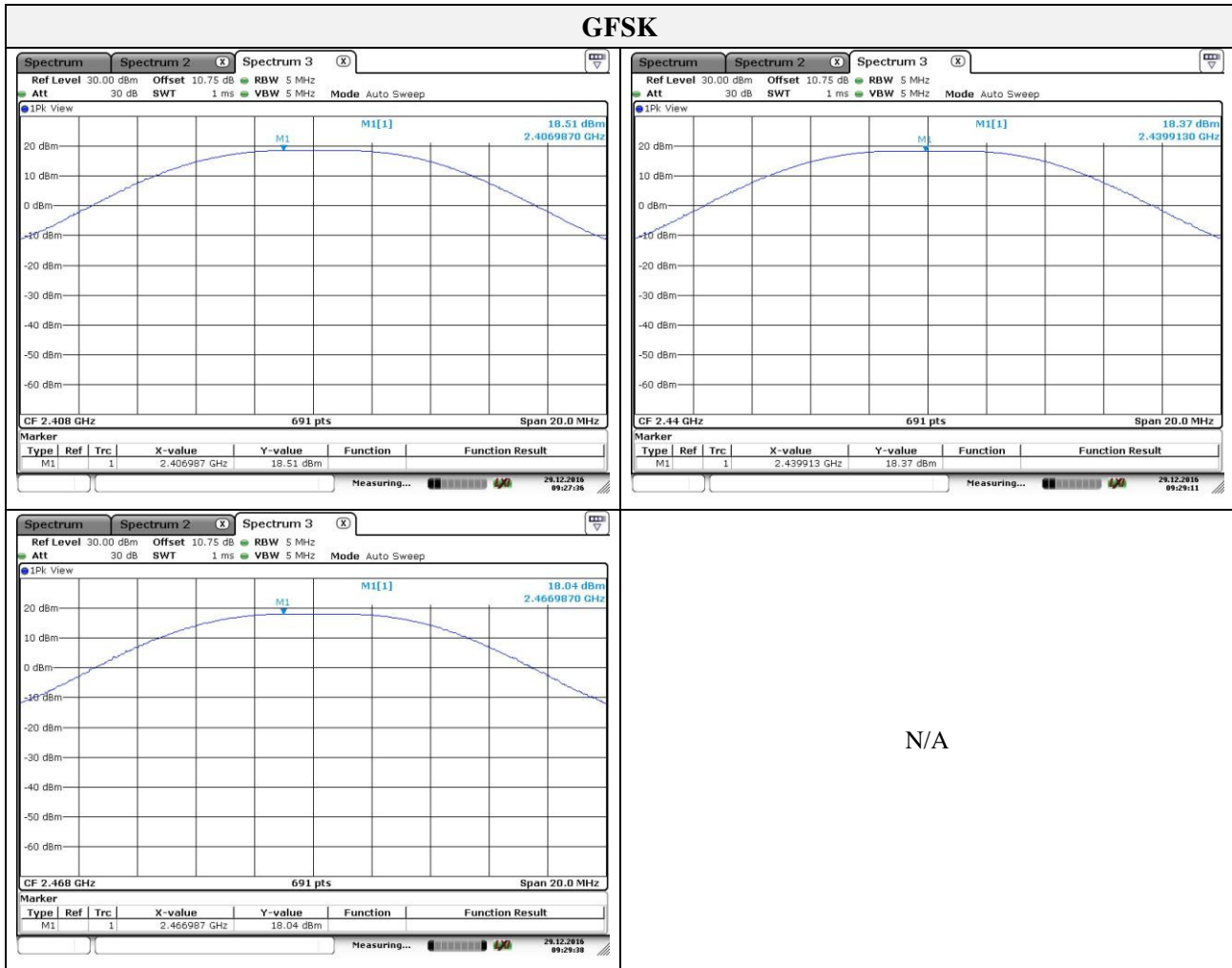
Limit

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.	Measured power (dBm)	Peak Power Limit (dBm)
2 408	01	18.51	20.97
2 440	09	18.37	20.97
2 468	16	18.04	20.97



3.3. Carrier frequency separation

Test procedure

DA 00-705

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

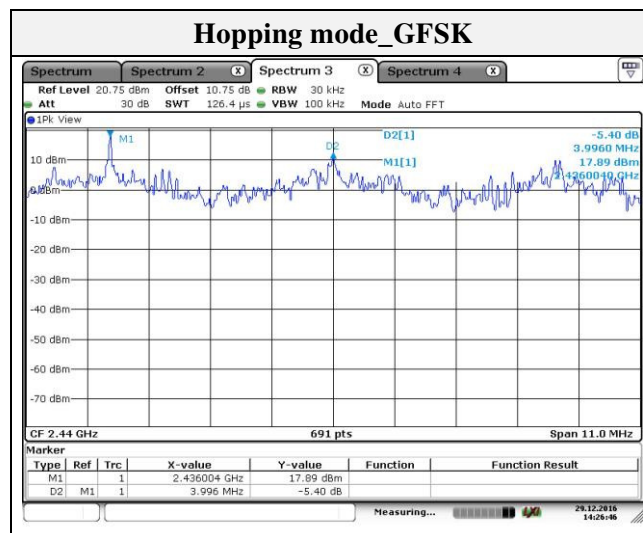
Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

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.

Test results

Frequency(MHz)	Channel no.	Channel Separation (MHz)
2 440	09	3.996



3.4. Number of hopping frequency

Test procedure

DA 00-705

Test setting

1. The EUT must have its hopping function enabled.
2. Frequency range: 2 400 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

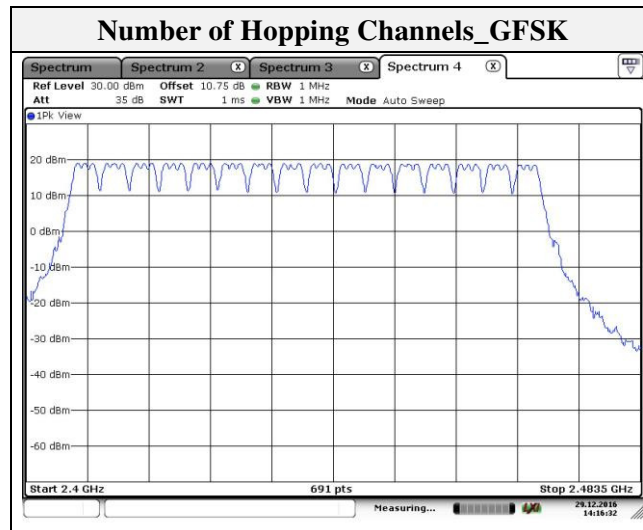
All the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

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.

