FCC / ISED Test Report

FOR:
Motive Technologies, Inc.

Model Name:
LBB-3.6CA-b

Product Description:
LBB-3.6CA-b is a Vehicle Gateway. Its purpose is to act as the primary gateway between various pieces of hardware and software in a motor vehicle and the Motive Technologies database back-end in the cloud.

FCC ID: 2AQM7-36B
IC: 24516-36B

Applied Rules and Standards:
47 CFR Part 15.247 (DSS)
RSS-247 Issue 2 (FHSs) & RSS-Gen Issue 5

REPORT #: EMC_KPTRK-036-23001_15_247_BT_C2PC

DATE: 01-27-2023

A2LA Accredited

IC recognized #
3462B-2
CABID: US0187

CETECOM **Inc.**
411 Dixon Landing Road ◆ Milpitas, CA 95035 ◆ U.S.A.
Phone: + 1 (408) 586 6200 ◆ Fax: + 1 (408) 586 6299 ◆ E-mail: info@cetecom.com ◆ http://www.cetecom.com
CETECOM Inc. is a Delaware Corporation with Corporation number: 2905571

TABLE OF CONTENTS

1 Assessment

The following device was evaluated against the applicable criteria specified in FCC rules Parts 15.247 of Title 47 of the Code of Federal Regulations and the relevant ISED Canada standard RSS-247.

No deviations were ascertained.

Company	Description	Model #
Motive Technologies, Inc.	LBB-3.6CA-b is a Vehicle Gateway. Its purpose is to act as the primary gateway between various pieces of hardware and software in a motor vehicle and the Motive Technologies database back-end in the cloud.	LBB-3.6CA-b

Responsible for Testing Laboratory:

Date	Section	Name	Signature
01-27-2023	Compliance	Arndt Stoecker (Director of Regulatory Services)	Arndt Stoecker Digitally signed by: Arndt Stoecker DN: CN = Arndt Stoecker email = arndt.stoecker@cetecom.com C = US O = CETECOM Inc Date: 2023.03.01 17:53:11 -08'00'

Responsible for the Report:

Date	Section	Name	Signature
01-27-2023	Compliance	Kris Lazarov (Test Engineer)	Kris Lazarov Digitally signed by Kris Lazarov Date: 2023.03.01 17:18:47 -08'00'

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
Director of Regulatory Services:	Arndt Stoecker
Responsible Project Leader:	Akanksha Baskaran

2.2 Identification of the Client

Client's Name:	Motive Technologies, Inc.
Street Address:	55 Hawthorne Street #400
City/Zip Code	San Francisco, California 94105
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:	LBB-3.6CA-b
HW Version :	3
SW Version :	75012
FCC-ID :	2AQM7-36B
IC:	24516-36B
FWIN:	N/A
HVIN:	LBB-3.6CA-b
PMN:	Vehicle Gateway
Product Description:	LBB-3.6CA-b is a Vehicle Gateway. Its purpose is to act as the primary gateway between various pieces of hardware and software in a motor vehicle and the Motive Technologies database back-end in the cloud.
Frequency Range / number of channels:	Nominal band: 2400 MHz – 2483.5 MHz Center to center: 2402 MHz (ch 0) – 2480 MHz (ch 78), 79 Channels
Radio Information:	Bluetooth: Manufacture: Laird Connectivity Module name/number: LSR 450-0159R FCC ID: TFB-1003 IC: 5969A-1003 Type(s) of Modulation: BDR/EDR: GFSK, π /4 DQPSK, 8DPSK
Modes of Operation:	Hopping
Antenna Information as declared:	Antenna Type for Wi-Fi / BT Model Name : LTE Diversity with GPS & Wi-Fi Antenna Part No : WA-C2-LTAE12LBG1-12-001 Type & Gain: Inverted F Antenna (IFA), 2.59 dBi
Max. declared output Powers:	Conducted Power 8.9 dBm
Power Supply/ Rated Operating Voltage Range:	Vmin: 6 VDC/ Vnom: 12 VDC / Vmax: 32 VDC
Operating Temperature Range	Low -20ºC, Nominal 20ºC, High 85ºC
Other Radios included in the device:	❖ WLAN • Manufacture: Laird Connectivity • Module name/number: LSR 450-0159R • FCC ID: TFB-1003 • IC: 5969A-1003 ❖ UMTS, LTE • Manufacture: Sierra Wireless • Module name/number: RC7612 • FCC ID: N7NRC76C • IC: 2417C-RC76C
Sample Revision	☐Prototype Unit; ☐Production Unit; ■Pre-Production
EUT Dimensions(mm)	110 X 105 X 25

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	AABL36RC400018	3	75012	Radiated Emissions

3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
1	Vehicle Cable	-	-	-

3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1 + AE#1	A Linux tool for manipulating the BlueZ BT stack called HCItool used to configure the Bluetooth radio to low, mid and high channels provided by the client that will not be available to the end user. For radiated measurements, the internal antenna was connected.

