

TEST REPORT

Application No.: HKEM2011001183AT
Applicant: Wise Ally Holdings Limited
Address of Applicant: Unit 3203-3207 , Tower 1 , Enterprise Square Five , Kowloon Bay , Hong Kong
Equipment Under Test (EUT):
EUT Name: Asset Tracker
Model No.: AP81
FCC ID: 2AGEG-AP81
Standard(s) : 47 CFR Part 15, Subpart C 15.247
Date of Receipt: 2021-01-04
Date of Test: 2021-01-04 to 2021-01-08
Date of Issue: 2021-01-08

| | |
|---------------------|--------------|
| Test Result: | Pass* |
|---------------------|--------------|

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



Law Man Kit
EMC Manager

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Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 30 days only.

| Revision Record | | | | |
|------------------------|----------------|-------------|-----------------|---------------|
| Version | Chapter | Date | Modifier | Remark |
| 01 | | 2021-01-08 | | Original |
| | | | | |
| | | | | |

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|---------------------------------|--|--|------------------|
| Authorized for issue by: | | | |
| | |  | |
| | | <hr/> Leo Xu /Project Engineer | Date: 2021-01-08 |
| | |  | |
| | | <hr/> Law Man Kit /Reviewer | Date: 2021-01-08 |

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 |

Declaration of EUT Family Grouping:

N/A

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.

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4 General Information

4.1 Details of E.U.T.

| | |
|-----------------------------|---|
| Power supply: | Adaptor Model: IEC 005 Input: AC 100 V - 240 V, 50/60 Hz, 0.75 A Output: DC 5 V, 1 A or Battery Model: SD803041 Output: DC 3.7 V, 3.7 Wh |
| Test voltage: | AC 120 V |
| Cable: | Power Cable: 18.8 cm unshielded 4-wire USB cable Data Cable: 18.8 cm unshielded 4-wire USB cable |
| Antenna Gain: | 2 dBi |
| Antenna Type: | Integral Antenna |
| Bluetooth Version: | V4.2 Classic |
| Channel Spacing: | 1MHz |
| Modulation Type: | GFSK |
| Number of Channels: | 79 |
| Operation Frequency: | 2402MHz to 2480MHz |
| Spectrum Spread Technology: | Frequency Hopping Spread Spectrum(FHSS) |
| Series No.: | A1 |
| Firmware Version: | 1.0.8 |
| Hardware Version: | 4.2 |

Frequency List:

| Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---------|-----------------|---------|-----------------|
| 0 | 2402 | 40 | 2441 |
| 1 | 2403 | 41 | 2443 |
| 2 | 2404 | 42 | 2444 |
| 3 | 2405 | 43 | 2445 |
| 4 | 2406 | 44 | 2446 |
| 5 | 2407 | 45 | 2447 |
| 6 | 2408 | 46 | 2448 |
| 7 | 2409 | 47 | 2449 |
| 8 | 2410 | 48 | 2450 |
| 9 | 2411 | 49 | 2451 |
| 10 | 2412 | 50 | 2452 |
| 11 | 2413 | 51 | 2453 |
| 12 | 2414 | 52 | 2454 |
| 13 | 2415 | 53 | 2455 |
| 14 | 2416 | 54 | 2456 |
| 15 | 2417 | 55 | 2457 |
| 16 | 2418 | 56 | 2458 |
| 17 | 2419 | 57 | 2459 |
| 18 | 2420 | 58 | 2460 |
| 19 | 2421 | 59 | 2461 |
| 20 | 2422 | 60 | 2462 |
| 21 | 2423 | 61 | 2463 |
| 22 | 2424 | 62 | 2464 |
| 23 | 2425 | 63 | 2465 |
| 24 | 2426 | 64 | 2466 |
| 25 | 2427 | 65 | 2467 |
| 26 | 2428 | 66 | 2468 |
| 27 | 2429 | 67 | 2469 |
| 28 | 2430 | 68 | 2470 |
| 29 | 2431 | 69 | 2471 |
| 30 | 2432 | 70 | 2472 |
| 31 | 2433 | 71 | 2473 |
| 32 | 2434 | 72 | 2474 |
| 33 | 2435 | 73 | 2475 |
| 34 | 2436 | 74 | 2476 |
| 35 | 2437 | 75 | 2477 |
| 36 | 2438 | 76 | 2478 |
| 37 | 2439 | 77 | 2479 |
| 38 | 2440 | 78 | 2480 |
| 39 | 2441 | | |

4.2 Description of Support Units

| Description | Manufacturer | Model No. | Serial No. |
|---------------------------|---|-----------|------------|
| Laptop | DELL | P75F | H55LXQ2 |
| Linear Adaptor | SGS HK Ltd | IEC 005 | N/A |
| ESP_RF_test_tool_v2.5.exe | PricewaterhouseCoopers Advisory Services LLC | N/A | N/A |

4.3 Modulation config

| RF software: | ESP_RF_test_tool_v2.5.exe | | | |
|--------------|---|-------------|-------------|-------|
| Modulation | Packet | Packet Type | Packet Size | Power |
| GFSK | DH1 | 5 | Default | 8 |
| | DH3 | 5 | Default | 8 |
| | DH5 | 5 | Default | 8 |
| Remark: | <ol style="list-style-type: none">1. 8 value was set in test software as maximum output power setting.2. Only two samples were used for RF test. | | | |

4.4 Measurement Uncertainty

RF

| No. | Item | Measurement Uncertainty |
|-----|---|---------------------------|
| 1 | Radio Frequency | $\pm 7.25 \times 10^{-8}$ |
| 2 | Duty cycle | $\pm 0.37\%$ |
| 3 | Occupied Bandwidth | $\pm 3\%$ |
| 4 | RF conducted power (30MHz-40GHz) | 1.5dB |
| 5 | RF power density | 1.5dB |
| 6 | Conducted Spurious emissions | 1.5dB |
| 7 | RF Radiated power & Radiated Spurious emission test | 4.9dB (30MHz-1GHz) |
| | | 4.6dB (1GHz-6GHz) |
| | | 4.7dB (6GHz-18GHz) |
| | | 5.6dB (18GHz-40GHz) |
| 8 | Temperature test | $\pm 1^{\circ}\text{C}$ |
| 9 | Humidity test | $\pm 3\%$ |
| 10 | Supply voltages | $\pm 1.5\%$ |
| 11 | Time | $\pm 3\%$ |

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors in calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report according to TR-100028-01 "Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 1" and TR-100028-02 "Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 2" and is documented in the test lab quality system according to ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

4.5 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.

4.6 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 and 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.

4.7 Deviation from Standards

None

4.8 Abnormalities from Standard Conditions

None

5 Equipment List

| Conducted Emissions at AC Power Line (150kHz-30MHz) | | | | | |
|---|-----------------|----------------------|--------------|------------|--------------|
| Equipment | Manufacturer | Model No | Inventory No | Cal Date | Cal Due Date |
| EMI Test Receiver 9kHz to 3.6GHz | Rohde & Schwarz | ESR3 / 102326 | E231 | 2020/08/31 | 2021/08/30 |
| Artificial Mains Network (LISN) | Schwarzbeck | NSLK 8127 / 8127312 | E005 | 2020/05/12 | 2021/05/11 |
| Impulse Limiter | Rohde & Schwarz | ESH-3-Z2 / 357881052 | E028 | 2020/09/12 | 2021/09/11 |
| EMC32 Test software | Rohde & Schwarz | Version 10 | N/A | N/A | N/A |

| Conducted Peak Output Power | | | | | |
|----------------------------------|-----------------|-----------------|--------------|------------|--------------|
| Equipment | Manufacturer | Model No | Inventory No | Cal Date | Cal Due Date |
| SMBV100A VECTOR SIGNAL GENERATOR | Rohde & Schwarz | SMBV100A | E234 | 2020/08/31 | 2021/08/30 |
| FSV40 SIGNAL ANALYZER 40GHz | Rohde & Schwarz | FSV40 | E235 | 2020/08/31 | 2021/08/30 |
| Wireless Conn. Tester (CMW) | Rohde & Schwarz | CMW270 | E240 | CAL IN USE | CAL IN USE |
| OSP | Rohde & Schwarz | OSP-B157W8 | E242 | 2020/08/31 | 2021/08/30 |
| Cable | Rohde & Schwarz | J12J103539-00-2 | E239 | 2020/09/21 | 2021/09/20 |
| Cable | Rohde & Schwarz | J12J103539-00-2 | E239 | 2020/09/21 | 2021/09/20 |
| WMS32 Test software | Rohde & Schwarz | N/A | Version 11 | N/A | N/A |

| 20dB Bandwidth | | | | | |
|----------------------------------|-----------------|-----------------|--------------|------------|--------------|
| Equipment | Manufacturer | Model No | Inventory No | Cal Date | Cal Due Date |
| SMBV100A VECTOR SIGNAL GENERATOR | Rohde & Schwarz | SMBV100A | E234 | 2020/08/31 | 2021/08/30 |
| FSV40 SIGNAL ANALYZER 40GHz | Rohde & Schwarz | FSV40 | E235 | 2020/08/31 | 2021/08/30 |
| Wireless Conn. Tester (CMW) | Rohde & Schwarz | CMW270 | E240 | CAL IN USE | CAL IN USE |
| OSP | Rohde & Schwarz | OSP-B157W8 | E242 | 2020/08/31 | 2021/08/30 |
| Cable | Rohde & Schwarz | J12J103539-00-2 | E239 | 2020/09/21 | 2021/09/20 |
| Cable | Rohde & Schwarz | J12J103539-00-2 | E239 | 2020/09/21 | 2021/09/20 |
| WMS32 Test software | Rohde & Schwarz | N/A | Version 11 | N/A | N/A |

| Carrier Frequencies Separation | | | | | |
|----------------------------------|-----------------|-----------------|--------------|------------|--------------|
| Equipment | Manufacturer | Model No | Inventory No | Cal Date | Cal Due Date |
| SMBV100A VECTOR SIGNAL GENERATOR | Rohde & Schwarz | SMBV100A | E234 | 2020/08/31 | 2021/08/30 |
| FSV40 SIGNAL ANALYZER 40GHz | Rohde & Schwarz | FSV40 | E235 | 2020/08/31 | 2021/08/30 |
| Wireless Conn. Tester (CMW) | Rohde & Schwarz | CMW270 | E240 | CAL IN USE | CAL IN USE |
| OSP | Rohde & Schwarz | OSP-B157W8 | E242 | 2020/08/31 | 2021/08/30 |
| Cable | Rohde & Schwarz | J12J103539-00-2 | E239 | 2020/09/21 | 2021/09/20 |
| Cable | Rohde & Schwarz | J12J103539-00-2 | E239 | 2020/09/21 | 2021/09/20 |
| WMS32 Test software | Rohde & Schwarz | N/A | Version 11 | N/A | N/A |

| Hopping Channel Number | | | | | |
|----------------------------------|-----------------|-----------------|--------------|------------|--------------|
| Equipment | Manufacturer | Model No | Inventory No | Cal Date | Cal Due Date |
| SMBV100A VECTOR SIGNAL GENERATOR | Rohde & Schwarz | SMBV100A | E234 | 2020/08/31 | 2021/08/30 |
| FSV40 SIGNAL ANALYZER 40GHz | Rohde & Schwarz | FSV40 | E235 | 2020/08/31 | 2021/08/30 |
| Wireless Conn. Tester (CMW) | Rohde & Schwarz | CMW270 | E240 | CAL IN USE | CAL IN USE |
| OSP | Rohde & Schwarz | OSP-B157W8 | E242 | 2020/08/31 | 2021/08/30 |
| Cable | Rohde & Schwarz | J12J103539-00-2 | E239 | 2020/09/21 | 2021/09/20 |
| Cable | Rohde & Schwarz | J12J103539-00-2 | E239 | 2020/09/21 | 2021/09/20 |
| WMS32 Test software | Rohde & Schwarz | N/A | Version 11 | N/A | N/A |

| Dwell Time | | | | | |
|----------------------------------|-----------------|-----------------|--------------|------------|--------------|
| Equipment | Manufacturer | Model No | Inventory No | Cal Date | Cal Due Date |
| SMBV100A VECTOR SIGNAL GENERATOR | Rohde & Schwarz | SMBV100A | E234 | 2020/08/31 | 2021/08/30 |
| FSV40 SIGNAL ANALYZER 40GHz | Rohde & Schwarz | FSV40 | E235 | 2020/08/31 | 2021/08/30 |
| Wireless Conn. Tester (CMW) | Rohde & Schwarz | CMW270 | E240 | CAL IN USE | CAL IN USE |
| OSP | Rohde & Schwarz | OSP-B157W8 | E242 | 2020/08/31 | 2021/08/30 |
| Cable | Rohde & Schwarz | J12J103539-00-2 | E239 | 2020/09/21 | 2021/09/20 |
| Cable | Rohde & Schwarz | J12J103539-00-2 | E239 | 2020/09/21 | 2021/09/20 |
| WMS32 Test software | Rohde & Schwarz | N/A | Version 11 | N/A | N/A |

| Conducted Band Edges Measurement | | | | | |
|---|---------------------|-----------------|---------------------|-----------------|---------------------|
| Equipment | Manufacturer | Model No | Inventory No | Cal Date | Cal Due Date |
| SMBV100A VECTOR SIGNAL GENERATOR | Rohde & Schwarz | SMBV100A | E234 | 2020/08/31 | 2021/08/30 |
| FSV40 SIGNAL ANALYZER 40GHz | Rohde & Schwarz | FSV40 | E235 | 2020/08/31 | 2021/08/30 |
| Wireless Conn. Tester (CMW) | Rohde & Schwarz | CMW270 | E240 | CAL IN USE | CAL IN USE |
| OSP | Rohde & Schwarz | OSP-B157W8 | E242 | 2020/08/31 | 2021/08/30 |
| Cable | Rohde & Schwarz | J12J103539-00-2 | E239 | 2020/09/21 | 2021/09/20 |
| Cable | Rohde & Schwarz | J12J103539-00-2 | E239 | 2020/09/21 | 2021/09/20 |
| WMS32 Test software | Rohde & Schwarz | N/A | Version 11 | N/A | N/A |

| Conducted Spurious Emissions | | | | | |
|-------------------------------------|---------------------|-----------------|---------------------|-----------------|---------------------|
| Equipment | Manufacturer | Model No | Inventory No | Cal Date | Cal Due Date |
| SMBV100A VECTOR SIGNAL GENERATOR | Rohde & Schwarz | SMBV100A | E234 | 2020/08/31 | 2021/08/30 |
| FSV40 SIGNAL ANALYZER 40GHz | Rohde & Schwarz | FSV40 | E235 | 2020/08/31 | 2021/08/30 |
| Wireless Conn. Tester (CMW) | Rohde & Schwarz | CMW270 | E240 | CAL IN USE | CAL IN USE |
| OSP | Rohde & Schwarz | OSP-B157W8 | E242 | 2020/08/31 | 2021/08/30 |
| Cable | Rohde & Schwarz | J12J103539-00-2 | E239 | 2020/09/21 | 2021/09/20 |
| Cable | Rohde & Schwarz | J12J103539-00-2 | E239 | 2020/09/21 | 2021/09/20 |
| WMS32 Test software | Rohde & Schwarz | N/A | Version 11 | N/A | N/A |

