

Report on the FCC and IC Testing of the: Apple Inc. Model: A1993

In accordance with FCC 47 CFR Part 15C and Industry Canada RSS-247 / RSS-GEN

Prepared for: Apple Inc.
One Apple Park Way
Cupertino
California 95014
USA

FCC ID: BCGA1993

IC: 579C-A1993



Product Service

**Choose certainty.
Add value.**

COMMERCIAL-IN-CONFIDENCE

Document Number: 75942779-11 | Issue: 02

SIGNATURE

NAME	JOB TITLE	RESPONSIBLE FOR	ISSUE DATE
Simon Bennett	Chief Engineer	Authorised Signatory	09 October 2018

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service document control rules.

ENGINEERING STATEMENT

The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 15C and Industry Canada RSS-247 and Industry Canada RSS-GEN. The sample tested was found to comply with the requirements defined in the applied rules.

SIGNATURE

NAME	JOB TITLE	RESPONSIBLE FOR	ISSUE DATE
Mehadi Choudhury	Test Engineer	Testing	09 October 2018

FCC Accreditation

90987 Octagon House, Fareham Test Laboratory

Industry Canada Accreditation

IC2932B-1 Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15C: 2017, Industry Canada RSS-247: Issue 2 (2017-02) and Industry Canada RSS-GEN: Issue 5 (2018-04) for the tests detailed in section 1.3.



DISCLAIMER AND COPYRIGHT

This non-binding report has been prepared by TÜV SÜD Product Service with all reasonable skill and care. The document is confidential to the potential Client and TÜV SÜD Product Service. No part of this document may be reproduced without the prior written approval of TÜV SÜD Product Service. © 2018 TÜV SÜD Product Service.

ACCREDITATION

Our UKAS Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our UKAS Accreditation. Results of tests not covered by our UKAS Accreditation Schedule are marked NUA (Not UKAS Accredited).

TÜV SÜD Product Service
is a trading name of TÜV SÜD Ltd
Registered in Scotland at East Kilbride,
Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TÜV SÜD Ltd is a
TÜV SÜD Group Company

Phone: +44 (0) 1489 558100
Fax: +44 (0) 1489 558101
www.tuv-sud.co.uk

TÜV SÜD Product Service
Octagon House
Concorde Way
Fareham
Hampshire PO15 5RL
United Kingdom



Contents

1 Report Summary2

1.1 Report Modification Record.....2

1.2 Introduction.....2

1.3 Brief Summary of Results3

1.4 Product Information4

1.5 Deviations from the Standard.....4

1.6 EUT Modification Record4

1.7 Test Location.....5

2 Test Details6

2.1 Maximum Conducted Output Power6

2.2 Power Spectral Density.....13

2.3 Emission Bandwidth.....19

2.4 Authorised Band Edges25

2.5 Restricted Band Edges28

2.6 Spurious Radiated Emissions34

3 Measurement Uncertainty47



1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	26 September 2018
2	Second Issue - FCCID and ICID updated	09 October 2018

Table 1

1.2 Introduction

Applicant	Apple Inc.
Manufacturer	Apple Inc.
Model Number(s)	A1993
Serial Number(s)	C07WR00KK2T5and C07WT00HK2V0
Hardware Version(s)	EVT
Software Version(s)	18B2034
Number of Samples Tested	2
Test Specification/Issue/Date	FCC 47 CFR Part 15C (2017) Industry Canada RSS-247 Issue 2 (2017-02) Industry Canada RSS-GEN: Issue 5 (2018-04)
Order Number	0540058293
Date	18-May-2018
Date of Receipt of EUT	12-July-2018 and 20-June-2018
Start of Test	30-June-2018
Finish of Test	18-July-2018
Name of Engineer(s)	Mehadi Choudhury, Graeme Lawler, Tony Hubbard Malik Mohammed and Sharif Sendagire
Related Document(s)	ANSI C63.10 (2013)



Product Service

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15C and Industry Canada RSS-247 and Industry Canada RSS-GEN is shown below.

Section	Specification Clause			Test Description	Result	Comments/Base Standard
	Part 15C	RSS-247	RSS-GEN			
Configuration and Mode: Bluetooth Low Energy (1M)						
2.1	15.247 (b)	5.4	6.12	Maximum Conducted Output Power	Pass	ANSI C63.10
2.2	15.247 (e)	5.2	6.12	Power Spectral Density	Pass	ANSI C63.10
2.3	15.247 (a)(2)	5.2	6.7	Emission Bandwidth	Pass	ANSI C63.10
2.4	15.247 (d)	5.5	-	Authorised Band Edges	Pass	ANSI C63.10
2.5	15.205	-	8.10	Restricted Band Edges	Pass	ANSI C63.10
2.6	15.247 (d)	5.5	6.13	Spurious Radiated Emissions	Pass	ANSI C63.10
Configuration and Mode: Bluetooth Low Energy (2M)						
2.1	15.247 (b)	5.4	6.12	Maximum Conducted Output Power	Pass	ANSI C63.10
2.2	15.247 (e)	5.2	6.12	Power Spectral Density	Pass	ANSI C63.10
2.3	15.247 (a)(2)	5.2	6.7	Emission Bandwidth	Pass	ANSI C63.10
2.4	15.247 (d)	5.5	-	Authorised Band Edges	Pass	ANSI C63.10
2.5	15.205	-	8.10	Restricted Band Edges	Pass	ANSI C63.10

Table 2



1.4 Product Information

1.4.1 Technical Description

The Equipment Under Test (EUT) was a desktop computer, with Bluetooth, Bluetooth Low Energy and 802.11 b/g/n/ac capabilities in the 2.4GHz and 5GHz bands.

1.5 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

1.6 EUT Modification Record

The table below details modifications made to the EUT during the test programme.
The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Serial Number: C07WT00HK2V0			
0	As supplied by the customer	Not Applicable	Not Applicable
Serial Number: C07WR00KK2T5			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 3



1.7 Test Location

TÜV SÜD Product Service conducted the following tests at our Fareham Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: Bluetooth Low Energy (1M)		
Maximum Conducted Output Power	Mehadi Choudhury	UKAS
Power Spectral Density	Mehadi Choudhury	UKAS
Emission Bandwidth	Mehadi Choudhury	UKAS
Authorised Band Edges	Graeme Lawler, Tony Hubbard, Malik Mohammed & Sharif Sendagire	UKAS
Restricted Band Edges		UKAS
Spurious Radiated Emissions		
Configuration and Mode: Bluetooth Low Energy (2M)		
Maximum Conducted Output Power	Mehadi Choudhury	UKAS
Power Spectral Density	Mehadi Choudhury	UKAS
Emission Bandwidth	Mehadi Choudhury	UKAS
Authorised Band Edges	Graeme Lawler, Tony Hubbard, Malik Mohammed & Sharif Sendagire	UKAS
Restricted Band Edges		UKAS

Table 4

Octagon House
Concorde Way
Segensworth North
Fareham
Hampshire
PO15 5RL
United Kingdom



2 Test Details

2.1 Maximum Conducted Output Power

2.1.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (b)(3)
Industry Canada RSS-247, Clause 5.4

2.1.2 Equipment Under Test and Modification State

A1993, S/N: C07WR00KK2T5 - Modification State 0

2.1.3 Date of Test

18-July-2018

2.1.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 11.9.1

2.1.5 Environmental Conditions

Ambient Temperature 23.8 °C
Relative Humidity 46.6 %

2.1.6 Test Results

Bluetooth Low Energy (1M)

Testing was performed on the modulation/packet type with the highest conducted output power.

Modulation/Packet Type: GFSK/DH1

Frequency (MHz)	Maximum Output Power	
	dBm	mW
2402	8.30	6.76
2440	8.38	6.89
2480	8.22	6.64

Table 5

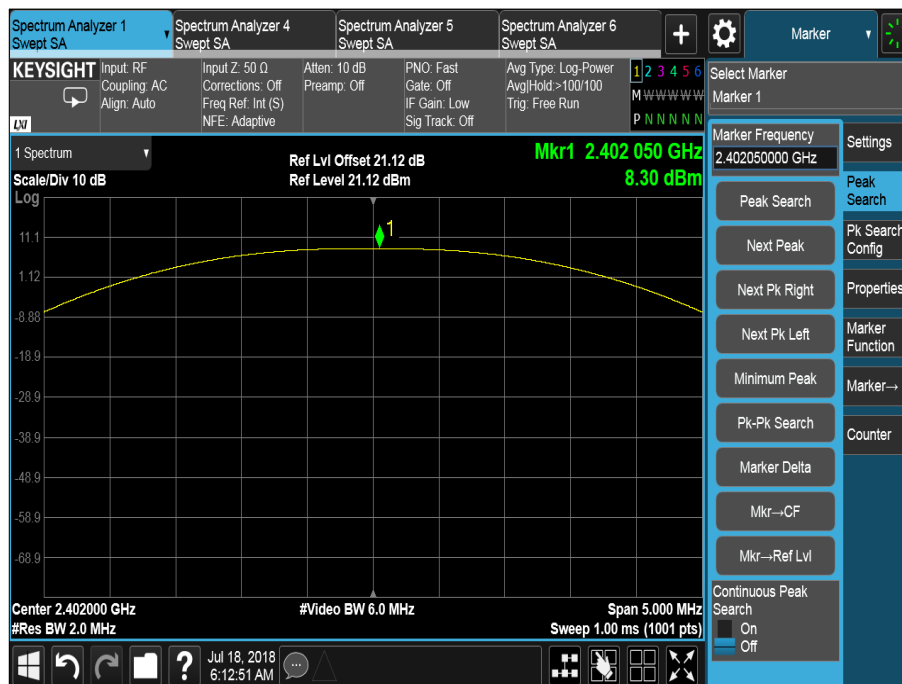


Figure 1 - 2402 MHz - Maximum Output Power (1M)

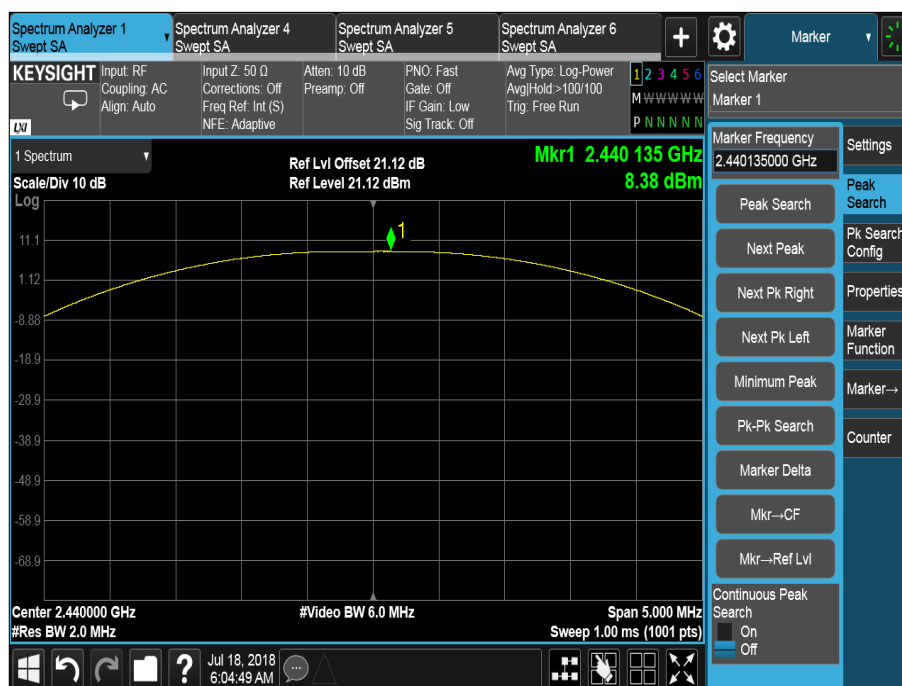


Figure 2 - 2440 MHz - Maximum Output Power (1M)