3.5 Justification for Worst Case Mode of Operation

During the testing process, the EUT was tested with transmitter sets on mid channel. For radiated measurements, all data in this report shows the worst case between horizontal and vertical antenna polarizations and for all orientations of the EUT.

List of Changes:
1. Change U3007 from SLG4A45639VTR to SLG4A45207VTR to support U22 buck IC change below
2. Change U22 from MP5416-0010 to TPS65216DORSLR
3. Add R5020 (0402 0 ohm resistor) for GPS RF tuning
4. Add C5039 footprint (reserve placeholder) for GPS RF tuning
5. Add C5038 footprint (reserve placeholder) for GPS RF tuning

4 Subject of Investigation

The objective of the measurements done by CETECOM Inc. was to assess the performance of the EUT according to the relevant requirements specified in FCC rules Part 15.247 of Title 47 of the Code of Federal Regulations and Radio Standard Specification RSS-247 Issue 2 of ISED Canada.

This test report is to support a request for C2PC under the FCC ID: 2AQM7-36B, and IC: 24516-36B

Testing procedures are based on ANSI C63.10:2013.

5 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	NA	NP	Result
§15.247(b)(1) RSS-247 5.4(b)	Maximum Peak Conducted Output Power	Nominal	GFSK MID CH	■	☐	☐	Note 1 Note 2 Note 4
§15.247(d) RSS-247 5.5 RSS-Gen 8.10	Band Edge Compliance	Nominal	N/A	☐	☐	■	Note 1 Note 2
§15.247(a)(1) RSS-247 5.1(b)	Spectrum Bandwidth	Nominal	N/A	☐	☐	■	Note 1 Note 2
§15.247(a)(1) RSS-247 5.1(b)	Carrier Frequency Separation	Nominal	N/A	☐	☐	■	Note 1 Note 2
§15.247(a)(1) RSS-247 5.1(d)	Number of Hopping Channels	Nominal	N/A	☐	☐	■	Note 1 Note 2
§15.247(a)(1)(iii) RSS-247 5.1(d)	Time of occupancy	Nominal	N/A	☐	☐	■	Note 1 Note 2
§15.247(d) §15.209 (a) RSS-Gen 6.13	TX Spurious emissions-Radiated	Nominal	GFSK MID CH	■	☐	☐	Complies
§15.207(a) RSS-Gen 8.8	AC Conducted Emissions	Nominal	N/A	☐	■	☐	Note 3

Note 1: NA= Not Applicable; NP= Not Performed.
Note2: The conducted measurements are leveraged from module certification FCC ID: TFB-1003 for compliance against the applicable rules and documented in report# .316050 FHSS from LSR LLC dated 4/20/2016
Note 3: DUT does not connect to AC power mains lines.
Note 4: Limited power verification measurement was conducted before RSE testing

6 Measurements

6.1 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=2.

