

TEST REPORT

of

ARIB STD-T106

Equipment Under Test : RFID Fixed Reader
Model Name : a312
Variant Model Name : -
Applicant : Apulse Technology Co., Ltd.
Manufacturer : Apulse Technology Co., Ltd.
Date of Receipt : 2020.01.17
Date of Test(s) : 2020.11.09 ~ 2021.01.05
Date of Issue : 2021.01.05

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:


Lily Jung

Technical
Manager:


Hunchae You

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 : Apulse Technology Co., Ltd.

Address : C-1211, 60, Haan-ro, Gwangmyeong-si, Gyeonggi-do, Republic of Korea

Contact Person : Kim, Nam-Joong

Phone No. : +82 10 5526 0605

1.3. Details of manufacturer

Company : Same as applicant

Address : Same as applicant

1.4. Description of EUT

Kind of Product	RFID Fixed Reader
Model Name	a312
Power Supply	DC 12.0 V
Frequency Range	916.8 MHz, 918.0 MHz, 919.2 MHz, 920.4 MHz
Modulation Technique	ASK
Number of Channels	4 channels
Antenna Type	PCB Patch antenna
Antenna Gain	6.90 dB i

1.5. Test Equipment List

Equipment	Manufacturer	Model	Serial No.	Cal. Date	Cal. Authority	Cal. Method
Spectrum Analyzer	R&S	FSV30	103101	Jun, 01, 2020	SICT	c)
Signal Generator	R&S	SMF100A	102098	Sep. 04, 2020	SICT	c)
DC Power Supply	R&S	HMP2020	019922876	Apr. 27, 2020	SICT	c)
Attenuator	Mini-Circuits	BW-N20W5+	0950-4	Dec. 04, 2020	SICT	c)
Attenuator	MCLI	FAS-12-10	1	Jun. 07, 2020	SICT	c)
Temperature Chamber	ESPEC CORP.	PL-1J	15000793	Jun. 02, 2020	SICT	c)
Vibration tester	DAEKYUNG ENGINEERING CO., LTD.	DSVT01	DSVT01	Jan. 31, 2020	SICT	c)
BAND REJECT FILTER	WAINWRIGHT	WRCT916.8/921.3-915/923.8-50/16EE	1	Nov. 20, 2020	SICT	c)
DIGITAL MULTIMETER	HIOKI	DT4211	N0301231	Sep. 17, 2020	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. Summary of test results

The EUT has been tested according to the following specifications:

Applied standard : Radio equipment regulations and ARIB STD-T108		
Article Reference	Test item	Result
STD-T106 3.2	Radio Channel	Complied
STD-T106 3.2	Frequency Tolerance	Complied
STD-T106 3.2	Occupied Bandwidth (99 %)	Complied
STD-T106 3.2	Antenna Power	Complied
STD-T106 3.2	Spurious Emission Intensity	Complied
STD-T106 3.2	Adjacent Channel Leakage Power	Complied
STD-T106 3.2	Secondary Radiated Emissions	Complied

1.7. Test report revision

Revision	Report number	Date of Issue	Description
0	F690501-RF-RTL001548	2021.01.05	Initial

1.8. Test method

Measurement was conducted by the temporary test method which DSP Research, Inc submitted to the Minister for Internal Affairs and Communications based on the Ordinance Concerning Technical Regulations Conformity Certification etc. of Specified Radio Equipment in Annex 1, the Ministry of Internal Affairs and Communication notification in Article 88, Paragraph 2

1.9. General information

- This test equipment operates only with SISO (Single Input Single Output).
This test equipment has 4 antenna terminals and uses a single amplifier, so after comparing the output of each terminal, test with worst output terminal (ANT1).

2. Radio Channel

2.1. Technical requirements for radio equipment

A radio channel shall consist of up to three consecutive unit radio channels which are defined that their center frequencies are located from 916.8 MHz to 920.8 MHz, and 916.8 MHz, 918.0 MHz, 919.2 MHz, 920.4 MHz or 920.4 MHz with $(n \times 200)$ kHz separation where n is an integer and their bandwidth are 200 kHz.
 The center frequencies of radio channels are shown through Table 3-1 to Table 3-4.

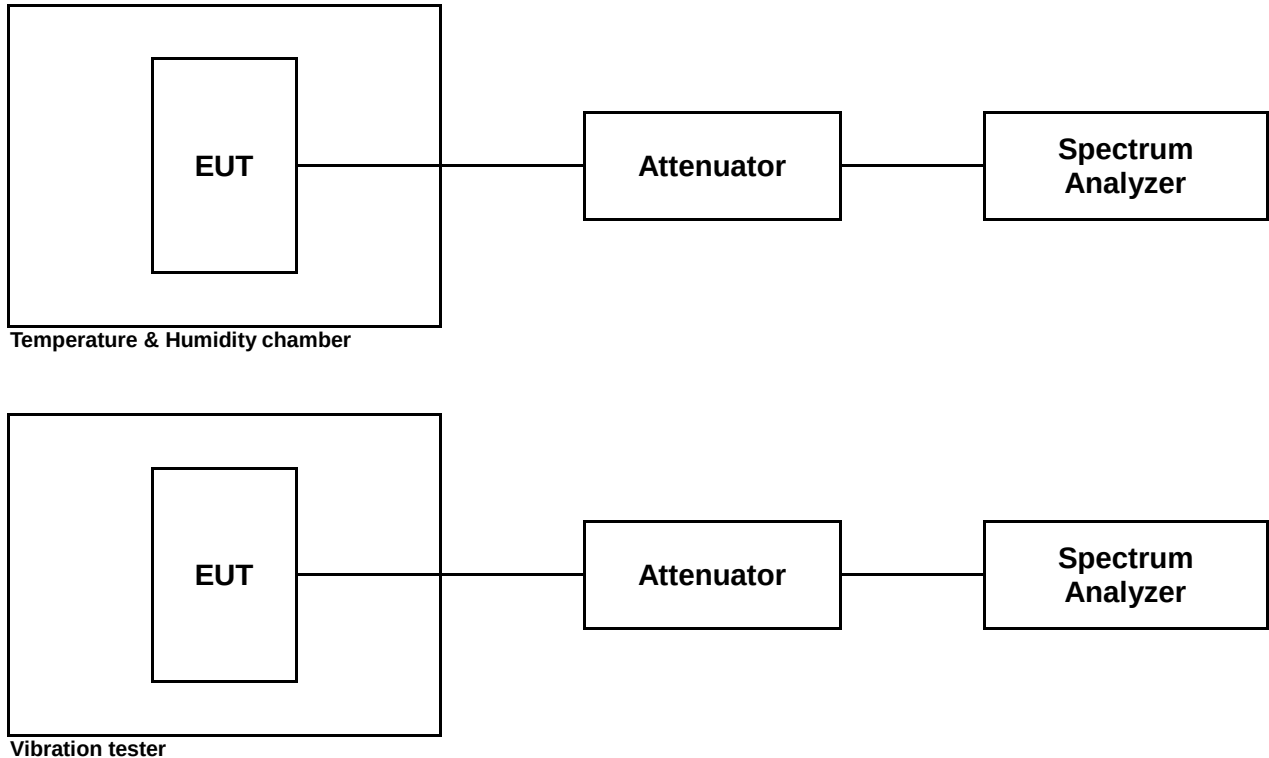
The case of using two unit radio channels

Table 3-1 Center frequency of radio channel using one unit radio channel
 (Interrogator using transmission time control and carrier sense)

Unit radio channel number	Center frequency (MHz)	Unit radio channel number	Center frequency (MHz)
<u>5</u>	<u>916.8</u>	<u>23</u>	<u>920.4</u>
<u>11</u>	<u>918.0</u>	24	920.6
<u>17</u>	<u>919.2</u>	25	920.8

3. Frequency Tolerance

3.1. Test Setup



3.2. Limit

$\pm 20 \times 10^{-6}$ or less

3.3. Test procedure

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

Center Frequency:	Test frequency
Span:	500 kHz
RBW:	3 kHz
VBW:	3 kHz
Sweep time:	Auto
Detector mode:	Positive peak
Indication mode:	Max hold
4. Find the peak carrier signal and measure its frequency

3.4. Test result

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

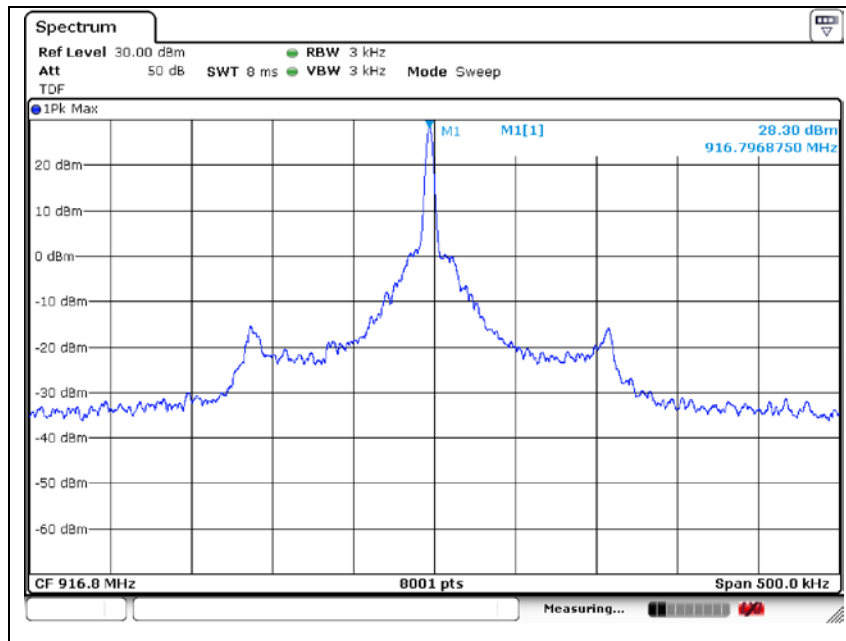
Test voltage (V _{d.c.})	Measured frequency (MHz)	Unit	Normal test	Temperature test (High : 50°C)	Temperature test (Low : -20°C)	Humidity test (35°C, 95%)
V _{nor} = 12.0	Low Ch. (916.8)	MHz	916.796 875	916.796 875	916.799 625	916.797 063
		ppm	-3.41	-3.41	-0.41	-3.20
	Middle Ch. (919.2)	MHz	919.196 875	919.197 063	919.199 813	919.196 875
		ppm	-3.40	-3.20	-0.20	-3.40
	High Ch. (920.4)	MHz	920.397 063	920.397 063	920.399 813	920.397 063
		ppm	-3.19	-3.19	-0.20	-3.19
Test voltage (V _{d.c.})	Measured frequency (MHz)	Unit	Vibration test			
V _{nor} = 12.0	Low Ch. (916.8)	MHz	916.797 063			
		ppm	-3.20			
	Middle Ch. (919.2)	MHz	919.193 875			
		ppm	-6.66			
	High Ch. (920.4)	MHz	920.396 875			
		ppm	-3.40			

Note;

