FCC / IC Test Report

FOR:
Pratt & Whitney Canada

Model Number:
MFAST-A-010-2

Product Description:
Data collection from Pratt & Whitney Engine Control LRU and wireless transmission of data to analytics center.

FCC ID: 2AJ6A-DCTU1
IC ID: 22451-DCTU1

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

REPORT #: EMC_ PRATT_004_19001_15.247_WLAN

DATE: 2019-12-13

A2LA Accredited

IC recognized # 3462B-2

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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 Issue 2.

No deviations were ascertained.

Company	Description	Model #
Pratt & Whitney Canada	Data collection from Pratt & Whitney Engine Control LRU and wireless transmission of data to analytics center.	MFAST-A-010-2

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2019-12-13	Compliance	Cindy Li (EMC Lab Manager)	Cindy Li Digitally signed by cindy.li@cetecom.com DN: CN=cindy.li@cetecom.com Reason: I am approving this document Location: Date: 2019-12-13 16:05:10

Responsible for the Report:

Date	Section	Name	Signature
2019-12-13	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: 2019.12.13 14:29:35 -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:	Pratt & Whitney Canada
Street Address:	249 Vanderbilt Avenue
City/Zip Code:	Norwood, MA 02062
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:	MFAST-A-010-2
HW Version :	A
SW Version :	1.0.0
FCC-ID:	2AJ6A-DCTU1
IC-ID:	22451-DCTU1
HVIN:	MFAST-A-010-2
PMN:	Data Collection and Transmission Unit
Product Description:	Data collection from Pratt & Whitney Engine Control LRU and wireless transmission of data to analytics center.
Frequency Range / number of channels:	Module name: Ti-Wi BLE Module number: TFB-TIWI1-01 / 5969A-TIWI101 Nominal band: 2400 MHz – 2483.5 MHz; Center to center: 2412 MHz (ch 1) – 2462 MHz (ch 11), 11 channels
Type(s) of Modulation:	BPSK, QPSK, 16-QAM, 64QAM
Modes of Operation:	802.11b/g/n, 20MHz
Antenna Information as declared:	Larsen, P/N:W5001 FSMAF, 1.5 dBi
Max. Average Output Power:	Conducted Power 0.093 W
Power Supply/ Rated Operating Voltage Range:	Battery / Vmin: 22 VDC/ Vnom: 28 VDC / Vmax: 32.2 VDC
Operating Temperature Range:	-40 ºC to +70 ºC
Other Radios included in the device:	❖ GSM, WCDMA, LTE • Module name: Gemalto • Model number: PLS62-W • FCC/IC ID: QIPPLS62-W / 7830A-PLS62W
Sample Revision:	☐Prototype Unit; ■Production Unit; ☐Pre-Production

3.2 EUT Sample details

EUT #	IMEI Number	HW Version	SW Version	Notes/Comments
1	358244080037825	A	1.0.0	Radiated Emissions

3.3 Accessary Equipment

AE #	Comments
1	Power Cable
2	External Antenna: Larsen, P/N:W5001 FSMAF, 1.5 dBi Coaxial cable consisting of: • Straight SMA Plug, Amphenol-RF P/N: 901-9511-1 • Right Angle RP-SMA connector; Amphenol-RF P/N 132194RP • Coaxial Cable, RG400; 10 Ft. • A separate Cinch “plug to plug” adapter (142-0901-801) permits the RP-SMA antenna • Plug to connect to the straight SMA plug of the cable assembly above.

3.4 Support Equipment

SE #	Comments
1	Communication USB Cable

3.5 Test Sample Configuration

EUT Set-up #	Combination of SE used for test set up	Comments
1	EUT#1 + AE#1 + AE#2 + SE#1	Special commands through command window used to configure the WLAN radio to 802.11b low, mid and high channels at maximum output power provided by the client that will not be available to the end user. For radiated measurements, the external antenna was connected.

3.6 Justification for Worst Case Mode of Operation

During the testing process, the EUT was tested with transmitter sets on 802.11b low, mid and high channels with the maximum output power and the customer declared 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.

Testing procedures are based on 558074 D01 DTS Meas Guidance v04 – "GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER SECTION 15.247" - April 5, 2017, 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	-	☐	☐	■	Note1 Note2
§15.247(e) RSS-247 5.2(2)	Power Spectral Density	Nominal	-	☐	☐	■	Note1 Note2
§15.247(b)(1) RSS-247 5.4(4)	Maximum Conducted Output Power and EIRP	Nominal	-	☐	☐	■	Note1 Note2
§15.247(d) RSS-247 5.5	Band edge compliance Unrestricted Band Edges	Nominal	-	☐	☐	■	Note1 Note2
§15.247; 15.209; 15.205 RSS-Gen 8.9; 8.10	Band edge compliance Restricted Band Edges	Nominal	-	☐	☐	■	Note1 Note2
§15.247(d); §15.209 RSS-Gen 6.13	TX Spurious emissions-Radiated	Nominal	802.11b	■	☐	☐	Complies
§15.207(a) RSS Gen 8.8	AC Conducted Emissions	Nominal	-	☐	■	☐	Note1 Note3

Note1: NA= Not Applicable; NP= Not Performed.
Note2: Leveraged from module certification FCC ID: TFB-TIWI1-01
Note3: EUT is powered by 28VDC battery

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:

07/02/2019 - 07/11/2019

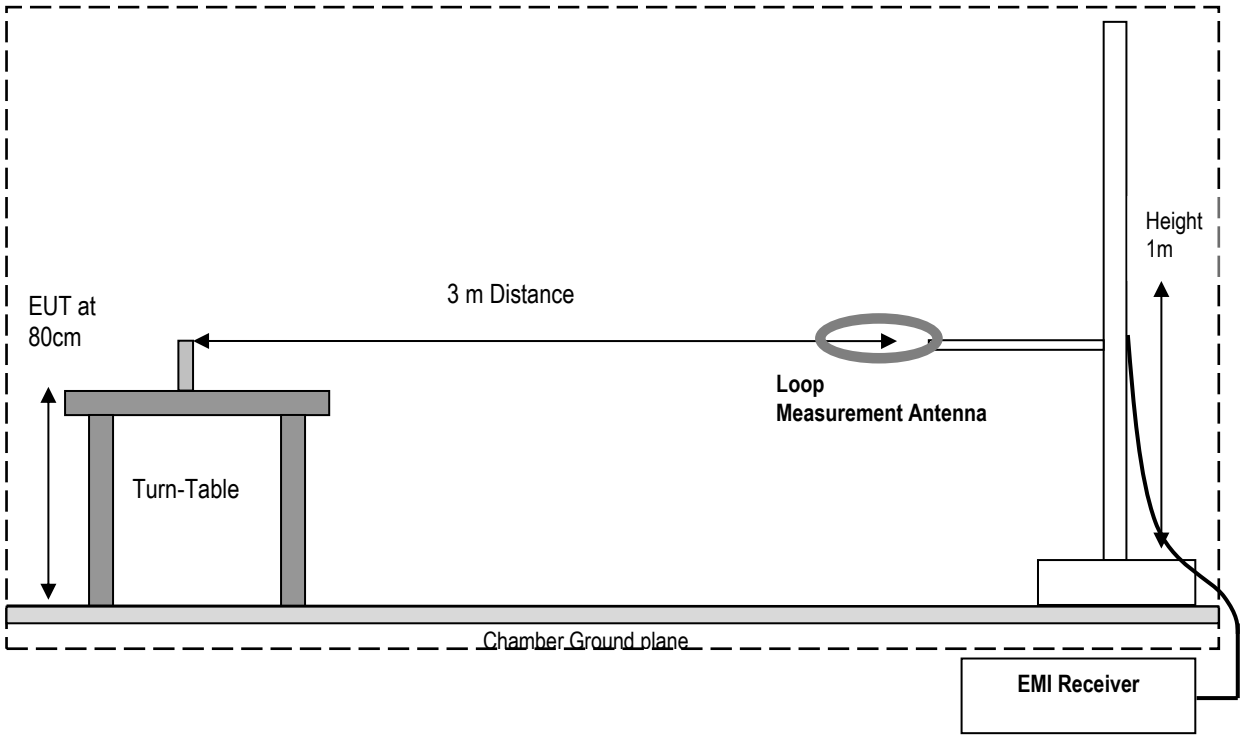
7 Measurement Procedures

7.1 Radiated Measurement

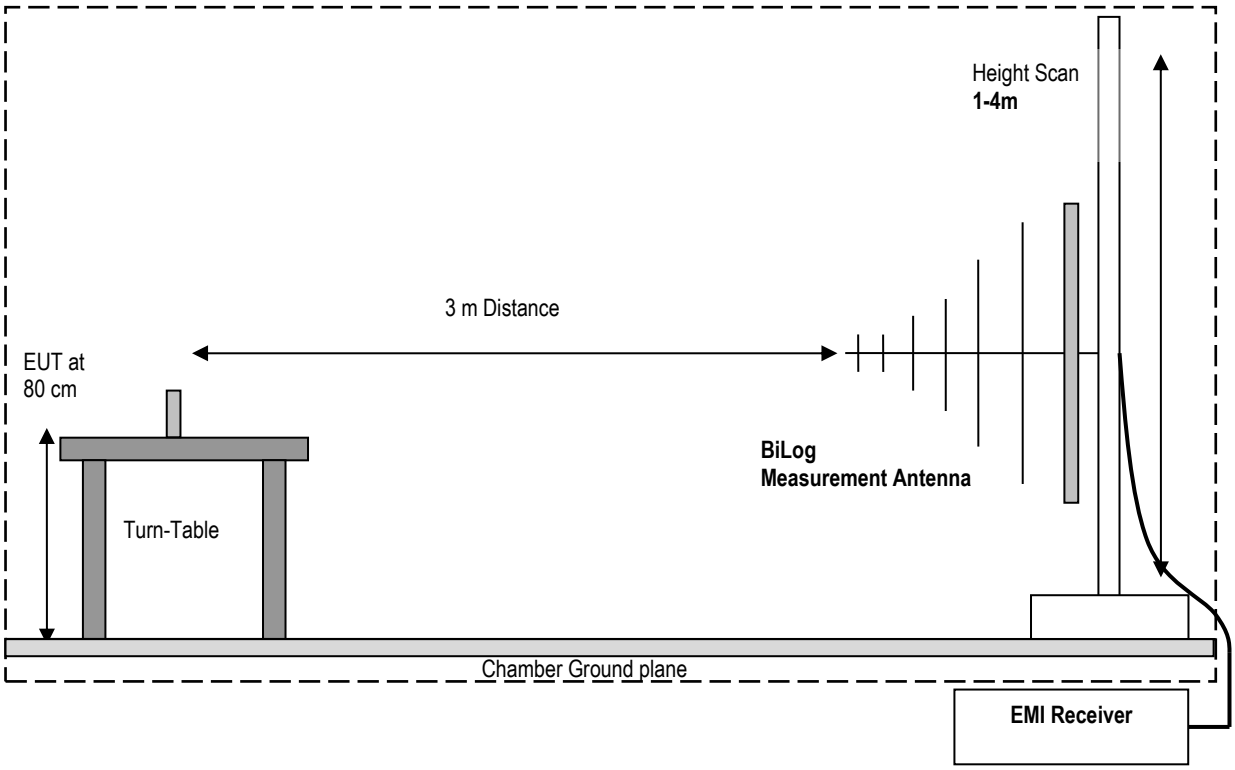
The radiated measurement is performed according to ANSI C63.10 (2013)

