Northwest Instrument Inc.

RF TEST REPORT

Report Type:
FCC Part 15.247

Model:
NTS03

REPORT NUMBER:
220601004SHA-001

ISSUE DATE:
Aug 3, 2022

DOCUMENT CONTROL NUMBER:
TTRF15.247-01_V1 © 2018 Intertek

Intertek Testing Services Shanghai
Building No.86, 1198 Qinzhou Road (North)
Caohejing Development Zone
Shanghai 200233, China

Telephone: 86 21 6127 8200
www.intertek.com
Report no.: 220601004SHA-001

Total Quality. Assured.

TEST REPORT

Applicant:	Northwest Instrument Inc. 69 King Street, Dover, NJ 07801, USA
Manufacturer:	Northwest Instrument (Shanghai) Co., Ltd. B2-B No.303, Xinke Road, Qingpu Industrial Zone, 201707 Shanghai, P.R. China
Product Name:	Total Station
Type/Model:	NTS03
FCC ID:	2ADA6-NTS03

SUMMARY:

The equipment complies with the requirements according to the following standard(s) or Specification:
47CFR Part 15 (2020): Radio Frequency Devices (Subpart C) **ANSI C63.10 (2013):** American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

PREPARED BY:	**REVIEWED BY:**
Scout Gong	Wakeyou Wang
Project Engineer	Reviewer

Total Quality. Assured.

TEST REPORT

Content

Total Quality. Assured.

TEST REPORT

Revision History

Report No.	Version	Description	Issued Date
220601004SHA-001	Rev. 01	Initial issue of report	Aug 3, 2022

Measurement result summary

TEST ITEM	FCC REFERANCE	RESULT
20 dB Bandwidth	15.247(a)(1)	Pass
Carrier Frequency Separation	15.247(a)(1)	Pass
Output power	15.247(b)(1)	Pass
Radiated Emissions	15.205 & 15.209	Pass
Conducted Spurious Emissions & Band Edge	15.247(d)	Pass
Power line conducted emission	15.207	Pass
Number of Hopping Frequencies	15.247(a)(1)(iii)	Pass
Dwell time	15.247(a)(1)(iii)	Pass
Occupied bandwidth	-	Tested
Antenna requirement	15.203	Pass

Notes: 1: NA =Not Applicable

TEST REPORT

1 GENERAL INFORMATION

1.1 Description of Equipment Under Test (EUT)

Product name:	Total Station
Type/Model:	NTS03
Description of EUT:	The equipment under test (EUT) is a detector with Bluetooth wireless function. There is only one model. After evaluation, the worst RF test date were listed in this report.
Rating:	7.4V DC RF module: 3.3V DC
Category of EUT:	Class B
EUT type:	☒ Tabletop ☐ Floor standing
Software Version:	/
Hardware Version:	/
Sample received date:	July 12, 2022
Date of test:	July 13, 2022, to July 28, 2022

1.2 Technical Specification

Frequency Range:	2400MHz ~ 2483.5MHz
Support Standards:	Bluetooth BR+EDR
Modulation Technique:	Frequency Hopping Spread Spectrum (FHSS)
Type of Modulation:	GFSK, π/4 DQPSK
Channel Number:	79 (0 - 78)
Data Rate:	1 Mbps
Channel Separation:	1 MHz
Antenna:	Internal PCB antenna, 2.07dBi gain

1.3 Frequency Hopping System Requirement

Test Requirement: Section 15.247 (a)(1), (g), (h) requirement:

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

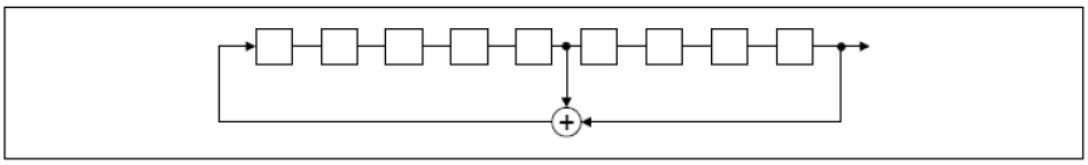
Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented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

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

Compliance for section 15.247(a)(1)

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

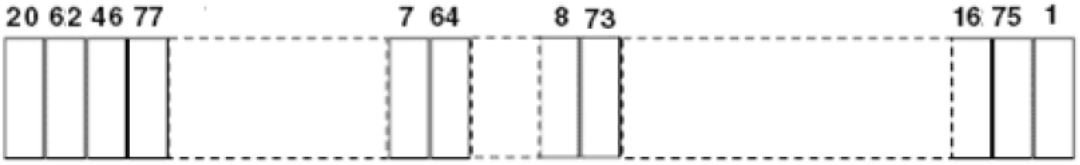
- Number of shift register stages: 9
- Length of pseudo-random sequence: 2^9 -1 = 511 bits
- Longest sequence of zeros: 8 (non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence

TEST REPORT

An example of Pseudorandom Frequency Hopping Sequence as follow:



Each frequency used equally on the average by each transmitter.
According to Bluetooth Core Specification, Bluetooth receivers are designed to have input and IF bandwidths that match the hopping channel bandwidths of any Bluetooth transmitters and shift frequencies in synchronization with the transmitted signals.

Compliance for section 15.247(g)

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

Compliance for section 15.247(h)

According to Bluetooth Core specification, the Bluetooth system incorporates with an adaptive system to detect other user within the spectrum band so that it individually and independently to avoid hopping on the occupied channels.
According to the Bluetooth Core specification, the Bluetooth system is designed not have the ability to coordinate with other FHSS System in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitter.

1.4 Description of Test Facility

Name:	Intertek Testing Services Shanghai
Address:	Building 86, No. 1198 Qinzhou Road (North), Shanghai 200233, P.R. China
Telephone:	86 21 61278200
Telefax:	86 21 54262353

The test facility is recognized, certified, or accredited by these organizations:	CNAS Accreditation Lab Registration No. CNAS L0139
	FCC Accredited Lab Designation Number: CN1175
	IC Registration Lab Registration code No.: 2042B-1
	VCCI Registration Lab Registration No.: R-4243, G-845, C-4723, T-2252
	A2LA Accreditation Lab Certificate Number: 3309.02

2 TEST SPECIFICATIONS

2.1 Standards or specification

47CFR Part 15 (2020)
ANSI C63.10 (2013)
KDB 558074 (v05or02)

2.2 Mode of operation during the test

While testing the transmitter mode of the EUT, the internal modulation is applied.
All the functions of the host device except the BT module were set on stand-by mode.

The test setting software is offered by the manufactory. The pre-scan for the conducted power with all rates in each modulation and bands was used, and the worst case was found and used in all test cases.

The worst-case modulation configuration:

Worst Modulation Used for Conformance Testing			
Bluetooth Mode	**Data Rate**	**Packet Type**	**Worst Mode**
GFSK	BR-1Mbps	DH1, DH3, DH5	**BR-1Mbps DH5** EDR-2Mbps 2DH5
π/4 DQPSK	EDR-2Mbps	2DH1, 2DH3, 2DH5	
Note: The BR-1Mbps DH5 mode was chosen for radiation emission bellow 1GHz and Conducted emission testing as representative in this report.			

The power setting parameter:

The worst-case power setting parameter			
Test software Version	CH34x_Install_Windows_v3_4		
Modulation Mode	2402MHz	2441MHz	2480MHz

Radiated test mode: EUT transmitted signal with BT antenna;
Conducted test mode: EUT transmitted signal from BT RF port connected to SPA directly;

2.3 Test software list

Test Items	Software	Manufacturer	Version
Conducted emission	ESxS-K1	R&S	V2.1.0
Radiated emission	ES-K1	R&S	V1.71

2.4 Test peripherals list

Item No.	Name	Band and Model	Description
1	Laptop computer	Dell	-
2	Adaptor	ZCH10	Input 100-240VAC, 0.25A

2.5 Test environment condition:

Test items	Temperature	Humidity
20 dB Bandwidth	23°C	52% RH
Output power		
Carrier Frequency Separation		
Number of Hopping Frequencies		
Dwell time		
Occupied bandwidth		
Conducted Spurious Emissions & Band Edge		
Power line conducted emission	22°C	51% RH
Radiated Emissions	22°C	55% RH

2.6 Instrument list

Conducted Emission					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
☑	Test Receiver	R&S	ESR7	EC 6194	2022-12-09
☑	A.M.N.	R&S	ESH2-Z5	EC 3119	2022-11-09
☑	Attenuator	Weinschel	68-6-44	EC 3043-9	2023-02-08
☑	Shielded room	Zhongyu	-	EC 2838	2023-01-11
Radiated Emission					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
☑	Test Receiver	R&S	ESIB 26	EC 3045	2022-10-19
☑	Bilog Antenna	TESEQ	CBL 6112B	EC 6411	2022-11-05
☑	Pre-amplifier	tonscend	tap01018050	EC 6432-1	2022-12-26
☑	Horn antenna	tonscend	bha9120d	EC 6432-2	2023-01-09
☑	Horn antenna	ETS	3117	EC 4792-1	2023-03-27
☑	Horn antenna	TOYO	HAP18-26W	EC 4792-3	2023-07-08
☑	Pre-amplifier	R&S	AFS42-00101800 -25-S-42	EC 5262	2022-09-08
☑	Semi-anechoic chamber	Albatross project	-	EC 3048	2022-08-22
RF test					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
☑	PXA Signal Analyzer	Keysight	N9030A	EC 5338	2023-03-14
☑	Power sensor	Agilent	U2021XA	EC 5338-1	2023-03-14
☑	Vector Signal Generator	Agilent	N5182B	EC 5175	2023-03-14
☑	MXG Analog Signal Generator	Agilent	N5181A	EC 5338-2	2023-03-14
☑	Test Receiver	R&S	ESCI 7	EC 4501	2022-12-09
☑	Climate chamber	GWS	MT3065	EC 6021	2023-03-06
☑	Spectrum Analyzer	Keysight	N9030b	EC 6078	2022-09-08
☑	Universal Radio Communication Tester	R&S	CMW500	EC 6209	2023-01-20
☑	Signal generator	Agilent	N5182A	EC 6172	2022-08-19
☑	Signal generator	Agilent	N5181A	EC 6171	2022-08-19
Additional instrument					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
☑	Therom-Hygrograph	ZJ1-2A	S.M.I.F.	EC 3442	2023-01-03
☑	Pressure meter	YM3	Shanghai Mengde	EC 3320	2022-10-21

2.7 Measurement uncertainty

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

Test item	Measurement uncertainty
Maximum peak output power	± 0.74dB
Radiated Emissions in restricted frequency bands below 1GHz	± 4.90dB
Radiated Emissions in restricted frequency bands above 1GHz	± 5.02dB
Emission outside the frequency band	± 2.89dB
Power line conducted emission	± 3.19dB

3 20dB bandwidth

Test result: Pass

3.1 Limit

☐ 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.

