

TEST REPORT

of

FCC Part 15 Subpart C §15.225

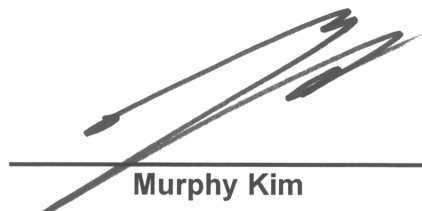
FCC ID: 2AV76-NMOK-351W

Equipment Under Test : WIRELESS POWER CHARGING SYSTEM
Model Name : NMOK-351W
Variant Model Name(s) : -
Applicant : NIDEC MOBILITY KOREA CORPORATION
Manufacturer : NIDEC MOBILITY KOREA CORPORATION
Date of Receipt : 2023.05.02
Date of Test(s) : 2023.05.03 ~ 2023.11.14
Date of Issue : 2023.11.14

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

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- 2) The SGS Korea is not responsible for the sampling, the results of this test report apply to the sample as received.
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We are responsible for all the information of this test report except for the data(※) provided by the customer.

Tested by:


Murphy Kim

Technical Manager:


Inho Park

SGS Korea Co., Ltd. Gunpo Laboratory



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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-351W
Serial Number	0001
Power Supply	DC 12 V
Frequency Range	13.56 MHz (NFC)
Modulation Technique	ASK
Number of Channels	1 channel
Antenna Type	PCB pattern antenna
Antenna Part Number	N/A
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	259067	Jun. 15, 2023	Annual	Jun. 15, 2024
DC Power Supply	Agilent	U8002A	MY50020026	Nov. 30, 2022	Annual	Nov. 30, 2023
Temperature Chamber	ESPEC CORP.	SH-662	93000533	Jun. 01, 2023	Annual	Jun. 01, 2024
Spectrum Analyzer	R&S	FSV30	103210	Dec. 07, 2022	Annual	Dec. 07, 2023
Spectrum Analyzer	Agilent	N9020A	MY53421758	Sep. 01, 2023	Annual	Sep. 01, 2024
Amplifier	H.P.	8447F	2944A03909	Aug. 04, 2023	Annual	Aug. 04, 2024
Loop Antenna	Schwarzbeck Mess-Elektronik	FMZB 1519	1519-039	Aug. 21, 2023	Biennial	Aug. 21, 2025
Bilog Antenna	Schwarzbeck Mess-Elektronik	VULB9163	01126	Feb. 09, 2023	Annual	Feb. 09, 2024
Test Receiver	R&S	ESU26	100109	Jan. 18, 2023	Annual	Jan. 18, 2024
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	CO3000/963/3833 0516/L	N.C.R.	N/A	N.C.R.
Antenna Mast	Innco systems GmbH	MA4640-XP-ET	MA4640/536/3833 0516/L	N.C.R.	N/A	N.C.R.
Anechoic Chamber	SY Corporation	L × W × H (9.6 m × 6.4 m × 6.6 m)	N/A	N.C.R.	N/A	N.C.R.
Coaxial Cable	RFONE	PL360P-292M292M-1.5M-A	20200324002	Oct. 14, 2023	Semi-Annual	Apr. 14, 2024
Coaxial Cable	RFONE	MWX221-NMSNMS (4 m)	J1023142	Oct. 04, 2023	Semi-Annual	Apr. 04, 2024
Coaxial Cable	Qualwave Inc.	QA500-18-NN-10 (10 m)	22200114	Oct. 04, 2023	Semi-Annual	Apr. 04, 2024

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/m) + 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	
20 dB Bandwidth	0.04 kHz	
Frequency Stability	0.11 kHz	
Radiated Emission, 9 kHz to 30 MHz	H	3.60 dB
	V	3.60 dB
Radiated Emission, below 1 GHz	H	4.60 dB
	V	4.90 dB

