



FCC RADIO TEST REPORT

FCC ID : UZ7FXR9001
Equipment : INDUSTRIAL FIXED RFID READER
Brand Name : ZEBRA
Model Name : FXR9001
Applicant : Zebra Technologies Corporation
1 Zebra Plaza, Holtsville, NY 11742
Manufacturer : Zebra Technologies Corporation
1 Zebra Plaza, Holtsville, NY 11742
Standard : FCC Part 15 Subpart C §15.247

The product was received on Aug. 16, 2023 and testing was performed from Sep. 14, 2023 to Nov. 01, 2023. We, Sporton International Inc. EMC & Wireless Communications Laboratory, would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval from Sporton International Inc. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

Approved by: Louis Wu

Sportun International Inc. EMC & Wireless Communications Laboratory
No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.)



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History of this test report



Summary of Test Result

| Report Clause | Ref Std. Clause | Test Items | Result (PASS/FAIL) | Remark |
|---------------|------------------------------|--|--------------------|--|
| 3.1 | 15.247(a)(1) | Number of Channels | Pass | - |
| 3.2 | 15.247(a)(1) | Hopping Channel Separation | Pass | - |
| 3.3 | 15.247(a)(1) | Dwell Time of Each Channel | Pass | - |
| 3.4 | 15.247(a)(1) | 20dB Bandwidth | Pass | - |
| 3.4 | 2.1049 | 99% Occupied Bandwidth | Reporting only | - |
| 3.5 | 15.247(b)(1) 15.247(b)(4) | Peak Output Power | Pass | - |
| 3.6 | 15.247(d) | Conducted Band Edges | Pass | - |
| 3.7 | 15.247(d) | Conducted Spurious Emission | Pass | - |
| 3.8 | 15.247(d) | Radiated Band Edges and Radiated Spurious Emission | Pass | 7.96 dB under the limit at 30.00 MHz |
| 3.9 | 15.207 | AC Conducted Emission | Pass | 25.05 dB under the limit at 0.17 MHz |
| 3.10 | 15.203 | Antenna Requirement | Pass | - |

Conformity Assessment Condition:

1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacturer who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account.
2. The measurement uncertainty please refer to each test result in the section "Measurement Uncertainty".

Disclaimer:

The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.

Reviewed by: Wei Chen**Report Producer: Michelle Chen**



1 General Description

1.1 Product Feature of Equipment Under Test

| Product Feature | |
|--|--|
| Equipment | INDUSTRIAL FIXED RFID READER |
| Brand Name | ZEBRA |
| Model Name | FXR9001 |
| Sample 1 | FXR90011-400000-WR 4+1 Port & Bolt-on: BT, WLAN |
| Sample 2 | FXR90010-800000-WR 8-Port: BT, WLAN |
| Sample 3 | FXR90010-400000-WR 4-Port: BT, WLAN |
| FCC ID | UZ7FXR9001 |
| EUT supports Radios application | RFID WLAN 11a/b/g/n HT20/HT40 WLAN 11ac VHT20/VHT40/VHT80 WLAN 11ax HE20/HE40/HE80 Bluetooth BR/EDR/LE |
| HW Version | EV2 |
| SW Version | 0.4.11 |
| MFD | 01AUG23 |
| EUT Stage | Identical Prototype |

Remark: The EUT's information above is declared by manufacturer.

| Supported Unit Used in Test Configuration and System | | | | |
|---|------------|-------|------------|--------------------|
| Cable, 3-way USB Splitter | Brand Name | ZEBRA | Model Name | ADP-USB0010-M12 |
| Cable, USB-C Host, 5ft. | Brand Name | ZEBRA | Model Name | CBL-USBCHST015-M12 |
| Cable, USB-C Host, 15ft. | Brand Name | ZEBRA | Model Name | CBL-USBCHST035-M12 |
| Cable, USB-C Client, 5ft. | Brand Name | ZEBRA | Model Name | CBL-USBCCLT015-M12 |
| Cable, USB-C Client, 15ft. | Brand Name | ZEBRA | Model Name | CBL-USBCCLT035-M12 |
| Cable, USB-A Client, 5ft. | Brand Name | ZEBRA | Model Name | CBL-USBACLT015-M12 |
| Cable, USB-A Client, 15ft. | Brand Name | ZEBRA | Model Name | CBL-USBACLT035-M12 |
| Cable, GPIO | Brand Name | ZEBRA | Model Name | CBL-GP0050-M12M12A |
| Cable, 12V (Cigarette Lighter) Power Adapter, 3.5 meter | Brand Name | ZEBRA | Model Name | CBL-PWRD035-M12CL |
| Cable, DC Power Cord (Flying Leads), 3.5m | Brand Name | ZEBRA | Model Name | CBL-PWRD035-M1200 |
| Cable, DC Power Cord (Flying Leads), 10m | Brand Name | ZEBRA | Model Name | CBL-PWRD100-M1200 |
| Cable, Power Supply Output Adapter, 3.5m | Brand Name | ZEBRA | Model Name | CBL-PWRD035-M12M12 |
| Cable, Power Supply Output Adapter, 10m | Brand Name | ZEBRA | Model Name | CBL-PWRD100-M12M12 |



| Supported Unit Used in Test Configuration and System | | | | |
|--|------------|-------|------------|--------------------------------------|
| Cable, DC-DC Power Supply Input | Brand Name | ZEBRA | Model Name | CBL-PWRD150-M12M00 |
| Cable, AC-DC Power Supply Input (Flying Leads) | Brand Name | ZEBRA | Model Name | CBL-PWRA150-M1200 |
| Cable, AC-DC Power Supply Input (IEC plug) | Brand Name | ZEBRA | Model Name | CBL-PWRA035-M12IEC |
| CBL: RF, N STR PLUG TO RP-TNC STR PLUG ON LMR-240, 68", IP67 Sealed | Brand Name | ZEBRA | Model Name | CBLRD-3B4000680R |
| CBL: RF, N STR PLUG TO RP-TNC STR PLUG ON LMR-240, 180", IP67 Sealed | Brand Name | ZEBRA | Model Name | CBLRD-3B4001800R |
| CBL: RF, N STR PLUG TO RP-TNC STR PLUG ON LMR-240, 240", IP67 Sealed | Brand Name | ZEBRA | Model Name | CBLRD-3B4002400R |
| CBL: RF, N STR PLUG TO RP-TNC STR PLUG ON LMR-240, 360", IP67 Sealed | Brand Name | ZEBRA | Model Name | CBLRD-3B4003600R |
| CBL: RF, N STR PLUG TO RP-TNC STR PLUG ON LMR-240, 68", IP67 Sealed | Brand Name | ZEBRA | Model Name | CBLRD-1B4000680R |
| CBL: RF, N STR PLUG TO RP-TNC STR PLUG ON LMR-240, 180", IP67 Sealed | Brand Name | ZEBRA | Model Name | CBLRD-1B4001800R |
| CBL: RF, N STR PLUG TO RP-TNC STR PLUG ON LMR-240, 240", IP67 Sealed | Brand Name | ZEBRA | Model Name | CBLRD-1B4002400R |
| CBL: RF, N STR PLUG TO RP-TNC STR PLUG ON LMR-240, 360", IP67 Sealed | Brand Name | ZEBRA | Model Name | CBLRD-1B4003600R |
| CHIMERA ETHERNET CABLE 5M | Brand Name | ZEBRA | Model Name | CBL-ENT00500-M1200 |
| CHIMERA ETHERNET CABLE 15M | Brand Name | ZEBRA | Model Name | CBL-ENT01500-M1200 |
| Outdoor AC-DC PSU | Brand Name | ZEBRA | Model Name | PWR-BGA24V90W0WW (Spec PD-007875-01) |
| Forklift DC-DC PSU | Brand Name | ZEBRA | Model Name | PWR-BGA24V90W1WW (Spec PD-007876-01) |
| Indoor AC-DC PSU | Brand Name | ZEBRA | Model Name | PWR-BGA24V78W3WW (Spec PD-007877-01) |
| PoE adaptor | Brand Name | ZEBRA | Model Name | PD-9001GR/AT/AC |



| Supported Unit Used in Test Configuration and System | | | | |
|--|------------|----------|------------|------------------|
| External RFID Antenna | Brand Name | ZEBRA | Model Name | AN480 |
| External RFID Antenna | Brand Name | ZEBRA | Model Name | AN650 |
| External RFID Antenna | Brand Name | ZEBRA | Model Name | SR5502 |
| External RFID Antenna | Brand Name | ZEBRA | Model Name | AN510 |
| External RFID Antenna | Brand Name | ZEBRA | Model Name | AN520 |
| External RFID Antenna | Brand Name | ZEBRA | Model Name | AN610 |
| External RFID Antenna | Brand Name | ZEBRA | Model Name | AN620 |
| External RFID Antenna | Brand Name | ZEBRA | Model Name | AN720 |
| External RFID Antenna | Brand Name | ZEBRA | Model Name | AN440 |
| External RFID Antenna | Brand Name | ZEBRA | Model Name | SP5504 |
| BT/WLAN_External Antenna | Brand Name | Amphenol | Model Name | ST0228-30-502-A |
| BT/WLAN_External Antenna | Brand Name | Amphenol | Model Name | ZB511A-02-001-C |
| AN650 Antenna cable(5ft/1524mm) | Brand Name | ZEBRA | Model Name | CBLRD-1C4000600R |
| AN650 Antenna cable(20ft/6096mm) | Brand Name | ZEBRA | Model Name | CBLRD-1C4002400R |
| AN650 Antenna cable(15ft/4572mm) | Brand Name | ZEBRA | Model Name | CBLRD-1C4001800R |
| AN650 Antenna cable(30ft/9144mm) | Brand Name | ZEBRA | Model Name | CBLRD-1C4003600R |
| AN650 Antenna cable(10ft/3048mm) | Brand Name | ZEBRA | Model Name | CBLRD-1C4001200R |



1.2 Product Specification of Equipment Under Test

| Product Specification is subject to this standard | |
|---|--|
| Tx/Rx Frequency Range | 2402 MHz ~ 2480 MHz |
| Number of Channels | 79 |
| Carrier Frequency of Each Channel | 2402+n*1 MHz; n=0~78 |
| Maximum Output Power to Antenna | <Internal Antenna> Bluetooth BR (1Mbps): 10.46 dBm (0.111 W) Bluetooth EDR (2Mbps): 9.63 dBm (0.092 W) Bluetooth EDR (3Mbps): 9.85 dBm (0.097 W) |
| 99% Occupied Bandwidth | <Internal Antenna> Bluetooth BR (1Mbps): 0.855 MHz Bluetooth EDR (2Mbps): 1.165 MHz Bluetooth EDR (3Mbps): 1.157 MHz |
| Antenna Type / Gain | <Internal Antenna> PIFA Antenna with gain 4.02 dBi <External Antenna 1> Dipole Antenna with gain 2.98 dBi <External Antenna 2> Dipole Antenna with gain 3.59 dBi |
| Type of Modulation | Bluetooth BR (1Mbps) : GFSK Bluetooth EDR (2Mbps) : $\pi/4$ -DQPSK Bluetooth EDR (3Mbps) : 8-DPSK |

Remark: The above EUT's information was declared by manufacturer. Please refer to Disclaimer in report summary.

1.3 Modification of EUT

No modifications made to the EUT during the testing.



1.4 Testing Location

| | |
|---------------------------|---|
| Test Site | Sportun International Inc. EMC & Wireless Communications Laboratory |
| Test Site Location | No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.) TEL: +886-3-327-3456 FAX: +886-3-328-4978 |
| Test Site No. | Sportun Site No. CO05-HY, 03CH07-HY |

Note: The test site complies with ANSI C63.4 2014 requirement.

| | |
|---------------------------|--|
| Test Site | Sportun International Inc. Wensan Laboratory |
| Test Site Location | No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855 |
| Test Site No. | Sportun Site No. TH05-HY (TAF Code: 3786) |
| Remark | The Conducted test item subcontracted to Sporton International Inc. Wensan Laboratory. |

FCC designation No.: TW1190 and TW3786

1.5 Applicable Standards

According to the specifications declared by the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ FCC Part 15 Subpart C §15.247
- ♦ FCC KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02
- ♦ FCC KDB 414788 D01 Radiated Test Site v01r01
- ♦ ANSI C63.10-2013

Remark:

1. All the test items were validated and recorded in accordance with the standards without any modification during the testing.
2. The TAF code is not including all the FCC KDB listed without accreditation.
3. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.



2 Test Configuration of Equipment Under Test

2.1 Carrier Frequency Channel

| Frequency Band | Channel | Freq. (MHz) | Channel | Freq. (MHz) | Channel | Freq. (MHz) |
|-----------------|---------|----------------|---------|----------------|---------|----------------|
| 2400-2483.5 MHz | 0 | 2402 | 27 | 2429 | 54 | 2456 |
| | 1 | 2403 | 28 | 2430 | 55 | 2457 |
| | 2 | 2404 | 29 | 2431 | 56 | 2458 |
| | 3 | 2405 | 30 | 2432 | 57 | 2459 |
| | 4 | 2406 | 31 | 2433 | 58 | 2460 |
| | 5 | 2407 | 32 | 2434 | 59 | 2461 |
| | 6 | 2408 | 33 | 2435 | 60 | 2462 |
| | 7 | 2409 | 34 | 2436 | 61 | 2463 |
| | 8 | 2410 | 35 | 2437 | 62 | 2464 |
| | 9 | 2411 | 36 | 2438 | 63 | 2465 |
| | 10 | 2412 | 37 | 2439 | 64 | 2466 |
| | 11 | 2413 | 38 | 2440 | 65 | 2467 |
| | 12 | 2414 | 39 | 2441 | 66 | 2468 |
| | 13 | 2415 | 40 | 2442 | 67 | 2469 |
| | 14 | 2416 | 41 | 2443 | 68 | 2470 |
| | 15 | 2417 | 42 | 2444 | 69 | 2471 |
| | 16 | 2418 | 43 | 2445 | 70 | 2472 |
| | 17 | 2419 | 44 | 2446 | 71 | 2473 |
| | 18 | 2420 | 45 | 2447 | 72 | 2474 |
| | 19 | 2421 | 46 | 2448 | 73 | 2475 |
| | 20 | 2422 | 47 | 2449 | 74 | 2476 |
| | 21 | 2423 | 48 | 2450 | 75 | 2477 |
| | 22 | 2424 | 49 | 2451 | 76 | 2478 |
| | 23 | 2425 | 50 | 2452 | 77 | 2479 |
| | 24 | 2426 | 51 | 2453 | 78 | 2480 |
| | 25 | 2427 | 52 | 2454 | - | - |
| | 26 | 2428 | 53 | 2455 | - | - |



2.2 Test Mode

- a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, the measured emission level of the EUT was maximized by rotating the EUT on a turntable, adjusting the orientation of the EUT and EUT antenna in three orthogonal axis (X: flat, Y: portrait, Z: landscape) for Internal Antenna, two Antenna Degree, Ant. Horizontal and Ant. Vertical for External Antenna, and adjusting the measurement antenna orientation, following C63.10 exploratory test procedures and only the worst plane, and the worst mode of radiated spurious emissions is Bluetooth 1Mbps mode, and recorded in this report.

- b. AC power line Conducted Emission was tested under maximum output power.

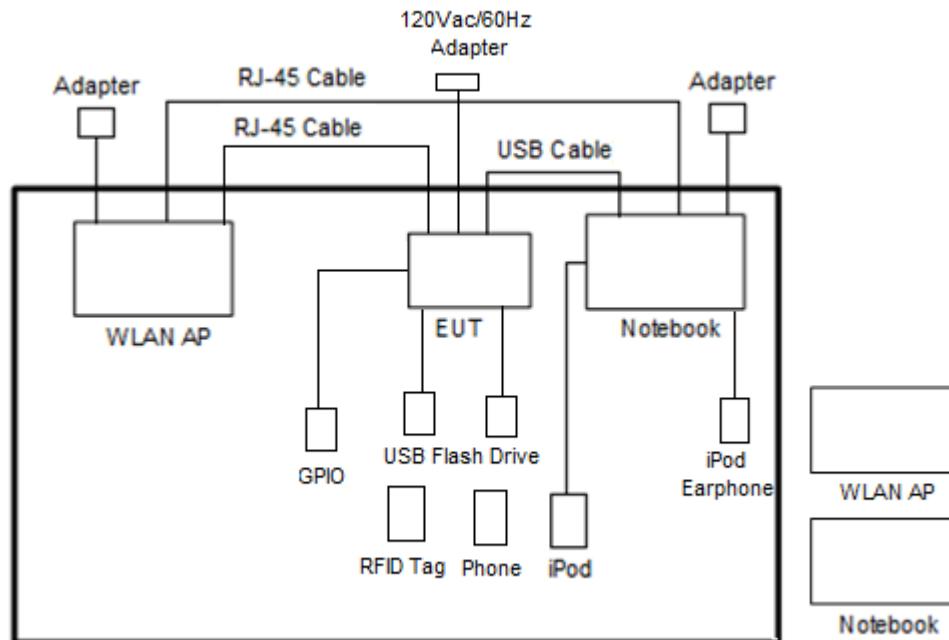


The following summary table is showing all test modes to demonstrate in compliance with the standard.

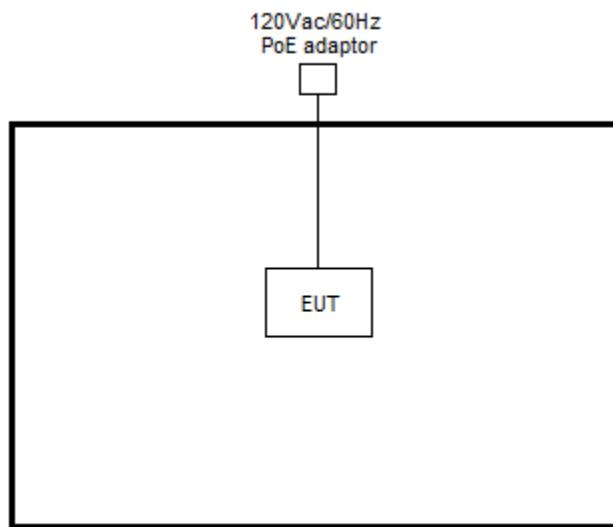
| Summary table of Test Cases | | | | | | |
|--|--|---|-----------------------------------|--|--|--|
| Test Item | Data Rate / Modulation | | | | | |
| Conducted Test Cases | Bluetooth BR 1Mbps GFSK | Bluetooth EDR 2Mbps $\pi/4$-DQPSK | Bluetooth EDR 3Mbps 8-DPSK | | | |
| | Mode 1: CH00_2402 MHz | Mode 4: CH00_2402 MHz | Mode 7: CH00_2402 MHz | | | |
| | Mode 2: CH39_2441 MHz | Mode 5: CH39_2441 MHz | Mode 8: CH39_2441 MHz | | | |
| Radiated Test Cases | Bluetooth BR 1Mbps GFSK | | | | | |
| | <Sample 2> | | | | | |
| | <Internal Antenna> | | | | | |
| | Mode 1: CH00_2402 MHz | | | | | |
| | Mode 2: CH39_2441 MHz | | | | | |
| | Mode 3: CH78_2480 MHz | | | | | |
| | <External Antenna> | | | | | |
| | Mode 1: CH00_2402 MHz | | | | | |
| | Mode 2: CH39_2441 MHz | | | | | |
| AC Conducted Emission | Mode 1 : WLAN (2.4GHz) Link + Bluetooth Link + RFID Link + ADP-USB0010-M12 (3-way USB Splitter) (2) + CBL-GP0050-M12M12A, 5m (GPIO Extension) (7) + CBL-PWRD035-M12M12, 3.5 meter (16) + PWR-BGA24V90W0WW (Outdoor AC-DC PSU) (28) + CBL-PWRA035-M12IEC (22) +CBL-USBCHST015-M12, 1.5m (3) load with USB Flash Drive + CBL-ENT01500-M1200,15M (27) (Data Link with Notebook) + CBL-USBCHST035-M12, 3.5m (23) load with USB Flash Drive + CBL-USBACLT035-M12, 3.5m (24) load with Notebook for Sample 1 | | | | | |
| | Remark: | | | | | |
| 1. For Radiated Test Cases, the worst mode data rate 1Mbps was reported only since the highest RF output power in the preliminary tests. The conducted spurious emissions and conducted band edge measurement for other data rates were not worse than 1Mbps, and no other significantly frequencies found in conducted spurious emission. | | | | | | |
| 2. Data Link with Notebook means data application transferred mode between EUT and Notebook. | | | | | | |

2.3 Connection Diagram of Test System

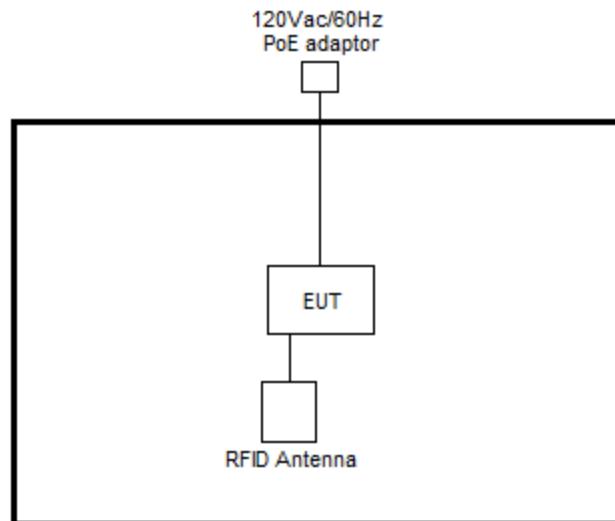
<AC Conducted Emission Mode>



<Bluetooth Tx Mode for Internal Antenna>



<Bluetooth Tx Mode for External Antenna>



2.4 Support Unit used in test configuration and system

| Item | Equipment | Brand Name | Model Name | FCC ID | Data Cable | Power Cord |
|------|-----------------|------------|---------------|--------------|-------------------|--|
| 1. | WLAN AP | ASUS | RT-AC66U | MSQ-RTAC66U | N/A | Unshielded, 1.8 m |
| 2. | Notebook | Dell | Latitude 3420 | FCC DoC | N/A | AC I/P: Unshielded, 1.2 m DC O/P: Shielded, 1.8 m |
| 3. | iPod | Apple | A1285 | DoC | Shielded, 1.0m | N/A |
| 4. | iPod Earphone | Apple | N/A | Verification | Unshielded, 1.0 m | N/A |
| 5. | Phone | ZEBRA | TC26 | N/A | N/A | N/A |
| 6. | USB Flash Drive | SanDisk | E8BOC | N/A | N/A | N/A |



2.5 EUT Operation Test Setup

The RF test items, utility “Tera Term Version 4.95” was installed in Notebook which was programmed in order to make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

2.6 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example:

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

Following shows an offset computation example with cable loss 4.2 dB and 10 dB attenuator.

$$\begin{aligned} \text{Offset(dB)} &= \text{RF cable loss(dB)} + \text{attenuator factor(dB)} \\ &= 4.2 + 10 = 14.2 \text{ (dB)} \end{aligned}$$



3 Test Result

3.1 Number of Channel Measurement

3.1.1 Limits of Number of Hopping Frequency

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

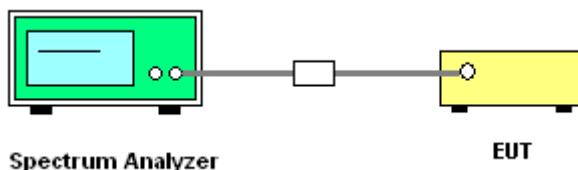
3.1.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.1.3 Test Procedure

1. The testing follows ANSI C63.10-2013 clause 7.8.3.
2. The RF output of EUT is connected to the spectrum analyzer by RF cable and attenuator. The path loss is compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings: Span = the frequency band of operation; RBW = 300 kHz; VBW \geq RBW; Sweep = auto; Detector function = peak; Trace = max hold.
6. The number of hopping frequency used is defined as the number of total channel.
7. Record the measurement data derived from spectrum analyzer.

3.1.4 Test Setup



3.1.5 Test Result of Number of Hopping Frequency

Please refer to Appendix A.

3.2 Hopping Channel Separation Measurement

3.2.1 Limit of Hopping Channel Separation

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

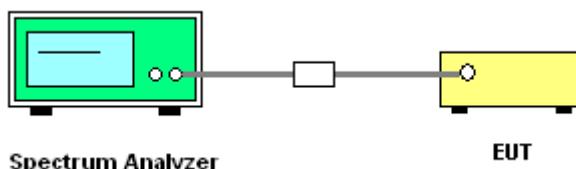
3.2.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.2.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.2.
2. The RF output of EUT is connected to the spectrum analyzer by RF cable and attenuator. The path loss is compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings:
Span = wide enough to capture the peaks of two adjacent channels;
RBW = 300 kHz; VBW \geq RBW; Sweep = auto; Detector function = peak; Trace = max hold.
6. Measure and record the results in the test report.

3.2.4 Test Setup



3.2.5 Test Result of Hopping Channel Separation

Please refer to Appendix A.

3.3 Dwell Time Measurement

3.3.1 Limit of Dwell Time

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

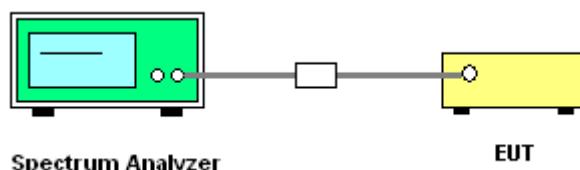
3.3.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.3.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.4.
2. The RF output of EUT is connected to the spectrum analyzer by RF cable and attenuator. The path loss is compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings: Span = zero span, centered on a hopping channel; RBW = 1 MHz; VBW \geq RBW; Sweep = as necessary to capture the entire dwell time per hopping channel; Detector function = peak; Trace = max hold.
6. Measure and record the results in the test report.

3.3.4 Test Setup



3.3.5 Test Result of Dwell Time

Please refer to Appendix A.

3.4 20dB and 99% Bandwidth Measurement

3.4.1 Limit of 20dB and 99% Bandwidth

Reporting only

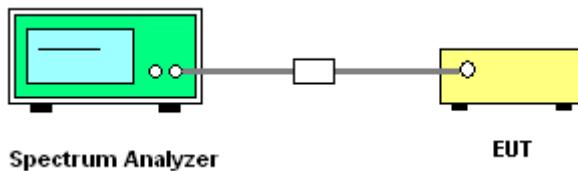
3.4.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.4.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 6.9.2 and 6.9.3.
2. The RF output of EUT is connected to the spectrum analyzer by RF cable and attenuator. The path loss is compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Use the following spectrum analyzer settings for 20 dB Bandwidth measurement.
Span = approximately 2 to 5 times the 20 dB bandwidth, centered on a hopping channel;
RBW \geq 1% of the 20 dB bandwidth; VBW \geq RBW; Sweep = auto; Detector function = peak;
Trace = max hold.
5. Use the following spectrum analyzer settings for 99 % Bandwidth measurement.
Span = approximately 1.5 to 5 times the 99% bandwidth, centered on a hopping channel;
RBW \geq 1-5% of the 99% bandwidth; VBW \geq 3 * RBW; Sweep = auto; Detector function = peak;
Trace = max hold.
6. Measure and record the results in the test report.

