

## Nemko Korea Co., Ltd.

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### FCC and IC EVALUATION REPORT FOR CLASS II PERMISSIVE CHANGE

**Applicant :**129, Samsung-ro, Yeongtong-gu,  
Suwon-si, Gyeonggi-do, 16677,  
Korea

Attn. : JunTaek Oh

Dates of Issue : January 13, 2022

Test Report No. : NK-21-R-457-1

Test Site : Nemko Korea Co., Ltd.

FCC ID  
ICA3LSMR180L  
649E-SMR180L

Brand Name

Samsung

Contact Person

129, Samsung-ro, Yeongtong-gu,  
Suwon-si, Gyeonggi-do,  
16677, Korea  
Mr. JunTaek Oh  
Telephone No. : +82-10-3311-0003

Applied Standard: FCC 47 CFR Part 15.247  
IC RSS-247 Issue 2 and IC RSS-GEN Issue 5  
Classification: Digital Transmission System (DTS)  
EUT Type: Bluetooth Headset

The device bearing the brand name and model specified above has been shown to comply with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10-2013. The client should not use it to claim product endorsement by TAF or any government agencies. The test results in the report only apply to the tested sample.

I attest to the accuracy of data and all measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

  
Jan. 13. 2022Tested By : Yonghwan Kim  
Test Engineer  
Jan. 13. 2022Reviewed By : Seungyong Shin  
Technical Manager

Revision History

Rev.	Issue Date	Revisions	Revised By
00	June 24, 2020	Initial issue	
01	July 16, 2020	Class I Permissive Change 1. Antenna change (Basic Report : Initial Report NK-20-R-142-1)	
02	January 13, 2022	Class II Permissive Change 1. Antenna change and minor change in PCB layout (Basic Report : Amendment 1 Report NK-20-R-183-1)	

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## 1. SCOPE

Measurement and determination of electromagnetic emissions (EME) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission under FCC part 15 and IC RSS-247 Issue2.

**Responsible Party :** 129, Samsung-ro, Yeongtong-gu, Suwon-si,  
Gyeonggi-do, 16677, Korea

**Contact Person :** JunTaek Oh

**Manufacturer :** Samsung Electronics Co., Ltd.  
129, Samsung-ro, Yeongtong-gu, Suwon-si,  
Gyeonggi-do, 16677, Korea

- FCC ID: A3LSMR180L
- IC: 649E-SMR180L
- Model: SM-R180
- Variant Models -
- HVIN: SM-R180L
- Brand Name: Samsung
- EUT Type: Bluetooth Headset
- Classification: Digital Transmission System (DTS)
- Applied Standard: FCC 47 CFR Part 15.247  
IC RSS-247 Issue 2 and IC RSS-GEN Issue 5
- Test Procedure(s): ANSI C63.10-2013  
KDB 558074 D01 15.247 Meas Guidance v05r02
- Dates of Test: January 08, 2022 ~ January 10, 2022
- Place of Test: Nemko Korea Co., Ltd.

## 2. INTRODUCTION

### 2.1 Test facility

The measurement procedure described in American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2014), the American National Standard for Testing Unlicensed Wireless Devices (ANSI C63.10-2013) was used in determining radiated and conducted emissions emanating from **Samsung Electronics Co., Ltd. FCC ID : A3LSMR180L** and **IC : 649E-SMR180L**.

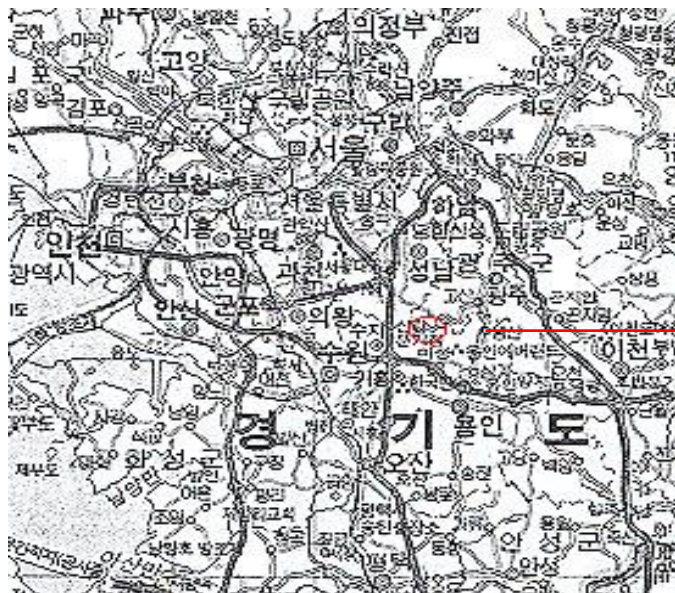
These measurement tests were conducted at **Nemko Korea Co., Ltd. EMC Laboratory** .

The site address 155 & 159, Osan-Ro, Mohyeon-Eup, Cheoin-Gu, Yongin-Si, Gyeonggi-Do 16885 KOREA, REPUBLIC OF.

The area of Nemko Korea Corporation Ltd. EMC Test Site is located in a mountain area at 80 km (48 miles) southeast and Incheon International Airport (Incheon Airport), 30 km (18miles) south-southeast from central Seoul.

It is located in the valley surrounded by mountains in all directions where ambient radio signal conditions are quiet and a favorable area to measure the radio frequency interference on open field test site for the computing and ISM devices manufactures.

The detailed description of the measurement facility was found to be in compliance with the requirements of ANSI C63.4-2014 according to §2.948.









Nemko Korea Co., Ltd.  
EMC Lab.  
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Fig. 1. The map above shows the Seoul in Korea vicinity area.

The map also shows Nemko Korea Corporation Ltd. EMC Lab. and Incheon Airport.

## 2.2 Accreditation and listing

	Accreditation type	Accreditation number
	CAB Accreditation for DOC	Designation No. KR0026
	KOLAS Accredited Lab. (Korea Laboratory Accreditation Scheme)	Registration No. KT155
	Canada IC Registered site	Site No. 2040E
	VCCI registration site(RE/CE/Telecom CE)	Member No. 2118
	EMC CBTL	TL124
	KCC(RRL)Designated Lab.	Registration No. KR0026

### 3. TEST CONDITIONS & EUT INFORMATION

#### 3.1 Operation During Test

The EUT is the transceiver which is Bluetooth 5.0 supporting BDR/EDR/LE mode.

The Mobile phone was used to control the EUT to transmit the wanted TX channel continuously (duty cycle < 98%) by the program (BudsOdin2.0) supported by manufacturer.

The EUT was tested at the lowest, middle and the highest channels with the maximum output power in accordance with the manufacturer's specifications. The worst data were recorded in the report.

##### 3.1.1 Table of test power setting

Frequency	Mode	Power setting Level
2402 MHz ~ 2480 MHz	LE 1M	Default
2402 MHz ~ 2480 MHz	LE 2M	Default

##### 3.1.2 Table of test channels

Frequency band	Mode	Test Channel (CH)	Frequency (MHz)
2.4 GHz	LE 1M	0	2402
		19	2440
		39	2480
2.4 GHz	LE 2M	0	2402
		19	2440
		39	2480

##### 3.1.3 Antenna information

Frequency band	Mode	Antenna TX mode	Support CDD	Support MIMO
2.4 GHz	LE 1M	<input checked="" type="checkbox"/> 1TX, <input type="checkbox"/> 2TX	<input type="checkbox"/> Yes, <input checked="" type="checkbox"/> No	<input type="checkbox"/> Yes, <input checked="" type="checkbox"/> No
2.4 GHz	LE 2M	<input checked="" type="checkbox"/> 1TX, <input type="checkbox"/> 2TX	<input type="checkbox"/> Yes, <input checked="" type="checkbox"/> No	<input type="checkbox"/> Yes, <input checked="" type="checkbox"/> No



**3.1.4 Additional Information Related to Testing**

The cable and attenuator loss from 30MHz to 26.5GHz was reflected in spectrum analyzer with correction factor for all conducted testing.

There is no change except for antenna change and minor change in PCB layout.

(Refer to 'description of change')

Minor change in PCB layout does not affect to radio performance.

There is no change of power setting level.

Therefore, only radiated emissions testing was performed in worst case with the highest value of the original report. And all conducted raw data in original report (NK-20-R-142-1) was used in this report. Measured Spurious emissions was increase more than 3 dB from measured Spurious emissions in basic report (NK-20-R-183-1).

Therefore, Class II permissive change is required according to KDB 178919 D01 v06 I.B.

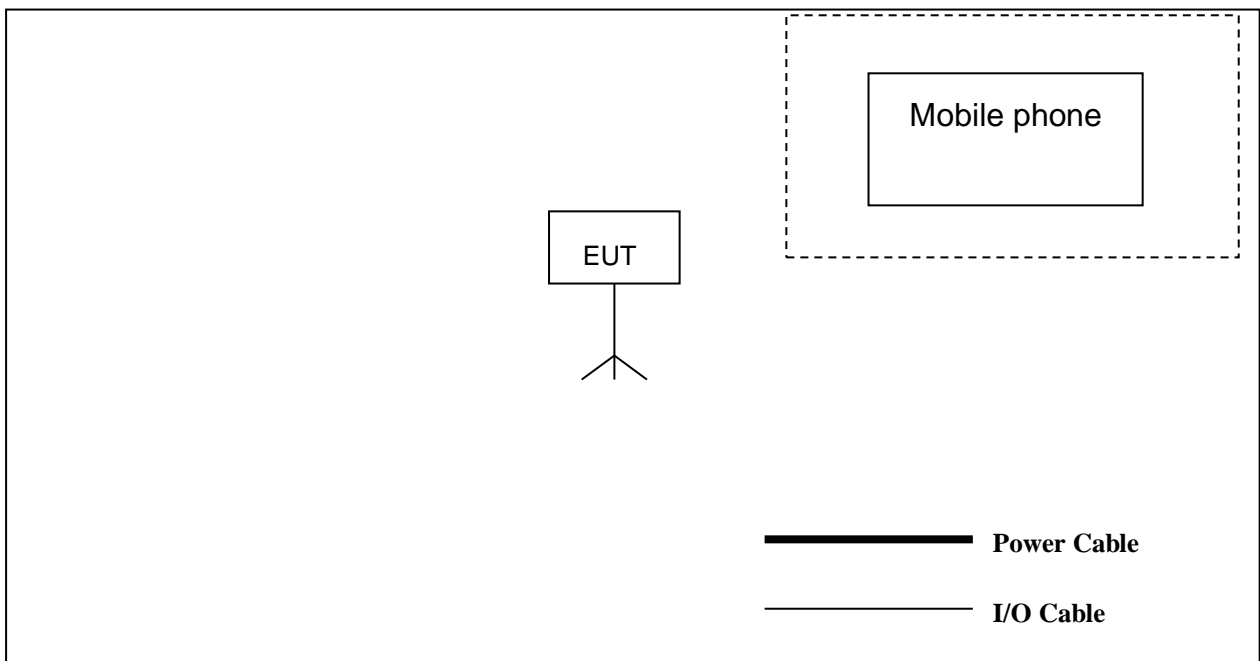
**3.1.5 Table of test modes**

2.4GHz - Part 15.247, RSS-247 Issue 2 and RSS-GEN Issue 5				
Test Items	Mode	Modulation	Test Channel (CH)	Remark
Radiated Emissions	LE 1M, 2M	GFSK	39	Radiated
6 dB Bandwidth	LE 1M, 2M	GFSK	0/19/39	Conducted
Peak Output Power and E.I.R.P	LE 1M, 2M	GFSK	0/19/39	Conducted
Power Spectral Density	LE 1M, 2M	GFSK	0/19/39	Conducted
Conducted Spurious Emission, Band edge Emission	LE 1M, 2M	GFSK	0/19/39	Conducted
Radiated Spurious Emission, Band edge Emission	LE 2M	GFSK	0/19/39	Radiated

### 3.2 Support Equipment

Equipment	Manufacturer	Model Name	Serial Number
Mobile phone	Samsung	SM-G960N	R39K30EN92Z

### 3.3 Setup Drawing



 Mobile phone was removed after Transmission setup

### **3.4 EUT Information**

The EUT is the **Samsung Electronics Co., Ltd. Bluetooth Headset FCC ID:A3LSMR180L, IC: 649E-SMR180L.**

Specifications:

EUT Type	Bluetooth Headset
Model Name	SM-R180
Variant Model Name	-
Brand Name	Samsung
Frequency of Operation	2402 MHz ~ 2480 MHz
Peak Output Power(Conducted)	LE1M : 11.07 dBm LE2M : 11.07 dBm
FCC Classification	Digital Transmission System (DTS)
Number of Channels	40 CH
Modulations	GFSK(BLE)
Antenna Gain (peak)	-7.50 dBi
Antenna Setup	1TX / 1RX
EUT Rated Voltage	3.7 Vdc
EUT Test Voltage	3.7 Vdc
Temperature Range	-20 °C ~ +60 °C
Size (W x H x D)	About 15 mm x 26 mm x 14 mm
Weight	About 5 g
HVIN (Hardware Version Number)	SM-R180L
FVIN (Firmware Version Identification Number)	R180.001
Remarks	-

## 4. SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specification:

Name of Test	FCC Paragraph No.	IC Paragraph No.	Result	Remark
Conducted Emission	15.207	RSS-GEN Issue 5 8.8	N/A	Refer to clause 3.1.4 in this report
Radiated Emission	15.209	RSS-GEN Issue 5 8.9	N/A	Refer to clause 3.1.4 in this report
6 dB Bandwidth	15.247(a)(2)	RSS-247 Issue 2 5.2	N/A	Refer to clause 3.1.4 in this report
Peak Output Power and E.I.R.P	15.247(b)(3)	RSS-247 Issue 2 5.4	N/A	Refer to clause 3.1.4 in this report
Power Spectral Density	15.247(e)	RSS-247 Issue 2 5.2	N/A	Refer to clause 3.1.4 in this report
Conducted Spurious Emission	15.247(d)	RSS-247 Issue 2 5.5	N/A	Refer to clause 3.1.4 in this report
Radiated Spurious Emission	15.247(d)	RSS-247 Issue 2 5.5	Complies	
Maximum Permissible Exposure	1.1307(b)	RSS-102 Issue 5	N/A	Refer to clause 3.1.4 in this report

## 5. RECOMMENDATION/CONCLUSION

The data collected shows that the **Samsung Electronics Co., Ltd. Bluetooth Headset FCC ID: A3LSMR180L, IC: 649E-SMR180L** is in compliance with Part 15.247 of the FCC Rule and RSS-247 Issue 2 of the IC Specification.

## 6. ANTENNA REQUIREMENTS

### §15.203 of the FCC Rules part 15 Subpart C

: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

The antenna of the **Samsung Electronics Co., Ltd. Bluetooth Headset FCC ID: A3LSMR180L, IC: 649E-SMR180L** is **permanently attached** and there are no provisions for connection to an external antenna. It complies with the requirement of §15.203.

Used Antenna		
No.	Model name	Max. gain (dBi)
		2.4GHz
1	SM-R180 / Left[BT] (LT31300)	-6.90
2	SM-R180 / Left[BT] (LT31300)	-7.30
3	SM-R180 / Left[BT] (LT31300)	-7.50

## 7. DESCRIPTION OF TESTS

### 7.1 Conducted Emissions

The Line conducted emission test facility is located inside a 4 x 7 x 2.5 meter shielded enclosure. It is manufactured by EM engineering. The shielding effectiveness of the shielded room is in accordance with MIL-STD-285 or NSA 65-6. A 1 m x 1.5 m wooden table 0.8 m height is placed 0.4 m away from the vertical wall and 1.5 m away from the side of wall of the shielded room. Rohde & Schwarz (ESH3-Z5) and (ESH2-Z5) of the 50 ohm/50  $\mu$ H Line Impedance Stabilization Network (LISN) are bonded to the shielded room. The EUT is powered from the Rohde & Schwarz LISN (ESH3-Z5) and the support equipment is powered from the Rohde & Schwarz LISN (ESH2-Z5). Power to the LISNs are filtered by high-current high insertion loss Power line filters. The purpose of filter is to attenuate ambient signal interference and this filter is also bonded to shielded enclosure. All electrical cables are shielded by tinned copper zipper tubing with inner diameter of 1 / 2 ". If DC power device, power will be derived from the source power supply it normally will be powered from and this supply lines will be connected to the LISNs, All interconnecting cables more than 1 meter were shortened by non-inductive bundling (serpentine fashion) to a 1 meter length. Sufficient time for EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the spectrum analyzer to determine the frequency producing the maximum EME from the EUT. The spectrum was scanned from 150 kHz to 30 MHz with 200 msec sweep time. The frequency producing the maximum level was re-examined using the EMI test receiver. (Rohde & Schwarz ESCS30). The detector functions were set to CISPR quasi-peak mode & average mode. The bandwidth of receiver was set to 9 kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each EME emission. Each emission was maximized by; switching power lines; varying the mode of operation or resolution; clock or data exchange speed; scrolling H pattern to the EUT and of support equipment, and powering the monitor from the floor mounted outlet box and computer aux AC outlet, if applicable; whichever determined the worst case emission. Each EME reported was calibrated using the R&S signal generator.

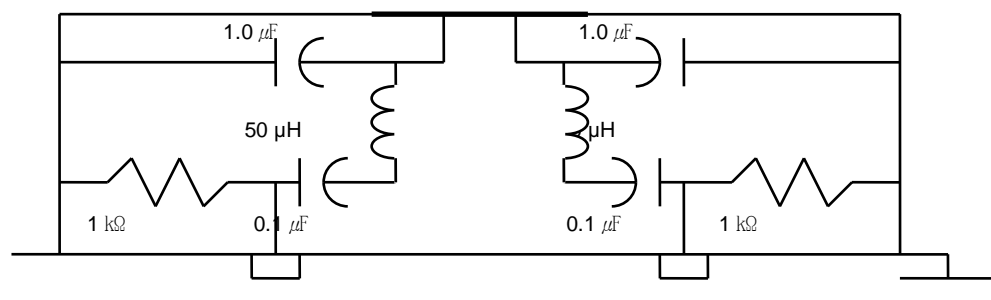


Fig. 2. LISN Schematic Diagram

## 7.2 Radiated Emissions

The measurement was performed at the test site that is specified in accordance with ANSI C63.10-2013.

The spurious emission was scanned from 9 kHz to 30 MHz using Loop Antenna(Rohde&Schwarz, HFH2-Z2) and 30 to 1000 MHz using Trilog broadband test antenna(Schwarzbeck, VULB 9163). Above 1 GHz, Horn antenna (Schwarzbeck BBHA 9120D: up to 18 GHz, Q-par Angus QSH20S20 : 18 to 26.5 GHz) was used.

For emissions testing at below 1GHz, The test equipment was placed on turntable with 0.8 m above ground. For emission measurements above 1 GHz, The test equipment was placed on turntable with 1.5 m above ground. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The EUT, cable, wire arrangement and mode of operation that has the highest amplitude relative to the limit was selected. Then, the turn table was rotated from 0° to 360° and an antenna mast was moved from 1 m to 4 m height to maximize the suspected highest amplitude signal. The final maximized level was recorded.

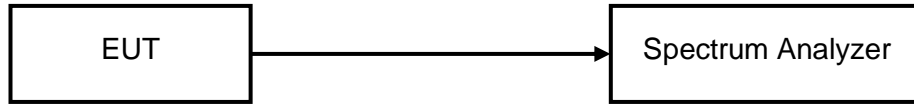
At frequencies below 1000 MHz, measurements performed using the CISPR quasi-peak detection. At frequencies above 1000 MHz, measurements performed using the peak and average measurement procedures described in ANSI 63.10-2013 section 11.12. Peak emission levels were measured by setting the analyzer RBW = 1 MHz, VBW = 3 MHz, Detector = Peak, Trace mode = max hold. Average emission levels were measured by setting the analyzer RBW = 1 MHz, VBW = 10 kHz, Detector = Peak, Trace mode = max hold. Allow max hold to run for at least 50 times (1/duty cycle) traces.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009–0.490	2400/F(kHz)	300
0.490–1.705	24000/F(kHz)	30
1.705–30.0	30	30
30–88	100	3
88–216	150	3
216–960	200	3
Above 960	500	3

Radiated Emissions Limits per 47 CFR 15.209(a) and RSS-GEN Issue 5 8.9

### 7.3 6 dB Bandwidth

#### Test Setup



#### Test Procedure

EUTs 6 dB bandwidth is measured at low, middle, high channels with a spectrum analyzer connected to the antenna terminal while the EUTs operating at its maximum power control level. The spectrum analyzer setting is as follows.

RBW = 100 kHz

VBW > 3 x RBW

Detector = Peak

Trace mode = max hold

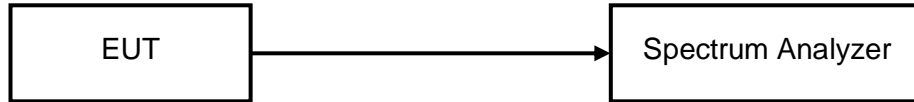
Sweep = auto couple

The bandwidth measurement function on the spectrum analyzer is used to measure the 6 dB bandwidth.



## **7.4 Peak Output Power and E.I.R.P**

### **Test Setup**



### **Test Procedure**

EUTs Maximum Peak Conducted Output Power is measured at low, middle, high channels with a spectrum analyzer connected to the antenna terminal while the EUTs operating at its maximum power control level.

