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Date: 22 November 2023

I.T.L. Product Testing Ltd.

FCC/IC Radio Test Report

for

Colibri Spindles Ltd.

Equipment under test:

BLE RPM Meter

TJEH-030A

FCC ID: 2ACJNTJEH-030A

Tested by: _____
N. Yakobov

Approved by: _____
M. Zohar

This report concerns: Original Grant

Equipment type:	FCC: (DTS) Digital Transmission System ISED: Spread Spectrum Digital Device (2400-2483.5)
Limits used:	47CFR15 Section 15.247 RSS-247, Issue 2, February 2017, Section 5 RSS-Gen, Issue 5, April 2018
Measurement procedure used:	KDB 558074 D01 v03r05, ANSI C63.10:2013 RSS-Gen, Issue 5, April 2018+AMD 1 2019 + AMD 2 2021

Prepared by:

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Applicant:

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Table of Contents

1. General Information

1.1 Administrative Information

Manufacturer:	As applicant
Manufacturer's Address:	As applicant
Manufacturer's Representative:	As applicant
Equipment Under Test (E.U.T):	BLE RPM Meter
Equipment Model no.:	TJEH-030A
Equipment Serial No.:	N/A
Date of Receipt of E.U.T:	February 23, 2023
Start of Test:	February 23, 2023
End of Test:	March 7, 2023
Test Laboratory Location:	I.T.L Product Testing Ltd. 1 Bat Sheva St., Lod 7120101, Israel
Test Specifications:	FCC Part 15, Subpart C RSS-247, Issue 2, February 2017, Section 5 RSS-Gen, Issue 5, April 2018+A1 2019 + A2 2021

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

The BLE RPM meter is an electronic device designed to measure spindle speed in CNC machines and transmit the RPM data to a phone application in real-time. The device is small and is installed on the spindle itself, allowing for accurate measurement of the spindle speed.

1.4 Test Methodology

Both conducted and radiated testing was performed according to the procedures in KDB 558074 D01 v03r05, ANSI C63.10: 2013 and RSS-Gen, Issue 5, April 2018. Radiated testing was performed at an antenna to EUT distance of three meters.

1.5 Test Facility

Emissions tests were performed at I.T.L.'s testing facility in Modi'in, 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 an IEEE 802.15.1 standard (BLE) transceiver
2. For BLE was evaluated while transmitting at the low channel (2402MHz), the mid channel (2440MHz), and the high channel (2480MHz).
3. Final radiated emissions tests were performed after exploratory emission testing that was performed in three orthogonal polarities, to determine the "worst case" radiation, which was founded at the Y axis

2.2 EUT Exercise Software

No special exercise software was used.

2.3 Special Accessories

N/A

2.4 Equipment Modifications

Initially, the E.U.T failed in radiated emission in restricted bands test .The customer reduced the power level from 8dBm to 4dBm and the E.U.T. passed the test.

2.5 Configuration of Tested System

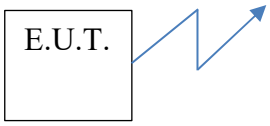


Figure 1. Configuration of Tested System

3. Setup Photos

See a separate file.

4. 6 dB Minimum Bandwidth

4.1 Test Specification

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

RSS-247, Issue 2, Section 5.2(a)

4.2 Test Procedure

(Temperature (22°C)/ Humidity (61%RH))

The E.U.T operation mode and test set-up are as described in Section 2 of this report.

The E.U.T was tested in the chamber and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 1.5 meters above the ground. The emissions were measured at a distance of 3 meters.

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.

4.3 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.

4.4 Test Results

Protocol Type	Operation Frequency (MHz)	Reading (kHz)	Limit (kHz)
BLE	2402.0	679.0	>500.0
	2440.0	659.0	>500.0
	2480.0	649.0	>500.0

Figure 2 6 dB Minimum Bandwidth

JUDGEMENT: Passed

For additional information see Figure 3 to Figure 5.

