

Prüfbericht-Nr.: Test report no.:	60349842-003	Auftrags-Nr.: Order no.:	23870325 030	Seite 1 von 41 Page 1 of 41
Kunden-Referenz-Nr.: Client reference no.:	--	Auftragsdatum: Order date:	2019.08.28	
Auftraggeber: Client:	Amazon Data Services, Inc.			
Prüfgegenstand: Test item:	IoT Device			
Bezeichnung / Typ-Nr.: Identification / Type no.:	TE1A001 / 2AVPL-TE1A001			
Auftrags-Inhalt: Order content:	FCC Part 15 subpart C compliance testing			
Prüfgrundlage: Test specification:	FCC 47 CFR Part 15.247 & 15.209 ANSI C63.10: 2013			
Wareneingangsdatum: Date of sample receipt:	2020.02.17			
Prüfmuster-Nr.: Test sample no.:	See chapter 2.3			
Prüfzeitraum: Testing period:	2020.02.19 – 2020.04.30			
Ort der Prüfung: Place of testing:	Lund, Sweden			
Prüflaboratorium: Testing laboratory:	TÜV Rheinland Sweden			
Prüfergebnis*: Test result*:	Pass			
überprüft von: reviewed by:	genehmigt von: authorized by:			
Datum: 2020.07.14 Date:	Datum: 2020.07.14 Date:			
Stellung / Position:	Stellung / Position:			
Sonstiges / Other:				
Zustand des Prüfgegenstandes bei Anlieferung: Condition of the test item at delivery:				
Prüfmuster vollständig und unbeschädigt Test item complete and undamaged				
* Legende:	1 = sehr gut P(ass) = entspricht o.g. Prüfgrundlage(n)	2 = gut F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	3 = befriedigend F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	4 = ausreichend N/A = nicht anwendbar
* Legend:	1 = very good P(ass) = passed a.m. test specification(s)	2 = good F(ail) = failed a.m. test specification(s)	3 = satisfactory F(ail) = failed a.m. test specification(s)	4 = sufficient N/A = not applicable
5 = mangelhaft N/T = nicht getestet				
5 = poor N/T = not tested				
Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens. This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts.				

Revision History60349842-00360349842-003

REVISION	DATE	REMARKS	AUTHOR
001	2020-04-15	First Release	Fariborz Abasi
002	2020-05-20	Updated CTE Results	Niall Forrester
003	2020.07.14	Updated customer contact information in page 4	Fariborz Abasi
Note: Latest revision report will replace all previous reports			
This report based on FCC Part 15.247 Template version 1.1			

Summary of Test Results

FCC 47 CFR Rule Part	Test Description	Applicability	Report Section	RESULT	REMARKS
15.207	AC Power Line Conducted Emissions (Intentional Radiators)	NO	--	N/A	No A/C Supply
15.209	Radiated Emissions (Intentional Radiators)	YES	4.1	PASS	
15.247 (d)	Out of Band Emissions	YES	4.2	PASS	
15.247 (d)	Band Edge Compliance (Authorized Band)	YES	4.3	PASS	
15.247 (d)	Band Edge Compliance (Restricted Band)	YES	4.4	PASS	
15.247 (a)(1)	20dB Bandwidth	NO	4.5	N/A	Device is non-hopping
15.247 (a)(1)	Carrier (Hopping Channel) Separation	NO	4.6	N/A	Device is non-hopping
15.247 (a)(1)	Number of Hopping Channels	NO	4.7	N/A	Device is non-hopping
15.247 (a)(1)	Time of Occupancy (Dwell Time)	NO	4.8	N/A	Device is non-hopping
15.247 (a)(2)	6dB Bandwidth	YES	4.9	PASS	
15.247 (b)	Peak Conducted Output Power	YES	4.10	PASS	
15.247 (e)	Power Spectral Density	YES	4.11	PASS	

Possible test case verdicts:

- Test case does not apply to the test object: N/A
- Test object complies with the requirement: PASS or COMPLIANT
- Test object does not meet the requirement: FAIL or NOT COMPLIANT
- Test case not performed on the test object: N.P.

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1. GENERAL INFORMATION

1.1 Test Site

Test Facility:	TÜV Rheinland Sweden AB
Address:	Mobilvägen 10
	223 62 Lund
	Sweden
Swedac Registration Number:	10325
FCC Test Firm Registration Number:	517458
ISED Test Site Registration Number:	24753

1.2 Client Information

Company Name:	Amazon Data Services, Inc.
Address:	410 Terry Ave N, Seattle,
	WA 98109, USA
Contact Person:	
Contact e-Mail / Telephone	gtpcrequests@amazon.com

2. PRODUCT INFORMATION

2.1 General Description

Model name:	IoT Device
Manufacturer:	Amazon Data Services, Inc.
Model number / Marketing name:	TE1A001
FCC ID:	2AVPL-TE1A001
Description:	IoT Device
Ancillary Equipment:	See section 2.7

2.2 Device Characteristics

Type of Power Supply	2 x CR2450 coin cells
Nominal Supply Voltage	3 VDC
Supply Voltage Range	2,5 -3,2 VDC
Highest Internal Frequency Source	2480MHz (BLE Radio high channel)

2.3 Test Samples

EUT #	EUT ID	Description	Used For:
1	A000256602-002 (S/N: F6119711)	Standard Sample HW: TE1A001, SW: JAX_OTA_1.0	Radiated Tests (SAC 5)
2	A002813643_001 (S/N: F6119723)	Modified with semi-rigid antenna connector HW: TE1A001, SW: JAX_OTA_1.0	Conducted Tests (CTE)

2.4 Wireless Technologies and Bands Supported by the EUT

Technology	Band	Frequency Range (Tx)	Evaluation Performed*
Bluetooth Low Energy	2,4 GHz	2402 MHz – 2480 MHz	YES
RFID / NFC	13.56 MHz	13.56 MHz	NO

*This statement refers only to this report. Other wireless technologies may be covered by other reports.

2.5 Antenna Information

Technology	Band	Number of Antennas	Antenna Type(s)	Gain
Bluetooth Low Energy	2,4 GHz	1	Integral Antenna	2.22 dBi

2.6 Wireless Technology Details

Technology	Band	Modulation Type(s)	No. of Channels	Channel Spacing	Adaptivity
Bluetooth Low Energy	2,4 GHz	GFSK	40	2 MHz	Non adaptive

2.7 Ancillary Equipment

None

3. TEST METHODS

3.1 Test Standards

Testing was performed according to the following standards / references

Standard	Version	Description
FCC 47 CFR 15.209	-	Radiated emission limits; general requirements

3.2 Additional references

The following standards / references were also considered for the testing

Standard	Version	Description
ANSI C63.10	2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

3.3 Limits

FCC 47 CFR Rule Part	Test Description	Limit Reference (FCC 47 CFR Reference)
15.209	Radiated Emissions (Intentional Radiators)	15.209 (a) *See Note 1
15.247 (d)	Out of Band Emissions	15.247 (d)
15.247 (d)	Band Edge Compliance (Authorized Band)	15.247 (d)
15.247 (d)	Band Edge Compliance (Restricted Band)	15.247 (d)
15.247 (a)(1)	20dB Bandwidth	15.247 (a)(1)
15.247 (a)(1)	Carrier (Hopping Channel) Separation	15.247 (a)(1)
15.247 (a)(1)	Number of Hopping Channels	15.247 (a)(1)
15.247 (a)(1)	Time of Occupancy (Dwell Time)	15.247 (a)(1)
15.247 (a)(2)	6dB Bandwidth	15.247 (a)(2)
15.247 (b)	Peak Conducted Output Power	§15.247 (b)(3) [Non-Hopping]
15.247 (e)	Power Spectral Density	15.247 (e)

Note 1

Radiated Emissions limits in the tables from 47 CFR sections 15.109 & 15.209 are presented in $\mu\text{V/m}$. Measurements on the test system are made in $\text{dB}\mu\text{V/m}$. To convert between these, the following adjustment is used:

$$\text{New Limit} = 20 \log \left(\frac{\text{Original Limit}}{10^6} \right) + 120$$

Example: from 15.209(a) the limit for 30MHz – 88MHz is $100\mu\text{V/m}$ at 3m. This gives:

$$\text{New Limit} = 20 \log \left(\frac{100}{10^6} \right) + 120 = 40\text{dB}\mu\text{V/m at 3m}$$

Additionally, in some cases testing has been performed at distances other than those specified in the tables. When this has occurred, the limits have been adjusted in accordance with the requirements in 47 CFR 15.31, using an extrapolation factor of 40dB/decade at frequencies below 30MHz and 20dB/decade at or above 30MHz

Example: from 15.209(a) the limit for 1.705MHz – 30MHz is $30\mu\text{V/m}$ (=29.54 $\text{dB}\mu\text{V/m}$) at 30m

$$\text{Limit@3m} = \text{Limit@30m} + 40 \log \left(\frac{30}{3} \right) = 29.54 + 40.00 = 69.54 \text{ dB}\mu\text{V/m at 3m}$$

Example: from 15.209(a) the limit for 1GHz – 18GHz is $500\mu\text{V/m}$ (=53.98 $\text{dB}\mu\text{V/m}$) at 3m

$$\text{Limit@1m} = \text{Limit@3m} + 20 \log \left(\frac{3}{1} \right) = 53.98 + 9.54 = 63.52 \text{ dB}\mu\text{V/m at 1m}$$

3.4 Description of Test Methods and Equipment Setup

3.4.1 General Description

Testing was performed in accordance with the various requirements of ANSI C63.10. Any deviations from the test methods are described in section 3.6

Where different arrangements of equipment were used for different types of measurements, these are tabulated in section 3.4.2 and details of each arrangement are included in subsequent sections

3.4.2 Test Equipment Setup Used by Test Type

FCC 47 CFR Rule Part	Test Description	Test Equipment Used
15.209	Radiated Emissions (Intentional Radiators)	SAC5
15.247 (d)	Out of Band Emissions	CTE
15.247 (d)	Band Edge Compliance (Authorized band)	CTE
15.247 (d)	Band Edge Compliance (Restricted band)	SAC 5
15.247 (a)(1)	20dB Bandwidth	N/A
15.247 (a)(1)	Carrier (Hopping Channel) Separation	N/A
15.247 (a)(1)	Number of Hopping Channels	N/A
15.247 (a)(1)	Time of Occupancy (Dwell Time)	N/A
15.247 (a)(2)	6dB Bandwidth	CTE
15.247 (b)	Peak Conducted Output Power	CTE
15.247 (e)	Power Spectral Density	CTE

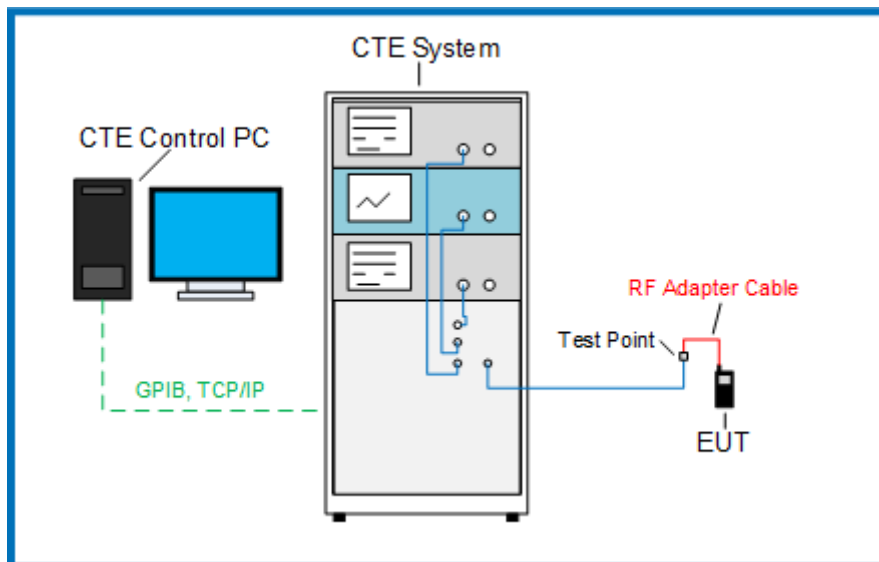
3.4.3 Test Equipment Setup – CTE System

The Comprehensive Test Environment (CTE) system consists of a number of instruments (see section 5.1.1) mounted in a rack together with automated relays and interconnecting hardware. The instruments and other equipment are controlled from a standard PC running software provided by the manufacturer. The RF output of the EUT is connected to the test system via a coaxial cable.

