Luxshare Precision Industry Co.,Ltd.

TEST REPORT

SCOPE OF WORK
FCC TESTING–116452505

REPORT NUMBER
240920028SZN-001

ISSUE DATE	**[REVISED DATE]**
17 December 2024	[----------]

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TEST REPORT

Intertek Report No.: 240920028SZN-001

Luxshare Precision Industry Co.,Ltd.

Application
For
Certification

FCC ID: 2AYYS-CS116K4Y

CS116K4

Model: 116452505

2.4GHz Transceiver

Report No.: 240920028SZN-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 [10-1-23]

Prepared and Checked by:

Allen Qin
Engineer

Approved by:

Johnny Wang
Project Engineer
Date: 17 December 2024

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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 [10-1-23 Edition] provision.

Report prepared by:

Allen Qin
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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Table of Contents

1.0 Summary of Test Results

Applicant: Luxshare Precision Industry Co.,Ltd.
Address: Floor 2, Block A, Sanyo New Industrial Area, West Haoyi Community, Shajing Subdistrict Office, Bao an District Shenzhen, China.
Manufacturer: Luxshare Precision Industry Co.,Ltd.
Address: Floor 2, Block A, Sanyo New Industrial Area, West Haoyi Community, Shajing Subdistrict Office, Bao an District Shenzhen, China.

Model: 116452505

FCC ID: 2AYYS-CS116K4Y

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 15.209	Pass

Notes:

1. 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 CS116K4 with Bluetooth (dual-mode) function operating in 2402-2480MHz, 2.4G WIFI function operating in 2412-2462MHz and 5G WIFI function operating in 5150MHz~5250 MHz, 5250MHz~5350MHz, 5470MHz-5725MHZ, 5725MHz~5850MHz. The EUT is powered by DC 5V 1.5A from adapter. For more detail information please refer to the user manual.

Bluetooth Version: 5.2
Antenna Type: Metal antenna
Antenna Gain: 2.68 dBi (This information is provided by manufacturer, and the manufacturer is responsible for the authenticity of the provided information.)
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 CS116K4 which has Bluetooth function.
For the BT BLE function was tested and demonstrated in report 240920028SZN-002.
For the 2.4GHz WIFI function was tested and demonstrated in report 240920028SZN-003.
For the 5GHz WIFI function was tested and demonstrated in report 240920028SZN-004.

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 **Intertek Testing Services Shenzhen Ltd. Longhua Branch** and located at 101, 201, Building B, No. 308 Wuhe Avenue, Zhangkengjing Community, GuanHu Subdistrict, LongHua District, Shenzhen. This test facility and site measurement data have been fully placed on file with File Number: CN1188.

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).

The EUT was powered by 5VDC 1.5A from adapter during the test.

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 EUT and transmitting antenna was centered on the turntable.

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: CMD

3.3 Special Accessories

No special accessory attached.

3.4 Equipment Modification

Any modifications installed previous to testing by Luxshare Precision Industry 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.

3.5 Measurement Uncertainty

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

3.6 Support Equipment List and Description

Description	Manufacturer	Model No.
TV (Provided by Intertek)	SONY	150B4CG
HDMI Cable (Provided by applicant)	N/A	shielded, 100cm
Adaptor 1 (Provided by applicant)	N/A	Model: FC010A07-050015U, Input: 100-240V~50/60Hz 0.3A, Output: DC 5.0V/1.5A
Adaptor 2 (Provided by applicant)	N/A	Model: SA52C-050150U Input: 100-240V~50/60Hz 0.35A Max Output: DC 5.0V/1.5A
Remote control (Provided by applicant)	N/A	N/A

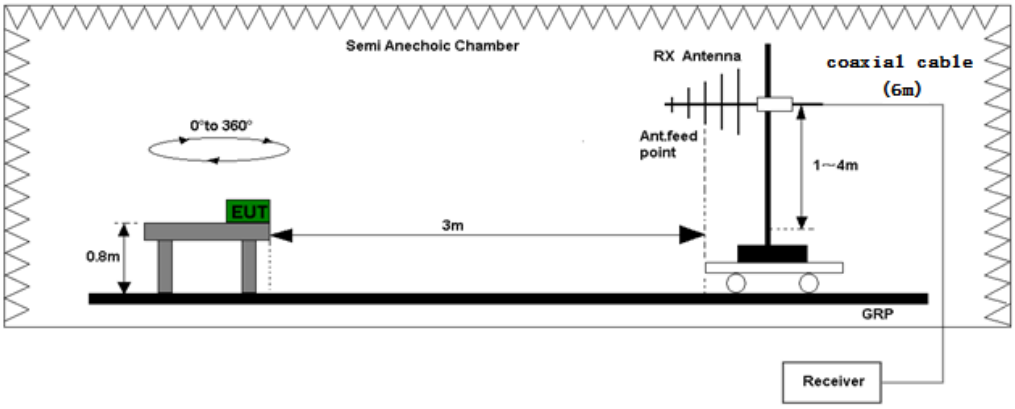
4.0 Test Results

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

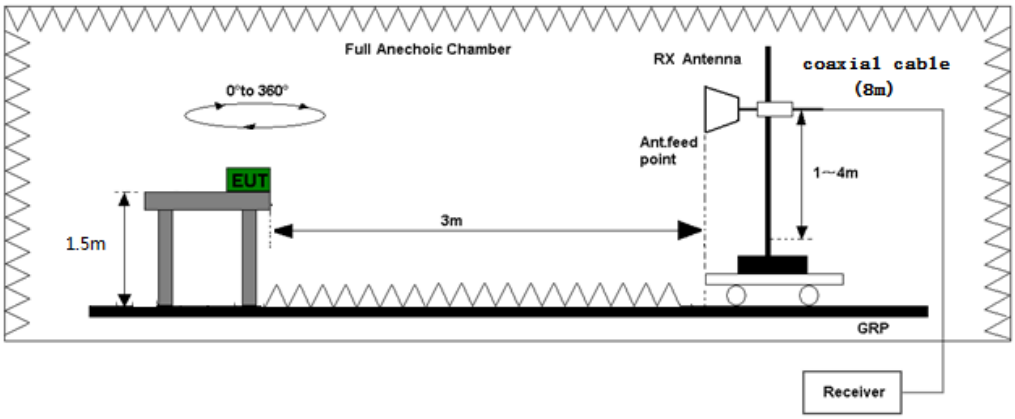
4.1 Radiated Test Results

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

The Diagram below shows the test setup, which is utilized to make these measurements.



Test set-up of radiated disturbance (Up to1GHz)



Test set-up of radiated disturbance (Above 1GHz)

Radiated emission measurements were performed from 9 KHz to tenth harmonic or 40GHz. The EUT for testing is arranged on a styrene turntable. If some peripherals apply to the EUT, the peripherals will be connected to EUT and the whole system. During the test, all cables were arranged to produce worst-case emissions. The signal is maximized through rotation. The height of antenna and polarization is changing constantly for exploring for maximum signal level. The height of antenna can be up to 4 meters and down to 1 meter.

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/m 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 716.501333 MHz

Judgement: Passed by 8.4 dB

TEST PERSONNEL:

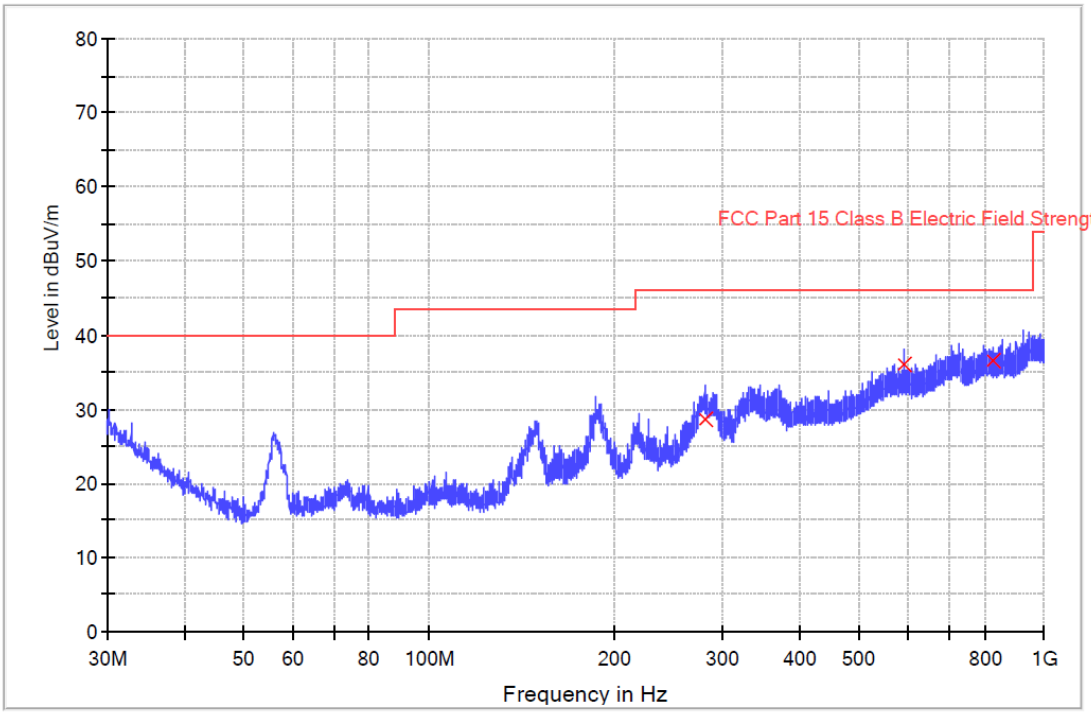
Sign on file

Allen Qin, Engineer
Typed/Printed Name

25 November 2024
Date

Applicant: Luxshare Precision Industry Co.,Ltd.
Date of Test: 25 November 2024
Model:116452505
Sample: 1/1
Worst-case operating Mode: transmission(2402MHz)

ANT Polarity: Horizontal

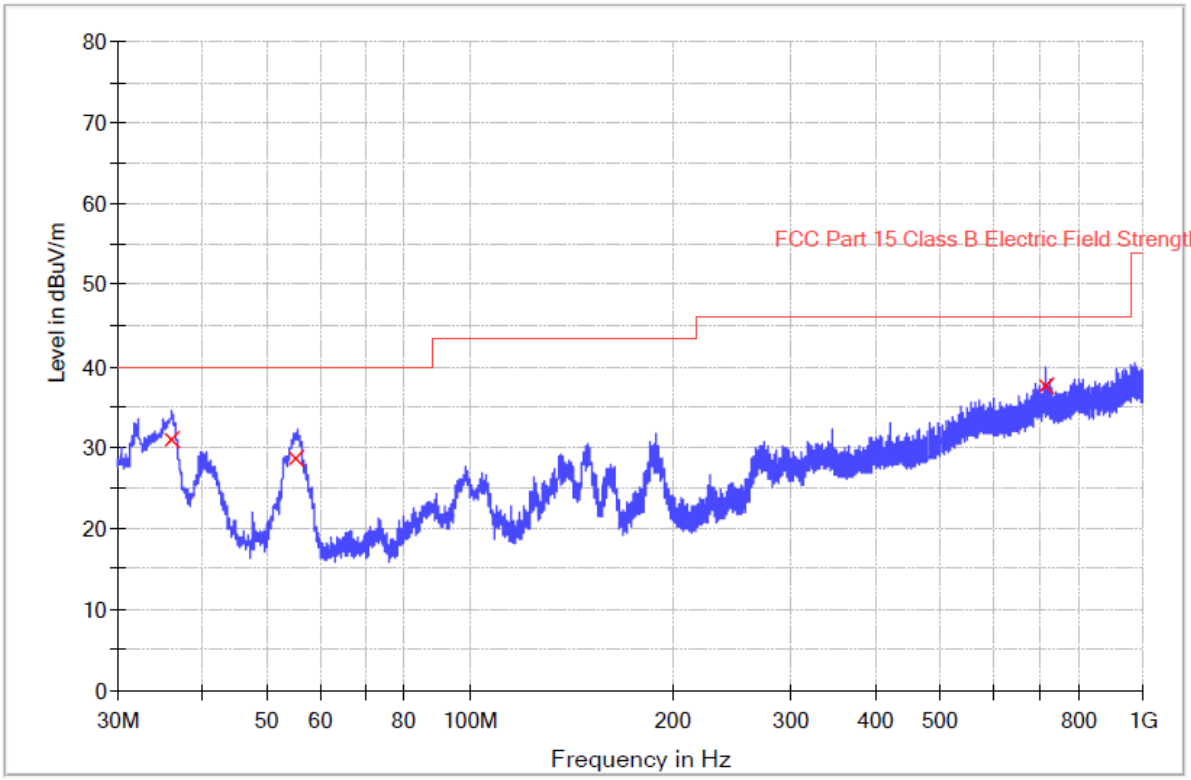


Frequency (MHz)	Quasi Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Polarization	Corr. (dB/m)	Margin - QPK (dB)	Limit – QPK dBµV/m)
280.421667	28.5	1000.0	120.000	H	19.9	17.5	46.0
593.408333	36.0	1000.0	120.000	H	29.0	10.0	46.0
824.850333	36.5	1000.0	120.000	H	32.1	9.5	46.0

Remark:
1. Corr. (dB/m) = Antenna Factor (dB/m) + Cable Loss (dB)
2. Quasi Peak (dBµV/m) = Corr. (dB/m) + Read Level (dBµV)
3. Margin (dB) = Limit Line (dBµV/m) – Level (dBµV/m)

Applicant: Luxshare Precision Industry Co.,Ltd.
Date of Test: 25 November 2024
Model: 116452505
Sample: 1/1
Worst-case operating Mode: transmission(2402MHz)

ANT Polarity: Vertical



Frequency (MHz)	Quasi Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Polarization	Corr. (dB/m)	Margin - QPK (dB)	Limit – QPK (dBµV/m)
36.111000	30.8	1000.0	120.000	V	19.0	9.2	40.0
55.349333	28.8	1000.0	120.000	V	13.2	11.2	40.0
716.501333	37.6	1000.0	120.000	V	31.0	8.4	46.0

Remark:
1. Corr. (dB/m) = Antenna Factor (dB/m) + Cable Loss (dB)
2. Quasi Peak (dBµV/m) = Corr. (dB/m) + Read Level (dBµV)
3. Margin (dB) = Limit Line (dBµV/m) – Level (dBµV/m)

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 7440.000 MHz

Judgement: Passed by 27.2 dB

TEST PERSONNEL:

Sign on file

Allen Qin, Engineer
Typed/Printed Name

08 October 2024
Date

Applicant: Luxshare Precision Industry Co.,Ltd.
Date of Test: 08 October 2024
Model: 116452505
Sample: 1/1
Worst-case operating Mode: Transmit (2402MHz)
Modulation type: GFSK

Table 1

Radiated Emissions

(2402MHz)

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB/m)	Net at 3m (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	**2402.000	109.9	36.7	28.1	101.3	--	--
Horizontal	*4804.000	41.4	36.7	35.5	40.2	74.0	-33.8

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB/m)	Average Factor (-dB)	Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	**2402.000	109.9	36.7	28.1	22.5	78.8	--	--
Horizontal	*4804.000	41.4	36.7	35.5	22.5	17.7	54.0	-36.3

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.