The spectrum analyzer setting is as follows.

RBW = 1 MHz

VBW = 3 MHz

Span = fully encompass the DTS bandwidth

Detector = peak

Sweep time = auto couple

Trace mode = max hold

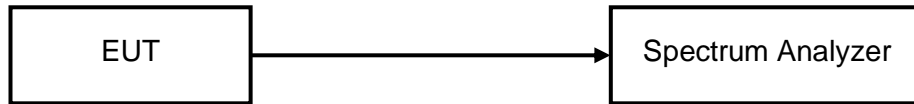
Allow the trace to stabilize.

Use peak marker function to determine the peak amplitude level.

E.I.R.P is calculated according to KDB412172 D01 Determining ERP and EIRP v01r01

## **7.5 Peak Power Spectral Density**

### **Test Setup**



### **Test Procedure**

EUTs Peak Power Spectral Density is measured at low, middle, high channels with a spectrum analyzer connected to the antenna terminal while the EUTs operating at its maximum power control level.

The spectrum analyzer setting is as follows.

Center frequency = DTS channel center frequency

Span = 1.5 times the DTS channel bandwidth

RBW  $\geq$  3kHz

VBW  $\geq$  3 x RBW

Detector = peak

Sweep time = auto couple

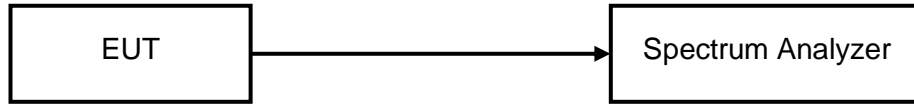
Trace mode = max hold

Allow the trace to stabilize.

The peak search function on the spectrum analyzer is used to determine the maximum amplitude level within the RBW.

## 7.6 Conducted Spurious Emissions

### Test Setup



### Test Procedure

EUTs Conducted spurious emissions are measured at low, middle, high channels with a spectrum analyzer connected to the antenna terminal while the EUTs operating at its maximum power control level. The spectrum analyzer setting is as follows.

#### 1) Reference Level

Center frequency = DTS channel center frequency

Span  $\geq 1.5 \times$  DTS bandwidth

RBW = 100 kHz

VBW  $\geq 3 \times$  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 PSD level.

Note that the channel found to contain the maximum PSD level can be used to establish the reference level.

#### 2) Unwanted Emissions

Set the center frequency and span to encompass frequency range to be measured.

RBW = 100 kHz

VBW  $\geq 3 \times$  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.

## 8. TEST DATA

### 8.1 Radiated Emissions

#### FCC §15.209, IC RSS-Gen Issue 5 8.9

#### Result

Frequency (MHz)	Reading (dB $\mu$ V/m)	Pol* (H/V)	Mode	AF+CL+Amp (dB)**	Result (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
104.59	32.78	H	QP	-29.5	3.3	43.5	40.2
354.56	31.76	V	QP	-25.7	6.1	46.0	39.9
437.50	41.77	H	QP	-24.1	17.7	46.0	28.3
772.00	31.49	H	QP	-18.5	13.0	46.0	33.0
864.20	32.14	V	QP	-17.9	14.2	46.0	31.8
935.25	32.65	H	QP	-18.1	14.6	46.0	31.5

#### Radiated Measurements at 3meters

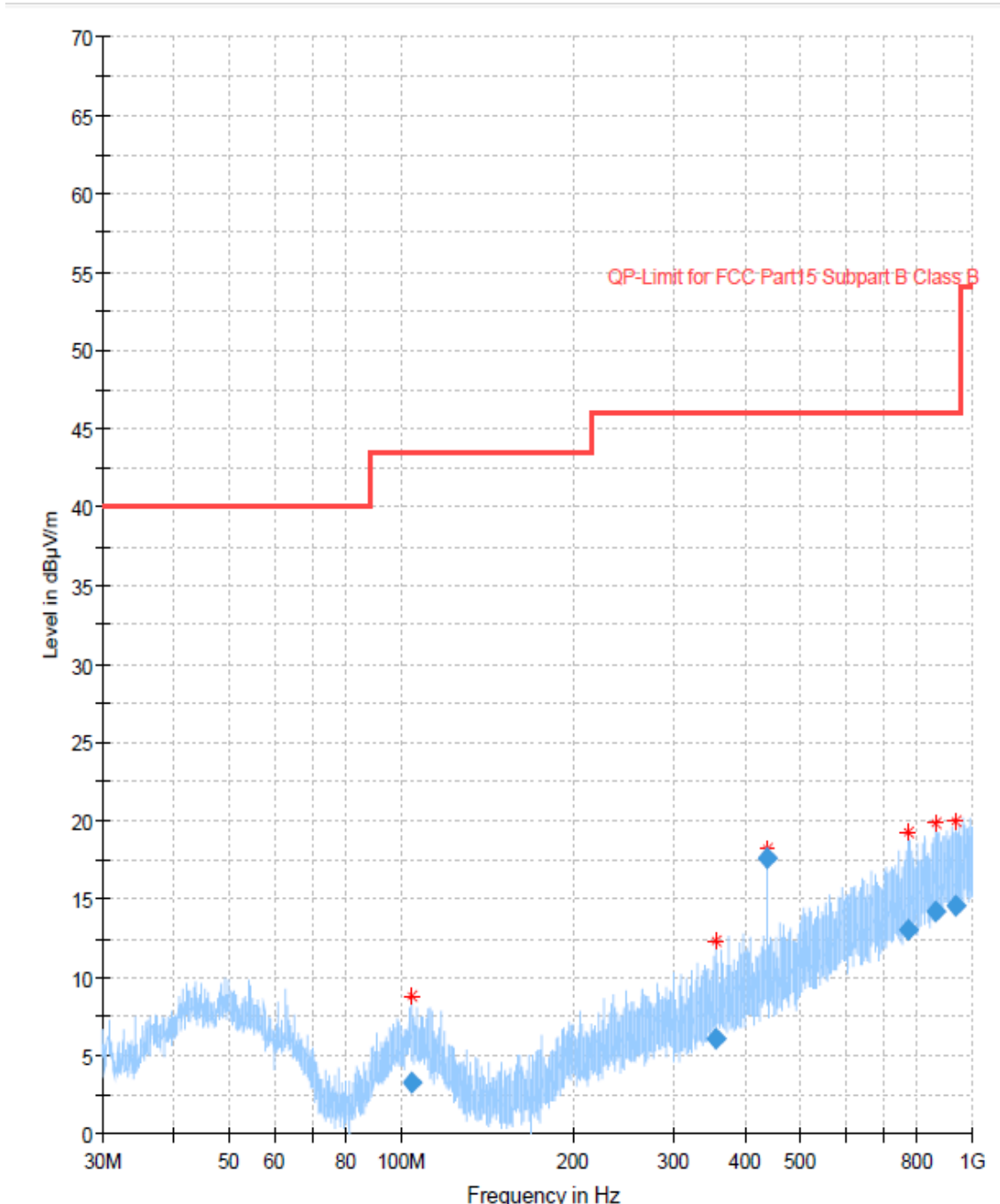
#### Notes:

1. The worst-case emission was reported.
2. \*Pol. H = Horizontal, V = Vertical
3. \*\*AF + CL + Amp. = Antenna Factor + Cable Loss + Amplifier.
4. Measurements using CISPR quasi-peak mode below 1 GHz.
5. The radiated emissions testing were made by rotating EUT through three orthogonal axes and rotating the receive antenna with horizontal, Vertical polarization. The worst data was recorded. (Y-axis below 1GHz)
6. Highest channel (2480 MHz) in LE2M is the worst case.
7. No emission found between lowest internal used/generated frequency to 30MHz (9kHz~30MHz).
8. The limit is on the FCC §15.209 and RSS-Gen Issue 5 8.9.

# PLOTS OF EMISSIONS

## Worst Case

### Radiated emission below 1GHz\_2480 MHz



## TEST DATA

### 8.2 6 dB Bandwidth

#### FCC §15.247(a)(2), IC RSS-247 Issue 2 5.2

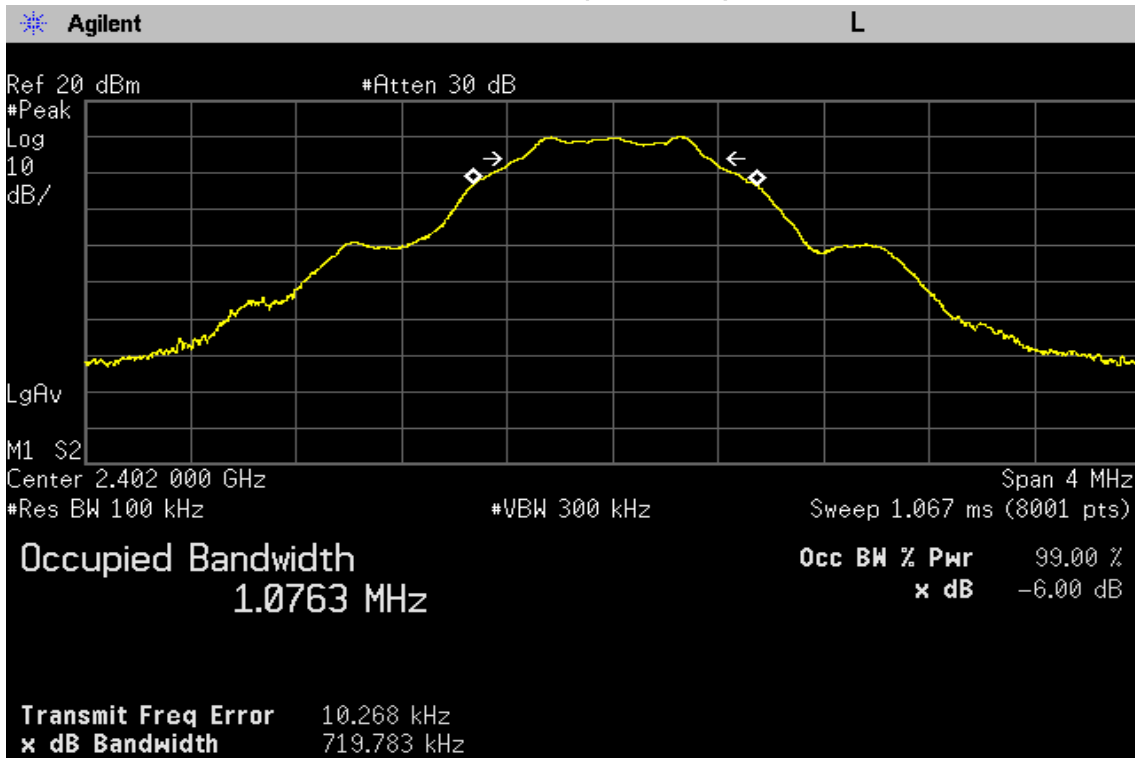
**Test Mode : Set to Lowest channel, Middle channel and Highest channel,**

#### Result

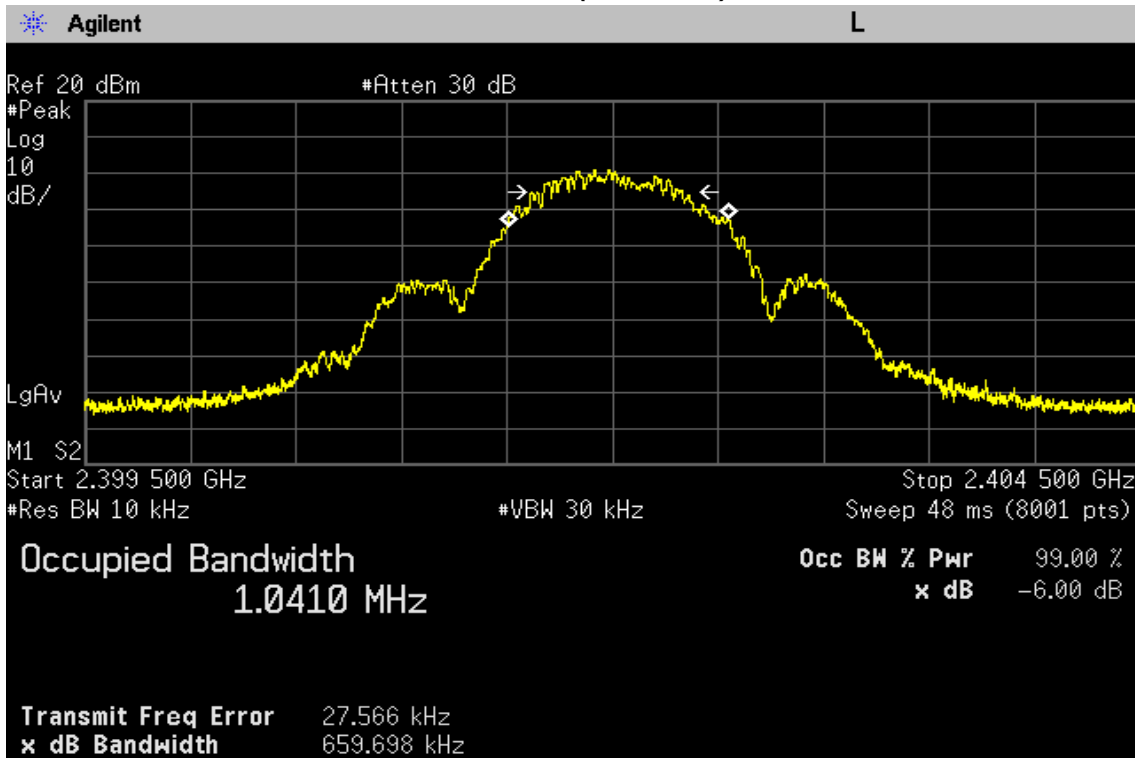
Mode	Channel	Frequency (MHz)	6 dB modulated bandwidth (MHz)	Limit (MHz)	Margin (MHz)	99% emission bandwidth (MHz)
LE 1M	Lowest	2402	0.72	0.50	0.22	1.04
	Middle	2440	0.71	0.50	0.21	1.04
	Highest	2480	0.72	0.50	0.22	1.04
LE 2M	Lowest	2402	1.18	0.50	0.68	2.03
	Middle	2440	1.18	0.50	0.68	2.04
	Highest	2480	1.20	0.50	0.70	2.04

# PLOTS OF EMISSIONS

6 dB Bandwidth, Lowest Channel, LE 1M (2402 MHz)

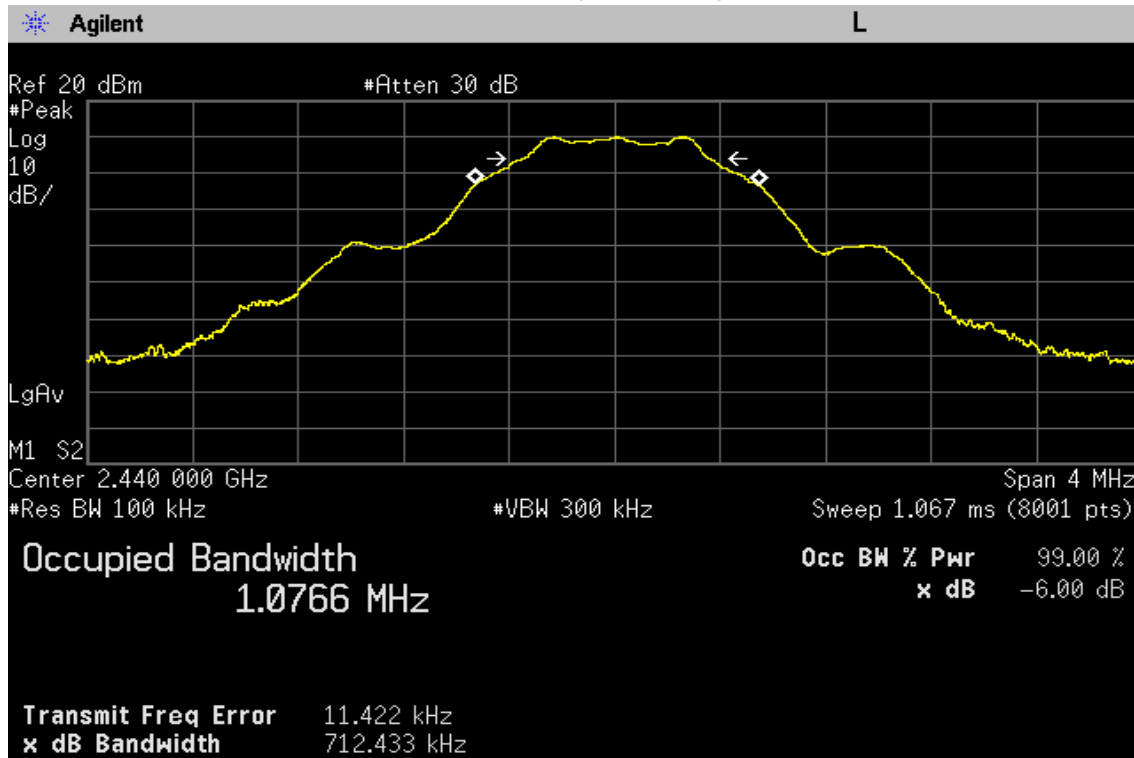


99% Bandwidth, Lowest Channel, LE 1M (2402 MHz)

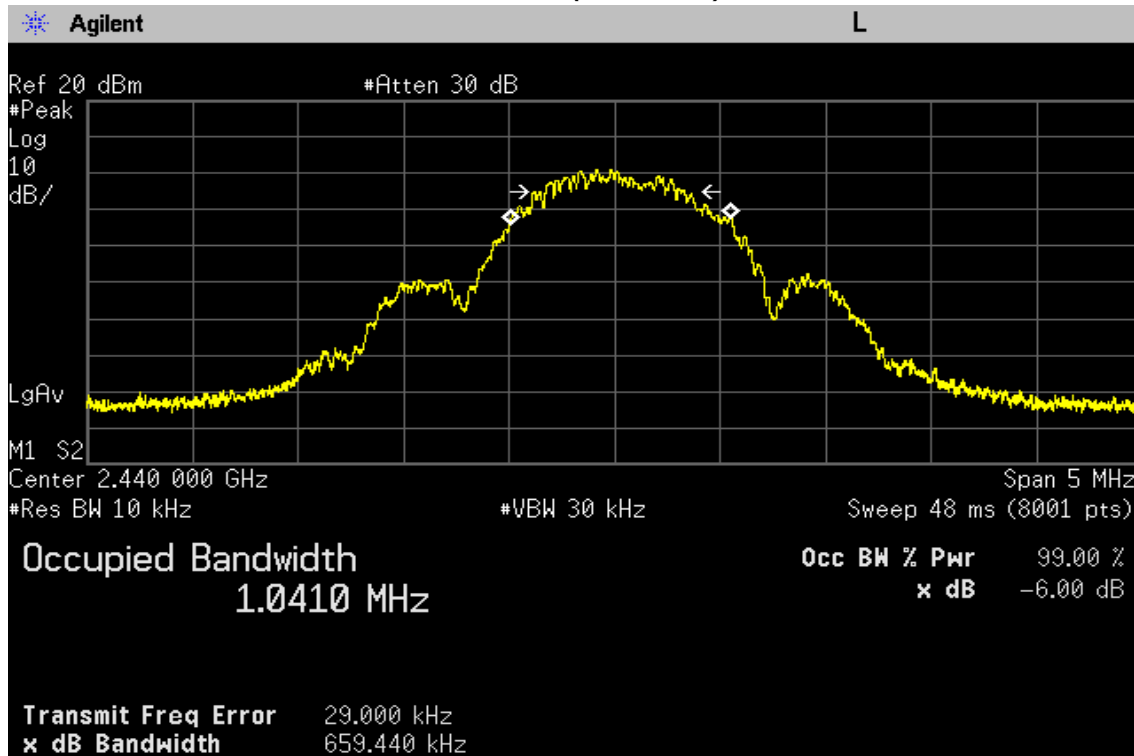


# PLOTS OF EMISSIONS

**6 dB Bandwidth, Middle Channel, LE 1M (2440 MHz)**



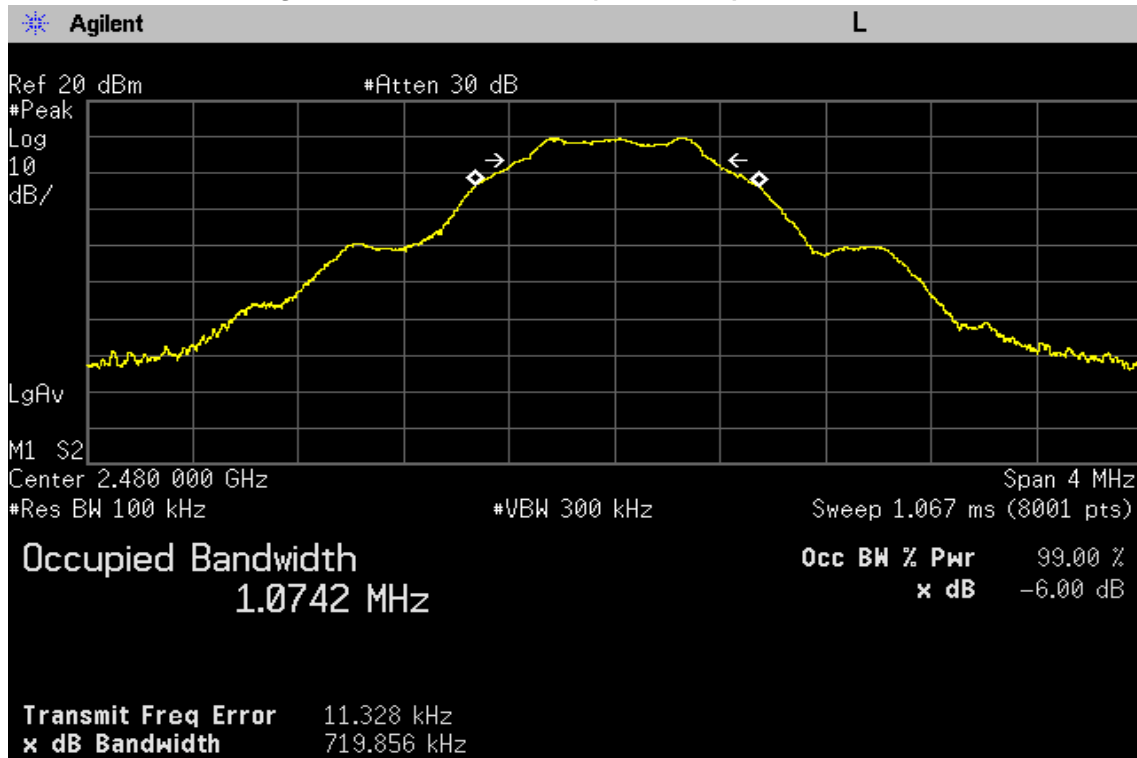
**99% Bandwidth, Middle Channel, LE 1M (2440 MHz)**



