



DATE: 07 November 2019

I.T.L. (PRODUCT TESTING) LTD.

FCC Radio Test Report
for
Atomation Net, Inc.

Equipment under test:
BLE Radio Module Transceiver

M52840-QI

Tested by: _____


M. Zohar

Approved by: _____


D. Shidlow

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This report relates only to items tested.



Measurement/Technical Report for Atomation Net, Inc.

BLE Radio Module Transceiver

M52840-QI

FCC ID: 2AT8A-M52840-QI-V1

This report concerns:	Original Grant: X Class I Change: Class II Change:
Equipment type:	FCC: (DTS) Digital Transmission System
Limits used:	47CFR15 Section 15.247
Measurement procedure used is KDB 558074 D01 15.247 Meas Guidance v05r02 and ANSI C63.10:2013	
Application for Certification prepared by: R. Pinchuck ITL (Product Testing) Ltd. 1 Bat Sheva St. Lod 7116002 e-mail Rpinchuck@itlglobal.org	Applicant for this device: (different from "prepared by") Steve Hassell Atomation Net, Inc. 190 Carondelet Plaza, Suite 1130 St. Louis, Missouri, 63105 Phone: 314-578-9811 Email: Steve@atomation.net



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1. General Information

1.1 Administrative Information

Manufacturer:	Atomation Net, Inc.
Manufacturer's Address:	190 Carondelet Plaza Suite 1130 St. Louis, Missouri, 63105 Tel: 314-578-9811
Manufacturer's Representative:	Steve Hassell
Equipment Under Test (E.U.T):	BLE Radio Module Transceiver
Equipment Model:	M52840-QI
Equipment Serial No.:	Not designated
Date of Receipt of E.U.T:	August 21, 2019
Start of Test:	August 21, 2019
End of Test:	October 06, 2019
Test Laboratory Location:	I.T.L (Product Testing) Ltd. 1 Batsheva St., Lod ISRAEL 7120101
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. The Israel Ministry of the Environment (Israel), Registration No. 1104/01.
4. 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**

BLE module that will be assembled on Atomation various IoT systems. The module connects to sensor, sample them and send the information to smartphone or gateway via BLE.

Working voltage	3.2VDC internal regulated
Mode of operation	BLE transceiver
Modulations	GFSK
Assigned Frequency Range	2400.0-2483.5MHz
Operating Frequency Range	2402.0-2480.0MHz
Transmit power(conducted)	~6.0dBm
Antenna Gain	+8.0 dBi, PCB IFA antenna
Modulation BW	2MHz
Bit rate (Mbit/s)	1, 2, 3

1.4 **Test Methodology**

Both conducted and radiated testing was performed according to the procedures in KDB 558074 D01 15.247 Meas Guidance v05r02 and ANSI C63.10: 2013. 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 a standard (BLE) IEEE 802.15.1 transceiver.
2. The unit was evaluated while transmitting at the low channel (2402MHz), the mid channel (2440MHz) and the high channel (2480MHz).
3. The evaluation was performed with the E.U.T connected to a 3VDC battery only for testing evaluation.
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 below indicate the worst case was the Y axis.

Orientation	Frequency	2 nd Harmonic	3 rd Harmonic	Band Edge
	(MHz)	(dBuV/m)	(dBuV/m)	(dBuV/m)
X axis	2402.0	56.0	52.3	53.1
	2440.0	57.3	52.5	-
	2480.0	57.5	52.7	54.3
Y axis	2402.0	58.5	52.5	53.2
	2440.0	58.0	52.9	-
	2480.0	58.5	53.0	54.8
Z axis	2402.0	54.4	52.4	53.4
	2440.0	54.2	52.5	-
	2480.0	54.4	52.7	54.1

Figure 1. Screening Results BLE mode

2.2 EUT Exercise Software

No special exercise software was used.

2.3 Special Accessories

No special accessories was used.

2.4 Equipment Modifications

No modifications were necessary in order to achieve compliance.

