TEST REPORT

Application No.:	HKEM2007000666AT
Applicant:	VTECH TELECOMMUNICATIONS LTD
Address of Applicant:	23/F.,BLOCK 1, TAI PING INDUSTRIAL CENTRE,NO. 57 TING KOK ROAD,TAI PO,N.T.,Hong Kong
Equipment Under Test (EUT):	
EUT Name:	2.4 GHz FHSS Video Baby Monitor (BU)
Model No.:	VM5251 BU, VM5251-2 BU, VM5X51-ab BU, VM5212 BU, VM5212-ab BU, LM808-1W BU, LM808-ab BU
FCC ID:	EW780-1323-08
IC:	1135B-80132308
HVIN:	35-201390BU
Standard(s) :	CFR 47 FCC Part 15, Subpart C, 2019 RSS-247 Issue 2: May 2017 RSS-Gen: Issue 5 Amdt 2019
Date of Receipt:	2020-07-03
Date of Test:	2020-07-03 to 2020-07-15
Date of Issue:	2020-07-16
Test Result:	**Pass***

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

Law Man Kit
EMC Manager

Revision Record				
Version	**Chapter**	**Date**	**Modifier**	**Remark**
01		*2020-07-16*		*Original*

Authorized for issue by:				
				
		Leo Xu /Project Engineer		Date: 2020-07-16
				
		Law Man Kit /Reviewer		Date: 2020-07-16

2 Test Summary

Radio Spectrum Technical Requirement				
Item	**Standard**	**Method**	**Requirement**	**Result**
Antenna Requirement	47 CFR Part 15, Subpart C 15.247	N/A	47 CFR Part 15, Subpart C 15.203 & 15.247(b)(4)	Pass
Other requirements Frequency Hopping Spread Spectrum System Hopping Sequence	47 CFR Part 15, Subpart C 15.247	N/A	47 CFR Part 15, Subpart C 15.247(a)(1),(g),(h)	Pass

Radio Spectrum Matter Part				
Item	**Standard**	**Method**	**Requirement**	**Result**
Conducted Emissions at AC Power Line (150kHz-30MHz)	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 6.2	47 CFR Part 15, Subpart C 15.207	Pass
Conducted Peak Output Power	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 7.8.5	47 CFR Part 15, Subpart C 15.247(b)(1)	Pass
20dB Bandwidth	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 7.8.7	47 CFR Part 15, Subpart C 15.247(a)(1)	Pass
Carrier Frequencies Separation	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 7.8.2	47 CFR Part 15, Subpart C 15.247a(1)	Pass
Hopping Channel Number	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 7.8.3	47 CFR Part 15, Subpart C 15.247a(1)(iii)	Pass
Dwell Time	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 7.8.4	47 CFR Part 15, Subpart C 15.247a(1)(iii)	Pass
Conducted Band Edges Measurement	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 7.8.6	47 CFR Part 15, Subpart C 15.247(d)	Pass
Conducted Spurious Emissions	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 7.8.8	47 CFR Part 15, Subpart C 15.247(d)	Pass
Radiated Emissions which fall in the restricted bands	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 6.10.5	47 CFR Part 15, Subpart C 15.205 & 15.209	Pass
Radiated Spurious Emissions	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 6.4,6.5,6.6	47 CFR Part 15, Subpart C 15.205 & 15.209	Pass

Radio Spectrum Technical Requirement				
Item	**Standard**	**Method**	**Requirement**	**Result**
Antenna Requirement	RSS-247 Issue 2, February 2017	N/A	RSS-Gen Section 6.8	Pass
Pseudorandom Frequency Hopping Sequence	RSS-247 Issue 2, February 2017	N/A	RSS-247 Section 5.1(a)	Pass

Radio Spectrum Matter Part				
Item	**Standard**	**Method**	**Requirement**	**Result**
Conducted Emissions at AC Power Line (150kHz-30MHz)	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 6.2	RSS-Gen Section 8.8	Pass
99% Bandwidth	RSS-247 Issue 2, February 2017	ANSI C63.10 Section 6.9.3	RSS-Gen Section 6.7	Pass
Conducted Peak Output Power	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 7.8.5	RSS-247 Section 5.4(b)	Pass
20dB Bandwidth	RSS-247 Issue 2, February 2017	ANSI C63.10 Section 6.9.2	RSS-247 Section 5.1(a)	Pass
Carrier Frequencies Separation	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 7.8.2	RSS-247 Section 5.1(b)	Pass
Hopping Channel Number	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 7.8.3	RSS-247 Section 5.1(d)	Pass
Dwell Time	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 7.8.4	RSS-247 Section 5.1(d)	Pass
Conducted Band Edges Measurement	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section7.8.6	RSS-247 Section 5.5	Pass
Conducted Spurious Emissions	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 7.8.8	RSS-247 Section 5.5	Pass
Radiated Emissions which fall in the restricted bands	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 6.10.5	Section 3.3 & RSS-Gen Section 8.10	Pass
Radiated Spurious Emissions	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 6.4&6.5&6.6	Section 3.3 & RSS-Gen Section 8.9	Pass
Frequency stability	RSS-247 Issue 2, February 2017	RSS-Gen Section 6.11	RSS-Gen Section 8.11	Pass

Note: Frequency stability requested in RSS GEN Section 8.1.1 has been complied since the result of band edge can demonstrate.

Declaration of EUT Family Grouping:

Item no.: VM5251 BU, VM5251-2 BU, VM5X51-ab BU, VM5212 BU, VM5212-ab BU, LM808-1W BU, LM808-ab BU

a = any alphanumeric character or blank is presenting number of baby unit.

b = any alphanumeric character or blank is presenting color of enclosure

x = any alphanumeric character is presenting different type packaging

According to the confirmation from the applicant, the above models are identical in all electrical aspects in relating to the circuit design, PCB layout, electrical components used, internal wiring and functions. The differences are only the color, cosmetic details and model number.

Therefore only the model VM5251 BU was tested in this report.

Abbreviation:

Tx: In this whole report Tx (or tx) means Transmitter.

Rx: In this whole report Rx (or rx) means Receiver.

RF: In this whole report RF means Radiated Frequency.

CH: In this whole report CH means channel.

Volt: In this whole report Volt means Voltage.

Temp: In this whole report Temp means Temperature.

Humid: In this whole report Humid means humidity.

Press: In this whole report Press means Pressure.

N/A: In this whole report not application.

3 Contents

Page

1 COVER PAGE 1

2 TEST SUMMARY 3

3 CONTENTS 6

4 GENERAL INFORMATION 8

4.1 DETAILS OF E.U.T. 8
4.2 DESCRIPTION OF SUPPORT UNITS 9
4.3 MEASUREMENT UNCERTAINTY 10
4.4 TEST LOCATION 11
4.5 TEST FACILITY 11
4.6 DEVIATION FROM STANDARDS 11
4.7 ABNORMALITIES FROM STANDARD CONDITIONS 11

5 EQUIPMENT LIST 12

6 RADIO SPECTRUM TECHNICAL REQUIREMENT 15

6.1 ANTENNA REQUIREMENT 15
6.1.1 Test Requirement: 15
6.1.2 Conclusion 15
6.2 OTHER REQUIREMENTS FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM HOPPING SEQUENCE 16
6.2.1 Test Requirement: 16
6.2.2 Conclusion 16
6.3 PSEUDORANDOM FREQUENCY HOPPING SEQUENCE 17
6.3.1 Test Requirement: 17
6.3.2 Test Setup Diagram 17
6.3.3 Conclusion 17

7 RADIO SPECTRUM MATTER TEST RESULTS 18

7.1 CONDUCTED EMISSIONS AT AC POWER LINE (150KHZ-30MHZ) 18
7.1.1 E.U.T. Operation 19
7.1.2 Test Setup Diagram 19
7.1.3 Measurement Procedure and Data 19
7.2 99% BANDWIDTH 24
7.2.1 E.U.T. Operation 24
7.2.2 Test Setup Diagram 24
7.2.3 Measurement Procedure and Data 24
7.3 CONDUCTED PEAK OUTPUT POWER 25
7.3.1 E.U.T. Operation 25
7.3.2 Test Setup Diagram 25
7.3.3 Measurement Procedure and Data 25
7.4 20DB BANDWIDTH 26
7.4.1 E.U.T. Operation 26
7.4.2 Test Setup Diagram 26
7.4.3 Measurement Procedure and Data 26
7.5 CARRIER FREQUENCIES SEPARATION 27
7.5.1 E.U.T. Operation 27
7.5.2 Test Setup Diagram 27
7.5.3 Measurement Procedure and Data 27
7.6 HOPPING CHANNEL NUMBER 28

7.6.1 E.U.T. Operation 28
7.6.2 Test Setup Diagram 28
7.6.3 Measurement Procedure and Data 28
7.7 DWELL TIME 29
7.7.1 E.U.T. Operation 29
7.7.2 Test Setup Diagram 29
7.7.3 Measurement Procedure and Data 29
7.8 CONDUCTED BAND EDGES MEASUREMENT 30
7.8.1 E.U.T. Operation 32
7.8.2 Test Setup Diagram 32
7.8.3 Measurement Procedure and Data 32
7.9 CONDUCTED SPURIOUS EMISSIONS 33
7.9.1 E.U.T. Operation 33
7.9.2 Test Setup Diagram 33
7.9.3 Measurement Procedure and Data 33
7.10 RADIATED EMISSIONS WHICH FALL IN THE RESTRICTED BANDS 34
7.10.1 E.U.T. Operation 35
7.10.2 Test Setup Diagram 35
7.10.3 Measurement Procedure and Data 36
7.10.4 Measurement Procedure and data 36
7.11 RADIATED SPURIOUS EMISSIONS 37
7.11.1 E.U.T. Operation 38
7.11.2 Test Setup Diagram 38
7.11.3 Measurement Procedure and Data 39

8 PHOTOGRAPHS 43

9 APPENDIX 44

9.1 PEAK CONDUCTED OUTPUT POWER 44
9.2 EMISSION BANDWIDTH 20 DB 46
9.3 OCCUPIED CHANNEL BANDWIDTH 99% 48
9.4 CARRIER FREQUENCY SEPARATION 50
9.5 DWELL TIME 51
9.6 HOPPING FREQUENCIES 53
9.7 CONDUCTED BAND EDGE MEASUREMENT 54
9.8 CONDUCTED SPURIOUS EMISSION 60

4 General Information

4.1 Details of E.U.T.

Power supply:	Adaptor Model 1: VT05EUS05100 Input: AC 100 V - 240 V, 50/60 Hz, 0.15 A Output: DC 5.0 V, 1.0 A Adaptor Model 2: S006AKU0500100 Input: 100 V - 240 V, 50/60 Hz, 0.2 A Output: DC 5.0 V, 1 A
Test voltage:	AC 110 V
Cable:	Adaptor Model 1: VT05EUS05100 Power Cable: 201.5 cm unshielded 2-wire DC cable Adaptor Model 2: S006AKU0500100 Power Cable: 185.5 cm unshielded 2-wire DC cable
Antenna Gain:	0dBi
Antenna Type:	PCB Antenna
Channel Spacing:	2 MHz
Modulation Type:	GFSK
Number of Channels:	16
Operation Frequency:	2405 MHz to 2475 MHz
Spectrum Spread Technology:	Frequency Hopping Spread Spectrum(FHSS)
Hardware Version:	35-201390
Firmware version	R0

Frequency List

Channel Number	TX Freq (MHz)	Channel Number	TX Freq (MHz)	Channel Number	TX Freq (MHz)
1	**2405**	12	2428	23	2454
2	2407	13	2430	24	2456
3	2409	14	2433	25	2458.5
4	2411	15	2435	26	2460.5
5	2413	16	2437	27	2462.5
6	2415	**17**	**2439**	28	2467
7	2418	18	2441	29	2469
8	2420	19	2444	30	2471
9	2422	20	2446	31	2473
10	2424	21	2450	**32**	**2475**
11	2426	22	2452		

Remark: 1. Operation channel is only 16 within total channel 32.
2. Testing Channels are highlighted in **bold**.

4.2 Description of Support Units

Description	Manufacturer	Model No.	SN/Certificate NO
UART Test board	SGS HK Limited	MX3232	N/A
Test Software	MicroRidge System	Version 3.0.0.108	N/A
NoteBook (EMC4)	Dell	P75F	N/A

4.3 Measurement Uncertainty

EMI

No.	Item	Measurement Uncertainty
1	Conduction emission	2.5dB (9kHz to 150kHz)
		2.6dB (150kHz to 30MHz)
2	Radiated emission	5.1dB (30MHz-1GHz)
		4.9dB (1GHz-6GHz)
		4.7dB (6GHz-18GHz)
		5.6dB (18GHz-40GHz)

RF

No.	Item	Measurement Uncertainty
1	Radio Frequency	± 7.25 x 10^{-8}
2	Duty cycle	± 0.37%
3	Occupied Bandwidth	± 3%
4	RF conducted power (30MHz-40GHz)	1.5dB
5	RF power density	1.5dB
6	Conducted Spurious emissions	1.5dB
7	RF Radiated power	5.1dB (below 1GHz)
		5.3dB (above 1GHz)
8	Radiated Spurious emission test	5.1dB (below 1GHz)
		5.3dB (above 1GHz)
9	Temperature test	± 1℃
10	Humidity test	± 3%
11	Supply voltages	± 1.5%
12	Time	± 3%

Remark:

The U_{lab} (lab Uncertainty) is less than U_{cispr} (CISPR Uncertainty), so the test results

- compliance is deemed to occur if no measured disturbance level exceeds the disturbance limit;
- non-compliance is deemed to occur if any measured disturbance level exceeds the disturbance limit.

According to decision rule based on Clause 4.2 of CISPR 16-4-2, the EUT complied with the standards specified above.

4.4 Test Location

All tests were performed at:

SGS Hong Kong Limited

Unit 2 and 3, G/F, Block A, Po Lung Centre,

11 Wang Chiu Road, Kowloon Bay, Kowloon, Hong Kong

Tel: +852 2305 2570 Fax: +852 2756 4480

No tests were sub-contracted.

4.5 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

- **HOKLAS (Lab Code: 009)**

SGS Hong Kong Limited has been accepted by HKAS Executive, on the recommendation of the Accreditation Advisory Board, as a HOKLAS Accredited Laboratory, this laboratory meets the requirements of ISO/IEC 17025:2017 an it has been accredited for performing specific test as listed in the scope of accreditation within the test category of Electrical and Electronic Products.

- **IAS Accreditation (Lab Code: TL-187)**

SGS Hong Kong Limited has met the requirements of AC89, IAS Accreditation Criteria for Testing Laboratories, and has demonstrated compliance with ISO/IEC Standard 17025:2017, General requirements for the competence of testing and calibration laboratories. This organization is accredited to provide the services specified in the scope of accreditation maintained on the IAS website (www.iasonline.org).

The report must not be used by the client to claim product certification, approval, or endorsement by IAS, NIST, or any agency of the Federal Government.

- **FCC Recognized Accredited Test Firm(CAB Registration No.: 514599)**

SGS Hong Kong Limited has been accredited and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Designation Number: HK0015, Test Firm Registration Number: 514599.

- **Industry Canada (Site Registration No.: 26103; CAB Identifier No.: HK0015)**

SGS Hong Kong Limited has been recognized by Department of Innovation, Science and Economic Development (ISED) Canada as a wireless testing laboratory. The acceptance letter from the ISED is maintained in our files. CAB Identifier No: HK0015, Site Registration Number: 26103.

