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LAB N° 1356

Test Report

47 CFR FCC Part 15 subpart C Intentional Radiators

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Applicant's name	Flextronics Design S.r.l.
Address	Via Ernesto Breda 176, 20126 Milano (MI) - Italy
Test item description	Insulin injector pen
Trade Mark	LILLY
Manufacturer	Flextronics Design S.r.l.
Model/Type reference	SQUIRE 2.0 E0 Build
FCC ID	2AS69LLY00043845100
Ratings	Internal battery CR1616 3V
Sample	
Samples received on	02/04/2019
TUV reference samples	190295 (sampled by the customer)
Samples tested n.	1 with integral antenna
Testing	
Start Date:	02/04/2019
End Date:	04/04/2019
<i>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</i>	



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RELEASE CONTROL RECORD

Test report Number	Reason of change	Date of Issue
28113143 001	Original release	2019-05-16

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	N.A. ¹
§ 15.209 (a) (f)	Radiated Emission	PASS
§ 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. ²
§ 15.247 (a) (1) (i)	Number of Hopping Channels Used, Carrier frequency Separation and Time occupancy in band 902÷908MHz	N.A. ²
§ 15.247 (a) (1) (ii)	Number of Hopping Channels Used, Carrier frequency Separation and Time occupancy in band 5725÷ 5850 MHz	N.A. ²
§ 15.247 (a) (1) (iii)	Number of Hopping Channels Used, Carrier frequency Separation and Time occupancy in band 2400÷2483,5 MHz	N.A. ²
§ 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. ²
§ 15.247 (b) (2)	Peak Output Power (conducted) in band 902÷908MHz (Hopping systems)	N.A. ²
§ 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. ³
§ 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. ⁴
§ 15.247 (g)	FHSS Transmission characteristics	N.A. ²
§ 15.247 (h)	Recognition of occupied channel and multiple transmission system	N.A. ²
§ 15.247 (i) (§ 47CFR 1.1307(b)(1))	RF humane exposure	PASS

Note 1	Equipment supplied with internal battery; no connection to AC Main Power.
Note 2	Not applicable for DTS equipment
Note 3	Antenna Gain <6dBi
Note 4	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

Insulin injector pen

4. General Chipset information

Chipset type: Nordic semiconductor Type nRF52832

General information:

2.4 GHz transceiver

- -96 dBm sensitivity in *Bluetooth®* low energy mode
- Supported data rates: 1 Mbps, 2 Mbps *Bluetooth®* low energy mode
- -20 to +4 dBm TX power, configurable in 4 dB steps
- On-chip balun (single-ended RF)
- 5.3 mA peak current in TX (0 dBm)
- 5.4 mA peak current in RX
- RSSI (1 dB resolution)
- ARM® Cortex®-M4 32-bit processor with FPU, 64 MHz
- 215 EEMBC CoreMark® score running from flash memory
- 58 µA/MHz running from flash memory
- 51.6 µA/MHz running from RAM
- Data watchpoint and trace (DWT), embedded trace macrocell (ETM), and instrumentation trace macrocell (ITM)
- Serial wire debug (SWD)
- Trace port
- Flexible power management
- 1.7 V–3.6 V supply voltage range
- Fully automatic LDO and DC/DC regulator system
- Fast wake-up using 64 MHz internal oscillator
- 0.3 µA at 3 V in System OFF mode
- 0.7 µA at 3 V in System OFF mode with full 64 kB RAM retention
- 1.9 µA at 3 V in System ON mode, no RAM retention, wake on RTC

• Memory

- 512 kB flash/64 kB RAM
- 256 kB flash/32 kB RAM
- Nordic SoftDevice ready
- Support for concurrent multi-protocol
- Type 2 near field communication (NFC-A) tag with wakeup-on-field and touch-to-pair capabilities
- 12-bit, 200 ksp/s ADC - 8 configurable channels with programmable gain
- 64 level comparator
- 15 level low power comparator with wakeup from System OFF mode
- Temperature sensor
- 32 general purpose I/O pins
- 3x 4-channel pulse width modulator (PWM) unit with EasyDMA
- Digital microphone interface (PDM)
- 5x 32-bit timer with counter mode
- Up to 3x SPI master/slave with EasyDMA
- Up to 2x I2C compatible 2-wire master/slave
- I2S with EasyDMA
- UART (CTS/RTS) with EasyDMA

EasyDMA

- 3x real-time counter (RTC)
- Single crystal operation
- Package variants
- QFN48 package, 6 × 6 mm
- WLCSP package, 3.0 × 3.2 mm

5. General Antennas information

2.4 GHz Surface Mount, Above Metal, Low Profile Mini Chip Antenna
Johanson Technology mod. 2450AT42E0100E; Peak Gain: -2.0 dBi typ.



6. Equipment Used During Test

Use*	Product Type	Manufacturer	Model	Comments
EUT	Insulin injector pen	FLEXTRONICS	SQUIRE 2.0 E0 Build	---
AE	PC	---	---	Software "test suite v.0.1.13" by Flextronics, used to set Bluetooth Module

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	Pressure
2	AC Power Port	Port not present	
3	DC Power Port	DC	Internal battery 3,0V

*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 (W)	Frequency (DC/AC-Hz)	Phases (#)	Comments
Rated	3,0	---	---	DC	---	---



9. EUT Operation Modes

Operation mode	Description
#1	Continuous BLE Modulation RF Transmission (DTS) RF setting during tests: Frequency: 2402MHz (low channel); 2440MHz (mid channel); 2480MHz (high channel); Data rate 2Mbit/s Power setting: Max Power (0dBm) Duty cycle: 100%

BLE frequency (Transmission) DTS – Declared by applicant

Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
00	2402 MHz	01	2404 MHz	02	2406 MHz	03	2408 MHz
04	2410 MHz	05	2412 MHz	06	2414 MHz	07	2416 MHz
08	2418 MHz	09	2420 MHz	10	2422 MHz	11	2424 MHz
12	2426 MHz	13	2428 MHz	14	2430 MHz	15	2432 MHz
16	2434 MHz	17	2436 MHz	18	2438 MHz	19	2440 MHz
20	2442 MHz	21	2444 MHz	22	2446 MHz	23	2448 MHz
24	2450 MHz	25	2452 MHz	26	2454 MHz	27	2456 MHz
28	2458 MHz	29	2460 MHz	30	2462 MHz	31	2464 MHz
32	2466 MHz	33	2468 MHz	34	2470 MHz	35	2472 MHz
36	2474 MHz	37	2476 MHz	38	2478 MHz	39	2480 MHz

**10. EUT Configuration Modes****Description**

SQUIRE 2.0 E0 Build supplied with internal battery (fully charged)

Par.	test	EUT Operation Modes
§ 15.203 § 15.247 (b) (4) (i)	Antenna Requirements	#1
§ 15.209 (a) (f)	Radiated Emission 9kHz-30MHz	#1
§ 15.209 (a) (f)	Radiated Emission 30MHz-1GHz	#1
§ 15.209 (a) (f)	Radiated Emission 1GHz-3GHz	#1
§ 15.209 (a) (f)	Radiated Emission 3GHz-25GHz	#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

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 (dBμV)

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 (dBuV/m)

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

**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	+3,0V dc	Enclosure
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	Mini Chip Antenna	
Maximum total gain	-2.0 dBi	
External power amplifiers	Not present	

**11.2 TEST: Radiated Emission****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 (%)	54%
	Air pressure (hPa)	1020
—	Power Supply / Frequency	Application Point
Fully configured sample tested at the power line frequency	+3,0V dc	Enclosure
Equipment mode:	Operation mode	#1
FCC Standard	§15.205; §15.209; §15.247	

Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table :

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

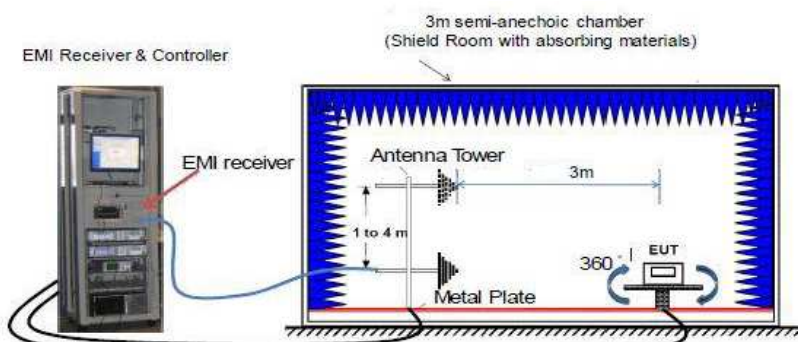
Remark: In accordance with part 15.31 (f) (2), where the measurement distance was specified to be 30 or 300 meters, a correction factor was applied in order to permit measurement to be performed at a separation distance. The applied formula for limits at 3 meter is:

Limit 3m(dBµV/m)=Limit 300m(dBµV/m)+40Log(300m/3m) (Below 30MHz)

Limit 3m(dBµV/m)=Limit 300m(dBµV/m)+40Log(30m/3m) (Below 30MHz)

Further information to test setup.

For frequencies above 1GHz, the anechoic material is also placed on the metallic floor between EUT and Antenna





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Test Equipment Used					
Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
CSSA	ETS Lindgren	FACT3	2926063	05/2017	05/2019
EMI Test Receiver	R&S	ESW 44	2782867	07/2018	07/2019
Loop Antenna	EMCO	6512	2782356	02/2017	02/2020
Antenna BiConiLog	ETS Lindgren	3124E-PA	2782348	04/2017	04/2020
Antenna Horn with Preamplifier	ETS Lindgren	3117-PA	2782349	04/2017	04/2020
Antenna Horn	ETS Lindgren	114514	2782350	05/2017	05/2020

Test Method Used
According to Par. 8.6 of KDB 558074 D01 15.247 Meas Guidance v05 (and par. 11.12.1 Radiated emission measurements of ANSI C63.10)

