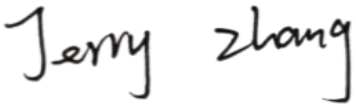
RF Test Report

Applicant:	Quectel Wireless Solutions Co., Ltd.
Address:	Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, 200233 China
Product:	Wi-Fi & Bluetooth Module
Model No.:	FGS061N
Brand Name:	QUECTEL
FCC ID:	XMR2024FGS061N
Standards:	FCC CFR47 Part 15C
Report No.:	PD20240082RF08
Issue Date:	2024/07/15
Test Result:	PASS *

* **Testing performed at Hefei Panwin Technology Co., Ltd. on the above equipment indicates the product meets the requirements of the relevant standards.**



Reviewed By: Jerry Zhang **Approved By:** Alec Yang

Hefei Panwin Technology Co., Ltd.

Floor 1, Zone E, Plant 2#, Mingzhu Industrial Park, No.106 Chuangxin Avenue, High-tech Zone, Hefei City, Anhui Province,China

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Revision History

Report No.	Version	Description	Issue Date	Note
PD20240082RF08	01	Initial Report	2024/07/15	Valid

CONTENTS

Summary of Test Results

No.	Test Case	FCC Rules	Verdict
1	Peak Output Power	15.247(b)(1)	PASS
2	20dB and 99% Bandwidth	15.247(a)(1)	Reporting only
3	Conducted Band Edges	15.247(d)	PASS
4	Dwell Time of Each Channel	15.247(a)(1)	PASS
5	Hopping Channel Separation	15.247(a)(1)	PASS
6	Number of Channels	15.247(a)(1)	PASS
7	Conducted Spurious Emission	15.247(d)	PASS
8	Radiated Band Edges and Radiated Spurious Emission	15.247(d)	PASS
9	AC Conducted Emission	15.207	NA
10	Antenna Requirement	15.203 & 15.247(b)	PASS

Date of Testing: 2024/06/06 to 2024/07/13
Date of Sample Received: 2024/06/05

- The samples tested have been evaluated in accordance with the procedures given in the application standards in **Section 2.3** of this report and have been shown to comply with the applicable technical standards.
- All indications of PASS/FAIL in this report are based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only.

1 General Information

1.1 Notes of the Test Report

This report is invalid without signature of auditor and approver or with any alterations. The report shall not be partially reproduced without written approval of the testing company. Entrusted test results are only responsible for incoming samples. If there is any objection to the testing report, it shall be raised to the testing company within 15 days from the date of receiving the report. In the test results, "NA" means "not applicable", and the test items marked with "Δ" are subcontracted projects.

1.2 Test Facility

A2LA (Certificate Number: 6849.01)

Hefei Panwin Technology Co., Ltd. has been accredited by American Association for Laboratory Accreditation to perform measurement.

FCC (Designation Number: CN1361, Test Firm Registration Number: 473156)

Hefei Panwin Technology Co., Ltd. has been accredited on the US Federal Communications Commission list of test facilities recognized to perform measurements.

1.3 Testing Laboratory

Company Name	Hefei Panwin Technology Co., Ltd.
Address	Floor 1, Zone E, Plant 2#, Mingzhu Industrial Park, No.106 Chuangxin Avenue, High-tech Zone, Hefei City, Anhui Province,China
Telephone	+86-0551-63811775
Post Code	230031

2 General Description of Equipment under Test

2.1 Details of Application

Applicant	Quectel Wireless Solutions Co., Ltd.
Applicant Address	Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, 200233 China
Manufacturer	Quectel Wireless Solutions Co., Ltd.
Manufacturer Address	Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, 200233 China

2.2 General Information

Product	Wi-Fi & Bluetooth Module
Model	FGS061N
SN	1. D1Y24E73E000276 2. D1Y24E73E000282
Hardware Version	R1.0
Software Version	/
Antenna Type	External Antenna
Max. Conducted Power	9.77dBm
Antenna Gain	0.20dBi
Operating voltage	Typical 3.3Vdc
Modulation Type	Frequency Hopping Spread Spectrum (FHSS):GFSK, π/4-DQPSK, 8-DPSK
Operating Frequency Range(s)	Bluetooth : 2402 ~2480 MHz
Number of channels	79
Carrier Frequency of Each Channel	2402+n*1 MHz; n=0~78
Note: The declared of product specification for EUT and/or Antenna presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.	

2.3 Application Standards

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

- 47 CFR Part 15 Subpart C §15.247
- FCC KDB 558074 D01 15.247 Meas Guidance v05r02
- ANSI C63.10-2013

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

3 Test Condition

3.1 Test Configuration

Test mode

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture). The worst cases were recorded in this report.

Radiated measurements are performed by rotating the EUT in three different orthogonal test planes (Z, X, Y axis), receiver antenna polarization (horizontal and vertical), the worst emission was found in Z position and the worst case was recorded.This report presents the data for the worst polarity.

3.2 Carrier Frequency Channel

Frequency Band	Channel	Freq（MHz）	Channel	Freq（MHz）	Channel	Freq（MHz）
2400-2483.5MHz	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	-	-

3.3 Equipment List

Conducted

Instrument	Manufacturer	Model	Asset No.	Cal. Interval	Cal. Due Date
Spectrum Analyzer	KEYSIGHT	N9020B	PWC0048	1 Year	2024/10/10
RF Control Unit	Tonseced	JS0806-2	PWC0055	/	/
Shielded Chamber	Maorui	MR543	PWC0041	3 Years	2026/08/26
Test Software	Tonseced	JS1120-3 V3.2.22	/	/	/

Radiated

Instrument	Manufacturer	Model	Asset No.	Cal. Interval	Cal. Due Date
EMI Test Receiver	R&S	ESR7	PWB0023	1 Year	2024/10/11
Spectrum Analyzer	R&S	FSV3044	PWB0024	1 Year	2024/10/11
Loop Antenna	R&S	HFH2-Z2E	PWB0026	1 Year	2024/10/21
TRILOG Broadband Antenna	Schwarzbeck	VULB9162	PWB0029	1 Year	2024/10/13
Double-Ridged Guide Antenna	ETS-Lindgren	3117	PWB0031	1 Year	2024/10/11
k Type Horn Antenna	Steatite Antennas	QMS-00880	PWB0035	1 Year	2024/10/17
Pre-Amplifier	R&S	OSP220 (OSP-B155G)	PWB0042	1 Year	2024/10/13
Anechoic Chamber	ETS.LINDGREN	Fact 3-2m	PWB0003	3 Years	2026/06/05
Pre-Amplifier	R&S	SCU18F	PWB0034	1 Year	2024/10/11
Pre-Amplifier	R&S	SCU40F1	PWB0036	1 Year	2024/10/11
Pre-Amplifier	COM-MW	DLNA8	PWB0094	1 Year	2024/11/08
Test Software	R&S	ELEKTRA 4.20.2	/	/	/

3.4 Support Equipment List

Equipment	Manufacturer	Description	Model	Serial Number
EVB	QUECTEL	/	/	/
Laptop	Lenovo	/	/	/
Adapter	Something High Electric (Xiamen) Gompany Inc.	Output:12V/5A	P60EB120500	/

3.5 Test Uncertainty

No.	Parameter	Uncertainty
1	20dB Emission Bandwidth	1.9%
2	Occupied channel bandwidth	1.9%
3	Carrier Frequency Separation	1.9%
4	Band-edge Spurious Emission	1.21dB
5	Conducted RF Spurious Emission	9kHz-7GHz:1.21dB 7GHz-40GHz: 3.31dB
6	Radiated Band Edges and Spurious Emission	Below 1GHz: 4.88 dB Above 1GHz: 5.06 dB
7	Temperature	3 °C
8	Humidity	1.3 %
9	Supply voltages	0.006 V

4 Test Items Description

Ambient condition

Shielded Chamber

Temperature [°C]	21.4 to 24.7
Humidity [%RH]	43 to 62
Pressure [kPa]	99.9 to 101.9

Anechoic Chamber

Temperature [°C]	20.1 to 25.5
Humidity [%RH]	42 to 62
Pressure [kPa]	99.4 to 100.9

4.1 Output Power Measurement

4.1.1 Limit of Output Power

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

(1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75non-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. The power limit for 1Mbps, 2Mbps, 3Mbps and AFH modes are 0.125 watts.

4.1.2 Measuring Instruments

The measuring equipment is listed in the section 3.3 of this test report.

