


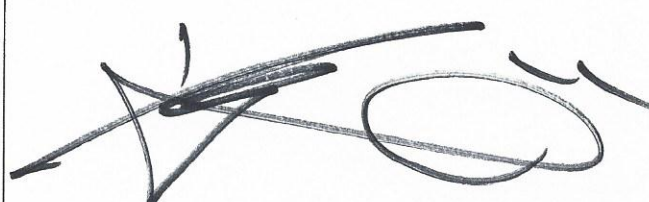
# TEST REPORT

## Part 15 Subpart C 15.247

**Equipment under test** Prota S  
**Model name** PRT-SAR1A-01PS  
**FCC ID** 2AJO9PRT-SAR1A-01PS  
**Applicant** Naran Inc  
**Manufacturer** Platel Co., Ltd  
**Date of test(s)** 2016.09.19 ~ 2016.10.18  
**Date of issue** 2016.10.19

**Issued to**  
**Naran Inc**  
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Test and report completed by :	Report approval by :
	
Kwang-yeol Choo Test engineer	Jeff Do Technical manager

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



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### Revision history

Revision	Date of issue	Test report No.	Description
-	2016.10.06	KES-RF-16T0085	Initial
1	2016.10.19	KES-RF-16T0085-R1	Retest radiated emissions & AC conducted emissions



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## 1. General information

Applicant: Naran Inc  
Applicant address: 4th Floor, Munbal-dong, 57-9, Hoedong-gil Gyeonggi-do  
Paju-si, South Korea  
Test site: KES Co., Ltd.  
Test site address: C-3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, Korea  
473-29, Gayeo-ro, Yeosu-si, Gyeonggi-do, Korea  
FCC rule part(s): 15.247  
FCC ID: 2AJ09PRT-SAR1A-01PS  
Test device serial No.: ☒ Production ☐ Pre-production ☐ Engineering

### 1.1. EUT description

Equipment under test Prota S  
Frequency range BT : 2 402 MHz ~ 2 480 MHz (BDR/EDR/LE)  
WIFI : 2 412 MHz ~ 2 462 MHz (11b/g/n\_HT20)  
2 422 MHz ~ 2 452 MHz(11n\_HT40)  
Model PRT-SAR1A-01PS  
Modulation technique BT : FHSS, GFSK  
WIFI : DSSS, OFDM  
Number of channels BT : 79 (BDR/EDR), 40(LE)  
WIFI : 11(802.11b/g/n\_HT20), 7(802.11n\_HT40)  
Antenna specification Antenna type: PCB, Peak gain: 0.25 dBi  
Power source DC 5V

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

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.

**Example of a 79 hopping sequence in data mode:**

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

**System receiver input bandwidth**

Each channel bandwidth is 1 MHz.

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

**1.2. Test configuration**

The **Naran Inc Prota S FCC ID: 2AJO9PRT-SAR1A-01PS** 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)	Rate(Mbps)
00	2402	1,2,3
.	.	.
40	2442	1,2,3
.	.	.
78	2480	1,2,3

**1.4. Accessory information**

Applicant	Equipment	Manufacturer	Model	Power source
-	-	-	-	-

## 2. Summary of tests

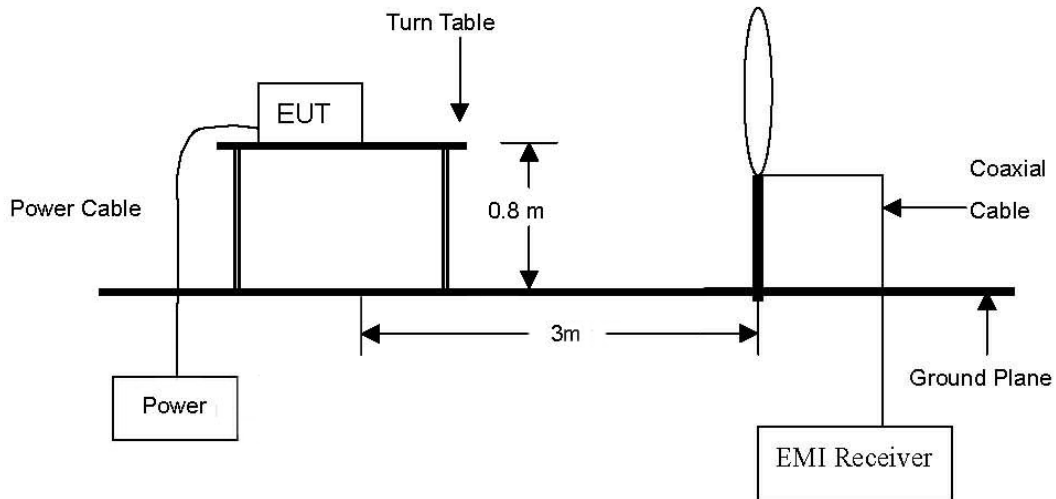
Reference	Test description	Test results
15.247(a)(1)(iii)	20 dB bandwidth	Pass
15.247(b)(1)	Output power	Pass
15.247(a)(1)	Channel separation	Pass
15.247(a)(1)(iii)	Number of channels	Pass
15.247(a)(1)(iii)	Time of occupancy	Pass
15.205, 15.209	Radiated restricted band and emission	Pass
15.207(d)	Conducted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

### 3. Test results

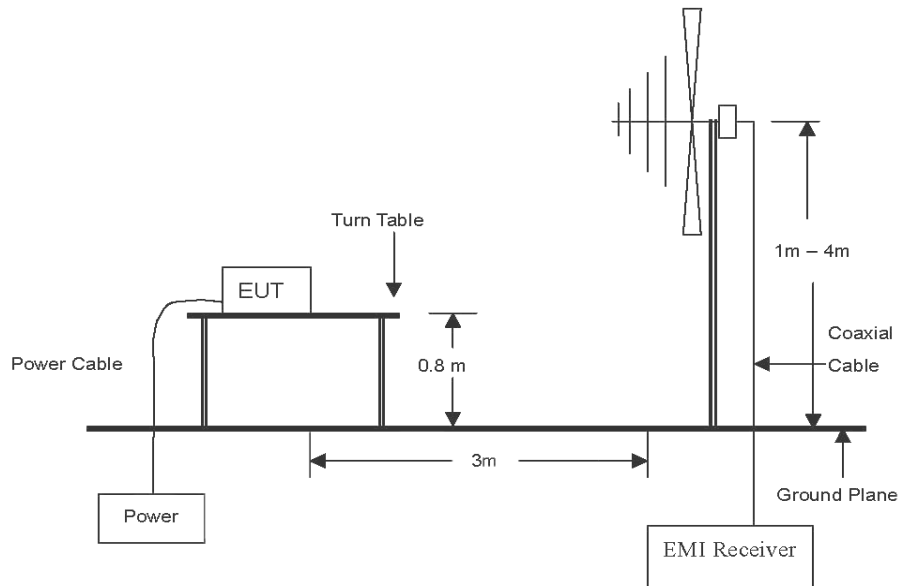
#### 3.1. Radiated restricted band and emissions

##### Test setup

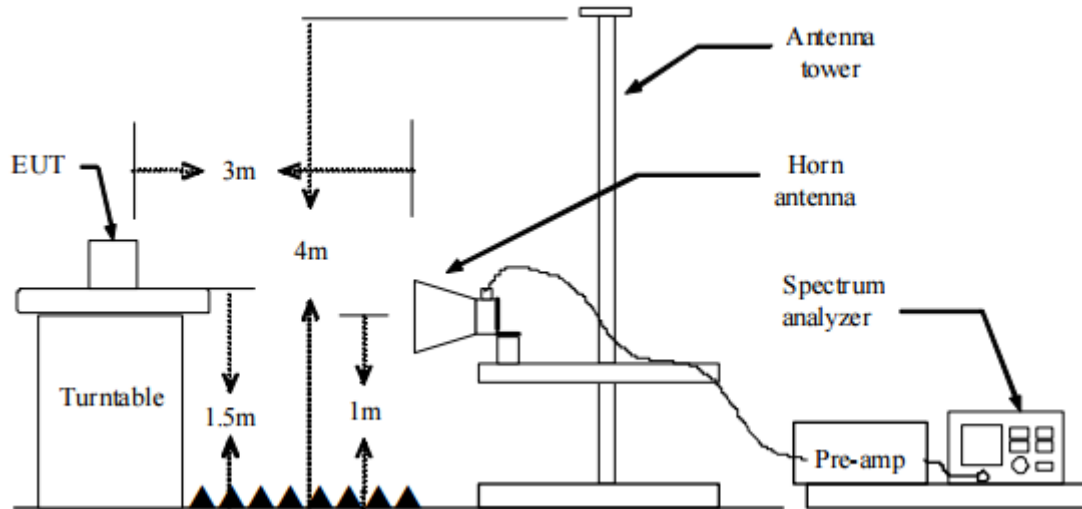
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions.



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  $f < 1 \text{ GHz}$ :
  - 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  $f \geq 1 \text{ GHz}$ : 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  $f \geq 1 \text{ GHz}$ : Average
  - Span = wide enough to fully capture the emission being measured
  - RBW = 1 MHz
  - VBW  $\geq 1/T \text{ Hz}$ , where T= pulse width in seconds
  - Sweep = auto
  - Detector function = average
  - Trace = max hold
10. Duty Cycle Correction Factor (79 channel hopping)
  - a. Time to cycle through all channels =  $\Delta t = \tau[\text{ms}] \times 79 \text{ channels} = 230.601 \text{ ms}$ , where  $\tau$  = 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 =  $\tau[\text{ms}] \times H' = 2.919 \text{ ms}$
  - d. Duty Cycle Correction =  $20 \log (\text{Worst Case Dwell Time} / 100 \text{ ms}) \text{ dB} = -30.695 \text{ dB}$

**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 :

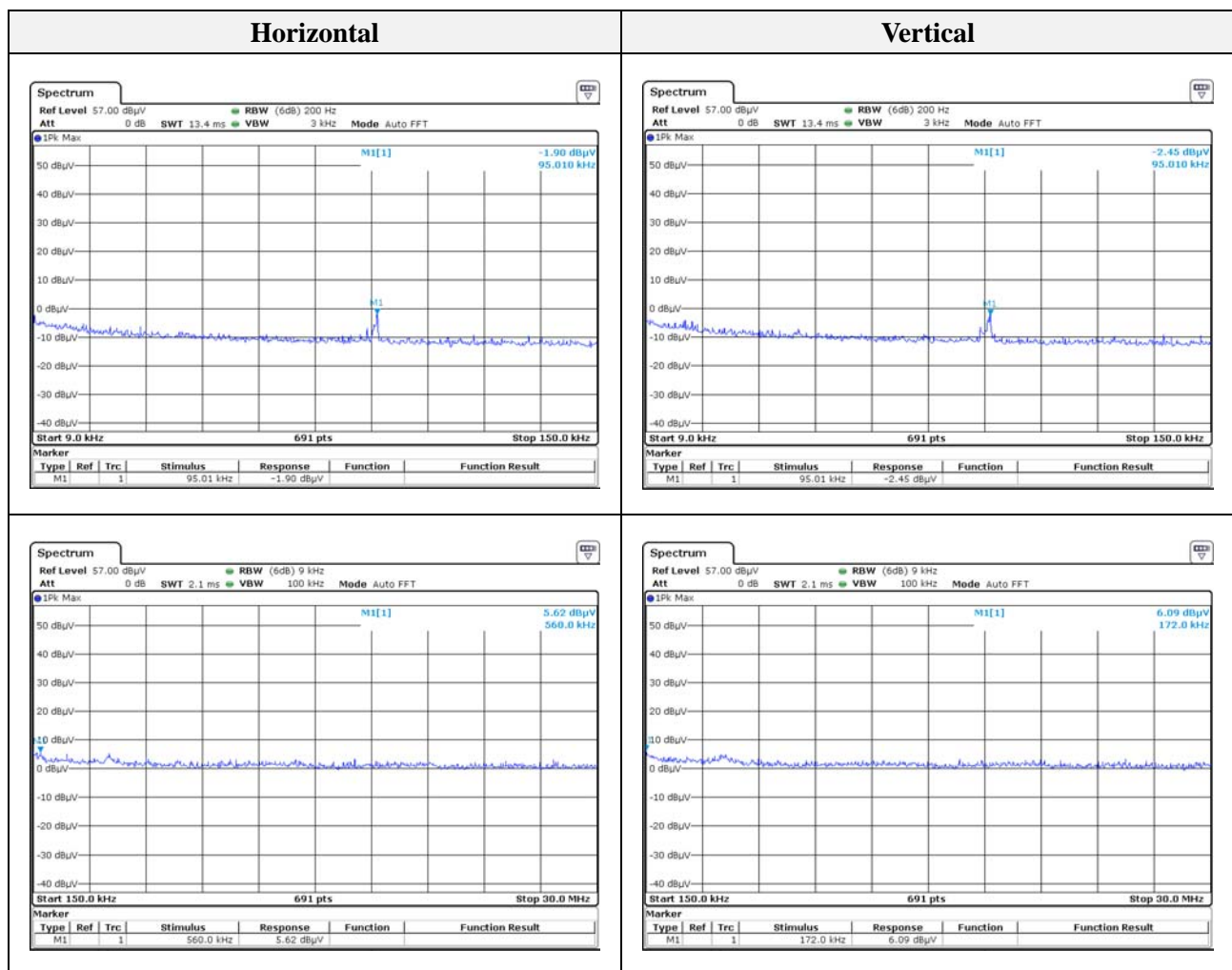
Frequency (MHz)	Distance (Meters)	Radiated ( $\mu V/m$ )
0.009 ~ 0.490	300	2 400 / F(kHz)
0.490 ~ 1.705	30	24 000 / F(kHz)
1.705 ~ 30.0	30	30
30 ~ 88	3	100**
88 ~ 216	3	150**
216 ~ 960	3	200**
Above 960	3	500

