



Test Report No.: NK-13-R-189

FCC Certification

## Nemko Korea Co., Ltd.

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### FCC EVALUATION REPORT FOR CERTIFICATION

**Applicant :**

**Ray Co., Ltd.**

**332-7, Samsung 1-ro, Hwaseong-si,**

**Gyeonggi-do, Korea**

**(Post code : 445-330)**

**Attn. : Mr. Seho Lee**

**Dates of Issue : January 14, 2014**

**Test Report No. : NK-13-R-189**

**Test Site : Nemko Korea Co., Ltd.**

**FCC ID**

**2ABBPRSA4000**

**Brand Name**

**Ray**

**Contact Person**

**Ray Co., Ltd.**

**332-7, Samsung 1-ro, Hwaseong-si,**

**Gyeonggi-do, Korea**

**Telephone No. : +82-70-7601-0275**

**Applied Standard: FCC 47 CFR Part 15.247**

**Classification: Digital modulation Transmitter**

**EUT Type: Zigbee Remote controller**

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 C63.4-2003, ANSI C63.10-2009. 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 14, 2014

**Tested By : Won-ho Son**  
**Engineer**

 Jan 14, 2014

**Reviewed By : Deokha Ryu**  
**Technical Manager**

**Ray Co., Ltd.**

**FCC ID : 2ABBPRSA4000**

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## 1. SCOPE

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*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 15.247.*

<b>Responsible Party :</b>	Ray Co., Ltd.
<b>Contact Person :</b>	Mr. Seho Lee
<b>Manufacturer :</b>	Ray Co., Ltd. 332-7, Samsung 1-ro, Hwaseong-si, Gyeonggi-do, Korea, 445-330

- FCC ID: 2ABBPRSA4000
- Model: RSA-4000
- Brand Name: Ray
- EUT Type: Zigbee Remote controller
- Classification: Digital modulation Transmitter
- Applied Standard: FCC 47 CFR Part 15.247
- Test Procedure(s): ANSI C63.4-2003, ANSI C63.10 and FCC guidance of Guidance 558074 D01 DTS Meas. Guidance v03r01
- Dates of Test: Aug. 14, 2013 ~ Sep. 05, 2013
- Place of Tests: 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 C63.4-2003), the American National Standard for Testing Unlicensed Wireless Devices (ANSI C63.10-2009) was used in determining radiated and conducted emissions emanating from **Ray Co., Ltd. FCC ID : 2ABBPRSA4000**

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

The site address 155 & 159, Osan-Ro, Mohyeon-Myeon, Cheoin-Gu, Yongin-Si, Gyeonggi-Do 449-852 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 §2.948 according to ANSI C63.4-2003.










Nemko Korea Co., Ltd.  
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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
	FCC part 15/18 Filing site	Registration No. 97992
	CAB Accreditation for DOC	Designation No. KR0026
	KOLAS Accredited Lab. (Korea Laboratory Accreditation Scheme)	Registration No. 155
	Canada IC Registered site	Site No. 2040E
	VCCI registration site(RE/CE/Telecom CE)	Member No. 2118
	EMC CBTL	-
	KCC(RRL)Designated Lab.	Registration No. KR0026
	SASO registered Lab and Certification Body	Registration No. 2008-15



### 3. TEST CONDITIONS & EUT INFORMATION

#### 3.1 Operation During Test

The Laptop and Test Jig were used to control the EUT to transmit the wanted TX channel by the Tera-term testing program which manufacturer supported. The Laptop and test jig were removed after controlling the EUT to transmit the wanted signal (with Duty cycle  $\geq 98\%$ ).

The EUT was measured at X, Y, Z-Axis in Zigbee traffic mode with the maximum output power in accordance with the manufacturer's specifications. The worst data were recorded in the report.

The EUT was programmed with the following output power setting that was used during testing:

Test frequency	2425 MHz	2440 MHz	2470 MHz
Power Level	05	05	05

##### 3.1.1 Table of test channels

Test Items	Mode	Data rate (Mbps)	Test Channel (CH)
Conducted Emissions	-	-	-
Radiated Emissions	802.15.4	250 kbps	18
6 dB Bandwidth	802.15.4	250 kbps	15/18/24
Peak Output Power	802.15.4	250 kbps	15/18/24
Peak Power Spectral Density	802.15.4	250 kbps	15/18/24
Conducted Spurious Emission	802.15.4	250 kbps	15/18/24
Radiated Spurious Emission, Band edge Emission	802.15.4	250 kbps	15/18/24

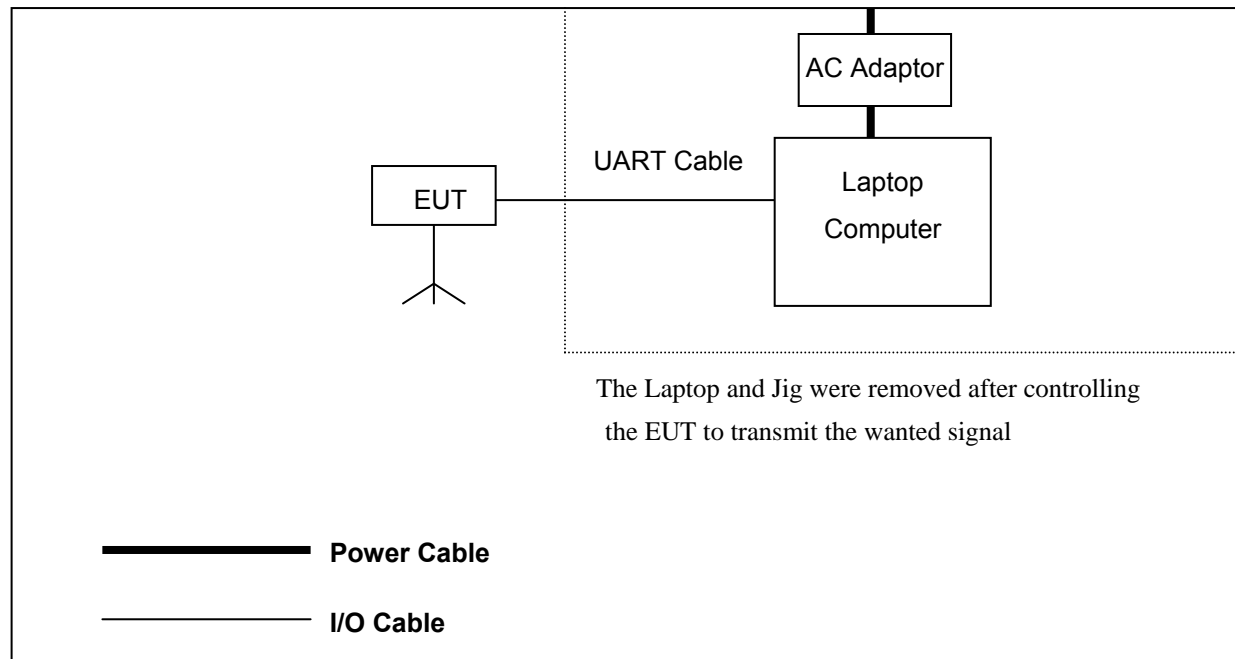
##### 3.1.2 Antenna TX mode information:

Frequency band	Mode	Antenna TX mode	Support MIMO
2.4 GHz	802.15.4	<input checked="" type="checkbox"/> 1TX, <input type="checkbox"/> 2TX	<input type="checkbox"/> Yes, <input checked="" type="checkbox"/> No

### 3.2 Support Equipment

EUT	RAY Co., Ltd. Model: RSA-4000	FCC ID: 2ABBPRSA4000 S/N: N/A
Laptop Computer	HP Model : G62-355TU 0.3 m Unshielded 6 pin UART cable	FCC DOC S/N : CNF0452FN3
AC/DC Adapter	LITE-ON TECHNOLOGY (CHANGZHOU) CO., LTD. Model : Series PPP009L-E 1.5 m unshielded power cable	FCC DOC S/N : WBGST03UZOFQ6

### 3.3 Setup Drawing





### 3.4 EUT Information

The EUT is the **Ray Co., Ltd. Zigbee Remote controller, FCC ID: 2ABBPRSA4000.**

Specifications:

Category	Zigbee Remote controller
Model Name	RSA-4000
Brand Name	RAY
Frequency of Operation	2425 MHz ~ 2470 MHz
Maximum Peak Conducted Output Power	4.16 dBm
Channels	4 CH (2425, 2440, 2455, 2470 MHz)
Antenna Gain (peak)	3.0 dBi
Antenna Setup	1TX / 1RX
Modulations	DSSS(OQPSK) for 802.15.4
Temperature Range	0 °C ~ +40 °C
Voltage	1.9 Vdc ~ 3.3 Vdc
Dimensions (H x W x D)	212 mm x 53 mm x 15 mm
Weight	150 g
Remarks	-

## 4. SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specification:

Name of Test	FCC Paragraph No.	Result	Remark
Conducted Emission	15.207	NA	Battery operation
Radiated Emission	15.209	Complies	
6 dB Bandwidth	15.247(a)(2)	Complies	
Peak Power Output	15.247(b)(3)	Complies	
Power Spectral Density	15.247(e)	Complies	
Conducted Spurious Emission	15.247(d)	Complies	
Radiated Spurious Emission	15.247(d)	Complies	
Maximum Permissible Exposure	1.1307(b)	Complies	

## 5. RECOMMENDATION/CONCLUSION

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The data collected shows that the **Ray Co., Ltd. Zigbee Remote controller, FCC ID: 2ABBPRSA4000** is in compliance with Part 15.247 of the FCC rule.

## 6. ANTENNA REQUIREMENTS

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### §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 **Ray Co., Ltd. Zigbee Remote controller, FCC ID: 2ABBPRSA4000** is **permanently attached** and there are no provisions for connection to an. It complies with the requirement of §15.203.

## 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.

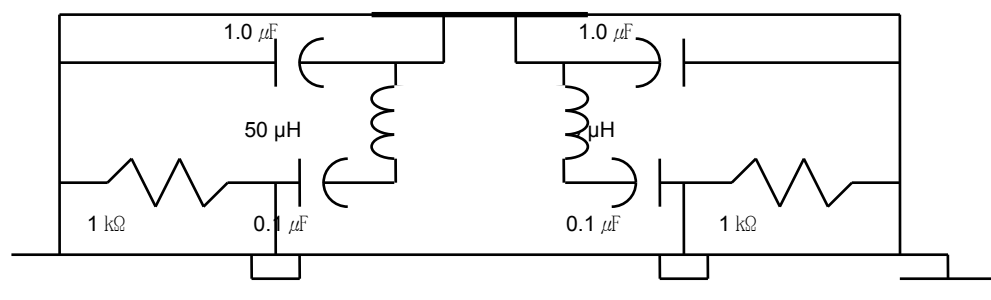


Fig. 2. LISN Schematic Diagram

## 7.2 Radiated Emissions

The measurement was performed at the test site that is specified in accordance with ANSI C63.4-2003 and ANCI C63.10-2009.

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, QSH22K20: up to 40 GHz) was used.

The test equipment was placed on turntable with 0.8 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.

