



**FCC LISTED,  
REGISTRATION  
NUMBER: 905266**

**IC LISTED  
REGISTRATION  
NUMBER IC 4621**

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## TEST REPORT

**Report No.: 25810RET.101**

**TEST NAME:** FCC PART 15.247 RADIO TESTING FOR BLUETOOTH RADIO DEVICE

<b>Product</b>	: Mobile phone with bluetooth
<b>Trade Mark</b>	: Neonode
<b>Model/type Ref.</b>	: N2
<b>Manufacturer</b>	: NEONODE AB
<b>Requested by</b>	: NEONODE AB
<b>Other identification of the product</b>	: FCC ID: U76GC444277
<b>Standard(s)</b>	: USA FCC Part 15.247, 15.205, 15.209, 15.109, 15.207

This test report includes 3 annexes and therefore the total number of pages is 55.

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Date: 2007-08-03	Test operator A. Llamas/R. López 	Approved by: Date: 2007-08-03 J. C. Soler  Consultant 	Page: 1 of 8
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FDT08\_04

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## 1. COMPETENCE AND GUARANTEES

Centro de Tecnología de las Comunicaciones (AT4 WIRELESS), S.A. is a laboratory with a measurement facility in compliance with the requirements of Section 2.948 of the FCC rules and has been added to the list of facilities whose measurements data will be accepted in conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Registration Number: 905266.

Centro de Tecnología de las Comunicaciones (AT4 WIRELESS), S.A. is a laboratory with a measurement site in compliance with the requirements of RSS 212, Issue 1 (Provisional) and has been added to the list of filed sites of the Canadian Certification and Engineering Bureau. Reference File Number: IC 4621.

In order to assure the traceability to other national and international laboratories, AT4 WIRELESS has a calibration and maintenance programme for its measuring equipment.

AT4 WIRELESS guarantees the reliability of the data presented in this report, which is the result of measurements and tests performed to the item under test on the date and under the conditions stated on the report and is based on the knowledge and technical facilities available at AT4 WIRELESS at the time of execution of the test.

AT4 WIRELESS is liable to the client for the maintenance by its personnel of the confidentiality of all information related to the item under test and the results of the test.

## 2. GENERAL CONDITIONS

1. This report only refers to the item that has undergone the test.
2. This report does not constitute or imply by its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without written approval of AT4 WIRELESS.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written approval of AT4 WIRELESS and the Accreditation Bodies.

## 3. CHARACTERISTICS OF THE TEST

### 3.1 TEST REQUESTED

1. Measurements for frequency hopping spread spectrum equipment (Bluetooth) operating in the 2400 MHz -2483.5 MHz band and using, according to FCC Part 15.247.
2. Continuous conducted emission, power leads:

Standard: FCC Rules and Regulations 47 CFR Part 15

Limit: Class B

Method: FCC Rules and Regulations 47 CFR Part 15, Subpart C

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### 3.2 REQUIREMENTS AND METHOD

1. FCC parts 15.33, 15.35, 15.247, 15.207, 15.205, 15.209, 15.109 and the document DA 00-705:"Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems".

The testing was performed according to the procedure in ANSI C63.4: 2003. Radiated testing was performed in AT4 WIRELESS's semi-anechoic chamber. This site has been fully described in a report submitted to the FCC and was accepted in a letter dated July 25, 2002.

2. FCC Rules and Regulations 47 CFR Part 15, Subpart C: Limits and methods of measurements for radio frequency devices. Intentional radiators.

The instrumentation used to perform the testing is listed below:

1. Semianechoic Absorber Lined Chamber IR 11. BS.
2. Control Chamber IR 12.BC.
3. Antenna mast EM 1072 NMT.
4. Rotating table EM 1084-4. ON.
5. Multi device controller ETS 2090.
6. Bluetooth test set Anritsu MT8852A.
7. Bilog antenna CHASE CBL6111.
8. Antenna tripod EMCO 11968C.
9. Double-ridge Guide Horn antenna 1-18 GHz HP 11966E.
10. Double-ridge Guide Horn antenna 18-40 GHz Agilent 119665J.
11. RF pre-amplifier Miteq JS4-12002600-30-5A.
12. Semianechoic Absorber Lined Chamber IR 11. BS.
13. RF pre-amplifier Miteq AFS5-04001300-15-10P-6.
14. Spectrum analyzer R&S ESIB 26.
15. Spectrum analyzer Agilent E4440A.
16. RF pre-amplifier Schaffner CPA 9231.
17. DC power supply R&S NGPE 40/40.
18. Transient limiter. HP 11947A.
19. Line Impedance Stabilization Network (L.I.S.N.) R&S. ESH2-Z5.

#### 4. IDENTIFICATION DATA SUPPLIED BY THE APPLICANT

Identification data in this section has been supplied by the client.

##### 4.1 APPLICANT

**Name or Company:** NEONODE AB.

**V.A.T.:** 556655-5099

**Address:** Biblioteksgastan 11

**City:** Stockholm

**Postal code:** SE-11146

**Country:** Sweden

**Telephone:** +46 8 6781850

**Fax:** +46 8 6781851

##### 4.2 REPRESENTATIVE

**Name:** Ulf Martensson.

##### 4.3 TEST SAMPLES SUPPLIER

**Name or Company:** Same as indicated in point 4.1

Samples undergoing test have been selected by: **the client**

##### 4.4 IDENTIFICATION OF ITEM/ITEMS TESTED

**Product:** Mobile phone with bluetooth

**Trade mark:** Neonode

**Model:** N2

**HW version:** R1

**SW version:** 2.1.231.1

**Manufacturer:** NEONODE AB.

**Country of manufacture:** Sweden

**Description:** Mobile phone with bluetooth

## 5. USAGE OF SAMPLES, PERIOD OF TESTING AND ENVIRONMENTAL CONDITIONS

### 5.1 USAGE OF SAMPLES

Sample M/01 is formed by the following elements:

<u>Control No.</u>	<u>Description</u>	<u>Model</u>	<u>Serial No.</u>	<u>Date of reception</u>
25810/31	Mobile phone with integral antenna	N2	353153000112805	30/05/07

Sample M/02 is formed by the following elements:

<u>Control No.</u>	<u>Description</u>	<u>Model</u>	<u>Serial No.</u>	<u>Date of reception</u>
25810/54	Mobile phone with antenna connector	N2	----	18/07/07

Sample S/01 is composed of the following elements:

<u>Control No.</u>	<u>Description</u>	<u>Model</u>	<u>Serial No.</u>	<u>Date of reception</u>
25810/31	Mobile phone with integral antenna	N2	353153000112805	30/05/07
25810/24	Battery charger	Y-RAY81	----	26/04/07

1. Sample M/01 has undergone following test(s).  
Radiated tests indicated in annex A.
2. Sample M/02 has undergone following test(s).  
All tests indicated in annex A, except radiated tests.
3. Sample S/01 has undergone to the following test(s):  
Continuous conducted emission, power leads, in Annex B.

### 5.2 PERIOD OF TESTING

The performed test started on 2007-06-20 and finished on 2007-07-19.

The tests as detailed in this report have been performed at AT4 WIRELESS.

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### 5.3 ENVIROMENTAL CONDITIONS

In the control chamber the following limits were not exceeded during the test:

Temperature	Min. = 24 °C Max. = 24 °C
Relative humidity	Min. = 56 % Max. = 56 %
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 0,5 Ω

In the semianechoic chamber (21 meters x 11 meters x 8 meters) the following limits were no exceeded during the test.

Temperature	Min. = 23 °C Max. = 23 °C
Relative humidity	Min. = 55 % Max. = 55 %
Air pressure	Min. = 1020 mbar Max. = 1020 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 0,5 Ω
Normal site attenuation (NSA)	< ±4 dB at 10 m distance between item under test and receiver antenna, (30 MHz to 1000 MHz)
Field homogeneity	More than 75% of illuminated surface is between 0 and 6 dB (26 MHz to 1000 MHz).

In the chamber for conducted measurements the following limits were not exceeded during the test

Temperature	Min. = 24 °C Max. = 24 °C
Relative humidity	Min. = 51 % Max. = 51 %
Air pressure	Min. = 1020 mbar Max. = 1020 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 0,5 Ω

## 6. TEST RESULTS

Abbreviations used in the VERDICT column of the following tables are:

- P** Pass  
**F** Fail  
**NA** not applicable  
**NM** not measured

FCC PART 15 PARAGRAPH	VERDICT			
	NA	P	F	NM
15.247 Subclause (a) (1). 20 dB Bandwidth and Carrier frequency separation		P		
15.247 Subclause (a) (1) (iii). Number of hopping channels		P		
15.247 Subclause (a) (1) (iii). Time of occupancy (Dwell Time)		P		
15.247 Subclause (b). Maximum peak output power and antenna gain		P		
15.247 Subclause (c). Band-edge of conducted emissions (Transmitter)		P		
15.247 Subclause (c). Emission limitations conducted (Transmitter)		P		
15.247 Subclause (c). Emission limitations radiated (Transmitter)		P		
15.109. Radiated emission limits for receiver		P		
15.207. Conducted limits		P		

## 7. REMARKS AND COMMENTS

None.

## 8. SUMMARY

Based on the results of the performed test, stated in annex A the item under test is **IN COMPLIANCE** with the specifications listed in section 3.1 “TEST REQUESTED”.

NOTE: The results presented in this Test Report apply only to the particular item under test declared in section 4.4 “IDENTIFICATION OF ITEM/ITEMS TESTED” of this document, as presented for test on the date(s) declared in section 5, “USAGE OF SAMPLES, PERIOD OF TESTING AND ENVIRONMENTAL CONDITIONS”.

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## ANNEX A

# TEST RESULTS

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## TEST CONDITIONS

Power supply (V):

$$V_{\text{nominal}} = 3.8 \text{ Vdc}$$

Type of power supply = Rechargeable battery

Type of antenna = Integral antenna

Maximum Declared Gain for antenna = -0.5 dBi

Operating Temperature Range (°C):

$$T_n = -10 \text{ to } +55$$

### TEST FREQUENCIES:

Lowest channel: 2402 MHz

Middle channel: 2441 MHz

Highest channel: 2480 MHz

The test set-up was made in accordance to the general provisions of ANSI C63.4: 2003.

### CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is connected to a Bluetooth signalling unit (Bluetooth test set) and to the spectrum analyser using a 6 dB power splitter. The reading in the spectrum analyser is corrected taking into account the power splitter loss.