Radiated Spurious Emissions

| Equipment | Manufacturer | Model No | Inventory No | Cal Date | Cal Due Date |
|---|-----------------|-----------------------|--------------|------------|--------------|
| 3m Semi-Anechoic Chamber | ChamPro | N/A | E229 | 2020/08/09 | 2021/08/08 |
| Coaxial Cable | SGS | N/A | E167 | 2020/07/20 | 2021/07/19 |
| EMI Test Receiver 9kHz to 7GHz | Rohde & Schwarz | ESR7 / 102298 | E314 | 2020/05/18 | 2021/05/18 |
| TRILOG Super Broadb. Test Antenna, (25) 30-1000 (2) | Schwarzbeck | 9168-1110 | E311 | 2020/02/13 | 2022/02/12 |
| EMC32 Test software | Rohde & Schwarz | Version 10 | N/A | N/A | N/A |
| Spectrum Analyzer 9kHz - 30GHz | Rohde & Schwarz | FSP30 | E204 | 2020/05/11 | 2021/05/10 |
| Horn Antenna 1 - 18GHz | Schwarzbeck | BBHA9120D | E211 | 2020/03/11 | 2022/03/10 |
| Preamplifier 33dB, 1 - 18GHz | Schwarzbeck | BBV9718 | E214 | 2020/04/09 | 2021/04/08 |
| Band Reject Filter 2.4-2.5GHz | Wainwright | WRCJV 2400/2500-2100 | E206 | 2019/04/24 | 2021/04/23 |
| RF cable SMA to SMA 10000mm | HUBER+SUHNER | SF104-26.5/2*11SMA 45 | E207 | 2020/09/21 | 2021/09/20 |
| Boresight Mast Controller | ChamPro | AM-BS-4500-E | E237 | N/A | N/A |
| Turntable with Controller | ChamPro | EM1000 | E238 | N/A | 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 | 2020/09/12 | 2021/09/11 |
| Electronic Digital Thermometer with Hygrometer | nil | 2074/2075 | E159 | 2020/09/12 | 2021/09/11 |
| Barometer with digital thermometer | SATO | 7612-00 | E218 | 2020/4/23 | 2021/4/22 |
| Conditional Chamber | Zhong Zhi Testing Instruments | CZ-E-608D | E216 | 2020/8/31 | 2021/8/30 |

6 Radio Spectrum Technical Requirement

6.1 Antenna Requirement

6.1.1 Test Requirement:

47 CFR Part 15, Subpart C 15.203 & 15.247(b)(4)

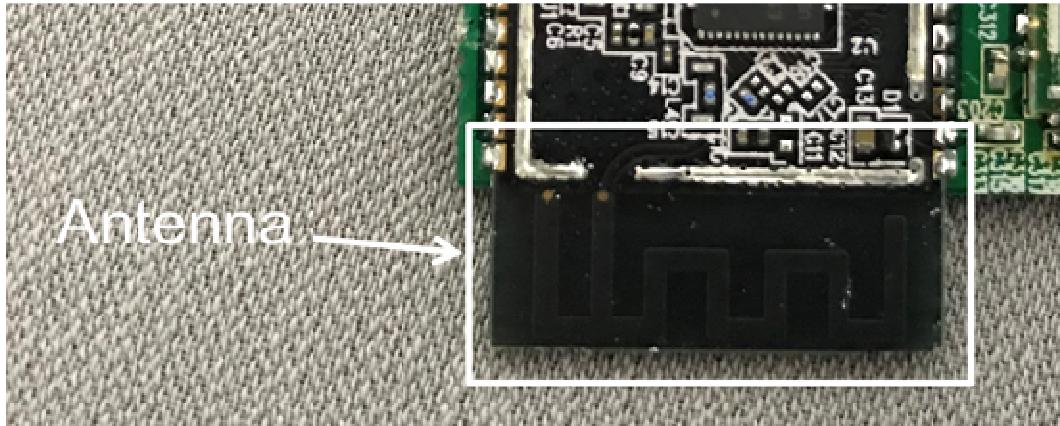
6.1.2 Conclusion

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.

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 2 dBi.

Antenna location: Refer to internal photo.

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: $2^9 - 1 = 511$ 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 coordinate 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

Test Method: ANSI C63.10 (2013) Section 6.2

Limit:

| Frequency of emission(MHz) | Conducted limit(dB μ V) | |
|----------------------------|-----------------------------|-----------|
| | 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.

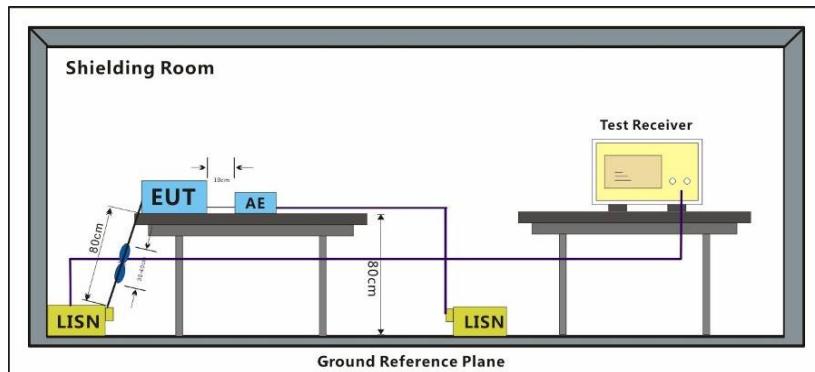
7.1.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH

Test mode a: Charge + 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 (DH5) is recorded in the report.

7.1.2 Test Setup Diagram

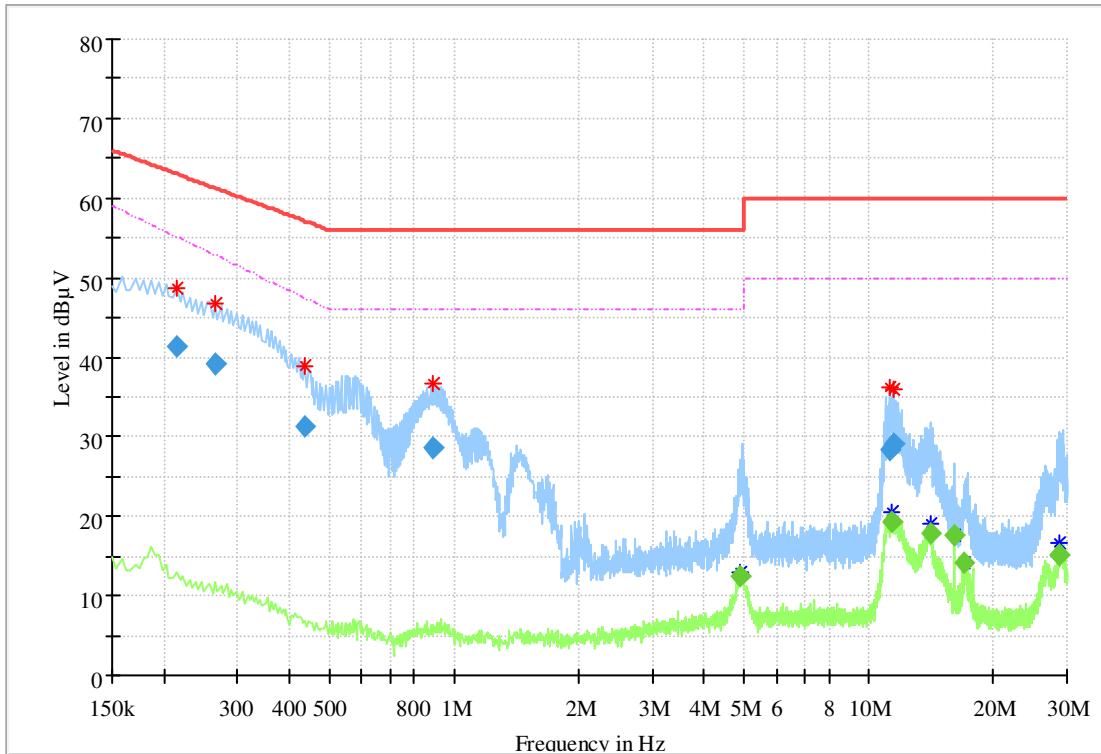


7.1.3 Measurement Procedure and Data

- 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/50 μ H + 50hm 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.

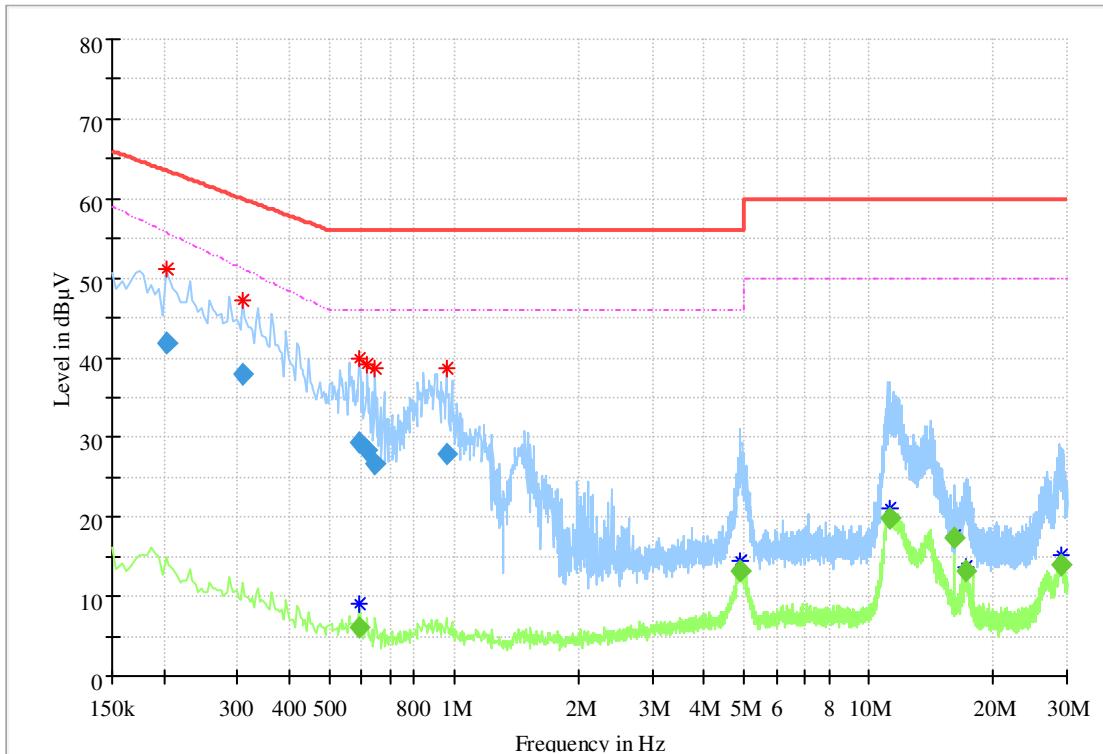
Remark: LISN=Read Level+ Cable Loss+ LISN Factor

