FCC / ISED Test Report

For:
Soberlink Healthcare

Brand:
Connect ST

Model Name/Number:
Connect ST

Marketing Name:
Connect

Product Description:
Breathalyzer

FCC ID: 2A8ZY-3900

Applied Rules and Standards:
47 CFR Part 15.247 (DTS)

REPORT #:
EMC_SOBER-012-22001_FCC_15.247_BLE_DTS_Rev2

DATE: 12/6/2022

A2LA Accredited

***CETECOM* Inc.**
411 Dixon Landing Road ◆ Milpitas, CA 95035 ◆ U.S.A.
Phone: + 1 (408) 586 6200 ◆ Fax: + 1 (408) 586 6299 ◆ E-mail: Contact@cetecom.com ◆ http://www.cetecom.com
CETECOM Inc. is a Delaware Corporation with Corporation number: 2905571

TABLE OF CONTENTS

1 Assessment

The following device was evaluated against the applicable criteria specified in FCC rules Parts 15.247 of Title 47 of the Code of Federal Regulations.

No deviations were ascertained.

According to section 5 of this report, the overall result is Pass.

Company	Description	Model #
Soberlink Healthcare	Breathalyzer	Connect ST

Responsible for Testing Laboratory:

Date	Section	Name	Signature
12/6/2022	Compliance	Stoecker, Arndt (Director of Regulatory Services)	Arndt Stoecker Digitally signed by: Arndt Stoecker DN: CN = Arndt Stoecker email = arndt.stoecker@cetecom.com C = US O = CETECOM Inc Date: 2022.12.06 16:49:42 -08'00'

Responsible for the Report:

Date	Section	Name	Signature
12/6/2022	Compliance	Ghanma, Issa (EMC Engineer)	Digitally signed by: Issa Ghanma DN: CN = Issa Ghanma email = Issa.Ghanma@cetecom.com C = US O = CETECOM, Inc. OU = EMC Date: 2022.12.06 14:42:37 -08'00'

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the EMC Test Report

Company Name:	CETECOM Inc.
Department:	Compliance
Street Address:	411 Dixon Landing Road
City/Zip Code	Milpitas, CA 95035
Country	USA
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
Director of Regulatory Services:	Stoecker, Arndt
Responsible Project Leader:	Sivaraman, Sangeetha

2.2 Identification of the Client

Applicant's Name:	Soberlink Healthcare
Street Address:	7711 Center Ave, Ste 400
City/Zip Code	Huntington Beach, CA 92647
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

Brand:	Connect ST
Model No:	Connect ST
Marketing name:	Connect
FCC-ID :	2A8ZY-3900
HW Version :	0001
SW Version :	18.14
Product Description:	Breathalyzer
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
Radio information:	❖ Bluetooth Low Energy 4.2: Nordic • Chipset name/number: nRF52832 • Modulation: GFSK
Max. Measured Conducted Output Power:	+5.27 dBm
Power Supply/ Rated Operating Voltage Range:	Fixed battery: Low 4.5 V DC, Nominal 5 V DC, High 5.5 V DC
Operating Temperature Range:	Low 0º C, Nominal 23º C, High +50º C
Other Radios included in the device:	☐ Yes _____ ☑ No
Antenna Information as declared:	PCB trace; Gain: 3.63 dBi
Sample Revision:	☐ Prototype Unit; ☐ Production Unit; ☑ Pre-Production
Product dimensions [mm]:	103 x 70 x 156
Note 1: The information of the EUT specifications in the table above are provided by the client.	

3.2 EUT Sample details

EUT #	S/N	HW Version	SW Version	Notes/Comments
1	3900000A	0001	18.14	Conducted measurement
2	39000009	0001	18.14	Radiated measurement

3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Notes/Comments
1	Wall Charger	DSA-5PFU1-05 FUS	Generic	Input: 100-240V ~50-60Hz 0.2A Output: +5V --- 1A
2	Cable	N/A	INSIGNIA	USB A – USB C

3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT # 1 + AE # 2	The measurement equipment was connected to the 50 ohm RF port of the EUT.
2	EUT # 2 + AE # 1, 2	The internal antenna was connected.

3.5 Mode of Operation details

Mode of Operation	Description of Operating modes	Additional Information
Op. 1	Bluetooth LE	❖ Putty terminal used to communicate with the device, and send commands provided by client, that will not be available to end-user, to configure the BLE radio to: ▪ Maximum output power setting → 4 dBm ▪ Continuous transmission ▪ Modulated signal ▪ Switch between supported data rates: 1 Mb/s, 2 Mb/s ▪ Select TX channel(s) o Low channel → 2402 MHz o Mid channel → 2440 MHz o High channel → 2480 MHz
Op. 2	Bluetooth LE	❖ Putty terminal used to communicate with the device, and send commands provided by client, that will not be available to end-user, to configure the BLE radio to: ▪ Maximum output power setting → 4 dBm ▪ Continuous transmission ▪ Modulated signal ▪ Worst case data rates: 2 Mb/s ▪ Select TX channel(s) o Low channel → 2402 MHz o Mid channel → 2440 MHz o High channel → 2480 MHz

3.6 Justification for Worst Case Mode of Operation

During the testing process, the EUT was tested with transmitter sets on low, mid and high channels, and highest possible duty cycle and output power.

For radiated measurements;

- All data in this report show the worst case of BLE radio transmitting at the highest output power representing worst case of BLE transmission mode.
- All data in this report show 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.

This test report is to support a request for new equipment authorization under:

- FCC ID: 2A8ZY-3900

Testing procedures are based on 558074 D01 15.247 Meas Guidance v05r02 – "GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES" - April 2, 2019, by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division.

5 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	NA	NP	Result
§15.247(a)(1)	Emission Bandwidth	Nominal	BLE	☑	☐	☐	Complies
§15.247(e)	Power Spectral Density	Nominal	BLE	☑	☐	☐	Complies
§15.247(b)(1)	Maximum Conducted Output Power and EIRP	Nominal	BLE	☑	☐	☐	Complies
§15.247(d)	Band edge compliance Unrestricted Band Edges	Nominal	BLE	☑	☐	☐	Complies
§15.247; 15.209; 15.205	Band edge compliance Restricted Band Edges	Nominal	BLE	☑	☐	☐	Complies
§2.1055	Frequency Stability	Extreme temperature	BLE	☑	☐	☐	Complies
§15.247(d); §15.209	TX Spurious emissions-Radiated	Nominal	BLE	☑	☐	☐	Complies
§15.207(a)	AC Conducted Emissions	Nominal	BLE	☑	☐	☐	Complies

Note1: NA= Not Applicable; NP= Not Performed.

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=2.

Measurement System		EMC 1	EMC 2
Conducted emissions (mains port)		1.12 dB	0.46 dB
Radiated emissions	(< 30 MHz)	3.66 dB	3.88 dB
	(30 MHz – 1GHz)	3.17 dB	3.34 dB
	(1 GHz – 3 GHz)	5.01 dB	4.45 dB
	(>3 GHz)	4.0 dB	4.79 dB

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:

8/31/2022 – 12/6/2022

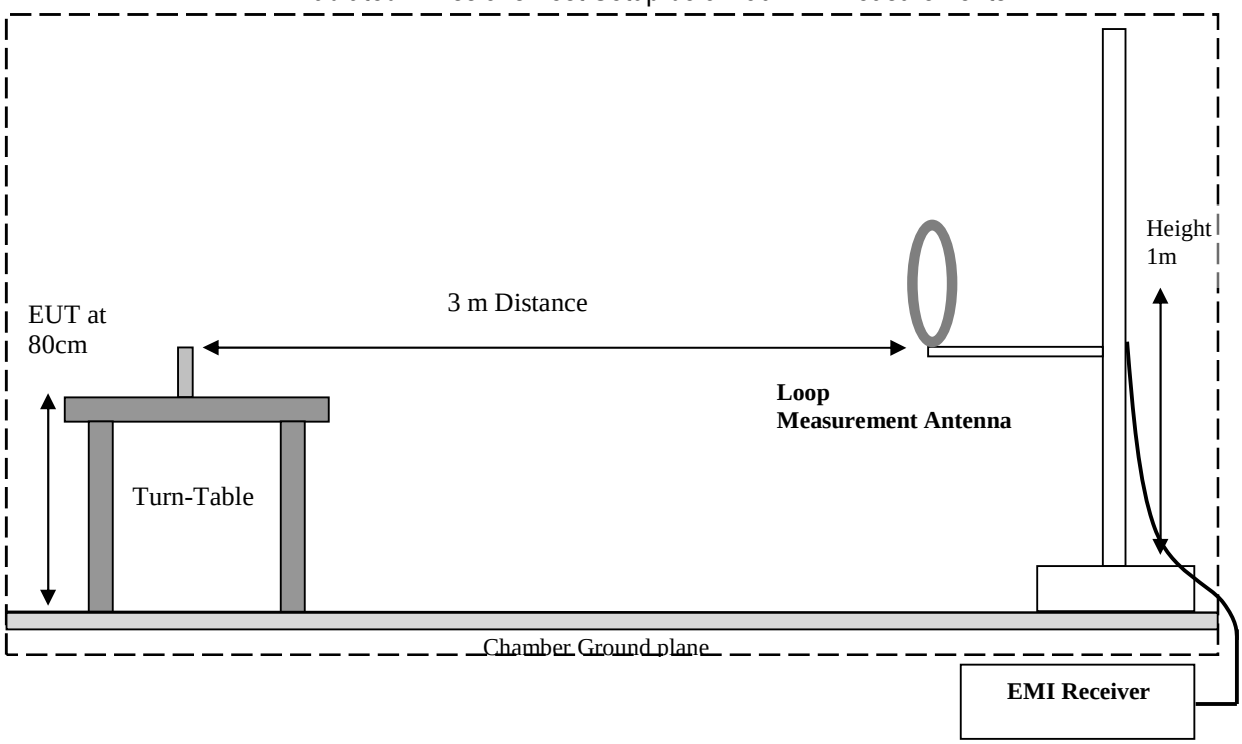
7 Measurement Procedures

7.1 Radiated Measurement

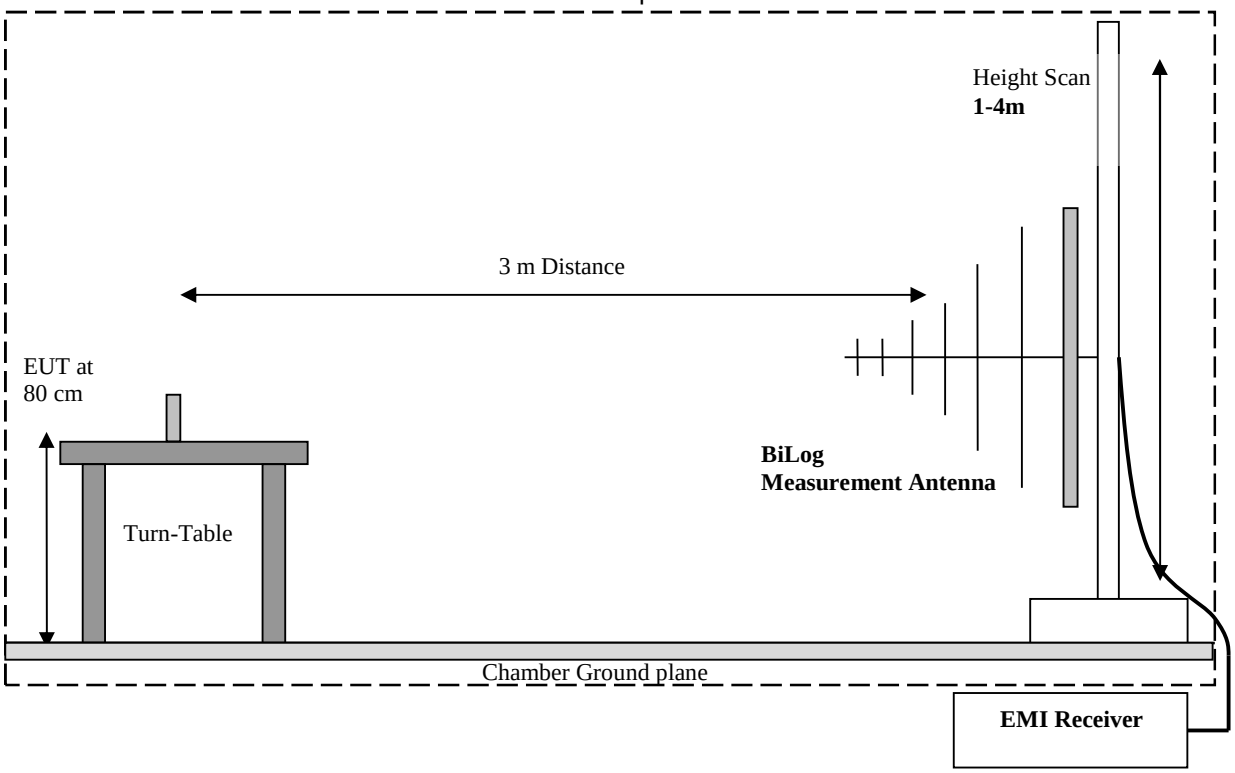
The radiated measurement is performed according to ANSI C63.10 (2013)

- The exploratory measurement is accomplished by running a matrix of 16 sweeps over the required frequency range with R&S Test-SW EMC32 for 360º continuous measurement 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.

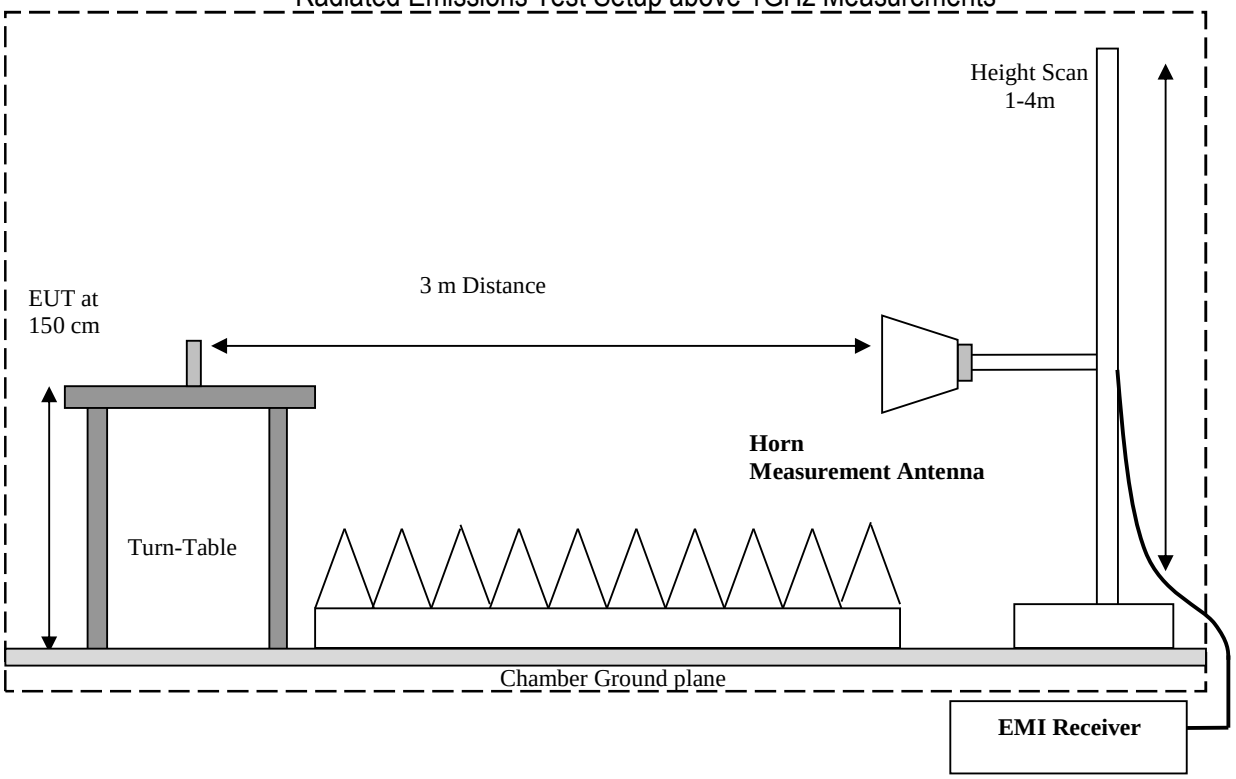
Radiated Emissions Test Setup below 30MHz Measurements



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:

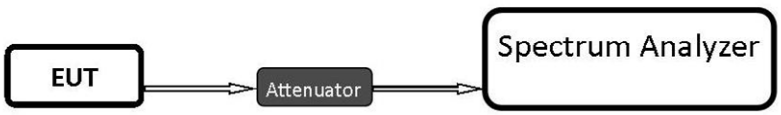
FS (dBµV/m) = Measured Value on SA (dBµV) + Cable Loss (dB) + Antenna Factor (dB/m)

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 15.247 Meas Guidance v05r02 – "GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES" - April 2, 2019, 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.

7.3 Power Line Conducted Measurement Procedure

AC Power Line conducted emissions measurements performed according to: ANSI C63.4 (2014)

8 Test Result Data

8.1 Duty Cycle

8.1.1 Measurement according to ANSI C63.10 clause 11.6;

Measurements of duty cycle and transmission duration shall be performed using the following technique

b) The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on-and off-times of transmitted signal.

1. Set the center frequency of the instrument to the center frequency of the transmission.
2. Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value.
3. Set VBW ≥ RBW. Set detector = peak or average.
4. The zero-span measurement method shall not be used unless both RBW and VBW are >50/T and the number of sweep points across duration T exceeds 100.

(For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≥ 16.7 microseconds.)

8.1.2 Test conditions and setup:

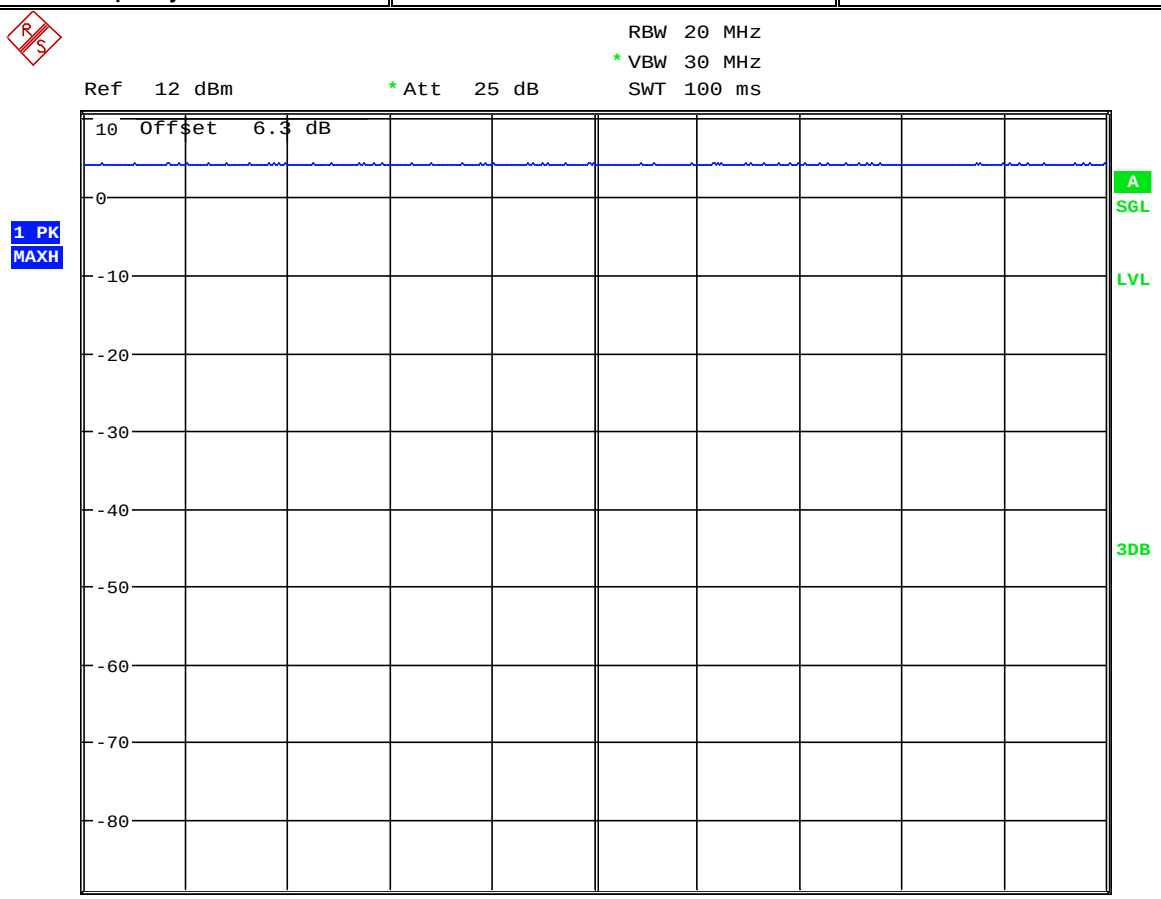
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23.8°C	1	Op.1	5V DC

8.1.3 Measurement result:

Plot #	Mode	TX Frequency	Data Rate	Duty cycle
1	BLE	2440 MHz	1 Mb/s	≥ 98%
2	BLE	2440 MHz	2 Mb/s	≥ 98%

8.1.4 Measurement plots:

Plot # 1		
Tx Frequency: 2440 MHz	**Mode: BLE**	**Data rate: 1 Mb/s**



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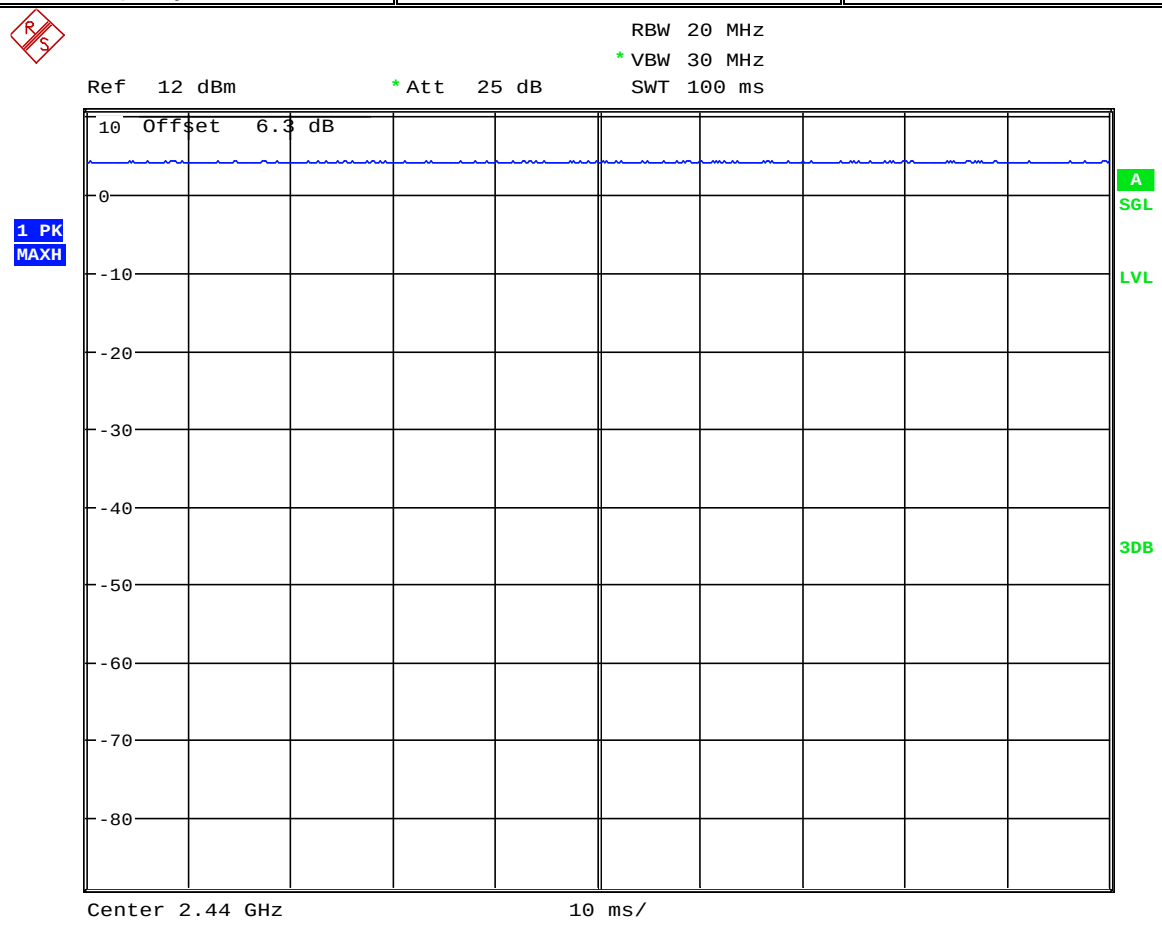
Plot # 2

Tx Frequency: 2440 MHz	Mode: BLE	Data rate: 2 Mb/s



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8.2 Emission Bandwidth 6dB and 99% Occupied Bandwidth

8.2.1 Measurement according to ANSI C63.10 clause 11.8

Spectrum Analyzer settings

6dB (DTS) Bandwidth

- 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.

99% Occupied Bandwidth

- Set frequency = nominal EUT channel center frequency
- Set Span = 1.5 x to 5.0 x OBW
- Set RBW = 1% to 5% of OBW
- Set the video bandwidth (VBW) ≈ 3 x RBW
- Detector = Peak
- Trace mode = Max hold
- Sweep = Auto couple
- Allow the trace to stabilize
- Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth
- If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.

8.2.2 Limits:

FCC §15.247(a)(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.

