

TEST REPORT

Test Report No.: UL-RPT-RP-14317245-216-FCC

Applicant : Workaround GmbH

Model No. : LEO

FCC ID : 2AOJL-LEO

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

- 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 1.0

5. Result of the tested sample: PASS

Prepared by: Sercan Usta Title: Laboratory Engineer

Date: 12 July 2022

Approved by: Rachid, Acharkaoui

Title: Laboratory Manager

Date: 12 July 2022





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

TEST REPORT VERSION 1.0

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1. Customer Information

1.1.Applicant Information

Company Name:	Workaround GmbH	
Company Address:	Rupert-Mayer-Str. 44, 81379 Munich, Germany	
Company Phone No.: +49 89 26203500		
Company E-Mail:	support@proglove.com	
Contact Person:	Arif Şamil Çılgın	
Contact E-Mail Address:	arif.cilgin@proglove.de	
Contact Phone No.:	+4917677379345	

1.2.Manufacturer Information

Company Name:	Workaround GmbH	
Company Address:	Rupert-Mayer-Str. 44, 81379 Munich, Germany	
Company Phone No.: +49 89 26203500		
Company E-Mail:	support@proglove.com	
Contact Person:	Arif Şamil Çılgın	
Contact E-Mail Address:	arif.cilgin@proglove.de	
Contact Phone No.:	+4917677379345	



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:	06 May 2022
EUT arrived:	18 May 2022
Test Dates:	07 June 2022 – 22 June 2022
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	\boxtimes			
Part 15.247(a)(2)	Transmitter Minimum 6 dB Bandwidth	\boxtimes			
Part 15.35(c)	Transmitter Duty Cycle (1)	\boxtimes			
Part 15.247(e)	Transmitter Power Spectral Density (2)			\boxtimes	
Part 15.247(b)(3)	Transmitter Maximum Peak Output Power	\boxtimes			
Part 15.247(d)/15.209(a)	Transmitter Radiated Emissions	\boxtimes			
Part 15.247(d)/15.209(a)	Transmitter Band Edge Radiated Emissions	\boxtimes			

Note(s):

- 1. The measurement was performed to assist in the calculation of the average measurements.
- 2. In accordance with ANSI C63.10-2013 Section 11.10.1, PSD is not required if the maximum conducted output power is less than the PSD limit of 8 dBm / 3 kHz. The PSD level is therefore deemed to be equal to the measured total output power.

2.3. Methods and Procedures

Reference:	ANSI C63.10-2013	
Title: American National Standard of Procedures for Compliance Testin Unlicensed Wireless Devices		
Reference: FCC 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: FCC 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:	ProGlove	
Model Name or Number:	LEO	
Test Sample Serial Number:	L1SRC01000001 (Conducted Test Sample))	
Hardware Version Number:	С	
Software Version Number:	01	
FCC ID:	2AOJL-LEO	

Brand Name:	ProGlove	
Model Name or Number:	LEO	
Test Sample Serial Number:	L1SRC01000067 (Radiated Test Sample)	
Hardware Version Number:	С	
Software Version Number:	01	
FCC ID:	2AOJL-LEO	

Brand Name:	ProGlove	
Model Name or Number:	LEO	
Test Sample Serial Number:	L1SRC01000070 (Radiated Test Sample)	
Hardware Version Number:	С	
Software Version Number:	01	
FCC ID:	2AOJL-LEO	

3.2. Description of EUT

The equipment under test was a Wireless wearable bar-code reader, 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 (4.0 / 5.0) / Digital Transmission System			
Type of Unit:	Transceiver			
Power Supply Requirement(s):	Nominal	3.7 V DC (Internal Red	chargeable Battery)	
Channel Spacing:	2 MHz			
Modulation:	GFSK	GFSK		
Data Rate:	1 Mbps / 2 Mbps	1 Mbps / 2 Mbps		
Maximum Conducted Output Power:	0.15 dBm			
Declared Antenna Gain:	0 dBm	0 dBm		
Antenna Type:	Custom Flex PC	Custom Flex PCB Antenna		
Antenna Details:	2.4GHz Flex PCB antenna			
Transmit Frequency Range:	2402 MHz to 24	2402 MHz to 2480 MHz		
Transmit Channels Tested:	Channel ID	RF Channel	Channel Frequency (MHz)	
	Bottom	37	2402	
	Middle 19 2444			
	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	Brand Name Model Name or Number	
	-/-	-/-	-/-	-/-

B. Support Equipment (Manufacturer supplied)

Item	Description	Brand Name	Model Name or Number	Serial Number
1	Glove with button to trigger Mark	PROGLOVE	Not marked or stated	Not marked or stated
2	Charging Station S (5 V DC 1.2 A LPS)	PROGLOVE	PGCS 2420 06213	Not marked or stated
3	AC/DC Adapter (5 V DC 2.1 A)	Sunny Electronics	SYS1561-1105	Not marked or stated
4	Type A to USB Type C USB Charging Cable Length 1.5 m	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):

 $\ oxdot$ Continuously transmitting modulated carrier with combination of

BT-LE Test Mode :1 Mbps | PRBS9 | Maximum Power Settings (PWR MAX)

BT-LE Test Mode :2 Mbps | PRBS9 | Maximum Power Settings (PWR MAX)



4.2. Configuration and Peripherals

EUT Power Supply:

- The EUT was powered via 3.6V Internal battery for radiated and conducted measurements.
- EUT was tested in charging mode for AC conducted emission measurements.

Test Mode Activation:

- The customer supplied a document containing the setup instructions "LEO& MARK 3 Certification Helper (rev-A).pdf", 17.05.2022
- The EUTs were configured into required Bluetooth LE TX test modes using the QR codes which were supplied by the customer.
- For the modulated test mode activation TXRAND and PRBS9 options were selected.
- The transmitter power was configured to maximum value & was not a accessable during the tests.

