SHENZHEN 3NOD DIGITAL TECHNOLOGY CO., LTD

TEST REPORT

SCOPE OF WORK
FCC Testing – VG22-GSPL-WIREDBTPCRGBSPEAKER

REPORT NUMBER
220425003SZN-001

ISSUE DATE **[REVISED DATE]**

26 May 2022 [----------]

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TEST REPORT

Intertek Report No.: 220425003SZN-001

SHENZHEN 3NOD DIGITAL TECHNOLOGY CO., LTD

Application
For
Certification

FCC ID: 2AA3HP10032

Gaming Speaker Set

Model: VG22-GSPL-WIREDBTPCRGBSPEAKER

2.4GHz Transceiver

Report No.: 220425003SZN-001

We hereby certify that the sample of the above item is considered to comply with the requirements of FCC Part 15, Subpart C for Intentional Radiator, mention 47 CFR [10-1-20]

Prepared and Checked by:

Ryan Chen
Project Engineer

Approved by:

Peter Kang
Senior Technical Supervisor
Date: 26 May 2022

MEASUREMENT/TECHNICAL REPORT

This report concerns (check one:) Original Grant X Class II Change _____

Equipment Type: DSS - Part 15 Spread Spectrum Transmitter

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? Yes _____ No X

If yes, defer until: _____
date

Company Name agrees to notify the Commission by: _____
date
of the intended date of announcement of the product so that the grant can be issued on that date.

Transition Rules Request per 15.37? Yes _____ No X

If no, assumed Part 15, Subpart C for intentional radiator – the new 47 CFR [10-1-20 Edition] provision.

Report prepared by:

Ryan Chen
Intertek Testing Services Shenzhen Ltd. Longhua Branch
101, 201, Building B, No. 308 Wuhe Avenue, Zhangkengjing
Community, GuanHu Subdistrict, LongHua District, Shenzhen.
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1.0 Summary of Test Results

Applicant: SHENZHEN 3NOD DIGITAL TECHNOLOGY CO., LTD

Address: 401, Zone 101A, Workshop 15, Zhongfu road, Tangxiayong community, yanluo street, Shenzhen, China

Manufacturer: SHENZHEN 3NOD DIGITAL TECHNOLOGY CO., LTD

Address: 401, Zone 101A, Workshop 15, Zhongfu road, Tangxiayong community, yanluo street, Shenzhen, China

Model: VG22-GSPL-WIREDBTPCRGBSPEAKER

FCC ID: 2AA3HP10032

TEST	REFERENCE	RESULTS
Max. Output power / Max. e.i.r.p.	FCC 15.247(b)(1)	Pass
20dB Bandwidth	FCC 15.247(a)(1)	Pass
Channel Separation	FCC 15.247(a)(1)	Pass
Channel Number	FCC 15.247(a)(1) (iii)	Pass
Dwell Time	FCC 15.247(a)(1)(iii)	Pass
Out of Band Antenna Conducted Emission	FCC 15.247(d)	Pass
Radiated Emission in Restricted Bands	FCC 15.247(d), FCC 15.209, FCC 15.205	Pass
Band Edge	FCC 15.247(d), FCC 15.209, FCC 15.205	Pass
AC Conducted Emission	FCC 15.207	Pass

Note:
The EUT uses an Integral Antenna which in accordance to Section 15.203 is considered sufficient to comply with the provisions of this section.

2.0 General Description

2.1 Product Description

The equipment under test (EUT) is a Gaming Speaker Set with Bluetooth FHSS technology operating in 2402-2480MHz. The EUT is powered by DC 5V 1A via USB port. For more detail information pls. refer to the user manual.

Bluetooth Version: 5.3 EDR(Single Mode)
Antenna Type: Integral antenna
Antenna Gain: -0.58 dBi max
Modulation Type: GFSK, π/4-DQPSK and 8-DPSK

For electronic filing, the brief circuit description is saved with filename: descri.pdf.

2.2 Related Submittal(s) Grants

This is an application for certification of transceiver for the Gaming Speaker Set which has Bluetooth EDR function. Other digital functions were reported in the SDOC report: 220425003SZN-002.

2.3 Test Methodology

Both AC mains line-conducted and radiated emission measurements were performed according to the procedures in ANSI C63.10 (2013). Radiated emission measurement was performed in semi-anechoic chamber and conducted emission measurement was performed in shield room. For radiated emission measurement, preliminary scans were performed in the semi-anechoic chamber only to determine the worst case modes. All radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "**Justification Section**" of this Application.

2.4 Test Facility

The Semi-anechoic chamber and shielding room used to collect the radiated data and conducted data are **Beijing TIRT Technology Service Co.,Ltd Shenzhen** and located at 101, 3 # Factory Building, Gongjin Electronics Shatin Community, Kengzi Street, Pingshan District, Shenzhen, China. This test facility and site measurement data have been fully placed on file with File Number: CN1309.

3.0 System Test Configuration

3.1 Justification

The system was configured for testing in a typical fashion (as a customer would normally use it), and in the confines as outlined in ANSI C63.10 (2013).

During test, the EUT was powered by AC120V, 60Hz via adapter or laptop. Both have been tested and only the worst-case data were recorded in this report.

All packets DH1, DH3 & DH5 mode in modulation type GFSK, π/4-DQPSK and 8-DPSK were tested and only the worst data was reported in this report.

For maximizing emissions below 30 MHz, the EUT was rotated through 360°, the bottom of the loop antenna was placed 1 meter above the ground, and the antenna polarization was changed. For maximizing emissions, the EUT was rotated through 360°, the antenna height was varied from 1 meter to 4 meters above the ground plane, and the antenna polarization was changed. This step by step procedure for maximizing emissions led to the data reported in Section 4.

The rear of unit was flushed with the rear of the table.

The equipment under test (EUT) was configured for testing in a typical fashion (as a customer would normally use it). The EUT was placed on a turn table, which enabled the engineer to maximize emissions through its placement in the three orthogonal axes.

3.2 EUT Exercising Software

The EUT exercise program (provided by client) used during radiated and conducted testing was designed to exercise the various system components in a manner similar to a typical use. The worst case configuration is used in all specified testing.

The parameters of test software setting:
During the test, Channel and power controlling software provided by the applicant was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the application and is going to be fixed on the firmware of the end product.

Test Software: FCC_assist_1.0.2.2

3.3 Special Accessories

No special accessory attached.

3.4 Equipment Modification

Any modifications installed previous to testing by SHENZHEN 3NOD DIGITAL TECHNOLOGY CO., LTD will be incorporated in each production model sold / leased in the United States.

No modifications were installed by Intertek Testing Services Shenzhen Ltd. Longhua Branch / Beijing TIRT Technology Service Co.,Ltd Shenzhen.

3.5 Measurement Uncertainty

When determining the test conclusion, the Measurement Uncertainty of test has been considered.

Measurement Uncertainty	Uncertainty
Channel Bandwidth	±5.92%
RF Output Power	±0.74dB
Conducted Unwanted Emission	±1.78dB
Spurious emission (Above 18GHz)	±5.1dB
Spurious emission (6GHz to 18GHz)	±4.9dB
Radiated emission (1GHz to 6GHz)	±4.8dB
Radiated emission (Up to 1GHz)	±4.6dB
AC Conducted emission	±3.1 dB
Dwell time	±5%
Temperature	±0.7°C
Humidity	±4.6%

3.6 Support Equipment List and Description

Description	Manufacturer	Model No.
iPhone (Provided by Test Lab TIRT)	Apple	iPhone 13
Laptop (Provided by Test Lab TIRT)	Lenovo	M4500T
Adapter (Provided by Test Lab TIRT)	Lenovo	ADLX65NLC3A
Adapter (Provided by Test Lab TIRT)	canary	Model: CAN100USAPTW Input: 100-240V 50~60Hz Output: DC 5V 1A
Adapter (Provided by Test Lab TIRT)	LE	Model: EQ-24AC Input: 100-240V 50~60Hz Output: DC 5V 1A

4.0 Test Results

Data is included worst-case configuration (the configuration which resulted in the highest emission levels).

4.1 Radiated Test Results

A sample calculation, configuration photographs and data tables of the emissions are included.

4.1.1 Field Strength Calculation

The field strength is calculated by adding the reading on the Spectrum Analyzer to the factors associated with preamplifiers (if any), antennas, cables, pulse desensitization and average factors (when specified limit is in average and measurements are made with peak detectors). A sample calculation is included below.

FS = RA + AF + CF - AG + PD + AV

Where FS = Field Strength in dBµV/m
RA = Receiver Amplitude (including preamplifier) in dBµV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB/m
AG = Amplifier Gain in dB
PD = Pulse Desensitization in dB
AV = Average Factor in -dB

In the radiated emission table which follows, the reading shown on the data table may reflect the preamplifier gain. An example of the calculations, where the reading does not reflect the preamplifier gain, follows:

FS = RA + AF + CF - AG + PD + AV

Assume a receiver reading of 62.0 dBµV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted. The pulse desensitization factor of the spectrum analyzer was 0 dB, and the resultant average factor was -10 dB. The net field strength for comparison to the appropriate emission limit is 32 dBµV/m. This value in dBµV/m was converted to its corresponding level in µV/m.

RA = 62.0 dBµV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
PD = 0 dB
AV = -10 dB

FS = 62 + 7.4 + 1.6 - 29 + 0 + (-10) = 32 dBµV/m
Level in µV/m = Common Antilogarithm [(32 dBµV/m)/20] = 39.8 µV/m

4.1.2 Radiated Emission Configuration Photograph

For electronic filing, the worst case radiated emission configuration photograph is saved with filename: radiated photos. pdf.

4.1.3 Radiated Emissions- FCC section 15.209

The data on the following page lists the significant emission frequencies, the limit and the margin of compliance. Numbers with a minus sign are below the limit.

Worst Case Radiated Emission

at 39.1616 MHz

Judgement: Passed by 5.3 dB

TEST PERSONNEL:

Sign on file

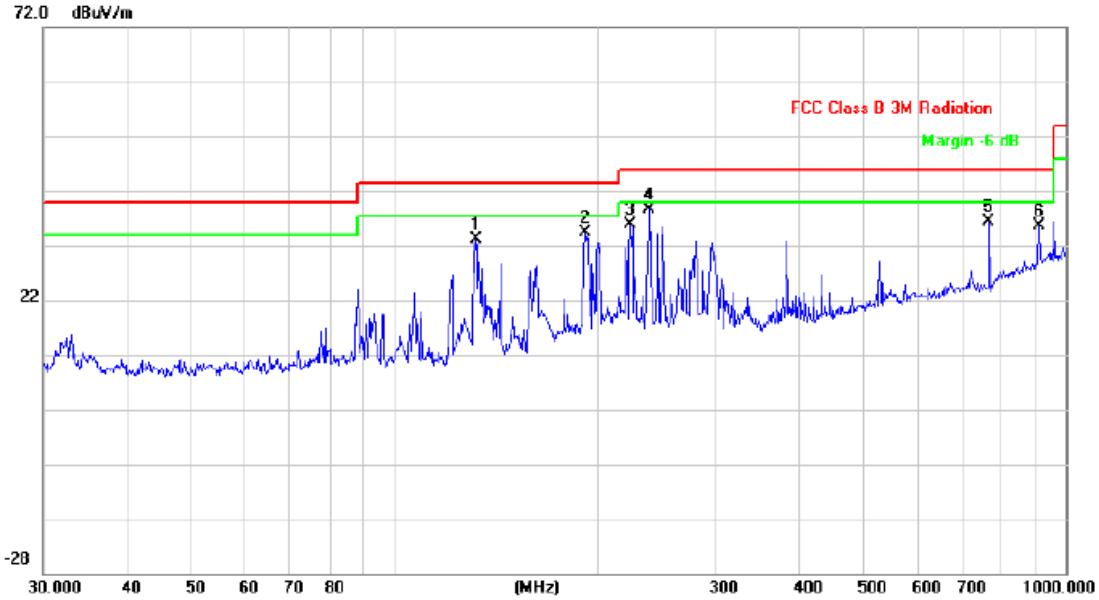
George Zhong, Project Engineer
Typed/Printed Name

07 May 2022
Date

Applicant: SHENZHEN 3NOD DIGITAL TECHNOLOGY CO., LTD
Date of Test: 07 May 2022
Model:VG22-GSPL-WIREDBTPCRGBSPEAKER
Worst-case and operating Mode: BT Link

