

**FCC LISTED, REGISTRATION  
NUMBER: 905266**

**IC LISTED REGISTRATION NUMBER  
IC 4621A-1**

**AT4 wireless, S.A.**

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Registro Mercantil de Málaga, Tomo 1169,  
Libro 82, Folio 133, Hoja MA3729

**TEST REPORT**

**REFERENCE STANDARD:**

**USA FCC Part 15.247, 15.109**

**CANADA RSS-210, RSS-Gen**

**Radio Frequency Devices. Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz.**

**Licence-Exempt Radio Apparatus (All Frequency Bands): Category I Equipment.**

**General Requirements and Information for the Certification of Radio Apparatus.**

**NIE**..... : 32032RET.003

Approved by  
(name / position & signature) ..... : A. Llamas / RF Lab. Manager

Elaboration date ..... : 2011-03-30

**Identification of item tested** ..... : WIRELESS MODULE 2.4 GHz

Trademark ..... : TELIT

Model and/or type reference ..... : ZE51-2.4

Serial number ..... : FRCJ1000038

Other identification of the product ..... : Commercial name: ZE51-2.4  
HW version: Rev C1 / SW version: 1.02  
FCC ID: RI7ZE51  
IC ID: 5131A-ZE51

Features ..... : ZigBee module with integrated antenna

Description ..... : ZigBee module integrated antenna

**Applicant** ..... : Telit Communications S.p.A.

Address..... : Via Stazione di Prosecco, 5/B 34010 -SGONICO (TRIESTE) – ITALY

CIF/NIF/Passport..... : ----

Contact person: Xavier TATOPOULOS

Telephone / Fax ..... : +33.(0) 4.97.21.33.18 / +33.(0) 4.97.21.33.11

e-mail: ..... : xavier.tatopoulos@telit.com

**Test samples supplier** ..... : Same as applicant

**Manufacturer** ..... : TELIT RF TECHNOLOGIES SAS

Address..... : Rue Evariste Galois Emerald Square - Bâtiment D, Sophia-Antipolis,  
FRANCE

Contact person: Xavier TATOPOULOS (xavier.tatopoulos@telit.com)

Telephone / Fax ..... : +33.(0) 4.97.21.33.18 / +33.(0) 4.97.21.33.11

<b>Test method requested</b> .....	See Standard			
<b>Standard</b> .....	USA FCC Part 15.247 10-01-09 Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz: -Section 15.247 Subclause (b). Maximum output power and antenna gain. -Section 15.247 Subclause (d). Band-edge emissions compliance (Transmitter). -Section 15.247 Subclause (d). Emissions radiated (Transmitter). USA FCC Part 15.109: Receiver radiated emission. CANADA RSS-210 Issue 8 (December 2010). CANADA RSS-Gen Issue 3 (December 2010). Guidelines for measurement of Digital Transmission Systems operating under section 15.247 dated March 23, 2005. ANSI C63.10-2009: American National Standard for Testing Unlicensed Wireless Devices.			
<b>Test procedure</b> .....	PEET034: Medidas radioeléctricas a equipos de radio de espectro ensanchado en la banda de 2,4 GHz.			
<b>Non-standardized test method</b> .....	N/A			
<b>Used instrumentation</b> .....		<b>Last Cal. date</b>	<b>Cal. due date</b>	
	1.	Semianechoic Absorber Lined Chamber IR 11. BS	N.A.	N.A.
	2.	Control Chamber IR 12.BC	N.A.	N.A.
	3.	Hybrid Bilog antenna Sunol Sciences Corporation JB6	2008/10	2011/10
	4.	Antenna mast EM 1072 NMT	N.A.	N.A.
	5.	Rotating table EM 1084-4. ON	N.A.	N.A.
	6.	Double-ridge Guide Horn antenna 1-18 GHz HP 11966E	2008/03	2011/03
	7.	Double-ridge Guide Horn antenna 18-40 GHz Agilent 119665J	2008/09	2011/09
	8.	EMI Test Receiver R&S ESIB26	2009/09	2011/09
	9.	RF pre-amplifier Miteq JS4-12002600-30-5A.	2010/07	2012/07
	10.	Multi Device Controller EMCO 2090	N.A.	N.A.
	11.	Spectrum Analyzer Agilent E4440A	2010/02	2012/02
	12.	RF pre-amplifier Miteq AFS5-04001300-15-10P-6.	2010/07	2012/07
	13.	RF pre-amplifier Schaffner CPA 9231.	2009/03	2011/03
<b>Report template No.</b> .....	FDT08_12			
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## Competences and guarantees

AT4 wireless 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.

AT4 wireless 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 4621A-1.

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

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

AT4 wireless is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

## General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on 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 previous written permission of AT4 wireless.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of AT4 wireless and the Accreditation Bodies.

## Uncertainty

Uncertainty (factor k=2) was calculated according to the AT4 wireless internal document PODT000.

## Usage of samples

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

**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>
32032/01	RF module with integral antenna on DIP support	ZE51-2.4	FRCJ1000038	08/12/2010
32032/06	Test board	B DIGITAL CEB	---	08/12/2010
32032/13	AC/DC adaptor	FBC12050	---	08/12/2010

1. Sample M/01 has undergone following test(s).  
All tests indicated in appendix A.

## Testing period

The performed test started on 2011-02-22 and finished on the same day

The tests have been performed at AT4 wireless.

## Environmental conditions

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

Temperature	Min. = 22.1 °C Max. = 22.7 °C
Relative humidity	Min. = 43.3 % Max. = 44.7 %
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 not exceeded during the test.

Temperature	Min. = 23.2 °C Max. = 23.8 °C
Relative humidity	Min. = 41 % Max. = 43 %
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).

**Summary**

Considering the results of the performed test according to standard USA FCC Parts 15.247 and 15.109 / RSS-210, the item under test is **IN COMPLIANCE** with the requested specifications specified in the standard.

NOTE: The results presented in this Test Report apply only to the particular item under test established in page 1 of this document, as presented for test on the date(s) shown in section, "USAGE OF SAMPLES, TESTING PERIOD AND ENVIRONMENTAL CONDITIONS".

**Remarks and comments**

1: Test not requested. Only radiated measurements were requested.

**Testing verdicts**

Not applicable .....: NA  
 Pass.....: P  
 Fail .....: F  
 Not measured.....: NM

FCC PART 15 PARAGRAPH / RSS-210		VERDICT			
		NA	P	F	NM <sup>1</sup>
Section 15.247 Subclause (a) (2) / RSS-210 A8.2. (a)	6 dB Bandwidth				NM <sup>1</sup>
Section 15.247 Subclause (b) / RSS-210 A8.4. (4)	Maximum radiated output power and antenna gain		P		
Section 15.247 Subclause (d) / RSS-210 A8.5.	Emission limitations conducted (Transmitter)				NM <sup>1</sup>
Section 15.247 Subclause (d) / RSS-210 A8.5.	Band-edge conducted emissions compliance (Transmitter)				NM <sup>1</sup>
Section 15.247 Subclause (d) / RSS-210 A8.5.	Band-edge radiated emissions compliance (Transmitter)		P		
Section 15.247 Subclause (e) / RSS-210 A8.2. (b)	Power spectral density				NM <sup>1</sup>
Section 15.247 Subclause (d) / RSS-210 A8.5.	Emission limitations radiated (Transmitter)		P		
Section 15.109 / RSS-210 2.5.	Radiated emission limits for receiver		P		

1: See point "Remarks and comments".

## **APPENDIX A: Test result**

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## TEST CONDITIONS

Power supply (V):

$$V_{\text{nominal}} = 12 \text{ Vdc}$$

Type of power supply = DC voltage from AC/DC adaptor.

Type of antenna = Integral chip antennal.

### TEST FREQUENCIES:

Lowest channel: 2405 MHz

Middle channel: 2440 MHz

Highest channel: 2480 MHz

The test set-up was made in accordance to the general provisions of ANSI C63.4: 2009.

### 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.

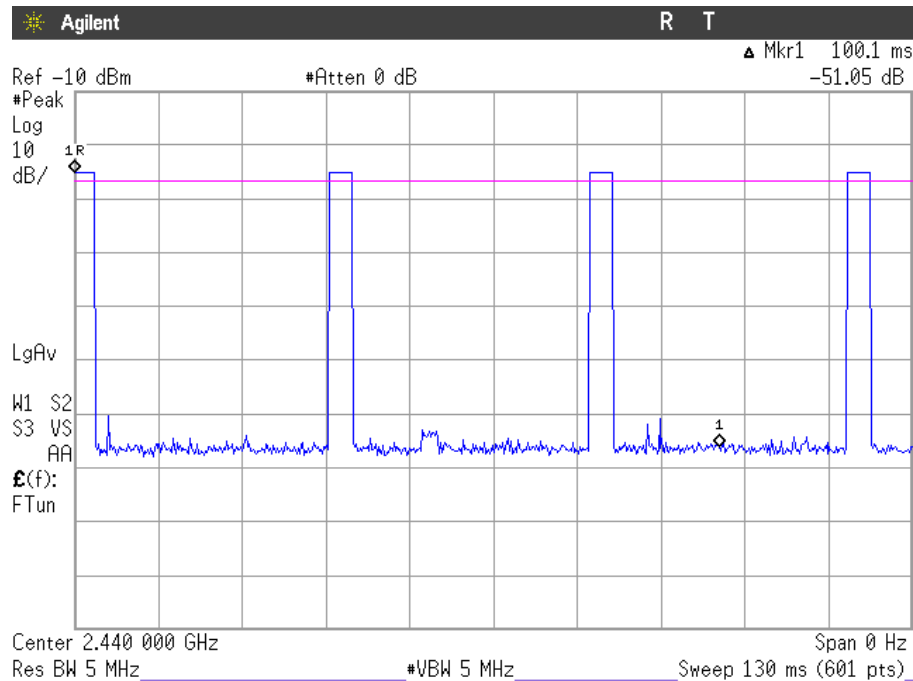
The equipment under test was set up on a non-conductive (wooden) platform one meter above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

The transmission is pulsed so the average values of transmitter fundamental and spurious emissions are calculated from the measured peak values using the duty cycle correction factor  $\delta$  as indicated in standard ANSI C63.10-2009.

