



FCC / ISED Test Report

FOR:
Telular AMETEK

Model Name:
SHB1000

Product Description:
SkyHub Wireless Telematics Hub

FCC ID: MTFSHB1000
IC ID: 2175D-SHB1000

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

REPORT #: EMC_TELUL_087_20001_15.247_BT_DTS_R1

DATE: 2020-11-04



A2LA Accredited

IC recognized #
3462B-1

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CETECOM Inc. is a Delaware Corporation with Corporation number: 2905571

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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 #
Telular AMETEK	SkyHub Wireless Telematics Hub	SHB1000

Responsible for Testing Laboratory:

2020-11-04	Compliance	Cindy Li (Lab Manager)	
Date	Section	Name	Signature

Responsible for the Report:

2020-11-04	Compliance	Yuchan Lu (Test Engineer)	
Date	Section	Name	Signature

The test results of this test report relate exclusively to the test item specified in Section 3.

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

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the EMC Test Report

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

2.2 Identification of the Client

Client's Name:	Telular AMETEK
Street Address:	3225 Cumberland Blvd, Suite 300
City/Zip Code:	Atlanta, GA 30339
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:	SHB1000
HW Version :	B
SW Version :	EM.00.01.1025,BM.00.01.1017,CM.00.01.1021
FCC-ID:	MTFSHB100
IC-ID:	2175D-SHB1000
HVIN:	SHB1000
PMN:	SkyHub
Product Description:	SkyHub Wireless Telematics Hub
Frequency Range / number of channels:	Module name: BL654 Module number: 451-00001 FCC/IC ID: SQGBL654 / 3147A-BL654 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:	PCB Trace 0 dBi
Max. Peak Output Power:	Conducted Power 7.56 dBm
Power Supply/ Rated Operating Voltage Range:	Low 10 VDC, Nominal 12 VDC, High 30 VDC
Operating Temperature Range:	Low -40°C, Nominal 25°C, High 70°C
Other Radios included in the device:	❖ <u>WCDMA, LTE</u> • Module name: LE910 • Module number: LE910B1-NA1 • FCC/IC ID: RI7LE910NAV2 / 5131A-LE910NAV2 ❖ <u>GPS</u> • Module name: L86 • Module number: L86s-M3 ❖ <u>ISM</u> • Module name: EFR32 • Module number: EFR32FG1P131F256GM32-C0

Sample Revision:	☐ Prototype Unit; ☐ Production Unit; ☒ Pre-Production
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3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	SHB5AKEY202600190	B	EM.00.01.1025,BM.00.01.1017,CM.00.01.1021	Radiated Emissions

3.3 Accessory Equipment details

AE #	Type	Manufacture	Model	P/N
1	DC Charging 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 Tera Term used to configure the BLE radio to low, mid and high channels, simultaneously transmitting with UMTS Band II mid channel provided by the client that will not be available to the end user. For radiated measurements, the internal antenna was connected.
2	EUT#1+ AE#1	Special commands through Tera Term 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 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, simultaneously transmitting with UMTS Band II mid channel. The EUT was configured to the highest duty cycle and maximum output power through commands. Intermodulation is present between 1 – 3 GHz, and plots #12 - #14 shows the BLE radio transmitting only.

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: SQGBL654

Note3: EUT is powered by 12VDC

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)
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RF conducted measurement	± 0.5 dB
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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:

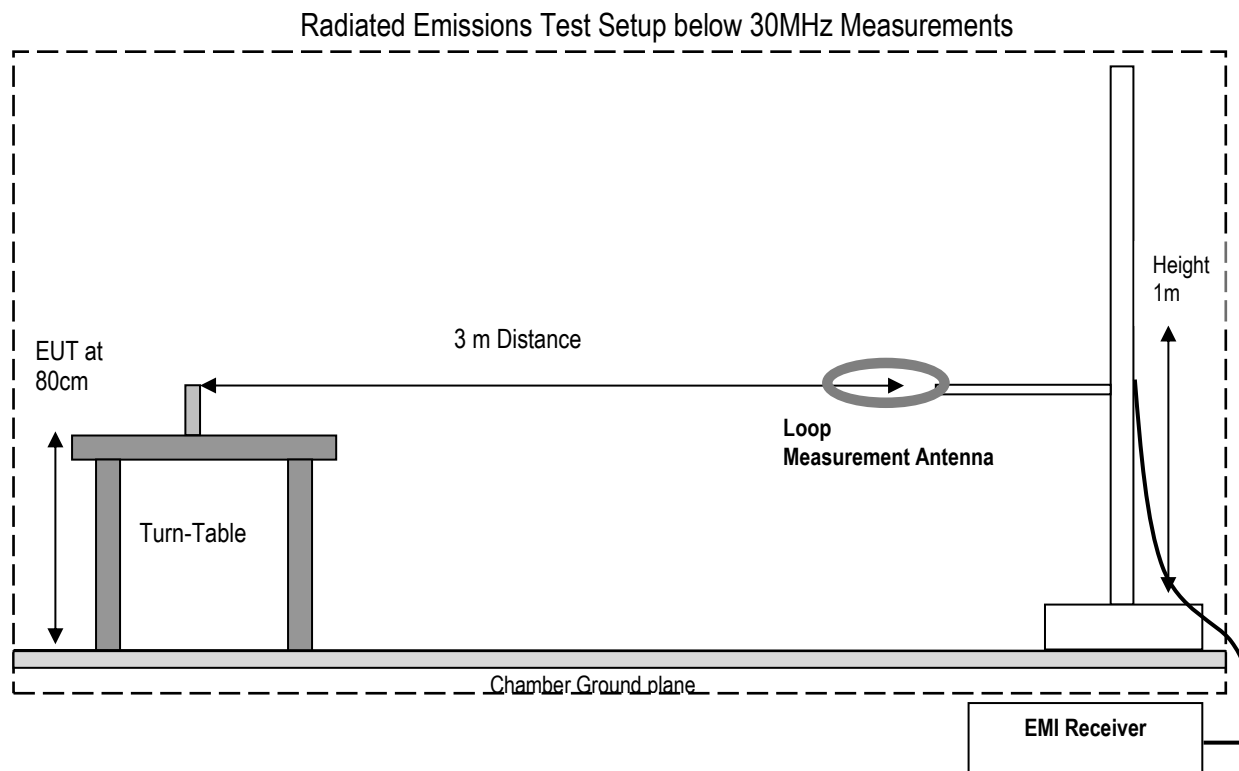
07/24/2020-07/31/2020

7 Measurement Procedures

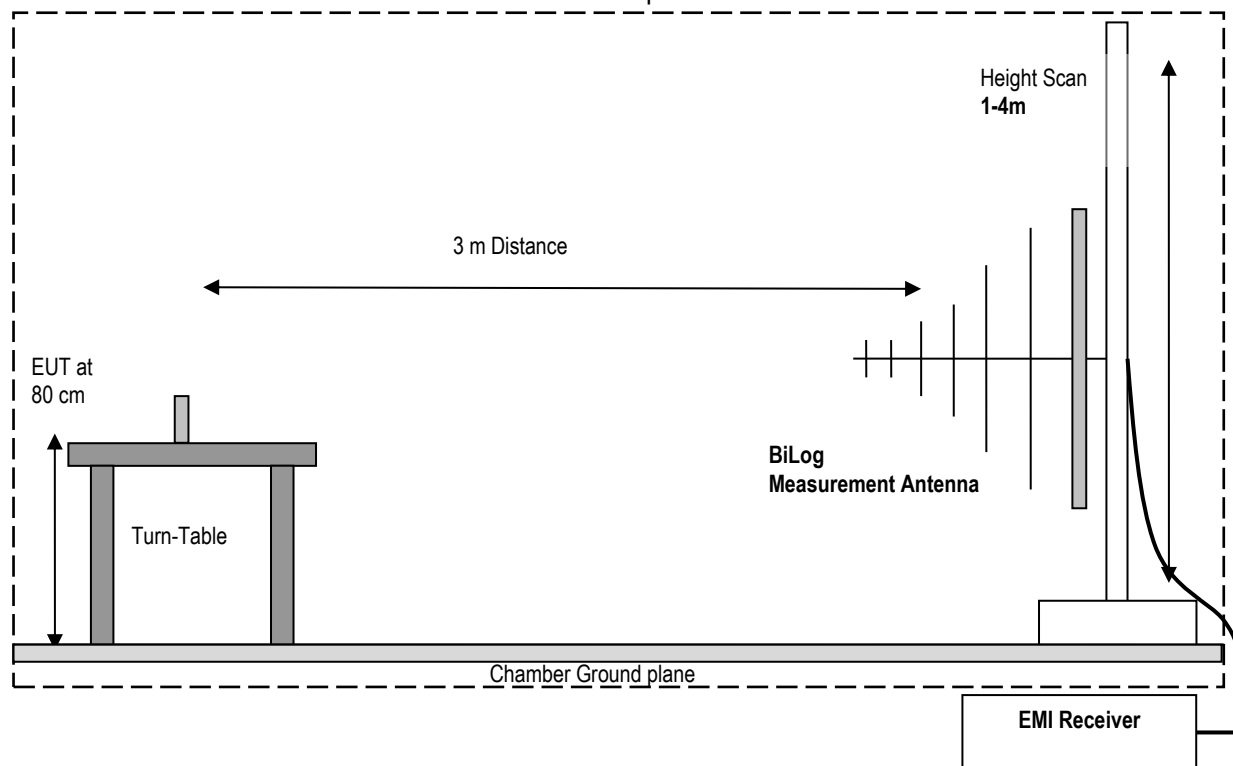
7.1 Radiated Measurement

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

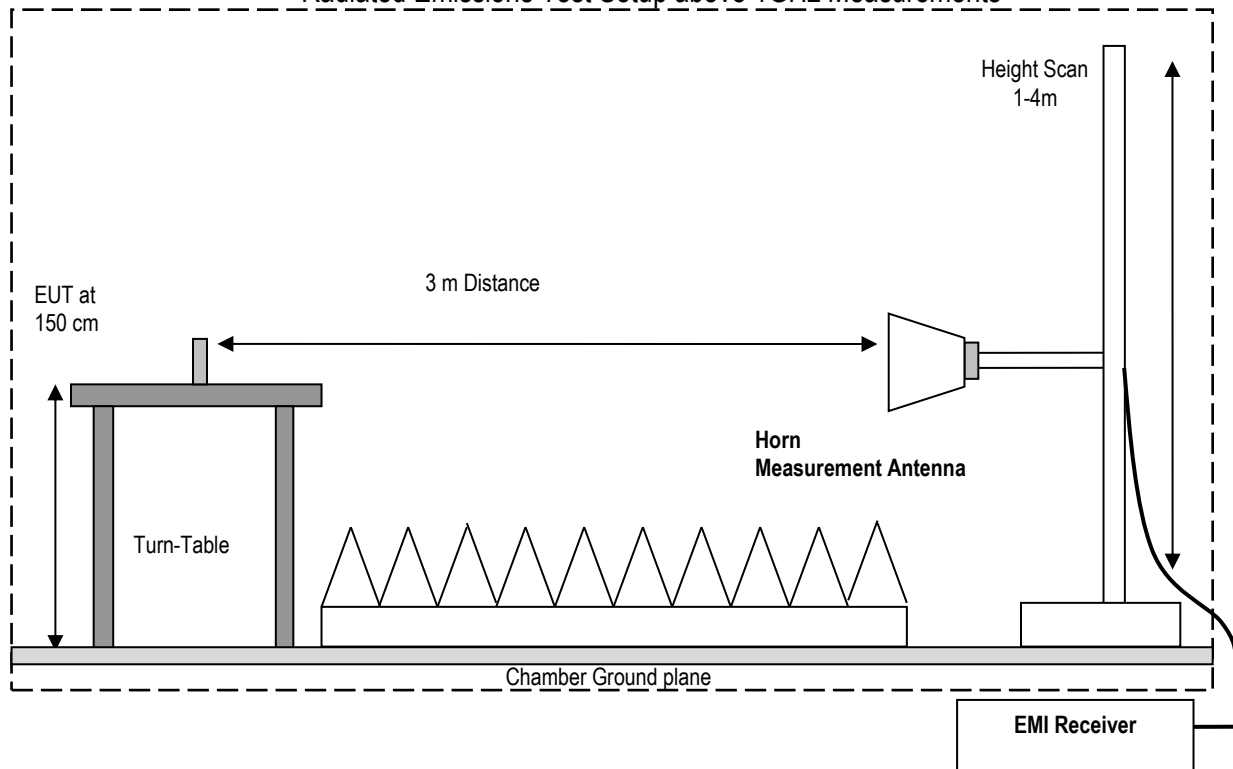
- The exploratory measurement is accomplished by running a matrix of 16 sweeps over the required frequency range with R&S Test-SW EMC32 for 4 positions of the turntable, two orthogonal positions of the EUT and both antenna polarizations. This procedure exceeds the requirement of the above standards to 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 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 dB μ V
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:

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

Example:

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

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) = $40 \log (D/d) = 40 \log (300\text{m} / 3\text{m}) = 80\text{dB}$

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
10.495-0.505	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