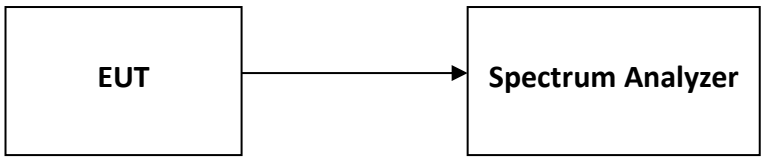
☒ Frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125mW.

3.2 Measurement Procedure

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency.The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW.
b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement.
c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level.
d) Steps a) through c) might require iteration to adjust within the specified tolerances.
e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target “−xx dB down” requirement; that is, if the requirement calls for measuring the −20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the reference value.
f) Set detection mode to peak and trace mode to max hold.
g) Determine the reference value: Set the EUT to transmit an unmodulated carrier or modulated signal, as applicable. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).
h) Determine the “−xx dB down amplitude” using [(reference value) − xx]. Alternatively, this calculation may be made by using the marker-delta function of the instrument.
i) If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j).
j) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the “−xx dB down amplitude” determined in step h). If a marker is below this “−xx dB down amplitude” value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the “−xx dB down amplitude” determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.

k) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

3.3 Test Configuration



3.4 Test Results of 20dB bandwidth

Please refer to Appendix A.

4 Carrier Frequency Separation

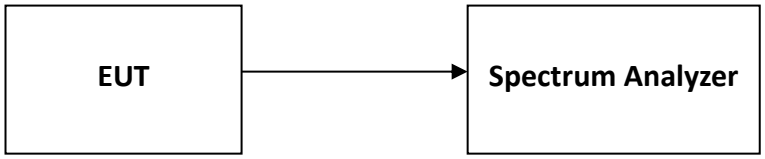
Test result: Pass

4.1 Limit

☐ Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

☒ 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 125mW.

4.2 Test Configuration



4.3 Test Procedure and test setup

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: Wide enough to capture the peaks of two adjacent channels.
b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
c) Video (or average) bandwidth (VBW) ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.

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

4.4 Test Results of Carrier Frequency Separation

Please refer to Appendix A.

5 Output power

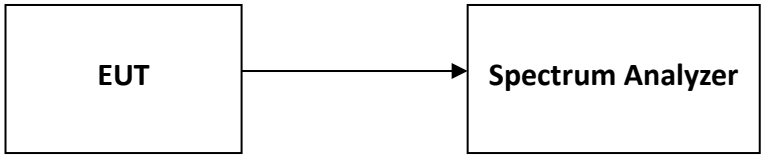
Test result: Pass

5.1 Limit

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. (The e.i.r.p. shall not exceed 4 W)

If the transmitting antenna of directional gain greater than 6dBi is used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

5.2 Test Configuration



5.3 Measurement Procedure

This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test:

a) Use the following spectrum analyzer settings:
   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.
b) Allow trace to stabilize.
c) Use the marker-to-peak function to set the marker to the peak of the emission.
d) The indicated level is the peak output power, after any corrections for external attenuators and cables.
e) A plot of the test results and setup description shall be included in the test report.

5.4 Test Results of Output Power

Please refer to Appendix A.

6 Radiated Emissions

Test result: **Pass**

6.1 Limit

The radiated emissions which fall in the restricted bands, must also comply with the radiated emission limits specified showed as below:

Frequencies (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

6.2 Measurement Procedure

For Radiated emission below 30MHz:

a) The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
b) The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c) Both X and Y axes of the antenna are set to make the measurement.
d) For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
e) The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

TEST REPORT

For Radiated emission above 30MHz:

a) The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.

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

c) The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

d) For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e) The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.

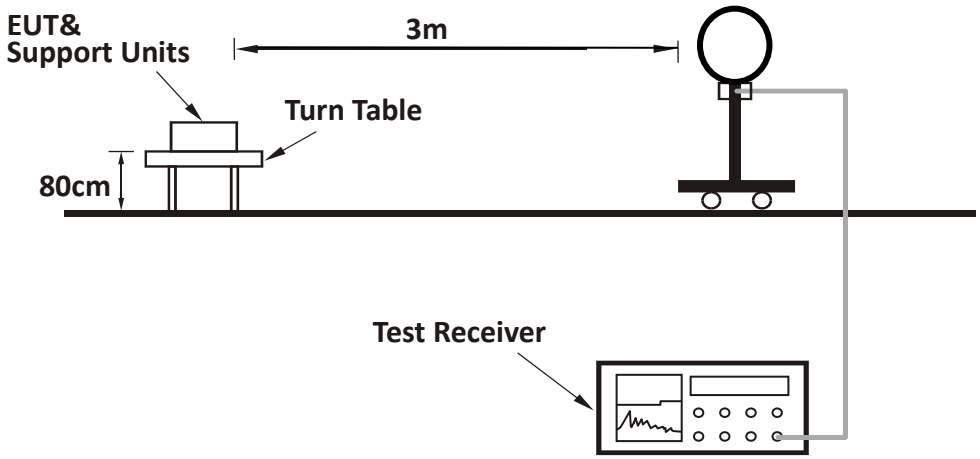
f) The test-receiver system was set to peak and average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

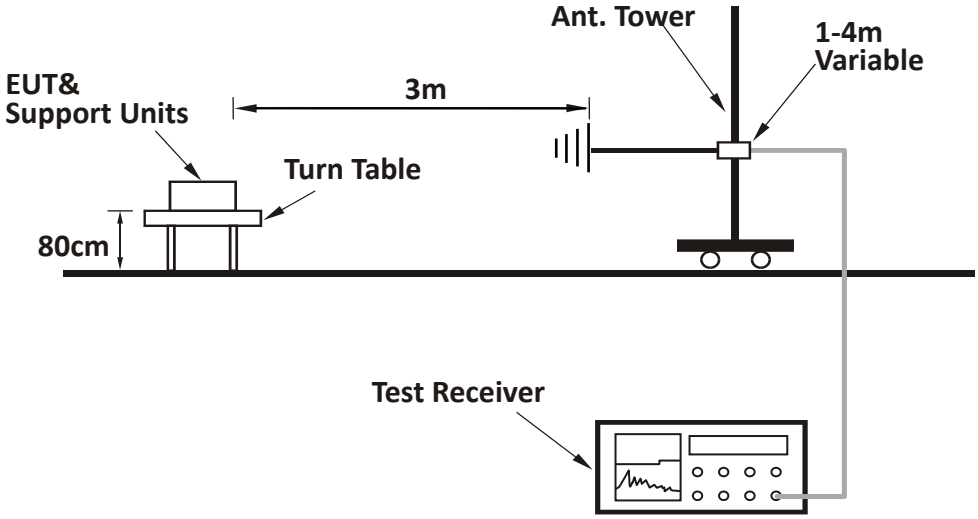
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is ≥ 1/T (Duty cycle < 98%) or 3 x RBW (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported

6.3 Test Configuration

For Radiated emission below 30MHz:

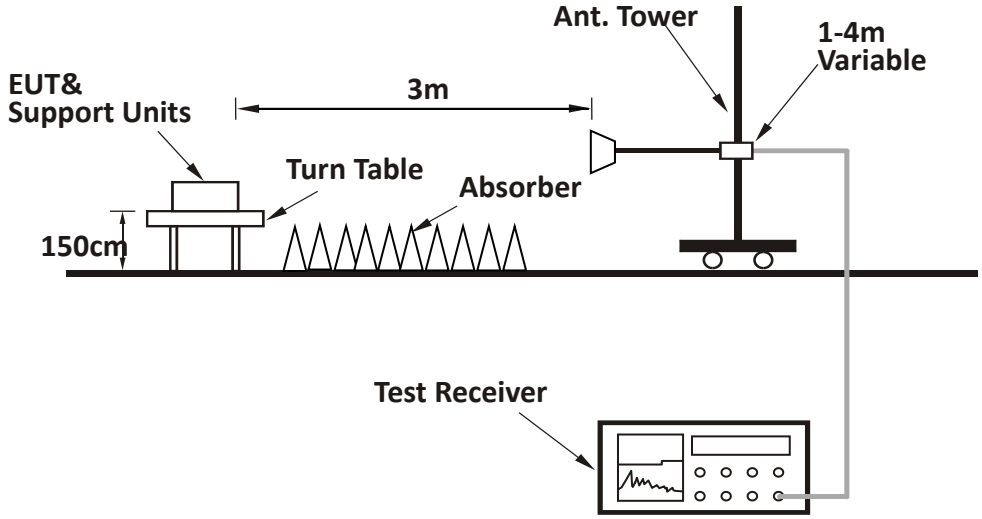


For Radiated emission 30MHz to 1GHz:



TEST REPORT

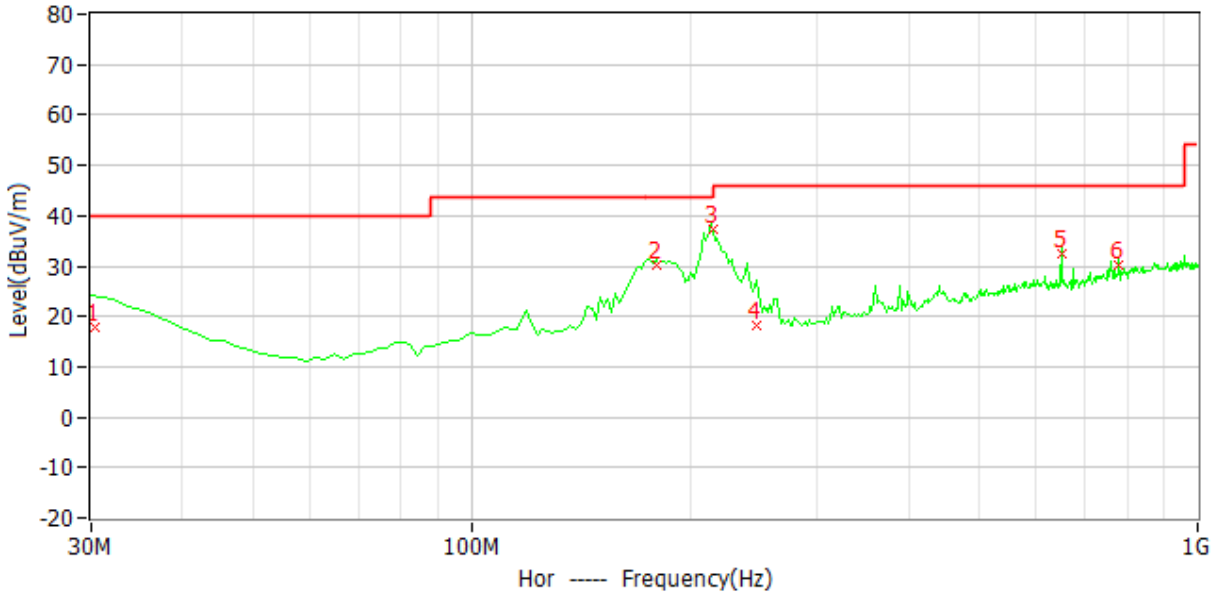
For Radiated emission above 1GHz:

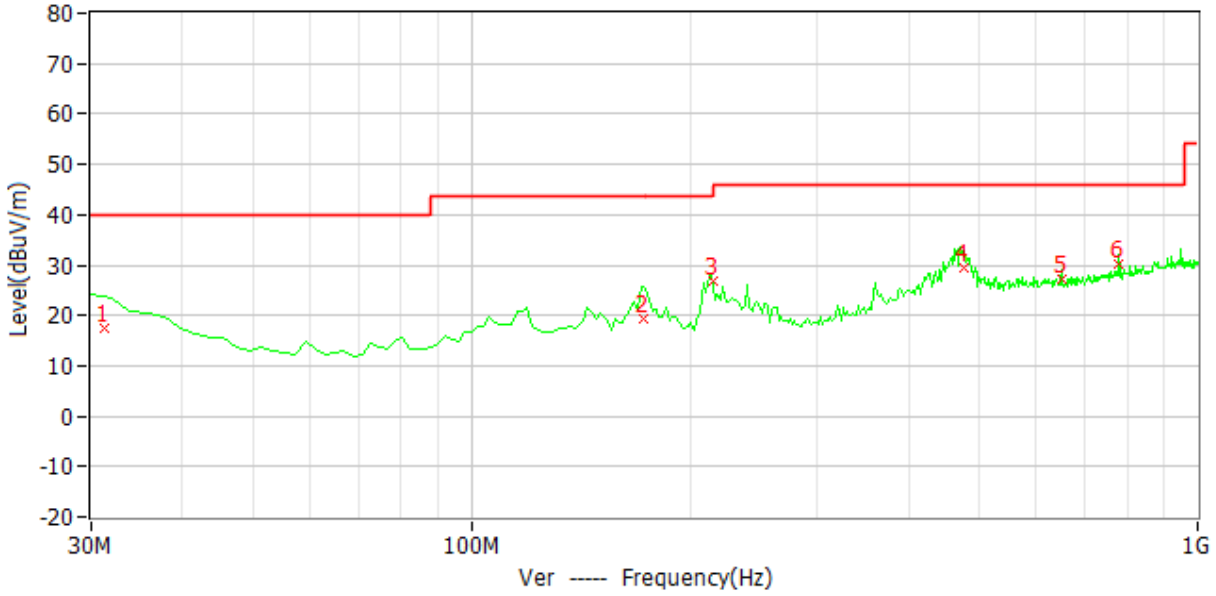


6.4 Test Results of Radiated Emissions

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

The worst waveform from 30MHz to 1000MHz is listed as below:





TEST REPORT

Test data 30MHz~1GHz:

Polarization	Frequency (MHz)	Measured level (dBμV/m)	Correct Factor (dB/m)	Limits (dBμV/m)	Margin (dB)	Detector
H	30.33	18.00	21.20	40.00	22.00	QP
	180.41	30.30	11.10	43.50	13.20	QP
	215.30	37.30	11.30	43.50	6.20	QP
	247.55	18.10	14.40	46.00	27.90	QP
	649.89	32.30	22.40	46.00	13.70	QP
	779.99	30.20	23.50	46.00	15.80	QP
V	31.33	17.40	20.60	40.0	22.60	QP
	172.96	19.30	11.40	43.50	24.20	QP
	215.28	26.80	11.30	43.50	16.70	QP
	475.69	29.30	20.00	46.00	16.70	QP
	649.99	27.30	22.40	46.00	18.70	QP
	779.99	30.10	23.50	46.00	15.90	QP

Remark:

1. Correct Factor = Antenna Factor + Cable Loss (+ Amplifier, for higher than 1GHz), the value was added to Original Receiver Reading by the software automatically.
2. Measured Level= Original Receiver Reading + Correct Factor
3. Margin= Limit - Measured Level
4. If the PK Corrected Reading is lower than AV limit, the AV test can be elided.

Example:

Assuming Antenna Factor = 30.20dB/m, Cable Loss= 2.00dB,
Gain of Preamplifier = 32.00dB, Original Receiver Reading = 10.00dBuV,
Limit= 40.00dBuV/m.
Then Correct Factor = 30.20 + 2.00 –32.00 = 0.20dB/m;
Measured Level= 10dBuV + 0.20dB/m = 10.20dBuV/m;
Margin= 40.00dBuV/m -10.20dBuV/m = 29.80dB.

TEST REPORT

Test result of 1GHz to 25GHz:

GFSK (DH5) Modulation:

CH	Antenna	Frequency (MHz)	Correct Factor (dB/m)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
L	H	2390.00	30.30	45.30	74.00	28.70	PK
	V	2390.00	30.30	46.50	74.00	27.50	PK
	H	4804.00	-1.50	41.50	74.00	32.50	PK
	V	4804.00	-1.50	41.70	74.00	32.30	PK
M	H	4882.00	-1.00	40.90	74.00	33.10	PK
	V	4882.00	-1.00	40.20	74.00	33.80	PK
H	H	2483.50	30.80	44.80	74.00	29.20	PK
	V	2483.50	30.80	45.20	74.00	28.80	PK
	H	4960.00	-0.80	41.80	74.00	32.20	PK
	V	4960.00	-0.80	41.60	74.00	32.40	PK

π/4DQPSK (2DH5) Modulation:

CH	Antenna	Frequency (MHz)	Correct Factor (dB/m)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
L	H	2390.00	30.30	45.10	74.00	28.90	PK
	V	2390.00	30.30	45.80	74.00	28.20	PK
	H	4804.00	-1.50	41.20	74.00	32.80	PK
	V	4804.00	-1.50	40.50	74.00	33.50	PK
M	H	4882.00	-1.00	41.40	74.00	32.60	PK
	V	4882.00	-1.00	42.60	74.00	31.40	PK
H	H	2483.50	30.80	46.20	74.00	27.80	PK
	V	2483.50	30.80	45.60	74.00	28.40	PK
	H	4960.00	-0.80	41.90	74.00	32.10	PK
	V	4960.00	-0.80	40.80	74.00	33.20	PK

Remark: 1. Correct Factor = Antenna Factor + Cable Loss (- Amplifier, for higher than 1GHz), the value was added to Original Receiver Reading by the software automatically.
2. Corrected Reading = Original Receiver Reading + Correct Factor
3. Margin = Limit - Corrected Reading
4. If the PK Corrected Reading is lower than AV limit, the AV test can be elided.

Example: Assuming Antenna Factor = 30.20dB/m, Cable Loss = 2.00dB,
Gain of Preamplifier = 32.00dB, Original Receiver Reading = 10.00dBuV,
Limit = 40.00dBuV/m.
Then Correct Factor = 30.20 + 2.00 – 32.00 = 0.20dB/m;
Corrected Reading = 10dBuV + 0.20dB/m = 10.20dBuV/m;
Margin = 40.00dBuV/m - 10.20dBuV/m = 29.80dB.

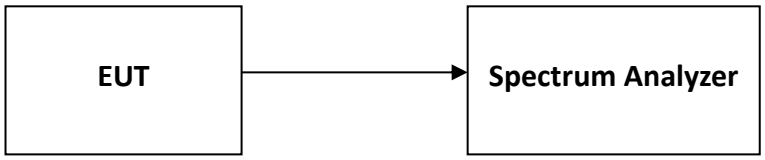
7 Conducted Spurious Emissions & Band Edge

Test result: **Pass**

7.1 Limit

In any 100kHz bandwidth outside the frequency band in which the spread spectrum 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 100kHz bandwidth within the band that contains the highest level of the desired power.

7.2 Test Configuration



7.3 Measurement Procedure

a) Connect the EMI receiver or spectrum analyzer to the EUT using an appropriate RF cable connected to the EUT output. Configure the spectrum analyzer settings as described in step e)
b) Set the EUT to the lowest frequency channel (for the hopping on test, the hopping sequence shall include the lowest frequency channel).
c) Set the EUT to operate at maximum output power and 100% duty cycle, or equivalent “normal mode of operation” as specified in 6.10.3. of ANSI C63.10.
d) If using the radiated method, then use the applicable procedure(s) of 6.4, 6.5, or 6.6 of ANSI C63.10, and orient the EUT and measurement antenna positions to produce the highest emission level.
e) Perform the test as follows:
    1) Span: Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.
    2) Reference level: As required to keep the signal from exceeding the maximum instrument input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level.
    3) Attenuation: Auto (at least 10 dB preferred).
    4) Sweep time: Coupled.
    5) Resolution bandwidth: 100 kHz
    6) Video bandwidth: 300 kHz
    7) Detector: Peak
    8) Trace: Max hold
f) Allow the trace to stabilize. For the test with the hopping function turned ON, this can take several minutes to achieve a reasonable probability of intercepting any emissions due to oscillator

overshoot.

g) Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.

h) Repeat step c) through step e) for every applicable modulation.

i) Set the EUT to the highest frequency channel (for the hopping on test, the hopping sequence shall include the highest frequency channel) and repeat step c) through step d).

j) The band-edge measurement shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

7.4 Test Results of Conducted Spurious Emissions & Band Edge

Please refer to Appendix A

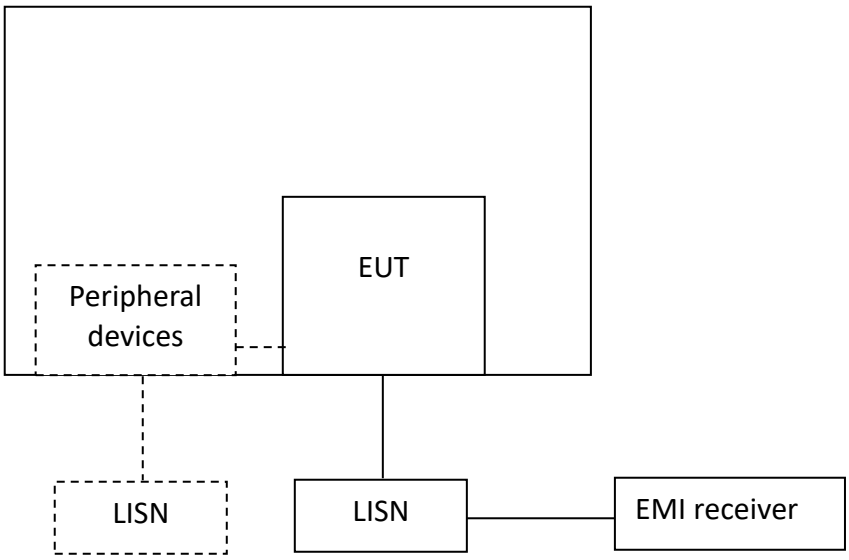
8 Power line conducted emission

Test result: **Pass**

8.1 Limit

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	QP	AV
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.		

