


**Produkte**  
*Products*

<b>Prüfbericht - Nr.:</b>		<b>19660010 001</b>		<b>Seite 1 von 26</b>	
<i>Test Report No.:</i>		<i>Page 1 of 26</i>			
<b>Auftraggeber:</b> <i>Client:</i>		<b>Si2 Microsystems Pvt Ltd</b> <b>Deep Towers, Plot No:84, Survey No:150,</b> <b>EPIP, Whitefield Industrial Area</b> <b>Bangalore - 560066</b> <b>Karnataka, India</b>			
<b>Gegenstand der Prüfung:</b> <i>Test item:</i>		<b>YODA</b>			
<b>Bezeichnung:</b> <i>Identification:</i>	<b>V2.1</b>	<b>Serien-Nr.:</b> <i>Serial No.</i>	<b>Engineering Sample</b>		
<b>Wareneingangs-Nr.:</b> <i>Receipt No.:</i>	<b>1403020312</b>	<b>Eingangsdatum:</b> <i>Date of receipt:</i>	<b>30.05.2013</b>		
<b>Prüfort:</b> <i>Testing location:</i>		<b>Refer Page 4 of 26 for test facilities</b>			
<b>Prüfgrundlage:</b> <i>Test specification:</i>		<b>FCC Part 15, Subpart C</b>			
<b>Prüfergebnis:</b> <i>Test Result:</i>		<b>Der Prüfgegenstand entspricht oben genannter Prüfgrundlage(n).</b> <i>The test items passed the test specification(s).</i>			
<b>Prüflaboratorium:</b> <i>Testing Laboratory:</i>		<b>TÜV Rheinland (India) Pvt. Ltd.</b> 82/A, 3rd Main, West Wing, Electronic City Phase 1 Hosur Road, Bangalore – 560 100. India			
<b>geprüft / tested by:</b>		<b>kontrolliert / reviewed by:</b>			
10.06.2013	Saibaba Siddapur Engineer		12.06.2013	Raghavendra Kulkarni Manager	
<b>Datum</b> <i>Date</i>	<b>Name/Stellung</b> <i>Name/Position</i>	<b>Unterschrift</b> <i>Signature</i>	<b>Datum</b> <i>Date</i>	<b>Name/Stellung</b> <i>Name/Position</i>	<b>Unterschrift</b> <i>Signature</i>
<b>Sonstiges / Other Aspects:</b>		<b>FCC ID : 2AAGG-YODA2P1</b>			
<b>Abkürzungen:</b>		<b>Abbreviations:</b>			
P(ass) = entspricht Prüfgrundlage F(ail) = entspricht nicht Prüfgrundlage N/A = nicht anwendbar N/T = nicht getestet		P(ass) = passed F(ail) = failed N/A = not applicable N/T = not tested			
<b>Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens.</b> <i>This test report relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any safety mark on this or similar products.</i>					

www.tuv.com

## Test Result Summary

Clause	Test Item	Result
FCC 15.247(b) (3)	Maximum Conducted Peak Output Power	Pass
FCC 15.247(a) (2)	6dB Bandwidth	Pass
FCC 15.247(e)	Power Spectral Density	Pass
FCC 15.247(d)	Band-edge compliance	Pass
FCC 15.209 / FCC 15.205	Spurious Radiated Emissions and Restricted Bands of Operation	Pass

# Content

<b>List of Type and Measurement Instruments .....</b>	<b>4</b>
<b>General Product Information .....</b>	<b>5</b>
Product Function and Intended Use .....	5
Operational description .....	6
<b>Test Set-up and Operation Mode.....</b>	<b>7</b>
Principle of Configuration Selection .....	7
Test Operation and Test Software .....	7
Special Accessories and Auxiliary Equipment .....	7
Countermeasures to achieve EMC Compliance .....	7
<b>Test Methodology .....</b>	<b>8</b>
Radiated Emission Test .....	8
<b>Test Results .....</b>	<b>9</b>
Maximum Conducted Peak Output Power	Section 15.247(b) (3) .....9
Power Spectral Density	Section 15.247(e) .....12
6 dB Bandwidth	Section 15.247(a) (2).....15
Band-edge Compliance	Section 15.247(d) .....19
Spurious Radiated Emissions and Restricted Bands of Operation	Section 15.209 and 15.205 .....25
Appendix 1: Test Setup Photo	
Appendix 2: EUT External Photo	
Appendix 3: EUT Internal Photo	
Appendix 4: FCC Label and Label Location	
Appendix 5: Block Diagram	
Appendix 6: Specification of EUT	
Appendix 7: Schematic Diagrams	
Appendix 8: Bill of Material	
Appendix 9: User Manual	
Appendix 10: Maximum Permissible Exposure Calculation	

www.tuv.com

## List of Type and Measurement Instruments

### TÜV Rheinland (India) Pvt. Ltd, Bangalore

Equipment	Manufacturer	Model	S/N	Calibration Due Date
EMI Test Receiver	Rohde &Schwarz	ESU 40	100288	04.10.2013
Hybrid Log Periodic antenna	ETS Lindgren	3142D	00081354	26.07.2013
Broadband Horn Antenna	Frankonia	HAX-18	HAX18-802	23.03.2014
Double-Ridged Waveguide Horn Antenna	ETS Lindgren	116794	00133356	01-09-2013
Emission Horn Antenna	ETS Lindgren	116706	00107323	24-08-2013
Active Loop Antenna	Frankonia	LAX-10	LAX-10-800	11-04-2014
Spectrum Analyser	Agilent Technologies	E4407B	US41192772	21.03.2014

#### Testing Facilities:

- 1) TÜV Rheinland (India) Private Limited  
No. 108, West Wing  
Electronic city Phase I  
Bangalore – 560100

[www.tuv.com](http://www.tuv.com)

## General Product Information

### Product Function and Intended Use

Yoda, the programmable intelligent RF module, combines a 2.4GHz radio transceiver module with a 16-bit MCU. The radios provide industry standard RF performance with excellent sensitivity and transmit power for long range. Designed specifically using extreme low power microcontroller and a ZigBee protocol stack on IEEE802.15.4 standards, Yoda is ideal for designs requiring long battery life, flexible application integration, and a reliable, proven, best-in-class networking solution.

### Ratings and System Details

Operating Frequency	2400MHz – 2483.5MHz
No. of channels	15
Channel Spacing	5MHz
Modulation	DSSS ( O-QPSK)
Transmitted Power	10.46dBm
Data Rate	250 kbps
Antenna Type	Inverted 'F' PCB antenna
Number of antenna	1
Antenna Gain	0 dBi
Supply Voltage to Module	3.3V DC
Dimensions	40 mm x 25mm
Environmental Condition	0 to +85 degrees C range.

### Test Conditions:

**Voltage: 10V DC to Base Board**

### Environmental conditions:

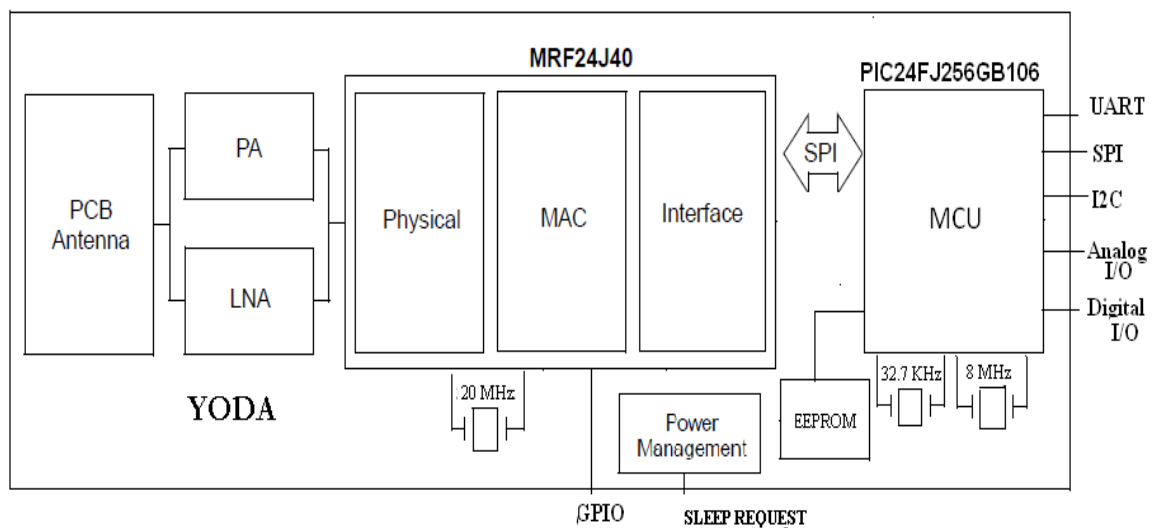
**Temperature: +23 °C   RH: 62%**

[www.tuv.com](http://www.tuv.com)

## Operational description

High performance 16-Bit PIC MCU with 16MIPS operation at 32MHz Low power consumption with sleep option MCU with A/D converter at 500Ksps 256 Kb Built in EEPROM on module Power-on Reset (POR), Power-up Timer (PWRT), Low-Voltage Detect (LVD) and Oscillator Start-up Timer (OST) ISM band 2.400– 2.4835GHz operation +10.46dBm output power Integrated low phase noise VCO, frequency synthesizer and PLL Loop filter digital VCO and Filter Calibration high receiver and RSSI dynamic range. Option for LNA bypass

### Block Diagram:



www.tuv.com

## Test Set-up and Operation Mode

### Principle of Configuration Selection

The test was performed under non-continuous transmission to obtain the maximum emissions.