2.5 Configuration of Tested System

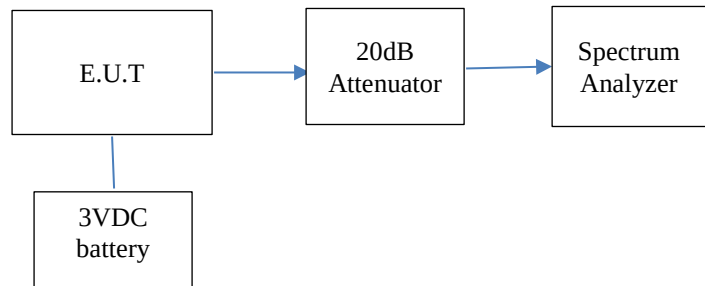


Figure 2. Configuration of Tested System Conducted

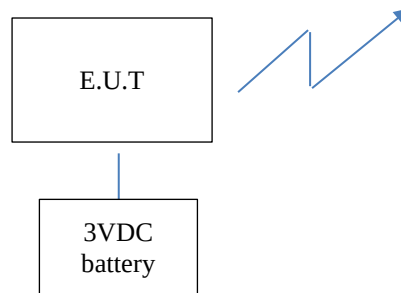


Figure 3. Configuration of Tested System Radiated

3. Conducted & Radiated Measurement Test Set-Up Photos

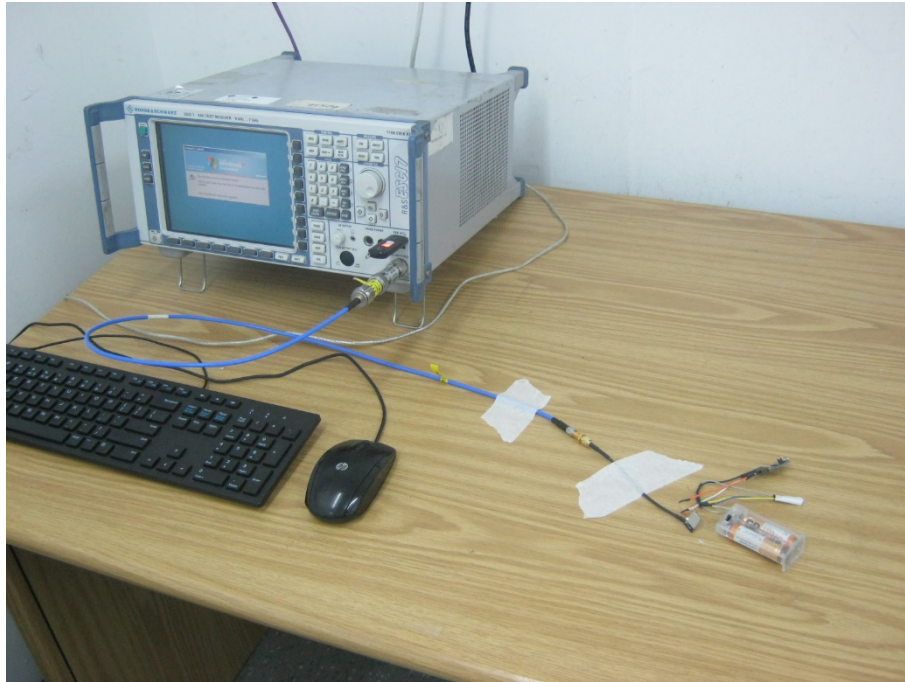


Figure 4. Conducted Emission Test



Figure 5. Radiated Emission Test, 0.009-30MHz



Figure 6. Radiated Emission Test, 30-200MHz



Figure 7. Radiated Emission Test, 200-1000MHz



Figure 8. Radiated Emission Test, 1-18GHz



Figure 9. Radiated Emission Test, 18-26.5GHz

4. 6 dB Minimum Bandwidth

4.1 Test Specification

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

4.2 Test Procedure

(Temperature (21°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. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (total loss=20.5 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.

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	Reading	Limit
	(MHz)	(kHz)	(kHz)
BLE	2402.0	750.0	>500.0
	2440.0	720.0	>500.0
	2480.0	740.0	>500.0

Figure 10 6 dB Minimum Bandwidth

JUDGEMENT: Passed

For additional information see *Figure 11* to *Figure 13*.

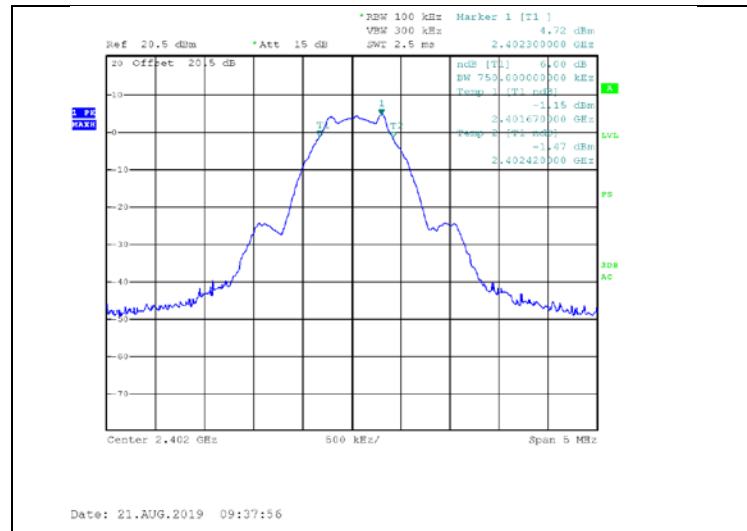


Figure 11. 2402.0 MHz, BLE

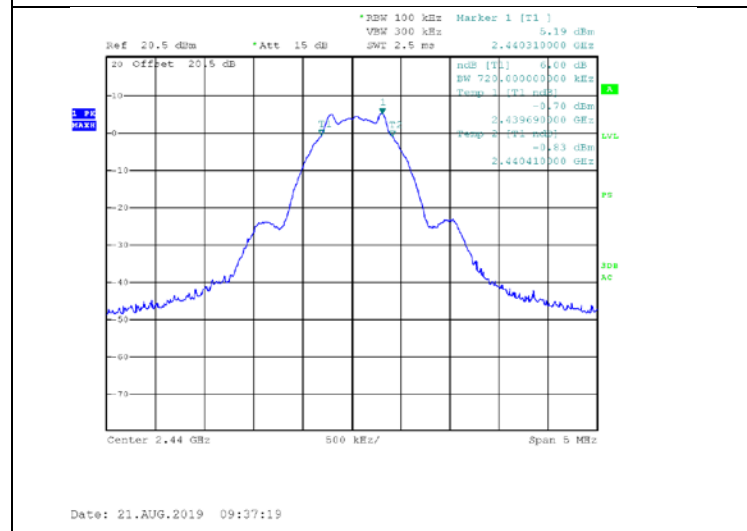


Figure 12. 2440.0 MHz, BLE

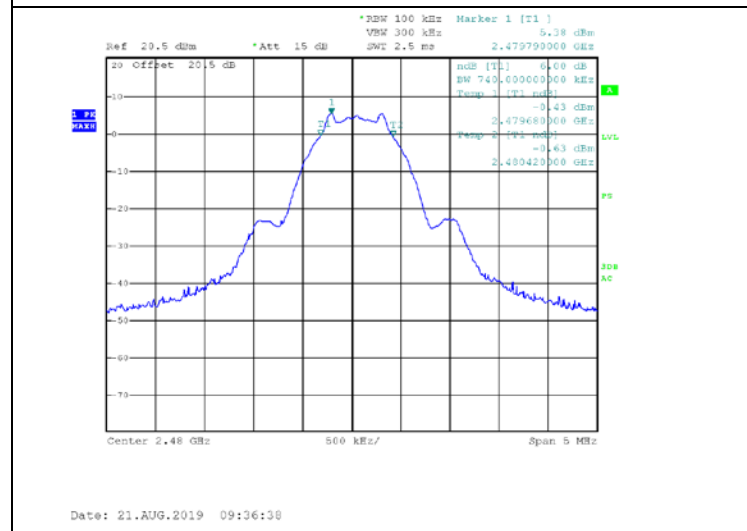


Figure 13. 2480.0 MHz, BLE



4.5 Test Equipment Used; 6dB Bandwidth

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
EMI Receiver	R&S	ESCI7	100724	February 27, 2019	February 28, 2020
20dB Attenuator	Microwave Midwest	ATT-0217-20-NNN-02	-	December 24, 2018	December 31, 2019
RF Cable	EIM	705A009401EIM	-	December 24, 2018	December 31, 2019

Figure 14 Test Equipment Used

5. Maximum Conducted Output Power

5.1 Test Specification

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

5.2 Test Procedure

(Temperature (21°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. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (total loss=20.5 dB). Special attention was taken to prevent Spectrum Analyzer RF input overload.