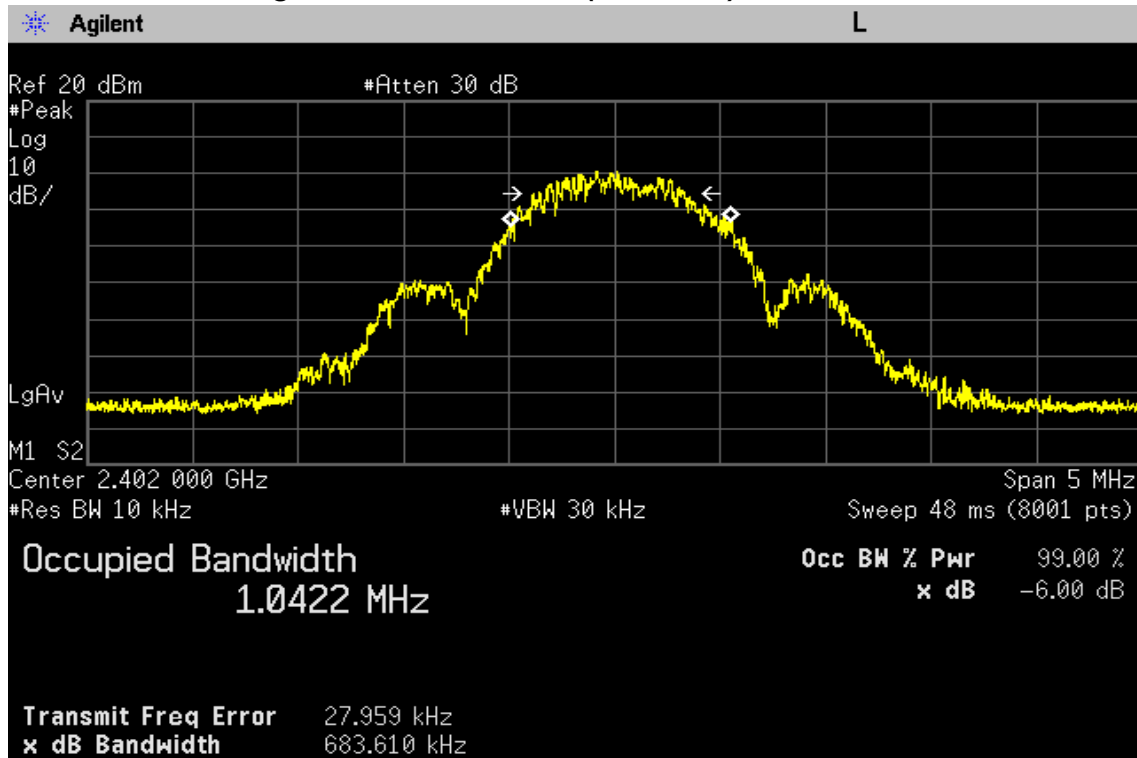


# PLOTS OF EMISSIONS

**6 dB Bandwidth, Highest Channel, LE 1M (2480 MHz)**

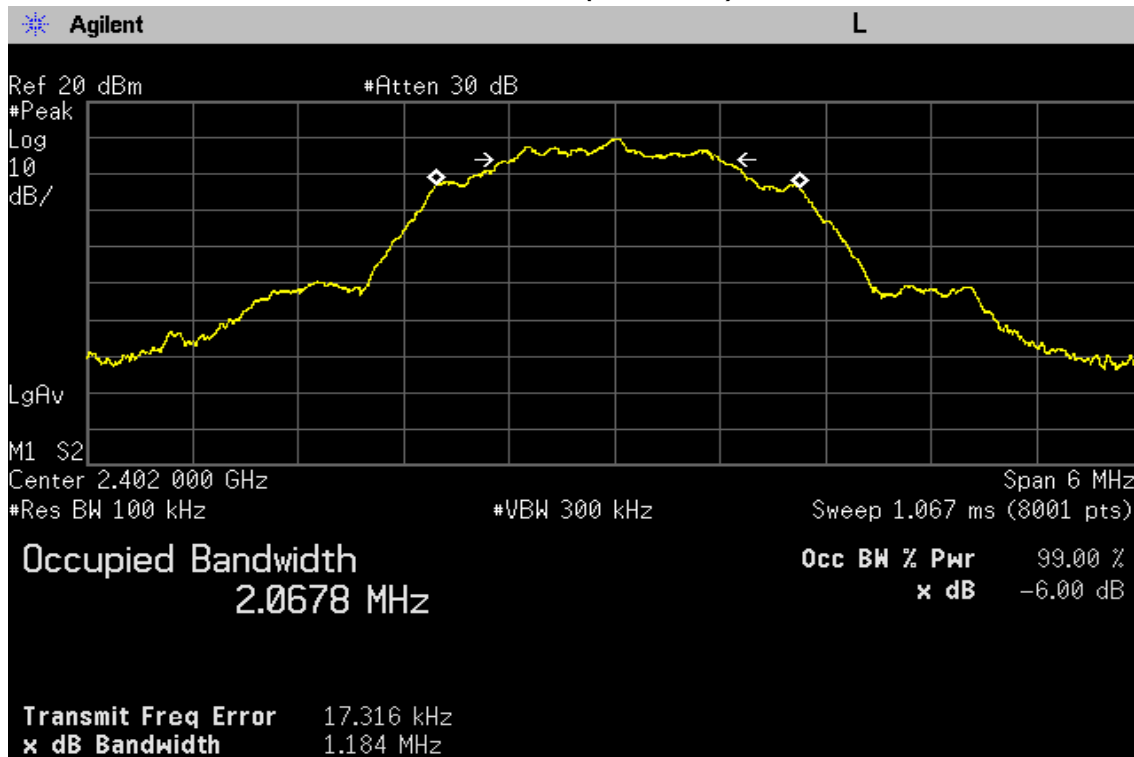


**99% Bandwidth, Highest Channel, LE 1M (2480 MHz)**

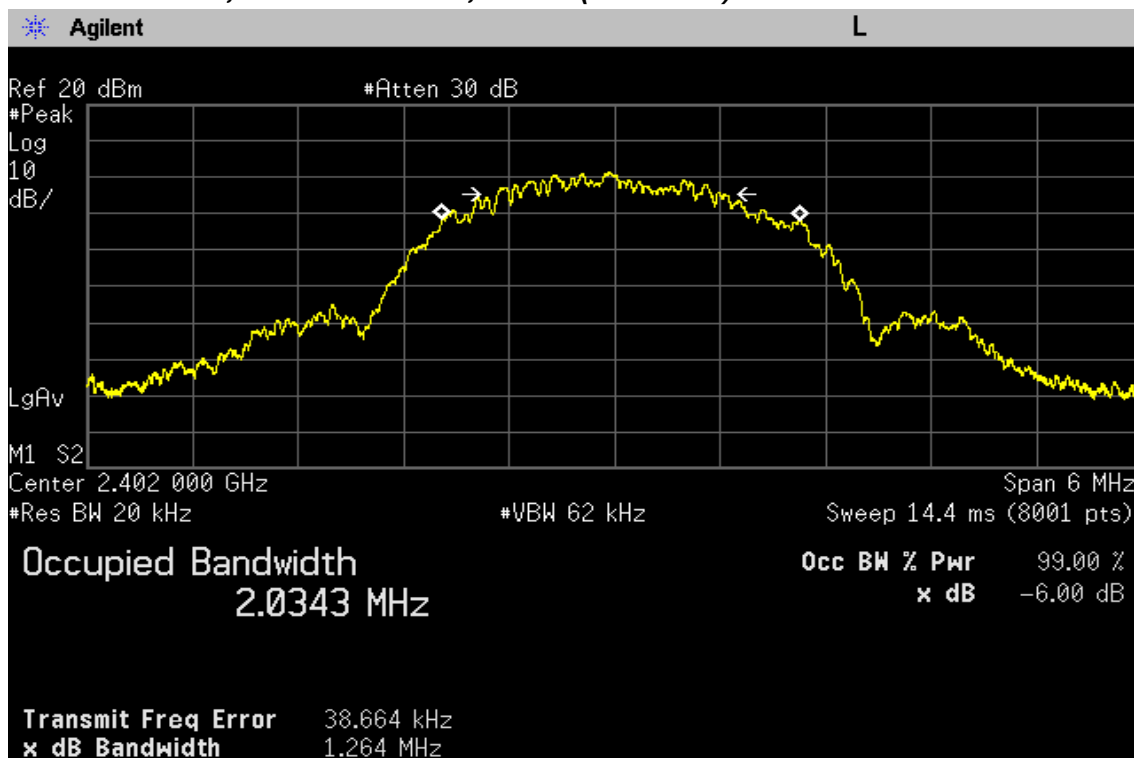


# PLOTS OF EMISSIONS

**6 dB Bandwidth, Lowest Channel, LE 2M (2402 MHz)**

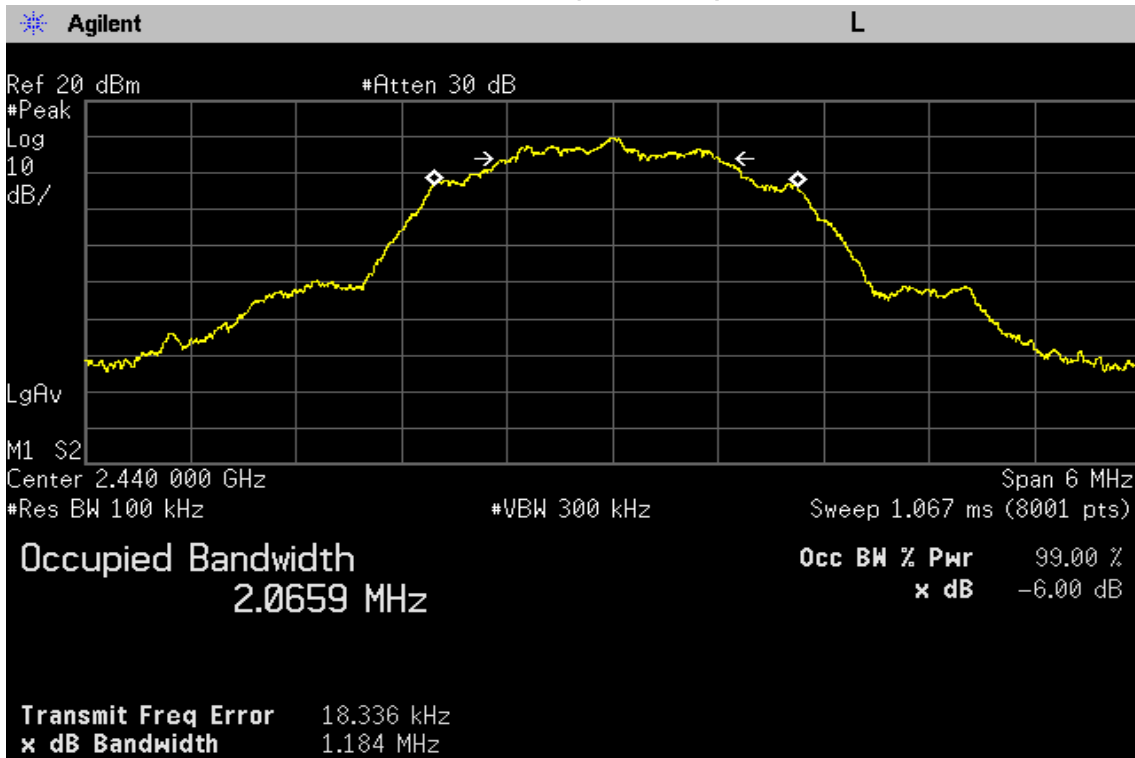


**99% Bandwidth, Lowest Channel, LE 2M (2402 MHz)**

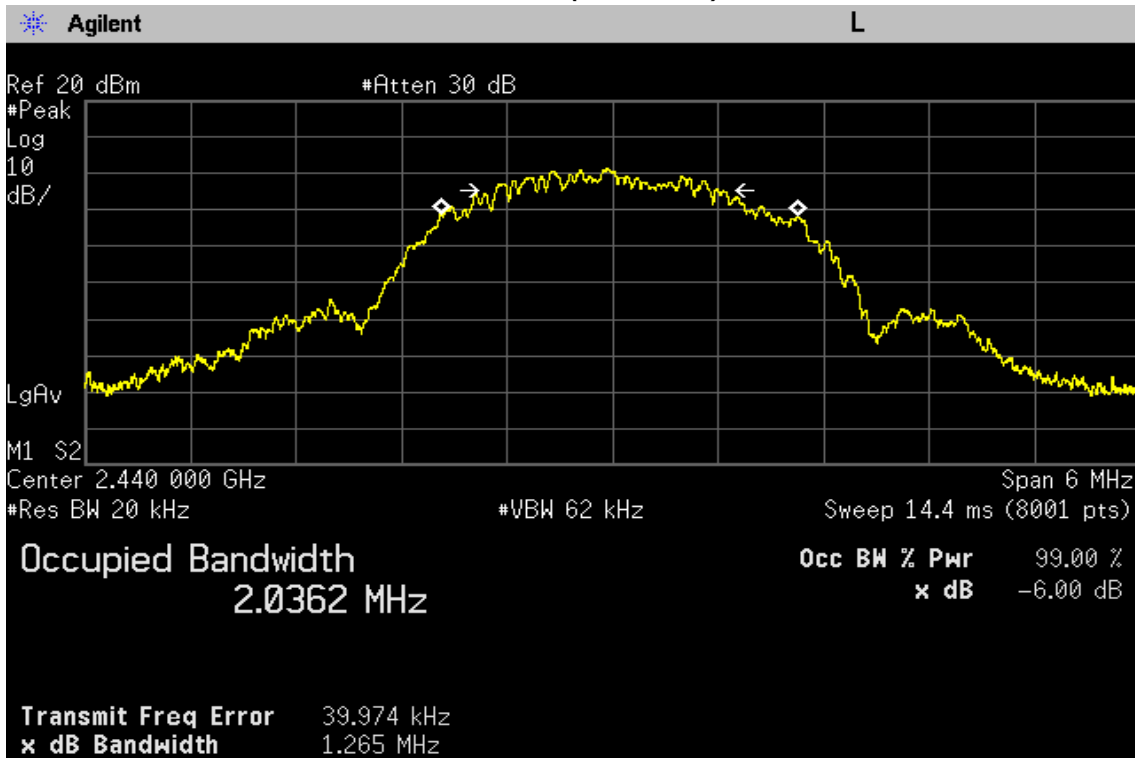


# PLOTS OF EMISSIONS

**6 dB Bandwidth, Middle Channel, LE 2M (2440 MHz)**

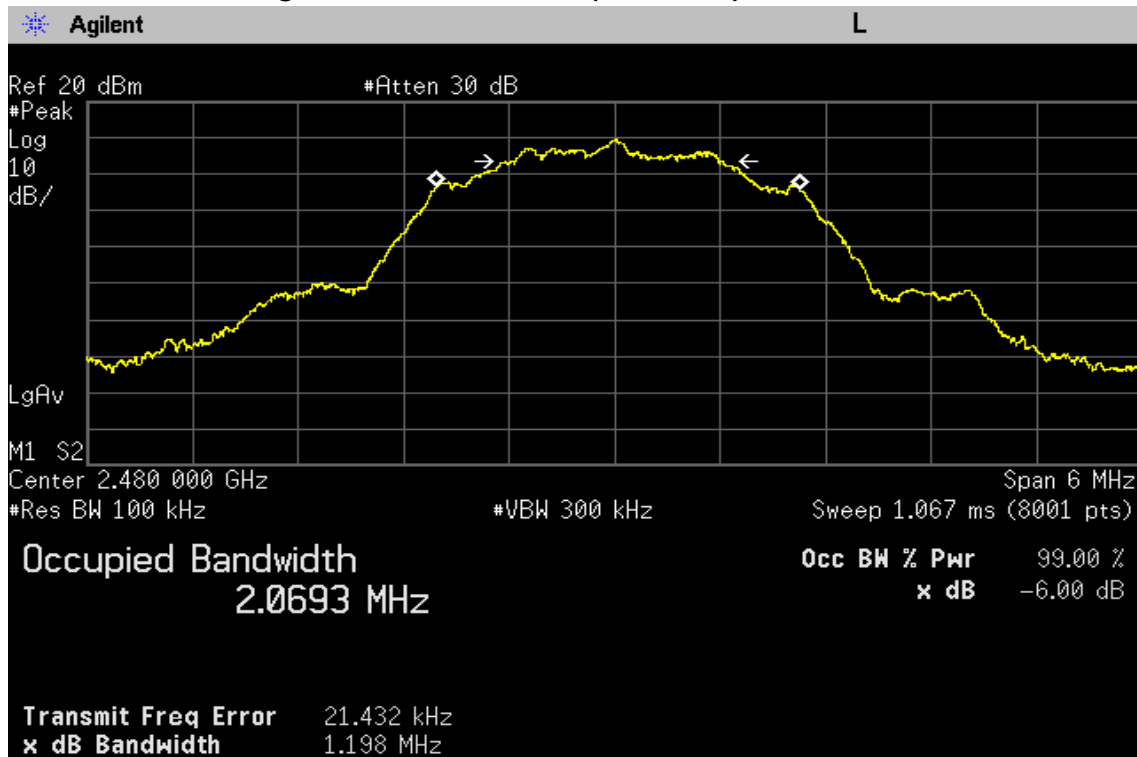


**99% Bandwidth, Middle Channel, LE 2M (2440 MHz)**

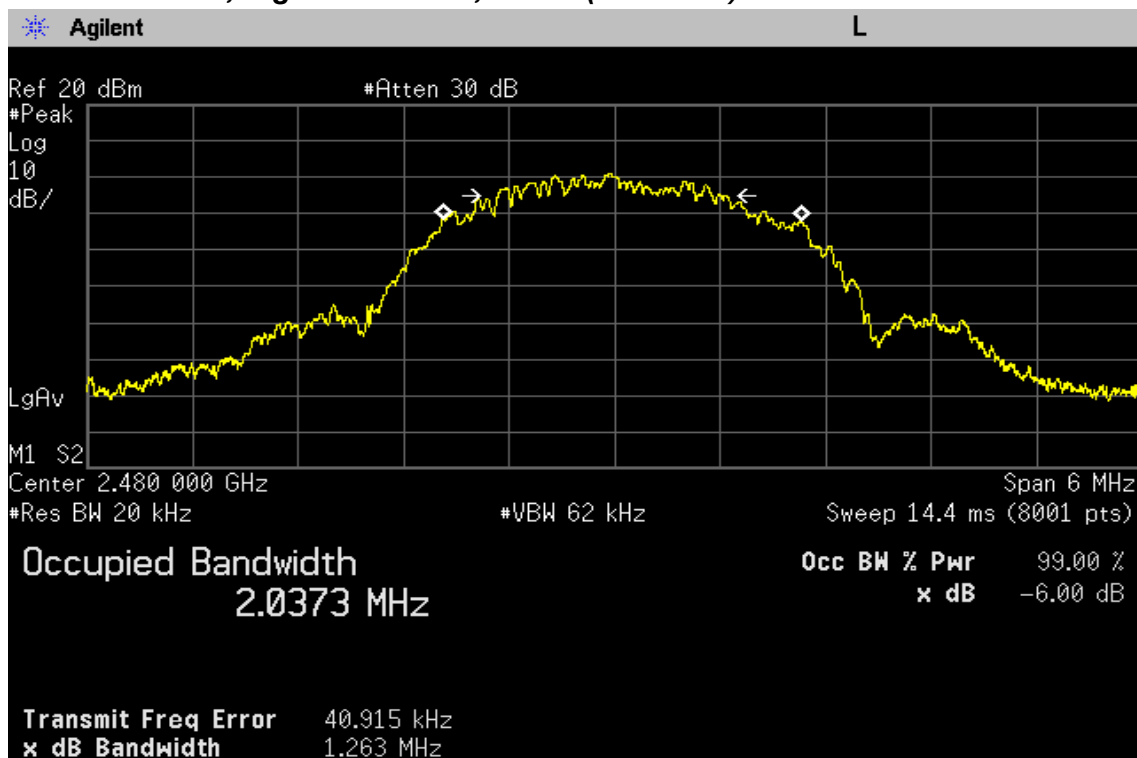


# PLOTS OF EMISSIONS

## 6 dB Bandwidth, Highest Channel, LE 2M (2480 MHz)



## 99% Bandwidth, Highest Channel, LE 2M (2480 MHz)



## TEST DATA

### 8.3 Peak Output Power and E.I.R.P.

#### FCC §15.247(b)(3), IC RSS-247 Issue 2 5.4

**Test Mode : Set to Lowest channel, Middle channel and Highest channel,**

#### Result

Mode	Channel	Frequency (MHz)	Peak Output Power (dBm)	Limit (dBm)	E.I.R.P (dBm)
LE 1M	Lowest	2402	11.01	30.00	4.11
	Middle	2440	11.07	30.00	4.17
	Highest	2480	10.78	30.00	3.88
LE 2M	Lowest	2402	11.07	30.00	4.17
	Middle	2440	11.06	30.00	4.16
	Highest	2480	10.88	30.00	3.98

#### **Note:**

1. E.I.R.P was calculated by following equation according to KDB412172 D01 Determining ERP and EIRP v01r01.

$$E.I.R.P = P_T + G_T - L_C$$

$P_T$  = Peak output power (dBm)

$G_T$  = Gain of the transmitting antenna in dBi, Directional antenna gain is **-6.9 dBi**.

