intertek
Total Quality. Assured.

Microsoft Corporation

TEST REPORT

SCOPE OF WORK
FCC TESTING–1919

REPORT NUMBER
190929011SZN-001

ISSUE DATE **[REVISED DATE]**

14 January 2020 [----------]

PAGES
50

DOCUMENT CONTROL NUMBER
FCC ID 247_b

101, 201, Building B, No. 308 Wuhe Avenue, Zhangkengjing Community,
GuanHu Subdistrict, LongHua District, Shenzhen, P.R. China

Tel: (86 755) 8601 6288
Fax: (86 755) 8601 6751
www.intertek.com

Total Quality. Assured.

TEST REPORT

Intertek Report No.: 190929011SZN-001

Microsoft Corporation

Application
For
Certification

FCC ID: C3K1830

Bluetooth Accessory

Model: 1919

2.4GHz Transceiver

Report No.: 190929011SZN-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 [10-1-18]

Prepared and Checked by:

Rui Zhou
Project Engineer

Approved by:

Kidd Yang
Technical Supervisor
Date: 14 January 2020

MEASUREMENT/TECHNICAL REPORT

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

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 [10-1-18 Edition] provision.

Report prepared by:

Rui Zhou
Intertek Testing Services Shenzhen Ltd. Longhua Branch
101, 201, Building B, No. 308 Wuhe Avenue, Zhangkengjing
Community, GuanHu Subdistrict, LongHua District, Shenzhen, P.R. China.

Tel: (86 755) 8601 6288 Fax: (86 755) 8601 6661

Revision History

Report No.	Version	Description	Issued Date
190929011SZN-001	Rev.01	Initial issue of report	31 December 2019
190929011SZN-001	Rev.02	Update some description	10 January 2020
190929011SZN-001	Rev.03	Update some description	14 January 2020

Note: This report replaces previous report dated: 10 January 2020.

Table of Contents

1.0 Summary of Test Results

Applicant: Microsoft Corporation
Address: One Microsoft Way Redmond, WA 98052 USA

Bluetooth Accessory
Model: 1919

FCC ID: C3K1830

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: 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 an Bluetooth Accessory with Bluetooth FHSS technology operating in 2402-2480MHz. The EUT is powered by DC 3.7V from inner battery or DC 5V from USB port. For more detail information pls. refer to the user manual.

Bluetooth Version: 5.0
Antenna Type: Integral antenna
Antenna Gain: 2.5 dBi
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 Bluetooth Accessory which has Bluetooth function, (classic Bluetooth mode), and for the BLE mode was tested and demonstrated in report 190929011SZN-002. Other digital functions were reported in the SDOC report:190929014SZN-001.

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).

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 centre 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 unit was placed at the center of turntable and the rear of unit was flushed with the rear of the styrene 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.

3.3 Special Accessories

No special accessory attached.

3.4 Equipment Modification

Any modifications installed previous to testing by Microsoft Corporation 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.

Measurement Uncertainty	Uncertainty
Occupied Channel Bandwidth	±5%
RF Output Power	±1.5dB
Conducted Unwanted Emission	±3.0dB
Spurious emission (Above 1GHz)	±6.0dB
Radiated emission (Up to 1GHz)	±4.8dB
AC Conducted emission	±3.6 dB
Temperature	±1°C
Humidity	±5%

3.6 Support Equipment List and Description

Description	Manufacturer	Model No.
Laptop PC (Provided by Intertek)	DELL	3450
USB A-C Cable (Provided by Applicant)	N/A	Shielded, 135cm
AC Adaptor (Provided by Intertek)	HMD Global Oy	FC0200

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
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
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

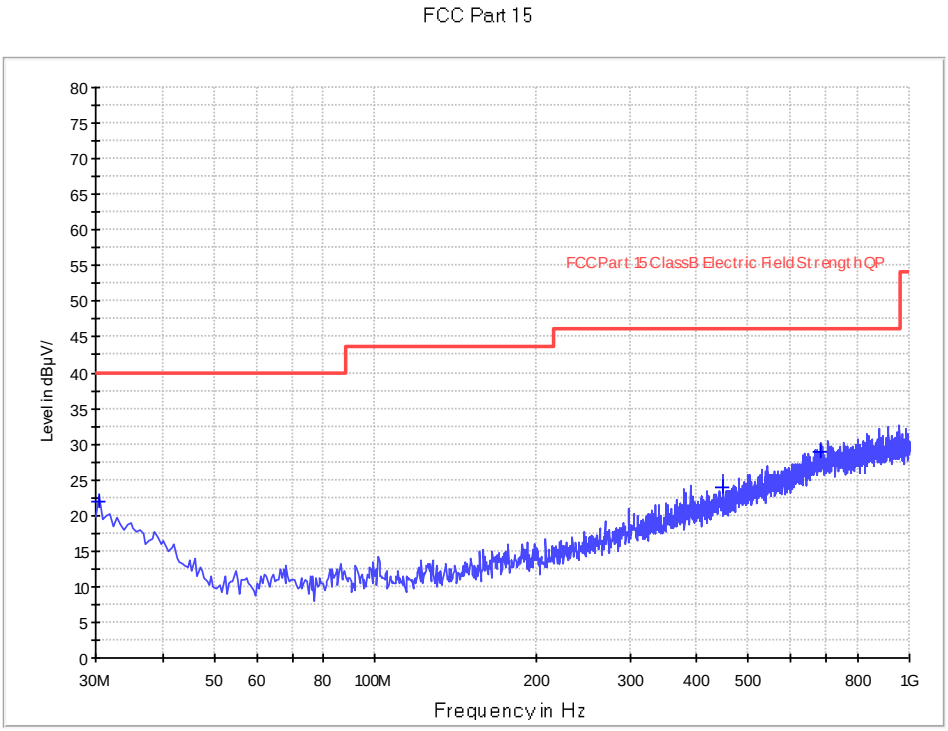
For electronic filing, the worst case radiated emission configuration photograph is saved with filename: radiated photos. pdf.

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.

Applicant: Microsoft Corporation
Date of Test: October 28, 2019
Model:1919
Worst-case operating Mode: Transmitting(2402MHz)
Worst-case Modulation type: GFSK

ANT Polarity: Horizontal



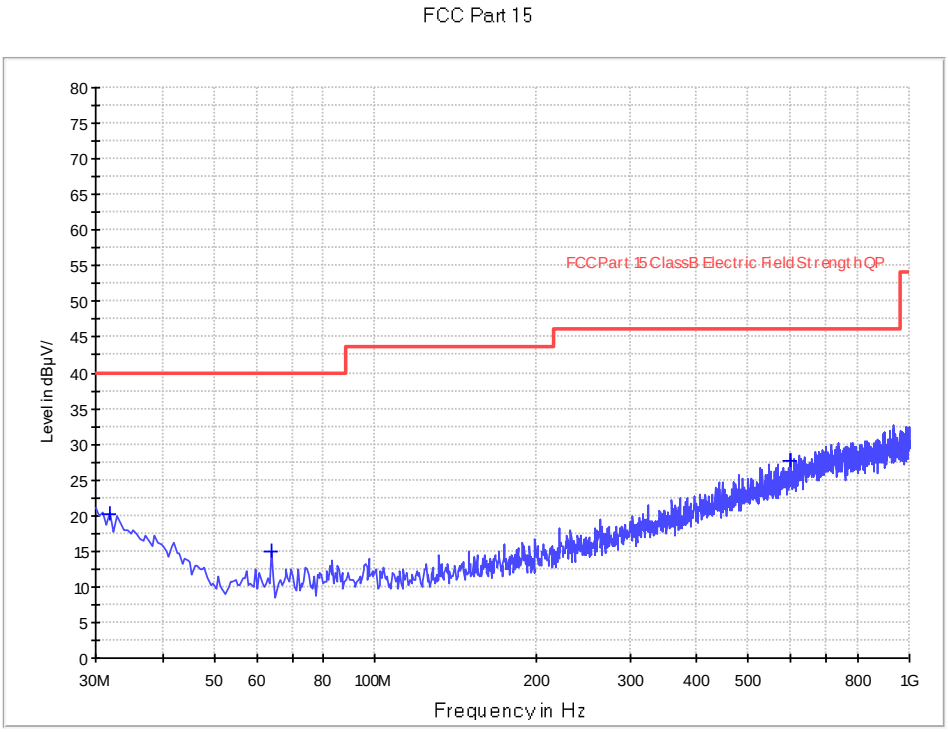
Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBuV/m)
30.486000	21.9	1000.0	120.000	0.0	H	17.8	-18.1	40.0
447.585000	23.8	1000.0	120.000	0.0	H	20.0	-22.2	46.0
679.900000	28.8	1000.0	120.000	0.0	H	25.0	-17.2	46.0

Remark:
1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
2. QuasiPeak (dBµV/m)= Corr. (dB/m)+ Read Level (dBµV)

NOTES:
1. Quasi-Peak detector is used for frequency below 1GHz.
2. All measurements were made at 3 meters.
3. Negative value in the margin column shows emission below limit.
4. All emissions are below the QP limit.
5. The spurious emissions were very low against the limit in the frequency range 9KHz to 30MHz. The amplitude of spurious emissions that is attenuated by more than 20dB below the permissible limit has no need to be reported.

Applicant: Microsoft Corporation
Date of Test: October 28, 2019
Model: 1919
Worst-case operating Mode: Transmitting(2402MHz)
Worst-case Modulation type: GFSK

ANT Polarity: Vertical



Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBuV/m)
31.930000	20.2	1000.0	120.000	0.0	V	17.1	-19.8	40.0
63.950000	14.9	1000.0	120.000	0.0	V	8.0	-25.1	40.0
598.420000	27.6	1000.0	120.000	0.0	V	23.2	-18.4	46.0

Remark:
1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
2. QuasiPeak (dBµV/m)= Corr. (dB/m)+ Read Level (dBµV)

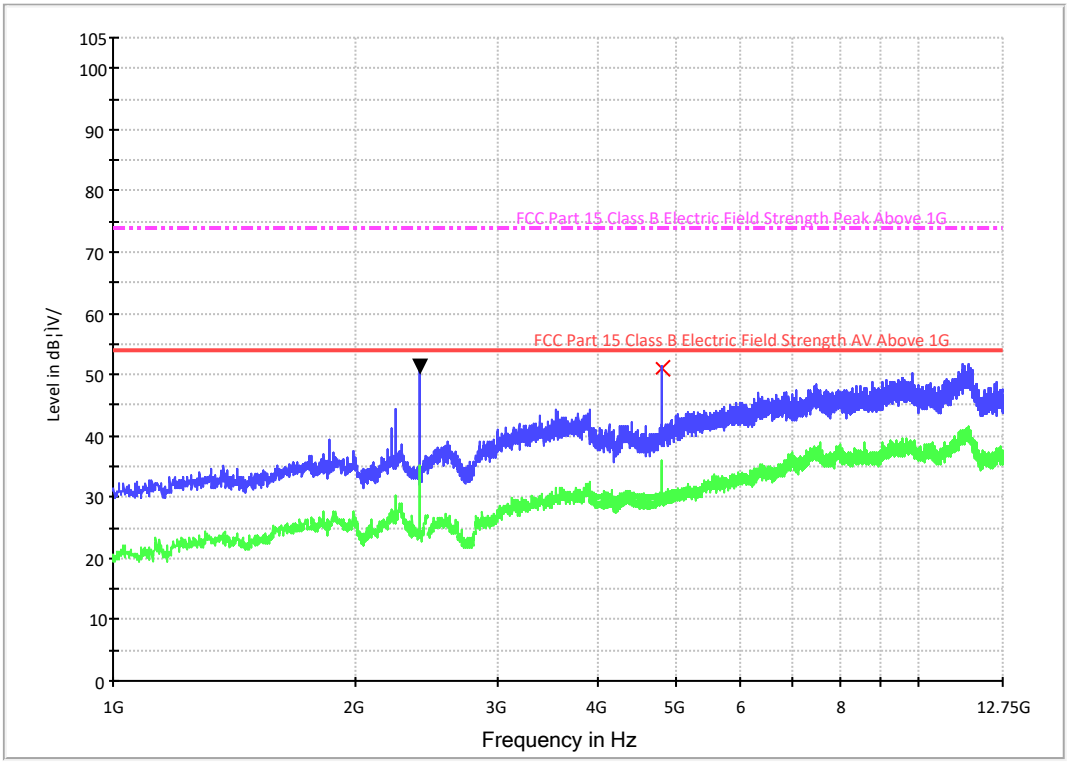
NOTES:
1. Quasi-Peak detector is used for frequency below 1GHz.
2. All measurements were made at 3 meters.
6. Negative value in the margin column shows emission below limit.
7. All emissions are below the QP limit.
8. The spurious emissions were very low against the limit in the frequency range 9KHz to 30MHz. The amplitude of spurious emissions that is attenuated by more than 20dB below the permissible limit has no need to be reported.

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.