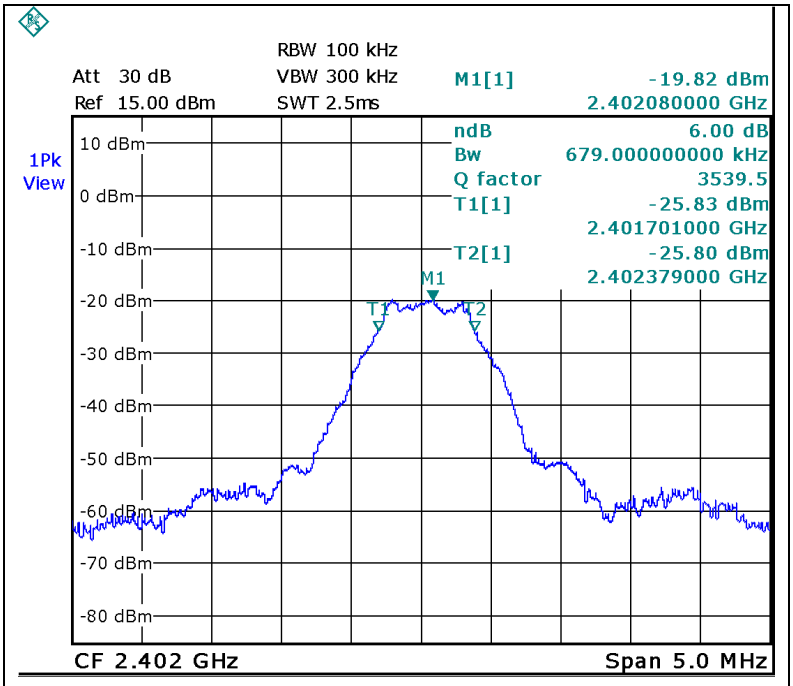


Figure 3. 2402.0 MHz, BLE

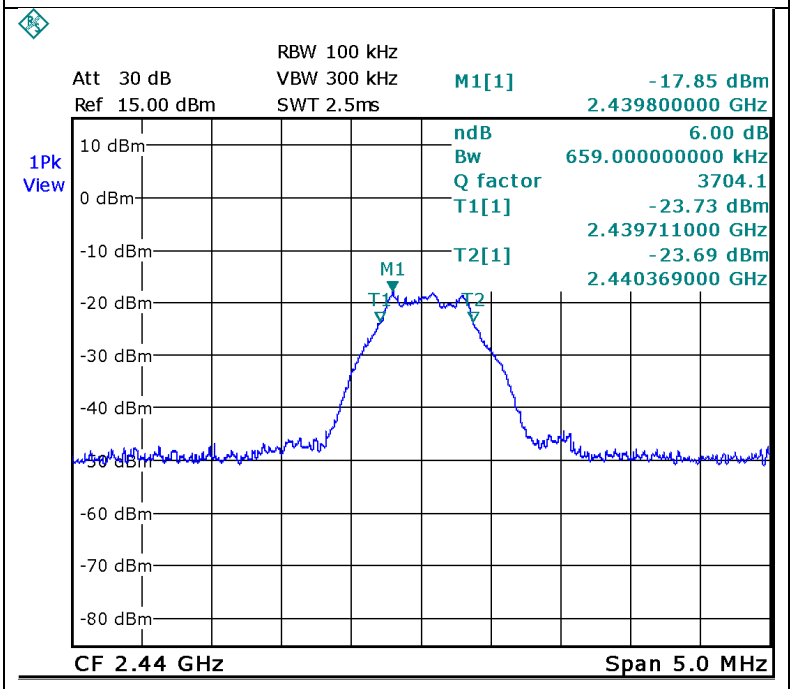


Figure 4. 2440.0 MHz, BLE

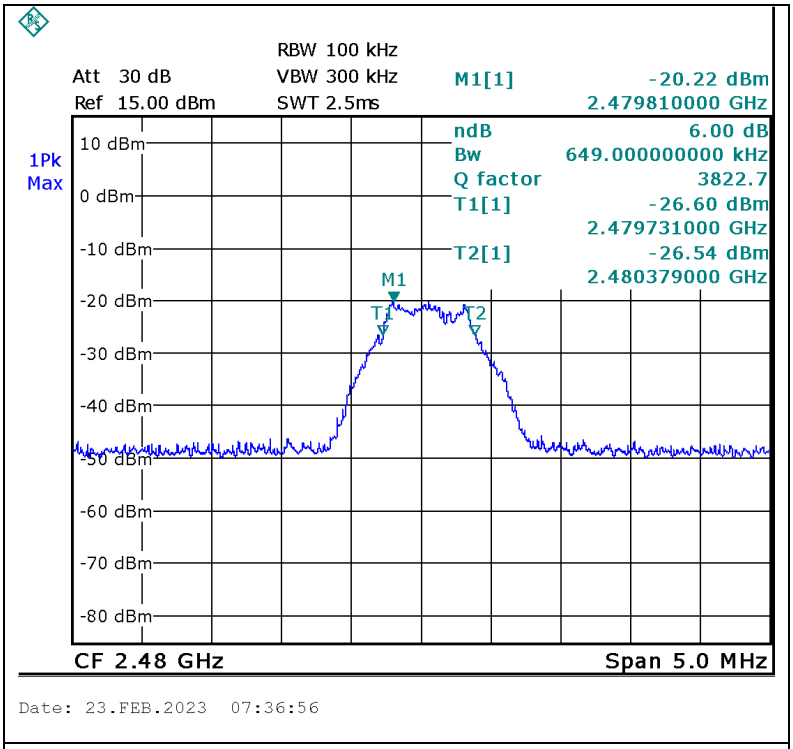


Figure 5. 2480.0 MHz, BLE

4.5 Test Equipment Used; 6dB Bandwidth

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
Spectrum Analyzer	Rohde & Schwarz	FSL6	100194	February 20, 2023	February 20, 2024
Horn Antenna	ETS	3115	29845	May 25, 2021	May 25, 2024
10 m RF cable	Commscope ORS (Serge)	0623 WBC-400	G020133	May 16, 2022	May 16, 2023
Full Anechoic Civil Chamber	ETS	S81	SL 11643	NCR	NCR

Figure 6 Test Equipment Used

5. Maximum Conducted Output Power

5.1 Test Specification

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

RSS-247, Issue 2, Section 5.4(d)

5.2 Test Procedure

(Temperature (22°C)/ Humidity (70%RH))

The E.U.T operation mode and test set-up are as described in Section 2 of this report.

The E.U.T was tested in the chamber, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 1.5 meters above the ground. The readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization. The emissions were measured at a distance of 3 meters.

Radiated output power levels were measured at selected operation frequencies and the results were converted to power level according to the formula as shown below:

$$P = \frac{(E_{V/m} \times d)^2}{(30 \times G)} \text{ [W]}$$

E - Field Strength (V/m)
d – Distance from transmitter (m)
G – Antenna gain
P – Peak power (W)

5.3 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.

5.4 Test Results

Protocol Type	Operation Frequency (MHz)	Pol. (V/H)	Field Strength (dBuV/m)	EIRP (dBm)	Ant. Gain[1] (dBi)	Power (dBm)	Power (mW)	Limit (mW)	Margin (mW)
BLE	2402.0	V	93.2	-2.0	0.5	-2.5	0.5	1000.0	-999.5
		H	93.1	-2.1	0.5	-2.6	0.5	1000.0	-999.5
	2440.0	V	87.3	-7.9	0.5	-8.4	0.1	1000.0	-999.9
		H	92.7	-2.5	0.5	-3.0	0.5	1000.0	-999.5
	2480.0	V	86.5	-8.7	0.5	-9.2	0.1	1000.0	-999.9
		H	90.2	-5.0	0.5	-5.5	0.3	1000.0	-999.7

Figure 7 Maximum Peak Power Output

JUDGEMENT: PASS

For additional information see *Figure 8* to *Figure 13*.

[1] Provided by the customer.