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

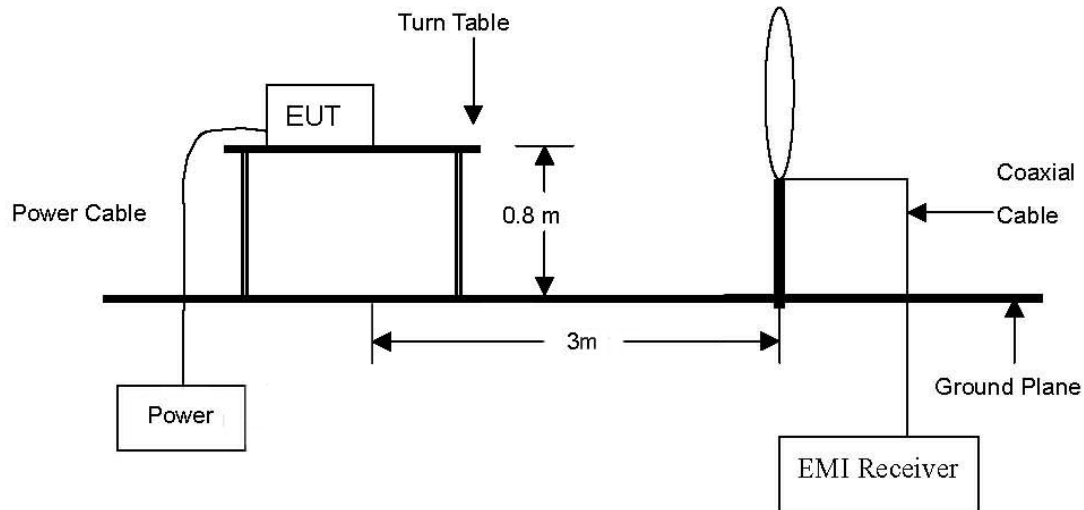
1.10. Test report revision

Revision	Report number	Date of Issue	Description
0	F690501-RF-RTL004558	2023.11.14	Initial

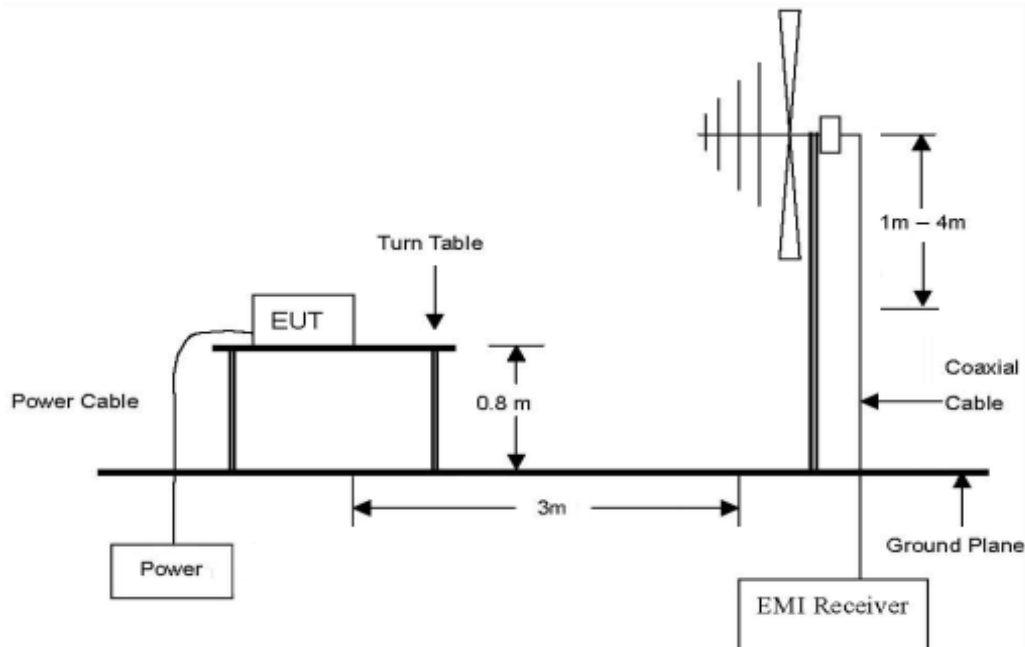
2. Radiated Emissions

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 radiation test of the EUT was investigated in three orthogonal orientations X, Y, and Z, and the worst case data is reported.

