FCC / ISED Test Report

For:

CalAmp

Model Name:

TTU-2900

Product Description:

Telematics Gateway with built in ECU (Engine Control unit)

FCC ID: APV-2900LABL
IC ID: 5843C-2900LABL

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

REPORT #: EMC_CALAM-116-20001_15.247_BTLE_Rev1

DATE: 2020-12-16

A2LA Accredited

IC recognized # 3462B-1

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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 #
CalAmp	Telematics Gateway with built in ECU (Engine Control unit)	TTU-2900

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2020-12-16	Compliance	Cindy Li (EMC Lab Manager)	Cindy Li Digitally signed by cindy.li@cetecom.com DN: CN=cindy.li@cetecom.com Reason: I have reviewed this document Location: your signing location here Date: 2020-12-16 12:24:03 Foxit Reader Version: 10.0.1

Responsible for the Report:

Date	Section	Name	Signature
2020-12-16	Compliance	Kevin Wang (Senior EMC Engineer)	kevin. wang@cetecom.com Digitally signed by: kevin.wang@cetecom.com DN: CN = kevin.wang@cetecom.com Date: 2020.12.16 11:26:59 -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
EMC Lab Manager:	Cindy Li
Responsible Project Leader:	Cathy Palacios

2.2 Identification of the Client

Client's Name:	CalAmp
Street Address:	2200 Faraday Avenue, Suite 220
City/Zip Code	Carlsbad, CA 92008
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:	TTU-2900
HW Version :	REV B2
SW Version :	8.4
FCC-ID :	APV-2900LABL
IC-ID:	5843C-2900LABL
HVIN:	REV B2
PMN:	TTU-2900
Product Description:	Telematics Gateway with built in ECU (Engine Control unit)
Frequency Range / number of channels:	Nominal band: 2400 MHz – 2483.5 MHz; Center to center: 2402 MHz (ch 0) – 2480 MHz (ch 39), 40 channels
Radio Information:	Bluetooth Low Energy (BLE): Module Name:CalAmp Module Number: BlueBoard FCC ID: APV-BLD01 IC ID: 5843C-BLD01 Modulation: Bluetooth version 4.2, Low Energy, using Dynamic Sequence Spread Spectrum with GFSK modulation.
Modes of Operation:	Bluetooth LE in both advertising and connected mode of operation
Antenna Information as declared:	max gain 2.5 dBi
Max. Peak Output Power:	Conducted Power 0 dBm
Power Supply/ Rated Operating Voltage Range:	Dedicated Battery Pack Vmin: 8 VDC/ Vnom: 12 VDC / Vmax: 32 VDC
Operating Temperature Range	-30 ºC to 70 ºC
Other Radios included in the device:	UMTS / LTE
Sample Revision	☐Prototype Unit; ■Production Unit; ☐Pre-Production

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	4674642338	REV B2	8.4	Radiated Sample

3.3 Accessory Equipment (AE) details

N/A

3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1	The radio of the EUT was configured to a fixed channel transmission with highest possible duty cycle using software that is not available to the end user. 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 low, mid and high channels, and highest possible duty cycle. 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.

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 of ISED Canada.

This test report is to support a request for new equipment authorization under

FCC ID: APV-2900LABL
IC ID: 5843C-2900LABL

Testing procedures are based on 558074 D01 15.247 Meas Guidance v05r02 – "GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES" - April 2, 2019, by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division.

5 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	NA	NP	Result
§15.247(a)(1) RSS-247 5.2(a)	Emission Bandwidth	Nominal	BTLE	☐	☐	■	Note1
§15.247(e) RSS-247 5.2(b)	Power Spectral Density	Nominal	BTLE	☐	☐	■	Note1
§15.247(b)(1) RSS-247 5.4(d)	Maximum Conducted Output Power and EIRP	Nominal	BTLE	☐	☐	■	Note1
§15.247(d) RSS-247 5.5	Band edge compliance Unrestricted Band Edges	Nominal	BTLE	☐	☐	■	Note1
§15.247; 15.209; 15.205 RSS-Gen 8.9; 8.10	Band edge compliance Restricted Band Edges	Nominal	BTLE	☐	☐	■	Note1
§15.215 RSS-Gen8.11	Frequency Stability	Extreme Condition	BTLE	☐	☐	■	Note2
§15.247(d); §15.209 RSS-Gen 6.13	TX Spurious emissions-Radiated	Nominal	BTLE	■	☐	☐	Complies
§15.207(a) RSS Gen 8.8	AC Conducted Emissions	Nominal	BTLE	☐	☐	■	Note1

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

Note1: Leveraged from Modular Approval report, FCC ID: APV-BLD01; IC ID: 5843C-BLD01.

Note 2: "Frequency stability requirement is ensured by design study of the voltage regulator (PT7M8202B33C5E) delivering the supply voltage of the BTLE chip (CC2640R2F) with the used 24-MHz Crystal Oscillator clock option as identified in the schematic exhibit. As the device is a slave it will transmit without calibration/synchronization. In a PLL structure the +-40 ppm accuracy will translate up to the radio frequency resulting in a frequency deviation of +-0.09608 MHz = +-96 kHz. This will not cause any out of band transmissions based on analysis of the spectrum on low and high channel from conducted report. Further it has been verified that above components cover the operating temperature range of the product from -30 to 75 deg C"

8.14 24-MHz Crystal Oscillator (XOSC_HF)

T_c = 25°C, V_{DDS} = 3.0 V, unless otherwise noted.(1)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
ESR Equivalent series resistance(2)	6 pF < C_L ≤ 9 pF		20	60	Ω
ESR Equivalent series resistance(2)	5 pF < C_L ≤ 6 pF			80	Ω
L_M Motional inductance(2)	Relates to load capacitance (C_L in Farads)		< 1.6 × 10^{-24} / C_L ^{2}		H
C_L Crystal load capacitance(2) (3)		5		9	pF
Crystal frequency(2) (4)			24		MHz
Crystal frequency tolerance(2) (5)		–40		40	ppm
Start-up time(4) (6)			150		µs

(1) Probing or otherwise stopping the crystal while the DC/DC converter is enabled may cause permanent damage to the device.
(2) The crystal manufacturer's specification must satisfy this requirement
(3) Adjustable load capacitance is integrated into the device. External load capacitors are not required
(4) Measured on the TI CC2650EM-5XD reference design with T_c = 25°C, V_{DDS} = 3.0 V
(5) Includes initial tolerance of the crystal, drift over temperature, ageing and frequency pulling due to incorrect load capacitance. As per specification.
(6) Kick-started based on a temperature and aging compensated RCOSC_HF using precharge injection.

6 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.