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

6.2 Environmental Conditions During Testing:

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

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

6.3 Dates of Testing:

01/16/2023 – 01/20/2023

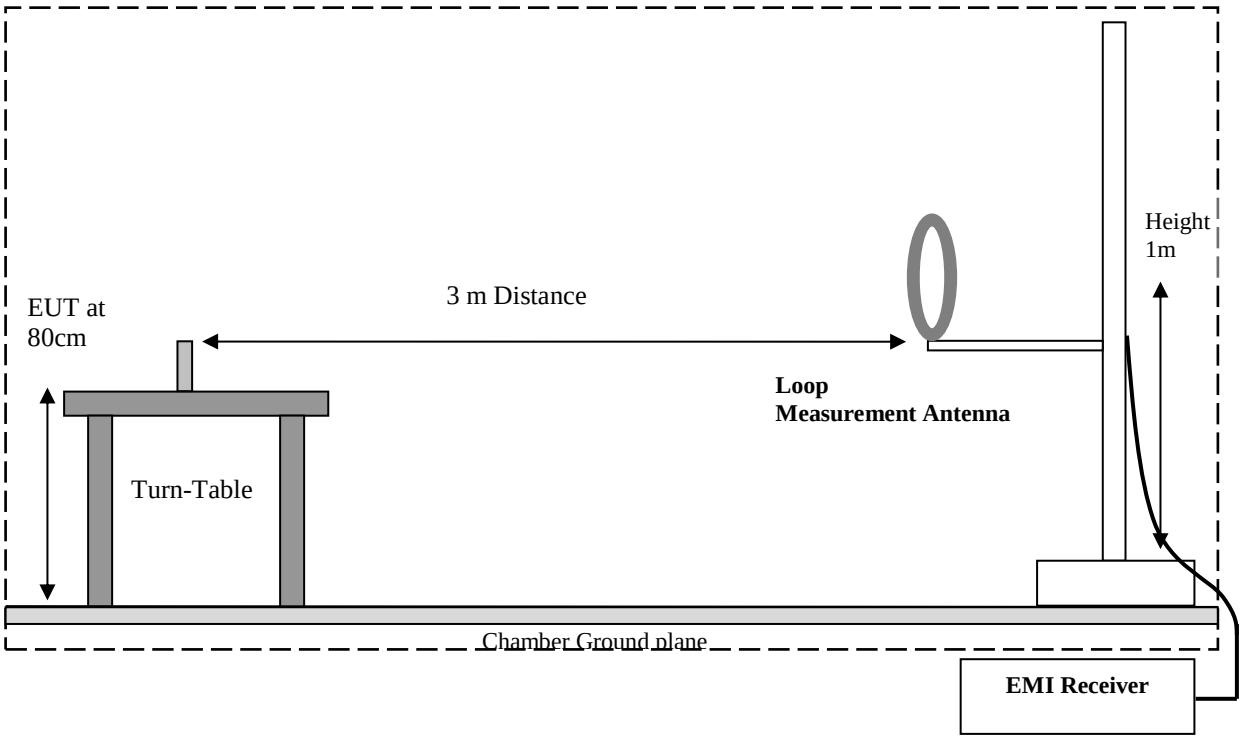
7 Measurement Procedures

7.1 Radiated Measurement

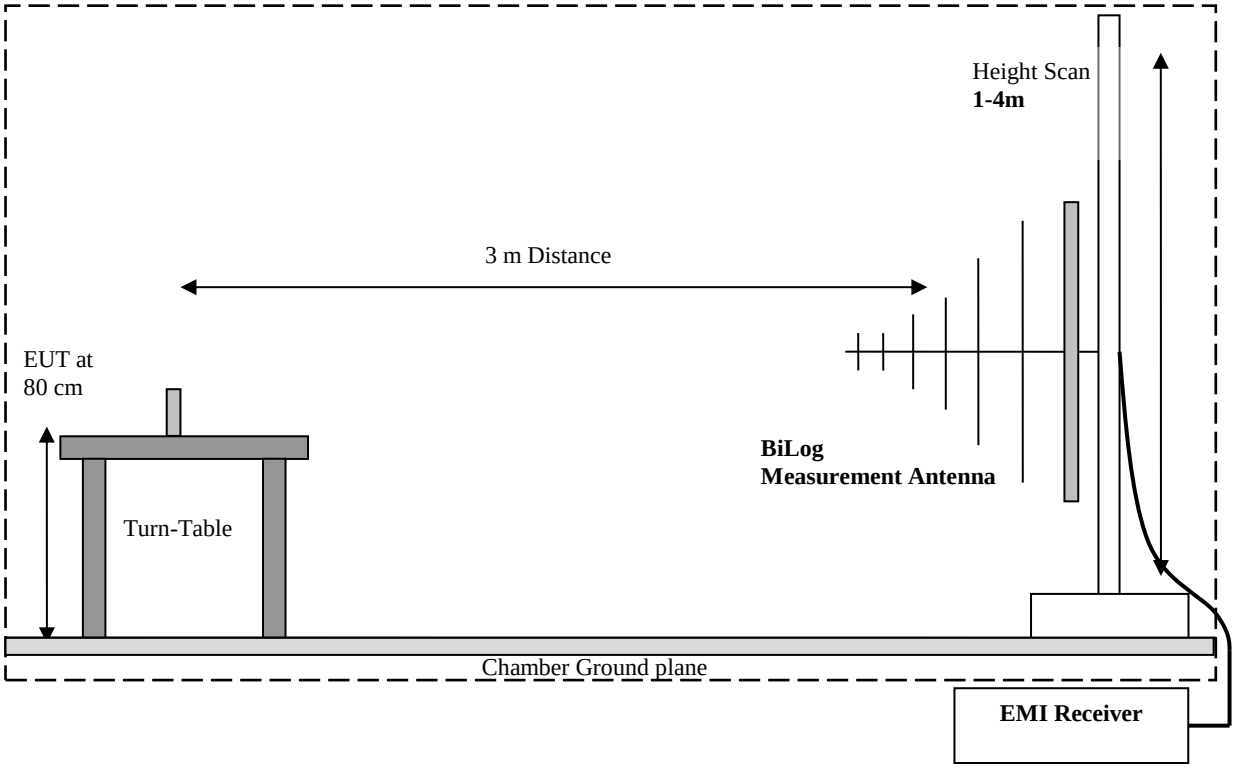
The radiated measurement is performed according to: ANSI C63.10 (2013)

- 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.

