

FCC EVALUATION REPORT FOR CERTIFICATION

Manufacturer: Unitrust Development Co., Ltd.**21, Yongsugongdan 2-gil,
Jeonggwan-eup Gijang-gun, Busan
South Korea****Attn: Young-seung, Choi / CEO****Date of Issue: Oct. 08, 2018****Order Number: GETEC-C1-18-319****Test Report Number: GETEC-E3-18-018****Test Site: GUMI UNIVERSITY EMC CENTER****(Test firm Registration Number: 269701)****FCC ID. : 2ARG4IQKEYRC001****Applicant : Unitrust Development Co., Ltd.****Rule Part(s) : FCC Part 15 Subpart C-Intentional Radiator § 15.247****Test Method : ANSI C63.10 (2013)****Equipment Class : Spread Spectrum Transmitter (DSS)****EUT Type : IQ KEY Receiver capsule****Type of Authority : Certification****Model Name : IQKEY-RC001**

This equipment has been shown to be in compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10 (2013)

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the vest of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Tested by,**Hyun Kim, Senior Engineer
GUMI UNIVERSITY EMC CENTER****Reviewed by,****Jae-Hoon Jeong, Technical Manager
GUMI UNIVERSITY EMC CENTER**



CONTENTS

1. GENERAL INFORMATION	4
2. INTRODUCTION	5
3. PRODUCT INFORMATION	6
3.1 DESCRIPTION OF EUT.....	6
3.2 DEFINITION OF MODELS	6
3.3 SUPPORT EQUIPMENT / CABLES USED	7
3.4 MODIFICATION ITEM(S)	7
4. ANTENNA REQUIREMENT - §15.203	8
4.1 DESCRIPTION OF ANTENNA.....	8
5. DESCRIPTION OF TESTS.....	8
5.1 TEST CONDITION.....	8
6. REFERENCES STANDARDS	8
7. SUMMARY OF TEST RESULTS	9
8. 20 DB BANDWIDTH MEASUREMENT	10
8.1 OPERATING ENVIRONMENT.....	10
8.2 TEST SET-UP (LAYOUT)	10
8.3 LIMIT	10
8.4 TEST EQUIPMENT USED.....	10
8.5 TEST TEST PROCEDURE	10
8.6 TEST RESULT	11
9. CONDUCTED MAXIMUM PEAK OUTPUT POWER MEASUREMENT.....	13
9.1 OPERATING ENVIRONMENT.....	13
9.2 TEST SET-UP (LAYOUT)	13
9.3 LIMIT	13
9.4 TEST EQUIPMENT USED.....	13
9.5 TEST PROCEDURE	13
9.6 TEST RESULT	14
10. CARRIER FREQUENCY SEPARATION MEASUREMENT	15
10.1 OPERATING ENVIRONMENT	15
10.2 TEST SET-UP (LAYOUT)	15
10.3 LIMIT	15
10.4 TEST EQUIPMENT USED.....	15
10.5 TEST PROCEDURE	15
10.6 TEST RESULT	16
11. NUMBER OF HOPPING FREQUENCIES MEASUREMENT	18
11.1 OPERATING ENVIRONMENT.....	18
11.2 TEST SET-UP (LAY-OUT).....	18
11.3 LIMIT	18
11.4 TEST EQUIPMENT USED	18
11.5 TEST PROCEDURE.....	18
11.6 TEST RESULT	19
12. AVERAGE TIME OF OCCUPANCY MEASUREMENT	20
12.1 OPERATING ENVIRONMENT	20



12.2 TEST SET-UP (LAYOUT)	20
12.3 LIMIT	20
12.4 TEST EQUIPMENT USED.....	20
12.5 TEST PROCEDURE	20
12.6 TEST RESULT	21
13. CONDUCTED SPURIOUS EMISSION & OUT OF BAND EMISSION	23
13.1 OPERATING ENVIRONMENT	23
13.2 TEST SET-UP (LAY-OUT).....	23
13.3 LIMIT	23
13.4 TEST EQUIPMENT USED	23
13.5 TEST PROCEDURE	23
13.6 TEST RESULT	24
14. AC POWER LINE CONDUCTED EMISSION	29
14.1 OPERATING ENVIRONMENT	30
14.2 TEST SET-UP	30
14.3 MEASUREMENT UNCERTAINTY.....	30
14.4 LIMIT	31
14.5 TEST EQUIPMENT USED.....	31
14.6 TEST DATA FOR CONDUCTED EMISSION	31
15. RADIATED SPURIOUS & RESTRICTED BAND EDGE EMISSION.....	32
15.1 OPERATING ENVIRONMENT	33
15.2 TEST SET-UP.....	33
15.3 MEASUREMENT UNCERTAINTY	33
15.4 LIMIT	34
15.5 TEST EQUIPMENT USED.....	34
15.6 TEST DATA FOR RADIATED SPURIOUS EMISSION.....	35
15.7 TEST DATA FOR RADIATED RESTRICTED BAND EDGE EMISSION	37
16. SAMPLE CALCULATIONS.....	38
16.1 EXAMPLE 1 :	38
16.2 EXAMPLE 2 :	38
17. RECOMMENDATION & CONCLUSION.....	39
APPENDIX A – ATTESTATION STATEMENT	
APPENDIX B – LABELLING	
APPENDIX C – BLOCK DIAGRAM	
APPENDIX D – SCHEMATIC DIAGRAM	
APPENDIX E – TEST SETUP PHOTOGRAPH	
APPENDIX F – EXTERNAL PHOTOGRAPH	
APPENDIX G – INTERNAL PHOTOGRAPH	
APPENDIX H – USER’S MANUAL	
APPENDIX I – OPERATIONAL DESCRIPTION	
APPENDIX J – ANTENNA SPECIFICATION	
APPENDIX K – PART LIST	
APPENDIX L – RF EXPOSURE EVALUATION	



Scope: Measurement and determination of electromagnetic emissions (EME) of radio frequency devices including intentional and / or unintentional radiators for compliance with technical rules and regulations of the Federal Communications Commission.

1. General Information

Applicant: Unitrust Development Co., Ltd.

Applicant Address: 21, Yongsugongdan 2-gil, Jeonggwan-eup Gijang-gun, Busan, Korea

Manufacturer: Unitrust Development Co., Ltd.

Manufacturer Address: 21, Yongsugongdan 2-gil, Jeonggwan-eup Gijang-gun, Busan, Korea

Contact Person: Young-seung, Choi / CEO

Telephone Number: +82-51-464-7447 **Fax Number:** +82-51-467-7070

● FCC ID.	2ARG4IQKEYRC001
● Equipment Class	Spread Spectrum Transmitter (DSS)
● EUT Type	IQ KEY Receiver capsule
● Model Name	IQKEY-RC001
● Rule Part(s)	FCC Part 15 Subpart C-Intentional Radiator § 15.247
● Test Method	ANSI C63.10 (2013)
● Type of Authority	Certification
● Test Procedure(s)	ANSI C63.10 (2013)
● Dates of Test	May 03 ~ Sep. 04, 2018
● Place of Test	GUMI UNIVERSITY EMC CENTER (FCC Test firm Registration No.: 269701) 37 Yaeun-ro, Gumi-si, Gyeongsangbuk-do, 730-711, Republic of Korea
● Test Report Number	GETEC-E3-18-018
● Dates of Issue	Oct. 08, 2018



2. Introduction

The measurement procedure described in American National Standard for Methods of Measurement of Radio-Nose Emissions From Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2009) was used in determining radiated and conducted emissions emanating from **Unitrust Development Co., Ltd. IQ KEY Receiver capsule (Model name: IQKEY-RC001)**

These measurement tests were conducted at **GUMI UNIVERSITY EMC CENTER.**

The site address is 37 Yaeun-ro, Gumi-si, Gyeongsangbuk-do, 730-711, Republic of Korea

This test site is one of the highest point of GUMI UNIVERSITY at about 200 kilometers away from Seoul city and 40 kilometers away from Daegu city. It is located in the valley surrounded by mountains in all directions where ambient radio signal conditions are quiet and a favorable area to measure the radio frequency interference on open field test site for the computing and ISM devices manufactures. The detailed description of the measurement facility was found to be in compliance with the requirements of §2.948 according to ANSI C63.10 (2013)

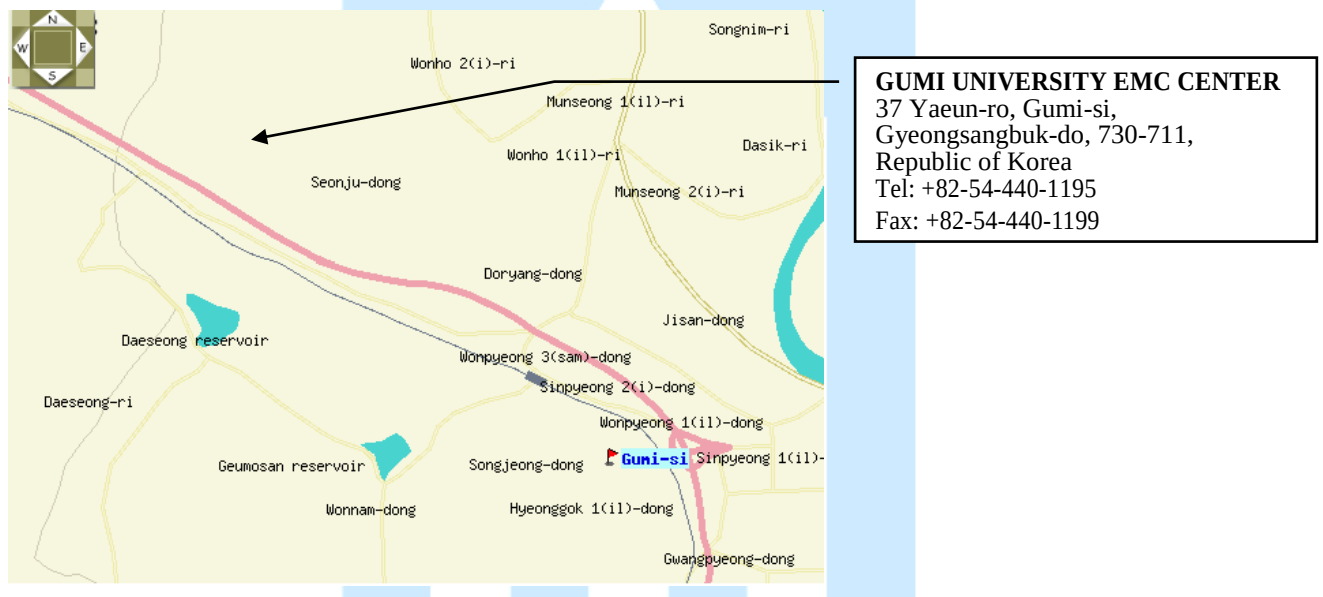


Fig 1. The map above shows the Gumi University in vicinity area.