Tests are in the form of pre-defined scripts that can be loaded on the PC. The scripts, as well as the hardware setup, have been verified for conformance with the relevant test specifications.

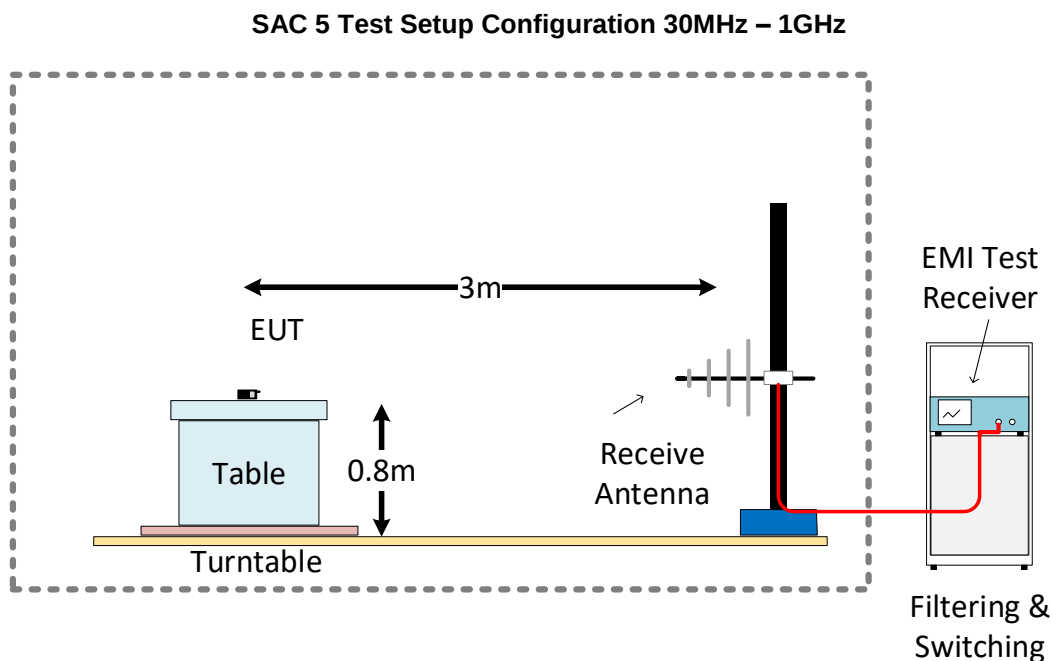
Losses in the cables and interconnects have been measured using the system's own automated routines and are compensated for automatically. Any additional loss in RF adapter cables supplied together with the EUT can be compensated for using the known characteristics of that adapter.

CTE Block Diagram

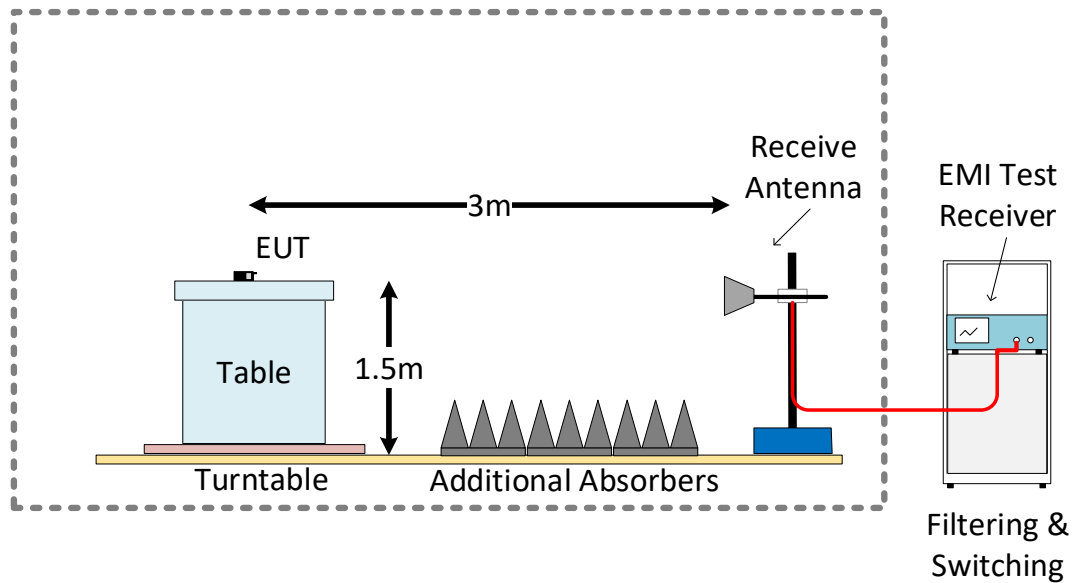


3.4.4 Test Equipment Setup – SAC 5 (Radiated Emissions and Restricted Band Edge)

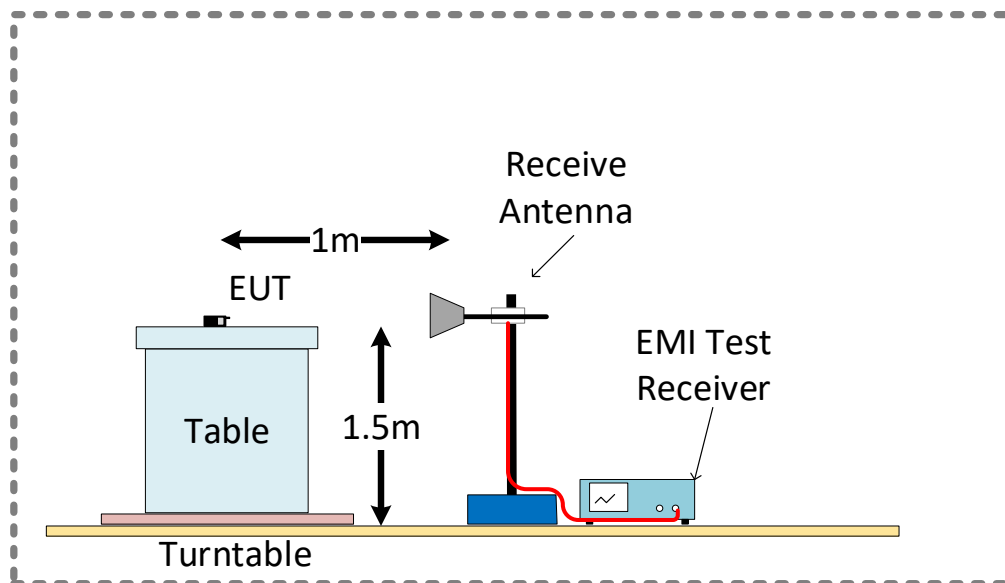
- For frequency range 30MHz-1GHz Log-Periodic Antenna was used. Antenna elevated from 100 cm from floor to 400 cm from floor, and was placed at 3 m from center of turntable in tilted position. The equipment under test (EUT) was placed at the middle of the turntable at 150 cm height from floor. The antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Repeat the measurement steps until the maximum emissions were obtained.
- For frequency range 1GHz-18GHz horn Antenna was used. Antenna elevated from 100 cm from floor to 200 cm from floor, and was placed at 3 m from center of turntable. The equipment under test (EUT) was placed at the middle of the turntable at 150 cm height from floor. The antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Repeat the measurement steps until the maximum emissions were obtained.
- For frequency range 18GHz-40GHz double horn Antenna was used. Antenna's height was adjusted to 150 cm from floor, and 1 m distance to center of turntable. The equipment under test (EUT) was placed at the middle of the turntable on at 150 cm height from floor.
- For all frequency ranges the turntable was rotated 360° for obtaining the maximum emission.



SAC 5 Test Setup Configuration 1GHz – 18GHz



SAC 5 Test Setup Configuration 18GHz – 40GHz



3.5 EUT Operation Modes

Operation mode	Description
#1	Transmitting at maximum power with a modulated signal on channels Low; Mid or High as required, using the supported data. A PC was used in order to set the EUT in the different required operation modes
#2	Operating in Direct Test Mode (DTM) as defined by Bluetooth specifications.

3.6 Deviations from the Test Standard

None

3.7 Environmental Conditions

3.7.1 Environmental Conditions – CTE System

Environmental Conditions Log - CTE

Date	Time	Temperature (°C)	Relative Humidity (%)
2020-04-29	15:40	22.9	28.7
2020-04-30	07:05	19.3	32.8

3.7.2 Environmental Conditions – SAC5 (Radiated Emissions)

See details for each individual test below

4. TEST RESULTS

4.1 Test Results – Radiated Emissions (Intentional Transmitter)

4.1.1 Radiated Emissions (Intentional) – Test Summary

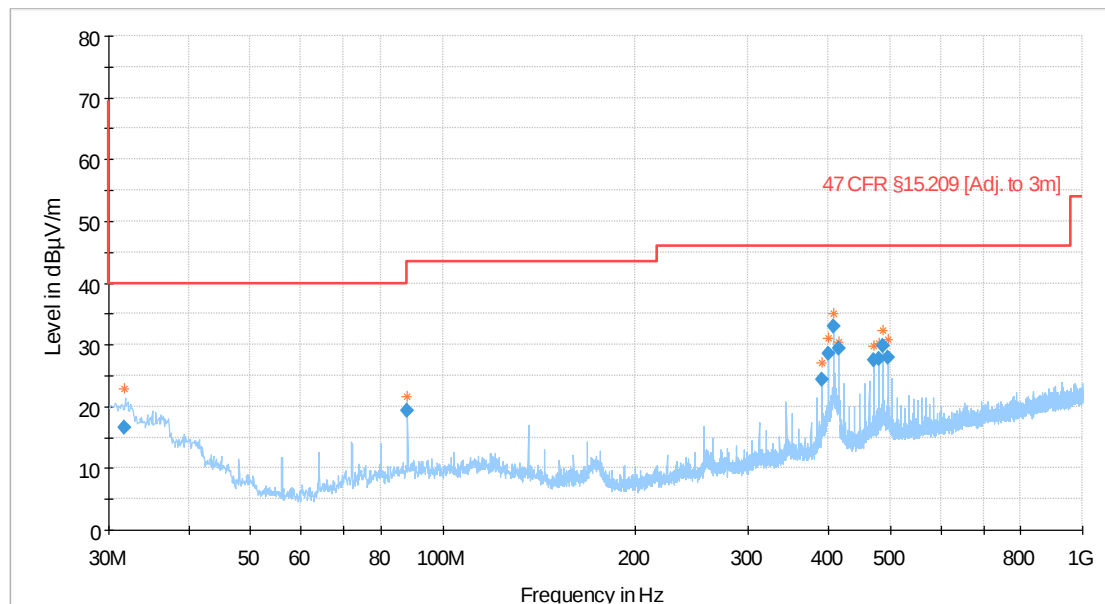
Test Specification		FCC 47 CFR 15.209 (Part 15 Subpart C)	
Test Engineer & Date		Fariborz Abasi Simon Palmhager	2020.02.19 – 2020.04.08
EUT and Ancillary Equipment IDs		A000256602-002	None
EUT Operation Mode(s)		#1	
EUT Wireless Configuration(s)		See below	
EUT Hardware Configuration(s)		-	
Overall Result		Pass	