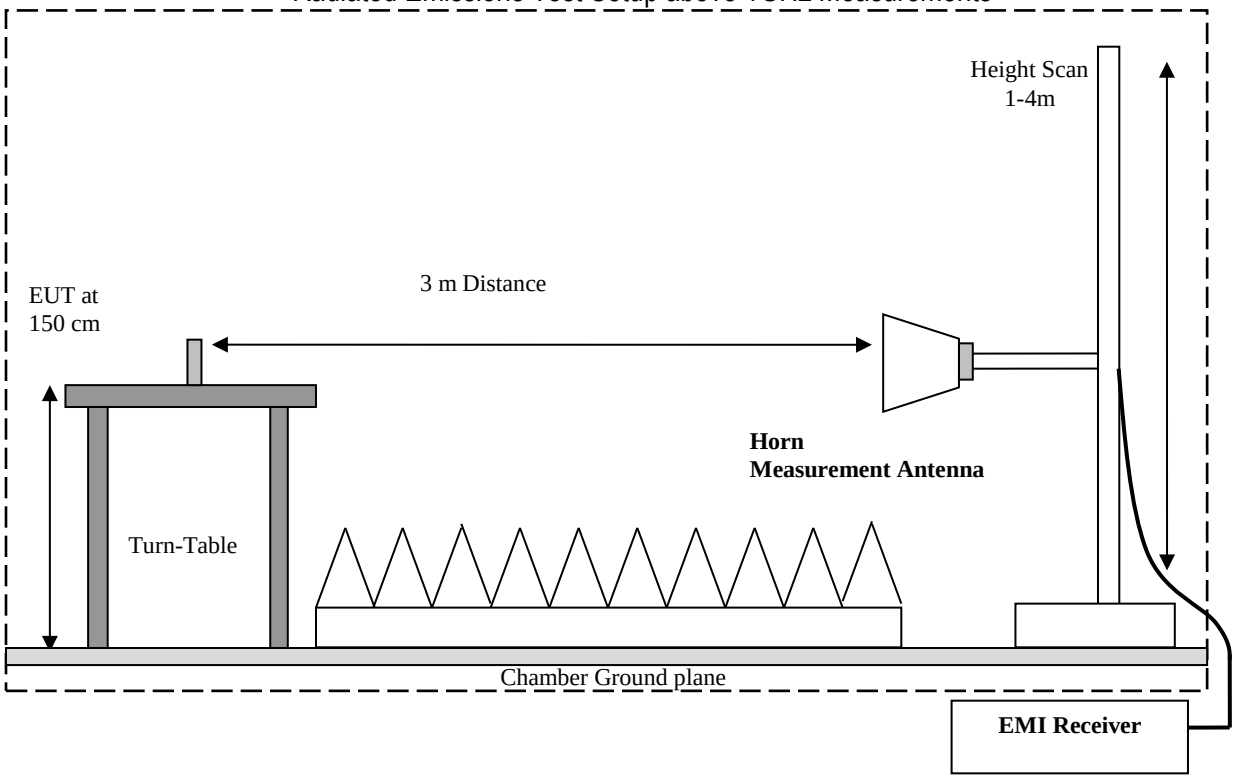
Radiated Emissions Test Setup below 30MHz Measurements



Radiated Emissions Test Setup 30MHz-1GHz Measurements



Radiated Emissions Test Setup above 1GHz Measurements



7.1.1 Sample Calculations for Field Strength Measurements

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

1. Measured reading in dBµV
2. Cable Loss between the receiving antenna and SA in dB and
3. 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 (dBµV/m) = Measured Value on SA (dBµV) + Cable Loss (dB) + Antenna Factor (dB/m)

Example:

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

8 Test Result

8.1 Output Power Verification Measurement according to ANSI C63.10-2020

Spectrum Analyzer settings:

- RBW ≥ DTS bandwidth.
- VBW ≥ 3 x RBW
- Span ≥ [3 × RBW]
- Sweep = Auto couple
- Detector function = Peak
- Trace = Max-hold
- Use peak marker function to determine the peak amplitude level.