Radiated measurement

9 kHz to 30 MHz	±2.5 dB (Magnetic Loop Antenna)
30 MHz to 1000 MHz	±2.0 dB (Biconilog Antenna)
1 GHz to 40 GHz	±2.3 dB (Horn Antenna)

Conducted measurement

150 kHz to 30 MHz	±0.7 dB (LISN)
RF conducted measurement	±0.5 dB

According to TR 102 273 a multiplicative propagation of error is assumed for RF measurement systems. For this reason the RMS method is applied to dB values and not to linear values as appropriate for additive propagation of error. Also used: http://physics.nist.gov/cuu/Uncertainty/typeb.html. The above calculated uncertainties apply to direct application of the Substitution method. The Substitution method is always used when the EUT comes closer than 3 dB to the limit.

6.1 Environmental Conditions During Testing:

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

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

6.2 Dates of Testing:

11/10/2020 - 11/11/2020

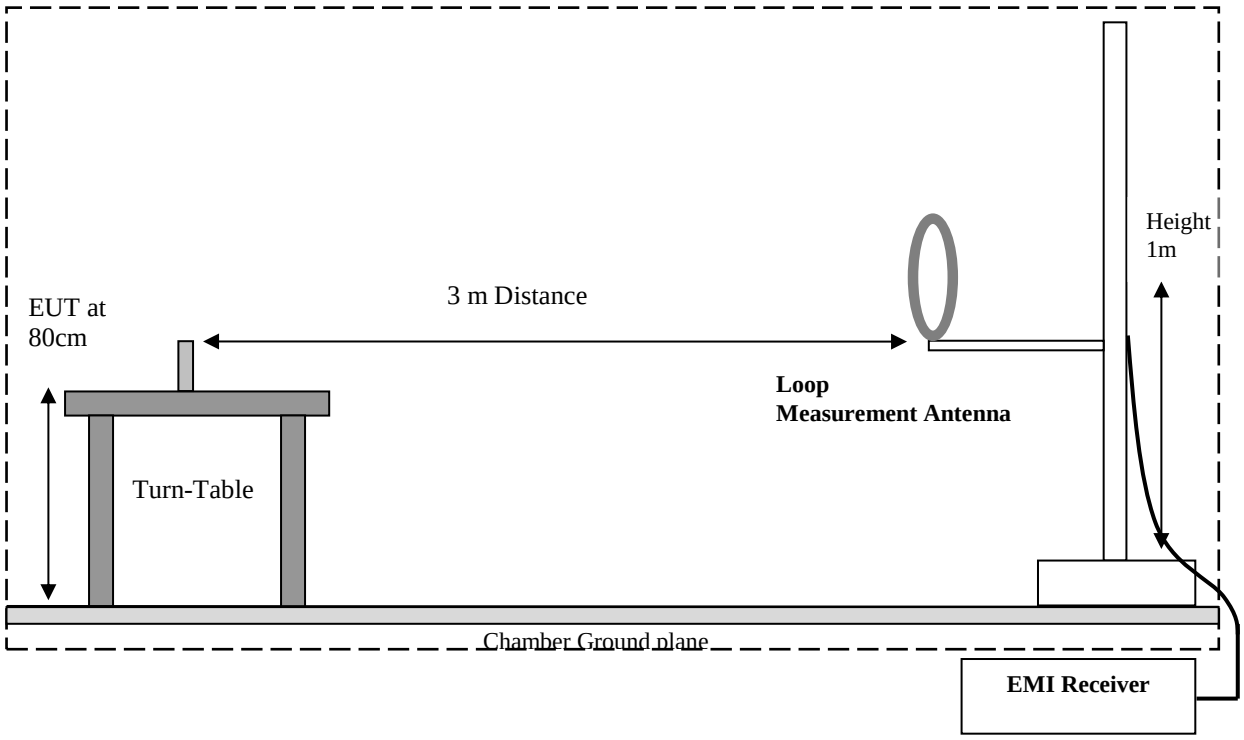
7 Measurement Procedures

7.1 Radiated Measurement

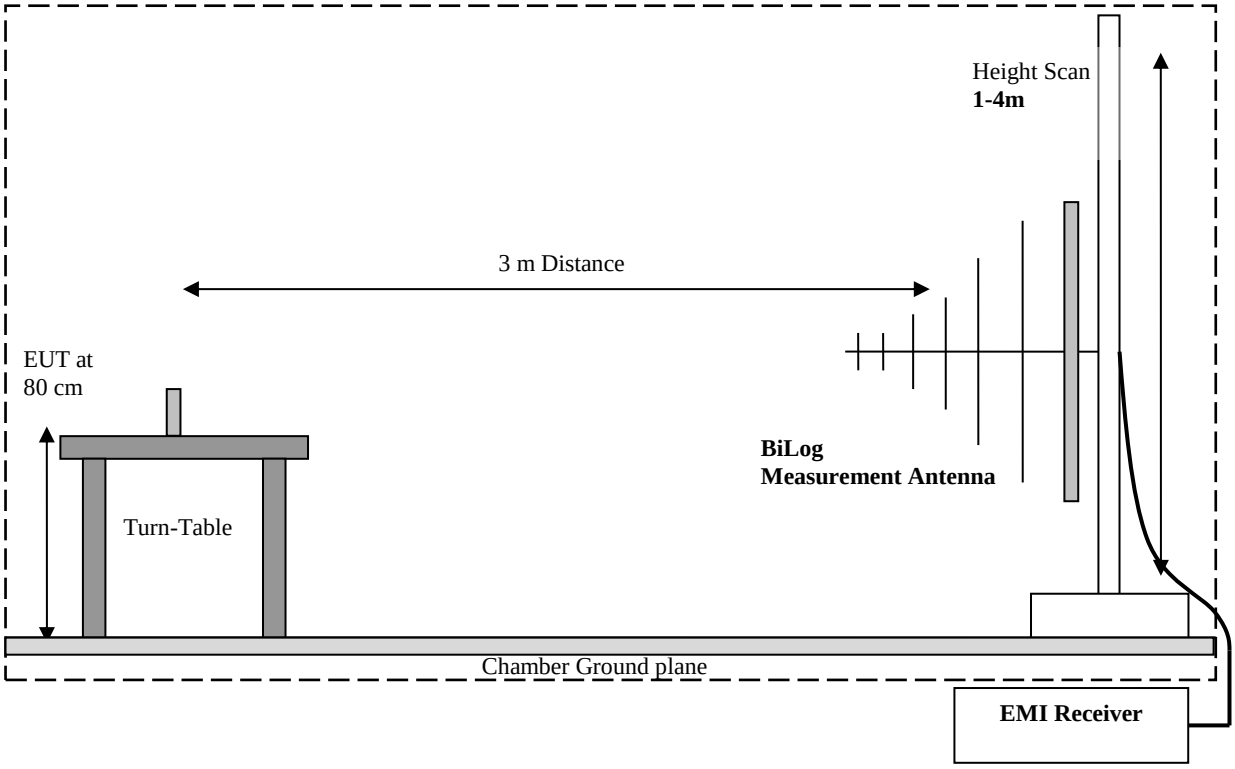
The radiated measurement is performed according to ANSI C63.10 (2013)

- 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.

