



# **TEST REPORT**

Applicant Name : Address :

Report Number : FCC ID: TECNO MOBILE LIMITED FLAT N 16/F BLOCK B UNIVERSAL INDUSTRIAL CENTRE 19-25 SHAN MEI STREET FOTAN NT HONGKONG RA221122-56020E-RF-00A 2ADYY-TU01-L

# Test Standard (s)

FCC PART 15.247

# **Sample Description**

Product Type: Model No.: Multiple Model(s) No.: Trade Mark: Date Received: Report Date: Wireless Earphone TU01 N/A TECNO 2022/11/22 2023/01/11

Test Result:

Pass\*

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

Prepared and Checked By:

Andy. Yu

Andy Yu EMC Engineer

# Approved By:

Candry . Li

Candy Li EMC Engineer

Note: This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "\* ".

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the sample(s) tested. This report is valid only with a valid digital signature. The digital signature may be available only under the Adobe software above version 7.0.

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# **DOCUMENT REVISION HISTORY**

Revision Number	Revision NumberReport NumberDescription of Revision		Date of Revision
0	RA221122-56020E-RF-00A	Original Report	2023/01/11

# **GENERAL INFORMATION**

#### **Product Description for Equipment under Test (EUT)**

Frequency Range	Bluetooth: 2402~2480MHz
Maximum conducted Peak output power	Bluetooth:0.99dBm
Modulation Technique	Bluetooth: GFSK, π/4-DQPSK, 8DPSK
Antenna Specification*	1.63dBi (provided by the applicant)
Voltage Range	DC3.7V from battery
Sample serial number	1RT5-4 for Radiated Emissions Test 1RT4-3 for RF Conducted Test (Assigned by ATC)
Sample/EUT Status	Good condition

# Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, section 15.203, 15.205, 15.209 and 15.247 rules.

# **Test Methodology**

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

All emissions measurement was performed at Shenzhen Accurate Technology Co., Ltd. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Each test item follows test standards and with no deviation.

# **Measurement Uncertainty**

Parameter		Uncertainty
Occupied Cha	nnel Bandwidth	5%
RF output po	wer, conducted	0.73dB
Unwanted Emi	ssion, conducted	1.6dB
AC Line Conducted emission		2.72dB
	30MHz - 1GHz	4.28dB
Emissions, Radiated	1GHz - 18GHz	4.98dB
Radiated	18GHz - 26.5GHz	5.06dB
Temperature		1℃
Humidity		6%
Supply	voltages	0.4%

Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

# **Test Facility**

The test site used by Shenzhen Accurate Technology Co., Ltd. to collect test data is located on the 1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 708358, the FCC Designation No.: CN1189. Accredited by American Association for Laboratory Accreditation (A2LA) The Certificate Number is 429 7.01.

Listed by Innovation, Science and Economic Development Canada (ISEDC), the Registration Number is 5077A.

# SYSTEM TEST CONFIGURATION

# **Description of Test Configuration**

The system was configured for testing in an engineering mode.

# **EUT Exercise Software**

"BQB.exe \*" exercise software was used and the power level is 0\*. The software and power level was provided by the manufacturer.

# **Special Accessories**

No special accessory.

# **Equipment Modifications**

No modification was made to the EUT tested.

# Support Equipment List and Details

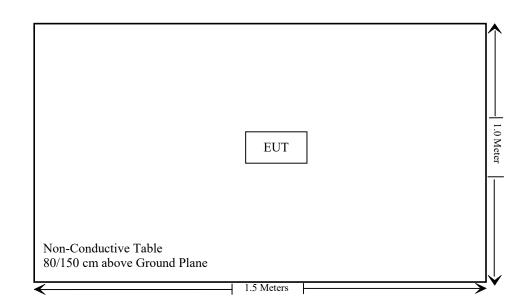
Manufacturer	Description	Model	Serial Number
/	/	/	/

# External I/O Cable

Cable Description	Length (m)	From Port	То
/	/	/	/

# **Block Diagram of Test Setup**

For Radiated Emissions:



# SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i), §1.1307 (b) (3) & §2.1093	RF Exposure	Compliant
§15.203	Antenna Requirement	Compliant
§15.207(a)	AC Line Conducted Emissions	Not Applicable
§15.205, §15.209 & §15.247(d)	Radiated Emissions	Compliant
§15.247(a)(1)	20 dB Emission Bandwidth & 99% Occupied Bandwidth	Compliant
§15.247(a)(1)	Channel Separation Test	Compliant
§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Compliant
§15.247(a)(1)(iii)	Quantity of hopping channel Test	Compliant
§15.247(b)(1)	Peak Output Power Measurement	Compliant
§15.247(d)	Band edges	Compliant

Not Applicable: The Bluetooth function cannot use when charging.

# **TEST EQUIPMENT LIST**

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date		
Radiated emission test							
Rohde& Schwarz	Test Receiver	ESR	102725	2021/12/13	2022/12/12		
Rohde&Schwarz	Spectrum Analyzer	FSV40	101949	2021/12/13	2022/12/12		
SONOMA INSTRUMENT	Amplifier	310 N	186131	2022/11/08	2023/11/07		
A.H. Systems, inc.	Preamplifier	PAM-0118P	135	2022/11/08	2023/11/07		
Quinstar	Amplifier	QLW- 18405536-J0	15964001002	2022/11/08	2023/11/07		
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2021/07/06	2024/07/05		
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2020/01/05	2023/01/04		
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	2020/01/05	2023/01/04		
Radiated Emission T	est Software: e3 19821b	(V9)					
Unknown	RF Coaxial Cable	No.10	N050	2021/12/14	2022/12/13		
Unknown	RF Coaxial Cable	No.11	N1000	2021/12/14	2022/12/13		
Unknown	RF Coaxial Cable	No.12	N040	2021/12/14	2022/12/13		
Unknown	RF Coaxial Cable	No.13	N300	2021/12/14	2022/12/13		
Unknown	RF Coaxial Cable	No.14	N800	2021/12/14	2022/12/13		
Unknown	RF Coaxial Cable	No.15	N600	2021/12/14	2022/12/13		
Unknown	RF Coaxial Cable	No.16	N650	2021/12/14	2022/12/13		
Wainwright	High Pass Filter	WHKX3.6/18 G-10SS	5	2021/12/14	2022/12/13		
RF conducted test							
Rohde&Schwarz	Spectrum Analyzer	FSV-40	101590	2022/01/19	2023/01/18		
Tonscend	RF Control Unit	JS0806-2	19G8060182	2022/10/24	2023/10/23		
WEINSCHEL	10dB Attenuator	5324	AU 3842	2022/11/25	2023/11/24		
Unknown RF Coaxial Cable No.31 RF-01 Each time							

\* **Statement of Traceability:** Shenzhen Accurate Technology Co., Ltd. attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

# FCC§15.247 (i), §1.1307 (b) (3) &§2.1093 – RF EXPOSURE

#### **Applicable Standard**

According to FCC §2.1093 and §1.1307(b) (3), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB 447498 D04 Interim General RF Exposure Guidance

SAR-Based Exemption:

SAR-based thresholds are derived based on frequency, power, and separation distance of the RF source. The formula defines the thresholds in general for either available maximum timeaveraged power or maximum time-averaged ERP, whichever is greater.

