



FCC/IC Test Report

For:
Particle Industries, Inc.

Model:
B404X

Product Description:
LTE CAT-M1 (NorAm) with EtherSIM

FCC ID: 2AEMI-B404X
IC ID: 20127-B404X

Applied Rules and Standards:
47 CFR Parts: 15B, and ICES-003 Issue 7

REPORT #: EMC_PARTI-002-21001_FCC_15B

DATE: 2022-10-21



A2LA Accredited

IC recognized #
3462B-2

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1 Assessment

The following device as further described in section 3 of this report was evaluated against the applicable criteria specified in the Code of Federal Regulations Title 47 parts 15B and ICES-003 Issue 7.

No deficiencies were ascertained.

Company	Description	Model #
Particle Industries, Inc.	LTE CAT-M1 (NorAm) with EtherSIM	B404X

Responsible for Testing Laboratory:

2022-10-21	Compliance	Kevin Wang (EMC Lab Manager)	
Date	Section	Name	Signature

Responsible for the Report:

2022-10-21	Compliance	Cheng Song (EMC Engineer)	
Date	Section	Name	Signature

The test results of this test report relate exclusively to the test item specified in Section 3. CETECOM Inc. USA does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CETECOM Inc. USA.

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the EMC Test Report

Company Name:	CETECOM Inc.
Department:	Compliance
Street Address:	411 Dixon Landing Road
City/Zip Code	Milpitas, CA 95035
Country	USA
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
EMC Lab Manager:	Kevin Wang
Responsible Project Leader:	Phillip Quintal

2.2 Identification of the Client

Client Firm/Name:	Particle Industries, Inc.
Street Address:	325 9th St
City/Zip Code	San Francisco, CA 94103
Country	USA

2.3 Identification of the Manufacturer

Manufacturer's Name:	Same as Client
Manufacturers Address:	
City/Zip Code	
Country	

3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model No	B404X
HW Version	V1.3.0
SW Version	V4.0.0
PMN	B Series
FCC-ID	2AEMI-B404X
IC-ID:	20127-B404X
Product Description	LTE CAT-M1 (NorAm) with EtherSIM
Operating Voltage Range	VCC 3.6V~4.2V Typ 3.6V 3V3 3.3V~3.6V Typ 3.3V VBUS 4.35V~5.5V Typ 5V
Operating Temperature Range	Normal operating temperature: Tmin: -20°C / Tmax: 65°C / Tnom: 25°C Extended operating temperature: Tmin: -40°C / Tmax: 85°C
Radios included in the device	<p>Cellular:</p> <ul style="list-style-type: none"> • u-blox SARA-R510S • FCC ID: XPYUBX19KM01; IC ID: 8595A-UBX19KM01 <p>Bluetooth:</p> <ul style="list-style-type: none"> • Nordic Semiconductor nRF52840 SoC • Bluetooth 5 LE
Antenna Information:	<p>Cellular:</p> <ul style="list-style-type: none"> • G142-10006-A antenna • Wide band FPC antenna: 3.86dBi max gain <p>Bluetooth:</p> <ul style="list-style-type: none"> • PCB antenna: 2dBi max gain
Sample Revision	<input type="checkbox"/> Prototype <input type="checkbox"/> Production <input checked="" type="checkbox"/> Pre-Production
EUT Diameter	<input checked="" type="checkbox"/> < 60 cm <input type="checkbox"/> Other _____

3.2 EUT Sample details

EUT #	Model Number	HW Version	SW Version	Comments
1	B404X	V1.3.0	V4.0.0	

3.3 Test Sample Configuration

Set-up #	EUT / AE used for set-up	Comments
1	EUT#1	Idle

4 **Subject of Investigation**

The objective of the measurements done by CETECOM Inc. was to evaluate the compliance of the EUT against the relevant requirements specified in the Code of Federal Regulations Title 47 parts 15B and ICES-003 Issue 7.