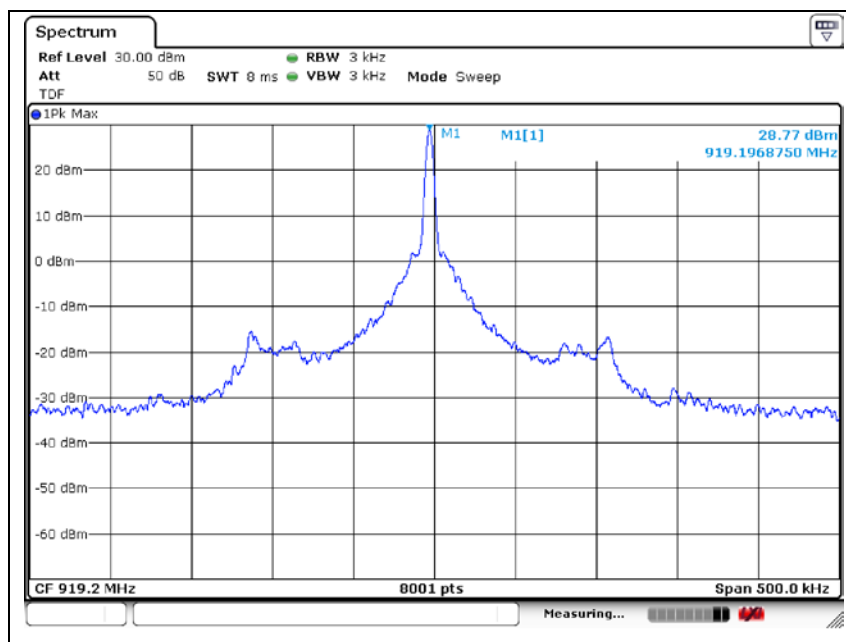
1. FT (ppm) = [(RF-MF)/MF] × 10⁶
 - FT: Frequency Tolerance, RF: Reading Frequency and MF: Measurement Frequency