Per § 1.1307(b)(3)(i)(B), for single RF sources (i.e., any single fixed RF source, mobile device, or portable device, as defined in paragraph (b)(2) of this section): A single RF source is exempt if:

the available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold  $P_{th}$  (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive).  $P_{th}$  is given by:

$$P_{th} (mW) = \begin{cases} ERP_{20 \ cm} (d/20 \ cm)^{x} & d \le 20 \ cm \\ ERP_{20 \ cm} & 20 \ cm < d \le 40 \ cm \end{cases}$$

Where

$$x = -\log_{10}\left(\frac{60}{ERP_{20\ cm}\sqrt{f}}\right)$$
 and  $f$  is in GHz;

and

$$ERP_{20\ cm}\ (\text{mW}) = \begin{cases} 2040f & 0.3\ \text{GHz} \le f < 1.5\ \text{GHz} \\ \\ 3060 & 1.5\ \text{GHz} \le f \le 6\ \text{GHz} \end{cases}$$

d = the separation distance (cm);

#### For worst case:

Exemption limit:

For f=2.48GHz, d=0.5cm, the  $P_{th}=2.72$ mW

The higher of the available maximum time-averaged power or effective radiated power (ERP):

The antenna gain is 1.63dBi (-0.52dBd), 0dBd=2.15dBi

The maximum tune-up conducted power is 1.0dBm (1.26mW), which less than 2.72 mW@2480MHz exemption limit

So the stand-alone SAR evaluation can be exempted.

# FCC §15.203 – ANTENNA REQUIREMENT

# **Applicable Standard**

According to FCC § 15.203, 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. 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.

# **Antenna Connector Construction**

The EUT has one internal antenna, which was permanently attached, and the maximum antenna gain is 1.63dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Result: Compliant.

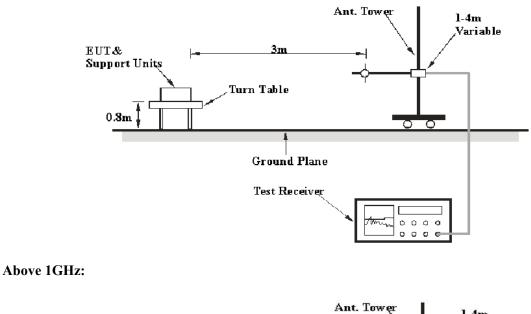
# FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

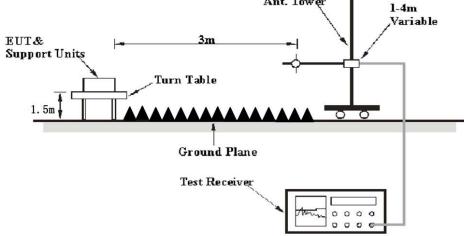
# Applicable Standard

FCC §15.205; §15.209; §15.247(d)

# **EUT Setup**

Below 1 GHz:





The radiated emission tests were performed in the 3 meters, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209 and FCC 15.247 limits.

## EMI Test Receiver & Spectrum Analyzer Setup

The EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1 MHz	3 MHz	/	РК

For average measurement:

Use the duty cycle factor correction factor method per 15.35(c). Duty cycle=On time/100milliseconds, On time=N1\*L1+N2\*L2+...Nn-1\*Ln-1+Nn\*Ln, where N1 is number of type 1 pulses, L1 is length of type 1 pulse, etc. Average Emission Level=Peak Emission Level+20\*log(Duty cycle)

#### **Test Procedure**

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All final data was recorded in Quasi-peak detection mode for frequency range of 30 MHz -1 GHz and peak and Average detection modes for frequencies above 1 GHz.

## Factor & Margin Calculation

The Factor is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain. The basic equation is as follows:

Factor = Antenna Factor + Cable Loss - Amplifier Gain

The "**Over Limit/Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, an Over Limit/margin of -7dB means the emission is 7dB below the limit. The equation for calculation is as follows:

Over Limit/Margin = Level / Corrected Amplitude – Limit Level / Corrected Amplitude = Read Level + Factor

#### **Test Data**

#### **Environmental Conditions**

Temperature:	24~25.5 °C
<b>Relative Humidity:</b>	52~57 %
ATM Pressure:	101.0 kPa

*The testing was performed by Jimi Zheng on 2022-12-05 for below 1GHz and Jason Liu on 2022-12-03 for above 1GHz* 

EUT operation mode: Transmitting

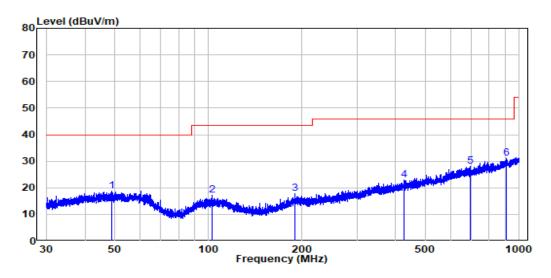
Note: Pre-scan in the X, Y and Z axes of orientation, the worst case X-axis of orientation was recorded

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#### **30MHz-1GHz:** (worst case is 8DPSK Mode, high channel)

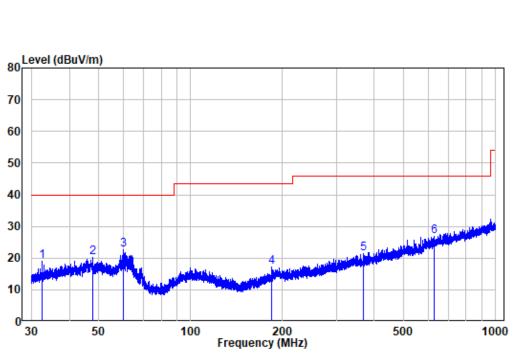
Note: When the test result of peak was less than the limit of QP more than 6dB, just peak value were recorded.

#### Horizontal:



Site : chamber Condition: 3m HORIZONTAL Job No. : RA221122-56020E-RF Test Mode: BT Transmitting L

	Freq	Factor			Limit Line		Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	48.886	-9.97	28.82	18.85	40.00	-21.15	Peak
2	102.674	-11.63	28.79	17.16	43.50	-26.34	Peak
3	189.406	-11.66	29.38	17.72	43.50	-25.78	Peak
4	424.470	-5.89	28.69	22.80	46.00	-23.20	Peak
5	694.417	-1.52	29.50	27.98	46.00	-18.02	Peak
6	908.073	1.67	29.54	31.21	46.00	-14.79	Peak





Site : chamber Condition: 3m VERTICAL Job No. : RA221122-56020E-RF Test Mode: BT Transmitting L

	Freq	Factor			Limit Line		Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	32.577	-12.08	31.17	19.09	40.00	-20.91	Peak
	47.805	-10.00	30.33	20.33	40.00	-19.67	Peak
3	60.227	-10.71	33.25	22.54	40.00	-17.46	Peak
4	184.328	-12.26	29.49	17.23	43.50	-26.27	Peak
5	369.081	-7.36	28.86	21.50	46.00	-24.50	Peak
6	628.650	-2.15	29.17	27.02	46.00	-18.98	Peak

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# Above 1GHz: (worst case is 8DPSK Mode, 3DH5)