4.6 Deviation from Standards

None

4.7 Abnormalities from Standard Conditions

None

5 Equipment List

RF Conducted Test					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
SMBV100A VECTOR SIGNAL GENERATOR	Rohde & Schwarz	SMBV100A	E234	2019/8/21	2020/8/20
FSV40 SIGNAL ANALYZER 40GHz	Rohde & Schwarz	FSV40	E235	2019/8/21	2020/8/20
Wireless Conn. Tester (CMW)	Rohde & Schwarz	CMW270	E240	2019/8/21	2020/8/20
OSP	Rohde & Schwarz	OSP-B157W8	E242	2019/8/21	2020/8/20
Cable	Rohde & Schwarz	J12J103539-00-2	E239	2019/9/23	2020/9/22
WMS32 Test Software	R&S	Version 10	N/A	--	--

Conducted Emissions at Mains Terminals (150kHz-30MHz)					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
Test Receiver	Rohde & Schwarz	ESHS 30 / 839667/002	TE279D	2019/8/21	2020/8/20
Signal Generator	Rohde & Schwarz	SMT03	E177	2020/5/11	2021/5/10
Artificial Mains Network (LISN)	Schwarzbeck	NSLK 8127 / 8127312	TE10	2020/5/11	2021/5/10
Impulse Limiter	Rohde & Schwarz	ESH-3-Z2 / 357881052	TE36	2020/5/11	2021/5/10
EMC32 Test Software	R&S	Version 10	N/A	--	--

Radiated Spurious Emissions (30MHz-1GHz)					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
3m Semi-Anechoic Chamber	ChamPro	N/A	E229	2019/8/9	2020/8/8
Coaxial Cable	SGS	N/A	E167	2019/7/22	2020/7/21
EMI Test Receiver 9kHz to 3.6GHz	Rohde & Schwarz	ESR3 / 102326	E231	2019/9/2	2020/9/1
TRILOG Super Broadb. Test Antenna, (25) 30-1000 (2	Schwarzbeck	VULB 9168	E264	2018/10/20	2020/10/19
Boresight Mast Controller	ChamPro	AM-BS-4500-E	E237	--	--
Turntable with Controller	ChamPro	EM1000	E238	--	--
EMC32 Test Software	R&S	Version 10	N/A	--	--

Radiated Spurious Emissions (above 1GHz)					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
3m Semi-Anechoic Chamber	ChamPro	N/A	E229	2019/8/9	2020/8/8

Coaxial Cable	SGS	N/A	E167	2019/7/22	2020/7/21
EMI Test Receiver 9kHz to 3.6GHz	Rohde & Schwarz	ESR3 / 102326	E231	2019/9/2	2020/9/1
Signal and Spectrum Analyzer 2Hz - 26.5GHz	Rohde & Schwarz	FSW26	E296	2019/10/29	2020/10/28
Spectrum Analyzer 9kHz - 30GHz	Rohde & Schwarz	FSP30	E204	2020/5/11	2021/5/10
Horn Antenna 1 - 18GHz	Schwarzbeck	BBHA9120D	E211	2020/1/29	2022/1/29
Horn Antenna 15 - 40GHz	Schwarzbeck	BBHA9170	E212	2017/10/17	2020/10/16
Preamplifier 33dB, 1 - 18GHz	Schwarzbeck	BBV9718	E214	2020/4/14	2021/4/12
Preamplifier 33dB, 18 - 26.5GHz	Schwarzbeck	BBV9719	E215	2019/4/24	2021/4/23
Broadband Coaxial Preamplifier typ. 30 dB, 18-40 G	Schwarzbeck	BBV 9721	E266	2019/8/22	2020/8/21
Highpass Filter 3.5-26.5GHz	Wainwright	WHNX3.5/26.5 G-6SS	E205	2019/4/24	2021/4/23
Band Reject Filter 2.4-2.5GHz	Wainwright	WRCJV 2400/2500-2100	E206	2019/4/24	2021/4/23
RF cable SMA to SMA 10000mm	HUBER+SUHNER	SF104-26.5/2*11SMA 45	E207-1	2019/9/26	2020/9/25
Boresight Mast Controller	ChamPro	AM-BS-4500-E	E237	--	--
Turntable with Controller	ChamPro	EM1000	E238	--	--
EMC32 Test Software	R&S	Version 10	N/A	--	--

Conducted Spurious Emissions					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
SMBV100A VECTOR SIGNAL GENERATOR	Rohde & Schwarz	SMBV100A	E234	2019/8/21	2020/8/20
FSV40 SIGNAL ANALYZER 40GHz	Rohde & Schwarz	FSV40	E235	2019/8/21	2020/8/20
Wireless Conn. Tester (CMW)	Rohde & Schwarz	CMW270	E240	2019/8/21	2020/8/20
OSP	Rohde & Schwarz	OSP-B157W8	E242	2019/8/21	2020/8/20
Cable	Rohde & Schwarz	J12J103539-00-2	E239	2019/9/23	2020/9/22
WMS32 Test Software	R&S	Version 10	N/A	--	--

General used equipment					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
Digital temperature & humidity data logger	SATO	SK-L200TH II	E232	2019/10/28	2020/10/27

Electronic Digital Thermometer with Hygrometer	nil	2074/2075	E159	2019/10/28	2020/10/27
Barometer with digital thermometer	SATO	7612-00	E218	2019/05/19	2020/05/18
Conditional Chamber	Zhong Zhi Testing Instruments	CZ-E-608D	E216	2019/08/22	2020/08/21

6 Radio Spectrum Technical Requirement

6.1 Antenna Requirement

6.1.1 Test Requirement:

FCC Part 15 Subpart C Section 15.247 & 15.203

RSS-Gen Section 8.3

6.1.2 Conclusion

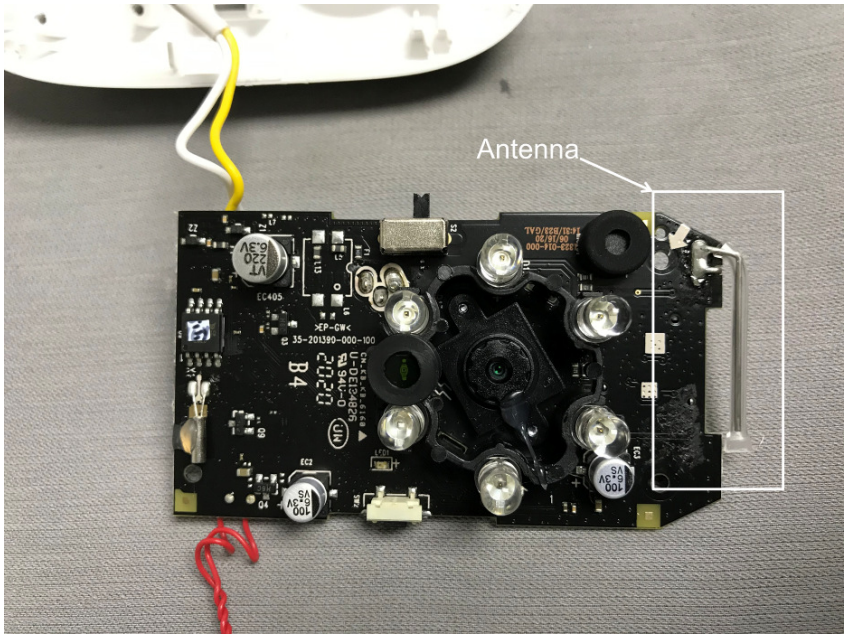
Standard Requirement:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

RSS-Gen Section 6.8,Testing shall be performed using the highest gain antenna of each combination of licence-exempt transmitter and antenna type, with the transmitter output power set at the maximum level. When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

15.247(b) (4) requirement:

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.



EUT Antenna:

The antenna is integrated on the main PCB and no consideration of replacement. The best case gain of the antenna is 0 dBi.

6.2 Other requirements Frequency Hopping Spread Spectrum System Hopping Sequence

6.2.1 Test Requirement:

47 CFR Part 15, Subpart C 15.247(a)(1),(g),(h)

6.2.2 Conclusion

Standard Requirement:

The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

Compliance for section 15.247(a)(1):

According to Technical Specification, the pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONEs; i.e. the shift register is initialized with nine ones.

> Number of shift register stages: 9

> Length of pseudo-random sequence: 29 -1 = 511 bits

> Longest sequence of zeros: 8 (non-inverted signal)

Linear Feedback Shift Register for Generation of the PRBS sequence

An example of Pseudorandom Frequency Hopping Sequence as follow:

Each frequency used equally on the average by each transmitter.

According to Technical Specification, the receivers are designed to have input and IF bandwidths that match the hopping channel bandwidths of any transmitters and shift frequencies in synchronization with the transmitted signals.

Compliance for section 15.247(g):

According to Technical Specification, the system transmits the packet with the pseudorandom hopping frequency with a continuous data and the short burst transmission from the Bluetooth system is also transmitted under the frequency hopping system with the pseudorandom hopping frequency system.

Compliance for section 15.247(h):

According to Technical specification, the system incorporates with an adaptive system to detect other user within the spectrum band so that it individually and independently to avoid hopping on the occupied channels.

The system is designed not have the ability to coordinated with other FHSS System in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitter.

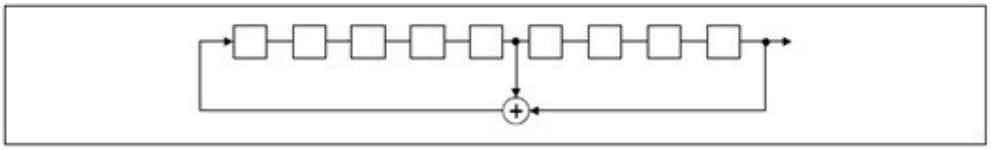
6.3 Pseudorandom Frequency Hopping Sequence

6.3.1 Test Requirement:

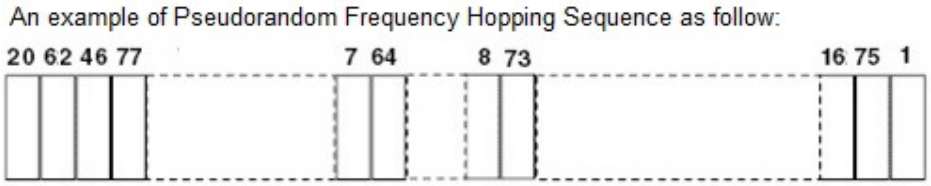
FCC Part 15 Subpart C Section 15.247(a)(1)

RSS-247 Section 5.1(a)

6.3.2 Test Setup Diagram



Linear Feedback Shift Register for Generation of the PRBS sequence



6.3.3 Conclusion

Standard Requirement:

The pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONEs; i.e. the shift register is initialized with nine ones.

? Number of shift register stages: 9

? Length of pseudo-random sequence: 29 -1 = 511 bits

? Longest sequence of zeros: 8 (non-inverted signal)

Linear Feedback Shift Register for Generation of the PRBS sequence

An example of Pseudorandom Frequency Hopping Sequence as follow:

Each frequency used equally on the average by each transmitter.

According to Technical Specification, the receivers are designed to have input and IF bandwidths that match the hopping channel bandwidths of any transmitters and shift frequencies in synchronization with the transmitted signals.

According to Technical specification, the system incorporates with an adaptive system to detect other user within the spectrum band so that it individually and independently to avoid hopping on the occupied channels.

The system is designed not have the ability to coordinated with other FHSS System in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitter.

7 Radio Spectrum Matter Test Results

7.1 Conducted Emissions at AC Power Line (150kHz-30MHz)

Test Requirement 47 CFR Part 15, Subpart C 15.207, RSS-Gen Section 8.8
Test Method: ANSI C63.10 (2013) Section 6.2
Limit:

Frequency of emission(MHz)	Conducted limit(dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50
*Decreases with the logarithm of the frequency.		

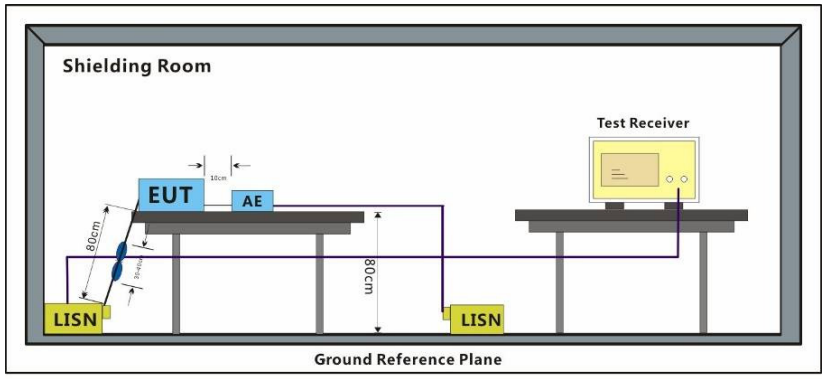
7.1.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH :

Test mode: c:Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.1.2 Test Setup Diagram



7.1.3 Measurement Procedure and Data

1) The mains terminal disturbance voltage test was conducted in a shielded room.

2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50ohm/50μH + 5ohm linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.

3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,

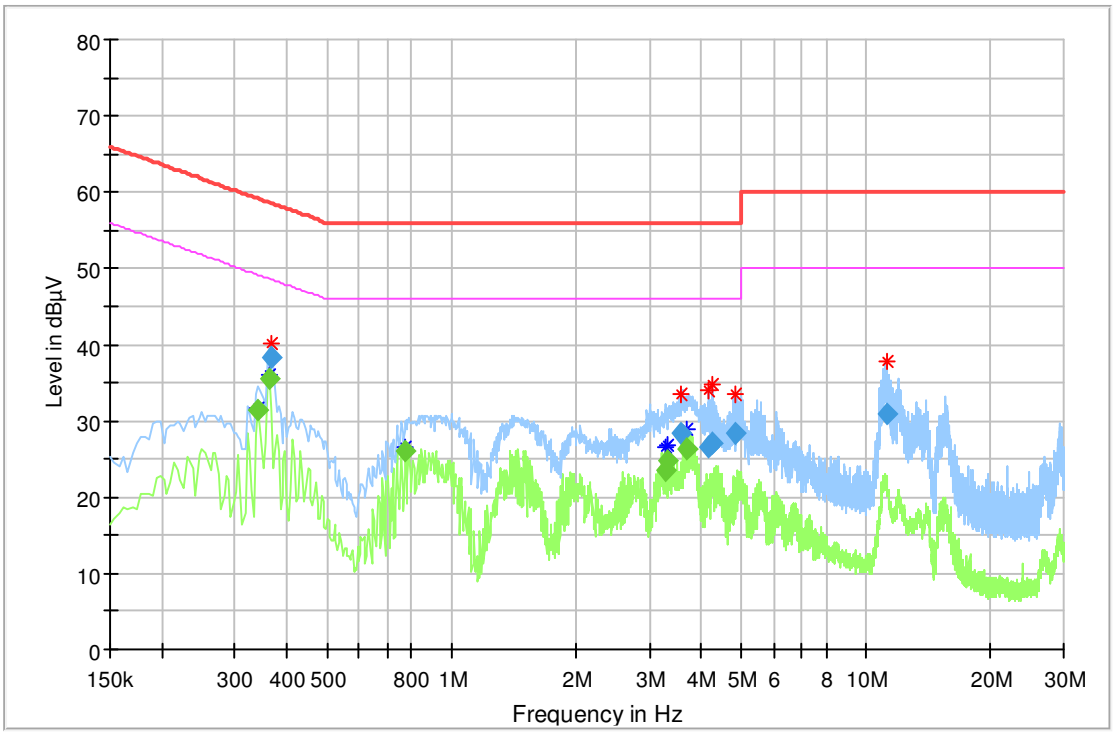
4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.

5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 on conducted measurement.