8.2.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23.8°C	1	Op.1	5V DC

8.2.4 Measurement result:

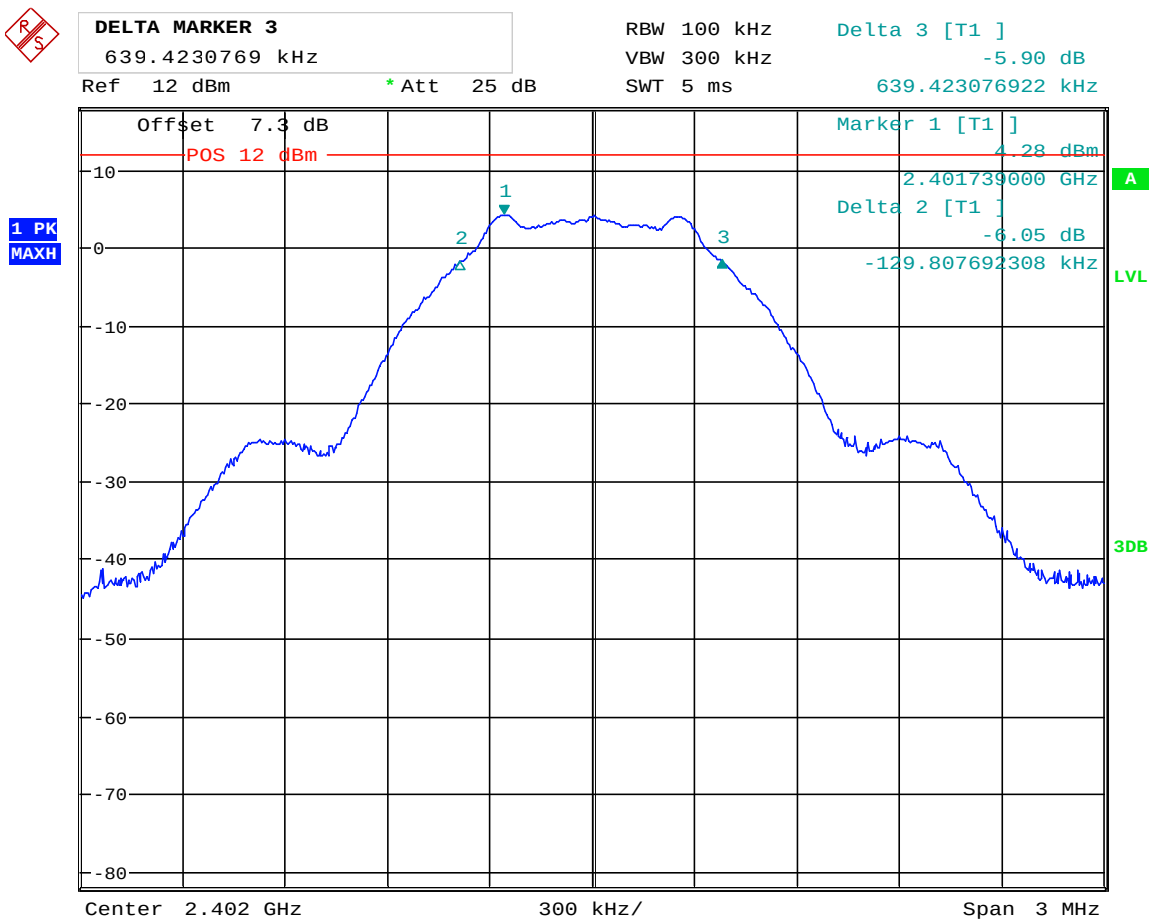
Plot #	Frequency (MHz)	Payload	Data rate	6dB Emission Bandwidth (MHz)	Limit (MHz)	Result
3	2402	1M	1 Mb/s	0.77	> 0.5	Pass
4	2440			0.77	> 0.5	Pass
5	2480			0.74	> 0.5	Pass
6	2402	2M	2 Mb/s	1.33	> 0.5	Pass
7	2440			1.30	> 0.5	Pass
8	2480			1.40	> 0.5	Pass

Plot #	Frequency (MHz)	Payload	Data rate	99% Occupied Bandwidth (MHz)	Limit (MHz)	Result
9	2402	1M	1 Mb/s	1.08	> 0.5	Pass
10	2440			1.08	> 0.5	Pass
11	2480			1.08	> 0.5	Pass
12	2402	2M	2 Mb/s	2.08	> 0.5	Pass
13	2440			2.09	> 0.5	Pass
14	2480			2.09	> 0.5	Pass

8.2.5 Measurement Plots:

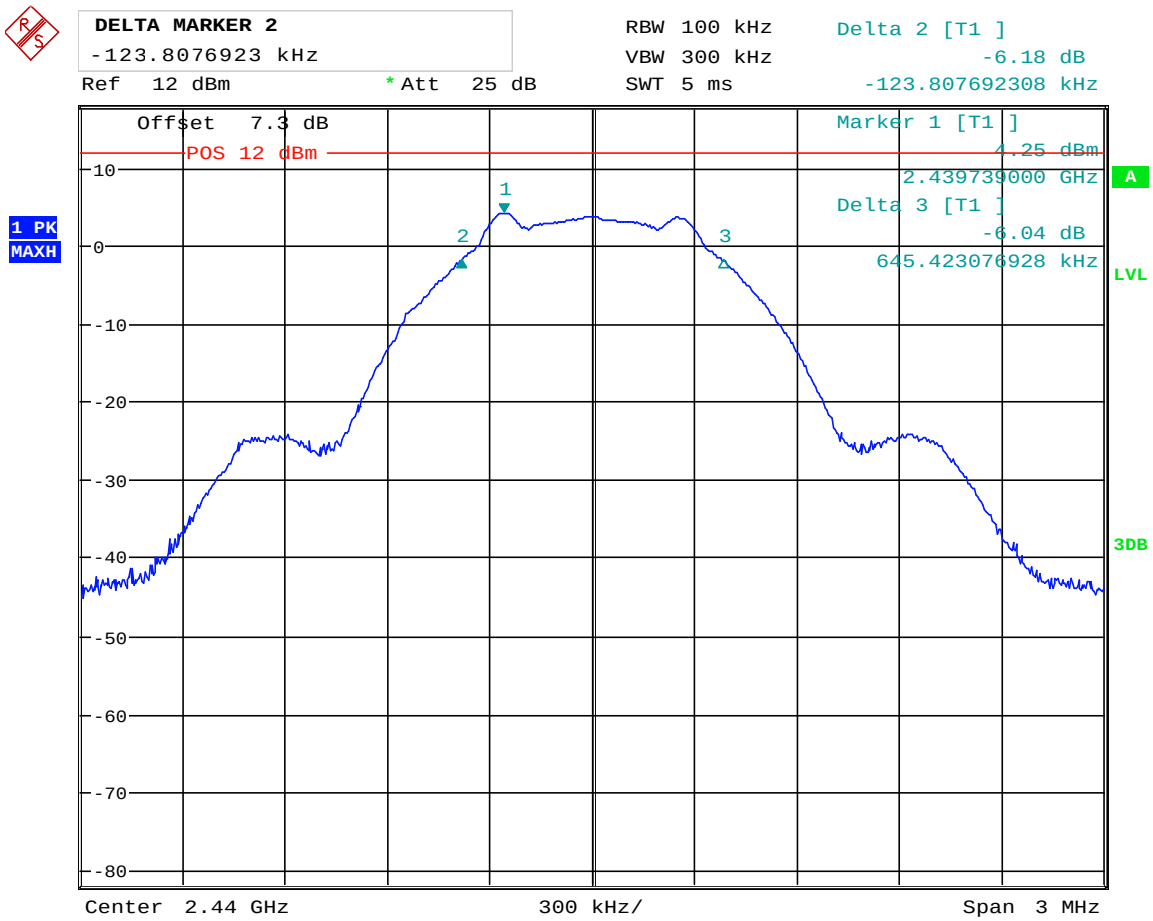
6 dB Emission Bandwidth

Plot # 3		
Tx Frequency: 2402 MHz	**Mode: LE 1M**	**Data rate: 1 Mb/s**



Plot # 4

Tx Frequency: 2440 MHz	Mode: LE 1M	Data rate: 1 Mb/s



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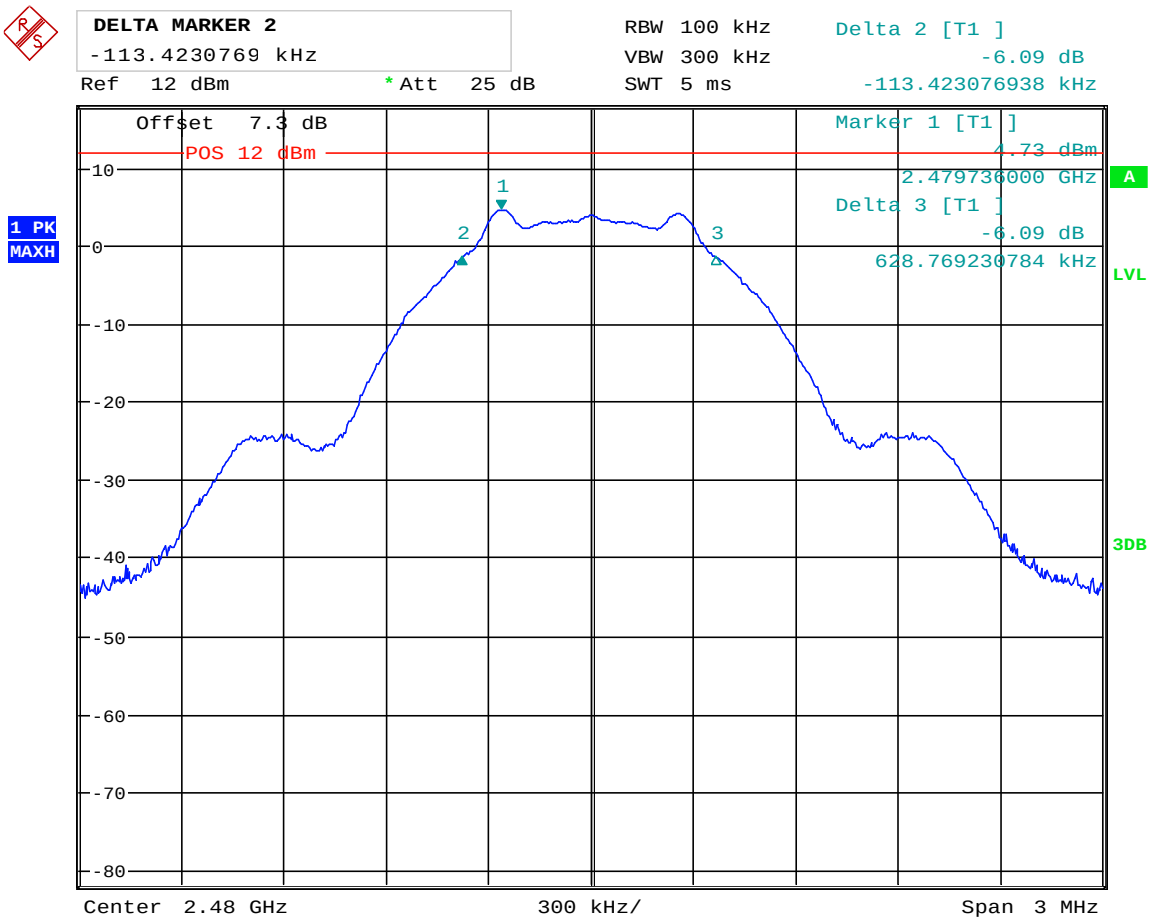
Plot # 5

Tx Frequency: 2480 MHz	Mode: LE 1M	Data rate: 1 Mb/s



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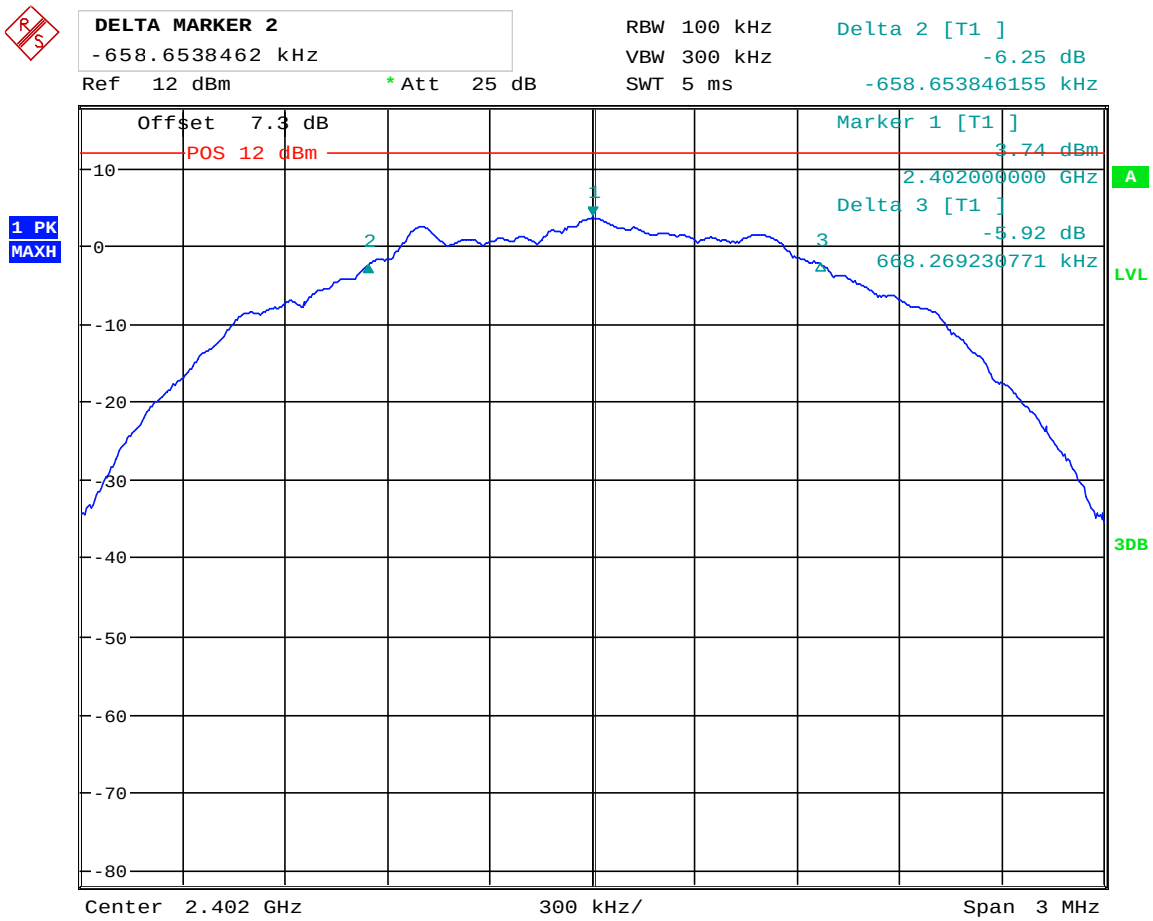
Plot # 6

Tx Frequency: 2402 MHz	Mode: LE 2M	Data rate: 2 Mb/s



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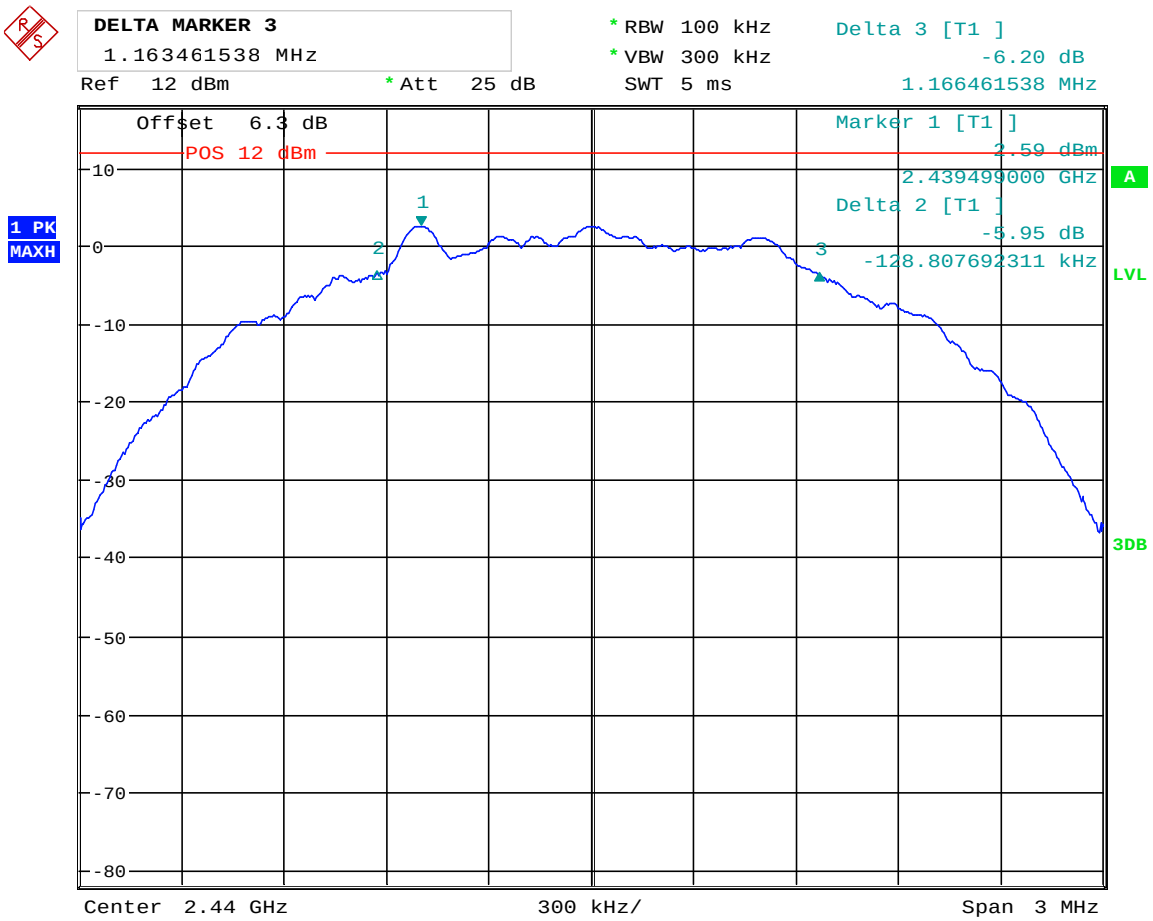
Plot # 7

Tx Frequency: 2440 MHz	Mode: LE 2M	Data rate: 2 Mb/s



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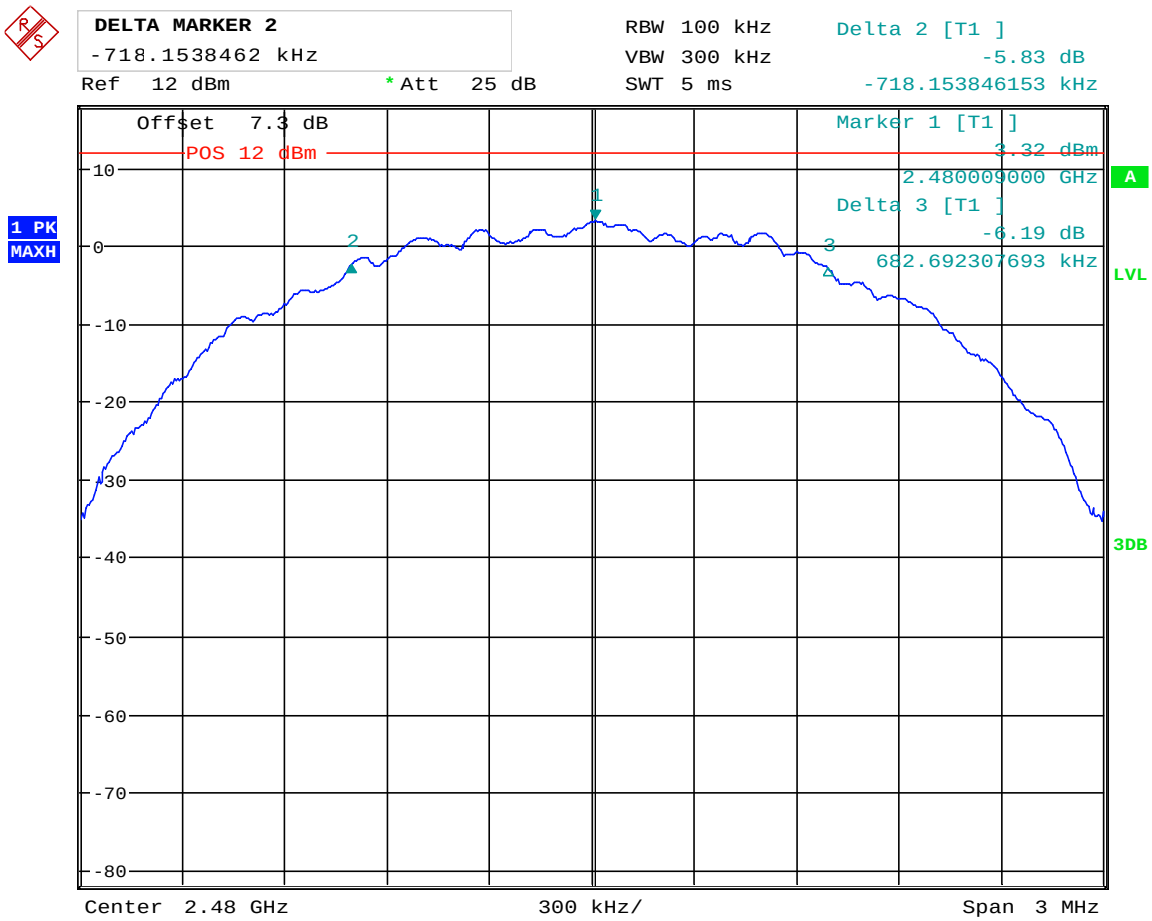
Plot # 8

Tx Frequency: 2480 MHz	Mode: LE 2M	Data rate: 2 Mb/s



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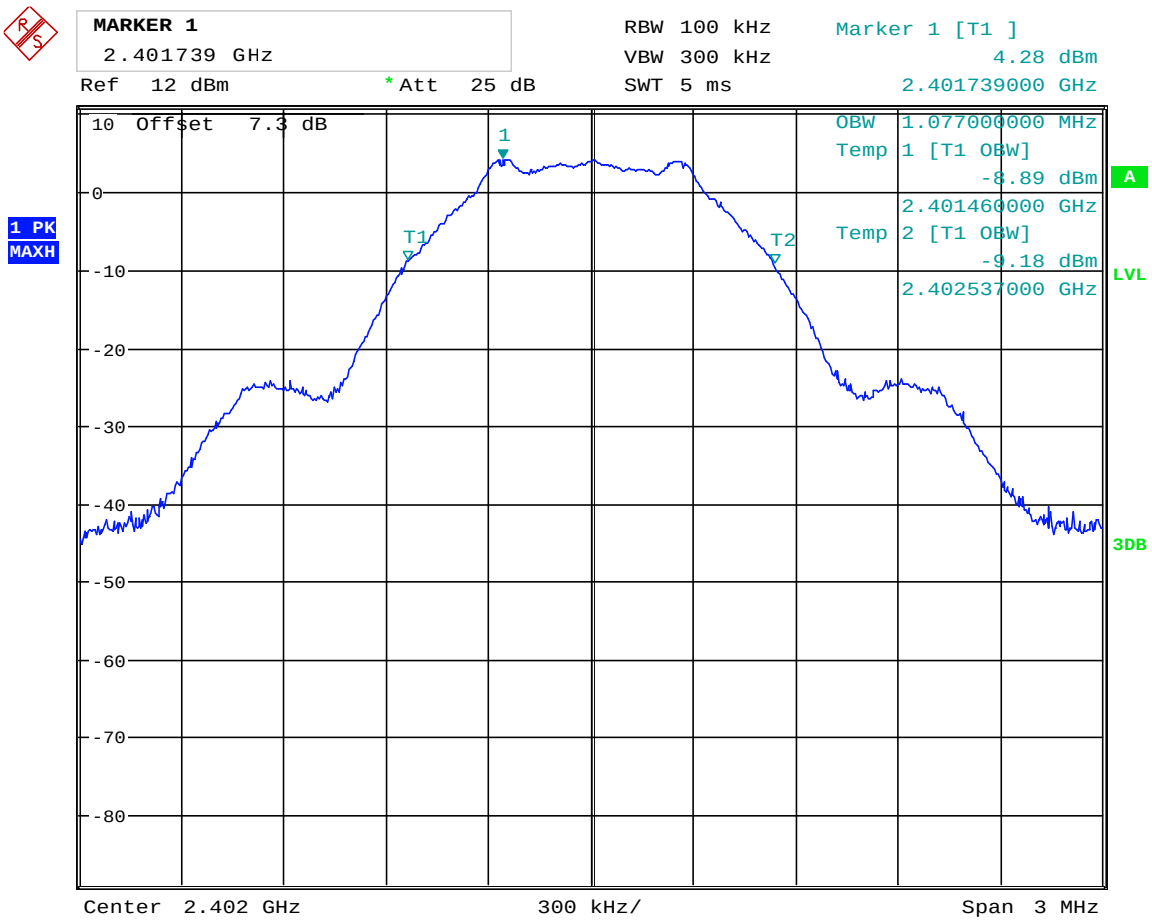
99% Occupied Bandwidth

Plot # 9		
Tx Frequency: 2402 MHz	Mode: LE 1M	Data rate: 1 Mb/s



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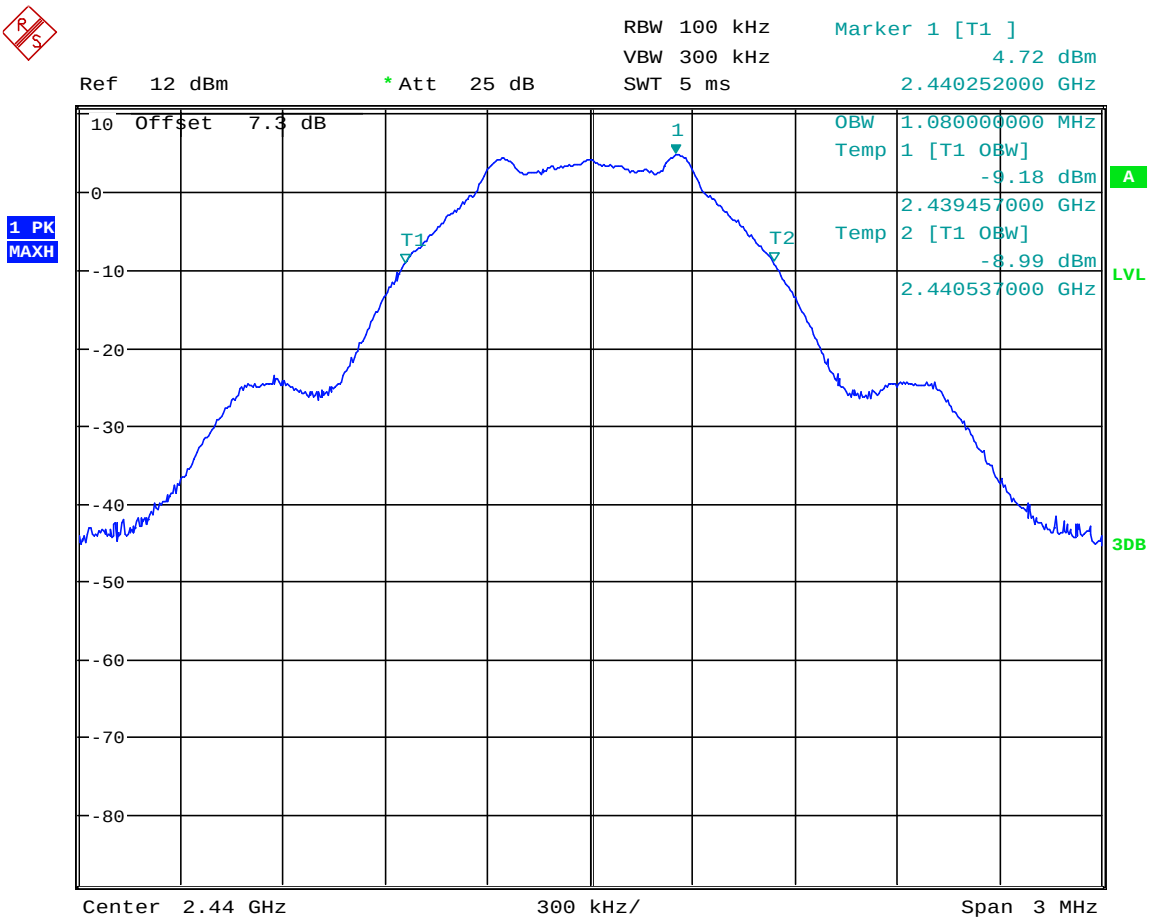
Plot # 10