Engguenau	Receiver		Turntable	Rx An	tenna	Factor	Corrected.	Limit	Mongin	
Frequency (MHz)	Reading (dBµV)	PK/Ave	Degree	Height (m)	Polar (H/V)	(dB/m)	Amplitude (dBµV/m)	(dBµV/m)	Margin (dB)	
	Low Channel 2402MHz									
2310	61.08	PK	290	1.2	Н	-7.24	53.84	74	-20.16	
2310	60.95	PK	346	2.4	V	-7.24	53.71	74	-20.29	
2390	64.11	РК	301	2	Н	-7.22	56.89	74	-17.11	
2390	63.98	РК	334	1.4	V	-7.22	56.76	74	-17.24	
4804	57.94	РК	64	2.5	Н	-3.51	54.43	74	-19.57	
4804	57.71	РК	227	2.5	V	-3.51	54.20	74	-19.80	
			Mide	dle Channel	2441MHz					
4882	57.81	РК	115	1.6	Н	-3.37	54.44	74	-19.56	
4882	57.58	РК	27	1.6	V	-3.37	54.21	74	-19.79	
			Hig	h Channel 2	480MHz					
2483.5	65.90	РК	72	2.3	Н	-7.20	58.70	74	-15.30	
2483.5	65.74	РК	302	2.2	V	-7.20	58.54	74	-15.46	
2500	62.57	РК	223	1.4	Н	-7.18	55.39	74	-18.61	
2500	62.46	РК	208	2.2	V	-7.18	55.28	74	-18.72	
4960	57.15	РК	248	1.5	Н	-3.01	54.14	74	-19.86	
4960	56.94	РК	99	1.5	V	-3.01	53.93	74	-20.07	

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	Field Strength of Average									
Frequency	Peak Measurement Polar		Duty Cycle Correction	Corrected	FCC Part 15.247					
(MHz)	@3m (dBµV/m)	(H/V)	Factor (dB)	Ampitude (dBµV/m)	Limit (dBµV/m)	Margin (dB)				
		Lo	w Channel(240	2MHz)						
2310	53.84	Н	-24.73	29.11	54	-24.89				
2310	53.71	V	-24.73	28.98	54	-25.02				
2390	56.89	Н	-24.73	32.16	54	-21.84				
2390	56.76	V	-24.73	32.03	54	-21.97				
4804	54.43	Н	-24.73	29.70	54	-24.30				
4804	54.20	V	-24.73	29.47	54	-24.53				
		Mic	ldle Channel(24	41MHz)						
4882	54.44	Н	-24.73	29.71	54	-24.29				
4882	54.21	V	-24.73	29.48	54	-24.52				
		Hig	gh Channel(248	0 MHz)						
2483.5	58.70	Н	-24.73	33.97	54	-20.03				
2483.5	58.54	V	-24.73	33.81	54	-20.19				
2500	55.39	Н	-24.73	30.66	54	-23.34				
2500	55.28	V	-24.73	30.55	54	-23.45				
4960	54.14	Н	-24.73	29.41	54	-24.59				
4960	53.93	V	-24.73	29.20	54	-24.80				

Note:

Corrected. Amplitude = Factor + Reading Margin = Corrected. Amplitude - Limit Average level= Peak level+ Duty Cycle Corrected Factor

The worst case duty cycle as below: Duty cycle = Ton/100ms = 2.899\*2/100=0.05798 Duty Cycle Corrected Factor = 20lg (Duty cycle) = 20lg0.05798 = -24.73

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Spect										
Ref Le	evel	97.00			BRBW 10 MHz					
Att			0 dB 👄 SWT :	100 ms (	VBW 10 MHz					
SGL TR 1Pk Ma		TDF								
JIEK MG	10			1		D	2[1]			-7.17 dE
90 dBµV	-									5.072 m
						M	1[1]			1.38 dBµ\
80 dBµV	-							1		50.000 m
70 dBµV	-				MI					
हार्षिप्रदेश	т	RG 61	.000 dBµV		M1	D1				
JU UBUV						D2				
50 dBuV										
oo abpi										
40 dBuV	da Latta	ashi.as	allounan	har	wheel when the week with	What has	Johaulta	and more the prover	al works that me and	Nili acusto a life
							(			
30 dBµV										
20 dBµV										
10 dBµV										
to appv										
0 dBµV-										
CF 2.40	)2 GH	z			691 p	ts				10.0 ms/
Marker										
	Ref	Trc	X-value		Y-value		nction Function Res		nction Result	
M1		1		0.0 ms	61.38 dBµ∨					
D1 D2	M1	1		399 ms	-0.04 dB					
D2	M1	1	5.1	072 ms	-7.17 dB					

Date: 3.DEC.2022 01:52:47

# 1-18GHz

## Pre-scan for Middle Channel

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# 18-25GHz

Pre-scan for Middle Channel

 100
 Level (dBuV/m)

 90
 0

 80
 0

 70
 0

 60
 2

 50
 0

 40
 0

 30
 0

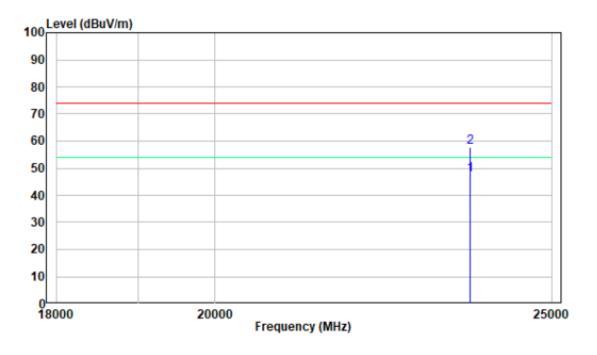
 20
 0

 10
 2000

 Frequency (MHz)
 25000

Horizontal:

#### Vertical:



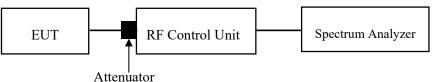
# FCC §15.247(a) (1)-CHANNEL SEPARATION TEST

## **Applicable Standard**

Frequency hopping systems shall have hoping 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. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly 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.

## **Test Procedure**

- 1. Set the EUT in transmitting mode, maxhold the channel.
- 2. Set the adjacent channel of the EUT and maxhold another trace.
- 3. Measure the channel separation.



## **Test Data**

#### **Environmental Conditions**

Temperature:	25 °C	
Relative Humidity:	65 %	
ATM Pressure:	101.0 kPa	

The testing was performed by Andy Yu on 2022-12-02.

EUT operation mode: Transmitting

# FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH & 99% OCCUPIED BANDWIDTH

# **Applicable Standard**

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.

## **Test Procedure**

The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:

• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

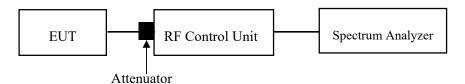
• The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.

• The detector of the spectrum analyzer shall be set to "Sample". However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or "Max Hold") may be necessary to determine the occupied / 20 dB bandwidth if the device is not transmitting continuously.

• The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / 20 dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).



# **Test Data**

# **Environmental Conditions**

Temperature:	25 °C
<b>Relative Humidity:</b>	65 %
ATM Pressure:	101.0 kPa

The testing was performed by Andy Yu on 2022-12-02.