** Fundamental emission was measured for determining band-edge compliance of using delta measurement technique.

Applicant: Luxshare Precision Industry Co.,Ltd.
Date of Test: 08 October 2024
Model: 116452505
Sample: 1/1
Worst-case operating Mode: Transmit (2441MHz)
Modulation type: GFSK

Table 2

Radiated Emissions

(2441MHz)

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB/m)	Net at 3m (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4882.000	41.8	36.7	35.5	40.6	74.0	-33.4
Horizontal	*7323.000	45.4	36.1	37.2	46.5	74.0	-27.5

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB/m)	Average Factor (-dB)	Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4882.000	41.8	36.7	35.5	22.5	18.1	54.0	-35.9
Horizontal	*7323.000	45.4	36.1	37.2	22.5	24.0	54.0	-30.0

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: Luxshare Precision Industry Co.,Ltd.
Date of Test: 08 October 2024
Model: 116452505
Sample: 1/1
Worst-case operating Mode: Transmit (2480MHz)
Modulation type: GFSK

Table 3

Radiated Emissions

(2480MHz)

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB/m)	Net at 3m (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	**2480.000	112.8	36.7	28.1	104.2	--	--
Horizontal	*4960.000	41.3	36.7	35.5	40.1	74.0	-33.9
Horizontal	*7440.000	45.7	36.1	37.2	46.8	74.0	-27.2

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB/m)	Average Factor (-dB)	Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	**2480.000	112.8	36.7	28.1	22.5	81.7	--	--
Horizontal	*4960.000	41.3	36.7	35.5	22.5	17.6	54.0	-36.4
Horizontal	*7440.000	45.7	36.1	37.2	22.5	24.3	54.0	-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.

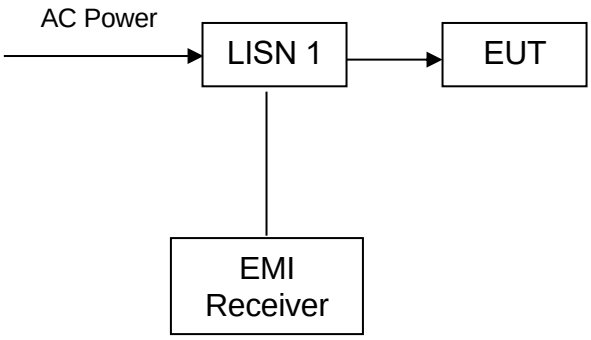
* Emission within the restricted band meets the requirement of section 15.205. The corresponding limit as per 15.209 is based on Quasi peak limit for frequencies below 1000 MHz and average limit for frequencies over 1000 MHz. The radio frequency emissions above 1GHz also meet corresponding 20dB permitted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

** Fundamental emission was measured for determining band-edge compliance of using delta measurement technique.

4.2 Conducted Emission at Mains Terminal

4.2.1 Conducted Emissions Configuration Photograph

Block Diagram:



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 0.586000 MHz

Judgement: Passed by 4.9 dB margin

TEST PERSONNEL:

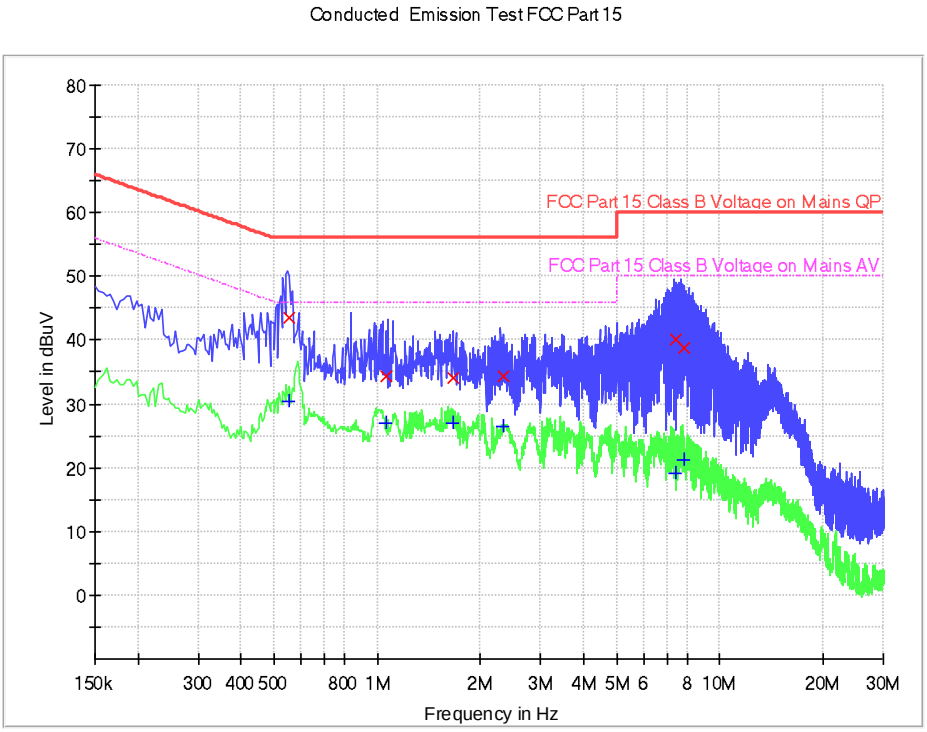
Sign on file

Allen Qin Engineer
Typed/Printed Name

08 October 2024
Date

Applicant: Luxshare Precision Industry Co.,Ltd.
Date of Test: 08 October 2024
Model: 116452505
Sample: 1/1
Worst-case operating Mode: transmission(2402MHz)
Phase: Live

Conducted Emission Test - FCC



Result Table QP

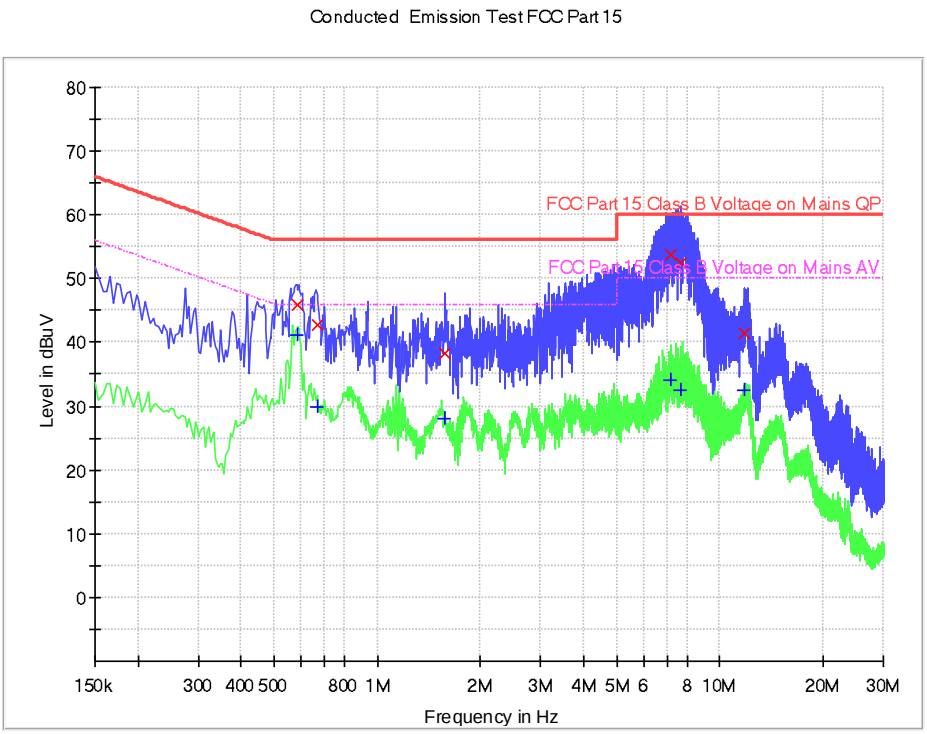
Frequency (MHz)	Quasi Peak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.550000	43.6	9.000	L1	9.6	12.4	56.0
1.062000	34.4	9.000	L1	9.6	21.6	56.0
1.666000	34.1	9.000	L1	9.7	21.9	56.0
2.346000	34.4	9.000	L1	9.7	21.6	56.0
7.474000	40.0	9.000	L1	9.8	20.0	60.0
7.874000	38.7	9.000	L1	9.9	21.3	60.0

Result Table AV

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.550000	30.5	9.000	L1	9.6	15.5	46.0
1.062000	27.0	9.000	L1	9.6	19.0	46.0
1.666000	27.0	9.000	L1	9.7	19.0	46.0
2.346000	26.4	9.000	L1	9.7	19.6	46.0
7.474000	19.3	9.000	L1	9.8	30.7	50.0
7.874000	21.1	9.000	L1	9.9	28.9	50.0

Applicant: Luxshare Precision Industry Co.,Ltd.
Date of Test: 08 October 2024
Model: 116452505
Sample: 1/1
Worst-case operating Mode: transmission(2402MHz)
Phase: Neutral

Conducted Emission Test - FCC



Result Table QP

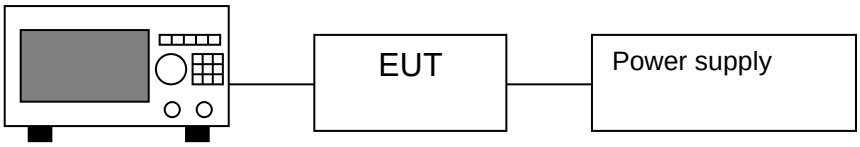
Frequency (MHz)	Quasi Peak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.586000	45.9	9.000	N	9.6	10.1	56.0
0.666000	42.7	9.000	N	9.6	13.3	56.0
1.582000	38.4	9.000	N	9.7	17.6	56.0
7.158000	53.8	9.000	N	9.8	6.2	60.0
7.686000	52.6	9.000	N	9.9	7.4	60.0
11.802000	41.3	9.000	N	10.2	18.7	60.0

Result Table AV

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.586000	41.1	9.000	N	9.6	4.9	46.0
0.666000	29.8	9.000	N	9.6	16.2	46.0
1.582000	27.9	9.000	N	9.7	18.1	46.0
7.158000	34.1	9.000	N	9.8	15.9	50.0
7.686000	32.6	9.000	N	9.9	17.4	50.0
11.802000	32.4	9.000	N	10.2	17.6	50.0

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.



Spectrum Analyzer

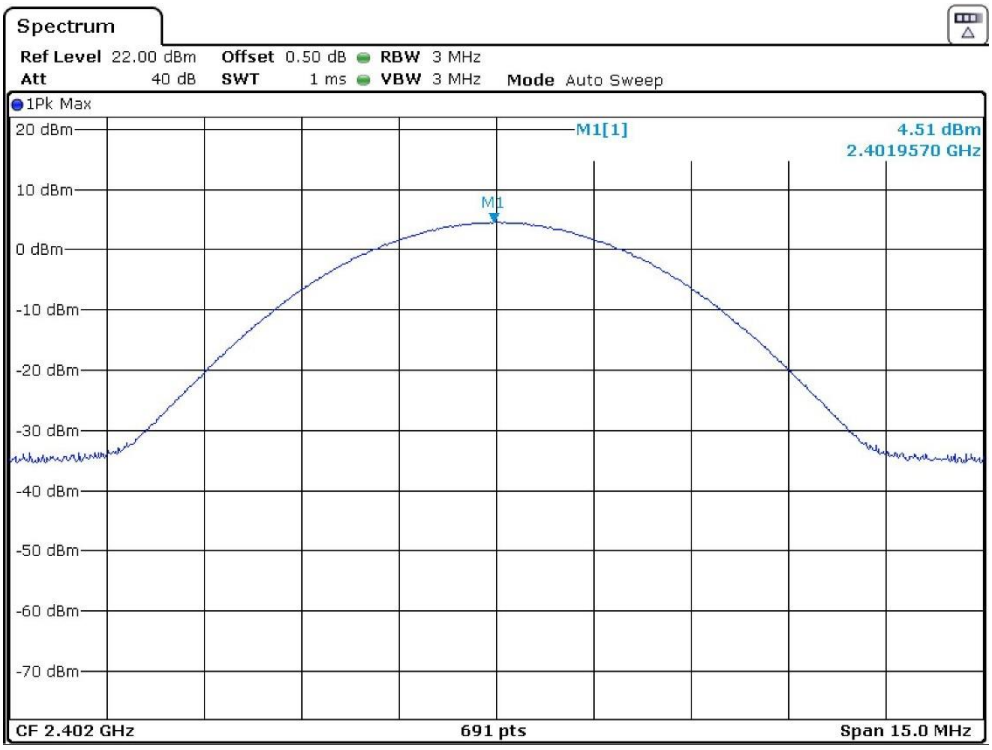
For antenna with gains of 6dBi or less, and frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, the systems operate with an output power no greater than 125 mW.