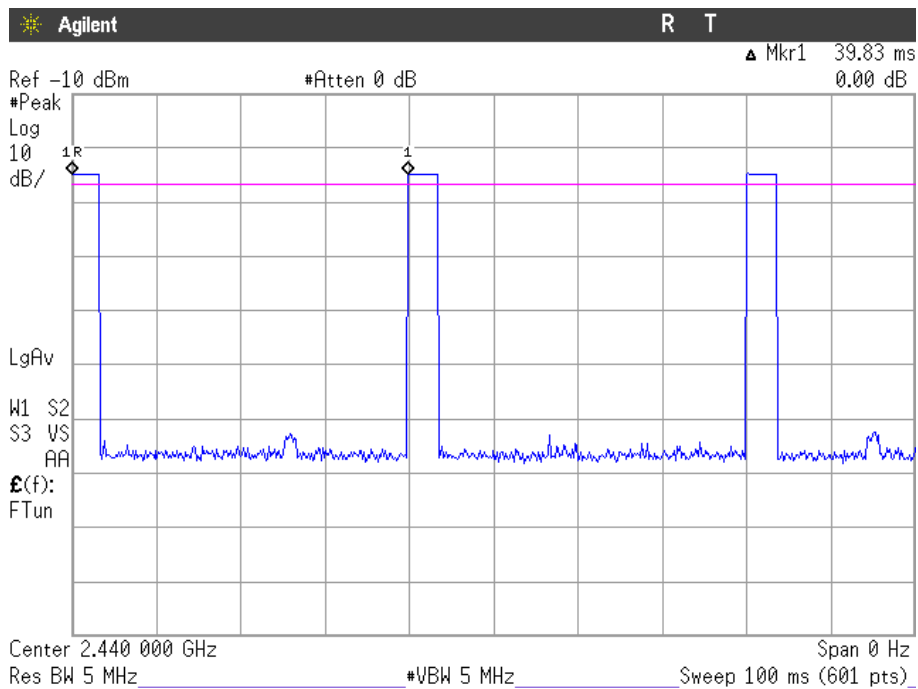
## Computation of duty-cycle correction factor

### 1. Pulse train length.



The pulse train length is > 100 ms

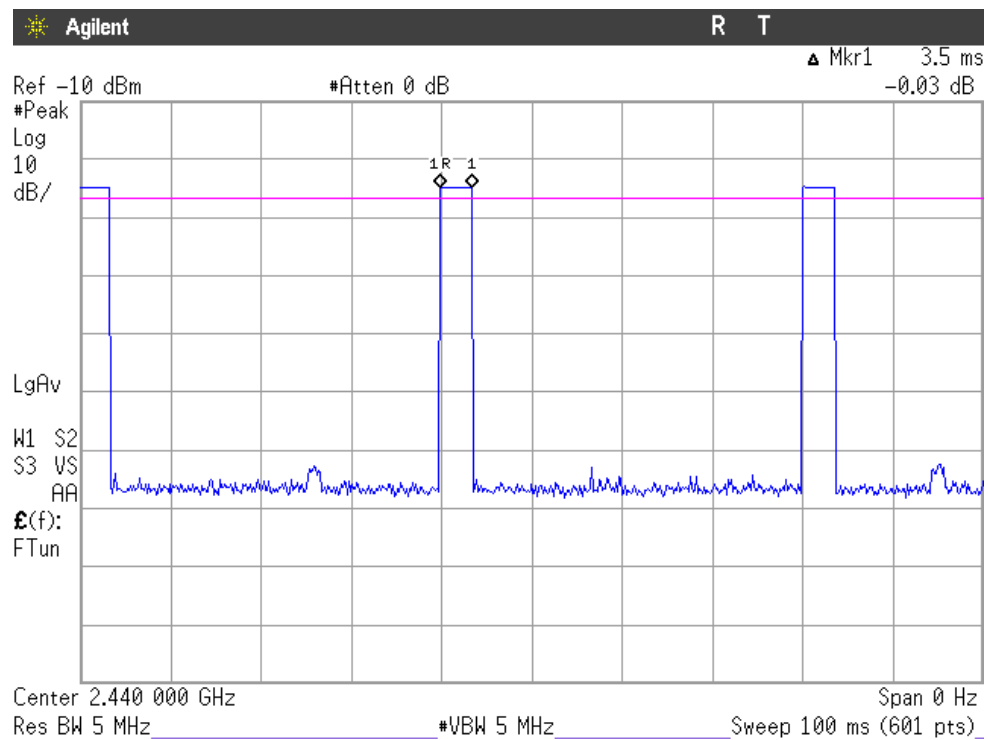
### 2. Pulse train period and number of pulses within 100 ms.



Pulse train period: 39.83 ms

Number of pulses within 100 ms: 3

### 3. Pulse duration.



Pulse duration: 3.5 ms

### 4. Duty-cycle correction factor calculation.

Sub-pulse	Duration (ms)	Number of pulses	Sub-pulse "On Time" (ms)
1	3.5	3	10.5
		TOTAL ON TIME:	10.5

Duty cycle correction factor  $\delta = 10.5 / 100 = 0.105$

$\delta = 20 \log (0.105) = -19.58 \text{ dB}$

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

SPECIFICATION

For systems using digital modulation in the 2400-2483.5 MHz band: 1 watt (30 dBm).

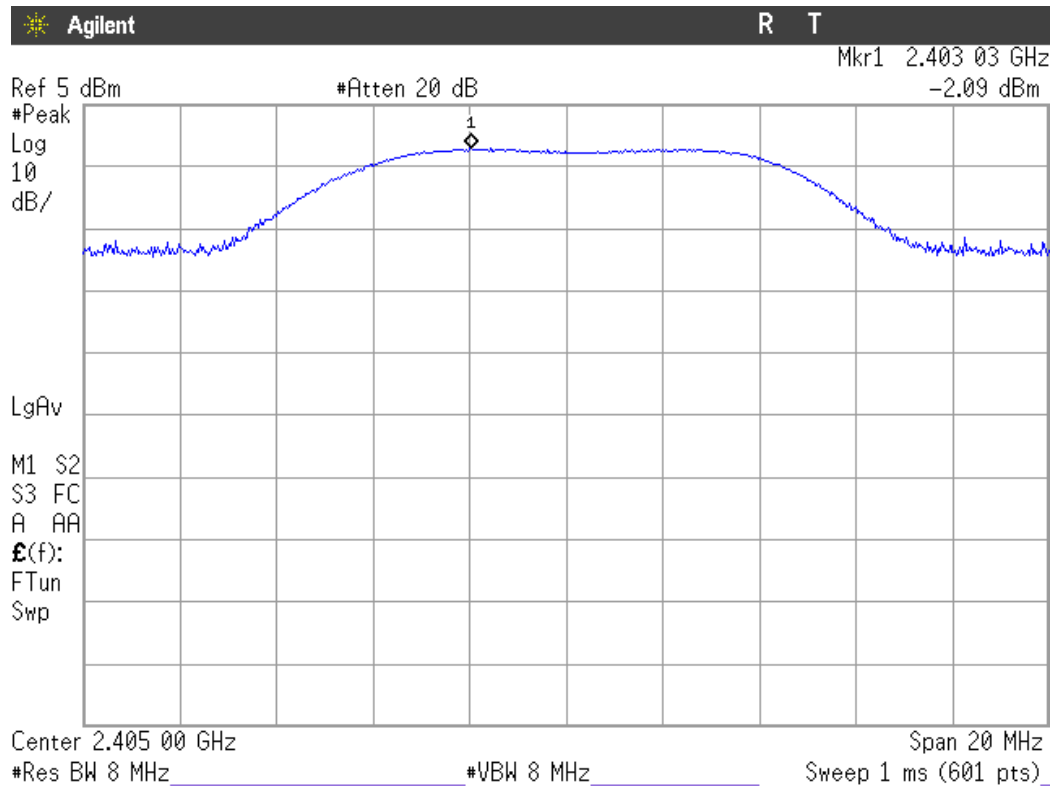
RESULTS

MAXIMUM OUTPUT POWER (RADIATED). See next plots.

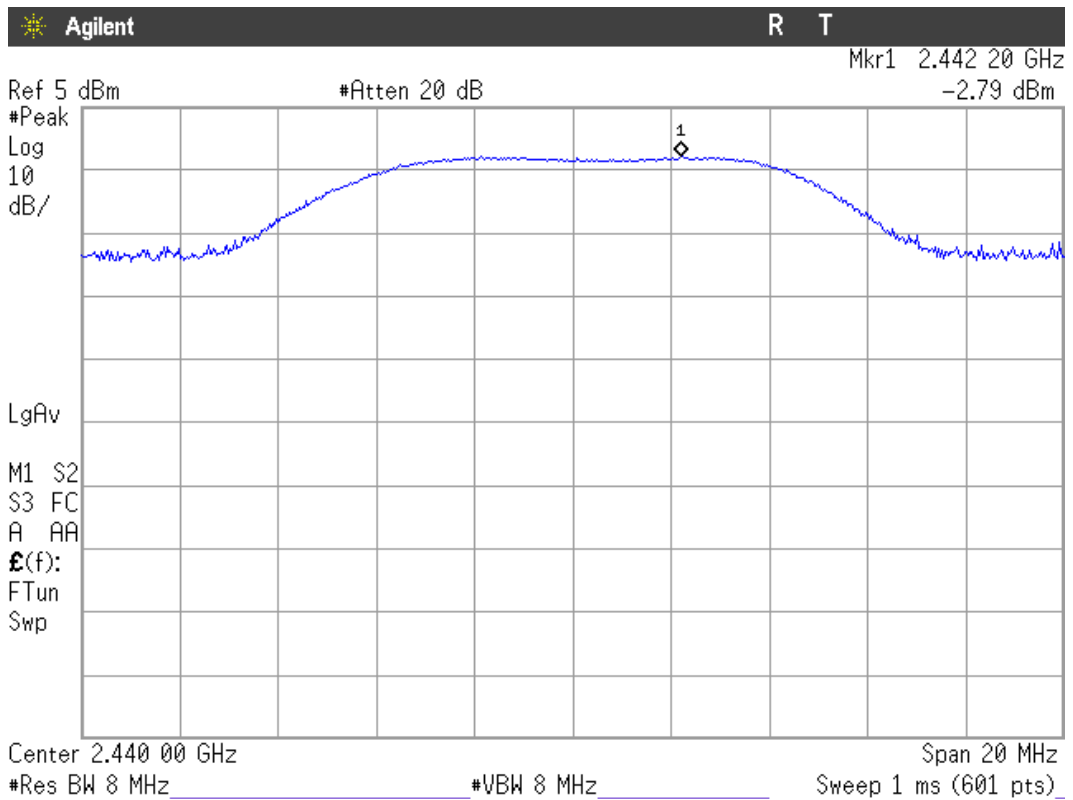
	Lowest frequency 2405 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Maximum EIRP power (dBm)	-2.09	-2.79	-3.38
Measurement uncertainty (dB)	±4.0		

