FCC Part 15 Subpart E §15.407

Test Report

Equipment Under Test	**Harmonix Wireless OWL**
Model Name	**HDX5GHz-Tx1000**
Applicant	**Harmonix Co., Ltd.**
FCC ID	**SWCHDX5GHZ-TX1000**
Manufacturer	**Harmonix Co., Ltd.**
Date of Test(s)	**2013. 10. 08 ~2013. 10. 30**
Date of Issue	**2013. 11. 18**

In the configuration tested, the EUT complied with the standards specified above.

Issue to	Issue by
Harmonix Co., Ltd. RM T-7004, Techno, Garden 5 Life, 516 Munjeong-dong, Songpa-gu SEOUL 138-960 KOREA Tel.: +82-2-585-7360 Fax: +82-2-2157-7362	MOVON CORPORATION 194-1, Geumeo-ri, Pogok-eup, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea, 449-812 Tel.: +82-31-338-8837 Fax: +82-31-338-8847

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Revision history

Revision	Date of issue	Description	Revised by
--	Oct 17, 2013	Initial	--
1	Nov 18, 2013	Revised Restricted Band & band-edge data & antenna requirement	Raymond.kim

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Table of contents

1. GENERAL INFORMATION....4
2. EUT DESCRIPTION....5
3. MEASUREMENT EQUIPMENT....6
4. TRANSMITTER RADIATED SPURIOUS EMISSIONS AND CONDUCTED SPURIOUS EMISSIONS....7
5. 26 dB BANDWIDTH....20
6. OUTPUT POWER....23
7. PEAK POWER SPECTRAL DENSITY....26
8. PEAK EXCURSION....29
9. FREQUENCY STABILITY....32
9. ANTENNA REQUIREMENT....34
10. RF EXPOSURE EVALUATION....35
11. TEST SETUP PHOTO OF EUT....37

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1. General information

1.1. Details of applicant

Applicant	:	Harmonix Co., Ltd.
Address	:	RM T-7004, Techno, Garden 5 Life, 516 Munjeong-dong, Songpa-gu SEOUL 138-960 KOREA
Contact Person	:	YoungKeun Kim
Telephone	:	+82-2-585-7360
Fax	:	+82-2-2157-7362

1.2. Summary of test results

The EUT has been tested according to the following specifications;

Section in FCC part 15	Description	Result
§15.205(a) §15.209(a) §15.407(b)(1)	Transmitter radiated spurious emissions, Conducted spurious emission	C
§15.407(a)(1)	Output power	C
§15.407(a)(1)	Peak power spectral density	C
§15.407(a)(1)	Peak excursion	C
§15.407(g)	frequency stability	C
§1.1307(b)(1)	RF exposure evaluation	C

The sample was tested according to the following specification:
ANSI C63.4-2003
FCC Public Notice KDB789033 D01 v01r03.
TEST SITE REGISTRATION NUMBER:
FCC(670686)

※ Abbreviation

C Complied
N/A Not applicable
F Fail

Approval Signatories

Test and Report Completed by :	Report Approval by :
Raymond Kim Test Engineer MOVON CORPORATION	Issac Jin Technical Manager MOVON CORPORATION

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2. EUT Description

Kind of product	Harmonix Wireless OWL
Model Name	HDX5GHz-Tx1000
Serial Number	N/A
Power supply	DC 12 V
Frequency range	5 180 ㎒ ~ 5 220 ㎒, 5 735 ㎒ ~ 5 815 ㎒
Modulation technique	DSSS (11Mbps)
Number of channels	3 / 5
Antenna gain	3.81 ㏈i (Max.)
Test Site Registration Number	FCC(670686)

2.1. Declarations by the manufacturer

None

2.2. Details of modification

None

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3. Measurement equipment

Equipment	Manufacturer	Model	Serial number	Calibration Interval	Calibration due.
EMI Test Receiver	R&S	ESIB26	100196/026	1 year	2013-12-14
Signal Generator	R&S	SMR27	100089	1 year	2013-12-13
Spectrum Analyzer	R&S	FSV-40	100832	1 year	2014-10-04
Power Meter	Agilent	E4416A	GB41290645	1 year	2014-10-04
Power Sensor	Agilent	9327A	US40441490	1 year	2014-10-04
Double Redge Horn Antenna	R&S	HF906	100236	2 year	2015-02-28
Ultra Broadband Antenna	R&S	HL562	100170	1 year	2013-12-13
Power Amplifier	MITEQ	AM-1431	1497315	1 year	2014-10-04
Power Amplifier	MITEQ	AFS43-01002600	1374382	1 year	2014-10-04
High Pass Filter	Wainwright	WHK3.0/18G-10SS	508	1 year	2014-10-04
DC Power Supply	HP	6674A	3637A01351	1 year	2014-10-04
Controller	INNCO	CO2000	co200/064/6961003/L	N/A	N/A
Antenna Master	INNCO	MA4000	MA4000/038/6961003/L	N/A	N/A
Loop Antenna	ETS LINDGREN	6502	00118166	2 year	2015-09-27

※ Remark;
Support equipment

Description	Manufacturer	Model	Serial number
Notebook computer	HP.	HP Mini 110-3721TU	5CB1351VK9

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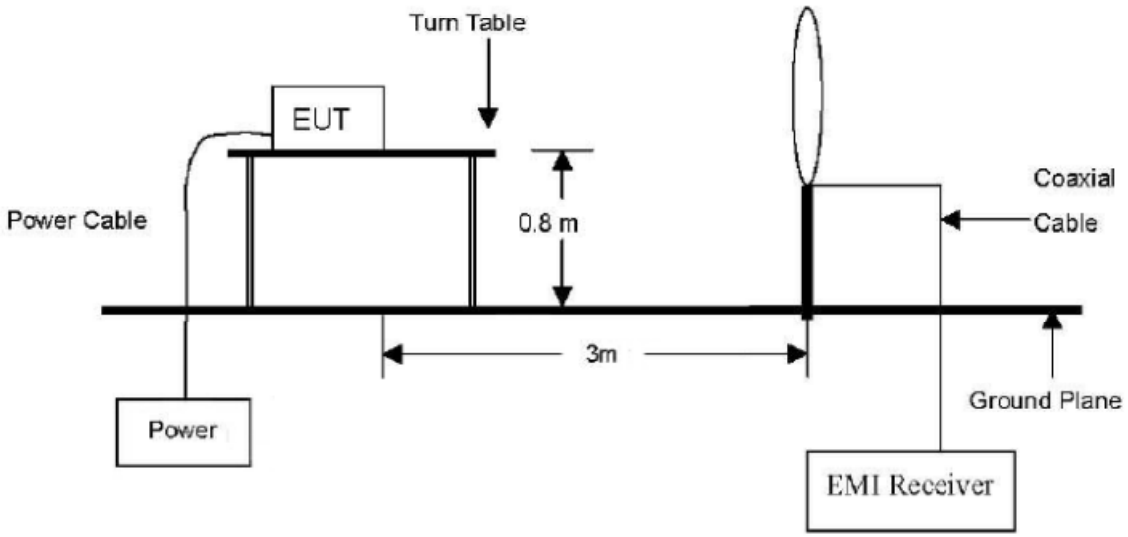
4. Transmitter radiated spurious emissions and conducted spurious emissions