4.1 **Date of Testing:**

08/11/2022 – 08/12/2022

4.2 **Measurement Uncertainty**

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus, with 95% confidence interval (in dB delta to result), based on a coverage factor k=1.

Measurement System	EMC 1	EMC 2
Conducted emissions (mains port)	1.12 dB	0.46 dB
Radiated emissions (< 30 MHz)	3.66 dB	3.88 dB
(30 MHz – 1GHz)	3.17 dB	3.34 dB
(1 GHz – 3 GHz)	5.01 dB	4.45 dB
(>3 GHz)	4.0 dB	4.79 dB

4.3 **Environmental Conditions during Testing:**

The following environmental conditions were maintained during the course of testing:

- Ambient Temperature: 20-25°C
- Relative humidity: 40-60%

Deviating test conditions are indicated at individual test description where applicable.

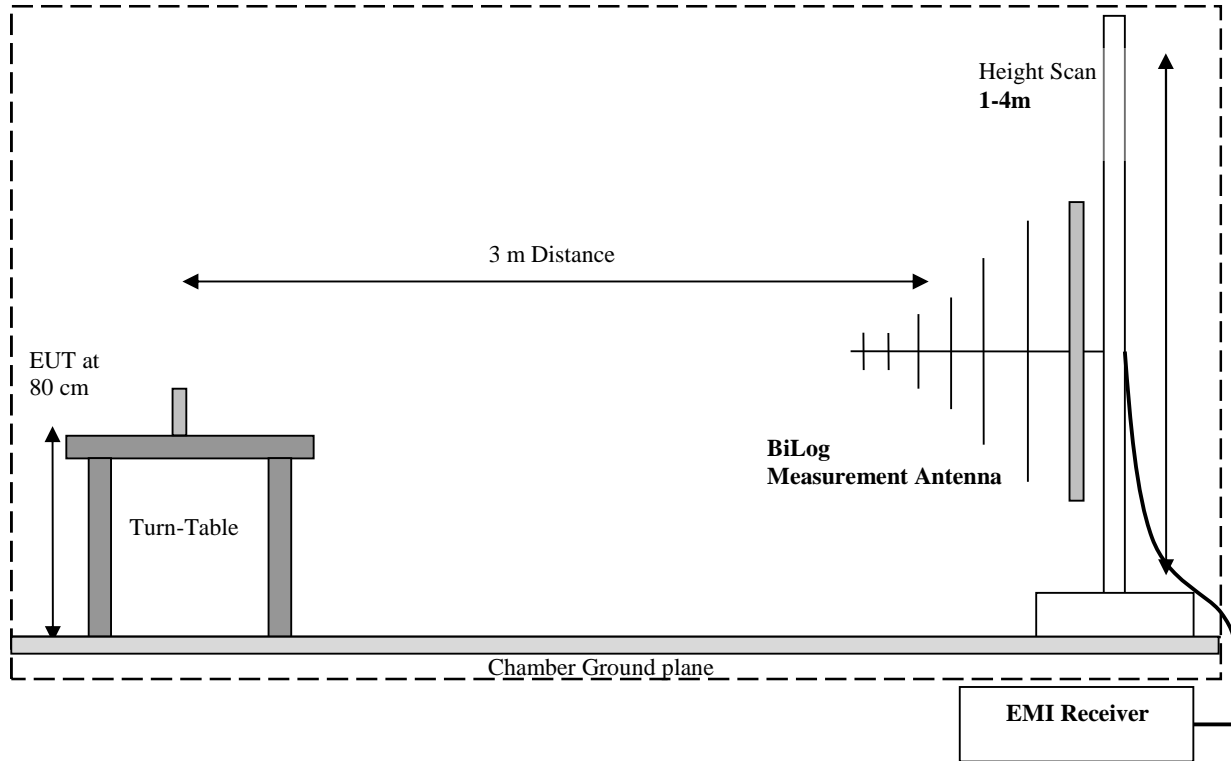
5 Measurement Procedures

Testing is performed according to the guidelines provided in ANSI C63.4-2014 American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