- 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.

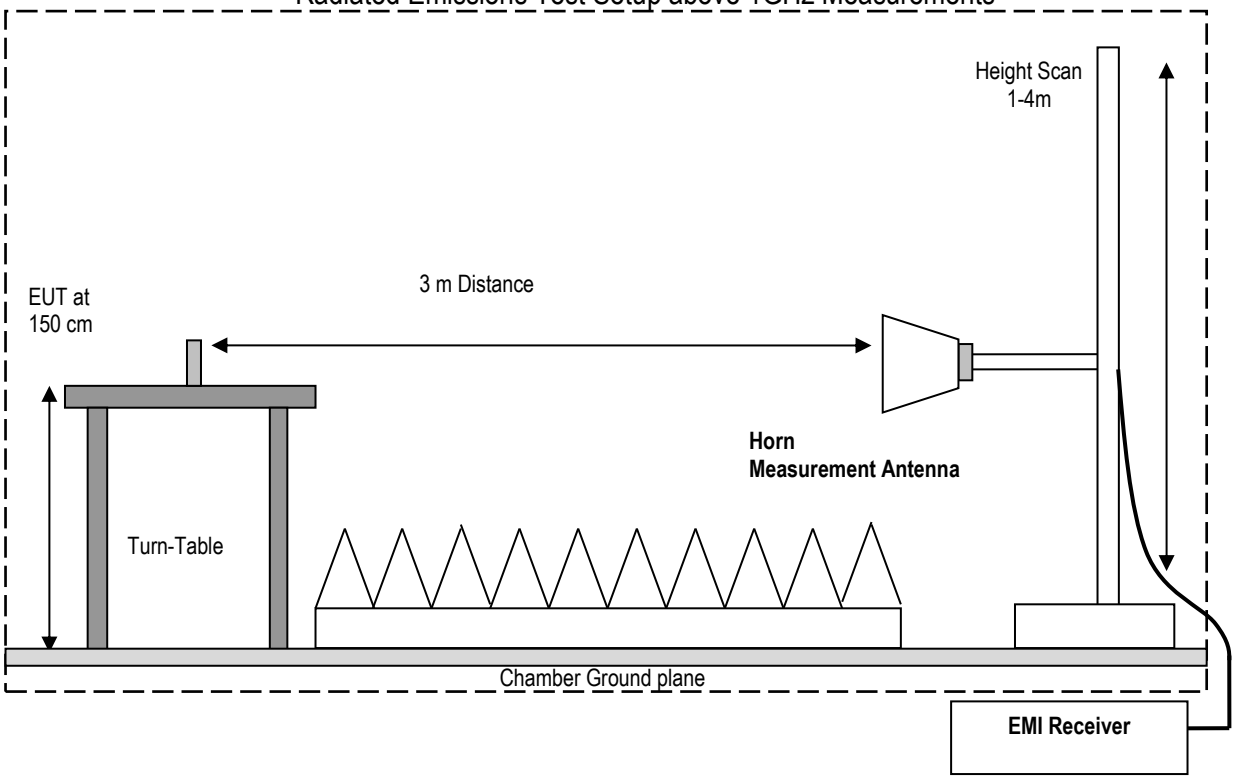
Radiated Emissions Test Setup below 30MHz Measurements



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:

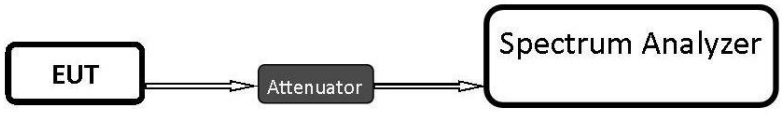
FS (dBµV/m) = Measured Value on SA (dBµV)- Cable Loss (dB)+ Antenna Factor (dB/m)

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 RF Conducted Measurement Procedure

Testing procedures are based on 558074 D01 DTS Meas Guidance v04 – "GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER SECTION 15.247" - April 5, 2017, 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.
- Calculate the conducted power by taking into account attenuation of the cable and the attenuator

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	802.11b	28 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

