

TEST REPORT

of

FCC Part 15 Subpart C §15.225

FCC ID: 2AV76-NMOK-301W

Equipment Under Test : WIRELESS POWER CHARGING SYSTEM
Model Name : NMOK-301W
Variant Model Name(s) : -
Applicant : NIDEC MOBILITY KOREA CORPORATION
Manufacturer : NIDEC MOBILITY KOREA CORPORATION
Date of Receipt : 2022.03.23
Date of Test(s) : 2022.05.12 ~ 2022.08.26
Date of Issue : 2022.09.02

In the configuration tested, the EUT complied with the standards specified above. This test report does not assure KOLAS accreditation.

- 1) The results of this test report are effective only to the items tested.
- 2) The SGS Korea is not responsible for the sampling, the results of this test report apply to the sample as received.
- 3) This test report cannot be reproduced, except in full, without prior written permission of the Company.
- 4) The data marked ※ in this report was provided by the customer and may affect the validity of the test results.

We are responsible for all the information of this test report except for the data(※) provided by the customer.

Tested by:



Teo Kim

Technical
Manager:



Jinhyoung Cho

SGS Korea Co., Ltd. Gunpo Laboratory



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Report Number: F690501-RF-RTL003404

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1. General Information

1.1. Testing Laboratory

- SGS Korea Co., Ltd. (Gunpo Laboratory)
- 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
 - 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
 - Designation number: KR0150

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1.2. Details of Applicant

Applicant : NIDEC MOBILITY KOREA CORPORATION
 Address : 790-12, Bogaewonsam-ro, Bogae-myeon, Anseong-si, Gyeonggi-do, South Korea, 17507
 Contact Person : Nam, Sang-il
 Phone No. : +82 2 850 5789

1.3. Details of manufacturer

Company : Same as applicant
 Address : Same as applicant

1.4. Description of EUT

Kind of Product	WIRELESS POWER CHARGING SYSTEM
Model Name	NMOK-301W
Serial Number	001
Power Supply	DC 12 V
Frequency Range	13.56 MHz (NFC)
Modulation Technique	ASK
Number of Channels	1 channel
Antenna Type	PCB antenna
H/W Version	1.00
S/W Version	1.00

1.5. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Interval	Cal. Due
Signal Generator	R&S	SMBV100A	255834	May 25, 2022	Annual	May 25, 2023
Spectrum Analyzer	R&S	FSV30	103210	Dec. 08, 2021	Annual	Dec. 08, 2022
Spectrum Analyzer	Agilent	N9020A	MY53421758	Aug. 27, 2021	Annual	Aug. 27, 2022
DC Power Supply	Agilent	U8002A	MY50020026	Dec. 01, 2021	Annual	Dec. 01, 2022
Temperature Chamber	ESPEC CORP.	SH-662	93000533	Jun. 02, 2022	Annual	Jun. 02, 2023
Preamplifier	H.P.	8447F	2944A03909	Aug. 04, 2022	Annual	Aug. 04, 2023
Loop Antenna	Schwarzbeck Mess-Elektronik	FMZB 1519	1519-039	Aug. 23, 2021	Biennial	Aug. 23, 2023
Bilog Antenna	Schwarzbeck Mess-Elektronik	VULB 9163	01126	Feb. 07, 2022	Annual	Feb. 07, 2023
EMI Test Receiver	R&S	ESU26	100109	Jan. 18, 2022	Annual	Jan. 18, 2023
Turn Table	Innco systems GmbH	DS 1200 S	N/A	N.C.R.	N/A	N.C.R.
Controller	Innco systems GmbH	CONTROLLER CO3000-4P	CO3000/963/38 330516/L	N.C.R.	N/A	N.C.R.
Antenna Mast	Innco systems GmbH	MA4640-XP-ET	MA4640/536/38 330516/L	N.C.R.	N/A	N.C.R.
Anechoic Chamber	SY Corporation	L x W x H (9.6 m x 6.4 m x 6.6 m)	N/A	N.C.R.	N/A	N.C.R.
Coaxial Cable	RFONE	MWX221-NMSNMS (4 m)	J1023142	Apr. 04, 2022	Semi-Annual	Oct. 04, 2022
Coaxial Cable	micro-coax UTiflex	142A SERIES 502839-8 (10 m)	90000034	Apr. 04, 2022	Semi-Annual	Oct. 04, 2022

Note;

- For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date.