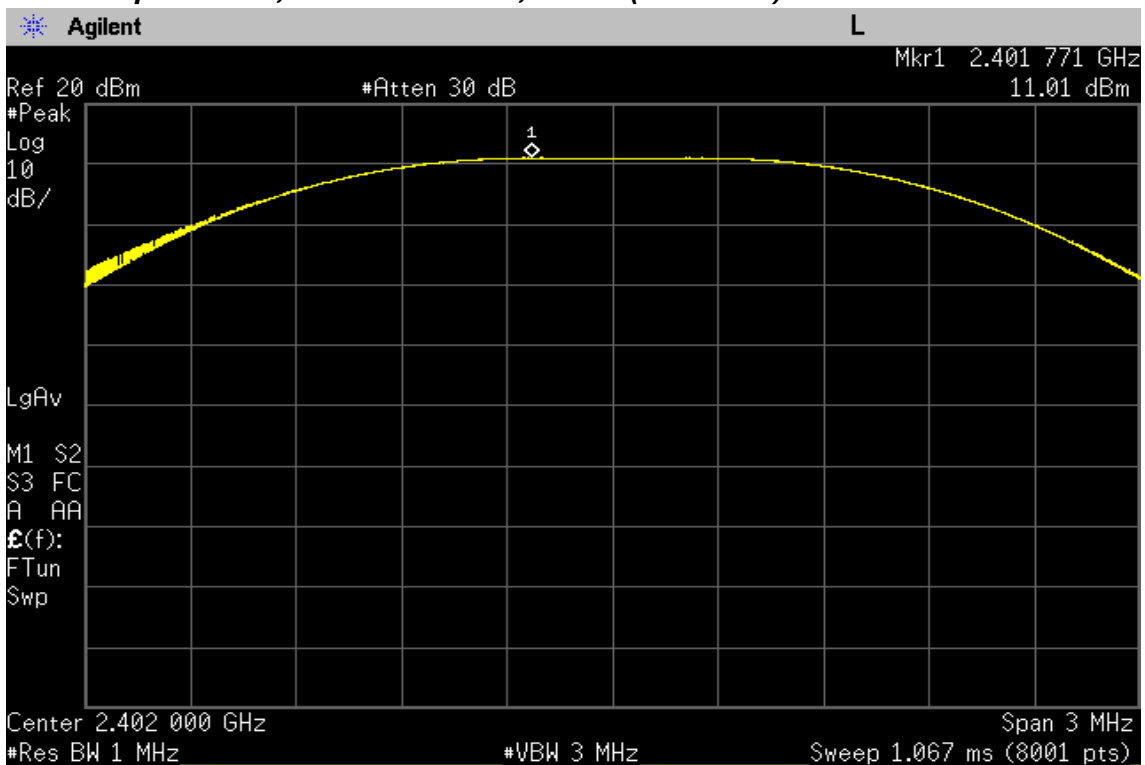
$L_C$  = Signal attenuation in the connecting cable between the transmitter and antenna in dB. This factor of an integral antenna is negligible.

2. The following equation was used for spectrum offset:

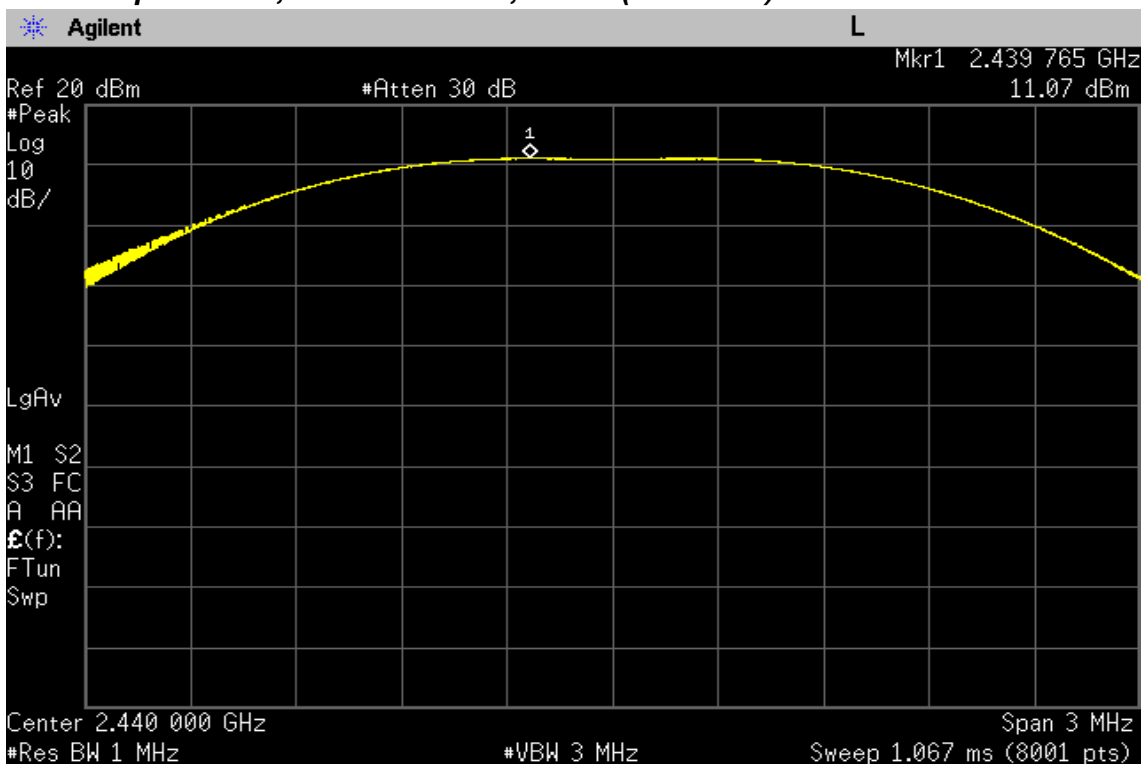
$$\text{Spectrum offset (dB)} = \text{Attenuator (dB)} + \text{Cable Loss (dB)} + \text{SMA Type Connector Loss (dB)}$$

# PLOTS OF EMISSIONS

**Peak Output Power, Lowest Channel, LE 1M (2402 MHz)**

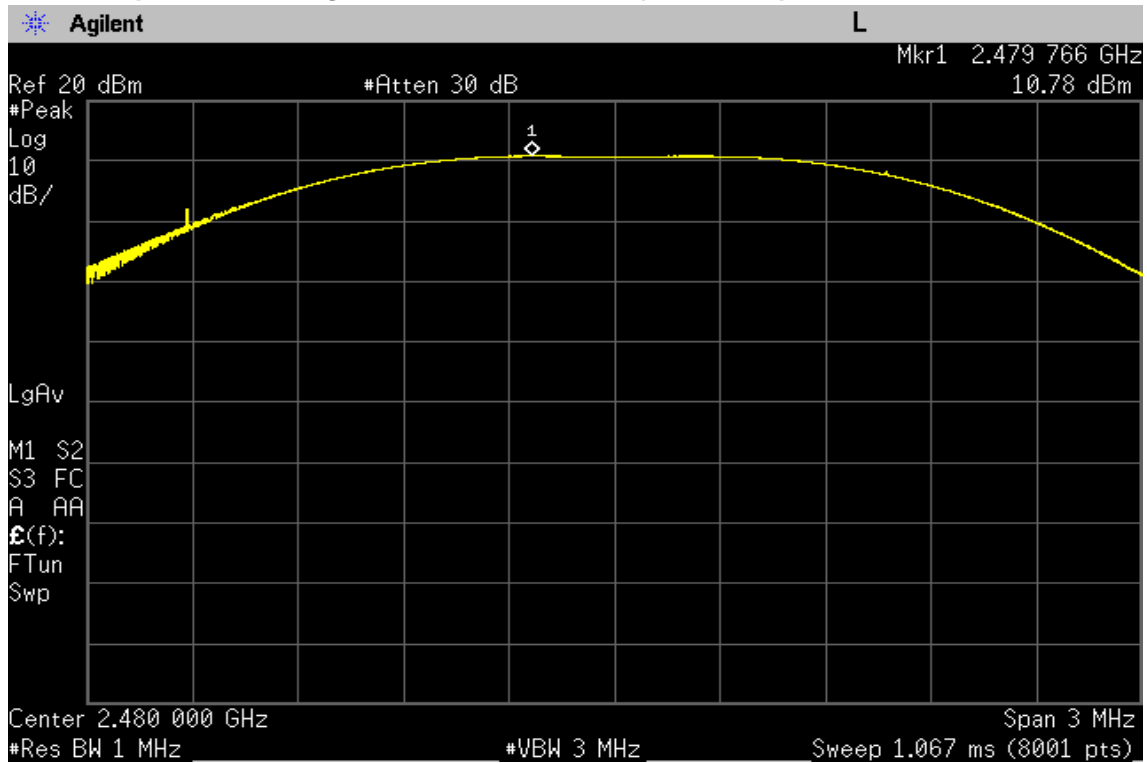


**Peak Output Power, Middle Channel, LE 1M (2440 MHz)**

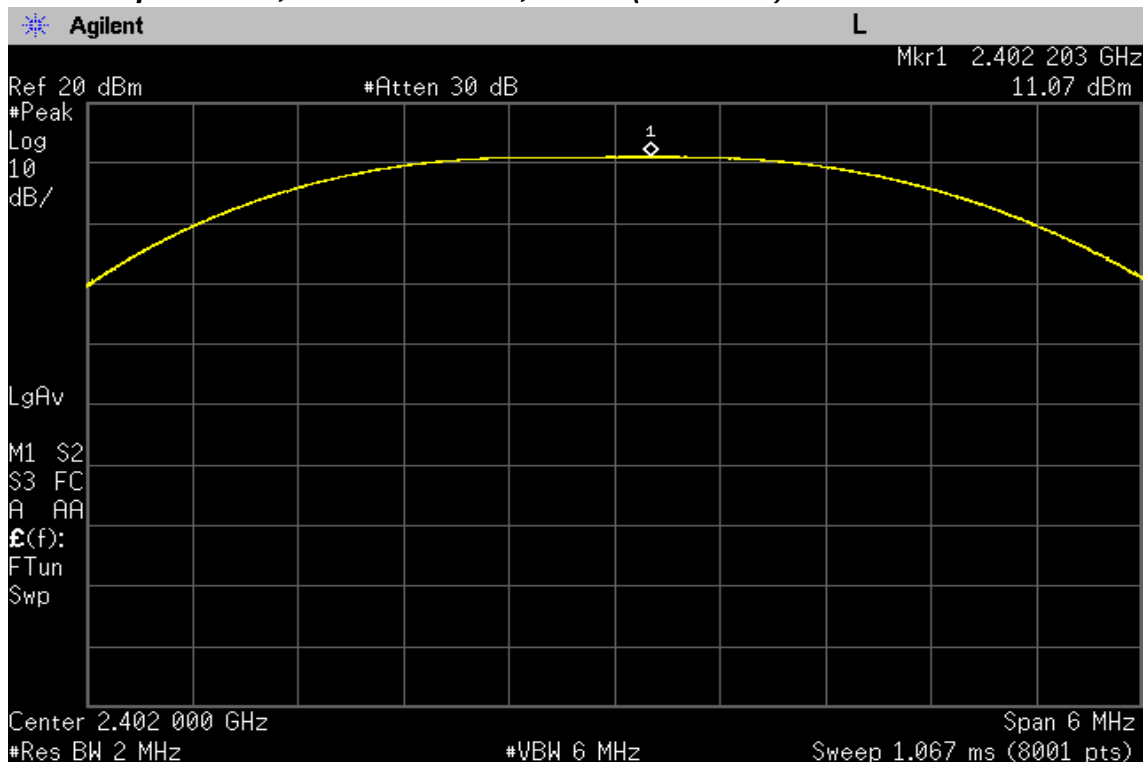


# PLOTS OF EMISSIONS

**Peak Output Power, Highest Channel, LE 1M (2480 MHz)**

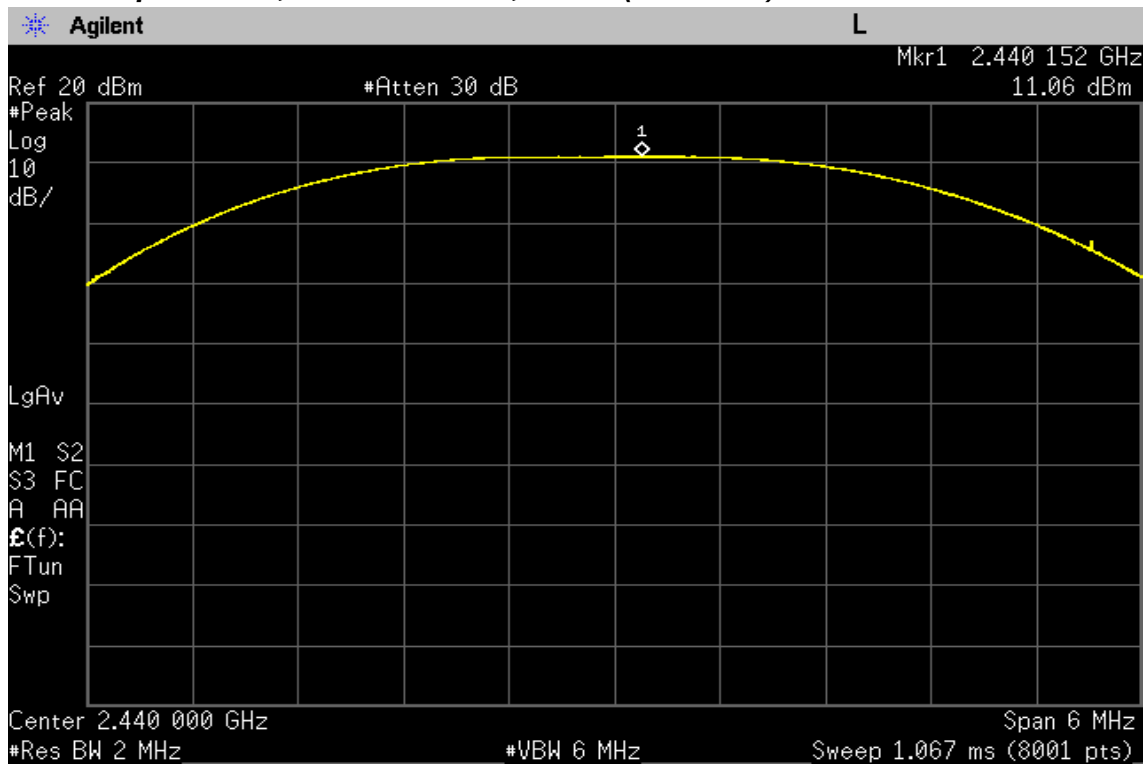


**Peak Output Power, Lowest Channel, LE 2M (2402 MHz)**

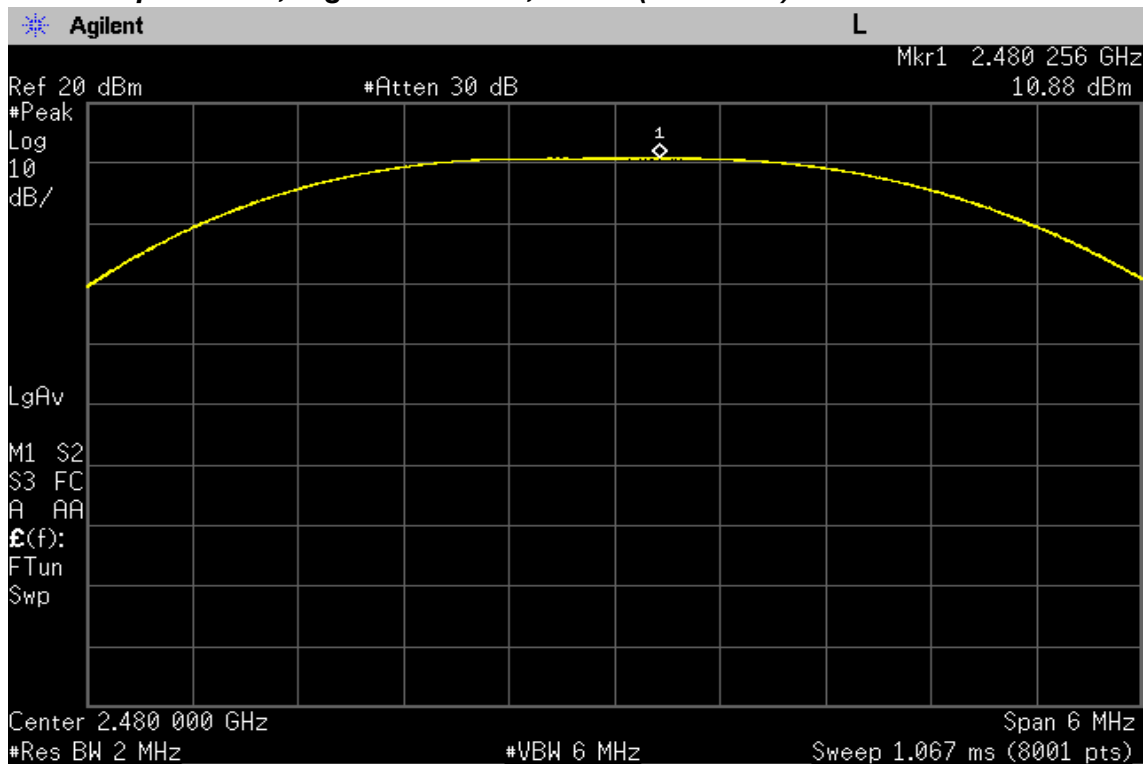


# PLOTS OF EMISSIONS

**Peak Output Power, Middle Channel, LE 2M (2440 MHz)**



**Peak Output Power, Highest Channel, LE 2M (2480 MHz)**





## TEST DATA

### 8.4 Peak Power Spectral Density

#### FCC §15.247(e), IC RSS-247 Issue 2 5.2

Test Mode : Set to Lowest channel, Middle channel and Highest channel,

#### Result

Mode	Channel	Frequency (MHz)	Peak Power Spectral Density (dBm/10kHz)	Limit (dBm/3kHz)
LE 1M	Lowest	2402	0.75	8.00
	Middle	2440	0.69	8.00
	Highest	2480	0.45	8.00
LE 2M	Lowest	2402	-1.28	8.00
	Middle	2440	-1.21	8.00
	Highest	2480	-1.51	8.00

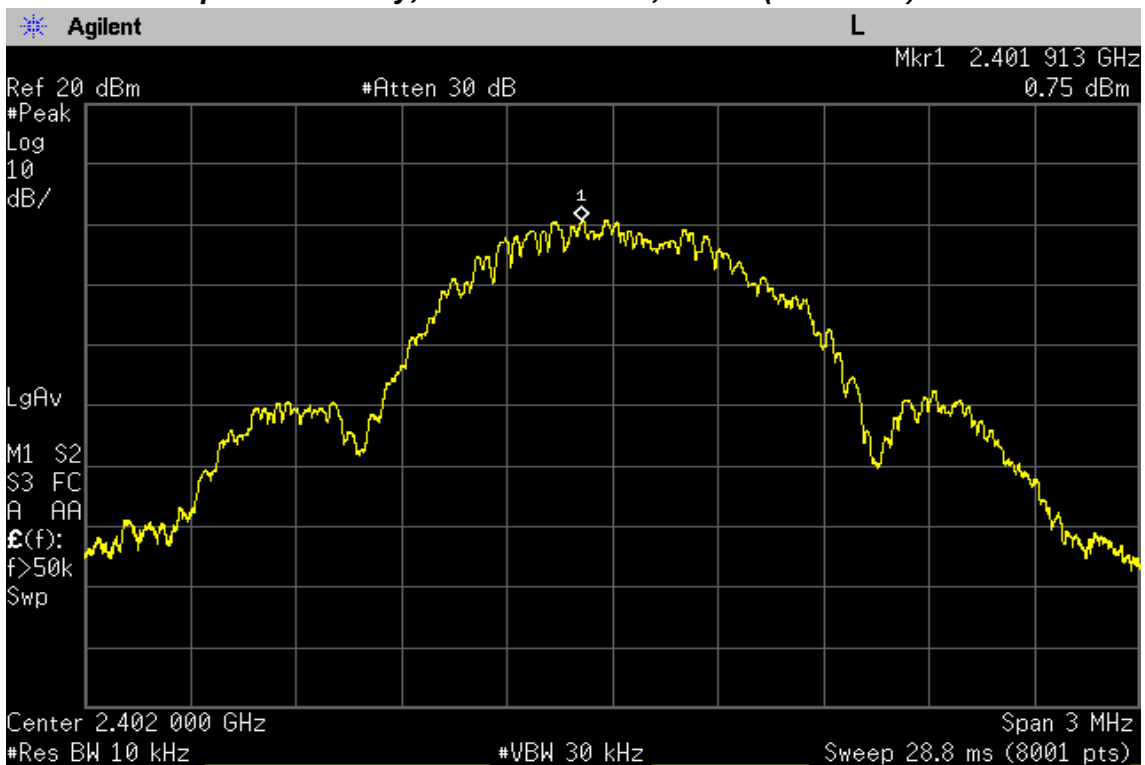
#### Note:

1. The following equation was used for spectrum offset:

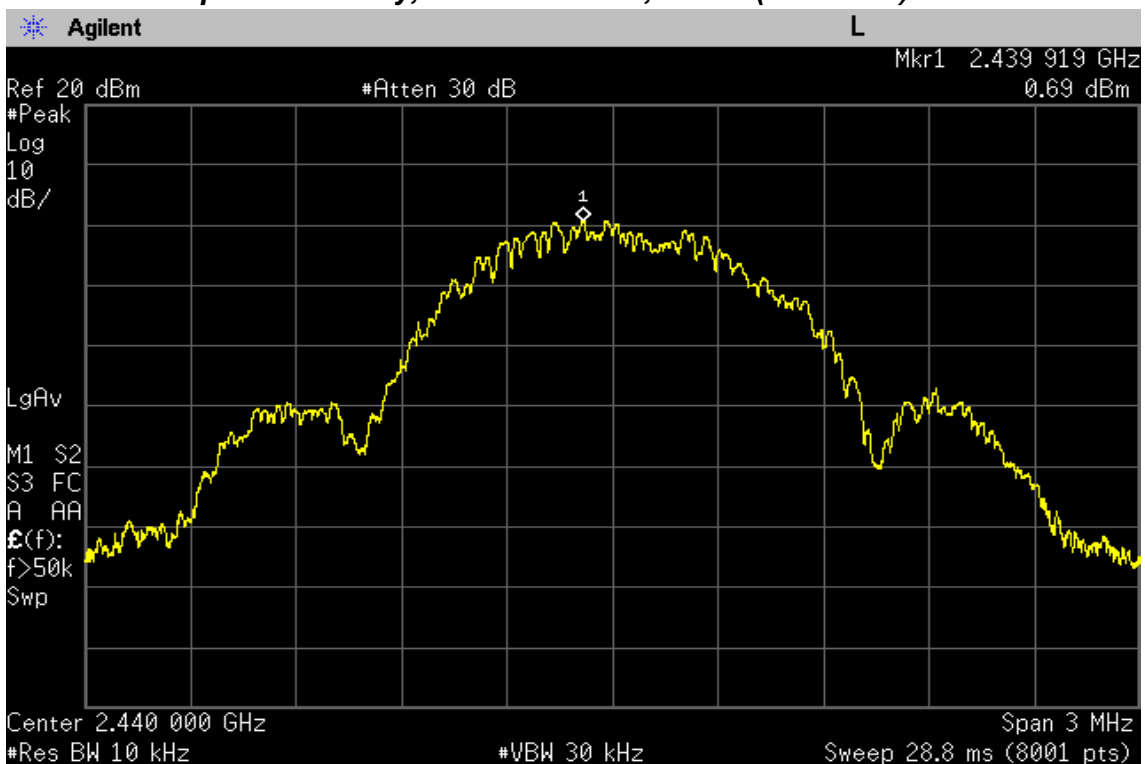
$$\text{Spectrum offset (dB)} = \text{Attenuator (dB)} + \text{Cable Loss (dB)} + \text{SMA Type Connector Loss (dB)}$$

# PLOTS OF EMISSIONS

**Peak Power Spectral Density, Lowest Channel, LE 1M (2402 MHz)**

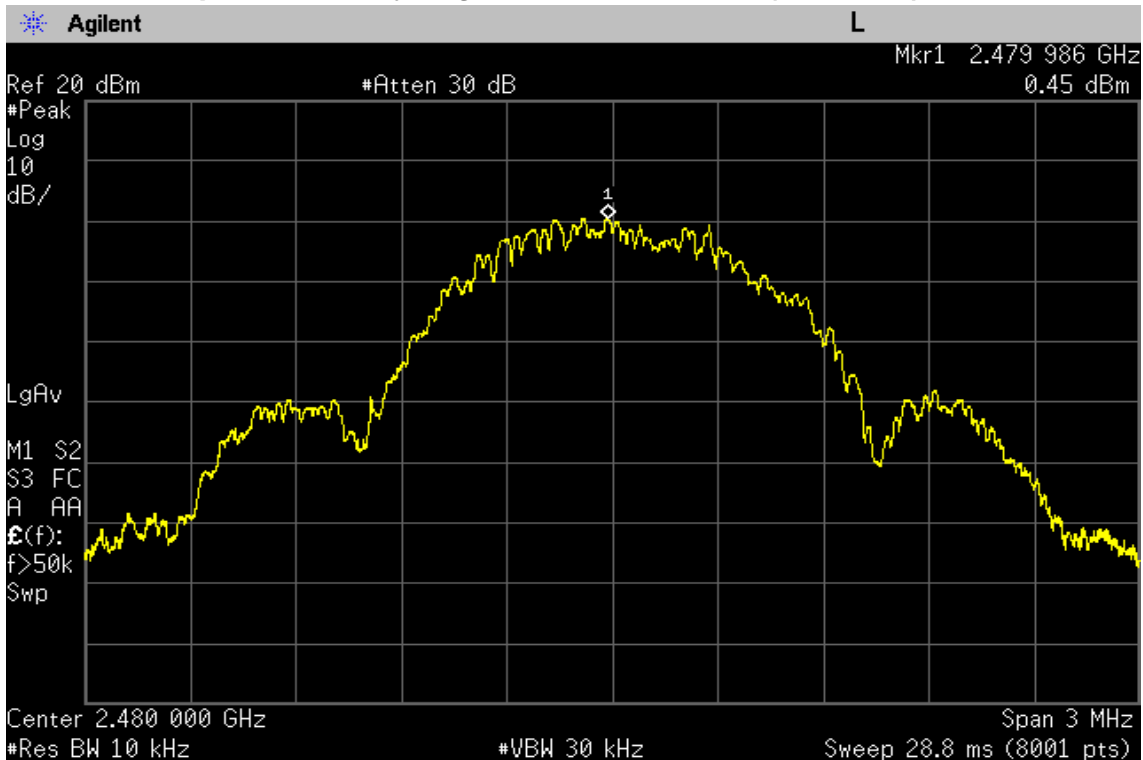


**Peak Power Spectral Density, Middle Channel, LE 1M (2440 MHz)**

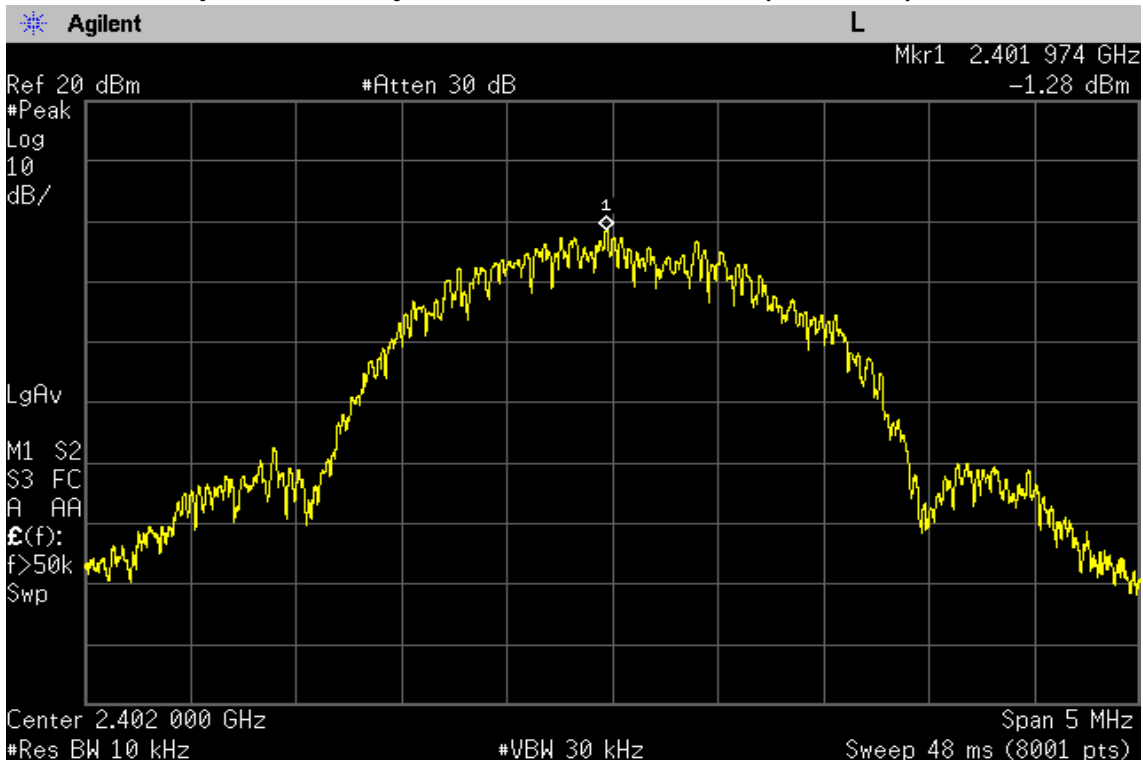


# PLOTS OF EMISSIONS

**Peak Power Spectral Density, Highest Channel, LE 1M (2480 MHz)**

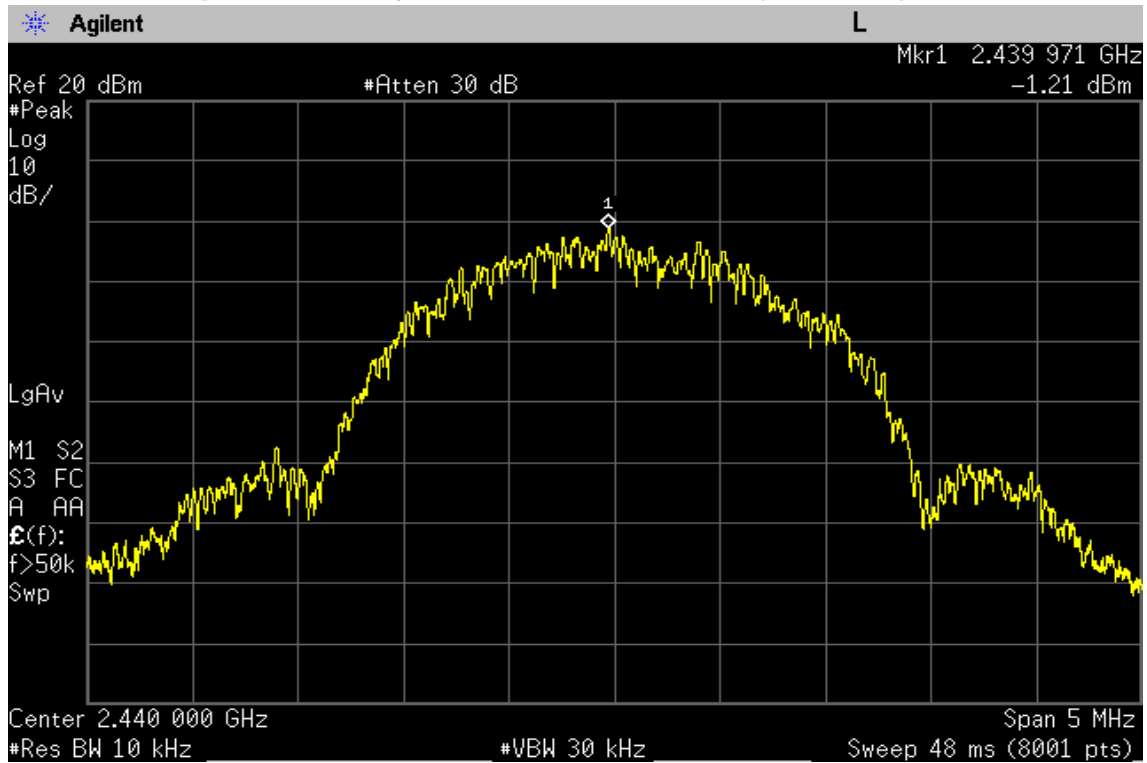


**Peak Power Spectral Density, Lowest Channel, LE 2M (2402 MHz)**

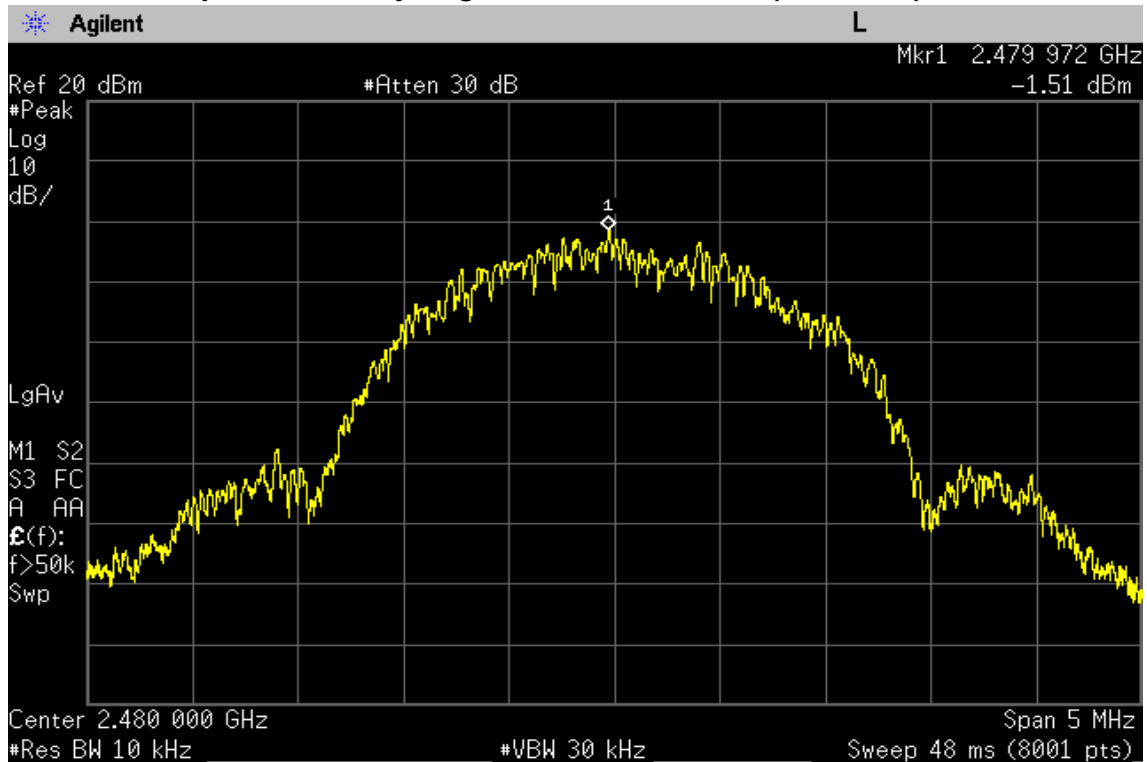


# PLOTS OF EMISSIONS

**Peak Power Spectral Density, Middle Channel, LE 2M (2440 MHz)**



**Peak Power Spectral Density, Highest Channel, LE 2M (2480 MHz)**



## TEST DATA

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### 8.5 Conducted Spurious Emissions

#### FCC §15.247(d), IC RSS-247 Issue 2 5.5

**Test Mode : Set to Lowest channel, Middle channel and Highest channel,**

#### Result

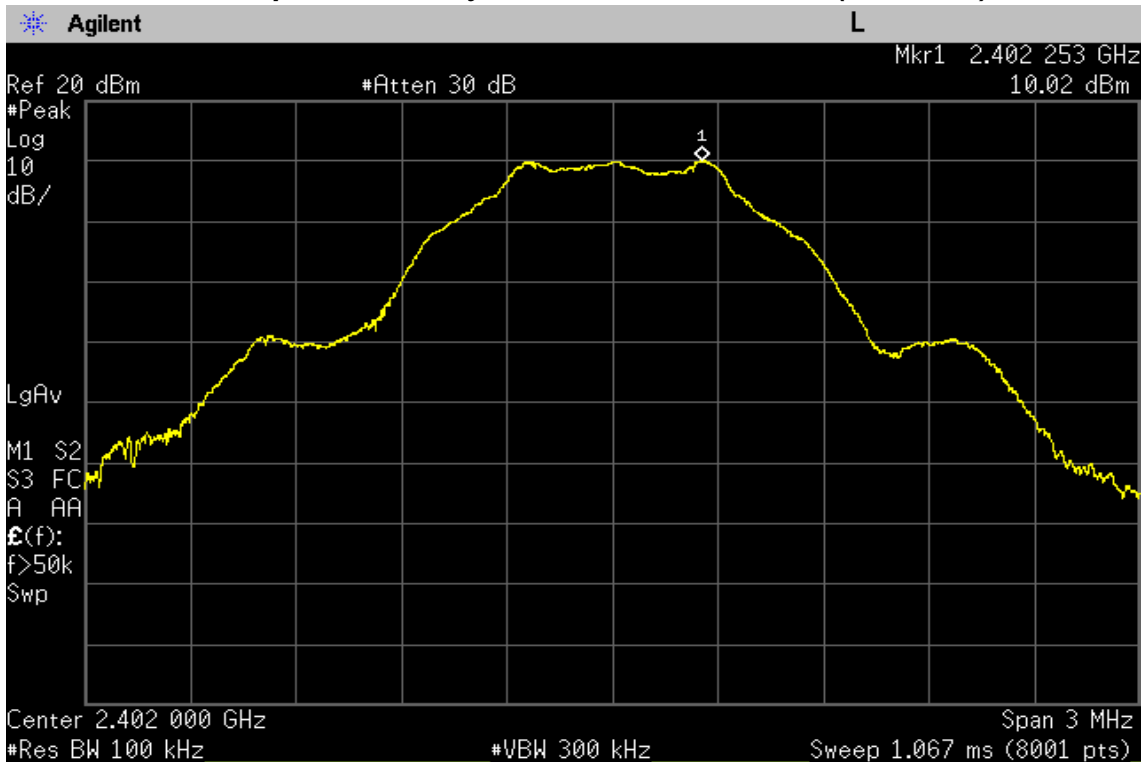
Mode	Channel	Frequency (MHz)	Reference Level (dBm/100kHz)	Conducted Spurious Emissions (dBc)	Limit (dBc)
LE 1M	Lowest	2402	10.02	More than 20 dBc	20
	Middle	2440	10.07	More than 20 dBc	20
	Highest	2480	9.75	More than 20 dBc	20
LE 2M	Lowest	2402	9.79	More than 20 dBc	20
	Middle	2440	9.82	More than 20 dBc	20
	Highest	2480	9.51	More than 20 dBc	20

#### **Notes:**

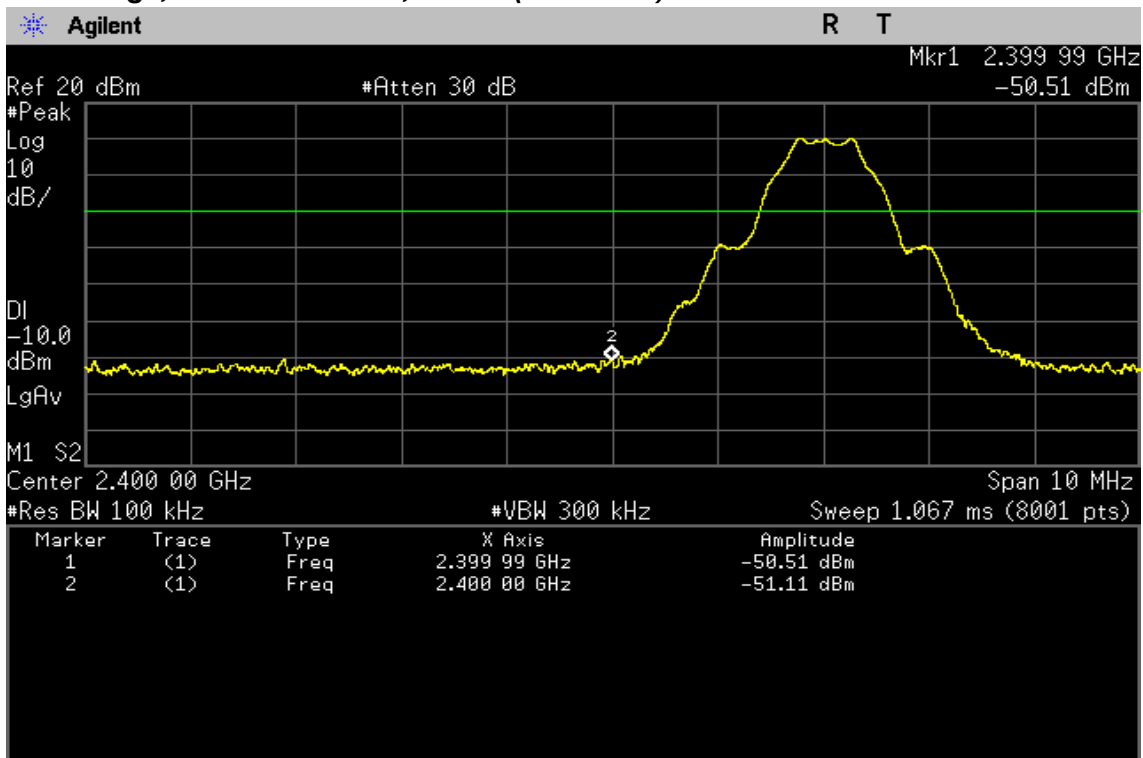
*The cable and attenuator loss from 30 MHz to 26.5 GHz was reflected in spectrum analyzer with correction factor for the spurious emissions test.*