Test Parameter	Wireless Configuration	Frequency Range	Result
Radiated Emissions	BLE Low Channel (2402 MHz) GFSK	30 MHz – 1 GHz	Pass
Radiated Emissions	BLE Low Channel (2402 MHz) GFSK	1 GHz – 18 GHz	Pass
Radiated Emissions	BLE Low Channel (2402 MHz) GFSK	18 GHz – 40 GHz	Pass
Radiated Emissions	BLE Mid Channel (2440 MHz) GFSK	30 MHz – 1 GHz	Pass
Radiated Emissions	BLE Mid Channel (2440 MHz) GFSK	1 GHz – 18 GHz	Pass
Radiated Emissions	BLE Mid Channel (2440 MHz) GFSK	18 GHz – 40 GHz	Pass
Radiated Emissions	BLE High Channel (2480 MHz) GFSK	30 MHz – 1 GHz	Pass
Radiated Emissions	BLE High Channel (2480 MHz) GFSK	1 GHz – 18 GHz	Pass
Radiated Emissions	BLE High Channel (2480 MHz) GFSK	18 GHz – 40 GHz	Pass

4.1.2 Radiated Emissions (Intentional) – Test Details

Low Channel

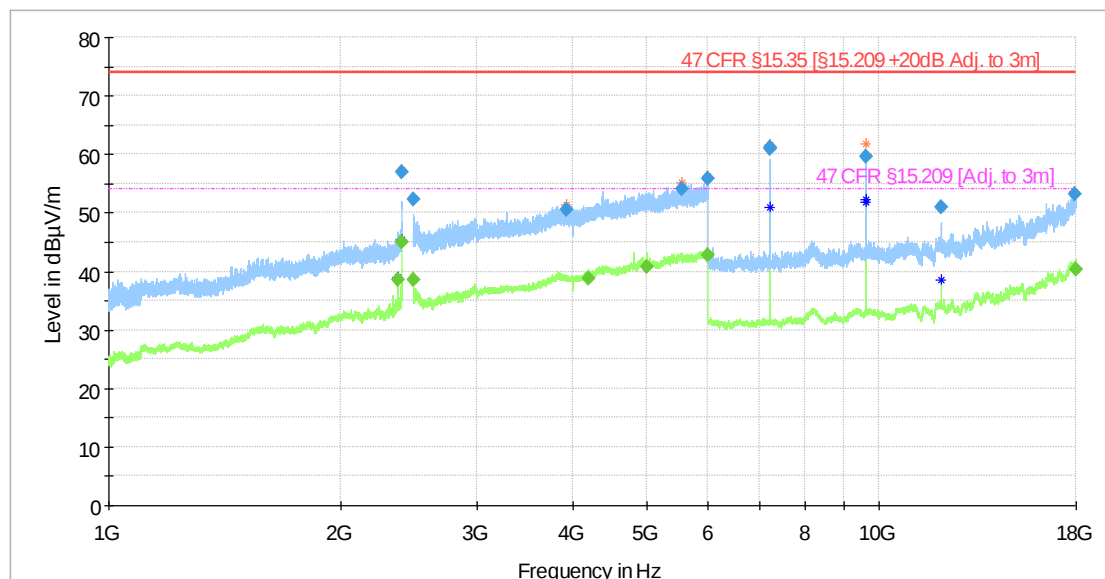
Test mode condition	Traffic – BLE Low channel	
Antenna orientation	Horizontal and Vertical	
Sweep frequency	30 MHz-1 GHz	
Standard	47 CFR FCC Part 15 subpart C	
EUT	A000256602-002	
Ancillary Equipment	None	
Test Engineer	Simon Palmhager	Date: 2020-02-19
Environmental conditions	Temperature: 20,7 °C	Humidity: 32,8 %
Chamber details	Chamber: SAC 5	



— PreviewResult 2-AVG
* Critical_Freqs AVG
— 47 CFR §15.209 [Adj. to 3m]
♦ Final_Result AVG
— PreviewResult 1-PK+
* Critical_Freqs PK+
♦ Final_Result QPK

Frequency (MHz)	QuasiPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
400.00712	28.64	---	46.02	17.38	1000	120	125	V	188
408.00816	32.93	---	46.02	13.09	1000	120	375	H	115
416.00152	29.36	---	46.02	16.66	1000	120	364	H	112
479.99728	27.67	---	46.02	18.35	1000	120	100	H	264
488.0178	29.77	---	46.02	16.25	1000	120	100	H	112
496.03684	27.87	---	46.02	18.15	1000	120	100	H	108

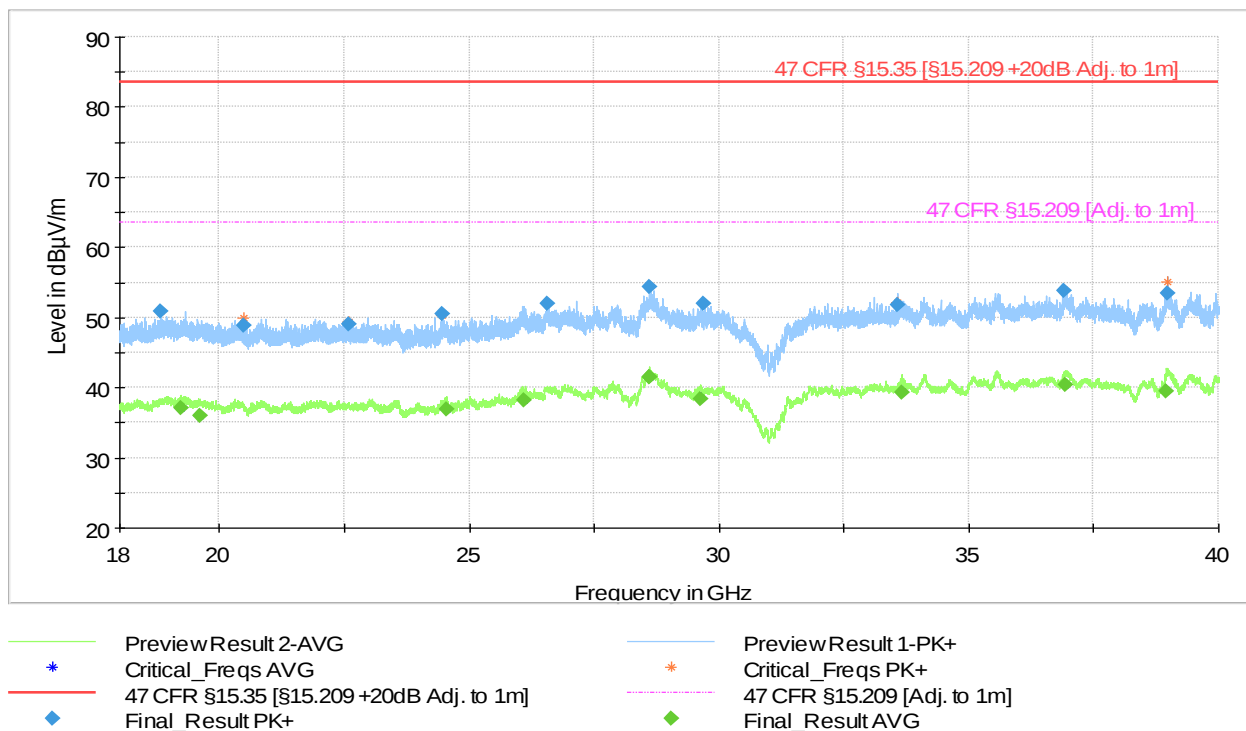
Test mode condition	Traffic – BLE Low channel	
Antenna orientation	Horizontal and Vertical	
Sweep frequency	1 GHz-18 GHz	
Standard	47 CFR FCC Part 15 subpart C	
EUT	A000256602-002	
Ancillary Equipment	None	
Test Engineer	Fariborz Abasi	Date: 2020-02-18
Environmental conditions	Temperature: 21,7 °C	Humidity: 34,6 %
Chamber details	Chamber: SAC 5	



	PreviewResult 2-AVG		PreviewResult 1-PK+
	Critical_Freqs AVG		Critical_Freqs PK+
	47 CFR §15.35 [§15.209 +20dB Adj. to 3m]		47 CFR §15.209 [Adj. to 3m]
	Final_Result PK+		Final_Result AVG
	MaxPeak-PK+ (Single)		Average-AVG (Single)

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2399.9928	---	45.05	53.98	8.93	1000	1000	138	H	265
4999.603	---	40.86	53.98	13.12	1000	1000	100	H	157
5989.191	---	42.7	53.98	11.28	1000	1000	100	H	129
7205.316	61.2	---	73.98	12.78	1000	1000	210	V	318
7205.365	60.99	---	73.98	12.99	1000	1000	206	V	318
17998.514	---	40.27	53.98	13.71	1000	1000	125	H	228

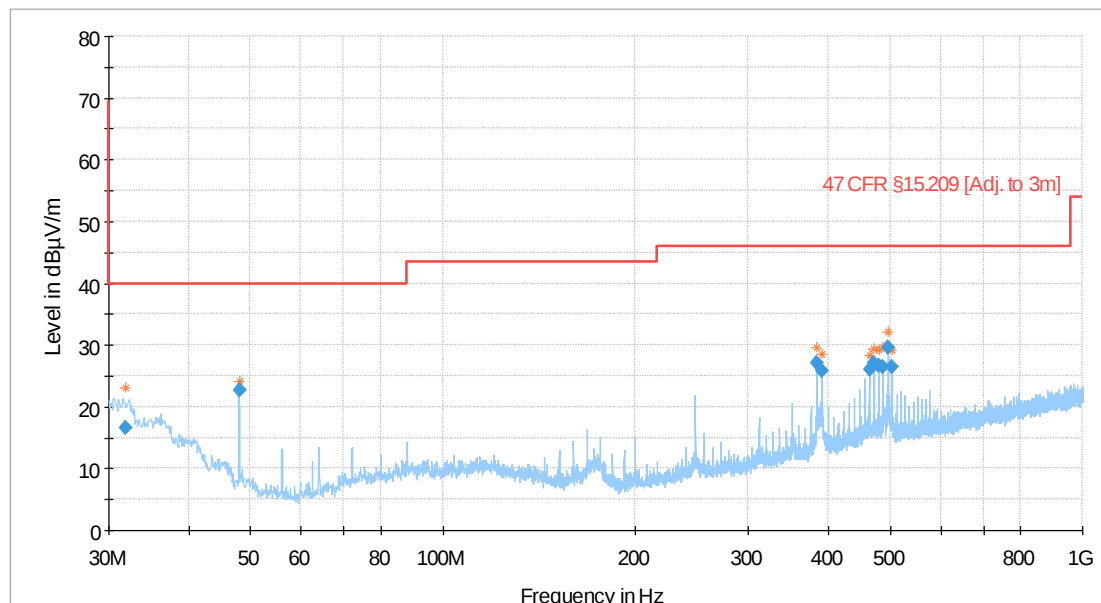
Test mode condition	Traffic – BLE Low channel	
Antenna orientation	Horizontal and Vertical	
Sweep frequency	18 GHz-40 GHz	
Standard	47 CFR FCC Part 15 subpart C	
EUT	A000256602-002	
Ancillary Equipment	None	
Test Engineer	Fariborz Abasi	Date: 2020-04-08
Environmental conditions	Temperature: 18,4 °C	Humidity: 32,8 %
Chamber details	Chamber: SAC 5	



Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
28601.619000	---	41.48	63.52	22.05	1000.0	1000.000	155.0	H	10.0
28605.925000	---	41.50	63.52	22.03	1000.0	1000.000	155.0	H	10.0
29624.762000	---	38.41	63.52	25.12	1000.0	1000.000	155.0	H	202.0
33655.297000	---	39.34	63.52	24.18	1000.0	1000.000	155.0	H	337.0
36924.716000	---	40.37	63.52	23.16	1000.0	1000.000	155.0	H	97.0
38962.670000	---	39.52	63.52	24.00	1000.0	1000.000	155.0	V	157.0

Mid Channel

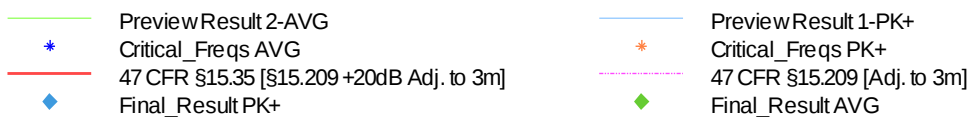
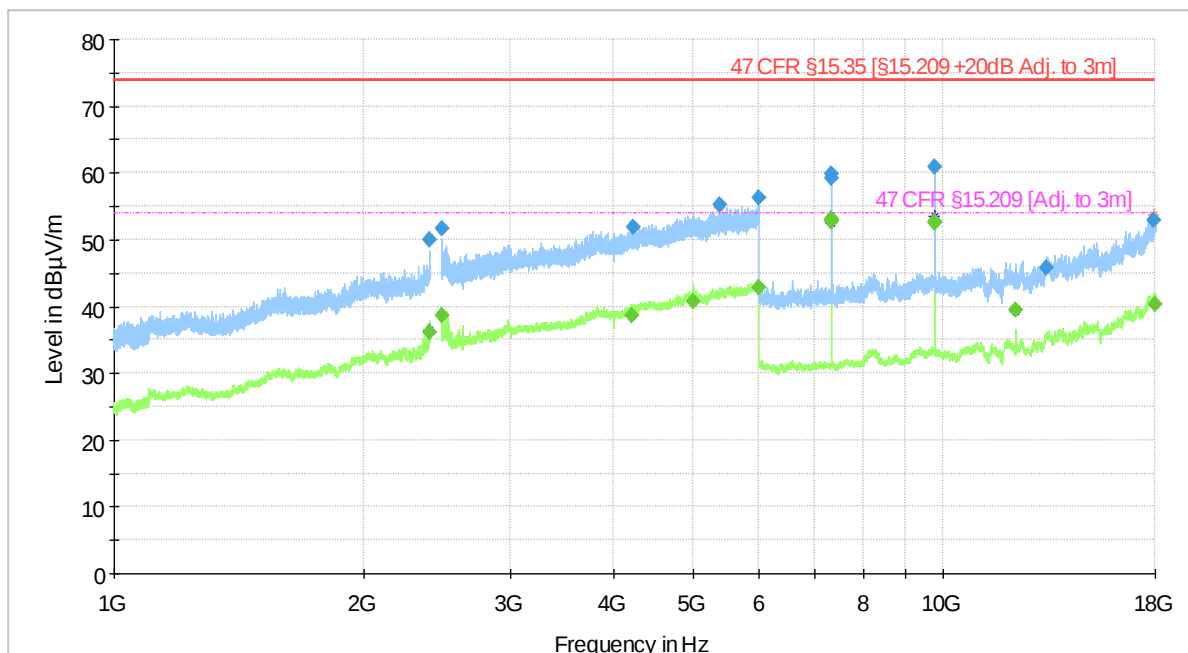
Test mode condition	Traffic- BLE Mid channel	
Antenna orientation	Horizontal and Vertical	
Sweep frequency	30 MHz-1 GHz	
Standard	47 CFR FCC Part 15 subpart C	
EUT	A000256602-002	
Ancillary Equipment	None	
Test Engineer	Simon Palmhager	Date: 2020-02-19
Environmental conditions	Temperature: 20,7 °C	Humidity: 32,8 %
Chamber details	Chamber: SAC 5	



— PreviewResult 2-AVG
* Critical_Freqs AVG
— 47 CFR §15.209 [Adj. to 3m]
◆ Final Result AVG
— PreviewResult 1-PK+
* Critical_Freqs PK+
◆ Final Result QPK

Frequency (MHz)	QuasiPeak (dBμV/m)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
48.0014	22.6	---	40	17.4	1000	120	100	V	95
384.00856	27.17	---	46.02	18.85	1000	120	100	H	116
472.00872	27	---	46.02	19.02	1000	120	299	H	63
480.01024	26.61	---	46.02	19.41	1000	120	252	H	71
495.9958	29.64	---	46.02	16.38	1000	120	227	H	116
504.00984	26.49	---	46.02	19.53	1000	120	226	H	130

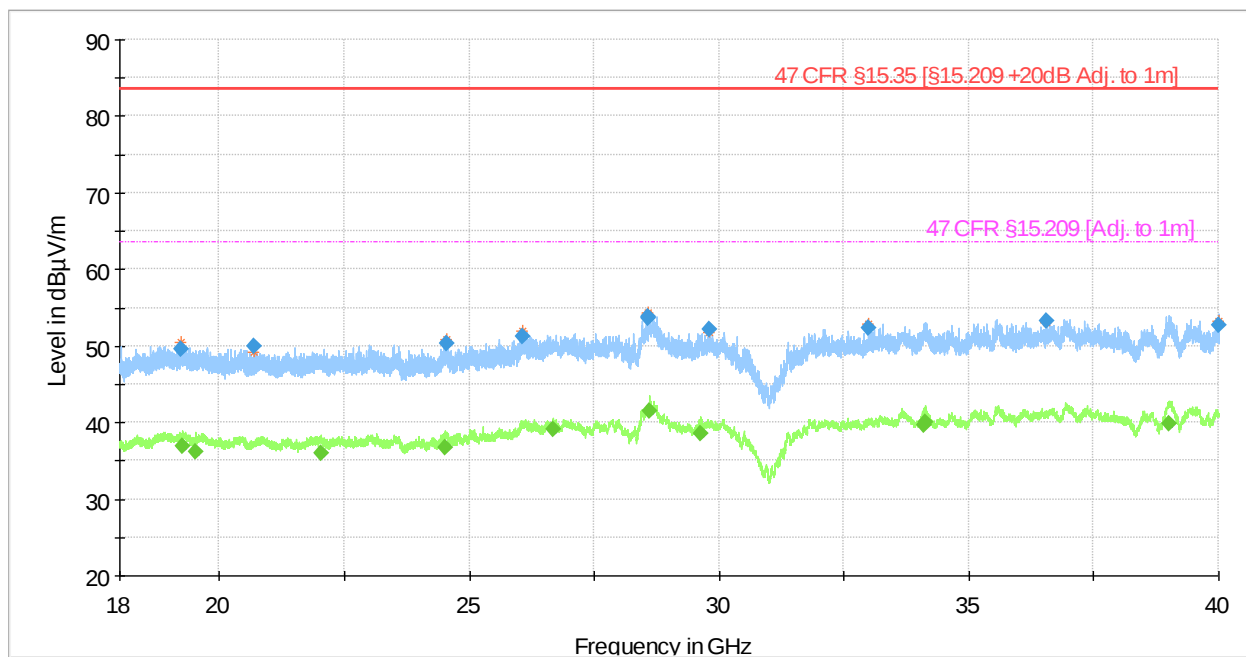
Test mode condition	Traffic- BLE Mid channel	
Antenna orientation	Horizontal and Vertical	
Sweep frequency	1 GHz-18 GHz	
Standard	47 CFR FCC Part 15 subpart C	
EUT	A000256602-002	
Ancillary Equipment	None	
Test Engineer	Fariborz Abasi	Date: 2020-04-01
Environmental conditions	Temperature: 18,1 °C	Humidity: 32,4 %
Chamber details	Chamber: SAC 5	



Frequency (MHz)	MaxPeak (dBμV/m)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
5980.596000	---	42.87	53.98	11.11	1000.0	1000.000	175.0	H	293.0
7319.316000	---	52.96	53.98	1.02*	1000.0	1000.000	197.0	V	232.0
7319.449000	---	52.72	53.98	1.25*	1000.0	1000.000	198.0	V	229.0
7319.460000	---	53.03	53.98	0.95*	1000.0	1000.000	210.0	V	229.0
9759.032000	---	52.78	53.98	1.20*	1000.0	1000.000	206.0	V	127.0
9759.232000	---	52.49	53.98	1.49*	1000.0	1000.000	206.0	V	307.0

Remark: Emission at Frequencies marked with * in above table are closer to the margin than the calculated measurement uncertainty for the used measurement system. This emission peaks could be challenged please consider this. For these frequencies the measurement uncertainties is 4,88 dB (See section 6.2 in this rapport with a 95% confidence).