3.4.4 Test Setup



3.4.5 Test Result of 20dB Bandwidth

Please refer to Appendix A.

3.4.6 Test Result of 99% Occupied Bandwidth

Please refer to Appendix A.



3.5 Output Power Measurement

3.5.1 Limit of Output Power

The maximum peak conducted output power of the intentional radiator shall not exceed the following:

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band 0.125 watts.

If directional gain of transmitting antennas is greater than 6 dBi, the power shall be reduced by the same level in dB comparing to gain minus 6 dBi.

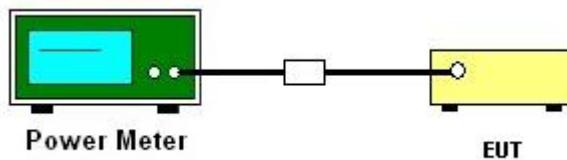
3.5.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.5.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.5.
2. The RF output of EUT is connected to the power meter by RF cable and attenuator. The path loss is compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Measure the conducted output power with cable loss and record the results in the test report.
5. Measure and record the results in the test report.

3.5.4 Test Setup



3.5.5 Test Result of Peak Output Power

Please refer to Appendix A.

3.5.6 Test Result of Average Output Power (Reporting Only)

Please refer to Appendix A.

3.6 Conducted Band Edges Measurement

3.6.1 Limit of Band Edges

In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.

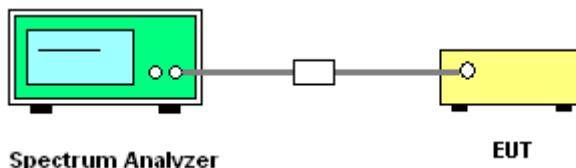
3.6.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.6.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.6.
2. Set the maximum power setting and enable the EUT to transmit continuously.
3. Set RBW = 100 kHz, VBW = 300 kHz. Band edge emissions must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW. The attenuation shall be 30 dB instead of 20 dB when RMS conducted output power procedure is used.
4. Enable hopping function of the EUT and then repeat step 2 and 3.
5. Measure and record the results in the test report.

3.6.4 Test Setup



3.6.5 Test Result of Conducted Band Edges

Please refer to Appendix A.

3.6.6 Test Result of Conducted Hopping Mode Band Edges

Please refer to Appendix A.

3.7 Conducted Spurious Emission Measurement

3.7.1 Limit of Spurious Emission Measurement

In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.

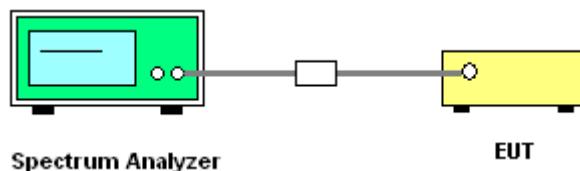
3.7.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.7.3 Test Procedure

1. The testing follows ANSI C63.10-2013 clause 7.8.8.
2. The RF output of EUT is connected to the spectrum analyzer by RF cable and attenuator. The path loss is compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Set RBW = 100 kHz, VBW = 300 kHz, scan up through 10th harmonic. All harmonics / spurious must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW.
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

3.7.4 Test Setup



3.7.5 Test Result of Conducted Spurious Emission

Please refer to Appendix A.



3.8 Radiated Band Edges and Spurious Emission Measurement

3.8.1 Limit of Radiated Band Edges and Spurious Emission

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics / spurious must be at least 20 dB below the highest emission level within the authorized band. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

| 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 |

3.8.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.



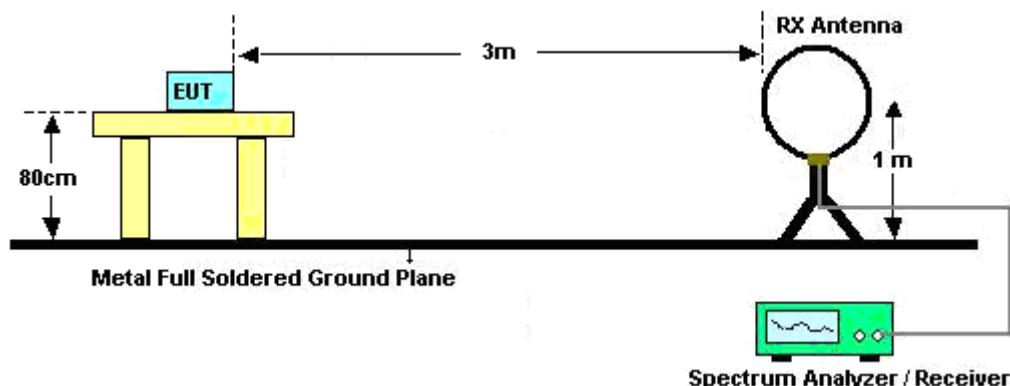
3.8.3 Test Procedures

1. The EUT is placed on a turntable with 0.8 meter for frequency below 1 GHz and 1.5 meter for frequency above 1 GHz respectively above ground.
2. The EUT is set 3 meters away from the receiving antenna, which is mounted on the top of a variable height antenna tower.
3. For each suspected emission, the EUT is arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.
4. Set the maximum power setting and enable the EUT to transmit continuously.
5. Use the following spectrum analyzer settings:
 - (1) Span shall wide enough to fully capture the emission being measured;
 - (2) Set RBW = 100 kHz for $f < 1$ GHz, RBW = 1 MHz for $f > 1$ GHz ; VBW \geq RBW; Sweep = auto; Detector function = peak; Trace = max hold for peak
 - (3) For average measurement: use duty cycle correction factor method per 15.35(c).
Duty cycle = On time/100 milliseconds
On time = $N_1 \cdot L_1 + N_2 \cdot L_2 + \dots + N_{n-1} \cdot L_{n-1} + N_n \cdot L_n$
Where N_1 is number of type 1 pulses, L_1 is length of type 1 pulses, etc.
Average Emission Level = Peak Emission Level + $20 \cdot \log_{10}$ (Duty cycle)
6. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
7. Radiated testing below 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading. When there is no suspected emission found and the emission level is with at least 6 dB margin against QP limit line, the position is marked as "-".
8. Radiated testing above 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading for scanning all frequencies. When there is no suspected emission found and the harmonic emission level is with at least 6 dB margin against average limit line, the position is marked as "-".

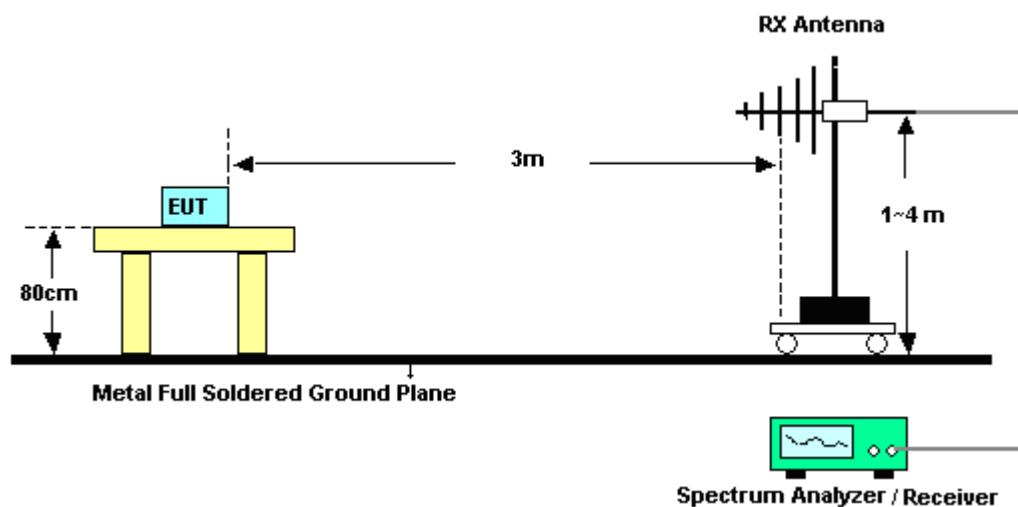
Note: The average levels are calculated from the peak level corrected with duty cycle correction factor (-24.76dB) derived from $20 \cdot \log_{10}$ (dwell time/100ms). This correction is only for signals that hop with the fundamental signal, such as band-edge and harmonic. Other spurious signals that are independent of the hopping signal would not use this correction.

3.8.4 Test Setup

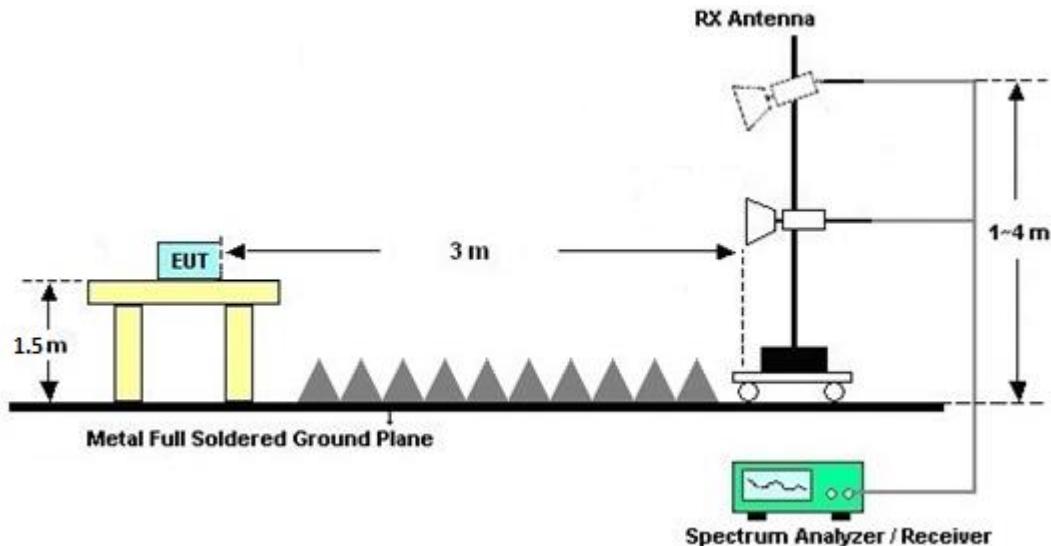
For radiated test below 30MHz



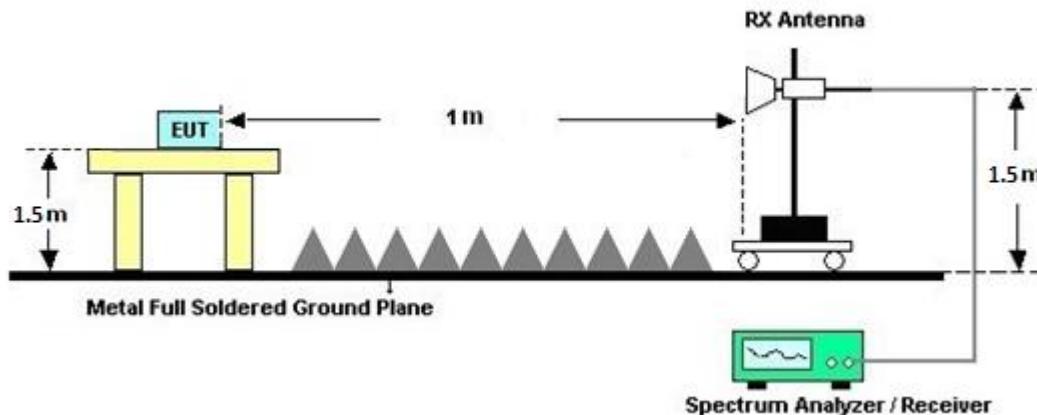
For radiated test from 30MHz to 1GHz



For radiated test from 1GHz to 18GHz



For radiated test above 18GHz



3.8.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

The low frequency, which starts from 9 kHz to 30 MHz, is pre-scanned and the result which is 20 dB lower than the limit line is not reported.

There is adequate comparison measurement of both open-field test site and alternative test site - semi-Anechoic chamber according to 414788 D01 Radiated Test Site v01r01, and the result comes out very similar.

3.8.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C and D.

3.8.7 Duty Cycle

Please refer to Appendix E.

3.8.8 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic)

Please refer to Appendix C and D.



3.9 AC Conducted Emission Measurement

3.9.1 Limit of AC Conducted Emission

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

| 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.

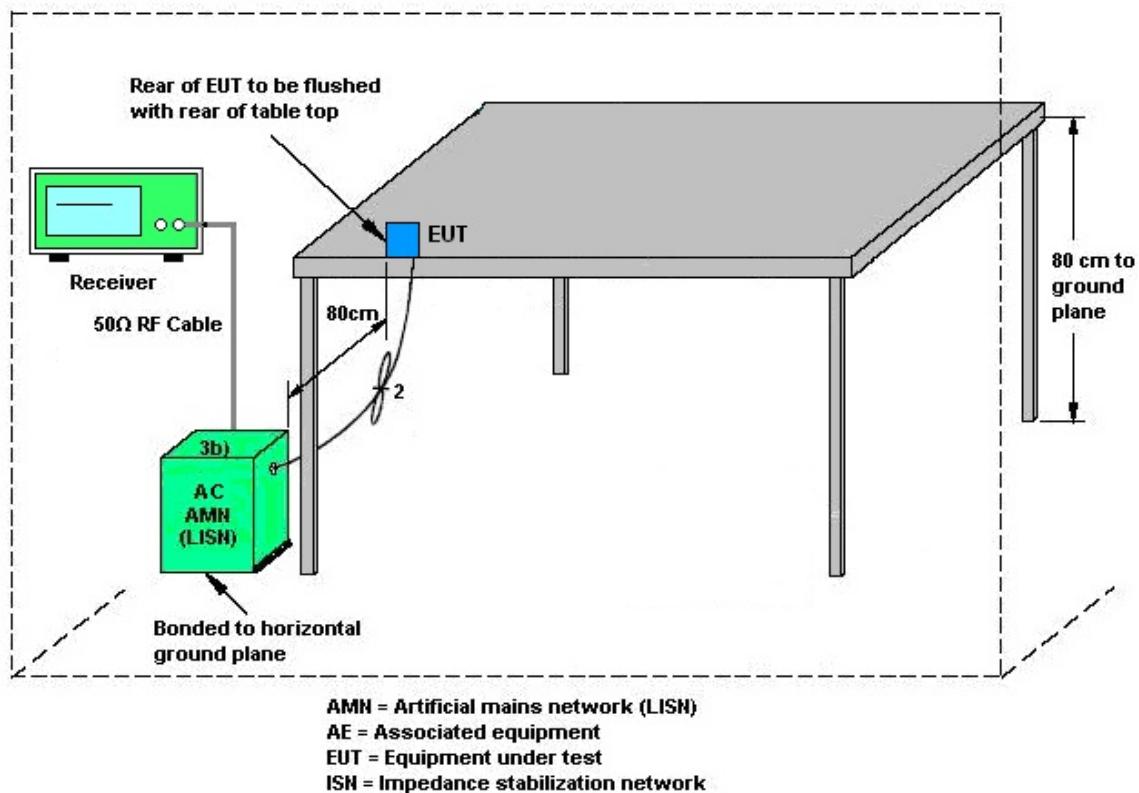
3.9.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.9.3 Test Procedures

1. The EUT is placed 0.4 meter away from the conducting wall of the shielding room, and is kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN shall be used.
6. Both Line and Neutral shall be tested in order to find out the maximum conducted emission.
7. The frequency range from 150 kHz to 30 MHz is scanned.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9 kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

3.9.4 Test Setup



3.9.5 Test Result of AC Conducted Emission

Please refer to Appendix B.



3.10 Antenna Requirements

3.10.1 Standard Applicable

The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the rule.

3.10.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.



4 List of Measuring Equipment

| Instrument | Brand Name | Model No. | Serial No. | Characteristics | Calibration Date | Test Date | Due Date | Remark |
|---------------------------|-----------------|-----------------------------|-------------------------|-----------------|------------------|-------------------------------|---------------|-----------------------|
| AC Power Source | ChainTek | APC-1000W | N/A | N/A | N/A | Sep. 14, 2023 | N/A | Conduction (CO05-HY) |
| EMI Test Receiver | Rohde & Schwarz | ESR3 | 102388 | 9kHz~3.6GHz | Dec. 01, 2022 | Sep. 14, 2023 | Nov. 30, 2023 | Conduction (CO05-HY) |
| Hygrometer | Testo | 608-H1 | 34913912 | N/A | Nov. 17, 2022 | Sep. 14, 2023 | Nov. 16, 2023 | Conduction (CO05-HY) |
| LISN | Rohde & Schwarz | ENV216 | 100080 | 9kHz~30MHz | Dec. 01, 2022 | Sep. 14, 2023 | Nov. 30, 2023 | Conduction (CO05-HY) |
| LISN | Rohde & Schwarz | ENV216 | 100081 | 9kHz~30MHz | Nov. 17, 2022 | Sep. 14, 2023 | Nov. 16, 2023 | Conduction (CO05-HY) |
| Software | Rohde & Schwarz | EMC32 | N/A | N/A | N/A | Sep. 14, 2023 | N/A | Conduction (CO05-HY) |
| Pulse Limiter | SCHWARZBECK | VTSD 9561-FN | 00691 | 9kHz-200MHz | Jul. 28, 2023 | Sep. 14, 2023 | Jul. 27, 2024 | Conduction (CO05-HY) |
| LISN Cable | MVE | RG-400 | 260260 | N/A | Dec. 29, 2022 | Sep. 14, 2023 | Dec. 28, 2023 | Conduction (CO05-HY) |
| Hygrometer | TECPEL | DTM-303A | TP201996 | N/A | Nov. 17. 2022 | Sep. 19, 2023~Oct. 11, 2023 | Nov. 16. 2023 | Conducted (TH05-HY) |
| Power Meter | Anritsu | ML2495A | 0932001 | N/A | Sep. 08, 2023 | Sep. 19, 2023~Oct. 11, 2023 | Sep. 07, 2024 | Conducted (TH05-HY) |
| Power Sensor | Anritsu | MA2411B | 0846202 | 300MHz~40GHz | Sep. 08, 2023 | Sep. 19, 2023~Oct. 11, 2023 | Sep. 07, 2024 | Conducted (TH05-HY) |
| Power Sensor | DARE | RPR3006W | 15I00041SNO 10 (NO:248) | 10MHz~6GHz | Jan. 05, 2023 | Sep. 19, 2023~Oct. 11, 2023 | Jan. 04, 2024 | Conducted (TH05-HY) |
| Signal Analyzer | Rohde & Schwarz | FSV40 | 101566 | 10Hz~40GHz | Aug. 23, 2023 | Sep. 19, 2023~Oct. 11, 2023 | Aug. 22, 2024 | Conducted (TH05-HY) |
| BT Base Station(Measur e) | Rohde & Schwarz | CBT | 101136 | BT 3.0 | Oct. 25, 2022 | Sep. 19, 2023~Oct. 11, 2023 | Oct. 24, 2023 | Conducted (TH05-HY) |
| Bilog Antenna | TESEQ | CBL 6111D & 00800N1D01N -06 | 35419 & 03 | 30MHz~1GHz | Apr. 23, 2023 | Sep. 21, 2023~Nov. 01, 2023 | Apr. 22, 2024 | Radiation (03CH07-HY) |
| Double Ridge Horn Antenna | ESCO | 3117 | 00075962 | 1GHz ~ 18GHz | Dec. 01, 2022 | Sep. 21, 2023~Nov. 01, 2023 | Nov. 30, 2023 | Radiation (03CH07-HY) |
| Loop Antenna | Rohde & Schwarz | HFH2-Z2 | 100315 | 9 kHz~30 MHz | Feb. 28, 2023 | Sep. 21, 2023~Nov. 01, 2023 | Feb. 27, 2024 | Radiation (03CH07-HY) |
| Preamplifier | MITEQ | AMF-7D-0010 1800-30-10P | 1590075 | 1GHz~18GHz | Apr. 20, 2023 | Sep. 21, 2023~Nov. 01, 2023 | Apr. 19, 2024 | Radiation (03CH07-HY) |
| Preamplifier | COM-POWER | PA-103A | 161241 | 10MHz~1GHz | Oct. 03, 2022 | Sep. 21, 2023~Oct. 01, 2023 | Oct. 02, 2023 | Radiation (03CH07-HY) |
| Preamplifier | COM-POWER | PA-103A | 161241 | 10MHz~1GHz | Oct. 02, 2023 | Oct. 02, 2023 ~ Nov. 01, 2023 | Oct. 01, 2024 | Radiation (03CH07-HY) |
| Preamplifier | Agilent | 8449B | 3008A02362 | 1GHz~26.5GHz | Mar. 24, 2023 | Sep. 21, 2023~Nov. 01, 2023 | Mar. 23, 2024 | Radiation (03CH07-HY) |
| Spectrum Analyzer | Agilent | N9030A | MY52350276 | 3Hz~44GHz | Mar. 28, 2023 | Sep. 21, 2023~Nov. 01, 2023 | Mar. 27, 2024 | Radiation (03CH07-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 104 | MY15682/4 | 30MHz to 18GHz | Feb. 22, 2023 | Sep. 21, 2023~Nov. 01, 2023 | Feb. 21, 2024 | Radiation (03CH07-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 104 | MY24971/4 | 9kHz to 18GHz | Feb. 22, 2023 | Sep. 21, 2023~Nov. 01, 2023 | Feb. 21, 2024 | Radiation (03CH07-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 104 | MY28655/4 | 9kHz to 18GHz | Feb. 22, 2023 | Sep. 21, 2023~Nov. 01, 2023 | Feb. 21, 2024 | Radiation (03CH07-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 126 | 532078/126E | 30MHz~18GHz | Sep. 15, 2023 | Sep. 21, 2023~Nov. 01, 2023 | Sep. 14 2024 | Radiation (03CH07-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 102 | MY2858/2 | 18GHz~40GHz | Feb. 22, 2023 | Sep. 21, 2023~Nov. 01, 2023 | Feb. 21, 2024 | Radiation (03CH07-HY) |
| RF Cable | HUBER + SUHNER | SUCOFLEX 102 | 801606/2 | 9KHz ~ 40GHz | Apr. 20, 2023 | Sep. 21, 2023~Nov. 01, 2023 | Apr. 19, 2024 | Radiation (03CH07-HY) |



| Instrument | Brand Name | Model No. | Serial No. | Characteristics | Calibration Date | Test Date | Due Date | Remark |
|----------------------|-------------|---------------|--------------|----------------------|------------------|-----------------------------|---------------|-----------------------|
| Controller | EMEC | EM1000 | N/A | Control Ant Mast | N/A | Sep. 21, 2023~Nov. 01, 2023 | N/A | Radiation (03CH07-HY) |
| Controller | MF | MF-7802 | N/A | Control Turn table | N/A | Sep. 21, 2023~Nov. 01, 2023 | N/A | Radiation (03CH07-HY) |
| Antenna Mast | EMEC | AM-BS-4500E | N/A | Boresight mast 1M~4M | N/A | Sep. 21, 2023~Nov. 01, 2023 | N/A | Radiation (03CH07-HY) |
| Turn Table | ChainTek | Chaintek 3000 | N/A | 0~360 Degree | N/A | Sep. 21, 2023~Nov. 01, 2023 | N/A | Radiation (03CH07-HY) |
| Software | Audix | E3 | N/A | N/A | N/A | Sep. 21, 2023~Nov. 01, 2023 | N/A | Radiation (03CH07-HY) |
| USB Data Logger | TECPEL | TR-32 | HE17XB2495 | N/A | Mar. 14, 2023 | Sep. 21, 2023~Nov. 01, 2023 | Mar. 13, 2024 | Radiation (03CH07-HY) |
| Preamplifier | EMEC | EM18G40G | 060801 | 18GHz~40GHz | Jun. 27, 2023 | Sep. 21, 2023~Nov. 01, 2023 | Jun. 26, 2024 | Radiation (03CH07-HY) |
| SHF-EHF Horn Antenna | SCHWARZBECK | BBHA 9170 | BBHA917025 1 | 18GHz~40GHz | Nov. 24, 2022 | Sep. 21, 2023~Nov. 01, 2023 | Nov. 23, 2023 | Radiation (03CH07-HY) |



5 Measurement Uncertainty

Uncertainty of Conducted Emission Measurement (150 kHz ~ 30 MHz)

| | |
|---|---------|
| Measuring Uncertainty for a Level of Confidence of 95% (U = 2U _c (y)) | 3.50 dB |
|---|---------|

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

| | |
|---|---------|
| Measuring Uncertainty for a Level of Confidence of 95% (U = 2U _c (y)) | 6.30 dB |
|---|---------|

Uncertainty of Radiated Emission Measurement (1000 MHz ~ 6000 MHz)

| | |
|---|---------|
| Measuring Uncertainty for a Level of Confidence of 95% (U = 2U _c (y)) | 4.60 dB |
|---|---------|

Uncertainty of Radiated Emission Measurement (6000 MHz ~ 18000 MHz)

| | |
|---|---------|
| Measuring Uncertainty for a Level of Confidence of 95% (U = 2U _c (y)) | 4.30 dB |
|---|---------|

Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

| | |
|---|---------|
| Measuring Uncertainty for a Level of Confidence of 95% (U = 2U _c (y)) | 5.30 dB |
|---|---------|

Appendix A. Test Result of Conducted Test Items

| | | | | |
|----------------|----------------------|--------------------|-------|----|
| Test Engineer: | Ray Wang | Temperature: | 21~25 | °C |
| Test Date: | 2023/9/19~2023/10/11 | Relative Humidity: | 51~54 | % |