Normal test

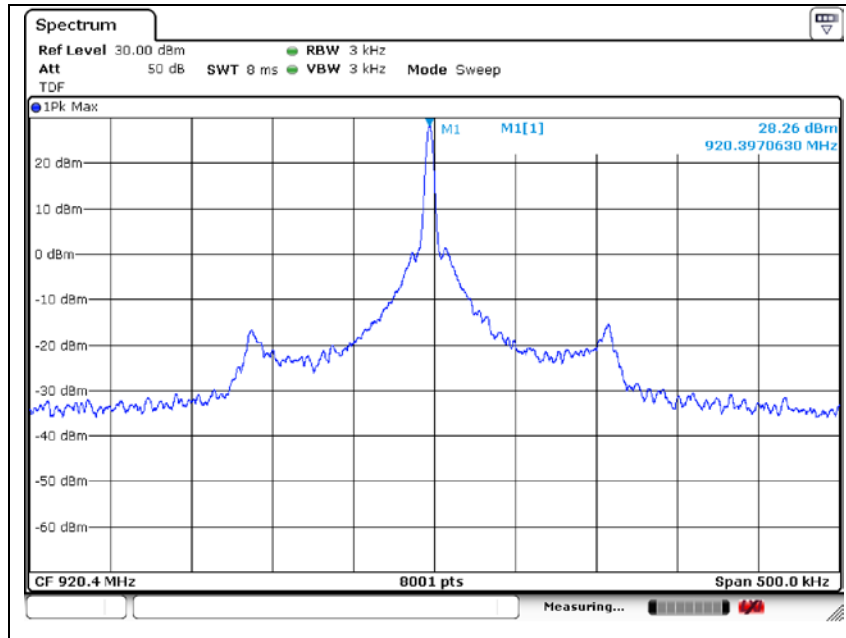
Low channel



Middle channel

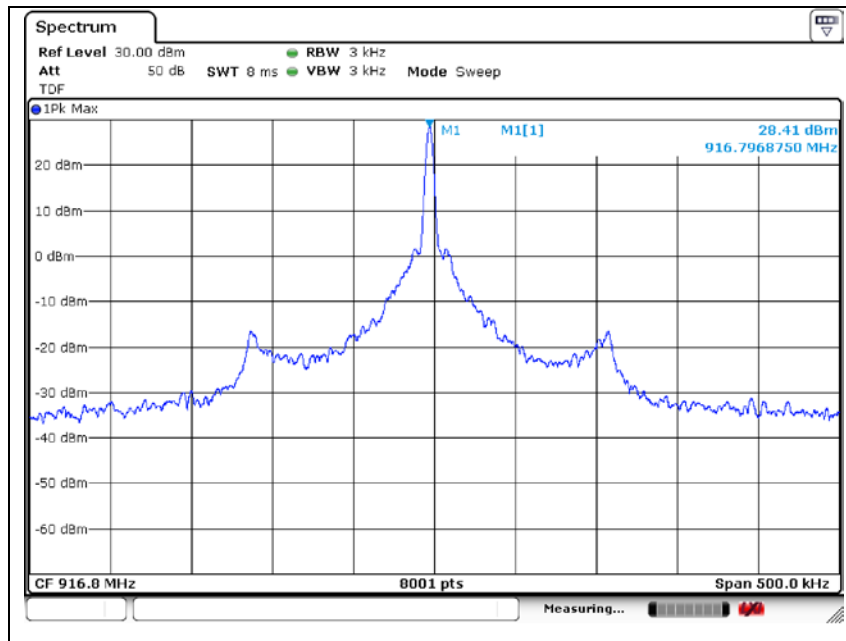


High channel

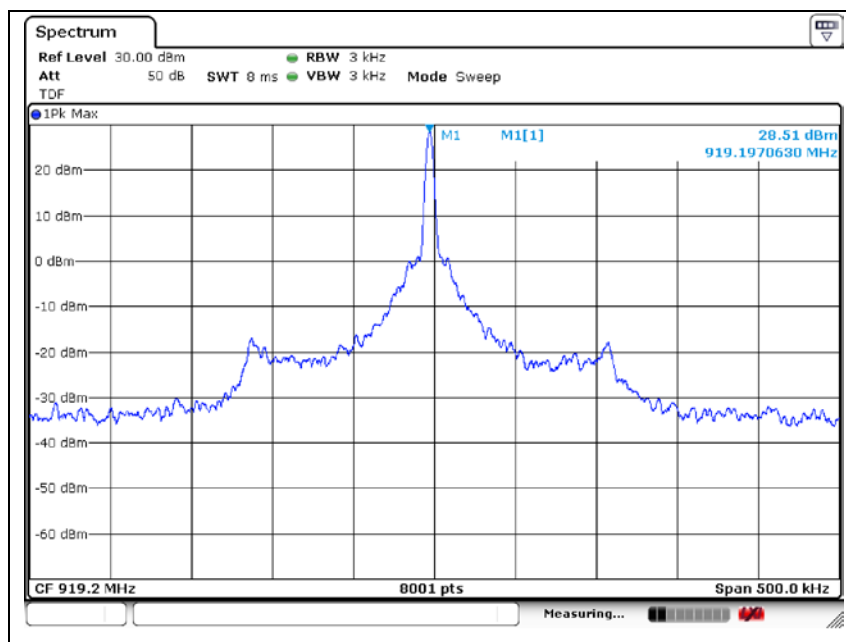


High temperature test

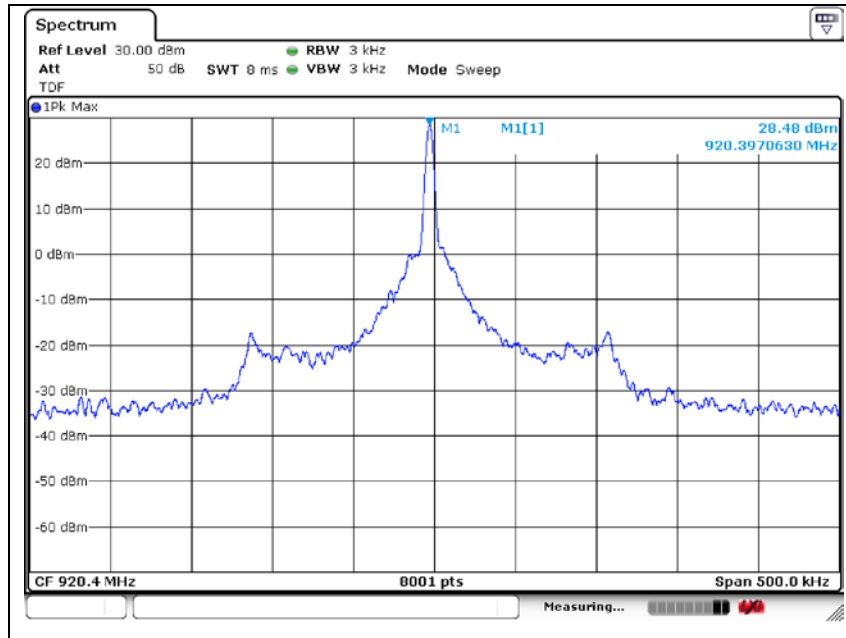
Low channel



Middle channel

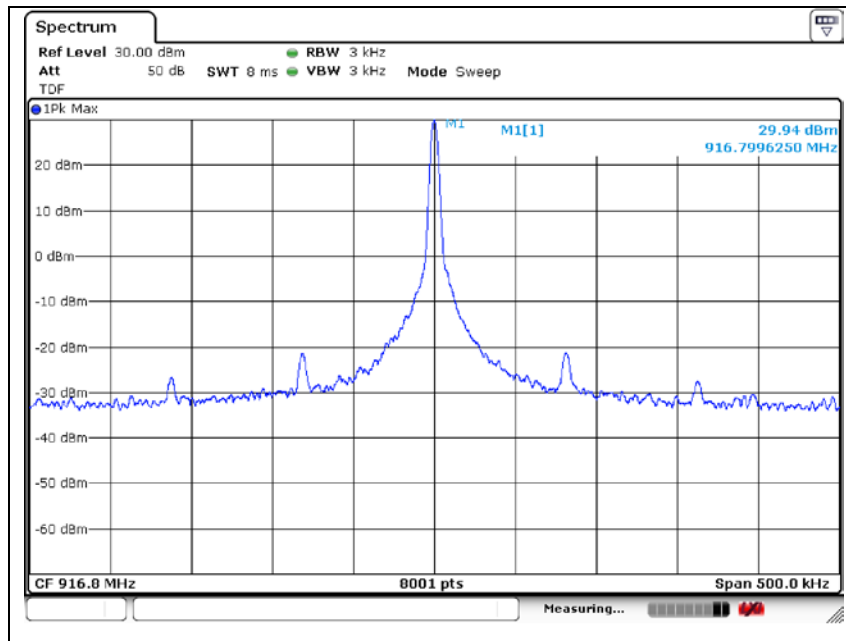


High channel

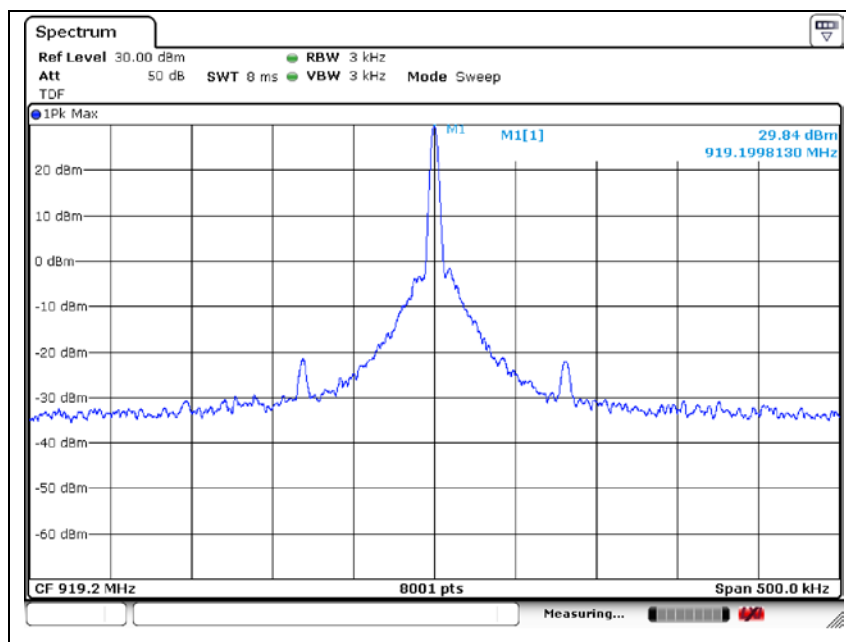


Low temperature test

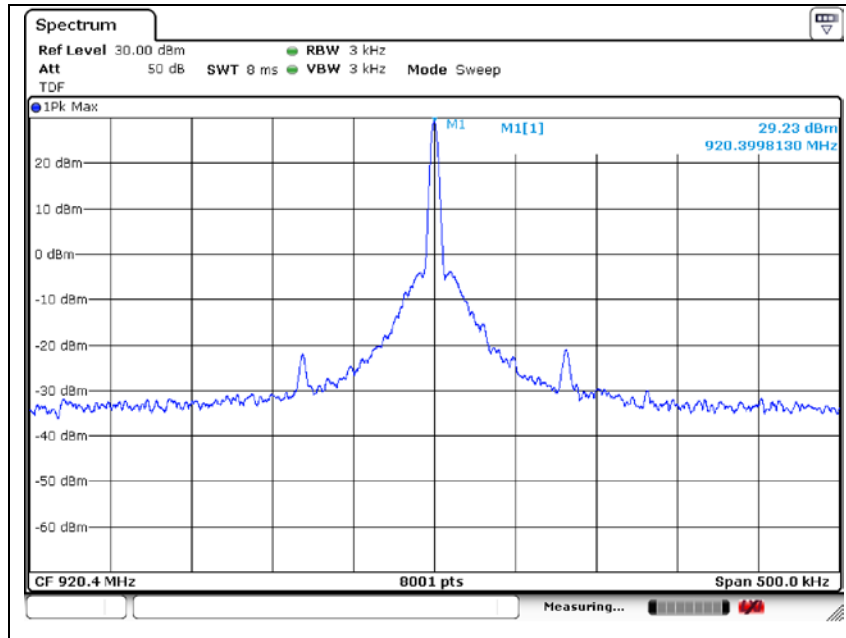
Low channel



Middle channel

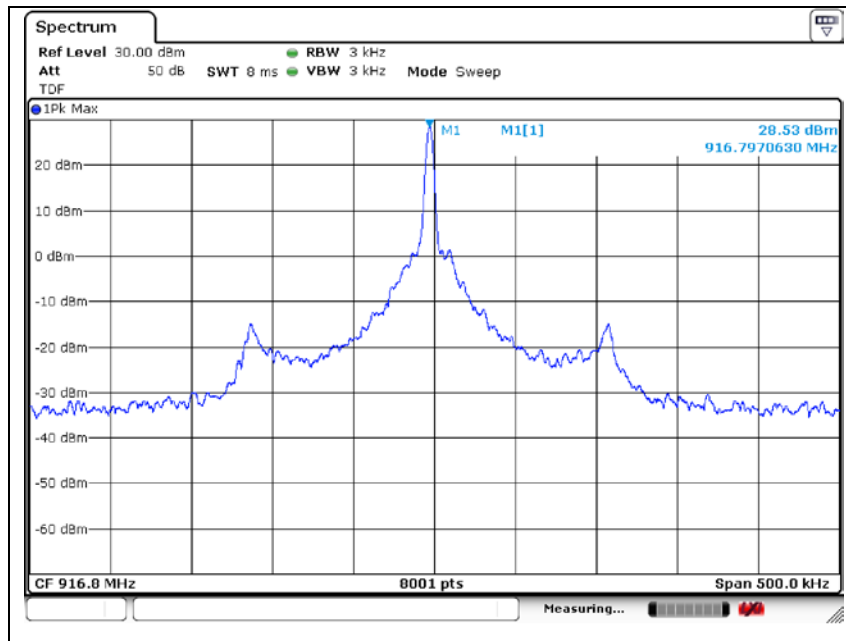


High channel

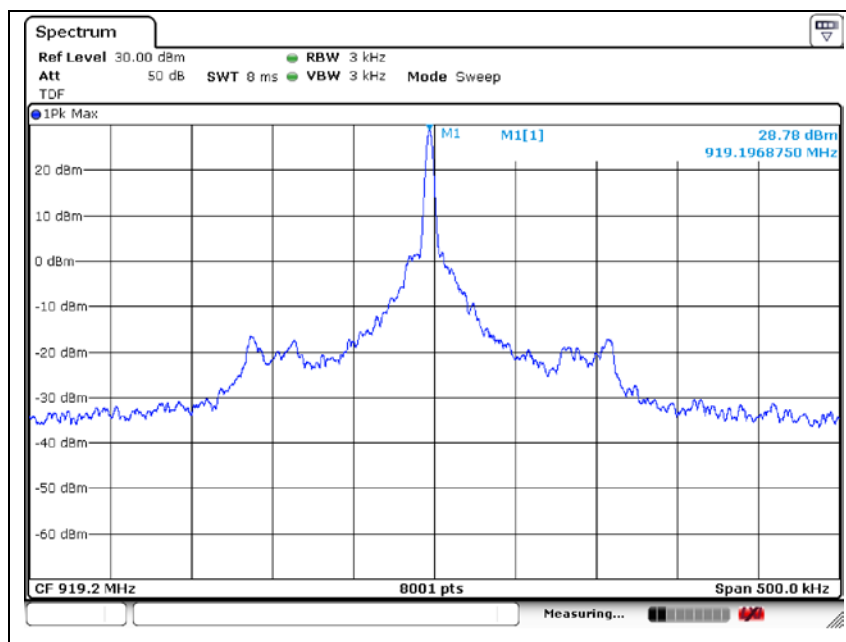


Humidity test

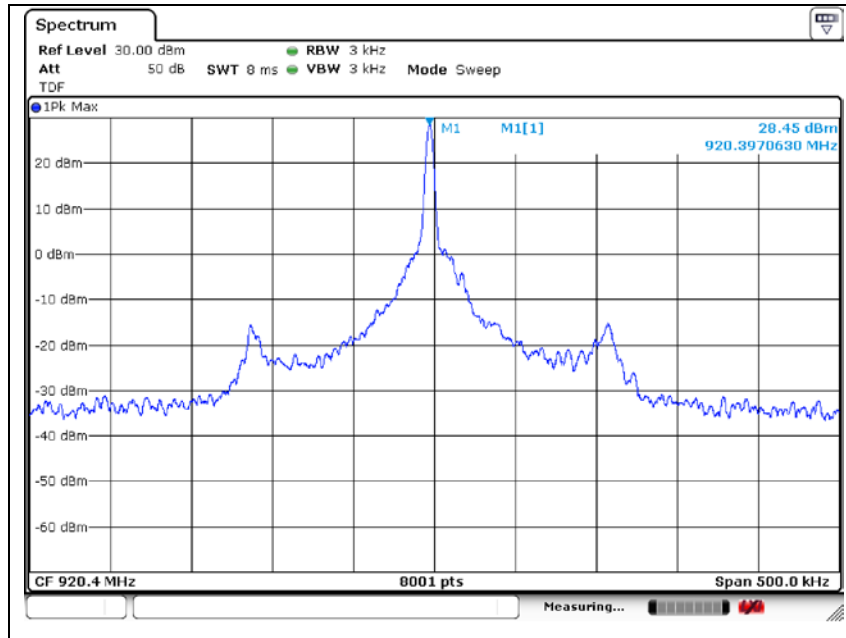
Low channel



Middle channel

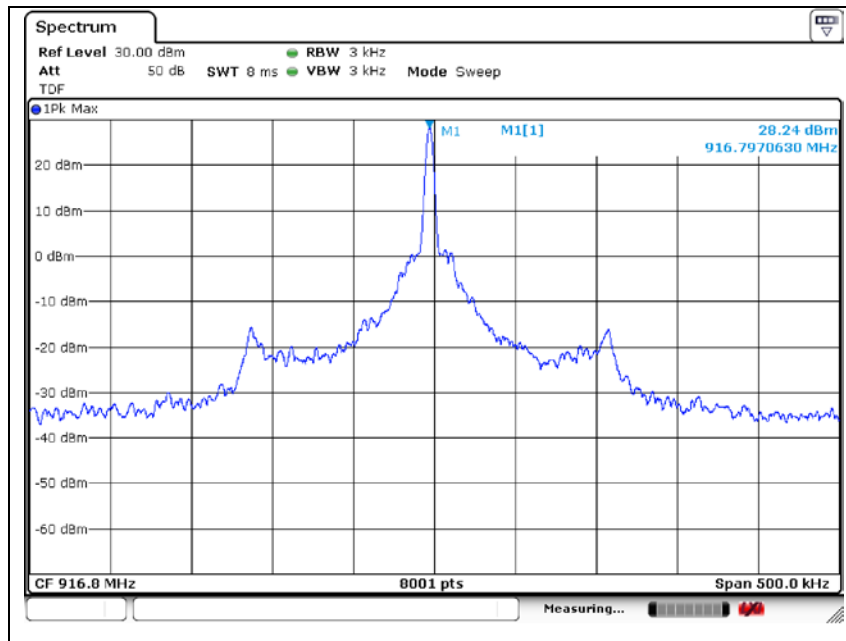


High channel

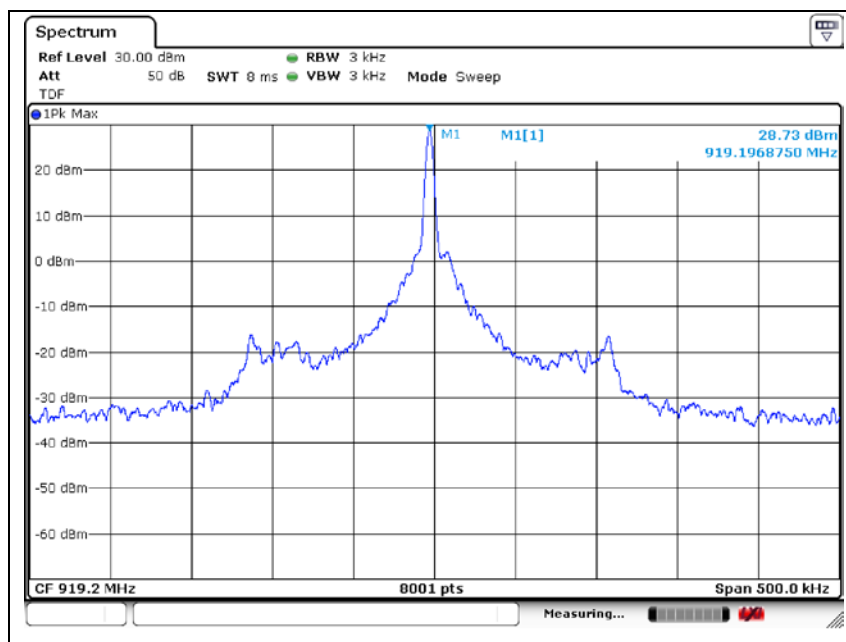


Vibration test

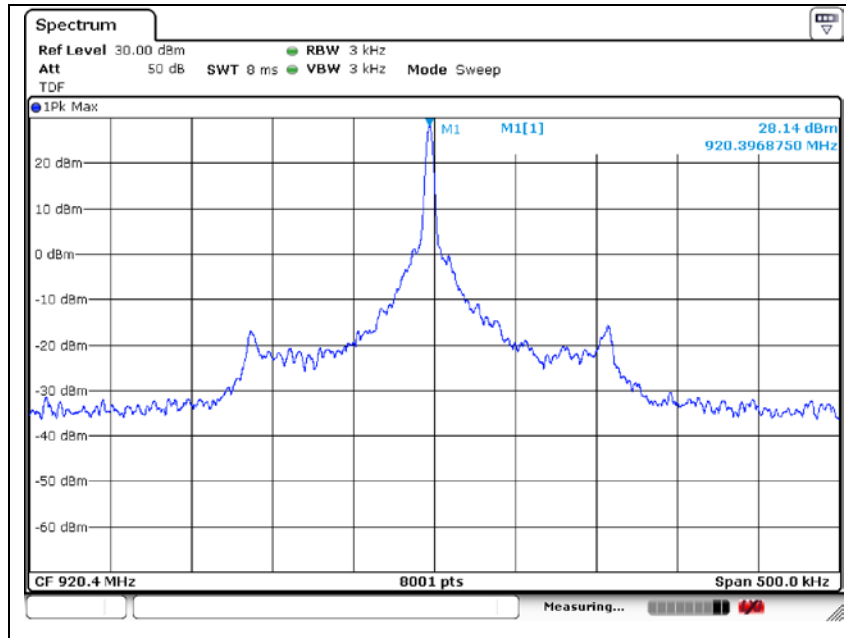
Low channel



Middle channel



High channel



4. Occupied Bandwidth (99 %)

4.1. Test Setup



4.2. Limit

200 kHz or less

4.3. Test Procedure

1. Connect transmitter output to the spectrum analyzer input port.
2. Occupied Bandwidth and spread bandwidth is measured by following setting:
 Use OBW capability of spectrum analyzer

