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TEST REPORT

of

FCC Part 15 Subpart C §15.225
RSS-210 Issue 10 and RSS-Gen Issue 5

FCC ID: IYZNR2
IC Certification: 2701A-NR2

Equipment Under Test	:	Stellantis NFC Reader
Model Name	:	NR2
Variant Model Name(s)	:	-
FCC Applicant	:	Marquardt GmbH
IC Applicant	:	MARQUARDT GMBH
Manufacturer	:	Marquardt GmbH
Date of Receipt	:	2024.05.10
Date of Test(s)	:	2024.05.17 ~ 2024.05.30
Date of Issue	:	2024.06.04

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: **Murphy Kim**

Technical Manager: **JinHyoung Cho**

SGS Korea Co., Ltd. Gunpo Laboratory

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1. General Information

1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)
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- Designation number: KR0150

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1.2. Details of Applicant

FCC Applicant : Marquardt GmbH
FCC Address : Schloss - Str. 16, Rietheim - Weilheim, Germany, 78604
IC Applicant : MARQUARDT GMBH
IC Address : Schloss-Str. 16, Rietheim-Weilheim, Germany (Federal Republic Of), 78604
Contact Person : Gerd, Villing
Phone No. : 49 74 2499 1747

1.3. Details of manufacturer

Company : Marquardt GmbH
Address : Schloss - Str. 16, 78604 Rietheim - Weilheim, Germany, 78604

1.4. Description of EUT

Kind of Product	Stellantis NFC Reader
Model Name	NR2
Serial Number	124101094590834
Power Supply	DC 12 V
Frequency Range	13.56 ㎒ (NFC)
Modulation Technique	ASK
Number of Channels	1 channel
Antenna Type	PCB loop antenna
Antenna Part Number	N/A
H/W Version	243.761.011
S/W Version	24.16
FVIN	N/A

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	R&S	HMP2020	102130	May 02, 2024	Annual	May 02, 2025
DC Power Supply	Agilent	U8002A	MY49030063	Jan. 17, 2024	Annual	Jan. 17, 2025
Temperature Chamber	ESPEC CORP.	PL-1J	15000796	Dec. 01, 2023	Annual	Dec. 01, 2024
Spectrum Analyzer	R&S	FSW8	101660	May 23, 2024	Annual	May 23, 2025
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	VULB 9163	9163-437	May 29, 2024	Biennial	May 29, 2026
EMI Test Receiver	R&S	ESU26	100109	Jan. 16, 2024	Annual	Jan. 16, 2025
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	SENSORVIEW	NMST-13A26-NMST-5 m	TPC2402190004	Apr. 03, 2024	Semi-Annual	Oct. 03, 2024
Coaxial Cable	SENSORVIEW	NMST-13A26-NMST-10 m	TPC2402190001	Apr. 03, 2024	Semi-Annual	Oct. 03, 2024
Coaxial Cable	RADIALL	TESTPRO 3	182287	Apr. 12, 2024	Semi-Annual	Oct. 12, 2024

1.6. Summary of Test Results

The EUT has been tested according to the following specifications:

Applied standard : FCC Part15 subpart C, IC RSS-210 Issue 10, RSS-Gen Issue 5			
Section in FCC	**Section in IC**	**Test item(s)**	**Result**
15.225(a)(b)(c)(d) 15.209	RSS-210 Issue 10 B.6 RSS-Gen Issue 5 8.9	Radiated Emission, Spurious Emission and Field Strength of Fundamental	Complied
15.225(e)	RSS-210 Issue 10 B.6 RSS-Gen Issue 5 6.11	Frequency Stability	Complied
15.215(c)	RSS-Gen Issue 5 6.7	20 dB Bandwidth & 99 % Bandwidth	Complied
15.207	RSS-Gen Issue 5 8.8	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 (dBμV/m) = Measured level (dBμV) + Antenna factor (dB/m) + Cable loss (dB) - Amplifier gain (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	
99 % Bandwidth	0.04 ㎑	
20 ㏈ Bandwidth	0.04 ㎑	
Frequency Stability	0.11 ㎑	
Radiated Emission, 9 ㎑ to 30 ㎒	H	3.60 ㏈
	V	3.60 ㏈
Radiated Emission, below 1 ㎓	H	4.60 ㏈
	V	4.90 ㏈

