TEST REPORT

of

FCC Part 15 Subpart C §15.249
RSS-210 Issue 9, RSS-Gen Issue 5

FCC ID: 2ABFG-YRIZW2USTS1
IC Certification: 11626A-YRIZW2USTS1

Equipment Under Test	:	Digital Door Lock
Model Name	:	YRD156-ZW-619
Variant Model Name	:	YRD156-ZW-605, YRD156-ZW-0BP
Applicant	:	iRevo-ASSA ABLOY Korea
Manufacturer	:	iRevo-ASSA ABLOY Korea
Date of Receipt	:	2018.06.28
Date of Test(s)	:	2018.07.01 ~ 2018.08.28
Date of Issue	:	2018.08.29

In the configuration tested, the EUT complied with the standards specified above.

Tested By: **Date:** **2018.08.29**

Jinhyoung Cho

Technical Manager: **Date:** **2018.08.29**

Jungmin Yang

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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
- Designation number: KR0150

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.
Phone No. : +82 31 688 0901
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1.2. Details of Applicant

Applicant : iRevo-ASSA ABLOY Korea
Address : 205-29, Gasan Digital 1-ro, Geumcheon-gu, Seoul, South Korea, 08503
Contact Person : Jang, Soo-kyung
Phone No. : +82 2 2107 5741

1.3. Details of Manufacturer

Applicant : Same as applicant
Address : Same as applicant

1.4. Description of EUT

Kind of Product	Digital Door Lock
Model Name	YRD156-ZW-619
Variant Model Names	YRD156-ZW-605, YRD156-ZW-0BP
Power Supply	DC 6.0 V
Frequency Range	908.4 ㎒ ~ 916 ㎒
Modulation Technique	FSK
Number of Channels	3 channels
Antenna Type	Helical antenna
Antenna Gain	-1.22 ㏈i

1.5. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Interval	Cal. Due
Signal Generator	R&S	SMBV100A	259067	Jun. 15, 2018	Annual	Jun. 15, 2019
Signal Generator	Agilent	E8257D	MY51501169	Jul. 03, 2018	Annual	Jul. 03, 2019
Spectrum Analyzer	Agilent	N9020A	MY53421758	Sep. 25, 2017	Annual	Sep. 25, 2018
Spectrum Analyzer	R&S	FSV30	100768	Mar. 12, 2018	Annual	Mar. 12, 2019
High Pass Filter	Wainwright Instrument GmbH	WHK2.2/12.75G-10SS	8	Mar. 21, 2018	Annual	Mar. 21, 2019
Low Pass Filter	Mini-Circuits	NLP-1200+	V8979400903-2	Feb. 22, 2018	Annual	Feb. 22, 2019
DC Power Supply	R&S	HMP2020	020089489	May 30, 2018	Annual	May 30, 2019
Preamplifier	H.P.	8447F	2944A03909	Aug. 07, 2018	Annual	Aug. 07, 2019
Signal Conditioning Unit	R&S	SCU-18	102244	Sep. 22, 2017	Annual	Sep. 22, 2018
Loop Antenna	Schwarzbeck Mess-Elektronik	FMZB 1519	1519-039	Aug. 23, 2017	Biennial	Aug. 23, 2019
Bilog Antenna	Schwarzbeck Mess-Elektronik	VULB 9163	01126	Mar. 26, 2018	Biennial	Mar. 26, 2020
Horn Antenna	R&S	HF906	100326	Feb. 14, 2018	Biennial	Feb. 14, 2020
Horn Antenna	Schwarzbeck Mess-Elektronik	BBHA 9170	9170-540	Jul. 17, 2017	Biennial	Jul. 17, 2019
Horn Antenna	Schwarzbeck Mess-Elektronik	BBHA 9170	BBHA9170223	Aug. 23, 2017	Biennial	Aug. 23, 2019
Turn Table	INN-CO systems	CONTROLLER CO3000	N/A	N. C. R	N/A	N. C. R
Antenna Master	INN-CO systems	MA4640-XP-ET	N/A	N. C. R	N/A	N. C. R
Test Receiver	R&S	ESU26	100109	Jan. 07, 2018	Annual	Jan. 07, 2019
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	SUCOFLEX	104 (3 m)	MY3258414	Jul. 04, 2018	Semi-annual	Jan. 04, 2019
Coaxial Cable	SUCOFLEX	104 (10 m)	MY3145814	Jul. 04, 2018	Semi-annual	Jan. 04, 2019

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 9, RSS-Gen Issue 5			
Section		**Test Item**	**Result**
15.205 15.209(a) 15.249(a) 15.249(c) 15.249(d)	RSS-210 Issue 9 B.10 RSS-Gen Issue 5 8.9 RSS-Gen Issue 5 8.10	Fundamental and Radiated Spurious Emission	Complied
15.215(c)	RSS-Gen Issue 5 6.7	20 ㏈ Bandwidth & 99% Bandwidth	Complied

Note;

- Due to the frequency range of the device operate (908.4 ㎒ ~ 916 ㎒) is 1 to 10 ㎒, so we perform test Lowest and Highest frequency according to 15.31 requirement.

1.7. Test Procedure(s)

The measurement procedures described in the American National Standard of Procedure for Compliance Testing of unlicensed Wireless Devices (ANSI C63.10-2013) was used in the measurement of the DUT.

1.8. Sample Calculation

Where relevant, the following sample calculation is provided

1.8.1. Radiation Test

Field strength level (㏈㎶/m) = Measured level (㏈㎶) + Antenna factor (㏈) + Cable loss (㏈) - Amplifier gain (㏈)

1.9. Measurement Uncertainty

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

Parameter	Uncertainty (㏈)
Radiated Disturbance, 9 ㎑ to 30 ㎒	±3.59
Radiated Disturbance, below 1 ㎓	±5.88
Radiated Disturbance, above 1 ㎓	±5.94

Uncertainty figures are valid to a confidence level of 95 %.