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	Power	Power	Limit	Margin
	(MHz)	(dBm)	(mW)	(mW)	(mW)
BLE	2402.0	5.2	3.31	1000.0	-996.69
	2440.0	5.4	3.47	1000.0	-996.53
	2480.0	5.8	3.80	1000.0	-996.20

Figure 15 Maximum Peak Power Output

JUDGEMENT: Passed by 996.20 mW

For additional information see *Figure 16* to *Figure 18*.

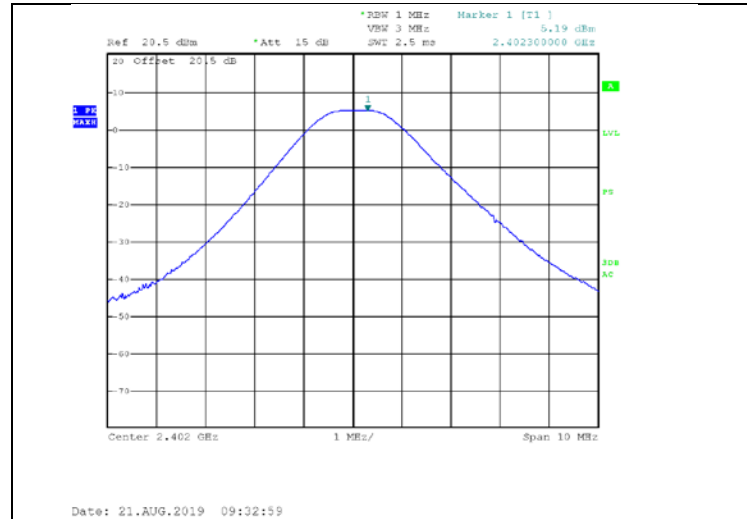


Figure 16. 2402.0 MHz, BLE

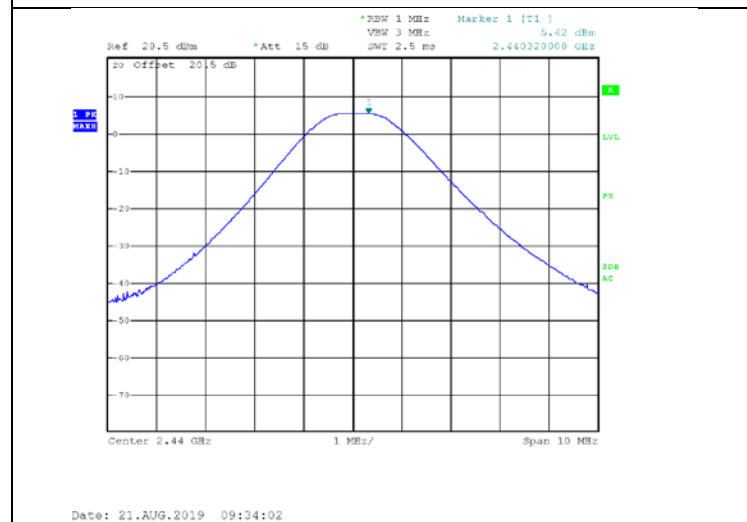


Figure 17. 2440.0 MHz, BLE

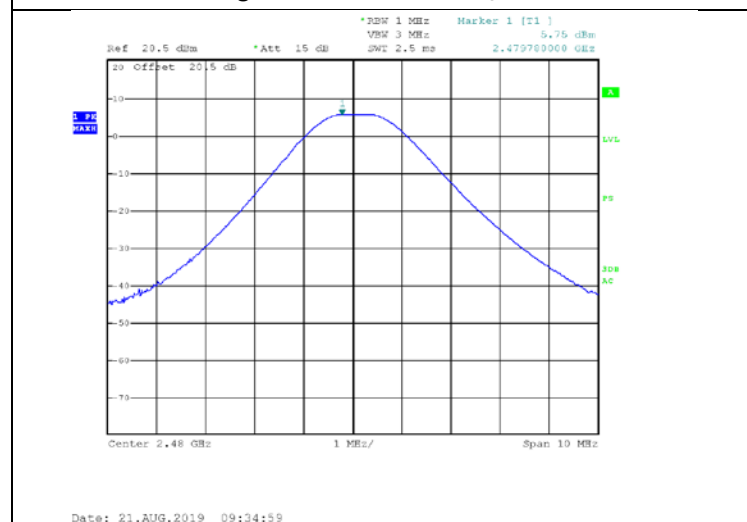


Figure 18. 2480.0 MHz, BLE



5.5 Test Equipment Used; Maximum Peak Power Output

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
EMI Receiver	R&S	ESCI7	100724	February 27, 2019	February 28, 2020
20dB Attenuator	Microwave Midwest	ATT-0217-20-NNN-02	-	December 24, 2018	December 31, 2019
RF Cable	EIM	705A009401EIM	-	December 24, 2018	December 31, 2019

Figure 19 Test Equipment Used

6. Band Edge Spectrum

6.1 Test Specification

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

6.2 Test Procedure

(Temperature (21°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. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (loss=20.5 dB). Special attention was taken to prevent Spectrum Analyzer RF input overload.

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)	(dBm)	(dBm)	(dB)
BLE	2402.0	2400.0	-45.9	-15.7	-30.2
	2480.0	2483.5	-47.9	-14.5	-33.4

Figure 20 Band Edge Spectrum

JUDGEMENT: Passed by 30.2 dB

For additional information see *Figure 21* and *Figure 22*.