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

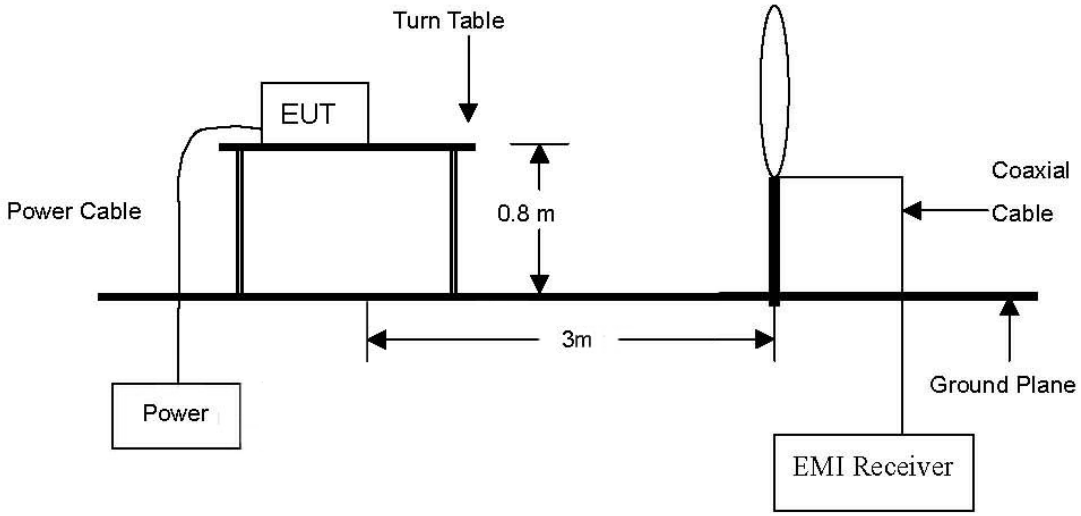
1.10. Test report revision

Revision	Report number	Date of Issue	Description
0	F690501-RF-RTL005126	2024.06.04	Initial

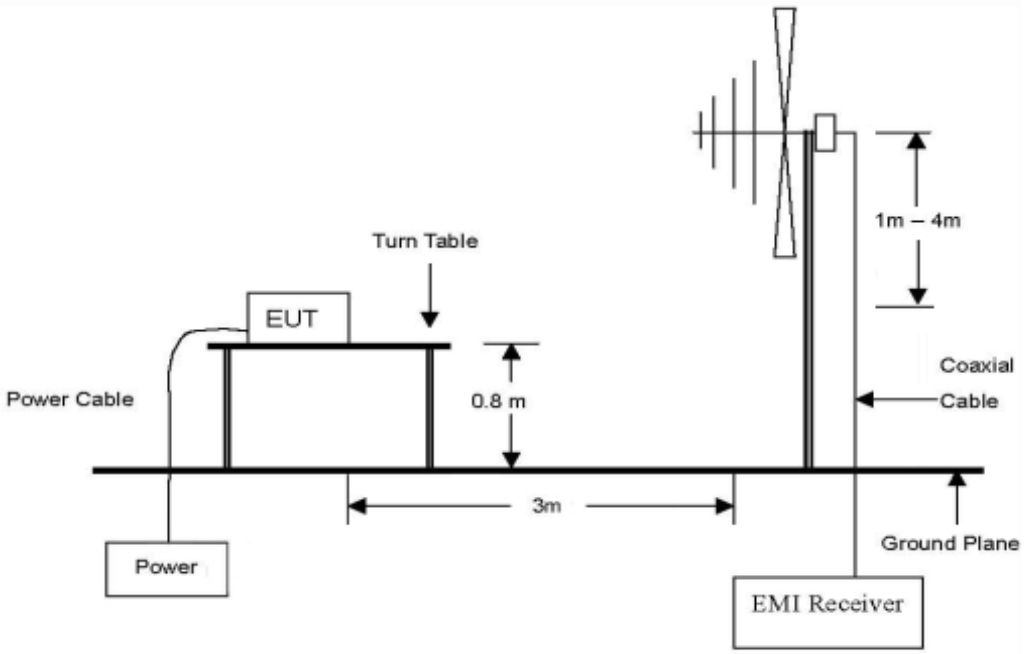
2. Radiated Emissions

2.1. Test Setup

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



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 000 ㎒ Emissions.