### Test Operation and Test Software

Test software was used to enable the non-continuous transmission with maximum duty cycle and channels in 2.4 GHz band on the EUT for the tests in this report.

### Special Accessories and Auxiliary Equipment

- None

### Countermeasures to achieve EMC Compliance

- None

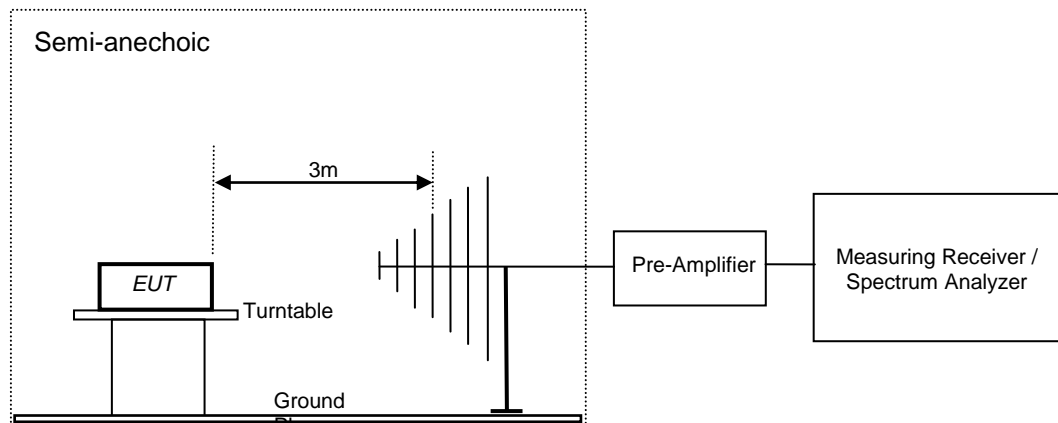
### Table of frequencies

Frequency Band	Channel No.	Frequency (MHz)
2400-2483.5 MHz	11	2405
	12	2410
	13	2415
	14	2420
	15	2425
	16	2430
	17	2435
	18	2440
	19	2445
	20	2450
	21	2455
	22	2460
	23	2465
	24	2470
	25	2475

## Test Methodology

### Radiated Emission Test

The radiated emission measurement was performed according to the procedures in ANSI C63.4-2003. The equipment under test (EUT) was placed at the middle of the 80 cm high turntable, and the EUT is 3 meters far from the measuring antenna. The turntable was rotated 360° for obtaining the maximum emission. The height of the measuring antennas was scanned between 1m and 4m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Repeat the measurement steps until the maximum emissions were obtained. The measurement above 1000MHz was performed by horn antenna. The measurement below 30MHz was performed by loop antenna. The EUT was rotated around the X-, Y-, and Z-Axis and the results from worst case axis are recorded.





www.tuv.com

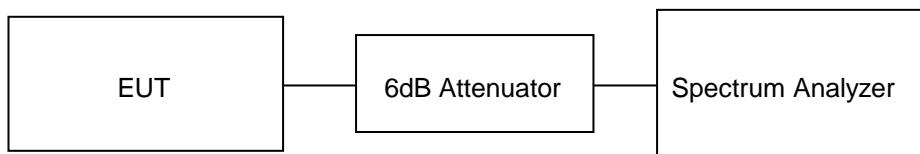
## Test Results

### Maximum Conducted Peak Output Power Result

Section 15.247(b) (3)  
Pass

Test Specification	FCC Part 15 Subpart C
Measurement Bandwidth (RBW)	1 MHz
Detector	Peak
Requirement	<1 watt (30dBm).

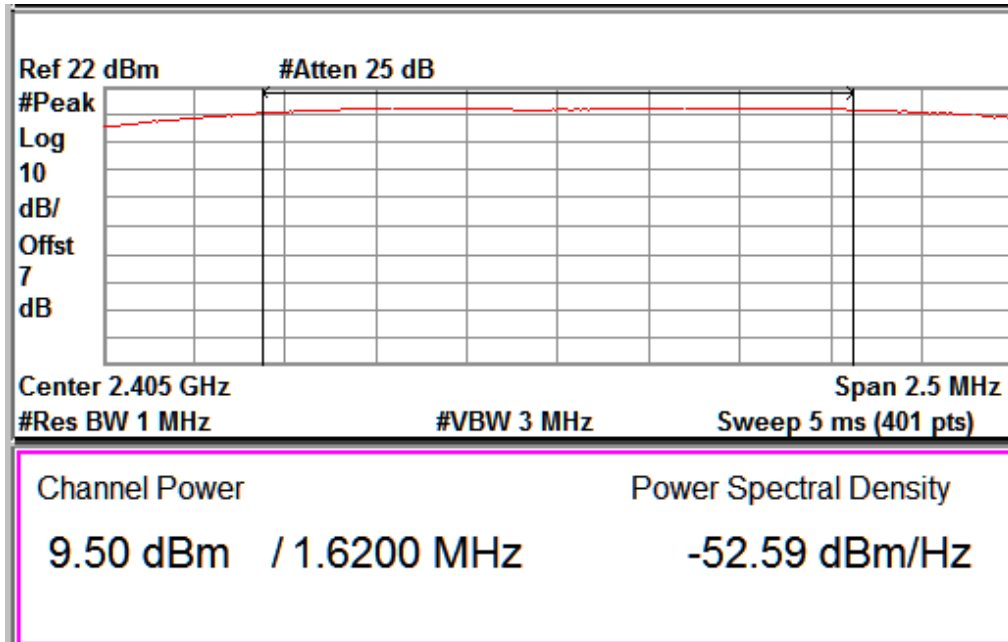
### Test Method:



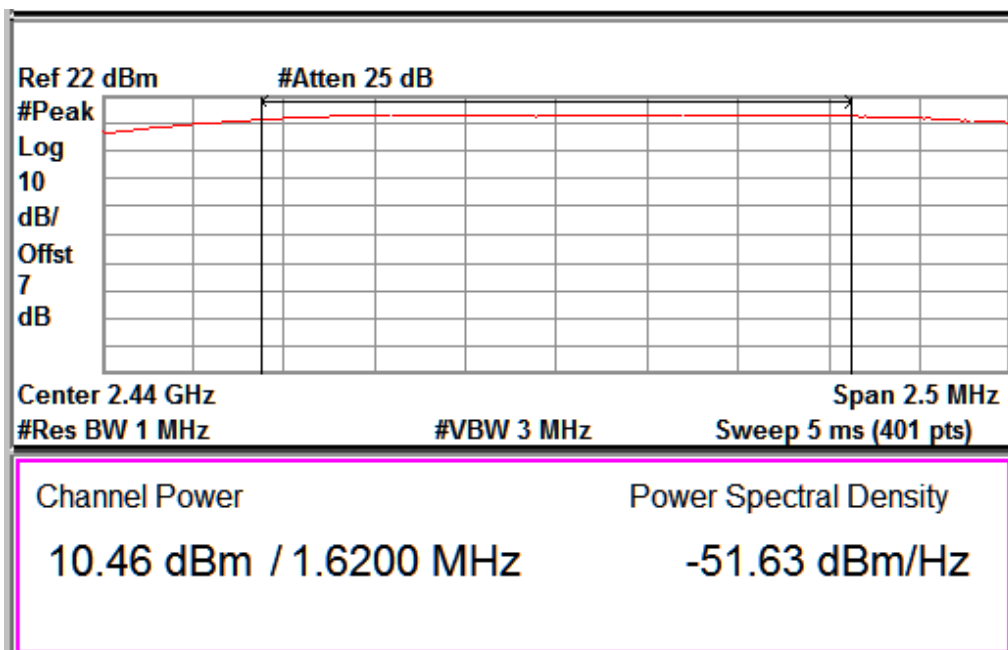
Cable Loss: 1dB

### Test Result:

Frequency (MHz)	Total Output power (dBm)	Limit (dBm)
2405	09.50	30.00
2440	10.46	30.00
2475	10.42	30.00

