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Date: 29 January 2023

I.T.L. Product Testing Ltd.

FCC Radio Test Report

for

ImpacX.io Ltd.

Equipment under test:

Integrated Bluetooth Smart Cap

GX CAP

FCC ID: 2AZ2T-GXCAP2

Tested by: _____
M. Zohar

Approved by: _____
I. Mansky

This report concerns: Original Grant

Equipment type: FCC: (DTS) Digital Transmission System

Limits used: 47CFR15 Section 15.247

Measurement procedure used is KDB 558074 D01 v05r01, ANSI C63.10:2013

Prepared by:
R. Ezrah
I.T.L. Product Testing Ltd.
1 Bat Sheva St., Lod 7116002, Israel
Email: rame@itlglobal.org

Applicant:
Alexander Brandin
ImpacX.io Ltd.
3 Haim Pekeris St., Ruhrberg Science Building Bell Entrance, 2th floor, Rabin Science Park, Rehovot, Israel 7670211
Email: alex@impacx.io

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1. General Information

1.1 Administrative Information

Manufacturer:	ImpacX.io Ltd.
Manufacturer's Address:	3 Haim Pekeris St., Ruhrberg Science Building Bell Entrance, 2th floor, Rabin Science Park, Rehovot, Israel 7670211 Tel: +972-8-373-0370
Equipment Under Test (E.U.T):	Integrated Bluetooth Smart Cap
Equipment Serial No.:	Not designated
Date of Receipt of E.U.T:	September 28, 2022
Start of Test:	September 28, 2022
End of Test:	November 17, 2022
Test Laboratory Location:	I.T.L Product Testing Ltd. 1 Bat Sheva St., Lod 7120101, Israel
Test Specifications:	FCC Part 15, Subpart C

1.2 List of Accreditations

The EMC laboratory of I.T.L. is accredited by the following bodies:

1. The American Association for Laboratory Accreditation (A2LA) (U.S.A.), Certificate No. 1152.01.
2. The Federal Communications Commission (FCC) (U.S.A.), FCC Designation No. IL1005.
3. Department of Innovation, Science and Economic Development (ISED) Canada, CAB identifier: IL1002

I.T.L. Product Testing Ltd. is accredited by the American Association for Laboratory Accreditation (A2LA) and the results shown in this test report have been determined in accordance with I.T.L.'s terms of accreditation unless stated otherwise in the report.

1.3 Product Description

GX CAP is an integrated Bluetooth Smart Cap, located on a bottle cap. The unit is battery-operated (rechargeable) and contains a non-approved 2.4 GHz BLE radio with a PCB antenna. The PCB has a charging port (magnetic) and can operate while being charged. Charging mode as a worst case is done by a typical USB AC/DC power adapter.
The EUT has a 21 LED display for user interface.

Type of Equipment							
☒	Stand Alone (Equipment with/without its own control provisions)						
☐	Combined (Equipment where radio part is fully integrated with another type of equipment)						
☐	Plug in card (Equipment intended for a variety of host systems)						
Intended Use		Condition of use					
☐	Fixed	Always of distance >2m from the people					
☐	Mobile	Always of distance >20cm from the people					
☒	Portable	Always of distance <20cm to human body					
Assigned frequency band		2400 to 2483.5 MHz					
Operational frequencies		2402 MHz to 2480 MHz					
Maximum rated output power		At transmitter 50Ω RF output connector [dBm]	~2dBm				
		Effective Radiated Power (for equipment without RF connector)					
Antenna Connection							
☐	Unique Coupling	☐	Standard Connection	☒	Integral	☒	With temporary RF connector
						☐	Without temporary RF connector
Antenna Gain(peak)		2.11dBi					
Operating channel bandwidth		1M					
Type of modulation		GFSK					
Bit rate		1 Mbps data rate					
Maximum transmitter duty cycle		98%					
Transmitter power source		USB power adaptor					
☐	AC	Nominal rated voltage					
☒	Battery	Nominal rated voltage	3.7 Vdc				

1.4 Test Methodology

Conducted and radiated testing were performed according to the procedures in KDB 558074 D01 v05r01, ANSI C63.10: 2013, RSS-Gen, Issue 5, April 2018. Radiated testing was performed at an antenna to EUT distance of 3 meters.

1.5 Test Facility

Emissions tests were performed at I.T.L.'s testing facility in Lod, Israel. I.T.L.'s EMC Laboratory is accredited by A2LA, certificate No. 1152.01 and its FCC Designation Number is IL1005.

1.6 Measurement Uncertainty

Conducted Emission
Conducted Emission (CISPR 11, EN 55011, CISPR 22, EN 55022, ANSI C63.4)

0.15 – 30 MHz:
Expanded Uncertainty (95% Confidence, K=2):
± 3.44 dB

Radiated Emission
Radiated Emission (CISPR 11, EN 55011, CISPR 22, EN 55022, ANSI C63.4) for open site:

30-1000MHz:
Expanded Uncertainty (95% Confidence, K=2):
± 4.96 dB

1 GHz to 6 GHz
Expanded Uncertainty (95% Confidence, K=2):
±5.19 dB

>6 GHz
Expanded Uncertainty (95% Confidence, K=2):
±5.51 dB

2. System Test Configuration

2.1 Justification

1. The E.U.T contains IEEE 802.15.1 standard (BLE)
2. For BLE - The unit was evaluated while transmitting at the low channel (2402MHz), the mid channel (2440MHz) and the high channel (2480MHz).
3. Spurious radiated emission test was performed while the E.U.T was connected in charging mode as a worst case, by a typical USB AC/DC power adapter.
4. Conducted emission tests were performed with the E.U.T. antenna terminal connected by a RF cable to the Spectrum Analyzer through a 20dB external attenuator.
5. Final radiated emission tests were performed after exploratory emission testing that was performed in 3 orthogonal polarities to determine the "worst case" radiation.
6. The results are shown on the following page.

Orientation	Frequency	2nd Harmonic	3rd Harmonic	Band Edge
	(MHz)	(dBuV/m)	(dBuV/m)	(dBuV/m)
X axis	2402.0	50.9(N.L)	55.8	56.1
	2440.0	50.8(N.L)	58.6	-
	2480.0	50.4(N.L)	63.2	63.0
Y axis	2402.0	50.4(N.L)	57.7	56.8
	2440.0	50.8(N.L)	59.1	-
	2480.0	50.5(N.L)	63.6	63.6
Z axis	2402.0	50.1(N.L)	54.8	53.6
	2440.0	49.9(N.L)	56.5	-
	2480.0	49.8(N.L)	60.2	61.2

Figure 1. Screening Results BLE mode

According to above results the worst case was the Y axis

2.2 EUT Exercise Software

No special exercise software was used.

2.3 Special Accessories

No special accessories were used

2.4 Equipment Modifications

Initially the E.U.T get fail at radiated spurious emission in restricted bands test. the customer implements low pass filter and in addition reduced the power level to 2dBm (software level).

2.5 Configuration of Tested System

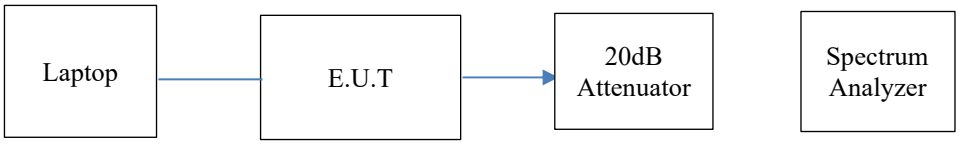

Figure 2. Configuration of Tested System Conducted

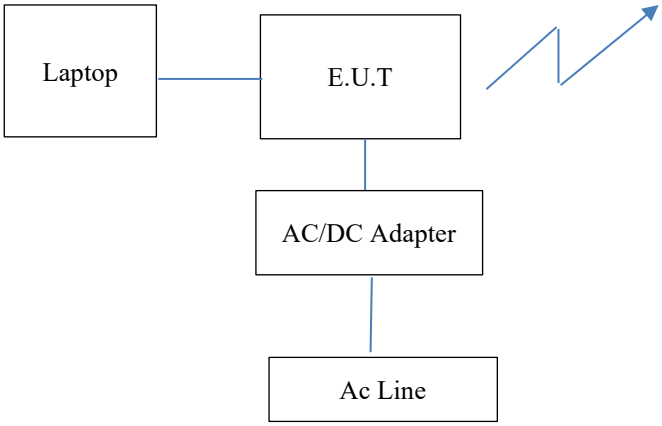

Figure 3. Configuration of Tested System Radiated

3. Test Setup Photos

See a separate file.