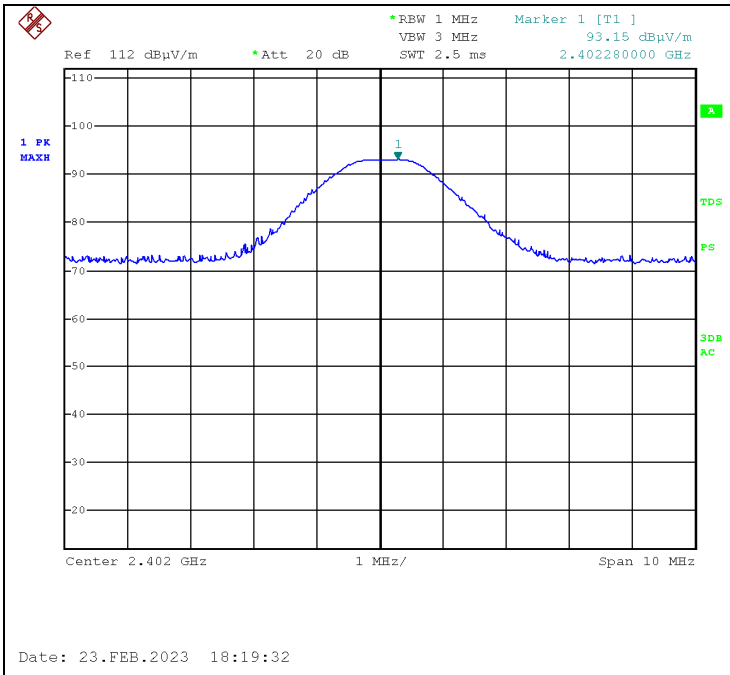


Figure 8. 2402.0 MHz, BLE, Vertical

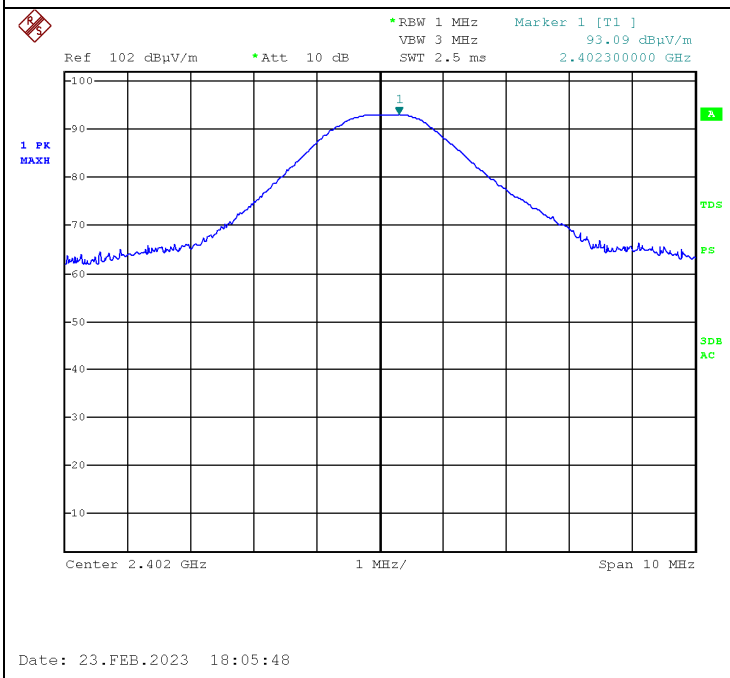


Figure 9. 2402.0 MHz, BLE, Horizontal

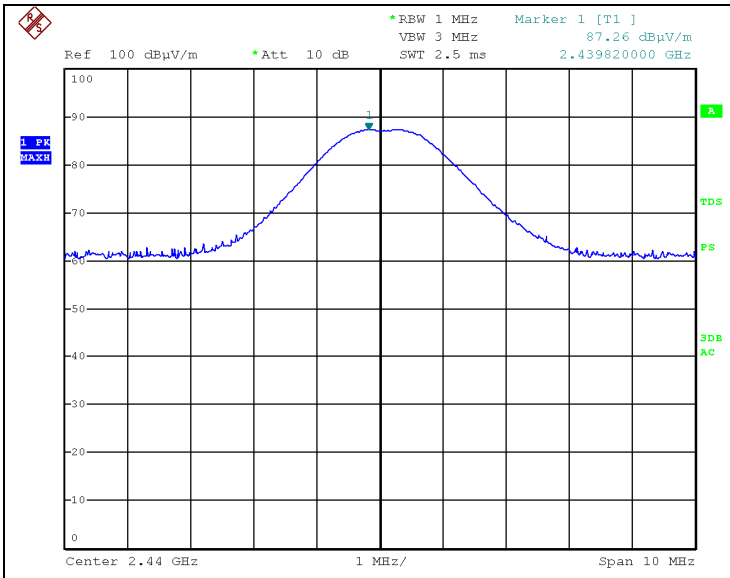


Figure 10. 2440.0 MHz, BLE, Vertical

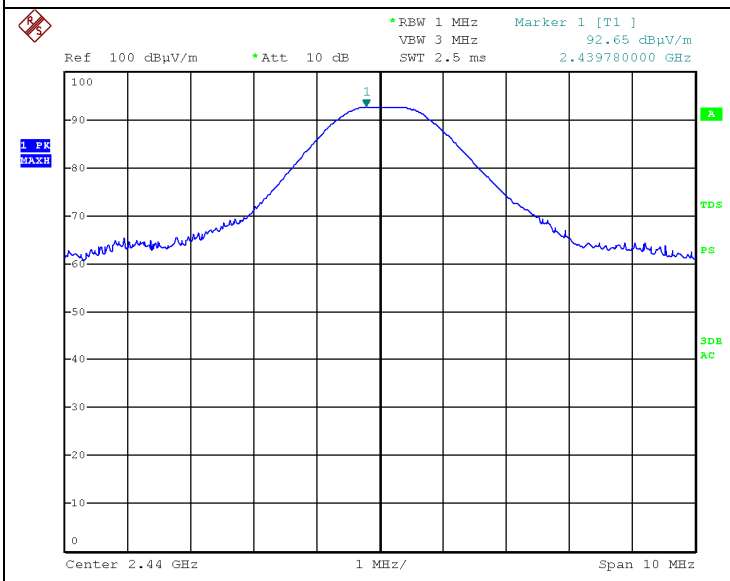


Figure 11. 2440.0 MHz, BLE, Horizontal

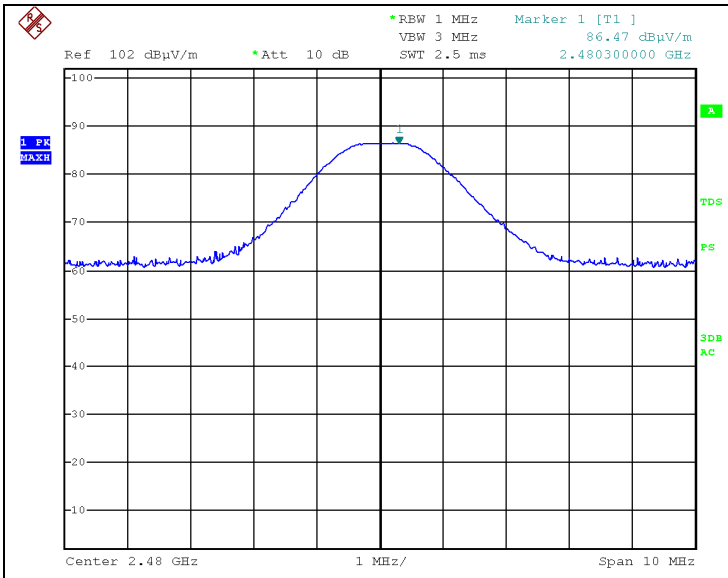


Figure 12. 2480.0 MHz, BLE, Vertical

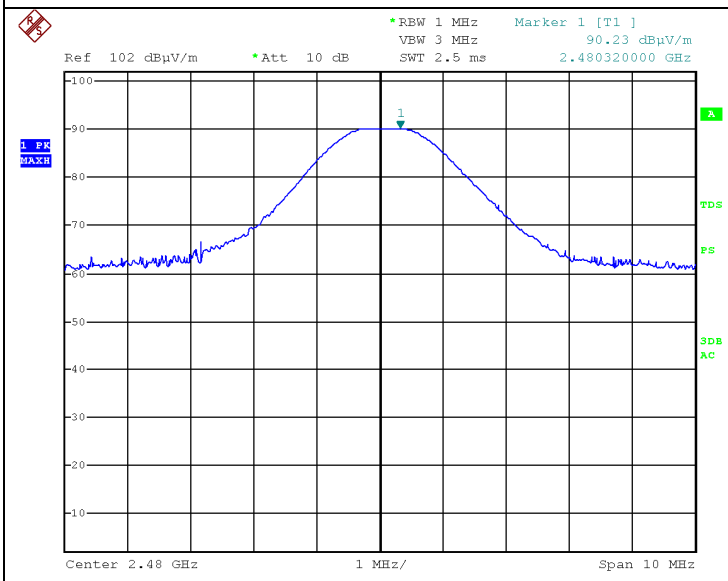


Figure 13. 2480.0 MHz, BLE, Horizontal

5.5 Test Equipment Used; Maximum Conducted Output Power

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
EMI Test Receiver	Rohde & Schwarz	ESCI7	100724	February 20, 2023	February 20, 2024
Horn Antenna	ETS	3115	29845	May 25, 2021	May 25, 2024
10 m RF cable	Commscope ORS (Serge)	0623 WBC-400	G020133	May 16, 2022	May 16, 2023
Full Anechoic Civil Chamber	ETS	S81	SL 11643	NCR	NCR

Figure 14 Test Equipment Used

6. Band Edge Spectrum

6.1 Test Specification

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

RSS-247, Issue 2, Section 5.5

6.2 Test Procedure

(Temperature (20°C)/ Humidity (59%RH))

The E.U.T operation mode and test set-up are as described in Section 2 of this report.