Test results

Frequency	Number of hopping frequency	Limit
2 408 ~ 2 468 MHz	16	≥ 15



3.5. Time of occupancy

Test procedure

DA 00-705

Test setting

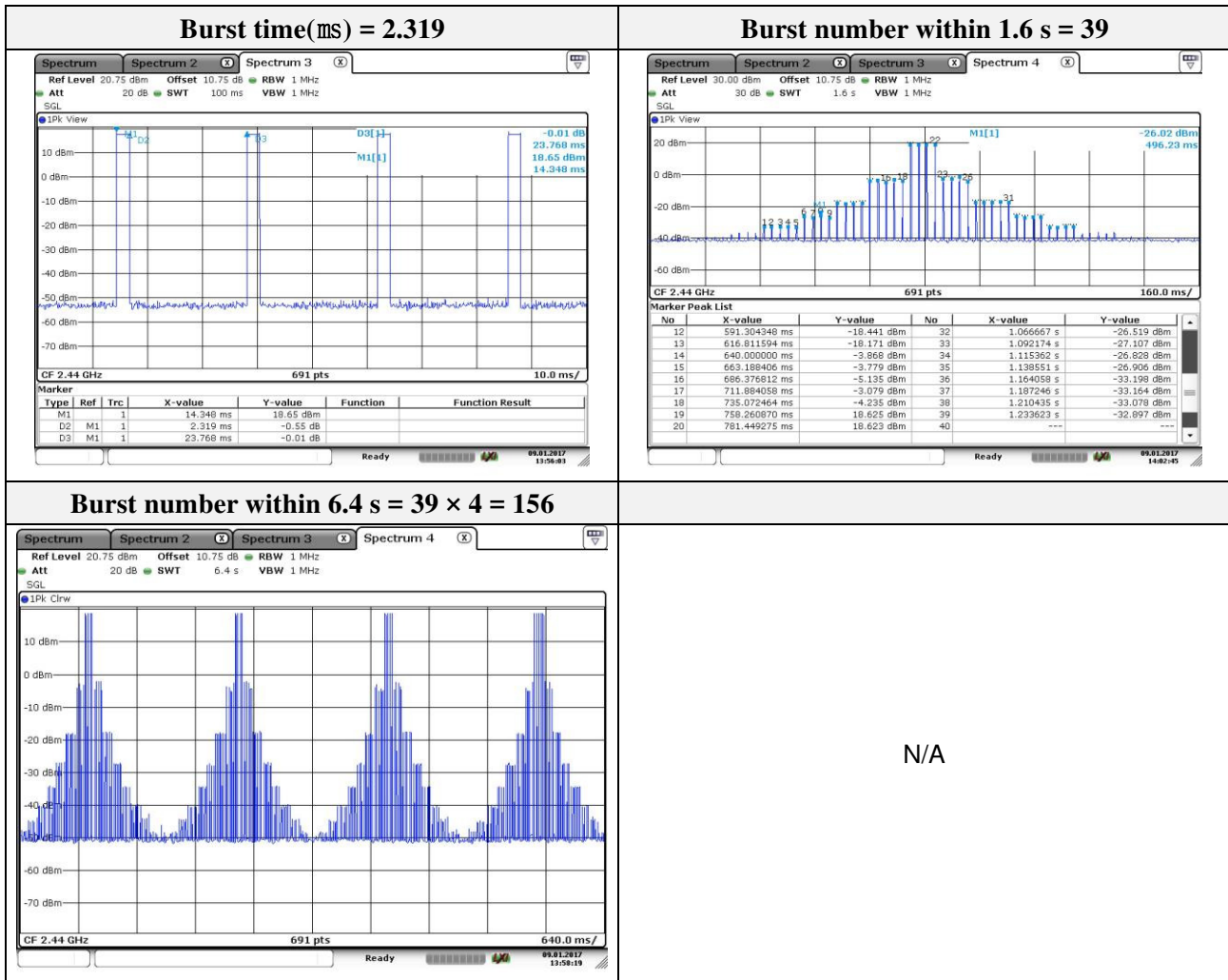
1. The EUT must have its hopping function enabled.
2. Span = zero span, centered on a hopping channel
4. RBW = 1 MHz
5. VBW = 1 MHz ($\geq$ RBW)
6. Sweep = as necessary to capture the entire dwell time per hopping channel
7. Detector function = peak
8. Trace = max hold

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 6.4 second period.

A period time = $0.4(s) \times 16 = 6.4(s)$

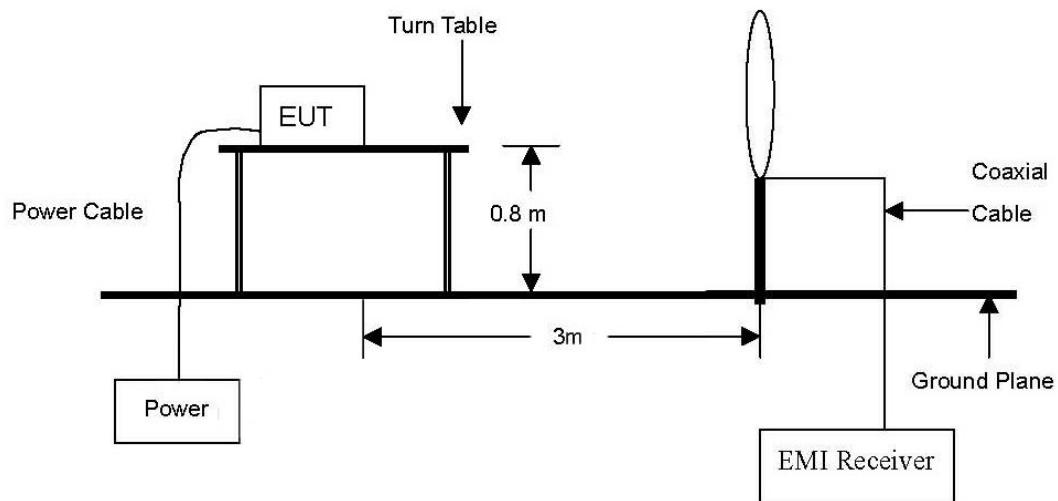
Frequency (MHz)	Burst time (ms)	Burst number	Time of occupancy (ms)	Limit (ms)
2 440	2.319	156	361.764	400



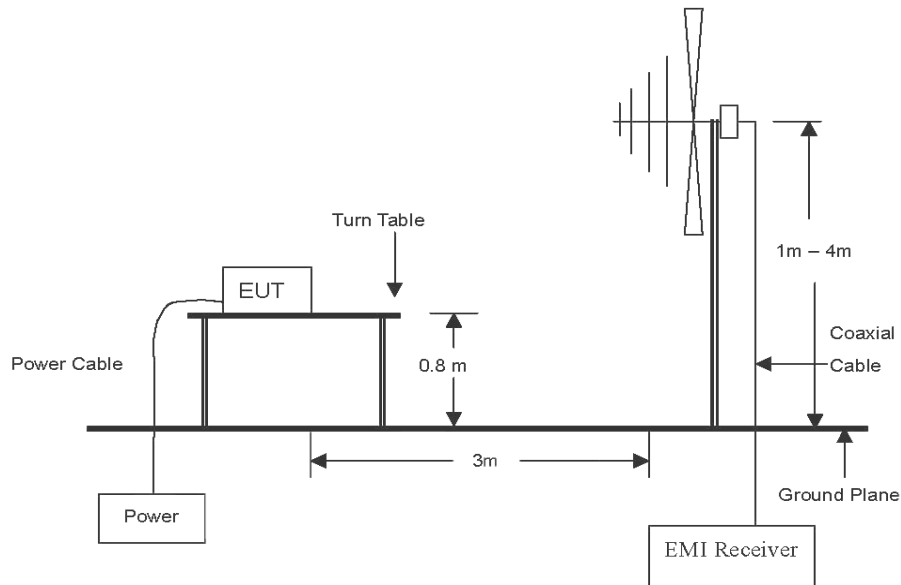
3.6 Radiated restricted band and emissions