Verdict: PASS

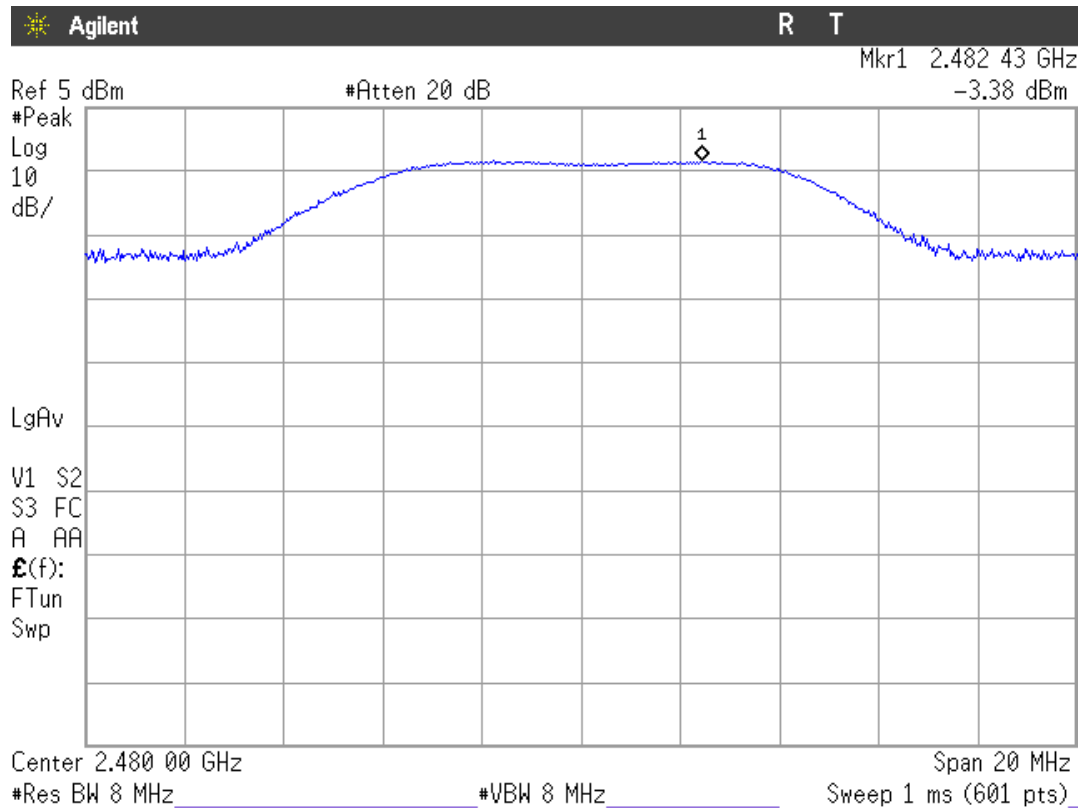
Lowest frequency



Middle frequency



Highest frequency



**Section 15.247 Subclause (d). Band-edge emissions compliance (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.

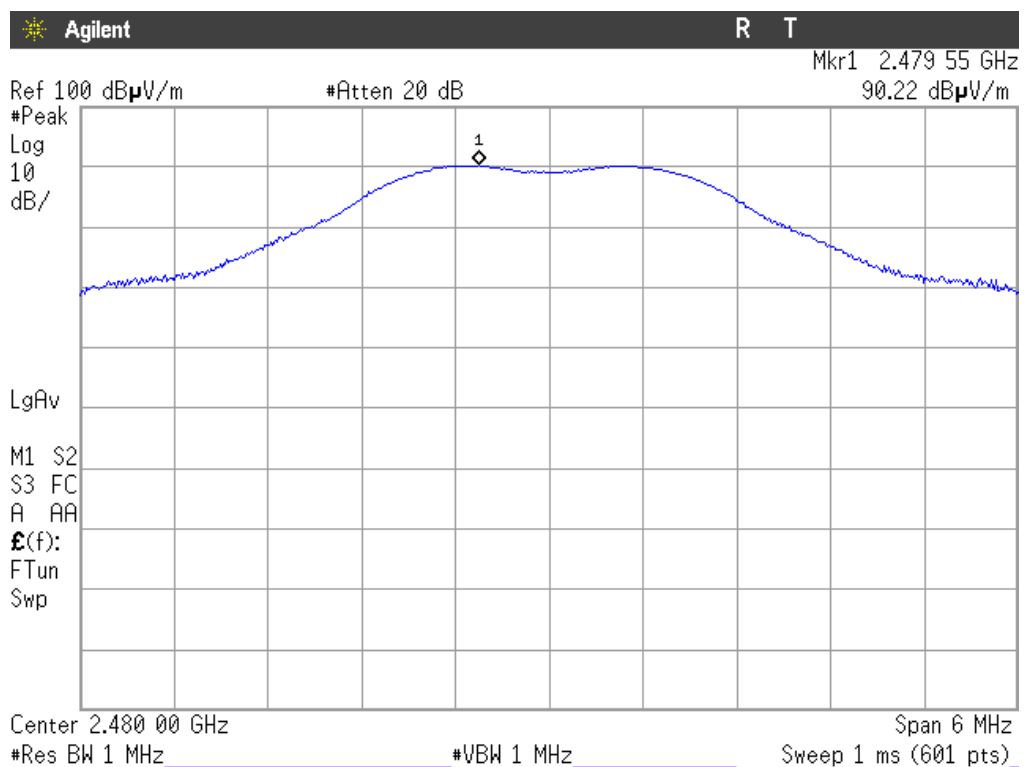
RESULTS:

**Band-edge compliance of radiated emissions**

Maximum peak and average field strength of fundamental emission at 3 m distance.

HIGHEST CHANNEL

Maximum field strength at 3 m. Peak value.

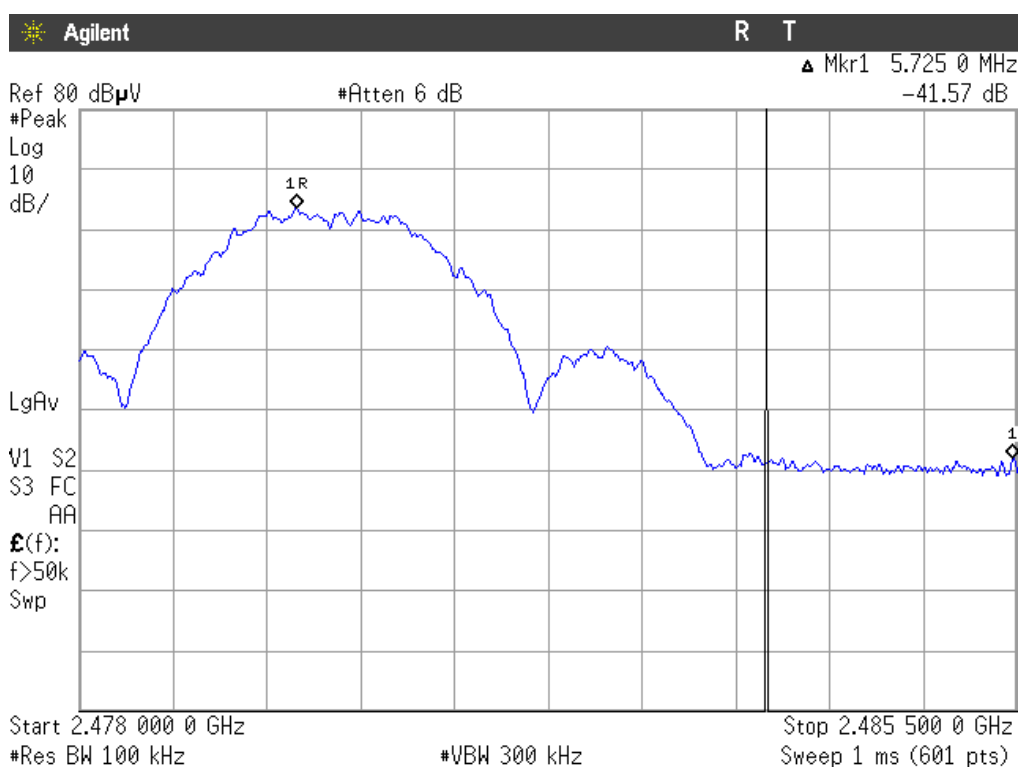


Note: The correction factor is already included in the spectrum analyzer as a transducer factor so that the marker shows directly the field strength level.

Maximum field strength at 3 m. Average value.

E-Field at 3m Peak (dB $\mu$ V/m)	Duty-cycle correction factor $\delta$ (dB)	Corrected E-Field at 3m Average (dB $\mu$ V/m)
90.22	-19.58	70.64

BAND-EDGE COMPLIANCE. RADIATED. Marker-Delta Method.



Note: No correction is applied for this relative measurement.

Band edge compliance of radiated emissions

Fundamental max. average value 3 m	Delta value	Calculated value 3 m	Limit
70.64 dB $\mu$ V/m	41.57 dB	29.07	54 dB $\mu$ V/m

Fundamental max. Peak value 3 m	Delta value	Calculated value 3 m	Limit
90.22 dB $\mu$ V/m	41.57 dB	48.65	74 dB $\mu$ V/m

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 ( $\mu\text{V}/\text{m}$ )	Field strength ( $\text{dB}\mu\text{V}/\text{m}$ )	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 analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

The transmission is pulsed so the average values of transmitter fundamental and spurious emissions are calculated from the measured peak values using the duty cycle correction factor  $\delta$  as indicated in standard ANSI C63.10-2009.

**Frequency range 30 MHz-1000 MHz.**

Note: The spurious emissions below 1 GHz do not depend on the operating channel selected in the EUT.

**Spurious levels operating (radiated) closest to limit.**

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dB $\mu$ V/m)	Measurement Uncertainty (dB)
39.7194	V	Quasi-peak	23.50	$\pm 3.8$
49.4389	V	Quasi-peak	24.18	$\pm 3.8$
121.3627	V	Quasi-peak	31.80	$\pm 3.8$
171.9038	V	Quasi-peak	38.20	$\pm 3.8$
216.6132	V	Quasi-peak	25.98	$\pm 3.8$
237.9961	V	Quasi-peak	27.08	$\pm 3.8$

**Frequency range 1 GHz-25 GHz**

1. CHANNEL: LOWEST.

No spurious signals were found.