3. Product Information

3.1 Description of EUT

The Equipment under Test (EUT) is the **Unitrust Development Co., Ltd. IQ KEY Receiver capsule**
(Model Name: IQKEY-RC001) FCC ID.: 2ARG4IQKEYRC001

- Equipment	: IQ KEY Receiver capsule
- Model name	: IQKEY-RC001
- Serial number	: Proto type
- Electrical Rating	: DC 6 V
- Manufacturer	: Unitrust Development Co., Ltd.
- Channel Separations	: 1 MHz
- Type of Modulation	: GFSK
- Channel frequency	: 2 405 MHz ~ 2 475 MHz
- Number of channel	: 71
- Type of chain	: One
- Antenna specification	: Manufacturer: Unitrust Development Co., Ltd. Antenna type : Printed antenna Gain : 2 dBi

3.2 Definition of models

-None.



3.3 Support Equipment / Cables used

3.3.1 Used Support Equipment

Description	Manufacturer	Model Name	S/N & FCC ID.
-	-	-	-

3.3.2 System configuration

Description	Manufacturer	Model Name	S/N & FCC ID.
-	-	-	-

3.3.3 Used Cable(s)

Cable Name	Condition	Description
-	-	-

3.4 Modification Item(s)

-. None



4. Antenna Requirement - §15.203

An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the applicant can be used with the device. The use of permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with this requirement.

4.1 Description of Antenna

The **Unitrust Development Co., Ltd. IQ KEY Receiver capsule**. comply with the requirement of §15.203 with a PCB printed antenna permanently attached to the transmitter.

5. Description of tests

5.1 Test Condition

The EUT was installed, arranged and operated in a manner that is most representative of equipment as typically used.

The measurements were carried out while varying operating modes and cable positions within typically arrangement to determine maximum emission level.

The representative and worst test mode(s) were noted in the test report.

- Test Voltage / Frequency: 6 V / DC
- Operating condition during the test(s) :
 - Continuous RF transmitting mode with nominal maximum RF output power.
 - Operating channel frequency and modulation technology

Mode	Available channel	Frequency	Modulation Technology
Other short range device	1 ~ 71	2405 ~ 2475 MHz	GFSK

- EUT set condition (RF power setting value)

Test Software	None
Test Software version	-

6. References Standards

- FCC Part 15 (2009) Subpart C-Intentional Radiator §15.247
- ANSI C 63.10 (2013): American National Standard for Testing Unlicensed Wireless Devices



7. SUMMARY OF TEST RESULTS

FCC Part Section(s)	Test Description	Test Result
§15.247(a)(1)	20 dB Bandwidth	Pass
§15.247(a)(1)	Carrier Frequency Separation	Pass
§15.247(a)(1)(iii)	Number of Hopping Frequencies	Pass
§15.247(a)(1)(iii)	Average Time of Occupancy	Pass
§15.247(b)(1)	Conducted Maximum Peak Output Power	Pass
§15.247(d)	Conducted Out of Band Emission Emissions	Pass
§15.207(a)	AC Power line Conducted Emissions	N/A ¹⁾
§15.205, 15.209	Radiated Spurious Emissions	Pass
§15.247(d), 15.205, 15.209	Radiated Restricted Band Edge	Pass

1) The EUT powered by internal battery.

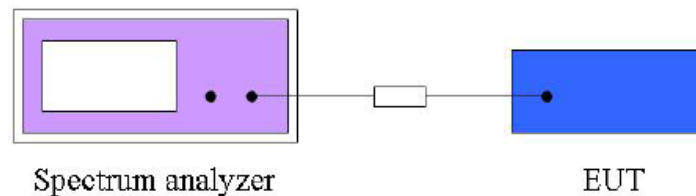


8. 20 dB Bandwidth Measurement

8.1 Operating environment

Temperature : 24.1 °C
Relative Humidity : 59.4 % R.H.

8.2 Test Set-up (Layout)



8.3 Limit

For frequency hopping systems, the minimum 20 dB bandwidth shall be at least 25 kHz

8.4 Test Equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ - FSV	Rohde & Schwarz	Spectrum Analyzer	101552	Apr. 16, 2019
■ - 10 dB Attenuator	Rohde & Schwarz	Attenuator 10 dB	SEP-10-14-046	Apr. 17, 2019
■ - WMS 32	Rohde & Schwarz	Testing Software	VER10.20.01	N/A

8.5 Test Test Procedure

- Set RBW = the range of 1% to 5% of the OBW.
- Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
- Detector = Peak.
- Trace mode = max hold.
- Sweep time = auto couple.
- Span = between two times and five times the OBW
- Allow the trace to stabilize.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 20 dB relative to the maximum level measured in the fundamental emission.

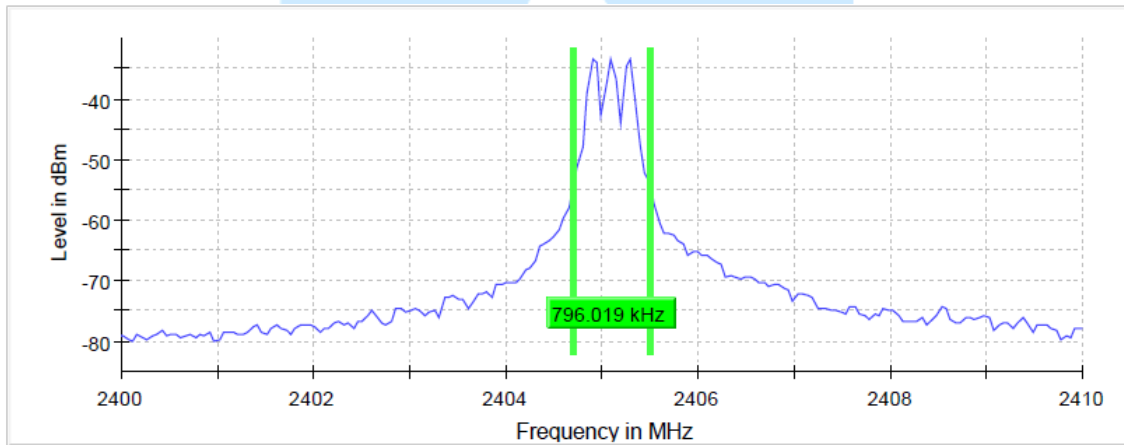


8.6 Test result

- Test Date : Sep. 04, 2018
- Reference Standard : Part 15 Subpart C, Sec. 15.247(a)(1)
- Test Procedure(s) : ANSI C63.10 (2013)
- Operating Condition : RF transmitting mode (1 ch: 2 405 MHz, 37 ch: 2 440 MHz, 71 ch: 2 475 MHz)
- Power Source : DC 6.0 V

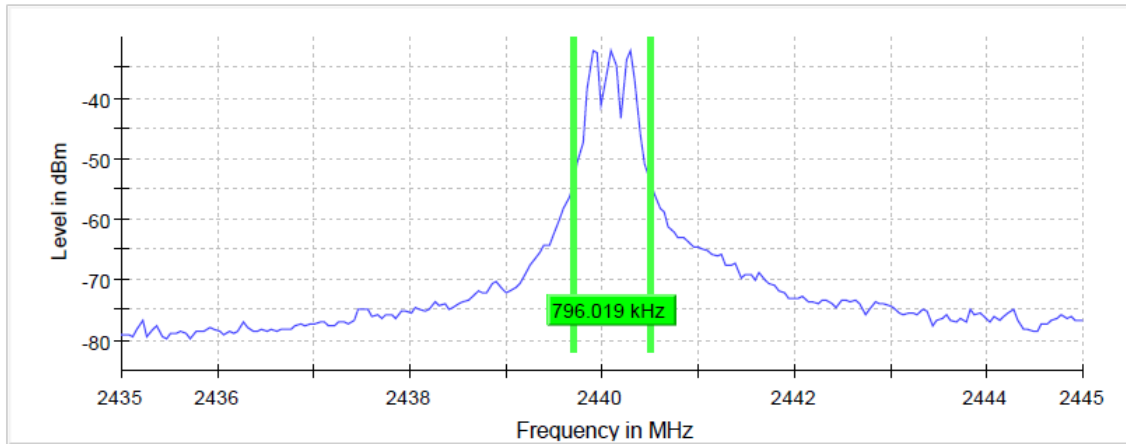
Frequency (MHz)	20 dB Bandwidth (MHz)	Min. Limit (kHz)	Result
2 405	0.796	25.0	Complies
2 440	0.796	25.0	Complies
2 475	0.796	25.0	Complies