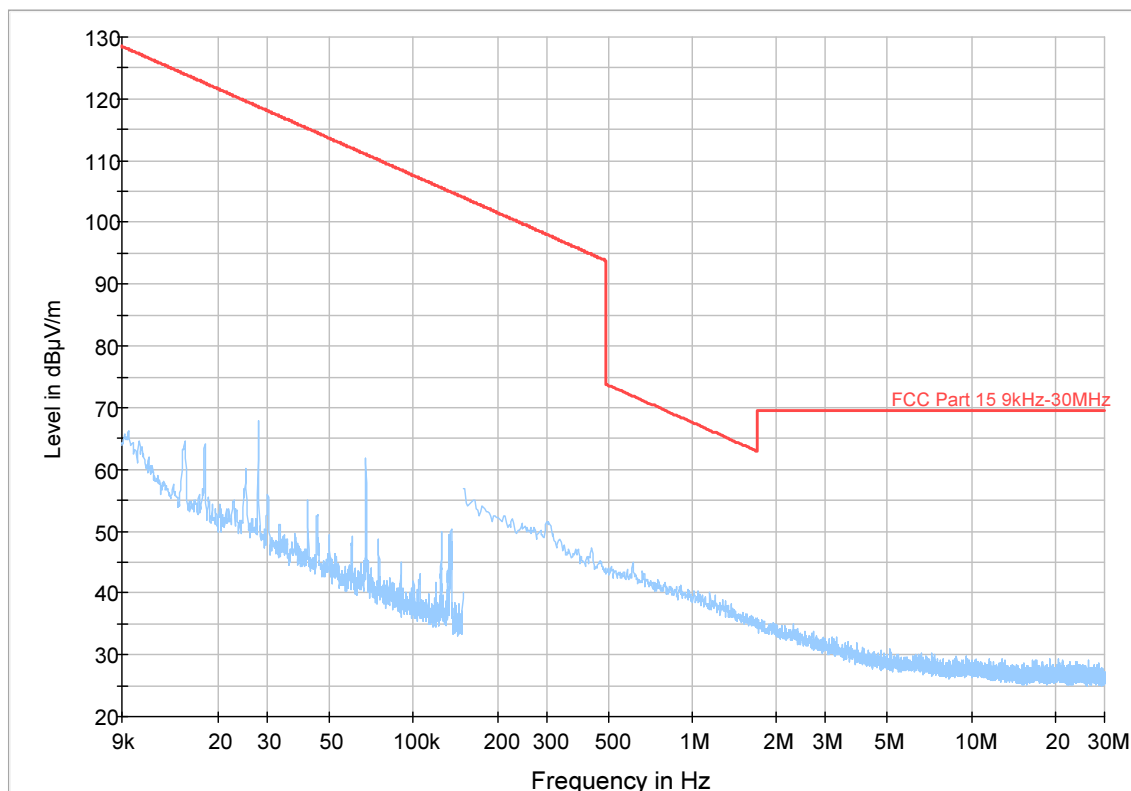


Graphical representation of Radiated Emission Measurement

Operation Mode: #1 – Low Channel (2402 MHz) – 2Mbit/s

Frequency: 9kHz – 30MHz

Full Spectrum



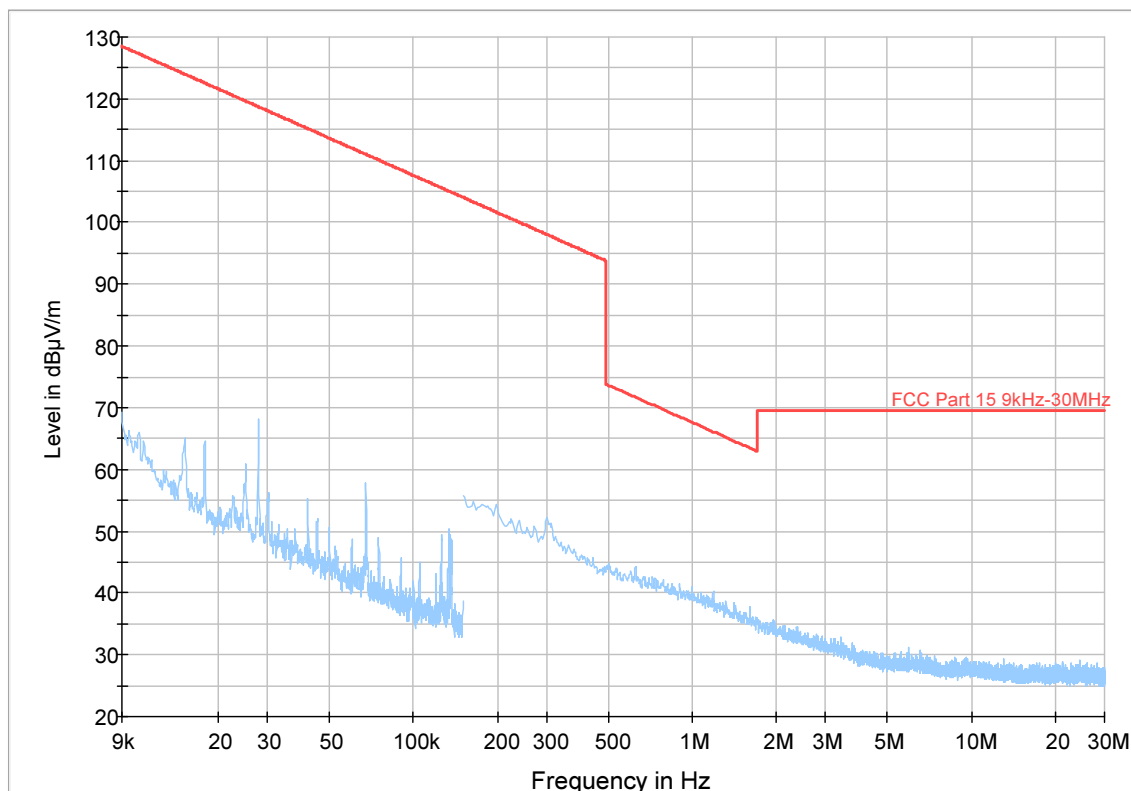


Graphical representation of Radiated Emission Measurement

Operation Mode: #1 – Middle Channel (2440 MHz) – 2Mbit/s

Frequency: 9kHz – 30MHz

Full Spectrum



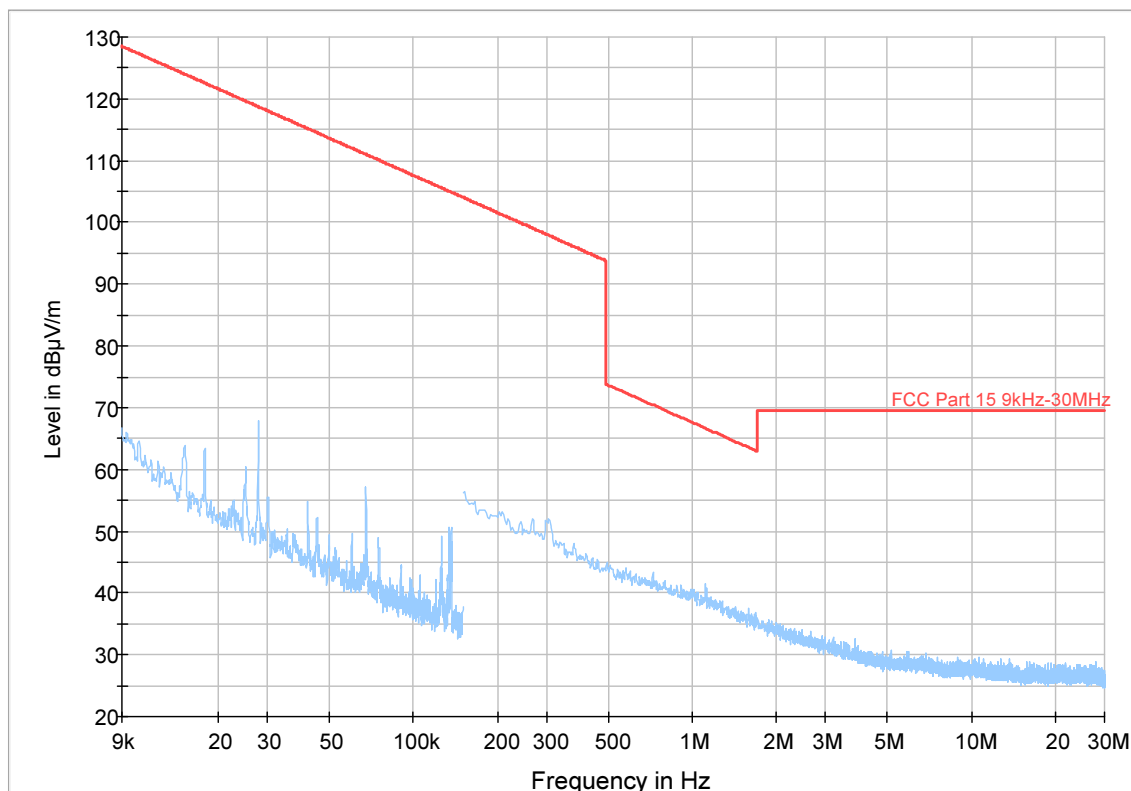


Graphical representation of Radiated Emission Measurement

Operation Mode: #1 – High Channel (2480 MHz) – 2Mbit/s

Frequency: 9kHz – 30MHz

Full Spectrum





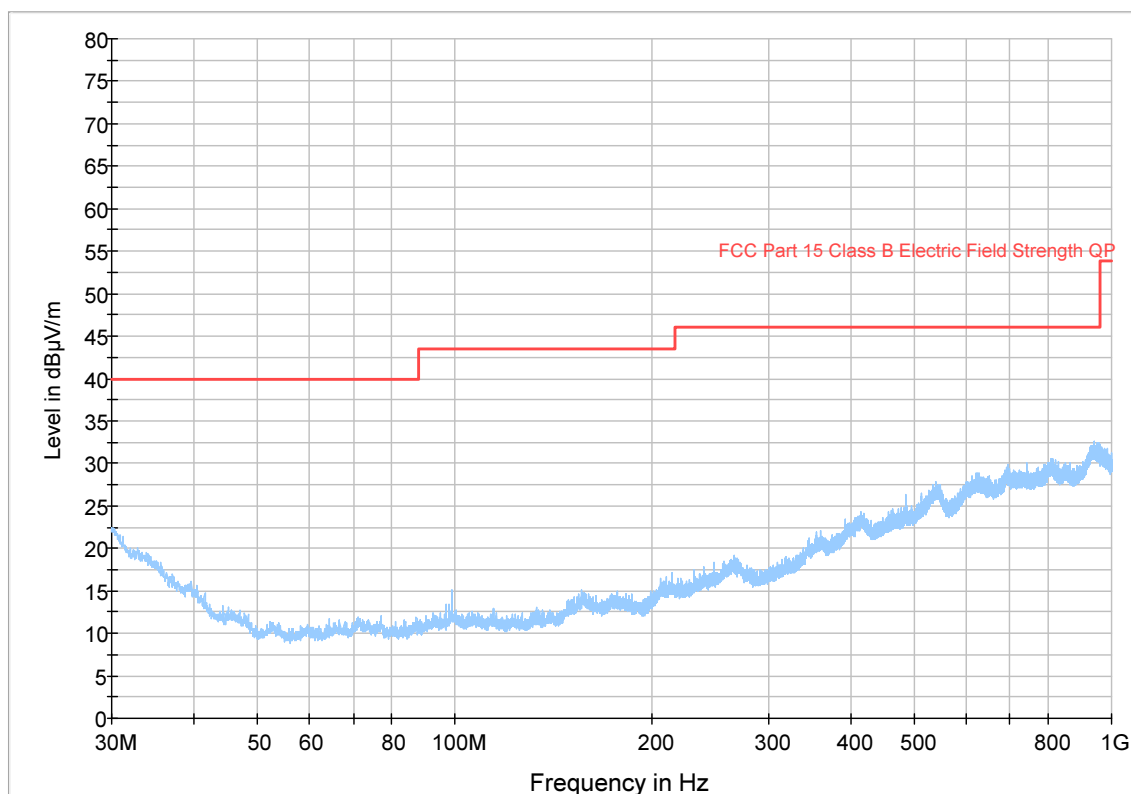
Graphical representation of Radiated Emission Measurement