2. CHANNEL: MIDDLE

Spurious frequency (MHz)	Polarization	Emission Level (dB $\mu$ V/m) Peak	Duty-cycle correction factor $\delta$ (dB)	Corrected Emission Level (dB $\mu$ V/m) Average
4880.011	V	44.85	-19.58	25.27

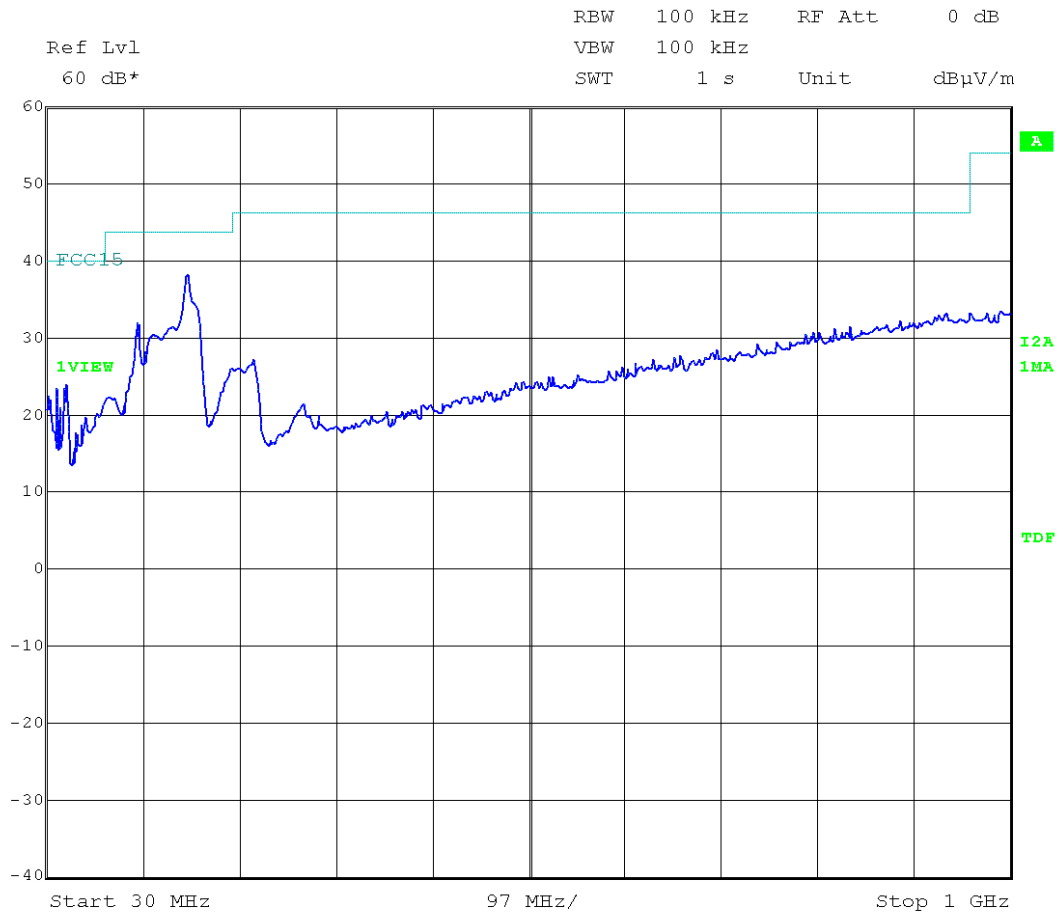
3. CHANNEL: HIGHEST

Spurious frequency (MHz)	Polarization	Emission Level (dB $\mu$ V/m) Peak	Duty-cycle correction factor $\delta$ (dB)	Corrected Emission Level (dB $\mu$ V/m) Average
4959.966	V	46.28	-19.58	26.70

Measurement Uncertainty (dB):  $\pm 4.0$  dB.

Verdict: PASS

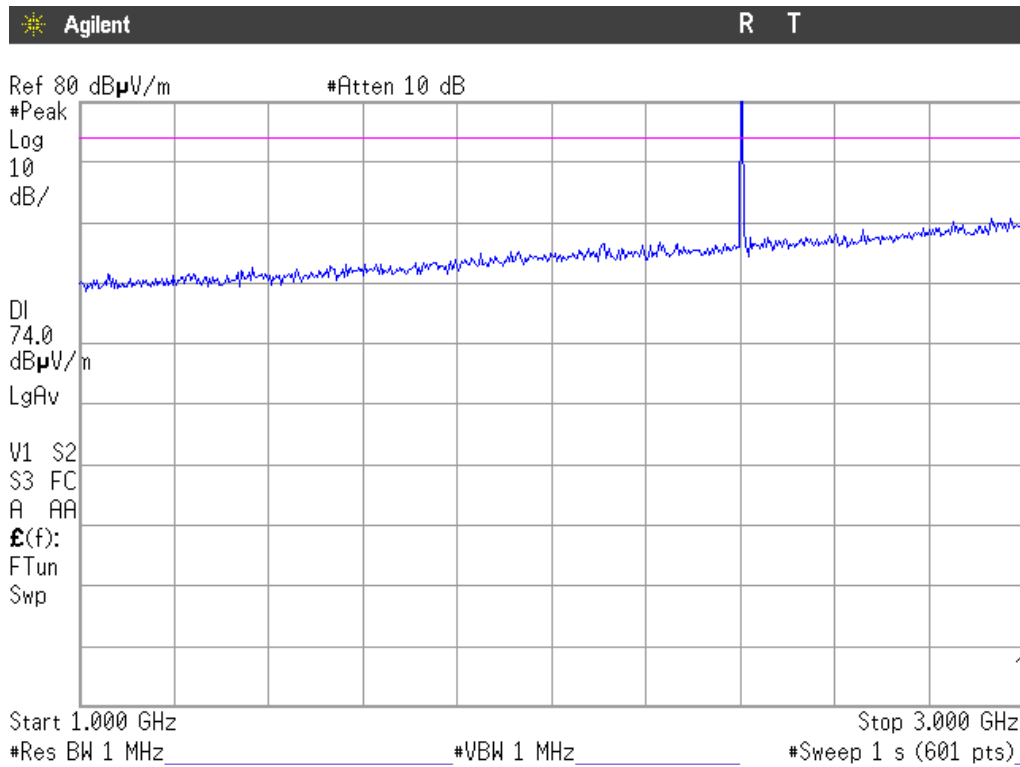
FREQUENCY RANGE 30 MHz-1000 MHz.



(This plot is valid for all three channels).

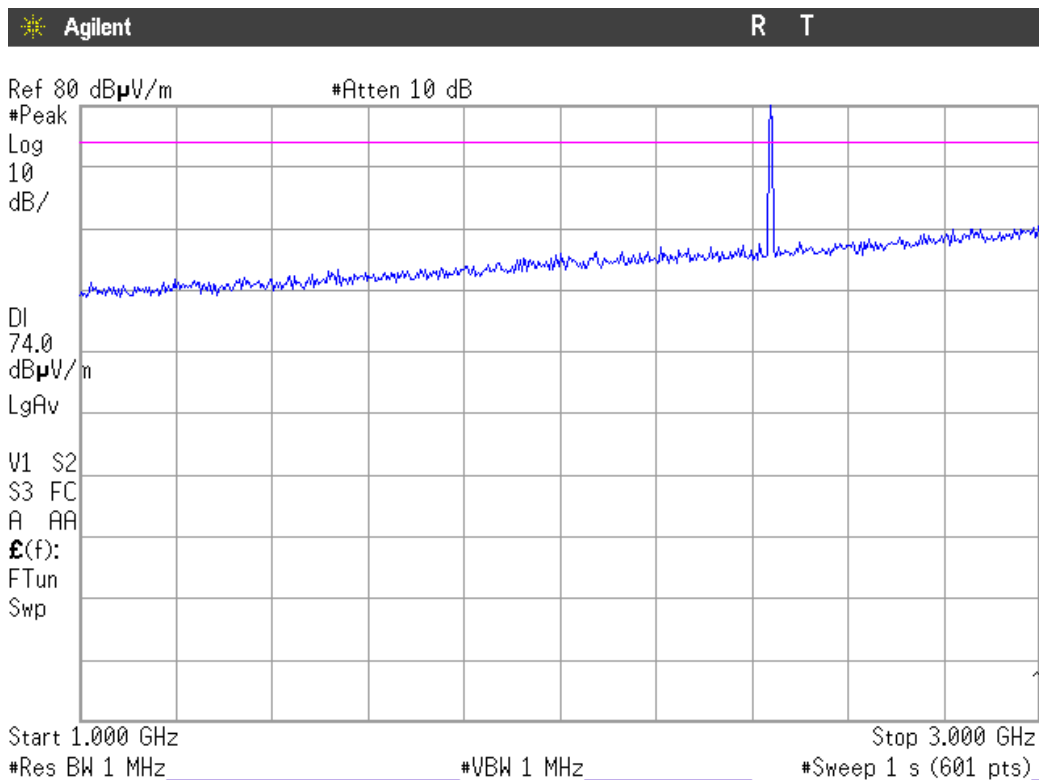
FREQUENCY RANGE 1 GHz to 3 GHz.

**CHANNEL: Lowest (2405 MHz).**



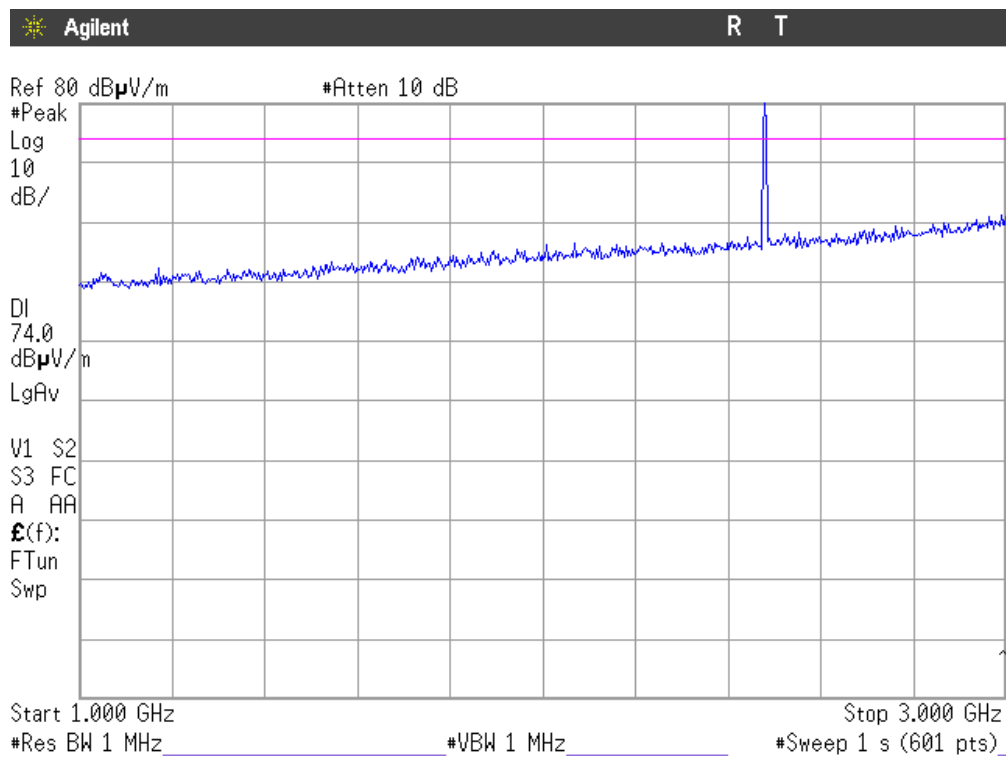
Note: The peak shown in the plot is the carrier frequency.

