FCC / ISED Test Report

FOR:
Innophase Inc.

Model Name:
INP2045 Module

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_005_19001_15.247_BT_DTS

DATE: 2020-01-06

A2LA Accredited

IC recognized # 3462B-2

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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	INP2045 Module

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2020-01-06	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: 2020-01-06 18:05:06

Responsible for the Report:

Date	Section	Name	Signature
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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:	Trina Noor

2.2 Identification of the Client

Client's Name:	Innophase Inc.
Street Address:	6815 Flanders Drive, Suite 150
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:	INP2045 Module
HW Version :	INP2045-H
SW Version :	7d721afe
FCC-ID:	2AVAL-INP2045
IC-ID:	25715-INP2045
HVIN:	INP2045-H
PMN:	Talaria-TWO
Product Description:	Low Power Wi-Fi/BLE IOT Module
Frequency Range / number of channels:	Module name: INP2045 Module 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:	0 dBi
Max. Peak Output Power:	Conducted Power 9.33 dBm
Power Supply/ Rated Operating Voltage Range:	Vmin: 2.7 VDC/ Vnom: 3.3 VDC / Vmax: 3.6 VDC
Operating Temperature Range:	-10 ºC to 75 ºC
Other Radios included in the device:	❖ WiFi • Module name: INP2045 Module • Antenna Gain: 0 dBi
Sample Revision:	☐Prototype Unit; ■ Production Unit; ☐ Pre-Production

3.2 EUT Sample details

EUT #	Sample Number	HW Version	SW Version	Notes/Comments
1	3919055	INP2045-H	7d721afe	Radiated Emissions
2	533293	INP2045-H	7d721afe	Conducted RF

3.3 Support Equipment

SE #	Type	Model	Manufacturer	Serial Number
1	USB Power Cable	-	-	-

3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1+ SE#1	Special commands through command window used to configure the Bluetooth LE 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.
2	EUT#2 + SE#1	Special commands through command window used to configure the Bluetooth LE radio to low, mid and high channel provided by the client that will not be available to the end user. For conducted measurements, the equipment was connected to 50 ohm RF port of the EUT.

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. Based on client declaration, the EUT was configured to the highest duty cycle and maximum output power 10dBm.
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	BTLE	■	☐	☐	Complies
§15.247(e) RSS-247 5.2(2)	Power Spectral Density	Nominal	BTLE	■	☐	☐	Complies
§15.247(b)(1) RSS-247 5.4(4)	Maximum Conducted Output Power and EIRP	Nominal	BTLE	■	☐	☐	Complies
§15.247(d) RSS-247 5.5	Band edge compliance Unrestricted Band Edges	Nominal	BTLE	■	☐	☐	Complies
§15.247; 15.209; 15.205 RSS-Gen 8.9; 8.10	Band edge compliance Restricted Band Edges	Nominal	BTLE	■	☐	☐	Complies
§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	☐	■	☐	N/A[2]

Note1: NA= Not Applicable; NP= Not Performed.
Note2: EUT is powered by 5VDC USB cable

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:

12/09/2019-12/19/2019

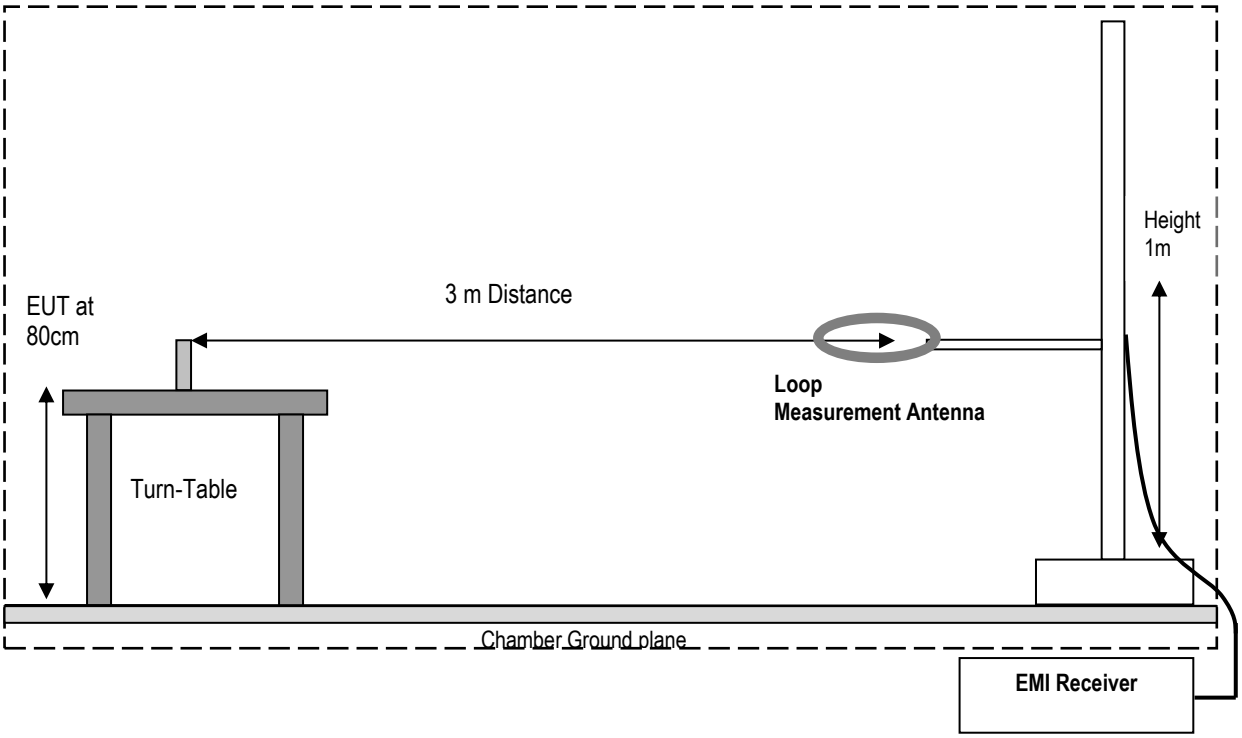
7 Measurement Procedures

7.1 Radiated Measurement

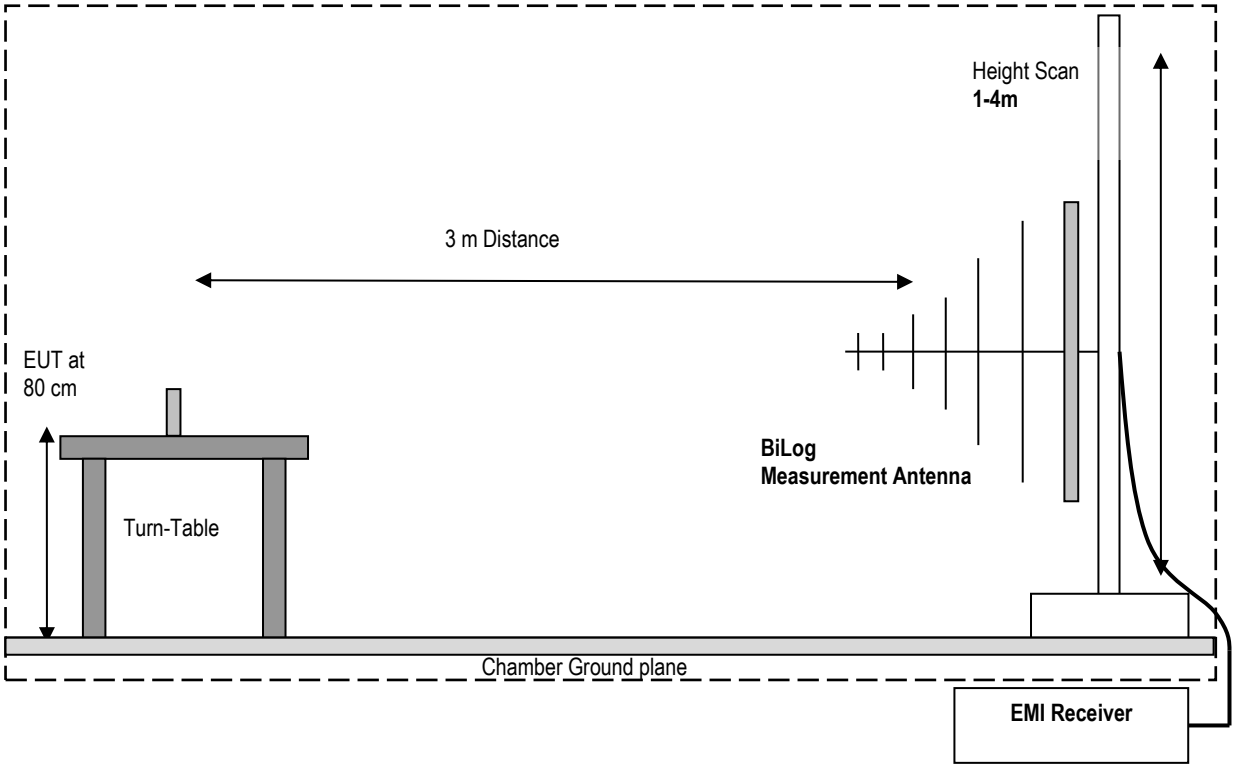
The radiated measurement is performed according to ANSI C63.10 (2013)

- 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.

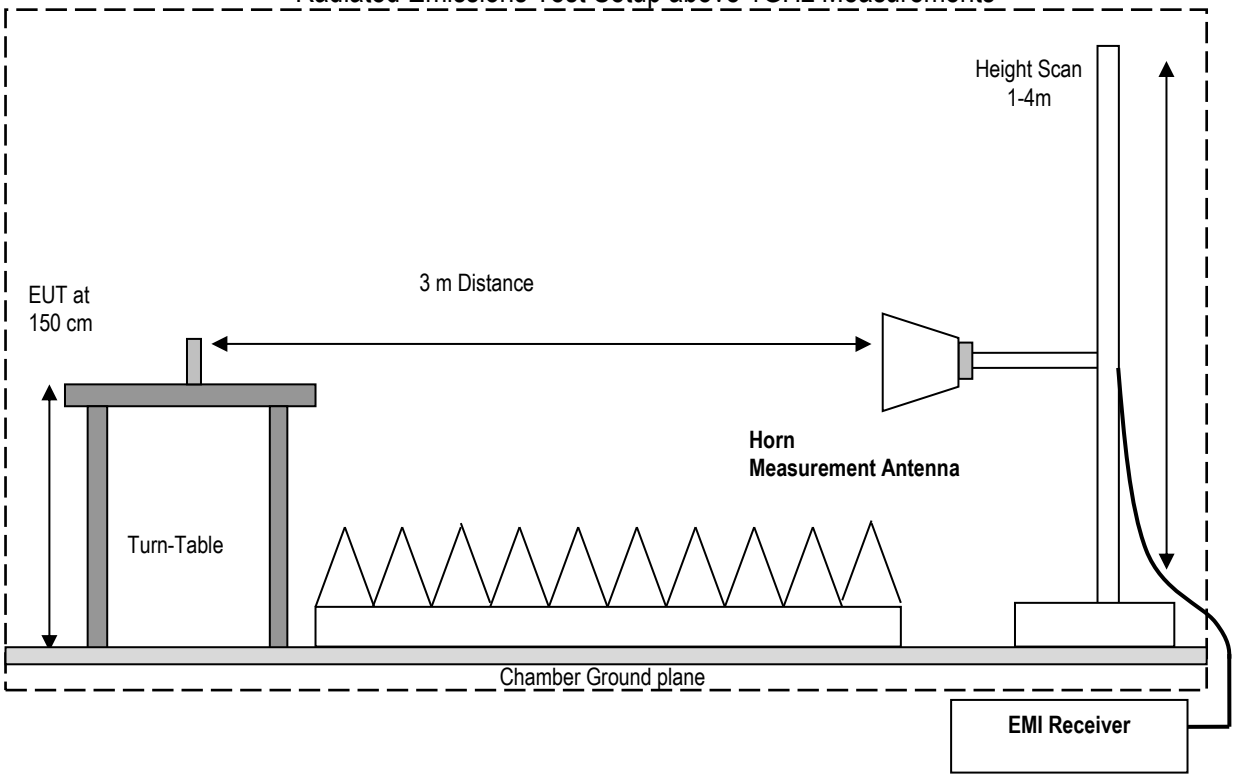
Radiated Emissions Test Setup below 30MHz Measurements



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:

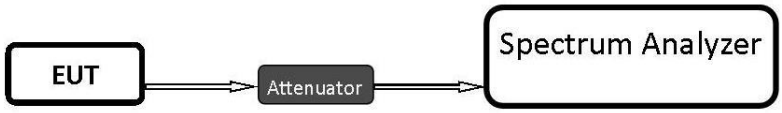
FS (dBµV/m) = Measured Value on SA (dBµV)- Cable Loss (dB)+ Antenna Factor (dB/m)