20 dB Bandwidth Plot on Configuration : 1ch

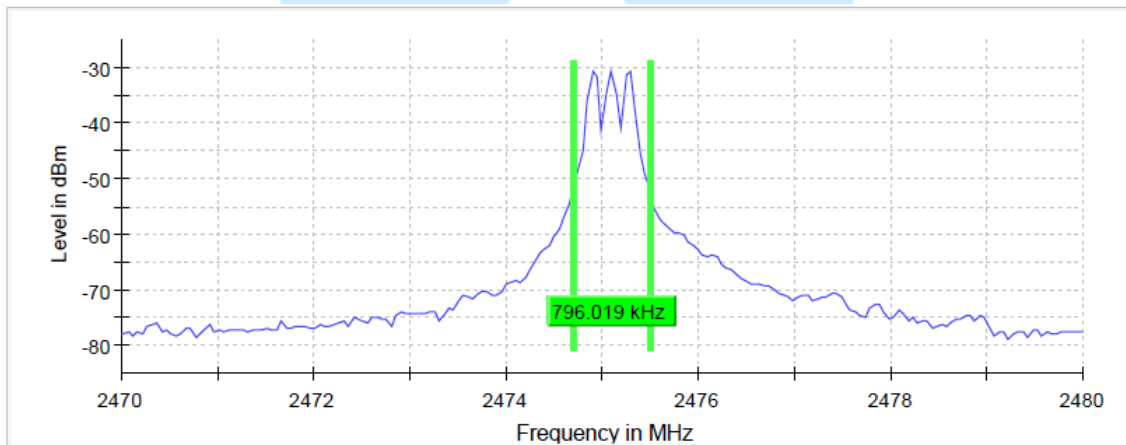




20 dB Bandwidth Plot on Configuration : 37ch



20 dB Bandwidth Plot on Configuration : 71ch



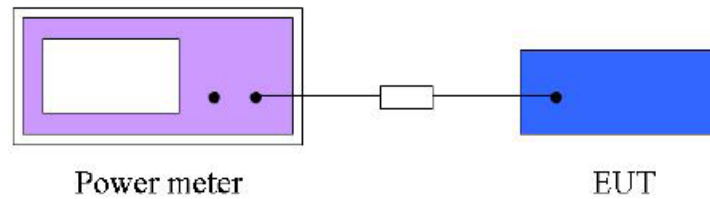


9. Conducted Maximum Peak Output Power Measurement

9.1 Operating environment

Temperature : 24.1 °C
Relative Humidity : 59.4 % R.H.

9.2 Test Set-up (Layout)



9.3 Limit

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band 0.125 watts.

9.4 Test Equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ - FSV	Rohde & Schwarz	Spectrum Analyzer	101552	Apr. 16, 2019
■ - 10 dB Attenuator	Rohde & Schwarz	Attenuator 10 dB	SEP-10-14-046	Apr. 17. 2019
■ - WMS 32	Rohde & Schwarz	Testing Software	VER10.20.01	N/A

9.5 Test Procedure

A peak power sensor was used on the output port of the EUT. A power meter was used to read the response of the peak power sensor. Record the power level.



9.6 Test Result

- Test Date : Sep. 04, 2018
- Reference Standard : Part 15 Subpart C, Sec. 15.247(b)(1)
- Test Procedure(s) : ANSI C63.10 (2013)
- Operating Condition : RF transmitting mode (1 ch: 2 405 MHz, 37 ch: 2 440 MHz, 71 ch: 2 475 MHz)
- Power Source : DC 6.0V

Frequency (MHz)	Average Conducted Power ¹⁾ (dBm)	Peak Conducted Power (dBm)	Max. Limit (dBm)	Result
2 405	- 33.7	- 31.4	30.00	Complies
2 440	- 32.5	- 31.0	30.00	Complies
2 475	- 32.3	- 31.0	30.00	Complies

Note: 1) The Average output power is reference data for RF Exposure.

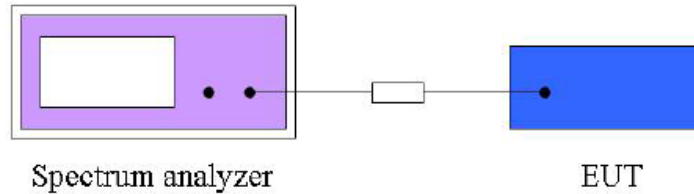


10. Carrier Frequency Separation Measurement

10.1 Operating Environment

Temperature : 24.1 °C
Relative Humidity : 59.4 % R.H.

10.2 Test Set-up (Layout)



10.3 Limit

Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.

10.4 Test Equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ - FSV	Rohde & Schwarz	Spectrum Analyzer	101552	Apr. 16, 2019
■ - 10 dB Attenuator	Rohde & Schwarz	Attenuator 10 dB	SEP-10-14-046	Apr. 17, 2019
■ - WMS 32	Rohde & Schwarz	Testing Software	VER10.20.01	N/A

10.5 Test Procedure

- Span : Wide enough to capture the peaks of two adjacent channels.
- RBW : Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
- VBW $\geq$ RBW
- Sweep : Auto
- Detector = peak.
- Trace mode = max hold.
- Allow trace to fully stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Compliance of EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

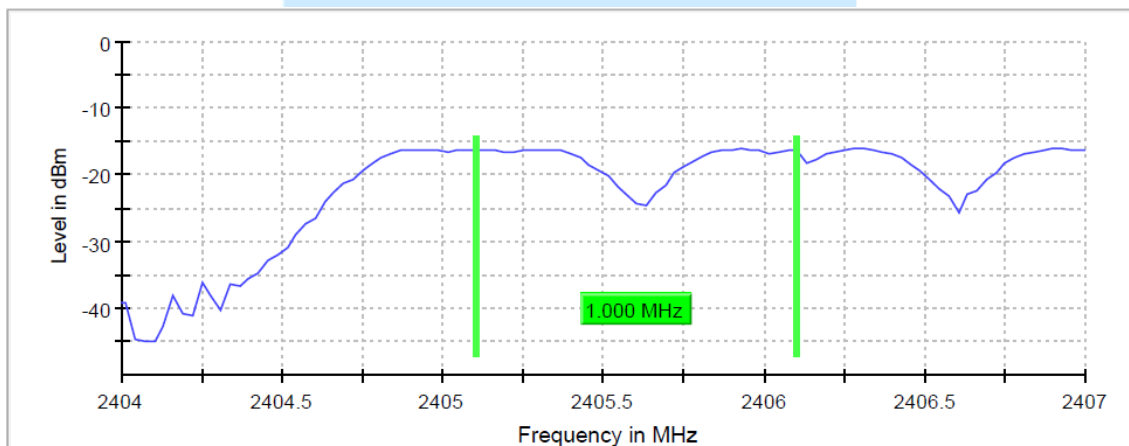


10.6 Test Result

- Test Date : Sep. 04, 2018
- Reference Standard : Part 15 Subpart C, Sec. 15.247(a)(1)
- Test Procedure(s) : ANSI C63.10 (2013)
- Operating Condition : RF transmitting mode (1 ch: 2 405 MHz, 37 ch: 2 440 MHz, 71 ch: 2 475 MHz)
- Power Source : DC 6.0 V

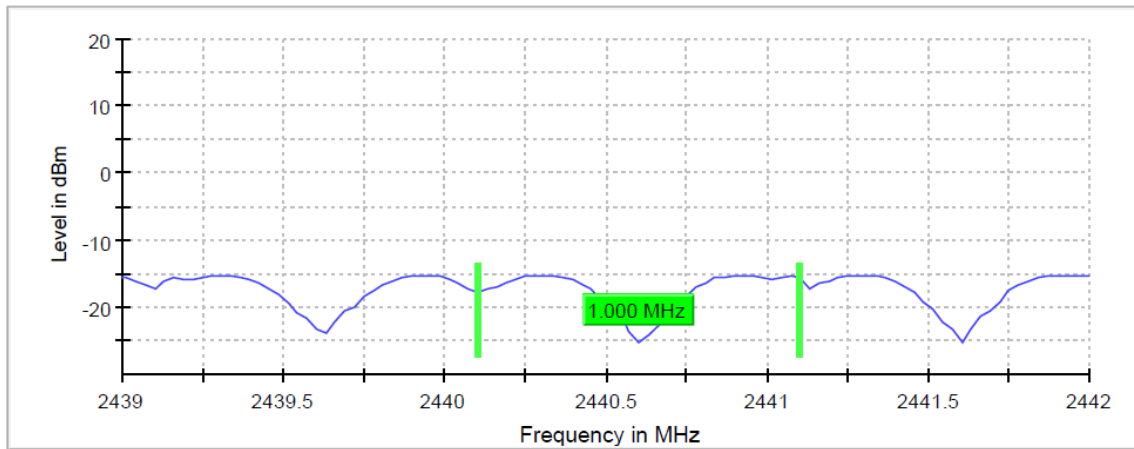
Frequency	Frequency Separation (MHz)	(2/3 of 20 dB BW) Limit (MHz)	Result
2 405 MHz	1.00	0.53	Complies
2 440 MHz	1.00	0.53	Complies
2 475 MHz	1.00	0.53	Complies