**CHANNEL: Middle (2440 MHz).**



Note: The peak shown in the plot is the carrier frequency.

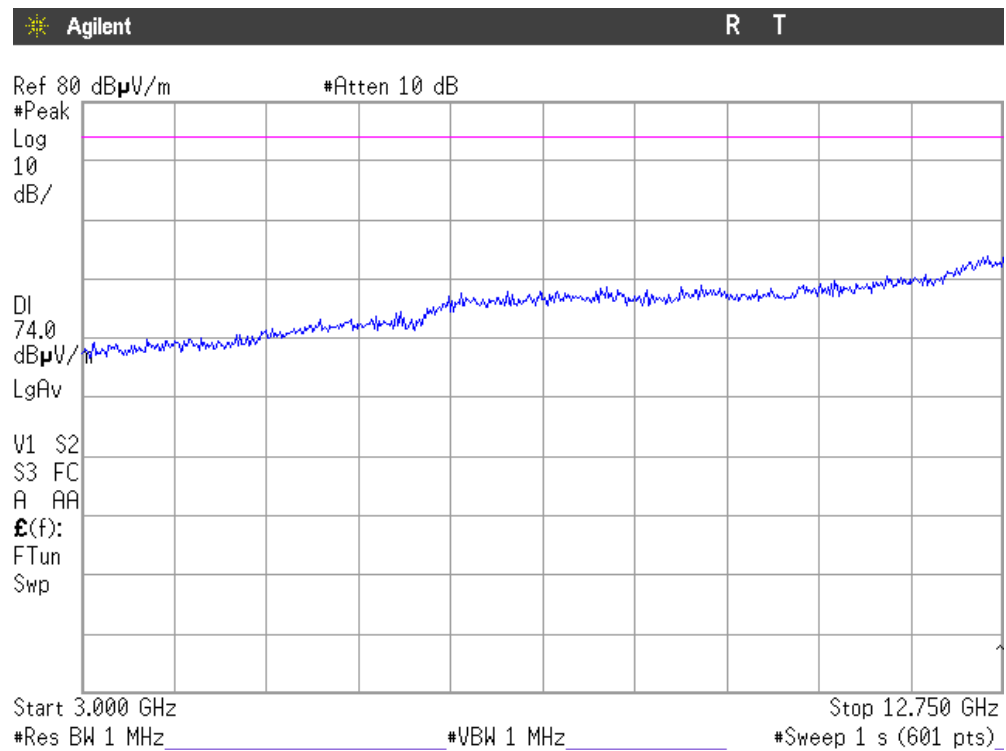
**CHANNEL: Highest (2480 MHz).**



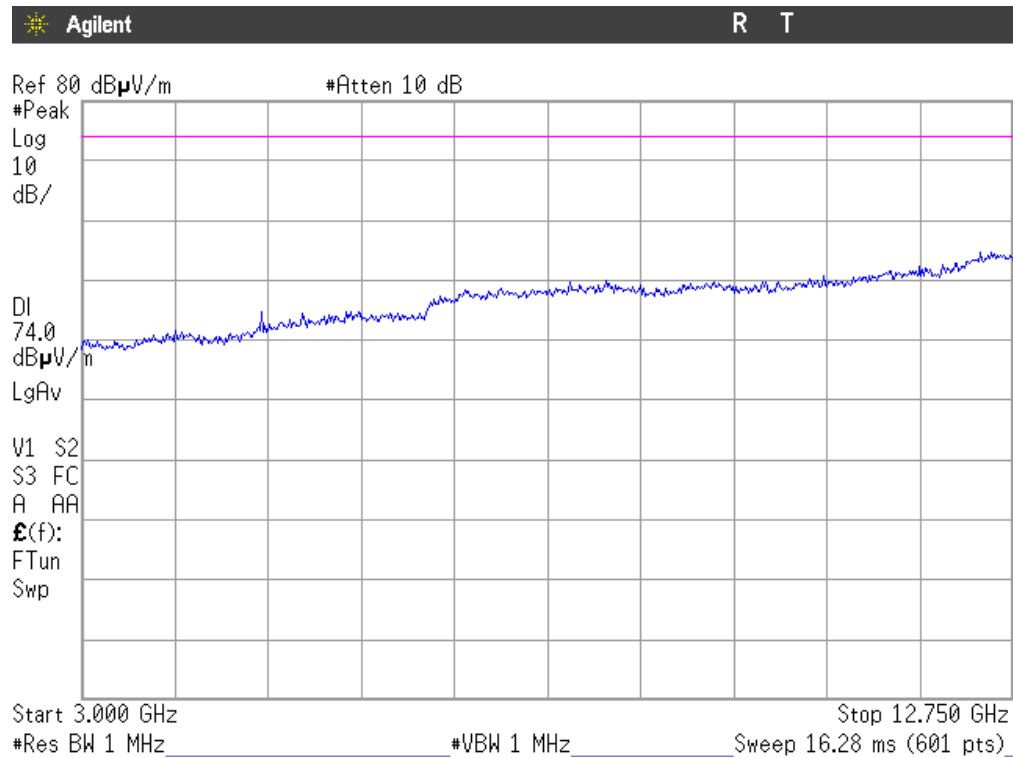
Note: The peak shown in the plot is the carrier frequency.