Test mode condition	Traffic- BLE Mid channel	
Antenna orientation	Horizontal and Vertical	
Sweep frequency	18 GHz-40 GHz	
Standard	47 CFR FCC Part 15 subpart C	
EUT	A000256602-002	
Ancillary Equipment	None	
Test Engineer	Fariborz Abasi	Date: 2020-04-08
Environmental conditions	Temperature: 18,4 °C	Humidity: 32,8 %
Chamber details	Chamber: SAC 5	

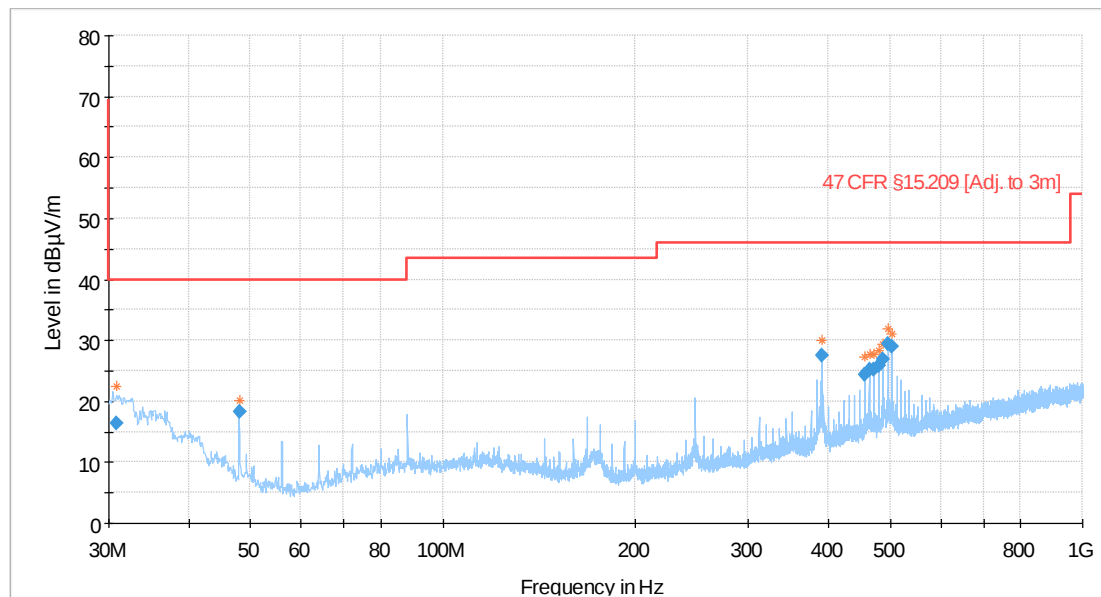


- PreviewResult 2-AVG
- PreviewResult 1-PK+
- * Critical_Freqs AVG
- * Critical_Freqs PK+
- 47 CFR §15.35 [§15.209 +20dB Adj. to 1m]
- 47 CFR §15.209 [Adj. to 1m]
- ◆ Final_Result PK+
- ◆ Final_Result AVG

Frequency (MHz)	MaxPeak (dBμV/m)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
26678.978000	---	39.02	63.52	24.50	1000.0	1000.000	155.0	V	157.0
28609.293000	---	41.54	63.52	21.98	1000.0	1000.000	155.0	V	5.0
29629.997000	---	38.49	63.52	25.03	1000.0	1000.000	155.0	V	187.0
34084.638000	---	39.72	63.52	23.80	1000.0	1000.000	155.0	H	322.0
34124.479000	---	40.02	63.52	23.50	1000.0	1000.000	155.0	V	172.0
38995.463000	---	39.86	63.52	23.66	1000.0	1000.000	155.0	V	187.0

High Channel

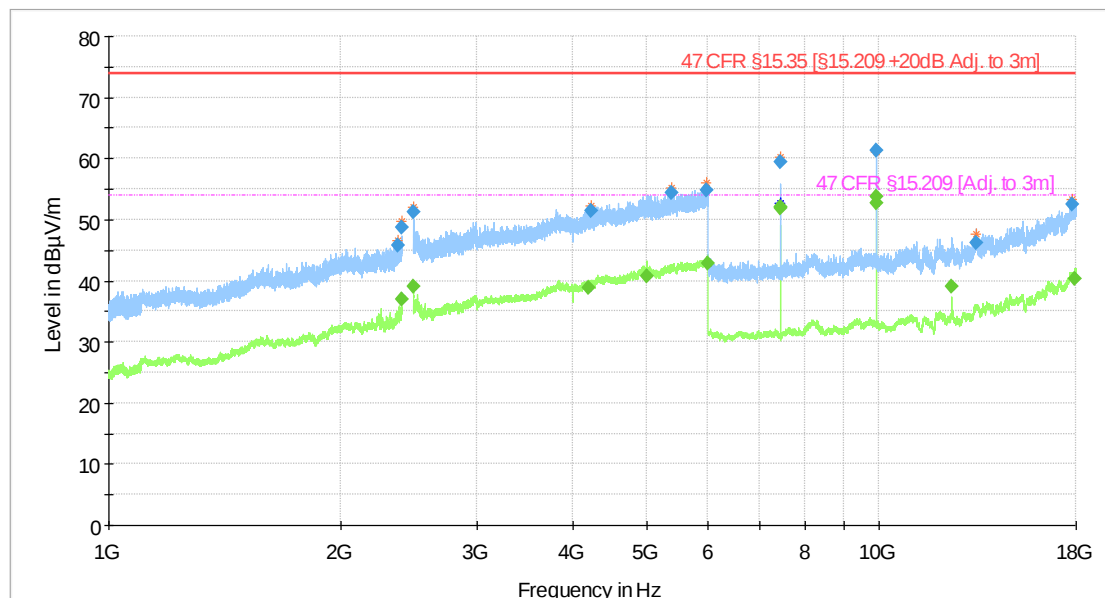
Test mode condition	Traffic – BLE high channel	
Antenna orientation	Horizontal and Vertical	
Sweep frequency	30 MHz-1 GHz	
Standard	47 CFR FCC Part 15 subpart C	
EUT	A000256602-002	
Ancillary Equipment	None	
Test Engineer	Simon Palmhager	Date: 2020-02-19
Environmental conditions	Temperature: 20,7 °C	Humidity: 32,8 %
Chamber details	Chamber: SAC 5	



— PreviewResult 2-AVG
* Critical_Freqs AVG
— 47 CFR §15.209 [Adj. to 3m]
◆ Final_Result AVG
— PreviewResult 1-PK+
* Critical_Freqs PK+
◆ Final_Result QPK

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
392.0034	---	46.02	18.43	1000	120	100	H	247
472.01256	---	46.02	20.75	1000	120	280	H	67
480.01228	---	46.02	20.26	1000	120	279	H	97
487.99284	---	46.02	19.16	1000	120	275	H	263
496	---	46.02	16.67	1000	120	264	H	116
504.00636	---	46.02	16.96	1000	120	275	H	128

Test mode condition	Traffic- BLE high channel	
Antenna orientation	Horizontal and Vertical	
Sweep frequency	1 GHz-18 GHz	
Standard	47 CFR FCC Part 15 subpart C	
EUT	A000256602-002	
Ancillary Equipment	None	
Test Engineer	Simon Palmhager	Date: 2020-02-19
Environmental conditions	Temperature: 20,7 °C	Humidity: 32,8 %
Chamber details	Chamber: SAC 5	

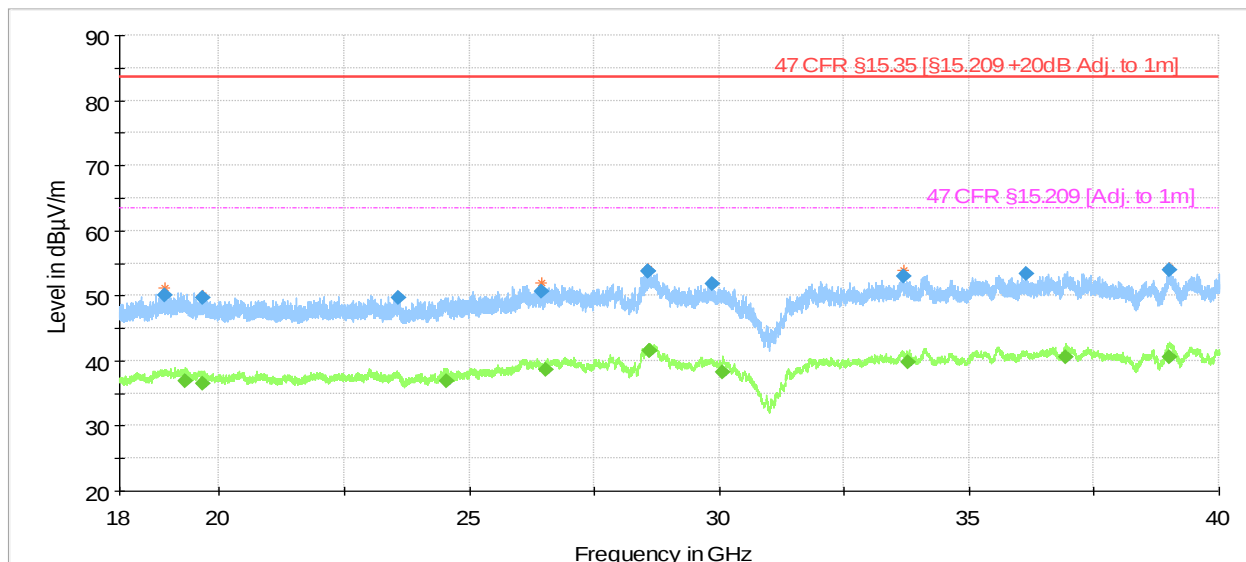


— PreviewResult 2-AVG
— PreviewResult 1-PK+
* Critical_Freqs AVG
* Critical_Freqs PK+
◆ 47 CFR §15.35 [§15.209 +20dB Adj. to 3m]
◆ 47 CFR §15.209 [Adj. to 3m]
◆ Final_Result PK+
◆ Final_Result AVG

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
5981.729	---	42.91	53.98	11.07	1000	1000	100	V	338
7439.442	---	51.93	53.98	2.05*	1000	1000	210	V	318
7440.691	---	52.07	53.98	1.91*	1000	1000	210	V	319
9920.961	---	52.68	53.98	1.3*	1000	1000	185	V	247
9920.974	---	53.81	53.98	0.17*	1000	1000	206	V	229
9921.105	61.29	---	73.98	12.69	1000	1000	185	V	228

Remark: Emission at Frequencies marked with * in above table are closer to the margin than the calculated measurement uncertainty for the used measurement system. This emission peaks could be challenged please consider this. For these frequencies the measurement uncertainties is 4,88 dB (See section 6.2 in this rapport with a 95% confidence).

Test mode condition	Traffic- BLE high channel	
Antenna orientation	Horizontal and Vertical	
Sweep frequency	18 GHz-40 GHz	
Standard	47 CFR FCC Part 15 subpart C	
EUT	A000256602-002	
Ancillary Equipment	None	
Test Engineer	Fariborz Abasi	Date: 2020-04-08
Environmental conditions	Temperature: 18,4 °C	Humidity: 32,8 %
Chamber details	Chamber: SAC 5	



— PreviewResult 2-AVG
— PreviewResult 1-PK+
* Critical_Freqs AVG
* Critical_Freqs PK+
— 47 CFR §15.35 [§15.209 +20dB Adj. to 1m]
— 47 CFR §15.209 [Adj. to 1m]
◆ Final_Result PK+
◆ Final_Result AVG
× MaxPeak-PK+ (Single)
+ Average-AVG (Single)

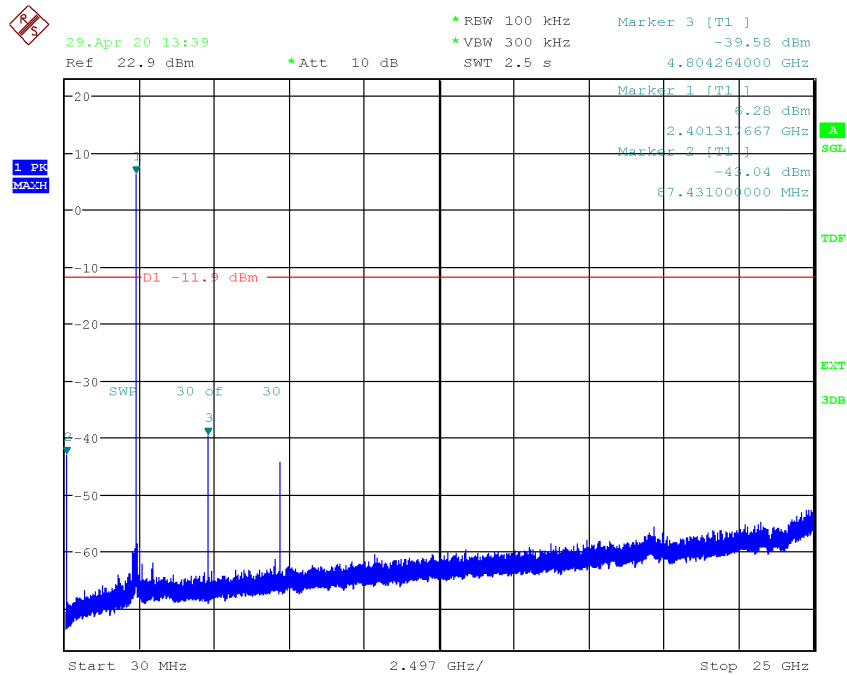
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
26545.435000	---	38.54	63.52	24.98	1000.0	1000.000	155.0	H	305.0
28603.940000	---	41.51	63.52	22.02	1000.0	1000.000	155.0	H	52.0
28604.678000	---	41.49	63.52	22.04	1000.0	1000.000	155.0	H	64.0
33788.032000	---	39.77	63.52	23.76	1000.0	1000.000	155.0	V	82.0
36933.948000	---	40.62	63.52	22.90	1000.0	1000.000	155.0	H	37.0
38993.447000	---	40.48	63.52	23.04	1000.0	1000.000	155.0	H	142.0