### RADIATED MEASUREMENTS

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-25 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

For radiated emissions in the range 1 GHz-25 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive (wooden) platform one meter above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

An additional horn antenna is used to control the equipment under test with the Bluetooth signalling unit (Bluetooth test set).

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## Section 15.247 Subclause (a) (1). 20 dB Bandwidth and Carrier frequency separation

### SPECIFICATION

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

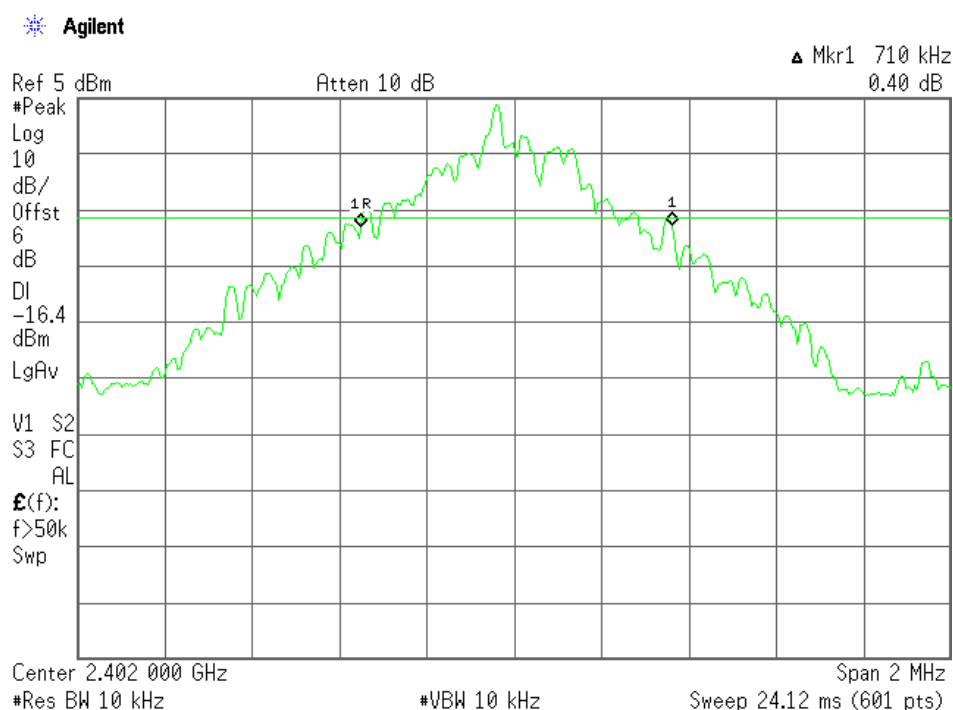
### RESULTS

20 dB Bandwidth (see next 3 plots).

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
20 dB Spectrum bandwidth (kHz)	710	710	733
Measurement uncertainty (kHz)	<±110		

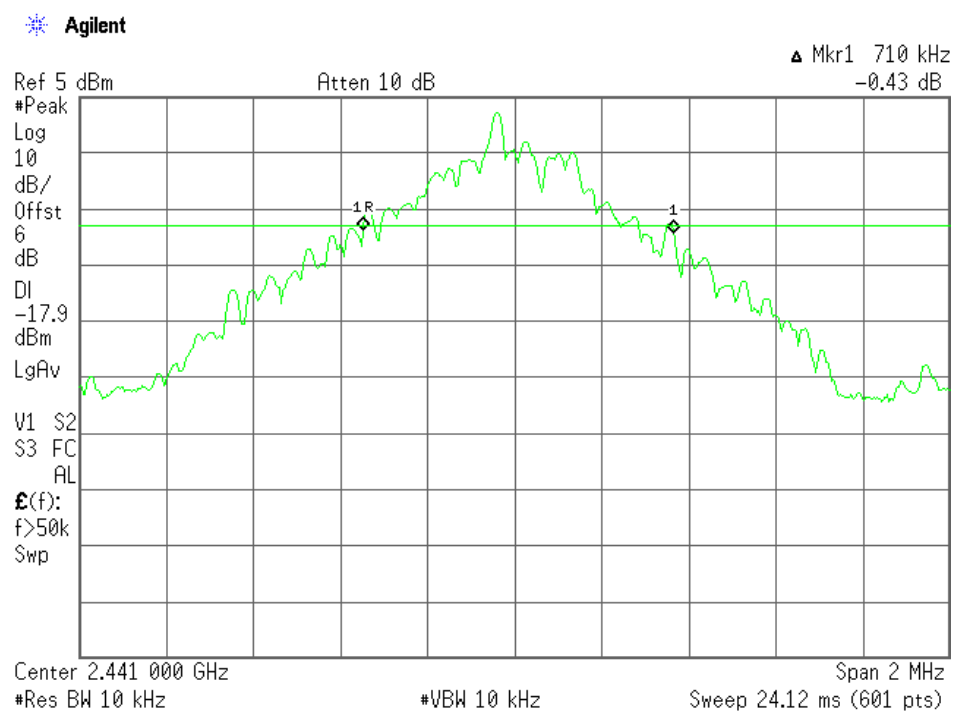
20 dB BANDWIDTH.

Lowest Channel: 2402 MHz.



20 dB BANDWIDTH.

Middle Channel: 2441 MHz.



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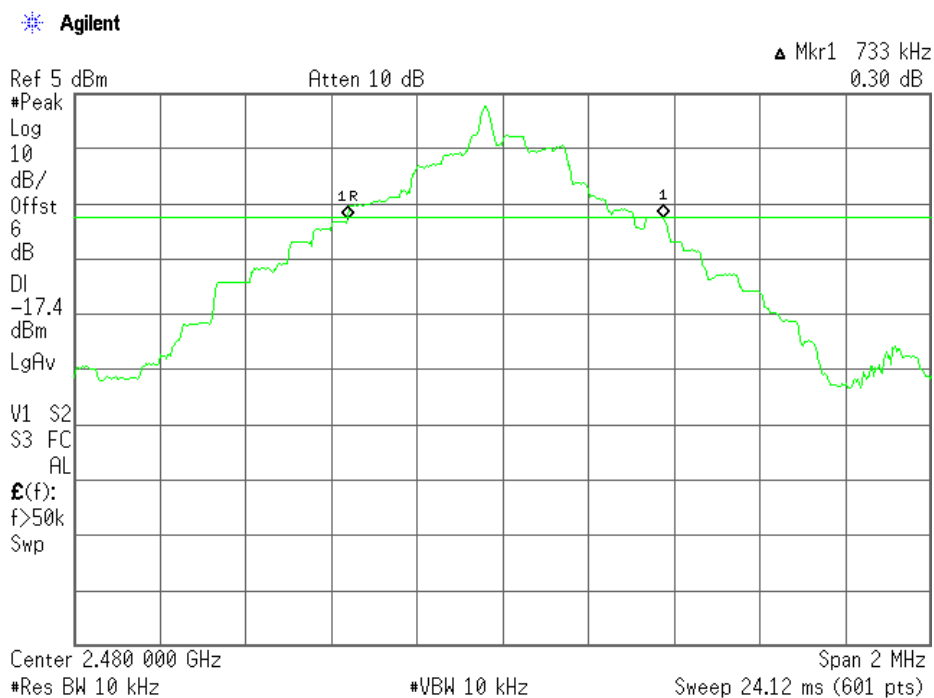
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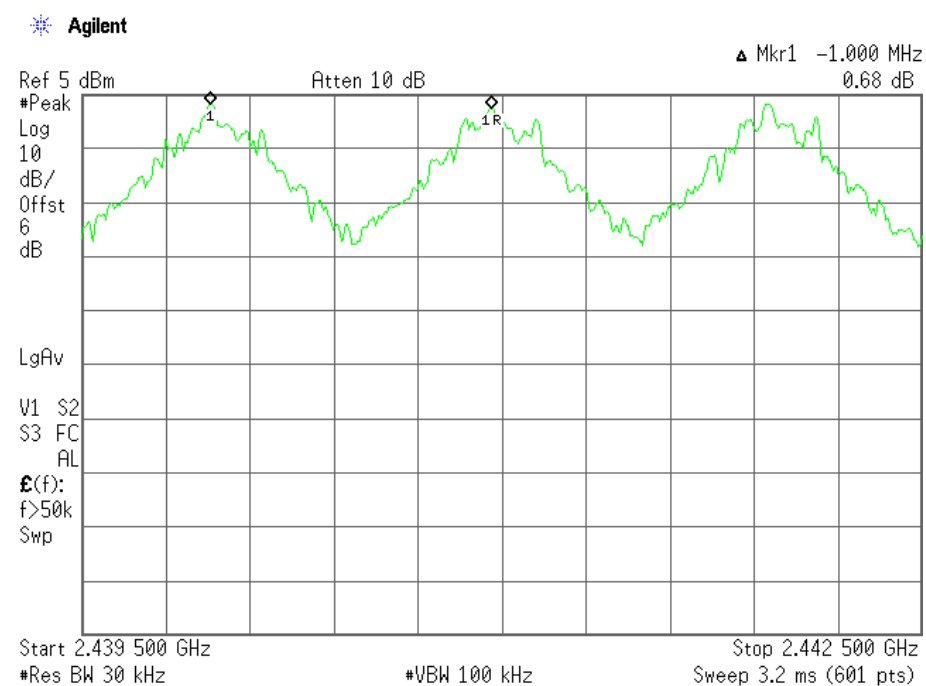
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20 dB BANDWIDTH.

Highest Channel: 2480 MHz.



Carrier frequency separation (see next plot).



The hopping channel carrier frequencies are separated by a minimum of the 20 dB bandwidth of the hopping channel.