2.2. Limit

FCC

According to §15.225,

(a) The field strength of any emissions within the band 13.553-13.567 ㎒ shall not exceed 15 848 microvolts/meter at 30 meters.

(b) Within the bands 13.410-13.553 ㎒ and 13.567-13.710 ㎒, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.

(c) Within the bands 13.110-13.410 ㎒ and 13.710-14.010 ㎒ 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 ㎒ 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 (㎒)	Field Strength (microvolts/meter)	Measurement Distance (meter)
0.009-0.490	2400/F(㎑)	300
0.490-1.705	24000/F(㎑)	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 ㎒, 76-88 ㎒, 174-216 ㎒ or 470-806 ㎒. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

IC

According to RSS-210 Issue 10, B.6

The field strength of any emission shall not exceed the following limits:

(a) 15.848 millivolts/m (84 dBμV/m) at 30 m, within the band 13.553-13.567 MHz.

(b) 334 microvolts/m (50.5 dBμV/m) at 30 m, within the bands 13.410-13.553 MHz and 13.567-13.710 MHz.

(c) 106 microvolts/m (40.5 dBμV/m) at 30 m, within the bands 13.110-13.410 MHz and 13.710-14.010 MHz.

(d) RSS-Gen general field strength limits for frequencies outside the band 13.110-14.010 MHz.

According to RSS-Gen Issue 5, 8.9

Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

Table 5 - General field strength limits at frequencies above 30 MHz

Frequency (MHz)	Field Strength (μV/m at 3 m)
30-88	100
88-216	150
216-960	200
Above 960	500

Table 6 - General field strength limits at frequencies below 30 MHz

Frequency	Magnetic Field Strength (H-Field) (μA/m)	Measurement Distance (m)
9-490 kHz [1]	6.37/F (F in kHz)	300
490-1 705 kHz	63.7/F (F in kHz)	30
1.705-30 MHz	0.08	30

Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

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 ㎒

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 ㎒

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 ㎓, 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 ㎓ resolution bandwidth is set to 100 ㎑ for peak detection measurements or 120 ㎑ 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) ℃
Relative humidity : 47 % R.H.

The following table shows the highest levels of radiated emissions.

- Fundamental within the band 13.553 ㎒ - 13.567 ㎒

Radiated Emissions			Ant.	Correction Factors		Total		Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	Ant. Factor (dB/m)	Cable loss (dB)	Actual (dB㎶/m) at 3 m	Actual (dB㎶/m) at 30 m	Limit (dB㎶/m) at 30 m	Margin (dB)
13.560	37.92	Peak	H	18.93	0.31	57.16	17.16	84.00	66.84

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

Radiated Emissions			Ant.	Correction Factors		Total		Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	Ant. Factor (dB/m)	Cable loss (dB)	Actual (dB㎶/m) at 3 m	Actual (dB㎶/m) at 30 m	Limit (dB㎶/m) at 30 m	Margin (dB)
13.553	36.46	Peak	H	18.93	0.31	55.70	15.70	50.47	34.77
13.567	36.33	Peak	H	18.93	0.31	55.57	15.57	50.47	34.90

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

Radiated Emissions			Ant.	Correction Factors		Total		Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	Ant. Factor (dB/m)	Cable loss (dB)	Actual (dB㎶/m) at 3 m	Actual (dB㎶/m) at 30 m	Limit (dB㎶/m) at 30 m	Margin (dB)
*13.392	9.07	Peak	H	18.93	0.32	28.32	-11.68	29.54	41.22
*13.388	10.04	Peak	H	18.93	0.32	29.29	-10.71	29.54	40.25
13.865	9.83	Peak	H	18.92	0.29	29.04	-10.96	40.51	51.47

- Spurious emission within the bands 9 ㎑ - 13.110 ㎒

Radiated Emissions			Ant.	Correction Factors		Total		Limit	
Frequency (㎒)	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)
0.019	40.96	Peak	H	18.73	0.06	59.75	-20.25	42.03	62.28
0.067	28.13	Peak	H	18.29	0.04	46.46	-33.54	31.08	64.62
0.150	29.62	Peak	H	18.20	0.02	47.84	-32.16	24.08	56.24
1.692	30.81	Peak	H	18.54	0.51	49.86	9.86	23.04	13.18
*12.292	8.29	Peak	H	18.95	0.33	27.57	-12.43	29.54	41.97

