FCC / ISED Test Report

FOR:
Innophase Inc.

Model Name:
INP1011

Product Description:
Low Power Wi-Fi/BLE IOT Module

FCC ID: 2AVAL-INP2045
IC ID: 25715-INP2045

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

REPORT #: EMC_INNOP_008_20001_15.247_BT_DTS_INP1011

DATE: 2020-09-11

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 #
Innophase Inc.	Low Power Wi-Fi/BLE IOT Module	INP1011

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2020-09-11	Compliance	Cindy Li (Lab Manager)	Cindy Li Digitally signed by cindy.li@cetecom.com DN: CN=cindy.li@cetecom.com Reason: I am approving this document Location: your signing location here Date: 2020-09-11 13:10:26 Foxit Reader Version: 10.0.1

Responsible for the Report:

Date	Section	Name	Signature
2020-09-11	Compliance	Yuchan Lu (Test Engineer)	Yuchan Lu Digitally signed by: Yuchan Lu DN: CN = Yuchan Lu email = Yuchan.Lu@cetecom.com C = US O = CETECOM Inc. OU = EMC Date: 2020.09.11 12:40:47 -07'00'

The test results of this test report relate exclusively to the test item specified in Section3.
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:	Cindy Li
Responsible Project Leader:	Akanksha Baskaran

2.2 Identification of the Client

Client's Name:	Innophase Inc.
Street Address:	6815 Flanders Drive
City/Zip Code:	San Diego, CA 92121
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:	INP1011
HW Version :	INP1011-A2
SW Version :	master/16f3f74f.
FCC-ID:	2AVAL-INP2045
IC-ID:	25715-INP2045
HVIN:	INP1011
PMN:	Talaria TWO
Product Description:	Low Power Wi-Fi/BLE IOT Module
Frequency Range / number of channels:	Module name: Talaria TWO Module number: INP2045-H FCC/IC ID: 2AVAL-INP2045/25715-INP2045 Nominal band: 2400 MHz – 2483.5 MHz; Center to center: 2402 MHz (ch 0) – 2480 MHz (ch 39), 40 channels
Type(s) of Modulation:	Bluetooth 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:	External Antenna W24-RSMA Antenna gain: 2.15 dBi
Max. Peak Output Power:	Conducted Power 9.33 dBm
Power Supply/ Rated Operating Voltage Range:	Low 3.0 VDC, High 3.6 VDC
Operating Temperature Range:	Low -40ºC, High 85ºC
Other Radios included in the device:	❖ WLAN • Module name: Talaria TWO • Module number: INP2045-H • FCC/IC ID: 2AVAL-INP2045/25715-INP2045
Sample Revision:	☐Prototype Unit; ☐Production Unit; ■Pre-Production

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	TS-ES-3011-00-0157	INP1011-A2	master/16f3f74f.	Radiated Emissions

3.3 Accessory Equipment details

AE #	Type	Manufacture	Model	P/N
1	USB Power Cable	-	-	-

3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1+ AE#1	Special commands through command window used to configure the BLE radio to low, mid and high channels provided by the client that will not be available to the end user. For radiated measurements, the external 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. The EUT was configured to the highest duty cycle and maximum output power through commands.

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.

Testing procedures are based on 558074 D01 DTS Meas Guidance v05r02 – “GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER SECTION 15.247” - 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(1)	Emission Bandwidth	Nominal	BTLE	☐	☐	■	Note1 Note2
§15.247(e) RSS-247 5.2(2)	Power Spectral Density	Nominal	BTLE	☐	☐	■	Note1 Note2
§15.247(b)(1) RSS-247 5.4(4)	Maximum Conducted Output Power and EIRP	Nominal	BTLE	☐	☐	■	Note1 Note2
§15.247(d) RSS-247 5.5	Band edge compliance Unrestricted Band Edges	Nominal	BTLE	☐	☐	■	Note1 Note2
§15.247; 15.209; 15.205 RSS-Gen 8.9; 8.10	Band edge compliance Restricted Band Edges	Nominal	BTLE	☐	☐	■	Note1 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	☐	☐	■	Note3

Note1: NA= Not Applicable; NP= Not Performed.
Note2: Leveraged from module certification FCC ID: 2AVAL-INP2045
Note3: EUT is powered by USB Power 5VDC

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=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.

6.2 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:

08/18/2020-08/19/2020

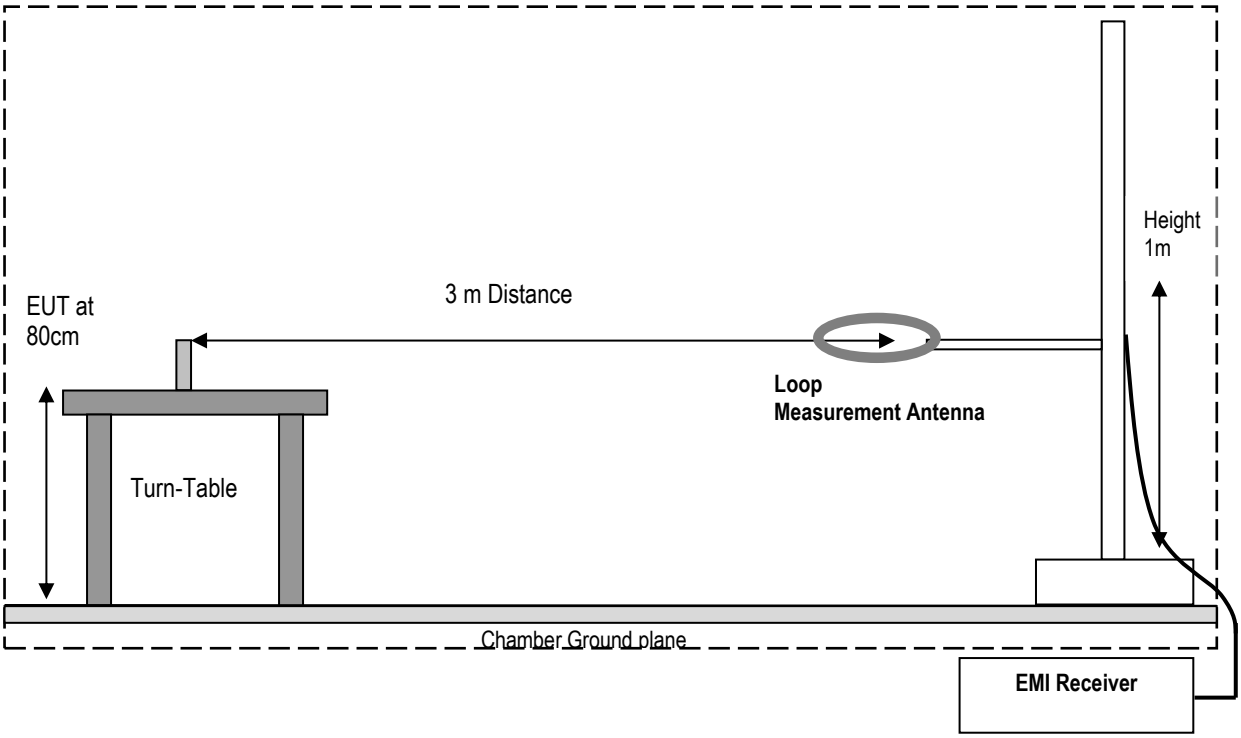
7 Measurement Procedures

7.1 Radiated Measurement

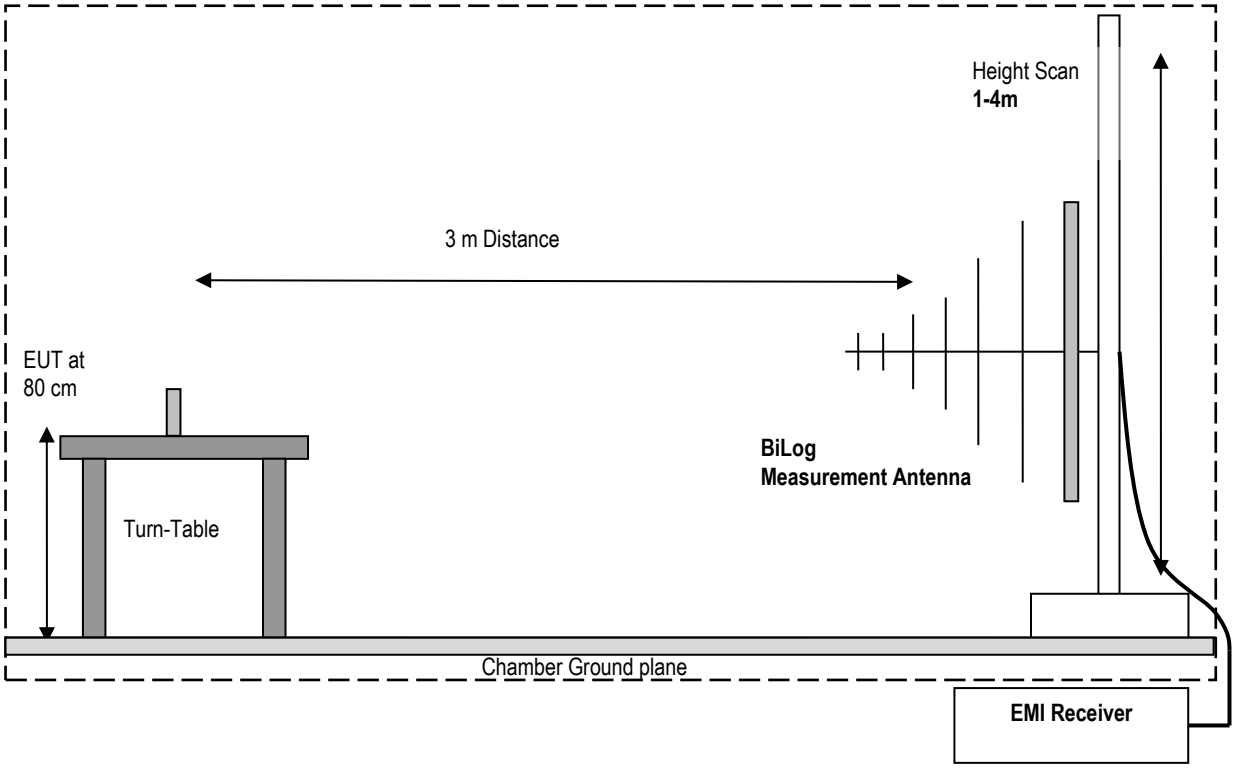
The radiated measurement is performed according to ANSI C63.10 (2013)

- 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.