1.10. Test Report Revision

Revision	Report number	Date of Issue	Description
0	F690501/RF-RTL012938	2018.08.02	Initial
1	F690501/RF-RTL012938-1	2018.08.29	Revised standard and retested radiate emission

1.11. Information of Variant Models

Model Name		Description
Basic model	YRD156-ZW-619	- Basic model
Variant models	YRD156-ZW-605	- Same as basic model but with different color of case
	YRD156-ZW-0BP	- Same as basic model but with different color of case

1.12. Duty Cycle Correction Factor of EUT

According to 15.35 (c), as a “duty cycle correction factor”
Average Reading = Peak Reading (dBμV/m) + 20log (Duty Cycle)

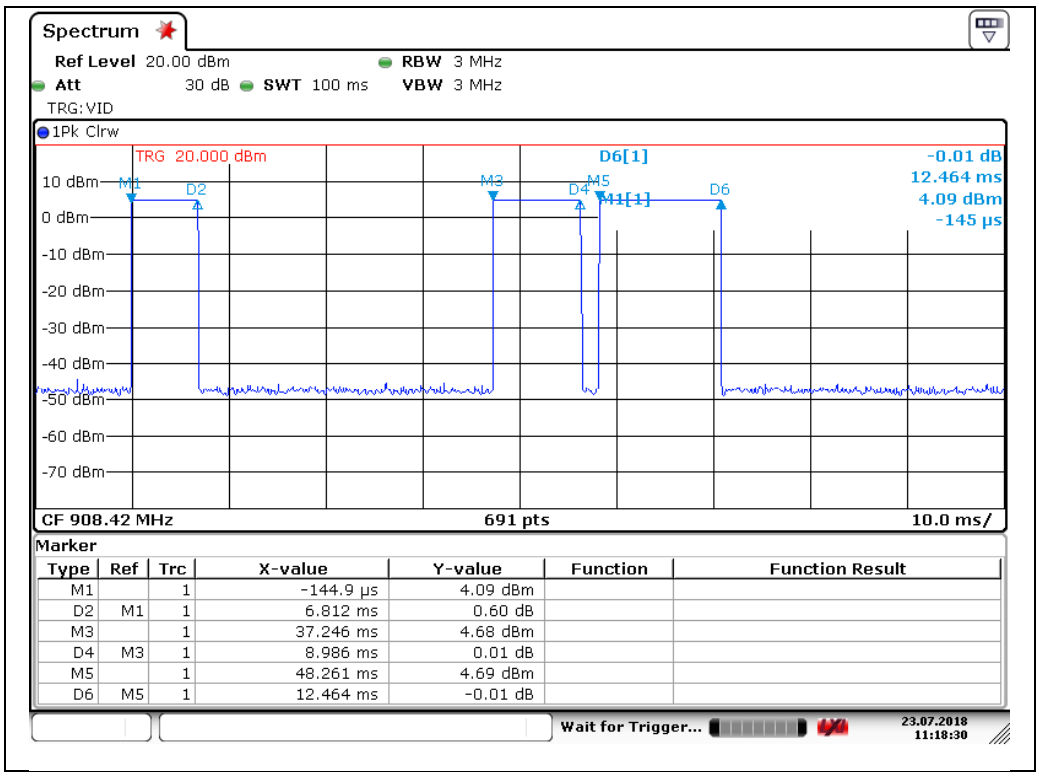
In order to determine possible Maximum Modulation percentage, alternations are made to the EUT.
We measured;

T_{on+off}	T_{on}	M % = (T_{on} / T_{on+off}) * 100 %	Duty Correction Factor
100 ㎳	28.262 ㎳	28.262	-10.98

T_{on+off} = 100 ㎳
T_{on} = 6.812 ㎳ + 8.986 ㎳ + 12.464 ㎳ = 28.262 ㎳
Duty Cycle = 20log (T_{on} / T_{on+off}) = 20log (28.262 / 100) = -10.98

