

TEST REPORT

of

FCC Part 15 Subpart C §15.249
RSS-210 Issue 10, RSS-Gen Issue 5

FCC ID: 2ABFG-YRIZW2USTS2
IC Certification: 11626A-YRIZW2USTS2

Equipment Under Test : Digital Door Lock
Model Name : YRD157-ZW-619
Variant Model Name(s) : Refer to the page 3
Applicant : iRevo-ASSA ABLOY Korea
Manufacturer : iRevo-ASSA ABLOY Korea
Date of Receipt : 2022.06.22
Date of Test(s) : 2022.06.23 ~ 2022.07.18
Date of Issue : 2022.08.25

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

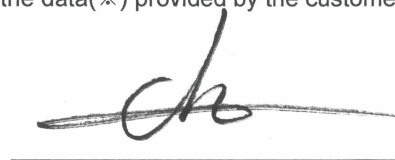
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Tested by:


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Technical
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Report Number: F690501-RF-RTL003326-1

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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 : iRevo-ASSA ABLOY Korea

Address : 10f of JEI PLATZ Bldg., 186, Gasandigital 1-ro, Geumcheon-gu, Seoul, South Korea, 08502

Contact Person : Soo-kyung, Jang

Phone No. : +82 2 2107 5741

1.3. Details of Manufacturer

Company : Same as applicant

Address : Same as applicant

1.4. Description of EUT

Kind of Product	Digital Door Lock
Model Name	YRD157-ZW-619
Variant Model Name	YRD157-ZW-605, YRD157-ZW-0BP, YRD157-ZW-BSP
Serial Number	Conducted: 001, Radiated: 002
Power Supply	DC 6.0 V
Frequency Range	908.42 MHz ~ 916 MHz
Modulation Technique	FSK
Number of Channels	2 channels
Antenna Type	HELICAL antenna
Antenna Gain	-4.55 dB i
H/W Version	PV01
S/W Version	V2.2.6

1.6. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Interval	Cal. Due
Signal Generator	R&S	SMBV100A	255834	May 25, 2022	Annual	May 25, 2023
Spectrum Analyzer	R&S	FSV30	103210	Dec. 08, 2021	Annual	Dec. 08, 2022
Spectrum Analyzer	Agilent	N9020A	MY53421758	Aug. 27, 2021	Annual	Aug. 27, 2022
Attenuator	AEROFLEX / INMET	26A-10dB	3	Mar. 13, 2022	Annual	Mar. 13, 2023
High Pass Filter	Wainwright Instrument GmbH	WHKX10-900-1000-1800 0-40SS	7	Mar. 04, 2022	Annual	Mar. 04, 2023
DC Power Supply	Agilent	U8002A	MY54110041	Sep. 14, 2021	Annual	Sep. 14, 2022
Preamplifier	H.P.	8447F	2944A03909	Aug. 06, 2021	Annual	Aug. 06, 2022
Signal Conditioning Unit	R&S	SCU 18	10117	Jun. 13, 2022	Annual	Jun. 13, 2023
Loop Antenna	Schwarzbeck Mess-Elektronik	FMZB 1519	1519-039	Aug. 23, 2021	Biennial	Aug. 23, 2023
Bilog Antenna	Schwarzbeck Mess-Elektronik	VULB 9163	1126	Feb. 07, 2022	Annual	Feb. 07, 2023
Horn Antenna	R&S	HF906	100326	Feb. 18, 2022	Annual	Feb. 18, 2023
EMI Test Receiver	R&S	ESU26	100109	Jan. 18, 2022	Annual	Jan. 18, 2023
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	CO3000/963/383 30516/L	N.C.R.	N/A	N.C.R.
Antenna Mast	Innco systems GmbH	MA4640-XP-ET	MA4640/536/383 30516/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	MWX221-NMSNMS (4 m)	J1023142	Apr. 04, 2022	Semi-annual	Oct. 04, 2022
Coaxial Cable	micro-coax UTiflex	142A SERIES 502839-8 (10 m)	90000034	Apr. 04, 2022	Semi-annual	Oct. 04, 2022
Coaxial Cable	RFONE	PL360P-292M292M-1.5 M-A	20200324002	Feb. 18, 2022	Semi-annual	Aug. 18, 2022

1.7. 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
15.205 15.209(a) 15.249(a) 15.249(c) 15.249(d)	RSS-210 Issue 10 B.10, Table B2 RSS-Gen Issue 5 8.9 RSS-Gen Issue 5 8.10	Field Strength of Fundamental and Radiated Spurious emission	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 Emission	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.