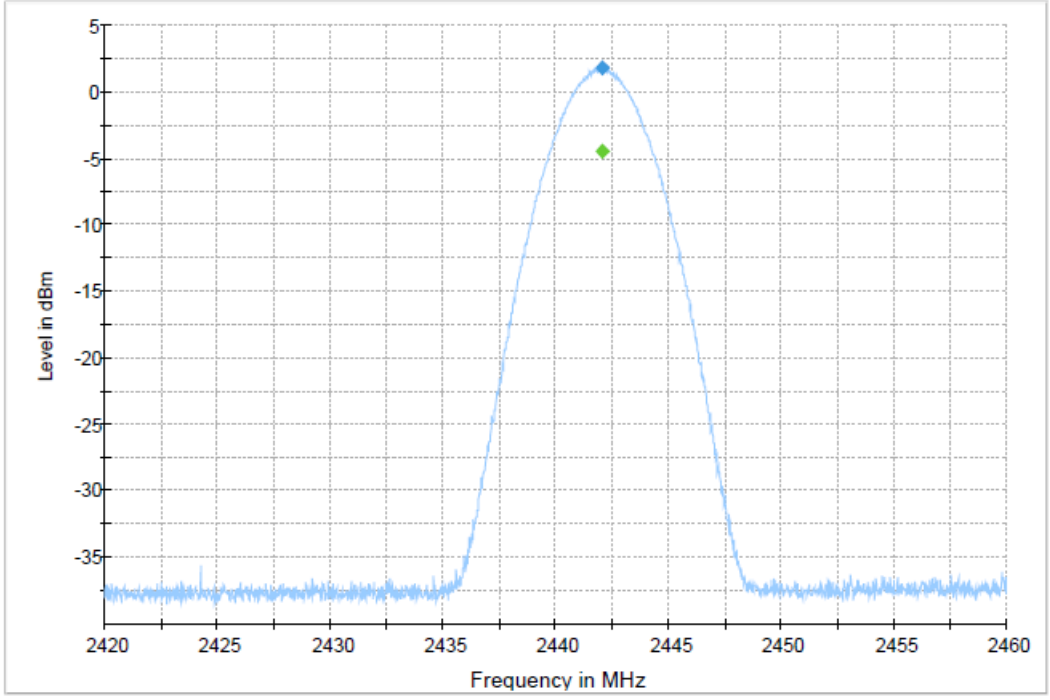
8.1.1 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23°C	1	BT DH5_MID CH	12 VDC

8.1.2 Measurement result:

Mid channel / 2440 MHz | **Mode of Operation:** BT DH5

Frequency (MHz)	MaxPeak (dBm)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
2442.08	---	-4.43	---	---	500.0	3000.0	202.0	V	57.0	-62.2
2442.08	1.85	---	---	---	500.0	3000.0	202.0	V	57.0	-62.2



8.2 Transmitter Spurious Emissions and Restricted Bands

8.2.1 Measurement according to ANSI C63.10-2020

Analyzer Settings:

- Frequency = 9 KHz – 30 MHz
- RBW = 9 KHz
- Detector = Peak

- Frequency = 30 MHz – 1 GHz
- Detector = Peak / Quasi-Peak
- RBW = 120 KHz (<1 GHz)

- Frequency > 1 GHz
- Detector = Peak / Average
- RBW = 1MHz

- Radiated spurious emissions shall be measured for the transmit frequencies, transmit power, and data rate for the lowest, middle and highest channel in each frequency band of operation and for the highest gain antenna for each antenna type, and using the appropriate parameters and test requirements.
- The highest (or worst-case) data rate shall be recorded for each measurement.
- For testing frequencies below 30 MHz at distance other than the specified in the standard, the limit conversion is calculated by using the FCC materials for the ANSI 63 committee issued on January, 27 1991.

8.2.2 Limits:

FCC §15.247

- 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, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, 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)).

FCC §15.209 & RSS-Gen 8.9

- Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency of emission (MHz)	Field strength (µV/m)	Measurement Distance (m)	Field strength @ 3m (dBµV/m)
0.009–0.490	2400/F(kHz) / ---------	300	-
0.490–1.705	24000/F(kHz) / --------	30	-
1.705–30.0	30 / (29.5)	30	-
30–88	100	3	40 dBµV/m
88–216	150	3	43.5 dBµV/m
216–960	200	3	46 dBµV/m
Above 960	500	3	54 dBµV/m

FCC §15.205 & RSS-Gen 8.10

- Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

- 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)).
  *PEAK LIMIT= 74 dBµV/m
  *AVG. LIMIT= 54 dBµV/m

8.2.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	GFSK fixed channel	12 VDC

