FCC / IC Test Report

FOR:
Virscient Limited

Model Name:
Trimble Comm board Tornado

Product Description:
WIFI/BT Module

FCC ID: YK5-73350047
IC ID: ----------

Applied Rules and Standards:
47 CFR Part 15.247 (DTS)
RSS-247 Issue 2 (DTS) & RSS-Gen Issue 4

REPORT #: EMC_VIRSC-001-17001_15.247_BT_DTS

DATE: 2019-02-08

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 #
Virscient Limited	WIFI/BT Module	V0009F

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2019-02-08	Compliance	Cindy Li (EMC Lab Manager)	Cindy Li Digitally signed by Cindy Li DN: cn=Cindy Li, o=Cetecom Inc., ou=EMC, email=cindy.li@cetecom.com, c=US Date: 2019.02.08 16:01:04 -08'00'

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
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EMC Lab Manager:	Cindy Li
Responsible Project Leader:	Rami Saman

2.2 Identification of the Client

Applicant's Name:	Virscient Limited
Street Address:	Ruakura Research Centre, 10 Bisley Road
City/Zip Code	Hamilton/3214
Country	New Zealand

2.3 Identification of the Manufacturer

Manufacturer's Name:	Trimble Jena GmbH
Manufacturers Address:	Carl-Zeiss-Promenade 10
City/Zip Code	Jena/07745
Country	Germany

3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model No:	Trimble Comm board Tornado
HW Version :	F
SW Version :	v4.5.10.016.DFS
FCC-ID:	YK5-73350047
IC-ID:	--------
HVIN:	--------
PMN:	--------
Product Description:	WIFI/BT Module
Frequency Range / number of channels:	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 version 4.2, 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:	Pulse W3334B0150, 2.4G 4dBi 5G 5.5dBi
Max. Peak Output Power:	Conducted Power 2.97 dBm
Power Supply/ Rated Operating Voltage Range:	USB / Vmin: 4.75 VDC/ Vnom: 5 VDC / Vmax: 5.5 VDC
Operating Temperature Range:	-20 ºC to +70 ºC
Other Radios included in the device:	Bluetooth BR / EDR WIFI 802.11a/b/g/n/ac
Sample Revision:	☐Prototype Unit; ■Production Unit; ☐Pre-Production

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	311	F	V4.5.10.016.DFS	Radiated Emissions
2	351	F	V4.5.10.016.DFS	Conducted RF

3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
1	Laptop	Dell	Latitude E6440	00186-242-768-970
2	Laptop	Dell	Latitude E6430s	00186-210-105-587

3.4 Test Sample Configuration

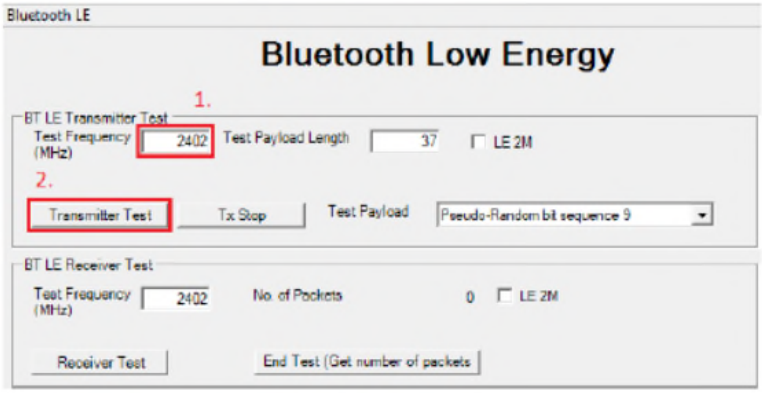
EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#2 + AE#1 + AE#2	The radio of the EUT was configured to a fixed channel transmission with highest possible duty cycle using software “QRCT” provided by client that is not available to the end user. The measurement equipment was connected to the 50 ohm RF port of the EUT.
2	EUT#1 + AE#1 + AE#2	The radio of the EUT was configured to a fixed channel with highest possible duty cycle using software “QRCT” provided by client that is not available to the end user. The external antenna “Pulse W3334B0150” provided by client was used for radiated testing.

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 with the highest possible duty cycle. For radiated measurements, all data in this report shows the worst case between horizontal and vertical antenna polarizations and for all orientations of the EUT.

The EUT were configured by “QRCT” provided by client (not available to the end user).

QRCT Tool:



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 USB

6 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus, with 95% confidence interval (in dB delta to result), based on a coverage factor k=1.

Radiated measurement

9 kHz to 30 MHz	±2.5 dB (Magnetic Loop Antenna)
30 MHz to 1000 MHz	±2.0 dB (Biconilog Antenna)
1 GHz to 40 GHz	±2.3 dB (Horn Antenna)

Conducted measurement

150 kHz to 30 MHz	±0.7 dB (LISN)

RF conducted measurement	±0.5 dB

According to TR 102 273 a multiplicative propagation of error is assumed for RF measurement systems. For this reason the RMS method is applied to dB values and not to linear values as appropriate for additive propagation of error. Also used: http://physics.nist.gov/cuu/Uncertainty/typeb.html. The above calculated uncertainties apply to direct application of the Substitution method. The Substitution method is always used when the EUT comes closer than 3 dB to the limit.

6.1 Environmental Conditions During Testing:

The following environmental conditions were maintained during the course of testing:

- Ambient Temperature: 20-25° C
- Relative humidity: 40-60%

6.2 Dates of Testing:

07/10/2018 - 07/16/2018

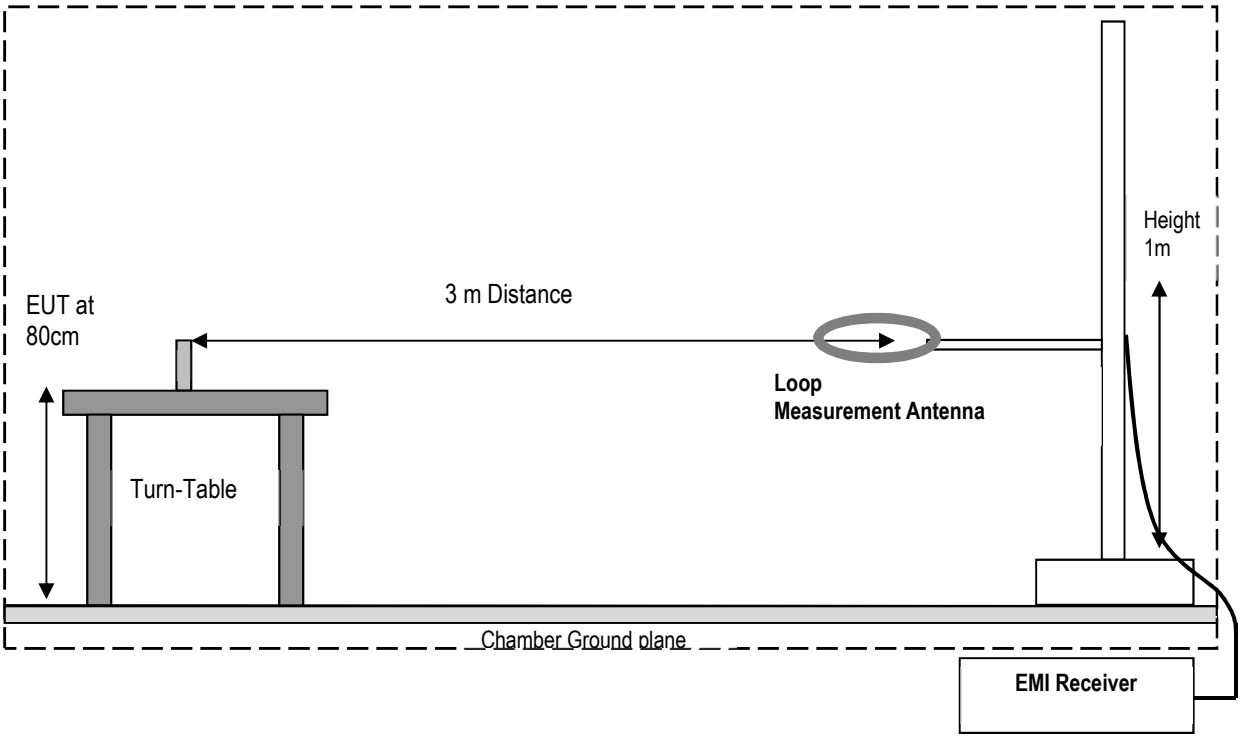
7 Measurement Procedures

7.1 Radiated Measurement

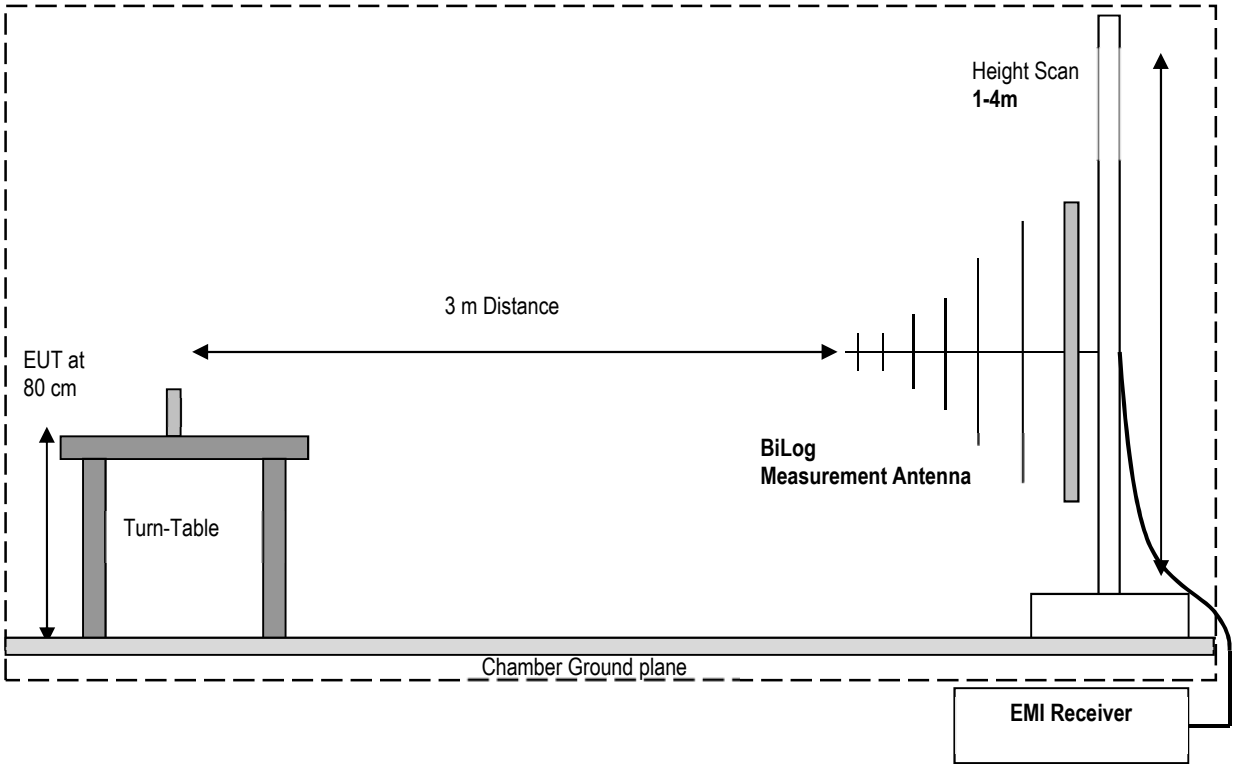
The radiated measurement is performed according to ANSI C63.10 (2013)

- 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.