1.6. Summary of Test Results

The EUT has been tested according to the following specifications:

Applied standard : FCC Part 15 subpart C		
Section	Test item(s)	Result
15.225(a)(b)(c)(d) 15.209	Radiated Emission, Spurious Emission and Field Strength of Fundamental	Complied
15.225(e)	Frequency Stability	Complied
15.215(c)	20 dB Bandwidth	Complied
15.207	AC Power Line Conducted Emissions	N/A ¹⁾

Note;

1) The AC power line test was not performed because the EUT use battery power for operation and which do not operate from the AC power lines.

1.7. Sample calculation

Where relevant, the following sample calculation is provided:

1.7.1. Radiation test

Field strength level (dB μ V/m) = Measured level (dB μ V) + Antenna factor (dB) + Cable loss (dB) - amplifier (dB)

1.8. Information of software for test.

Using the software of Internal to testing of EUT.

1.9. Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

Parameter	Uncertainty	
Occupied Bandwidth	3.90 kHz	
Radiated Emission, 9 kHz to 30 MHz	H	3.30 dB
	V	3.30 dB
Radiated Emission, below 1 GHz	H	4.80 dB
	V	5.20 dB

All measurement uncertainty values are shown with a coverage factor $k = 2$ to indicate a 95 % level of confidence.

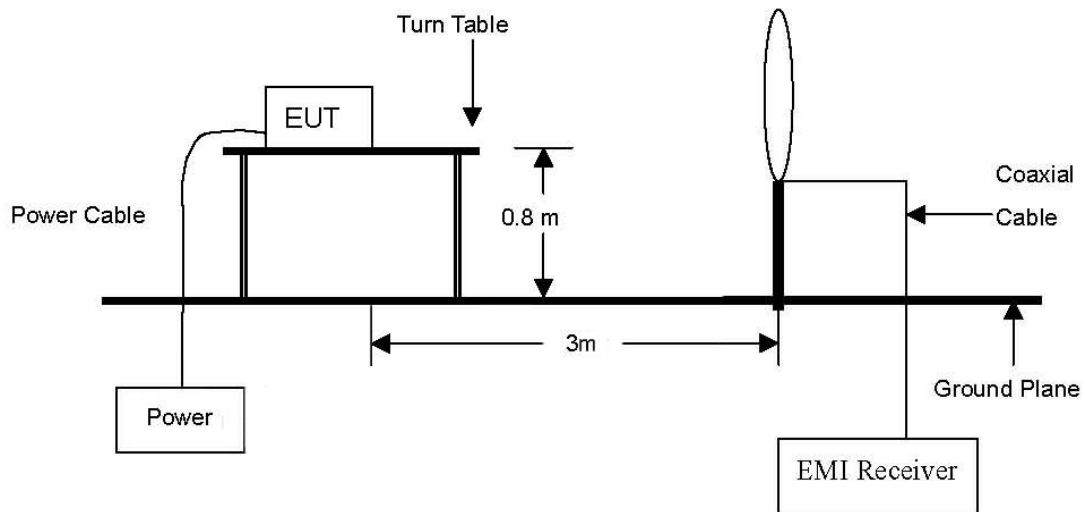
1.10. Test report revision

Revision	Report number	Date of Issue	Description
0	F690501-RF-RTL003404	2022.09.02	Initial