Operation Mode: #1 – Low Channel (2402 MHz) – 2Mbit/s

Frequency: 30MHz – 1GHz

Note: worst case with EUT on X,Y and Z axis

Full Spectrum





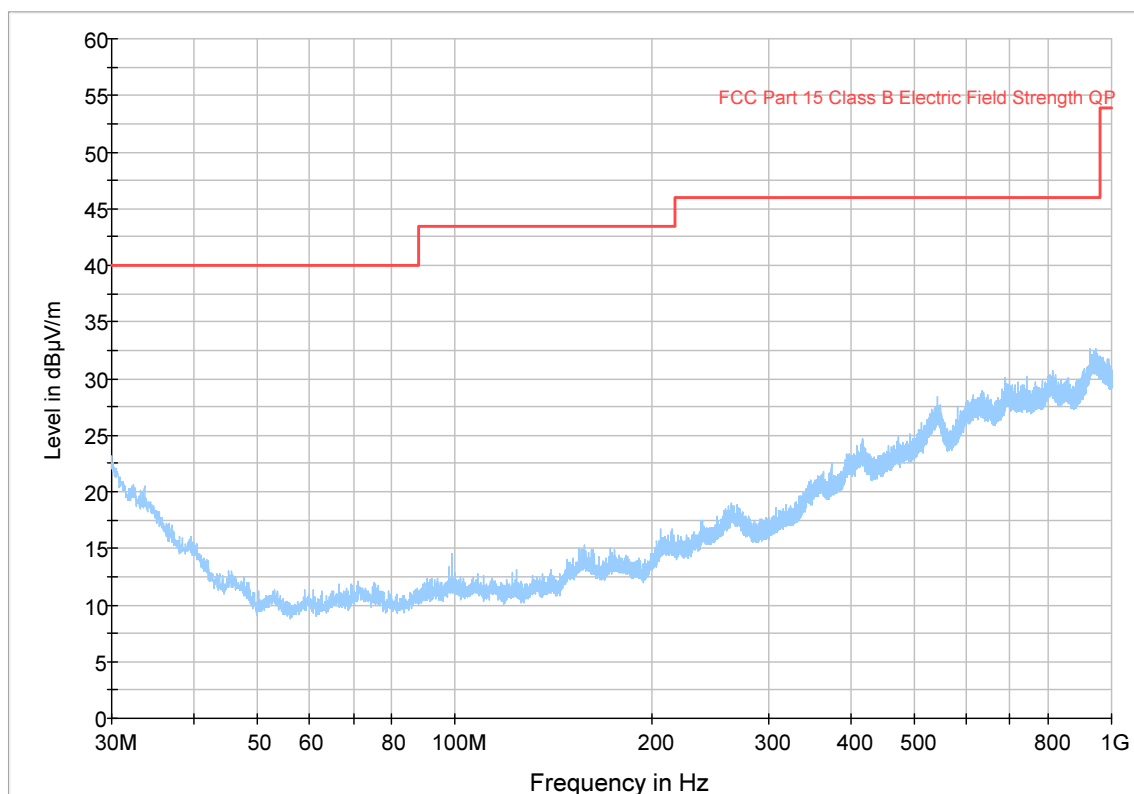
Graphical representation of Radiated Emission Measurement

Operation Mode: #1 – Middle Channel (2440 MHz) – 2Mbit/s

Frequency: 30MHz – 1GHz

Note: worst case with EUT on X,Y and Z axis

Full Spectrum





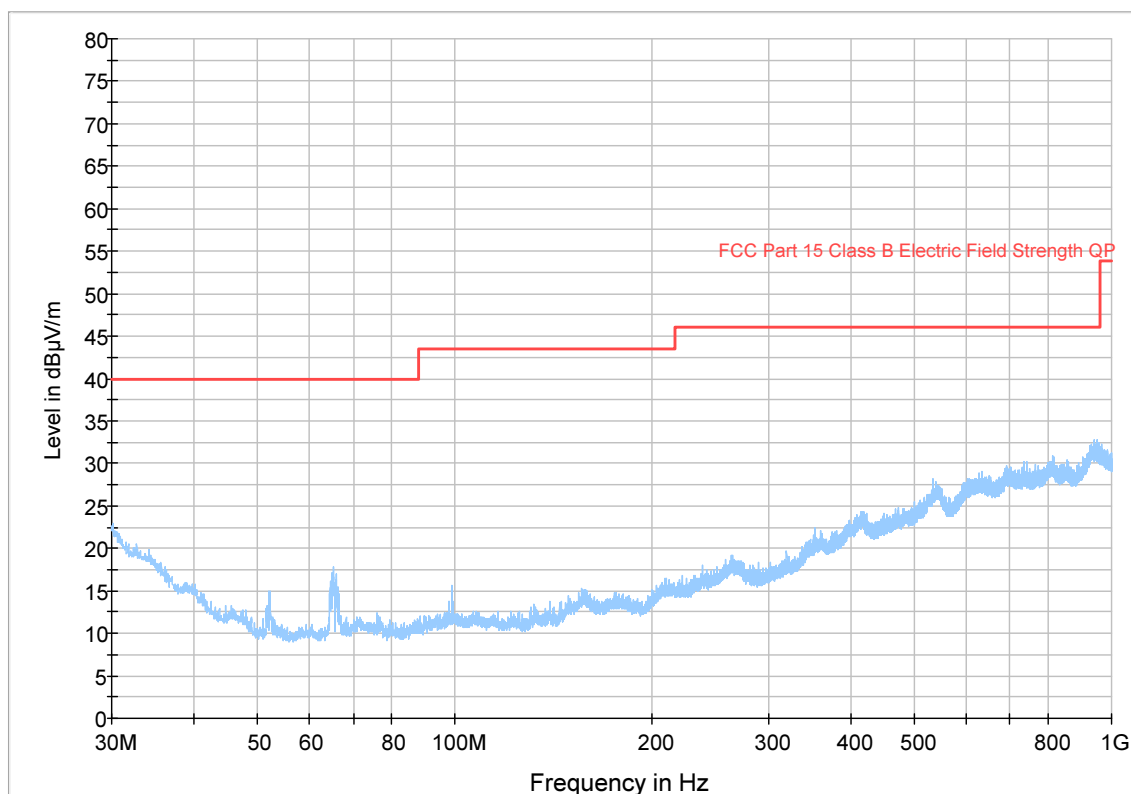
Graphical representation of Radiated Emission Measurement