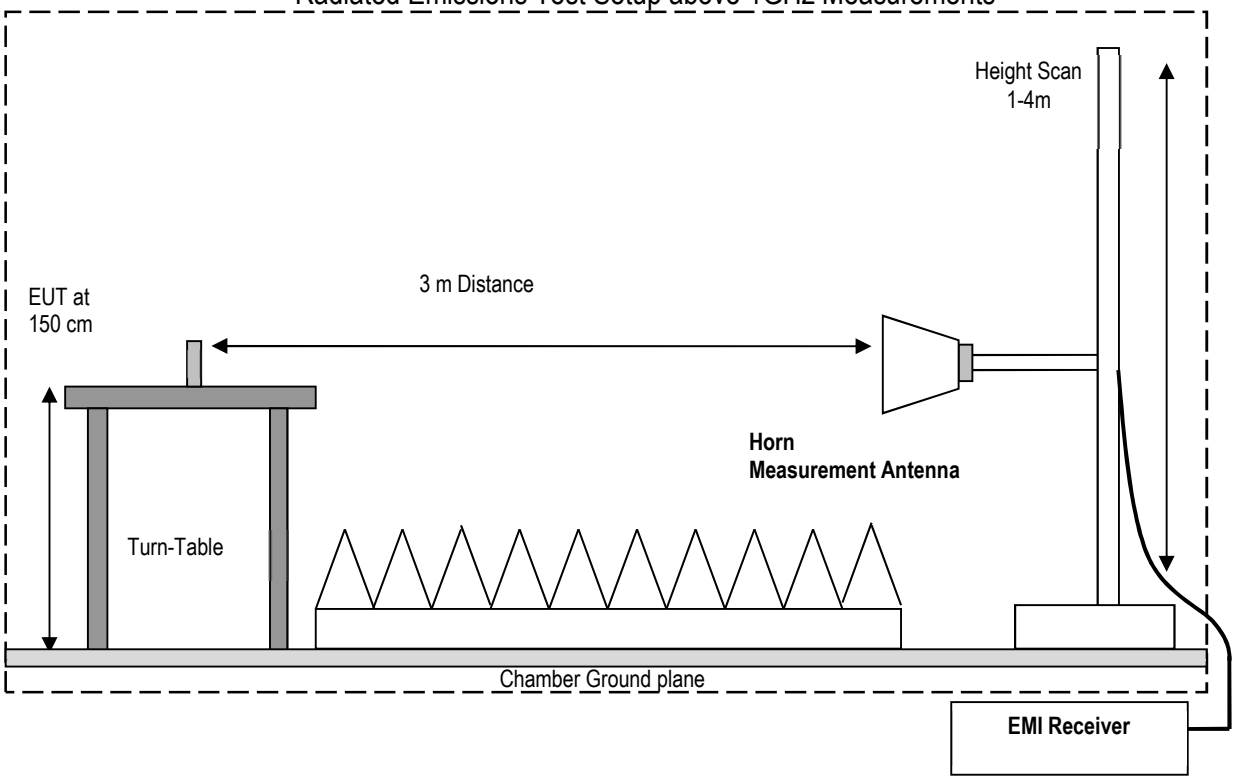
Radiated Emissions Test Setup below 30MHz Measurements



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:

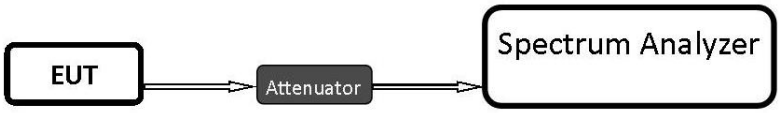
FS (dBµV/m) = Measured Value on SA (dBµV)- Cable Loss (dB)+ Antenna Factor (dB/m)

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	1	GFSK continuous fixed channel	USB 5 VDC	4dBi

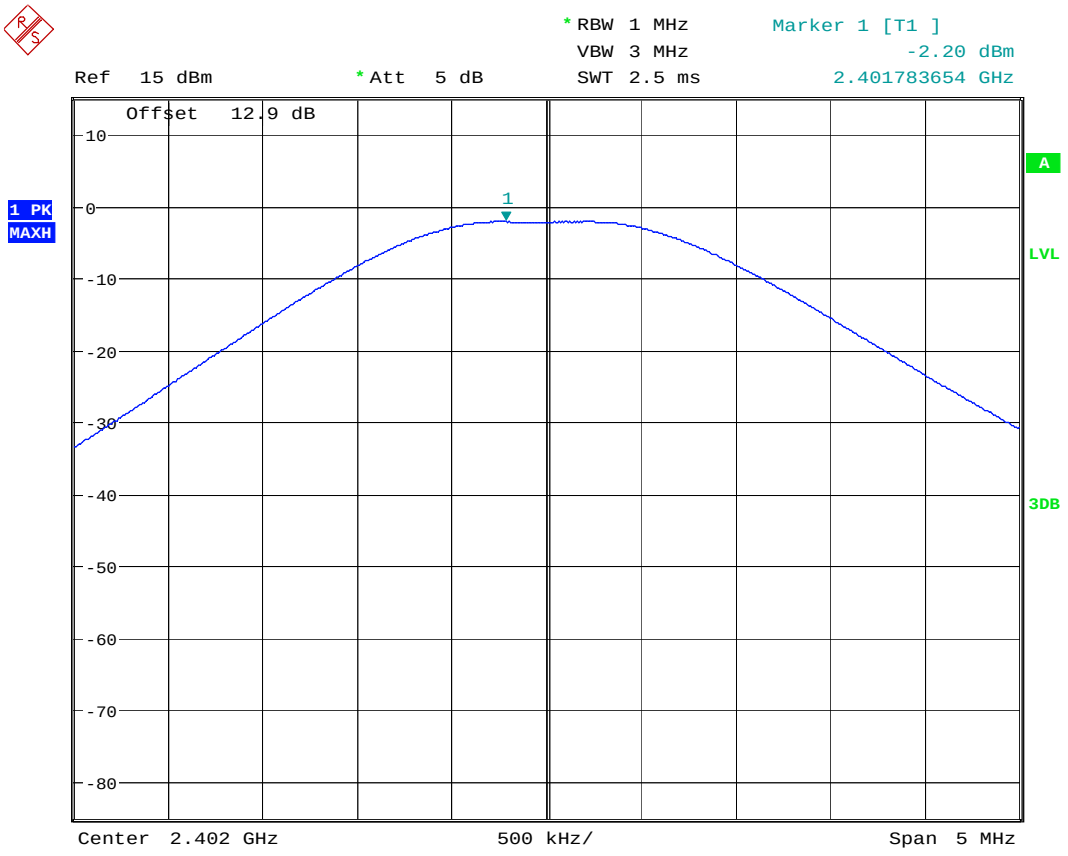
8.1.4 Measurement result:

Attenuation of cable and attenuator (already taken into account): 12.9 dB

Plot #	Frequency (MHz)	Maximum Peak Conducted Output Power (dBm)	EIRP (dBm)	Limit (dBm)	Result
1	2402	-2.2	1.8	30 (Pk) / 36 (EIRP)	Pass
2	2442	-1.6	2.4	30 (Pk) / 36 (EIRP)	Pass
3	2480	-1.03	2.97	30 (Pk) / 36 (EIRP)	Pass

8.1.5 Measurement Plots:

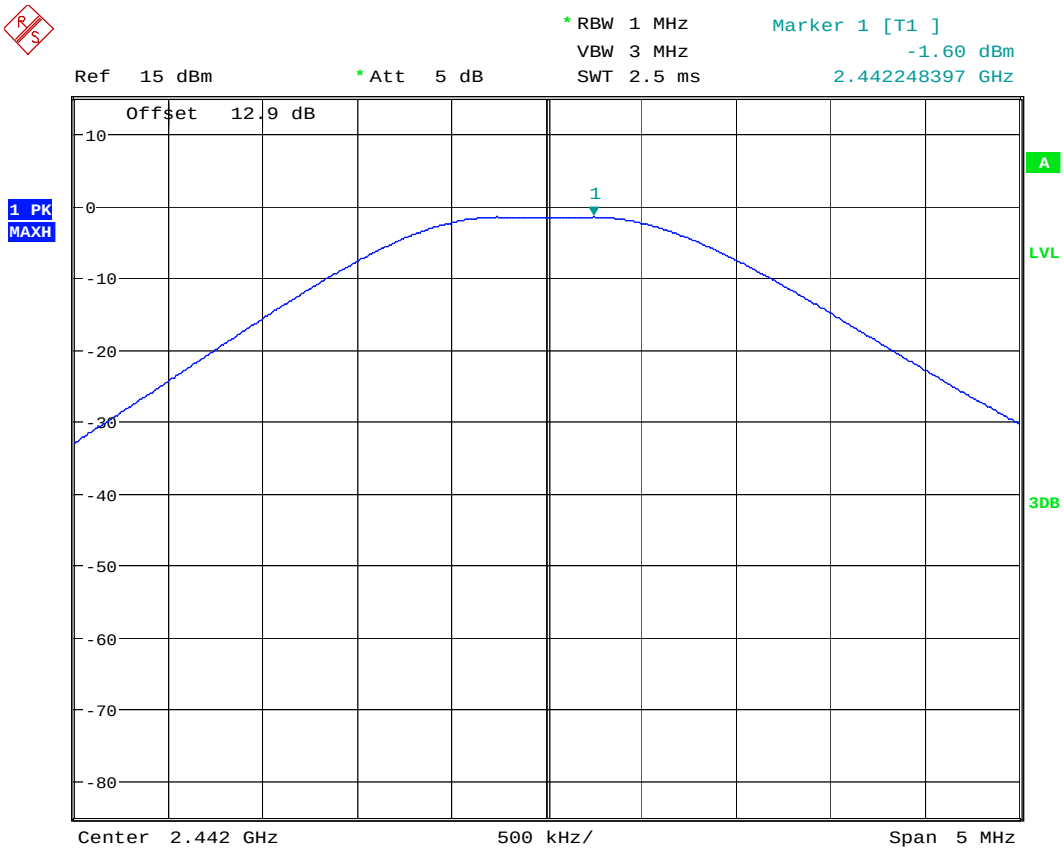
Plot #1	
Low channel	Modulation/Packet Type: BTLE



Date: 10.JUL.2018 16:03:24

Plot #2

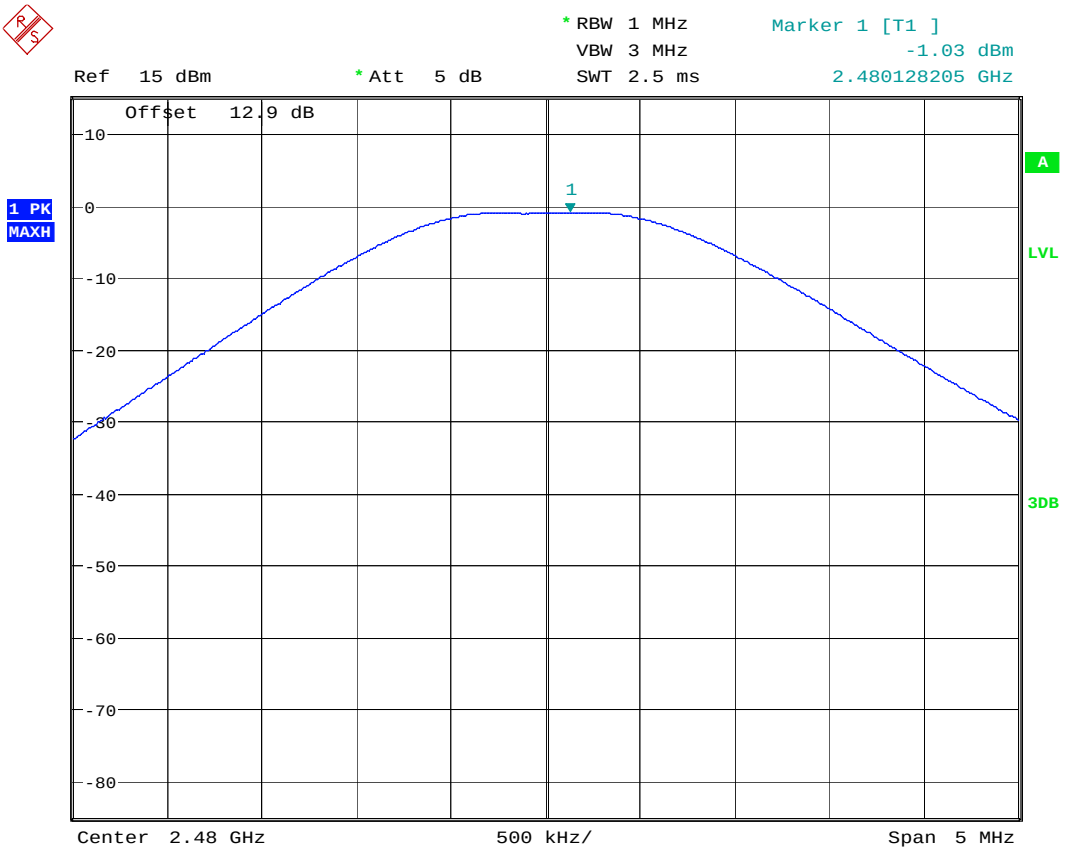
Mid channel	Modulation/Packet Type: BTLE



Date: 10.JUL.2018 16:04:05

Plot #3

High channel	Modulation/Packet Type: BTLE



Date: 10.JUL.2018 16:04:47

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	1	GFSK continuous fixed channel	USB 5 VDC	4dBi