<Internal Antenna>

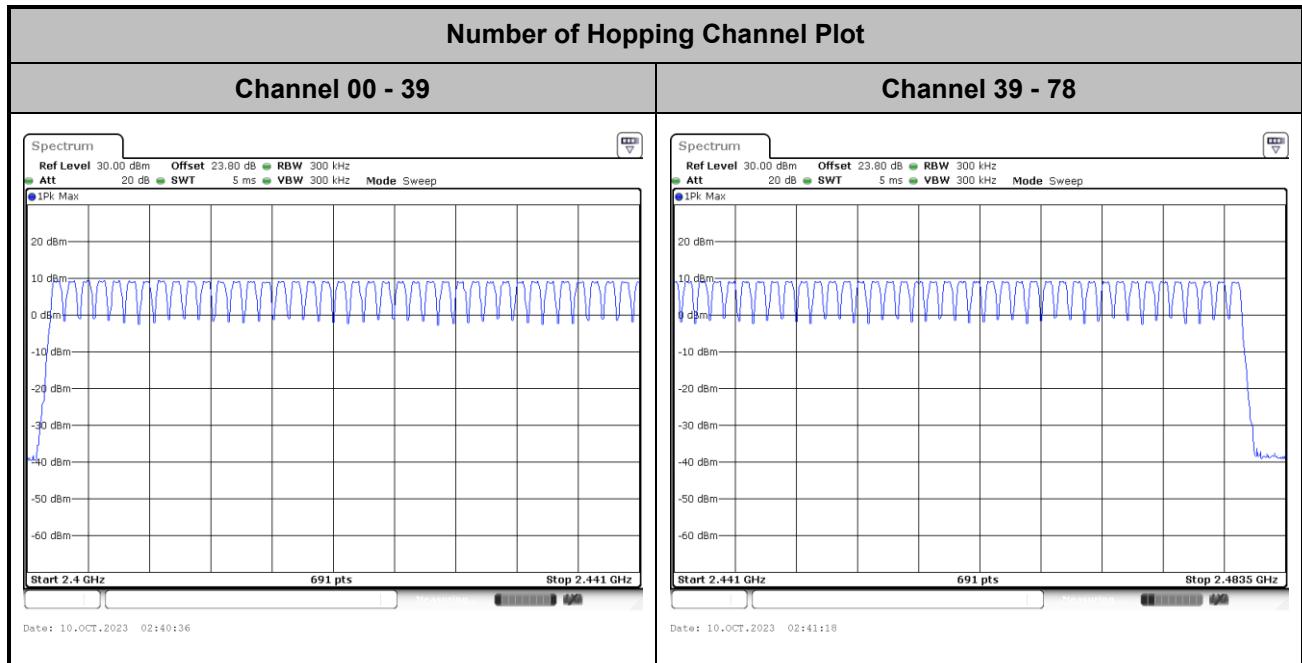
| <u>TEST RESULTS DATA</u> | | | | | | | | |
|---|-----------|-----|-----|-------------|---------------|---------------------|--|--|
| <u>20dB and 99% Occupied Bandwidth and Hopping Channel Separation</u> | | | | | | | | |
| Mod. | Data Rate | NTX | CH. | Freq. (MHz) | 20db BW (MHz) | 99% Bandwidth (MHz) | Hopping Channel Separation Measurement (MHz) | Hopping Channel Separation Measurement Limit (MHz) |
| DH | 1Mbps | 1 | 0 | 2402 | 0.943 | 0.827 | 1.337 | 0.6290 |
| DH | 1Mbps | 1 | 39 | 2441 | 0.943 | 0.855 | 0.999 | 0.6290 |
| DH | 1Mbps | 1 | 78 | 2480 | 0.943 | 0.853 | 0.994 | 0.6290 |
| 2DH | 2Mbps | 1 | 0 | 2402 | 1.261 | 1.157 | 0.994 | 0.8406 |
| 2DH | 2Mbps | 1 | 39 | 2441 | 1.309 | 1.165 | 0.990 | 0.8725 |
| 2DH | 2Mbps | 1 | 78 | 2480 | 1.304 | 1.165 | 1.329 | 0.8696 |
| 3DH | 3Mbps | 1 | 0 | 2402 | 1.270 | 1.155 | 1.007 | 0.8464 |
| 3DH | 3Mbps | 1 | 39 | 2441 | 1.270 | 1.157 | 0.994 | 0.8464 |
| 3DH | 3Mbps | 1 | 78 | 2480 | 1.270 | 1.155 | 1.003 | 0.8464 |
| | | | | | | | | |

| <u>TEST RESULTS DATA</u> | | | | | | |
|--------------------------|-----------------------------|---------------------------------|------------------------------|------------------|--------------|-----------|
| <u>Dwell Time</u> | | | | | | |
| Mod. | Hopping Channel Number Rate | Hops Over Occupancy Time (hops) | Package Transfer Time (msec) | Dwell Time (sec) | Limits (sec) | Pass/Fail |
| DH5 | 79 | 106.670 | 2.90 | 0.31 | 0.4 | Pass |
| DH5 (AFH) | 20 | 53.330 | 2.90 | 0.15 | 0.4 | Pass |

| <u>TEST RESULTS DATA</u> | | | | | |
|--------------------------|-----|-----|------------------|-------------------|-------------|
| <u>Peak Power Table</u> | | | | | |
| DH | CH. | NTX | Peak Power (dBm) | Power Limit (dBm) | Test Result |
| DH1 | 0 | 1 | 10.46 | 30.00 | Pass |
| | 39 | 1 | 10.30 | 30.00 | Pass |
| | 78 | 1 | 10.19 | 30.00 | Pass |
| 2DH1 | 0 | 1 | 9.63 | 20.97 | Pass |
| | 39 | 1 | 9.41 | 20.97 | Pass |
| | 78 | 1 | 9.33 | 20.97 | Pass |
| 3DH1 | 0 | 1 | 9.85 | 20.97 | Pass |
| | 39 | 1 | 9.61 | 20.97 | Pass |
| | 78 | 1 | 9.55 | 20.97 | Pass |

| <u>TEST RESULTS DATA</u> | | | | |
|----------------------------|-----|-----|---------------------|------------------|
| <u>Average Power Table</u> | | | | |
| <u>(Reporting Only)</u> | | | | |
| DH | CH. | NTX | Average Power (dBm) | Duty Factor (dB) |
| DH1 | 0 | 1 | 9.78 | 5.06 |
| | 39 | 1 | 9.57 | 5.06 |
| | 78 | 1 | 9.49 | 5.06 |
| 2DH1 | 0 | 1 | 7.04 | 5.17 |
| | 39 | 1 | 6.87 | 5.17 |
| | 78 | 1 | 6.82 | 5.17 |
| 3DH1 | 0 | 1 | 7.05 | 5.09 |
| | 39 | 1 | 6.88 | 5.09 |
| | 78 | 1 | 6.85 | 5.09 |

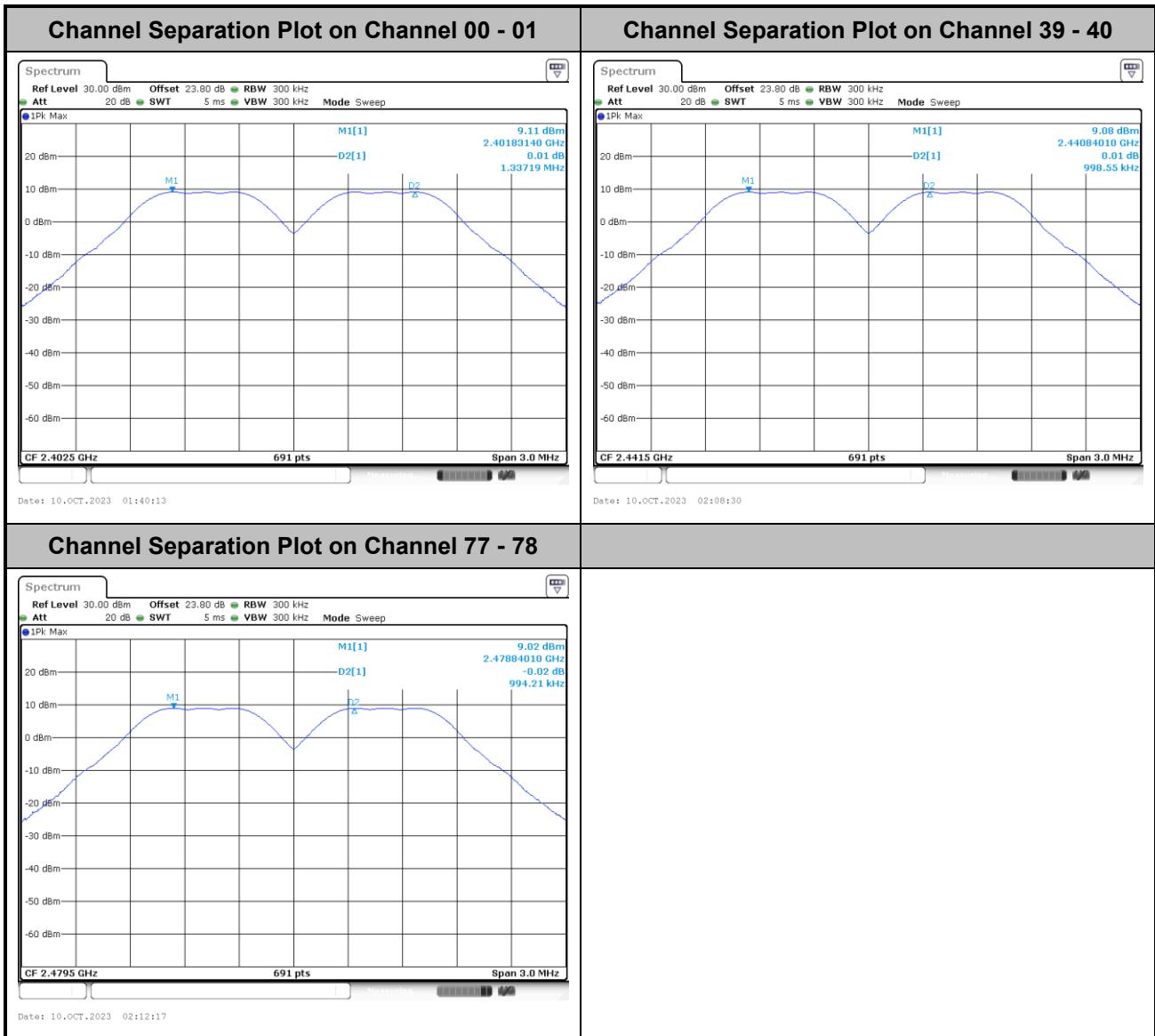
| <u>TEST RESULTS DATA</u> | | | |
|------------------------------------|--------------------------------------|------------------|-----------|
| <u>Number of Hopping Frequency</u> | | | |
| Number of Hopping (Channel) | Adaptive Frequency Hopping (Channel) | Limits (Channel) | Pass/Fail |
| 79 | 20 | > 15 | Pass |