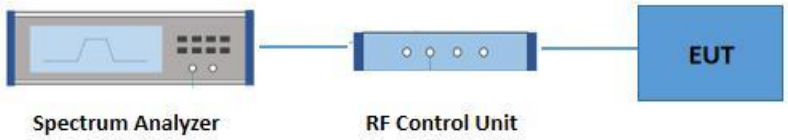
4.1.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.5.
2. Set to the maximum power setting and enable the EUT transmit continuously.
3. Use the following spectrum analyzer settings for 20dB Bandwidth measurement
   1）Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
   2）RBW > 20 dB bandwidth of the emission being measured.
   3）VBW ≥ RBW.
   4）Sweep: Auto.
   5）Detector function: Peak.
   6）Trace: Max hold.
   7）Allow trace to stabilize.
   8）Use the marker-to-peak function to set the marker to the peak of the emission.
4. The indicated level is the peak output power, after any corrections for external attenuators and

cables.

5. A plot of the test results and setup description shall be included in the test report.

4.1.4 Test Setup



4.1.5Test Results

See Appendix A.1.

4.2 20dB and 99% Bandwidth Measurement

4.2.1 Limit of 20dB and 99% Bandwidth

Reporting only

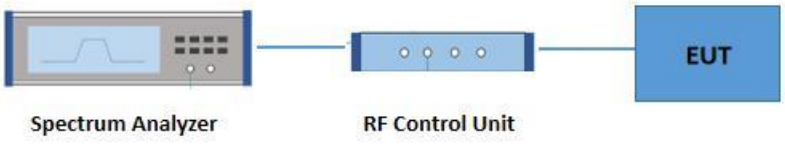
4.2.2 Measuring Instruments

The measuring equipment is listed in the section 3.3 of this test report.

4.2.3 Test Procedures

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

4.2.4 Test Setup



4.2.5Test Results

See Appendix A.2.

4.3 Conducted Band Edges Measurement

4.3.1 Limit of Band Edges

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.

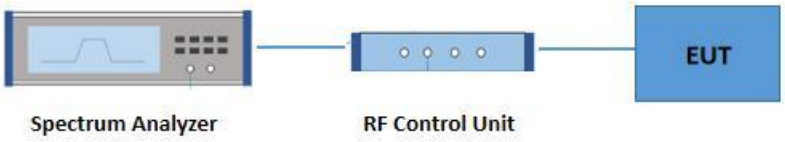
4.3.2 Measuring Instruments

The measuring equipment is listed in the section 3.3 of this test report.

4.3.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.6.
2. Set to the maximum power setting and enable the EUT transmit continuously.
3. Set RBW = 100kHz, VBW = 300kHz. Band edge emissions must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100kHZ 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.

4.3.4 Test Setup



4.3.5 Test Results

See Appendix A.3.

4.4 Dwell Time Measurement

4.4.1 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.

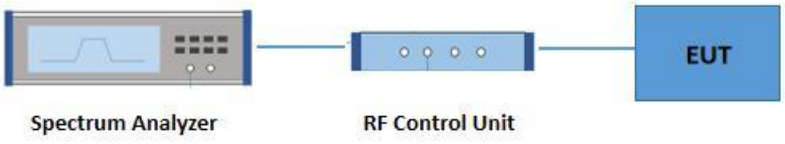
4.4.2 Measuring Instruments

The measuring equipment is listed in the section 3.3 of this test report

4.4.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.4.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator.The path loss was compensated to the results for each measurement
3. Set to the maximum power setting and enable the EUT 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 ≥ 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.

4.4.4 Test Setup



4.4.5 Test Results

See Appendix A.4.

4.5 Hopping Channel Separation Measurement

4.5.1 Limit of Hopping Channel Separation

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, 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, provided the systems operate with an output power no greater than 125 mW.

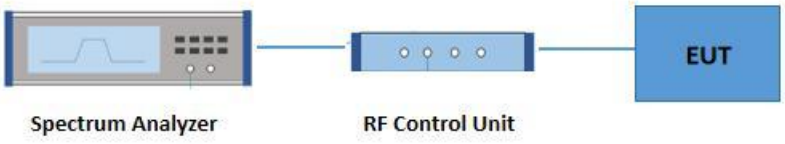
4.5.2 Measuring Instruments

The measuring equipment is listed in the section 3.3 of this test report.

4.5.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.2.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT 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 = 300kHz; VBW ≥ RBW; Sweep = auto; Detector function = peak;
   Trace = max hold.
6. Measure and record the results in the test report.

4.5.4 Test Setup



4.5.5 Test Results

See Appendix A.5.

4.6 Number of Channel Measurement

4.6.1 Limits of Number of Hopping Frequency

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

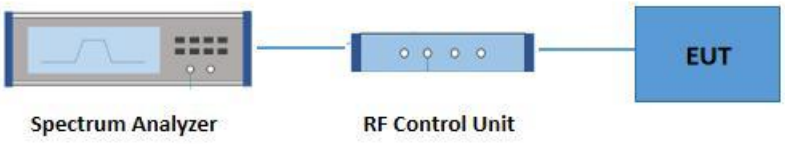
4.6.2 Measuring Instruments

The measuring equipment is listed in the section 3.3 of this test report.

4.6.3 Test Procedure

1. The testing follows ANSI C63.10-2013 clause 7.8.3.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings: Span = the frequency band of operation;RBW = 300kHz; VBW ≥ 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.

4.6.4 Test Setup



4.6.5 Test Results

See Appendix A.6.

4.7 Conducted Spurious Emission Measurement

4.7.1 Limit of Spurious Emission Measurement

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.

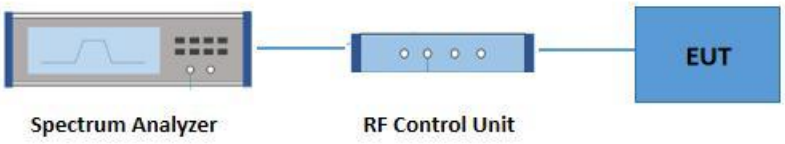
4.7.2 Measuring Instruments

The measuring equipment is listed in the section 3.3 of this test report

4.7.3 Test Procedure

1. The testing follows ANSI C63.10-2013 clause 7.8.8.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW= 300kHz, scan up through 10th harmonic. All harmonics / spurs 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.

4.7.4 Test Setup



4.7.5 Test Results

See Appendix A.7.

4.8 Radiated Band Edges and Spurious Emission Measurement

4.8.1 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 of emission (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
Above960	500	3

4.8.2 Measuring Instruments

The measuring equipment is listed in the section 3.3 of this test report.

4.8.3 Test Procedures

1. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
2. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
3. For each suspected emission, the EUT was 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 to the maximum power setting and enable the EUT 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 GH, RBW=1MHz for f>1GHz ; VBW ≥ 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 = $N_1*L_1+N_2*L_2+...+N_{n-1}*L_{n-1}+N_n*L_n$

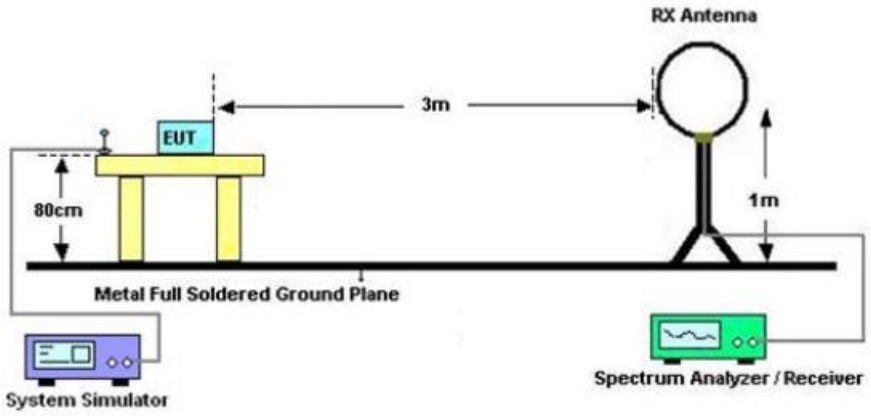
Where N_1 is number of type 1 pulses, L, is length of type 1 pulses, etc.

Average Emission Level = Peak Emission Level + 20*log(Duty cycle).