AC Conducted Line Measurements:

- The EUT radiated samples with fully discharged internal battery were used for AC conducted emissions measurements.
- Testing performed on the charging station of the EUT and not on the EUT directly
- In accordance with ANSI C63.10 section 5.10.7, emission tests shall be performed with the EUT and accessories configured in a manner that tends to produce maximum emissions; therefore 2 EUT radiated samples were placed inside Charging Station S during the AC conducted emission measurements.
- The Charging Station S was connected via USB cable to AC/DC Power Supply Adapter.
 The Power Supply Adapter was connected to either 120 VAC /60 Hz or 240 VAC/60 Hz single phase supply via a LISN.

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's attenuation (maximum 0.5 dB@2.4GHz) was added to a reference level offset to each of the conducted plots.

Radiated Measurements:

- The EUT radiated samples with fully charged internal battery were used for 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 Standing-position was found to be the worst case therefore this report includes relevant results.
- The radiated measurements below 30 MHz were performed with the EUT positioned on the turn table and rotating 360 degrees while the loop antenna height was set to 100 cm.
- The 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.
- R&S® EMC32 V11.30.00 Software was used for the Radiated spurious emission measurements.

Duty Cycle:

As the EUT continuous transmission of the EUT (D≥ 98%) cannot be achieved and EUT was
transmitting continuously with a constant Duty Cycle of 72.1 % & 37.3 % (duty cycle variations are
less than ±2%) in 1 Mbps and 2 Mbps data rates. Therefore, a Duty Cycle Correction Factor of
1.42dB & 4.28 dB was added to all average measurements to compute the corrected average values
of the emissions that would have been measured had the test been performed at 100% Duty Cycle.



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:	Sercan Usta	Test Date:	09 June 2022	
Test Sample Serial Number:	L1SRC01000067 (Radiated Test Sample) L1SRC01000070 (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):	24.0
Relative Humidity (%):	35.0

Settings of the Instrument

Detector	Quasi Peak/ Average Peak
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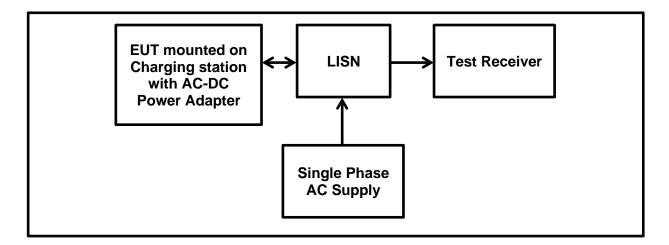
Note(s):

- 1. In accordance with FCC KDB 174176 Q4, tests were also 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.
- In accordance with ANSI C63.10 section 5.10.7, emission tests shall be performed with the EUT and accessories configured in a manner that tends to produce maximum emissions; therefore 2 EUT radiated samples were placed inside Charging Station S during the AC conducted emission measurements.
- The Charging Station S was connected via USB cable to AC/DC Power Supply Adapter.
 The Power Supply Adapter was connected to either 120 VAC /60 Hz single phase supply via a LISN. 240 VAC / 50 Hz
- 4. 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.
- 5. The EUT was not able to transmit while charging and was in Idle mode during the Testing.
- 6. 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.
- 7. The final measured value, for the given emission, in the table below incorporates the cable loss.
- 8. All other emissions shown on the pre-scan plot were investigated and only the highest 6 emissions have been reported in the tables below in accordance with ANSI C63.10 section 6.2.5.
- 9. 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 in a distance of 40 cm from the vertical ground plane at the edge of the table.
- 10. Measurement software used: Toyo EMI Software; CE measurement software EP5/CE Ver 4.0.1.



Transmitter AC Conducted Spurious Emissions (continued)

Test setup:



<u>Transmitter AC Conducted Spurious Emissions (continued)</u>

Results: BT-LE / Idle mode

Results: Live / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dB _µ V)	Limit (dB _µ V)	Margin (dB)	Result
0.25069	Live	28.00	61.70	33.70	Complied
0.55607	Live	26.20	56.00	29.80	Complied
1.77618	Live	15.70	56.00	40.30	Complied
4.49866	Live	20.20	56.00	35.80	Complied
5.08054	Live	19.10	60.00	40.90	Complied
18.40844	Live	9.10	60.00	50.90	Complied

Results: Live / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBµV)	Margin (dB)	Result
0.25069	Live	17.70	51.70	34.00	Complied
0.55607	Live	17.10	46.00	28.90	Complied
1.77618	Live	7.30	46.00	38.70	Complied
4.49866	Live	7.90	46.00	38.10	Complied
5.08054	Live	7.30	50.00	42.70	Complied
18.40844	Live	5.40	50.00	44.60	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dB _µ V)	Margin (dB)	Result
0.23419	Neutral	24.10	62.30	38.20	Complied
0.56684	Neutral	34.10	56.00	21.90	Complied
1.13121	Neutral	23.80	56.00	32.20	Complied
1.44979	Neutral	22.90	56.00	33.10	Complied
3.96499	Neutral	22.60	56.00	33.40	Complied
8.15548	Neutral	15.60	60.00	44.40	Complied

Transmitter AC Conducted Spurious Emissions (continued)

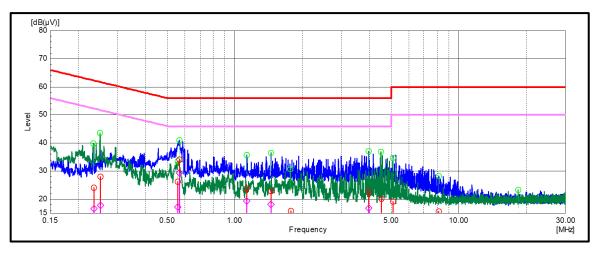
Results: BT-LE / Idle mode

Results: Neutral / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dB _µ V)	Margin (dB)	Result
0.23419	Neutral	16.60	52.30	35.70	Complied
0.56684	Neutral	29.40	46.00	16.60	Complied
1.13121	Neutral	19.30	46.00	26.70	Complied
1.44979	Neutral	18.10	46.00	27.90	Complied
3.96499	Neutral	16.80	46.00	29.20	Complied
8.15548	Neutral	9.50	50.00	40.50	Complied

Result: Pass

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.

