

TEST REPORT

of

ARIB STD-T66

Equipment Under Test : Car infotainment system
Model Name : VN470ZZZGX
Variant Model Name(s) : VN450ZZZGX
Applicant : Hyundai Mobis Co., Ltd.
Manufacturer : Hyundai Mobis Co., Ltd.
Date of Receipt : 2022.08.08
Date of Test(s) : 2022.09.19 ~ 2022.10.05
Date of Issue : 2022.10.14

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.
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Tested by:



Gilbert Park

Technical
Manager:



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SGS Korea Co., Ltd. Gunpo Laboratory

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1. General Information

1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)

- Wireless Div. 2FL, 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807

All SGS services are rendered in accordance with the applicable SGS conditions of service available on request and accessible at <http://www.sgs.com/en/Terms-and-Conditions.aspx>.

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1.2. Details of Applicant

Applicant : Hyundai Mobis Co., Ltd.

Address : 203, Teheran-ro, Gangnam-gu, Seoul, 06141, Republic of Korea

1.3. Details of Manufacturer

Company : Same as applicant

Address : Same as applicant

1.4. Description of EUT

Kind of Product		Car infotainment system
Model Name		VN470ZZZGX
Variant Model		VN450ZZZGX
Power Supply		DC 14.4 V
Frequency Range		2 402 MHz ~ 2 480 MHz (Bluetooth Low Energy)
Modulation Technique		GFSK
Rated Output Power		4 mW
Number of Channels		40 channels (Bluetooth Low Energy)
Antenna Type		PCB Pattern Antenna
Antenna Gain	Ant.1	2 400 MHz ~ 2 483.5 MHz: -1.34 dB i (Bluetooth Low Energy) 5 470 MHz ~ 5 730 MHz: 2.39 dB i
	Ant.2	2 400 MHz ~ 2 483.5 MHz: 0.19 dB i 5 470 MHz ~ 5 730 MHz: 2.41 dB i

1.5. Test Equipment List

Equipment	Manufacturer	Model	Serial No.	Cal. Date	Cal. Authority	Cal. Method
Spectrum Analyzer	R&S	FSV30	103102	Jun. 09, 2022	SICT	c)
Signal Generator	R&S	E8257D	MY51501169	Mar. 04, 2022	SICT	c)
Attenuator	AEROFLEX / INMET	26A-10 dB	3	Mar. 13, 2022	SICT	c)
DC Power Supply	R&S	HMP2020	020089489	May 17, 2022	SICT	c)
DIGITAL MULTIMETER	HIOKI	DT4211	N0301231	Sep. 14, 2022	SICT	c)

Note;

- a): Calibration conducted by the National Institute of Information and Communications Technology or a designated calibration agency under Article 102-18 paragraph (1).
- b): Correction conducted pursuant to the provisions of Article 135 or Article 144 of the Measurement Law. (Law No. 51 of 1992)
- c): Calibration conducted in foreign countries, which shall be equivalent to the calibration conducted by the NICT or a designated calibration agency under Article 102-18 paragraph (1).
- d): Calibration conducted by using other equipment that listed above from a) to c).

1.6. Test Method

Measurement was conducted by the following test method:

The test method of Ordinance Concerning Technical Regulations Conformity Certification etc. of Specified Radio Equipment in Annex 1, the Ministry of Internal Affairs and Communication notification in Annex 43 of Article 88, Paragraph 1 or the test method more than equivalent.

1.7. Information of Variant Model

Model Name		Description			
		Speaker ch.	Built-in Camera	SVM Camera	ICC Camera
Basic Model	VN470ZZZGX	10	O	O	O
Variant Model	VN450ZZZGX	6	X	X	X

1.8. Summary of Test Results

The EUT has been tested according to the following specifications:

Applied Standard : Radio equipment regulations and ARIB STD-T66		
Section	Test item	Result
STD-T66 3.2	Frequency Tolerance	Complied
STD-T66 3.2	Occupied Bandwidth (99 %)	Complied
STD-T66 3.2	Spurious Emission Intensity	Complied
STD-T66 3.2	Antenna Power	Complied
STD-T66 3.3	Secondary Radiated Emissions	Complied
STD-T66 3.4	Interference Prevention Function	Complied

1.9. Test Report Revision

Revision	Report number	Date of Issue	Description
0	F690501-RF-RTL003463	2022.10.14	Initial

2. Frequency Tolerance

2.1. Test Setup



2.2. Limit

Tolerance of frequency: $\pm 50 \times 10^{-6}$ or less.