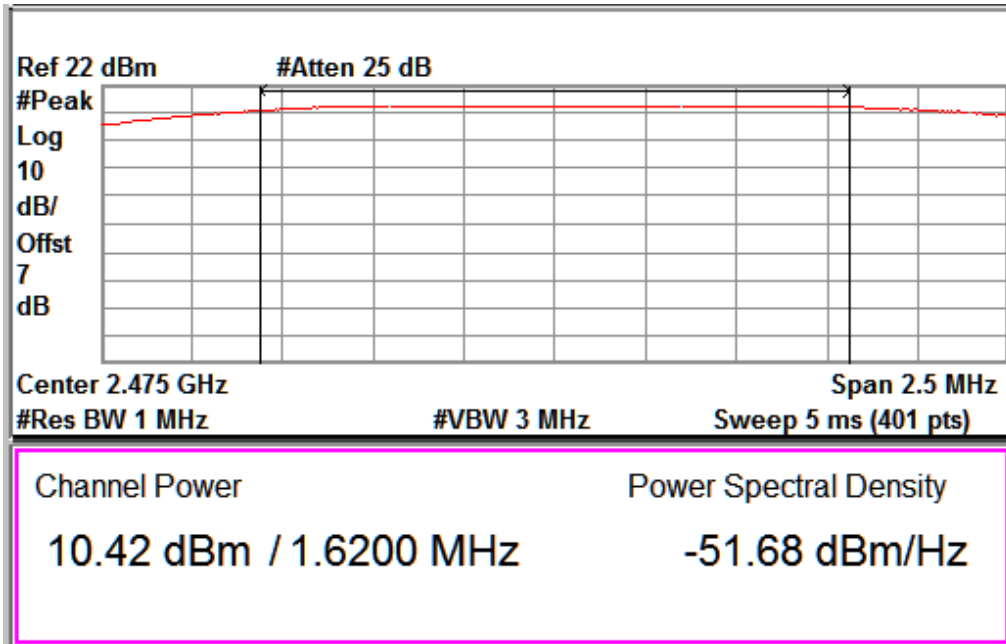


Channel Frequency: 2405 MHz



Channel Frequency: 2440 MHz

www.tuv.com



Channel Frequency: 2475 MHz

www.tuv.com

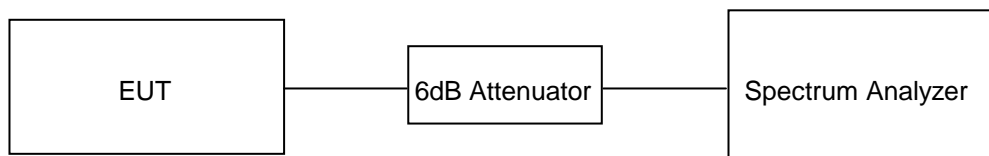
**Power Spectral Density  
Result**

**Section 15.247(e)  
Pass**

Test Specification      FCC Part 15 Subpart C  
Detector Function      Peak

Requirement      For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm.

**Test Method:**

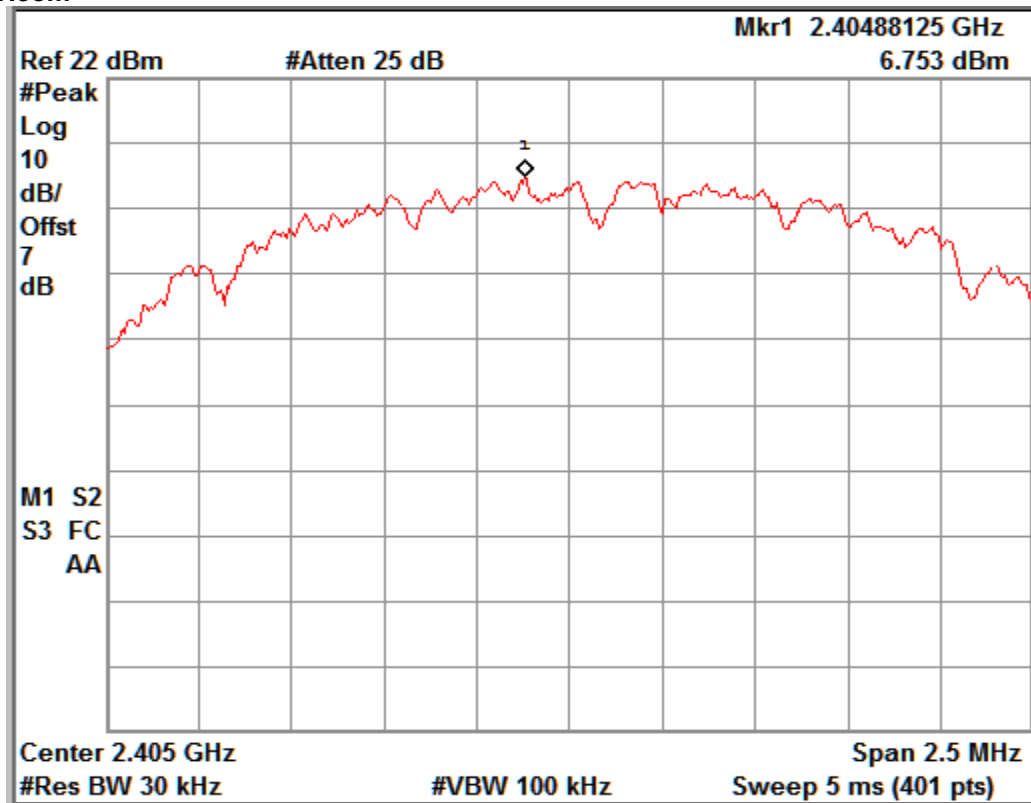


Cable Loss: 1dB

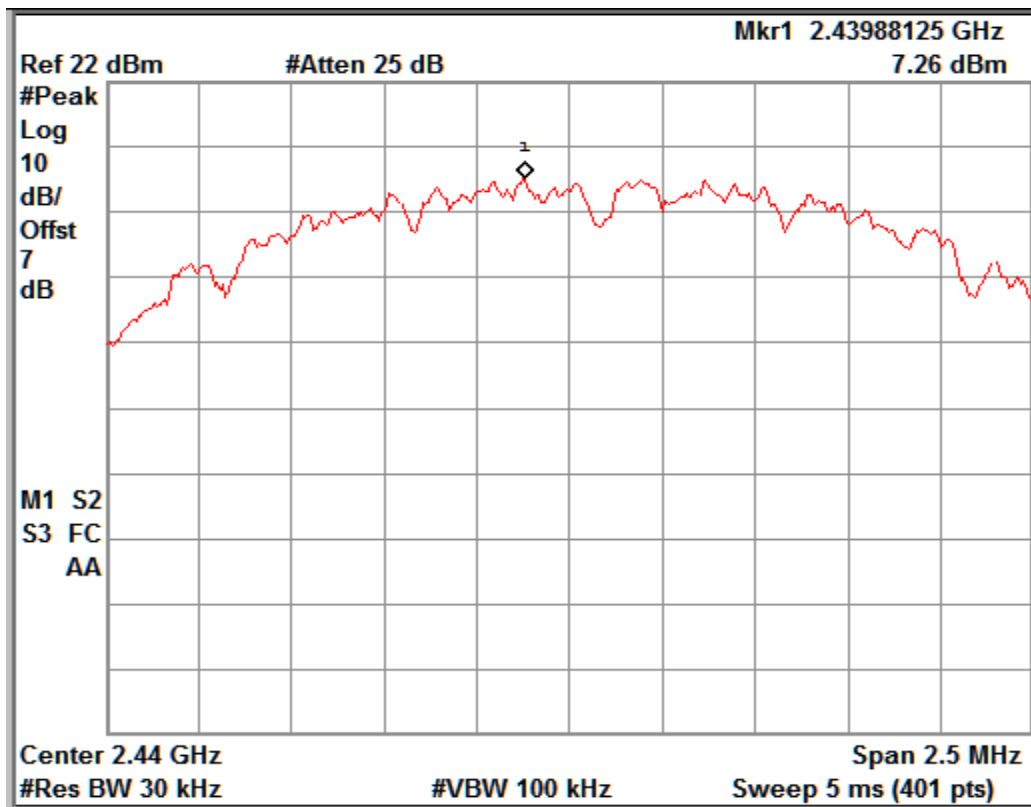
**Test Result:**

Frequency (MHz)	Total PSD (dBm)	Limit (dBm)
2405	6.75	8.00
2440	7.26	8.00
2475	7.20	8.00

www.tuv.com

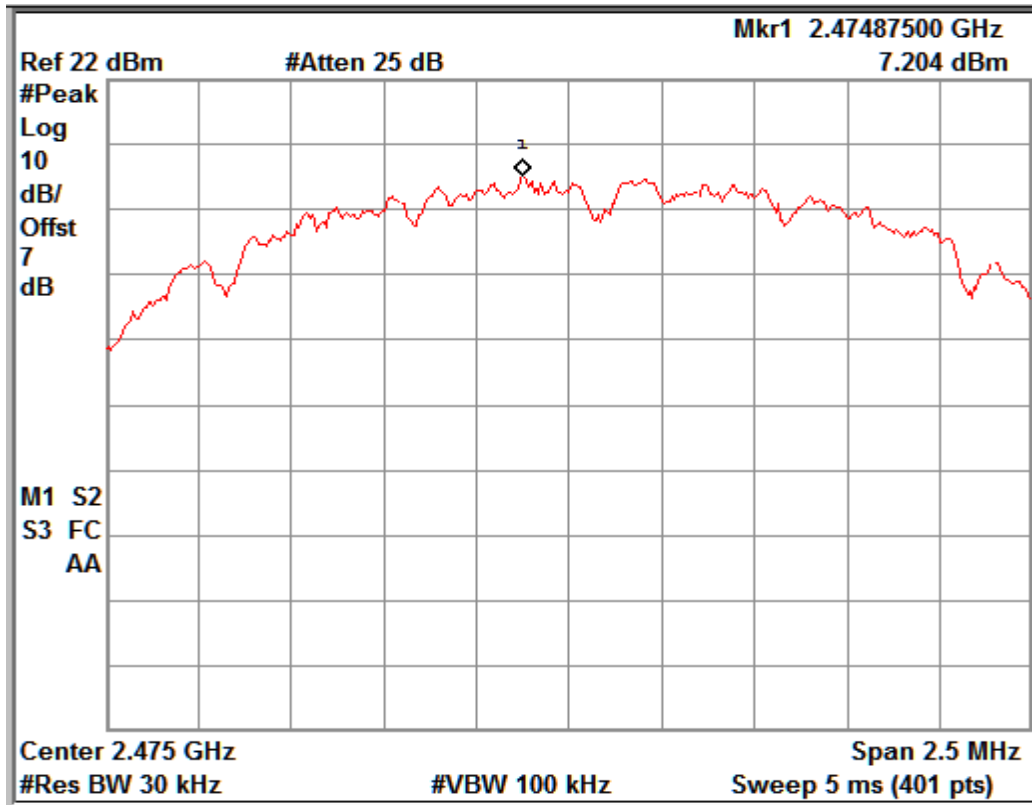


Channel Frequency: 2405 MHz



Channel Frequency: 2440 MHz

www.tuv.com



Channel Frequency: 2475 MHz

www.tuv.com

**6 dB Bandwidth  
Result**

**Section 15.247(a) (2)  
Pass**

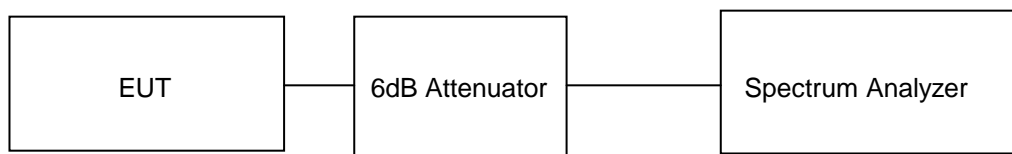
Test Specification

FCC Part 15 Subpart C

Requirement

The minimum 6 dB bandwidth shall be at least 500 kHz.