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 Maximum Peak Conducted Output Power

8.1.1 Measurement according to FCC 558074 D01 DTS Meas Guidance v04

Spectrum Analyzer settings:

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

8.1.2 Limits:

Maximum Peak Output Power:

- FCC §15.247 (b)(1): 1 W
- IC RSS-247: 1 W

8.1.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
22° C	2	GFSK continuous fixed channel	5 VDC	0 dBi

8.1.4 Measurement result:

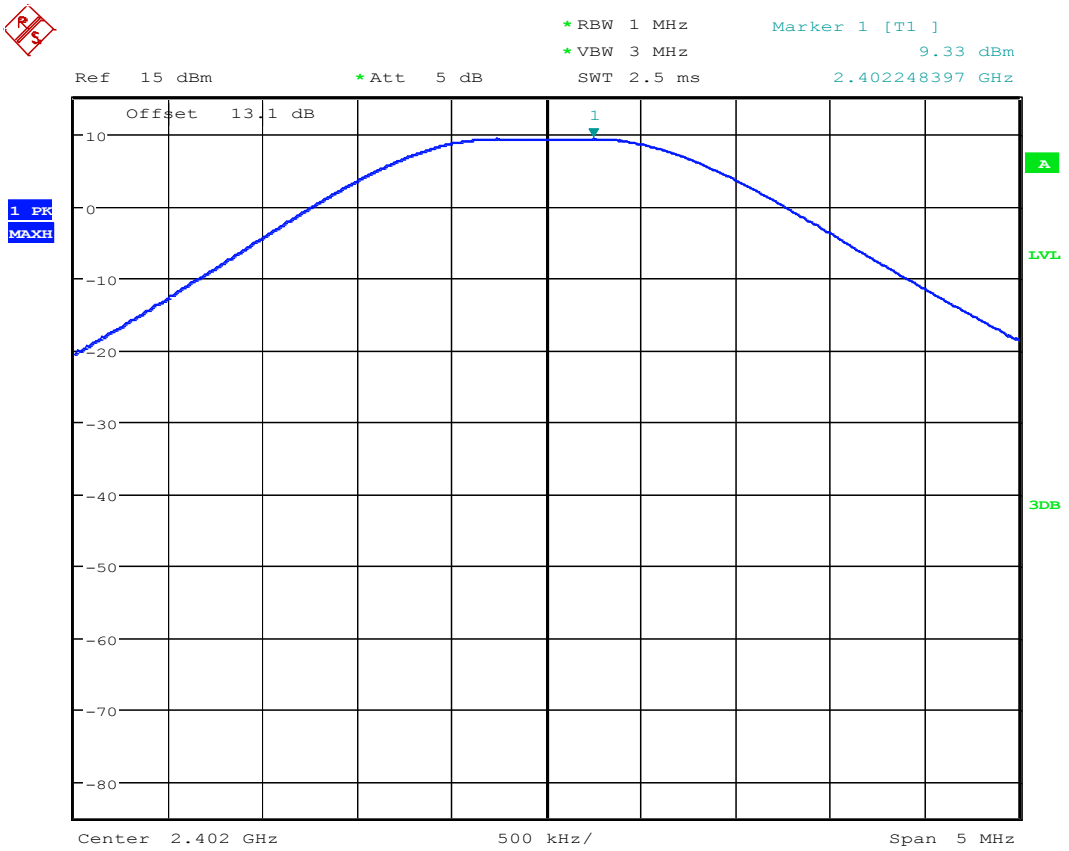
Attenuation of cable and attenuator (already taken into account): 13.1 dB

Plot #	Frequency (MHz)	Maximum Peak Conducted Output Power (dBm)	EIRP (dBm)	Limit (dBm)	Result
1	2402	9.33	11.33	30 (Pk) / 36 (EIRP)	Pass
2	2442	9.17	11.17	30 (Pk) / 36 (EIRP)	Pass
3	2480	8.56	10.56	30 (Pk) / 36 (EIRP)	Pass

Note: According to ANSI C63.10 §11.12.2.6, if Antenna Gain is less than 2 dBi, then 2 dBi should be used to determine the EIRP.

8.1.5 Measurement Plots:

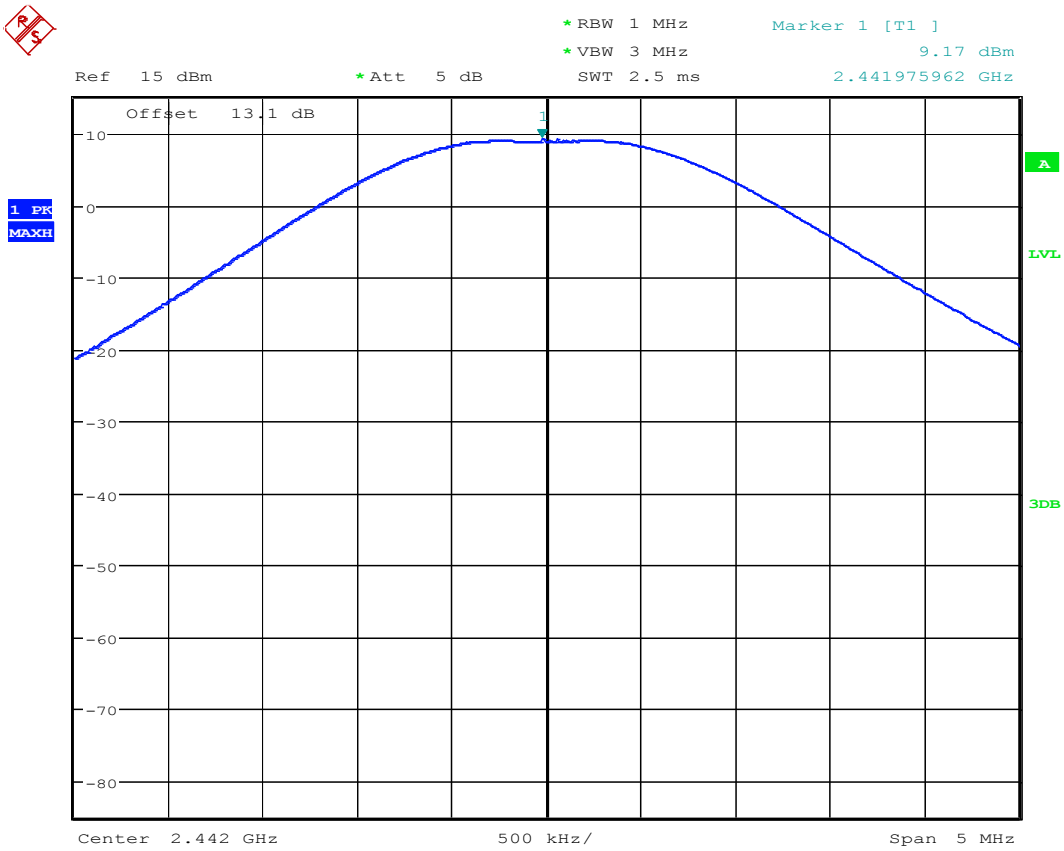
Plot #1	
Low channel	Modulation/Packet Type: BTLE



Date: 18.DEC.2019 16:48:42

Plot #2

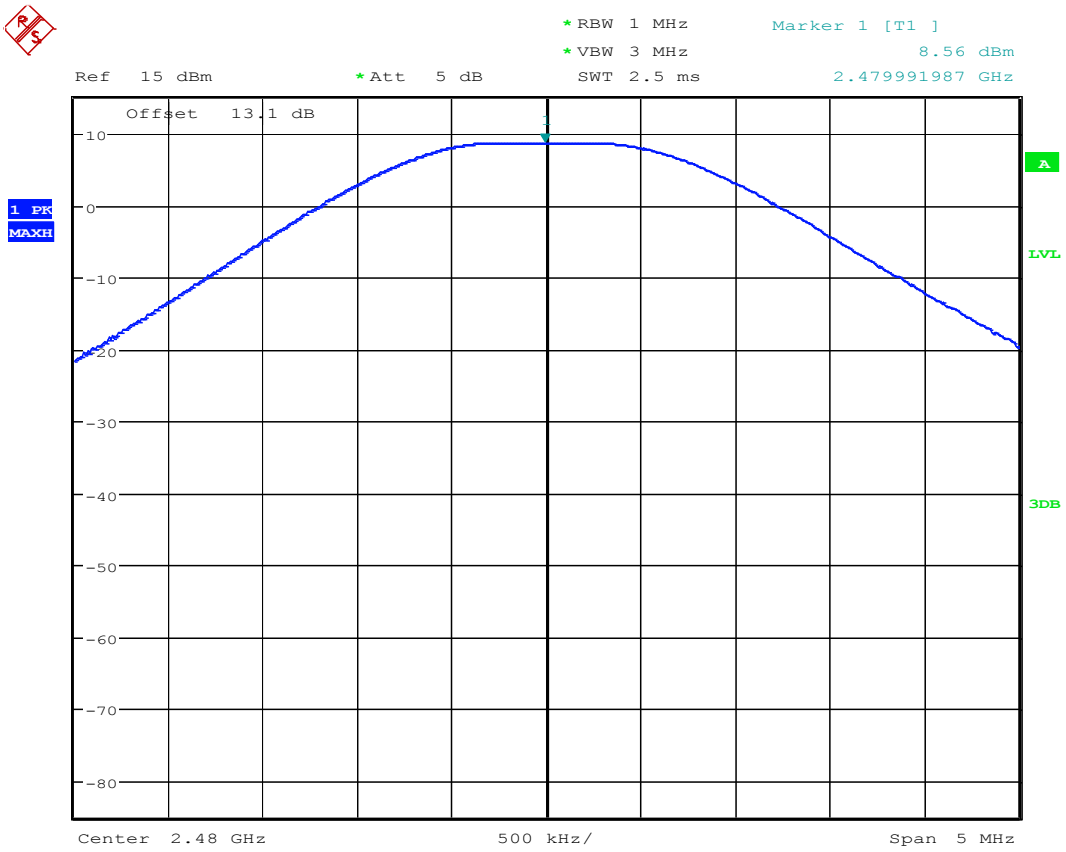
Mid channel	Modulation/Packet Type: BTLE



Date: 18.DEC.2019 16:52:33

Plot #3

High channel	Modulation/Packet Type: BTLE



Date: 18.DEC.2019 16:38:31

8.2 Power Spectral Density

8.2.1 Measurement according to FCC 558074 D01 DTS Meas Guidance v04

Spectrum Analyzer settings for Peak PSD method:

- Set analyzer center frequency to DTS channel center frequency
- Set the span to 1.5 x DTS bandwidth
- Set RBW to: 3 kHz ≤ RBW ≤ 100 kHz
- Set the VBW ≥ 3 x RBW
- Detector = Peak
- Sweep time = Auto couple
- Trace mode = Max hold
- Allow trace to fully stabilize
- Use the peak marker function to determine the maximum amplitude level within the RBW
- If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat

8.2.2 Limits:

FCC§15.247(e) & RSS-247 5.2(2)

- For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

8.2.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
23° C	2	GFSK continuous fixed channel	5 VDC	0dBi