Remark;
- T_{on+off} > 100 ㎳. Use 100 ㎳ for calculation

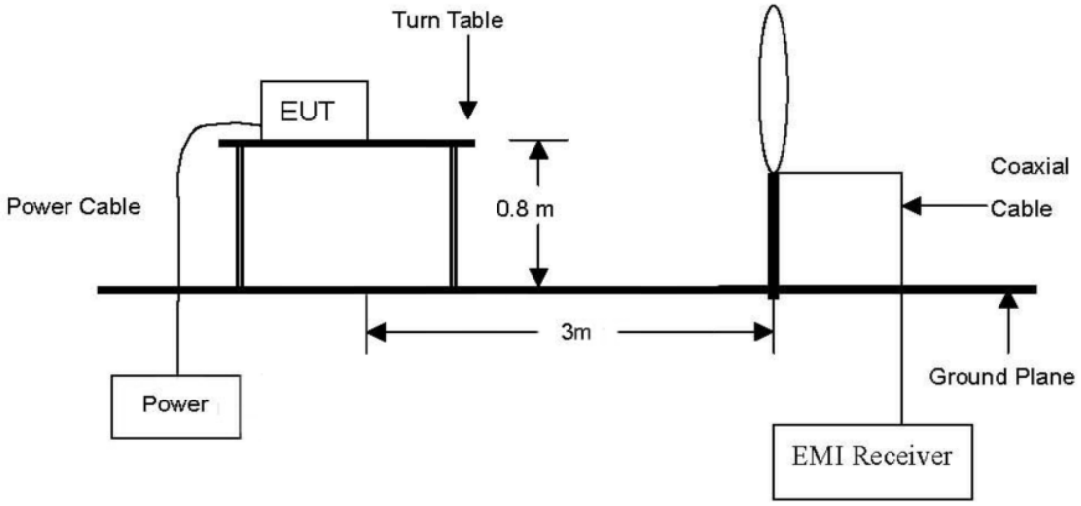
- Test plot



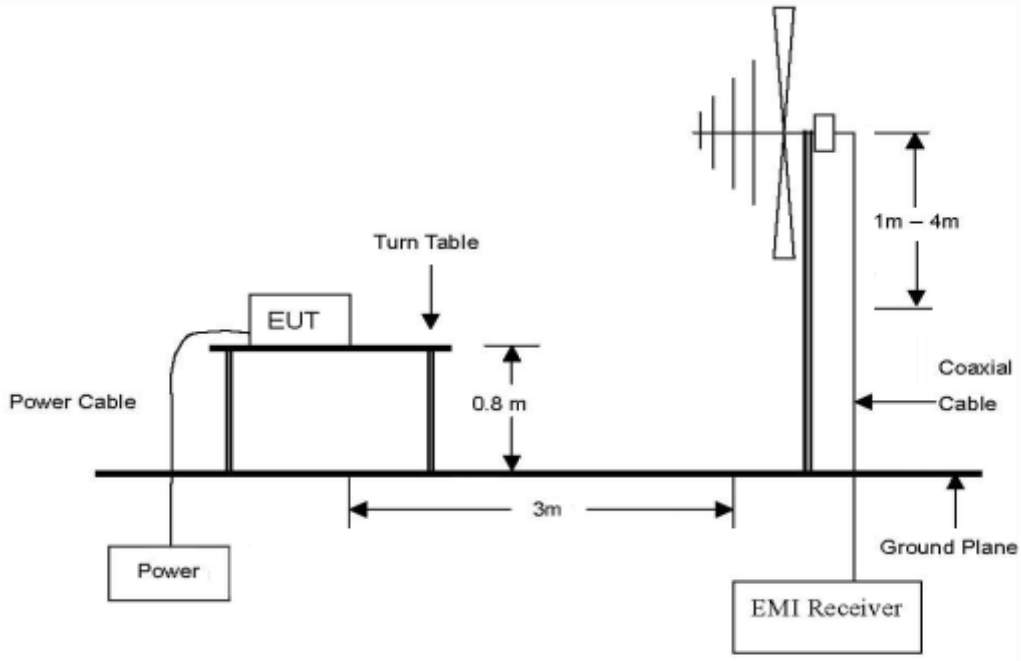
2. Fundamental and Radiated Spurious Emission

2.1. Test Setup

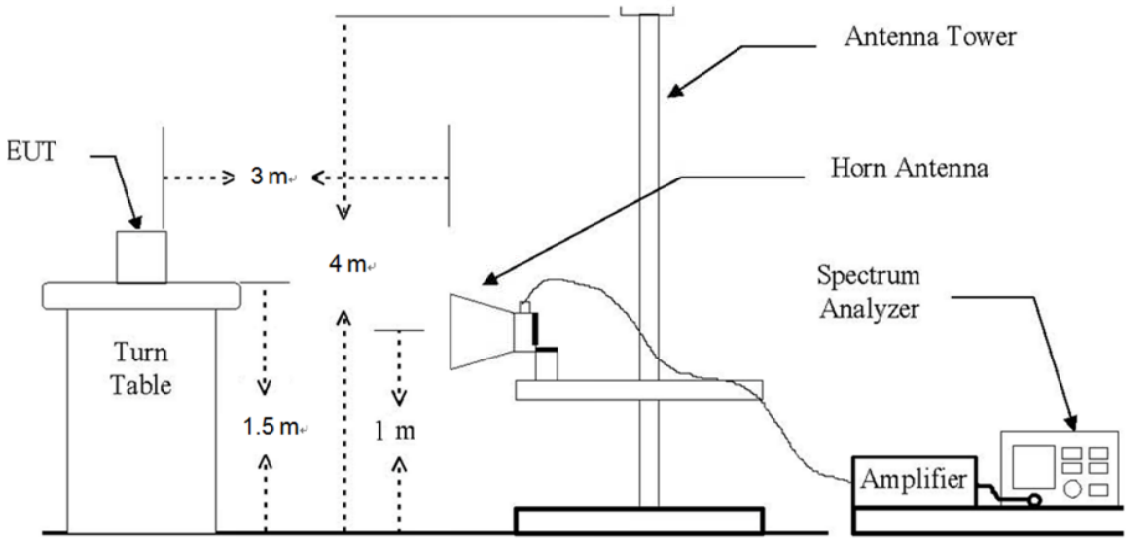
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



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



The diagram below shows the test setup that is utilized to make the measurements for emission. The spurious emissions were investigated form 1 ㎓ to the 10th harmonic of the highest fundamental frequency or 40 ㎓, whichever is lower.



2.2. Limit

2.2.1. FCC

According to §15.249(a), Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental (㎷/m)	Field strength of harmonics (㎶/m)
902-928 ㎒	50	500
2 400-2 483.5 ㎒	50	500
5 725-5 875 ㎒	50	500
24.0-24.25 ㎓	250	2 500

According to §15.249(d), Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 ㏈ below the level of the fundamental or to the general radiated emission limits in §15.209, whichever the lesser attenuation.

According to §15.209(a), 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 (㎶/m)	Measurement distance (Meters)
0.009-0.490	2 400/F(㎑)	300
0.490-1.705	24 000/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.

2.2.2. IC

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 ㎒

Frequency (㎒)	Field strength (㎶/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 ㎒

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

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

According to B.10 of RSS-210 Issue 9, Devices shall comply with the following requirements:

(a) The field strength of fundamental and harmonic emissions, measured at 3 m, shall not exceed 50 ㎷/m and 0.5 ㎷/m respectively.

The field strength limits shall be measured using an average detector, except for the fundamental emission in the frequency band 902-928 ㎒, which is based on measurements using an International Special Committee on Radio Interference (CISPR) quasi-peak detector.

(b) Emissions radiated outside of the specified frequency bands, except for harmonic emissions, shall be attenuated by at least 50 dB below the level of the fundamental emissions or to general field strength limits specified in RSS-Gen, whichever is less stringent.

The provisions of RSS-Gen regarding pulsed operation do not apply to CISPR measurement for the band 902-928 ㎒.

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 average or quasi peak detect function and Specified Bandwidth with Maximum Hold Mode.

