



## 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:

| 2020-01-06 | Compliance | Cindy Li<br>(EMC Lab Manager) |           |
|------------|------------|-------------------------------|-----------|
| Date       | Section    | Name                          | Signature |

### Responsible for the Report:

| 2020-01-06 | Compliance | Kevin Wang<br>(Senior 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: | 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

|   |  |
|---|--|
| <b>Model No:</b>                                    | INP2045 Module   |
| <b>HW Version :</b>                                 | INP2045-H  |
| <b>SW Version :</b>                                 | 7d721afe   |
| <b>FCC-ID:</b>                                      | 2AVAL-INP2045  |
| <b>IC-ID:</b>                                       | 25715-INP2045  |
| <b>HVIN:</b>  | INP2045-H  |
| <b>PMN:</b>   | Talaria-TWO  |
| <b>Product Description:</b>                         | Low Power Wi-Fi/BLE IOT Module   |
| <b>Frequency Range / number of channels:</b>        | Module name: INP2045 Module<br>Nominal band: 2400 MHz – 2483.5 MHz;<br>Center to center: 2402 MHz (ch 0) – 2480 MHz (ch 39), 40 channels |
| <b>Type(s) of Modulation:</b>                       | Bluetooth Low Energy, using Dynamic Sequence Spread Spectrum with GFSK modulation.   |
| <b>Modes of Operation:</b>                          | Bluetooth LE in both advertising and connected mode of operation   |
| <b>Antenna Information as declared:</b>             | 0 dBi  |
| <b>Max. Peak Output Power:</b>                      | Conducted Power 9.33 dBm   |
| <b>Power Supply/ Rated Operating Voltage Range:</b> | Vmin: 2.7 VDC/ Vnom: 3.3 VDC / Vmax: 3.6 VDC   |
| <b>Operating Temperature Range:</b>                 | -10 °C to 75 °C  |
| <b>Other Radios included in the device:</b>         | ❖ <u>WiFi</u> <ul style="list-style-type: none"><li>• Module name: INP2045 Module</li><li>• Antenna Gain: 0 dBi</li></ul>                |
| <b>Sample Revision:</b>                             | <input type="checkbox"/> Prototype Unit; <input checked="" type="checkbox"/> Production Unit; <input type="checkbox"/> 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.<br>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)<br>RSS-247 5.2(1)              | Emission Bandwidth                              | Nominal                            | BTLE | ■    | □  | □  | Complies         |
| §15.247(e)<br>RSS-247 5.2(2)                 | Power Spectral Density                          | Nominal                            | BTLE | ■    | □  | □  | Complies         |
| §15.247(b)(1)<br>RSS-247 5.4(4)              | Maximum Conducted Output Power and EIRP         | Nominal                            | BTLE | ■    | □  | □  | Complies         |
| §15.247(d)<br>RSS-247 5.5                    | Band edge compliance<br>Unrestricted Band Edges | Nominal                            | BTLE | ■    | □  | □  | Complies         |
| §15.247; 15.209; 15.205<br>RSS-Gen 8.9; 8.10 | Band edge compliance<br>Restricted Band Edges   | Nominal                            | BTLE | ■    | □  | □  | Complies         |
| §15.247(d); §15.209<br>RSS-Gen 6.13          | TX Spurious emissions-<br>Radiated              | Nominal                            | BTLE | ■    | □  | □  | Complies         |
| §15.207(a)<br>RSS Gen 8.8                    | AC Conducted Emissions                          | Nominal                            | BTLE | □    | ■  | □  | N/A <sup>2</sup> |

**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

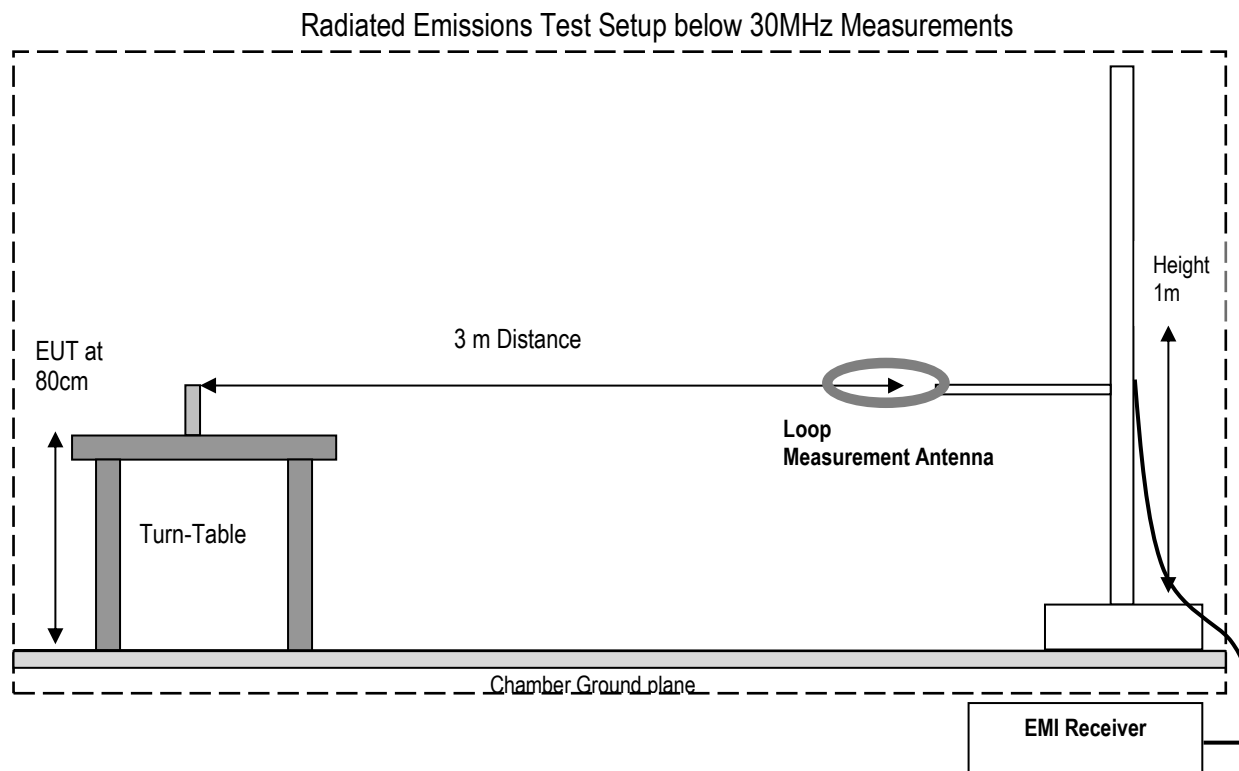


## 7 Measurement Procedures

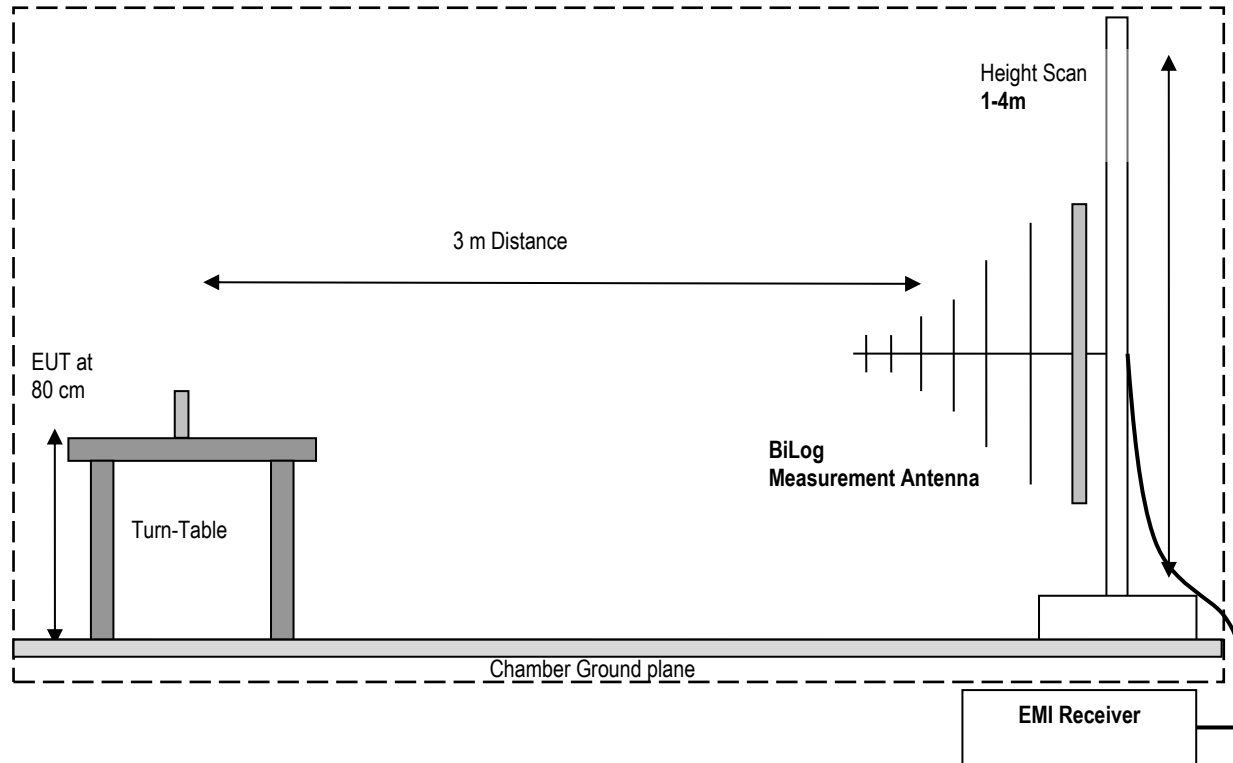
### 7.1 Radiated Measurement

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

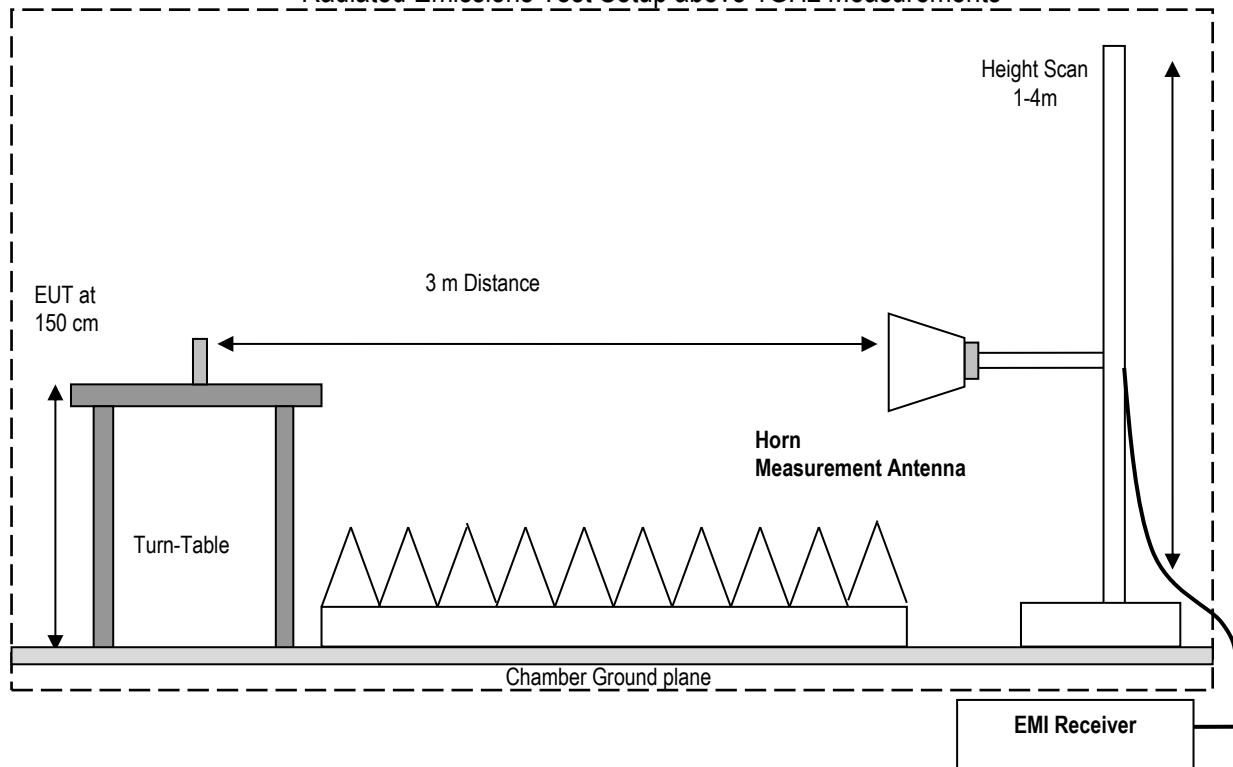
- The exploratory measurement is accomplished by running a matrix of 16 sweeps over the required frequency range with R&S Test-SW EMC32 for 4 positions of the turntable, two orthogonal positions of the EUT and both antenna polarizations. This procedure exceeds the requirement of the above standards to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

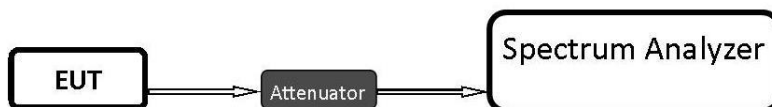
$$FS \text{ (dB}\mu\text{V/m)} = \text{Measured Value on SA (dB}\mu\text{V)} - \text{Cable Loss (dB)} + \text{Antenna Factor (dB/m)}$$