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

## Test results (Below 30 MHz)

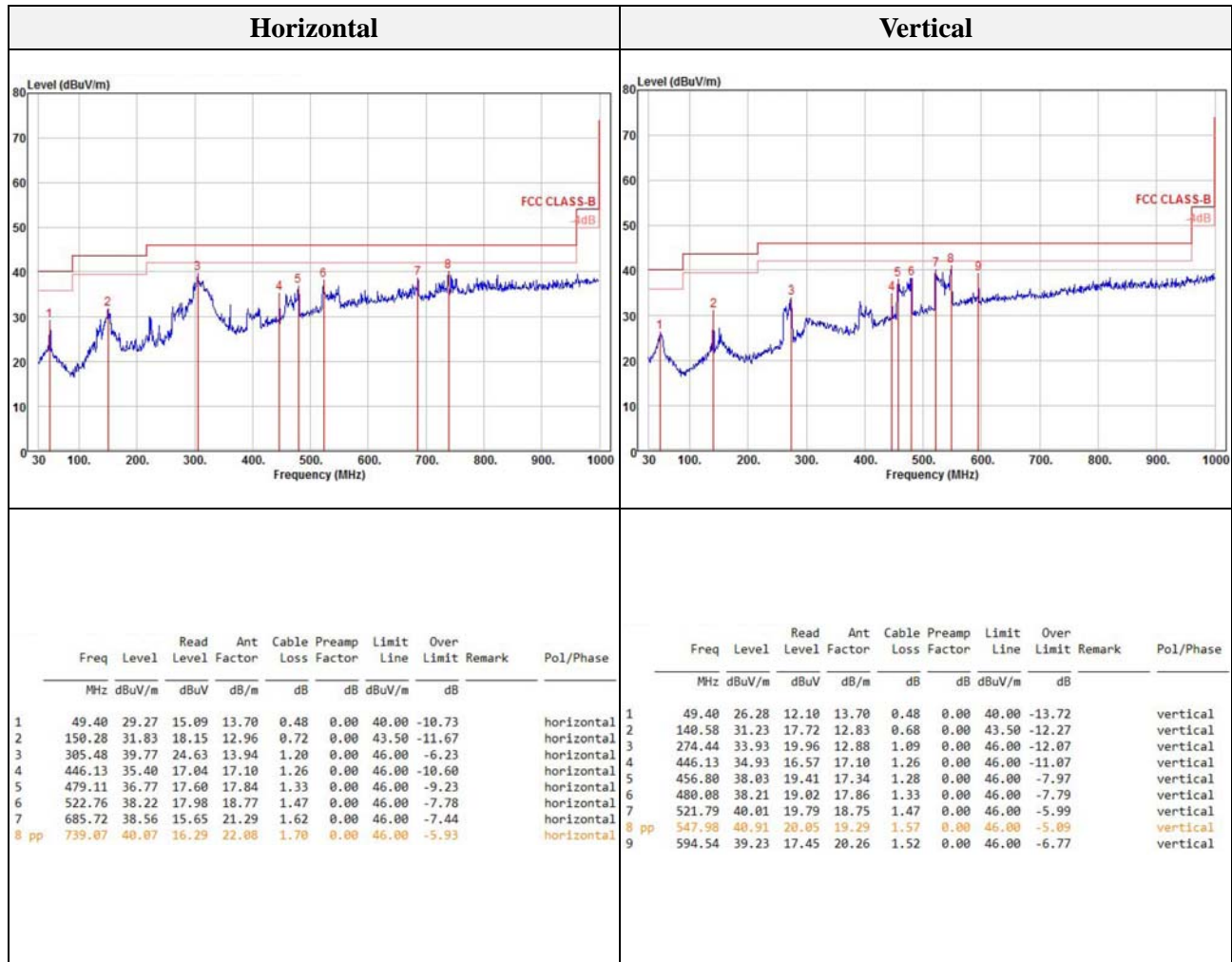
Mode: EDR  
Transfer rate: 3 Mbps  
Distance of measurement: 3 meter  
Channel: 00(Worst case)

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



### Test results (Below 1 000 MHz)

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



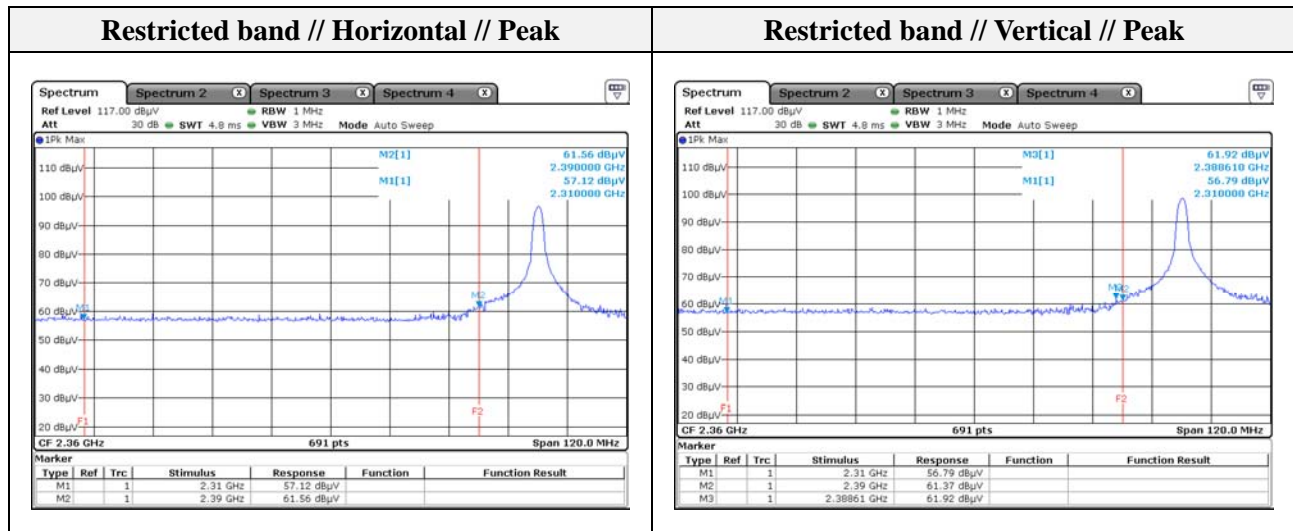
### Note.

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.

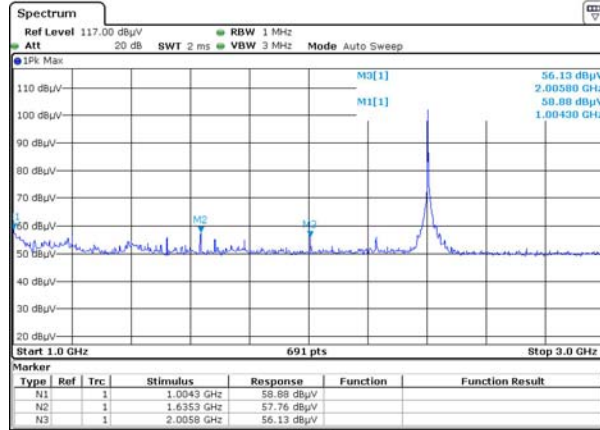
### Test results (Above 1 000 MHz)

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

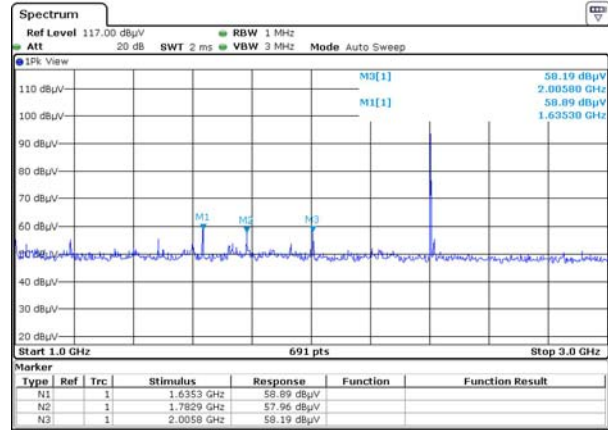
Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1004.30	58.88	Peak	H	-16.65	-	42.23	74.00	31.77
1635.30	57.76	Peak	H	-13.86	-	43.90	74.00	30.10
2005.80	56.13	Peak	H	-11.20	-	44.93	74.00	29.07
1635.30	58.89	Peak	V	-13.86	-	45.03	74.00	28.97
1782.90	57.96	Peak	V	-12.66	-	45.30	74.00	28.70
2005.80	58.19	Peak	V	-11.20	-	46.99	74.00	27.01
2390.00	61.56	Peak	H	-9.77	-	51.79	74.00	22.21
2388.61	61.92	Peak	V	-9.77	-	52.15	74.00	21.85



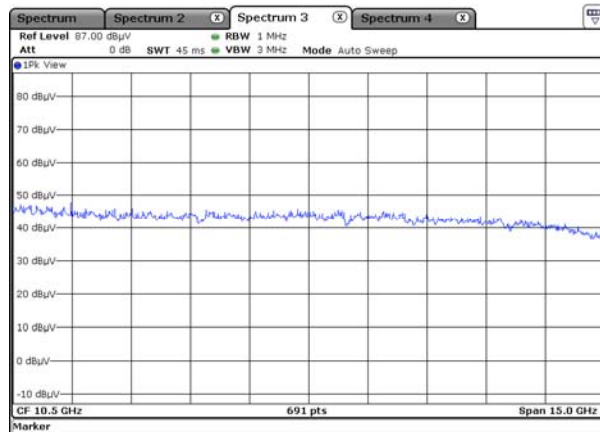
### Horizontal // Peak for 1 GHz to 3 GHz



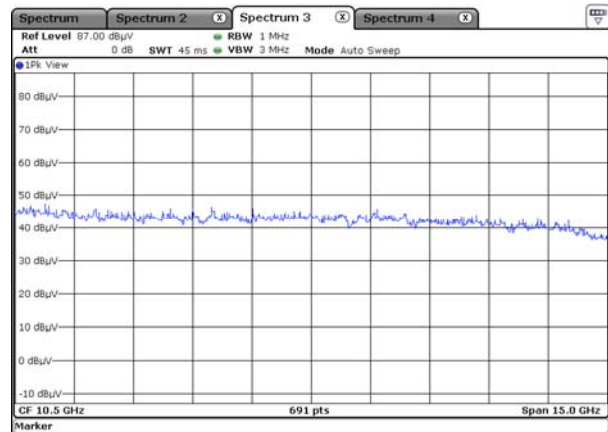
### Vertical // Peak for 1 GHz to 3 GHz



### Horizontal // Peak for 3 GHz to 18 GHz



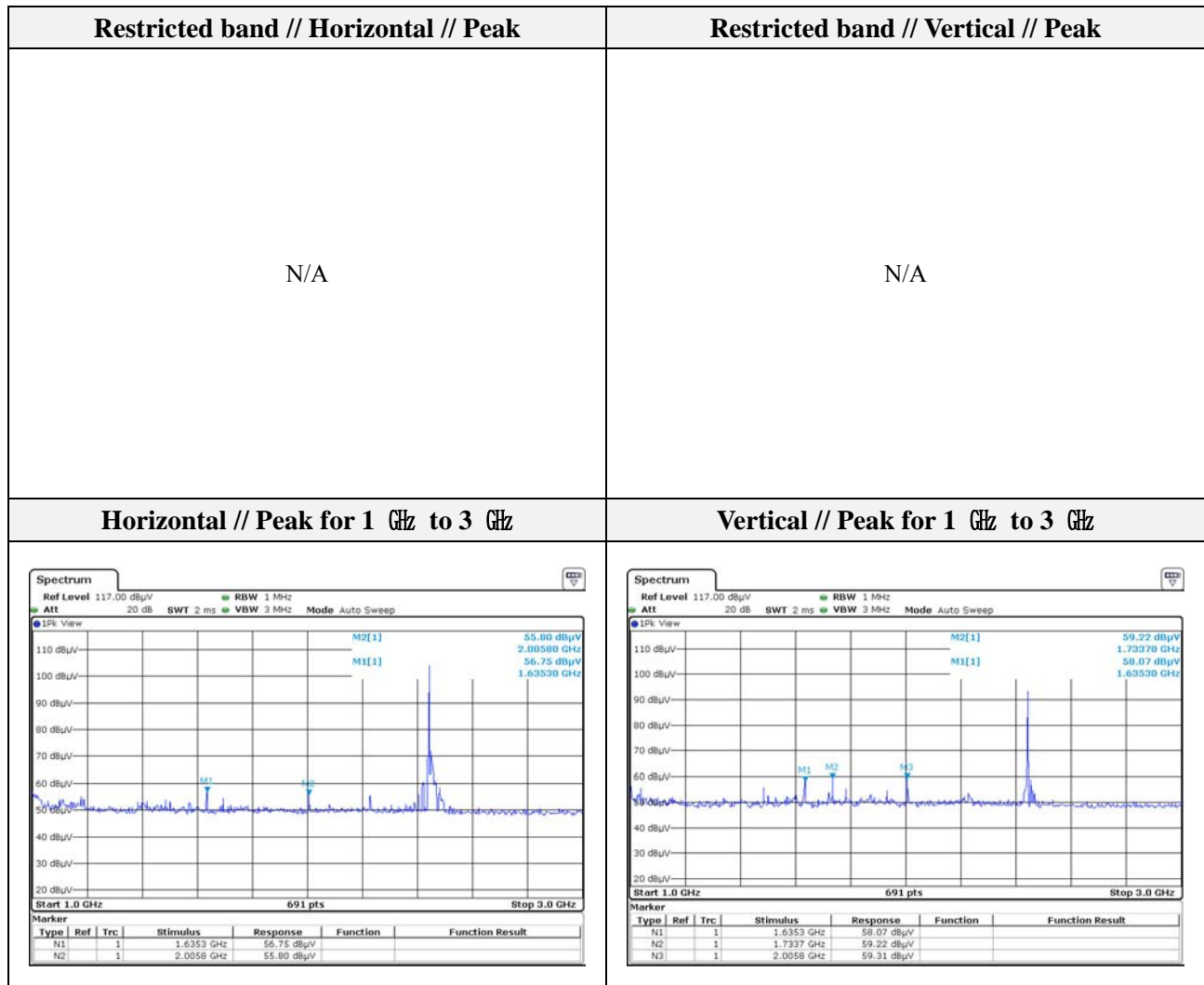
### Vertical // Peak for 3 GHz to 18 GHz