**Number of Hopping Frequency**



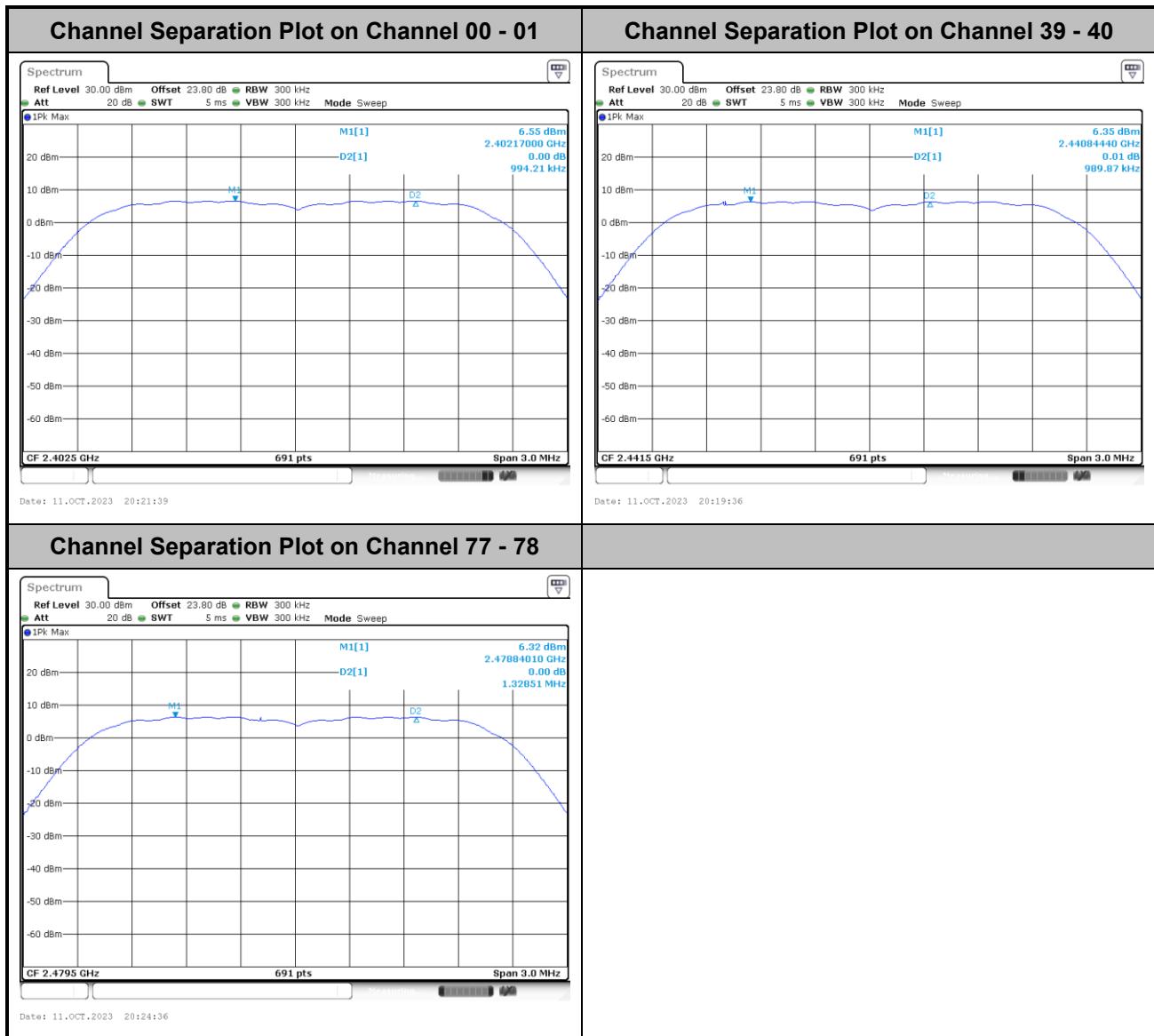
Hopping Channel Separation

<1Mbps



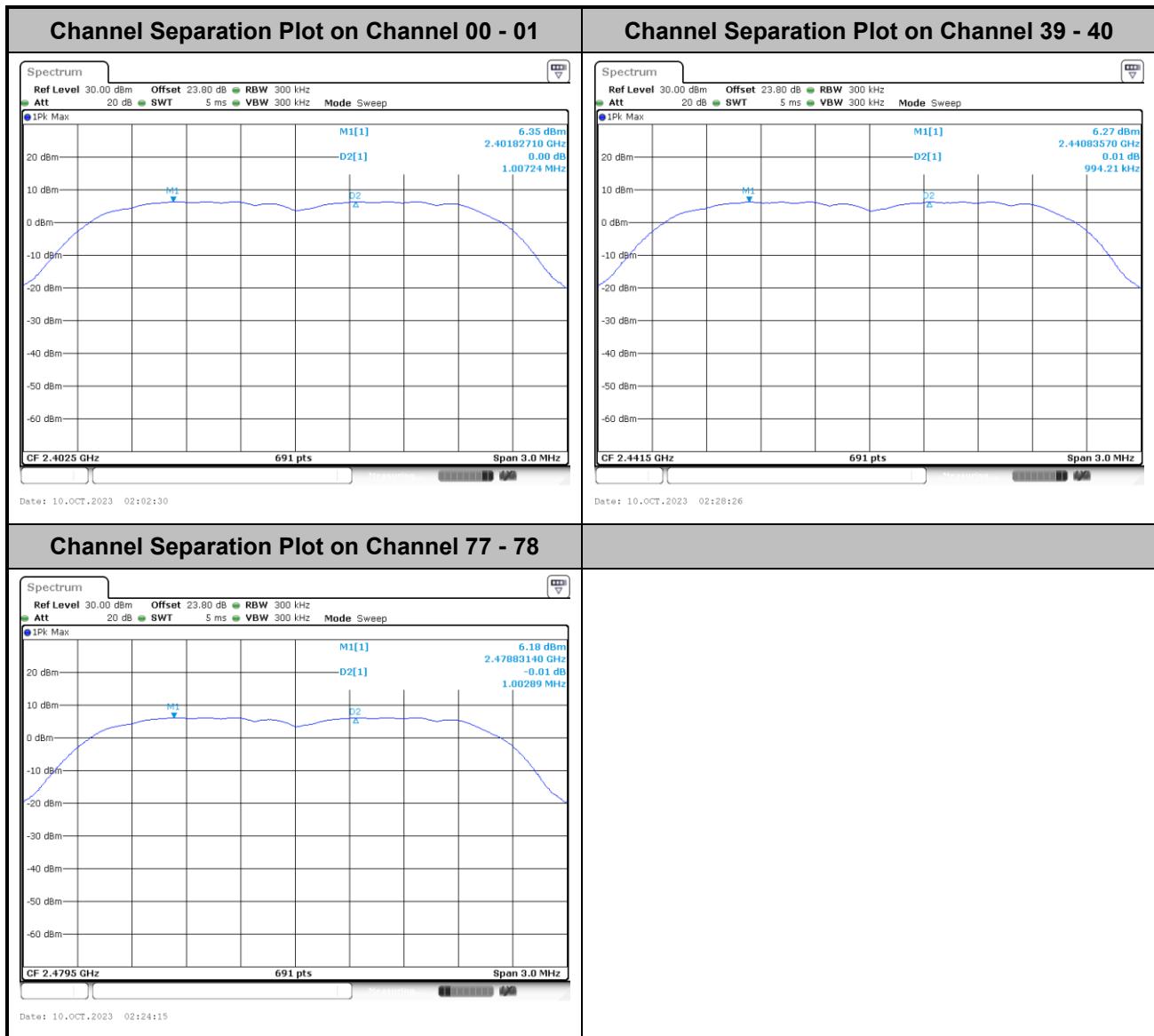


<2Mbps>



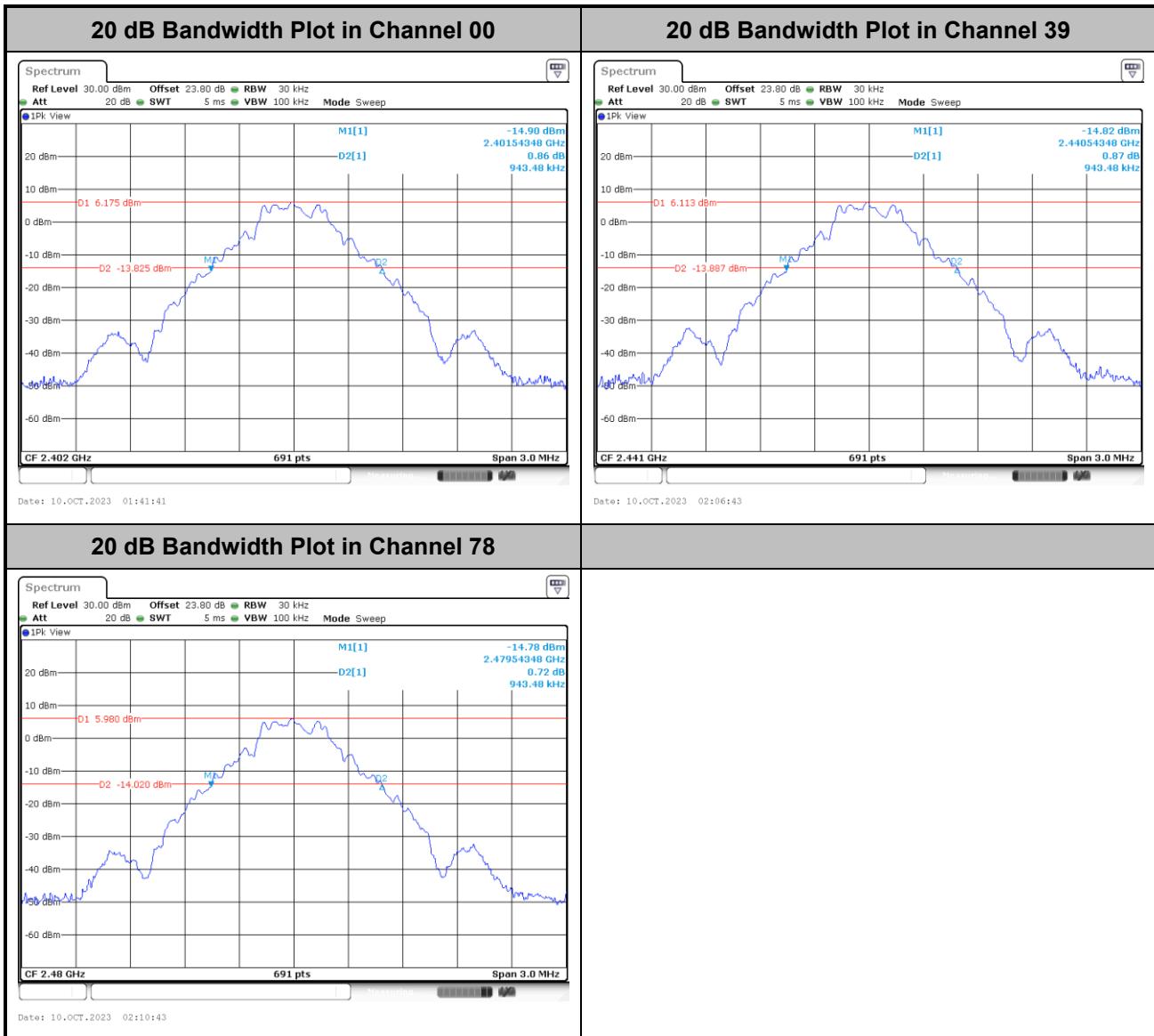


<3Mbps>



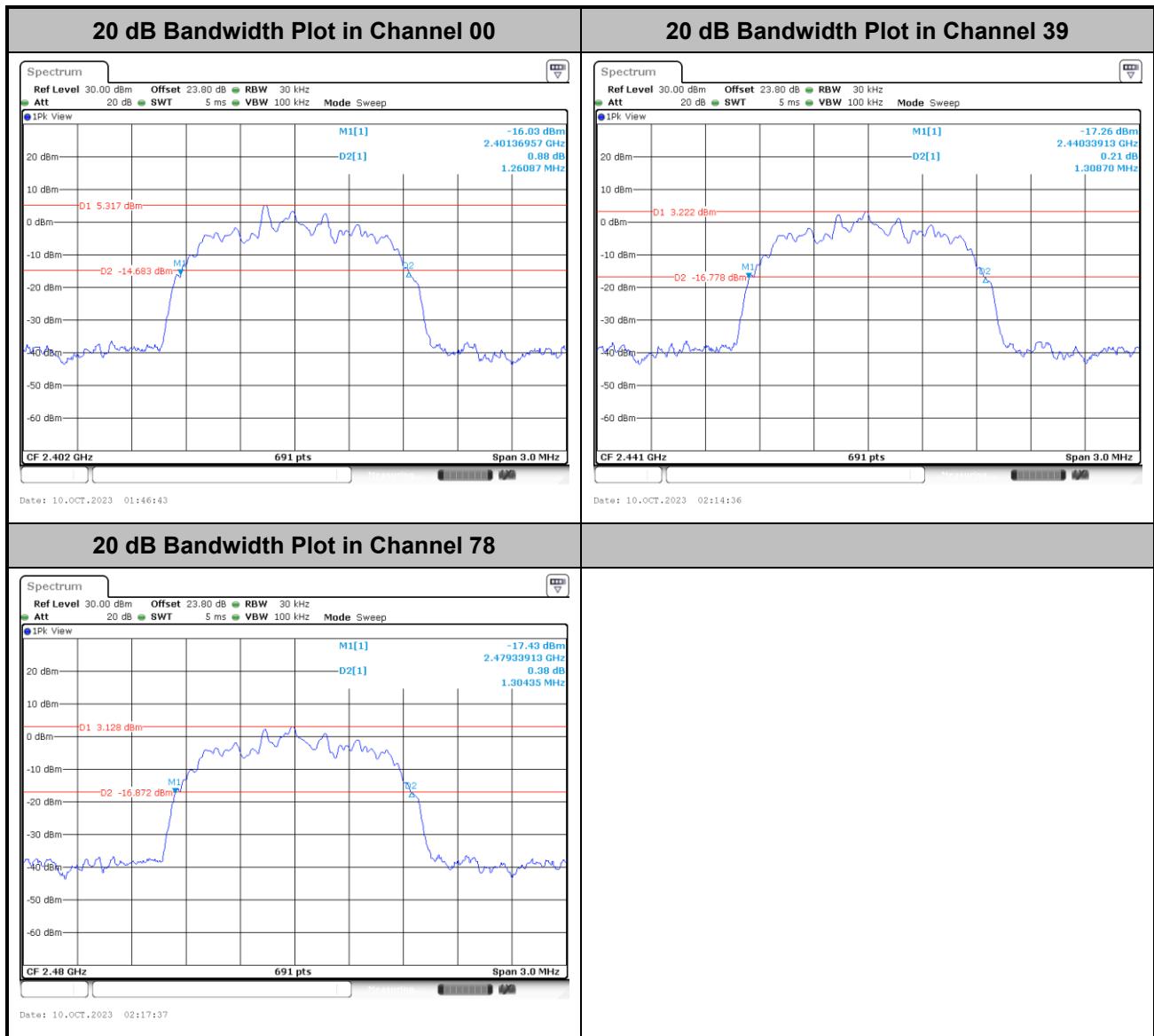
**20dB Bandwidth**

<1Mbps>



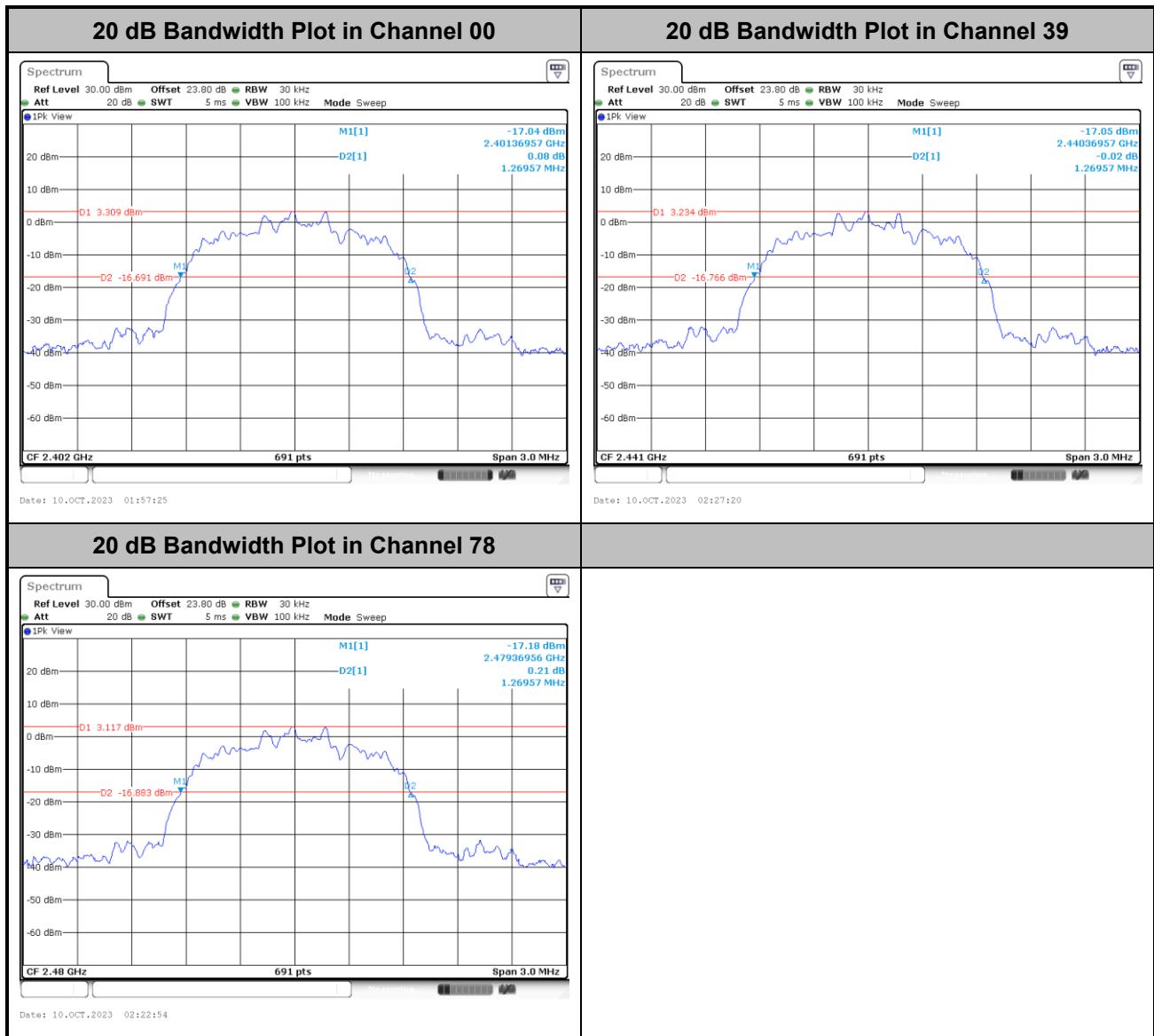


<2Mbps>



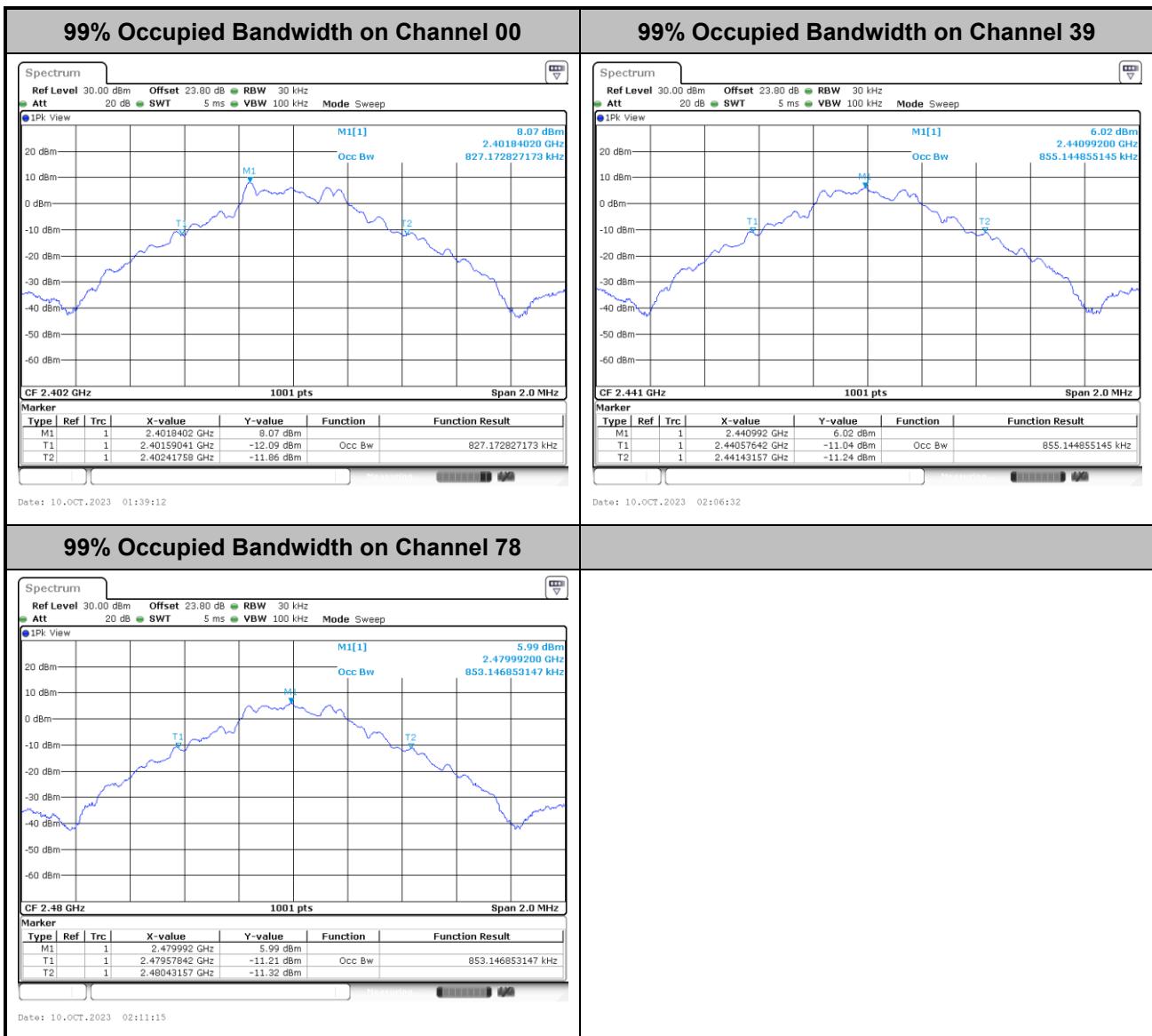


<3Mbps>



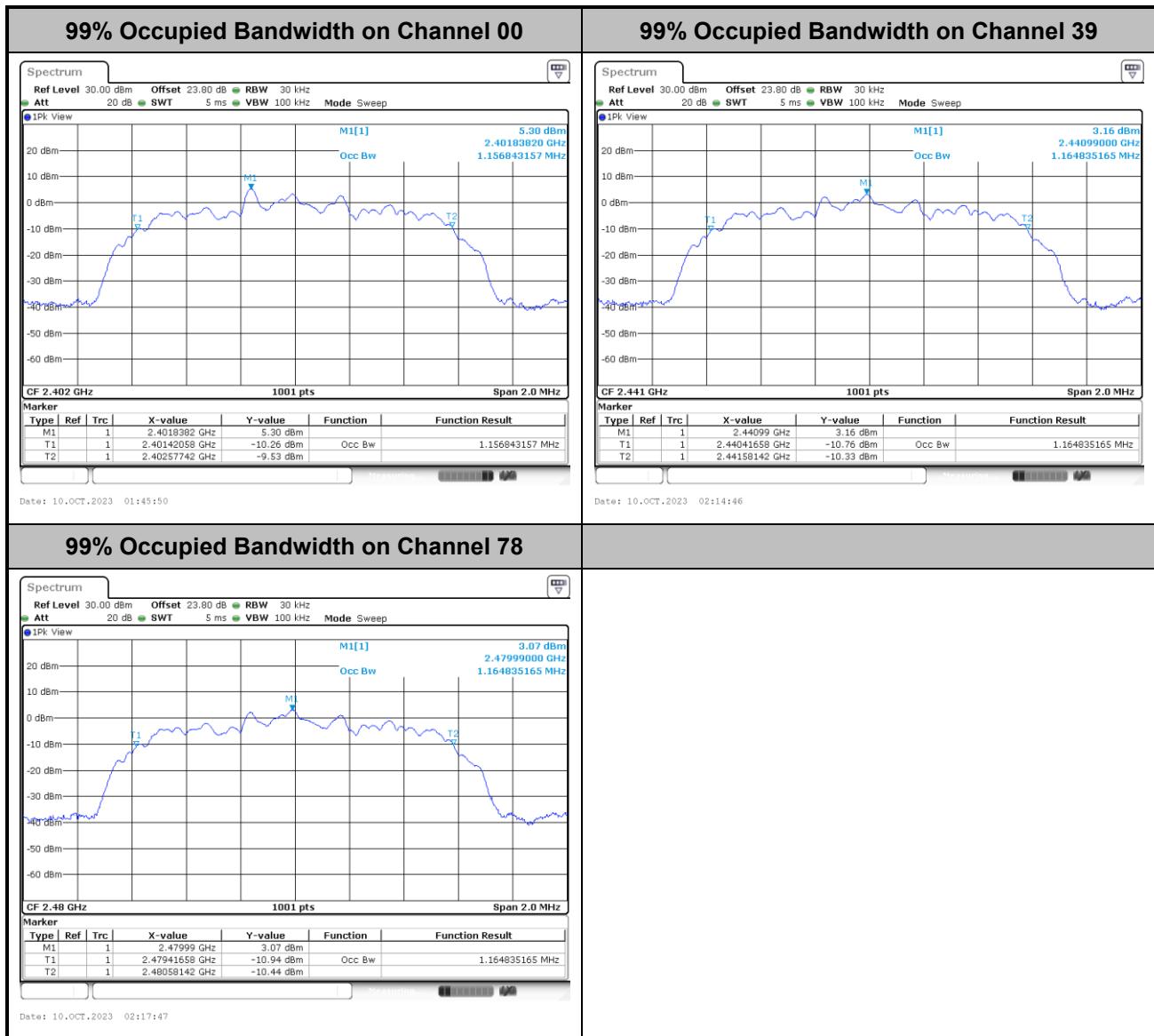
**99% Occupied Bandwidth**

<1Mbps>



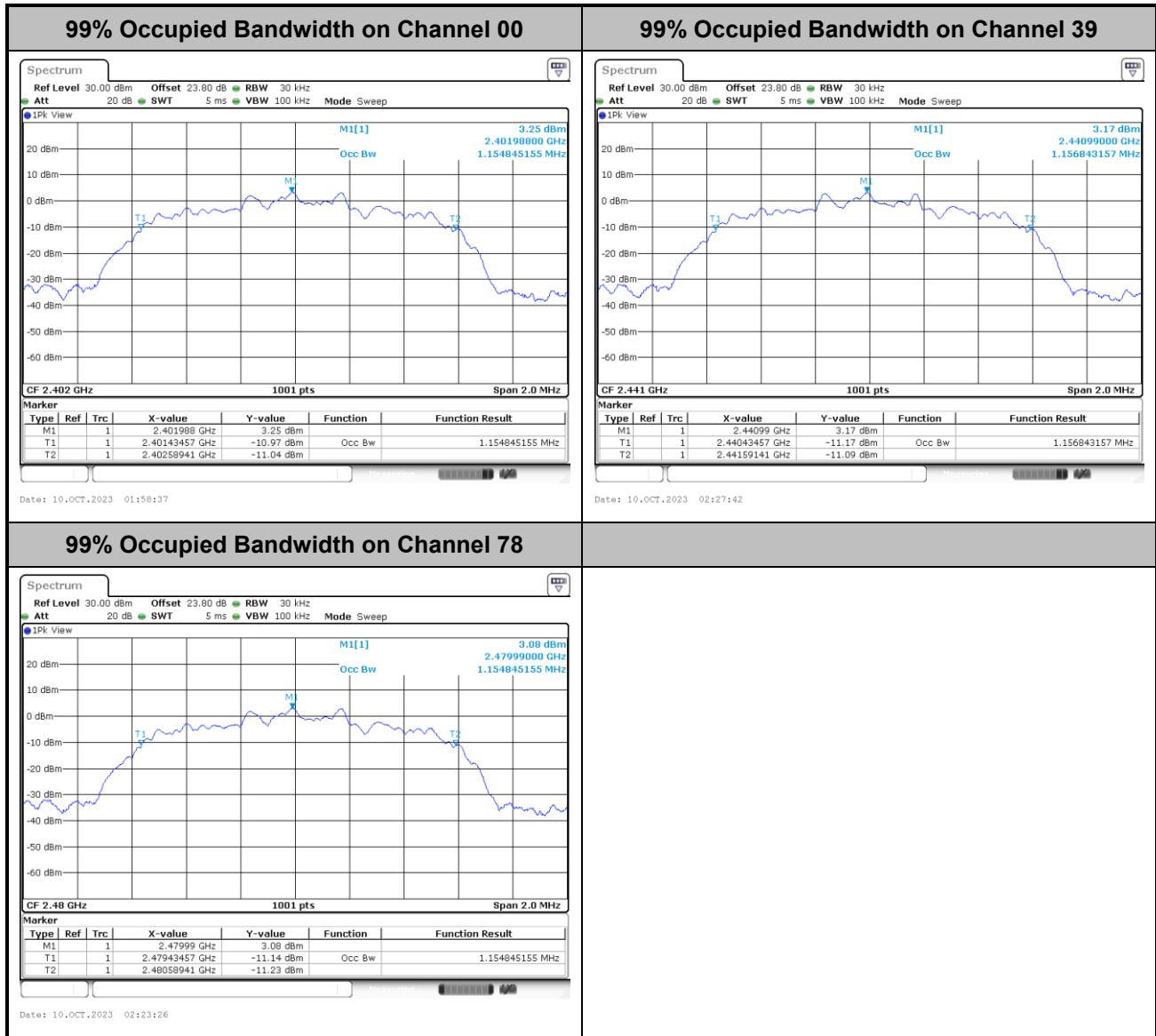


<2Mbps>





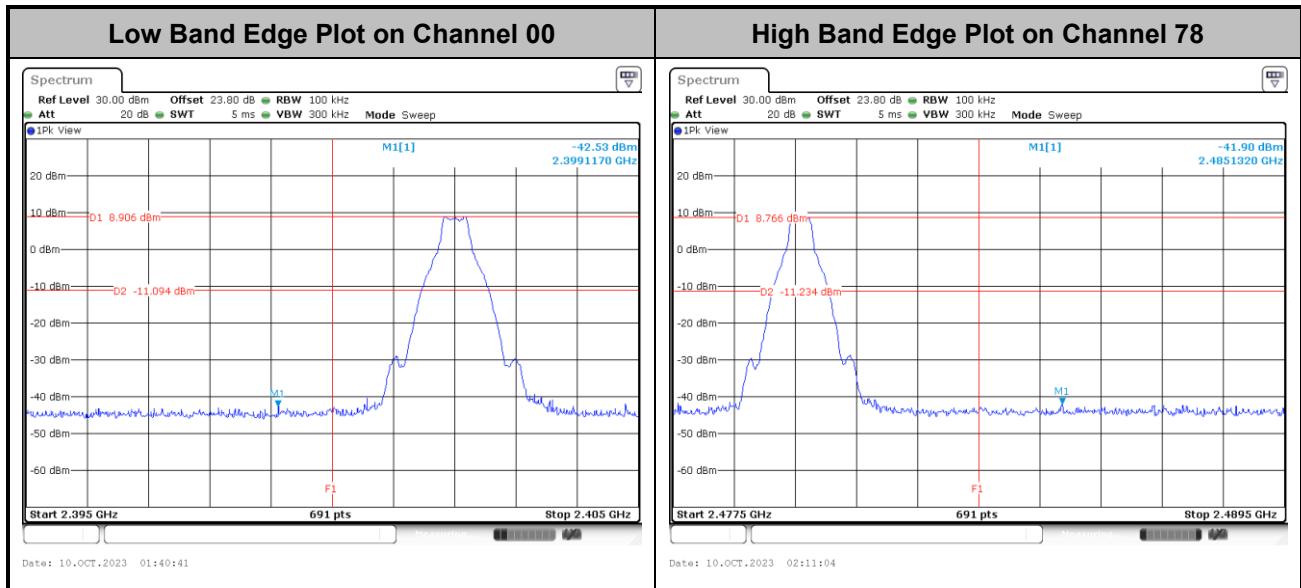
<3Mbps>



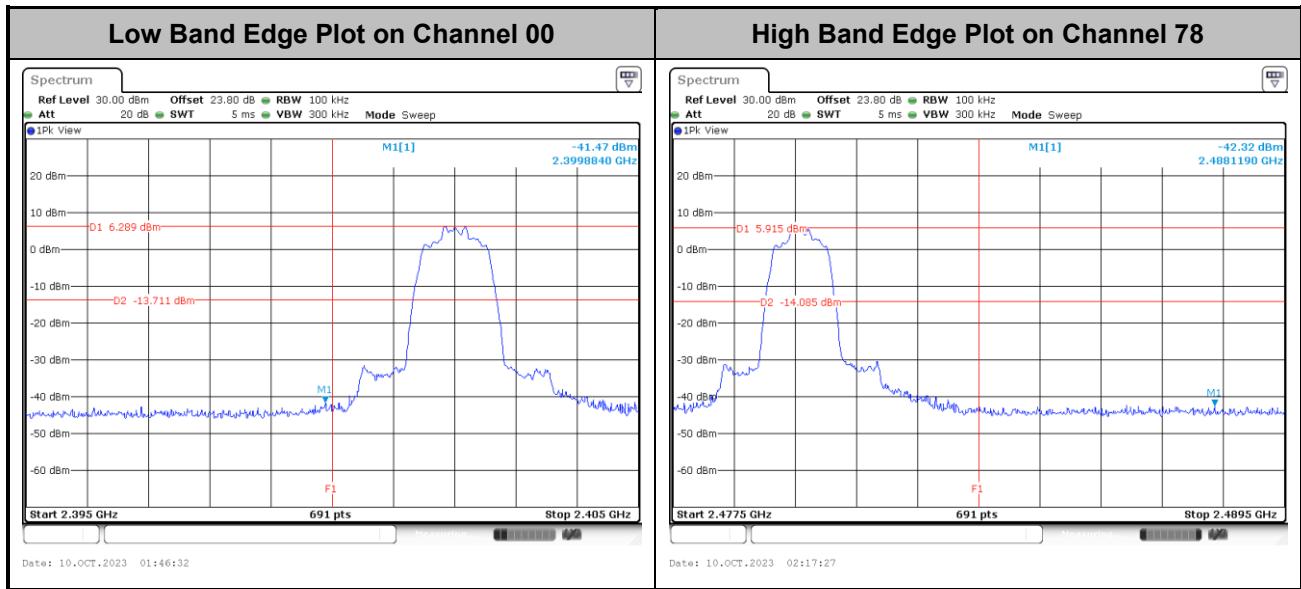


Band Edges

<1Mbps>

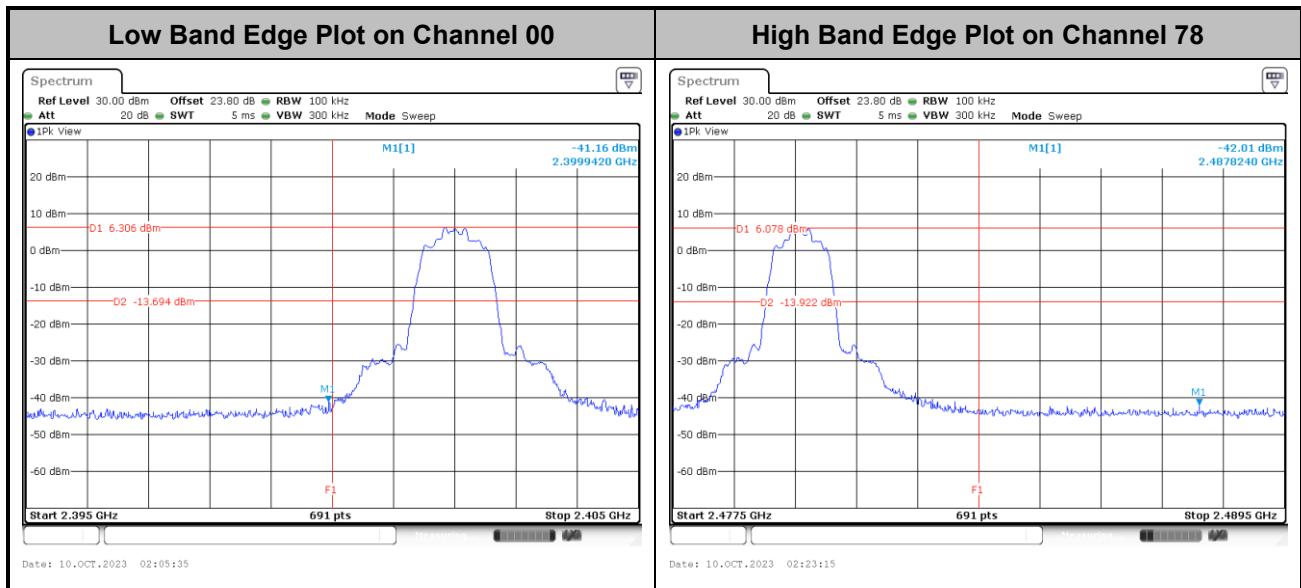


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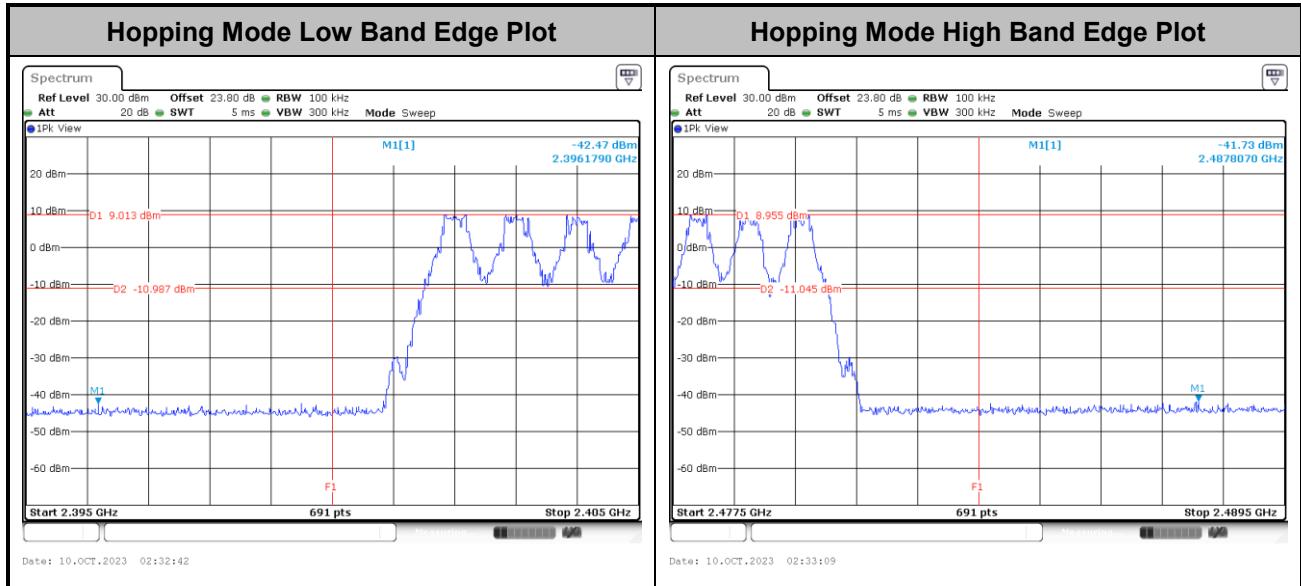