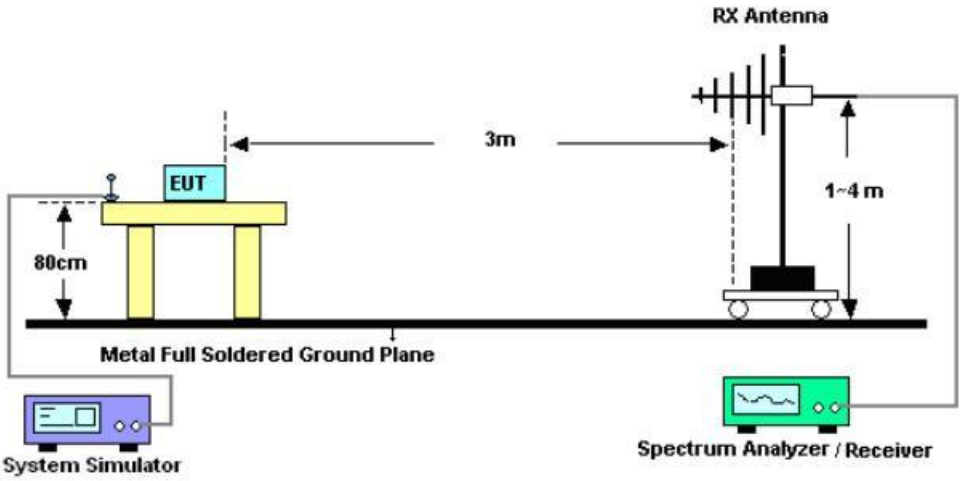
6. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Pre-amp Factor = Level
7. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
8. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than peak limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.

4.8.4 Test Setup

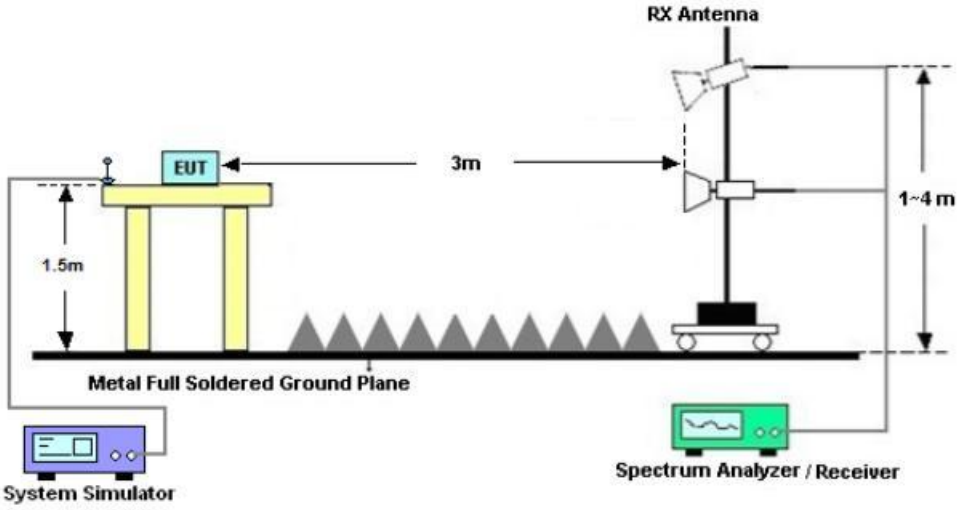
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



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

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was20dB lower than the limit line was not reported.There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

4.8.6Test Result of Radiated Spurious at Band Edges

See Appendix B.1.

4.8.7 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic or40GHz, whichever is lower)

See Appendix B.1.

4.8.8 Duty cycle correction factor for average measurement

See Appendix A.8.

4.9 AC Conducted Emission Measurement

4.9.1 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 (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

Decreases with the logarithm of the frequency.

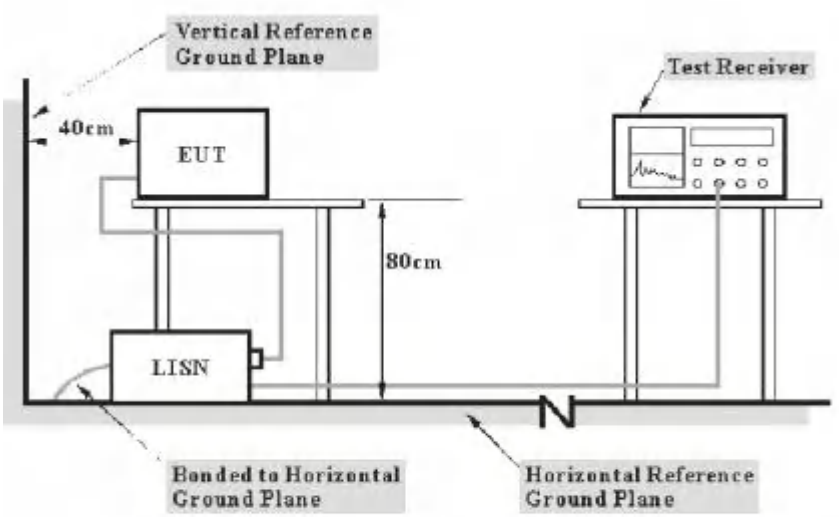
4.9.2 Measuring Instruments

The section 3.3 of List of Measuring Equipment of this test report is used for test.

4.9.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was 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 should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth =9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

4.6.4 Test Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

4.9.5 Uncertainty Measurement

Where relevant,the following measurement uncertainty levels have been estimated for tests performed on the EUT. The listed uncertainties are the worst case uncertainty for the entire range of measurement. Please note that the uncertainty values are provided for informational purposes only and are not used in determining the PASS/FAIL results.

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

CASE	Uncertainty
Continuous Emission (AC port)	2.92 dB

4.9.6 Test Result

Remark: The product is DC powered, this test item is not applicable.

4.10 Antenna Requirements

4.10.1 Standard Applicable

15.203 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 6dBi.

4.10.2 Antenna Anti-Replacement Construction

The antenna is External on the main PCB and no consideration of replacement. The best case gain of the antenna is 0.20dBi.

Appendix A – Test Results of Conducted Test

A.1 Output Power Measurement

Test Result Peak

Test Mode	Antenna	Frequency [MHz]	Conducted Peak Power[dBm]	Conducted Limit[dBm]	EIRP [dBm]	EIRP Limit[dBm]	Verdict
DH5	Ant1	2402	9.76	≤30	9.96	≤36	PASS
DH5	Ant1	2441	9.77	≤30	9.97	≤36	PASS
DH5	Ant1	2480	9.22	≤30	9.42	≤36	PASS
2DH5	Ant1	2402	8.03	≤20.97	8.23	≤36	PASS
2DH5	Ant1	2441	8.00	≤20.97	8.20	≤36	PASS
2DH5	Ant1	2480	7.68	≤20.97	7.88	≤36	PASS
3DH5	Ant1	2402	7.53	≤20.97	7.73	≤36	PASS
3DH5	Ant1	2441	7.47	≤20.97	7.67	≤36	PASS
3DH5	Ant1	2480	7.16	≤20.97	7.36	≤36	PASS

Test Graphs

DH5-Ant1-2402-PASS

DH5-Ant1-2441-PASS

DH5-Ant1-2480-PASS

2DH5-Ant1-2402-PASS

2DH5-Ant1-2441-PASS

2DH5-Ant1-2480-PASS

	
3DH5-Ant1-2402-PASS	3DH5-Ant1-2441-PASS
	
3DH5-Ant1-2480-PASS	/
	/

A.2 20dB and 99% Bandwidth Measurement

Test Result

20dB Bandwidth

Test Mode	Antenna	Frequency[MHz]	20db EBW[MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
DH5	Ant1	2402	0.954	2401.514	2402.468	---	---
DH5	Ant1	2441	0.948	2440.517	2441.465	---	---
DH5	Ant1	2480	0.960	2479.511	2480.471	---	---
2DH5	Ant1	2402	1.278	2401.340	2402.618	---	---
2DH5	Ant1	2441	1.278	2440.349	2441.627	---	---
2DH5	Ant1	2480	1.278	2479.349	2480.627	---	---
3DH5	Ant1	2402	1.287	2401.337	2402.624	---	---
3DH5	Ant1	2441	1.308	2440.328	2441.636	---	---
3DH5	Ant1	2480	1.287	2479.334	2480.621	---	---