ANT Polarity: Horizontal

Radiated Emission



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		132.2206	20.26	12.88	33.14	43.50	-10.36	QP	200	4	
2		192.4186	19.12	15.19	34.31	43.50	-9.19	QP	200	1	
3		224.5193	19.88	15.99	35.87	46.00	-10.13	QP	130	360	
4	*	239.9873	22.37	16.36	38.73	46.00	-7.27	QP	100	355	
5		768.7481	10.96	25.36	36.32	46.00	-9.68	QP	100	161	
6		912.8620	6.35	29.24	35.59	46.00	-10.41	QP	100	247	

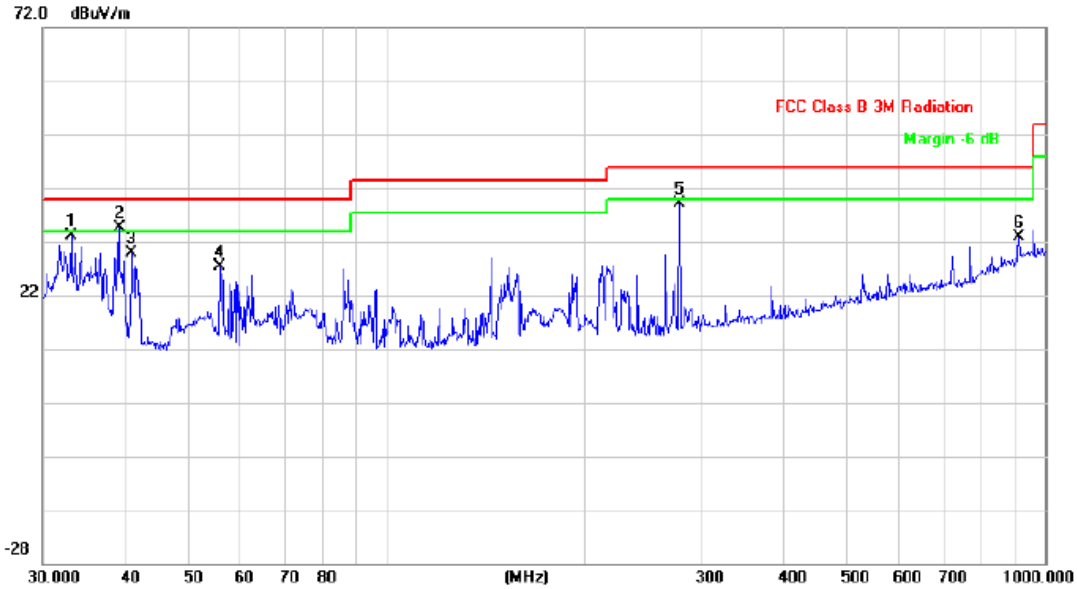
Remark:

1. Corr. (dB/m)= Antenna Factor (dB/m) + Cable Loss (dB)
2. Measurement (dBµV/m)= Corr. (dB/m)+ Read Level (dBµV)
3. Over (dB) = Limit Line(dBµV/m) – Level (dBµV/m)
4. Negative sign (-) in the margin column signify levels below the limit.

Applicant: SHENZHEN 3NOD DIGITAL TECHNOLOGY CO., LTD
Date of Test: 07 May 2022
Model: VG22-GSPL-WIREDBTPCRGBSPEAKER
Worst-case and operating Mode: BT Link

ANT Polarity: Vertical

Radiated Emission



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		33.0950	18.81	14.32	33.13	40.00	-6.87	QP	100	75	
2	*	39.1616	20.16	14.54	34.70	40.00	-5.30	QP	100	3	
3		40.9881	15.24	14.57	29.81	40.00	-10.19	QP	100	0	
4		55.6094	12.66	14.63	27.29	40.00	-12.71	QP	100	20	
5		278.0668	21.61	17.59	39.20	46.00	-6.80	QP	100	85	
6		912.8620	3.68	29.24	32.92	46.00	-13.08	QP	100	217	

Remark:

1. Corr. (dB/m)= Antenna Factor (dB/m) + Cable Loss (dB)
2. Measurement (dBµV/m)= Corr. (dB/m)+ Read Level (dBµV)
3. Over (dB) = Limit Line(dBµV/m) – Level (dBµV/m)
4. Negative sign (-) in the margin column signify levels below the limit.

4.1.4 Transmitter Spurious Emissions (Radiated) - FCC section 15.209

The data on the following page lists the significant emission frequencies, the limit and the margin of compliance. Numbers with a minus sign are below the limit.

Worst Case Radiated Emission

at 7983.300 MHz

Judgement: Passed by 12.6 dB

TEST PERSONNEL:

Sign on file

George Zhong, Project Engineer
Typed/Printed Name

07 May 2022
Date

Applicant: SHENZHEN 3NOD DIGITAL TECHNOLOGY CO., LTD
Date of Test: 07 May 2022
Model: VG22-GSPL-WIREDBTPCRGBSPEAKER
Worst-case and operating Mode: Transmit (2402MHz)
Modulation type: 3DH5

Table 1

Radiated Emissions

(2402MHz)

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
Vertical	*7961.500	38.4	36.7	36.5	38.2	74.0	-35.8
Vertical	*2390.000	55.8	34.8	25.8	46.8	74.0	-27.2

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Average Factor (-dB)	Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Vertical	*7961.500	38.4	36.7	36.5	22.5	15.7	54	-38.3
Vertical	*2390.000	55.8	34.8	25.8	22.5	24.3	54	-29.7

NOTES:
1. Peak detector is used for the emission measurement.
2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.
3. Negative value in the margin column shows emission below limit.
4. Horn antenna used for the emission over 1000MHz.

* Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.

Applicant: SHENZHEN 3NOD DIGITAL TECHNOLOGY CO., LTD
Date of Test: 07 May 2022
Model: VG22-GSPL-WIREDBTPCRGBSPEAKER
Worst-case and operating Mode: Transmit (2441MHz)
Modulation type: 3DH5

Table 2

Radiated Emissions

(2441MHz)

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
Vertical	*8777.500	54.5	36.7	34.6	52.4	74.0	-21.6

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Average Factor (-dB)	Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Vertical	*8777.500	54.5	36.7	34.6	22.5	29.9	54.0	-24.1

NOTES:
1. Peak detector is used for the emission measurement.

2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Horn antenna used for the emission over 1000MHz.

* Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.

Applicant: SHENZHEN 3NOD DIGITAL TECHNOLOGY CO., LTD
Date of Test: 07 May 2022
Model: VG22-GSPL-WIREDBTPCRGBSPEAKER
Worst-case and operating Mode: Transmit (2480MHz)
Modulation type: 3DH5

Table 3

Radiated Emissions

(2480MHz)

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
Vertical	*7983.300	62.6	36.7	35.5	61.4	74.0	-12.6
Vertical	*2483.500	56.4	34.8	26.1	47.7	74.0	-26.3

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Average Factor (-dB)	Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Vertical	*7983.300	62.6	36.7	35.5	22.5	38.9	54	-15.1
Vertical	*2483.500	56.4	34.8	26.1	22.5	25.2	54	-28.8

NOTES:
1. Peak detector is used for the emission measurement.

2. All measurements were made at 3 meters. Radiated emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other radiated emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Horn antenna used for the emission over 1000MHz.

* Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted peak limit with a peak detector function.

4.2 Conducted Emission at Mains Terminal

4.2.1 Conducted Emissions Configuration Photograph

For electronic filing, the worst case conducted emission configuration photograph is saved with filename: conducted photos.pdf.

4.2.2 Conducted Emissions

Worst Case Conducted Configuration

at 0.6740 MHz

Judgement: Passed by 13.12 dB margin

TEST PERSONNEL:

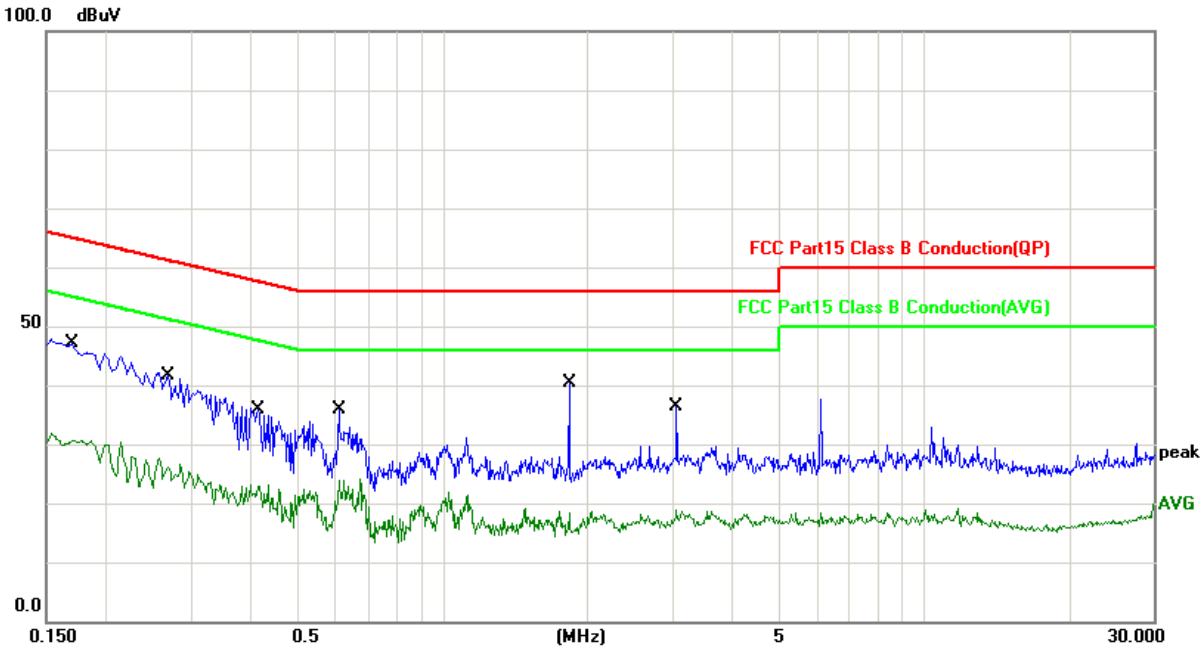
Sign on file

George Zhong, Project Engineer
Typed/Printed Name

07 May 2022
Date

Applicant: SHENZHEN 3NOD DIGITAL TECHNOLOGY CO., LTD
Date of Test: 12 May 2022
Model: VG22-GSPL-WIREDBTPCRGBSPEAKER
Worst-case and operating Mode: BT Link
Modulation type: GFSK
Test Voltage: AC 120V/60Hz
Phase: Live

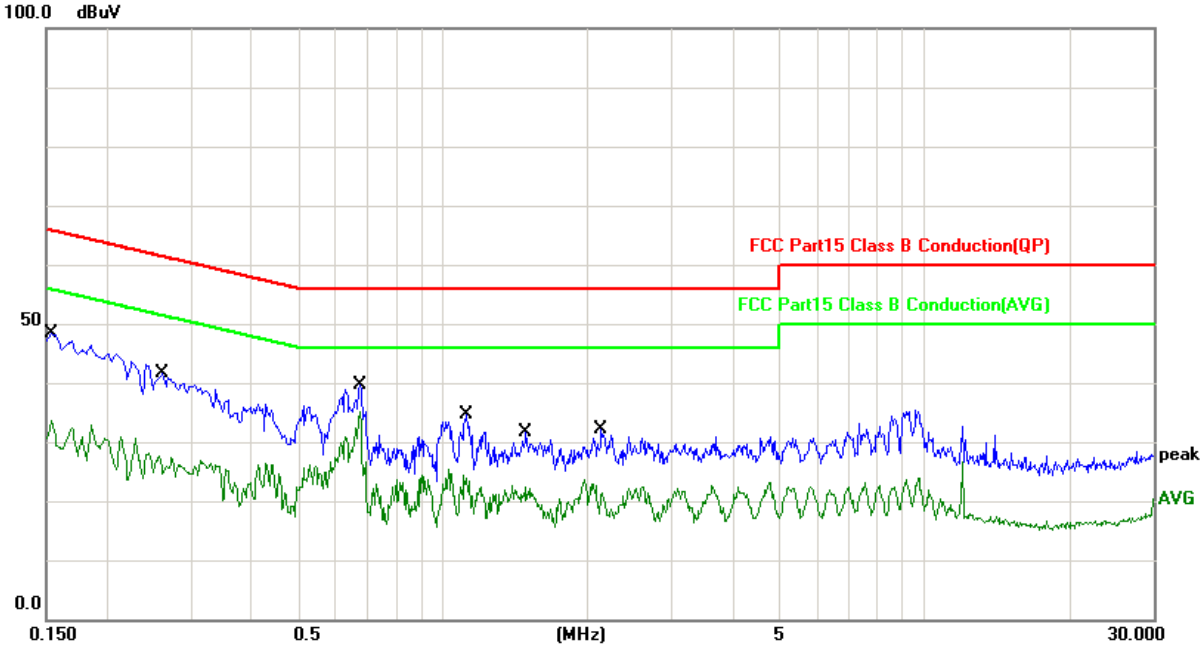
Conducted Emission Test - FCC



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1	*	0.1700	25.32	19.53	44.85	64.96	-20.11	QP	
2		0.1700	10.19	19.53	29.72	54.96	-25.24	AVG	
3		0.2700	19.90	19.53	39.43	61.12	-21.69	QP	
4		0.2700	4.84	19.53	24.37	51.12	-26.75	AVG	
5		0.4140	14.50	19.53	34.03	57.57	-23.54	QP	
6		0.4140	3.80	19.53	23.33	47.57	-24.24	AVG	
7		0.6100	7.53	19.53	27.06	56.00	-28.94	QP	
8		0.6100	0.73	19.53	20.26	46.00	-25.74	AVG	
9		1.8300	6.12	19.98	26.10	56.00	-29.90	QP	
10		1.8300	-5.19	19.98	14.79	46.00	-31.21	AVG	
11		3.0580	-0.72	20.73	20.01	56.00	-35.99	QP	
12		3.0580	-3.87	20.73	16.86	46.00	-29.14	AVG	