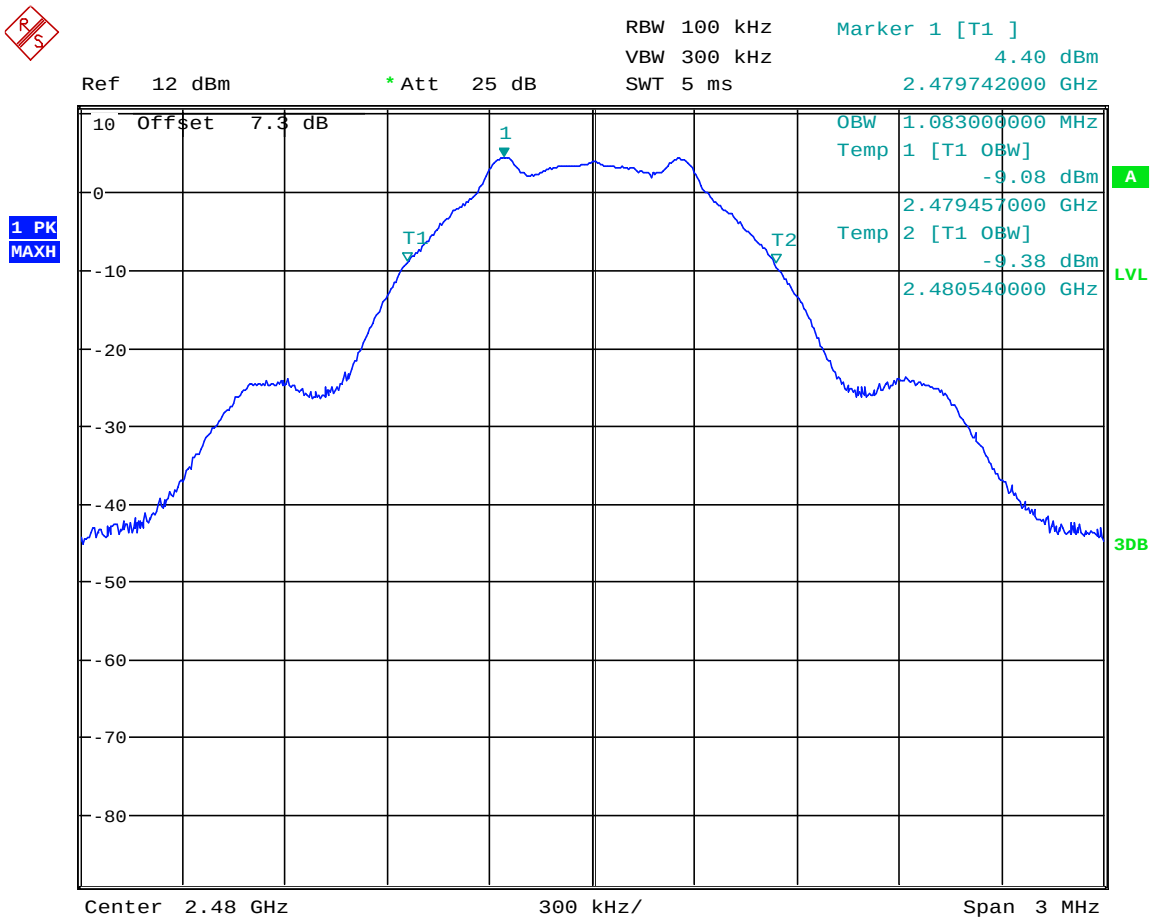
Tx Frequency: 2440 MHz	Mode: LE 1M	Data rate: 1 Mb/s



Date: 31.AUG.2022 14:22:37

Plot # 11

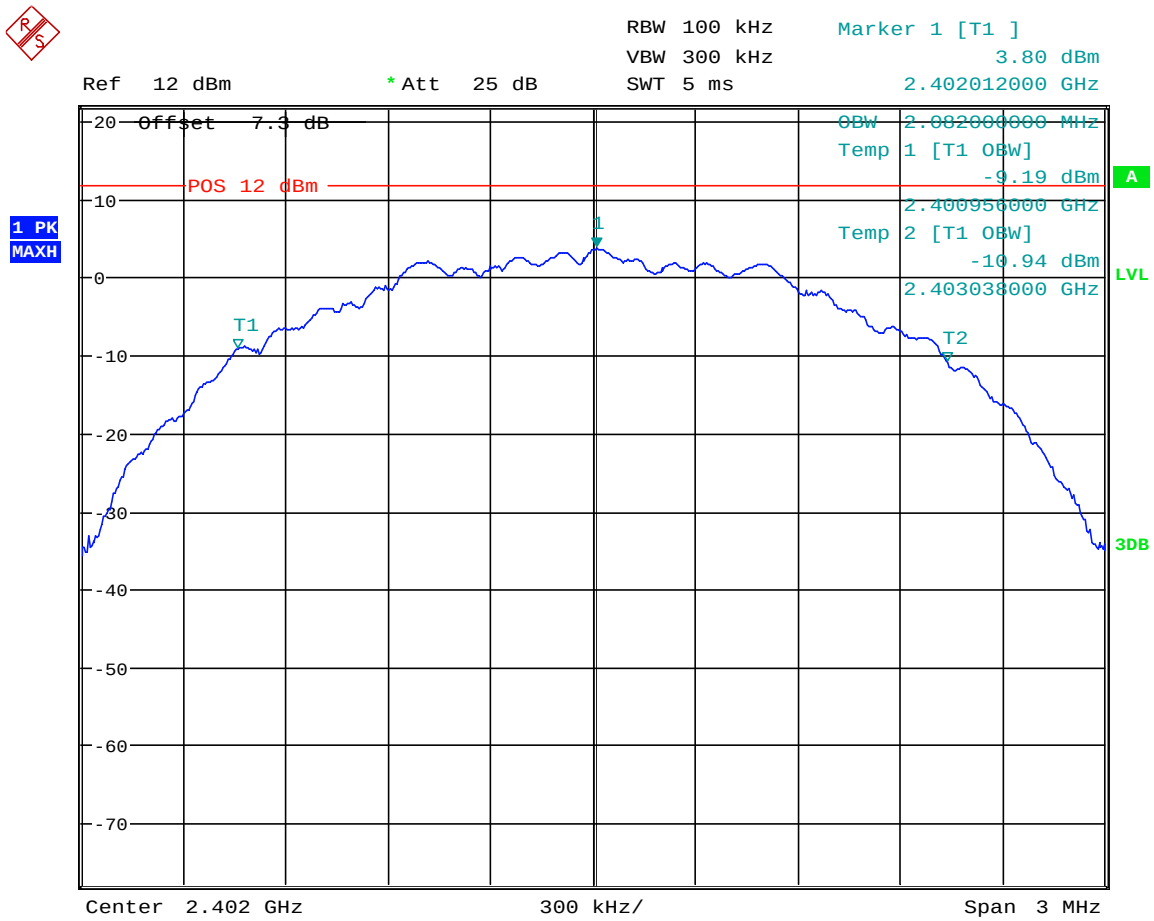
Tx Frequency: 2480 MHz	Mode: LE 1M	Data rate: 1 Mb/s



Date: 31.AUG.2022 14:24:39

Plot # 12

Tx Frequency: 2402 MHz	Mode: LE 2M	Data rate: 2 Mb/s



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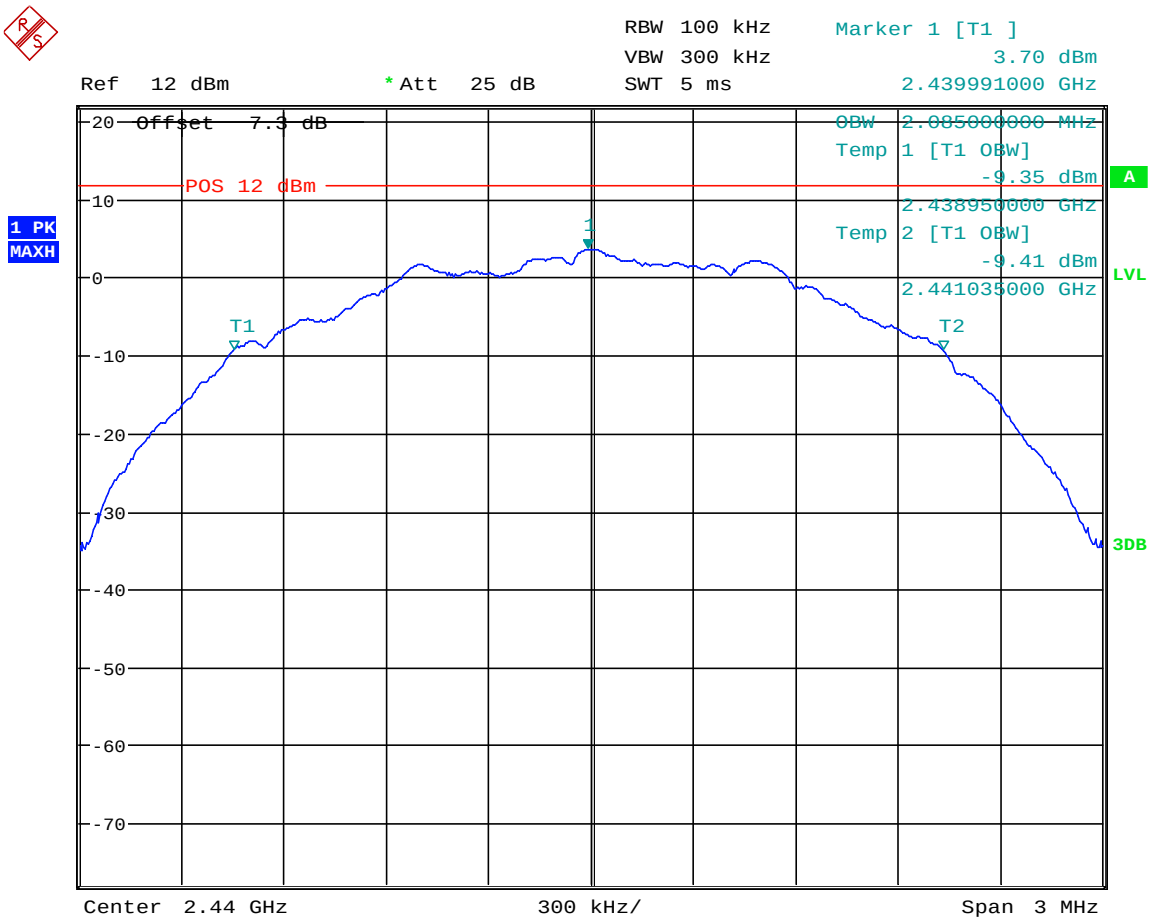
Plot # 13

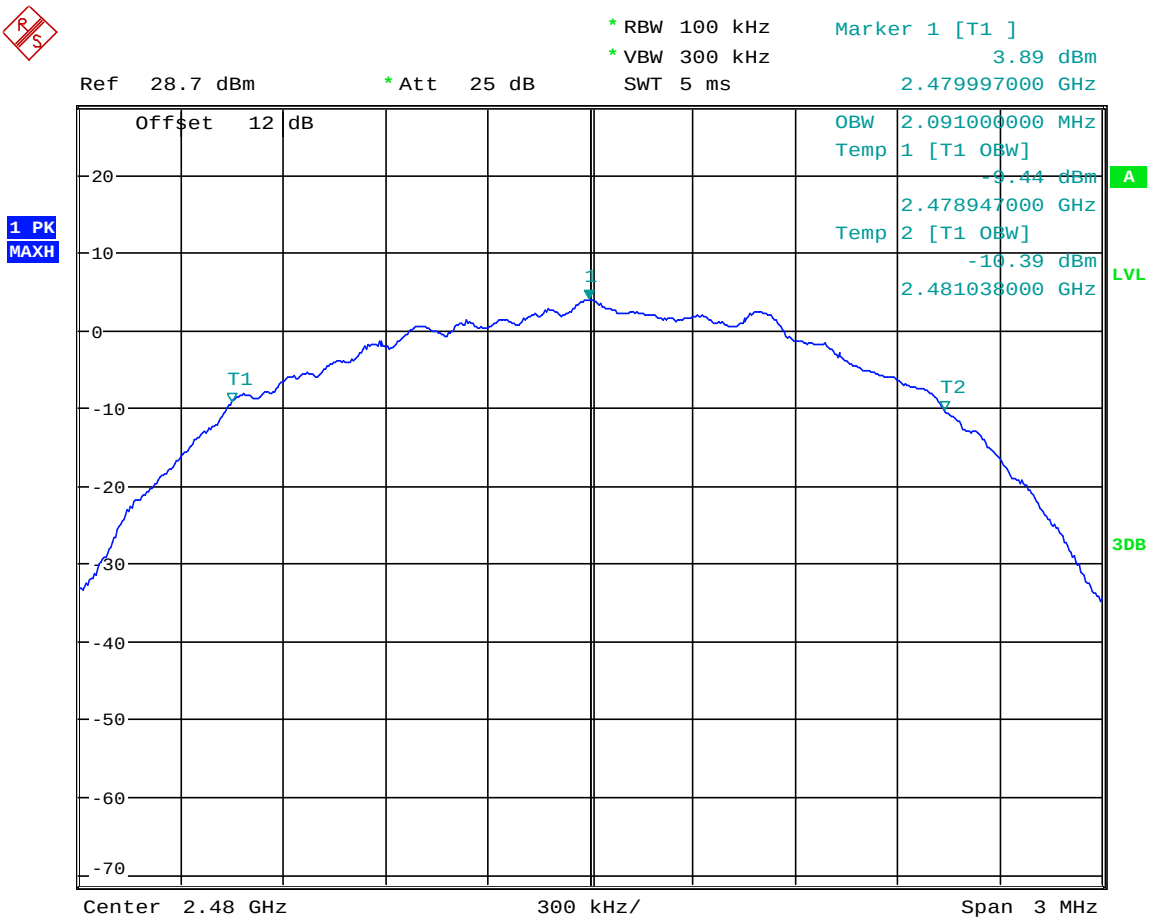
Tx Frequency: 2440 MHz	Mode: LE 2M	Data rate: 2 Mb/s



Date: 31.AUG.2022 14:20:39

Plot # 14

Tx Frequency: 2480 MHz	Mode: LE 2M	Data rate: 2 Mb/s



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8.3 Maximum peak conducted output power

8.3.1 Measurement according to ANSI C63.10 clause 11.9.1

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

8.3.2 Limits:

Maximum Output Power:

- FCC §15.247 (b)(1): 1 W

8.3.3 Test conditions and setup:

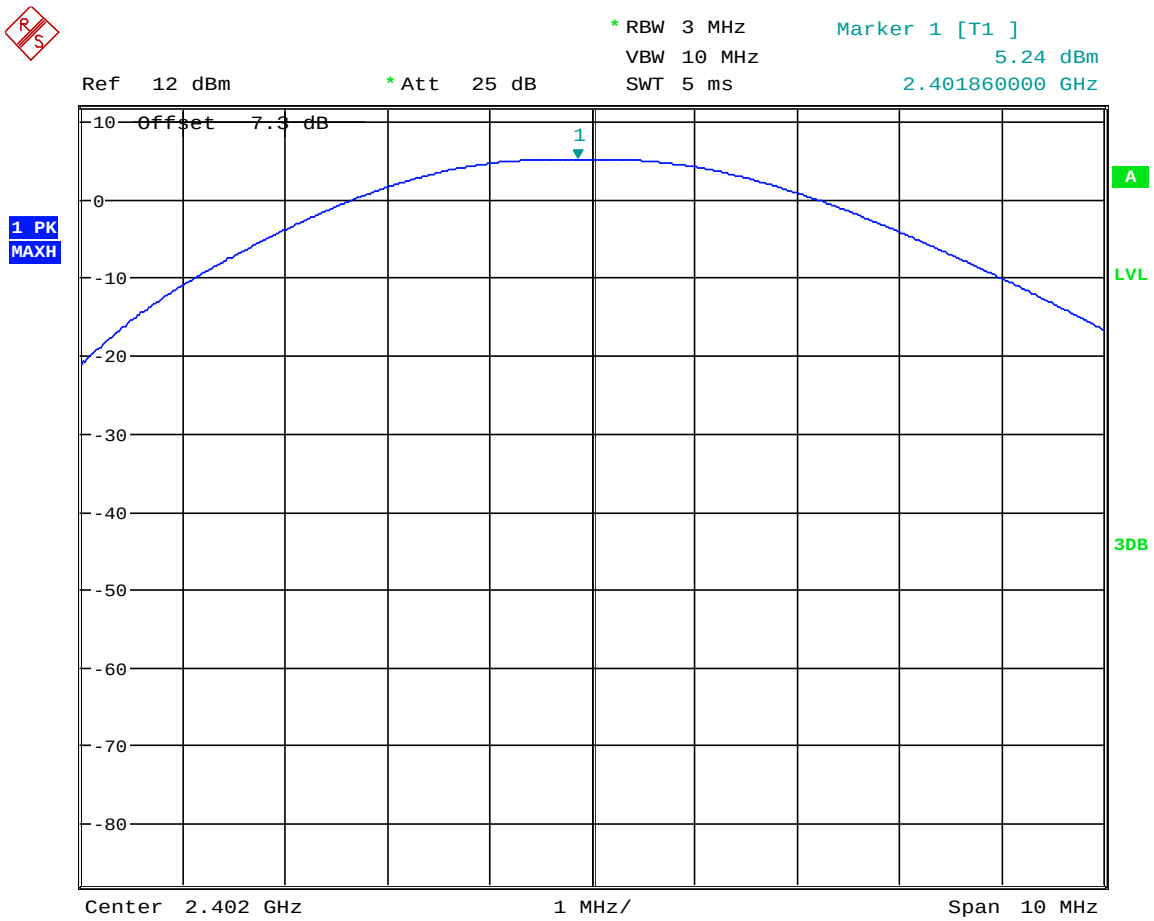
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
23.8°C	1	Op.1	5V DC	3.63 dBi

8.3.4 Measurement result:

Plot #	Frequency (MHz)	Payload	Data rate	Output Power Conducted / EIRP (dBm)	Limit (dBm)	Result
15	2402	1M	1 Mb/s	5.24 / 8.87	30 (Pk) / 36 (EIRP)	Pass
16	2440			5.15 / 8.78	30 (Pk) / 36 (EIRP)	Pass
17	2480			5.07 / 8.70	30 (Pk) / 36 (EIRP)	Pass
18	2402	2M	2 Mb/s	5.27 / 8.90	30 (Pk) / 36 (EIRP)	Pass
19	2440			5.18 / 8.81	30 (Pk) / 36 (EIRP)	Pass
20	2480			5.07 / 8.70	30 (Pk) / 36 (EIRP)	Pass

8.3.5 Measurement Plots:

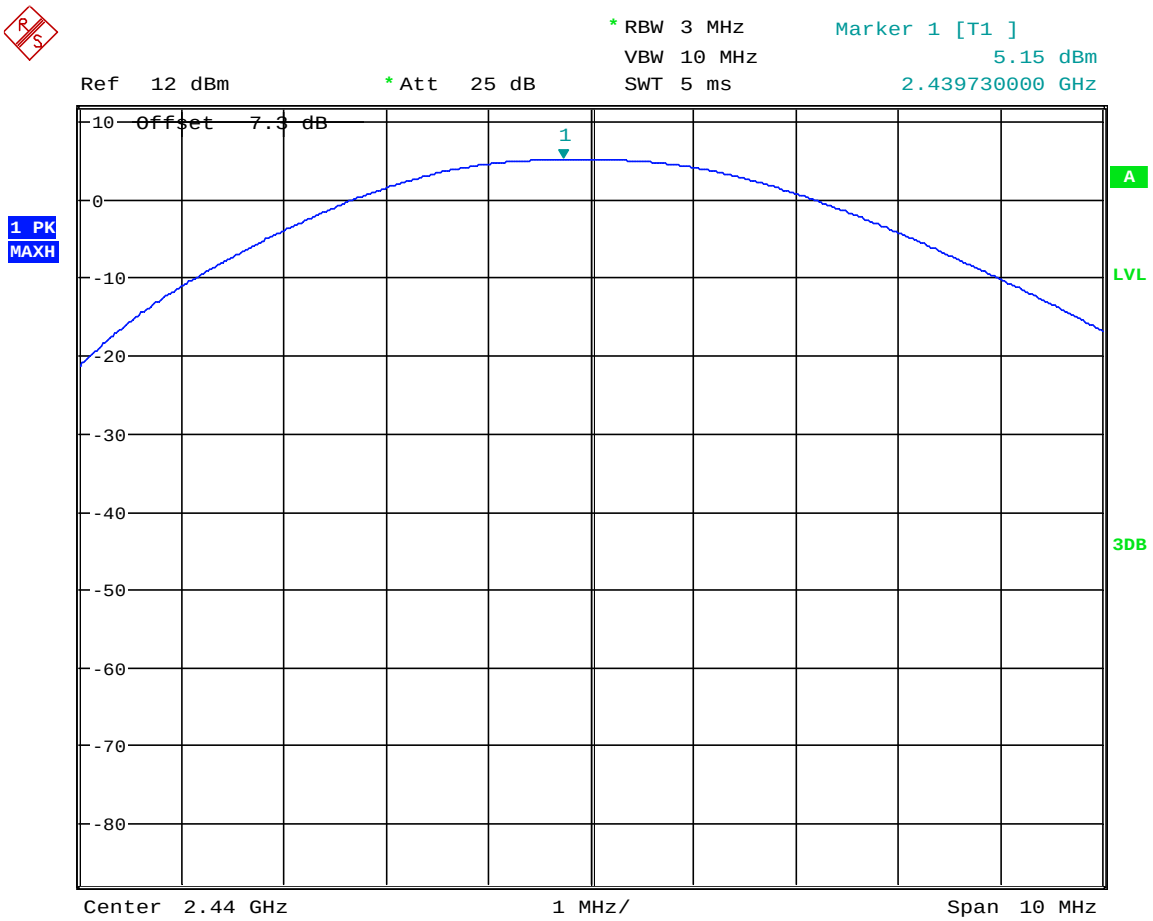
Plot # 15		
Tx Frequency: 2402 MHz	**Mode: LE 1M**	**Data rate: 1 Mb/s**



Date: 31.AUG.2022 14:42:47

Plot # 16

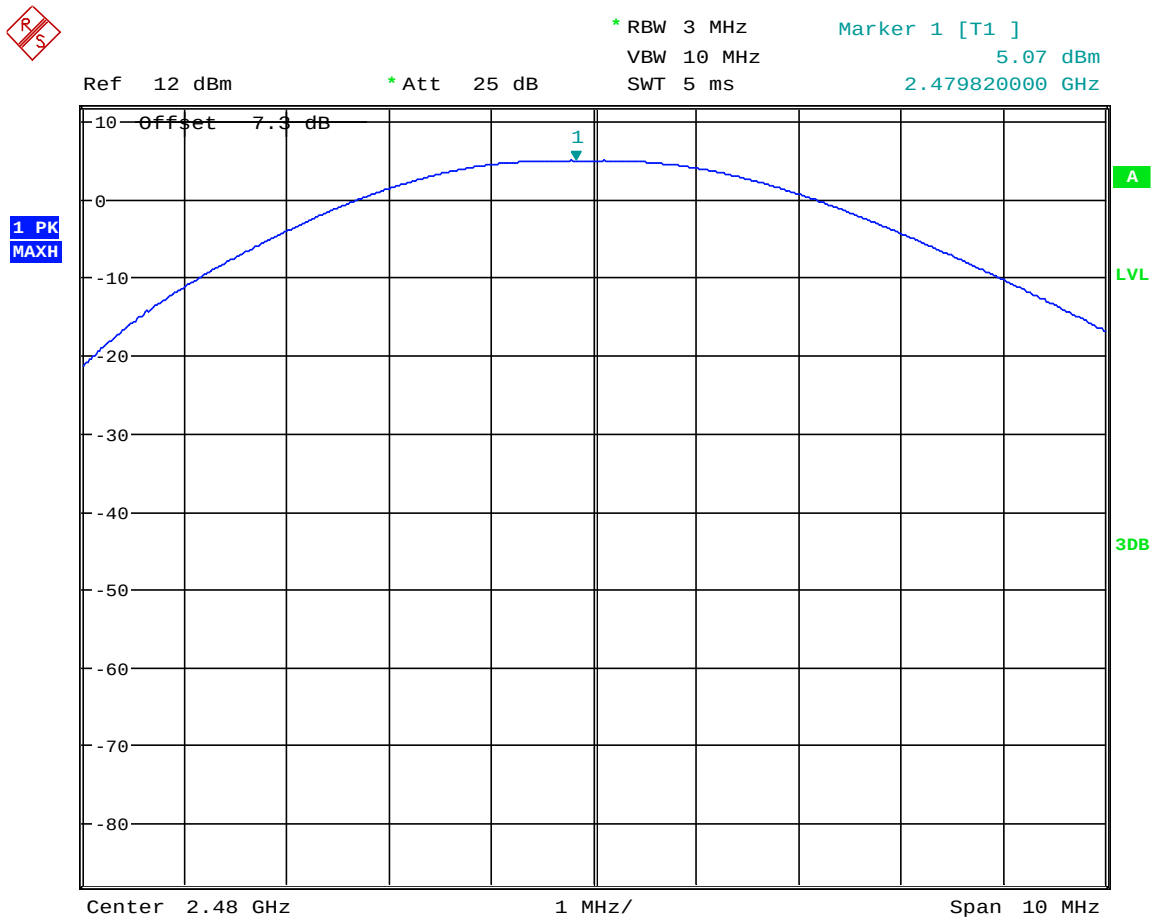
Tx Frequency: 2440 MHz	Mode: LE 1M	Data rate: 1 Mb/s



Date: 31.AUG.2022 14:39:11

Plot # 17

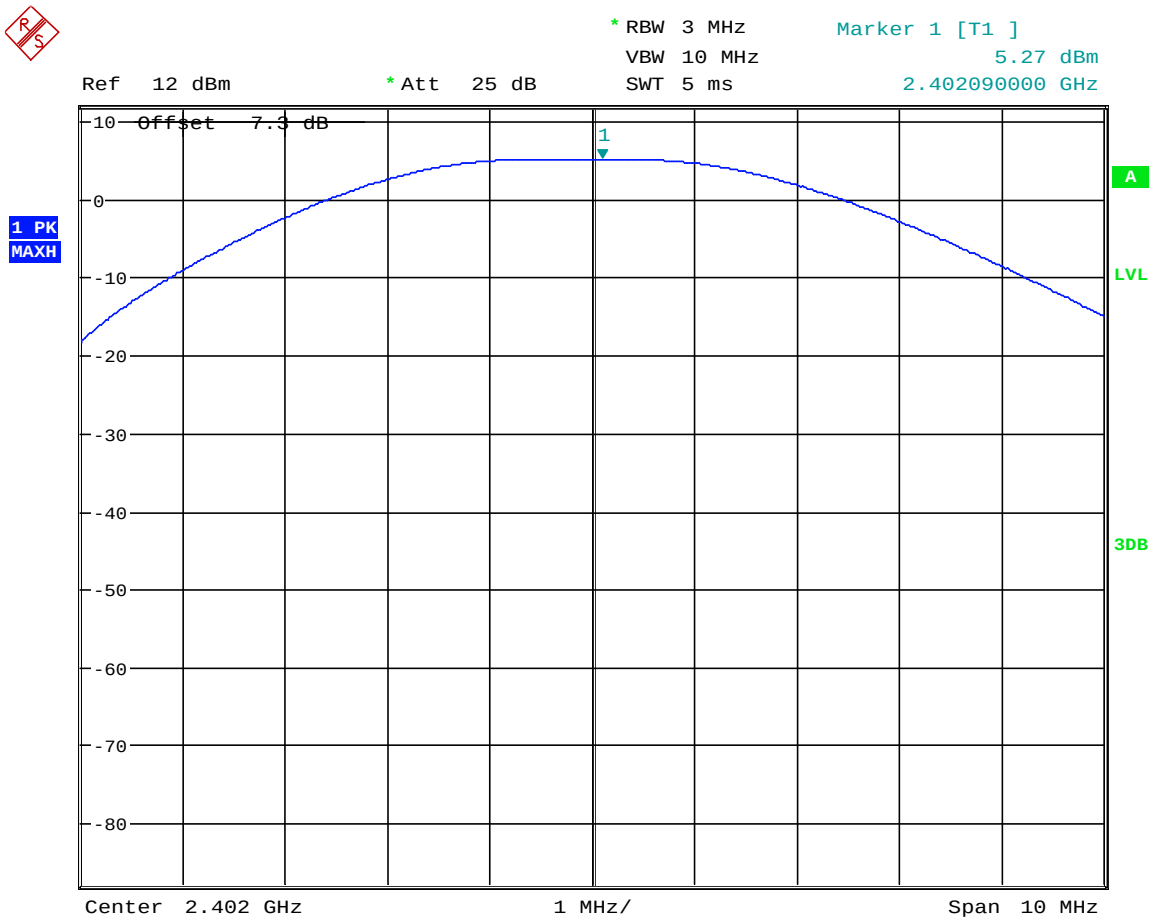
Tx Frequency: 2480 MHz	Mode: LE 1M	Data rate: 1 Mb/s