**Test Method:**

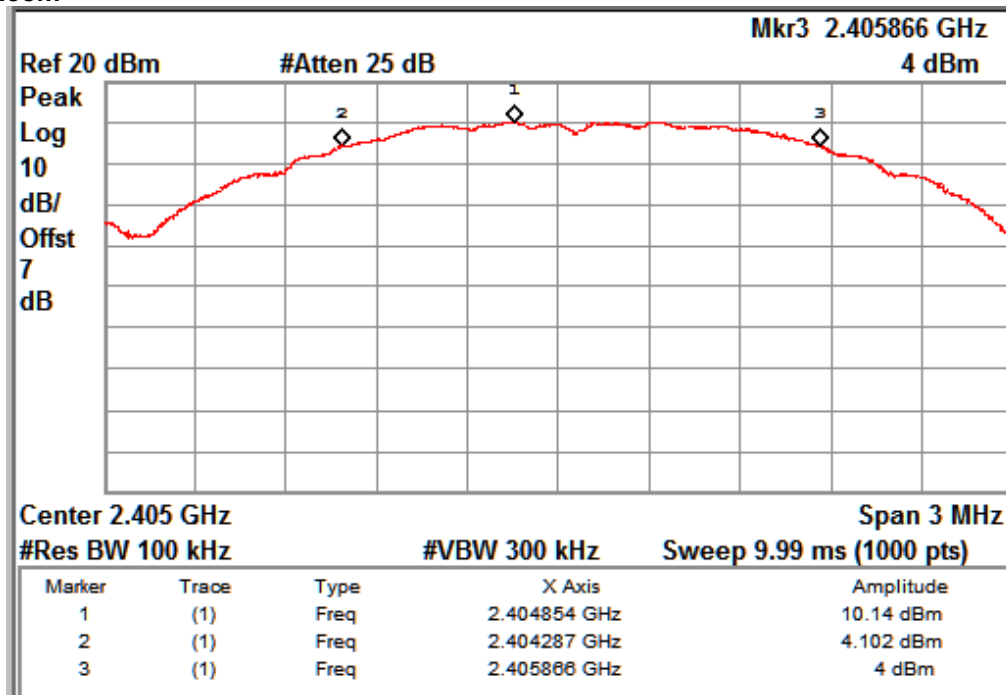


Cable Loss: 1dB

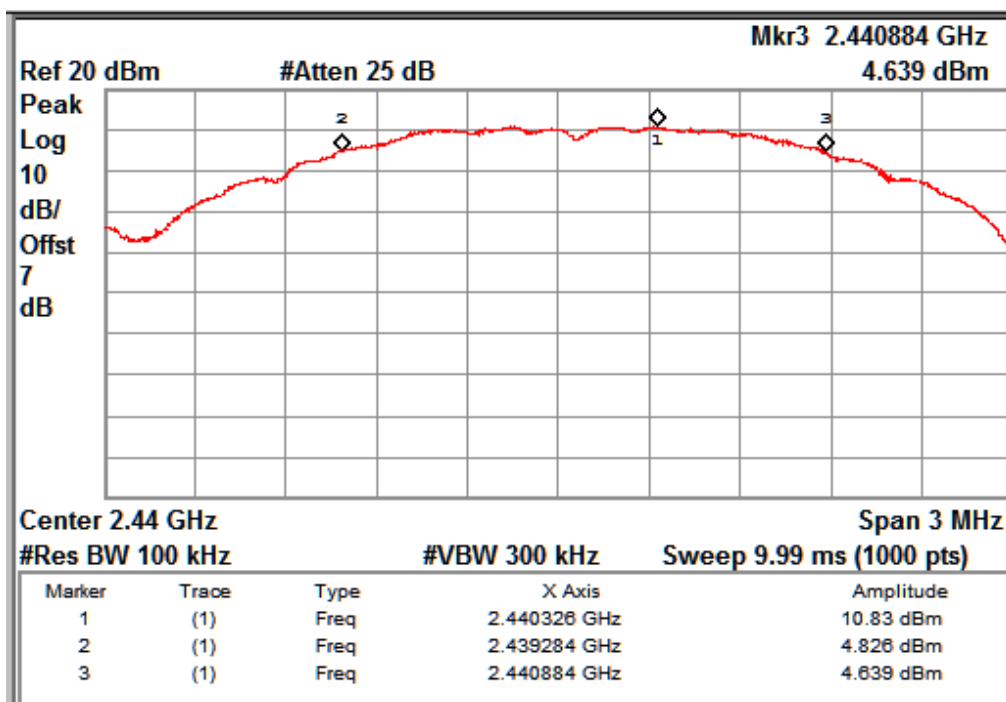
**Test Result:**

Frequency (MHz)	Lower Frequency (MHz)	Upper Frequency (MHz)	6 dB Bandwidth (MHz)	OBW (MHz)
2405	2404.28	2405.86	1.58	2.44
2440	2439.28	2440.88	1.60	2.43
2475	2474.26	2475.88	1.62	2.45