4.2 Test Results – Out of Band Emissions

4.2.1 Out of Band Emissions – Test Summary

Test Specification	47 CFR 15.247 (d)				
Test Engineer & Date	Niall Forrester		2020-04-29		
EUT and Ancillary Equipment IDs	A002813643_001		None		
EUT Operation Mode(s)	#2				
EUT Wireless Configuration(s)	See below				
EUT Hardware Configuration(s)	-				
Overall Result	Pass				
Test Parameter	Wireless Configuration	Tx Pwr (dBm)	Measured Lvl (dBm)	Limit (dBm)	Result
Spurious Emissions (30 MHz – 25 GHz)	BLE Low Channel (2402 MHz) GFSK – 1 MB/s	8.06	-39.58	-11.94	Pass
Spurious Emissions (30 MHz – 25 GHz)	BLE Low Channel (2402 MHz) GFSK – 2 MB/s	7.99	-40.16	-12.01	Pass
Spurious Emissions (30 MHz – 25 GHz)	BLE Mid Channel (2444 MHz) GFSK – 1 MB/s	7.81	-41.51	-12.19	Pass
Spurious Emissions (30 MHz – 25 GHz)	BLE Mid Channel (2444 MHz) GFSK – 2 MB/s	7.77	-42.79	-12.23	Pass
Spurious Emissions (30 MHz – 25 GHz)	BLE High Channel (2480 MHz) GFSK – 1 MB/s	7.89	-42.06	-12.11	Pass
Spurious Emissions (30 MHz – 25 GHz)	BLE High Channel (2480 MHz) GFSK – 2 MB/s	7.83	-44.83	-12.17	Pass

4.2.2 Out of Band Emissions – Test Details (Worst Case Plot)



Date: 29.APR.2020 13:39:50

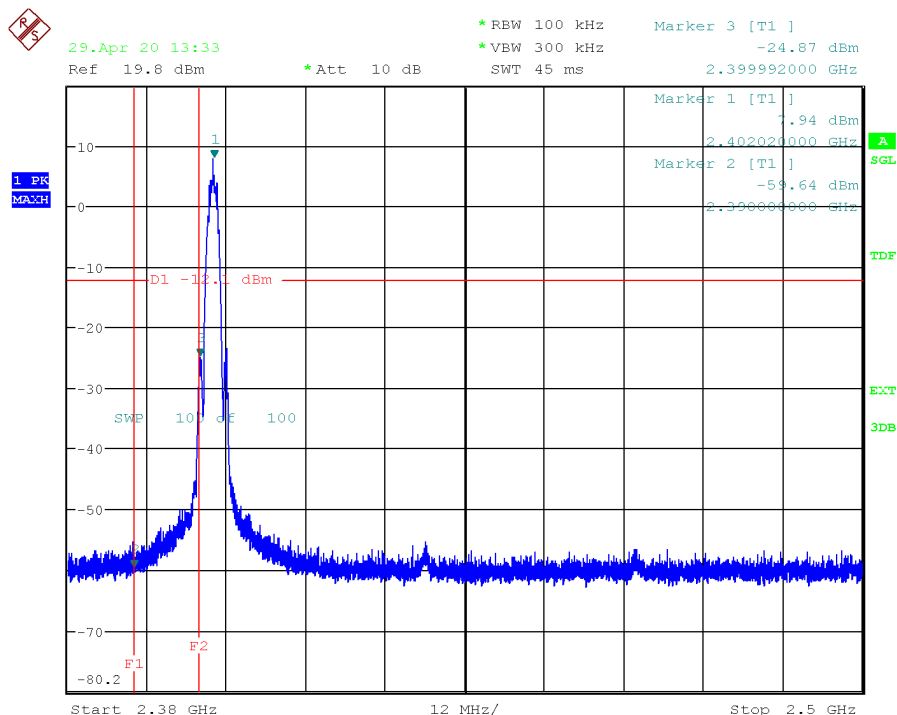
4.3 Test Results – Band Edge Compliance (Authorized Band)

4.3.1 Band Edge Compliance (Authorized Band) – Test Summary

Test Specification	47 CFR 15.247 (d)			
Test Engineer & Date	Niall Forrester		2020.04.29	
EUT and Ancillary Equipment IDs	A002813643_001		None	
EUT Operation Mode(s)	#2			
EUT Wireless Configuration(s)	See below			
EUT Hardware Configuration(s)	-			
Overall Result	Pass			

Test Parameter	Wireless Configuration	Measured Level (dBm)	Limit (dBm)	Result
Emissions at Band Edge (Auth. Band – Low Edge)	BLE Low Channel (2402 MHz) GFSK – 1 MB/s	-46.16	-11.96	Pass
Emissions at Band Edge (Auth. Band – Low Edge)	BLE Low Channel (2402 MHz) GFSK – 2 MB/s	-24.87	-12.06	Pass
Emissions at Band Edge (Auth. Band – High Edge)	BLE High Channel (2480 MHz) GFSK – 1 MB/s	-52.91	-12.10	Pass
Emissions at Band Edge (Auth. Band – High Edge)	BLE High Channel (2480 MHz) GFSK – 2 MB/s	-48.02	-12.7	Pass

4.3.2 Band Edge Compliance (Authorized Band) – Test Details (Worst Case Plot)



Date: 29.APR.2020 13:33:39

4.4 Test Results – Band Edge Compliance (Restricted Band)

4.4.1 Band Edge Compliance (Restricted Band) – Test Summary

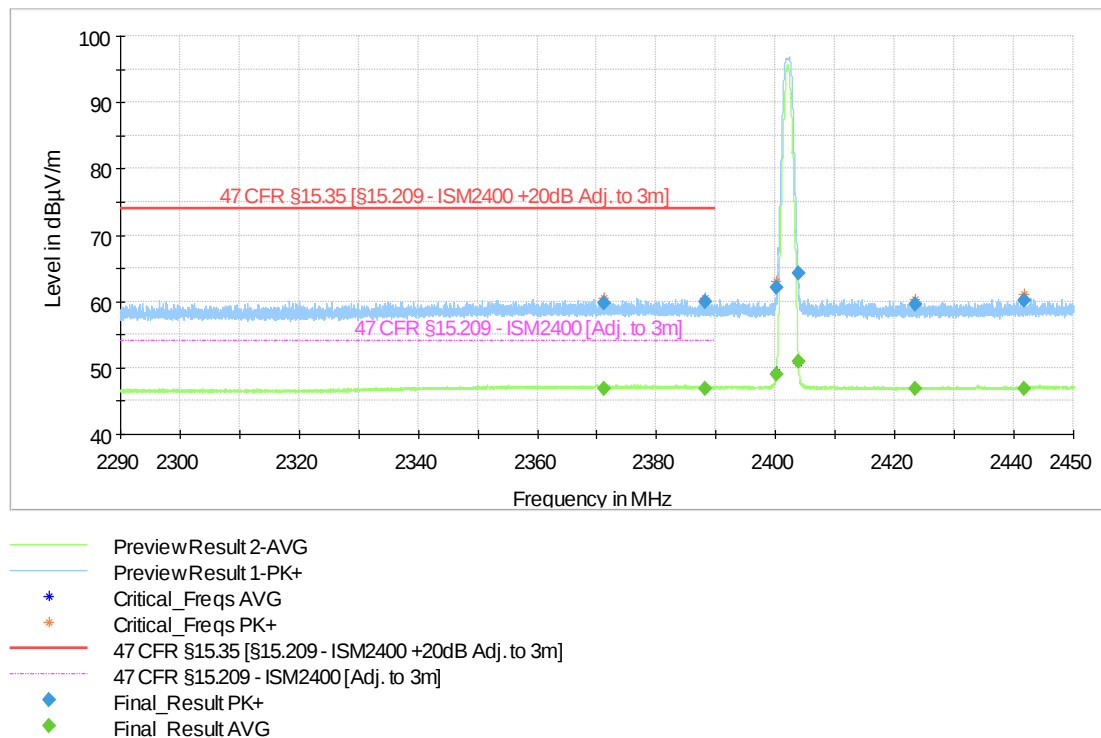
Test Specification	47 CFR 15.209 & 15.247 (d)	
Test Engineer & Date	Sam Ebadeh	2020-02-20
EUT and Ancillary Equipment IDs	A000256602-002	None
EUT Operation Mode(s)	#1	
EUT Wireless Configuration(s)	See below	
EUT Hardware Configuration(s)	-	
Overall Result	Pass	
Test Parameter	Wireless Configuration	Result*
Emissions at Band Edge (Rest. Band – Low Edge)	BLE Low Channel (2402 MHz) GFSK	PASS
Emissions at Band Edge (Rest. Band – High Edge)	BLE High Channel (2480 MHz) GFSK	PASS

* For detailed measurements, see tables and graphs in sections below

4.4.2 Band Edge Compliance (Restricted Band) – Test Details

Restricted Band – Low Edge – GFSK

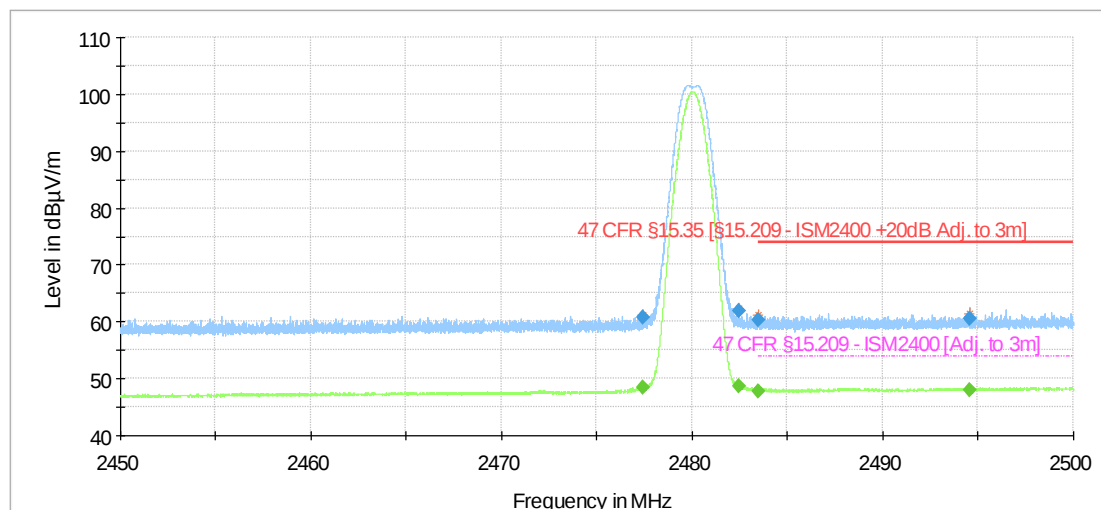
Test mode condition	Traffic – Band Edge BLE low channel	
Antenna orientation	Horizontal and Vertical	
Sweep frequency	2290 MHz-2450 MHz	
Standard	47 CFR FCC Part 15 subpart C	
EUT	A000256602-002	
Ancillary Equipment	None	
Test Engineer	Sam Ebadeh	Date: 2020-02-20
Environmental conditions	Temperature: 18,4 °C	Humidity: 36,6 %
Chamber details	Chamber: SAC 5	