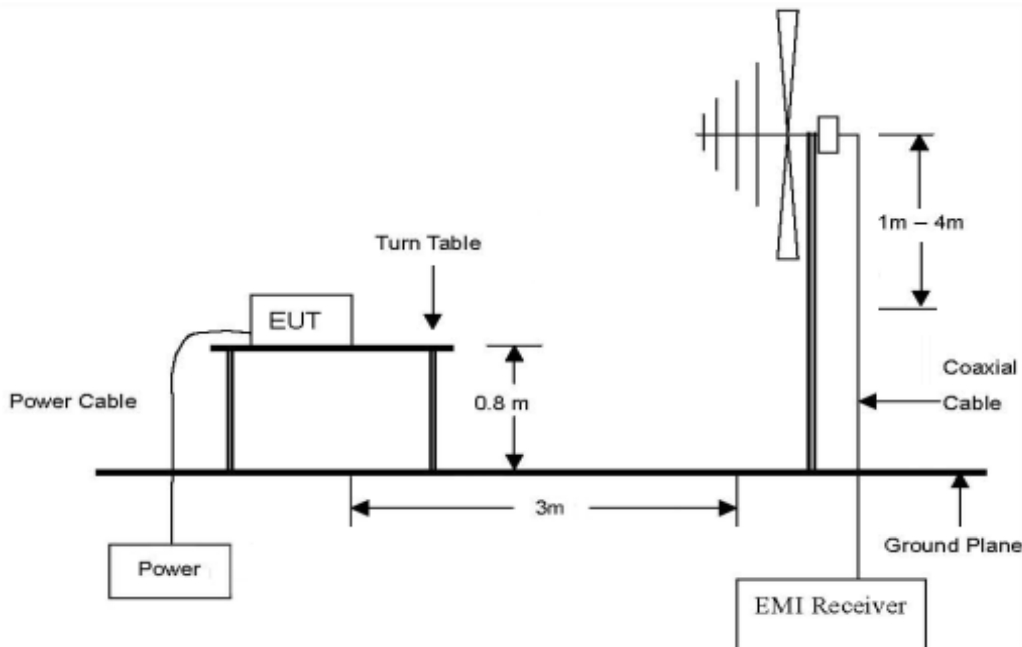
2. Radiated Emissions

2.1. 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 1 000 MHz Emissions.



2.2. Limit

According to §15.225,

- (a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15 848 microvolts/meter at 30 meters.
- (b) Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.
- (c) Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.
- (d) The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in §15.209.

According to §15.209,

Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meter)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

** 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., §§15.231 and 15.241.

2.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.10-2013.

2.3.1. Test Procedures for emission below 30 MHz

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
3. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test-receiver system was set to Quasi peak Detect Function with Maximum Hold Mode.

2.3.2. Test Procedures for emission above 30 MHz

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1 GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower.
3. The antenna is a bi-log antenna and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. For measurements below 1 GHz resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

Note;

The test orthogonal plan of EUT was investigated with three axis described in the test setup photo. The X-axis was worst-case, all radiated testing of EUT was performed with X-axis.

2.4. Test Result

Ambient temperature : (23 ± 1) °C
 Relative humidity : 47 % R.H.

The following table shows the highest levels of radiated emissions.

- Fundamental within the band 13.553 MHz - 13.567 MHz

Radiated Emissions			Ant.	Correction Factors		Total		Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	Ant. Factor (dB/m)	Cable loss (dB)	Actual (dBμV/m) at 3 m	Actual (dBμV/m) at 30 m	Limit (dBμV/m) at 30 m	Margin (dB)
13.561	25.96	Peak	H	19.00	0.58	45.54	5.54	84.00	78.46

- Spurious emission within the bands 13.410 MHz - 13.553 MHz and 13.567 MHz - 13.710 MHz

Radiated Emissions			Ant.	Correction Factors		Total		Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	Ant. Factor (dB/m)	Cable loss (dB)	Actual (dBμV/m) at 3 m	Actual (dBμV/m) at 30 m	Limit (dBμV/m) at 30 m	Margin (dB)
13.553	19.09	Peak	H	19.00	0.58	38.67	-1.33	50.47	51.80
13.567	21.81	Peak	H	19.00	0.58	41.39	1.39	50.47	49.08

- Spurious emission within the bands 13.110 MHz - 13.410 MHz and 13.710 MHz - 14.010 MHz