Applicant: Microsoft Corporation
Date of Test: November 25, 2019
Model: 1919
Worst-case operating Mode: Transmit (2402MHz)
Worst-case modulation type: GFSK

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)
Horizontal	**2402.000	107.4	36.7	28.1	98.8	--	--
Horizontal	*4804.000	54.0	36.7	33.5	50.8	74.0	-23.2

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)
Horizontal	**2402.000	107.4	36.7	28.1	22.5	76.3	--	--
Horizontal	*4804.000	54.0	36.7	33.5	22.5	28.3	54.0	-25.7

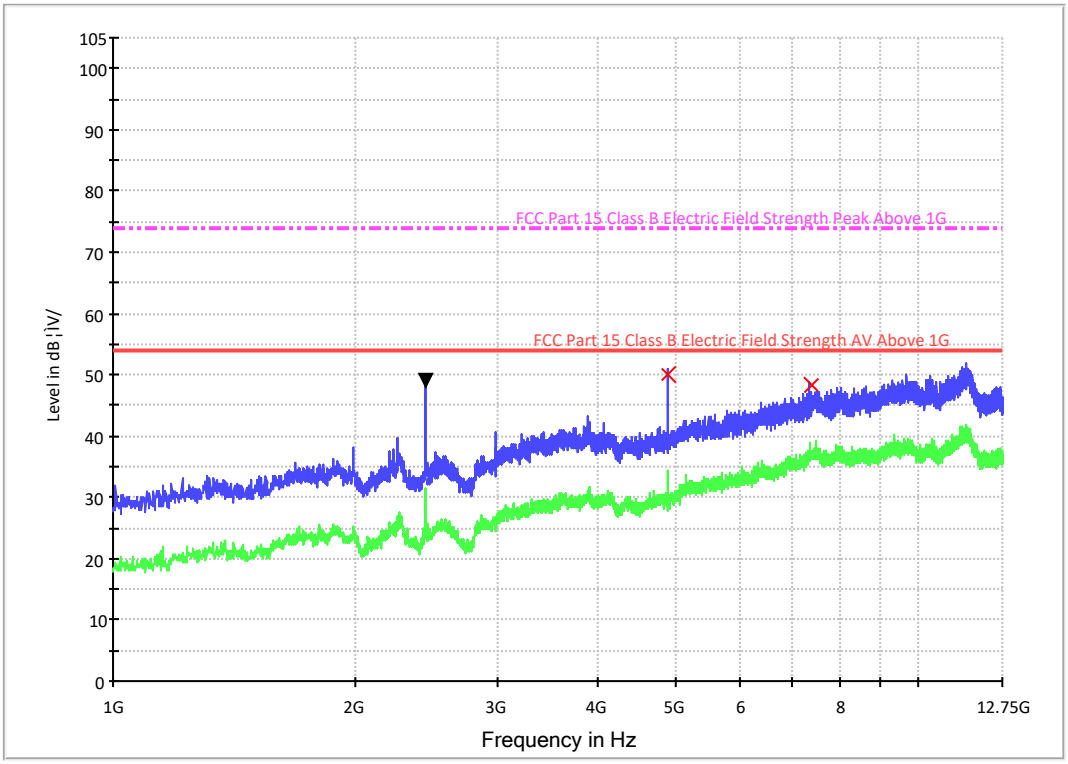
NOTES:
1. Peak detector is used for the emission measurement.
2. All measurements were made at 3 meters.
3. Negative value in the margin column shows emission below limit.
4. Horn antenna used for the emission over 1000MHz.

* 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: Microsoft Corporation
Date of Test: November 25, 2019
Model: 1919
Worst-case operating Mode: Transmit (2441MHz)
Worst-case modulation type: GFSK

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)
Horizontal	*4882.000	53.7	36.7	33.5	50.5	74.0	-23.5
Horizontal	*7323.000	46.1	36.1	37.2	47.2	74.0	-26.8

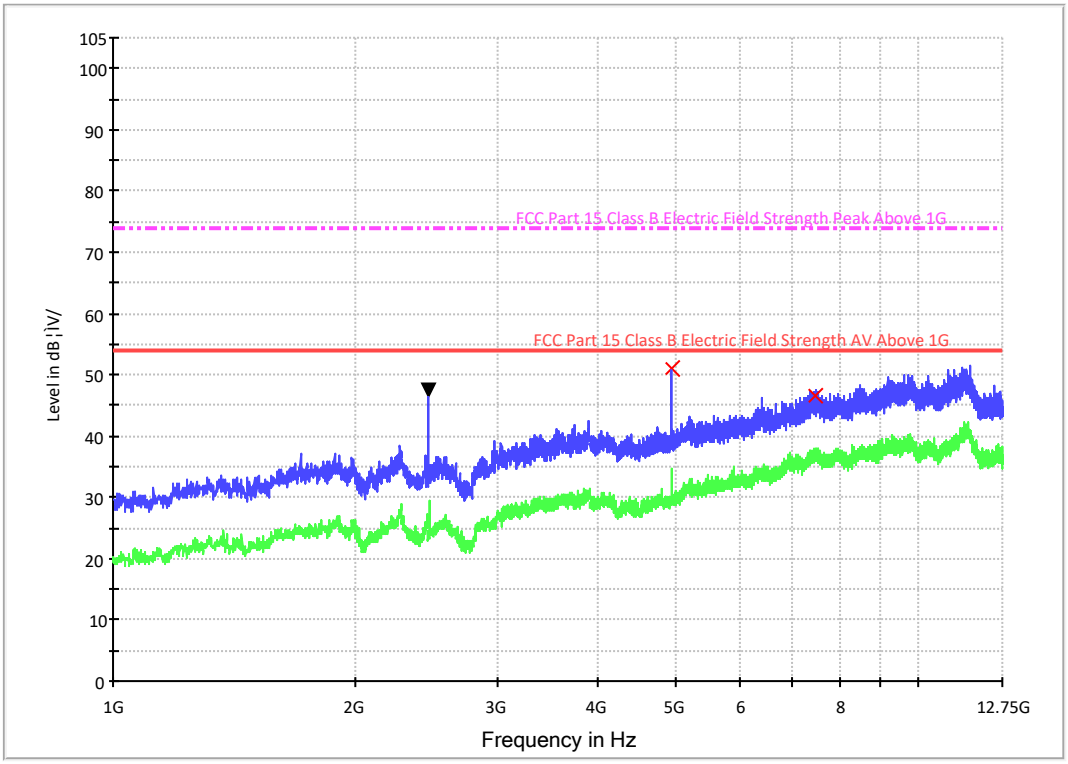
Polarization	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Average Factor (-dB)	Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	*4882.000	53.7	36.7	33.5	22.5	28.0	54.0	-26.0
Horizontal	*7323.000	46.1	36.1	37.2	22.5	24.7	54.0	-29.3

NOTES:
1. Peak detector is used for the emission measurement.
2. All measurements were made at 3 meters.
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: Microsoft Corporation
Date of Test: November 25, 2019
Model: 1919
Worst-case operating Mode: Transmit (2480MHz)
Worst-case modulation type: GFSK

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)
Horizontal	**2480.000	107.1	36.7	28.1	98.5	--	--
Horizontal	*4960.000	54.6	36.7	33.3	51.2	74.0	-22.8
Horizontal	*7440.000	45.7	36.1	36.7	46.3	74.0	-27.7

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)
Horizontal	**2480.000	107.1	36.7	28.1	22.5	76.0	--	--
Horizontal	*4960.000	54.6	36.7	33.3	22.5	28.7	54.0	-25.3
Horizontal	*7440.000	45.7	36.1	36.7	22.5	23.8	54.0	-30.2

NOTES:
1. Peak detector is used for the emission measurement.
2. All measurements were made at 3 meters.
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

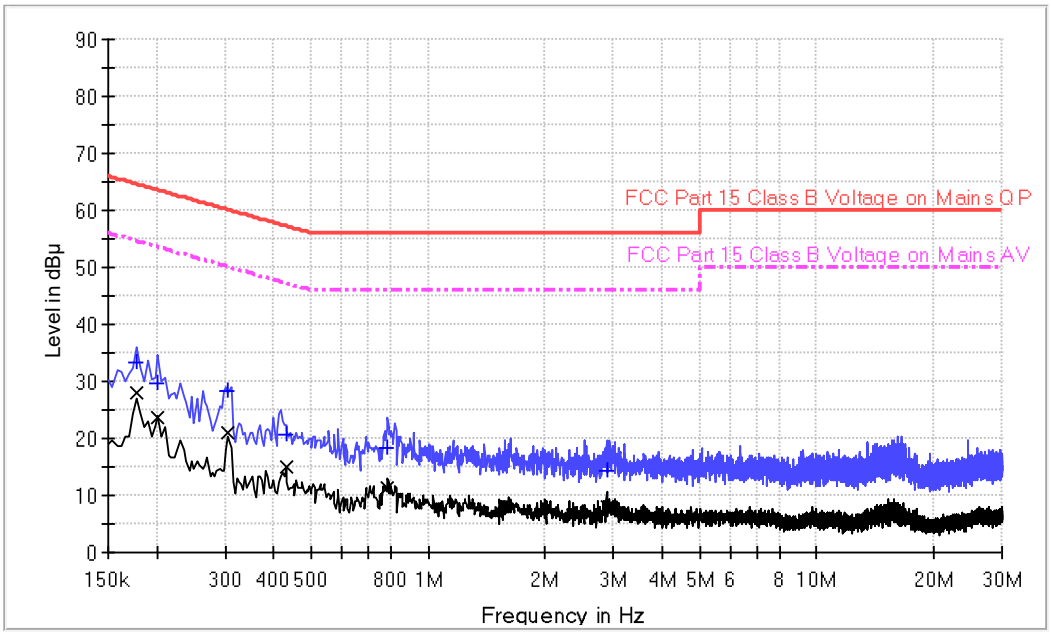
4.2.1 Conducted Emissions Configuration Photograph

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

4.2.2 Conducted Emissions

Applicant: Microsoft Corporation
Date of Test: December 20, 2019
Model: 1919
Worst Case Operating Mode: BT Link
Phase: Live

Conducted Emission Test



Result Table QP

Frequency (MHz)	QuasiPeak (dBµV)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.178000	33.5	L	9.6	-31.1	64.6
0.202000	29.7	L	9.7	-33.8	63.5
0.306000	28.2	L	9.7	-31.9	60.1
0.430000	20.6	L	9.7	-36.7	57.3
0.786000	18.2	L	9.7	-37.8	56.0
2.878000	14.3	L	10.1	-41.7	56.0

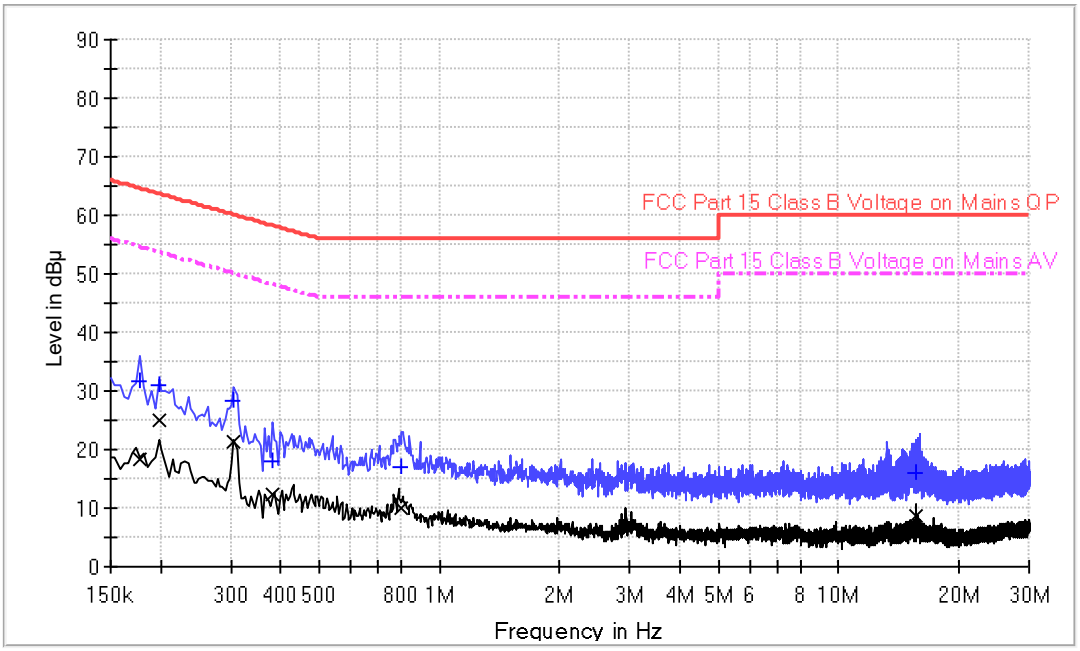
Result Table AV

Frequency (MHz)	Average (dBµV)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.178000	28.1	L	9.6	-26.5	54.6
0.202000	23.6	L	9.7	-29.9	53.5
0.306000	21.1	L	9.7	-29.0	50.1
0.430000	15.1	L	9.7	-32.2	47.3
0.786000	11.3	L	9.7	-34.7	46.0
2.878000	8.1	L	10.1	-37.9	46.0

Remark:
1. Corr. Factor (dB) = LISN Factor (dB) + Cable Loss (dB)
2. Margin (dB) = Level (dBµV) – Limit (dBµV)

Applicant: Microsoft Corporation
Date of Test: December 20, 2019
Model: 1919
Worst Case Operating Mode: BT Link
Phase: Neutral

Conducted Emission Test



Result Table QP

Frequency (MHz)	QuasiPeak (dBµV)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.178000	31.7	N	9.7	-32.9	64.6
0.198000	30.9	N	9.7	-32.8	63.7
0.306000	28.4	N	9.7	-31.7	60.1
0.382000	18.1	N	9.7	-40.1	58.2
0.806000	16.9	N	9.7	-39.1	56.0
15.646000	16.1	N	10.2	-43.9	60.0

Result Table AV

Frequency (MHz)	Average (dBµV)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.178000	18.2	N	9.7	-36.4	54.6
0.198000	25.0	N	9.7	-28.7	53.7
0.306000	21.2	N	9.7	-28.9	50.1
0.382000	12.2	N	9.7	-36.0	48.2
0.806000	9.9	N	9.7	-36.1	46.0
15.646000	8.7	N	10.2	-41.3	50.0

Remark:
1. Corr. Factor (dB) = LISN Factor (dB) + Cable Loss (dB)
2. Margin (dB) = Level (dBµV) – Limit (dBµV)

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.