Test setup

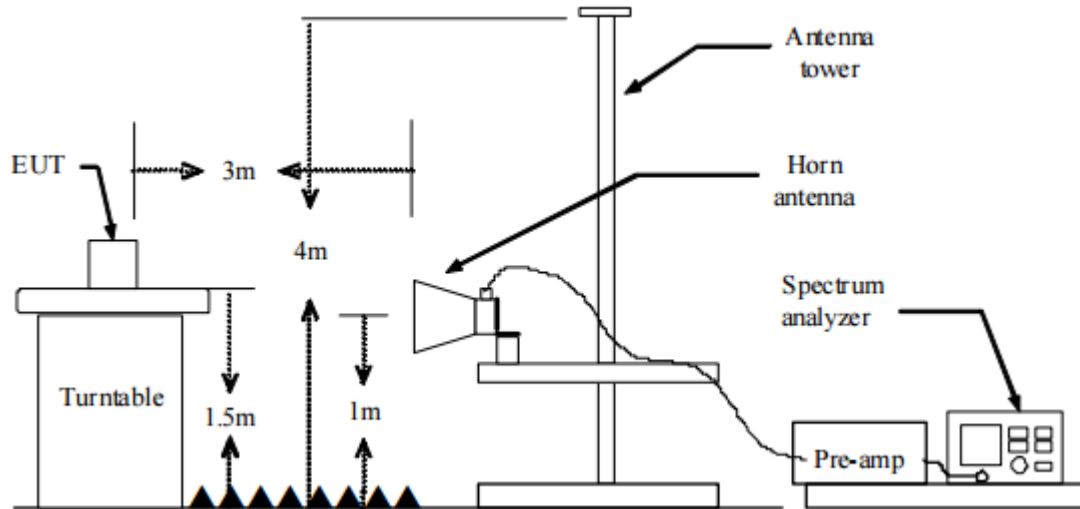
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions.



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 above 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 (16 channel hopping)
 - a. Time to cycle through all channels = $\Delta t = \tau[\text{ms}] \times 16 \text{ channels} = 37.104 \text{ ms}$, 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 = $\tau[\text{ms}] \times H' = 2.319 \text{ ms}$
 - d. Duty Cycle Correction = $20 \log (\text{Worst Case Dwell Time} / 100 \text{ ms}) \text{ dB} = -32.69 \text{ dB}$

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. $f < 30 \text{ MHz}$, 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

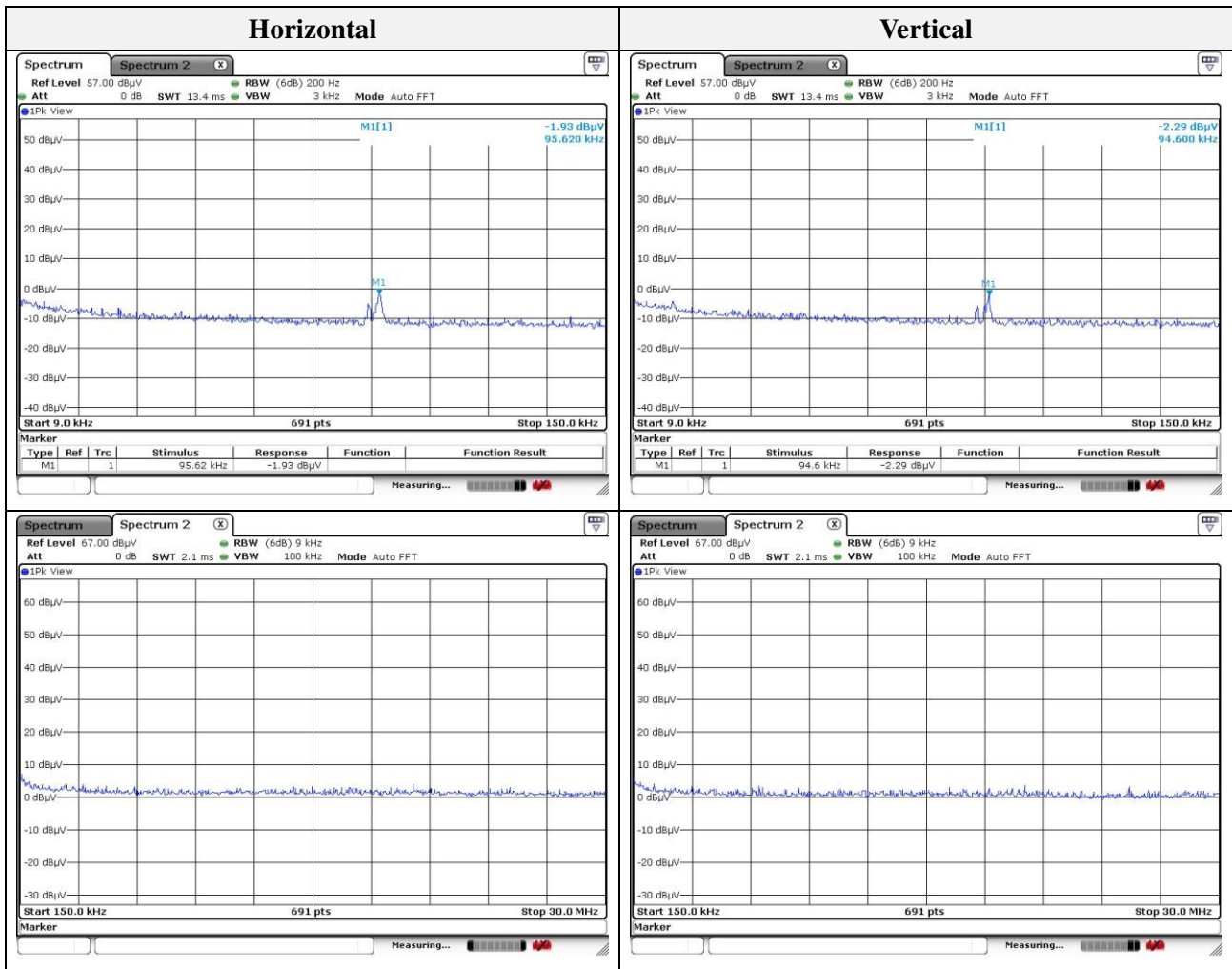
**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 ~ 72 MHz, 76 ~ 88 MHz, 174 ~ 216 MHz or 470 ~ 806 MHz. However, operation within these frequency bands is permitted under other sections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



Test results (Below 30 MHz)