www.tuv.com



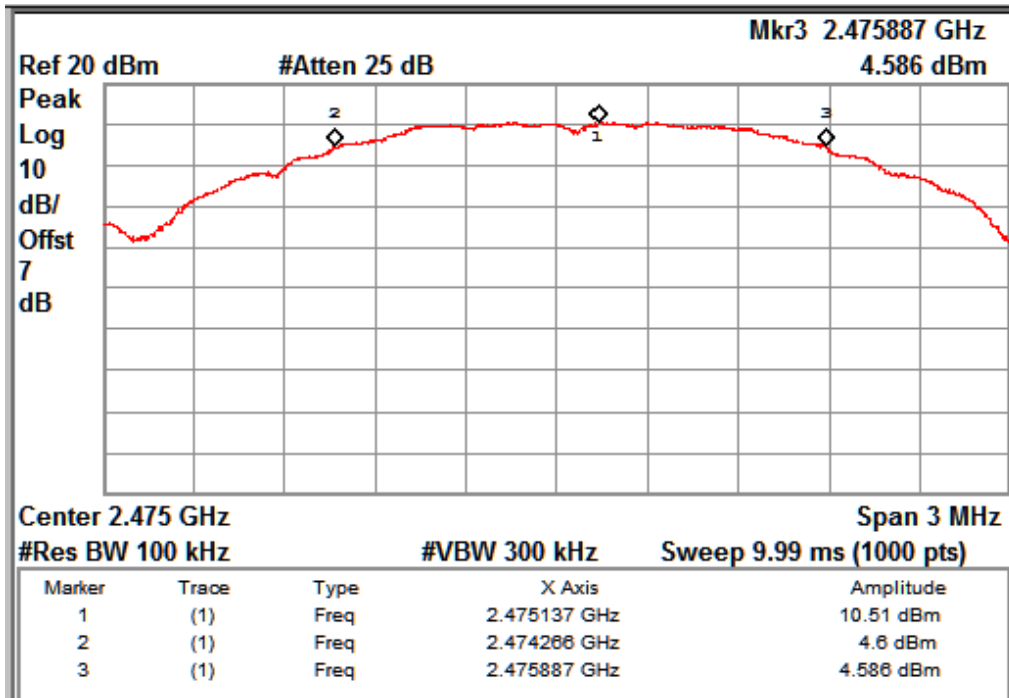
Channel frequency: 2405 MHz



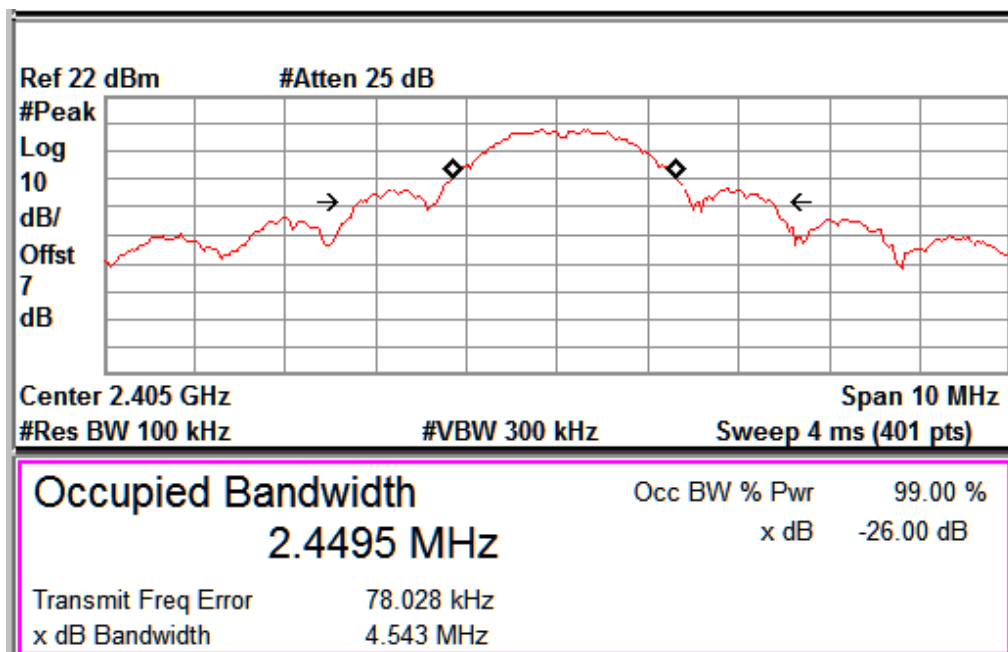
Channel frequency: 2440 MHz



www.tuv.com

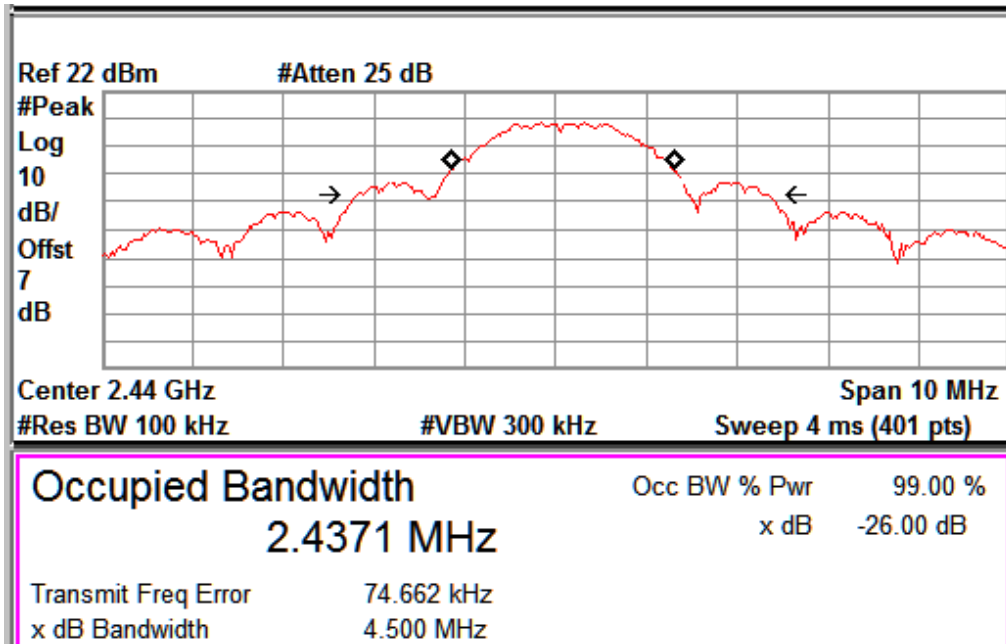


Channel frequency: 2475 MHz

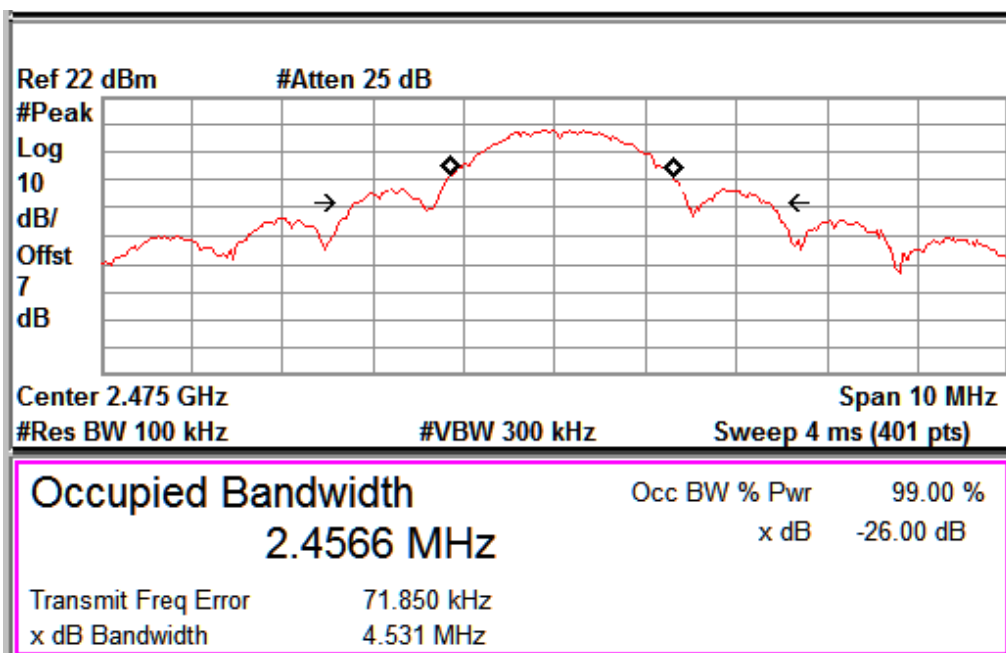


OBW Channel frequency: 2405 MHz

www.tuv.com



OBW Channel frequency: 2440 MHz



OBW Channel frequency: 2475 MHz

www.tuv.com

**Band-edge Compliance  
Result**

**Section 15.247(d)  
Pass**

Test Specification FCC Part 15 Subpart C

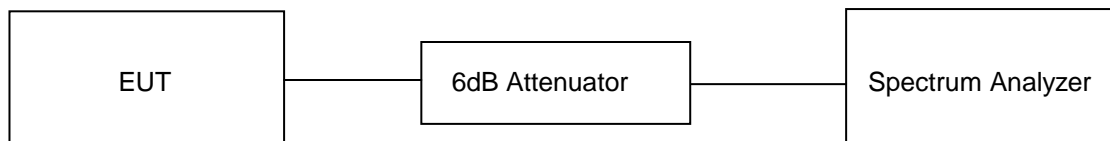
Detector Function Peak

Requirement

If the peak output power procedure is used to measure the fundamental emission power to demonstrate compliance to **15.247(b)(3)** requirements, then the peak conducted output power measured within any 100 kHz outside the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum measured in-band peak PSD level in 100kHz(i.e.20dBc)

If the average output power procedure is used to measure the fundamental emission power to demonstrate compliance to 15.247(b)(3) requirements, then the power in any 100 kHz outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum measured in-band average PSD level(i.e.30dBc)