2.3. Test Procedure

1. Connect transmitter output to the spectrum analyzer input port.
2. The EUT should be transmitting at low, middle and high channels.
3. Set the spectrum analyzer as below;

Center frequency:	LE	2 402 MHz, 2 442 MHz, 2 480 MHz (Bluetooth Low Energy)
Span:		3 MHz
RBW:		200 kHz
VBW:		200 kHz
Sweep time:		Auto
Sweep data points:		1 001 or greater
Detector mode:		Positive peak
Indication mode:		Max hold

4. Find the right and left peak values and calculate its frequency.

2.4. Test result

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

- Test mode: Modulated

Test voltage (V _{d.c.})	Measured frequency (MHz)	Reading frequency (MHz)	Frequency tolerance [ppm]
V _{nom} = 14.4	Low Ch. (2 402)	2 402.004	1.85
	Middle Ch. (2 442)	2 440.012	4.90
	High Ch. (2 480)	2 480.013	5.42

Note;

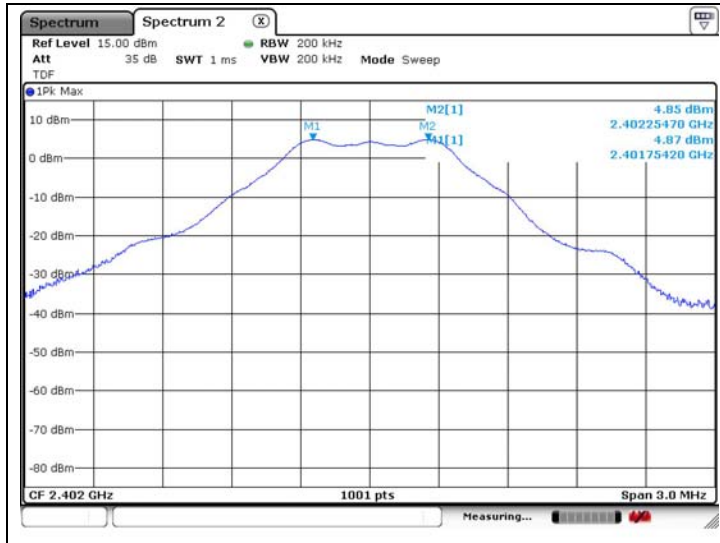
1. $(F_R + F_L)/2 = RF$

- F_R: Right peak value Frequency, F_L: Left peak value Frequency

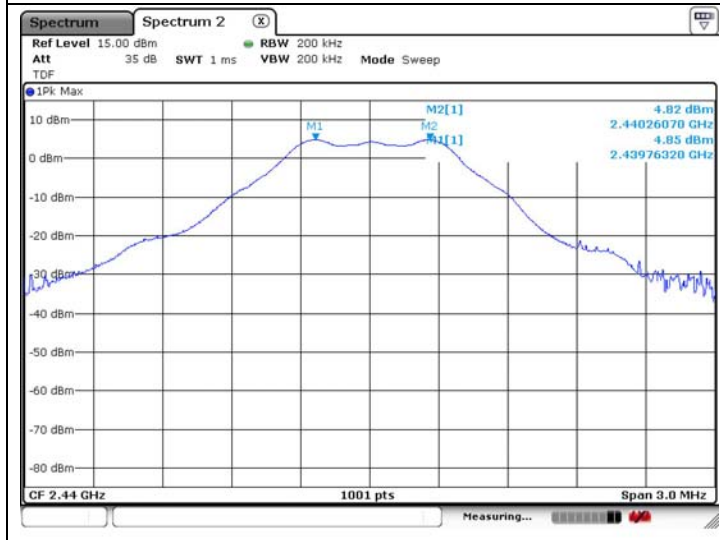
2. $FT \text{ (ppm)} = [(RF - MF)/MF] \times 10^6$

- FT: Frequency Tolerance, RF: Reading Frequency and MF: Measurement Frequency

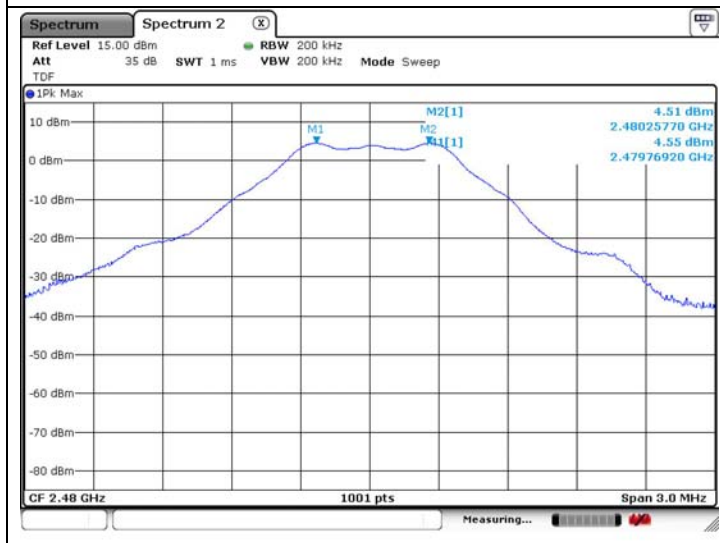
Low Channel



Middle Channel



High Channel



3. Occupied Bandwidth (99 %)

3.1. Test Setup



3.2. Limit

26 MHz or less

3.3. Test Procedure

1. Connect transmitter output to the spectrum analyzer input port.
2. Measure the signal bandwidth using a spectrum analyzer.
3. Set the spectrum analyzer as below;