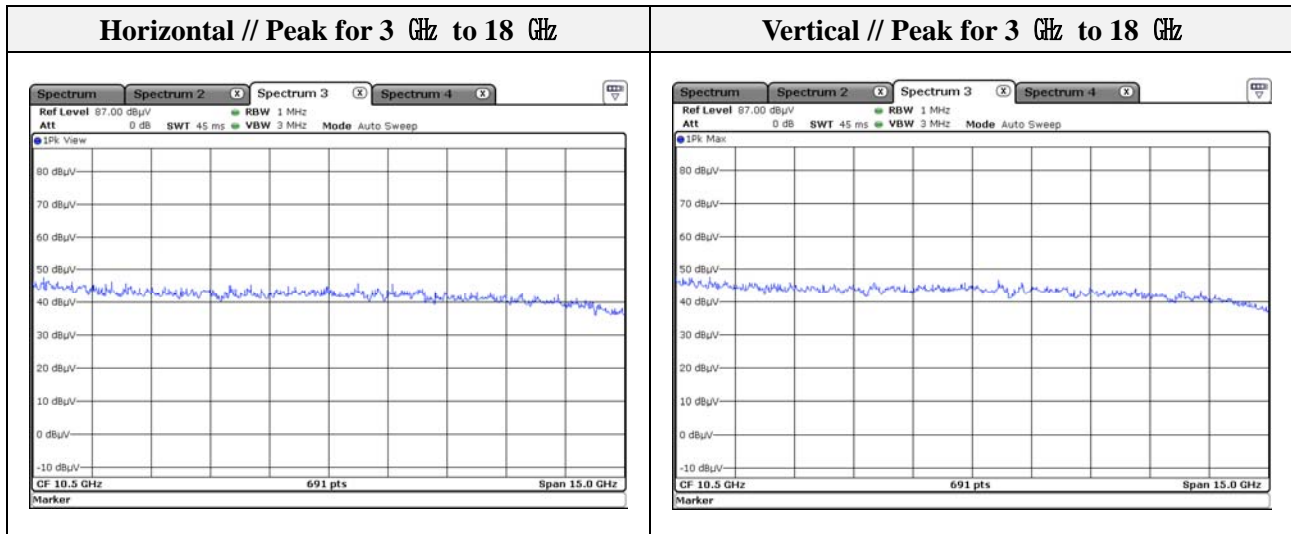


Mode: BDR  
Transfer rate: 1 Mbps  
Distance of measurement: 3 meter  
Channel: 40

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1635.30	56.75	Peak	H	-13.86	-	42.89	74.00	31.11
2005.80	55.80	Peak	H	-11.20	-	44.60	74.00	29.40
1635.30	58.07	Peak	V	-13.86	-	44.21	74.00	29.79
1733.70	59.22	Peak	V	-13.06	-	46.16	74.00	27.84
2005.80	59.31	Peak	V	-11.20	-	48.11	74.00	25.89



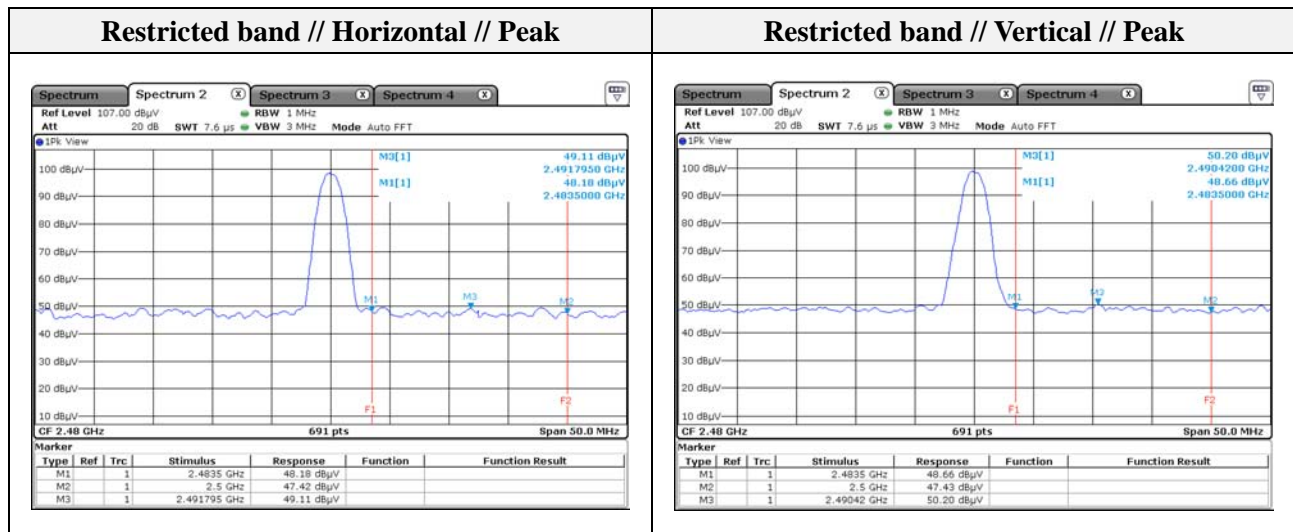




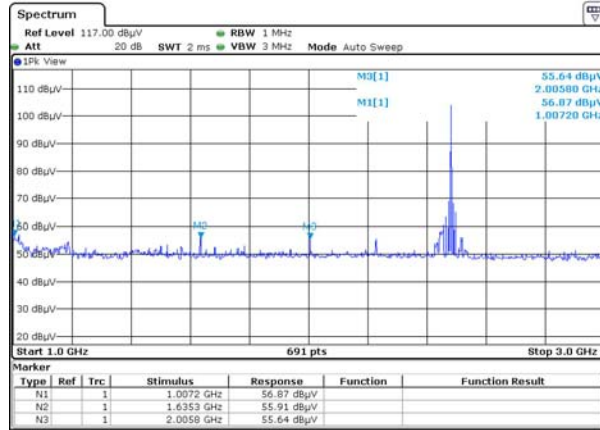
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The test results in the report only apply to the tested sample.

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

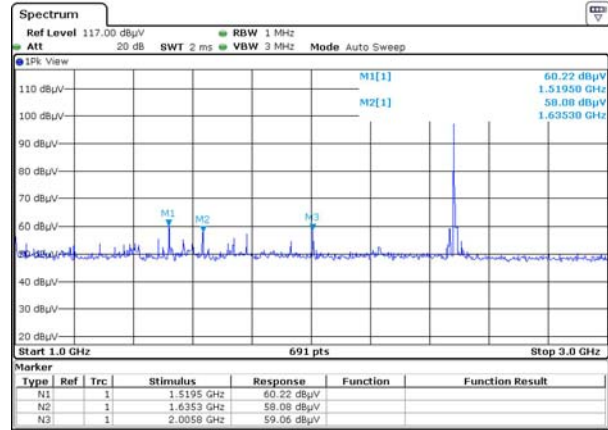
Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1007.20	56.87	Peak	H	-16.64	-	40.23	74.00	33.77
1635.30	55.91	Peak	H	-13.86	-	42.05	74.00	31.95
2005.80	55.64	Peak	H	-11.20	-	44.44	74.00	29.56
1519.50	60.22	Peak	V	-14.71	-	45.51	74.00	28.49
1635.30	58.08	Peak	V	-13.86	-	44.22	74.00	29.78
2005.80	59.06	Peak	V	-11.20	-	47.86	74.00	26.14
2491.80	49.11	Peak	H	-9.37	-	39.74	74.00	34.26
2490.42	50.20	Peak	V	-9.38	-	40.82	74.00	33.18



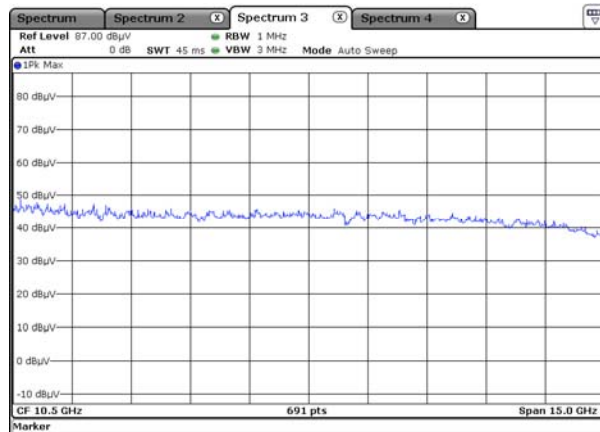
### Horizontal // Peak for 1 GHz to 3 GHz



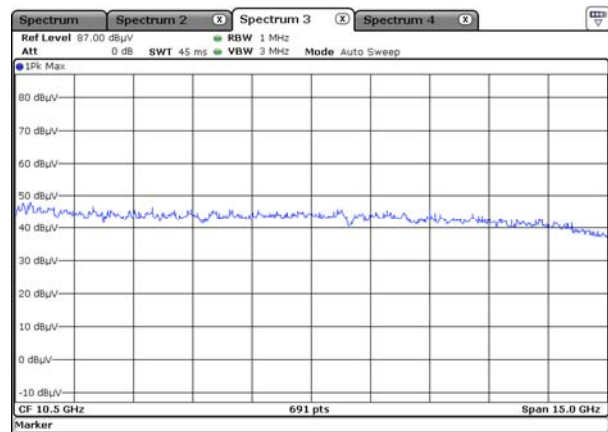
### Vertical // Peak for 1 GHz to 3 GHz



### Horizontal // Peak for 3 GHz to 18 GHz

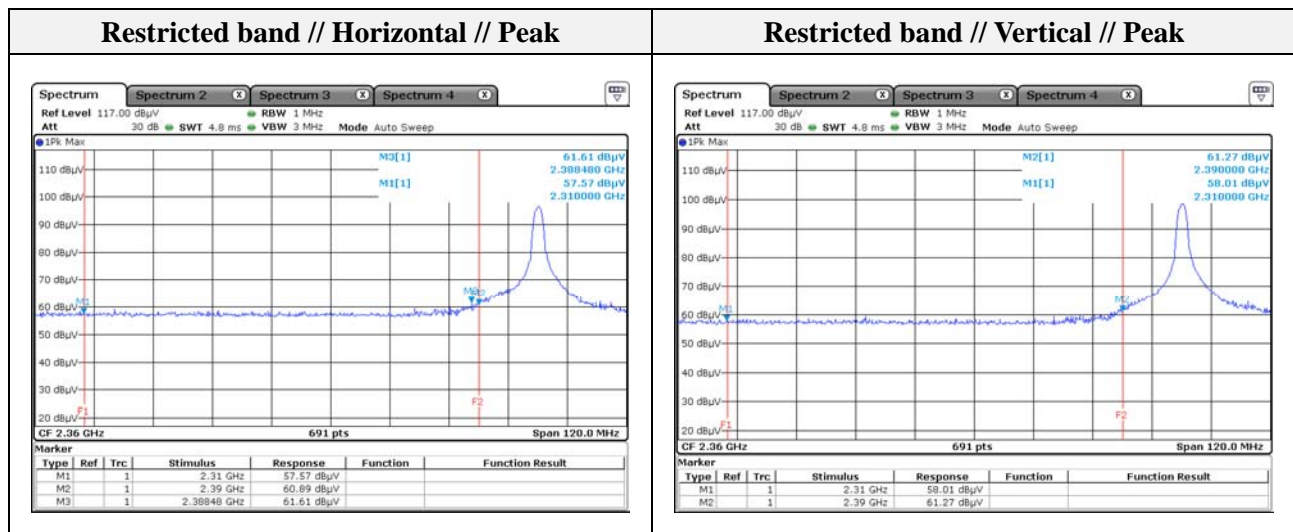


### Vertical // Peak for 3 GHz to 18 GHz

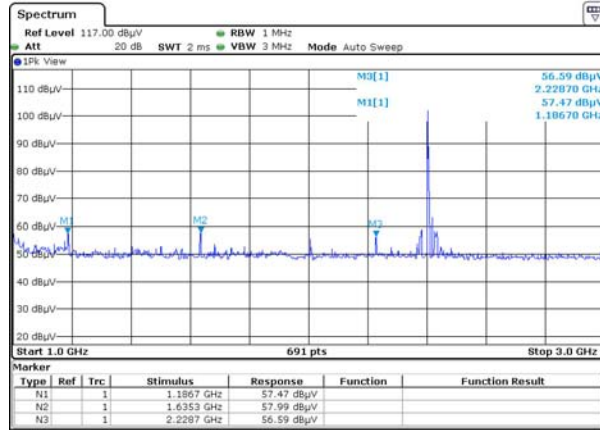


Mode: EDR  
Transfer rate: 3 Mbps(Worst case)  
Distance of measurement: 3 meter  
Channel: 00