Operation Mode: #1 – High Channel (2480 MHz) – 2Mbit/s

Frequency: 30MHz – 1GHz

Note: worst case with EUT on X,Y and Z axis

Full Spectrum





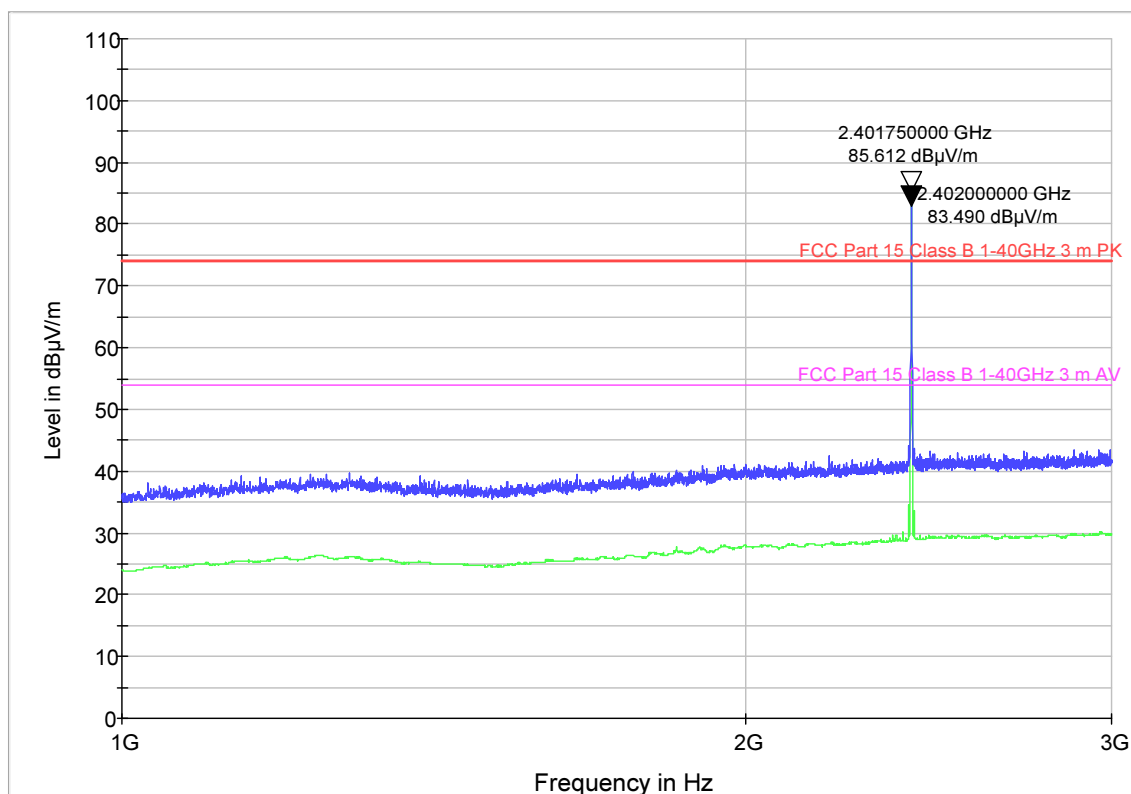
Graphical representation of Radiated Emission Measurement

Operation Mode: #1 – Low Channel (2402 MHz) – 2Mbit/s

Frequency: 1GHz – 3GHz

Note: worst case with EUT on X,Y and Z axis

Electric Field Strength 1-6GHz FCC



PEAK RESULT (RBW=1MHz)

Frequency	Reading value	Antenna Factor with Pre-Amp.	Cable Loss	Correcting reading	Restricted band	PK Limit (AV Limit + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dBµV/m)	/	(dBµV/m)	(dB)
2402 Fundamental	94,45	-12,41	3,57	85,61	---	---	---

AVERAGE RESULT (RBW=1MHz)

Frequency	Reading value	Antenna Factor with Pre-Amp.	Cable Loss	Correcting reading	Restricted band	AV Limit	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dBµV/m)	/	(dBµV/m)	(dB)
2402 Fundamental	92,33	-12,41	3,57	83,49	---	---	---



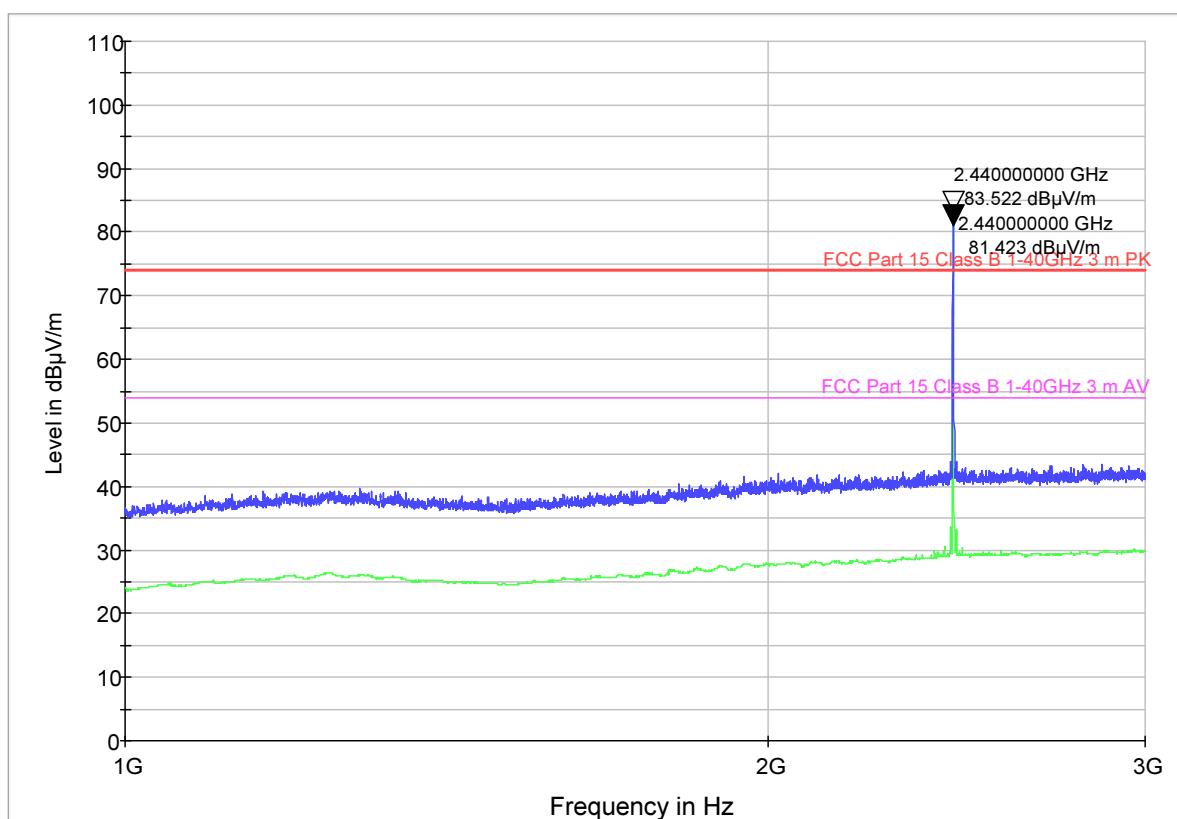
Graphical representation of Radiated Emission Measurement

Operation Mode: #1 – Middle Channel (2440 MHz) – 2Mbit/s

Frequency: 1GHz – 3GHz

Note: worst case with EUT on X,Y and Z axis

Electric Field Strength 1-6GHz FCC



PEAK RESULT (RBW=1MHz)

Frequency	Reading value	Antenna Factor with Pre-Amp.	Cable Loss	Correcting reading	Restricted band	PK Limit (AV Limit + 20dB)	Margin
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)	/	(dBμV/m)	(dB)
2440 Fundamental	92,21	-12,28	3,59	83,52	---	---	---

AVERAGE RESULT (RBW=1MHz)

Frequency	Reading value	Antenna Factor with Pre-Amp.	Cable Loss	Correcting reading	Restricted band	AV Limit	Margin
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)	/	(dBμV/m)	(dB)
2440 Fundamental	90,11	-12,28	3,59	81,42	---	---	---