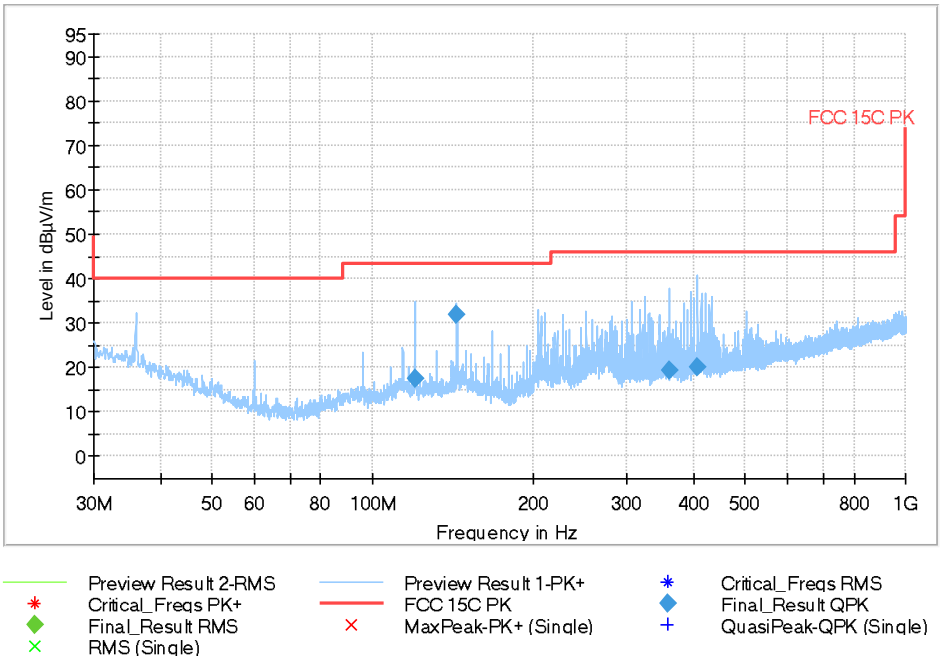
Modulation: 802.11b | **Channel: Low**

Final_Result

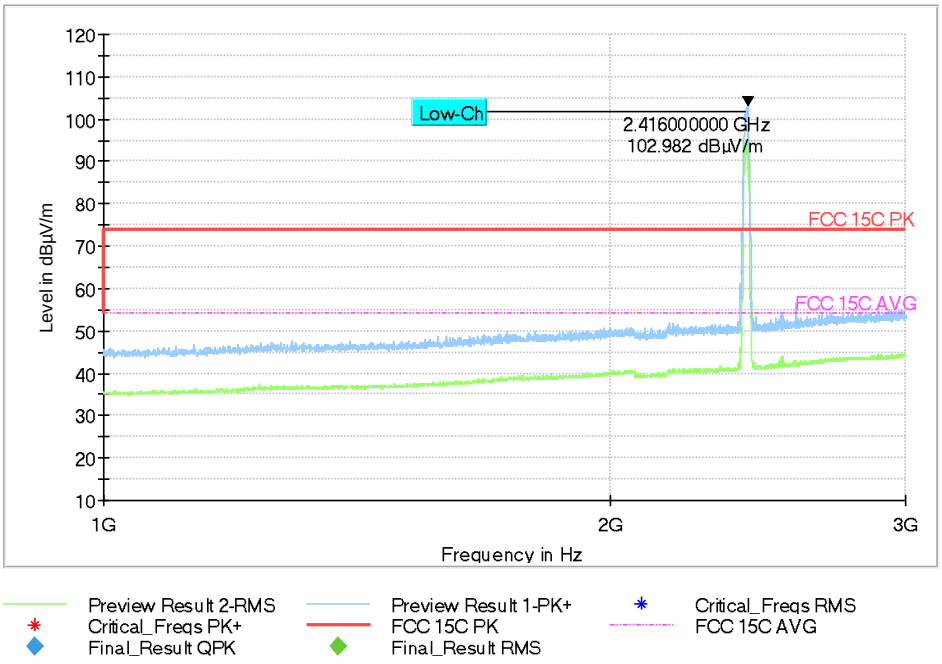
Frequency (MHz)	QuasiPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
360.005100	19.26	---	46.00	26.74	100.0	100.000	100.0	H
407.970700	19.97	---	46.00	26.03	100.0	100.000	139.0	V
119.999900	17.37	---	43.50	26.13	100.0	100.000	108.0	V
144.017900	31.77	---	43.50	11.73	100.0	100.000	124.0	V

(continuation of the "Final_Result" table from column 14 ...)