1.8. 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.

1.9. Sample Calculation

Where relevant, the following sample calculation is provided:

1.9.1. Conducted Test

Offset value (dB) = Attenuator (dB) + Cable loss (dB)

1.9.2. Radiation Test

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

1.10. Measurement Uncertainty

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

Parameter	Uncertainty	
Occupied Bandwidth	3.90 kHz	
Radiated Emission, 9 kHz to 30 MHz	H	3.30 dB
	V	3.30 dB
Radiated Emission, below 1 GHz	H	4.80 dB
	V	5.20 dB
Radiated Emission, above 1 GHz	H	3.90 dB
	V	4.00 dB

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

1.11. Test Report Revision

Revision	Report Number	Date of Issue	Description
0	F690501-RF-RTL003326	2022.07.27	Initial
1	F690501-RF-RTL003326-1	2022.08.25	Revised operation mode

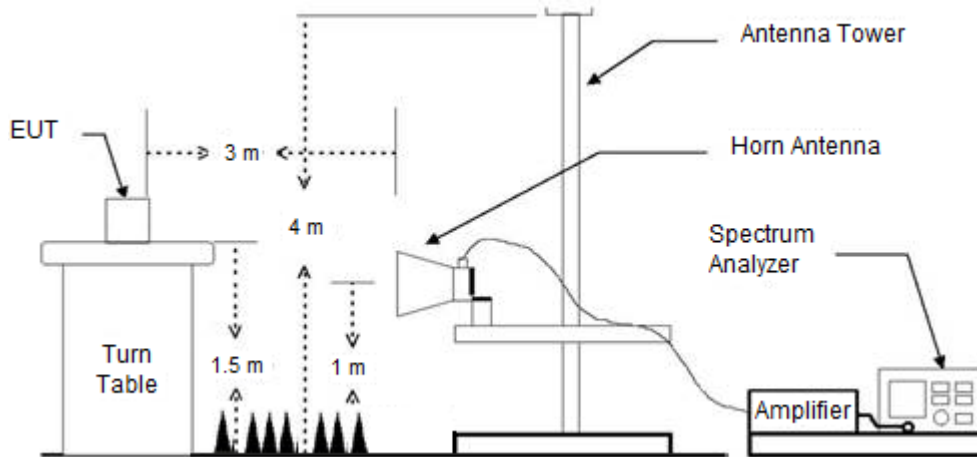
1.12. Information of software for test

- Operating software of EUT has integrated test interface. No additional software was used.

1.13. Information of Variant Models

Model Name	Description
YRD157-ZW-619	- Basic Model. - SILVER
YRD157-ZW-605	- GOLD
YRD157-ZW-0BP	- Oil Rubbed Bronze
YRD157-ZW-BSP	- Matt BLACK

The diagram below shows the test setup that is utilized to make the measurements for emission. The spurious emissions were investigated from 1 GHz to the 10th harmonic of the highest fundamental frequency or 40 GHz, 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 (mV/m)	Field strength of harmonics (μV/m)
902-928 MHz	50	500
2 400-2 483.5 MHz	50	500
5 725-5 875 MHz	50	500
24.0-24.25 GHz	250	2 500

According to §15.249(c), Field strength limits are specified at a distance of 3 meters.

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

According to §15.249(e), As shown in §15.35(b), for frequencies above 1 000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2 500 millivolts/meter at 3 meters along the antenna azimuth.

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 (MHz)	Field strength (μV/m)	Measurement distance (Meters)
0.009-0.490	2 400/F(kHz)	300
0.490-1.705	24 000/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.

2.2.2. 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 MHz

Frequency (MHz)	Field strength ($\mu\text{V/m}$ 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) ($\mu\text{A/m}$)	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

Note¹: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

According to B.10 of RSS-210 Issue 10, Bands 902-928 MHz, 2 400-2 483.5 MHz, 5 725-5 875 MHz and 24-24.25 GHz

Devices shall comply with the following requirements:

- a. The field strength of fundamental and harmonic emissions measured at 3m shall not exceed the limit in table B2.