<3Mbps>

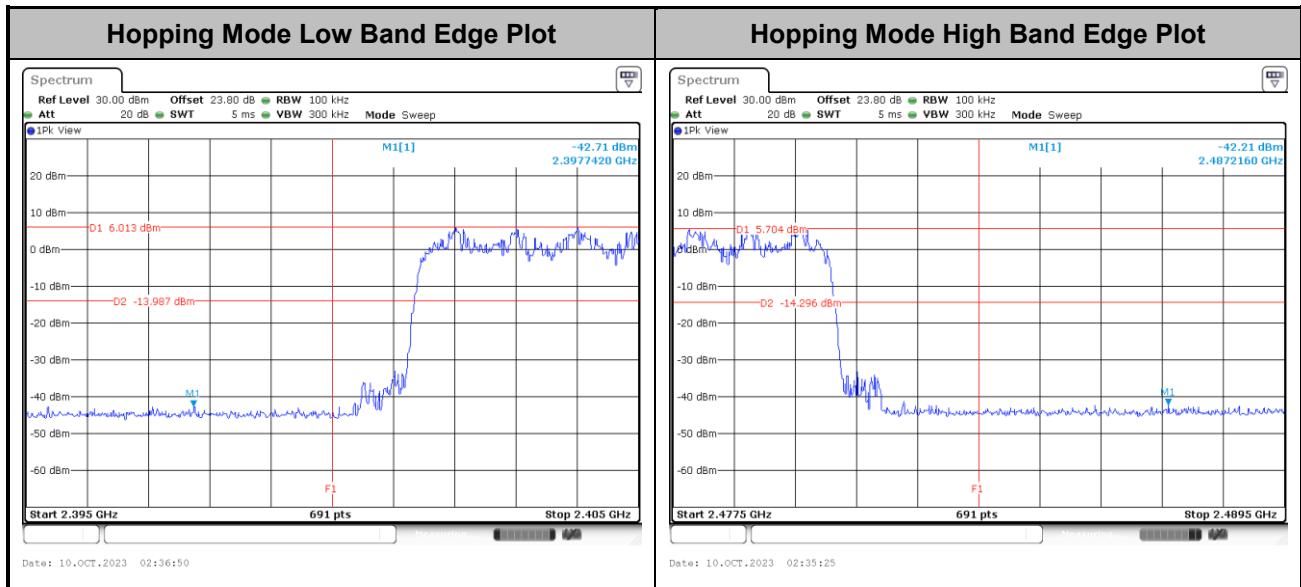


Hopping Mode Band Edges

<1Mbps>

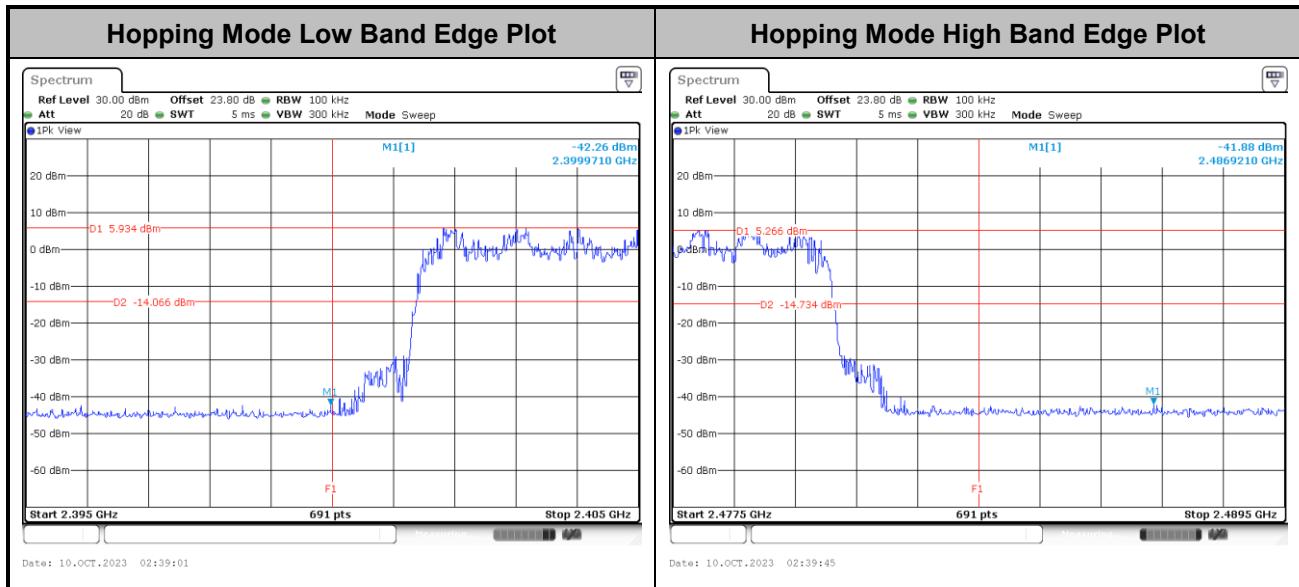


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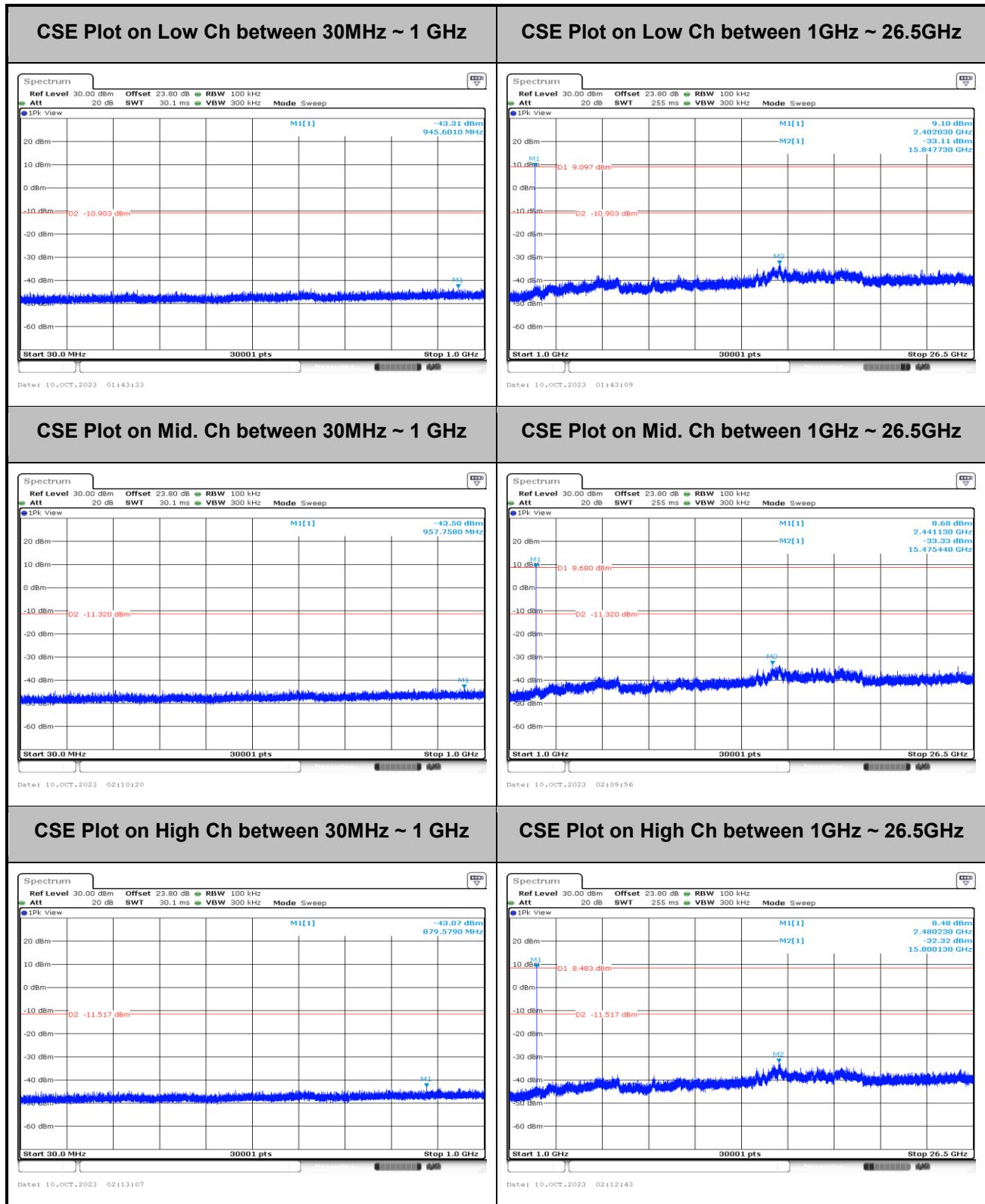


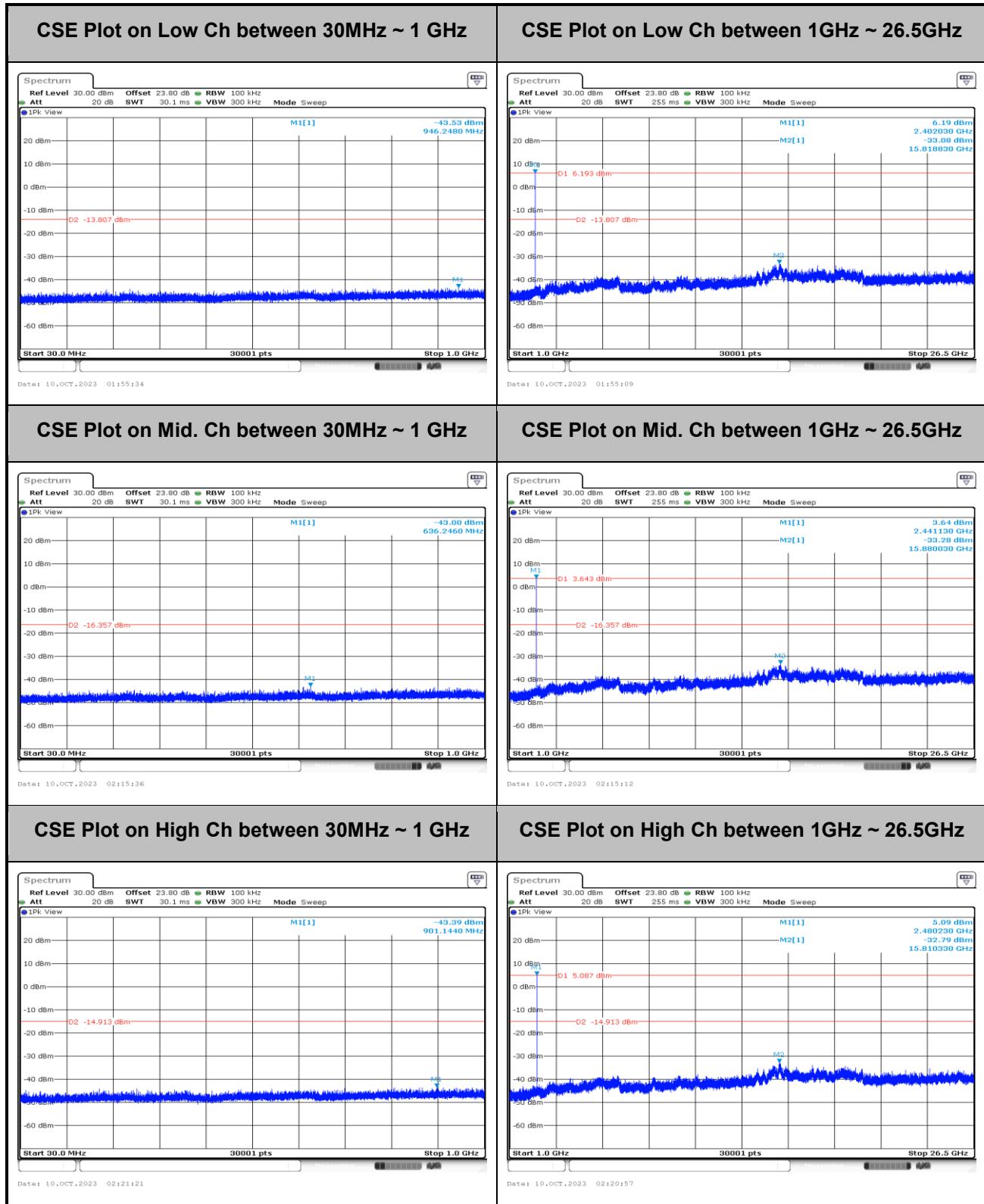
<3Mbps>



Conducted Spurious Emission

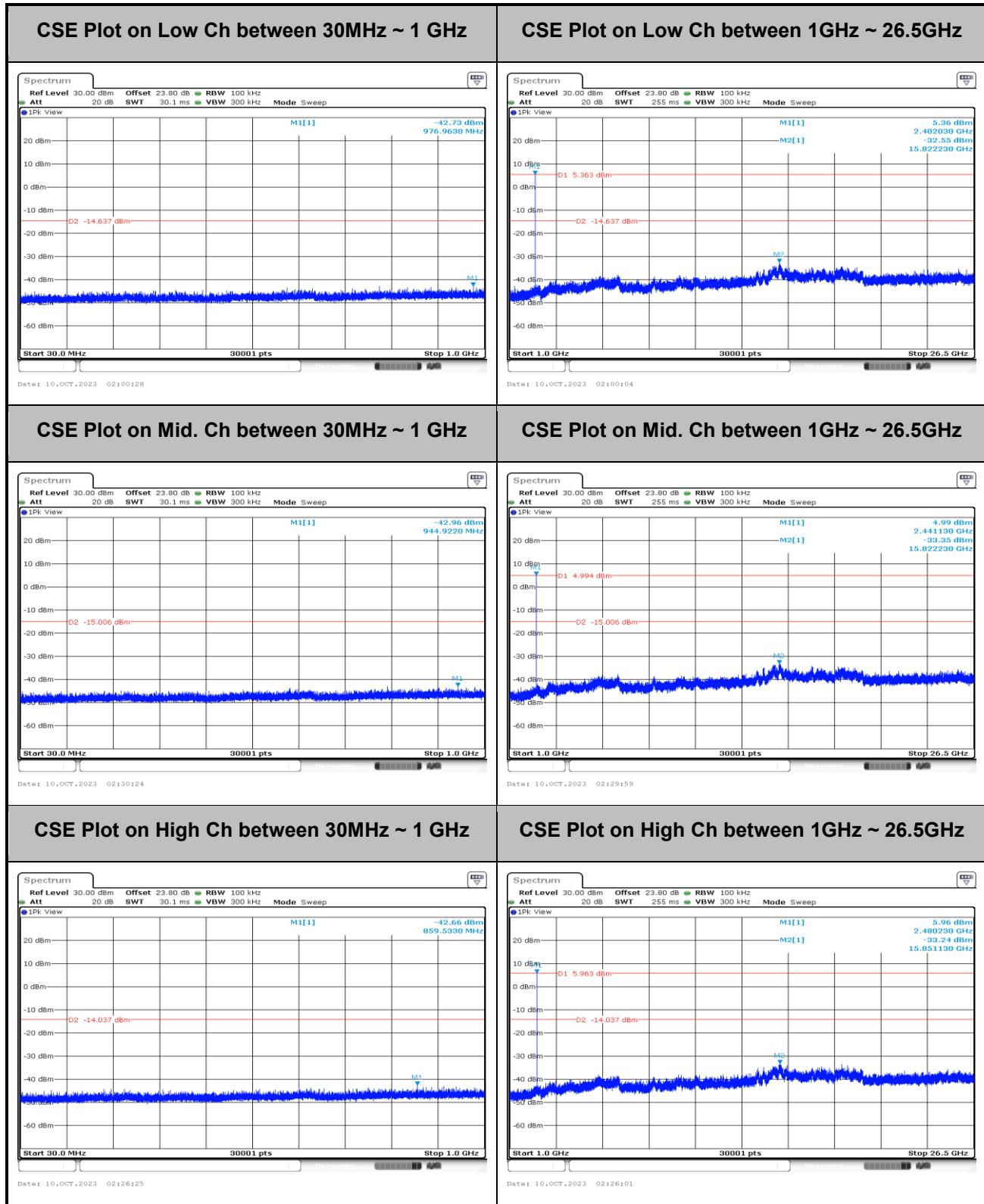
<1Mbps



<2Mbps>




<3Mbps>





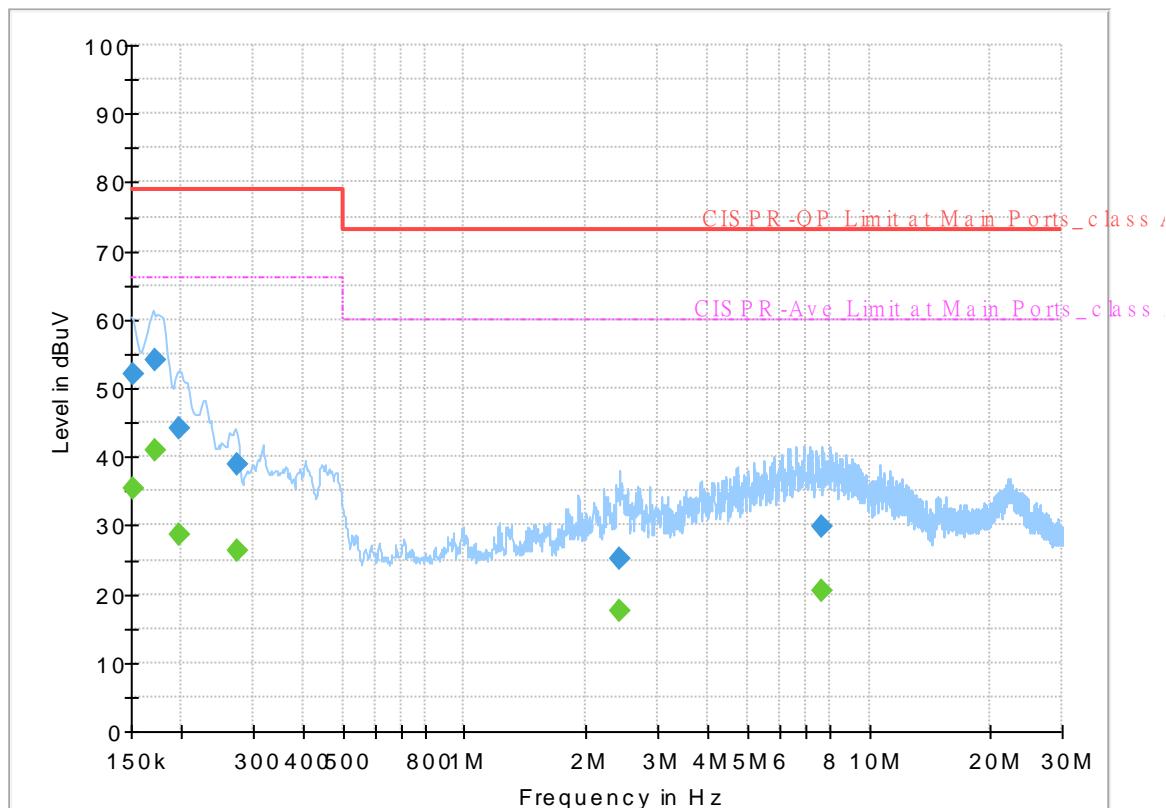
Appendix B. AC Conducted Emission Test Results

| | | | |
|------------------------|-------------|----------------------------|---------|
| Test Engineer : | Calvin Wang | Temperature : | 23~26°C |
| | | Relative Humidity : | 45~55% |

EUT Information

Report NO : 381616
 Test Mode : Mode 1
 Test Voltage : 120Vac/60Hz
 Phase : Line

Full Spectrum



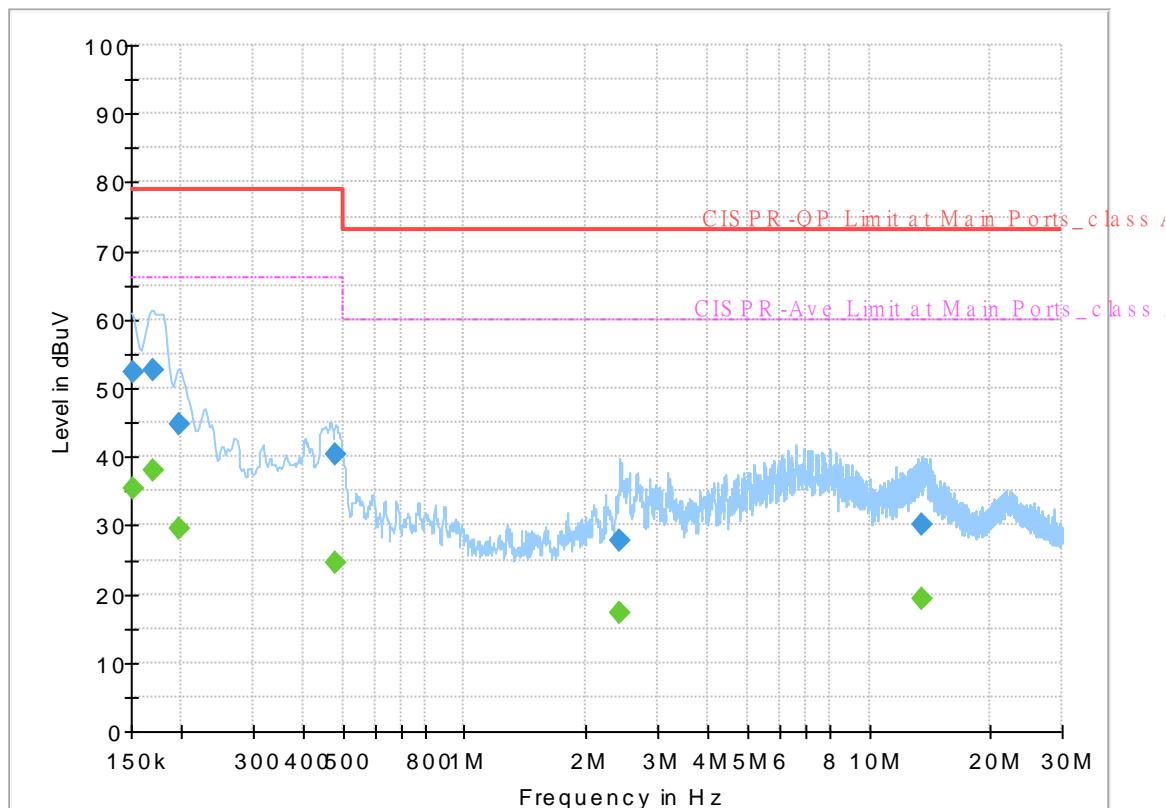
Final Result

| Frequency (MHz) | QuasiPeak (dBuV) | CAverage (dBuV) | Limit (dBuV) | Margin (dB) | Line | Filter | Corr. (dB) |
|-----------------|------------------|-----------------|--------------|-------------|------|--------|------------|
| 0.152250 | --- | 35.31 | 66.00 | 30.69 | L1 | OFF | 19.8 |
| 0.152250 | 52.01 | --- | 79.00 | 26.99 | L1 | OFF | 19.8 |
| 0.172500 | --- | 40.79 | 66.00 | 25.21 | L1 | OFF | 19.8 |
| 0.172500 | 53.95 | --- | 79.00 | 25.05 | L1 | OFF | 19.8 |
| 0.197250 | --- | 28.66 | 66.00 | 37.34 | L1 | OFF | 19.8 |
| 0.197250 | 44.05 | --- | 79.00 | 34.95 | L1 | OFF | 19.8 |
| 0.273750 | --- | 26.38 | 66.00 | 39.62 | L1 | OFF | 19.8 |
| 0.273750 | 38.87 | --- | 79.00 | 40.13 | L1 | OFF | 19.8 |
| 2.413500 | --- | 17.45 | 60.00 | 42.55 | L1 | OFF | 19.9 |
| 2.413500 | 25.25 | --- | 73.00 | 47.75 | L1 | OFF | 19.9 |
| 7.669500 | --- | 20.40 | 60.00 | 39.60 | L1 | OFF | 19.9 |
| 7.669500 | 29.72 | --- | 73.00 | 43.28 | L1 | OFF | 19.9 |

EUT Information

Report NO : 381616
 Test Mode : Mode 1
 Test Voltage : 120Vac/60Hz
 Phase : Neutral

Full Spectrum



Final Result

| Frequency (MHz) | QuasiPeak (dBuV) | CAverage (dBuV) | Limit (dBuV) | Margin (dB) | Line | Filter | Corr. (dB) |
|-----------------|------------------|-----------------|--------------|-------------|------|--------|------------|
| 0.152250 | --- | 35.33 | 66.00 | 30.67 | N | OFF | 19.8 |
| 0.152250 | 52.40 | --- | 79.00 | 26.60 | N | OFF | 19.8 |
| 0.170250 | --- | 37.87 | 66.00 | 28.13 | N | OFF | 19.8 |
| 0.170250 | 52.76 | --- | 79.00 | 26.24 | N | OFF | 19.8 |
| 0.197250 | --- | 29.56 | 66.00 | 36.44 | N | OFF | 19.8 |
| 0.197250 | 44.67 | --- | 79.00 | 34.33 | N | OFF | 19.8 |
| 0.478500 | --- | 24.64 | 66.00 | 41.36 | N | OFF | 19.8 |
| 0.478500 | 40.34 | --- | 79.00 | 38.66 | N | OFF | 19.8 |
| 2.413500 | --- | 17.26 | 60.00 | 42.74 | N | OFF | 19.8 |
| 2.413500 | 27.92 | --- | 73.00 | 45.08 | N | OFF | 19.8 |
| 13.506000 | --- | 19.26 | 60.00 | 40.74 | N | OFF | 20.0 |
| 13.506000 | 30.12 | --- | 73.00 | 42.88 | N | OFF | 20.0 |



Appendix C. Radiated Spurious Emission

| | | | |
|------------------------|-----------------------------------|----------------------------|-------------|
| Test Engineer : | Jesse Wang, Stan Hsieh and Ken Wu | Temperature : | 23.2~27.6°C |
| | | Relative Humidity : | 42.5~74.0% |



<Sample 2>

<Internal Antenna>

2.4GHz 2400~2483.5MHz

BT (Band Edge @ 3m)

| BT | Note | Frequency (MHz) | Level (dB μ V/m) | Margin (dB) | Limit Line (dB μ V/m) | Read Level (dB μ V) | Antenna Factor (dB/m) | Path Loss (dB) | Preamp Factor (dB) | Ant Pos (cm) | Table Pos (deg) | Peak Avg. (P/A) | Pol. (H/V) |
|------------------------|------|----------------------|---------------------------|------------------|-----------------------------------|---------------------------------|-------------------------------|------------------------|----------------------------|----------------------|-------------------------|-----------------------|---------------|
| BT CH00 2402MHz | | 2346.96 | 45.43 | -28.57 | 74 | 39.48 | 32.08 | 8.06 | 34.19 | 102 | 298 | P | H |
| | | 2346.96 | 20.67 | -33.33 | 54 | - | - | - | - | - | - | A | H |
| | * | 2402 | 106.13 | - | - | 100.03 | 32.1 | 8.2 | 34.2 | 102 | 298 | P | H |
| | | 2402 | 81.37 | 27.37 | 54 | - | - | - | - | - | - | A | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | 2339.295 | 45.24 | -28.76 | 74 | 39.34 | 32.04 | 8.05 | 34.19 | 128 | 15 | P | V |
| | | 2339.295 | 20.48 | -33.52 | 54 | - | - | - | - | - | - | A | V |
| | * | 2402 | 104.21 | - | - | 98.11 | 32.1 | 8.2 | 34.2 | 128 | 15 | P | V |
| | | 2402 | 79.45 | 25.45 | 54 | - | - | - | - | - | - | A | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| BT CH 39 2441MHz | | 2332.82 | 45.21 | -28.79 | 74 | 39.37 | 32 | 8.03 | 34.19 | 106 | 300 | P | H |
| | | 2332.82 | 20.45 | -33.55 | 54 | - | - | - | - | - | - | A | H |
| | * | 2441 | 106.85 | - | - | 100.76 | 32.02 | 8.28 | 34.21 | 106 | 300 | P | H |
| | * | 2441 | 82.09 | - | - | - | - | - | - | - | - | A | H |
| | | 2489.43 | 45.09 | -28.91 | 74 | 38.93 | 32 | 8.38 | 34.22 | 106 | 300 | P | H |
| | | 2489.43 | 20.33 | -33.67 | 54 | - | - | - | - | - | - | A | H |
| | | 2380.28 | 45.49 | -28.51 | 74 | 39.44 | 32.1 | 8.15 | 34.2 | 126 | 18 | P | V |
| | | 2380.28 | 20.73 | -33.27 | 54 | - | - | - | - | - | - | A | V |
| | * | 2441 | 103.95 | - | - | 97.86 | 32.02 | 8.28 | 34.21 | 126 | 18 | P | V |
| | * | 2441 | 79.19 | - | - | - | - | - | - | - | - | A | V |
| | | 2492.72 | 45.54 | -28.46 | 74 | 39.37 | 32 | 8.39 | 34.22 | 126 | 18 | P | V |
| | | 2492.72 | 20.78 | -33.22 | 54 | - | - | - | - | - | - | A | V |



| BT CH 78 2480MHz | * | 2480 | 105.49 | - | - | 99.35 | 32 | 8.36 | 34.22 | 340 | 294 | P | H |
|------------------------|---|---------|--------|--------|----|-------|----|------|-------|-----|-----|---|---|
| | * | 2480 | 80.73 | - | - | - | - | - | - | - | - | A | H |
| | | 2487.88 | 49.83 | -24.17 | 74 | 43.67 | 32 | 8.38 | 34.22 | 340 | 294 | P | H |
| | | 2487.88 | 25.07 | -28.93 | 54 | - | - | - | - | - | - | A | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | * | 2480 | 104.04 | - | - | 97.9 | 32 | 8.36 | 34.22 | 100 | 29 | P | V |
| | * | 2480 | 79.28 | - | - | - | - | - | - | - | - | A | V |
| | | 2483.52 | 50.56 | -23.44 | 74 | 44.41 | 32 | 8.37 | 34.22 | 100 | 29 | P | V |
| | | 2483.52 | 25.8 | -28.2 | 54 | - | - | - | - | - | - | A | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| Remark | 1. No other spurious found. 2. All results are PASS against Peak and Average limit line. | | | | | | | | | | | | |