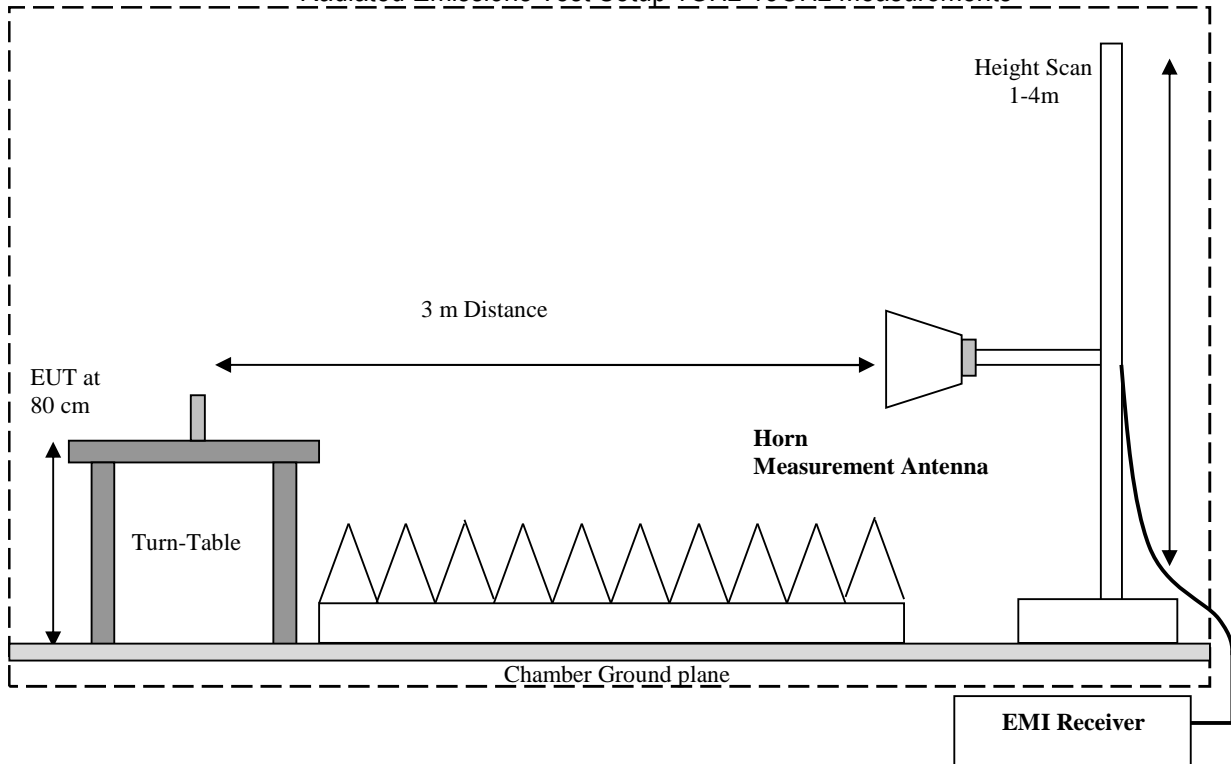
5.1 **Radiated Measurement for EUT with diameter less than 60 cm**