Date: 31.AUG.2022 14:37:19

Plot # 18

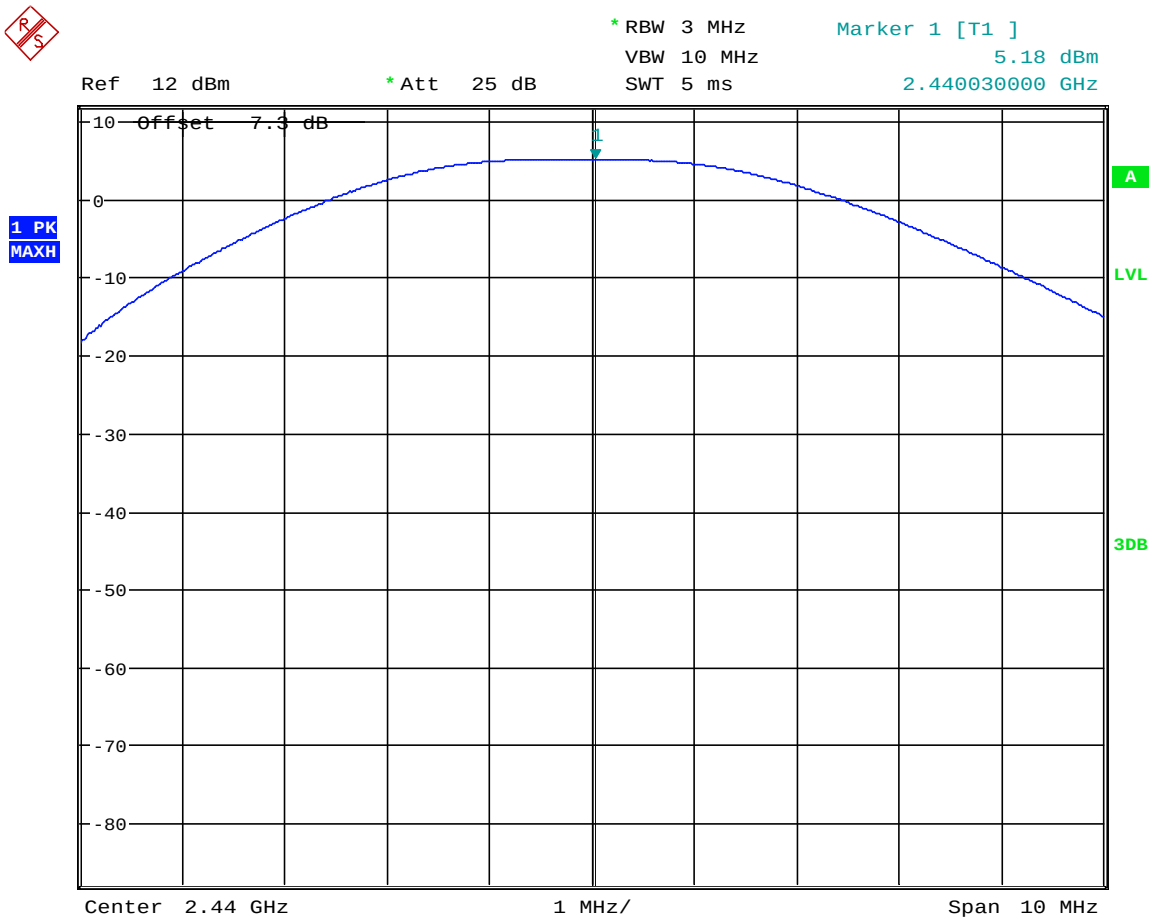
Tx Frequency: 2402 MHz	Mode: LE 2M	Data rate: 2 Mb/s



Date: 31.AUG.2022 14:41:28

Plot # 19

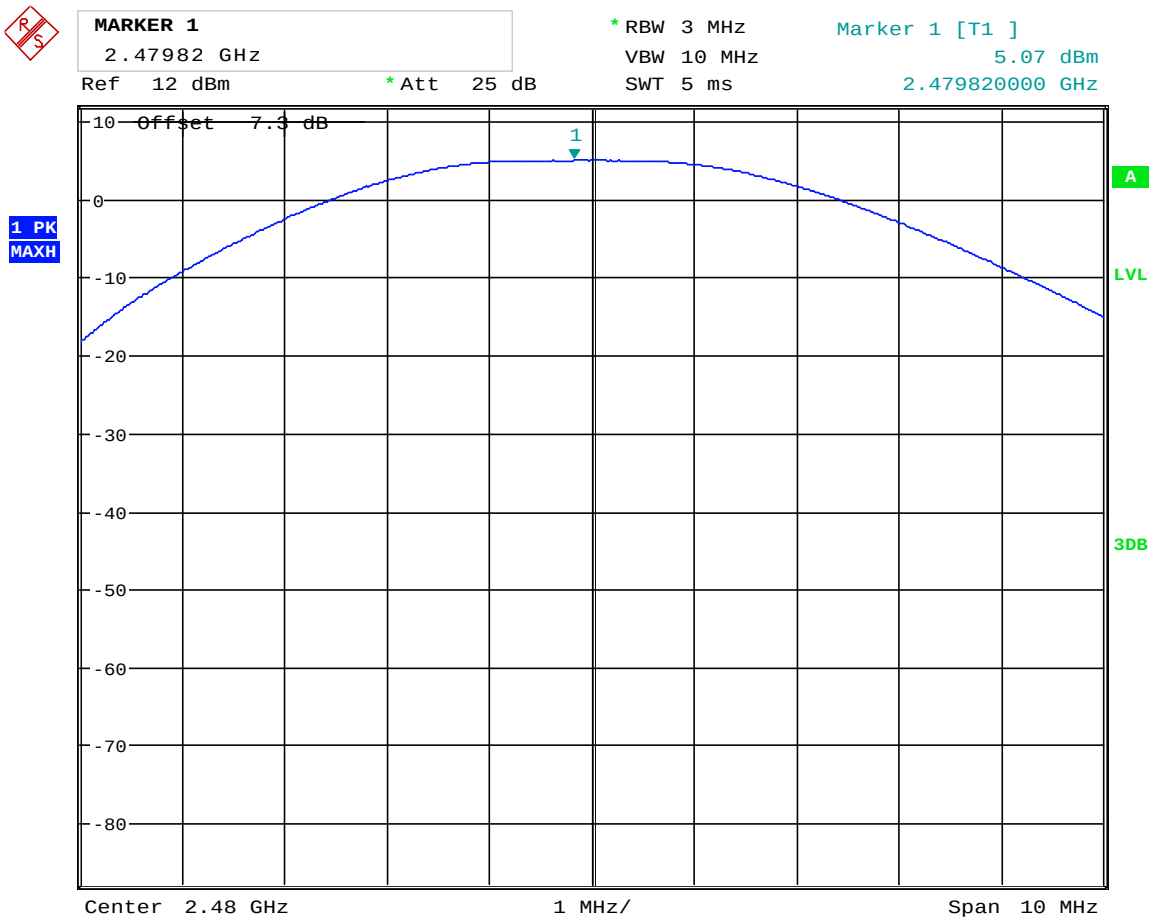
Tx Frequency: 2440 MHz	Mode: LE 2M	Data rate: 2 Mb/s



Date: 31.AUG.2022 14:40:21

Plot # 20

Tx Frequency: 2480 MHz	Mode: LE 2M	Data rate: 2 Mb/s



Date: 31.AUG.2022 14:35:29

8.4 Power Spectral Density

8.4.1 Measurement according to ANSI C63.10 clause 11.10.2

ANSI C63.10 Subclause 11.10.2 Method PKPSD (peak PSD)

The following procedure shall be used if maximum peak conducted output power was used to determine compliance, and it is optional if the maximum conducted (average) output power was used to determine compliance:

- Set analyzer center frequency to DTS channel center frequency.
- Set the span to 1.5 times the 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, then reduce RBW (but no less than 3 kHz) and repeat.

8.4.2 Limits:

FCC§15.247(e)

- 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.

8.4.3 Test conditions and setup:

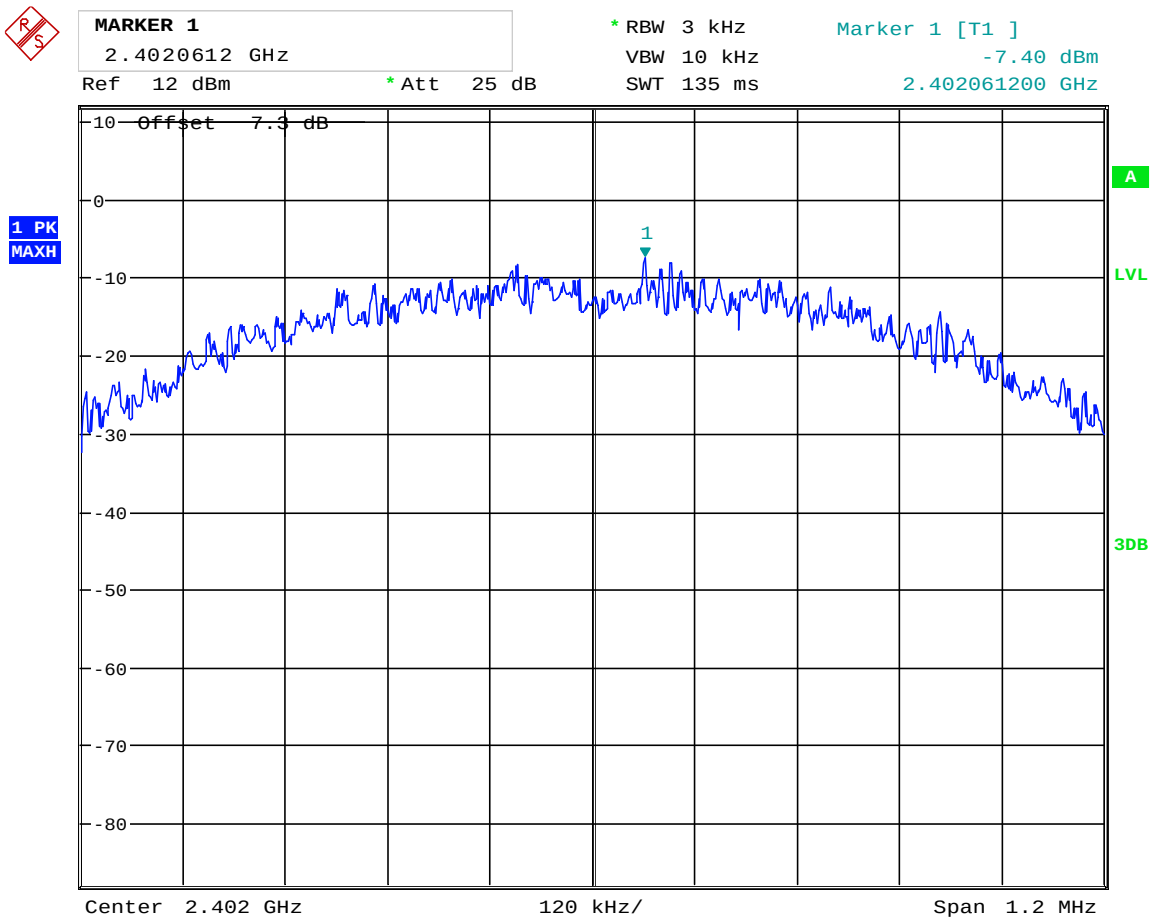
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
23.8°C	1	Op.1	5V DC	3.63 dBi

8.4.4 Measurement result:

Plot #	Frequency (MHz)	Payload	Data rate	PSD (dBm / 3 KHz)	Limit (dBm / 3 kHz)	Result
21	2402	1M	1 Mb/s	-7.40	8	Pass
22	2440			-7.55	8	Pass
23	2480			-9.02	8	Pass
24	2402	2M	2 Mb/s	-10.82	8	Pass
25	2440			-10.53	8	Pass
26	2480			-11.05	8	Pass

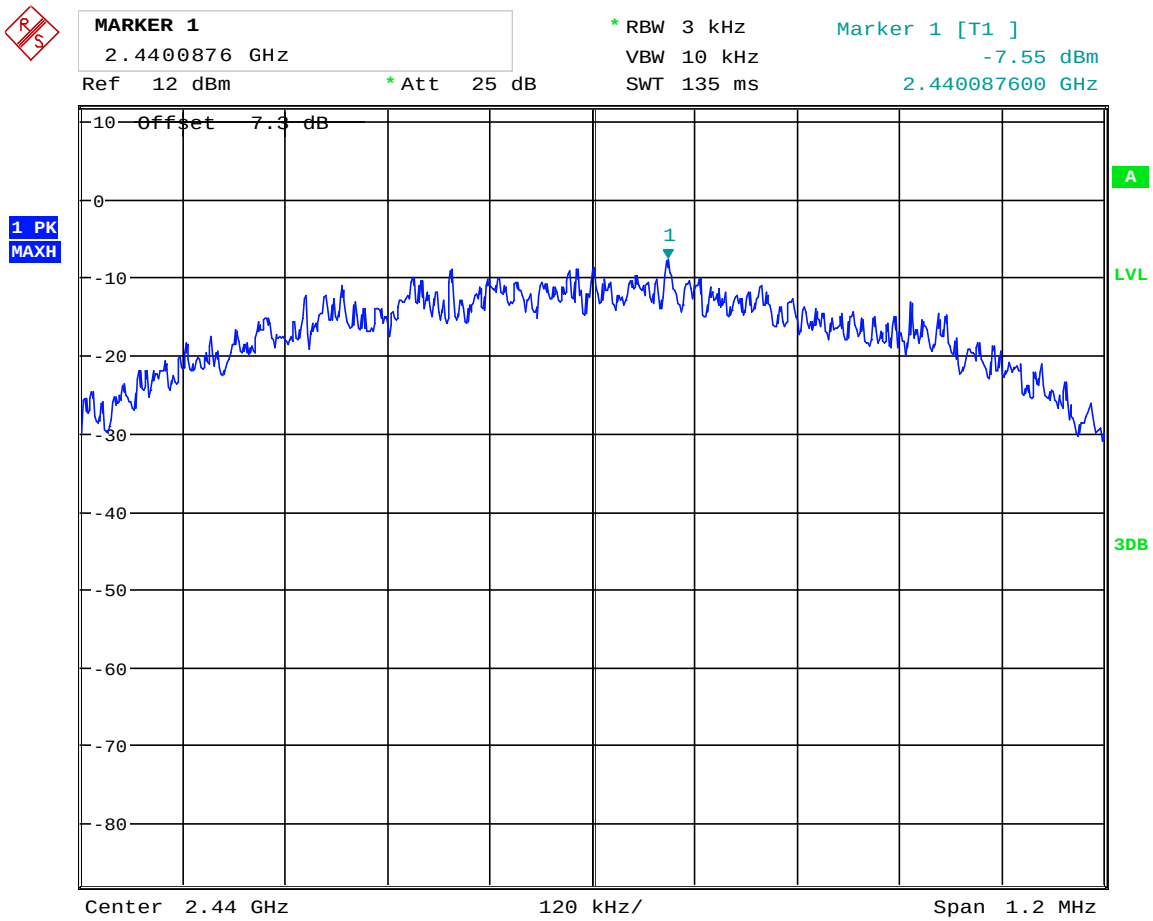
8.4.5 Measurement Plots:

Plot # 21		
Tx Frequency: 2402 MHz	**Mode: LE 1M**	**Data rate: 1 Mb/s**



Plot # 22

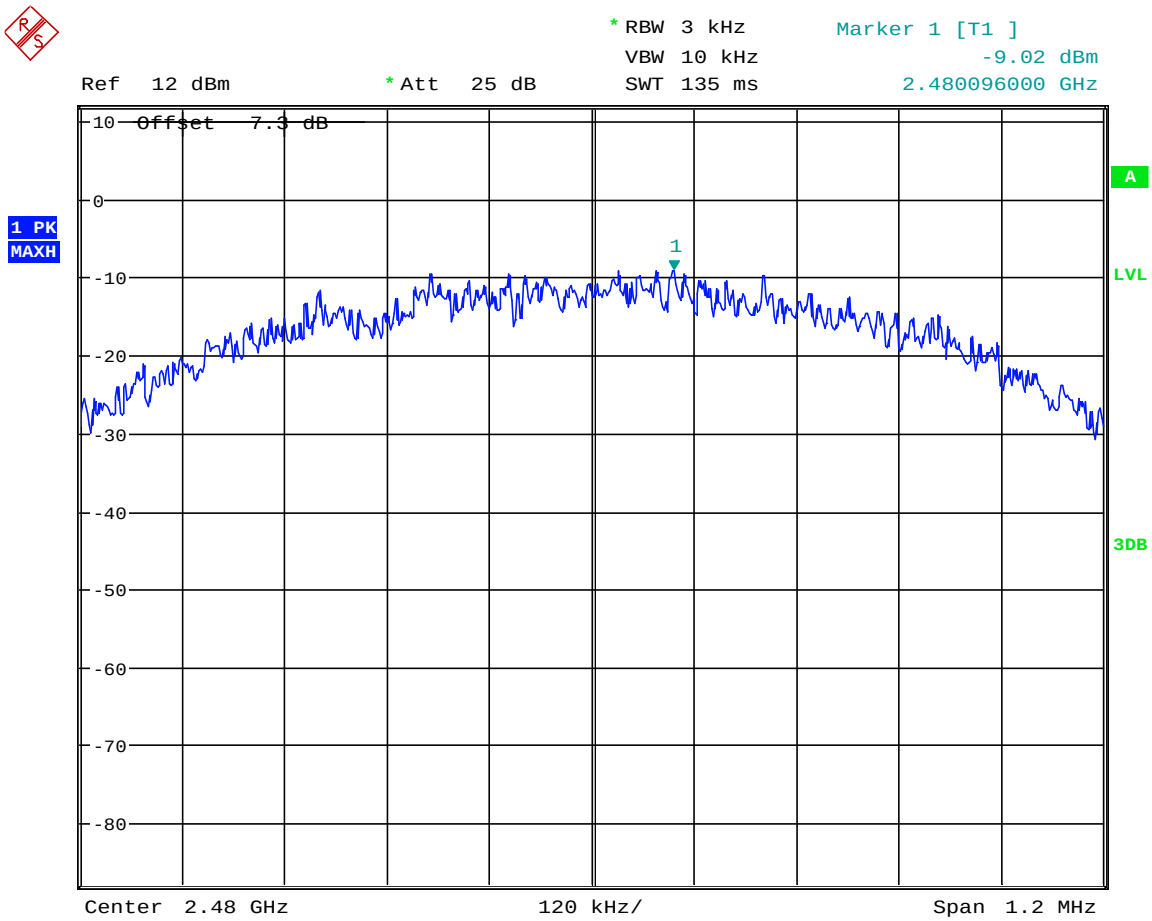
Tx Frequency: 2440 MHz	Mode: LE 1M	Data rate: 1 Mb/s



Date: 31.AUG.2022 15:09:14

Plot # 23

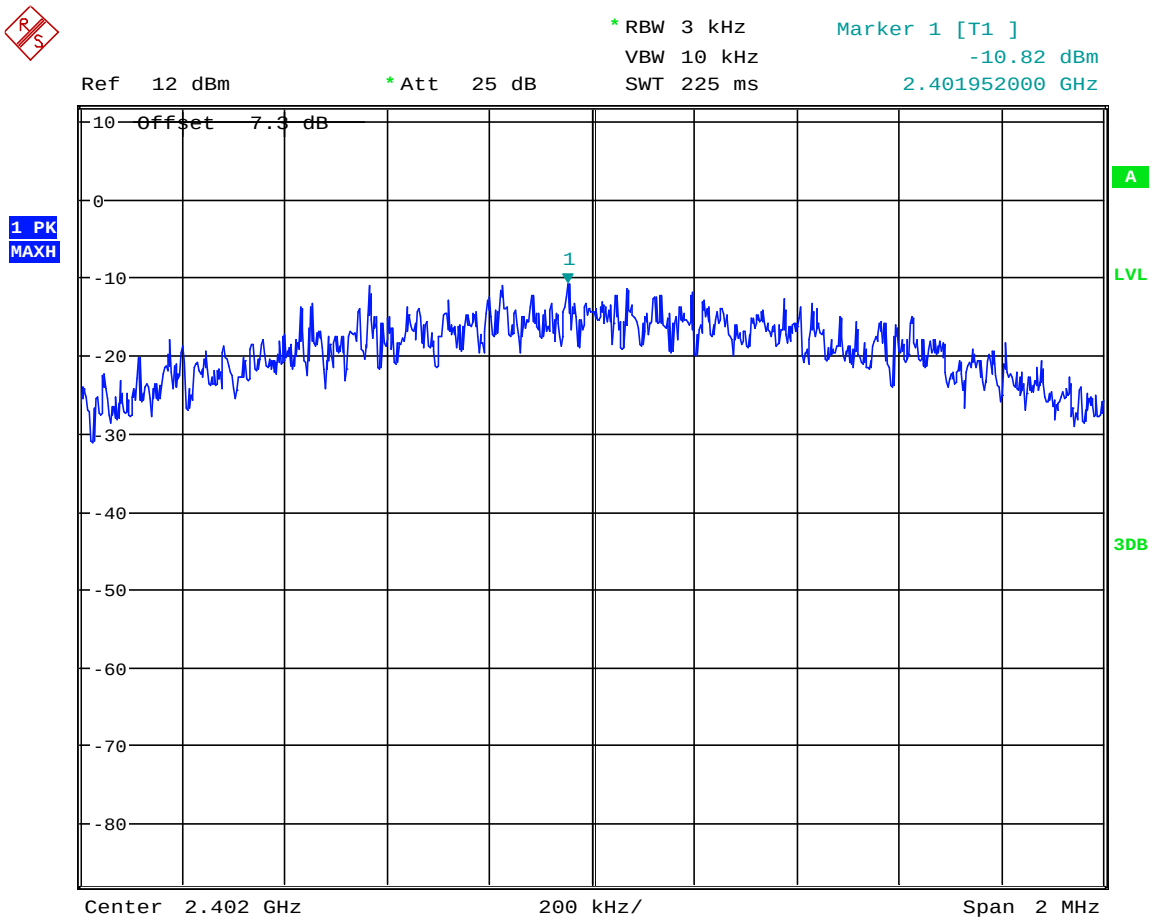
Tx Frequency: 2480 MHz	Mode: LE 1M	Data rate: 1 Mb/s



Date: 31.AUG.2022 15:12:51

Plot # 24

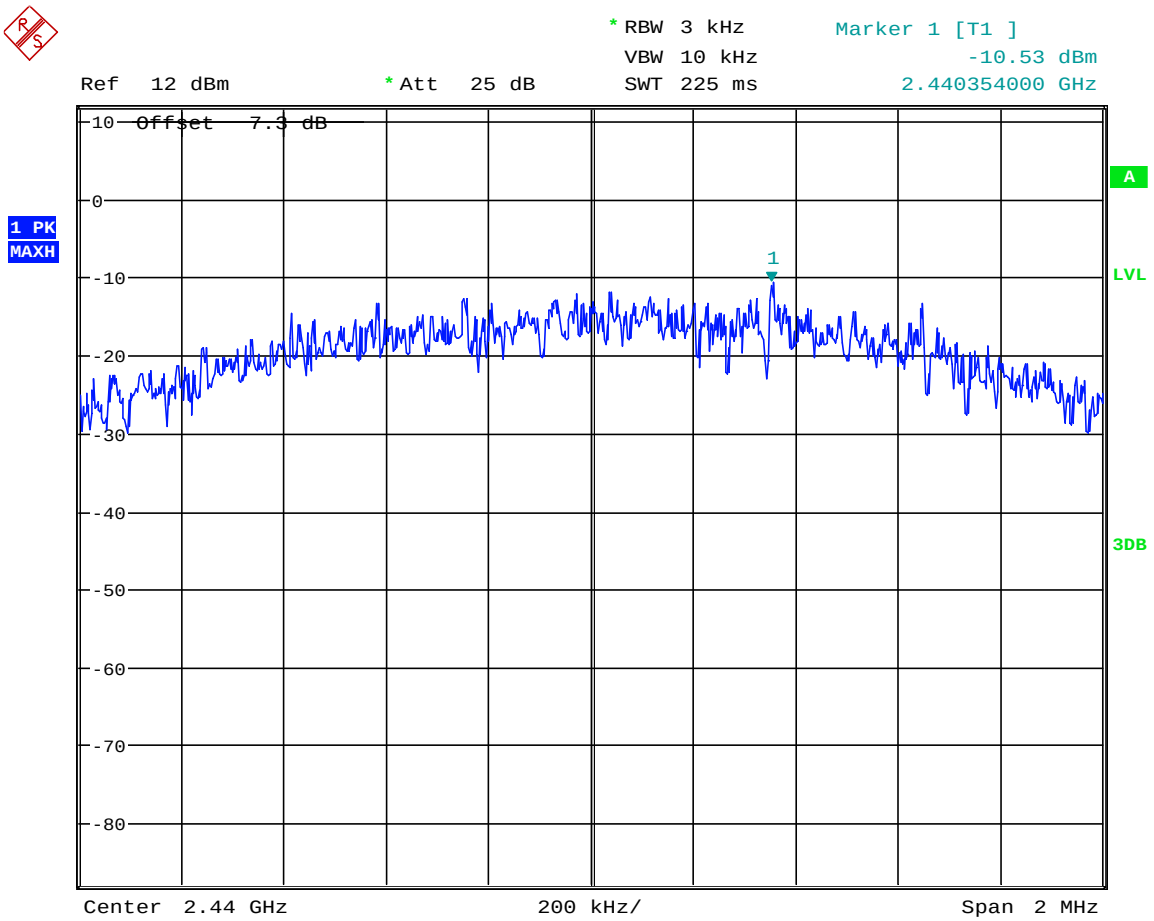
Tx Frequency: 2402 MHz	Mode: LE 2M	Data rate: 2 Mb/s



Date: 31.AUG.2022 15:19:08

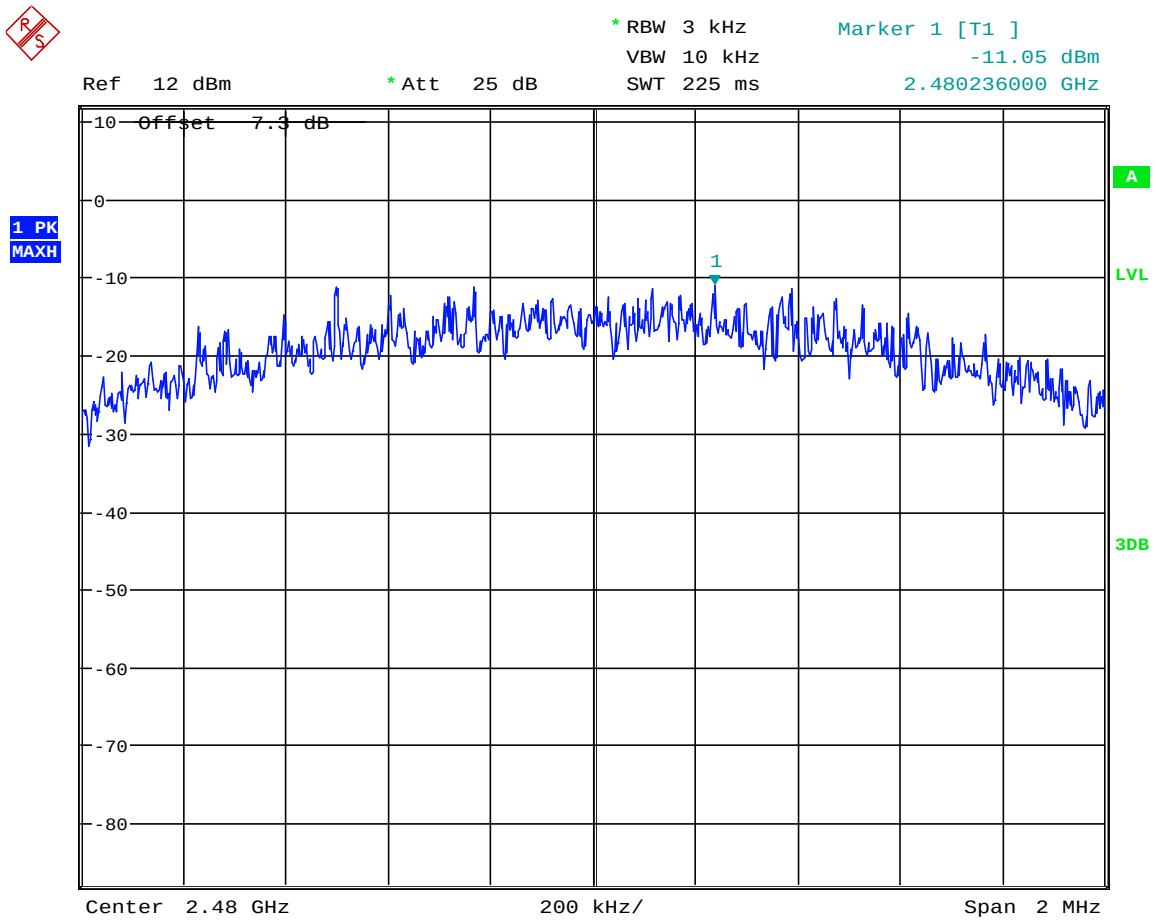
Plot # 25

Tx Frequency: 2440 MHz	Mode: LE 2M	Data rate: 2 Mbps



Plot # 26

Tx Frequency: 2480 MHz	Mode: LE 2M	Data rate: 2 Mbps



8.5 Band Edge Compliance

8.5.1 Emissions in non-restricted frequency bands

Measurement according to ANSI C63.10 clause 11.11 (Conducted)

- 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

8.5.2 Emissions in restricted frequency bands

Measurement according to ANSI C63.10 clause 11.12.1 (Radiated)

- RBW = 1 MHz
- Detector: Peak/RMS

8.5.3 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)).

