TEST REPORT

Test Report No. : UL-RPT-RP-13326679-619-FCC

Applicant	:	Vitec Imaging Solutions spa
Model No.	:	WAVO PRO
FCC ID	:	2AQK5-WAVOPRO
Technology	:	Bluetooth – Low Energy
Test Standard(s)	:	FCC Parts 15.207, 15.209(a) & 15.247
		For details of applied tests refer to test result summary

1. This test report shall not be reproduced in full or partial, without the written approval of UL International Germany GmbH.
2. The results in this report apply only to the sample tested.
3. The test results in this report are traceable to the national or international standards.
4. **Test Report Version 1.1 supersede Version 1.0 with immediate effect**
   Test Report No. UL-RPT-RP-13326679-619-FCC Version 1.1, Issue Date 17 MAY 2021 replaces
   Test Report No. UL-RPT-RP-13326679-619-FCC Version 1.0, Issue Date 11 JANUARY 2021 which is no longer valid.
5. Result of the tested sample: **PASS**

Prepared by: Krume, Ivanov
Title: Laboratory Engineer
Date: 17 May 2021

Approved by: Ajit, Phadtare
Title: Lead Test Engineer
Date: 17 May 2021

Deutsche Akkreditierungsstelle D-PL-19381-02-00

This laboratory is accredited by DAkkS.
The tests reported herein have been performed in accordance with its' terms of accreditation.

UL INTERNATIONAL GERMANY GMBH
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70327 Stuttgart, Germany
STU.CTECHLab@ul.com

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1. Customer Information

1.1.Applicant Information

Company Name:	Vitec Imaging Solutions spa
Company Address:	Via Valsugana, 100 - 36022 Cassola (VI), Italy
Company Phone No.:	+39 0424555855
Company E-Mail:	info-imaging@vitecgroup.com
Contact Person:	Diego Selmin
Contact E-Mail Address:	diego.selmin@vitecgroup.com
Contact Phone No.:	+39 0424 555815

1.2.Manufacturer Information

Company Name:	Comyo El.Tech.Co.,Ltd
Company Address:	Third Floor, Building 5, No.680, Fenggong Road ,Malu Town, Jiading District, Shanghai, China
Company Phone No.:	+39 3457482453
Company E-Mail:	lucycaoyang@nextosrl.com
Contact Person:	Lucy Caoyang
Contact E-Mail Address:	lucycaoyang@nextosrl.com
Contact Phone No.:	+39 3457482453

2. Summary of Testing

2.1. General Information

Applied Standards

Specification Reference:	47CFR15.247
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
Specification Reference:	47CFR15.207 and 47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.207 and 15.209

Location

Location of Testing:	UL International Germany GmbH Hedelfinger Str. 61 70327 Stuttgart Germany
Test Firm Registration:	399704

Date information

Order Date:	21 April 2020
EUT arrived:	10 September 2020
Test Dates:	15 September 2020 to 29 October 2020
EUT returned:	-/-

2.2. Summary of Test Results

Clause	Measurement	Complied	Did not comply	Not performed	Not applicable
Part 15.207	Transmitter AC Conducted Emissions	☒	☐	☐	☐
Part 15.247(a)(2)	Transmitter Minimum 6 dB Bandwidth	☒	☐	☐	☐
Part 15.35(c)	Transmitter Duty Cycle(1)	☒	☐	☐	☐
Part 15.247(e)	Transmitter Power Spectral Density	☒	☐	☐	☐
Part 15.247(b)(3)	Transmitter Maximum Peak Output Power	☒	☐	☐	☐
Part 15.247(d)/15.209(a)	Transmitter Radiated Emissions	☒	☐	☐	☐
Part 15.247(d)/15.209(a)	Transmitter Band Edge Radiated Emissions	☒	☐	☐	☐

Note(s):

1. The measurement was performed to assist in the calculation of the level of average emissions.

2.3. Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	KDB 558074 D01 DTS Meas Guidance v05r02 April 2, 2019
Title:	Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section 15.247 of the FCC Rules
Reference:	KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015
Title:	AC Power-Line Conducted Emissions Frequently Asked Questions

2.4. Deviations from the Test Specification

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	Joby
Model Name or Number:	WAVO PRO
Test Sample Serial Number:	00012 (Radiated Test Sample)
Hardware Version Number:	Version 4
Firmware Version Number:	v6.11_v0022D
FCC ID:	2AQK5-WAVOPRO

Brand Name:	Joby
Model Name or Number:	WAVO PRO
Test Sample Serial Number:	00006 (Conducted Test Sample)
Hardware Version Number:	Version 4
Firmware Version Number:	v6.11_v0022D
FCC ID:	2AQK5-WAVOPRO

3.2. Description of EUT

The equipment under test was a microphone Model: WAVO PRO, supporting Bluetooth Low Energy operations in 2.4- 2.4835 GHz ISM band.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Technology Tested:	Bluetooth Low Energy (Digital Transmission System)		
Type of Unit:	Transceiver		
Channel Spacing:	2 MHz		
Modulation:	GFSK		
Data Rate:	1 Mbps		
Power Supply Requirement(s):	Nominal	4.2 V DC / Max. 20 mA	
Maximum measured Conducted Output Power:	2.33 dBm		
Maximum Antenna Gain:	0 dBi (Peak Gain)		
Antenna Type:	Passive antenna on PCB		
Antenna Details:	Manufacturer: Comyo | Part number: Y000-056-000040		
Transmit Frequency Range:	2402 MHz to 2480 MHz		
Transmit Channels Tested:	**Channel ID**	**RF Channel**	**Channel Frequency (MHz)**
	Bottom	37	2402
	Middle	17	2440
	Top	39	2480

3.5. Support Equipment

The following support equipment was used to exercise the EUT during testing:

A. Support Equipment (In-house)

Item	Description	Brand Name	Model Name or Number	Serial Number
1	Test Laptop with Qualcomm Bluesuite software Version: 3.2.3	HP	HP Probook 650 G1	5CG614419V
2	AC/DC Power Adapter	Samsung	EP-TA20EWE	R37J62G2F64DK3

B. Support Equipment (Manufacturer supplied)

Item	Description	Brand Name	Model Name or Number	Serial Number
1	USB extension cable (USB A to USB C | 1m)	Not Marked or stated	Not Marked or stated	Not marked or stated

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

The EUT was tested in the following operating mode(s):
☒ Continuous transmissions at maximum power (+2 dBm), Bluetooth LE mode with modulation, maximum possible data length available and Pseudorandom Bit Sequence 9 (PRBS9)

4.2. Configuration and Peripherals

EUT Power Supply:

- For AC conducted line emissions measurements the EUT with discharged battery was powered via AC/DC power adapter. The measurments were carried out with 120 VAC /60 Hz & 240 VAC/60 Hz.
- All other tests were carried out with the EUT powered via fully charged internal battery.

Test Mode Activation:

- The following documents containing the setup instructions were supplied by the customer
  - VITEC -Radio Instructions.docx
  - 80-ct507-1_ar_bluetest3_user_guide.pdf" Version: 80-CT507-1 Rev. AR from January 29, 2020
- The test modes were activated using USB Type C Programming Cable and Qualcomm Bluesuite application supplied by the customer.
- The Qualcomm Bluesuite software Version: 3.2.3 was used to enable continuous transmission or reception mode and to select the test channels as required.
- The transmitter test modes were configured to maximum power settings 2 dBm.

Conducted Measurements:

- All conducted measurements were carried out by using conducted samples with SMA (Female) RF Cable soldered on PCB by the customer.
- The SMA (Female) RF Cable soldered on PCB with maximum 0.5 dB at tested frequencies was added to a reference level offset to each of the conducted plots.

Radiated Measurements:

- The EUT radiated sample was used for AC conducted emissions, radiated spurious emission & radiated band edge measurements.
- Before starting final radiated spurious emission measurements "worst case verification" with the EUT in Standing-position & Laying-position was performed by Lab.
- The EUT in Laying-position was found to be the worst case therefore this report includes relevant results.
- Radiated measurements above 30 MHz were performed with the EUT positioned on the turn table and rotating 360 degrees while the antenna height varies from 1 to 4 m over the measurement frequency range.
- EMC32 V10.1.0 Software was used for the Radiated spurious emission measurements.
- **As the EUT was transmitting continuously with a duty cycle of 85.37 % a duty Cycle Correction factor of 0.69 dB was added to all average measurements.

5. Measurements, Examinations and Derived Results

5.1. General Comments

Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to Section 6 *Measurement Uncertainty* for details.

In accordance with DAkkS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

5.2. Test Results

5.2.1. Transmitter AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	Asim Shahzad	**Test Date:**	29 October 2020
Test Sample Serial Number:	00012 (Radiated Test Sample)		
Test Site Identification	SR 7/8		

FCC Reference:	Part 15.207
Test Method Used:	ANSI C63.10 Section 6.2 / FCC KDB 174176 and notes below

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	35

Settings of the Instrument

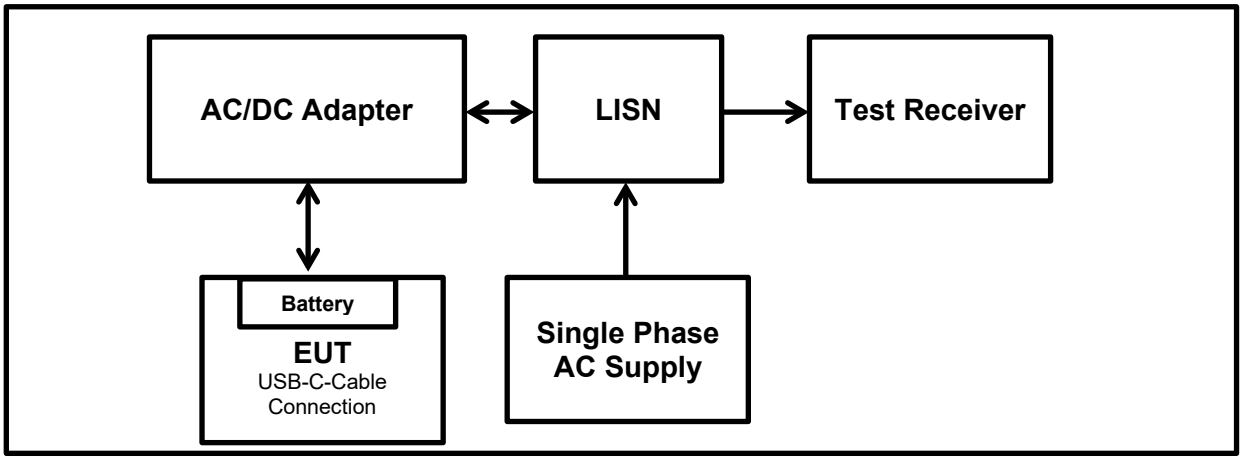
Detector	Quasi Peak/ Average Peak

Note(s):

1. For AC conducted line emissions measurements the EUT with discharged battery was powered via a USB-Type C cable to an AC/DC power adapter. This AC/DC power adapter was connected to 120 VAC / 60 Hz single phase supply via a LISN.
2. In accordance with FCC KDB 174176 Q4, tests were performed with a 240 VAC 60 Hz single phase supply as this was within the voltage range marked on the 100-240 VAC~50/60 Hz power supply.
3. The EUT was configured on Top channel BT-LE test mode with maximum power settings 2 dBm.
4. Pre-scans were performed and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered into the tables below.
5. The final measured value, for the given emission, in the table below incorporates the cable loss.
6. All other emissions shown on the pre-scan plot were investigated. Only the highest 6 emissions have been reported in the tables below in accordance with ANSI C63.10 section 6.2.5.
7. Measurements were performed in shielded room (SR7/ 8 Asset Number 1603671). The EUT was placed at a height of 80 cm above the reference ground plane and at distance of 40 cm from the vertical ground plane at the edge of the table.
8. Measurement software used: Toyo EMI Software; CE measurement software EP5/CE Ver 4.0.1.