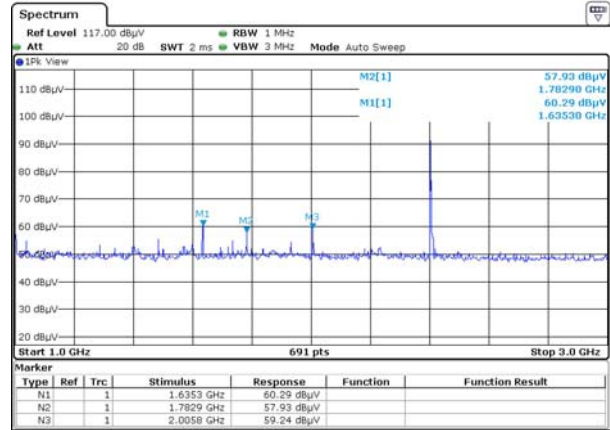
Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1186.70	57.47	Peak	H	-15.98	-	41.49	74.00	32.51
1635.30	57.99	Peak	H	-13.86	-	44.13	74.00	29.87
2228.70	56.59	Peak	H	-10.26	-	46.33	74.00	27.67
1635.30	60.29	Peak	V	-13.86	-	46.43	74.00	27.57
1782.90	57.93	Peak	V	-12.66	-	45.27	74.00	28.73
2005.80	59.24	Peak	V	-11.20	-	48.04	74.00	25.96
2388.48	61.61	Peak	H	-9.77	-	51.84	74.00	22.16
2390.00	61.27	Peak	V	-9.77	-	51.50	74.00	22.50



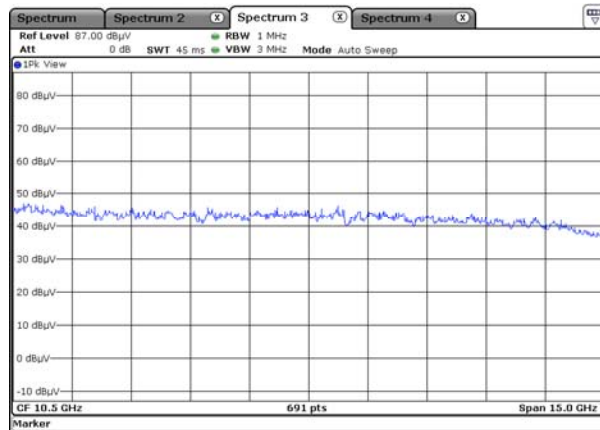
### Horizontal // Peak for 1 GHz to 3 GHz



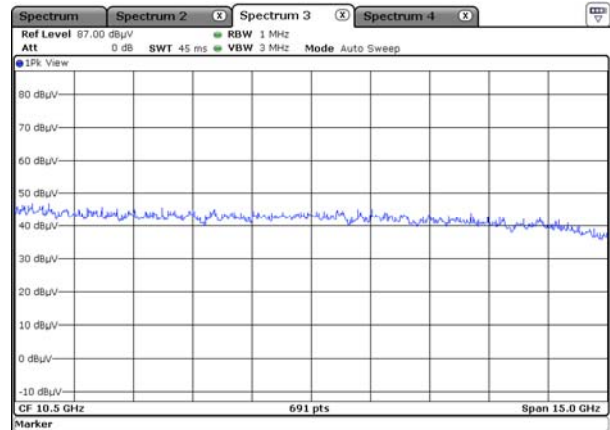
### Vertical // Peak for 1 GHz to 3 GHz



### Horizontal // Peak for 3 GHz to 18 GHz



### Vertical // Peak for 3 GHz to 18 GHz



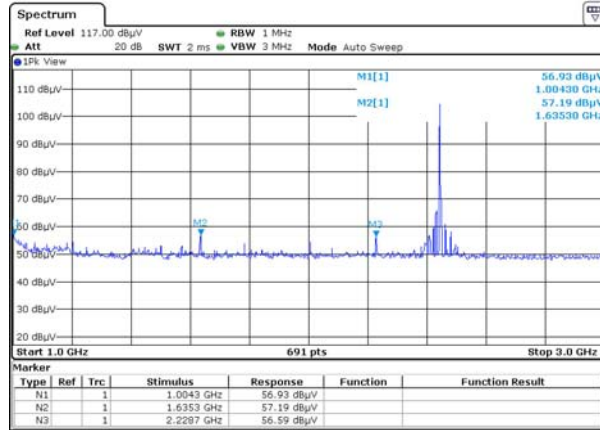


Mode: EDR  
Transfer rate: 3 Mbps(Worst case)  
Distance of measurement: 3 meter  
Channel: 40

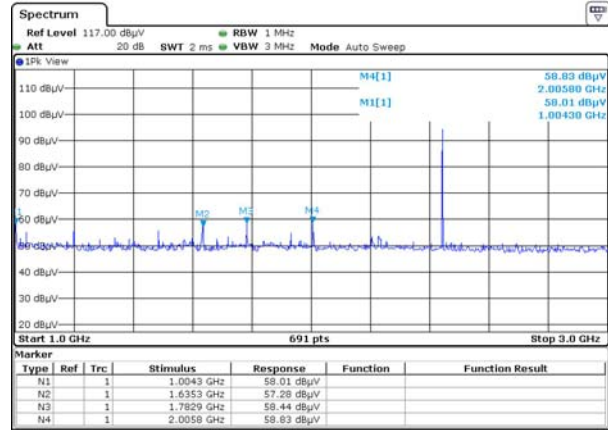
Frequency (MHz)	Level (dB $\mu$ V)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
1004.30	56.93	Peak	H	-16.65	-	40.28	74.00	33.72
1635.30	57.19	Peak	H	-13.86	-	43.33	74.00	30.67
2228.70	56.59	Peak	H	-10.26	-	46.33	74.00	27.67
1004.30	58.01	Peak	V	-16.65	-	41.36	74.00	32.64
1635.30	57.28	Peak	V	-13.86	-	43.42	74.00	30.58
1782.90	58.44	Peak	V	-12.66	-	45.78	74.00	28.22
2005.80	58.83	Peak	V	-11.20	-	47.63	74.00	26.37

Restricted band // Horizontal // Peak	Restricted band // Vertical // Peak
N/A	N/A

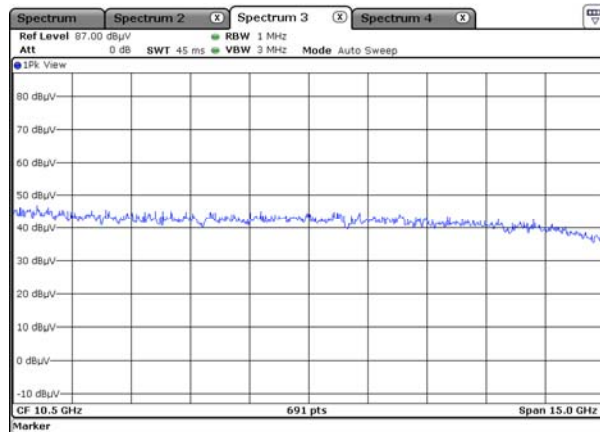
### Horizontal // Peak for 1 GHz to 3 GHz



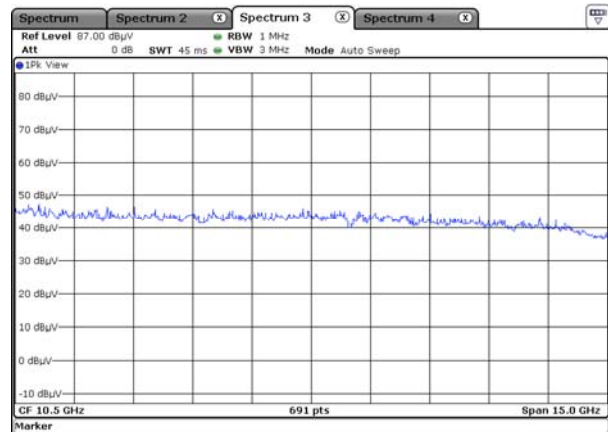
### Vertical // Peak for 1 GHz to 3 GHz



### Horizontal // Peak for 3 GHz to 18 GHz



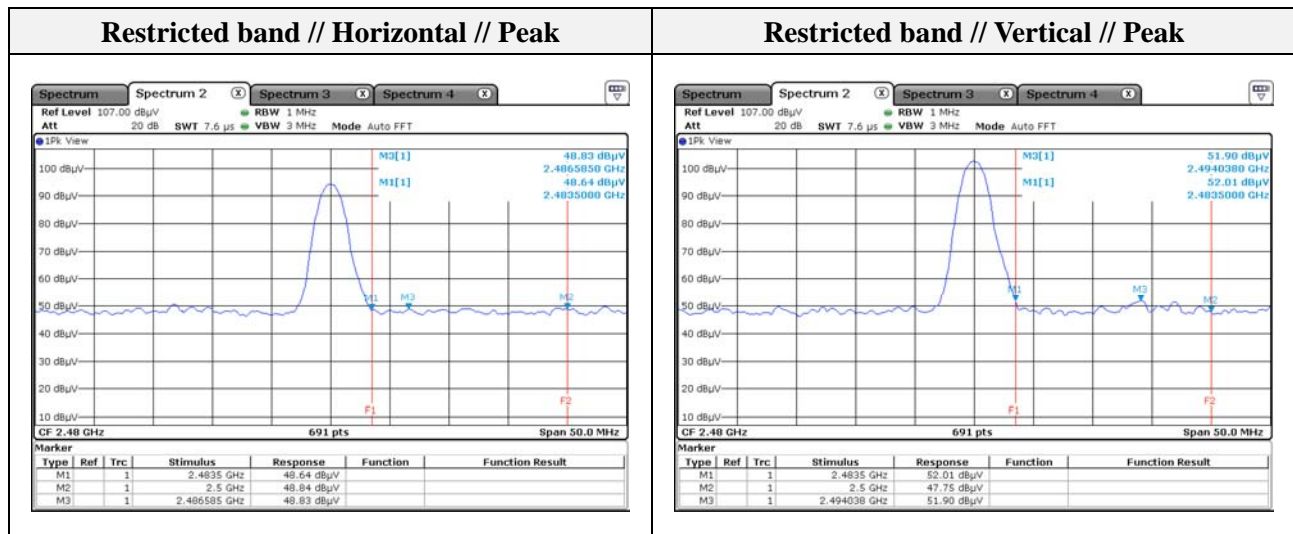
### Vertical // Peak for 3 GHz to 18 GHz





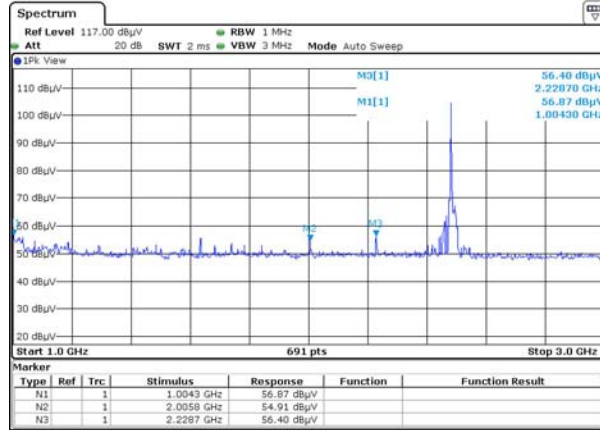
Mode: EDR  
Transfer rate: 3 Mbps(Worst case)  
Distance of measurement: 3 meter  
Channel: 78

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1004.30	56.87	Peak	H	-16.65	-	40.22	74.00	33.78
2005.80	54.91	Peak	H	-11.20	-	43.71	74.00	30.29
2228.70	56.40	Peak	H	-10.26	-	46.14	74.00	27.86
1635.30	58.20	Peak	V	-13.86	-	44.34	74.00	29.66
1782.90	58.61	Peak	V	-12.66	-	45.95	74.00	28.05
2005.80	58.74	Peak	V	-11.20	-	47.54	74.00	26.46
2500.00	48.84	Peak	H	-9.34	-	39.50	74.00	34.50
2483.50	52.01	Peak	V	-9.41	-	42.60	74.00	31.40

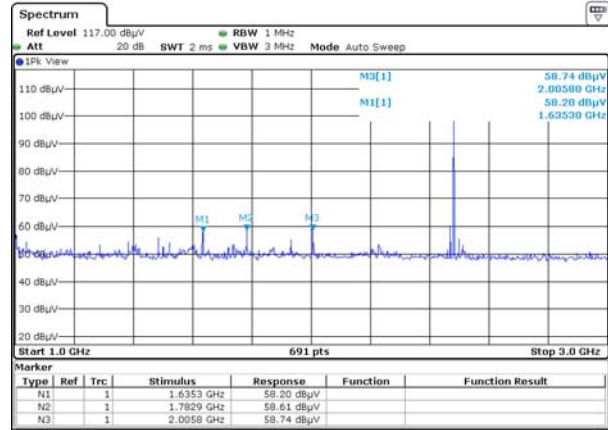




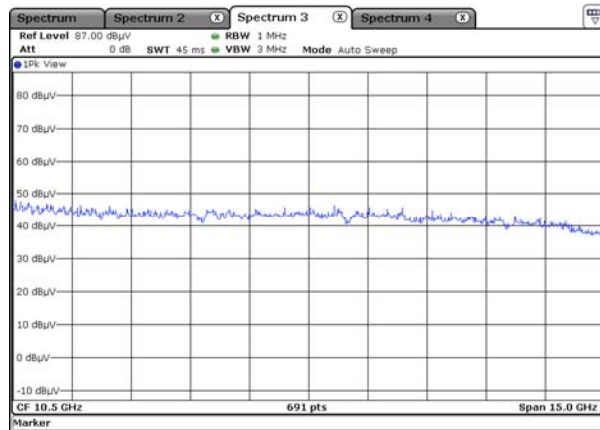
### Horizontal // Peak for 1 GHz to 3 GHz