Frequency (MHz)	MaxPeak (dBμV/m)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2371.216	---	46.94	53.98	7.04	1000	1000	210	H	282
2371.216	59.71	---	73.98	14.27	1000	1000	210	H	0
2388.112	---	46.87	53.98	7.11	1000	1000	134	H	285
2388.112	60	---	73.98	13.98	1000	1000	204	V	316

Restricted Band – High Edge – GTSK

Test mode condition	Traffic – Band Edge BLE high channel	
Antenna orientation	Horizontal and Vertical	
Sweep frequency	2450 MHz-2500 MHz	
Standard	47 CFR FCC Part 15 subpart C	
EUT	A000256602-002	
Ancillary Equipment	None	
Test Engineer	Sam Ebadeh	Date: 2020-02-20
Environmental conditions	Temperature: 18,4 °C	Humidity: 36,6 %
Chamber details	Chamber: SAC 5	



- PreviewResult 2-AVG
- PreviewResult 1-PK+
- Critical_Freqs AVG
- Critical_Freqs PK+
- 47 CFR §15.35 [§15.209 - ISM2400 +20dB Adj. to 3m]
- 47 CFR §15.209 - ISM2400 [Adj. to 3m]
- Final_Result PK+
- Final_Result AVG

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2483.5	---	47.86	53.98	6.12	1000	1000	111	H	168
2483.5	60.35	---	73.98	13.63	1000	1000	111	H	0
2494.59	---	47.94	53.98	6.04	1000	1000	192	H	177
2494.59	60.58	---	73.98	13.4	1000	1000	145	V	0

4.5 Test Results – 20dB Bandwidth

4.5.1 20dB Bandwidth – Test Summary

Requirement is not applicable as the device is non-hopping

4.6 Test Results – Carrier (Hopping Channel) Separation

4.6.1 Carrier (Hopping Channel) Separation – Test Summary

Requirement is not applicable as the device is non-hopping

4.7 Test Results – Number of Hopping Channels

4.7.1 Number of Hopping Channels – Test Summary

Requirement is not applicable as the device is non-hopping

4.8 Test Results – Time of Occupancy (Dwell Time)

4.8.1 Time of Occupancy (Dwell Time) – Test Summary

Requirement is not applicable as the device is non-hopping

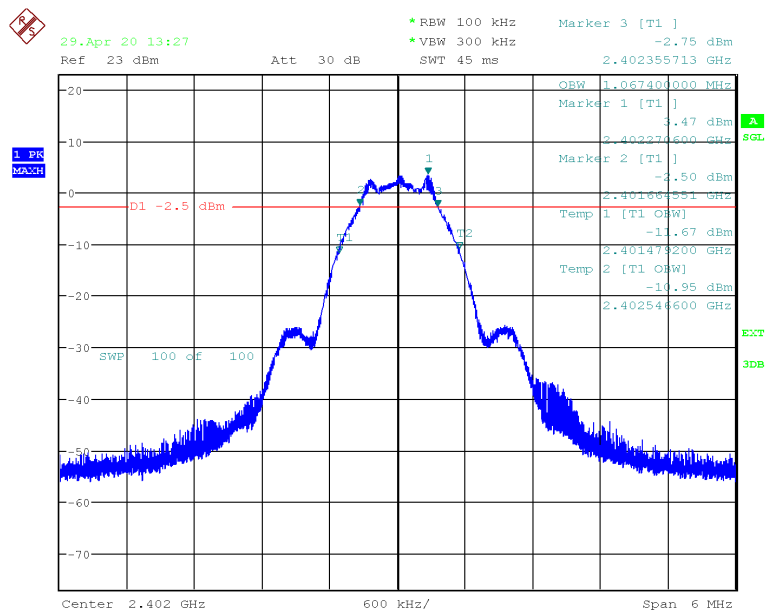
4.9 Test Results – 6dB Bandwidth

4.9.1 6dB Bandwidth – Test Summary

Test Specification	47 CFR 15.247 (a)(2)			
Test Engineer & Date	Niall Forrester		2020.04.29	
EUT and Ancillary Equipment IDs	A002813643_001		None	
EUT Operation Mode(s)	#2			
EUT Wireless Configuration(s)	See below			
EUT Hardware Configuration(s)	-			
Overall Result	Pass			

Test Parameter	Wireless Configuration	Measured Level (kHz)	Limit (kHz)	Result
6dB Bandwidth	BLE Low Channel (2402 MHz) GFSK – 1 MB/s	691.2	500	Pass
6dB Bandwidth	BLE Low Channel (2402 MHz) GFSK – 2 MB/s	1144.2	500	Pass
6dB Bandwidth	BLE Mid Channel (2444 MHz) GFSK – 1 MB/s	696	500	Pass
6dB Bandwidth	BLE Mid Channel (2444 MHz) GFSK – 2 MB/s	1144.8	500	Pass
6dB Bandwidth	BLE High Channel (2480 MHz) GFSK – 1 MB/s	700.2	500	Pass
6dB Bandwidth	BLE High Channel (2480 MHz) GFSK – 2 MB/s	1141.2	500	Pass

4.9.2 6dB Bandwidth – Test Details (Worst Case Plot)



Date: 29.APR.2020 13:27:36

4.10 Test Results – Peak Conducted Output Power

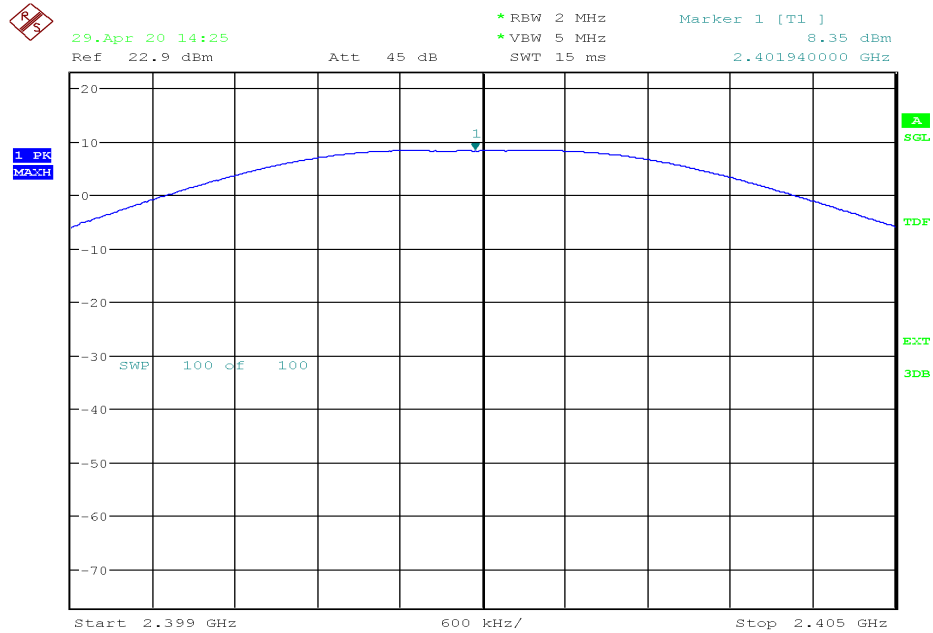
4.10.1 Peak Conducted Output Power – Test Summary

Test Specification	47 CFR 15.247(b)	
Test Engineer & Date	Niall Forrester	2020.04-29 – 2020-04-30
EUT and Ancillary Equipment IDs	A002813643_001	None
EUT Operation Mode(s)	#2	
EUT Wireless Configuration(s)	See below	
EUT Hardware Configuration(s)	-	
Overall Result	Pass	

Test Parameter	Wireless Configuration	Measured Level (dBm)			Limit (dBm)		Result
		Low 2.5 V	Nom 3.0 V	High 3.2V	Low	High	
Peak Conducted Output Power	BLE Low Channel (2402 MHz) GFSK – 1 MB/s	8.34	8.37	8.37	-20	30	Pass
Peak Conducted Output Power	BLE Low Channel (2402 MHz) GFSK – 2 MB/s	8.35	8.38	8.38	-20	30	Pass
Peak Conducted Output Power	BLE Mid Channel (2444 MHz) GFSK – 1 MB/s	8.06	8.12	8.12	-20	30	Pass
Peak Conducted Output Power	BLE Mid Channel (2444 MHz) GFSK – 2 MB/s	8.11	8.14	8.14	-20	30	Pass
Peak Conducted Output Power	BLE High Channel (2480 MHz) GFSK – 1 MB/s	8.14	8.18	8.17	-20	30	Pass
Peak Conducted Output Power	BLE High Channel (2480 MHz) GFSK – 2 MB/s	8.16	8.23	8.19	-20	30	Pass

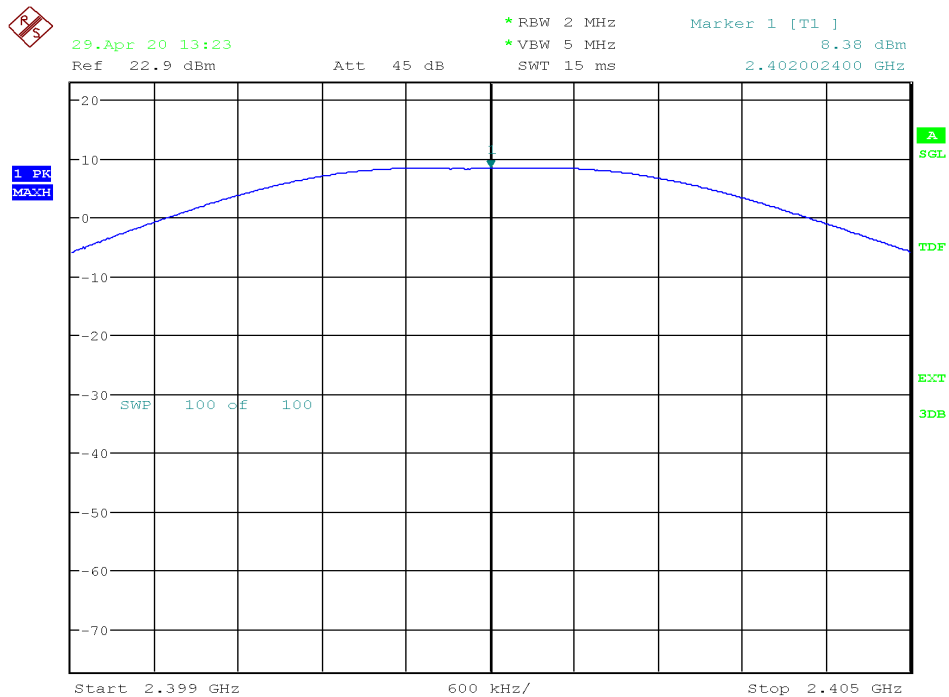
4.10.2 Peak Conducted Output Power – Test Details (Worst Case Plot)