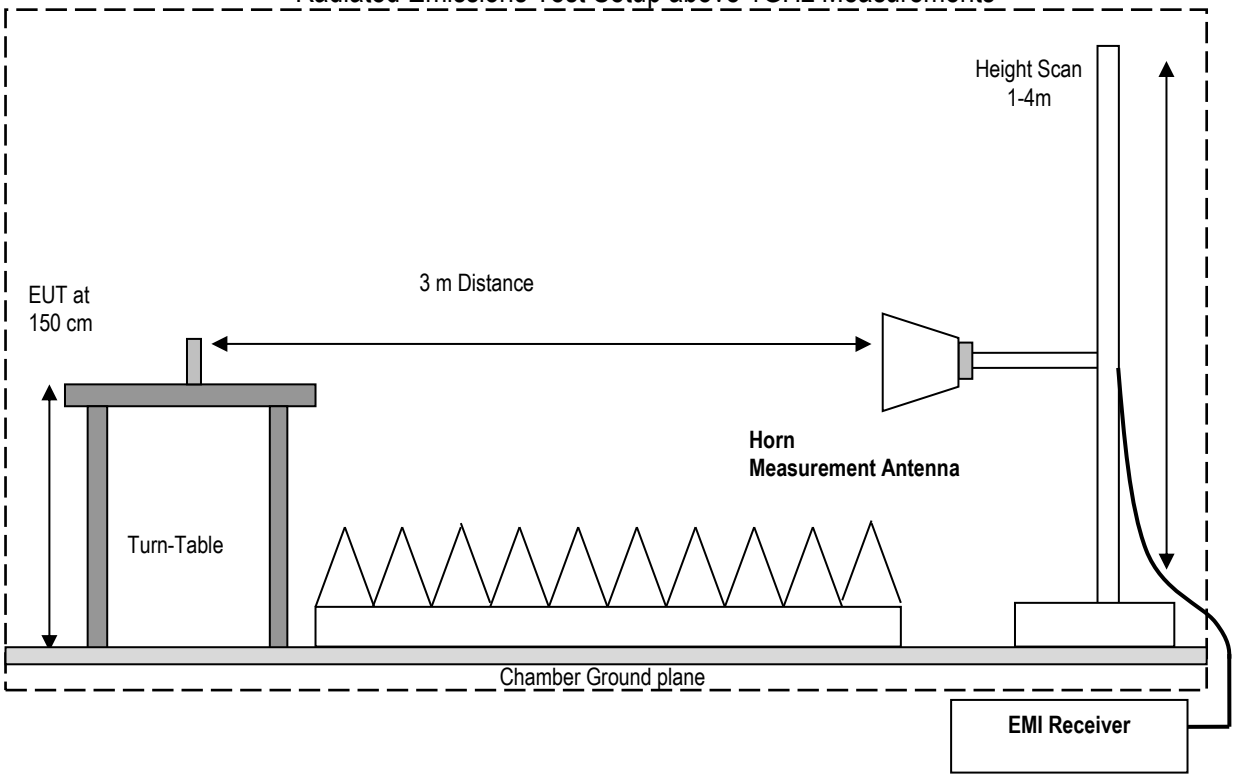
Radiated Emissions Test Setup below 30MHz Measurements



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

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 at distance other than the specified in the standard, the limit conversion is calculated by using 40 dB/decade extrapolation factor as follow: Conversion factor (CF) = 40 log (D/d) = 40 log (300m / 3m) = 80dB

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
23° C	1	BTLE	5 VDC

8.1.4 Measurement result:

Plot #	Channel #	Scan Frequency	Limit	Result
1-3	Low	30 MHz – 18 GHz	See section 8.1.2	Pass
4-8	Mid	9 kHz – 26 GHz	See section 8.1.2	Pass
9-11	High	30 MHz – 18 GHz	See section 8.1.2	Pass

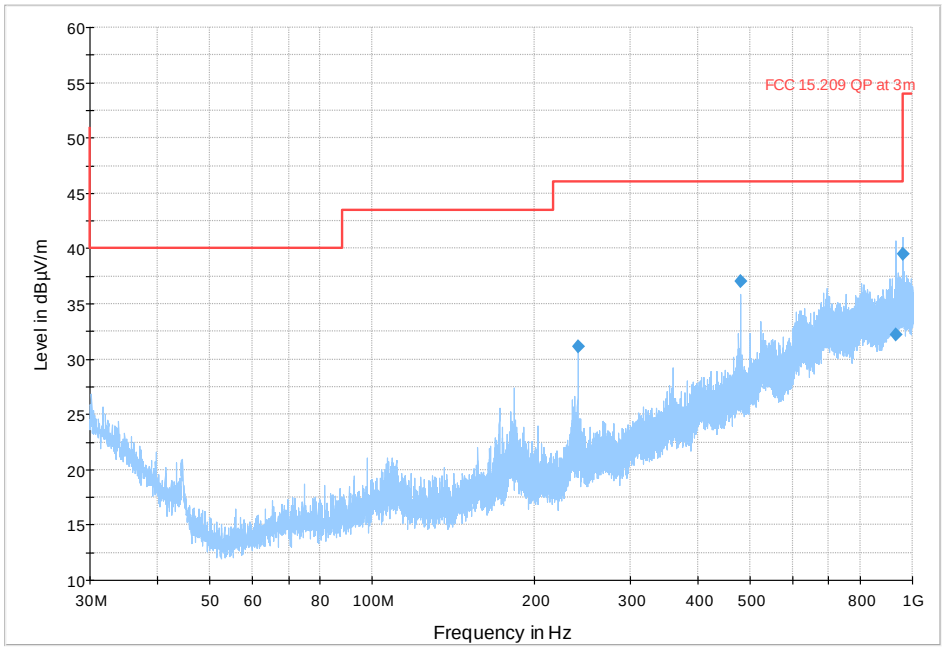
8.1.5 Measurement Plots:

Plot #1 Radiated Emissions: 30 MHz – 1GHz

Modulation: BTLE	Channel: Low

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
239.973	31.11	---	46.02	14.91	500.0	120.000	140.0	H	135.0	17.0	
480.015	37.04	---	46.02	8.99	500.0	120.000	164.0	H	195.0	23.6	
929.675	32.24	---	46.02	13.78	500.0	120.000	270.0	V	262.0	30.3	
960.036	39.54	---	53.98	14.44	500.0	120.000	153.0	H	149.0	30.8	



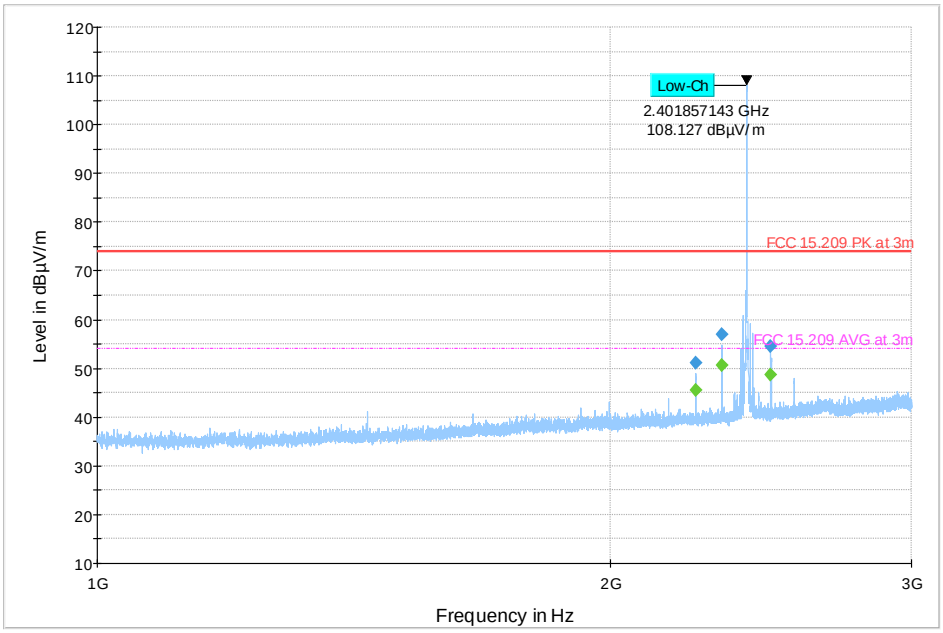
Preview Result 1-PK+ FCC 15.209 QP at 3m Final_Result QPK Final_Result PK+

Plot #2 Radiated Emissions: 1-3 GHz

Modulation: BTLE | **Channel: Low**

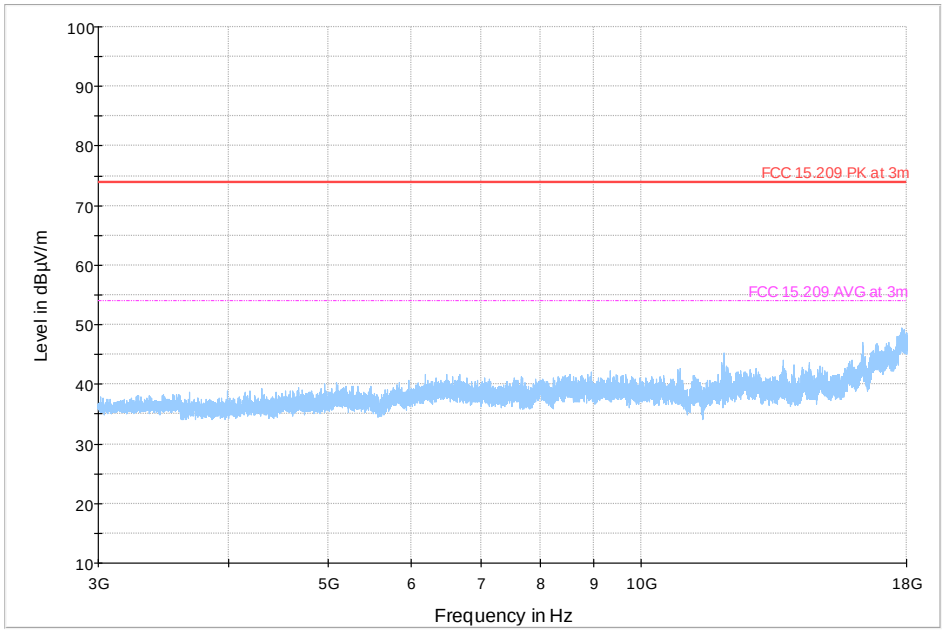
Final_Result

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
2241.857	---	45.58	53.98	8.40	500.0	1000.000	140.0	V	31.0	8.8	
2241.857	51.12	---	73.98	22.86	500.0	1000.000	140.0	V	31.0	8.8	
2321.714	57.07	---	73.98	16.91	500.0	1000.000	198.0	V	327.0	9.2	
2321.714	---	50.59	53.98	3.39	500.0	1000.000	198.0	V	327.0	9.2	
2481.857	54.65	---	73.98	19.33	500.0	1000.000	184.0	V	24.0	9.6	
2481.857	---	48.66	53.98	5.32	500.0	1000.000	184.0	V	24.0	9.6	