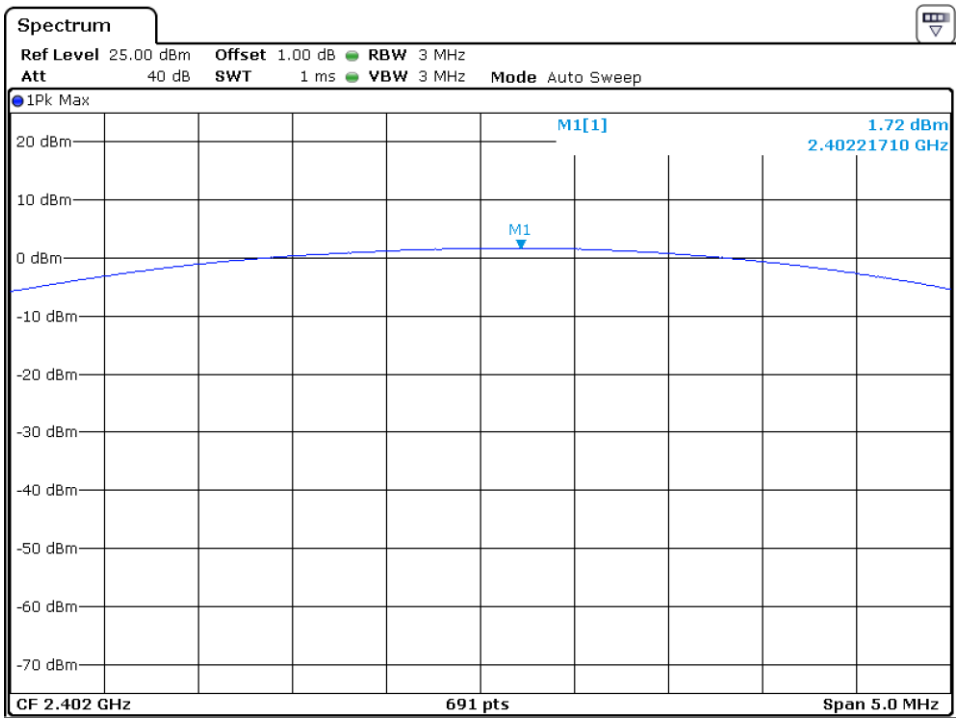
For antenna with gains of 6dBi or less, and frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, the systems operate with an output power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

Antenna Gain = 2.5 dBi			
Modulation Type	Frequency (MHz)	Output Power (Peak Reading) (dBm)	Output Power (mW)
GFSK	2402	1.72	1.486
	2441	3.82	2.410
	2480	3.52	2.249

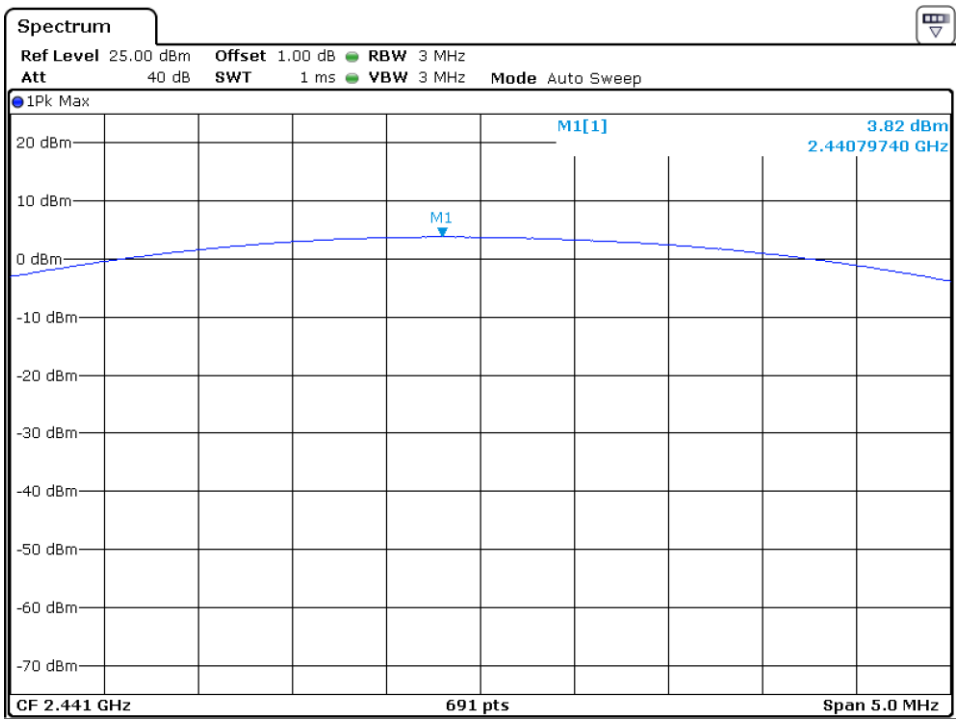
Cable loss, external attenuation has been included in OFFSET function.

Test Date: 30 December 2019
Worst Case Modulation Type: GFSK

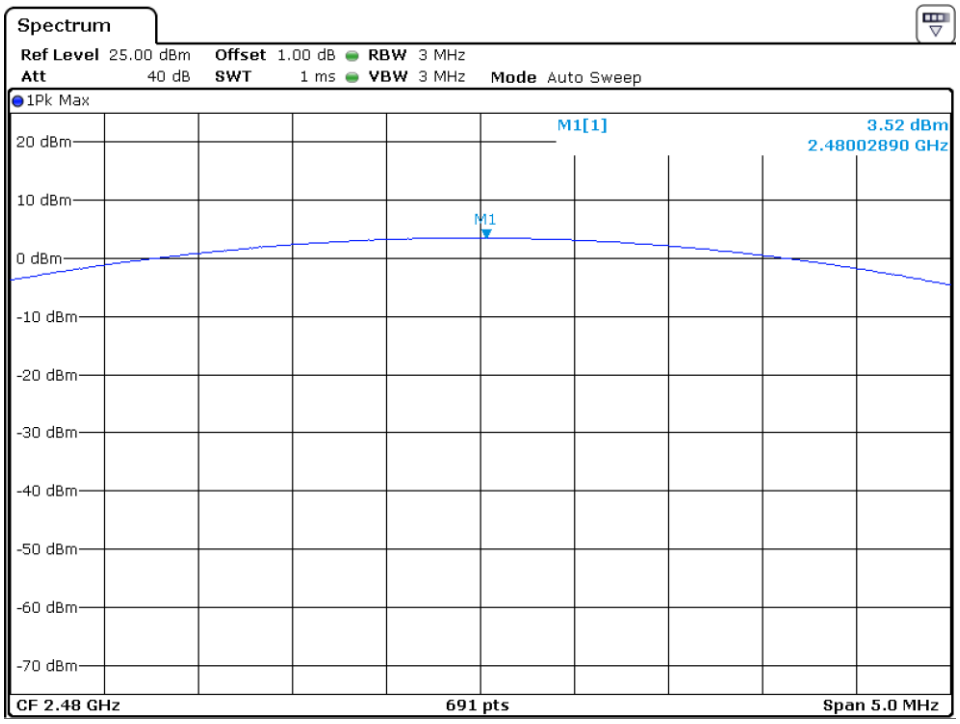
CH00



CH39



CH78


Spectrum
Ref Level 25.00 dBm Offset 1.00 dB RBW 3 MHz
Att 40 dB SWT 1 ms VBW 3 MHz Mode Auto Sweep
1Pk Max
M1[1] 3.52 dBm
2.48002890 GHz
M1
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
CF 2.48 GHz
691 pts
Span 5.0 MHz

4.4 20dB Bandwidth

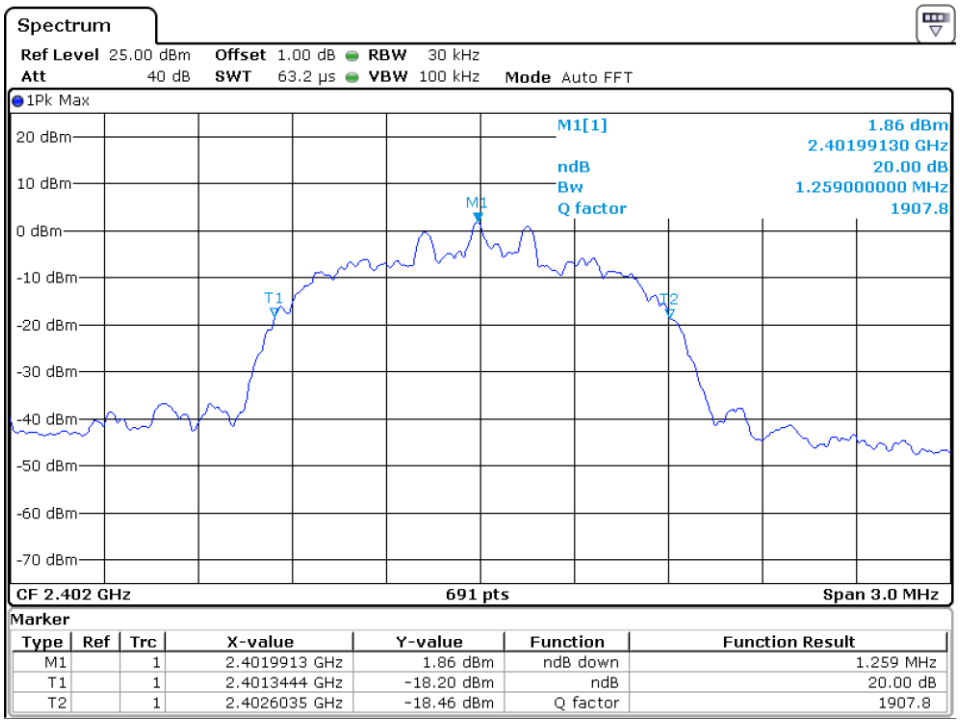
Maximum 20dB RF Bandwidth, FCC Rule 15.247(a) (1):

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.

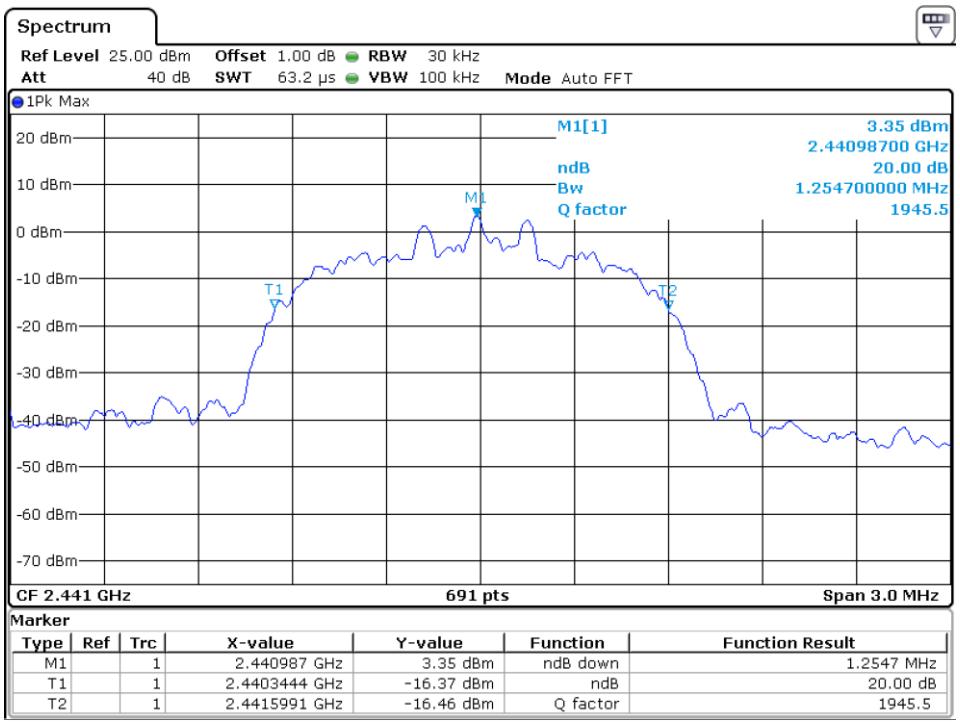
Frequency (MHz)	20 dB Bandwidth (MHz)
2402	1.259
2441	1.255
2480	1.255