8.2.4 Measurement result:

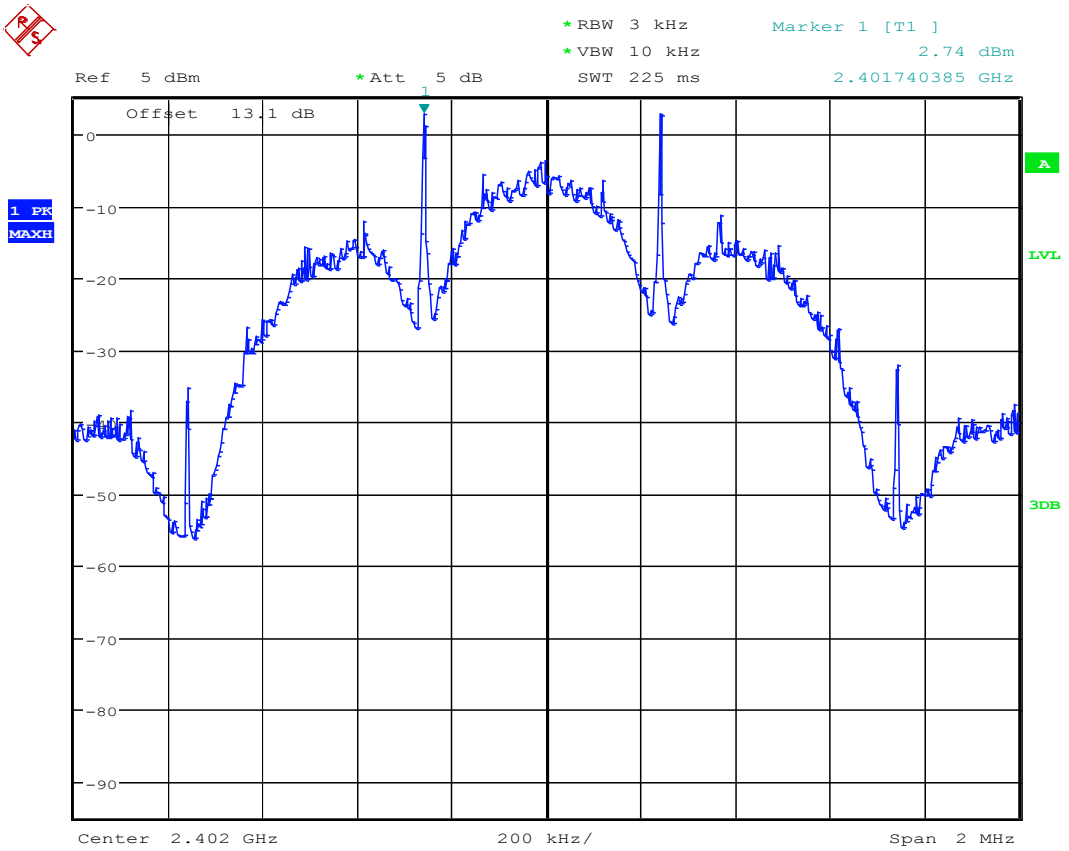
Attenuation of cable and attenuator (already taken into account): 13.1 dB

Plot #	Frequency (MHz)	Maximum Power Spectral Density (dBm/3 kHz)	PSD Adjusted for Antenna Gain (dBm/3 kHz)	Limit (dBm / 3 kHz)	Result
4	2402	2.74	4.74	8	Pass
5	2442	2.35	4.35	8	Pass
6	2480	2.06	4.06	8	Pass

Note: According to ANSI C63.10 §11.12.2.6, if Antenna Gain is less than 2 dBi, then 2 dBi should be used to determine the EIRP.

8.2.5 Measurement Plots:

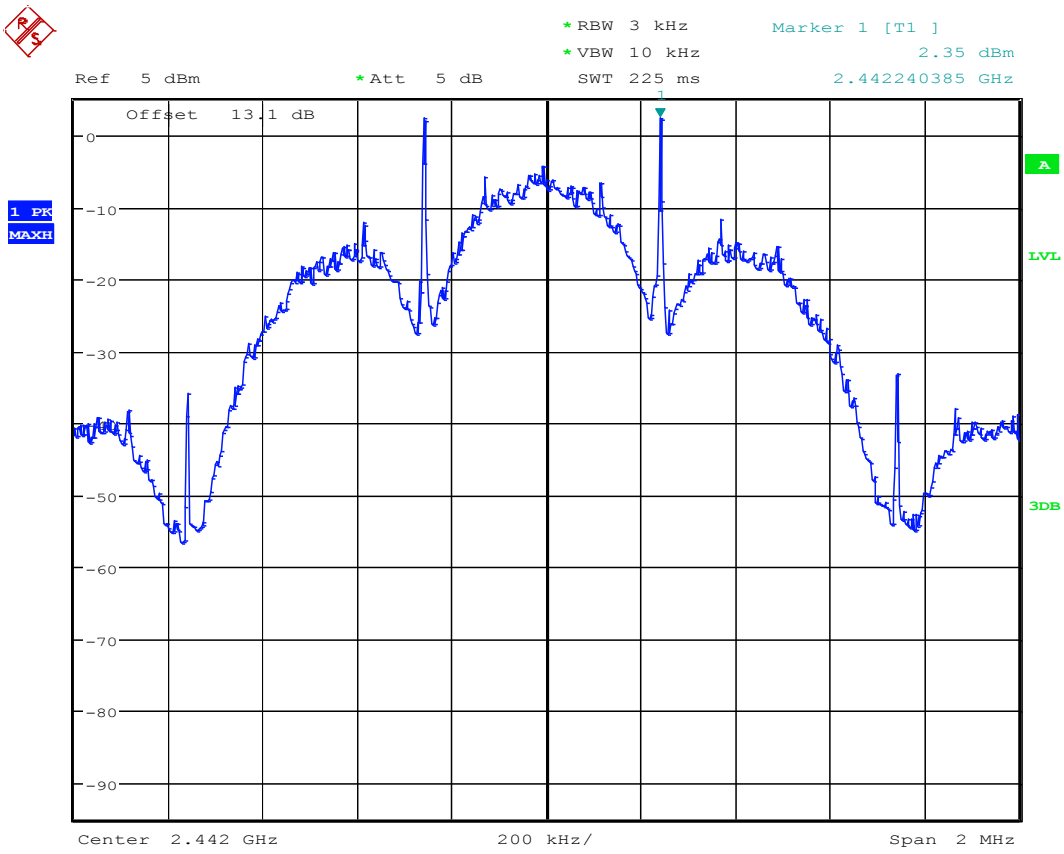
Plot #4	
Low channel	Modulation/Packet Type: BTLE



Date: 18.DEC.2019 16:48:56

Plot #5

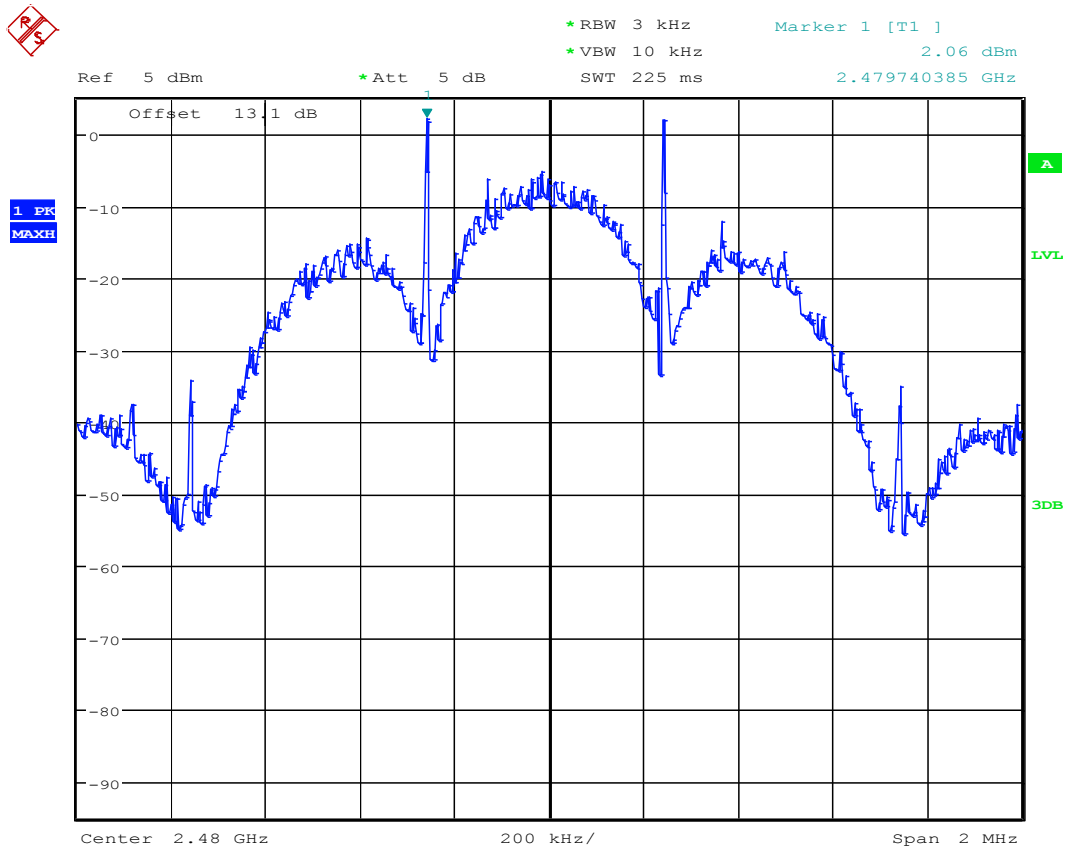
Mid channel	Modulation/Packet Type: BTLE



Date: 18.DEC.2019 16:52:47

Plot #6

High channel	Modulation/Packet Type: BTLE



Date: 18.DEC.2019 16:39:19

8.3 Duty cycle

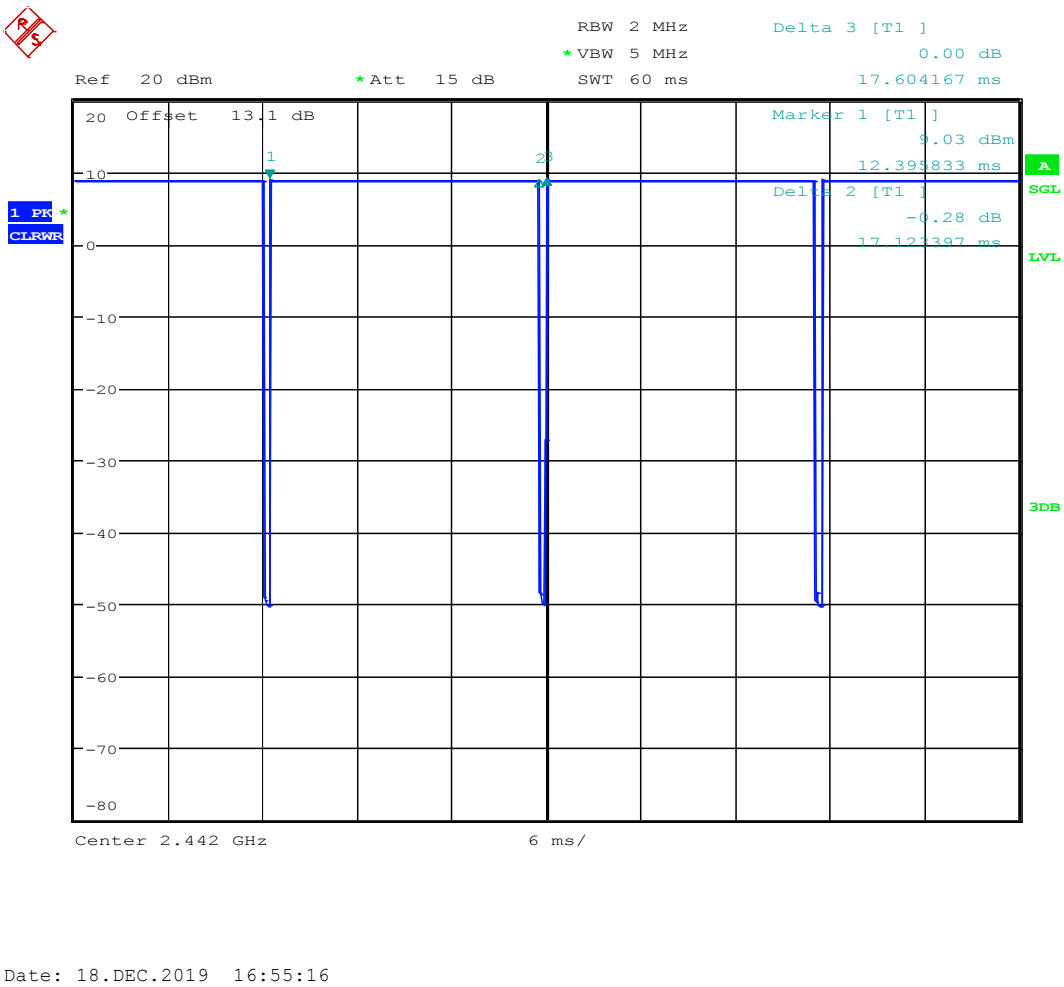
8.3.1 Measurement according to FCC 558074 D01 DTS Meas Guidance v04

Spectrum Analyzer settings:

- Set the center frequency and of the instrument to the center frequency of the transmission
- Zero span
- Set RBW >=OBW if possible; otherwise, set RBW to the largest available value
- Detector = Peak or average

8.3.2 Measurement result

Duty cycle measurement	
Mid channel / 244 MHz	**Modulation/Packet Type: BTLE**



Duty cycle =97.27%
Duty cycle correction factor =10*log (1/0.9727) = 0.12 dB

8.4 Band Edge Compliance

8.4.1 Measurement according to FCC 558074 D01 DTS Meas Guidance v04

Spectrum Analyzer settings for band edge:

- Set the center frequency and span to encompass frequency range to be measured
- RBW = 100 kHz
- VBW ≥ 3 x RBW
- Sweep Time: Auto couple
- Detector = Peak
- Trace = Max hold
- Allow trace to fully stabilize
- Use the peak marker function to determine the maximum amplitude level
- Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge

8.4.2 Limits non restricted band:

FCC§15.247 (d)

- 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)).