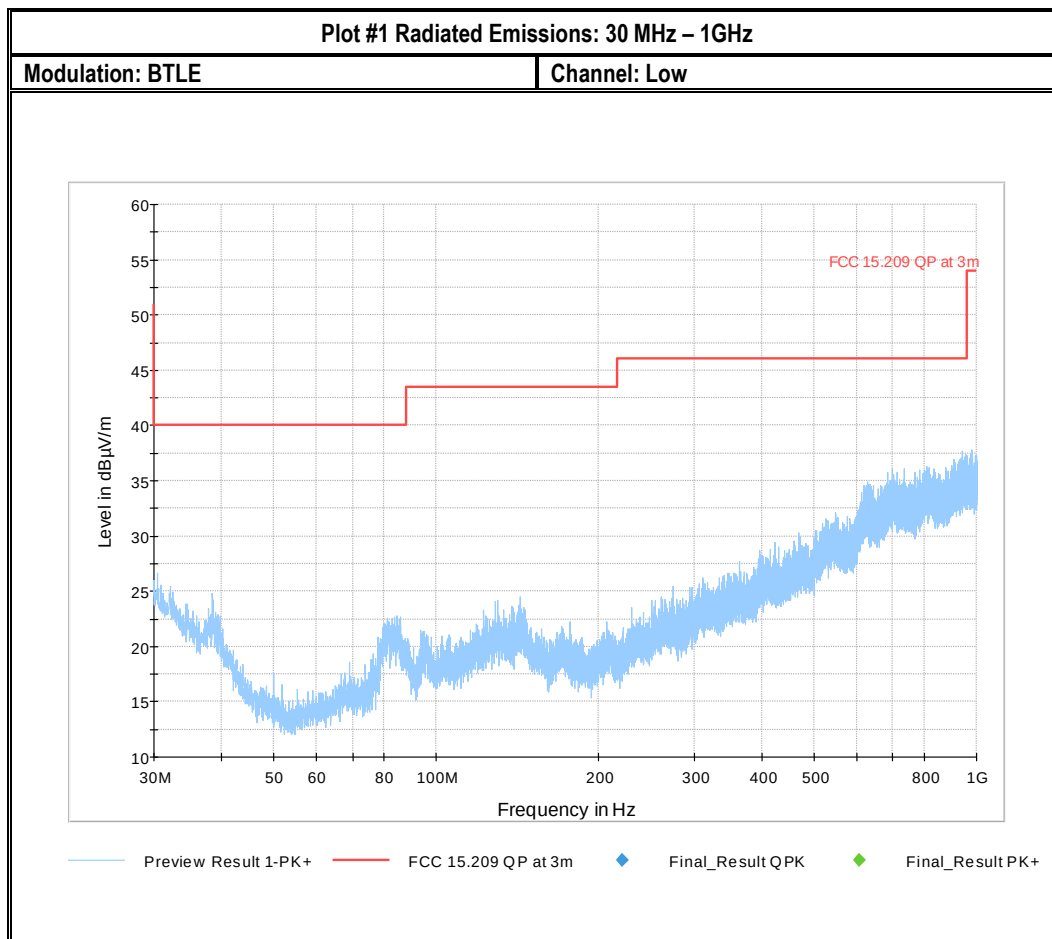
8.1.3 Test conditions and setup:

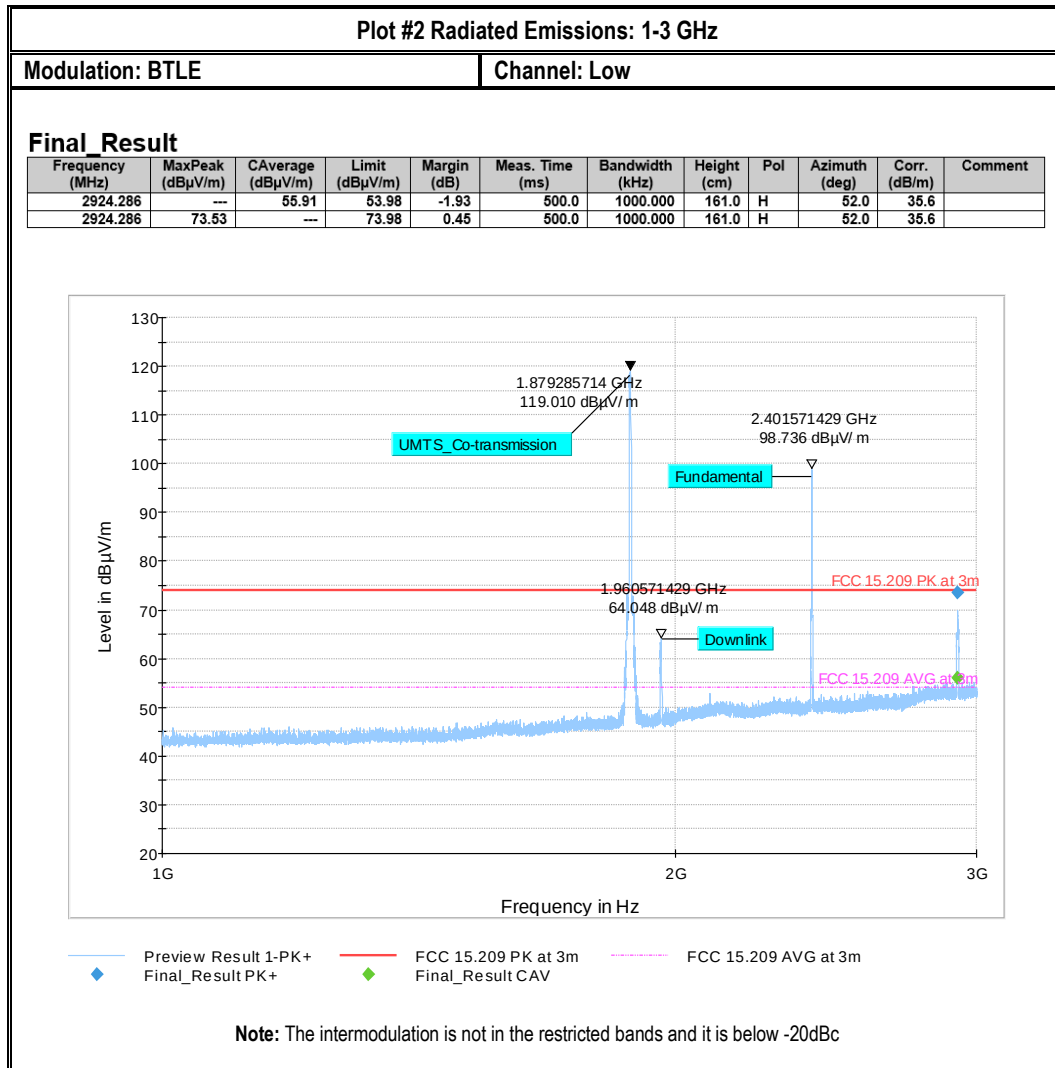
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	BTLE	12 VDC

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:





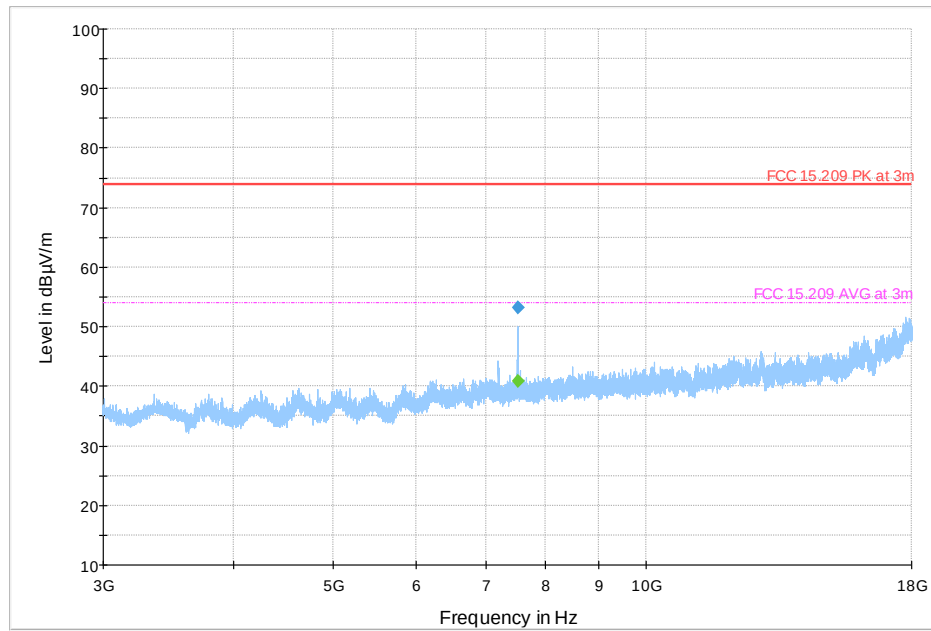
Plot #3 Radiated Emissions: 3-18 GHz

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
7525.000	---	40.95	53.98	13.03	500.0	1000.000	140.0	V	17.0	0.0	
7525.000	53.15	---	73.98	20.83	500.0	1000.000	140.0	V	17.0	0.0	

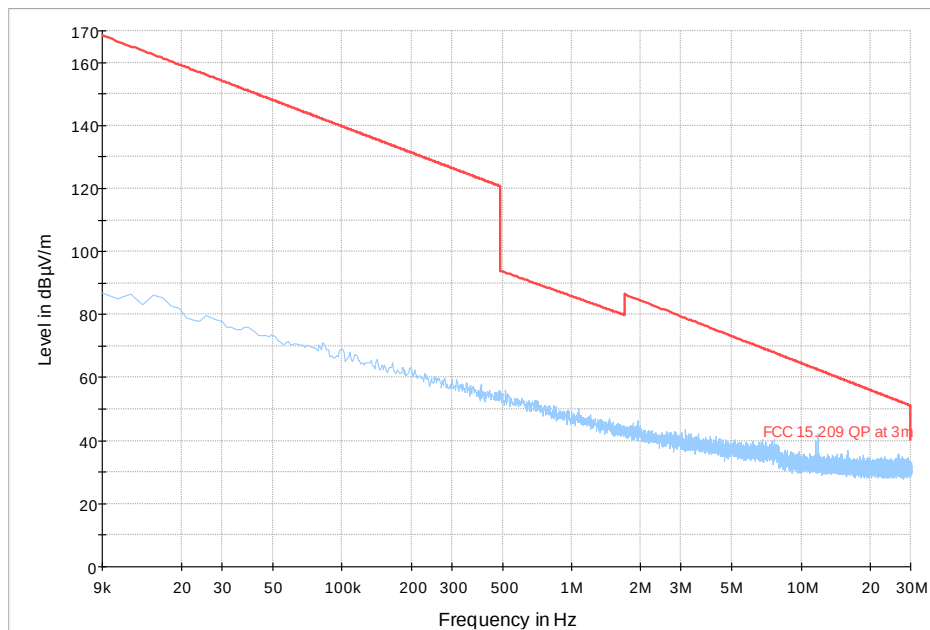


◆ Preview Result 1-PK+ Final_Result PK+
 — FCC 15.209 PK at 3m
 — FCC 15.209 AVG at 3m
 ◆ Final_Result CAV

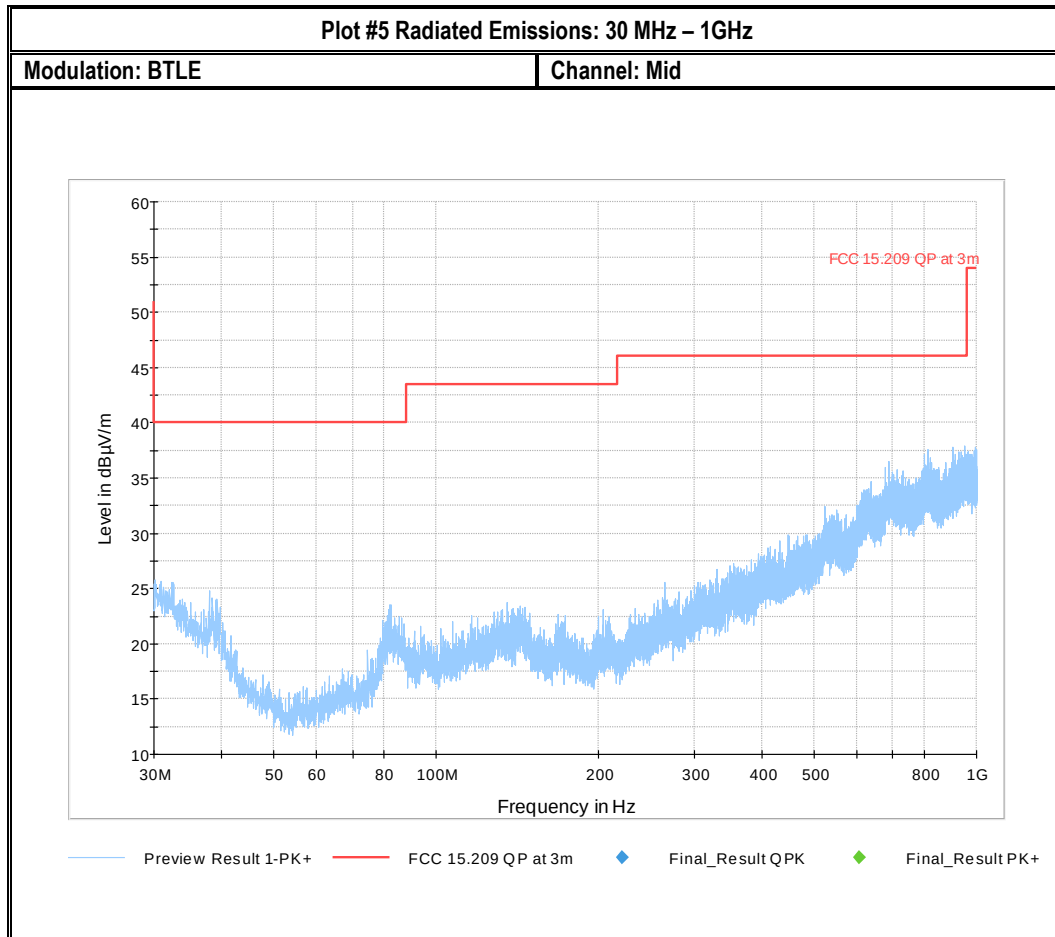
Plot #4 Radiated Emissions: 9 KHz – 30 MHz