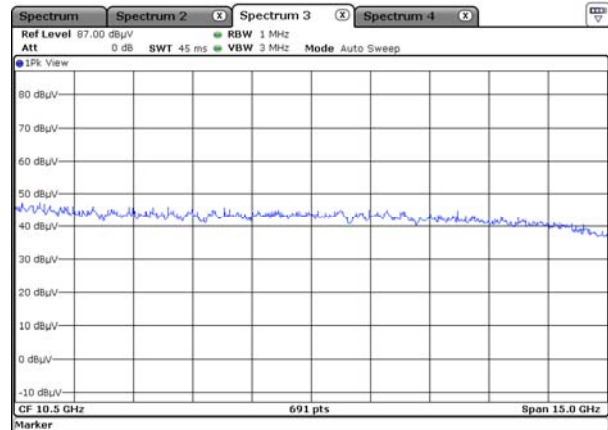
### Vertical // Peak for 1 GHz to 3 GHz



### Horizontal // Peak for 3 GHz to 18 GHz



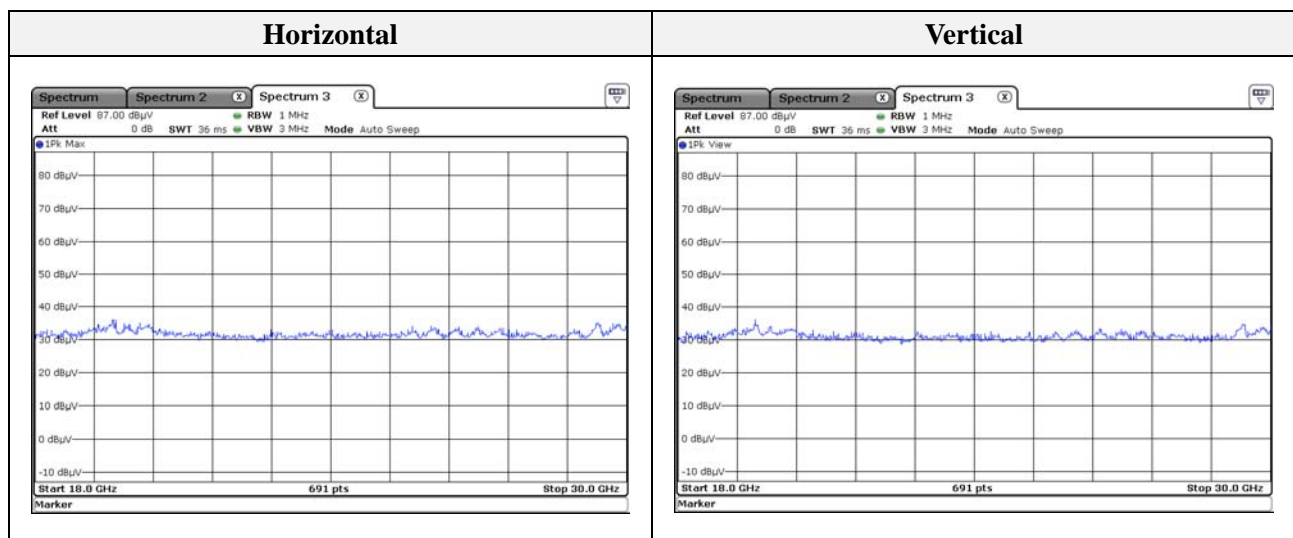
### Vertical // Peak for 3 GHz to 18 GHz



### Test results (18 GHz to 30 GHz)

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

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

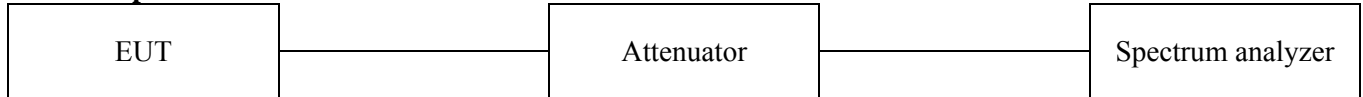


### Note.

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 =  $20\log(\text{dwell time}/100 \text{ ms})$

### 3.2. Conducted band edge and out of band emissions

#### Test setup



#### Test procedure

DA 00-705

#### Test setting

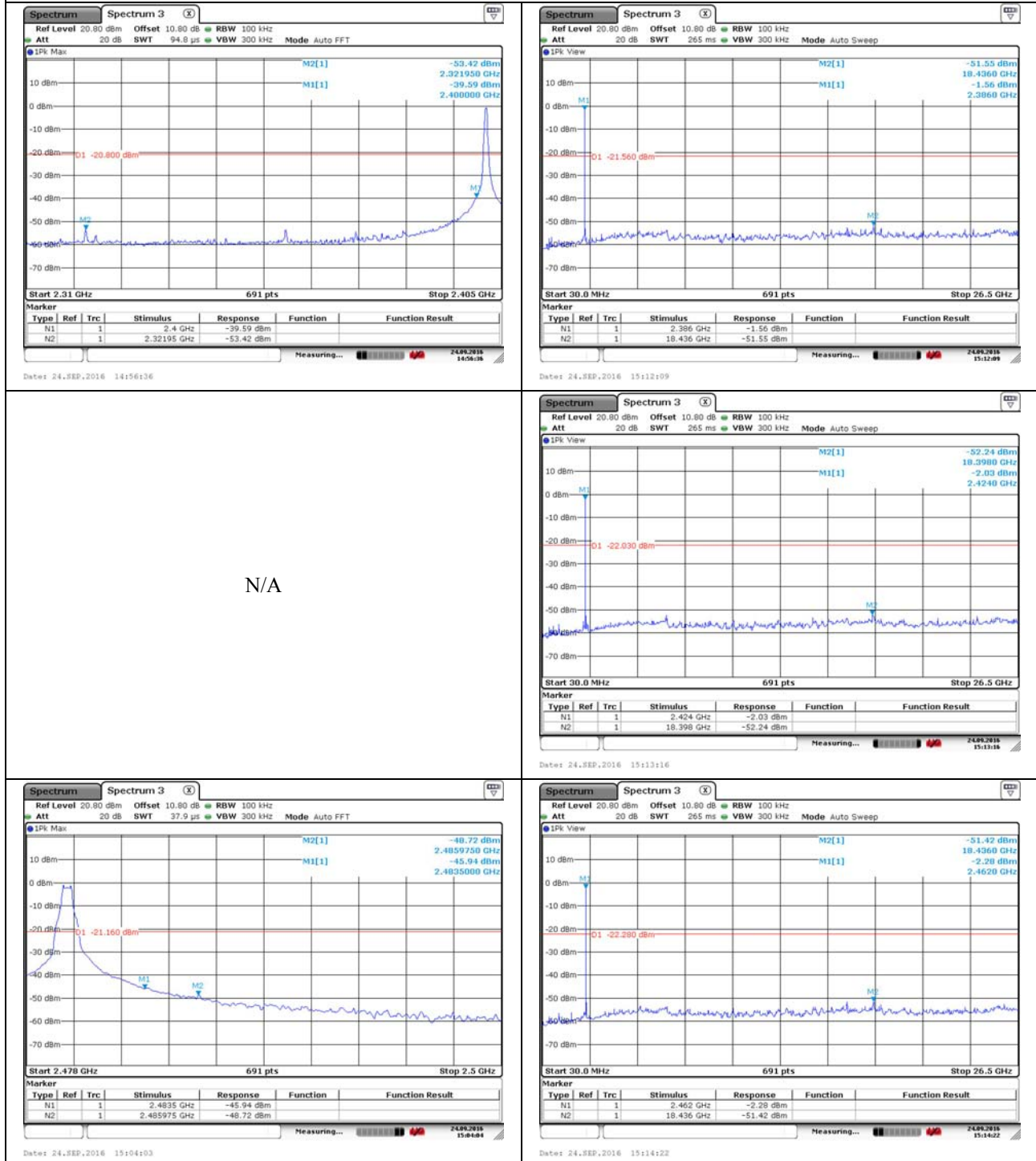
1. Span = wide enough to capture the peak level of the in-band emission and all spurious emissions(e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic.
2. RBW = 100 kHz
3. VBW  $\geq$  300 kHz
4. Detector = Peak
5. Number of sweep points  $\geq 2 \times \text{Span/RBW}$
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))

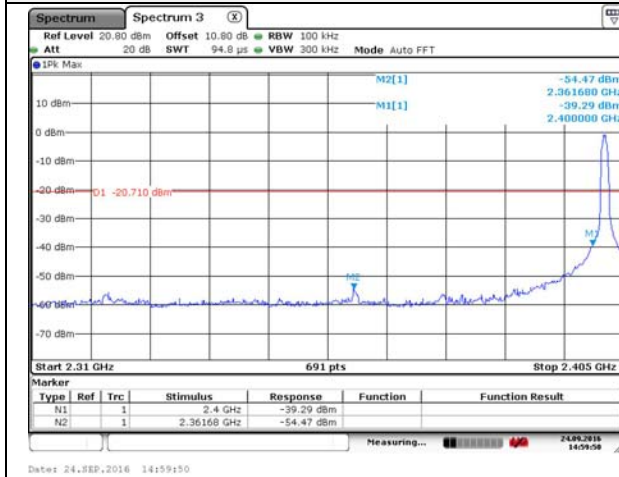
## Test results

### BDR(1Mbps)

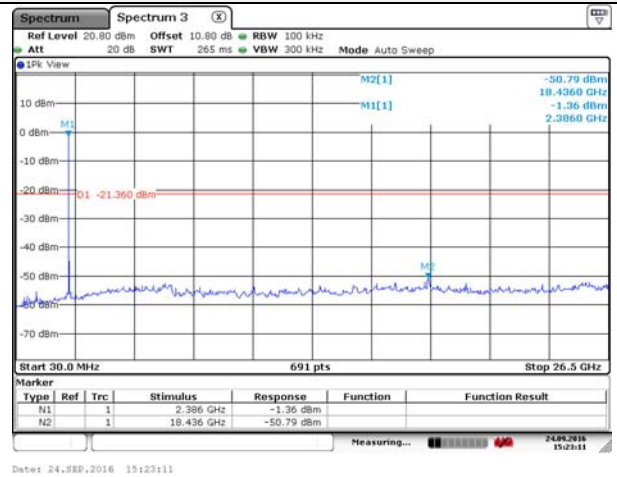


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### EDR(3Mbps)