Example:

| Frequency (MHz) | Measured SA (dB $\mu$ V) | Cable Loss (dB) | Antenna Factor Correction (dB) | Field Strength Result (dB $\mu$ V/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  $\geq$  DTS bandwidth
- VBW  $\geq 3 \times$  RBW
- Span  $\geq 3 \times$  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        |

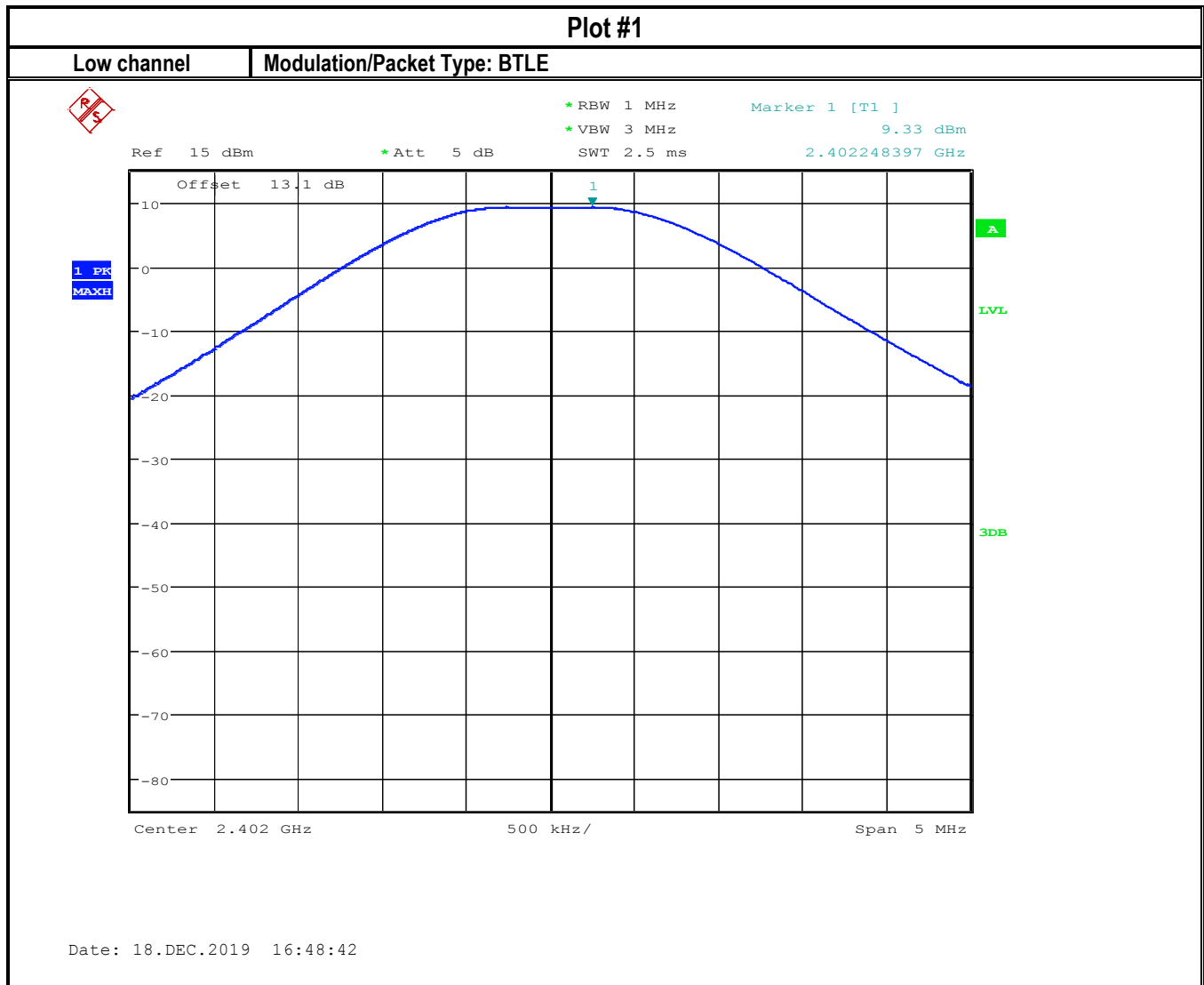
#### 8.1.4 Measurement result:

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 #2**

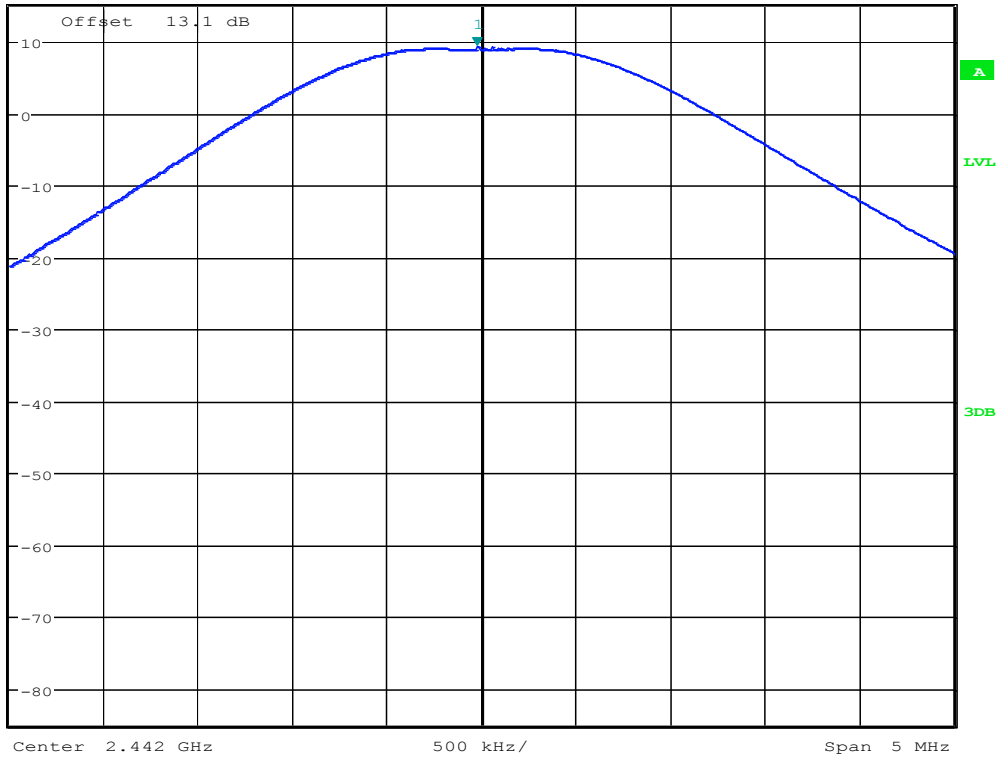
Mid channel

Modulation/Packet Type: BTLE

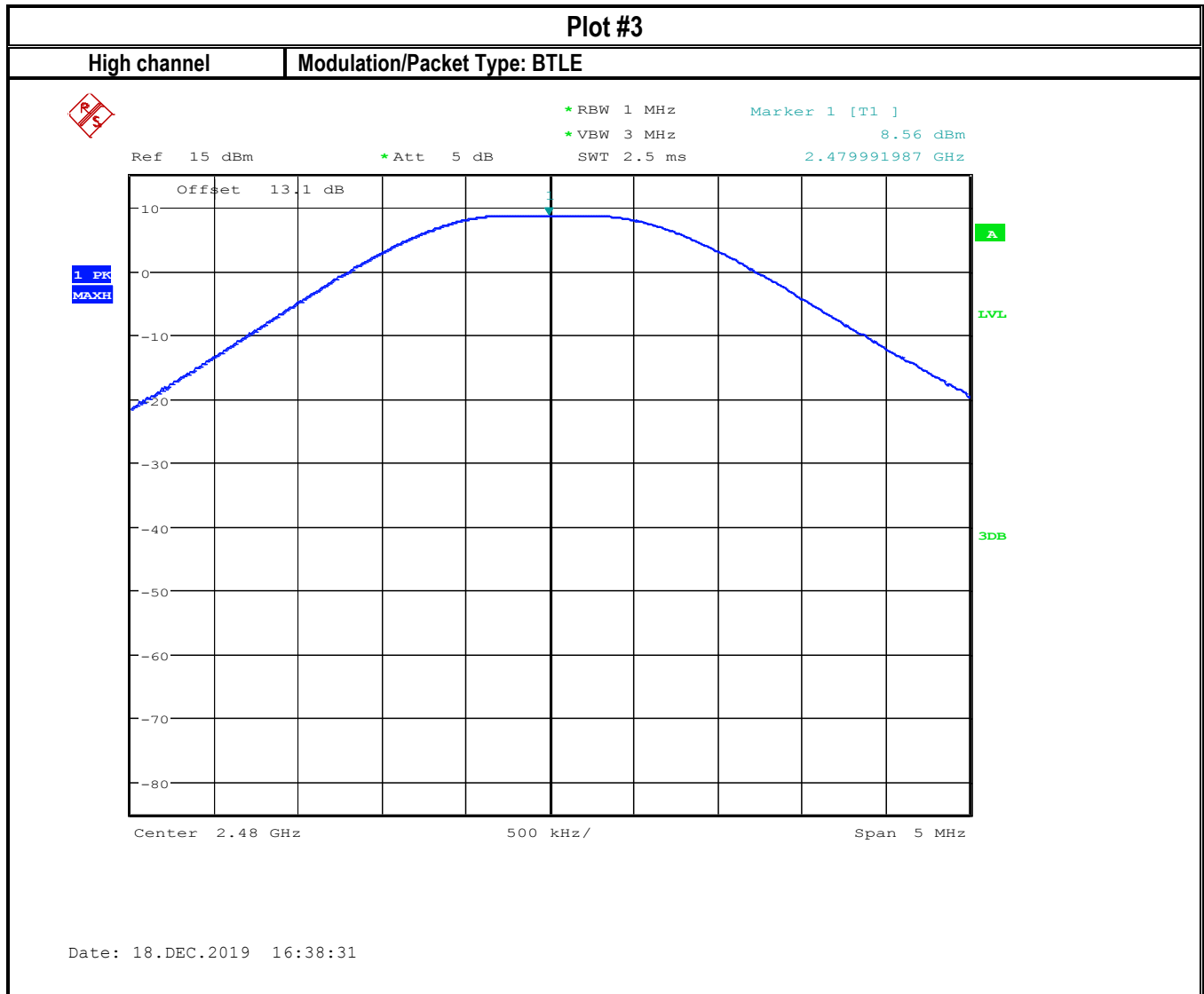


Ref 15 dBm      \*Att 5 dB      \*RBW 1 MHz      Marker 1 [T1]      9.17 dBm  
\*VBW 3 MHz      SWT 2.5 ms      2.441975962 GHz

1 PK  
MAXH



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



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:  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$
- Set the VBW  $\geq 3 \times \text{RBW}$
- 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:

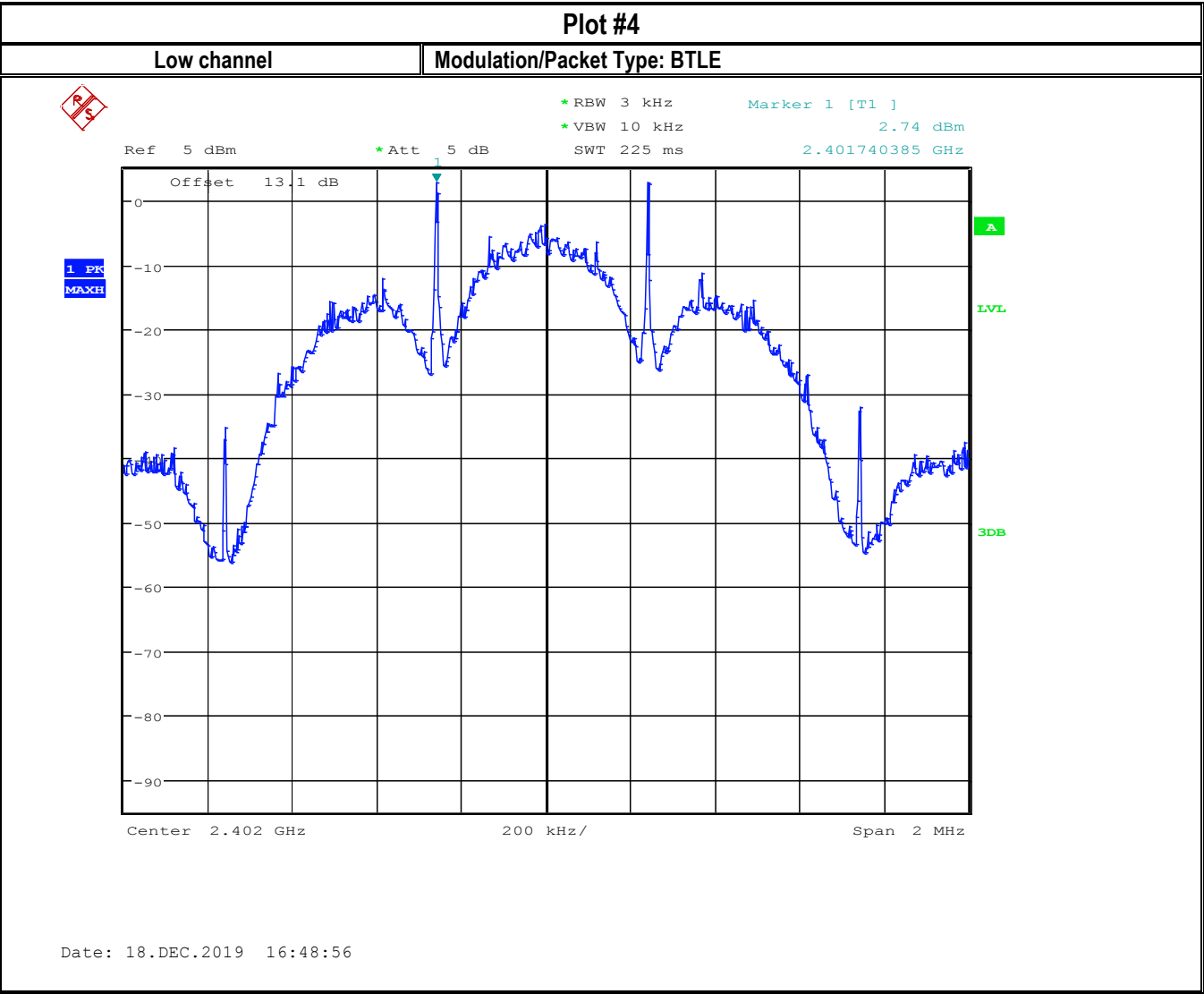
Attenuation of cable and attenuator (already taken into account): 13.1 dB

| 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:



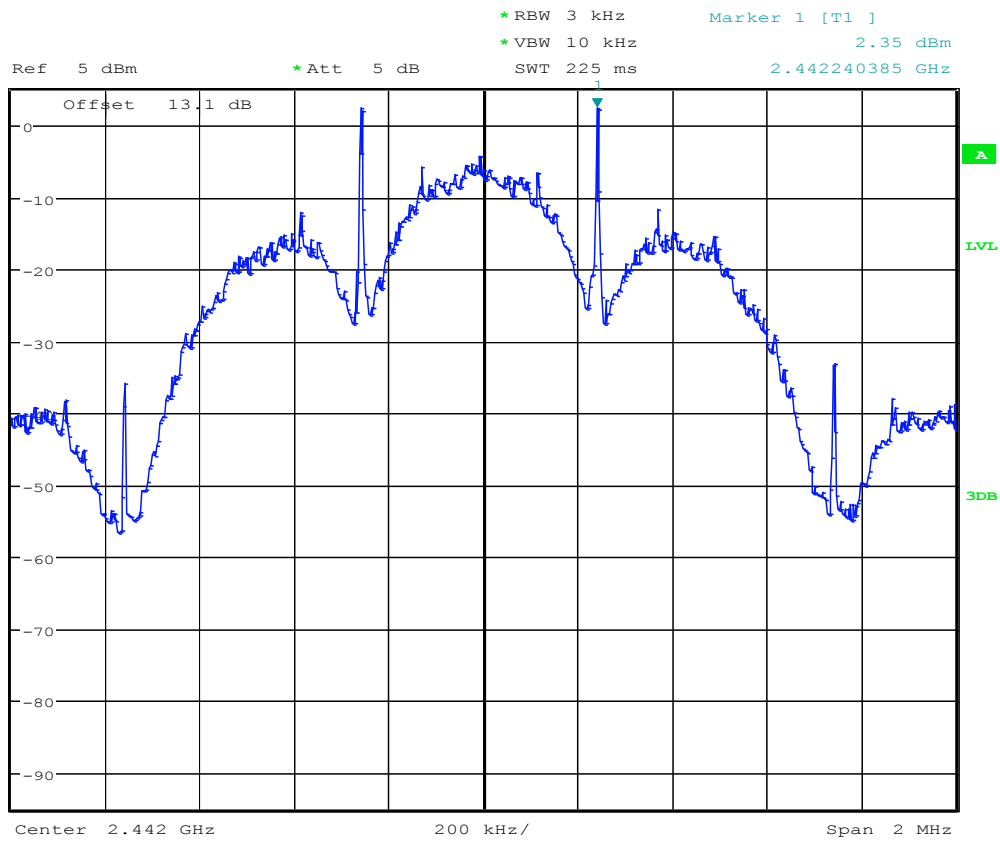
**Plot #5**

Mid channel

Modulation/Packet Type: BTLE



1 PK  
MAXH

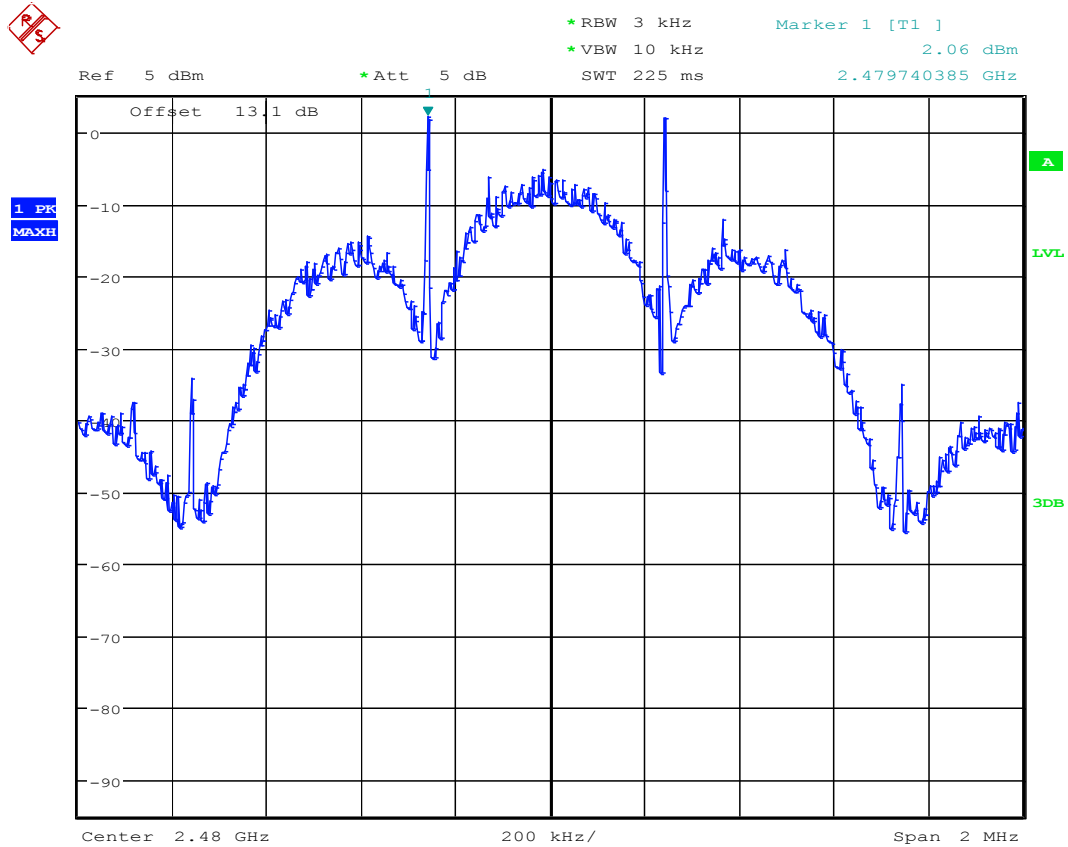


Date: 18.DEC.2019 16:52:47

**Plot #6**

High channel

Modulation/Packet Type: BTLE



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

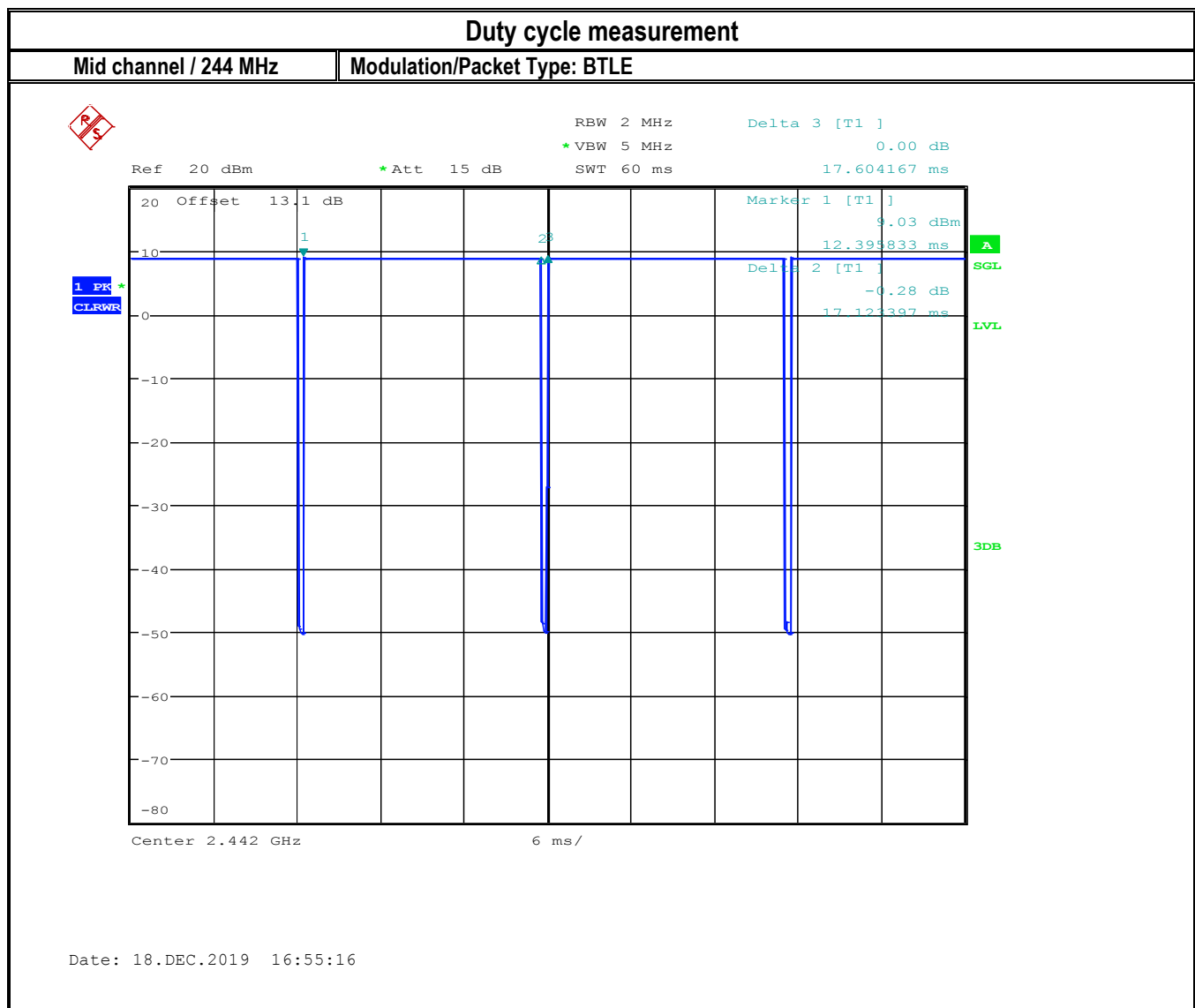
### 8.3 Duty cycle

#### 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 =97.27%

Duty cycle correction factor =  $10 \cdot \log(1/0.9727) = 0.12$  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  $\geq 3 \times$  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)).

#### **RSS-247 5/5**

- 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    |
| 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       |                     |               |             |

### 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        |

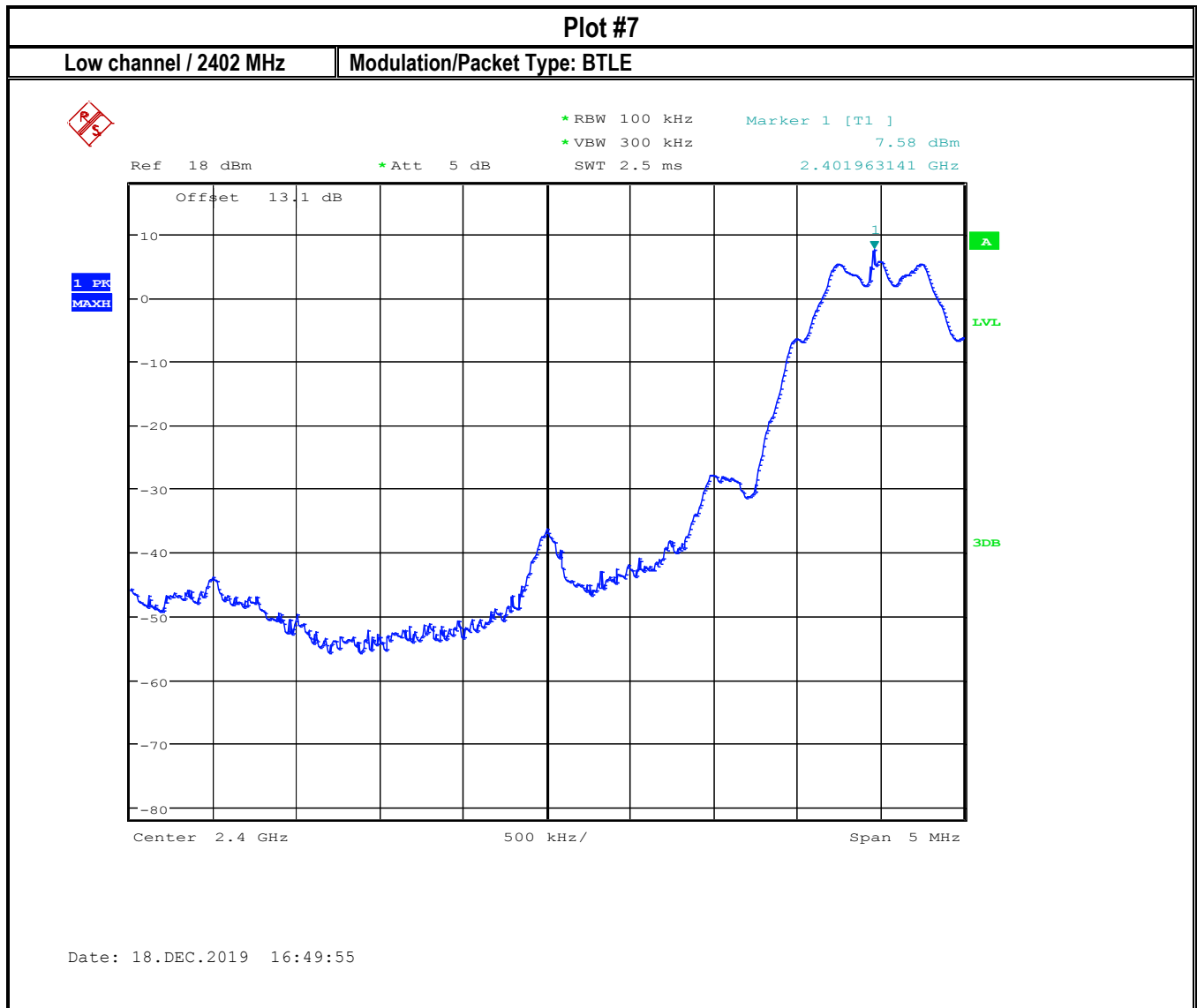
### 8.4.5 Measurement result:

| 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:



Test Report #: EMC\_INNOP-005-19001\_15.247\_BT\_DTS  
Date of Report: 2020-01-06

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



### Plot #8

Low channel / 2402 MHz

Modulation/Package Type: BTLE

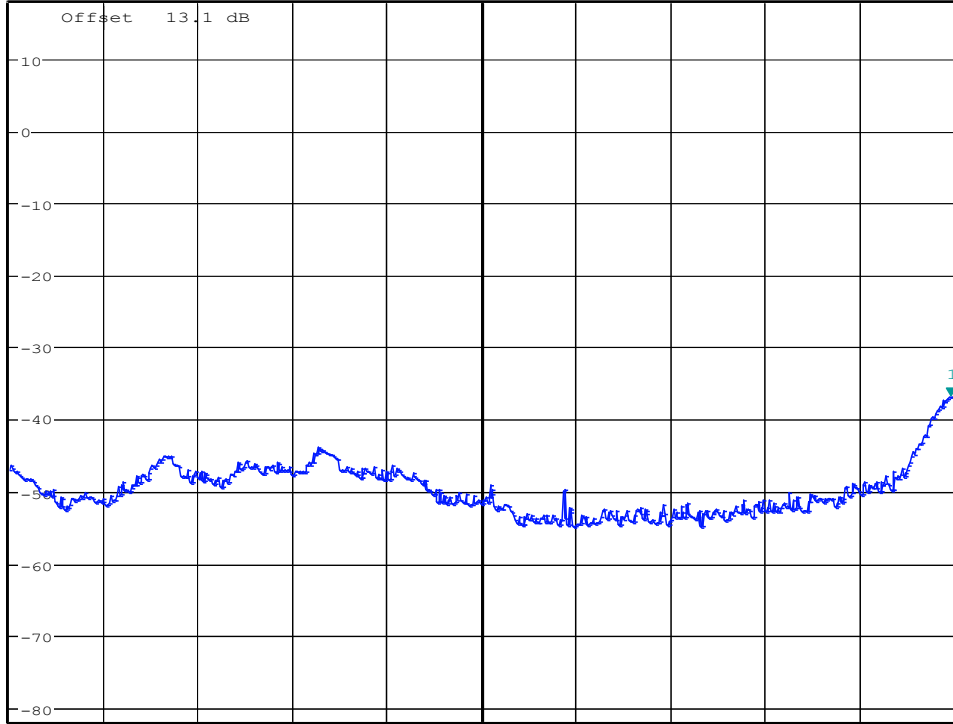


\* RBW 100 kHz      Marker 1 [T1 ]  
\* VBW 300 kHz      -36.87 dBm  
SWT 2.5 ms      2.399990385 GHz

Ref 18 dBm

\* Att 5 dB

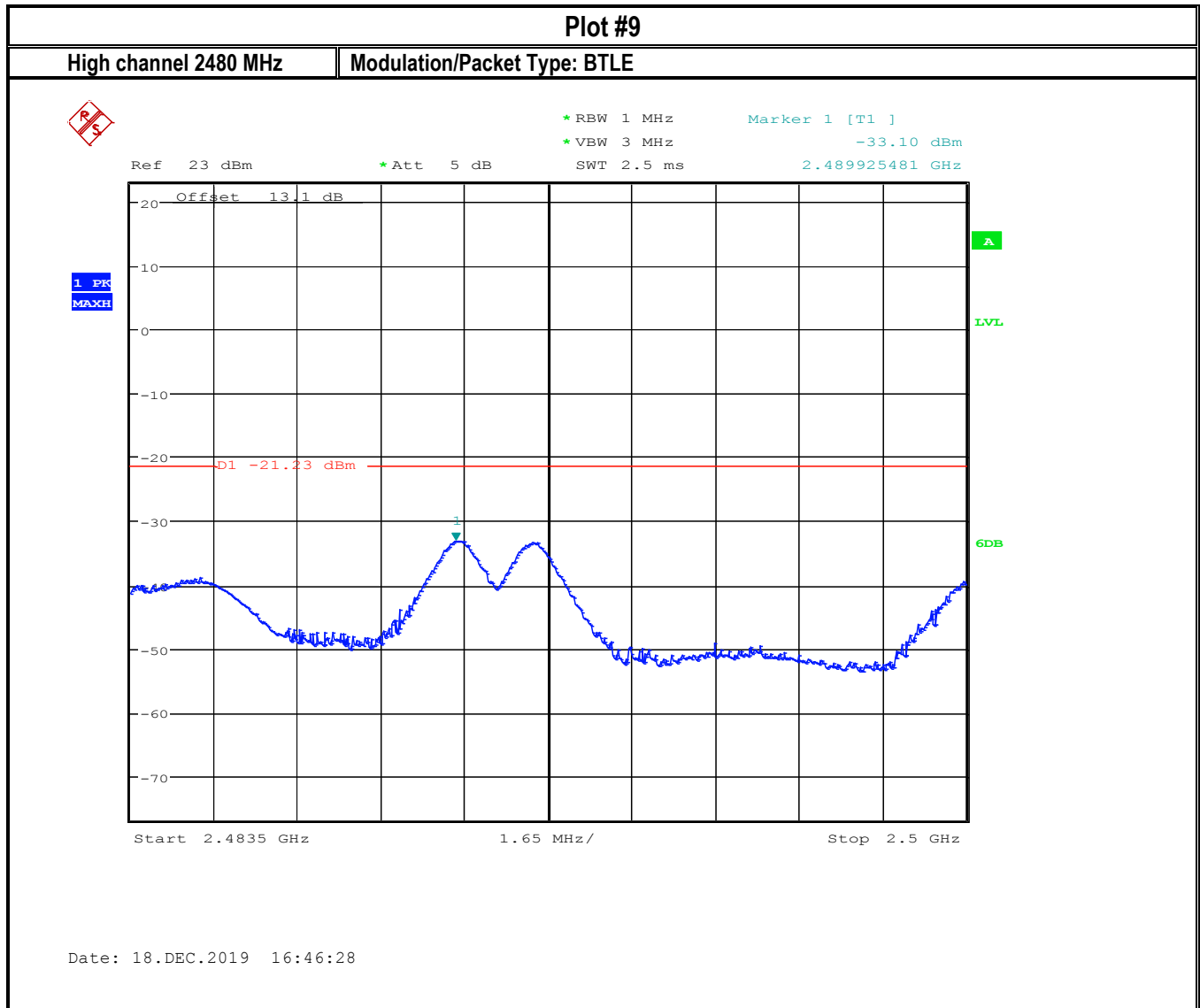
1 PK  
MAXH



Start 2.397 GHz      300 kHz/      Stop 2.4 GHz

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





**Plot #10**

**High channel 2480 MHz**

**Modulation/Packet Type: BTLE**

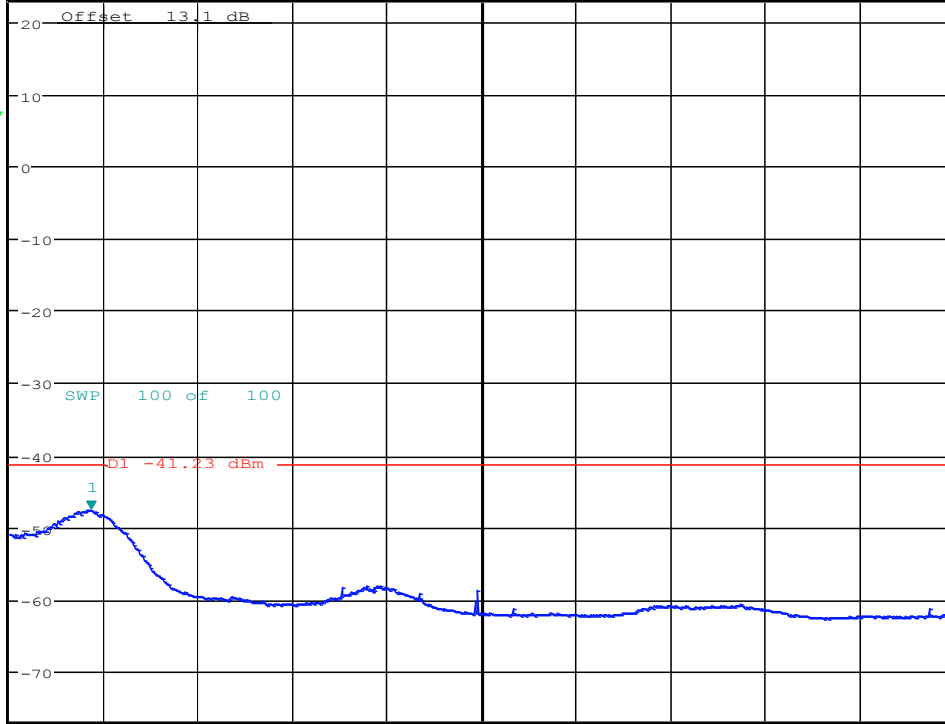


\*RBW 1 MHz      Marker 1 [T1 ]  
\*VBW 3 MHz      -47.64 dBm  
SWT 2.5 ms      2.484927885 GHz

Ref 23 dBm

\*Att 5 dB

1 RM  
AVG



A  
SGL  
LVL  
6DB

Center 2.49175 GHz      1.65 MHz/      Span 16.5 MHz

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)  $\geq 3 \times$  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:

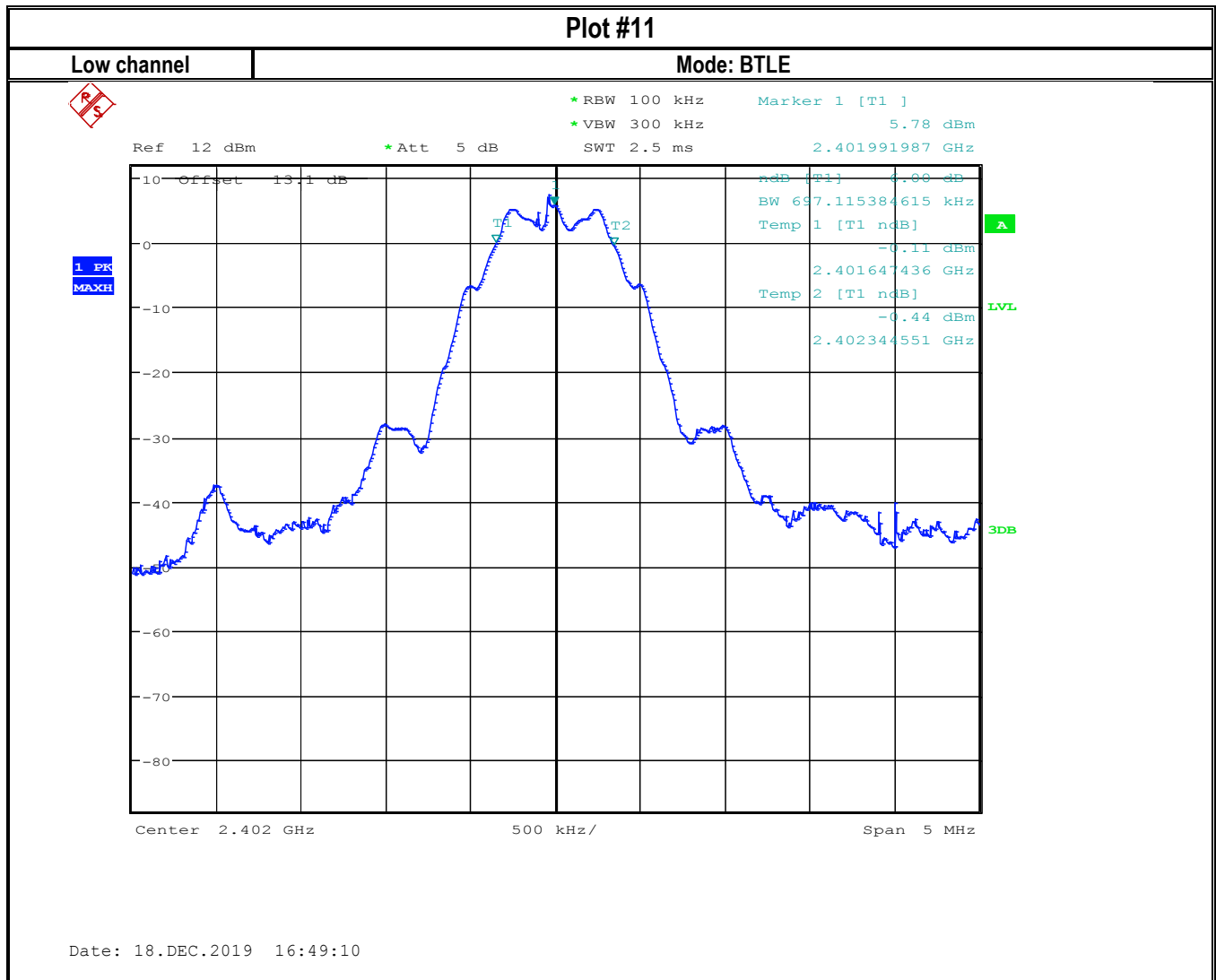
| Ambient Temperature | EUT Set-Up # | EUT operating mode            | Power Input |
|---------------------|--------------|-------------------------------|-------------|
| 22° C               | 2            | GFSK continuous fixed channel | 12 VDC      |