**Test Method:**

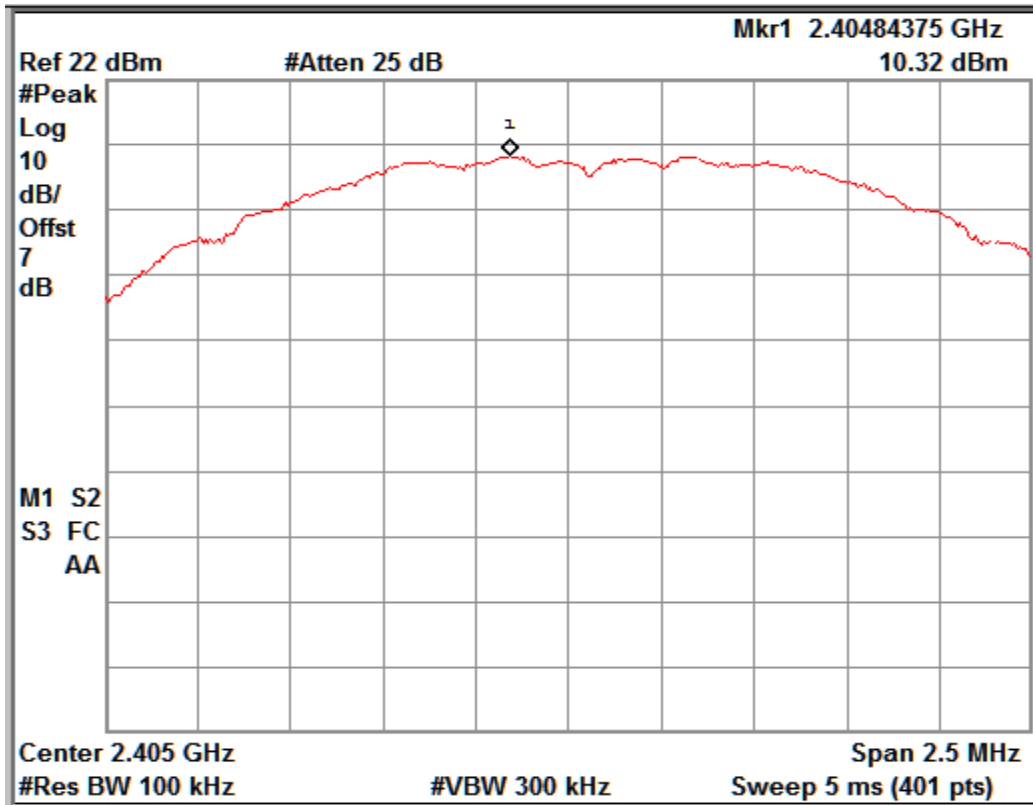


Cable Loss: 1dB

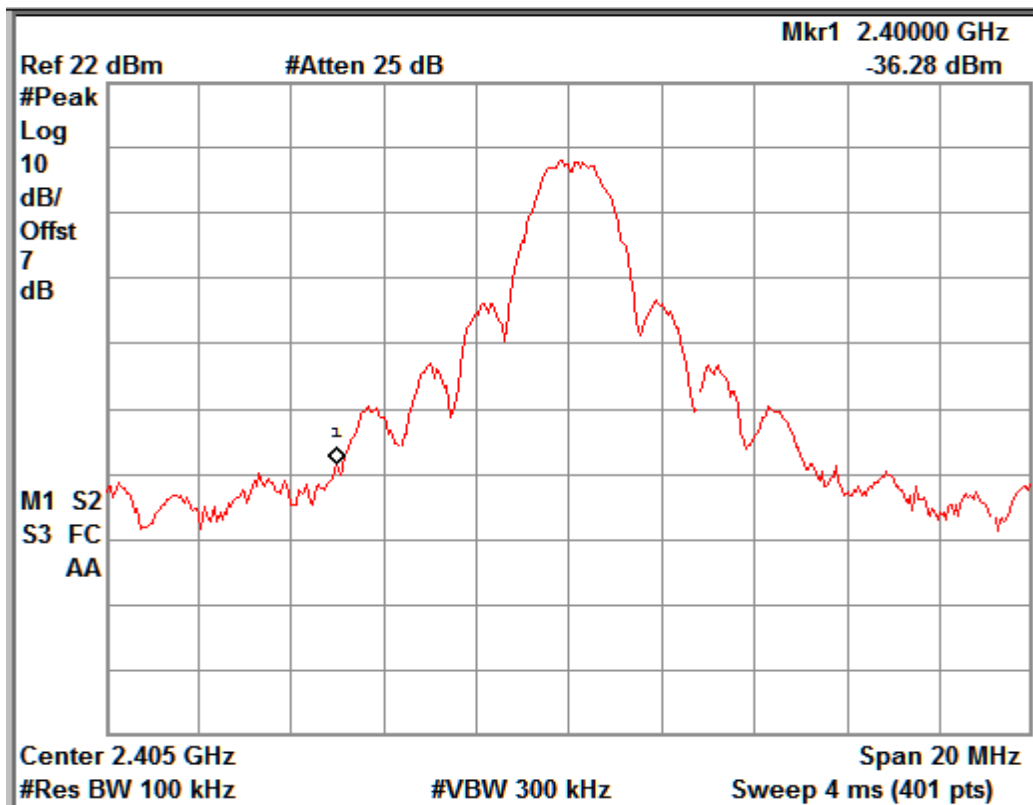
**Test Result:**

Frequency (MHz)	Value at Band Edge				Limit (dBc)
	Frequency(MHz)	PSD Reference(dBm)	Band Edge Value(dBm)	Value (dBc)	
2405	2400.00	10.32	-36.28	46.60	20.00
2480	2483.50	10.17	-41.30	51.47	20.00