Mode:a; Line:Live Line



| Frequency (MHz) | QuasiPeak (dB μ V) | Average (dB μ V) | Limit (dB μ V) | Margin (dB) | Corr. (dB) | Result |
|--------------------|---------------------------|-------------------------|-----------------------|----------------|---------------|--------|
| 0.214000 | 41.4 | --- | 63.1 | 21.6 | 10.1 | Pass |
| 0.266000 | 39.1 | --- | 61.2 | 22.1 | 10.0 | Pass |
| 0.438000 | 31.2 | --- | 57.1 | 25.9 | 10.0 | Pass |
| 0.894000 | 28.6 | --- | 56.0 | 27.4 | 10.2 | Pass |
| 4.910000 | --- | 12.4 | 46.0 | 33.6 | 10.6 | Pass |
| 11.286000 | 28.4 | --- | 60.0 | 31.6 | 11.0 | Pass |
| 11.334000 | --- | 19.2 | 50.0 | 30.8 | 11.1 | Pass |
| 11.506000 | 29.0 | --- | 60.0 | 31.0 | 11.1 | Pass |
| 14.062000 | --- | 17.8 | 50.0 | 32.2 | 11.3 | Pass |
| 16.002000 | --- | 17.5 | 50.0 | 32.5 | 11.3 | Pass |
| 16.990000 | --- | 14.2 | 50.0 | 35.8 | 11.2 | Pass |
| 28.770000 | --- | 15.2 | 50.0 | 34.8 | 11.1 | Pass |

Mode:a; Line:Neutral Line



| Frequency (MHz) | QuasiPeak (dB μ V) | Average (dB μ V) | Limit (dB μ V) | Margin (dB) | Corr. (dB) | Result |
|--------------------|---------------------------|-------------------------|-----------------------|----------------|---------------|--------|
| 0.202000 | 41.9 | --- | 63.5 | 21.6 | 10.1 | Pass |
| 0.310000 | 37.8 | --- | 60.0 | 22.2 | 10.0 | Pass |
| 0.590000 | --- | 6.1 | 46.0 | 39.9 | 10.1 | Pass |
| 0.590000 | 29.3 | --- | 56.0 | 26.7 | 10.1 | Pass |
| 0.618000 | 28.3 | --- | 56.0 | 27.7 | 10.1 | Pass |
| 0.646000 | 26.6 | --- | 56.0 | 29.4 | 10.1 | Pass |
| 0.958000 | 27.9 | --- | 56.0 | 28.1 | 10.2 | Pass |
| 4.914000 | --- | 13.1 | 46.0 | 32.9 | 10.6 | Pass |
| 11.214000 | --- | 19.9 | 50.0 | 30.1 | 11.0 | Pass |
| 15.998000 | --- | 17.5 | 50.0 | 32.5 | 11.3 | Pass |
| 17.094000 | --- | 13.2 | 50.0 | 36.8 | 11.2 | Pass |
| 29.054000 | --- | 14.0 | 50.0 | 36.0 | 11.1 | Pass |

7.2 Conducted Peak Output Power

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

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 $25 \leq$ 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 |

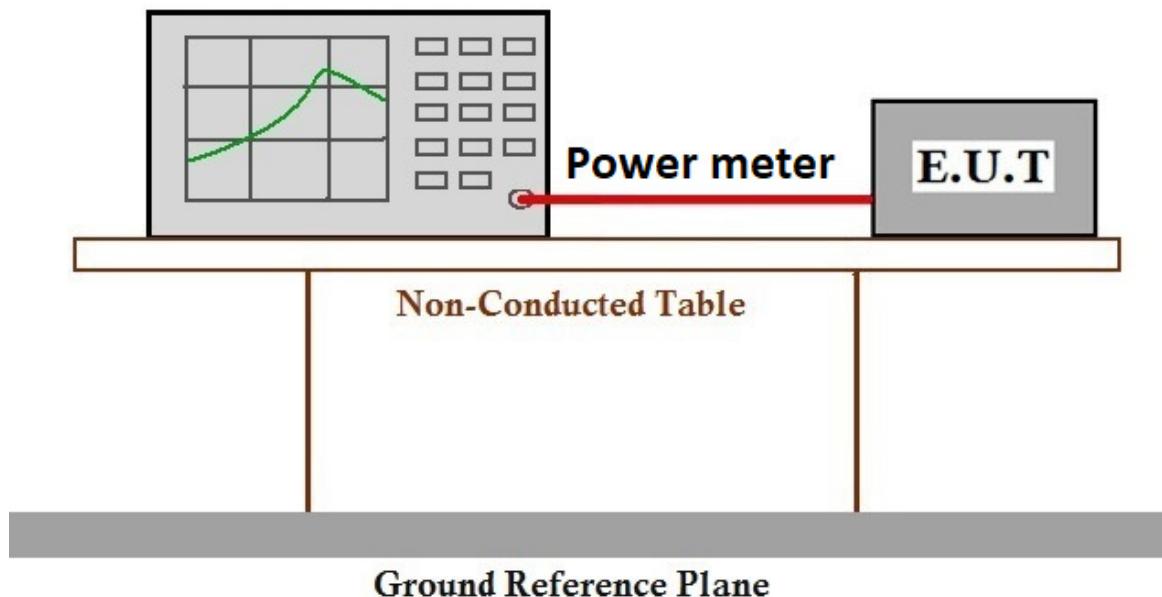
7.2.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH :

Test mode b: 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 (DH5) is recorded in the report.

7.2.2 Test Setup Diagram



7.2.3 Measurement Procedure and Data

The detailed test data see: Appendix 15.247

7.3 20dB Bandwidth

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

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

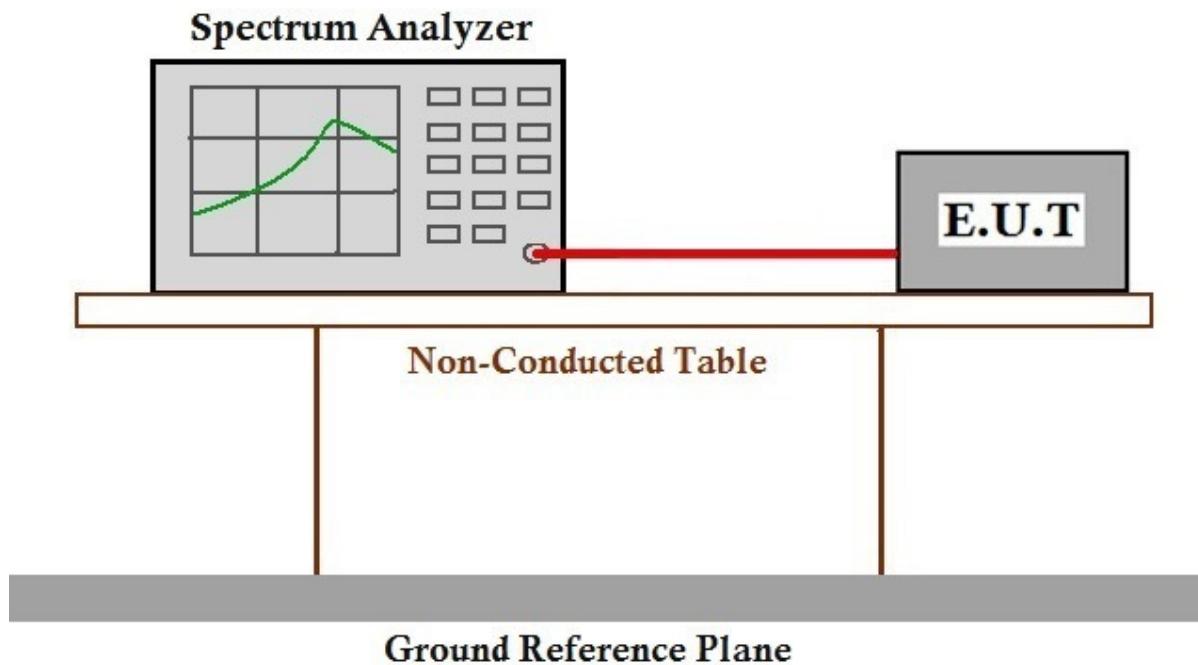
7.3.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH :

Test mode b: 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 (DH5) is recorded in the report.

7.3.2 Test Setup Diagram



7.3.3 Measurement Procedure and Data

The detailed test data see: Appendix 15.247

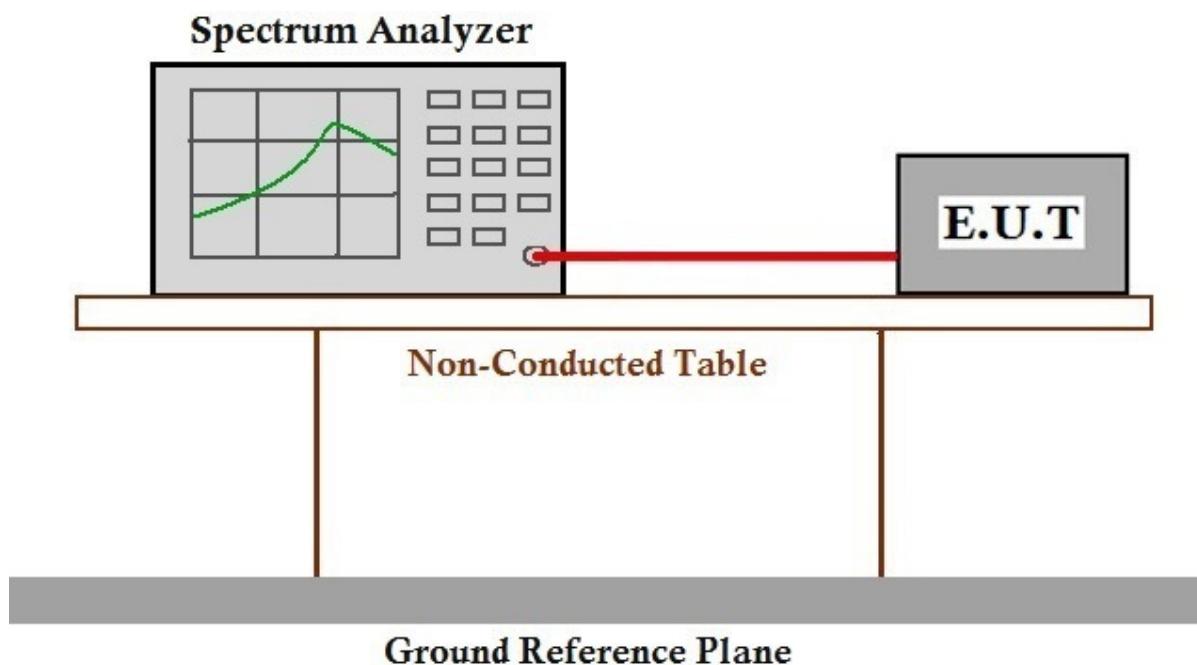
7.4 Carrier Frequencies Separation

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

7.4.1 E.U.T. Operation

Operating Environment:
Temperature: 25 °C Humidity: 50 % RH :
Test mode a: Charge + 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 (DH5) is recorded in the report.

7.4.2 Test Setup Diagram



7.4.3 Measurement Procedure and Data

The detailed test data see: Appendix 15.247

7.5 Hopping Channel Number

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

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 \geq 250kHz |
| 2400-2483.5 | 15 |
| 5725-5850 | 75 |

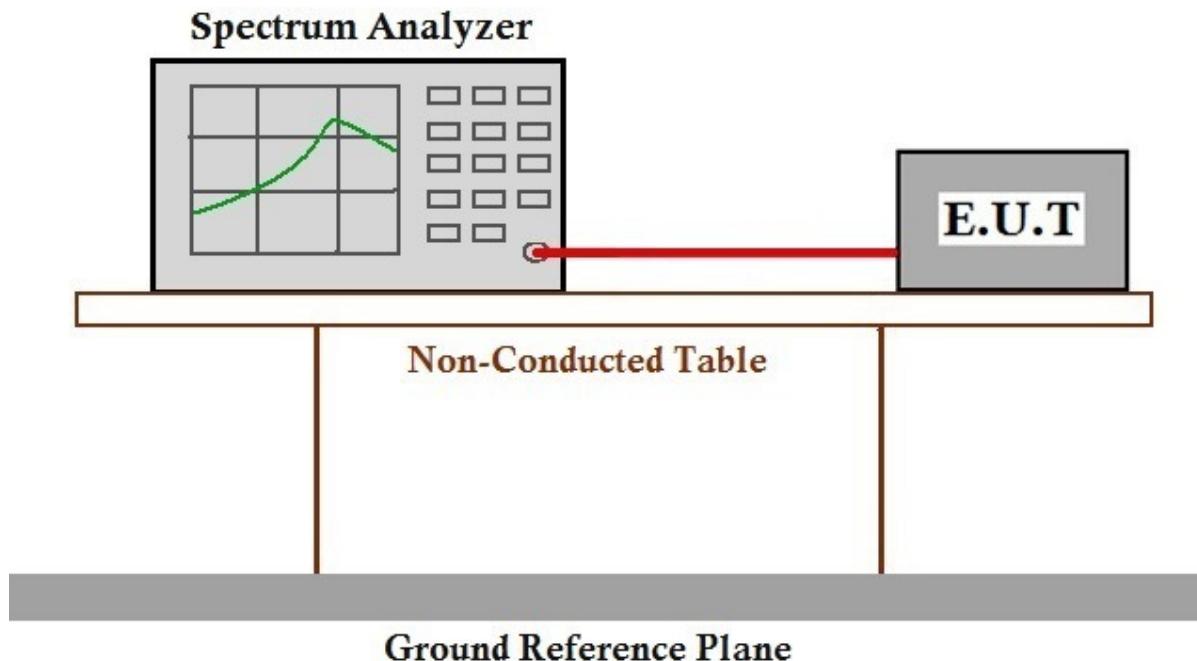
7.5.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH :

Test mode a: Charge + 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 (DH5) is recorded in the report.