The E.U.T was tested in the chamber, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 1.5 meters above the ground. The readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization.
The emissions were measured at a distance of 3 meters.

The RBW was set to 100 kHz.

6.3 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.

6.4 Test Results

Protocol Type	Operation Frequency	Band Edge Frequency	Spectrum Level	Limit	Margin
	(MHz)	(MHz)	(dBuV/m)	(dBuV/m)	(dB)
BLE	2402.0	2400.0	-59.98	-41.03	-18.95
	2480.0	2483.5	-76.35	-48.1	-28.25

Figure 15 Band Edge Spectrum

JUDGEMENT: Passed by -18.95 dB

For additional information see Figure 16 to Figure 17 .

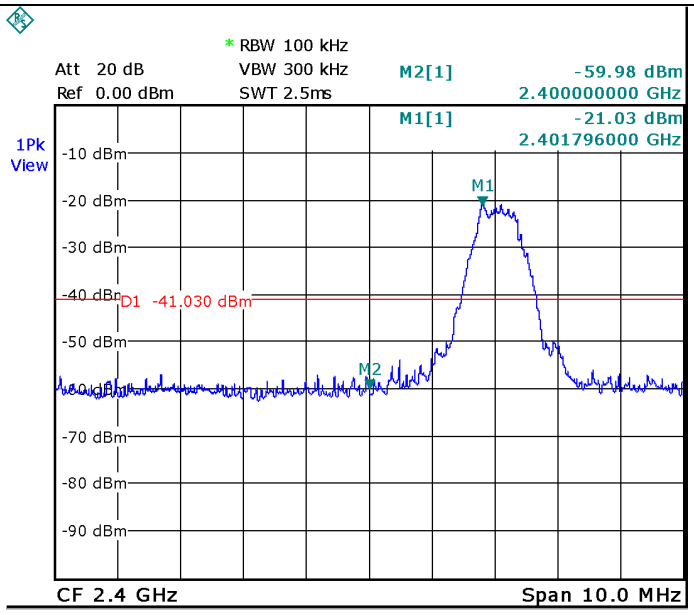


Figure 16 Band Edge Low, BLE

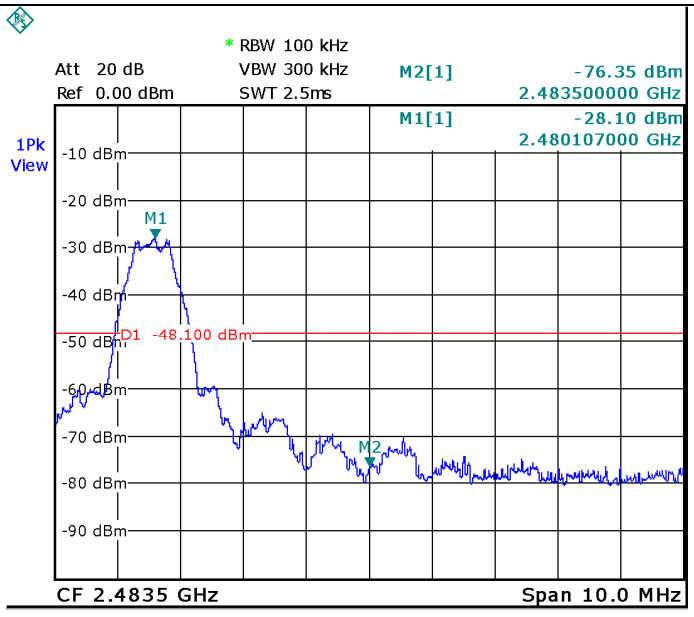


Figure 17 Band Edge High, BLE

6.5 Test Equipment Used; Band Edge

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
EMI Test Receiver	Rohde & Schwarz	ESCI7	100724	February 20, 2023	February 20, 2024
Horn Antenna	ETS	3115	29845	May 25, 2021	May 25, 2024
10 m RF cable	Commscope ORS (Serge)	0623 WBC-400	G020133	May 16, 2022	May 16, 2023
Full Anechoic Civil Chamber	ETS	S81	SL 11643	NCR	NCR

Figure 18 Test Equipment Used

7. Transmitted Power Density

7.1 Test Specification

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

RSS-247, Issue 2, Section 5.2(b)

7.2 Test Procedure

(Temperature (22°C)/ Humidity (70%RH))

The E.U.T operation mode and test set-up are as described in Section 2 of this report.

The E.U.T was tested in the chamber, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 1.5 meters above the ground.

The readings were maximized by the turntable azimuth between 0-360°, and the antenna polarization. The emissions were measured at a distance of three meters.

The spectrum analyzer was set to 3 kHz RBW and VBW to 10 kHz.

Radiated output power levels were measured at selected operation frequencies and the results were converted to power level according to the formula as shown below:

$$P = \frac{(E_{V/m} \times d)^2}{(30 \times G)} \text{ [W]}$$

E - Field Strength (V/m)
d – Distance from transmitter (m)
G – Antenna gain
P – Peak power (W)

7.3 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.

7.4 Test Results

Protocol Type	Operation Frequency	Polarity	Reading Spectrum Analyzer	Reading Spectrum Analyzer	Limit	Margin
	(MHz)	(V/H)	(dBµV/m)	(dBm)	(dBm)	(dB)
BLE	2402.0	V	76.6	-18.6	8.0	-26.6
		H	82.1	-13.1	8.0	-21.1
	2440.0	V	71.6	-23.6	8.0	-31.6
		H	76.7	-18.5	8.0	-26.5
	2480.0	V	71.3	-23.9	8.0	-31.9
		H	73.9	-21.3	8.0	-29.3

Figure 19 Test Results

JUDGEMENT: Passed by_-21.1 dB

For additional information see Figure 20 to Figure 25 .