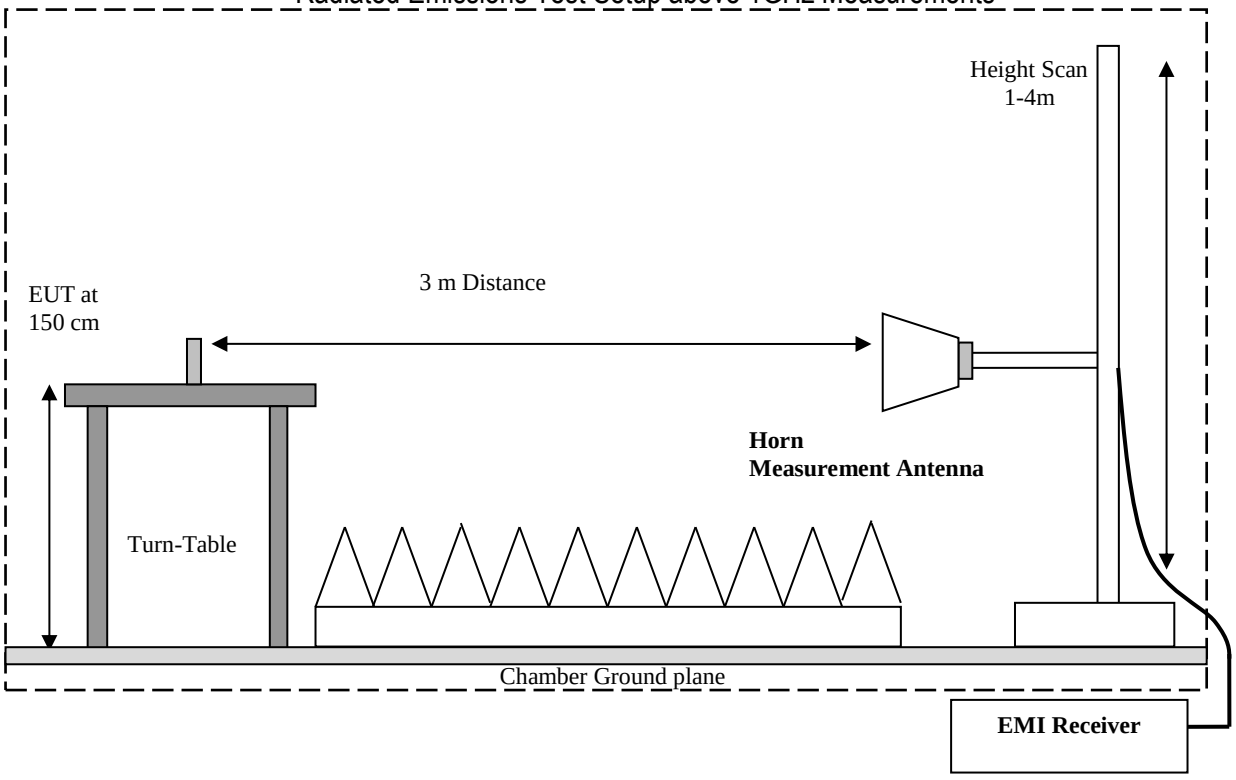
Radiated Emissions Test Setup below 30MHz Measurements



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:

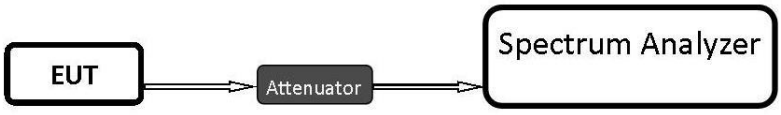
Frequency (MHz)	Measured SA (dBµV)	Cable Loss (dB)	Antenna Factor Correction (dB)	Field Strength Result (dBµV/m)
1000	80.5	3.5	14	98.0

7.2 Power Line Conducted Measurement Procedure

AC Power Line conducted emissions measurements performed according to: ANSI C63.4 (2014)

7.3 RF Conducted Measurement Procedure

Testing procedures are based on 558074 D01 15.247 Meas Guidance v05r02 – "GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES" - April 2, 2019, by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division.



- Connect the equipment as shown in the above diagram.
- Adjust the settings of the SA (Rohde-Schwarz Spectrum Analyzer) to connect the EUT at the required mode of test.
- Measurements are to be performed with the EUT set to the low, middle and high channels and for worst case modulation schemes.

8 Test Result Data

8.1 Radiated Transmitter Spurious Emissions and Restricted Bands

8.1.1 Measurement according to ANSI C63.10 (2013)

Spectrum Analyzer Settings:

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

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

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

- 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.

8.1.2 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

8.1.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22° C	1	GFSK continuous fixed channel	12 VDC

8.1.4 Measurement result:

Plot #	Channel #	Scan Frequency	Limit	Result
1-3	Low	30 MHz – 18 GHz	See section 8.5.2	Pass
4-8	Mid	9 kHz – 26 GHz	See section 8.5.2	Pass
9-11	High	30 MHz – 18 GHz	See section 8.5.2	Pass