7.5.2 Test Setup Diagram



7.5.3 Measurement Procedure and Data

The detailed test data see: Appendix 15.247

7.6 Dwell Time

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

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 |

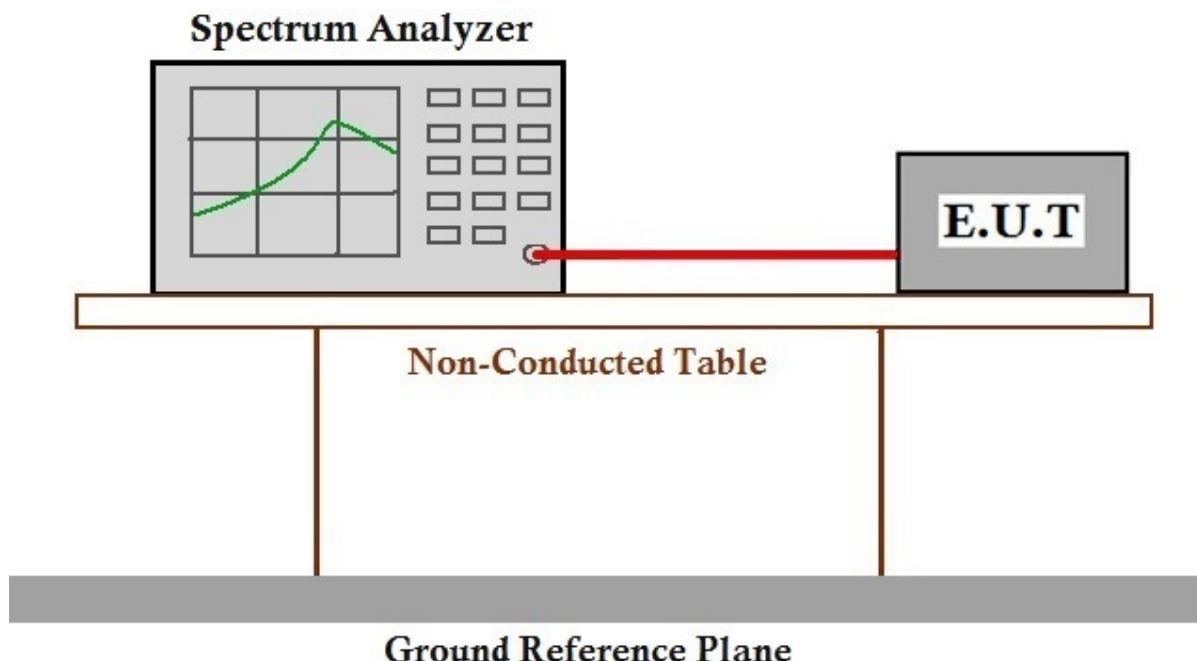
7.6.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH :

Test mode a: Charge + 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 (DH5) is recorded in the report.

7.6.2 Test Setup Diagram



7.6.3 Measurement Procedure and Data

The detailed test data see: Appendix 15.247

7.7 Conducted Band Edges Measurement

| | |
|------------------|--|
| Test Requirement | 47 CFR Part 15, Subpart C 15.247(d) |
| Test Method: | ANSI C63.10 (2013) Section 7.8.6 |
| Limit: | <p>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))</p> |

7.7.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH :

Pretest these modes to find the worst case:

a: Charge + 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 (DH5) is recorded in the report.

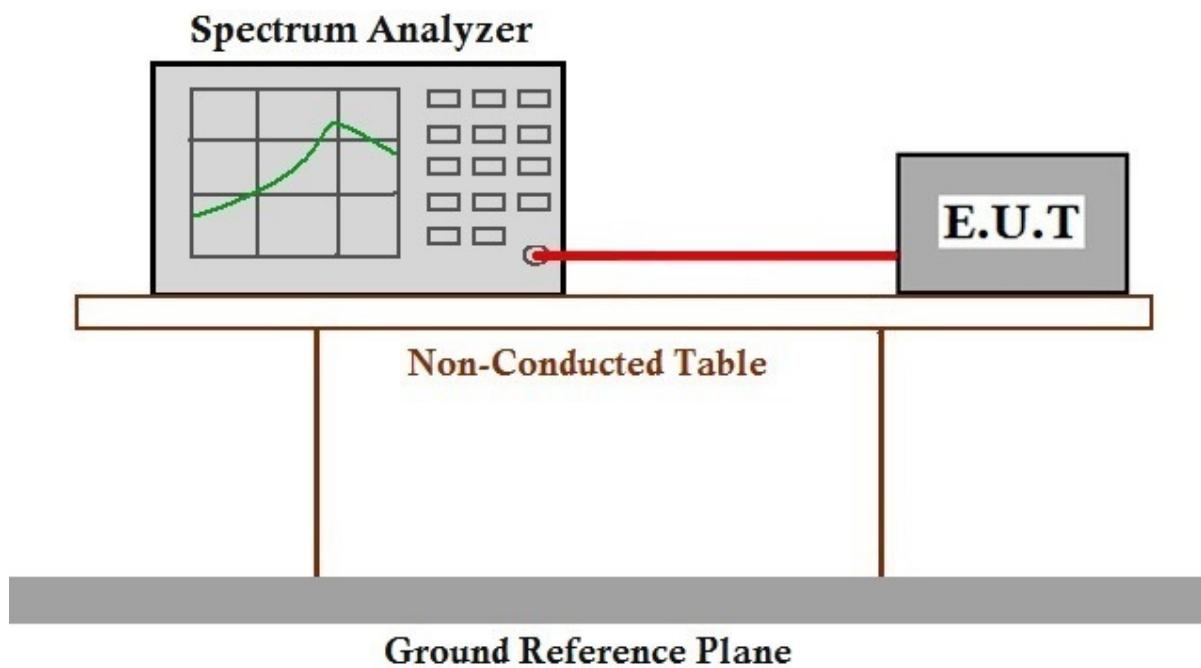
b: Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation. All modes have been tested and only the data of worst case (DH5) is recorded in the report.

The worst case for final test:

a: Charge + 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 (DH5) is recorded in the report.

b: 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 (DH5) is recorded in the report.

7.7.2 Test Setup Diagram



7.7.3 Measurement Procedure and Data

The detailed test data see: Appendix 15.247

7.8 Conducted Spurious Emissions

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

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))

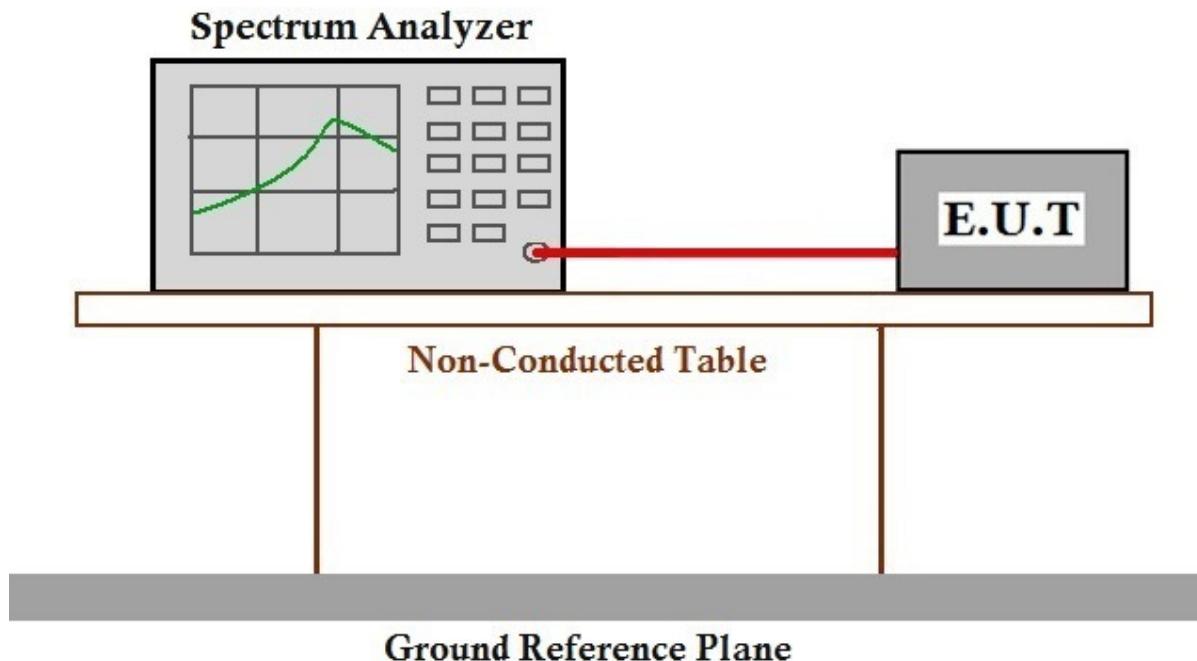
7.8.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH :

Test mode b: 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 (DH5) is recorded in the report.

7.8.2 Test Setup Diagram



7.8.3 Measurement Procedure and Data

The detailed test data see: Appendix 15.247

7.9 Radiated Emissions which fall in the restricted bands

Test Requirement 47 CFR Part 15, Subpart C 15.205 & 15.209

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.

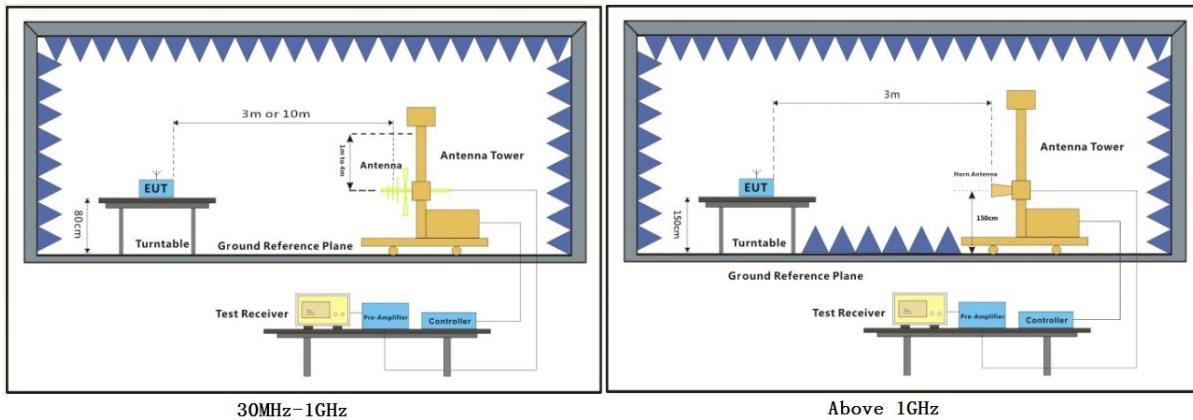
7.9.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH :

Test mode b: 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 (DH5) is recorded in the report.

7.9.2 Test Setup Diagram



7.9.3 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.

| Frequency (MHz) | Antenna Polarization | Emission Level (dB μ V/m) | | Limit (dB μ V/m) | | Remark |
|--------------------|-------------------------|-------------------------------|---------|----------------------|---------|--------|
| | | Peak | Average | Peak | Average | |
| 2390.000 | H | 52.4 | 27.2 | 74.0 | 54.0 | Pass |
| 2483.500 | H | 55.0 | 33.3 | 74.0 | 54.0 | Pass |
| 2390.000 | V | 50.4 | 25.4 | 74.0 | 54.0 | Pass |
| 2483.500 | V | 43.4 | 26.8 | 74.0 | 54.0 | Pass |

7.10 Radiated Spurious Emissions

Test Requirement 47 CFR Part 15, Subpart C 15.205 & 15.209

Test Method: ANSI C63.10 (2013) Section 6.4,6.5,6.6

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.

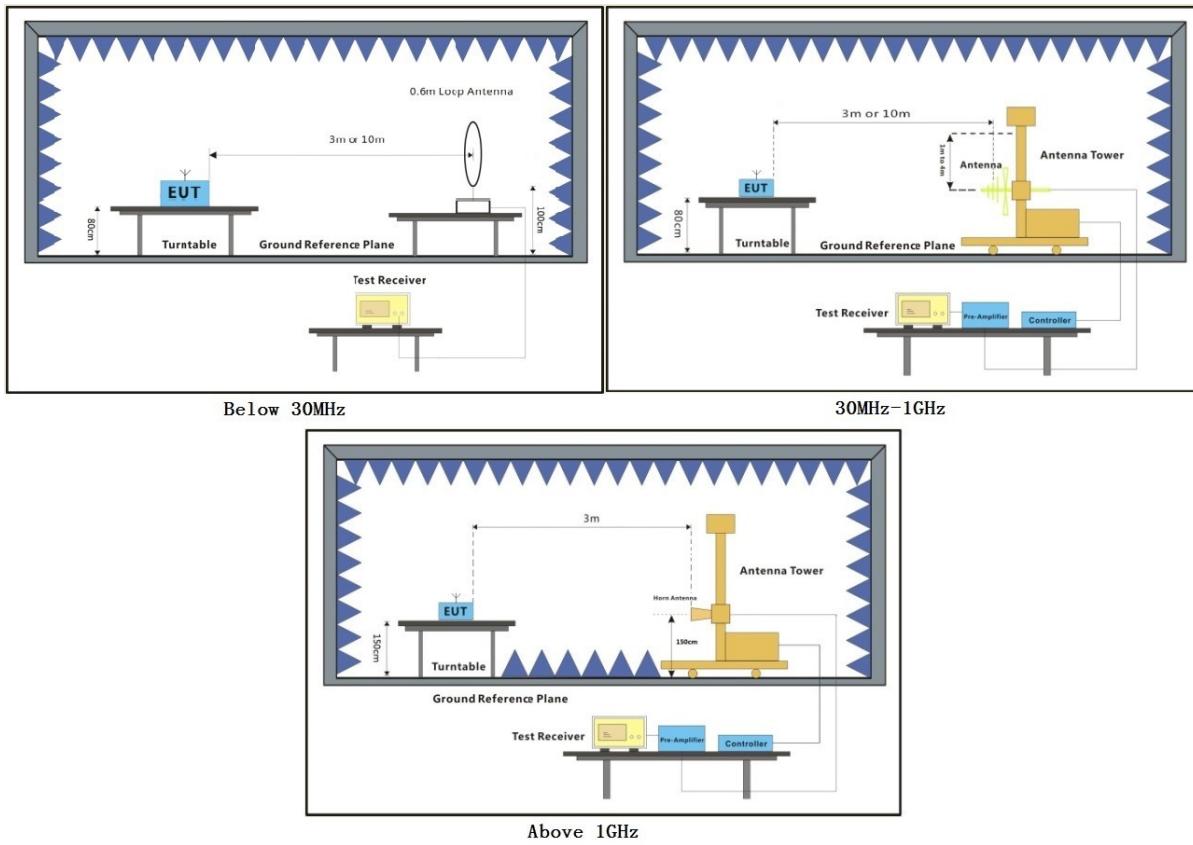
7.10.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 50 % RH :

Test mode b: 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 (DH5) is recorded in the report.