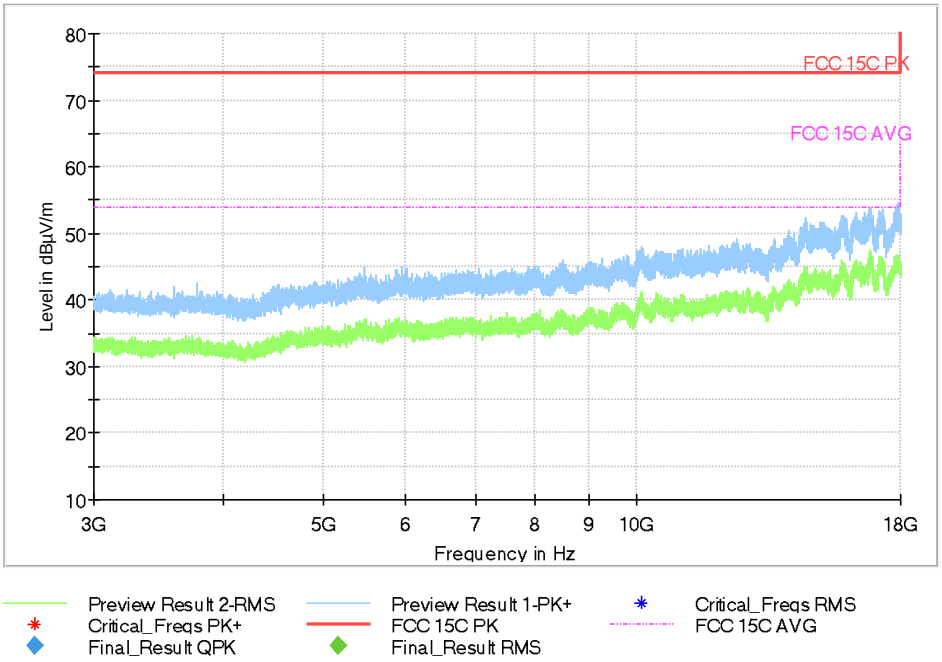
Frequency (MHz)	Azimuth (deg)	Corr. (dB/m)	Comment
360.005100	179.0	-15.5	11:12:37 AM - 7/9/2019
407.970700	5.0	-14.3	11:15:40 AM - 7/9/2019
119.999900	141.0	-19.8	11:21:30 AM - 7/9/2019
144.017900	201.0	-18.9	11:24:18 AM - 7/9/2019



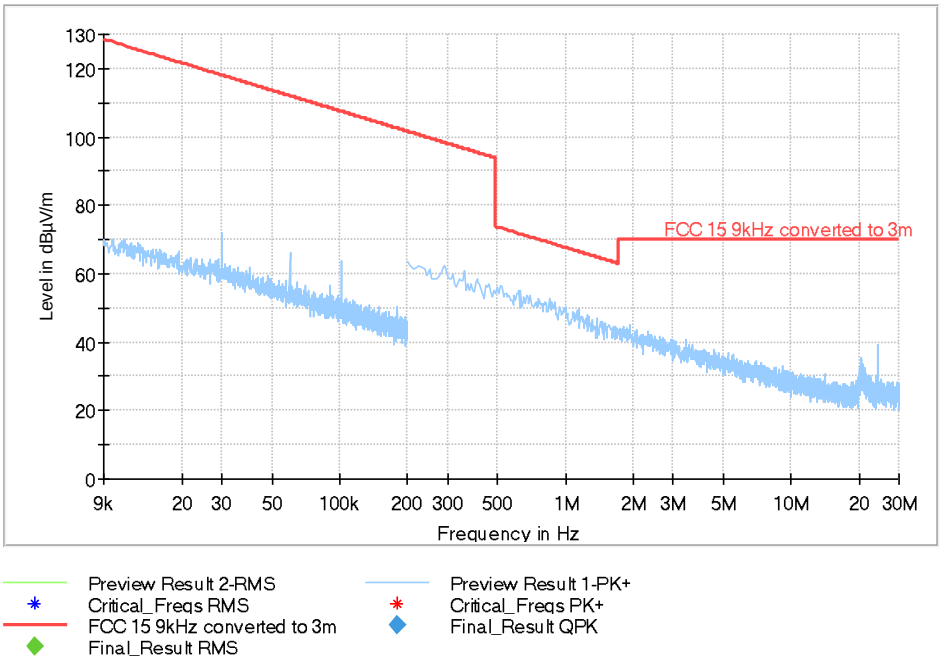
Plot #2 Radiated Emissions: 1-3 GHz	
Modulation: 802.11b	**Channel: Low**