Transmitter AC Conducted Spurious Emissions (continued)

Test Setup:



Transmitter AC Conducted Spurious Emissions (continued)

Results: Live / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.1855	Live	50.90	64.20	13.30	Complied
0.2291	Live	42.50	62.50	20.00	Complied
0.7436	Live	45.30	56.00	10.70	Complied
0.8619	Live	37.50	56.00	18.50	Complied
5.3116	Live	32.20	60.00	27.80	Complied
15.4068	Live	34.20	60.00	25.80	Complied

Results: Live / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.1855	Live	37.80	54.20	16.40	Complied
0.2291	Live	31.00	52.50	21.50	Complied
0.7436	Live	39.50	46.00	6.50	Complied
0.8619	Live	31.50	46.00	14.50	Complied
5.3116	Live	26.10	50.00	23.90	Complied
15.4068	Live	27.00	50.00	23.00	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.1740	Neutral	45.50	64.80	19.30	Complied
0.2487	Neutral	44.90	61.8	16.90	Complied
0.3093	Neutral	40.50	60.00	19.50	Complied
0.7607	Neutral	40.30	56.00	15.70	Complied
8.7535	Neutral	37.20	60.00	22.80	Complied
15.4368	Neutral	34.70	60.00	25.30	Complied

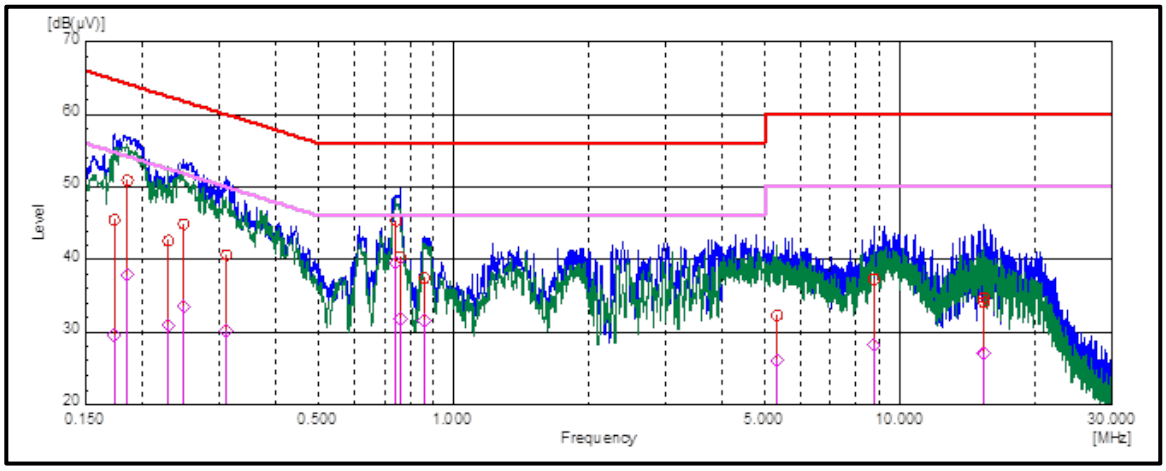
Results: Neutral / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.1740	Neutral	29.50	54.80	25.30	Complied
0.2487	Neutral	33.50	51.80	18.30	Complied
0.3093	Neutral	30.10	50.00	19.90	Complied
0.7607	Neutral	31.90	46.00	14.10	Complied
8.7535	Neutral	28.10	50.00	21.90	Complied
15.4368	Neutral	27.10	50.00	22.90	Complied

Result: Pass

Transmitter AC Conducted Spurious Emissions (continued)

Plot: Live and Neutral Line / 120 VAC 60 Hz



Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter AC Conducted Spurious Emissions (continued)

Results: Live / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.1630	Live	43.50	65.30	21.80	Complied
0.2046	Live	41.20	63.40	22.20	Complied
0.5533	Live	42.90	56.00	13.10	Complied
0.7236	Live	41.10	56.00	14.90	Complied
1.5503	Live	38.20	56.00	17.80	Complied
2.5370	Live	38.90	56.00	17.10	Complied

Results: Live / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.1630	Live	31.80	55.30	23.50	Complied
0.2046	Live	31.10	53.40	22.30	Complied
0.5533	Live	36.90	46.00	9.10	Complied
0.7236	Live	33.60	46.00	12.40	Complied
1.5503	Live	30.10	46.00	15.90	Complied
2.5370	Live	32.00	46.00	14.00	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.1535	Neutral	44.90	65.80	20.90	Complied
0.2562	Neutral	41.40	61.60	20.20	Complied
0.5573	Neutral	45.20	56.00	10.80	Complied
0.7216	Neutral	44.60	56.00	11.40	Complied
1.5040	Neutral	40.10	56.00	15.90	Complied
2.4969	Neutral	39.50	56.00	16.50	Complied

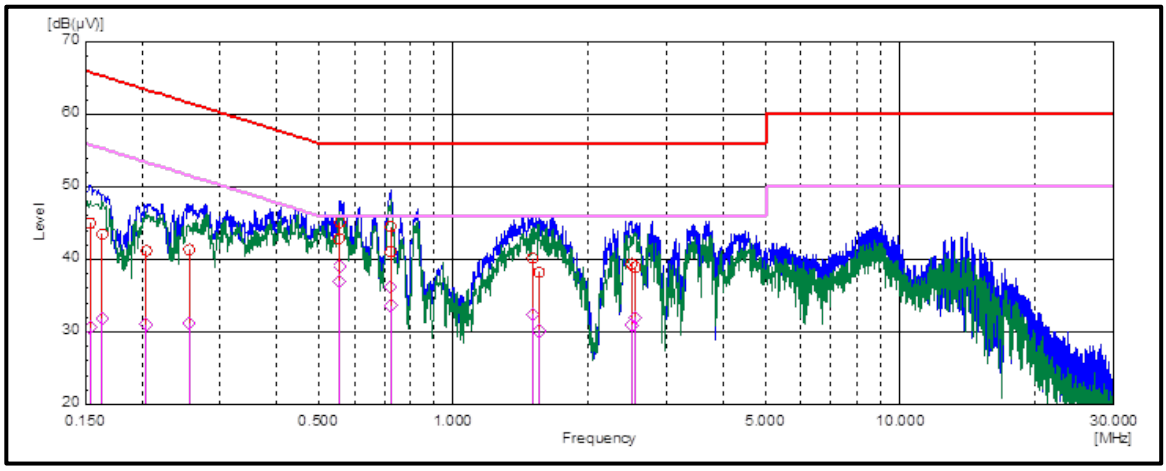
Results: Neutral / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.1535	Neutral	30.60	55.80	25.20	Complied
0.2562	Neutral	31.20	51.60	20.40	Complied
0.5573	Neutral	39.00	46.00	7.00	Complied
0.7216	Neutral	36.20	46.00	9.80	Complied
1.5040	Neutral	32.50	46.00	13.50	Complied
2.4969	Neutral	30.90	46.00	15.10	Complied

Result: Pass

Transmitter AC Conducted Spurious Emissions (continued)

Plot: Live and Neutral Line / 240 VAC 60 Hz



Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

5.2.2. Transmitter 6 dB Bandwidth

Test Summary:

Test Engineer:	Krume Ivanov	**Test Date:**	13 October 2020
Test Sample Serial Number:	00006 (Conducted Test Sample)		
Test Site Identification	SR 9		

FCC Reference:	Part 15.247(a)(2)
Test Method Used:	FCC KDB 558074 Section 8.2 referencing ANSI C63.10:2013 Section 11.8.1 Option 1

Environmental Conditions:

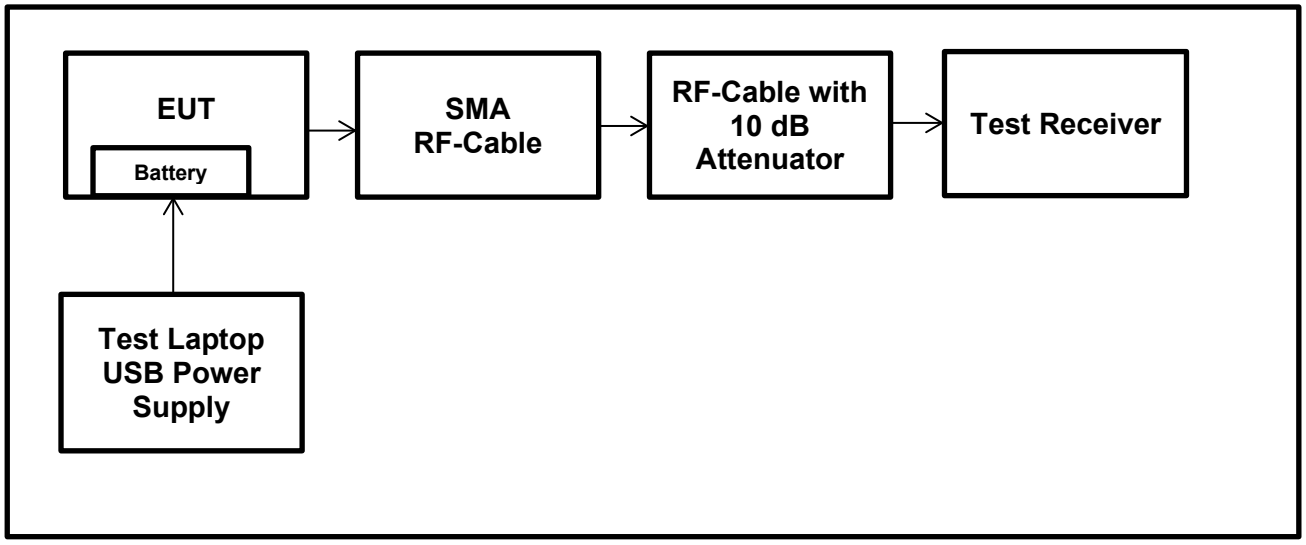
Temperature (°C):	22
Relative Humidity (%):	42

Note(s):

1. The measurements were performed using the above configurations on the bottom, middle and top channels in accordance FCC KDB 558074 Section 8.2 referencing ANSI C63.10 Section 11.8 (11.8.1 Option 1 measurement procedure).
2. The spectrum analyser resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The DTS bandwidth was measured at 6 dB down from the peak of the signal.
3. The RF port on the EUT was connected to the spectrum analyser using suitable attenuation and RF cable. The measured values take into consideration the external attenuation correction factors.
    - The SMA (Female) RF Cable soldered on PCB with maximum attenuation of 0.5 dB at the tested frequencies.
    - The RF cable from the EUT to Analyzer with maximum attenuation of 0.3 dB at the tested frequencies including the 10 dB attenuator at the input of Spectrum Analyzer

    Therefore, total a reference level offset 10.8 dB was added to each of the at the tested frequencies conducted plots.

