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LAB N° 1356

Test Report

47 CFR FCC Part 15 subpart C Intentional Radiators

Report reference no. : 28113121-007

FCC Designation Number : IT0008

FCC Test Firm Registration # : 804595

Tested by (name + signature) :

Andrea Bortolotti \ Tester

Approved by (name + signature) :

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Testing Laboratory : TÜV Rheinland Italia S.r.l.

Address : Via Mattei 3 - 20010 - Pogliano Milanese (MI) – Italy

Applicant's name : myUpTech AB

Address : Box 14, 285 21 Markaryd

Test item description : Temperature & humidity sensing electronic control

Trade Mark : myUpTech AB

Manufacturer : Scanfil Poland Sp. z o.o. Oddział w Sieradzu

Model/Type reference : HMI-L

FCC ID : 2AS2W-10000026

Ratings : 18-30V~ 50/60Hz or

5-15Vdc powered by external AC/DC adapter

Sample :

Samples received on : 22/03/2019

TUV reference samples : 190623 (sampled by the customer)

Samples tested n. : 1 with temporary RF connector

Testing :

Start Date : 23/03/2019

End Date : 11/04/2019

The results in this Test Report are exclusively referred to the tested samples. Without the written authorization of TÜV Rheinland Italia S.r.l., this document can be reproduced only integrally



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RELEASE CONTROL RECORD

Test report Number	Reason of change	Date of Issue
28113121-002	Original release	02/07/2019
28113121-005	Correct channel number & antenna gain, editorial change This version cancel and replaces full test report nr.28113121-002 issue date 02/07/2019 and its previous versions	17/09/2019
28113121-007	Editorial change This version cancel and replaces full test report nr.28113121-005 issue date 17/09/2019 and its previous versions	09/10/2019

1. Reference Standards

Standard	Description
FCC Part 15 (Subpart C)	§15.247 Operation within the bands 902-928 MHz, 2400-2483,5 MHz, and 5725-5850 MHz.
FCC Part 15 (Subpart C)	§15.207 Conducted Limits
FCC Part 15 (Subpart C)	§15.209 Radiated emission limits; general requirements
FCC Part 15 (Subpart C)	§15.203 Antenna Requirement
ANSI C63.4:2014	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10:2013	American National Standard for Testing Unlicensed Wireless Devices
558074 D01 DTS Meas Guidance v05 - August 24, 2018	Guidance for performing compliance measurements on digital transmission systems (DTS) operating under §15.247

**2. Summary of testing**

§ 15.203 § 15.247 (b)(4)(i)	Antenna Requirements	PASS
§ 15.207 (a)	Power Line Conducted Emission	Not performed
§ 15.209 (a) (f)	Radiated Emission	Not performed
§ 15.215 (a) (b) (c)	Additional provisions to the general radiated emission limitations	PASS
§ 15.247 (a)	Frequency Hopping Spread Spectrum Specifications:	
§ 15.247 (a) (1)	20 dB Bandwidth	N.A. ¹
§ 15.247 (a) (1) (i)	Number of Hopping Channels Used, Carrier frequency Separation and Time occupancy in band 902÷908MHz	N.A. ¹
§ 15.247 (a) (1) (ii)	Number of Hopping Channels Used, Carrier frequency Separation and Time occupancy in band 5725÷ 5850 MHz	N.A. ¹
§ 15.247 (a) (1) (iii)	Number of Hopping Channels Used, Carrier frequency Separation and Time occupancy in band 2400÷2483,5 MHz	N.A. ¹
§ 15.247 (a) (2)	6dB Minimum Bandwidth for systems using digitally modulation	PASS
§ 15.247 (b)	Maximum Peak Output Power:	
§ 15.247 (b) (1)	Peak Output Power (conducted) in band 2400÷2483,5 MHz and 5725÷ 5850 MHz (Hopping systems)	N.A. ¹
§ 15.247 (b) (2)	Peak Output Power (conducted) in band 902÷908MHz (Hopping systems)	N.A. ¹
§ 15.247 (b) (3)	RF power output (conducted) for systems using digitally modulation	PASS
§ 15.247 (b) (4)	Antenna gain	<6dBi
§ 15.247 (c)	Operation with directional antenna gains greater than 6 dBi	N.A. ²
§ 15.247 (d)	Out-of-band emissions	PASS
§ 15.247 (d)	100 kHz Bandwidth of Frequency Band Edges	PASS
§ 15.247 (e)	Power Spectral Density	PASS
§ 15.247 (f)	Hybrid systems	N.A. ³
§ 15.247 (g)	FHSS Transmission characteristics	N.A. ¹
§ 15.247 (h)	Recognition of occupied channel and multiple transmission system	N.A. ¹
§ 15.247 (i) (§ 47CFR 1.1307(b)(1))	RF humane exposure	PASS

Note 1	Not applicable for DTS equipment
Note 2	Antenna Gain <6dBi
Note 3	No hybrid system



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Possible test case verdicts:

- test case does not apply to the test object: N/A
- test object does meet the requirement: PASS
- test object does not meet the requirement.....: FAIL

General remarks:

The test results presented in this report relate only to the object tested.

The results contained in this report reflect the results for this particular model and serial number. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report.

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"(see Enclosure #)" refers to additional information appended to the report.

"(see appended table)" refers to a table appended to the report.

Throughout this report a comma is used as the decimal separator.

**3. General product information**

Temperature & humidity sensing electronic control

4. General Chipset information

Radio module(s) model	NXP Semiconductors MKW41Z/31Z/21Z – Working on Zigbee mode
Modulation	Generic FSK modulation
Number of channels	16
Channels Separation	2MHz
Frequency band	2,4 ISM frequency band
Operating frequency	2400÷2483.5 MHz

5. General Antenna information

Antenna	Gain:	Integral antenna gain 2,98dBi
	Model:	
	Type:	<input checked="" type="checkbox"/> Integral <input type="checkbox"/> Dedicated <input type="checkbox"/> External



6. Equipment Used During Test

Use*	Product Type	Manufacturer	Model	Comments
EUT	Temperature & humidity sensing electronic control	myUpTech AB	HMI-L	---
AE	PC	---	---	Used to set EUT Radio parameters

Note:

* Use :

EUT - Equipment Under Test,
AE - Auxiliary/Associated Equipment, or
SIM - Simulator (Not Subjected to Test)

No other Auxiliary/Associated Equipment was connected/installed on the EUT

7. Input/Output Ports

CONNECTIONS

Port		Description	Connection	Cable lenght
1	Enclosure	Non conductive surface	Closed by pressure	---
2	AC Power Port	AC Input	18-30V~ 50/60Hz	<1m
3	DC Power Port	DC Input	5-15Vdc powered by external AC/DC adapter	<1m
4	I/O	USB	1 USB 2.0 device port (mini-B)	<1m
5	WN	---	Not present	---

*Note: AC = AC Power Port DC = DC Power Port N/E = Non-Electrical
I/O = Signal Input or Output Port (Not Involved in Process Control)
WN = Wired Network

8. Power Interface

Mode #	Voltage (V)	Current (A)	Power (VA)	Frequency (DC/AC-Hz)	Phases (#)	Comments
Rated	5Vdc	---	---	---	---	Powered by USB port

**9. EUT Operation Modes**

Operation mode	Description
#1	RF Transmission with packet data RF setting during tests: Frequency: 2405MHz (low channel); 2445MHz (mid channel); 2480MHz (high channel); Power setting: maximum level

Frequency (Transmission) DTS – Declared by applicant

Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
11	2405 MHz	12	2410 MHz	13	2415 MHz	14	2420 MHz
15	2425 MHz	16	2430 MHz	17	2435 MHz	18	2440 MHz
19	2445 MHz	20	2450 MHz	21	2455 MHz	22	2460 MHz
23	2465 MHz	24	2470 MHz	25	2475 MHz	26	2480 MHz

10. EUT Configuration Modes

Continuous transmission mode on selected channel



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Par.	Test	EUT Operation Modes
§ 15.203 § 15.247 (b) (4) (i)	Antenna Requirements	#1
§ 15.215 (a) (b) (c)	Additional provisions to the general radiated emission limitations	#1
§ 15.247 (a) (2)	6 dB minimum Bandwidth	#1
§ 15.247 (b) (3)	RF power output (conducted) for systems using digitally modulation	#1
§ 15.247 (d)	Out-of-band emissions	#1
§ 15.247 (d)	100 kHz Bandwidth of Frequency Band Edges	#1
§ 15.247 (e)	Power Spectral Density	#1
§ 15.247 (i) (§ 47CFR 1.1307(b)(1))	RF humane exposure	#1