99% Bandwidth

Test Mode	Antenna	Frequency[MHz]	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
DH5	Ant1	2402	0.87815	2401.5392	2402.4173	---	---
DH5	Ant1	2441	0.87938	2440.5430	2441.4224	---	---
DH5	Ant1	2480	0.87479	2479.5454	2480.4202	---	---
2DH5	Ant1	2402	1.1800	2401.3794	2402.5594	---	---
2DH5	Ant1	2441	1.1849	2440.3873	2441.5722	---	---
2DH5	Ant1	2480	1.1826	2479.3874	2480.5700	---	---
3DH5	Ant1	2402	1.1814	2401.3910	2402.5724	---	---
3DH5	Ant1	2441	1.1811	2440.3905	2441.5716	---	---
3DH5	Ant1	2480	1.1851	2479.3861	2480.5712	---	---

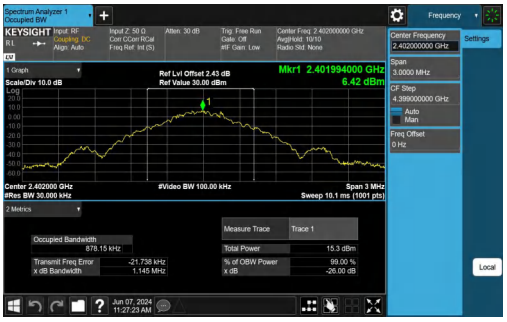
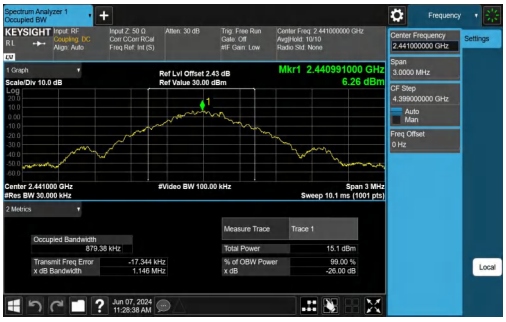
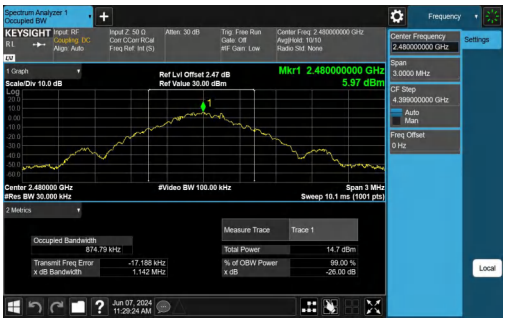
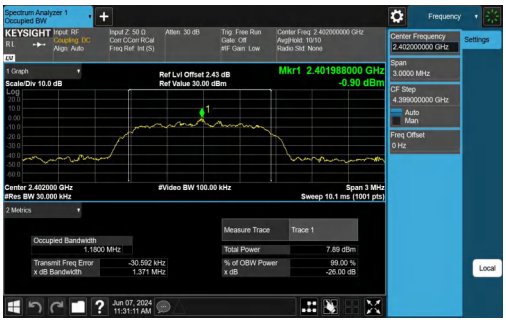
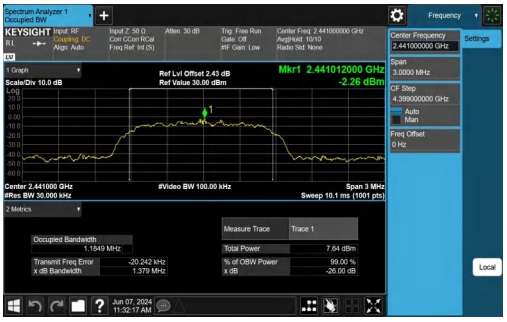
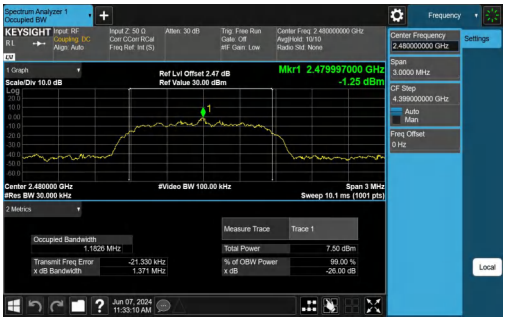
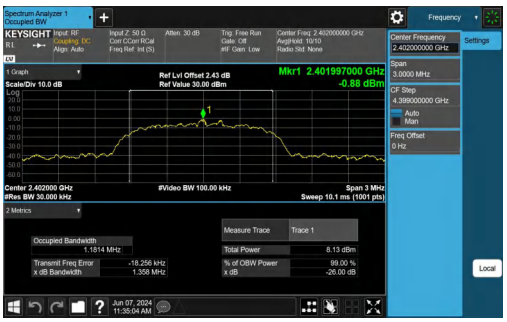
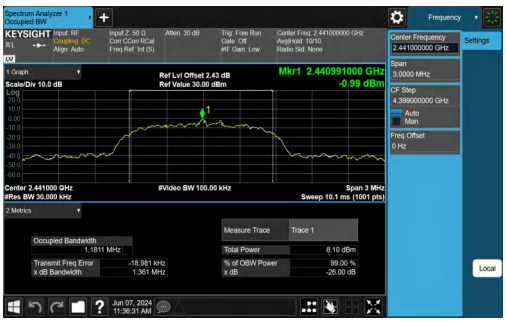
Test Graphs

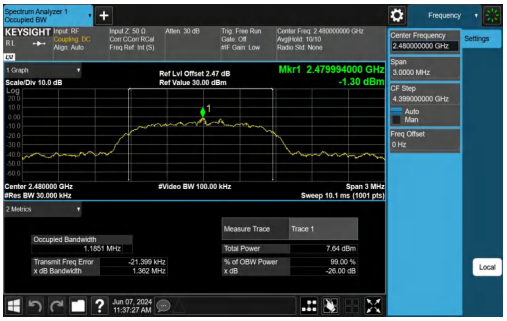
20dB Bandwidth

DH5-Ant1-2402	DH5-Ant1-2441
	

DH5-Ant1-2480	2DH5-Ant1-2402
	
2DH5-Ant1-2441	**2DH5-Ant1-2480**
	
3DH5-Ant1-2402	**3DH5-Ant1-2441**
	
3DH5-Ant1-2480	**/**
	/

99% Bandwidth

DH5-Ant1-2402	DH5-Ant1-2441
	
DH5-Ant1-2480	2DH5-Ant1-2402
	
2DH5-Ant1-2441	2DH5-Ant1-2480
	
3DH5-Ant1-2402	3DH5-Ant1-2441
	
3DH5-Ant1-2480	/

 Spectrum Analyzer 1 Occupied BW KEYSIGHT Frequency Center Frequency 2.480000000 GHz Settings Span 3.0000 MHz CF Step 4.399000000 GHz Auto Man Freq Offset 0 Hz 1 Graph Ref Lvl Offset 2.47 dB Ref Value 30.00 dBm Mkr1 2.479994000 GHz -1.30 dBm Scale/Div 10.0 dB Log Center 2.480000 GHz #Res BW 30.000 kHz #Video BW 100.00 kHz Span 3 MHz Sweep 10.1 ms (1001 pts) 2 Metrics Occupied Bandwidth 1.1851 MHz Transmit Freq Error -21.399 kHz x dB Bandwidth 1.362 MHz Measure Trace Trace 1 Total Power 7.64 dBm % of OBW Power 99.00 % x dB -26.00 dB Local Jun 07, 2024 11:37:27 AM	/

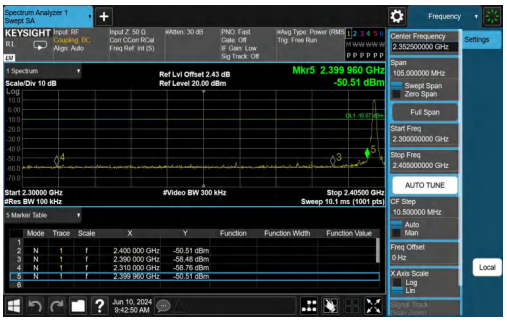
A.3 Conducted Band Edges Measurement

Test Result

Test Mode	Antenna	Ch Name	Frequency[MHz]	Ref Level[dBm]	Result[dBm]	Limit[dBm]	Verdict
DH5	Ant1	Low	2402	9.93	-50.51	≤-10.07	PASS
DH5	Ant1	High	2480	10.01	-53.52	≤-9.99	PASS
DH5	Ant1	Low	Hop_2402	8.93	-50.83	≤-11.08	PASS
DH5	Ant1	High	Hop_2480	9.11	-53.1	≤-10.89	PASS
2DH5	Ant1	Low	2402	6.25	-47.69	≤-13.75	PASS
2DH5	Ant1	High	2480	5.98	-54.04	≤-14.02	PASS
2DH5	Ant1	Low	Hop_2402	1.00	-55.89	≤-19	PASS
2DH5	Ant1	High	Hop_2480	-1.10	-55.77	≤-21.1	PASS
3DH5	Ant1	Low	2402	5.40	-46.6	≤-14.6	PASS
3DH5	Ant1	High	2480	5.14	-53.43	≤-14.86	PASS
3DH5	Ant1	Low	Hop_2402	-1.35	-52.8	≤-21.35	PASS
3DH5	Ant1	High	Hop_2480	-0.76	-56.44	≤-20.76	PASS