8.1.5 Measurement Plots:

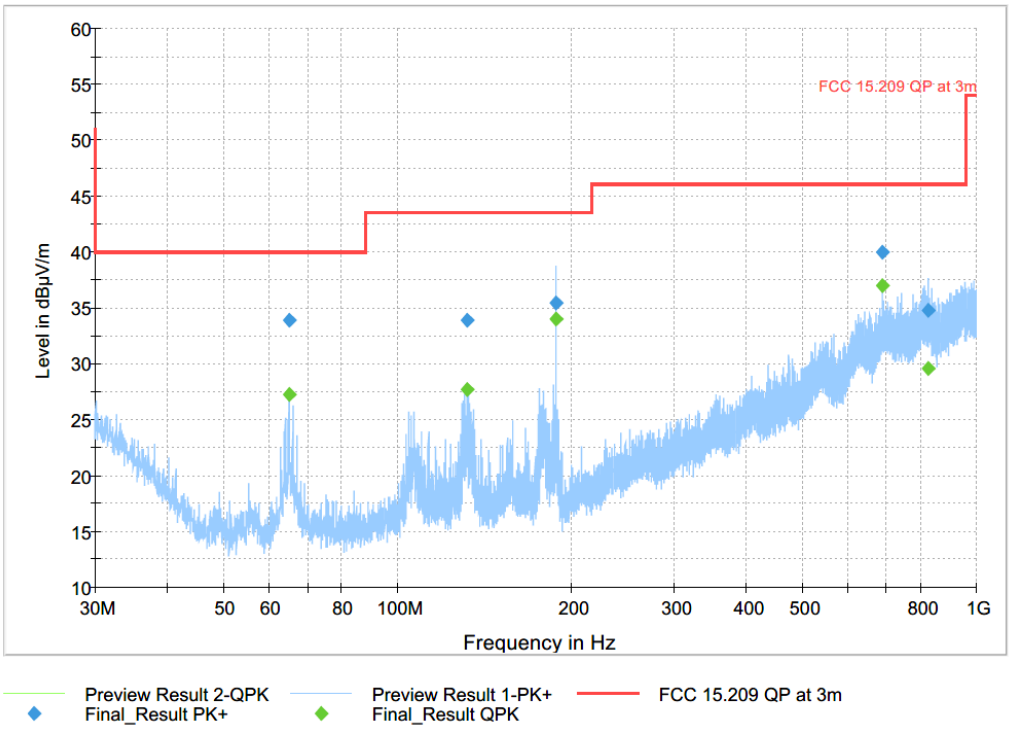
Plot #1 Radiated Emissions: 30 MHz – 1GHz

Modulation: GFSK | **Channel: Low**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
64.855	33.89	---	40.00	6.11	500.0	120.000	230.0	V	194.0	11.0	
64.855	---	27.30	---	---	500.0	120.000	230.0	V	194.0	11.0	
131.979	---	27.70	---	---	500.0	120.000	276.0	H	286.0	13.0	
131.979	33.91	---	43.50	9.59	500.0	120.000	276.0	H	286.0	13.0	
187.496	---	33.98	---	---	500.0	120.000	301.0	V	45.0	14.4	
187.496	35.39	---	43.50	8.11	500.0	120.000	301.0	V	45.0	14.4	
687.531	40.02	---	46.02	6.00	500.0	120.000	152.0	V	322.0	29.0	
687.531	---	37.00	---	---	500.0	120.000	152.0	V	322.0	29.0	
824.171	---	29.53	---	---	500.0	120.000	315.0	H	236.0	29.8	
824.171	34.74	---	46.02	11.28	500.0	120.000	315.0	H	236.0	29.8	

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.

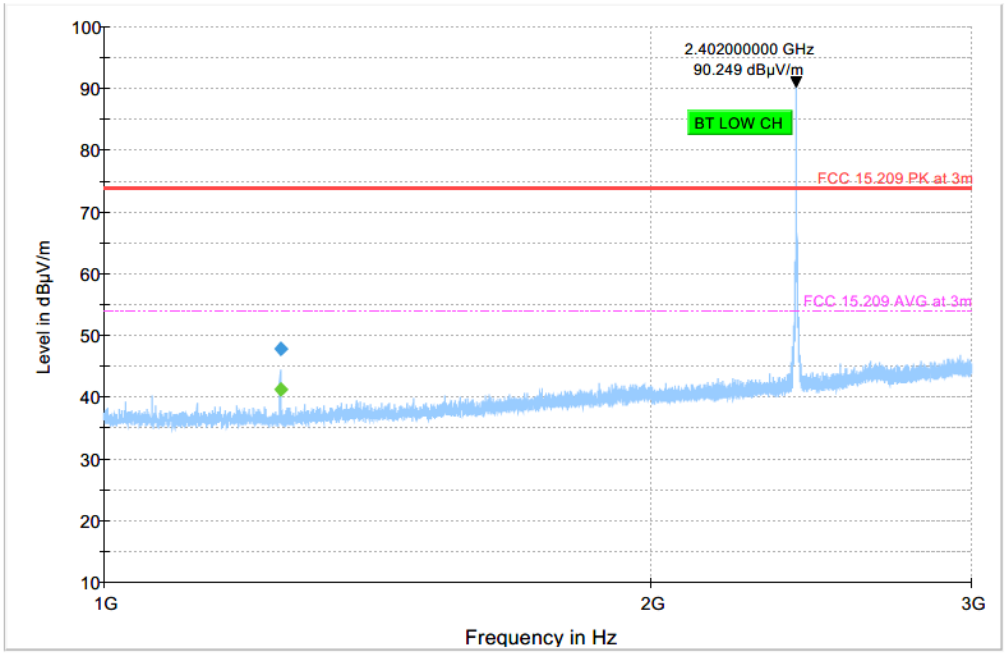


Plot # 2 Radiated Emissions: 1-3 GHz		
Modulation: GFSK	**Channel: Low**	

Final_Result

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)	Comment
1250.000	---	41.24	53.98	12.74	500.0	1000.000	184.0	V	69.0	4.2	
1250.000	47.75	---	73.98	26.23	500.0	1000.000	184.0	V	69.0	4.2	

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.