**FREQUENCY RANGE 3 GHz to 12.75 GHz.**

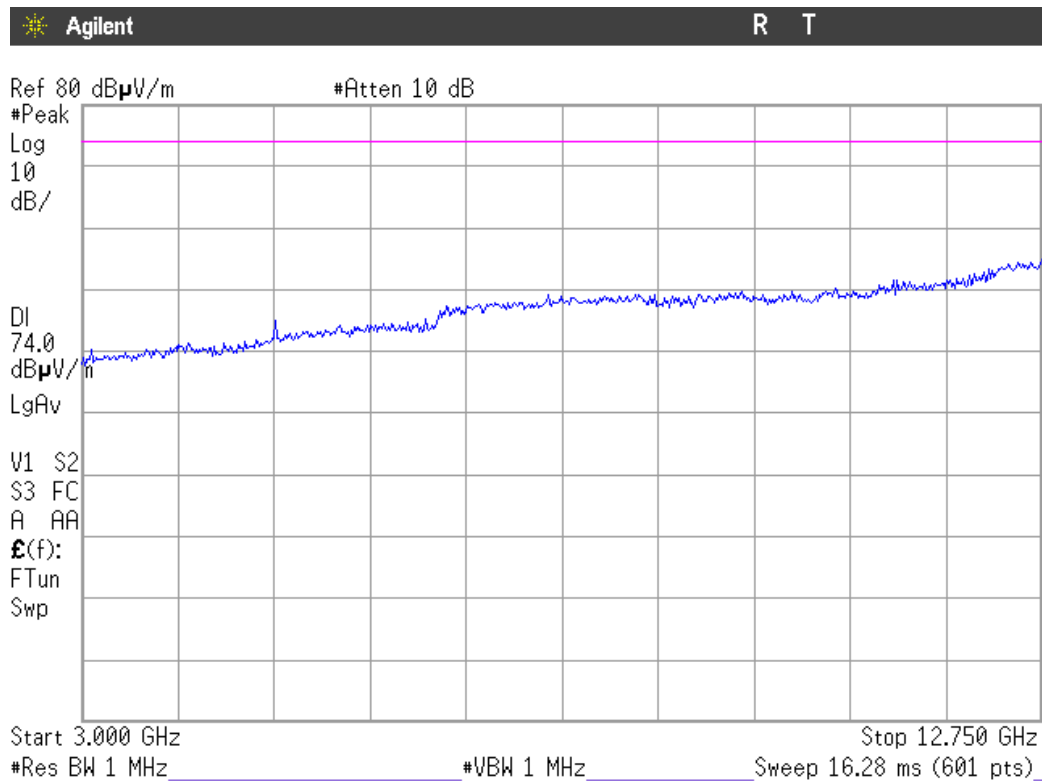
**CHANNEL: Lowest (2405 MHz).**



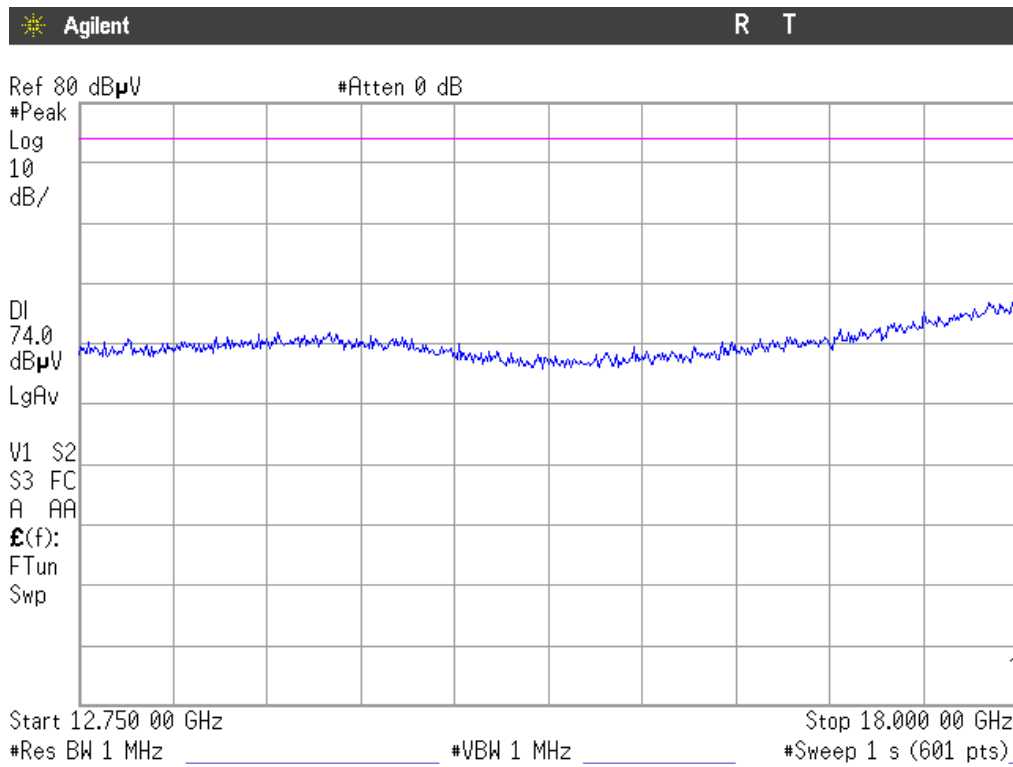
**CHANNEL: Middle (2440 MHz).**



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

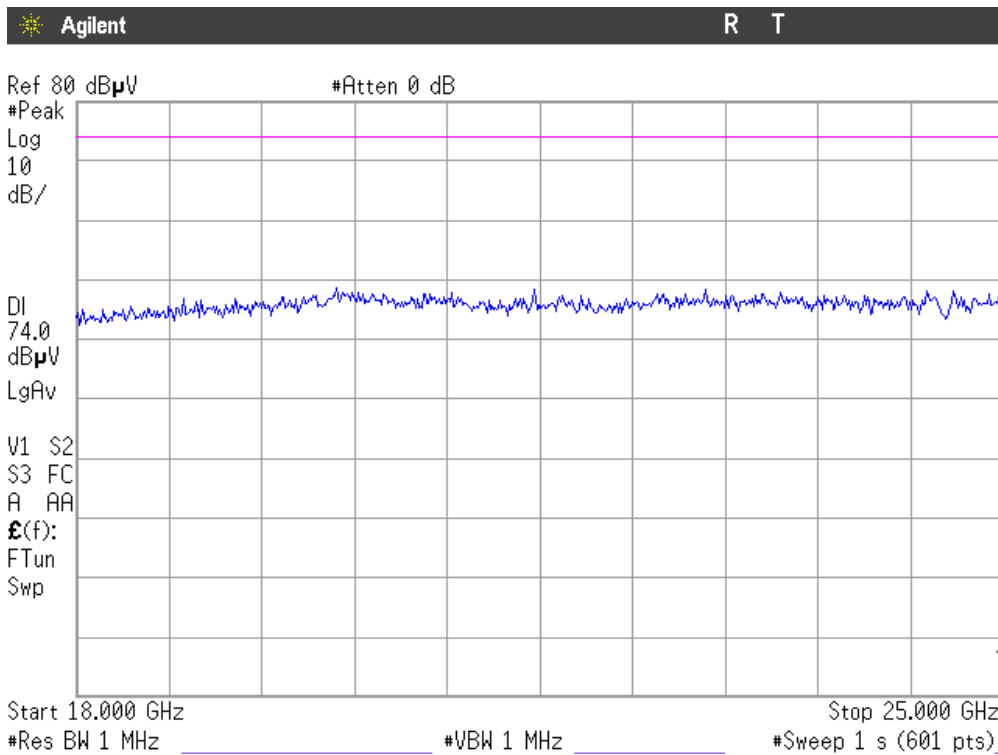


FREQUENCY RANGE 12.75 GHz to 18 GHz.



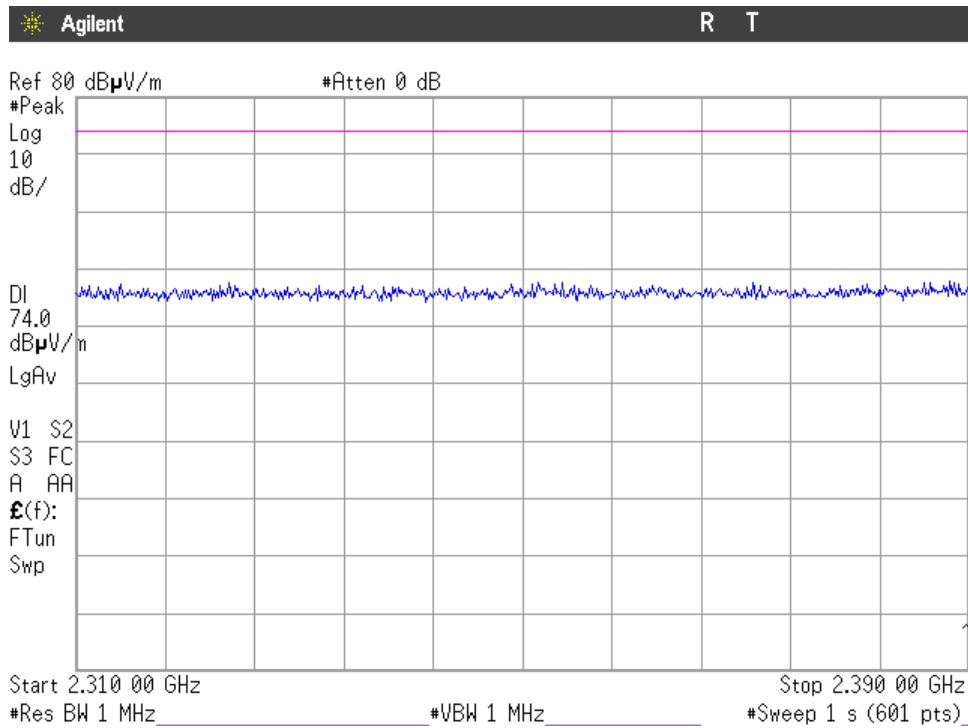
(This plot is valid for all three channels).

FREQUENCY RANGE 18 GHz to 25 GHz.



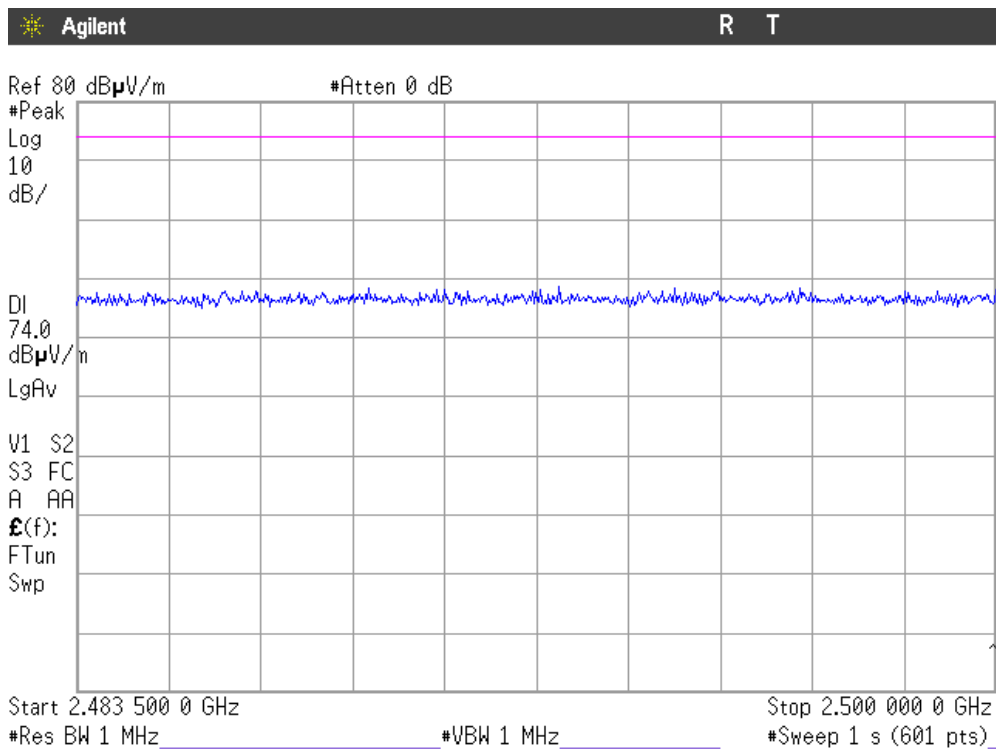
(This plot is valid for all three channels).

FREQUENCY RANGE 2.31 GHz to 2.39 GHz. (RESTRICTED BAND)



(This plot is valid for all three channels).

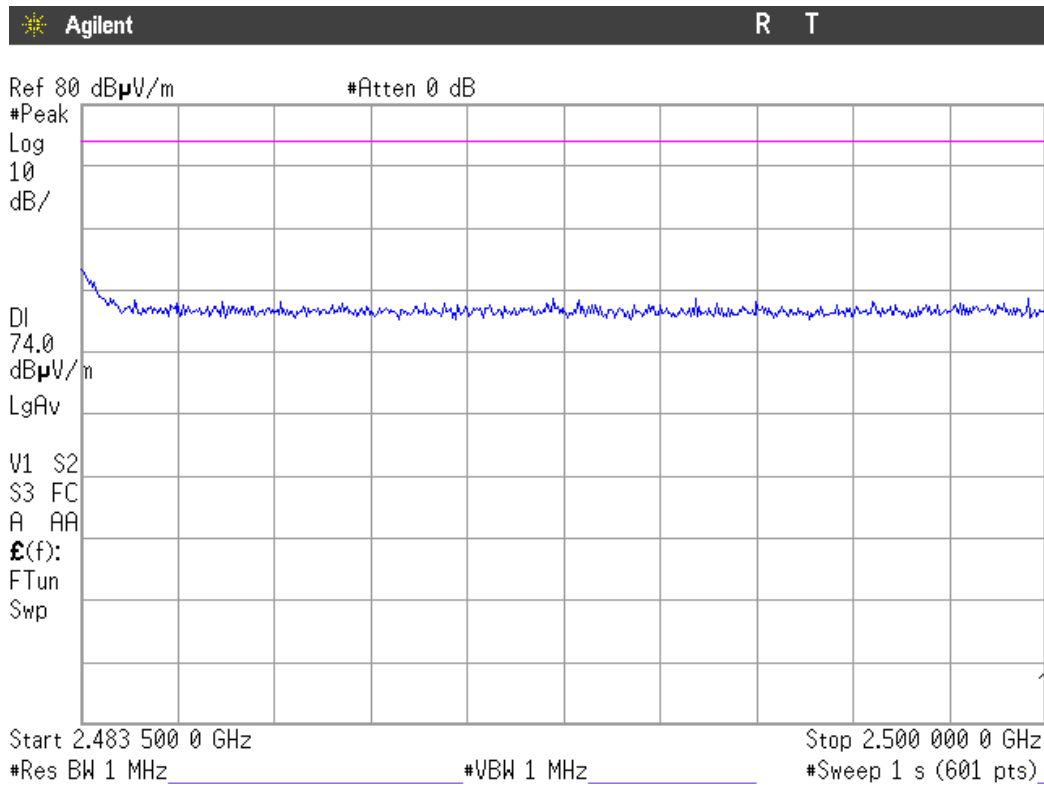
FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)



(This plot is valid for the lowest and middle channels).