7.10.2 Test Setup Diagram



7.10.3 Measurement Procedure and Data

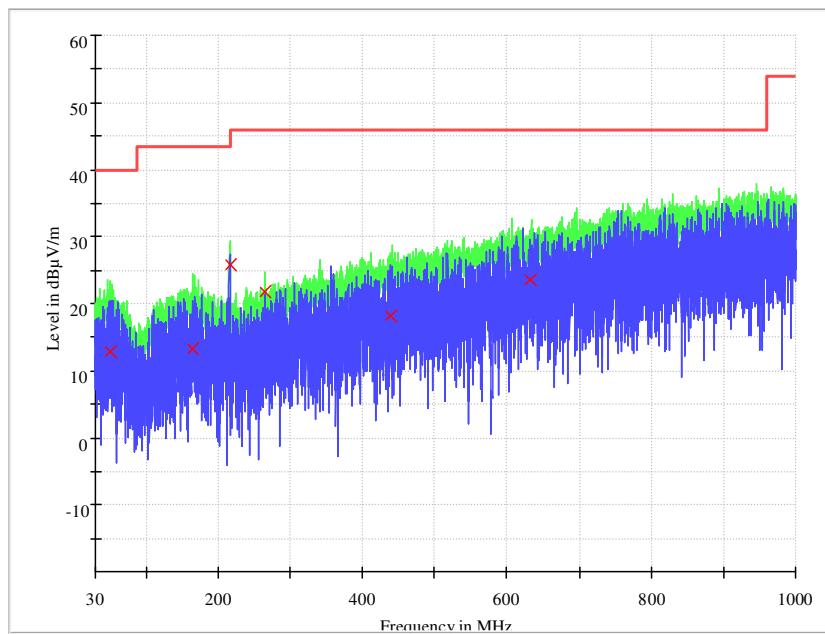
- a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 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) 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.

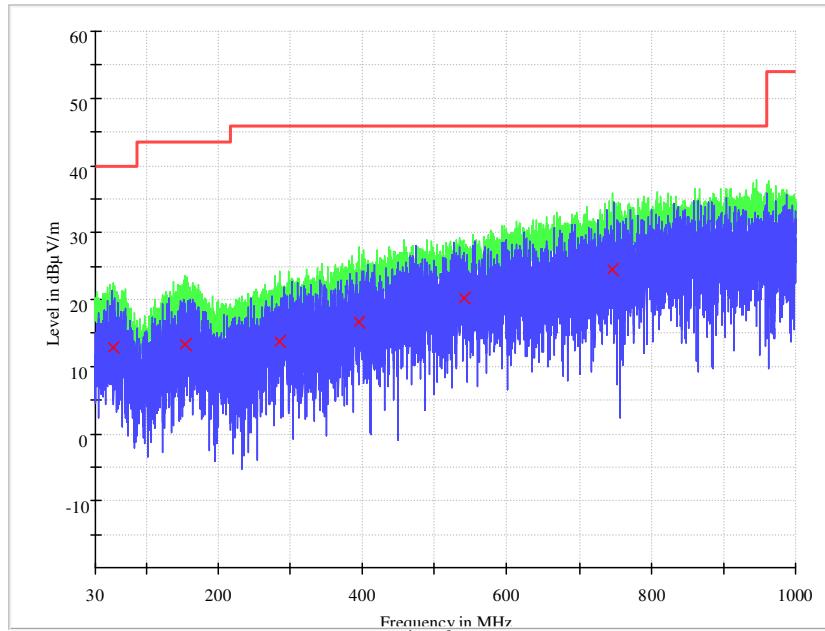
Radiated emission below 1GHz

Mode:b; Polarization:Horizontal; Modulation:GFSK;



| Frequency (MHz) | QuasiPeak (dBμV/m) | Pol. | Corr. (dB/m) | Margin (dB) | Limit (dBμV/m) | Result |
|-----------------|--------------------|------|--------------|-------------|----------------|--------|
| 50.508571 | 12.9 | H | 14.2 | 27.1 | 40.0 | Pass |
| 165.869286 | 13.3 | H | 14.3 | 30.2 | 43.5 | Pass |
| 215.962857 | 25.8 | H | 11.2 | 17.7 | 43.5 | Pass |
| 263.977857 | 21.8 | H | 13.5 | 24.2 | 46.0 | Pass |
| 438.716429 | 18.2 | H | 18.4 | 27.8 | 46.0 | Pass |
| 631.954286 | 23.6 | H | 22.3 | 22.4 | 46.0 | Pass |

Mode:b; Polarization:Vertical; Modulation:GFSK;



| Frequency (MHz) | QuasiPeak (dB μ V/m) | Pol. | Corr. (dB/m) | Margin (dB) | Limit (dB μ V/m) | Result |
|-----------------|--------------------------|------|--------------|-------------|----------------------|--------|
| 54.180714 | 12.8 | V | 14.1 | 27.2 | 40.0 | Pass |
| 154.021429 | 13.2 | V | 14.3 | 30.3 | 43.5 | Pass |
| 284.763571 | 13.6 | V | 14.4 | 32.4 | 46.0 | Pass |
| 396.175000 | 16.7 | V | 17.4 | 29.3 | 46.0 | Pass |
| 539.942857 | 20.3 | V | 20.4 | 25.7 | 46.0 | Pass |
| 747.037857 | 24.5 | V | 24.6 | 21.5 | 46.0 | Pass |

Remark: Only the worst case is shown.

Above 1GHz

Channel:Low

| Frequency (MHz) | Antenna Polarization | Emission Level (dB μ V/m) | | Limit (dB μ V/m) | | Remark |
|--------------------|-------------------------|----------------------------------|---------|----------------------|---------|--------|
| | | Peak | Average | Peak | Average | |
| 1665.000 | H | 40.4 | 24.2 | 74.0 | 54.0 | PASS |
| 3203.000 | H | 43.4 | 33.9 | 74.0 | 54.0 | PASS |
| 4938.000 | H | 43.7 | 30.7 | 74.0 | 54.0 | PASS |
| 1666.000 | V | 46.2 | 26.7 | 74.0 | 54.0 | PASS |
| 4538.300 | V | 43.5 | 30.4 | 74.0 | 54.0 | PASS |
| 7968.837 | V | 50.0 | 36.8 | 74.0 | 54.0 | PASS |

Channel:Middle

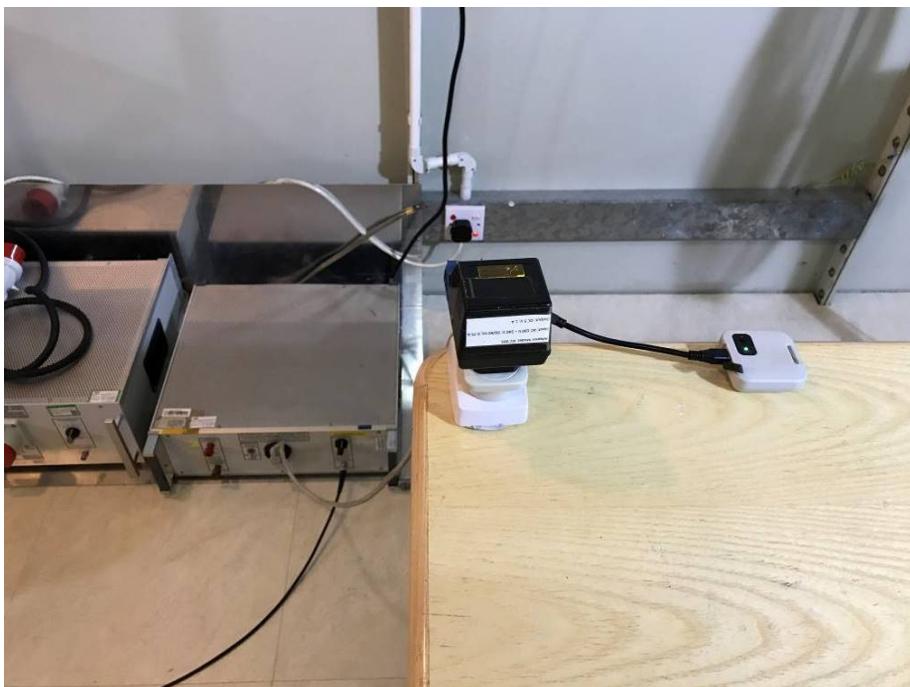
| Frequency (MHz) | Antenna Polarization | Emission Level (dB μ V/m) | | Limit (dB μ V/m) | | Remark |
|--------------------|-------------------------|----------------------------------|---------|----------------------|---------|--------|
| | | Peak | Average | Peak | Average | |
| 2158.000 | H | 38.5 | 25.3 | 74.0 | 54.0 | PASS |
| 4543.000 | H | 43.8 | 30.5 | 74.0 | 54.0 | PASS |
| 8635.000 | H | 49.2 | 36.9 | 74.0 | 54.0 | PASS |
| 1662.000 | V | 47.1 | 26.1 | 74.0 | 54.0 | PASS |
| 5333.600 | V | 43.2 | 29.8 | 74.0 | 54.0 | PASS |
| 8945.000 | V | 49.5 | 36.3 | 74.0 | 54.0 | PASS |

Channel: High

| Frequency (MHz) | Antenna Polarization | Emission Level (dB μ V/m) | | Limit (dB μ V/m) | | Remark |
|--------------------|-------------------------|----------------------------------|---------|----------------------|---------|--------|
| | | Peak | Average | Peak | Average | |
| 1993.000 | H | 42.4 | 24.2 | 74.0 | 54.0 | PASS |
| 4968.970 | H | 43.1 | 30.1 | 74.0 | 54.0 | PASS |
| 7385.430 | H | 48.8 | 35.7 | 74.0 | 54.0 | PASS |
| 1997.000 | V | 48.1 | 25.1 | 74.0 | 54.0 | PASS |
| 3312.000 | V | 40.8 | 28.1 | 74.0 | 54.0 | PASS |
| 6898.960 | V | 46.1 | 33.0 | 74.0 | 54.0 | PASS |

8 Photographs

8.1 Conducted Emissions at AC Power Line (150kHz-30MHz) Test Setup



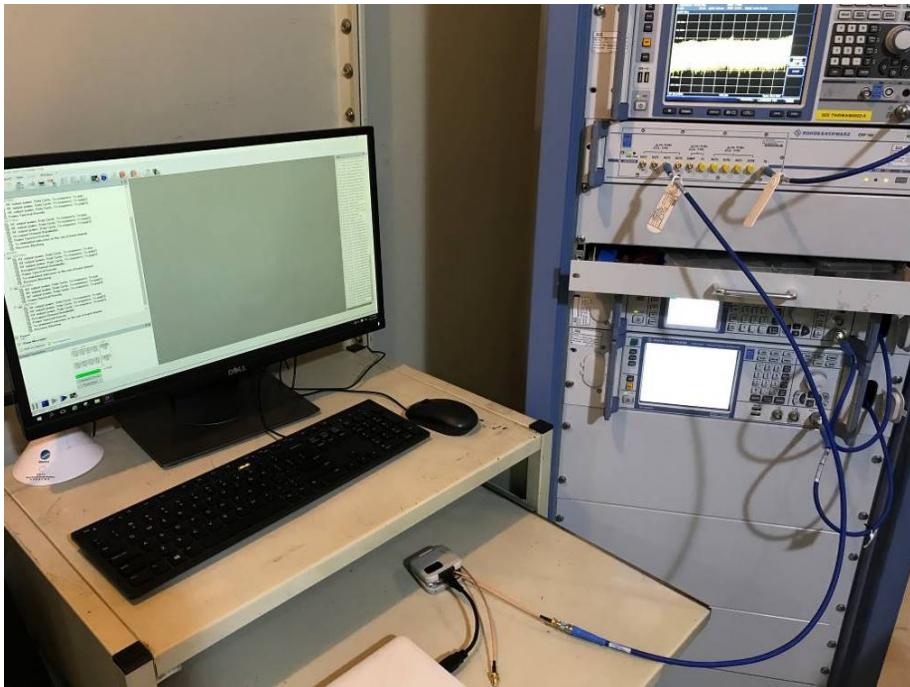
8.2 Radiated Emissions (30 MHz – 1 GHz) Test Setup