4. Conducted Emission on AC Mains

4.1 Test Specification

FCC Part 15, Subpart C, Section 15.207

4.2 Test Procedure

(Temperature (20°C)/ Humidity (60%RH))

The E.U.T operation mode and test setup are as described in Section 2 of this report. In order to minimize background noise interference, the conducted emission testing was performed inside a shielded room, with the E.U.T placed on a 0.8 meter high wooden table, 0.4 meter from the room's vertical wall. In the case of a floor-standing E.U.T., it was placed on the horizontal ground plane.

The E.U.T was powered from 115 V AC / 60 Hz via 50 Ohm / 50 µHn Line Impedance Stabilization Network (LISN) on the phase and neutral lines. The LISN's were grounded to the shielded room ground plane (floor), and were kept at least 0.8 meters from the nearest boundary of the E.U.T.

The center of the E.U.T.'s AC cable was folded back and forth, in order to form a bundle less than 0.40 meters and a total cable length of 1 meter.

The effect of varying the position of the cables was investigated to find the configuration that produces maximum emission.

The emission voltages at the LISN's outputs were measured using a computerized receiver, complying with CISPR 16 requirements. The specification limits are loaded to the receiver and are displayed on the receiver's spectrum display.

The E.U.T was evaluated in TX operation mode.

A frequency scan between 0.15 and 30 MHz was performed at 9 kHz I.F. band width, using peak detection.

The spectral components having the highest level on each line were measured using a quasi-peak and average detector.

4.3 Test Limit

Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* *Decreases with the logarithm of the frequency.*

4.4 Test Results

JUDGEMENT: Passed by -17.22 dB

The margin between the emission levels and the specification limit is, in the worst case, -17.22 dB for the phase line at 24.022 MHz, and -17.77 dB at 24.022 MHz for the neutral line.

The EUT met the FCC Part 15, Subpart C specification requirements.

The details of the highest emissions are given in *Figure 4* to *Figure 7*.

Conducted Emission

E.U.T Description	Integrated Bluetooth Smart Cap
Type	GX CAP
Serial Number:	Not designated

Specification:	FCC Part 15, Subpart C;
Lead:	Phase
Detectors: :	Peak, Quasi-peak, Average
Power Operation	AC/DC Adapter

EDIT PEAK LIST (Final Measurement Results)

Trace1: CE22BQP
Trace2: CE22BAP
Trace3: ---

	TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
2	Average	194 kHz	9.06	-44.79
1	Quasi Peak	242 kHz	11.39	-50.63
1	Quasi Peak	414 kHz	9.56	-48.00
2	Average	426 kHz	7.97	-39.35
2	Average	578 kHz	10.19	-35.80
1	Quasi Peak	686 kHz	11.59	-44.40
1	Quasi Peak	890 kHz	10.36	-45.63
2	Average	966 kHz	6.66	-39.33
2	Average	1.93 MHz	6.66	-39.33
1	Quasi Peak	2.086 MHz	11.19	-44.80
1	Quasi Peak	3.514 MHz	11.06	-44.93
2	Average	3.55 MHz	6.51	-39.48
2	Average	3.63 MHz	6.83	-39.16
1	Quasi Peak	4.046 MHz	12.67	-43.32
1	Quasi Peak	10.27 MHz	20.34	-39.65
2	Average	10.27 MHz	11.40	-38.59
2	Average	10.654 MHz	12.38	-37.61
1	Quasi Peak	11.842 MHz	20.33	-39.66
1	Quasi Peak	24.022 MHz	32.75	-27.24
2	Average	24.022 MHz	32.77	-17.22

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Figure 4. Detectors: Peak, Quasi-peak, Average

Note: QP Delta/Av Delta refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.

Conducted Emission

E.U.T Description	Integrated Bluetooth Smart Cap
Type	GX CAP
Serial Number:	Not designated

Specification:	FCC Part 15, Subpart C;
Lead:	Phase
Detectors:	Peak, Quasi-peak, Average
Power Operation	AC/DC Adapter

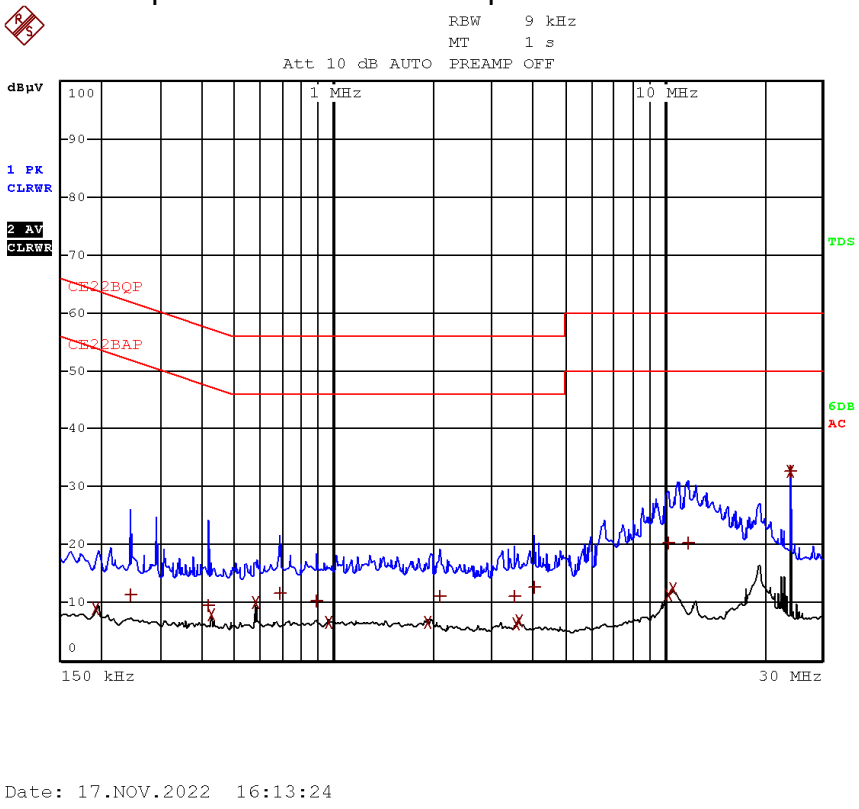

Figure 5. Detectors: Peak, Quasi-peak, Average

Conducted Emission

E.U.T Description	Integrated Bluetooth Smart Cap
Type	GX CAP
Serial Number:	Not designated

Specification:	FCC Part 15, Subpart C;
Lead:	Neutral
Detectors:	Peak, Quasi-peak, Average
Power Operation	AC/DC Adapter

EDIT PEAK LIST (Final Measurement Results)

Trace1: CE22BQP
Trace2: CE22BAP
Trace3: ---

	TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
2	Average	194 kHz	22.70	-31.16
1	Quasi Peak	578 kHz	30.95	-25.04
2	Average	578 kHz	25.25	-20.74
1	Quasi Peak	10.914 MHz	20.75	-39.24
1	Quasi Peak	10.982 MHz	20.39	-39.60
1	Quasi Peak	11.174 MHz	18.29	-41.70
1	Quasi Peak	11.542 MHz	19.40	-40.59
1	Quasi Peak	11.71 MHz	19.83	-40.16
1	Quasi Peak	11.798 MHz	16.39	-43.61
1	Quasi Peak	12.458 MHz	19.19	-40.80
2	Average	14.906 MHz	9.43	-40.56
1	Quasi Peak	15.582 MHz	14.69	-45.30
2	Average	15.582 MHz	9.40	-40.59
2	Average	16.262 MHz	9.95	-40.04
2	Average	16.602 MHz	10.37	-39.62
2	Average	17.278 MHz	11.44	-38.55
2	Average	17.958 MHz	12.49	-37.50
2	Average	18.978 MHz	12.64	-37.35
1	Quasi Peak	24.022 MHz	32.22	-27.77
2	Average	24.022 MHz	32.23	-17.77

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Figure 6. Detectors: Peak, Quasi-peak, Average

Note: QP Delta/Av Delta refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.