Band Edge Spectrum

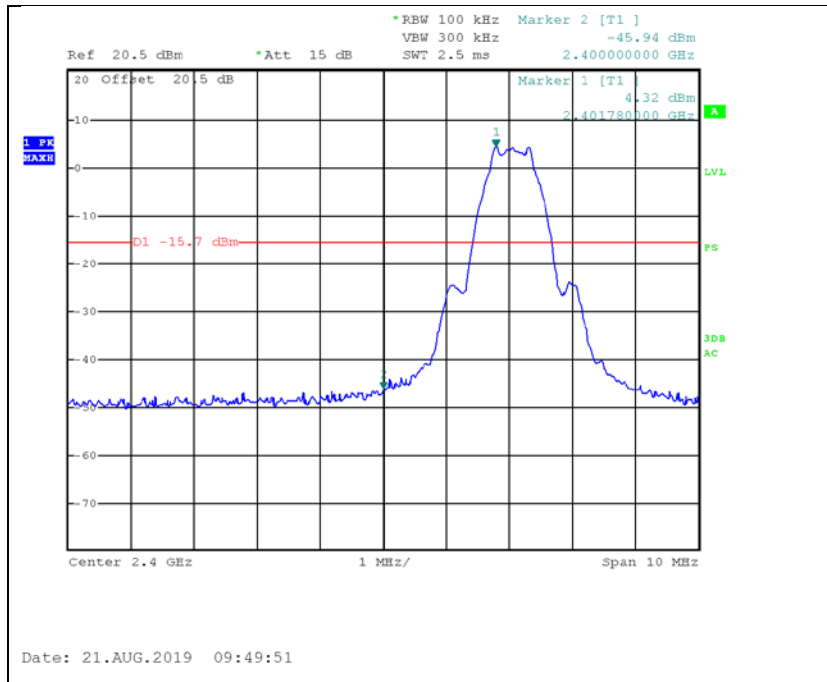


Figure 21. 2402.0 MHz, BLE

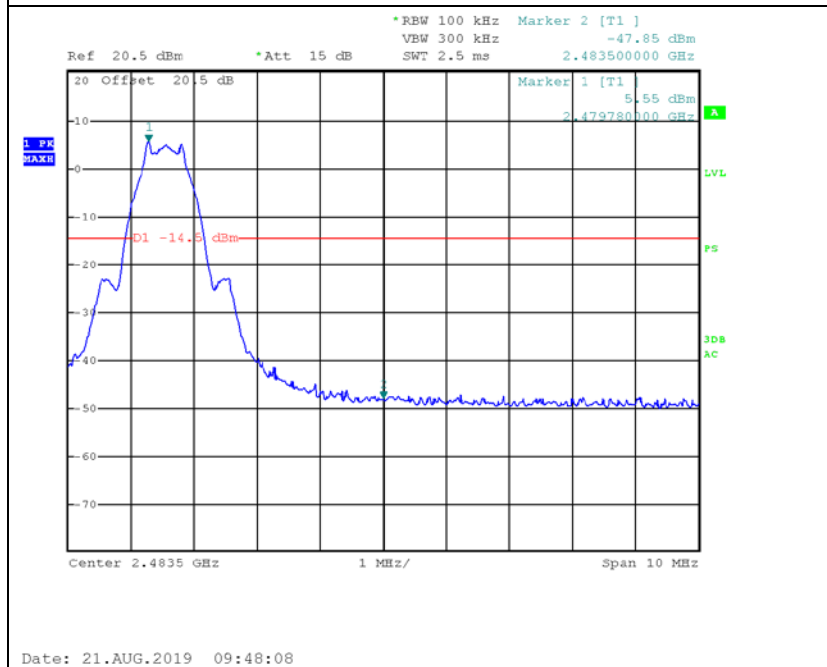


Figure 22. 2480.0 MHz, BLE



6.5 Test Equipment Used; Band Edge

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
EMI Receiver	R&S	ESCI7	100724	February 27, 2019	February 28, 2020
20dB Attenuator	Microwave Midwest	ATT-0217-20-NNN-02	-	December 24, 2018	December 31, 2019
RF Cable	EIM	705A009401EIM	-	December 24, 2018	December 31, 2019

Figure 23 Test Equipment Used

7. Transmitted Power Density

7.1 Test Specification

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

7.2 Test Procedure

(Temperature (21°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. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (total loss= 5~20dB). Special attention was taken to prevent Spectrum Analyzer RF input overload.

The spectrum analyzer was set to 3 kHz RBW.

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	PSD Reading	Limit	Margin
	(MHz)	(dBm)	(dBm)	(dB)
BLE	2402.0	-8.1	8.0	-16.1
	2440.0	-6.6	8.0	-14.6
	2480.0	-8.4	8.0	-16.4

Figure 24 Test Results

JUDGEMENT: Passed by 14.6 dB

For additional information see *Figure 25* to *Figure 27*.