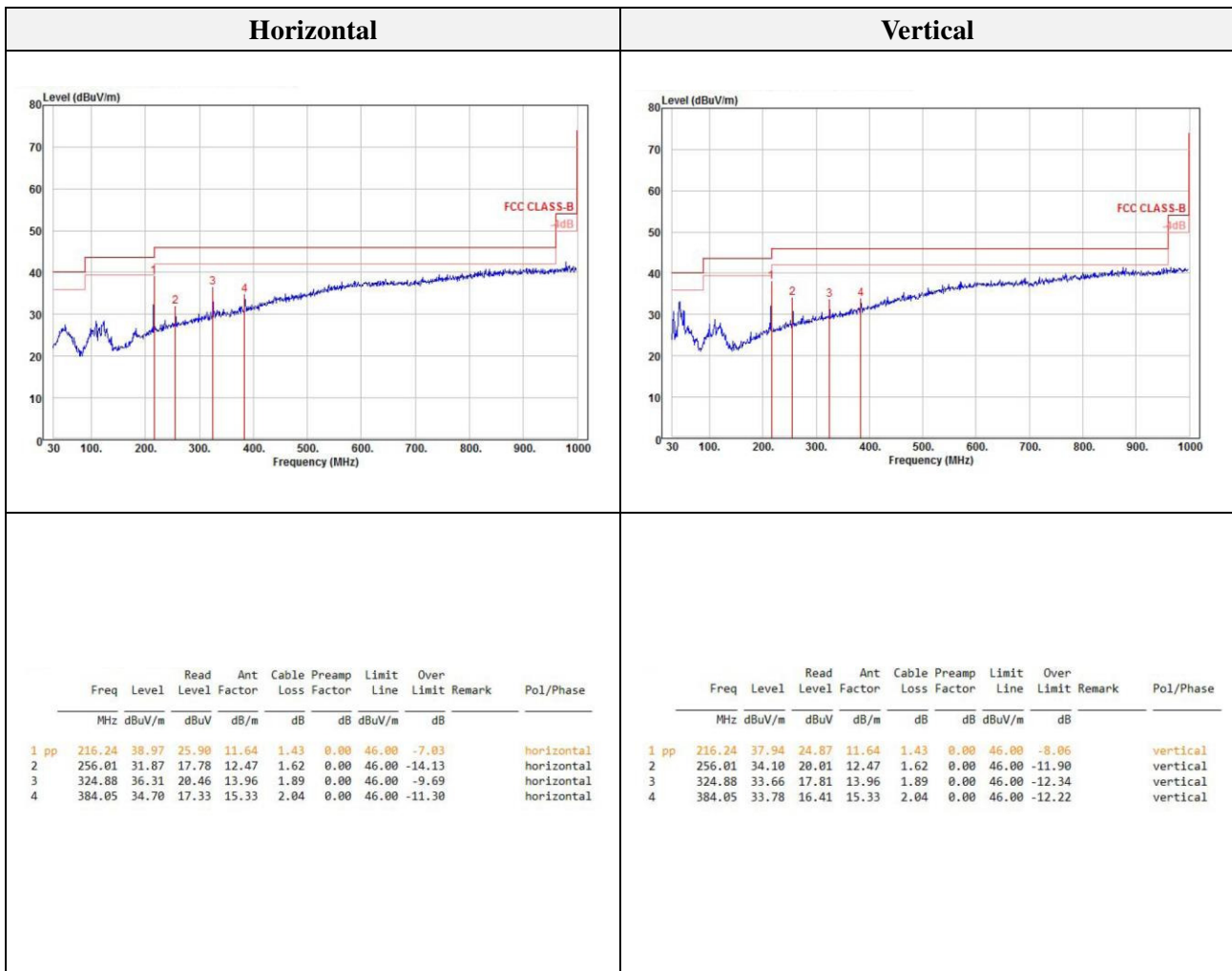
Mode: GFSK
Distance of measurement: 3 meter
Channel: 01 (Worst case)

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 20 dB of the limit							



Test results (Below 1 000 MHz)

Mode: GFSK
Distance of measurement: 3 meter
Channel: 01 (Worst case)



Note.

1. All spurious emission at channels are almost the same below 1 GHz, so that low channel was chosen at representative in final test.
2. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes.

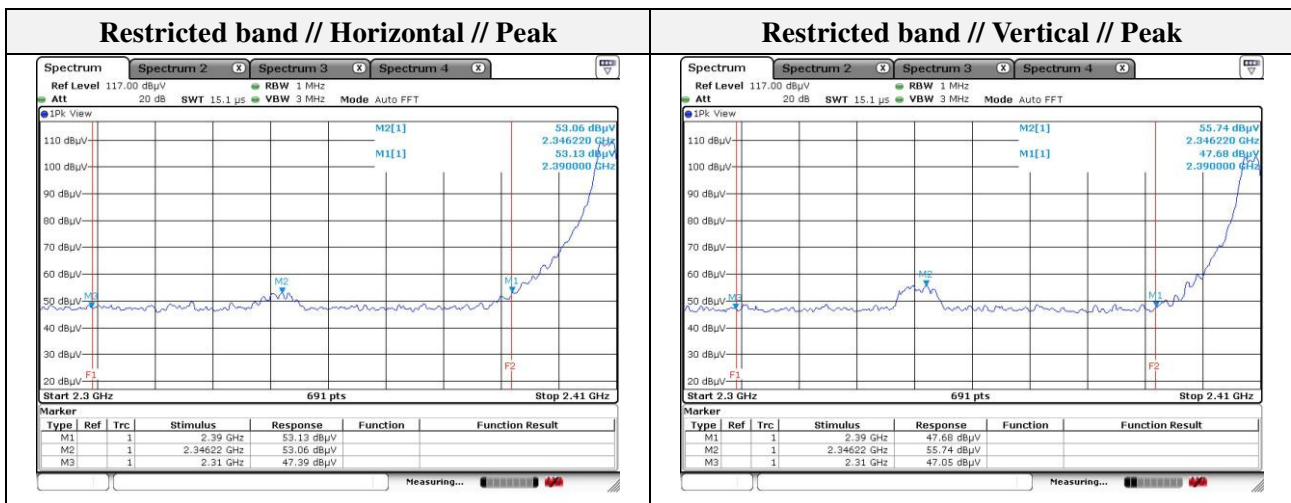
Test results (Above 1 000 MHz)