Modulation: BTLE

Channel: Mid



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



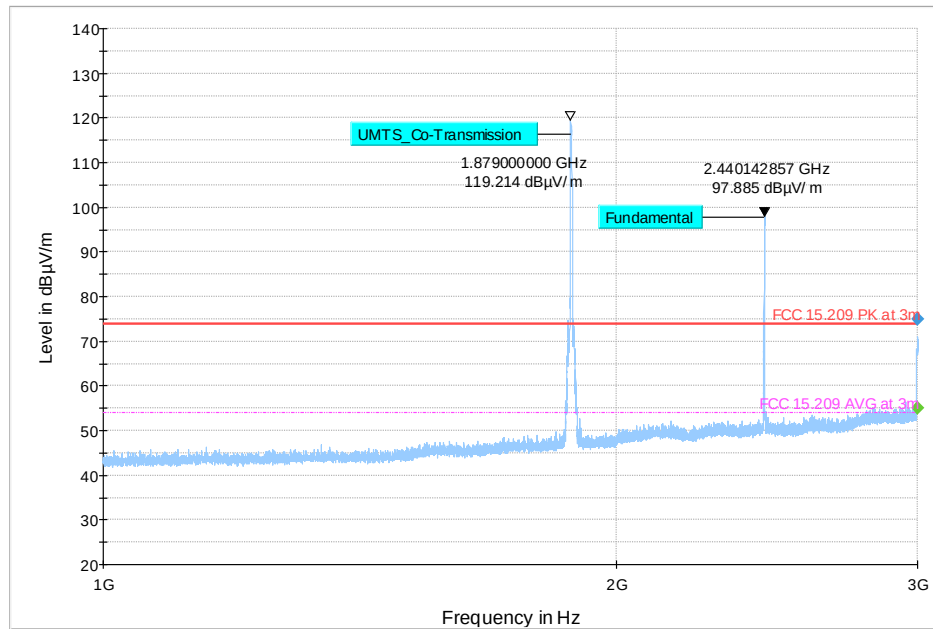
Plot #6 Radiated Emissions: 1-3 GHz

Modulation: BTLE

Channel: Mid

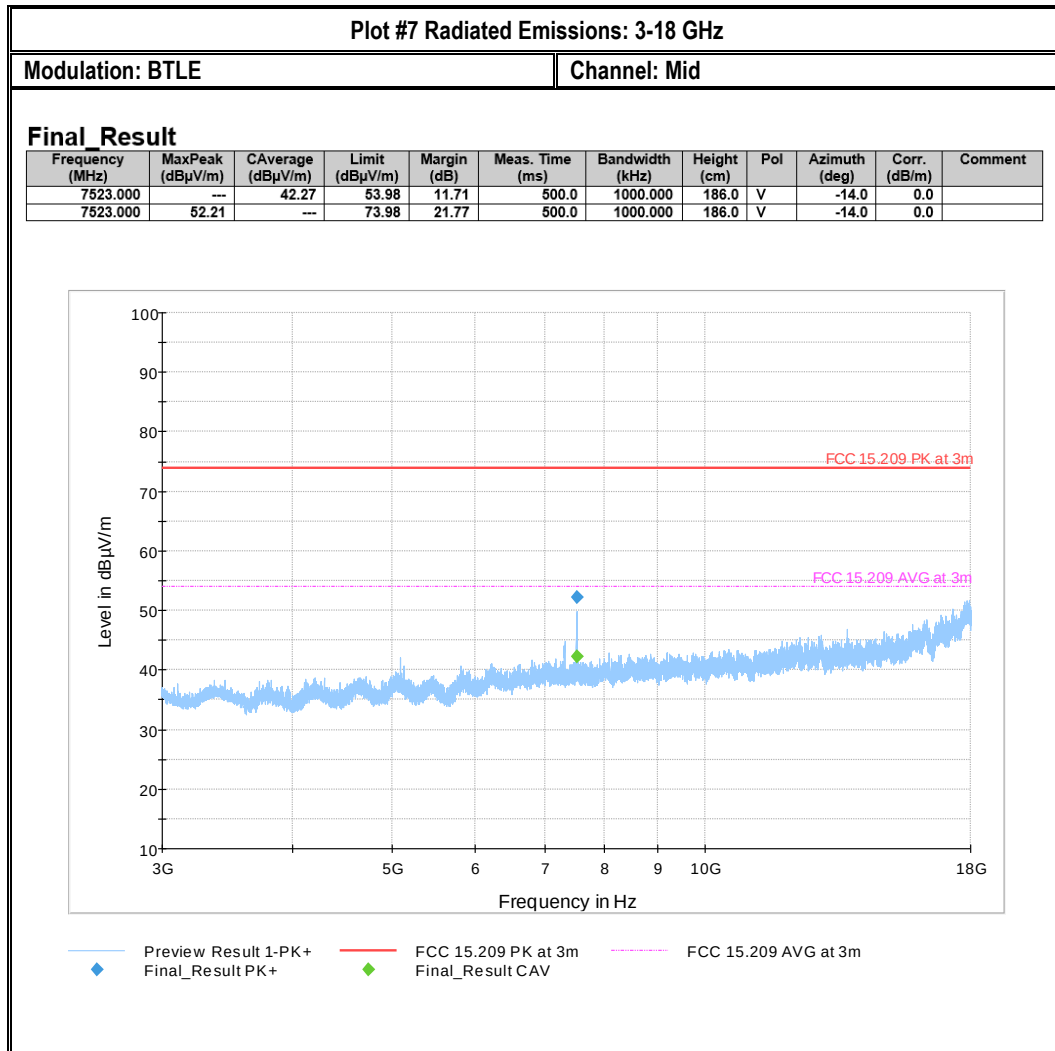
Final Result

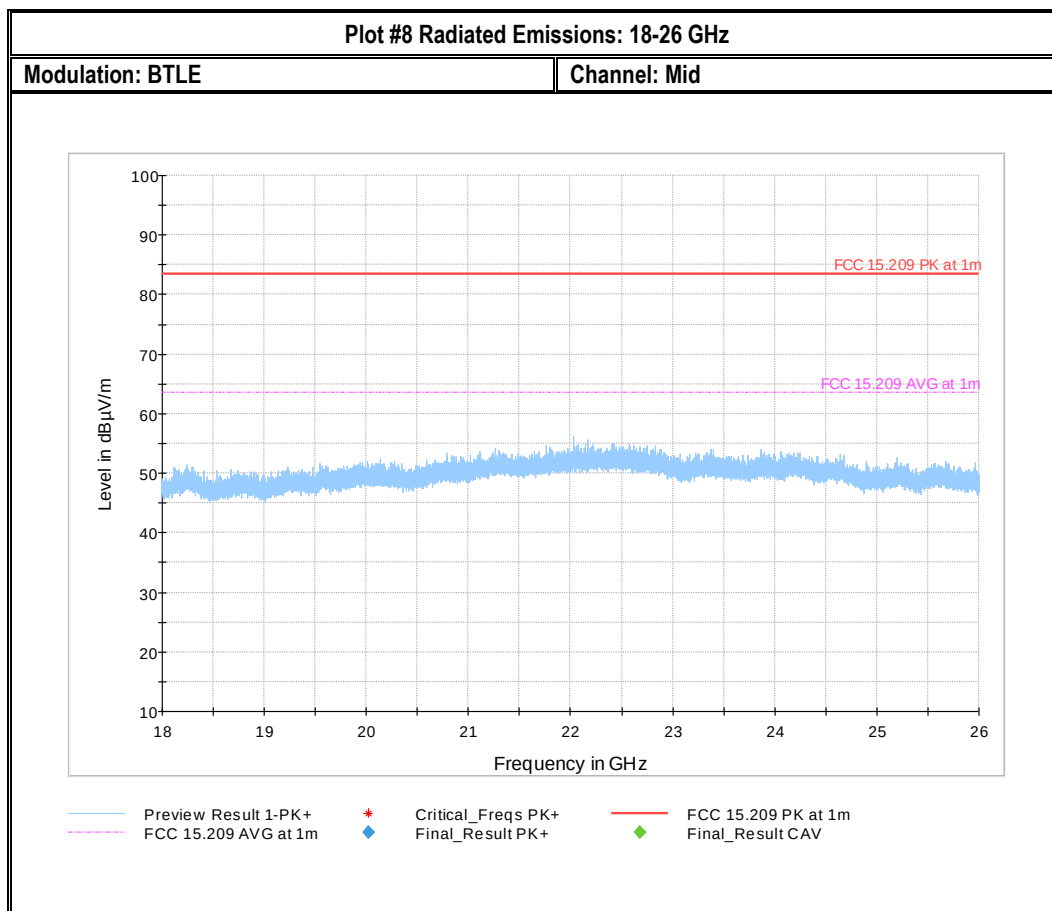
Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
2998.143	---	54.96	53.98	-0.98	500.0	1000.000	157.0	H	176.0	36.1	
2998.143	74.84	---	73.98	-0.86	500.0	1000.000	157.0	H	176.0	36.1	