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- 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 30dB instead of 20dB.

Spectrum Analyzer settings for restricted band:

- Peak measurements are made using a peak detector and RBW=1 MHz

8.4.3 Limits restricted band §15.247/15.209/15.205 and RSS-Gen 8.9/8.10

- *PEAK LIMIT= 74 dBµV/m @3m =-21.23 dBm
- *AVG LIMIT= 54 dBµV/m @3m =-41.23 dBm
- Start frequency & stop frequency according to frequency range specified in the restricted band table in FCC section 15.205 & RSS-Gen 8.10
- Measurements with a peak detector were used to show compliance to average limits, thus showing compliance to both peak and average limits.

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

(b)

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			

8.4.4 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
22° C	2	GFSK continuous fixed channel	5 VDC	0 dBi

8.4.5 Measurement result:

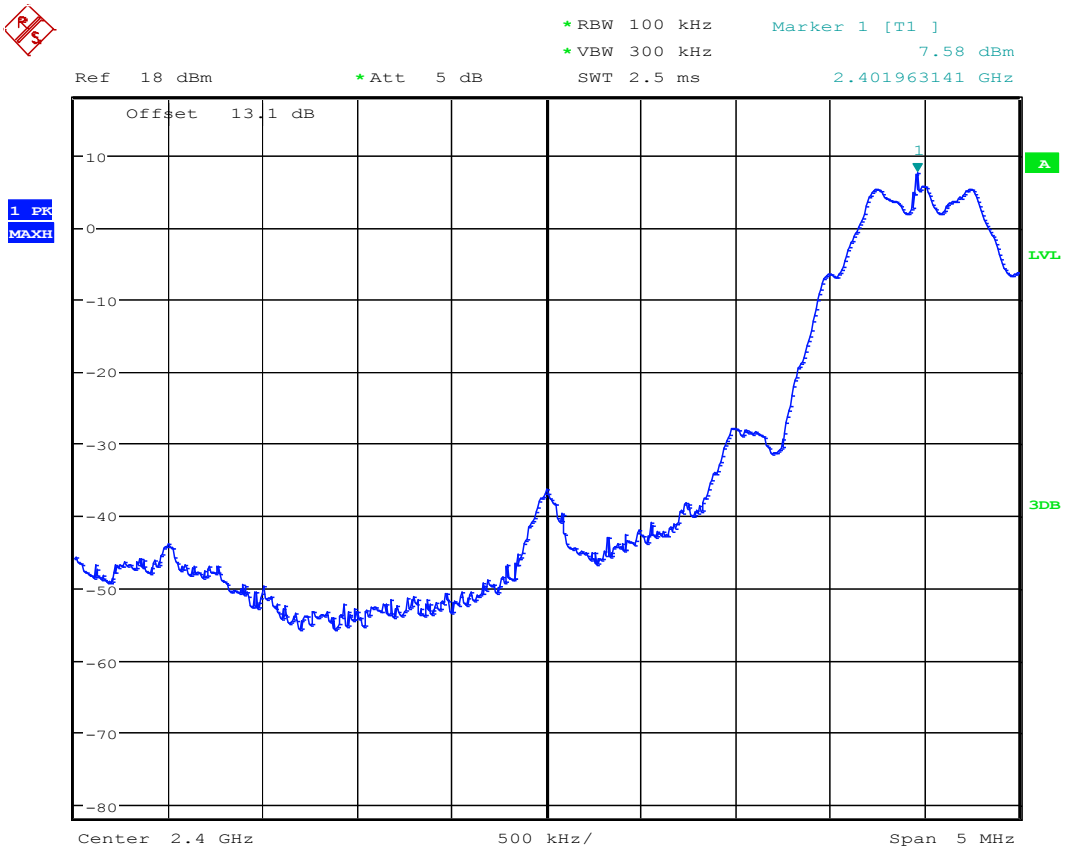
Plot #	EUT operating mode	Band Edge	Band Edge Delta (dBc)	Limit (dBc)	Result
7, 8	GFSK continuous fixed channel	Lower, Non-restricted	-44.45	-20	Pass

Plot #	EUT operating mode	Band Edge	Measured Peak Value (dBm)	Corrected by duty cycle	Corrected by Antenna Gain (dBm)	Limit (dBm)	Result
9	GFSK continuous fixed channel	Upper Restricted peak	-33.10	NA	-31.10	-21.23 Peak	Pass
10	GFSK continuous fixed channel	Upper Restricted Average	-47.64	-47.52	-45.52	-41.23 AVG	Pass

Note: According to ANSI C63.10 §11.12.2.6, if Antenna Gain is less than 2 dBi, then 2 dBi should be used to determine the EIRP.

8.4.6 Measurement Plots:

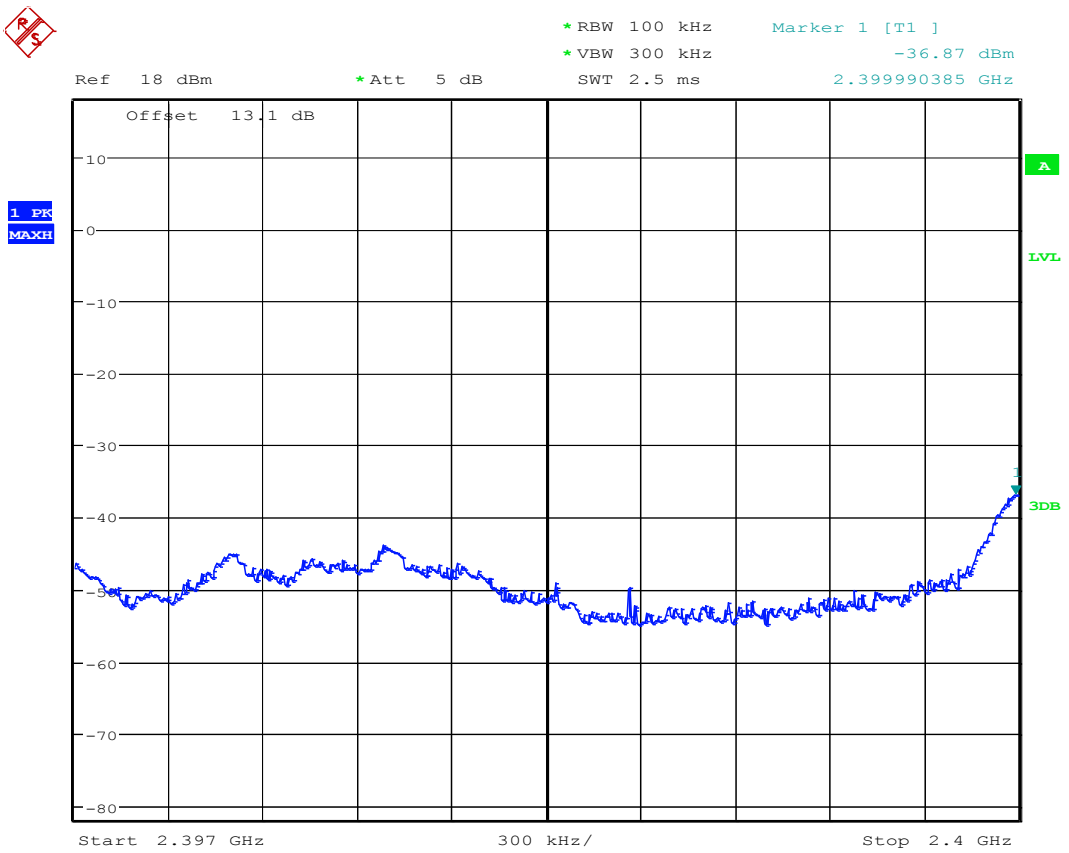
Plot #7	
Low channel / 2402 MHz	Modulation/Packet Type: BTLE



Date: 18.DEC.2019 16:49:55

Plot #8

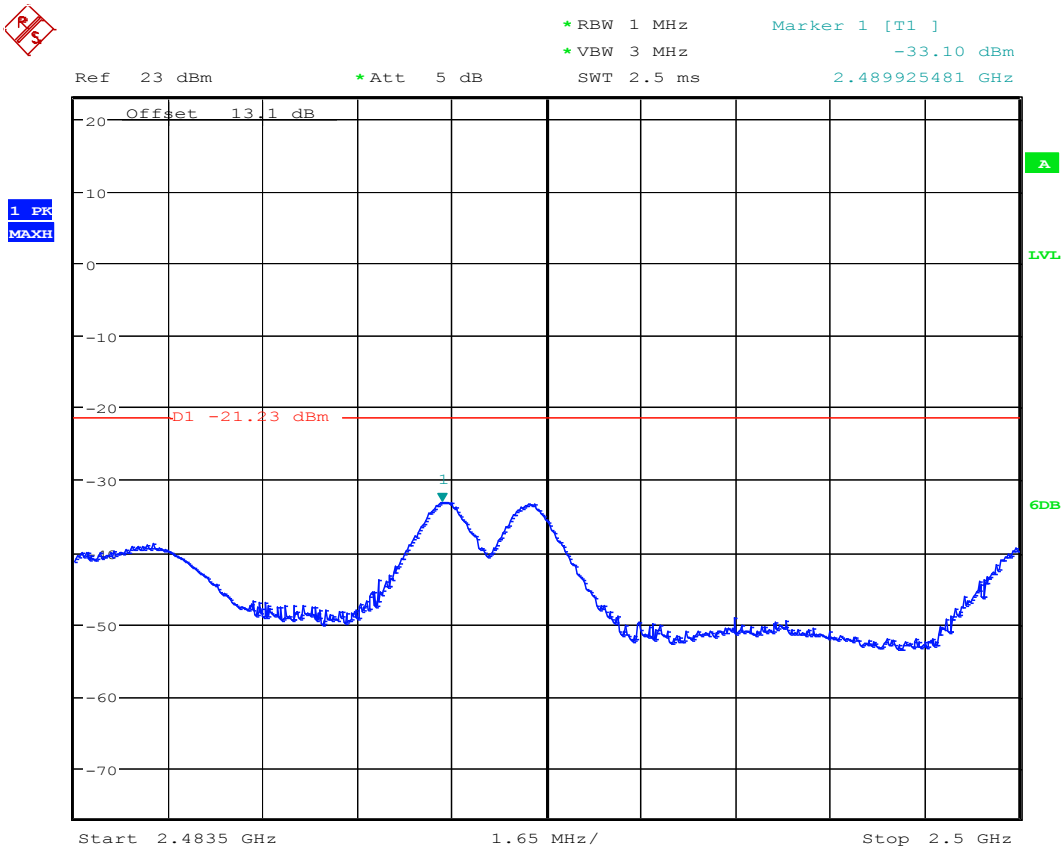
Low channel / 2402 MHz	Modulation/Packet Type: BTLE



Date: 18.DEC.2019 16:49:59

Plot #9

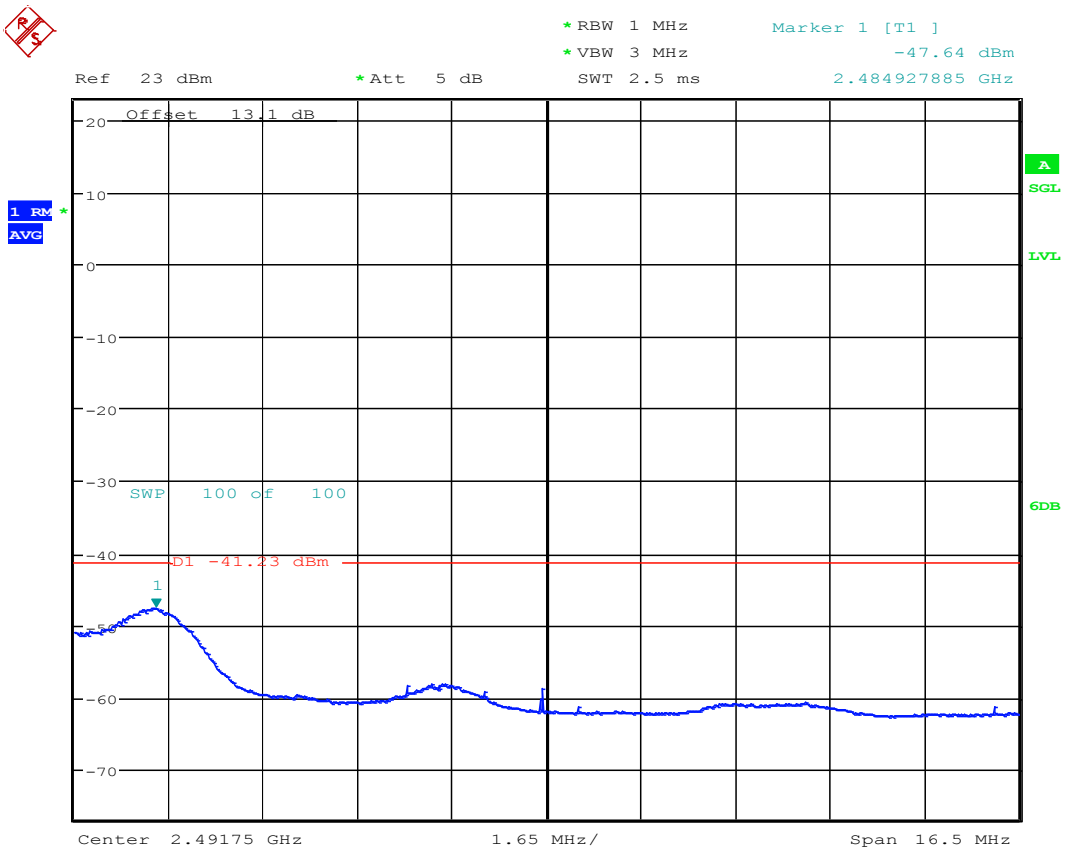
High channel 2480 MHz	Modulation/Packet Type: BTLE