Product Service



Figure 3 - 2480 MHz - Maximum Output Power (1M)



Bluetooth Low Energy (2M)

Frequency (MHz)	Maximum Output Power	
	dBm	mW
2402	8.17	6.56
2440	8.47	7.03
2480	8.56	7.18

Table 6

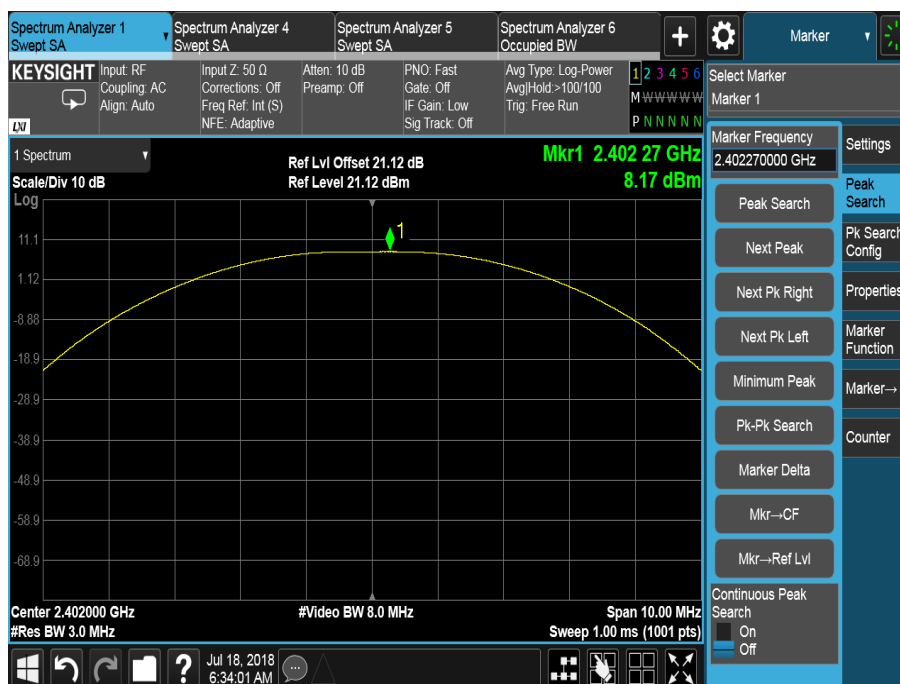


Figure 8 - 2402 MHz - Maximum Output Power (2M)

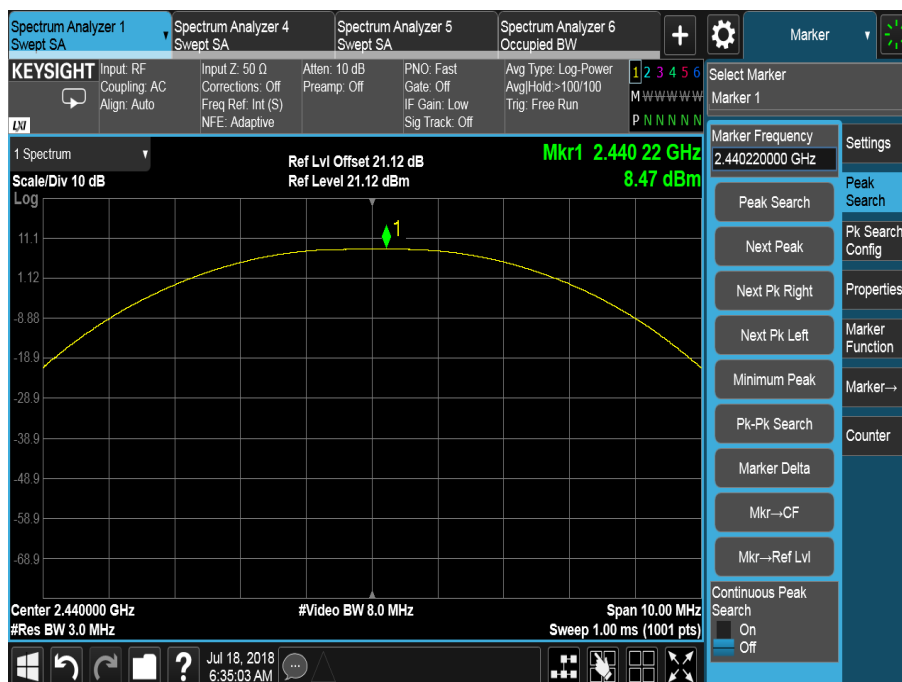


Figure 9 - 2440 MHz - Maximum Output Power (2M)

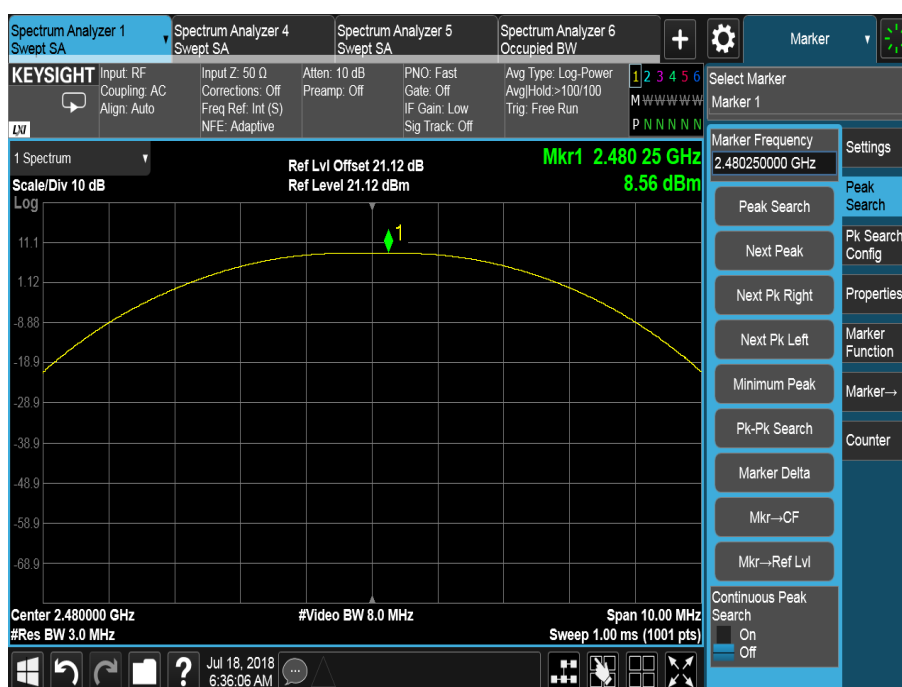


Figure 10 - 2480 MHz - Maximum Output Power (2M)



Product Service

FCC 47 CFR Part 15, Limit Clause 15.247 (b)(3)

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt.

Industry Canada RSS-247, Limit Clause 5.4 (d)

For DTSSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e) of the specification.



2.1.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 3.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
20dB/2W Attenuator	Narda	4772-20	462	-	TU
Mains Voltage Monitor	TUV SUD Product Service	MVM1	1378	12	17-Apr-2019
Cable (3m, SMA(m) - SMA(m))	Reynolds	262-0248-3000	2402	12	19-Sep-2018
Hygrometer	Rotronic	I-1000	2891	12	30-Aug-2018
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	02-Oct-2018
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	06-Mar-2019
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	20-Oct-2018
EXA	Keysight Technologies	N9010B	4969	12	21-Dec-2018

Table 7

TU - Traceability Unscheduled



2.2 Power Spectral Density

2.2.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (e) and Industry Canada RSS-247 5.2

2.2.2 Equipment Under Test and Modification State

A1993, S/N: C07WR00KK2T5 - Modification State 0

2.2.3 Date of Test

18-July-2018

2.2.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 11.10.2

2.2.5 Environmental Conditions

Ambient Temperature 23.8 °C

Relative Humidity 46.6 %

2.2.6 Test Results

Bluetooth Low Energy (1M)

Modulation/Packet Type: GFSK/DH1

Frequency (MHz)	Power Spectral Density (dBm)
2402	4.89
2440	5.15
2480	5.05

Table 8 - Power Spectral Density



Figure 4 - 2402 MHz, Power Spectral Density (1M)

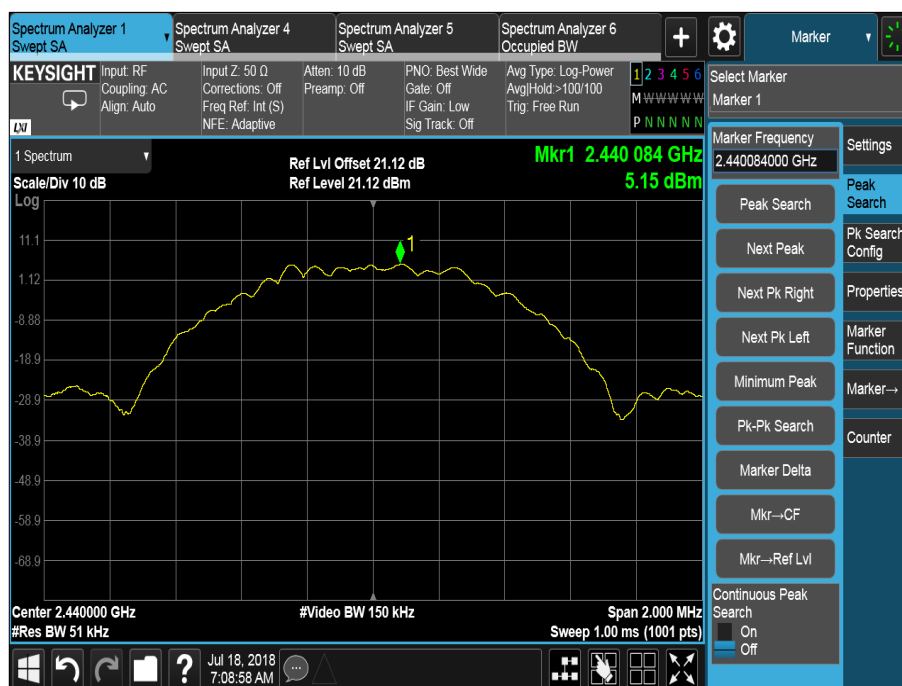


Figure 5 - 2440 MHz, Power Spectral Density (1M)

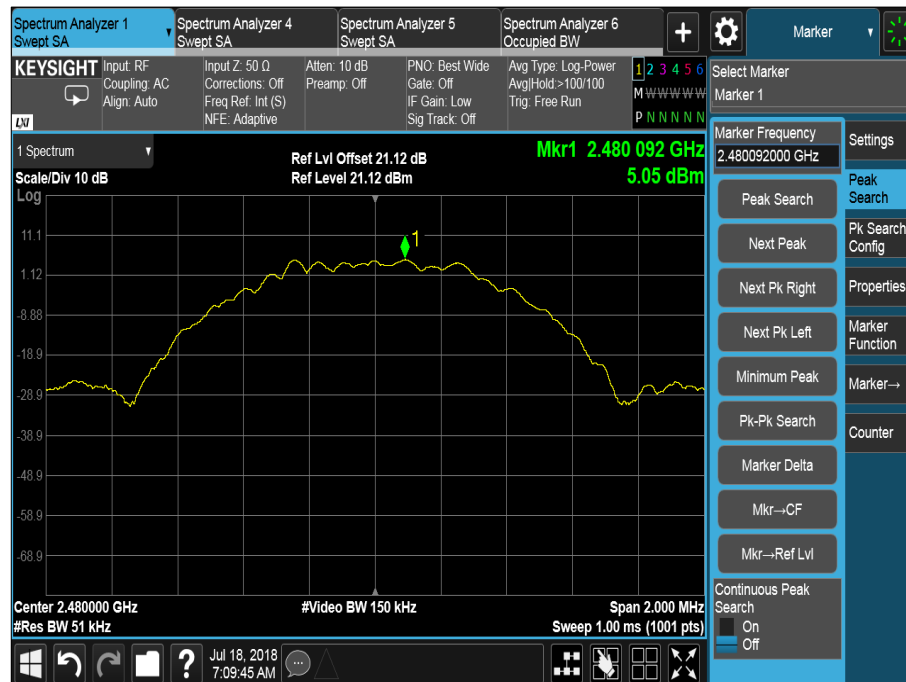


Figure 6 - 2480 MHz, Power Spectral Density (1M)