- The exploratory measurement is accomplished by running a matrix of 16 sweeps over the required frequency range with R&S Test-SW EMC32 for 4 positions of the turntable, two orthogonal positions of the EUT and both antenna polarizations. This procedure exceeds the requirement of the above standards to cover the 3 orthogonal axis of the EUT. A max peak detector is utilized during the exploratory measurement. The Test-SW creates an overall maximum trace for all 12 sweeps and saves the settings for each point of this trace. The maximum trace is part of the test report.
- The 10 highest emissions are selected with an automatic algorithm of EMC32 searching for peaks in the noise floor and ensuring that broadband signals are not selected multiple times.
- The maxima are then put through the final measurement and again maximized in a 90deg range of the turntable, fine search in frequency domain and height scan between 1m and 4m.
- The above procedure is repeated for all possible ways of power supply to EUT and for all supported modulations.
- In case there are no emissions above noise floor level only the maximum trace is reported as described above.
- The results are split up into up to 4 frequency ranges due to antenna bandwidth restrictions. A magnetic loop is used from 9 kHz to 30 MHz, a Biconilog antenna is used from 30 MHz to 1 GHz, and two different horn antennas are used to cover frequencies up to 40 GHz.

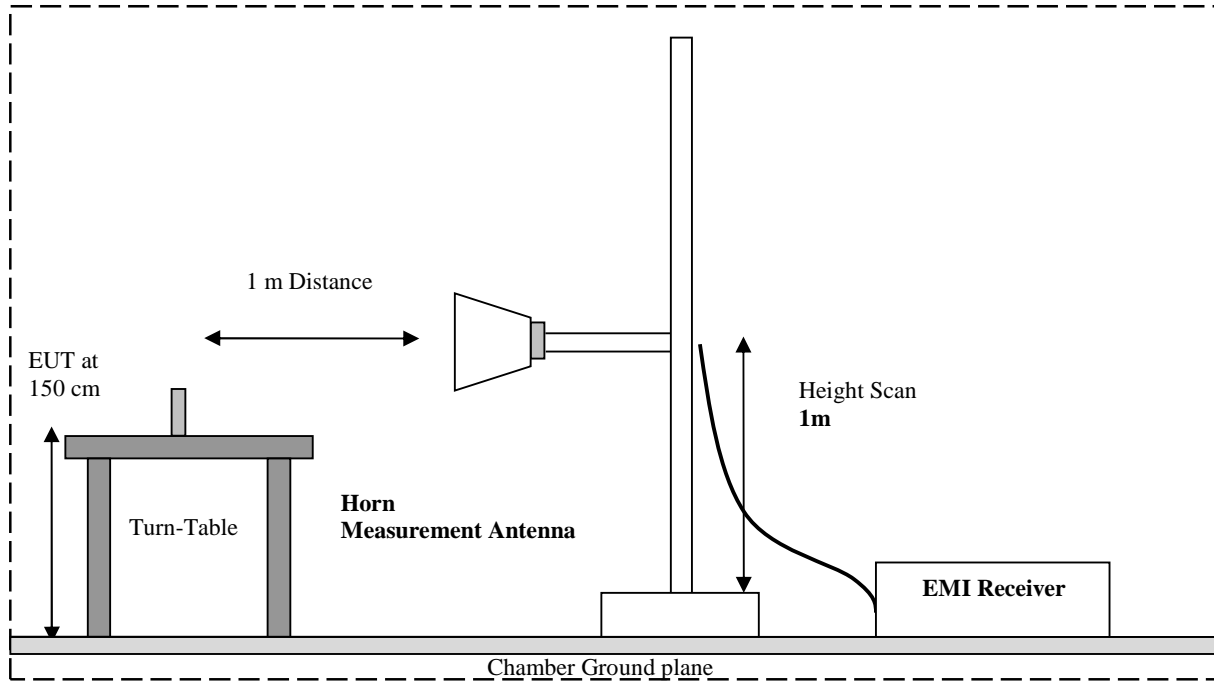
Radiated Emissions Test Setup 30MHz-1GHz Measurements



Radiated Emissions Test Setup 1GHz-18GHz Measurements



Radiated Emissions Test Setup 18GHz-40GHz Measurements



5.2 Sample Calculations for Field Strength Measurements

Field Strength is calculated from the Spectrum Analyzer/ Receiver readings, taking into account the following parameters:

- Measured reading in dB μ V
- Cable Loss between the receiving antenna and SA in dB and
- Antenna Factor in dB/m