Conducted Emission

E.U.T Description	Integrated Bluetooth Smart Cap
Type	GX CAP
Serial Number:	Not designated

Specification:	FCC Part 15, Subpart C;
Lead:	Neutral
Detectors:	Peak, Quasi-peak, Average
Power Operation	AC/DC Adapter

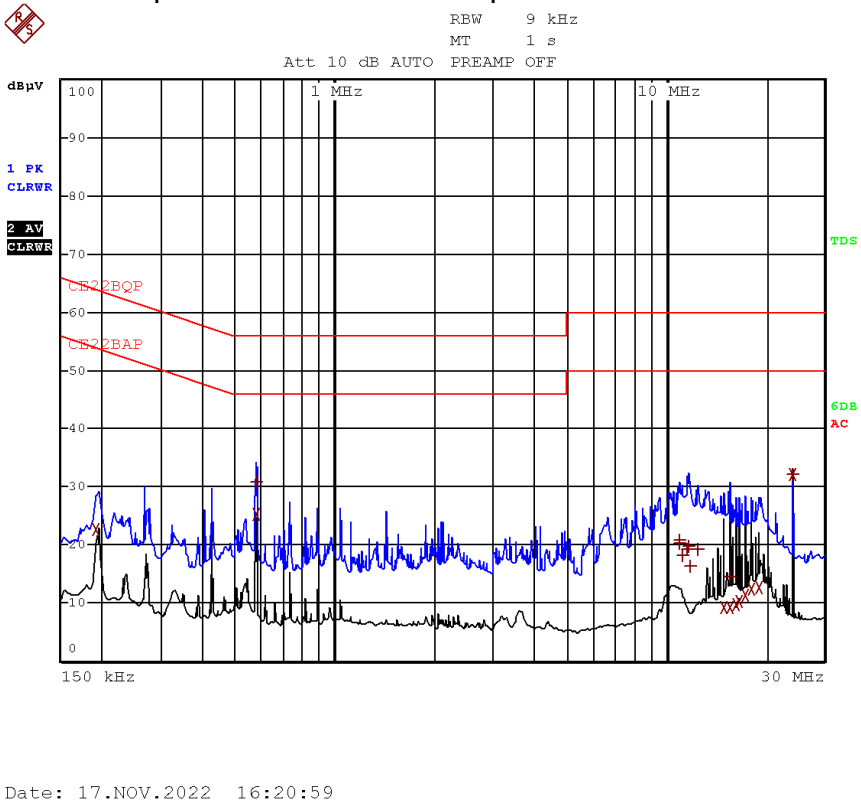


Figure 7 Detectors: Peak, Quasi-peak, Average

4.5 *Test Equipment Used; Conducted Emission*

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
LISN	Fischer	FCC-LISN-25A	127	November 4, 2022	November 4, 2023
Transient Limiter	HP	11947A	3107A03042	January 20, 2022	January 20, 2023
EMI Receiver	Rohde & Schwarz	ESCI7	100724	February 20, 2022	February 20, 2023
Cable CE Chamber 5M	Telrad	RJ214	-	June 7, 2022	June 7, 2023

Figure 8 Test Equipment Used

5. 6 dB Minimum Bandwidth

5.1 Test Specification

FCC Part 15, Subpart C, Section 247(a)(2)

5.2 Test Procedure

(Temperature (20°C)/ Humidity (55%RH))

The E.U.T operation mode and test set-up are as described in Section 2 of this report. The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (total loss=22.0 dB). Special attention was taken to prevent Spectrum Analyzer RF input overload.
The spectrum bandwidth of the E.U.T. at the point of 6 dB below maximum peak power was measured and recorded. The RBW was set to 100 kHz.

5.3 Test Limit

Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

5.4 Test Results

Protocol Type	Operation Frequency (MHz)	Reading (kHz)	Limit (kHz)
BLE	2402.0	652.7	>500.0
	2440.0	646.7	>500.0
	2480.0	646.7	>500.0

Figure 9 6 dB Minimum Bandwidth

JUDGEMENT: Passed

For additional information see Figure 10 to Figure 12.

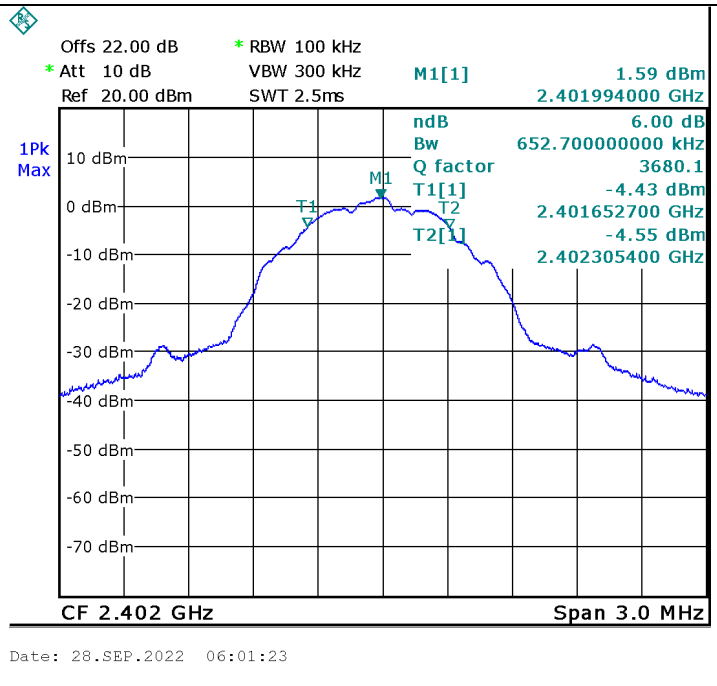


Figure 10. 2402.0 MHz, BLE

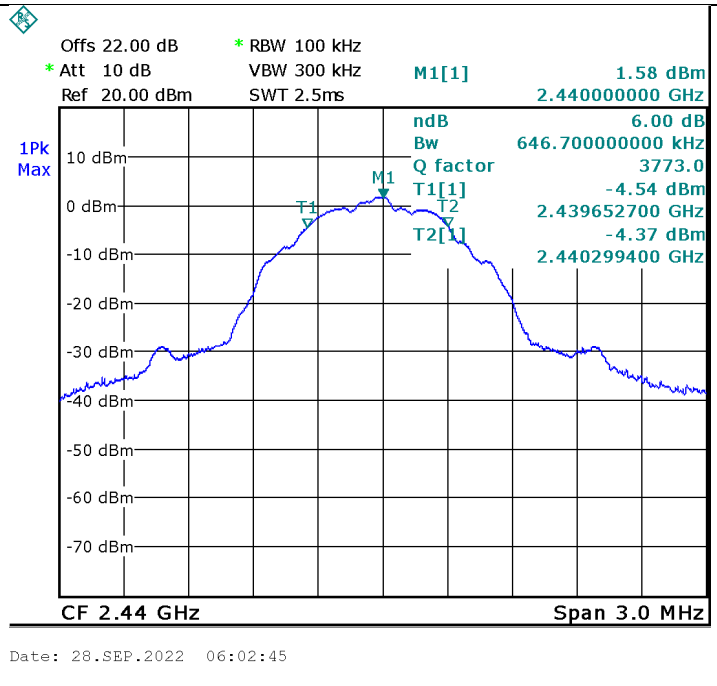


Figure 11. 2440.0 MHz, BLE

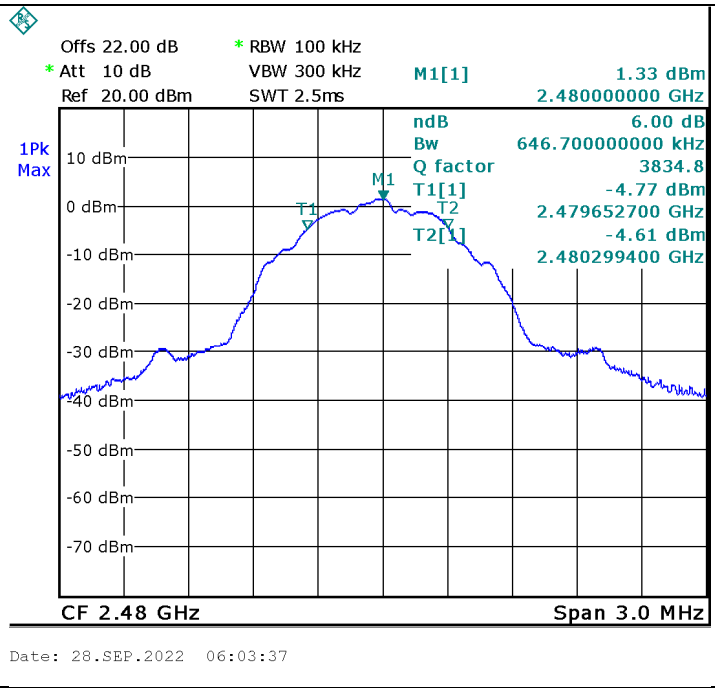


Figure 12. 2480.0 MHz, BLE

5.5 Test Equipment Used; 6dB Bandwidth

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
Spectrum Analyzer	R&S	FSL6	100194	February 20, 2022	February 20, 2023
20dB attenuator	RLC ELECTRONICS	A-8-20-N	9644	August 7, 2021	December 7, 2022
Low Loss cable	Huber Suhner	Sucofelex	27504/4PEA	May 16, 2022	May 16, 2023

Figure 13 Test Equipment Used

6. Maximum Conducted Output Power

6.1 Test Specification

FCC, Part 15, Subpart C, Section 247(b)(3)

6.2 Test Procedure

(Temperature (20°C)/ Humidity (57%RH))

The E.U.T operation mode and test set-up are as described in Section 2 of this report. The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (total loss=22.0 dB). Special attention was taken to prevent Spectrum Analyzer RF input overload.