Bluetooth Low Energy (2M)

Modulation/Package Type: GFSK/DH1

Frequency (MHz)	Power Spectral Density (dBm)
2402	6.63
2440	6.66
2480	6.86

Table 9 - Power Spectral Density



Figure 7 - 2402 MHz, Power Spectral Density (2M)



Figure 8 - 2440 MHz, Power Spectral Density (2M)



Figure 9 - 2480 MHz, Power Spectral Density (2M)



FCC 47 CFR Part 15, Limit Clause 15.247 (e)

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Industry Canada RSS-247, Limit Clause 5.2(b)

The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission

2.2.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 3.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
20dB/2W Attenuator	Narda	4772-20	462	-	TU
Mains Voltage Monitor	TUV SUD Product Service	MVM1	1378	12	17-Apr-2019
Cable(3m, SMA(m) - SMA(m))	Reynolds	262-0248-3000	2402	12	19-Sep-2018
Hygrometer	Rotronic	I-1000	2891	12	30-Aug-2018
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	02-Oct-2018
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	06-Mar-2019
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	20-Oct-2018
EXA	Keysight Technologies	N9010B	4969	12	21-Dec-2018

Table 10

TU - Traceability Unscheduled



2.3 Emission Bandwidth

2.3.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (a)(2) and Industry Canada RSS-247 5.2

2.3.2 Equipment Under Test and Modification State

A1993, S/N: C07WR00KK2T5 - Modification State 0

2.3.3 Date of Test

18-July-2018

2.3.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 11.8 option 2

2.3.5 Environmental Conditions

Ambient Temperature 23.8 °C

Relative Humidity 46.6 %

2.3.6 Test Results

Bluetooth Low Energy (1M)

Modulation/Packet Type: GFSK/DH1

Frequency (MHz)	6 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)
2402	734.400	1.066
2440	725.300	1.067
2480	728.000	1.065

Table 11

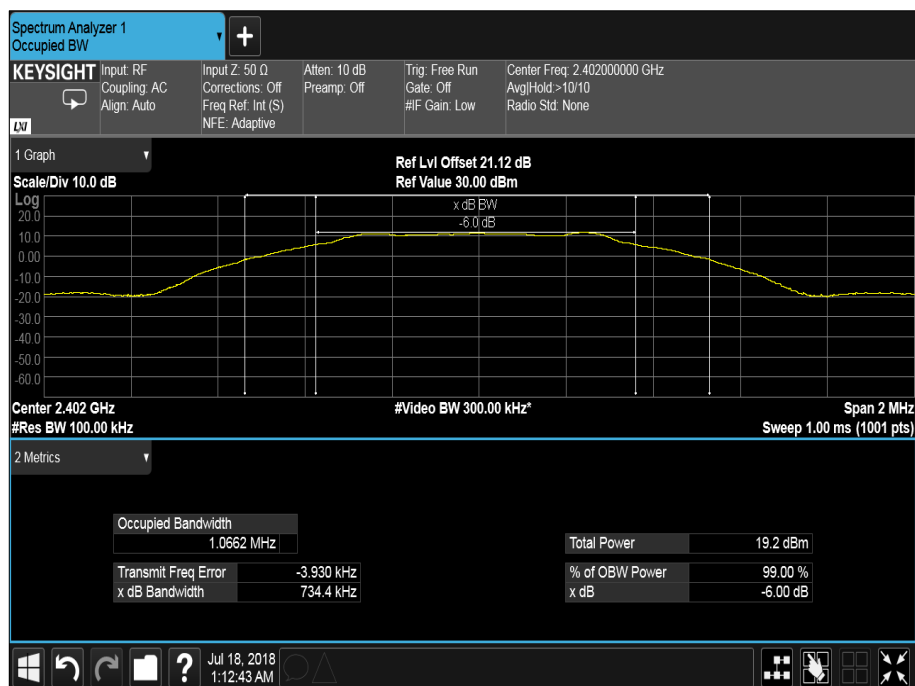


Figure 10 - 2402 MHz – 6 dB Bandwidth (1M)

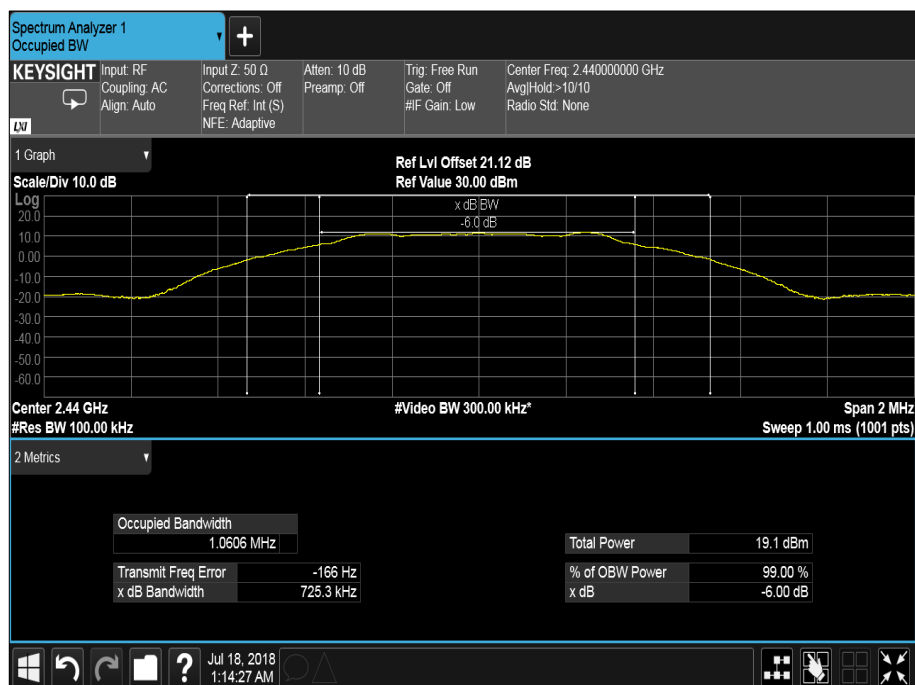


Figure 11 - 2440 MHz – 6 dB Bandwidth (1M)

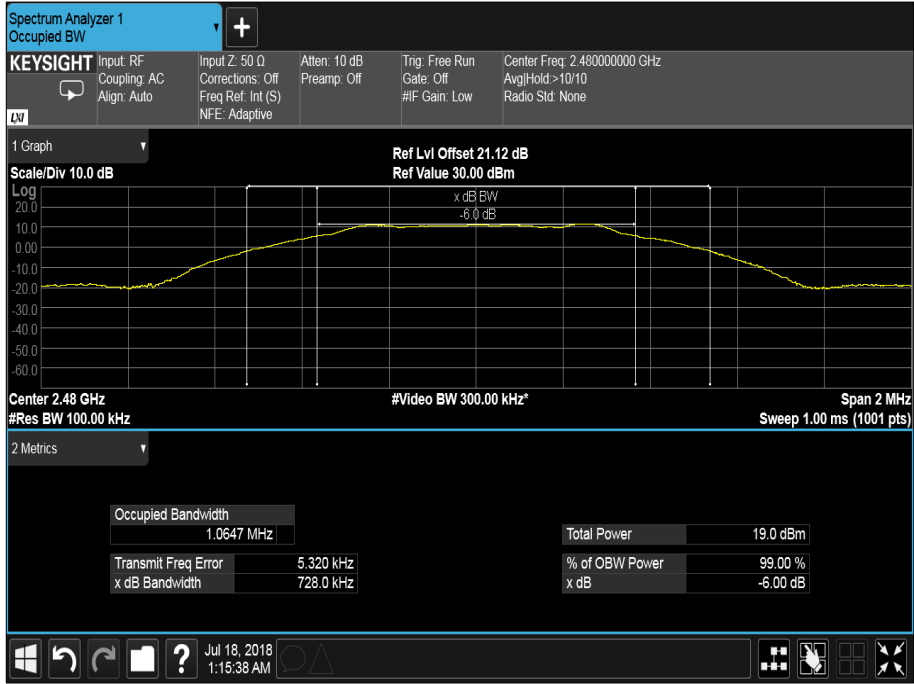


Figure 12 - 2480 MHz – 6 dB Bandwidth (1M)



Bluetooth Low Energy (2M)

Modulation/Packet Type: GFSK/DH1

Frequency (MHz)	6 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)
2402	1.104	2.069
2440	1.095	2.065
2480	1.097	2.065

Table 12

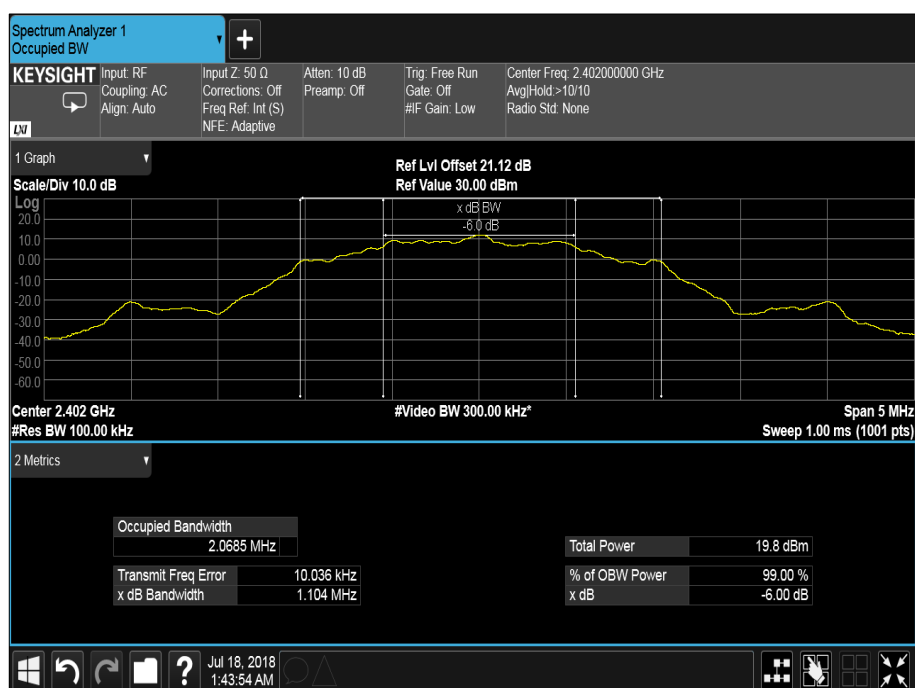


Figure 13 - 2402 MHz – 6 dB Bandwidth (2M)