Radiated Emissions			Ant.	Correction Factors		Total		Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	Ant. Factor (dB/m)	Cable loss (dB)	Actual (dBμV/m) at 3 m	Actual (dBμV/m) at 30 m	Limit (dBμV/m) at 30 m	Margin (dB)
13.346	7.89	Peak	H	19.00	0.58	27.47	-12.53	40.51	53.04
*13.396	7.62	Peak	H	19.00	0.58	27.20	-12.80	29.54	42.34
13.772	8.58	Peak	H	19.00	0.58	28.16	-11.84	40.51	52.35

- Spurious emission within the bands 9 kHz - 13.110 MHz

Radiated Emissions			Ant.	Correction Factors		Total		Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	Ant. Factor (dB/m)	Cable loss (dB)	Actual (dB μ V/m) at 3 m	Actual (dB μ V/m) at 30 or 300 m	Limit (dB μ V/m) at 30 or 300 m	Margin (dB)
*12.290	7.14	Peak	H	19.00	0.58	26.72	-13.28	29.54	42.82
Above 13.000	Not detected								

- Spurious emission within the bands 14.010 MHz - 30 MHz

Radiated Emissions			Ant.	Correction Factors		Total		Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	Ant. Factor (dB/m)	Cable loss (dB)	Actual (dB μ V/m) at 3 m	Actual (dB μ V/m) at 30 m	Limit (dB μ V/m) at 30 m	Margin (dB)
14.378	8.18	Peak	H	19.00	0.58	27.76	-12.24	29.54	41.78
*16.422	6.67	Peak	H	19.23	0.58	26.48	-13.52	29.54	43.06
*25.550	7.71	Peak	H	19.20	0.73	27.64	-12.36	29.54	41.90
Above 26.000	Not detected	-	-	-	-	-	-	-	-

Remark;

1. Fundamental limit (μ V/m) = $20 \log(15\ 848) = 84.00$ dB μ V/m.
2. 30 m distance compensation = $40 \log(3/30) = -40$ dB μ V/m.
3. 300 m distance compensation = $40 \log(3/300) = -80$ dB μ V/m.
4. "*" means the restricted band.
5. If the spurious emissions are in the restricted band, the limit complied with §15.209.
6. All data were recorded using a spectrum analyzer employing a peak detector.
 If PK results were meet Quasi-peak limit, Quasi-peak measurements were omitted.
7. Radiated spurious emission measurement as below 30 MHz.
 (Actual (dB μ A/m) at 3m = Reading (dB μ V) + AF (dB/m) + CL (dB))

- Spurious emission above 30 MHz

Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Freq. (MHz)	Reading (dBμV)	Detect Mode	Pol.	Ant. Factor (dB/m)	AMP + CL (dB)	Actual (dBμV/m) at 3 m	Limit (dBμV/m) at 3 m	Margin (dB)
67.81	42.70	Peak	H	16.06	-26.22	32.54	40.00	7.46
189.84	40.70	Peak	H	16.28	-24.99	31.99	43.50	11.51
201.27	37.20	Peak	H	17.00	-24.85	29.35	43.50	14.15
216.99	40.30	Peak	H	16.98	-24.70	32.58	46.00	13.42
244.09	45.20	Peak	H	18.26	-24.48	38.98	46.00	7.02
271.24	47.10	Peak	H	18.35	-24.33	41.12	46.00	4.88
Above 300.00	Not detected	-	-	-	-	-	-	-

Remark;