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 (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)
13.561	59.39	Peak	H	19.00	0.37	78.76	38.76	84.00	45.24

- 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 (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)
13.553	51.98	Peak	H	19.00	0.37	71.35	31.35	50.47	19.12
13.567	55.23	Peak	H	19.00	0.37	74.60	34.60	50.47	15.87

- 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 (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)
13.260	24.35	Peak	H	19.00	0.37	43.72	3.72	40.51	36.79
13.361	29.89	Peak	H	19.00	0.37	49.26	9.26	29.54	20.28
13.848	30.30	Peak	H	19.00	0.37	49.67	9.67	40.51	30.84

- Spurious emission within the bands 9 MHz - 13.110 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 or 300 m	Limit (dBμV/m) at 30 or 300 m	Margin (dB)
0.034	37.40	Peak	H	18.09	0.02	55.51	-24.49	36.97	61.46
0.150	28.28	Peak	H	17.90	0.05	46.23	-33.77	24.08	57.85
0.902	21.02	Peak	H	18.16	0.70	39.88	-0.12	28.50	28.62
2.418	18.47	Peak	H	18.48	0.67	37.62	-2.38	29.54	31.92
6.786	40.16	Peak	H	18.87	0.46	59.49	19.49	29.54	10.05
12.291	9.67	Peak	H	19.00	0.36	29.03	-10.97	29.54	40.51
12.916	25.36	Peak	H	19.00	0.36	44.72	4.72	29.54	24.82

- Spurious emission within the bands 14.010 MHz - 30 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)
16.420	7.65	Peak	H	19.23	0.38	27.26	-12.74	29.54	42.28
20.340	24.57	Peak	H	19.76	0.41	44.74	4.74	29.54	24.80
25.557	7.16	Peak	H	19.20	0.54	26.90	-13.10	29.54	42.64
27.120	14.05	Peak	H	19.20	0.58	33.83	-6.17	29.54	35.71
Above 28.000	Not detected	-	-	-	-	-	-	-	-

Remark;

1. Fundamental limit ($\mu V/m$) = $20 \log(15\ 848) = 84.00$ dBμV/m.
2. 30 m distance compensation = $40 \log(3/30) = -40$ dBμV/m.
3. 300 m distance compensation = $40 \log(3/300) = -80$ dBμV/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 (dBμA/m) at 3m = Reading (dBμV) + 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)
154.08	43.10	Peak	H	13.91	-26.54	30.47	43.50	13.03
344.81	44.80	Peak	H	20.64	-25.11	40.33	46.00	5.67
366.27	45.80	Peak	H	20.50	-25.17	41.13	46.00	4.87
461.08	46.30	Peak	V	21.90	-25.26	42.94	46.00	3.06
488.20	47.00	Peak	H	22.80	-25.73	<u>44.07</u>	46.00	1.93
515.32	38.90	Peak	V	23.20	-25.48	36.62	46.00	9.38
Above 600.00	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