Verdict: PASS

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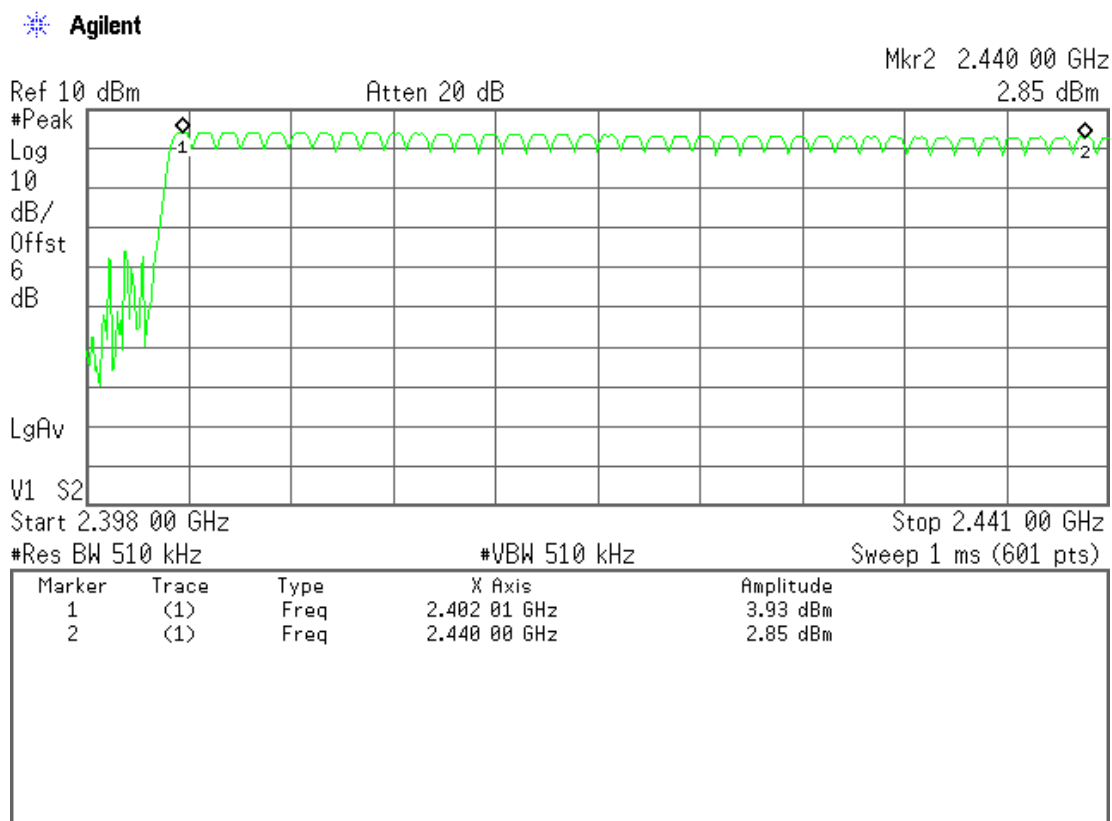
## Section 15.247 Subclause (a) (1) (iii). Number of hopping channels

### SPECIFICATION

Frequency hopping system in the 2400-2483.5 MHz band shall use at least 15 channels.

### RESULTS

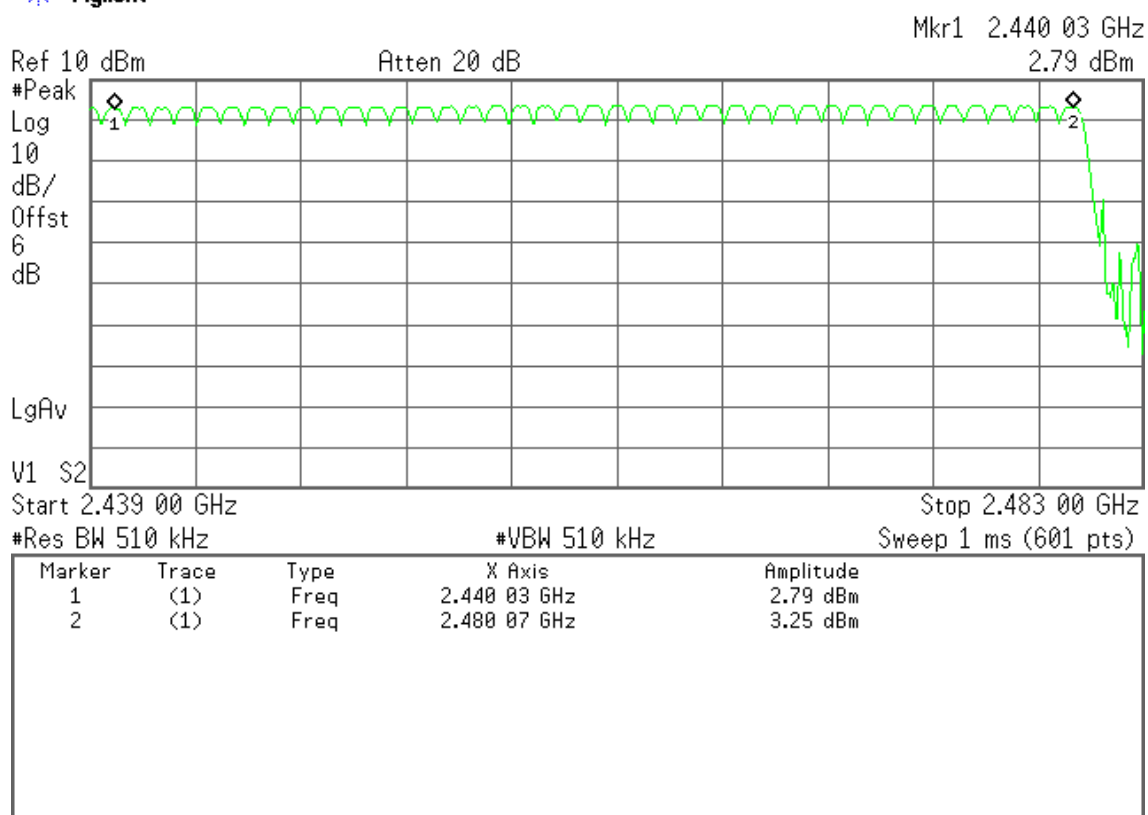
The number of hopping channels is 79 (see next two plots).



Number of hopping frequencies: 39

Number of hopping frequencies: 40

✱ Agilent



Total number of hopping frequencies: 79

Verdict: PASS

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## Section 15.247 Subclause (a) (1) (iii). Time of occupancy (Dwell Time)

### SPECIFICATION

The average time of occupancy on any channel shall not be greater than 0.4 seconds (400 ms) within a period of 0.4 seconds multiplied by the number of hopping channels employed =  $0.4 \times 79 = 31.6$  seconds.

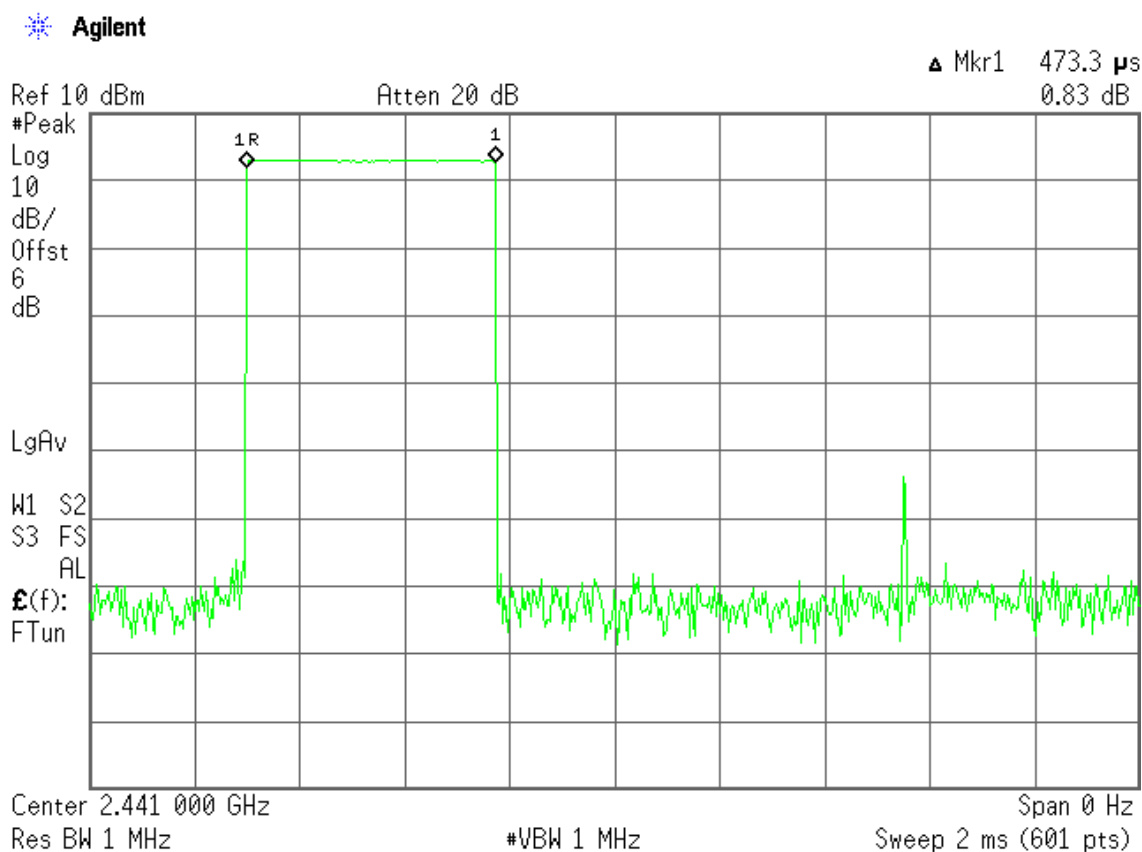
### RESULTS

#### TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE DH1.

The system makes worst case 1600 hops per second or 1 time slot has a length of  $625\mu\text{s}$  with 79 channels. A DH1 Packet need 1 time slot for transmitting and 1 time slot for receiving. Then the system makes worst case  $1600/2 = 800$  hops per second with 79 channels. So you have each channel  $800/79 = 10.13$  times per second and so for a period of  $0.4 \times 79 = 31.6$  seconds you have  $10.13 \times 31.6 = 320.11$  times of appearance.

Each Tx-time per appearance is  $473.3\mu\text{s}$  (see next plot).

So we have  $320.11 \times 473.3\mu\text{s} = 151.51\text{ ms}$  per 31.6 seconds.