8.5.4 Limits restricted band §15.247/15.209/15.205

- *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
- 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:

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			

8.5.5 Test conditions and setup:

Restricted and Non-Restricted Band

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
23.8°C	1	Op.1	5V DC	3.63 dBi

8.5.6 Measurement result:

2390 – 2400 MHz

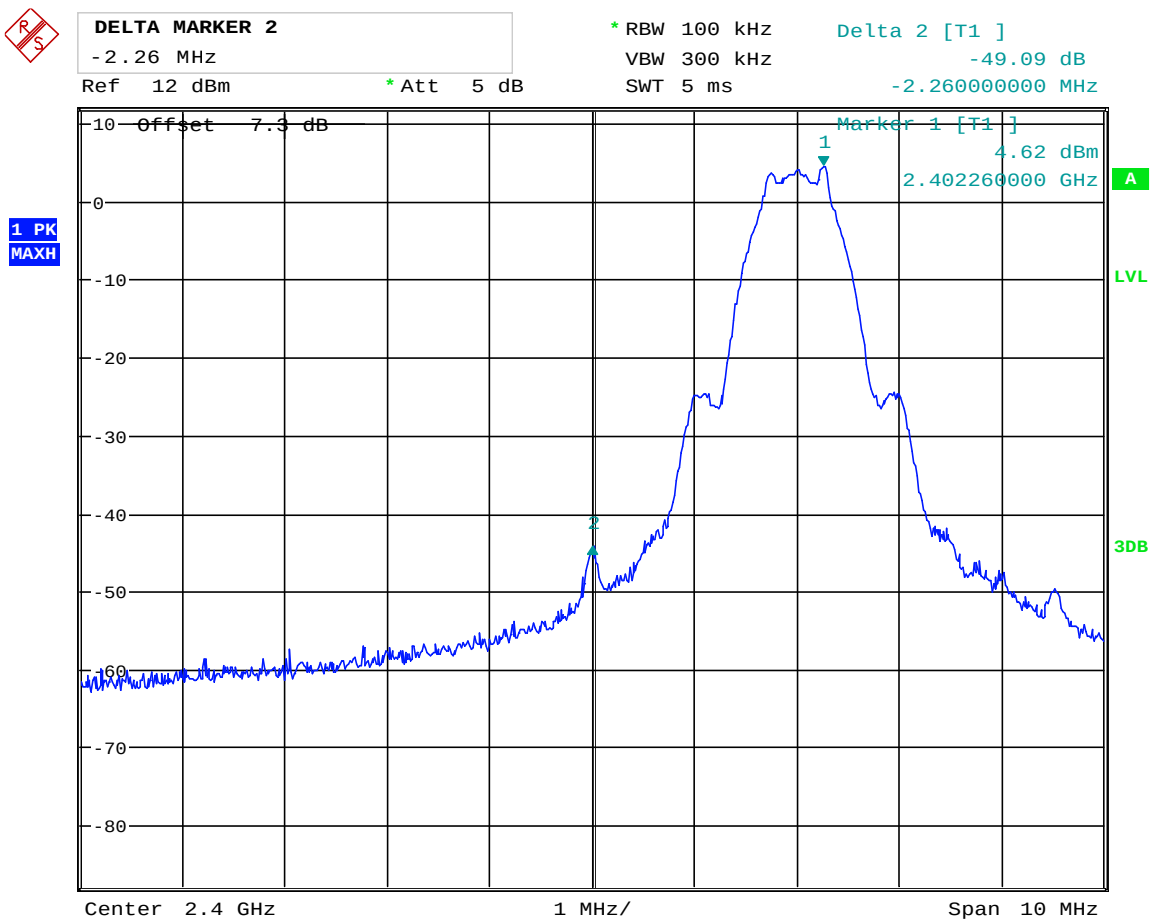
Plot #	Frequency (MHz)	Payload	Data rate	Band Edge	Band Edge Delta (dBc)	Limit (dBc)	Result
27	2402	1M	1 Mb/s	Lower, Non-restricted	-49.09	-20	Pass
28	2402	2M	2 Mb/s	Lower, Non-restricted	-30.03	-20	Pass

2483.5 – 2500 MHz

Plot #	TX Frequency (MHz)	Payload	Data rate	Band Edge	Measured Value (dBm)	Limit (dBµV/m)	Result
29	2480	2M	2 Mb/s	Upper Restricted (AVG)	40.72	54	Pass
30	2480			Upper Restricted (Peak)	54.122	74	Pass

8.5.7 Measurement Plots:

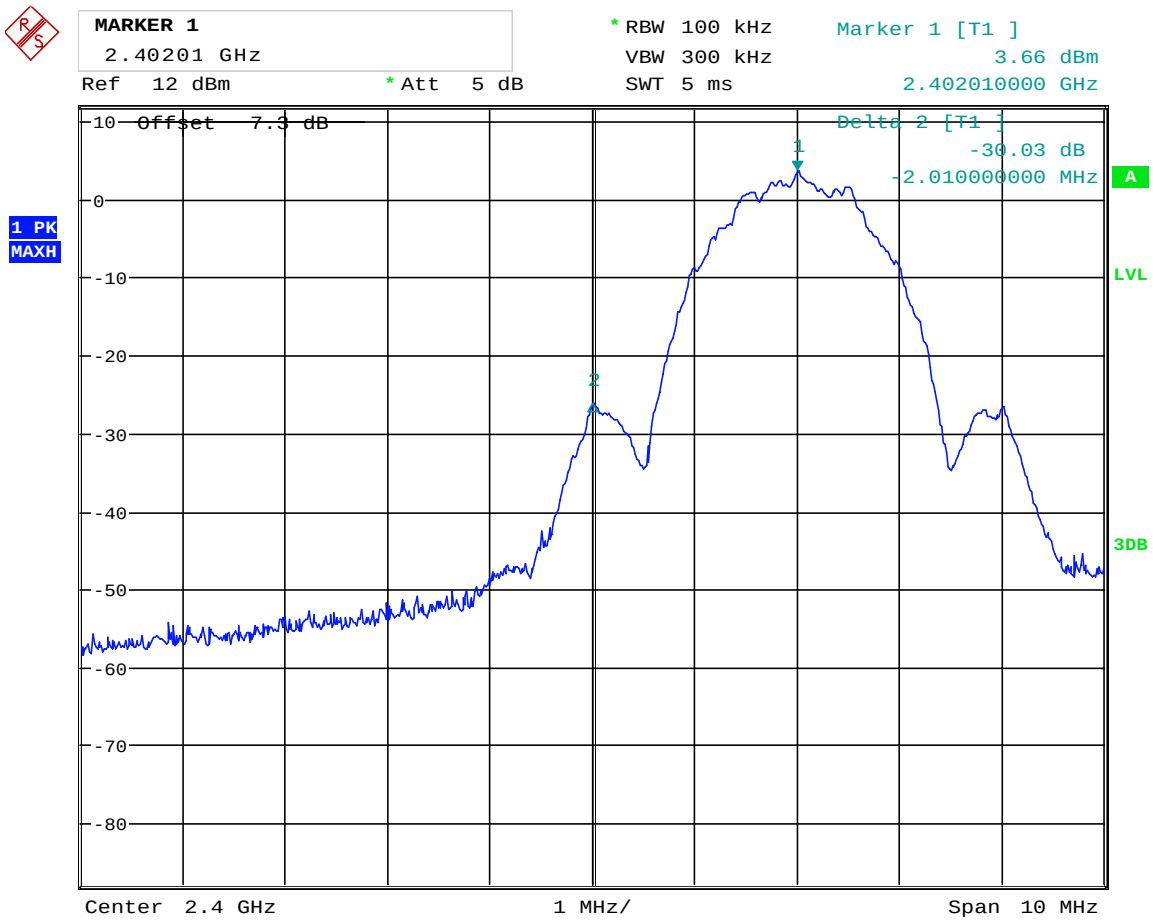
Plot # 27		
Tx Frequency: 2402 MHz	Mode: LE 1M	Data rate: 1 Mb/s



Date: 31.AUG.2022 15:50:58

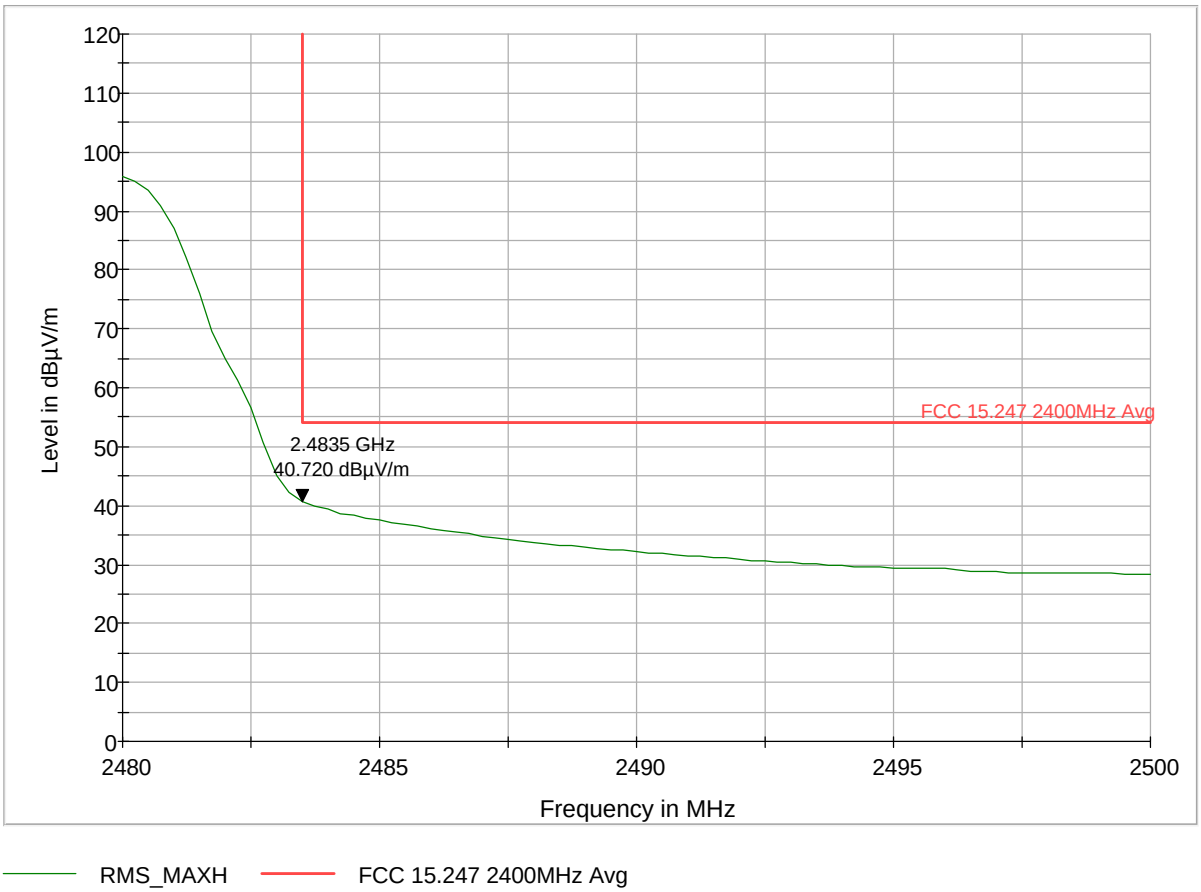
Plot # 28

Tx Frequency: 2402 MHz	Mode: LE 2M	Data rate: 2 Mb/s

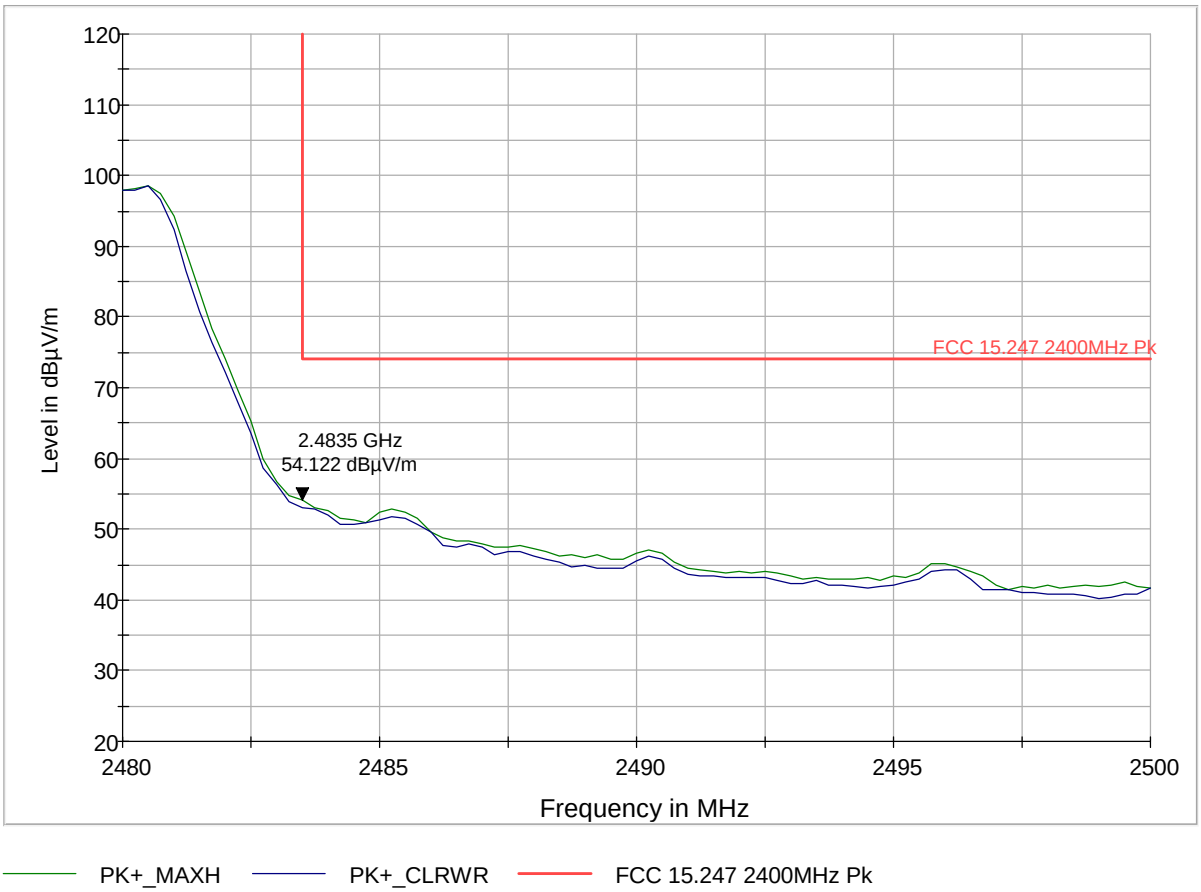


Date: 31.AUG.2022 15:47:15

Plot # 29		
Tx Frequency: 2480 MHz	**Mode: LE 2M**	**Data rate: 2 Mb/s**



Plot # 30		
Tx Frequency: 2480 MHz	**Mode: LE 2M**	**Data rate: 2 Mb/s**



8.6 Frequency Stability

8.6.1 Measurement according to FCC: CFR 47 Part 2.1055 and ANSI C63.10-2013 6.8

Frequency stability with respect to ambient temperature

a) Supply the EUT with a nominal ac voltage or install a new or fully charged battery in the EUT.

If possible, a dummy load shall be connected to the EUT because an antenna near the metallic walls of an environmental test chamber could affect the output frequency of the EUT. If the EUT is equipped with a permanently attached, adjustable-length antenna, then the EUT shall be placed in the center of the chamber with the antenna adjusted to the shortest length possible.

Turn ON the EUT and tune it to one of the number of frequencies shown in 5.6.

b) Couple the unlicensed wireless device output to the measuring instrument by connecting an antenna to the measuring instrument with a suitable length of coaxial cable and placing the measuring antenna near the EUT (e.g., 15 cm away), or by connecting a dummy load to the measuring instrument, through an attenuator if necessary.

NOTE – An instrument that has an adequate level of accuracy as specified by the procuring or regulatory agency is the recommended measuring instrument.

c) Adjust the location of the measurement antenna and the controls on the measurement instrument to obtain a suitable signal level (i.e., a level that will not overload the measurement instrument but is strong enough to allow measurement of the operating or fundamental frequency of the EUT).

d) Turn the EUT OFF and place it inside the environmental temperature chamber. For devices that have oscillator heaters, energize only the heater circuit.

e) Set the temperature control on the chamber to the highest specified in the regulatory requirements for the type of device and allow the oscillator heater and the chamber temperature to stabilize.

f) While maintaining a constant temperature inside the environmental chamber, turn the EUT ON and record the operating frequency at startup, and at 2 minutes, 5 minutes, and 10 minutes after the EUT is energized. Four measurements in total are made.

g) Measure the frequency at each of frequencies specified in 5.6.

h) Switch OFF the EUT but do not switch OFF the oscillator heater.

i) Lower the chamber temperature by not more than 10 °C, and allow the temperature inside the chamber to stabilize.

j) Repeat step f) through step i) down to the lowest specified temperature.

Spectrum Analyzer settings

- RBW =200 kHz
- VBW ≥ 1 MHz
- Set span = 10 MHz
- Sweep time = auto couple
- Detector = Pk
- Trace mode = MaxHold
- Use N dB Down function to set the low and high frequency.

8.6.2 Test conditions and setup:

EUT Set-Up #	EUT operating mode	Power Input (V DC)
1	Op. 1	5V DC

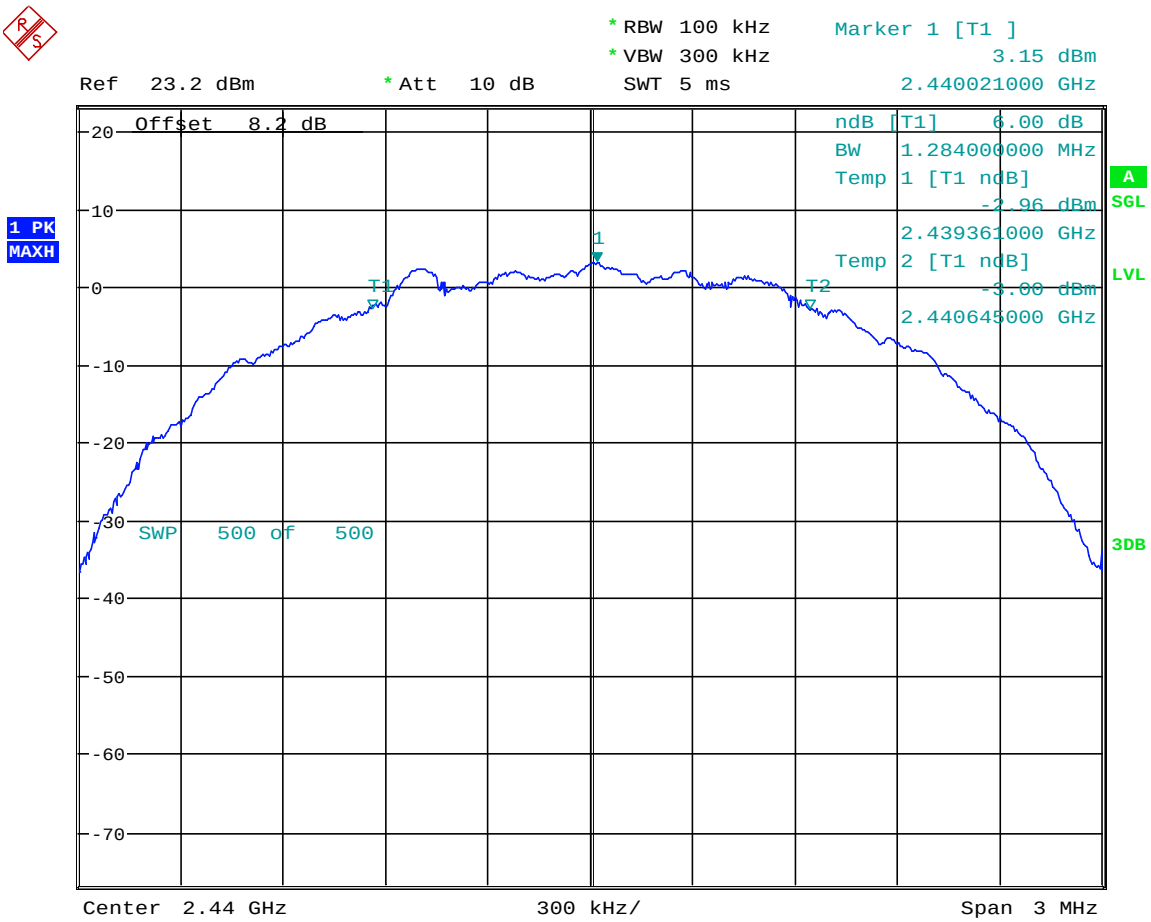
8.6.3 Measurement result:

*1 RCF: Reference Center Frequency measured in normal environment conditions 23° C
*2 F low: Low frequency; -6 dB
*3 F high: High frequency; +6 dB
*4 CCF: Calculated Center Frequency; CCF = F low + (F high – F low)/2
*5 PPM: [(CCF/RCF)-1] * 10^6

Plot #	RCF *1 (MHz)	Temperature (°C)	Measurement Time (Minutes)	F Low *2 (MHz)	F High *3 (MHz)	CCF *4 (MHz)	PPM *5 (+-)100
33	-	23	-	2439.361	2440.645	2440.003	-
34	2440.003	50	0	2439.295	2440.567	2439.931	-29.508
			2	2439.421	2440.585	2440.003	0.000
			5	2439.292	2440.570	2439.931	-29.508
			10	2439.292	2440.570	2439.931	-29.508
35	2440.003	40	0	2439.361	2440.633	2439.997	-2.459
			2	2439.400	2440.636	2440.018	6.148
			5	2439.379	2440.633	2440.006	1.230
			10	2439.361	2440.636	2439.999	-1.844
36	2440.003	30	0	2439.355	2440.618	2439.987	-6.762
			2	2439.355	2440.624	2439.990	-5.533
			5	2439.370	2440.621	2439.996	-3.074
			10	2439.364	2440.621	2439.993	-4.303
37	2440.003	20	0	2439.406	2440.663	2440.035	12.910
			2	2439.346	2440.591	2439.969	-14.139
			5	2439.409	2440.609	2440.009	2.459
			10	2439.367	2440.645	2440.006	1.230
38	2440.003	10	0	2439.346	2440.609	2439.9775	-10.451
			2	2439.376	2440.63	2440.003	0.000
			5	2439.346	2440.648	2439.997	-2.459
			10	2439.358	2440.603	2439.981	-9.221
39	2440.003	0	0	2439.406	2440.618	2440.012	3.689
			2	2439.3418	2440.618	2439.9799	-9.467
			5	2439.344	2440.627	2439.985	-7.193
			10	2439.342	2440.621	2439.982	-8.729

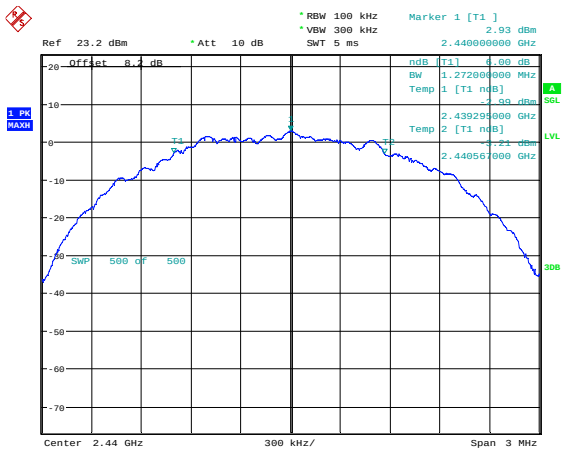
8.6.4 Measurement plots:

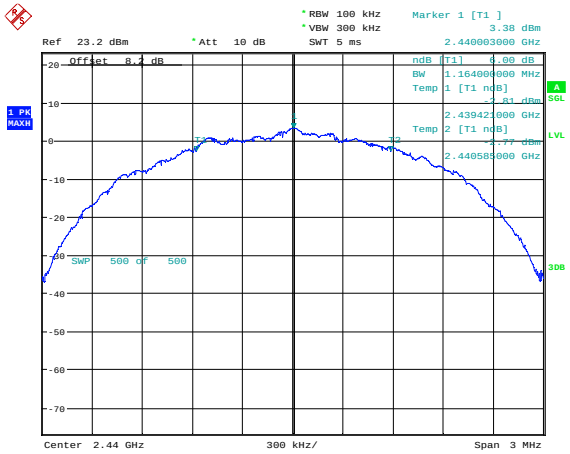
Plot #31		
2440 MHz	Reference Measurement	Temperature: 23°C



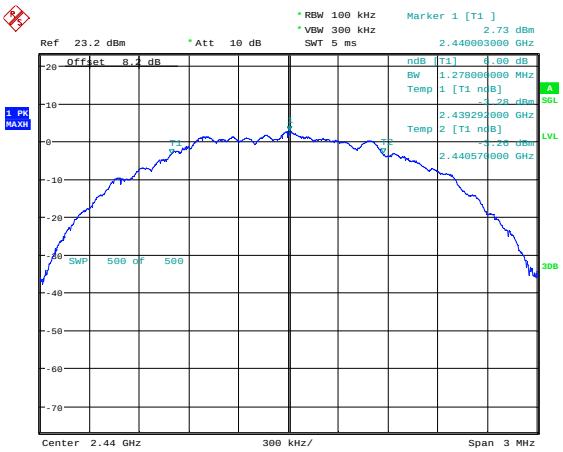
Plot #32

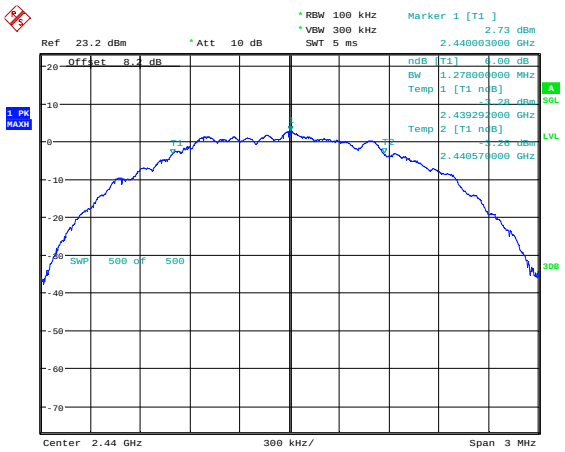
2440 MHz	Measurement time: 0 min	Temperature: 50°C	2440 MHz	Measurement time: 2 min	Temperature: 50°C