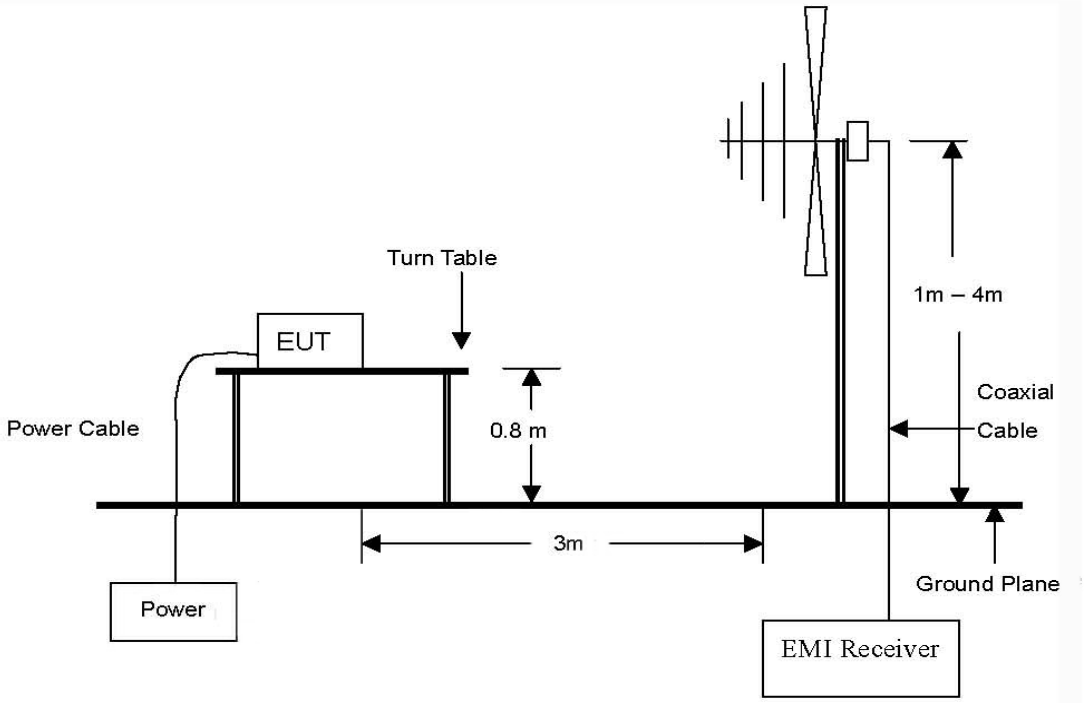
4.1. Test setup

4.1.1. Transmitter radiated spurious emissions

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



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



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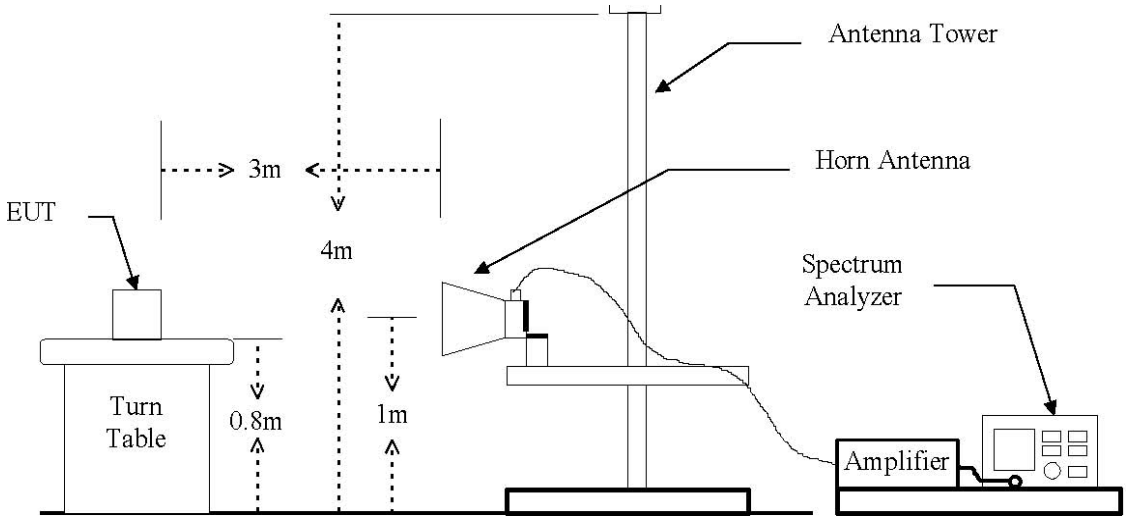
The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to 40 ㎓ emissions.



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4.2. Limit

For transmitters operating in the 5.15 ~ 5.25 ㎓ band : all emissions outside of the 5.15 ~ 5.35 ㎓ band shall not exceed an EIRP of -27 ㏈ m/㎒

$$E=\frac{1000000\sqrt{30P}}{3}$$ ㎶/m, where P is the eirp (Watts)

EIRP (㏈ m)	Field Strength at 3m (㏈㎶/m)
-27	68

According to §15.205(a), Except as provided elsewhere in this Subpart, the emissions from Restricted bands of operation shall not exceed the field strength levels specified in the following table:

㎒	㎒	㎒	㎓
0.090 – 0.110	16.42 – 16.423	399.9 – 410	4.5 – 5.15
0.495 – 0.505	16.694 75 – 16.695 25	608 – 614	5.35 – 5.46
2.173 5 – 2.190 5	16.804 25 -16.804 75	960 – 1240	7.25 – 7.75
4.125 – 4.128	25.5 – 25.67	1300 – 1427	8.025 – 8.5
4.177 25 – 4.177 75	37.5 – 38.25	1435 – 1626.5	9.0 – 9.2
4.207 25 – 4.207 75	73 – 74.6	1645.5 – 1646.5	9.3 – 9.5
6.215 – 6.218	74.8 – 75.2	1660 – 1710	10.6 – 12.7
6.267 75 – 6.268 25	108 – 121.94	1718.8 – 1722.2	13.25 – 13.4
6.311 75 – 6.312 25	123 – 138	2200 – 2300	14.47 – 14.5
8.291 – 8.294	149.9 – 150.05	2310 – 2390	15.35 – 16.2
9.362 – 8.366	156.524 75 – 156.525 25	2483.5 – 2500	17.7 – 21.4
8.376 25 – 8.386 75	156.7 – 156.9	2655 – 2900	22.01 – 23.12
8.414 25 – 8.414 75	162.012 5 – 167.17	3260 – 3267	23.6 – 24.0
12.29 – 12.293	167.72 – 173.2	3332 - 3339	31.2 – 31.8
12.519 75 – 12.520 25	240 – 285	3345.8 – 3358	36.43 – 36.5
12.576 75 – 12.577 25	322 -335.4	3600 – 4400	
13.36 – 13.41			

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4.3. Test procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.4:2003

4.3.1. Test procedures for radiated spurious emissions

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.

※ **Remark;**

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 10 ㎑ for Peak detection (PK) at frequency below 30 ㎒
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 ㎑ for Peak detection (PK) or Quasi-peak detection (QP) at frequency below 1 ㎓.
3. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 ㎒ for Peak detection and frequency above 1 ㎓.

4.3.2. Test procedures for conducted spurious emissions

1. The transmitter output was connected to the spectrum analyzer through an attenuator.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW = 1 ㎒, VBW = 1 ㎒.

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4.4. Test result

Ambient temperature: 25 ℃
Relative humidity: 45 % R.H.

4.4.1. Spurious radiated emission

The frequency spectrum from 9㎑ to 30 ㎒ was investigated. Emission levels are not reported much lower than the limits by over 20 ㏈. All reading values are peak values.
To get a maximum emission levels from the EUT, the EUT was moved throughout the XY, XZ, and YZ planes.

Operation mode
A. Low channel (5 180 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.								

B. Middle channel (5 200 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.								

C. High channel (5 220 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.								

※ Remark
1. Actual = Reading + Ant. factor + CL (Cable loss)
2. Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
3. Limit line = specific Limits (dBuV) + Distance extrapolation factor
4. 15.31 Measurement standards.
The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

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4.4.2. Spurious radiated emission

The frequency spectrum from 30 ㎒ to 1 000 ㎒ was investigated. Emission levels are not reported much lower than the limits by over 20 ㏈. All reading values are peak values.
To get a maximum emission levels from the EUT, the EUT was moved throughout the XY, XZ, and YZ planes.