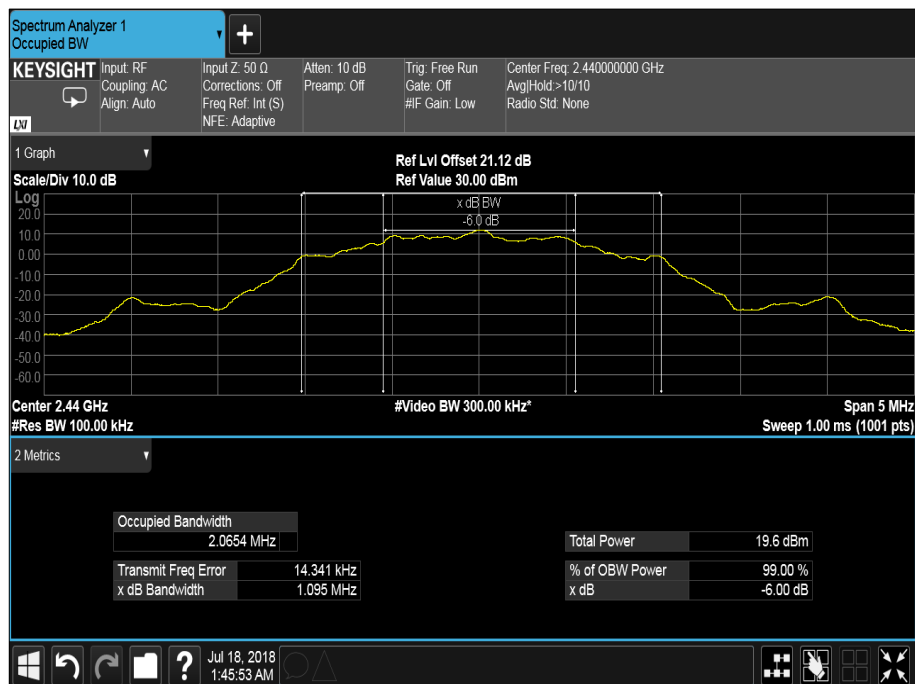


Figure 14 - 2440 MHz – 6 dB Bandwidth (2M)

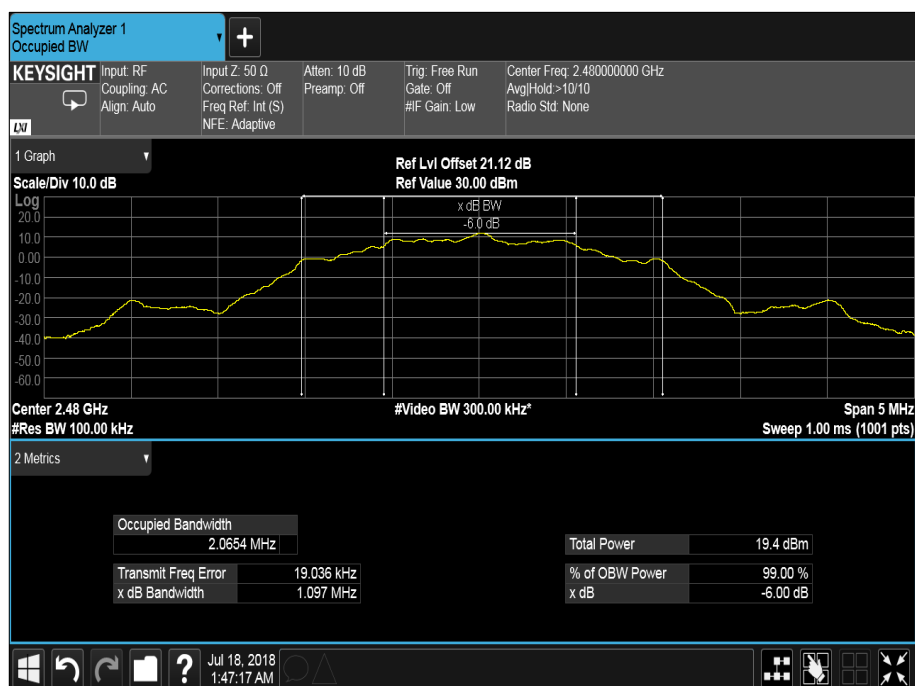


Figure 15 - 2480 MHz – 6 dB Bandwidth (2M)



FCC 47 CFR Part 15, Limit Clause 15.247(a)(2) and Industry Canada RSS-247, Clause 5.2(a)

The minimum 6 dB Bandwidth shall be at least 500 kHz.

2.3.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 3.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
20dB/2W Attenuator	Narda	4772-20	462	-	TU
Mains Voltage Monitor	TUV SUD Product Service	MVM1	1378	12	17-Apr-2019
Cable(3m, SMA(m) - SMA(m))	Reynolds	262-0248-3000	2402	12	19-Sep-2018
Hygrometer	Rotronic	I-1000	2891	12	30-Aug-2018
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	02-Oct-2018
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	06-Mar-2019
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	20-Oct-2018
EXA	Keysight Technologies	N9010B	4969	12	21-Dec-2018

Table 13

TU - Traceability Unscheduled



2.4 Authorised Band Edges

2.4.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (d)
Industry Canada RSS-247, Clause 5.5

2.4.2 Equipment Under Test and Modification State

A1993, S/N: C07WT00HK2V0 - Modification State 0

2.4.3 Date of Test

30-June-2018 to 03-July-2018

2.4.4 Test Method

The test was performed in accordance with ANSI C63.10, clause 6.10.4.

Note: 2483.5 MHz is both an Authorised Bandwidth and a Restricted Band Edge. Of the two limits, the Restricted Band Edge is the most stringent and therefore demonstrates compliance with the 20 dBc Authorised Bandwidth requirement.”

2.4.5 Environmental Conditions

Ambient Temperature 19.3 - 23.6 °C
Relative Humidity 50.8 - 51.6 %

2.4.6 Test Results

Bluetooth Low Energy (1M)

Modulation	Packet Type	Frequency (MHz)	Measured Frequency (MHz)	Level (dBc)
GFSK	DH1	2402	2400.0	-58.70

Table 14

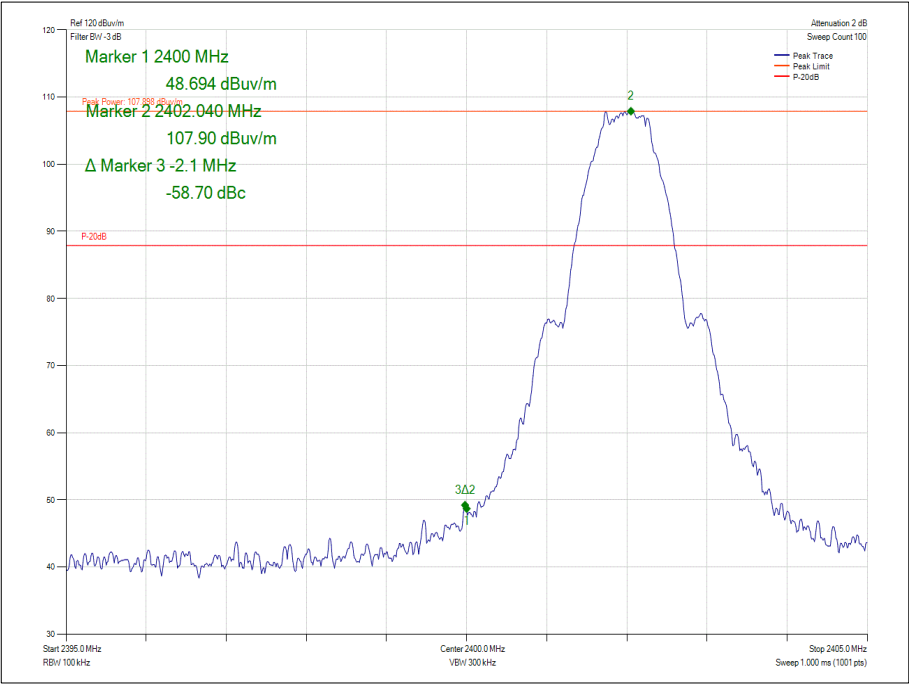


Figure 16 - GFSK/DH1 (1M) - 2402 MHz - Measured Frequency 2400.0 MHz

Bluetooth Low Energy (2M)

Modulation	Packet Type	Frequency (MHz)	Measured Frequency (MHz)	Level (dBc)
GFSK	DH1	2402	2400.0	-34.76

Table 15

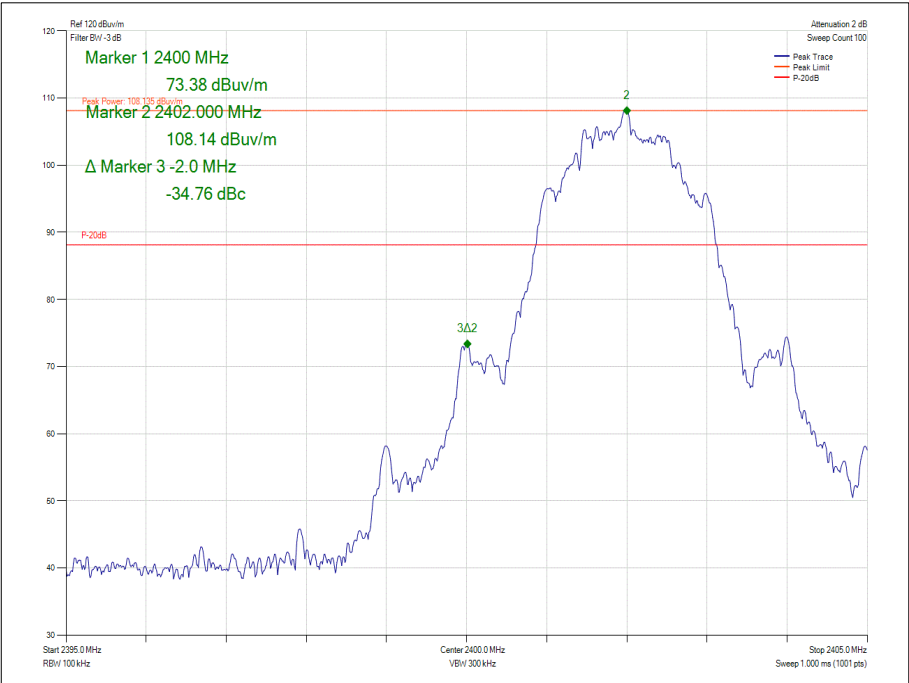


Figure 17 - GFSK/DH1 (2M) - 2402 MHz - Measured Frequency 2400.0 MHz



FCC 47 CFR Part 15, Limit Clause 15.247 (d)

20 dB below the fundamental measured in a 100 kHz bandwidth using a peak detector. If the transmitter complies with the conducted power limits, based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB below the fundamental instead of 20 dB.

Industry Canada RSS-247, Limit Clause 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

2.4.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
10dB/1W SMA Attenuator dc - 18GHz	Sealectro	60-674-1010-89	3	12	31-Aug-2018
Screened Room (5)	Rainford	Rainford	1545	36	23-Jan-2021
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	22-Nov-2018
1 Metre SMA Cable	Rhophase	3PS-1801A-1000-3PS	4099	12	19-Sep-2018
Cable (Rx, Nm-Nm, 7m)	Scott Cables	SLU18-NMNM-07.00M	4498	-	O/P Mon
Cable (Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4526	6	31-Aug-2018
EMI Receiver	Keysight Technologies	N9038A MXE	4628	12	4-Jul-2019
EMI Receiver	Keysight Technologies	N9038A MXE	4629	12	13-Sep-2018
Mast Controller	Maturo GmbH	NCD	4810	-	TU
Tilt Antenna Mast	Maturo GmbH	TAM 4.0-P	4811	-	TU
9m N type RF cable	Rosenberger	2303-0 9.0m PNm PNm	4827	6	4-Jan-2019
Double Ridge Broadband Horn Antenna	Schwarzbeck	BBHA 9120 B	4848	12	12-Feb-2019
Hygrometer	Rotronic	HP21	4989	12	26-Apr-2019

Table 16

TU - Traceability Unscheduled

O/P Mon – Output Monitored using calibrated equipment



2.5 Restricted Band Edges

2.5.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.205
Industry Canada RSS-GEN, Clause 8.10

2.5.2 Equipment Under Test and Modification State

A1993, S/N: C07WT00HK2V0 - Modification State 0

2.5.3 Date of Test

30-June-2018 to 03-July-2018

2.5.4 Test Method

Testing was performed in accordance with ANSI C63.10, clause 11.11, 11.12.1 and 11.12.2.7.

Plots for average measurements were taken in accordance with ANSI C63.10, clause 4.1.4.2.3.