Remark: LISN=Read Level+ Cable Loss+ LISN Factor

Mode: c
Adaptor Model 1: VT05EUS05100
Line: Live

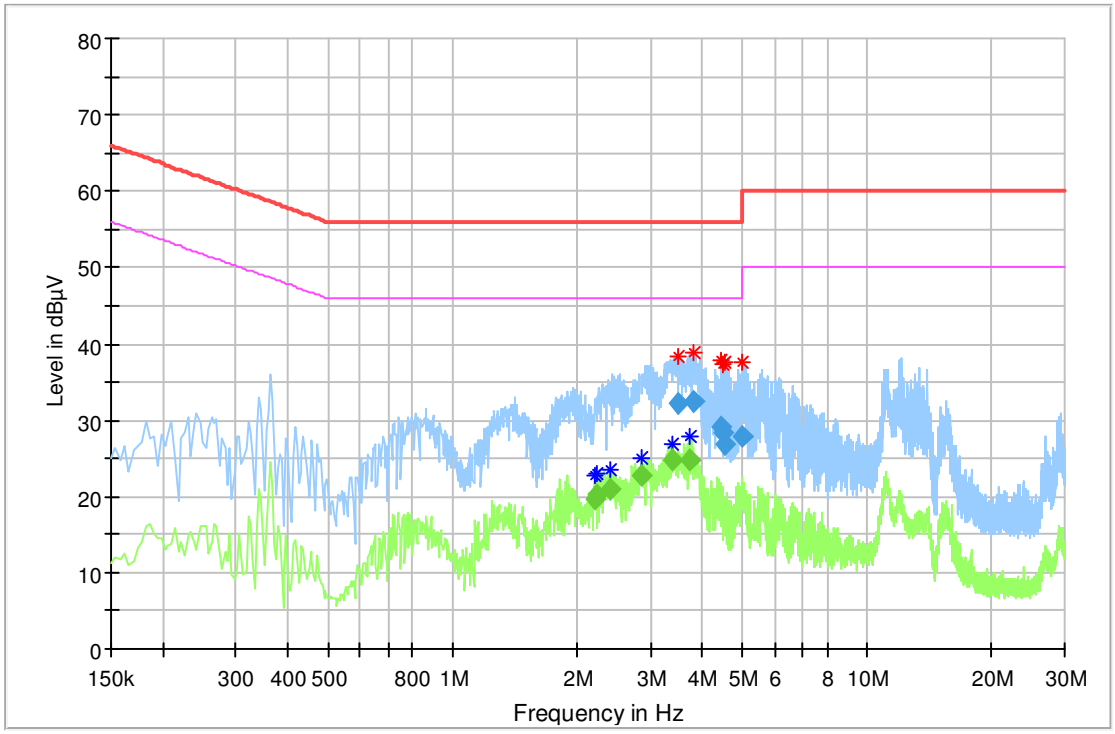
Full Spectrum



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Corr. (dB)	Result
0.342000	---	31.4	49.2	17.7	10.1	Pass
0.362000	---	35.5	48.7	13.2	10.1	Pass
0.366000	38.4	---	58.6	20.2	10.1	Pass
0.774000	---	26.1	46.0	19.9	10.1	Pass
3.294000	---	23.4	46.0	22.6	10.2	Pass
3.306000	---	24.7	46.0	21.3	10.2	Pass
3.574000	28.5	---	56.0	27.5	10.2	Pass
3.698000	---	26.3	46.0	19.7	10.3	Pass
4.186000	26.7	---	56.0	29.3	10.3	Pass
4.246000	27.2	---	56.0	28.9	10.3	Pass
4.850000	28.2	---	56.0	27.8	10.3	Pass
11.202000	31.0	---	60.0	29.1	10.7	Pass

Line: Neutral

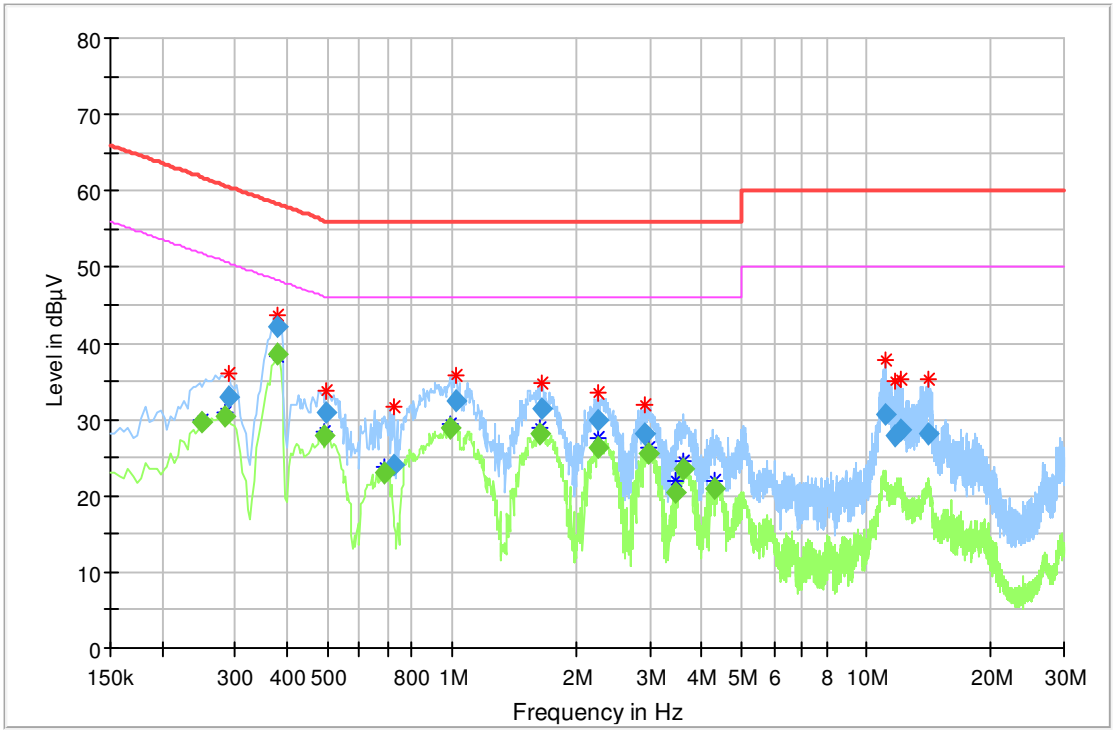
Full Spectrum



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Corr. (dB)	Result
2.194000	---	19.8	46.0	26.3	10.4	Pass
2.230000	---	20.1	46.0	25.9	10.4	Pass
2.406000	---	21.0	46.0	25.0	10.4	Pass
2.858000	---	22.7	46.0	23.3	10.5	Pass
3.402000	---	24.8	46.0	21.3	10.5	Pass
3.506000	32.2	---	56.0	23.8	10.5	Pass
3.722000	---	24.9	46.0	21.1	10.5	Pass
3.826000	32.4	---	56.0	23.6	10.5	Pass
4.458000	29.0	---	56.0	27.0	10.6	Pass
4.486000	28.3	---	56.0	27.7	10.6	Pass
4.530000	26.9	---	56.0	29.1	10.6	Pass
4.990000	27.8	---	56.0	28.2	10.6	Pass

Adaptor Model 2: S006AKU0500100
Line: Live

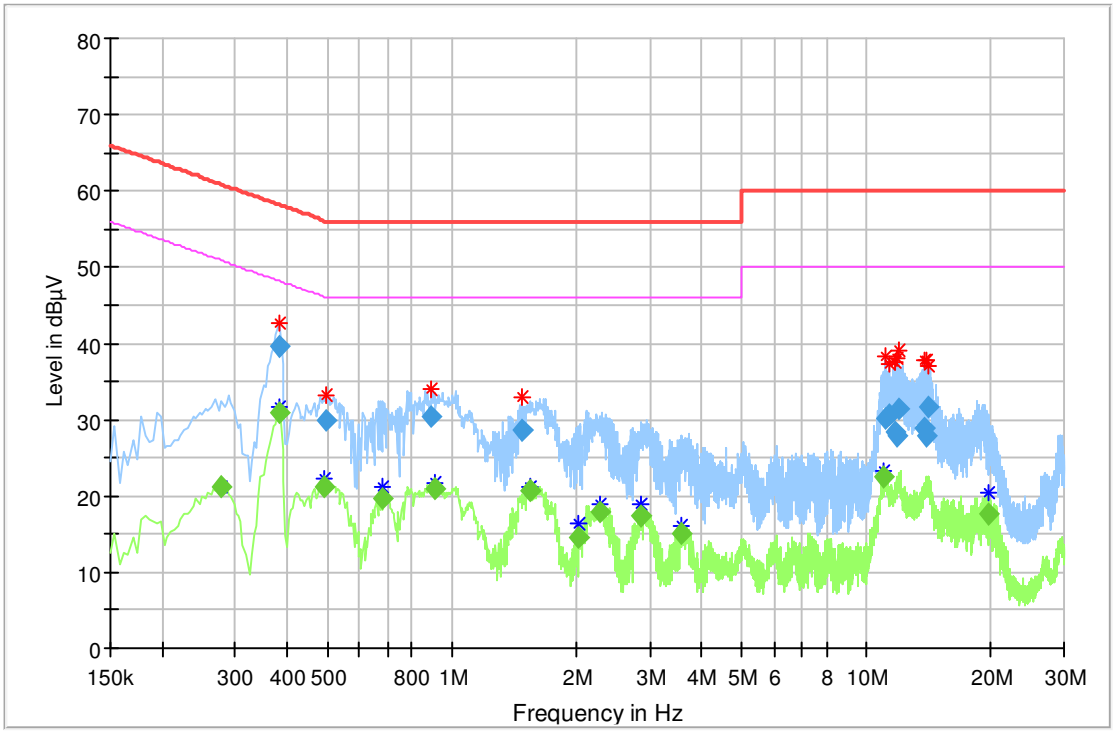
Full Spectrum



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Corr. (dB)	Result
0.282000	---	30.4	50.8	20.4	10.1	Pass
0.290000	32.9	---	60.5	27.6	10.1	Pass
0.378000	---	38.6	48.3	9.7	10.1	Pass
0.378000	42.3	---	58.3	16.1	10.1	Pass
0.490000	---	27.9	46.2	18.3	10.1	Pass
0.498000	30.8	---	56.0	25.2	10.1	Pass
0.690000	---	23.1	46.0	22.9	10.1	Pass
0.726000	24.0	---	56.0	32.0	10.1	Pass
0.990000	---	28.8	46.0	17.2	10.1	Pass
1.026000	32.4	---	56.0	23.6	10.1	Pass
1.634000	---	28.1	46.0	17.9	10.2	Pass
1.654000	31.4	---	56.0	24.6	10.2	Pass

Mode:a
Line: Neutral

Full Spectrum



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Corr. (dB)	Result
1.542000	---	20.6	46.0	25.4	10.2	Pass
2.018000	---	14.6	46.0	31.4	10.2	Pass
2.274000	---	18.0	46.0	28.0	10.2	Pass
2.866000	---	17.3	46.0	28.7	10.2	Pass
3.594000	---	15.0	46.0	31.0	10.2	Pass
10.974000	---	22.5	50.0	27.5	10.7	Pass
11.106000	30.3	---	60.0	29.7	10.7	Pass
11.354000	30.6	---	60.0	29.4	10.7	Pass
11.742000	28.5	---	60.0	31.5	10.7	Pass
11.890000	27.8	---	60.0	32.2	10.8	Pass
11.946000	31.4	---	60.0	28.6	10.8	Pass
13.802000	28.8	---	60.0	31.2	10.9	Pass

7.2 99% Bandwidth

Test Requirement RSS-Gen Section 6.7

Test Method: ANSI C63.10 Section 6.9.3

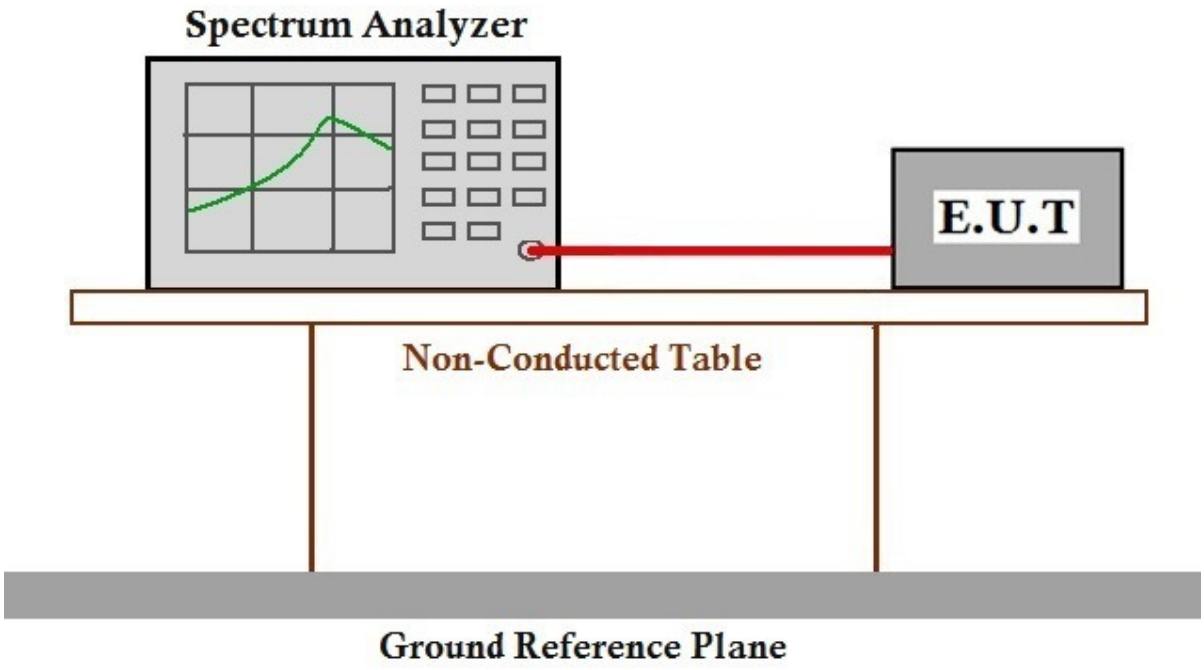
7.2.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH :

Test mode c:Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.2.2 Test Setup Diagram



7.2.3 Measurement Procedure and Data

The detailed test data see section 9: Appendix

7.3 Conducted Peak Output Power

Test Requirement 47 CFR Part 15, Subpart C 15.247(b)(1) / RSS-247 Section 5.4(b)

Test Method: ANSI C63.10 (2013) Section 7.8.5

Limit:

Frequency range(MHz)	Output power of the intentional radiator(watt)
902-928	1 for ≥50 hopping channels
	0.25 for 25≤ hopping channels <50
	1 for digital modulation
2400-2483.5	1 for ≥75 non-overlapping hopping channels
	0.125 for all other frequency hopping systems
	1 for digital modulation
5725-5850	1 for frequency hopping systems and digital modulation

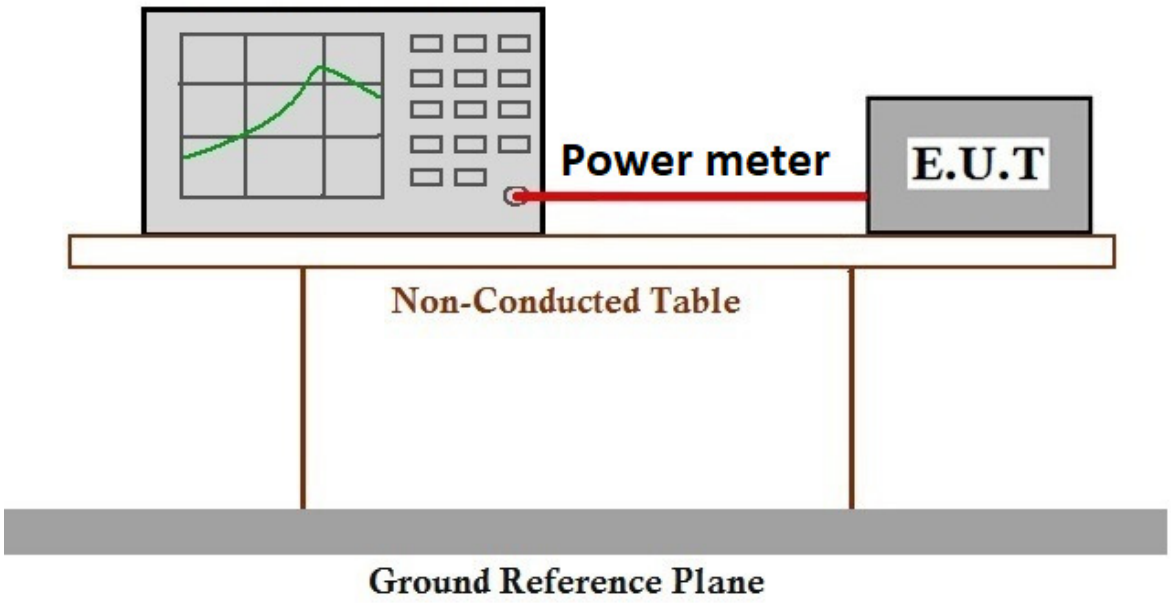
7.3.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH :

Test mode: c:Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.3.2 Test Setup Diagram



7.3.3 Measurement Procedure and Data

The detailed test data see section 9: Appendix

7.4 20dB Bandwidth

Test Requirement 47 CFR Part 15, Subpart C 15.247(a)(1)