Applicant: SHENZHEN 3NOD DIGITAL TECHNOLOGY CO., LTD
Date of Test: 12 May 2022
Model: VG22-GSPL-WIREDBTPCRGBSPEAKER
Worst-case and operating Mode: BT Link
Modulation type: GFSK
Test Voltage: AC 120V/60Hz
Phase: Neutral

Conducted Emission Test – FCC



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1540	25.75	19.70	45.45	65.78	-20.33	QP	
2		0.1540	10.71	19.70	30.41	55.78	-25.37	AVG	
3		0.2620	20.96	19.69	40.65	61.37	-20.72	QP	
4		0.2620	6.92	19.69	26.61	51.37	-24.76	AVG	
5		0.6740	14.29	19.78	34.07	56.00	-21.93	QP	
6	*	0.6740	13.10	19.78	32.88	46.00	-13.12	AVG	
7		1.1220	7.72	19.92	27.64	56.00	-28.36	QP	
8		1.1220	1.03	19.92	20.95	46.00	-25.05	AVG	
9		1.4900	2.43	20.06	22.49	56.00	-33.51	QP	
10		1.4900	0.13	20.06	20.19	46.00	-25.81	AVG	
11		2.1380	0.90	20.38	21.28	56.00	-34.72	QP	
12		2.1380	-2.72	20.38	17.66	46.00	-28.34	AVG	

4.3 Peak Power

Maximum Conducted Output Power at Antenna Terminals, FCC Rules 15.247(b)(1).
The antenna port of the EUT was connected to the input of a spectrum analyzer. The analyzer was set for RBW > 20dB bandwidth and power was read directly in dBm.

For antenna with gains of 6dBi or less, and 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, the systems operate with an output power no greater than 125 mW.

Antenna Gain = -0.58 dBi			
Modulation Type	Frequency (MHz)	Output Power (Peak Reading) (dBm)	Output Power (mW)
3DH1	2402	-1.05	0.79
	2441	0.10	1.02
	2480	0.25	1.06

Cable loss: 0.5 dB External Attenuation: 10 dB
Note: The ref offset in the spectrum analyzer includes cable loss, external attenuation and the attenuation of Power Collection Unit.

TEST PERSONNEL:

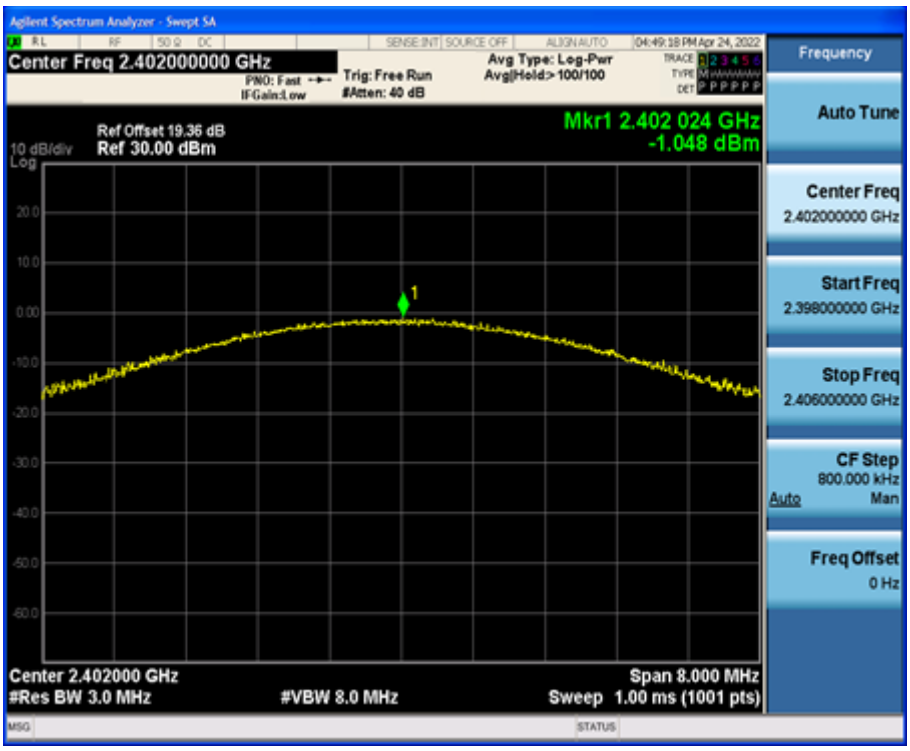
Sign on file

George Zhong, Project Engineer
Typed/Printed Name

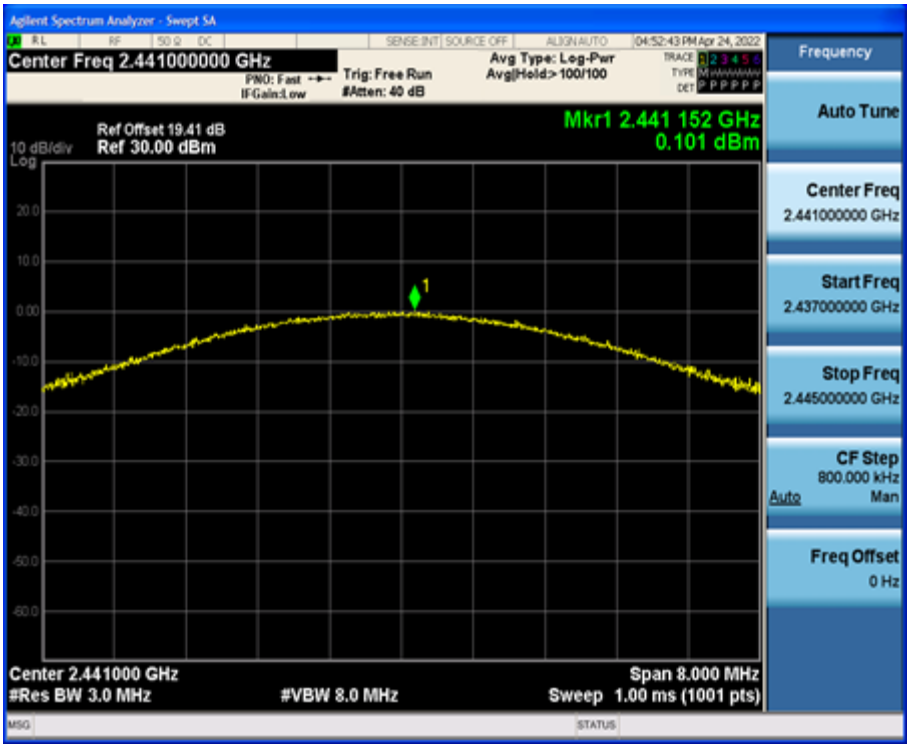
07 May 2022
Date

Modulation Type: 3DH1

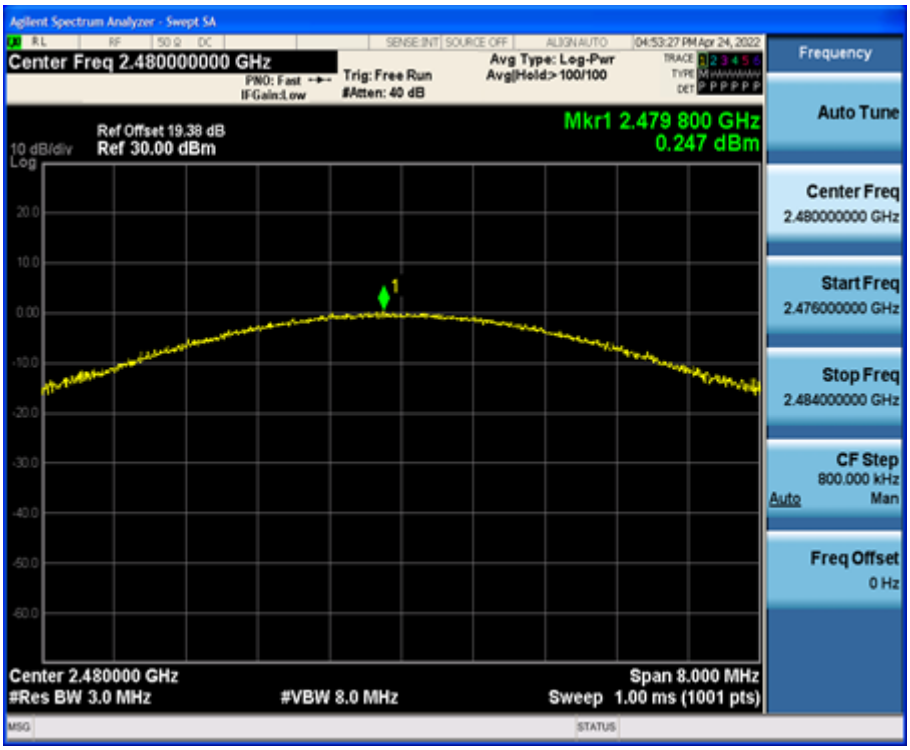
CH00



CH39



CH78


Agilent Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 40 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
04:53:27 PM Apr 24, 2022
Ref Offset 19.38 dB
10 dB/div
Log
Ref 30.00 dBm
Mkr1 2.479 800 GHz
0.247 dBm
Center 2.480000 GHz
#Res BW 3.0 MHz
#VBW 8.0 MHz
Span 8.000 MHz
Sweep 1.00 ms (1001 pts)
Frequency
Auto Tune
Center Freq
2.480000000 GHz
Start Freq
2.476000000 GHz
Stop Freq
2.484000000 GHz
CF Step
800.000 kHz
Auto
Man
Freq Offset
0 Hz

4.4 20dB Bandwidth

Maximum 20dB RF Bandwidth, FCC Rule 15.247(a) (1):

The antenna port of the EUT was connected to the input of a spectrum analyzer. Analyzer RBW was chosen so that the display was a result of the hopping channel modulation. For each RF output channel investigated, the spectrum analyzer center frequency was set to the channel carrier. Use the spectrum 20dB down delta function to measure the bandwidth.

Frequency (MHz)	20 dB Bandwidth (MHz)
2402	1.266
2441	1.224
2480	1.230

TEST PERSONNEL:

Sign on file

George Zhong, Project Engineer
Typed/Printed Name

07 May 2022
Date

Modulation Type: 2DH1

CH00

CH39

CH78


Agilent Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Wide
IFGain:Low
Trig: Free Run
#Atten: 40 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
04:24:45 PM Apr 24, 2022
Ref Offset 19.38 dB
10 dB/div
Ref 30.00 dBm
ΔMkr3 1.230 MHz
-0.181 dB
Center 2.480000 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 3.000 MHz
Sweep 3.20 ms (1001 pts)
1 N 1 f 2.479 394 GHz -24.321 dBm
2 N 1 f 2.480 003 GHz -4.068 dBm
3 Δ1 1 f (Δ) 1.230 MHz (Δ) -0.181 dB
Frequency
Auto Tune
Center Freq
2.480000000 GHz
Start Freq
2.478500000 GHz
Stop Freq
2.481500000 GHz
CF Step
300.000 kHz
Auto
Man
Freq Offset
0 Hz

4.5 Channel Number (Number of Hopping Frequencies)

Minimum Number of Hopping Frequencies, FCC Rule 15.247(a) (1) (iii):

The RF passband of the EUT was divided into 3 approximately equal bands. With the analyzer set to MAX HOLD readings were taken for 2-3 minutes. The channel peaks so recorded were added together, and the total number compared to the minimum number of channels required in the regulation.