EUT operation mode: Transmitting

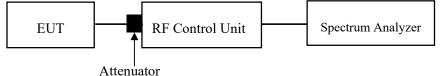
# FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST

## **Applicable Standard**

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

## **Test Procedure**

- 1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
- 2. Set the EUT in hopping mode from first channel to last.
- 3. By using the max-hold function record the quantity of the channel.



# **Test Data**

# **Environmental Conditions**

Temperature:	25 ℃	
<b>Relative Humidity:</b>	65 %	
ATM Pressure:	101.0 kPa	

The testing was performed by Andy Yu on 2022-12-02.

EUT operation mode: Transmitting

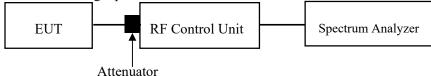
# FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME)

# **Applicable Standard**

Frequency hopping systems in the 2400-2483.5 MHz shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

# **Test Procedure**

- 1. The EUT was worked in channel hopping.
- 2. Set the RBW to: 1MHz.
- 3. Set the VBW  $\geq 3 \times RBW$ .
- 4. Set the span to 0Hz.
- 5. Detector = peak.
- 6. Sweep time = auto couple.
- 7. Trace mode = max hold.
- 8. Allow trace to fully stabilize.
- 9. Recorded the time of single pulses



# **Test Data**

# **Environmental Conditions**

Temperature:	20~25 ℃
<b>Relative Humidity:</b>	55~65 %
ATM Pressure:	101.0 kPa

The testing was performed by Andy Yu on 2022-12-02 and 2023-01-10.

EUT operation mode: Transmitting

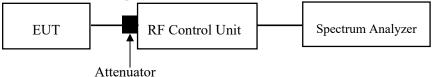
# FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT

## **Applicable Standard**

According to §15.247(b) (1), 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. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

# **Test Procedure**

- 1. Place the EUT on a bench and set in transmitting mode.
- 2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
- 3. Add a correction factor to the display.



# **Test Data**

## **Environmental Conditions**

Temperature:	25 ℃
<b>Relative Humidity:</b>	65 %
ATM Pressure:	101.0 kPa

The testing was performed by Andy Yu on 2022-12-02.

EUT operation mode: Transmitting

# FCC §15.247(d) - BAND EDGES TESTING

# **Applicable Standard**

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in \$15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in \$15.205(a), must also comply with the radiated emission limits specified in \$15.209(a) (see \$15.205(c)).

# **Test Procedure**

- 1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- 2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
- 3. Set RBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
- 4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
- 5. Repeat above procedures until all measured frequencies were complete.



Attenuator

# **Test Data**

# **Environmental Conditions**

Temperature:	25 °C	
<b>Relative Humidity:</b>	65 %	
ATM Pressure:	101.0 kPa	

The testing was performed by Andy Yu on 2022-12-02.

EUT operation mode: Transmitting

# APPENDIX

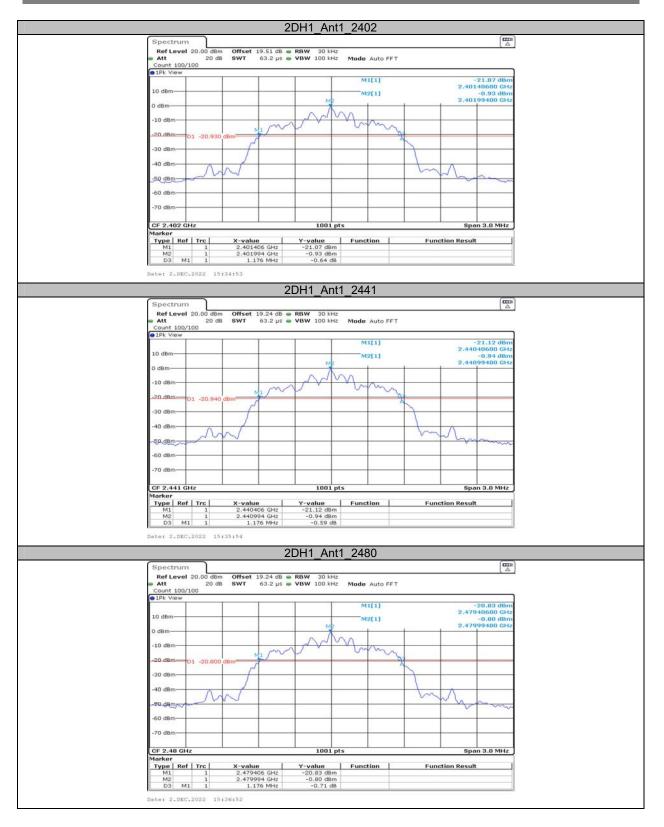
# Appendix A: 20dB Emission Bandwidth Test Result

Test Mode	Antenna	Frequency[MHz]	20db EBW[MHz]	Limit[MHz]	Verdict
		2402	1.04		
DH1	Ant1	2441	1.04		
		2480	1.04		
		2402	1.18		
2DH1	Ant1	2441	1.18		
		2480	1.18		
		2402	1.17		
3DH1	Ant1	2441	1.17		
		2480	1.17		

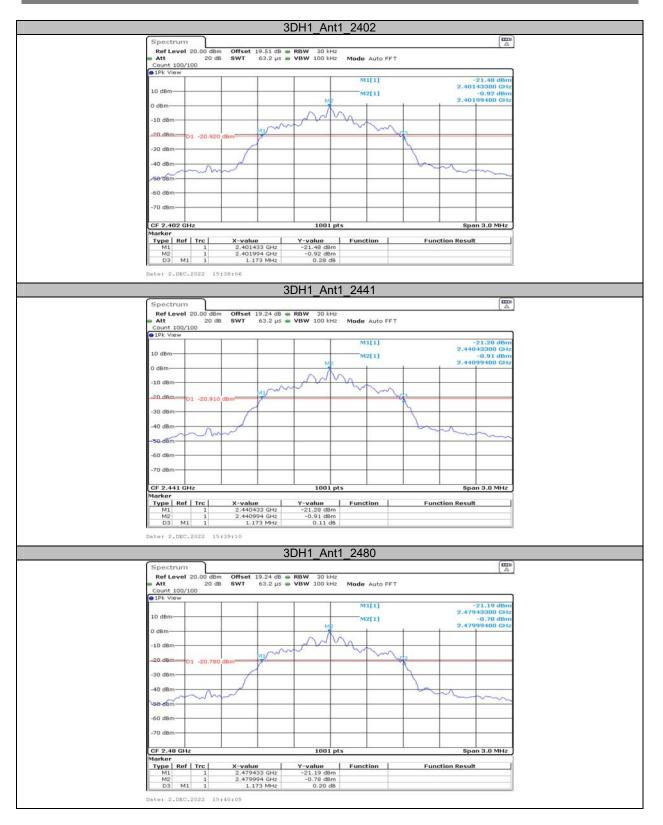
#### Report No.: RA221122-56020E-RF-00A



Report No.: RA221122-56020E-RF-00A



Report No.: RA221122-56020E-RF-00A



# Appendix B: Occupied Channel Bandwidth Test Result

Test Mode	Antenna	Frequency[MHz]	OCB [MHz]	Limit[MHz]	Verdict
		2402	0.929		
DH1	Ant1	2441	0.926		
		2480	0.929		
		2402	1.115		
2DH1	Ant1	2441	1.115		
		2480	1.118		
		2402	1.094		
3DH1	Ant1	2441	1.094		
		2480	1.100		