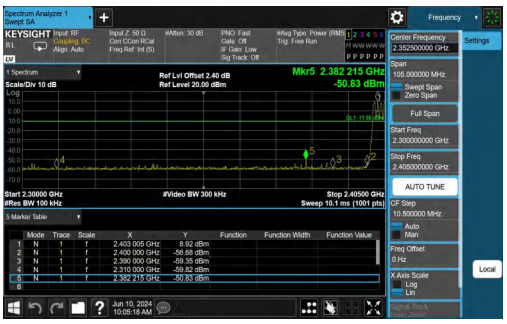
Test Graphs

DH5-Ant1-2402-PASS



DH5-Ant1-2480-PASS

DH5-Ant1-Hop_2402-PASS

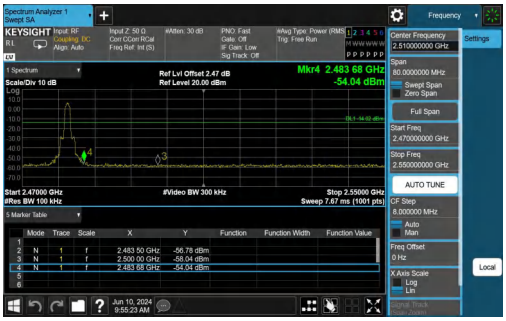


DH5-Ant1-Hop_2480-PASS

2DH5-Ant1-2402-PASS

2DH5-Ant1-2480-PASS

2DH5-Ant1-Hop_2402-PASS

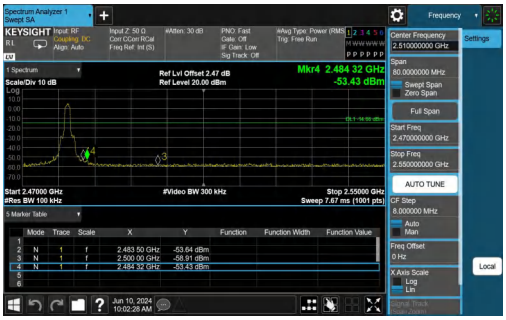


2DH5-Ant1-Hop_2480-PASS

3DH5-Ant1-2402-PASS

3DH5-Ant1-2480-PASS

3DH5-Ant1-Hop_2402-PASS



3DH5-Ant1-Hop_2480-PASS

A.4 Dwell Time Measurement

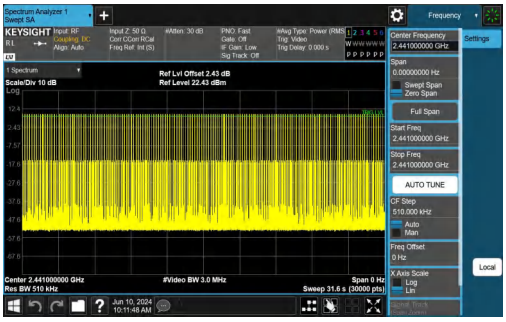
Test Result

Test Mode	Antenna	Frequency[MHz]	Burst Width[ms]	Total Hops[Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.370	316	0.117	≤0.4	PASS
DH3	Ant1	Hop	1.630	154	0.251	≤0.4	PASS
DH5	Ant1	Hop	2.870	103	0.296	≤0.4	PASS
2DH1	Ant1	Hop	0.370	318	0.118	≤0.4	PASS
2DH3	Ant1	Hop	1.610	151	0.243	≤0.4	PASS
2DH5	Ant1	Hop	2.870	113	0.324	≤0.4	PASS
3DH1	Ant1	Hop	0.370	318	0.118	≤0.4	PASS
3DH3	Ant1	Hop	1.620	162	0.262	≤0.4	PASS
3DH5	Ant1	Hop	2.870	109	0.313	≤0.4	PASS

Test Graphs

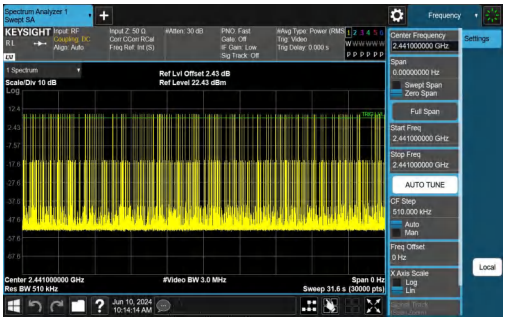
DH1-Ant1-Hop-PASS

DH1-Ant1-Hop-PASS



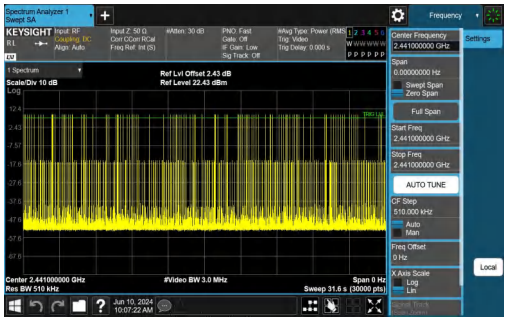
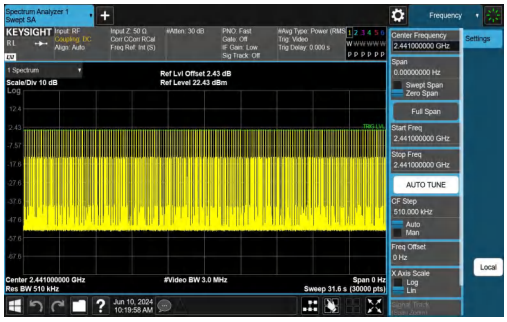
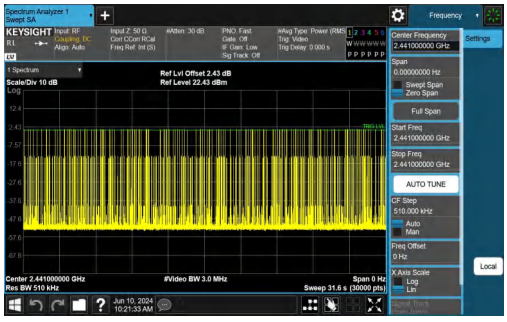
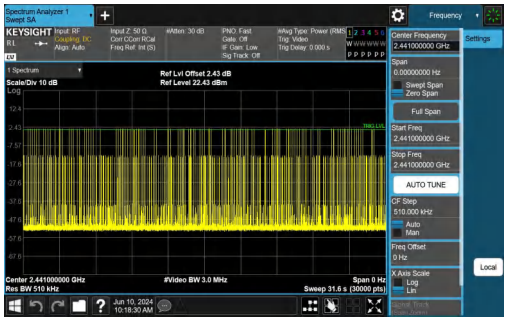
DH3-Ant1-Hop-PASS

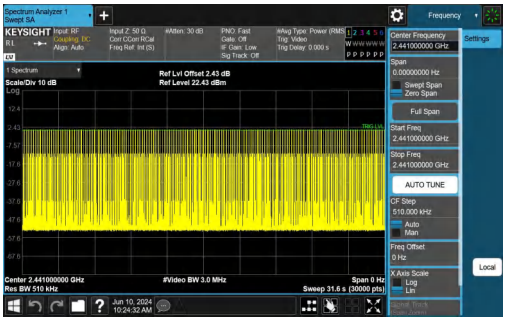
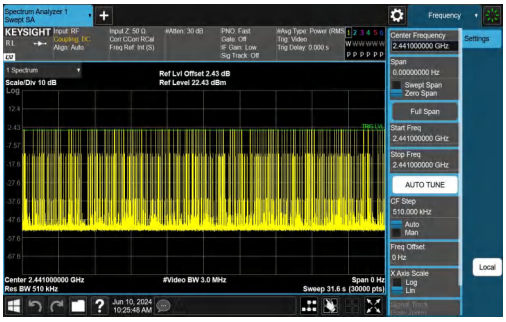
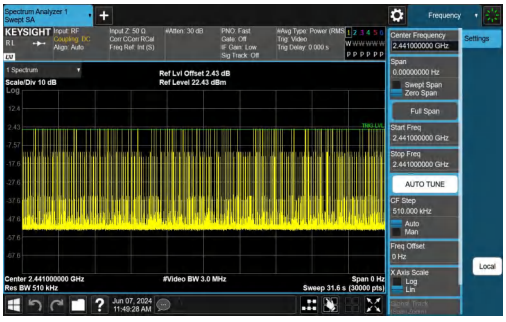
DH3-Ant1-Hop-PASS