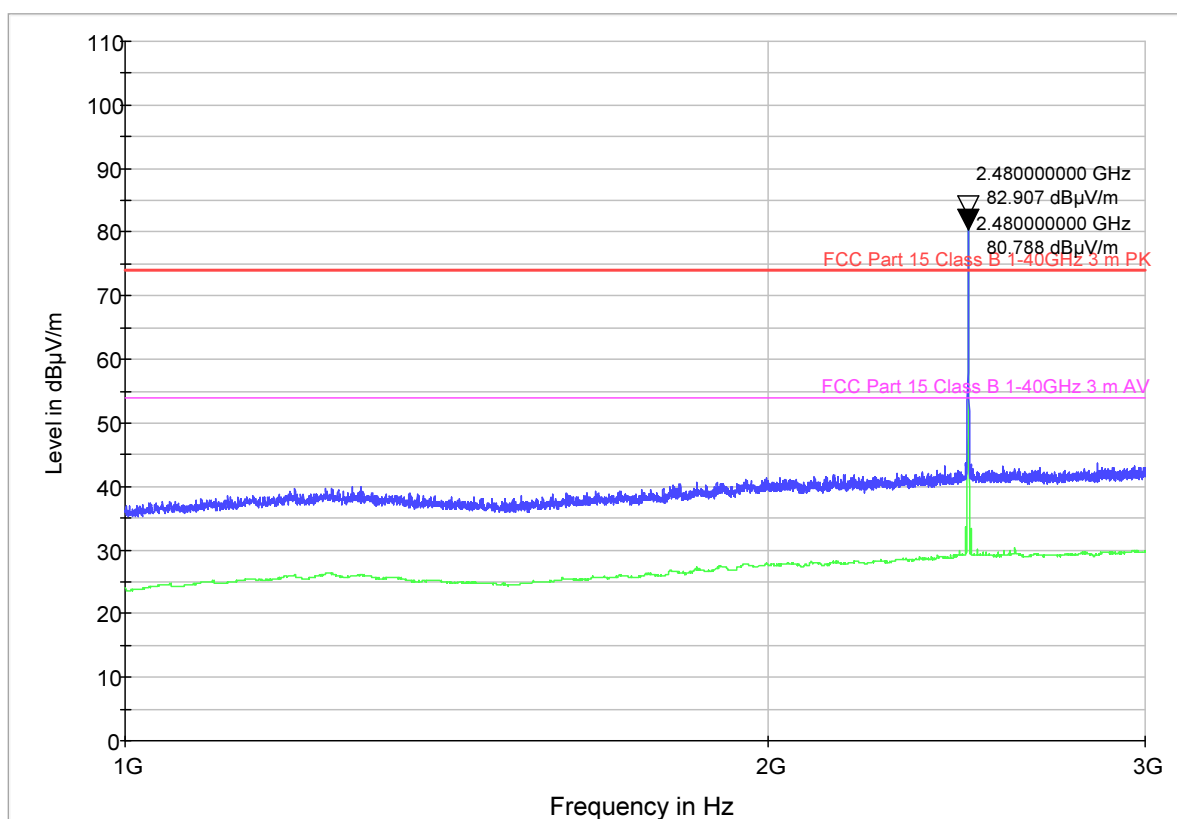
Graphical representation of Radiated Emission Measurement

Operation Mode: #1 – High Channel (2480 MHz) – 2Mbit/s

Frequency: 1GHz – 3GHz

Note: worst case with EUT on X,Y and Z axis

Electric Field Strength 1-6GHz FCC



PEAK RESULT (RBW=1MHz)

Frequency	Reading value	Antenna Factor with Pre-Amp.	Cable Loss	Correcting reading	Restricted band	PK Limit (AV Limit + 20dB)	Margin
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)	/	(dBμV/m)	(dB)
2480 Fundamental	91,43	-12,15	3,62	82,90	---	---	---

AVERAGE RESULT (RBW=1MHz)

Frequency	Reading value	Antenna Factor with Pre-Amp.	Cable Loss	Correcting reading	Restricted band	AV Limit	Margin
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)	/	(dBμV/m)	(dB)
2480 Fundamental	89,31	-12,15	3,62	80,78	---	---	---



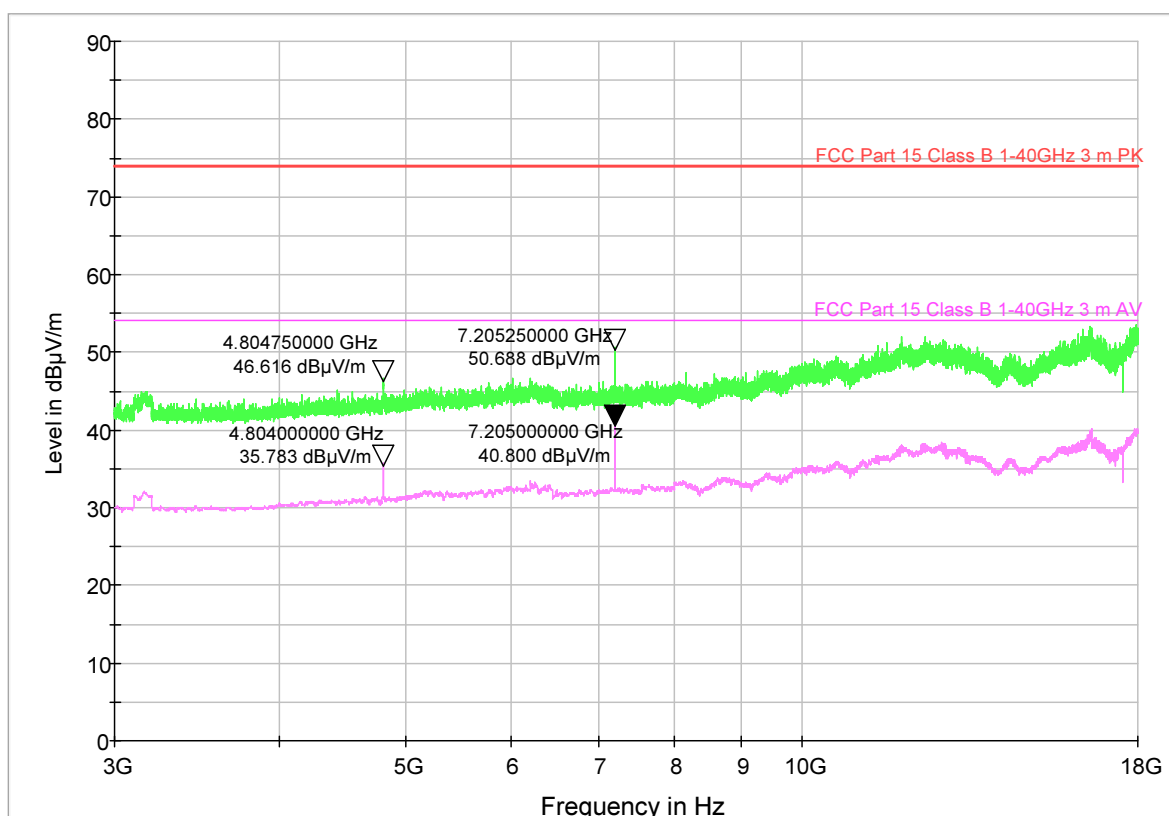
Graphical representation of Radiated Emission Measurement

Operation Mode: #1 – Low Channel (2402 MHz) – 2Mbit/s

Frequency: 3GHz – 18GHz

Note: worst case with EUT on X,Y and Z axis

Electric Field Strength 1-18GHz





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PEAK RESULT (RBW=1MHz)							
Frequency	Reading value	Antenna Factor with Pre-Amp.	Cable Loss	Correcting reading	Restricted band	PK Limit (AV Limit + 20dB)	Margin
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)	/	(dBμV/m)	(dB)
4804,75	50,93	-9,53	5,21	46,61	yes	74,00	27,39
7205,25	52,54	-8,35	6,49	50,68	no	74,00	23,32

AVERAGE RESULT (RBW=1MHz)							
Frequency	Reading value	Antenna Factor with Pre-Amp.	Cable Loss	Correcting reading	Restricted band	AV Limit	Margin
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)	/	(dBμV/m)	(dB)
4804,75	40,10	-9,53	5,21	35,78	yes	54,00	18,22
7205,25	42,66	-8,35	6,49	40,80	no	54,00	13,20