Carrier Frequency Separation Plot on configuration : 1ch

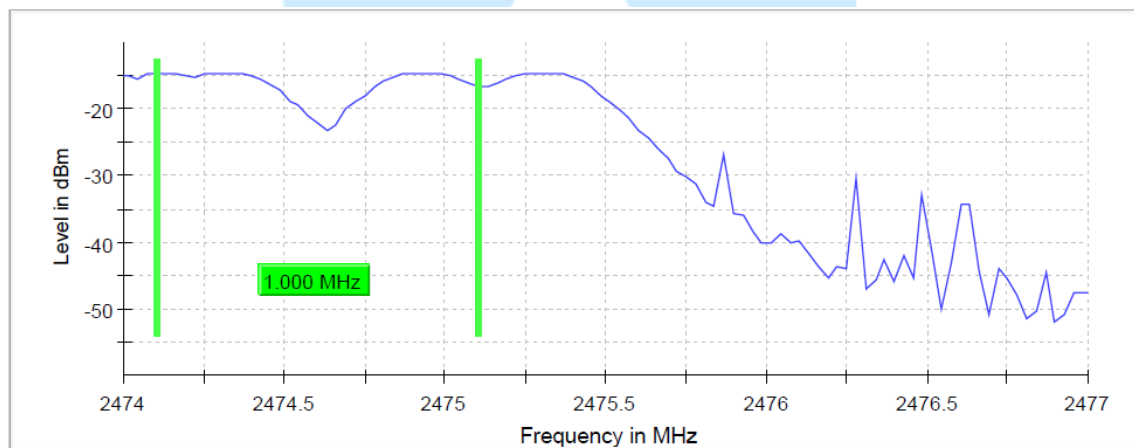




Carrier Frequency Separation Plot on configuration : 37ch



Carrier Frequency Separation Plot on configuration : 71ch



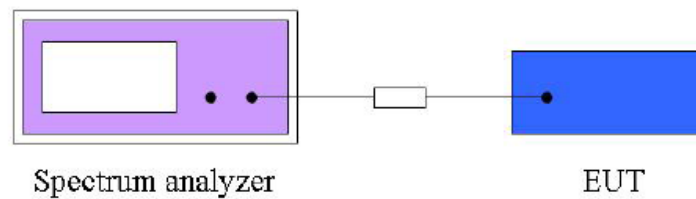


11. Number of Hopping Frequencies Measurement

11.1 Operating environment

Temperature : 24.1 °C
Relative Humidity : 59.4 % R.H.

11.2 Test set-up (Lay-out)



11.3 Limit

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

11.4 Test equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ - FSV	Rohde & Schwarz	Spectrum Analyzer	101552	Apr. 16, 2019
■ - 10 dB Attenuator	Rohde & Schwarz	Attenuator 10 dB	SEP-10-14-046	Apr. 17. 2019
■ - WMS 32	Rohde & Schwarz	Testing Software	VER10.20.01	N/A

11.5 Test Procedure

- Span : The frequency band of operation. Depending on the number of channels the device supports, it may necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
- RBW : To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
- $VBW \geq RBW$
- Sweep : Auto
- Detector function : Peak
- Trace : Max hold
- Allow the trace to stabilize

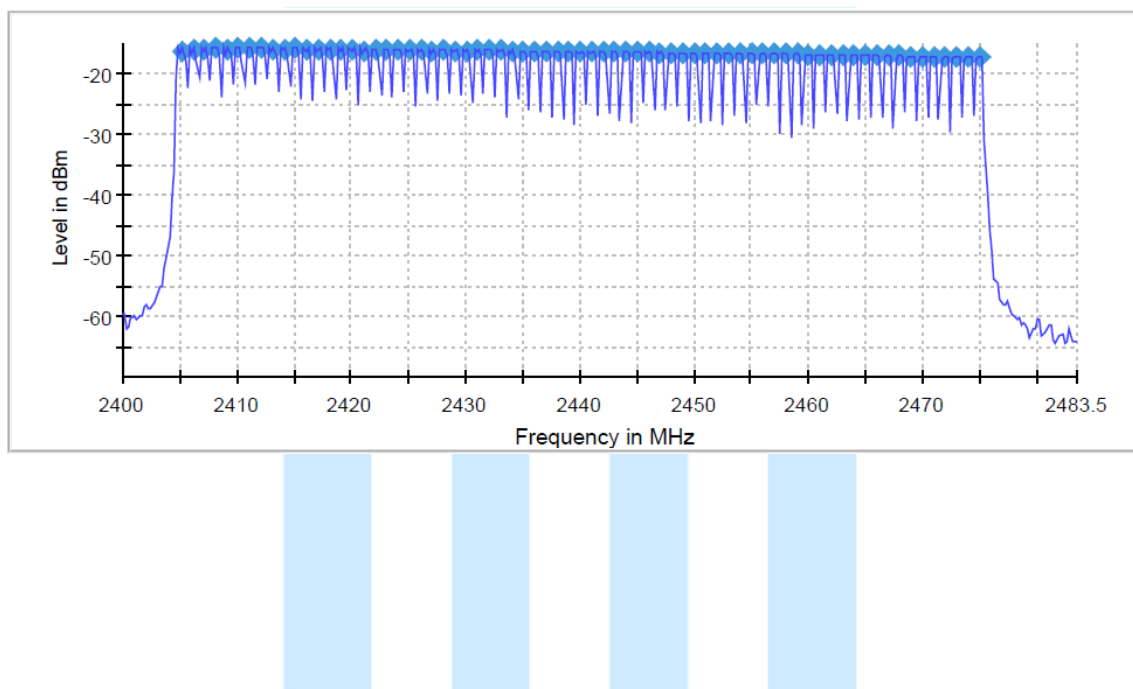


11.6 Test Result

- Test Date : Sep. 04, 2018
- Reference standard : Part 15 Subpart C, Sec. 15.247(a)(1)(iii)
- Test Procedure(s) : ANSI C63.10 (2013)
- Operating condition : RF transmitting mode (1 ch: 2 405 MHz, 37 ch: 2 440 MHz, 71 ch: 2 475 MHz)
- Power Source : DC 6.0 V

Number of Hopping Channel	Limit (Channel)	Result
71	>15	Complies

Number of Hopping Frequencies Plot on configuration



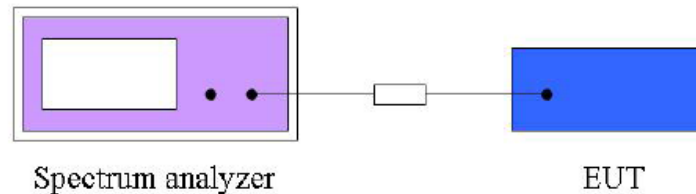


12. Average time of occupancy Measurement

12.1 Operating Environment

Temperature : 24.1 °C
Relative Humidity : 59.4 % R.H.

12.2 Test Set-up (Layout)



12.3 Limit

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

12.4 Test Equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ - FSV	Rohde & Schwarz	Spectrum Analyzer	101552	Apr. 16, 2019
■ - 10 dB Attenuator	Rohde & Schwarz	Attenuator 10 dB	SEP-10-14-046	Apr. 17, 2019
■ - WMS 32	Rohde & Schwarz	Testing Software	VER10.20.01	N/A

12.5 Test Procedure

- Span : Zero span, centered on a hopping channel.
- RBW shall be $\leq$ channel spacing and where possible RBW should be set $\gg 1/T$, where T is the expected dwell time per channel.
- Sweep : As necessary to capture the entire dwell time per hopping channel.
- Detector function : Peak.
- Trace : Max hold.

Use the marker-delta function to determine the transmit time per hop.

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements.

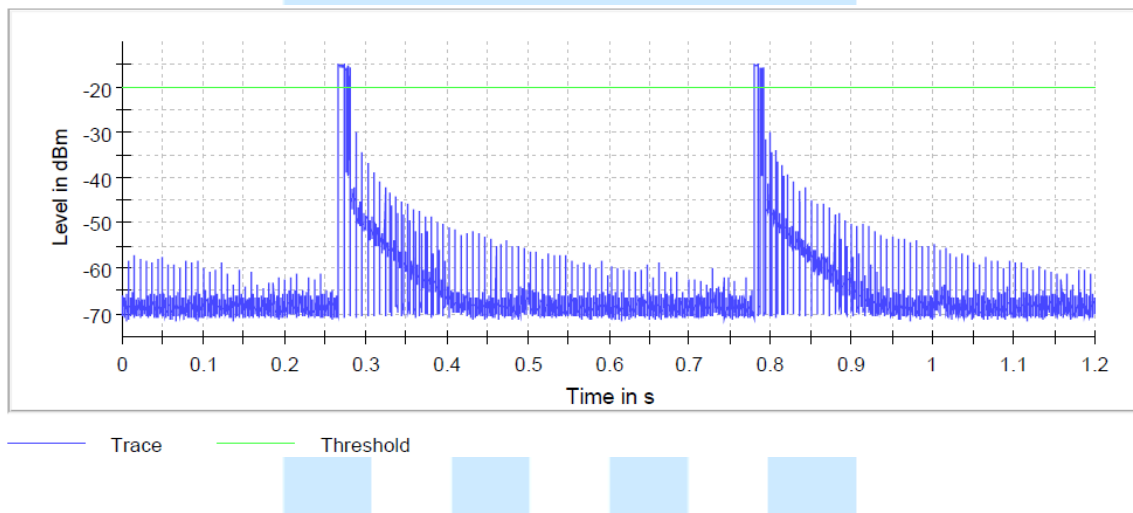


12.6 Test Result

- Test Date : Sep. 04, 2018
- Reference Standard : Part 15 Subpart C, Sec. 15.247(a)(1)(iii)
- Test Procedure(s) : ANSI C63.10 (2013)
- Operating Condition : RF transmitting mode (1 ch: 2 405 MHz, 37 ch: 2 440 MHz, 71 ch: 2 475 MHz)
- Power Source : DC 6.0V