<u>Transmitter AC Conducted Spurious Emissions (continued)</u>

Results: BT-LE / Idle mode

Results: Live / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dB _µ V)	Margin (dB)	Result
0.22778	Live	35.90	62.50	26.60	Complied
0.57758	Live	32.30	56.00	23.70	Complied
1.06759	Live	25.10	56.00	30.90	Complied
2.23012	Live	24.40	56.00	31.60	Complied
4.15722	Live	27.20	56.00	28.80	Complied
5.31846	Live	26.50	60.00	33.50	Complied

Results: Live / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBµV)	Margin (dB)	Result
0.22778	Live	23.10	52.50	29.40	Complied
0.57758	Live	22.30	46.00	23.70	Complied
1.06759	Live	10.00	46.00	36.00	Complied
2.23012	Live	13.00	46.00	33.00	Complied
4.15722	Live	15.00	46.00	31.00	Complied
5.31846	Live	13.60	50.00	36.40	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dB _µ V)	Margin (dB)	Result
0.28507	Neutral	34.80	60.70	25.90	Complied
0.58023	Neutral	37.20	56.00	18.80	Complied
1.05670	Neutral	28.40	56.00	27.60	Complied
2.63040	Neutral	27.10	56.00	28.90	Complied
5.28802	Neutral	25.20	60.00	34.80	Complied
6.62356	Neutral	18.40	60.00	41.60	Complied

Transmitter AC Conducted Spurious Emissions (continued)

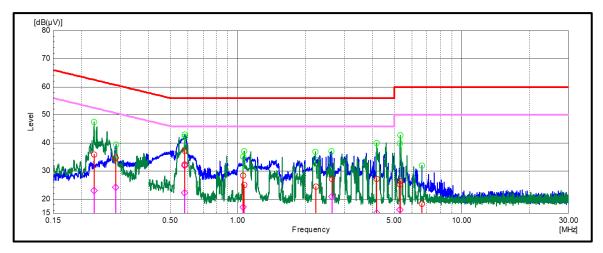
Results: BT-LE / Idle mode

Results: Neutral / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dB _µ V)	Margin (dB)	Result
0.28507	Neutral	24.20	50.70	26.50	Complied
0.58023	Neutral	31.90	46.00	14.10	Complied
1.05670	Neutral	17.10	46.00	28.90	Complied
2.63040	Neutral	21.00	46.00	25.00	Complied
5.28802	Neutral	16.20	50.00	33.80	Complied
6.62356	Neutral	11.30	50.00	38.70	Complied

Result: Pass

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:	Sercan Usta	Test Date:	07 June 2022 & 22 June 2022
Test Sample Serial Number:	L1SRC01000001 (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:

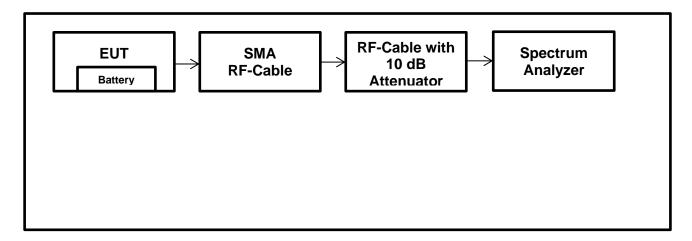
Temperature (°C):	25.0
Relative Humidity (%):	53.0

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 0.5 dB at the tested frequencies including the 10 dB attenuator at the input of Spectrum Analyzer

Therefore, total a reference level offset 11.0 dB was added to each of the at the tested frequencies conducted plots.

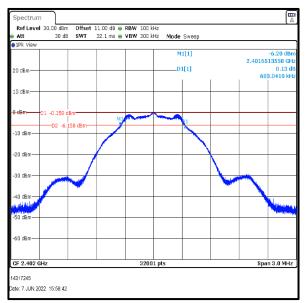
Test Setup:



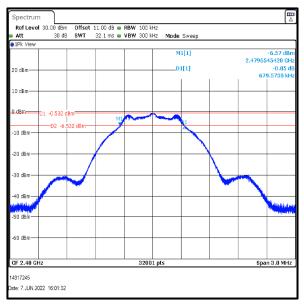
Transmitter Minimum 6 dB Bandwidth (continued)

Results: BT-LE Mode / TXRAND / PRBS9 / 1 Mbps / PWR MAX

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	683.041	≥ 500	183.041	Complied
Middle	686.135	≥ 500	186.135	Complied
Тор	679.573	≥ 500	179.573	Complied

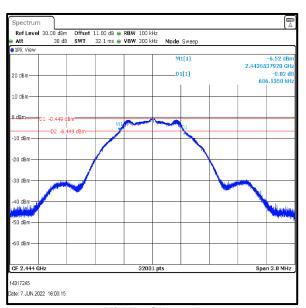


Bottom Channel



Top Channel

Result: Pass

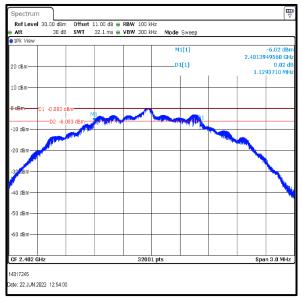


Middle Channel

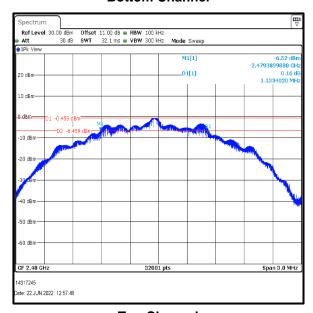
Transmitter Minimum 6 dB Bandwidth (continued)

Results: BT-LE Mode / TXRAND / PRBS9 / 2 Mbps / PWR MAX

Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	1129.371	≥ 500	629.371	Complied
Middle	1145.965	≥ 500	645.965	Complied
Тор	1133.402	≥ 500	633.402	Complied

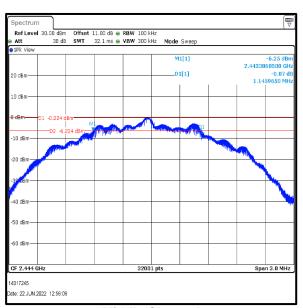


Bottom Channel



Top Channel

Result: Pass



Middle Channel



5.2.3. Transmitter Duty Cycle

Test Summary:

Test Engineer:	Sercan Usta	Test Date:	22 June 2022
Test Sample Serial Number:	L1SRC01000001 (Conducted Test Sample)		
Test Site Identification	SR 9		