DH5-Ant1-Hop-PASS

DH5-Ant1-Hop-PASS

	
2DH1-Ant1-Hop-PASS	2DH1-Ant1-Hop-PASS
	
2DH3-Ant1-Hop-PASS	2DH3-Ant1-Hop-PASS
	
2DH5-Ant1-Hop-PASS	2DH5-Ant1-Hop-PASS
	
3DH1-Ant1-Hop-PASS	3DH1-Ant1-Hop-PASS

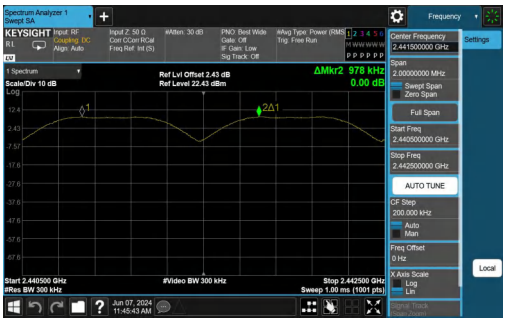
	
3DH3-Ant1-Hop-PASS	3DH3-Ant1-Hop-PASS
	
3DH5-Ant1-Hop-PASS	3DH5-Ant1-Hop-PASS
	

A.5 Hopping Channel Separation

Test Result

Test Mode	Antenna	Frequency[MHz]	Result[MHz]	Limit[MHz]	Verdict
DH5	Ant1	Hop	0.978	≥0.960	PASS
2DH5	Ant1	Hop	0.996	≥0.852	PASS
3DH5	Ant1	Hop	1.01	≥0.872	PASS

Test Graphs

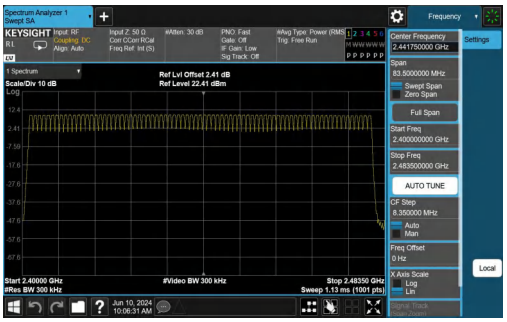
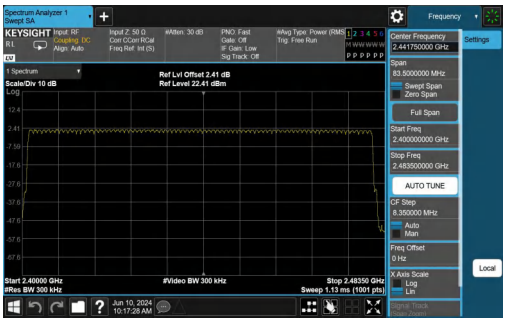
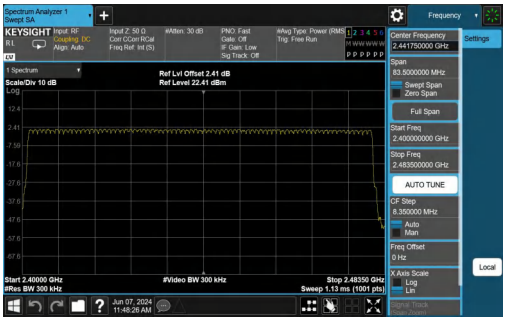
DH5-Ant1-Hop-PASS	2DH5-Ant1-Hop-PASS
	
3DH5-Ant1-Hop-PASS	/
	/

A.6 Number of Channel Measurement

Test Result

Test Mode	Antenna	Frequency[MHz]	Result[Num]	Limit[Num]	Verdict
DH5	Ant1	Hop	79	≥15	PASS
2DH5	Ant1	Hop	79	≥15	PASS
3DH5	Ant1	Hop	79	≥15	PASS

Test Graphs

DH5-Ant1-Hop-PASS	2DH5-Ant1-Hop-PASS
	
3DH5-Ant1-Hop-PASS	/
	/

A.7 Conducted Spurious Emission Measurement

Test Result

Test Mode	Antenna	Frequency [MHz]	Freq Range [MHz]	Ref Level [dBm]	Result [dBm]	Limit [dBm]	Verdict
DH5	Ant1	2402	30~1000	9.93	-68.77	≤-10.07	PASS
DH5	Ant1	2402	1000~26500	9.93	-55.39	≤-10.07	PASS
DH5	Ant1	2441	30~1000	10.50	-67.93	≤-9.5	PASS
DH5	Ant1	2441	1000~26500	10.50	-54.05	≤-9.5	PASS
DH5	Ant1	2480	30~1000	10.01	-68.7	≤-9.99	PASS
DH5	Ant1	2480	1000~26500	10.01	-54.99	≤-9.99	PASS
2DH5	Ant1	2402	30~1000	6.25	-69.21	≤-13.75	PASS
2DH5	Ant1	2402	1000~26500	6.25	-54.53	≤-13.75	PASS
2DH5	Ant1	2441	30~1000	6.25	-69.49	≤-13.75	PASS
2DH5	Ant1	2441	1000~26500	6.25	-54.8	≤-13.75	PASS
2DH5	Ant1	2480	30~1000	5.98	-69.07	≤-14.02	PASS
2DH5	Ant1	2480	1000~26500	5.98	-54.2	≤-14.02	PASS
3DH5	Ant1	2402	30~1000	5.40	-67.92	≤-14.6	PASS
3DH5	Ant1	2402	1000~26500	5.40	-55.12	≤-14.6	PASS
3DH5	Ant1	2441	30~1000	5.41	-69.2	≤-14.59	PASS
3DH5	Ant1	2441	1000~26500	5.41	-54.92	≤-14.59	PASS
3DH5	Ant1	2480	30~1000	5.14	-67.93	≤-14.86	PASS
3DH5	Ant1	2480	1000~26500	5.14	-54.4	≤-14.86	PASS