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



### Section 15.109. Receiver spurious radiation

#### SPECIFICATION

The field strength shall not exceed the following values:

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.

**Frequency range 30 MHz-1000 MHz.**

Note: The spurious emissions below 1 GHz do not depend on either the receiving channel.

**Spurious levels operating (radiated) closest to limit.**

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dB $\mu$ V/m)	Measurement Uncertainty (dB)
123.3066	V	Quasi-peak	28.63	$\pm 3.8$
136.9138	V	Quasi-peak	27.47	$\pm 3.8$
169.9599	V	Quasi-peak	32.13	$\pm 3.8$

**Frequency range 1 GHz-25 GHz.**

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dB $\mu$ V/m)	Measurement Uncertainty (dB)
4810.033	V	Peak	43.98	$\pm 4.0$
4810.033	V	Average	40.50	$\pm 4.0$

2. CHANNEL: MIDDLE (2441 MHz).

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dB $\mu$ V/m)	Measurement Uncertainty (dB)
4879.967	V	Peak	43.74	$\pm 4.0$
4879.967	V	Average	39.60	$\pm 4.0$

3. CHANNEL: HIGHEST (2480 MHz).

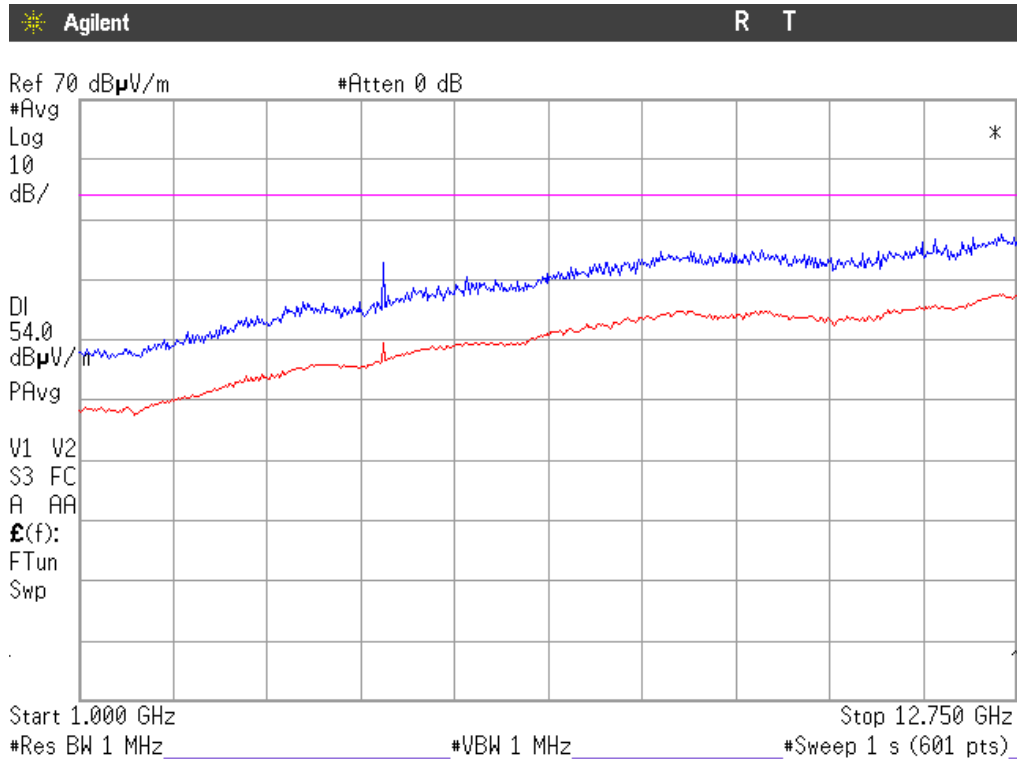
Spurious frequency (MHz)	Polarization	Detector	Emission Level (dB $\mu$ V/m)	Measurement Uncertainty (dB)
4959.975	V	Peak	43.22	$\pm 4.0$
4959.975	V	Average	39.36	$\pm 4.0$

Verdict: PASS.

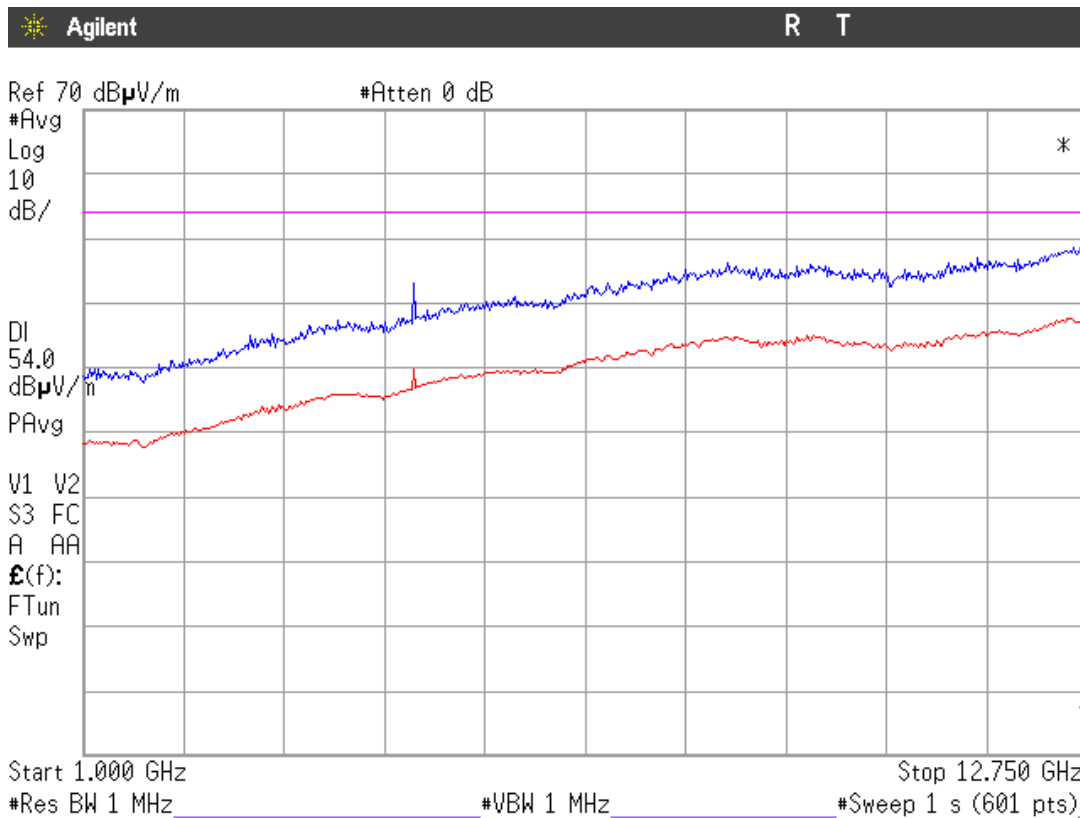


FREQUENCY RANGE 1 GHz-12.75 GHz.

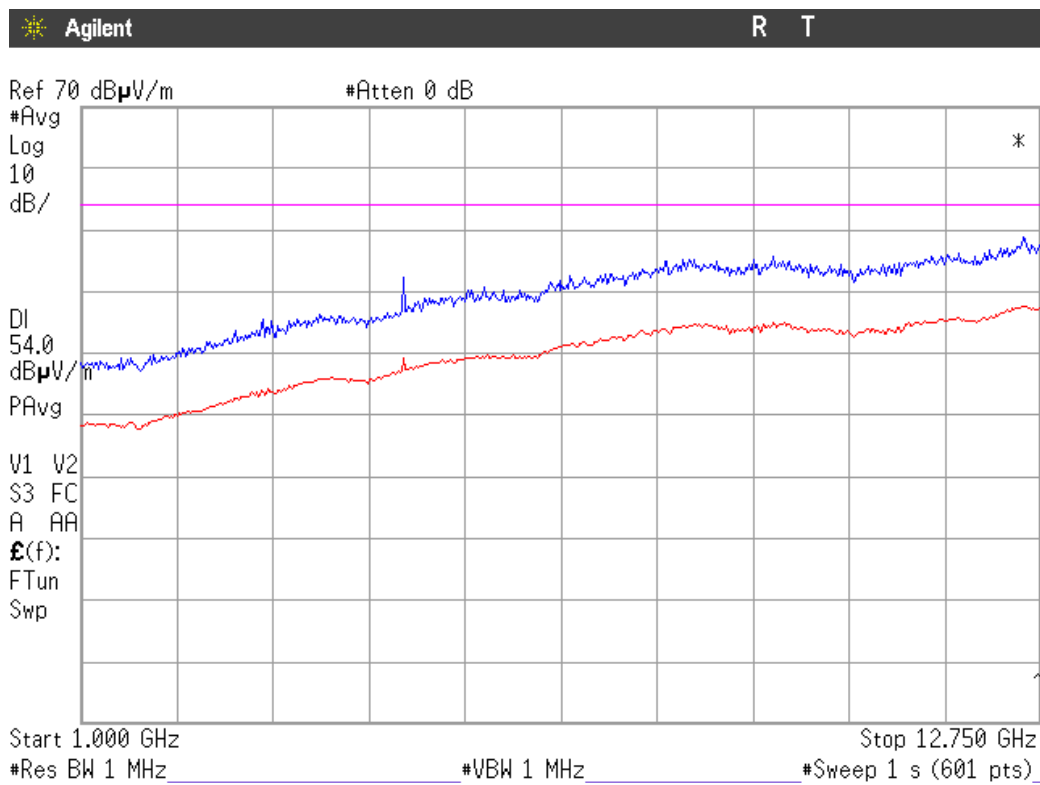
CHANNEL: Lowest (2405 MHz).