Antenna Gain = 2.68dBi			
Modulation Type	Frequency (MHz)	Output Power (Peak Reading) (dBm)	Output Power (mW)
GFSK	2402	4.51	2.82
	2441	3.18	2.08
	2480	1.37	1.37

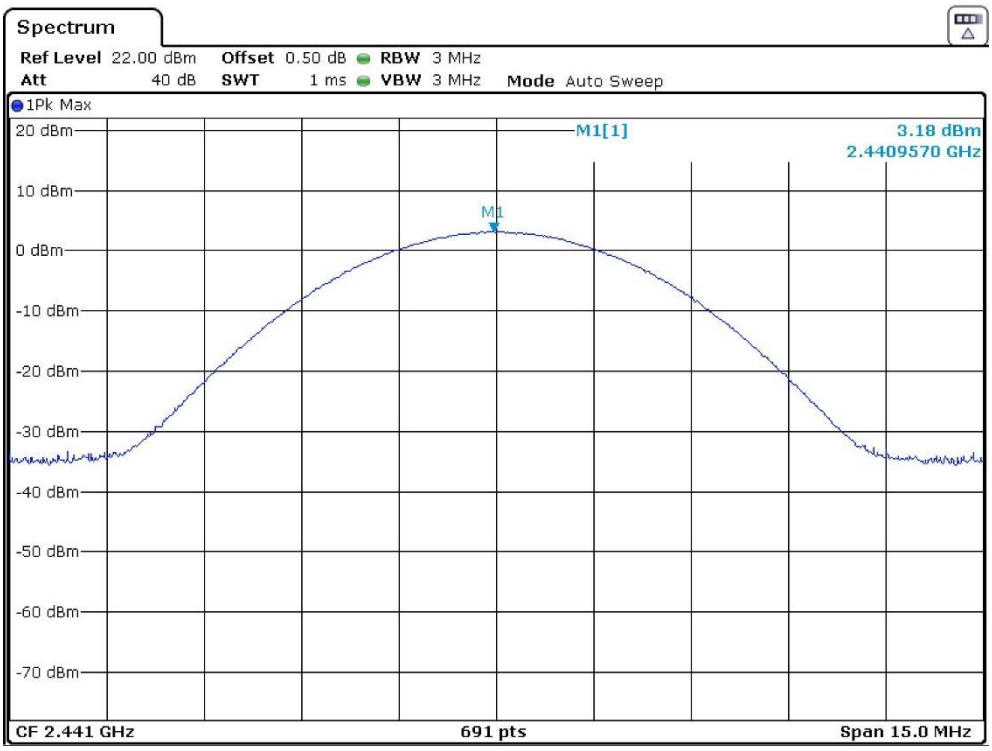
Cable loss: 0.5 dB External Attenuation: 0 dB

Modulation Type: GFSK

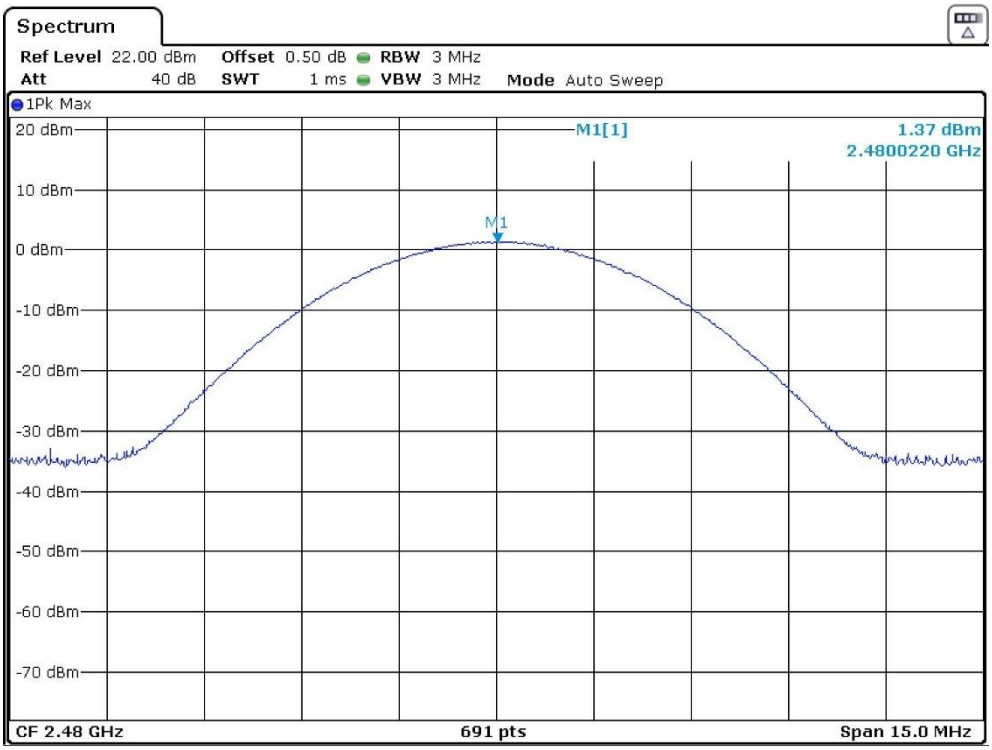
CH00



CH39



CH78

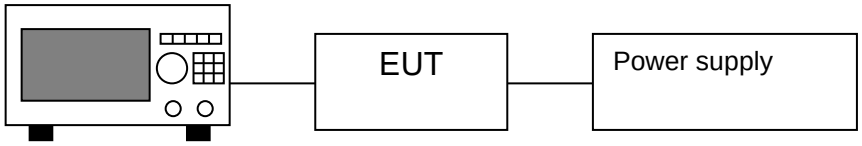

Spectrum
Ref Level 22.00 dBm Offset 0.50 dB RBW 3 MHz
Att 40 dB SWT 1 ms VBW 3 MHz Mode Auto Sweep
1Pk Max
M1[1]
1.37 dBm
2.4800220 GHz
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
CF 2.48 GHz
691 pts
Span 15.0 MHz

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.

Block Diagram:

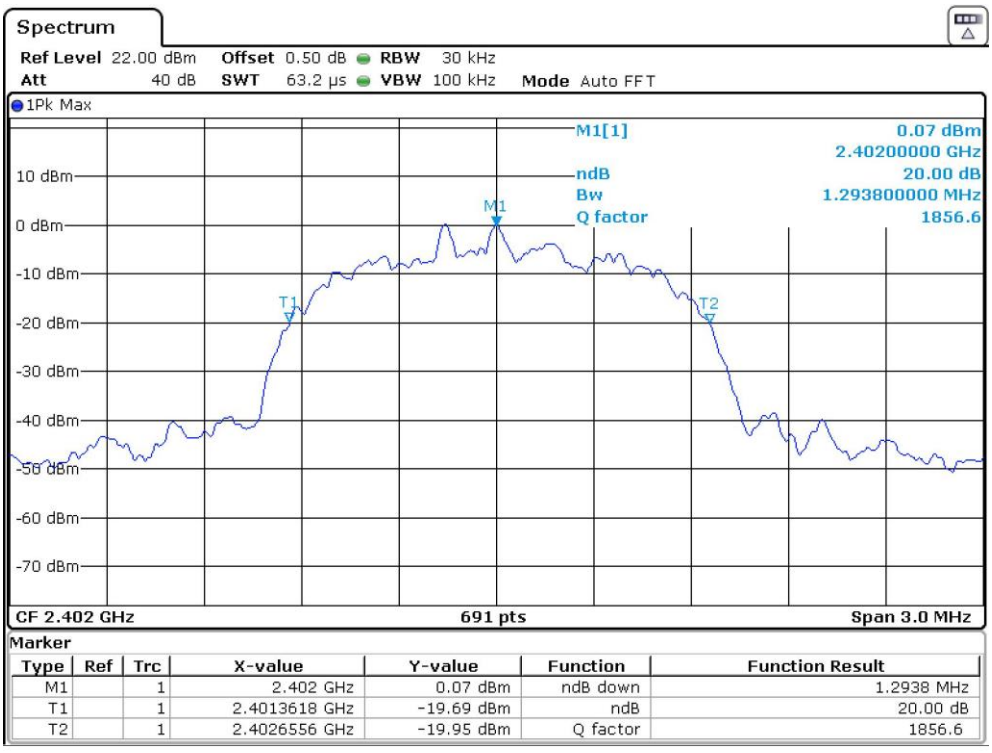


Spectrum Analyzer

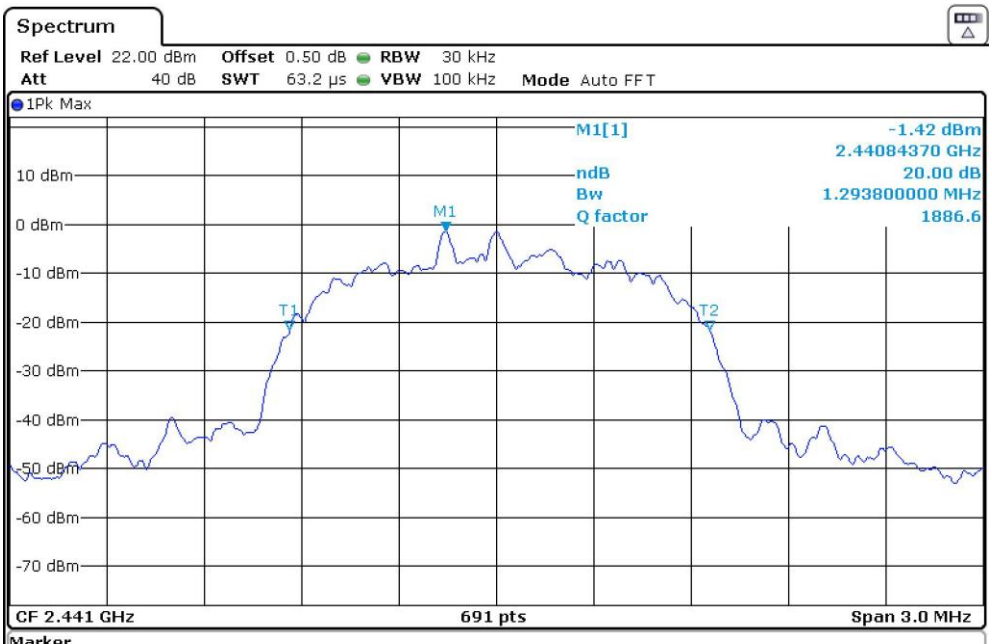
Frequency (MHz)	20 dB Bandwidth (MHz)
2402	1.294
2441	1.294
2480	1.294

Modulation Type: 8DPSK

CH00



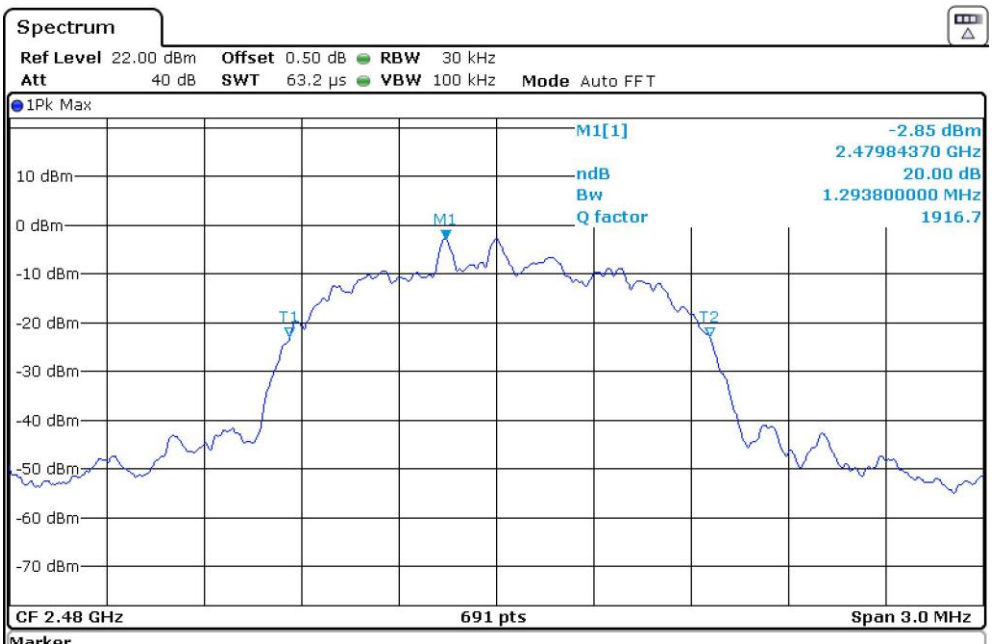
CH39



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4408437 GHz	-1.42 dBm	ndB down	1.2938 MHz
T1		1	2.4403618 GHz	-21.47 dBm	ndB	20.00 dB
T2		1	2.4416556 GHz	-21.55 dBm	Q factor	1886.6

CH78



Marker

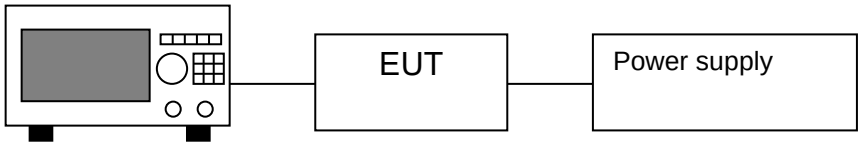
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4798437 GHz	-2.85 dBm	ndB down	1.2938 MHz
T1		1	2.4793618 GHz	-22.82 dBm	ndB	20.00 dB
T2		1	2.4806556 GHz	-22.91 dBm	Q factor	1916.7

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.