8.2 Test Configuration



8.3 Measurement Procedure

Measured levels of ac power-line conducted emission shall be the emission voltages from the voltage probe, where permitted, or across the 50 Ω LISN port (to which the EUT is connected), where permitted, terminated into a 50 Ω measuring instrument. All emission voltage and current measurements shall be made on each current-carrying conductor at the plug end of the EUT power cord by the use of mating plugs and receptacles on the LISN, if used. Equipment shall be tested with power cords that are normally supplied or recommended by the manufacturer and that have electrical and shielding characteristics that are the same as those cords normally supplied or recommended by the manufacturer. For those measurements using a LISN, the 50 Ω measuring port is terminated by a measuring instrument having 50 Ω input impedance. All other ports are terminated in 50 Ω loads.

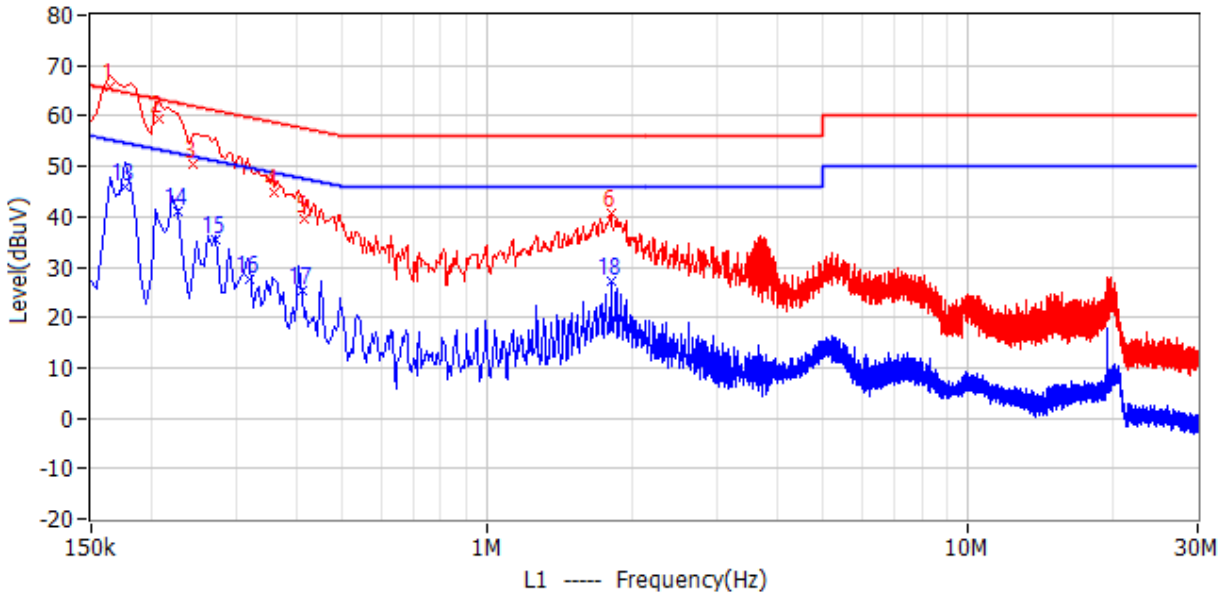
Tabletop devices shall be placed on a platform of nominal size 1 m by 1.5 m, raised 80 cm above the reference ground plane. The vertical conducting plane or wall of an RF-shielded (screened) room shall be located 40 cm to the rear of the EUT. Floor-standing devices shall be placed either directly on the reference ground-plane or on insulating material as described in ANSI C63.4. All other surfaces of tabletop or floor-standing EUTs shall be at least 80 cm from any other grounded conducting surface, including the case or cases of one or more LISNs.

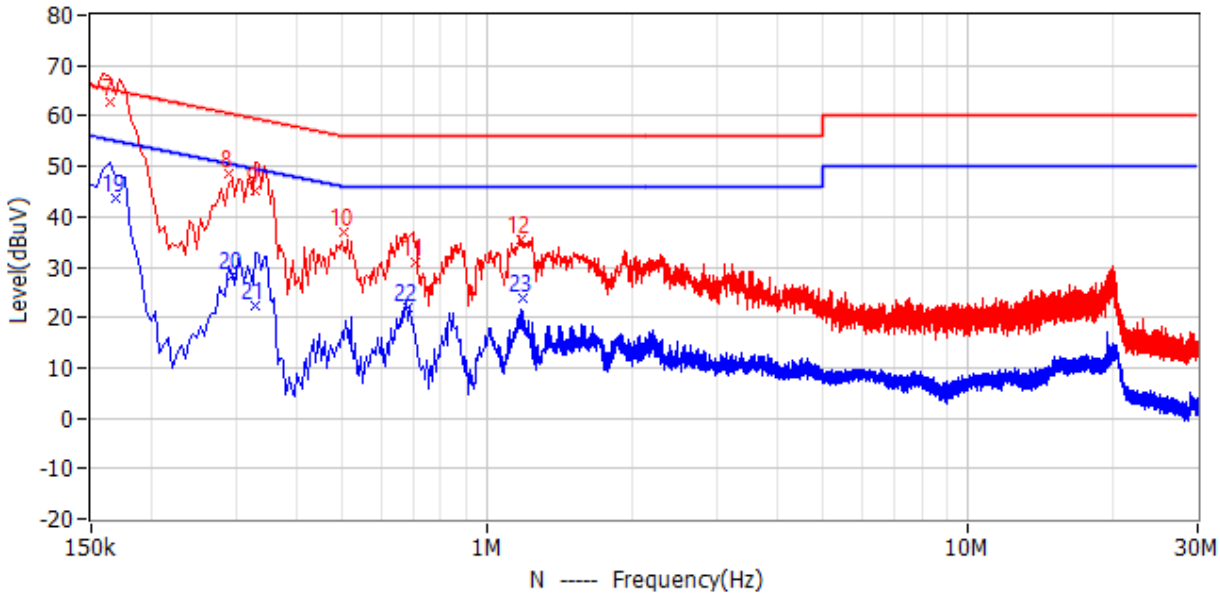
The bandwidth of the test receiver is set at 9 kHz.

8.4 Test Results of Power line conducted emission

Tested pass under 120VAC, 60Hz Input.

Test Curve:





TEST REPORT

Test Data:

Frequency	Limit (dBuV)	Correct Reading (dBuV)	Delta (dB)	Original Reading (dBuV)	Correct Factor (dB)	Detector	Phase
163.50kHz	65.30	65.90	-0.60	59.70	6.20	QP	L1
208.50kHz	63.30	59.50	3.80	53.30	6.20	QP	L1
244.50kHz	61.90	50.50	11.40	44.30	6.20	QP	L1
361.50kHz	58.70	44.70	14.00	38.50	6.20	QP	L1
415.50kHz	57.50	39.40	18.10	33.20	6.20	QP	L1
1.82MHz	56.00	40.70	15.30	34.50	6.20	QP	L1
163.50kHz	65.30	62.80	2.50	56.60	6.20	QP	N
289.50kHz	60.50	48.40	12.10	42.20	6.20	QP	N
330.00kHz	59.50	45.30	14.20	39.10	6.20	QP	N
501.00kHz	56.00	37.10	18.90	30.80	6.30	QP	N
708.00kHz	56.00	31.00	25.00	24.70	6.30	QP	N
1.17MHz	56.00	35.30	20.70	29.00	6.30	QP	N
177.00kHz	54.60	45.80	8.90	39.70	6.10	CAV	L1
226.50kHz	52.60	41.10	11.50	34.90	6.20	CAV	L1
271.50kHz	51.10	35.40	15.70	29.20	6.20	CAV	L1
321.00kHz	49.70	27.70	22.00	21.50	6.20	CAV	L1
411.00kHz	47.60	25.30	22.30	19.10	6.20	CAV	L1
1.82MHz	46.00	27.10	18.90	20.90	6.20	CAV	L1
168.00kHz	55.10	43.60	11.50	37.40	6.20	CAV	N
294.00kHz	50.40	28.20	22.20	22.00	6.20	CAV	N
330.00kHz	49.50	22.20	27.20	16.00	6.20	CAV	N
681.00kHz	46.00	22.00	24.00	15.70	6.30	CAV	N
1.19MHz	46.00	23.70	22.30	17.40	6.30	CAV	N

Remark:

1. *Correct Factor = LISN Factor + Cable Loss, the value was added to Original Receiver Reading by the software automatically.*
2. *Corrected Reading = Original Receiver Reading + Correct Factor*
3. *Margin = Limit - Corrected Reading*
4. *If the PK Corrected Reading is lower than AV limit, the AV test can be elided.*

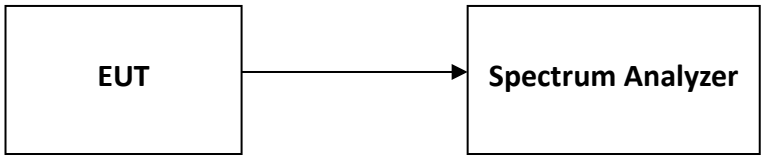
9 Number of Hopping Frequencies

Test result: **Pass**

9.1 Limit

Number of Hopping Frequencies in the 2400-2483.5 MHz band shall use at least 15 channels.