Final average measurements were taken in accordance with ANSI C63.10, clause 4.1.4.2.2.

The following conversion can be applied to convert from dB μ V/m to μ V/m:
 $10^{(\text{Field Strength in dB}\mu\text{V/m}/20)}$.

2.5.5 Environmental Conditions

Ambient Temperature 19.3 - 23.6 °C
Relative Humidity 50.8 - 51.6 %

2.5.6 Test Results

Bluetooth Low Energy (1M)

Modulation	Packet Type	Frequency (MHz)	Measured Frequency (MHz)	Peak Level (dB μ V/m)	Average Level (dB μ V/m)
GFSK	DH1	2402	2390.0	52.80	41.70
GFSK	DH1	2480	2483.63	54.29	45.04

Table 17

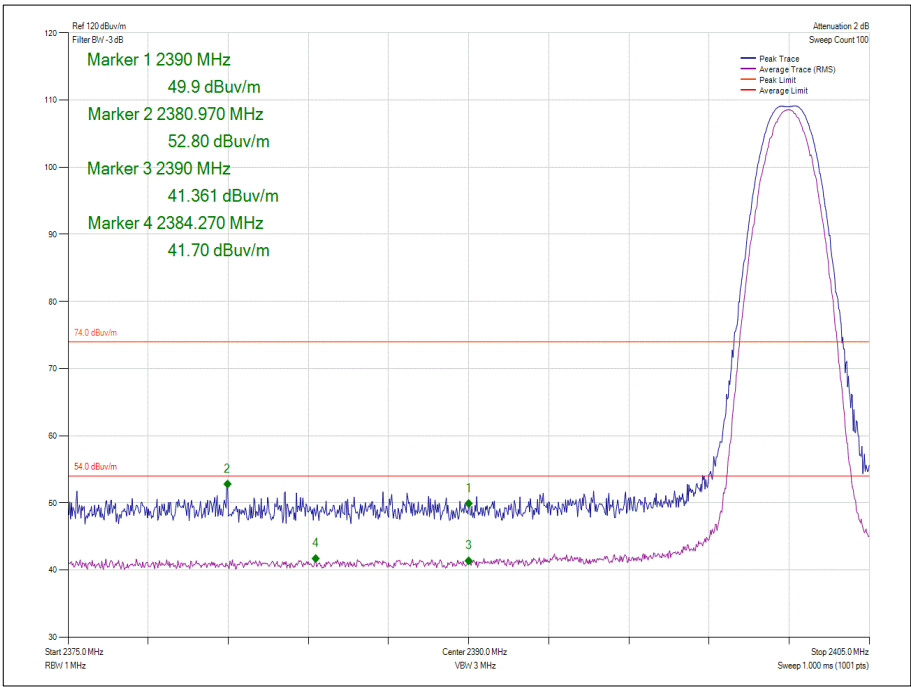


Figure 18 - GFSK/DH1 (1M) - 2402 MHz - Measured Frequency 2390.0 MHz

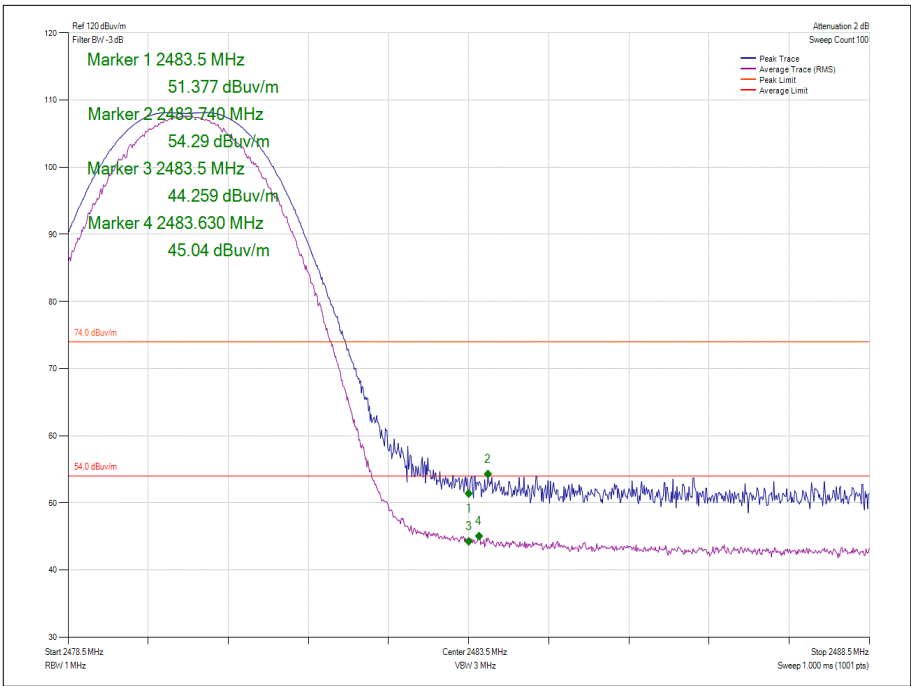


Figure 19 - GFSK/DH1 (1M) - 2480 MHz - Measured Frequency 2483.5 MHz



Bluetooth Low Energy (2M)

Modulation	Packet Type	Frequency (MHz)	Measured Frequency (MHz)	Peak Level (dBμV/m)	Average Level (dBμV/m)
GFSK	DH1	2402	2390.0	53.42	43.38
GFSK	DH1	2480	2483.53	61.18	47.82

Table 18

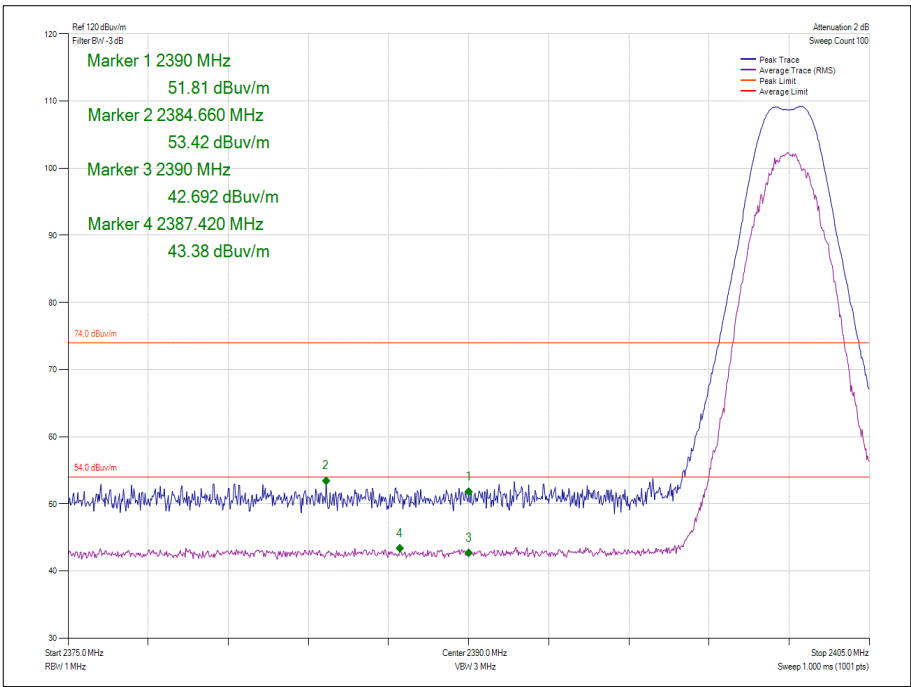


Figure 20 - GFSK/DH1 (2M) - 2402 MHz - Measured Frequency 2390.0 MHz

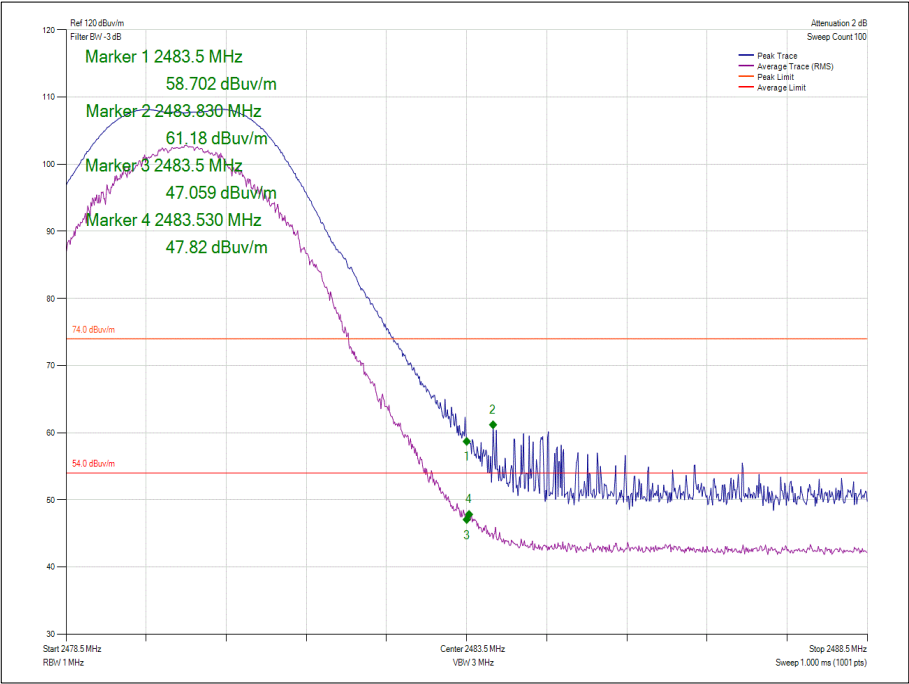


Figure 21 - GFSK/DH1 (2M) - 2480 MHz - Measured Frequency 2483.5 MHz



FCC 47 CFR Part 15, Limit Clause 15.209

Frequency (MHz)	Field Strength ($\mu\text{V}/\text{m}$ at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

Table 19

Industry Canada RSS-GEN, Limit Clause 8.9

Frequency (MHz)	Field Strength ($\mu\text{V}/\text{m}$ at 3 metres)
30-88	100
88-216	150
216-960	200
Above 960*	500

Table 20

*Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.



2.5.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
10dB/1W SMA Attenuator dc - 18GHz	Sealectro	60-674-1010-89	3	12	31-Aug-2018
Mains Voltage Monitor	TUV SUD Product Service	MVM1	1378	12	17-Apr-2019
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	22-Nov-2018
1 Metre SMA Cable	Rhophase	3PS-1801A-1000-3PS	4099	12	19-Sep-2018
Cable (Rx, Nm-Nm, 7m)	Scott Cables	SLU18-NMNM-07.00M	4498	-	O/P Mon
Cable (Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4526	6	31-Aug-2018
EMI Receiver	Keysight Technologies	N9038A MXE	4628	12	4-Jul-2019
EMI Receiver	Keysight Technologies	N9038A MXE	4629	12	13-Sep-2018
Mast Controller	Maturo GmbH	NCD	4810	-	TU
Tilt Antenna Mast	Maturo GmbH	TAM 4.0-P	4811	-	TU
9m N type RF cable	Rosenberger	2303-0 9.0m PNm PNm	4827	6	4-Jan-2019
Double Ridge Broadband Horn Antenna	Schwarzbeck	BBHA 9120 B	4848	12	12-Feb-2019
Hygrometer	Rotronic	HP21	4989	12	26-Apr-2019

Table 21

TU - Traceability Unscheduled

O/P Mon – Output Monitored using calibrated equipment



2.6 Spurious Radiated Emissions

2.6.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.247 (d) and 15.205
Industry Canada RSS-247, Clause 5.5
Industry Canada RSS-GEN, Clause 6.13

2.6.2 Equipment Under Test and Modification State

A1993, S/N: C07WT00HK2V0 - Modification State 0

2.6.3 Date of Test

10-July-2018 to 17-July-2018

2.6.4 Test Method

Testing was performed in accordance with ANSI C63.10 clause 6.3, 6.5 and 6.6.