# PLOTS OF EMISSIONS

**Reference Power Spectral Density, Lowest Channel, LE 1M (2402 MHz)**

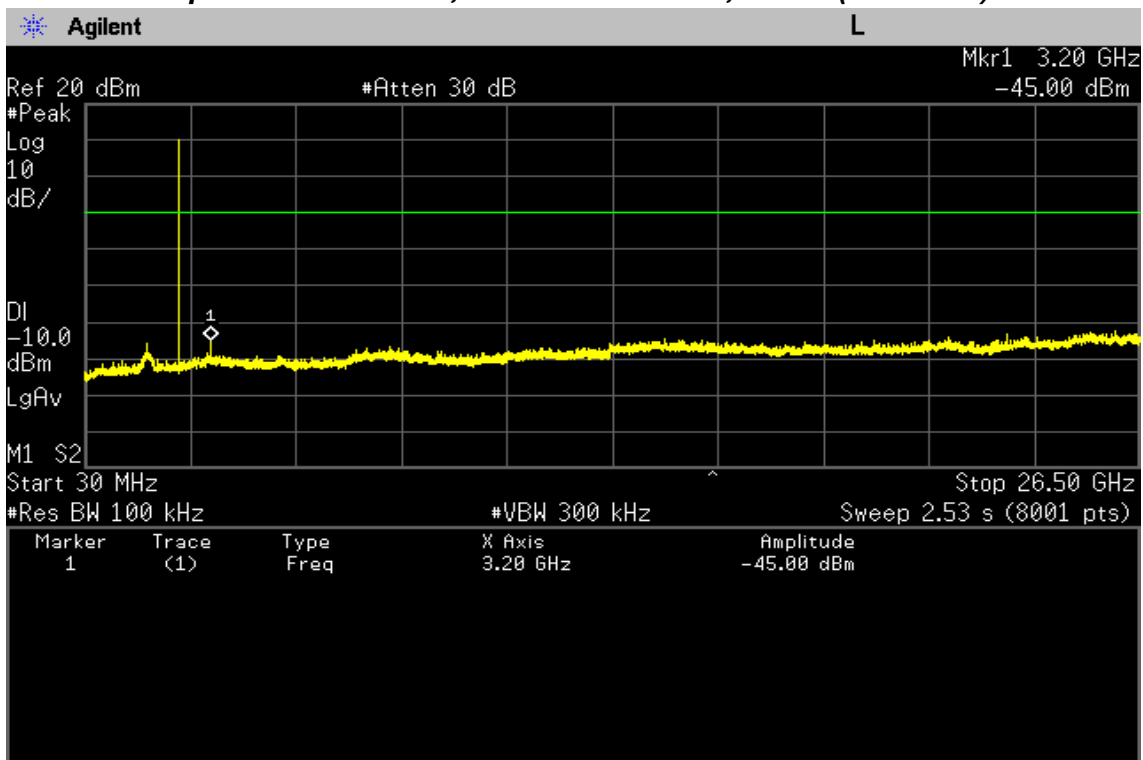


**Band Edge, Lowest Channel, LE 1M (2402 MHz)**

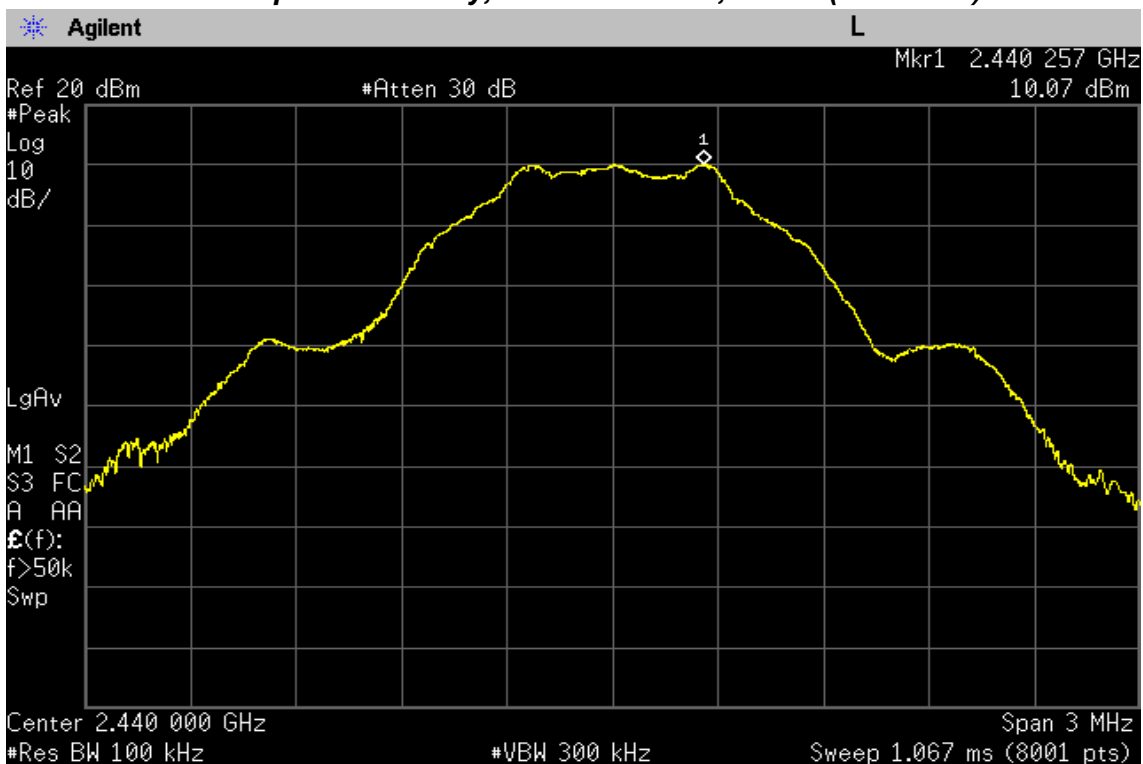


# PLOTS OF EMISSIONS

**Conducted Spurious Emissions, 30 MHz ~ 26.5 GHz, LE 1M (2402 MHz)**

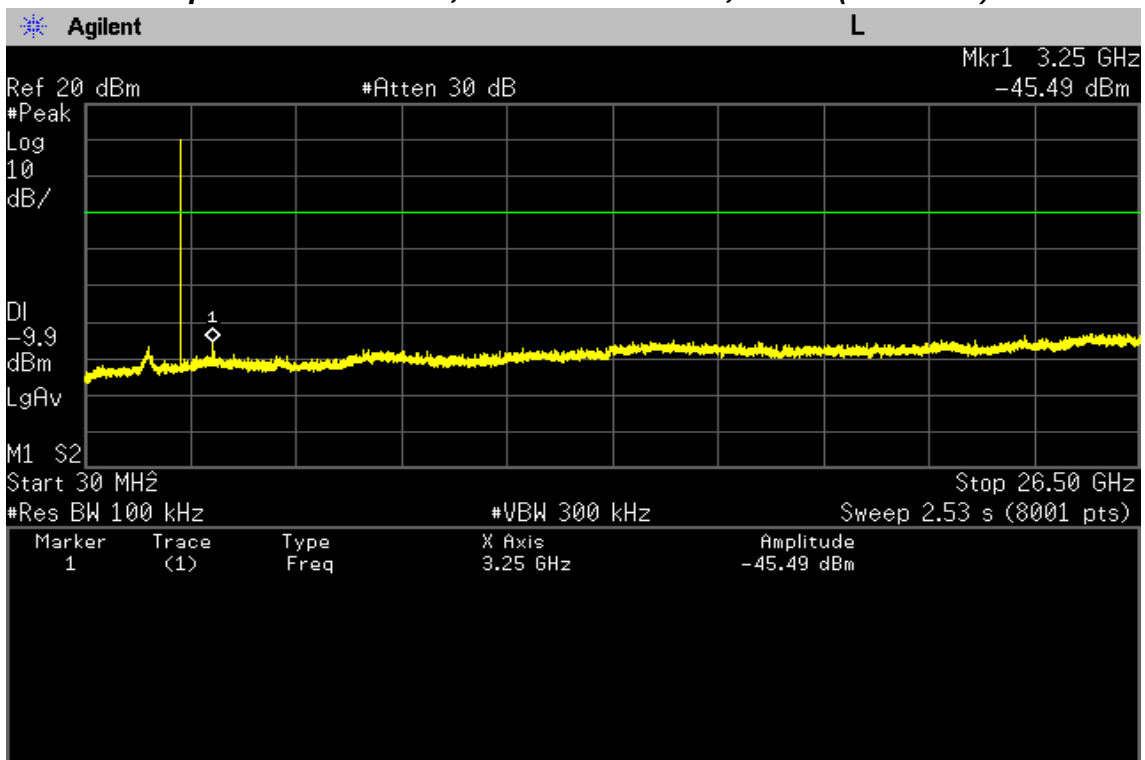


**Reference Power Spectral Density, Middle Channel, LE 1M (2440 MHz)**

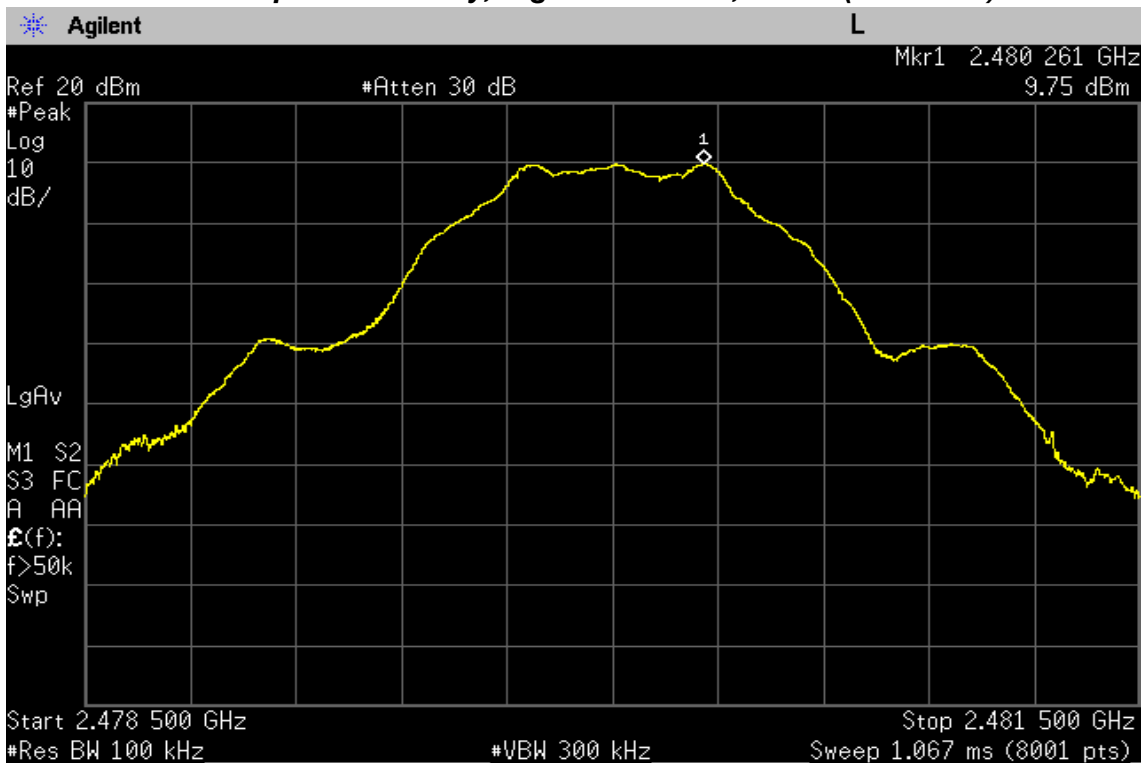


# PLOTS OF EMISSIONS

**Conducted Spurious Emissions, 30 MHz ~ 26.5 GHz, LE 1M (2440 MHz)**



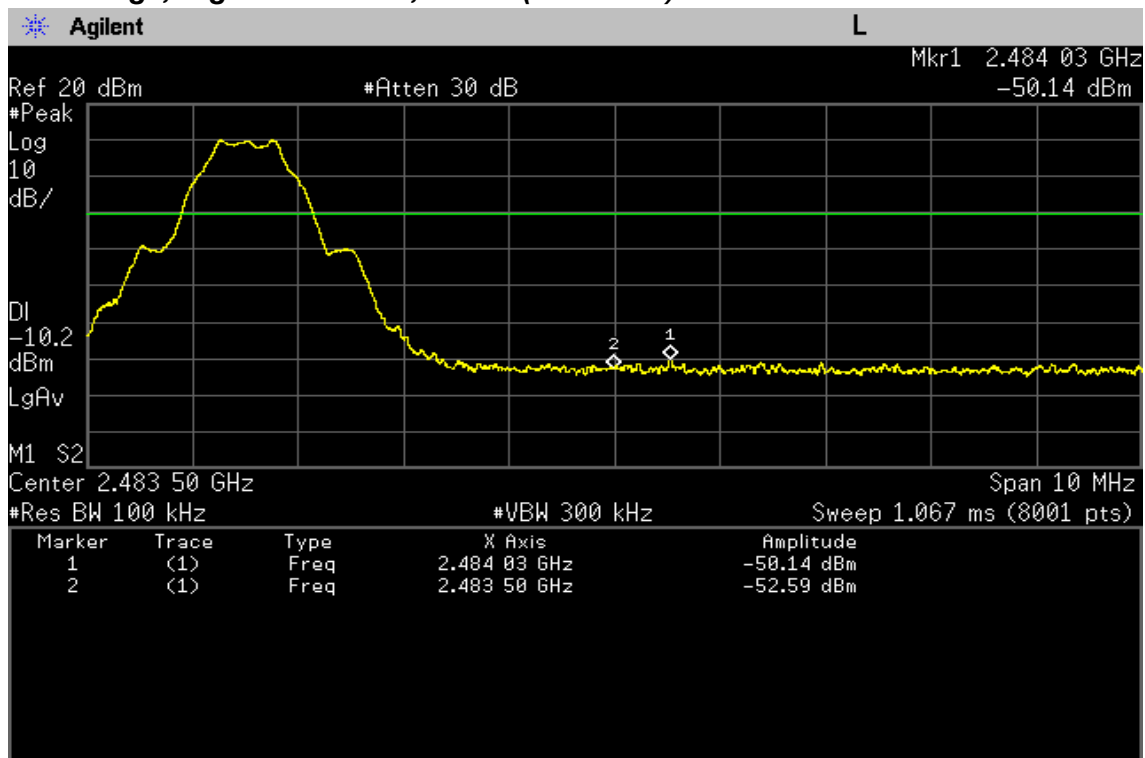
**Reference Power Spectral Density, Highest Channel, LE 1M (2480 MHz)**