- Spurious emission within the bands 14.010 ㎒ - 30 ㎒

Radiated Emissions			Ant.	Correction Factors		Total		Limit	
Frequency (㎒)	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)
14.074	8.65	Peak	H	18.92	0.28	27.85	-12.15	29.54	41.69
*16.421	7.54	Peak	H	19.07	0.30	26.91	-13.09	29.54	42.63
*25.620	7.39	Peak	H	19.29	0.30	26.98	-13.02	29.54	42.56
Above 26.000	Not detected	-	-	-	-	-	-	-	-

Remark;

1. Fundamental limit (μV/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 ㎒.
   (Actual (dBμA/m) at 3m = Reading (dBμV) + AF (dB/m) + CL (dB))

- Spurious emission above 30 ㎒

Radiated Emissions			Ant	Correction (㏈/m)	Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detect Mode	Pol.		Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
352.53	35.59	Quasi - Peak	V	-5.53	30.06	46.00	15.94
379.65	34.63	Quasi - Peak	V	-4.80	29.83	46.00	16.17

Remark;

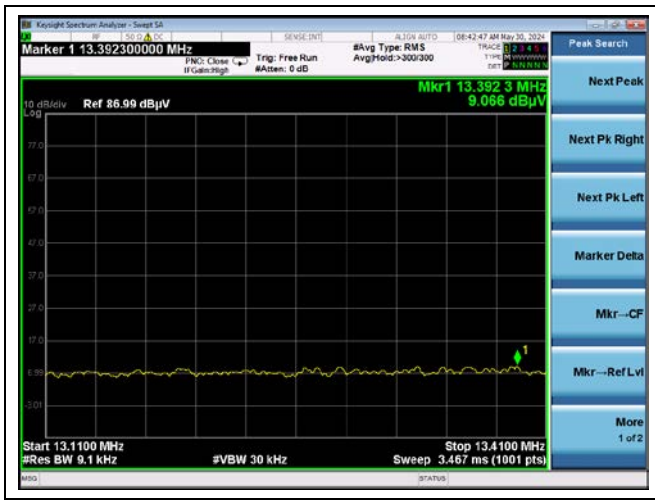
1. Radiated spurious emission measurement as below.
   (Actual (㏈㎶/m) = Reading (㏈㎶) + Correction)
   (Correction = Antenna Factor (㏈/m) + AMP Factor (㏈) + Cable Loss (㏈))
2. According to §15.31(o), emission levels are not report much lower than the limits by over 20 ㏈.
3. Test from 30 ㎒ to 1 000 ㎒ was performed using the software of ELEKTRA(V5.02) from Rohde & Schwarz GmbH & Co. KG.