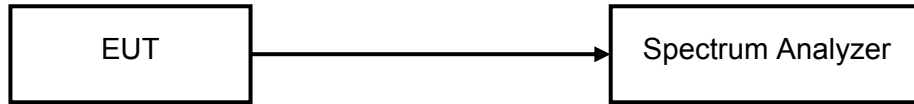
At frequencies above 1000 MHz, measurements performed using the peak and average measurement procedures described in KDB "558074D01 DTS Meas Guidance v03r01" in section 12.2.4 and 12.2.5.1. Peak emission levels were measured by setting the analyzer RBW = 1 MHz, VBW = 3 MHz, Detector = Peak, Trace mode = max hold. Average emission levels were measured by setting the analyzer RBW = 1 MHz, VBW = 3 MHz, Detector = RMS, Trace averaging in power averaging (RMS) mode over a minimum of 100 traces, If continuous transmission of the EUT couldn't be achieved and duty cycle was constant, a correction factor ( $10 \log (1 / x)$ ) was added to the measurement result.

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)

### **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  $\geq$  3 x RBW

Detector = Peak

Trace mode = max hold

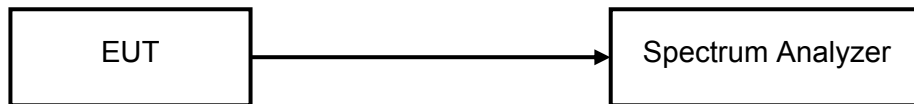
Sweep = auto couple

Allow the trace to stabilize.

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

## **7.4 Maximum Peak Output Power**

### **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  $\geq$  DTS bandwidth

VBW  $\geq 3 \times$  RBW

Span  $\geq 3 \times$  RBW

Detector = peak

Sweep time = auto couple

Trace mode = Max hold

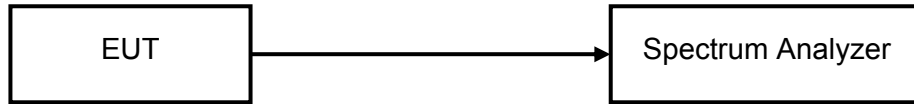
Allow the trace to stabilize.

Use peak marker function to determine the peak amplitude level.



## **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 to :  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$

VBW  $\geq 3 \times \text{RBW}$

Detector = peak

Sweep time = auto couple

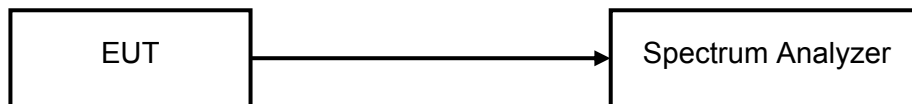
Trace mode = max hold

Allow the trace to stabilize.

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

## **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

RBW = 100 kHz

VBW  $\geq 3 \times$  RBW

Span = 1.5 times the DTS channel bandwidth

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 PSD level.

#### 2) Emission level measurement

RBW = 100 kHz

VBW  $\geq 3 \times$  RBW

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

Ensure that the number of measurement points  $\geq$  span / RBW

Detector = peak

Sweep time = auto couple

Allow the trace to stabilize.

The amplitude of all unwanted emissions outside of the authorized frequency band is confirmed that it is attenuated by at least the minimum requirements specified.

## 8. TEST DATA

### 8.1 Radiated Emissions

#### FCC §15.209

##### Result:

Frequency (MHz)	Reading (dBμV/m)	Pol* (H/V)	Antenna Heights (cm)	Turntable Angles (°)	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
31.09	47.02	V	195	83	-24.0	23.0	40.0	17.0
41.03	46.62	V	105	199	-23.2	23.4	40.0	16.6
47.21	47.72	V	195	83	-23.2	24.5	40.0	15.5
213.81	43.10	H	150	268	-25.1	18.0	46.0	28.0
243.27	44.10	H	150	107	-25.1	19.0	46.0	27.0
258.07	43.39	H	150	96	-22.5	20.9	46.0	25.1

Radiated Measurements at 3meters

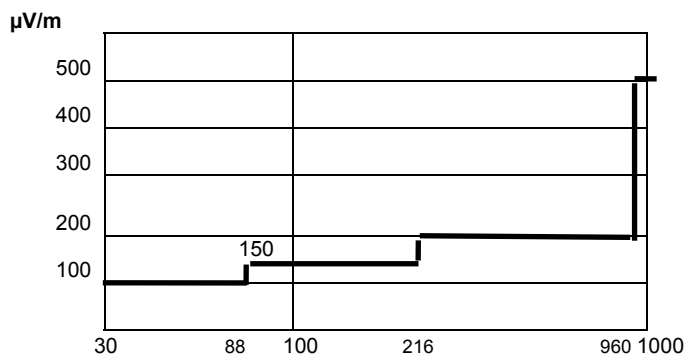


Fig. 3. Limits at 3 meters

##### Note(s):

1. All modes were measured and the worst-case emission was reported.

2 The radiated limits are shown on Figure 3.

Above 1 GHz the limit is 500 μV/m.

MHz

3. \*Pol. H = Horizontal, V = Vertical

4. \*\*AF + CL + Amp. = Antenna Factor + Cable Loss + Amplifier.

5. Measurements using CISPR quasi-peak mode.

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.

7. The limit is on the FCC Part section 15.209(a).

## TEST DATA

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### 8.2 6 dB Modulated Bandwidth

FCC §15.247(a)(2)

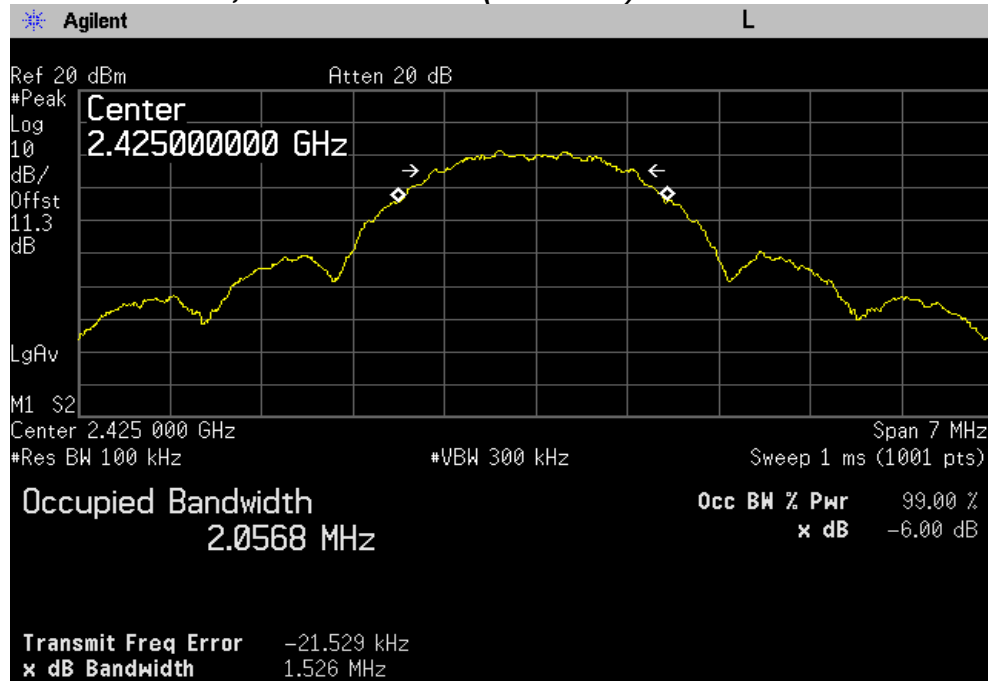
Test Mode : Set to Lowest channel, Middle channel and Highest channel

**Result:**

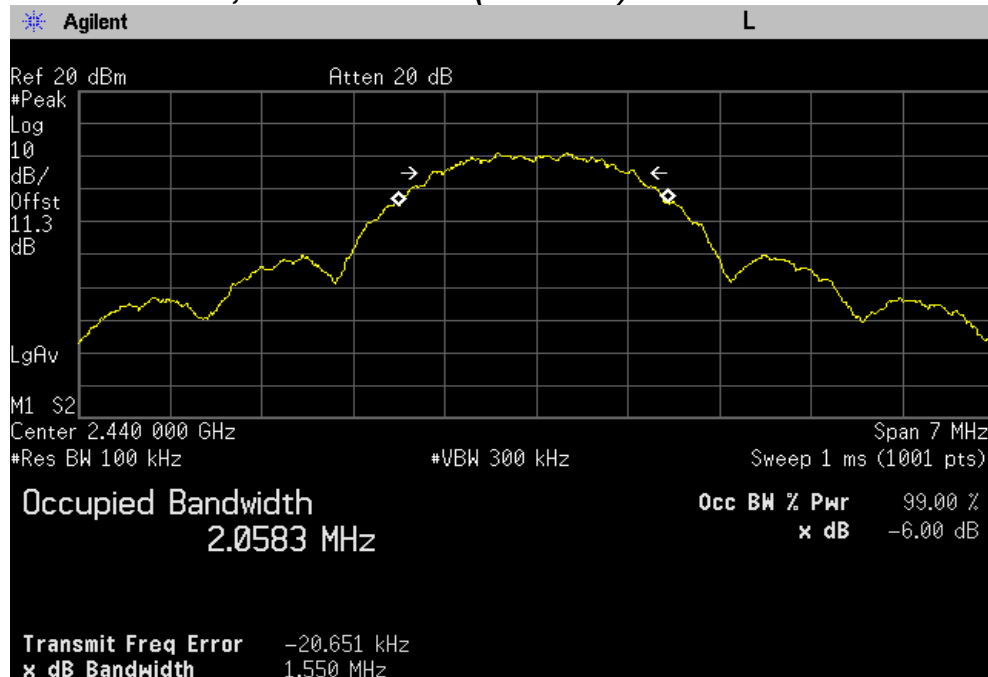
Channel	Frequency(MHz)	Result(MHz)	Limit (MHz)
Low	2425	1.526	0.5
Middle	2440	1.550	0.5
High	2470	1.540	0.5

# PLOTS OF EMISSIONS

## 6 dB Bandwidth, Lowest Channel (2425 MHz)

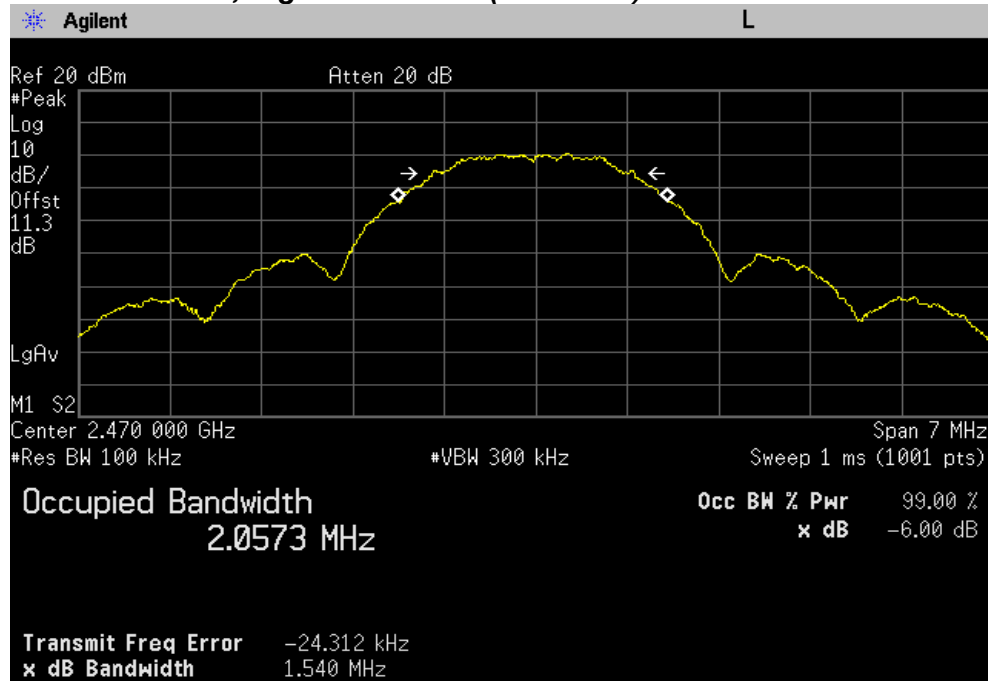


## 6 dB Bandwidth, Middle Channel (2440 MHz)



# PLOTS OF EMISSIONS

## 6 dB Bandwidth, Highest Channel (2470 MHz)



## TEST DATA

---

### 8.3 Maximum peak conducted power

#### FCC §15.247(b)(3)

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

#### Result:

Frequency (MHz)	Data rate (kbps)	Conducted Output Power (dBm)	Limit (dBm)	Margin (dB)
2425	250	4.16	30.00	25.84
2440	250	4.08	30.00	25.92
2470	250	3.88	30.00	26.12