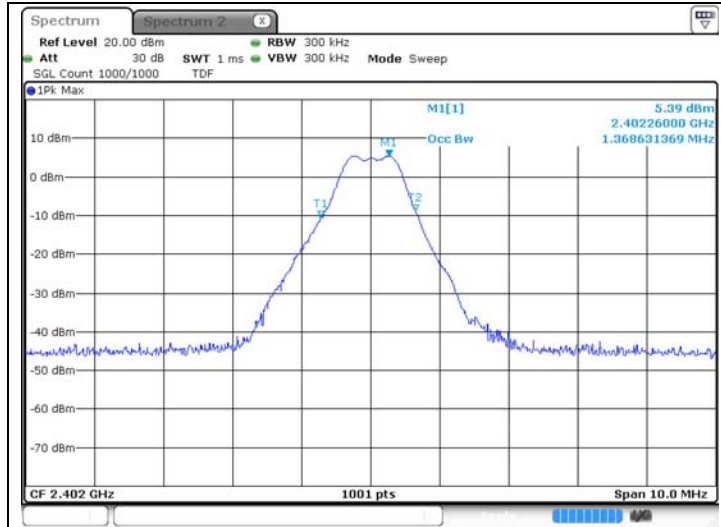
Center frequency:	LE	2 402 MHz, 2 442 MHz, 2 480 MHz
Span:		10 MHz
RBW:		300 kHz
VBW:		300 kHz
Sweep time:		Auto
Sweep data points:		1 001 or greater
Detector mode:		Positive peak
Indication mode:		Max hold
BW setting:		99 %

3.4. Test result

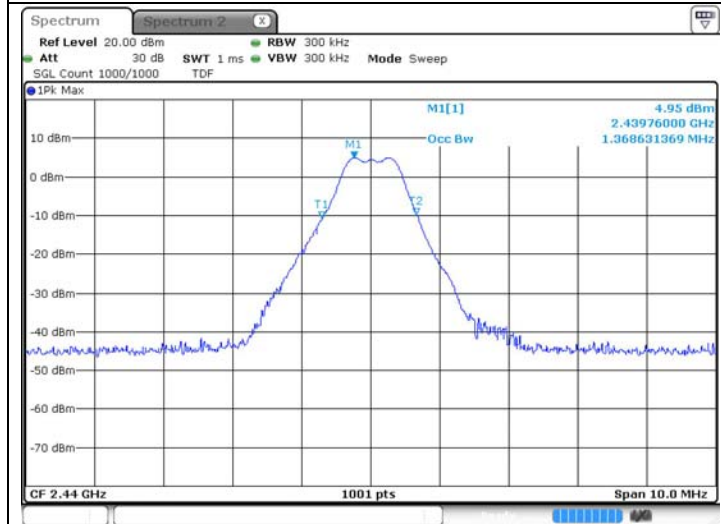
Ambient temperature : (23 ± 1) °C
 Relative humidity : 47 % R.H.

Test voltage (V _{d.c.})	Measured frequency (MHz)	Occupied bandwidth (MHz)
V _{nom} = 14.4	Low Ch. (2 402)	1.37
	Middle Ch. (2 442)	1.37
	High Ch. (2 480)	1.37

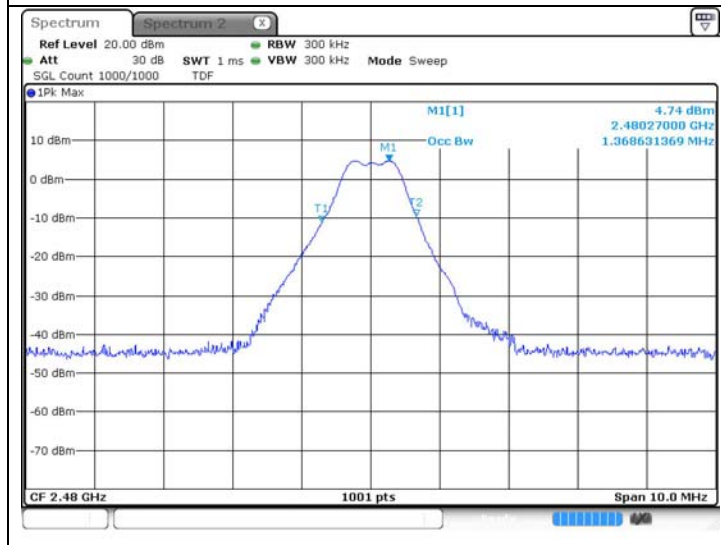
Low Channel



Middle Channel



High Channel



4. Spurious Emission Intensity

4.1. Test Setup



4.2. Limit

Below 2 387 MHz:	2.5 μ W (-26 dB m)/MHz or less
2 387 to 2 400 MHz:	25.0 μ W (-16 dB m)/MHz or less
2 483.5 to 2 496.5 MHz:	25.0 μ W (-16 dB m)/MHz or less
Over 2 496.5 MHz:	2.5 μ W (-26 dB m)/MHz or less

4.3. Test Procedure

1. Connect transmitter output to the spectrum analyzer input port.
2. Configure the EUT
 - Test channels: low, middle, high

[Setting 1]

Frequency range:	LE	30 MHz to 12.5 GHz, except for 2 400 MHz to 2 483.5 MHz
RBW:		1 MHz
VBW:		1 MHz
Sweep time:		Minimum time required to make an accurate measurement
Sweep data points:		1 001 or greater
Detector mode:		Positive peak
Indication mode:		Max hold

Note: sweep shall be repeated until the max hold waveform is stable.