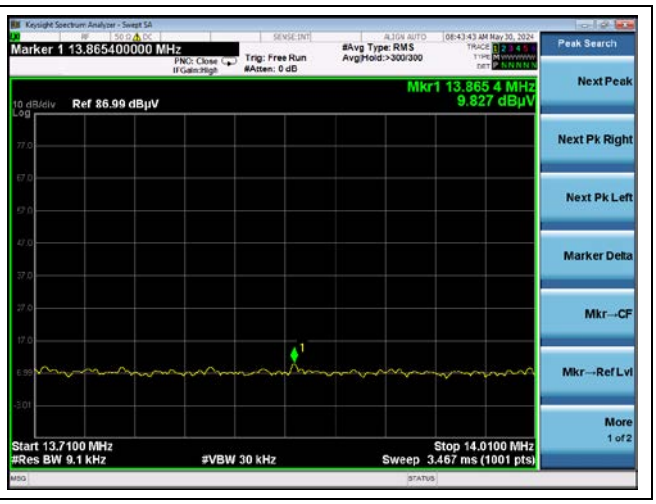
Test plots

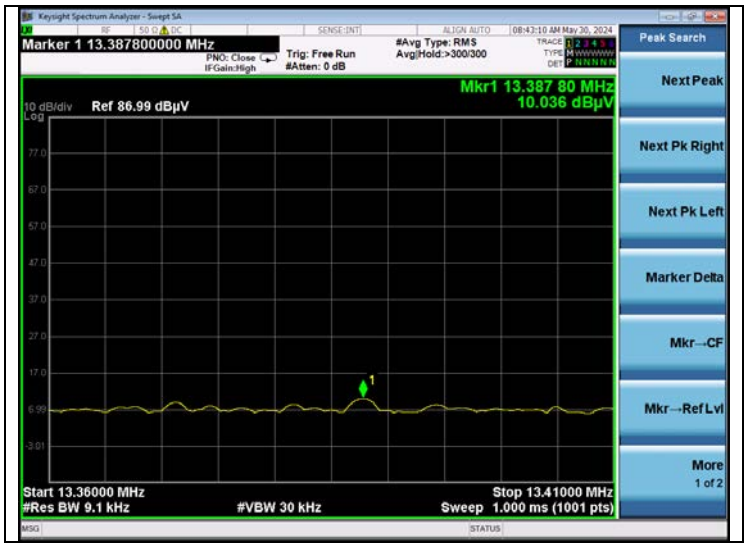
- Fundamental within the band 13.553 ㎒ - 13.567 ㎒

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

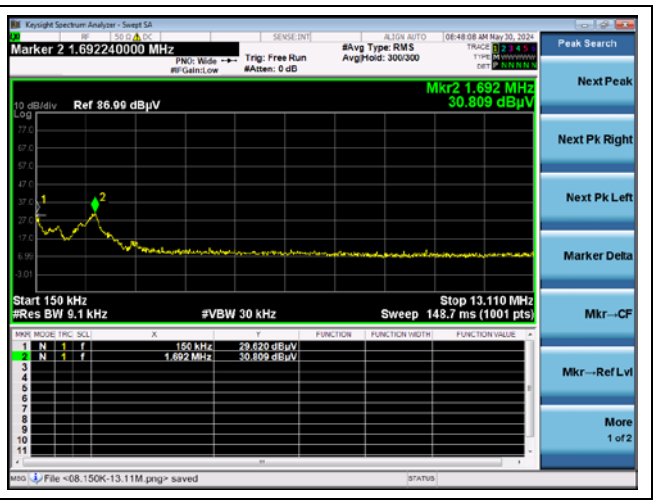
- Spurious emission within the bands 13.110 ㎒ - 13.410 ㎒ and 13.710 ㎒ - 14.010 ㎒



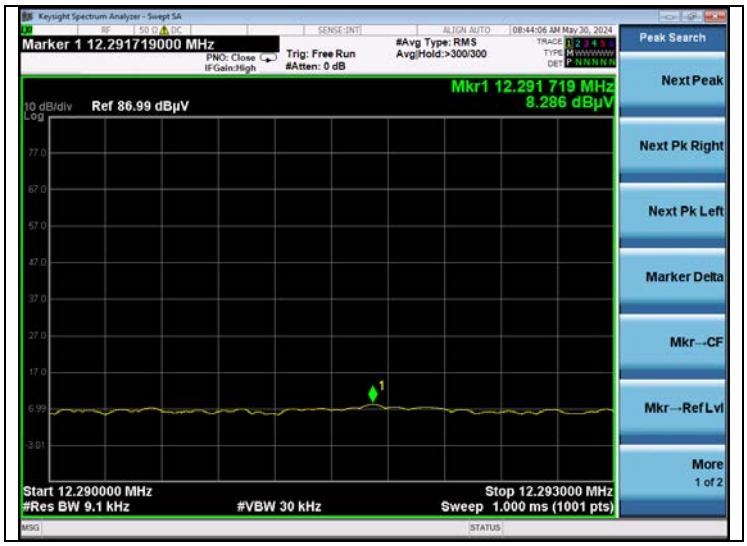




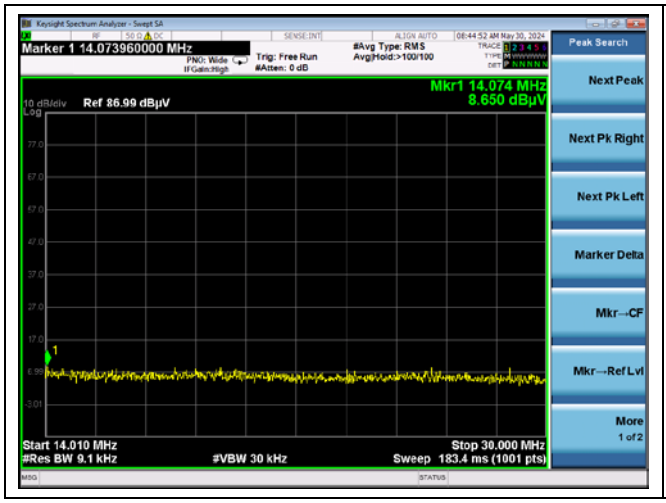
- Spurious emission within the bands 9 ㎑ – 13.110 ㎒