Verdict: PASS

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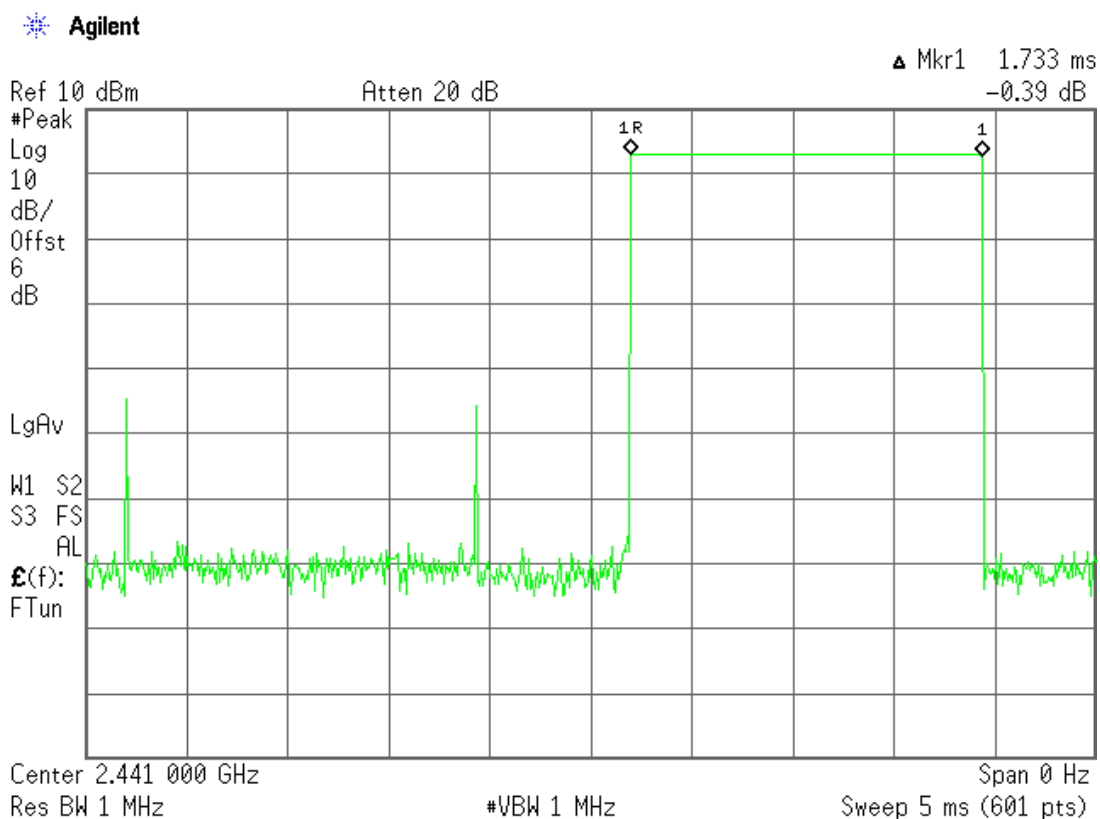
Annex A

## 2. TIME OF OCCUPANCY (DWEELL TIME) FOR PACKET TYPE DH3.

A DH3 Packet needs 3 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case  $1600/4 = 400$  hops per second with 79 channels. So you have each channel  $400/79 = 5.1$  times per second and so for a period of  $0.4 \times 79 = 31.6$  seconds you have  $5.1 \times 31.6 = 161.16$  times of appearance.

Each Tx-time per appearance is 1.733 ms (see next plot).

So we have  $161.16 \times 1.733 \text{ ms} = 279.29 \text{ ms}$  per 31.6 seconds.



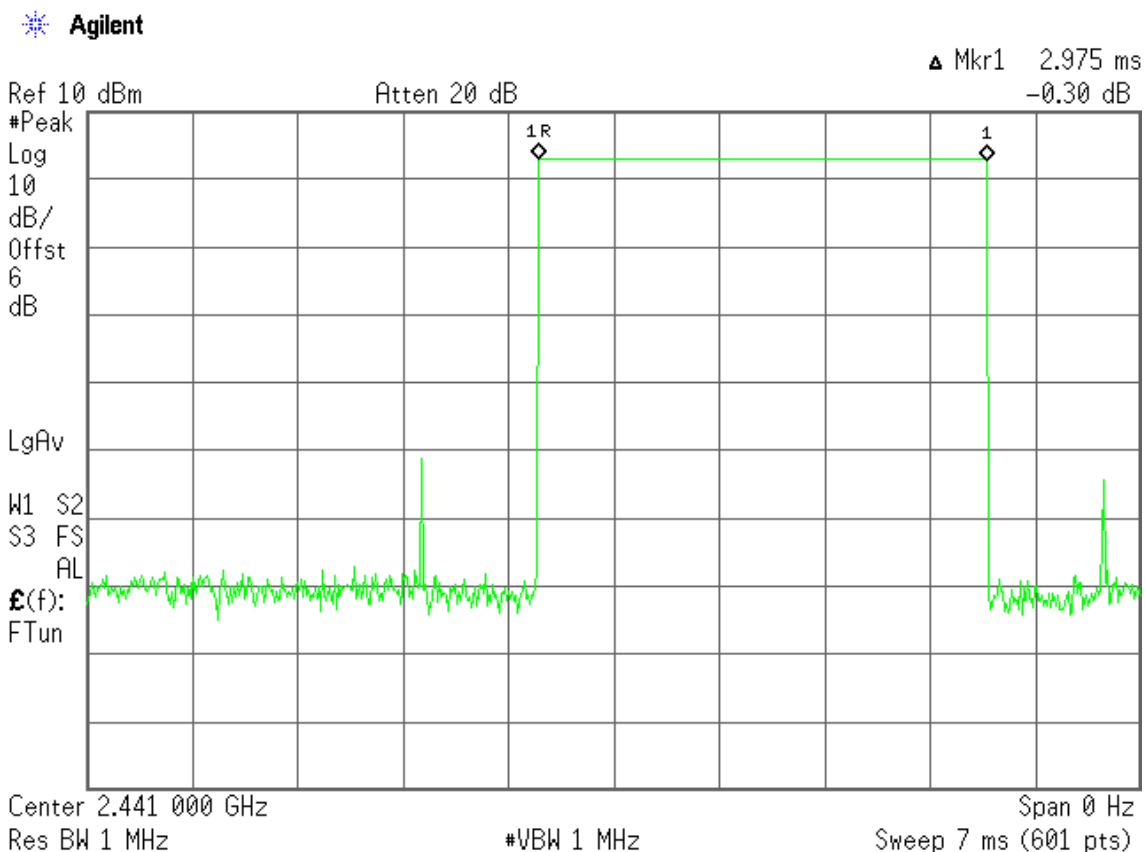
Verdict: PASS

### 3. TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE DH5.

A DH5 Packet need 5 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case  $1600/6 = 266.67$  hops per second with 79 channels. So you have each channel  $266.67/79 = 3.37$  times per second and so for a period of  $0.4 \times 79 = 31.6$  seconds you have  $3.37 \times 31.6 = 106.49$  times of appearance.

Each Tx-time per appearance is 2.975 ms (see next plot).

So we have  $106.49 \times 2.975 \text{ ms} = 316.80 \text{ ms}$  per 31.6 seconds.



Verdict: PASS

## Section 15.247 Subclause (b). Maximum peak output power and antenna gain

### SPECIFICATION

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels: 1 watt (30 dBm).

### RESULTS

MAXIMUM PEAK OUTPUT POWER (CONDUCTED). See next plots.

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Maximum peak power (dBm)	4.13	3.03	3.31
Measurement uncertainty (dB)	±1.5		

The maximum declared antenna gain for this device is -0.5 dBi, therefore the maximum theoretical peak radiated power (EIRP) in the three measurement channels for this device is 3.63 dBm or 2.31 mW.

The actual peak radiated power (EIRP) was measured for the lowest, middle and highest frequency (see next plots):

MAXIMUM PEAK OUTPUT POWER (RADIATED).

	Lowest frequency 2402 MHz	Middle frequency 2441 MHz	Highest frequency 2480 MHz
Correction Factor (dB)	35.00	35.10	35.20
Maximum EIRP peak power (dBm)	0.47	0.40	-0.76
Measurement uncertainty (dB)	±4.0		

Declared peak gain: -0.5 dBi

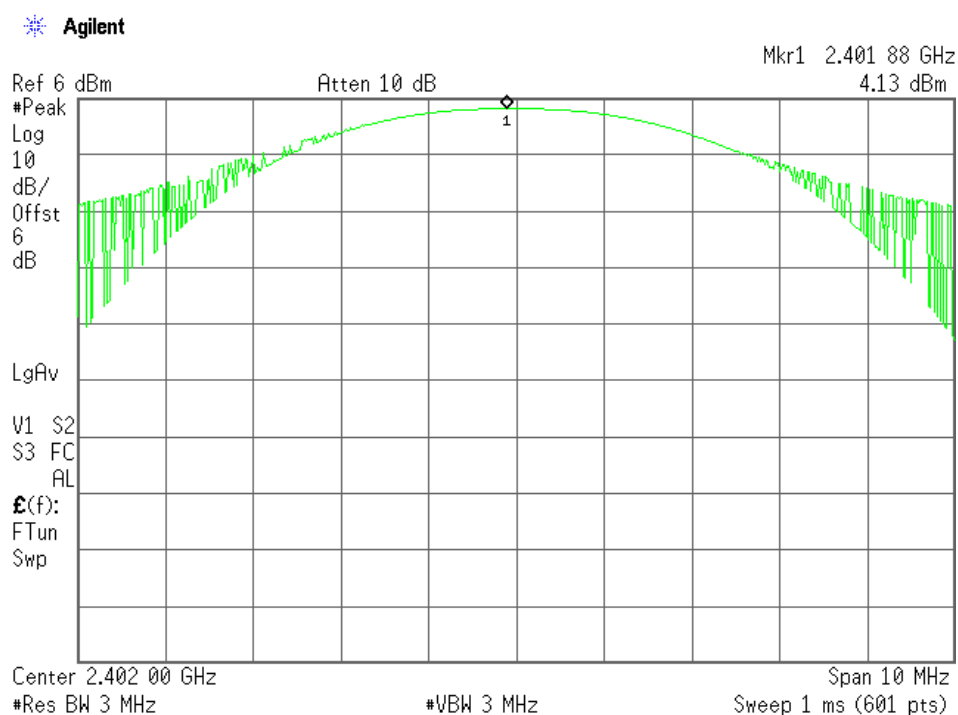
The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