#### Report No.: RA221122-56020E-RF-00A



Report No.: RA221122-56020E-RF-00A



Report No.: RA221122-56020E-RF-00A



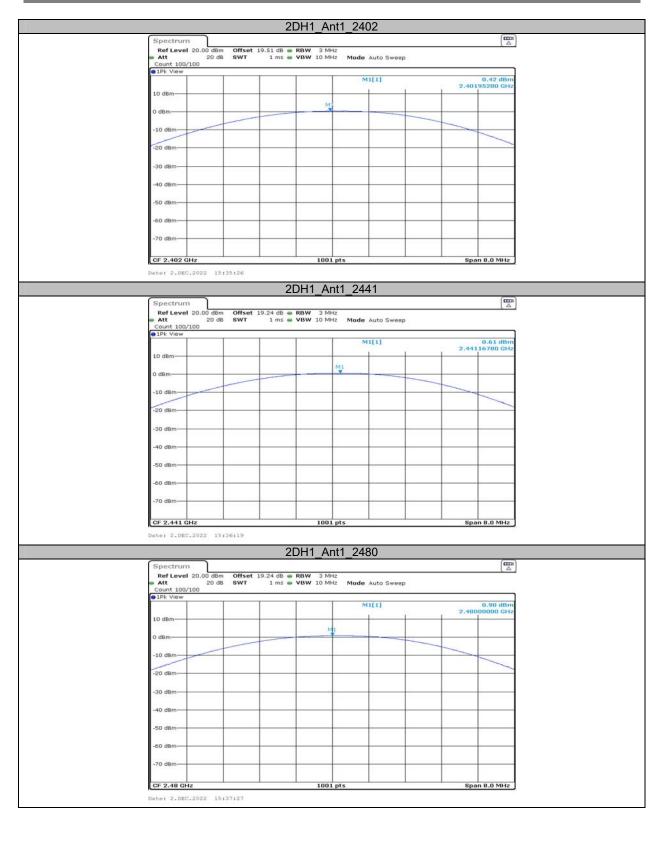
# Appendix C: Maximum conducted output power Test Result Peak

Test Mode	Antenna	Frequency[MHz]	Conducted Peak Power [dBm]	Conducted Limit [dBm]	Verdict
		2402	0.45	≤20.97	PASS
DH1	Ant1	2441	0.60	≤20.97	PASS
		2480	0.92	≤20.97	PASS
	2DH1 Ant1	2402	0.42	≤20.97	PASS
2DH1		2441	0.61	≤20.97	PASS
		2480	0.90	≤20.97	PASS
		2402	0.48	≤20.97	PASS
3DH1	Ant1	2441	0.65	≤20.97	PASS
		2480	0.99	≤20.97	PASS

Report No.: RA221122-56020E-RF-00A

st Graphs		DH1_Ant1_2402		
	Spectrum			
	Ref Level 20.00 dBm Offset 19.51 dB Att 20 dB SWT 1 ms	RBW 3 MHz     Nede to to C	Constraint.	1
	Count 100/100	VBW 10 MHz Mode Auto S	weep	
	1Pk View	M1[1]	0.45 dBm	
	10 dBm-		2.40230370 GHz	
	10 000	MI		
	0 dBm			
	-10 dBm			
	-20 dBm			
	-30 dBm			
	-40 dBm-			
	- Ho upin			
	-50 dBm			
	-60 dBm			
	-70 dBm			
	CF 2.402 GHz	1001 pts	Span 8.0 MHz	
	Date: 2.DEC.2022 15:32:23			
		DH1_Ant1_2441	(more)	
	Ref Level 20.00 dBm Offset 19.24 dB	RBW 3 MHz		
		. VBW 10 MHz Mode Auto S	weep	
	o 1Pk View			
		M1[1]	0.60 dBm 2.44111190 GHz	
	10 dBm-			
	0 dBm	M1		
	-10 dBm			
	-10 000			
	-20 dBm			
	-30 dBm			
	-40 dBm-			
	-50 dBm			
	-60 dBm			
	-70 dBm			
	CF 2.441 GHz	1001 pts	Span 8.0 MHz	
	Date: 2.DEC.2022 15:33:19	roorpes	apan a.u Minz	1
		DH1_Ant1_2480	(	
	Ref Level 20.00 dBm Offset 19.24 dB	RBW 3 MHz		1
		VBW 10 MHz Mode Auto S	weep	
	• 1Pk View			1
		M1[1]	0.92 dBm 2.48006390 GHz	
	10 dBm-			
	0 dBm			1
	-10 dBm			
	-40 000			
	-20 dBm			1
	-30 dBm			1
	-40 dBm			
	-50 dBm			
	-60 dBm			1
				1
	-70 dBm-			
	-70 dBm CF 2.48 GHz Date: 2.DEC.2022 15:34:21	1001 pts	Span 8.0 MHz	

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Report No.: RA221122-56020E-RF-00A



# Appendix D: Carrier frequency separation Test Result

Test Mode	Antenna	Frequency[MHz]	Result[MHz]	Limit[MHz]	Verdict
DH1	Ant1	Нор	1.006	≥0.693	PASS
2DH1	Ant1	Нор	1.003	≥0.787	PASS
3DH1	Ant1	Нор	1.006	≥0.780	PASS

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# Appendix E: Time of occupancy Test Result

Test Mode	Antenna	Frequency[MHz]	Burst Width [ms]	Total Hops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Нор	0.39	320	0.125	≤0.4	PASS
DH3	Ant1	Нор	1.64	160	0.262	≤0.4	PASS
DH5	Ant1	Нор	2.87	120	0.344	≤0.4	PASS
2DH1	Ant1	Нор	0.40	330	0.132	≤0.4	PASS
2DH3	Ant1	Нор	1.65	170	0.281	≤0.4	PASS
2DH5	Ant1	Нор	2.89	130	0.376	≤0.4	PASS
3DH1	Ant1	Нор	0.41	330	0.135	≤0.4	PASS
3DH3	Ant1	Нор	1.64	180	0.295	≤0.4	PASS
3DH5	Ant1	Нор	2.88	110	0.317	≤0.4	PASS

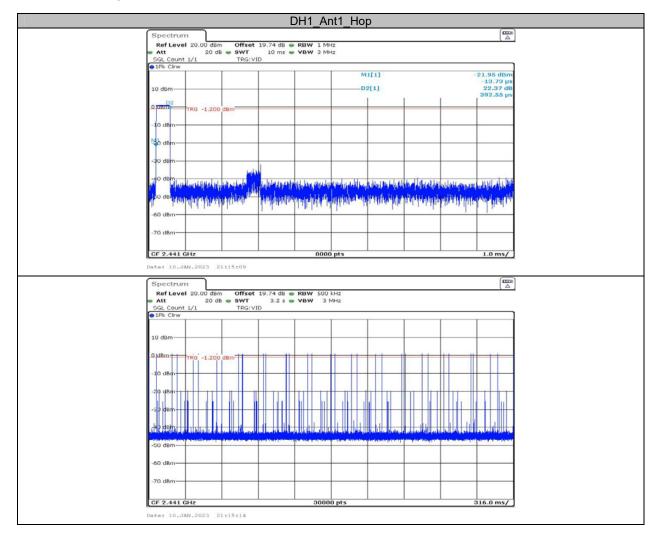
Note 1: A period time=0.4\*79=31.6(S), Result=Burst Width\*Total hops