Table B2 – Field Strengths limits at various frequencys

Fundamental Frequency (MHz)	Field Strength (mV/m)	
	Fundamental Emissions	Harmonic Emissions
902-928	50	0.5
2 400-2 483.5	50	0.5
5 725-5 875	50	0.5
24 000-24 250	250	2.5

The field strength shall be measured using an average detector, except for the fundamental emission in the frequency band 902-928 MHz, 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 the general field strength limits listed in RSS-Gen, whichever is less stringent.

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

2.3.2. Test Procedures for emission from 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 below 1 GHz and 1.5 meters above the ground at a 3 meter anechoic chamber test site above 1 GHz. 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. During performing radiated emission above 1 GHz, 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. 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.
6. For measurements Above 1 GHz resolution bandwidth is set to 1 MHz, the video bandwidth is set to 3 MHz for peak measurements and as applicable for average measurements.

Note;

The test orthogonal plan of EUT was investigated with three axis described in the test setup photo. The Y-axis was worst-case, all radiated testing of EUT was performed with Y-axis.

2.4. Test Results

Ambient temperature : $(23 \pm 1) ^\circ\text{C}$
 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.

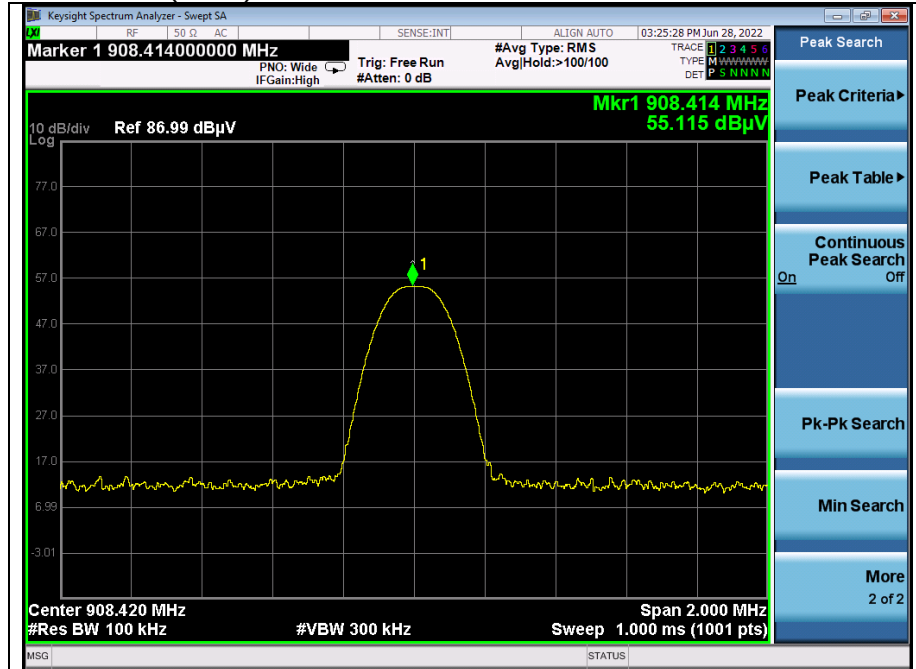
Frequency (MHz)	Detect Mode	Ant. Pol.	Reading (dB μV)	AF (dB/m)	CL (dB)	Result (dB $\mu\text{V}/\text{m}$)	Limit (dB $\mu\text{V}/\text{m}$)	Margin (dB)
<Low channel 908.42 MHz>								
908.41	Peak	H	55.12	28.17	5.89	89.18	93.98	4.80
<High channel 916 MHz>								
915.99	Peak	H	52.09	28.30	5.93	86.32	93.98	7.66

Remark;