Verdict: PASS

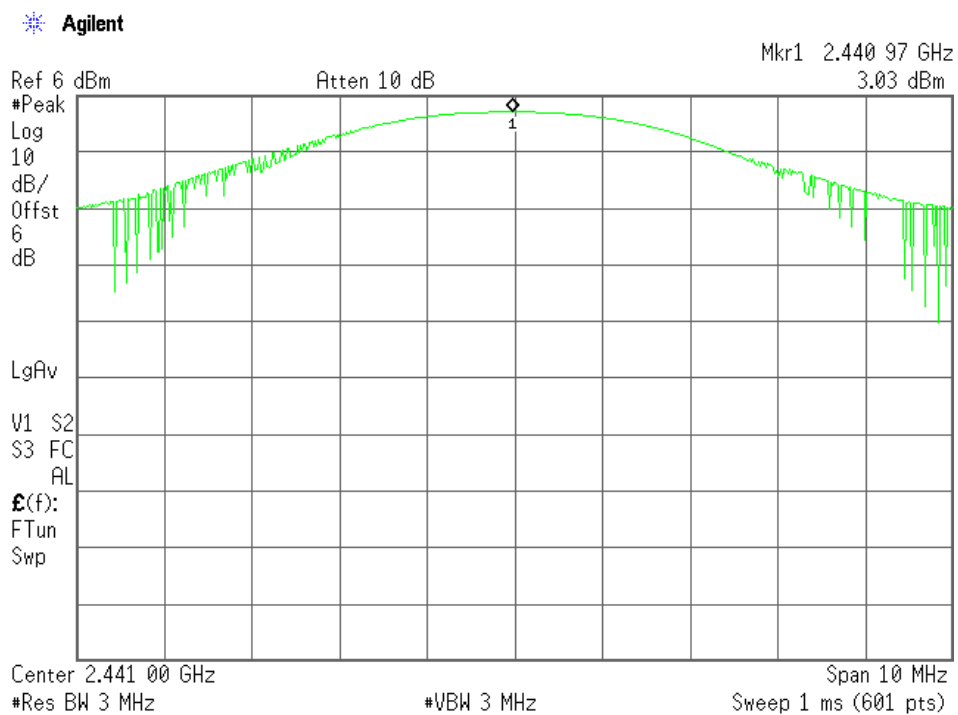
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# PEAK OUTPUT POWER (CONDUCTED).

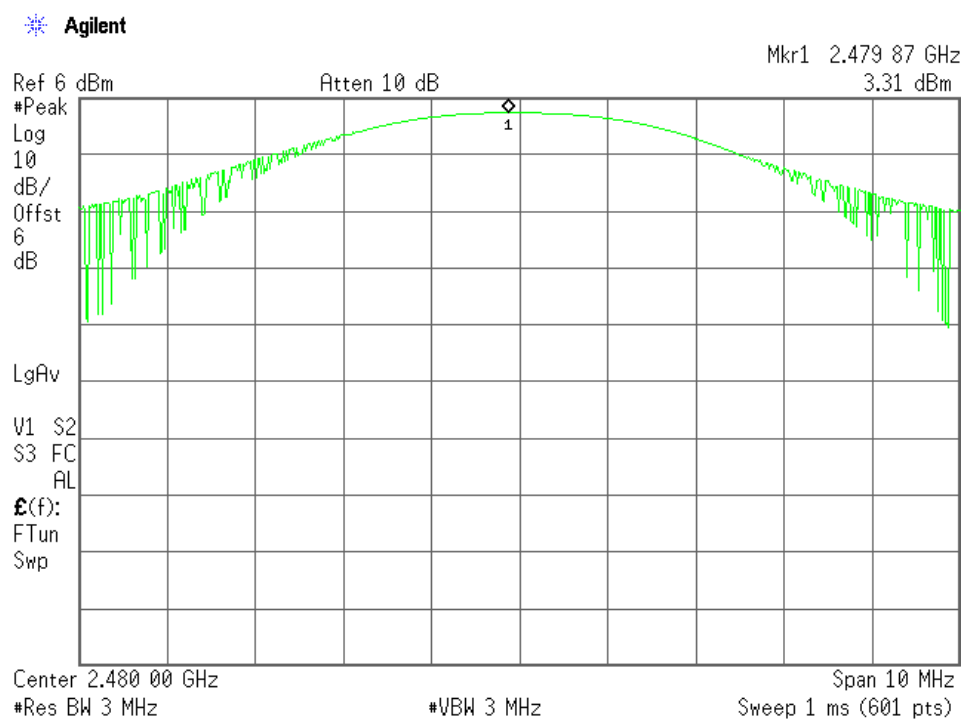
Lowest Channel: 2402 MHz.



Middle Channel: 2441 MHz.



Highest Channel: 2480 MHz.



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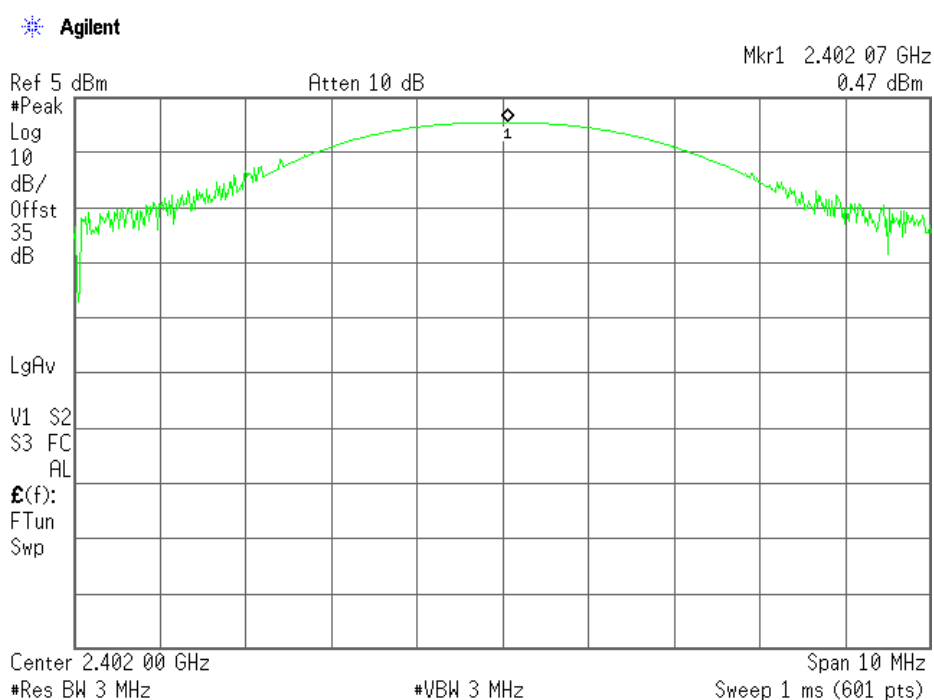
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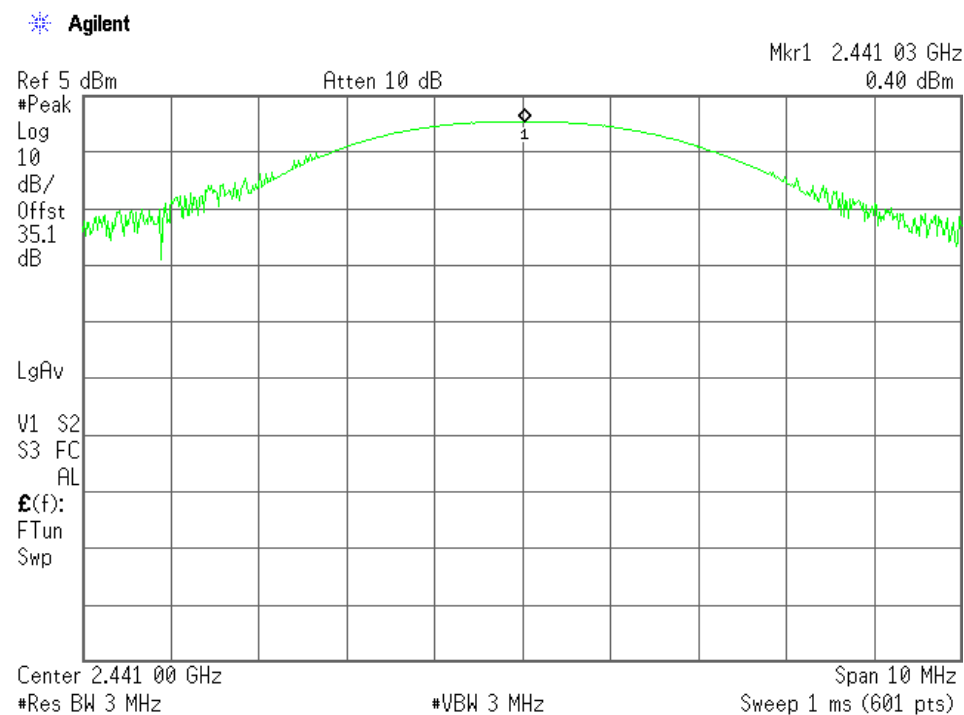
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# PEAK OUTPUT POWER (RADIATED).

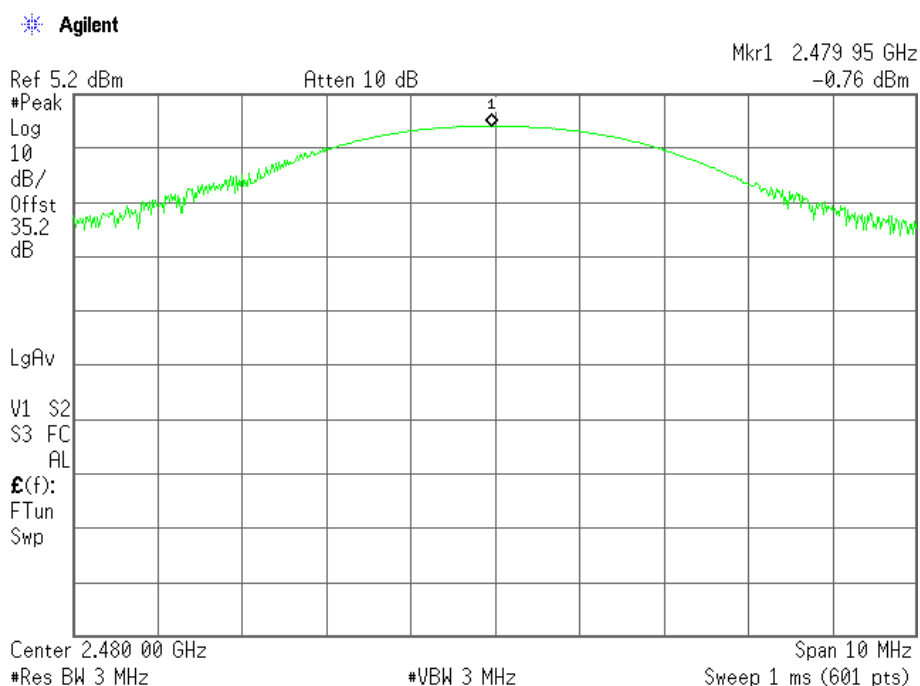
Lowest Channel: 2402 MHz.