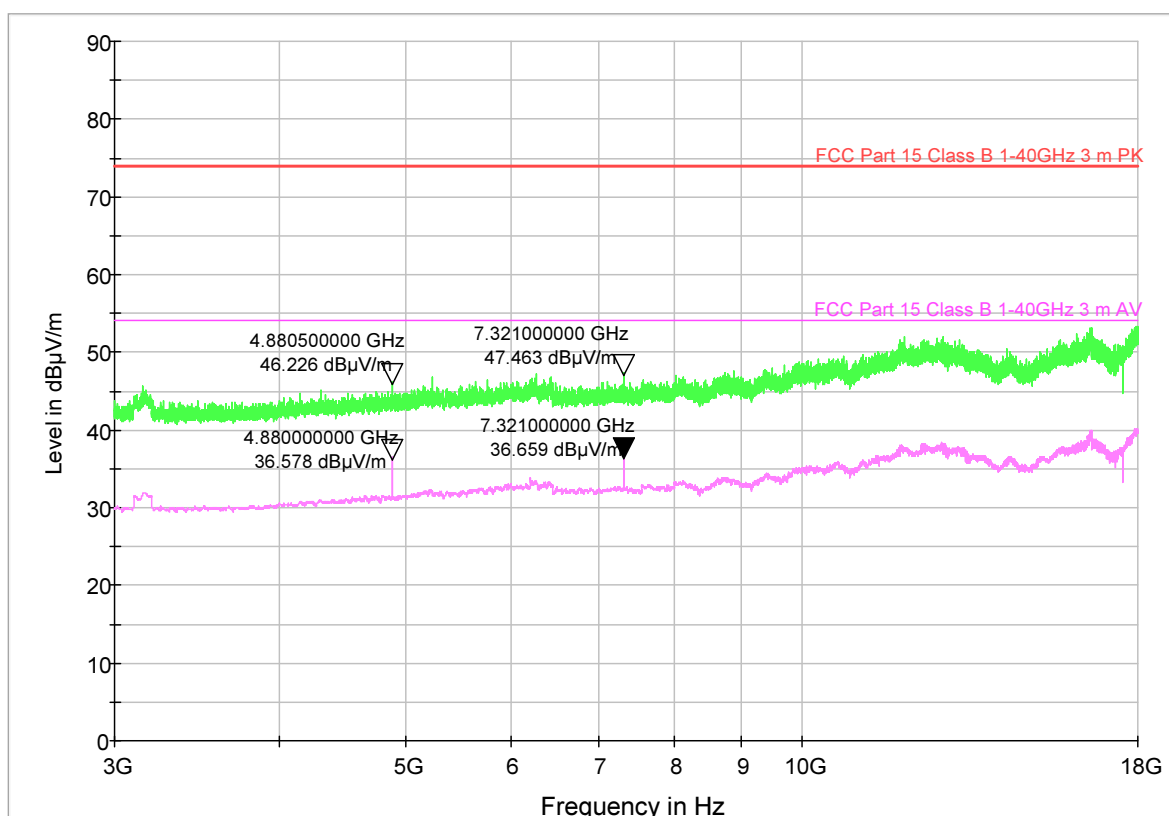
Graphical representation of Radiated Emission Measurement

Operation Mode: #1 – Middle Channel (2440 MHz) – 2Mbit/s

Frequency: 3GHz – 18GHz

Note: worst case with EUT on X,Y and Z axis

Electric Field Strength 1-18GHz





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PEAK RESULT (RBW=1MHz)							
Frequency	Reading value	Antenna Factor with Pre-Amp.	Cable Loss	Correcting reading	Restricted band	PK Limit (AV Limit + 20dB)	Margin
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)	/	(dBμV/m)	(dB)
4880,50	50,46	-9,50	5,26	46,22	yes	74,00	27,78
7321,00	49,36	-8,43	6,53	47,46	yes	74,00	26,54

AVERAGE RESULT (RBW=1MHz)							
Frequency	Reading value	Antenna Factor with Pre-Amp.	Cable Loss	Correcting reading	Restricted band	AV Limit	Margin
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)	/	(dBμV/m)	(dB)
4880,00	40,81	-9,50	5,26	36,57	yes	54,00	17,43
7321,00	38,56	-8,43	6,53	36,66	yes	54,00	17,34



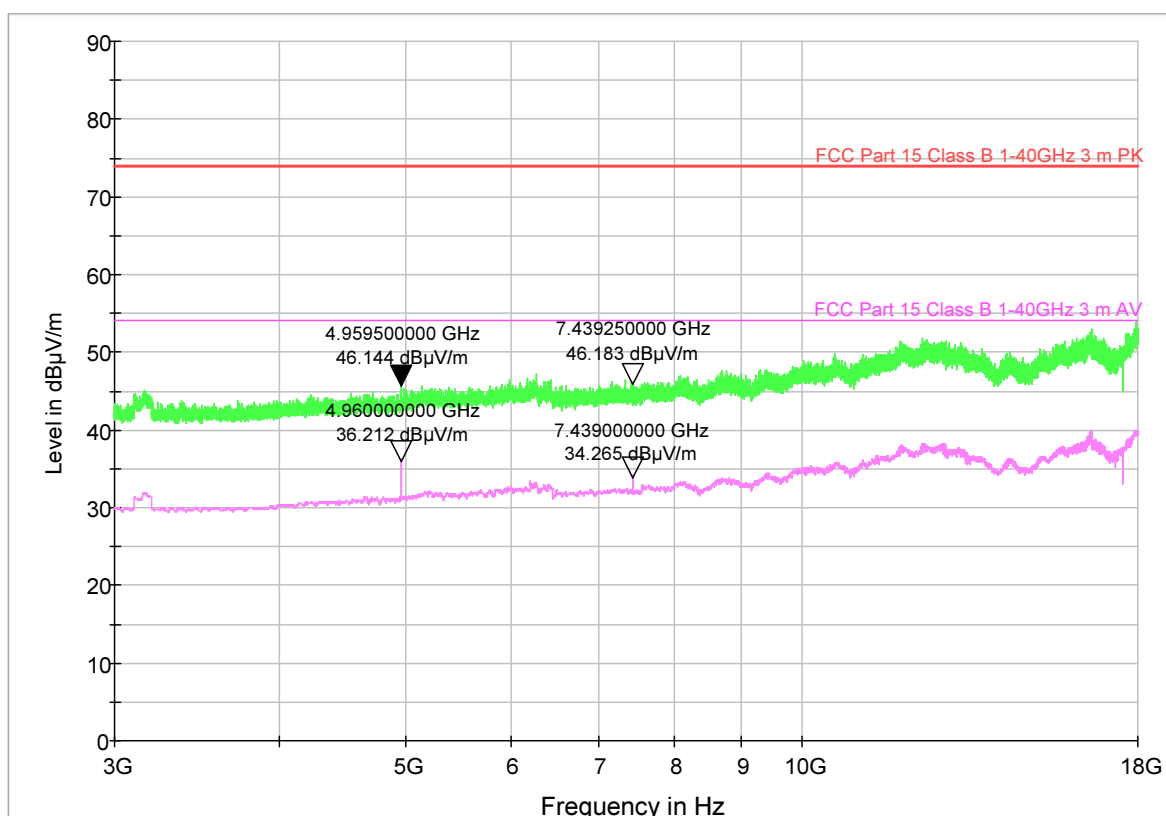
Graphical representation of Radiated Emission Measurement