Block Diagram:



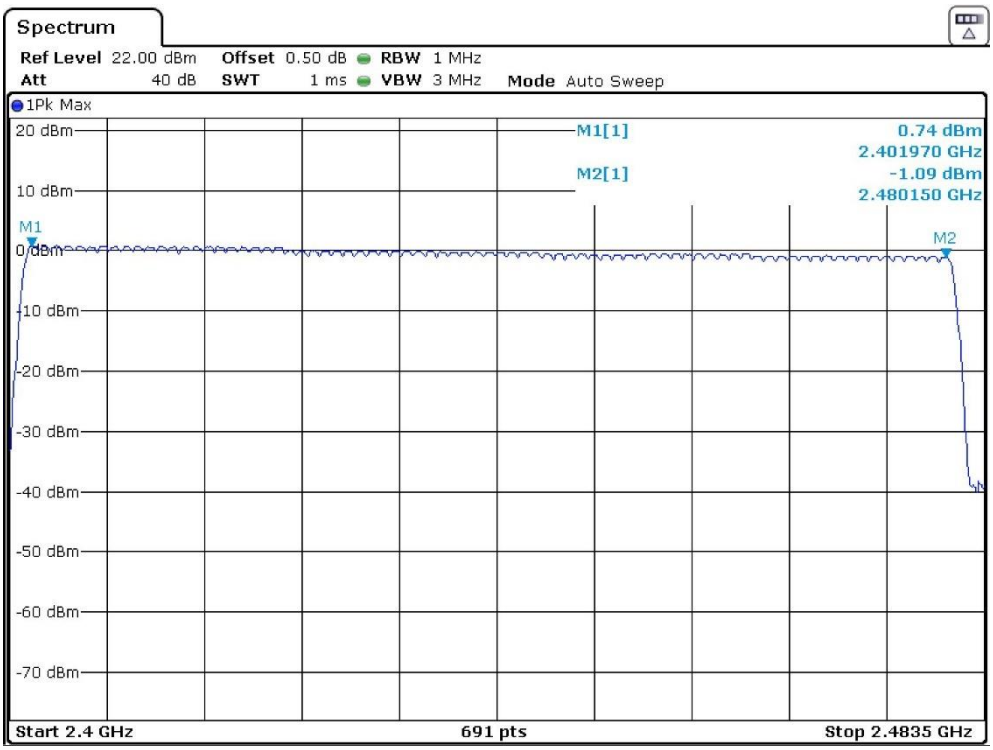
Spectrum Analyzer

Number of hopping channels =	79

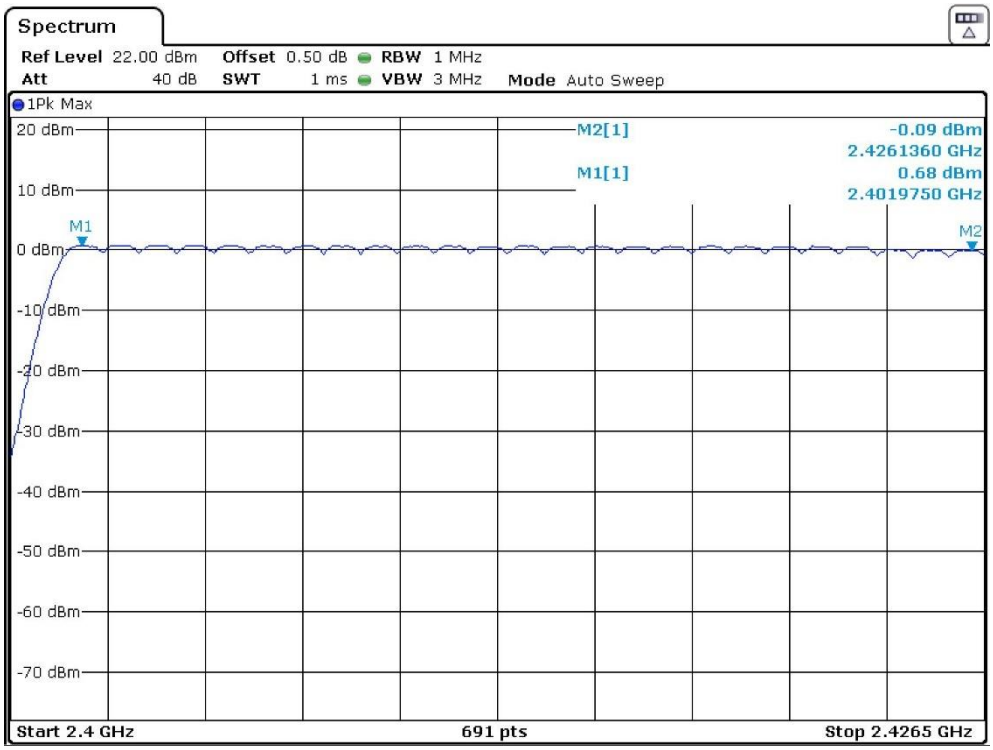
Note: In AFH mode, this device operates using 20 channels and it's satisfied the requirement of limit of minimum of 15 hopping channels.

Modulation Type: GFSK

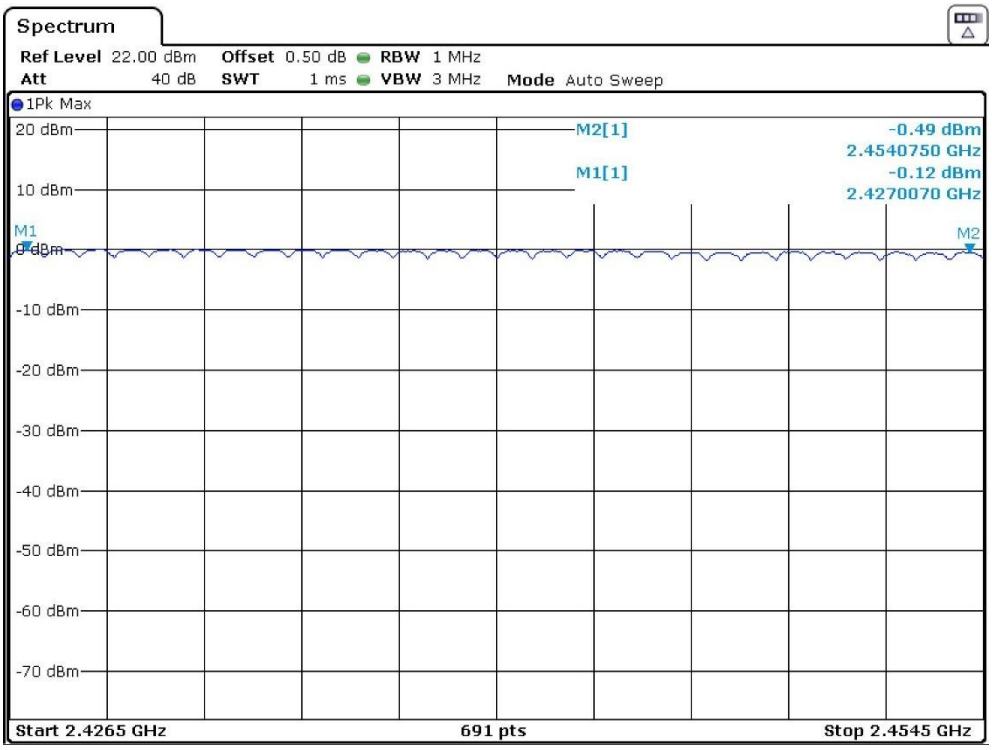
CH00-CH78



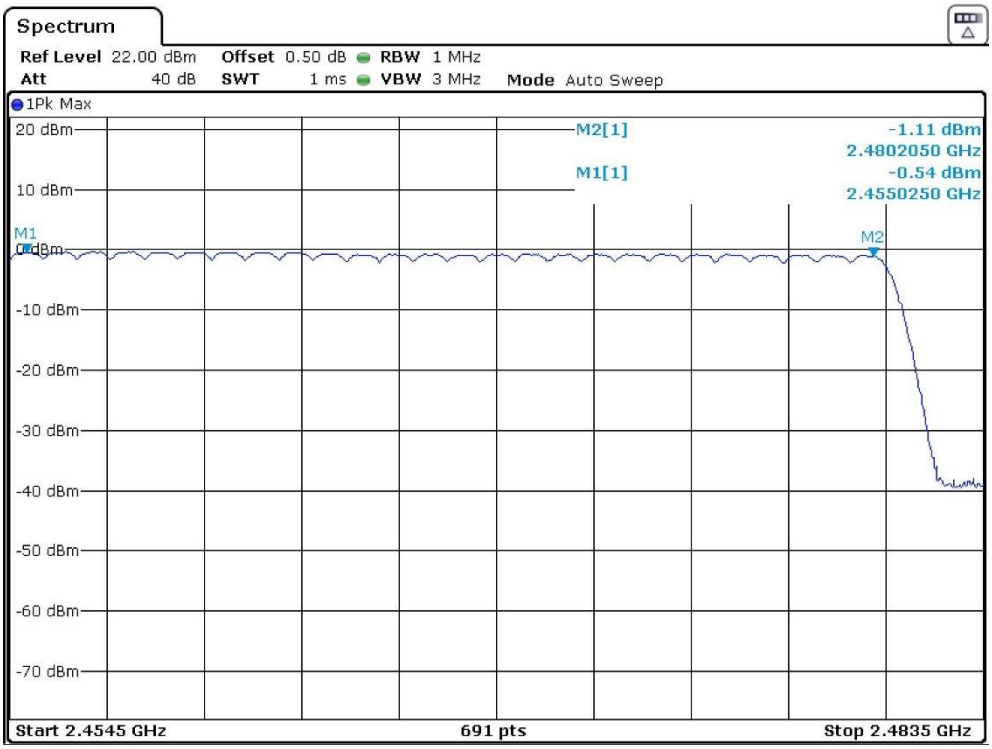
CH00-CH24



CH25-CH52



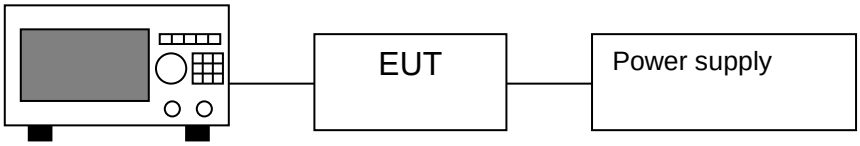
CH53-CH78


Spectrum
Ref Level 22.00 dBm Offset 0.50 dB RBW 1 MHz
Att 40 dB SWT 1 ms VBW 3 MHz Mode Auto Sweep
1Pk Max
M2[1] -1.11 dBm
2.4802050 GHz
M1[1] -0.54 dBm
2.4550250 GHz
20 dBm
10 dBm
M1
0 dBm
M2
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
Start 2.4545 GHz
691 pts
Stop 2.4835 GHz

4.6 Channel Separation (Carrier Frequency Separation)

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

Block Diagram:



Spectrum Analyzer

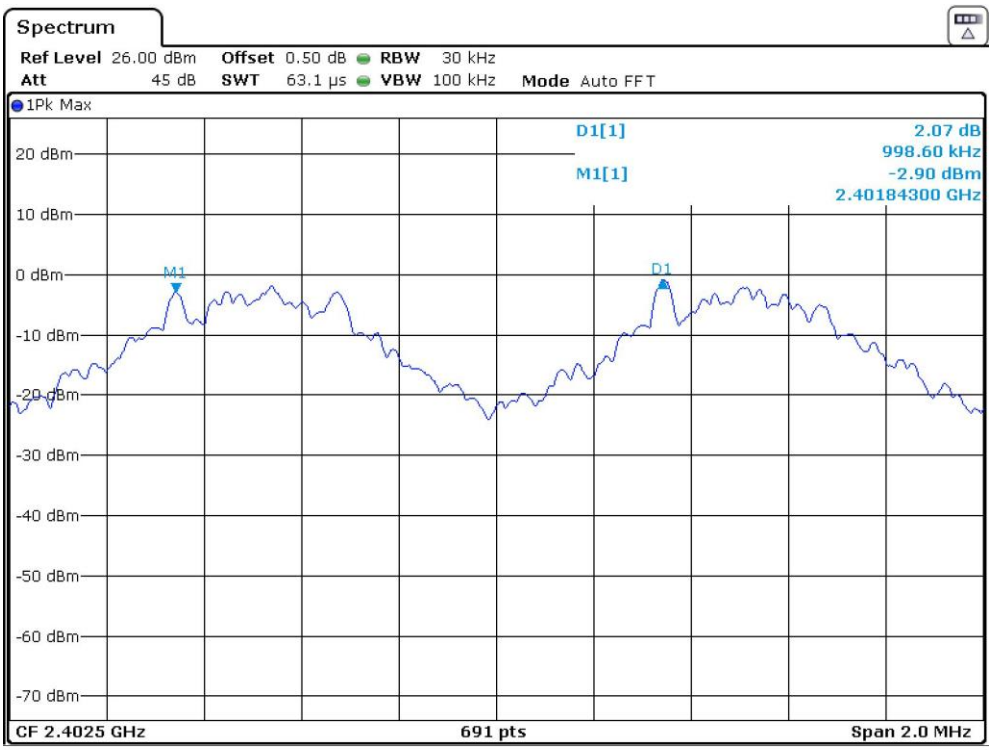
Using the DELTA MARKER function of the analyzer, the frequency separation between two adjacent channels was measured and compared against the limit:

Not less than 2/3 of 20dB bandwidth of hopping channel: 1.294 x 2/3 = 0.86MHz

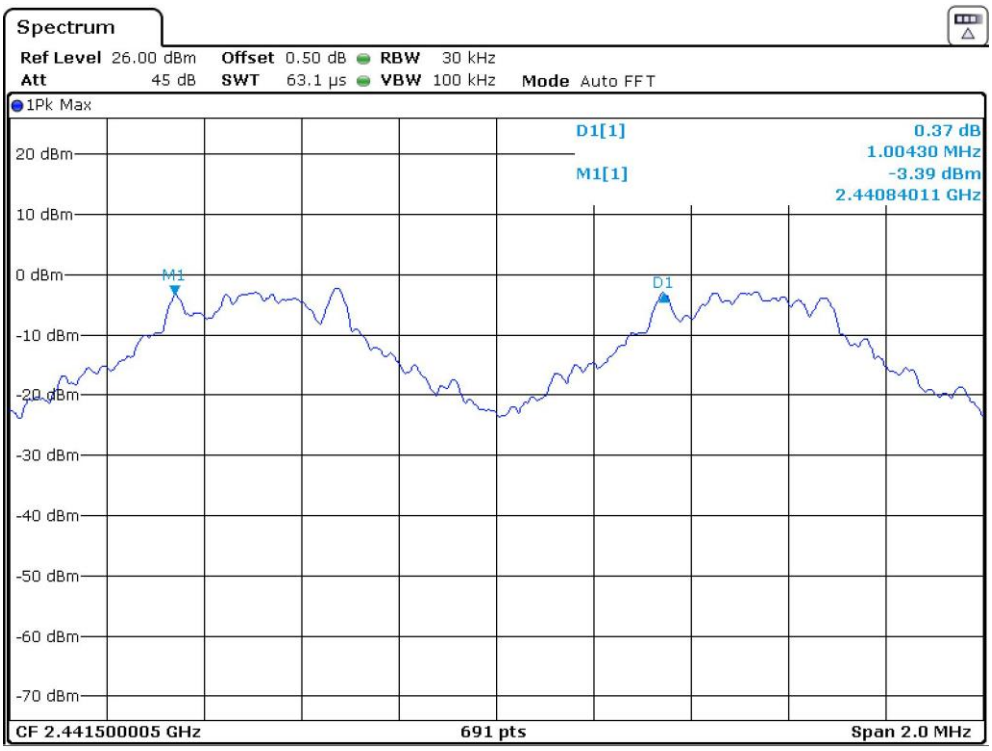
Minimum Channel Separation	0.999 MHz

Modulation Type: GFSK

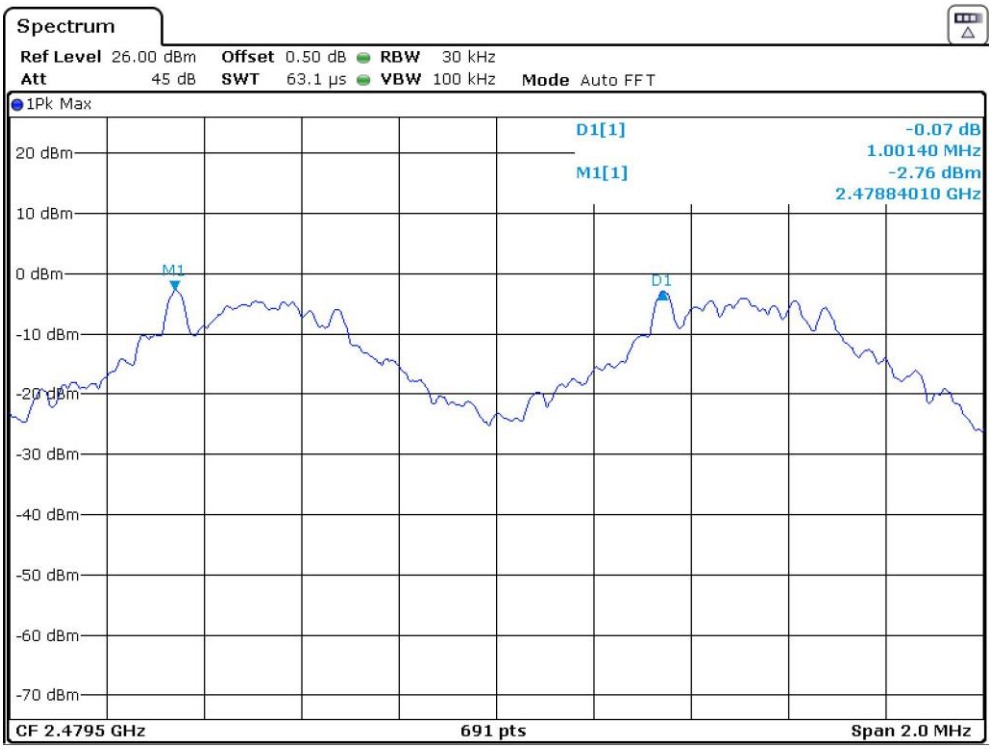
Low Channel



Middle Channel



High Channel



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.

Block Diagram:

Spectrum Analyzer

Worst Test Result:

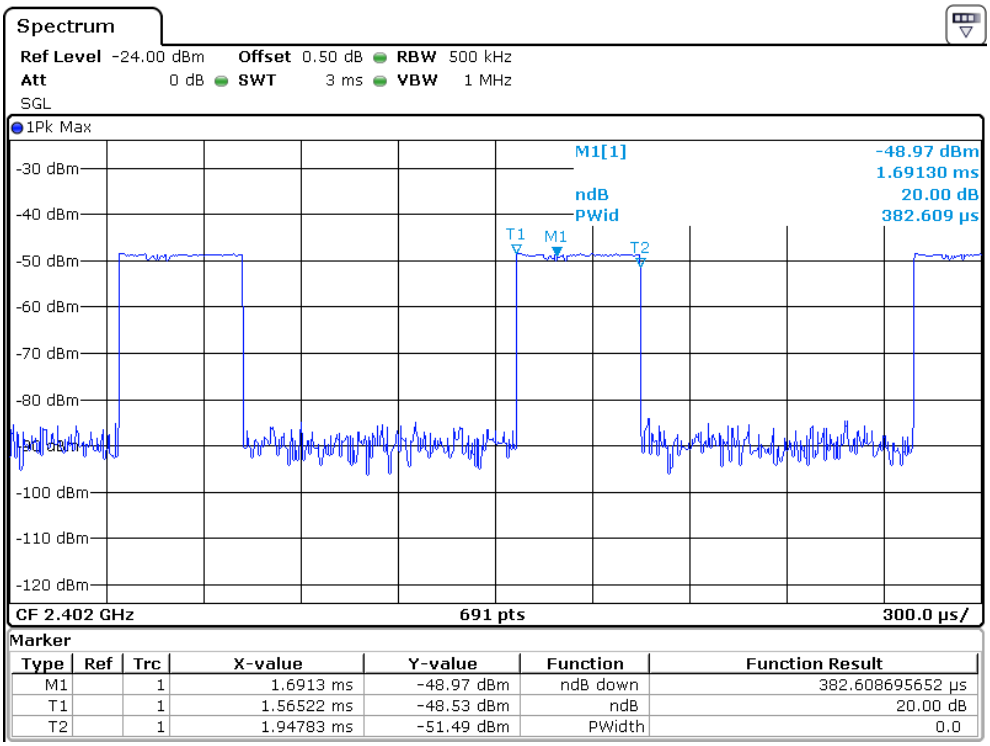
Normal hopping mode

Modulation Type	Packet	Max Dwell Time	Limit (s)	Result
GFSK	DH1	0.382ms * 170 = 64.94ms	0.4	Pass
	DH3	1.635ms * 150 = 245.25ms	0.4	Pass
	DH5	2.913ms * 98 =285.474ms	0.4	Pass

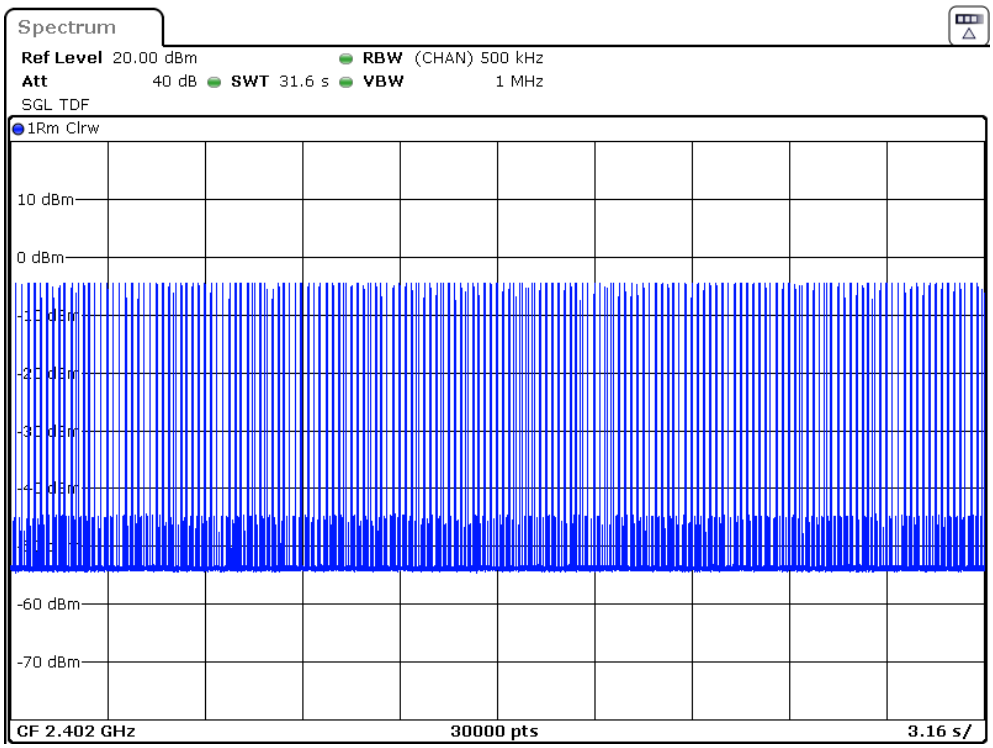
AFH mode:

Modulation Type	Packet	Max Dwell Time	Limit (s)	Result
GFSK	DH1	0.382ms * 79 = 30.178ms	0.4	Pass
	DH3	1.635ms * 41 = 67.035ms	0.4	Pass
	DH5	2.913ms * 33= 96.129ms	0.4	Pass

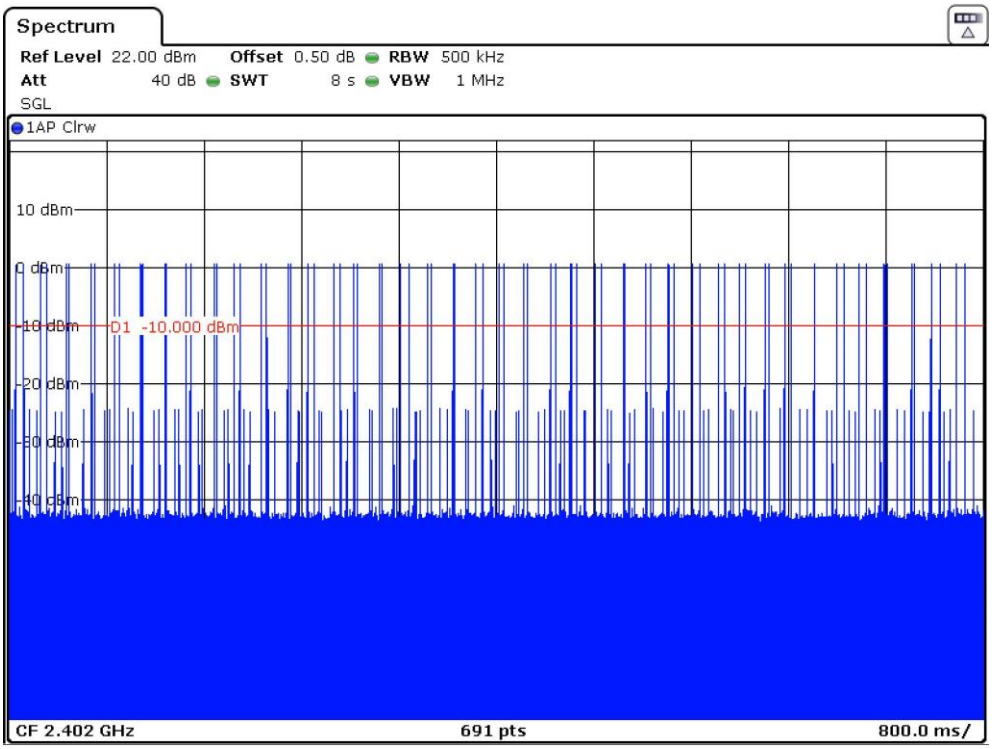
Modulation Type: GFSK
Packet: DH1



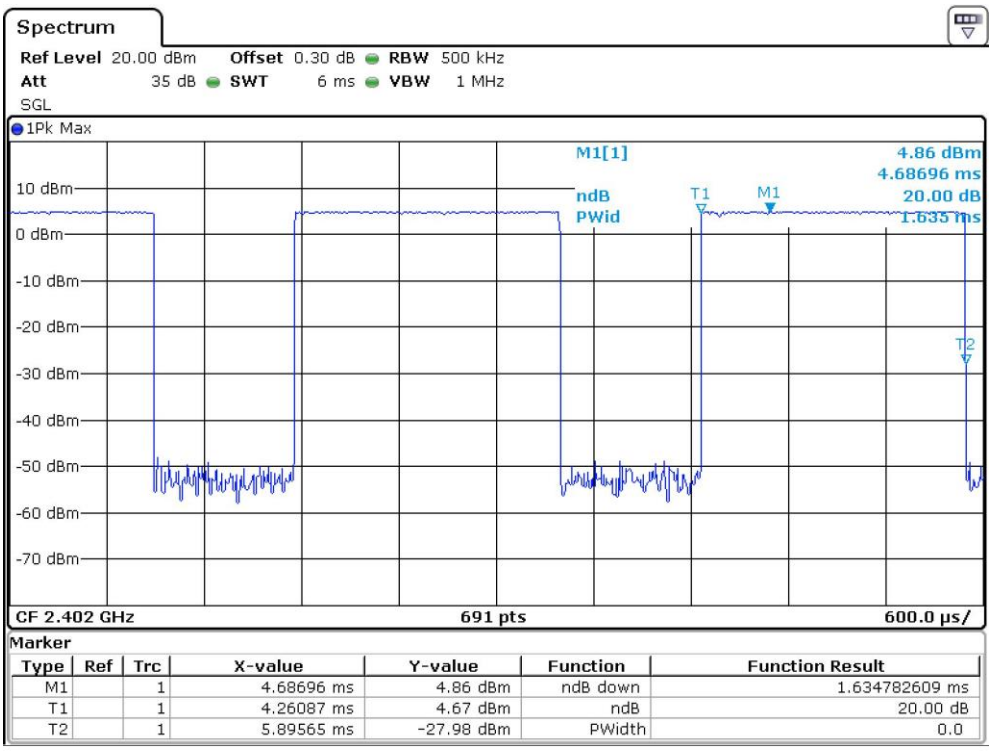
Number of hops (Normal hopping mode)