Note;

- Although these tests were performed other than open field test site, adequate comparison measurements were confirmed against 30 meter open field test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788 D01 Radiated Test Site v01r01.

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 below 1 ㎓ and 1.5 meters above the ground at a 3 meter anechoic chamber test site above 1 ㎓. 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. During performing radiated emission above 1 ㎓, the EUT was set 3 meter away from the interference-receiving antenna.
3. The antenna is a bi-log antenna, a horn 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. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. If the emission level of the EUT in peak mode was 10 ㏈ lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 ㏈ margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

Note;

1. For frequency below 1 ㎓, set spectrum analyzer detector to peak, and resolution bandwidth is 100 ㎑ and video bandwidth is 300 ㎑.
2. For frequency above 1 ㎓, set spectrum analyzer detector to peak, and resolution bandwidth is 1 ㎒ and video bandwidth is 3 ㎒.
3. According to 15.35 (c), as a “duty cycle correction factor”, pulse averaging with 20 log (worst case dwell time / 100 ㎳) has to be used for average result.
4. To get a maximum emission level from the EUT, the EUT is manipulated through three orthogonal planes (X, Y, Z). Worst orthogonal plan of EUT is **X – axis** during radiation test.

2.4. Test result

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

2.4.1. Field Strength of Fundamental

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical.

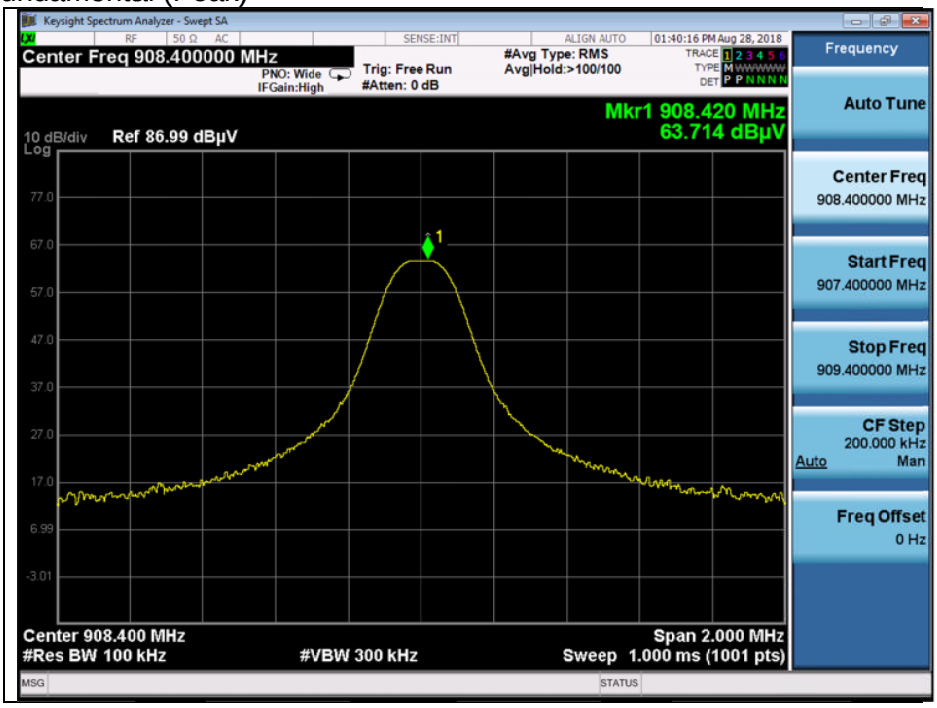
Frequency (㎒)	Detect Mode	Ant. Pol.	Reading (dB㎶)	AF (dB/m)	CL (dB)	Result (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
<Low channel 908.4 ㎒>								
908.42	Peak	V	63.71	22.47	4.92	91.10	94.00	2.90
<High channel 916 ㎒>								
915.97	Peak	V	65.00	22.56	4.87	92.43	94.00	1.57

Remark;

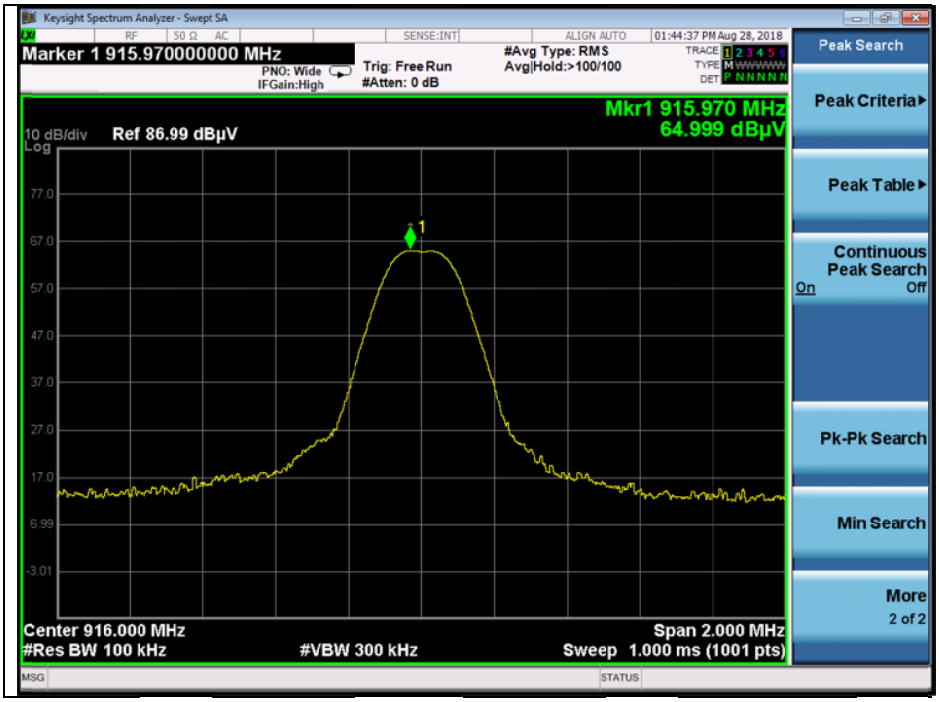
1. Result = Reading + AF + CL

- Test plots

Low channel fundamental (Peak)