Middle Channel: 2441 MHz.



Highest Channel: 2480 MHz.



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**Section 15.247 Subclause (d). Band-edge of conducted emissions (Transmitter)**

**SPECIFICATION**

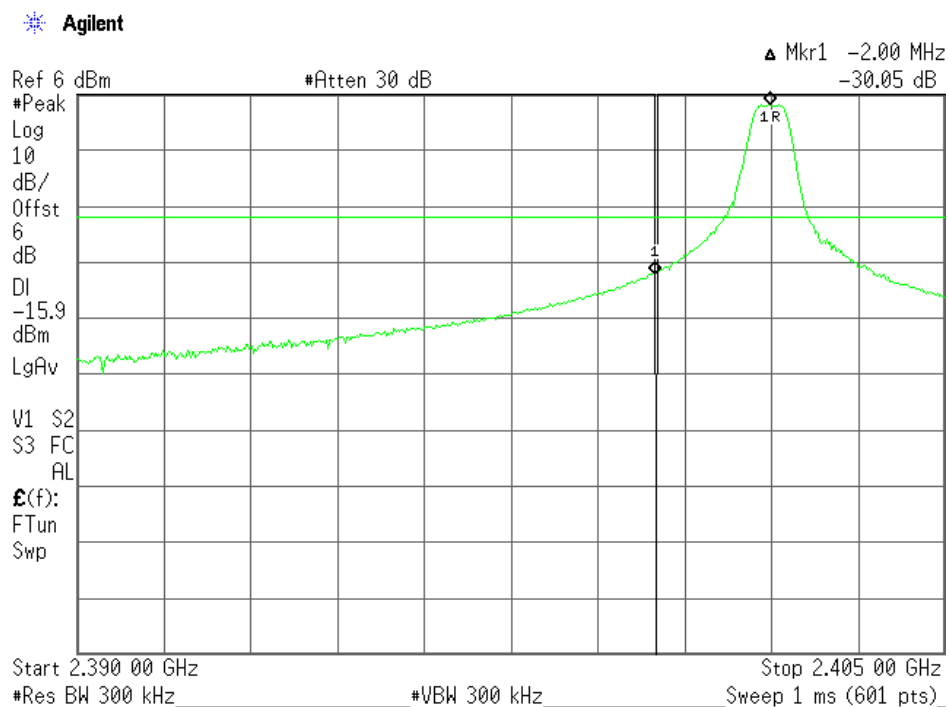
Emissions outside the frequency band in which the intentional radiator is operating shall be at least 20dB below the highest level of the desired power.

**RESULTS:**

See next plots

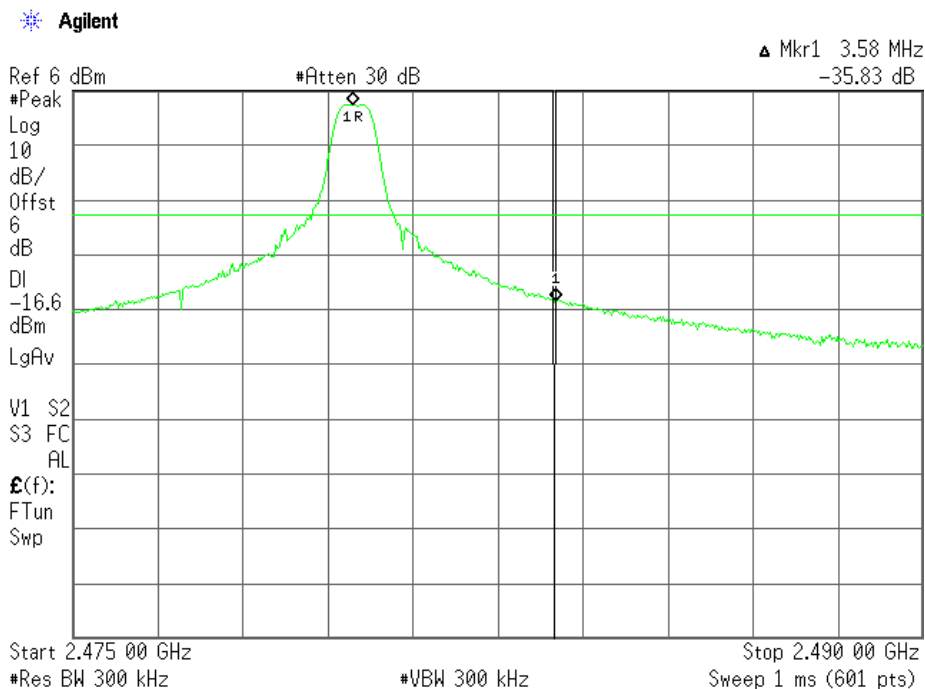
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# 1. LOW FREQUENCY SECTION 2402 MHz (HOPPING OFF). CONDUCTED



Verdict: PASS

# 2. HIGH FREQUENCY SECTION 2480 MHz (HOPPING OFF). CONDUCTED



Verdict: PASS

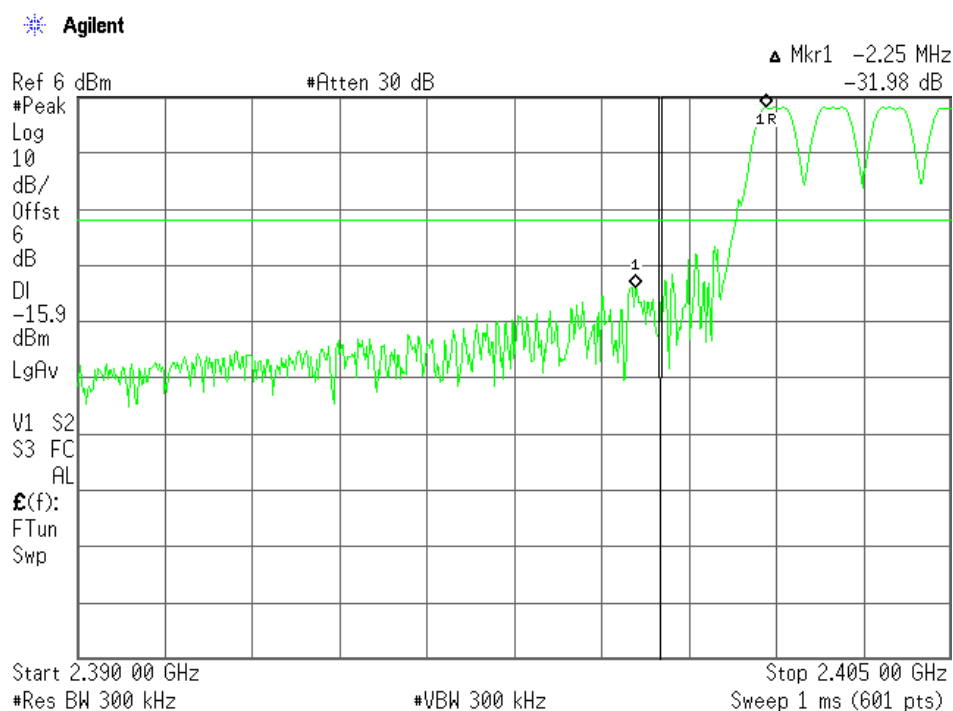
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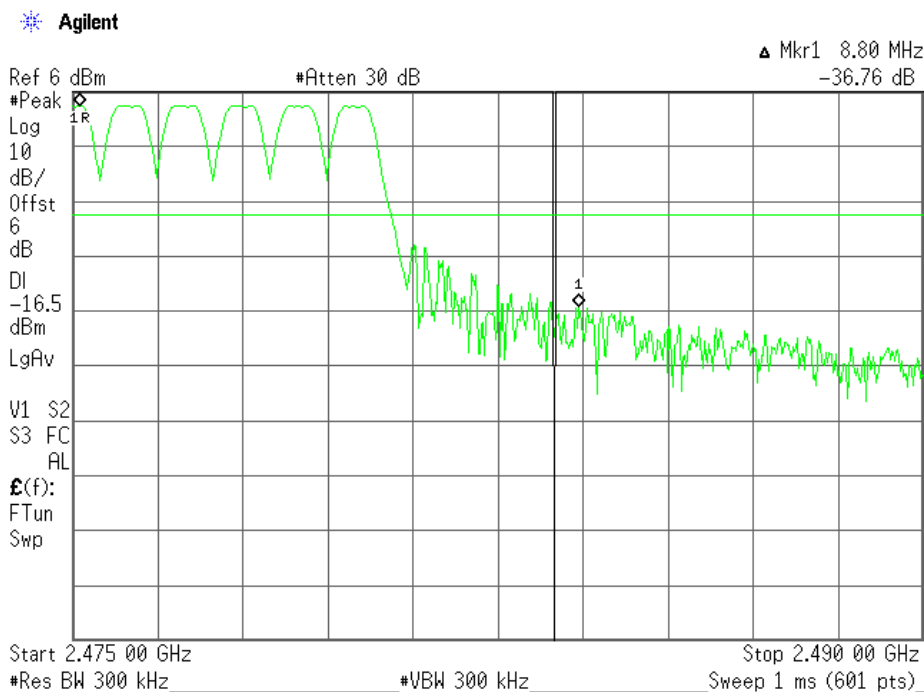
Annex A