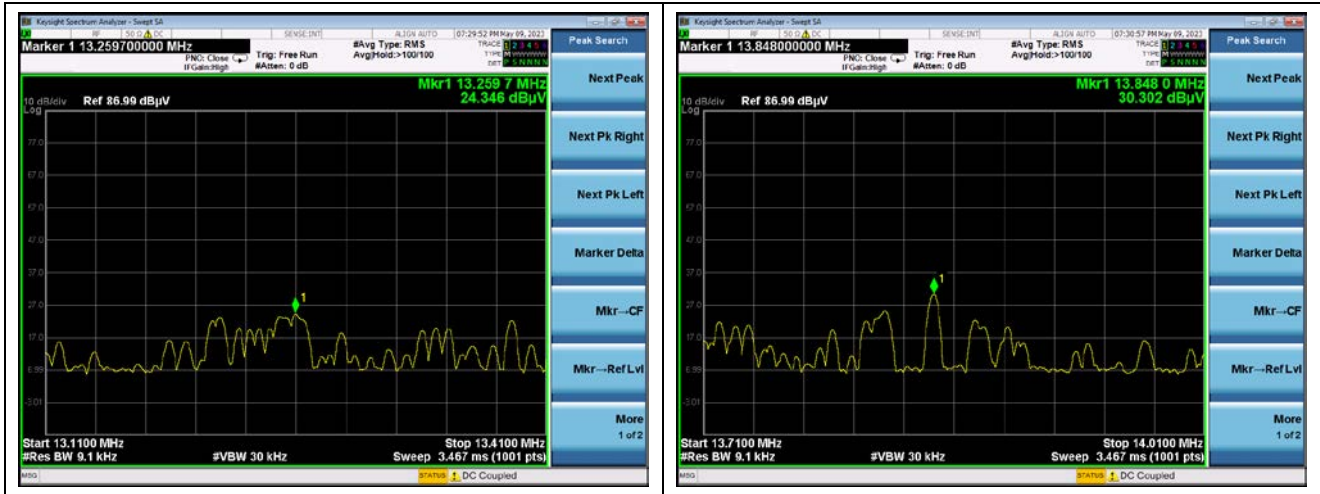
- Fundamental within the band 13.553 MHz - 13.567 MHz



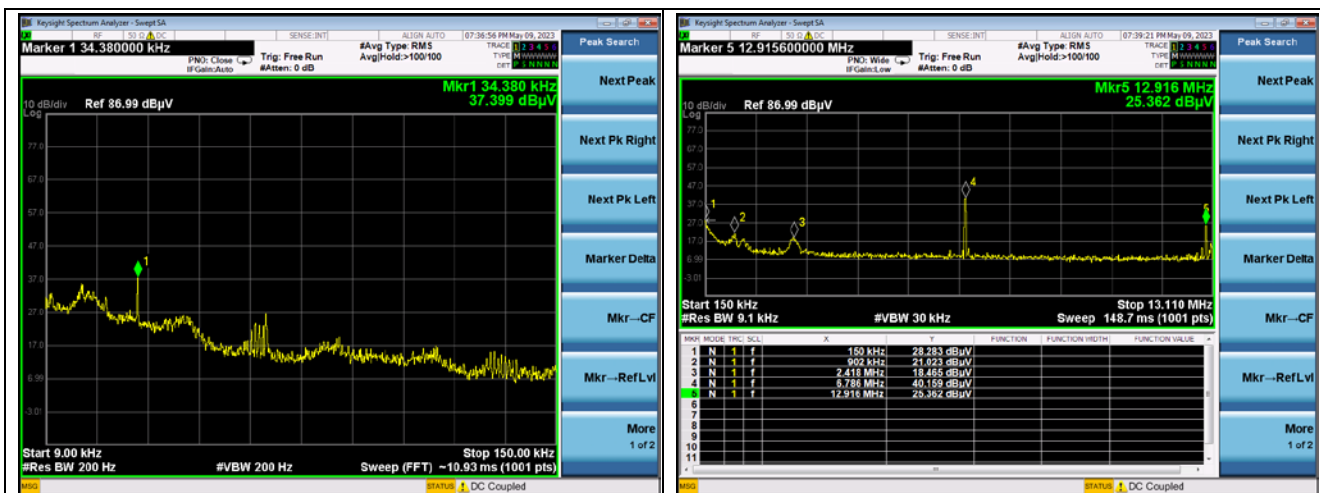
- Spurious emission within the bands 13.410 MHz - 13.553 MHz and 13.567 MHz - 13.710 MHz