High channel fundamental (Peak)



2.4.2. Radiated Spurious Emission below 1 000 ㎒

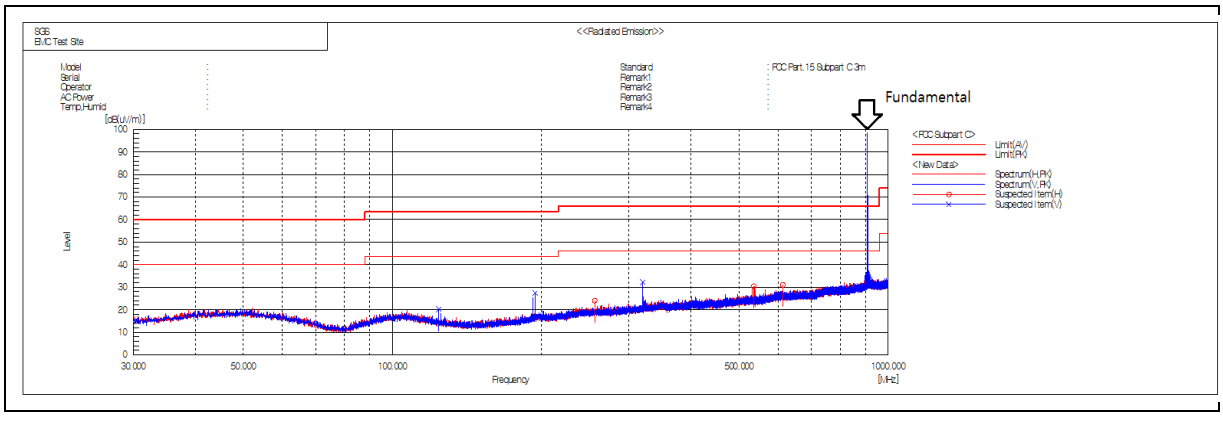
The frequency spectrum from 9 ㎑ to 1 000 ㎒ was investigated. All reading values are peak values.

Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
193.97	41.30	Peak	V	11.14	-25.13	27.31	43.50	16.19
319.99	42.70	Peak	V	13.80	-24.36	32.14	46.00	13.86
535.33	37.50	Peak	H	17.80	-24.71	30.59	46.00	15.41
612.61	36.00	Peak	H	19.57	-24.62	30.95	46.00	15.05
Above 700.00	Not detected	-	-	-	-	-	-	-

Remark;

1. Spurious emissions for all channels were investigated and almost the same below 1 ㎓.
2. Reported spurious emissions are in **Low channel** as worst case among other channels.
3. Radiated spurious emission measurement as below.
   (Actual = Reading + AF + Amp + CL)
4. According to §15.31(o), emission levels are not report much lower than the limits by over 20 ㏈.

- Test plot



2.4.3. Radiated Band edge Emission and Spurious Emission above 1 000 ㎒

A. Low Channel (908.40 ㎒)

Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
900.10	14.39	Peak	V	22.30	4.96	41.65	46.00	4.35
902.00	12.03	Peak	V	22.34	4.95	39.32	46.00	6.68

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Duty (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
6 359.10	46.18	Peak	H	34.68	-31.63	-	49.23	74.00	24.77
6 359.10	46.18	Average	H	34.68	-31.63	-10.98	38.25	54.00	15.75
Above 6 400.00	Not detected	-	-	-			-	-	-

B. High Channel (916.00 ㎒)

Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
928.00	12.25	Peak	V	22.52	4.88	39.65	46.00	6.35
929.50	14.22	Peak	V	22.51	4.89	41.62	46.00	4.38

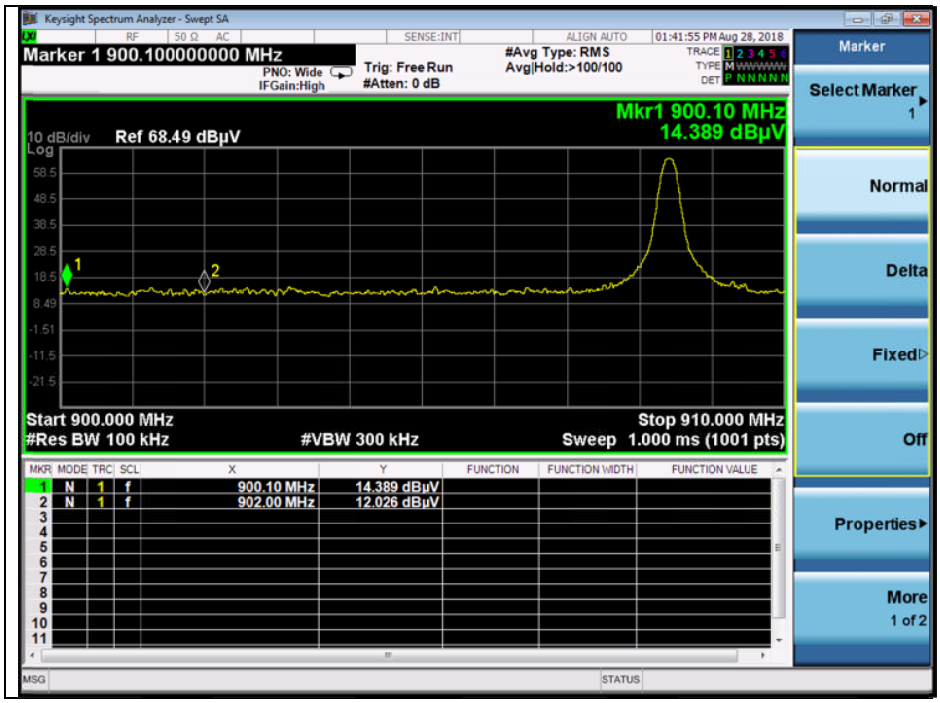
Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Duty (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
6 412.26	45.60	Peak	H	34.55	-31.78	-	48.37	74.00	25.63
6 412.26	45.60	Average	H	34.55	-31.78	-10.98	37.39	54.00	16.61
Above 6 500.00	Not detected	-	-	-			-	-	-