Minimum Voltage (2.5 V)



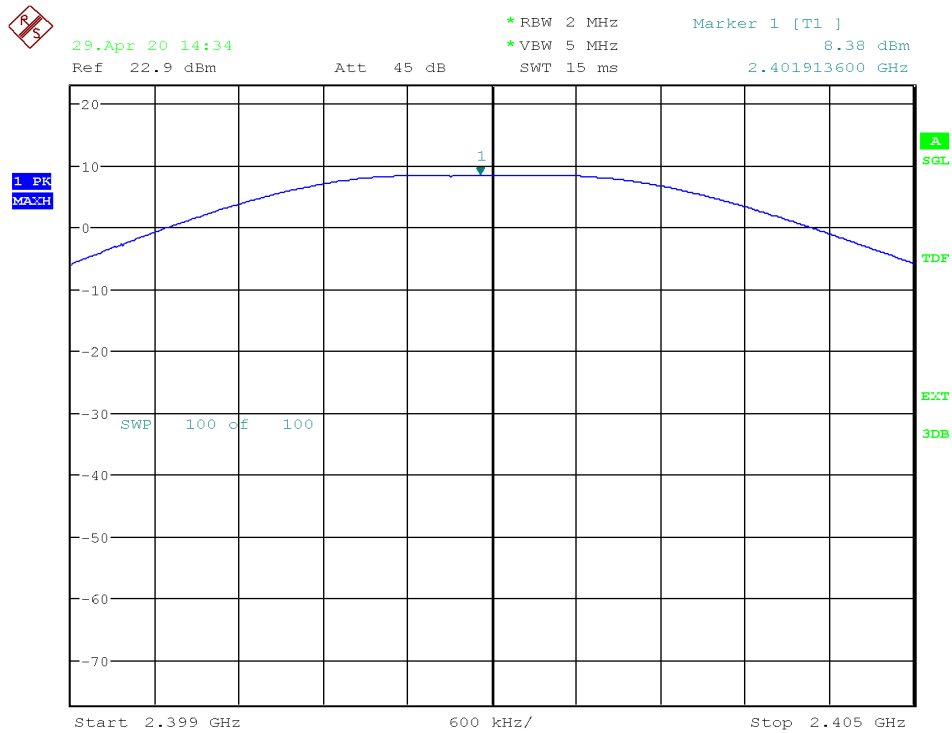
Date: 29.APR.2020 14:25:28

Nominal Voltage (3.0 V)



Date: 29.APR.2020 13:23:30

Maximum Voltage (3.2 V)



Date: 29.APR.2020 14:34:01

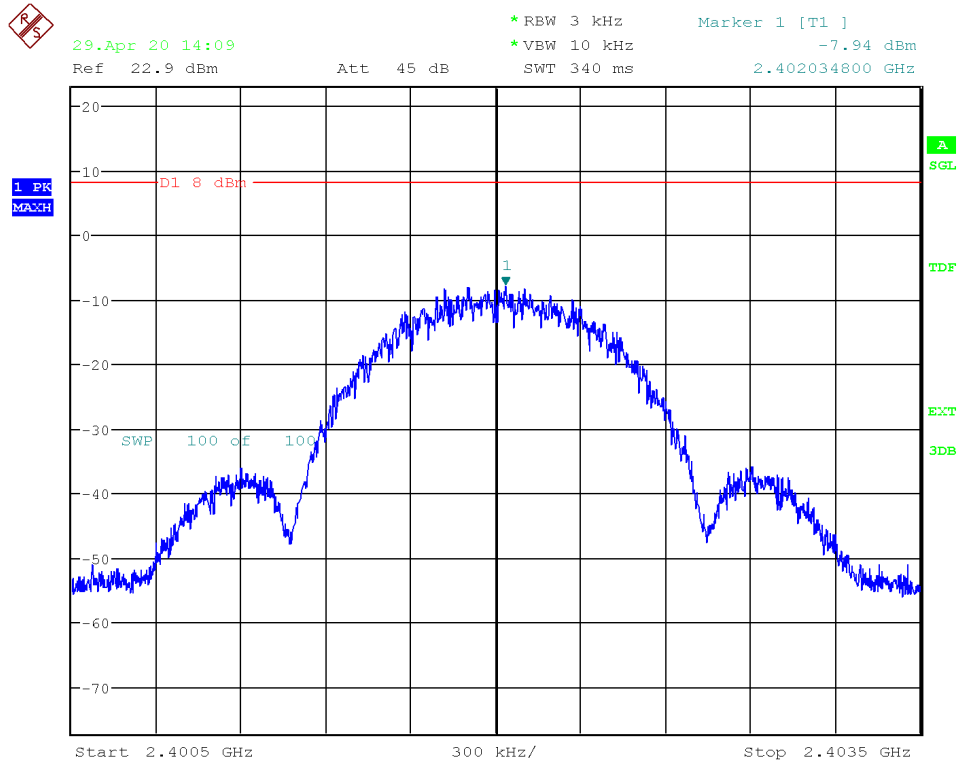
4.11 Test Results – Power Spectral Density

4.11.1 Power Spectral Density – Test Summary

Test Specification		47 CFR 15.247 (e)			
Test Engineer & Date		Niall Forrester		2020.04.30	
EUT and Ancillary Equipment IDs		A002813643_001		None	
EUT Operation Mode(s)		#2			
EUT Wireless Configuration(s)		See below			
EUT Hardware Configuration(s)		-			
Overall Result		Pass			

Test Parameter	Wireless Configuration	Measured (dBm/3kHz)	Low Limit (dBm/3kHz)	High Limit (dBm/3kHz)	Result
Power Density	BLE Low Channel (2402 MHz) GFSK – 1 MB/s	-7.94	-30	8	Pass
Power Density	BLE Low Channel (2402 MHz) GFSK – 2 MB/s	-9.69	-30	8	Pass
Power Density	BLE Mid Channel (2444 MHz) GFSK – 1 MB/s	-8.12	-30	8	Pass
Power Density	BLE Mid Channel (2444 MHz) GFSK – 2 MB/s	-10.07	-30	8	Pass
Power Density	BLE High Channel (2480 MHz) GFSK – 1 MB/s	-8.01	-30	8	Pass
Power Density	BLE High Channel (2480 MHz) GFSK – 2 MB/s	-10.08	-30	8	Pass

4.11.2 Power Spectral Density – Test Details (Worst Case Plot)



Date: 29.APR.2020 14:09:09

5. TEST EQUIPMENT STATUS

5.1 List of Hardware with Calibration Dates

5.1.1 Hardware List – CTE System

Type	Manufacturer	Model	Serial Number / ID	Calibration Date	Calibration Due
Comprehensive Testing Environment	TÜV Rheinland LGA Products	HWE 6000	00139	N/A	N/A
Wideband Radio comm.tester	Rohde & Schwarz	CMW500	163750 2711468	15.07.2019	15.07.2020
Spectrum Analyzer	Rohde & Schwarz	FSU26	100308 2704108	10.07.2019	10.07.2020
Vector Signal Generator	Rohde & Schwarz	SMU 200A	101584 2704111	12.07.2019	12.07.2020
High Speed Power Supply	Keithley	2303	1198722 2717714	19.08.2019	19.08.2020
Multimeter / Data Acquisition System	Keithley	2700	995343 2704115	10.07.2019	10.07.2020
Power Probe	Rohde & Schwarz	NRP-Z31	102145 2704104	11.07.2019	11.07.2020
RadiPower Wireless 6 GHz Power meter	Dare	RPR3006W	RPR6W-1901-006 2969972	16.07.2019	16.07.2020
Signal Generator	Rohde & Schwarz	SMF 100A	102374 2704110	30.07.2019	30.07.2022
Baseband & Fading Simulator	Rohde & Schwarz	AMU200A	100304 2704114	09.10.2017	09.10.2020
Digital Multimeter	Fluke	87	61320241 2744110	03.07.2019	03.07.2020
Single Input Thermometer	Fluke	Fluke-51-2	41410362WS 2807523	08.07.2019	08.07.2020
Temperature & humidity Logger	Lufft	OPUS 20	145.0216.0802.030 2703979	05.07.2018	05.07.2020
Temperature Chamber	Vötsch	VT4002	58566032870010 2709706	N/A	N/A

5.1.2 Hardware List – SAC5 System

Type	Manufacturer	Model	Serial Number / ID	Calibration Date	Calibration Due
EMI Test Receiver	Rohde & Schwarz	ESW44	101760 2881044	28.10.2019	28.10.2020
Ultra Broadband Antenna	Rohde & Schwarz	HL562E	100988 2823181	23.07.2019	23.07.2021
Double Ridged Waveguide Horn Antenna	Rohde & Schwarz	HF907	102678 2823164	15.07.2019	15.07.2021
Control Device	Maturo	NCD	NCD/393/2372.01	N/A	N/A
Open Switch & Control Unit	Rohde & Schwarz	OSP150	100081 2884198	01.04.2019	01.04.2020
Open Switch & Control Unit	Rohde & Schwarz	OSP120	100084 2761253	01.04.2019	01.04.2020
Shielded Filter Unit	Rohde & Schwarz	OSP-F Extension	101333 2761265	01.04.2019	01.04.2020
Shielded Filter Unit	Rohde & Schwarz	OSP-F Extension	101335 2761266	01.04.2019	01.04.2020
Shielded Filter Unit	Rohde & Schwarz	OSP-F Base Unit	101330 2761262	01.04.2019	01.04.2020
Humidity Temperature Probe	Rotronic	HF532-DG1XX21X	0061829280 2926379	14.08.2018	14.08.2020

5.2 Software / Firmware Versions

Equipment	Software / Firmware Name	Version
Comprehensive Testing Environment (CTE)	CTE – TMF CTE – BT	V47.1 V43.1
SAC 5	EMC 32	V10.50.40

6. MEASUREMENT UNCERTAINTY

6.1 Measurement Uncertainty for CTE

Parameter	Uncertainty (Coverage Factor k=2)
Maximum Output Power (15.247b)	±0.51 dB
6dB / 20dB Channel Bandwidth & 99% Occupied bandwidth (15.247a)	<5%
Carrier Frequency Separation (15.247a)	N/A
Number of Hopping Channels (15.247a)	N/A
Time of Occupancy – Dwell Time (15.247a)	N/A
Band Edge Compliance of Conducted Emissions (15.247a)	±1.04 dB
Conducted Spurious Emissions (15.247d)	±2.98 dB
Power Spectral Density (15.247e)	±0.51 dB

6.2 Measurement Uncertainty for SAC 5 (Radiated Emissions & Band Edge)

Parameter	Uncertainty (Coverage Factor k=2)
Field Strength 10 Hz -9 kHz	3.38 dB
Field Strength 9 kHz -30 MHz	3.38 dB
Field Strength 30 MHz -1000 MHz	3.38 dB
Field Strength 1 GHz -18 GHz	4.88 dB
Field Strength 18 GHz - 40 GHz	5.14 dB

7. PHOTOGRAPHS

7.1 Photographs of the Test Setup

See report 60349842-002 Appendix 1