www.tuv.com

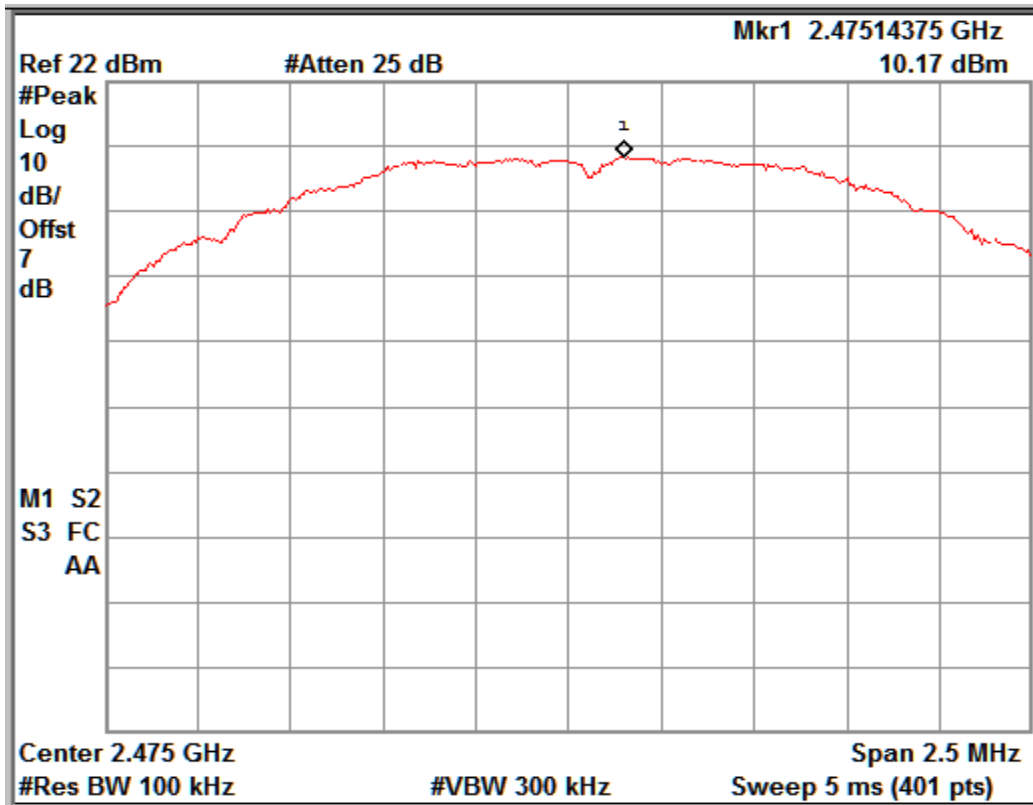


PSD Reference Plot

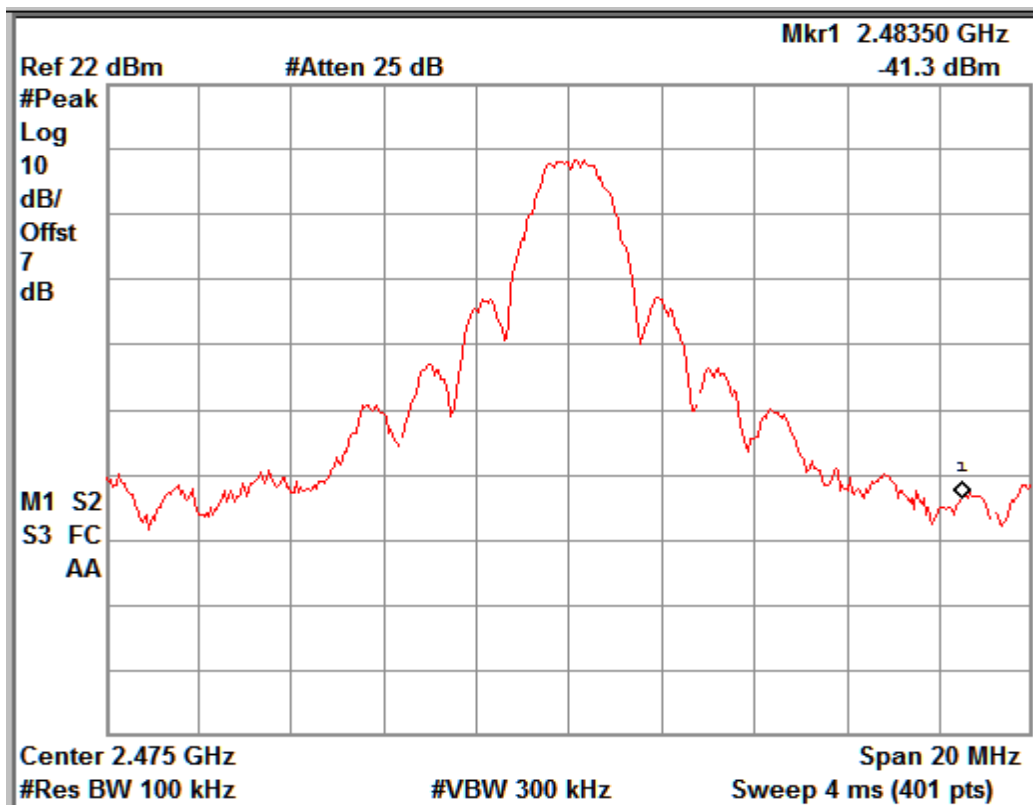


Channel frequency: 2405 MHz

www.tuv.com



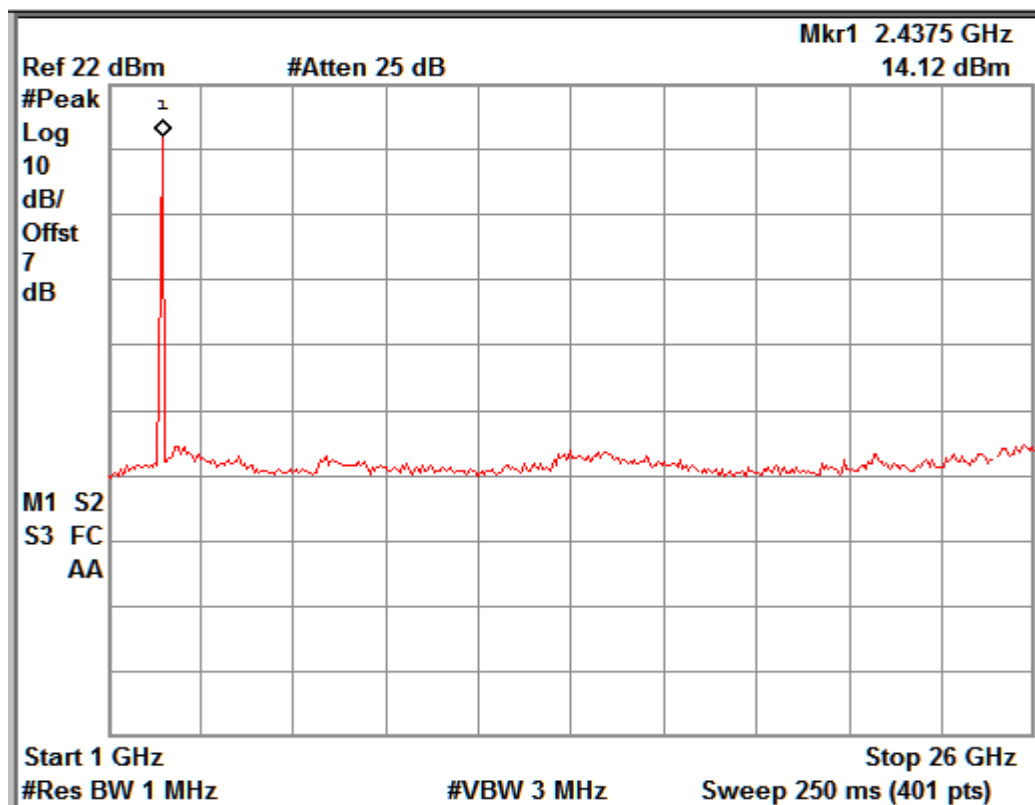
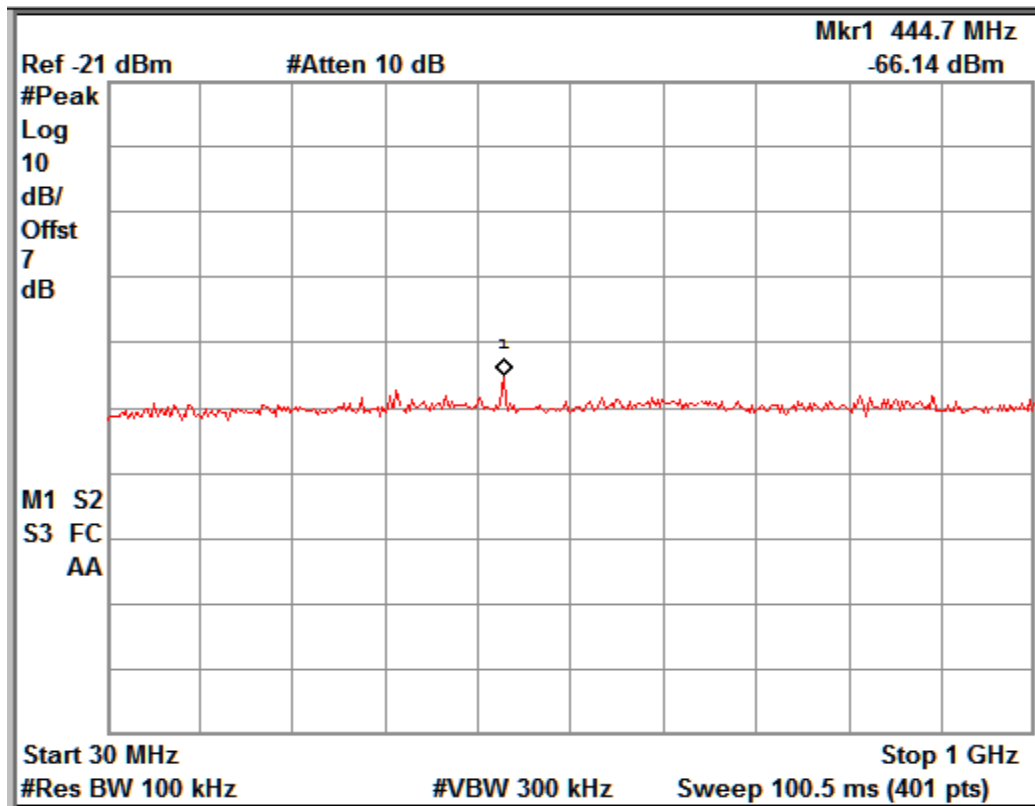
PSD Reference Plot



Channel frequency: 2475 MHz

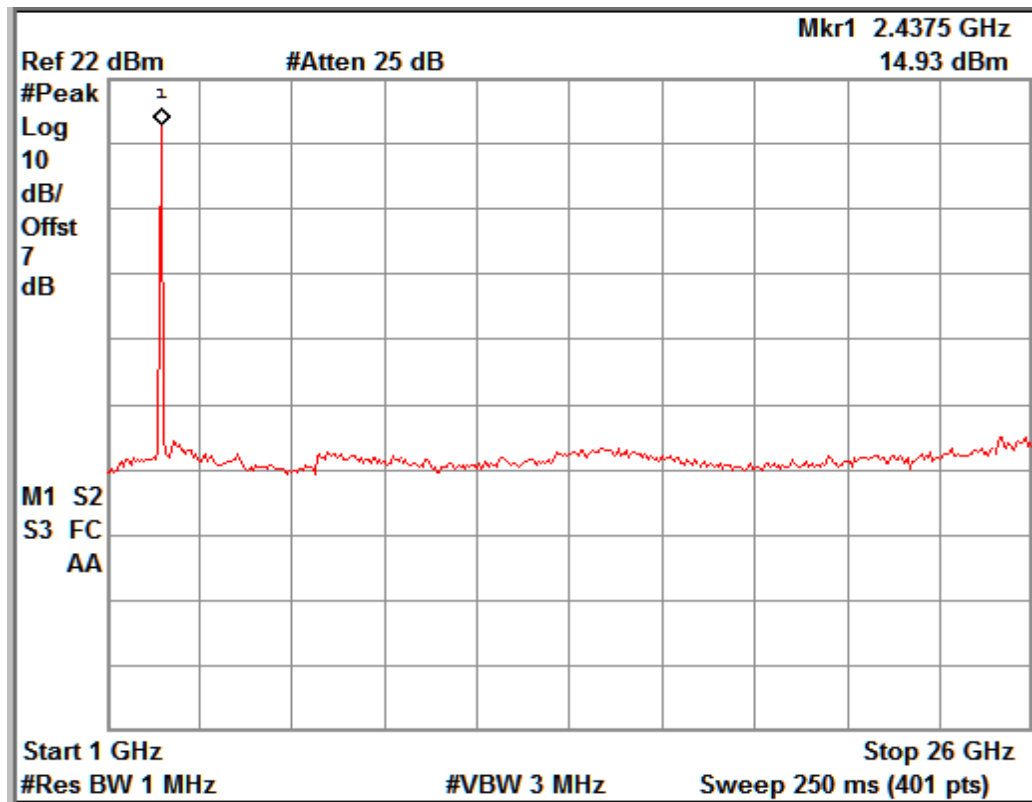
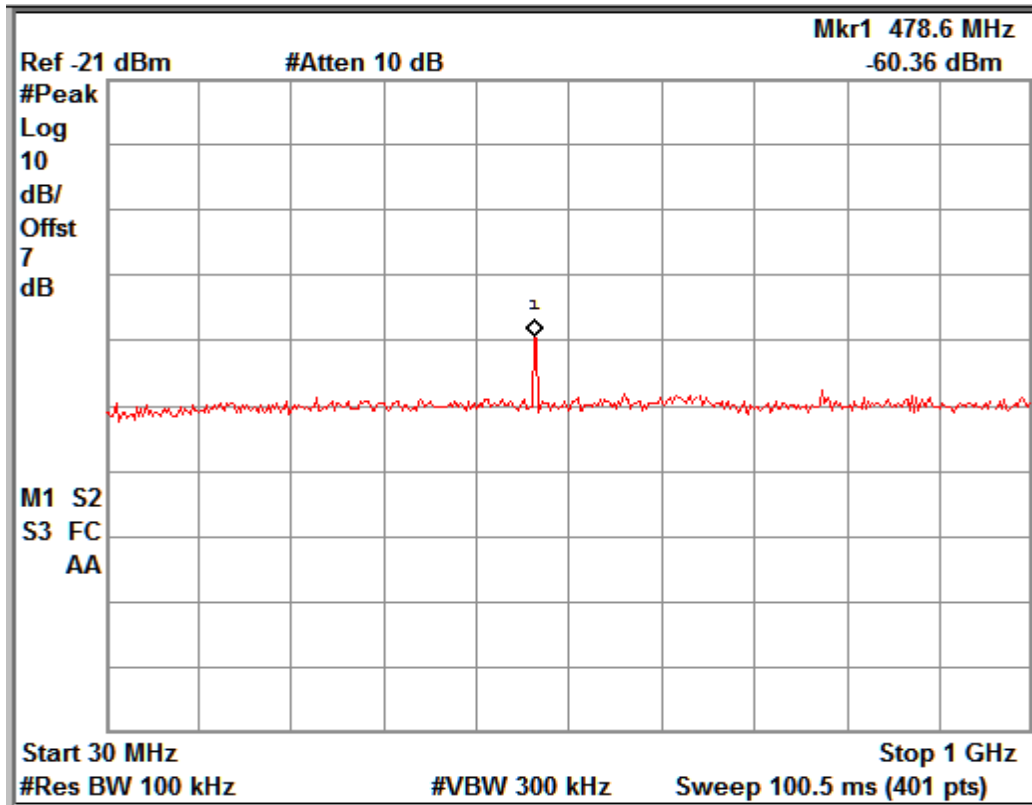
www.tuv.com