#### Note(s):

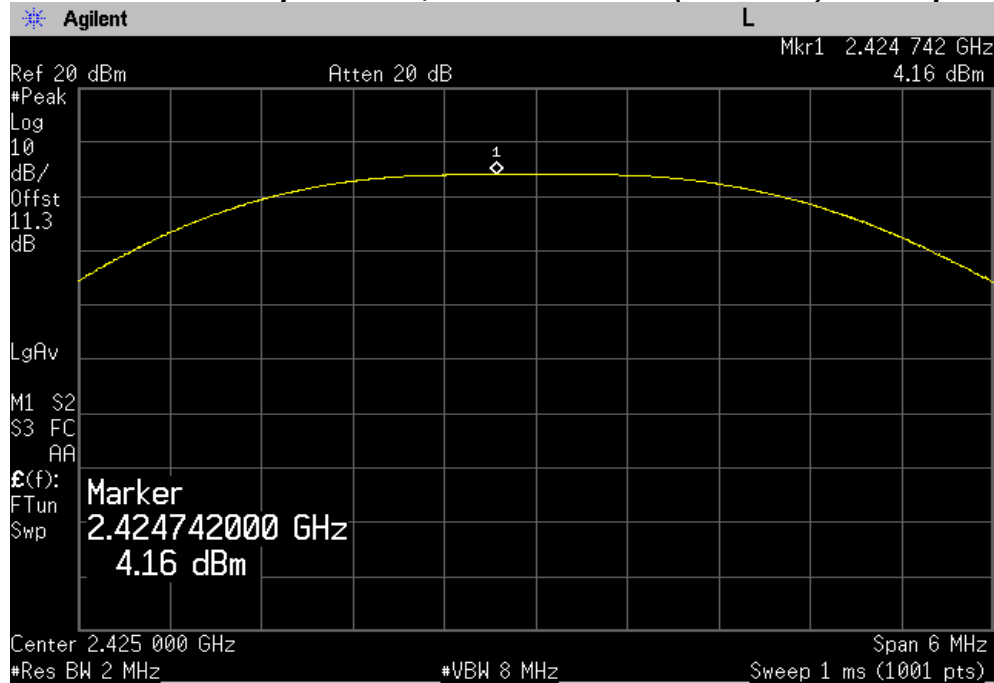
The following equation was used for spectrum offset:

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

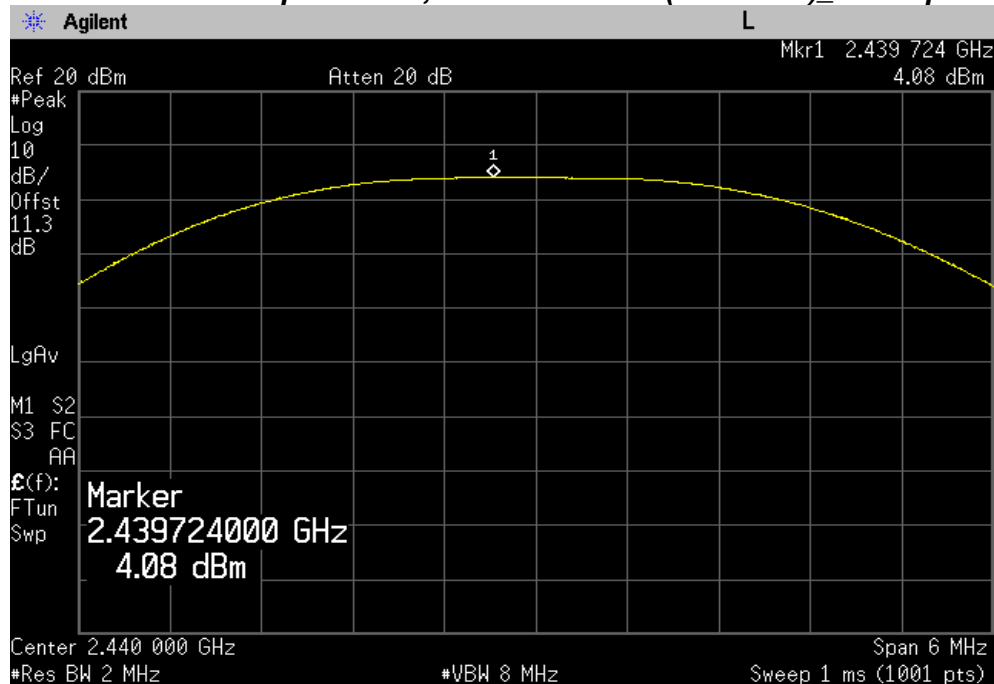


## PLOT OF TEST DATA

### Maximum Peak Output Power, Lowest Channel (2425 MHz)\_250 kbps

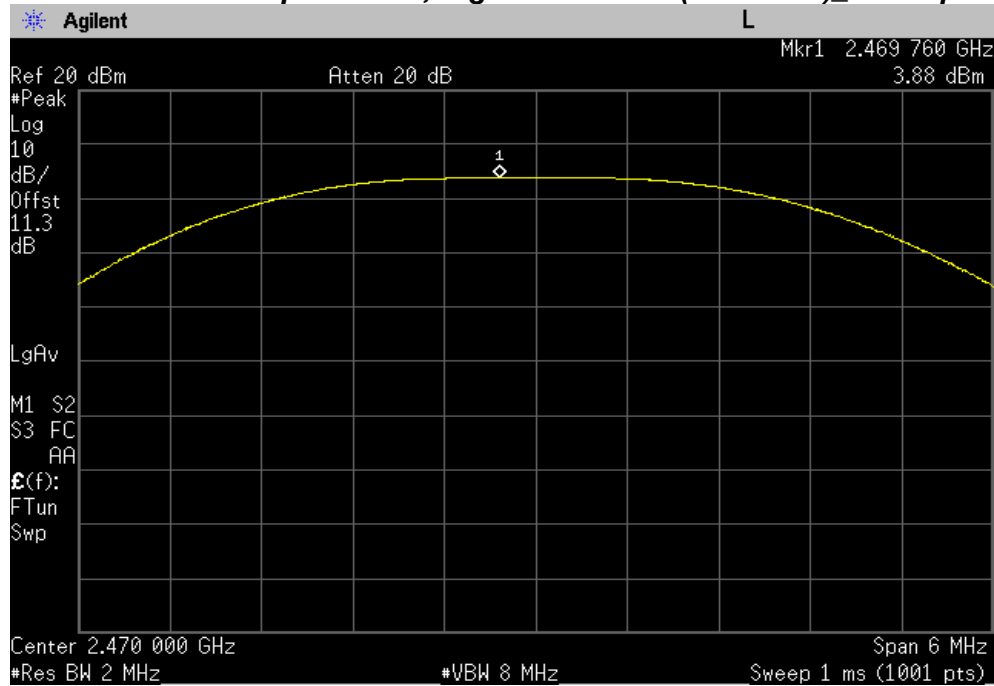


### Maximum Peak Output Power, Middle Channel (2440 MHz)\_250 kbps



## PLOT OF TEST DATA

### Maximum Peak Output Power, Highest Channel (2470 MHz) 250 kbps



## TEST DATA

---

### 8.4 Power Spectral Density

#### FCC §15.247(e)

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

#### Result :

Channel	Frequency(MHz)	Result(dBm)	Limit (dBm)
Low	2425	1.32	8.0
Middle	2440	1.14	8.0
High	2470	0.64	8.0

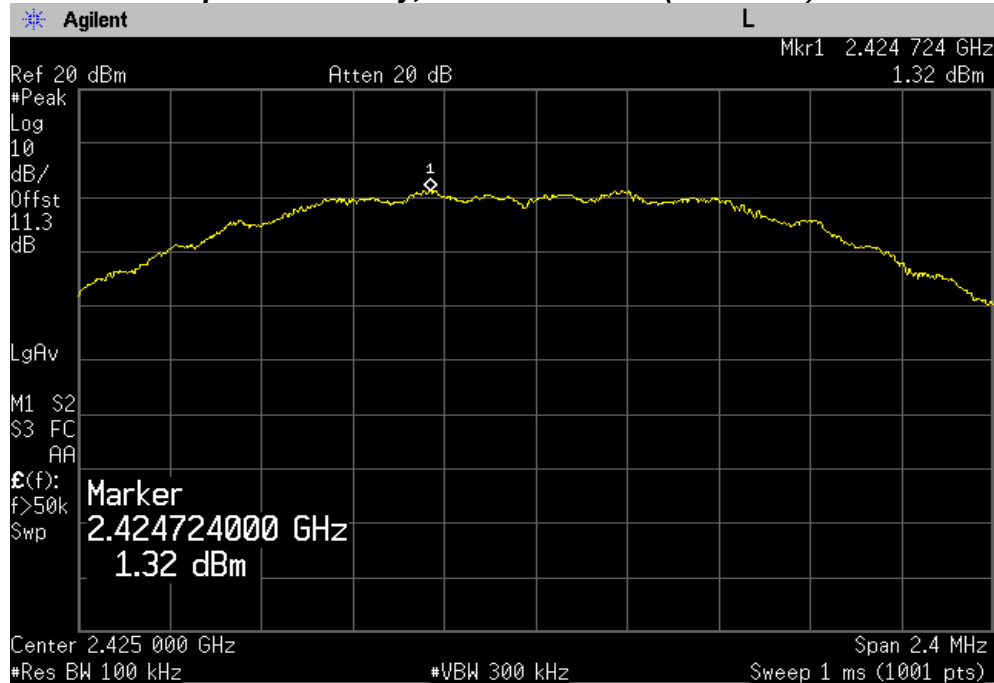
#### Note(s):

The following equation was used for spectrum offset:

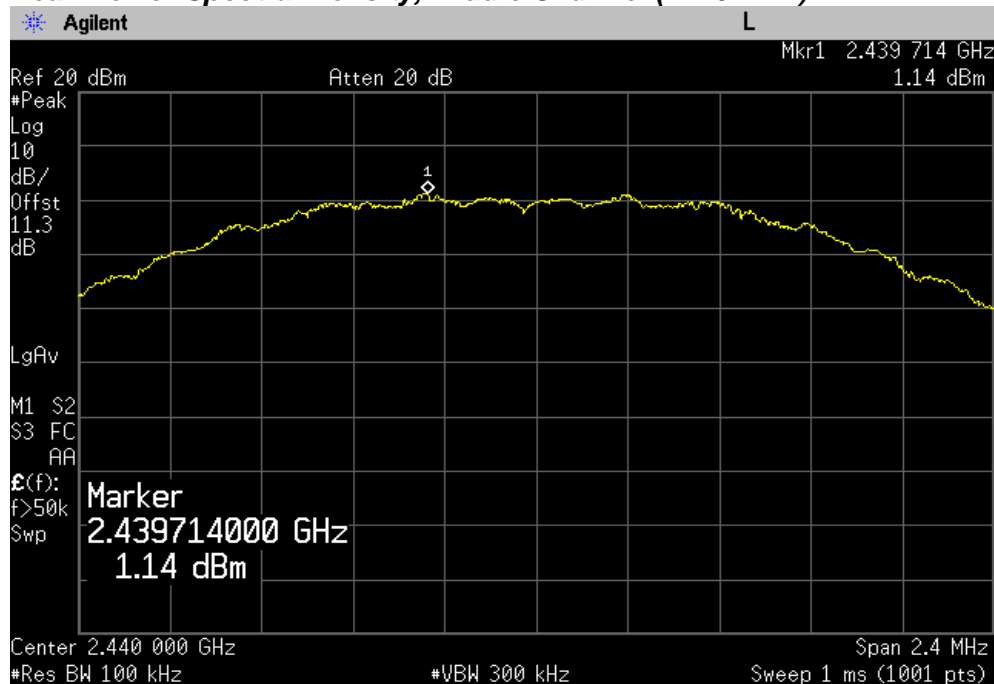
$\text{Spectrum offset (dB)} = \text{Attenuator (dB)} + \text{Cable Loss (dB)} + \text{SMA Type Connector Loss (dB)}$

## PLOT OF TEST DATA

**Peak Power Spectral Density, Lowest Channel (2425 MHz)**

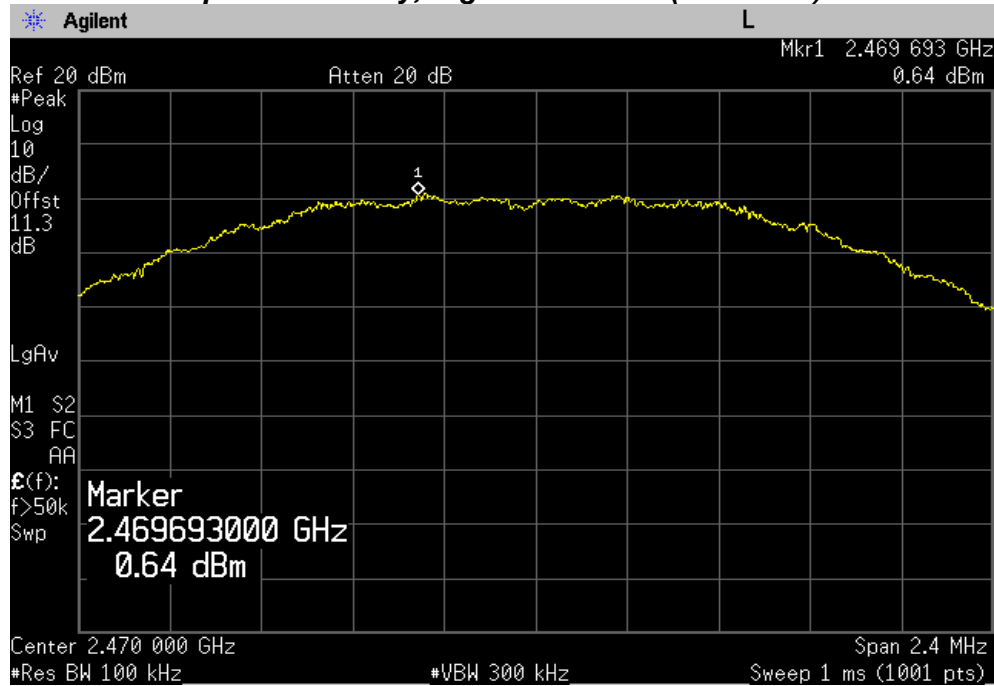


**Peak Power Spectral Density, Middle Channel (2440 MHz)**



## PLOT OF TEST DATA

### Peak Power Spectral Density, Highest Channel (2470 MHz)



## TEST DATA

### 8.5 Conducted Spurious Emissions

#### FCC §15.247(d)

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

#### **Result**

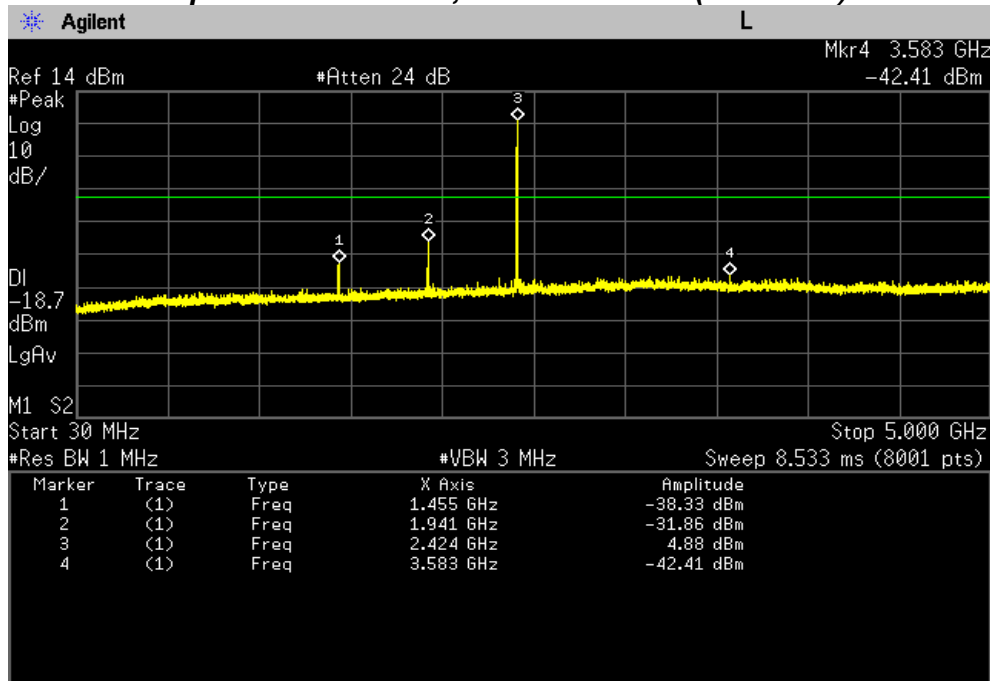
Channel	Frequency (MHz)	Reference Level (dBm)	Conducted Spurious Emissions (dBc)	Limit (dBc)
Low	2425	1.32	More than 20 dBc	20
Middle	2440	1.14	More than 20 dBc	20
High	2470	0.64	More than 20 dBc	20

#### **Notes:**

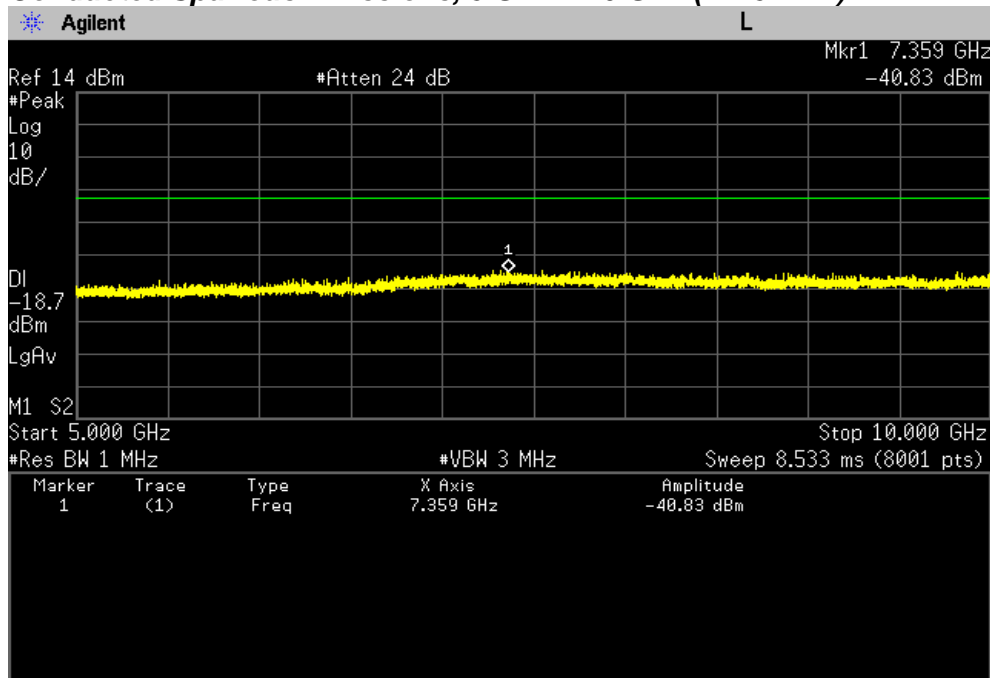
1. The cable and attenuator loss from 30 MHz to 25 GHz was reflected in spectrum analyzer with correction factor for the spurious emissions test.
2. RBW was set to 1 MHz rather than 100 kHz in order to increase the test span.
3. The display line shown in the following plots indicates the limit at 20 dB below the fundamental emission level measured in a 100 kHz bandwidth.
4. For plots showing conducted spurious emissions near the limit, the frequencies were investigated with a reduced RBW to ensure that no emissions were present.
5. During the test, the sweep point was set 8001 for the conducted spurious emissions test and 4001 for the Band Edge test.