Center Frequency:	Carrier frequency
Span:	2 – 3.5 times the technical standard
RBW:	About 1 % of the technical standard
VBW:	Same as RBW
Sweep time:	Minimum time required to make an accurate measurement.
Sweep data points:	400 or greater
Detector mode:	Positive Peak
Indication mode:	Max hold

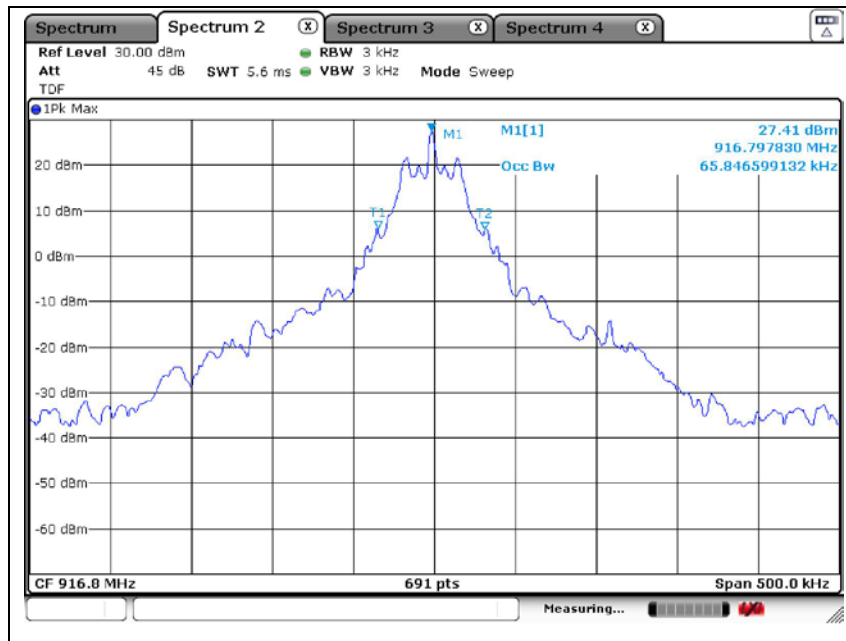
4.4. Test result

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

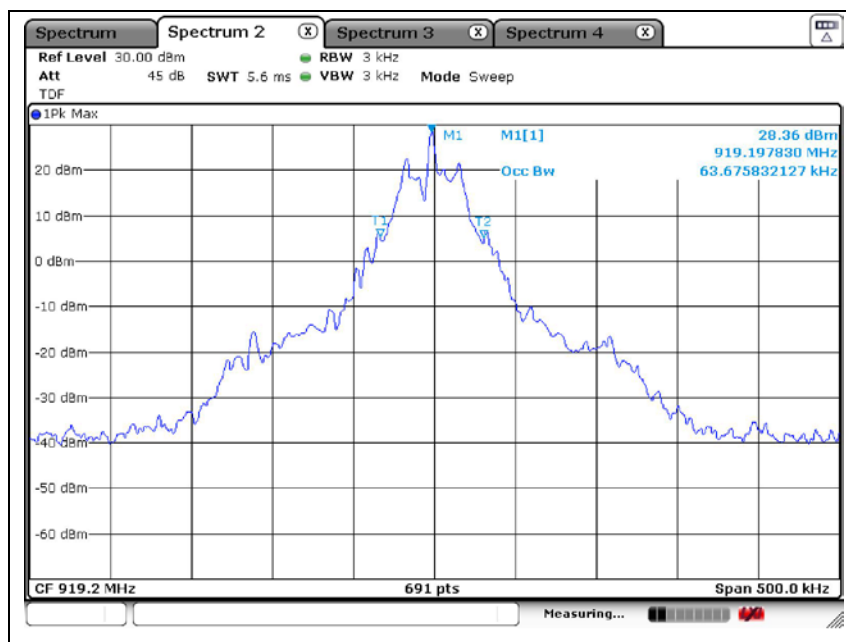
Test voltage (V _{d.c.})	Measured frequency (MHz)	Occupied bandwidth (kHz)
V _{nor} = 12.0	Low Ch. (916.8)	65.85
	Middle Ch. (919.2)	63.68
	High Ch. (920.4)	65.12

Normal voltage

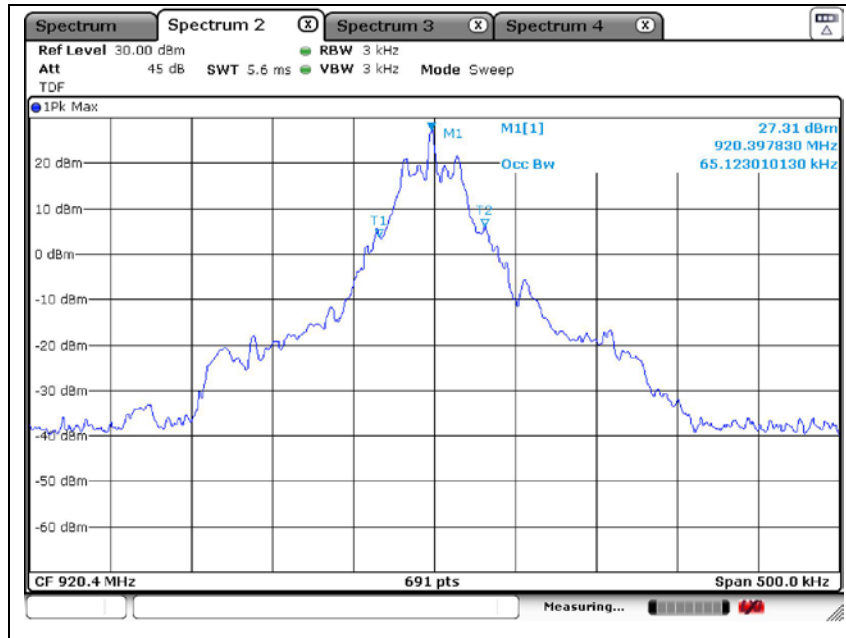
Low channel



Middle channel

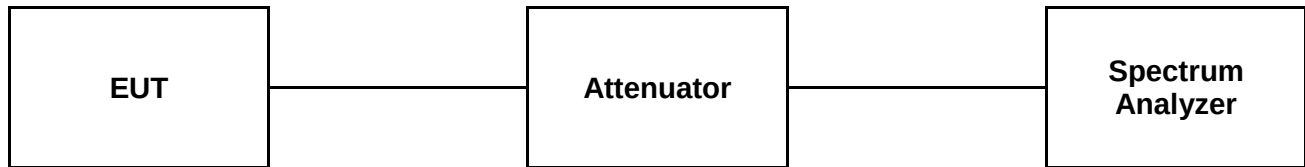


High channel



5. Antenna Power

5.1. Test setup



5.2. Limit

- Antenna power
812.83 mW or less
- Tolerance for antenna power
+20 %, -80 %
- Peak Antenna Gain
6 dB i or less

5.3. Test procedure

1. Connect transmitter output to the spectrum analyzer input port.
2. Antenna power is measured by following setting:

[Setting 1] - Setting for Peak power

-Search for peak power frequency	
Center Frequency:	Carrier frequency
Span:	Approximately 2-3.5 times the occupied bandwidth
RBW:	1 MHz
VBW:	Approximately three times or more than the RBW
Sweep data points:	400 or greater
Sweep time:	Minimum time required to make an accurate measurement. (see Note1) For burst type (intermittent) spurious emissions, sweep time shall be greater than one burst interval
Detector mode:	Positive peak
Indication mode:	Max hold

[Setting 2] – Setting for Average power

-Search for peak power frequency	
Center Frequency:	Carrier frequency
Span:	0 Hz
RBW:	1 MHz
VBW:	Approximately three times or more than the RBW
Sweep data points:	400 or greater
Sweep time:	Minimum time required to make an accurate measurement. (see Note1) For burst type (intermittent) spurious emissions, sweep time shall be greater than one burst interval
Detector mode:	Sample

5.4. Test result

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

Test voltage (V _{d.c.})	Channel	Antenna gain (dB i)	Rated Output Power		Peak Output Power		Power Tolerance (%)
V _{nom} = 12.0	Low Ch. (916.8 MHz)	6.90	650.00 mW	28.13 dB m	562.34 mW	27.50 dB m	-13.49
	Middle Ch. (919.2 MHz)	6.90	650.00 mW	28.13 dB m	706.32 mW	28.49 dB m	8.66
	High Ch. (920.4 MHz)	6.90	650.00 mW	28.13 dB m	558.47 mW	27.47 dB m	-14.08

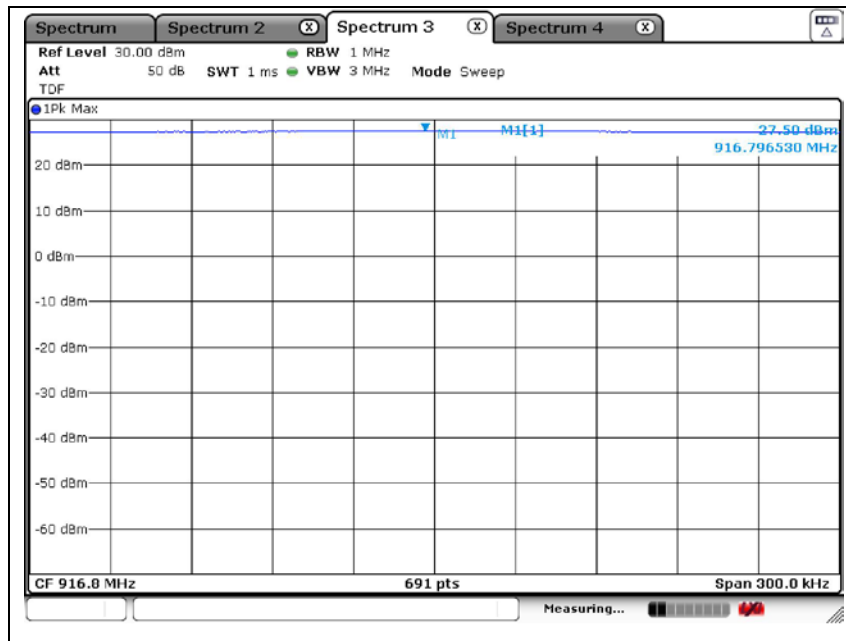
Note;

Antenna Power (mW) = Peak Output Power (mW)