2.4GHz 2400~2483.5MHz

BT (Harmonic @ 3m)



| BT | Note | Frequency (MHz) | Level (dB μ V/m) | Margin (dB) | Limit Line (dB μ V/m) | Read Level (dB μ V) | Antenna Factor (dB/m) | Path Loss (dB) | Preamp Factor (dB) | Ant Pos (cm) | Table Pos (deg) | Peak Avg. (P/A) | Pol. (H/V) |
|------------------------|------|----------------------|---------------------------|------------------|-----------------------------------|---------------------------------|-------------------------------|------------------------|----------------------------|----------------------|-------------------------|-----------------------|---------------|
| BT CH 39 2441MHz | | 4882 | 49.6 | -24.4 | 74 | 61.51 | 34.14 | 12.86 | 58.91 | 400 | 311 | P | H |
| | | 4882 | 24.84 | -29.16 | 54 | - | - | - | - | - | - | A | H |
| | | 7323 | 43.49 | -30.51 | 74 | 50.18 | 35.7 | 15.19 | 57.58 | - | - | P | H |
| | | 7323 | 18.73 | -35.27 | 54 | - | - | - | - | - | - | A | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | 4882 | 47.83 | -26.17 | 74 | 59.74 | 34.14 | 12.86 | 58.91 | 100 | 65 | P | V |
| | | 4882 | 23.07 | -30.93 | 54 | - | - | - | - | - | - | A | V |
| | | 7323 | 42.94 | -31.06 | 74 | 49.63 | 35.7 | 15.19 | 57.58 | - | - | P | V |
| | | 7323 | 18.18 | -35.82 | 54 | - | - | - | - | - | - | A | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |



| BT | Note | Frequency (MHz) | Level (dB μ V/m) | Margin (dB) | Limit Line (dB μ V/m) | Read Level (dB μ V) | Antenna Factor (dB/m) | Path Loss (dB) | Preamp Factor (dB) | Ant Pos (cm) | Table Pos (deg) | Peak Avg. (P/A) | Pol. (H/V) |
|------------------------|------|--|---------------------------|------------------|-----------------------------------|---------------------------------|-------------------------------|------------------------|----------------------------|----------------------|-------------------------|-----------------------|---------------|
| BT CH 78 2480MHz | | 4960 | 40.68 | -33.32 | 74 | 52.23 | 34.3 | 12.93 | 58.78 | - | - | P | H |
| | | 4960 | 15.92 | -38.08 | 54 | - | - | - | - | - | - | A | H |
| | | 7440 | 41.1 | -32.9 | 74 | 47.95 | 35.6 | 15.25 | 57.7 | - | - | P | H |
| | | 7440 | 16.34 | -37.66 | 54 | - | - | - | | | | A | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| Remark | 1. | No other spurious found. | | | | | | | | | | | |
| | 2. | All results are PASS against Peak and Average limit line. | | | | | | | | | | | |
| | 3. | The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only. | | | | | | | | | | | |



Emission below 1GHz

2.4GHz BT (LF)



<External Antenna>

2.4GHz 2400~2483.5MHz

BT (Band Edge @ 3m)

| BT | Note | Frequency | Level | Margin | Limit Line | Read Level | Antenna Factor | Path Loss | Preamp Factor | Ant Pos | Table Pos | Peak Avg. | Pol. |
|------------------------|------|-----------|------------------|--------|------------------|----------------|----------------|-----------|---------------|---------|-----------|-----------|-------|
| | | (MHz) | (dB μ V/m) | (dB) | (dB μ V/m) | (dB μ V) | (dB/m) | (dB) | (dB) | (cm) | (deg) | (P/A) | (H/V) |
| BT CH00 2402MHz | | 2385.81 | 45.54 | -28.46 | 74 | 39.48 | 32.1 | 8.16 | 34.2 | 135 | 280 | P | H |
| | | 2385.81 | 20.78 | -33.22 | 54 | - | - | - | - | - | - | A | H |
| | * | 2402 | 109.76 | - | - | 103.66 | 32.1 | 8.2 | 34.2 | 135 | 280 | P | H |
| | * | 2402 | 85 | - | - | - | - | - | - | - | - | A | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | 2311.68 | 45.83 | -28.17 | 74 | 40.17 | 31.87 | 7.97 | 34.18 | 100 | 202 | P | V |
| | | 2311.68 | 21.07 | -32.93 | 54 | - | - | - | - | - | - | A | V |
| | * | 2402 | 101.7 | - | - | 95.6 | 32.1 | 8.2 | 34.2 | 100 | 202 | P | V |
| | * | 2402 | 76.94 | - | - | - | - | - | - | - | - | A | V |
| | | | | | | | | | | | | | V |
| BT CH 39 2441MHz | | 2355.64 | 45.55 | -28.45 | 74 | 39.55 | 32.1 | 8.09 | 34.19 | 400 | 292 | P | H |
| | | 2355.64 | 20.79 | -33.21 | 54 | - | - | - | - | - | - | A | H |
| | * | 2441 | 109.54 | - | - | 103.45 | 32.02 | 8.28 | 34.21 | 400 | 292 | P | H |
| | * | 2441 | 84.78 | - | - | - | - | - | - | - | - | A | H |
| | | 2493.35 | 44.37 | -29.63 | 74 | 38.2 | 32 | 8.39 | 34.22 | 400 | 292 | P | H |
| | | 2493.35 | 19.61 | -34.39 | 54 | - | - | - | - | - | - | A | H |
| | | 2376.22 | 45.82 | -28.18 | 74 | 39.78 | 32.1 | 8.14 | 34.2 | 100 | 203 | P | V |
| | | 2376.22 | 21.06 | -32.94 | 54 | - | - | - | - | - | - | A | V |
| | * | 2441 | 101.92 | - | - | 95.83 | 32.02 | 8.28 | 34.21 | 100 | 203 | P | V |
| | * | 2441 | 77.16 | - | - | - | - | - | - | - | - | A | V |
| | | 2497.97 | 44.87 | -29.13 | 74 | 38.69 | 32 | 8.4 | 34.22 | 100 | 203 | P | V |
| | | 2497.97 | 20.11 | -33.89 | 54 | - | - | - | - | - | - | A | V |



| BT CH 78 2480MHz | * | 2480 | 108.94 | - | - | 102.8 | 32 | 8.36 | 34.22 | 387 | 276 | P | H |
|------------------------|---|---------|--------|--------|----|-------|----|------|-------|-----|-----|---|---|
| | | 2480 | 84.18 | 30.18 | 54 | - | - | - | - | - | - | A | H |
| | | 2483.6 | 52.67 | -21.33 | 74 | 46.52 | 32 | 8.37 | 34.22 | 387 | 276 | P | H |
| | | 2483.6 | 27.91 | -26.09 | 54 | - | - | - | - | - | - | A | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | * | 2480 | 100.48 | - | - | 94.34 | 32 | 8.36 | 34.22 | 388 | 179 | P | V |
| | | 2480 | 75.72 | 21.72 | 54 | - | - | - | - | - | - | A | V |
| | | 2488.24 | 46.17 | -27.83 | 74 | 40.01 | 32 | 8.38 | 34.22 | 388 | 179 | P | V |
| | | 2488.24 | 21.41 | -32.59 | 54 | - | - | - | - | - | - | A | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| Remark | 1. No other spurious found. 2. All results are PASS against Peak and Average limit line. | | | | | | | | | | | | |



2.4GHz 2400~2483.5MHz

BT (Harmonic @ 3m)



| BT | Note | Frequency (MHz) | Level (dB μ V/m) | Margin (dB) | Limit Line (dB μ V/m) | Read Level (dB μ V) | Antenna Factor (dB/m) | Path Loss (dB) | Preamp Factor (dB) | Ant Pos (cm) | Table Pos (deg) | Peak Avg. (P/A) | Pol. (H/V) |
|------------------------|------|----------------------|---------------------------|------------------|-----------------------------------|---------------------------------|-------------------------------|------------------------|----------------------------|----------------------|-------------------------|-----------------------|---------------|
| BT CH 39 2441MHz | | 4882 | 50.28 | -23.72 | 74 | 62.19 | 34.14 | 12.86 | 58.91 | 400 | 88 | P | H |
| | | 4882 | 25.52 | -28.48 | 54 | - | - | - | - | - | - | A | H |
| | | 7323 | 42.62 | -31.38 | 74 | 49.31 | 35.7 | 15.19 | 57.58 | - | - | P | H |
| | | 7323 | 17.86 | -36.14 | 54 | - | - | - | - | - | - | A | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | 4882 | 48.68 | -25.32 | 74 | 60.59 | 34.14 | 12.86 | 58.91 | 400 | 345 | P | V |
| | | 4882 | 23.92 | -30.08 | 54 | - | - | - | - | - | - | A | V |
| | | 7323 | 42.44 | -31.56 | 74 | 49.13 | 35.7 | 15.19 | 57.58 | - | - | P | V |
| | | 7323 | 17.68 | -36.32 | 54 | - | - | - | - | - | - | A | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | V |



| BT | Note | Frequency (MHz) | Level (dB μ V/m) | Margin (dB) | Limit Line (dB μ V/m) | Read Level (dB μ V) | Antenna Factor (dB/m) | Path Loss (dB) | Preamp Factor (dB) | Ant Pos (cm) | Table Pos (deg) | Peak Avg. (P/A) | Pol. (H/V) |
|------------------------|------|--|---------------------------|------------------|-----------------------------------|---------------------------------|-------------------------------|------------------------|----------------------------|----------------------|-------------------------|-----------------------|---------------|
| BT CH 78 2480MHz | | 4960 | 45.16 | -28.84 | 74 | 56.71 | 34.3 | 12.93 | 58.78 | 100 | 270 | P | H |
| | | 4960 | 20.4 | -33.6 | 54 | - | - | - | - | - | - | A | H |
| | | 7440 | 41.97 | -32.03 | 74 | 48.82 | 35.6 | 15.25 | 57.7 | - | - | P | H |
| | | 7440 | 17.21 | -36.79 | 54 | - | - | - | - | - | - | A | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | V |
| Remark | 1. | No other spurious found. | | | | | | | | | | | |
| | 2. | All results are PASS against Peak and Average limit line. | | | | | | | | | | | |
| | 3. | The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only. | | | | | | | | | | | |



Emission below 1GHz

2.4GHz BT (LF)

| BT | Note | Frequency | Level | Margin | Limit | Read | Antenna | Path | Preamp | Ant | Table | Peak | Pol. | | | |
|--------------------|--------|-----------|---|--------|-------|-------|---------|------|--------|-----|-------|--------|--------|--------|---------|---------|
| | | | | | | | | | | | | Line | Level | Factor | | |
| | | | | | | | | | | | | (dB) | (dB) | (cm) | (deg) | (P/A) |
| 2.4GHz BT LF | | 48.36 | 28.05 | -11.95 | 40 | 41.58 | 15.04 | 1.35 | 29.92 | - | - | P | H | | | |
| | | 179.58 | 29.14 | -14.36 | 43.5 | 41.48 | 15.07 | 2.42 | 29.83 | - | - | P | H | | | |
| | | 229.53 | 32.9 | -13.1 | 46 | 43.91 | 16.24 | 2.57 | 29.82 | - | - | P | H | | | |
| | | 878.9 | 32.25 | -13.75 | 46 | 27.06 | 28.88 | 5.29 | 28.98 | - | - | P | H | | | |
| | | 932.8 | 34.16 | -11.84 | 46 | 28.1 | 29.32 | 5.48 | 28.74 | - | - | P | H | | | |
| | | 975.5 | 34.29 | -19.71 | 54 | 26.42 | 30.73 | 5.58 | 28.44 | - | - | P | H | | | |
| | | | | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | | | | H |
| | | | | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | | | | V |
| | | | | | | | | | | | | | | | | V |
| | Remark | 1. | No other spurious found. | | | | | | | | | | | | | |
| | | 2. | All results are PASS against limit line. | | | | | | | | | | | | | |
| | | 3. | The emission position marked as “-” means no suspected emission found and emission level has at least 6dB margin against limit or emission is noise floor only. | | | | | | | | | | | | | |

**Note symbol**

| | |
|-----|--|
| * | Fundamental Frequency which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency. |
| ! | Test result is Margin line. |
| P/A | Peak or Average |
| H/V | Horizontal or Vertical |

**A calculation example for radiated spurious emission is shown as below:**

| BT | Note | Frequency | Level | Margin | Limit | Read | Antenna | Path | Preamp | Ant | Table | Peak | Pol. |
|---------------------------------|------|-----------|------------------|--------|------------------|----------------|----------|--------|--------|--------|---------|---------|---------|
| | | | | Line | Level | Factor | Loss | Factor | Pos | Pos | Avg. | | |
| | | (MHz) | (dB μ V/m) | (dB) | (dB μ V/m) | (dB μ V) | (dB/m) | (dB) | (dB) | (cm) | (deg) | (P/A) | (H/V) |
| BT CH 00 2402MHz | | 2390 | 55.45 | -18.55 | 74 | 54.51 | 32.22 | 4.58 | 35.86 | 103 | 308 | P | H |

1. Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)

2. Level(dB μ V/m) =

Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dB μ V) - Preamp Factor(dB)

3. Margin(dB) = Level(dB μ V/m) – Limit Line(dB μ V/m)

For Peak Limit @ 2390MHz:

1. Level(dB μ V/m)

= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dB μ V) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 54.51(dB μ V) – 35.86 (dB)

= 55.45 (dB μ V/m)

2. Margin(dB)

= Level(dB μ V/m) – Limit Line(dB μ V/m)

= 55.45(dB μ V/m) – 74(dB μ V/m)

= -18.55(dB)

Peak measured complies with the limit line, so test result is “PASS”.



Appendix D. Radiated Spurious Emission Plots

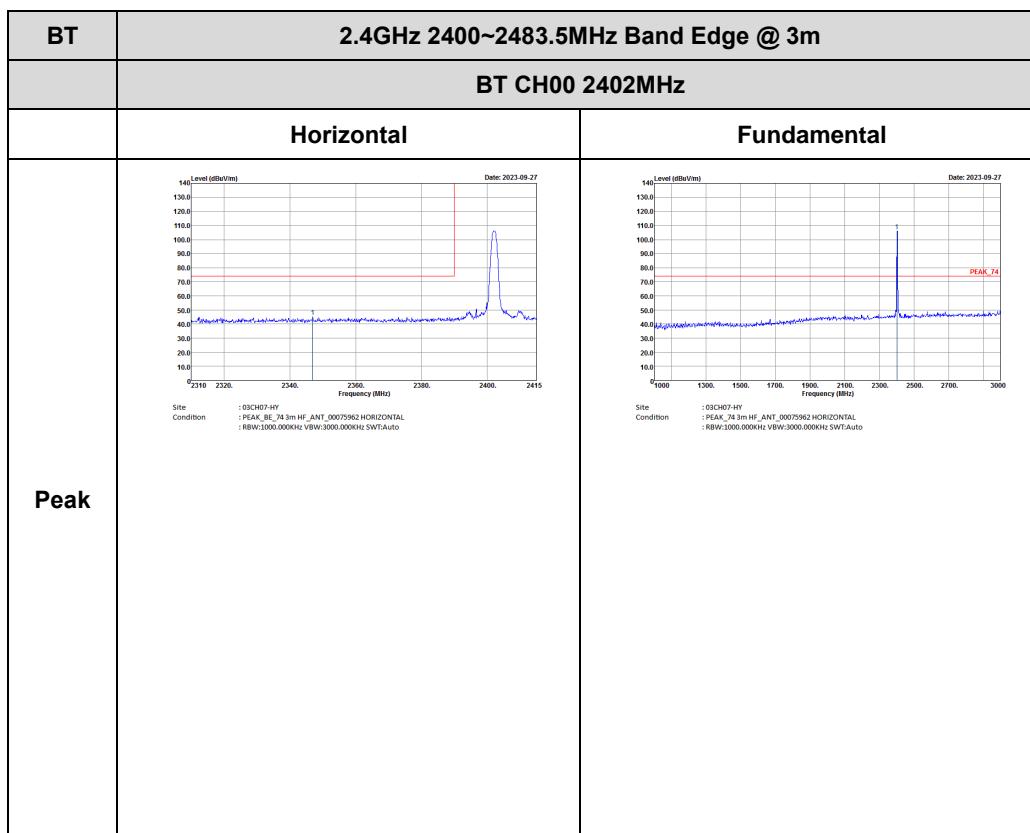
| | | | |
|------------------------|-----------------------------------|----------------------------|-------------|
| Test Engineer : | Jesse Wang, Stan Hsieh and Ken Wu | Temperature : | 23.2~27.6°C |
| | | Relative Humidity : | 42.5~74.0% |