In the 30MHz to 1GHz range pre-scans were only performed on mid channel (2441 MHz) and any emissions identified then measured on bottom (2402 MHz) and top (2480 MHz).

Plots for average measurements were taken in accordance with ANSI C63.10-2013 clause 4.1.4.2.3 to characterize the EUT. Where emissions were detected, final average measurements were taken in accordance with ANSI C63.10-2013 clause 4.1.4.2.2.

The plots shown are the characterization of the EUT. The limits on the plots represent the most stringent case for restricted bands, (54/74 dBuV/m @ 3m and 64/84 dBuV/m @ 1m) when compared to 20 dBc outside restricted bands. The limits shown have been used as a threshold to determine where further measurements are necessary. Where results are within 10 dB of the limits shown on the plots, further investigation was carried out and reported in results tables.

The following conversion can be applied to convert from dBuV/m to uV/m:
 $10^{\frac{\text{Field Strength in dBuV/m} - 20}{20}}$

2.6.5 Environmental Conditions

Ambient Temperature 20.4 °C
Relative Humidity 60.8 %

2.6.6 Test Results

Bluetooth Low Energy (1M)

Testing was performed on the modulation and packet type which resulted in the highest conducted output power. Modulation/Packet Type: GFSK/DH1

Frequency (GHz)	Result (dBuV/m)		Limit (dBuV/m)		Margin (dBuV/m)	
	Peak	Average	Peak	Average	Peak	Average
*						

Table 22 – 2441 MHz - 30 MHz to 1 GHz – Radiated

*No emissions were detected within 10 dB of the limit.

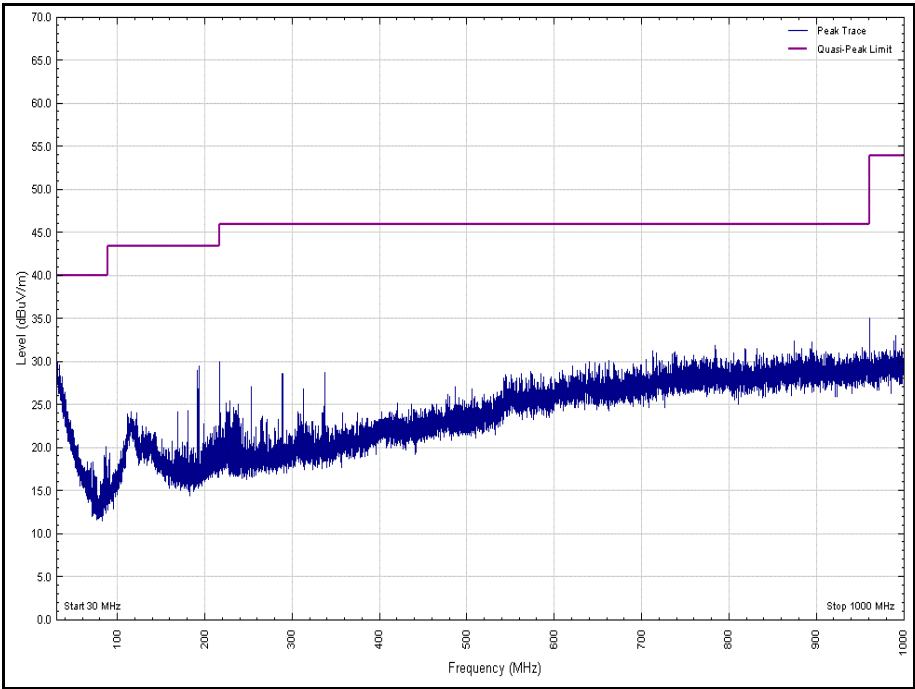


Figure 22 - 2441 MHz - 30 MHz to 1 GHz - Horizontal

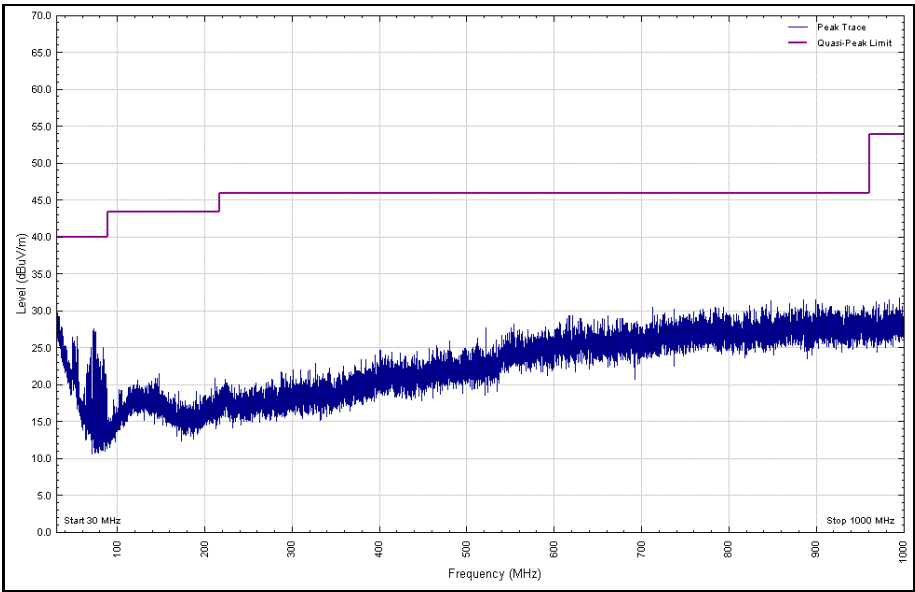


Figure 23 - 2441 MHz - 30 MHz to 1 GHz - Vertical



2402 MHz

Frequency (GHz)	Result (µV/m)		Limit (µV/m)		Margin (µV/m)	
	Peak	Average	Peak	Average	Peak	Average
*						

Table 23 - 1 GHz to 26 GHz - Radiated

*No emissions were detected within 10 dB of the limit.

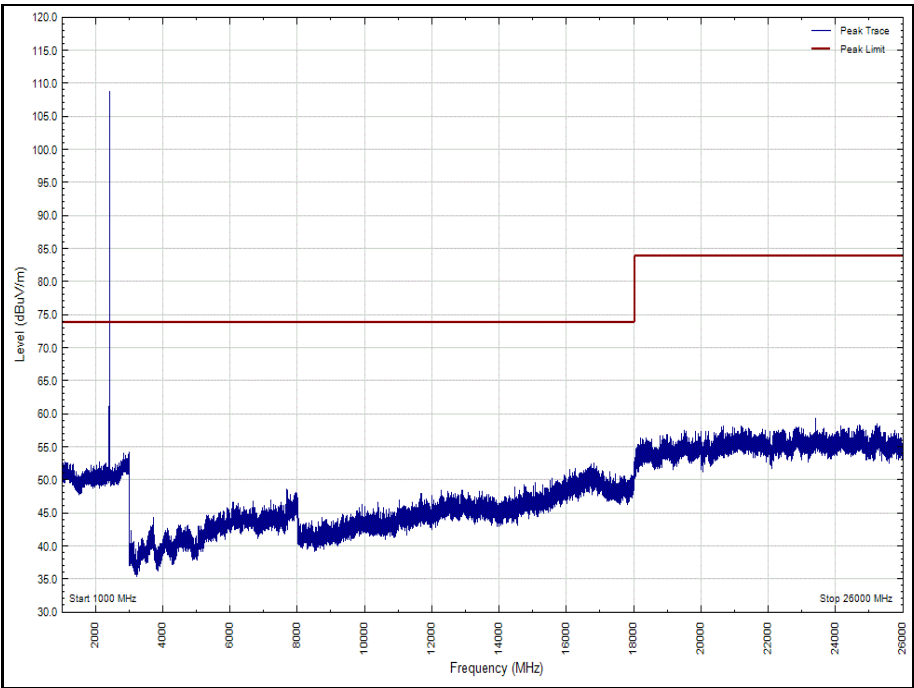


Figure 24 - 1 GHz to 26 GHz – Horizontal (Peak)

Note - The emissions seen at 2402 MHz is the EUT’s intentional transmitter frequency and is therefore not subject to this test.

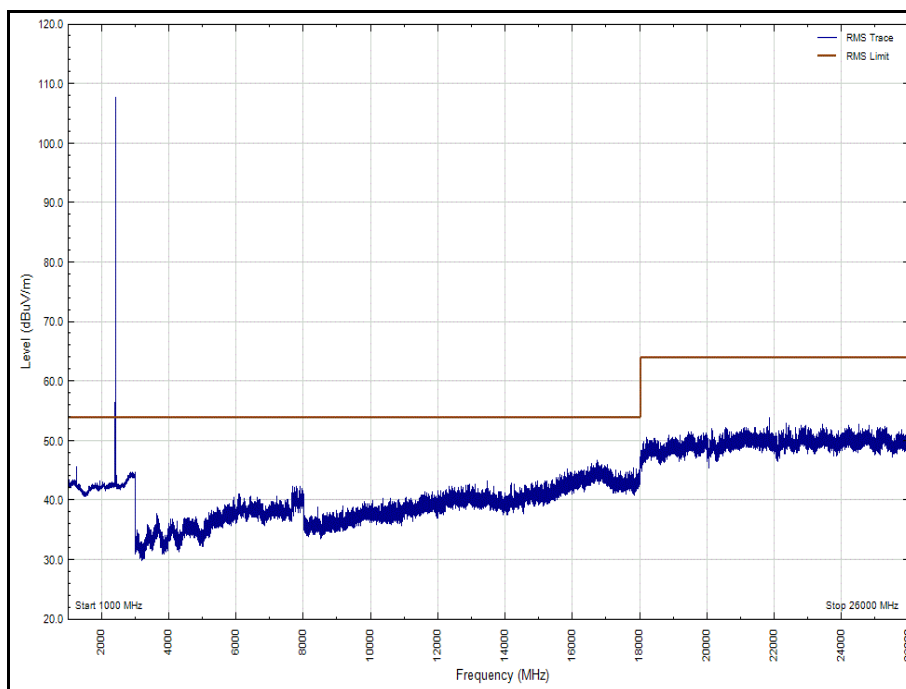


Figure 25 - 1 GHz to 26 GHz – Horizontal (Average)

Note - The emissions seen at 2402 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.

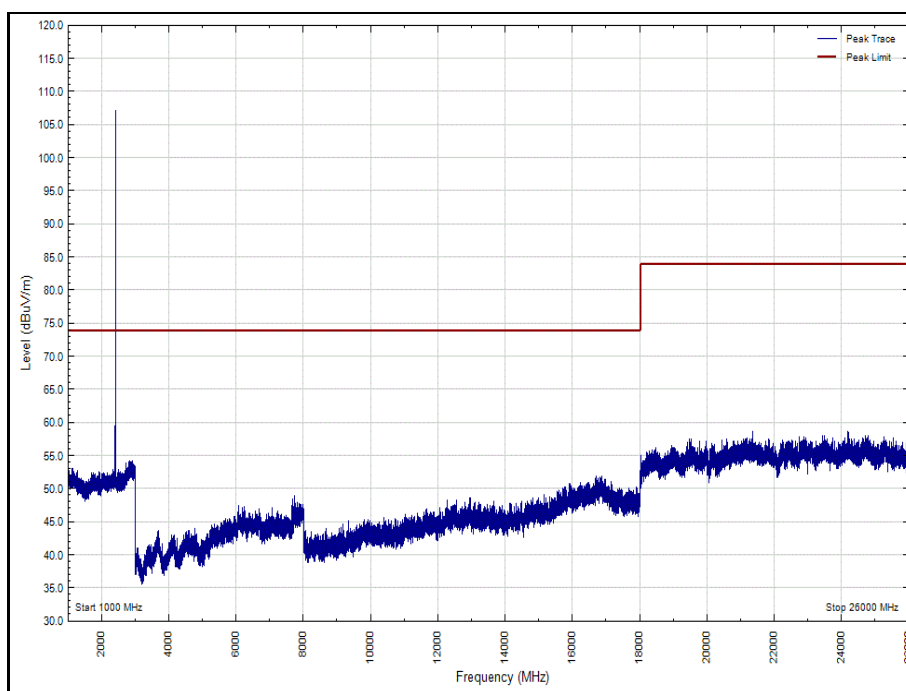


Figure 26 - 1 GHz to 26 GHz - Vertical (Peak)

Note - The emissions seen at 2402 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.