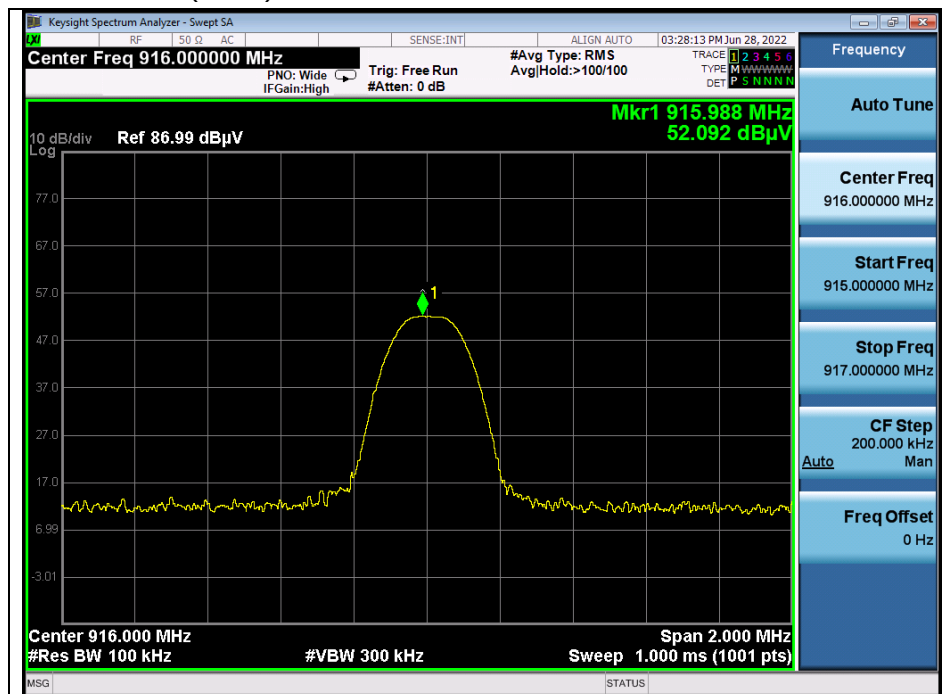
1. Result = Reading + AF + CL

- Test plots

Low channel fundamental (Peak)



High channel fundamental (Peak)



2.4.2. Radiated Spurious Emission below 1 000 MHz

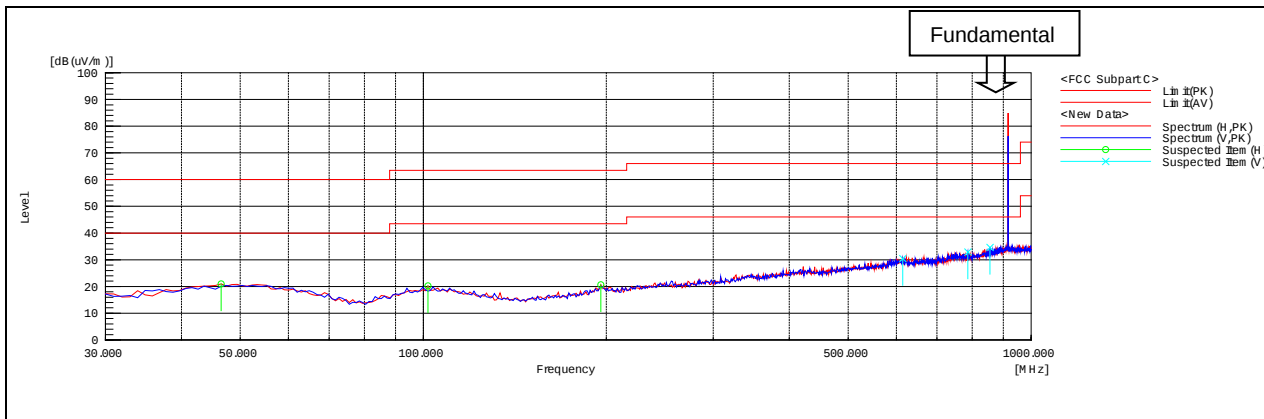
The following table shows the highest levels of radiated emissions.
The frequency spectrum from 9 kHz to 10 GHz was investigated.

Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
46.49	27.90	Peak	H	19.65	-26.50	21.05	40.00	18.95
614.91	29.00	Peak	V	25.30	-23.89	30.41	46.00	15.59
786.60	29.50	Peak	V	26.63	-23.27	32.86	46.00	13.14
855.47	30.20	Peak	V	27.31	-22.81	34.70	46.00	11.30
Above 900.00	Not Detected	-	-	-	-	-	-	-

Remark;

1. Spurious emissions for all channels were investigated and almost the same below 1 GHz.
2. Reported spurious emissions are in **Low Channel** as worst case among other modes.
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 dB.