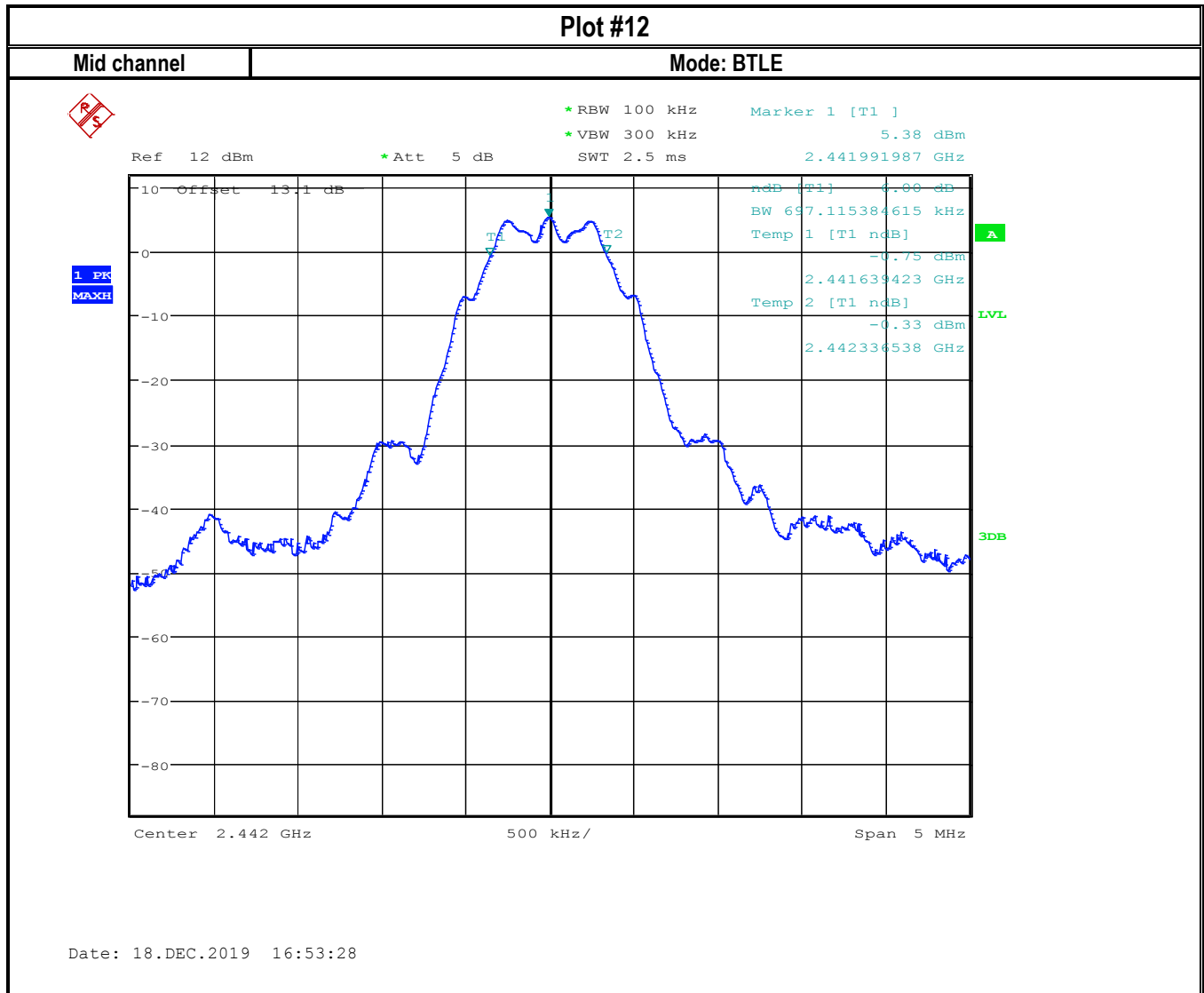
#### 8.5.4 Measurement result:

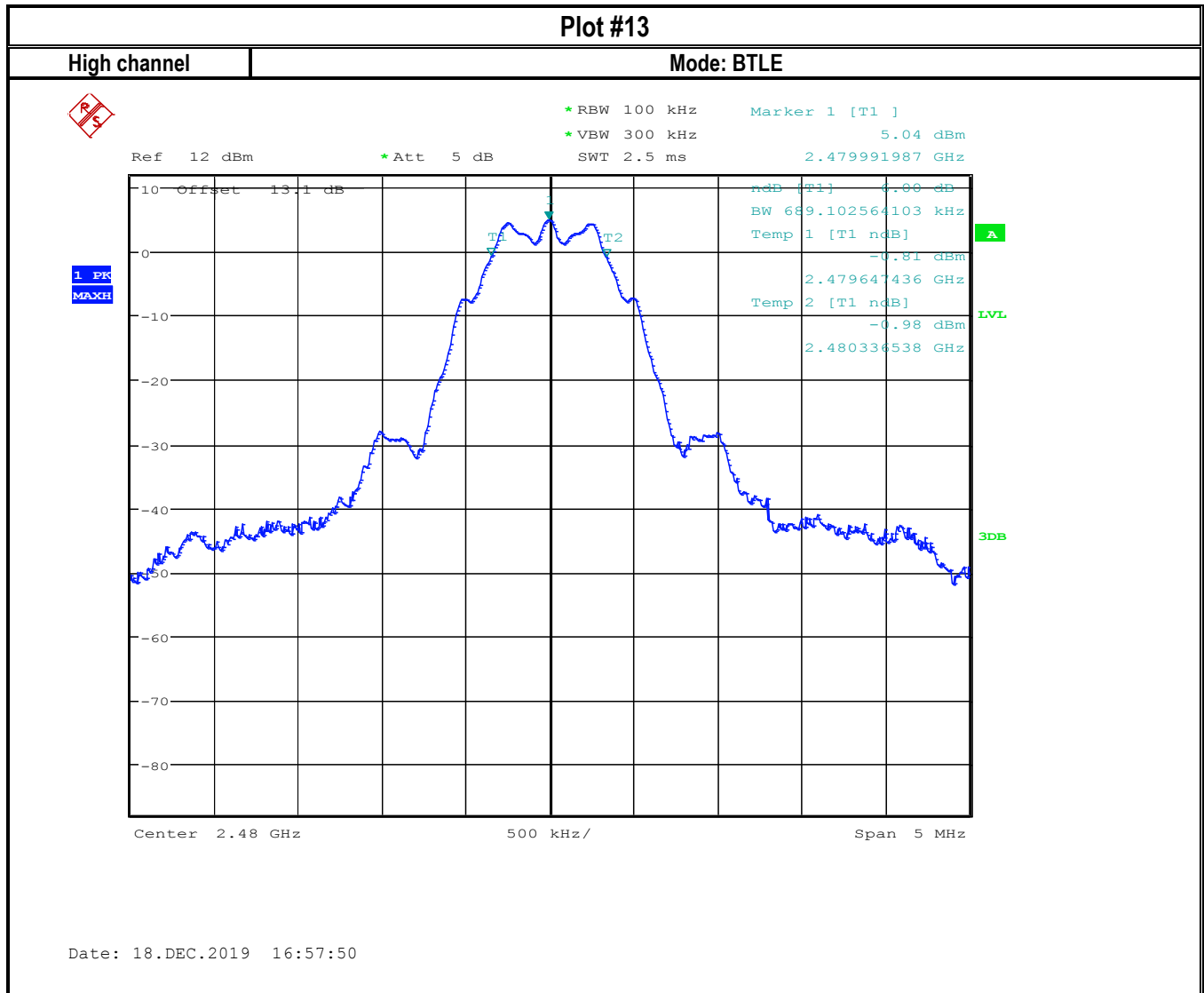
| Plot # | Frequency (MHz) | 6 dB Emissions Bandwidth (MHz) | Limit (MHz) | Result |
|--------|-----------------|--------------------------------|-------------|--------|
| 11     | 2402            | 0.697                          | > 0.5       | Pass   |
| 12     | 2440            | 0.697           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

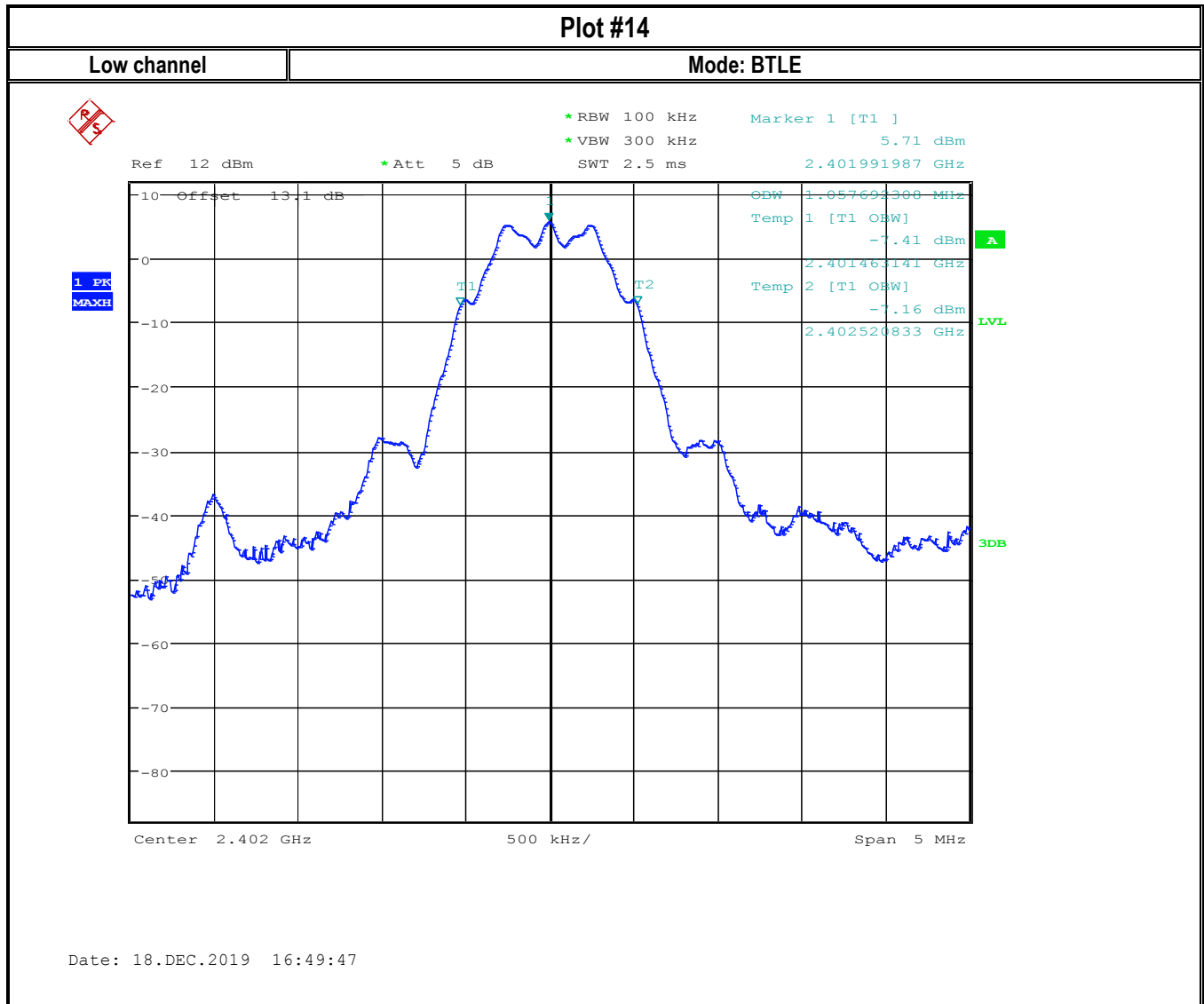
| Plot # | Frequency (MHz) | 99% Occupied Bandwidth (MHz) | Limit (MHz) | Result |
|--------|-----------------|------------------------------|-------------|--------|
| 14     | 2402            | 1.058                        | > 0.5       | Pass   |
| 15     | 2440            | 1.058                 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