6.3 Test Limit

The maximum peak conducted output power of the intentional radiator for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

6.4 Test Results

Protocol Type	Operation Frequency	Power	Power	Limit	Margin
	(MHz)	(dBm)	(mW)	(mW)	(mW)
BLE	2402.0	1.9	1.5	1000.0	-998.5
	2440.0	1.9	1.5	1000.0	-998.5
	2480.0	1.6	1.4	1000.0	-998.6

Figure 14 Maximum Peak Power Output

JUDGEMENT: Passed by -998.5 mW

For additional information see Figure 15 to Figure 17.

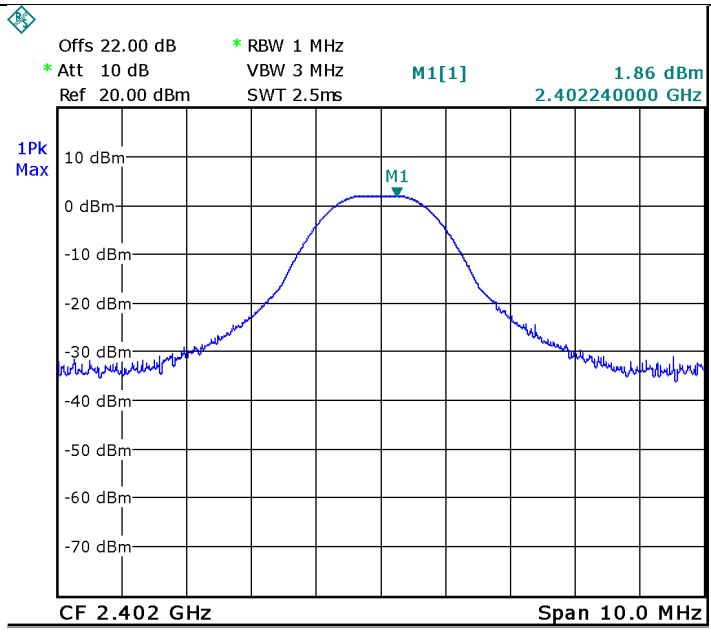


Figure 15. 2402.0 MHz, BLE

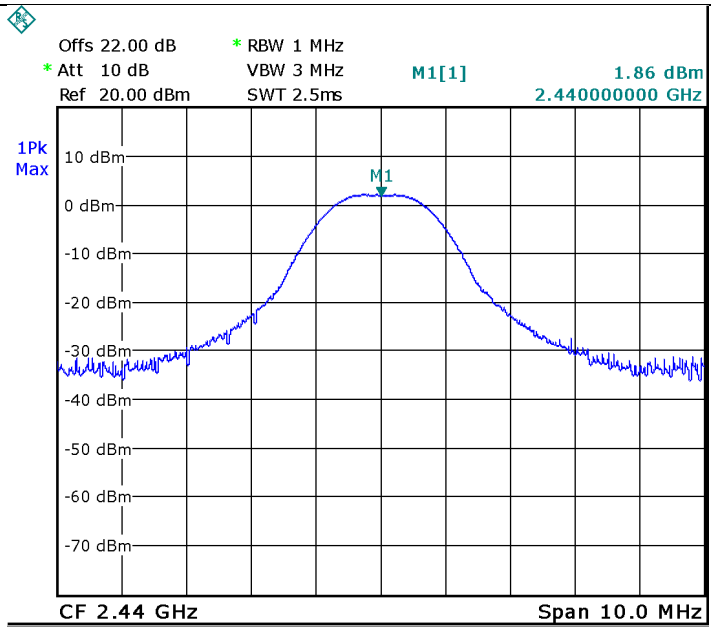


Figure 16. 2440.0 MHz, BLE

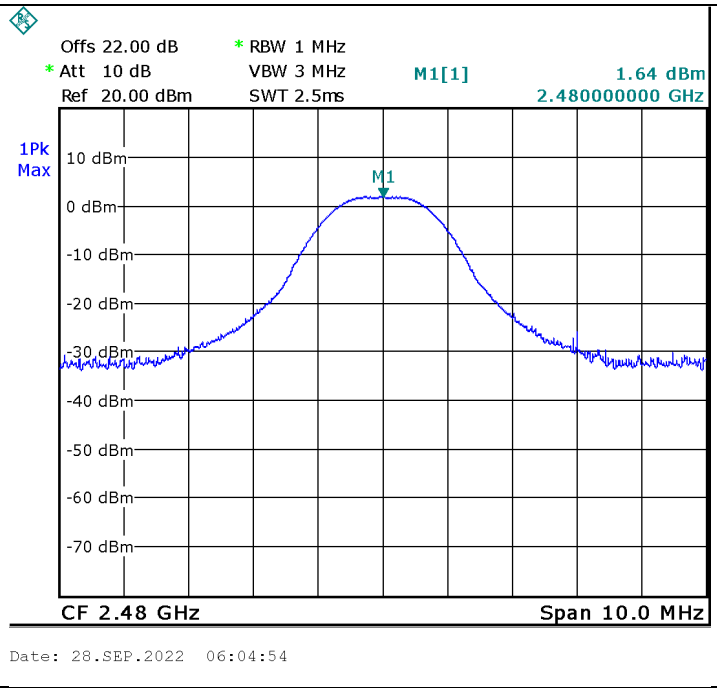


Figure 17. 2480.0 MHz, BLE

6.5 Test Equipment Used; Maximum Peak Power Output

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
Spectrum Analyzer	R&S	FSL6	100194	February 20, 2022	February 20, 2023
20dB attenuator	RLC ELECTRONICS	A-8-20-N	9644	August 7, 2021	December 7, 2022
Low Loss cable	Huber Suhner	Sucofelex	27504/4PEA	May 16, 2022	May 16, 2023

Figure 18 Test Equipment Used

7. Band Edge Spectrum

7.1 Test Specification

FCC, Part 15, Subpart C, Section 247(d)

7.2 Test Procedure

(Temperature (20°C)/ Humidity (57%RH))

The E.U.T operation mode and test set-up are as described in Section 2 of this report. The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (loss=22.0 dB). Special attention was taken to prevent Spectrum Analyzer RF input overload.

The RBW was set to 100 kHz.

7.3 Test Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

7.4 Test Results

Protocol Type	Operation Frequency	Band Edge Frequency	Spectrum Level	Limit	Margin
	(MHz)	(MHz)	(dBm)	(dBm)	(dB)
BLE	2402.0	2400.0	-45.0	-18.5	-26.5
	2480.0	2483.5	-46.8	-18.8	-28.0

Figure 19 Band Edge Spectrum

JUDGEMENT: Passed by -26.5 dB

For additional information see Figure 20 and Figure 21.