# PLOT OF TEST DATA

## Conducted Spurious Emissions, 30 MHz ~ 5 GHz (2425 MHz)



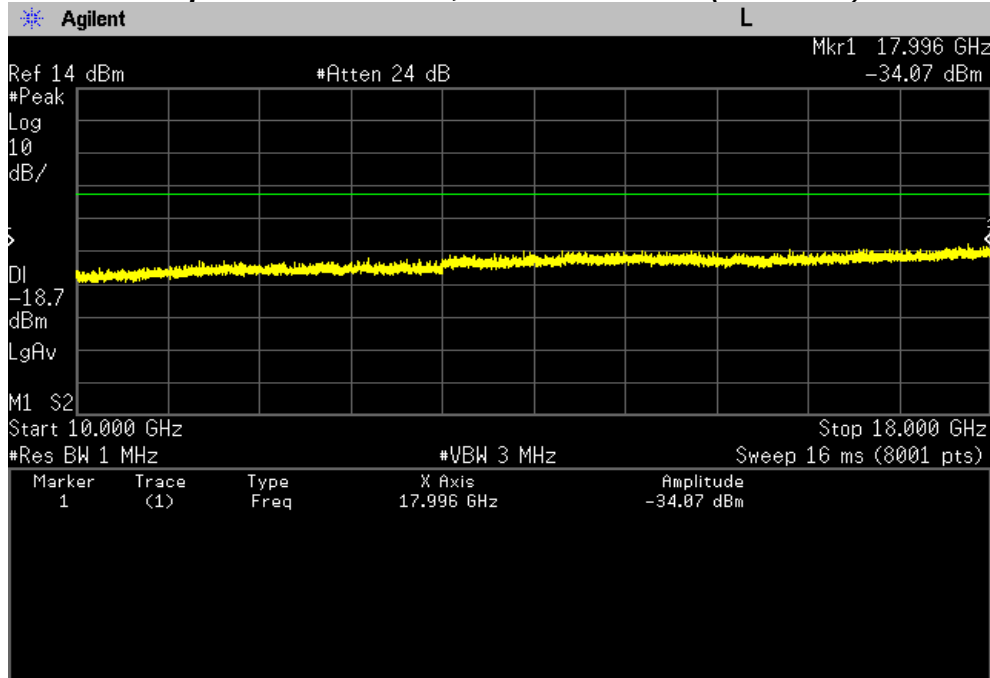
## Conducted Spurious Emissions, 5 GHz ~ 10 GHz (2425 MHz)