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



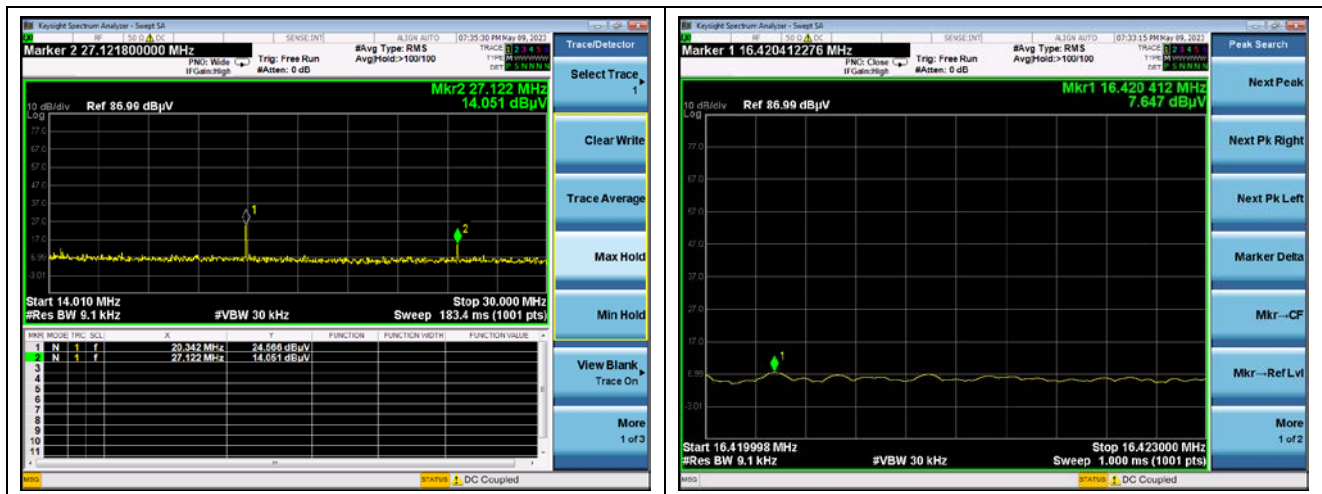
- Spurious emission within the bands 9 kHz - 13.110 MHz



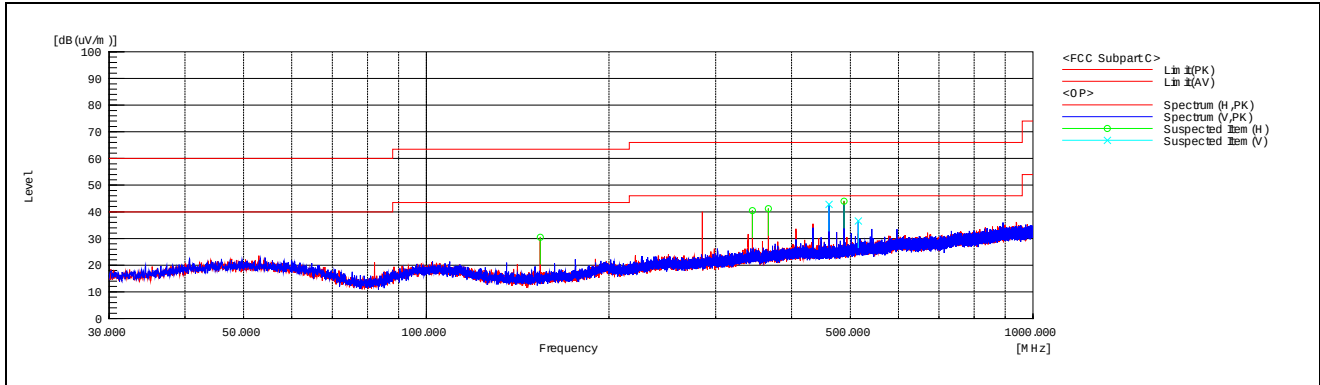
- Spurious emission within the bands 12.290 MHz – 12.293 MHz