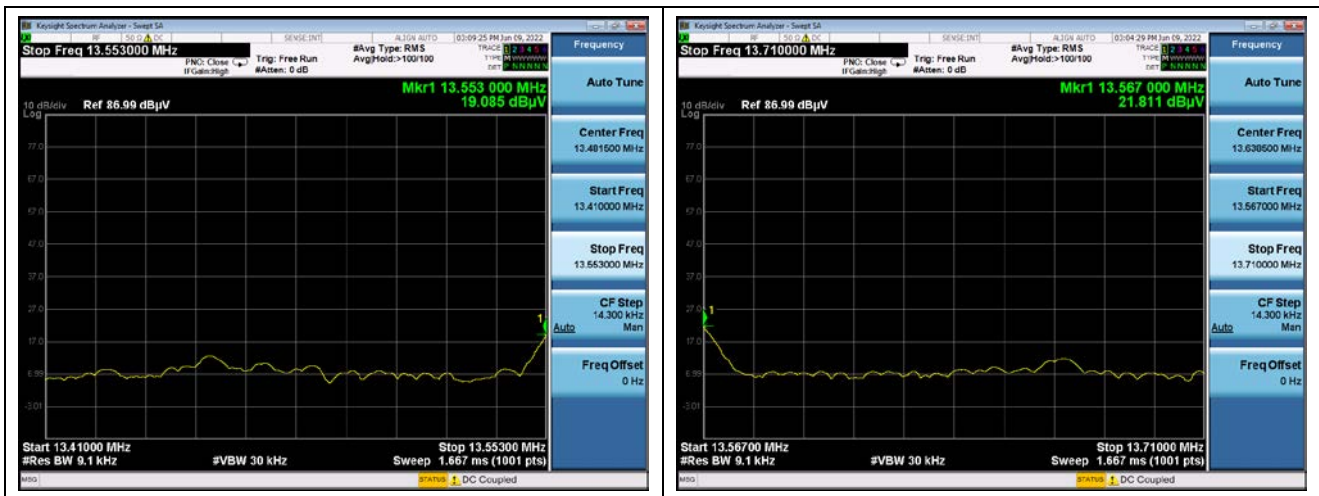
1. Radiated spurious emission measurement as below.
 (Actual = Reading + Antenna Factor + Amp + CL)
2. According to §15.31(o), emission levels are not report much lower than the limits by over 20 dB.
3. Radiated spurious emission measurement as above 30 MHz.
 (Actual (dBμA/m) = Reading (dBμV) + AF (dB/m) + CL (dB) + AMP (dB))

Test plots

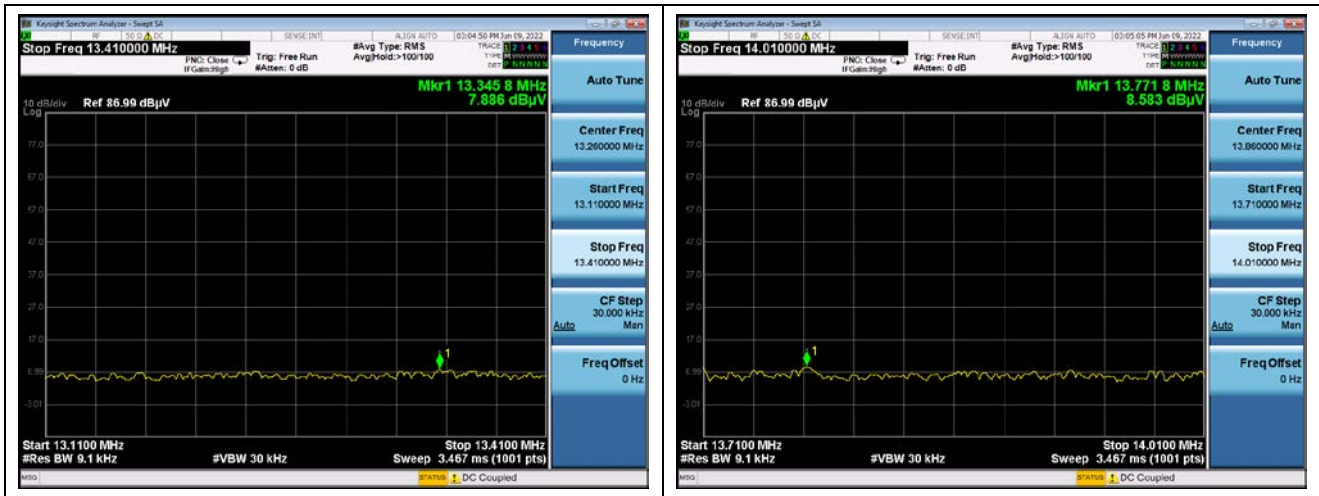
- Fundamental within the band 13.553 MHz - 13.567 MHz