FCC Reference:	Part 15.35(c)
Test Method Used:	FCC KDB 558074 Section 6.0 referencing ANSI C63.10 Section 11.6

Environmental Conditions:

Temperature (°C):	25.9
Relative Humidity (%):	51.7

Note:

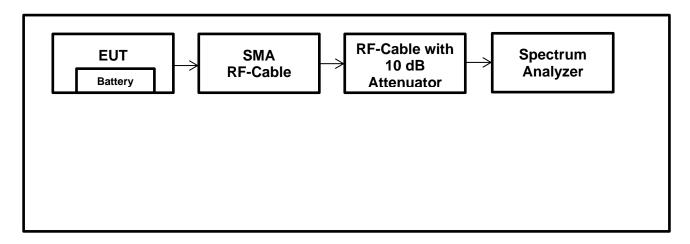
1. The transmitter duty cycle was measured using a spectrum analyser in the time domain and calculated by using the following calculation:

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

- 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 0.5 dB at the tested frequencies including the 10 dB attenuator at the input of Spectrum Analyzer

Therefore, total a reference level offset 11.0 dB was added to each of the at the tested frequencies conducted plots.

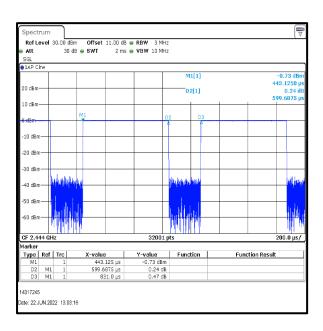
Test Setup:



Transmitter Duty Cycle (continued)

Results: BT-LE Mode / TXRAND / PRBS9 / 1 Mbps / PWR MAX

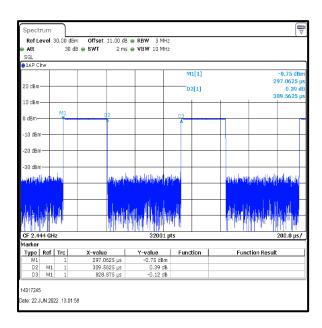
Pulse On Time (T _{ON})	Pulse Period (T _{ON} +T _{OFF})	Duty Cycle	Duty Cycle Correction Factor (dB)
(ms)	(ms)	(%)	
0.599	0.831	72.1	1.42



Transmitter Duty Cycle (continued)

Results: BT-LE Mode / TXRAND / PRBS9 / 2 Mbps / PWR MAX

Pulse On Time (T _{ON})	Pulse Period (T _{ON} +T _{OFF})	Duty Cycle	Duty Cycle Correction Factor (dB)
(ms)	(ms)	(%)	
0.309	0.828	37.3	4.28





5.2.4. Transmitter Maximum Peak Output Power

Test Summary:

Test Engineer:	Sercan Usta	Test Date:	07 June 2022 & 22 June 2022	
Test Sample Serial Number:	L1SRC01000001 (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):	25.0
Relative Humidity (%):	53.0

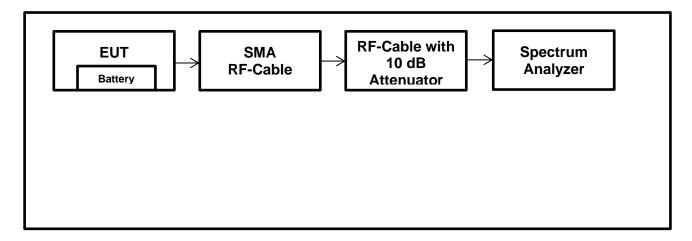
Notes:

- 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 0.5 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 11.0 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:



<u>Transmitter Maximum Peak Output Power (continued)</u> Results: BT-LE Mode / TXRAND / PRBS9 / 1 Mbps / PWR MAX

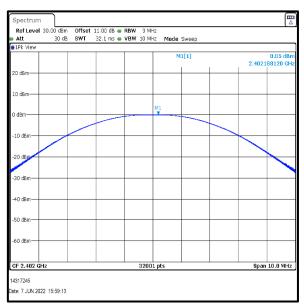
Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	0.05	30.00	29.95	Complied
Middle	-0.23	30.00	30.23	Complied
Тор	-0.30	30.00	30.30	Complied

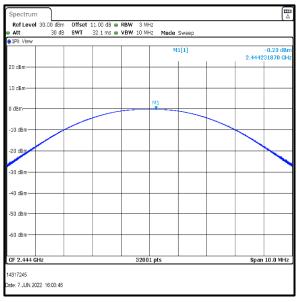
Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	0.05	0.00	0.05	36.00	35.95	Complied
Middle	-0.23	0.00	-0.23	36.00	36.23	Complied
Тор	-0.30	0.00	-0.30	36.00	36.30	Complied

Result: Pass

<u>Transmitter Maximum Peak Output Power (continued)</u>

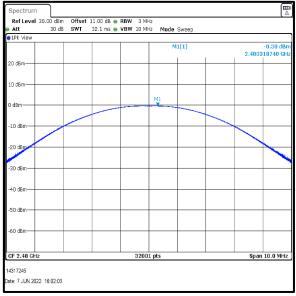
Results: BT-LE Mode / TXRAND / PRBS9 / 1 Mbps / PWR MAX





Middle Channel

Bottom Channel



Top Channel

<u>Transmitter Maximum Peak Output Power (continued)</u> Results: BT-LE Mode / TXRAND / PRBS9 / 2 Mbps / PWR MAX

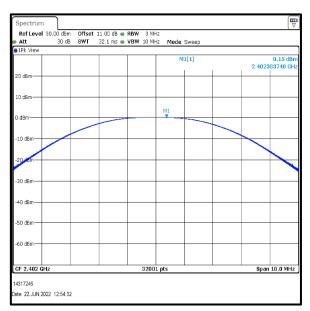
Channel	Conducted Peak Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	0.15	30.00	29.85	Complied
Middle	0.04	30.00	29.96	Complied
Тор	-0.13	30.00	30.13	Complied