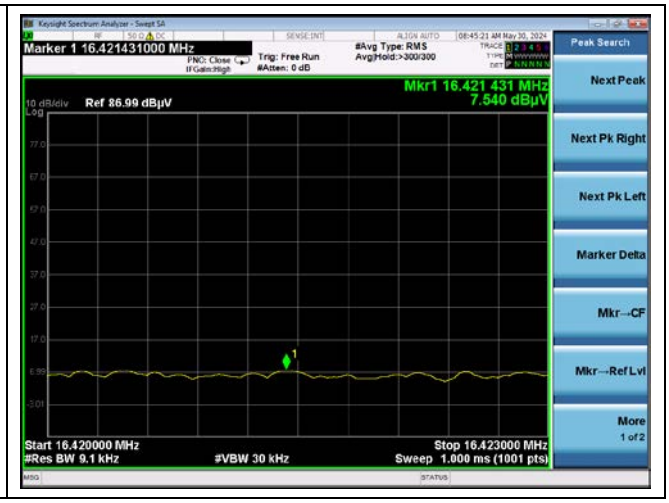


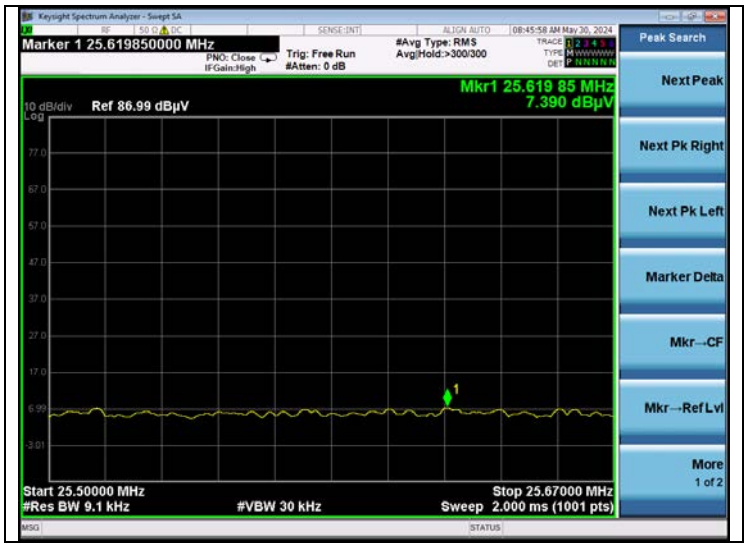
- Spurious emission within the bands 12.290 ㎒ – 12.293 ㎒