8.3 Radiated Emissions (above 1 GHz) Test Setup



8.4 Conducted Emissions Test Setup



8.5 EUT Constructional Details (EUT Photos)

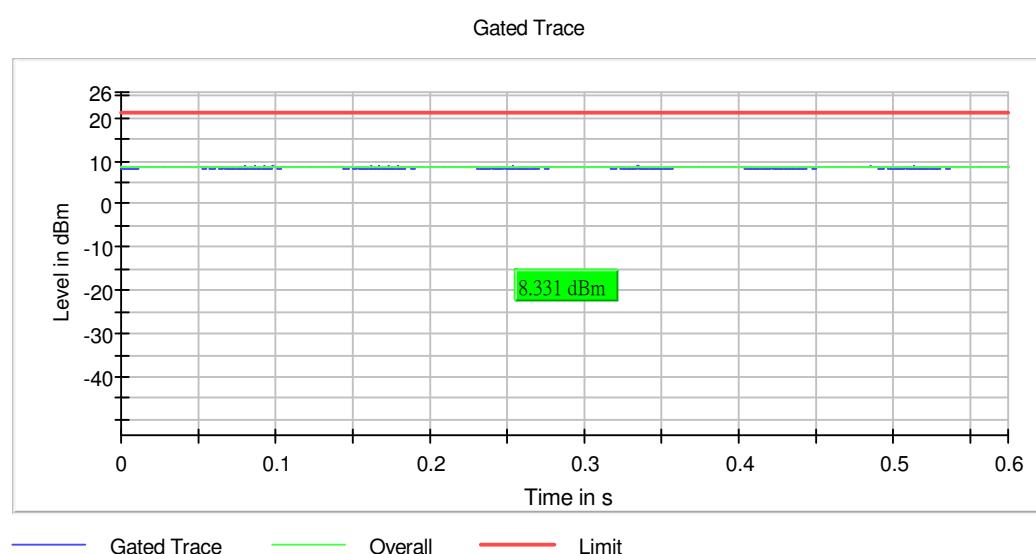
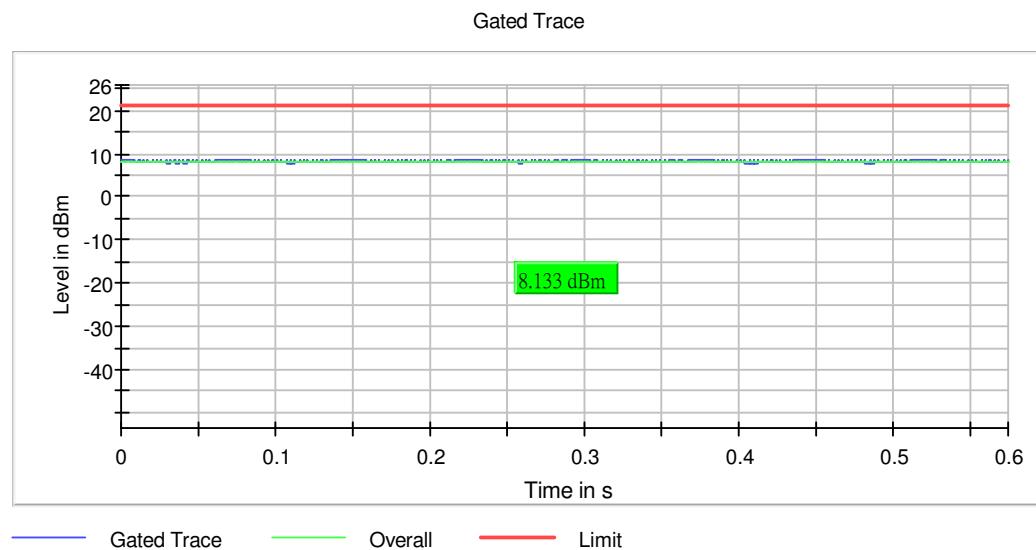
Refer to the appendices external and internal photos of of HKEM2010001076AT.

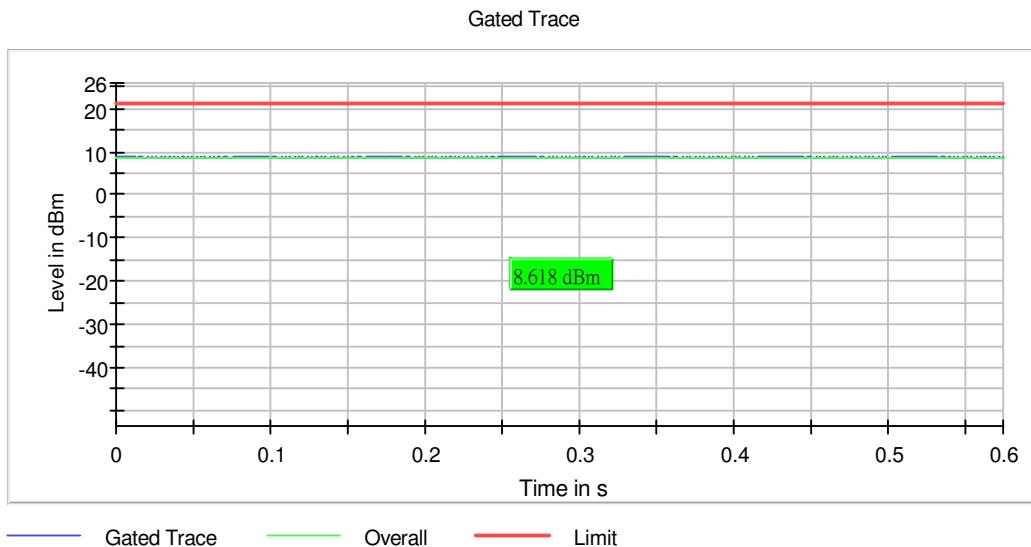
9 Appendix 15.247

9.1 Peak conducted output power

| DUT Frequency (MHz) | Peak Power (dBm) | Limit Max (dBm) | Result |
|---------------------|------------------|-----------------|--------|
| 2402.000000 | 8.1 | 21.0 | PASS |
| 2441.000000 | 8.3 | 21.0 | PASS |
| 2480.000000 | 8.6 | 21.0 | PASS |

Remark: Antenna gain is 2 dBi

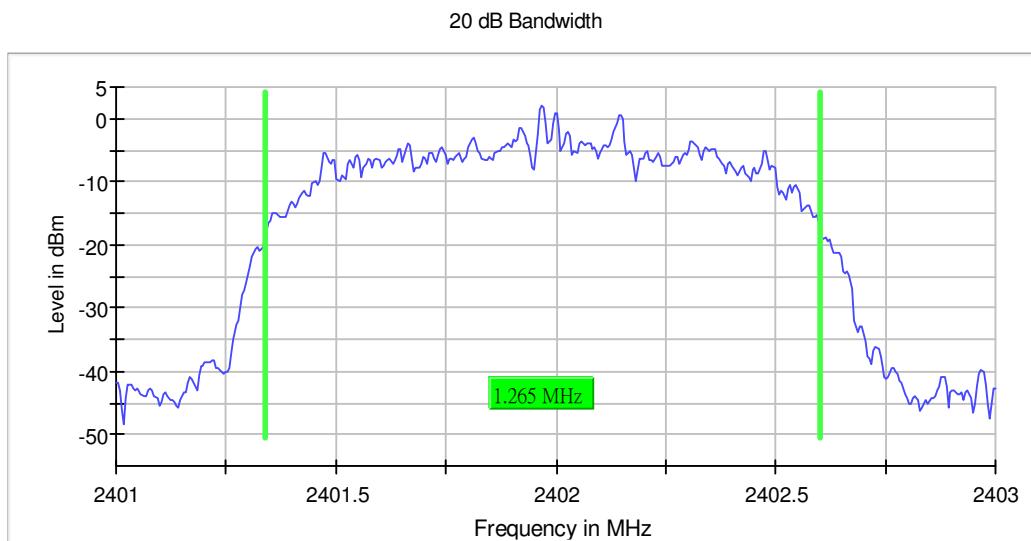


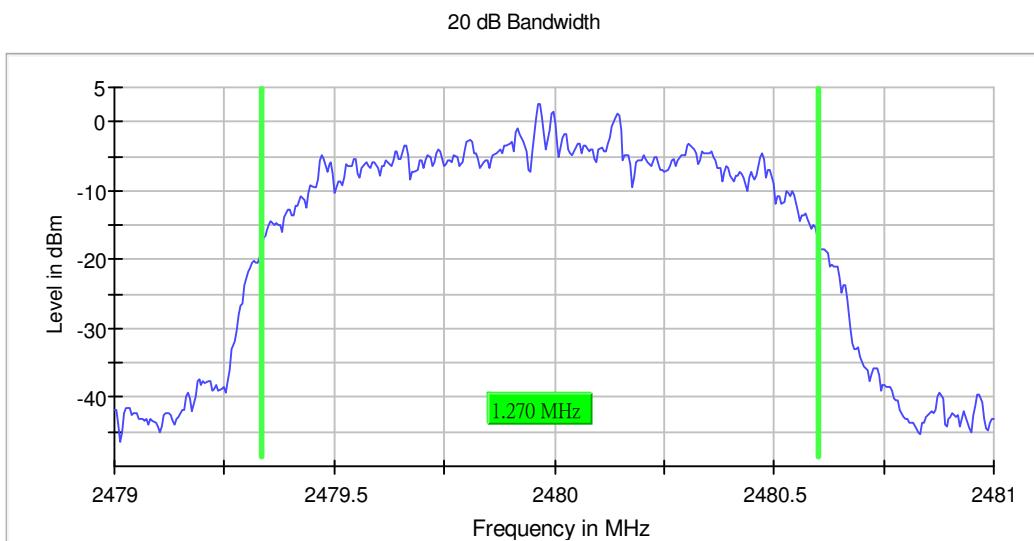
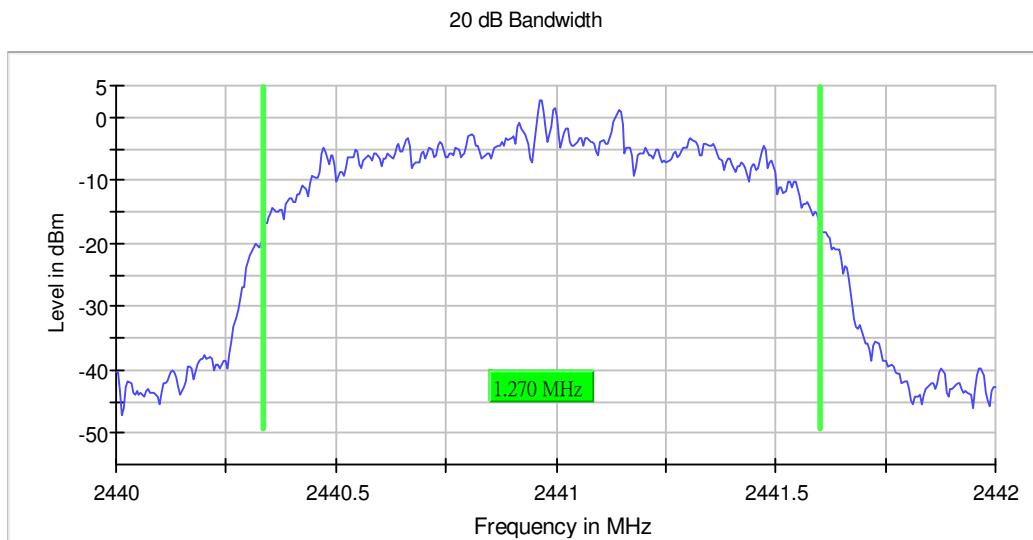


Remark: Cable loss 0.8dB was considered and set in system configuration.