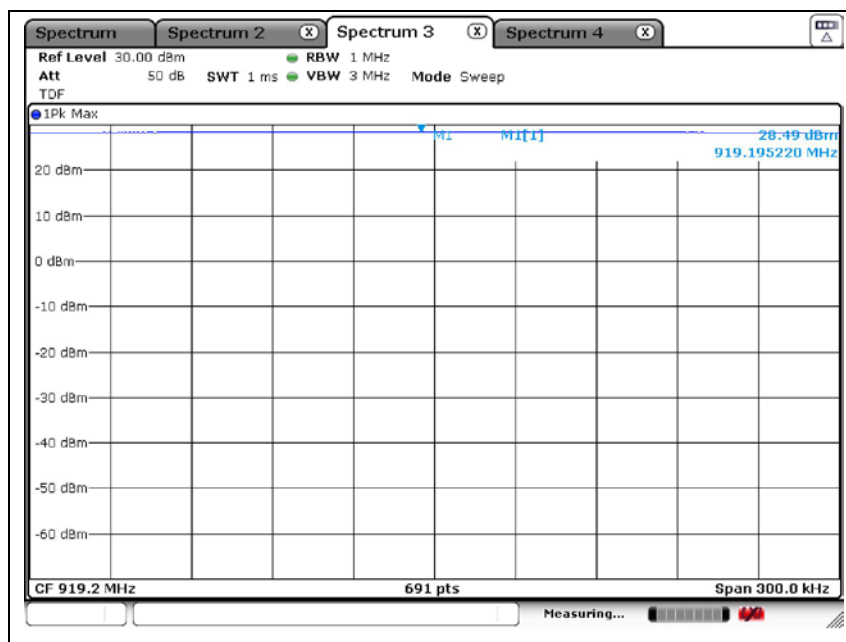
Power Tolerance (%) = {[Antenna Power (mW) - Rated Output Power (mW)] ÷ Rated Output Power (mW)} × 100

Normal voltage

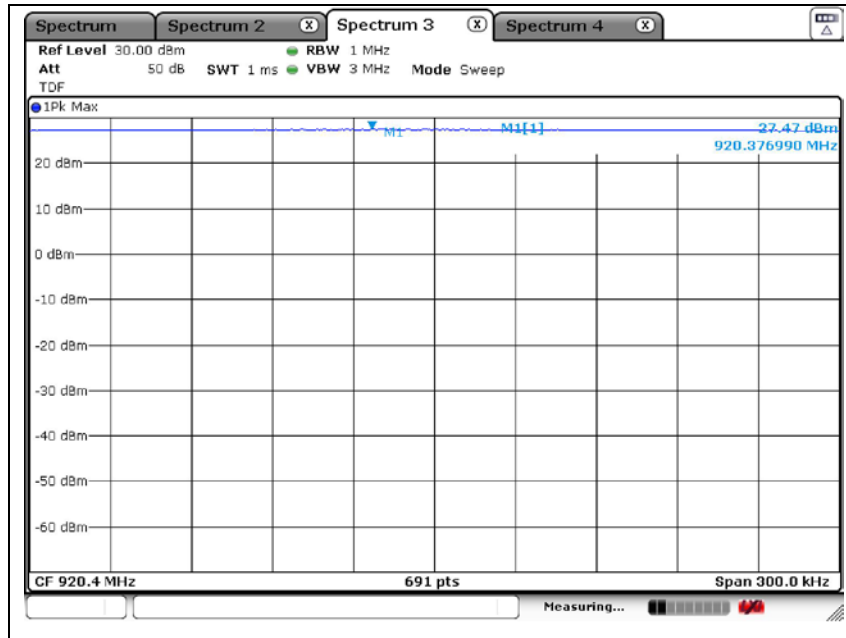
Low channel



Middle channel

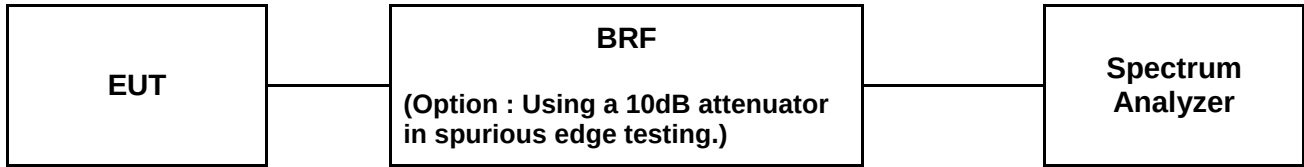


High channel



6. Spurious Emission Intensity

6.1. Test Setup



6.2. Limit

Frequency band	Permissible Value for Spurious Emission / Unwanted Emission Intensity (average power)	Reference bandwidth
$f \leq 710 \text{ MHz}$	- 36 dB m	100 kHz
$710 \text{ MHz} < f \leq 900 \text{ MHz}$	- 58 dB m	1 MHz
$900 \text{ MHz} < f \leq 915 \text{ MHz}$	- 58 dB m	100 kHz
$915 \text{ MHz} < f \leq 915.7 \text{ MHz}$ $923.5 \text{ MHz} < f \leq 930 \text{ MHz}$	- 39 dB m	100 kHz
$915.7 \text{ MHz} < f \leq 923.5 \text{ MHz}$ (except for $ f-f_c \leq 100x(n+1) \text{ kHz}$)	- 29 dB m	100 kHz
$930 \text{ MHz} < f \leq 1000 \text{ MHz}$	- 58 dB m	100 kHz
$1000 \text{ MHz} < f \leq 1215 \text{ MHz}$	- 48 dB m	1 MHz
$1.215 \text{ GHz} < f$	- 30 dB m	1 MHz

(Note: n is the number of unit channels used simultaneously in a radio channel.)

6.3. Test Procedure

1. Connect transmitter output to the spectrum analyzer input port.
2. The EUT should be transmitting at low, middle and high channel.
3. Spurious Emission Intensity is measured by following setting

[Setting 1]

Setting for except near Carrier frequency (See Note 2)

Span and RBW :

Span	RBW
30 to 710 MHz or less	100 kHz
710 to 900 MHz or less	1 MHz
900 to 915 MHz or less	100 kHz
930 to 1,000 MHz or less	100 kHz
1,000 to 1,215 MHz or less	1 MHz
1,215 to 5 GHz or less	1 MHz

VBW : Same as RBW

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

Sweep Data Points : 400 or greater

Note 2: Near Carrier frequency is 915 MHz ~ 930 MHz

[Setting 2]

Setting for near Carrier frequency

Span : 915 MHz ~ 930 MHz (see Note6)

RBW : 3 kHz

VBW : Same as RBW

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

Sweep Data Points : 400 or greater

Detector mode : Positive peak

Note 6: Except within 100(n+1) from center frequency

(1) After configuring the spectrum analyzer to [Setting 1], search for spurious emission except near carrier frequency (Note 2)

(2) If spurious emissions satisfy the regulation, measured value is result value.

(3) Configure the spectrum analyzer to [Setting 2], search for spurious emissions

(4) Calculate the spurious emission value (Calculated Value) using following the formula below:

$$\text{Calculated Value} = (\text{Measured Value using (3)} + 15.2 \text{ dB})$$

Note 10: 15.2 dB adjustment is derived from the Conversion Factor of RBW

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

Where: Reference Bandwidth = 1 MHz

RBW of measurement = 30 kHz

6.4. Test result

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

Test voltage (V _{d.c.})	Frequency Range		Low Ch. (916.8 MHz)	Middle Ch. (919.2 MHz)	High Ch. (920.4 MHz)	Limit
V _{nor} = 12.0	30 MHz to 710 MHz	Frequency (MHz)	245.020	257.810	175.150	-
		Level (dB m)	-61.56	-64.26	-61.38	-36
	710 MHz to 900 MHz	Frequency (MHz)	793.180	892.990	792.630	-
		Level (dB m)	-62.01	-62.85	-62.11	-58
	900 MHz to 915 MHz	Frequency (MHz)	914.989	914.815	911.907	-
		Level (dB m)	-61.04	-63.38	-60.25	-58
	915 MHz to 915.7 MHz	Frequency (MHz)	915.676	915.679	915.374	-
		Level (dB m)	-46.40	-51.53	-42.55	-39
	915.7 MHz to 923.5 MHz	Frequency (MHz)	916.399	918.998	920.008	-
		Level (dB m)	-43.22	-45.05	-41.81	-29
	923.5 MHz to 930 MHz	Frequency (MHz)	929.647	925.038	923.900	-
		Level (dB m)	-56.38	-55.40	-55.45	-39
	930 MHz to 1 000 MHz	Frequency (MHz)	960.040	960.040	960.040	-
		Level (dB m)	-65.84	-66.09	-66.23	-58
	1 000 MHz to 1 215 MHz	Frequency (MHz)	1 009.180	1 009.49	1 009.180	-
		Level (dB m)	-64.38	-67.15	-65.49	-48
	1 215 MHz to 5 000 MHz	Frequency (MHz)	2 751.50	2 756.90	2 762.40	-
		Level (dB m)	-42.16	-42.20	-40.82	-30

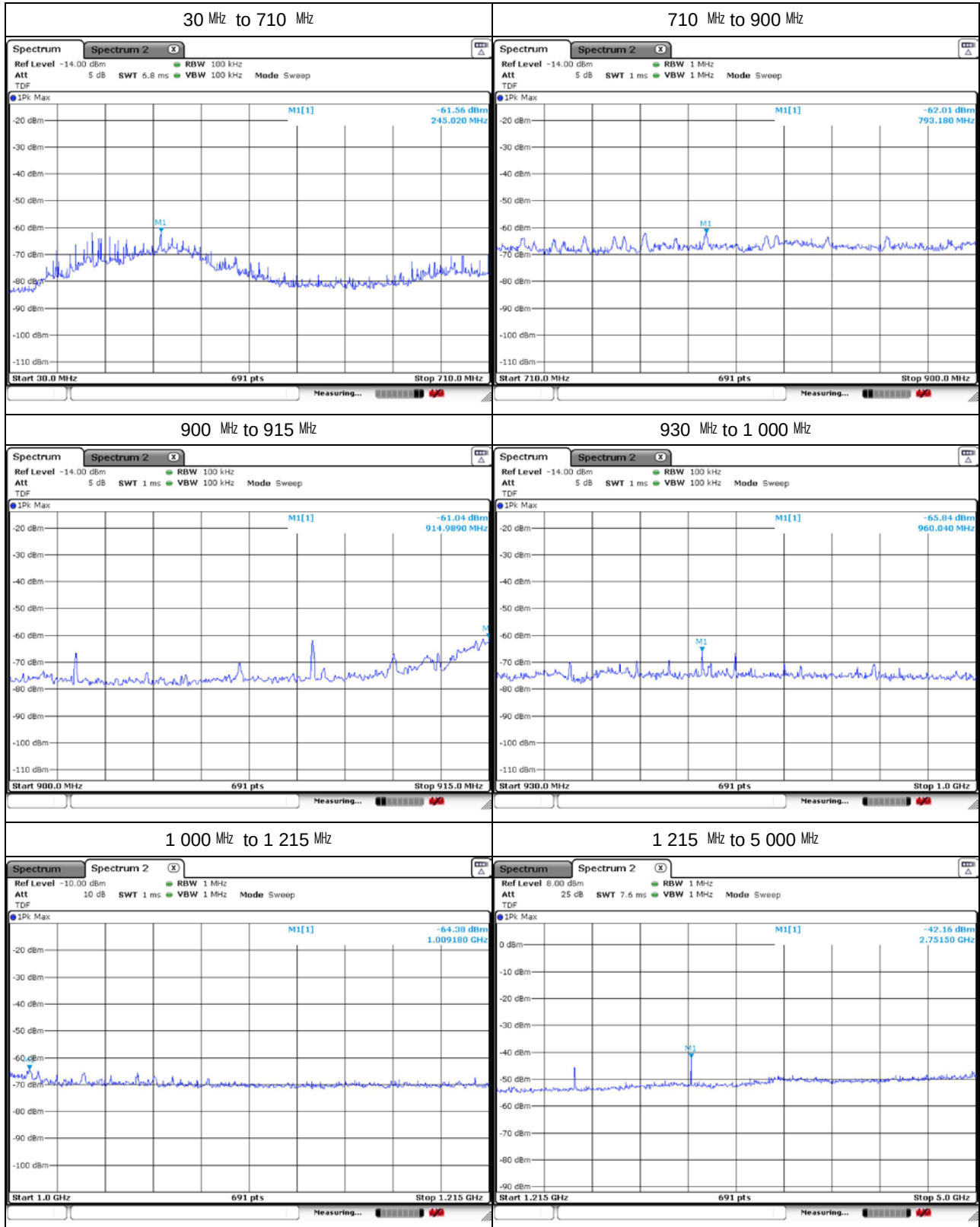
Note;