Date: 18.DEC.2019 16:46:28

Plot #10

High channel 2480 MHz	Modulation/Packet Type: BTLE



Date: 18.DEC.2019 16:47:32

8.5 Emission Bandwidth 6 dB and 99% Occupied Bandwidth

8.5.1 Measurement according to FCC 558074 D01 DTS Meas Guidance v04

Spectrum Analyzer settings:

- Set RBW = 100 kHz
- Set the video bandwidth (VBW) ≥ 3 x RBW
- Detector = Peak
- Trace mode = Max hold
- Sweep = Auto couple
- Allow the trace to stabilize
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

8.5.2 Limits:

FCC §15.247(a)(1) and RSS-247 5.2(1)

- Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

8.5.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22° C	2	GFSK continuous fixed channel	12 VDC

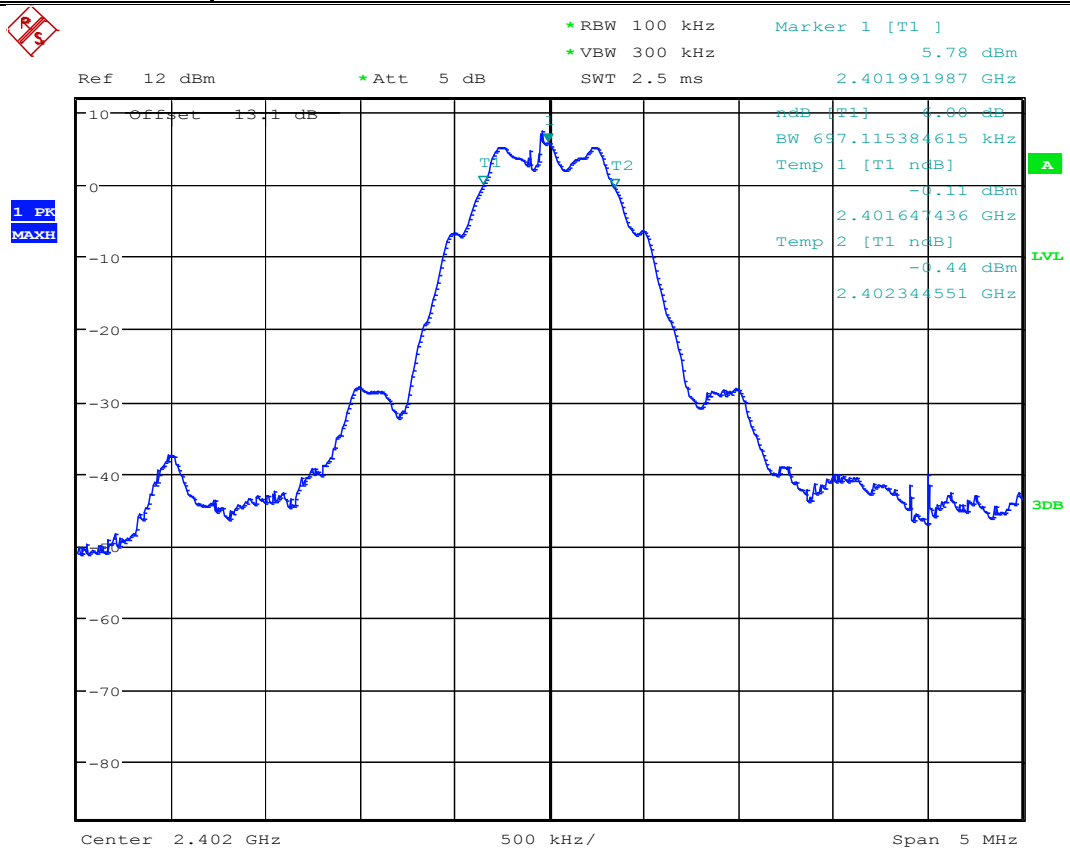
8.5.4 Measurement result:

Plot #	Frequency (MHz)	6 dB Emissions Bandwidth (MHz)	Limit (MHz)	Result
11	2402	0.697	> 0.5	Pass
12	2440	0.697	> 0.5	Pass
13	2480	0.689	> 0.5	Pass

Plot #	Frequency (MHz)	99% Occupied Bandwidth (MHz)	Limit (MHz)	Result
14	2402	1.058	> 0.5	Pass
15	2440	1.058	> 0.5	Pass
16	2480	1.058	> 0.5	Pass