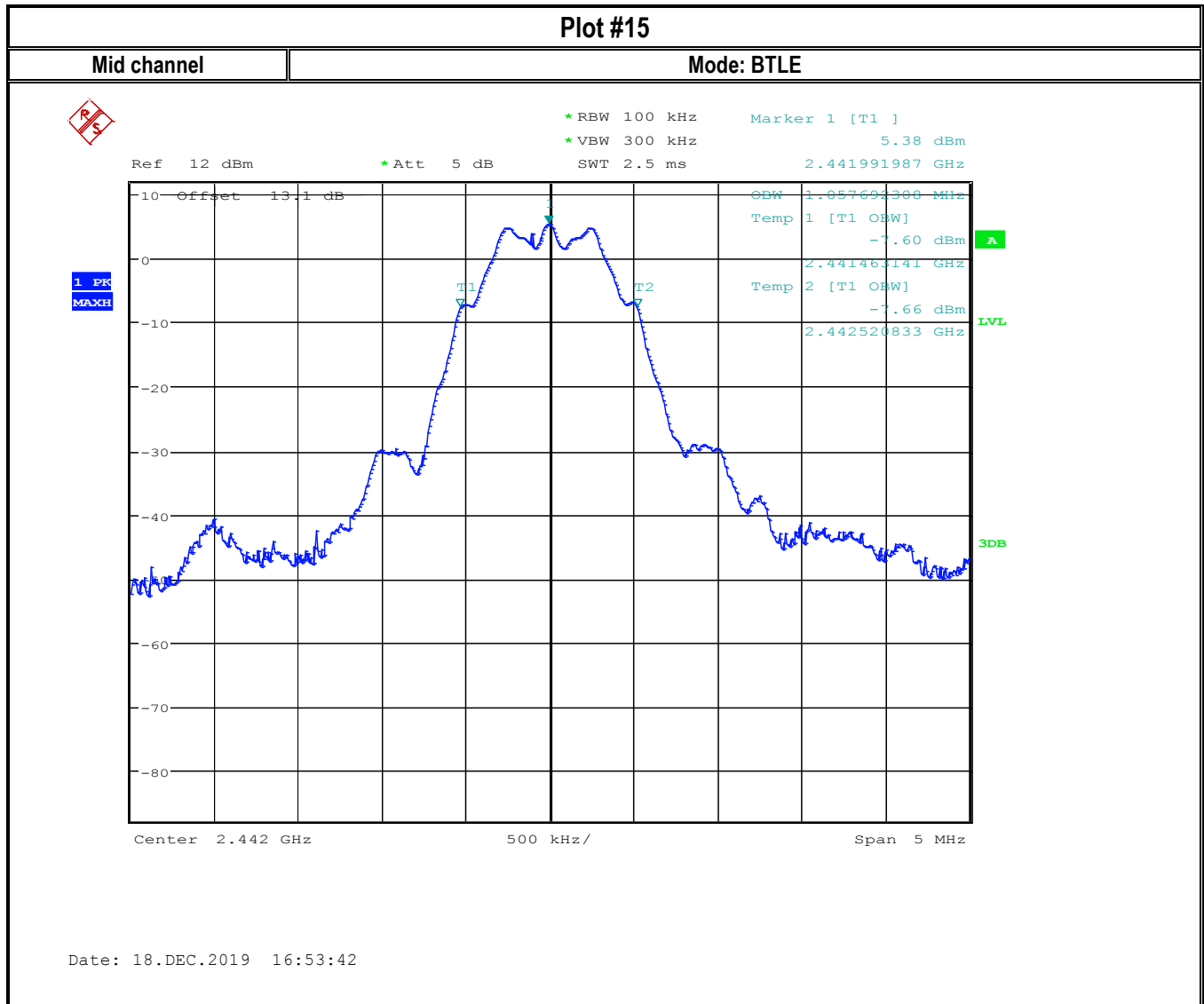
## 8.5.5 Measurement Plots:





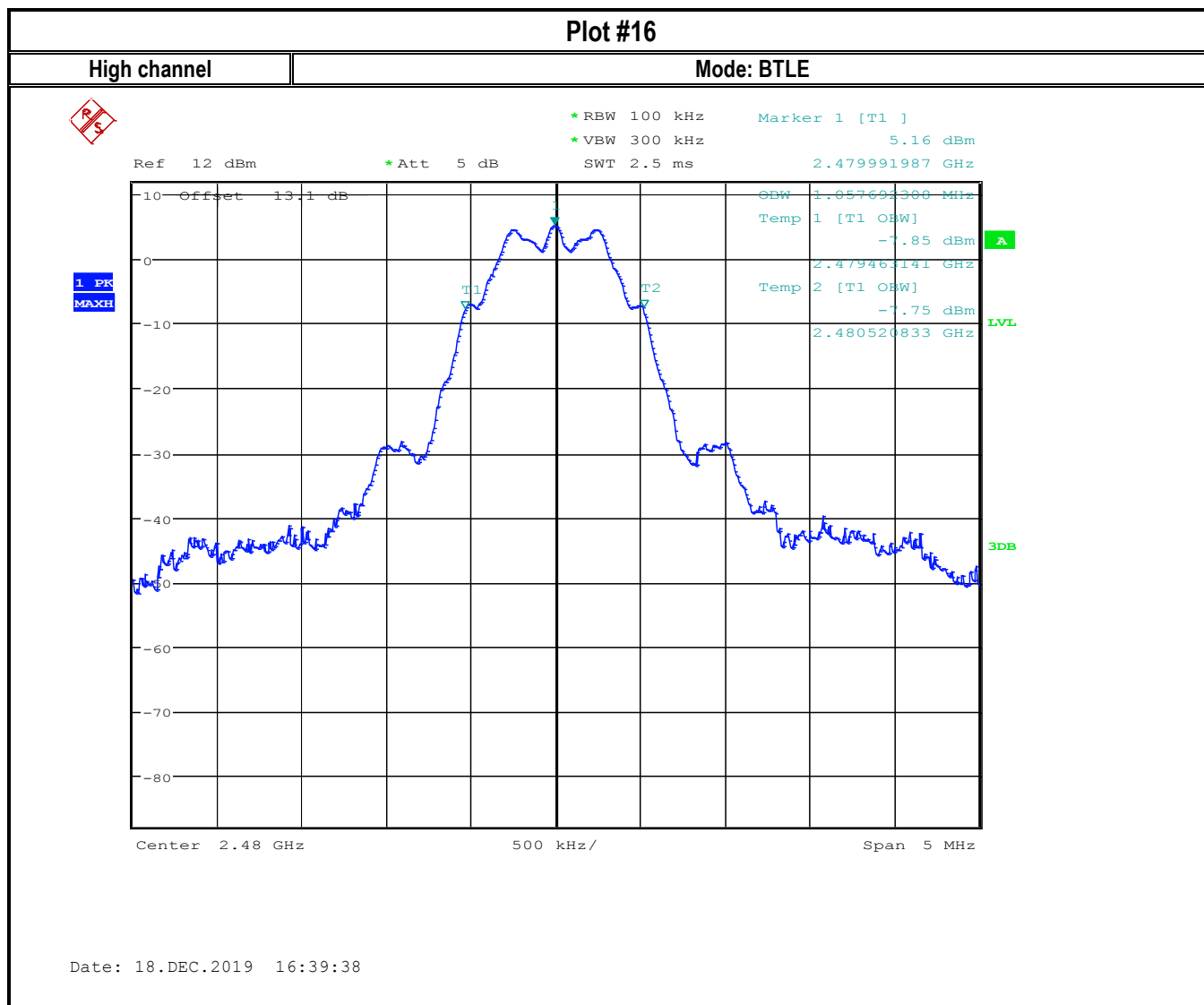






Date: 18.DEC.2019 16:53:42





## **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    |
| 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

### 8.6.3 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

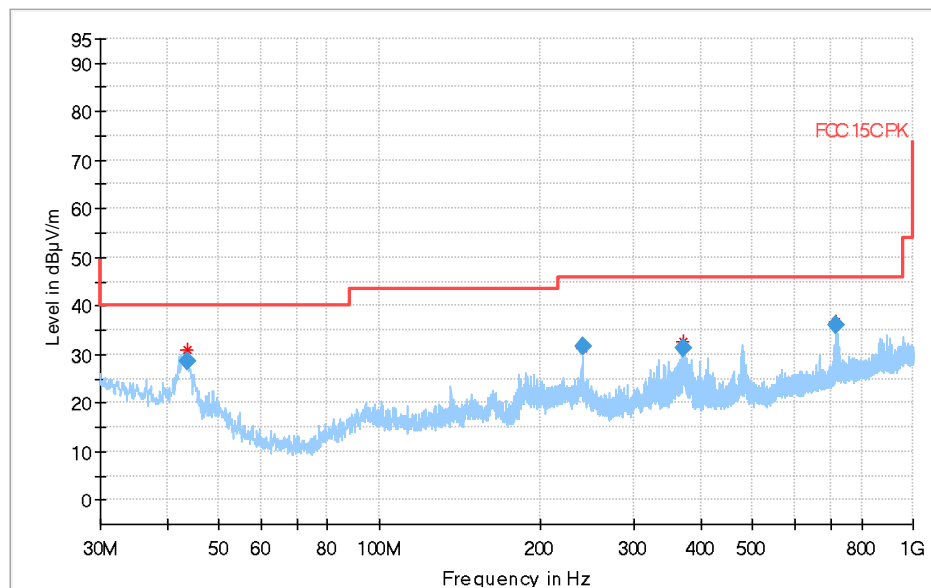
97.27% Duty Cycle

**Final Result**

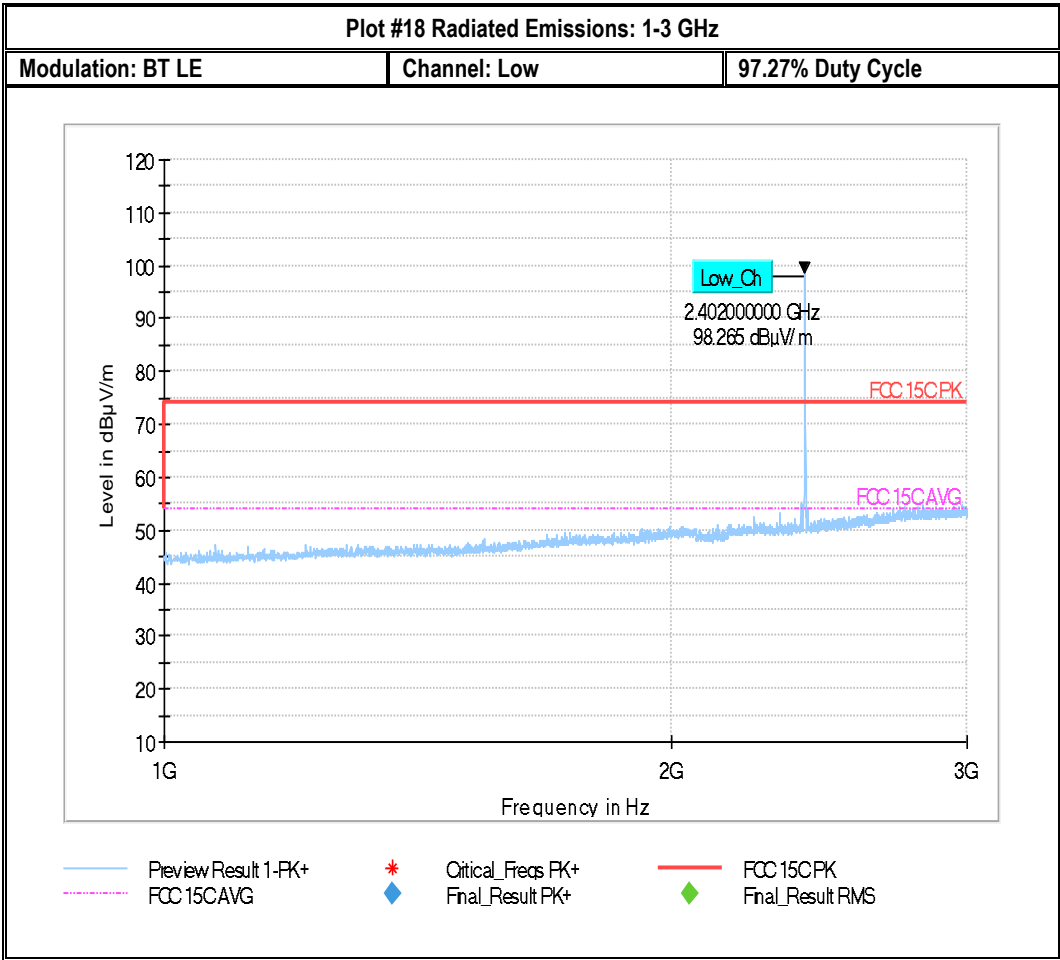
| Frequency (MHz) | MaxPeak (dBμV/m) | RMS (dBμV/m) | Limit (dBμV/m) | Margin | Meas. Time (ms) | Bandwidth (h) | Height (t) | Pol | Azimuth (h) | Corr. (dB/m) |
|-----------------|------------------|--------------|----------------|--------|-----------------|---------------|------------|-----|-------------|--------------|
| 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-FK+  
◆ Final Result PK+
 ★ Critical Freqs PK+  
◆ Final Result RMS
 — FCC 15C PK