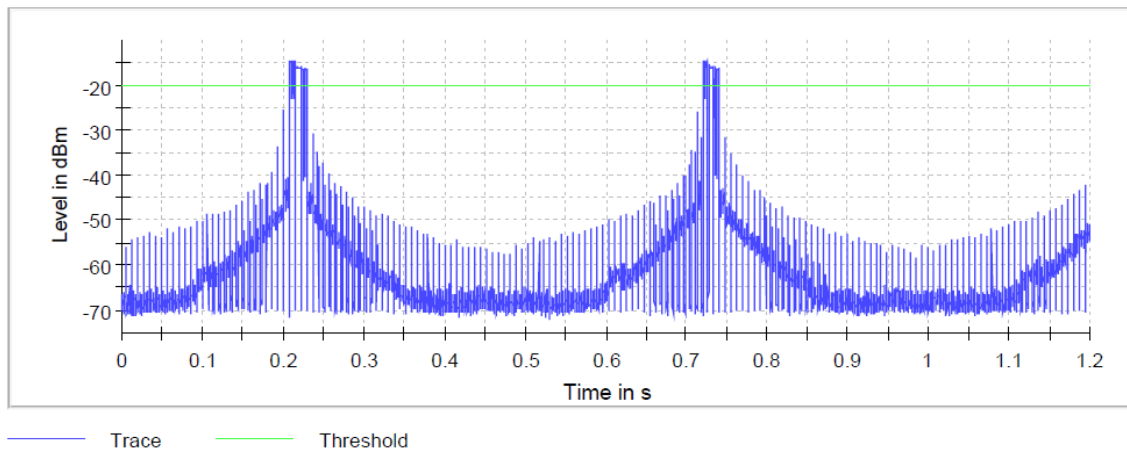
Frequency	Time (ms)	Threshold (dBm)	Limit (ms)	Result
2 405 MHz	18.17	- 20	400	Complies
2 440 MHz	23.56	- 20	400	Complies
2 475 MHz	25.82	- 20	400	Complies

Average time of occupancy Plot on Configuration : 1ch

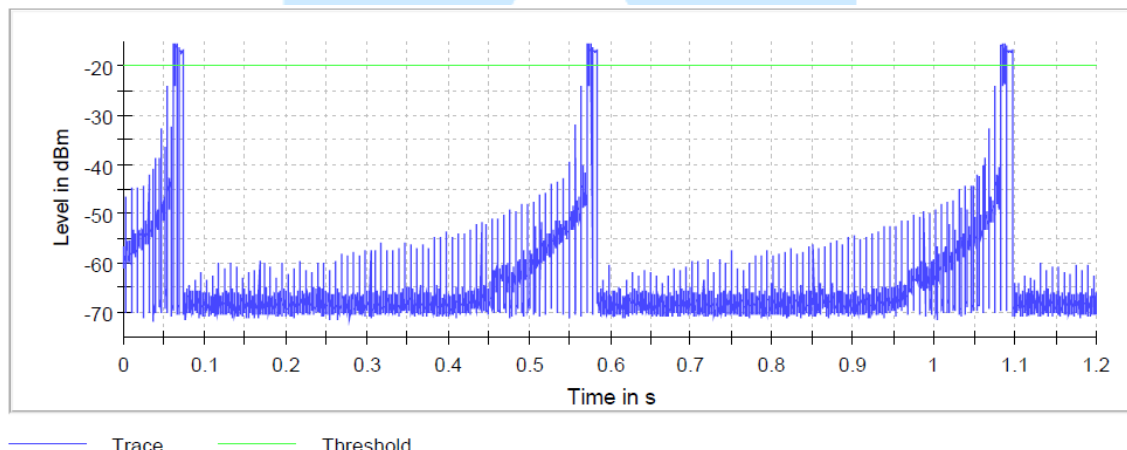




Average time of occupancy Plot on Configuration : 37ch



Average time of occupancy Plot on Configuration : 71ch



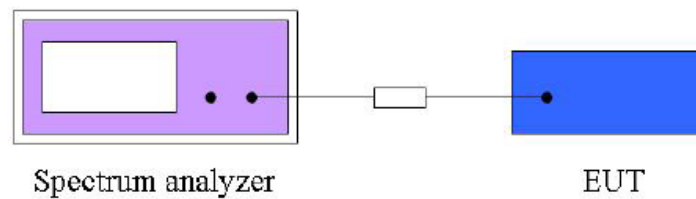


13. Conducted Spurious Emission & Out of Band Emission

13.1 Operating environment

Temperature : 24.1 °C
Relative Humidity : 59.4 % R.H.

13.2 Test set-up (Lay-out)



13.3 Limit

Below -20 dB of the highest emission level of operating band (in 100 kHz resolution band width)

13.4 Test equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ - FSV	Rohde & Schwarz	Spectrum Analyzer	101552	Apr. 16. 2018
■ - 56-10	Weinschel	10 dB Attenuator	53184	Apr. 17. 2018
■ - 10 dB Attenuator	Rohde & Schwarz	Attenuator 10 dB	SEP-10-14-046	Apr. 17. 2019
■ - WMS 32	Rohde & Schwarz	Testing Software	VER10.20.01	N/A

13.5 Test Procedure

- Span : 30 MHz to 10 times the operating frequency in GHz.
- Set the RBW to 100 kHz
- Set the VBW to 300 kHz
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.



13.6 Test Result

- Test Date : Sep. 04, 2018 ~ Sep. 05, 2018
- Reference standard : Part 15 Subpart C, Sec. 15.247(d)
- Test Procedure(s) : ANSI C63.10 (2013)
- Operating condition : RF transmitting mode (1 ch: 2 405 MHz, 37 ch: 2 440 MHz, 71 ch: 2 475 MHz)
- Power Source : DC 6.0 V

Conducted Spurious Emission

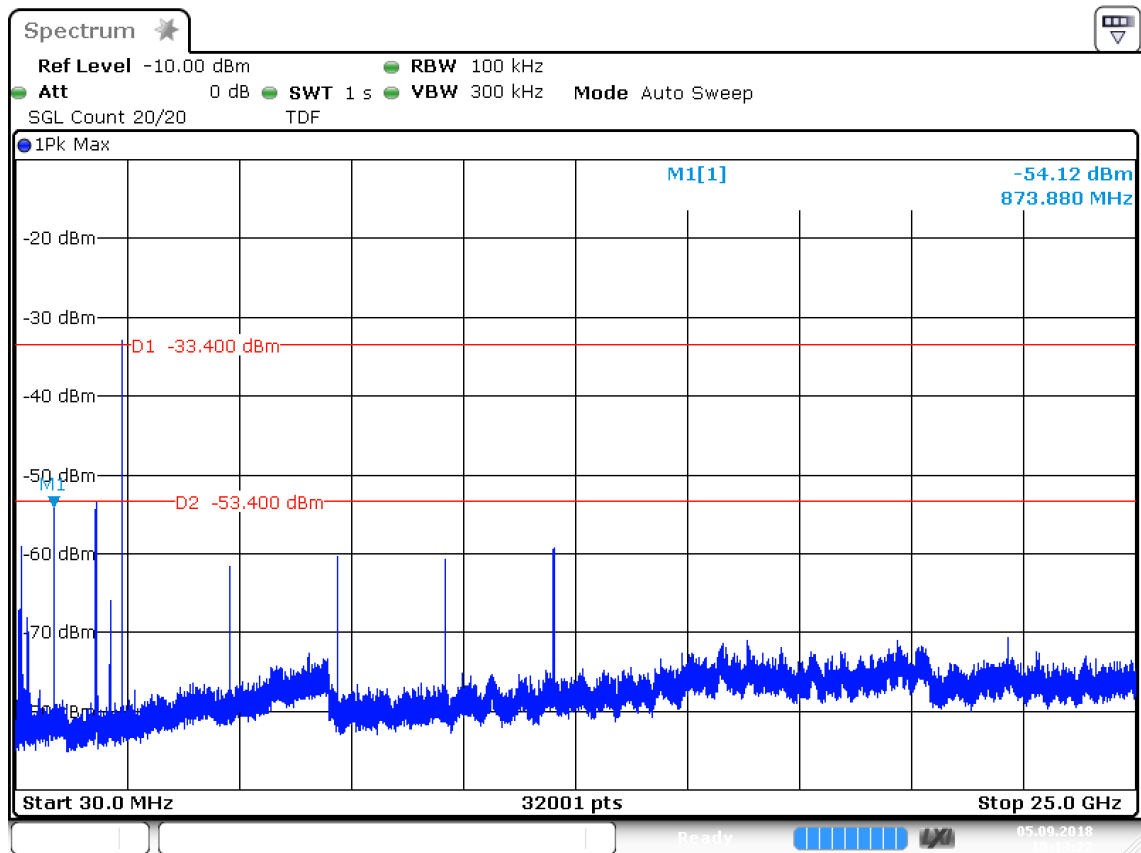
Operating Frequency	100 kHz PSD (dBm)	Spurious Level (dBm)	Deviation (dBc)	Limits (dBc)	Result
2 405 MHz	- 33.40	- 54.12	- 20.72	-20.00	Complies
2 440 MHz	- 31.23	- 53.26	- 22.03		Complies
2 475 MHz	- 30.80	- 51.34	- 20.54		Complies

Conducted Out of Band(Band Edge) Emission

Operating Frequency	100 kHz PSD (dBm)	Bandedge Level (dBm)	Deviation (dBc)	Limits (dBc)	Result
2 405 MHz	- 33.40	- 75.70	- 42.30	-20.00	Complies
2 475 MHz	- 30.80	- 77.40	- 46.60		Complies