8.5.5 Measurement Plots:

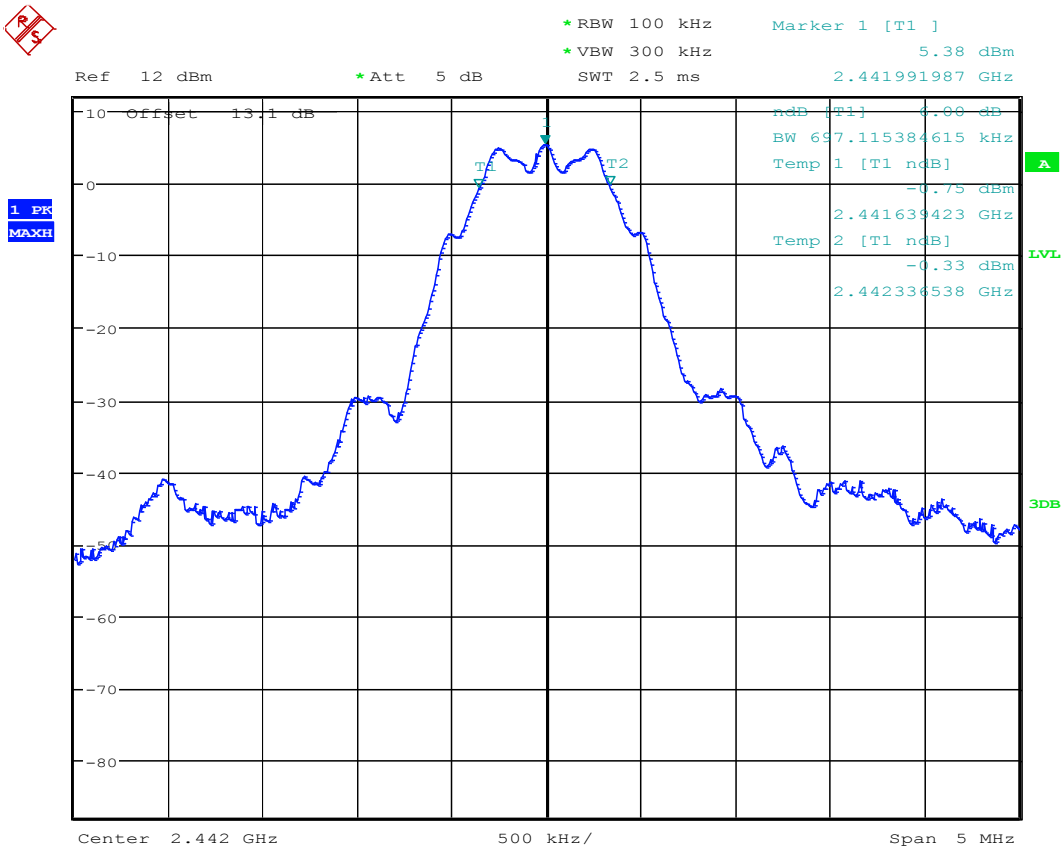
Plot #11	
Low channel	Mode: BTLE



Date: 18.DEC.2019 16:49:10

Plot #12

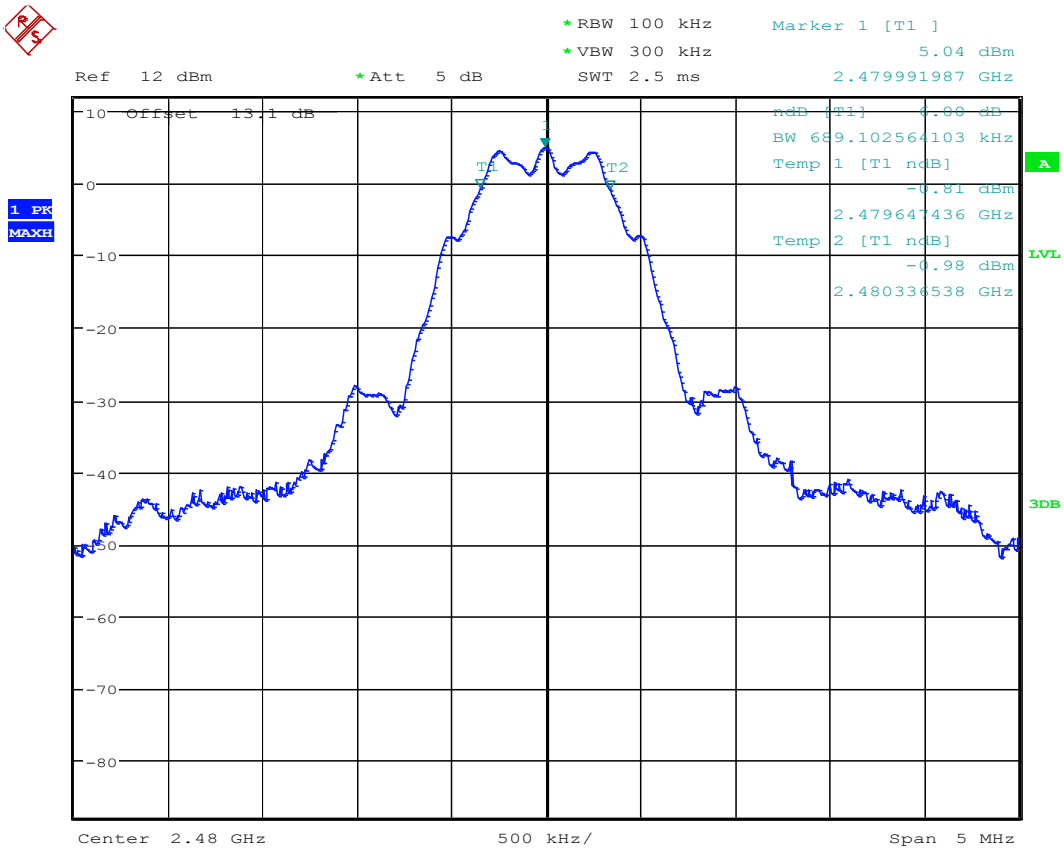
Mid channel	Mode: BTLE



Date: 18.DEC.2019 16:53:28

Plot #13

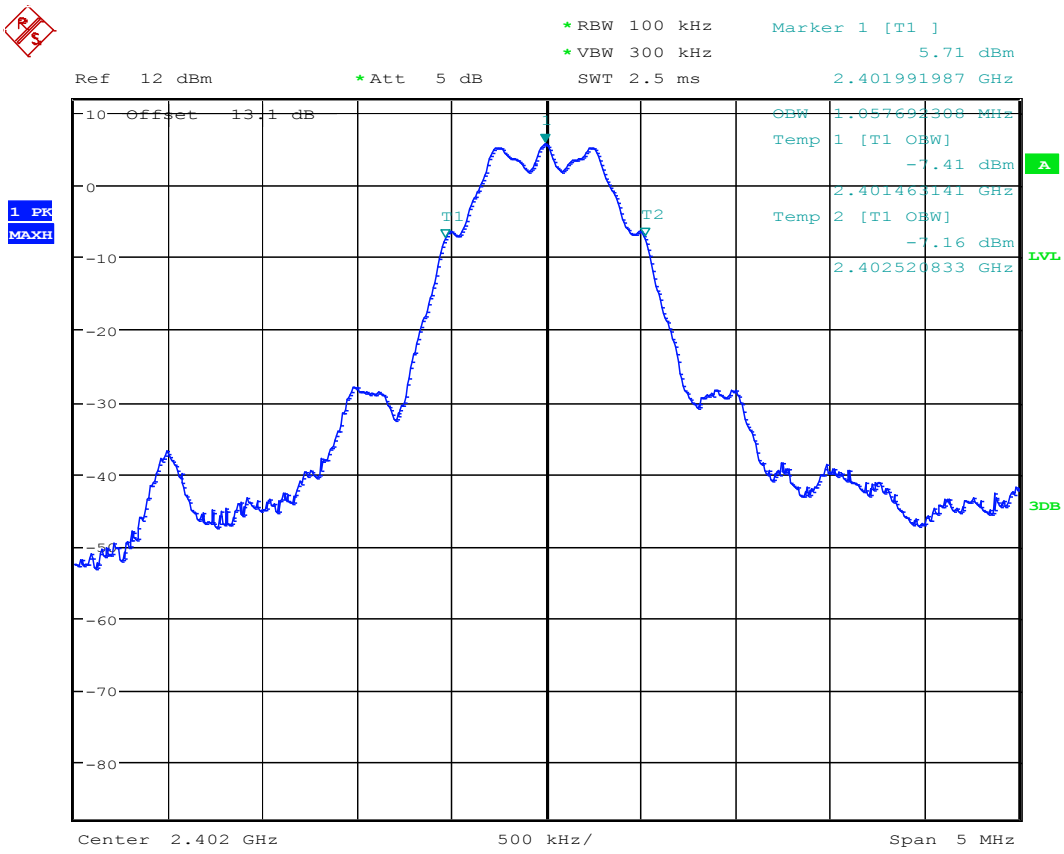
High channel	Mode: BTLE



Date: 18.DEC.2019 16:57:50

Plot #14

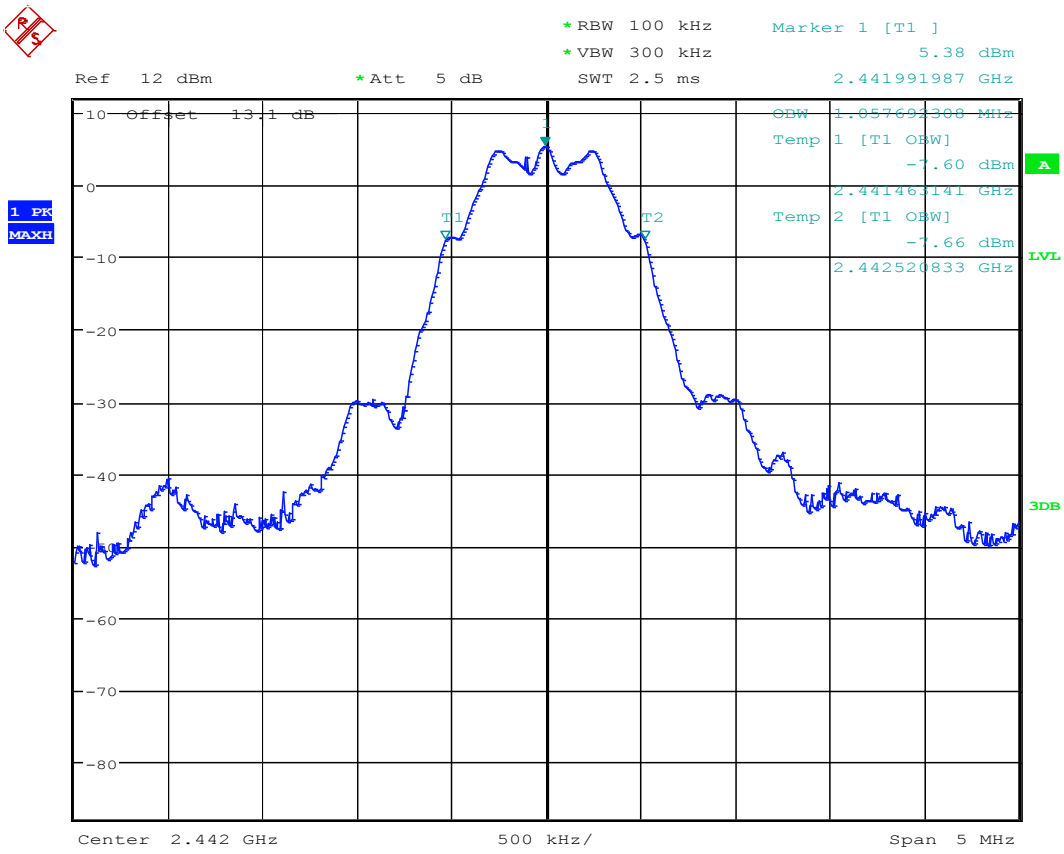
Low channel	Mode: BTLE



Date: 18.DEC.2019 16:49:47

Plot #15

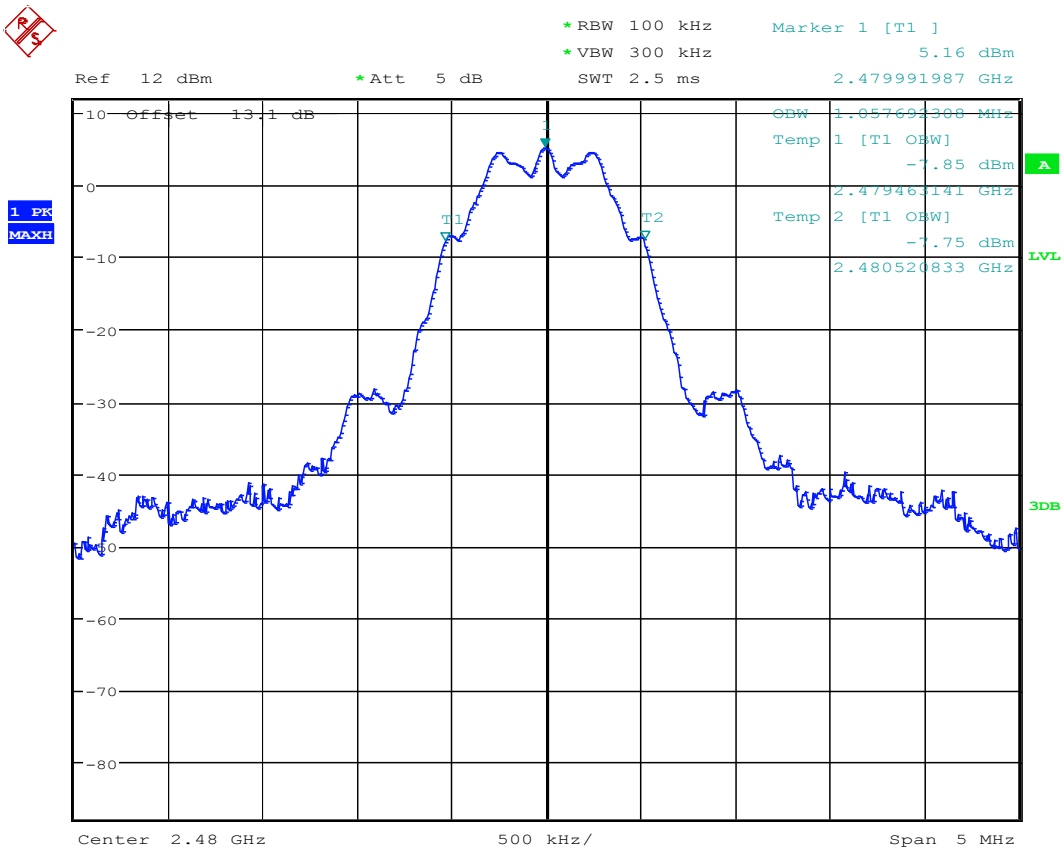
Mid channel	Mode: BTLE



Date: 18.DEC.2019 16:53:42

Plot #16

High channel	Mode: BTLE



Date: 18.DEC.2019 16:39:38

8.6 Radiated Transmitter Spurious Emissions and Restricted Bands

8.6.1 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

8.6.2 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

8.6.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	GFSK continuous fixed channel	5 VDC

8.6.4 Measurement result:

Plot #	Channel #	Scan Frequency	Limit	Result
17-19	Low	30 MHz – 18 GHz	See section 8.5.2	Pass
20-24	Mid	9 kHz – 26 GHz	See section 8.5.2	Pass
25-27	High	30 MHz – 18 GHz	See section 8.5.2	Pass

8.6.5 Measurement Plots:

Plot #17 Radiated Emissions: 30 MHz – 1GHz

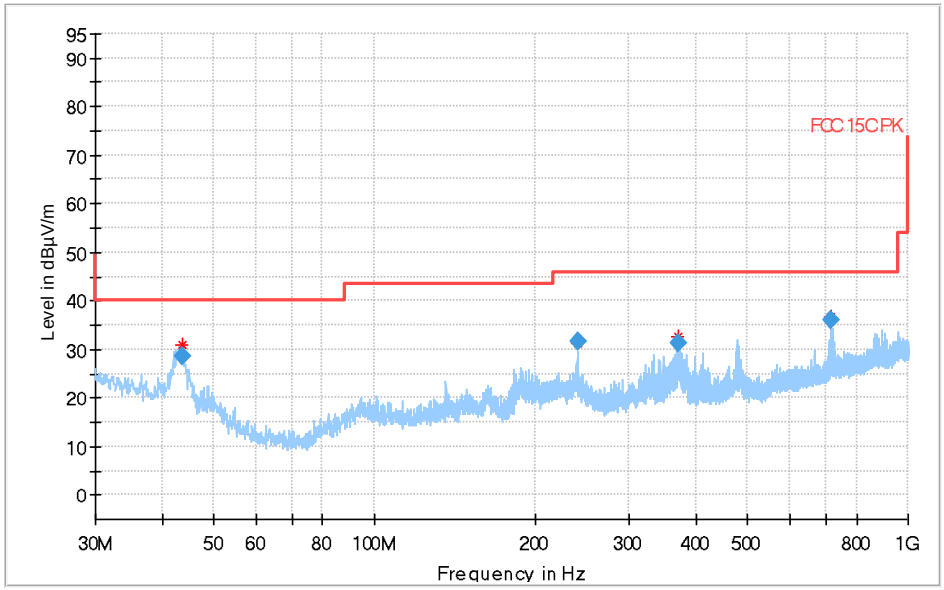
Modulation: BT LE	Channel: Low	97.27% Duty Cycle

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB/m)
43.727	28.675	---	40.00	11.33	500.0	100.000	142.0	H	285.0	-14.9
239.997	31.478	---	46.00	14.52	500.0	100.000	121.0	V	131.0	-18.9
371.140	31.333	---	46.00	14.67	500.0	100.000	108.0	V	104.0	-15.3
715.727	36.111	---	46.00	9.89	500.0	100.000	100.0	V	66.0	-8.3

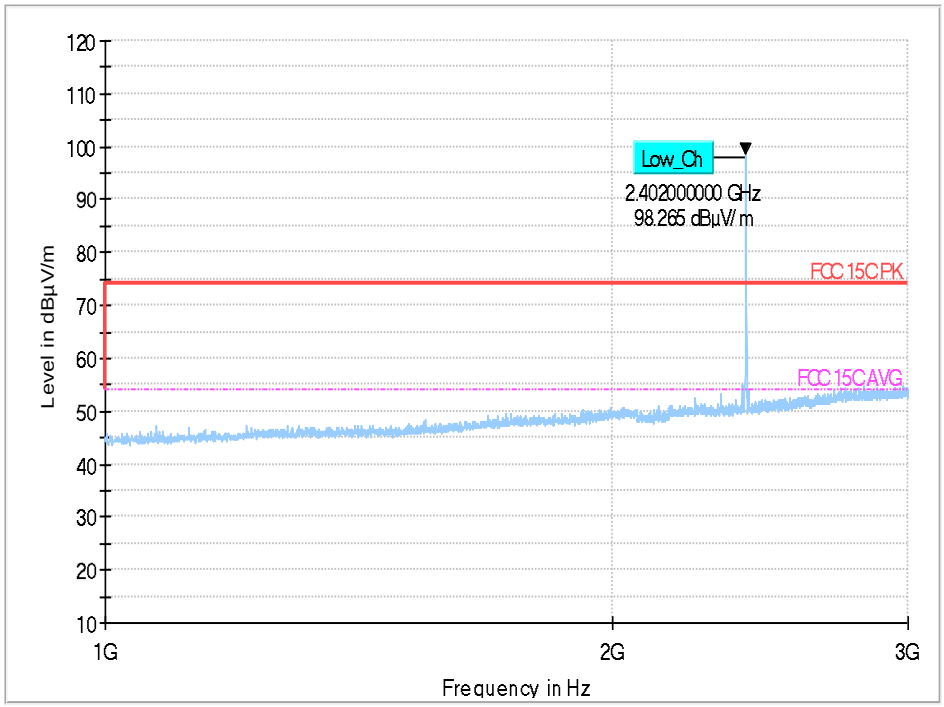
(continuation of the "Final_Result" table from column 16 ...)