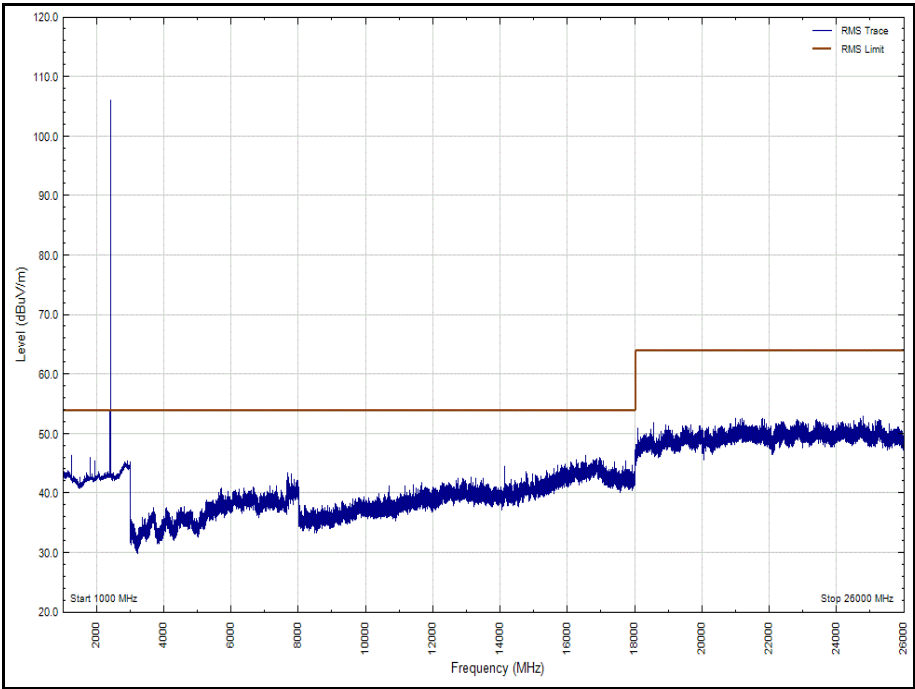


Figure 27 - 1 GHz to 26 GHz – Vertical (Average)

Note - The emissions seen at 2402 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.



2441 MHz

Frequency (GHz)	Result (µV/m)		Limit (µV/m)		Margin (µV/m)	
	Peak	Average	Peak	Average	Peak	Average
*						

Table 24 - 1 GHz to 26 GHz - Radiated

*No emissions were detected within 10 dB of the limit.

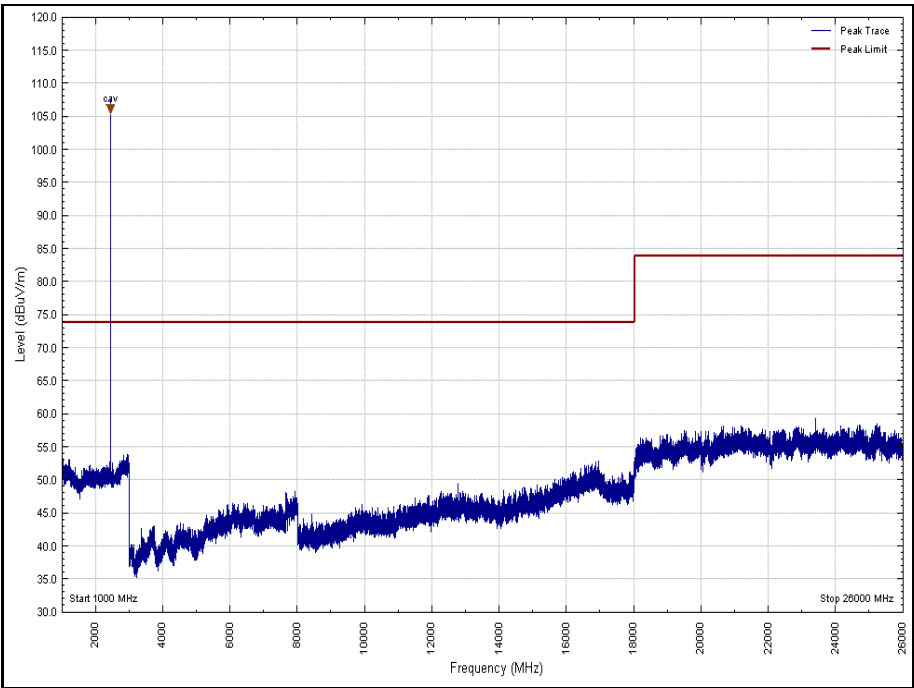


Figure 28 - 1 GHz to 26 GHz Horizontal (Peak)

Note - The emissions seen at 2441 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.

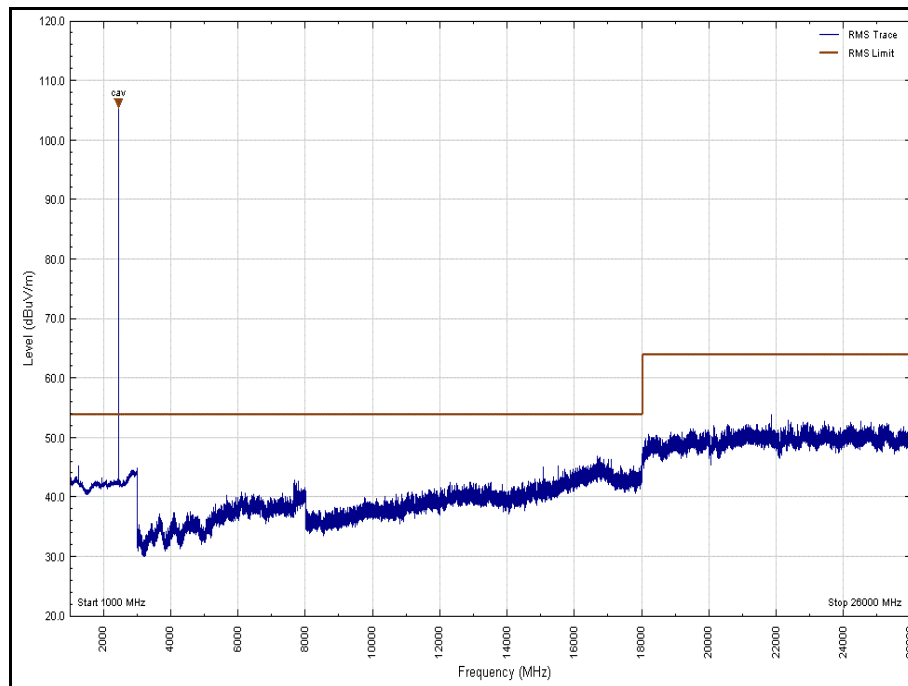


Figure 29 - 1 GHz to 26 GHz Horizontal (Average)

Note - The emissions seen at 2441 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.

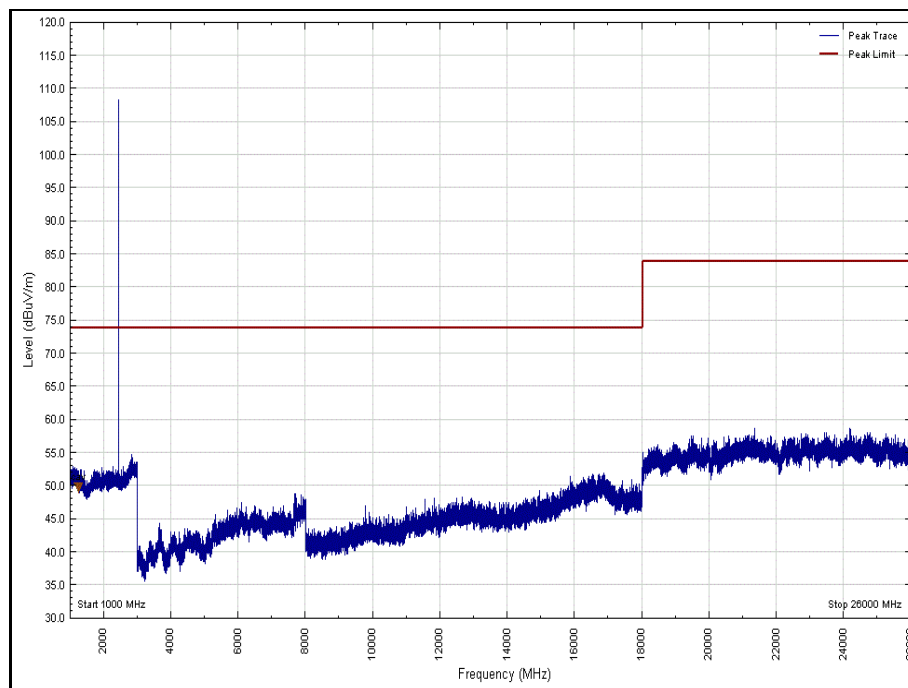


Figure 30 - 1 GHz to 26 GHz Vertical (Peak)

Note - The emissions seen at 2441 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.

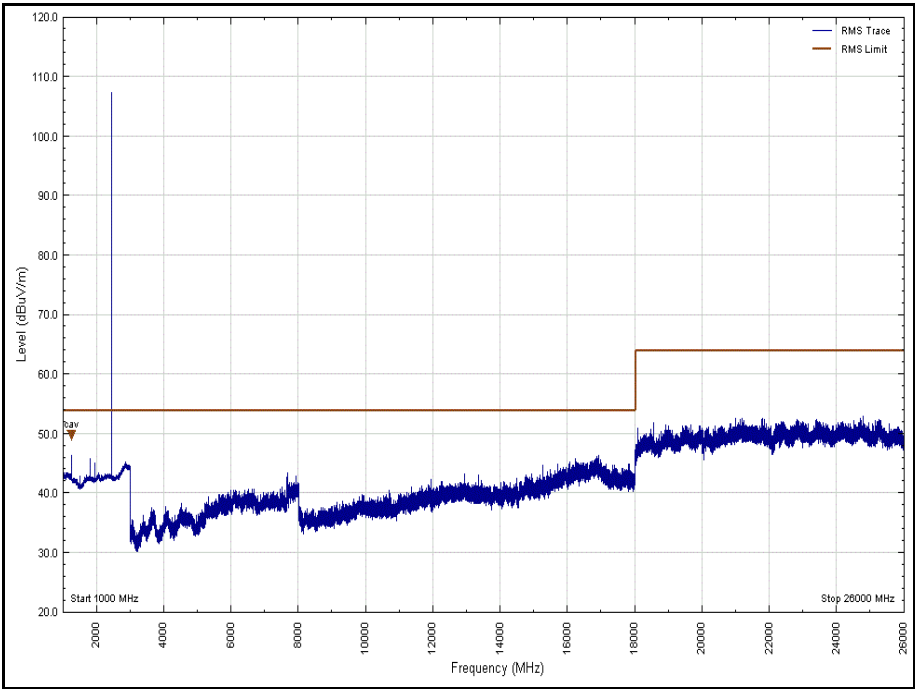


Figure 31 - 1 GHz to 26 GHz Vertical (Average)

Note - The emissions seen at 2441 MHz is the EUT's intentional transmitter frequency and is therefore not subject to this test.



2480 MHz

Frequency (GHz)	Result (µV/m)		Limit (µV/m)		Margin (µV/m)	
	Peak	Average	Peak	Average	Peak	Average
*						

Table 25 - 1 GHz to 26 GHz - Radiated

*No emissions were detected within 10 dB of the limit.