[Setting 2]

Center frequency:	Frequency of spurious emission found using [Setting 1]
Span:	0 Hz
RBW:	1 MHz
VBW:	1 MHz
Sweep:	Minimum time required to make an accurate measurement. For burst type (intermittent) spurious, sweep time shall be greater than one burst interval
Sweep data points:	1 001 or greater
Detector mode:	Sample

[Setting 3]

Frequency range: 2 374 MHz to 2 400 MHz
 2 483.5 MHz to 2 509.5 MHz

RBW: 30 kHz

VBW: 30 kHz

Sweep time: Minimum time required to make an accurate measurement.

Sweep data points: 1 001 or greater

Detector mode: Positive peak

Indication mode: Max hold

3. After configuring the spectrum analyzer to [Setting 1], search for spurious emissions from 30 MHz to 12.5 GHz. If spurious emissions greater than [Limit – 3 dB] are found, then more detailed measurements are required, go to step (4).

4. Configure the spectrum analyzer using [Setting 2] and measure the average signal amplitude. If the spurious emission is burst type (intermittent), then the average value shall not include signal OFF time. If spurious emissions ranging from 30 MHz to 2 374 MHz and from 2 509.5 MHz to 12.5 GHz are over the limit, then the test result is 'Fail'.

If spurious emissions ranging 2 374 MHz to 2 400 MHz and 2 483.5 MHz to 2 509.5 MHz are over the limit, then further detailed measurements are required, go to step (5).

5. Measure the spurious emissions using [Setting 3].

6. Calculate the spurious value (Calculated Value) using following formula:

Calculated Value = (Measured Value using [Setting 2] + 15.2 dB)

Note: 15.2 dB adjustment is derived from the Conversion Factor of RBW

Conversion Factor of RBW = $10 \times \log(\text{Reference Bandwidth} / \text{RBW of measurement}) = 15.2 \text{ [dB]}$

Where: Reference Bandwidth = 1 MHz

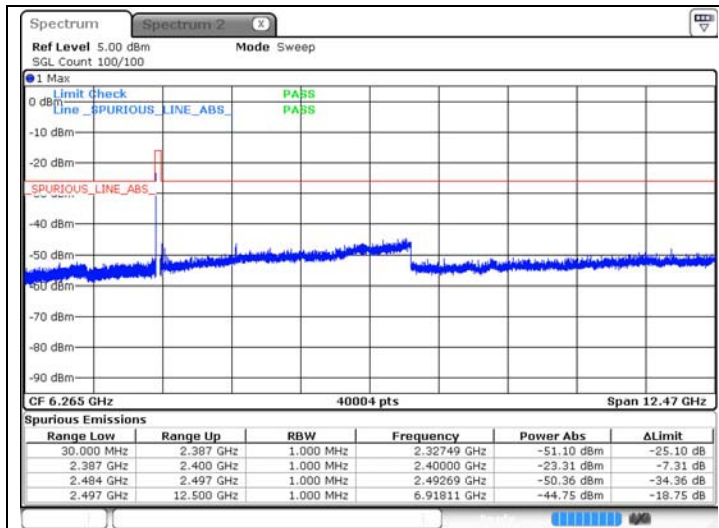
RBW of measurement = 30 kHz

4.4. Test result

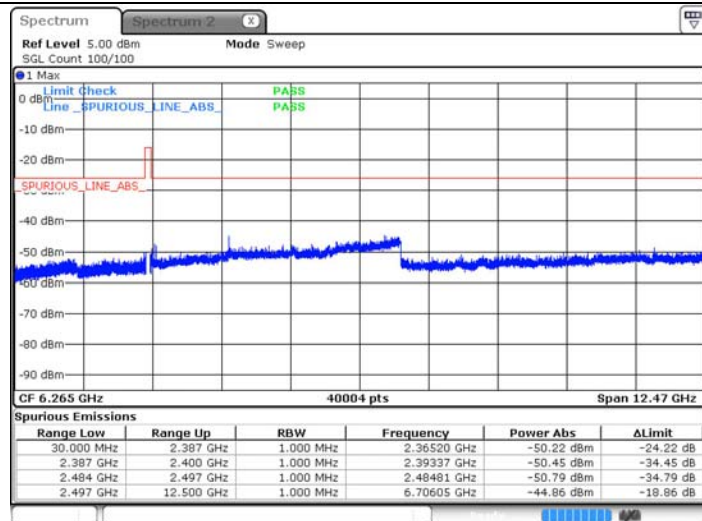
Ambient temperature : (23 ± 1) °C
 Relative humidity : 47 % R.H.