8.2.4 Measurement result:

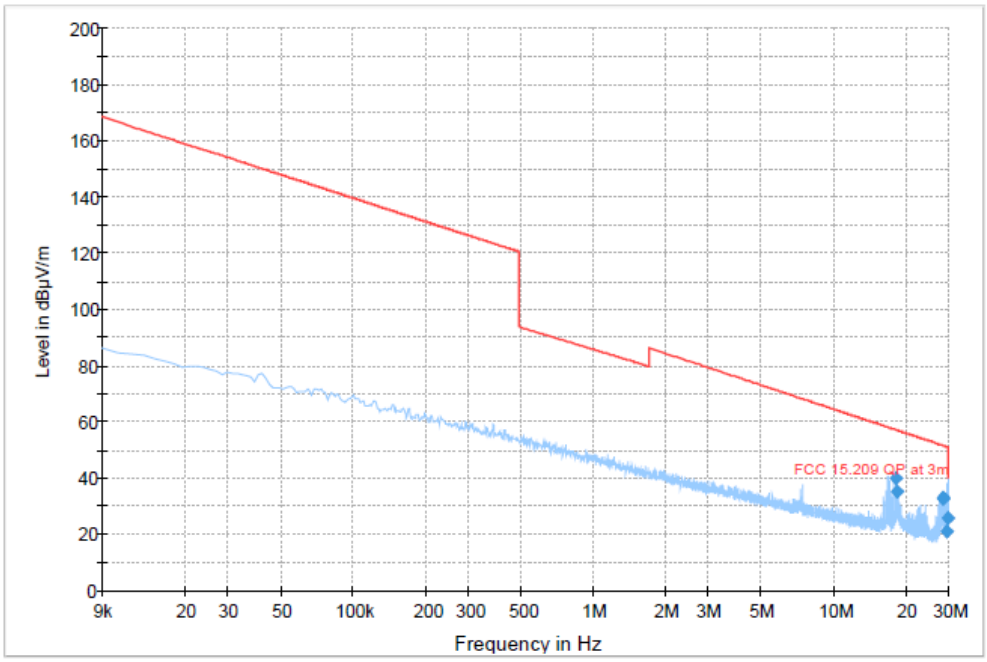
Plot #	Channel #	Scan Frequency	Limit	Result
1-5	Mid	9 kHz – 26 GHz	See section 8.2.2	Pass

8.2.5 Measurement Plots:

Plot # 1 Radiated Emissions: 9 KHz – 30 MHz

Modulation: GFSK | **Channel: Mid**

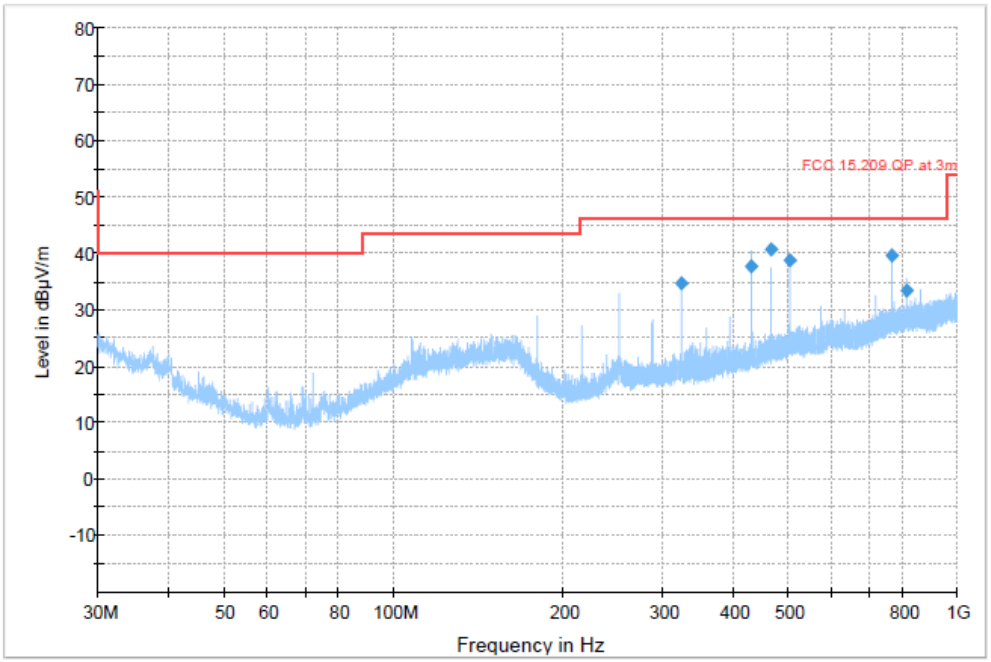
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18.25	39.70	57.16	17.46	500.0	9.0	100.0	V	233.0	16.6
18.37	35.31	57.08	21.77	500.0	9.0	100.0	V	126.0	16.6
28.48	32.46	51.68	19.22	500.0	9.0	100.0	V	28.0	15.9
28.69	32.90	51.59	18.69	500.0	9.0	100.0	H	150.0	15.9
29.69	20.98	51.17	30.19	500.0	9.0	100.0	H	175.0	15.9
30.00	25.89	40.00	14.11	500.0	9.0	100.0	H	245.0	15.9