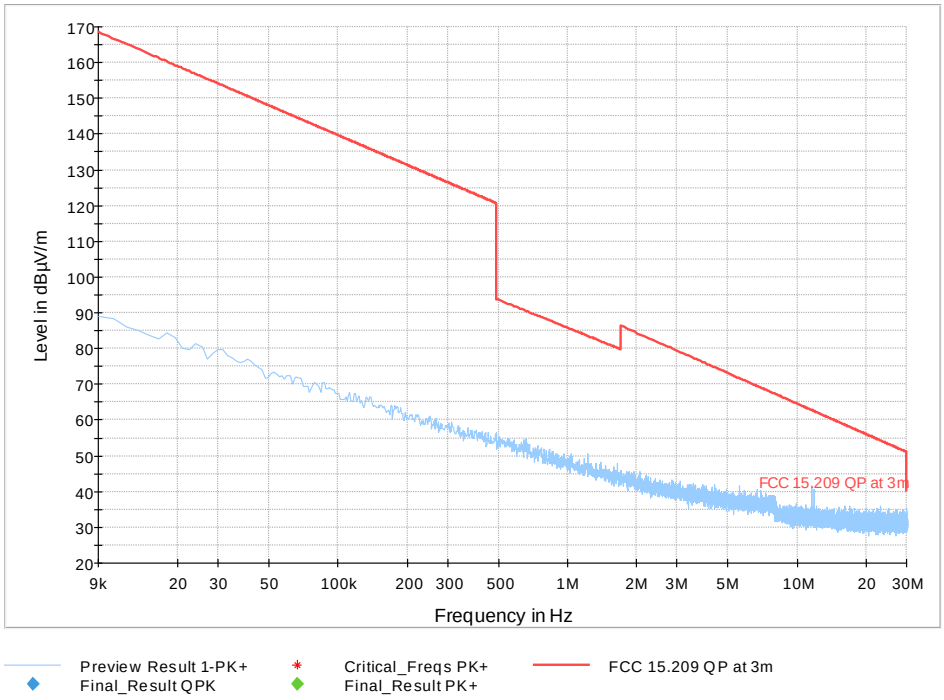


Preview Result 1-PK+ | FCC 15.209 PK at 3m | FCC 15.209 AVG at 3m
Final_Result PK+ | Final_Result CAV

Plot #3 Radiated Emissions: 3-18 GHz	
Modulation: BTLE	**Channel: Low**



Plot #4 Radiated Emissions: 9 KHz – 30 MHz	
Modulation: BTLE	**Channel: Mid**

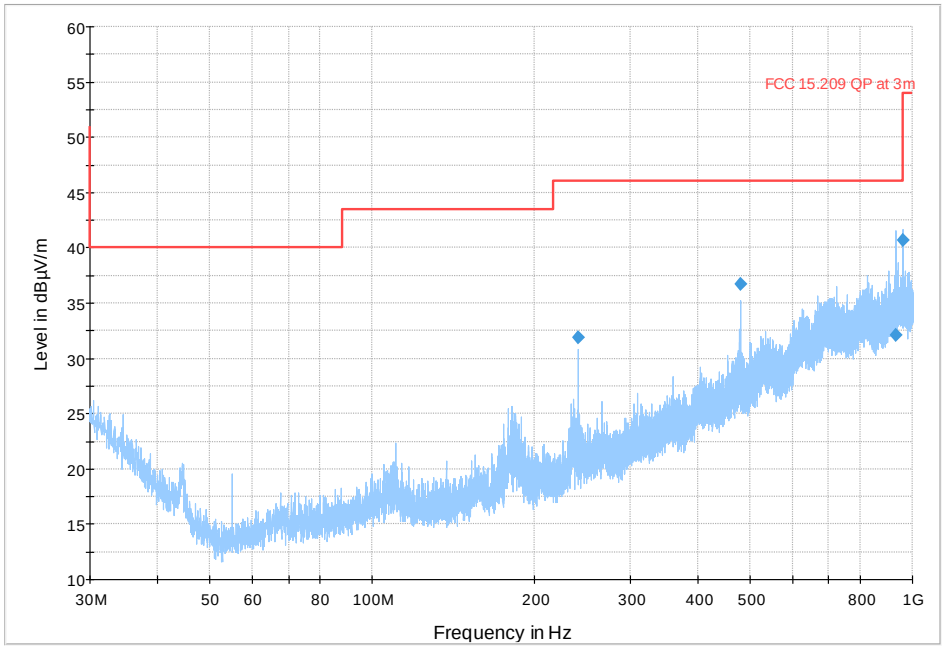


Plot #5 Radiated Emissions: 30 MHz – 1GHz

Modulation: BTLE | **Channel: Mid**

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
240.005	31.86	---	46.02	14.16	500.0	120.000	140.0	H	136.0	17.0	
480.015	36.67	---	46.02	9.35	500.0	120.000	198.0	H	193.0	23.6	
929.675	32.07	---	46.02	13.95	500.0	120.000	210.0	H	8.0	30.3	
960.036	40.72	---	53.98	13.26	500.0	120.000	163.0	V	192.0	30.8	