Operation mode: Basic mode
A. Low channel (5 180 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	CL (dB)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
49.44	23.93	PK	V	7.85	1.97	33.75	40.00	6.25
199.12	27.82	PK	H	10.48	4.04	42.34	43.50	1.16
224.39	19.52	PK	V	12.85	4.28	36.65	46.00	9.35
241.88	22.84	PK	V	14.60	4.45	41.89	46.00	4.11
269.10	22.31	PK	V	14.65	4.70	41.66	46.00	4.34
296.31	26.18	PK	V	13.56	4.95	44.69	46.00	1.31
350.74	11.91	PK	H	14.87	5.44	32.22	46.00	13.78
399.34	17.49	PK	V	16.26	5.88	39.63	46.00	6.37
479.04	8.47	PK	H	17.51	6.60	32.58	46.00	13.42
Above 500	Not detected							

※ Remark
1. Actual = Reading + Ant. factor + CL (Cable loss)
2. 15.31 Measurement standards.
The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

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B. Middle channel (5 200 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dBμV)	Detector mode	Pol.	Ant. factor (dB/m)	CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
49.44	26.48	PK	V	7.85	1.97	36.30	40.00	3.70
199.12	27.65	PK	H	10.48	4.04	42.17	43.50	1.33
224.39	21.60	PK	V	12.85	4.28	38.73	46.00	7.27
241.88	24.41	PK	V	14.60	4.45	43.46	46.00	2.54
269.10	23.63	PK	V	14.65	4.70	42.98	46.00	3.02
296.31	25.74	PK	V	13.56	4.95	44.25	46.00	1.75
350.74	14.18	PK	H	14.87	5.44	34.49	46.00	11.51
399.34	18.35	PK	V	16.26	5.88	40.49	46.00	5.51
479.04	10.28	PK	H	17.51	6.60	34.39	46.00	11.61
Above 500	Not detected							

※ Remark

1. Actual = Reading + Ant. factor + CL (Cable loss)
2. 15.31 Measurement standards.

The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

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C. High channel (5 220 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dBμV)	Detector mode	Pol.	Ant. factor (dB/m)	CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
49.44	25.36	PK	V	7.85	1.97	35.18	40.00	4.82
199.12	27.66	PK	H	10.48	4.04	42.18	43.50	1.32
224.39	19.83	PK	V	12.85	4.28	36.96	46.00	9.04
241.88	23.88	PK	V	14.60	4.45	42.93	46.00	3.07
269.10	22.21	PK	V	14.65	4.70	41.56	46.00	4.44
296.31	26.49	PK	V	13.56	4.95	45.00	46.00	1.00
350.74	13.42	PK	H	14.87	5.44	33.73	46.00	12.27
399.34	18.34	PK	V	16.26	5.88	40.48	46.00	5.52
479.04	9.74	PK	H	17.51	6.60	33.85	46.00	12.15
Above 500	Not detected							

※ **Remark**

1. Actual = Reading + Ant. factor + CL (Cable loss)
2. 15.31 Measurement standards.

The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

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4.4.3. Spurious radiated emission

The frequency spectrum above 1 000 ㎒ was investigated. Emission levels are not reported much lower than the limits by over 20 ㏈.
To get a maximum emission levels from the EUT, the EUT was moved throughout the XY, XZ, and YZ planes.

Operation mode: Basic mode

A. Low channel (5 180 ㎒)

Radiated emissions			Ant.	Correction factors			Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	Amp + CL (㏈)	D.C.F (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.									

B. Middle channel (5 200 ㎒)

Radiated emissions			Ant.	Correction factors			Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	Amp + CL (㏈)	D.C.F (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.									

C. High channel (5 220 ㎒)

Radiated emissions			Ant.	Correction factors			Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	Amp + CL (㏈)	D.C.F (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No other emissions were detected at a level greater than 20dB below limit.									

※ Remark

1 Measuring frequencies from 1 ㎓ to the 40 ㎓.
2 Radiated emissions measured in frequency above 1 000 ㎒ were made with an instrument using peak/average detector mode.
3 Average test would be performed if the peak result were greater than the average limit.
4 Actual = Reading + Ant. factor + Amp + CL (Cable loss)
5 15.31 Measurement standards.
The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

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4.4.4. Restricted Band

A. 4.5 – 5.15 ㎓ measurement

*** Low channel (5 180 ㎒)**

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dBμV)	Detector mode	Pol.	Ant. factor (dB/m)	Amp + CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
5 150	71.54	Peak	H	33.91	-40.71	64.74	74.00	9.26
5 150	58.25	Average	H	33.91	-40.71	51.45	54.00	2.55
5 150	72.34	Peak	V	33.91	-40.71	65.54	74.00	8.46
5 150	58.66	Average	V	33.91	-40.71	51.86	54.00	2.14

※ Remark

Actual = Reading + Ant. Factor + Amp + CL (Cable loss)

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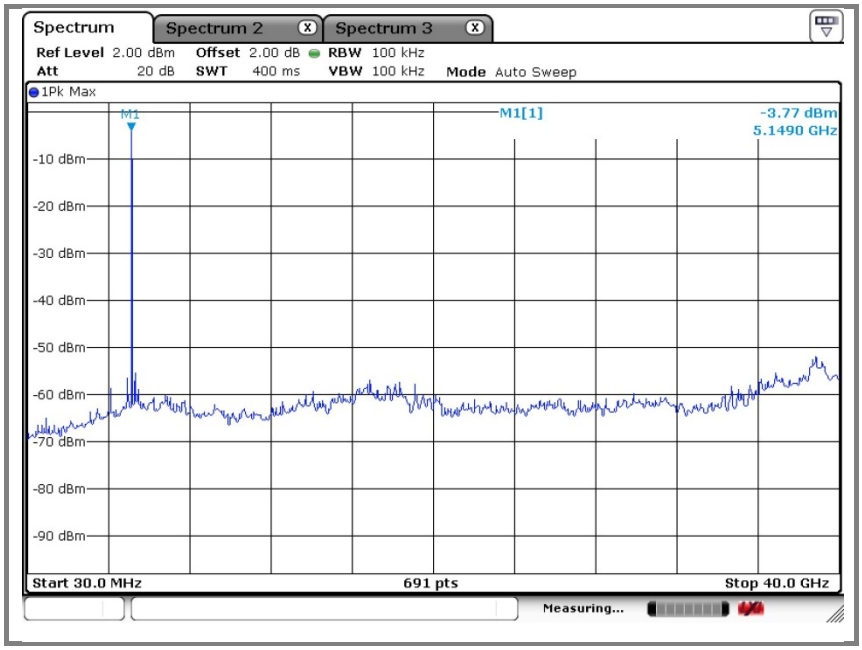
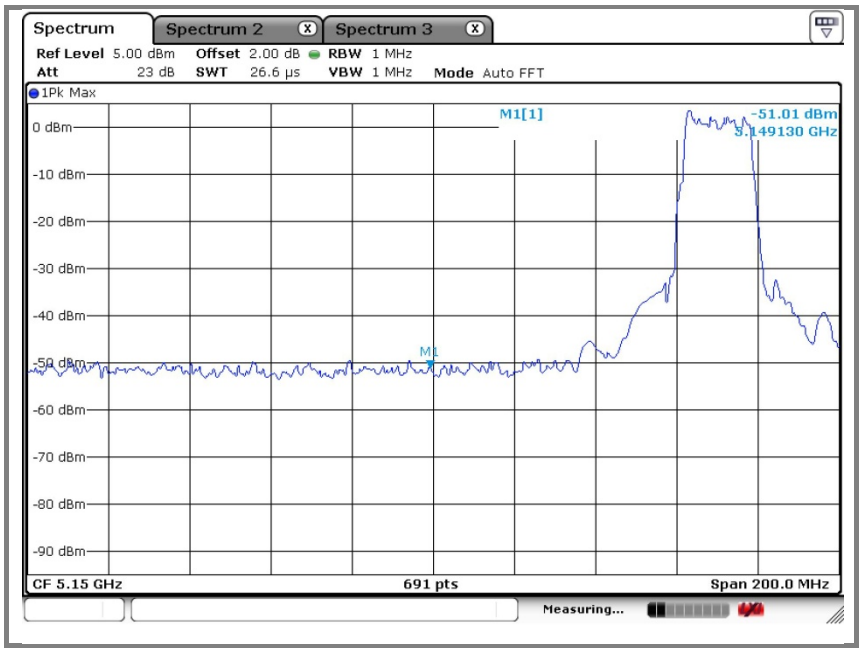
4.4.5. Spurious RF conducted emissions: Plot of spurious RF conducted emission
Operation mode: Basic mode