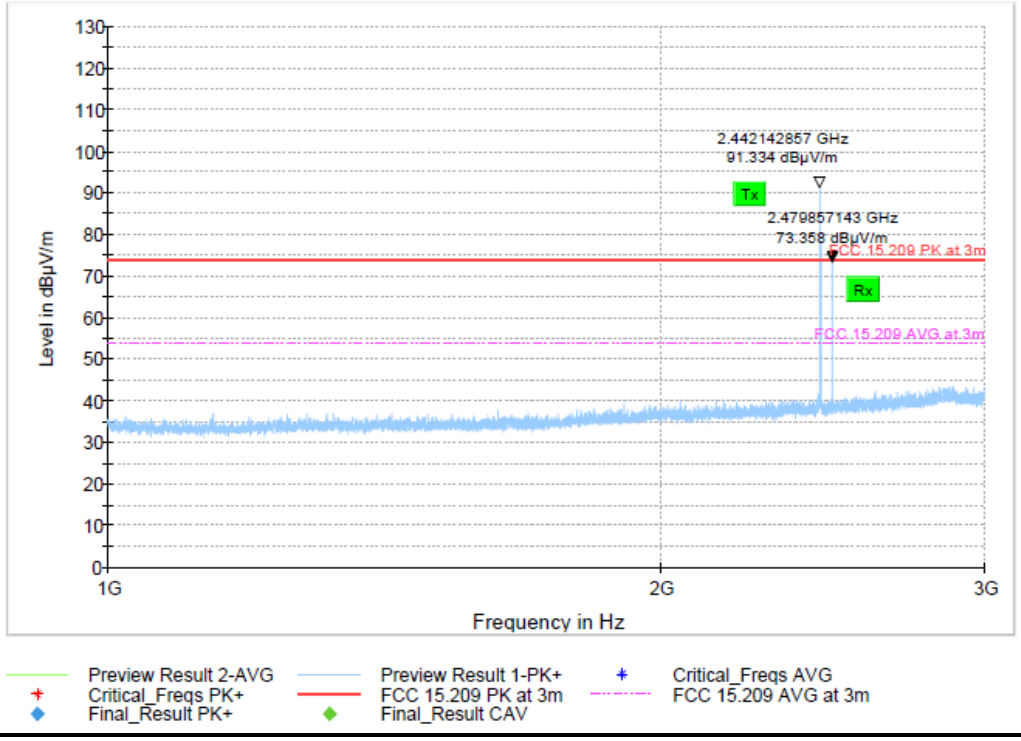
Plot # 2 Radiated Emissions: 30 MHz – 1GHz

Modulation: GFSK | **Channel: Mid**

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
324.76	34.77	46.02	11.25	500.0	120.0	100.0	H	253.0	21.8
432.96	37.63	46.02	8.39	500.0	120.0	107.0	V	194.0	24.1
469.14	40.82	46.02	5.20	500.0	120.0	275.0	H	207.0	25.4
505.25	38.81	46.02	7.21	500.0	120.0	100.0	V	129.0	26.0
767.98	39.69	46.02	6.33	500.0	120.0	100.0	H	99.0	30.4
816.02	33.41	46.02	12.61	500.0	120.0	116.0	H	123.0	31.1



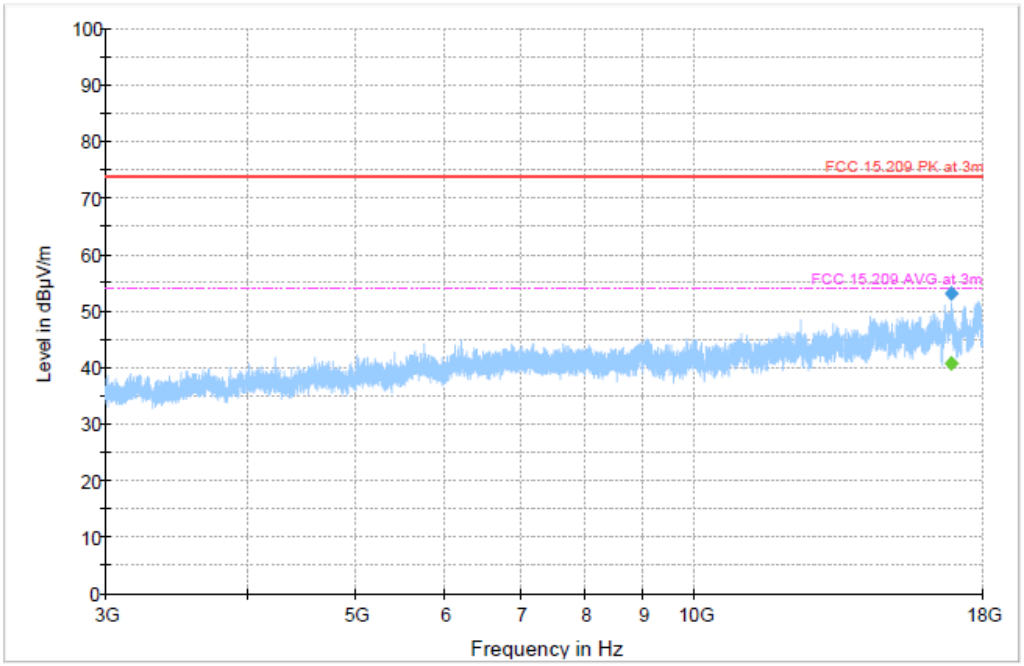
Plot # 3 Radiated Emissions: 1-3 GHz		
Modulation: GFSK	**Channel: Mid**	