Plot #3 Radiated Emissions: 3-18 GHz	
Modulation: 802.11b	**Channel: Low**



Plot #1 Radiated Emissions: 9 KHz – 30 MHz	
Modulation: 802.11b	**Channel: Mid**



Plot #5 Radiated Emissions: 30 MHz – 1GHz

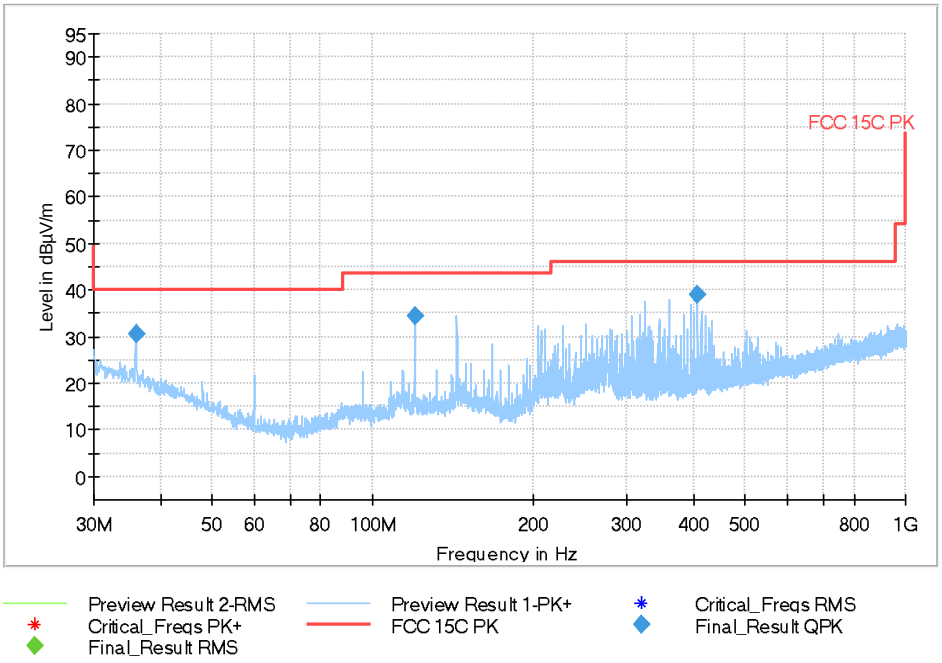
Modulation: 802.11b	Channel: Mid

Final_Result

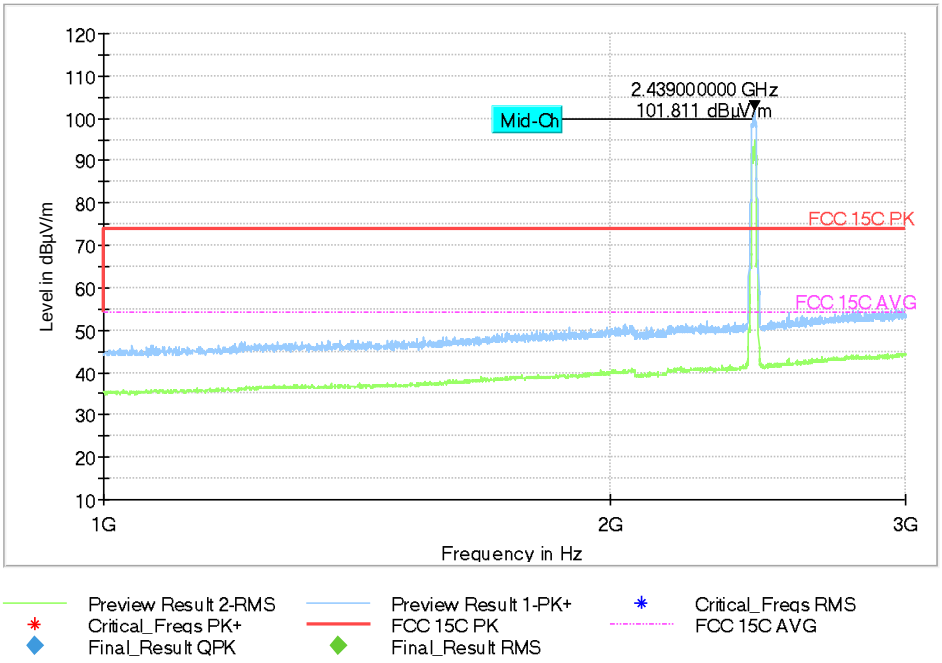
Frequency (MHz)	QuasiPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
36.022800	30.51	---	40.00	9.49	100.0	100.000	100.0	V
120.014600	34.53	---	43.50	8.97	100.0	100.000	100.0	V
408.010800	38.93	---	46.00	7.07	100.0	100.000	132.0	V

(continuation of the "Final_Result" table from column 14 ...)

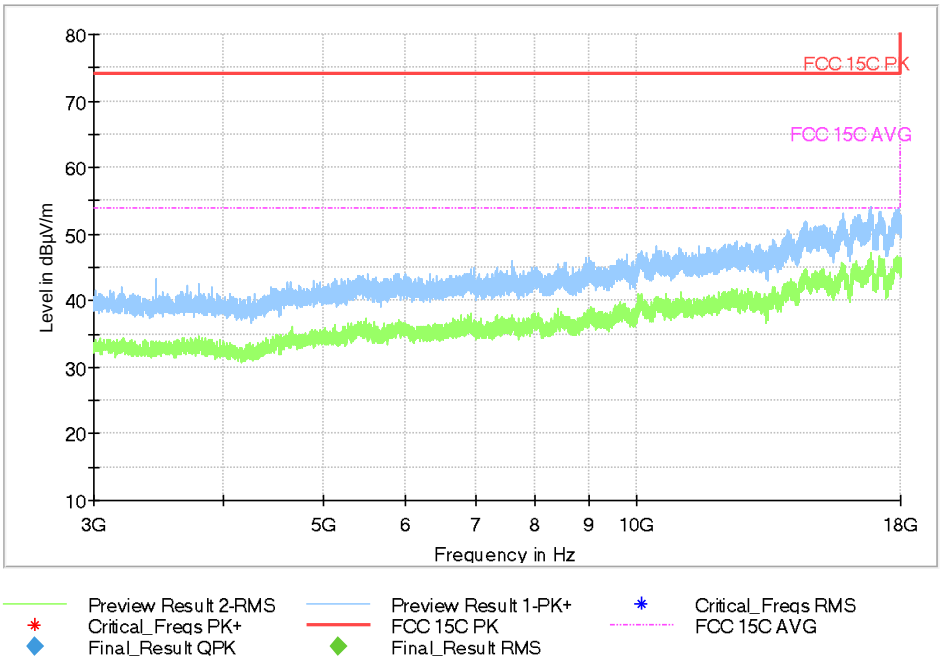
Frequency (MHz)	Azimuth (deg)	Corr. (dB/m)	Comment
36.022800	56.0	-13.0	11:36:29 AM - 7/9/2019
120.014600	135.0	-19.8	11:42:18 AM - 7/9/2019
408.010800	7.0	-14.3	11:39:16 AM - 7/9/2019