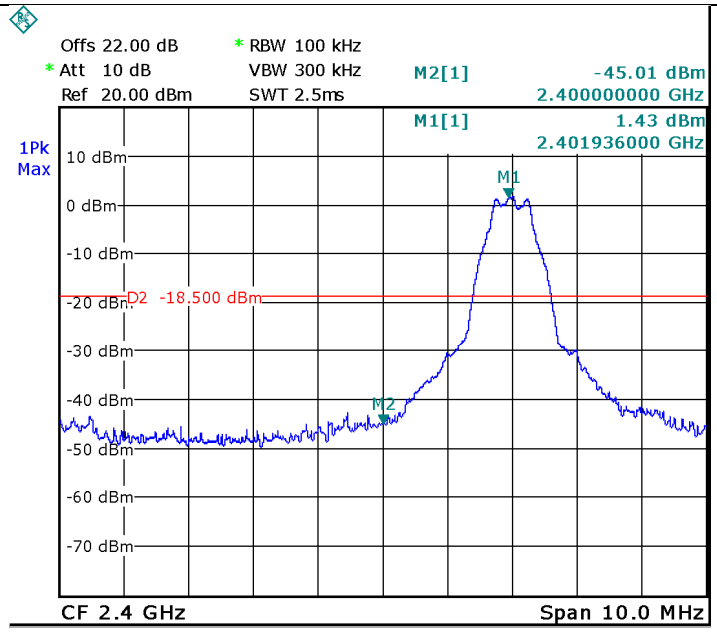


Figure 20. 2402.0 MHz, BLE

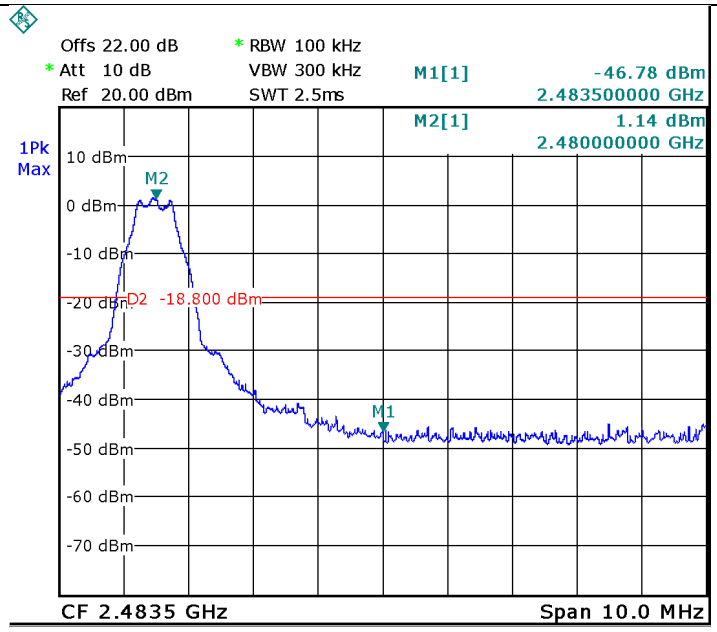


Figure 21. 2480.0 MHz, BLE

7.5 Test Equipment Used; Band Edge

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
Spectrum Analyzer	R&S	FSL6	100194	February 20, 2022	February 20, 2023
20dB attenuator	RLC ELECTRONICS	A-8-20-N	9644	August 7, 2021	December 7, 2022
Low Loss cable	Huber Suhner	Sucofelex	27504/4PEA	May 16, 2022	May 16, 2023

Figure 22 Test Equipment Used

8. Transmitted Power Density

8.1 Test Specification

FCC, Part 15, Subpart C, Section 247(e)

8.2 Test Procedure

(Temperature (20°C)/ Humidity (57%RH))

The E.U.T operation mode and test set-up are as described in Section 2 of this report. The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (total loss= 22.0dB). Special attention was taken to prevent Spectrum Analyzer RF input overload.

The spectrum analyzer was set to 3 kHz RBW.

8.3 Test Limit

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

8.4 Test Results

Protocol Type	Operation Frequency (MHz)	PSD Reading (dBm)	Limit (dBm)	Margin (dB)
BLE	2402.0	-12.6	8.0	-20.6
	2440.0	-12.8	8.0	-20.8
	2480.0	-13.0	8.0	-21.0

Figure 23 Test Results

JUDGEMENT: Passed by -20.6 dB

For additional information see Figure 24 to Figure 26.

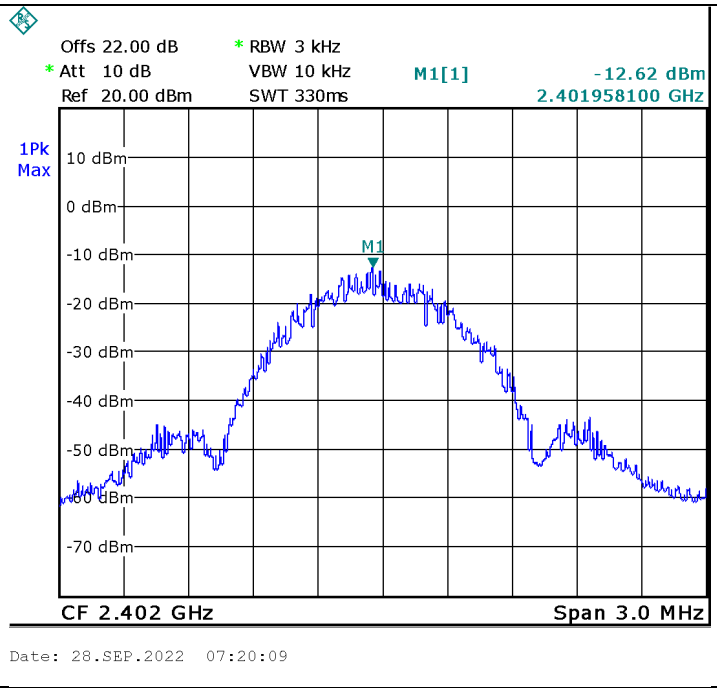


Figure 24. 2402.0 MHz, BLE

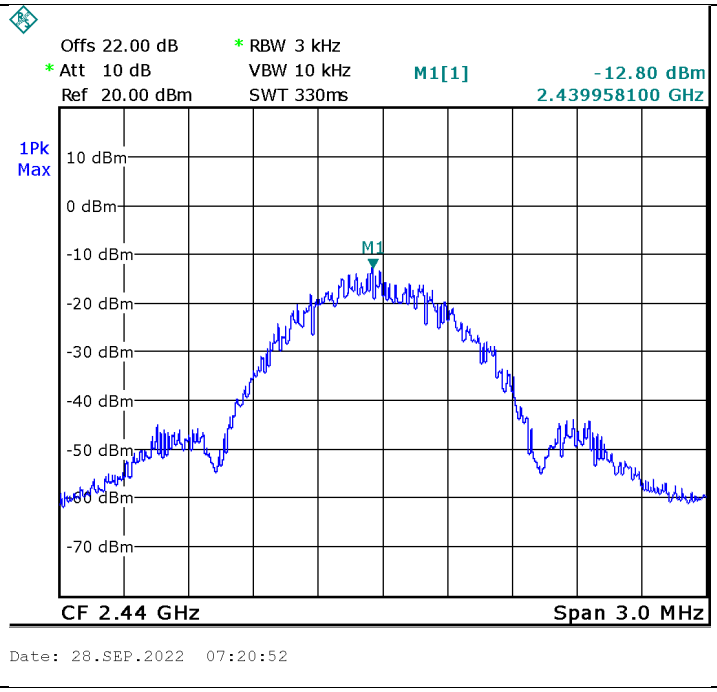


Figure 25. 2440.0 MHz, BLE

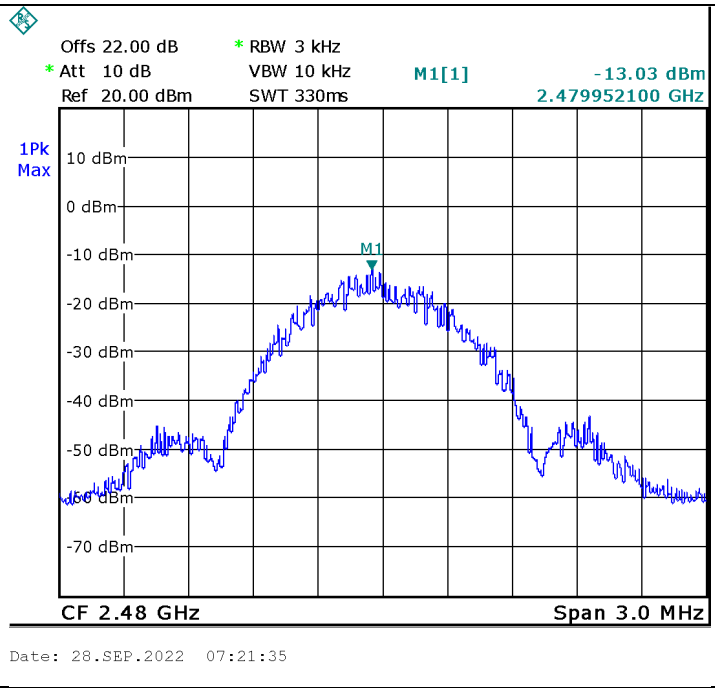


Figure 26. 2480.0 MHz, BLE

8.5 Test Equipment Used; Transmitted Power Density

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
Spectrum Analyzer	R&S	FSL6	100194	February 20, 2022	February 20, 2023
20dB attenuator	RLC ELECTRONICS	A-8-20-N	9644	August 7, 2021	December 7, 2022
Low Loss cable	Huber Suhner	Sucofelex	27504/4PEA	May 16, 2022	May 16, 2023

Figure 27 Test Equipment Used

9. Occupied Bandwidth

9.1 Test Specification

FCC, Part 2, Sub part J, Section 2.1049

9.2 Test Procedure

(Temperature (20°C)/ Humidity (57%RH))
The E.U.T. operation mode and test set-up are as described in Section 2 of this report. The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (total loss= 22.0dB). Special attention was taken to prevent Spectrum Analyzer RF input overload.

The RBW set to the range of 1% to 5% of the OBW.

The span was set between 1.5 to 5 times of the OBW.
99% occupied bandwidth function was set on.

9.3 Test Limit

N/A

9.4 Test Results

Protocol Type	Operation Frequency (MHz)	Reading (MHz)
BLE	2402.0	1.02
	2440.0	1.02
	2480.0	1.02

Figure 28. Bandwidth Test Results

JUDGEMENT: N/A

See additional information in Figure 29 to Figure 31.