A. Low channel (5 180 ㎒)

Unwanted Emission data



Band-edge data



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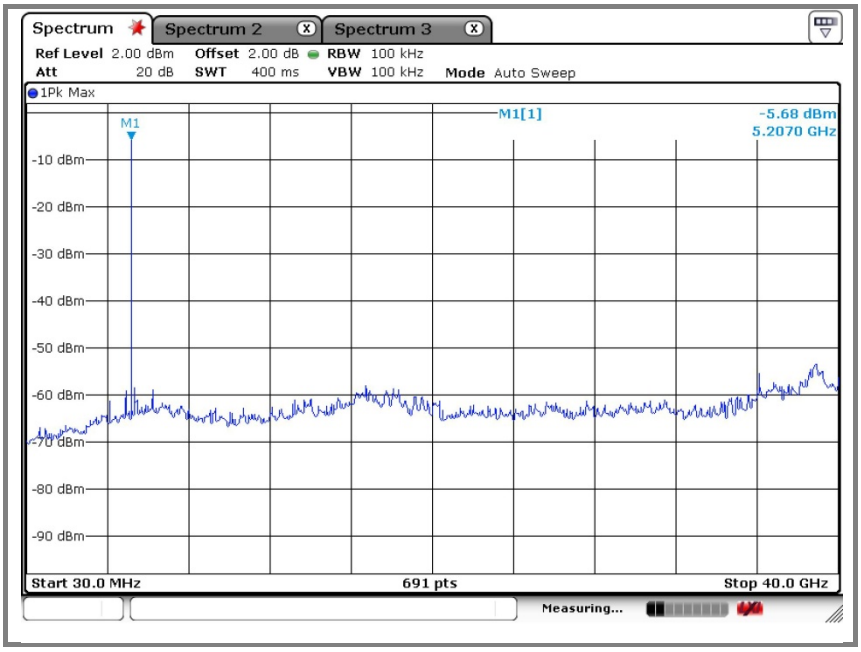
B. Middle channel (5 200 ㎒)



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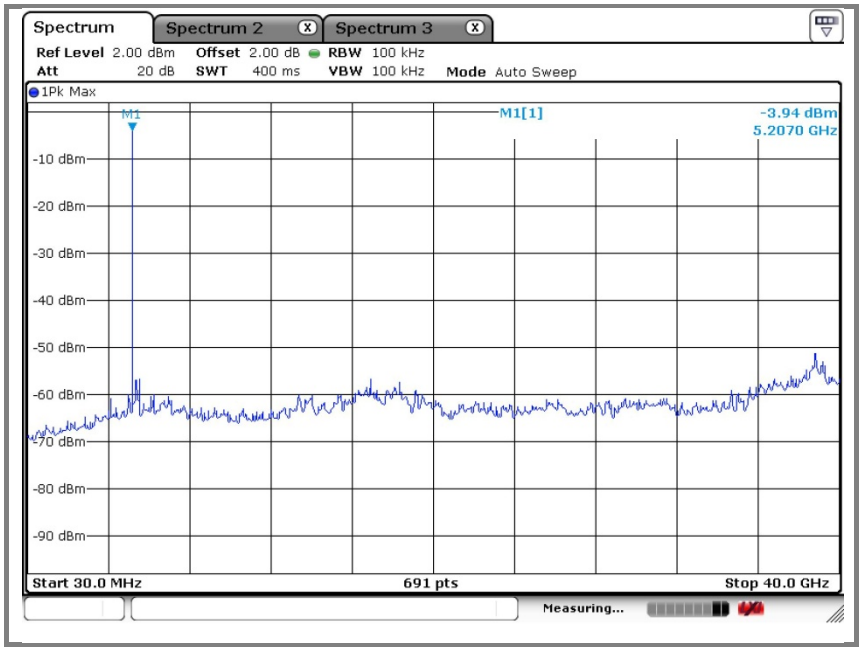
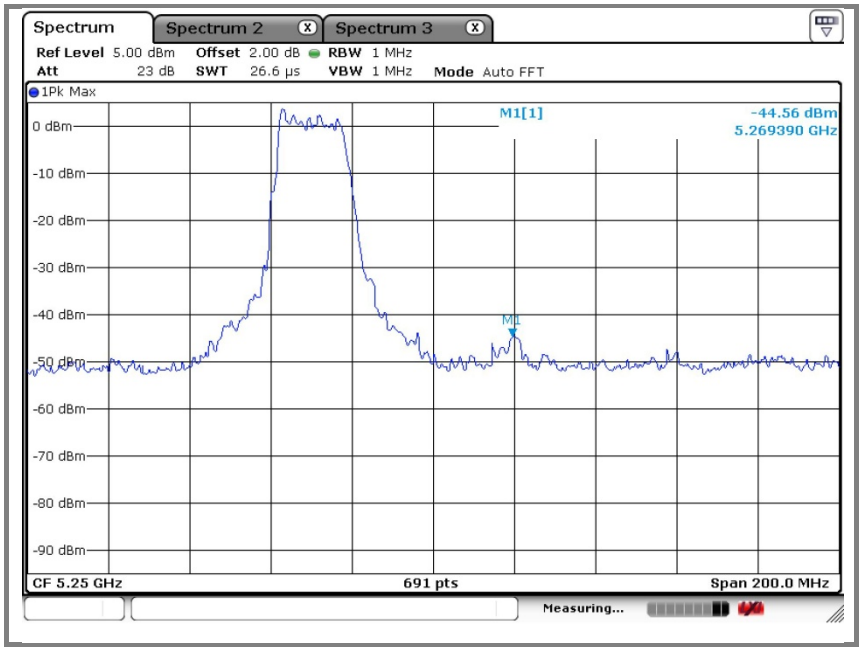
C. High channel (5 220 ㎒)



Band-edge data



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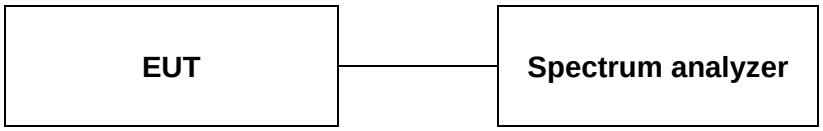
5. 26 dB bandwidth

5.1. Test setup



5.2. Limit

Not applicable

5.3. Test procedure

1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the spectrum analyzer as RBW = 100 ㎑, VBW = RBW, Span = 100 ㎒, Sweep = auto
4. Repeat until all the rest channels are investigated.

5.4. Test results

Ambient temperature: 23 ℃
Relative humidity: 45 % R.H.

Operation mode	Frequency(㎒)	26 dB bandwidth(㎒)
Basic	5 180	20.20
	5 200	20.38
	5 220	20.26

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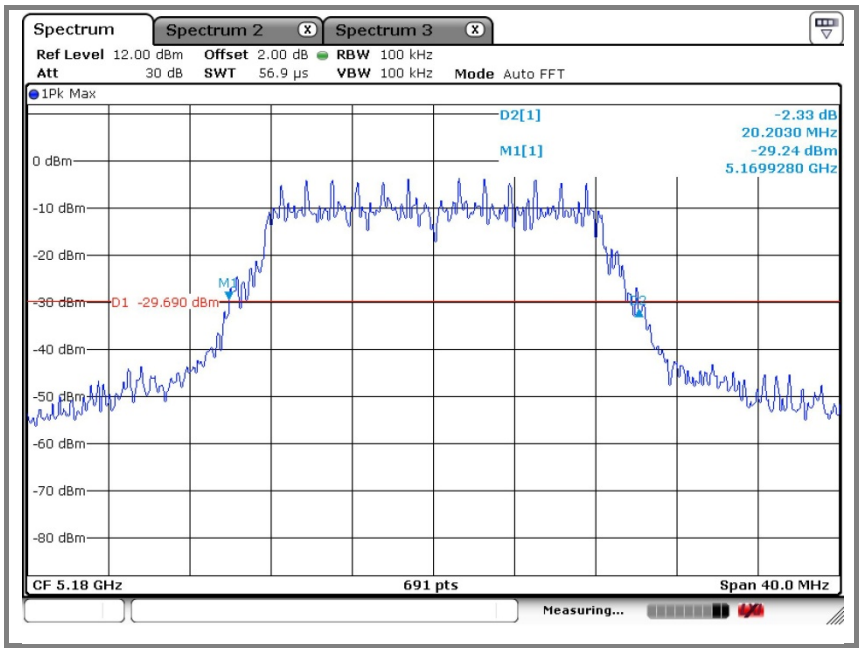
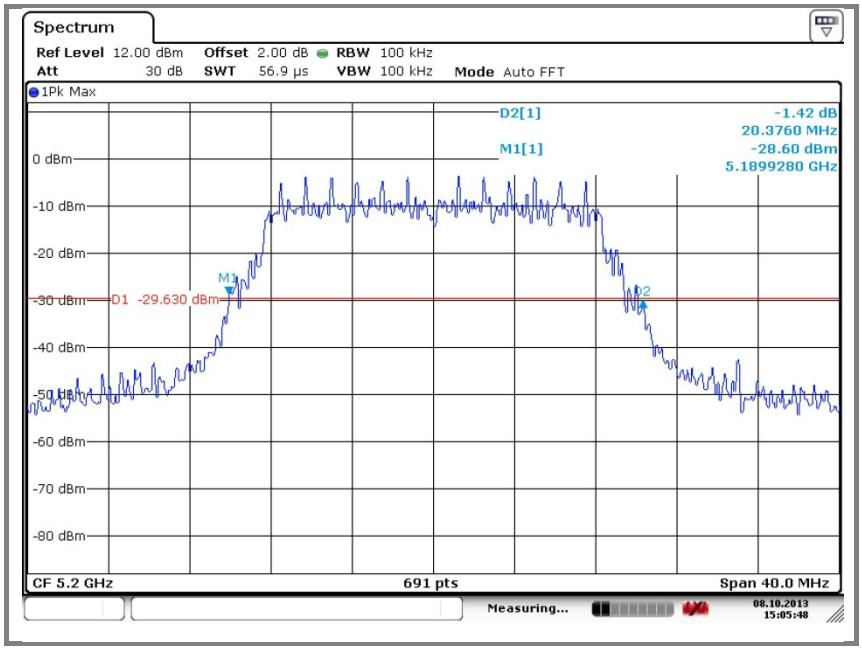
Operation mode: Basic mode