8.2.4 Measurement result:

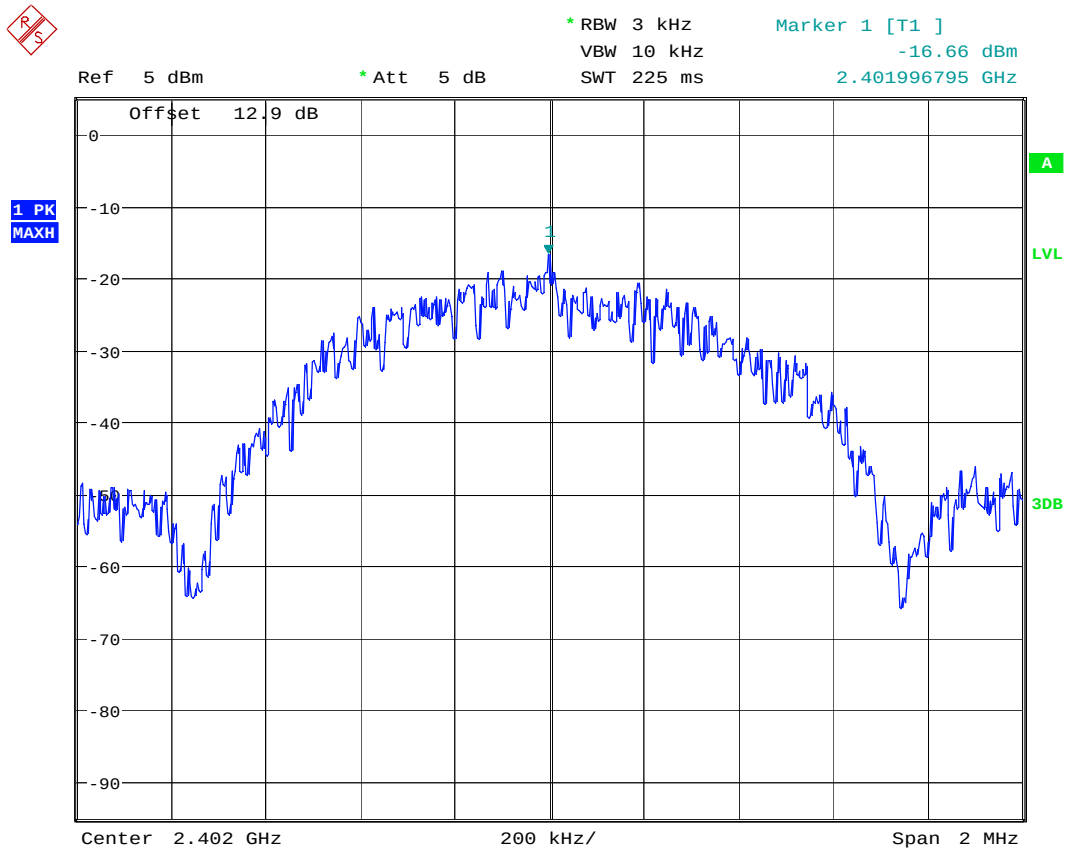
Attenuation of cable and attenuator (already taken into account): 12.9 dB

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	-16.66	-12.66	8	Pass
5	2442	-16.12	-12.12	8	Pass
6	2480	-15.58	-11.58	8	Pass

8.2.5 Measurement Plots:

Plot #4

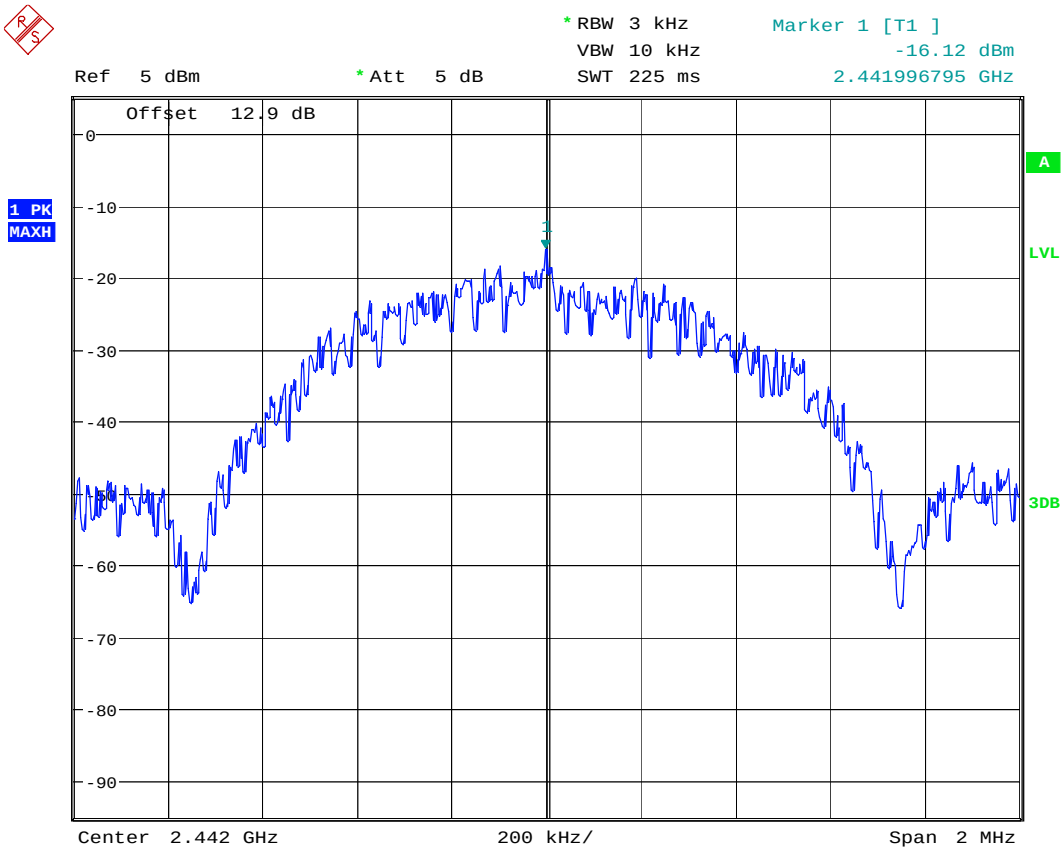
Low channel	Modulation/Packet Type: BTLE



Date: 13.JUL.2018 15:16:02

Plot #5

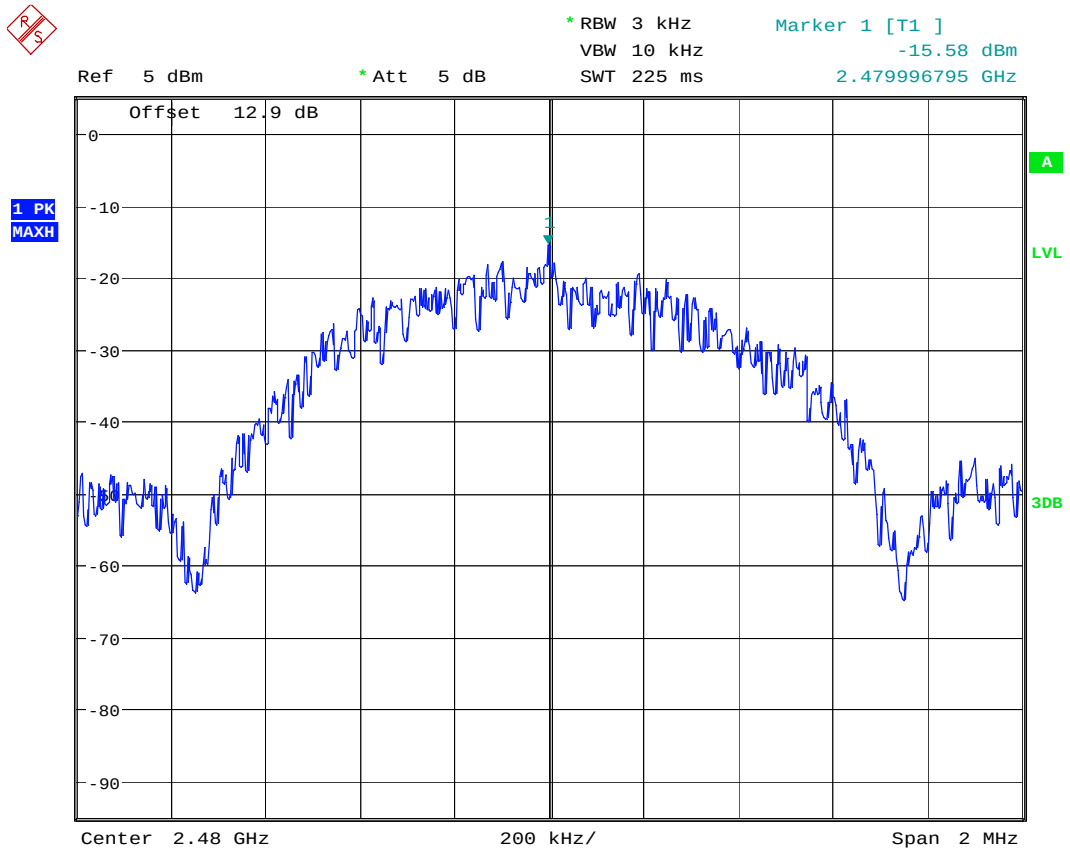
Mid channel	Modulation/Packet Type: BTLE



Date: 13.JUL.2018 15:21:03

Plot #6

High channel	Modulation/Packet Type: BTLE



Date: 13.JUL.2018 15:24:35

8.3 Duty cycle

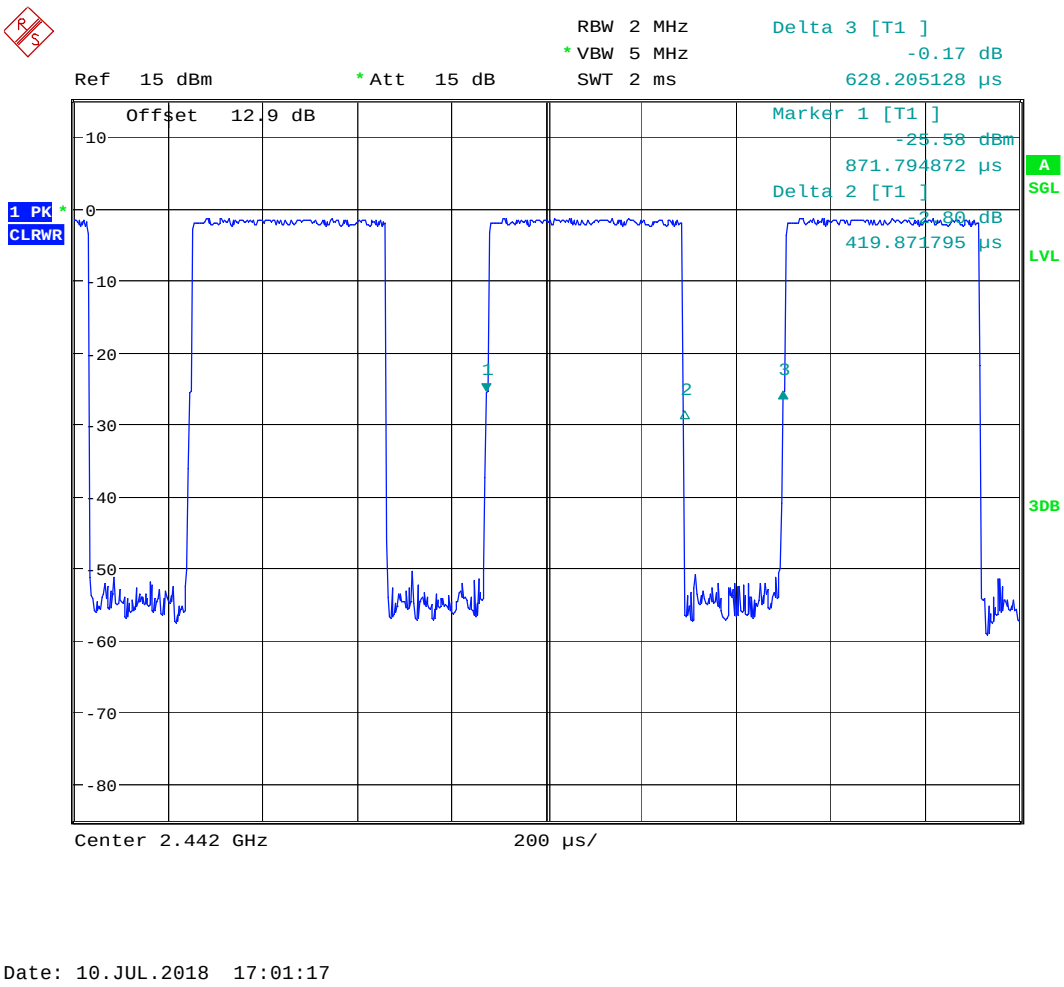
8.3.1 Measurement according to FCC 558074 D01 DTS Meas Guidance v04

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 / 2442 MHz	Modulation/Packet Type: BTLE



Duty cycle =66.8%
Duty cycle correction factor =10*log (0.668) = 1.75 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	1	GFSK continuous fixed channel	USB 5 VDC	4dBi