9.2 Test Configuration



9.3 Test procedure and test setup

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

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

9.4 Test Results of Number of Hopping Frequencies

Please refer to Appendix A

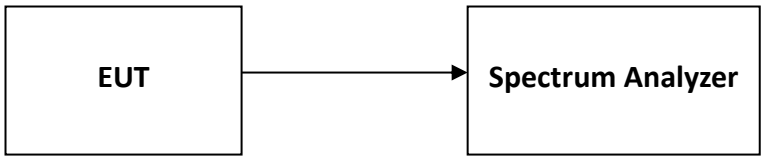
10 Dwell Time

Test result: **Pass**

10.1 Limit

The dwell time 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

10.2 Test Configuration



10.3 Test procedure and test setup

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: Zero span, centered on a hopping channel.
b) RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
d) Detector function: Peak.
e) Trace: Max hold.

Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:
(Number of hops in the period specified in the requirements) = (number of hops on spectrum analyzer) × (period specified in the requirements / analyzer sweep time)

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of

hops in the period specified in the requirements. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation.

The measured transmit time and time between hops shall be consistent with the values described in the operational description for the EUT.

10.4 Test Results of Dwell Time

Please refer to Appendix A

11 Occupied Bandwidth

Test result: **Tested**

11.1 Limit

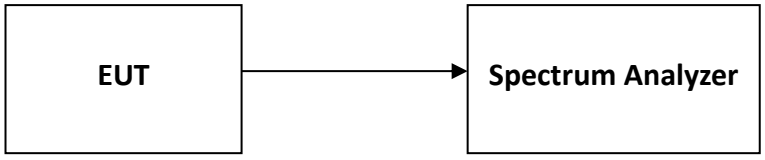
None

11.2 Measurement Procedure

The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.

The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

11.3 Test Configuration



11.4 The results of Occupied Bandwidth

Please refer to Appendix A

12 Antenna requirement

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 shall be considered sufficient to comply with the provisions of this section.

Result:
EUT uses permanently attached antenna to the intentional radiator, so it can comply with the provisions of this section.

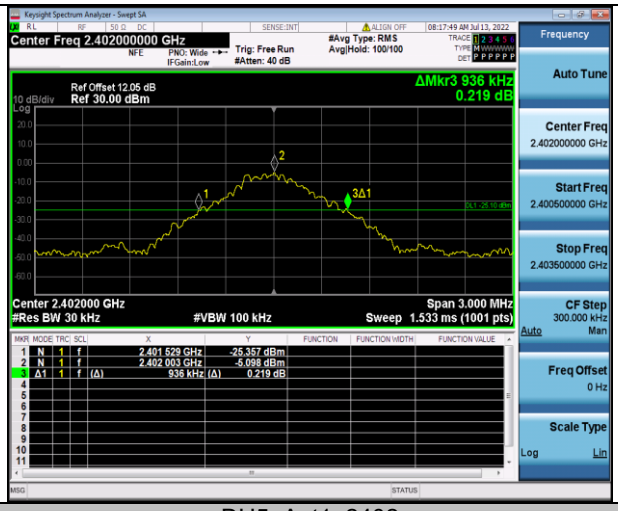
TEST REPORT

Appendix A: 20dB Emission Bandwidth

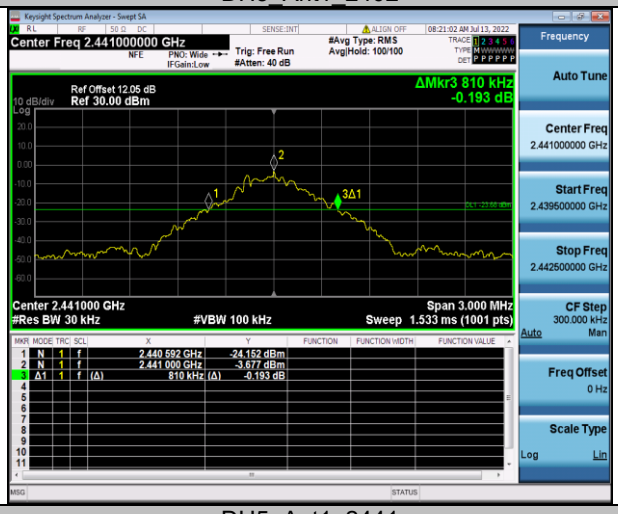
Test Result

TestMode	Antenna	Frequency[MHz]	20db EBW[MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
DH5	Ant1	2402	0.936	2401.529	2402.465	---	---
		2441	0.810	2440.592	2441.402	---	---
		2480	0.867	2479.544	2480.411	---	---
2DH5	Ant1	2402	1.278	2401.367	2402.645	---	---
		2441	1.221	2440.385	2441.606	---	---
		2480	1.233	2479.370	2480.603	---	---

Test Graphs

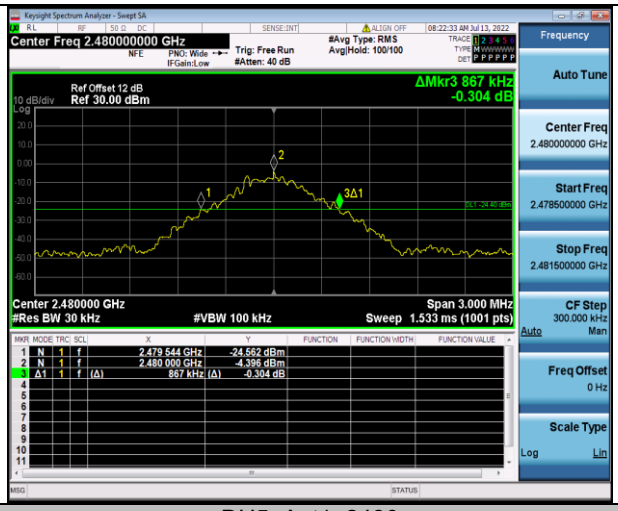


DH5_Ant1_2402



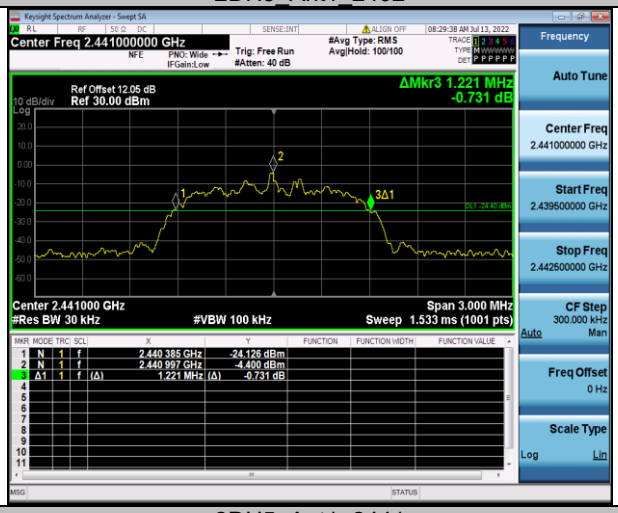
DH5_Ant1_2441

TEST REPORT



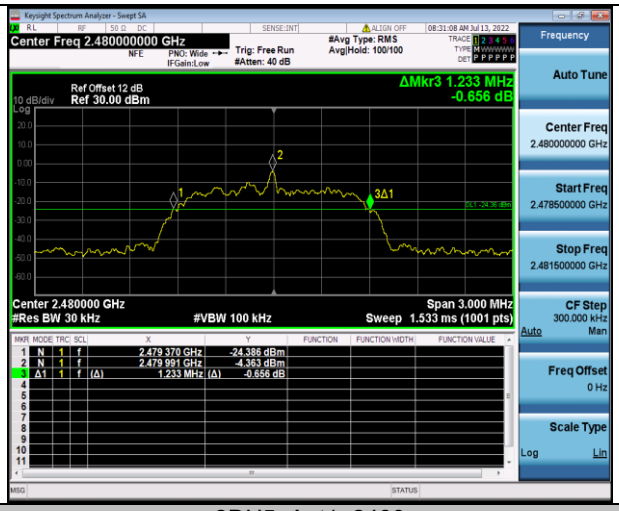
DH5_Ant1_2480

2DH5_Ant1_2402



2DH5_Ant1_2441

TEST REPORT



2DH5_Ant1_2480

TEST REPORT

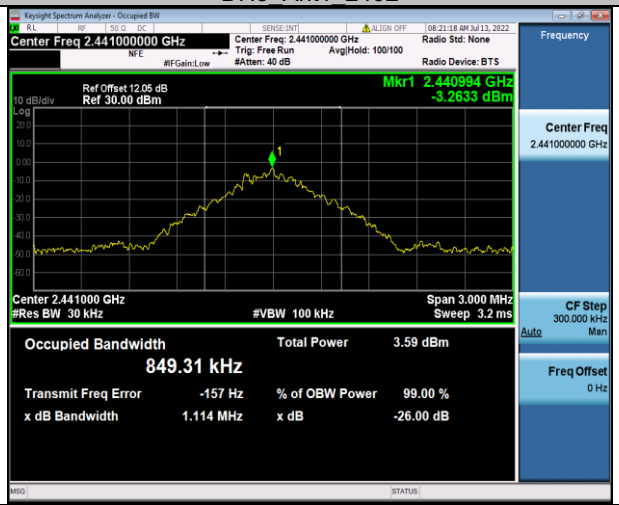
Appendix B: Occupied Channel Bandwidth

Test Result

TestMode	Antenna	Frequency[MHz]	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
DH5	Ant1	2402	0.85645	2401.562	2402.418	---	---
		2441	0.84931	2440.575	2441.424	---	---
		2480	0.85193	2479.569	2480.421	---	---
2DH5	Ant1	2402	1.1748	2401.406	2402.581	---	---
		2441	1.1784	2440.403	2441.582	---	---
		2480	1.1745	2479.404	2480.579	---	---