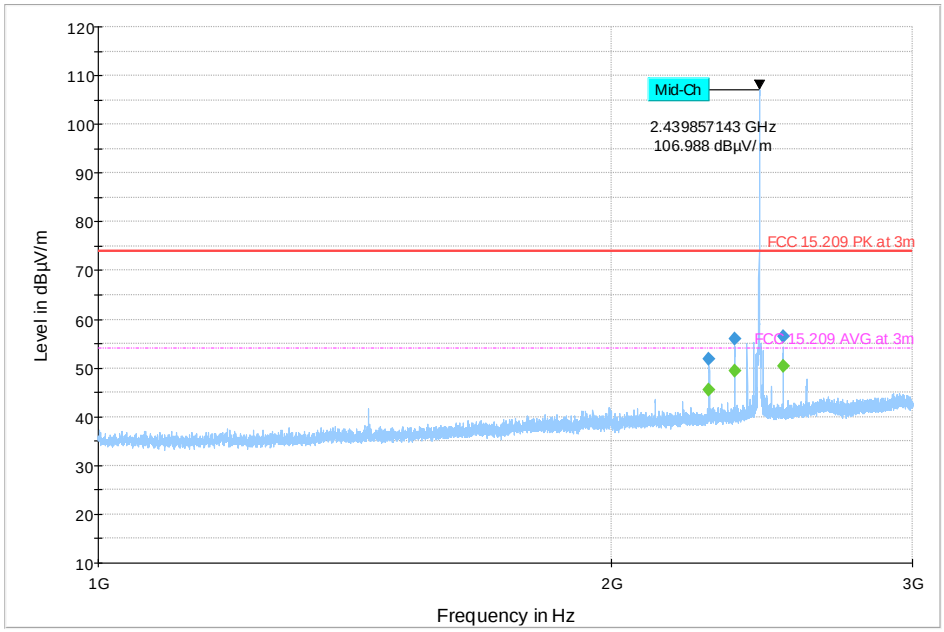
Preview Result 1-PK+ | FCC 15.209 QP at 3m | Final_Result QPK | Final_Result PK+

Plot #6 Radiated Emissions: 1-3 GHz

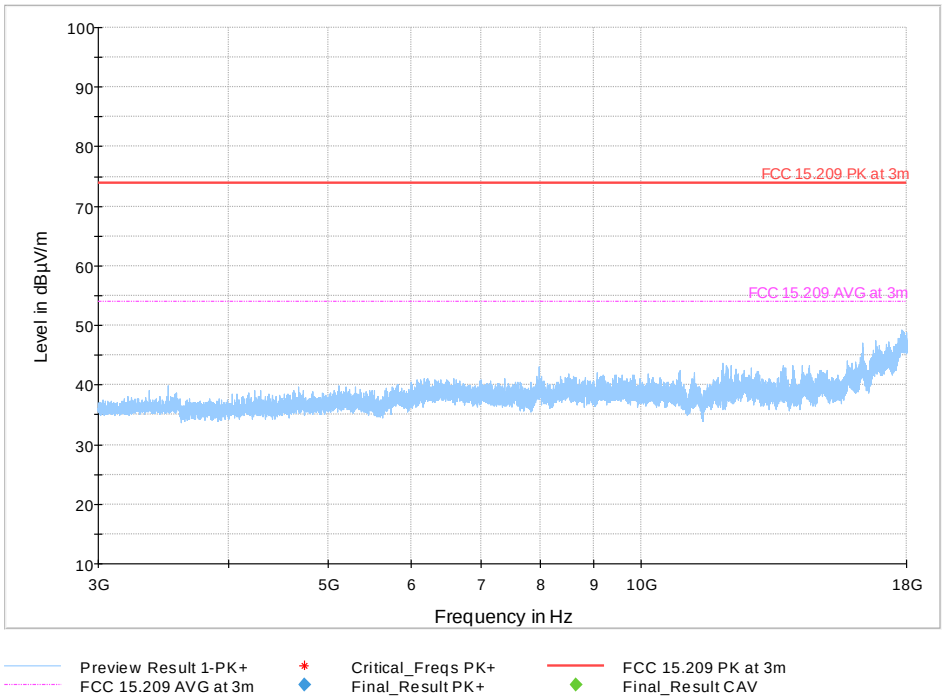
Modulation: BTLE | **Channel: Mid**

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
2280.286	51.97	---	73.98	22.01	500.0	1000.000	140.0	V	221.0	9.1	
2280.286	---	45.64	53.98	8.34	500.0	1000.000	140.0	V	221.0	9.1	
2360.286	56.06	---	73.98	17.92	500.0	1000.000	163.0	V	65.0	9.2	
2360.286	---	49.40	53.98	4.58	500.0	1000.000	163.0	V	65.0	9.2	
2519.857	---	50.45	53.98	3.53	500.0	1000.000	196.0	V	345.0	9.9	
2519.857	56.39	---	73.98	17.59	500.0	1000.000	196.0	V	345.0	9.9	