Test Date: 30 December 2019
Worst Case Modulation Type: 8DPSK

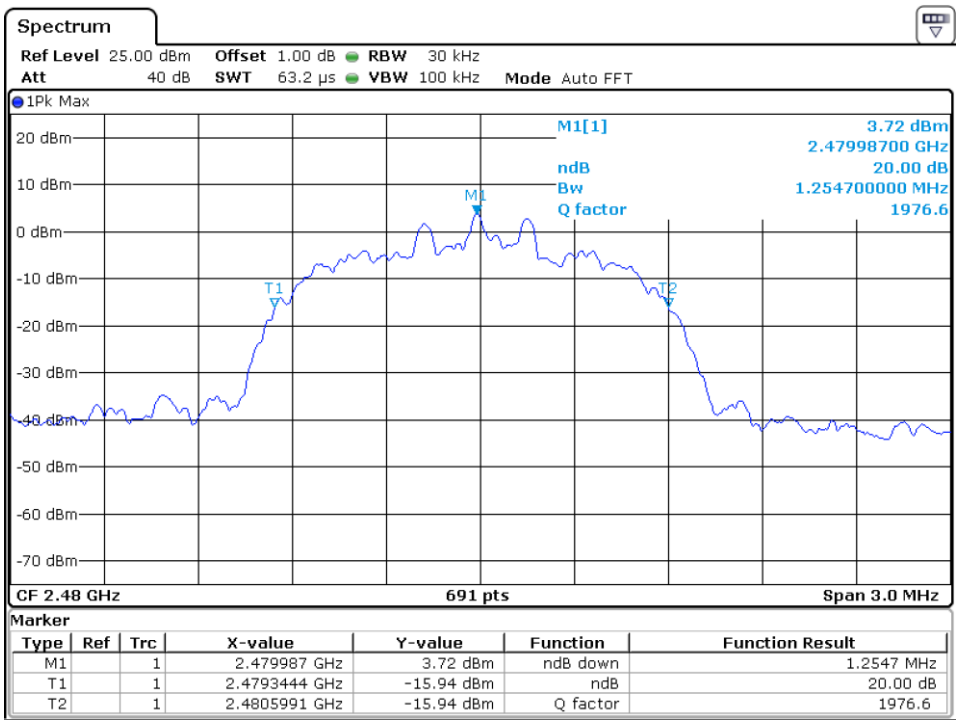
CH00



CH39


Spectrum
Ref Level 25.00 dBm Offset 1.00 dB RBW 30 kHz
Att 40 dB SWT 63.2 µs VBW 100 kHz Mode Auto FFT
1Pk Max
M1[1] 3.35 dBm
2.44098700 GHz
ndB 20.00 dB
Bw 1.254700000 MHz
Q factor 1945.5
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
T1
T2
CF 2.441 GHz
691 pts
Span 3.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.440987 GHz 3.35 dBm ndB down 1.2547 MHz
T1 1 2.4403444 GHz -16.37 dBm ndB 20.00 dB
T2 1 2.4415991 GHz -16.46 dBm Q factor 1945.5

CH78


Spectrum
Ref Level 25.00 dBm Offset 1.00 dB RBW 30 kHz
Att 40 dB SWT 63.2 µs VBW 100 kHz Mode Auto FFT
1Pk Max
M1[1] 3.72 dBm
2.47998700 GHz
ndB 20.00 dB
Bw 1.254700000 MHz
Q factor 1976.6
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
T1
T2
CF 2.48 GHz
691 pts
Span 3.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 2.479987 GHz 3.72 dBm ndB down 1.2547 MHz
T1 1 2.4793444 GHz -15.94 dBm ndB 20.00 dB
T2 1 2.4805991 GHz -15.94 dBm Q factor 1976.6

4.5 Channel Number (Number of Hopping Frequencies)

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

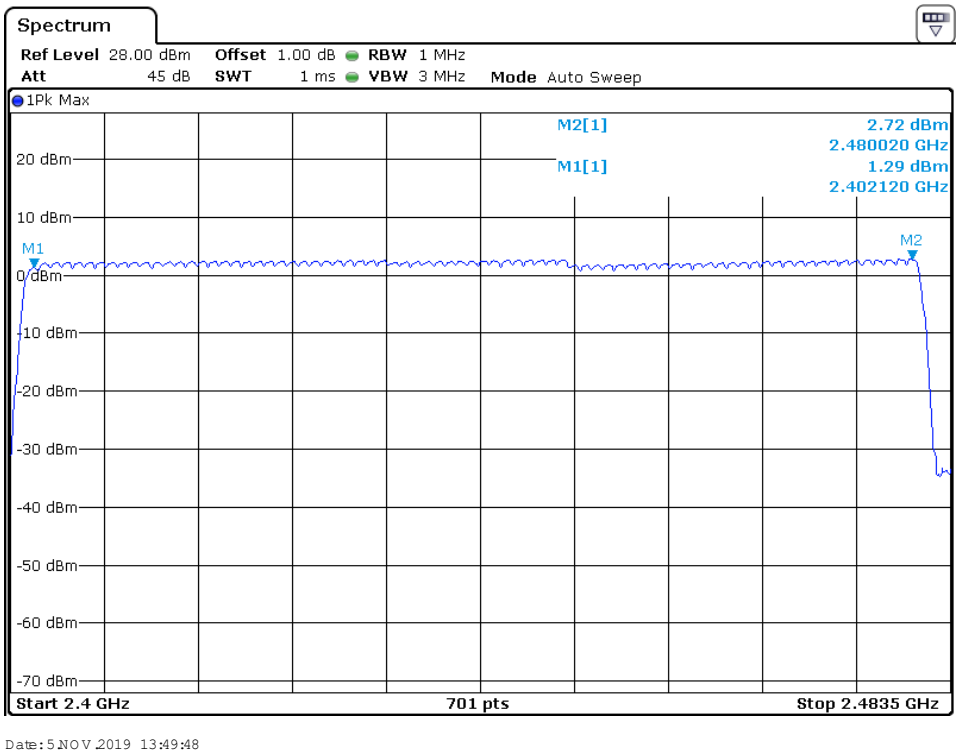
The RF passband of the EUT was divided into 3 approximately equal bands. With the analyzer set to MAX HOLD readings were taken for 2-3 minutes. The channel peaks so recorded were added together, and the total number compared to the minimum number of channels required in the regulation.

Number of hopping channels =	79

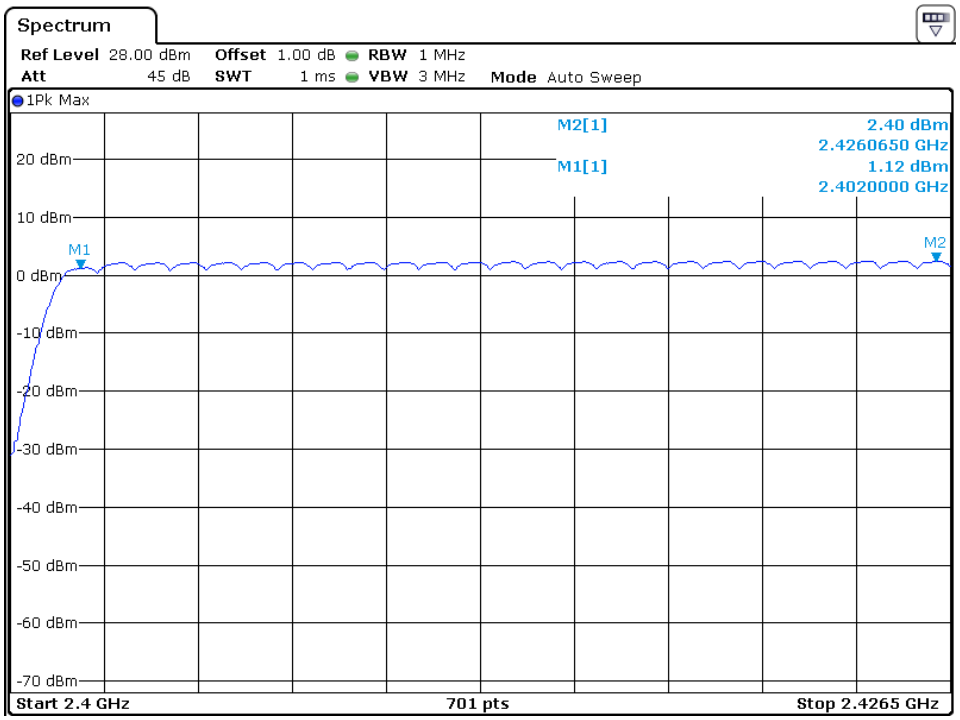
Note: In AFH mode, this device operates using 20 channels and it's satisfied the requirement of limit of minimum of 15 hopping channels.

Worst Case Modulation Type: GFSK

CH00-CH78

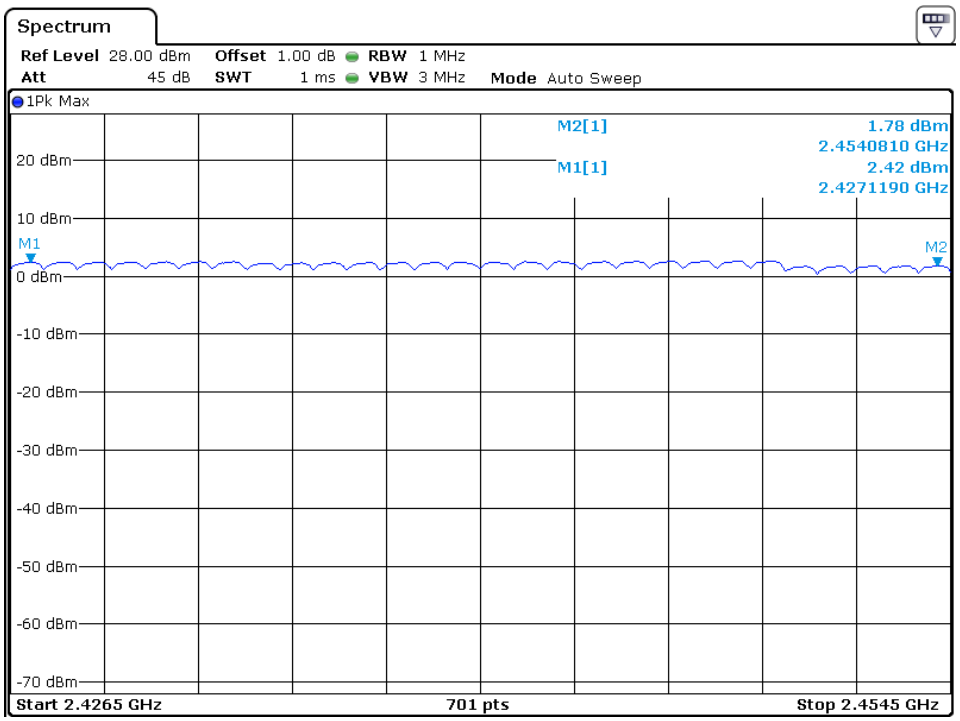


CH00-CH24



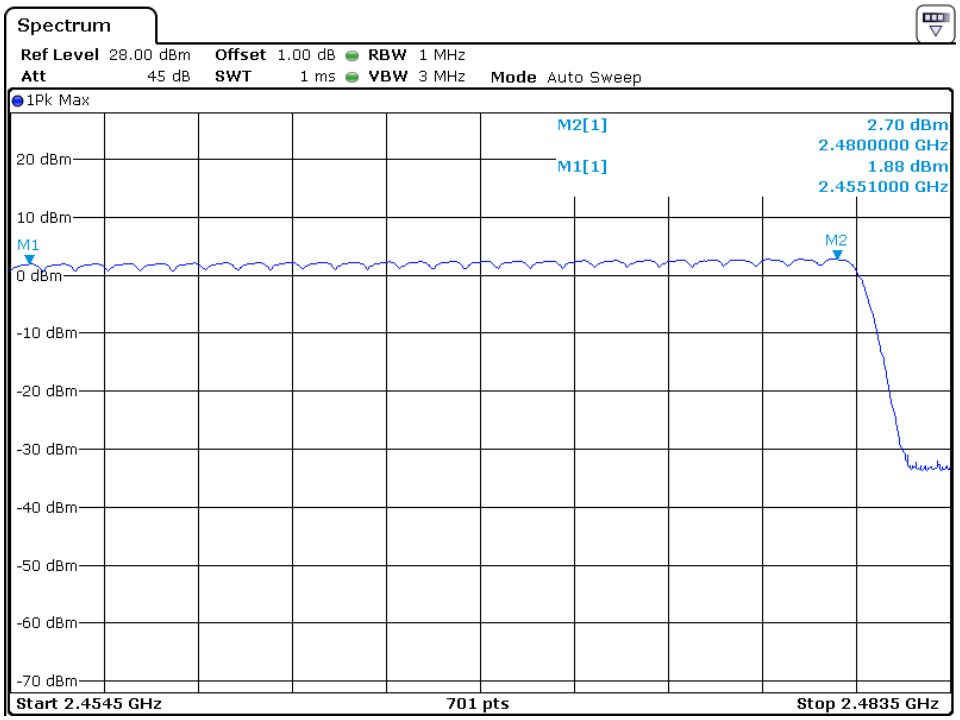
Date: 5.NOV.2019 13:48:26

CH25-CH52



Date: 5.NOV.2019 13:47:24

CH53-CH78


Spectrum
Ref Level 28.00 dBm Offset 1.00 dB RBW 1 MHz
Att 45 dB SWT 1 ms VBW 3 MHz Mode Auto Sweep
1Pk Max
M2[1] 2.70 dBm
2.4800000 GHz
M1[1] 1.88 dBm
2.4551000 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
701 pts
Stop 2.4835 GHz
Date: 5.NOV.2019 13:46:26