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

Note: The Intermodulation is not in the restricted bands and it is below -20dBc

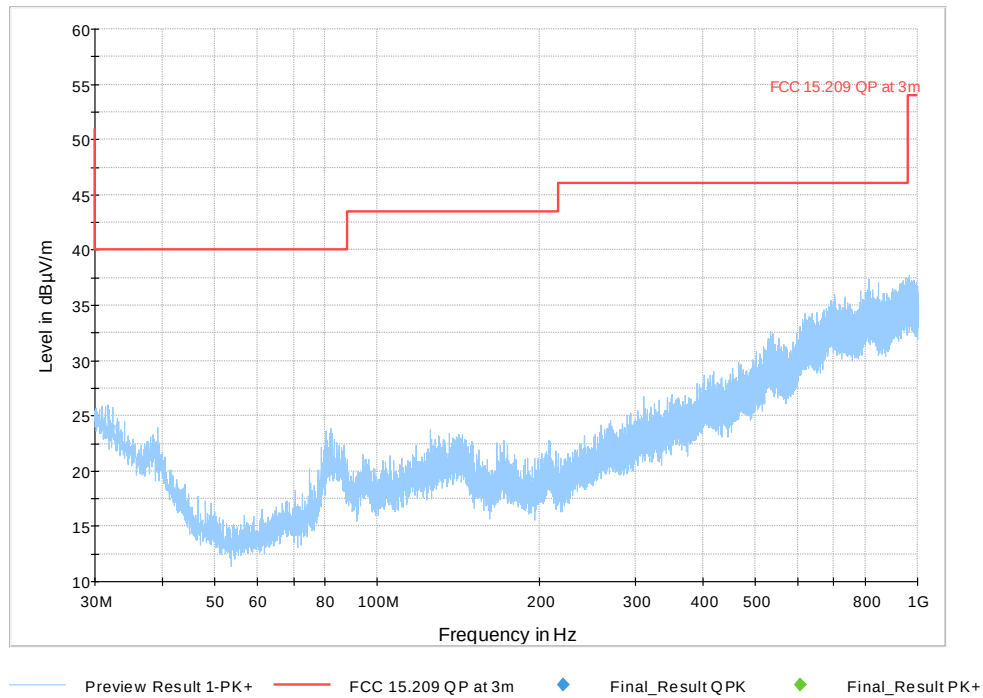


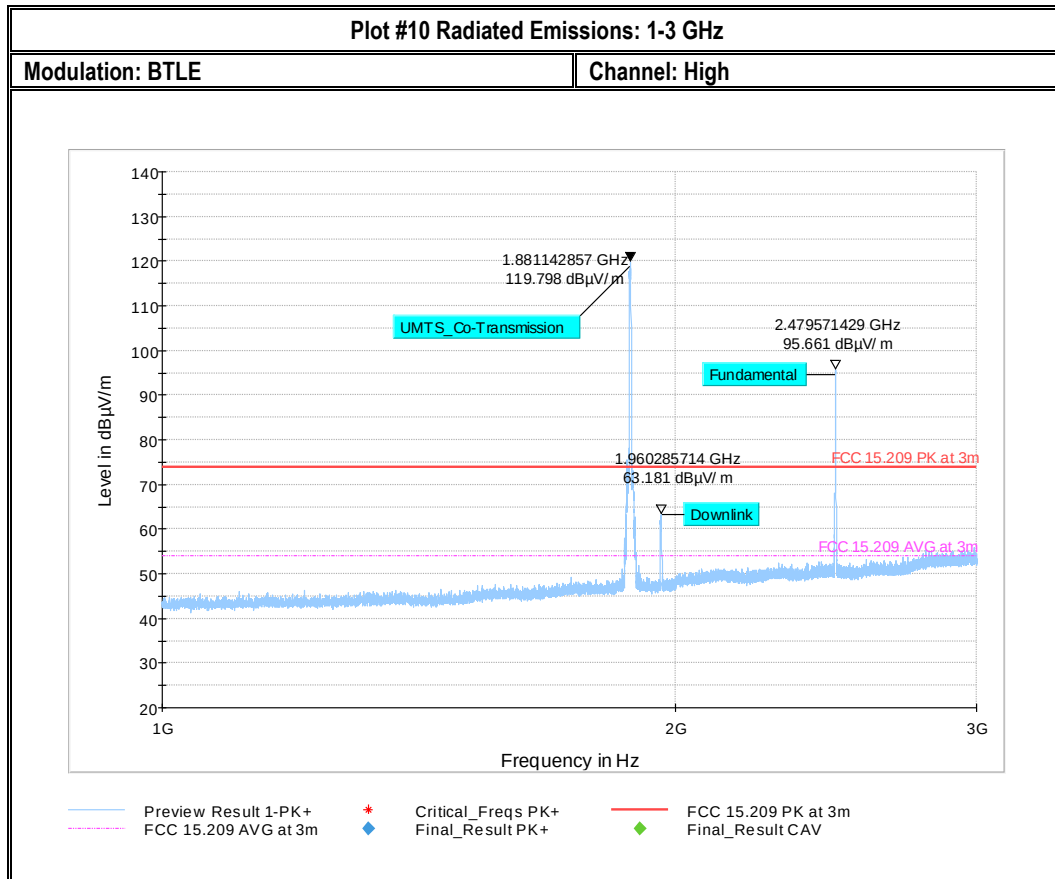


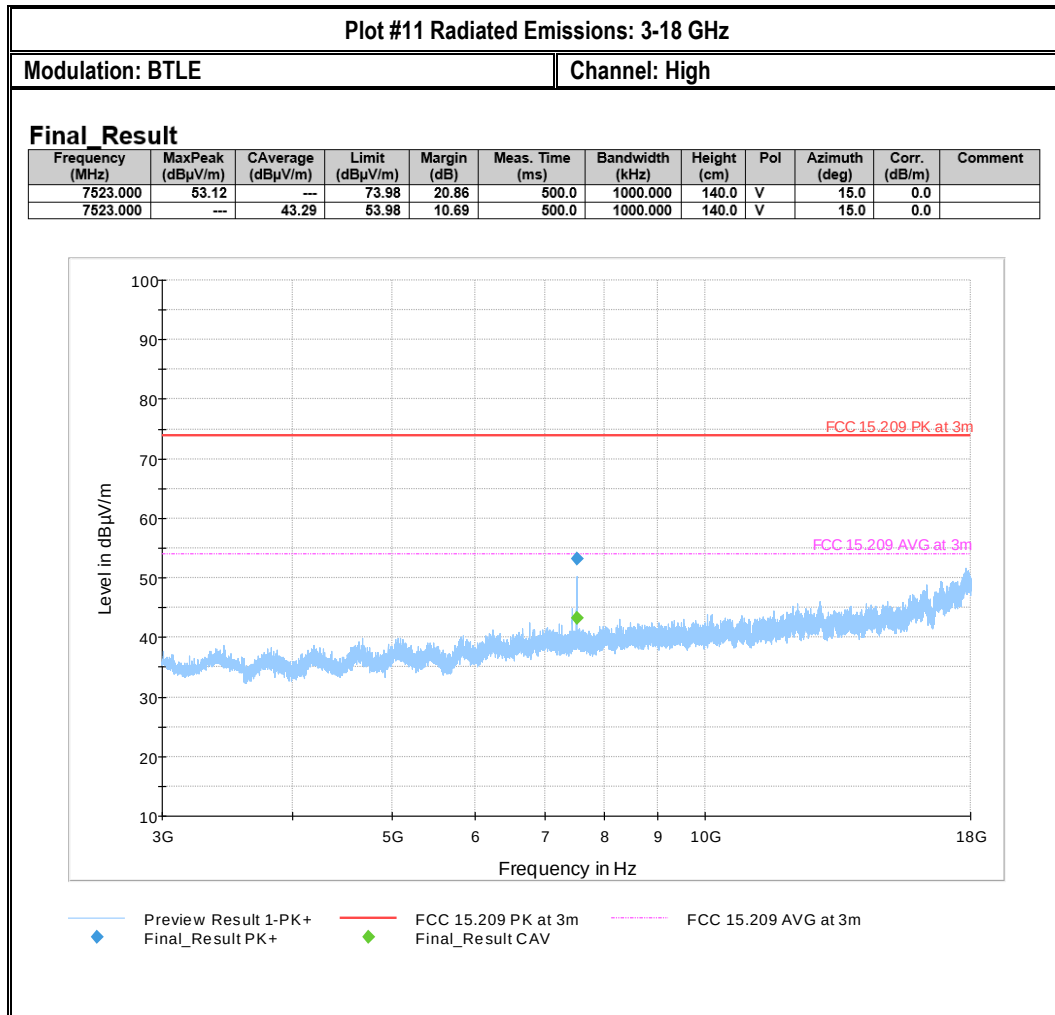
Plot #9 Radiated Emissions: 30 MHz – 1GHz

Modulation: BTLE