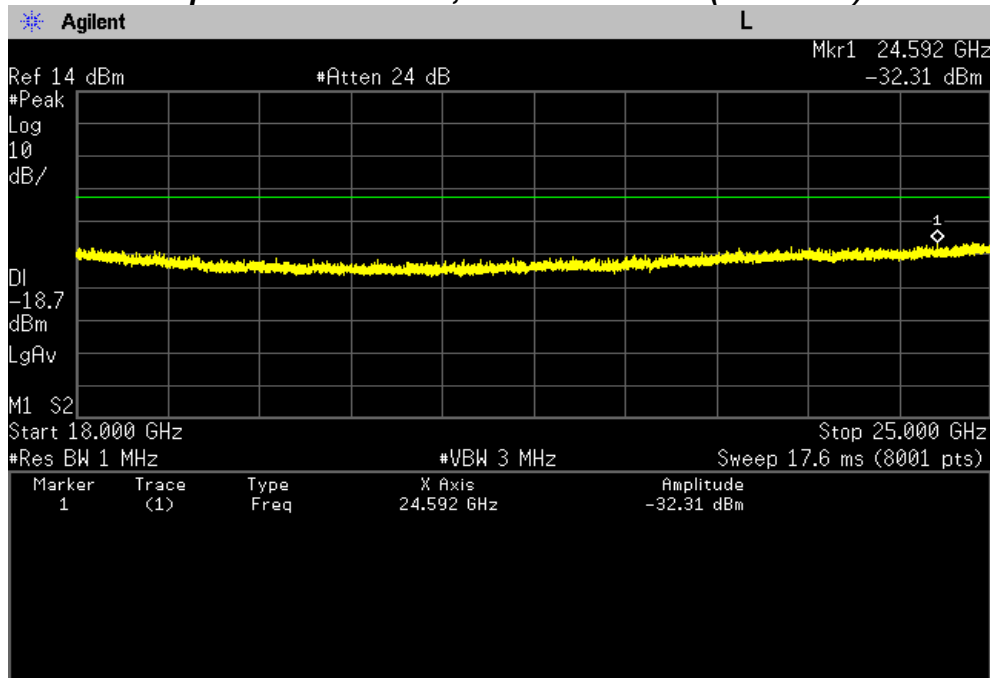


## PLOT OF TEST DATA

### Conducted Spurious Emissions, 10 GHz ~ 18 GHz (2425 MHz)

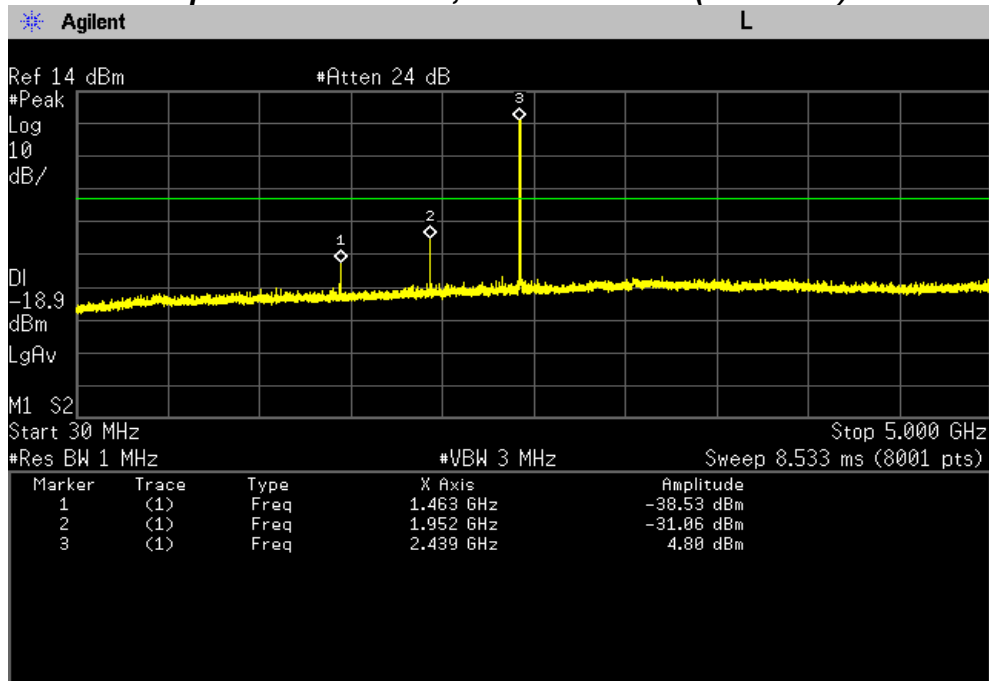


### Conducted Spurious Emissions, 18 GHz ~ 25 GHz (2425 MHz)

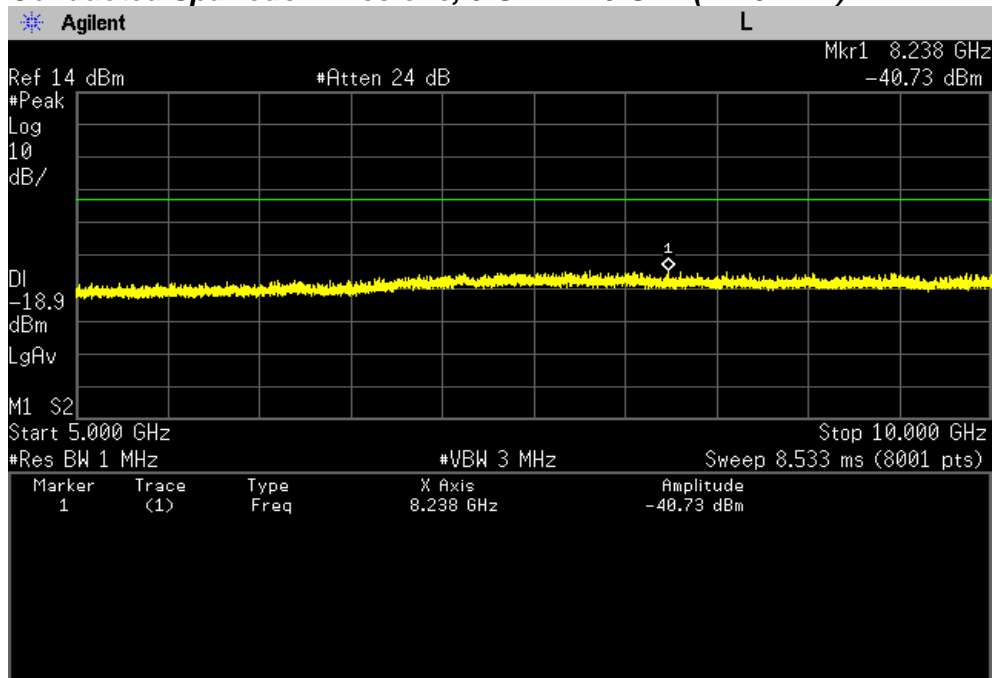


## PLOT OF TEST DATA

### Conducted Spurious Emissions, 30 MHz ~ 5 GHz (2440 MHz)

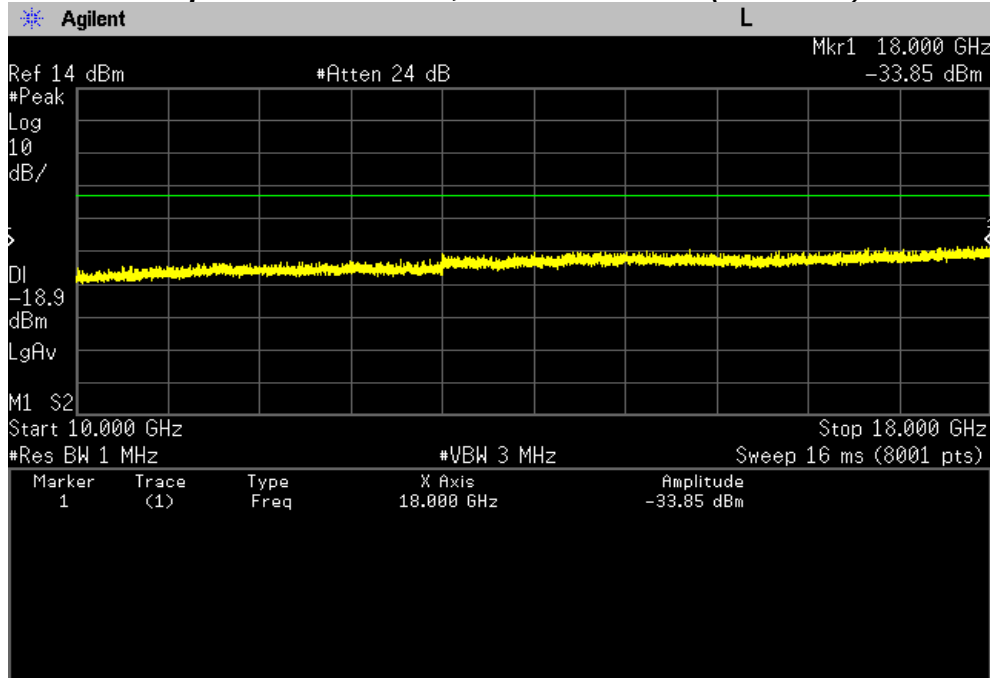


### Conducted Spurious Emissions, 5 GHz ~ 10 GHz (2440 MHz)

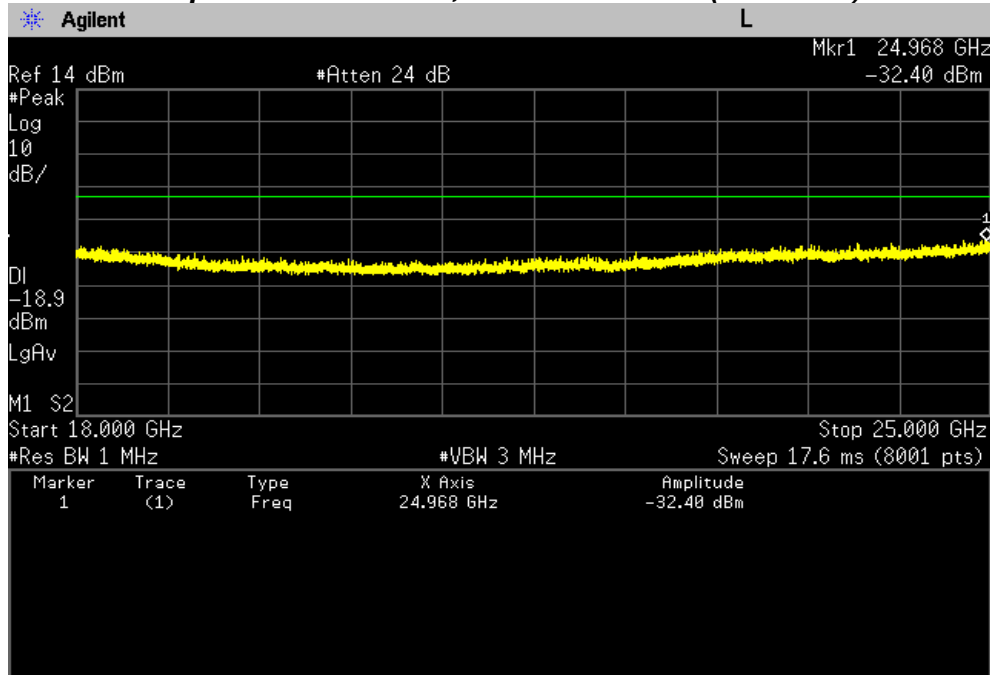


## PLOT OF TEST DATA

### Conducted Spurious Emissions, 10 GHz ~ 18 GHz (2440 MHz)

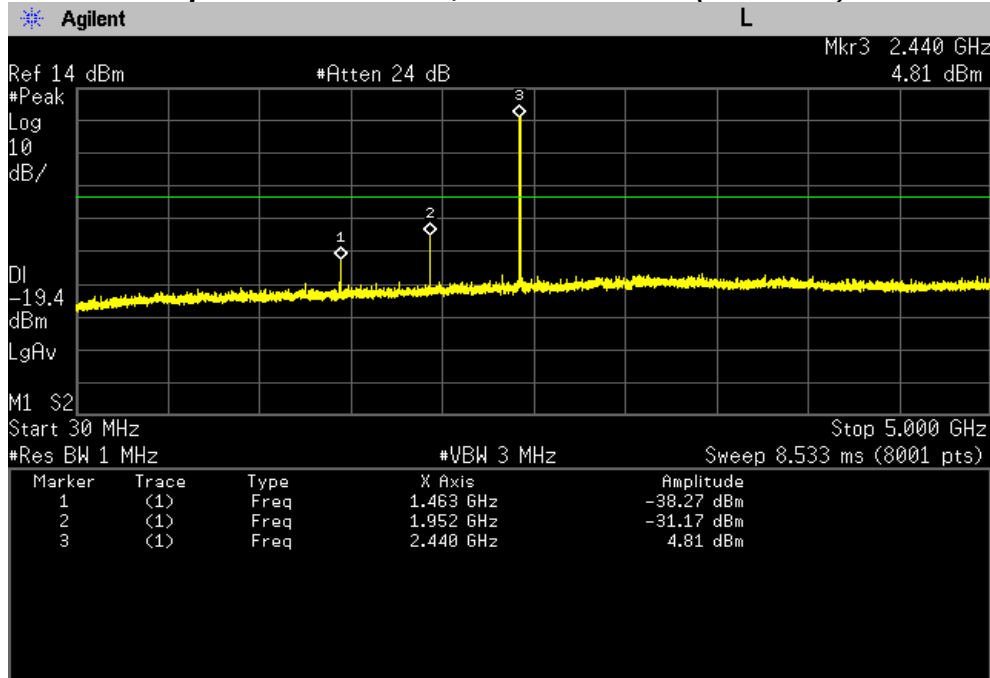


### Conducted Spurious Emissions, 18 GHz ~ 25 GHz (2440 MHz)

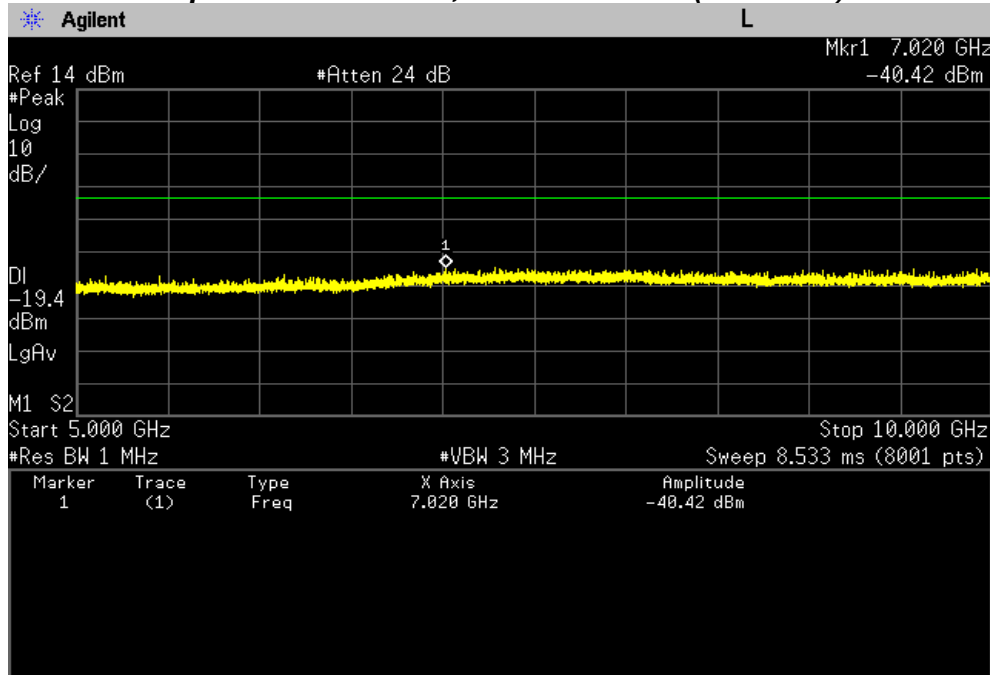


# PLOT OF TEST DATA

## Conducted Spurious Emissions, 30 MHz ~ 5 GHz (2470 MHz)

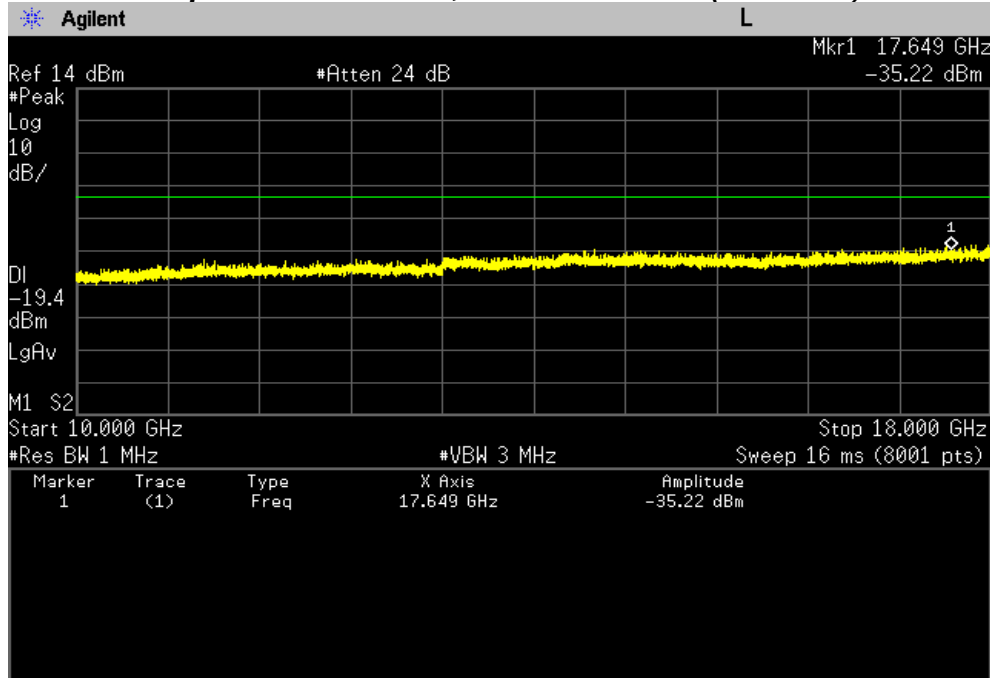


## Conducted Spurious Emissions, 5 GHz ~ 10 GHz (2470 MHz)

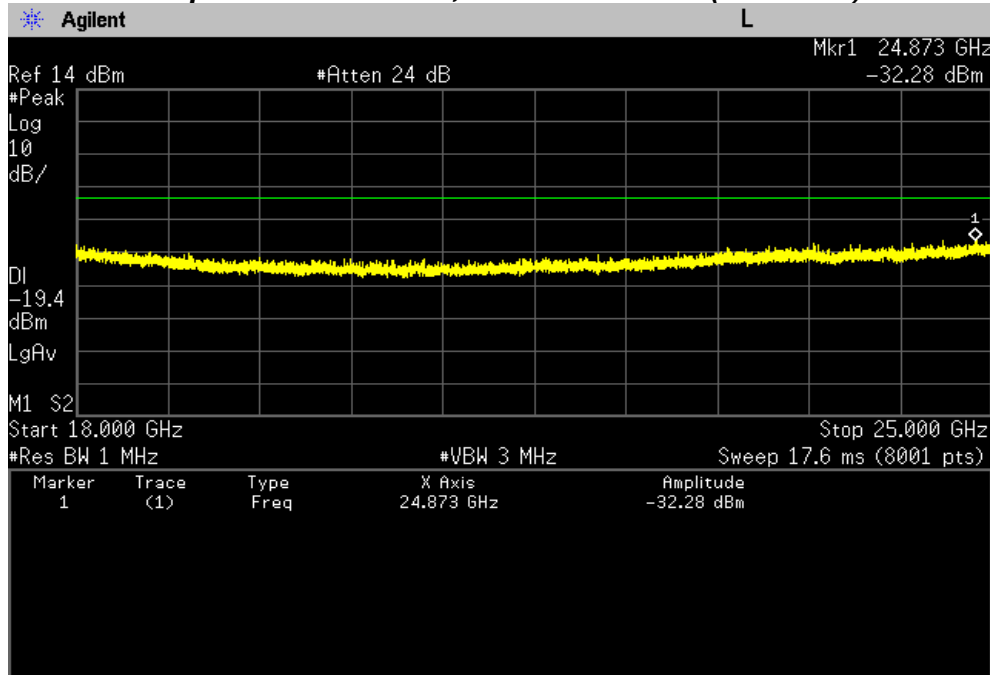


## PLOT OF TEST DATA

### Conducted Spurious Emissions, 10 GHz ~ 18 GHz (2470 MHz)

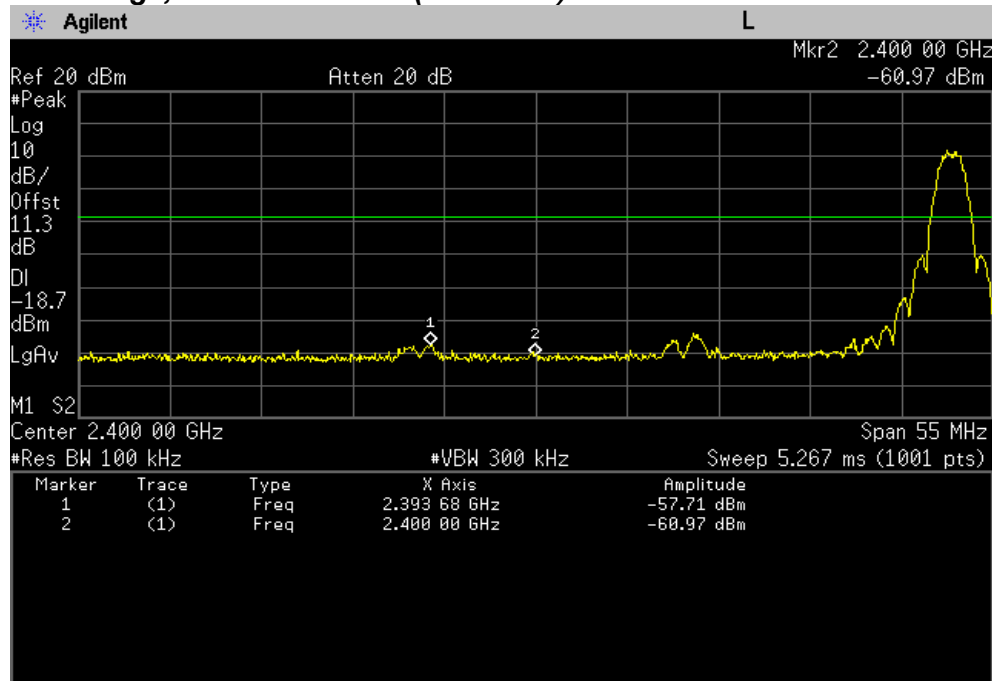


### Conducted Spurious Emissions, 18 GHz ~ 25 GHz (2470 MHz)

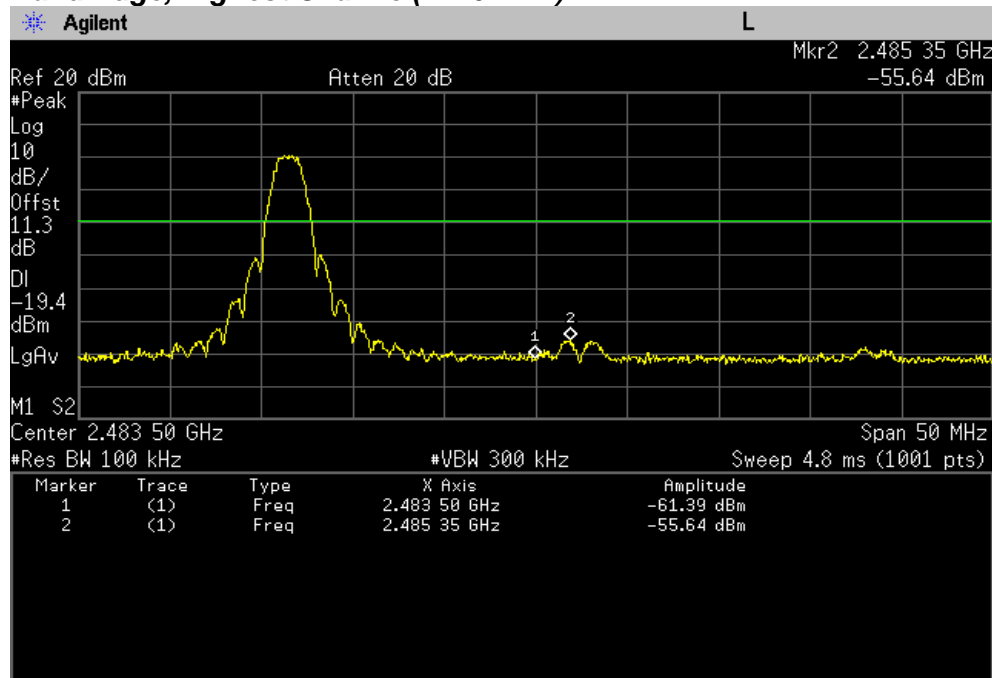


# PLOT OF TEST DATA

## Band Edge, Lowest Channel (2425 MHz)



## Band Edge, Highest Channel(2470 MHz)



# TEST DATA

## 8.6 Radiated Spurious Emissions

### FCC §15.247(d)

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

### Result:

#### Lowest Channel (2425 MHz)

Frequency (MHz)	Reading (dBμV/m)	Pol* (H/V)	Detector	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2489.50	44.5	H	Peak	-0.5	44.0	74.0	30.0
2489.50	37.4	H	Average	-0.5	36.9	54.0	17.1
3880.00	43.2	H	Peak	6.1	49.3	74.0	24.7
3880.00	39.4	H	Average	6.1	45.5	54.0	8.5
4850.85	44.9	H	Peak	9.2	54.1	74.0	19.9
4850.85	36.2	H	Average	9.2	45.4	54.0	8.6

#### Middle Channel (2440 MHz)

Frequency (MHz)	Reading (dBμV/m)	Pol* (H/V)	Detector	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
3903.75	43.0	H	Peak	6.1	49.1	74.0	24.9