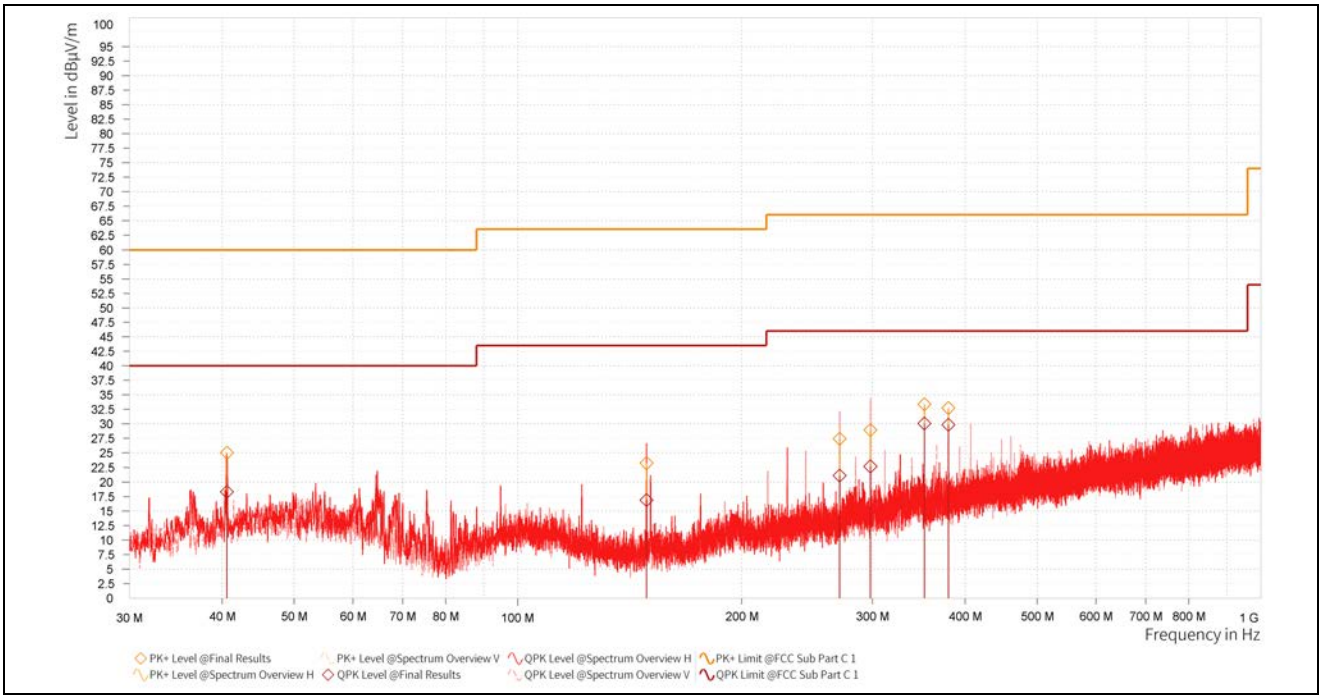
- Spurious emission within the bands 14.010 ㎒ – 30 ㎒





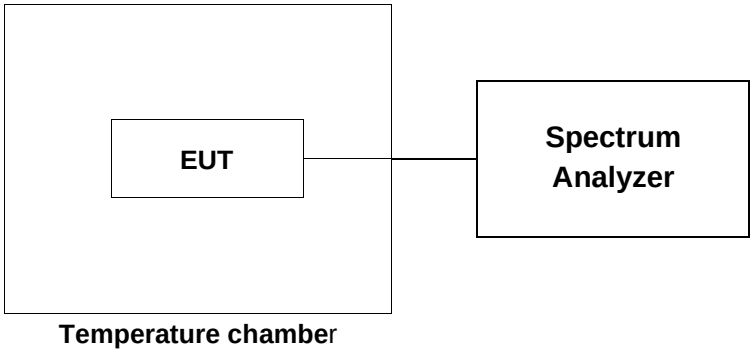


- Spurious emission above 30 ㎒



3. Frequency Stability

3.1. Test Setup



3.2. Limit

FCC

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.

IC

According to RSS-210, Annex B, Section B.6
Carrier frequency stability shall be maintained to ± 0.01 % (±100 ppm).

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 ㎐, VBW = 100 ㎐, Span = 10 ㎑, 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) ℃
Relative humidity : 47 % R.H.

Startup

Temperature Variations

Power ($V_{d.c}$)	Temperature (℃)	Frequency (㎐)	Freq. Dev. (㎐)	Deviation (%)
12	-20	13 560 200	440	0.003 245
	-10	13 560 080	320	0.002 360
	0	13 559 970	210	0.001 549
	+10	13 559 890	130	0.000 959
	+20(Ref.)	13 559 760	-	-
	+30	13 560 140	380	0.002 802
	+40	13 559 980	220	0.001 622
	+50	13 560 100	340	0.002 507

Voltage Variations

Power ($V_{d.c}$)	Temperature (℃)	Frequency (㎐)	Freq. Dev. (㎐)	Deviation (%)
115 % (13.80)	+20	13 560 000	240	0.001 770
85 % (10.20)	+20	13 560 200	440	0.003 245