Channel: High





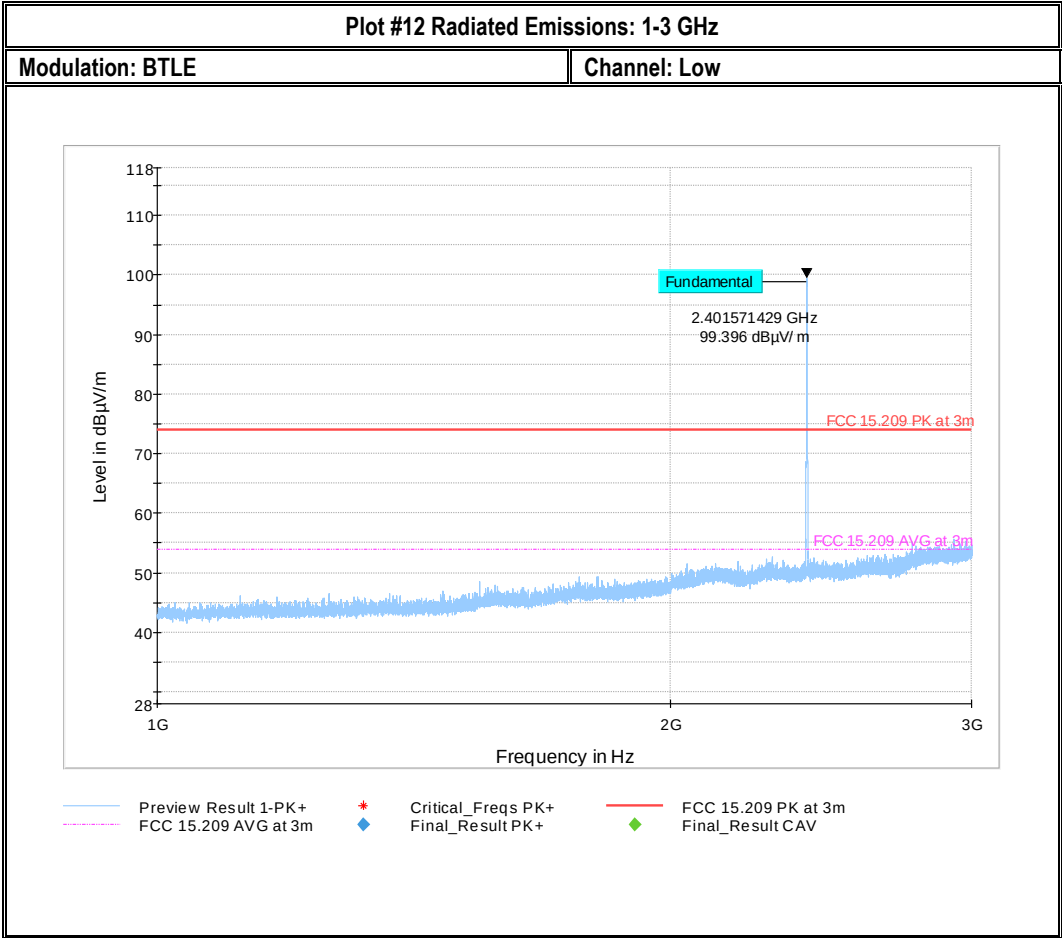


8.1.6 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	2	BTLE	12 VDC

8.1.7 Measurement result:

Plot #	Channel #	Scan Frequency	Limit	Result
12	Low	1 – 3 GHz	See section 8.1.2	Pass
13	Mid	1 – 3 GHz	See section 8.1.2	Pass
14	High	1 – 3 GHz	See section 8.1.2	Pass