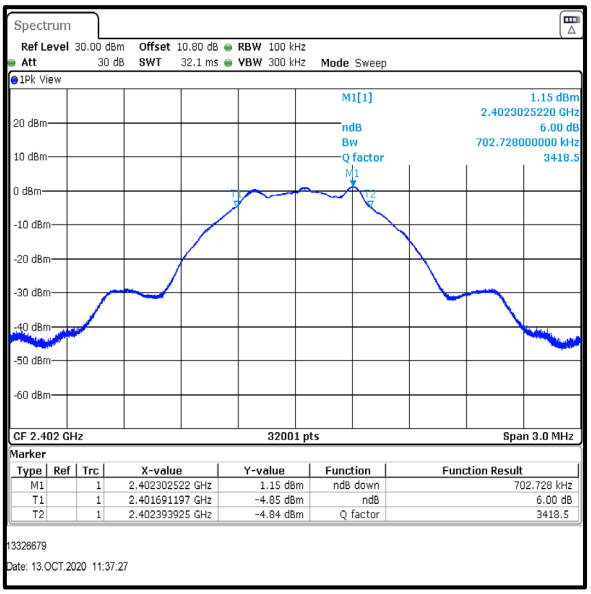
Test Setup:



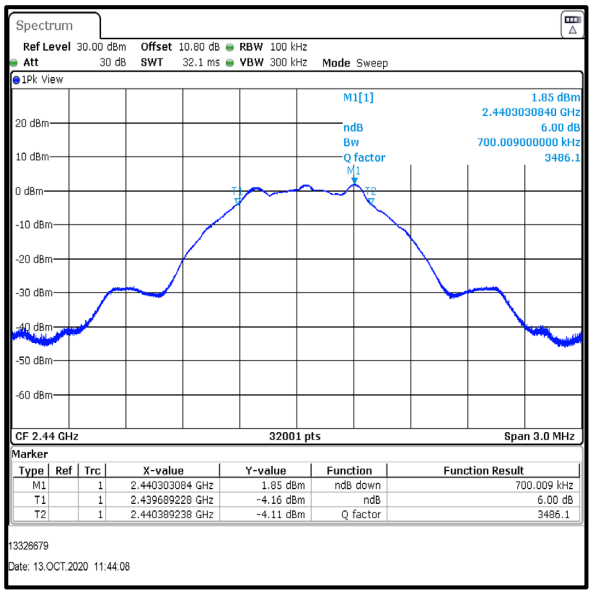
Transmitter Minimum 6 dB Bandwidth (continued)

Results:

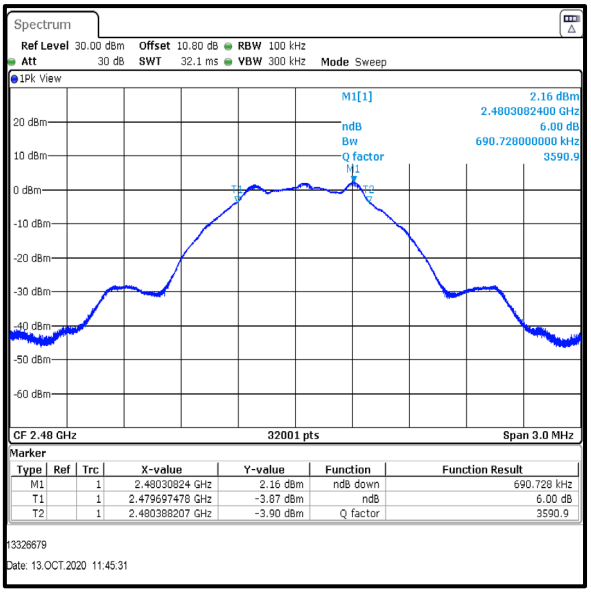
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	702.728	≥500	202.728	Complied
Middle	700.009	≥500	200.009	Complied
Top	690.728	≥500	190.728	Complied



Bottom Channel



Middle Channel



Top Channel

Result: Pass

5.2.3. Transmitter Duty Cycle

Test Summary:

Test Engineer:	Krume Ivanov	**Test Date:**	13 October 2020
Test Sample Serial Number:	00006 (Conducted Test Sample)		
Test Site Identification	SR 9		

FCC Reference:	Part 15.35(c)
Test Method Used:	FCC KDB 558074 Section 6.0

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	42

Note:

1. The transmitter duty cycle was measured using a spectrum analyser in the time domain and calculated by using the following calculation:

   Duty Cycle (%) = 100 X [On Time (T_{ON})] / [Period(T_{ON}+ T_{OFF}) or 100ms whichever is the lesser]

   Duty Cycle Correction Factor= 10 log 1 / [On Time (T_{ON})] / [Period(T_{ON}+ T_{OFF}) or 100ms whichever is the lesser]

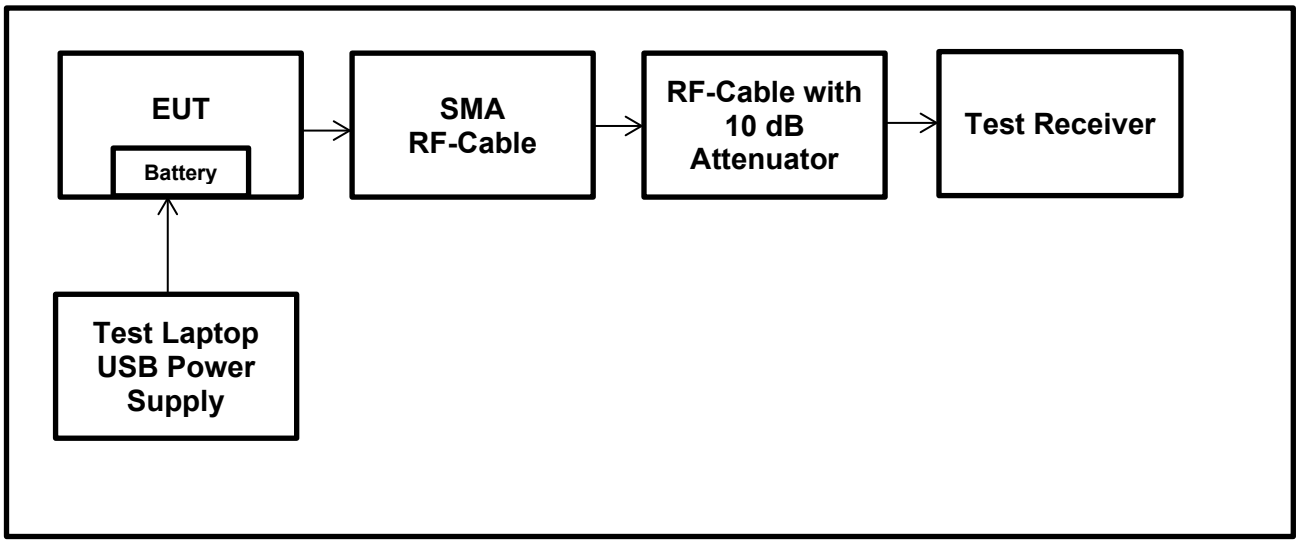
   10*Log (1 / (On Time / [Period or 100 ms whichever is the lesser])

   BLE *Duty Cycle Correction Factor*: 10 log (1 / (2.130 ms/ 2.495 ms)) = 0.686 dB

2. The RF port on the EUT was connected to the spectrum analyser using suitable attenuation and RF cable. The measured values take into consideration the external attenuation correction factors.
   - The SMA (Female) RF Cable soldered on PCB with maximum attenuation of 0.5 dB at the tested frequencies.
   - The RF cable from the EUT to Analyzer with maximum attenuation of 0.3 dB at the tested frequencies including the 10 dB attenuator at the input of Spectrum Analyzer

   Therefore, total a reference level offset 10.8 dB was added to each of the at the tested frequencies conducted plots.

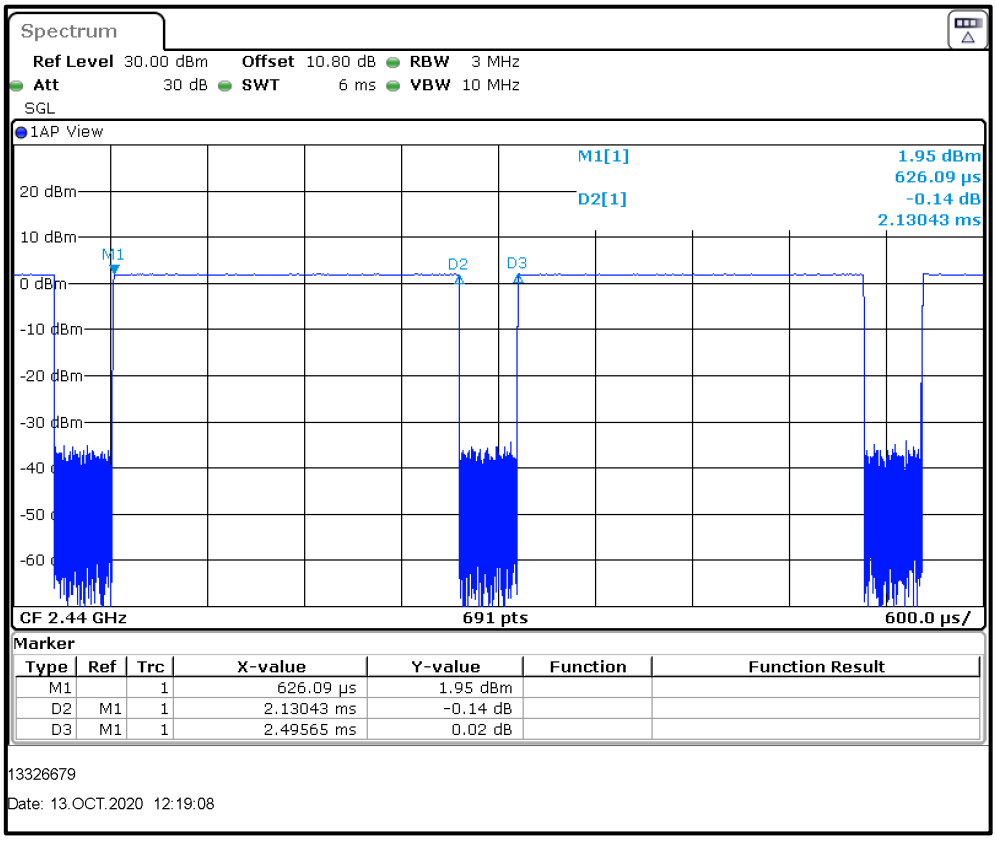
Test Setup:



Transmitter Duty Cycle (continued)

Results:

Pulse On Time (T_{ON}) (ms)	Pulse Period (T_{ON} +T_{OFF}) (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
2.130	2.495	85.37	0.686



5.2.4. Transmitter Power Spectral Density

Test Summary:

Test Engineer:	Krume Ivanov	**Test Date:**	13 October 2020
Test Sample Serial Number:	00006 (Conducted Test Sample)		
Test Site Identification	SR 9		

FCC Reference:	Part 15.247(e)
Test Method Used:	FCC KDB 558074 Section 8.4 referencing ANSI C63.10 Sections 11.10.2

Environmental Conditions:

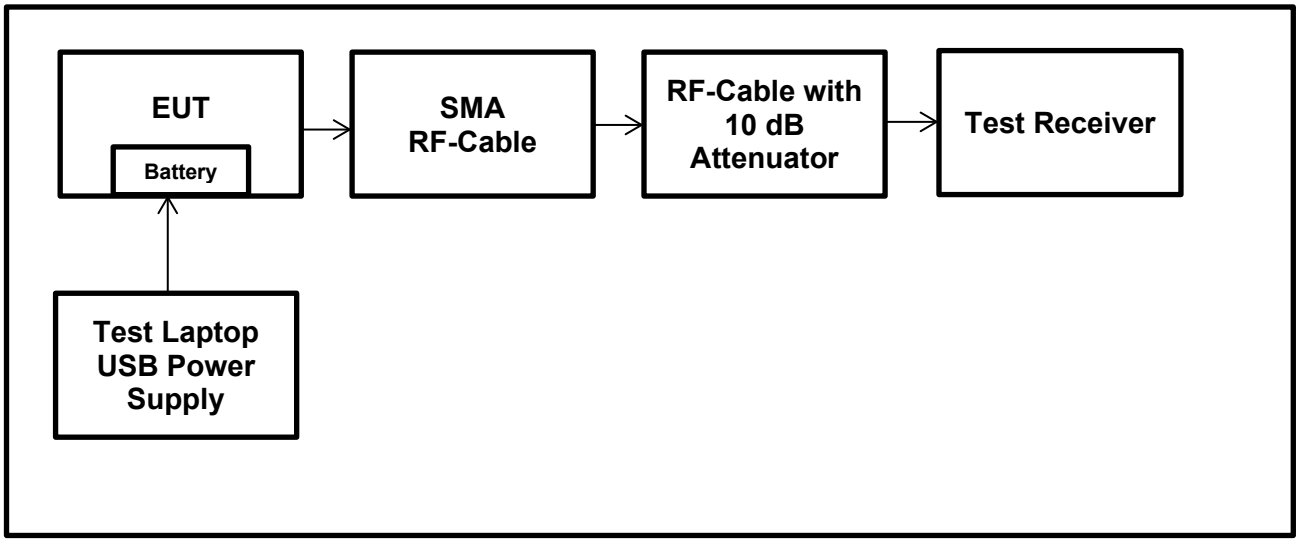
Temperature (°C):	22
Relative Humidity (%):	42

Notes:

1. Conducted power spectral density tests were performed using PKPSD (peak PSD) method in accordance with FCC KDB 558074 Section 8.4 referencing ANSI C63.10 section 11.10.2. This procedure should be used, if maximums peak conducted output power was used to determine compliance.
2. The signal analyser resolution bandwidth was set to 3 kHz and video bandwidth of 10 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 1.5 times OBW. A marker was placed at the peak of the signal and the results recorded in the table below.
3. The highest peak of the measured signal was recorded. The calculated duty cycle in section 5.2.3 was added to the measured average power spectral density in order to compute the average power spectral density during the actual transmission time.
4. The RF port on the EUT was connected to the spectrum analyser using suitable attenuation and RF cable. The measured values take into consideration the external attenuation correction factors.
    - The SMA (Female) RF Cable soldered on PCB with maximum attenuation of 0.5 dB at the tested frequencies.
    - The RF cable from the EUT to Analyzer with maximum attenuation of 0.3 dB at the tested frequencies including the 10 dB attenuator at the input of Spectrum Analyzer

    Therefore, total a reference level offset 10.8 dB was added to each of the at the tested frequencies conducted plots.

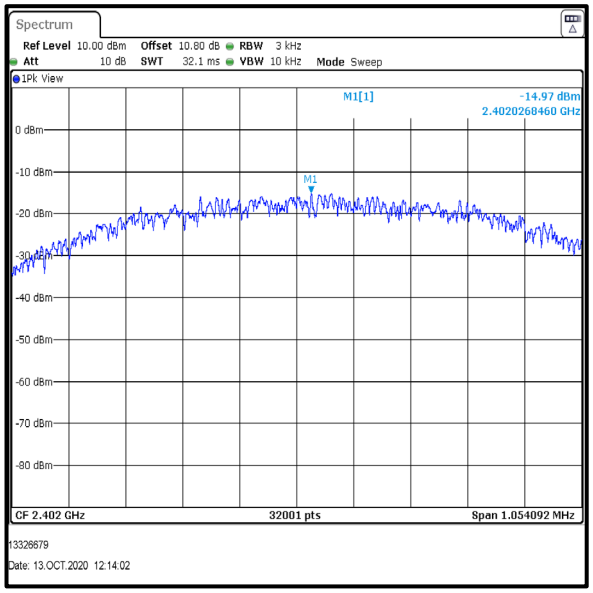
Test Setup:



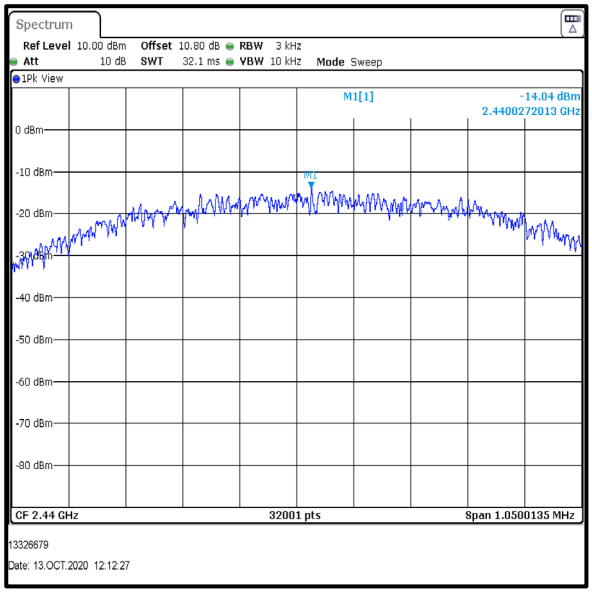
Transmitter Power Spectral Density (continued)

Results:

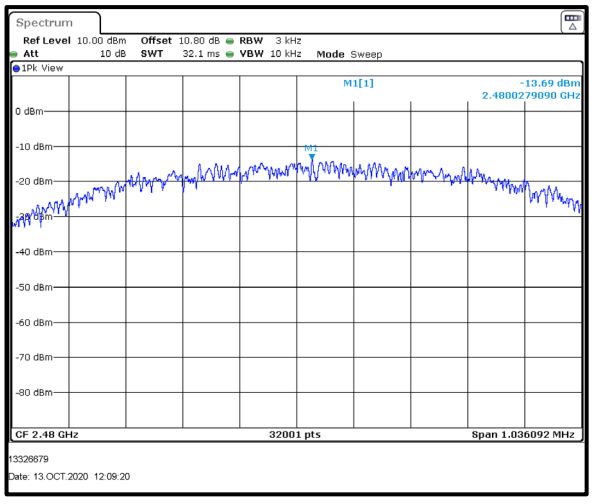
Channel	Output Power (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)	Result
Bottom	-14.97	8.0	22.97	Complied
Middle	-14.04	8.0	22.04	Complied
Top	-13.69	8.0	21.69	Complied



Bottom Channel



Middle Channel



Top Channel

Result: Pass

5.2.5. Transmitter Maximum Peak Output Power

Test Summary:

Test Engineer:	Krume Ivanov	**Test Date:**	13 October 2020
Test Sample Serial Number:	00006 (Conducted Test Sample)		
Test Site Identification	SR 9		

FCC Reference:	Part 15.247(b)(3)
Test Method Used:	FCC KDB 558074 Section 8.3.1.1 referencing ANSI C63.10 Section 11.9.1.1

Environmental Conditions:

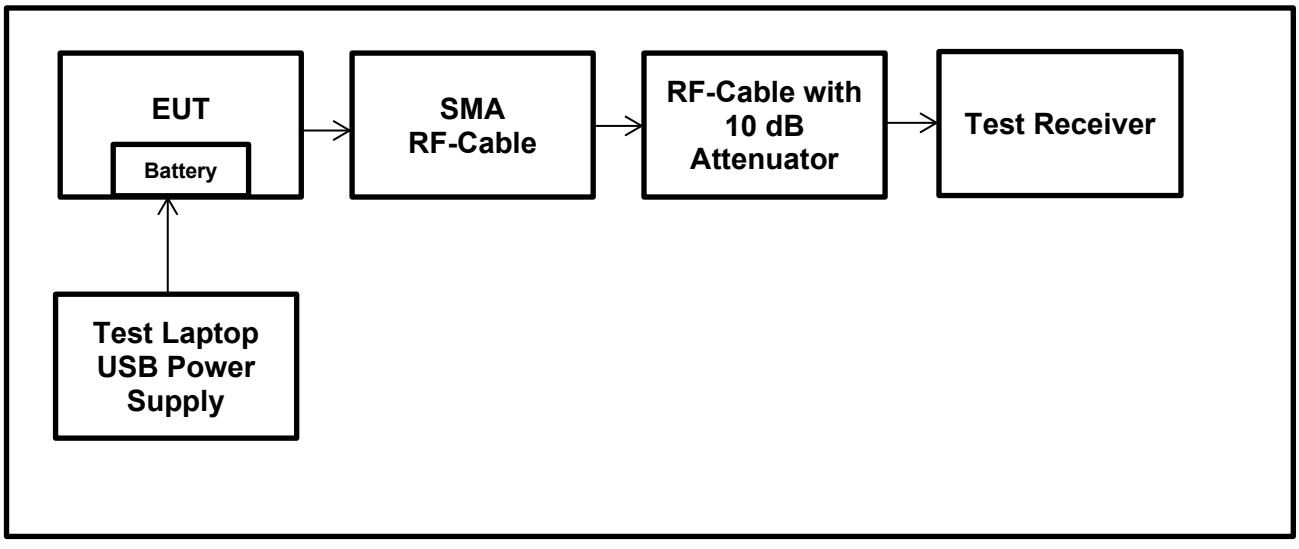
Temperature (°C):	22
Relative Humidity (%):	42

Notes:

1. Conducted power tests were performed using a spectrum analyser in accordance with FCC KDB 558074 Section 8.3.1.1 with the RBW ≥ DTS bandwidth referencing ANSI C63.10 Section 11.9.1.1.
2. The signal analyser resolution bandwidth was set to 3 MHz and video bandwidth of 10 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 10 MHz. A marker was placed at the peak of the signal and the results recorded in the table below.
3. The RF port on the EUT was connected to the spectrum analyser using suitable attenuation and RF cable. The measured values take into consideration the external attenuation correction factors.
    - The SMA (Female) RF Cable soldered on PCB with maximum attenuation of 0.3 dB at the tested frequencies.
    - The RF cable from the EUT to Analyzer with maximum attenuation of 0.5 dB at the tested frequencies including the 10 dB attenuator at the input of Spectrum Analyzer.