4.6 Channel Separation (Carrier Frequency Separation)

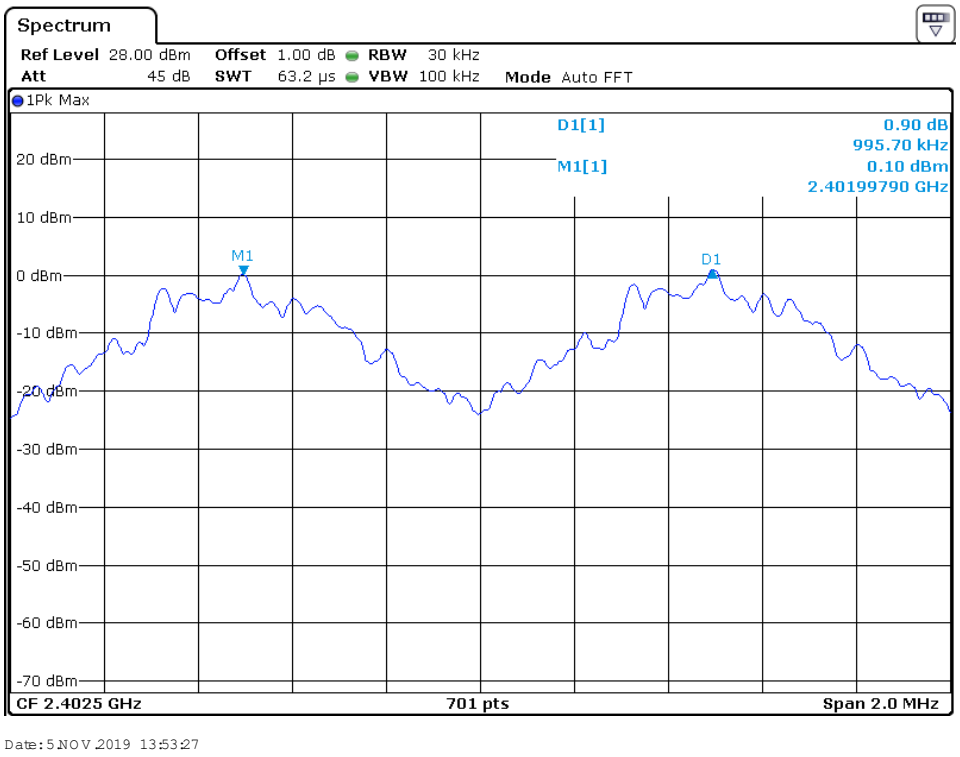
Minimum Hopping Channel Carrier Frequency Separation, FCC Ref: 15.247(a)(1):

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

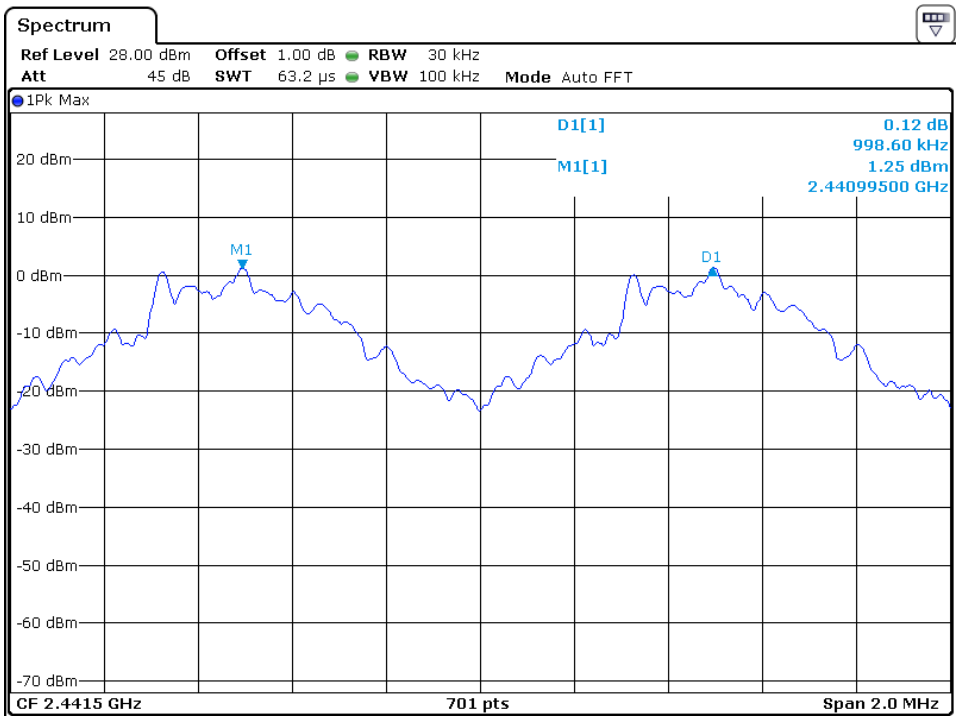
Not less than 2/3 of 20dB bandwidth of hopping channel: 1.372 x 2/3 = 0.915MHz

Minimum Channel Separation	0.9957 MHz

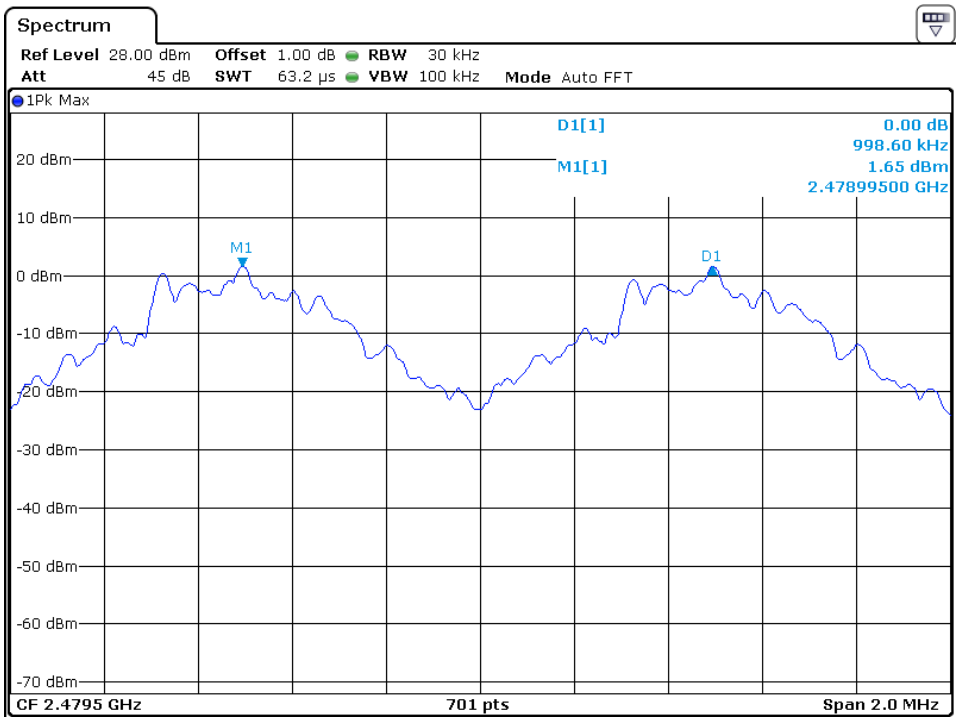
Low Channel



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.

Worst Test Result:

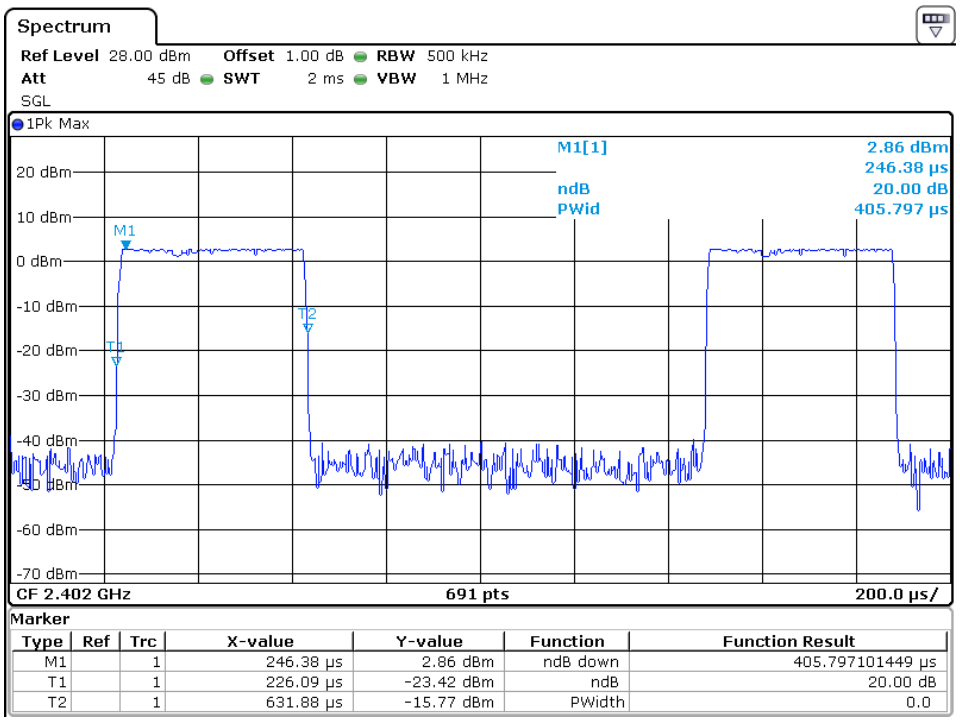
Normal hopping mode

Modulation Type	Packet	Max Dwell Time	Limit (s)	Result
GFSK	DH1	0.406ms * 321 = 130.326ms	0.4	Pass
	DH3	1.661ms * 162 = 269.082ms	0.4	Pass
	DH5	2.913ms * 108 = 314.604ms	0.4	Pass

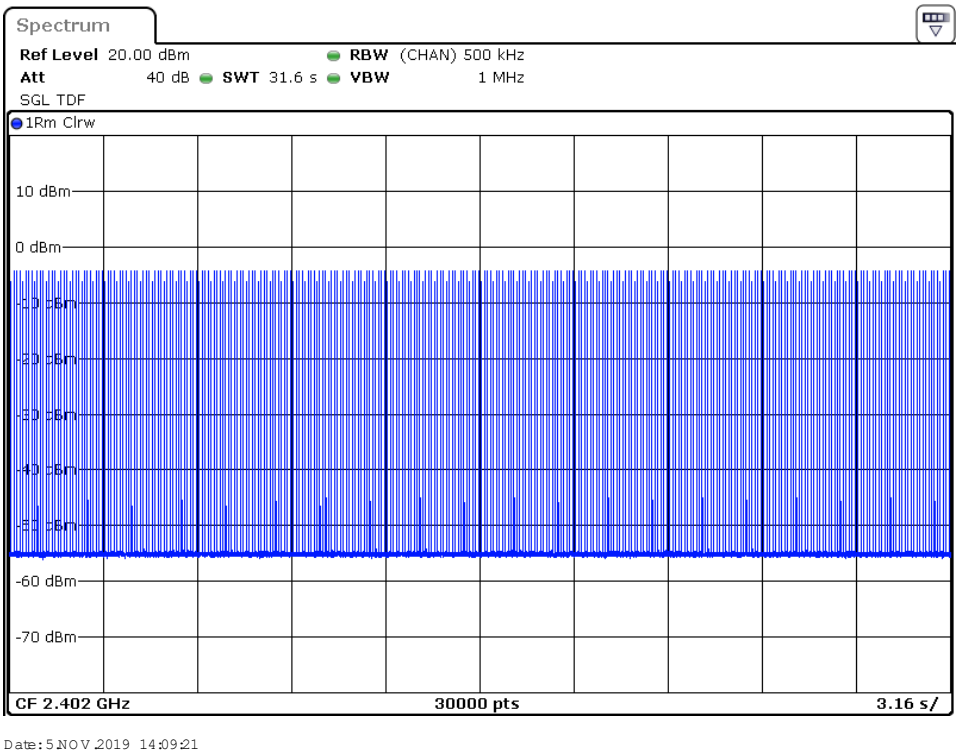
AFH mode:

Modulation Type	Packet	Max Dwell Time	Limit (s)	Result
GFSK	DH1	0.406ms * 85 = 34.51ms	0.4	Pass
	DH3	1.661ms * 42 = 69.762ms	0.4	Pass
	DH5	2.913ms * 32= 87.39ms	0.4	Pass