### 3. LOW FREQUENCY SECTION (HOPPING ON). CONDUCTED



Verdict: PASS

### 4. HIGH FREQUENCY SECTION (HOPPING ON). CONDUCTED



Verdict: PASS

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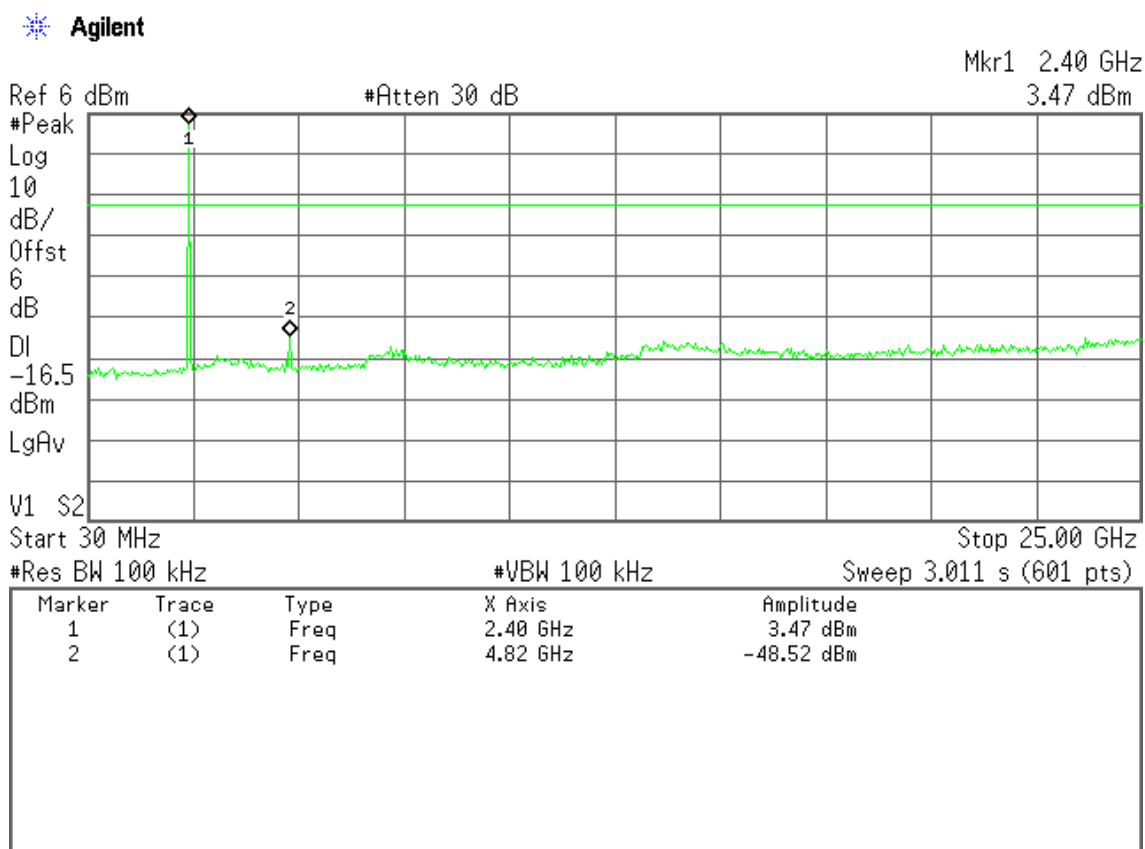
## Section 15.247 Subclause (d). Emission limitations conducted (Transmitter)

### SPECIFICATION

In any 100 kHz bandwidths outside the frequency band in which the intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power.

### RESULTS:

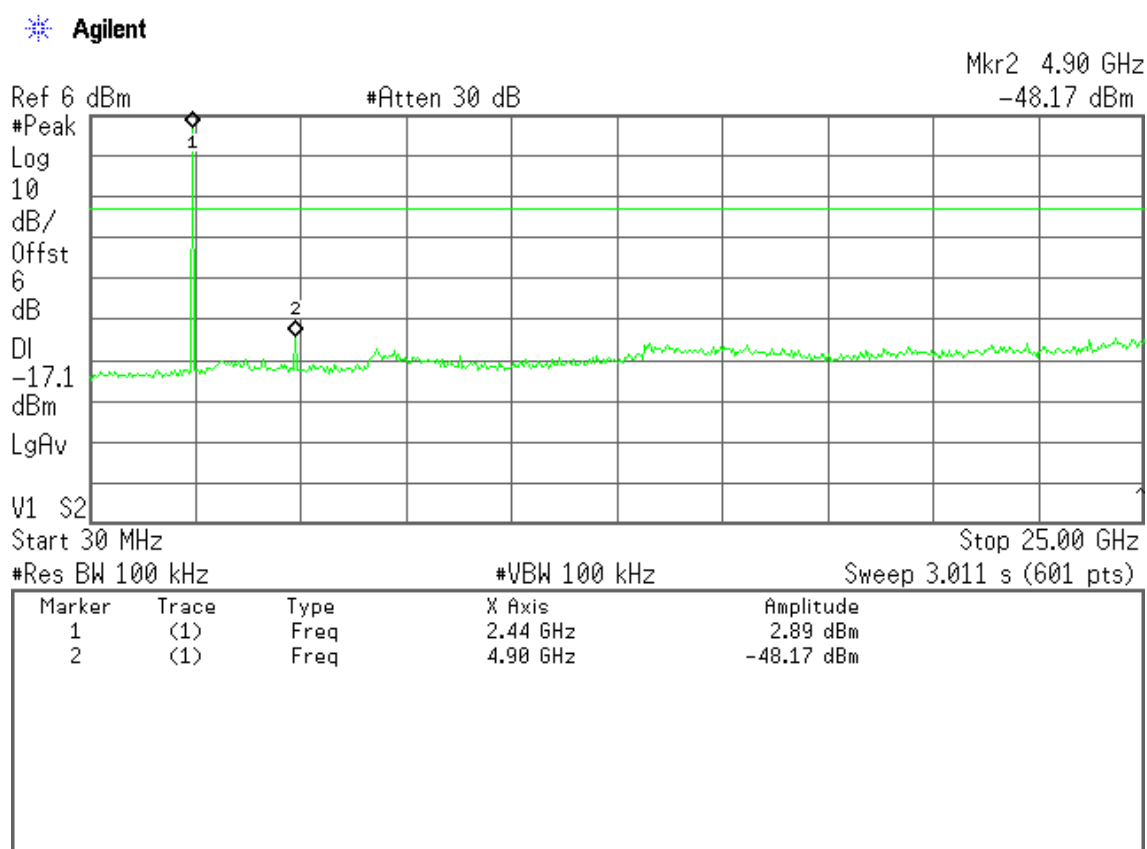
1. LOWEST CHANNEL (2402 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limit is the carrier frequency.

Verdict: PASS

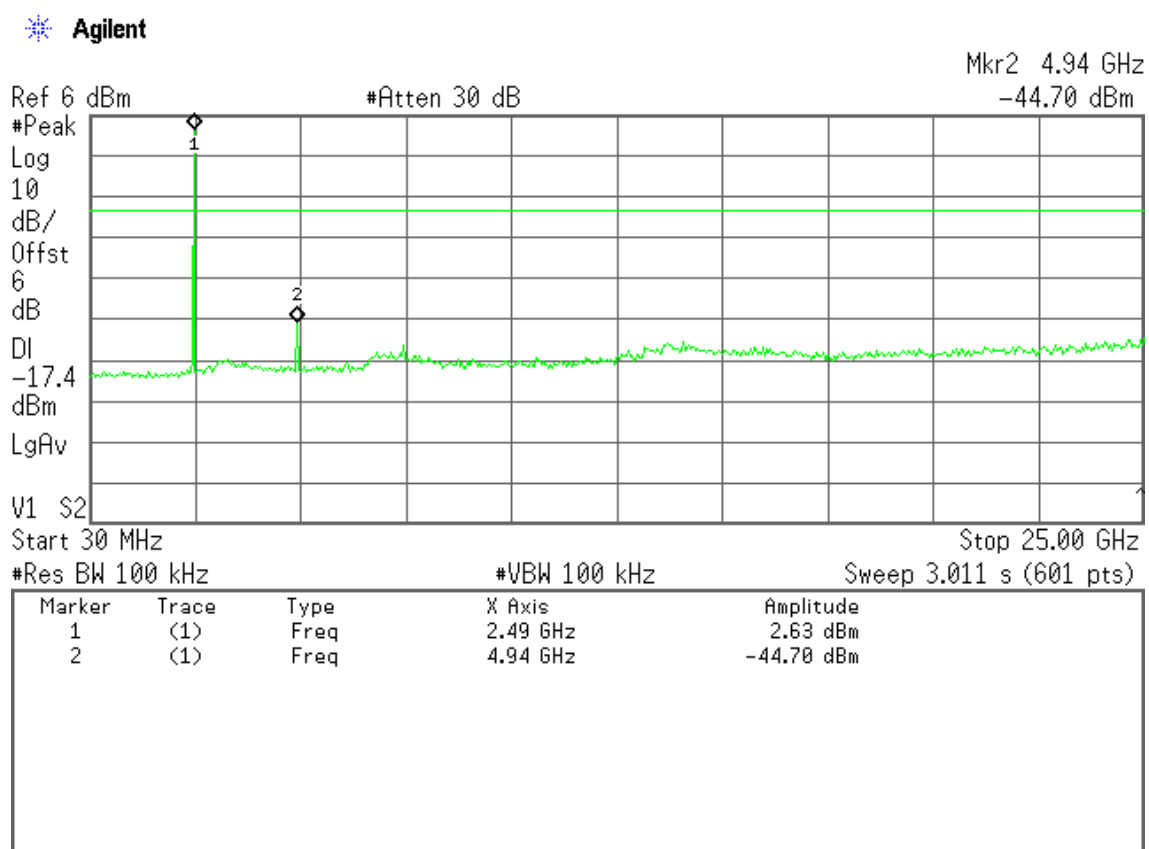
2. MIDDLE CHANNEL (2441 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limit is the carrier frequency.

Verdict: PASS

3. HIGH CHANNEL (2480 MHz): 30 MHz-25 GHz (see next plot).



Note: The peak above the limit is the carrier frequency.

Verdict: PASS

## Section 15.247 Subclause (d). Emission limitations radiated (Transmitter)

### SPECIFICATION

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)):

Frequency Range (MHz)	Field strength ( $\mu\text{V/m}$ )	Field strength ( $\text{dB}\mu\text{V/m}$ )	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	300
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 25000	500	54	3

The emission limits shown in the above table are based on measurements employing 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.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

### RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-1000 MHz and at distance of 1m for the frequency range 1 GHz-25 GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyser. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

The equipment transmits continuously in the selected channel so it is not necessary a duty cycle correction factor.

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### Frequency range 30 MHz-1000 MHz.

No spurious signals found.

### Frequency range 1 GHz-25 GHz

#### 1. CHANNEL: LOWEST (2402 MHz).

##### Spurious levels (radiated).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBμV/m)	Measurement Uncertainty (dB)
7206.017	H	Peak	56.86	± 4.0
7206.017	H	Average	53.78	± 4.0

Additionally, no spurious signals were found inside the restricted bands 2310-2390 MHz and 2483.5-2500 MHz.

#### 2. CHANNEL: MIDDLE (2441 MHz).

##### Spurious levels (radiated).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBμV/m)	Measurement Uncertainty (dB)
7322.925	H	Peak	58.08	± 4.0
7322.925	H	Average	53.85	± 4.0

Additionally, no spurious signals were found inside the restricted bands 2310-2390 MHz and 2483.5-2500 MHz.