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The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

$$\text{Field Strength (dB}\mu\text{V/m)} = \text{RAW} - \text{AMP} + \text{CBL} + \text{ACF}$$

Where: RAW = Measured level before correction (dB μ V)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu\text{V/m} = 10^{\frac{\text{dB}\mu\text{V/m}}{20}}$$

Sample radiated emissions calculation @ 30 MHz

Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dB μ V/m)

$$25 \text{ dB}\mu\text{V/m} + 17.5 \text{ dB} - 20 \text{ dB} + 1.0 \text{ dB} = 23.5 \text{ dB}\mu\text{V/m}$$

**11. Test Conditions and Results**

11.1 TEST: Antenna requirements		PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	21°C
	Relative Humidity (%)	56%
	Air pressure (hPa)	1020
—	Power Supply / Frequency	Application Point
Fully configured sample tested at the power line frequency	5Vdc	SMA Connector
Equipment mode:	Operation mode	#1
FCC Standard	§15.203 § 15.247 (B) (4) (I)	
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 manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.		
Antenna specifications		
N° of authorized antenna types	1	
Antenna type	Integrated antenna	
Maximum total gain	+2,98 dBi	
External power amplifiers	Not present	



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12.2 TEST: 6dB Bandwidth			PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C	
	Relative Humidity (%)	30 to 60 %	
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	24°C	
	Relative Humidity (%)	48%	
	Air pressure (hPa)	1020	
—	Frequency	Application Point	
Fully configured sample tested at the power line frequency	5V dc	SMA Connector	
Equipment mode:	Operation mode	#1	
FCC Standard	§15.247 (A) (2)		
Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.			
Further information to test setup	<div><div>EUT</div><div><div></div>Attenuator (optional)</div><div>Spectrum Analyzer (or Power Meter)</div></div>		



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Test Equipment Used

Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
EMI Test Receiver	R&S	ESU 40	2782345	05/2018	05/2019

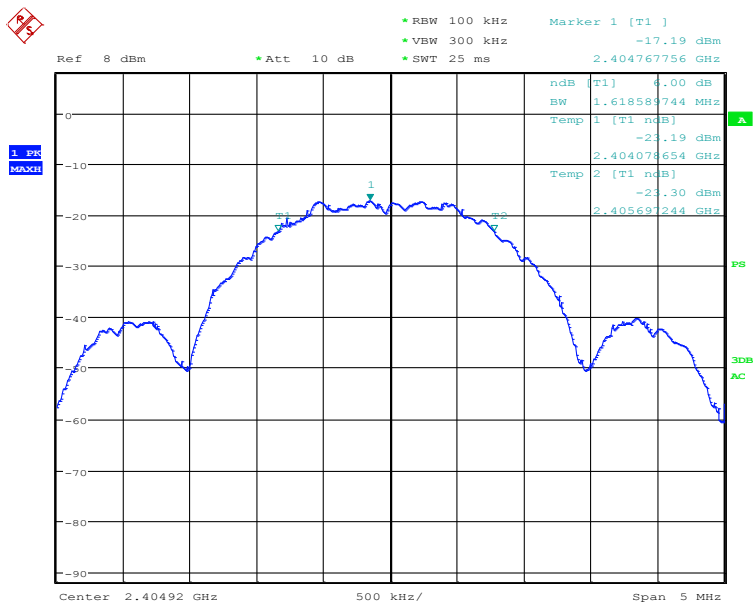
Test Method Used

According to Par. 8.2 of KDB 558074 D01 15.247 Meas Guidance v05 (and par. 11.8.1 Option 1 of ANSI C63.10)



Graphical representation of 6dB Bandwidth

Operation Mode: #1 – Low Channel (2405 MHz)



Graphical representation of 6dB Bandwidth

Operation Mode: #1 – Low Channel (2405 MHz)

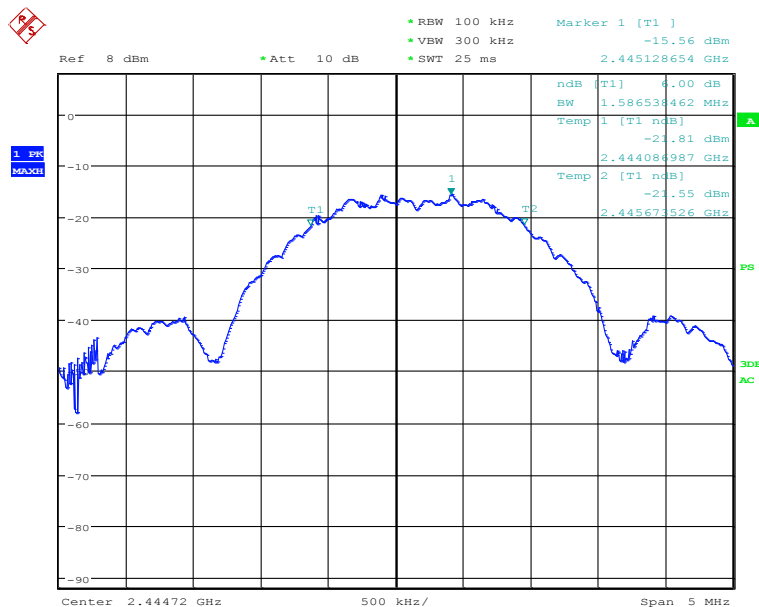
Channel (No.)	Frequency (MHz)	Channel Bandwidth at -6dB (MHz)
Low	2405	1.618

Bandwidth at -6dB (Fmin and Fmax)			
Fmin	2404,07 MHz	Fmax	2405,69 MHz



Graphical representation of 6dB Bandwidth

Operation Mode: #1 – Middle Channel (2445 MHz)



Graphical representation of 6dB Bandwidth

Operation Mode: #1 – Middle Channel (2445 MHz)

Channel (No.)	Frequency (MHz)	Channel Bandwidth at -6dB (MHz)
Middle	2445	1.586

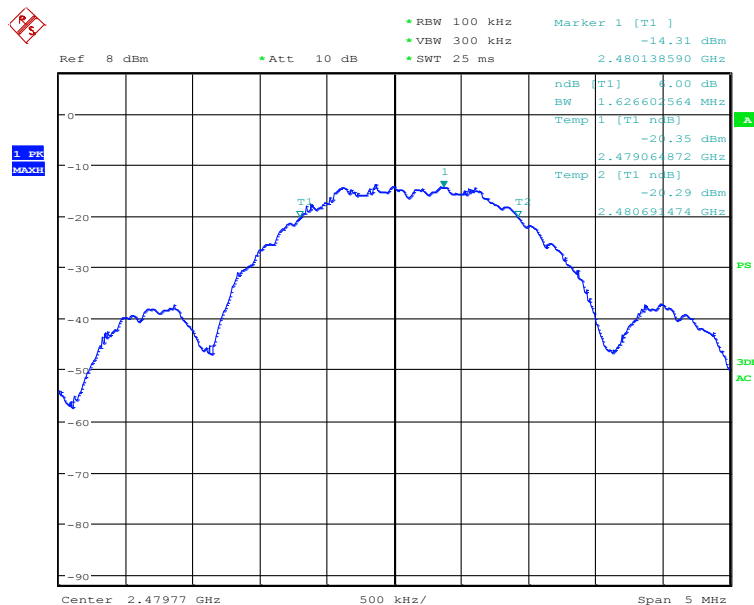
Bandwidth at -6dB (Fmin and Fmax)

Fmin	2444,08 MHz	Fmax	2445,67 MHz
------	-------------	------	-------------



Graphical representation of 6dB Bandwidth

Operation Mode: #1 – High Channel (2480 MHz)



Graphical representation of 6dB Bandwidth

Operation Mode: #1 – High Channel (2480 MHz)

Channel (No.)	Frequency (MHz)	Channel Bandwidth at -6dB (MHz)
High	2480	1,627

Bandwidth at -6dB (Fmin and Fmax)

Fmin	2479,06 MHz	Fmax	2480,69 MHz
------	-------------	------	-------------

**11.3 TEST: RF power output, radiated (EIRP)****PASS**

Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	22,5°C
	Relative Humidity (%)	51%
	Air pressure (hPa)	1020
—	Power Supply / Frequency	Application Point
Fully configured sample tested at the power line frequency	5V dc	RF Connector
Equipment mode:	Operation mode	#1
FCC Standard	§15.247 (B) (3)	