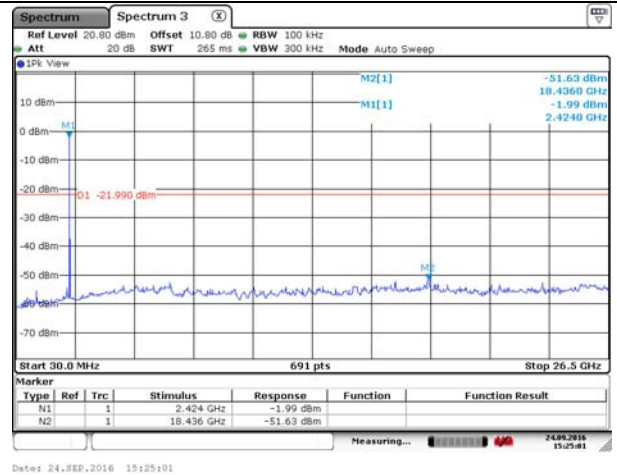


Date: 24.SEP.2016 14:59:50

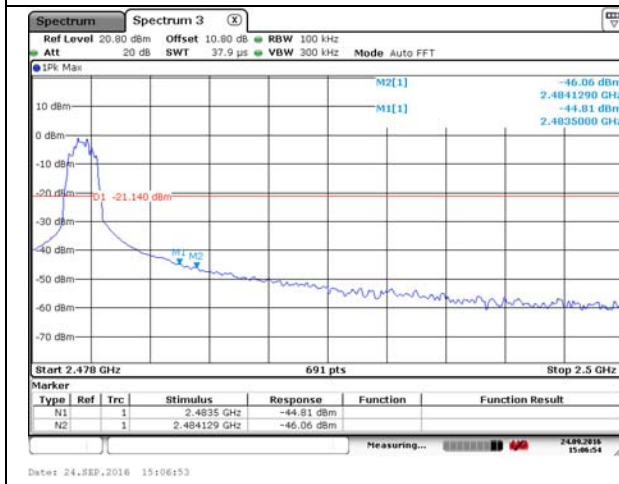


Date: 24.SEP.2016 15:23:11

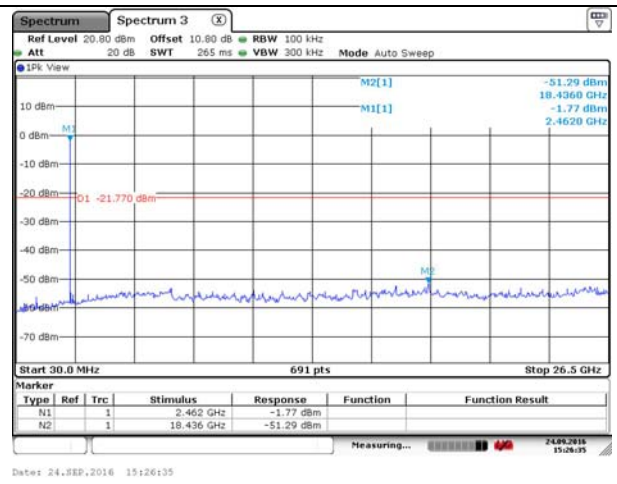
N/A



Date: 24.SEP.2016 15:25:01

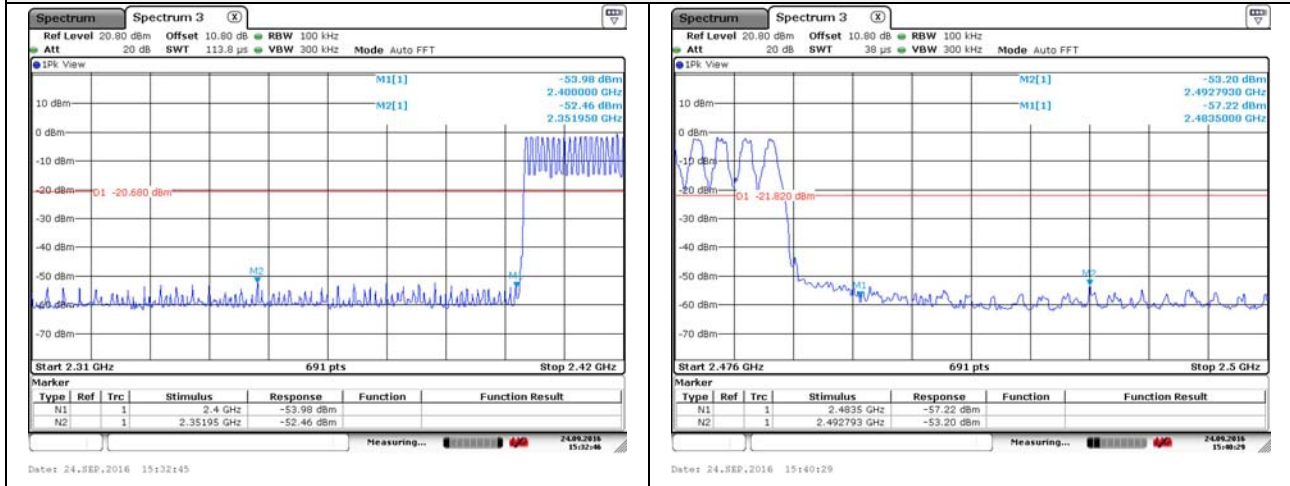


Date: 24.SEP.2016 15:06:53

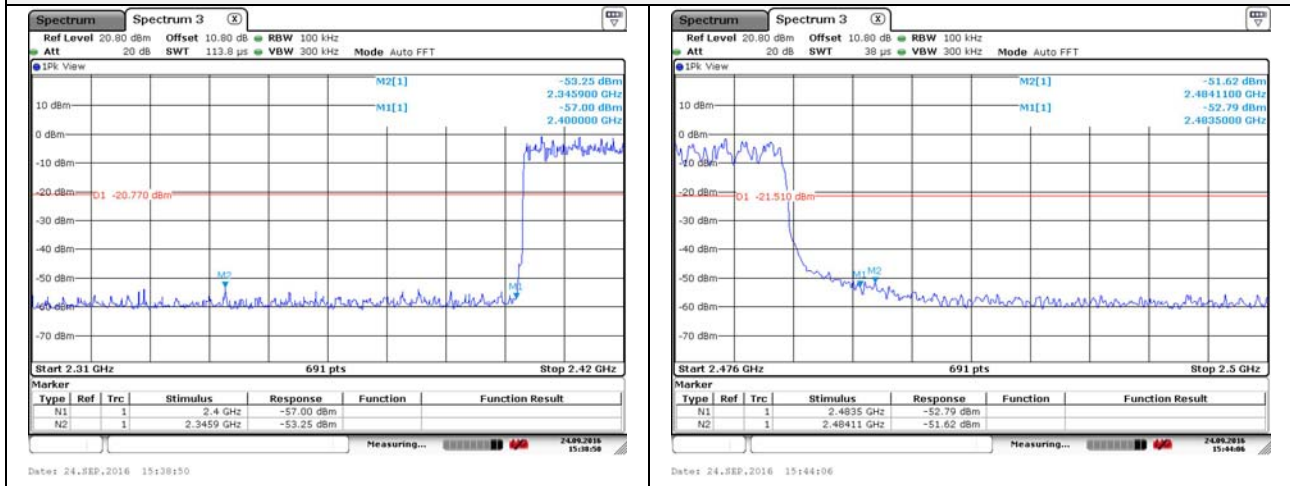


Date: 24.SEP.2016 15:26:35

### Hopping mode\_BDR(1Mbps)



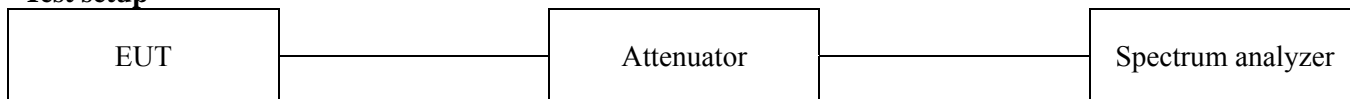
### Hopping mode\_EDR(3Mbps)





### 3.3. 20 dB bandwidth

#### Test setup



#### Test procedure

DA 00-705

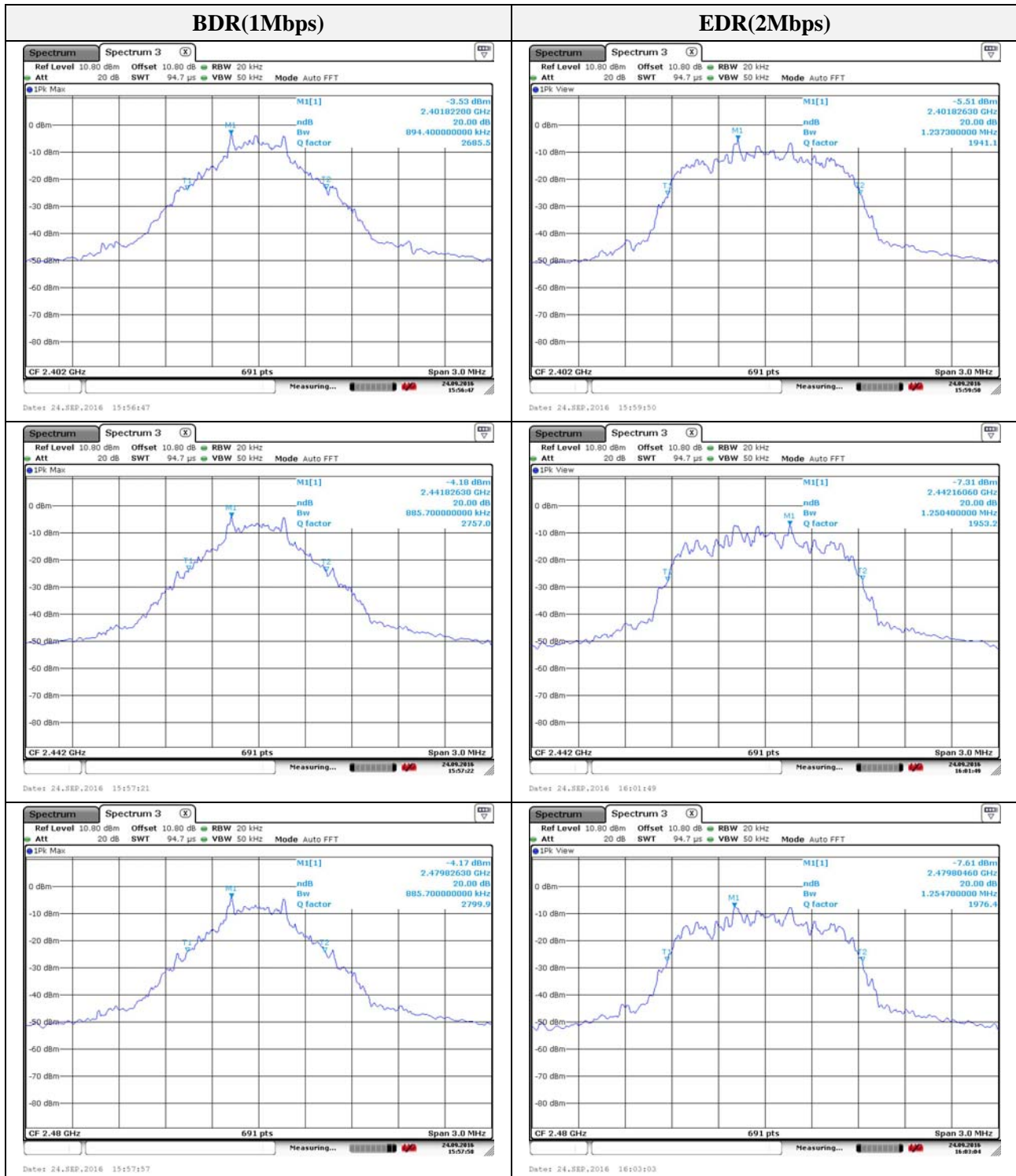
#### Test setting

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

Frequency(MHz)	Channel no.	Data rate(Mbps)	Measured bandwidth(MHz)
2 402	00	1	0.894
2 441	39		0.886
2 480	78		0.886
2 402	00	2	1.237
2 441	39		1.250
2 480	78		1.255
2 402	00	3	1.250
2 441	39		1.211
2 480	78		1.268



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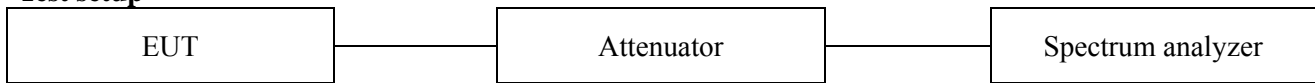




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### 3.4. Output power

#### Test setup



#### 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

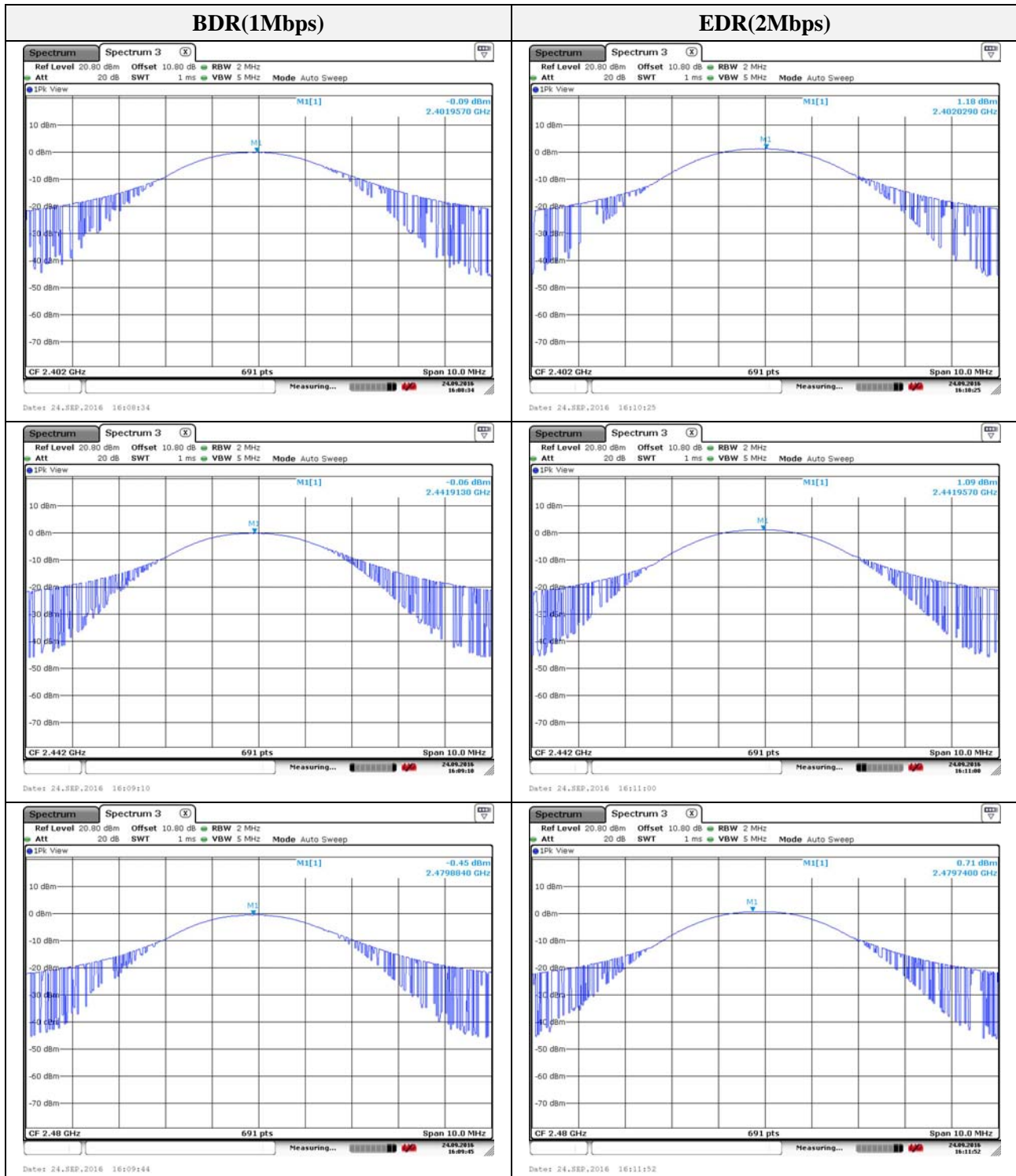
#### Limit

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.