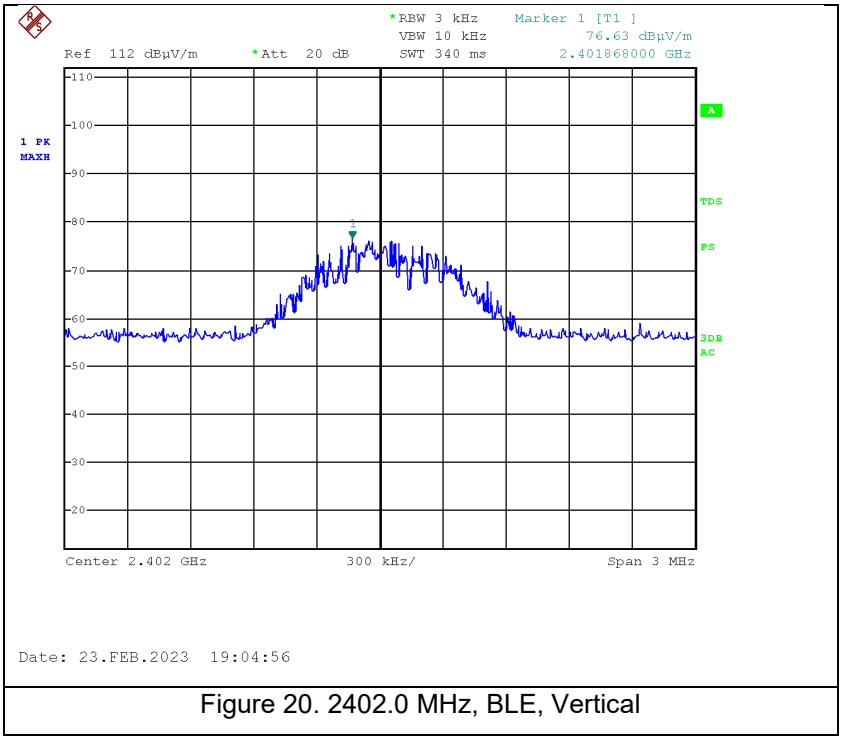


Figure 20. 2402.0 MHz, BLE, Vertical

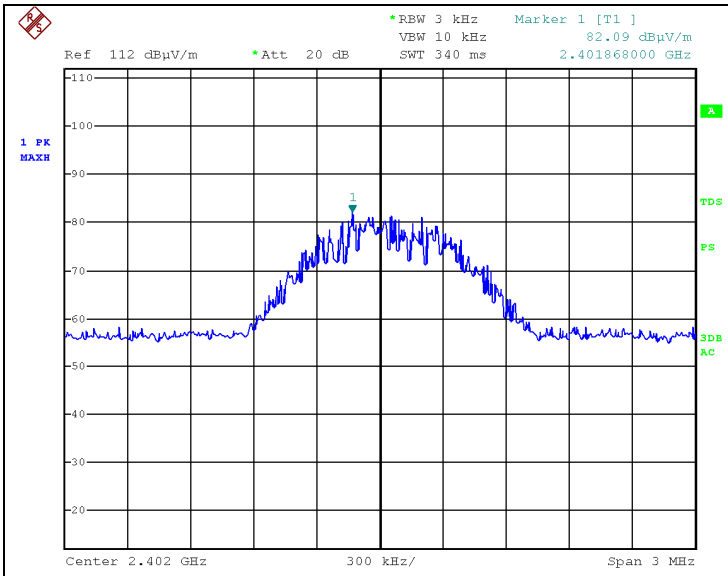


Figure 21. 2402.0 MHz, BLE, Horizontal

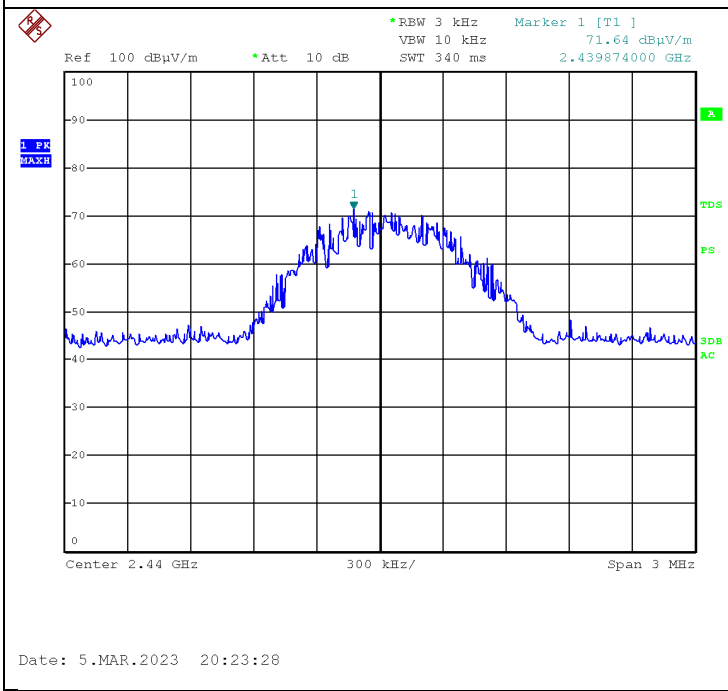


Figure 22. 2440.0 MHz, BLE, Vertical

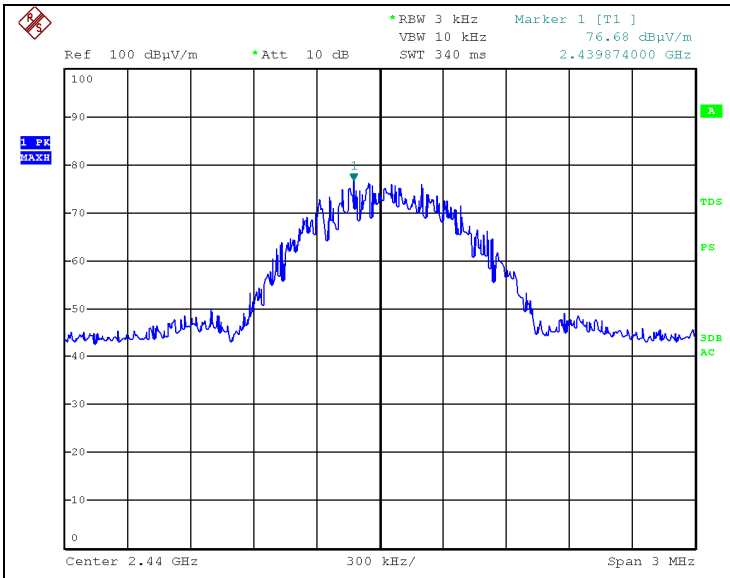


Figure 23. 2440.0 MHz, BLE, Horizontal

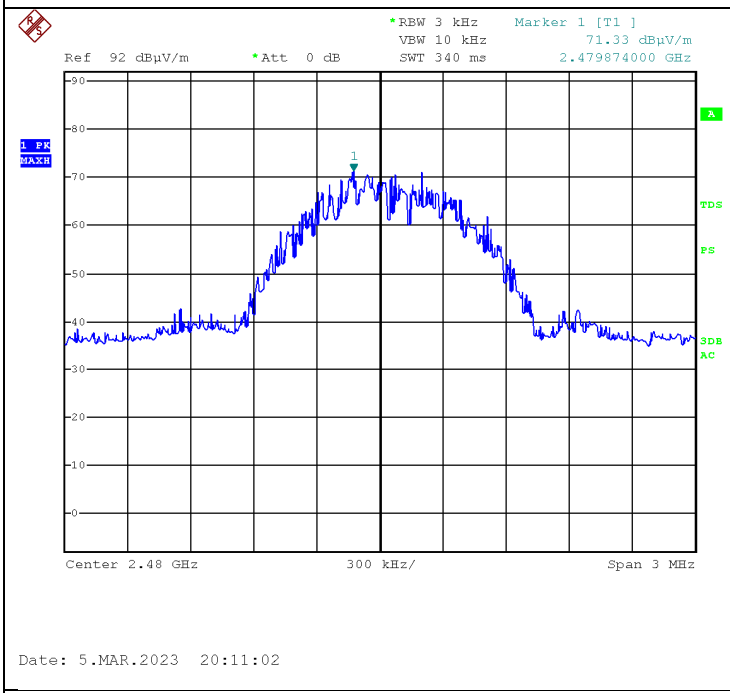


Figure 24. 2480.0 MHz, BLE, Vertical

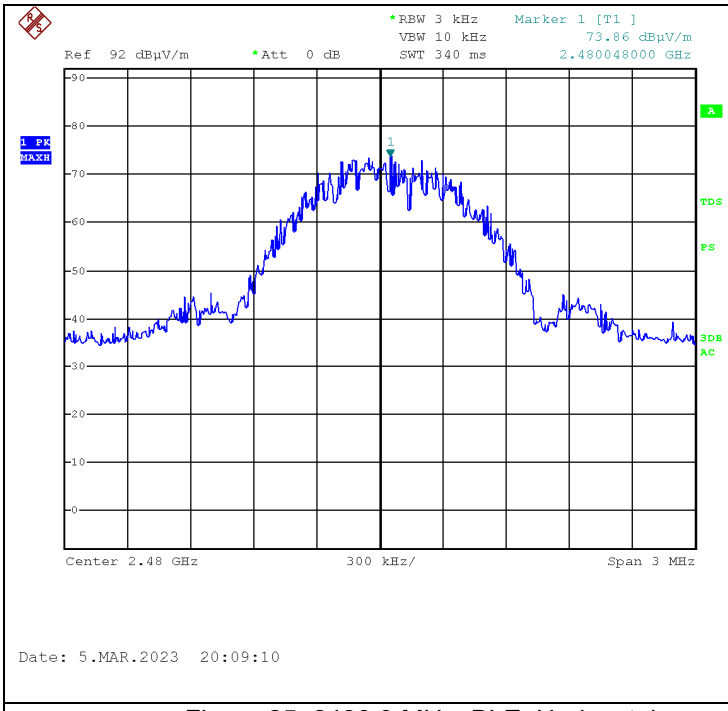


Figure 25. 2480.0 MHz, BLE, Horizontal

7.5 Test Equipment Used; Transmitted Power Density

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
EMI Test Receiver	Rohde & Schwarz	ESCI7	100724	February 20, 2023	February 20, 2024
Horn Antenna	ETS	3115	29845	May 25, 2021	May 25, 2024
10 m RF cable	Commscope ORS (Serge)	0623 WBC-400	G020133	May 16, 2022	May 16, 2023
Full Anechoic Civil Chamber	ETS	S81	SL 11643	NCR	NCR

Figure 26 Test Equipment Used

8. Occupied Bandwidth

8.1 Test Specification

FCC, Part 2, Sub part J, Section 2.1049

RSS-Gen, Issue 5: 2018, Section 6.6

8.2 Test Procedure

(Temperature (22°C)/ Humidity (56%RH))

The E.U.T. operation mode and test set-up are as described in Section 2 of this report. The E.U.T. was placed in the chamber on a non-conductive table, 0.8 meters above the ground.

The distance between the E.U.T. and test antenna was 3 meters.
The transmitter unit was operated with normal modulation. 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.

8.3 Test Limit

N/A

8.4 Test Results

Protocol Type	Operation Frequency (MHz)	Reading (kHz)
BLE	2402.0	1048.0
	2440.0	1077.0
	2480.0	1037.0

Figure 27. Bandwidth Test Results

JUDGEMENT: N/A

See additional information in Figure 28 to Figure 30.