Test Method: ANSI C63.10 (2013) Section 7.8.7

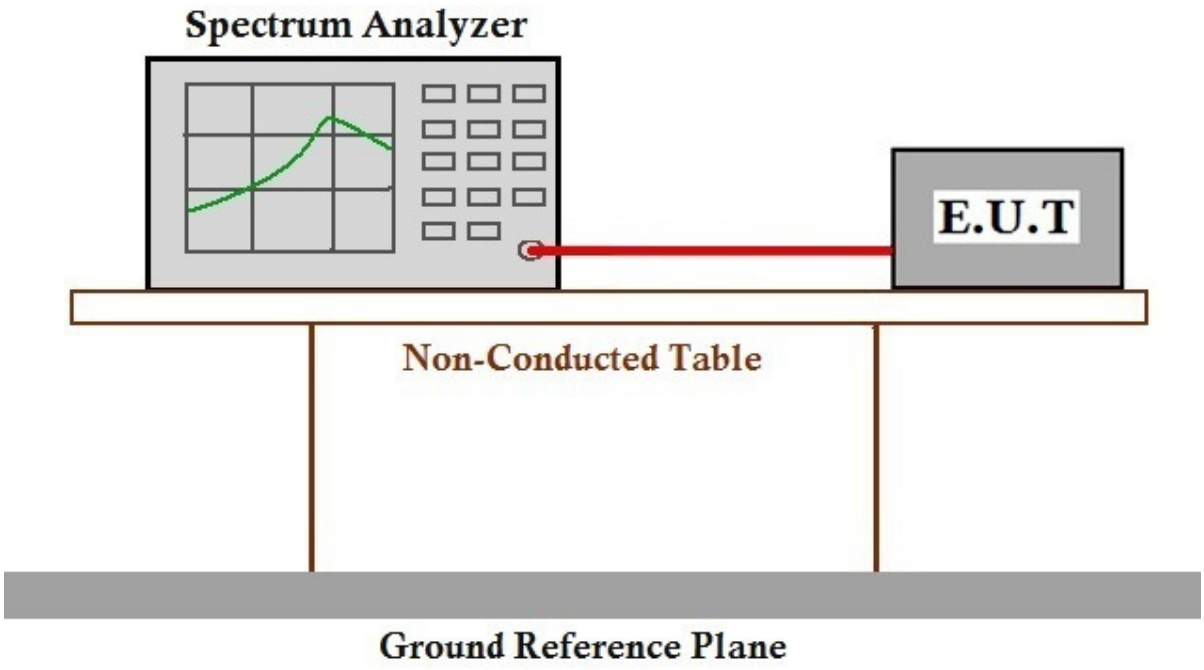
7.4.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH :

Test mode: c:Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.4.2 Test Setup Diagram



7.4.3 Measurement Procedure and Data

The detailed test data see section 9: Appendix

7.5 Carrier Frequencies Separation

Test Requirement	47 CFR Part 15, Subpart C 15.247:2019a(1), RSS-247 Section 5.1(b)
Test Method:	ANSI C63.10 (2013) Section 7.8.2
Limit:	2/3 of the 20dB bandwidth base on the transmission power is less than 0.125W

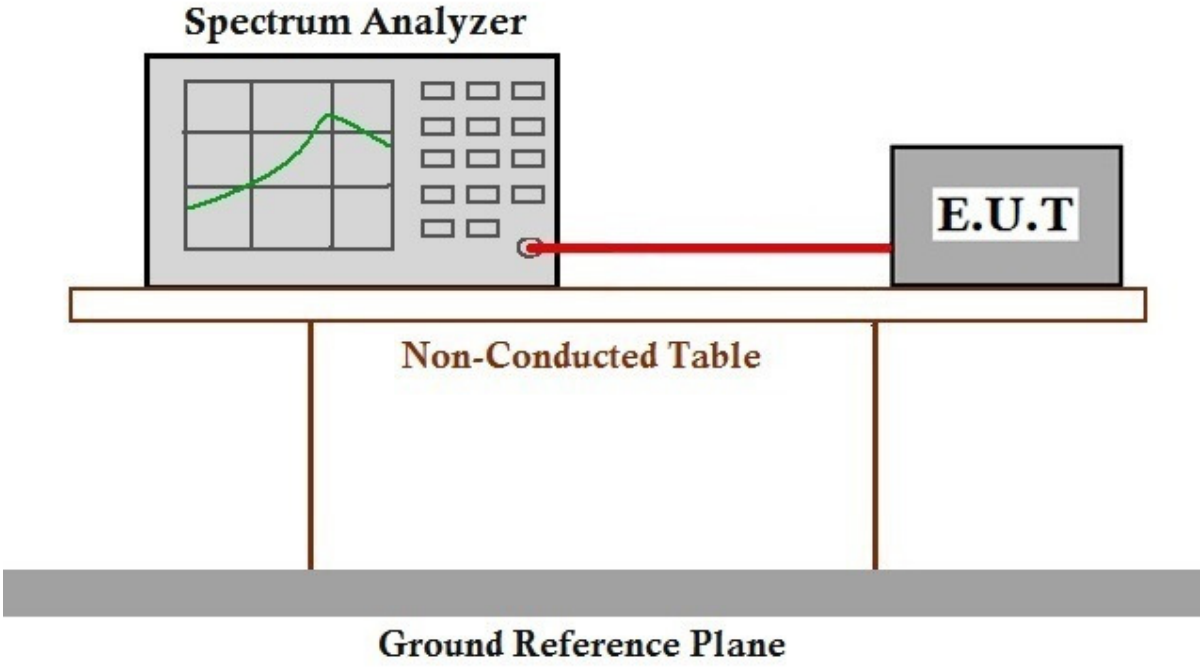
7.5.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH :

Test mode a:TX_Hop mode_Keep the EUT in frequency hopping mode with GFSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.5.2 Test Setup Diagram



7.5.3 Measurement Procedure and Data

The detailed test data see section 9: Appendix

7.6 Hopping Channel Number

Test Requirement 47 CFR Part 15, Subpart C 15.247:2019a(1)(iii), RSS-247 Section 5.1(d)

Test Method: ANSI C63.10 (2013) Section 7.8.3

Limit:

Frequency range(MHz)	Number of hopping channels (minimum)
902-928	50 for 20dB bandwidth <250kHz
	25 for 20dB bandwidth ≥250kHz
2400-2483.5	15
5725-5850	75

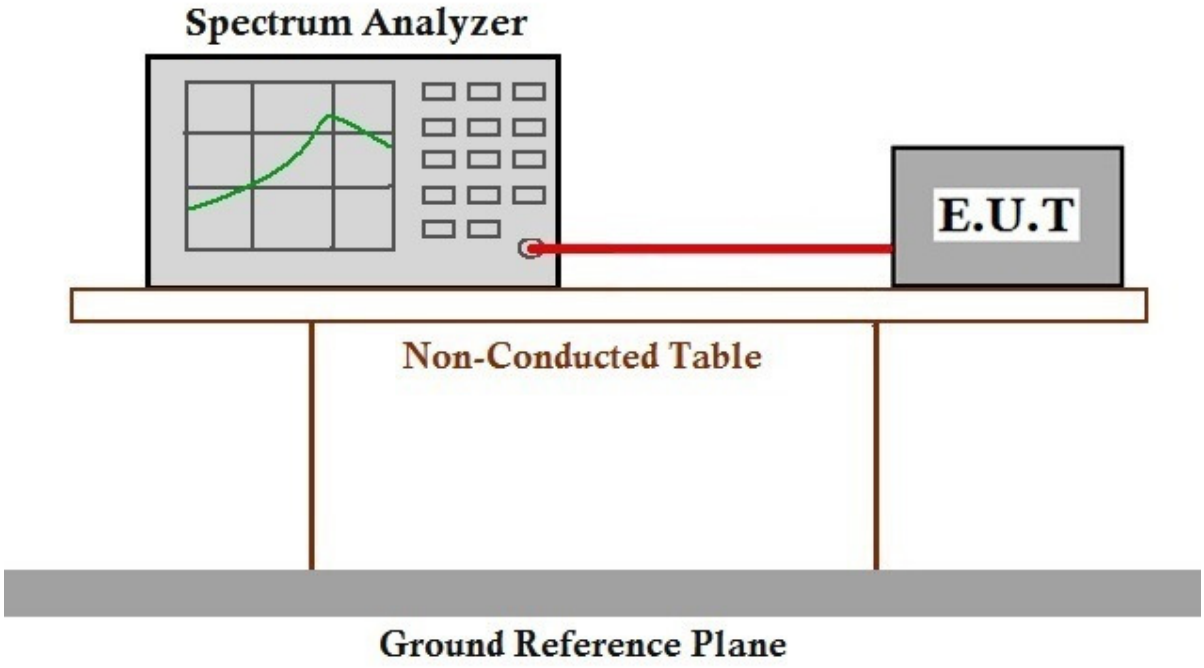
7.6.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH :

Test mode a:TX_Hop mode_Keep the EUT in frequency hopping mode with GFSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.6.2 Test Setup Diagram



7.6.3 Measurement Procedure and Data

The detailed test data see section 9: Appendix

7.7 Dwell Time

Test Requirement 47 CFR Part 15, Subpart C 15.247:2019a(1)(iii), RSS-247 Section 5.1(d)

Test Method: ANSI C63.10 (2013) Section 7.8.4

Limit:

Frequency(MHz)	Limit
902-928	0.4S within a 20S period(20dB bandwidth<250kHz)
	0.4S within a 10S period(20dB bandwidth≥250kHz)
2400-2483.5	0.4S within a period of 0.4S multiplied by the number of hopping channels
5725-5850	0.4S within a 30S period

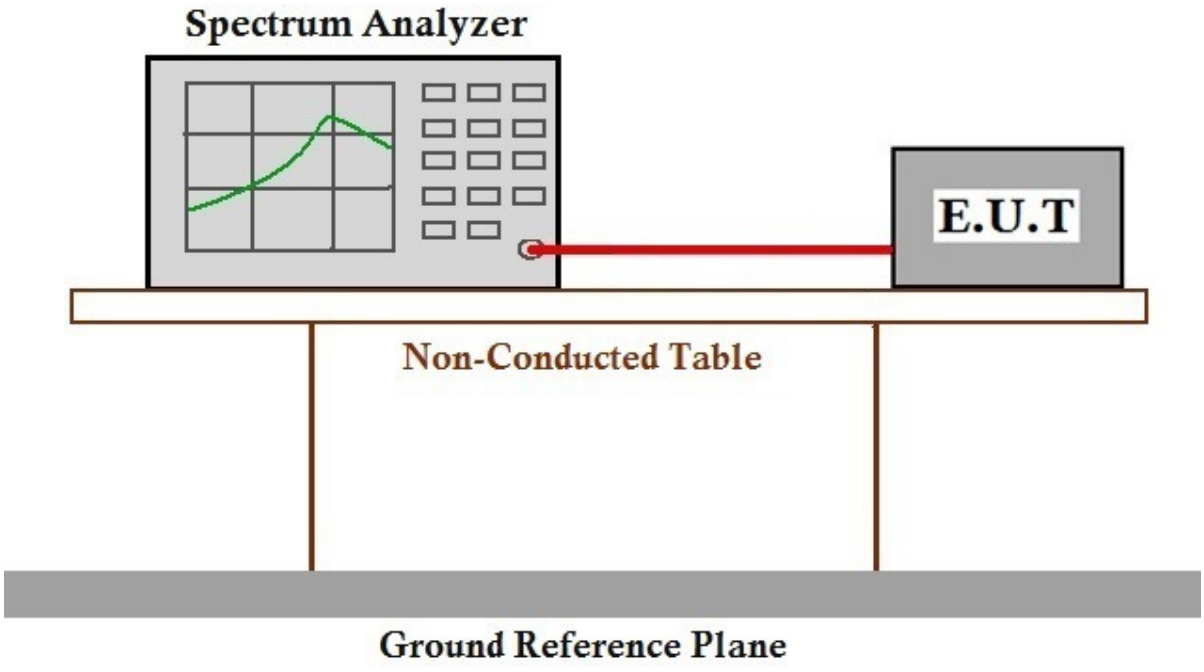
7.7.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH :

Test mode a:TX_Hop mode_Keep the EUT in frequency hopping mode with GFSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.7.2 Test Setup Diagram



7.7.3 Measurement Procedure and Data

The detailed test data see section 9: Appendix

7.8 Conducted Band Edges Measurement

Test Requirement: 47 CFR Part 15, Subpart C 15.247:2019(d), RSS-247 Section 5.5

Test Method: ANSI C63.10 (2013) Section7.8.6

Limit: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)

FCC Part15 C Section 15.205 Restricted bands of operation.

(a) Except as shown in paragraph (d) of this section. only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	
13.36 - 13.41			

RSS-Gen Section 8.10 Restricted bands of operation.

Restricted frequency bands, identified in table 7, are designated primarily for safety-of-life services (distress calling and certain aeronautical activities), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following conditions related to the restricted frequency bands apply:

(a) The transmit frequency, including fundamental components of modulation, of licence-exempt radio

apparatus shall not fall within the restricted frequency bands listed in table 7 except for apparatus compliant with RSS-287, *Emergency Position Indicating Radio Beacons (EPIRB), Emergency Locator Transmitters (ELT), Personal Locator Beacons (PLB), and Maritime Survivor Locator Devices (MSLD)*.
(b) Unwanted emissions that fall into restricted frequency bands listed in table 7 shall comply with the limits specified in table 5 and table 6.
(c) Unwanted emissions that do not fall within the restricted frequency bands listed in table 7 shall comply either with the limits specified in the applicable RSS or with those specified in table 5 and table 6.

Table 7 – Restricted frequency bands* MHz	**MHz**	**GHz**
0.090 - 0.110	149.9 - 150.05	9.0 - 9.2
0.495 - 0.505	156.52475 - 156.52525	9.3 - 9.5
2.1735 - 2.1905	156.7 - 156.9	10.6 - 12.7
3.020 - 3.026	162.0125 - 167.17	13.25 - 13.4
4.125 - 4.128	167.72 - 173.2	14.47 - 14.5
4.17725 - 4.17775	240 - 285	15.35 - 16.2
4.20725 - 4.20775	322 - 335.4	17.7 - 21.4
5.677 - 5.683	399.9 - 410	22.01 - 23.12
6.215 - 6.218	608 - 614	23.6 - 24.0
6.26775 - 6.26825	960 - 1427	31.2 - 31.8
6.31175 - 6.31225	1435 - 1626.5	36.43 - 36.5
8.291 - 8.294	1645.5 - 1646.5	Above 38.6
8.362 - 8.366	1660 - 1710	* Certain frequency bands listed in table 7 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.
8.37625 - 8.38675	1718.8 - 1722.2	
8.41425 - 8.41475	2200 - 2300	
12.29 - 12.293	2310 - 2390	
12.51975 - 12.52025	2483.5 - 2500	
12.57675 - 12.57725	2655 - 2900	
13.36 - 13.41	3260 - 3267	
16.42 - 16.423	3332 - 3339	
16.69475 - 16.69525	3345.8 - 3358	
16.80425 - 16.80475	3500 - 4400	
25.5 - 25.67	4500 - 5150	
37.5 - 38.25	5350 - 5460	
73 - 74.6	7250 - 7750	
74.8 - 75.2	8025 - 8500	
108 - 138	--	

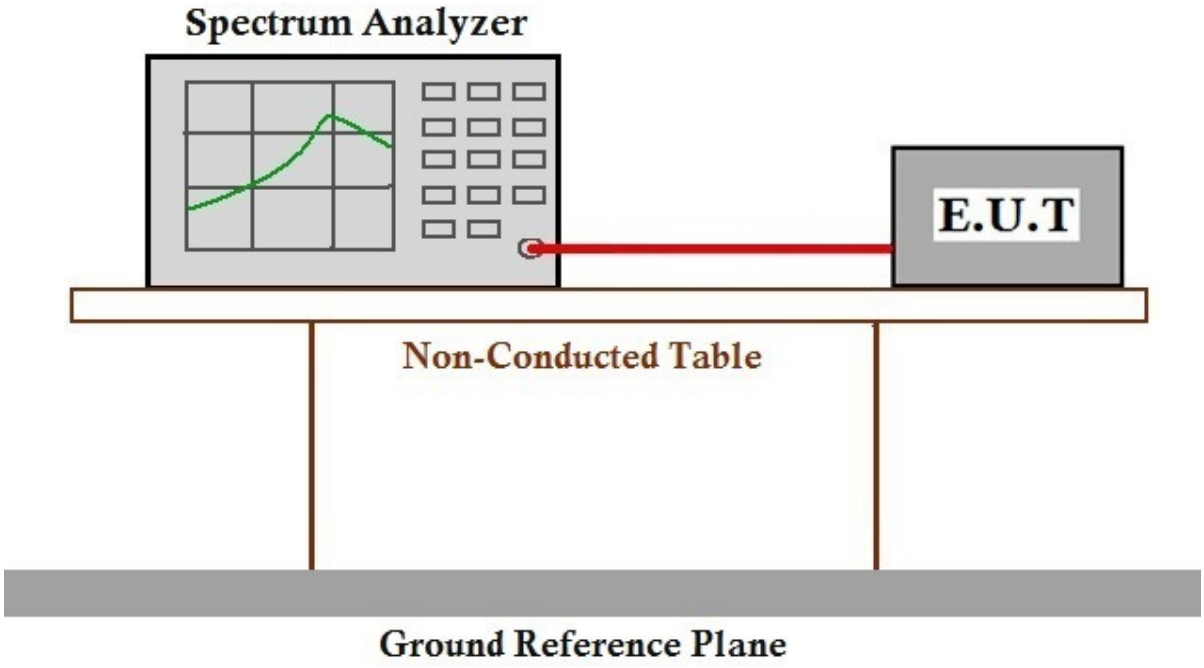
7.8.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH :

Test mode: c:Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.8.2 Test Setup Diagram



7.8.3 Measurement Procedure and Data

The detailed test data see section 9: Appendix

7.9 Conducted Spurious Emissions

Test Requirement	47 CFR Part 15, Subpart C 15.247:2019(d), RSS-247 Section 5.5
Test Method:	ANSI C63.10 (2013) Section 7.8.8
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)

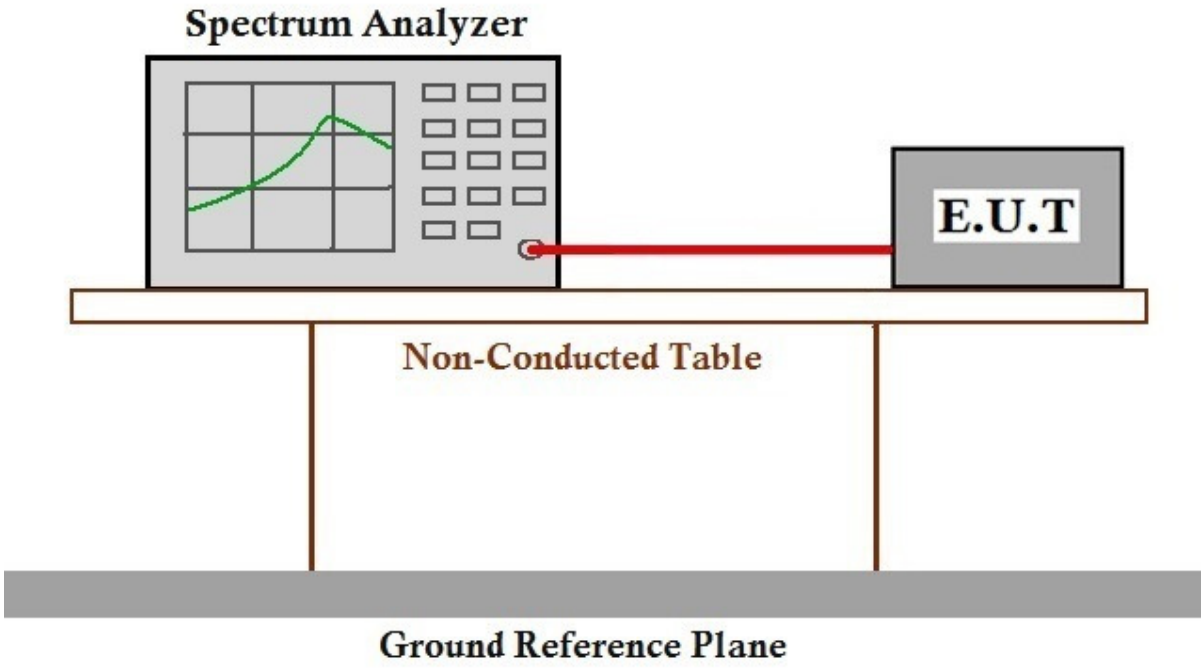
7.9.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH :

Test mode: c:Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.9.2 Test Setup Diagram



7.9.3 Measurement Procedure and Data

The detailed test data see section 9: Appendix

7.10 Radiated Emissions which fall in the restricted bands

Test Requirement 47 CFR Part 15, Subpart C 15.209 & 15.247(d), Section 3.3 & RSS-Gen Section 8.10

Test Method: ANSI C63.10 (2013) Section 6.10.5

Measurement Distance: 3m

Limit:

Frequency(MHz)	Field strength(microvolts/meter)	Measurement distance(meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/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
Remark: The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90kHz, 110-490kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, 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.		

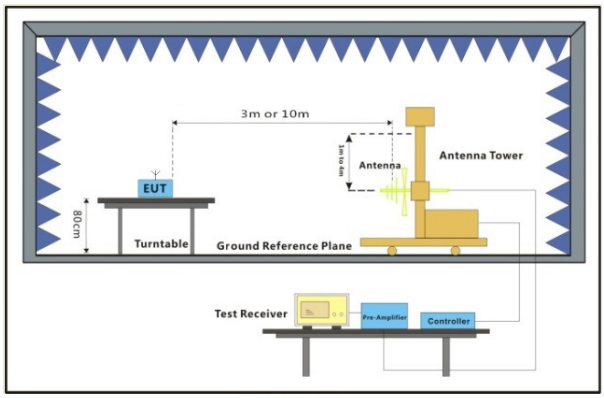
7.10.1 E.U.T. Operation

Operating Environment:

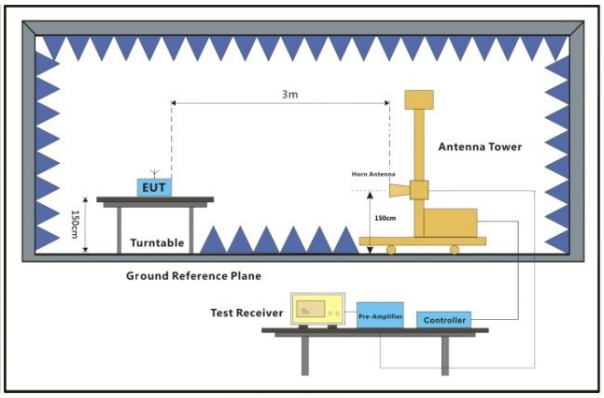
Temperature: 25 °C Humidity: 50 % RH :

Pretest these modes to find the worst case:	b:TX_non-Hop mode_Keep the EUT in continuously transmitting mode with GFSK modulation. All modes have been tested and only the data of worst case is recorded in the report.
	c:Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation. All modes have been tested and only the data of worst case is recorded in the report.
The worst case for final test:	c:Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.10.2 Test Setup Diagram



30MHz-1GHz



Above 1GHz

7.10.3 Measurement Procedure and Data

a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

d. The antenna 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.

e. 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 (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

g. If the emission level of the EUT in peak mode was 10dB 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 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

h. Test the EUT in the lowest channel, the middle channel, the Highest channel.

i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.

j. Repeat above procedures until all frequencies measured was complete.

Remark 1: Level= Read Level+ Cable Loss+ Antenna Factor- Preamp Factor

Remark 2: For frequencies above 1GHz, the field strength limits 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 the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.

7.10.4 Measurement Procedure and data

Frequency (MHz)	Antenna Polarization	Emission Level (dBµV/m)		Limit (dBµV/m)		Remark
		Peak	Average	Peak	Average	
2390.000	H	36.5	/	74.0	54.0	Pass
2483.500	H	48.5	/	74.0	54.0	Pass
2390.000	V	33.5	/	74.0	54.0	Pass
2483.500	V	47.4	/	74.0	54.0	Pass

7.11 Radiated Spurious Emissions

Test Requirement Section 3.3 & RSS-Gen Section 8.9
Test Method: ANSI C63.10 (2013) Section 6.4&6.5&6.6
Limit:

Table 5 – General field strength limits at frequencies above 30 MHz

Frequency (MHz)	Field strength (μ 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) (μ A/m)	Measurement distance (m)
9 - 490 kHz 1	6.37/F (F in kHz)	300
490 - 1705 kHz	63.7/F (F in kHz)	30
1.705 - 30 MHz	0.08	30

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

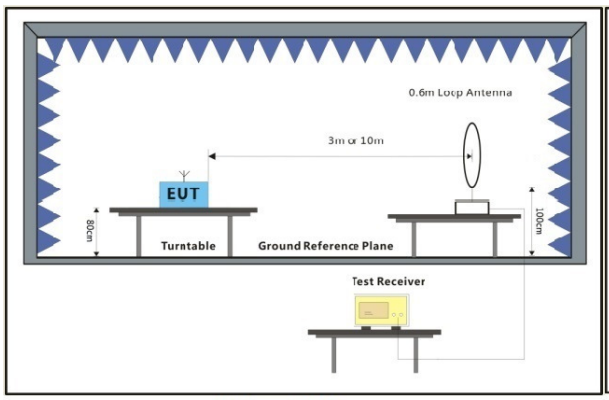
7.11.1 E.U.T. Operation

Operating Environment:

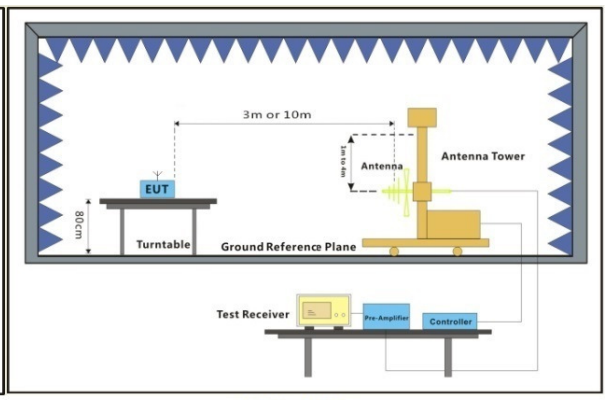
Temperature: 25 °C Humidity: 50 % RH :

Pretest these modes to find the worst case:	b:TX_non-Hop mode_Keep the EUT in continuously transmitting mode with GFSK modulation. All modes have been tested and only the data of worst case is recorded in the report.
	c:Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation. All modes have been tested and only the data of worst case is recorded in the report.
The worst case for final test:	c:Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

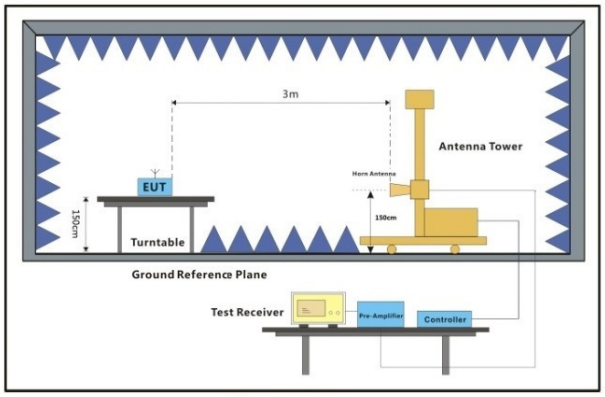
7.11.2 Test Setup Diagram



Below 30MHz



30MHz-1GHz



Above 1GHz

7.11.3 Measurement Procedure and Data

a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

d. The antenna 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.

e. 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 (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

g. If the emission level of the EUT in peak mode was 10dB 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 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

h. Test the EUT in the lowest channel, the middle channel, the Highest channel.

i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.

j. Repeat above procedures until all frequencies measured was complete.

Remark:

1) For emission below 1GHz, through pre-scan found the worst case is the lowest channel. Only the worst case is recorded in the report.

2) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

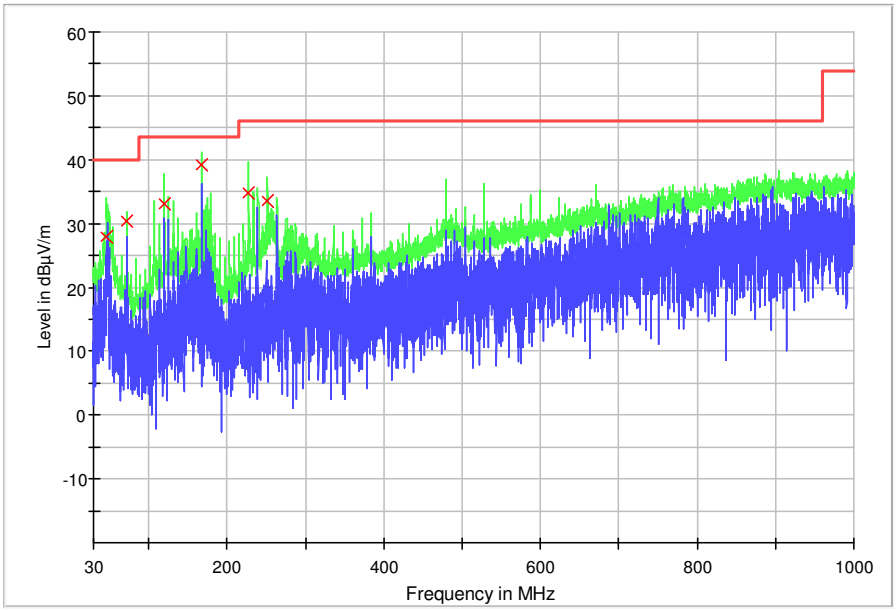
Final Test Level =Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor

3) Scan from 9kHz to 25GHz, the disturbance above 18GHz and below 30MHz was very low. The points marked on above plots are the highest emissions could be found when testing, so only above points had been displayed. The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.

4) For frequencies above 1GHz, the field strength limits 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 the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.

Radiated emission below 1GHz

Horizontal (worse plots was shown as below)

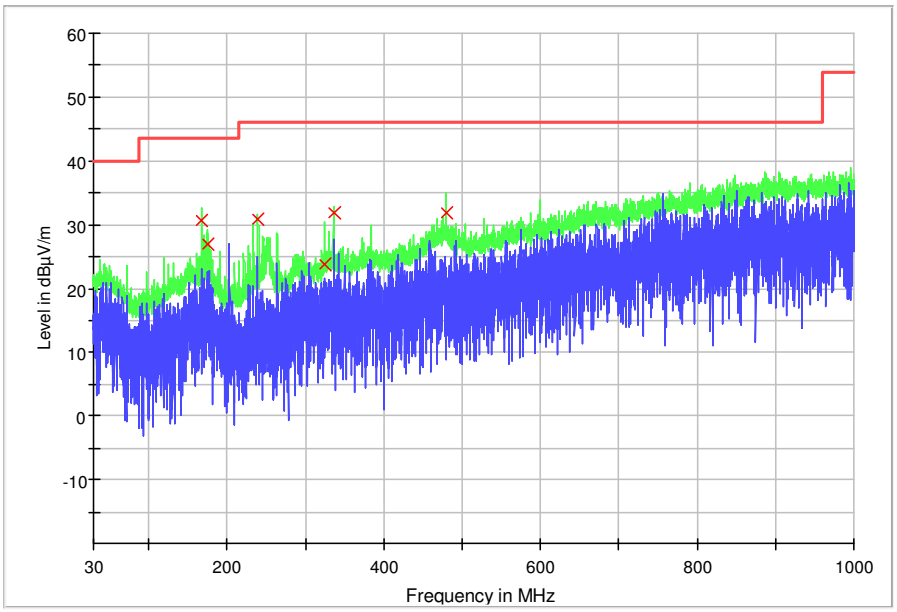


Frequency (MHz)	QuasiPeak (dBµV/m)	Pol.	Corr. (dB/m)	Margin (dB)	Limit (dBµV/m)	Result
46.005000	28.0	H	14.5	12.1	40.0	Pass
72.001000	30.4	H	11.2	9.6	40.0	Pass
119.919000	33.2	H	12.1	10.3	43.5	Pass
167.934000	39.2	H	14.1	4.3	43.5	Pass
227.977000	34.7	H	11.3	11.3	46.0	Pass
251.936000	33.7	H	12.8	12.3	46.0	Pass

Remark:

1. All readings are Quasi-Peak values.
2. Correction Factor = Antenna Factor + Cable Loss.
3. Pol. = antenna polarization

Vertical (worse plots was shown as below)



Frequency (MHz)	QuasiPeak (dBµV/m)	Pol.	Corr. (dB/m)	Margin (dB)	Limit (dBµV/m)	Result
167.934000	30.6	H	14.1	12.9	43.5	Pass
175.985000	27.0	H	13.1	16.5	43.5	Pass
240.005000	30.8	H	12.7	15.2	46.0	Pass
324.104000	23.8	H	15.1	22.2	46.0	Pass
335.938000	31.9	H	15.6	14.1	46.0	Pass
479.983000	32.0	H	19.0	14.0	46.0	Pass