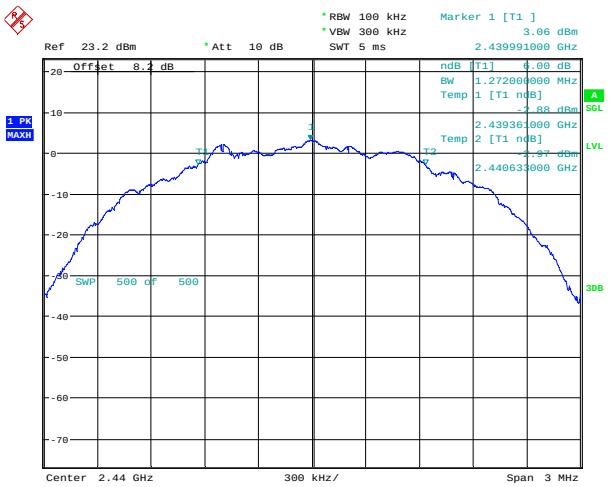
2440 MHz	Measurement time: 5 min	Temperature: 50°C	2440 MHz	Measurement time: 10 min	Temperature: 50°C

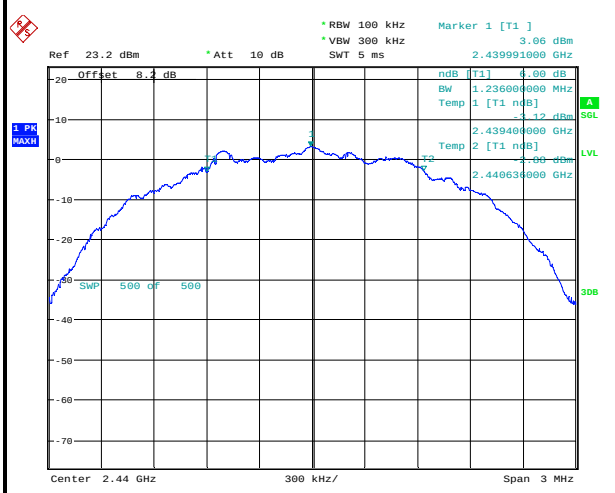




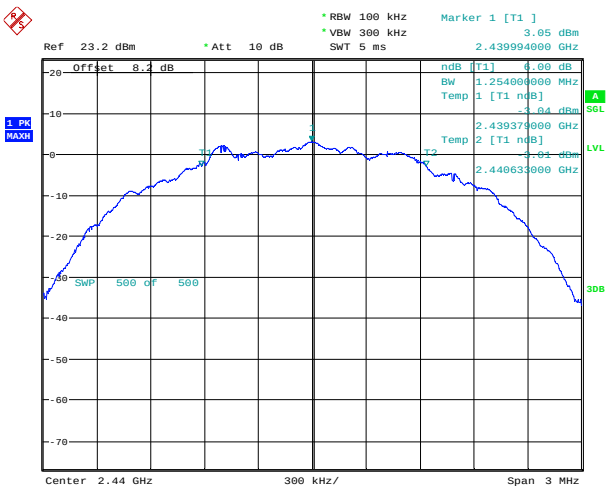
Plot #33

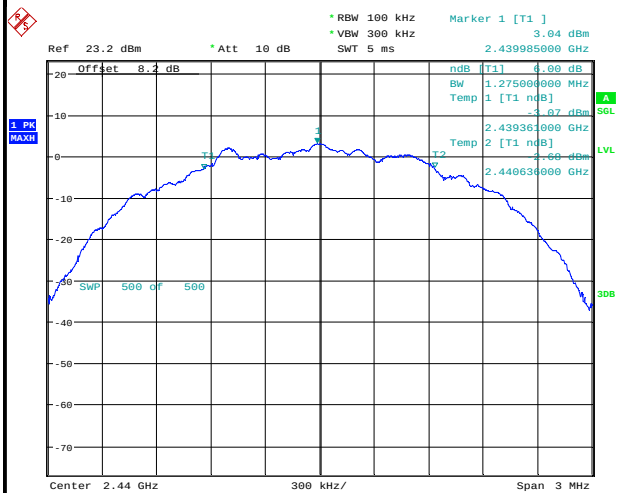
2440 MHz	Measurement time: 0 min	Temperature: 40°C	2440 MHz	Measurement time: 2 min	Temperature: 40°C





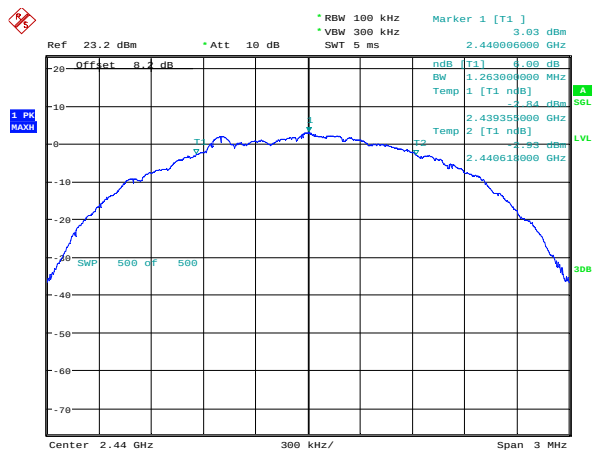
2440 MHz	Measurement time: 5 min	Temperature: 40°C	2440 MHz	Measurement time: 10 min	Temperature: 40°C

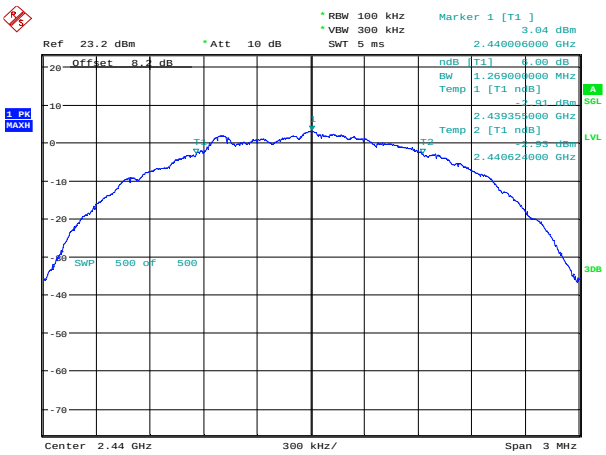




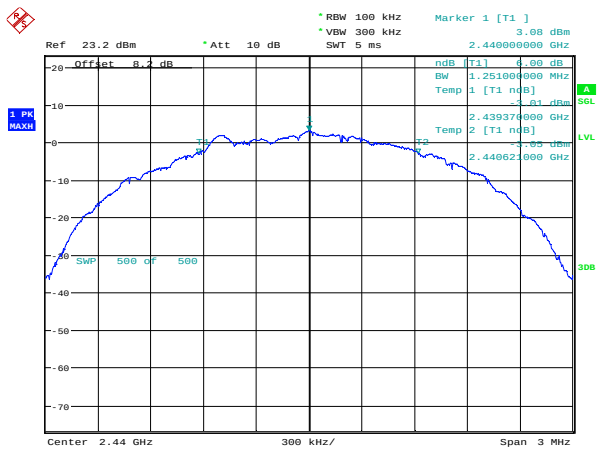
Plot #34

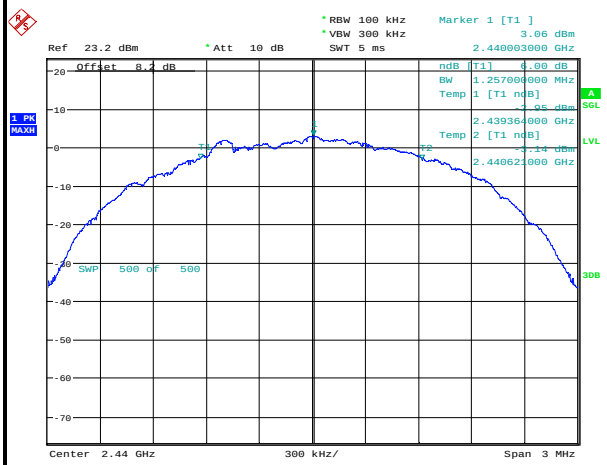
2440 MHz	Measurement time: 0 min	Temperature: 30°C	2440 MHz	Measurement time: 2 min	Temperature: 30°C





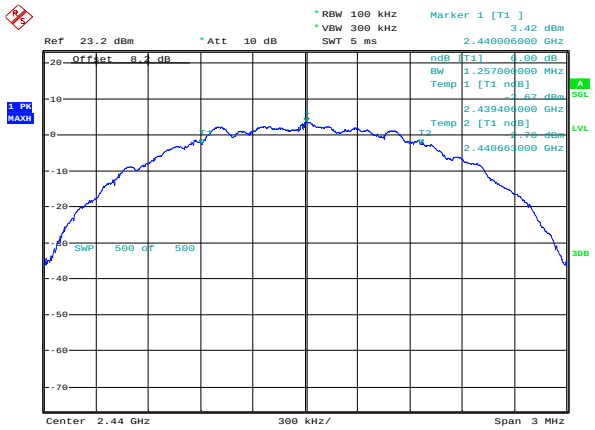
2440 MHz	Measurement time: 5 min	Temperature: 30°C	2440 MHz	Measurement time: 10 min	Temperature: 30°C

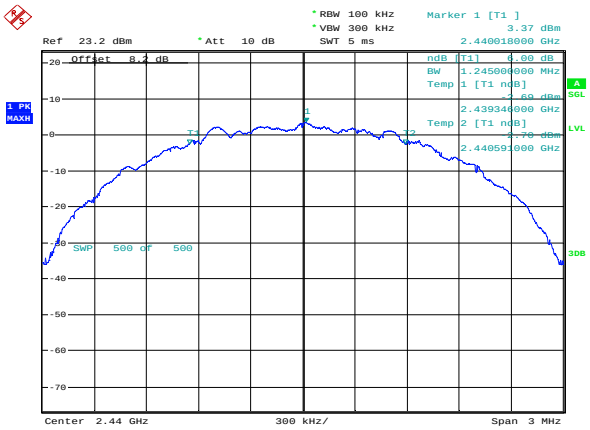




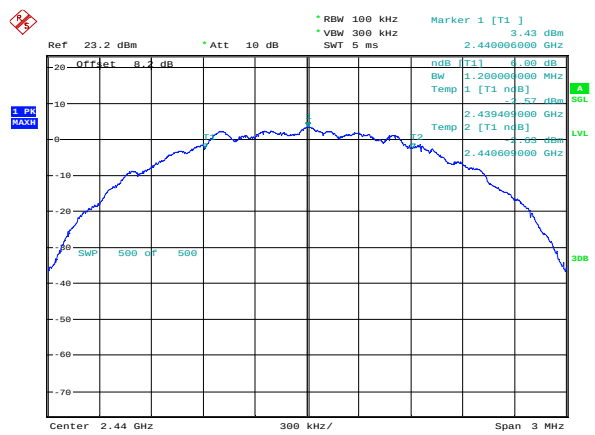
Plot #35

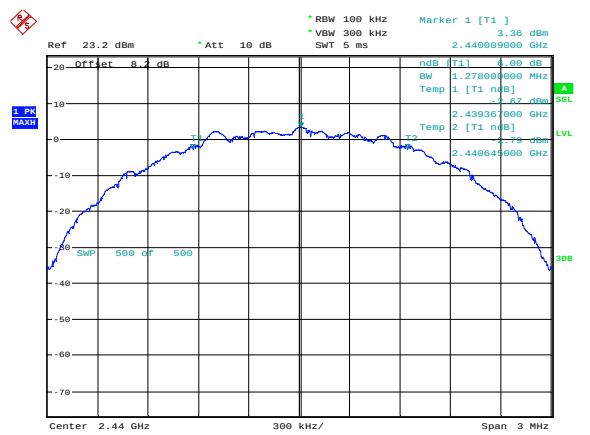
2440 MHz	Measurement time: 0 min	Temperature: 20°C	2440 MHz	Measurement time: 2 min	Temperature: 20°C





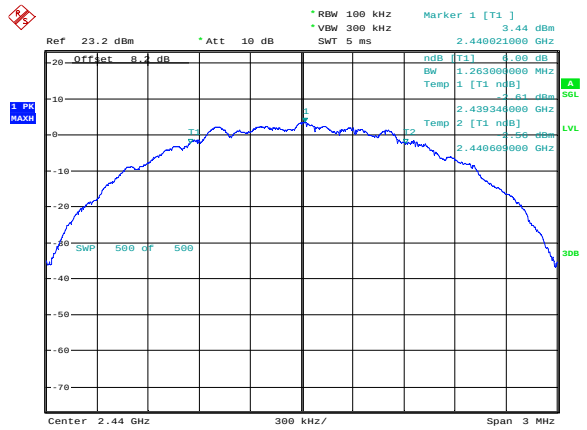
2440 MHz	Measurement time: 5 min	Temperature: 20°C	2440 MHz	Measurement time: 10 min	Temperature: 20°C

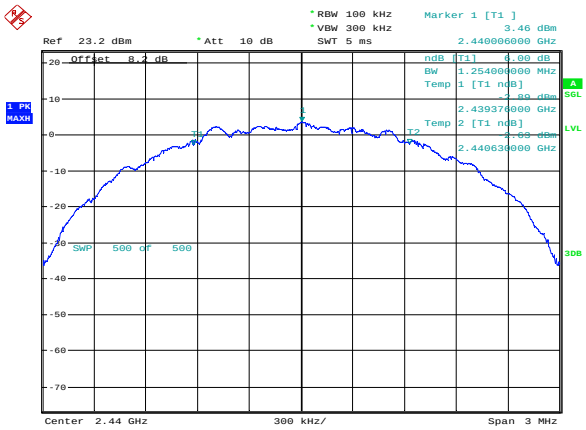




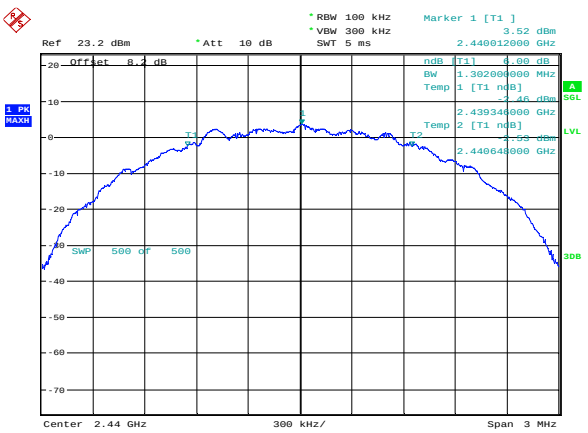
Plot #36

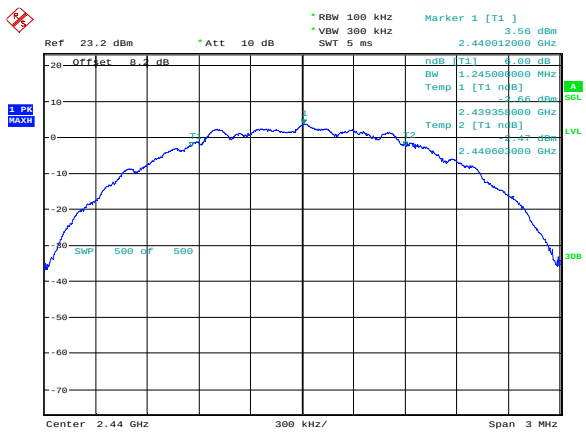
2440 MHz	Measurement time: 0 min	Temperature: 10°C	2440 MHz	Measurement time: 2 min	Temperature: 10°C





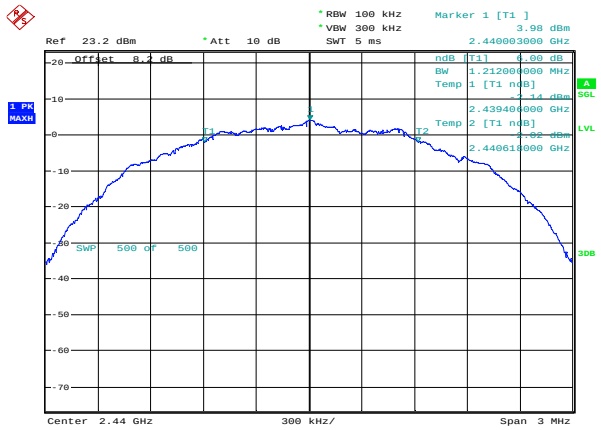
2440 MHz	Measurement time: 5 min	Temperature: 10°C	2440 MHz	Measurement time: 10 min	Temperature: 10°C

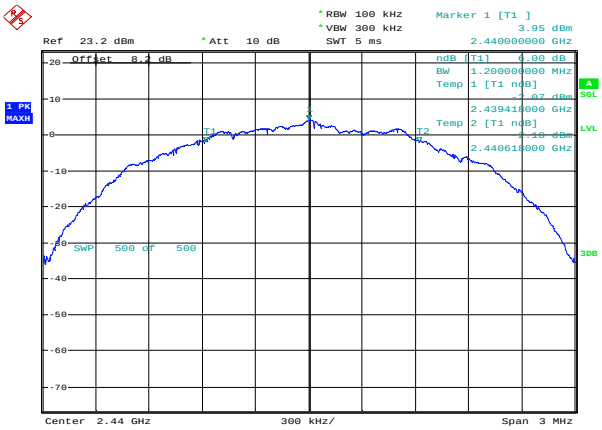




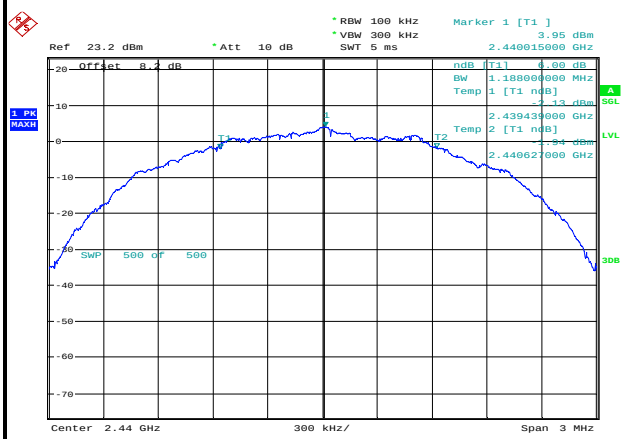
Plot #37

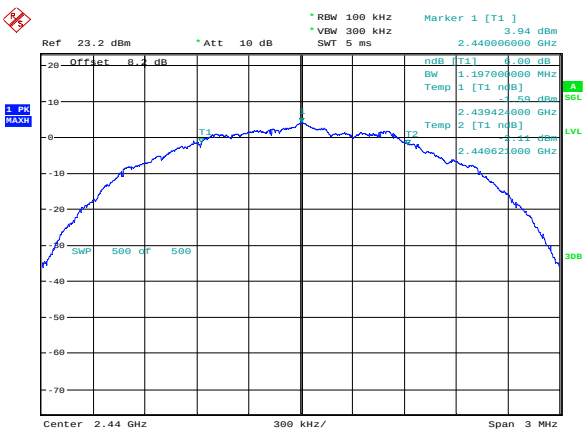
2440 MHz	Measurement time: 0 min	Temperature: 0°C	2440 MHz	Measurement time: 2 min	Temperature: 0°C





2440 MHz	Measurement time: 5 min	Temperature: 0°C	2440 MHz	Measurement time: 10 min	Temperature: 0°C





8.7 Radiated Transmitter Spurious Emissions and Restricted Bands

8.7.1 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

8.7.2 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

- 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

- 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

8.7.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23.8°C	2	Op.2	5V DC

8.7.4 Measurement result:

Plot #	Channel #	Scan Frequency	Lowest margin emission (dBµV/m) @3m	Limit	Result
40 – 42	Low	30 MHz – 18 GHz	47.32	See section 8.7.2	Pass
43 – 47	Mid	9 kHz – 26 GHz	47.15	See section 8.7.2	Pass
48 – 50	High	30 MHz – 18 GHz	46.31	See section 8.7.2	Pass

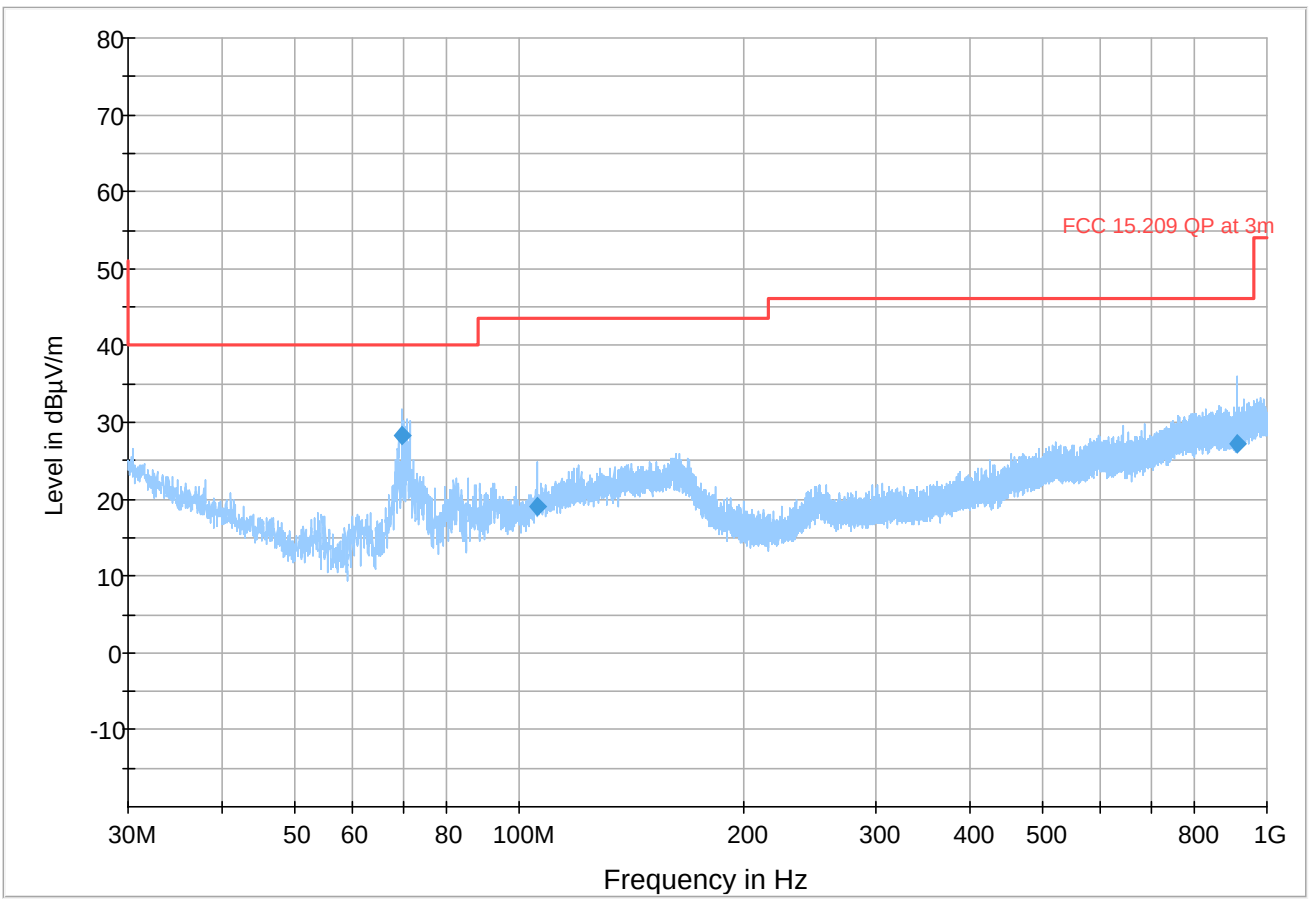
8.7.5 Measurement Plots:

Plot # 38 Radiated Emissions: 30 MHz – 1 GHz

Tx Frequency: 2402 MHz	Mode: LE 2M	Data rate: 2 Mb/s

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
69.67	28.23	40.00	11.77	500.0	120.0	100.0	V	-2.0	13.3
105.66	19.14	43.50	24.36	500.0	120.0	107.0	V	11.0	21.9
912.82	27.31	46.02	18.71	500.0	120.0	264.0	V	215.0	31.6

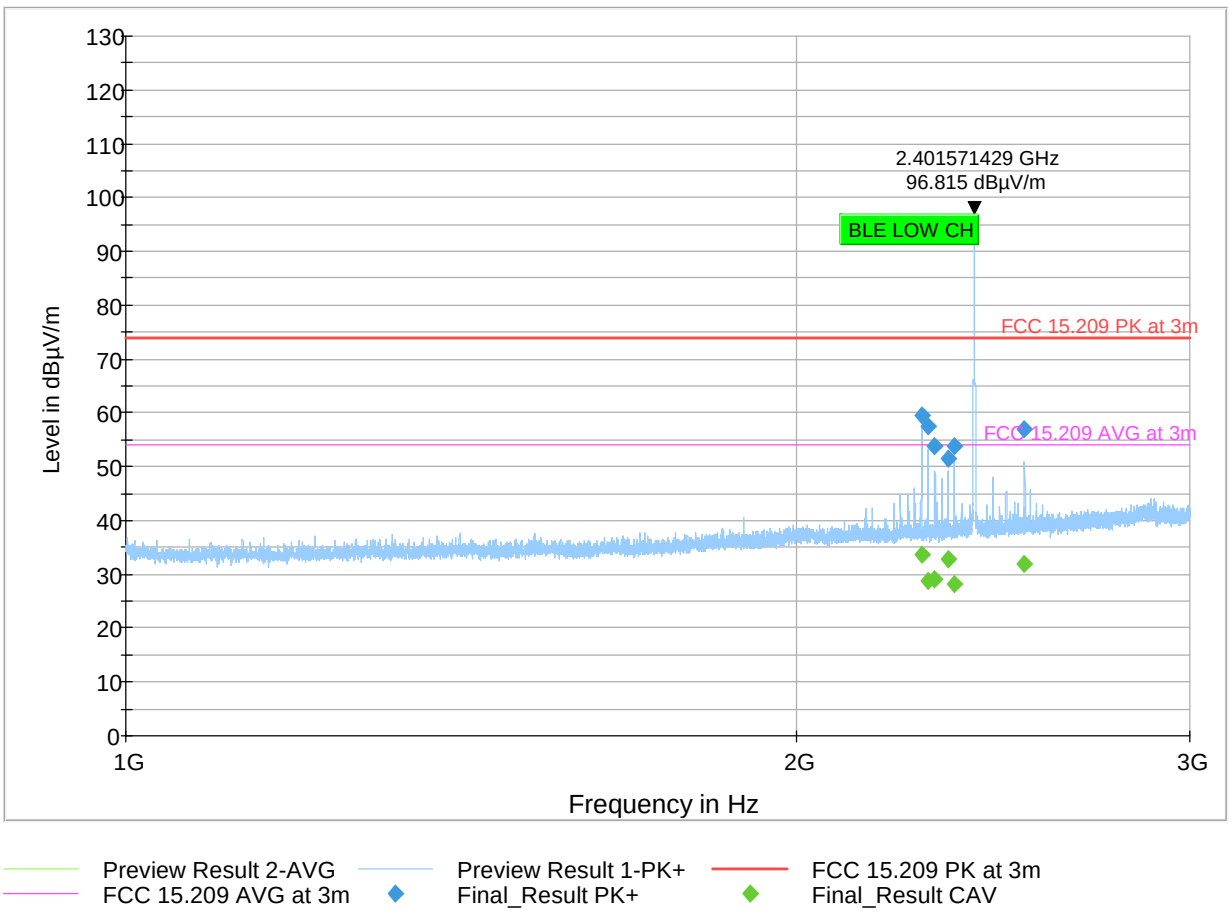


Plot # 39 Radiated Emissions: 1 – 3 GHz

Tx Frequency: 2402 MHz	Mode: LE 2M	Data rate: 2 Mb/s

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2274.00	59.40	---	73.98	14.58	500.0	1000.0	142.0	V	193.0	5.8
2274.00	---	33.79	53.98	20.19	500.0	1000.0	142.0	V	193.0	5.8
2290.00	57.39	---	73.98	16.59	500.0	1000.0	142.0	V	197.0	5.7
2290.00	---	28.77	53.98	25.21	500.0	1000.0	142.0	V	197.0	5.7
2306.00	---	28.91	53.98	25.07	500.0	1000.0	107.0	V	332.0	5.9
2306.00	53.69	---	73.98	20.29	500.0	1000.0	107.0	V	332.0	5.9
2338.00	---	32.92	53.98	21.06	500.0	1000.0	151.0	V	342.0	6.1
2338.00	51.47	---	73.98	22.51	500.0	1000.0	151.0	V	342.0	6.1
2354.14	---	28.16	53.98	25.82	500.0	1000.0	151.0	V	188.0	6.2
2354.14	53.77	---	73.98	20.21	500.0	1000.0	151.0	V	188.0	6.2
2530.00	---	32.07	53.98	21.91	500.0	1000.0	100.0	H	150.0	6.7
2530.00	56.95	---	73.98	17.03	500.0	1000.0	100.0	H	150.0	6.7