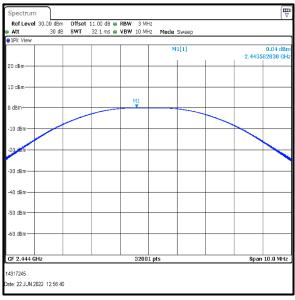
Channel	Conducted Peak Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	0.15	0.00	0.15	36.00	35.85	Complied
Middle	0.04	0.00	0.04	36.00	35.96	Complied
Тор	-0.13	0.00	-0.13	36.00	36.13	Complied

Result: Pass

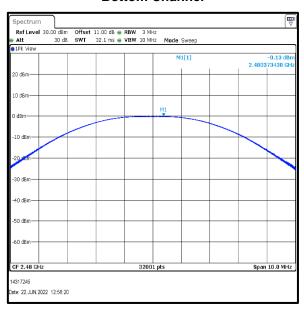
Transmitter Maximum Peak Output Power (continued)

Results: BT-LE Mode / TXRAND / PRBS9 / 2 Mbps / PWR MAX





Bottom Channel



Top Channel

Middle Channel

5.2.5. Transmitter Radiated Emissions

Test Summary:

Test Engineer:	Sercan Usta	Test Date:	07 June 2022	
Test Sample Serial Number:	L1SRC01000067 (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 and 11.12 ANSI C63.10:2013 Sections 6.3 and 6.4		
Frequency Range	9 kHz to 30 MHz		

Environmental Conditions:

Temperature (°C):	21.7
Relative Humidity (%):	53.0

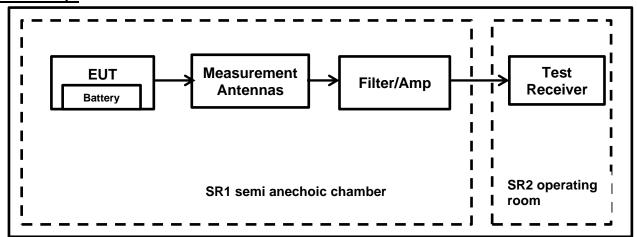
Notes:

- 1. In accordance with FCC KDB 414788 D01 Radiated Test Site & ANSI C63.10 clause 5.2 an alternative test site that can demonstrate equivalence to a open area test site may be used. Therefore, the measurement was performed in a Semi Anechoic Chamber. (The OATS / SAC comparison data is available upon request).
- 2. The limits are specified at a test distances of 30 and 300 metres. However, as specified in FCC Section 15.31 (f)(2) & ANSI C63.10 clause 6.4.3, measurements may be performed at a closer distance and the measured level extrapolated to the specified measurement distance using the method described in clauses 6.4.4, specifically sub-clause 6.4.4.1 which specifies that the measured level shall be extrapolated to the specified distance by conservatively presuming that the field strength decays at 40 dB/decade.
 - Therefore, measurements were performed at a measurement distance of 3 m.
- 3. Therefore, the limit values are extrapolated to a measurement distance of 3 m.
 - 9 kHz- 490 kHz: limits extrapolated from 300 m to 3 m by adding 80 dB at 40 dB /decade.
 - 490 kHz-1705 kHz: limits extrapolated from 30 m to 3 m by adding 40 dB at 40 dB /decade.
- 4. Measurements below 30 MHz 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. The measurement loop antenna height was 100 cm.
- 5. The measurement was performed only with 2 Mbps data rate on bottom channel as it was found out to be the worst-case.
- 6. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
- 7. All other emissions shown on the pre-scans were investigated and found to be > 20 dB below the applicable limits.
- 8. Pre-scans were performed and markers placed on the highest measured levels. The test receiver was set to:
 - Frequency range: 9 kHz-150 kHz : RBW: 1 kHz /VBW: 3 kHz
 - Frequency range: 150 kHz 30 MHz: RBW: 10 kHz /VBW: 30 kHz
 - Detector: Max-Peak detector
 - Trace Mode: Max Hold



Transmitter Radiated Emissions (continued)

Test Setup:



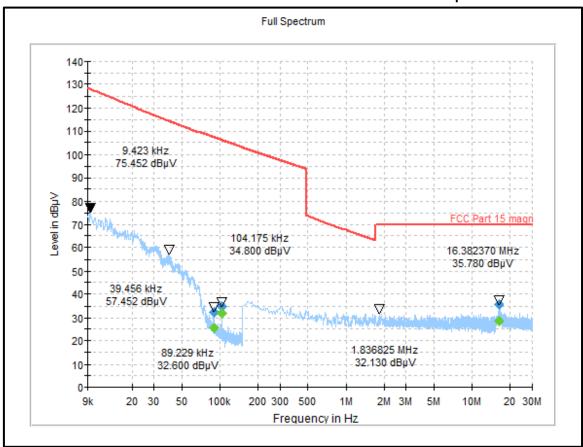


Transmitter Radiated Emissions (continued)

Results: BT-LE Mode / TXRAND / PRBS9 / PWR MAX / 2 Mbps / Bottom Channel

Frequency (MHz)	Loop Antenna Orientation	MaxPeak Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Result
0.089	90° to EUT	32.45	107.26	74.81	Complied
0.104	0° to EUT	34.80	105.96	71.16	Complied
16.382	90° to EUT	35.78	70.00	34.22	Complied

Plot: 9 kHz - 30 MHz: BT-LE Mode / TXRAND / PRBS9 / PWR MAX / 2 Mbps / Bottom Channel



Result: Pass

Transmitter Radiated Emissions (continued)

Test Summary:

Test Engineer:	Sercan Usta	Test Date:	07 June 2022	
Test Sample Serial Number:	L1SRC01000067 (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 and 11.12 ANSI C63.10:2013 Sections 6.3 and 6.5
Frequency Range	30 MHz to 1000 MHz

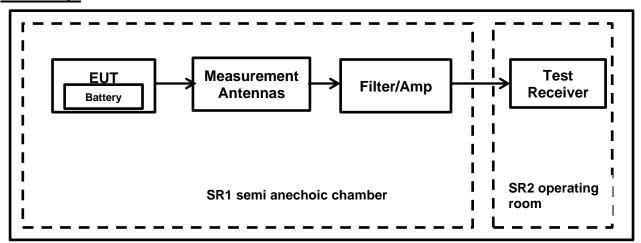
Environmental Conditions:

Temperature (°C):	21.7
Relative Humidity (%):	53.0

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. The measurement was performed only with 2 Mbps data rate on bottom channel as it was found out to be the worst-case.
- 3. 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.
- 4. All emissions shown on the pre-scan plots were investigated and found to be below system noise floor.