Test Graphs

DH5_Ant1_2402



DH5_Ant1_2441

DH5_Ant1_2480

2DH5_Ant1_2402

2DH5_Ant1_2441

2DH5_Ant1_2480

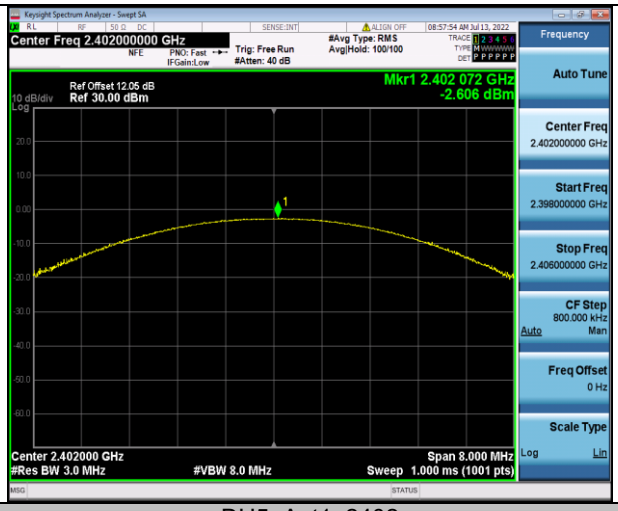
TEST REPORT

Appendix C: Maximum conducted output power

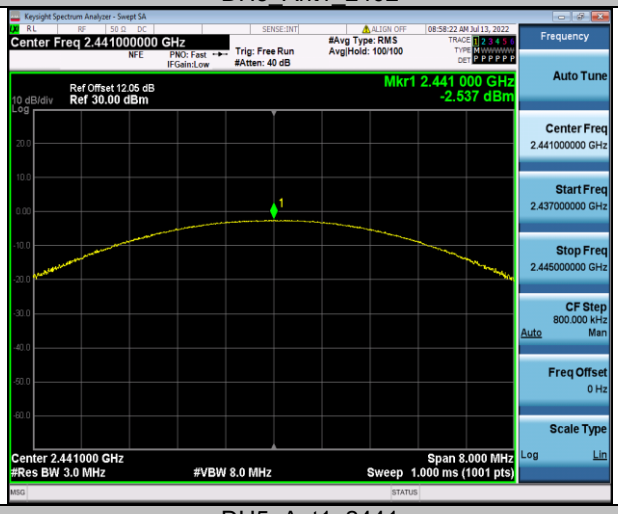
Test Result Peak

Test Mode	Antenna	Frequency[MHz]	Conducted Peak Powert[dBm]	Conducted Limit[dBm]	Verdict
DH5	Ant1	2402	-2.61	≤20.97	PASS
		2441	-2.54	≤20.97	PASS
		2480	-3.34	≤20.97	PASS
2DH5	Ant1	2402	-1.72	≤20.97	PASS
		2441	-1.59	≤20.97	PASS
		2480	-2.36	≤20.97	PASS

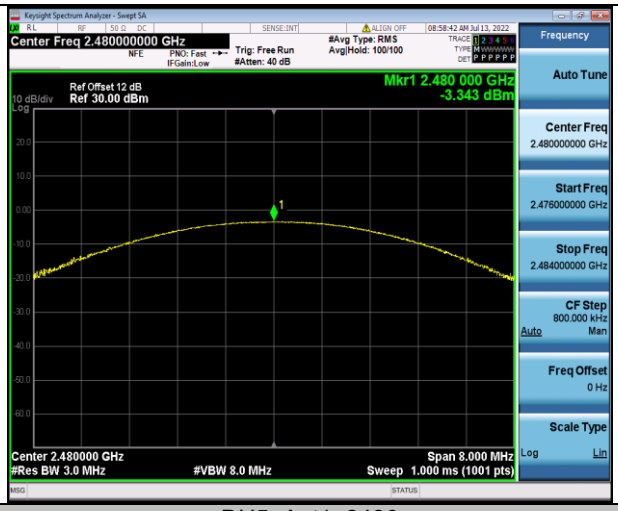
Test Graphs



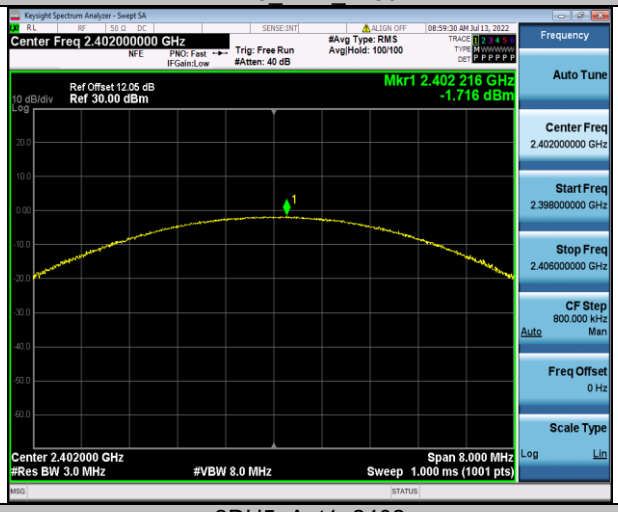
DH5_Ant1_2402



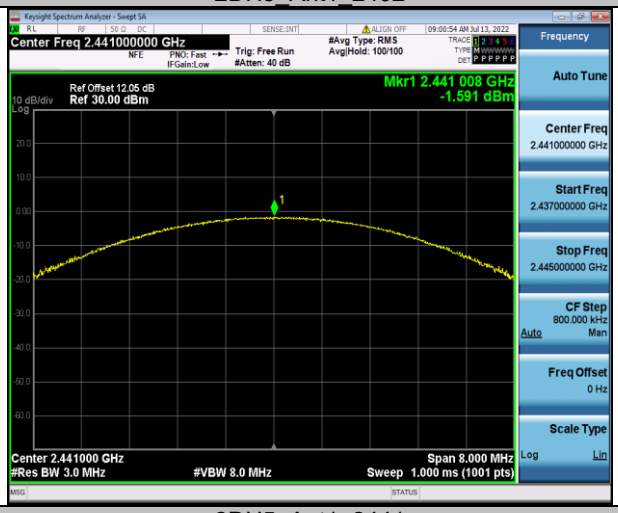
DH5_Ant1_2441



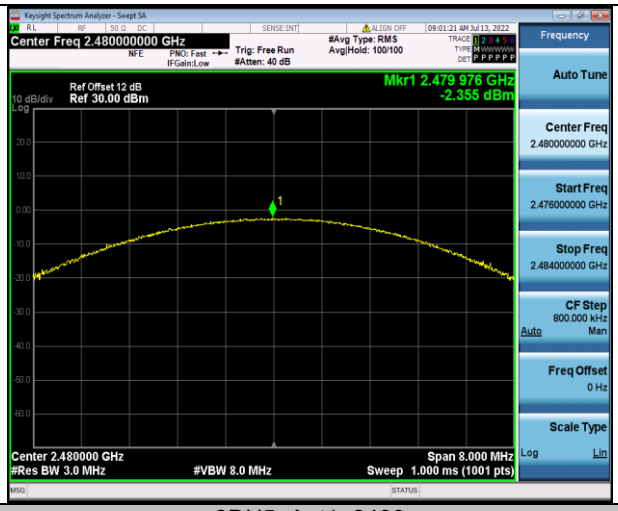
DH5_Ant1_2480



2DH5_Ant1_2402



2DH5_Ant1_2441



2DH5_Ant1_2480

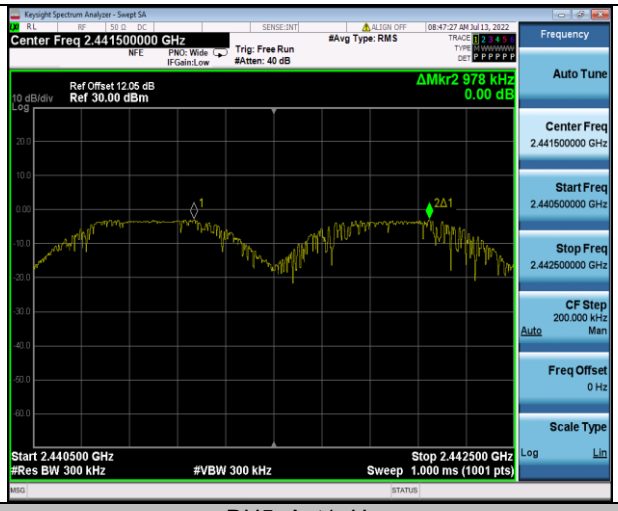
TEST REPORT

Appendix D: Carrier frequency separation

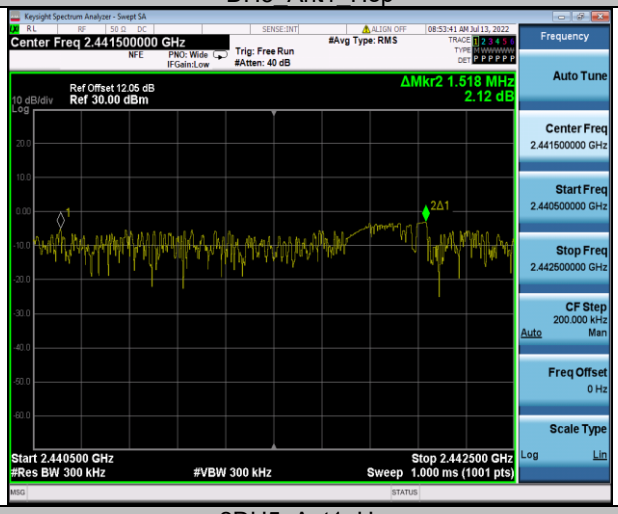
Test Result

TestMode	Antenna	Frequency[MHz]	Result[dBm]	Limit[dBm]	Verdict
DH5	Ant1	Hop	0.978	≥0.936	PASS
2DH5	Ant1	Hop	1.518	≥1.278	PASS