Test voltage (V _{d.c.})	Frequency range (MHz)	Measured	Low Ch. (2 402 MHz)	Middle Ch. (2 442 MHz)	High Ch. (2 480 MHz)	Limit
V _{nom} = 14.4	Below 2 387	Frequency (GHz)	2.327	2.365	2.319	-
		Level (dB m/MHz)	-51.10	-50.22	-51.35	-26
		Level (μW/MHz)	0.007 755	0.009 503	0.007 328	2.5
	2 387 to 2 400	Frequency (GHz)	2.400	2.393	2.394	-
		Level (dB m/MHz)	-23.31	-50.45	-50.24	-16
		Level (μW/MHz)	4.666 654	0.009 012	0.009 464	25
	2 483.5 to 2 496.5	Frequency (GHz)	2.493	2.485	2.484	-
		Level (dB m/MHz)	-50.36	-50.79	-39.82	-16
		Level (μW/MHz)	0.009 195	0.008 335	0.104 277	25
	Above 2 496.5	Frequency (GHz)	6.918	6.706	6.944	-
		Level (dB m/MHz)	-44.75	-44.86	-44.47	-26
		Level (μW/MHz)	0.033 484	0.032 685	0.035 749	2.5

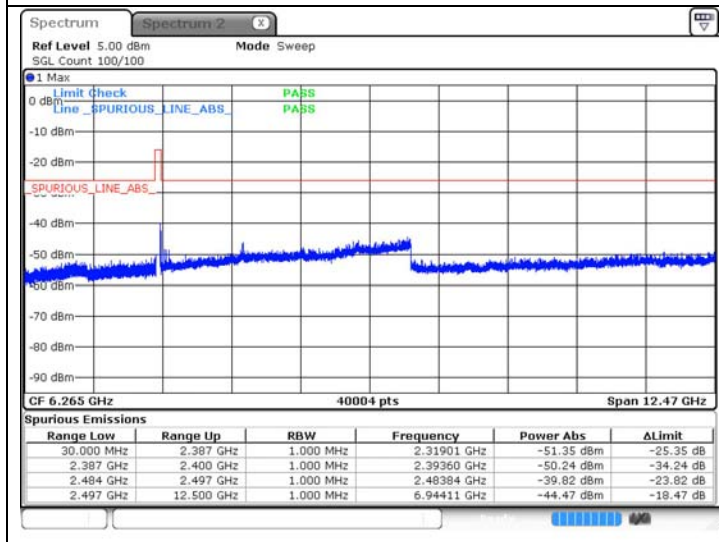
Low Channel



Middle Channel



High Channel



5. Antenna Power

5.1. Test setup



5.2. Limit

The difference between measured output power and the rated output power shall be within a tolerance of +20 % to -80 %. In addition, the rated output power shall not be over the limits shown below.

Limit (rated output power, upper limit)

- 10 mW or less

5.3. Test procedure

1. Connect transmitter output to the spectrum analyzer input port.
2. Configure the spectrum analyzer as below;

[Setting 1]–Search for peak power frequency according to below settings

Center frequency: 2 402 MHz, 2 442 MHz, 2 480 MHz

Span: 10 MHz

RBW: 1 MHz

VBW: 3 MHz

Sweep time: Auto

Sweep data points: 1 001 or greater

Detector mode: Positive peak

Indication mode: Max hold

Find the frequency of maximum transmitted power

[Setting 2]–Measurement of average antenna power according to below settings

Center frequency: Frequency of peak power

Span: 0 Hz

RBW: 3 MHz

VBW: 3 MHz

Sweep: Minimum time required to make an accurate measurement.
For burst type (intermittent) transmission, sweep time shall be greater than one burst interval.

Sweep data points: 1 001 or greater

Detector mode: Sample

Measure the Average Burst Power of the frequency

3. After configuring the spectrum analyzer to [Setting 1], find the frequency of maximum transmitted power.
4. After configuring the spectrum analyzer to [Setting 2], measure the Average Burst Power of the frequency Found in (3)

Antenna Power (W) = Average Burst Power

5.4. Test result

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

Test Voltage (V)	Channel	Antenna Gain (dB i)	Rated Output Power		E.I.R.P. (dB m)	Average Burst Power		Power Tolerance (%)
			(mW)	(dB m)		(mW)	(dB m)	
V _{nom} = 14.4	Low Ch. (2 402 MHz)	0.19	4.000	6.02	6.21	3.382 048	5.29	-17.98
	Mid Ch. (2 442 MHz)	0.19	4.000	6.02	6.21	3.137 248	4.97	-24.33
	High Ch. (2 480 MHz)	0.19	4.000	6.02	6.21	3.015 399	4.79	-37.93