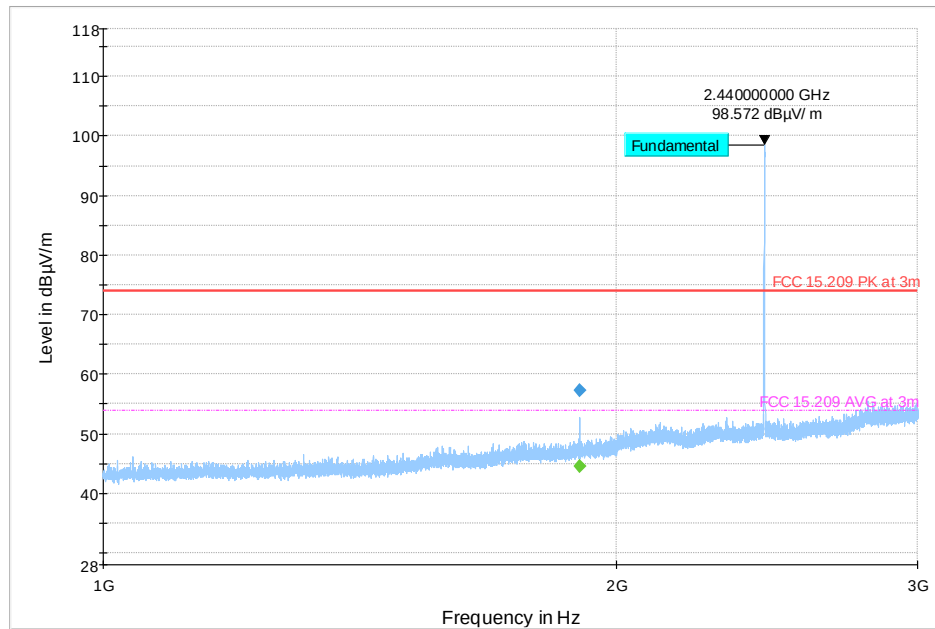
Plot #13 Radiated Emissions: 1-3 GHz

Modulation: BTLE

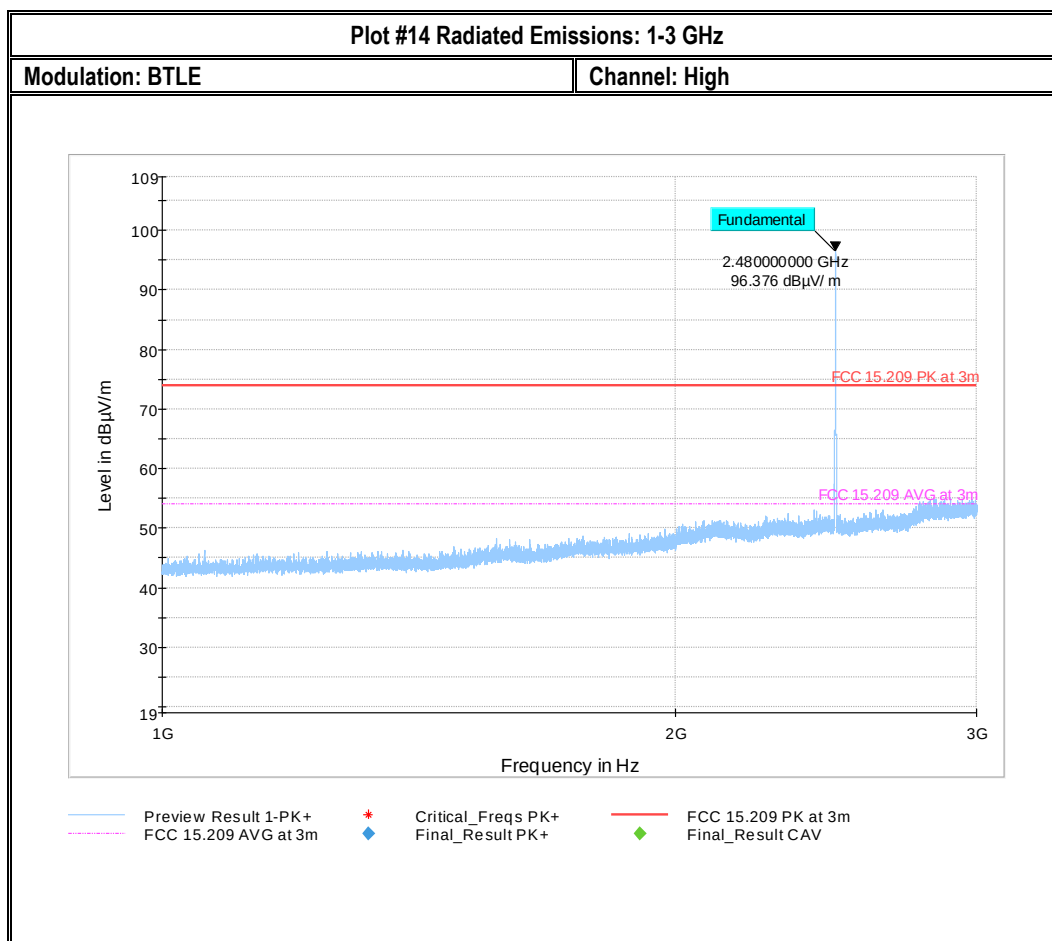
Channel: Mid

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
1901.286	---	44.49	53.98	9.49	500.0	1000.000	252.0	V	165.0	31.3	
1901.286	67.23	---	73.98	16.75	500.0	1000.000	252.0	V	165.0	31.3	



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



9 Test setup photos

Setup photos are included in supporting file name: "EMC_TELUL_087_20001_Setup_Photos_R1.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 ANALYZER	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 THERMOMETER	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
2020-08-10	EMC_TELUL_087_20001_15.247_BT_DTS	Initial version	Yuchan Lu
2020-11-04	EMC_TELUL_087_20001_15.247_BT_DTS_R1	Updated product description to "SkyHub Wireless Telematics Hub"	Yuchan Lu

<<The End>>