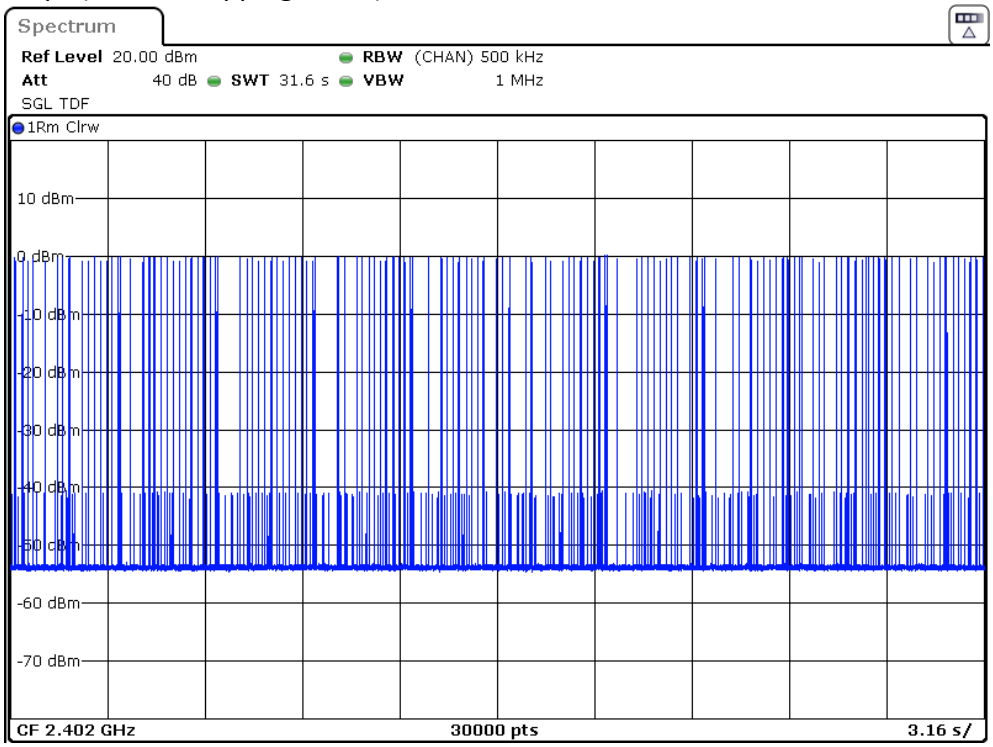
Number of hops (AFH mode)



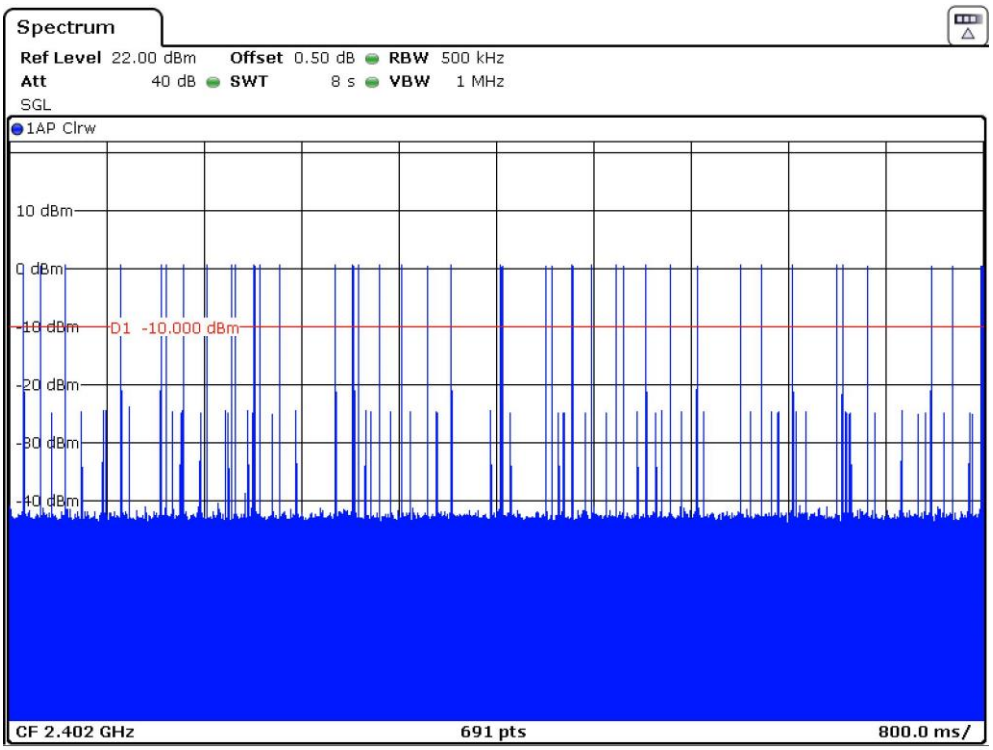
Packet: DH3



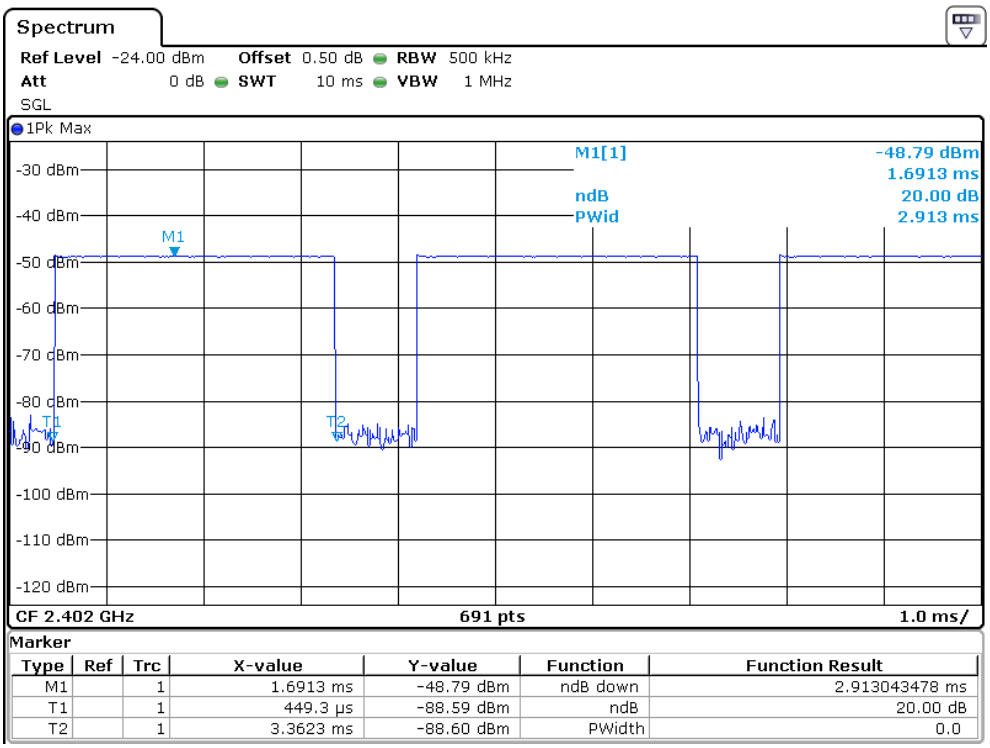
Number of hops (Normal hopping mode)



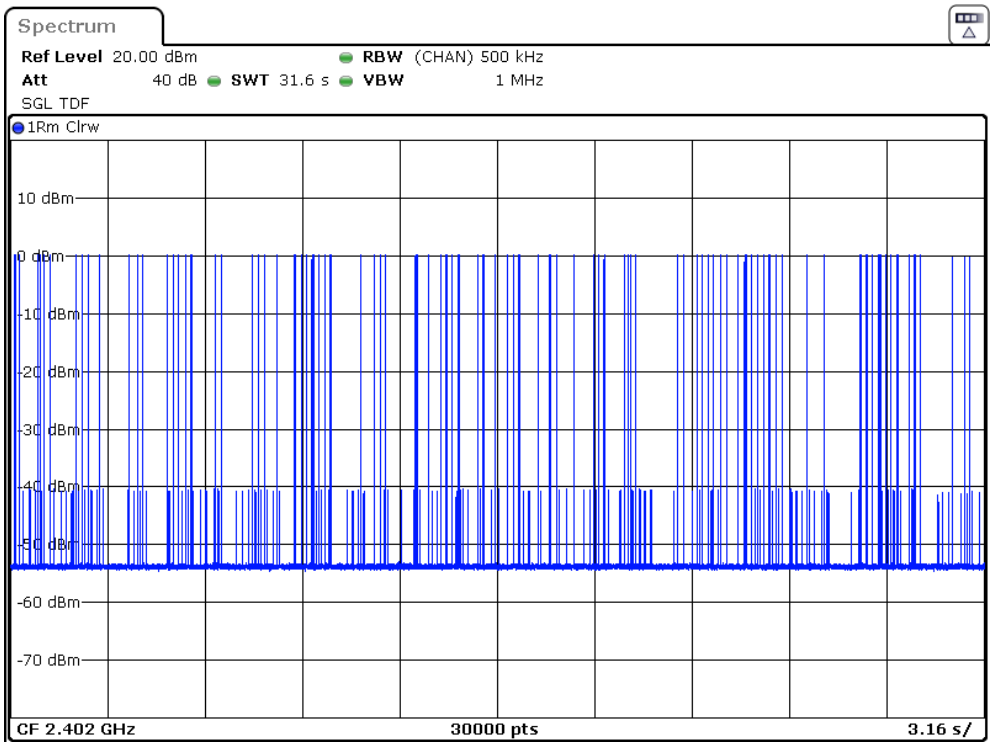
Number of hops (AFH mode)



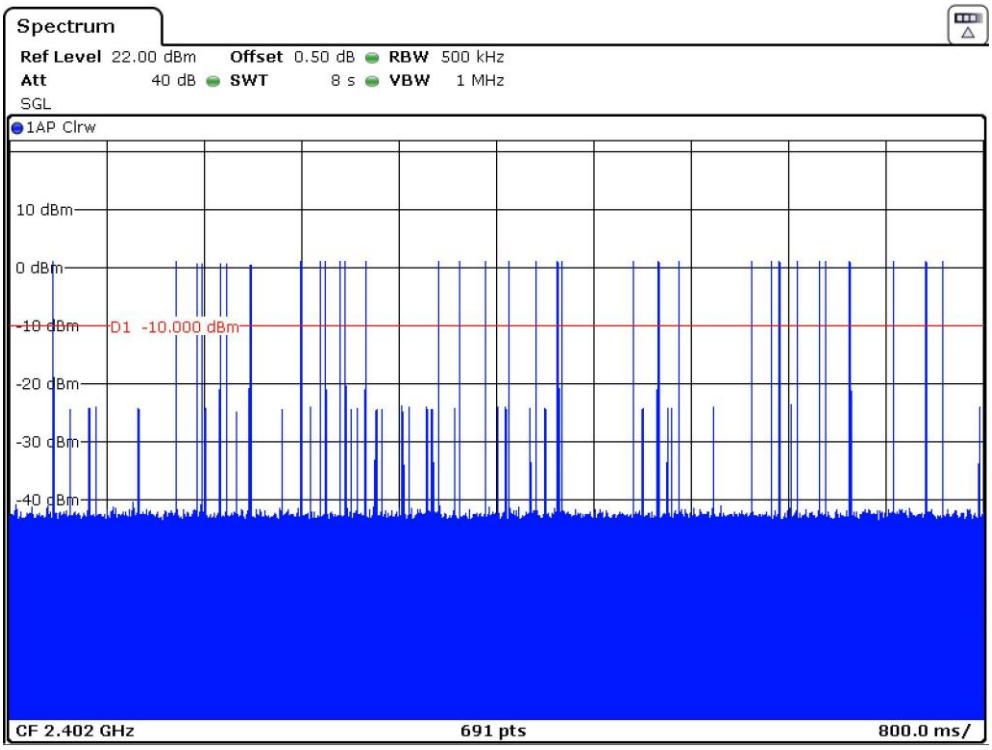
Packet: DH5



Number of hops (Normal hopping mode)



Number of hops (AFH mode)

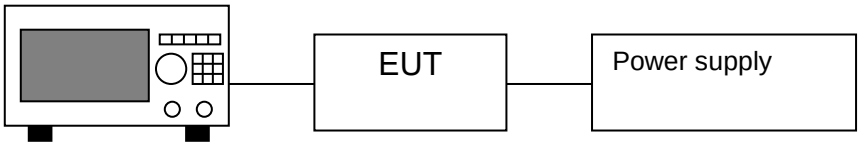


4.8 Band Edge

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.