Note 2: Total hops=Hopping Number in 3.16s\*10

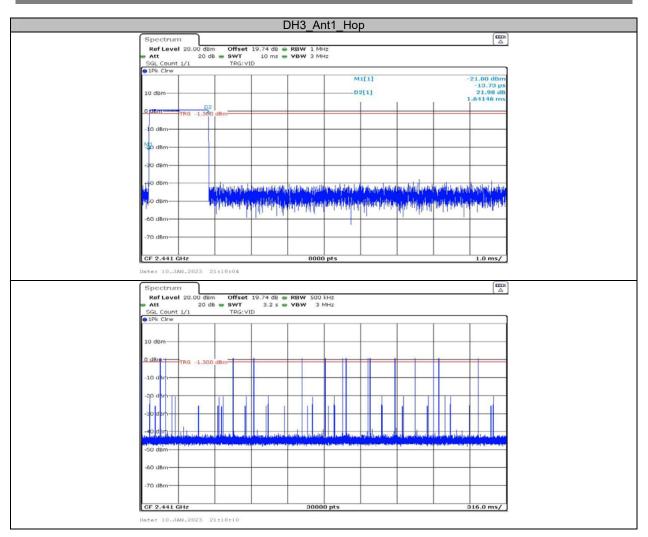
Note 3: Hopping Number in 3.16s=Total of highest signals in 3.16s (Second high signals were other channel)

#### Report No.: RA221122-56020E-RF-00A

# **Test Graphs**



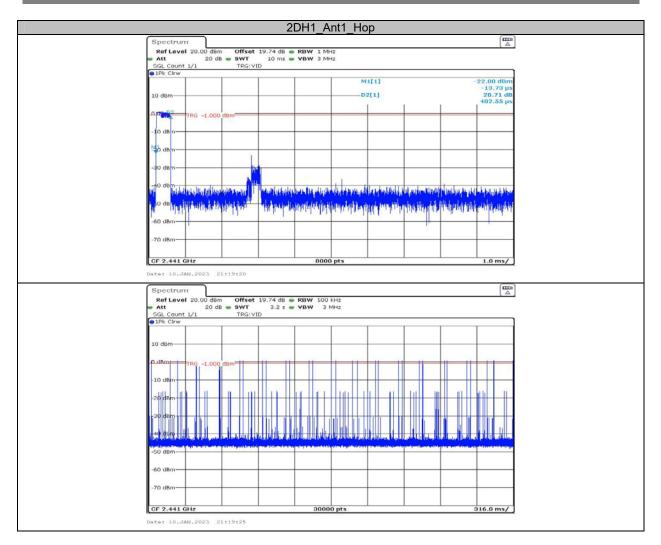
Report No.: RA221122-56020E-RF-00A



Report No.: RA221122-56020E-RF-00A

	DH5_A	nt1_Hop	
Spectrum			
Att 20 dB SWT	19.24 dB   RBW 1 Mi 10 ms   VBW 3 Mi	4z 4z	
SGL Count 1/1 TRG:V	D		,
1Pk Cirw		M1[1]	-24.88 dBm
10.40		D2[1]	-4.98 µs 12.68 dB
10 dBm		02[1]	2.87411 ms
0 dBm TRG -2.000 dBm			
-10 dBm	<u>∲</u> 2		
rao dBm			
1			
-30 dBm			
-40 d8m			
	Manuti Marillo data de data	bid along all had block and a la	in the state of the second state of the second state of the
0 dBm	Linghtshipphing	the internation of the line of	saisteile de die die entrie in a dat taal
60 rfBm	dentile a settle se les	A . III . II I. I I	The second of the second s
-60 dBm			
-70 dBm			
CF 2.441 GHz	8000	) pts	1.0 ms/
Date: 2.DEC.2022 15:45:51			
Spectrum			
	19.24 dB 🖝 RBW 500	kHz	
Att 20 dB = SWT SGL Count 1/1 TRG:V	3.2 s - VBW 31		
SGL Count 1/1 TRG:V     IPk Clrw			
10 dBm			
0 dBm TRG -2.000 dBm			
-10 cBm			
-20 cBm			
10 0.1			
-0 gen		The state that the state	
-50 dBm-	Conteres of the state of the second state of the	and a part of the second s	and the second
-50 dBm			
-60 dBm			
-70 dBm			
CF 2.441 GHz		0 pts	316.0 ms/

Report No.: RA221122-56020E-RF-00A



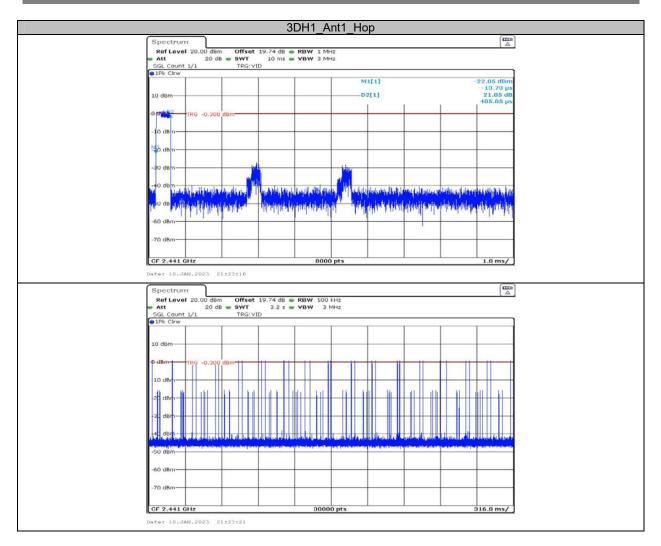
Report No.: RA221122-56020E-RF-00A

		2DH3	Ant1_Ho	р			
Spectrum							
Ref Level 20 Att		74 dB   RBW					
SGL Count 1/1 1Pk Clrw	TRG: VID						
			M	1[1]		-	22.77 dBm -13.73 µs
10 dBm			D	2[1]			21.37 dB .64771 ms
	- 1 D2 dam						
	1.000 0000						
-10 dBm							
bab dBm							
-30 dBm-							
0 dBm	Link harry de la blinde	handhallynydage	with the and the last	plada port de p	dettrictude	(pat-plattpb)	41. Applibilite
U <sup>p0</sup> dBm	bit providents de la la	<b>Description</b>	on and a state of the state of	ini mitorite	AN MERINA AND	dinia wa	i want pro
-60 dBm	1	11	20 E 10	114.6	1.1.1		6 10
-70 d8m							
-70 0011							
CF 2.441 GHz		6	000 pts				1.0 ms/
Date: 10.JAN.2	023 21:20:08						
Spectrum							
Ref Level 20 Att		3.2 s • VBW					
SGL Count 1/1 1Pk Clrw	TRG: VID						
10 dBm							
	-1.000 d8m	_		<b>T</b>			
-10 dBm	7 J 7 7 7			0.0	1 107	34 A	1.12
-20 dBm							
-30 dBm							
-40 d8m							
and the first firs	Products Complete Alexandrauet Days		adden adaday and 1				
-50 dBm							
-60 dBm							
-70 dBm							
-70 000							
						3	