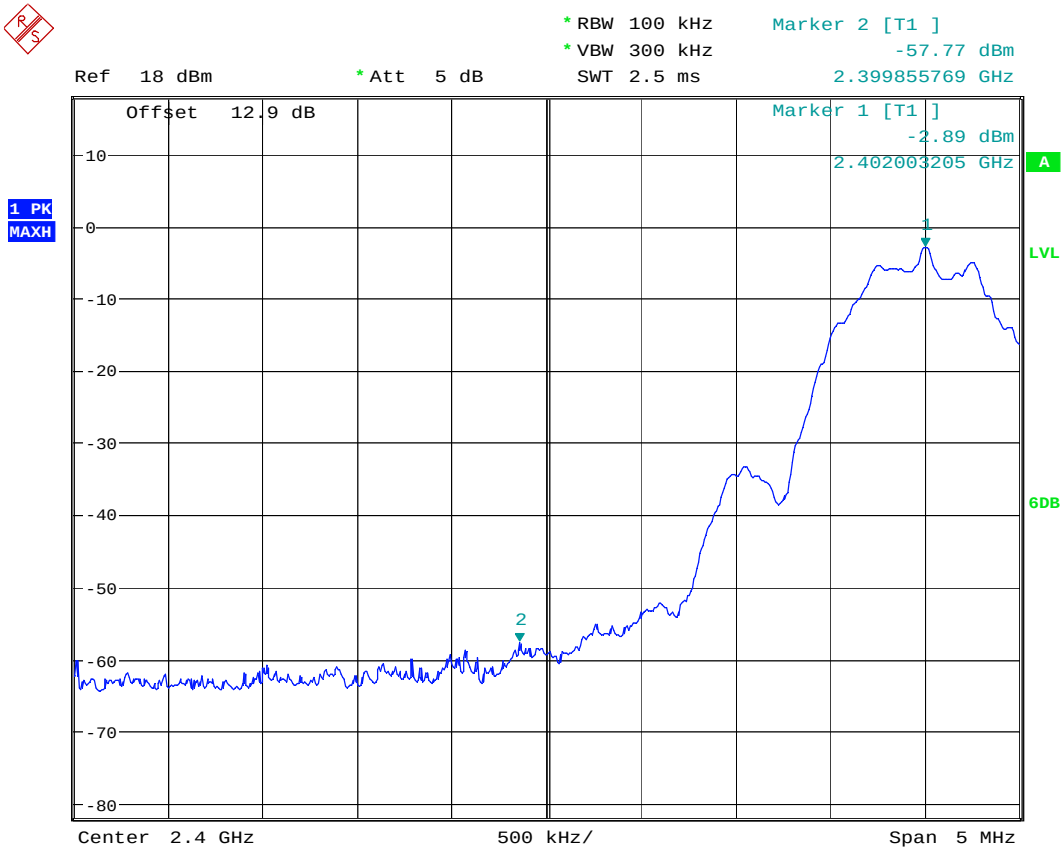
8.4.5 Measurement result:

Plot #	EUT operating mode	Band Edge	Band Edge Delta (dBc)	Limit (dBc)	Result
7	GFSK continuous fixed channel	Lower, Non-restricted	-54.88	20	Pass

Plot #	EUT operating mode	Band Edge	Measured Peak Value (dBm)	Corrected by duty cycle	Corrected by Antenna Gain (dBm)	Limit (dBm)	Result
8	GFSK continuous fixed channel	Upper Restricted peak	-45.14	NA	-41.14	-21.23 Peak	Pass
9	GFSK continuous fixed channel	Upper Restricted Average	-58.65	-56.9	-52.9	-41.23 AVG	Pass

8.4.6 Measurement Plots:

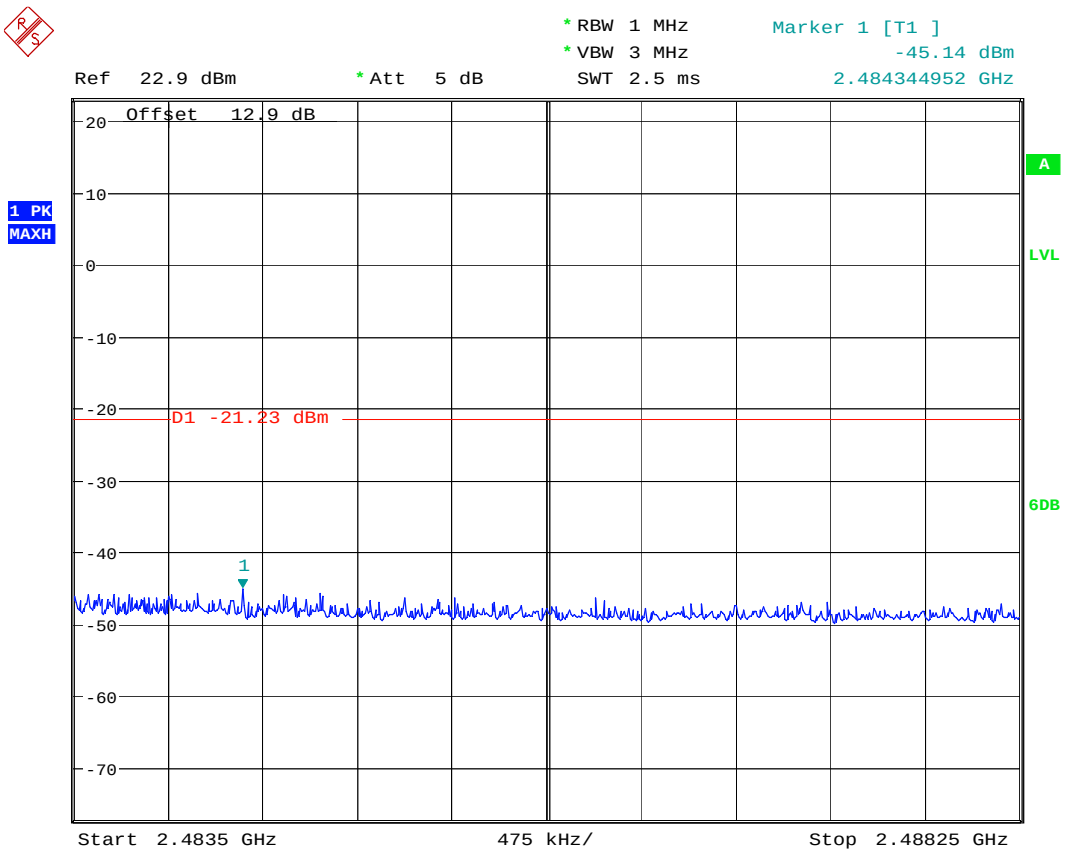
Plot #7	
Low channel / 2402 MHz	Modulation/Packet Type: BTLE



Date: 13.JUL.2018 13:43:22

Plot #8

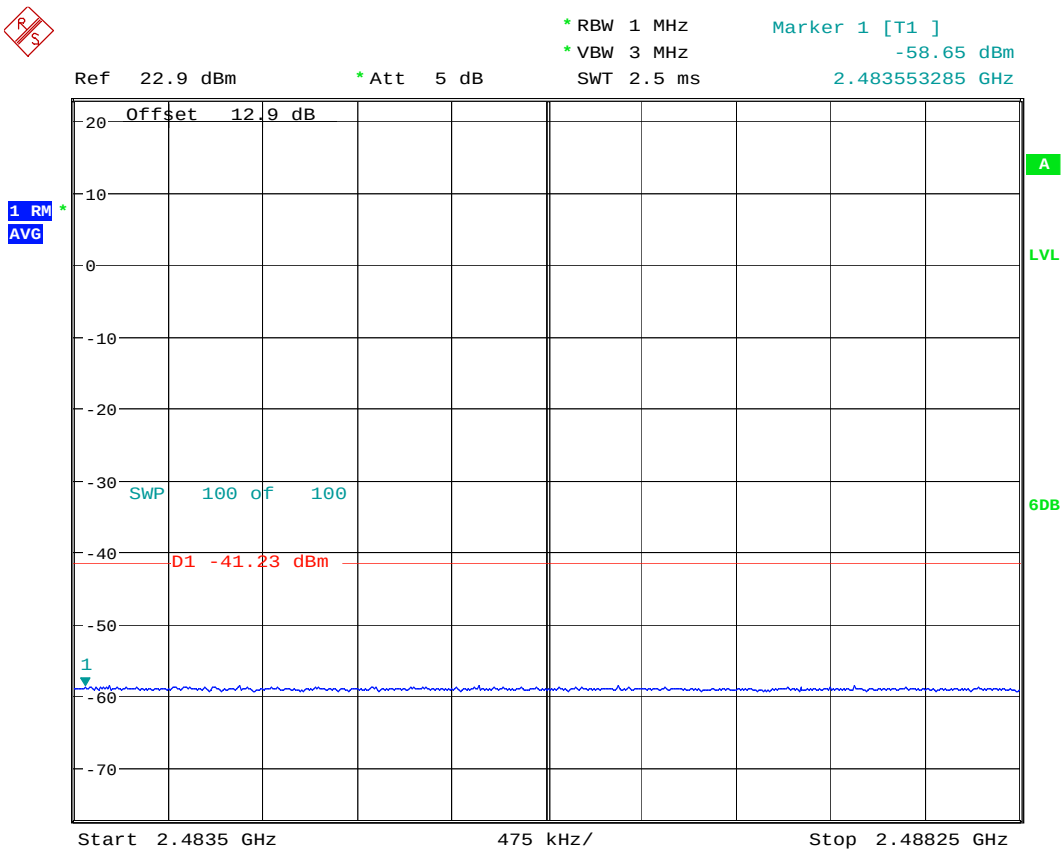
High channel 2480 MHz	Modulation/Packet Type: BTLE



Date: 13.JUL.2018 13:14:14

Plot #9

High channel 2480 MHz	Modulation/Packet Type: BTLE



Date: 13.JUL.2018 13:12:19

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	1	GFSK continuous fixed channel	USB 5VDC

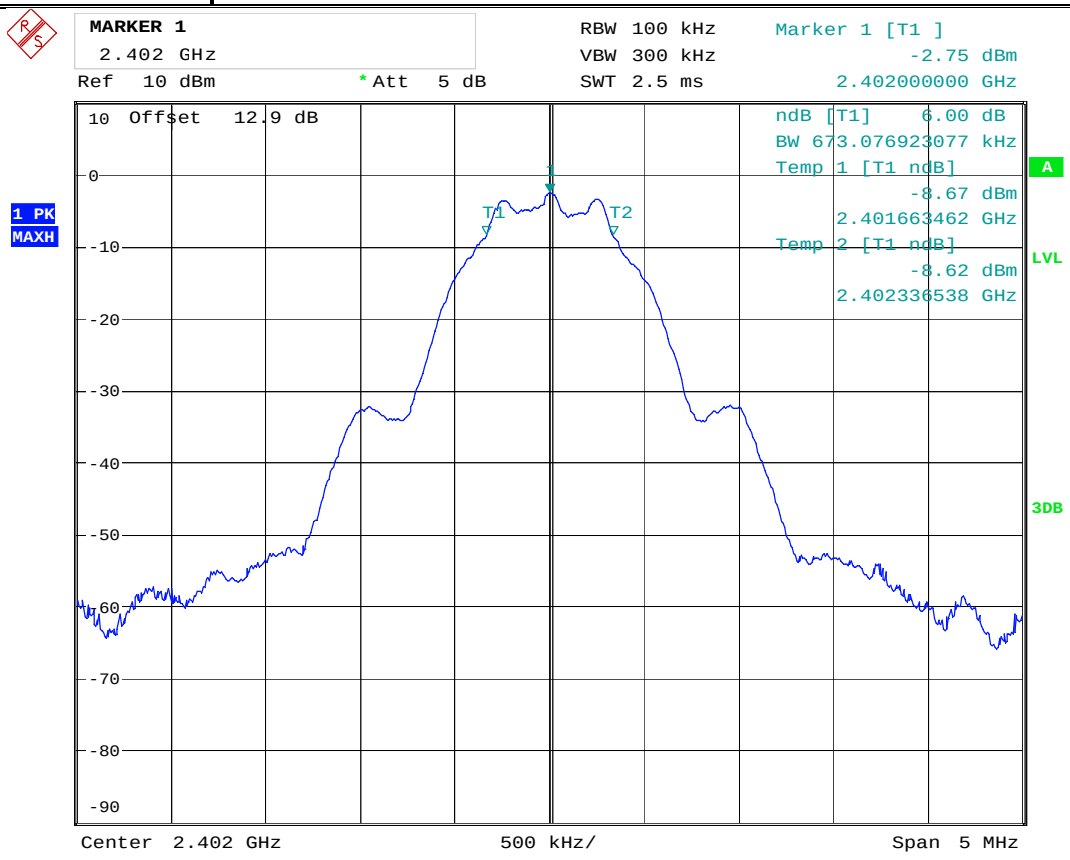
8.5.4 Measurement result:

Plot #	Frequency (MHz)	6 dB Emissions Bandwidth (MHz)	Limit (MHz)	Result
10	2402	0.673	> 0.5	Pass
11	2442	0.673	> 0.5	Pass
12	2480	0.673	> 0.5	Pass

Plot #	Frequency (MHz)	99% Occupied Bandwidth (MHz)	Limit (MHz)	Result
13	2402	1.1	> 0.5	Pass
14	2442	1.1	> 0.5	Pass
15	2480	1.1	> 0.5	Pass