**Plot #19 Radiated Emissions: 3-18 GHz**

**Modulation: BT LE**

**Channel: Low**

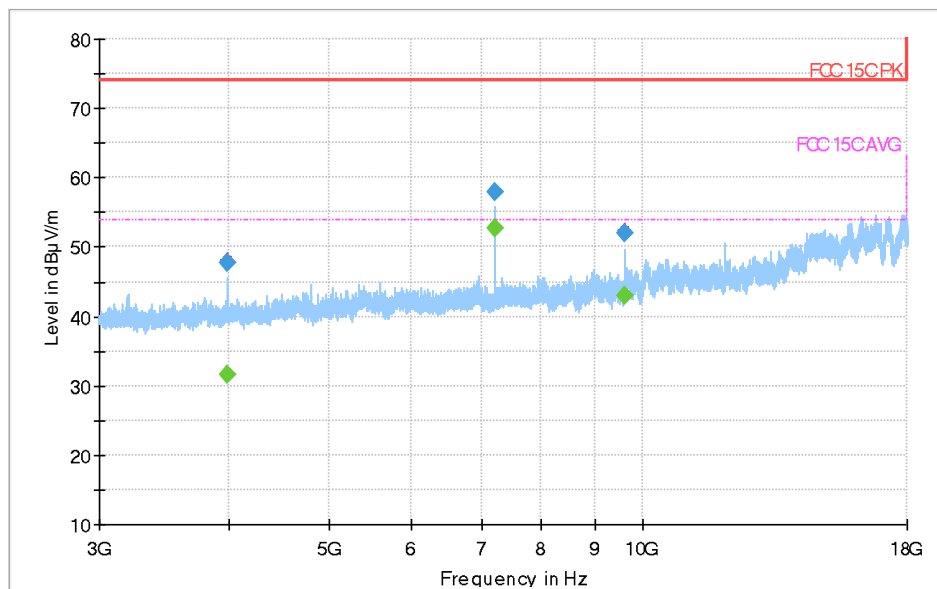
**97.27% Duty Cycle**

**Final\_Result**

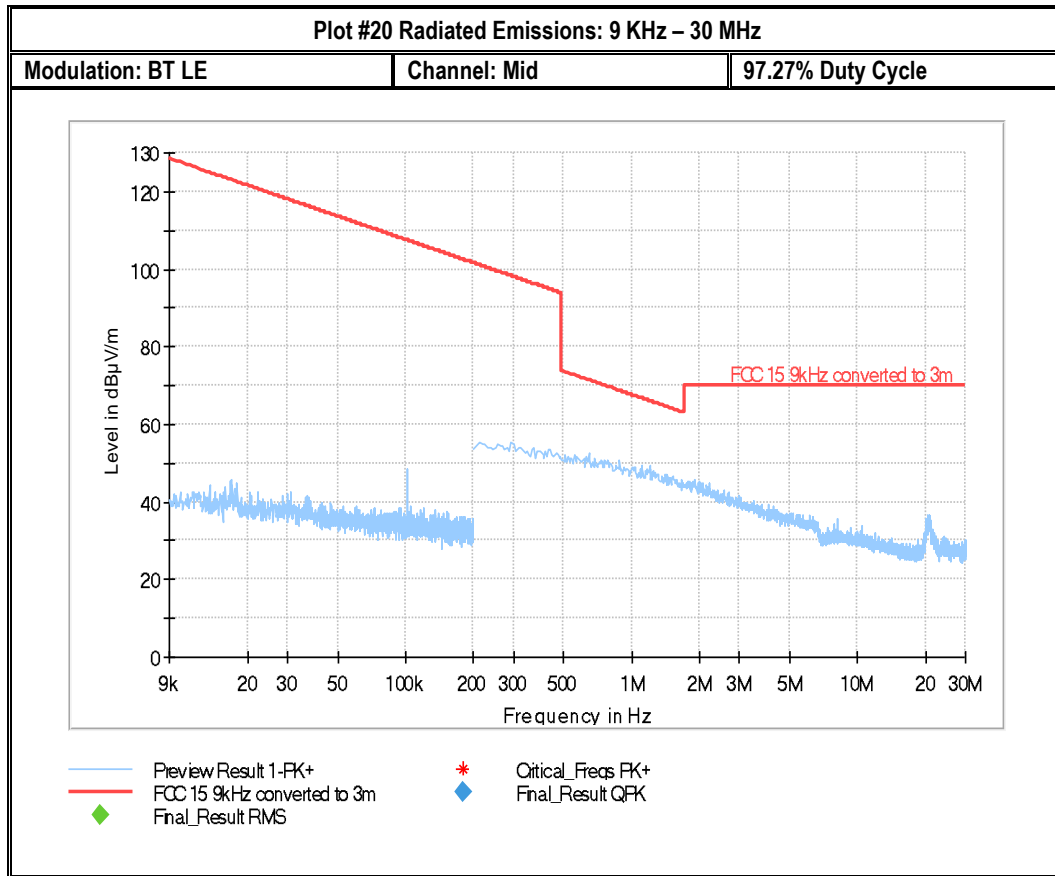
| Frequency (MHz) | MaxPeak (dBμV/m) | RMS (dBμV/m) | Limit (dBμV/m) | Margin | Meas. Time (ms) | Bandwidth (h) | Height | Pol | Azimuth | Corr. (dB/m) |
|-----------------|------------------|--------------|----------------|--------|-----------------|---------------|--------|-----|---------|--------------|
| 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 |



Preview Result 1-FK+ FCC 15CAVG  
Optical\_Freqs FK+ Final\_Result PK+  
FCC 15C PK  
Final\_Result RMS





**Plot #21 Radiated Emissions: 30 MHz – 1GHz**

**Modulation: BT LE**

**Channel: Mid**

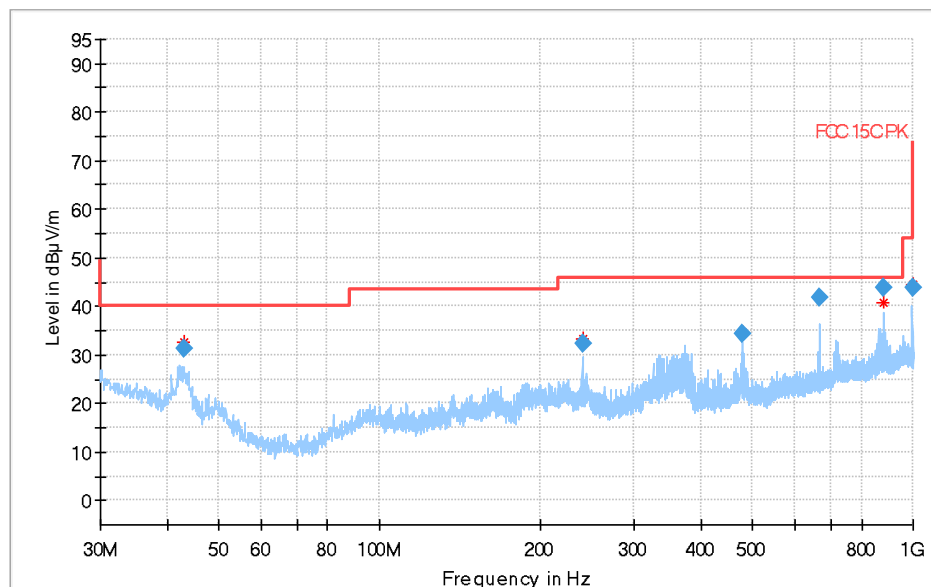
**97.27% Duty Cycle**

**Final Result**

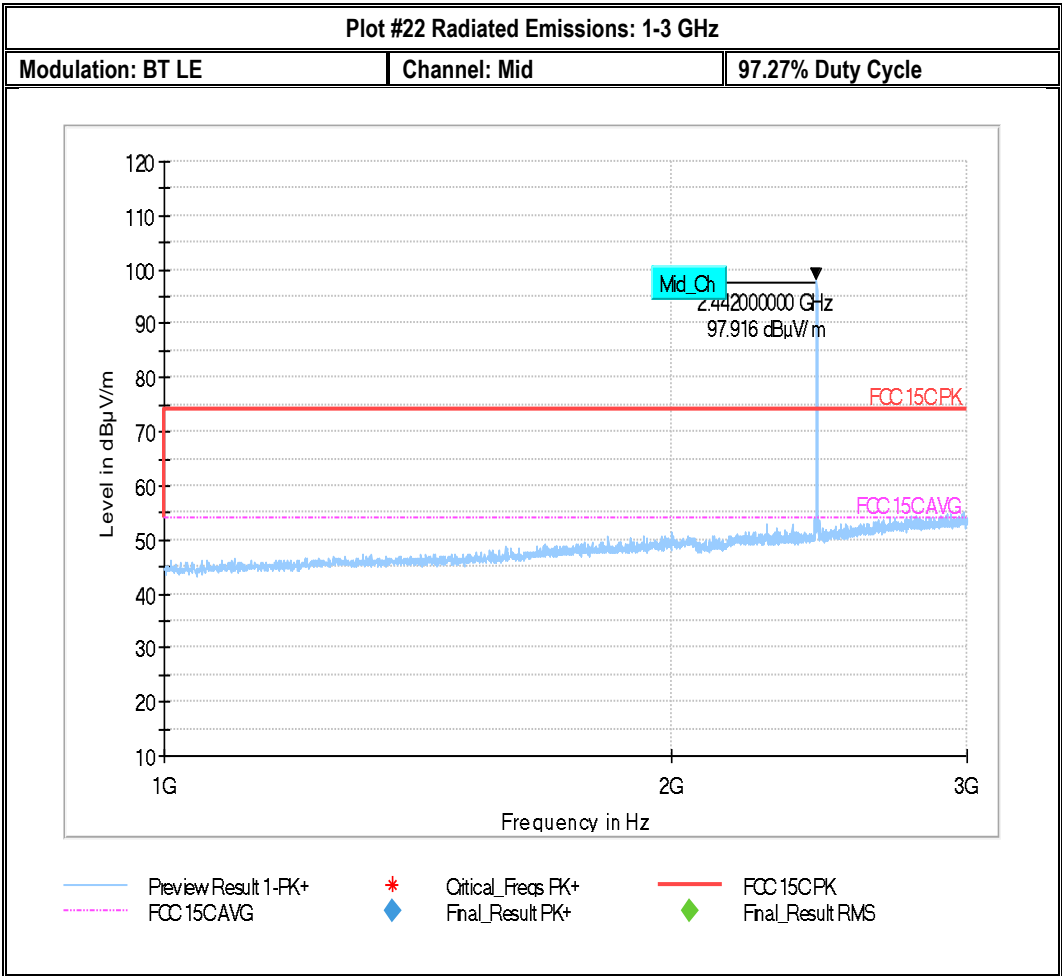
| Frequency (MHz) | MaxPeak (dBμV/m) | RMS (dBμV/m) | Limit (dBμV/m) | Margin | Meas. Time (ms) | Bandwidth (h) | Height (t) | Pol | Azimuth (h) | Corr. (dB/m) |
|-----------------|------------------|--------------|----------------|--------|-----------------|---------------|------------|-----|-------------|--------------|
| 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        |
| 685.595         | 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         |

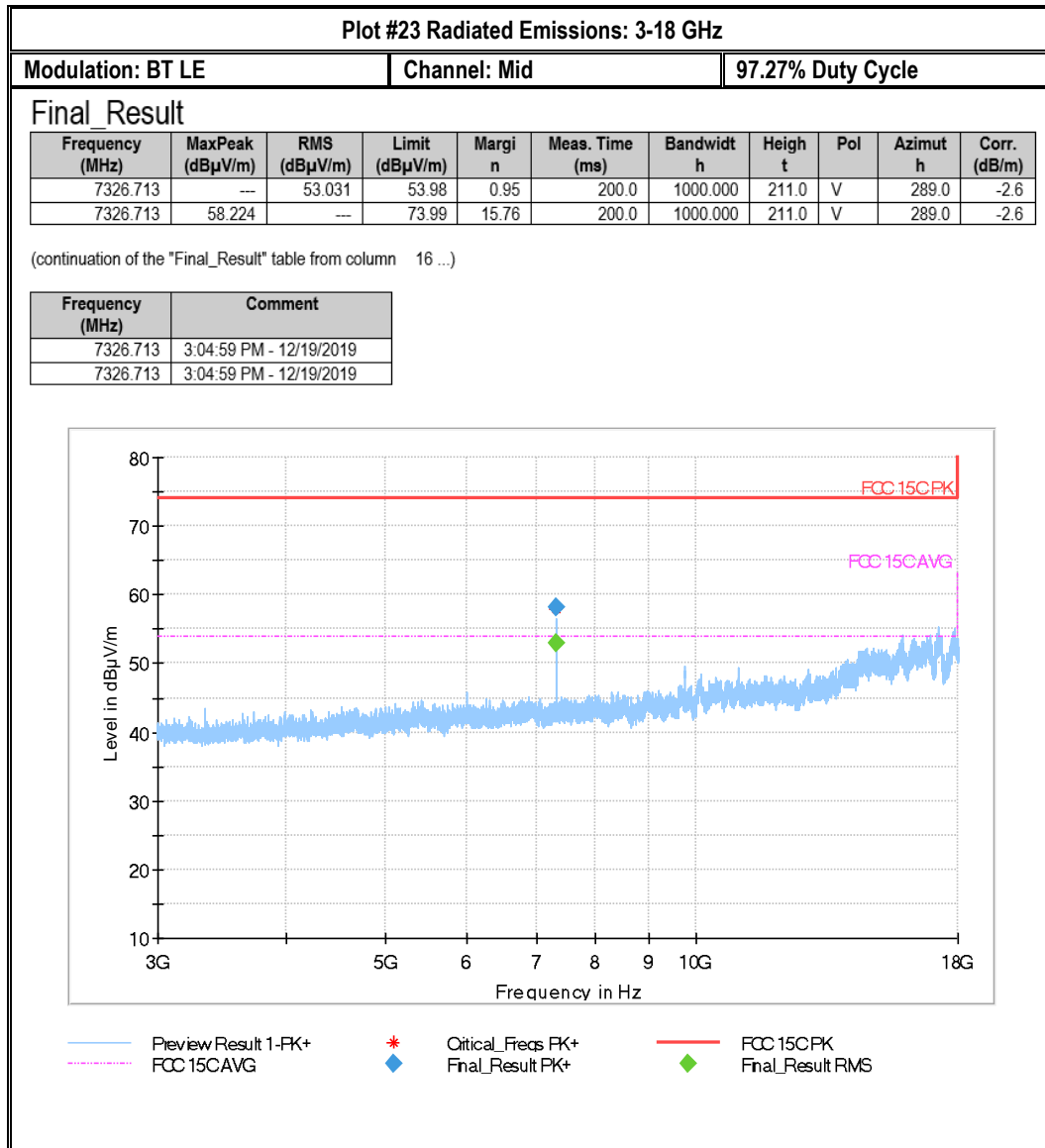
(continuation of the "Final\_Result" table from column 16 ...)