Remarks;

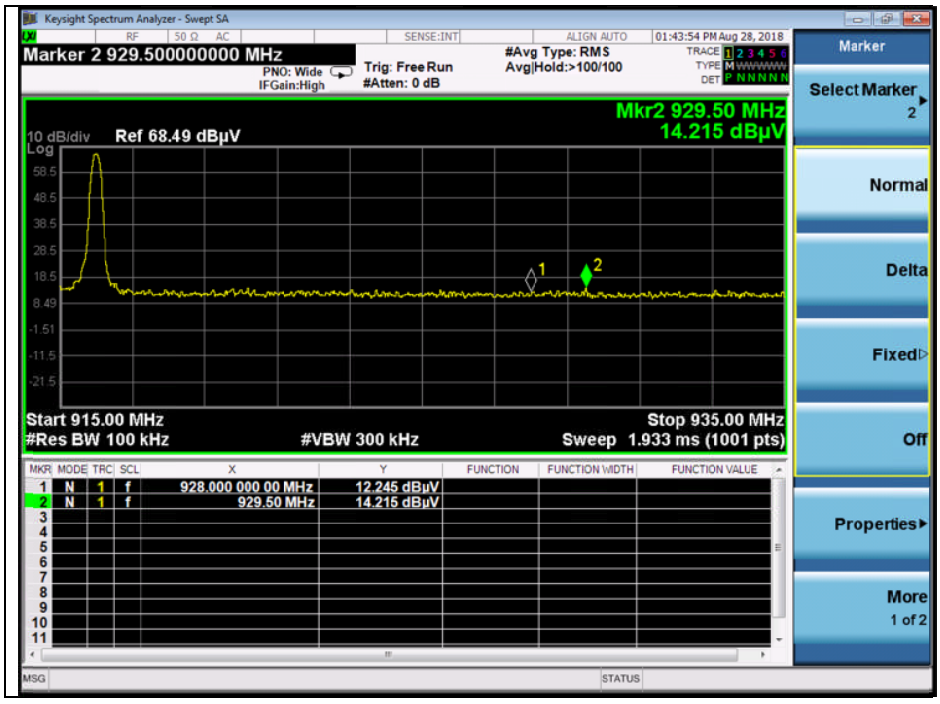
1. Measuring frequencies from 1 ㎓ to the 10th harmonic of highest fundamental frequency.
2. Actual = Reading + AF + AMP + CL + (Duty).
3. Average Reading = Peak Reading + Duty Cycle Correction Factor
4. Duty Cycle Correction Factor: 20log (T_{on} / 100 ㎳) = 20log (28.262 / 100) = -10.98
   - T_{on} time = 28.262 ㎳
5. According to § 15.31(o), emission levels are not reported much lower than the limits by over 20 ㏈.

- Test plots

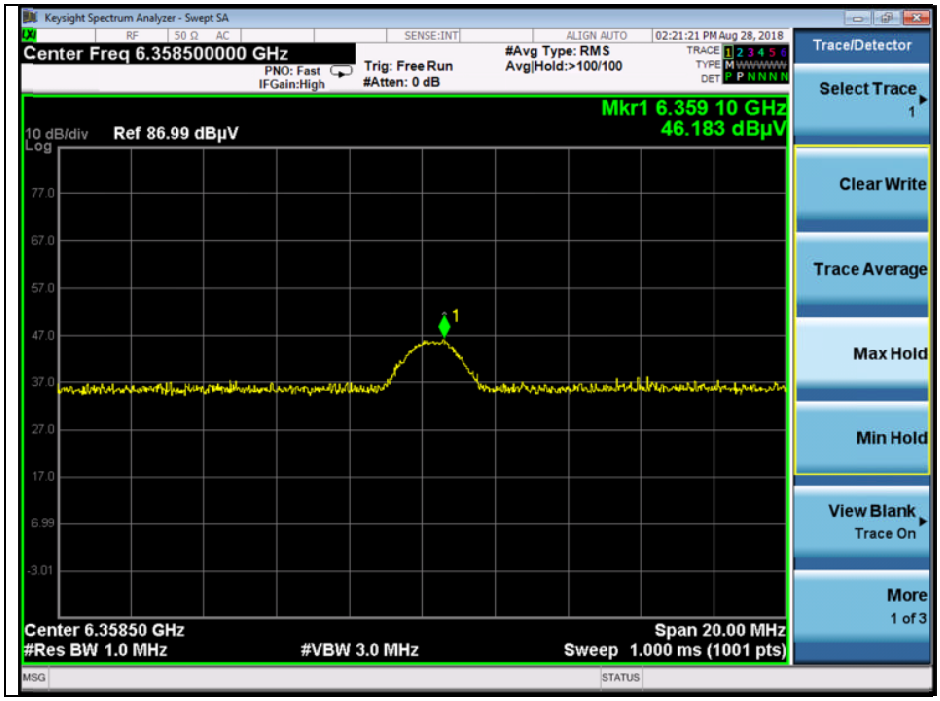
Low channel Band edge (Peak)