Conducted spurious Emission Plot on Configuration : 1ch

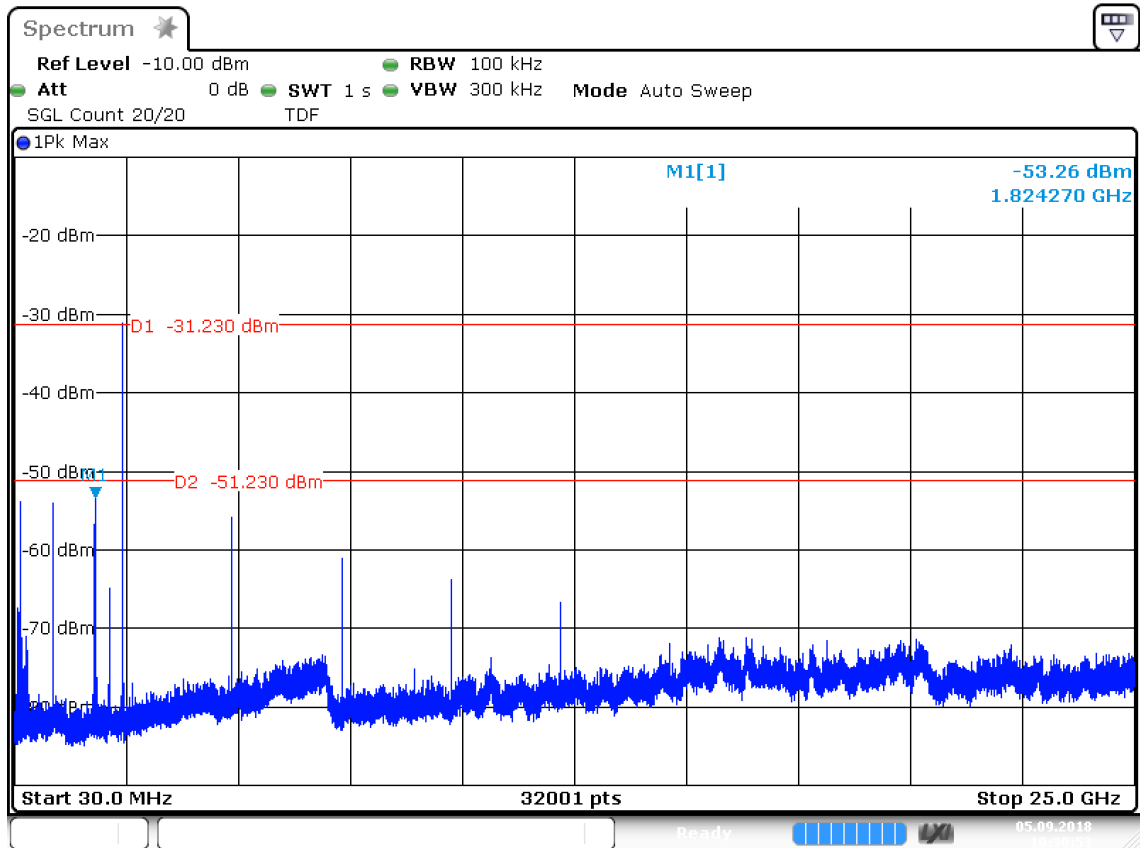


Date: 5.SEP.2018 10:13:23





Conducted spurious Emission Plot on Configuration : 37ch

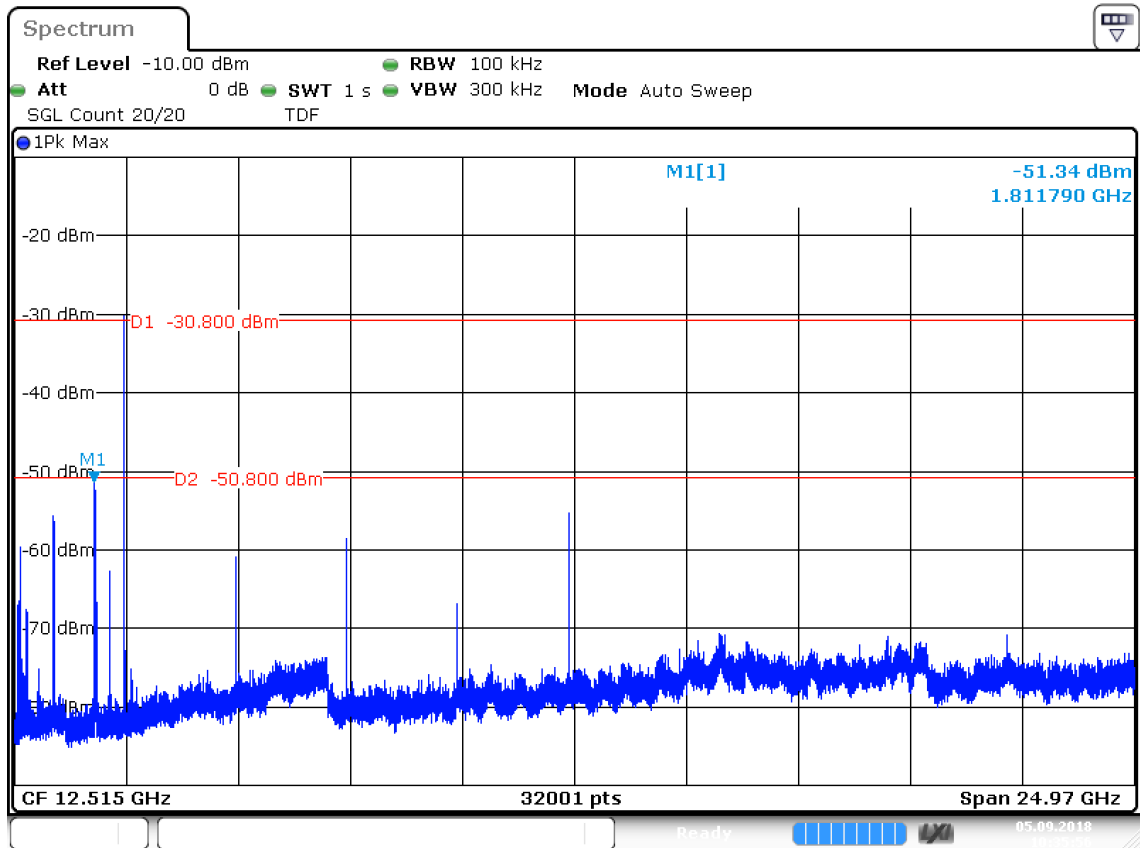


Date: 5.SEP.2018 10:30:53





Conducted spurious Emission Plot on Configuration : 71ch

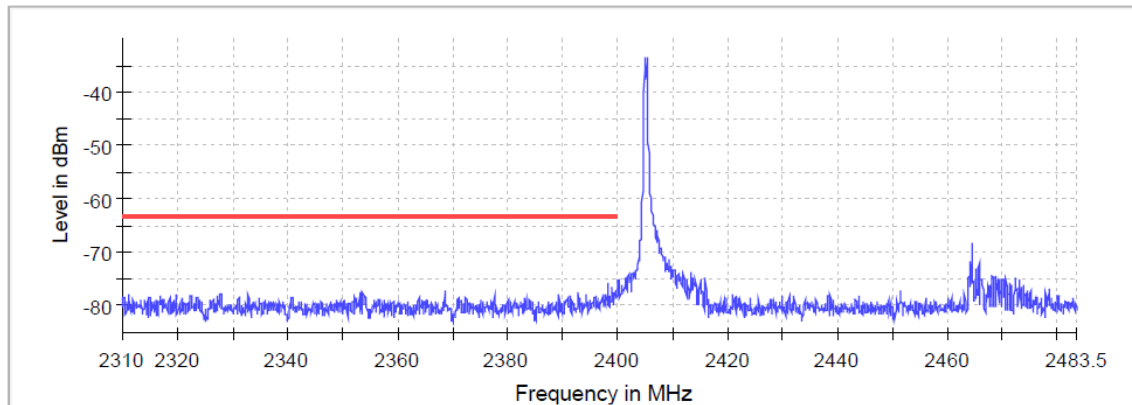


Date: 5.SEP.2018 10:35:56



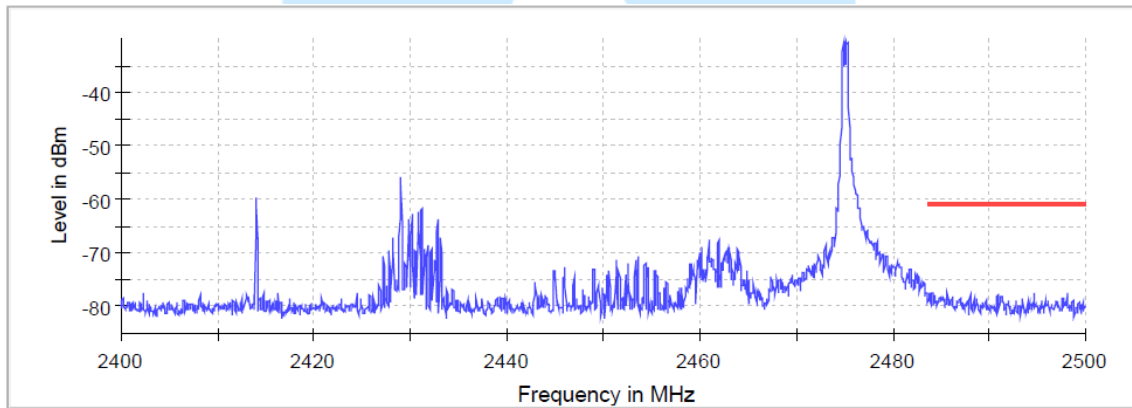


Low Band Edge Plot on Configuration : 1ch



— Limit — Sum Level × Fail

High Band Edge Plot on Configuration : 71ch



— Limit — Sum Level × Fail



14. AC Power line Conducted emission

-Test Description

The Line conducted emission test facility is inside a 4 m × 8 m × 2.5 m shielded enclosure. (Test firm Registration Number: 269701)

The EUT was placed on a non-conducting 1.0 m by 1.5 m table, which is 0.8 m in height and 0.4 m away from the vertical wall of the shielded enclosure.