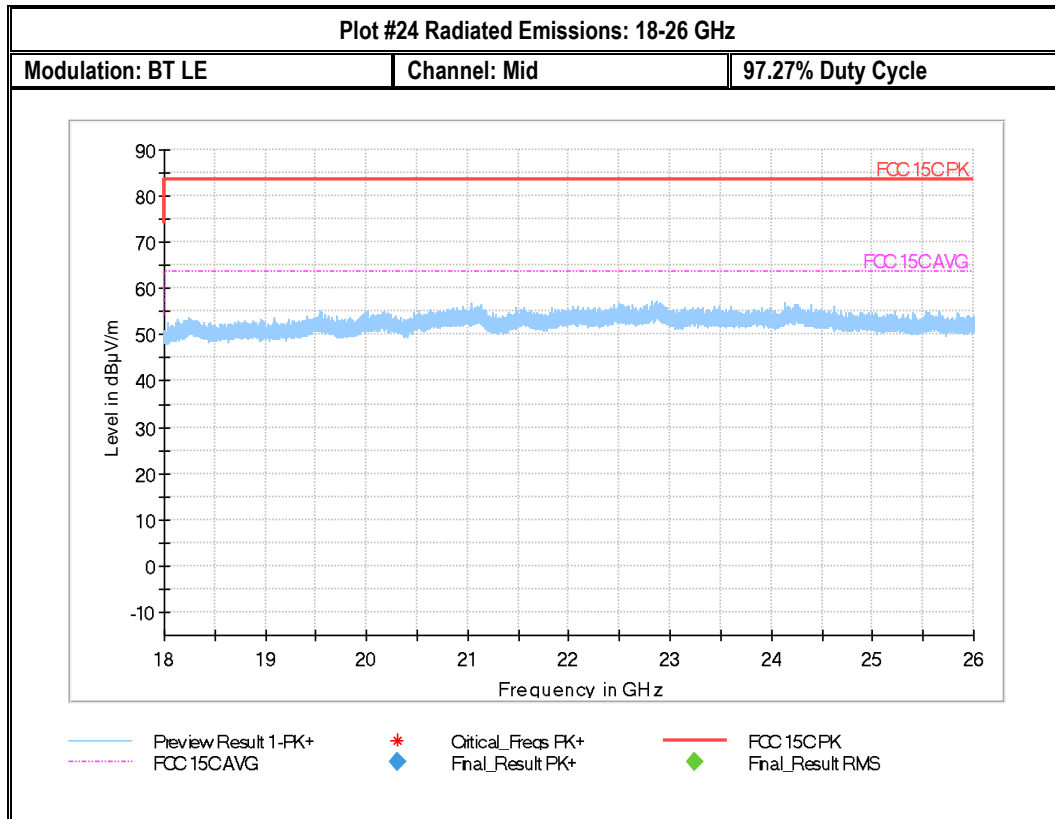
| Frequency (MHz) | Comment                  |
|-----------------|--------------------------|
| 43.130          | 12:28:17 PM - 12/19/2019 |
| 239.988         | 12:31:11 PM - 12/19/2019 |
| 479.644         | 12:33:49 PM - 12/19/2019 |
| 685.595         | 12:36:40 PM - 12/19/2019 |
| 880.950         | 12:39:15 PM - 12/19/2019 |
| 996.795         | 12:42:01 PM - 12/19/2019 |



◆ PreviewResult 1-FK+ Final\_Result PK+
 ◆ Critical\_Freqs FK+ Final\_Result RMS
 — FCC 15C PK







**Plot #25 Radiated Emissions: 30 MHz – 1GHz**

**Modulation: BT LE**

**Channel: High**

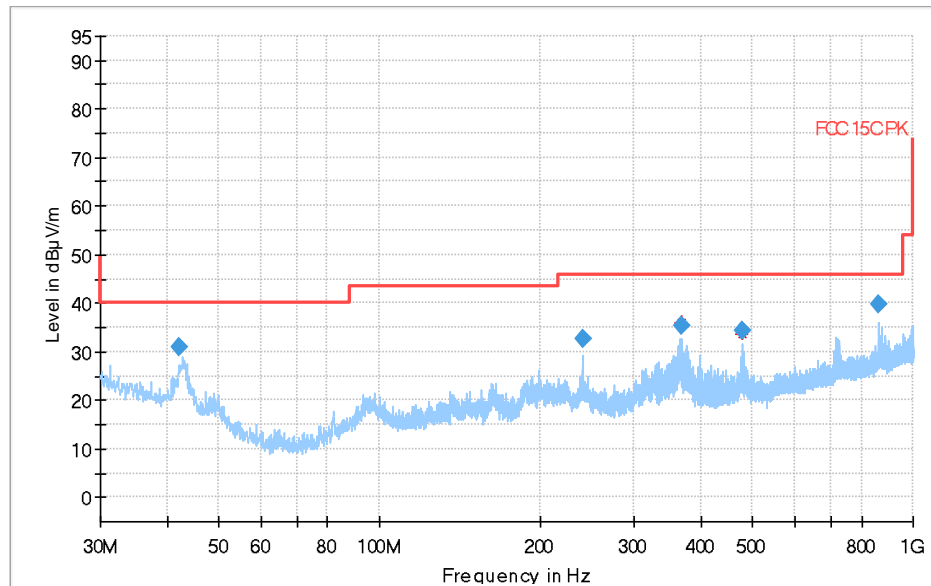
**97.27% Duty Cycle**

**Final Result**

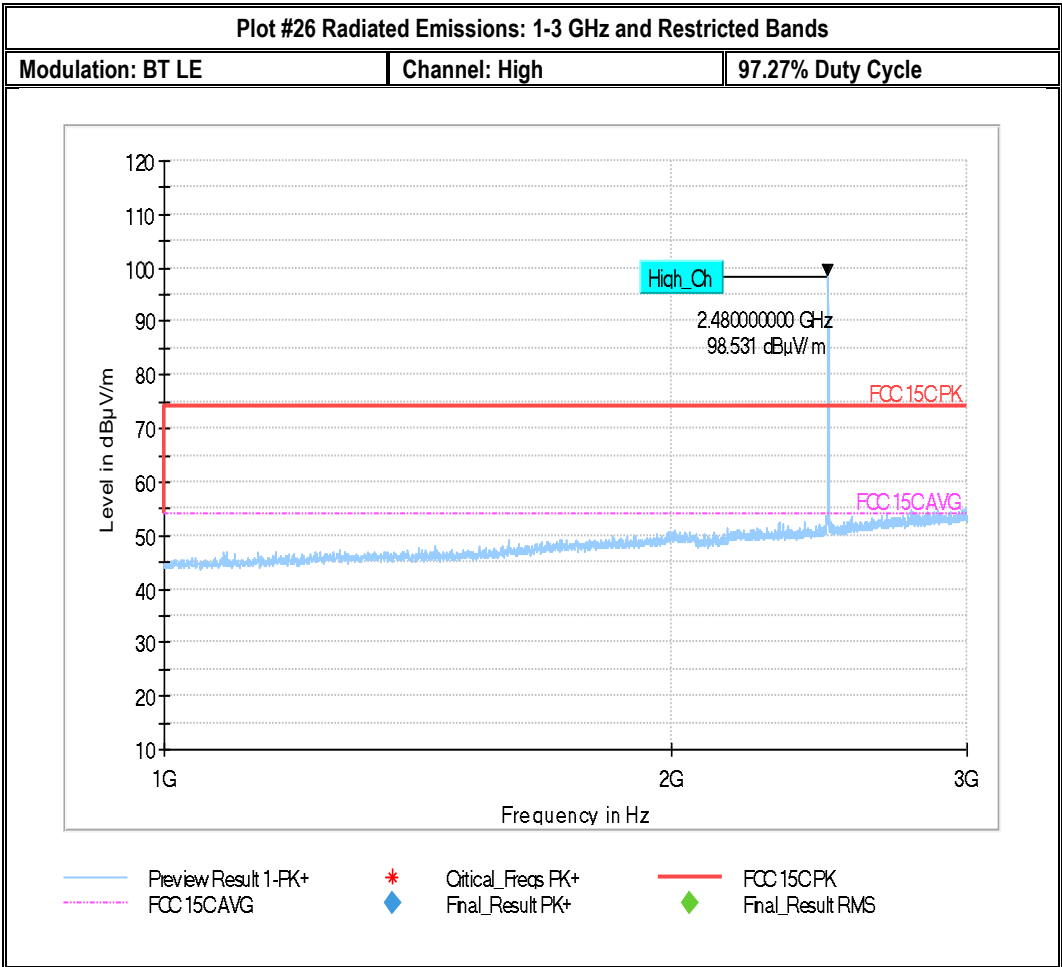
| Frequency (MHz) | MaxPeak (dBμV/m) | RMS (dBμV/m) | Limit (dBμV/m) | Margin | Meas. Time (ms) | Bandwidth (Hz) | Height (dB) | Pol | Azimuth (deg) | Corr. (dB/m) |
|-----------------|------------------|--------------|----------------|--------|-----------------|----------------|-------------|-----|---------------|--------------|
| 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         |

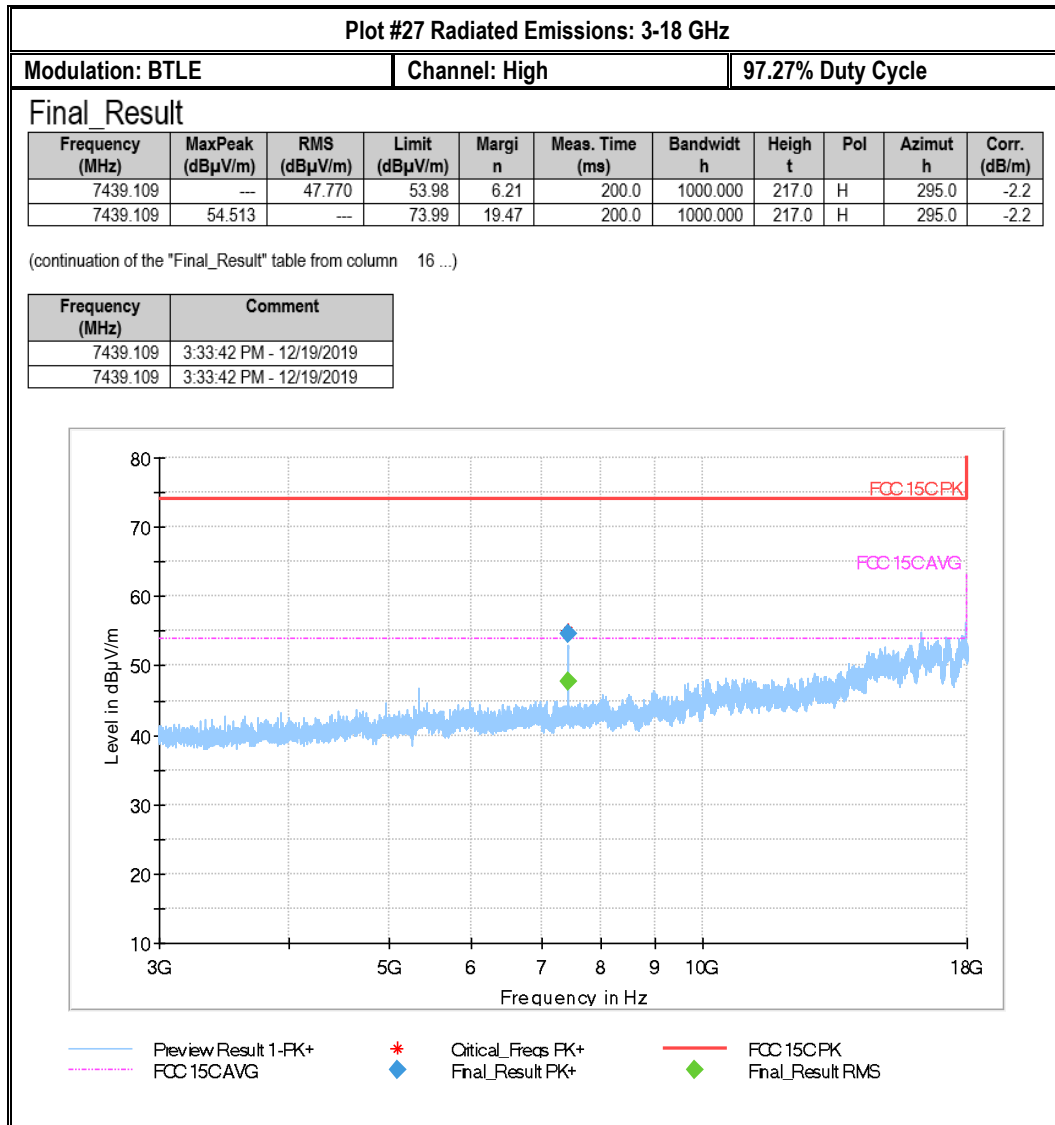
(continuation of the "Final\_Result" table from column 16 ...)

| 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 |



◆ Preview Result 1-FK+ Final\_Result PK+
 \* Critical\_Freqs FK+
 ◆ Final\_Result RMS
 — FCC 15C PK





## 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 THERMOMETER                  | 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.



Test Report #: EMC\_INNOP-005-19001\_15.247\_BT\_DTS  
Date of Report 2020-01-06

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



## 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         |