- Spurious emission within the bands 13.410 MHz - 13.553 MHz and 13.567 MHz - 13.710 MHz



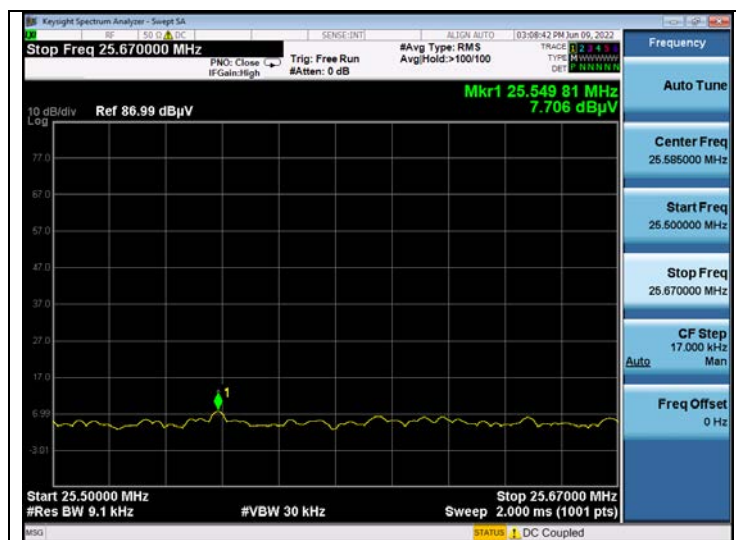
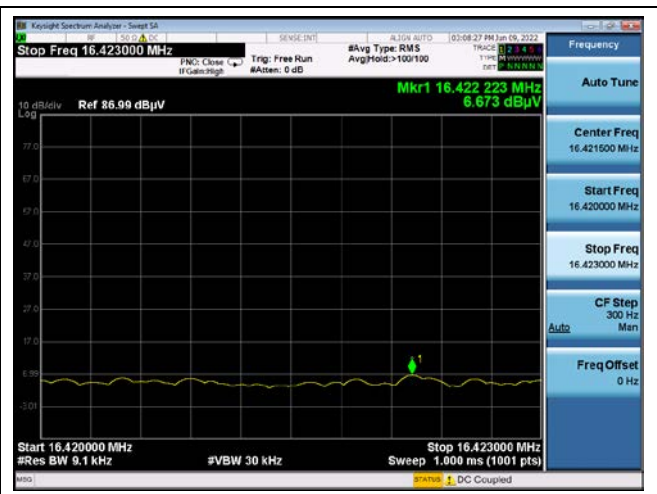
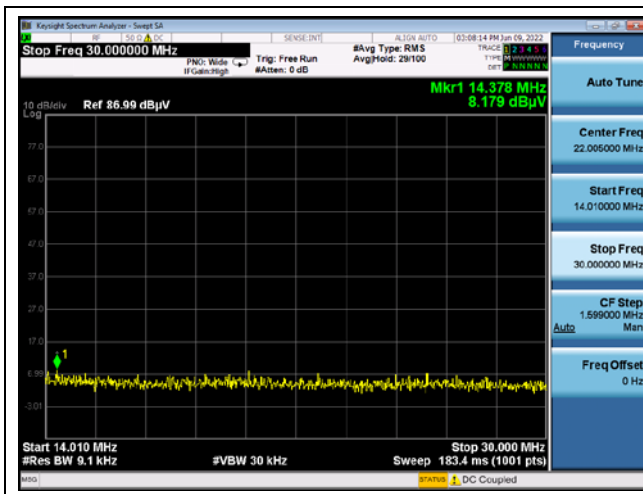
- Spurious emission within the bands 13.110 MHz - 13.410 MHz and 13.710 MHz - 14.010 MHz