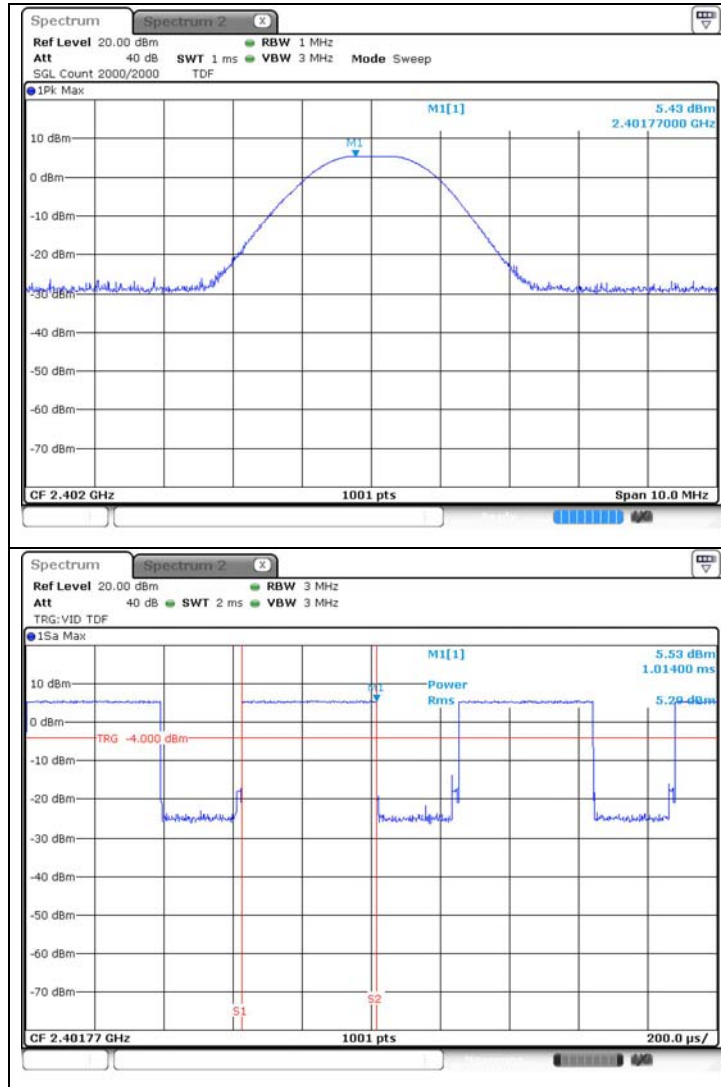
Note;

Antenna Power (mW) = Average Burst Power (mW)

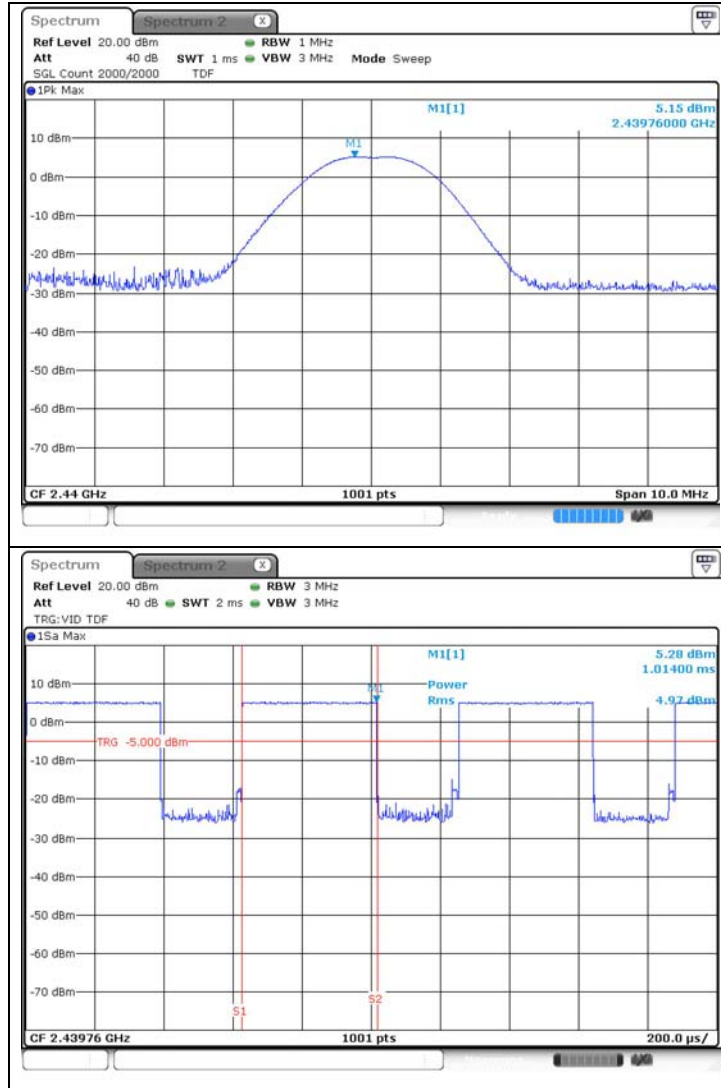
Power Tolerance (%) = {[Antenna Power (mW) - Rated Output Power (mW)] ÷ Rated Output Power (mW)} × 100

E.I.R.P. (dB m): Antenna gain (dB i) + Rated Output Power (dB m)