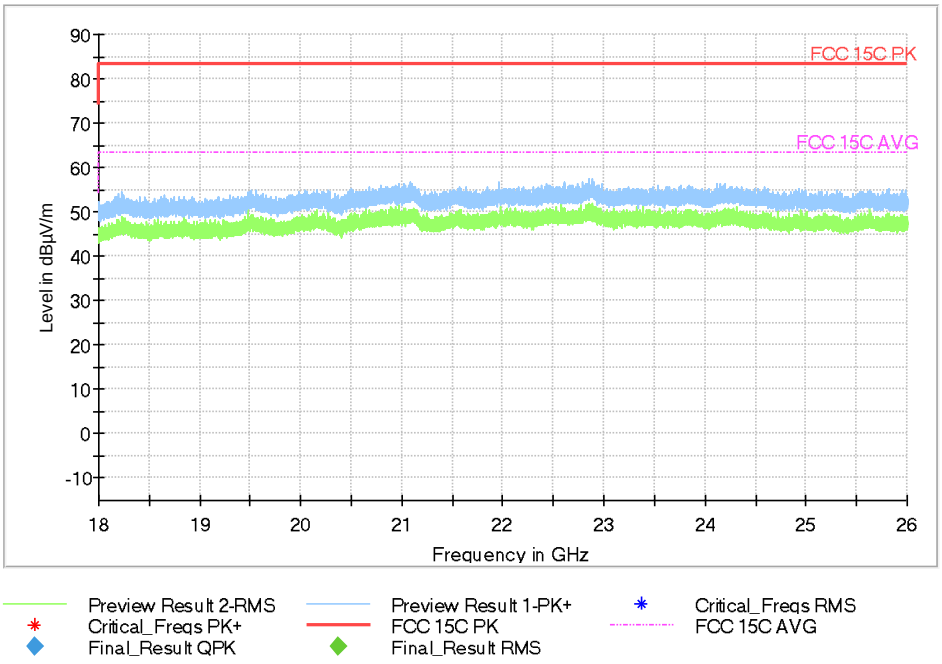
Plot #6 Radiated Emissions: 1-3 GHz	
Modulation: 802.11b	**Channel: Mid**