8.5.5 Measurement Plots:

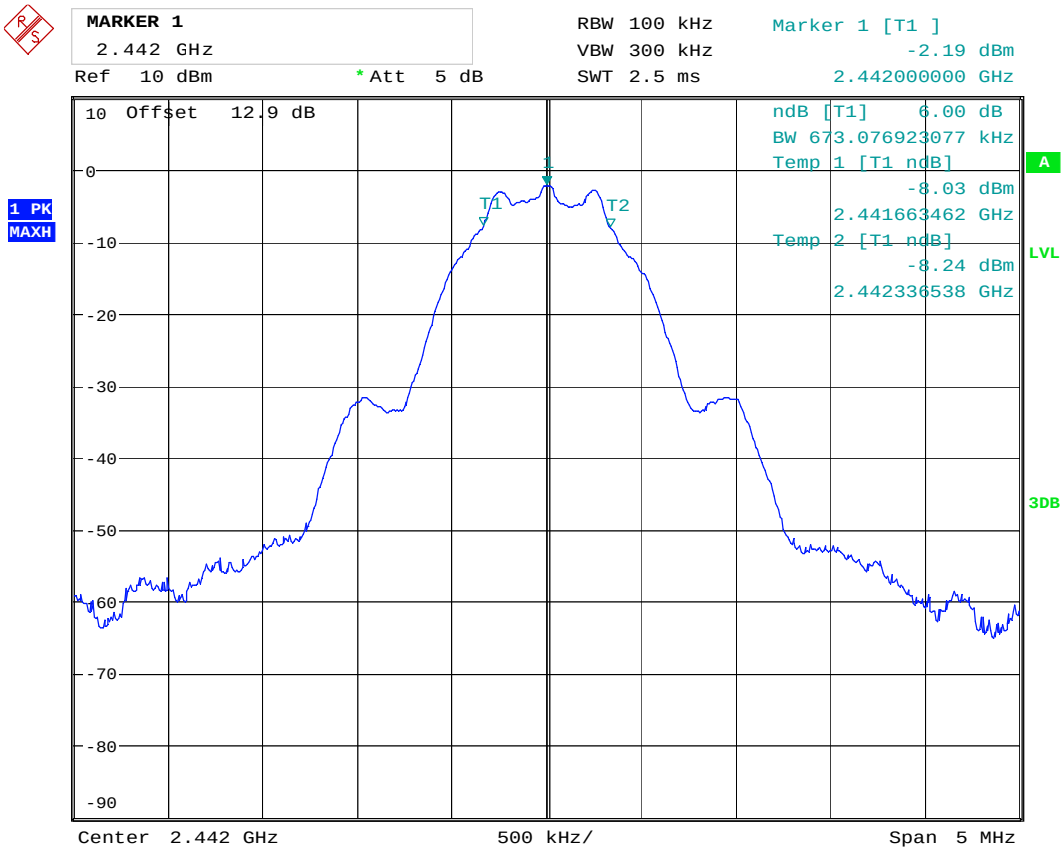
Plot #10	
Low channel	Mode: BTLE



Date: 10.JUL.2018 15:49:19

Plot #11

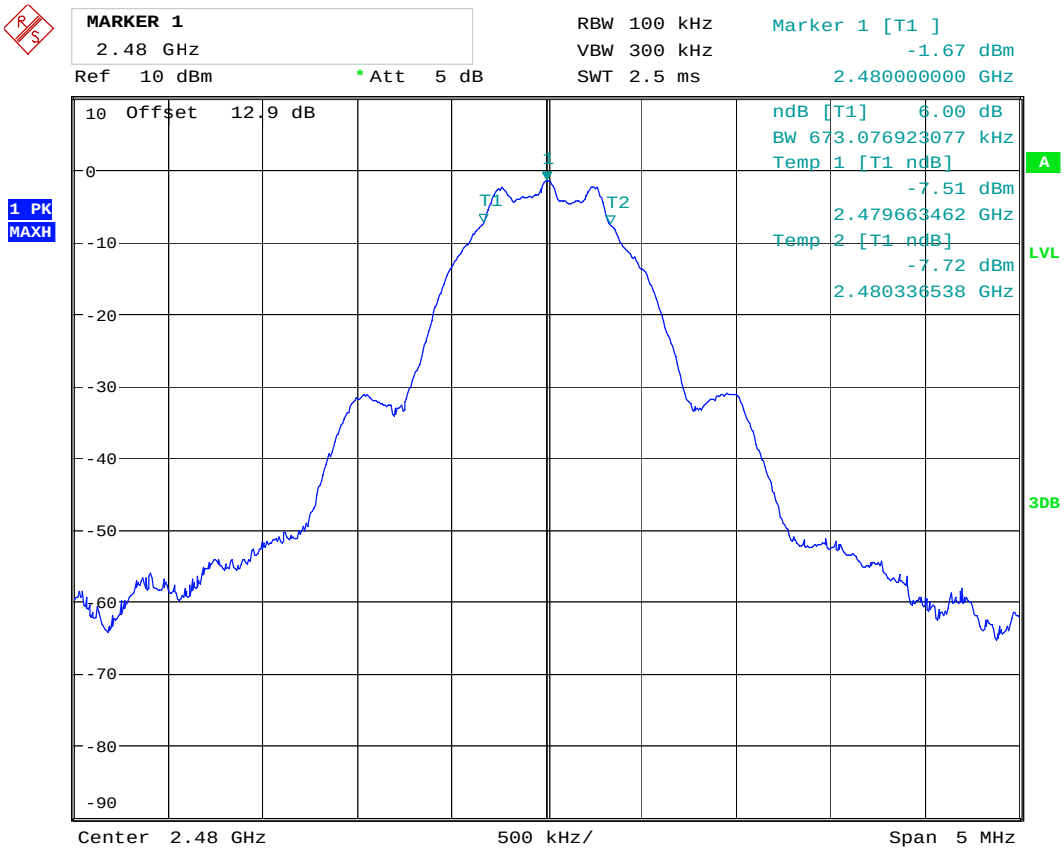
Mid channel	Mode: BTLE



Date: 10.JUL.2018 15:51:47

Plot #12

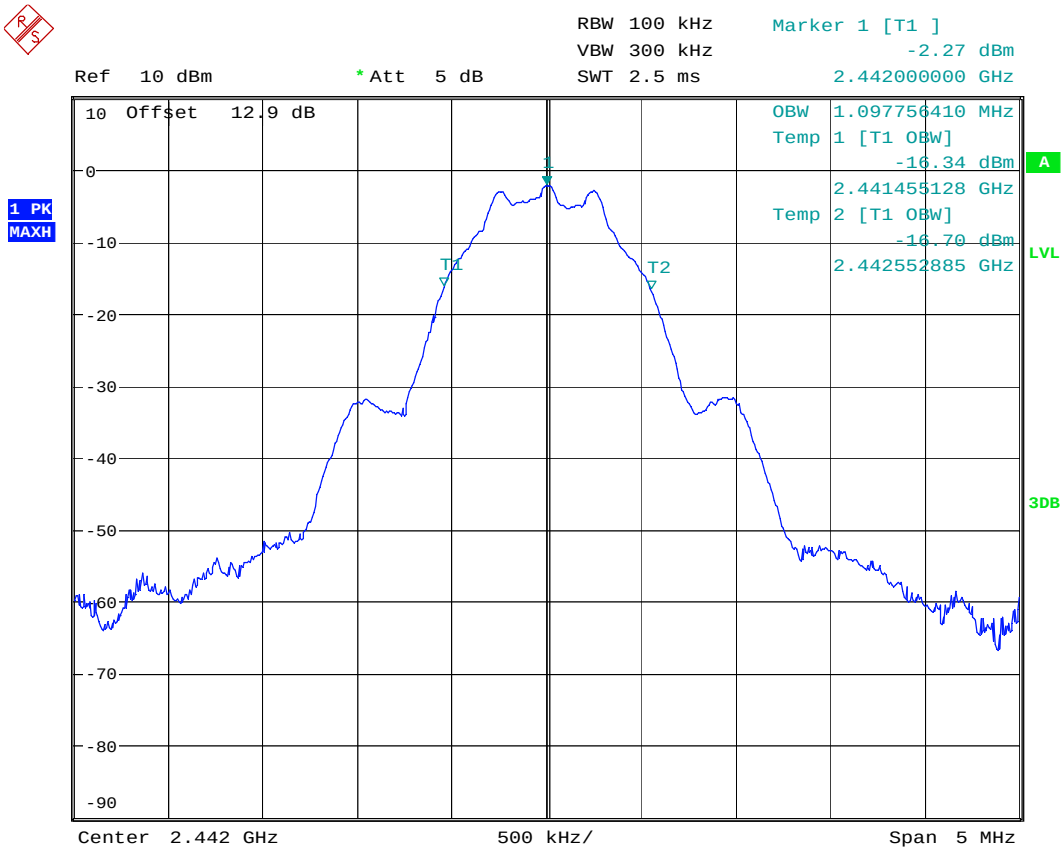
High channel	Mode: BTLE



Date: 10.JUL.2018 15:53:00

Plot #13

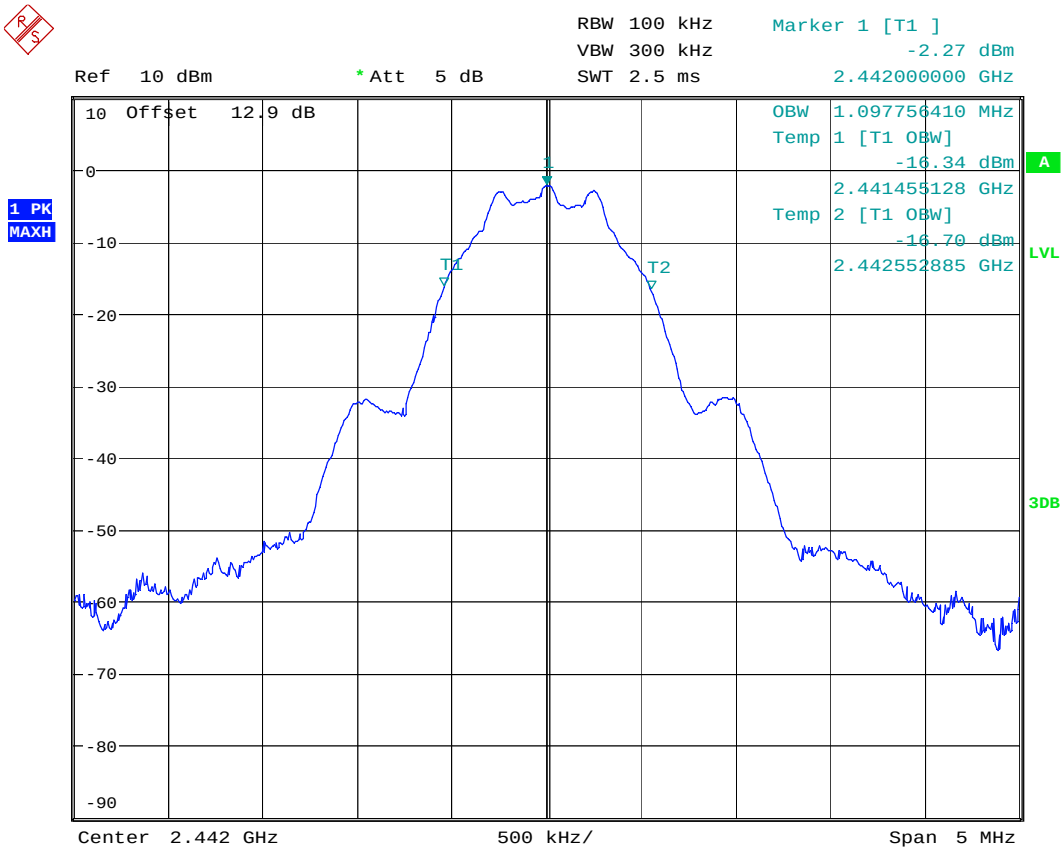
Low channel	Mode: BTLE



Date: 10.JUL.2018 15:58:55

Plot #14

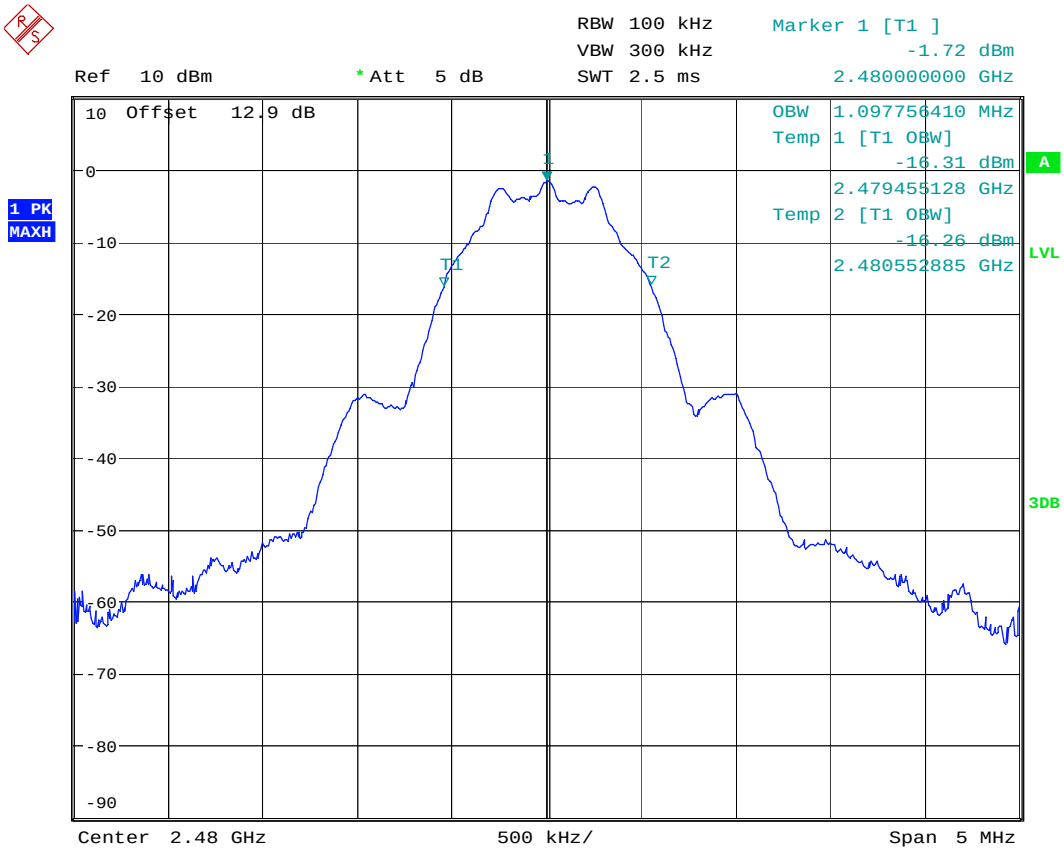
Mid channel	Mode: BTLE



Date: 10.JUL.2018 15:58:55

Plot #15

High channel	Mode: BTLE



Date: 10.JUL.2018 15:57:42

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
[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	2	GFSK continuous fixed channel	USB 5VDC

8.6.4 Measurement result:

Plot #	Channel #	Scan Frequency	Limit	Result
16-18	Low	30 MHz – 18 GHz	See section 8.5.2	Pass
19-23	Mid	9 kHz – 26 GHz	See section 8.5.2	Pass
24-26	High	30 MHz – 18 GHz	See section 8.5.2	Pass

8.6.5 Measurement Plots:

Plot #16 Radiated Emissions: 30 MHz – 1GHz