The EUT is powered from the Rohde & Schwarz LISN (ENV216) and the support equipment is powered from the Rohde & Schwarz LISN (ENV216). Powers to the LISN are filtered by high-current high insertion loss power line filter.

Sufficient time for EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition.

The RF output of the LISN was connected to the EMI test receiver (Rohde & Schwarz, ESCI).

Exploratory measurements were conducted to identify the highest emission by operating the EUT in a range of typical modes of operation, cable positions, system configuration and arrangement.

Based on exploratory measurements, the final measurements were conducted at the worst test conditions.

Exploratory measurements were scanned using Peak mode of EMI Test receiver from 150 kHz to 30 MHz with 20 ms sweep time. The final measurements were measured with Quasi-Peak and Average mode.

The bandwidth of EMI Test Receiver was set to 9 kHz. Interface cables were connected to the available interface ports of the test unit. Excess cable lengths were bundled at center with 30 cm ~ 40 cm.

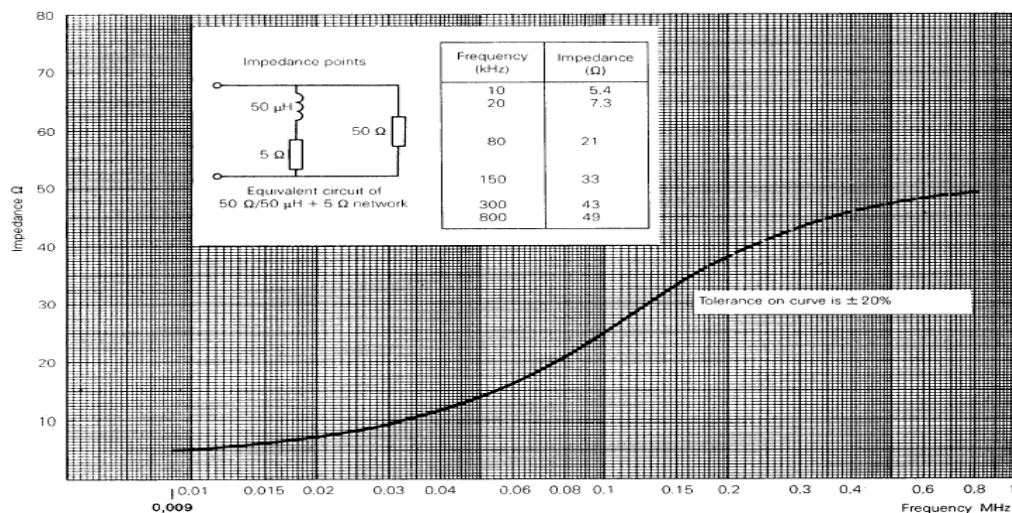


Fig 2. Impedance of LISN



14.1 Operating Environment

Temperature : - °C
Relative Humidity : - % R.H.

14.2 Test Set-up

The conducted emission measurements were performed in the shielded room.

The EUT was placed on wooden table, 0.8 m heights above the floor, 0.4 m from the reference ground plane (GRP) wall and 0.8 m from AMN & ISN.

AMN is bonded on horizontal reference ground plane.

The ground plane, which was electrically bonded to the shield room, ground system and all power lines entering the shield room, were filtered.

14.3 Measurement Uncertainty

The measurement uncertainty was calculated in accordance with ISO “Guide to the expression of uncertainty in measurement.”

The measurement uncertainty was given with a confidence of 95 %.

Test Items	Uncertainty	Remark
Conducted emission (9 kHz ~ 150 kHz)	3.85 dB	Confidence level of approximately 95 % ($k = 2$)
Conducted emission (150 kHz ~ 30 MHz)	3.32 dB	Confidence level of approximately 95 % ($k = 2$)



14.4 Limit

RFI Conducted	FCC Limit(dB μ V/m) Class B	
Freq. Range	Quasi-Peak	Average
150 kHz ~ 0.5 MHz	66 ~ 56*	56 ~ 46*
0.5 MHz ~ 5 MHz	56	46
5 MHz ~ 30 MHz	60	50
*Limits decreases linearly with the logarithm of frequency.		

14.5 Test Equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
☐ - ESCI	Rohde & Schwarz	EMI test receiver	100237	Apr 16. 2019
☐ - ENV216	Rohde & Schwarz	LISN	100172	Apr 12. 2019
☐ - ENV216	Rohde & Schwarz	LISN	100173	Apr 12. 2019
☐ - EMC 32	Rohde & Schwarz	Testing Software	VER8.53	N/A

14.6 Test data for Conducted Emission

- Test Date :
- Reference Standard :
- Test Procedure(s) :
- Operating Condition :
- Power Source :
- Frequency range :
- Line :
- Comment : Not Applicable

15. Radiated Spurious & Restricted Band Edge Emission

Exploratory Radiated measurements were conducted at the 3m semi anechoic chamber in order to identify the highest emission by operating the EUT in a range of typical modes of operation, cable positions, system configuration and arrangement.

Based on exploratory measurements, the final measurements were conducted at the worst test conditions.

Final measurements of below 1GHz were made at 3m or 10 m Chamber that complies with CISPR 16/ANSI C63.10. Above 1GHz final measurements were conducted at the 3m Chamber only.

For measurements above 1GHz, the bottom side of 3m chamber was installed with absorbers in order to meet SVSWR Limit.

Exploratory measurements were scanned using Peak mode of EMI Test receiver and final measurements were measured with Quasi-Peak mode (Below 1GHz) and Peak & Average mode (Above 1GHz).

The measurements were performed by rotating the EUT 360° and adjusting the receive antenna height from 1.0 m to 4.0 m. All frequencies were investigated in both horizontal and vertical antenna polarity.

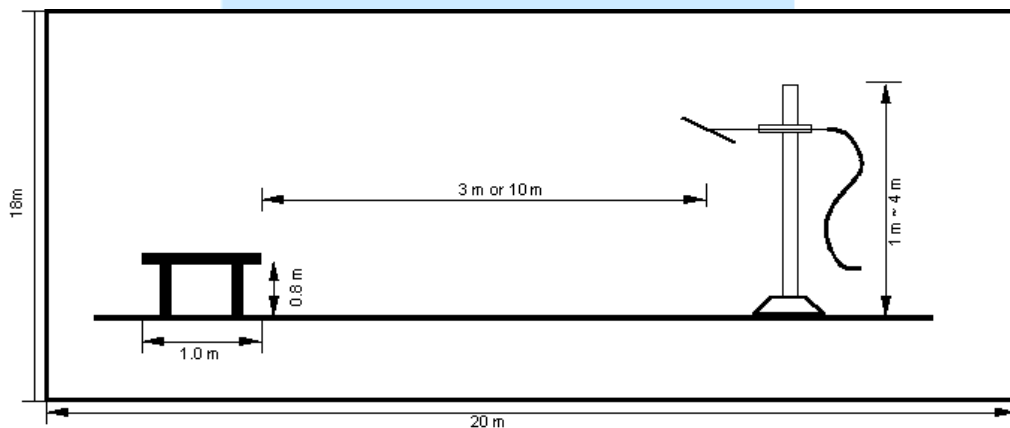


Fig 3. Dimensions of test site (Below 1GHz)

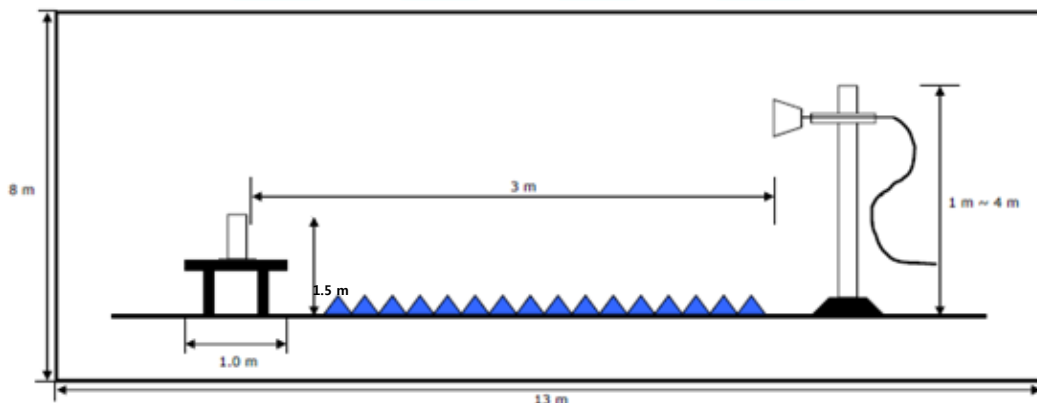


Fig 4. Dimensions of test site (Above 1GHz)



15.1 Operating environment

Temperature : 21.9 °C
Relative humidity : 37.9 % R.H.

15.2 Test set-up

A preliminary and final measurement was at 3 m anechoic chamber.

The EUT was placed on a non-conducting table.

For emissions testing at or below 1 GHz, the table height is 80 cm above the reference ground plane.

For emission measurements above 1 GHz, the table height is 1.5 m above the reference ground plane.

The turntable with EUT was rotated 360°, and the antenna was varied in height between 1.0 m and 4.0 m in order to determine the maximum emission levels.

This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

15.3 Measurement uncertainty

The measurement uncertainty was calculated in accordance with ISO “Guide to the expression of uncertainty in measurement”.