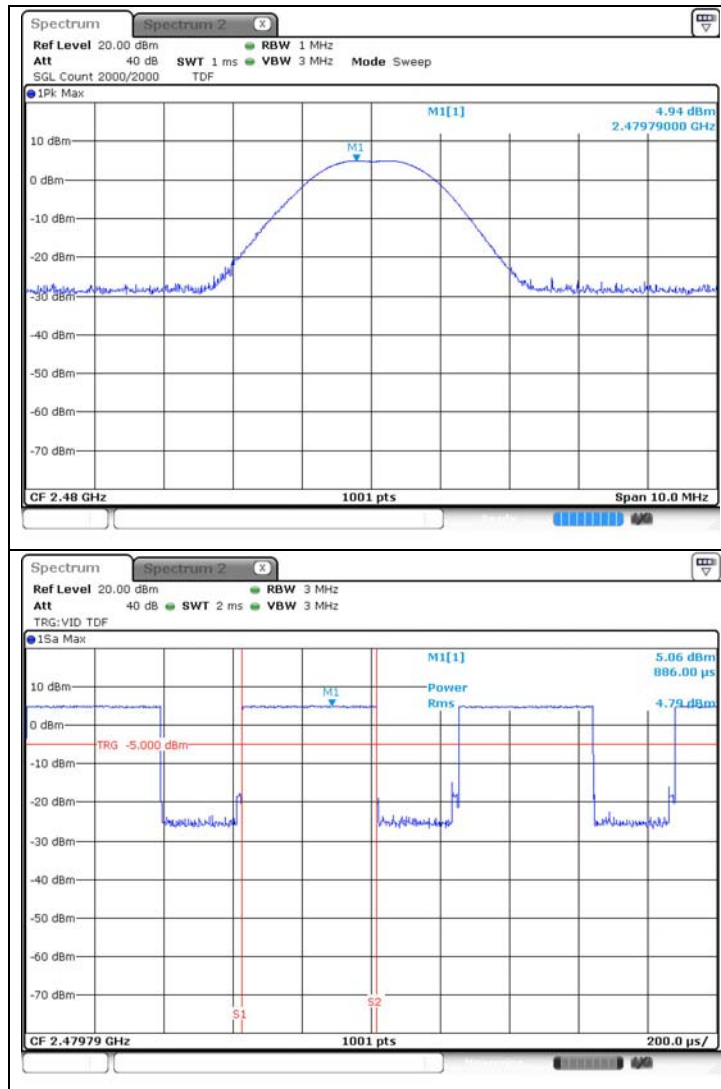
Low channel



Middle channel

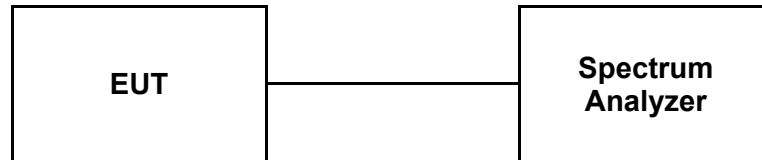


High channel



6. Secondary Radiated Emissions

6.1. Test Setup



6.2. Limit

Below 1 GHz: 4 nW (-54 dBm) or less
 Above 1 GHz: 20 nW (-47 dBm) or less

6.3. Test Procedure

1. Connect transmitter output to the spectrum analyzer input port.
2. The EUT should be receiver at low, middle and high channel.
3. Secondary Radiated Emissions is measured by following setting:

[Setting 1]

Frequency range: 30 MHz - 12.5 GHz
 RBW: Below 1 GHz: 100 kHz
 Above 1 GHz: 1 MHz
 VBW: Below 1 GHz: 100 kHz
 Above 1 GHz: 1 MHz
 Sweep time: Auto
 Sweep data points: 1 001 or greater
 Detector mode: Positive peak
 Indication mode: Max hold

[Setting 2]

Center Frequency: Frequency of spurious emission found using [Setting 1]
 Span: 0Hz
 RBW: Below 1 GHz: 100 kHz
 Above 1 GHz: 1 MHz
 VBW: Below 1 GHz: 100 kHz
 Above 1 GHz: 1 MHz
 Sweep time: Auto
 Sweep data points: 1 001 or greater
 Detector mode: Sample

4. Search for spurious emissions in the range 30 MHz to 12.5 GHz.

-
5. (1) After configuring the spectrum analyzer to [Setting 1], search for spurious emissions from 30 MHz to 12.5 GHz. If the sweep range does not cover the required measurement frequency range then the measurement range will need to be divided into sufficient sections of size [RBW x Sweep Data Points]. If spurious emissions greater than [Limit 10 dB] are found, then more detailed measurements are required, go to step (2)
- (2) Configure the spectrum analyzer using [Setting 2] and measure average signal amplitude. If the spurious emission is burst type (intermittent), then the average value shall not include signal OFF time.