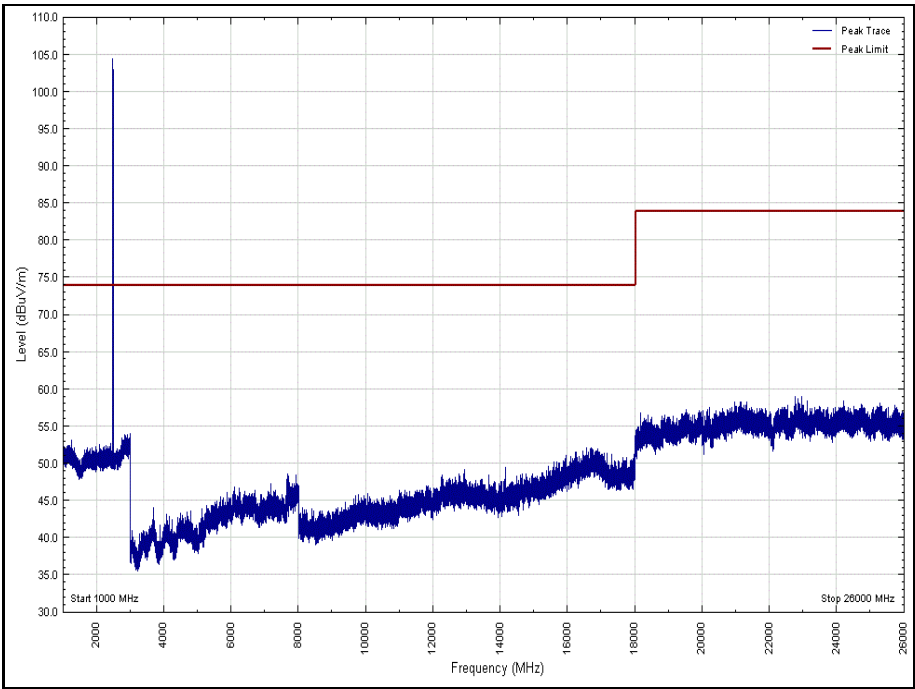


Figure 32 - 1 GHz to 26 GHz Horizontal (Peak)

Note - The emissions seen at 2480 MHz is the EUT’s intentional transmitter frequency and is therefore not subject to this test.

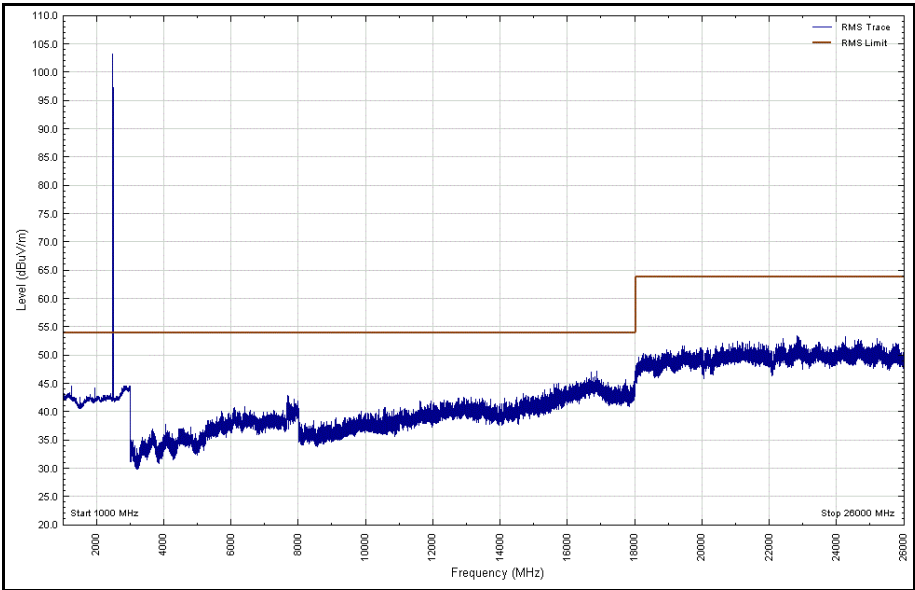


Figure 33 - 1 GHz to 26 GHz Horizontal (Average)

Note - The emissions seen at 2480 MHz is the EUT’s intentional transmitter frequency and is therefore not subject to this test.

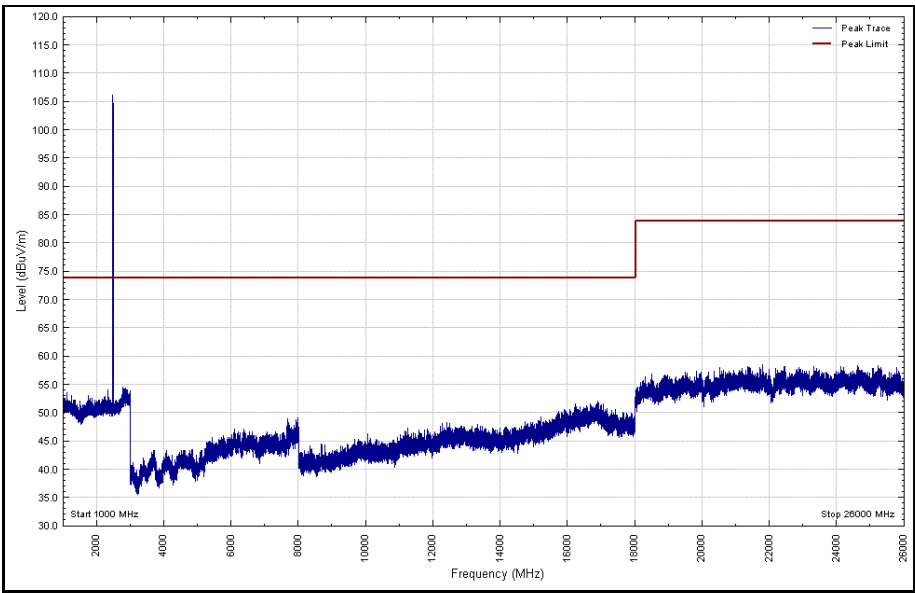


Figure 34 - 1 GHz to 26 GHz Vertical (Peak)

Note - The emissions seen at 2480 MHz is the EUT’s intentional transmitter frequency and is therefore not subject to this test.

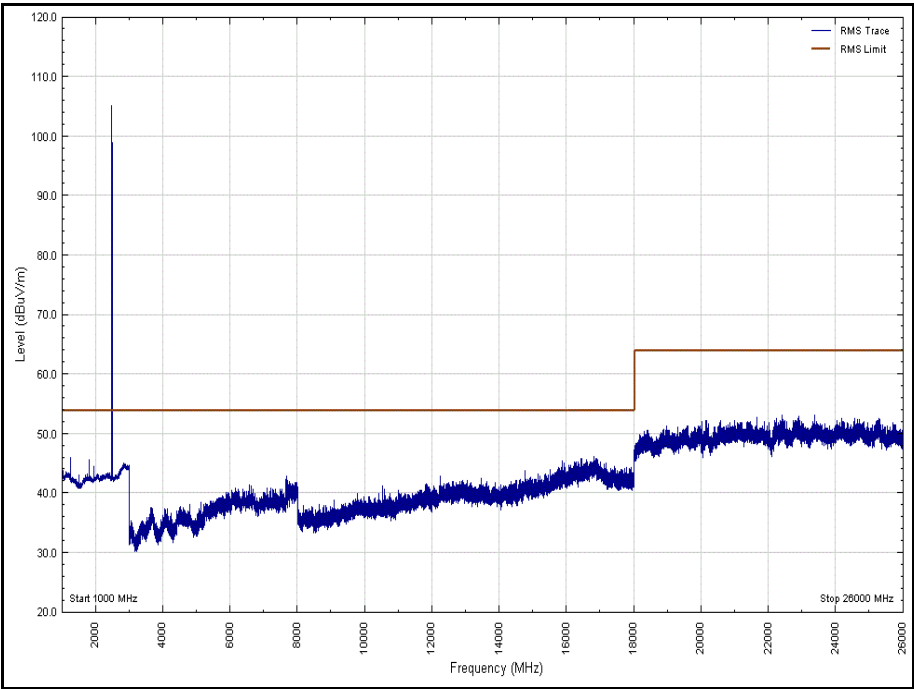


Figure 35 - 1 GHz to 26 GHz Vertical (Average)

Note - The emissions seen at 2480 MHz is the EUT’s intentional transmitter frequency and is therefore not subject to this test.



FCC 47 CFR Part 15, Limit Clause 15.247 (d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in 15.209(a)

Industry Canada RSS-247, Limit Clause 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.



2.6.7 Test Location and Test Equipment Used

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
10dB/1W SMA Attenuator dc -18GHz	Sealectro	60-674-1010-89	3	12	31-Aug-2018
Multimeter	White Gold	WG022	190	12	24-Nov-2018
Antenna 18-40GHz (Double Ridge Guide)	Link Microtek Ltd	AM180HA-K-TU2	230	24	2-May-2020
Antenna (Bilog)	Schaffner	CBL6143	287	24	15-May-2020
Dual Power Supply Unit	Thurlby	PL320	288	-	TU
Filter (High Pass)	Lorch	SHP7-7000-SR	566	12	10-May-2019
Pre-Amplifier	Phase One	PS04-0086	1533	12	12-Jan-2019
18GHz - 40GHz Pre-Amplifier	Phase One	PSO4-0087	1534	12	2-Feb-2019
Screened Room (5)	Rainford	Rainford	1545	36	23-Jan-2021
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
Antenna (Bilog)	Chase	CBL6143	2904	24	8-Aug-2019
Cable (N-N, 8m)	Rhophase	NPS-2302-8000-NPS	3248	-	O/P Mon
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	22-Nov-2018
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	2-Oct-2018
1 Metre SMA Cable	Rhophase	3PS-1801A-1000-3PS	4099	12	19-Sep-2018
1501A 4.0M Km Km Cable	Rhophase	KPS-1501A-4000-KPS	4301	12	19-Feb-2019
1GHz to 8GHz Low Noise Amplifier	Wright Technologies	APS04-0085	4365	12	18-Oct-2018
Cable (Rx, Nm-Nm, 7m)	Scott Cables	SLU18-NMNM-07.00M	4498	-	O/P Mon
Cable (Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4526	6	31-Aug-2018
Cable (Rx, SMAm-SMAm0.5m)	Scott Cables	SLSLL18-SMSM-00.50M	4528	6	15-Aug-2018
EMI Receiver	Keysight Technologies	N9038A MXE	4628	12	04-July-2019
Double Ridged Waveguide Horn Antenna	ETS-Lindgren	3117	4722	12	1-Mar-2019
Mast Controller	Maturo GmbH	NCD	4810	-	TU
Tilt Antenna Mast	Maturo GmbH	TAM 4.0-P	4811	-	TU
9m N type RF cable	Rosenberger	2303-0 9.0m PNm PNm	4827	6	4-Jan-2019
Double Ridge Broadband Horn Antenna	Schwarzbeck	BBHA 9120 B	4848	12	12-Feb-2019
4dB Attenuator	Pasternack	PE7047-4	4935	12	28-Nov-2018
Hygrometer	Rotronic	HP21	4989	12	26-Apr-2019
Cable (26.5GHz)	Rosenberger	LU7-133-5000	5019	-	O/P Mon
Cable (40GHz)	Rosenberger	LU1-001-2000	5020	-	O/P Mon

Table 26

TU - Traceability Unscheduled

O/P Mon – Output Monitored using calibrated equipment



3 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Test Name	Measurement Uncertainty
Maximum Conducted Output Power	± 3.2 dB
Power Spectral Density	± 3.2 dB
Emission Bandwidth	± 33.079 kHz
Authorised Band Edges	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Restricted Band Edges	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
Spurious Radiated Emissions	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB

Table 27