- Spurious emission within the bands 14.010 MHz – 30 MHz

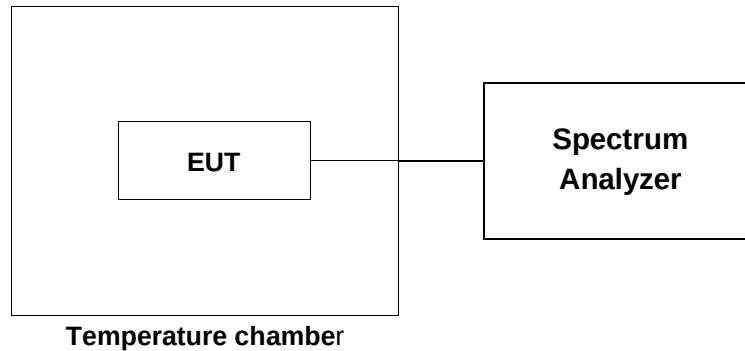


- Spurious emission above 30 MHz



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	13 560 838	-16	-0.000 118
	-10	13 561 017	163	0.001 202
	0	13 560 875	21	0.000 155
	+10	13 560 935	81	0.000 597
	+20(Ref.)	13 560 854	-	-
	+30	13 560 983	129	0.000 951
	+40	13 560 878	24	0.000 177
	+50	13 561 169	315	0.002 323

Voltage Variations

Power (V _{d.c})	Temperature (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
115 % (13.80)	+20	13 560 960	106	0.000 782
85 % (10.20)	+20	13 560 974	120	0.000 885

2 minutes

Temperature Variations

Power (V _{d.c})	Temperature (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
12	-20	13 560 958	106	0.000 782
	-10	13 560 824	-28	-0.000 206
	0	13 560 896	44	0.000 324
	+10	13 561 164	312	0.002 301
	+20(Ref.)	13 560 852	-	-
	+30	13 561 010	158	0.001 165
	+40	13 560 835	-17	-0.000 125
	+50	13 560 957	105	0.000 774

Voltage Variations

Power (V _{d.c})	Temperature (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
115 % (13.80)	+20	13 561 134	282	0.002 080
85 % (10.20)	+20	13 560 836	-16	-0.000 118

5 minutes

Temperature Variations

Power (V _{d.c})	Temperature (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
12	-20	13 560 945	90	0.000 664
	-10	13 560 847	-38	-0.000 059
	0	13 560 843	-42	-0.000 088
	+10	13 561 024	169	0.001 246
	+20(Ref.)	13 560 855	-	-
	+30	13 560 980	125	0.000 922
	+40	13 561 157	302	0.002 227
	+50	13 561 023	168	0.001 239

Voltage Variations

Power (V _{d.c})	Temperature (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
115 % (13.80)	+20	13 561 062	207	0.001 526
85 % (10.20)	+20	13 560 849	-66	-0.000 044

10 minutes

Temperature Variations

Power (V _{d.c})	Temperature (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
12	-20	13 560 960	107	0.000 789
	-10	13 560 998	145	0.001 069
	0	13 560 839	-14	-0.000 103
	+10	13 560 945	92	0.000 678
	+20(Ref.)	13 560 853	-	-
	+30	13 560 899	46	0.000 339
	+40	13 560 844	-19	-0.000 066
	+50	13 560 882	29	0.000 214

Voltage Variations

Power (V _{d.c})	Temperature (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
115 % (13.80)	+20	13 560 898	45	0.000 332
85 % (10.20)	+20	13 561 033	180	0.001 327

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	0.941

-Test plot

20 dB Bandwidth



-End of the Test report-