Test Graphs

DH5-Ant1-2402-30~1000-PASS

DH5-Ant1-2402-1000~26500-PASS

DH5-Ant1-2441-30~1000-PASS

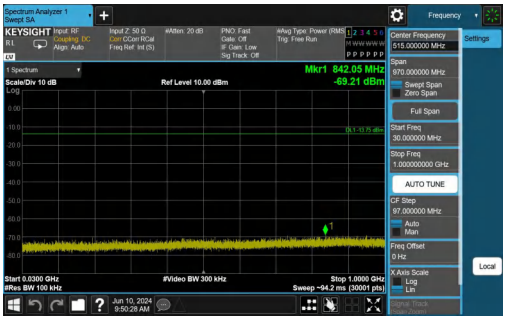
DH5-Ant1-2441-1000~26500-PASS

DH5-Ant1-2480-30~1000-PASS

DH5-Ant1-2480-1000~26500-PASS

2DH5-Ant1-2402-30~1000-PASS

2DH5-Ant1-2402-1000~26500-PASS



2DH5-Ant1-2441-30~1000-PASS

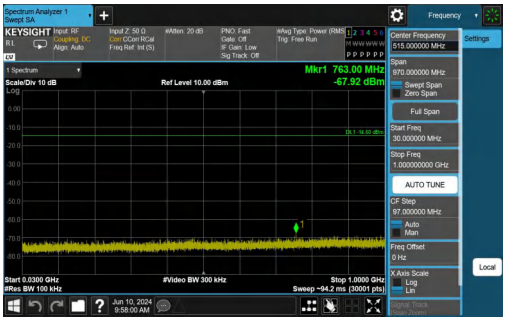
2DH5-Ant1-2441-1000~26500-PASS

2DH5-Ant1-2480-30~1000-PASS

2DH5-Ant1-2480-1000~26500-PASS

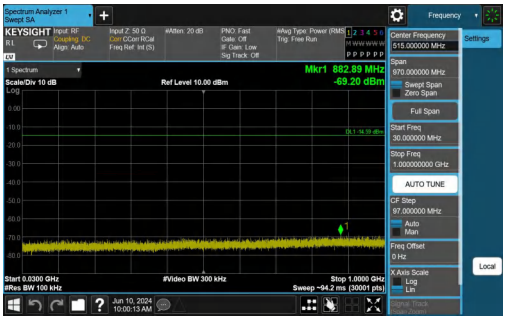
3DH5-Ant1-2402-30~1000-PASS

3DH5-Ant1-2402-1000~26500-PASS



3DH5-Ant1-2441-30~1000-PASS

3DH5-Ant1-2441-1000~26500-PASS



3DH5-Ant1-2480-30~1000-PASS

3DH5-Ant1-2480-1000~26500-PASS

A.8 Duty Cycle

Test Result

Test Mode	Antenna	Frequency[MHz]	ON Time[ms]	Period[ms]	Duty Cycle[%]	Duty Cycle Factor[dB]
DH5	Ant1	2402	2.89	3.75	77.07	1.13
DH5	Ant1	2441	2.88	3.75	76.80	1.15
DH5	Ant1	2480	2.89	3.75	77.07	1.13
2DH5	Ant1	2402	2.89	3.75	77.07	1.13
2DH5	Ant1	2441	2.89	3.75	77.07	1.13
2DH5	Ant1	2480	2.88	3.75	76.80	1.15
3DH5	Ant1	2402	2.89	3.75	77.07	1.13
3DH5	Ant1	2441	2.88	3.75	76.80	1.15
3DH5	Ant1	2480	2.89	3.75	77.07	1.13

Note:

Duty cycle=on time/100ms=2*2.89/100=5.78%

Duty cycle Correction factor= 20*log(Duty cycle)= -24.76dB

Test Graphs

NTNV-DH5-Ant1-2402

NTNV-DH5-Ant1-2441

NTNV-DH5-Ant1-2480

NTNV-2DH5-Ant1-2402

NTNV-2DH5-Ant1-2441

NTNV-2DH5-Ant1-2480

	
NTNV-3DH5-Ant1-2402	NTNV-3DH5-Ant1-2441
	
NTNV-3DH5-Ant1-2480	/
	/

Appendix B – Test Results of Radiated Test

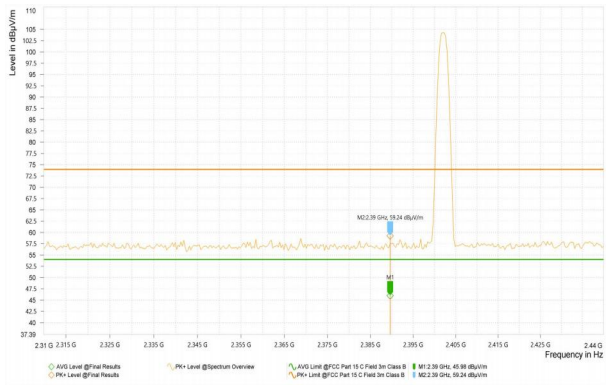
B.1 Radiated Band Edges and Spurious Emission

Test Result_Band Edges

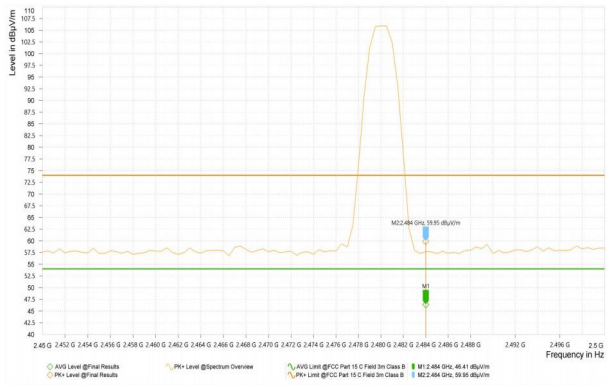
Test Mode & Test Freq.[MHz]	Frequency [MHz]	PK+ Level [dBμV/m]	PK+ Limit [dBμV/m]	PK+ Margin [dB]	AVG Level [dBμV/m]	AVG Limit dBμV/m]	AVG Margin [dB]	Polarization	Azimuth [deg]
BT_DH5_2402	2,389.625	59.24	74.00	14.76	34.48	54.00	19.52	H	292.5
BT_DH5_2480	2,484.000	59.95	74.00	14.05	35.19	54.00	18.81	V	357.4
BT_2DH5_2402	2,389.625	59.11	74.00	14.89	34.35	54.00	19.65	H	291.4
BT_2DH5_2480	2,484.000	60.01	74.00	13.99	35.25	54.00	18.75	V	266.2

Test Graphs_Band Edges

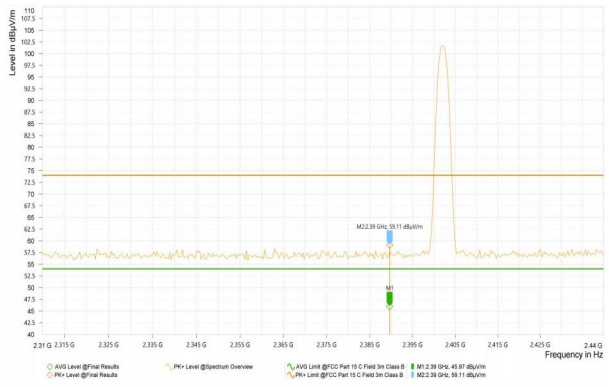
BT_DH5_2402_edge



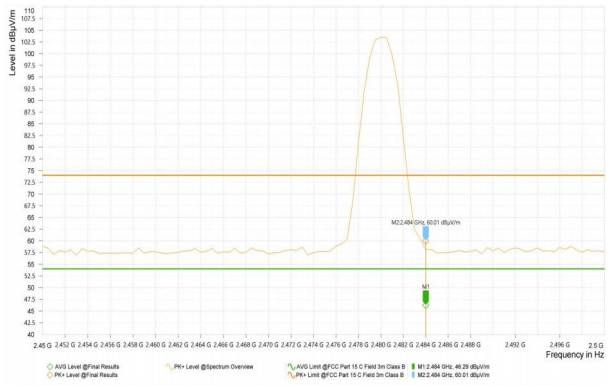
BT_DH5_2480_edge



BT_2DH5_2402_edge



BT_2DH5_2480_edge



Test Result_Spurious Emission

Note1: Test result Sweep the whole frequency band through the range from 9kHz to the 10th harmonic of the carrier the Emissions in the frequency band 9kHz-30MHz and above 18GHz are more than 20dB below the limit are not reported.

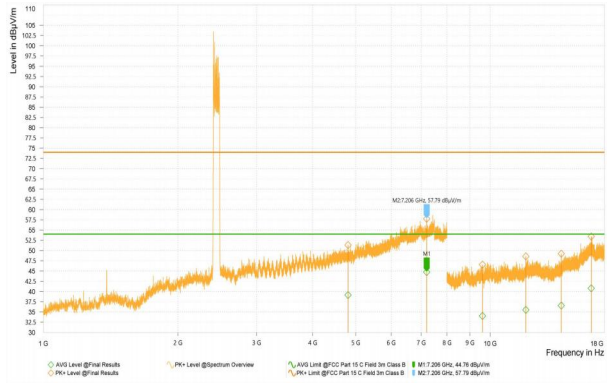
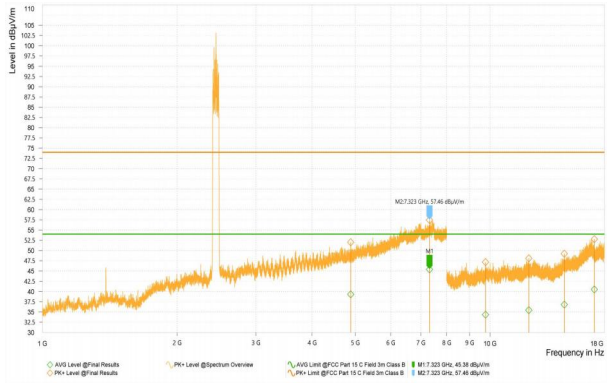
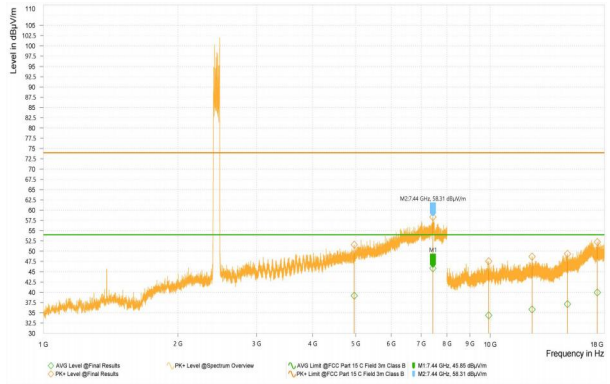
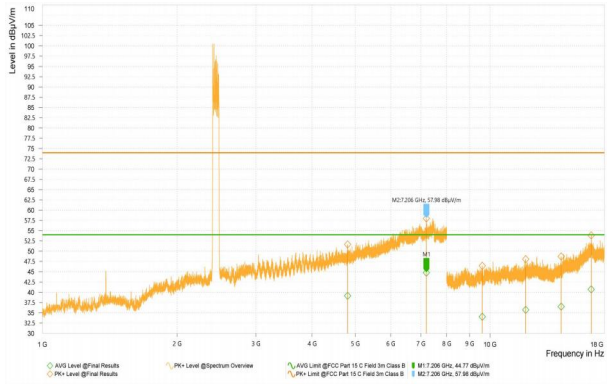
Note2: 'Low' indicates a frequency range below 1GHz, and 'High' indicates a frequency range above 1GHz.