# Conducted Spurious Emission



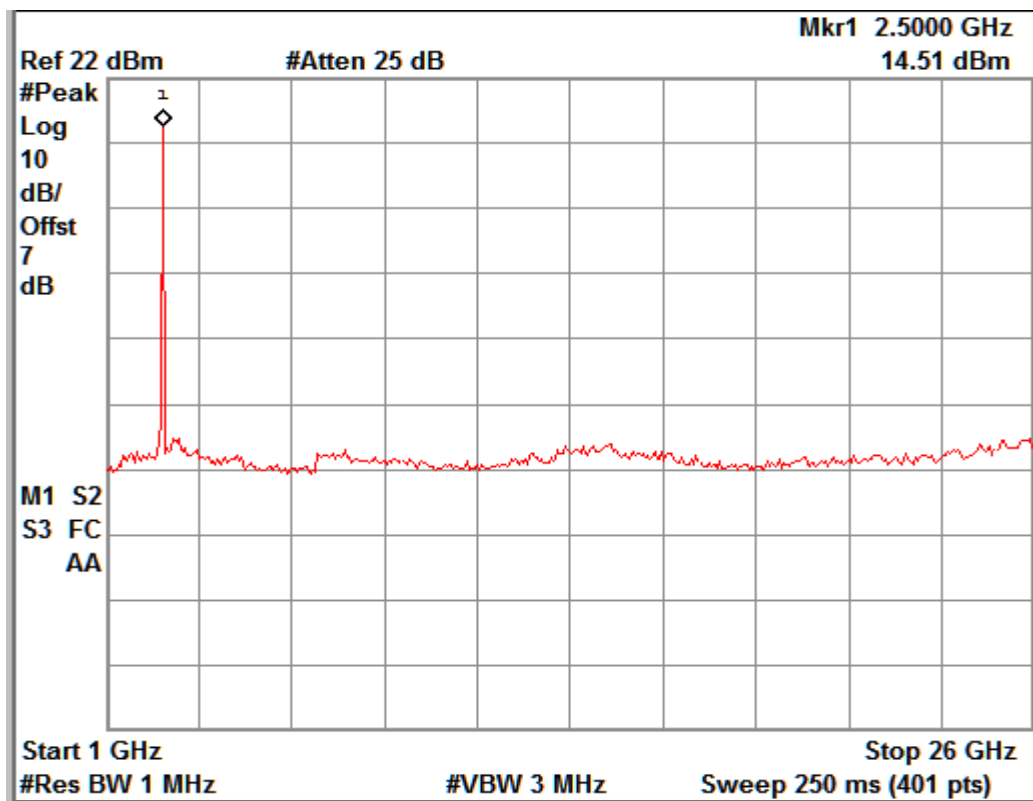
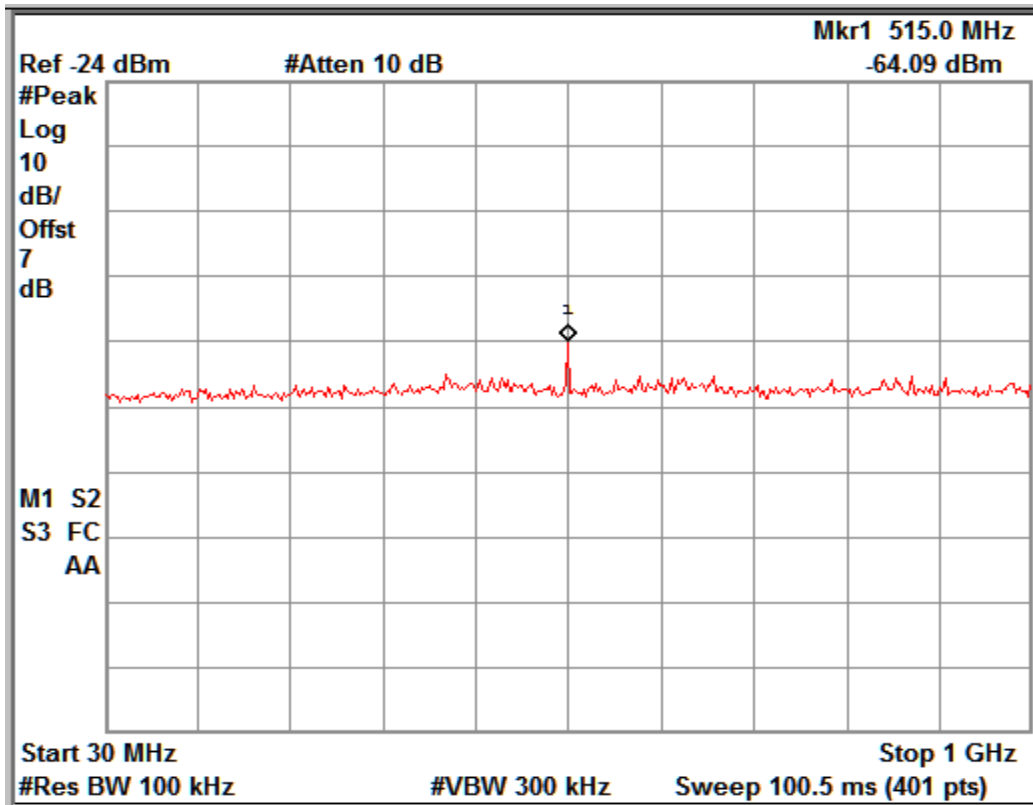
Channel frequency: 2405 MHz

www.tuv.com



Channel frequency: 2440 MHz

www.tuv.com



Channel frequency: 2475 MHz



**Spurious Radiated Emissions and  
Restricted Bands of Operation  
Result**
**Section 15.209 and 15.205  
Pass**

Test Specification	FCC Part 15 Subpart C
Test Method	ANSI C63.4-2003
Measurement Location	Semi Anechoic Chamber
Measuring Distance	3m
Detection	QP for frequency below 1GHz, Peak and Average for frequency above 1GHz
Requirement	As per the limits mentioned in the bellow table

**Limit for Radiated Emission of Section 15.209:**

Frequency (MHz)	Field strength (μV/m)	Field strength (dBμV/m)	Distance of Measurement (m)
0.009 – 0.490	2400/F(kHz)	48.50 – 13.80	300*
0.490 – 1.705	24000/F(kHz)	33.80 – 23.00	30*
1.705 -30	30	29.54	30*
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

Remark: \* the limit shows in the table above of frequency range 0.009 – 0.490, 0.490 – 1.705 MHz and 1.705-30MHz is at 300 meter, 30 meter and 30 meter range respectively, which corresponds to 88, 50 – 53.80, 53.80 – 43.00 and 49.5dBμV/m at 3m range by extrapolation calculation and the measurement of loop antenna.

The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz Radiated emission limits in these three bands are based on measurements employing an average detector.

**Test result:**
**Worst case emission in the frequency range from 30MHz tot 1GHz**

Polarization	Frequency (MHz)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Vertical	66.54	26.63	40	13.37
	265.77	33.38	46	12.62
	277.11	29.45	46	16.55
	281.34	34.13	46	11.87
Horizontal	66.67	29.50	40	10.50
	266.39	32.80	46	13.20
	273.88	31.93	46	14.07
	279.52	34.45	46	11.55

**Worst case test results for above 1GHz**

Channel	Polarization	Frequency (MHz)	Field Strength (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
Low	Vertical	2385.6(Pk)	56.18	74	-17.82
		2385.6(Av)	45.39	54	-8.61
		2405(Pk)	105.6	*	-
		2405(Av)	98.95	*	-
		4810(Pk)	52	74	-22
		4810(Av)	38.27	54	-15.73
	Horizontal	2385.7(Pk)	57.17	74	-16.83
		2385.7(Av)	47.01	54	-06.99
		2405(Pk)	106.67	*	-
		2405(Av)	99.25	*	-
		4810(Pk)	50.98	74	-23.02
		4810(Av)	38.15	54	-15.85
Mid	Vertical	2440(Pk)	107.8	*	*
		2440(Av)	101.08	-	-
		4880(Pk)	50.48	74	-23.52
		4880(Av)	37.79	54	-16.21
	Horizontal	2440(Pk)	107.39	*	*
		2440(Av)	100.09	-	-
		4880(Pk)	51.09	74	-22.91
		4880(Av)	38.3	54	-15.70
High	Vertical	2475(Pk)	107.57	*	-
		2475(Av)	100.54	*	-
		2483.5(Pk)	66.19	74	-07.81
		2485.4(Av)	49.86	54	-04.14
		4950(Pk)	52.44	74	-21.56
		4950(Av)	39.51	54	-14.49
	Horizontal	2475(Pk)	106.82	*	-
		2475(Av)	99.83	*	-
		2483.5(Pk)	64.26	74	-09.74
		2485.2(Av)	48.56	54	-05.44
		4950(Pk)	51.66	74	-22.34
		4950(Av)	38.81	54	-15.19

\* - --> Fundamental Frequency

Pk--> Peak Detector

Av--> Average Detector