Remark:
1. All readings are Quasi-Peak values.
2. Correction Factor = Antenna Factor + Cable Loss.
3. Pol. = antenna polarization

Above 1GHz

Channel:Low

Frequency (MHz)	Antenna Polarization	Emission Level (dBµV/m)		Limit (dBµV/m)		Remark
		Peak	Average	Peak	Average	
2149.000	H	46.7	29.3	74.0	54.0	Pass
2693.000	H	46.4	28.4	74.0	54.0	Pass
4809.000	H	54.6	43.1	74.0	54.0	Pass
2116.500	V	52.5	44.6	74.0	54.0	Pass
2677.000	V	44.9	27.5	74.0	54.0	Pass
4811.500	V	42.9	32.9	74.0	54.0	Pass

Channel:Middle

Frequency (MHz)	Antenna Polarization	Emission Level (dBµV/m)		Limit (dBµV/m)		Remark
		Peak	Average	Peak	Average	
2187.500	H	45.9	39.9	74.0	54.0	Pass
2730.500	H	45.4	37.6	74.0	54.0	Pass
4949.000	H	56.3	47.6	74.0	54.0	Pass
2116.500	V	52.5	44.6	74.0	54.0	Pass
2677.000	V	44.9	27.5	74.0	54.0	Pass
4811.500	V	42.9	32.9	74.0	54.0	Pass

Channel: High

Frequency (MHz)	Antenna Polarization	Emission Level (dBµV/m)		Limit (dBµV/m)		Remark
		Peak	Average	Peak	Average	
2171.000	H	49.0	30.8	74.0	54.0	Pass
2731.000	H	49.9	32.9	74.0	54.0	Pass
4949.000	H	56.8	46.2	74.0	54.0	Pass
2170.500	V	45.3	37.6	74.0	54.0	Pass
2763.500	V	43.6	37.6	74.0	54.0	Pass
4949.000	V	53.8	43.4	74.0	54.0	Pass

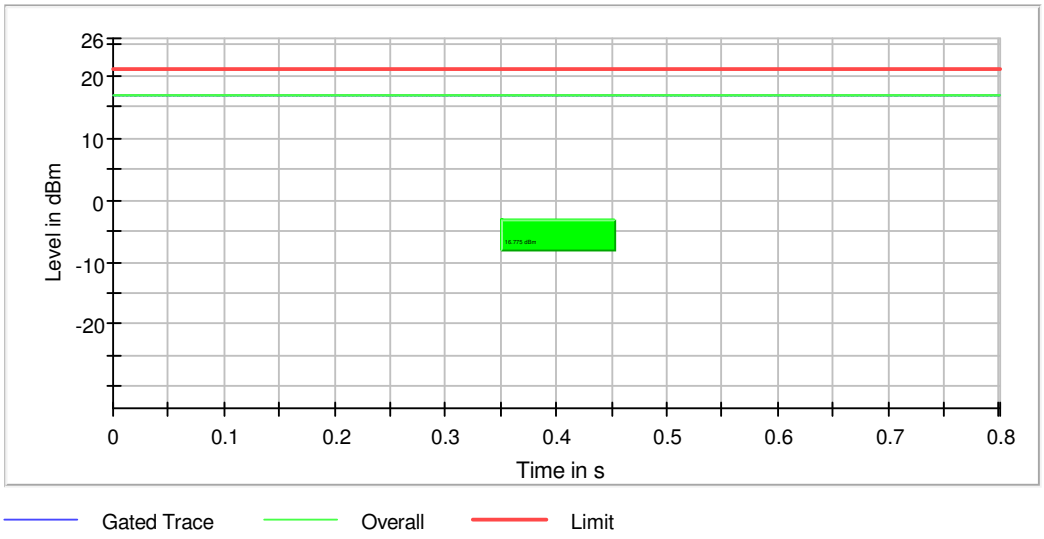
8 Photographs

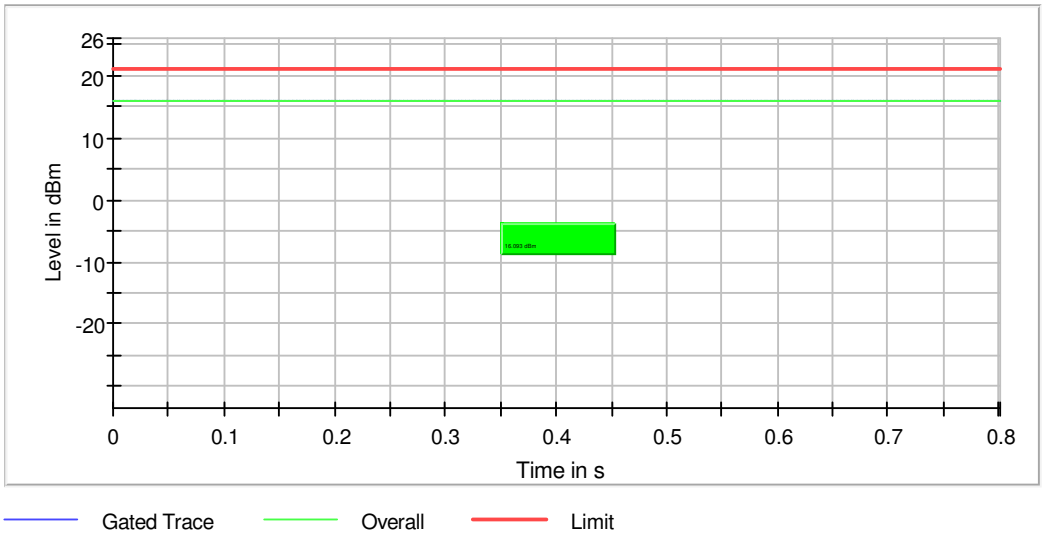
Remark: Photos refer to Appendix: External Photo, Internal Phot, and Setup Photo

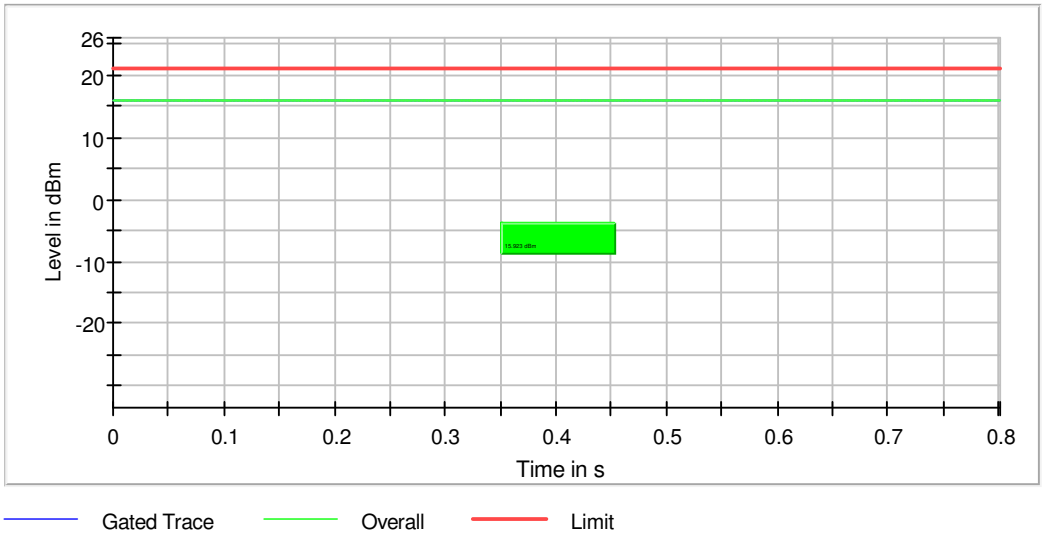
9 Appendix

9.1 Peak conducted output power

DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Result
2405.000000	16.8	21.0	PASS
2439.000000	16.1	21.0	PASS
2475.000000	15.9	21.0	PASS



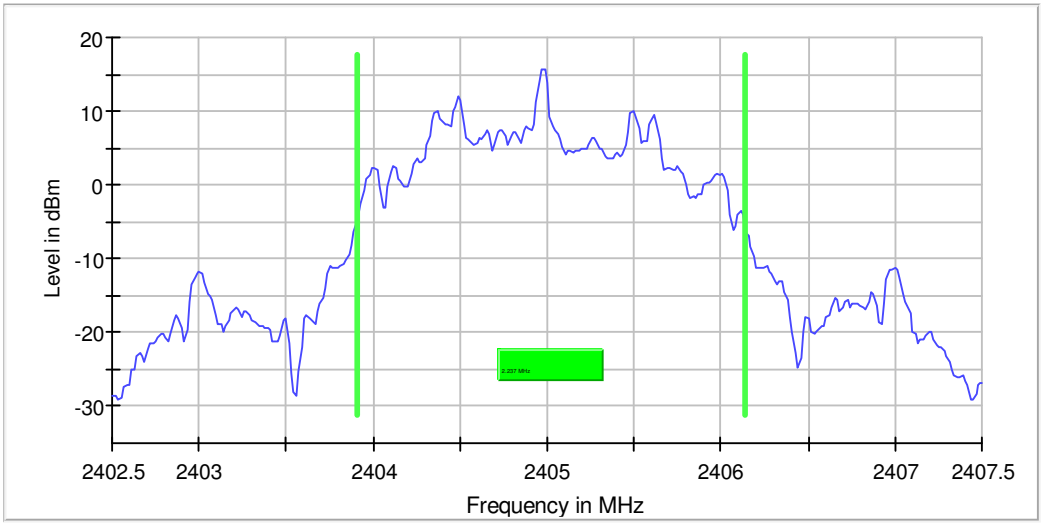


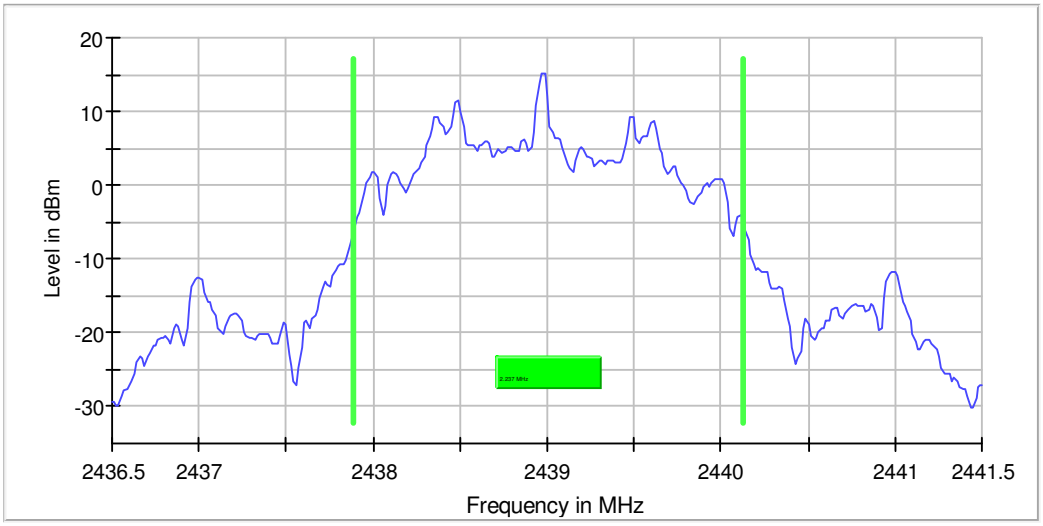


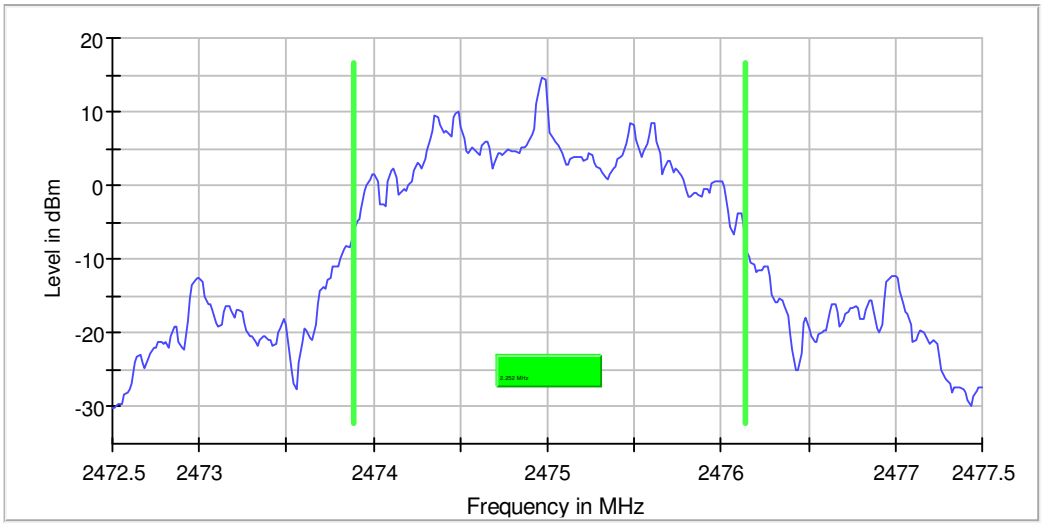
Remark: Cable loss 0.8 dB was considered and set in system configuration.

9.2 Emission Bandwidth 20 dB

DUT Frequency (MHz)	Bandwidth (MHz)	Limit (MHz)	Result
2405.000000	2.24	---	PASS
2439.000000	2.24	---	PASS
2475.000000	2.25	---	PASS







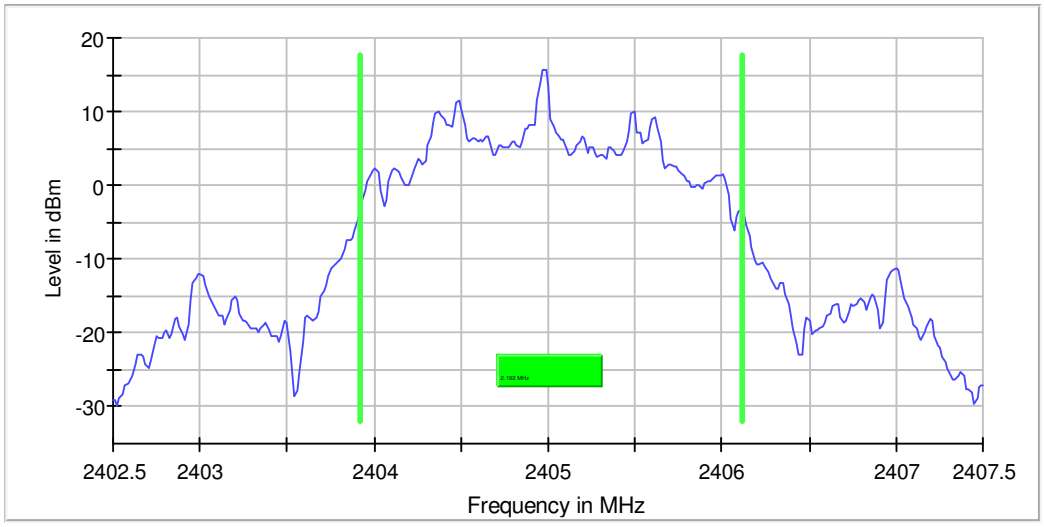
Measurement

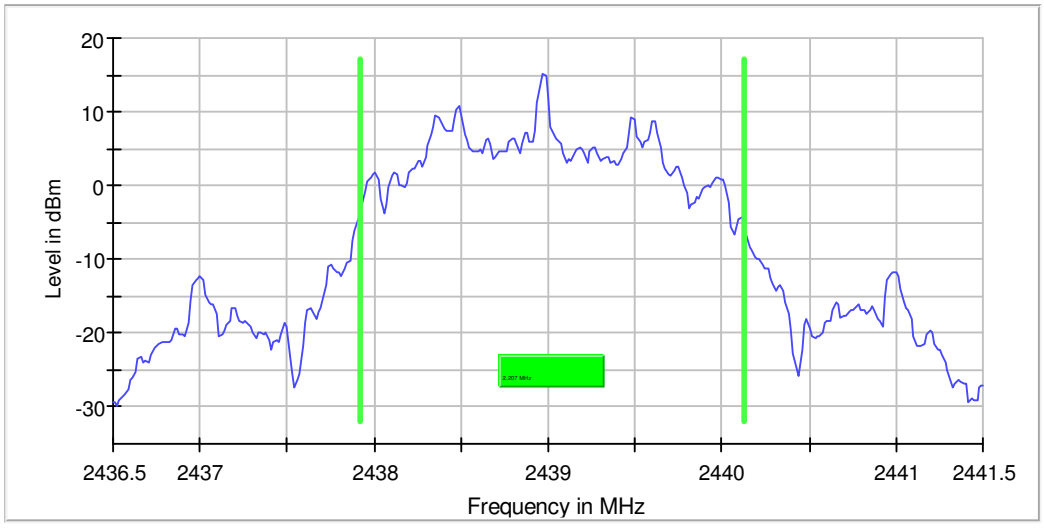
Setting	Instrument Value	Target Value
Start Frequency	2.47250 GHz	2.47250 GHz
Stop Frequency	2.47750 GHz	2.47750 GHz
Span	5.000 MHz	5.000 MHz
RBW	30.000 kHz	>= 25.000 kHz
VBW	100.000 kHz	>= 90.000 kHz
SweepPoints	333	~ 333
Sweeptime	63.218 µs	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	30.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	200	200
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	26 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.12 dB	0.50 dB