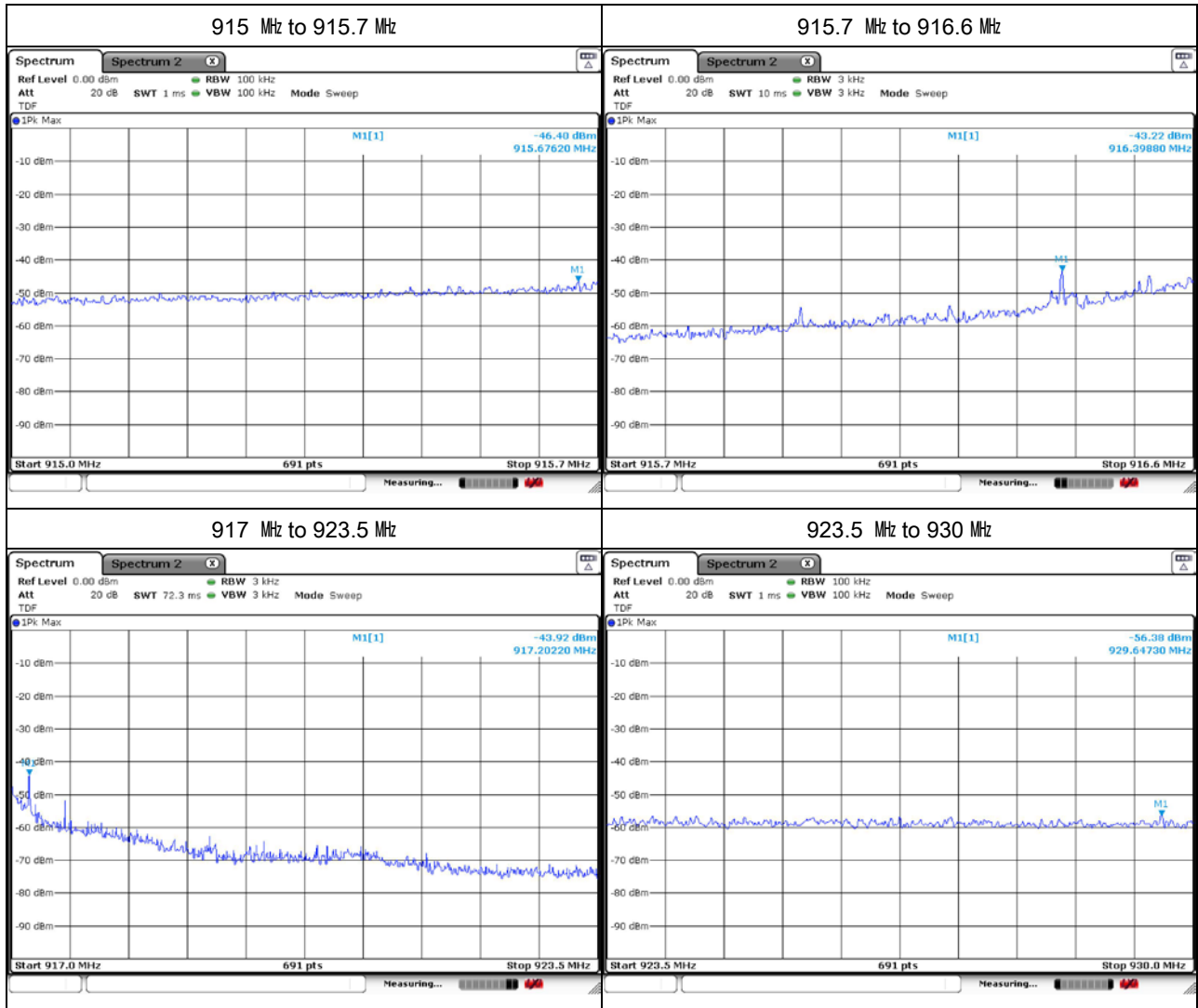
The levels within 915.7 MHz to 923.5 MHz is final results investigated by Resolution Bandwidth 3 kHz and considered by conversion factor of RBW.