Occupied Bandwidth

E.U.T Description Integrated Bluetooth Smart Cap
Model Number GX CAP
Part Number: Not designated

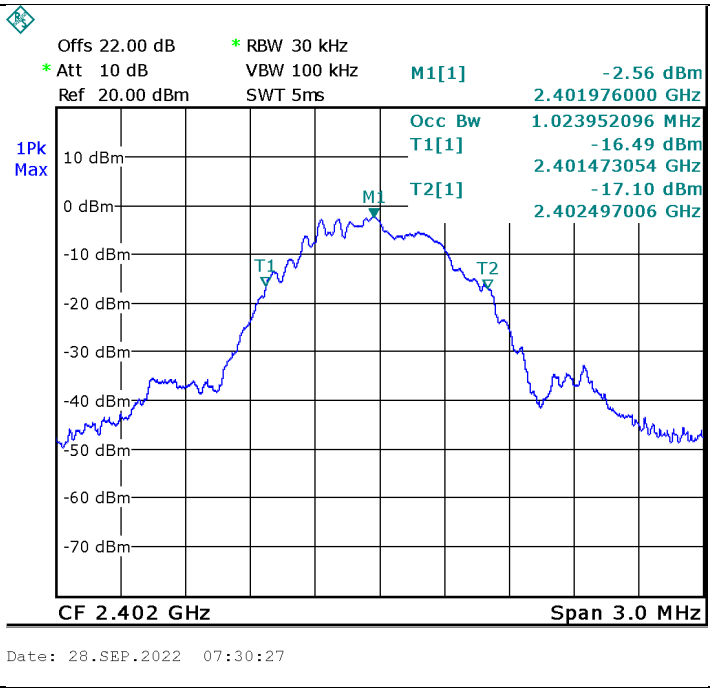


Figure 29. 2402.0 MHz, BLE

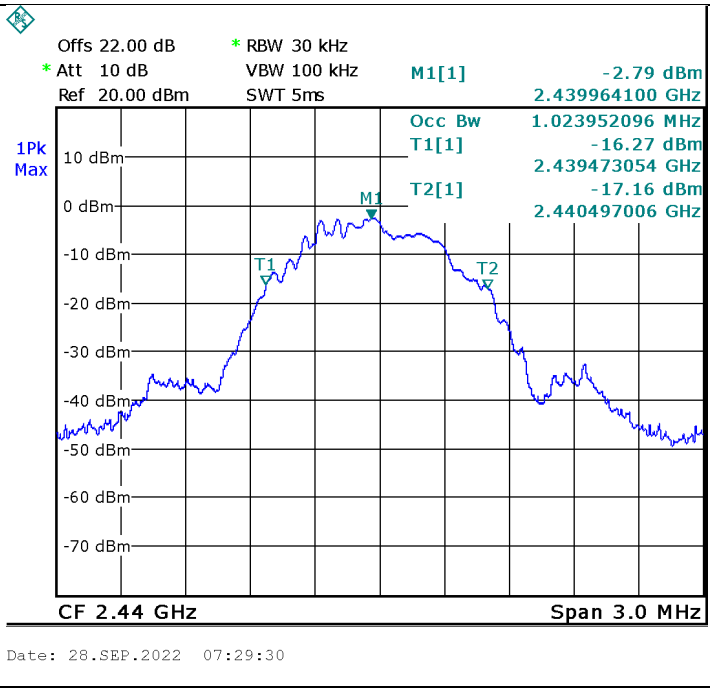


Figure 30. 2440.0 MHz, BLE

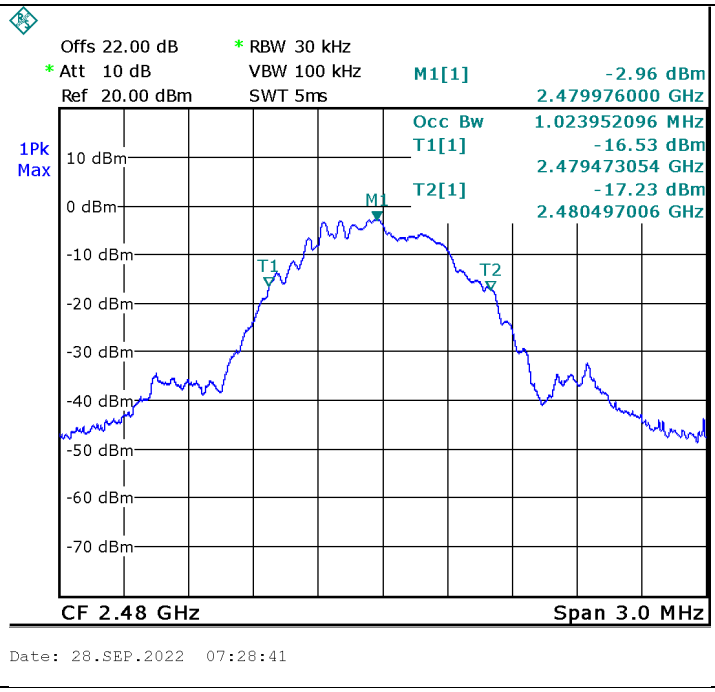


Figure 31. 2480.0 MHz, BLE

9.5 Test Equipment Used; Occupied Bandwidth

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
Spectrum Analyzer	R&S	FSL6	100194	February 20, 2022	February 20, 2023
20dB attenuator	RLC ELECTRONICS	A-8-20-N	9644	August 7, 2021	December 7, 2022
Low Loss cable	Huber Suhner	Sucofelex	27504/4PEA	May 16, 2022	May 16, 2023

Figure 32 Test Equipment Used

10. Emissions in non-Restricted Frequency Bands

10.1 Test Specification

FCC, Part 15, Subpart C, Section 247(d)

10.2 Test Procedure

(Temperature (20°C)/ Humidity (58%RH))
The E.U.T. operation mode and test set-up are as described in Section 2 of this report.
The E.U.T. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (max total loss=24.0 dB).
Special attention was taken to prevent Spectrum Analyzer RF input overload.
RBW was set to 100kHz, detector set to max peak and trace to “max hold”.

10.3 Test Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

10.4 Test Results

JUDGEMENT: Passed

The EUT met the requirements of the F.C.C. Part 15, Subpart C, Section 247(d) specification.

For additional information see *Figure 33* to *Figure 35*.