Test Setup:

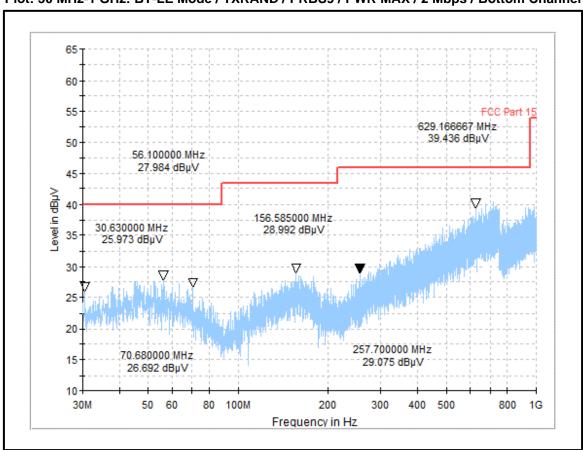


Transmitter Radiated Emissions (continued)

Results: BT-LE Mode / TXRAND / PRBS9 / PWR MAX / 2 Mbps / Bottom Channel

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

Plot: 30 MHz-1 GHz: BT-LE Mode / TXRAND / PRBS9 / PWR MAX / 2 Mbps / Bottom Channel



Result: Pass

Transmitter Radiated Emissions (continued)

Test Summary:

Test Engineer:	Sercan Usta	Test Date:	07 June 2022
Test Sample Serial Number:	L1SRC01000067 (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 and 11.12 ANSI C63.10:2013 Sections 6.3 and 6.6
Frequency Range	1 GHz to 25 GHz

Environmental Conditions:

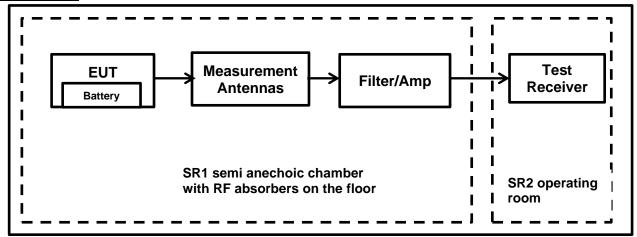
Temperature (°C):	21.7
Relative Humidity (%):	53.0

Note(s):

- 1. Pre-scans above 1 GHz were performed in a semi-anechoic chamber SR1/2 (Asset Number 1603665) with RF absorbers 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.
- 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.
- 3. The measurement from 1GHz to 18 GHz was performed only with 2 Mbps data rate as it was found out to be the worst-case.
- 4. 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.
- 5. For frequency range between 1 GHz and 18 GHz No critical spurious emissions were detected.
- 6. The measurement above 18 GHz was performed only with 2 Mbps data rate on bottom channel as it was found out to be the worst-case.
- 7. For frequency range between 18 GHz and 25 GHz, no critical emissions were found.

Transmitter Radiated Emissions (continued)

Test Setup:



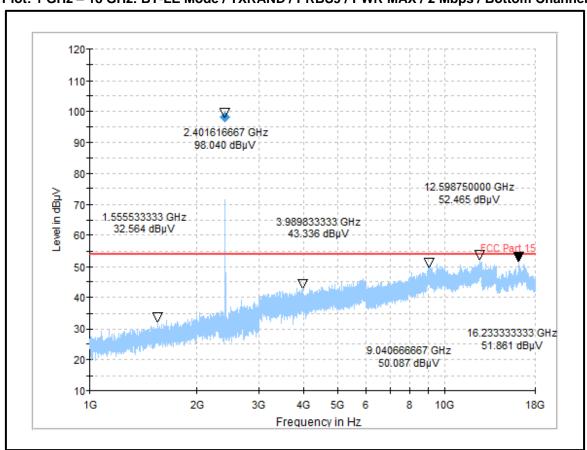


Transmitter Radiated Emissions (continued)

Results: BT-LE Mode / TXRAND / PRBS9 / PWR MAX / 2 Mbps / Bottom Channel

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

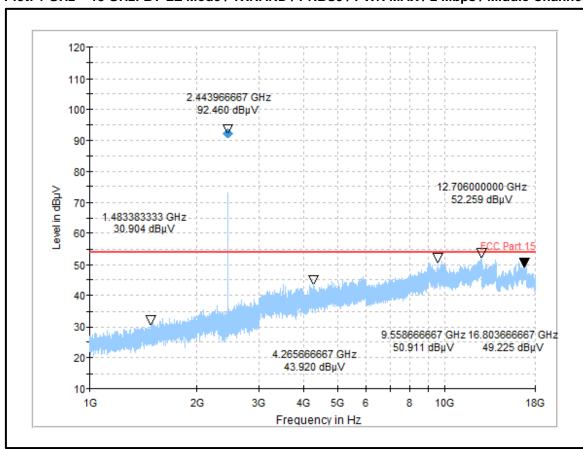
Plot: 1 GHz - 18 GHz: BT-LE Mode / TXRAND / PRBS9 / PWR MAX / 2 Mbps / Bottom Channel



<u>Transmitter Radiated Emissions (continued)</u> Results: BT-LE Mode / TXRAND / PRBS9 / PWR MAX / 2 Mbps / Middle Channel

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

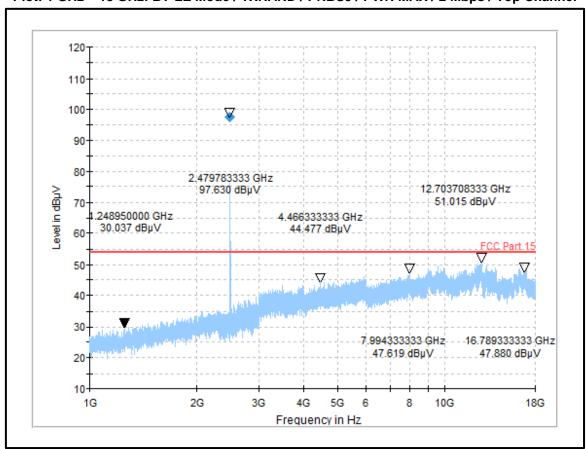
Plot: 1 GHz - 18 GHz: BT-LE Mode / TXRAND / PRBS9 / PWR MAX / 2 Mbps / Middle Channel