9.2 20dB Bandwidth

| DUT Frequency (MHz) | Bandwidth (MHz) | Limit Min (MHz) | Limit Max (MHz) | Band Edge Left (MHz) | Band Edge Right (MHz) |
|---------------------|-----------------|-----------------|-----------------|----------------------|-----------------------|
| 2402.000000 | 1.265000 | --- | --- | 2401.337500 | 2402.602500 |
| 2441.000000 | 1.270000 | --- | --- | 2440.332500 | 2441.602500 |
| 2480.000000 | 1.270000 | --- | --- | 2479.332500 | 2480.602500 |





Measurement

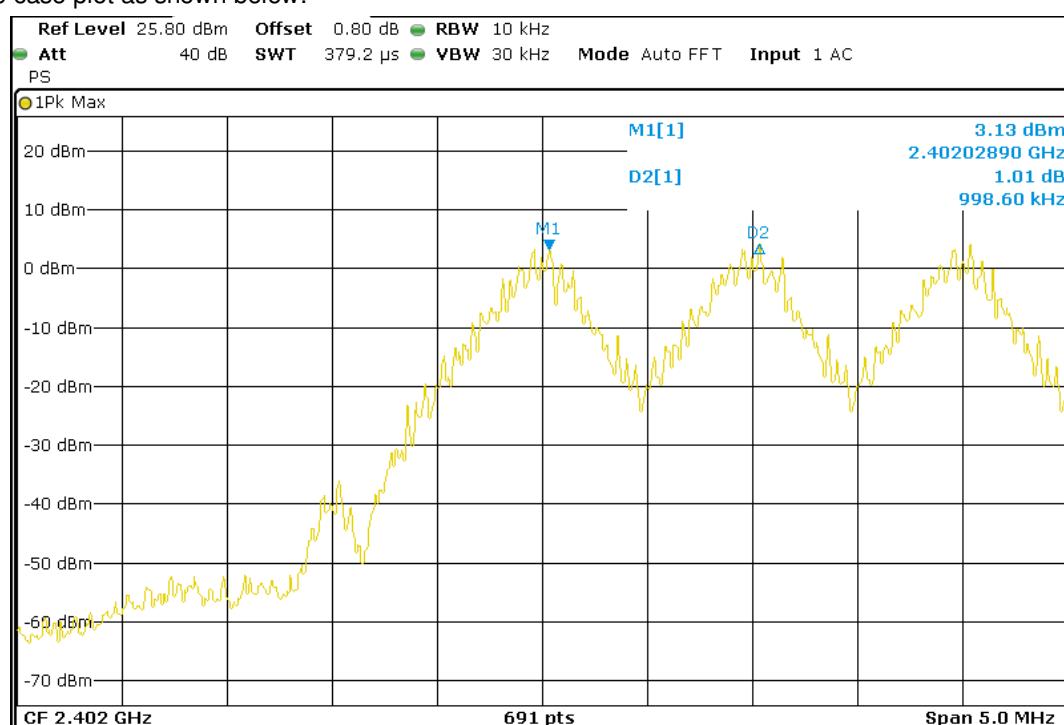
| Setting | Instrument Value | Target Value |
|-----------------------|------------------|-------------------|
| Start Frequency | 2.47900 GHz | 2.47900 GHz |
| Stop Frequency | 2.48100 GHz | 2.48100 GHz |
| Span | 2.000 MHz | 2.000 MHz |
| RBW | 20.000 kHz | ≥ 20.000 kHz |
| VBW | 50.000 kHz | ≥ 50.000 kHz |
| SweepPoints | 400 | ~ 400 |
| Sweeptime | 189.648 us | AUTO |
| Reference Level | 0.000 dBm | 0.000 dBm |
| Attenuation | 20.000 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 | 8 / max. 150 | max. 150 |
| Stable | 5 / 5 | 5 |
| Max Stable Difference | 0.12 dB | 0.50 dB |

9.3 Carrier Frequency Separation

| DUT Frequency (MHz) | Frequency Separation (MHz) | Limit (MHz) | Result |
|---------------------|----------------------------|-------------|--------|
| 2402.000000 | 0.998600 | 0.843333 | PASS |

Remark: Limit = $2/3 \times 20$ dB Bandwidth

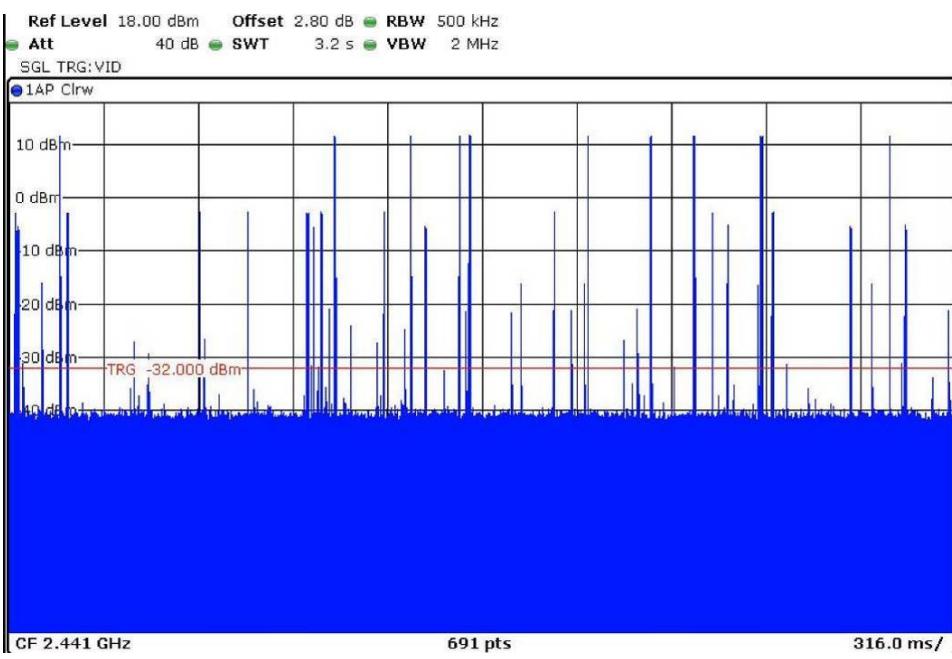
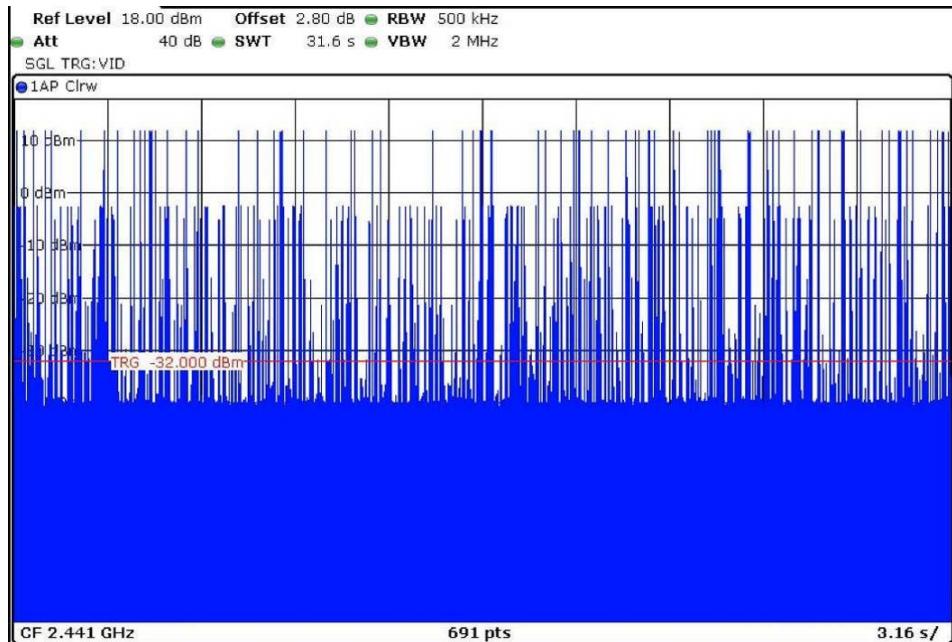
Worse case plot as shown below:

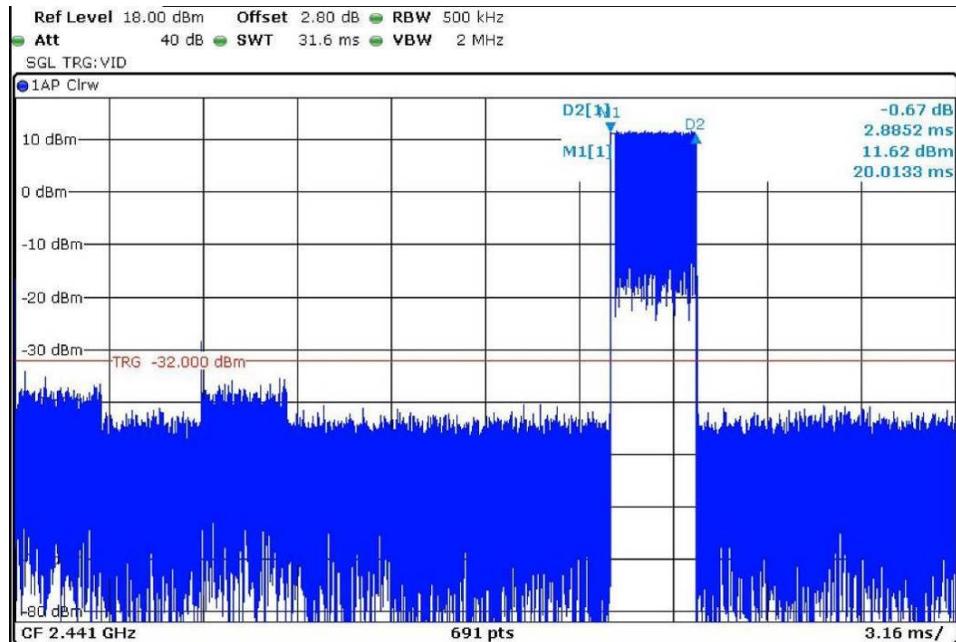


9.4 Dwell Time

| Channel (MHz) | Width of Burst (ms) | Number of Burst(s) | Active Channels | Measurement Time (s) | Dwell Time (ms) | Limit (ms) | Result |
|---------------|---------------------|--------------------|-----------------|----------------------|-----------------|------------|--------|
| 2441.000 | 2.8852 | 100 | 79 | 31.6 | 288.52 | ≤400 | Pass |

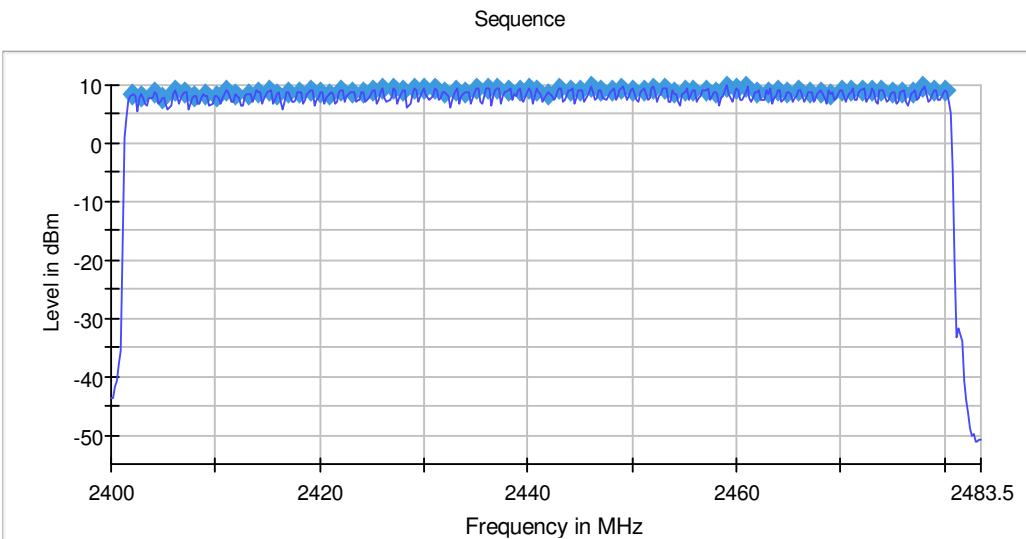
*Remark: the channel shown is the worst case.





9.5 Hopping Frequencies

| Channels | Limit Min | Result |
|----------|-----------|--------|
| 79 | 15 | PASS |



Measurement

| 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 | 200.000 kHz | <= 299.000 kHz |
| VBW | 200.000 kHz | >= 200.000 kHz |
| SweepPoints | 418 | ~ 418 |
| Sweeptime | 1.060 ms | AUTO |
| Reference Level | 0.000 dBm | 0.000 dBm |
| Attenuation | 20.000 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 | 92 / max. 150 | max. 150 |
| Stable | 3 / 3 | 3 |
| Max Stable Difference | 0.49 dB | 0.50 dB |

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

9.6 Conducted Band Edge Measurement

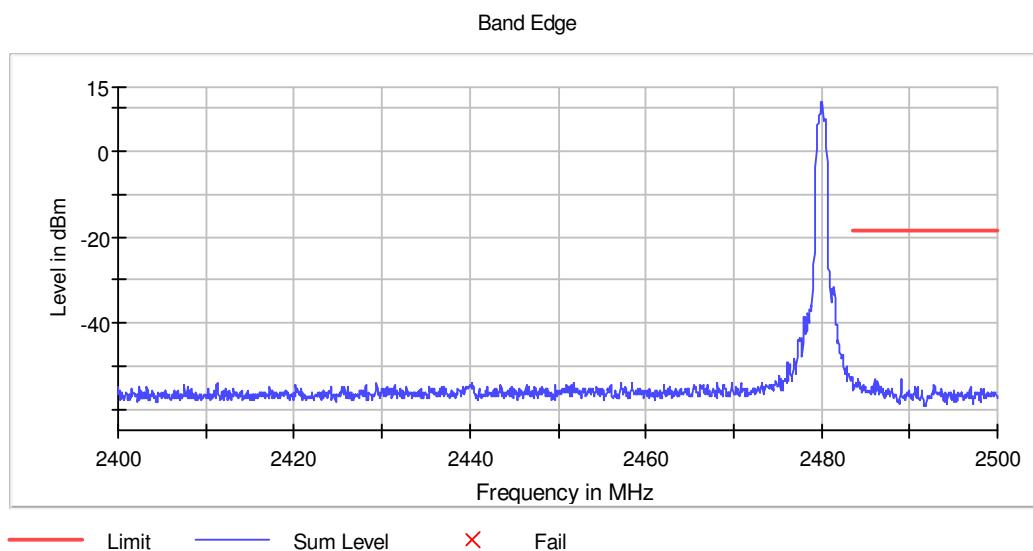
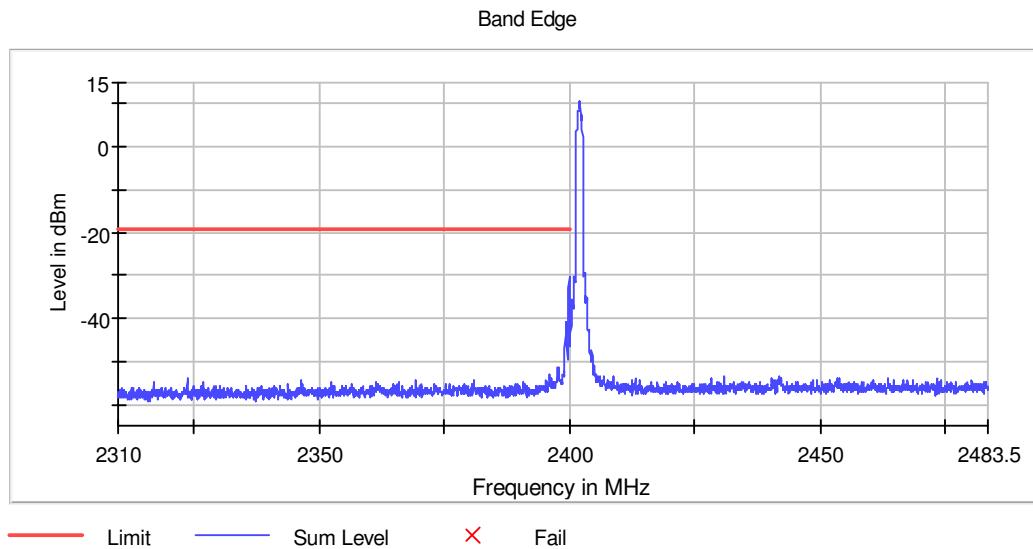
Non-hopping mode