Test Graphs



DH5_Ant1_Hop



2DH5_Ant1_Hop

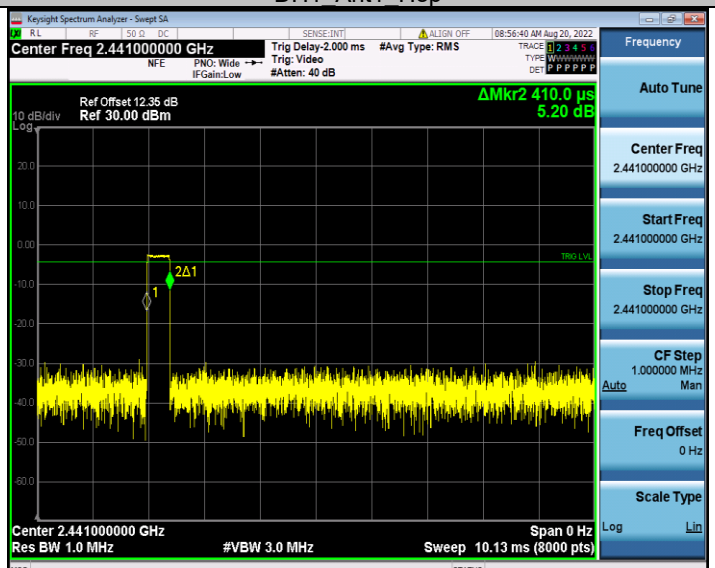
Appendix E: Time of occupancy

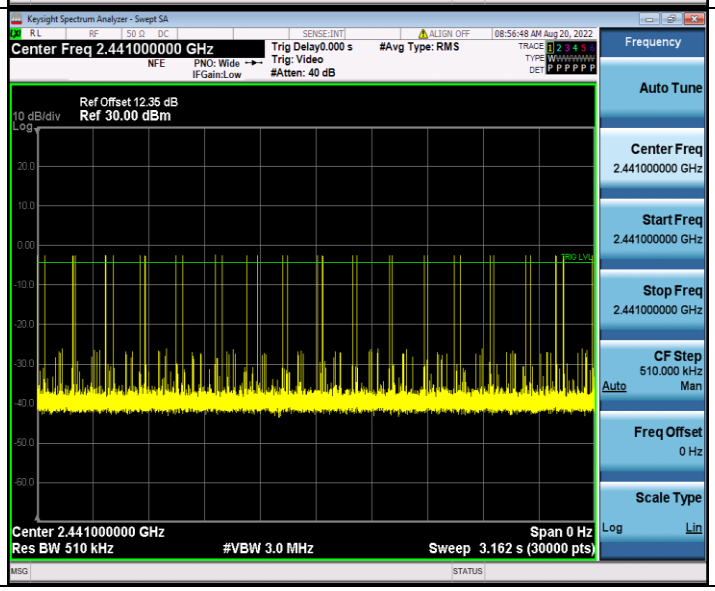
Test Result

TestMode	Antenna	Frequency[MHz]	BurstWidth [ms]	TotalHops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.41	330	0.135	≤0.4	PASS
DH3	Ant1	Hop	1.66	160	0.266	≤0.4	PASS
DH5	Ant1	Hop	2.91	110	0.32	≤0.4	PASS
2DH1	Ant1	Hop	0.42	330	0.139	≤0.4	PASS
2DH3	Ant1	Hop	1.67	160	0.267	≤0.4	PASS
2DH5	Ant1	Hop	2.92	120	0.35	≤0.4	PASS

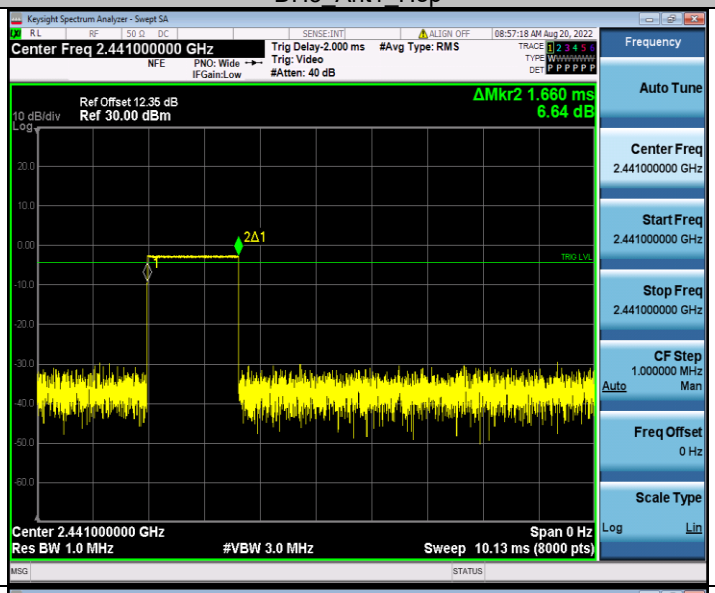
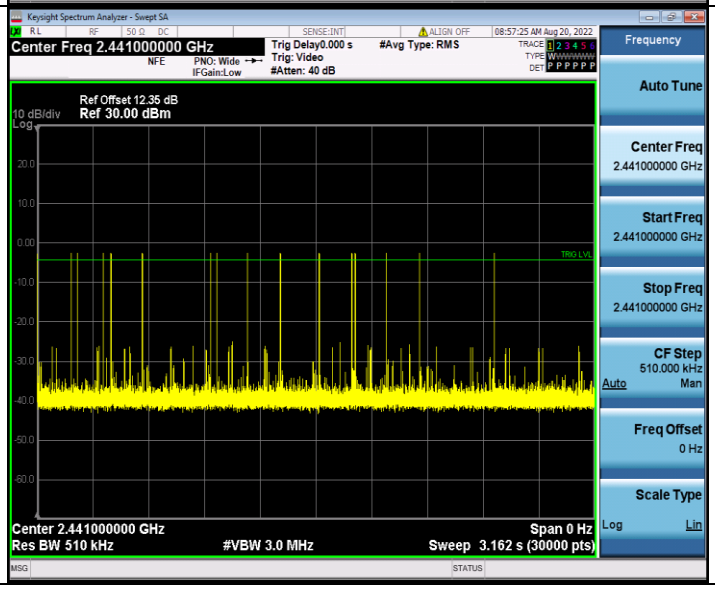
Test Graphs

DH1_Ant1_Hop

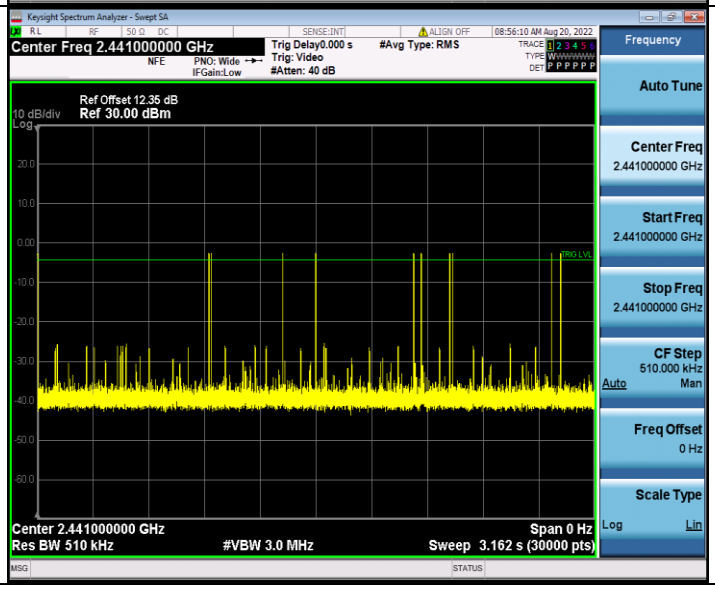




TEST REPORT

DH3_Ant1_Hop		
		
		

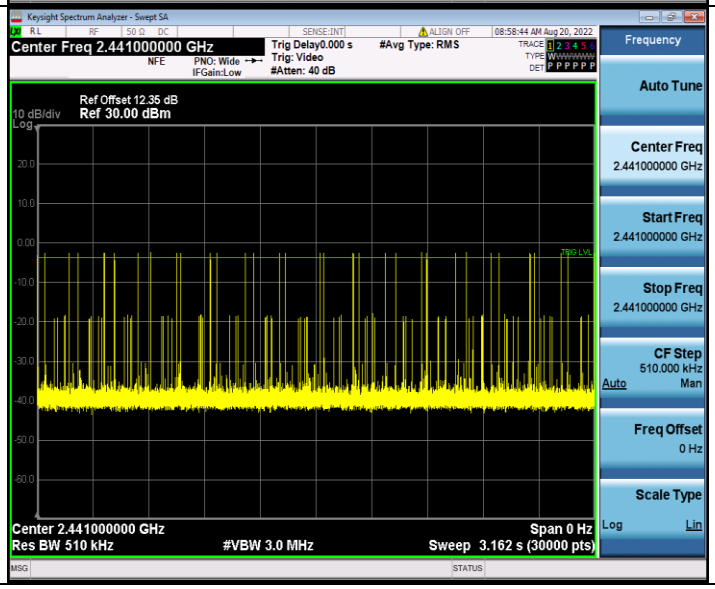
TEST REPORT

DH5_Ant1_Hop		
		
		

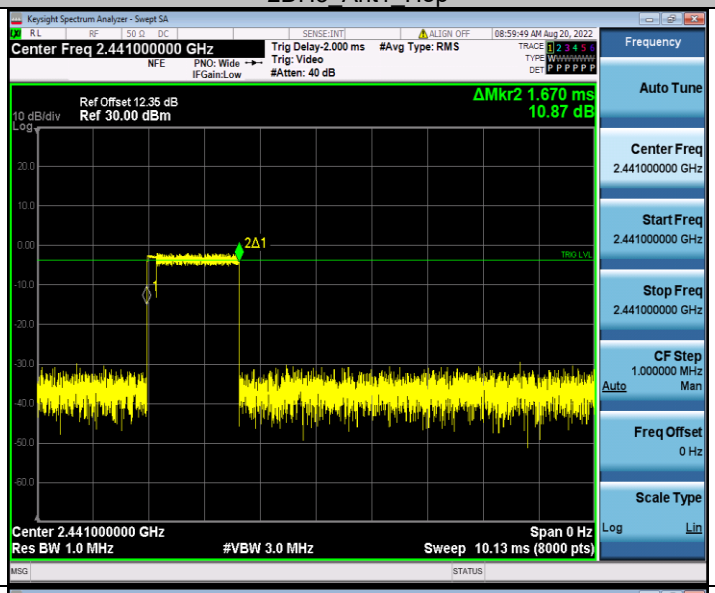
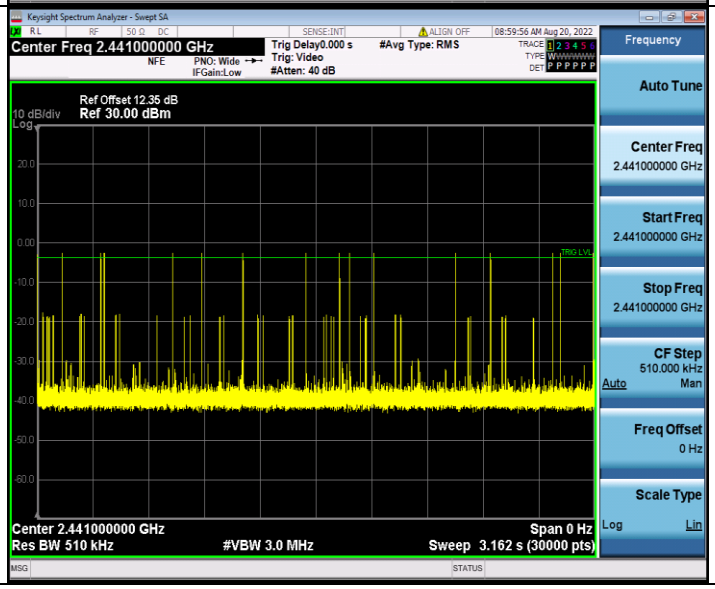
Total Quality. Assured.