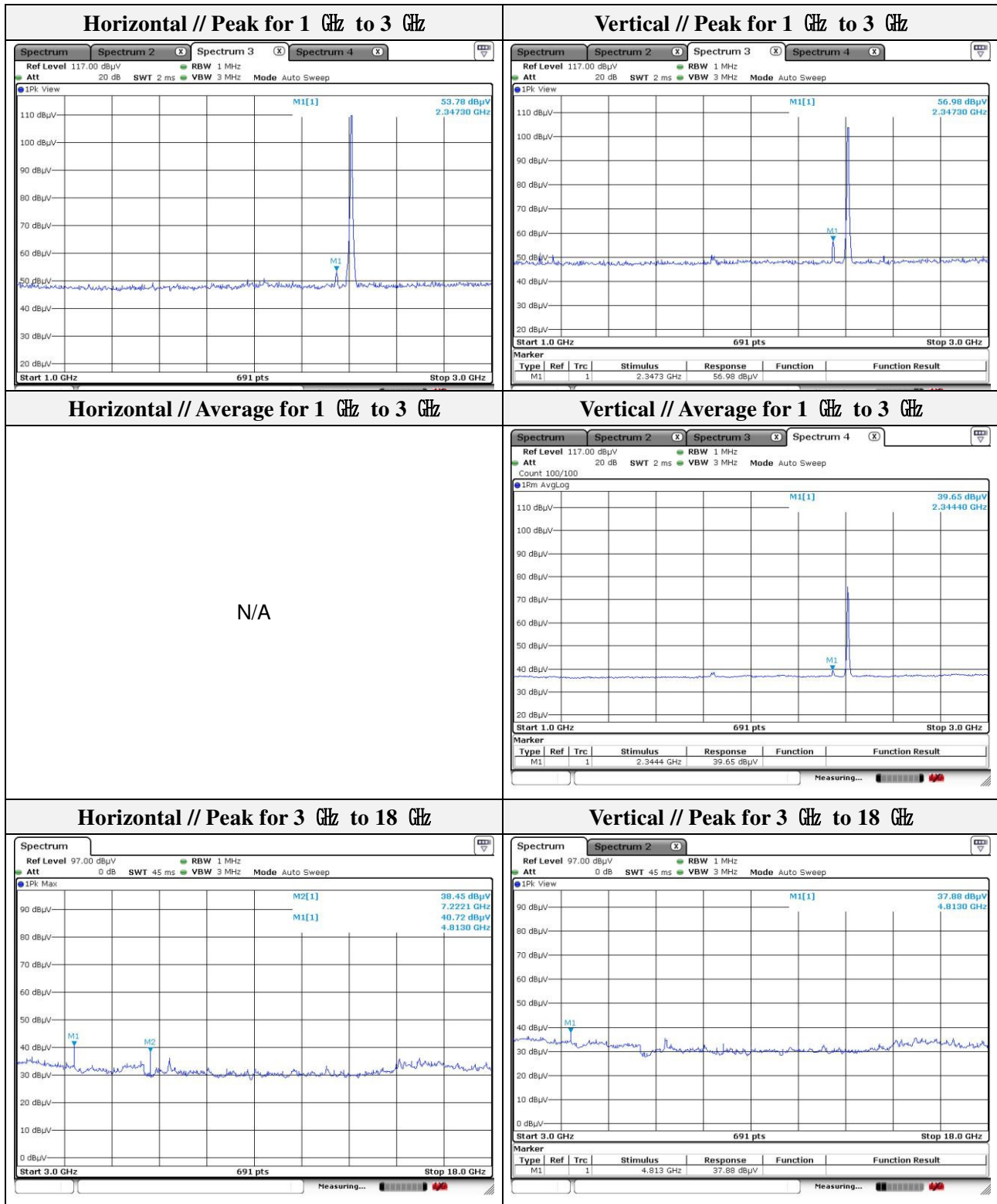
Mode: GFSK

Distance of measurement: 3 meter

Channel: 01

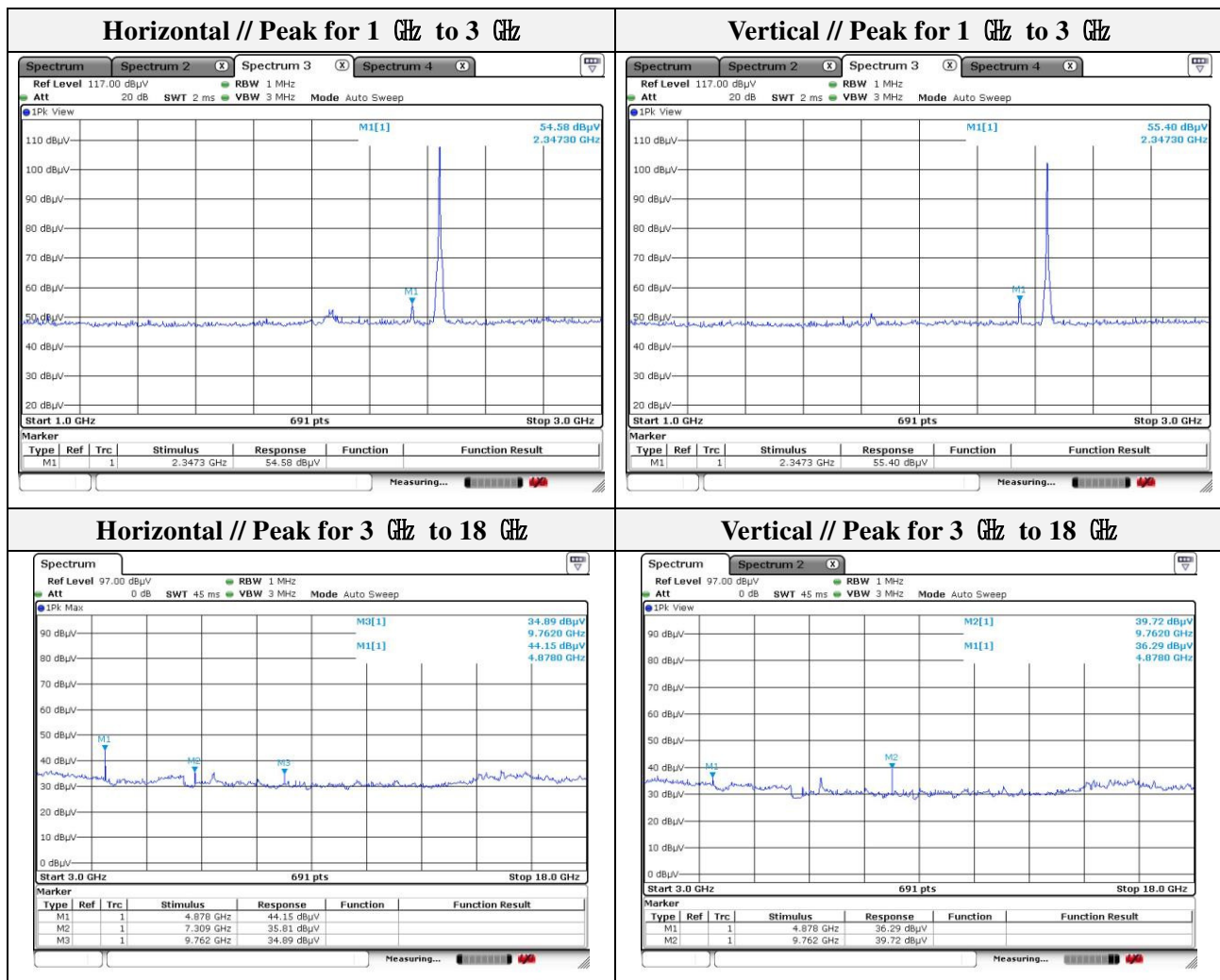
Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2344.40	39.65	Average	V	-1.95	-32.69	5.01	54.00	48.99
2346.22	53.06	Peak	H	-1.95	-	51.11	74.00	22.89
2346.22	55.74	Peak	V	-1.95	-	53.79	74.00	20.21
2347.30	53.78	Peak	H	-1.95	-	51.83	74.00	22.17
2347.30	56.98	Peak	V	-1.95	-	55.03	74.00	18.97
2390.00	53.13	Peak	H	-1.86	-	51.27	74.00	22.73
2390.00	47.68	Peak	V	-1.86	-	45.82	74.00	28.18
4813.00	40.72	Peak	H	6.56	-	47.28	74.00	26.72
4813.00	37.88	Peak	V	6.56	-	44.44	74.00	29.56
7222.10	38.45	Peak	H	13.80	-	52.25	74.00	21.75





Mode: GFSK
Distance of measurement: 3 meter
Channel: 09

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2347.30	54.58	Peak	H	-1.95	-	52.63	74.00	21.37
2347.30	55.40	Peak	V	-1.95	-	53.45	74.00	20.55
4878.00	44.15	Peak	H	7.01	-	51.16	74.00	22.84
4878.00	36.29	Peak	V	7.01	-	43.30	74.00	30.70
7309.00	35.81	Peak	H	17.22	-	53.03	74.00	20.97
9762.00	34.89	Peak	H	13.41	-	48.30	74.00	25.70
9762.00	39.72	Peak	V	13.41	-	53.13	74.00	20.87



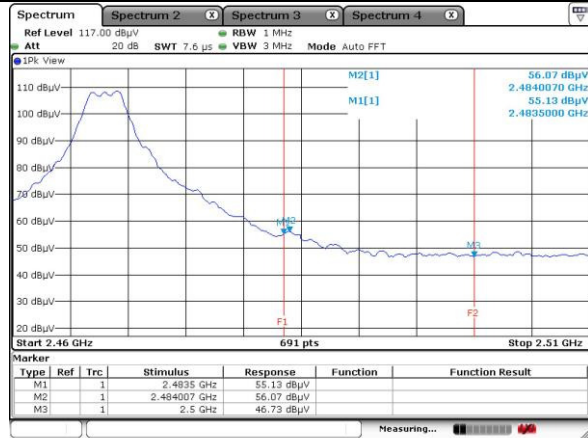
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The test results in the report only apply to the tested sample.