Occupied Bandwidth

E.U.T Description	BLE RPM Meter
Model Number	TJEH-030A
Part Number:	N/A

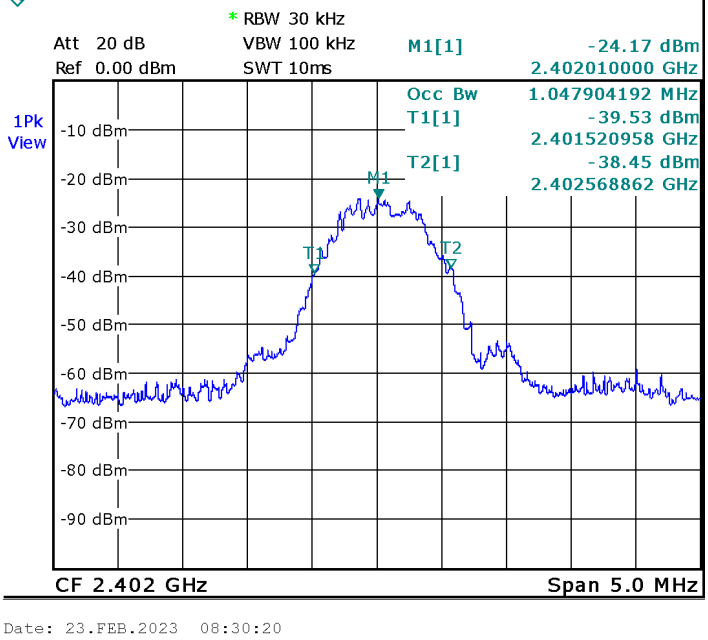


Figure 28. 2402.0 MHz, BLE

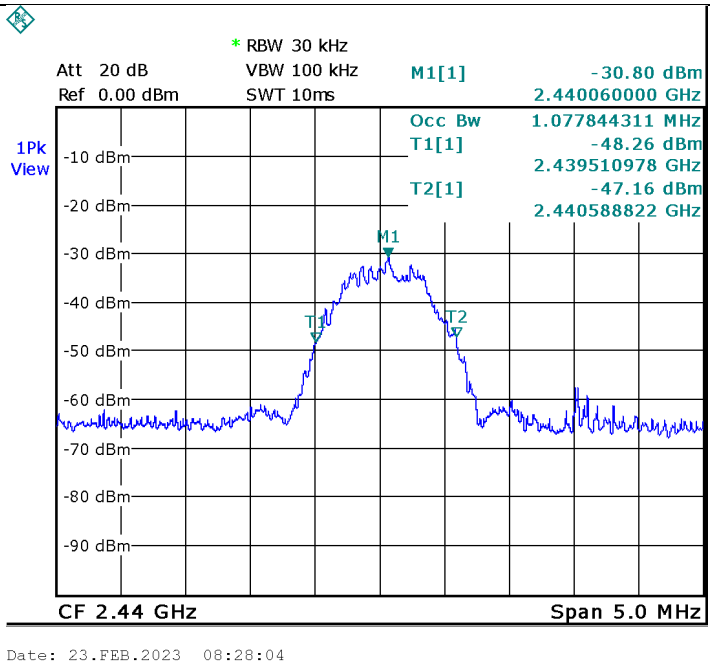


Figure 29. 2440.0 MHz, BLE

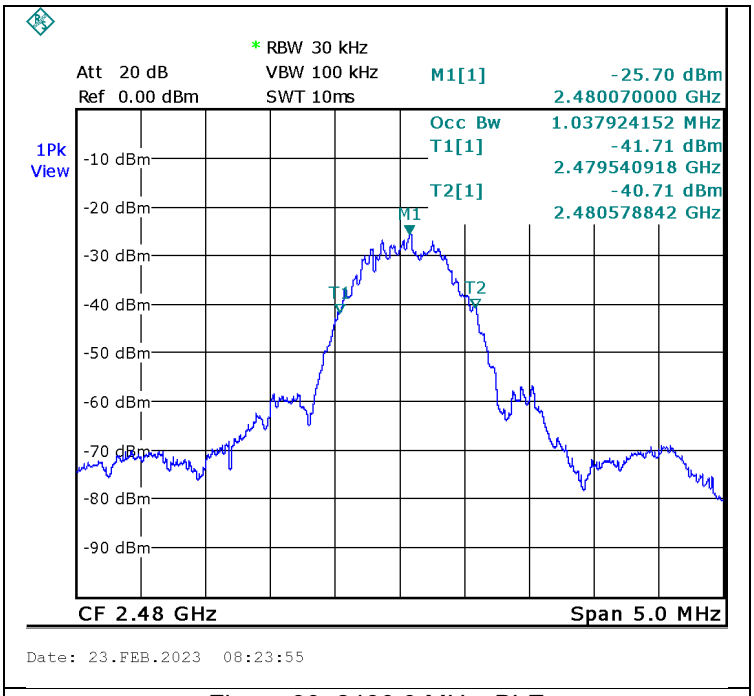


Figure 30. 2480.0 MHz, BLE

8.5 Test Equipment Used; Occupied Bandwidth

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
Spectrum Analyzer	Rohde & Schwarz	FSL6	100194	February 20, 2023	February 20, 2024
Horn Antenna	ETS	3115	29845	May 25, 2021	May 25, 2024
10 m RF cable	Commscope ORS (Serge)	0623 WBC-400	G020133	May 16, 2022	May 16, 2023
Full Anechoic Civil Chamber	ETS	S81	SL 11643	NCR	NCR

Figure 31 Test Equipment Used

9. Emissions in non-Restricted Frequency Bands

9.1 Test Specification

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

RSS-247, Issue 2, Section 5.5

9.2 Test Procedure

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

For measurements between 0.009MHz-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 30MHz-1GHz:
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 30.0MHz -1.0GHz 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 1.0GHz -25.0GHz was scanned.

RBW was set to 100 kHz, detector set to max peak and trace to “max hold”.

9.3 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.

9.4 Test Results

JUDGEMENT: Passed

All detected emissions were greater than 20dBc below the fundamental level.

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

9.5 Test Instrumentation Used, Emission in non-Restricted Frequency Bands

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
Active Loop Antenna	EMCO	6502	2950	July 5, 2022	July 5, 2023
EMI Receiver	HP(Agilent)	8542E	3906A00276	February 22, 2023	February 22, 2024
RF Filter	HP(Agilent)	85420E	3705A00248	February 22, 2023	February 22, 2024
Log-periodic Antenna	EMCO	3146	9505-4081	April 27, 2021	April 27, 2024
Horn Antenna	ETS	3115	29845	May 25, 2021	May 25, 2024
Biconical Antenna	EMCO	3110B	9912-3337	January 18, 2022	January 18, 2024
Multi device Controller	EMCO	2090	9908-1456	NCR	NCR
RF Amplifier	MIT	50-8P	AFSX4	NCR	NCR
LOD Semi anechoic Civil Chamber	ETS	S81	SL 11643	NCR	NCR
Pass Band Filter	Meuro	MFL040120H50	902252	May 16, 2022	May 16, 2023
Spectrum Analyzer	Rohde & Schwarz	FSL6	100194	February 20, 2023	February 20, 2023
EMI Test Receiver	Rohde & Schwarz	ESCI7	100724	February 20, 2023	February 20, 2024
Wideband RF Amplifier 100K-26.5GHz	OSR	N.A.	N.A	May 16, 2022	May 16, 2023
Low Loss cable	Huber Suhner	Sucofelex	27504/4PEA	May 16, 2022	May 16, 2023
Cable CE Chamber 5M	Telrad	RJ214	(blank)	June 7, 2022	June 7, 2023
30 dB attenuator	MCL	BW-S30W5	533	May 16, 2022	May 16, 2023
10 m RF cable	Commscope ORS (Serge)	0623 WBC-400	G020133	May 16, 2022	May 16, 2023

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
20dB/2W Attenuator	Midwest Microwave	ATT-0217-20-NNN-02	-	May 16, 2022	May 16, 2023
35m coaxial cable for oats	EIM (Huber Suhner)	RG214-11N(X2) RG214/U	(blank)	June 22, 2022	June 22, 2023
EMC Analyzer	HP Agilent/ Keysight	8593EM	3826A00265	February 20, 2023	February 20, 2024
20dB attenuator	Narda	4778-20	1325	May 16, 2022	May 16, 2023
Signal analyzer	Keysight	EXA signal analyzer N9010A	my51170071	February 13, 2023	February 13, 2024
Spectrum Analyzer	HP(Agilent)	8591E	3414U01226	February 21, 2023	February 21, 2024

Figure 32 Test Equipment Used

9.6 Field Strength Calculation

The field strength is calculated directly by the EMI Receiver software, and a "Correction Factors", using the following equation:

FS = RA + AF + CF

FS: Field Strength [dBµv/m]

RA: Receiver Amplitude [dBµv]

AF: Receiving Antenna Correction Factor [dB/m]

CF: Cable Attenuation Factor [dB]

Example: FS = 30.7 dBµV (RA) + 14.0 dB (AF) + 0.9 dB (CF) = 45.6 dBµV

No external pre-amplifiers are used.

10. Emissions in Restricted Frequency Bands

10.1 Test Specification

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

RSS-247, Issue 2, Section 3.3

RSS-Gen, Issue 5, Section 8.10

10.2 Test Procedure

(Temperature (23°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.

Tests done for all “worst case”, each protocol type. The highest radiations are described in the tables below.

The levels of the emissions within the frequency ranges of the restricted bands (Section 15.205 of FCC Part 15) were compared to the limits of the table in Section 15.209 (a), General Requirements.

10.3 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 33 Table of Limits

10.4 Test Results

JUDGEMENT: Passed by 1.5 dB

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 34*.