Number of hopping channels =	79

Note: In AFH mode, this device operates using 20 channels and it's satisfied the requirement of limit of minimum of 15 hopping channels.

TEST PERSONNEL:

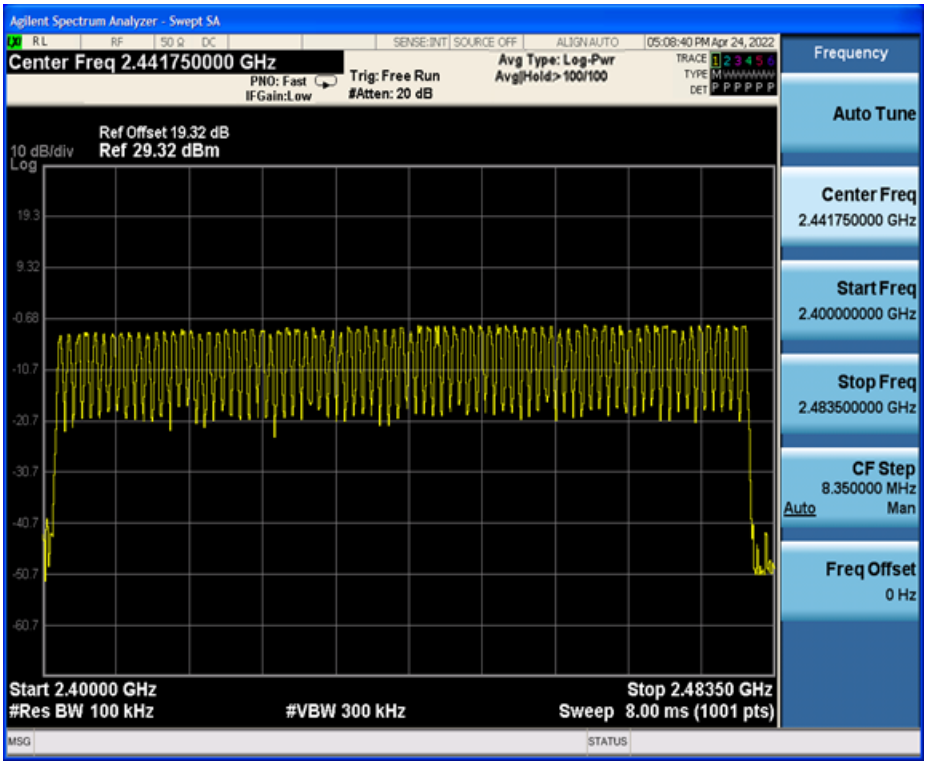
Sign on file

George Zhong, Project Engineer
Typed/Printed Name

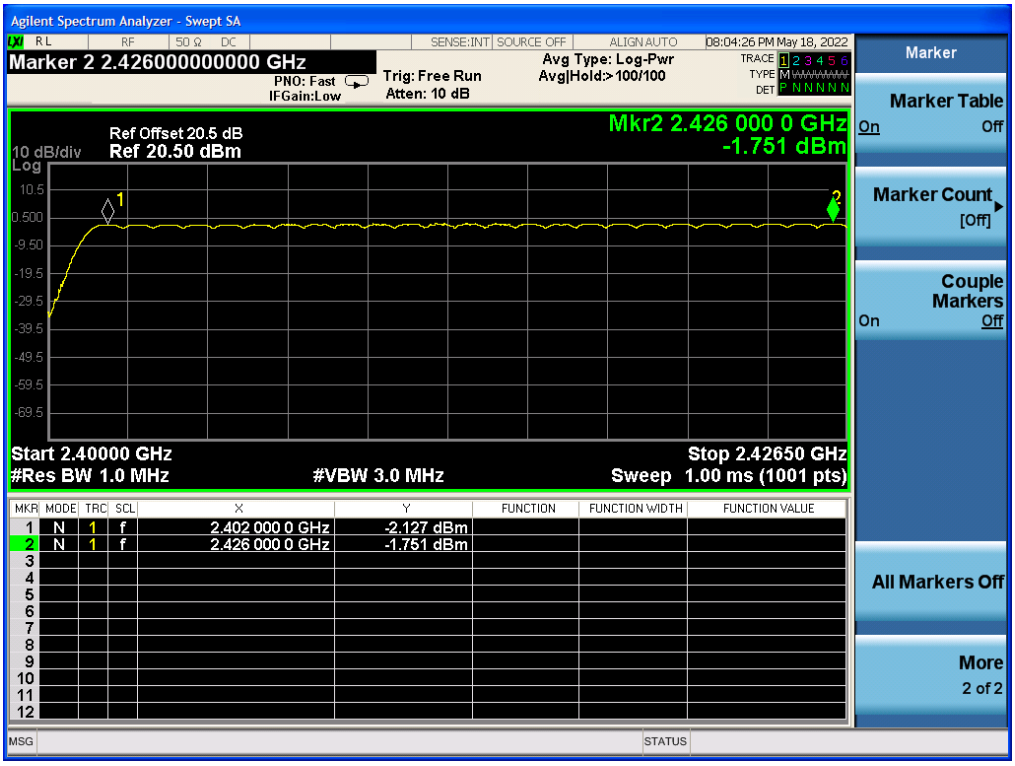
07 May 2022
Date

Modulation Type: GFSK

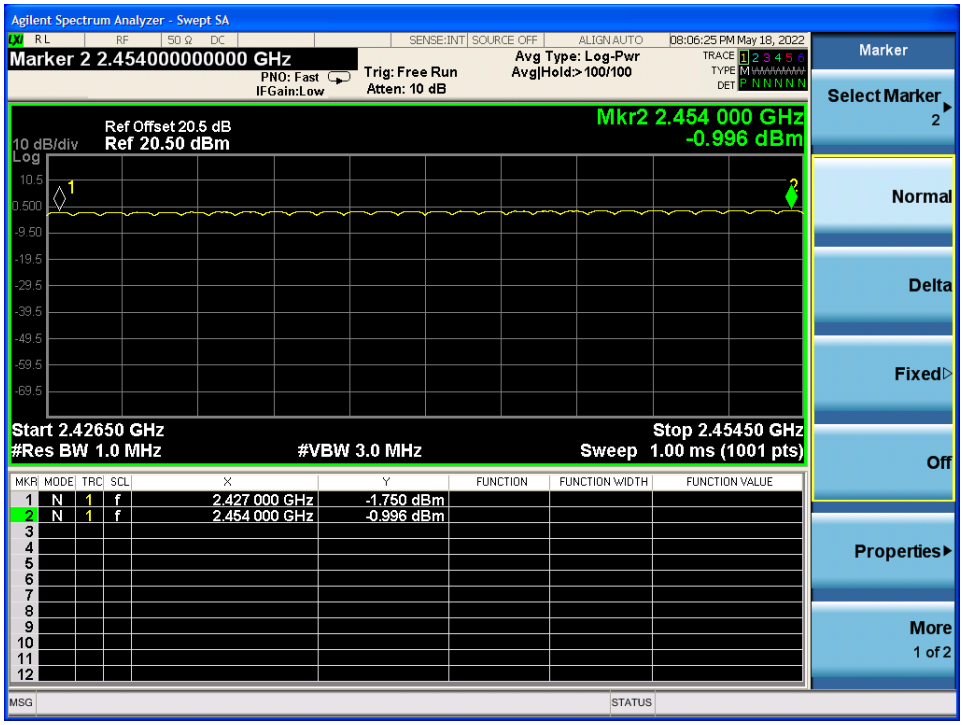
CH00-CH78



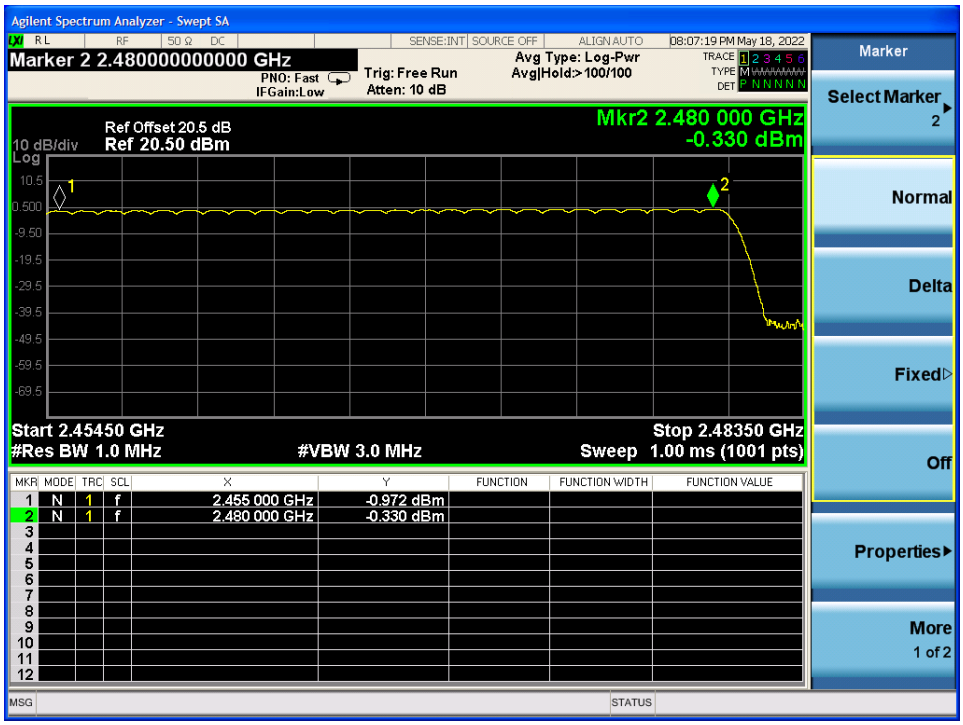
CH00-CH24



CH25-CH52



CH53-CH78



4.6 Channel Separation (Carrier Frequency Separation)

Minimum Hopping Channel Carrier Frequency Separation, FCC Ref: 15.247(a)(1):

Using the DELTA MARKER function of the analyzer, the frequency separation between two adjacent channels was measured and compared against the limit:

Not less than 2/3 of 20dB bandwidth of hopping channel: 1.266 x 2/3 = 0.844MHz

Minimum Channel Separation	0.998MHz

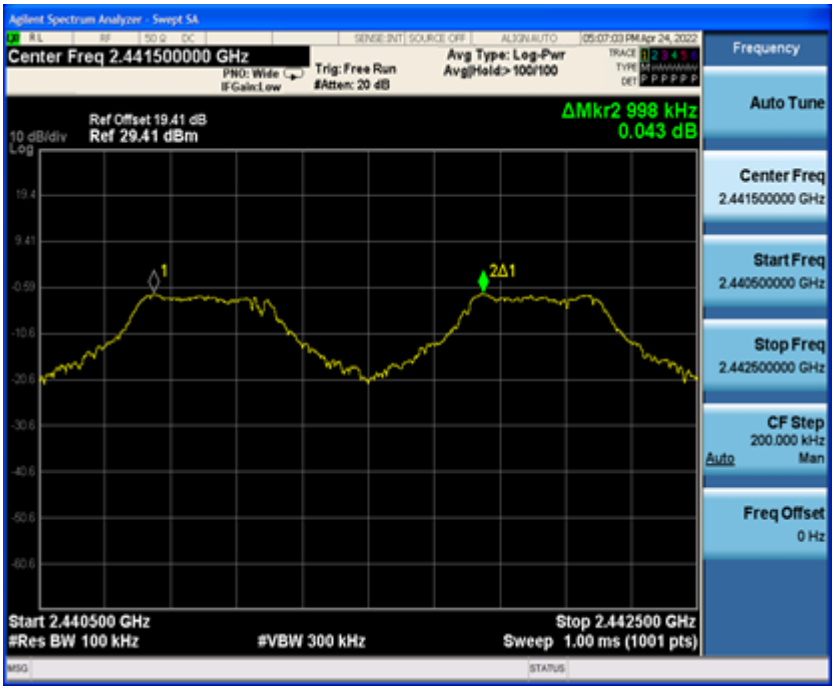
TEST PERSONNEL:

Sign on file

George Zhong, Project Engineer
Typed/Printed Name

07 May 2022
Date

Modulation Type: DH1 (Hopping)



Modulation Type: 2DH1 (Hopping)

Modulation Type: 3DH1 (Hopping)

4.7 Dwell Time (Time of Occupancy)

Average Channel Occupancy Time, FCC Ref: 15.247(a) (1)(iii):

The spectrum analyzer center frequency was set to one of the known hopping channels with a longer sweep time to show two successive hops on a channel; the SPAN was set to ZERO SPAN, and the TRIGGER was set to VIDEO. RBW shall be ≤channel spacing and where possible RBW should be set >>1/T, where T is the expected dwell time per channel. The time duration of the transmissions so captured was measured with the MARKER DELTA function.