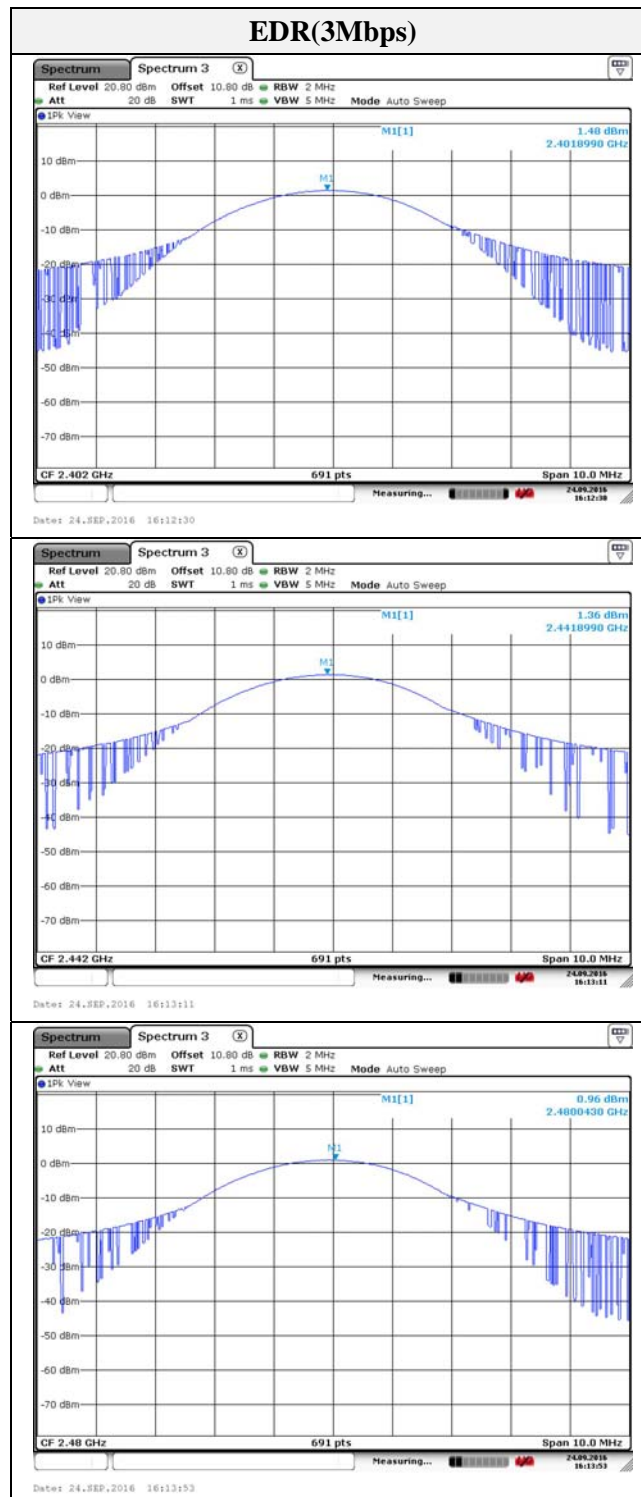
According to §15.247(b)(1), For frequency hopping systems operating in the 2 400 ~ 2 483.5 MHz employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 ~ 5 805 MHz band: 1 Watt.



Frequency(MHz)	Channel no.	Data rate(Mbps)	Measured power (dBm)	Peak Power Limit (dBm)
2 402	00	1	-0.09	20.97
2 441	39		-0.06	20.97
2 480	78		-0.45	20.97
2 402	00	2	1.18	20.97
2 441	39		1.09	20.97
2 480	78		0.71	20.97
2 402	00	3	1.48	20.97
2 441	39		1.36	20.97
2 480	78		0.96	20.97



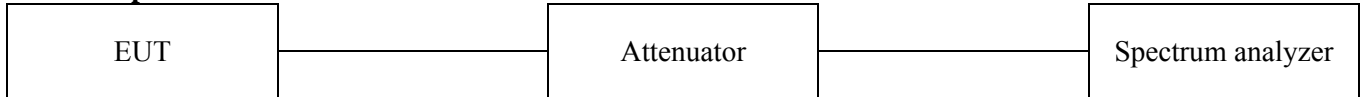
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### 3.5. Carrier frequency separation

#### Test setup



#### 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.

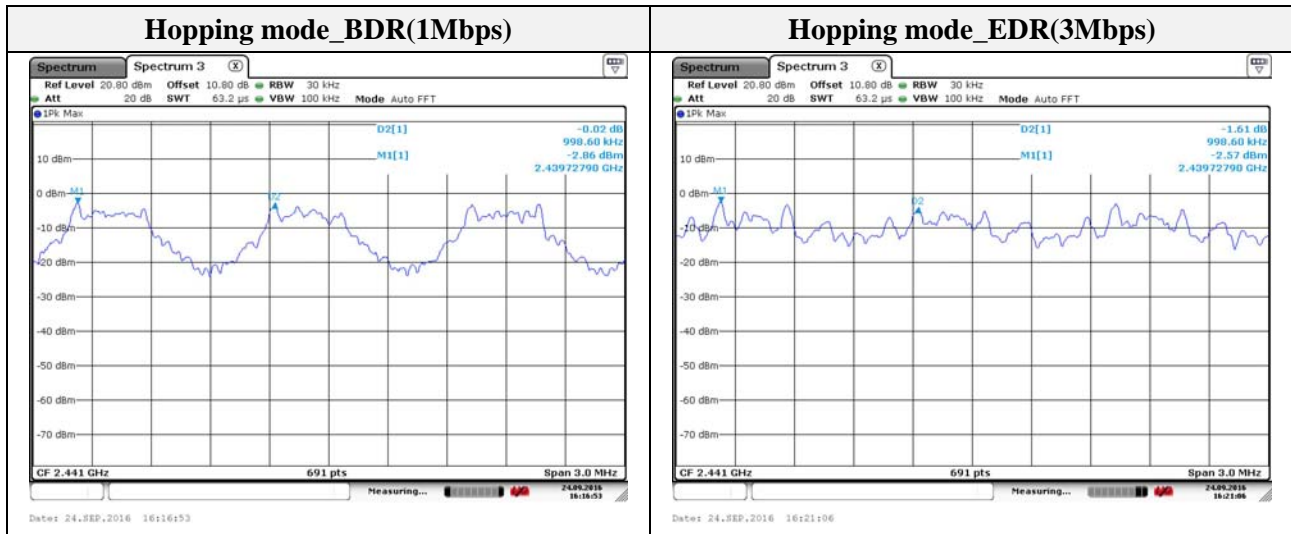
#### Limit

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.

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

#### Note:

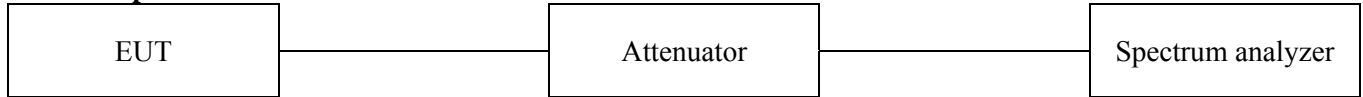
Measurement is made with EUT operating in hopping mode between 79 channels providing a worse case scenario as compared to AFH mode hopping between 20 channels.



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### 3.6. Number of hopping frequency

#### Test setup



#### Test procedure

DA 00-705

#### Test setting

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

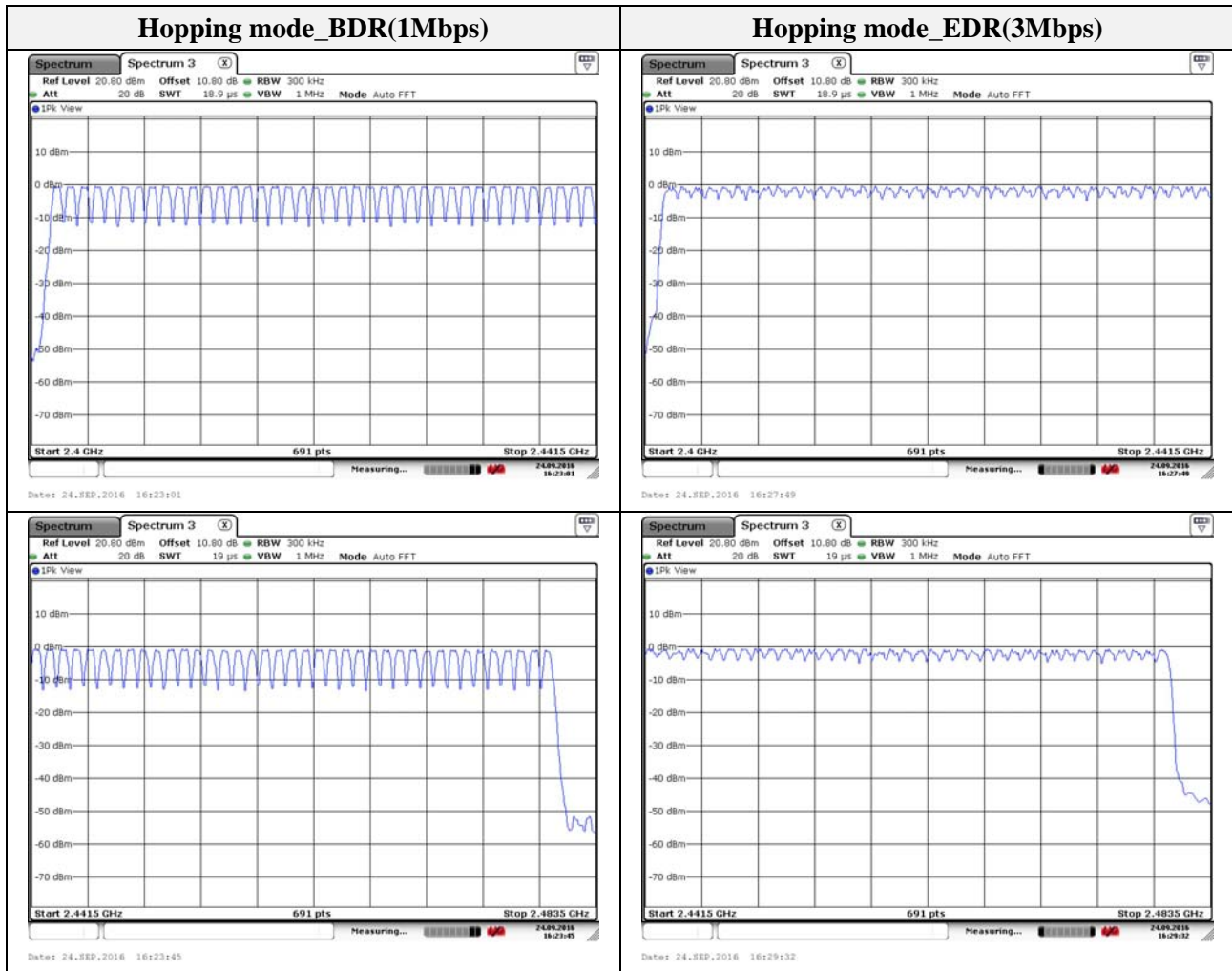
All the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

#### Limit

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

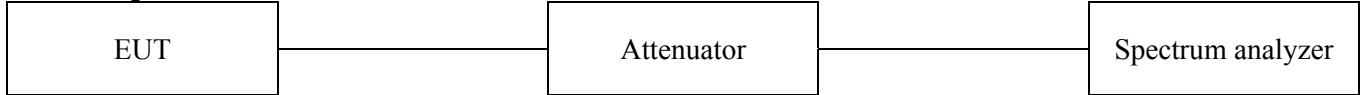
**Note:** In case of AFH mode, minimum number of hopping channels is 20.





### 3.7. Time of occupancy

#### Test setup



#### 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 31.6 second period.

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

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

#### • Adaptive Frequency Hopping

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

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

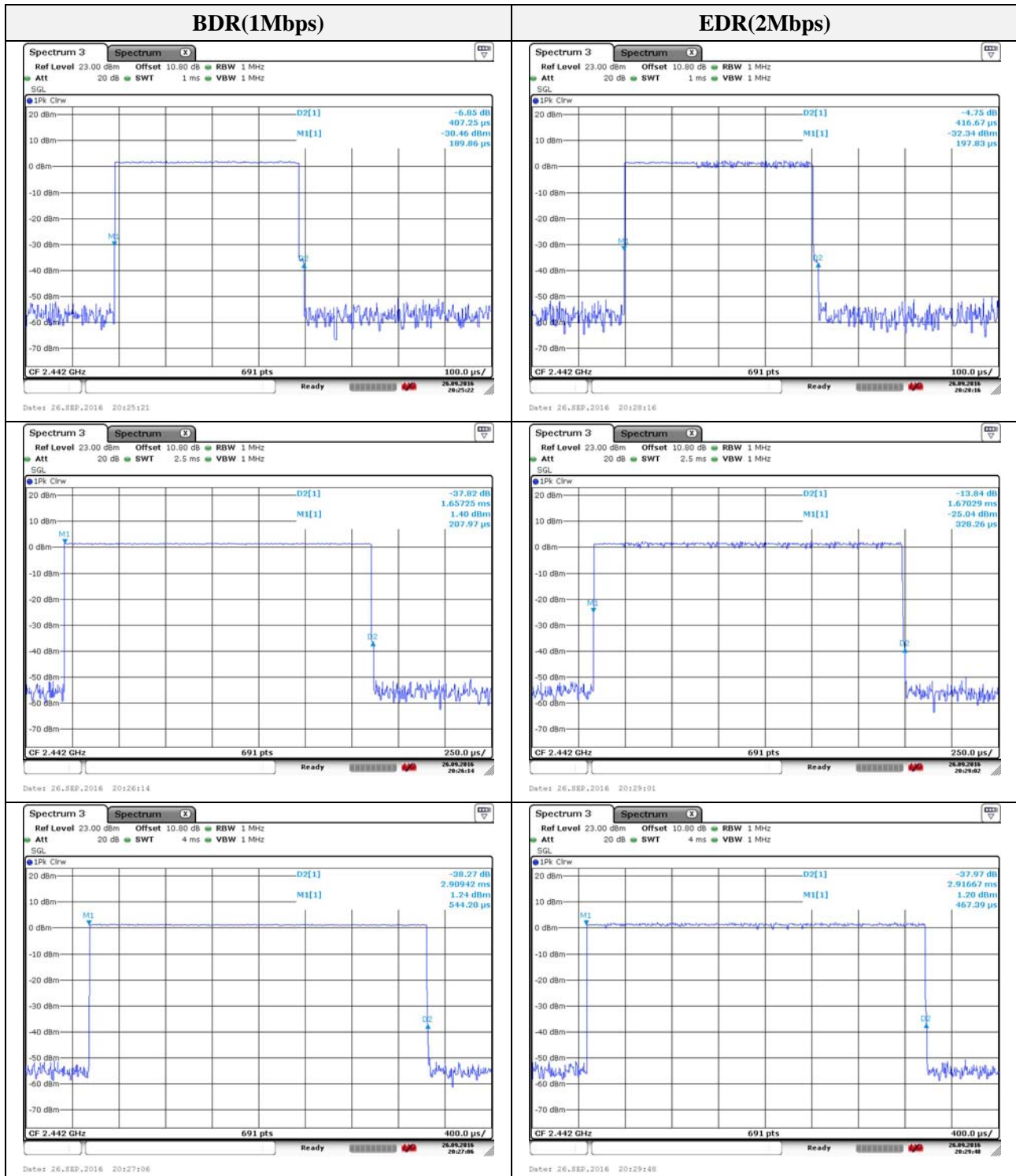
**Operation mode: GFSK ,  $\pi/4$ -DQPSK, 8DPSK**