A. Low channel (5 180 ㎒)



B. Middle channel (5 200 ㎒)



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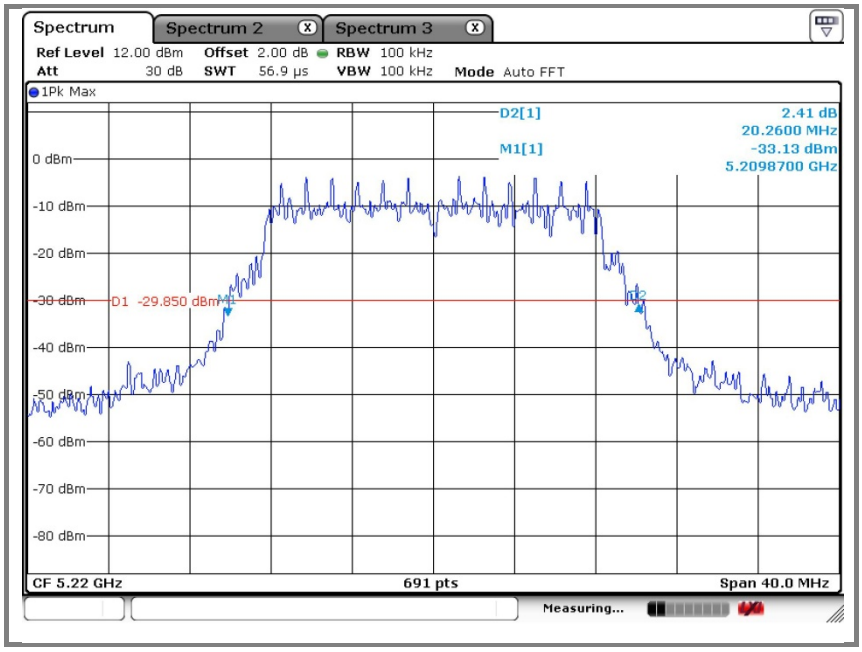
C. High channel (5 220 ㎒)



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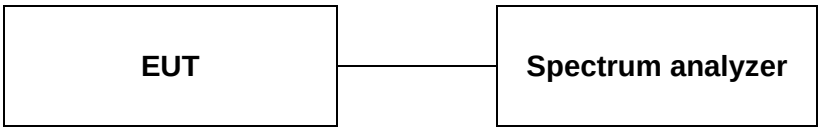
6. Output power

6.1. Test setup.



6.2. Limit

For the 5.15-5.25 ㎓ band, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 50 ㎽ or 40 ㏈m + 10 log B, where B is the 26 ㏈ emission bandwidth in ㎒. If transmitting antennas of directional gain greater than 6 ㏈i are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

6.3. Test procedure

1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the Spectrum analyzer as RBW = 1 ㎒, VBW = 3 ㎒, Span = Auto, Channel BW = 26 ㏈ bandwidth

6.4. Test results

Ambient temperature: 23 ℃
Relative humidity: 45 % R.H.

Limit

Frequency (㎒)	Fixed Limit (㏈m)	B (㎒)	4+10LogB (㏈m)	Antenna gain (㏈i)	Limit (㏈)
5 180	17	20.20	17.05	3.776	17
5 200	17	20.38	17.09	3.559	17
5 220	17	20.26	17.06	3.706	17

Result

Frequency (㎒)	Output power (㏈m)	Limit (㏈m)
5 180	13.18	17
5 200	12.92	
5 220	13.10	

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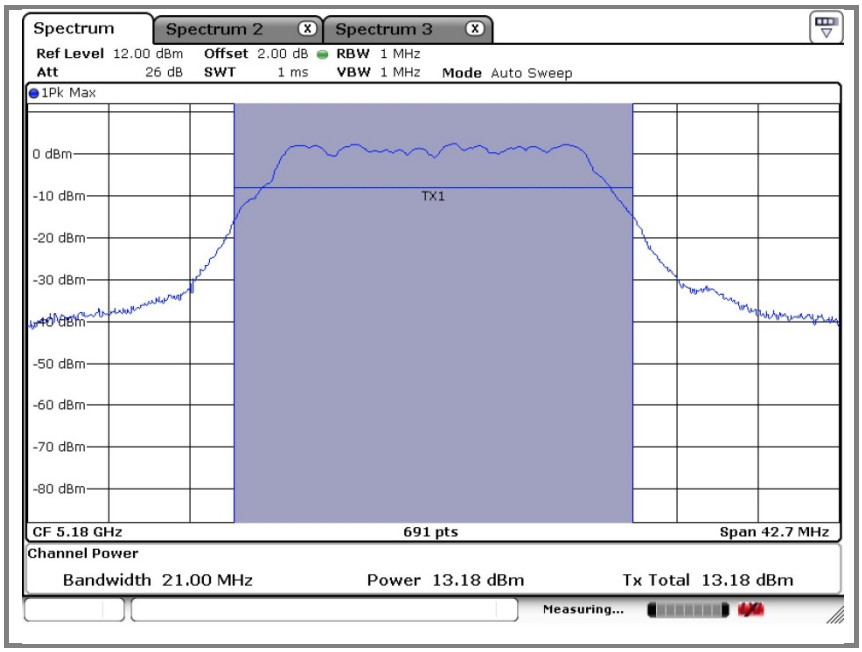
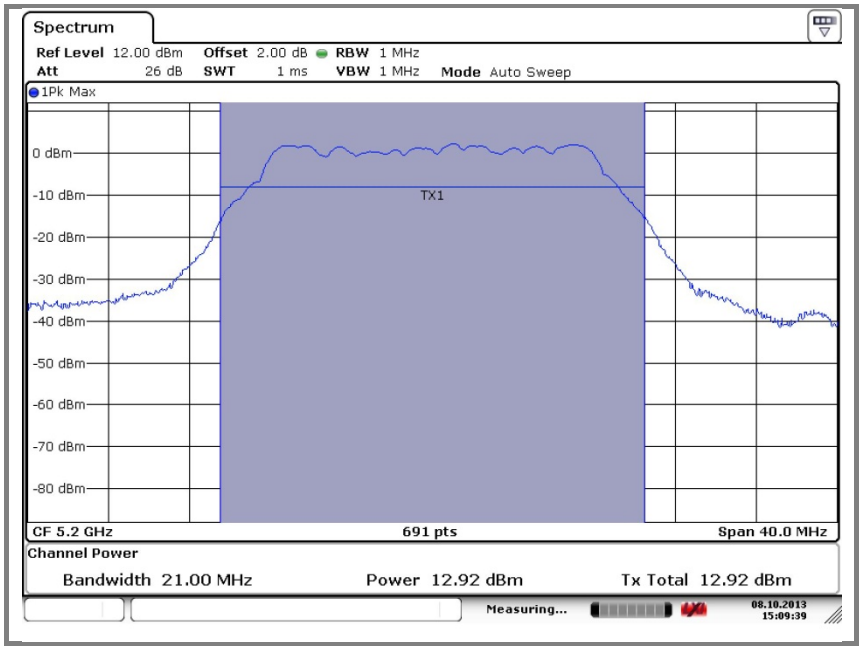
Operation mode: Basic mode