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. Different modes of operation were performed and only the worst case data was reported.

Worst Test Result:

Normal hopping mode

Modulation Type	Packet	Unit	Max Dwell Time	Limit (ms)	Result
8-DPSK	3DH1	ms	0.39*330 = 128.70	400	Pass
	3DH3	ms	1.63*150 = 244.50	400	Pass
	3DH5	ms	2.88*90 = 259.20	400	Pass

AFH mode:

Modulation Type	Packet	Unit	Max Dwell Time	Limit (ms)	Result
8-DPSK	3DH1	ms	0.39*115 = 44.85	400	Pass
	3DH3	ms	1.63*59 = 96.17	400	Pass
	3DH5	ms	2.88*39 = 112.32	400	Pass

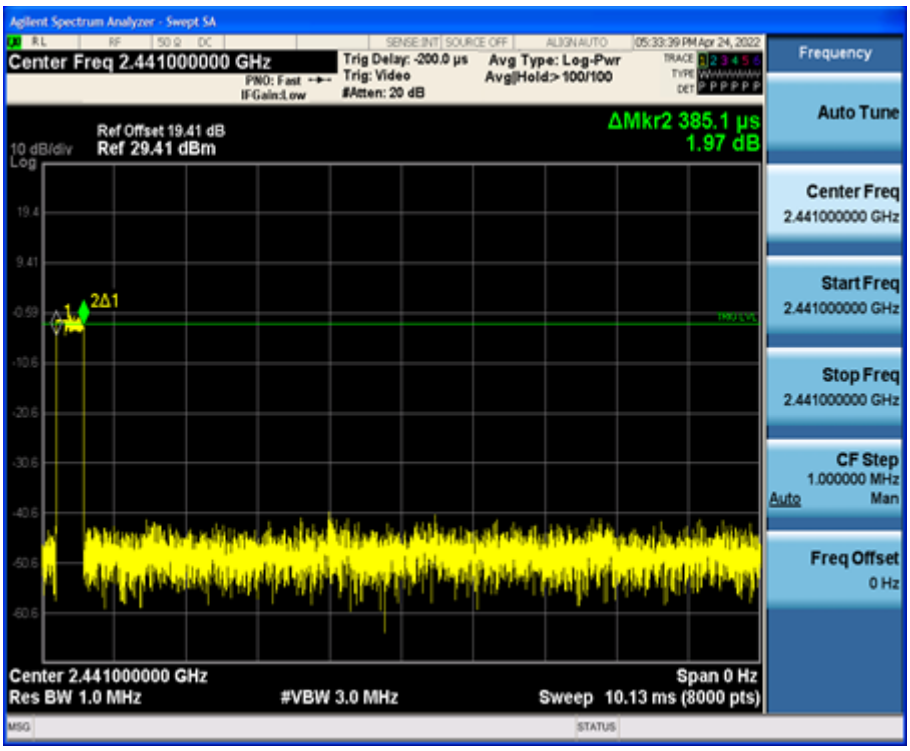
TEST PERSONNEL:

Sign on file

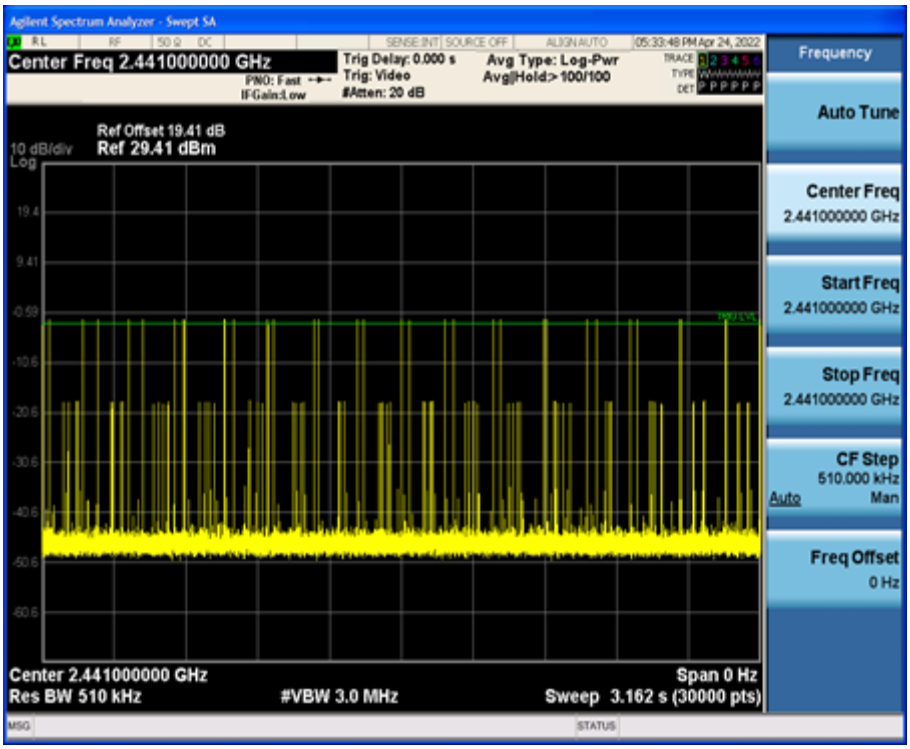
George Zhong, Project Engineer
Typed/Printed Name

07 May 2022
Date

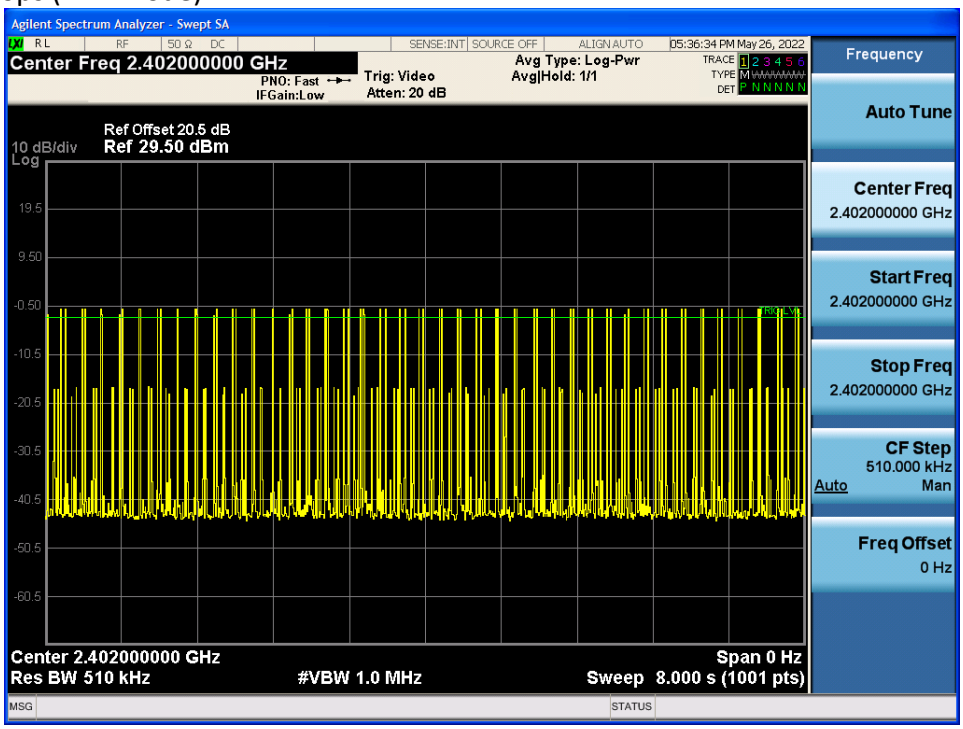
Modulation Type: 8-DPSK
Packet: 3DH1



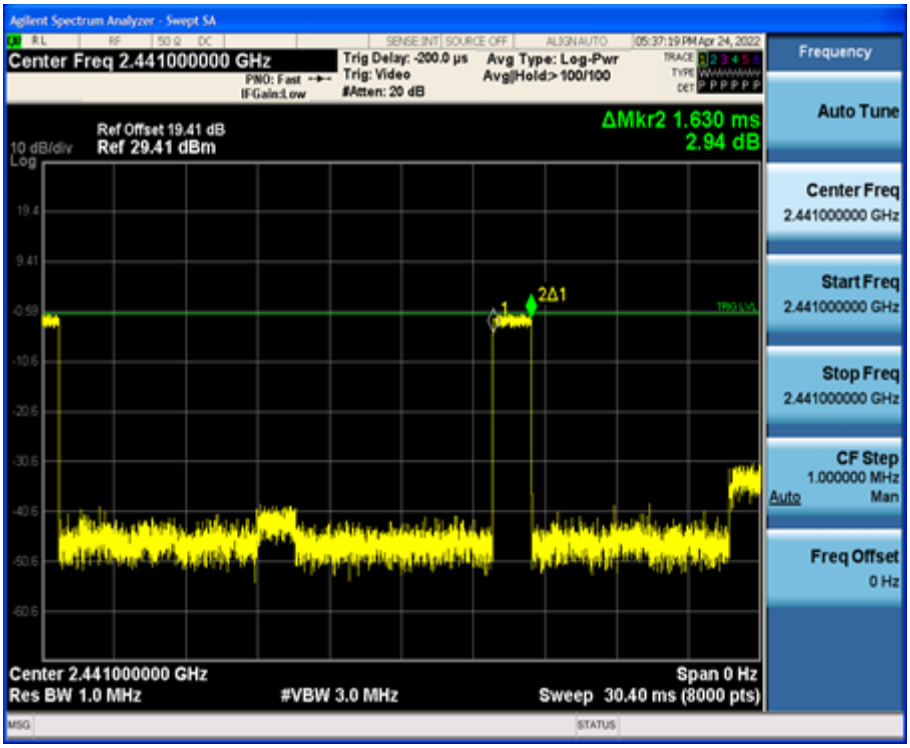
Number of hops (Normal hopping mode)



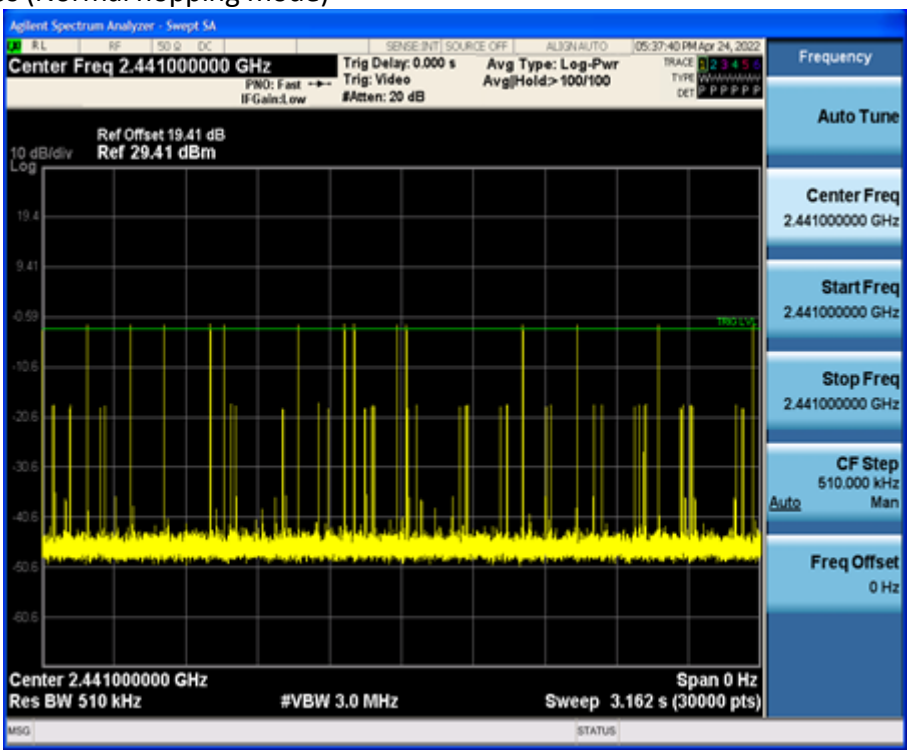
Number of hops (AFH mode)