All radiated measurement plots in this report are taken from a test SW that calculates the Field Strength based on the following equation:

$$FS \text{ (dB}\mu\text{V/m)} = \text{Measured Value on SA (dB}\mu\text{V)} + \text{Cable Loss (dB)} + \text{Antenna Factor (dB/m)}$$

Example:

Frequency (MHz)	Measured SA (dB μ V)	Cable Loss (dB)	Antenna Factor Correction (dB)	Field Strength Result (dB μ V/m)
1000	80.5	3.5	14	98.0

6 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	Fail	NA	NP	Result
FCC §15.109 ICES-003, §6.2	Radiated Emissions	Nominal	RX Mode	■	□	□	□	Complies
FCC §15.107 ICES-003, §6.1	Conducted Emissions	Nominal	RX Mode	□	□	■	□	Note 2

Note 1: NA= Not Applicable; NP= Not Performed.

Note 2: EUT powered by battery.

7 Test Result Data

7.1 Radiated Emissions Measurement according to CFR 47 Part 15.109 and ICES-003 6.2

Spectrum Analyzer settings		
Sweep Frequency Range	30 MHz – 1 GHz	1 GHz – 40 GHz
Resolution Bandwidth	120 kHz	1 MHz
Detector (Exploratory Measurements)	Peak	Peak, Average
Detector (Final Measurements)	Quasi-Peak	Peak, Average
Trace Mode	Max Hold	Max Hold
Step Size	40 kHz	800 kHz
Measurement Time (Exploratory Measurements)	2 ms	2 ms
Measurement Time (Final Measurements)	100 ms	100 ms

7.1.1 Limits:

Class A Limits		
Frequency of emission (MHz)	Field Strength @ 10 m ($\mu\text{V/m}$)	Field Strength @ 3 m ($\text{dB}\mu\text{V/m}$)
30-88	90	49.5
88-216	150	54
216-960	210	56.9
Above 960	300	60

Class B Limits		
Frequency of emission (MHz)	Field Strength @ 3 m ($\mu\text{V/m}$)	Field Strength @ 3 m ($\text{dB}\mu\text{V/m}$)
30-88	100	40
88-216	150	43.5
216-960	200	46
Above 960	500	54