A. Low channel (5 180 ㎒)



B. Middle channel (5 200 ㎒)



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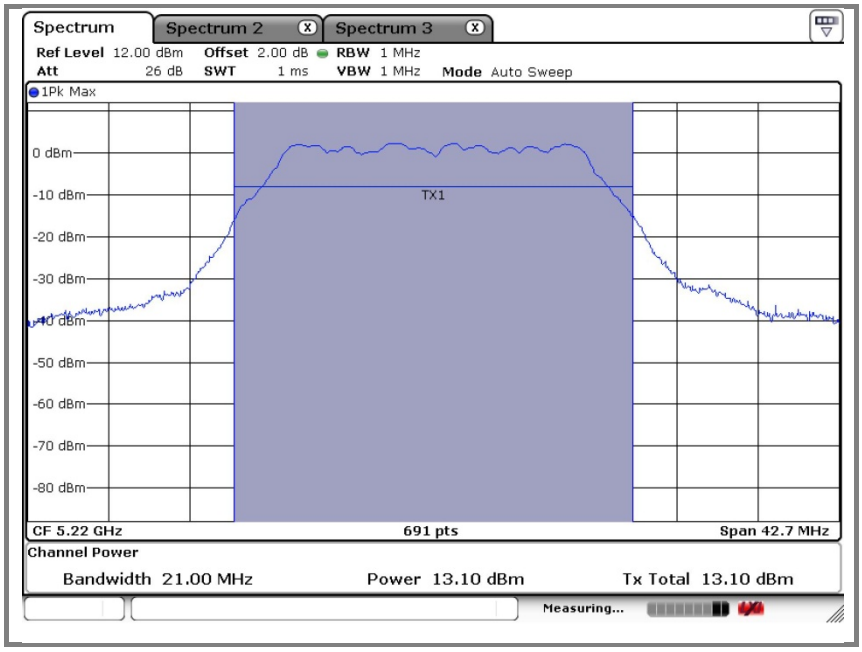
C. High channel (5 220 ㎒)



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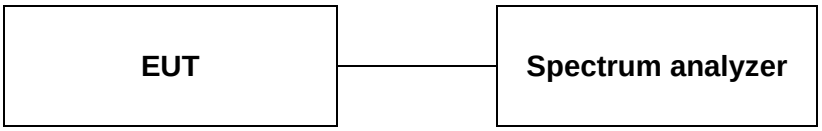
7. Peak power spectral density

7.1. Test setup



7.2. Limit

For the 5.15-5.25 ㎓ band, the peak power spectral density shall not exceed 4 ㏈m in any 1 ㎒ band. If transmitting antennas of directional gain greater than 6 ㏈I are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.
The maximum antenna gain in less than or equal to 6 ㏈I, therefore the limit is 4 ㏈m.

7.3. Test procedure

1. Place the EUT on the table and set it in transmitting mode
   Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
2. Set the spectrum analyzer as RBW = 1 ㎒, VBW = 300㎑, Span = 20 ㎒.
3. Record the max reading.
4. Repeat the above procedure until the measurements for all frequencies are completed.

7.4. Test results

Ambient temperature: 23 ℃
Relative humidity: 45 % R.H.

Operation mode	Frequency (㎒)	PPSD (㏈m)	Limit (㏈m)
Basic	5 180	0.42	4
	5 200	0.57	
	5 220	0.08	

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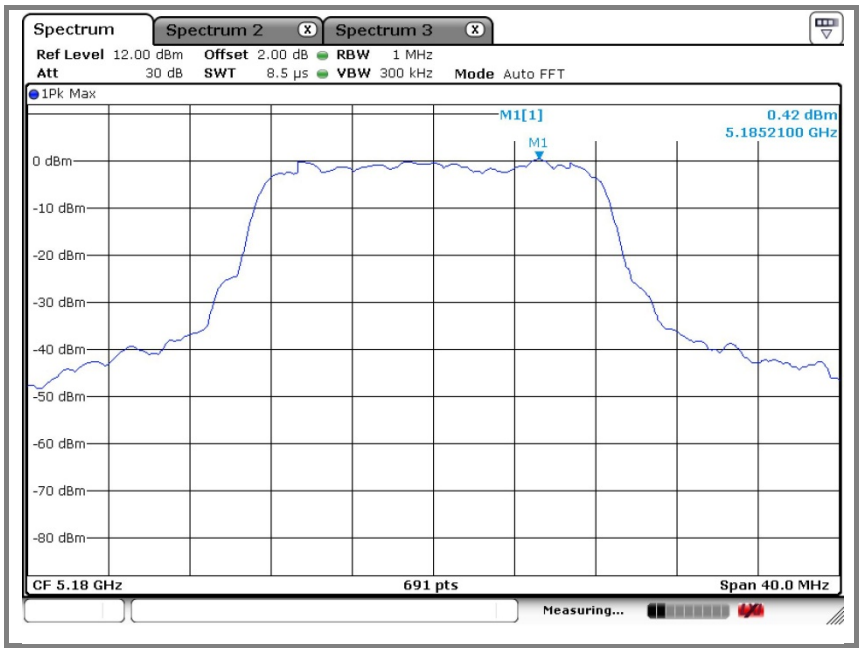
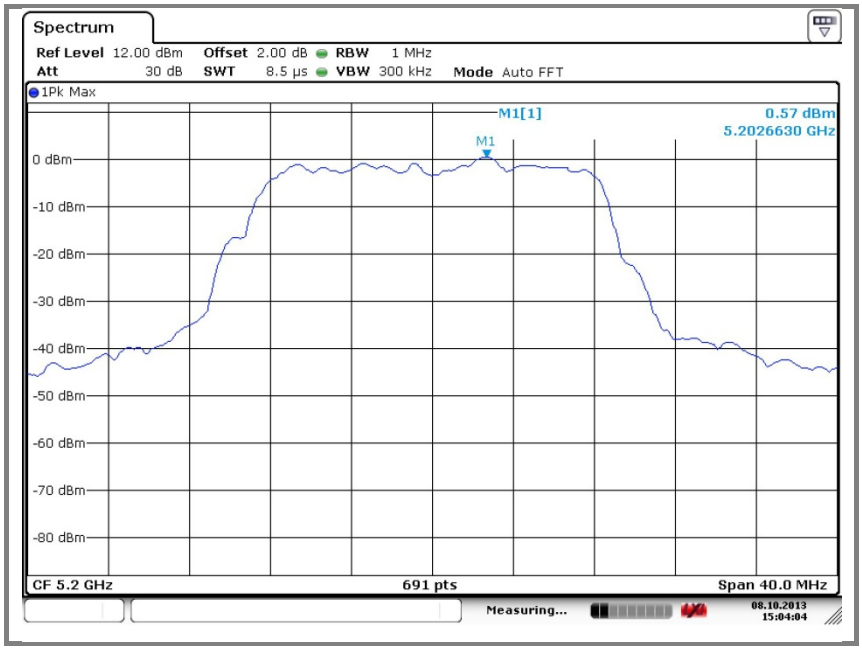
Operation mode: Basic mode