- Test plot



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

A. Low Channel (908.42 MHz)

Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
901.38	3.11	Peak	H	28.03	5.82	36.96	46.00	9.04
902.00	0.47	Peak	H	28.04	5.82	34.33	46.00	11.67

Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
6 359.27	40.79	Peak	V	34.60	-25.82	49.57	74.00	24.43
Above 6 400.00	Not detected	-	-	-			-	-

B. High Channel (916.00 MHz)

Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
928.00	1.49	Peak	H	28.30	5.91	35.70	46.00	10.30
929.22	3.15	Peak	H	28.30	5.90	37.35	46.00	8.65

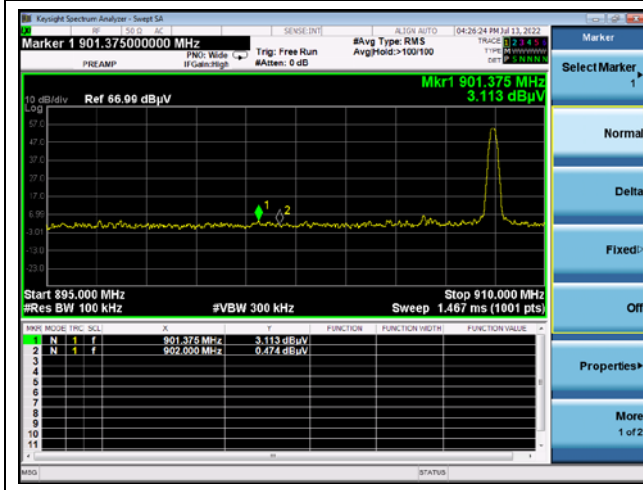
Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
6 412.31	38.91	Peak	V	34.60	-26.04	47.47	74.00	26.53
Above 6 500.00	Not detected	-	-	-			-	-

Remarks;

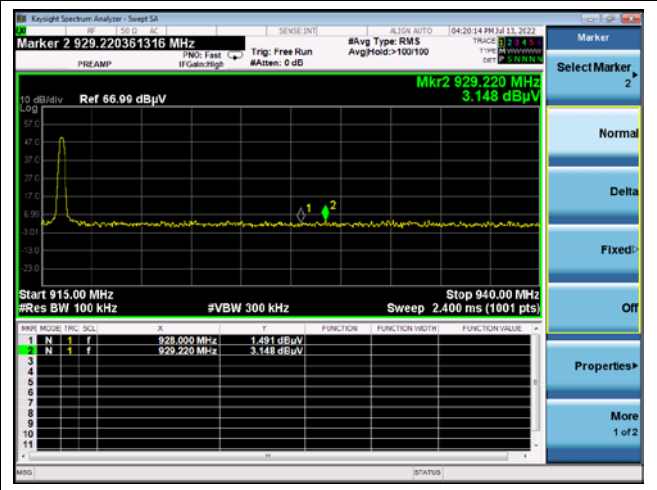
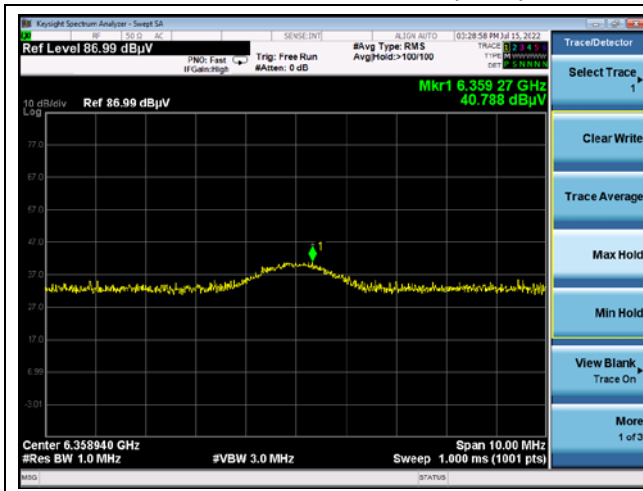
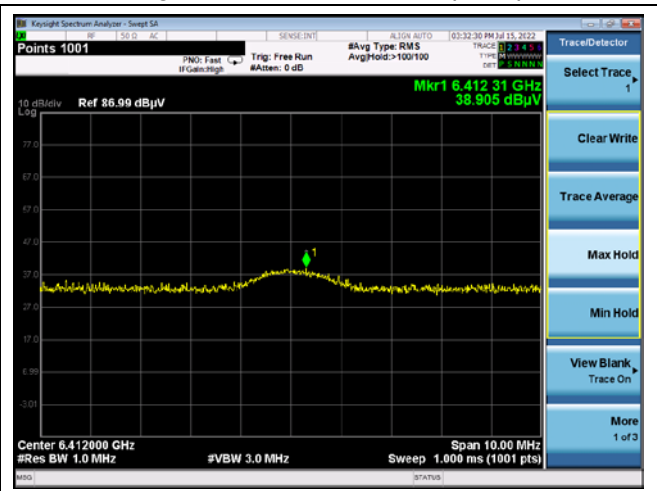
1. “*” means the restricted band.
2. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
3. Actual = Reading + AF + AMP + CL.
4. According to § 15.31(o), emission levels are not reported much lower than the limits by over 20 dB.
5. The maximized peak measured value complies with the average limit, to perform an average measurement is unnecessary.