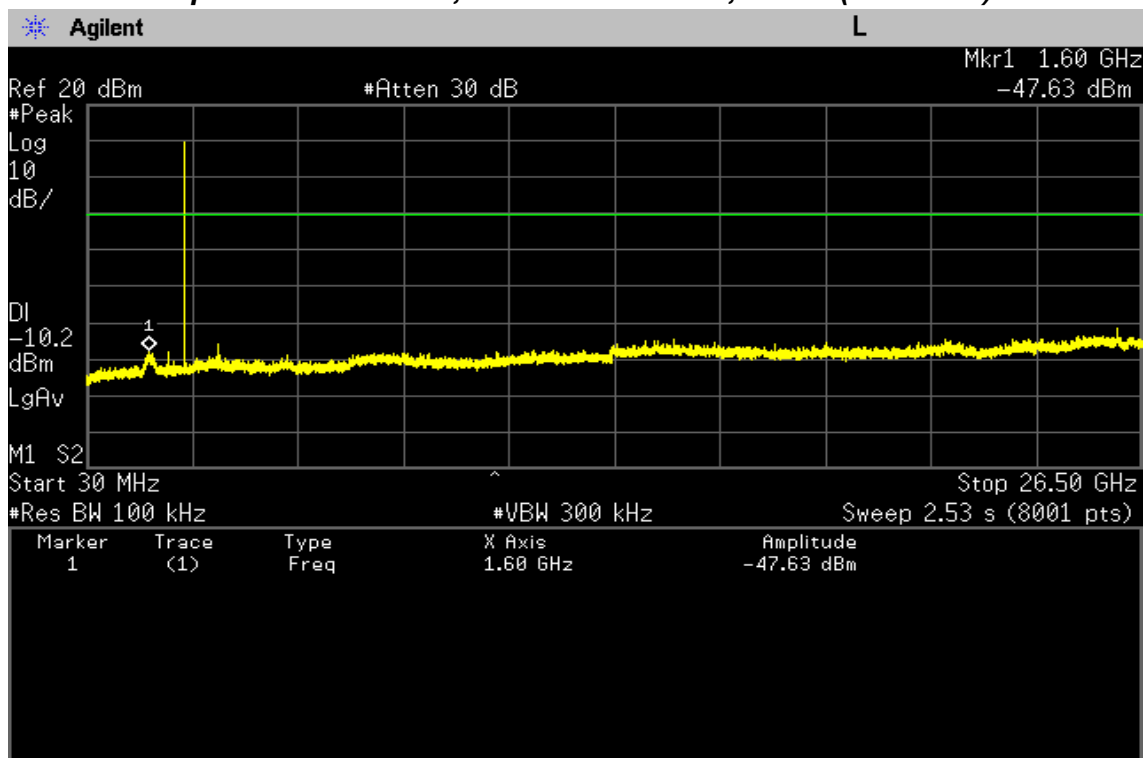


# PLOTS OF EMISSIONS

## Band Edge, Highest Channel, LE 1M (2480 MHz)

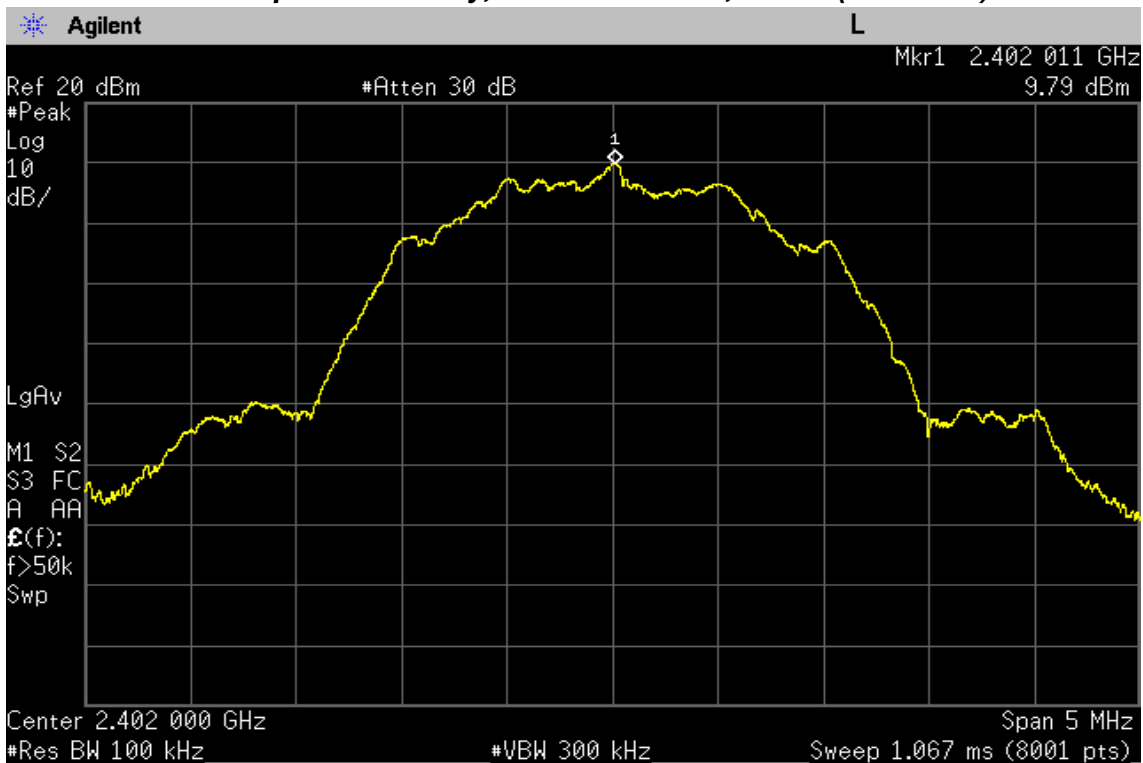


## Conducted Spurious Emissions, 30 MHz ~ 26.5 GHz, LE 1M (2480 MHz)

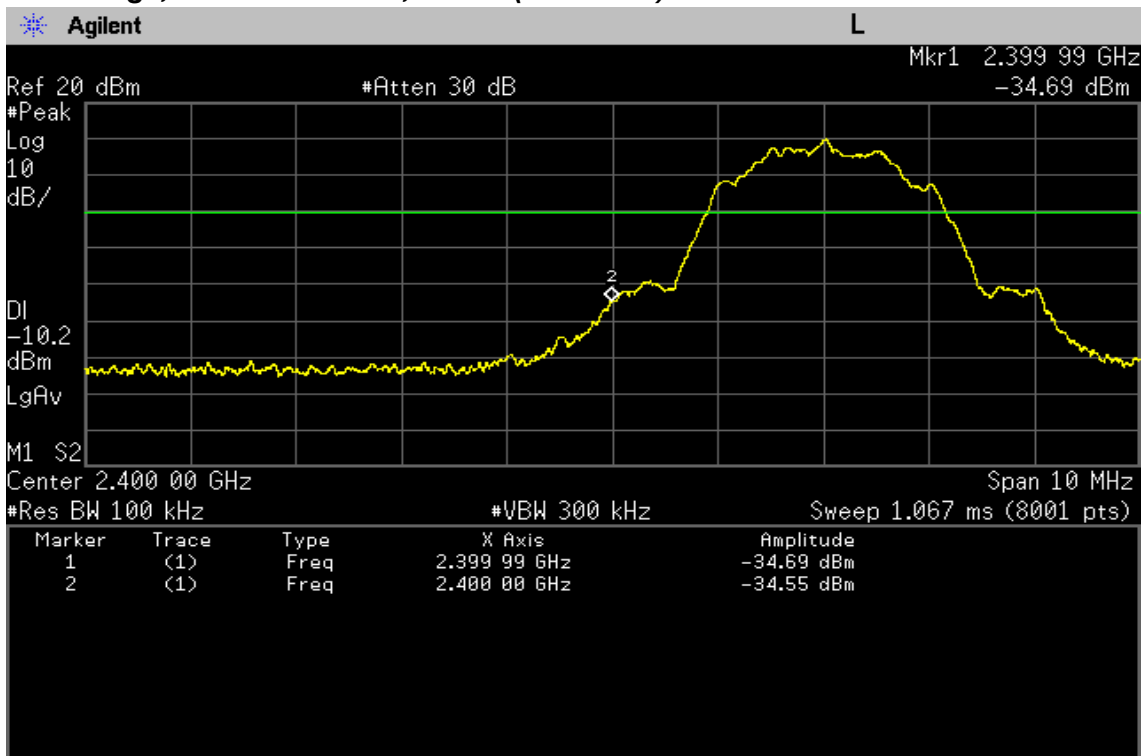


# PLOTS OF EMISSIONS

**Reference Power Spectral Density, Lowest Channel, LE 2M (2402 MHz)**

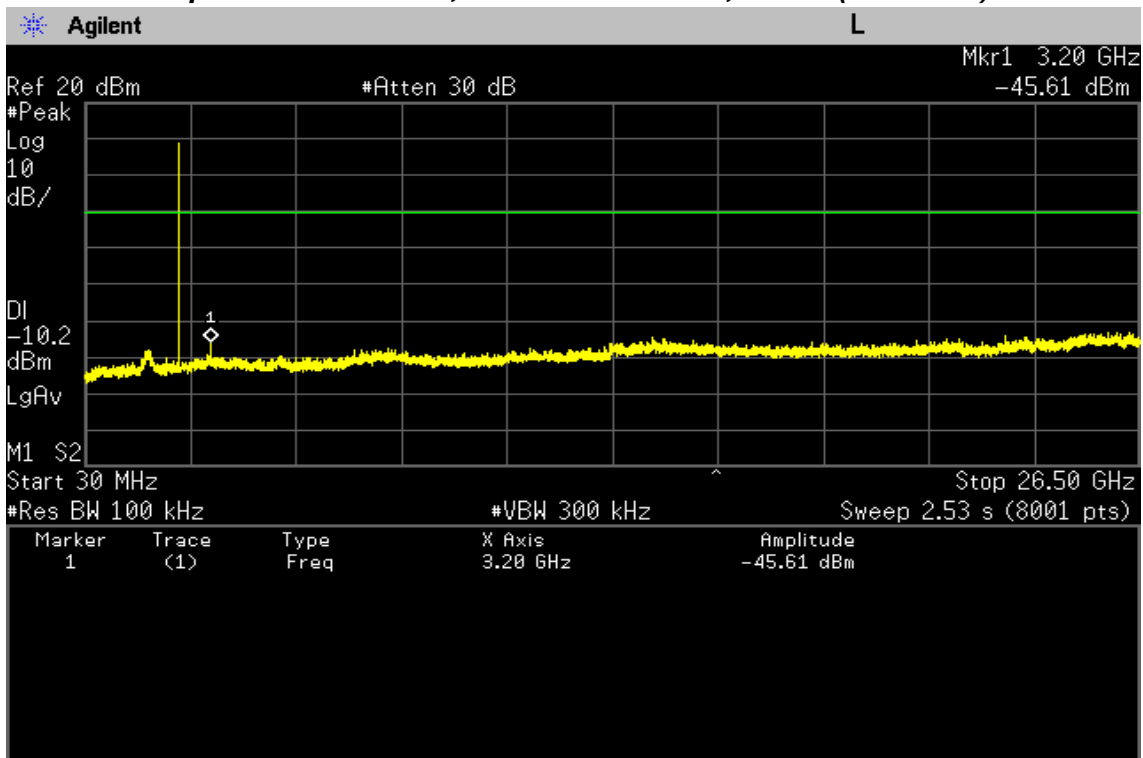


**Band Edge, Lowest Channel, LE 2M (2402 MHz)**

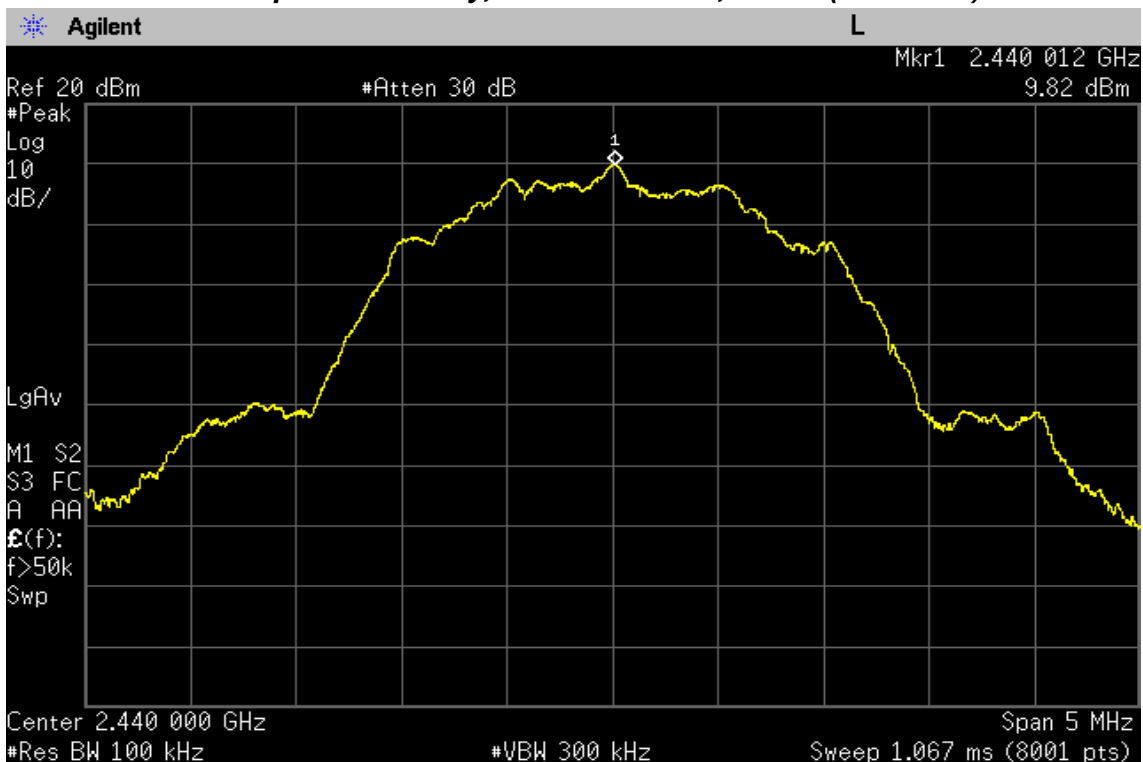


# PLOTS OF EMISSIONS

**Conducted Spurious Emissions, 30 MHz ~ 26.5 GHz, LE 2M (2402 MHz)**

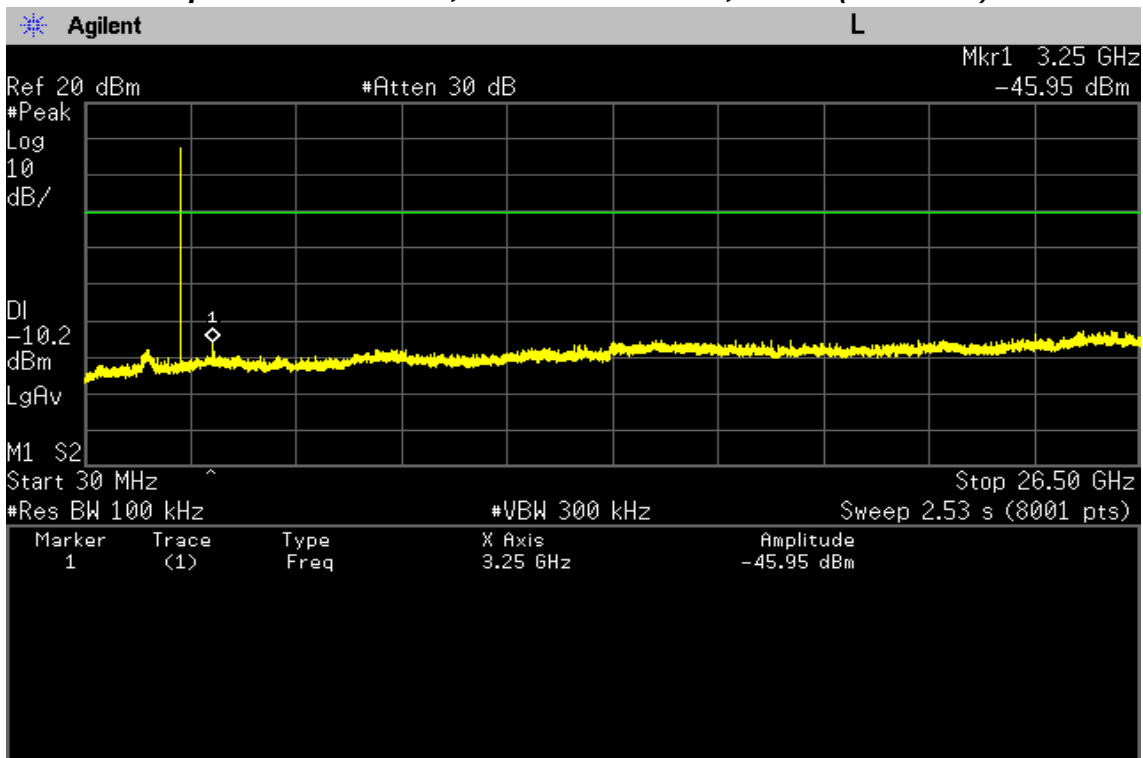


**Reference Power Spectral Density, Middle Channel, LE 2M (2440 MHz)**

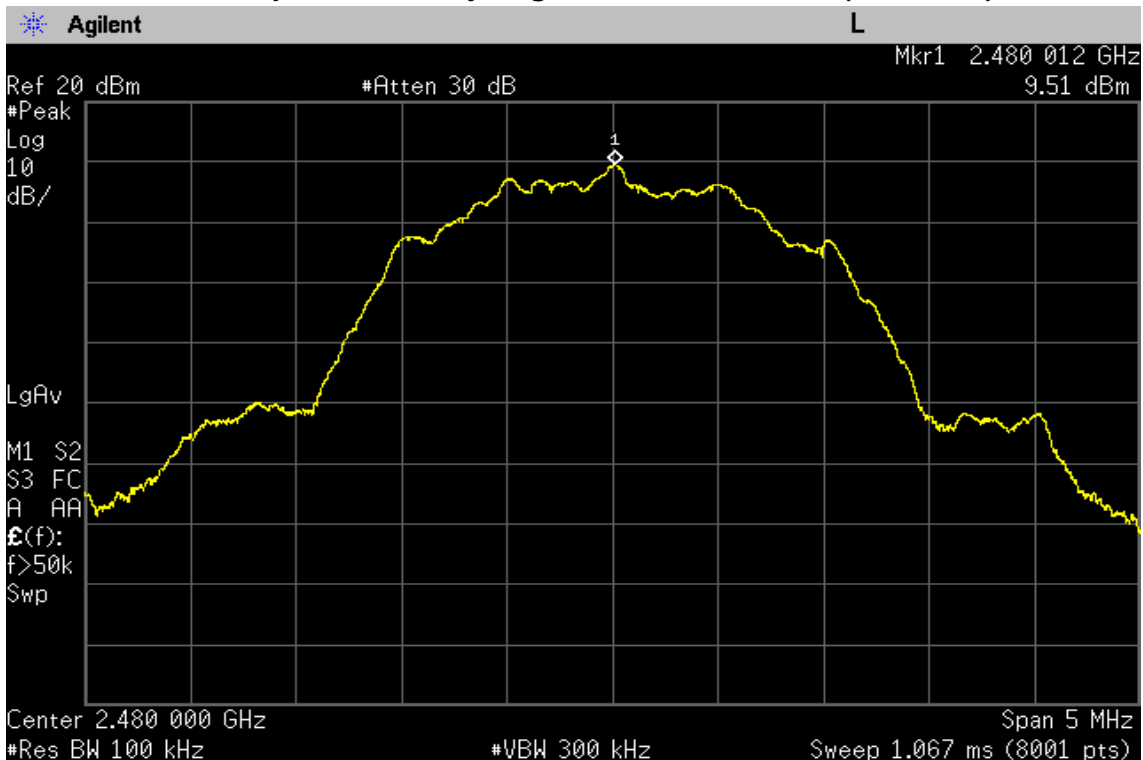


# PLOTS OF EMISSIONS

**Conducted Spurious Emissions, 30 MHz ~ 26.5 GHz, LE 2M (2440 MHz)**

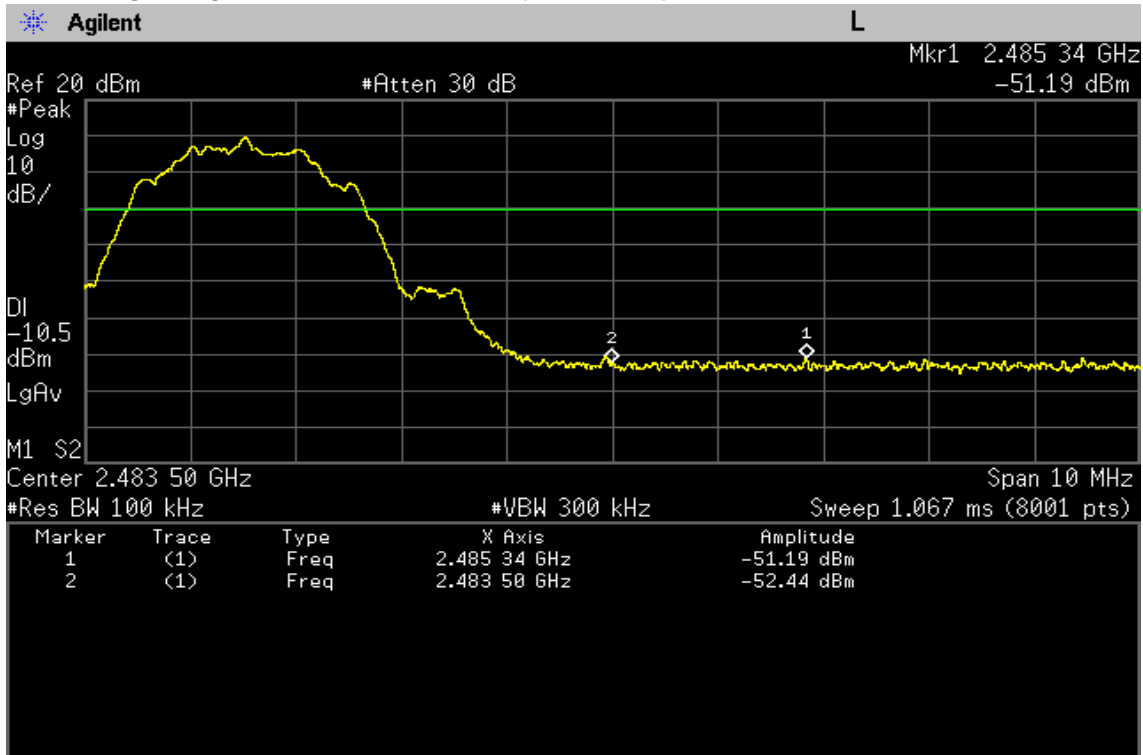


**Reference Power Spectral Density, Highest Channel, LE 2M (2480 MHz)**

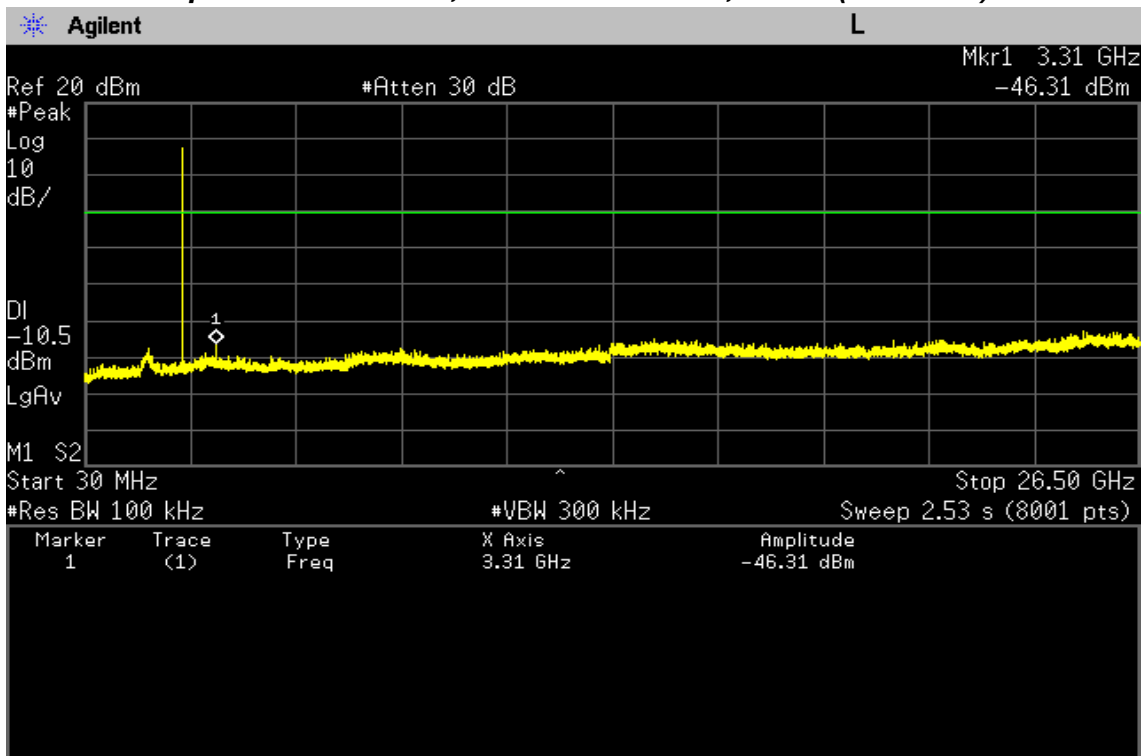


# PLOTS OF EMISSIONS

## Band Edge, Highest Channel, LE 2M (2480 MHz)



## Conducted Spurious Emissions, 30 MHz ~ 26.5 GHz, LE 2M (2480 MHz)



# TEST DATA

## 8.6 Radiated Spurious Emissions

### FCC §15.247(d), IC RSS-247 Issue 2 5.5

**Test Mode : Set to Lowest channel, Middle channel and Highest channel,**

### Result

#### **LE 2M\_Lowest Channel**

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
7668.17	39.0	V	peak	9.3	48.3	74.0	25.7

#### **LE 2M\_Middle Channel**

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
7663.00	39.0	V	peak	9.3	48.3	74.0	25.7

#### **LE 2M\_Highest Channel**

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
7665.50	39.5	V	peak	9.3	48.8	74.0	25.2

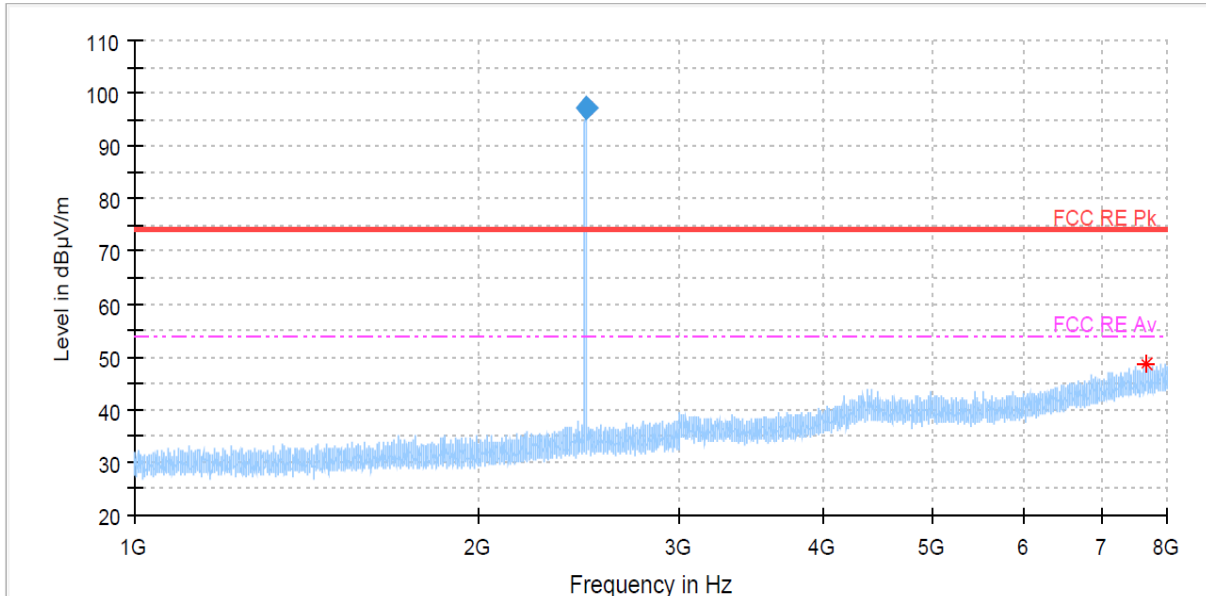
### **Note:**

- \*Pol. H = Horizontal V = Vertical
- \*\*AF + CL + Amp. = Antenna Factor + Cable Loss + Amplifier.
- Average measurement was not performed when peak-detected emission complies with the average limit.
- Other spurious was under 20 dB below Fundamental.
- Highest channel (2480 MHz) in LE 2M mode was the worst condition.
- The radiated emissions testing were made by rotating EUT through three orthogonal axes and rotating the receive antenna with horizontal, Vertical polarization. The worst data was recorded. (X-axis Above 1GHz)
- Peak emissions were measured using RBW = 1 MHz, VBW = 3 MHz, Detector = Peak.
- Average emissions were measured using RBW = 1 MHz, VBW = 10 kHz, Detector = Peak.
- The spectrum was measured from 9 kHz to 10<sup>th</sup> harmonic and the worst-case emissions were reported. No significant emissions were found beyond the 2nd harmonic for this device.