A. Low channel (5 180 ㎒)



B. Middle channel (5 220 ㎒)



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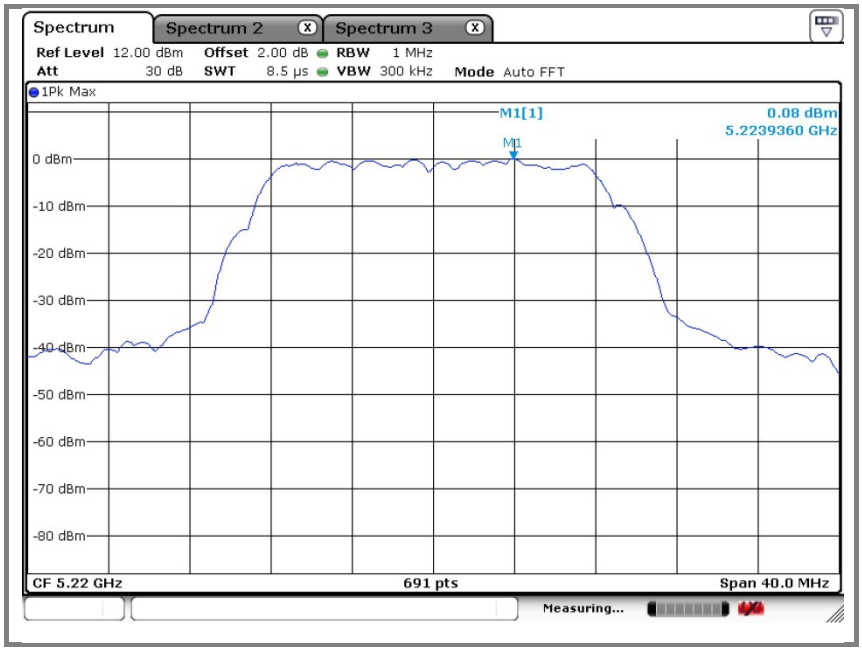
C. High channel (5 220 ㎒)



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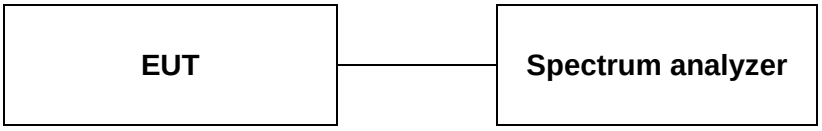
8. Peak excursion

8.1. Test setup



8.2. Limit

The ratio of the peak excursion of.the modulation envelope(measured using a peak hold function) to the peak transmit power (measured as specified above) shall not exceed 13 ㏈ across any 1 ㎒ bandwidth or the emission bandwidth whichever is less. The maximum antenna

8.3. Test procedure

1. Place the EUT on the table and set it in transmitting mode.
   Remove the antenna from the EUT and then connect a low loss RF cable from the antenna the port to the Spectrum analyzer
2. Set spectrum analyzer as ;
   RBW = 1 ㎒, VBW = 3 ㎒, Span = 30 ㎒, Detector mode: average, Trace 1: Max hold & View
3. Set spectrum analyzer as ;
   RBW = 1 ㎒, VBW = 300㎑, Span = 30 ㎒, Detector mode: peak, Trace 2: Max hold
4. Record the max reading.
5. Repeat the above procedure until the measurements for all frequencies are completed.

8.4. Test results

Ambient temperature: 23 ℃
Relative humidity: 45 % R.H.

Operating mode	Frequency (㎒)	Peak excursion (㏈)	Limit (㏈)
Basic	5 180	3.79	13
	5 200	3.59	
	5 220	2.59	

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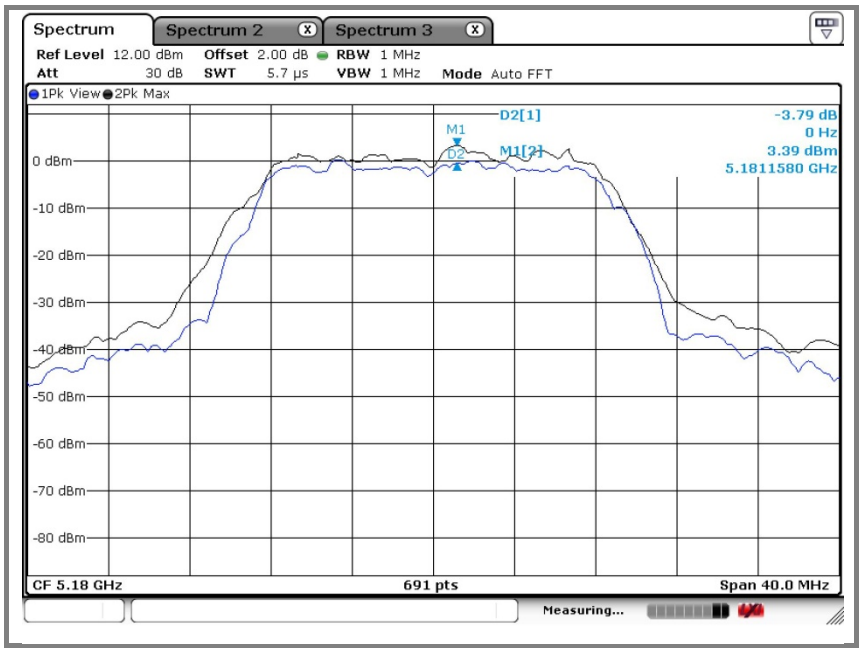
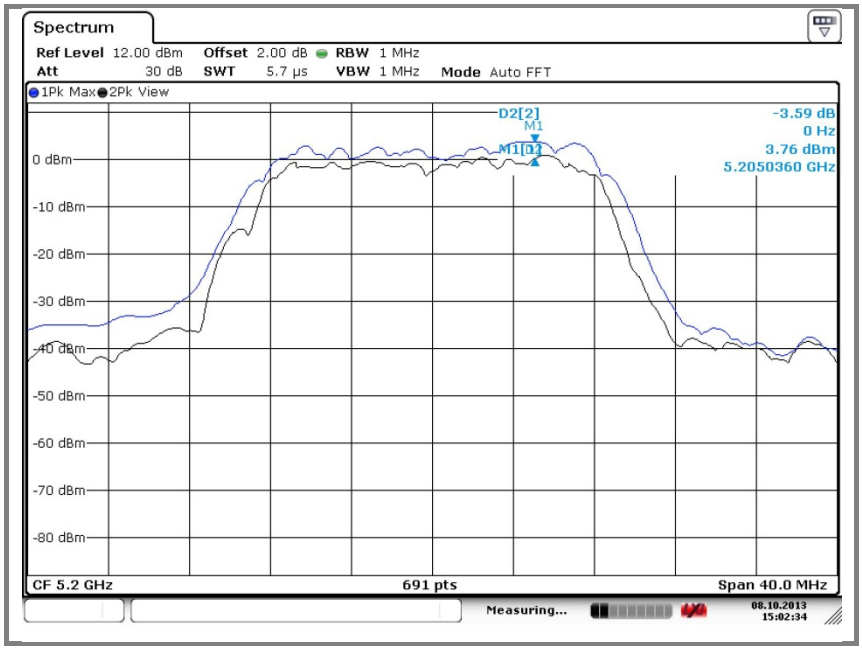
Operation mode: Basic mode

A. Low channel (5 180 ㎒)



B. Middle channel (5 220 ㎒)



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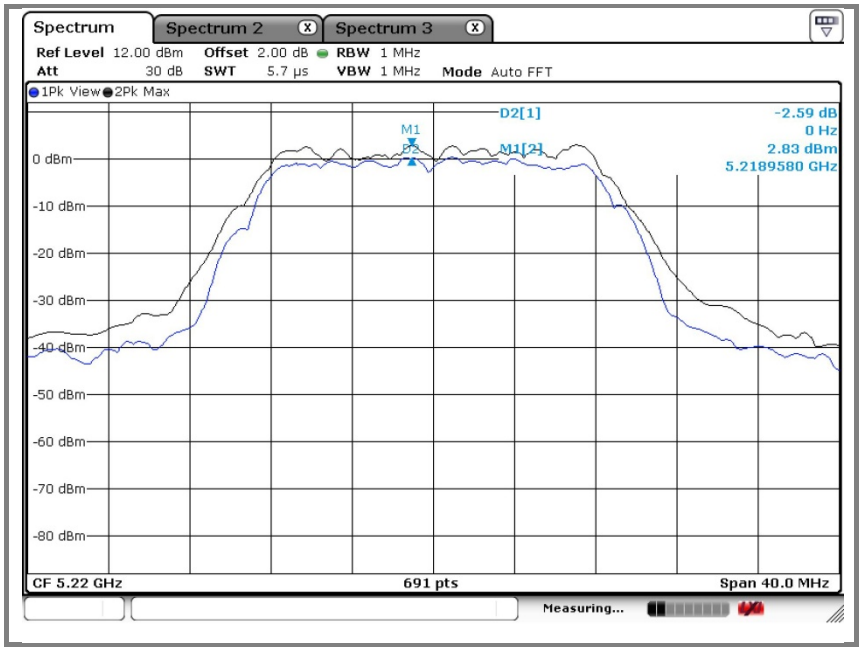
C. High channel (5 220 ㎒)



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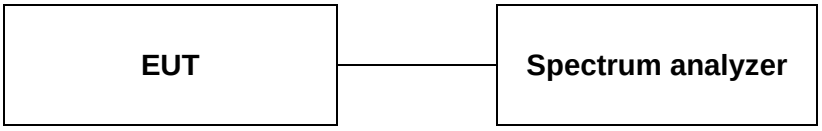
9. Frequency stability

9.1. Test setup



9.2. Limit

Not applicable

9.3. Test procedure

The frequency stability of the transmitter is measured by:

a) Temperature: The temperature is varied from -30℃ to +60℃ using an environmental c hamber.
b) Primary Supply Voltage: The primary supply voltage is varied from 85% to 115% of th e voltage normally at the input to the device or at the power supply terminals if cable s are not normally supplied.