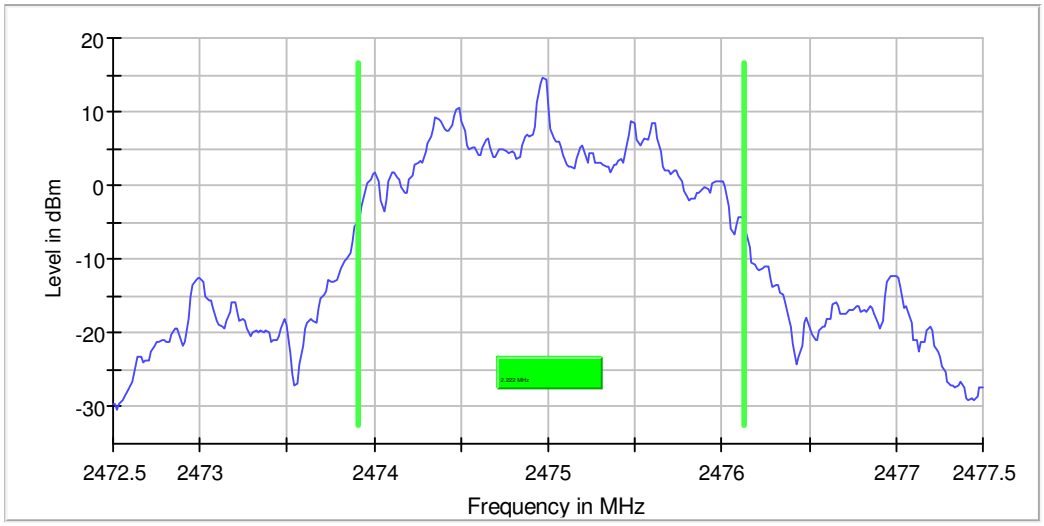
Remark: Cable loss 0.8 dB was considered and set in system configuration.

9.3 Occupied Channel Bandwidth 99%

DUT Frequency (MHz)	Bandwidth (MHz)	Limit (MHz)	Result
2405.000000	2.19	---	PASS
2439.000000	2.21	---	PASS
2475.000000	2.22	---	PASS







Measurement

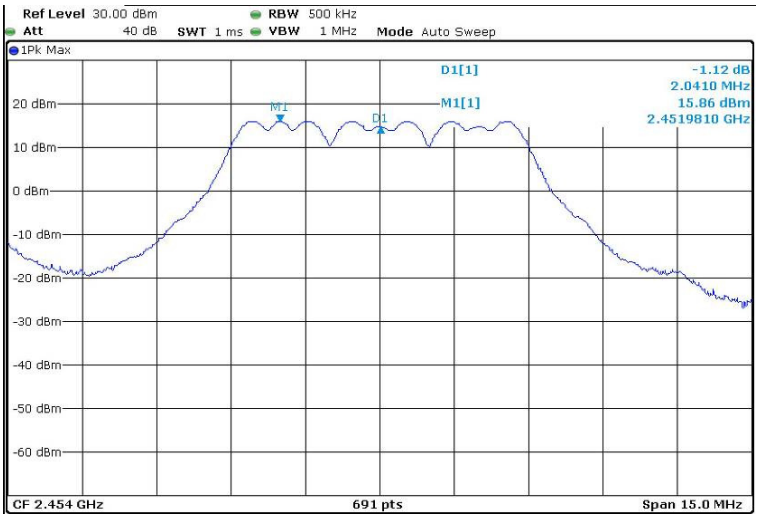
Setting	Instrument Value	Target Value
Start Frequency	2.47250 GHz	2.47250 GHz
Stop Frequency	2.47750 GHz	2.47750 GHz
Span	5.000 MHz	5.000 MHz
RBW	30.000 kHz	>= 25.000 kHz
VBW	100.000 kHz	>= 90.000 kHz
SweepPoints	333	~ 333
Sweeptime	63.218 µs	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	30.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	500	500
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.30 dB	0.30 dB
Run	28 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.30 dB

Remark: Cable loss 0.8 dB was considered and set in system configuration.

9.4 Carrier Frequency Separation

DUT Frequency (MHz)	Frequency Separation (MHz)	Limit (MHz)	Result
2451.98100	2.041	1.50	**PASS**

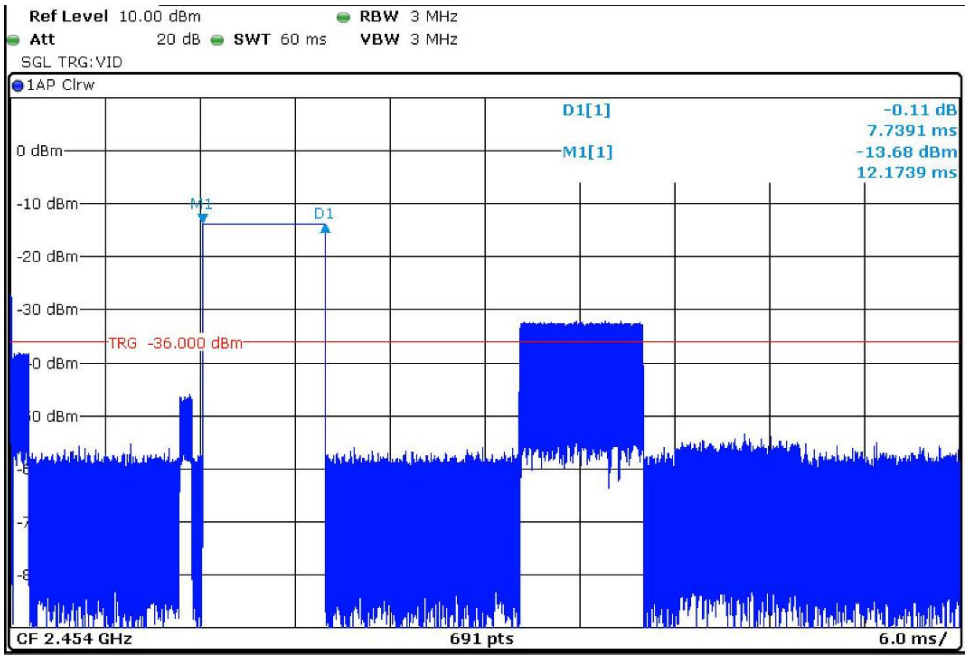
Remark: Limit = 2/3* 20dB Bandwidth
Worst case plot was shown as below:

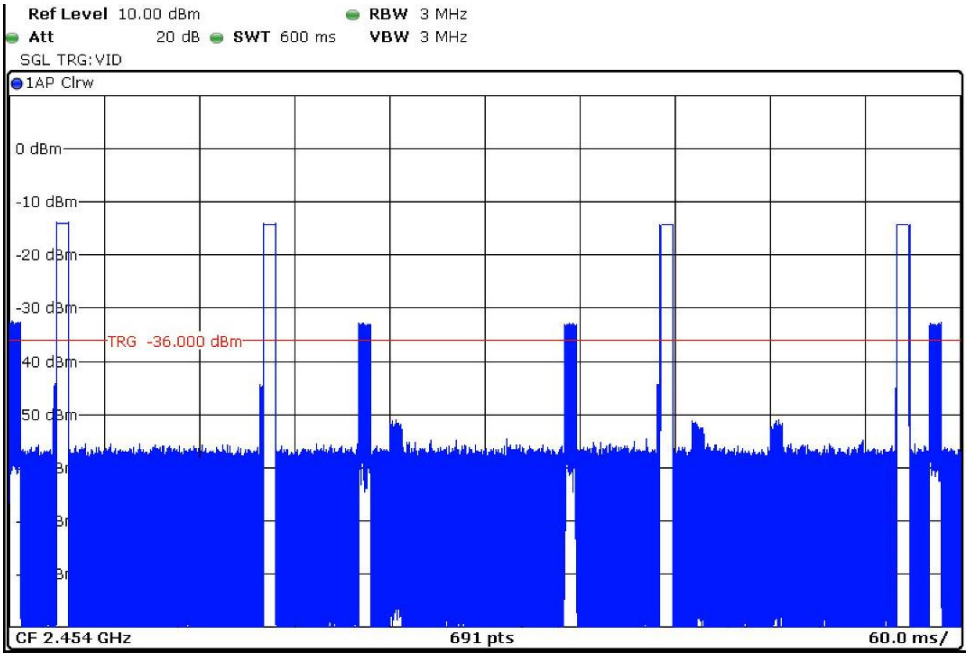


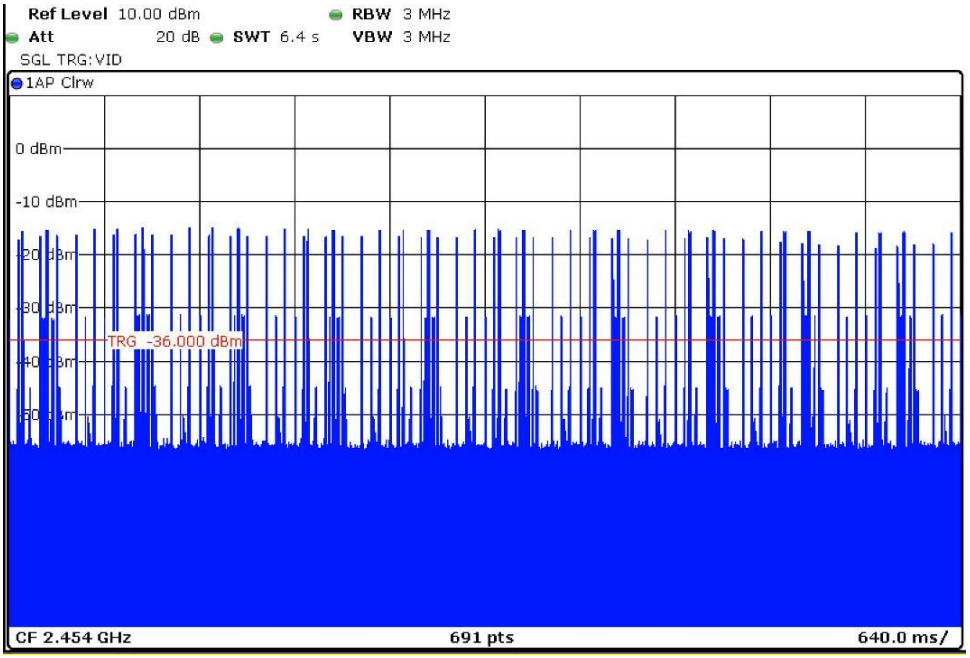
9.5 Dwell Time

Channel (MHz)	Width of Burst (ms)	Number of Burst(s)	Active Channels	Measurement Time (s)	Dwell Time (ms)	Limit (ms)	Result
2454	7.74	43	16	6.4	332.8	≤400	Pass

*Remark: the channel shown is the worst case.



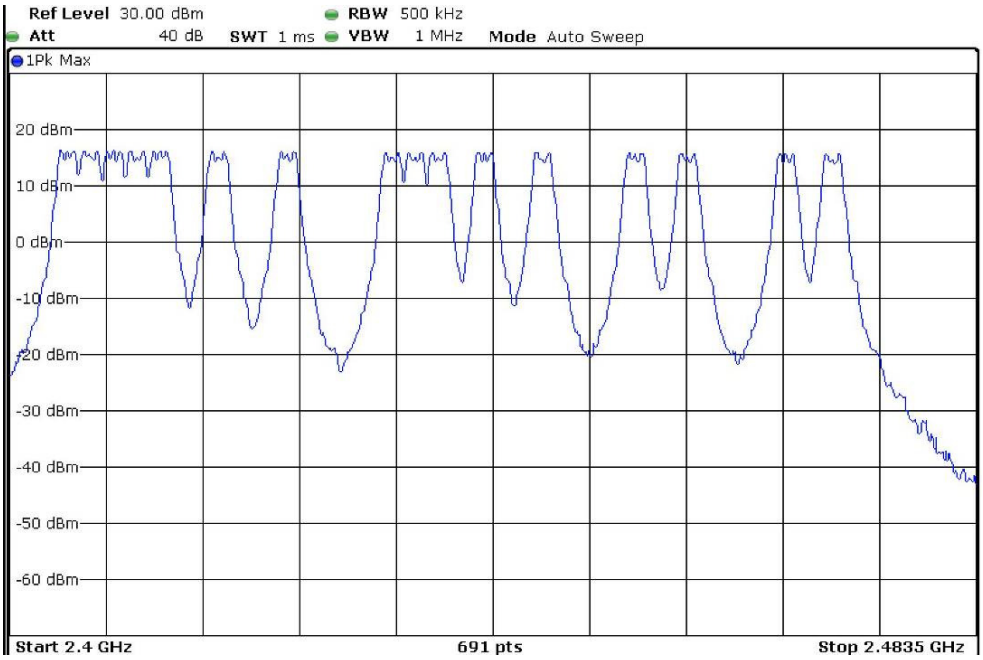

Ref Level 10.00 dBm
RBW 3 MHz
Att 20 dB SWT 600 ms VBW 3 MHz
SGL TRG: VID
1AP Clrw
0 dBm
-10 dBm
-20 dBm
-30 dBm
TRG -36.000 dBm
40 dBm
50 dBm
CF 2.454 GHz
691 pts
60.0 ms/


Ref Level 10.00 dBm
RBW 3 MHz
Att 20 dB SWT 6.4 s VBW 3 MHz
SGL TRG: VID
1AP Clrw
0 dBm
-10 dBm
TRG -36.000 dBm
CF 2.454 GHz
691 pts
640.0 ms/

9.6 Hopping Frequencies

Channels	Limit Min	Result
16	15	PASS

Worst case plot was shown as below:



9.7 Conducted Band Edge Measurement

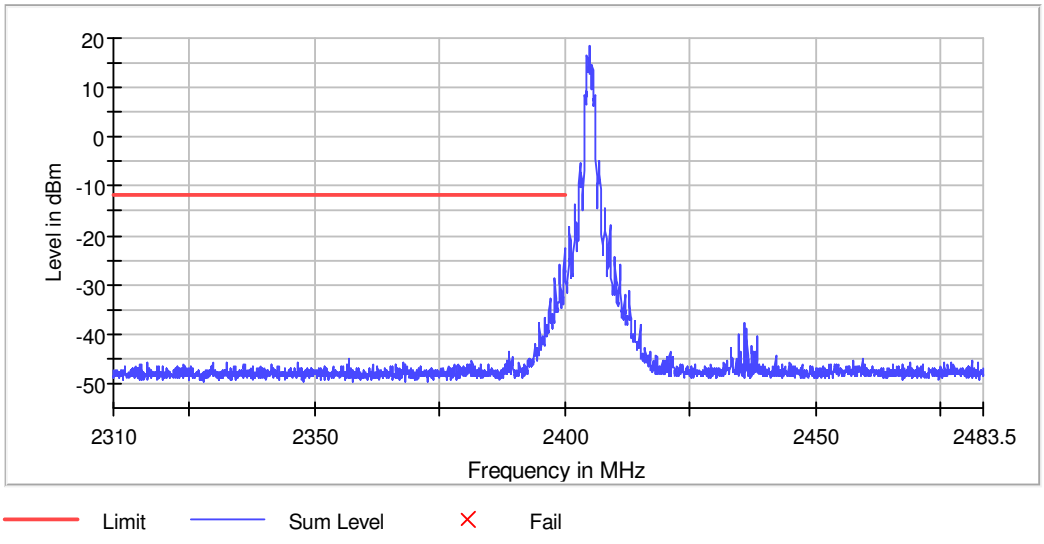
Non-hopping
Channel: Low

Inband Peak

Frequency (MHz)	Level (dBm)
2405.025000	18.4

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.975000	-22.4	10.9	-11.6	PASS
2399.025000	-26.0	14.5	-11.6	PASS
2398.975000	-26.3	14.8	-11.6	PASS
2399.925000	-27.2	15.6	-11.6	PASS
2398.925000	-28.3	16.7	-11.6	PASS
2398.025000	-28.7	17.2	-11.6	PASS
2397.975000	-29.2	17.6	-11.6	PASS
2399.075000	-29.4	17.8	-11.6	PASS
2399.175000	-29.7	18.1	-11.6	PASS
2399.125000	-29.8	18.2	-11.6	PASS
2399.875000	-30.7	19.1	-11.6	PASS
2399.225000	-31.3	19.7	-11.6	PASS
2399.825000	-31.7	20.1	-11.6	PASS
2399.775000	-32.0	20.4	-11.6	PASS
2398.875000	-32.0	20.4	-11.6	PASS