Plot #7 Radiated Emissions: 3-18 GHz	
Modulation: 802.11b	**Channel: Mid**



Plot #8 Radiated Emissions: 18-26 GHz	
Modulation: 802.11b	**Channel: Mid**



Plot #9 Radiated Emissions: 30 MHz – 1GHz

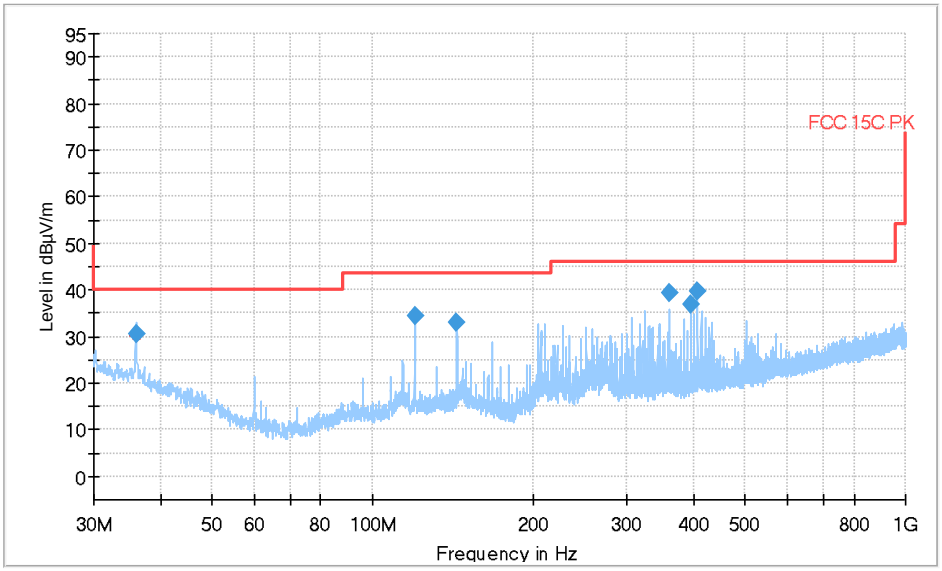
Modulation: 802.11b | **Channel: High**

Final_Result

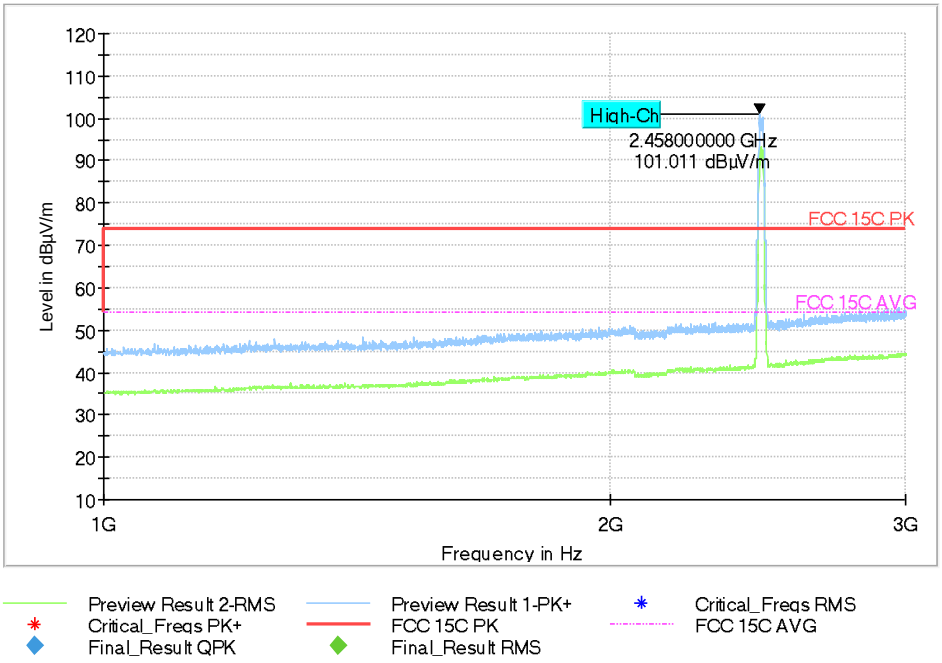
Frequency (MHz)	QuasiPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
36.016600	30.41	---	40.00	9.59	100.0	100.000	100.0	V
119.983500	34.51	---	43.50	8.99	100.0	100.000	108.0	V
143.998200	33.03	---	43.50	10.47	100.0	100.000	100.0	V
359.994800	39.27	---	46.00	6.73	100.0	100.000	199.0	H
395.986200	37.03	---	46.00	8.97	100.0	100.000	146.0	V
407.999600	39.65	---	46.00	6.35	100.0	100.000	147.0	V

(continuation of the "Final_Result" table from column 14 ...)

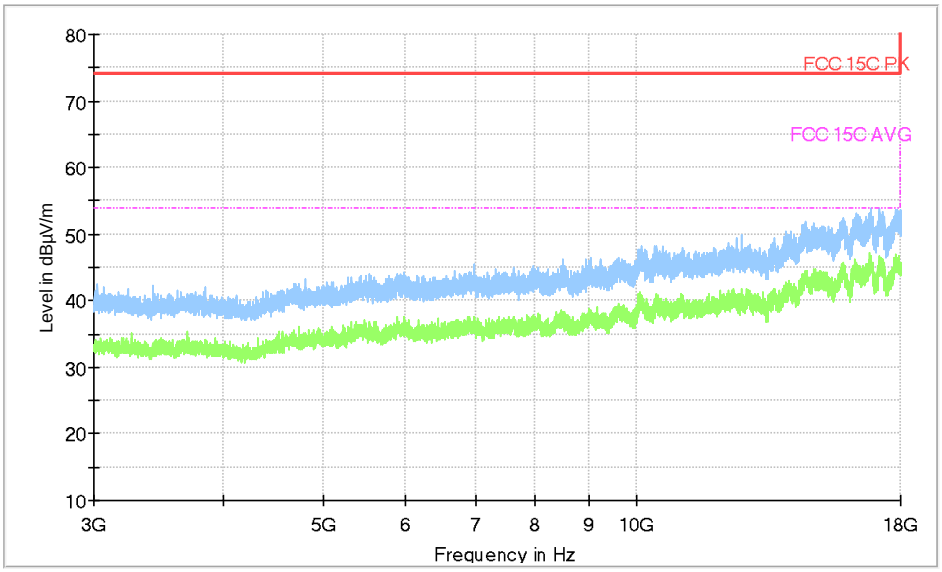
Frequency (MHz)	Azimuth (deg)	Corr. (dB/m)	Comment
36.016600	92.0	-13.0	10:47:50 AM - 7/9/2019
119.983500	130.0	-19.8	10:53:11 AM - 7/9/2019
143.998200	90.0	-18.9	10:50:26 AM - 7/9/2019
359.994800	182.0	-15.5	10:41:42 AM - 7/9/2019
395.986200	317.0	-15.0	10:56:09 AM - 7/9/2019
407.999600	3.0	-14.3	10:44:54 AM - 7/9/2019



Plot #10 Radiated Emissions: 1-3 GHz	
Modulation: 802.11b	**Channel: High**



Plot #11 Radiated Emissions: 3-18 GHz	
Modulation: 802.11b	**Channel: High**



9 Test setup photos

Setup photos are included in supporting file name: "EMC_PRATT_004_19001_ISED_Setup_Photos.pdf"

10 Test Equipment and Ancillaries Used For Testing

Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
PASSIVE LOOP ANTENNA	ETS LINDGREN	6512	00164698	3 YEARS	08/08/2017
BILOG ANTENNA	TESEO	CBL 6141B	41106	3 YEARS	11/01/2017
HORN ANTENNA	EMCO	3115	00035114	3 YEARS	07/31/2017
HORN ANTENNA	ETS LINDGREN	3117	00167061	3 YEARS	08/08/2017
HORN ANTENNA	ETS LINDGREN	3116C	00166821	3 YEARS	09/24/2017
UNIVERSAL RADIO COMMUNICATION TESTER	R&S	CMU 200	101821	3 YEARS	07/06/2017
WIDEBAND RADIO COMMUNICATION	R&S	CMW500	127068	3 YEARS	07/01/2017
SIGNAL ANALYZER	R&S	FSV 40	101022	3 YEARS	07/05/2017
COMPACT DIGITAL BAROMETER	CONTROL COMPANY	35519-055	91119547	3 YEARS	06/20/2017
DIGITAL THRMOMETER	CONTROL COMPANY	36934-164	191871994	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
2019-12-13	EMC_ PRATT_004_19001_15.247_WLAN	Initial version	Yuchan Lu