3903.75	38.9	H	Average	6.1	45.0	54.0	9.0
4880.89	42.2	H	Peak	9.4	51.6	74.0	22.4
4880.89	32.0	H	Average	9.4	41.4	54.0	12.6



## TEST DATA

### Highest Channel (2470 MHz)

Frequency (MHz)	Reading (dBμV/m)	Pol* (H/V)	Detector	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2374.25	42.8	H	Peak	-1.0	41.8	74.0	32.2
2374.25	36.6	H	Average	-1.0	35.6	54.0	18.4
3951.87	43.3	H	Peak	6.1	49.4	74.0	24.6
3951.87	39.0	H	Average	6.1	45.1	54.0	8.9
4940.79	42.5	H	Peak	9.6	52.1	74.0	21.9
4940.79	31.3	H	Average	9.6	40.9	54.0	13.1

### Note(s):

- \*Pol. H = Horizontal V = Vertical
- \*\*AF + CL + Amp. = Antenna Factor + Cable Loss + Amplifier.
- 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.
- Peak emissions were measured using RBW = 1 MHz, VBW = 3 MHz, Detector = Peak
- For average measurements, "12.2.5.2 Average Power Measurement Procedures" at "558074 D01 DTS Meas Guidance v03r01" was used.
- 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 2<sup>nd</sup> harmonic for this device.

## TEST DATA

### 8.7 Radiated Band Edge

#### FCC §15.247(d)

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

#### Result:

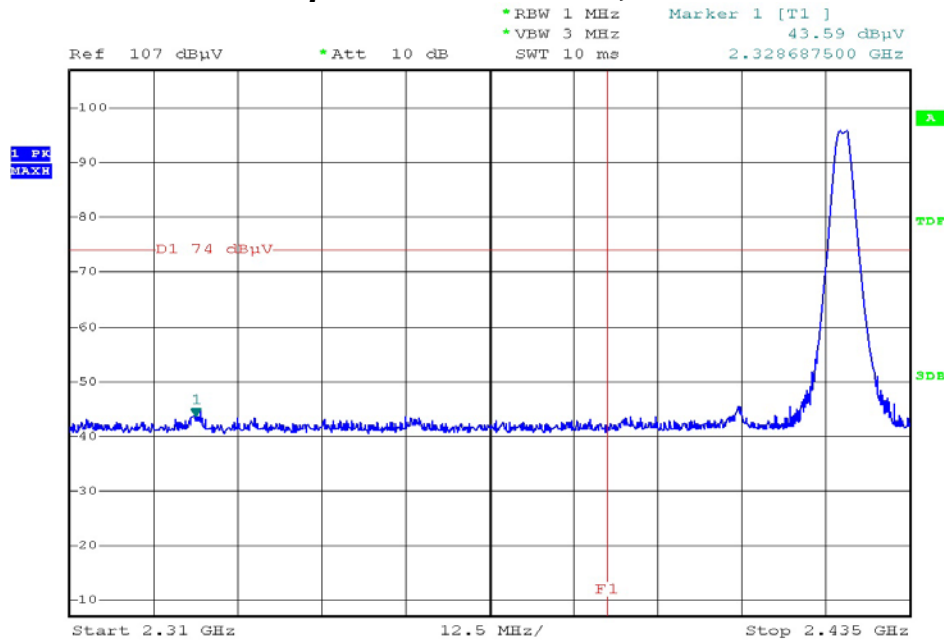
Frequency (MHz)	Reading (dBμV/m)	Pol* (H/V)	Detector	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2329.00	44.8	V	Peak	-1.2	43.6	74.0	30.4
2329.00	36.7	V	Average	-1.2	35.5	54.0	18.5
2486.60	48.6	H	Peak	-0.5	48.1	74.0	25.9
2486.60	38.3	H	Average	-0.5	37.8	54.0	16.2

#### Note(s):

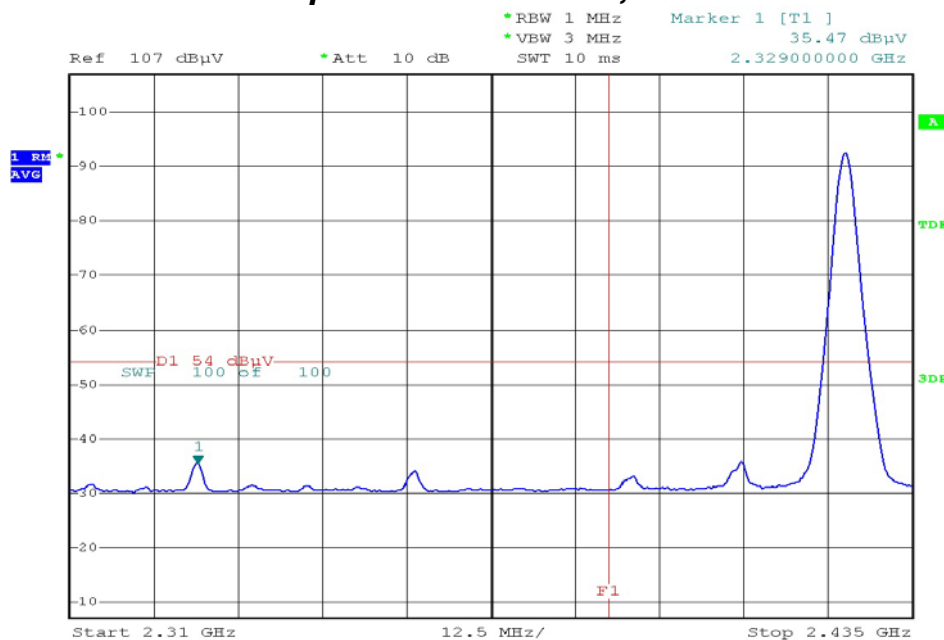
- \*Pol. H = Horizontal V = Vertical
- \*\*AF + CL + Amp. = Antenna Factor + Cable Loss + Amplifier.
- Measurement of the radiated emissions is performed in vertical and horizontal polarizations. The worst data were recorded
- For peak measurements, the resolution bandwidth was set to 1 MHz and the video bandwidth was set to 3 MHz.
- For average measurements, "12.2.5.1 Average Power Measurement Procedures" at "558074 D01 DTS Meas Guidance v03r01" was used.