Frequency (MHz)	Comment
43.727	12:08:31 PM - 12/19/2019
239.997	12:11:24 PM - 12/19/2019
371.140	12:14:04 PM - 12/19/2019
715.727	12:16:42 PM - 12/19/2019



Preview Result 1-PK+
Final_Result PK+
Critical_Freqs PK+
Final_Result RMS
FCC 15C PK

Plot #18 Radiated Emissions: 1-3 GHz		
Modulation: BT LE	**Channel: Low**	**97.27% Duty Cycle**



Preview Result 1-PK+ | Critical_Freqs PK+ | FCC 15C PK
FCC 15C AVG | Final_Result PK+ | Final_Result RMS

Plot #19 Radiated Emissions: 3-18 GHz

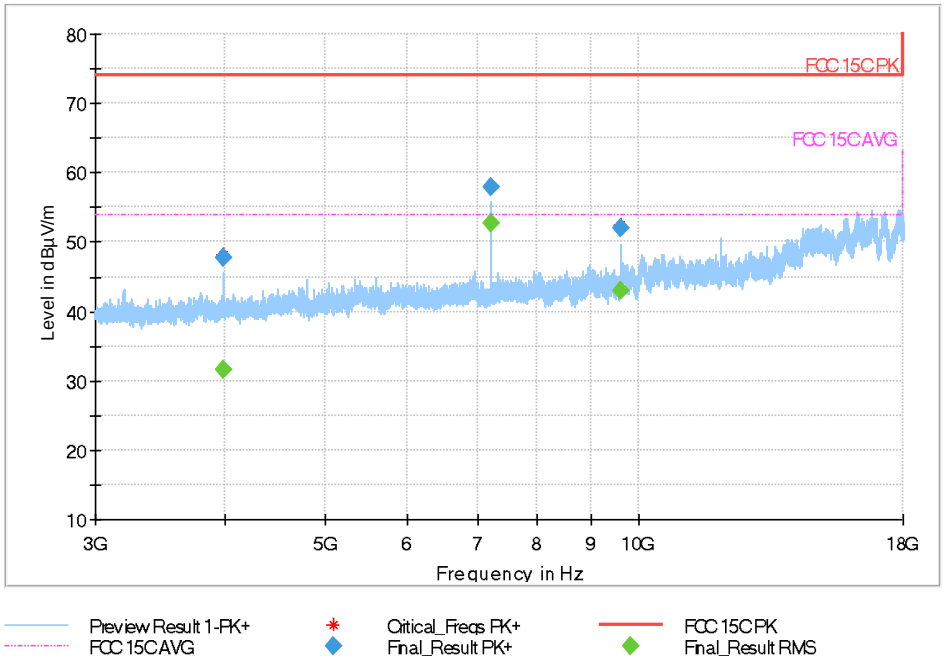
Modulation: BT LE	Channel: Low	97.27% Duty Cycle

Final_Result

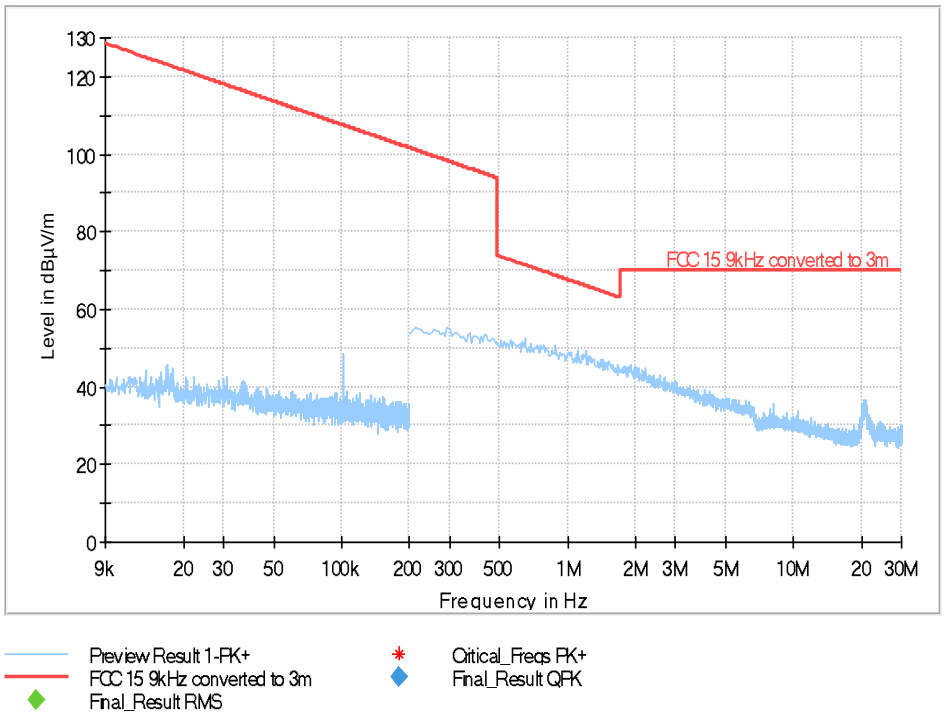
Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB/m)
3990.156	47.804	---	73.99	26.19	200.0	1000.000	163.0	V	310.0	-6.7
3990.156	---	31.519	53.98	22.46	200.0	1000.000	163.0	V	310.0	-6.7
7205.193	---	52.642	53.98	1.34	200.0	1000.000	222.0	V	341.0	-2.8
7205.193	57.892	---	73.99	16.09	200.0	1000.000	222.0	V	341.0	-2.8
9608.981	52.059	---	73.98	21.93	200.0	1000.000	151.0	H	359.0	2.8
9608.981	---	42.967	53.98	11.01	200.0	1000.000	151.0	H	359.0	2.8

(continuation of the "Final_Result" table from column 16 ...)

Frequency (MHz)	Comment
3990.156	3:22:38 PM - 12/19/2019
3990.156	3:22:38 PM - 12/19/2019
7205.193	3:19:43 PM - 12/19/2019
7205.193	3:19:43 PM - 12/19/2019
9608.981	3:16:48 PM - 12/19/2019
9608.981	3:16:48 PM - 12/19/2019



Plot #20 Radiated Emissions: 9 KHz – 30 MHz		
Modulation: BT LE	**Channel: Mid**	**97.27% Duty Cycle**



Plot #21 Radiated Emissions: 30 MHz – 1GHz

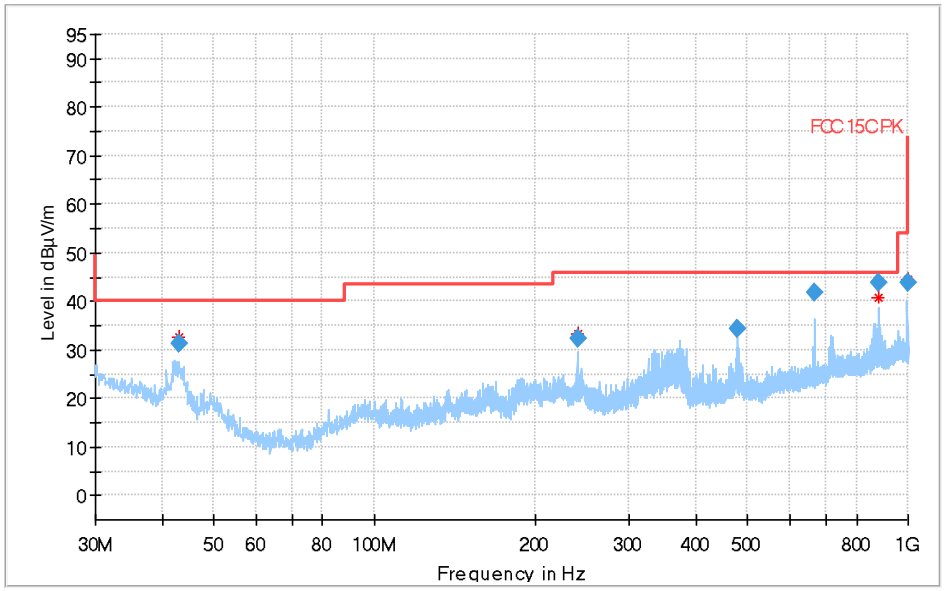
Modulation: BT LE	Channel: Mid	97.27% Duty Cycle

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB/m)
43.130	31.418	---	40.00	8.58	500.0	100.000	100.0	H	-16.0	-14.6
239.988	32.332	---	46.00	13.67	500.0	100.000	132.0	V	222.0	-18.9
479.644	34.287	---	46.00	11.71	500.0	100.000	100.0	V	354.0	-13.1
665.595	41.642	---	46.00	4.36	500.0	100.000	132.0	H	171.0	-9.1
880.950	43.773	---	46.00	2.23	500.0	100.000	108.0	H	161.0	-5.7
996.795	43.701	---	54.00	10.30	500.0	100.000	108.0	H	27.0	-4.4

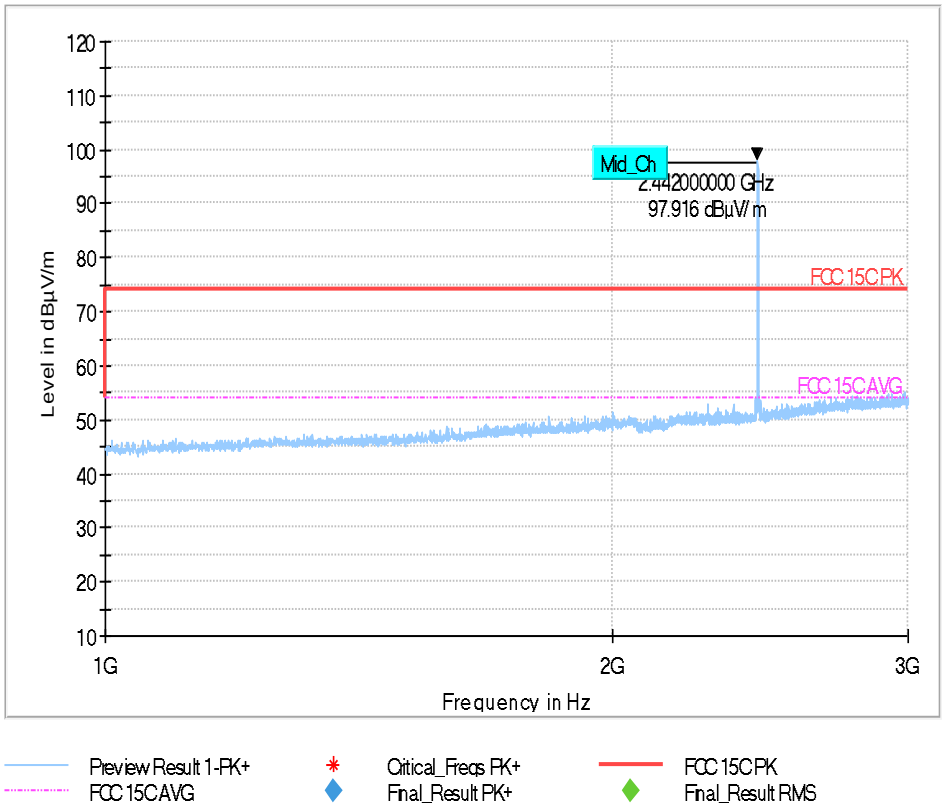
(continuation of the "Final_Result" table from column 16 ...)