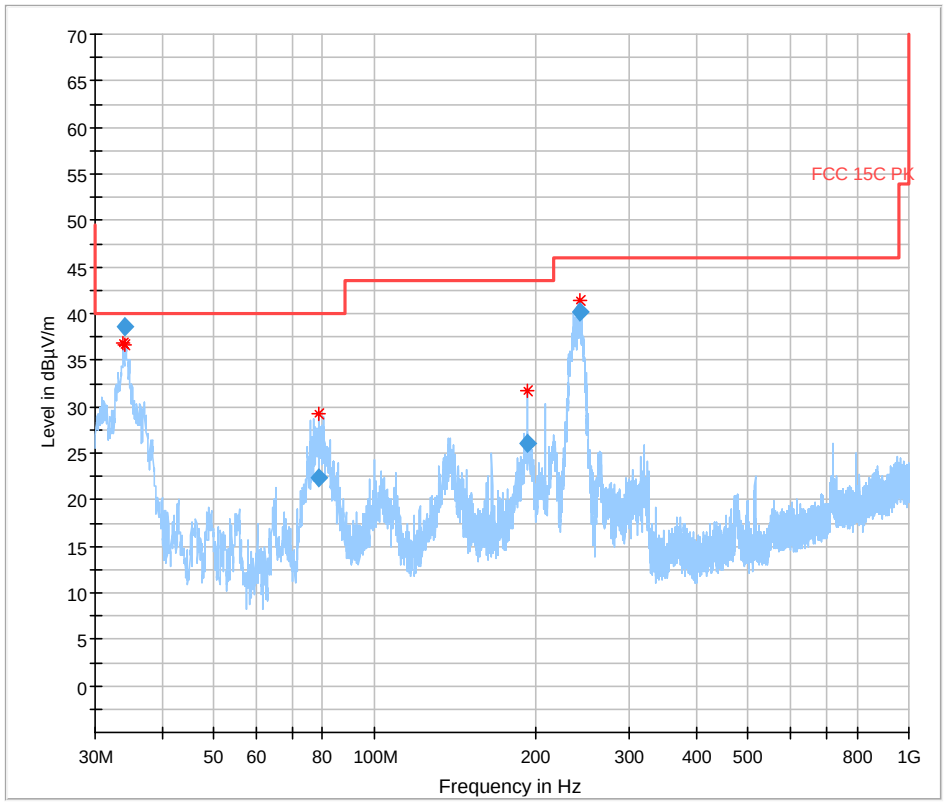
Modulation: BT LE	Channel: Low	66.7% Duty Cycle

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
34.139950	38.51	40.00	1.49	500.0	100.000	210.0	V	126.0	-12.0
78.514195	22.35	40.00	17.65	500.0	100.000	130.0	V	130.0	-24.6
193.181640	26.09	43.50	17.41	500.0	100.000	100.0	V	96.0	-21.1
242.400610	40.20	46.00	5.80	500.0	100.000	300.0	V	342.0	-18.6

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

Frequency (MHz)	Comment
34.139950	2:23:53 PM - 7/10/2018
78.514195	1:32:46 PM - 7/10/2018
193.181640	1:30:08 PM - 7/10/2018
242.400610	1:35:12 PM - 7/10/2018



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

Plot #97 Radiated Emissions: 1-3 GHz

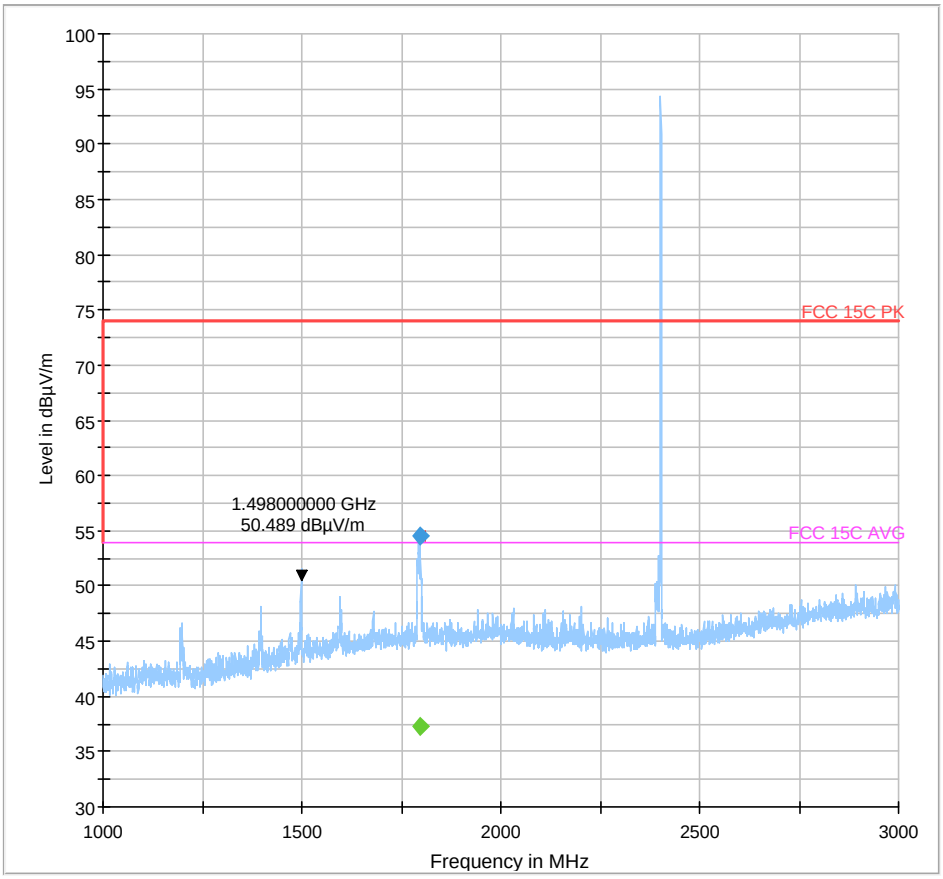
Modulation: BT LE	Channel: Low	100% Duty Cycle

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1798.265000	---	37.23	53.98	16.75	10.0	1000.000	157.0	H	-1.0
1798.265000	54.47	---	74.00	19.52	10.0	1000.000	157.0	H	-1.0

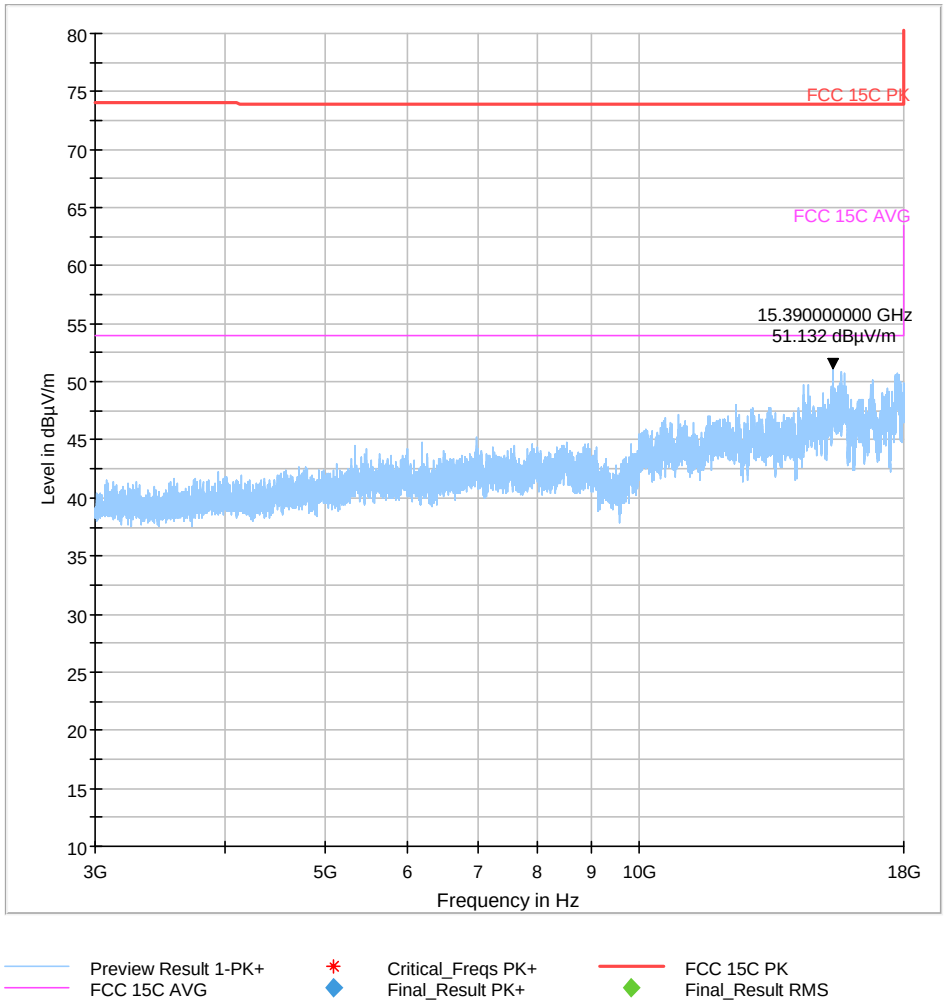
(continuation of the "Final_Result" table from column 15 ...)