Conversion factor: $10\log(100 \text{ kHz}/3 \text{ kHz})=15.2 \text{ dB}$

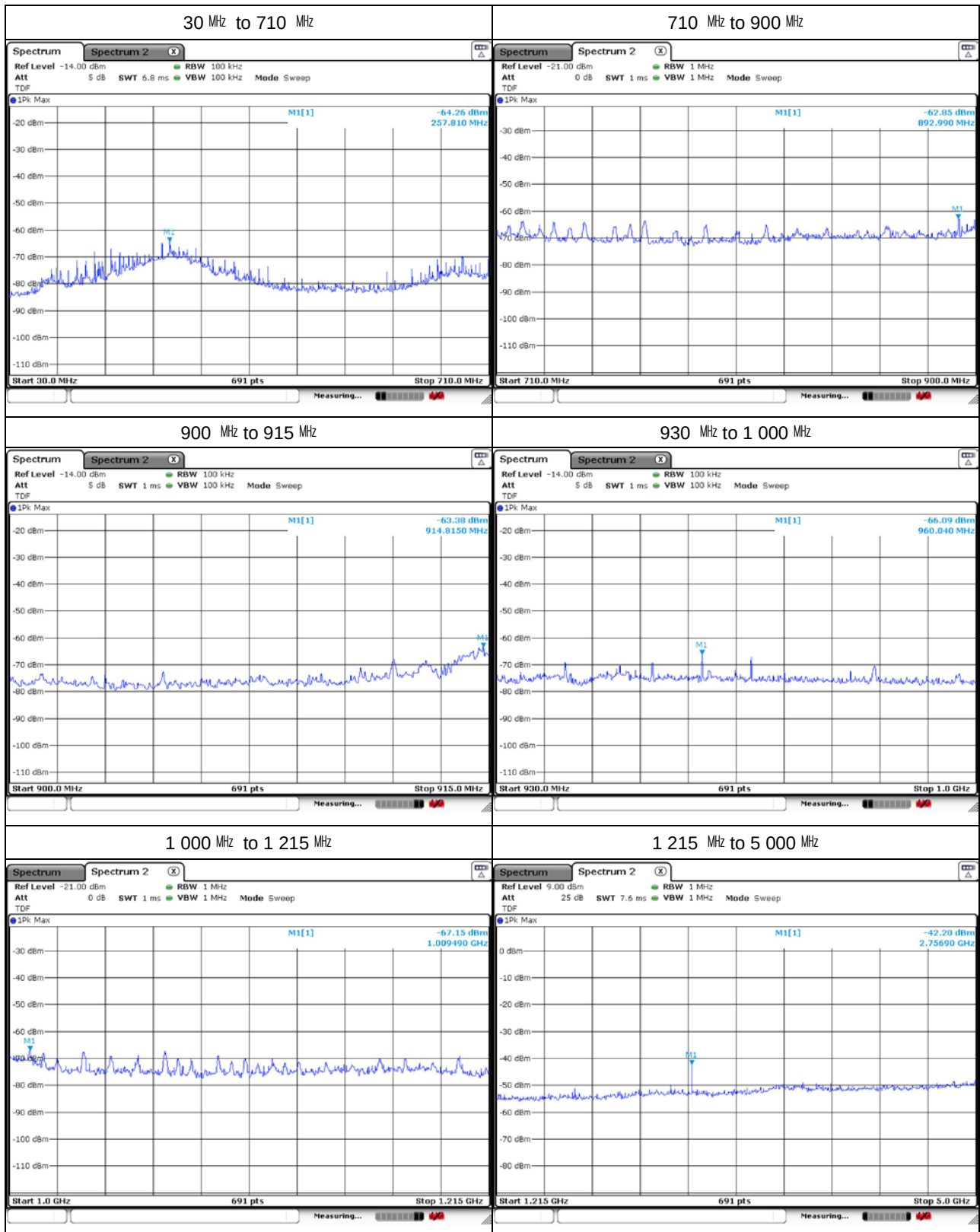
Normal voltage

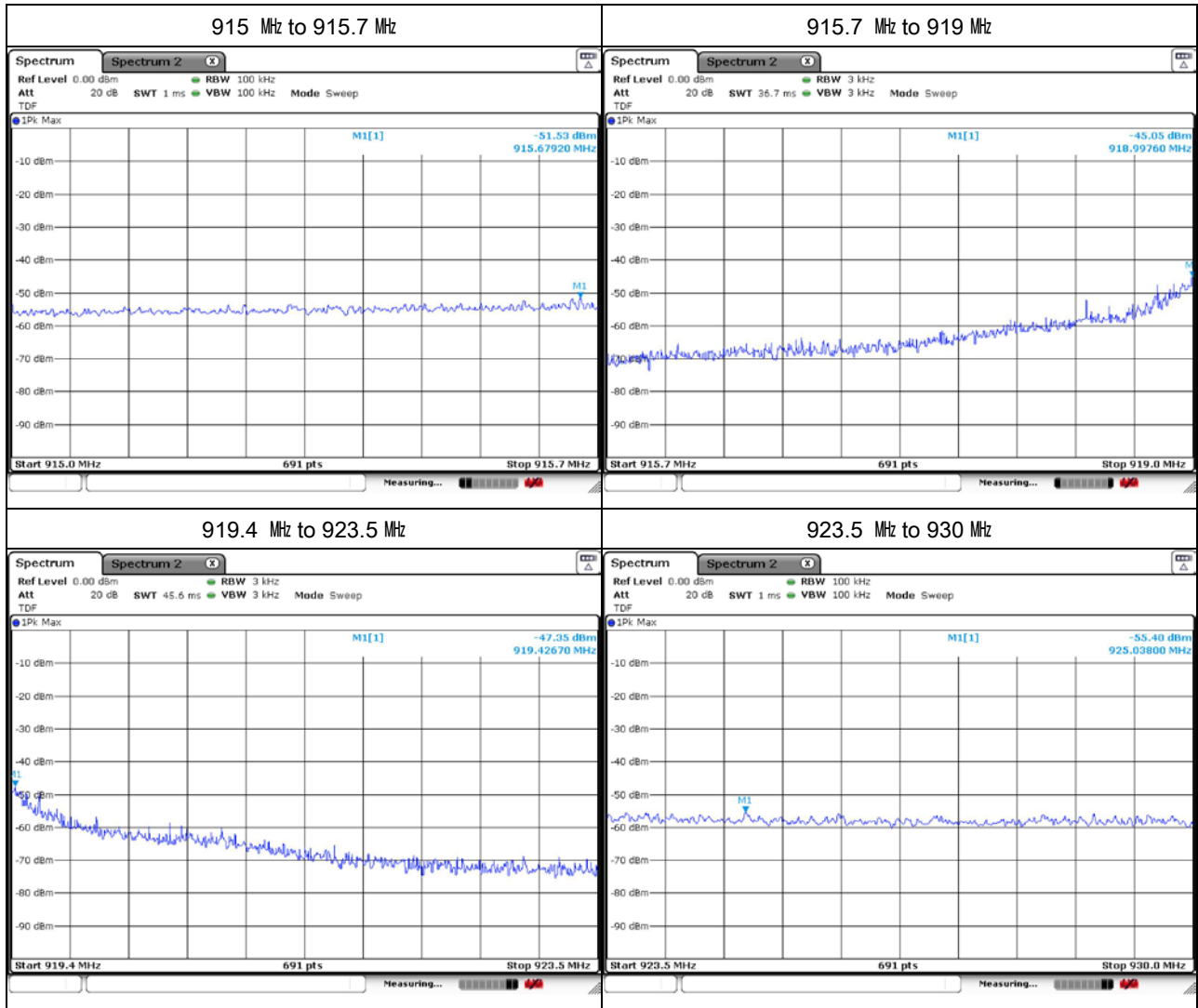
Low channel



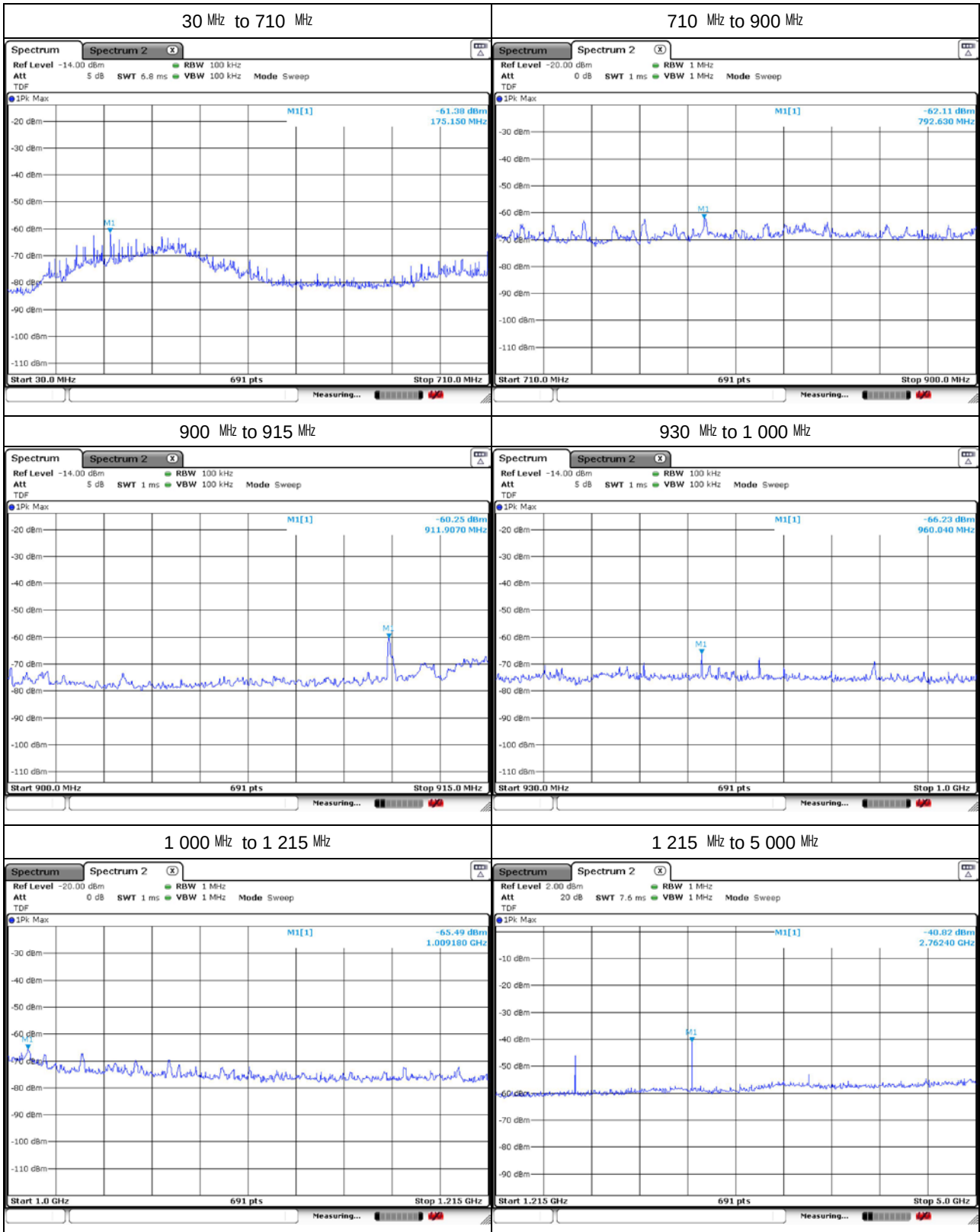


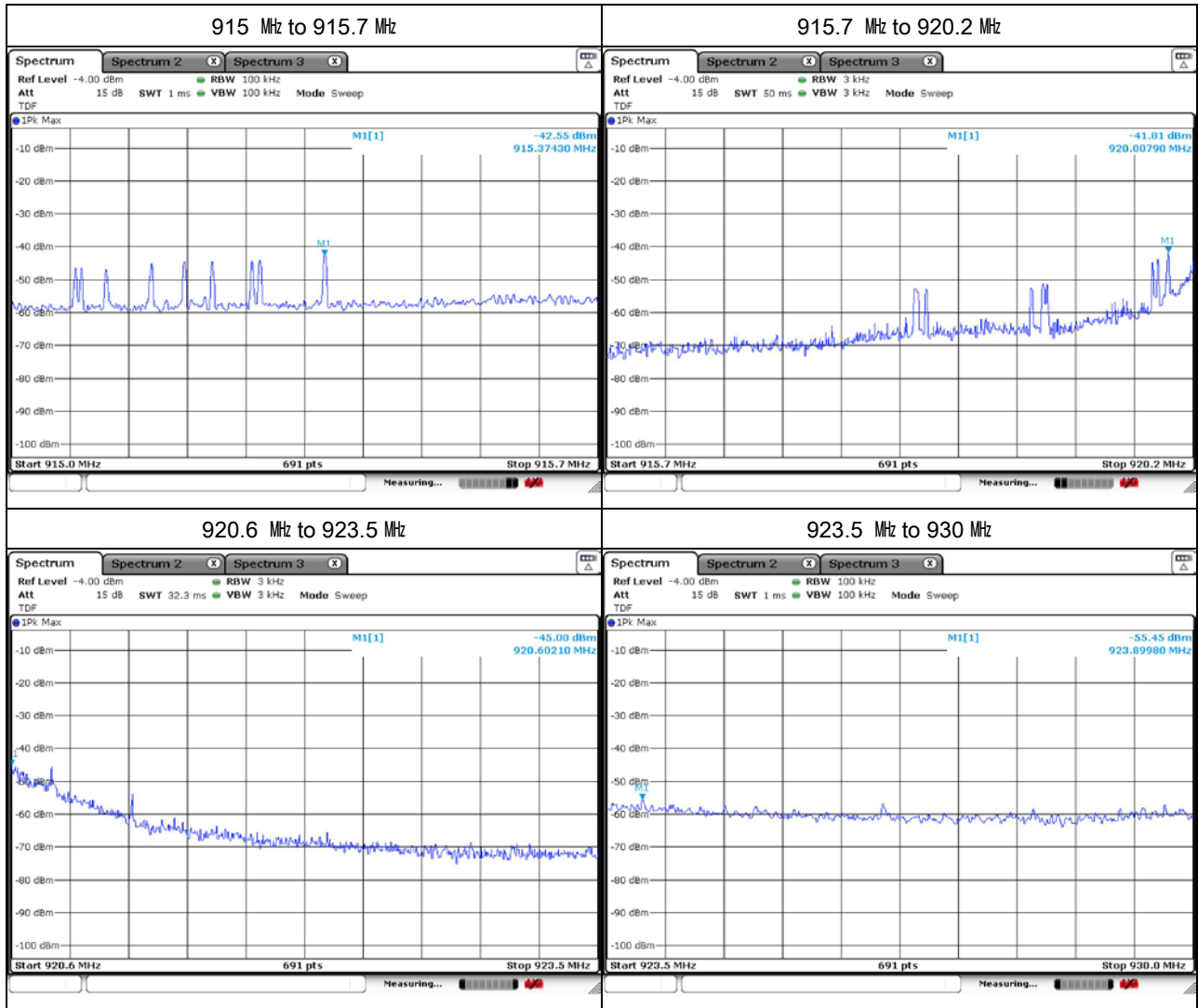
Middle channel





High channel





7. Adjacent channel Leakage Power

7.1. Test Setup



7.2. Limit

- Spectral power at the both edges of a radio channel
It shall be 10 dB m or less, respectively.
- Leakage power in a unit radio channel adjacent to a radio channel (200 kHz)
It shall be 0.5 dB m or less, respectively.

7.3. Test Procedure

1. Connect transmitter output of EUT to the spectrum analyzer input port.
2. The EUT should be transmitting at low, middle and high channel.
3. Adjacent channel Leakage Power is measured by ACLR measuring function on spectrum analyzer.

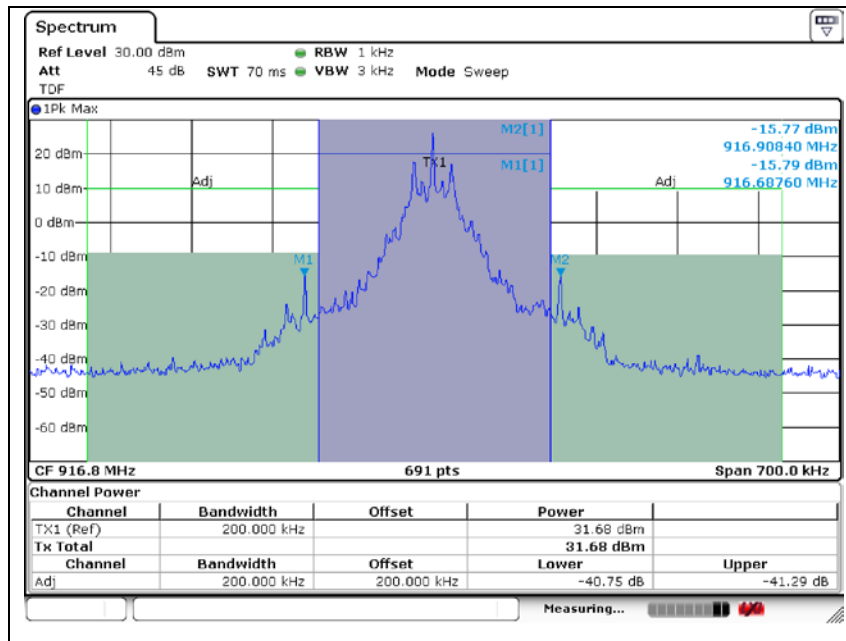
7.4. Test result

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

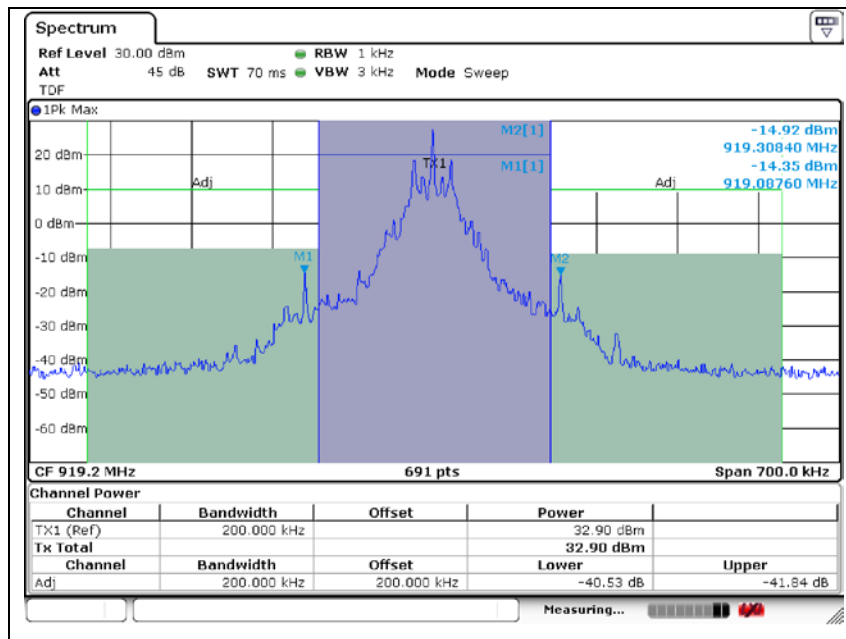
Test voltage (V _{d.c.})	Channel	Adjacent channel Leakage Power (dB m)		Limit (dB m)
		Lower	Upper	
V _{nor} = 12.0	Low Ch. (916.8 MHz)	-9.07	-9.61	0.5
	Middle Ch. (919.2 MHz)	-7.63	-8.94	0.5
	High Ch. (920.4 MHz)	-9.72	-9.28	0.5
	Channel	The power at both ends of the radio channel (dB m)		Limit (dB m)
		Lower	Upper	
	Low Ch. (916.8 MHz)	-15.79	-15.77	10.0
	Middle Ch. (919.2 MHz)	-14.35	-14.92	10.0
	High Ch. (920.4 MHz)	-16.61	-15.22	10.0