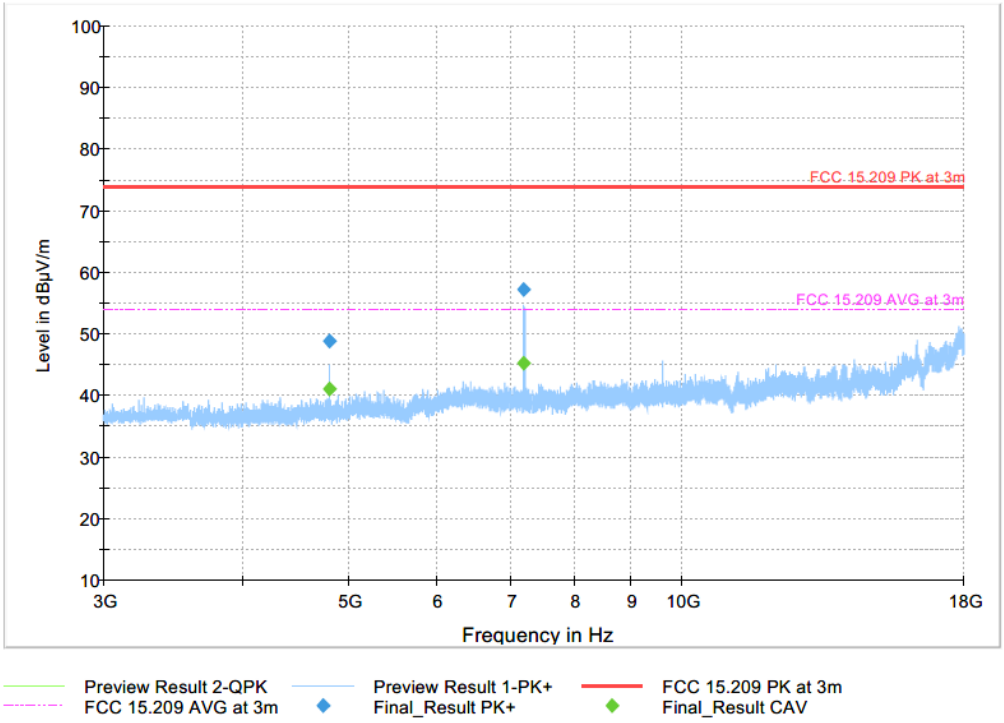
Plot # 3 Radiated Emissions: 3-18 GHz

Modulation: GFSK	Channel: Low	

Final Result

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)	Comment
4804.000	---	41.12	53.98	12.86	500.0	1000.000	315.0	V	133.0	-4.8	
4804.000	48.79	---	73.98	25.19	500.0	1000.000	315.0	V	133.0	-4.8	
7205.000	---	45.29	53.98	8.69	500.0	1000.000	298.0	V	164.0	-0.6	
7205.000	57.23	---	73.98	16.75	500.0	1000.000	298.0	V	164.0	-0.6	

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.

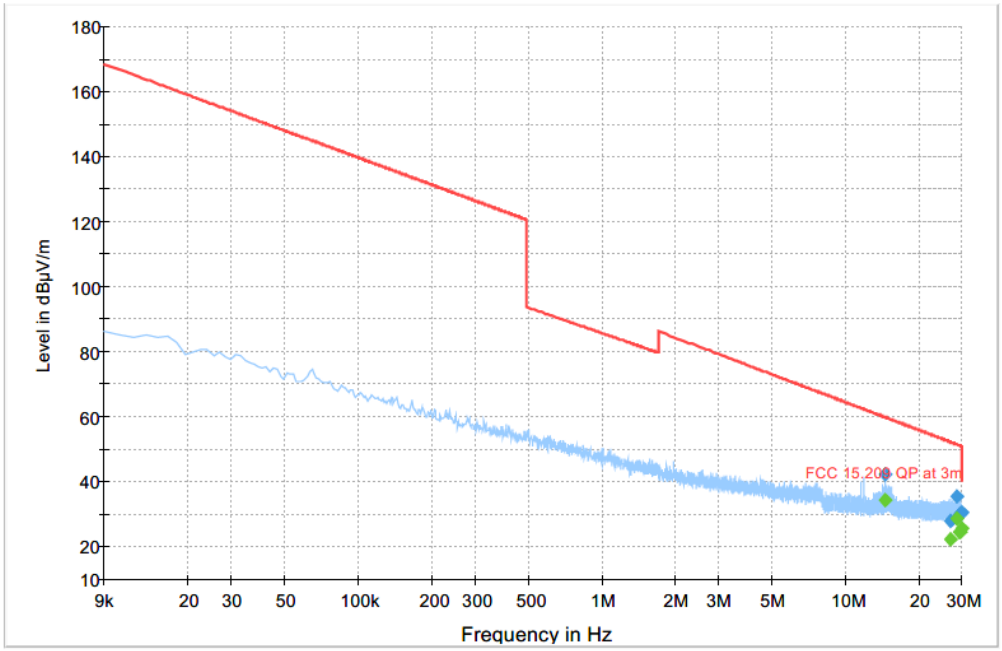


Plot # 4 Radiated Emissions: 9 KHz - 30 MHz		
Modulation: GFSK	**Channel: Mid**	

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
14.475	42.23	---	60.01	17.78	500.0	9.000	185.0	V	101.0	17.2	
14.475	---	34.43	60.01	25.58	500.0	9.000	185.0	V	101.0	17.2	
26.927	---	22.55	52.37	29.82	500.0	9.000	244.0	V	262.0	16.3	
26.927	28.08	---	52.37	24.29	500.0	9.000	244.0	V	262.0	16.3	
28.533	35.51	---	51.66	16.14	500.0	9.000	290.0	H	267.0	16.2	
28.533	---	28.84	51.66	22.81	500.0	9.000	290.0	H	267.0	16.2	
29.169	---	24.53	51.39	26.86	500.0	9.000	252.0	V	274.0	16.2	
29.169	29.84	---	51.39	21.55	500.0	9.000	252.0	V	274.0	16.2	
29.630	---	24.62	51.19	26.57	500.0	9.000	278.0	V	5.0	16.2	
29.630	30.26	---	51.19	20.93	500.0	9.000	278.0	V	5.0	16.2	
30.000	---	25.88	51.04	25.16	500.0	9.000	290.0	V	309.0	16.2	
30.000	30.75	---	40.00	9.25	500.0	9.000	290.0	V	309.0	16.2	

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.