Transmitted Power Density

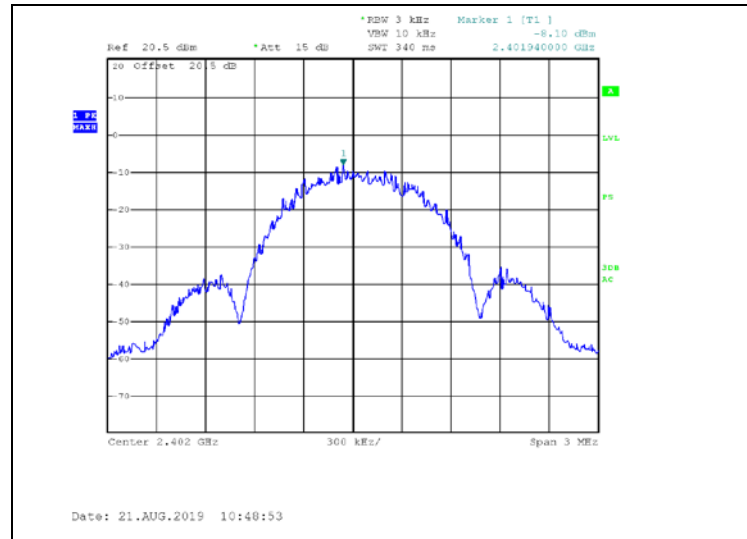


Figure 25. 2402.0 MHz, BLE

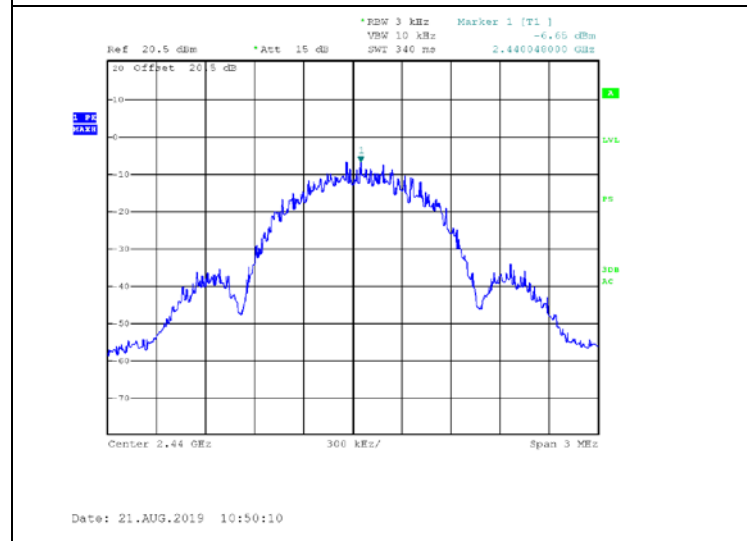


Figure 26. 2440.0 MHz, BLE

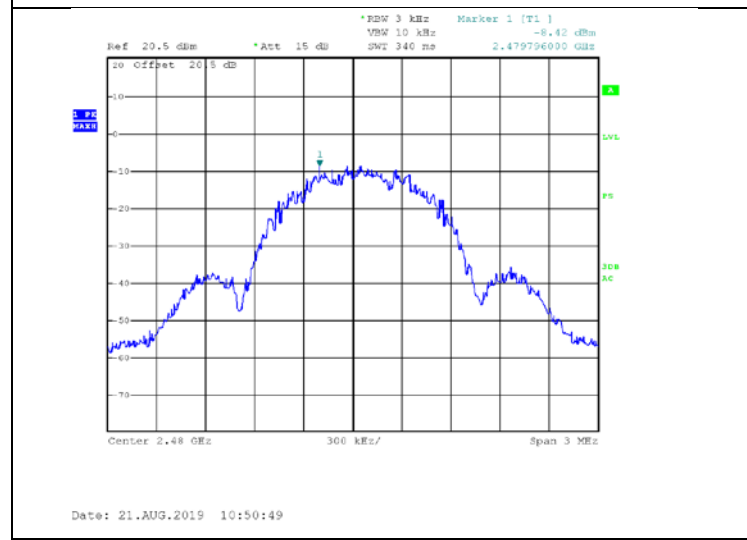


Figure 27. 2480.0 MHz, BLE



7.5 Test Equipment Used; Transmitted Power Density

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
EMI Receiver	R&S	ESCI7	100724	February 27, 2019	February 28, 2020
20dB Attenuator	Microwave Midwest	ATT-0217-20-NNN-02	-	December 24, 2018	December 31, 2019
RF Cable	EIM	705A009401EIM	-	December 24, 2018	December 31, 2019

Figure 28 Test Equipment Used

8. Occupied Bandwidth

8.1 Test Specification

FCC, Part 2, Sub part J, Section 2.1049

8.2 Test Procedure

(Temperature (21°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. antenna terminal was connected to the Spectrum Analyzer through an external attenuator and an appropriate coaxial cable (total loss= 20.5dB). 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 to ~ 3 times the OBW.

99% occupied bandwidth function was set on.

8.3 Test Limit

N/A

8.4 Test Results

Protocol Type	Operation Frequency	Reading
	(MHz)	(kHz)
BLE	2402.0	1062.0
	2440.0	1068.0
	2480.0	1080.0

Figure 29. Bandwidth Test Results

JUDGEMENT: N/A

See additional information in *Figure 30* to *Figure 32*.

Occupied Bandwidth

E.U.T Description BLE Radio Module
Transceiver
Model Number M52840-QI
Part Number: Not designated