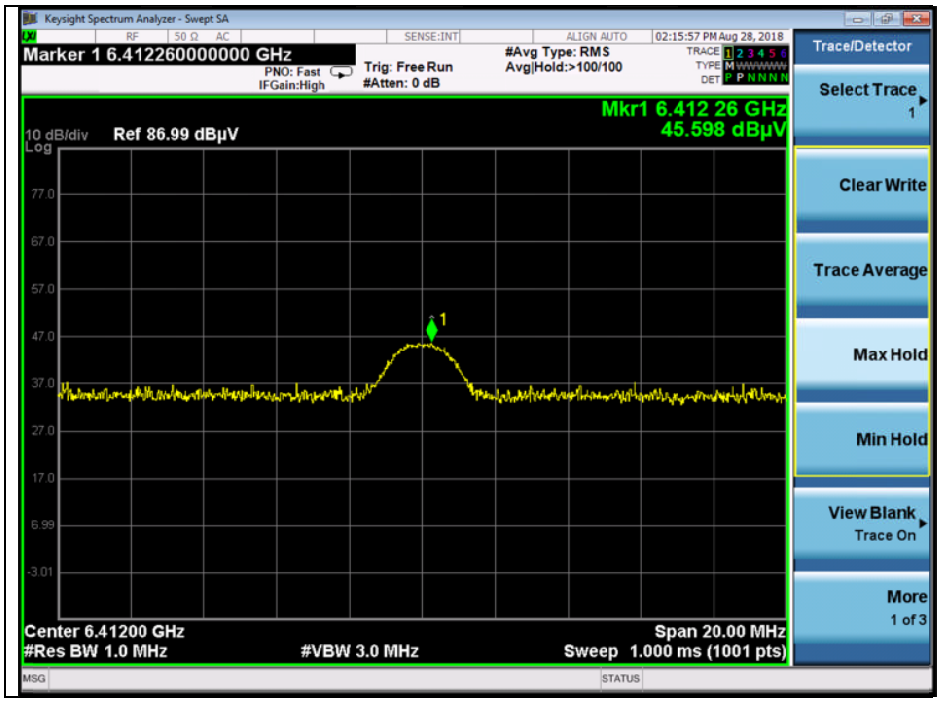
High channel Band edge (Peak)



Low channel 7th harmonic (Peak)



High channel 7th harmonic (Peak)



3. 20 ㏈ Bandwidth & 99% Bandwidth

3.1. Test Setup

3.2. Limit

Limit: Not Applicable

3.3. Test Procedure

3.3.1. 20 ㏈ Bandwidth

The test follows ANSI C63.10-2013.

The 20 ㏈ bandwidth was measured with a spectrum analyzer connected to RF antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency.

Use the following spectrum analyzer setting:

Span = approximately 2 to 5 times the 20 ㏈ bandwidth.
RBW ≥ 1 % to 5 % of the 20 ㏈ bandwidth.
VBW ≥ 3 x RBW
Sweep = auto
Detector = peak
Trace = max hold

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.

3.3.2. 99 % Bandwidth

- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.

- The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.

- The resolution bandwidth (RBW) shall be in the range of 1 % to 5 % of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5 % of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

3.4. Test Results

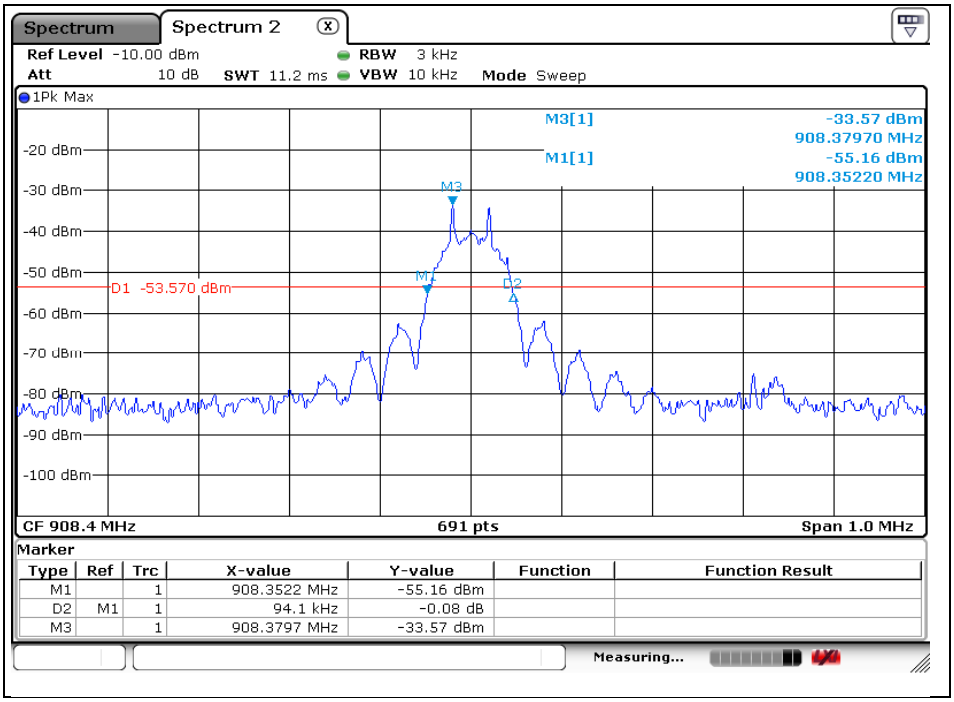
Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Channel	Frequency (㎒)	20 ㏈ Bandwidth (㎑)	99% Bandwidth (㎑)
Low	908.40	94.100	92.619
High	916.00	127.400	112.880