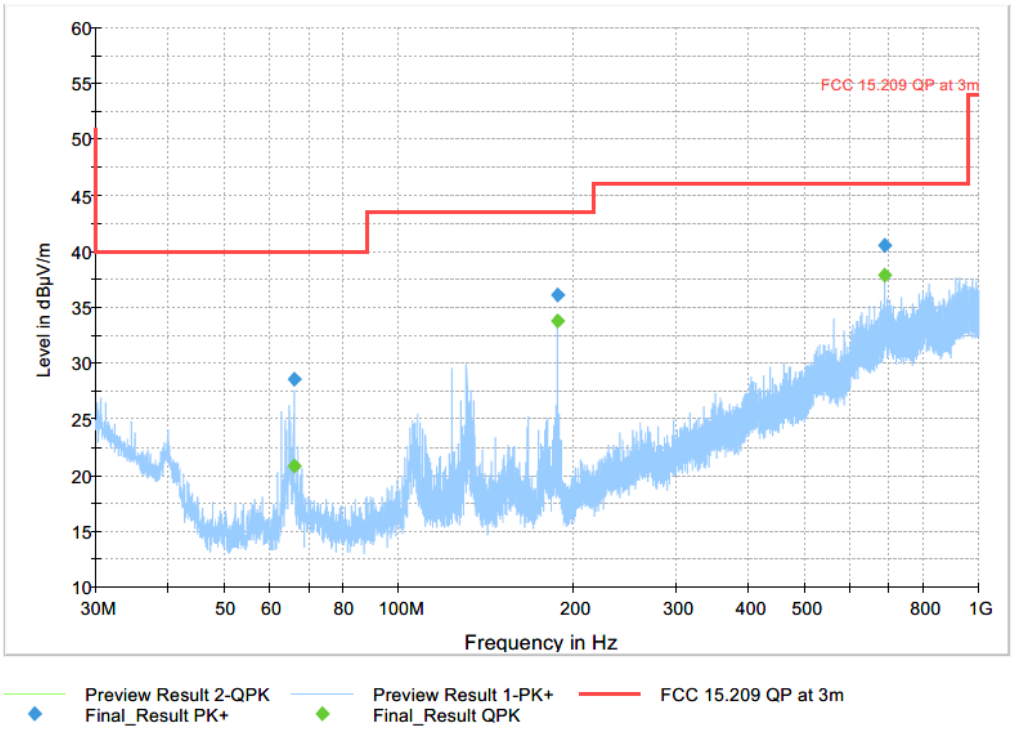


Plot #5 Radiated Emissions: 30 MHz – 1GHz		
Modulation: GFSK	**Channel: Mid**	

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
65.858	28.59	---	40.00	11.41	500.0	120.000	256.0	V	339.0	11.2	
65.858	---	20.82	---	---	500.0	120.000	256.0	V	339.0	11.2	
187.496	---	33.82	---	---	500.0	120.000	308.0	V	85.0	14.4	
187.496	36.13	---	43.50	7.37	500.0	120.000	308.0	V	85.0	14.4	
687.531	40.53	---	46.02	5.49	500.0	120.000	140.0	V	-33.0	29.0	
687.531	---	37.93	---	---	500.0	120.000	140.0	V	-33.0	29.0	

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.

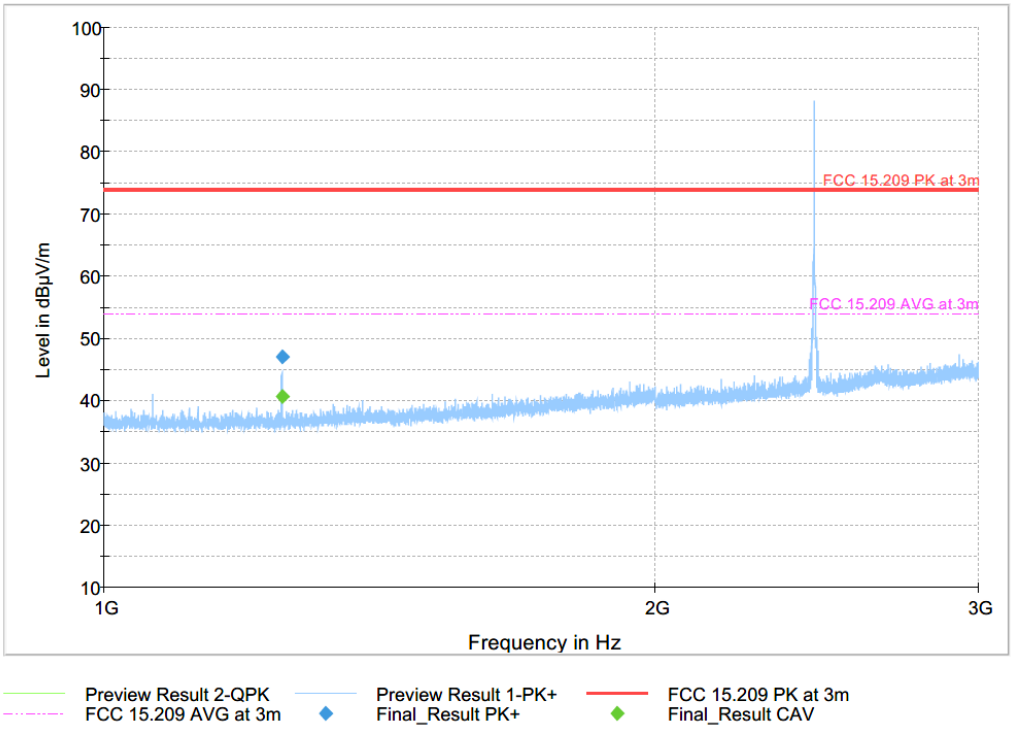


Plot #6 Radiated Emissions: 1-3 GHz		
Modulation: GFSK	**Channel: Mid**	

Final_Result

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)	Comment
1250.000	---	40.68	53.98	13.30	500.0	1000.000	185.0	V	59.0	4.2	
1250.000	47.07	---	73.98	26.91	500.0	1000.000	185.0	V	59.0	4.2	

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.