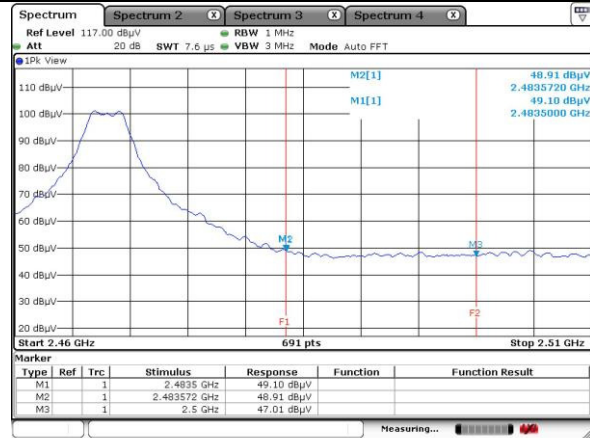
Mode: GFSK
Distance of measurement: 3 meter
Channel: 16

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2344.40	55.80	Peak	H	-1.95	-	53.85	74.00	20.15
2344.40	55.82	Peak	V	-1.95	-	53.87	74.00	20.13
2483.50	55.13	Peak	H	-1.60	-	53.53	74.00	20.47
2483.50	49.10	Peak	V	-1.60	-	47.50	74.00	26.50
2483.57	48.91	Peak	V	-1.60	-	47.31	74.00	26.69
2484.01	56.07	Peak	H	-1.60	-	54.47	74.00	19.53
2484.08	47.51	Average	H	-1.60	-32.69	13.22	54.00	40.78
4943.00	45.17	Peak	H	7.46	-	52.63	74.00	21.37
7418.00	35.80	Peak	V	20.31	-	56.11	74.00	17.89
7418.00	19.64	Average	V	20.31	-32.69	7.26	54.00	46.74
9870.00	37.31	Peak	V	13.40	-	50.71	74.00	23.29

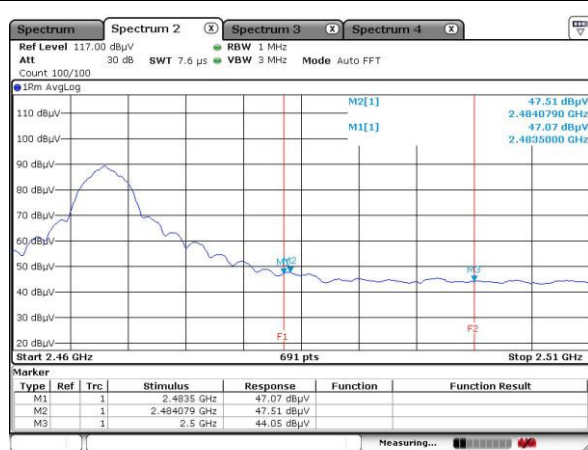
Restricted band // Horizontal // Peak



Restricted band // Vertical // Peak



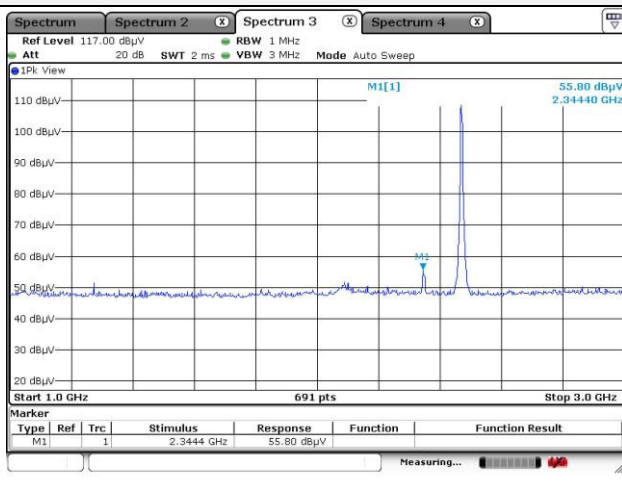
Restricted band // Horizontal // Average