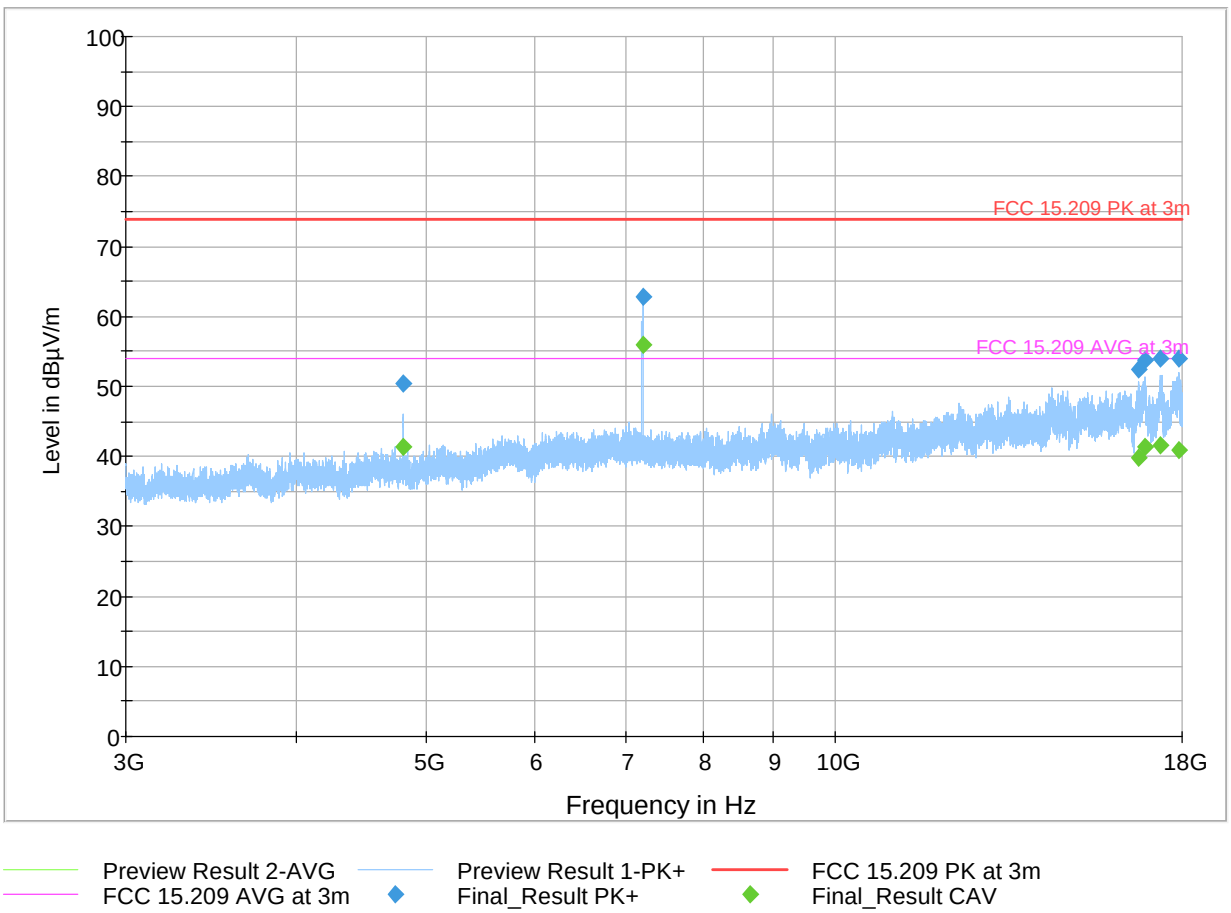


Plot # 40 Radiated Emissions: 3 – 18 GHz

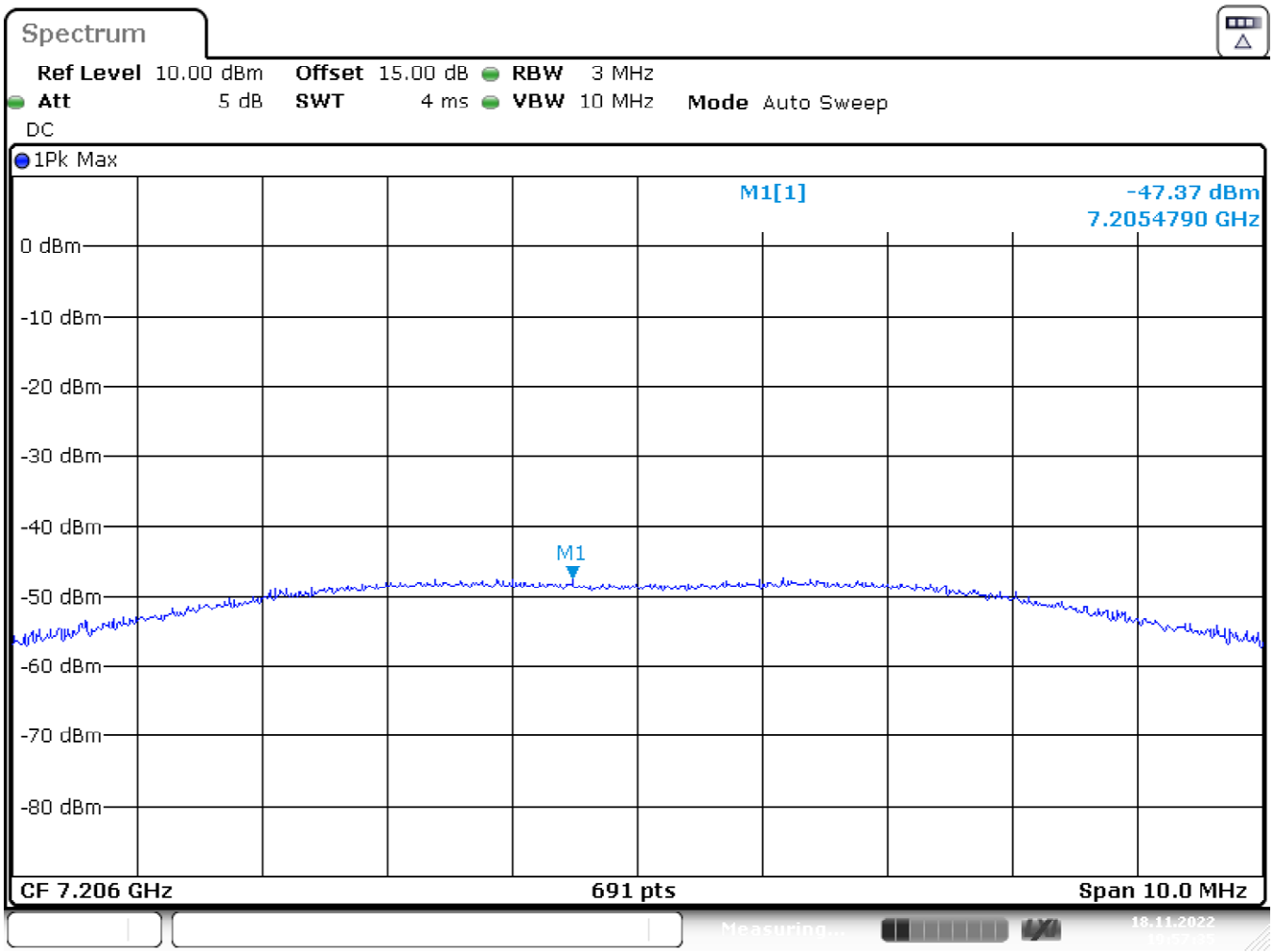
Tx Frequency: 2402 MHz	Mode: LE 2M	Data rate: 2 Mb/s

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4804.75	50.55	---	73.98	23.43	500.0	1000.0	152.0	V	326.0	-3.3
4804.75	---	41.38	53.98	12.60	500.0	1000.0	152.0	V	326.0	-3.3
7207.25	62.88	---	73.98	11.10	500.0	1000.0	100.0	V	134.0	-0.6
7207.25	---	56.07	53.98	-2.09	500.0	1000.0	100.0	V	134.0	-0.6
16709.00	52.44	---	73.98	21.53	500.0	1000.0	147.0	H	217.0	13.2
16709.00	---	39.77	53.98	14.21	500.0	1000.0	147.0	H	217.0	13.2
16880.25	---	41.28	53.98	12.70	500.0	1000.0	274.0	V	172.0	14.3
16880.25	53.71	---	73.98	20.27	500.0	1000.0	274.0	V	172.0	14.3
17357.00	---	41.53	53.98	12.45	500.0	1000.0	134.0	H	59.0	15.9
17357.00	54.08	---	73.98	19.90	500.0	1000.0	134.0	H	59.0	15.9
17908.75	54.06	---	73.98	19.92	500.0	1000.0	147.0	V	252.0	18.2
17908.75	---	41.02	53.98	12.96	500.0	1000.0	147.0	V	252.0	18.2



According to FCC 15.247 (d) *'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 RF conducted, provided the transmitter demonstrates compliance with the peak conducted power limits.'*
The 3rd harmonic peak power level (-47.37 dBm) is > 20 dB below the transmitter 2402 MHz peak power level (5.27 dBm → Plot# 18).



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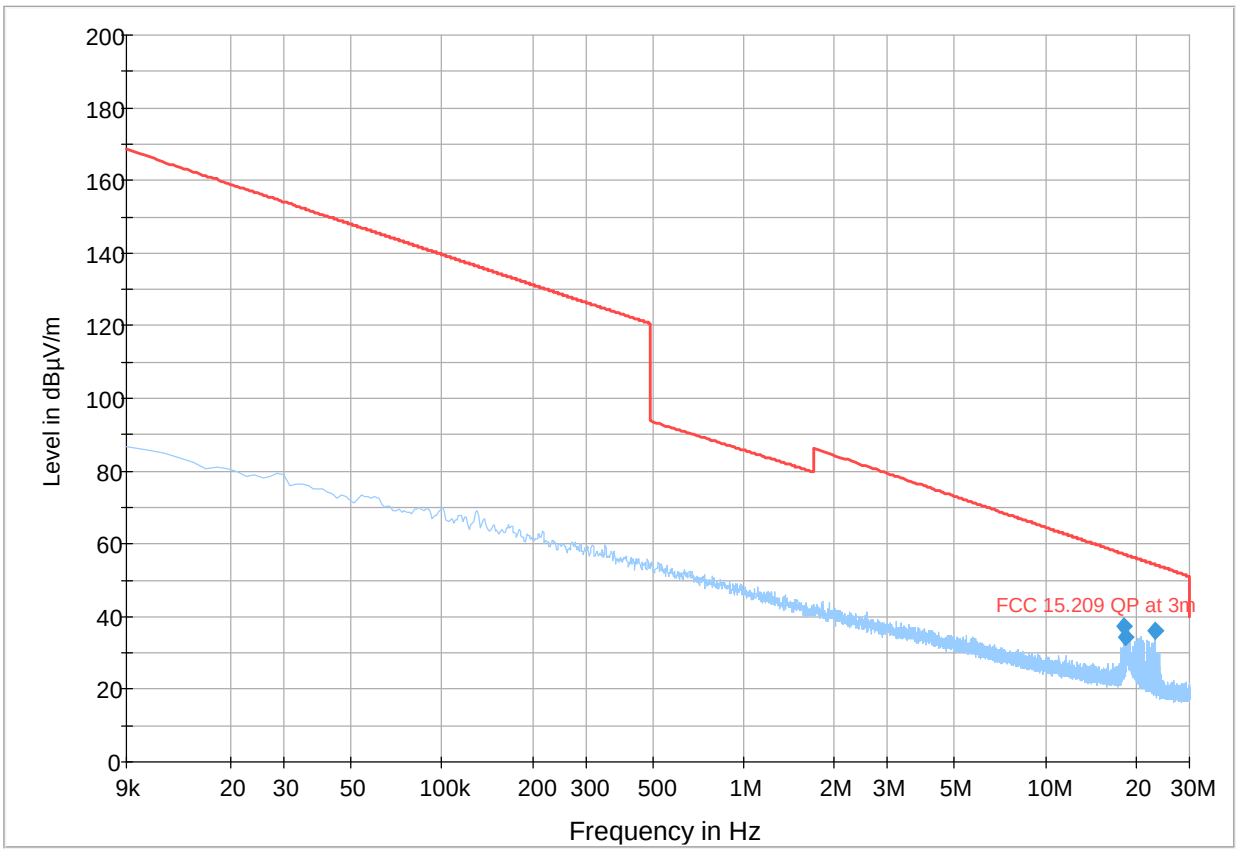
Plot # 41 Radiated Emissions: 9 KHz – 30 MHz

Tx Frequency: 2440 MHz	Mode: LE 2M	Data rate: 2 Mb/s

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18.25	37.14	57.16	20.02	500.0	9.0	100.0	V	257.0	16.6
18.37	34.35	57.08	22.73	500.0	9.0	100.0	V	107.0	16.6
23.13	36.17	54.24	18.07	500.0	9.0	100.0	V	314.0	16.2

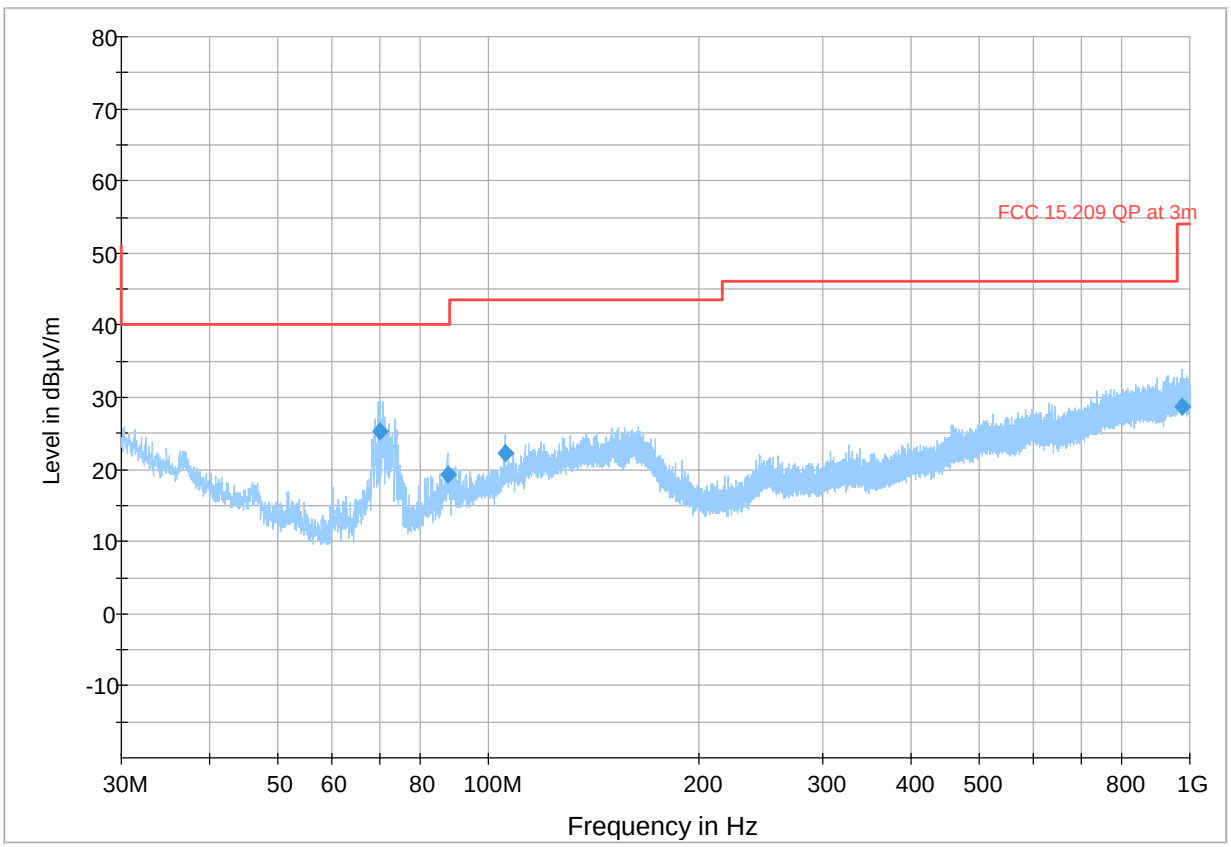


Plot # 42 Radiated Emissions: 30 MHz – 1 GHz

Tx Frequency: 2440 MHz	Mode: LE 2M	Data rate: 2 Mb/s

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
69.96	25.30	40.00	14.70	500.0	120.0	117.0	V	272.0	13.3
87.45	19.18	40.00	20.82	500.0	120.0	100.0	V	291.0	17.1
105.66	22.22	43.50	21.28	500.0	120.0	100.0	V	66.0	21.9
975.97	28.64	53.98	25.34	500.0	120.0	140.0	V	-60.0	32.9

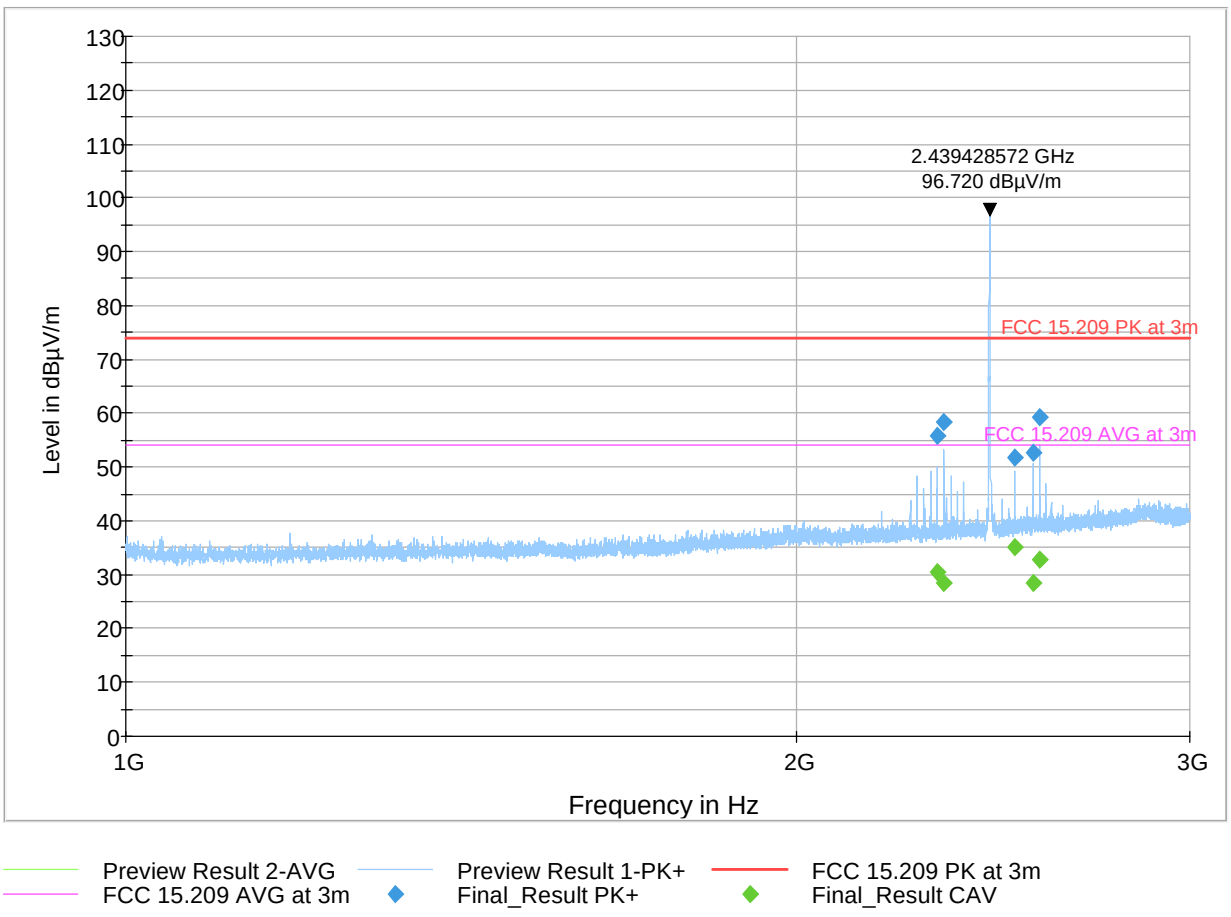


Plot # 43 Radiated Emissions: 1 – 3 GHz

Tx Frequency: 2440 MHz	Mode: LE 2M	Data rate: 2 Mb/s

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2312.00	---	30.44	53.98	23.54	500.0	1000.0	107.0	H	239.0	5.9
2312.00	55.71	---	73.98	18.27	500.0	1000.0	107.0	H	239.0	5.9
2328.14	---	28.53	53.98	25.45	500.0	1000.0	160.0	V	181.0	6.1
2328.14	58.35	---	73.98	15.63	500.0	1000.0	160.0	V	181.0	6.1
2504.00	---	34.97	53.98	19.01	500.0	1000.0	116.0	V	187.0	6.6
2504.00	51.84	---	73.98	22.14	500.0	1000.0	116.0	V	187.0	6.6
2551.71	52.52	---	73.98	21.46	500.0	1000.0	289.0	V	173.0	6.7
2551.71	---	28.45	53.98	25.53	500.0	1000.0	289.0	V	173.0	6.7
2568.00	59.30	---	73.98	14.68	500.0	1000.0	134.0	V	174.0	6.8
2568.00	---	32.84	53.98	21.14	500.0	1000.0	134.0	V	174.0	6.8



Plot # 44 Radiated Emissions: 3 – 18 GHz

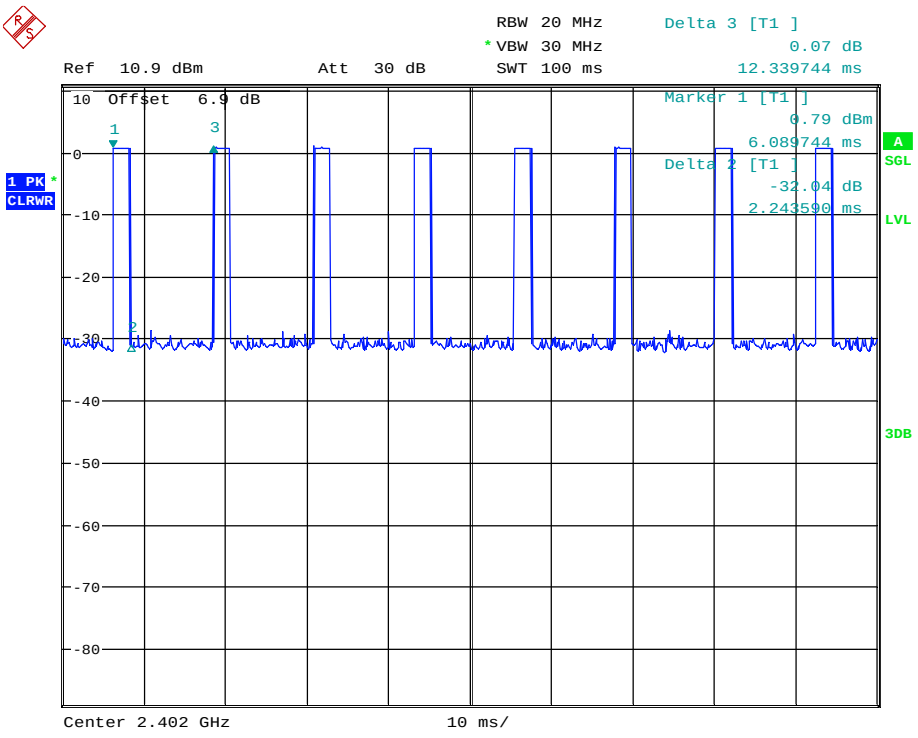
Tx Frequency: 2440 MHz	Mode: LE 2M	Data rate: 2 Mb/s

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4878.75	---	38.23	53.98	15.75	500.0	1000.0	232.0	V	336.0	-3.8
4878.75	48.91	---	73.98	25.07	500.0	1000.0	232.0	V	336.0	-3.8
7318.50	62.71	---	73.98	11.27	500.0	1000.0	292.0	V	96.0	-0.4
7318.50	---	54.24	53.98	-0.26	500.0	1000.0	292.0	V	96.0	-0.4
7321.25	61.76	---	73.98	12.22	500.0	1000.0	277.0	V	92.0	-0.4
7321.25	---	54.94	53.98	-0.96	500.0	1000.0	277.0	V	92.0	-0.4
16866.00	---	41.37	53.98	12.61	500.0	1000.0	134.0	H	105.0	14.3
16866.00	54.66	---	73.98	19.32	500.0	1000.0	134.0	H	105.0	14.3
17378.75	53.80	---	73.98	20.18	500.0	1000.0	214.0	H	207.0	16.0
17378.75	---	41.32	53.98	12.66	500.0	1000.0	214.0	H	207.0	16.0
17884.25	55.20	---	73.98	18.78	500.0	1000.0	249.0	H	251.0	18.2
17884.25	---	41.83	53.98	12.15	500.0	1000.0	249.0	H	251.0	18.2

Applying duty cycle correction factor:

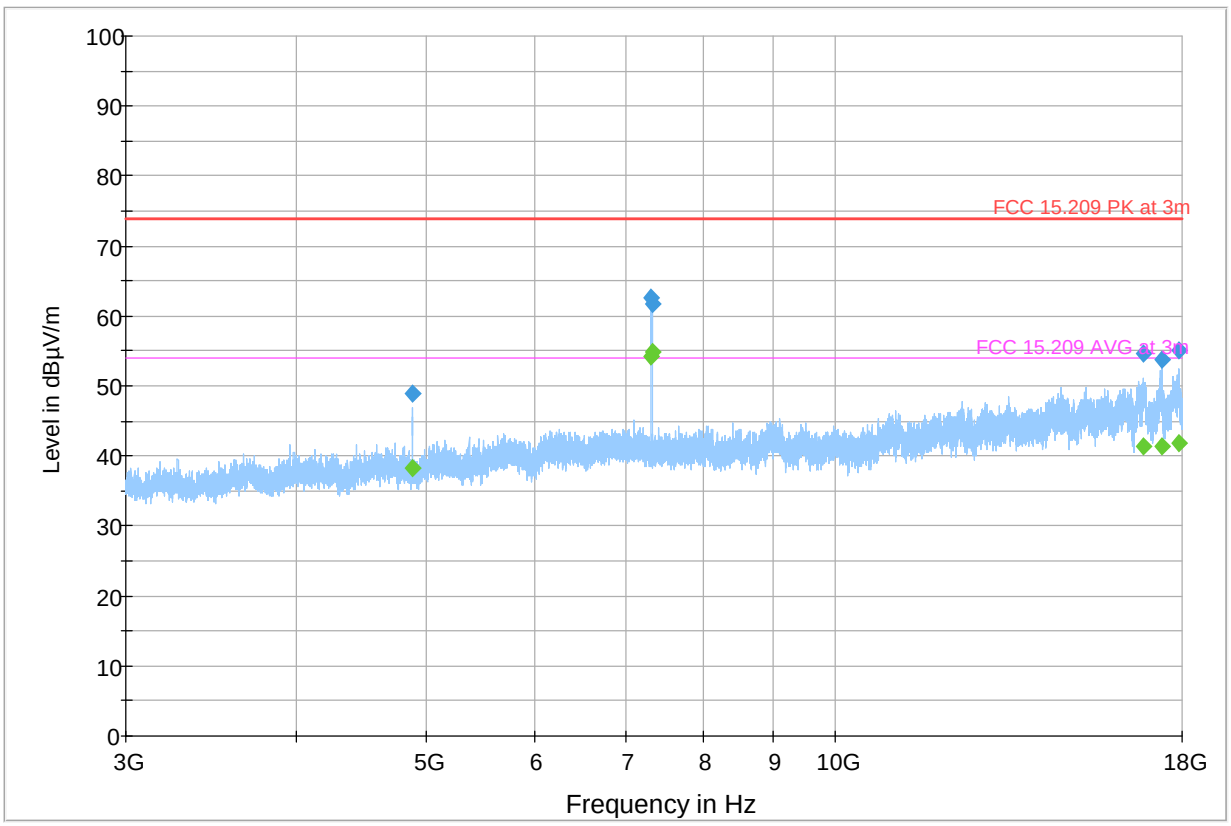
- The equipment under test Bluetooth LE radio was configured to continuous transmission mode.(Check section 8.1 in this document for the test mode duty cycle measurement)
- The highest duty cycle of Bluetooth LE End-User transmission mode is 16.67% based on the client declaration, and End-User mode duty cycle measurement below.