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

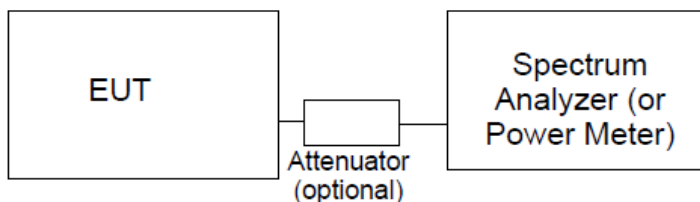
(1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

(2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Further information to test setup





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Test Equipment Used

Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
EMI Test Receiver	R&S	ESU 40	2782345	05/2018	05/2019

Test Method Used

According to Par. 8.3.1.1 of KDB 558074 D01 15.247 Meas Guidance v05 (and par. 11.9.1.1 RBW \geq DTS bandwidth of ANSI C63.10)



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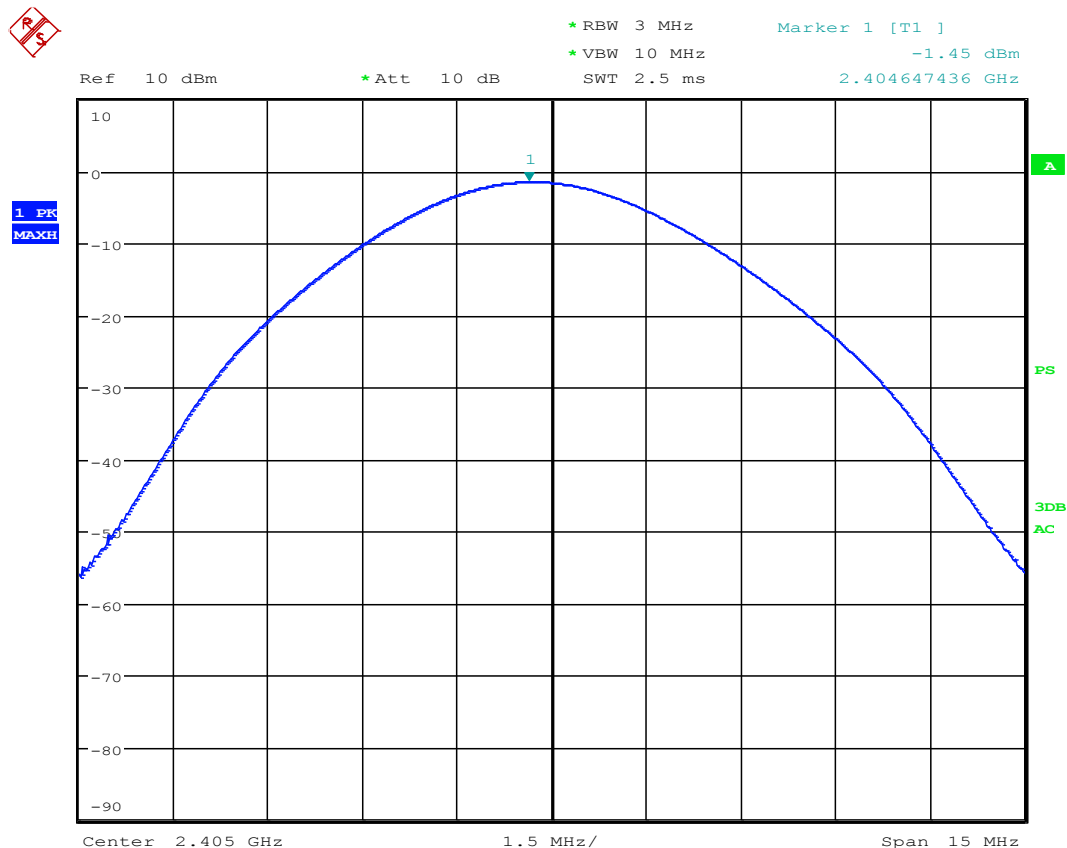
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Graphical representation of RF power output

Operation Mode: #1 – Low Channel (2445 MHz)

Plot n°1



Channel (No.)	Frequency (MHz)	Conducted Output Power		Limit (W)
		(dBm)	(mW)	
Low	2405	-1,45	0,72	1



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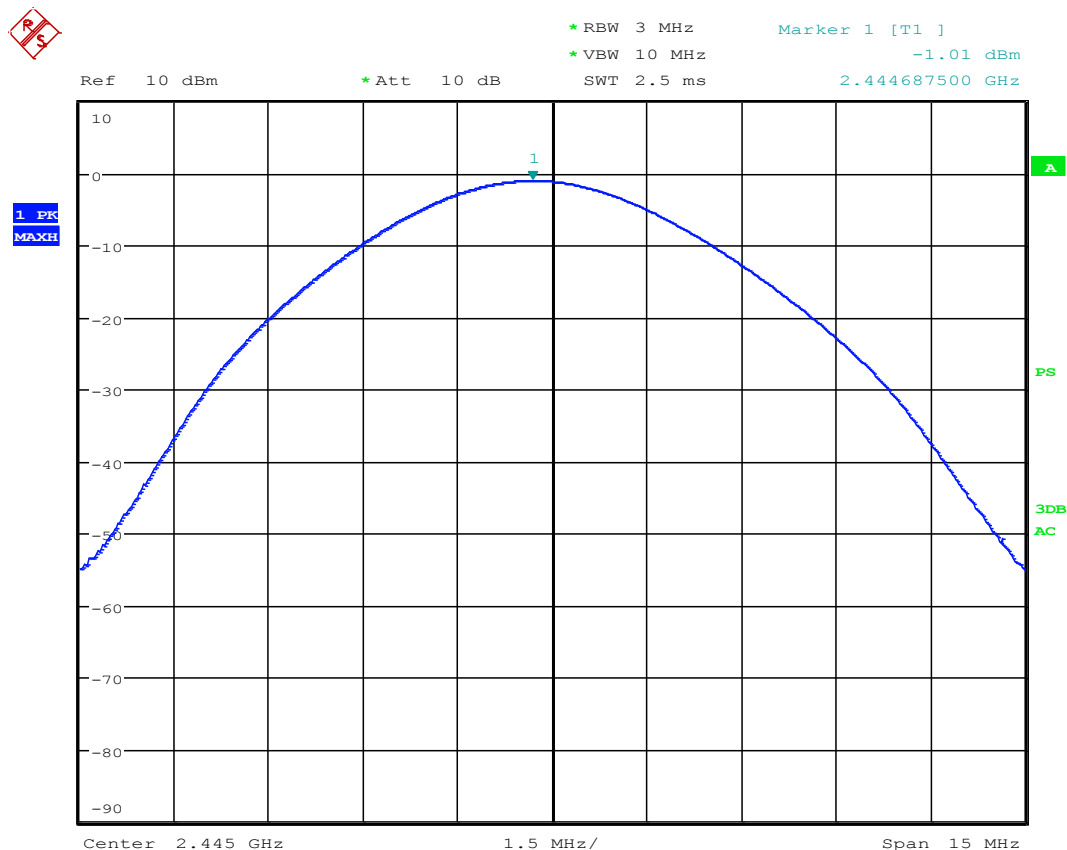
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Graphical representation of RF power output

Operation Mode: #1 – Middle Channel (2445 MHz)

Plot n°2



Channel (No.)	Frequency (MHz)	Conducted Output Power		Limit (W)
		(dBm)	(mW)	
Middle	2445	-1,01	0,79	1