Normal voltage

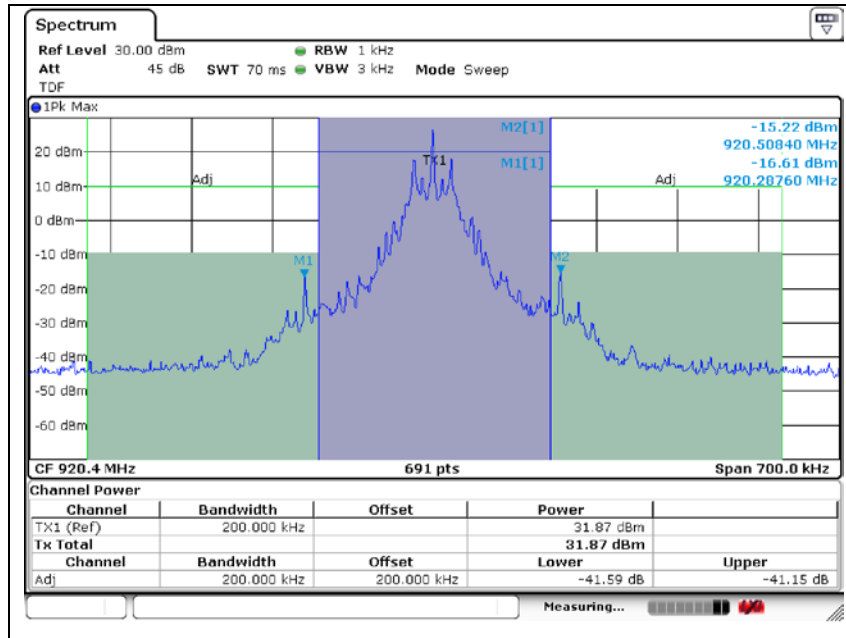
Low channel



Middle channel

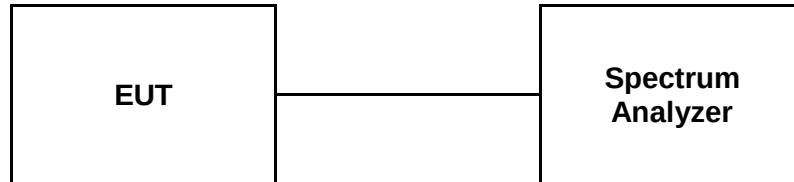


High channel



8. Secondary Radiated Emissions

8.1. Test Setup



8.2. Limit

Frequency band	Limit on Secondary Radiated Emissions, etc. (Antenna input)	Reference bandwidth
$f \leq 710 \text{ MHz}$	- 54 dB m	100 kHz
$710 \text{ MHz} < f \leq 900 \text{ MHz}$	- 58 dB m	1 MHz
$900 \text{ MHz} < f \leq 915 \text{ MHz}$	- 58 dB m	100 kHz
$915 \text{ MHz} < f \leq 930 \text{ MHz}$	- 54 dB m	100 kHz
$930 \text{ MHz} < f \leq 1000 \text{ MHz}$	- 58 dB m	100 kHz
$1000 \text{ MHz} < f \leq 1215 \text{ MHz}$	- 48 dB m	1 MHz
$1.215 \text{ GHz} < f$	- 47 dB m	1 MHz

8.3. Test Procedure

1. Configure the spectrum analyzer to [Setting 1] and then search for spurious emissions in the range 30 MHz to 5 GHz.

[Setting 1]

Span and RBW :

Span	RBW
30 to 710 MHz or less	100 kHz
over 710 to 900 MHz or less	1 MHz
over 900 to 915 MHz or less	100 kHz
over 915 to 930 MHz or less	100 kHz
over 930 to 1,000 MHz or less	100 kHz
over 1,000 to 5 GHz or less	1 MHz

VBW : Same as RBW
 Sweep time : Minimum time required to make an accurate measurement
 Sweep Data Points : 400 or greater
 Detector mode : Positive peak

[Setting 2]

Center Frequency: Frequency of spurious emission found using [Setting 1]
 Span: 0 Hz
 RBW:

Span	RBW
30 to 710 MHz or less	100 kHz
over 710 to 900 MHz or less	1 MHz
over 900 to 915 MHz or less	100 kHz
over 915 to 930 MHz or less	100 kHz
over 930 to 1,000 MHz or less	100 kHz
over 1,000 to 5 GHz or less	1 MHz

VBW : Same as RBW
 Sweep time : Minimum time required to make an accurate measurement
 Sweep Data Points : 400 or greater
 Detector mode : Sample

2. If spurious emissions are found with an amplitude greater than limit, then perform further detailed measurements
3. Configure the spectrum analyzer using [Setting 2] and measure the average signal amplitude.

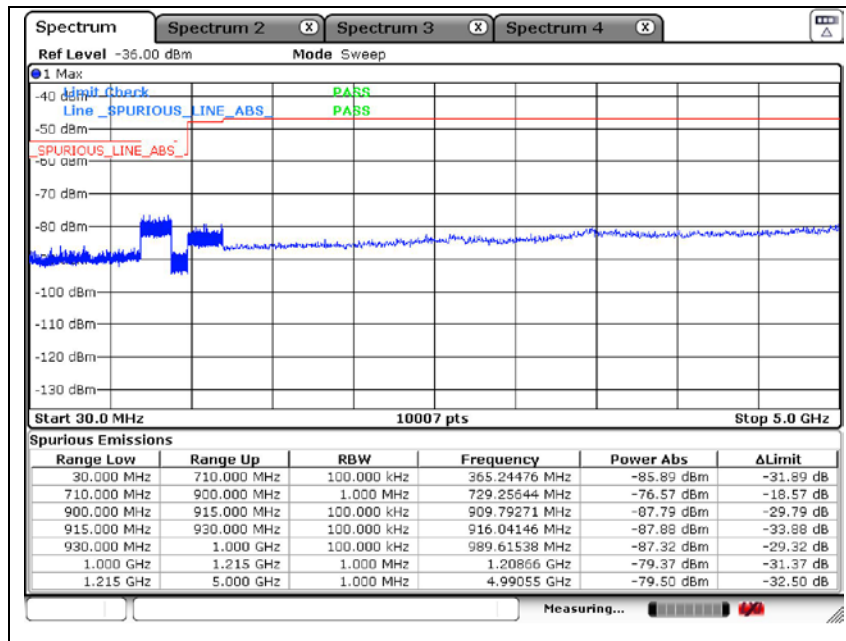
8.4. Test result

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

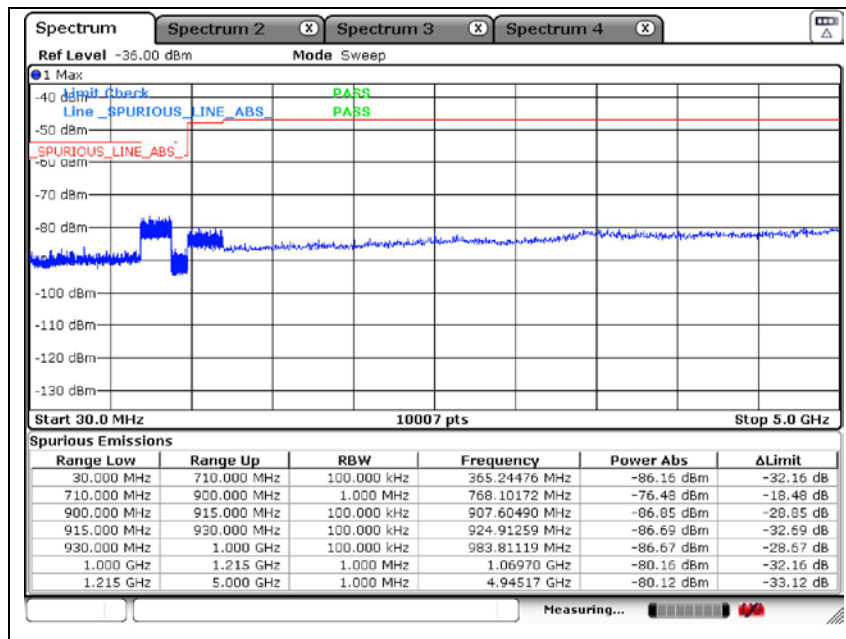
Test voltage (V _{d.c.})	Frequency Range (MHz)	Measured	Low Ch. (916.8 MHz)	Middle Ch. (919.2 MHz)	High Ch. (920.4 MHz)	Limit
V _{nor} = 12.0	30 MHz to 710 MHz	Frequency (MHz)	365.245	365.245	283.726	-
		Level (dB m)	-85.89	-86.16	-84.28	-54
	710 MHz to 900 MHz	Frequency (MHz)	729.256	768.102	725.647	-
		Level (dB m)	-76.57	-76.48	-76.58	-58
	900 MHz to 915 MHz	Frequency (MHz)	909.793	907.605	908.894	-
		Level (dB m)	-87.79	-86.85	-87.66	-58
	915 MHz to 930 MHz	Frequency (MHz)	916.041	924.913	924.313	
		Level (dB m)	-87.88	-86.69	-87.87	-54
	930 MHz to 1 000 MHz	Frequency (MHz)	989.615	983.811	990.245	
		Level (dB m)	-87.32	-86.67	-86.71	-58
	1 000 MHz to 1 215 MHz	Frequency (MHz)	1 208.660	1 069.700	1 155.610	
		Level (dB m)	-79.37	-80.16	-79.57	-48
	1 215 MHz to 5 000 MHz	Frequency (MHz)	4 990.550	4 945.170	4 960.300	-
		Level (dB m)	-79.50	-80.12	-79.64	-47

Normal voltage

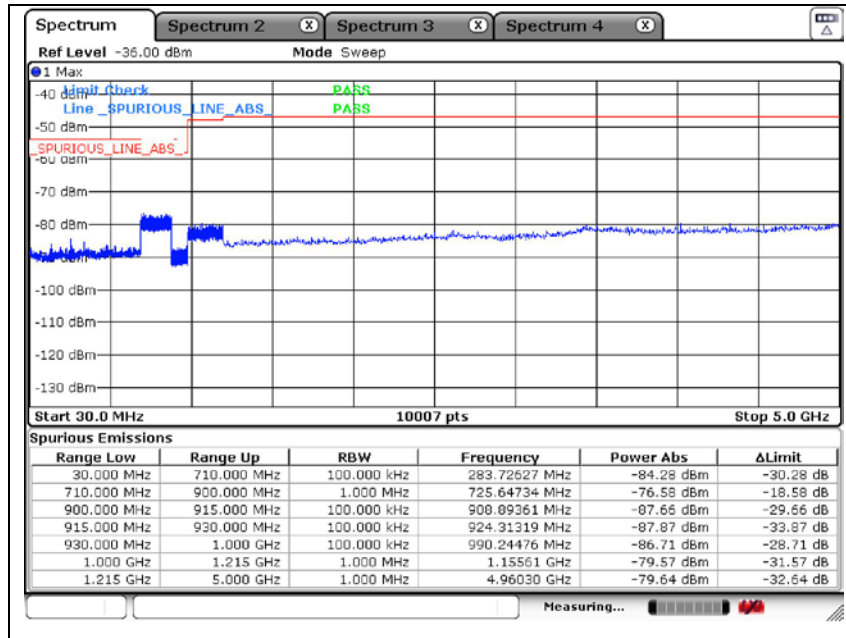
Low channel



Middle channel



High channel



9. Test Methodology & Conditions

11.1. 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.})	12.00	13.00	11.50
RF Part Output voltage (V _{d.c.})	3.306	3.304	3.307

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 -