- Test plot

Low channel band edge (Peak)

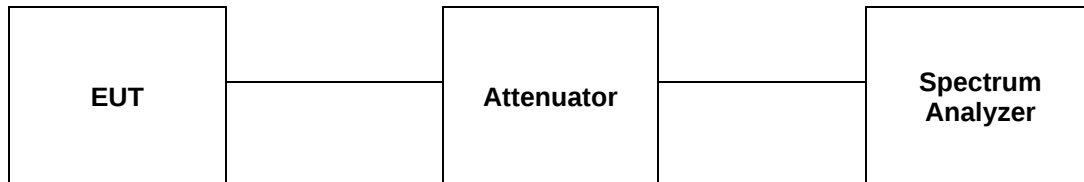


High channel band edge (Peak)


Low channel 7th harmonic (Peak)

High channel 7th harmonic (Peak)


3. 20 dB Bandwidth & 99% Bandwidth

3.1. Test Setup



3.2. Limit

Limit: Not Applicable

3.3. Test Procedure

3.3.1. 20 dB Bandwidth

The test follows ANSI C63.10-2013.

The 20 dB 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:

1. Span = approximately 2 to 5 times the 20 dB bandwidth.
2. RBW $\geq 1\%$ to 5 % of the 20 dB bandwidth.
3. VBW $\geq 3 \times$ RBW
4. Sweep = auto
5. Detector = peak
6. 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 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.

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.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

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).