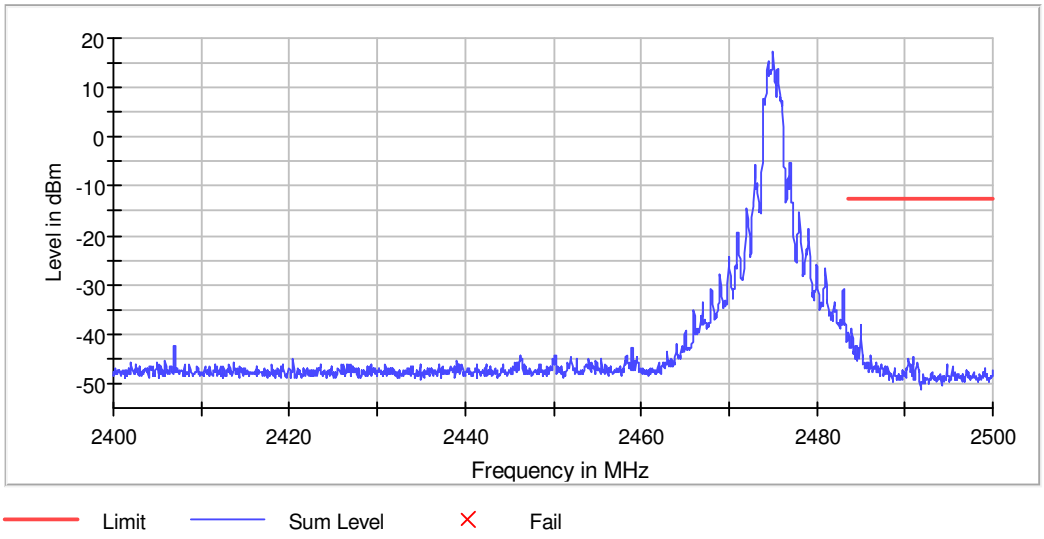
Channel: High

Inband Peak

Frequency (MHz)	Level (dBm)
2475.025000	17.4

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2484.975000	-38.3	25.7	-12.6	PASS
2485.025000	-38.5	25.9	-12.6	PASS
2483.975000	-39.0	26.4	-12.6	PASS
2484.025000	-39.5	26.9	-12.6	PASS
2483.575000	-39.9	27.3	-12.6	PASS
2483.925000	-40.3	27.7	-12.6	PASS
2484.925000	-40.4	27.8	-12.6	PASS
2483.525000	-40.4	27.8	-12.6	PASS
2483.625000	-40.5	27.9	-12.6	PASS
2484.075000	-40.9	28.3	-12.6	PASS
2485.075000	-41.0	28.4	-12.6	PASS
2484.125000	-41.3	28.7	-12.6	PASS
2484.525000	-42.3	29.7	-12.6	PASS
2484.475000	-42.4	29.8	-12.6	PASS
2483.825000	-42.7	30.1	-12.6	PASS



Measurement 1

Setting	Instrument Value	Target Value
Start Frequency	2.40000 GHz	2.40000 GHz
Stop Frequency	2.48350 GHz	2.48350 GHz
Span	83.500 MHz	83.500 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	1670	~ 1670
Sweeptime	1.670 ms	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	30.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	22 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Measurement 2

Setting	Instrument Value	Target Value
Start Frequency	2.48350 GHz	2.48350 GHz
Stop Frequency	2.50000 GHz	2.50000 GHz
Span	16.500 MHz	16.500 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	330	~ 330
Sweeptime	37.969 us	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	30.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	4 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Remark: Cable loss 0.8 dB was considered and set in system configuration.

Hopping
Channel: Low

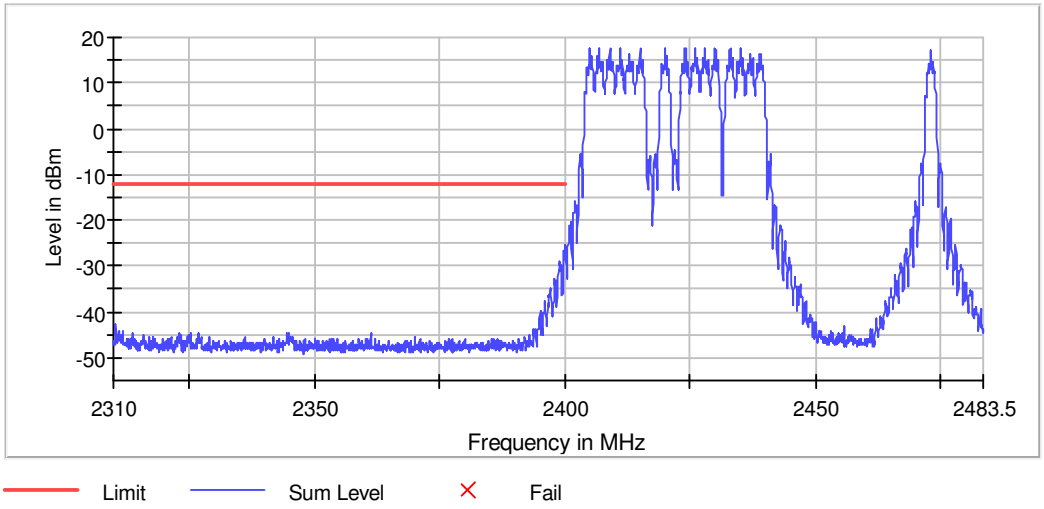
Inband Peak

Frequency (MHz)	Level (dBm)
2404.975000	17.7

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.925000	-26.7	14.3	-12.3	PASS
2399.975000	-27.1	14.8	-12.3	PASS
2399.875000	-27.4	15.0	-12.3	PASS
2399.825000	-28.5	16.2	-12.3	PASS
2399.075000	-29.0	16.7	-12.3	PASS
2399.775000	-29.2	16.9	-12.3	PASS
2399.175000	-29.5	17.2	-12.3	PASS
2399.025000	-29.5	17.2	-12.3	PASS
2399.225000	-29.8	17.5	-12.3	PASS
2399.125000	-30.0	17.6	-12.3	PASS
2398.975000	-30.4	18.1	-12.3	PASS
2398.925000	-30.5	18.2	-12.3	PASS
2399.275000	-30.5	18.2	-12.3	PASS
2399.325000	-30.5	18.2	-12.3	PASS
2398.825000	-30.8	18.5	-12.3	PASS

Band Edge



Channel: High

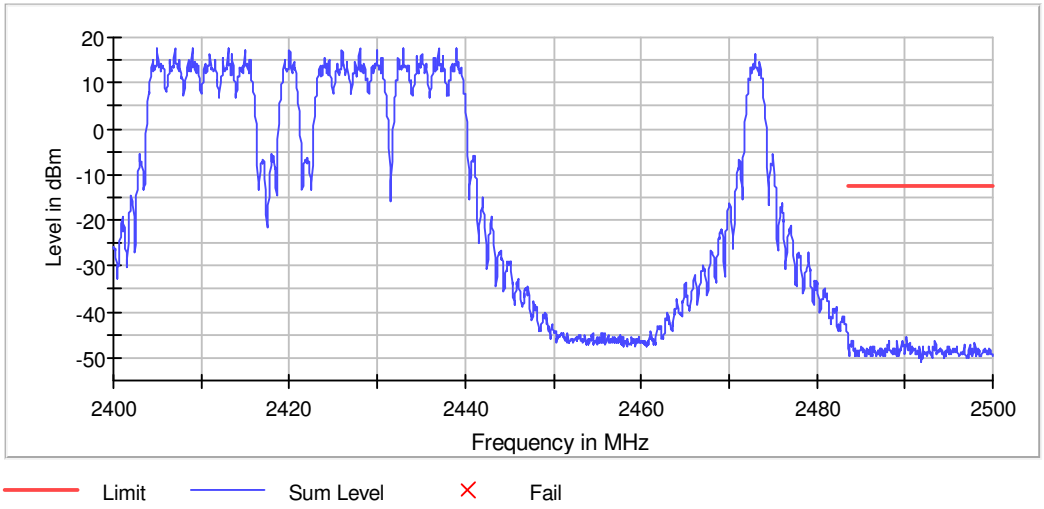
Inband Peak

Frequency (MHz)	Level (dBm)
2406.975000	17.6

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2490.175000	-45.5	33.1	-12.4	PASS
2490.125000	-45.7	33.3	-12.4	PASS
2490.225000	-46.0	33.5	-12.4	PASS
2484.075000	-46.2	33.7	-12.4	PASS
2489.175000	-46.2	33.8	-12.4	PASS
2489.625000	-46.4	34.0	-12.4	PASS
2489.125000	-46.4	34.0	-12.4	PASS
2493.425000	-46.4	34.0	-12.4	PASS
2488.175000	-46.4	34.0	-12.4	PASS
2484.025000	-46.4	34.0	-12.4	PASS
2488.225000	-46.5	34.0	-12.4	PASS
2489.725000	-46.6	34.2	-12.4	PASS
2484.125000	-46.6	34.2	-12.4	PASS
2490.575000	-46.7	34.3	-12.4	PASS
2490.075000	-46.8	34.3	-12.4	PASS

Band Edge



Measurement 1

Setting	Instrument Value	Target Value
Start Frequency	2.31000 GHz	2.31000 GHz
Stop Frequency	2.40000 GHz	2.40000 GHz
Span	90.000 MHz	90.000 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	1800	~ 1800
Sweeptime	1.800 ms	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	30.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	27 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.45 dB	0.50 dB

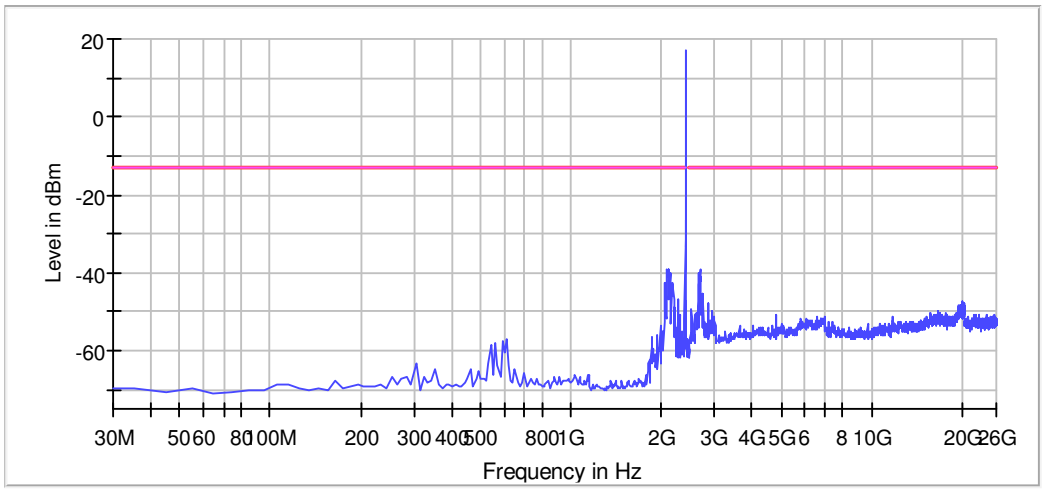
Measurement 2

Setting	Instrument Value	Target Value
Start Frequency	2.40000 GHz	2.40000 GHz
Stop Frequency	2.48350 GHz	2.48350 GHz
Span	83.500 MHz	83.500 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	1670	~ 1670
Sweeptime	1.670 ms	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	30.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	AUTO

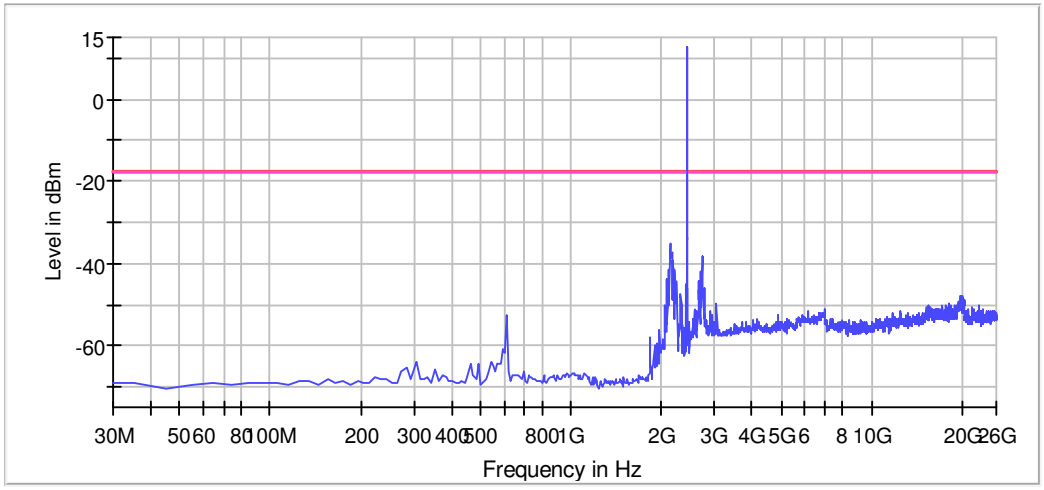
Remark: Cable loss 0.8 dB was considered and set in system configuration.

9.8 Conducted spurious emission

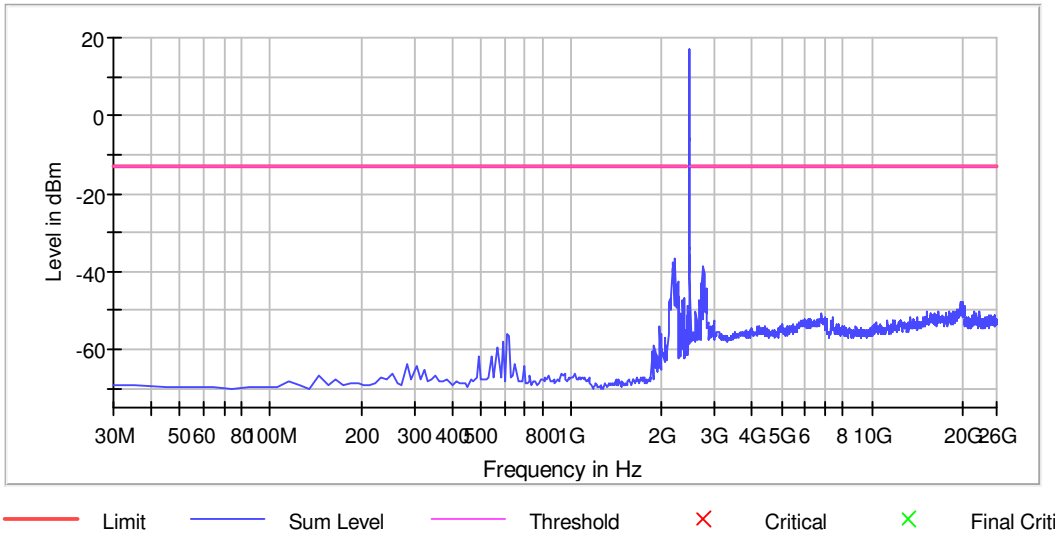
Lowest Channel



Middle Channel



Highest Channel



Measurement Setting

Setting	Instrument Value	Target Value
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	238	~ 238
Sweeptime	23.700 ms	AUTO
Reference Level	-10.000 dBm	-30.000 dBm
Attenuation	20.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	3	3
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	11 / max. 40	max. 40
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Remark: Cable loss 0.8 dB was considered and set in system configuration.

- End of the Report -