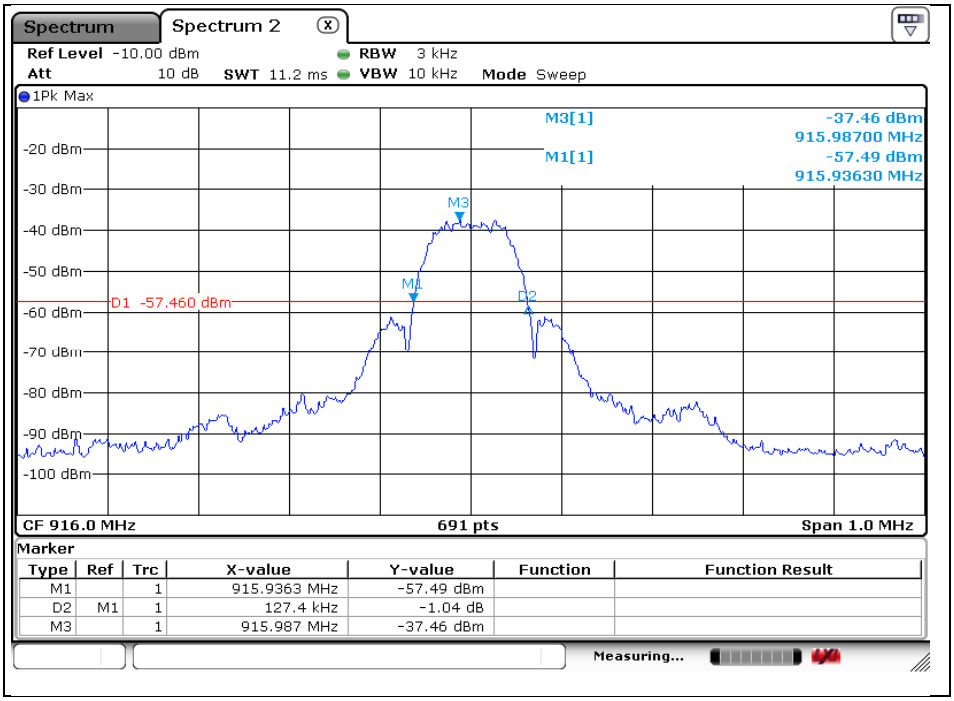
- Test plots

20 dB Bandwidth

Low Channel

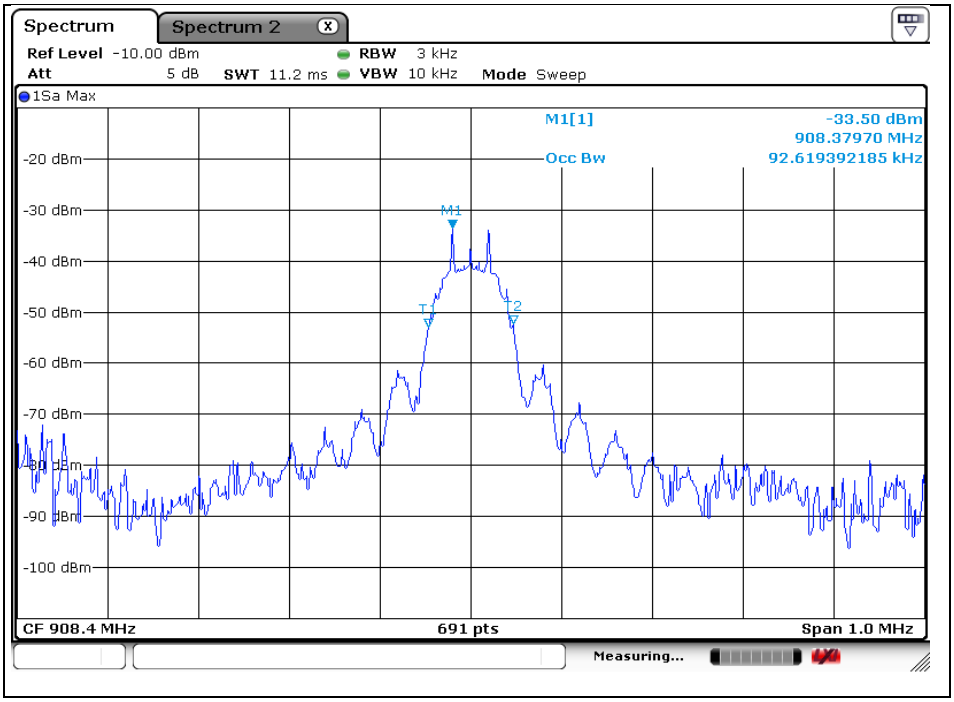


High Channel

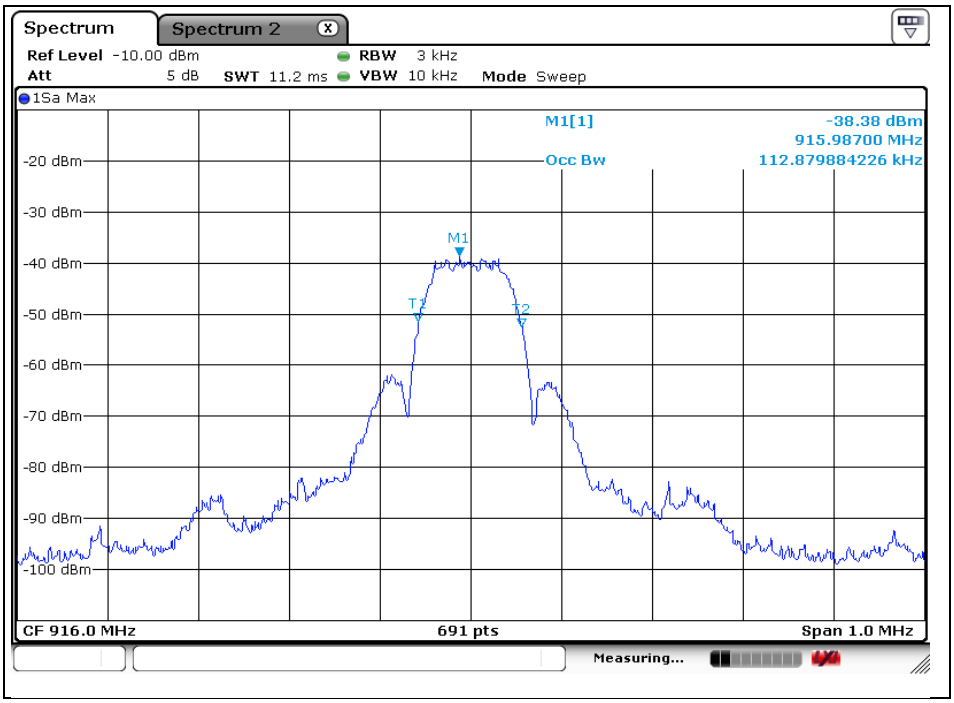


99% Bandwidth

Low Channel



High Channel



- End of the Test Report -