2 minutes

Temperature Variations

Power ($V_{d.c}$)	Temperature (℃)	Frequency (㎐)	Freq. Dev. (㎐)	Deviation (%)
12	-20	13 560 200	380	0.002 802
	-10	13 560 100	280	0.002 065
	0	13 560 060	240	0.001 770
	+10	13 560 020	200	0.001 475
	+20(Ref.)	13 559 820	-	-
	+30	13 559 600	-220	-0.001 622
	+40	13 559 920	100	0.000 737
	+50	13 560 000	180	0.001 327

Voltage Variations

Power ($V_{d.c}$)	Temperature (℃)	Frequency (㎐)	Freq. Dev. (㎐)	Deviation (%)
115 % (13.80)	+20	13 559 920	100	0.000 737
85 % (10.20)	+20	13 560 065	245	0.001 807

5 minutes

Temperature Variations

Power ($V_{d.c}$)	Temperature (℃)	Frequency (㎐)	Freq. Dev. (㎐)	Deviation (%)
12	-20	13 560 080	80	0.000 590
	-10	13 560 040	40	0.000 295
	0	13 560 000	0	0.000 000
	+10	13 560 000	0	0.000 000
	+20(Ref.)	13 560 000	-	-
	+30	13 559 800	-200	-0.001 475
	+40	13 559 740	-260	-0.001 917
	+50	13 559 820	-180	-0.001 327

Voltage Variations

Power ($V_{d.c}$)	Temperature (℃)	Frequency (㎐)	Freq. Dev. (㎐)	Deviation (%)
115 % (13.80)	+20	13 559 900	-100	-0.000 737
85 % (10.20)	+20	13 560 100	100	0.000 737

10 minutes

Temperature Variations

Power ($V_{d.c}$)	Temperature (℃)	Frequency (㎐)	Freq. Dev. (㎐)	Deviation (%)
12	-20	13 560 140	360	0.002 655
	-10	13 560 000	220	0.001 622
	0	13 560 040	260	0.001 917
	+10	13 559 980	200	0.001 475
	+20(Ref.)	13 559 780	-	-
	+30	13 560 200	420	0.003 097
	+40	13 559 960	180	0.001 327
	+50	13 559 990	210	0.001 549

Voltage Variations

Power ($V_{d.c}$)	Temperature (℃)	Frequency (㎐)	Freq. Dev. (㎐)	Deviation (%)
115 % (13.80)	+20	13 559 960	180	0.001 327
85 % (10.20)	+20	13 560 080	300	0.002 212

4. 20 ㏈ Bandwidth & 99 % Bandwidth

4.1. Test Setup

4.2. Limit

None; for reporting purposes only.

4.3. Test Procedures

20 ㏈ Bandwidth

1. Span = set to capture all products of the modulation process, including the emission skirts.
   RBW = 10 ㎑, VBW = 10 ㎑, 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 ㏈ 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 ㏈ bandwidth of the emission.

99 % Bandwidth

1. Set the spectrum analyzer as Span = set to capture all products of the modulation process, including the emission skirts, RBW = 10 ㎑, VBW = 10 ㎑, Detector = Peak, Trace mode = max hold.
2. Measure lowest and highest frequencies are placed in a running sum until 0.5 % and 99.5 % of the total is reached.
3. The difference between the two recorded frequencies is the occupied bandwidth.

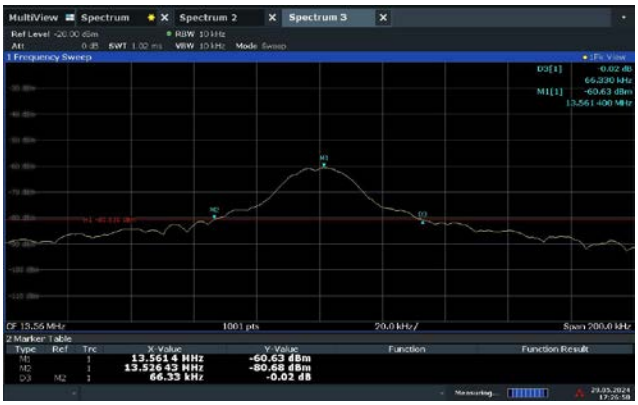
4.3. Test Result

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

Frequency (㎒)	20 ㏈ Bandwidth (㎑)	99 % Bandwidth (㎑)
13.560	66.33	114.80

-Test plots

20 ㏈ Bandwidth



99 % Bandwidth

-End of the Test report-