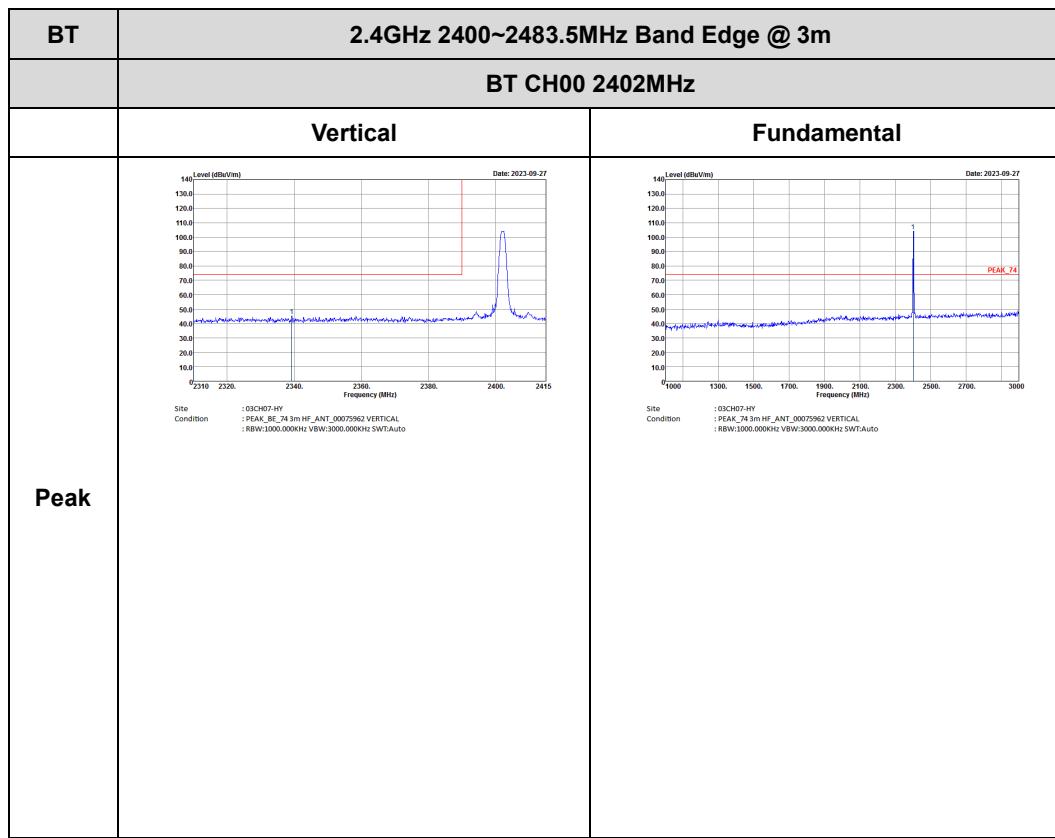
<Sample 2>

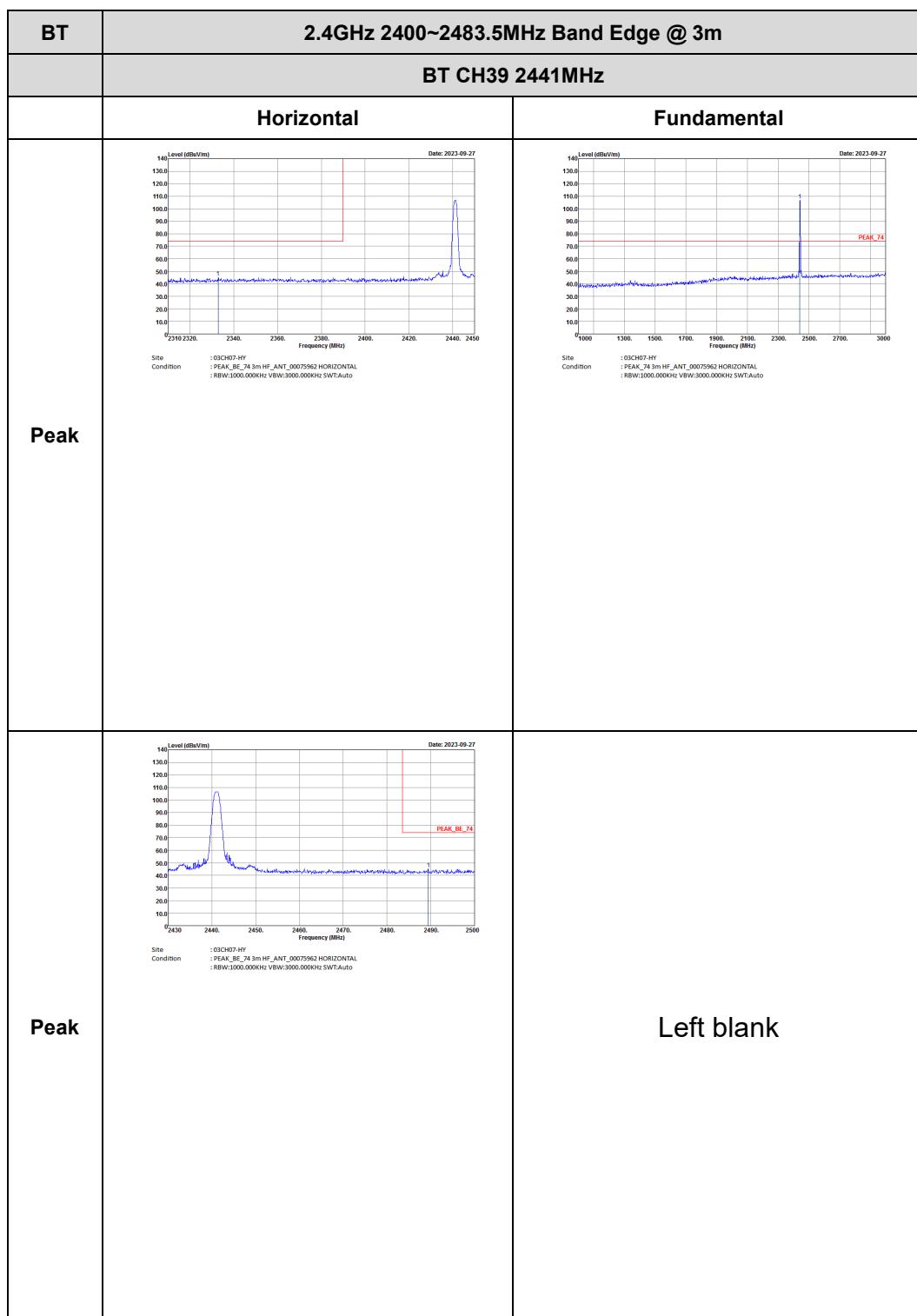
<Internal Antenna>

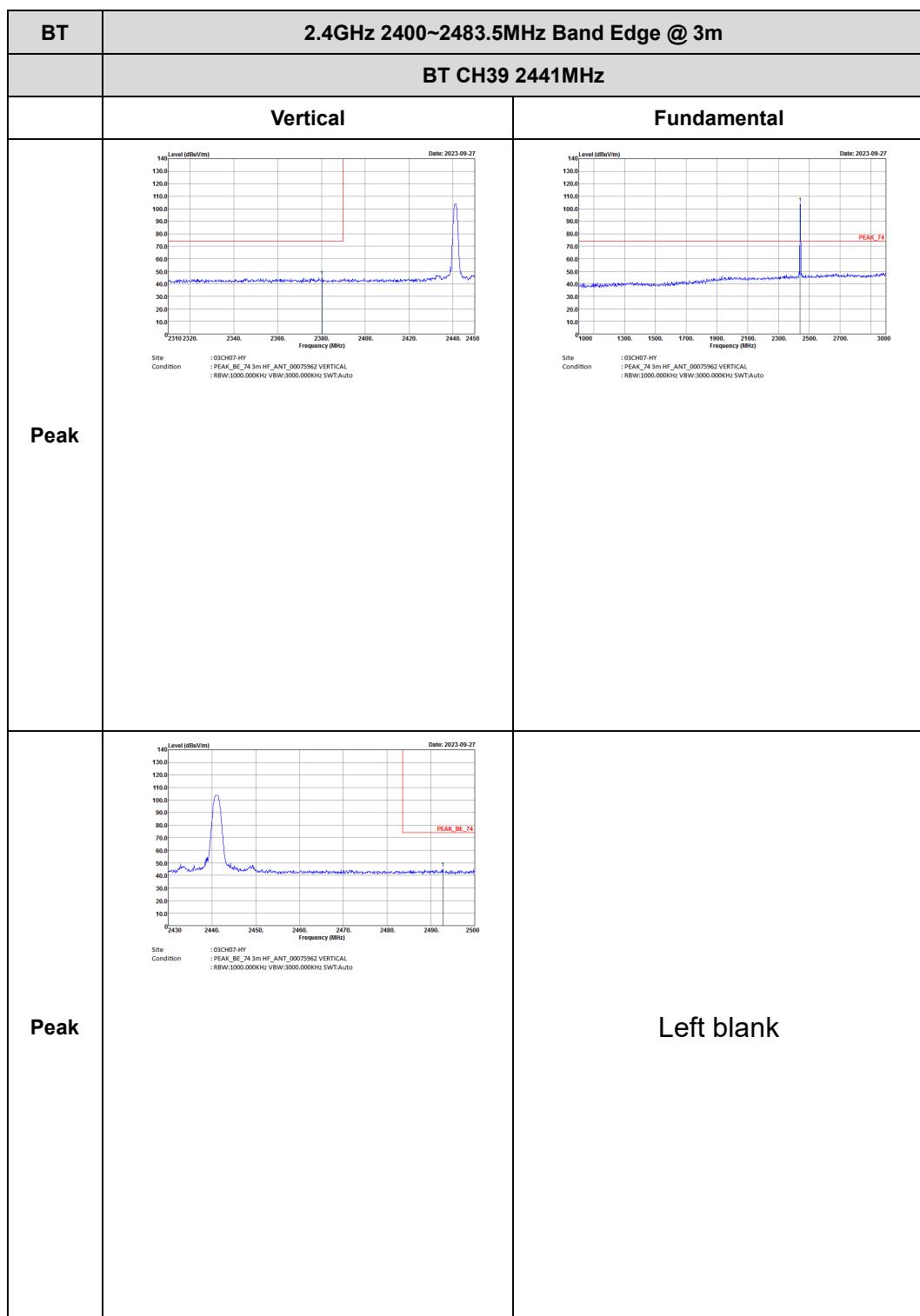
2.4GHz 2400~2483.5MHz

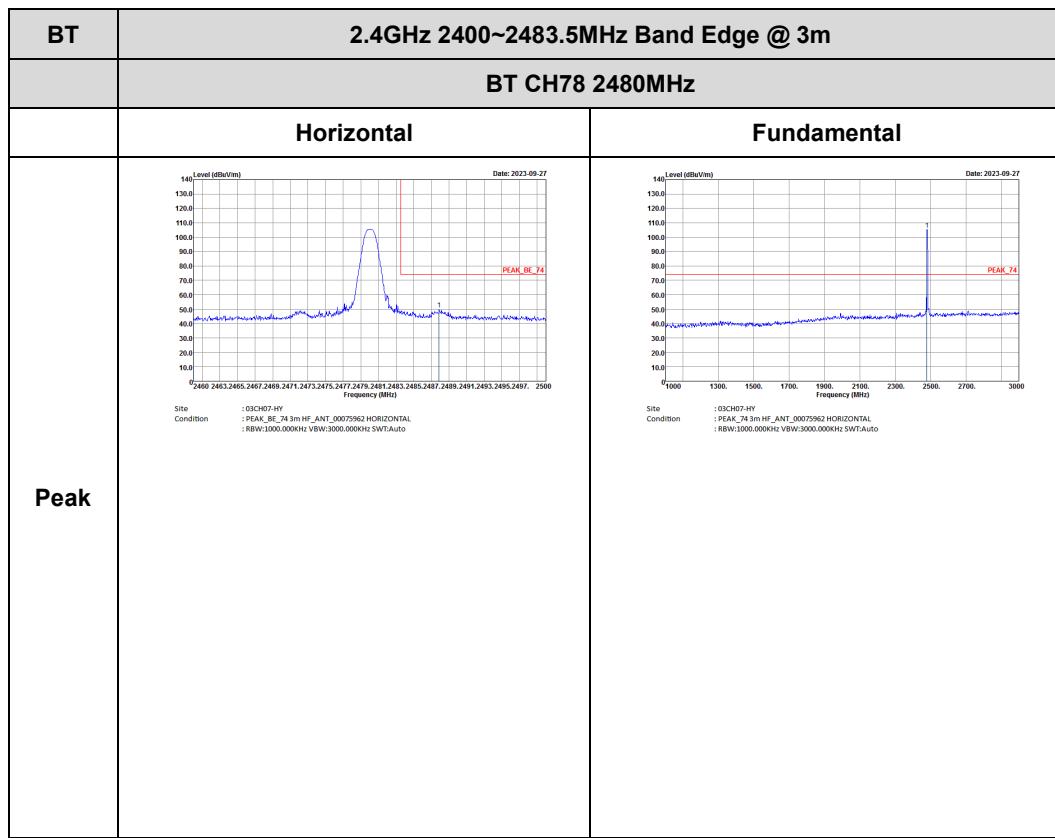
BT (Band Edge @ 3m)

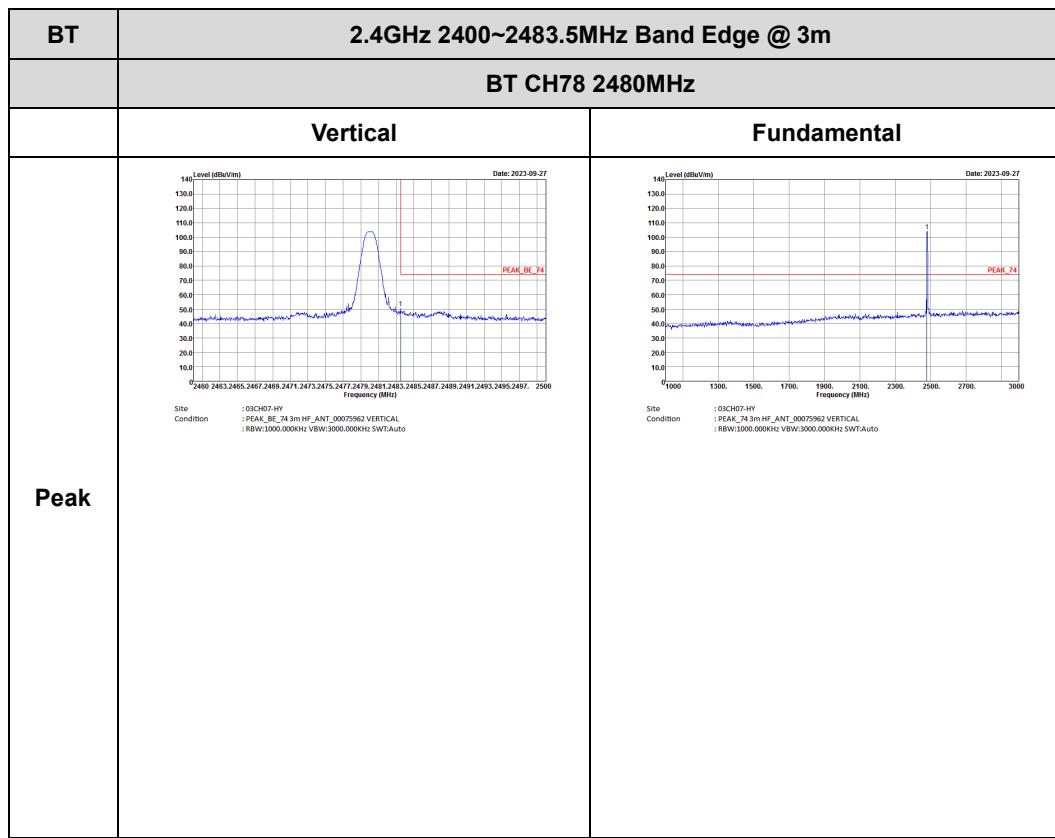








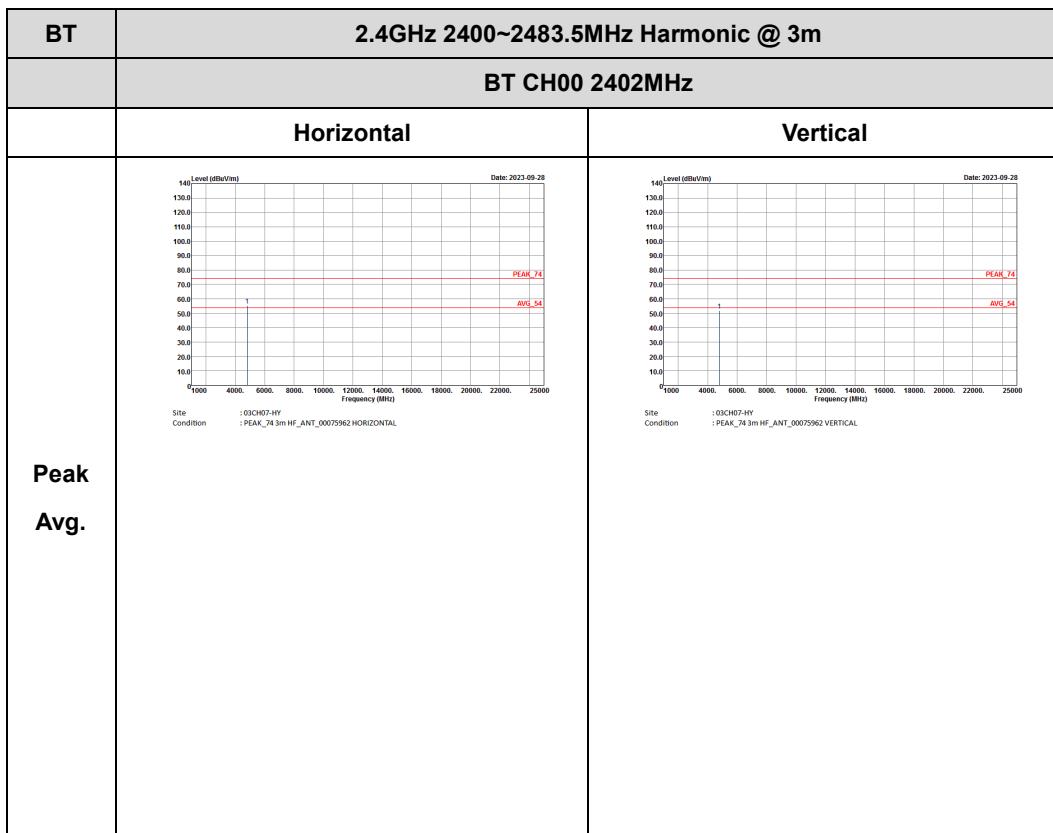


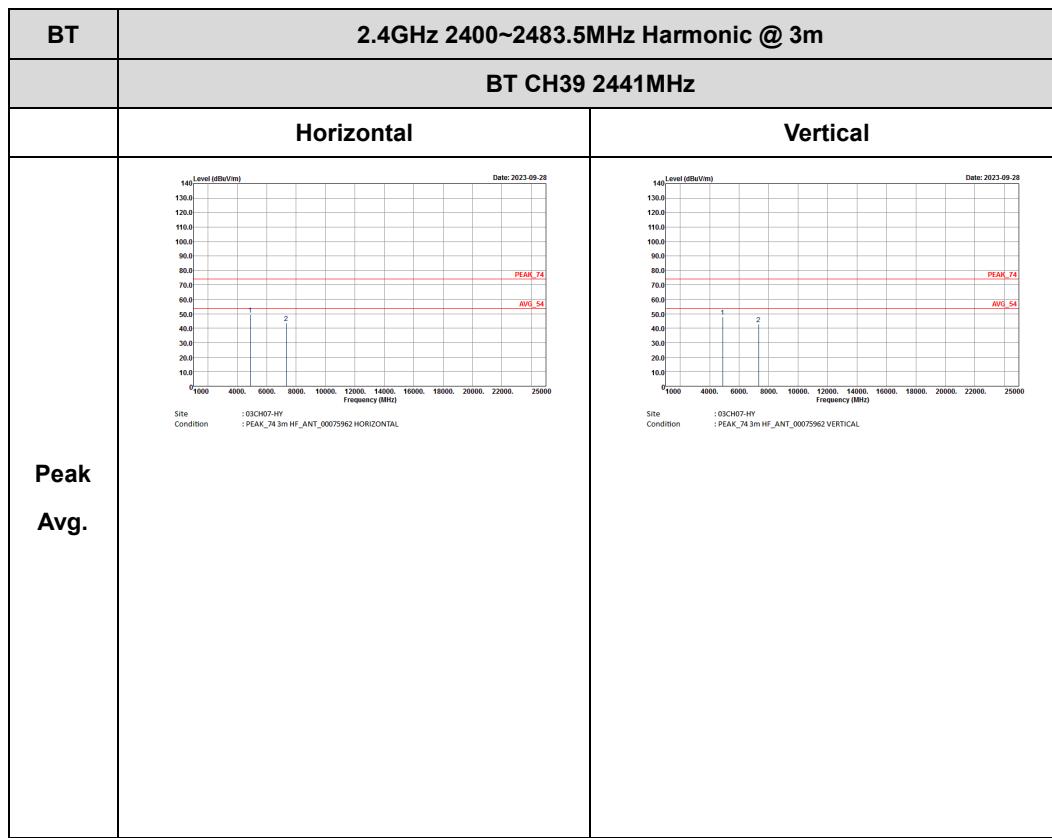


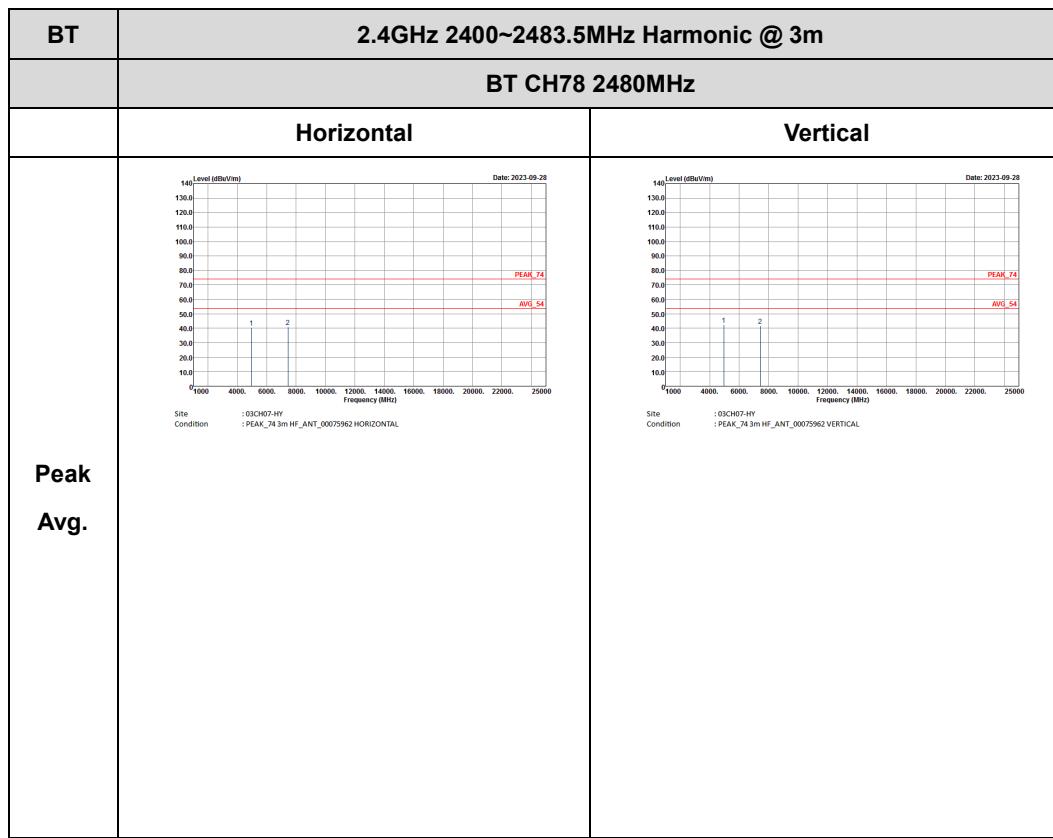


2.4GHz 2400~2483.5MHz

BT (Harmonic @ 3m)



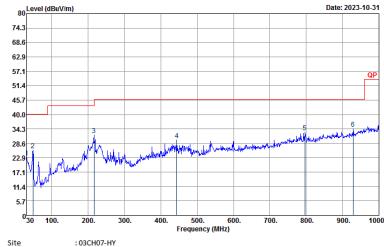
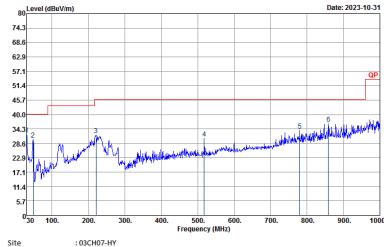






Emission below 1GHz

2.4GHz BT (LF)

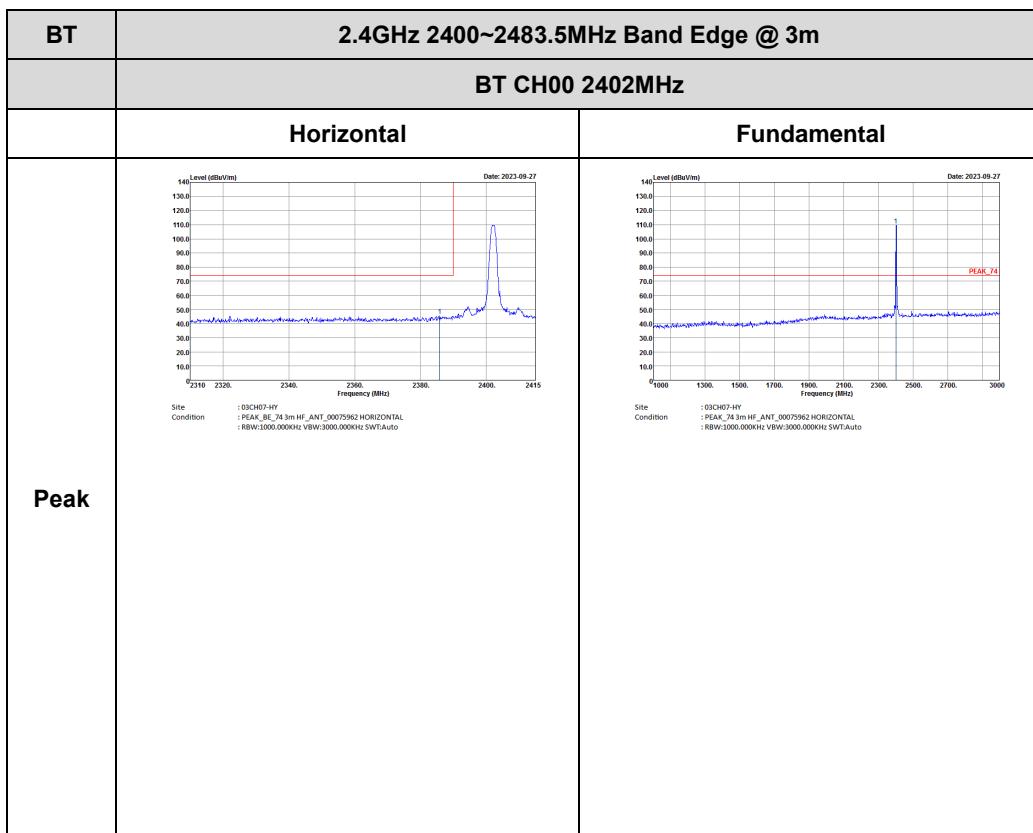
| BT | 2.4GHz 2400~2483.5MHz | |
|-----------|---|--|
| | BT LF | |
| | Horizontal | Vertical |
| QP / Peak |  Site : 000007-HY Condition : QP 3m LF-ANT-35419(6)_H HORIZONTAL |  Site : 000007-HY Condition : QP 3m LF-ANT-35419(6)_H VERTICAL |