#### 3. CHANNEL: HIGHEST (2480 MHz).

##### Spurious levels (radiated).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBμV/m)	Measurement Uncertainty (dB)
7440.008	H	Peak	55.80	± 4.0
7440.008	H	Average	51.90	± 4.0

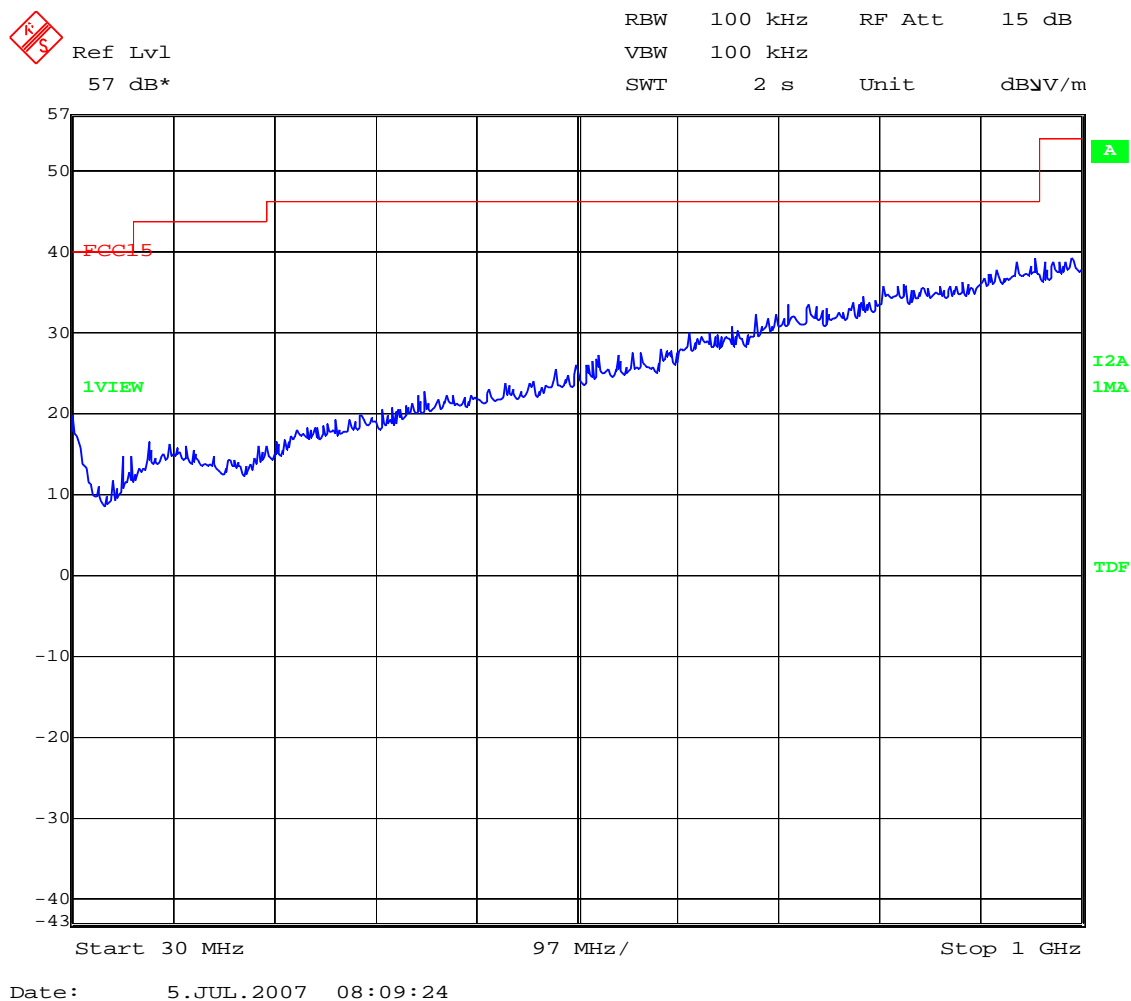
Additionally, no spurious signals were found inside the restricted bands 2310-2390 MHz and 2483.5-2500 MHz.

Verdict: PASS

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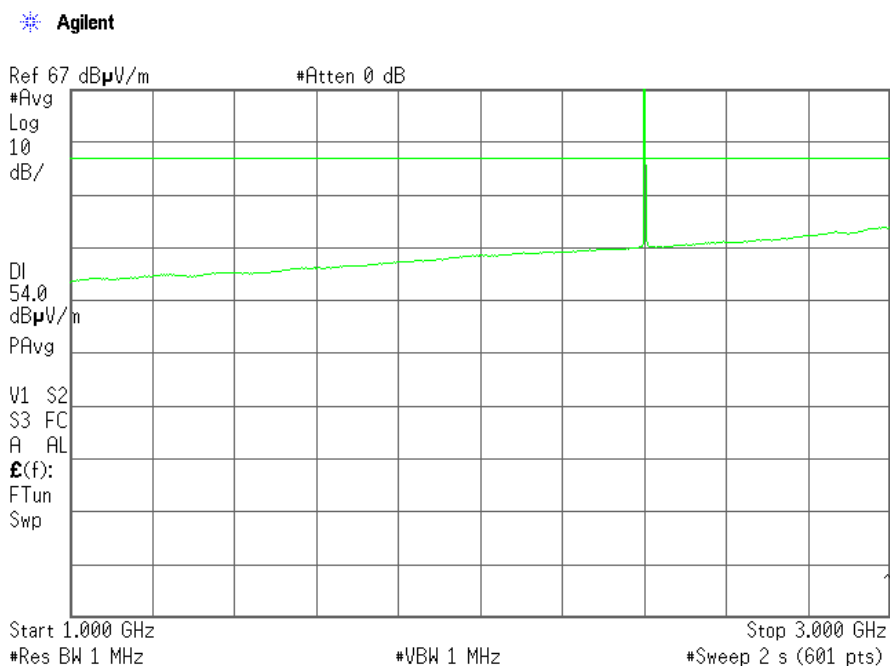
FREQUENCY RANGE 30 MHz-1000 MHz.



(This plot is valid for all three channels).

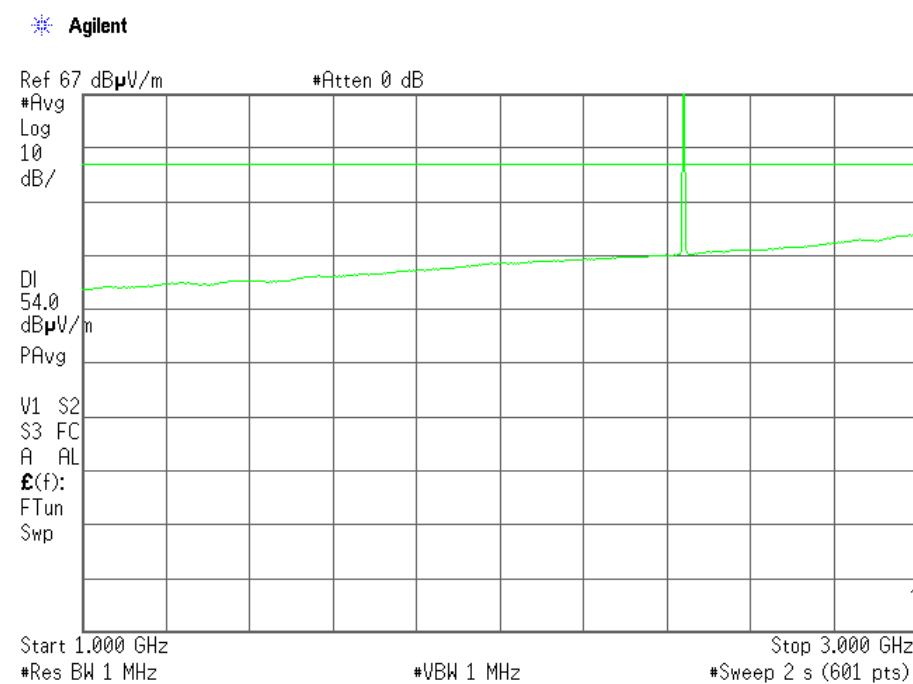
FREQUENCY RANGE 1 GHz to 3 GHz.

**CHANNEL: Lowest (2402 MHz).**



Note: The peak above the limit is the carrier frequency.

**CHANNEL: Middle (2441 MHz).**



Note: The peak above the limit is the carrier frequency.

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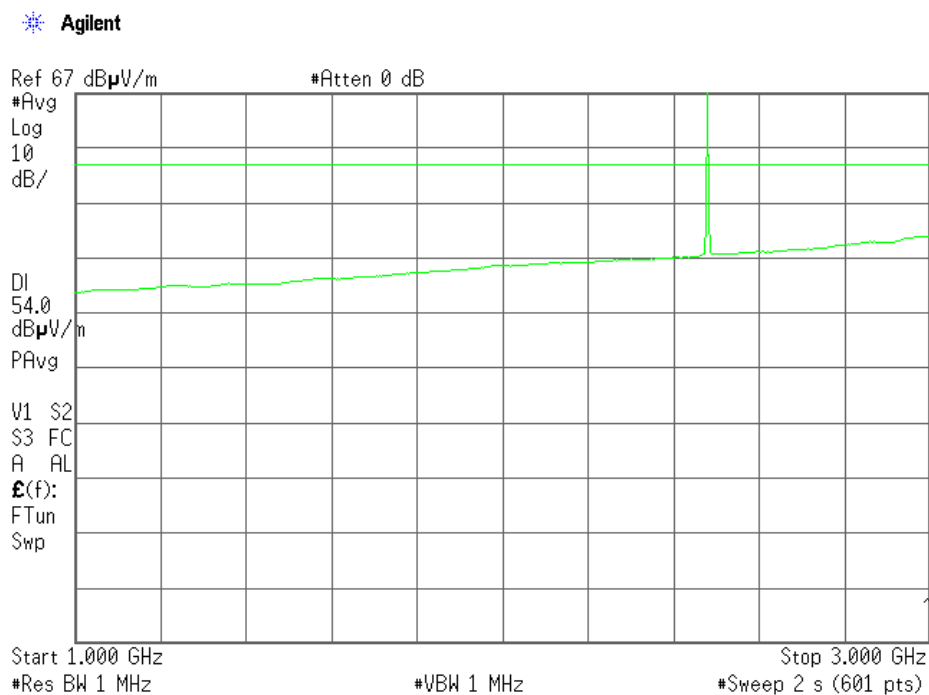
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**CHANNEL: Highest (2480 MHz).**



Note: The peak above the limit is the carrier frequency.

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