Inband Peak

| Frequency (MHz) | Level (dBm) |
|-----------------|-------------|
| 2402.025000 | 10.6 |
| 2479.975000 | 11.4 |

| Frequency (MHz) | Level (dBm) | Margin (dB) | Limit (dBm) | Result |
|-----------------|-------------|-------------|-------------|--------|
| 2399.975000 | -30.1 | 10.7 | -19.4 | PASS |
| 2484.175000 | -53.2 | 34.6 | -18.6 | PASS |

Remark: Limit = Inband peak – 30dB



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 | 0.000 dBm | 0.000 dBm |
| Attenuation | 20.000 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 | 11 / max. 150 | max. 150 |
| Stable | 3 / 3 | 3 |
| Max Stable Difference | 0.47 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 | 0.000 dBm | 0.000 dBm |
| Attenuation | 20.000 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 |

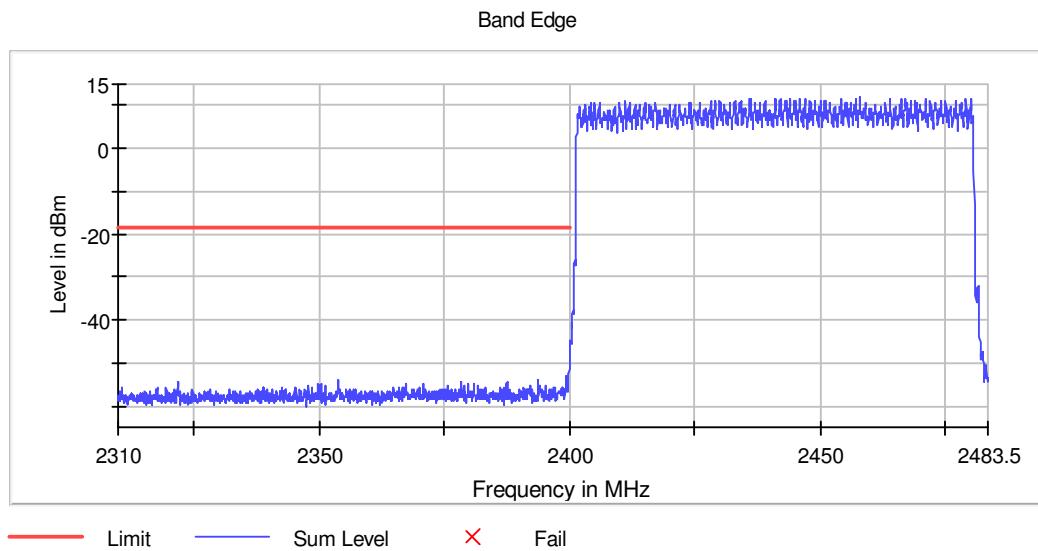
Remark: Cable loss 0.8dB was considered and set in system configuration.

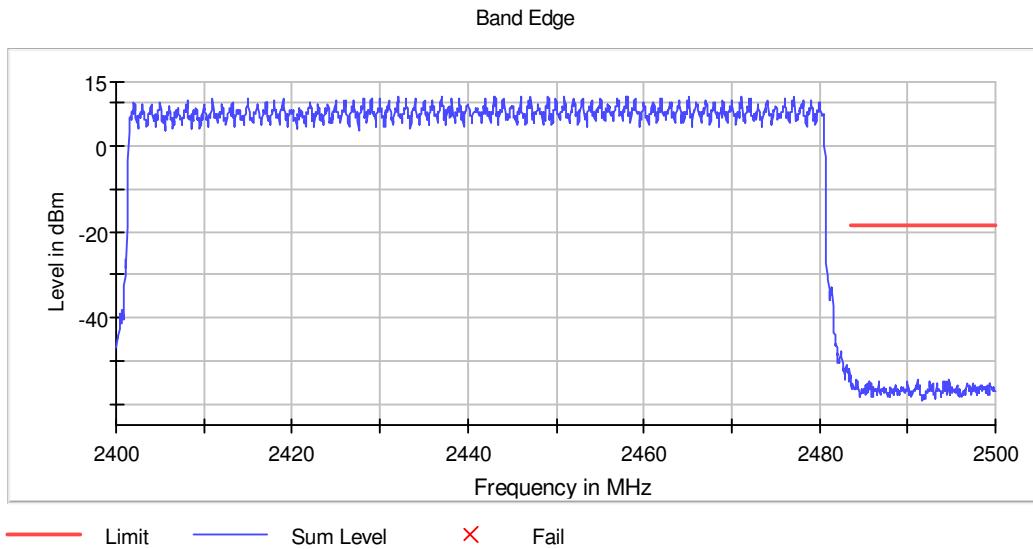
Hopping mode**Inband Peak**

| Frequency (MHz) | Level (dBm) |
|-----------------|-------------|
| 2457.975000 | 11.8 |
| 2457.975000 | 11.6 |

| Frequency (MHz) | Level (dBm) | Margin (dB) | Limit (dBm) | Result |
|-----------------|-------------|-------------|-------------|--------|
| 2399.975000 | -51.4 | 33.2 | -18.2 | PASS |
| 2484.175000 | -54.5 | 36.0 | -18.4 | PASS |

Remark: Limit = Inband peak – 30dB





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 | 0.000 dBm | 0.000 dBm |
| Attenuation | 20.000 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 | 120 / max. 150 | max. 150 |
| Stable | 3 / 3 | 3 |
| Max Stable Difference | 0.40 dB | 0.50 dB |

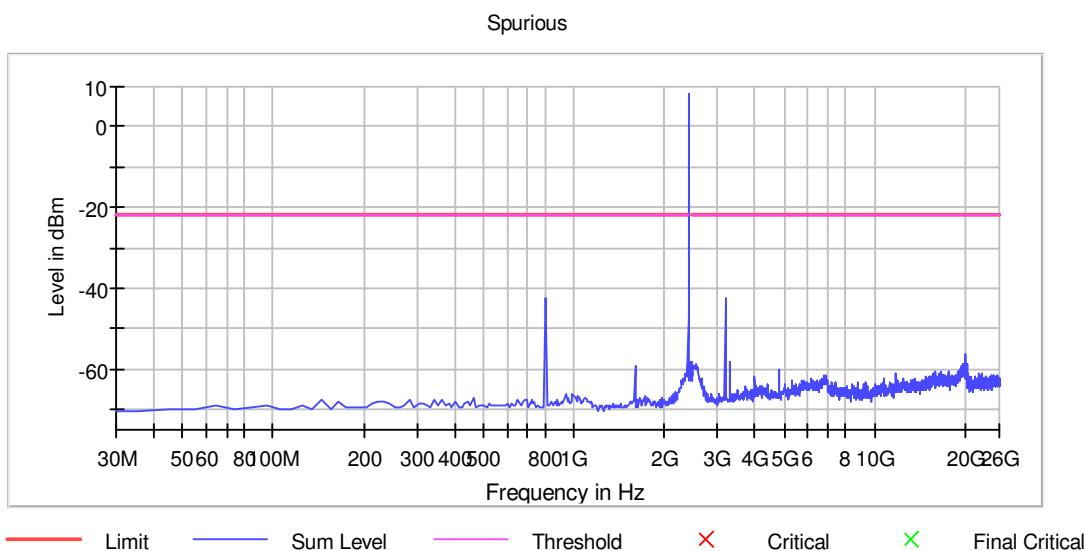
Measurement 2

| 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 | 0.000 dBm | 0.000 dBm |
| Attenuation | 20.000 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 |

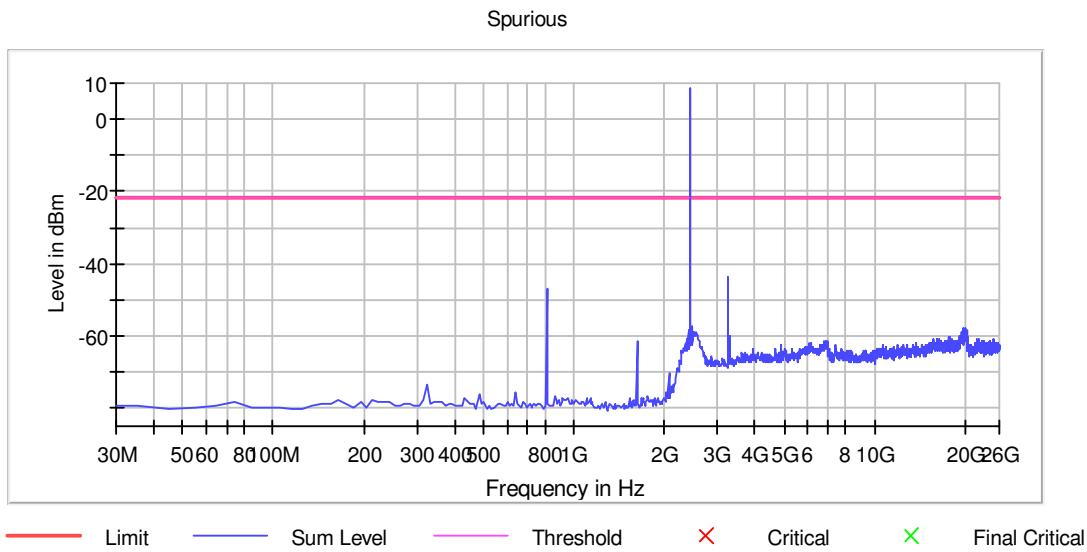
Remark: Cable loss 0.8dB was considered and set in system configuration.

9.7 Conducted spurious emission

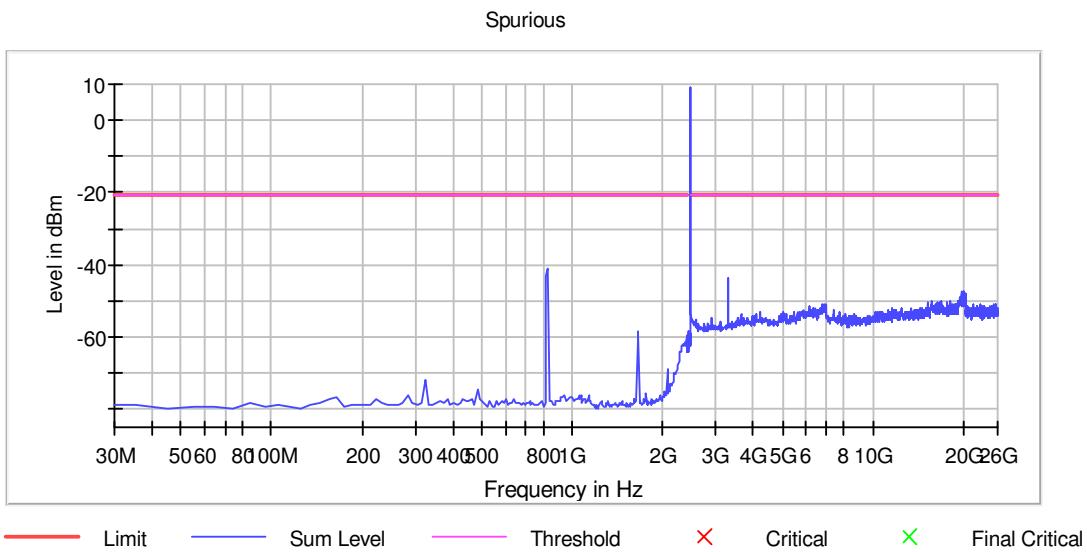
Lowest Channel



Middle Channel



Highest Channel



Pre Measurement 1

| 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 | -20.000 dBm | -30.000 dBm |
| Attenuation | 10.000 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 | 14 / max. 40 | max. 40 |
| Stable | 3 / 3 | 3 |
| Max Stable Difference | 0.00 dB | 0.50 dB |

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

- End of the Report -