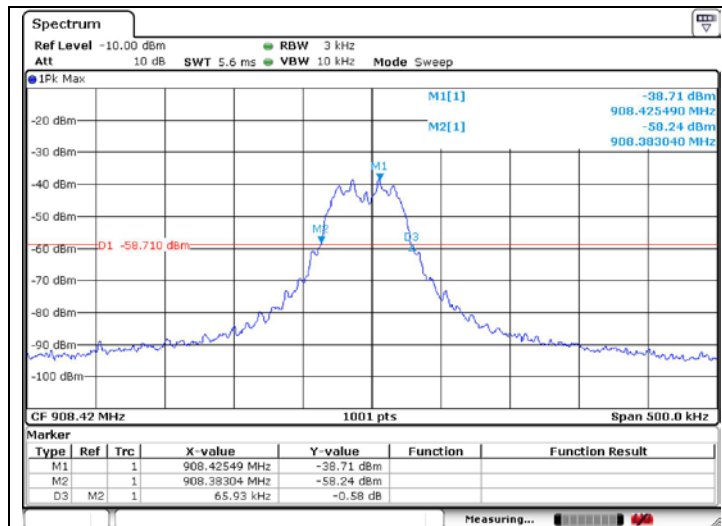
3.4. Test Results

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

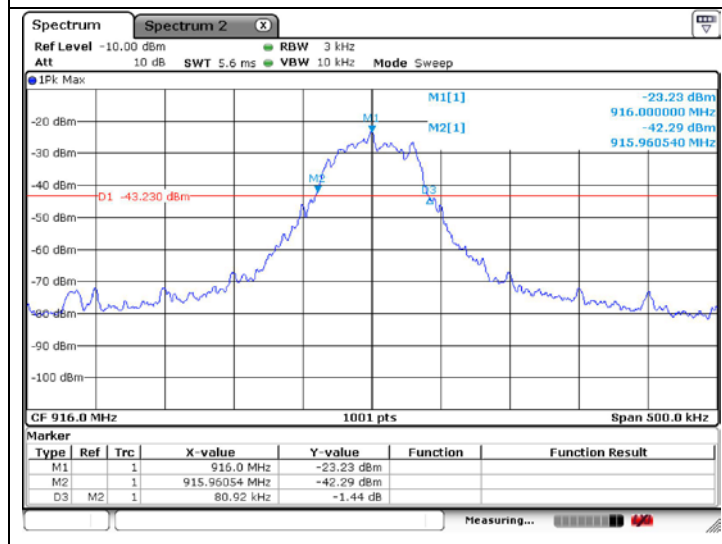
Operation Mode	Channel	Frequency (MHz)	20 dB Bandwidth (kHz)	99% Bandwidth (kHz)
Z-wave	Low	908.42	65.930	60.058
	High	916.00	80.920	74.530

- Test plots
20 dB Bandwidth

Low Channel

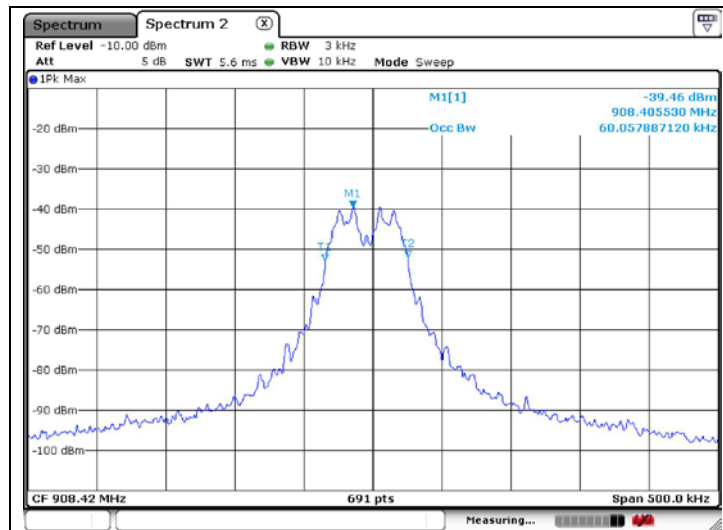


High Channel

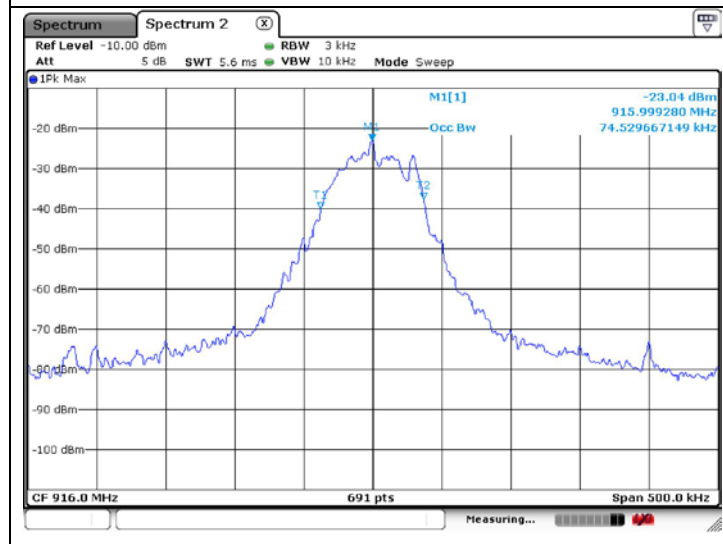


99% Bandwidth

Low Channel



High Channel



- End of the Test Report -