Frequency (MHz)	Comment
43.130	12:28:17 PM - 12/19/2019
239.988	12:31:11 PM - 12/19/2019
479.644	12:33:49 PM - 12/19/2019
665.595	12:36:40 PM - 12/19/2019
880.950	12:39:15 PM - 12/19/2019
996.795	12:42:01 PM - 12/19/2019



Preview Result 1-PK+
Final_Result PK+
Critical_Freqs PK+
Final_Result RMS
FCC 15C PK

Plot #22 Radiated Emissions: 1-3 GHz		
Modulation: BT LE	**Channel: Mid**	**97.27% Duty Cycle**



Plot #23 Radiated Emissions: 3-18 GHz

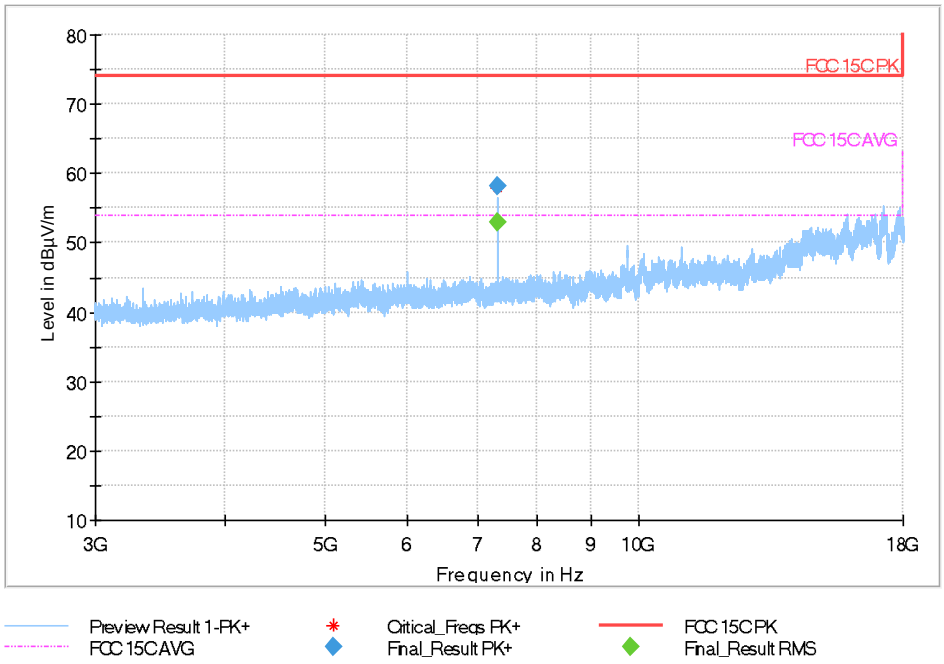
Modulation: BT LE	Channel: Mid	97.27% Duty Cycle

Final_Result

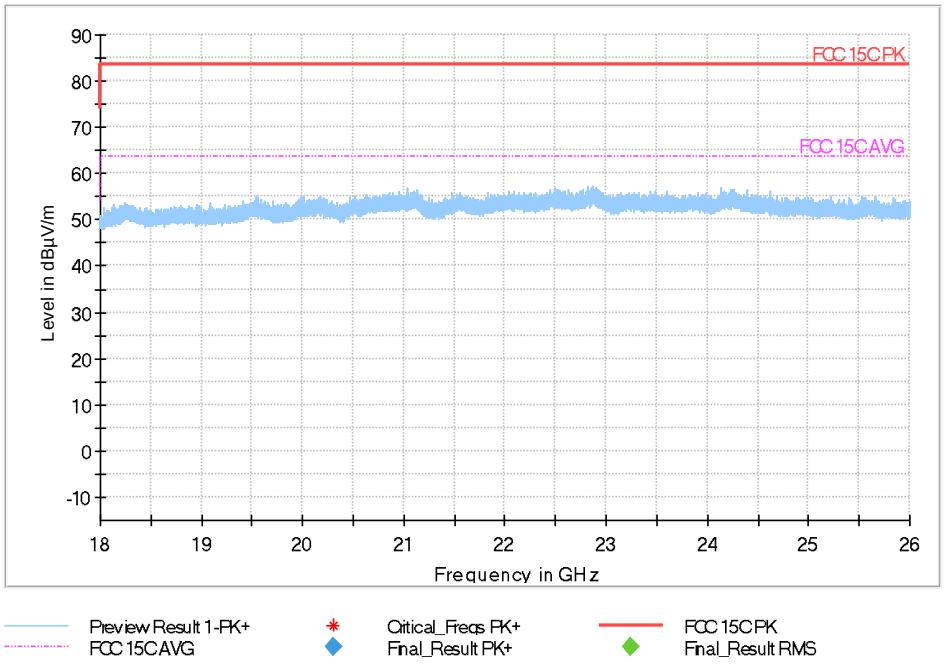
Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB/m)
7326.713	---	53.031	53.98	0.95	200.0	1000.000	211.0	V	289.0	-2.6
7326.713	58.224	---	73.99	15.76	200.0	1000.000	211.0	V	289.0	-2.6

(continuation of the "Final_Result" table from column 16 ...)

Frequency (MHz)	Comment
7326.713	3:04:59 PM - 12/19/2019
7326.713	3:04:59 PM - 12/19/2019



Plot #24 Radiated Emissions: 18-26 GHz		
Modulation: BT LE	**Channel: Mid**	**97.27% Duty Cycle**



Plot #25 Radiated Emissions: 30 MHz – 1GHz

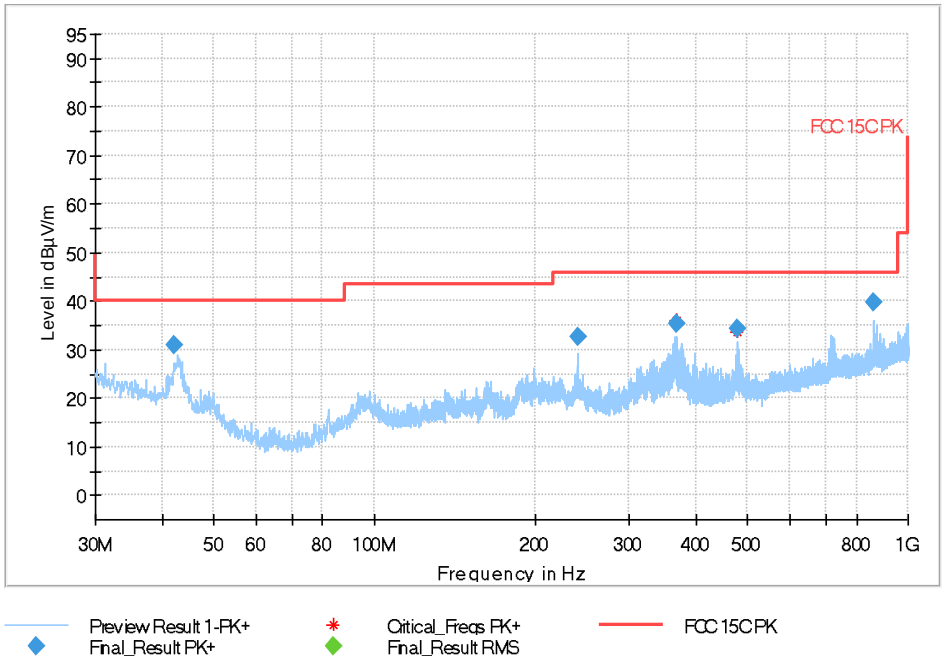
Modulation: BT LE	Channel: High	97.27% Duty Cycle

Final_Result

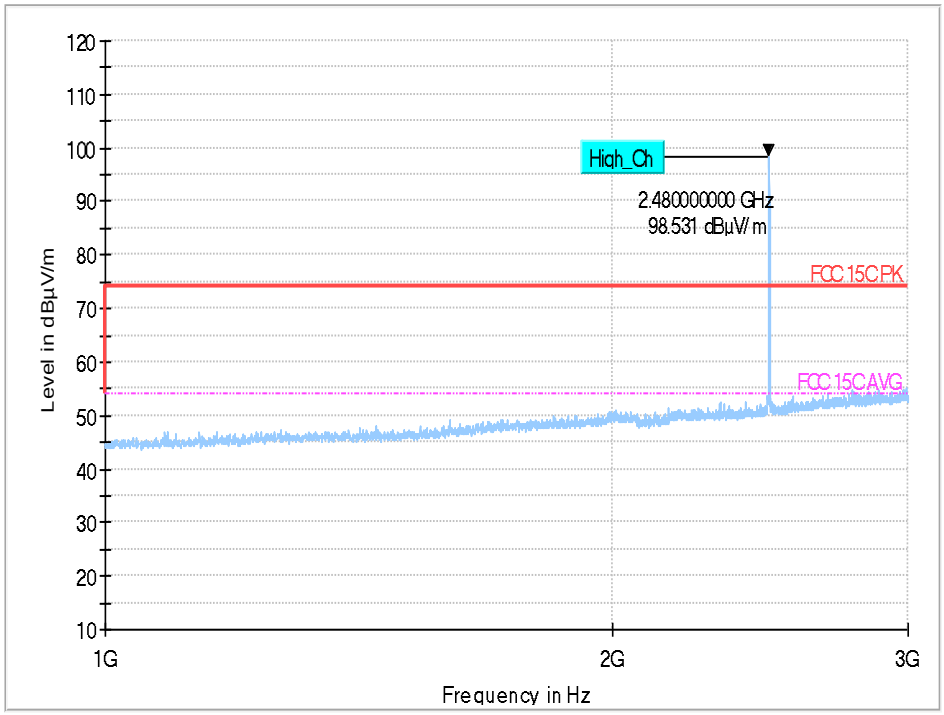
Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB/m)
42.272	30.792	---	40.00	9.21	500.0	100.000	108.0	H	-29.0	-14.2
240.012	32.754	---	46.00	13.25	500.0	100.000	131.0	V	41.0	-18.9
369.357	35.482	---	46.00	10.52	500.0	100.000	108.0	V	279.0	-15.3
480.141	34.230	---	46.00	11.77	500.0	100.000	100.0	V	355.0	-13.1
863.015	39.714	---	46.00	6.29	500.0	100.000	132.0	H	69.0	-5.9

(continuation of the "Final_Result" table from column 16 ...)

Frequency (MHz)	Comment
42.272	1:23:17 PM - 12/19/2019
240.012	1:26:08 PM - 12/19/2019
369.357	1:29:08 PM - 12/19/2019
480.141	1:31:51 PM - 12/19/2019
863.015	1:34:50 PM - 12/19/2019



Plot #26 Radiated Emissions: 1-3 GHz and Restricted Bands		
Modulation: BT LE	**Channel: High**	**97.27% Duty Cycle**



Plot #27 Radiated Emissions: 3-18 GHz

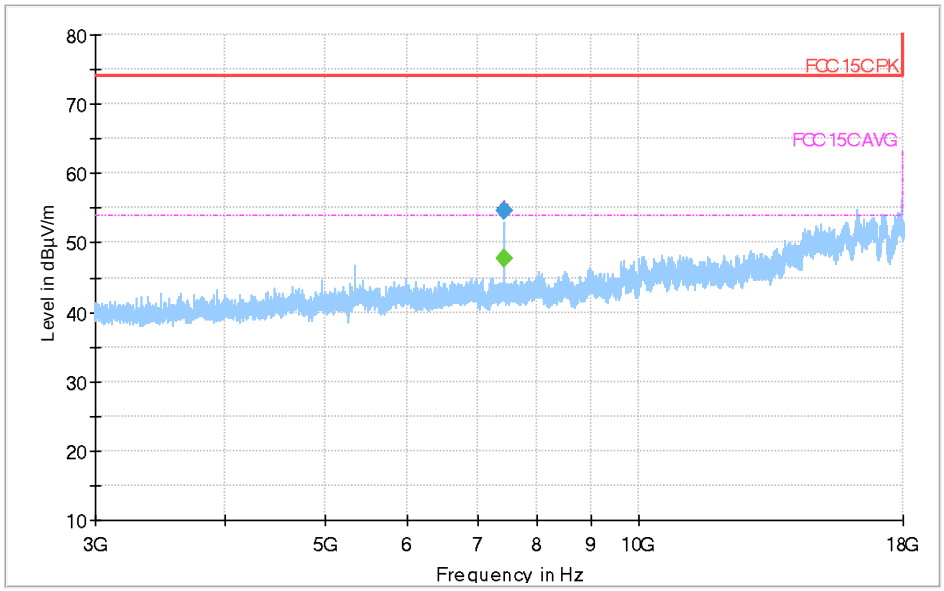
Modulation: BTLE	Channel: High	97.27% Duty Cycle

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB/m)
7439.109	---	47.770	53.98	6.21	200.0	1000.000	217.0	H	295.0	-2.2
7439.109	54.513	---	73.99	19.47	200.0	1000.000	217.0	H	295.0	-2.2

(continuation of the "Final_Result" table from column 16 ...)

Frequency (MHz)	Comment
7439.109	3:33:42 PM - 12/19/2019
7439.109	3:33:42 PM - 12/19/2019



Preview Result 1-PK+
FCC 15C AVG
Critical_Freqs PK+
Final_Result PK+
FCC 15C PK
Final_Result RMS

9 Test setup photos

Setup photos are included in supporting file name: “EMC_INNOP_005_19001_15.247_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	6507	00161344	3 YEARS	10/26/2017
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	00169547	3 YEARS	08/08/2017
HORN ANTENNA	ETS LINDGREN	3116C	00169535	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	2 YEARS	07/15/2019
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
2020-01-06	EMC_INNOP_005_19001_15.247_BT_DTS	Initial version	Kevin Wang