The measurement uncertainty was given with a confidence of 95 %.

Test items(Anechoic Chamber)	Uncertainty	Remark
Radiated emission (30 MHz ~ 300 MHz, 3 m, Vertical)	5.01 dB	Confidence level of approximately 95 % ($k = 2$)
Radiated emission (30 MHz ~ 300 MHz, 3 m, Horizontal)	5.01 dB	Confidence level of approximately 95 % ($k = 2$)
Radiated emission (300 MHz ~ 1 000 MHz, 3 m, Vertical)	5.10 dB	Confidence level of approximately 95 % ($k = 2$)
Radiated emission (300 MHz ~ 1 000 MHz, 3 m, Horizontal)	5.10 dB	Confidence level of approximately 95 % ($k = 2$)
Radiated emission (1 000 MHz ~ 6 000 MHz, 3 m, V/H)	4.53 dB	Confidence level of approximately 95 % ($k = 2$)
Radiated emission (6 000 MHz ~ 18 000 MHz, 3 m, V/H)	4.55 dB	Confidence level of approximately 95 % ($k = 2$)
Radiated emission (18 000 MHz ~ 26 000 MHz, 3 m, V/H)	5.40 dB	Confidence level of approximately 95 % ($k = 2$)

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2.

The listed uncertainties are the worst case uncertainty for the entire range of measurement. please note that the uncertainty values are provided for informational purposes only are not used in determining the PASS/FAIL results



15.4 Limit

20 dB in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a) limit in the table below has to be followed.

Frequencies (MHz)	Field Strength (microvolt/meter)	Measurement Distance (meters)
0.009 ~ 0.490	2 400/F (kHz)	300
0.490 ~ 1.705	2 400/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

15.5 Test Equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ - ESU40	Rohde & Schwarz	EMI Test Receiver	100266	Apr. 17, 2019
■ - HFH2-Z2	Rohde & Schwarz	Loop Antenna	100041	Dec. 06, 2019
■ - VULB9160	Schwarzbeck	Broadband Test Antenna	3099	Sep. 29, 2019
■ - BBHA9120D	Schwarzbeck	Horn Antenna	207	Sep. 29, 2018
■ - 3160-09	Schwarzbeck	Horn Antenna	LM3981	Feb. 01, 2019
■ - MCU066	maturo GmbH	Position Controller	1390306	N/A
■ - TT2.5SI	maturo GmbH	Turntable	1390307	N/A
■ - AM 4.0	maturo GmbH	Antenna Mast	1390308	N/A
■ - AFS 44 00101800-25-10P-44	MITEQ	Preamplifier	1258943	Apr. 18, 2019
■ - SCU-F1826-G47-BZ42-CSS	BONN Elektronik	Preamplifier	10003	Apr. 18, 2019
■ - WHKX3.0/18G-10SS	WAINWRIGHT INSTRUMENTS	High pass filter	SN31	Apr. 12, 2019
■- EMC 32	Rohde & Schwarz	Testing Software	VER9.15	N/A



15.6 Test data for Radiated Spurious Emission

- Test Date : May 03 ~ Jun. 15, 2018
- Reference Standard : Part 15 Subpart C, Sec. 15.247(d)
- Measuring Distance : 3 m
- Resolution Bandwidth : 200 Hz, 9 kHz(Below 30 MHz) / 120 kHz(30 MHz ~ 1GHz) / 1 MHz(Above 1GHz)
- Detector mode : Quasi Peak detector mode / Peak detector mode / Average detector mode
- Power Source : DC 6 V
- Note :

Radiated Spurious Emission (9 kHz to 30 MHz): 1ch

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas.Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
0.93	39.74	47.86	8.12	1000	9	100	V	256	19.1

Radiated Spurious Emission (9 kHz to 30 MHz): 37ch

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas.Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
0.93	37.92	47.88	9.96	1000	9	100	V	29	19.1

Radiated Spurious Emission (9 kHz to 30 MHz): 71ch

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas.Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
0.85	38.28	48.63	10.35	1000	9	100	V	166	19.1

Radiated Spurious Emission (30 MHz to 1 000 MHz): 1ch

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas.Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
48.05	32.53	40.00	7.47	1000	120	100	V	251	14.3
57.42	31.59	40.00	8.41	1000	120	100	V	136	13.7

Radiated Spurious Emission (30 MHz to 1 000 MHz): 37ch

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas.Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
48.02	34.26	40.00	5.74	1000	120	125	V	282	14.3

Radiated Spurious Emission (30 MHz to 1 000 MHz): 71ch

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas.Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
47.97	35.40	40.00	4.60	1000	120	100	V	132	14.3



Radiated Spurious Emission (1 GHz to 26 GHz): 1ch

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Frequency Component	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2 189.21	38.21	-	Other	74.00	35.79	1000	1000	139	H	10	- 9.2
2 189.21	-	25.37	Other	54.00	28.63	1000	1000	139	H	10	- 9.2
2 839.53	38.56	-	Other	74.00	35.44	1000	1000	175	H	340	- 8.5
2 839.53	-	26.28	Other	54.00	27.72	1000	1000	175	H	340	- 8.5
4 810.50	49.85	-	Harmonics	74.00	24.15	1000	1000	168	V	134	- 2.8
4 810.50	-	42.01	Harmonics	54.00	11.99	1000	1000	168	V	134	- 2.8
9 619.80	54.16	-	Harmonics	74.00	19.84	1000	1000	175	H	79	13.7
9 619.80	-	44.38	Harmonics	54.00	9.62	1000	1000	175	H	79	13.7
12 024.60	58.52	-	Harmonics	74.00	15.48	1000	1000	125	V	190	15.1
12 024.60	-	48.92	Harmonics	54.00	5.08	1000	1000	125	V	190	15.1

Radiated Spurious Emission (1 GHz to 26 GHz): 37ch

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Frequency Component	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2 312.01	41.69	-	Other	74.00	32.31	1000	1000	171	V	161	- 9.4
2 312.01	-	30.16	Other	54.00	23.84	1000	1000	171	V	161	- 9.4
2 600.36	40.43	-	Other	74.00	33.57	1000	1000	112	V	301	- 9.5
2 600.36	-	28.56	Other	54.00	25.44	1000	1000	112	V	301	- 9.5
7 320.80	50.22	-	Harmonics	74.00	23.78	1000	1000	113	H	337	6.1
7 320.80	-	39.25	Harmonics	54.00	14.75	1000	1000	113	H	337	6.1
12 199.60	55.07	-	Harmonics	74.00	18.93	1000	1000	175	V	288	15.2
12 199.60	-	43.64	Harmonics	54.00	10.36	1000	1000	175	V	288	15.2

Radiated Spurious Emission (1 GHz to 26 GHz): 71ch

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Frequency Component	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2 315.35	42.73	-	Other	74.00	31.27	1000	1000	110	V	169	- 9.4
2 315.35	-	32.78	Other	54.00	21.22	1000	1000	1100	V	169	- 9.4
9 899.60	54.98	-	Harmonics	74.00	19.02	1000	1000	125	H	206	14.6
9 899.60	-	44.22	Harmonics	54.00	9.78	1000	1000	125	H	206	14.6
12 374.60	55.68	-	Harmonics	74.00	18.32	1000	1000	157	H	256	14.9
12 374.60	-	45.79	Harmonics	54.00	8.21	1000	1000	157	H	256	14.9



15.7 Test data for Radiated Restricted Band Edge Emission

- Test Date : May 03, 2018
- Reference Standard : Part 15 Subpart C, Sec. 15.247(d)
- Measuring Distance : 3 m
- Resolution Bandwidth : 1 MHz
- Detector mode : Peak detector mode / Average detector mode
- Power Source : DC 6 V
- Note : Through three orthogonal axes were investigated and the worst case is report

Radiated Restricted Band Edge Emission: 1ch

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2 388.20	52.80	-	74.00	21.20	1000	1000	106	V	187	- 9.5
2 388.20	-	30.15	54.00	23.85	1000	1000	106	V	187	- 9.5

Radiated Restricted Band Edge Emission: 71ch

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2 484.31	54.81	-	74.00	19.19	1000	1000	109	V	170	- 9.5
2 484.31	-	33.34	54.00	20.66	1000	1000	109	V	170	- 9.5



16. Sample Calculations

$$\begin{aligned} \text{dB}\mu\text{V} &= 20 \text{ Log}_{10}(\mu\text{V}/\text{m}) \\ \text{dB}\mu\text{V} &= \text{dBm} + 107 \\ \mu\text{V} &= 10^{(\text{dB}\mu\text{V}/20)} \end{aligned}$$

16.1 Example 1 :

■ 20.3 MHz

Class B Limit	= 250 μV = 48 dB μV
Reading	= 39.2 dB μV
$10^{(39.2\text{dB}\mu\text{V}/20)}$	= 91.2 μV
Margin	= 48 dB μV - 39.2 dB μV = 8.8 dB

16.2 Example 2 :

■ 66.7 MHz

Class B Limit	= 100 $\mu\text{V}/\text{m}$ = 40.0 dB $\mu\text{V}/\text{m}$
Reading	= 31.0 dB μV
Antenna Factor + Cable Loss	= 5.8 dB
Total	= 36.8 dB $\mu\text{V}/\text{m}$
Margin	= 40.0 dB $\mu\text{V}/\text{m}$ - 36.8 dB $\mu\text{V}/\text{m}$ = 3.2 dB



17. Recommendation & Conclusion

The data collected shows that the **Unitrust Development Co., Ltd. IQ KEY Receiver capsule (Model Name: IQKEY-RC001)** was complies with §15.247 of the FCC Rules.

- The end -