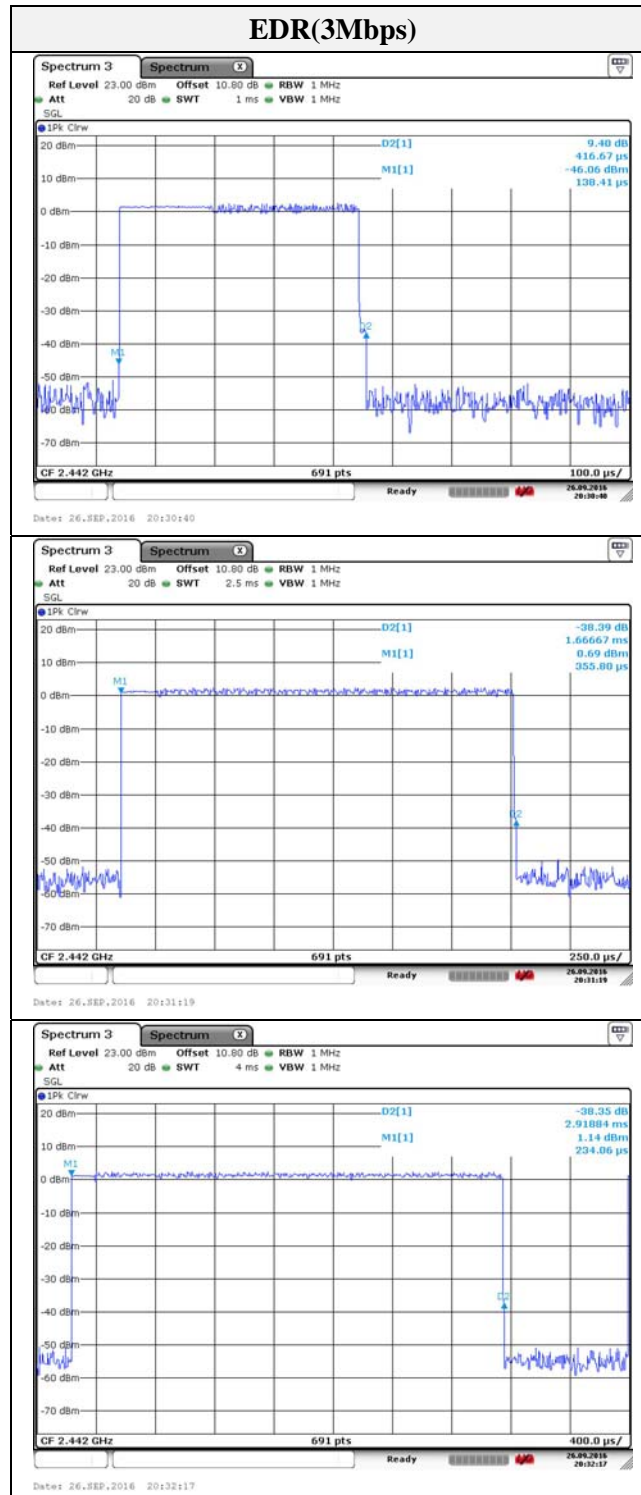
Packet type	Frequency (MHz)	Dwell time (ms)	Time of occupancy on the Tx channel in 31.6 sec (ms)	Limit for time of occupancy on the Tx channel in 31.6 sec (ms)
DH1	2 441	0.407	134.08	400
DH3	2 441	1.657	268.48	400
DH5	2 441	2.909	312.32	400
2-DH1	2 441	0.417	139.20	400
2-DH3	2 441	1.670	269.60	400
2-DH5	2 441	2.917	312.85	400
3-DH1	2 441	0.417	140.16	400
3-DH3	2 441	1.667	269.60	400
3-DH5	2 441	2.919	313.49	400

**Note:**

**Normal Mode**

DH1: Dwell time (ms)  $\times [(1\ 600 \div 2) \div 79] \times 31.6(s) = 134.08\ (ms)$   
DH3: Dwell time (ms)  $\times [(1\ 600 \div 4) \div 79] \times 31.6(s) = 268.48\ (ms)$   
DH5: Dwell time (ms)  $\times [(1\ 600 \div 6) \div 79] \times 31.6(s) = 312.32\ (ms)$   
2-DH1: Dwell time (ms)  $\times [(1\ 600 \div 2) \div 79] \times 31.6(s) = 139.20\ (ms)$   
2-DH3: Dwell time (ms)  $\times [(1\ 600 \div 4) \div 79] \times 31.6(s) = 269.60\ (ms)$   
2-DH5: Dwell time (ms)  $\times [(1\ 600 \div 6) \div 79] \times 31.6(s) = 312.85\ (ms)$   
3-DH1: Dwell time (ms)  $\times [(1\ 600 \div 2) \div 79] \times 31.6(s) = 140.16\ (ms)$   
3-DH3: Dwell time (ms)  $\times [(1\ 600 \div 4) \div 79] \times 31.6(s) = 269.60\ (ms)$   
3-DH5: Dwell time (ms)  $\times [(1\ 600 \div 6) \div 79] \times 31.6(s) = 313.49\ (ms)$





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

## Test results

Hot Line

Level in dBµV

Frequency in Hz

FCC Part 15 Class B Voltage on Mains OP

FCC Part 15 Class B Voltage on Mains AV

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.510000	---	31.39	46.00	14.61	1000.0	9.000	L1	9.8
0.510000	41.13	---	56.00	14.87	1000.0	9.000	L1	9.8
3.885000	---	30.60	46.00	15.40	1000.0	9.000	L1	10.1
3.885000	40.30	---	56.00	15.70	1000.0	9.000	L1	10.1
4.585000	---	31.91	46.00	14.09	1000.0	9.000	L1	10.0
4.585000	40.46	---	56.00	15.54	1000.0	9.000	L1	10.0
5.200000	---	31.05	50.00	18.95	1000.0	9.000	L1	10.0
5.200000	37.82	---	60.00	22.18	1000.0	9.000	L1	10.0
12.440000	---	24.50	50.00	25.50	1000.0	9.000	L1	9.9
12.440000	32.69	---	60.00	27.31	1000.0	9.000	L1	9.9

Neutral Line

Level in dBµV

Frequency in Hz

FCC Part 15 Class B Voltage on Mains OP

FCC Part 15 Class B Voltage on Mains AV

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.505000	---	34.55	46.00	11.45	1000.0	9.000	N	9.8
0.505000	44.50	---	56.00	11.50	1000.0	9.000	N	9.8
4.590000	---	34.08	46.00	11.92	1000.0	9.000	N	10.0
4.590000	44.31	---	56.00	11.69	1000.0	9.000	N	10.0
4.675000	---	32.75	46.00	13.25	1000.0	9.000	N	10.0
4.675000	43.71	---	56.00	12.29	1000.0	9.000	N	10.0
5.220000	---	33.51	50.00	16.49	1000.0	9.000	N	10.0
5.220000	42.69	---	60.00	17.31	1000.0	9.000	N	10.0
18.640000	---	27.72	50.00	22.28	1000.0	9.000	N	10.1
18.640000	37.38	---	60.00	22.62	1000.0	9.000	N	10.1



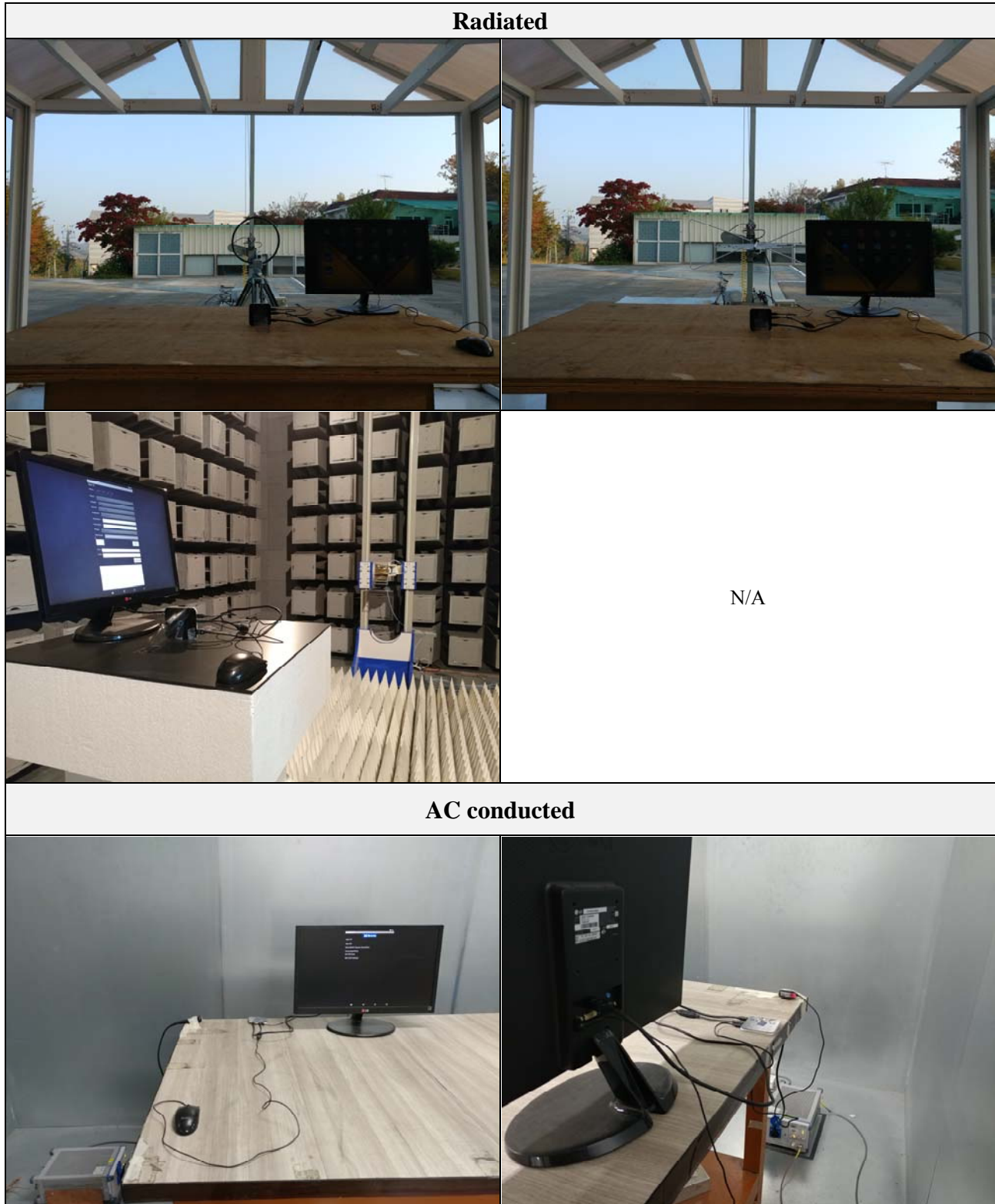
## Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum Analyzer	R&S	FSV40	101002	1 year	2017.07.06
Spectrum Analyzer	R&S	FSV30	10076	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	Agilent	8493C	51401	1 year	2017.07.05
Wideband Power Sensor	R&S	NRP-Z81	101886	1 year	2017.01.22
Power Meter	Anritsu	ML2495A	1438001	1 year	2017.01.25
Pulse Power Sensor	Anritsu	MA2411B	1339205	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	SCHWARZBECK	BBV-9718	9718-246	1 year	2016.10.23
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.
AC/DC Adapter	Weihai Sunlin electronics Co. Ltd	PPC-340-M5	N/A
Monitor	LG Electronics Inc.	FLATRON 23EN43V	312NDZJ75261
AC/DC Adapter	SHENZHEN HONOR ELECTRONIC CO.,Ltd.	ADS-40FSG-19	EAY62768606
Mouse	WORLD OF MAX TECHNOLOGIES COMPANY LIMITED	V200	N/A

## Appendix B. Test setup photo



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