TEST REPORT

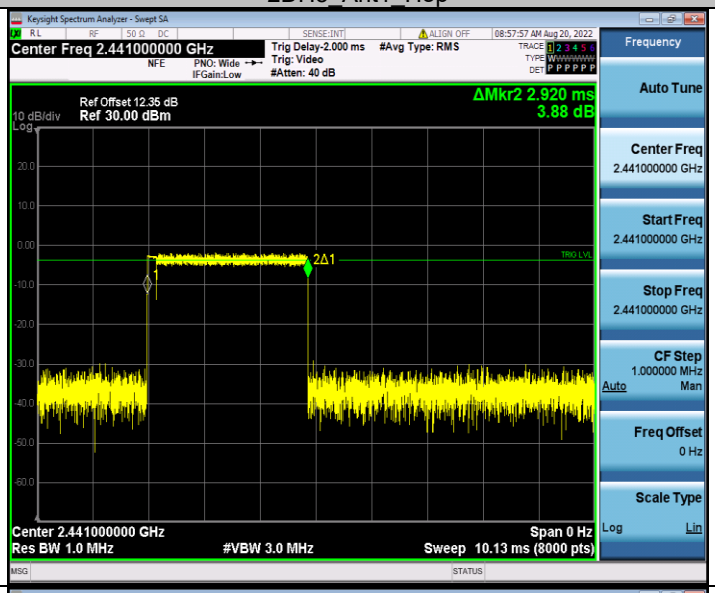
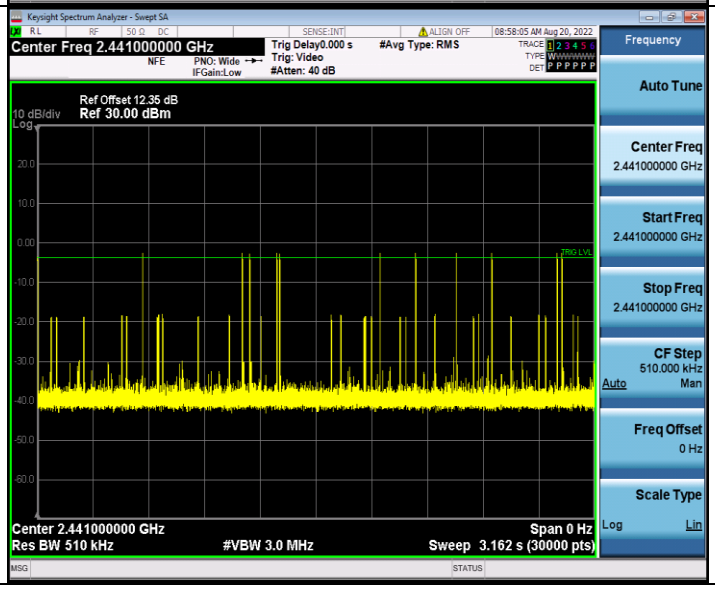
2DH1_Ant1_Hop



TEST REPORT

2DH3_Ant1_Hop		
		
		

TEST REPORT

2DH5_Ant1_Hop		
		
		

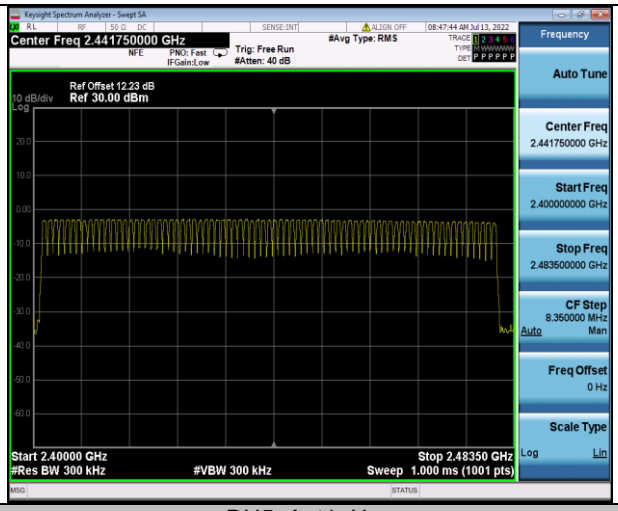
TEST REPORT

Appendix F: Number of hopping channels

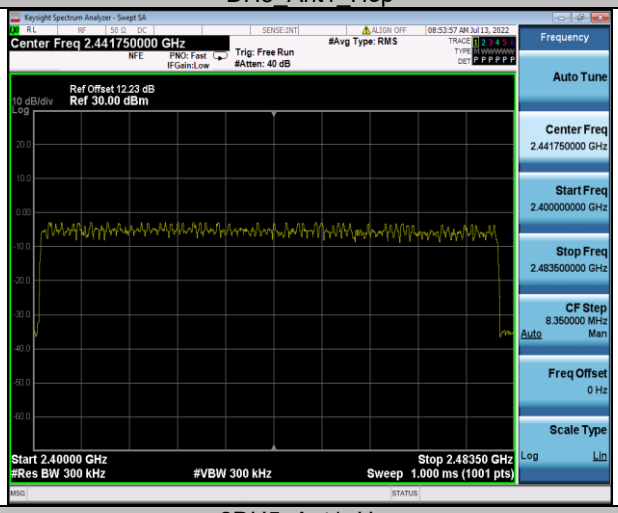
Test Result

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

Test Graphs



DH5_Ant1_Hop



2DH5_Ant1_Hop

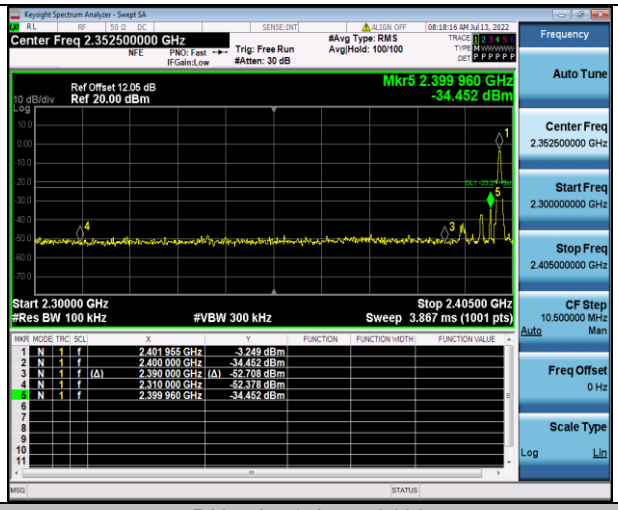
TEST REPORT

Appendix G: Band edge measurements

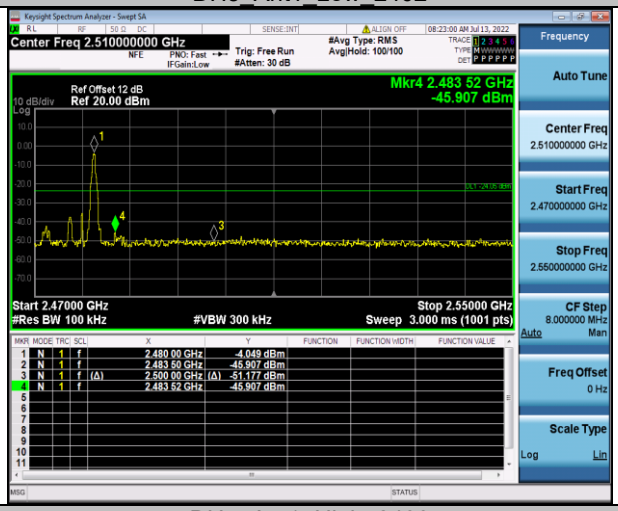
Test Result

TestMode	Antenna	ChName	Frequency[MHz]	RefLevel [dBm]	Result [dBm]	Limit [dBm]	Verdict
DH5	Ant1	Low	2402	-3.25	-34.45	≤-23.25	PASS
		High	2480	-4.05	-45.91	≤-24.05	PASS
2DH5	Ant1	Low	2402	-3.18	-34.49	≤-23.18	PASS
		High	2480	-4.12	-47.32	≤-24.12	PASS

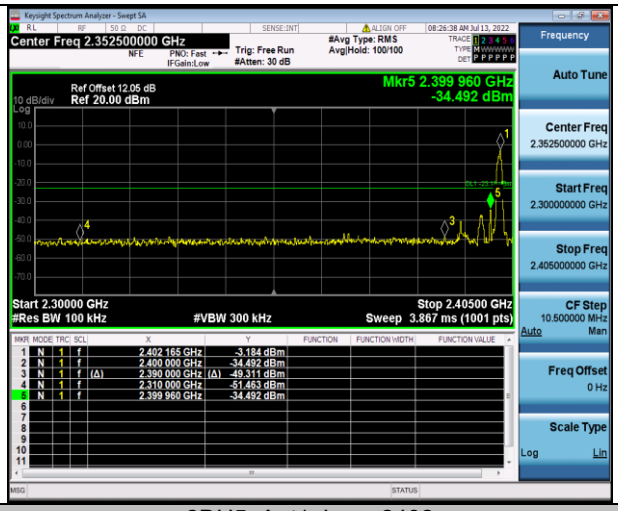
Test Graphs



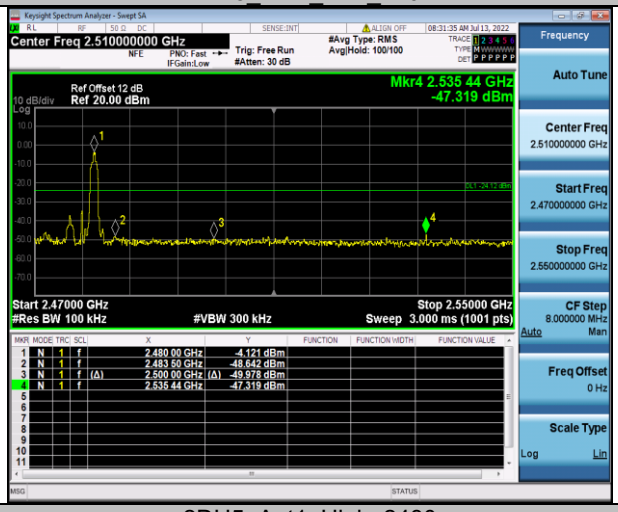
DH5_Ant1_Low_2402



DH5_Ant1_High_2480



2DH5_Ant1_Low_2402



2DH5_Ant1_High_2480