- The field strength result were corrected by applying duty cycle factor to the Max.Peak final result (dBµV/m) @ 3m using the following formula: 20 * Log_{10}(Duty cycle)
  - Duty cycle = 20 * Log_{10}(16.67%) → -15.56 dB

Corrected Final_Result

Frequency (MHz)	Corrected MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Corr. (dB)
7318.50	47.15	53.98	6.83	-15.56
7321.25	46.20	53.98	7.78	-15.56

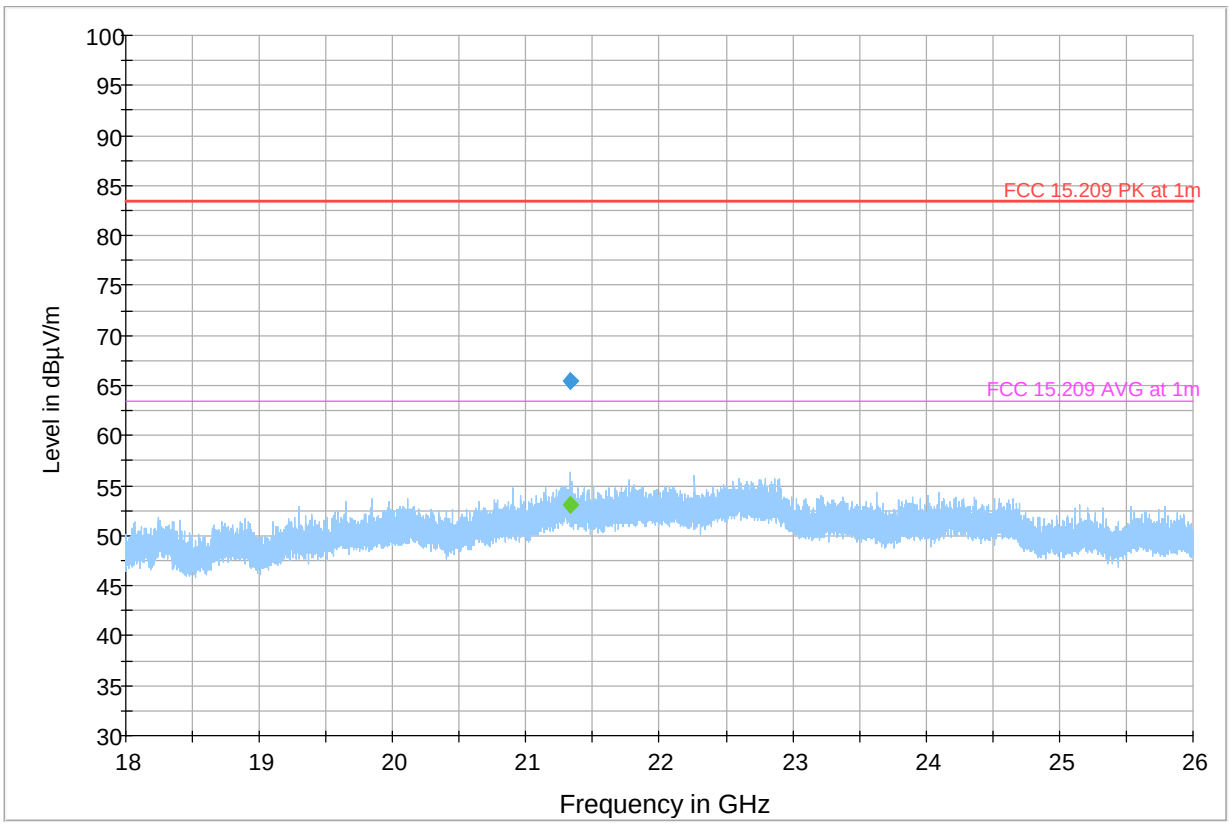


Plot # 45 Radiated Emissions: 18 – 26 GHz

Tx Frequency: 2440 MHz	Mode: LE 2M	Data rate: 2 Mb/s

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
21337.25	---	53.03	63.50	10.47	500.0	1000.0	180.0	H	239.0	18.2
21337.25	65.53	---	83.50	17.97	500.0	1000.0	180.0	H	239.0	18.2

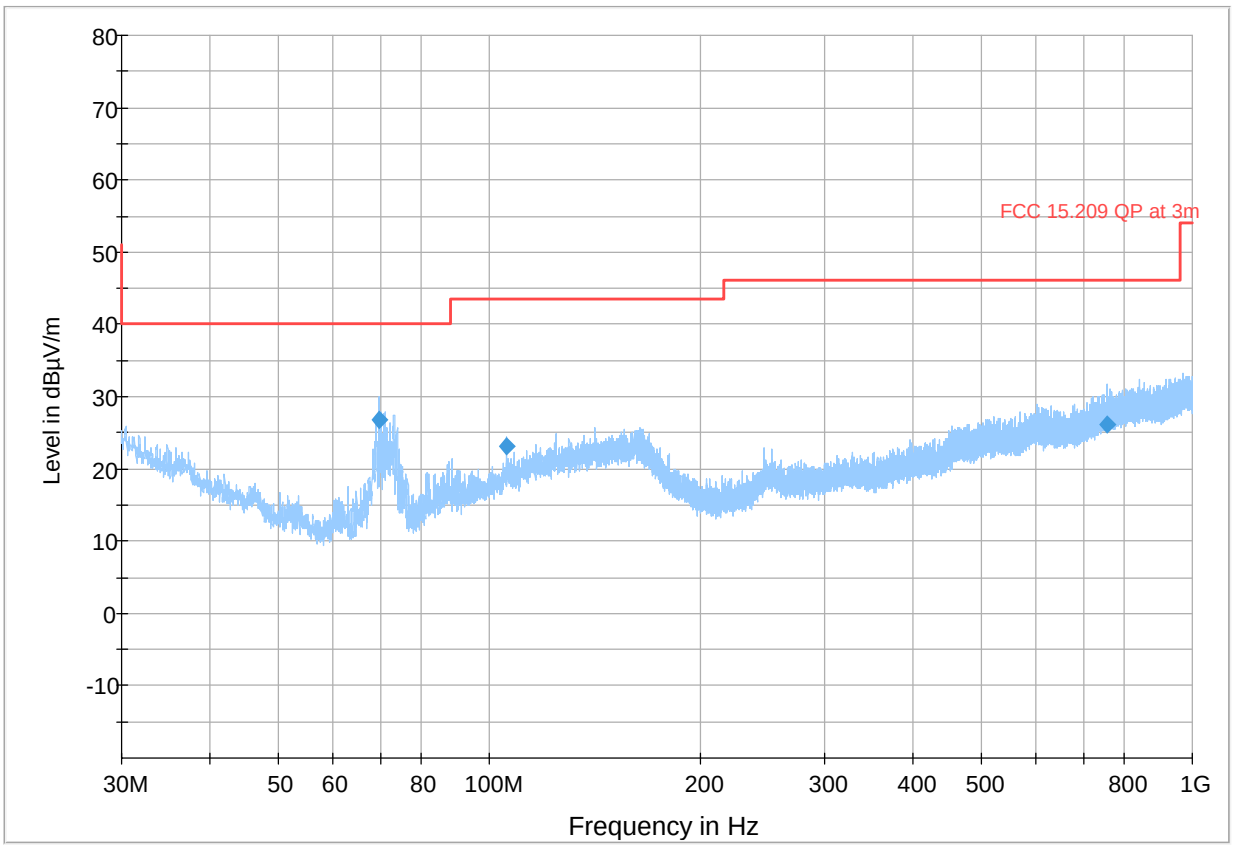


Plot # 46 Radiated Emissions: 30 MHz – 1 GHz

Tx Frequency: 2480 MHz	Mode: LE 2M	Data rate: 2 Mb/s

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
69.67	26.82	40.00	13.18	500.0	120.0	117.0	V	-41.0	13.3
105.66	23.21	43.50	20.29	500.0	120.0	144.0	V	88.0	21.9
755.61	26.14	46.02	19.88	500.0	120.0	236.0	H	78.0	30.4

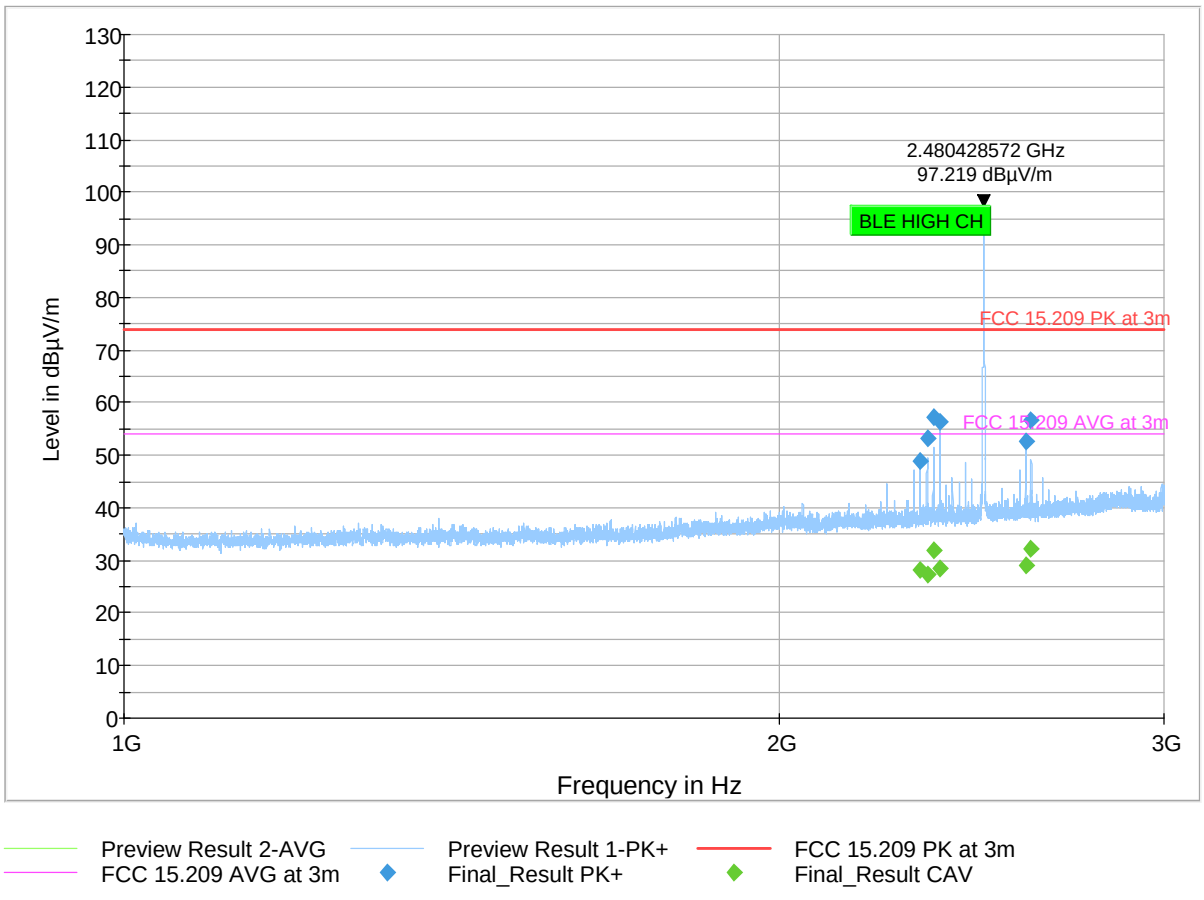


Plot # 47 Radiated Emissions: 1 – 3 GHz

Tx Frequency: 2480 MHz	Mode: LE 2M	Data rate: 2 Mb/s

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2320.00	48.81	---	73.98	25.16	500.0	1000.0	295.0	V	310.0	6.0
2320.00	---	28.11	53.98	25.87	500.0	1000.0	295.0	V	310.0	6.0
2336.00	---	27.42	53.98	26.56	500.0	1000.0	107.0	V	14.0	6.1
2336.00	53.18	---	73.98	20.80	500.0	1000.0	107.0	V	14.0	6.1
2352.00	57.35	---	73.98	16.63	500.0	1000.0	142.0	V	153.0	6.2
2352.00	---	32.02	53.98	21.96	500.0	1000.0	142.0	V	153.0	6.2
2368.00	---	28.36	53.98	25.62	500.0	1000.0	319.0	V	-10.0	6.3
2368.00	56.37	---	73.98	17.61	500.0	1000.0	319.0	V	-10.0	6.3
2592.00	52.76	---	73.98	21.22	500.0	1000.0	137.0	V	327.0	6.8
2592.00	---	28.94	53.98	25.04	500.0	1000.0	137.0	V	327.0	6.8
2608.14	56.75	---	73.98	17.23	500.0	1000.0	134.0	V	180.0	6.8
2608.14	---	32.10	53.98	21.88	500.0	1000.0	134.0	V	180.0	6.8



Plot # 48 Radiated Emissions: 3 – 18 GHz

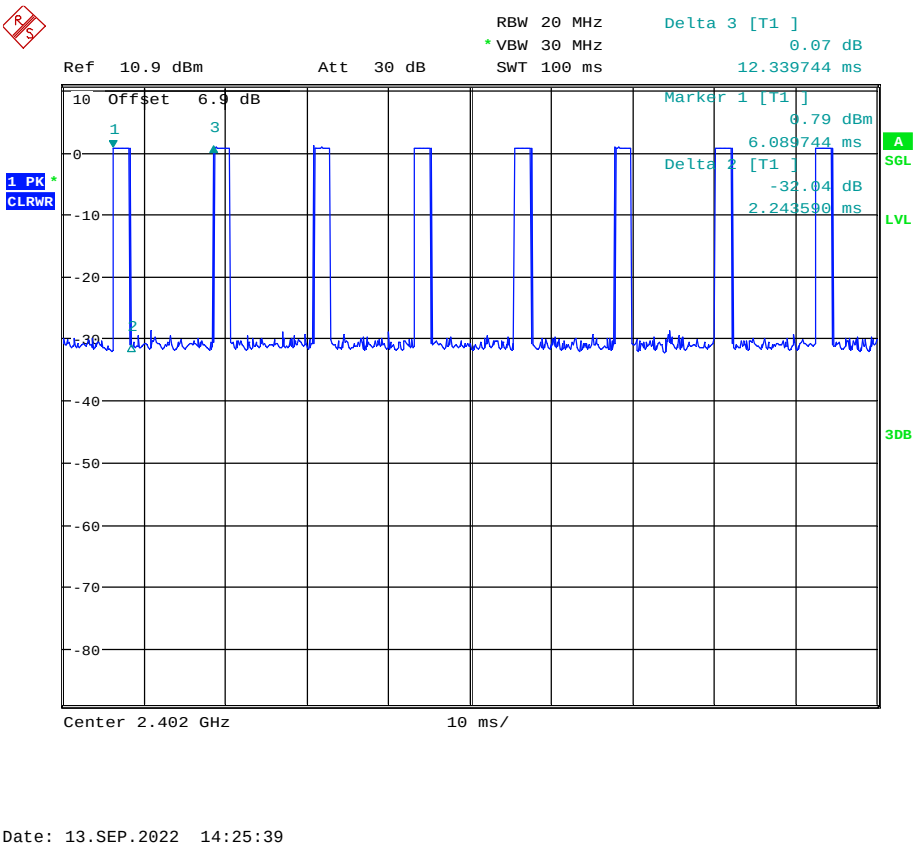
Tx Frequency: 2480 MHz	Mode: LE 2M	Data rate: 2 Mb/s

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4961.00	---	42.19	53.98	11.79	500.0	1000.0	187.0	V	328.0	-3.2
4961.00	51.31	---	73.98	22.67	500.0	1000.0	187.0	V	328.0	-3.2
7441.25	61.87	---	73.98	12.11	500.0	1000.0	100.0	H	91.0	0.2
7441.25	---	55.11	53.98	-1.13	500.0	1000.0	100.0	H	91.0	0.2
14831.50	50.81	---	73.98	23.17	500.0	1000.0	135.0	H	294.0	9.3
14831.50	---	38.23	53.98	15.75	500.0	1000.0	135.0	H	294.0	9.3
17353.25	54.56	---	73.98	19.42	500.0	1000.0	107.0	H	204.0	15.8
17353.25	---	41.78	53.98	12.20	500.0	1000.0	107.0	H	204.0	15.8
17881.75	54.49	---	73.98	19.49	500.0	1000.0	151.0	H	161.0	18.2
17881.75	---	42.19	53.98	11.79	500.0	1000.0	151.0	H	161.0	18.2

Applying duty cycle correction factor:

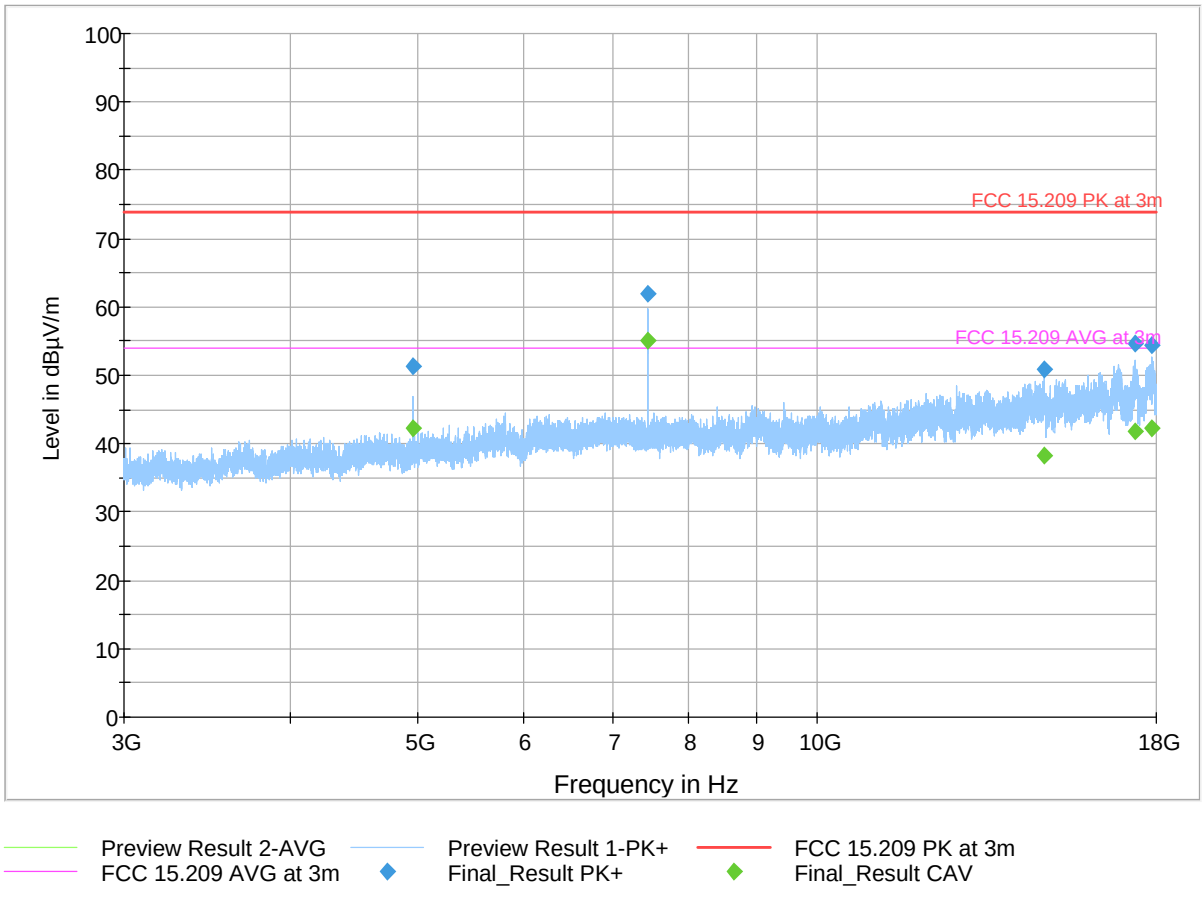
- The equipment under test Bluetooth LE radio was configured to continuous transmission mode.(Check section 8.1 in this document for the test mode duty cycle measurement)
- The highest duty cycle of Bluetooth LE End-User transmission mode is 16.67% based on the client declaration, and End-User mode duty cycle measurement below.



- The field strength result were corrected by applying duty cycle factor to the Max.Peak final result (dBµV/m) @ 3m using the following formula: 20 * Log_{10}(Duty cycle)
  - Duty cycle = 20 * Log_{10}(16.67%) → -15.56 dB

Corrected Final_Result

Frequency (MHz)	Corrected MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Corr. (dB)
7441.25	46.31	53.98	7.67	-15.56



8.8 AC Power Line Conducted Emissions

8.8.1 Measurement according to ANSI C63.4

Analyzer Settings

- RBW = 9 KHz (CISPR Bandwidth)
- Detector: Peak / Average for Pre-scan
- Quasi-Peak/Average for Final Measurements

8.8.2 Limits: §15.207

FCC §15.207(a)

- Except as shown in paragraphs (b) and (c) of this section of the CFR, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table (1), as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between frequency ranges.

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases with the logarithm of the frequency.

8.8.3 Test conditions and setup:

Ambient Temperature ©	Power line (L1, L2, L3, N)	Power Input
23° C	Line & Neutral	110V / 60Hz

8.8.4 Measurement Result

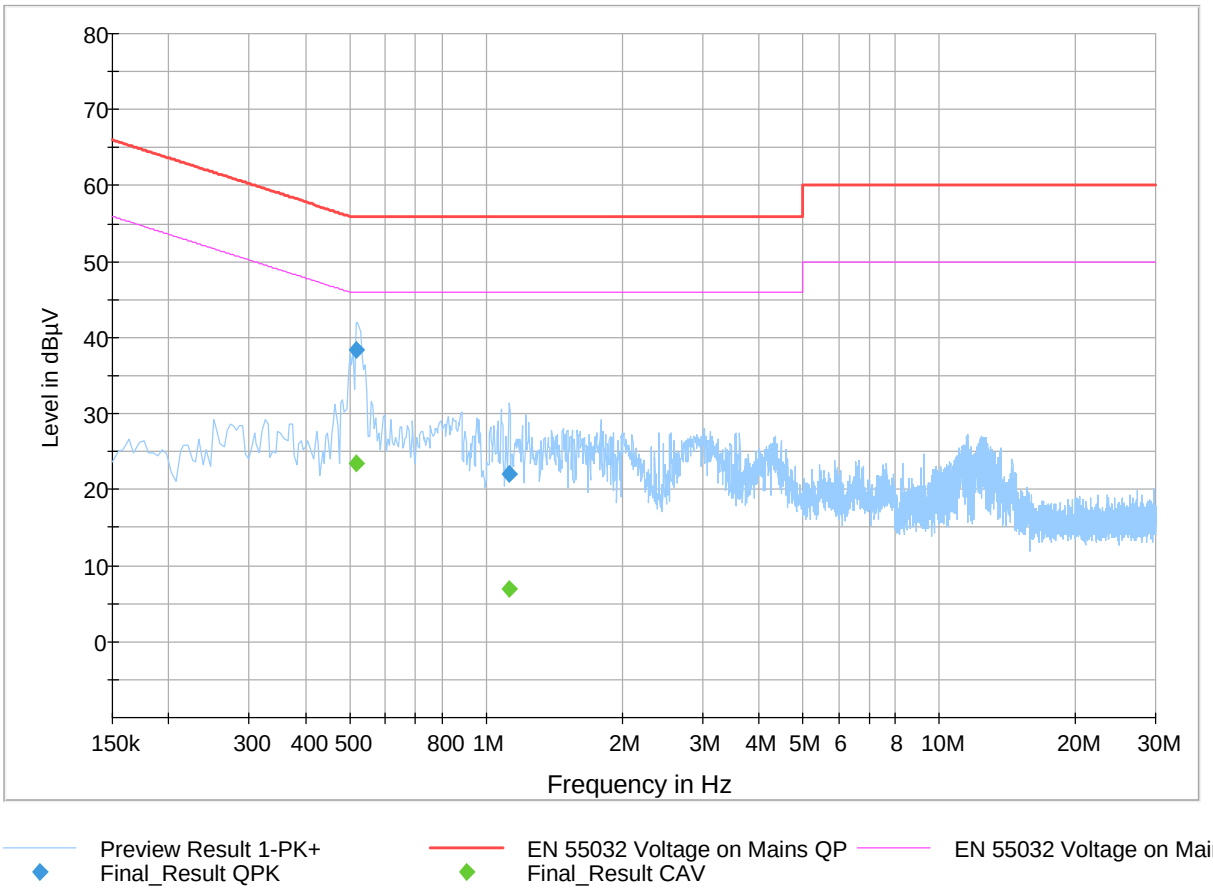
Plot #	Port	EUT Set-Up #	EUT operating mode	Scan Frequency	Limit	Result
51	AC Mains	2	Op.2	150 kHz – 30 MHz	See section 8.8.2	Pass

8.8.5 Measurement Plots:

Plot # 49 AC Conducted Emissions: 150 kHz – 30 MHz

Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.519	---	23.548	46.000	22.452	500.000	9.000	N	GND	9.988
0.519	38.477	---	56.000	17.523	500.000	9.000	N	GND	9.988
1.129	---	6.856	46.000	39.144	500.000	9.000	N	GND	10.050
1.129	22.080	---	56.000	33.920	500.000	9.000	N	GND	10.050



9 Test setup photos

Setup photos are included in supporting file name: "EMC_SOBER-012-22001_FCC_Setup_Photos_Rev2.pdf"

10 Test Equipment And Ancillaries Used For Testing

Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
ACTIVE LOOP ANTENNA	ETS LINDGREN	6507	00161344	3 YEARS	10/30/2020
BILOG ANTENNA	A.H. SYSTEMS	BiLA2G	569	2 YEARS	11/16/2021
HORN ANTENNA	EMCO	3115	00035111	2 YEARS	9/28/2021
HORN ANTENNA	ETS LINDGREN	3117-PA	00169547	3 YEARS	9/1/2020
HORN ANTENNA	ETS LINDGREN	3116C-PA	00169535	3 YEARS	9/23/2020
ESW.EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW44	101715	2 YEARS	9/14/2021
SPECTRUM ANALYZER	ROHDE & SCHWARZ	FSU26	100189	3 YEARS	5/25/2022
THERMOMETER HUMIDITY MONITOR	CONTROL COMPANY	36934-164	191872028	2 YEARS	10/20/2021

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 History

Date	Report Name	Changes to report	Report prepared by
10/26/2022	EMC_SOBER-012-22001_FCC_15.247_BLE_DTS	Initial Version	Issa Ghanma
11/4/2022	EMC_SOBER-012-22001_FCC_15.247_BLE_DTS_Rev1	Correction to: • FCC ID • Product Description • Setup photos file name	Issa Ghanma
12/6/2022	EMC_SOBER-012-22001_FCC_15.247_BLE_DTS_Rev2	• Separate sections 8.5.1, 8.5.2 for emissions in non-restricted, and restricted frequency bands. • Plot 42: Harmonic conducted power measurement. • Setup photos file name	Issa Ghanma

<<< The End >>>