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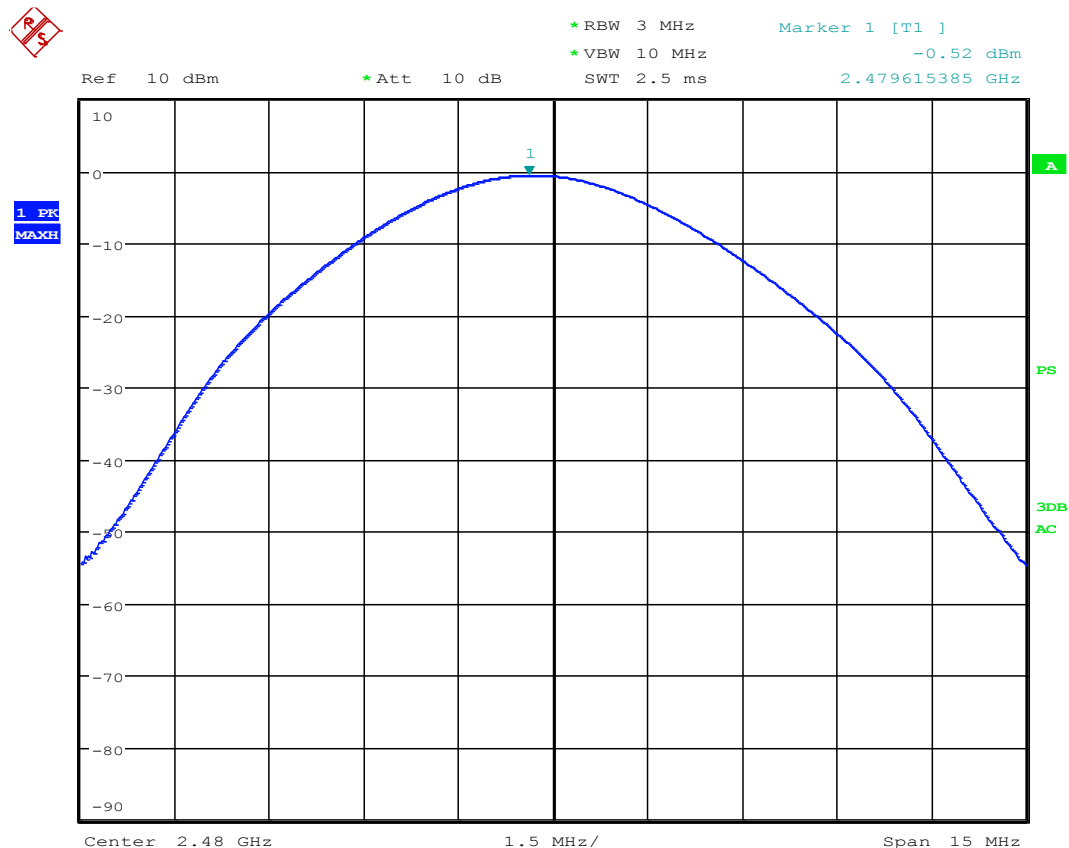
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Graphical representation of RF power output

Operation Mode: #1 – High Channel (2480 MHz)

Plot n°3



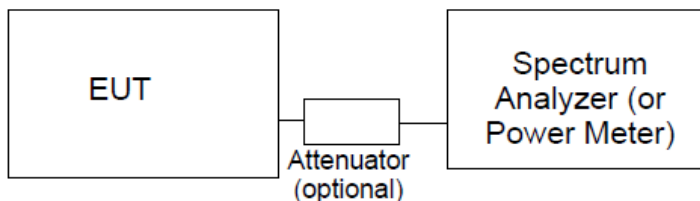
Channel (No.)	Frequency (MHz)	Conducted Output Power		Limit (W)
		(dBm)	(mW)	
High	2480	-0,52	0,89	1

**11.4 TEST: Out-of-band emissions****PASS**

Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	22°C
	Relative Humidity (%)	50%
	Air pressure (hPa)	1020
—	Power Supply / Frequency	Application Point
Fully configured sample tested at the power line frequency	5V dc	RF Connector
Equipment mode:	Operation mode	#1
FCC Standard	§15.247 (D)	

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, 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)).

Further information to test setup





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Test Equipment Used

Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
EMI Test Receiver	R&S	ESU 40	2782345	05/2018	05/2019

Test Method Used

According to Par. 8.5 of KDB 558074 D01 15.247 Meas Guidance v05 (and par. 11.11 of ANSI C63.10)

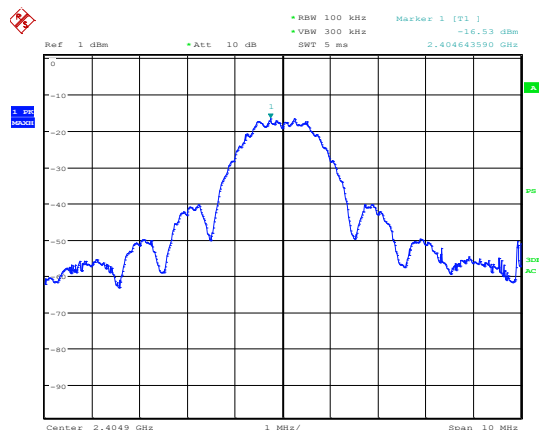
If the maximum peak conducted output power procedure was used to determine compliance as described in 11.9.1, then the peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 20 dBc).



Graphical representation of Antenna Port Spurious Emission - Conducted

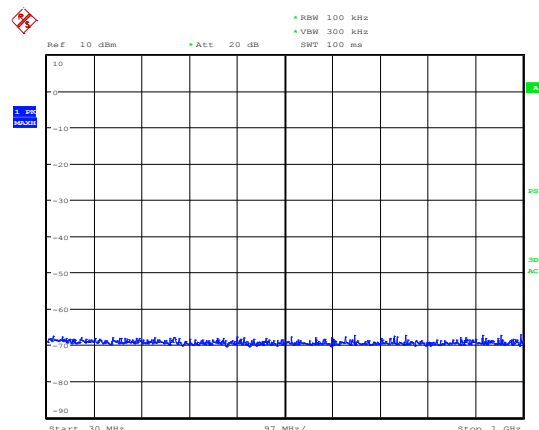
Operation Mode: #1 – Low Channel (2405 MHz)