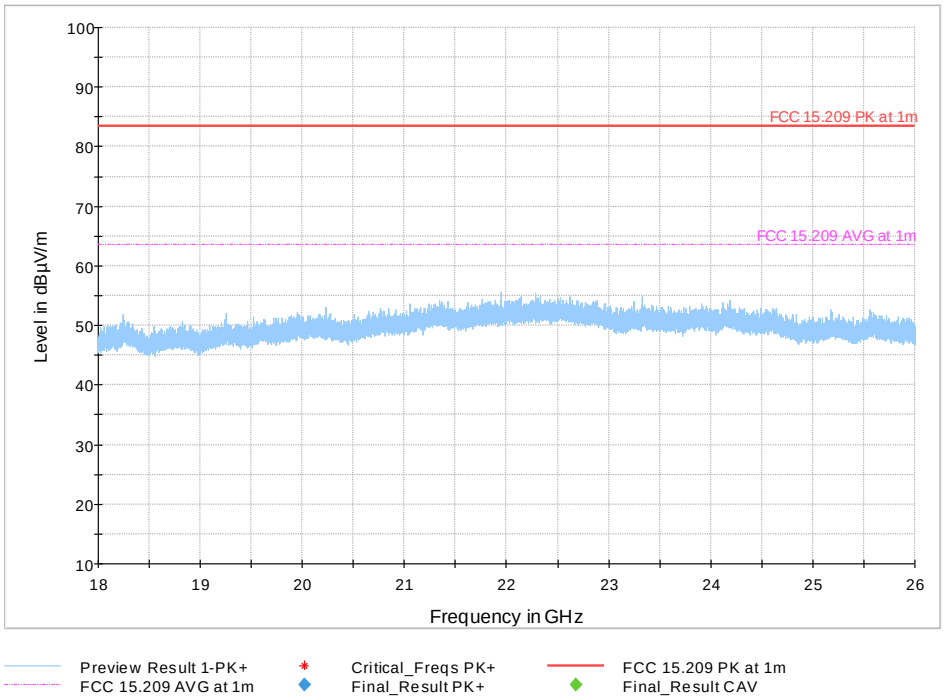


Plot #7 Radiated Emissions: 3-18 GHz	
Modulation: BTLE	**Channel: Mid**



Plot #8 Radiated Emissions: 18-26 GHz

Modulation: BTLE	Channel: Mid

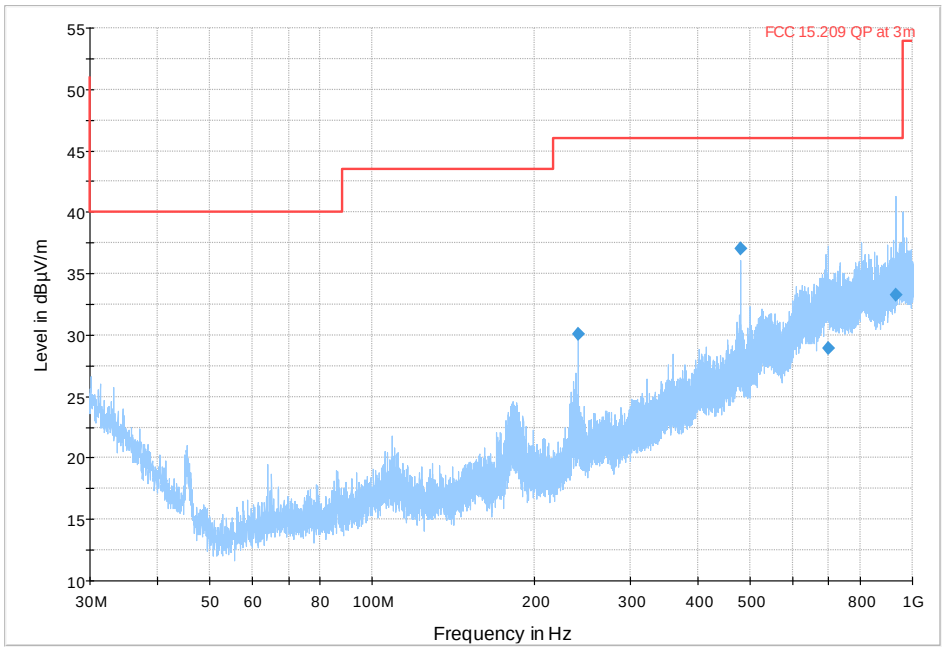


Plot #9 Radiated Emissions: 30 MHz – 1GHz

Modulation: BTLE | **Channel: High**

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
239.973	30.11	---	46.02	15.91	500.0	120.000	173.0	H	129.0	17.0	
480.015	37.04	---	46.02	8.98	500.0	120.000	197.0	H	192.0	23.6	
697.295	28.93	---	46.02	17.09	500.0	120.000	309.0	V	272.0	29.1	
929.675	33.25	---	46.02	12.77	500.0	120.000	173.0	V	214.0	30.3	



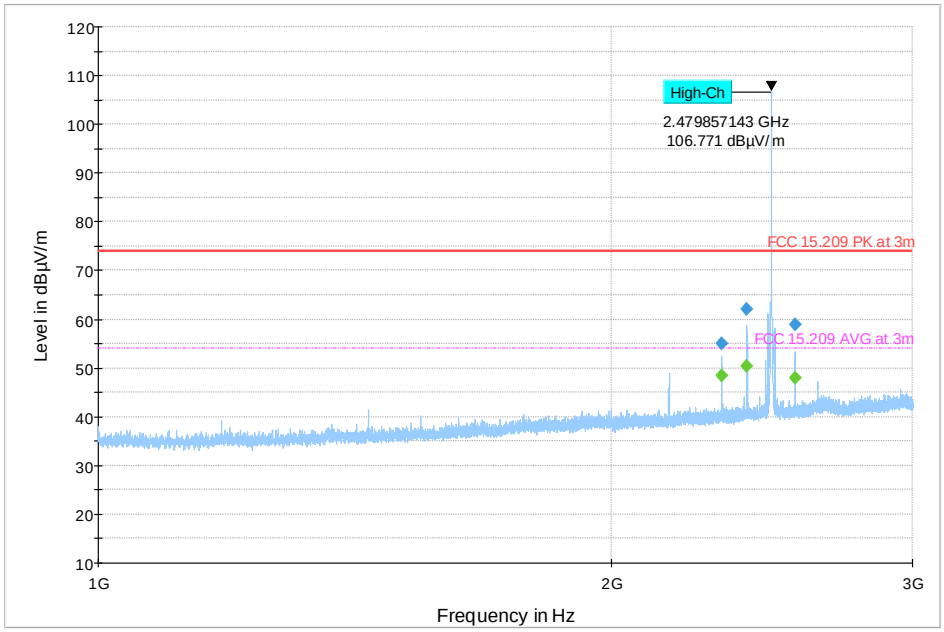
Preview Result 1-PK+ | FCC 15.209 QP at 3m | Final_Result QPK | Final_Result PK+