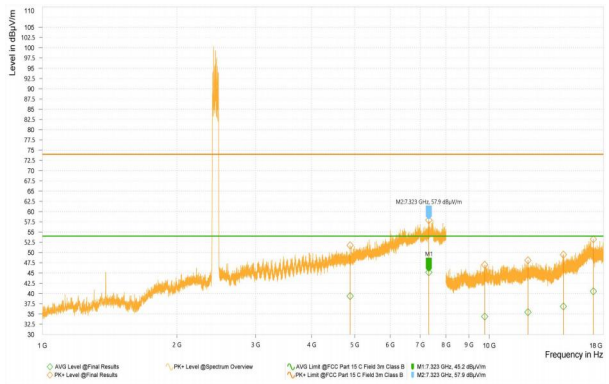
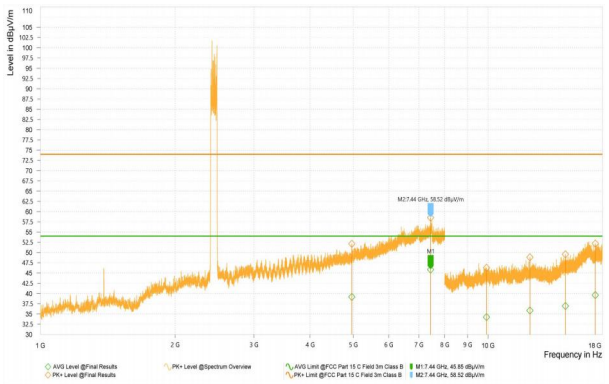
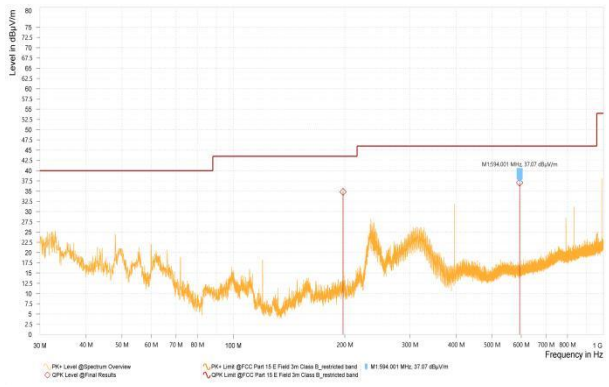
Test Mode & Test Freq.[MHz]	Frequency [MHz]	PK+ Level [dBμV/m]	PK+ Limit [dBμV/m]	PK+ Margin [dB]	AVG Level [dBμV/m]	AVG Limit dBμV/m]	AVG Margin [dB]	Polarization	Azimuth [deg]
BT_DH5_2402_High	4,804.000	51.35	74.00	22.65	26.59	54.00	27.41	H	360
	7,206.000	57.79	74.00	16.21	33.03	54.00	20.97	V	171.8
	9,608.000	46.56	74.00	27.44	21.8	54.00	32.2	H	200.2
	12,010.000	48.58	74.00	25.42	23.82	54.00	30.18	H	312.5
	14,412.000	49.22	74.00	24.78	24.46	54.00	29.54	V	151.2
	16,814.000	53.43	74.00	20.57	28.67	54.00	25.33	H	0
BT_DH5_2441_High	4,882.000	52.04	74.00	21.96	27.28	54.00	26.72	H	341.5
	7,323.000	57.46	74.00	16.54	32.7	54.00	21.3	H	174.2
	9,764.000	47.17	74.00	26.83	22.41	54.00	31.59	H	360
	12,205.000	48.11	74.00	25.89	23.35	54.00	30.65	H	48.8
	14,646.000	49.23	74.00	24.77	24.47	54.00	29.53	V	360
	17,087.000	52.77	74.00	21.23	28.01	54.00	25.99	H	161
BT_DH5_2480_High	4,960.000	51.60	74.00	22.40	26.84	54.00	27.16	V	67.8
	7,440.000	58.31	74.00	15.69	33.55	54.00	20.45	V	190.6
	9,920.000	47.54	74.00	26.46	22.78	54.00	31.22	H	42.8
	12,400.000	48.67	74.00	25.33	23.91	54.00	30.09	H	360
	14,880.000	49.38	74.00	24.62	24.62	54.00	29.38	V	357.8
	17,360.000	52.22	74.00	21.78	27.46	54.00	26.54	H	260
BT_2DH5_2402_High	4,804.000	51.64	74.00	22.36	26.88	54.00	27.12	V	64.2
	7,206.000	57.98	74.00	16.02	33.22	54.00	20.78	H	248
	9,608.000	46.46	74.00	27.54	21.7	54.00	32.3	H	360
	12,010.000	48.06	74.00	25.94	23.3	54.00	30.7	V	360
	14,412.000	48.72	74.00	25.28	23.96	54.00	30.04	V	1.9
	16,814.000	53.85	74.00	20.15	29.09	54.00	24.91	V	318.6
BT_2DH5_2441_High	4,882.000	51.74	74.00	22.26	26.98	54.00	27.02	H	310.5
	7,323.000	57.90	74.00	16.10	33.14	54.00	20.86	V	185.8
	9,764.000	47.01	74.00	26.99	22.25	54.00	31.75	H	0
	12,205.000	48.11	74.00	25.89	23.35	54.00	30.65	V	256.4
	14,646.000	49.50	74.00	24.50	24.74	54.00	29.26	V	0
	17,087.000	53.26	74.00	20.74	28.5	54.00	25.5	H	360
BT_2DH5_2480_High	4,960.000	52.14	74.00	21.86	27.38	54.00	26.62	H	12.4
	7,440.000	58.52	74.00	15.48	33.76	54.00	20.24	V	169.4

	9,920.000	46.27	74.00	27.73	21.51	54.00	32.49	H	0
	12,400.000	48.83	74.00	25.17	24.07	54.00	29.93	V	203.8
	14,880.000	49.55	74.00	24.45	24.79	54.00	29.21	H	0
	17,360.000	52.20	74.00	21.80	27.44	54.00	26.56	H	153.9

Test Mode & Test Freq.[MHz]	Frequency [MHz]	QPK Level [dBμV/m]	QPK Limit [dBμV/m]	QPK Margin [dB]	Polarization	Azimuth [deg]
BT_DH5_2441_Low	197.972	34.81	43.50	8.69	H	263.7
	594.001	37.07	46.00	8.93	V	359

Test Graphs_Spurious Emission

BT_DH5_2402_High	BT_DH5_2441_High
	
BT_DH5_2480_High	**BT_2DH5_2402_High**
	
BT_2DH5_2441_High	**BT_2DH5_2480_High**

	
BT_DH5_2441_Low	/
	/

Appendix C – The EUT Appearance

Refer to “Attachment A.1: External Photograph” and “ Attachment A.2: Internal Photograph” file.

Appendix D – Test Setup Photograph

Refer to “Attachment A.5: RF Test Setup Photograph” file.

******End of the Report******