    Therefore, total a reference level offset 10.8 dB was added to each of the at the tested frequencies conducted plots.
4. The declared antenna gain was added to conducted power to obtain the EIRP.

Test Setup:



Transmitter Maximum Peak Output Power (continued)

Results:

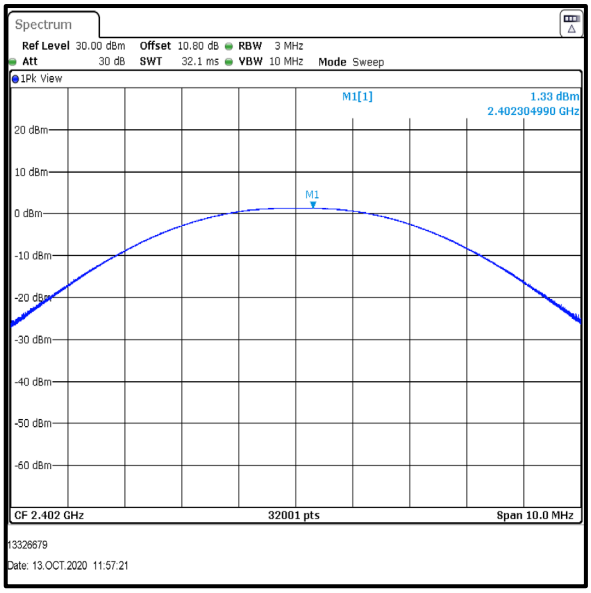
Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	1.33	30.00	28.67	Complied
Middle	2.03	30.00	27.97	Complied
Top	2.33	30.00	27.67	Complied

Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	1.33	0.0	1.33	36.00	34.67	Complied
Middle	2.03	0.0	2.03	36.00	33.97	Complied
Top	2.33	0.0	2.33	36.00	33.67	Complied

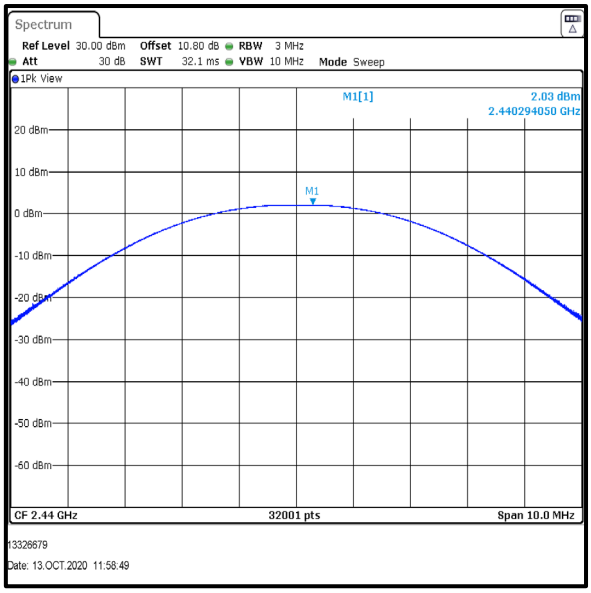
Result: Pass

Transmitter Maximum Peak Output Power (continued)

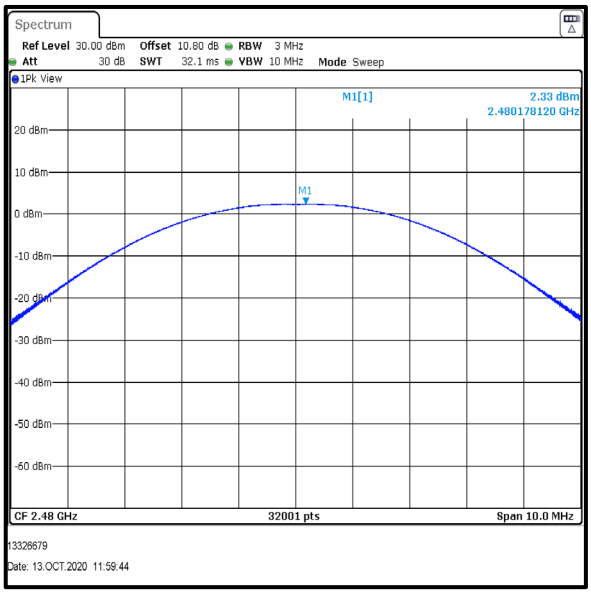
Results:



Bottom Channel



Middle Channel



Top Channel

5.2.6. Transmitter Radiated Emissions

Test Summary:

Test Engineer:	Sercan Usta	**Test Date:**	15 September 2020
Test Sample Serial Number:	00012 (Radiated Test Sample)		
Test Site Identification	SR 1/2		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	FCC KDB 558074 Sections 8.5 & 8.6 referencing ANSI C63.10 Sections 11.11 & 11.12, ANSI C63.10 Sections 6.3 & 6.5
Frequency Range	30 MHz to 1000 MHz

Environmental Conditions:

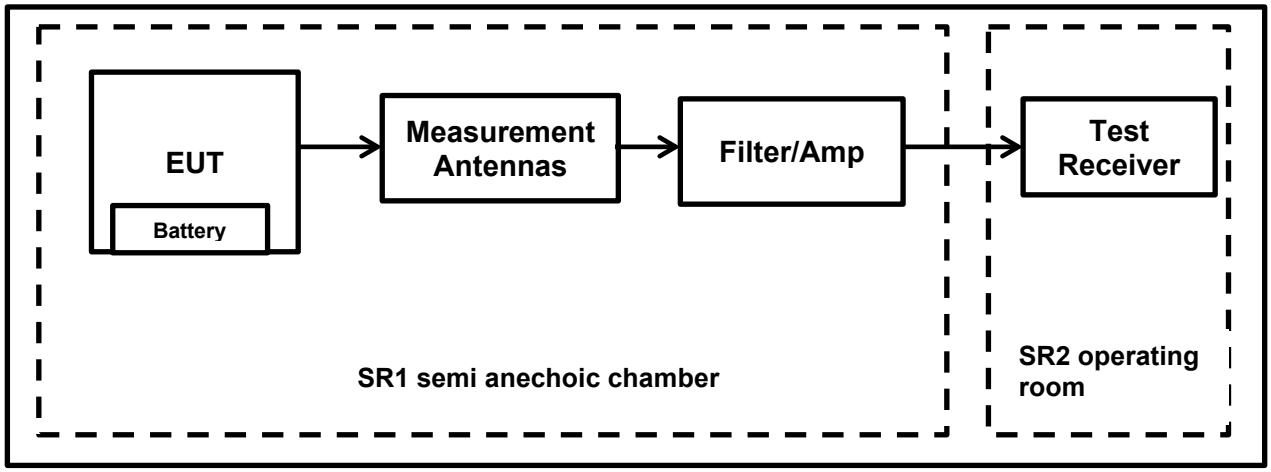
Temperature (°C):	23
Relative Humidity (%):	60

Notes:

1. Measurements below 1 GHz were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) at a distance of 3 m. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 m to 4 m.
2. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
3. The preliminary scans showed similar emission levels below 1 GHz, for each channel of operation. Therefore final radiated emissions measurements were performed with the EUT set to the Top channel only.
4. All emissions shown on the pre-scan plot were investigated and found to be below the system noise floor.

Transmitter Radiated Emissions (continued)

Test Setup:

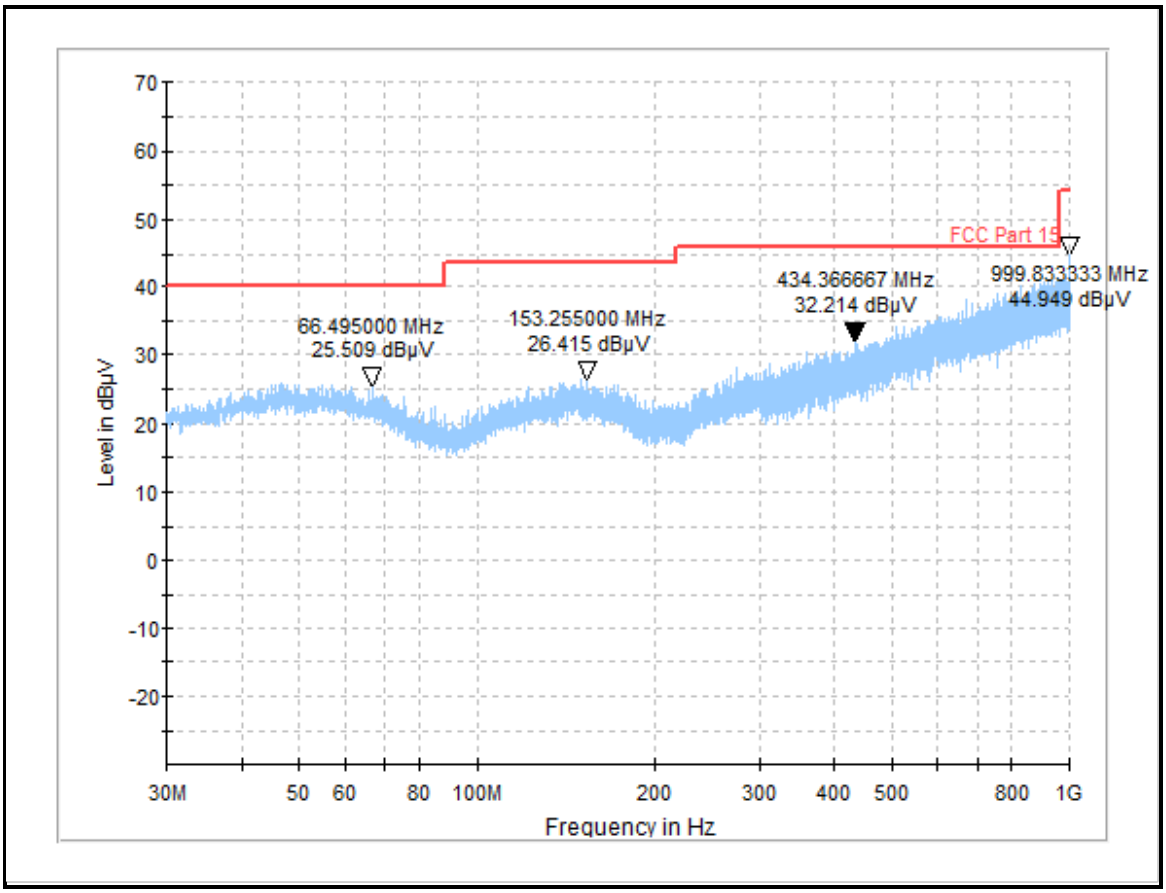


Transmitter Radiated Emissions (continued)