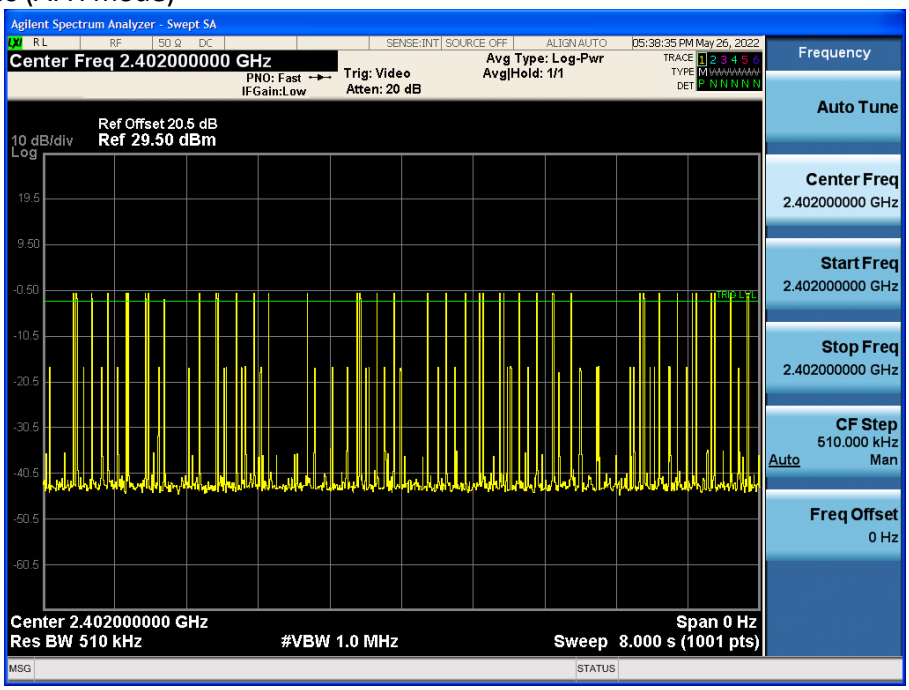
Packet: 3DH3



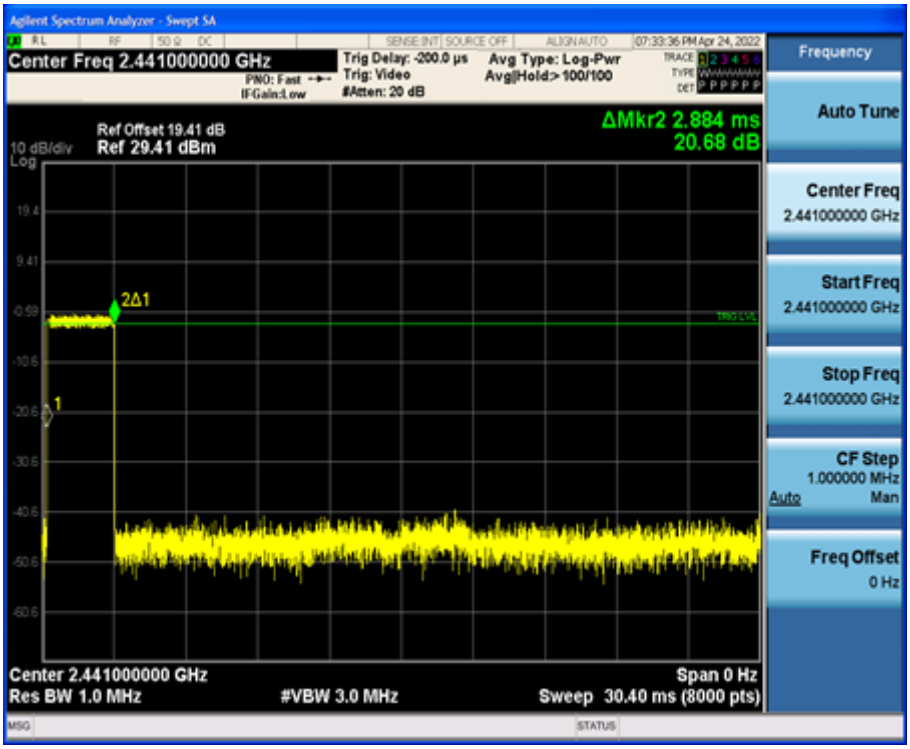
Number of hops (Normal hopping mode)



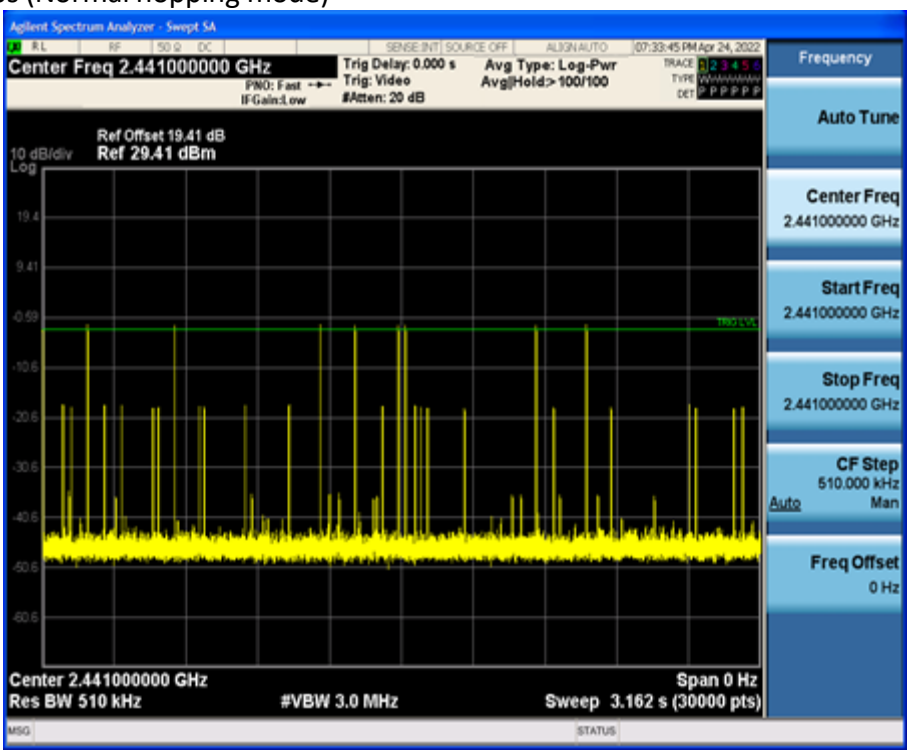
Number of hops (AFH mode)



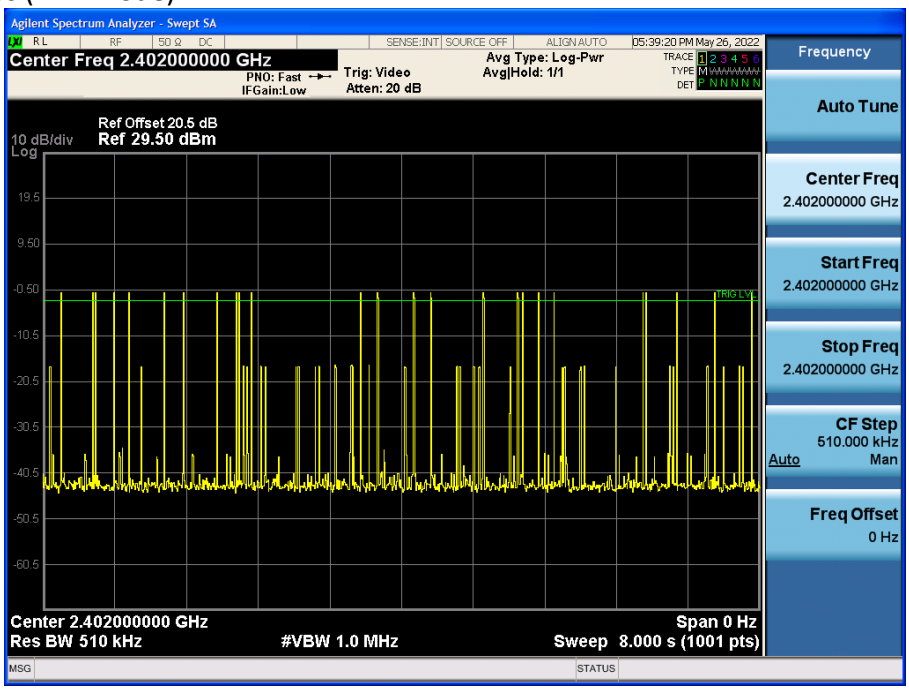
Packet: 3DH5



Number of hops (Normal hopping mode)



Number of hops (AFH mode)



4.8 Band Edge

Out of Band Conducted Emissions, FCC Rule 15.247(d):

In any 100 KHz bandwidth outside the EUT passband, the RF power produced by the modulation products of the spreading sequence, the information sequence, and the carrier frequency shall be at least 20 dB below that of the maximum in-band 100 kHz emission, or else shall meet the general limits for radiated emissions at frequencies outside the passband, whichever results in lower attenuation.

Furthermore, delta measurement technique for measuring bandage emissions was shown as below:

TEST PERSONNEL:

Sign on file

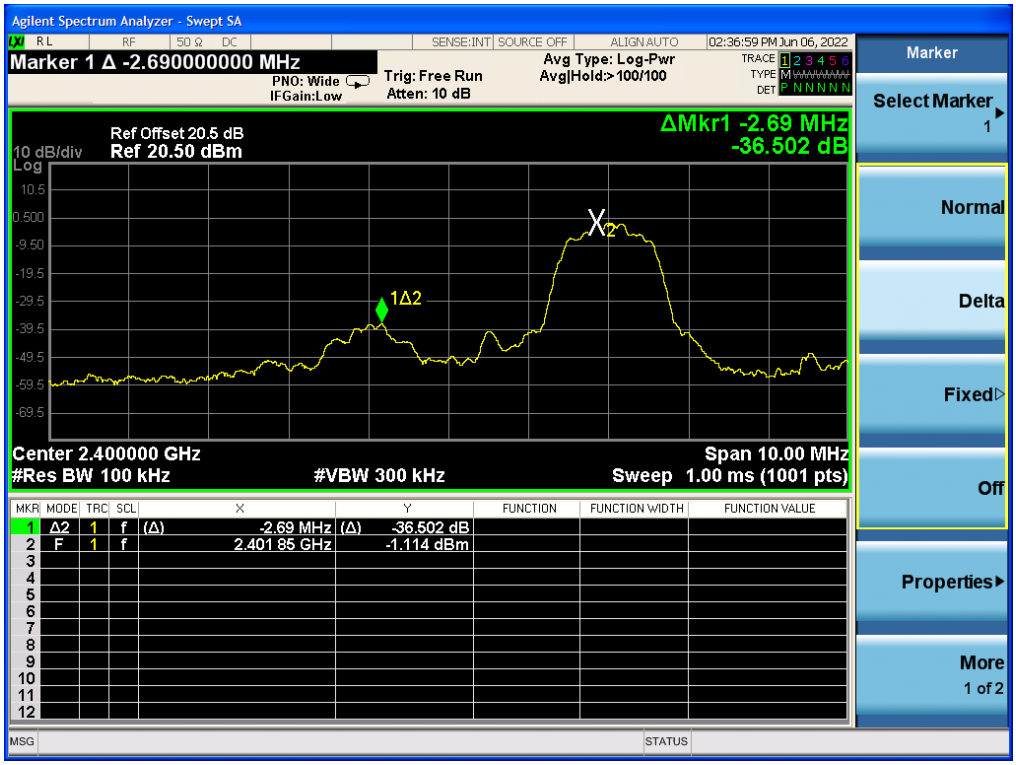
George Zhong, Project Engineer
Typed/Printed Name

07 May 2022
Date

Non-Hopping:

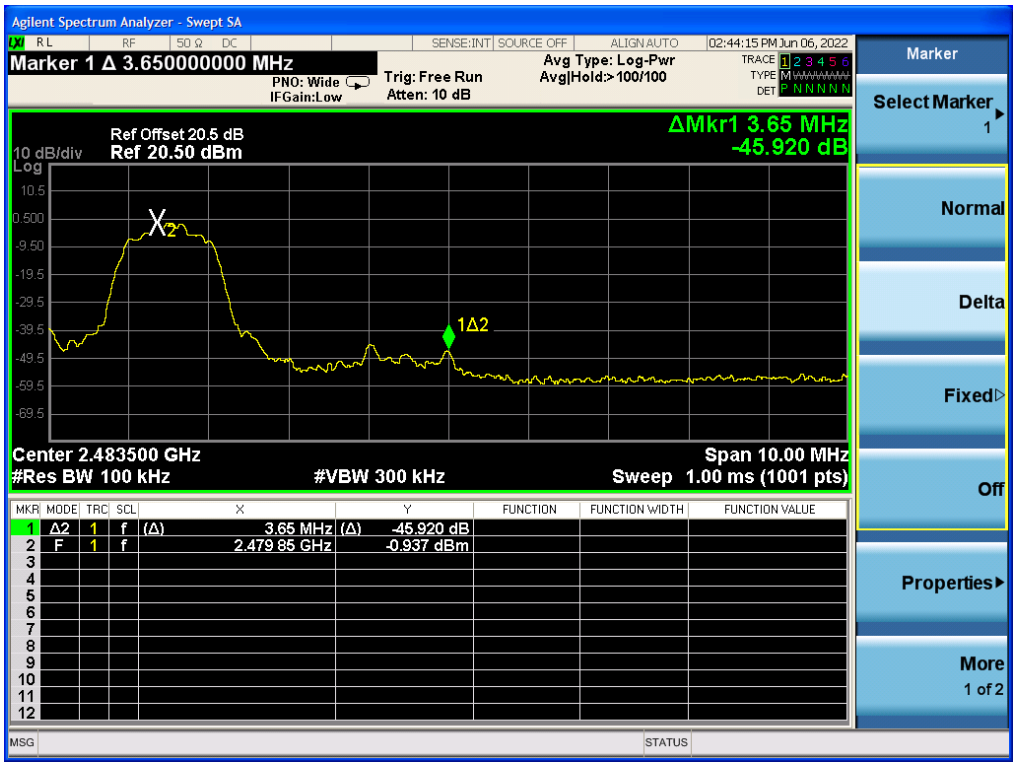
(i) Lower channel 2402MHz:

Worst Case: 3DH1



(ii) Upper channel 2480MHz:

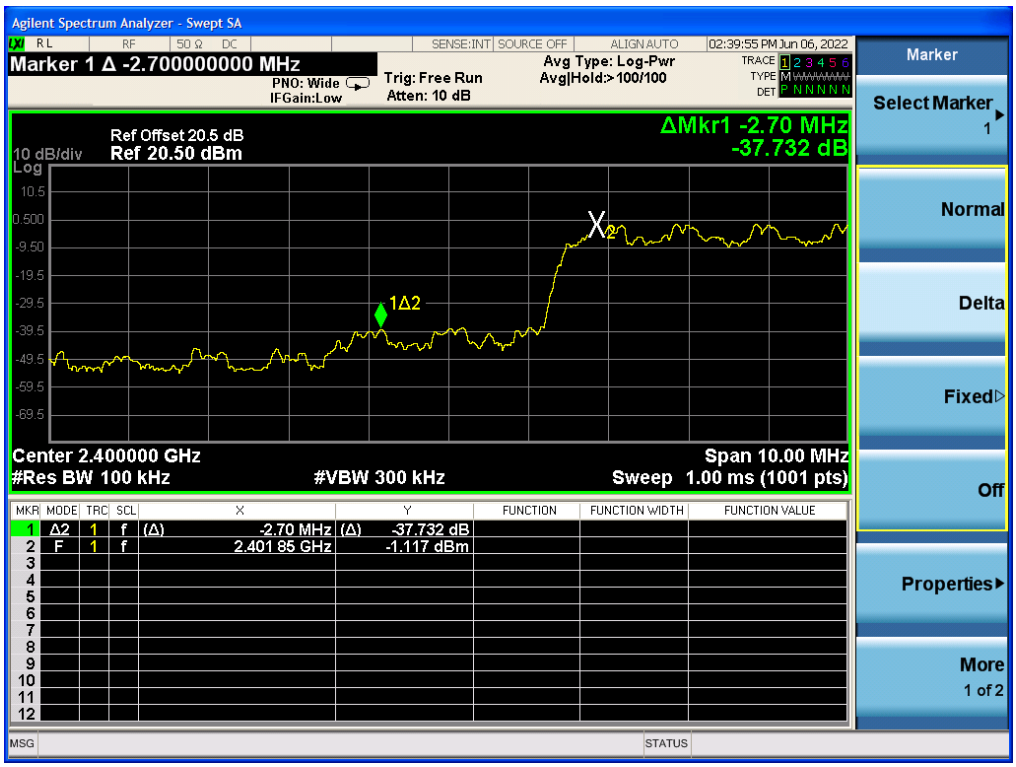
Worst Case: 3DH1



Hopping:

(i) Lower channel 2402MHz:

Worst Case: 3DH1



(ii) Upper channel 2480MHz:

Worst Case: 3DH1

4.9 Transmitter Spurious Emissions (Conducted)

Out of Band Conducted Spurious Emissions, FCC Rule 15.247(d):

All spurious emission and up to the tenth harmonic was measured and they were found to be at least 20 dB below the highest level of the desired power in the passband.

TEST PERSONNEL:

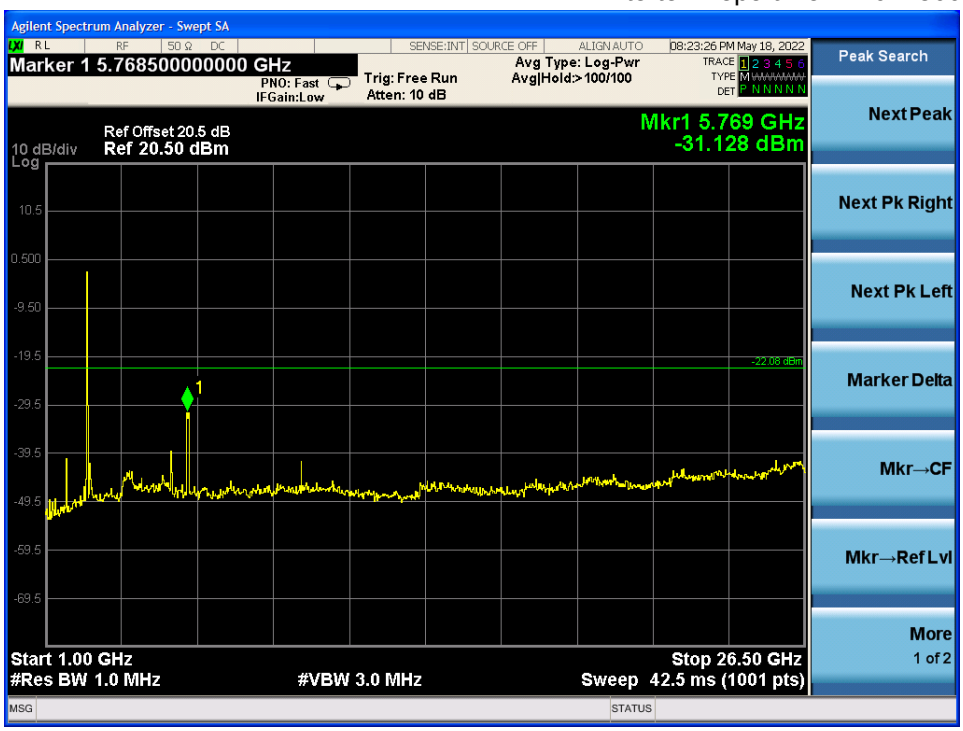
Sign on file

George Zhong, Project Engineer
Typed/Printed Name

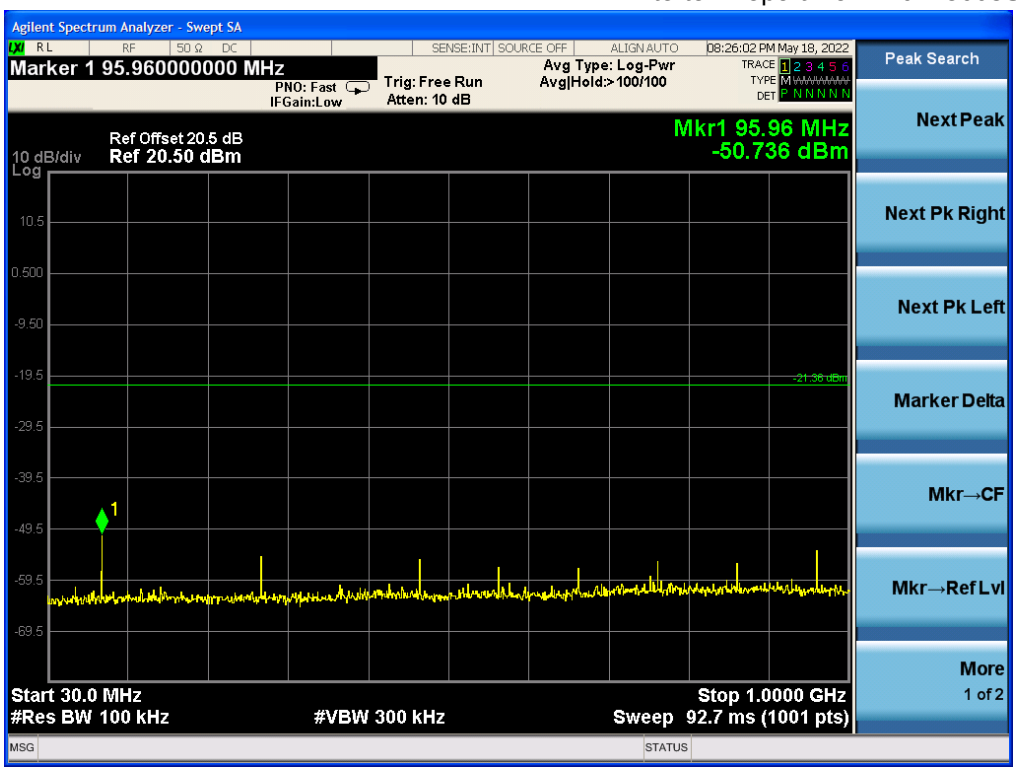
07 May 2022
Date

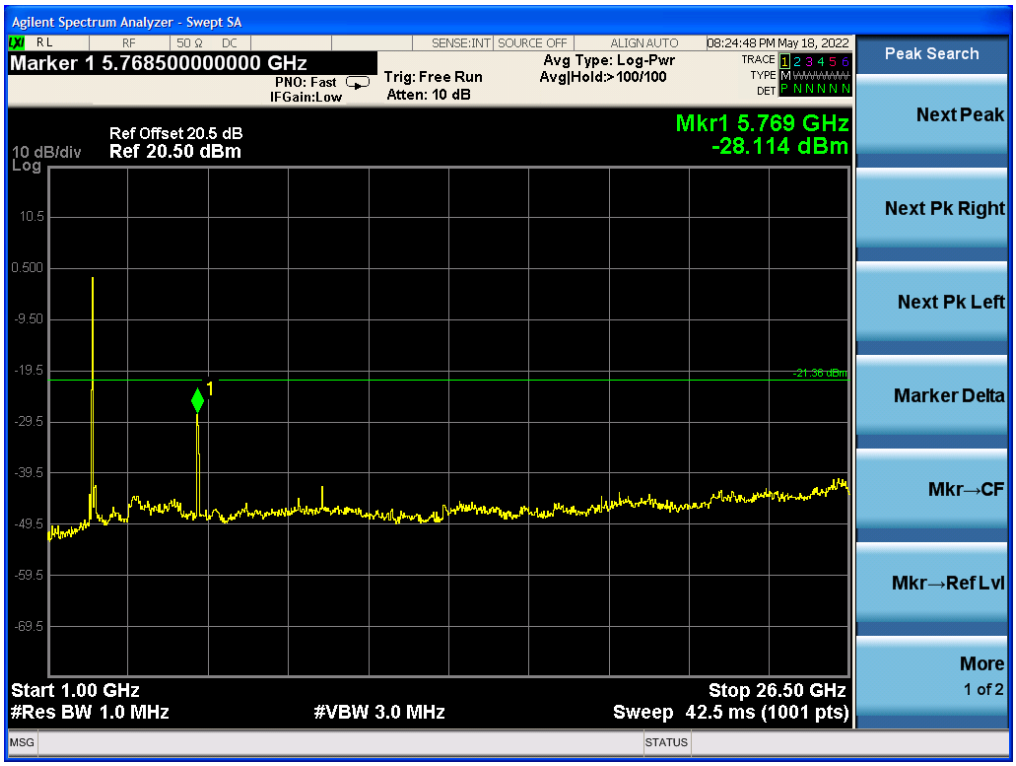
Modulation Type: GFSK

CH00 Reference Level: -2.081dBm

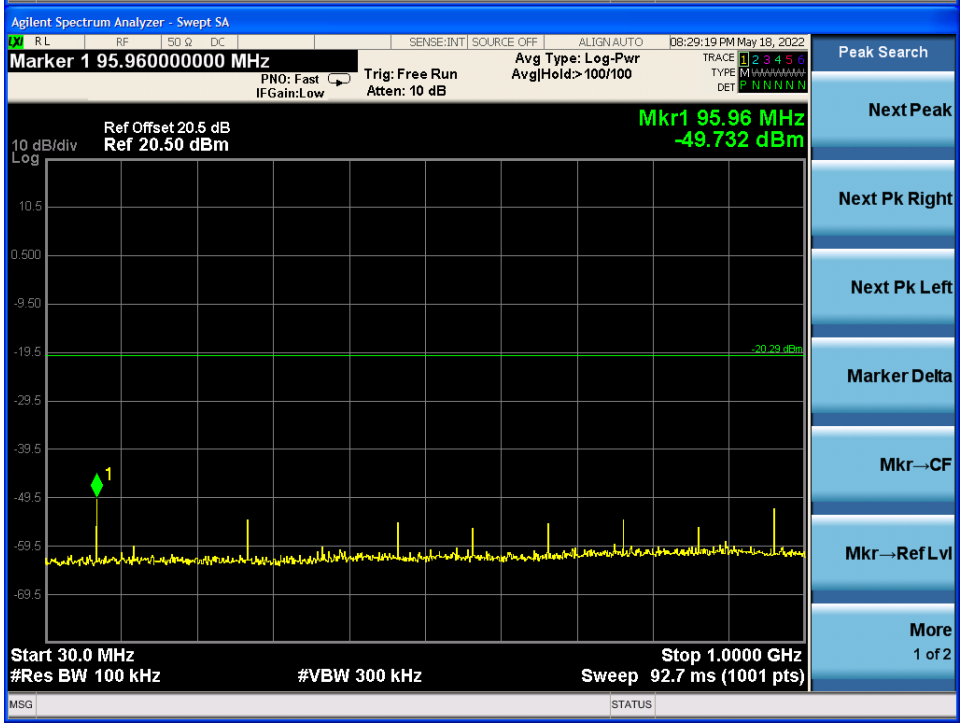


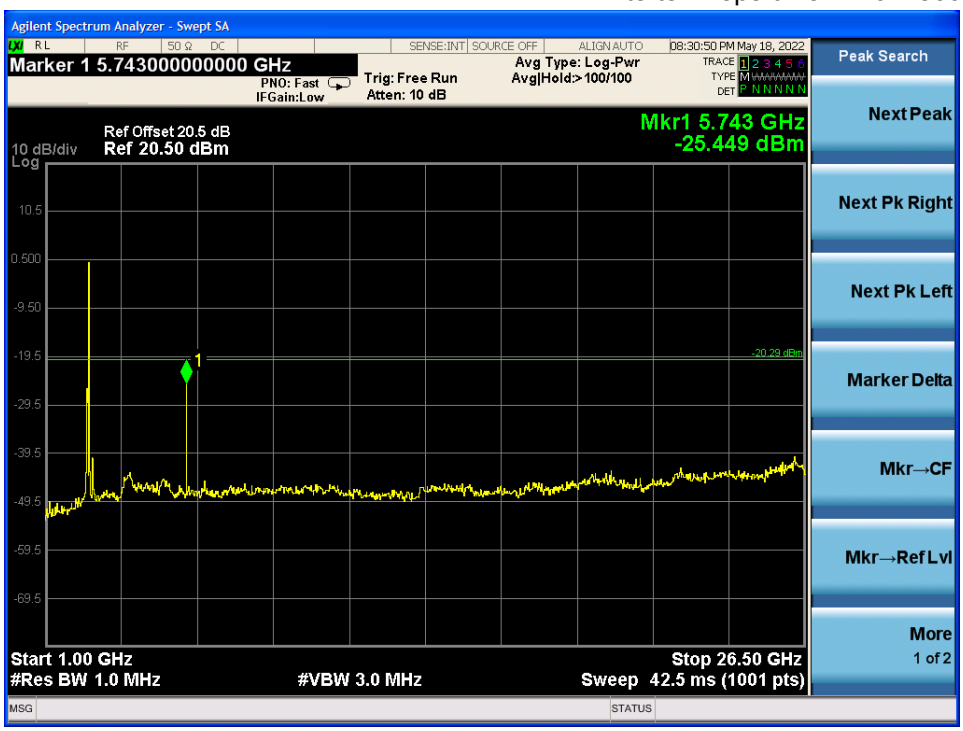
CH39 Reference Level: -1.356dBm


Agilent Spectrum Analyzer - Swept SA
Marker 1 95.960000000 MHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 10 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
08:26:02 PM May 18, 2022
Ref Offset 20.5 dB
10 dB/div
Ref 20.50 dBm
Mkr1 95.96 MHz
-50.736 dBm
Start 30.0 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 1.0000 GHz
Sweep 92.7 ms (1001 pts)
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2


Agilent Spectrum Analyzer - Swept SA
Marker 1 5.768500000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 10 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
08:24:48 PM May 18, 2022
Ref Offset 20.5 dB
10 dB/div
Ref 20.50 dBm
Mkr1 5.769 GHz
-28.114 dBm
Start 1.00 GHz
#Res BW 1.0 MHz
#VBW 3.0 MHz
Stop 26.50 GHz
Sweep 42.5 ms (1001 pts)
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

CH78 Reference Level: -0.294dBm




Agilent Spectrum Analyzer - Swept SA
Marker 1 5.743000000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 10 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
08:30:50 PM May 18, 2022
Ref Offset 20.5 dB
10 dB/div
Log
Ref 20.50 dBm
Mkr1 5.743 GHz
-25.449 dBm
10.5
0.500
-9.50
-19.5
-29.5
-39.5
-49.5
-59.5
-69.5
-20.29 dBm
Start 1.00 GHz
#Res BW 1.0 MHz
#VBW 3.0 MHz
Stop 26.50 GHz
Sweep 42.5 ms (1001 pts)
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2
MSG
STATUS

5.0 Equipment Photographs

For electronic filing, the photographs of the tested EUT are saved with filename: external photos.pdf & internal photos.pdf.

6.0 Product Labelling

For electronic filing, the FCC ID label artwork and the label location are saved with filename: label.pdf.

7.0 Technical Specifications

For electronic filing, the block diagram and schematics of the tested EUT are saved with filename: block.pdf and circuit.pdf respectively.

8.0 Instruction Manual

For electronic filing, a preliminary copy of the Instruction Manual is saved with filename: manual.pdf.

This manual will be provided to the end-user with each unit sold/leased in the United States.

9.0 Miscellaneous Information

This miscellaneous information includes details of the measured bandedge, the test procedure and calculation of factor such as pulse desensitization.

9.1 Discussion of Pulse Desensitization

Pulse desensitivity is not applicable for this device. The effective period (T_{eff}) is approximately 625µs for Bluetooth. With a resolution bandwidth (3dB) of 1MHz, so the pulse desensitivity factor is 0dB.

9.2 Calculation of Average Factor

Based on the Bluetooth Specification Version 5.3 (EDR mode) and worst case AFH mode, transmitter ON time is independent of packet type (DH1, DH3 and DH5) and packet length, the AFH mode Duty cycle connection factor as below:

Channel hop rate = 800 hops/second (AFH Mode)

Adjusted channel hop rate for DH5 mode = 133.33 hops/second

Time per channel hop = 1 / 133.33 hops/second = 7.5 ms

Time to cycle through all channels = 7.5 x 20 channels = 150 ms

Number of times transmitter hits on one channel = 100 ms / 150 ms = 1 time(s)

Worst case dwell time = 7.5 ms

Duty cycle connection factor = 20log10 (7.5ms / 100ms) = -22.5 dB

9.3 Emissions Test Procedures

The following is a description of the test procedure used by Intertek Testing Services in the measurements of transmitters operating under Part 15, Subpart C rules.

The test set-up and procedures described below are designed to meet the requirements of ANSI C63.10: 2013.

The transmitting equipment under test (EUT) is placed on a styrene turntable which is four feet in diameter, up to 1GHz 0.8m and above 1GHz 1.5m in height above the ground plane. During the radiated emissions test, the turntable is rotated and any cables leaving the EUT are manipulated to find the configuration resulting in maximum emissions. The EUT is adjust through all three orthogonal axes to obtain maximum emission levels. The antenna height and polarization are varied during the testing to search for maximum signal levels.

Detector function for radiated emissions is in peak mode. Average readings, when required, are taken by measuring the duty cycle of the equipment under test and subtracting the corresponding amount in dB from the measured peak readings. A detailed description for the calculation of the average factor can be found in section 9.2.

The frequency range scanned is from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or 40 GHz, whichever is lower. For line conducted emissions, the range scanned is 150 kHz to 30 MHz with RBW 9KHz used.

9.3 Emissions Test Procedures (cont'd)

The EUT is warmed up for 15 minutes prior to the test.

AC power to the unit is varied from 85% to 115% nominal and variation in the fundamental emission field strength is recorded. If battery powered, a new, fully charged battery is used.

Conducted measurements are made as described in ANSI C63.10: 2013.

The IF bandwidth used for measurement of radiated signal strength was 10 kHz for emission below 30 MHz and 120 kHz for emission from 30 MHz to 1000 MHz. Where pulsed transmissions of short enough pulse duration warrant, a greater bandwidth is selected according to the recommendations of Hewlett Packard Application Note 150-2. Above 1000 MHz, a resolution bandwidth of 1 MHz is used (RBW 3MHz used for fundamental emission).

Transmitter measurements are normally conducted at a measurement distance of three meters. However, to assure low enough noise floor in the restricted bands and above 1 GHz, signals are acquired at a distance of one meter or less. All measurements are extrapolated to three meters using inverse scaling, but those measurements taken at a closer distance are so marked.

10 Test Equipment List

Equipment No.	Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Due Date
JL044	EMI Receiver	Rohde&Schwarz	ESCI	1166.5950.03	2021/11/17	2022/11/16
JL056	AMN	Rohde&Schwarz	ENV216	3560.6550.05	2021/11/10	2022/11/09
JL204	AMN	Schwarzbeck	NSLK8127	#829	2021/11/10	2022/11/09
JL065	ECSI RF IN RF Cable	Rohde&Schwarz	RP-X1	\	2021/11/10	2022/11/18
JL078	ECSI RF IN RF Cable	Rohde&Schwarz	Sapre sm	\	2021/11/10	2022/11/09
NA	Shielding Room	ZhongShuo	6.2m*2.65 m*3m	N/A	2021/05/12	2024/05/12
JL232	EMI Receiver	Rohde&Schwarz	ESR7	102013	2021/11/10	2022/11/09
JL207	Spectrum analyzer	Rohde&Schwarz	FSV30	103741	2021/11/10	2022/11/09
JL118	Spectrum analyzer	KEYSIGHT	N9010A	MY51440158	2021/11/10	2022/11/09
JL199	Integral Antenna	Schwarzbeck	VULB 9163	VULB 9163-361	2021/11/10	2022/11/09
JL102	Integral Antenna	Schwarzbeck	BBHA 9120D	BBHA 9120D 1201	2021/11/10	2022/11/09
JL198	Integral Antenna	Schwarzbeck	BBHA 9170	9170#685	2021/11/10	2022/11/09
JL196	Preamplifier	Schwarzbeck	BBV9721	9721-019	2021/11/10	2022/11/09
JL294	Preamplifier	emci	EMC012645SE	980417	2021/11/10	2022/11/09
JL065	ECSI RF IN RF Cable	Rohde&Schwarz	AP-X1	\	2021/11/10	2022/11/09
JL251	Power Collection Unit	Tonscend	JS0806-2	188060134	2021/09/13	2022/09/12
NA	Tonscend Test System	Tonscend	2.6.77.0518	NA	NA	NA
JL253	Temp&Humidity Recorder	Anymetre	JR900	NA	2021/11/04	2022/11/03
JL200	Integral Antenna	Schwarzbeck	FMZB 1519B	00029	2021/11/05	2022/11/04
NA	3m Chamber	ZhongShuo	9.2m*6.2 m*6.3m	N/A	2021/05/12	2024/05/12
NA	Filter	STI	STI115-8629	Freq：2300-2500	2021/11/10	2022/11/09

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