Frequency (MHz)	Corr. (dB)	Comment
1798.265000	8.3	11:16:41 AM - 7/12/2018
1798.265000	8.3	11:16:41 AM - 7/12/2018

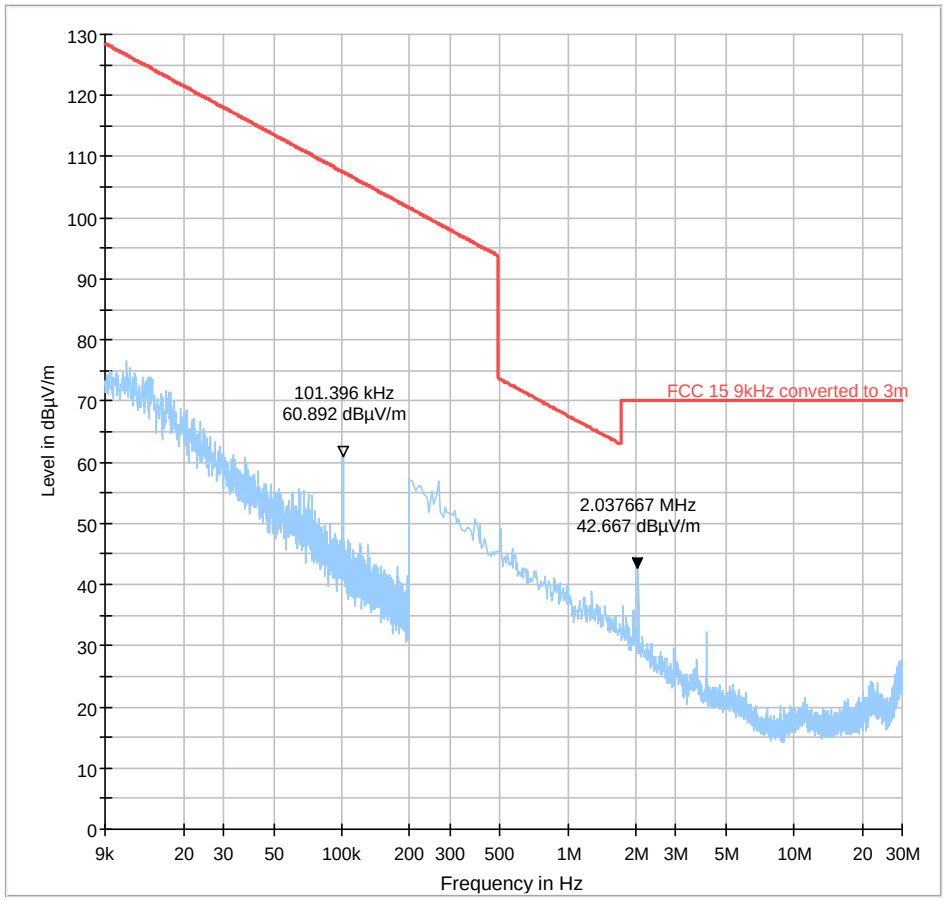


Preview Result 1-PK+ | Critical_Freqs PK+ | FCC 15C PK
FCC 15C AVG | Final_Result PK+ | Final_Result RMS

Plot #18 Radiated Emissions: 3-18 GHz		
Modulation: BT LE	**Channel: Low**	**100% Duty Cycle**



Plot #10 Radiated Emissions: 9 KHz – 30 MHz		
Modulation: BT LE	**Channel: Mid**	**100% Duty Cycle**



Preview Result 1-PK+
FCC 15 9kHz converted to 3m
Final_Result RMS
Critical_Freqs PK+
Final_Result PK+

Plot #20 Radiated Emissions: 30 MHz – 1GHz

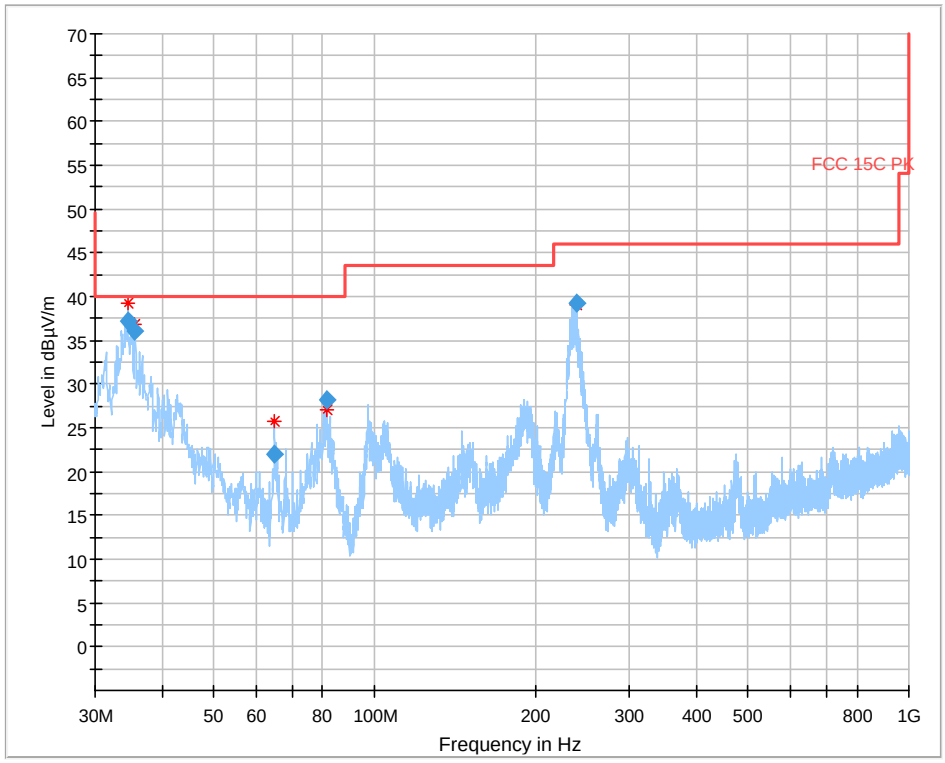
Modulation: BT LE	Channel: Mid	100% Duty Cycle

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
34.514625	37.25	40.00	2.75	500.0	100.000	100.0	V	-1.0	-12.3
35.578770	36.02	40.00	3.98	500.0	100.000	108.0	V	2.0	-12.8
65.034230	22.09	40.00	17.91	500.0	100.000	108.0	V	274.0	-24.5
81.415780	28.18	40.00	11.82	500.0	100.000	175.0	V	278.0	-23.4
238.730235	39.26	46.00	6.74	500.0	100.000	100.0	V	112.0	-19.2

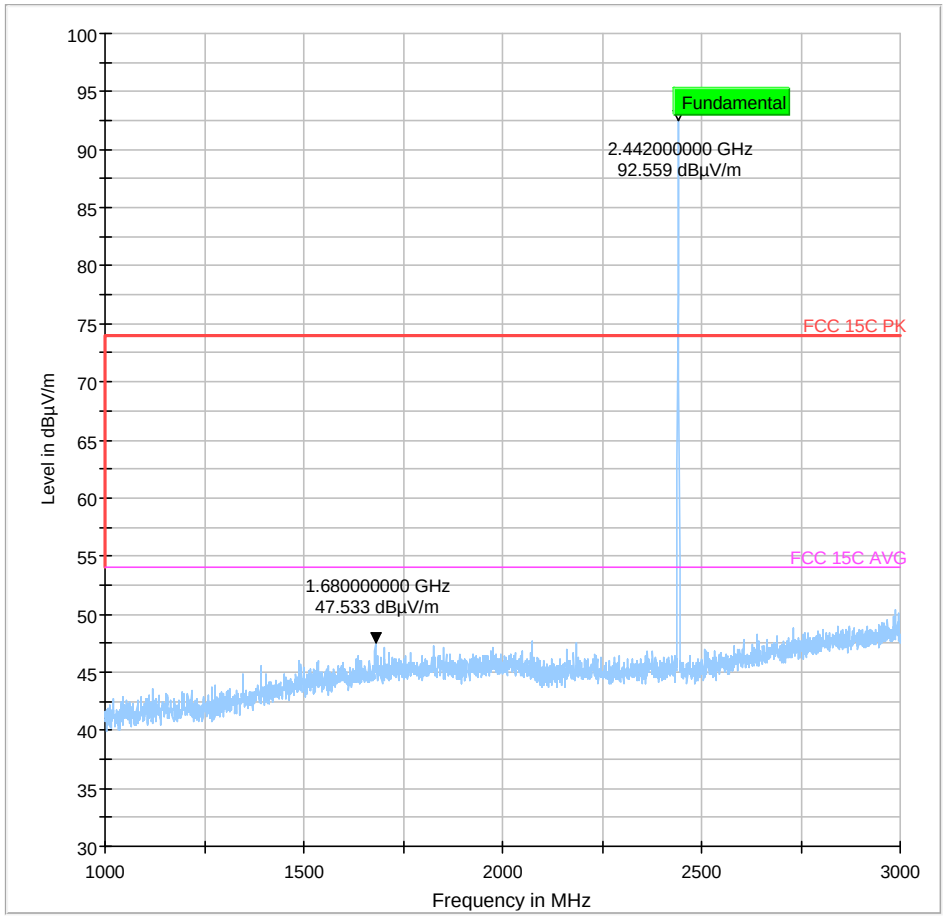
(continuation of the "Final_Result" table from column 16 ...)

Frequency (MHz)	Comment
34.514625	2:55:26 PM - 7/10/2018
35.578770	2:57:44 PM - 7/10/2018
65.034230	3:05:28 PM - 7/10/2018
81.415780	3:02:53 PM - 7/10/2018
238.730235	3:00:24 PM - 7/10/2018



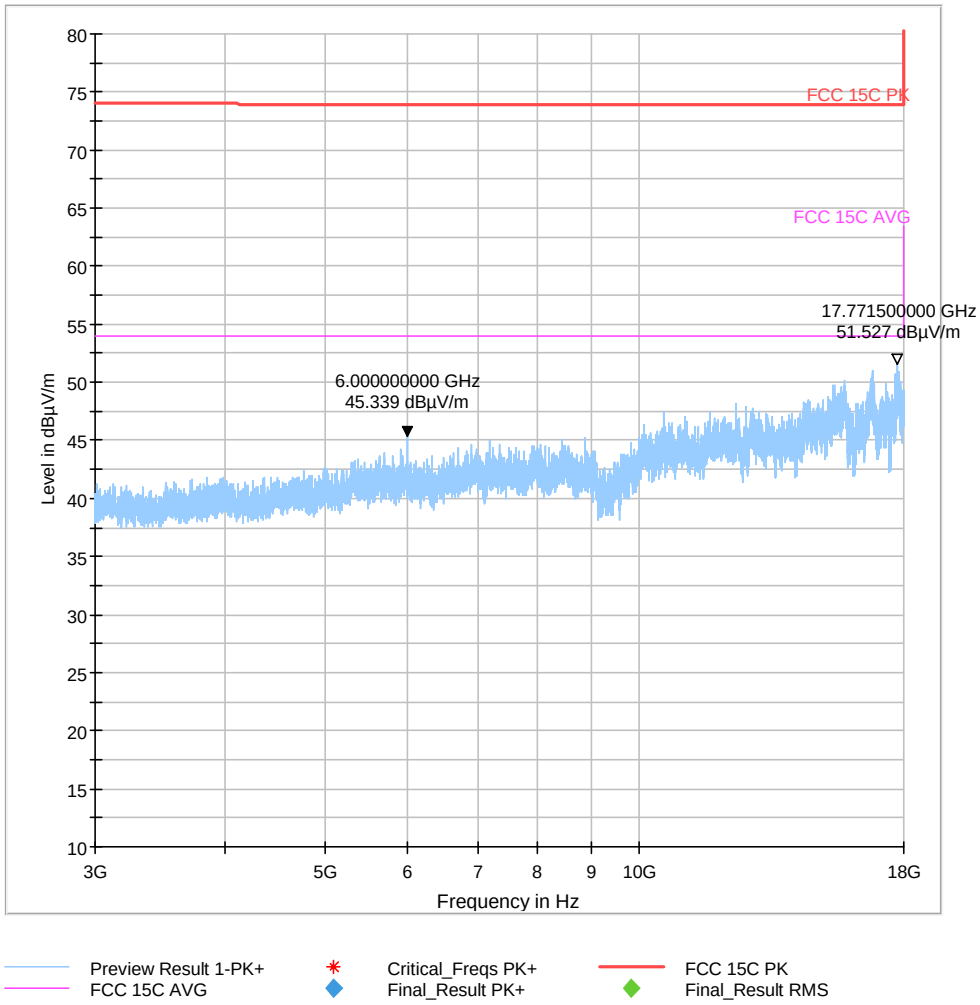
Preview Result 1-PK+
FCC 15C PK
Critical_Freqs PK+
Final_Result QPK

Plot #21 Radiated Emissions: 1-3 GHz		
Modulation: BT LE	**Channel: Mid**	**100% Duty Cycle**