<u>Transmitter Radiated Emissions (continued)</u>
Results: BT-LE Mode / TXRAND / PRBS9 / PWR MAX / 2 Mbps / Top Channel

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

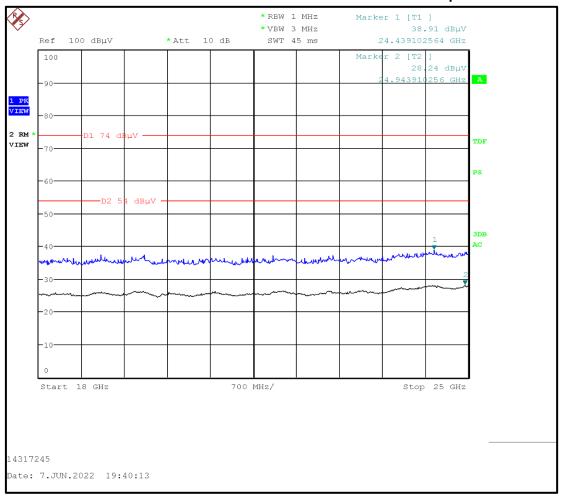
Plot: 1 GHz - 18 GHz: BT-LE Mode / TXRAND / PRBS9 / PWR MAX / 2 Mbps / Top Channel



<u>Transmitter Radiated Emissions (continued)</u> Results: BT-LE Mode / TXRAND / PRBS9 / PWR MAX / 2 Mbps / Bottom Channel

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

Plot: 18 GHz - 25 GHz: BT-LE Mode / TXRAND / PRBS9 / PWR MAX / 2 Mbps / Bottom Channel



5.2.6. Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer: Sercan Usta		Test Date: 07 June 2022		
Test Sample Serial Number:	L1SRC01000067 (Radiated Test Sample)			
Test Site Identification	SR 1/2			

FCC Reference:	Parts 15.247(d) & 15.209(a)
	DTS emissions in non-restricted frequency bands: FCC KDB 558074 Section 8.5 referencing ANSI C63.10:2013 Sections 11.11
Test Method Used:	DTS emissions in restricted frequency bands: FCC KDB 558074 Section 8.6 referencing ANSI C63.10:2013 Sections 11.12
	ANSI C63.10:2013 Sections 6.10.4, 6.10.5

Environmental Conditions:

Temperature (°C):	21.7
Relative Humidity (%):	53.0

Note(s):

- 1. The measurments were in a semi-anechoic chamber SR1/2 (Asset Number 1603665) with RF absorbers 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
- As the lower band edge falls within a non-restricted band, measurements were performed in accordance with FCC KDB 558074 Section 8.5 referencing ANSI C63.10 Section 11.11.
 As the maximum peak conducted output power was previously measured, in accordance with ANSI C63.10 Section 11.11.1(a) 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 avergaging mode was used. The test receiver was set to sweep for a 300 sweep counts 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. The restricted band peak measurements were performed in accordance with ANSI C63.10 Section 11.12.2.4.

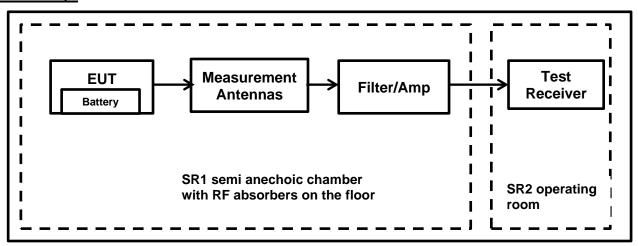


Transmitter Band Edge Radiated Emissions (continued)

Note(s):

- 6. 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 (300 sweeps) were performed with their respective detectors. Markers were placed on the highest point on each trace.
- 7. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
- 8. ** As the EUT continuous transmission of the EUT (D ≥ 98%) cannot be achieved and EUT was transmitting continuously with a constant Duty Cycle of 72.1 % & 37.3 % (duty cycle variations are less than ±2%) in 1 Mbps and 2 Mbps data rates. Therefore, a Duty Cycle Correction Factor of 1.42dB & 4.28 dB was added to all average measurements to compute the corrected average values of the emissions that would have been measured had the test been performed at 100% Duty Cycle.

Test Setup:



<u>Transmitter Band Edge Radiated Emissions (continued)</u> Results: BT-LE Mode / TXRAND / PRBS9 / 1 Mbps / PWR MAX

Results: Lower Band Edge / Peak

Frequency (MHz)	Peak Level (dBμV/m)	-20 dBc Limit (dBμV/m)	Margin (dB)	Result
2400.00	41.04	72.21	31.17	Complied

Results: 2310 to 2390 MHz Restricted Band / Peak

Frequency (MHz)	Peak Level (dBµV/m)	Peak Limit (dΒμV/m)	Margin (dB)	Result
2379.01	46.86	74.0	27.14	Complied

Results: 2310 to 2390 MHz Restricted Band / Average

Frequency (MHz)	Average Level (dBµV/m)	Duty Cycle Correction Factor (dB)	Corrected Avarage Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2374.29	35.25	1.42	36.67**	54.0	17.33	Complied

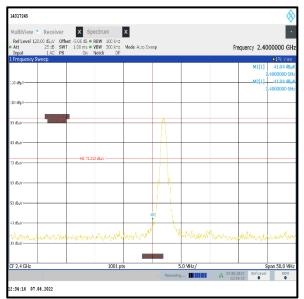
Results: Upper Band Edge / Peak

Frequency (MHz)	Peak Level (dBμV/m)	Peak Limit (dBμV/m)	Margin (dB)	Result
2483.50	47.20	74.0	26.80	Complied
2495.65	48.06	74.0	25.94	Complied