Plot #10 Radiated Emissions: 1-3 GHz

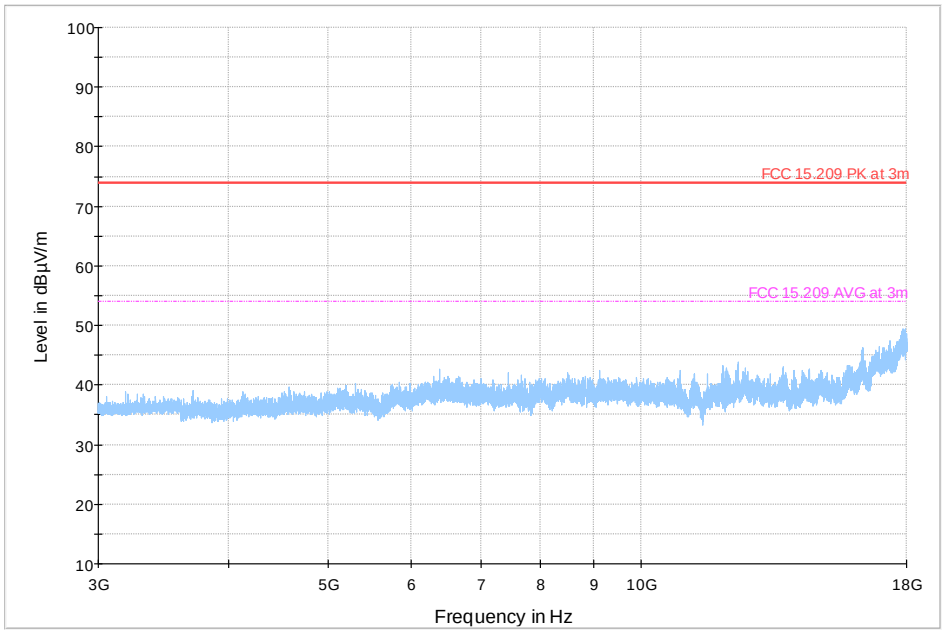
Modulation: BTLE | **Channel: High**

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
2319.714	---	48.43	53.98	5.55	500.0	1000.000	195.0	V	333.0	9.2	
2319.714	54.92	---	73.98	19.06	500.0	1000.000	195.0	V	333.0	9.2	
2400.143	62.00	---	73.98	11.98	500.0	1000.000	163.0	V	25.0	9.2	
2400.143	---	50.31	53.98	3.67	500.0	1000.000	163.0	V	25.0	9.2	
2560.286	58.97	---	73.98	15.01	500.0	1000.000	140.0	V	71.0	10.1	
2560.286	---	47.90	53.98	6.08	500.0	1000.000	140.0	V	71.0	10.1	



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



Preview Result 1-PK+ Critical_Freqs PK+ FCC 15.209 PK at 3m
FCC 15.209 AVG at 3m Final_Result PK+ Final_Result CAV

9 Test setup photos

Setup photos are included in supporting file name: “EMC_INNOP_008_20001_Setup_Photos_INP1011.pdf”

10 Test Equipment And Ancillaries Used For Testing

Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
PASSIVE LOOP ANTENNA	ETS.LINDGREN	6507	00161344	3 YEARS	10/26/2017
BILOG ANTENNA	ETS.LINDGREN	3142	00166067	3 YEARS	03/12/2020
HORN ANTENNA	ETS.LINDGREN	3115	00035111	3 YEARS	04/17/2019
HORN ANTENNA	ETS.LINDGREN	3117	00215984	3 YEARS	01/26/2018
HORN ANTENNA	ETS.LINDGREN	3116	00070497	3 YEARS	10/31/2017
SIGNAL ANALYZER	R&S	FSU26	200065	3 YEARS	07/16/2019
SIGNAL ANALAYZER	R&S	FSV 40	101022	3 YEARS	07/15/2019
TEST RECEIVER	R&S	ESU.EMI	100256	3 YEARS	07/16/2019
COMPACT DIGITAL BAROMETER	CONTROL COMPANY	10510-922	200236891	3 YEARS	04/13/2020
DIGITAL THRMOMETER	CONTROL COMPANY	36934-164	181230565	2 YEARS	01/10/2019

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	Report Name	Changes to report	Report prepared by
2020-09-11	EMC_INNOP_008_20001_15.247_BT_DTS_INP1011	Initial version	Yuchan Lu

<<The End>>