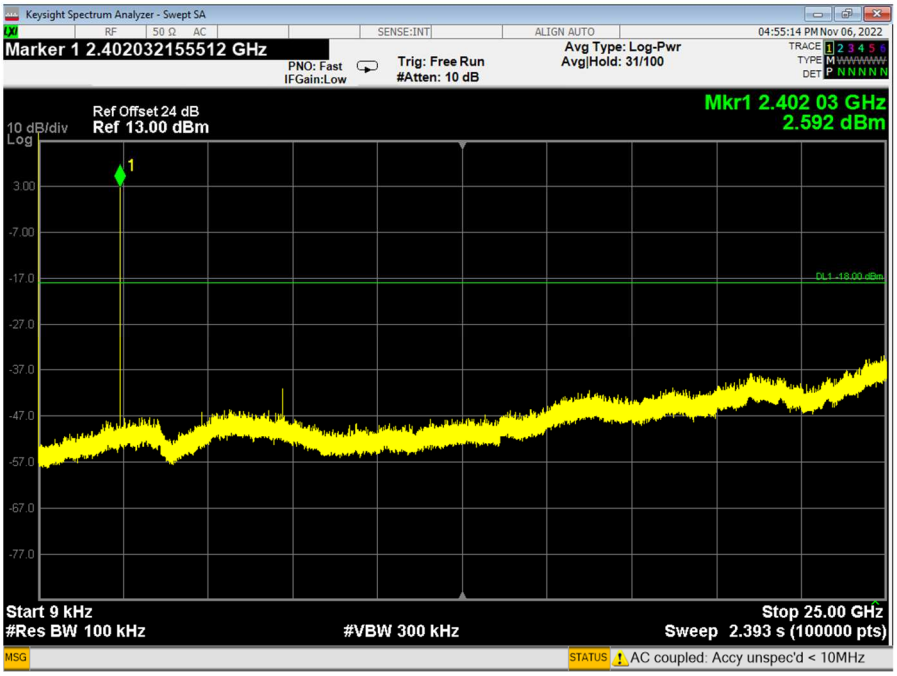


Figure 33 2402.0 MHz, BLE

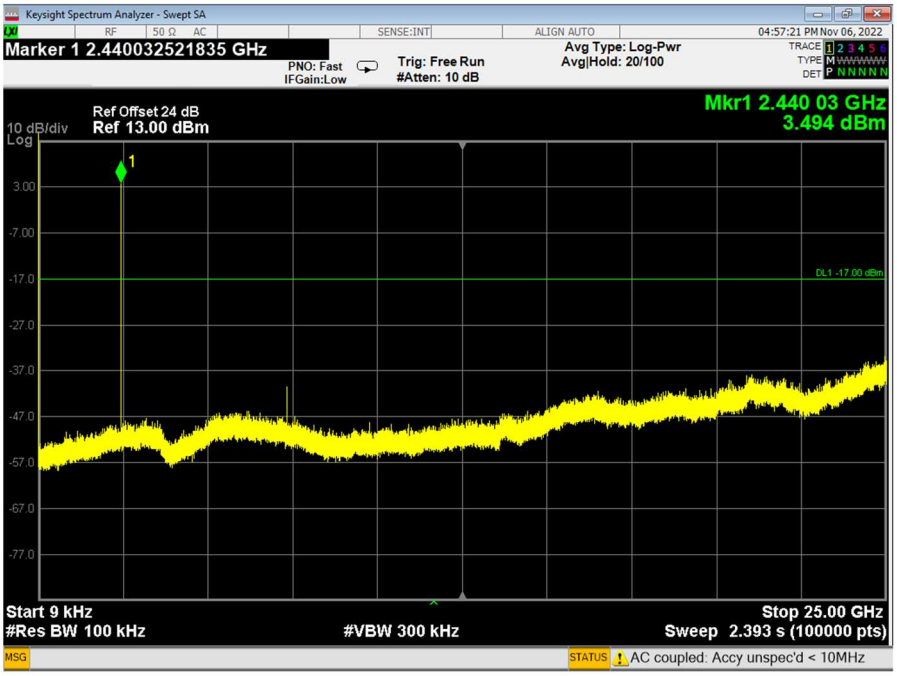


Figure 34 2440.0 MHz, BLE

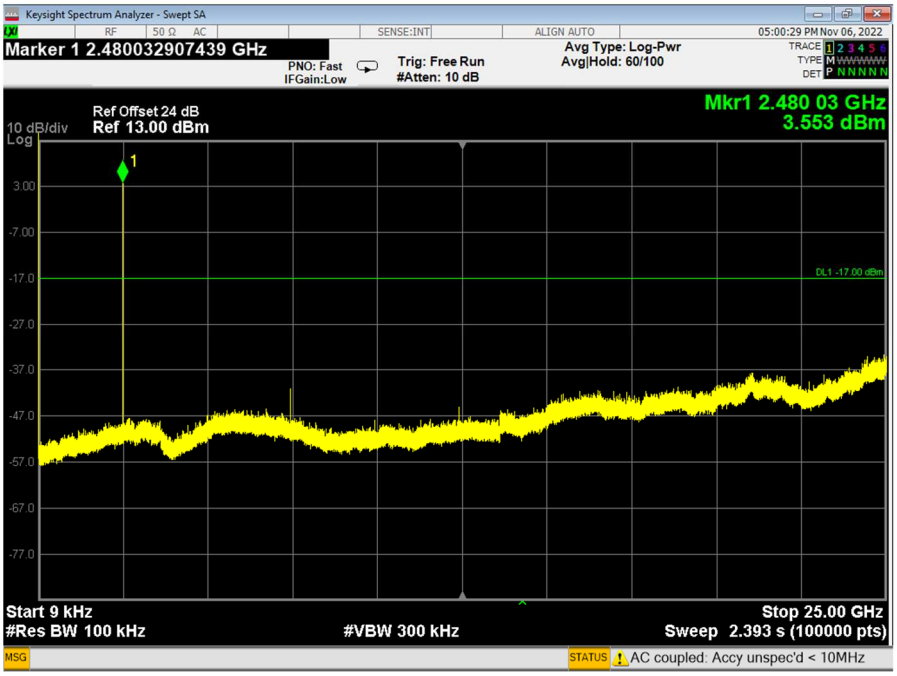


Figure 35 2480.0 MHz, BLE

Note: All peaks in plots are the fundamental transmission frequency.

10.1 Test Equipment Used; Emission in non-Restricted Frequency Bands

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
Signal analyzer	Keysight	EXA signal analyzer N9010A	my51170071	February 13, 2022	February 13, 2023
20dB attenuator	RLC ELECTRONICS	A-8-20-N	9644	August 7, 2021	December 7, 2022
Low Loss cable	Huber Suhner	Sucofelex	27504/4PEA	May 16, 2022	May 16, 2023

Figure 36 Test Equipment Used

11. Emissions in Restricted Frequency Bands

11.1 Test Specification

FCC Part 15, Subpart C, Sections 15.209, 15.205, 15.247(d)

11.2 *Test Procedure*

(Temperature (20°C)/ Humidity (65%RH))
The E.U.T. operation mode and test set-up are as described in Section 2 of this report.

For measurements between 0.009-30MHz:

The E.U.T was tested inside the shielded room and placed on a non-metallic table, 0.8 meters above the ground. The emissions were measured at a distance of 3 meters. The readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization.
The frequency range 0.009MHz-30MHz was scanned.

For measurements between 30-1000MHz:
A preliminary measurement to characterize the E.U.T was performed inside the shielded room at a distance of 3 meters, using peak detection mode and broadband antennas. The preliminary measurements produced a list of the highest emissions. The E.U.T was then transferred to the open site, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 0.8 meters above the ground. The emissions were measured at a distance of 3 meters. The readings were maximized by adjusting the antenna height between 1-4 meters, the turntable azimuth between 0-360°, and the antenna polarization. The frequency range 30MHz -1000MHz was scanned and the list of the highest emissions was verified and updated accordingly.

For measurements between 1GHz-25GHz:

The E.U.T was tested inside the shielded room and placed on a non-metallic table, 1.5 meters above the ground. The emissions were measured at a distance of 3 meters. The readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization.
The frequency range 1GHz -25GHz was scanned.

The highest radiation describes in the tables below

11.3 FCC Test Limit

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement distance (meters)	Field Strength* (dBµV/m)	Field Strength* (dBµV/m)@3m
0.009-0.490	2400/F(kHz)	300	48.5-13.8	128.5-73.8
0.490-1.705	24000/F(kHz)	30	33.8-23.0	73.8-63.0
1.705-30.0	30	30	29.5	69.5
30-88	100	3	40.0	40.0
88-216	150	3	43.5	43.5
216-960	200	3	46.0	46.0
Above 960	500	3	54.0	54.0

*The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector. For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

Figure 37 FCC Table of Limits

11.4 Test Results

JUDGEMENT: Passed by -1.4 dB

For the operation frequency of 2405 MHz, the margin between the emission level and the specification limit is in the worst case -4.0 dB at the frequency of 7206.0 MHz, horizontal polarization.

For the operation frequency of 2440 MHz, the margin between the emission level and the specification limit is in the worst case -3.5 dB at the frequency of 7320.0 MHz, vertical polarization.

For the operation frequency of 2475 MHz, the margin between the emission level and the specification limit is in the worst case -1.4 dB at the frequency of 2483.5 MHz, vertical polarization.

The EUT met the requirements of the F.C.C. Part 15, Subpart C Sections 15.209, 15.205, 15.247(d) specifications.

The details of the highest emissions are given in *Figure 38* .

Radiated Emission

E.U.T Description Integrated Bluetooth Smart Cap
Type GX CAP
Serial Number: Not designated

Specifications: FCC, Part 15, Subpart C, Sections 15.209, 15.205, 15.247(d)

Antenna Polarization: Horizontal/Vertical Frequency Range: 9kHz to 25.0 GHz
Protocol Type: BLE Detector: Peak, Average

Operation Frequency	Freq.	Pol	Peak Reading	Peak Limit	Peak Margin	Average Reading	Average Limit	Average Margin
(MHz)	(MHz)	(H/V)	(dBµV/m)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV/m)	(dB)
2402.0	2390.0	V	56.8	74.0	-17.2	47.1	54.0	-6.9
	2390.0	H	54.3	74.0	-19.7	46.8	54.0	-7.2
	7206.0	V	57.7	74.0	-16.3	49.9	54.0	-4.1
	7206.0	H	57.3	74.0	-16.7	50.0	54.0	-4.0
2440.0	7320.0	V	59.1	74.0	-14.9	50.5	54.0	-3.5
	7320.0	H	58.7	74.0	-15.3	50.3	54.0	-3.7
2480.0	7440.0	V	59.7	74.0	-14.3	50.9	54.0	-3.1
	7440.0	H	59.0	74.0	-15.0	50.6	54.0	-3.4
	2483.5	V	63.6	74.0	-10.4	52.6	54.0	-1.4
	2483.5	H	61.3	74.0	-12.7	51.8	54.0	-2.2

Figure 38. Radiated Emission Results

Margin refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.

"Peak Amp" includes correction factor.