Fundamental



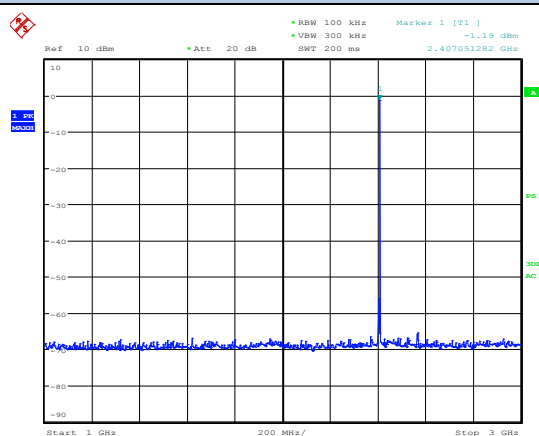
Date: 11.APR.2019 10:40:15

Frequency: 30MHz – 1000MHz



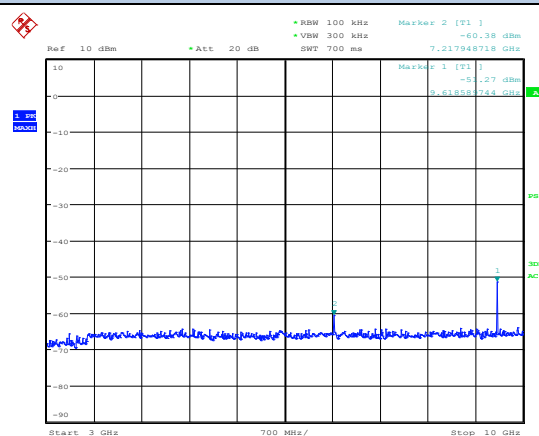
Date: 26.MAR.2019 10:20:32

Frequency: 1GHz – 3GHz



Date: 26.MAR.2019 10:22:44

Frequency: 3GHz – 10GHz



Date: 26.MAR.2019 10:14:32

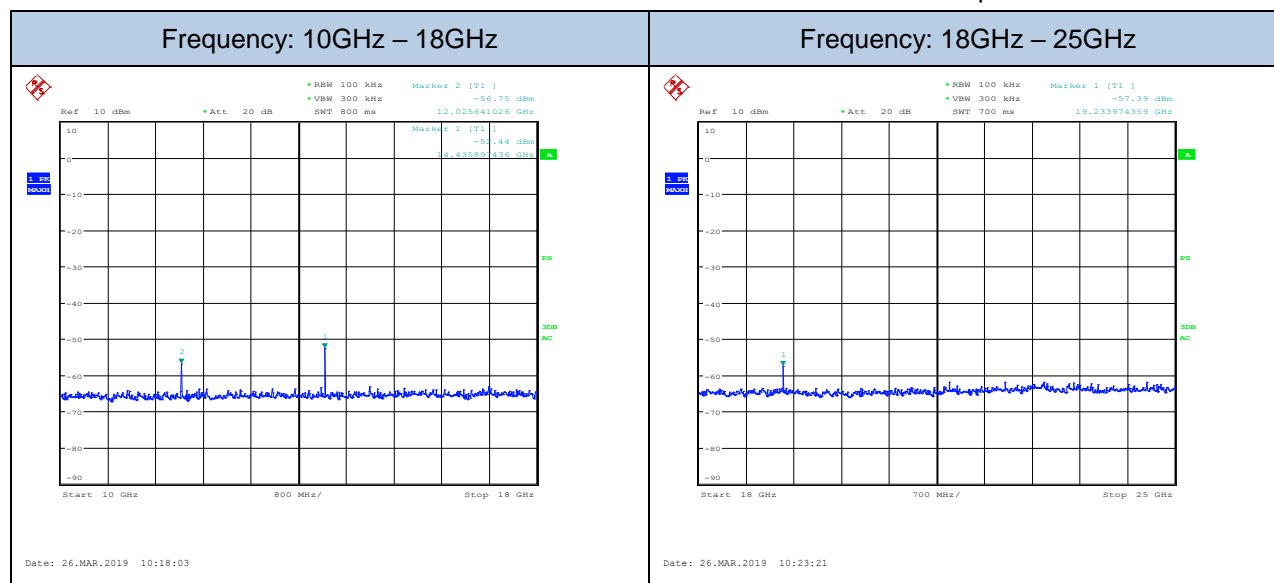


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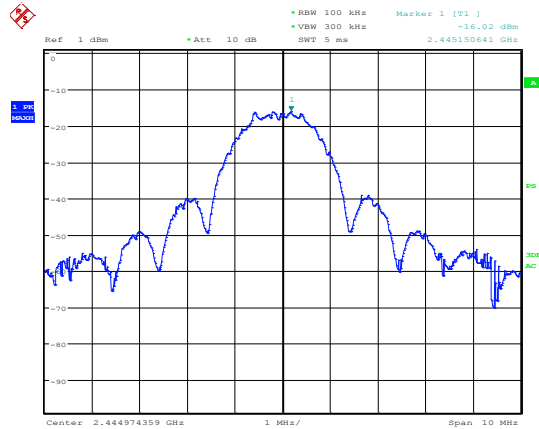
Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power -20dB (dBm)	Margin (dB)
7217.94	-60.38	-16.53	43.85	-36.53	23.85
9618.58	-51.27		34.74		14.74
12025.64	-56.75		40.22		20.22
14435.89	-52.44		35.91		15.91
19233.97	-57.39		40.86		20.86



Graphical representation of Antenna Port Spurious Emission - Conducted

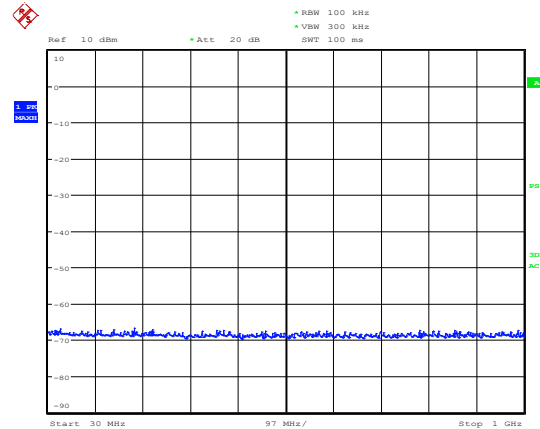
Operation Mode: #1 – Middle Channel (2445 MHz)

Fundamental



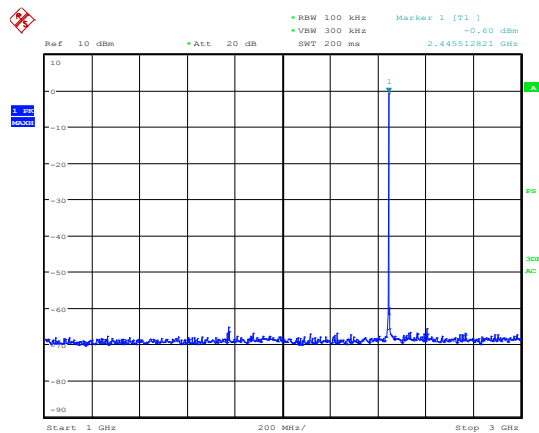
Date: 11.APR.2019 10:30:57

Frequency: 30MHz – 1000MHz



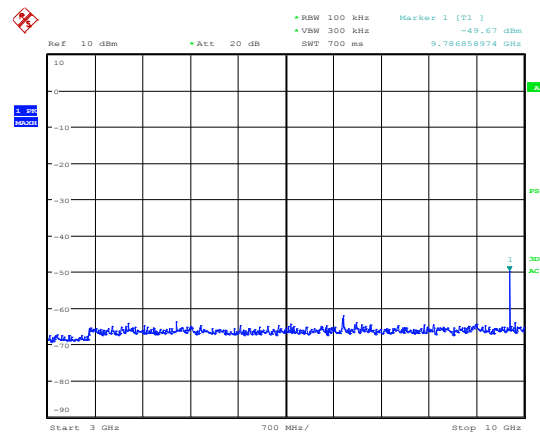
Date: 26.MAR.2019 15:28:55

Frequency: 1GHz – 3GHz



Date: 26.MAR.2019 15:29:23

Frequency: 3GHz – 10GHz



Date: 26.MAR.2019 15:29:55

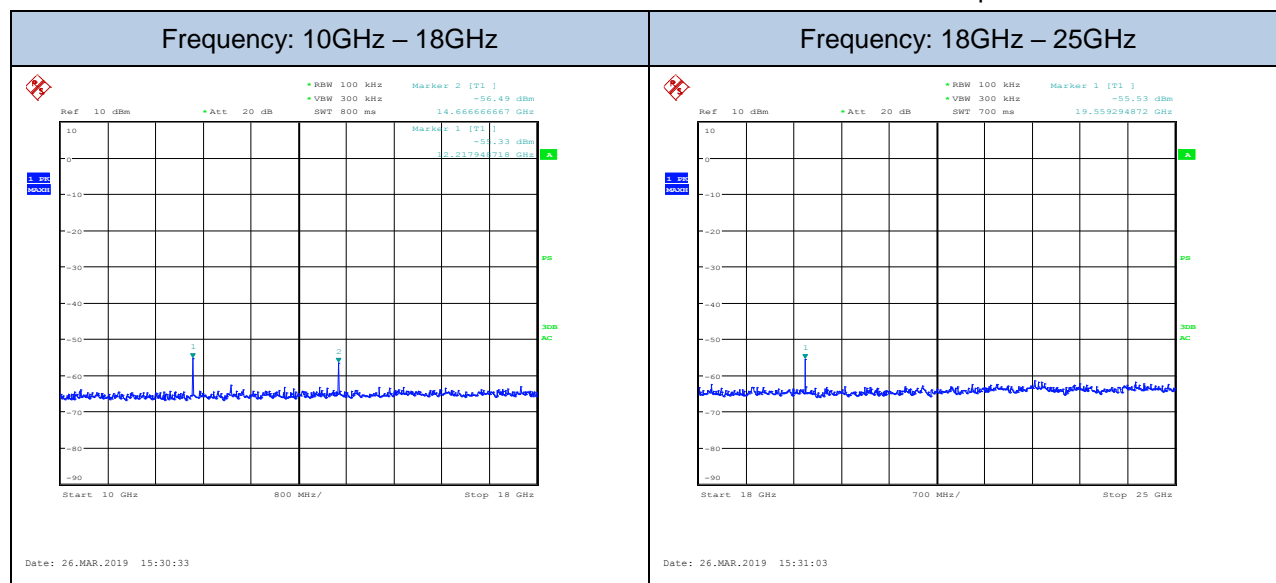


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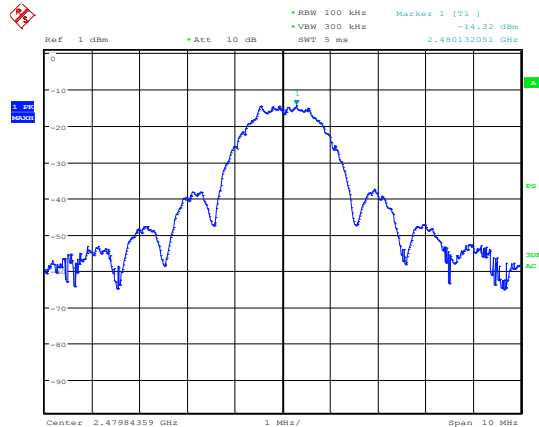
Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power -20dB (dBm)	Margin (dB)
9786.58	-49.67	-16.02	33.65	-36.02	13.65
12217.95	-55.33		39.31		19.31
14666.67	-56.49		40.47		20.47
19559.29	-55.53		39.51		16.02