## PLOT OF TEST DATA

### Restricted Band Spurious Emissions, Lowest channel Peak

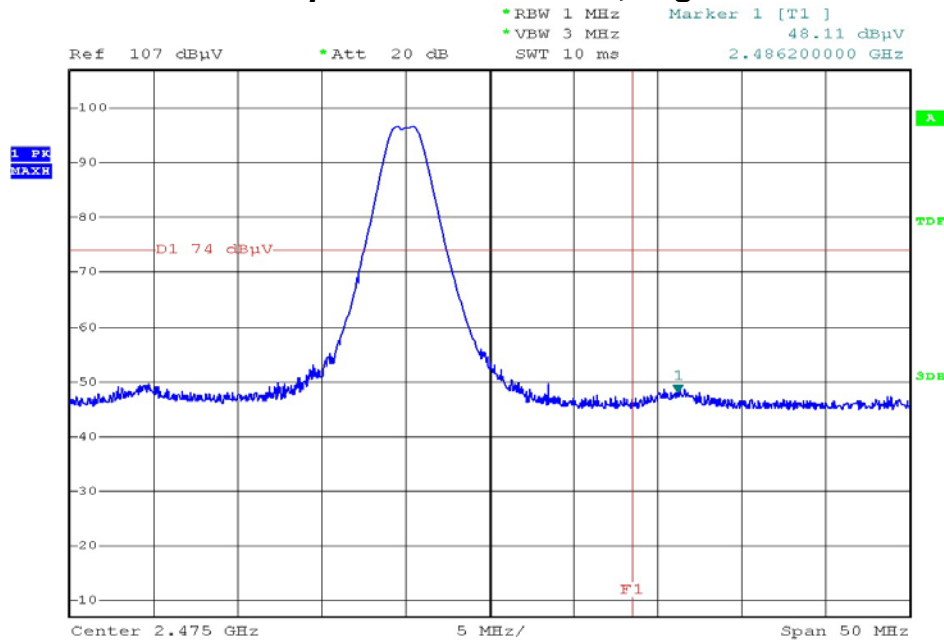


### Restricted Band Spurious Emissions, Lowest channel Average

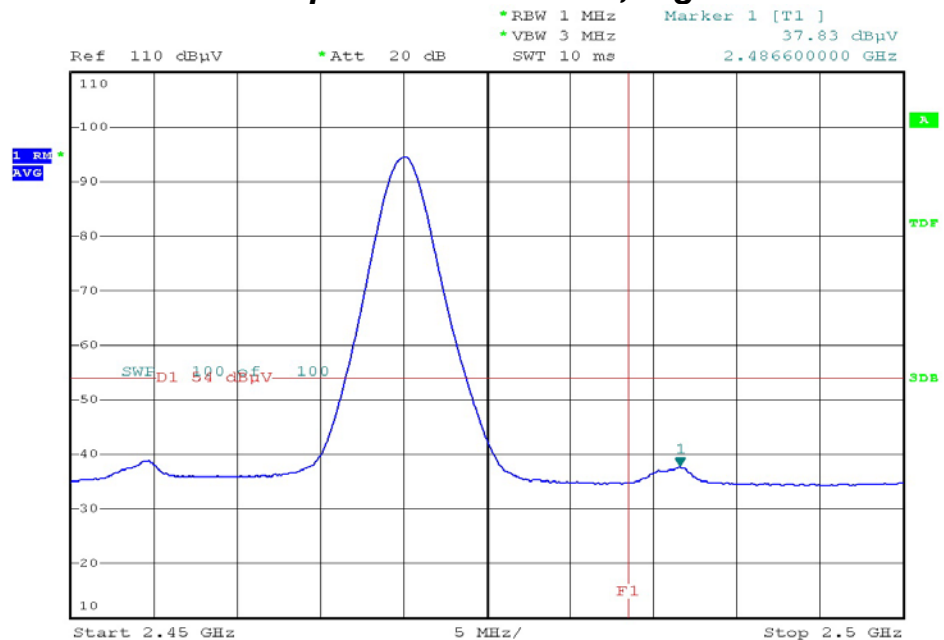


# PLOT OF TEST DATA

## Restricted Band Spurious Emissions, Highest channel Peak



## Restricted Band Spurious Emissions, Highest channel Average



## 9. TEST EQUIPMENT

No.	Instrument	Manufacturer	Model	Serial No.	Calibration Date	Calibration Interval
1	*Test Receiver	R & S	ESCS 30	833364/020	Jan. 09 2013	1 year
2	*Test Receiver	R & S	ESCS 30	100302	Oct. 08 2013	1 year
3	*Amplifier	R & S	SCU 01	10029	Apr. 05 2013	1 year
4	*Amplifier	Sonoma Instrument	310N	291916	Jul. 16 2013	1 year
5	*Amplifier	R & S	SCU18	10065	Apr. 05 2013	1 year
6	*Amplifier	R & S	SCU26	10011	Jul. 08 2013	1 year
7	Amplifier	R & S	SCU40	10008	Jul. 08 2013	1 year
8	*Pre Amplifier	HP	8449B	3008A00107	Jan. 09 2014	1 year
9	*Spectrum Analyzer	Agilent	E4440A	MY44303257	Jul. 16 2013	1 year
10	*Spectrum Analyzer	Agilent	E4440A	MY44022567	Apr. 05 2013	1 year
11	*Spectrum Analyzer	R & S	FSP40	100361	Jul. 16 2013	1 year
12	*Loop Antenna	R & S	HFH2-Z2	100279	Feb. 21 2012	2 year
13	Wideband Power Sensor	R & S	NRP-Z81	100634	Jul. 16 2013	1 year
14	*Biconical Log Antenna	ARA	LPB-2520/A	1180	Apr. 26 2012	2 year
15	*Horn Antenna	SCHWARZBECK	BBHA9120D	9120D-474	Aug. 13 2012	2 year
16	*Horn Antenna	Q-par Angus	QSH20S20	8179	Mar. 20 2013	2 year
17	Horn Antenna	Q-par Angus	QSH22K20	8180	Mar. 20 2013	2 year
18	Trilog-Broadband Antenna	SCHWARZBECK	VULB 9163	9163-454	Feb. 24 2012	2 year
19	*Trilog-Broadband Antenna	SCHWARZBECK	VULB 9168	9168-257	Mar. 06 2013	2 year
20	*LISN	R & S	ESH3-Z5	833874/006	Oct. 08 2013	1 year
21	*LISN	R & S	ESH2-Z5	100227	Apr. 04 2013	1 year
22	*Position Controller	DAEIL EMC	N/A	N/A	N/A	N/A
23	*Turn Table	DAEIL EMC	N/A	N/A	N/A	N/A
24	*Antenna Mast	DAEIL EMC	N/A	N/A	N/A	N/A
25	*Shielded Room	EM Eng.	N/A	N/A	N/A	N/A
26	*Position Controller	INNCO	CO2000	1480406/L	N/A	N/A
27	*Turn Table	INNCO	DS1200S	N/A	N/A	N/A
28	*Antenna Mast	INNCO	MA4000	N/A	N/A	N/A
29	*Anechoic Chamber	Seo-Young EMC	N/A	N/A	N/A	N/A
30	*Shielded Room	Seo-Young EMC	N/A	N/A	N/A	N/A

### Note(s)

- \* 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>	$\pm 0.1$	normal 1	1.000	0.1	1	0.1
Attenuation AMN-Receiver	<b>LC</b>	$\pm 0.08$	normal 2	2.000	0.04	1	0.04
AMN Voltage division factor	<b>LAMN</b>	$\pm 0.8$	normal 2	2.000	0.4	1	0.4
Sine wave voltage	<b>dVSW</b>	$\pm 2.00$	normal 2	2.000	1.00	1	1.00
Pulse amplitude response	<b>dVPA</b>	$\pm 1.50$	rectangular	1.732	0.87	1	0.87
Pulse repetition rate response	<b>dVPR</b>	$\pm 1.50$	rectangular	1.732	0.87	1	0.87
Noise floor proximity	<b>dVNF</b>	$\pm 0.00$	-	-	0.00	1	0.00
AMN Impedance	<b>dZ</b>	$\pm 1.80$	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			$\pm 1.88$			
Expended Uncertainty U	Normal ( $k = 2$ )			$\pm 3.76$			

## 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				
Receiver reading	$RI$	$\pm 0.10$	normal 1	1.000	0.10	1	0.10
Sine wave voltage	$dV_{sw}$	$\pm 2.00$	normal 2	2.000	1.00	1	1.00
Pulse amplitude response	$dV_{pa}$	$\pm 1.50$	rectangular	1.732	0.87	1	0.87
Pulse repetition rate response	$dV_{pr}$	$\pm 1.50$	rectangular	1.732	0.87	1	0.87
Noise floor proximity	$dV_{nf}$	$\pm 0.50$	normal 2	2.000	0.25	1	0.25
Antenna Factor Calibration	$AF$	$\pm 1.50$	normal 2	2.000	0.75	1	0.75
Attenuation Antenna-receiver	$CL$	$\pm 0.52$	normal 2	2.000	0.26	1	0.26
Antenna Directivity	$AD$	$\pm 1.00$	rectangular	1.732	0.58	1	0.58
Antenna Factor Height Dependence	$AH$	$\pm 0.50$	rectangular	1.732	0.29	1	0.29
Antenna Phase Centre Variation	$AP$	$\pm 0.30$	rectangular	1.732	0.17	1	0.17
Antenna Factor Frequency Interpolation	$AI$	$\pm 0.30$	rectangular	1.732	0.17	1	0.17
Site Imperfections	$SI$	$\pm 4.00$	triangular	2.449	1.63	1	1.63
Measurement Distance Variation	$DV$	$\pm 0.10$	rectangular	1.732	0.06	1	0.06
Antenna Balance	$Dbal$	$\pm 0.90$	rectangular	1.732	0.52	1	0.52
Cross Polarisation	$DCross$	$\pm 0.90$	rectangular	1.732	0.52	1	0.52
Ⓐ Mismatch	$M$	+ 0.25	U-Shaped	1.414	0.18	1	0.18
Ⓑ Mismatch	$M$	- 0.26	U-Shaped	1.414	- 0.18	1	- 0.18
Ⓒ Mismatch	$M$	+ 0.98	U-Shaped	1.414	0.69	1	0.69
Ⓓ Mismatch	$M$	- 1.11	U-Shaped	1.414	- 0.79	1	- 0.79
Measurement System Repeatability	$RS$	0.09	normal 1	1.000	0.09	1	0.09
Remark	Ⓐ: Biconical Antenna-receiver Mismatch : + (< 200 MHz) Ⓑ: Biconical Antenna-receiver Mismatch : - (< 200 MHz) Ⓒ: Log Periodic Antenna-receiver Mismatch : + ( $\geq$ 200 MHz) Ⓓ: Log Periodic Antenna-receiver Mismatch : - ( $\geq$ 200 MHz)						
Combined Standard Uncertainty	Normal			$\pm 2.63$ (< 200 MHz) $\pm 2.74$ ( $\geq$ 200 MHz)			
Expanded Uncertainty U	Normal ( $k = 2$ )			$\pm 5.26$ (< 200 MHz) $\pm 5.48$ ( $\geq$ 200 MHz)			