Block Diagram:



Spectrum Analyzer

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

(i) Lower channel 2402MHz:

Peak Resultant field strength = Fundamental emissions (peak value) – delta from the bandedge plot
= 101.3dBμv/m-48.69dB
= 52.61dBμv/m

Average Resultant field strength = Fundamental emissions (Average value) – delta from the bandedge plot
= 78.8dBμv/m-48.69dB
= 30.11dBμv/m

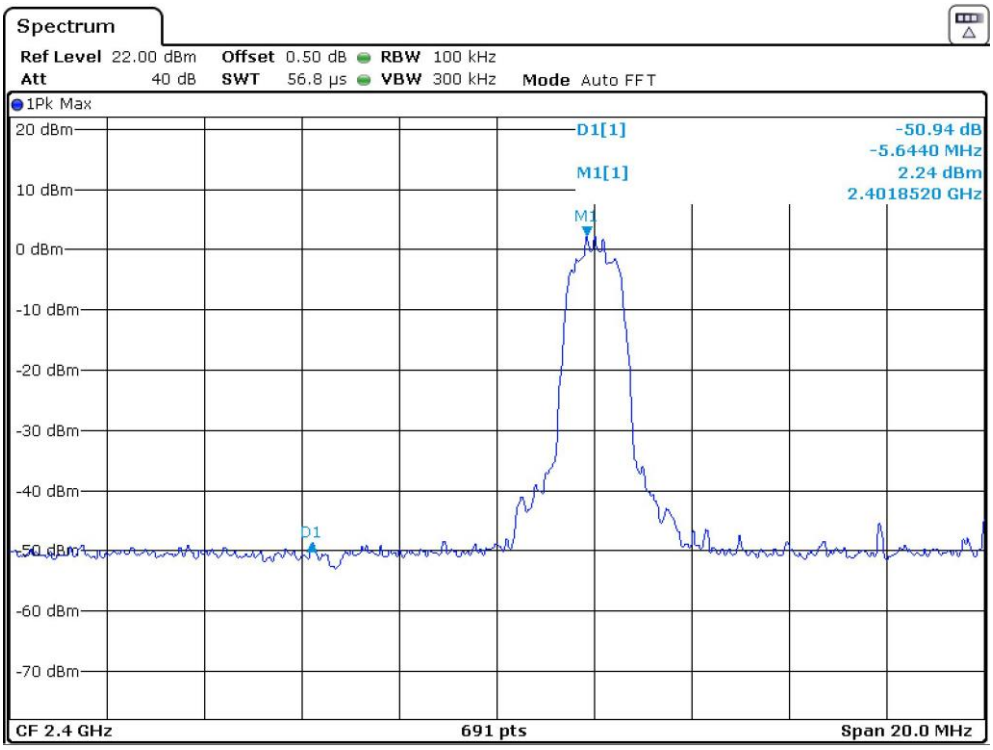
(ii) Upper channel 2480MHz:

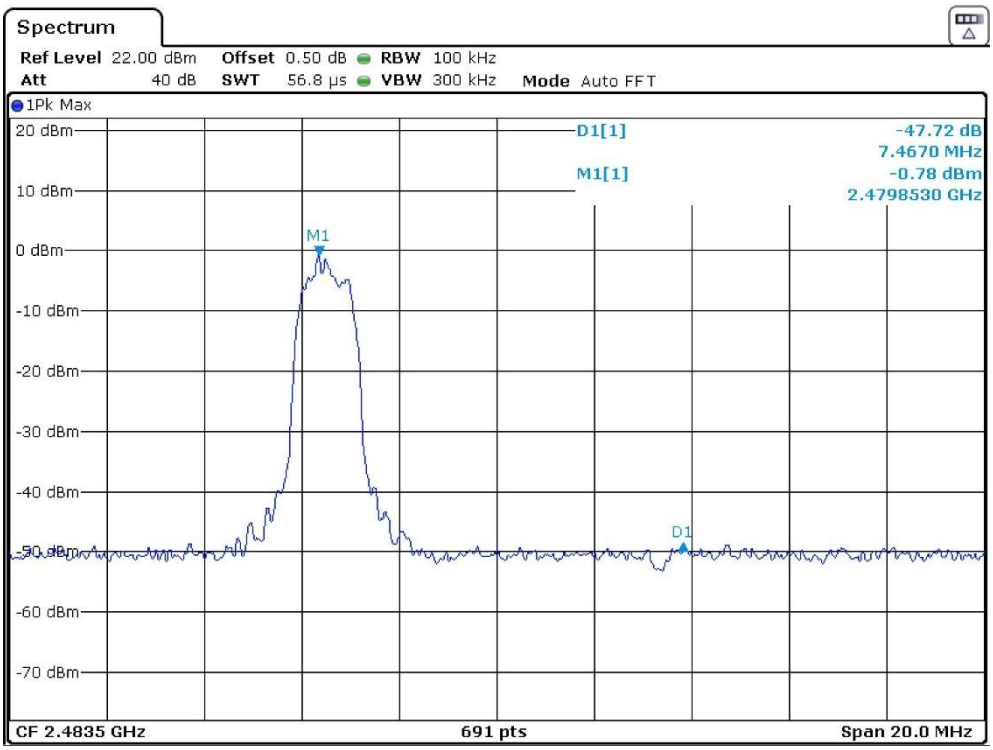
Peak Resultant field strength = Fundamental emissions (peak value) – delta from the bandedge plot
= 104.2dBμv/m-47.18dB
= 57.02dBμv/m

Average Resultant field strength = Fundamental emissions (Average value) – delta from the bandedge plot
= 81.7dBμv/m-47.18dB
= 34.52dBμv/m

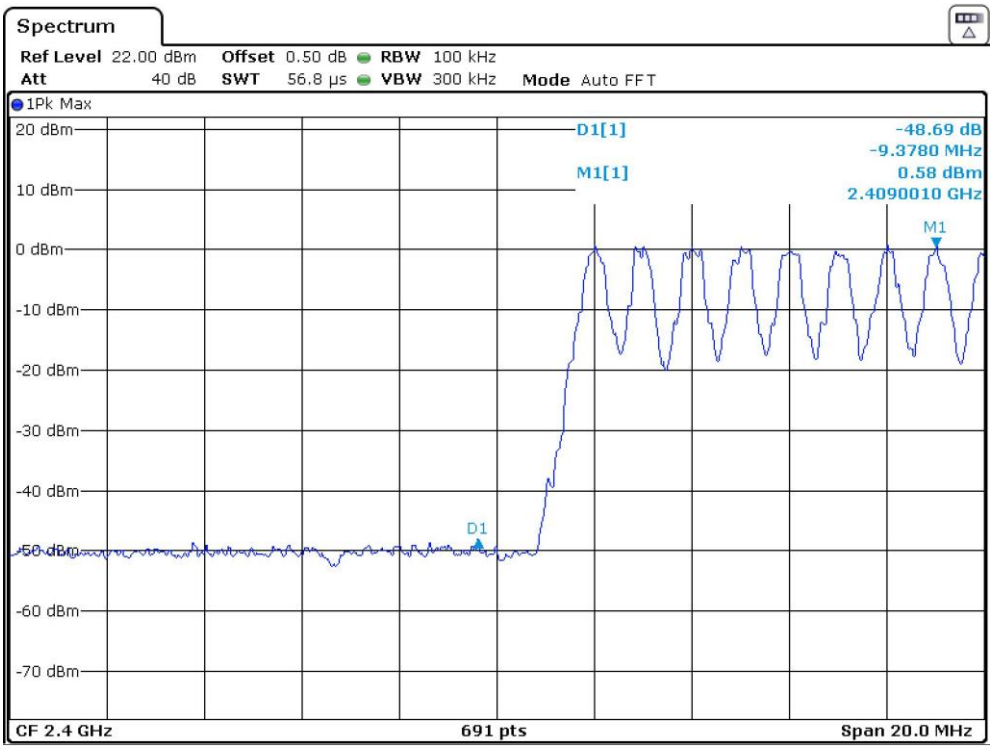
The resultant field strength meets the general radiated emission limit in section 15.209, which does not exceed 74dBμv/m (Peak Limit) and 54dBμv/m (Average Limit).

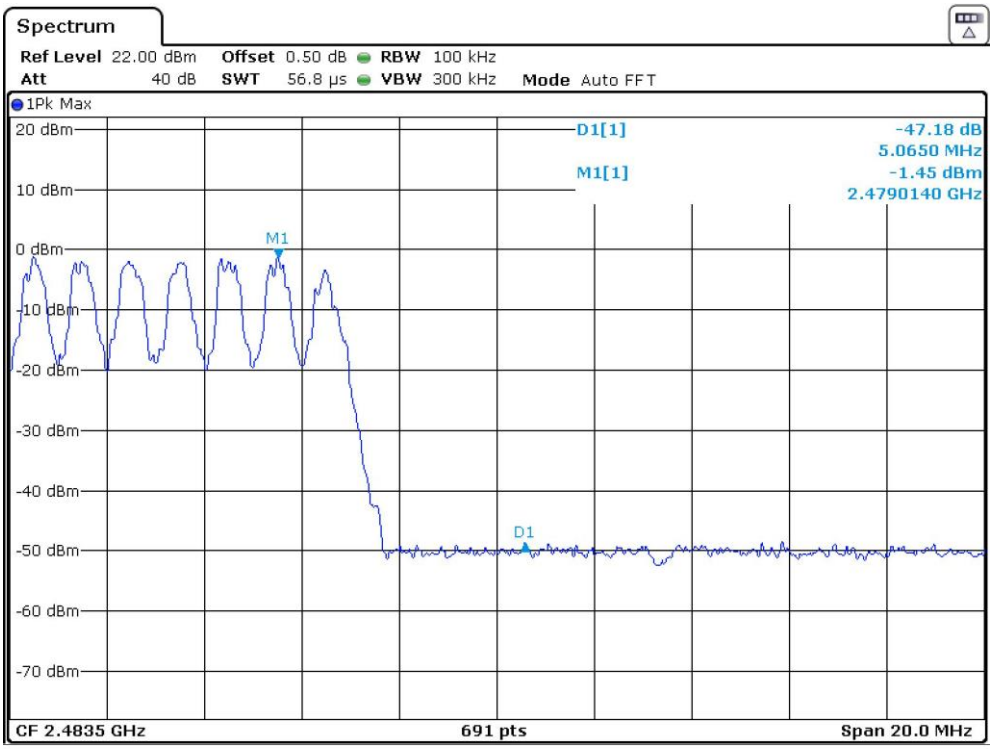
Modulation Type: GFSK
Hopping function off





Hopping function on



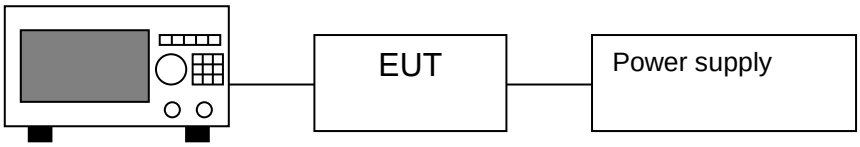


4.9 Transmitter Spurious Emissions (Conducted)

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.

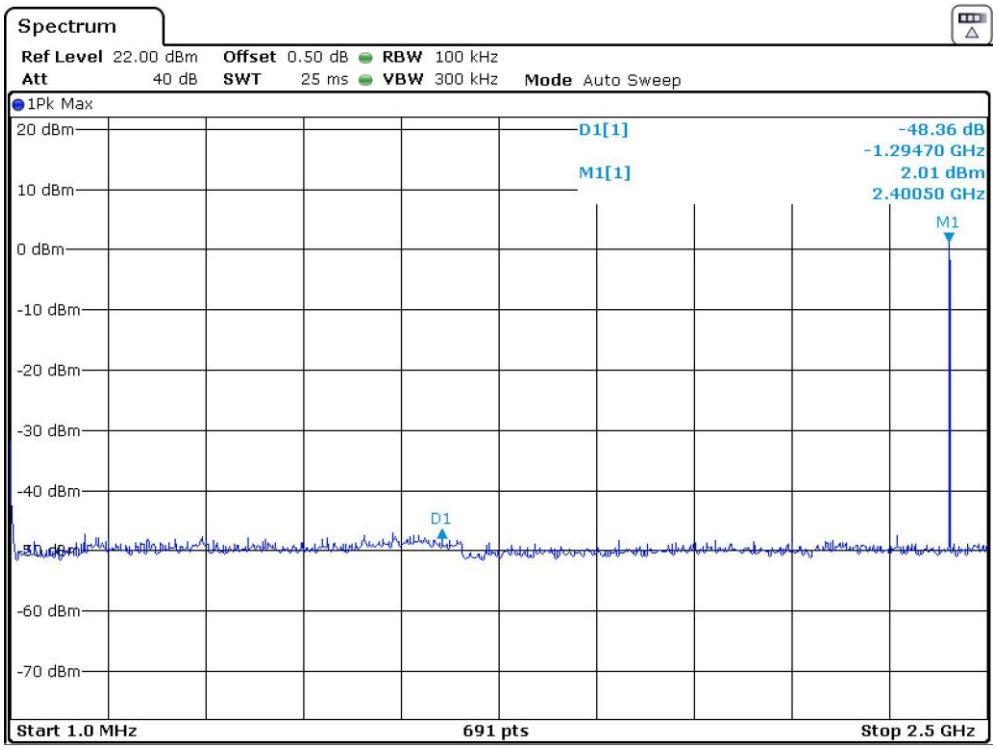
Block Diagram:

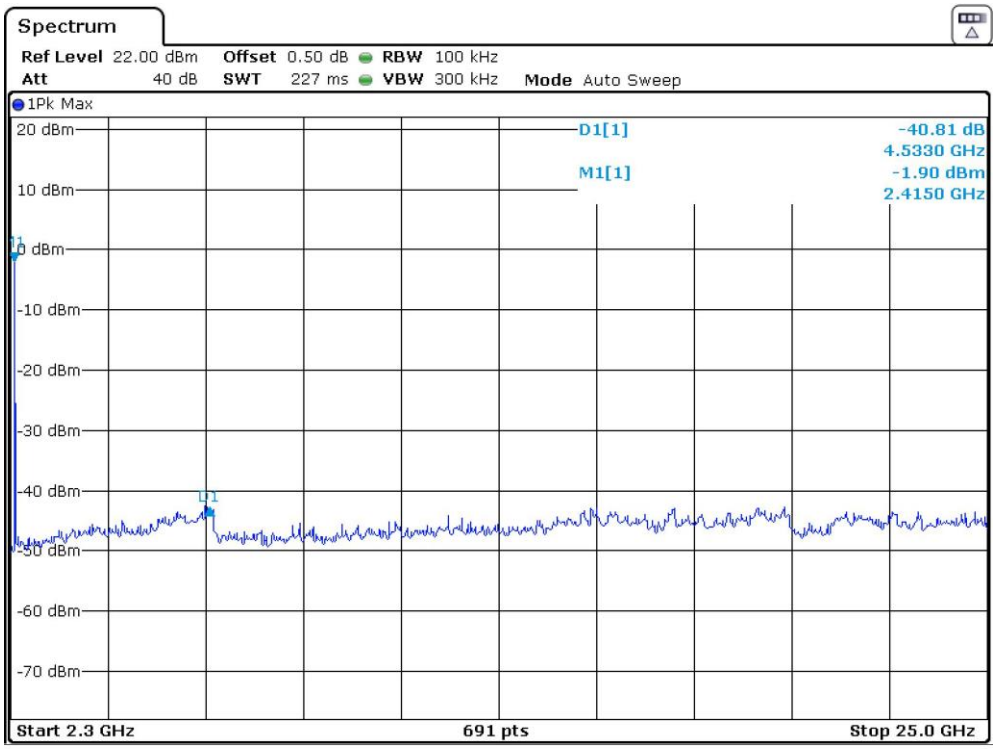


Spectrum Analyzer

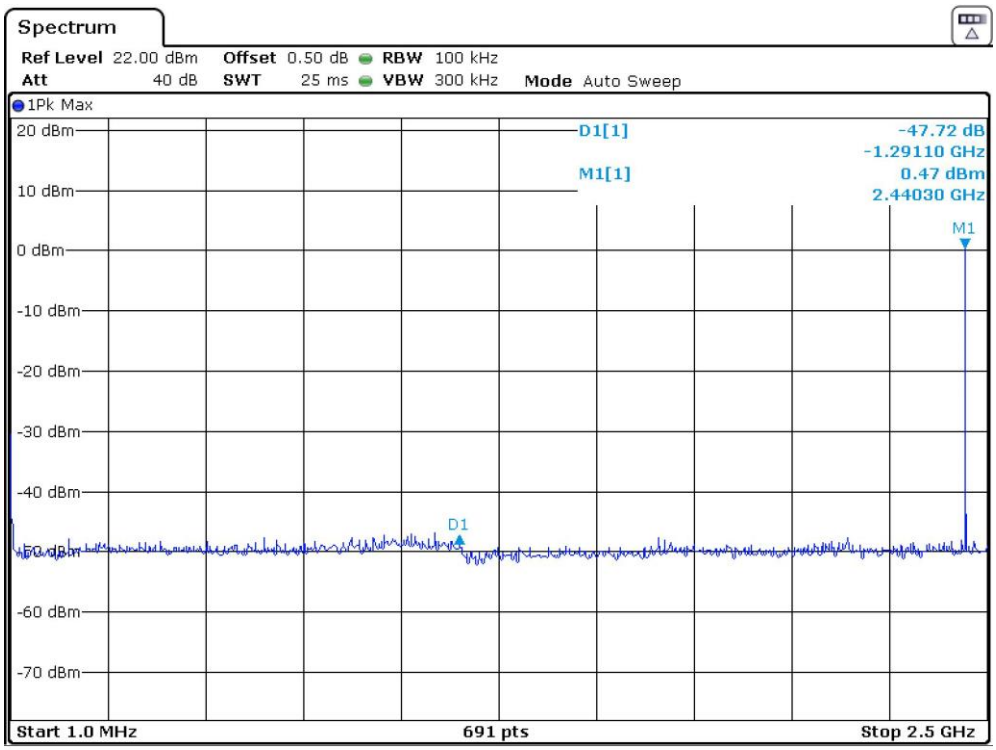
Modulation Type: GFSK

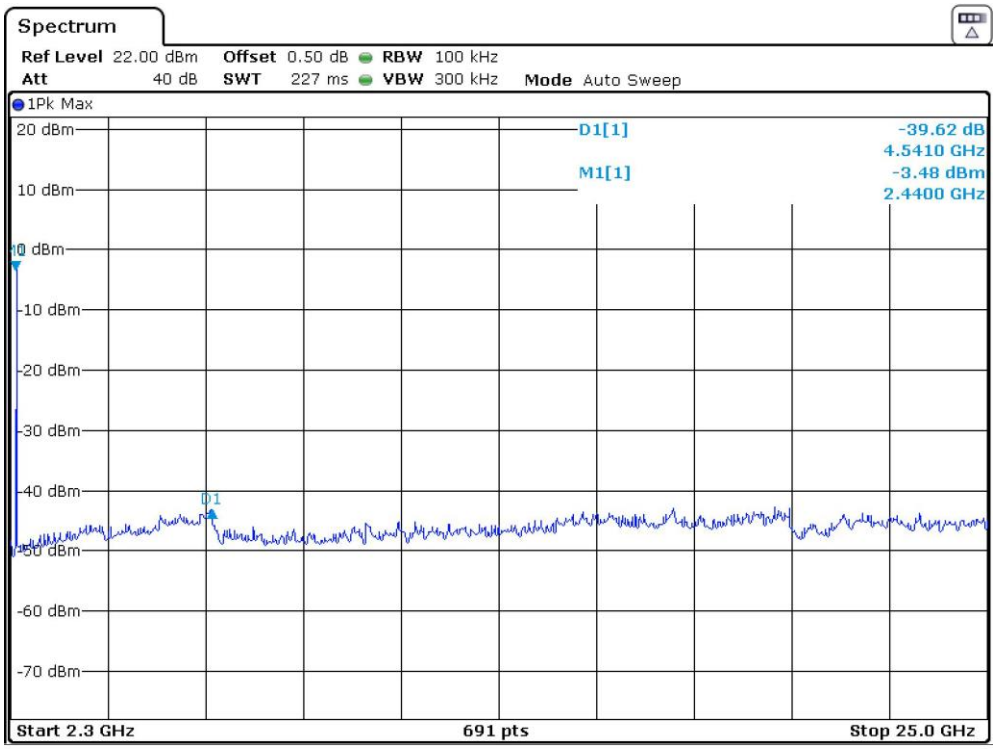
CH00



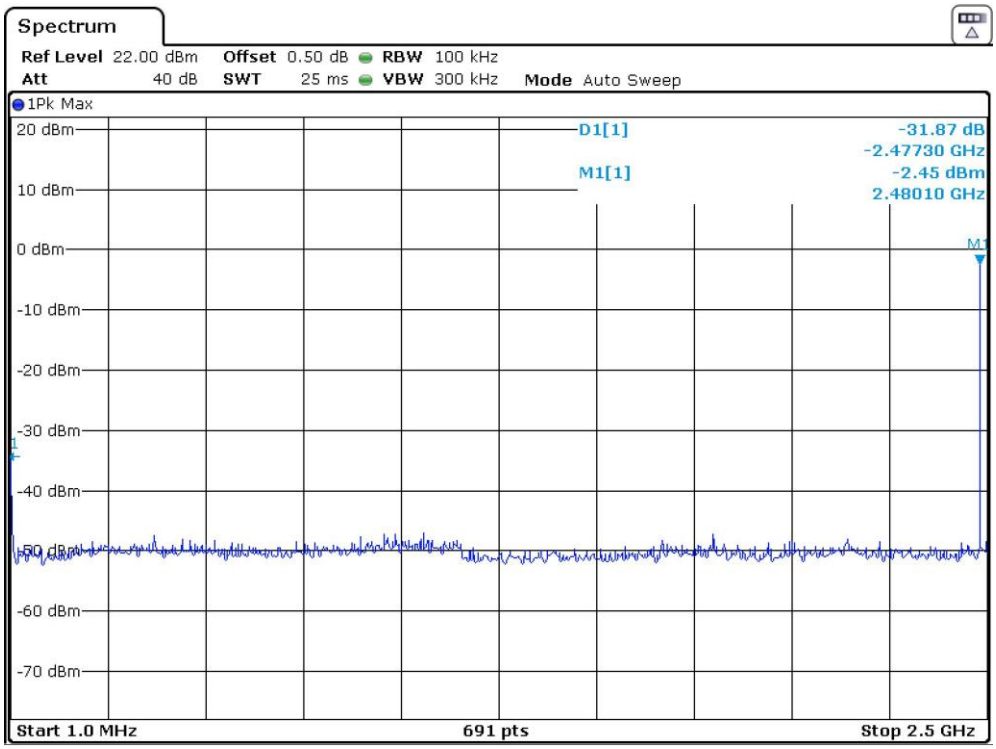


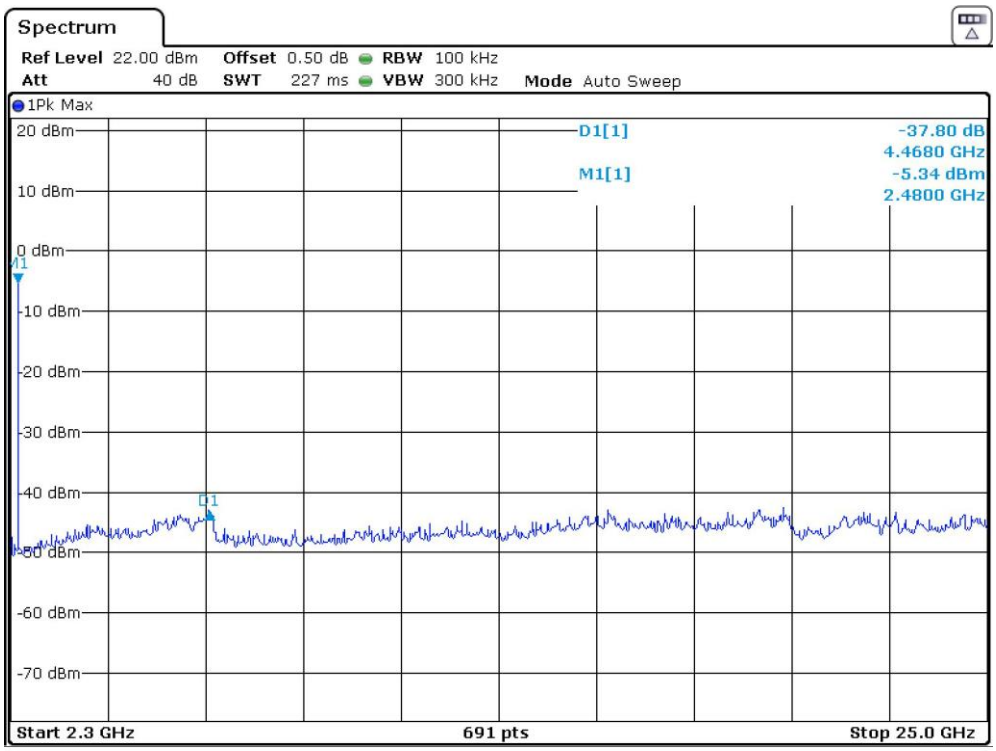
CH39


Spectrum
Ref Level 22.00 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 25 ms VBW 300 kHz Mode Auto Sweep
1Pk Max
D1[1] -47.72 dB
-1.29110 GHz
M1[1] 0.47 dBm
2.44030 GHz
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
D1
M1
Start 1.0 MHz
691 pts
Stop 2.5 GHz


Spectrum
Ref Level 22.00 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 227 ms VBW 300 kHz Mode Auto Sweep
1Pk Max
D1[1] -39.62 dB
4.5410 GHz
M1[1] -3.48 dBm
2.4400 GHz
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
D1
Start 2.3 GHz
691 pts
Stop 25.0 GHz

CH78


Spectrum
Ref Level 22.00 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 25 ms VBW 300 kHz Mode Auto Sweep
1Pk Max
D1[1] -31.87 dB
-2.47730 GHz
M1[1] -2.45 dBm
2.48010 GHz
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
Start 1.0 MHz
691 pts
Stop 2.5 GHz


Spectrum
Ref Level 22.00 dBm Offset 0.50 dB RBW 100 kHz
Att 40 dB SWT 227 ms VBW 300 kHz Mode Auto Sweep
1Pk Max
D1[1] -37.80 dB
4.4680 GHz
M1[1] -5.34 dBm
2.4800 GHz
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
Start 2.3 GHz
691 pts
Stop 25.0 GHz

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 5.0 (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
SZ061-13	BiConiLog Antenna	ETS	3142E	00217919	2022-07-13	2025-07-13
SZ185-03	EMI Receiver	R&S	ESCI	101975	2024-04-23	2025-04-23
SZ061-08	Horn Antenna	ETS	3115	00092346	2024-09-13	2027-09-13
SZ061-06	Active Loop Antenna	Electro-Metrics	EM-6876	217	2024-05-05	2027-05-05
SZ056-03	Spectrum Analyzer	R&S	FSP 30	101148	2024-04-22	2025-04-22
SZ056-08	Signal Analyzer	R&S	FSV 40	101430	2023-12-13	2024-12-13
SZ181-04	Preamplifier	Agilent	8449B	3008A02474	2024-04-22	2025-04-22
SZ188-01	Anechoic Chamber	ETS	RFD-F/A-100	4102	2021-12-12	2024-12-12
SZ062-02	RF Cable	RADIALL	RG 213U	--	2024-09-30	2025-09-30
SZ062-05	RF Cable	RADIALL	0.04-26.5GHz	--	2024-09-30	2025-09-30
SZ062-12	RF Cable	RADIALL	0.04-26.5GHz	--	2024-09-30	2025-09-30
SZ067-04	Notch Filter	Micro-Tronics	BRM50702-02	--	2024-04-23	2025-04-23
SZ185-02	EMI Test Receiver	R&S	ESCI	100692	2024-07-09	2025-07-09
SZ187-01	Two-Line V-Network	R&S	ENV216	100072	2024-04-23	2025-04-23
SZ188-03	Shielding Room	ETS	RFD-100	4100	2022-12-20	2025-12-20

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