* "Correction Factor" = Antenna Factor + Cable Loss- Low Noise Amplifier Gain

11.5 Test Equipment Used; Emissions in Restricted Frequency Bands

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
Low Noise Amplifier 16-30 GHz	Sophia Wireless	LNA28-B	232	16-May 2022	16-May 2023
Active Loop Antenna	EMCO	6502	2950	05-Jul 2022	05-Jul 2023
Low Noise Amplifier	Narda	DBS-0411N313	13	16-May 2022	16-May 2023
Filter Band pass 8-16 GHz	Serno	MFR01341-HI-3816JJ-1	322	16-May 2022	16-May 2023
Spectrum Analyzer	HP	8564E	3442A00275	23-Feb 2022	23-Feb 2023
EMI Receiver	HP (Agilent)	8542E	3906A00276	22-Feb 2022	22-Feb 2023
RF Filter	HP (Agilent)	85420E	3705A00248	22-Feb 2022	22-Feb 2023
Wideband RF Amplifier 100K-26.5GHz	OSR	N.A.	N.A	16-May-22	16-May-23
Log-periodic Antenna	EMCO	3146	9505-4081	27-Apr 2021	27-Apr 2024
Horn Antenna	ETS	3115	29845	25-May 2021	25-May 2024
Horn Antenna	ARA	SWH-28	1007	02-Nov 2021	02-Nov 2024
Biconical Antenna	EMCO	3110B	9912-3337	18-Jan 2022	18-Jan 2024
Multi device Controller	EMCO	2090	9908-1456	NCR	NCR
Fully anechoic Civil Chamber	ETS	2070-2	SL 11643	NCR	NCR
Spectrum Analyzer	Rohde & Schwarz	2087	100194	20-Feb 2022	20-Feb 2023
Antenna Mast	ETS	#N/A	9608-1497	NCR	NCR
Turntable	ETS	#N/A	-	NCR	NCR

Figure 39 Test Equipment Used

12. RF Exposure/Safety

See a separate file.

13. Appendix A - Correction Factors

13.1 ITL #1911: OATS RF Cable

Frequency (MHz)	Cable Loss (dB)		Frequency (MHz)	Cable Loss (dB)
1.00	0.50		450.00	5.83
10.00	1.00		500.00	6.33
20.00	1.34		550.00	6.67
30.00	1.50		600.00	6.83
50.00	1.83		650.00	7.17
100.00	2.67		700.00	7.66
150.00	3.17		750.00	7.83
200.00	3.83		800.00	8.16
250.00	4.17		850.00	8.50
300.00	4.50		900.00	8.83
350.00	5.17		950.00	8.84
400.00	5.50		1000.00	9.00

13.2 ITL #1840: Semi-Anechoic Chamber RF Cable

Frequency (MHz)	Cable Loss (dB)		Frequency (MHz)	Cable Loss (dB)
1,000.0	-1.40		10,000.0	-6.00
1,500.0	-1.70		10,500.0	-6.20
2,000.0	-2.00		11,000.0	-6.20
2,500.0	-2.30		11,500.0	-6.00
3,000.0	-2.60		12,000.0	-6.00
3,500.0	-2.80		12,500.0	-6.10
4,000.0	-3.10		13,000.0	-6.30
4,500.0	-3.30		13,500.0	-6.50
5,000.0	-3.60		14,000.0	-6.70
5,500.0	-3.70		14,500.0	-7.00
6,000.0	-4.00		15,000.0	-7.30
6,500.0	-4.40		15,500.0	-7.50
7,000.0	-4.7		16,000.0	-7.60
7,500.0	-4.80		16,500.0	-8.00
8,000.0	-5.00		17,000.0	-8.00
8,500.0	-5.10		17,500.0	-8.10
9,000.0	-5.60		18,000.0	-8.20
9,500.0	-5.80			

13.3 ITL # 1075: Active Loop Antenna

Frequency (MHz)	MAF (dBs/m)	AF (dB/m)		Frequency (MHz)	MAF (dBs/m)	AF (dB/m)
0.01	-33.10	18.40		3.00	-40.00	11.50
0.02	-37.20	14.30		4.00	-40.10	11.40
0.03	-38.20	13.30		5.00	-40.20	11.30
0.05	-39.80	11.70		6.00	-40.40	11.10
0.10	-40.10	11.40		7.00	-40.40	11.10

0.20	-40.30	11.20
0.30	-40.30	11.20
0.50	-40.30	11.20
0.70	-40.30	11.20
1.00	-40.10	11.40
2.00	-40.00	11.50

8.00	-40.40	11.10
9.00	-40.50	11.00
10.00	-40.50	11.00
20.00	-41.50	10.00
30.00	-43.50	8.00

13.4 ITL #1356: Biconical Antenna

Frequency (MHz)	AF (dB/m)
30.00	13.00
35.00	10.89
40.00	10.59
45.00	10.63
50.00	10.12
60.00	9.26
70.00	7.74
80.00	6.63

Frequency (MHz)	AF (dB/m)
90.00	8.23
100.00	11.12
120.00	13.16
140.00	13.07
160.00	14.80
180.00	16.95
200.00	17.17

13.5 ITL # 1349: Log Periodic Antenna

Frequency (MHz)	AF (dB/m)
200.00	11.58
250.00	12.04
300.00	14.76
400.00	15.55
500.00	17.85
600.00	18.66
700.00	20.87
800.00	21.15
900.00	22.32
1000.00	24.22

13.6 ITL # 1352: 1-18 GHz Horn Antenna

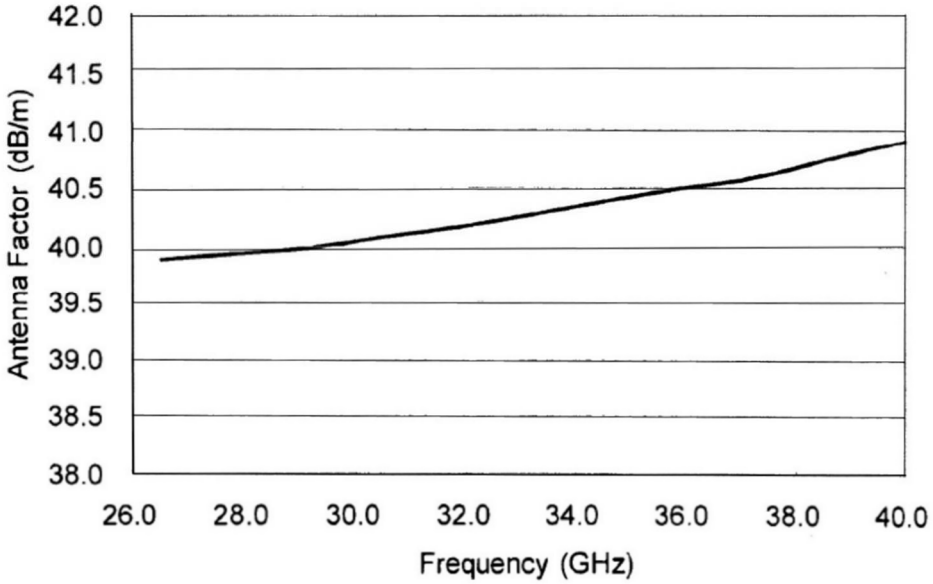
Frequency (GHz)	AF (dB/m)		Frequency (GHz)	AF (dB/m)
0.75	25.00		9.50	38.00
1.00	23.50		10.00	38.50
1.50	26.00		10.50	38.50
2.00	29.00		11.00	38.50
2.50	27.50		11.50	38.50
3.00	30.00		12.00	38.00
3.50	31.50		12.50	38.50
4.00	32.50		13.00	40.00
4.50	32.50		13.50	41.00
5.00	33.00		14.00	40.00
5.50	35.00		14.50	39.00
6.00	36.50		15.00	38.00
6.50	36.50		15.50	37.50
7.00	37.50		16.00	37.50
7.50	37.50		16.50	39.00
8.00	37.50		17.00	40.00
8.50	38.00		17.50	42.00
9.00	37.50		18.00	42.50

13.7 ITL # 1353: 18-26.5 GHz Horn Antenna

Frequency (MHz)	Measured antenna factor (dB/m)[1]		Frequency (MHz)	Measured antenna factor (dB/m)[1]
18,000.00	32.40		22,500.00	33.00
18,500.00	32.00		23,000.00	33.10
19,000.00	32.30		23,500.00	33.80
19,500.00	32.40		24,000.00	33.50
20,000.00	32.30		24,500.00	33.50
20,500.00	32.80		25,000.00	33.80
21,000.00	32.80		25,500.00	33.90
21,500.00	32.70		26,000.00	34.20
22,000.00	33.10		26,500.00	34.70

[1] The antenna factor shall be added to the receiver's reading in dBµV, to obtain field strength in dBµ V/m

13.8 ITL # 1777: 26.5-40 GHz Horn Antenna



End of Test Report