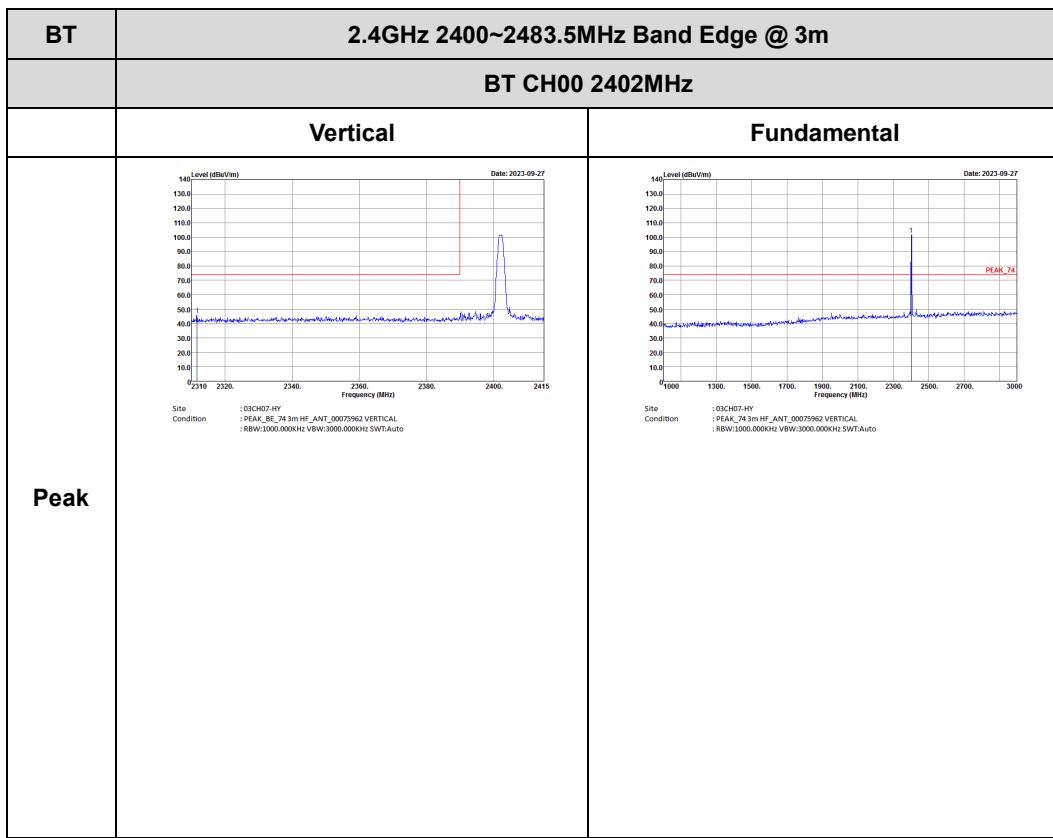


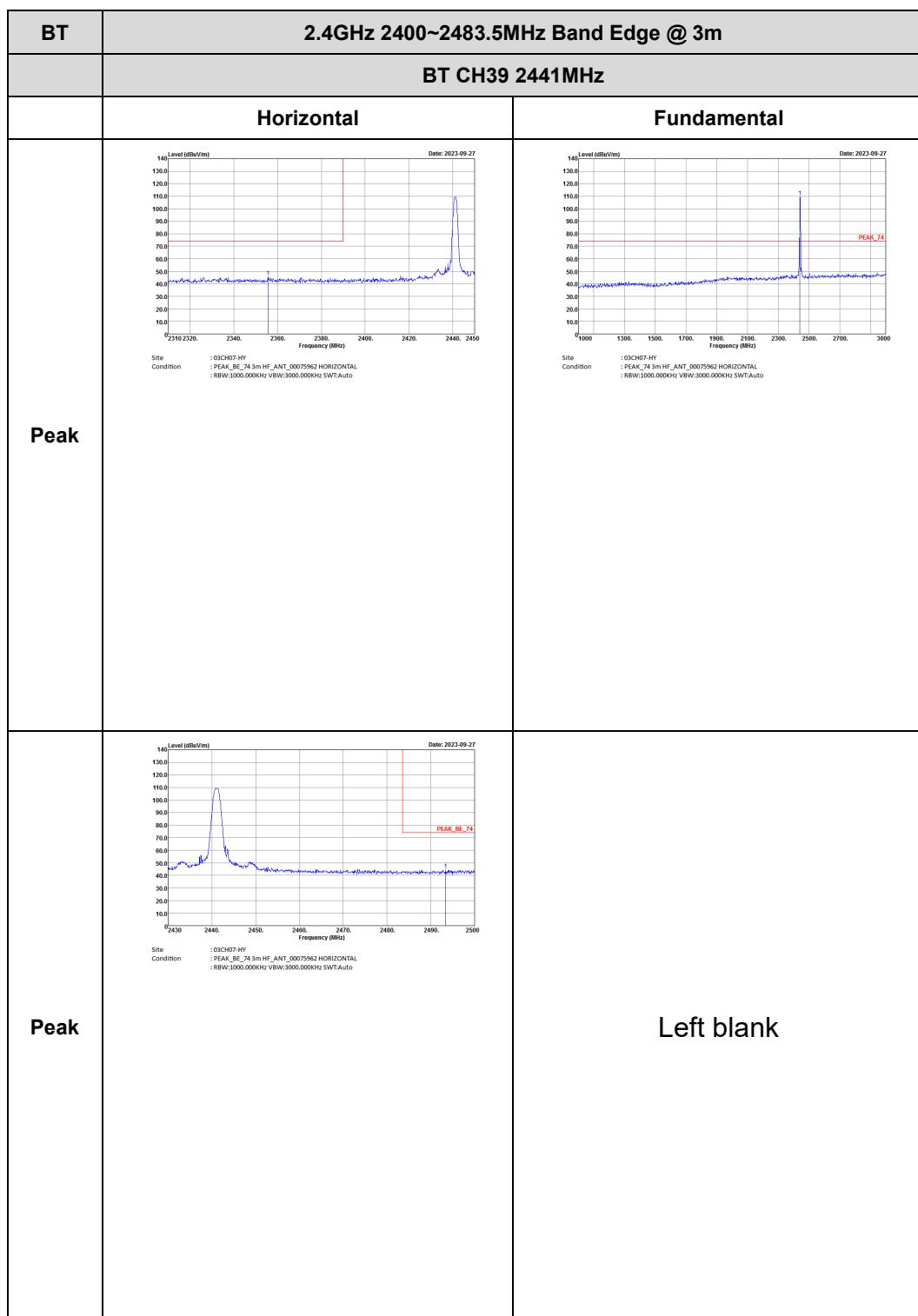
<External Antenna>

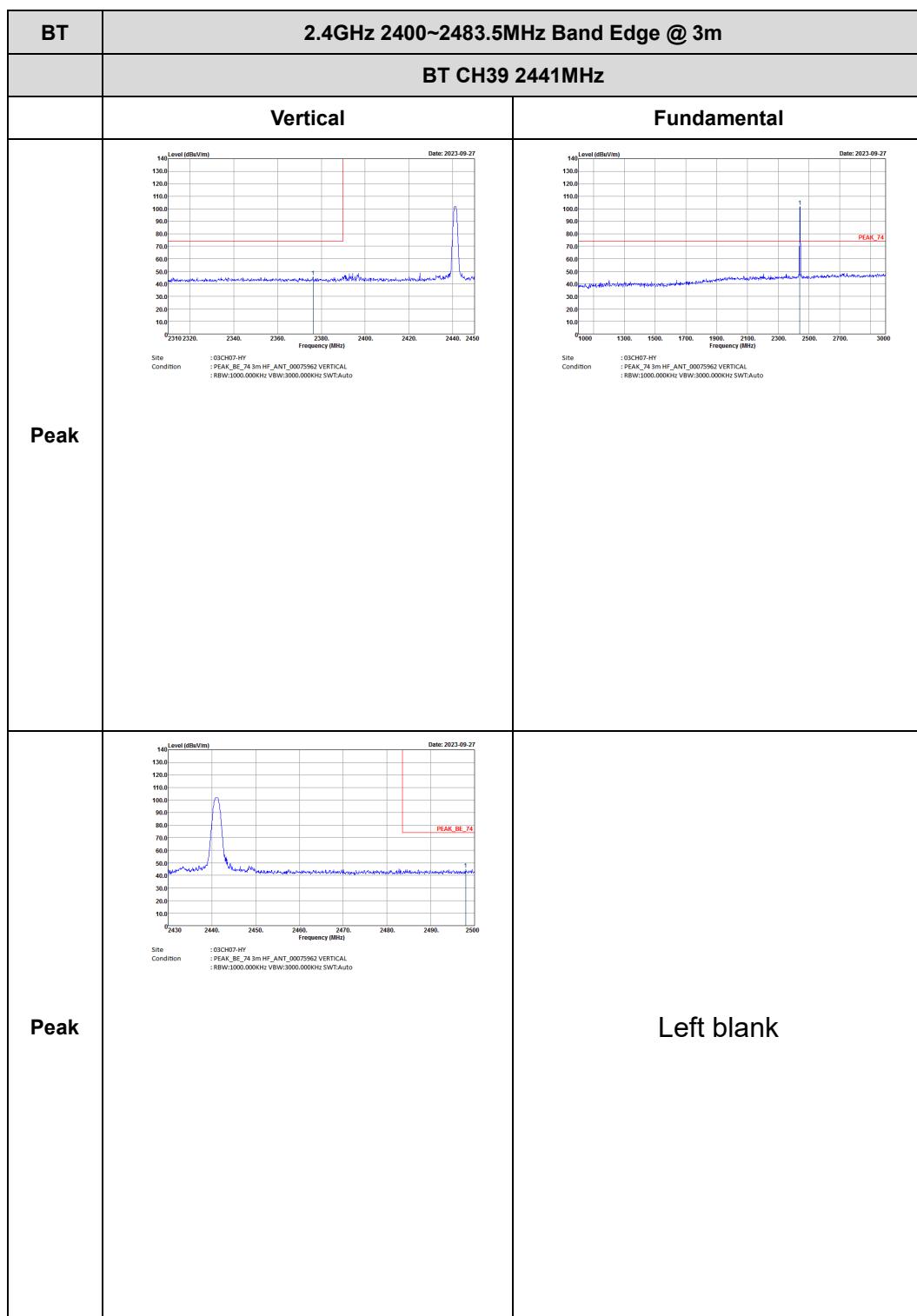
2.4GHz 2400~2483.5MHz

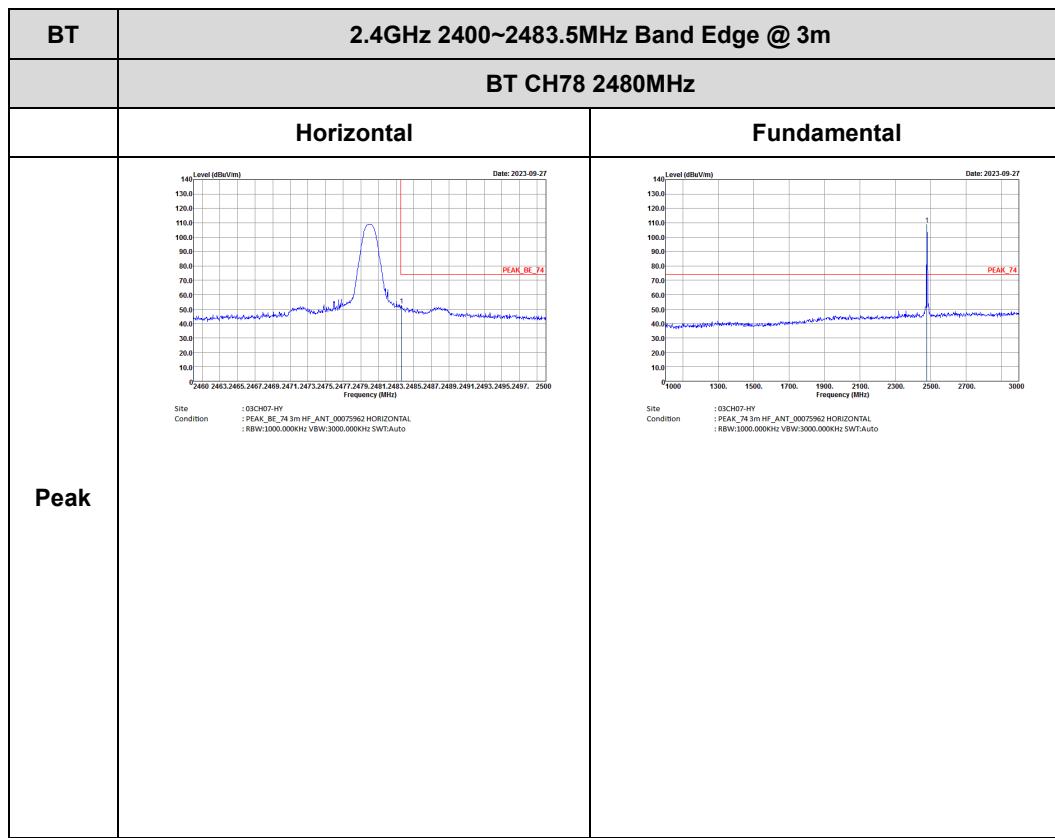
BT (Band Edge @ 3m)

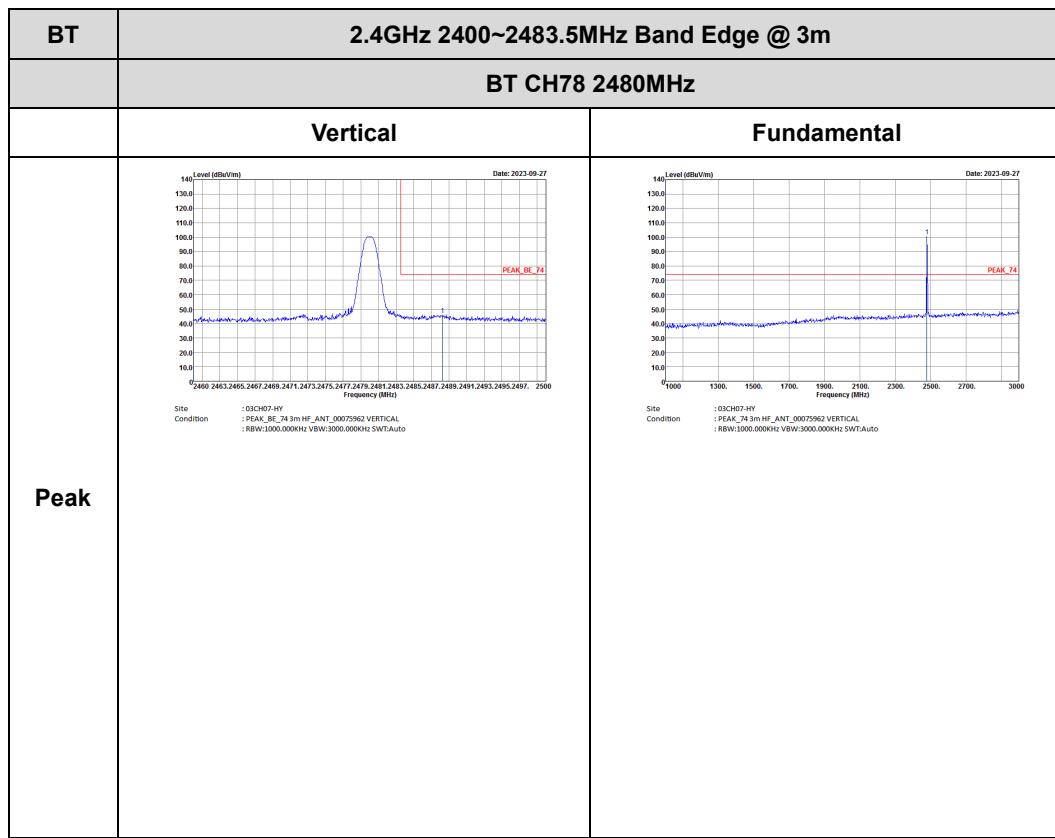








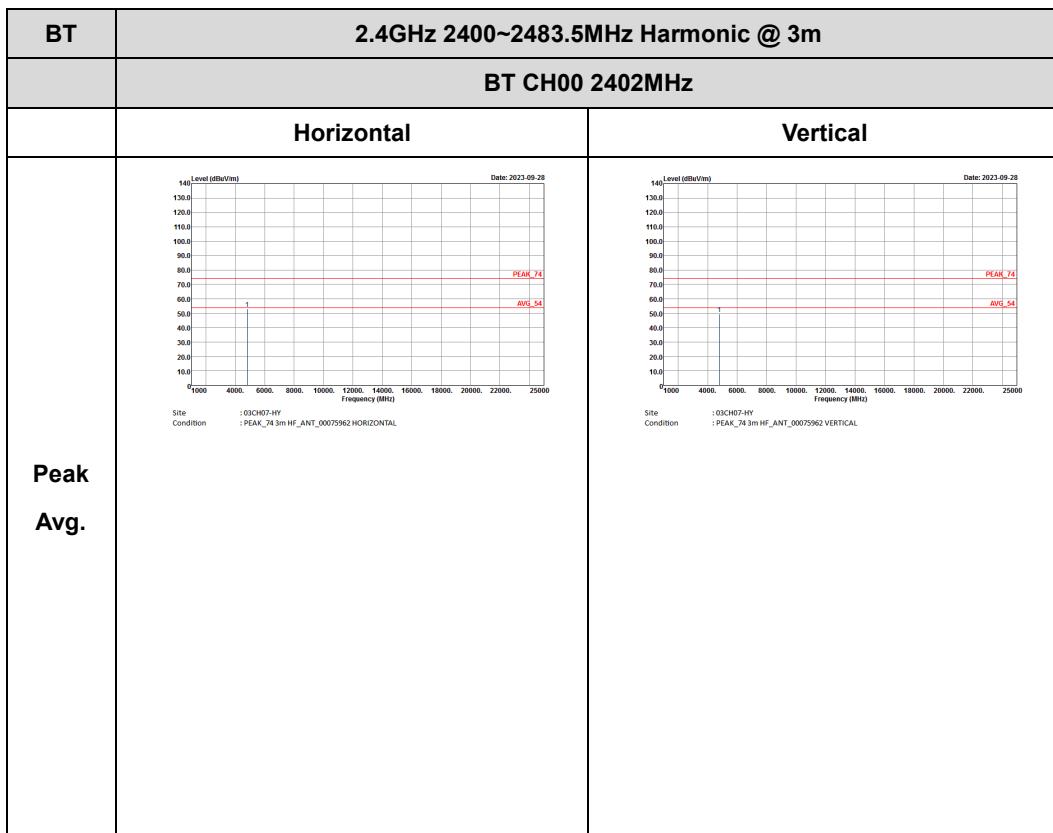


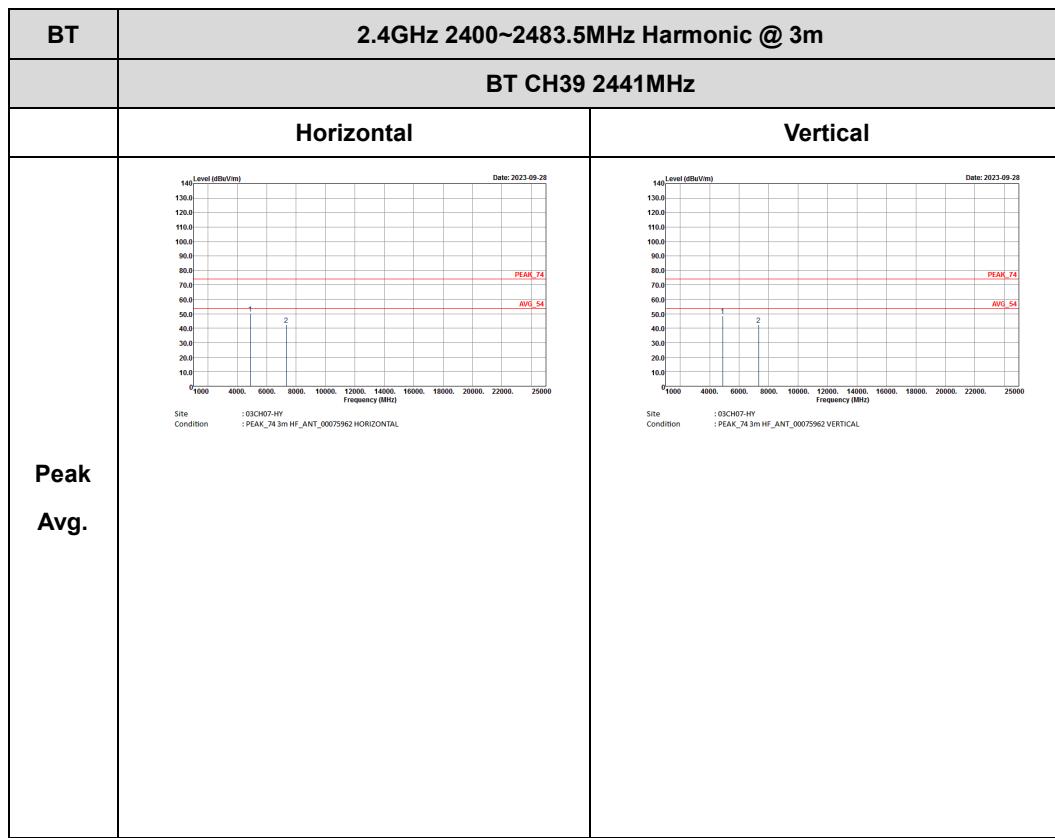


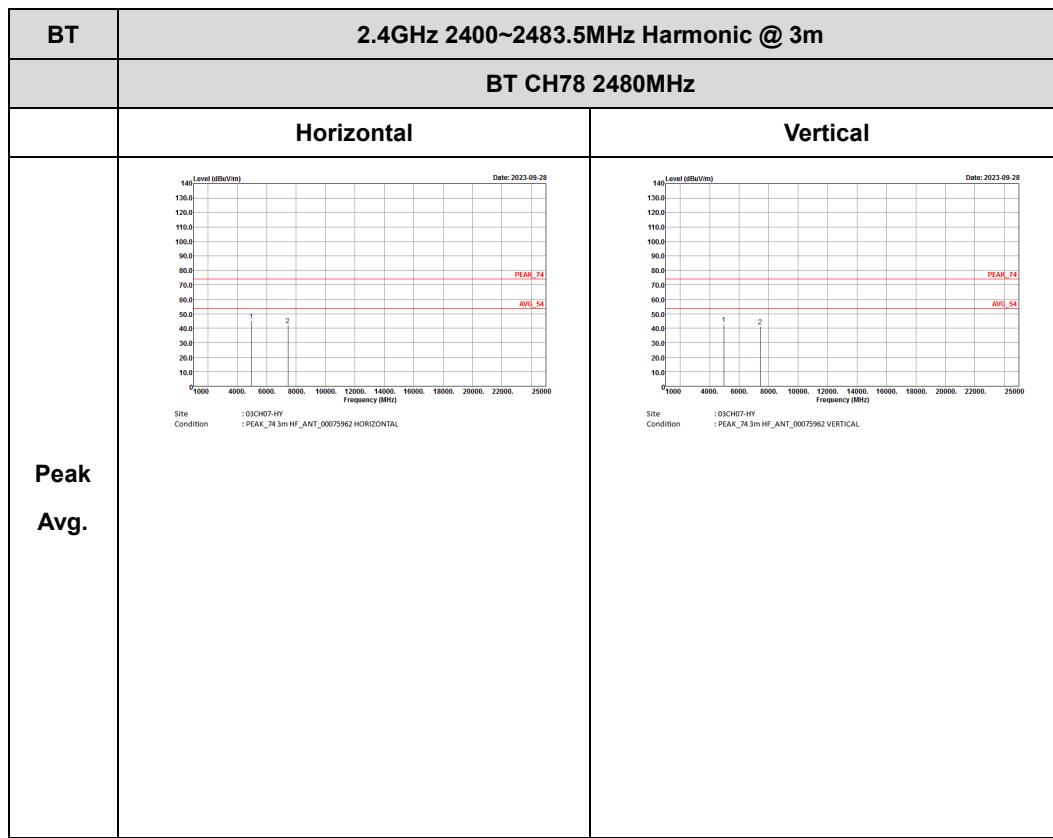


2.4GHz 2400~2483.5MHz

BT (Harmonic @ 3m)



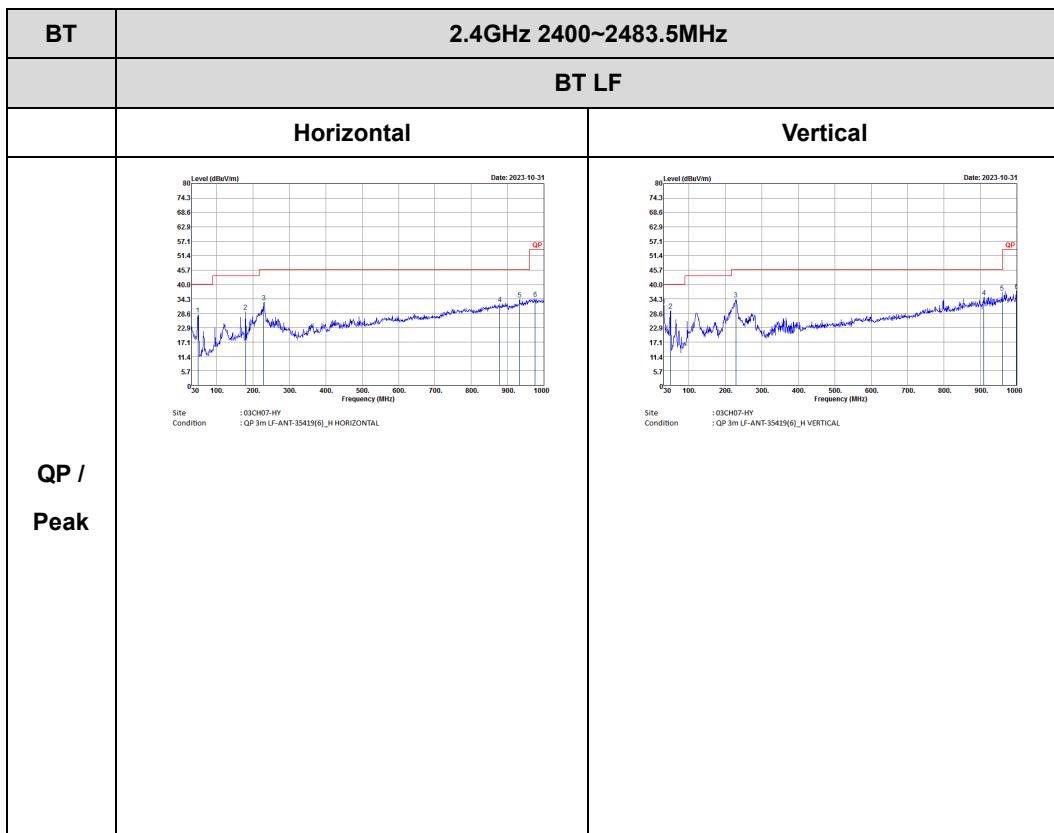






Emission below 1GHz

2.4GHz BT (LF)

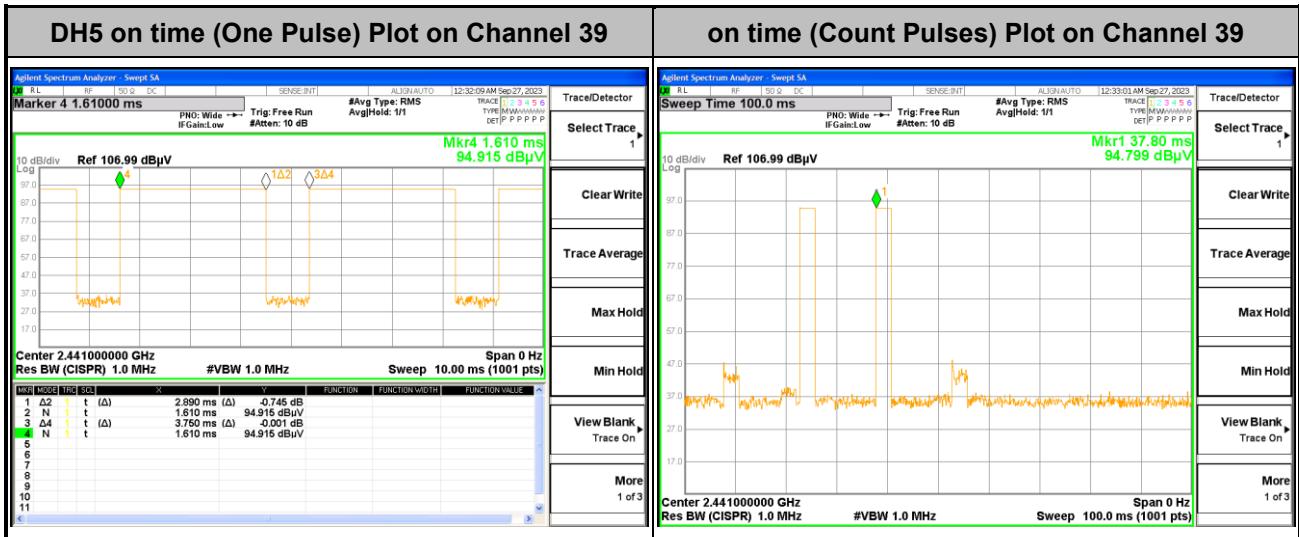




Appendix E. Duty Cycle Plots

<Sample 2>

<Internal Antenna>



Note:

1. Worst case Duty cycle = on time/100 milliseconds = $2 * 2.89 / 100 = 5.78 \%$
2. Worst case Duty cycle correction factor = $20 * \log(\text{Duty cycle}) = -24.76 \text{ dB}$
3. DH5 has the highest duty cycle worst case and is reported.

Duty Cycle Correction Factor Consideration for AFH mode:

Bluetooth normal hopping rate is 1600Hz and reduced to 800Hz in AFH mode; due to the reduced number of hopping frequencies, with the same packet configuration the dwell time in each channel frequency within 100msec period is longer in AFH mode than normal mode.

In AFH mode, the minimum hopping frequencies are 20, to get the longest dwell time DH5 packet is observed; the on time period to have DH5 packet completing one hopping sequence is

$$2.89 \text{ ms} \times 20 \text{ channels} = 57.8 \text{ ms}$$

There cannot be 2 complete hopping sequences within 100ms period, considering the random hopping behavior, maximum 2 hops can be possibly observed within the period. $[100 \text{ ms} / 57.8 \text{ ms}] = 2 \text{ hops}$
Thus, the maximum possible ON time:

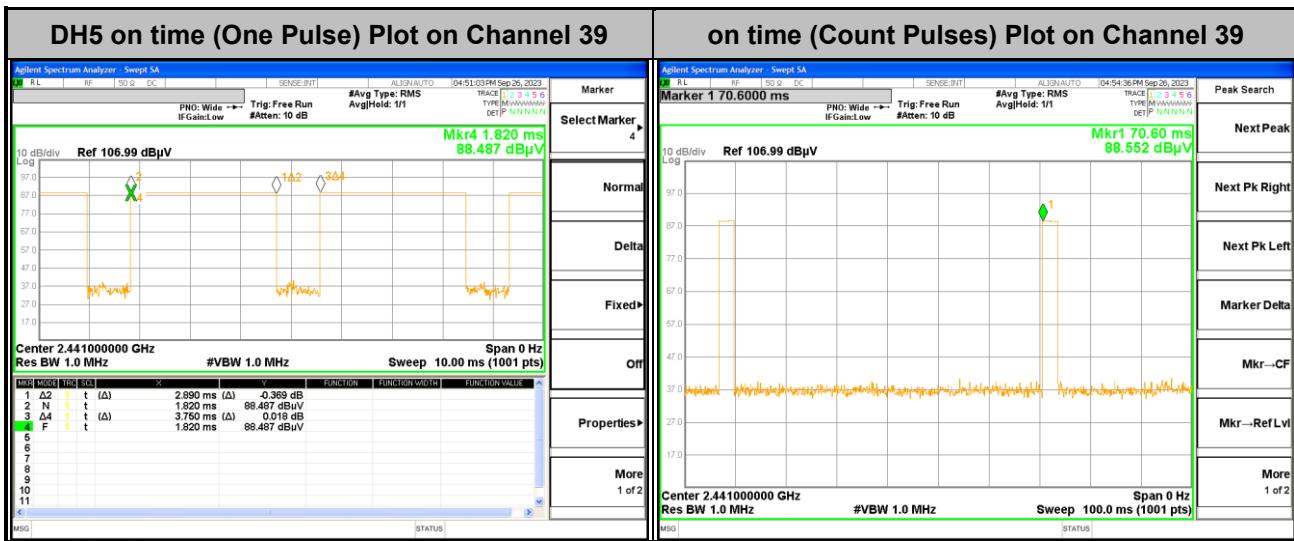
$$2.89 \text{ ms} \times 2 = 5.78 \text{ ms}$$

Worst case Duty Cycle Correction factor, which is derived from the maximum possible ON time,

$$20 \times \log(5.78 \text{ ms}/100 \text{ ms}) = -24.76 \text{ dB}$$



<External Antenna>

**Note:**

1. Worst case Duty cycle = on time/100 milliseconds = $2 * 2.89 / 100 = 5.78 \%$
2. Worst case Duty cycle correction factor = $20 * \log(\text{Duty cycle}) = -24.76 \text{ dB}$
3. DH5 has the highest duty cycle worst case and is reported.

Duty Cycle Correction Factor Consideration for AFH mode:

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Thus, the maximum possible ON time:

$$2.89 \text{ ms} \times 2 = 5.78 \text{ ms}$$

Worst case Duty Cycle Correction factor, which is derived from the maximum possible ON time,

$$20 \times \log(5.78 \text{ ms}/100 \text{ ms}) = -24.76 \text{ dB}$$