Graphical representation of Antenna Port Spurious Emission - Conducted

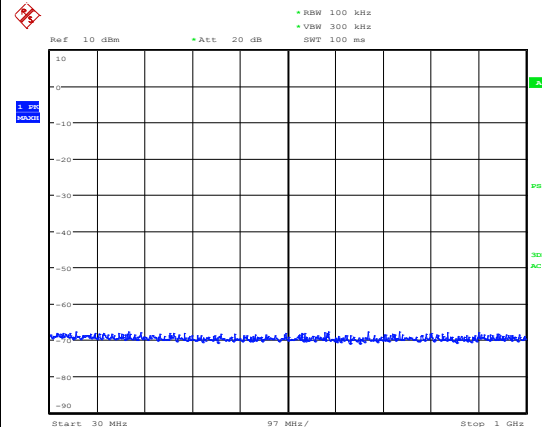
Operation Mode: #1 – High Channel (2480 MHz)

Fundamental



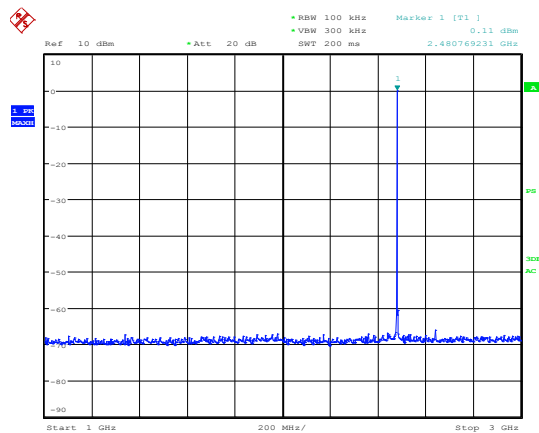
Date: 11.APR.2019 10:22:48

Frequency: 30MHz – 1000MHz



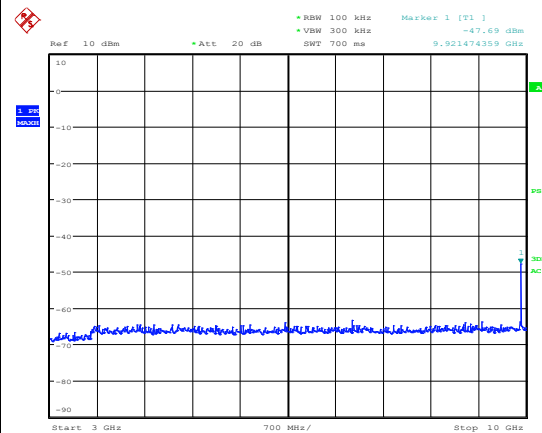
Date: 26.MAR.2019 15:33:03

Frequency: 1GHz – 3GHz

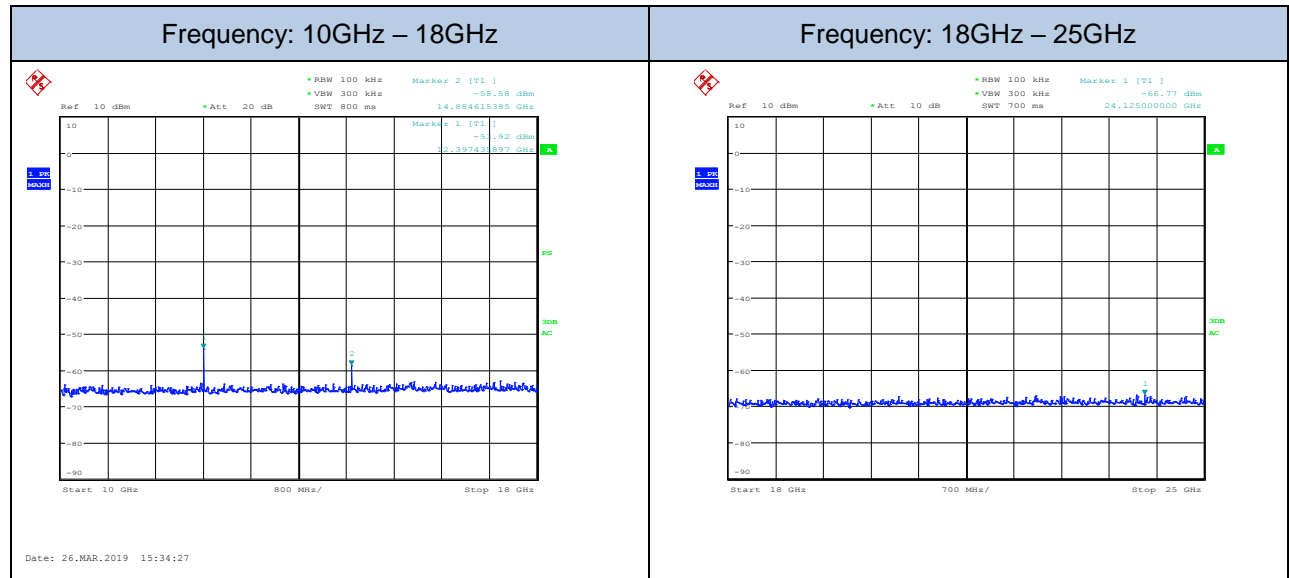


Date: 26.MAR.2019 15:33:31

Frequency: 3GHz – 10GHz



Date: 26.MAR.2019 15:34:00



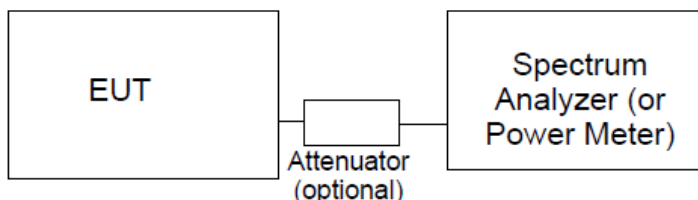
Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power -20dB (dBm)	Margin (dB)
9921.47	-47.69	-14.32	33.37	-34.32	13.37
12397.43	-53.92		39.60		19.60
14884.61	-58.58		44.26		24.26
24125.00	-66.77		52.45		32.45

**11.5 TEST: 100 kHz Bandwidth of Frequency Band Edges****PASS**

Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	21°C
	Relative Humidity (%)	52%
	Air pressure (hPa)	1020
—	Power Supply / Frequency	Application Point
Fully configured sample tested at the power line frequency	5Vdc	RF Connector
Equipment mode:	Operation mode	#1
FCC Standard	§15.247 (D)	

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, 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)).

Further information to test setup (conducted)





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Test Equipment Used

Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
EMI Test Receiver	R&S	ESU 40	2782345	05/2018	05/2019

Test Method Used

According to Par. 8.7.2 (Marker-Delta method) of KDB 558074 D01 15.247 Meas Guidance v05 (and par. 11.13.2 of ANSI C63.10)



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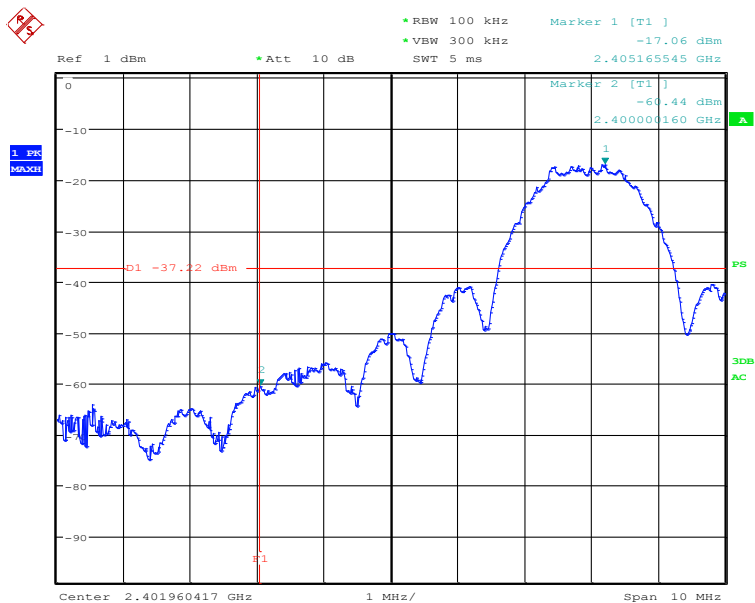