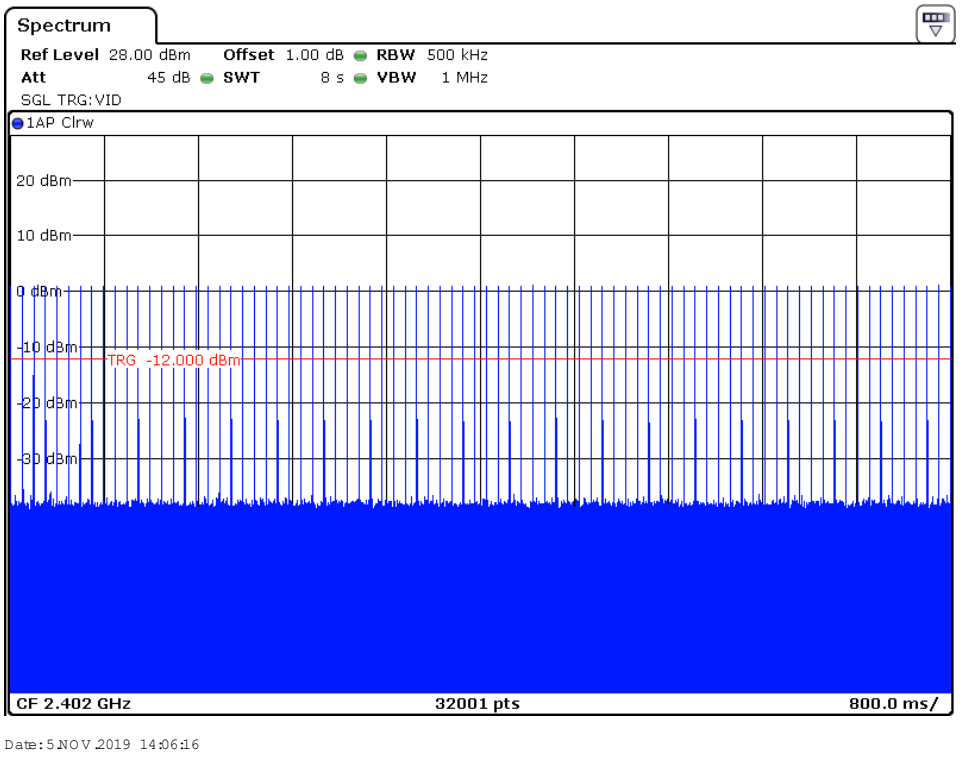
Modulation Type: GFSK
Packet: DH1



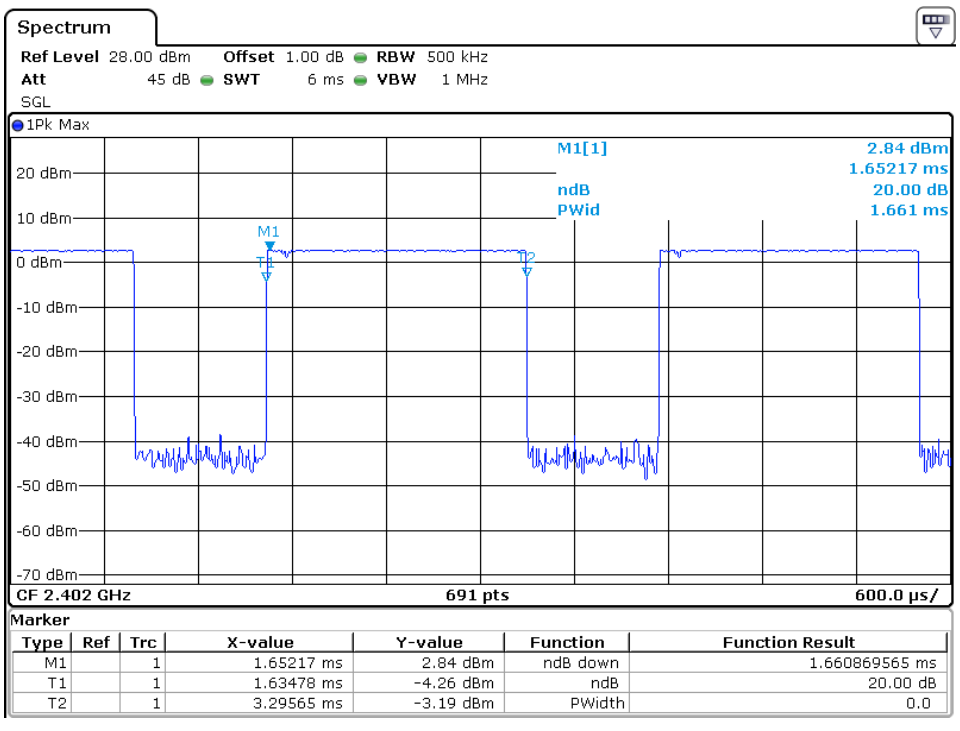
Number of hops (Normal hopping mode)



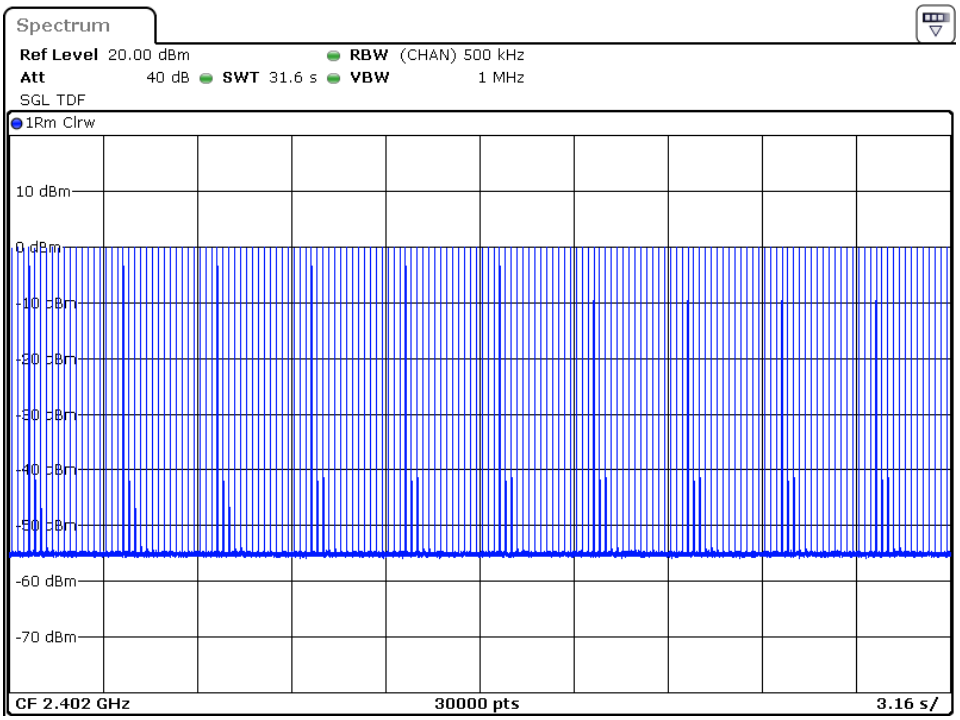
Number of hops (AFH mode)



Packet: DH3

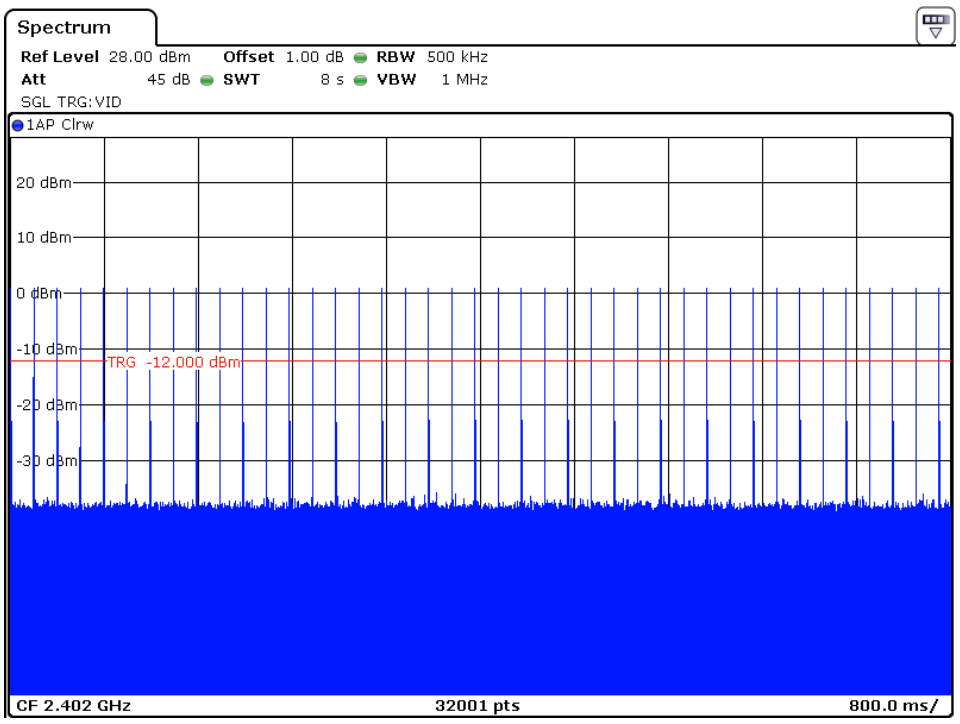


Number of hops (Normal hopping mode)



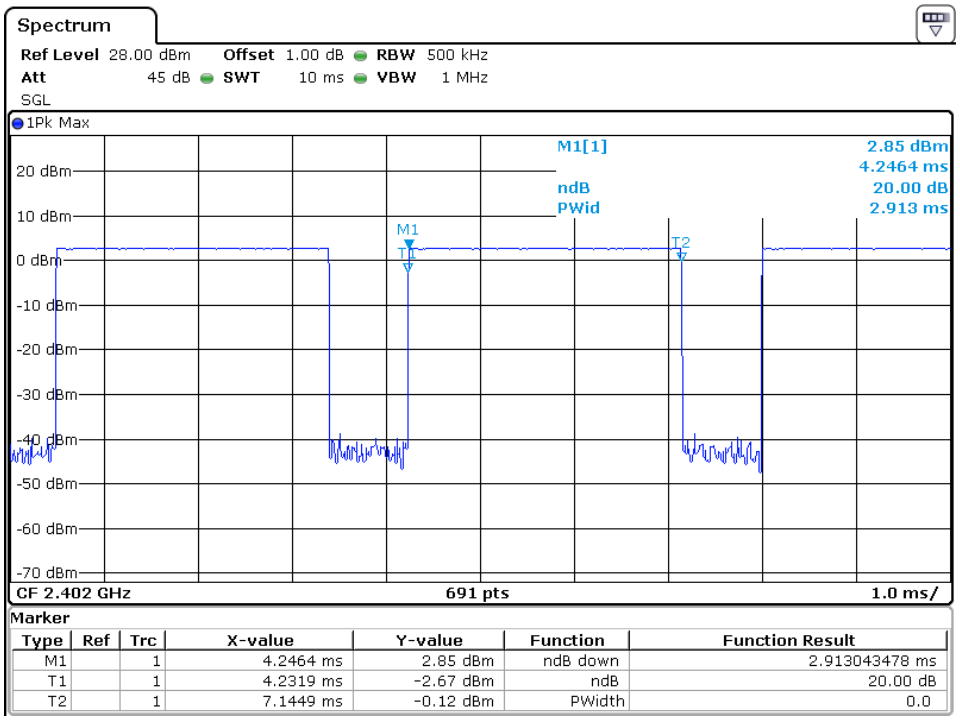
Date: 5.NOV.2019 14:16:05

Number of hops (AFH mode)

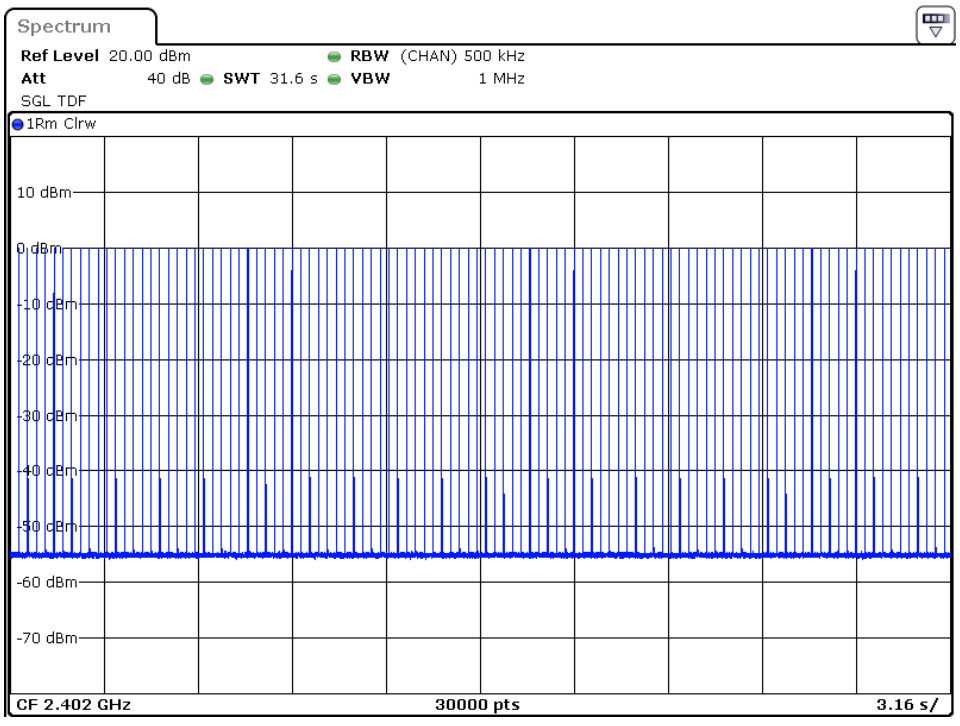


Date: 5.NOV.2019 14:05:31

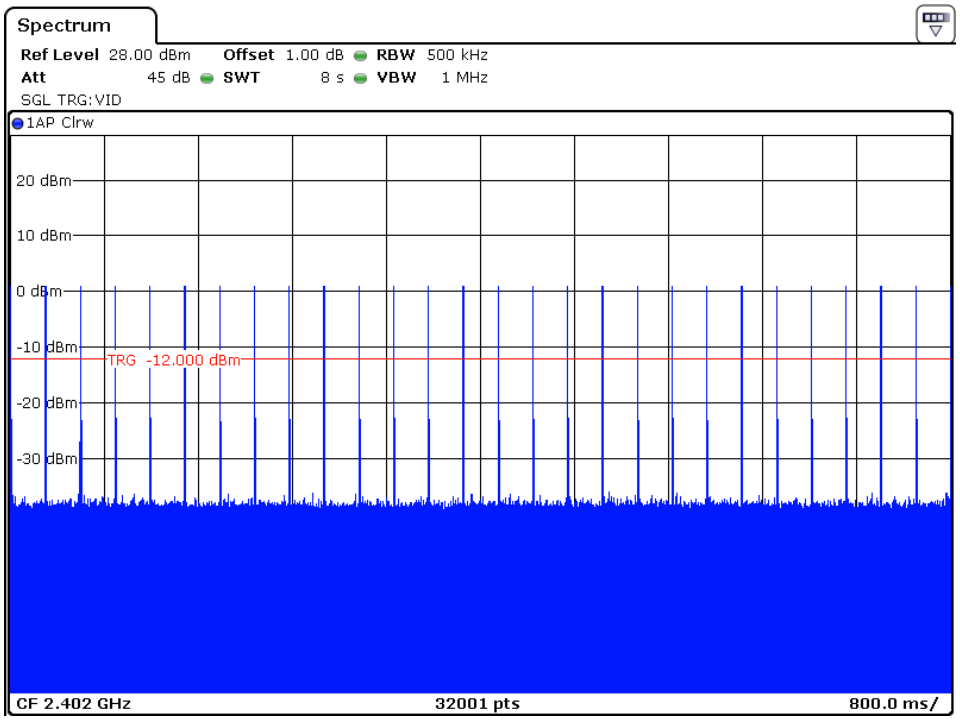
Packet: DH5



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.