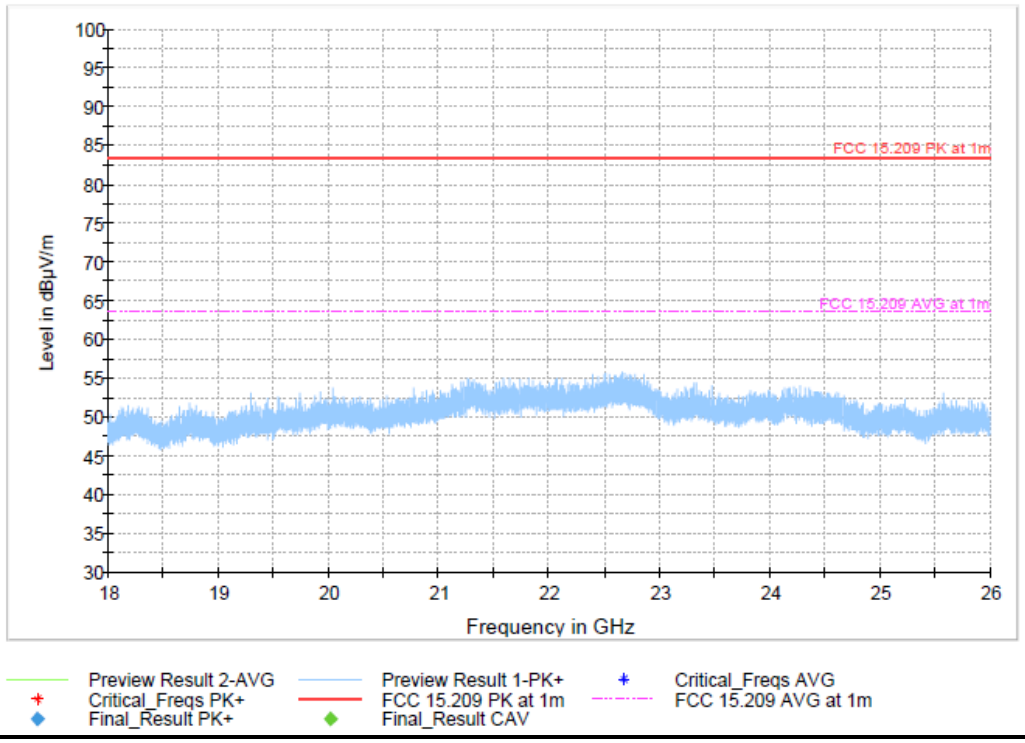
Plot # 4 Radiated Emissions: 3-18 GHz

Modulation: GFSK | **Channel: Mid**

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
16903.00	---	40.75	53.98	13.23	500.0	1000.0	292.0	H	194.0	14.2
16903.00	53.15	---	73.98	20.83	500.0	1000.0	292.0	H	194.0	14.2



Plot # 5 Radiated Emissions: 18-26 GHz		
Modulation: GFSK	**Channel: Mid**	



9 Test setup photos

Setup photos are included in supporting file name: "EMC_KPTRK-036-23001_Setup_Photos.pdf"

10 Test Equipment Used For Testing

Equipment Name/Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
EMI Receiver	Rohde & Schwarz	ESW44	101715	3 Years	9/13/2021
Signal Analyzer	Rohde & Schwarz	FSV40	101022	3 Years	9/14/2021
Active Loop antenna	ETS Lindgren	6507	161344	3 Years	10/30/2020
Loop antenna	ETS Lindgren	6512	164698	3 Years	8/14/2020
Biconlog Antenna	AH systems	BiLA2G	569	3 years	12/1/2020
Horn Antenna	EMCO	3115	35111	3 years	9/30/2021
Horn Antenna	ETS Lindgren	3117-PA	169547	3 years	9/1/2020
Horn Antenna	ETS Lindgren	3116C-PA	169535	3 years	9/30/2020
Digital Thermometer	Control Company	36934-164	191872028	3 Years	10/20/2021
Digital Barometer	VWR	10510-922	200236891	3 Years	4/13/2020

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.

11 Revision History

Date	Template Revision	Changes to report	Prepared by
01-27-2023	EMC_KPTRK-036-23001_15_247_BT_C2PC	Initial Version	Kris Lazarov

<<< The End >>>