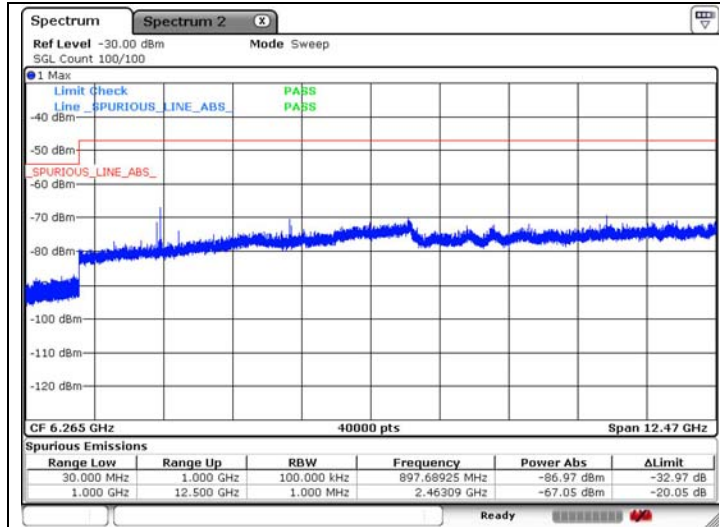
6.4. Test result

Ambient temperature : (23 ± 1) °C

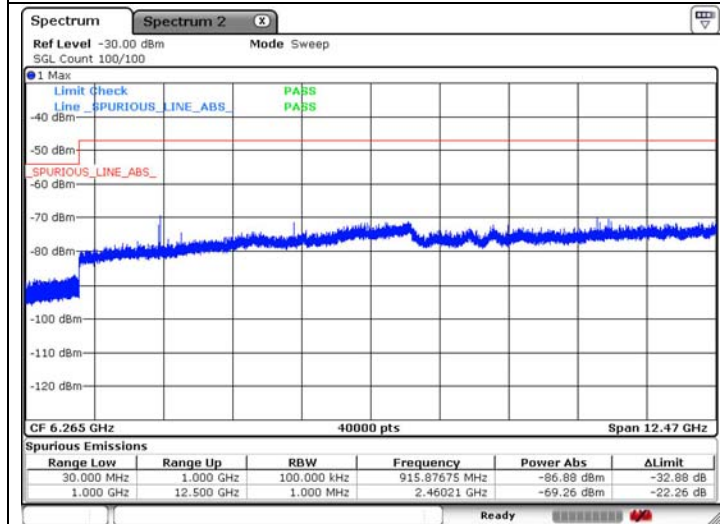
Relative humidity : 47 % R.H.

Test voltage (V _{d.c.})	Frequency Range	Measured	Low Ch. (2 402 MHz)	Middle Ch. (2 442 MHz)	High Ch. (2 480 MHz)	Limit
V _{nom} = 14.4	30 MHz to 1 000 MHz	Frequency (GHz)	0.898	0.916	0.956	-
		Level (dB m/100 kHz)	-86.97	-86.88	-86.18	-54
		Level (nW/100 kHz)	0.002 009	0.002 051	0.002 410	4
	1 000 MHz to 12 500 MHz	Frequency (GHz)	2.463	2.460	5.806	-
		Level (dB m/MHz)	-67.05	-69.26	-66.79	-47
		Level (nW/MHz)	0.197 242	0.118 577	0.209 411	20

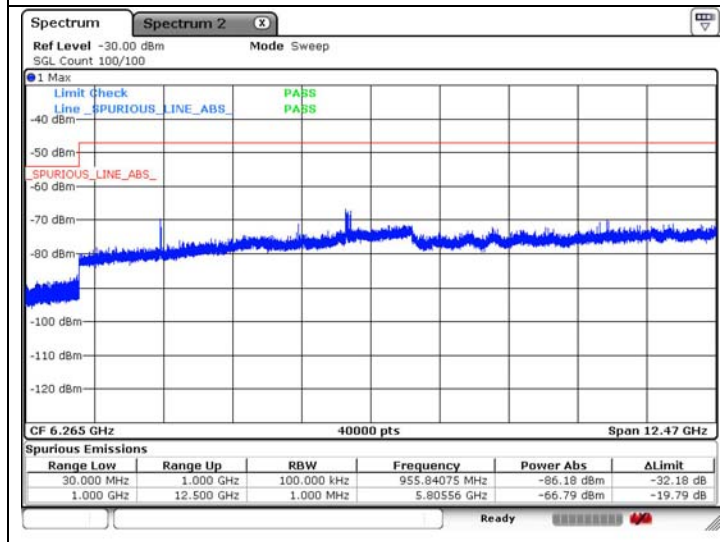
Low Channel



Middle Channel



High Channel



7. Interference Prevention Function

7.1. Test Procedure

- (1) For EUTs capable of automatically transmitting identification data
 - a. Transmit identification data from EUT to Demodulator
 - b. Confirm identification data is correctly received by Demodulator
- (2) For EUTs capable of automatically receiving identification data
 - c. Transmit identification data from Link Partner to EUT
 - d. Confirm communication link is established
 - e. Link Partner shall respond by transmitting different identification data back to the EUT
 - f. Confirm EUT stops transmitting, or confirm EUT recognizes that the two identification data are different

If the applicant has documentary evidence to show that their EUT complies with the requirements of the Interference Prevent Function then the EUT can be exempt from this test.

7.2. Test result

EUT Details :

28:0f:eb:b7:33:14

The unit does meet the requirements. (Pass)

8. Test Methodology & Conditions

8.1. Test Condition

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

Voltage Fluctuation Test	Normal Voltage	High Voltage + 10 % of Normal Voltage	Low Voltage - 10 % of Normal Voltage
EUT Input Voltage (V _{d.c.})	14.40	15.84	12.96
RF Part Output Voltage (V _{d.c.})	3.314	3.313	3.312

Voltage Variation (%) = (Output High or Low Voltage - Output Normal Voltage) / Output Normal Voltage * 100 During the input supply voltage to the EUT from the external power source is varied by +/- 10 % if output voltage had been confirmed that the fluctuation of power supply to the RF circuit of EUT (excluding power source) is equal to or less than +/- 1 %. Exempt extremely high and low supply voltage condition tests, EUT only operated in normal voltage to test all regulations.

- End of the Test Report -