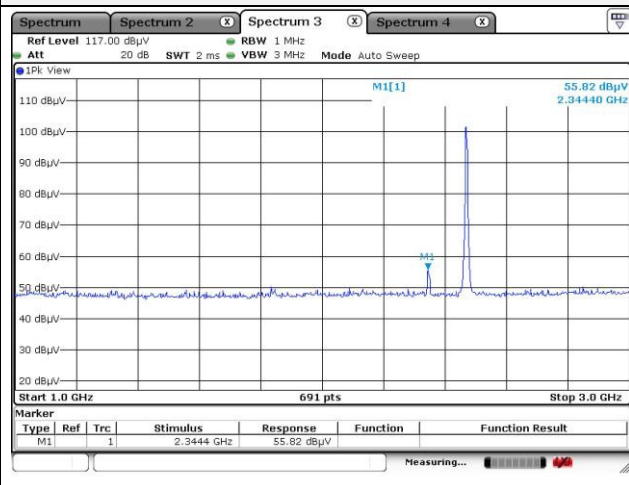
Restricted band // Vertical // Average

N/A

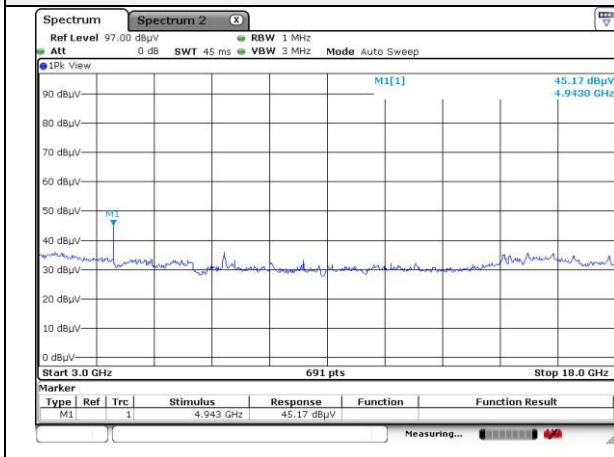
Horizontal // Peak for 1 GHz to 3 GHz



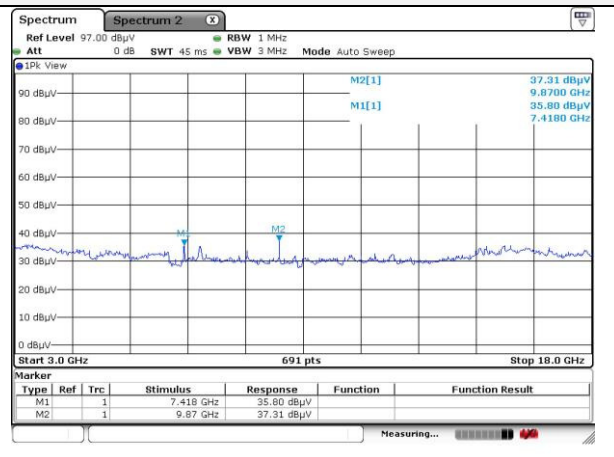
Vertical // Peak for 1 GHz to 3 GHz



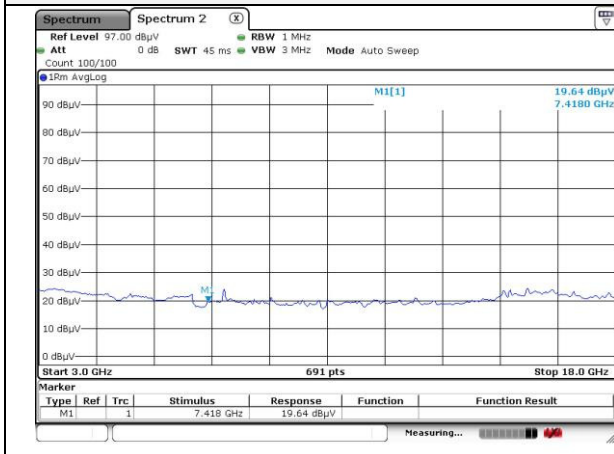
Horizontal // Peak for 3 GHz to 18 GHz



Vertical // Peak for 3 GHz to 18 GHz



Horizontal // Average for 3 GHz to 18 GHz



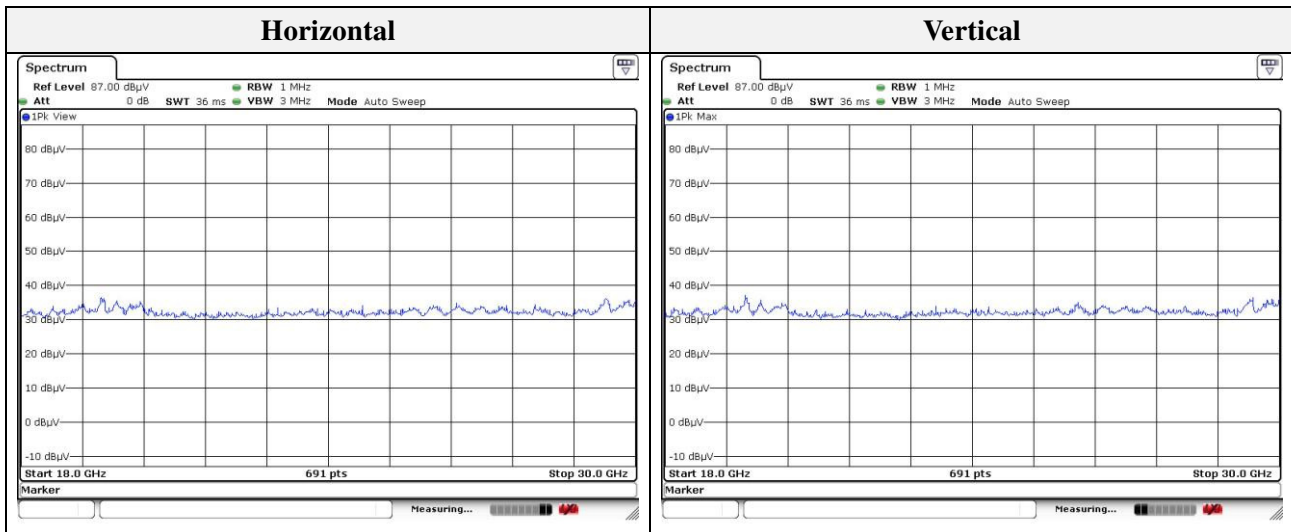
Vertical // Average for 3 GHz to 18 GHz

N/A

Test results (18 GHz to 30 GHz)

Mode: GFSK
Distance of measurement: 3 meter
Channel: 01(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 20dB of the limit							



Note.

1. Average test would be performed if the peak result were greater than the average limit.
2. Actual = Reading + AFCL(Ant. factor – Amp. gain + Cable loss) + DCF(Duty cycle correction factor)
3. Duty cycle correction factor = $20\log(\text{dwell time}/100 \text{ ms})$