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Graphical representation of 100 kHz Bandwidth of Frequency Band Edges - Conducted

Operation Mode: #1 – Low Channel (2405 MHz)

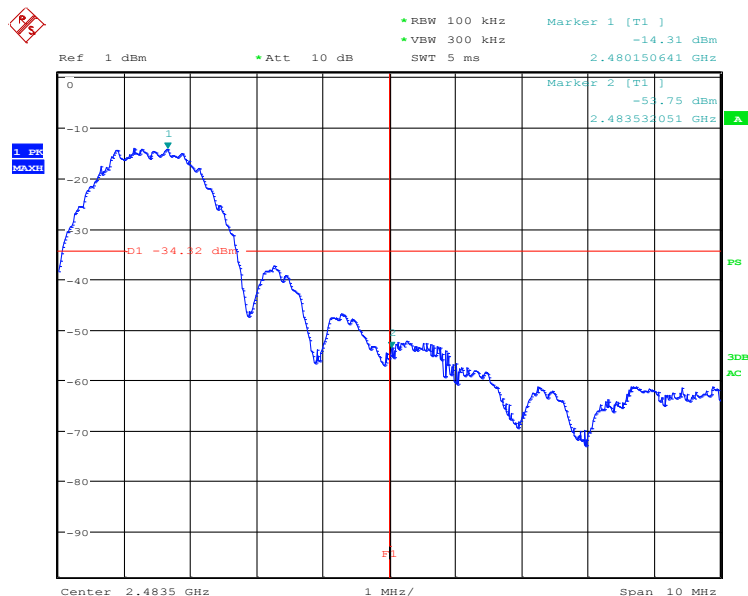


Frequency (MHz)	Measured power at the band edge (dBm)	Measured peak power at fundamental frequency (dBm)	Difference Peak / band edge (dB)	Peak Limit at PK power -20 dB (dBm)	Margin (dB)
2400	-60.44	-17.06	43.38	-37.06	23.38



Graphical representation of 100 kHz Bandwidth of Frequency Band Edges - Conducted

Operation Mode: #1 – High Channel (2480 MHz)



Frequency (MHz)	Measured power at the band edge (dBm)	Measured peak power at fundamental frequency (dBm)	Difference Peak / band edge (dB)	Peak Limit at PK power -20 dB (dBm)	Margin (dB)
2483,5	-53.75	-14.31	39.44	-34.31	19.44



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11.6 TEST: Additional provisions to the general radiated emission limitations.			PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C	
	Relative Humidity (%)	30 to 60 %	
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	24°C	
	Relative Humidity (%)	37%	
	Air pressure (hPa)	1020	
—	Power Supply / Frequency	Application Point	
Fully configured sample tested at the power line frequency	5V dc	-----	
Equipment mode:	Operation mode	#1	
FCC Standard	§15.215 (A) (B) (C)		
(A) The regulations in §§ 15.217-15.257 provide alternatives to the general radiated emission limits for intentional radiators operating in specified frequency bands. Unless otherwise stated, there are no restrictions as to the types of operation permitted under these sections.			
(B) In most cases, unwanted emissions outside of the frequency bands shown in these alternative provisions must be attenuated to the emission limits shown in Section 15.209. In no case shall the level of the unwanted emissions from an intentional radiator operating under these additional provisions exceed the field strength of the fundamental emission.		VERDICT	
		PASS	
(C) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least		VERDICT	
		PASS	



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11.7 TEST: Power Spectral Density			PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C	
	Relative Humidity (%)	30 to 60 %	
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	24°C	
	Relative Humidity (%)	37%	
	Air pressure (hPa)	1020	
—	Power Supply / Frequency	Application Point	
Fully configured sample tested at the power line frequency	5V dc	RF Connector	
Equipment mode:	Operation mode	#1	
FCC Standard	§15.247 (E)		
(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.			
Further information to test setup	<div><div>EUT</div><div><div></div>Attenuator (optional)</div><div>Spectrum Analyzer (or Power Meter)</div></div>		



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Test Equipment Used

Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
EMI Test Receiver	R&S	ESU 40	2782345	05/2018	05/2019

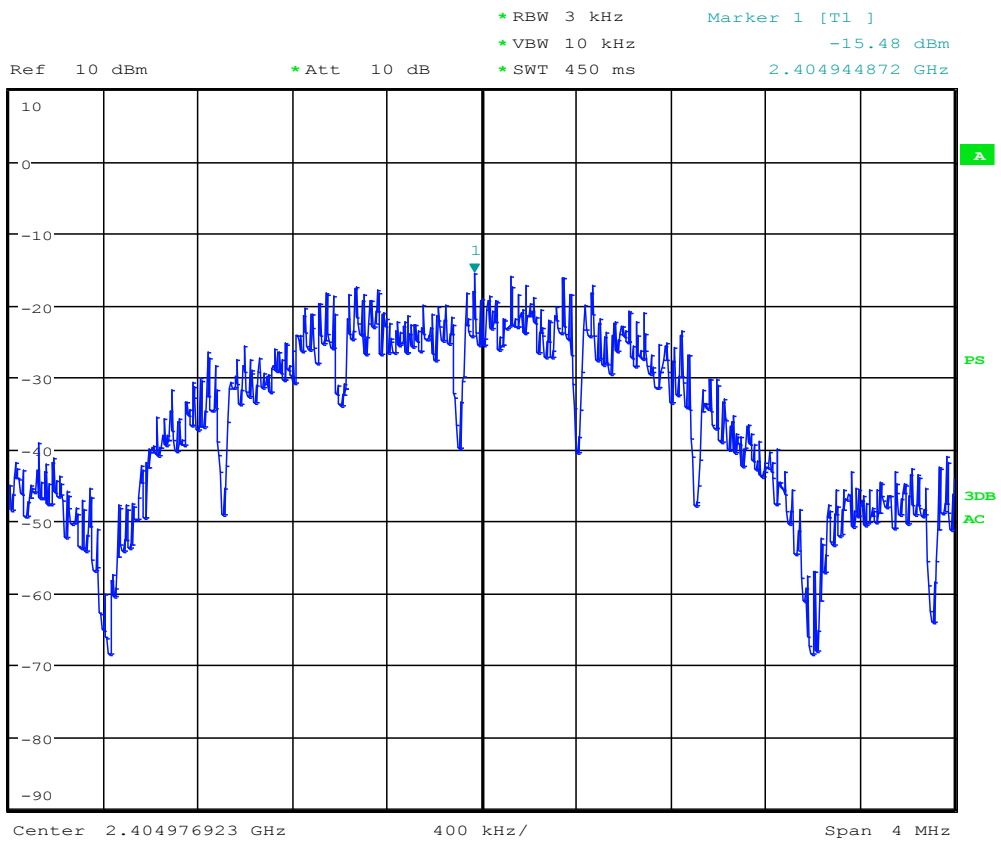
Test Method Used

According to Par. 8.4 of KDB 558074 D01 15.247 Meas Guidance v05 (and par. 11.10.2 Method PKPSD (peak PSD))



Graphical representation of Power Spectral Density

Operation Mode: #1 – Low Channel (2405 MHz)



Channel (No.)	Frequency (MHz)	Conducted Power Spectral Density (dBm)	Limit (dBm)
Low	2405	-15.48	8



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Graphical representation of Power Spectral Density

Operation Mode: #1 – Middle Channel (2445 MHz)