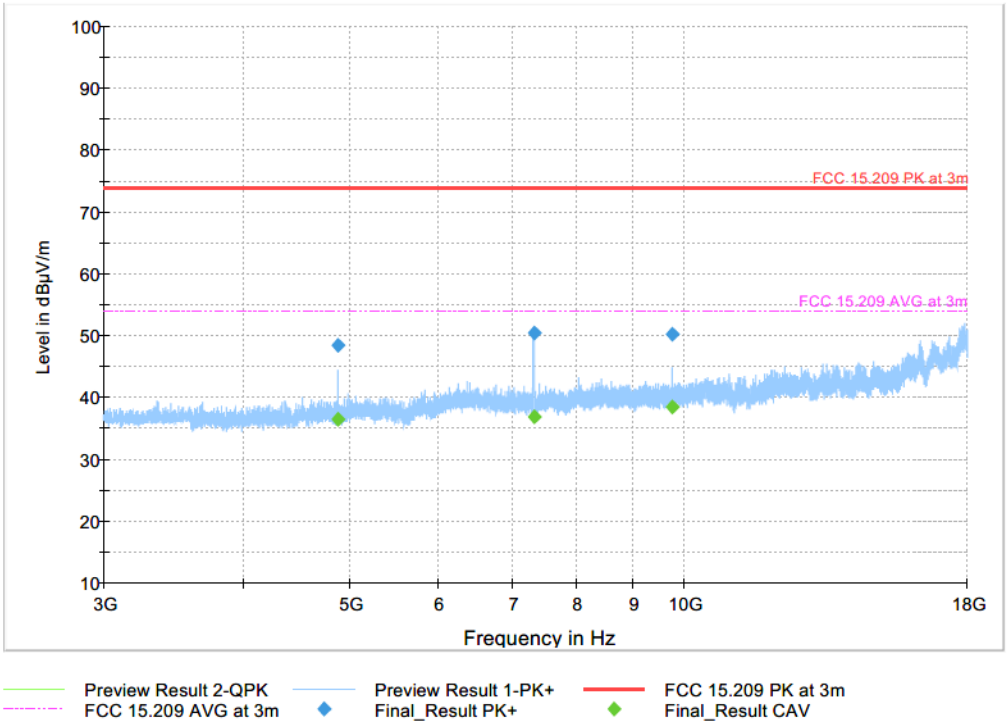


Plot #7 Radiated Emissions: 3-18 GHz		
Modulation: GFSK	**Channel: Mid**	

Final_Result

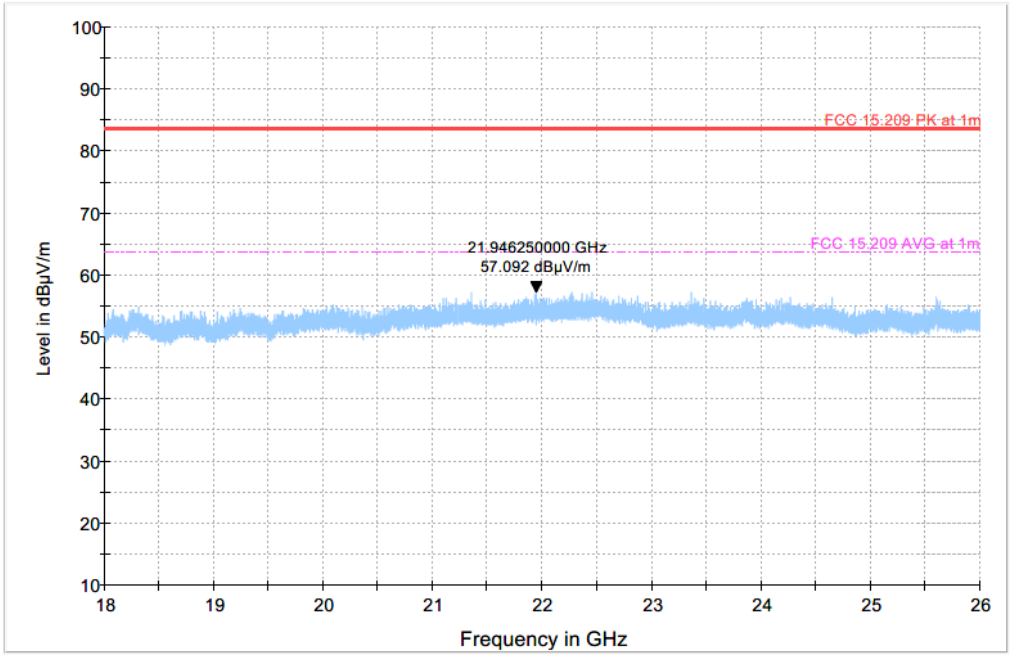
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
4880.500	48.44	---	73.98	25.54	500.0	1000.000	140.0	V	198.0	-5.0	
4880.500	---	36.39	53.98	17.59	500.0	1000.000	140.0	V	198.0	-5.0	
7321.000	50.43	---	73.98	23.55	500.0	1000.000	140.0	V	147.0	-0.5	
7321.000	---	36.80	53.98	17.18	500.0	1000.000	140.0	V	147.0	-0.5	
9760.000	---	38.50	53.98	15.48	500.0	1000.000	198.0	V	174.0	1.7	
9760.000	50.30	---	73.98	23.68	500.0	1000.000	198.0	V	174.0	1.7	

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.



Plot #8 Radiated Emissions: 18-26 GHz		
Modulation: GFSK	**Channel: Mid**	

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.

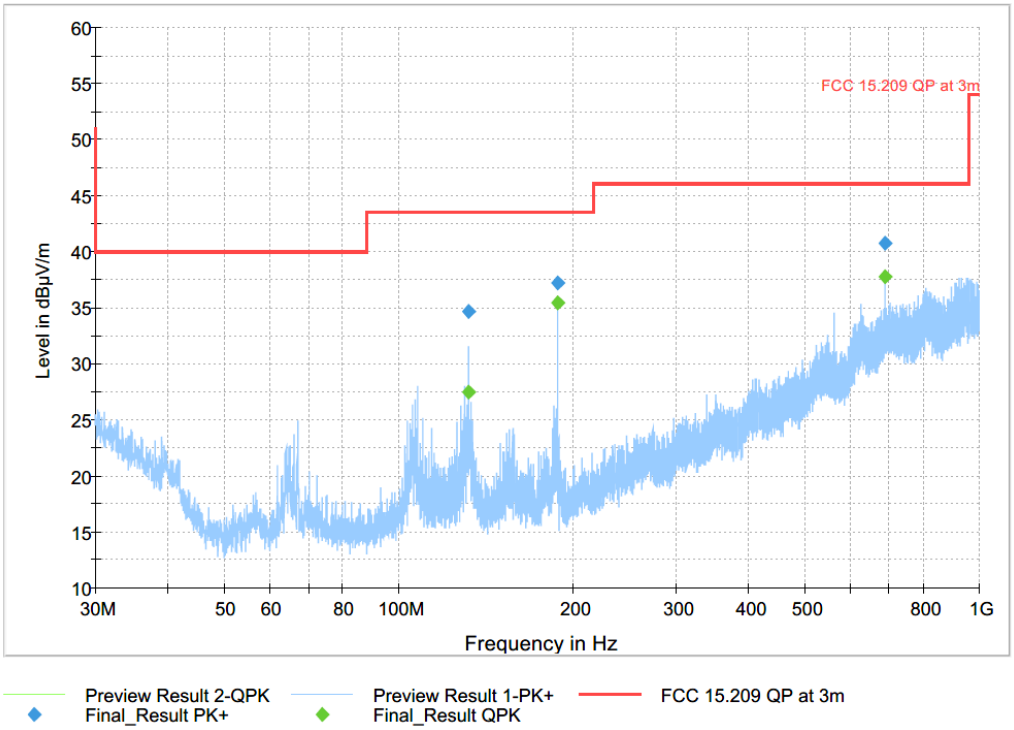


Plot #9 Radiated Emissions: 30 MHz – 1GHz		
Modulation: GFSK	**Channel: High**	

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
131.882	---	27.51	---	---	500.0	120.000	304.0	H	93.0	13.0	
131.882	34.62	---	43.50	8.88	500.0	120.000	304.0	H	93.0	13.0	
187.496	37.21	---	43.50	6.29	500.0	120.000	220.0	V	67.0	14.4	
187.496	---	35.40	---	---	500.0	120.000	220.0	V	67.0	14.4	
687.531	40.78	---	46.02	5.24	500.0	120.000	140.0	V	97.0	29.0	
687.531	---	37.80	---	---	500.0	120.000	140.0	V	97.0	29.0	

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.