1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the Spectrum analyzer as RBW = 10㎑, VBW = 10㎑, Sweep time = Auto

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9.4. Test results

Operation Frequency : 5 150 ㎒

VOLTAGE (%)	**POWER** (VDC)	TEMP (dB)	**FREQ** (Hz)	**Deviation** (%)
100%	12.0	+20(Ref)	5 150 005 435	-0.000106
100%		-30	5 150 003 845	-0.000075
100%		-20	5 150 002 345	-0.000046
100%		-10	5 150 003 152	-0.000061
100%		0	5 150 002 948	-0.000057
100%		+10	5 150 005 154	-0.000100
100%		+20	5 150 005 435	-0.000106
100%		+25	5 150 007 257	-0.000141
100%		+30	5 150 006 425	-0.000125
100%		+40	5 149 998 548	0.000028
100%		+50	5 149 997 254	0.000053
100%		+60	5 149 996 457	0.000069
85%	10.2	+20	5 150 005 254	-0.000102
115%	13.8	+20	5 150 004 875	-0.000095

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10. Antenna requirement

10.1. Standard Applicable

For intentional device, according to FCC 47 CFR Section §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to FCC 47 CFR Section §15.247 (b) if transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in 4.8dBi that the gain of the antenna exceeds 6 dBi.

10.2. Antenna Connected Construction

Antenna used in this product is RP-SMA type (Dipole Antenna) gain of 3.81 dBi.

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11. RF exposure evaluation

11.1. Environmental evaluation and exposure limit according to FCC CFR 47 part 1, 1.1307(b), 1.1310

According to §15.247(e)(i) and §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines. According to KDB 447498 (2)(a)(i)

Limits for maximum permissible exposure (MPE)

Frequency range (MHz)	Electric field strength(V/m)	Magnetic field strength (A/m)	Power density (mW/cm²)	Average time
(A) Limits for Occupational / Control exposures				
300 – 1 500	--	--	F/300	6
1 500 – 100 000	--	--	5	6
(B) Limits for General Population / Uncontrol Exposures				
300 – 1 500	--	--	F/1 500	6
1 500 – 100 000	--	--	1	30

11.2. Friis transmission formula : Pd=(Pout*G)\(4*pi*R2)

Where
Pd= Power density in mW/cm²
Pout=output power to antenna in mW
G= Numeric gain of the antenna relative to isotropic antenna
Pi=3.1416
R= distance between observation point and center of the radiator in cm
Pd the limit of MPE, 1 mW/cm². If we know the maximum gain of the antenna and total power input to the antenna, through the calculation, we will know the distance where the MPE limit is reached.

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11.2. Test result of RF exposure evaluation

Test Item ： RF Exposure evaluation data
Test Mode ： Normal operation

11.3. Output power into antenna & RF exposure evaluation distance

Frequency (MHz)	Output Peak power to antenna (dBm)	Antenna gain (dBi)	Antenna Gain (dBi) Numeric	Power density at 20 cm (mW/cm²)	Power density Limits (mW/cm²)
5 180	13.18	3.810	2.40	0.010 0	1
5 200	12.92	3.810	2.40	0.009 4	
5 220	13.10	3.810	2.40	0.009 8	

※ Remark

The power density Pd (5th column) at a distance of 20 cm calculated from the friis transmission formula is far below the limit of 1 mW/cm² .

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12. Test setup photo of EUT

Photo of radiated spurious emission at below 30 ㎒

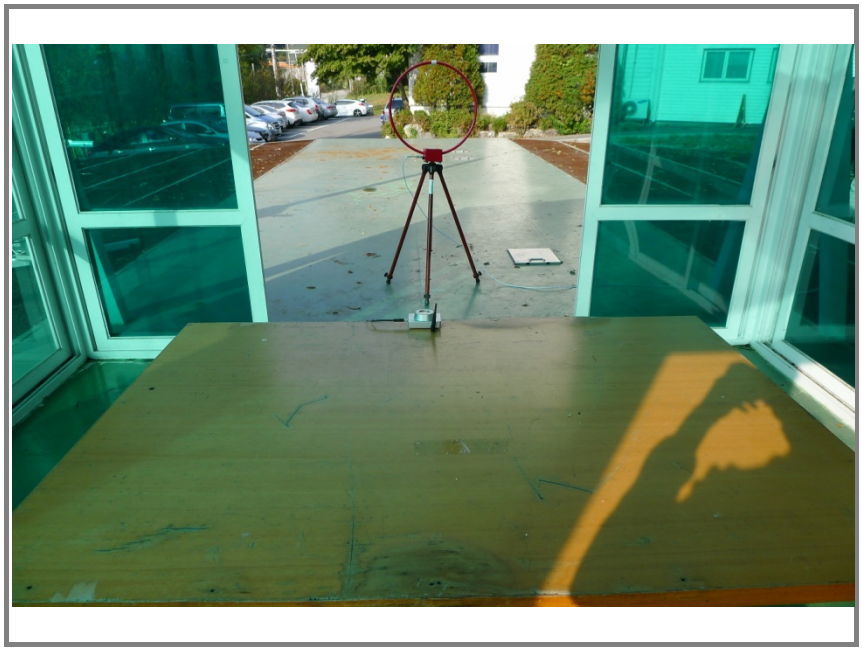

Photo of radiated spurious emission at 30 ㎒ ~ 1 000 ㎒

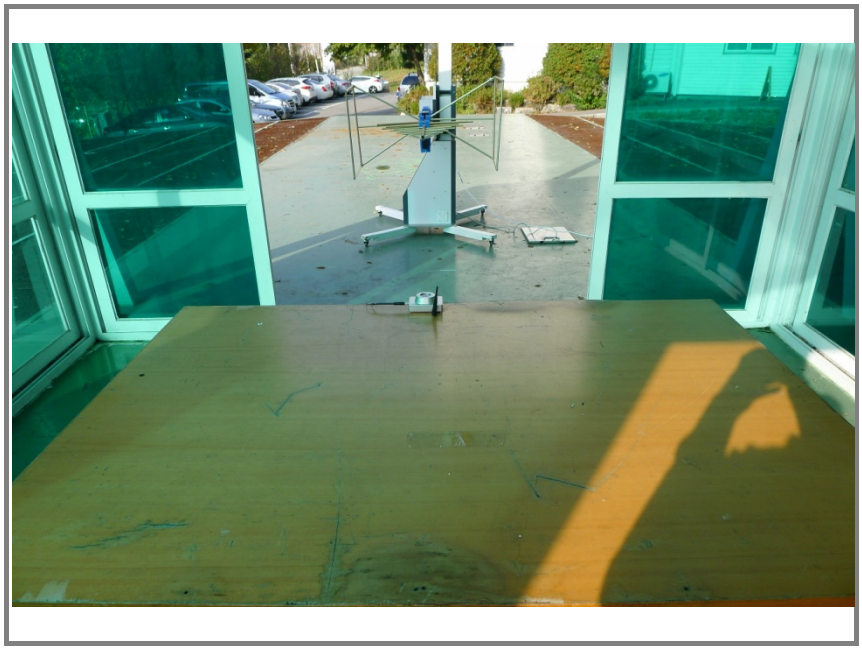

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Photo of radiated spurious emission at above 1 000 MHz

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