3.7 Conducted spurious emissions & band edge

Test procedure

DA 00-705

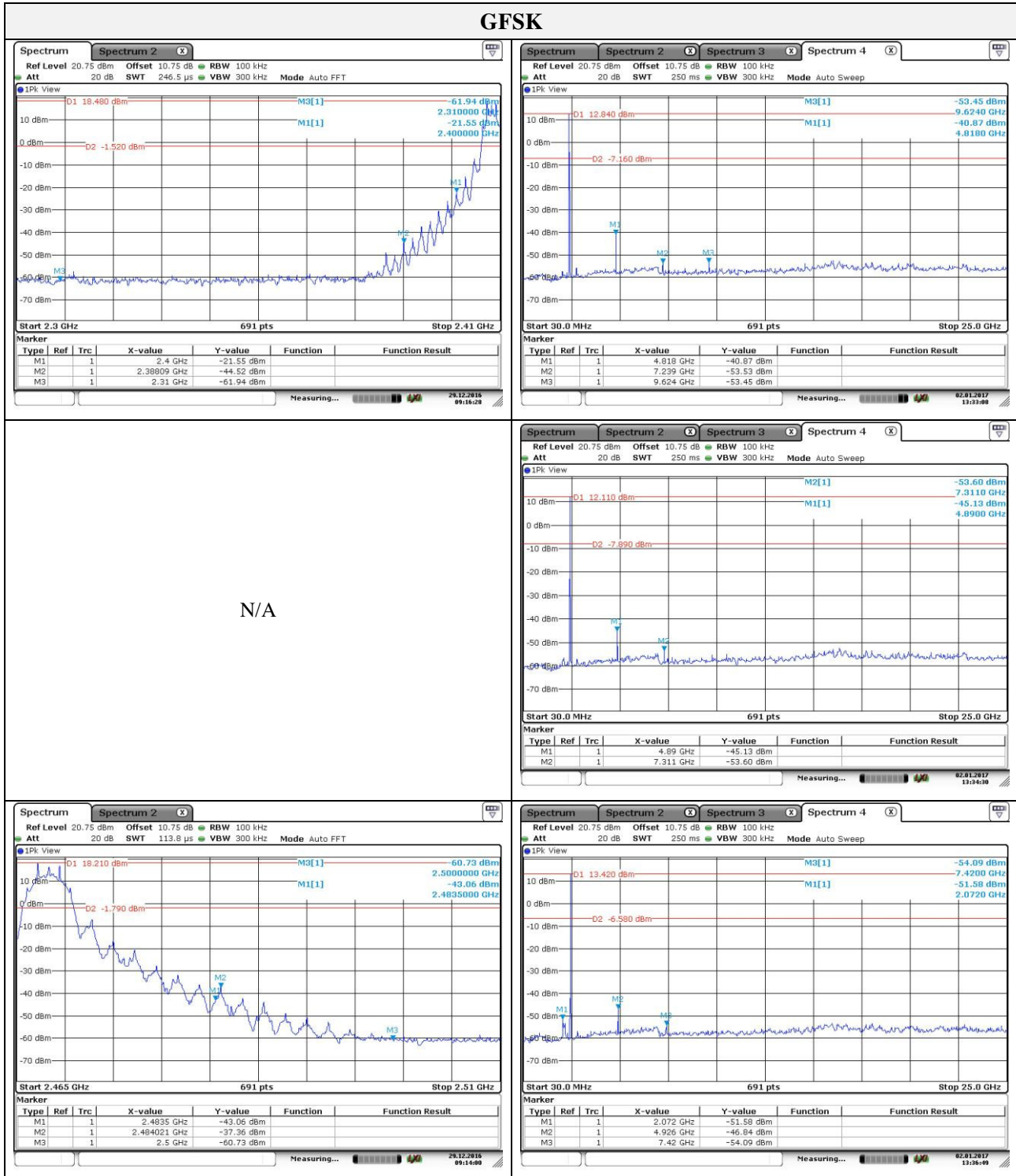
Test setting

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

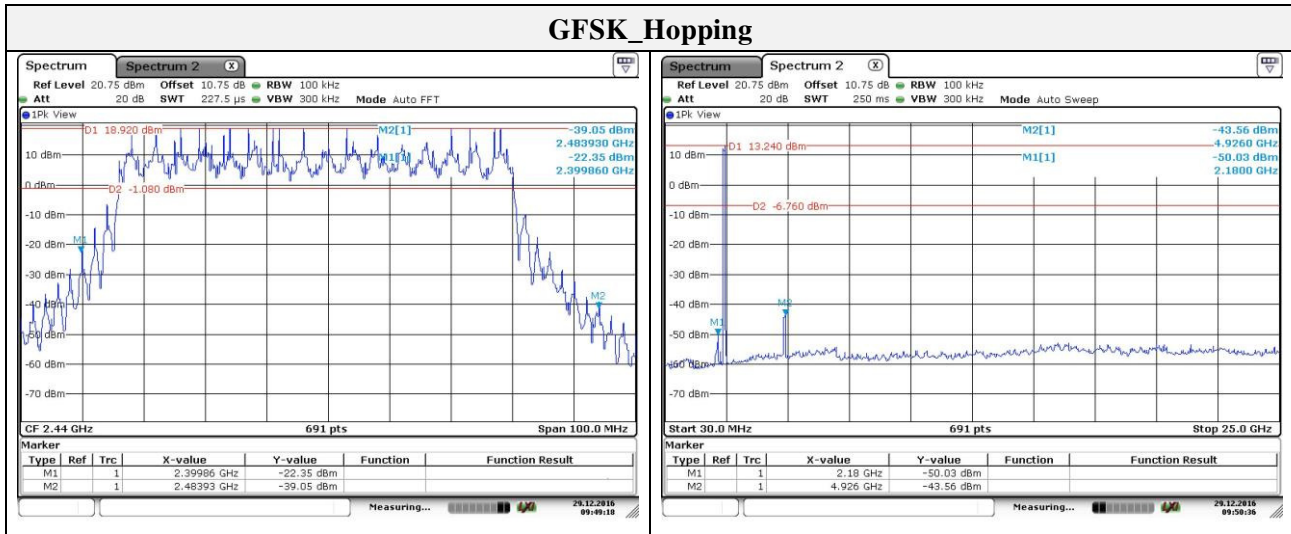
Limit

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



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The test results in the report only apply to the tested sample.



3.8. 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.

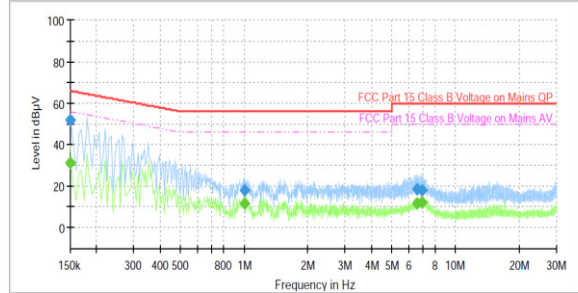
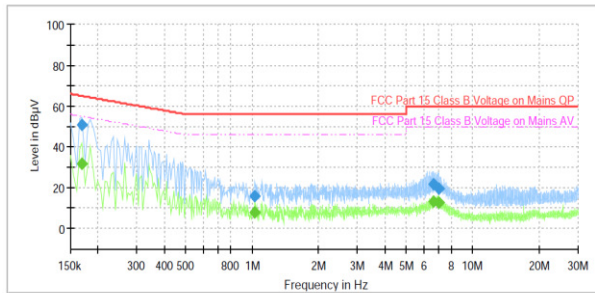
Frequency of Emission (MHz)	Conducted limit (dBμV/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

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.
2. Both Cable loss and LISN factor are included in measurement level(QP Level or AV Level)

Test results

Hot Line



Neutral Line

Final Result

Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.170000	---	31.76	54.96	23.20	1000.0	9.000	L1	21.0
0.170000	51.08	---	64.96	13.88	1000.0	9.000	L1	21.0
1.030000	---	8.19	46.00	37.81	1000.0	9.000	L1	20.2
1.030000	15.66	---	56.00	40.34	1000.0	9.000	L1	20.2
6.670000	---	13.13	50.00	36.87	1000.0	9.000	L1	19.8
6.670000	21.62	---	60.00	38.38	1000.0	9.000	L1	19.8
7.020000	---	12.89	50.00	37.11	1000.0	9.000	L1	19.8
7.020000	19.78	---	60.00	40.22	1000.0	9.000	L1	19.8

Final Result

Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.150000	---	31.24	56.00	24.76	1000.0	9.000	N	21.1
0.150000	51.77	---	66.00	14.23	1000.0	9.000	N	21.1
1.005000	---	11.61	46.00	34.39	1000.0	9.000	N	20.2
1.005000	17.89	---	56.00	38.11	1000.0	9.000	N	20.2
6.560000	---	11.78	50.00	38.22	1000.0	9.000	N	19.8
6.560000	18.67	---	60.00	41.33	1000.0	9.000	N	19.8
6.940000	---	12.28	50.00	37.72	1000.0	9.000	N	19.8
6.940000	18.24	---	60.00	41.76	1000.0	9.000	N	19.8

Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum Analyzer	R&S	FSV30	10076	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	2017.01.25
PSG Analog Signal Generator	Agilent	E8257C	US42340237	1 year	2017.07.05
Attenuator	KEYSIGHT	8493C	82509	1 year	2017.01.25
Loop Antenna	R&S	HFH2-Z2.335.4711.52	826532	2 years	2017.03.03
Trilog-broadband antenna	SCHWARZBECK	VULB 9163	9168-713	2 years	2017.05.15
Horn Antenna	A.H.	SAS-571	781	2 years	2017.05.07
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	WEINSCHEL	WLK1.0/18G-10TT	1	1 year	2017.07.04
Preamplifier	HP	8449B	3008A00538	1 year	2017.07.05
Broadband Amplifier	SCHWARZBECK	BBV-9721	PS9721-003	1 year	2017.01.25
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
LISN	R&S	ENV216	101137	1 year	2017.02.04

Peripheral devices

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