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
= 98.8dBµv/m-37.97dB
= 60.83dBµv/m

Average Resultant field strength = Fundamental emissions (Average value) – delta from the bandedge plot
= 76.3dBµv/m-37.97dB
= 38.33dBµv/m

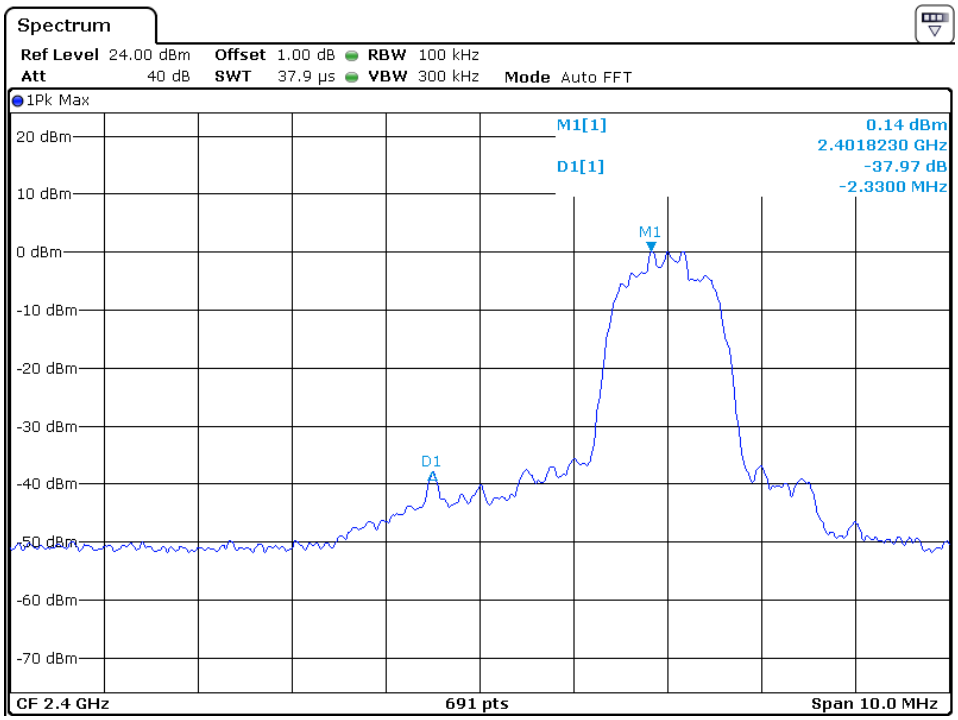
(ii) Upper channel 2480MHz:

Peak Resultant field strength = Fundamental emissions (peak value) – delta from the bandedge plot
= 98.5dBµv/m-49.73dB
= 48.77dBµv/m

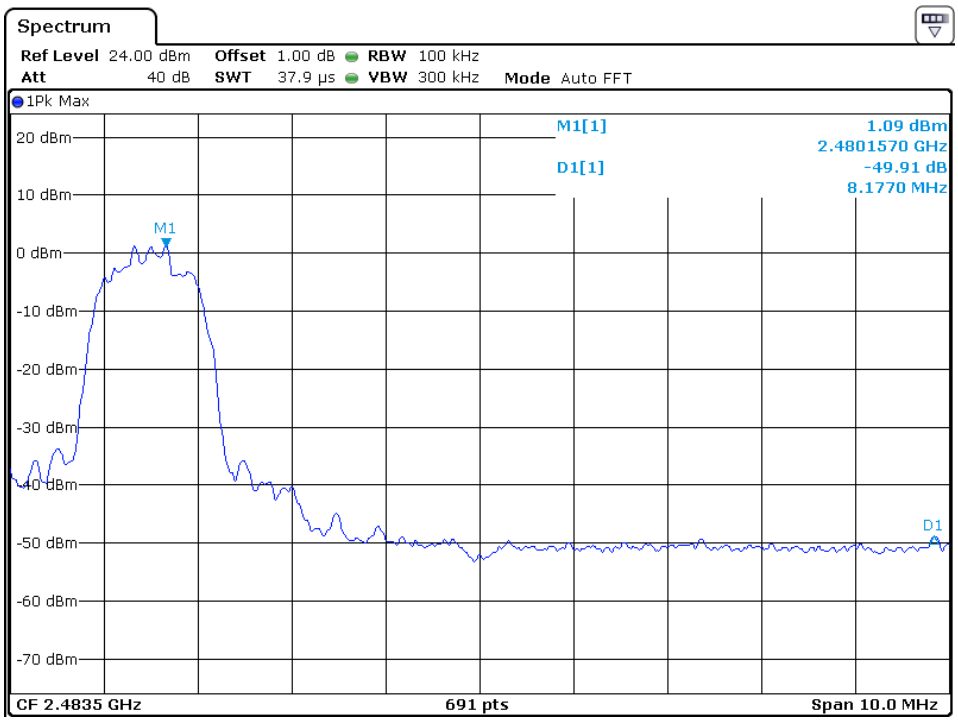
Average Resultant field strength = Fundamental emissions (Average value) – delta from the bandedge plot
= 76.0dBµv/m-49.73dB
= 26.27dBµv/m

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).

Worst Case Modulation Type: 8DPSK
Hopping function off:

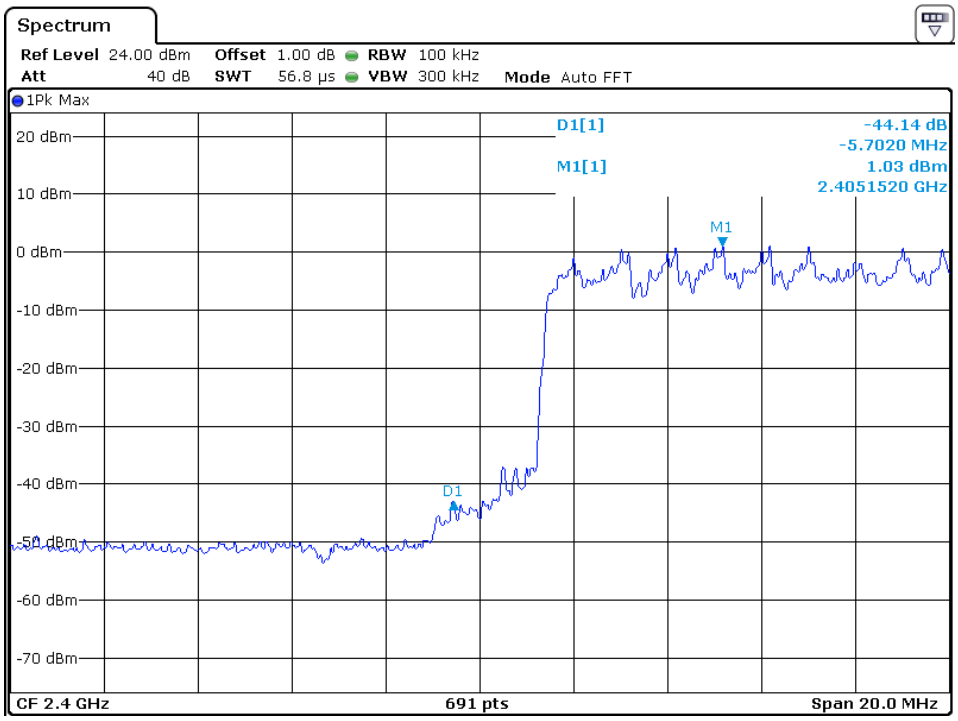


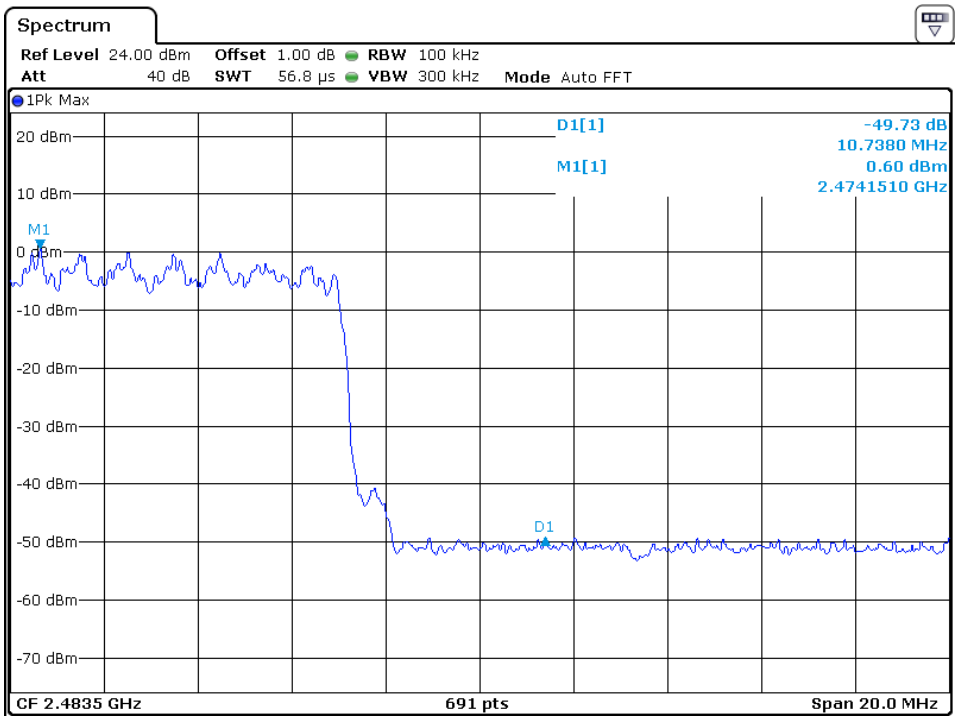
Date: 29.SEP.2019 16:36:54



Date: 29.SEP.2019 16:39:07

Hopping function on:





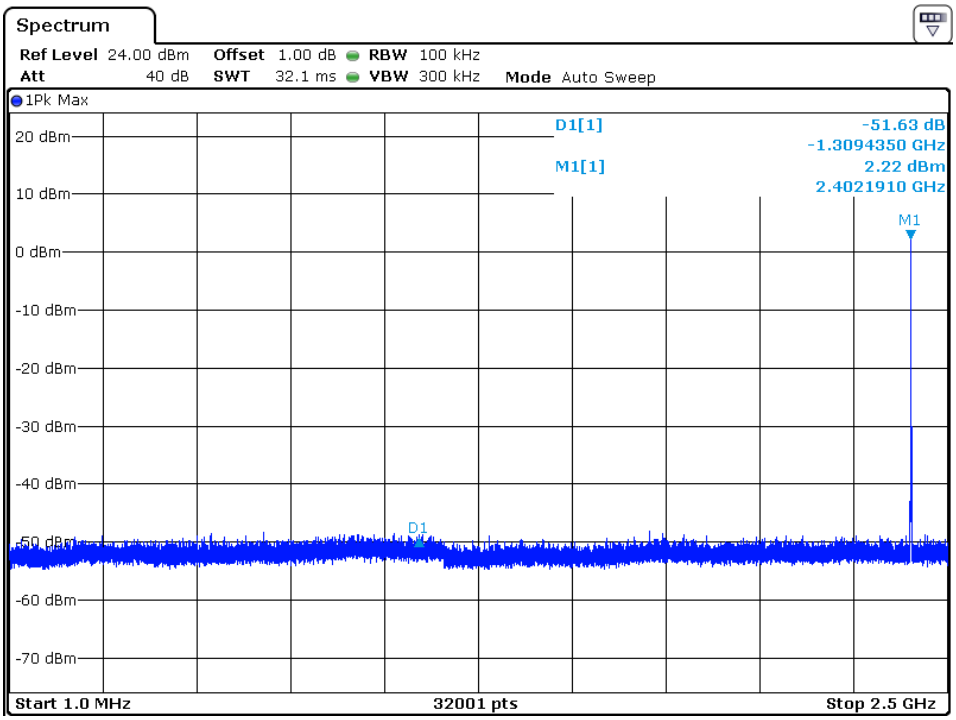
4.9 Transmitter Spurious Emissions (Conducted)

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

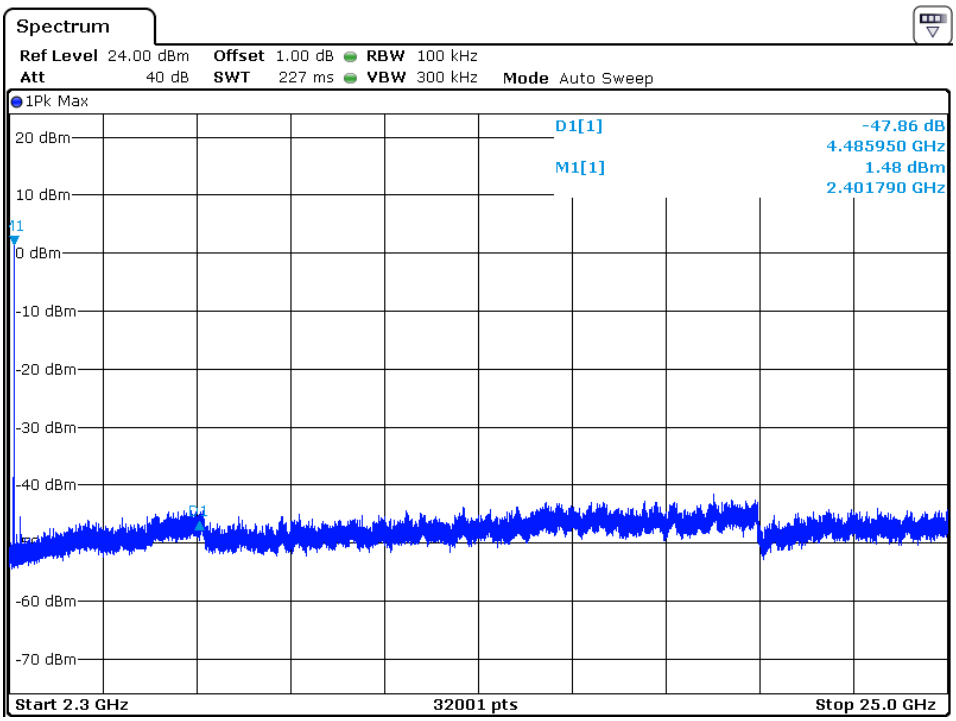
All spurious emission and up to the tenth harmonic was measured and they were found to be at least 20 dB below the highest level of the desired power in the passband.