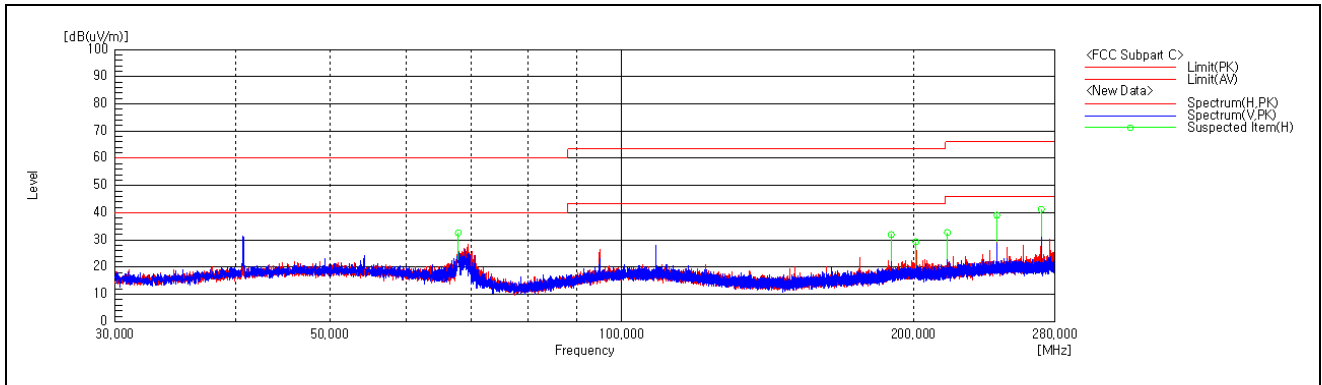
- Spurious emission within the bands 9 kHz – 13.110 MHz



- Spurious emission within the bands 14.010 MHz – 30 MHz

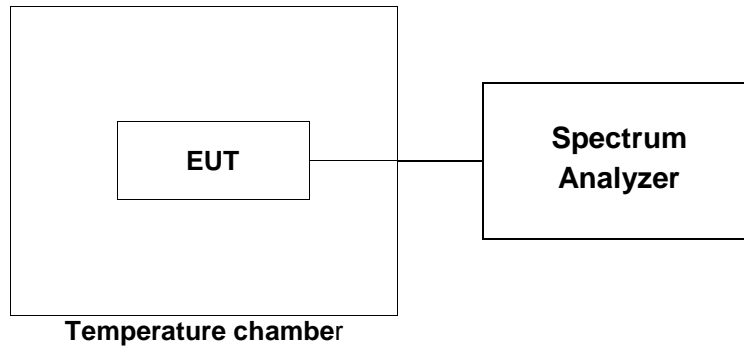


- Spurious emission above 30 MHz



3. Frequency Stability

3.1. Test Setup



3.2. Limit

According to §15.225(e), the frequency tolerance of the carrier signal shall be maintained within ± 0.01 % of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85 % to 115 % of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

3.3. Test Procedures

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 environment into appropriate environment.
4. Set the spectrum analyzer as RBW = 100 Hz, VBW = 100 Hz, Span = 10 kHz, Sweep time = auto.
5. Mark the peak frequency and measure the frequency tolerance using frequency counter function.
6. Repeat until all the results are investigated.

3.4. Test Result

Ambient temperature : (23 ± 1) °C
 Relative humidity : 47 % R.H.

Startup

Temperature Variations

Power (V _{d.c})	Temperature (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
12	-20	13 561 433	362	0.000 027
	-10	13 561 418	347	0.000 026
	0	13 561 404	333	0.000 025
	+10	13 561 404	333	0.000 025
	+20(Ref.)	13 561 071	-	-
	+30	13 560 651	-420	-0.000 031
	+40	13 560 651	-420	-0.000 031
	+50	13 560 651	-420	-0.000 031

Voltage Variations

Power (V _{d.c})	Temperature (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
115 % (13.80)	+20	13 561 404	333	0.000 025
85 % (10.20)	+20	13 561 404	333	0.000 025