Results: Top Channel

Frequency (MHz)	Antenna Polarization	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
No critical spurious emissions were detected					

Plot: 30 MHz-1 GHz: Top Channel



Result: Pass

Transmitter Radiated Emissions (continued)

Test Summary:

Test Engineer:	Sercan Usta	**Test Date:**	15 September 2020 & 13 October 2020
Test Sample Serial Number:	00012 (Radiated Test Sample)		
Test Site Identification	SR 1/2		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	FCC KDB 558074 Sections 8.5 & 8.6 referencing ANSI C63.10 Sections 11.11 & 11.12 ANSI C63.10 Sections 6.3 & 6.6
Frequency Range	1 GHz to 25 GHz

Environmental Conditions:

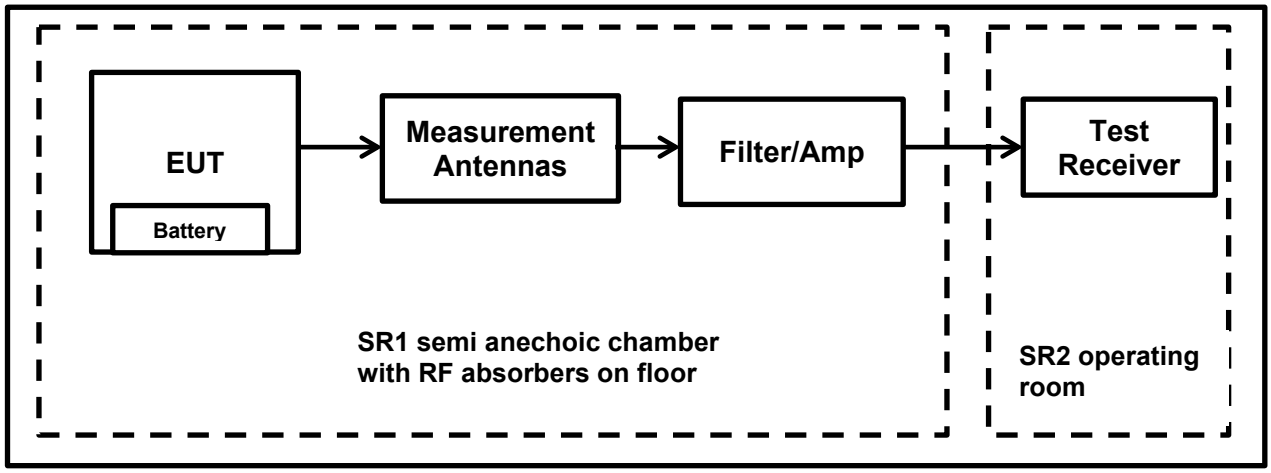
Temperature (°C):	22 & 23
Relative Humidity (%):	42 & 60

Note(s):

1. The emissions shown at frequencies approximately 2.4 GHz to 2.4835 GHz on the 1 GHz to 18 GHz plots are the EUT fundamental for the tested channel.
2. Pre-scans above 1 GHz were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) with absorber on the floor at a distance of 3 m. The EUT was placed at a height of 1.5 m above the test chamber floor in the centre of the chamber turntable. All measurement antennas were placed at a fixed height of 1.5 m above the test chamber floor, in line with the EUT. Final measurements above 1 GHz were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) with absorber on the floor at a distance of 3 m. The EUT was placed at a height of 1.5 m above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 m to 4 m.
3. Pre-scans were performed and a marker placed on the highest measured level of the appropriate plot. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. The sweep time was set to auto.
4. All emissions shown on the pre-scans were investigated and found to be below the noise floor of the measurement system.
5. The preliminary scans showed similar emission levels above 18 GHz, for each channel & modes of operation. Therefore final radiated emissions measurements were performed with the EUT set to the Top channel only.
6. All emissions shown on the pre-scans were investigated and found to be below the noise floor of the measurement system.
7. *In accordance with ANSI C63.10 Section 6.6.4.3 (Note 1), if the peak measured value complies with the average limit, it is unnecessary to perform an average measurement.
8. **As the EUT was transmitting continuously with a duty cycle of 85.37 % a duty Cycle Correction factor of 0.69 dB was added to all average measurements.

Transmitter Radiated Emissions (continued)

Test Setup:

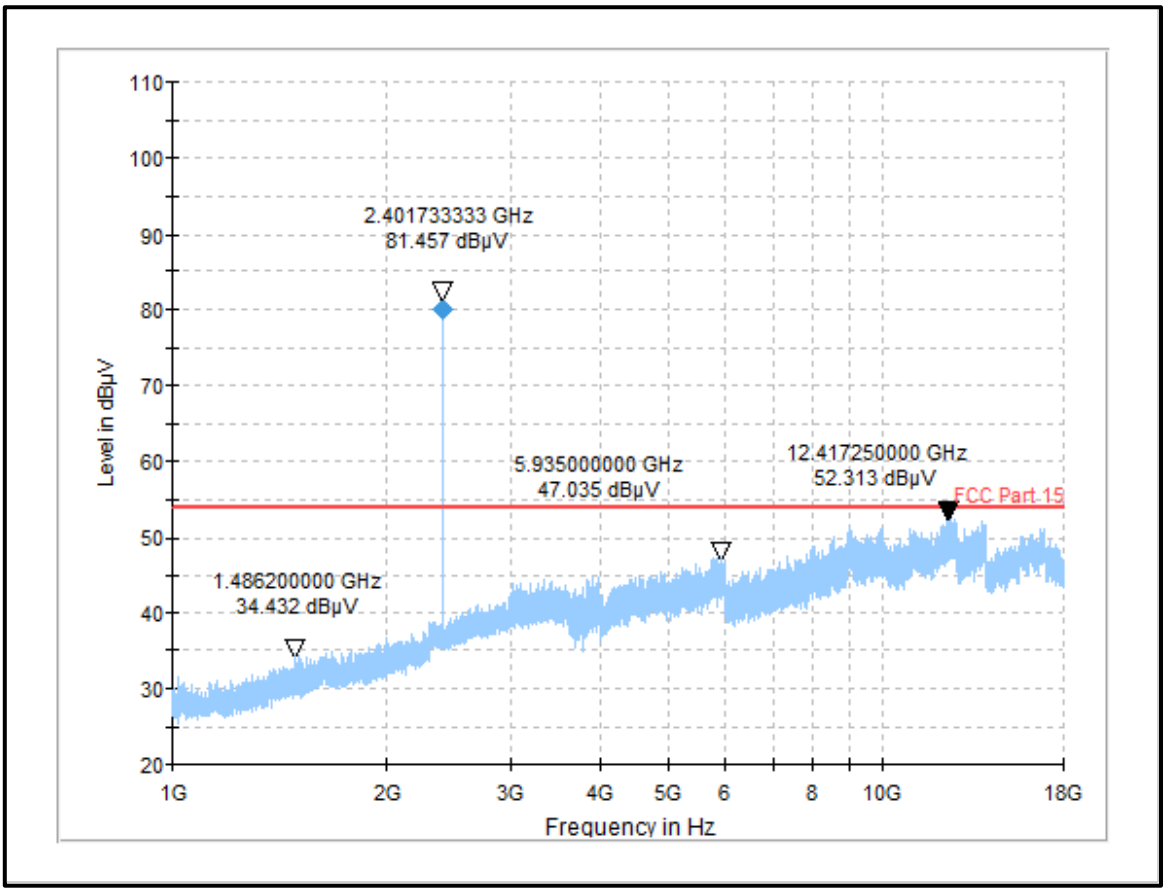


Transmitter Radiated Emissions (continued)

Results: Bottom Channel

Frequency (MHz)	Antenna Polarization	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
No critical spurious emissions were detected					

Plot: 1 GHz – 18 GHz: Bottom Channel



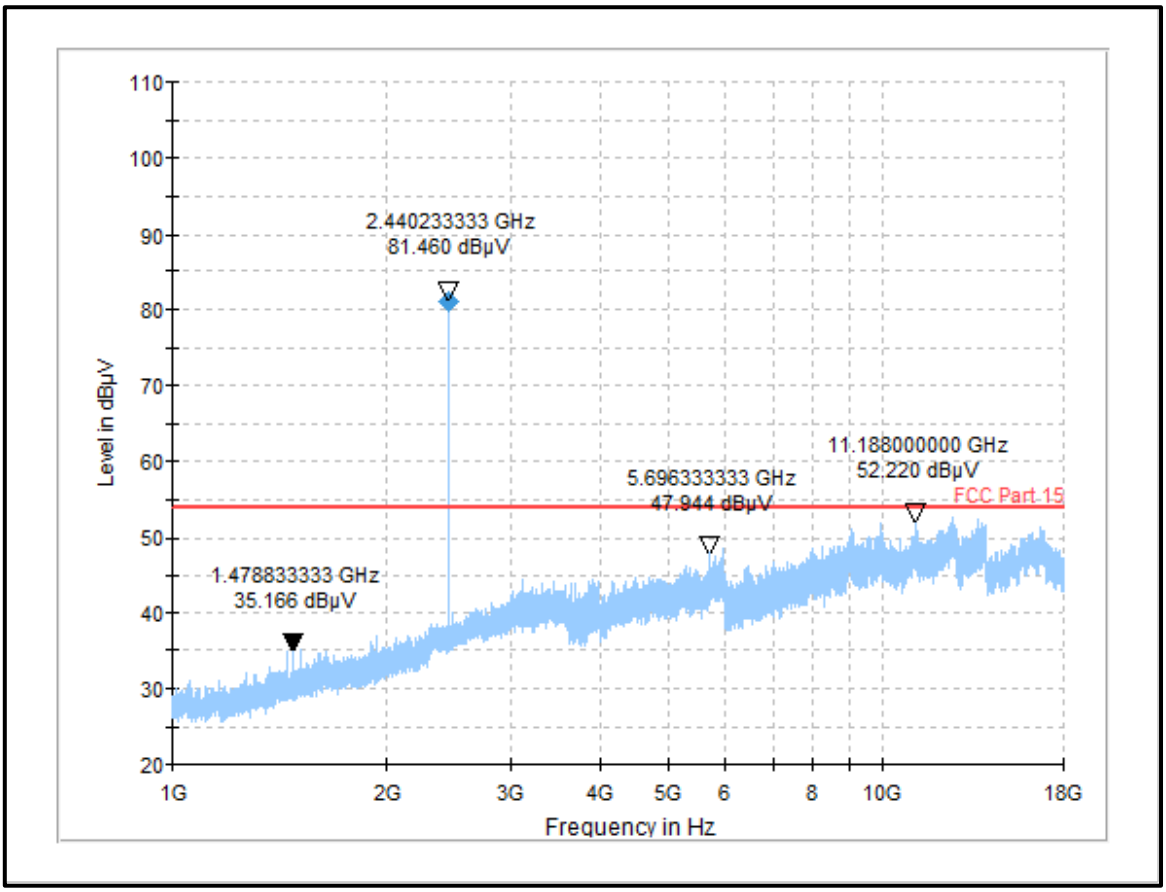
Result: Pass

Transmitter Radiated Emissions (continued)