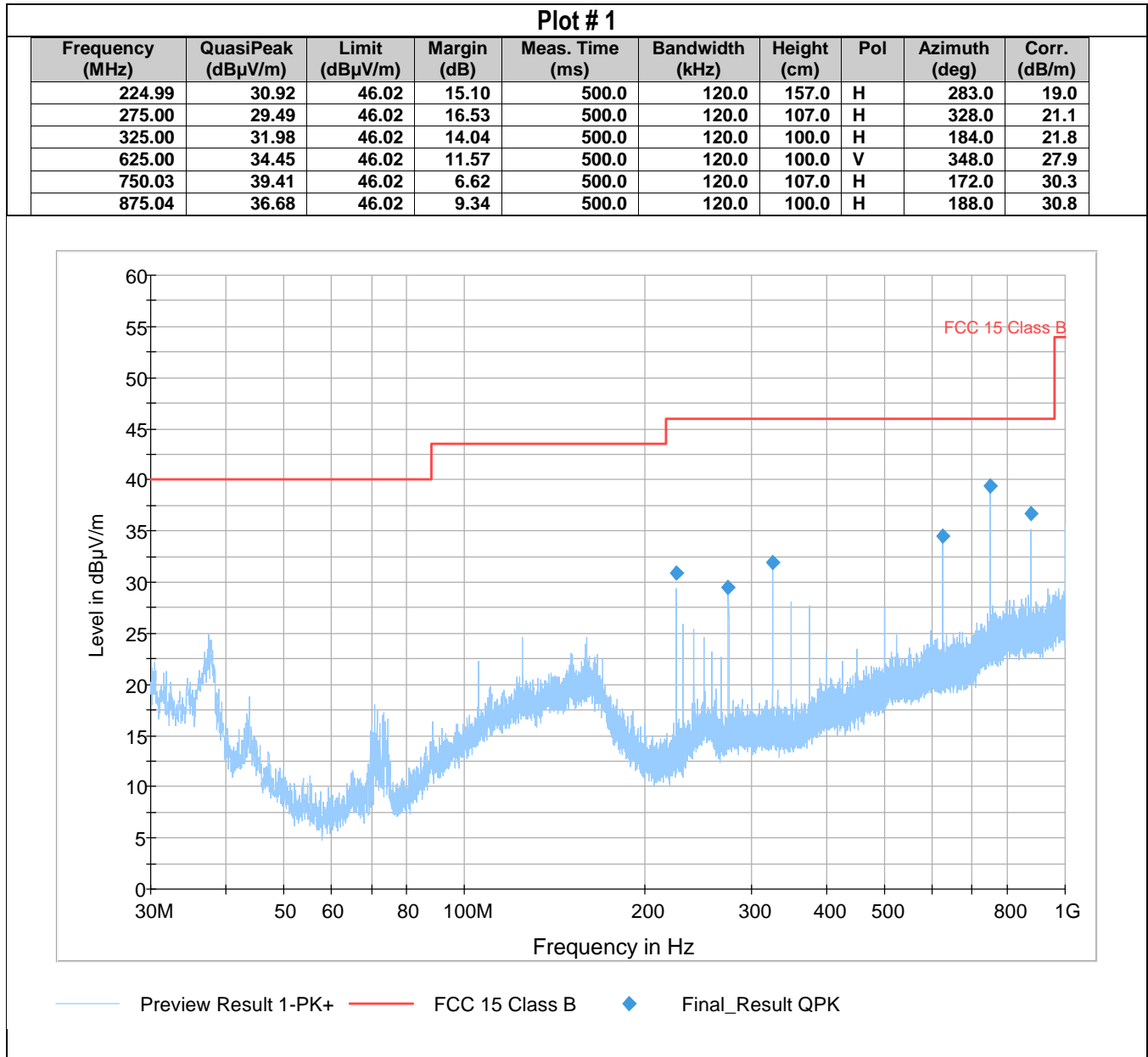
Note: For measurements below 1 GHz, the limits above use a quasi-peak detector. For measurements above 1 GHz, the limits above use an average detector.

7.1.2 Test Summary:

Environmental Conditions	
Ambient Temperature:	24.6°C
Relative Humidity:	45.1%
Atmospheric Pressure:	1010 mbar