Report No.: RA221122-56020E-RF-00A

Spectrum         Max           Ref Level 20.00 dim         Offset 19.74 die = RBW 1 MHz;           Att         20 die = SWT           10 dim         -10 dim           -10 dim         -21.00 dim           -10 dim         -10 dim           -10 dim         -110 dim           -20 dim         -21.221213		2DH5_A	nt1_Hop		
Att         20 db         SWT         10 ms         YBM         3 MHz           SGL Count L/L         TEG: VID         MI[1]         -21.30 dBm           0 dbm					
Sol. Count 1/1         TRG: VID           9 19t: Chw         -21.30 dom           10 dbm         -21.30 dom           10 dbm         -21.30 dom           -0 dbm         -21.30 dom           -70 dbm         -21.30 dom           Spectrum         -22.41 dbtz           Ref Level 20.00 dbm         Offset 19.74 db = RBW 500 kHz           Att         -20 db = SWT           -30 dbm         -20 db           -10 dbm         -20 db					
10 dbm       -21.30 dbm         10 dbm       -02[1]         20.10 dbm       20.10 dbm         -10 dbm       -21.30 dbm         -10 dbm       -21.30 dbm         -10 dbm       20.10 dbm         -10 dbm       -21.30 dbm         -10 dbm       -10 dbm         -10 dbm       -10 dbm         -10 dbm       -10 dbm         -10 dbm       -11	SGL Count 1/1 TRG:V				
10 dem       02[1]       20.10 de         11 mmanuel reginered regrader reginer reginer reginered reginered regrader reginered regr	IFR CITY		M1[1]		
nm       nm <td< td=""><td>10 dBm</td><td></td><td>D2[1]</td><td></td><td>20.10 dB</td></td<>	10 dBm		D2[1]		20.10 dB
10 dBm       10 dBm       10 dBm         20 dBm       10 dBm       10 dBm         10 dBm       11 dBm       10 dBm         10 dBm       10 dBm       10 dBm         20 dB       SWT       3.2 s         Spectrum       Cf       2.0 dB         Socout 1/1       Trace vio         10 dBm       10 dBm         -10 dBm       10 dBm			1	I I I	2.88786 ms
30 dBm	D TT THE TRG -0.900 dBm Partie				
30 dsm       40 dsm       41 dsm41 dsm       41 dsm       41 dsm41 dsm       41 dsm       41 ds	-10 dBm				
30 dsm       40 dsm       41 ds	ML dBm				
cf0 dBm       interference       interference       interference       interference         in0 dBm       interference       interference       interference       interference         -60 dBm       interference       interference       interference       interference         -70 dBm       interference       interference       interference       interference         -70 dBm       interference       interference       interference       interference         -70 dBm       interference       interference       interference       interference         CF 2.441 GHz       interference       interference       interference       interference         Signature       interference       interference       interference       interference         Signature       interference       interference       interference       interference         Interference       interference       interference       interference       interfere <t< td=""><td></td><td></td><td></td><td></td><td></td></t<>					
Ho dBm	-30 dBm				
Ho dBm			in the second se		
AB         AB<	<b>1</b>	- Aller - Actual -	edited and the first of the	index and the destruction of the second s	have don wear
-70 dBm	D dam-	and the second states and the second s	Low Disconsiding and the		<b>Filling Plan</b> t
CF 2.441 GHz         0000 pts         1.0 ms/           Date: 10.JAN.2023         21:22:13         Image: Construction of the construction of	-60 dBm	1.1		a al atan	
CF 2.441 GHz         0000 pts         1.0 ms/           Date: 10.JAN.2023         21:22:13         Image: Construction of the second s	-70 dBm-				
Date: 10.J3N.2023 21:22:13       Spectrum       Rof Level 20.00 dBm       Offset 19.74 dB = RBW 500 kHz       Att       20 dB = SWT       3.2 s = YBW 3 MHz       SGL Count 1/1       TRG: VID       91Pk Chw       10 dBm       -10 dBm       -30 dBm       -30 dBm       -50 dBm       -70 dBm	-50 dom				
Spectrum         Image: Construct of the second	CF 2.441 GHz	800	0 pts		1.0 ms/
Ref Level 20:00 dBm         Offset 19:74 dB         RBW 500 KHz           ext         20 dB         SWT         3.2 s         VBW 3 MHz           SGL Count 1/1         TBG:VID         TBG:VID         TBG:VID           ●1Pk Cirw         Image: State in the	Date: 10.JAN.2023 21:22:13				
Ref Level 20:00 dBm         Offset 19:74 dB         RBW 500 Hz           ext         20 dB         SWT         3.2 s         VBW 3 MHz           SGL Count 1/1         TBG:VID         TBG:VID         IMIZ           ●1Pk Cinw         Image: Signature in the second sec	Spectrum				(mm
SGL Count 1/1         TBG: VID                • IPk Cirw               • IPk Cirw                 10 dBm               • IPk Cirw                 -10 dBm               • IPk Cirw                 -10 dBm               • IPk Cirw                 -10 dBm                   -10 dBm                   -30 dBm                   -30 dBm                   -50 dBm                 -60 dBm                   -70 dBm	Ref Level 20.00 dBm Offset				2.5
10 dBm- 10 dBm- 10 dBm- -10 dBm- -20 dBm-	SGL Count 1/1 TRG:V		MHZ		
Ω dBm       TRO       -0.900 dBm       Image: state sta	• 1Pk Cirw				
Ω dBm       IRC -0.900 dBm       IRC -0.900 dBm       IRC -0.900 dBm         -10 dBm       IRC -0.900 dBm       IRC -0.900 dBm       IRC -0.900 dBm         -30 dBm       IRC -0.900 dBm       IRC -0.900 dBm       IRC -0.900 dBm         -30 dBm       IRC -0.900 dBm       IRC -0.900 dBm       IRC -0.900 dBm         -30 dBm       IRC -0.900 dBm       IRC -0.900 dBm       IRC -0.900 dBm         -30 dBm       IRC -0.900 dBm       IRC -0.900 dBm       IRC -0.900 dBm         -30 dBm       IRC -0.900 dBm       IRC -0.900 dBm       IRC -0.900 dBm         -50 dBm       IRC -0.900 dBm       IRC -0.900 dBm       IRC -0.900 dBm         -70 dBm       IRC -0.900 dBm       IRC -0.900 dBm       IRC -0.900 dBm	10 dBm				
-10 dBm					
-20 dBm -40 dBm -40 dBm -50 dBm -50 dBm -70 dBm -70 dBm -70 dBm	0.dBm TRG -0.900 dBm				
-30 dBm	-10 dBm				
-30 dBm		1 F 1 F 1		11 11 12	1
-90 dBm- -50 dBm- -60 dBm- -70 dBm-	-20 dBm				
-50 dBm	-30 dBm				
-50 dBm	-40 d8m				
-50 dBm		والمرجاع ويعتبنه كالرائدة ليحتمل متعاليه			
-70 dBm-	-50 dBm				
	-60 dBm				-
CF 2.441 GHz 30000 pts 316.0 ms/	-70 dBm-				-
			1 1		