Results: Middle Channel

Frequency (MHz)	Antenna Polarization	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
No critical spurious emissions were detected					

Plot: 1 GHz – 18 GHz: Middle Channel



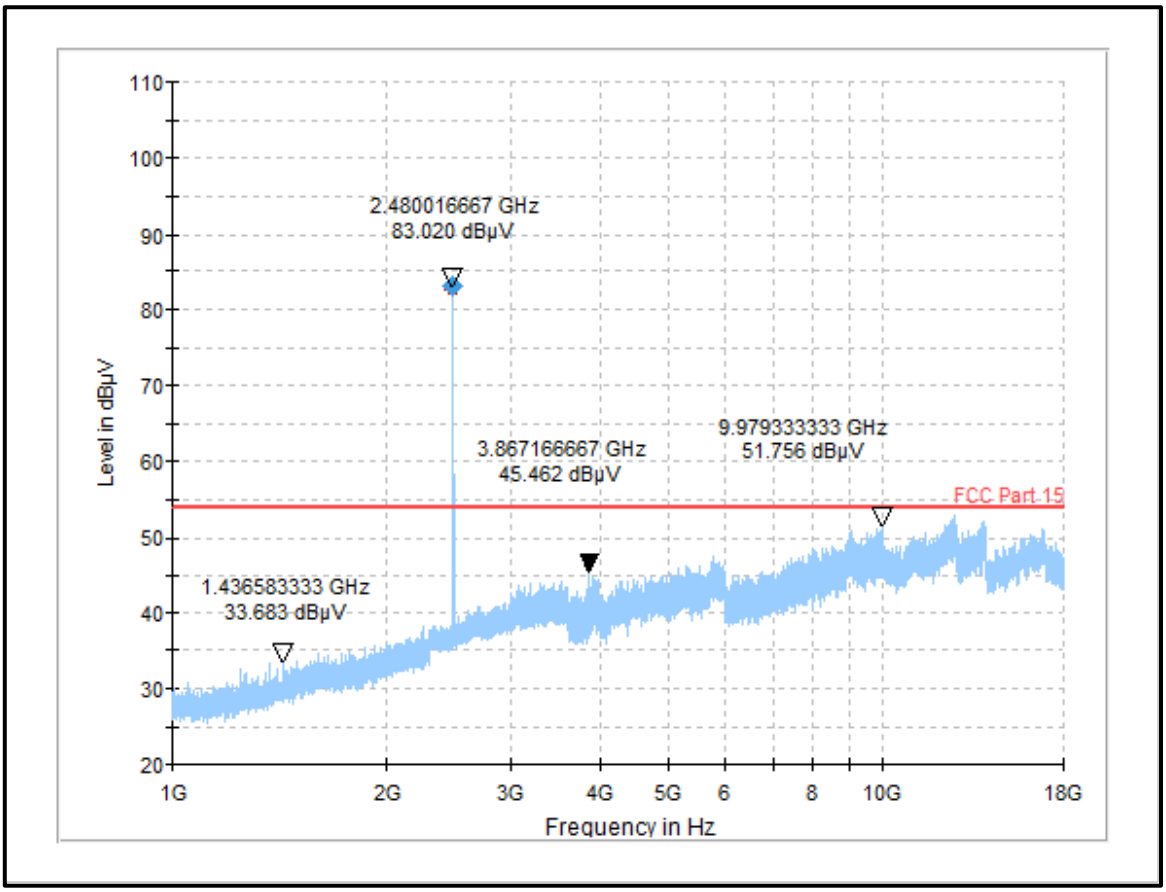
Result: Pass

Transmitter Radiated Emissions (continued)

Results: Top Channel

Frequency (MHz)	Antenna Polarization	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
No critical spurious emissions were detected					

Plot: 1 GHz – 18 GHz: Top Channel



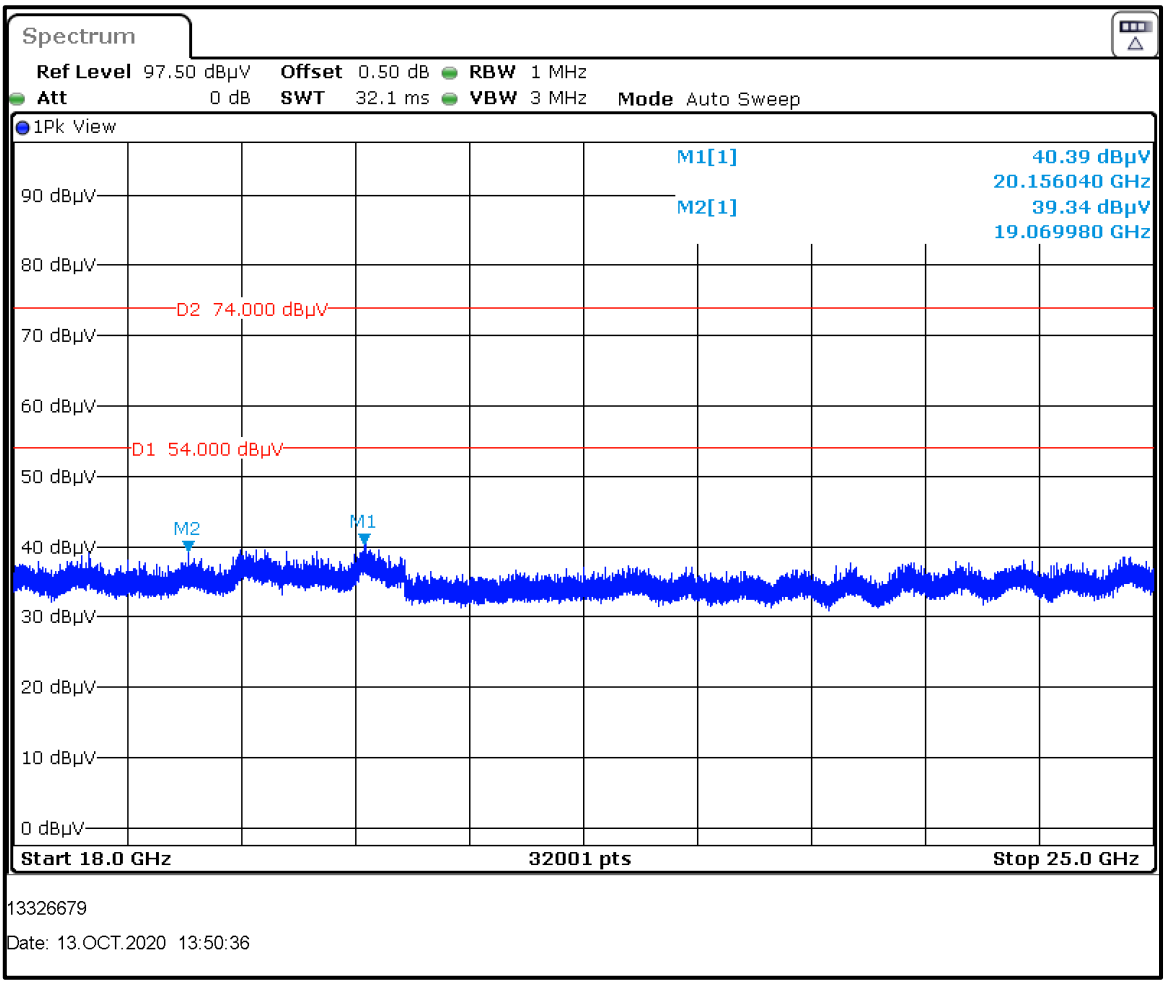
Result: Pass

Transmitter Radiated Emissions (continued)

Results: Top Channel

Frequency (MHz)	Antenna Polarization	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
No critical spurious emissions were detected					

Plot: 18 GHz – 25 GHz: Top Channel



Result: Pass

5.2.7. Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	Sercan Usta	**Test Date:**	15 September 2020
Test Sample Serial Number:	00012 (Radiated Test Sample)		
Test Site Identification	SR 1/2		

FCC Reference:	Part 15.247(d) & 15.209(a)
Test Method Used:	FCC KDB 558074 Sections 8.7 referencing ANSI C63.10 Sections 11.11,11.12 &11.13, ANSI C63.10 Sections 6.10.4 & 6.10.5

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	60

Note(s):

1. The measurements were in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) with absorber on the floor at a distance of 3 m. The EUT was placed at a height of 1.5 m above the test chamber floor in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 m to 4 m.

2. As the maximum peak conducted output power was previously measured. In accordance with FCC KDB 558074 Section 8.7 lower band edge measurement was performed with a peak detector and the -20 dBc limit applied.

3. As the lower band edge falls within a non-restricted band, only peak measurements are required. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The test receiver was left to sweep for a sufficient length of time in order to maximise the carrier level and out-of-band emissions. A marker and corresponding reference level line were placed on the peak of the carrier. Marker frequencies and levels were recorded.

4. As the upper band edge falls within a restricted band both peak and average measurements were recorded by placing a marker at the edge of the band. For peak measurements the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth 3 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. For average measurements the test receiver resolution bandwidth was set to 1 MHz and the video bandwidth 3 MHz. A RMS detector in power averaging mode was used. The test receiver was left to sweep for a sufficient length of time in order to maximise the carrier level and out-of-band emissions. A marker was placed on the band edge spot frequencies and a second marker placed on the highest emission level in the adjacent restricted band of operation (where a higher level emission was present). Marker frequencies and levels were recorded.

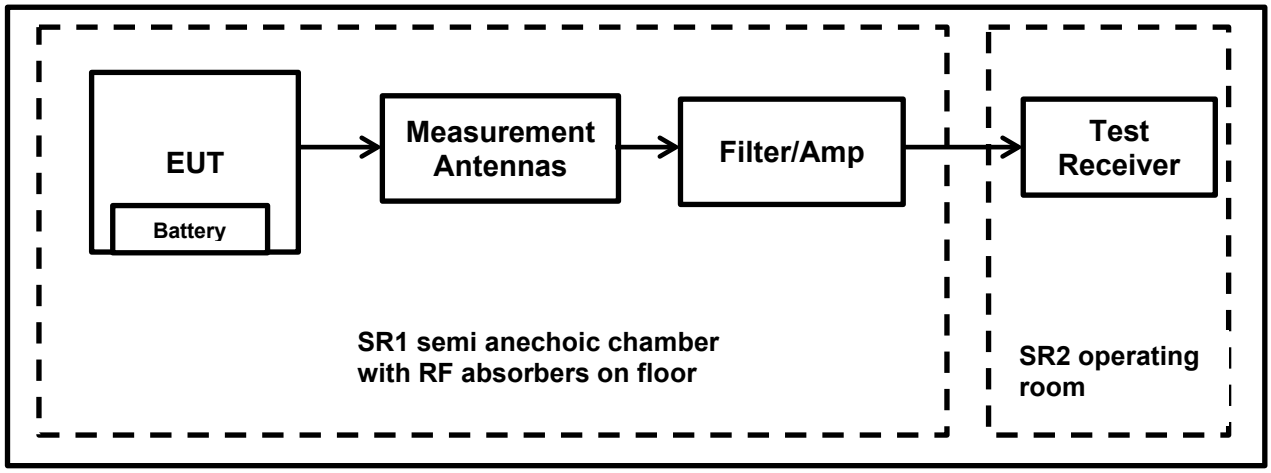
5. There is a restricted band 10 MHz below the lower band edge. The test receiver was set up as follows: the RBW set to 1 MHz, the VBW set to 3 MHz, with the sweep time set to auto couple. Peak and average measurements were performed with their respective detectors. Markers were placed on the highest point on each trace.

6. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.

7. **As the EUT was transmitting continuously with a duty cycle of 85.37 % a duty Cycle Correction factor of 0.69 dB was added to all average measurements.

Transmitter Band Edge Radiated Emissions (Continued)

Test Setup:



Transmitter Band Edge Radiated Emissions (continued)

Results: Bluetooth Low Energy / Lower Band Edge / Peak

Results: Lower Band Edge / Peak

Frequency (MHz)	Peak Level (dBµV/m)	-20 dBc Limit (dBµV/m)	Margin (dB)	Result
2398.92	35.76	61.79	26.03	Complied
2400.00	33.72	61.79	28.07	Complied

Results: 2310 to 2390 MHz Restricted Band / Peak

Frequency (MHz)	Peak Level (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Result
2342.90	44.57	74.0	29.43	Complied

Results: 2310 to 2390 MHz Restricted Band / Average

Frequency (MHz)	Average Level (dBµV/m)	Duty Cycle Correction (dB)	Corrected Avarage Level** (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2379.68	32.96	0.69	33.65	54.0	20.35	Complied

Results: Upper Band Edge / Peak

Frequency (MHz)	Peak Level (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Result
2483.50	45.49	74.0	28.51	Complied
2502.87	45.06	74.0	28.94	Complied

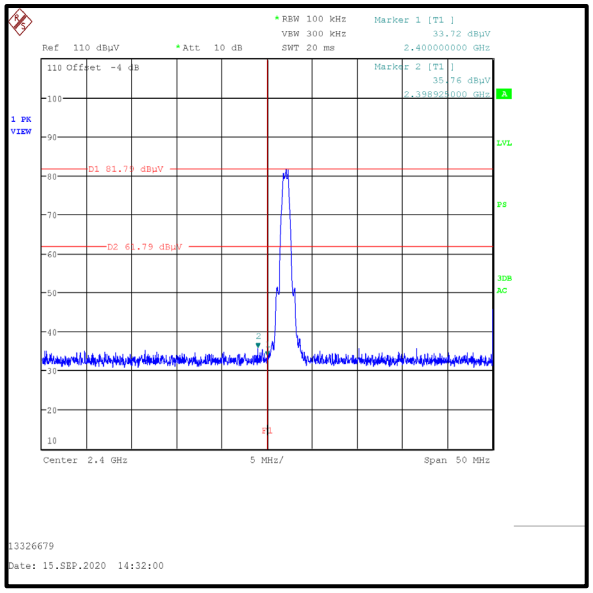
Results: Upper Band Edge / Average

Frequency (MHz)	Average Level (dBµV/m)	Duty Cycle Correction (dB)	Corrected Avarage Level** (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2483.50	40.43	0.69	41.12	54.0	12.88	Complied
2494.45	37.82	0.69	38.51	54.0	15.49	Complied

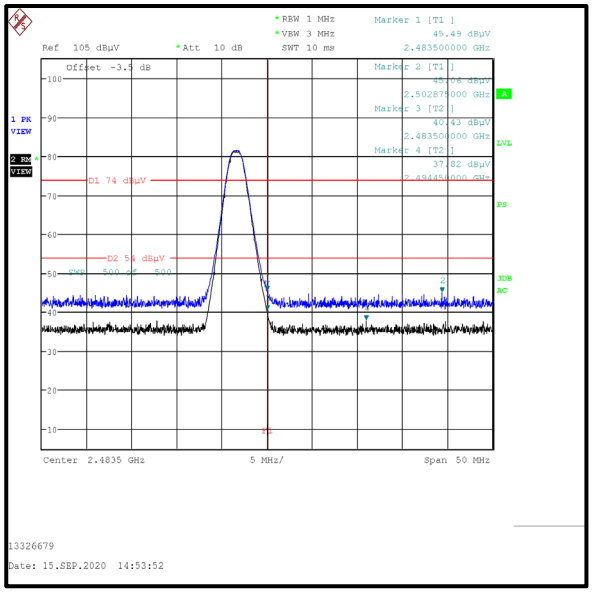
Result: Pass

Transmitter Band Edge Radiated Emissions (continued)

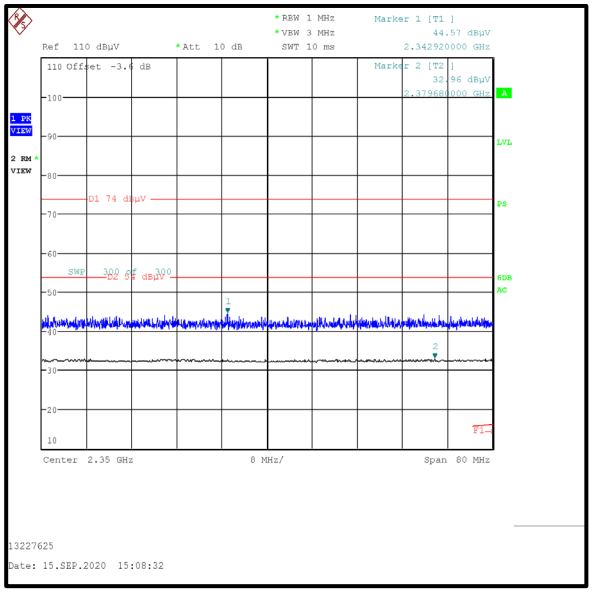
Plots: Bluetooth Low Energy / Lower Band Edge / Peak



Lower Band Edge Peak Measurement



Upper Band Edge Peak & Average Measurement



2310 MHz to 2390 MHz Restricted Band

Result: Pass

6. Measurement Uncertainty

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

Measurement Type	Confidence Level (%)	Calculated Uncertainty
Conducted Maximum Peak Output Power	95%	±0.59 dB
Transmitter Duty Cycle	95%	±3.4%
Spectral Power Density	95%	±0.59 dB
Conducted Maximum Peak Output Power	95%	±0.59 dB
Radiated Spurious Emissions	95%	±3.10 dB
Band Edge Radiated Emissions	95%	±3.10 dB
Minimum 6 dB Bandwidth	95%	±0.87 %

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

7. Used equipment

Test site: SR 1/2

ID	Manufacturer	Type	Model	Serial	Calibration Date	Cal. Cycle (months)
1	Rohde & Schwarz	Antenna, Loop	HFH2-Z2	831247/012	10/07/2020	36
377	BONN Elektronik	Amplifier, Low Noise Pre	BLMA 0118-1A	025294B	08/07/2020	12
460	Deisl	Turntable	DT 4250 S	n/a	n/a	n/a
465	Schwarzbeck	Antenna, Trilog Broadband	VULB 9168	9168-240	02/09/2020	24
496	Rohde & Schwarz	Antenna, log. - periodical	HL050	100297	05/08/2020	36
587	Maturo	antenna mast, tilting	TAM 4.0-E	011/7180311	n/a	n/a
588	Maturo	Controller	NCD	029/7180311	n/a	n/a
591	Rohde & Schwarz	Receiver	ESU 40	100244/040	07/07/2020	12
608	Rohde & Schwarz	Switch Matrix	OSP 120	101227	lab verification	n/a
628	Maturo	Antenna mast	CAM 4.0-P	224/19590716	n/a	n/a
629	Maturo	Kippeinrichtung	KE 2.5-R-M	MAT002	n/a	n/a
-/-	Testo	Thermo-Hygrometer	608-H1	01	lab verification	n/a
328	SPS	AC/DC power distribution system	PAS 5000	A2464 00/2 0200	lab verification	n/a
1603665	Siemens Matsushita Components	semi-anechoic chamber SR1/ 2	-/-	B83117-A1421-T161	n/a	n/a

Test site: SR 7/8

ID	Manufacturer	Type	Model	Serial	Calibration Date	Cal. Cycle (months)
23	Rohde & Schwarz	Artificial Mains	ESH3-Z5	831767/013	07/07/2020	12
28	Rohde & Schwarz	Passive Probe	ESH2-Z3	none	11/07/2020	12
349	Rohde & Schwarz	Receiver, EMI Test	ESIB7	836697/009	09/07/2020	12
351	Rohde & Schwarz	network, Artificial Mains	ESH3-Z5	862770/018	07/07/2020	12
616	Rohde & Schwarz	ISN	ENY81-CA6	101656	07/07/2020	12
-/-	Testo	Thermo-Hygrometer	608-H1	08	lab verification	n/a
327	SPS	AC/DC power distribution system	PAS 5000	A2464 00/1 0200	lab verification	n/a

Test site: SR 9

ID	Manufacturer	Type	Model	Serial	Calibration Date	Cal. Cycle (months)
445	Huber & Suhner	RF Attenuator (10dB)	6810.17.AC	--	lab verification	12
637	Rohde & Schwarz	Spectrum Analyzer	FSV40	101587	08/07/2020	12
-/-	Testo	Thermo-Hygrometer	608-H1	07	lab verification	n/a
-/-	Huber & Suhner	RF Cable (upto 18GHz)	-/-	-/-	lab verification	n/a
1603668	Siemens Matsushita Components	shielded room		B83117-B1422-T161	n/a	n/a

8. Report Revision History

Version Number	Revision Details		
	Page No (s)	**Clause**	**Details**
1.0	-	-	Initial Version
Test Report Version 1.1 supersede Version 1.0 with immediate effect Test Report No. UL-RPT-RP-13326679-619-FCC Version 1.1, Issue Date 17 MAY 2021 replaces Test Report No. UL-RPT-RP-13326679-619-FCC Version 1.0, Issue Date 11 JANUARY 2021 which is no longer valid.			
1.1	as below	as below	Current Version
	1	-	Model No. corrected from WAVOPRO to WAVO PRO
	7	3.1	Model No. corrected from WAVOPRO to WAVO PRO
	7	3.2	Model No. corrected from WAVOPRO to WAVO PRO
	9	4.2	Reference Note to Radiated Emission Measurements below 30 MHz was removed
	26-28	5.2.6	Reference Notes, Test Setup & Test Results to Radiated Emission Measurements below 30 MHz were removed