Radiated Emission

E.U.T Description BLE RPM Meter
Type TJEH-030A
Serial Number: N/A

Specifications: FCC, Part 15, Subpart C, Sections 15.209, 15.205, 15.247(d)
RSS-247, Issue 2, Section 3.3; RSS-Gen, Issue 5, Section 8.10

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	52.0	74.0	-22	-	54.0	-
	2390.0	H	52.9	74.0	-21.1	-	54.0	-
	4804.0	V	53.0	74.0	-21	-	54.0	-
	4804.0	H	53.4	74.0	-20.6	-	54.0	-
2440.0	4880.0	V	52.6	74.0	-21.4	-	54.0	-
	4880.0	H	52.8	74.0	-21.2	-	54.0	-
2480.0	4960.0	V	52.3	74.0	-21.7	-	54.0	-
	4960.0	H	51.6	74.0	-22.4	-	54.0	-
	2483.5	V	61.2	74.0	-12.8	51.6	54.0	-2.4
	2483.5	H	62.0	74.0	-12	52.5	54.0	-1.5

Figure 34. 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

10.5 Test Instrumentation Used; Emissions in Restricted Frequency Bands

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
Active Loop Antenna	EMCO	6502	2950	July 5, 2022	July 5, 2023

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
EMI Receiver	HP(Agilent)	8542E	3906A00276	February 22, 2022	February 22, 2023
RF Filter	HP(Agilent)	85420E	3705A00248	February 22, 2022	February 22, 2023
Log-periodic Antenna	EMCO	3146	9505-4081	April 27, 2021	April 27, 2024
Horn Antenna	ETS	3115	29845	May 25, 2021	May 25, 2024
Biconical Antenna	EMCO	3110B	9912-3337	January 18, 2022	January 18, 2024
Multi device Controller	EMCO	2090	9908-1456	NCR	NCR
RF Amplifier	MIT	50-8P	AFSX4	NCR	NCR
LOD Semi anechoic Civil Chamber	ETS	S81	SL 11643	NCR	NCR
Pass Band Filter	Meuro	MFL040120H50	902252	May 16, 2022	May 16, 2023
Spectrum Analyzer	Rohde & Schwarz	FSL6	100194	February 20, 2022	February 20, 2023
EMI Test Receiver	Rohde & Schwarz	ESCI7	100724	February 20, 2022	February 20, 2023
Wideband RF Amplifier 100K-26.5GHz	OSR	N.A.	N.A	May 16, 2022	May 16, 2023
Low Loss cable	Huber Suhner	Sucofelex	27504/4PEA	May 16, 2022	May 16, 2023
Cable CE Chamber 5M	Telrad	RJ214	(blank)	June 7, 2022	June 7, 2023
30 dB attenuator	MCL	BW-S30W5	533	May 16, 2022	May 16, 2023
10 m RF cable	Commscope ORS (Serge)	0623 WBC-400	G020133	May 16, 2022	May 16, 2023
20dB/2W Attenuator	Midwest Microwave	ATT-0217-20-NNN-02	-	May 16, 2022	May 16, 2023
35m coaxial cable for oats	EIM (Huber Suhner)	RG214-11N(X2) RG214/U	(blank)	June 22, 2022	June 22, 2023
EMC Analyzer	HPAgilent/Keysight	8593EM	3826A00265	February 20, 2022	February 20, 2023
20dB attentuator (round) small	unknown	unknown	unknown	August 7, 2021	August 7, 2022
Signal analyzer	Keysight	EXA signal analyzer N9010A	my51170071	February 13, 2022	February 13, 2023
Spectrum Analyzer	HP(Agilent)	8591E	3414U01226	February 21, 2022	February 21, 2023

Figure 35 Test Equipment Used

11. Antenna Gain/Information

As declared by the customer, the antenna gain is 0.5dBi, type: integral.

12. RF Exposure/Safety

See a separate report.

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	8.00	-40.40	11.10
0.30	-40.30	11.20	9.00	-40.50	11.00
0.50	-40.30	11.20	10.00	-40.50	11.00
0.70	-40.30	11.20	20.00	-41.50	10.00
1.00	-40.10	11.40	30.00	-43.50	8.00
2.00	-40.00	11.50			

13.4 ITL #1356: Biconical Antenna

Frequency (MHz)	AF (dB/m)	Frequency (MHz)	AF (dB/m)
30.00	13.00	90.00	8.23
35.00	10.89	100.00	11.12
40.00	10.59	120.00	13.16
45.00	10.63	140.00	13.07
50.00	10.12	160.00	14.80
60.00	9.26	180.00	16.95
70.00	7.74	200.00	17.17
80.00	6.63		

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

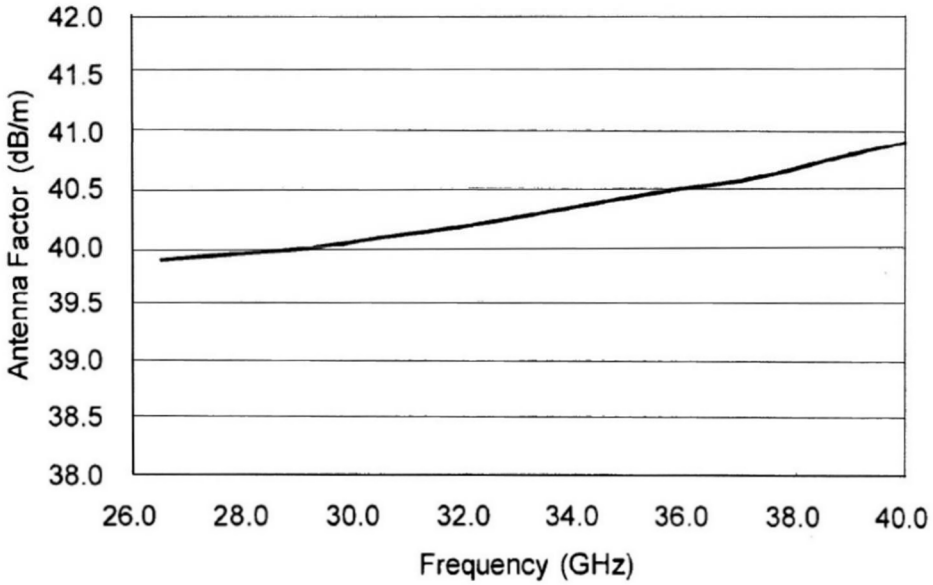
13.7 ITL # 1353: 18-26.5 GHz Horn Antenna

Frequency (MHz)	Measured antenna factor (dB/m)[2]		Frequency (MHz)	Measured antenna factor (dB/m)[2]
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

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

Frequency (MHz)	Measured antenna factor $(dB/m)^2$		Frequency (MHz)	Measured antenna factor $(dB/m)^2$
21,500.00	32.70		26,000.00	34.20
22,000.00	33.10		26,500.00	34.70

13.8 ITL # 1777: 26.5-40 GHz Horn Antenna



End of Test Report