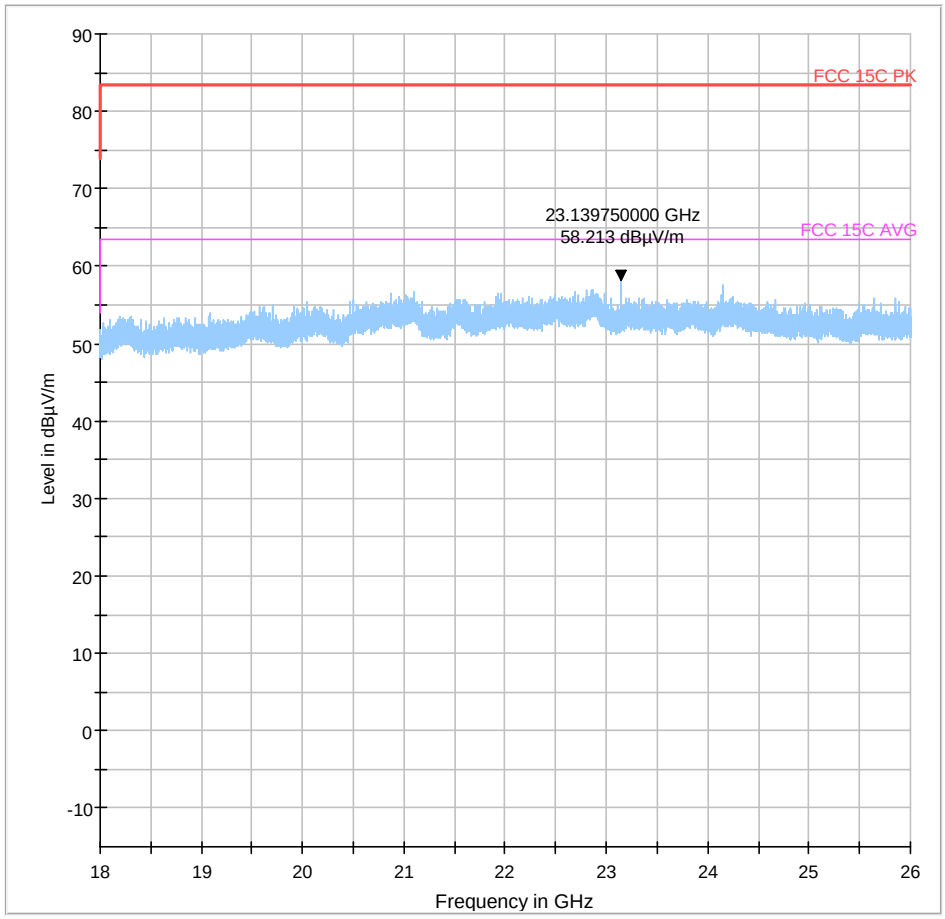


Preview Result 1-PK+ | Critical_Freqs PK+ | FCC 15C PK
FCC 15C AVG | Final_Result PK+ | Final_Result RMS

Plot #22 Radiated Emissions: 3-18 GHz		
Modulation: BT LE	**Channel: Mid**	**100% Duty Cycle**



Plot #23 Radiated Emissions: 18-26 GHz		
Modulation: BT LE	**Channel: Mid**	**100% Duty Cycle**



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

Plot #25 Radiated Emissions: 30 MHz – 1GHz

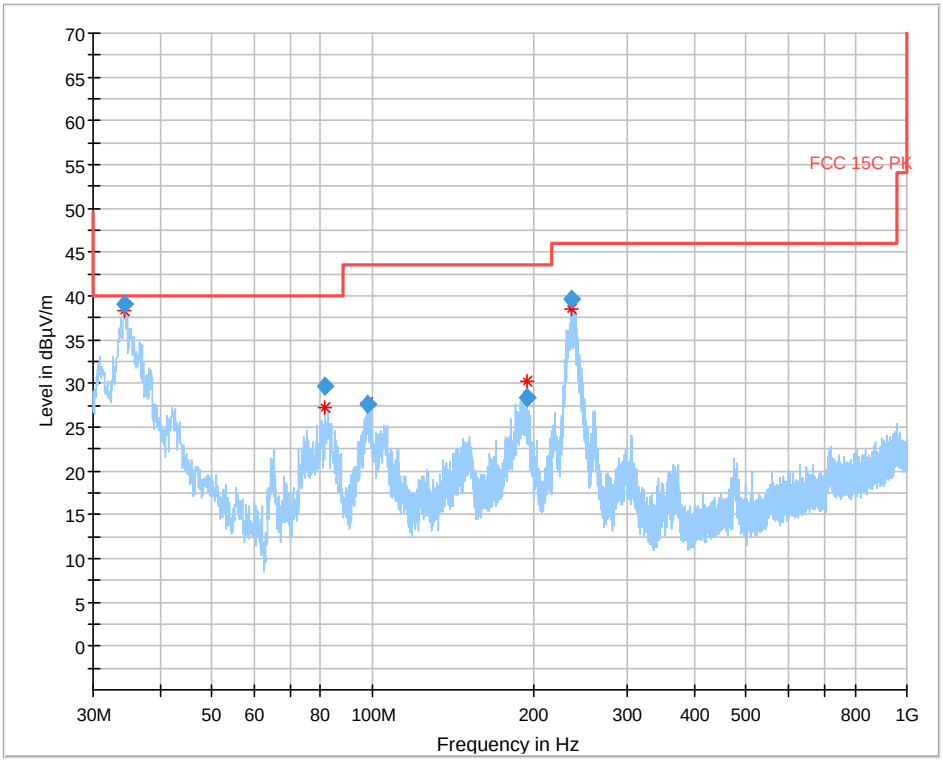
Modulation: BT LE	Channel: High	100% Duty Cycle

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
34.331045	39.14	40.00	0.86	500.0	100.000	221.0	V	32.0	-12.1
81.530205	29.60	40.00	10.40	500.0	100.000	169.0	V	260.0	-23.4
97.663390	27.64	43.50	15.86	500.0	100.000	141.0	V	46.0	-21.8
194.519040	28.38	43.50	15.12	500.0	100.000	100.0	V	8.0	-21.0
235.035615	39.64	46.00	6.36	500.0	100.000	100.0	V	106.0	-19.4

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

Frequency (MHz)	Comment
34.331045	3:13:12 PM - 7/10/2018
81.530205	3:23:30 PM - 7/10/2018
97.663390	3:18:16 PM - 7/10/2018
194.519040	3:15:49 PM - 7/10/2018
235.035615	3:20:57 PM - 7/10/2018



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

Plot #25 Radiated Emissions: 1-3 GHz and Restricted Bands

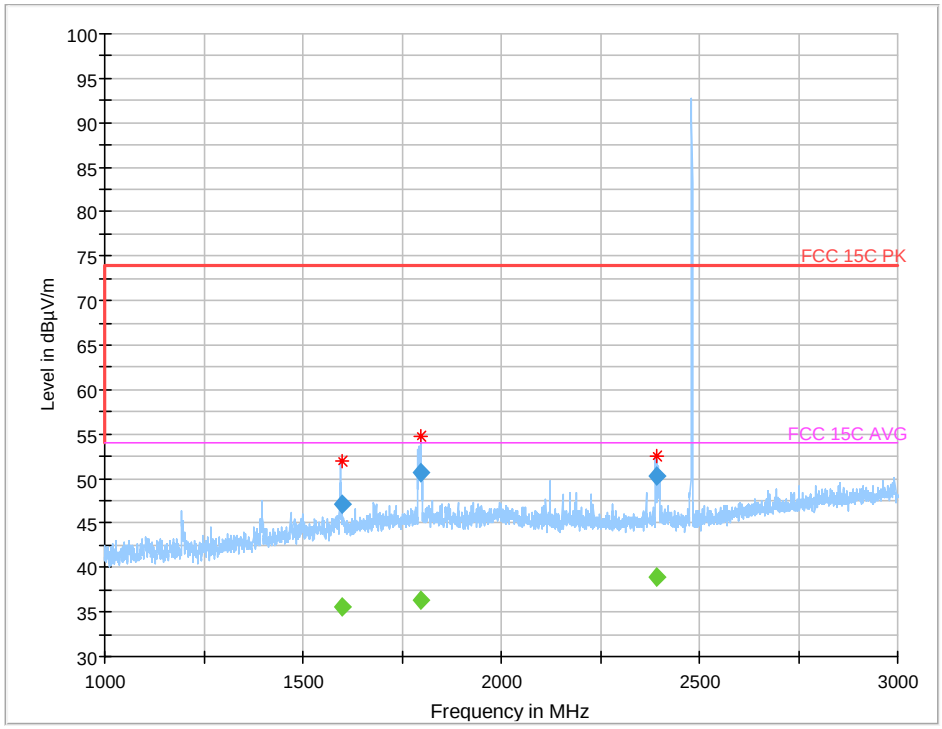
Modulation: BT LE	Channel: High	100% Duty Cycle

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1598.025000	---	35.54	53.98	18.44	10.0	1000.000	146.0	H	329.0
1598.025000	47.19	---	74.00	26.81	10.0	1000.000	146.0	H	329.0
1798.620000	---	36.25	53.98	17.73	10.0	1000.000	152.0	H	113.0
1798.620000	50.59	---	74.00	23.41	10.0	1000.000	152.0	H	113.0
2393.670000	---	38.89	53.98	15.09	10.0	1000.000	206.0	H	71.0
2393.670000	50.26	---	73.99	23.73	10.0	1000.000	206.0	H	71.0

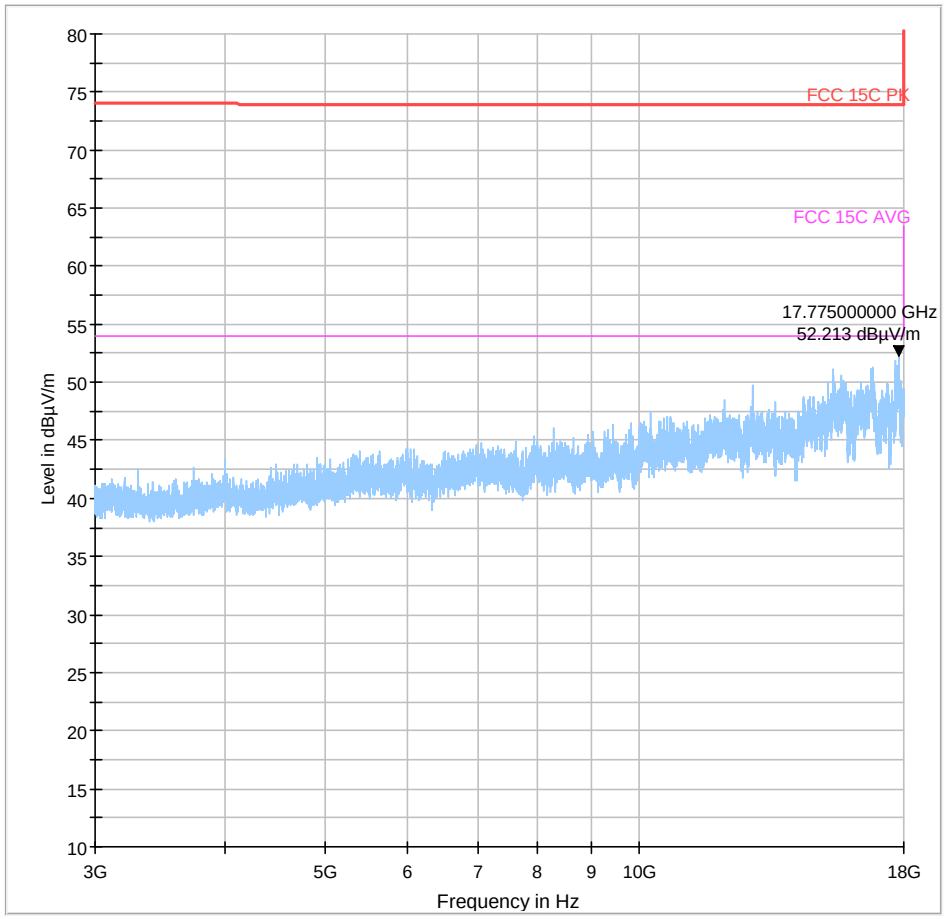
(continuation of the "Final_Result" table from column 15 ...)

Frequency (MHz)	Corr. (dB)	Comment
1598.025000	7.9	10:52:13 AM - 7/12/2018
1598.025000	7.9	10:52:13 AM - 7/12/2018
1798.620000	8.3	10:54:21 AM - 7/12/2018
1798.620000	8.3	10:54:20 AM - 7/12/2018
2393.670000	8.4	10:56:04 AM - 7/12/2018
2393.670000	8.4	10:56:04 AM - 7/12/2018



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

Plot #26 Radiated Emissions: 3-18 GHz		
Modulation: GFSK	**Channel: High**	**100% Duty Cycle**



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_VIRSC-001-17001_15.247_Setup_Photos.pdf"

10 Test Equipment And Ancillaries Used For Testing

Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
Biconlog Antenna	EMCO	3142E	166067	3 years	6/28/2017
Loop Antenna	ETS Lindgren	6507	161344	3 years	10/26/2017
Horn Antenna	EMCO	3115	35111	3 years	11/17/2015
Horn Antenna	ETS Lindgren	3117 PA	169547	3 years	10/31/2017
Compact Digital Barometer	Control Company	35519-055	91119547	2 Years	6/20/2017
Spectrum Analyzer	R&S	FSU26	200065	3 years	7/3/2017
Spectrum Analyzer	R&S	FSV40	101022	3 years	7/5/2017
Thermometer Humidity	Dickson	TM320	5280063	1 Year	11/2/2017

Note: Equipment used meets the measurement uncertainty requirements as required per applicable standards for 95% confidence levels. Calibration due dates, unless defined specifically, falls on the last day of the month. Items indicated "N/A" for cal status either do not specifically require calibration or is internally characterized before use.

11 Revision History

Date	Report Name	Changes to report	Report prepared by
2019-02-05	EMC_VIRSC-001-17001_15.247_BT_DTS	Initial version	Kevin Wang