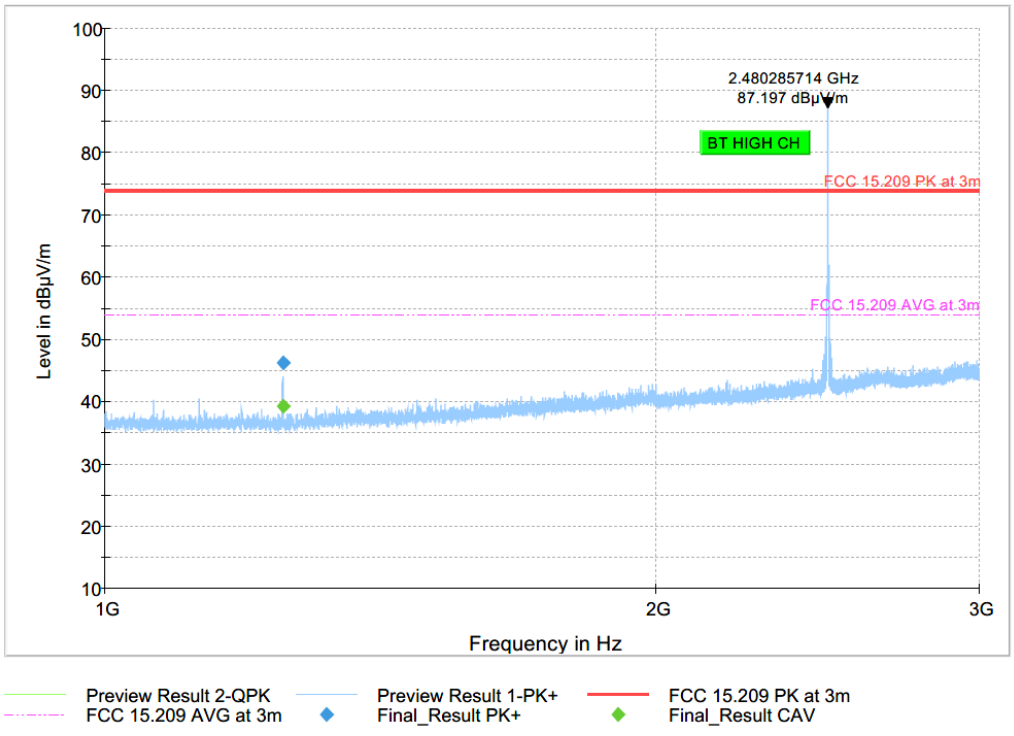


Plot # 10 Radiated Emissions: 1-3 GHz and Restricted Bands		
Modulation: GFSK	**Channel: High**	

Final_Result

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)	Comment
1250.000	---	39.18	53.98	14.79	500.0	1000.000	175.0	V	59.0	4.2	
1250.000	46.26	---	73.98	27.72	500.0	1000.000	175.0	V	59.0	4.2	

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.

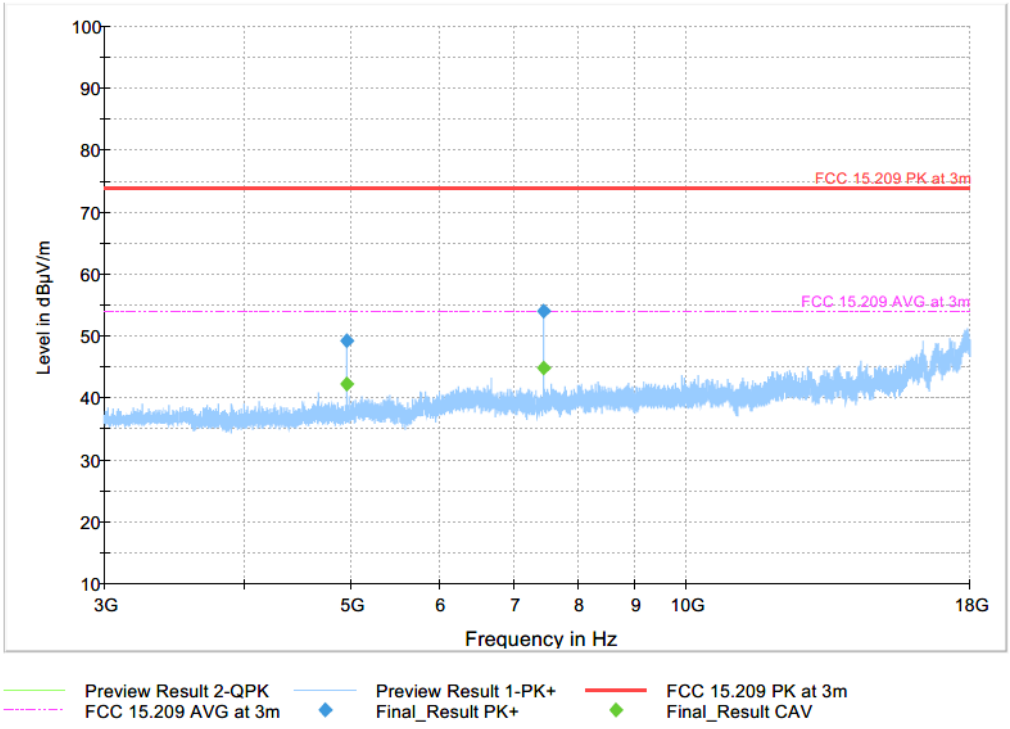


Plot #11 Radiated Emissions: 3-18 GHz		
Modulation: GFSK	**Channel: High**	

Final Result

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)	Comment
4960.000	49.28	---	73.98	24.70	500.0	1000.000	176.0	V	149.0	-4.5	
4960.000	---	42.21	53.98	11.77	500.0	1000.000	176.0	V	149.0	-4.5	
7440.000	53.91	---	73.98	20.07	500.0	1000.000	140.0	V	94.0	-0.2	
7440.000	---	44.87	53.98	9.11	500.0	1000.000	140.0	V	94.0	-0.2	

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.



9 Test setup photos

Setup photos are included in supporting file name: "EMC_CALAM-116-20001_FCC_Setup_Photos.pdf"

10 Test Equipment And Ancillaries Used For Testing

Item Name	Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
Antenna Biconilog 3142E	Biconlog Antenna	EMCO	3142E	166067	3 years	03/12/2020
Magnetic Loop Antenna	Loop Antenna	ETS Lindgren	6507	161344	3 years	10/30/2020
Antenna Horn 3115 SN 35111	Horn Antenna	EMCO	3115	35111	3 years	04/17/2019
Antenna Horn 3116	Horn Antenna	ETS Lindgren	3116	70497	3 years	11/23/2020
Antenna Horn 3117	Horn Antenna	ETS Lindgren	3117-PA	169547	3 years	09/01/2020
EMI Receiver/Analyzer	EMI Receiver/Analyzer	R&S	ESU 40	1000251-KB	3 years	07/16/2019
Thermometer Humidity	Thermometer Humidity	Control Company	36934-164	191871994	2 Year	1/10/2019

Note:

1. 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 History

Date	Template Revision	Changes to report	Prepared by
2020-12-08	EMC_CALAM-116-20001_15.247_BTLE	Initial Version	Kevin Wang
2020-12-16	EMC_CALAM-116-20001_15.247_BTLE_Rev1	Updated the Frequency Stability in Section 5	Kevin Wang

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