Modulation Type: GFSK

CH00

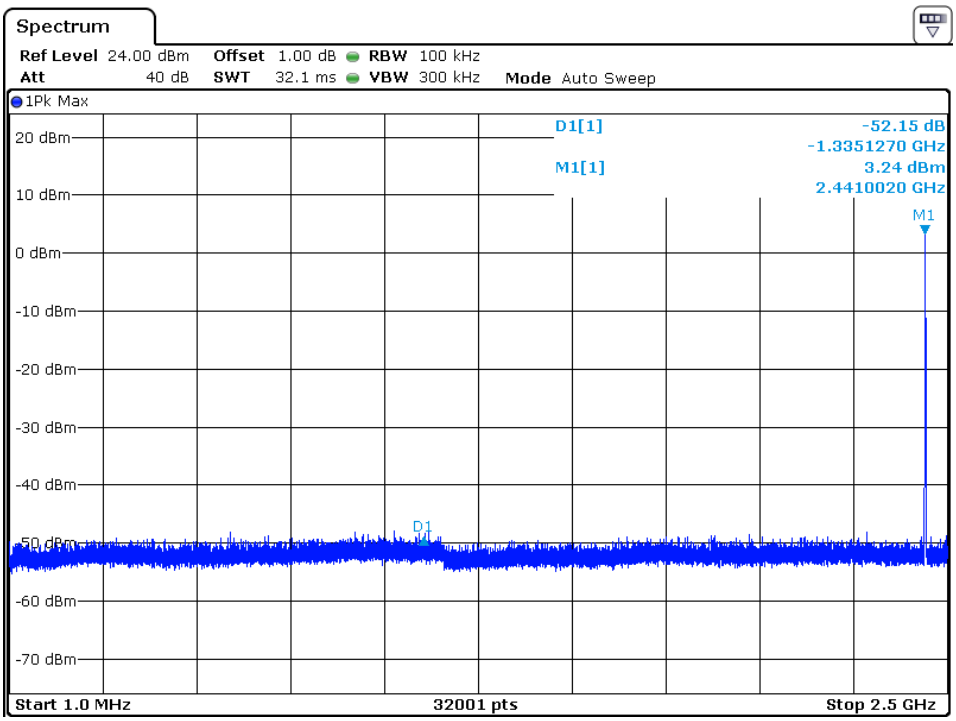


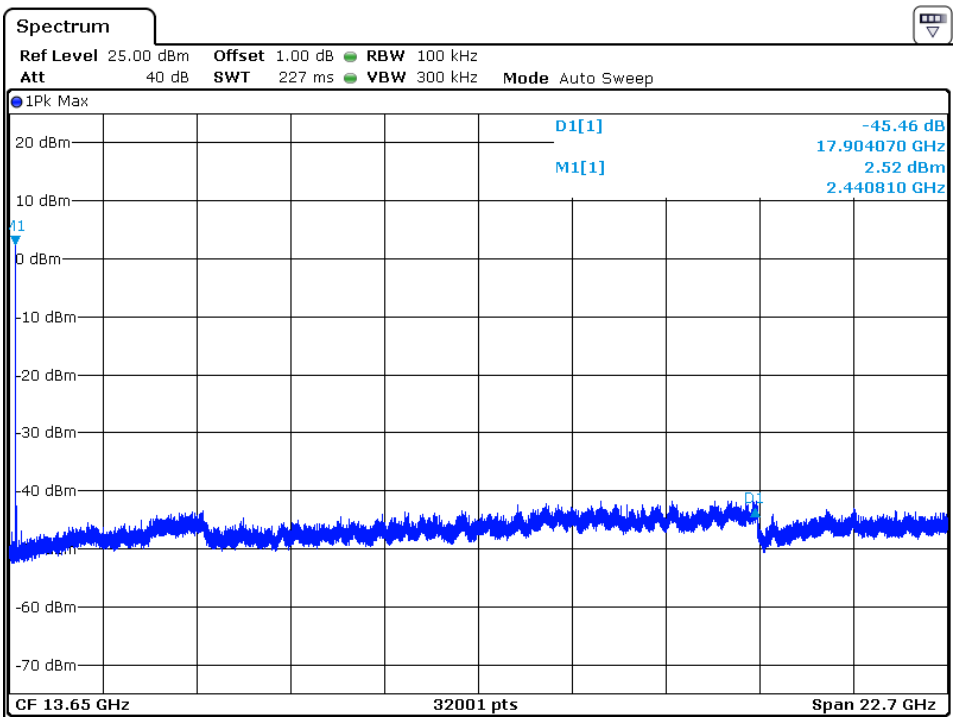
Date: 5.NOV.2019 15:32:16



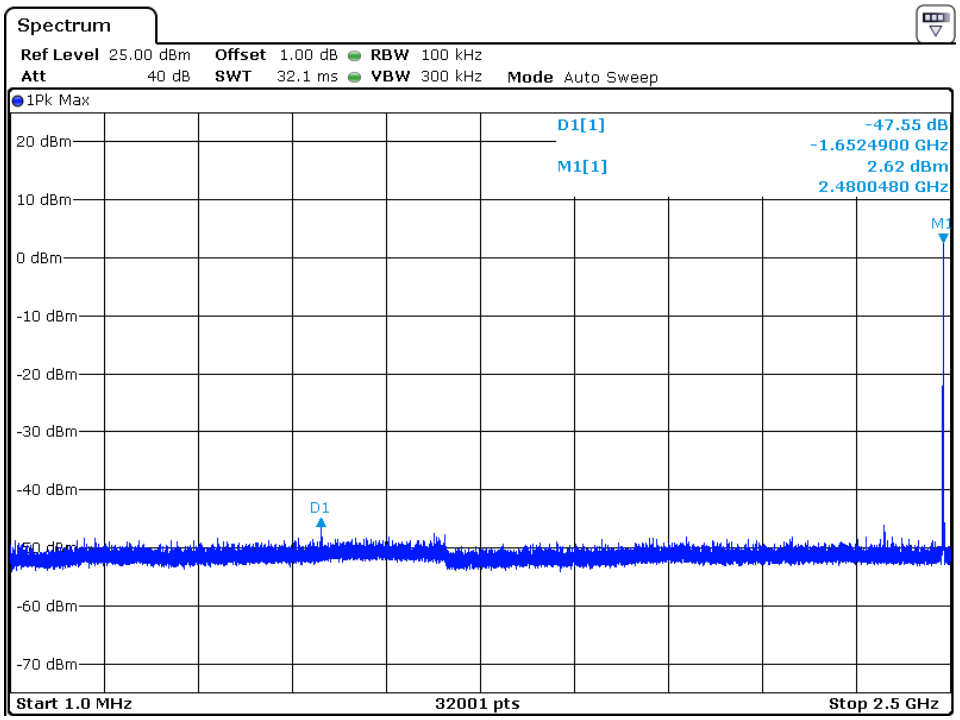
Date: 5.NOV.2019 15:34:38

CH39

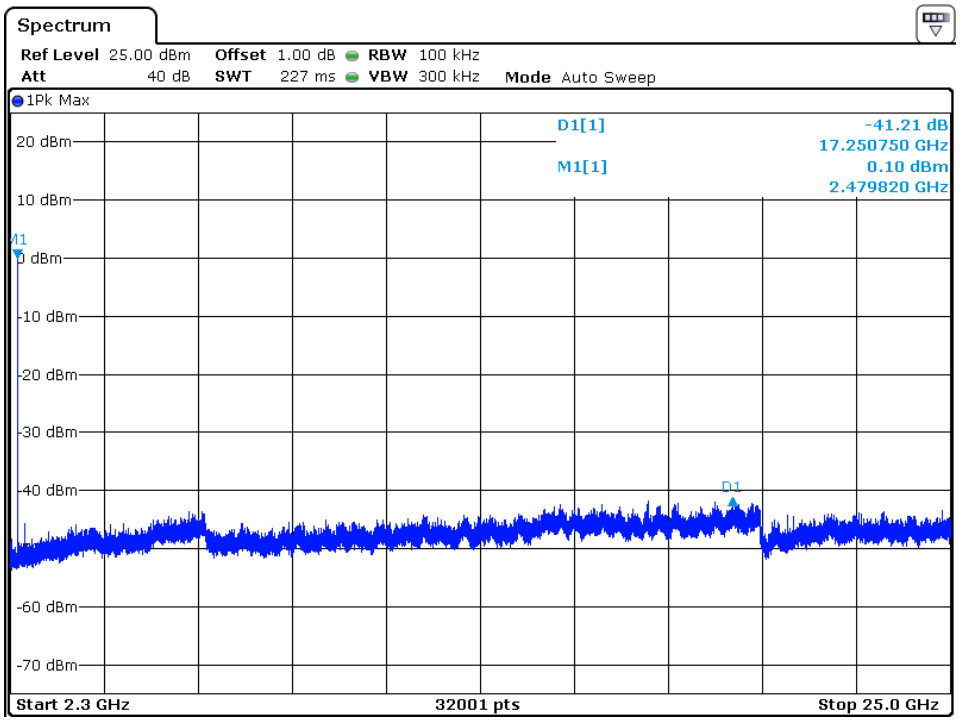

Spectrum
Ref Level 24.00 dBm Offset 1.00 dB RBW 100 kHz
Att 40 dB SWT 32.1 ms VBW 300 kHz Mode Auto Sweep
1Pk Max
D1[1] -52.15 dB
-1.3351270 GHz
M1[1] 3.24 dBm
2.4410020 GHz
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
Start 1.0 MHz
32001 pts
Stop 2.5 GHz
Date: 5.NOV.2019 15:29:51


Spectrum
Ref Level 25.00 dBm Offset 1.00 dB RBW 100 kHz
Att 40 dB SWT 227 ms VBW 300 kHz Mode Auto Sweep
1Pk Max
D1[1] -45.46 dB
17.904070 GHz
M1[1] 2.52 dBm
2.440810 GHz
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-60 dBm
-70 dBm
CF 13.65 GHz
32001 pts
Span 22.7 GHz
Date: 5.NOV.2019 15:16:32

CH78



Date: 5.NOV.2019 15:00:41



Date: 5.NOV.2019 15:02:16

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 (without BLE) 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
SZ061-12	BiConiLog Antenna	ETS	3142E	00166158	14-Sep-2018	14-Sep-2020
SZ185-01	EMI Receiver	R&S	ESCI	100547	04-Jan-2019	04-Jan-2020
SZ061-08	Horn Antenna	ETS	3115	00092346	24-Aug-2019	24-Aug-2021
SZ061-06	Active Loop Antenna	Electro-Metrics	EM-6876	217	24-May-2019	24-May-2020
SZ056-03	Spectrum Analyzer	R&S	FSP 30	101148	28-May-2019	28-May-2020
SZ056-06	Signal Analyzer	R&S	FSV 40	101101	28-May-2019	28-May-2020
SZ181-04	Preamplifier	Agilent	8449B	3008A02474	05-Jul-2019	05-Jul-2020
SZ188-01	Anechoic Chamber	ETS	RFD-F/A-100	4102	15-Dec-2018	15-Dec-2020
SZ062-02	RF Cable	RADIALL	RG 213U	--	10-Jun-2019	10-Jun-2020
SZ062-05	RF Cable	RADIALL	0.04-26.5GHz	--	10-Jun-2019	10-Jun-2020
SZ062-12	RF Cable	RADIALL	0.04-26.5GHz	--	10-Jun-2019	10-Jun-2020
SZ067-04	Notch Filter	Micro-Tronics	BRM50702-02	--	05-Jun-2018	05-Jun-2020
SZ185-02	EMI Test Receiver	R&S	ESCI	100692	29-Oct-2019	29-Oct-2020
SZ187-02	Two-Line V-Network	R&S	ENV216	100073	28-May-2019	29-May-2020
SZ188-03	Shielding Room	ETS	RFD-100	4100	16-Jan-2017	16-Jan-2020

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