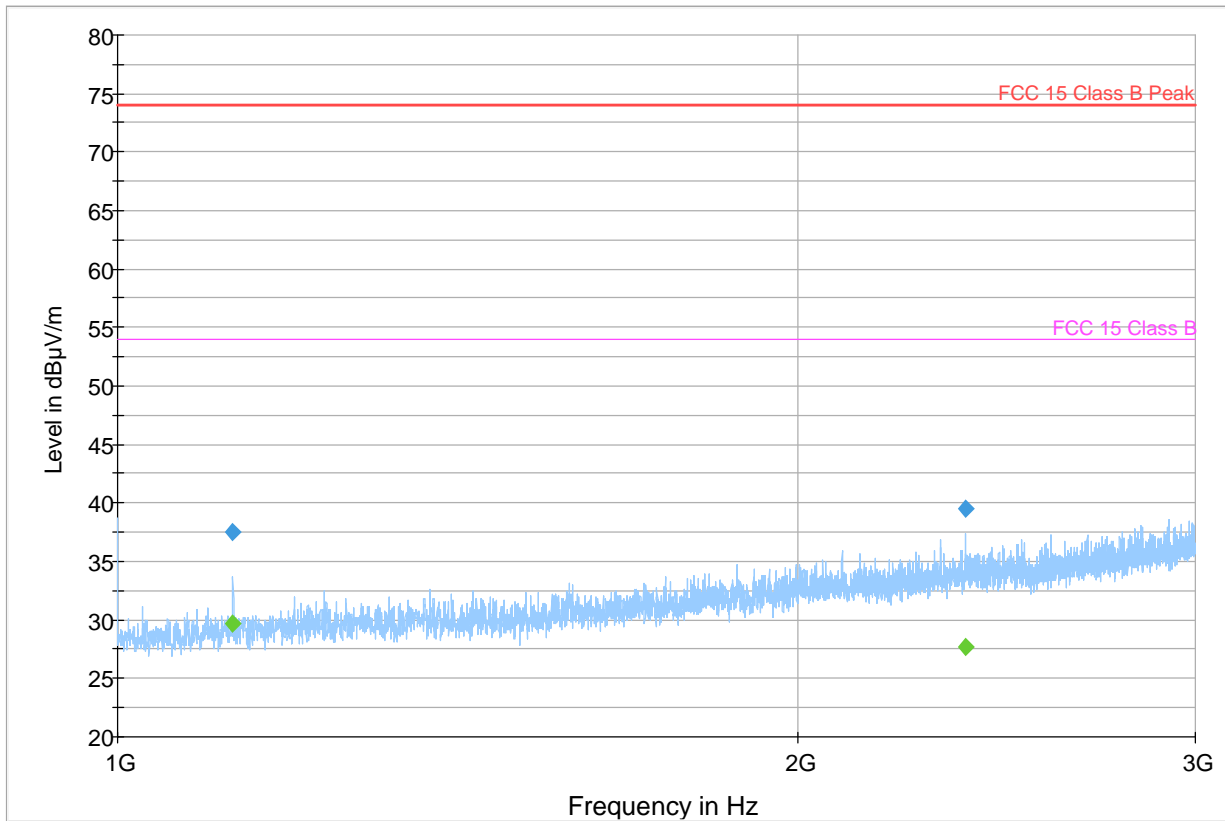
Test Results						
Plot #	EUT Set-Up #	EUT operating mode	Scan Frequency	Power Supply Input	Comments	Result
1 - 3	1	RX Mode	30 MHz – 18 GHz	Battery	Final measurement	Pass