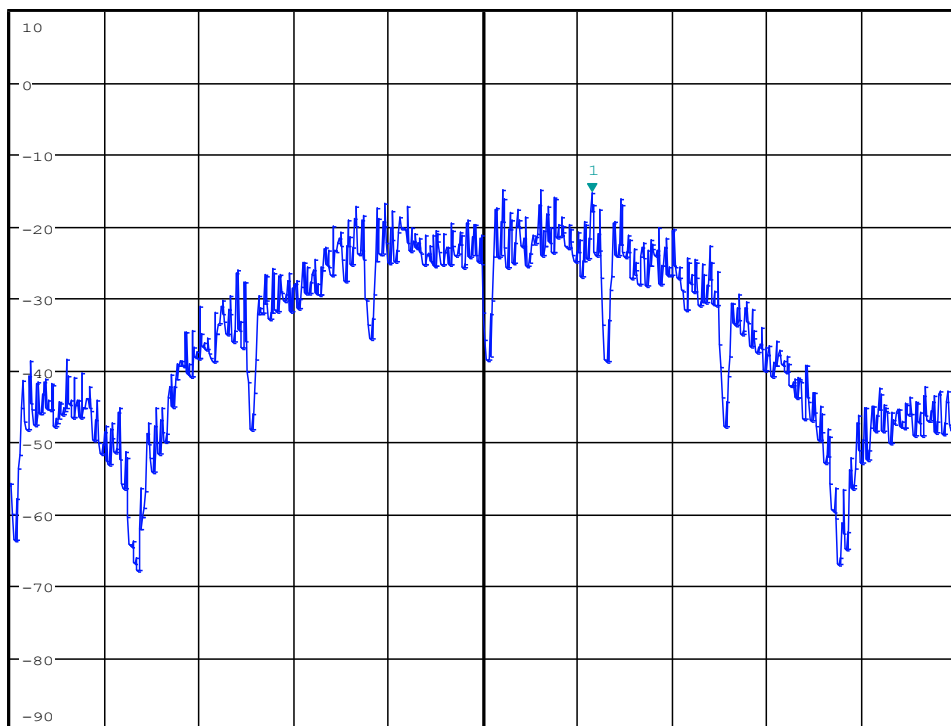


* RBW 3 kHz
* VBW 10 kHz
* SWT 450 ms
Marker 1 [T1]
-15.34 dBm
2.445321282 GHz

Ref 10 dBm

* Att 10 dB

1 PK
MAXH



Center 2.444856923 GHz

400 kHz/

Span 4 MHz

Channel (No.)	Frequency (MHz)	Conducted Power Spectral Density (dBm)	Limit (dBm)
Middle	2445	-15.34	8



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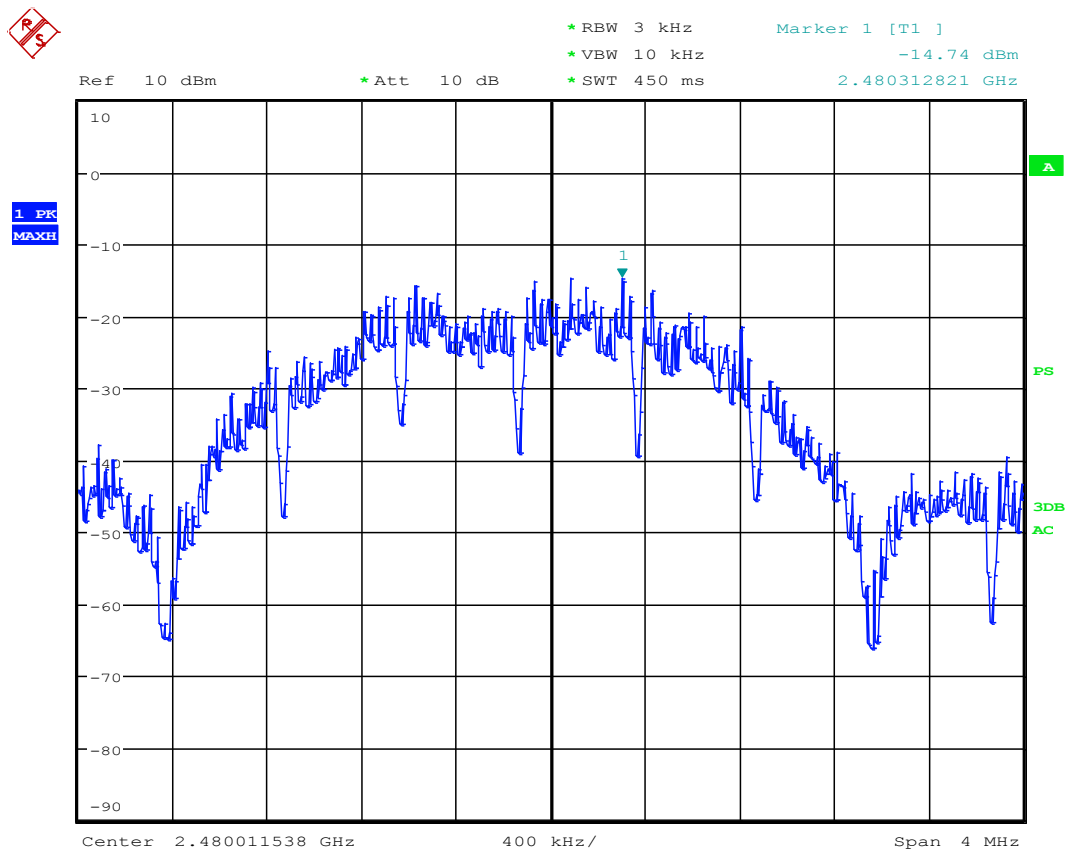


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Graphical representation of Power Spectral Density

Operation Mode: #1 – High Channel (2480 MHz)



Channel (No.)	Frequency (MHz)	Conducted Power Spectral Density (dBm)	Limit (dBm)
High	2480	-14.74	8



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11.8 TEST: RF Exposure Requirements		PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	---
	Relative Humidity (%)	---
	Air pressure (hPa)	1020
—	Power Supply / Frequency	Application Point
Fully configured sample tested at the power line frequency	5V dc	---
Equipment mode:	Operation mode	#1
FCC Standard	47 CFR 2.1093	
Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines 47 CFR 2.1093 - Radiofrequency radiation exposure evaluation: portable devices		
EUT classification (fixed, mobile or portable devices)	Fixed equipment	
Limits Freq. Range 2405÷2480MHz	See next table	

**Appendix A*****SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and ≤ 50 mm***

Approximate SAR Test Exclusion Power Thresholds at Selected Frequencies and Test Separation Distances are illustrated in the following Table. The equation and threshold in 4.3.1 must be applied to determine SAR test exclusion.

MHz	5	10	15	20	25	mm
150	39	77	116	155	194	<i>SAR Test Exclusion Threshold (mW)</i>
300	27	55	82	110	137	
450	22	45	67	89	112	
835	16	33	49	66	82	
900	16	32	47	63	79	
1500	12	24	37	49	61	
1900	11	22	33	44	54	
2450	10	19	29	38	48	
3600	8	16	24	32	40	
5200	7	13	20	26	33	
5400	6	13	19	26	32	
5800	6	12	19	25	31	
MHz	30	35	40	45	50	mm
150	232	271	310	349	387	<i>SAR Test Exclusion Threshold (mW)</i>
300	164	192	219	246	274	
450	134	157	179	201	224	
835	98	115	131	148	164	
900	95	111	126	142	158	
1500	73	86	98	110	122	
1900	65	76	87	98	109	
2450	57	67	77	86	96	
3600	47	55	63	71	79	
5200	39	46	53	59	66	
5400	39	45	52	58	65	
5800	37	44	50	56	62	

Note: 10-g Extremity SAR Test Exclusion Power Thresholds are 2.5 times higher than the 1-g *SAR Test Exclusion Thresholds* indicated above. These thresholds do not apply, by extrapolation or other means, to occupational exposure limits.



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Operating Condition #1						
Frequency	Max Conducted Output Power (P)		Numeric Antenna Gain (G)	Max Radiated Output Power (P)	Separation distance	Exemption Limit (obtained by linear interpolation) (mW)
(MHz)	(dBm)	(mW)	/	(mW)	(mm)	
2405	-1.45	0.72	1,99	1.43	<5	10.10
2445	-1.01	0.79	1,99	1.57	<5	10.03
2480	-0.52	0.89	1,99	1.77	<5	9.97
VERDICT						
SAR evaluation is not required because the output power value is less than exemption limit (separation distance <5mm)						

Note:

$G = \text{Numeric Gain } (10^{(\text{dBi}/10)}) / (10^{(2.98/10)}) = 1.99$



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12. MEASUREMENT UNCERTAINTY

TEST	Expanded uncertainty	Coverage probability	Coverage factor
6 dB minimum Bandwidth	0,25% of reading value	95%	2,3
RF power output (conducted)	1,2 dB	95%	2,2
Out-of-band emissions	1,2 dB	95%	2,2
100 kHz Bandwidth of Frequency Band Edges	1,2 dB	95%	2,2
Power Spectral Density	1,2 dB	95%	2,2



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13. ANNEX

Photographic Documentation

Set-up photo

See Report n° 28113121-001 Annex 1

END OF TEST REPORT