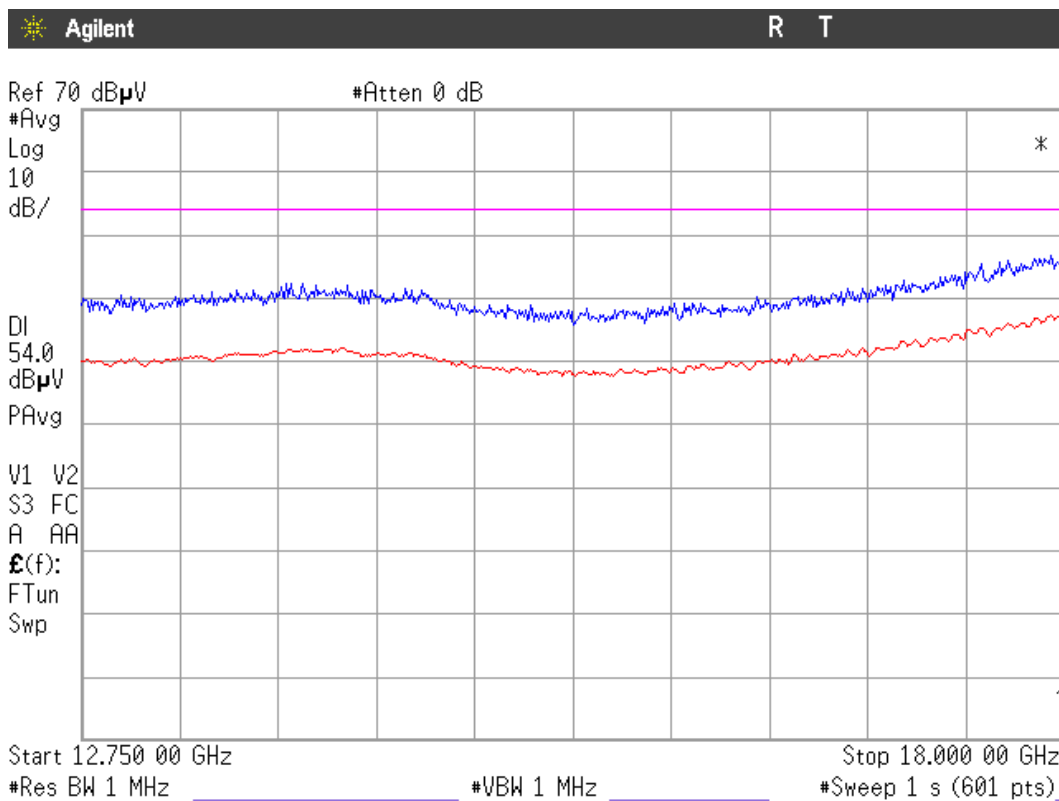
CHANNEL: Middle (2440 MHz).



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

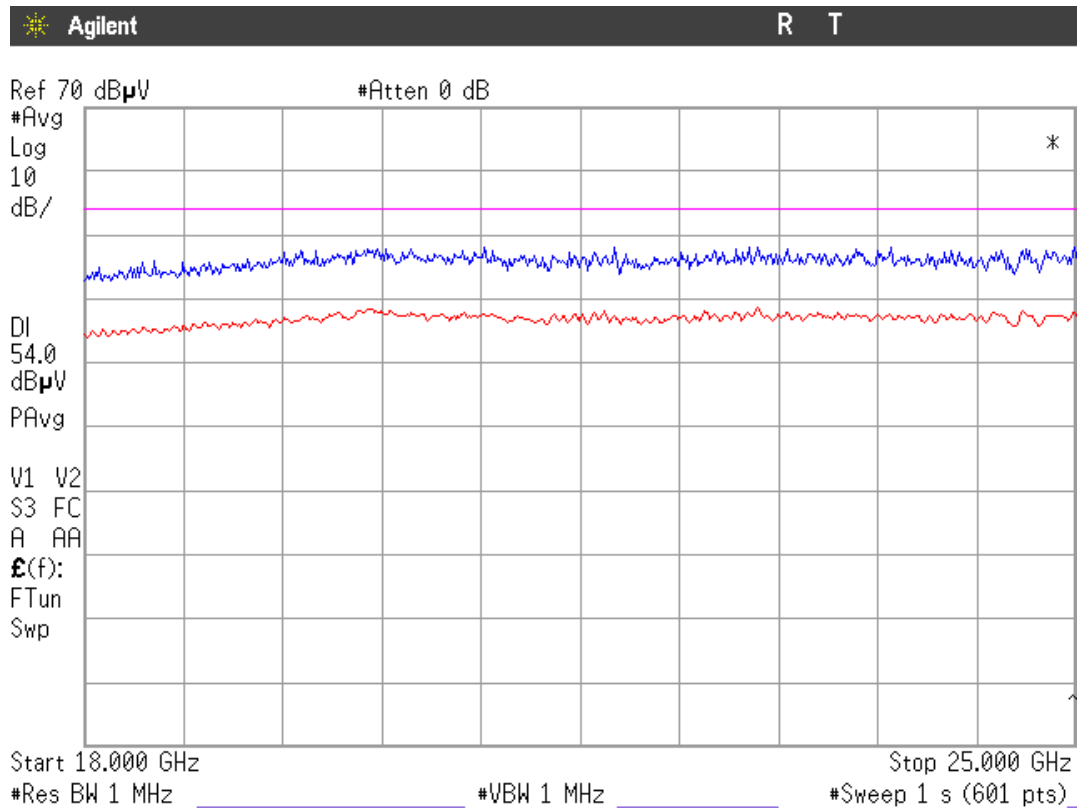


**FREQUENCY RANGE 12.75 GHz-18 GHz.**



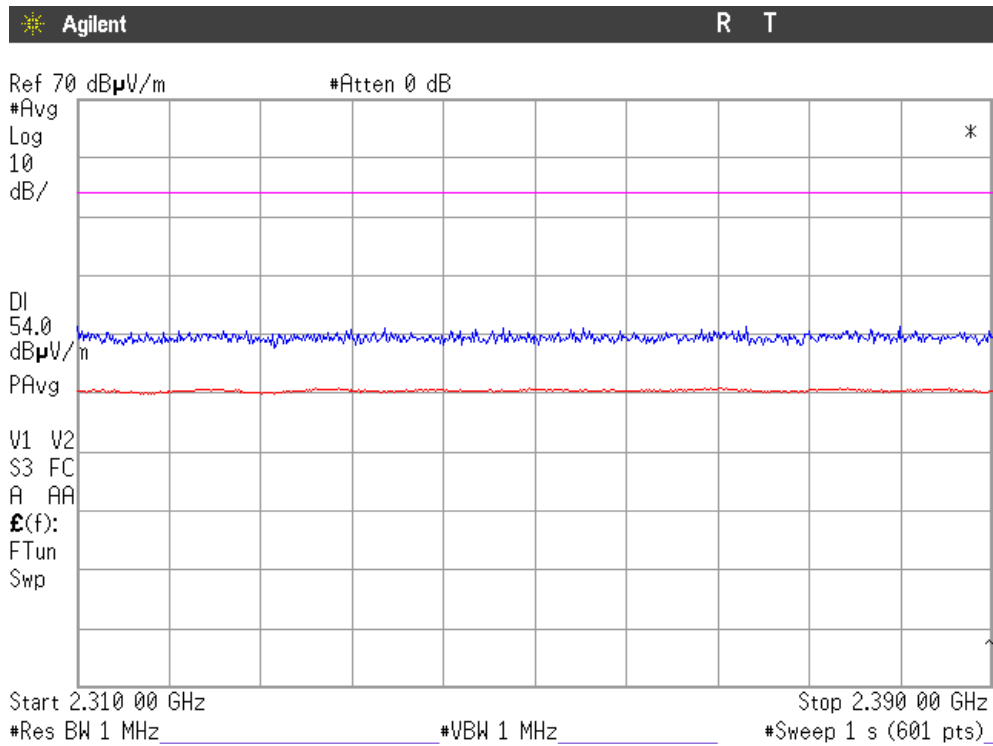
(This plot is valid for all three channels).

FREQUENCY RANGE 18 GHz-25 GHz.



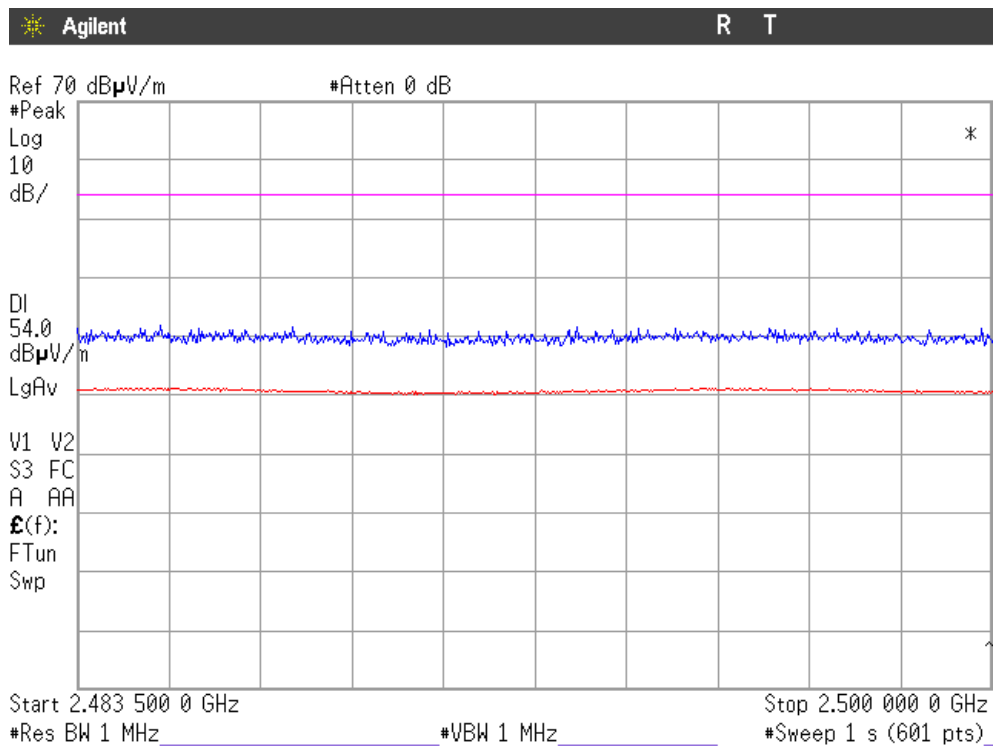
(This plot is valid for all three channels).

FREQUENCY RANGE 2.31 GHz to 2.39 GHz. (RESTRICTED BAND)



(This plot is valid for all three channels).

FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)



(This plot is valid for all three channels).