Report No.: RA221122-56020E-RF-00A



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				3DH3	Ant1	Hop				
Spectrun										6
Ref Level	20.00 dBm		19.24 dB							
GL Count		SWT TRG:V		VBW 3	MHZ					
1Pk Clrw			1	T	1	M1[1]	1			-24.59 dB
10.10						D2[1]				-4.98 11.47
10 dBm						_02[1]	Ζ.			1.63770 m
0 dBm	TRG -2.000	dBm			-	-				
-10 dBm-										
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O dBm-				-		-				-
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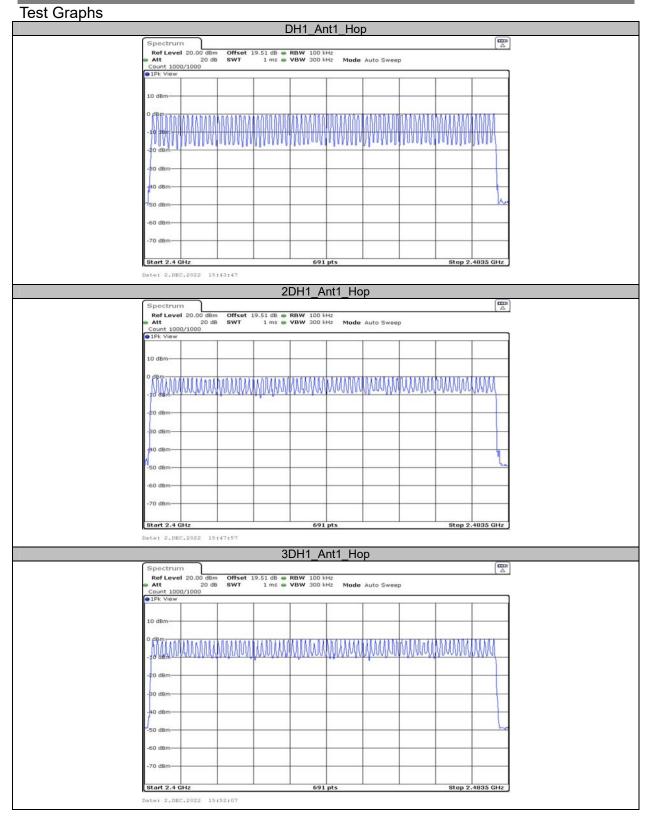
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# Appendix F: Number of hopping channels Test Result

Test Mode	Antenna	Frequency[MHz]	Result[Num]	Limit[Num]	Verdict
DH1	Ant1	Нор	79	≥15	PASS
2DH1	Ant1	Нор	79	≥15	PASS
3DH1	Ant1	Нор	79	≥15	PASS

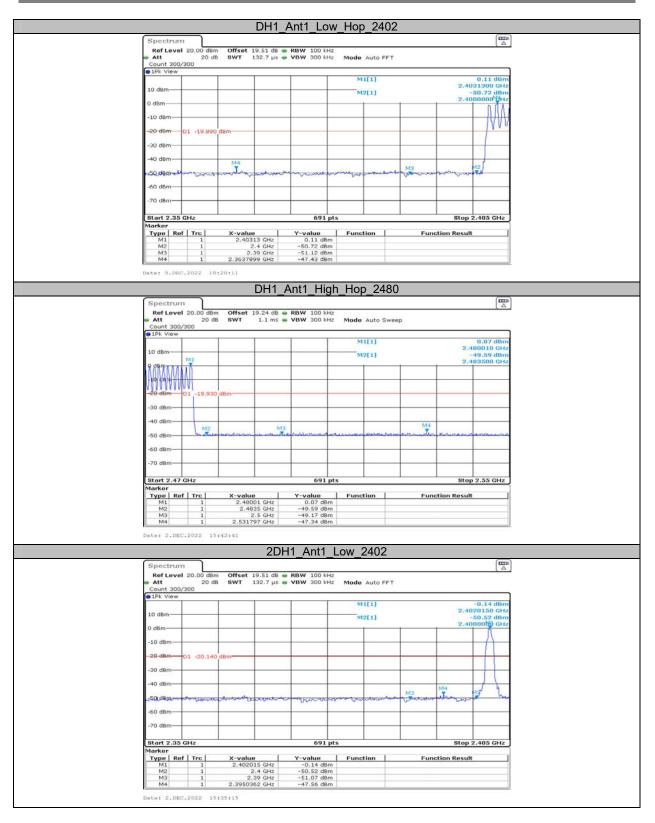
Report No.: RA221122-56020E-RF-00A



# Appendix G: Band edge measurements Test Graphs



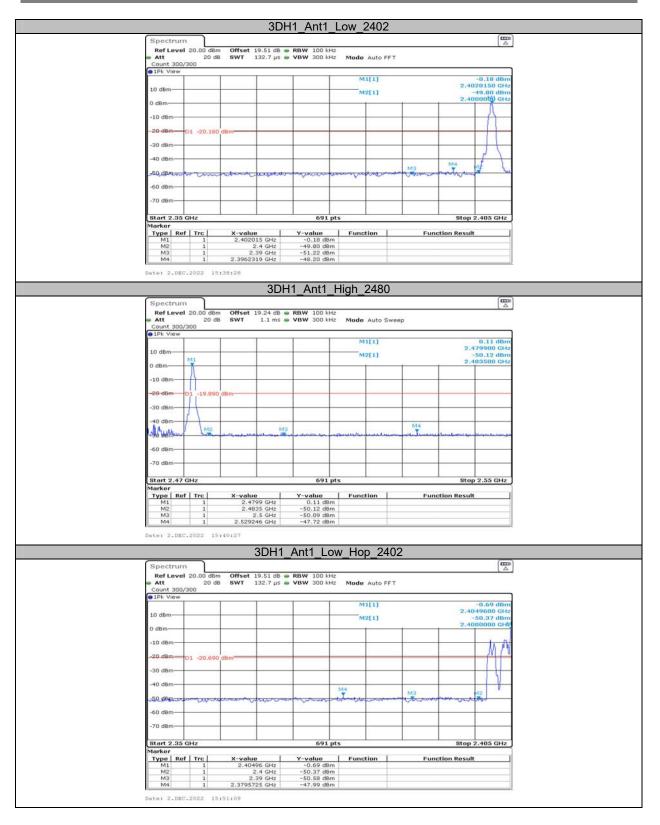
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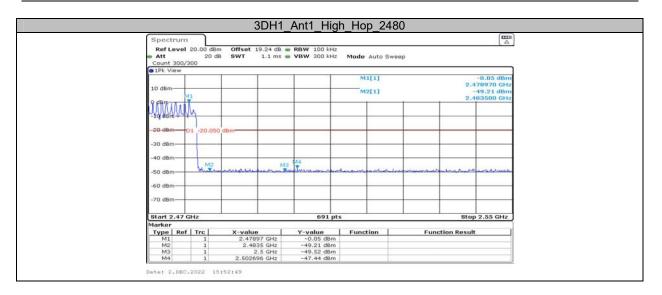
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# \*\*\*\*\* END OF REPORT \*\*\*\*\*