7.1.3 Measurement Plots:



Plot # 2

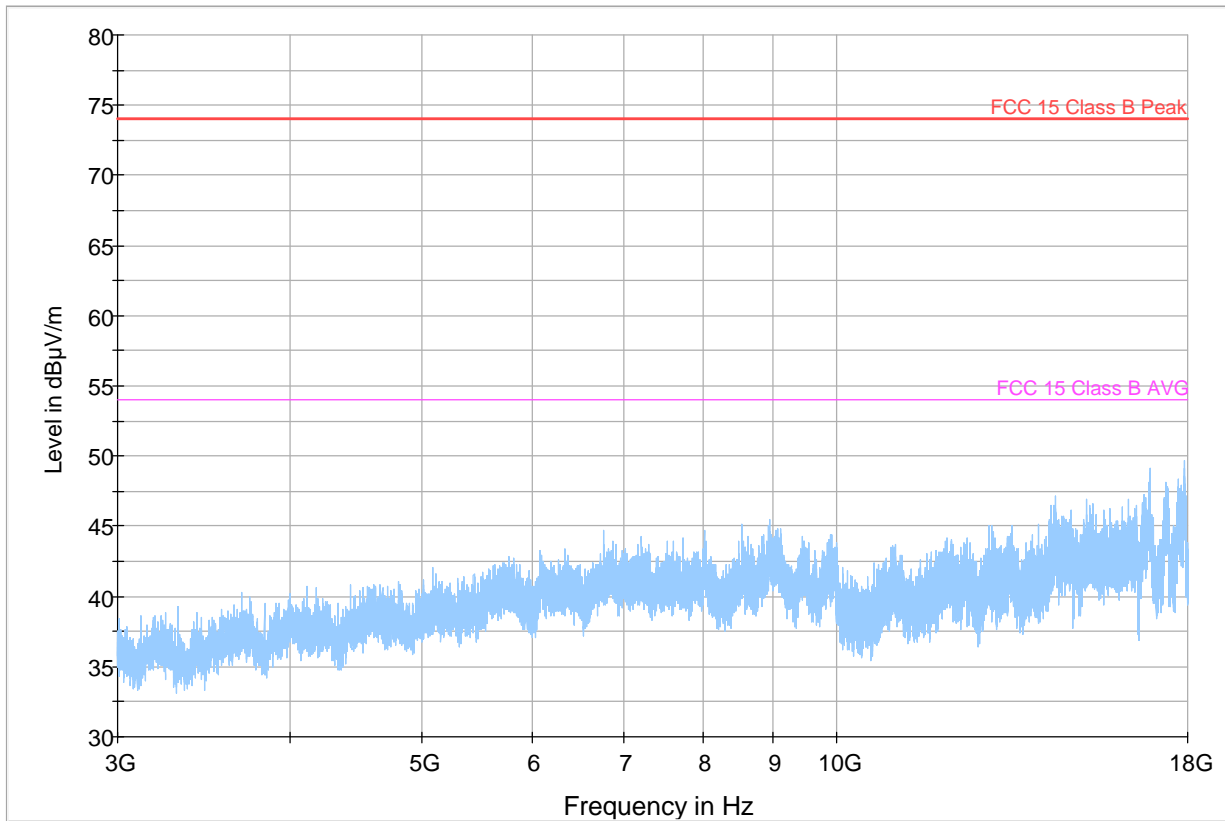
Frequency (MHz)	MaxPeak (dBμV/m)	RMS (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1124.75	37.54	---	73.98	36.44	500.0	1000.0	132.0	H	293.0	-6.5
1124.75	---	29.74	53.98	24.24	500.0	1000.0	132.0	H	293.0	-6.5
2374.75	39.54	---	73.98	34.44	500.0	1000.0	159.0	H	-42.0	-1.8
2374.75	---	27.75	53.98	26.23	500.0	1000.0	159.0	H	-42.0	-1.8



- ◆ Preview Result 1-PK+
 - ◆ FCC 15 Class B Peak
 - ◆ FCC 15 Class B
 -
- ◆ Final_Result PK+
 - ◆ Final_Result RMS
 -
 -

Plot # 3

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
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- Preview Result 1-PK+ * Critical_Freqs PK+
- FCC 15 Class B AVG ◆ Final_Result PK+
- FCC 15 Class B Peak ◆ Final_Result RMS

8 Test setup photos

Setup photos are included in supporting file name: "EMC_PARTI-002-21001_FCC_Setup_Photos"

9 Test Equipment And Ancillaries Used For Testing

Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
BILOG ANTENNA	ETS.LINDGREN	3142E	00166067	2 YEARS	10/21/2021
HORN ANTENNA	EMCO	3115	00035111	2 YEARS	09/30/2021
HORN ANTENNA	ETS.LINDGREN	3117	00215984	2 YEARS	01/31/2021
TEST RECEIVER	R&S	ESU40	100251	2 YEARS	09/13/2021
DIGITAL THRMOMETER	CONTROL COMPANY	36934-164	181230565	3 YEARS	10/20/2021

Note: Equipment used meets the measurement uncertainty requirements as required per applicable standards for 95% confidence levels. Calibration due dates, unless defined specifically, falls on the last day of the month. Items indicated "N/A" for cal status either do not specifically require calibration or is internally characterized before use.

10 Revision History

Date	Report Name	Changes to report	Prepared by
2022-10-21	EMC_PARTI-002-21001_FCC_15B	Initial Version	Cheng Song

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