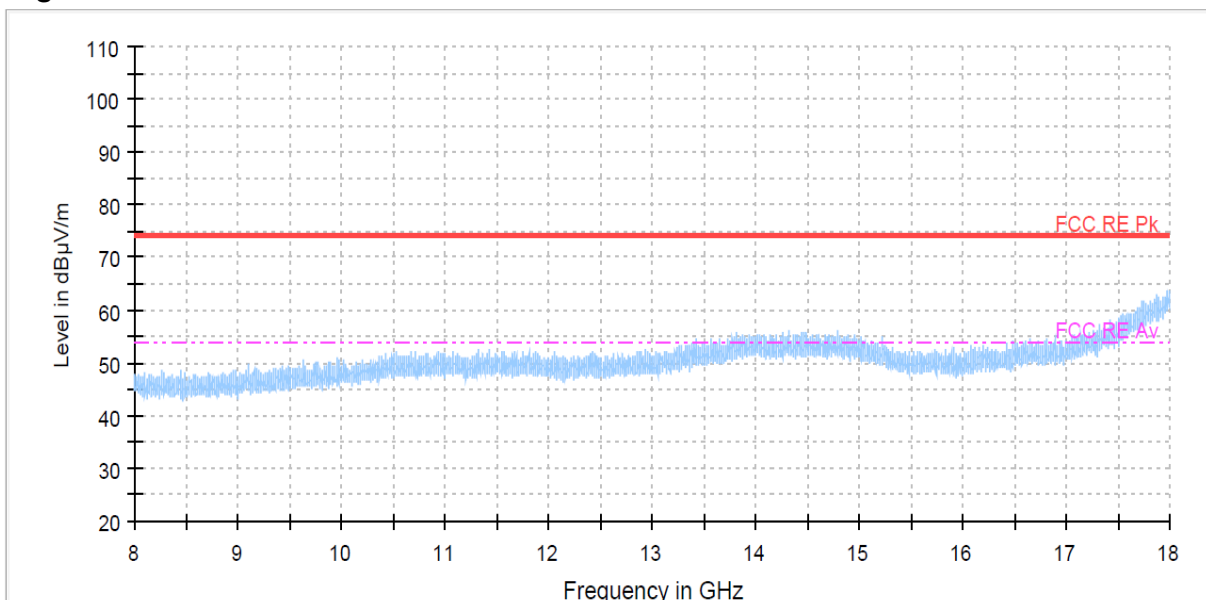
# PLOTS OF EMISSIONS

## Worst Case

### Highest channel : 1 GHz to 8 GHz\_Peak

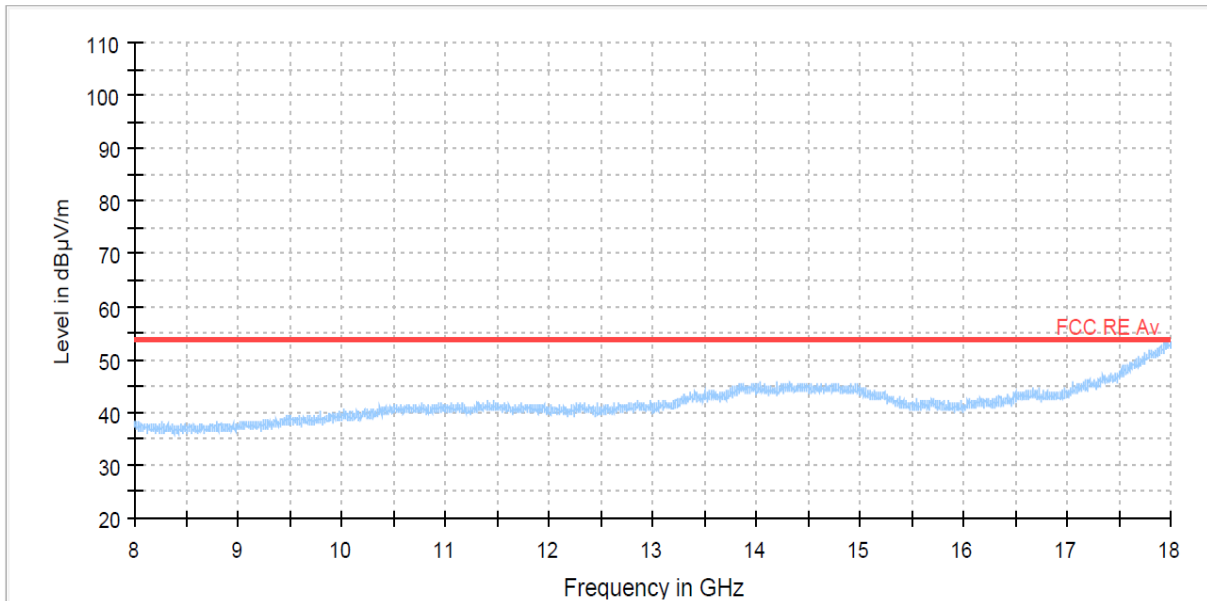


### Highest channel : 8 GHz to 18 GHz\_Peak

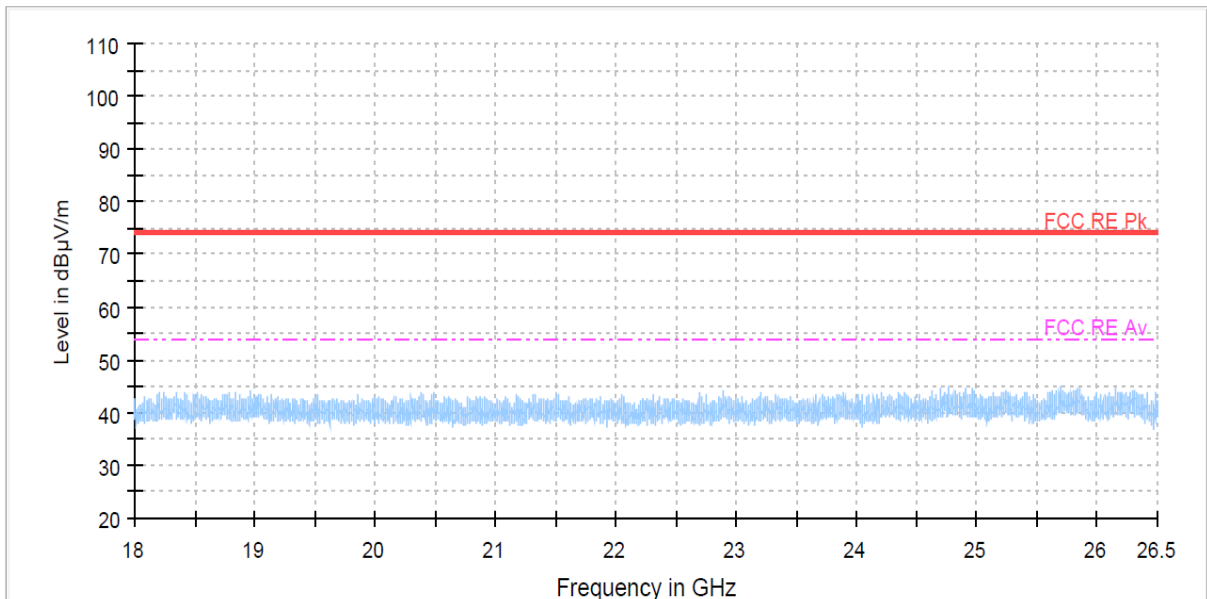


# PLOTS OF EMISSIONS

**Highest channel : 8 GHz to 18 GHz\_Average**



**Highest channel : 18 GHz to 26.5 GHz\_Peak**





# TEST DATA

## 8.7 Radiated Band Edge

### FCC §15.247(d), IC RSS-247 Issue 2 5.5

### Test Mode : Set to Lowest channel and Highest channel

### Result

#### **LE 2M\_Lowest Channel**

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2373.68	44.8	H	peak	-7.8	37.0	74.0	37.0
2390.00	43.1	V	peak	-7.8	35.3	74.0	38.7

#### **LE 2M\_Highest Channel**

Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2483.50	56.1	V	peak	-7.5	48.6	74.0	25.4

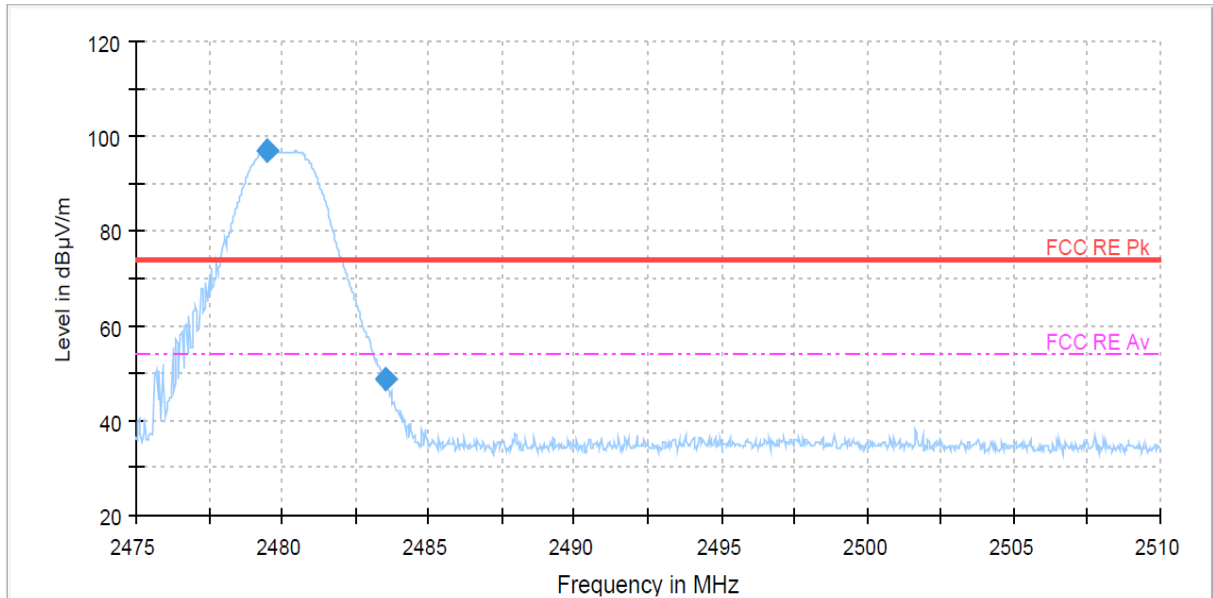
### **Note:**

1. \*Pol. H = Horizontal V = Vertical
2. \*\*AF + CL + Amp. = Antenna Factor + Cable Loss + Amplifier.
3. Average measurement was not performed when peak-detected emission complies with the average limit.
4. Other spurious was under 20 dB below Fundamental.
5. Highest channel (2480MHz) in LE 2M mode was the worst condition.
6. The radiated emissions testing were made by rotating EUT through three orthogonal axes and rotating the receive antenna with horizontal, Vertical polarization. The worst data was recorded. (X-axis Above 1GHz)
7. Peak emissions were measured using RBW = 1 MHz, VBW = 3 MHz, Detector = Peak.

# PLOT OF TEST DATA

## Worst Case

### Highest Channel\_Peak



## 9. TEST EQUIPMENT

No.	Instrument	Manufacturer	Model	Serial No.	Calibration Date	Calibration Interval
1	*Test Receiver	R & S	ESU 40	100202	Apr. 05 2021	1 year
2	Test Receiver	R & S	ESCI	101041	Apr. 05 2021	1 year
3	Attenuator	API technologies	40A2W-10	1912	Apr. 06 2021	1 year
4	Attenuator	WEINSCHTEL	56-10	58765	Oct. 15 2021	1 year
5	Amplifier	R & S	SCU 01	10029	Apr. 06 2021	1 year
6	*Amplifier	R & S	SCU18F	180025	Apr. 06 2021	1 year
7	*Amplifier	R & S	SCU26	10011	Jul. 12 2021	1 year
8	Amplifier	R & S	SCU40	100380	Jul. 12 2021	1 year
9	Spectrum Analyzer	R & S	FSW43	100732	Apr. 05 2021	1 year
10	Spectrum Analyzer	Agilent	E4440A	MY44022567	Oct. 13 2021	1 year
11	Spectrum Analyzer	Agilent	E4440A	MY44303257	Oct. 13 2021	1 year
12	Spectrum Analyzer	R & S	FSW43	104084	Apr. 05 2021	1 year
13	Loop Antenna	R & S	HFH2-Z2	100279	Feb. 25 2021	1 year
14	*Double Ridged Horn Ant	SCHWARZBECK	BBHA9120D	9120D-508	Jul. 19 2021	1 year
15	*Horn Antenna	Q-par Angus	QSH20S20	8179	Jul. 14 2021	1 year
16	Horn Antenna	Q-par Angus	QSH22K20	8180	Jul. 14 2021	1 year
17	Trilog-Broadband Antenna	SCHWARZBECK	VULB 9163	1431	May. 11 2021	2 year
18	LISN	R & S	ENV216	101156	Apr. 05 2021	1 year
19	*Position Controller	INNCO	CO2000	12480406/L	N/A	N/A
20	Controller	INNCO	CO3000	CO3000/937/38330516/L	N/A	N/A
21	*Turn Table	INNCO	DS1200S	N/A	N/A	N/A
22	Turn Table	INNCO	DT2000-2t	N/A	N/A	N/A
23	*Antenna Mast	INNCO	MA4000	N/A	N/A	N/A
24	TILT Antenna Mast	INNCO	MA4640-XP-EP	N/A	N/A	N/A
25	*Open Switch And Control Unit	R & S	OSP-120	100081	N/A	N/A
26	Open Switch And Control Unit	R & S	OSP-120	101766	N/A	N/A
27	Shielded Room	Seo-Young EMC	N/A	N/A	N/A	N/A
28	*Anechoic Chamber	Seo-Young EMC	N/A	N/A	N/A	N/A
29	*WiFi Filter Bank	R & S	U083	N/A	N/A	N/A

\*) Test equipment used during the test

## 10. ACCURACY OF MEASUREMENT

The Measurement Uncertainties stated were calculated in accordance with the requirements of measurement uncertainty contained in CISPR 16-4-2 with the confidence level of 95%

### 1. Conducted Uncertainty Calculation

Source of Uncertainty	$X_i$	Uncertainty of $X_i$		Coverage factor $k$	$u(X_i)$ (dB)	$C_i$	$C_i u(X_i)$ (dB)
		Value (dB)	Probability Distribution				
Receiver reading	<b>RI</b>	± 0.1	normal 1	1.000	0.1	1	0.1
Attenuation AMN-Receiver	<b>LC</b>	± 0.08	normal 2	2.000	0.04	1	0.04
AMN Voltage division factor	<b>LAMN</b>	± 0.8	normal 2	2.000	0.4	1	0.4
Sine wave voltage	<b>dVSW</b>	± 2.00	normal 2	2.000	1.00	1	1.00
Pulse amplitude response	<b>dVPA</b>	± 1.50	rectangular	1.732	0.87	1	0.87
Pulse repetition rate response	<b>dVPR</b>	± 1.50	rectangular	1.732	0.87	1	0.87
Noise floor proximity	<b>dVNF</b>	± 0.00	-	-	0.00	1	0.00
AMN Impedance	<b>dZ</b>	± 1.80	triangular	2.449	0.73	1	0.73
Ⓐ Mismatch	<b>M</b>	+ 0.70	U-Shaped	1.414	0.49	1	0.49
Ⓑ Mismatch	<b>M</b>	- 0.80	U-Shaped	1.414	- 0.56	1	- 0.56
Measurement System Repeatability	<b>RS</b>	0.05	normal 1	1.000	0.05	1	0.05
Remark	Ⓐ: AMN-Receiver Mismatch : + Ⓑ: AMN-Receiver Mismatch : -						
Combined Standard Uncertainty	Normal			± 1.88			
Expanded Uncertainty U	Normal ( $k = 2$ )			± 3.76			

## 2. Radiation Uncertainty Calculation

Source of Uncertainty	$X_i$	Uncertainty of $X_i$		Coverage factor $k$	$u(X_i)$ (dB)	$C_i$	$C_i u(X_i)$ (dB)
		Value (dB)	Probability Distribution				
Measurement System Repeatability	<b>RS</b>	0.34	normal 1	1.00	0.34	1	0.34
Receiver reading	<b>Ri</b>	± 0.02	normal 2	2.00	0.01	1	0.01
Sine wave voltage	<b>dVsw</b>	± 0.17	normal 2	2.00	0.09	1	0.09
Pulse amplitude response	<b>dVpa</b>	± 0.92	normal 2	2.00	0.46	1	0.46
Pulse repetition rate response	<b>dVpr</b>	± 0.35	normal 2	2.00	0.18	1	0.18
Noise floor proximity	<b>dVnf</b>	± 0.50	normal 2	2.00	0.25	1	0.25
Antenna Factor Calibration	<b>AF</b>	± 2.00	rectangular	$\sqrt{3}$	1.15	1	1.15
Cable Loss	<b>CL</b>	± 1.00	normal 2	2.00	0.50	1	0.50
Antenna Directivity	<b>AD</b>	± 0.00	rectangular	$\sqrt{3}$	0.00	1	0.00
Antenna Factor Height Dependence	<b>AH</b>	± 2.00	rectangular	$\sqrt{3}$	1.15	1	1.15
Antenna Phase Centre Variation	<b>AP</b>	± 0.20	rectangular	$\sqrt{3}$	0.12	1	0.12
Antenna Factor Frequency Interpolation	<b>Ai</b>	± 0.25	rectangular	$\sqrt{3}$	0.14	1	0.14
Site Imperfections	<b>Si</b>	± 4.00	triangular	$\sqrt{6}$	1.63	1	1.63
Measurement Distance Variation	<b>DV</b>	± 0.60	rectangular	$\sqrt{3}$	0.35	1	0.35
Antenna Balance	<b>Dbal</b>	± 0.90	rectangular	$\sqrt{3}$	0.52	1	0.52
Cross Polarisation	<b>DCross</b>	± 0.00	rectangular	$\sqrt{3}$	0.00	1	0.18
Mismatch	<b>M</b>	+ 0.98 - 1.11	U-Shaped	$\sqrt{2}$	0.74	1	0.74
EUT Volume Diameter	<b>Vd</b>	0.33	normal 1	1.00	0.33	1	0.11
Remark							
Combined Standard Uncertainty	Normal						
Expanded Uncertainty U	Normal ( $k = 2$ )						