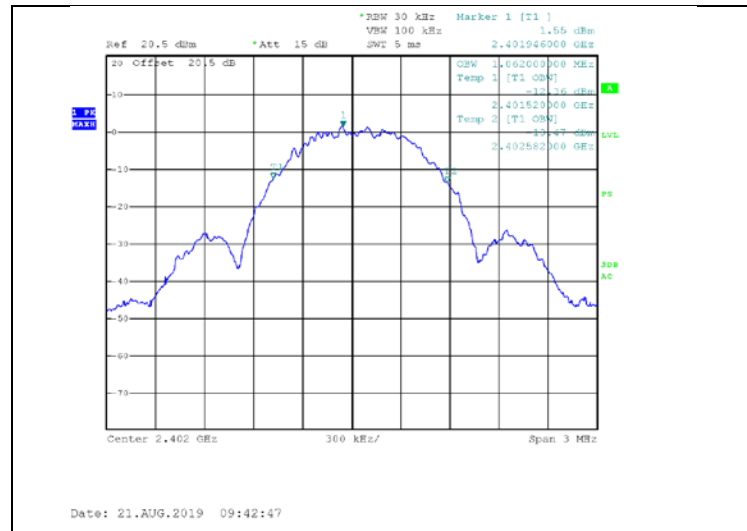


Figure 30. 2402.0 MHz, BLE

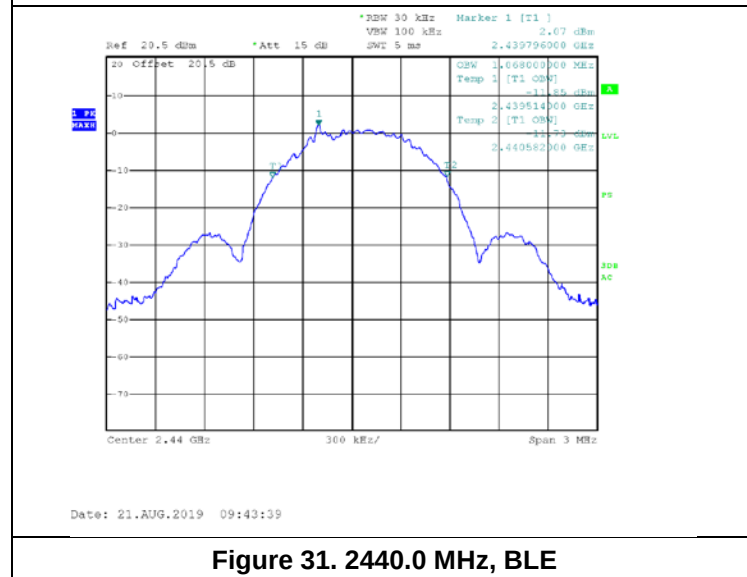
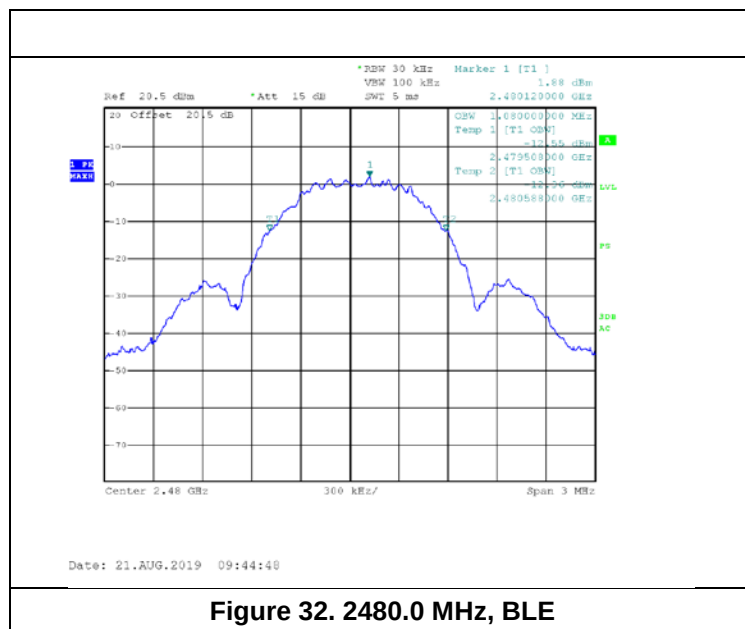


Figure 31. 2440.0 MHz, BLE

Occupied Bandwidth

E.U.T Description BLE Radio Module
Transceiver
Model Number M52840-QI
Part Number: Not designated



8.5 Test Equipment Used; Occupied Bandwidth

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
EMI Receiver	R&S	ESCI7	100724	February 27, 2019	February 28, 2020
20dB Attenuator	Microwave Midwest	ATT-0217-20-NNN-02	-	December 24, 2018	December 31, 2019
RF Cable	EIM	705A009401EIM	-	December 24, 2018	December 31, 2019

Figure 33 Test Equipment Used

9. Emissions in Non-Restricted Frequency Bands

9.1 Test Specification

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

9.2 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=34.0 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”.

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

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

For additional information see *Figure 34* to *Figure 36*.

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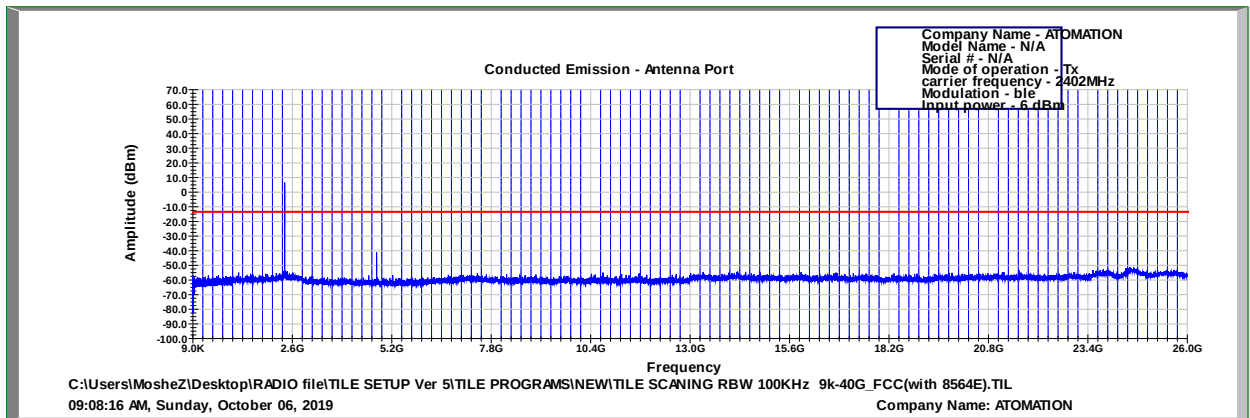