2 minutes

Temperature Variations

Power (V _{d.c})	Temperature (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
12	-20	13 561 433	362	0.000 027
	-10	13 561 418	347	0.000 026
	0	13 561 404	333	0.000 025
	+10	13 561 418	347	0.000 026
	+20(Ref.)	13 561 071	-	-
	+30	13 560 651	-420	-0.000 031
	+40	13 560 651	-420	-0.000 031
	+50	13 560 651	-420	-0.000 031

Voltage Variations

Power (V _{d.c})	Temperature (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
115 % (13.80)	+20	13 561 404	333	0.000 025
85 % (10.20)	+20	13 561 418	347	0.000 026

5 minutes

Temperature Variations

Power (V _{d.c})	Temperature (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
12	-20	13 561 433	362	0.000 027
	-10	13 561 418	347	0.000 026
	0	13 561 404	333	0.000 025
	+10	13 561 404	333	0.000 025
	+20(Ref.)	13 561 071	-	-
	+30	13 560 651	-420	-0.000 031
	+40	13 560 651	-420	-0.000 031
	+50	13 560 651	-420	-0.000 031

Voltage Variations

Power (V _{d.c})	Temperature (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
115 % (13.80)	+20	13 561 404	333	0.000 025
85 % (10.20)	+20	13 560 651	-420	-0.000 031

10 minutes

Temperature Variations

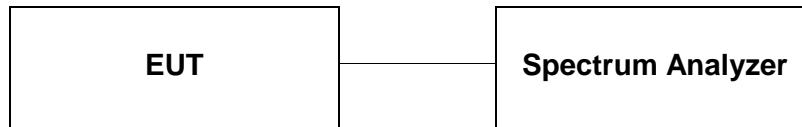
Power (V _{d.c})	Temperature (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
12	-20	13 561 433	362	0.000 027
	-10	13 561 418	347	0.000 026
	0	13 561 404	333	0.000 025
	+10	13 561 404	333	0.000 025
	+20(Ref.)	13 561 071	-	-
	+30	13 560 651	-420	-0.000 031
	+40	13 560 651	-420	-0.000 031
	+50	13 560 651	-420	-0.000 031

Voltage Variations

Power (V _{d.c})	Temperature (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
115 % (13.80)	+20	13 561 404	333	0.000 025
85 % (10.20)	+20	13 560 651	-420	-0.000 031

4. 20 dB Bandwidth

4.1. Test Setup



4.2. Limit

None; for reporting purposes only.

4.3. Test Procedures

1. Span = set to capture all products of the modulation process, including the emission skirts.
RBW = 200 Hz, VBW = 200 Hz, Sweep = auto, Detector = peak, Trace = max hold.
2. The marker-to-peak function to set the mark to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is 20 dB bandwidth of the emission.

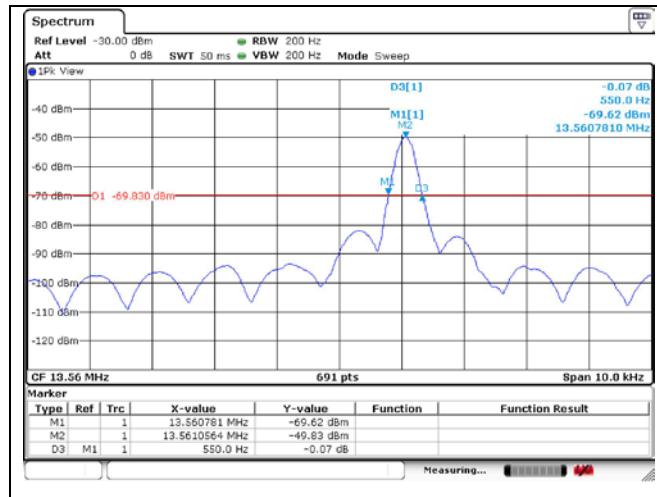
4.3. Test Result

Ambient temperature : (23 ± 1) °C
 Relative humidity : 47 % R.H.

Frequency (MHz)	20 dB Bandwidth (kHz)
13.560	0.550

-Test plots

20 dB Bandwidth



-End of the Test report-