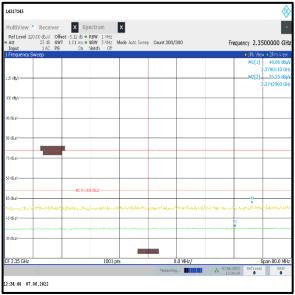
Results: Upper Band Edge / Average

Frequency (MHz)	Average Level (dBµV/m)	Duty Cycle Correction Factor (dB)	Corrected Avarage Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2483.50	36.76	1.42	38.18**	54.0	15.82	Complied

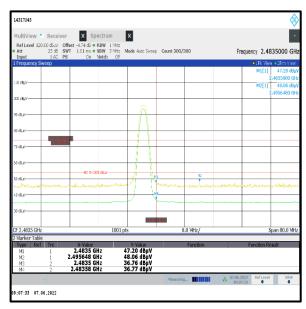
<u>Transmitter Band Edge Radiated Emissions (continued)</u> Results: BT-LE Mode / TXRAND / PRBS9 / 1 Mbps / PWR MAX



Lower Band Edge Peak Measurement



2310 MHz to 2390 MHz Restricted Band



Upper Band Edge Peak & Average Measurement

<u>Transmitter Band Edge Radiated Emissions (continued)</u> Results: BT-LE Mode / TXRAND / PRBS9 / 2 Mbps / PWR MAX

Results: Lower Band Edge / Peak

Frequency (MHz)	Peak Level (dBμV/m)	-20 dBc Limit (dBμV/m)	Margin (dB)	Result
2400.00	60.42	73.49	13.07	Complied

Results: 2310 to 2390 MHz Restricted Band / Peak

Frequency (MHz)	Peak Level (dBµV/m)	Peak Limit (dΒμV/m)	Margin (dB)	Result
2361.43	47.09	74.0	26.91	Complied

Results: 2310 to 2390 MHz Restricted Band / Average

Frequency (MHz)	Average Level (dBµV/m)	Duty Cycle Correction Factor (dB)	Corrected Avarage Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2388.92	35.25	4.28	39.53**	54.0	14.47	Complied

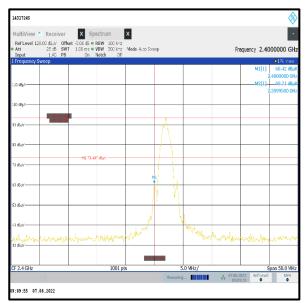
Results: Upper Band Edge / Peak

Frequency (MHz)	Peak Level (dBμV/m)	Peak Limit (dBμV/m)	Margin (dB)	Result
2483.50	51.12	74.0	22.88	Complied
2483.90	51.60	51.60 74.0 22.40		Complied

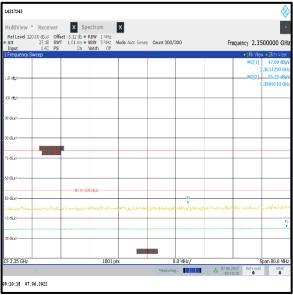
Results: Upper Band Edge / Average

Frequency (MHz)	Average Level (dBµV/m)	Duty Cycle Correction Factor (dB)	Corrected Avarage Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2483.50	38.65	4.28	42.93**	54.0	11.07	Complied

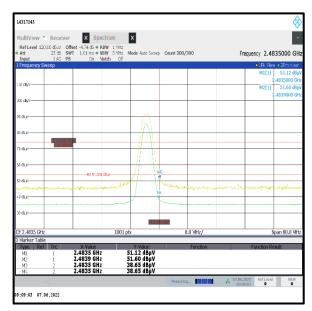
<u>Transmitter Band Edge Radiated Emissions (continued)</u> Results: BT-LE Mode / TXRAND / PRBS9 / 2 Mbps / PWR MAX



Lower Band Edge Peak Measurement



2310 MHz to 2390 MHz Restricted Band



Upper Band Edge Peak & Average Measurement

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
AC Conducted Spurious Emissions	95%	±2.49 dB
Minimum 6 dB Bandwidth	95%	±0.87 %
Transmitter Duty Cycle	95%	±3.4%
Conducted Maximum Peak Output Power	95%	±0.59 dB
Radiated Spurious Emissions	95%	±3.10 dB
Band Edge Radiated Emissions	95%	±3.10 dB

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	Туре	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	14/07/2021	12
423	Bonn Elektronik	Amplifier, Low Noise Pre	BLMA 1840-1A	55929	16/07/2021	12
460	Deisel	Turntable	DT 4250 S	n/a	n/a	n/a
452	Schwarzbeck	Antenna, Trilog Broadband	VULB 9168	9168-240	02/09/2020	24
496	Rohde & Schwarz	Antenna, log periodical	HL050	100297	05/08/2020	36
607	Schwarzbeck	Antenna broadband horn antenna	BBHA 9170	9170-561	15/10/2019	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	28/06/2021	12
669	Rohde & Schwarz	EMI Test Receiver	ESW 44	103087	03/02/2022	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
669	Rohde & Schwarz	EMI Test Receiver	ESW44	103087	03.02.2022	12
-/-	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	Туре	Model	Serial	Calibration Date	Cal. Cycle (months)
23	Rohde & Schwarz	Artificial Mains	ESH3-Z5	831767/013	14/07/2021	12
28	Rohde & Schwarz	Passive Probe	ESH2-Z3	none	11/07/2019	36
349	Rohde & Schwarz	Receiver, EMI Test	ESIB7	836697/009	13/07/2021	12
351	Rohde & Schwarz	network, Artificial Mains	ESH3-Z5	862770/018	14/07/2021	12
564	Teseq	Impedance stabilisation network (ISN)	ISN T800	26076	14/07/2021	24
616	Rohde & Schwarz	ISN	ENY81-CA6	101656	07/07/2020	36
-/-	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	Туре	Model	Serial	Calibration Date	Cal. Cycle (months)
445	Huber & Suhner	RF Attenuator (10dB)	6810.17.AC	1	lab verification	12
637	Rohde & Schwarz	Spectrum Analyzer	FSV40	101587	14/07/2021	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	Revision Det	ails	
Number	Page No(s)	Clause	Details
1.0	49	-	Initial Version

--- END OF REPORT ---