Figure 34 2402.0 MHz, BLE

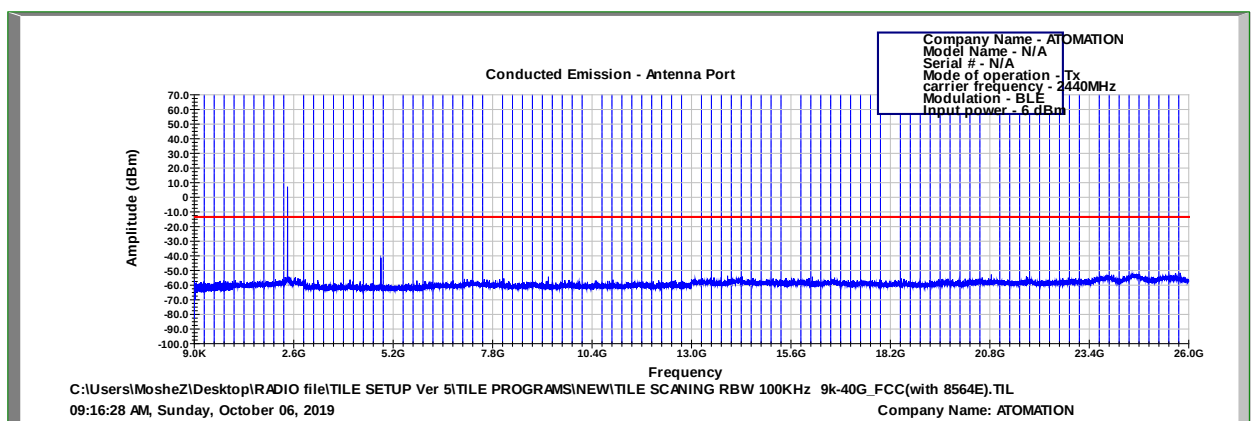


Figure 35 2440.0 MHz, BLE

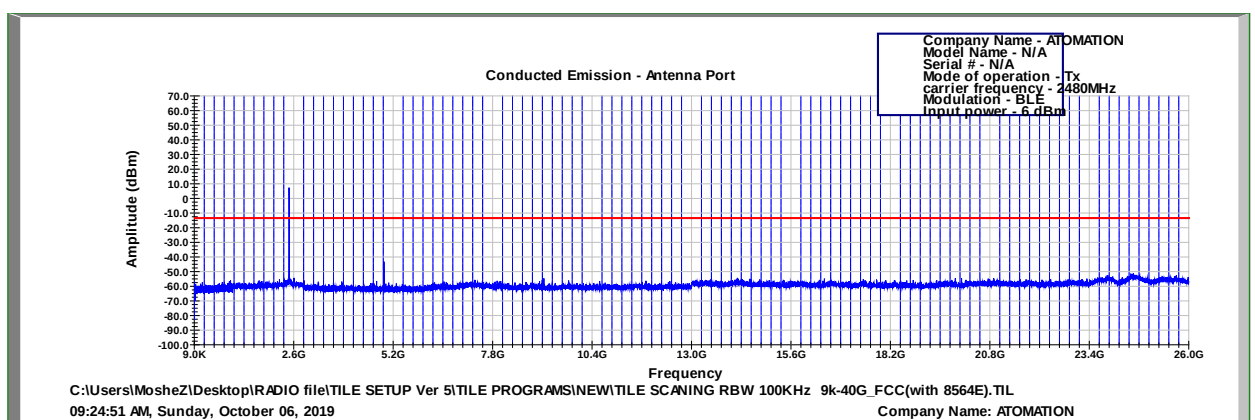


Figure 36 2480.0 MHz, BLE

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



9.5 Test Instrumentation Used, Emission in Non Restricted Frequency Bands

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Next Calibration Due
Spectrum Analyzer	HP	8564E	3442A00275	September 1, 2019	September 30, 2019
30dB Attenuator	MCL	BW-S30W5	533	December 24, 2018	December 31, 2019
RF Cable	EIM	705A009401 EIM	-	December 24, 2018	December 31, 2019

Figure 37 Test Equipment Used

10. Emissions in Restricted Frequency Bands

10.1 Test Specification

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

10.2 Test Procedure

(Temperature (28°C)/ Humidity (45%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 radiation describes 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 38 Table of Limits

10.4 Test Results

JUDGEMENT: Passed by 4.0 dB

For the operation frequency of 2402.0 MHz, the margin between the emission level and the specification limit is in the worst case 4.2 dB at the frequency of 4804.0 MHz, vertical polarization.

For the operation frequency of 2440.0 MHz, the margin between the emission level and the specification limit is in the worst case 4.0 dB at the frequency of 4880.0 MHz, vertical polarization.

For the operation frequency of 2480.0 MHz, the margin between the emission level and the specification limit is in the worst case 4.3 dB at the frequency of 4960.0 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 39*.



Radiated Emission

E.U.T Description BLE Radio Module Transceiver
Type M52840-QI
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	53.4	74.0	-20.6	45.7	54.0	-8.3
	2390.0	H	53.0	74.0	-21.0	45.4	54.0	-8.6
	4804.0	V	58.5	74.0	-15.5	49.8	54.0	-4.2
	4804.0	H	56.2	74.0	-17.8	48.7	54.0	-5.3
2440.0	4880.0	V	58.2	74.0	-15.8	50.0	54.0	-4.0
	4880.0	H	57.0	74.0	-17.0	49.1	54.0	-4.9
	7320.0	V	52.4	74.0	-21.6	-	54.0	-
	7320.0	H	52.2	74.0	-21.8	-	54.0	-
2480.0	4960.0	V	58.1	74.0	-15.9	49.7	54.0	-4.3
	4960.0	H	57.5	74.0	-16.5	49.3	54.0	-4.7
	2483.5	V	54.8	74.0	-19.2	45.2	54.0	-8.8
	2483.5	H	54.7	74.0	-19.3	45.1	54.0	-8.9

Figure 39. 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
EMI Receiver	R&S	ESCI7	100724	February 27, 2019	February 28, 2020
EMI Receiver	HP	8542E	3906A00276	February 28, 2019	February 28, 2020
RF Filter Section	HP	85420E	3705A00248	February 28, 2019	February 28, 2020
Spectrum Analyzer	HP	8593EM	3536A00120ADI	February 26, 2019	February 28, 2020
Active Loop Antenna	EMCO	6502	9506-2950	October 19, 2017	October 31, 2019
Biconical Antenna	EMCO	3110B	9912-3337	May 21, 2019	May 31, 2020
Log Periodic Antenna	EMCO	3146	9505-4081	May 31, 2018	May 31, 2020
Horn Antenna	ETS	3115	29845	May 31, 2018	May 31, 2021
Horn Antenna	ARA	SWH-28	1007	December 31, 2017	December 31, 2020
MicroWave System Amplifier	HP	83006A	3104A00589	December 24, 2019	December 31, 2019
Low Noise Amplifier 1GHz-18GHz	Miteq	AFSX4-02001800-50-8P	-	December 24, 2019	December 31, 2019
RF Cable Chamber	Commscope ORS	0623 WBC-400	G020132	December 24, 2019	December 31, 2019
RF Cable Oats	EIM	RG214-11N(X2)		May 26, 2019	May 30, 2020
Filter Band Pass 4-20 GHz	Meuro	MFL04012 0H50	902252	December 24, 2019	December 31, 2019
Semi Anechoic Civil Chamber	ETS	S81	SL 11643	NCR	NCR
Antenna Mast	ETS	2070-2	9608-1497	NCR	NCR
Turntable	ETS	2087	-	NCR	NCR
Mast & Table Controller	ETS/EMCO	2090	9608-1456	NCR	NCR

Figure 40 Test Equipment Used



11. Antenna Gain/Information

PCB IFA antenna, 8.0 dBi gain

12. R.F Exposure/Safety

The typical placement of the E.U.T. will be in sensors in IoT systems. The typical distance between the E.U.T. and the user is at least 20cm.

Calculation of Maximum Permissible Exposure (MPE)

Based on 47CFR1 Section 1.1307(b)(1) Requirements

- (a) FCC Limit at 2480 MHz is: $1 \frac{mW}{cm^2}$

Using Table 1 of 47CFR1 Section 1.1310 limit for general population/uncontrolled exposures, the above levels are an average over 30 minutes.

- (b) The power density produced by the E.U.T. is:

$$S = \frac{P_t G_t}{4\pi R^2}$$

P_t = Conducted Transmitted Power 5.8 dBm = 3.8 mW

G_t = Antenna Gain 8dBi = 6.31 numeric

R = Distance From Transmitter 20 cm

- (c) The peak power density produced by the E.U.T. is:

$$S = 3.8 * 6.31 / 4\pi(20)^2 = 0.005 \text{ mW/cm}^2$$

- (d) This is below the FCC limit.



13. APPENDIX A - CORRECTION FACTORS

13.1 **Correction factors for** **RF OATS Cable 35m**
ITL #1911

Frequency (MHz)	loss (dB)
30.0	1.3
50.0	1.7
100.0	2.6
200.0	3.7
300.0	4.7
400.0	5.5
500.0	6.3
600.0	7.0
700.0	7.6
800.0	8.4
900.0	9.0
1000.0	9.6

13.2 Correction factor for RF cable for Anechoic Chamber

ITL #1841

FREQ (MHz)	LOSS (dB)
1000.0	1.5
2000.0	2.1
3000.0	2.7
4000.0	3.1
5000.0	3.5
6000.0	4.1
7000.0	4.6
8000.0	4.9
9000.0	5.7
10000.0	5.7
11000.0	6.1
12000.0	6.1
13000.0	6.2
14000.0	6.7
15000.0	7.4
16000.0	7.5
17000.0	7.9
18000.0	8.1
19000.0	8.8
20000.0	9.1

NOTES:

1. The cable is manufactured by Commscope
2. The cable type is 0623 WBC-400, serial # G020132 and 10m long



13.3 Correction factors for Active Loop Antenna

Model 6502 S/N 9506-2950

ITL # 1075:

F(MHz)	AF(dB/m)
0.01	18.4
0.02	14.3
0.03	13.3
0.05	11.7
0.1	11.4
0.2	11.2
0.3	11.2
0.5	11.2
0.7	11.2
1	11.4
2	11.5
3	11.5
4	11.4
5	11.3
6	11.1
7	11.1
8	11.1
9	11
10	11
20	10
30	8



13.4 Correction factors for biconical antenna

ITL #1356

Model: EMCO 3110B

Serial No.: 9912-3337

Frequency	AF
[MHz]	[dB/m]
30	13.00
35	10.89
40	10.59
45	10.63
50	10.12
60	9.26
70	7.74
80	6.63
90	8.23
100	11.12
120	13.16
140	13.07
160	14.80
180	16.95
200	17.17



13.5 Correction factors for log periodic antenna

ITL # 1349

Model:EMCO 3146

Serial No.: 9505-4081

Frequency	AF
[MHz]	[dB/m]
200	11.58
250	12.04
300	14.76
400	15.55
500	17.85
600	18.66
700	20.87
800	21.15
900	22.32
1000	24.22



**13.6 Correction factors for
Horn ANTENNA**

Double –Ridged Waveguide

Model: 3115
Serial number:29845
3 meter range; ITL # 1352

FREQUENCY	AFE	FREQUENCY	AFE
(GHz)	(dB/m)	(GHz)	(dB/m)
0.75	25	9.5	38
1.0	23.5	10.0	38.5
1.5	26.0	10.5	38.5
2.0	29.0	11.0	38.5
2.5	27.5	11.5	38.5
3.0	30.0	12.0	38.0
3.5	31.5	12.5	38.5
4.0	32.5	13.0	40.0
4.5	32.5	13.5	41.0
5.0	33.0	14.0	40.0
5.5	35.0	14.5	39.0
6.0	36.5	15.0	38.0
6.5	36.5	15.5	37.5
7.0	37.5	16.0	37.5
7.5	37.5	16.5	39.0
8.0	37.5	17.0	40.0
8.5	38.0	17.5	42.0
9.0	37.5	18.0	42.5



13.7 Correction factors for Horn Antenna Model: SWH-28

CALIBRATION DATA

3 m distance

Frequency, MHz	Measured antenna factor, dB/m ¹⁾
18000	32.4
18500	32.0
19000	32.3
19500	32.4
20000	32.3
20500	32.8
21000	32.8
21500	32.7
22000	33.1
22500	33.0
23000	33.1
23500	33.8
24000	33.5
24500	33.5
25000	33.8
25500	33.9
26000	34.2
26500	34.7

¹⁾ The antenna factor shall be added to receiver reading in dB μ V to obtain field strength in dB μ V/m.