Operation Mode: #1 – High Channel (2480 MHz) – 2Mbit/s

Frequency: 3GHz – 18GHz

Note: worst case with EUT on X,Y and Z axis

Electric Field Strength 1-18GHz





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PEAK RESULT (RBW=1MHz)							
Frequency	Reading value	Antenna Factor with Pre-Amp.	Cable Loss	Correcting reading	Restricted band	PK Limit (AV Limit + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dBµV/m)	/	(dBµV/m)	(dB)
4959,50	50,29	-9,46	5,31	46,14	yes	74,00	27,86
7439,25	48,15	-8,54	6,57	46,18	yes	74,00	27,82

AVERAGE RESULT (RBW=1MHz)							
Frequency	Reading value	Antenna Factor with Pre-Amp.	Cable Loss	Correcting reading	Restricted band	AV Limit	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dBµV/m)	/	(dBµV/m)	(dB)
4960,00	40,36	-9,46	5,31	36,21	yes	54,00	17,79
7439,00	36,23	-8,54	6,57	34,26	yes	54,00	19,74



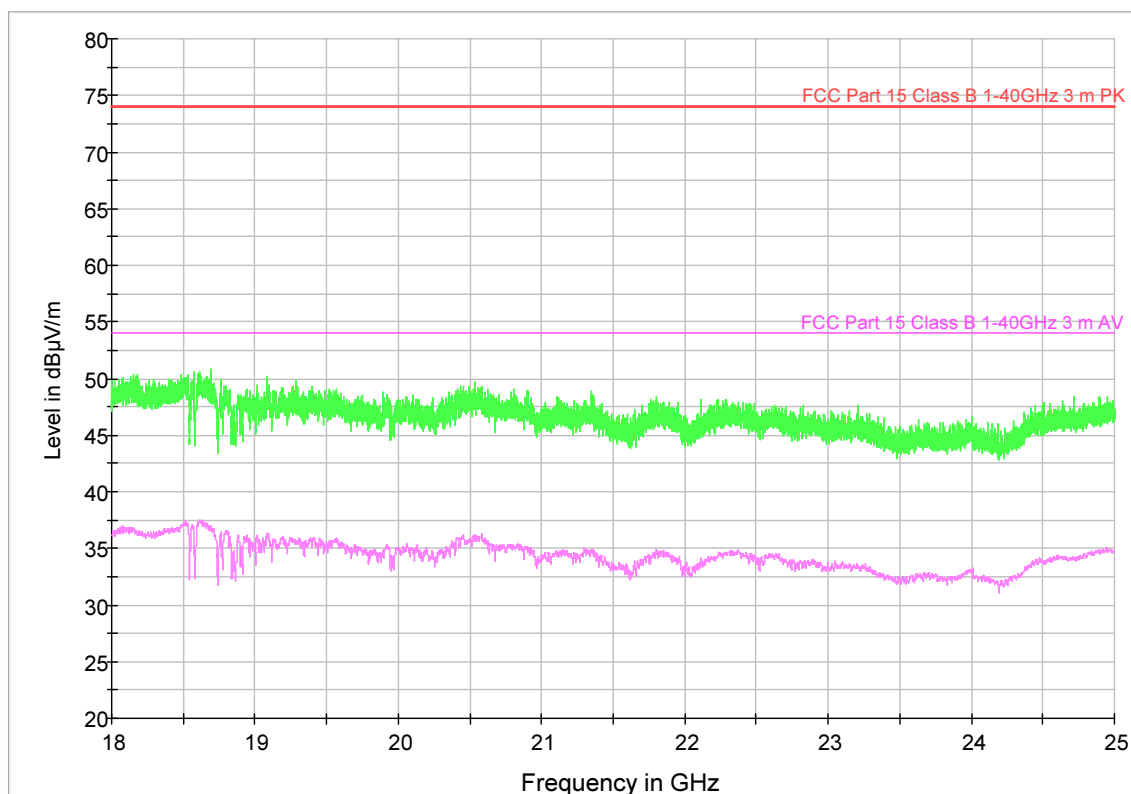
Graphical representation of Radiated Emission Measurement

Operation Mode: #1 – Low Channel (2402 MHz) – 2Mbit/s

Frequency: 18GHz – 25GHz

Note: worst case with EUT on X,Y and Z axis

Electric Field Strength 18-26.5GHz





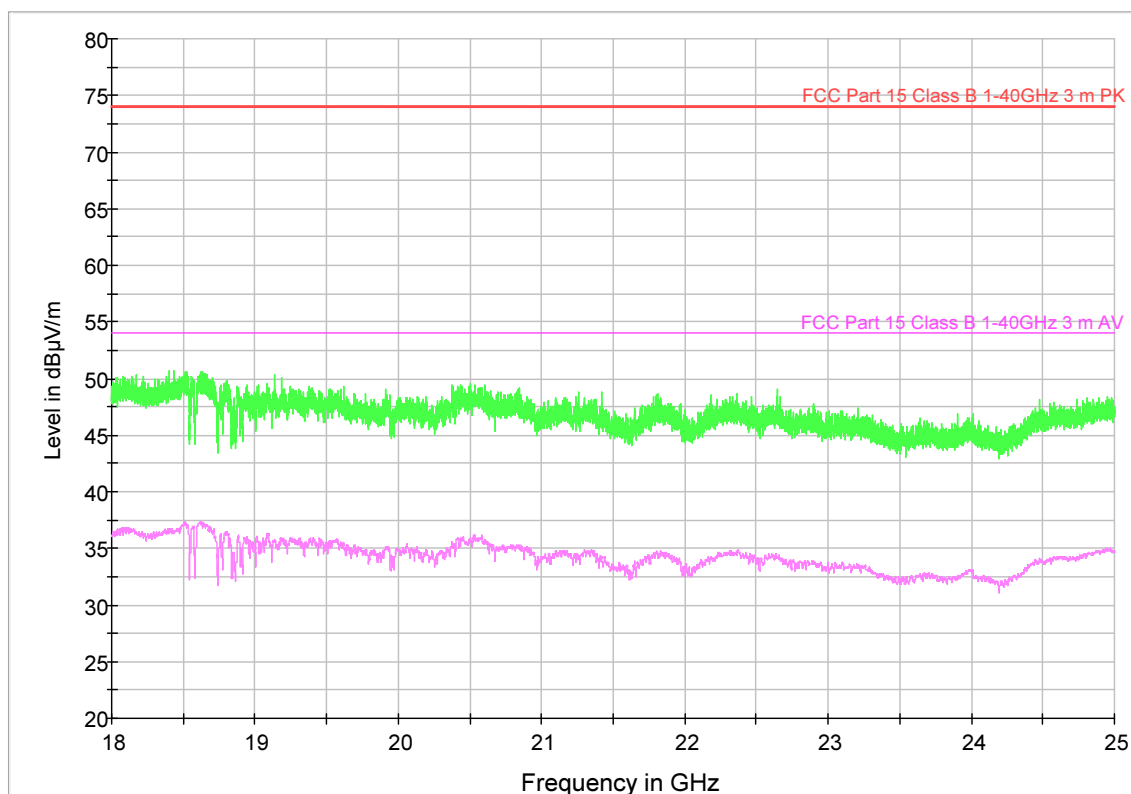
Graphical representation of Radiated Emission Measurement

Operation Mode: #1 – Middle Channel (2440 MHz) – 2Mbit/s

Frequency: 18GHz – 25GHz

Note: worst case with EUT on X,Y and Z axis

Electric Field Strength 18-26.5GHz





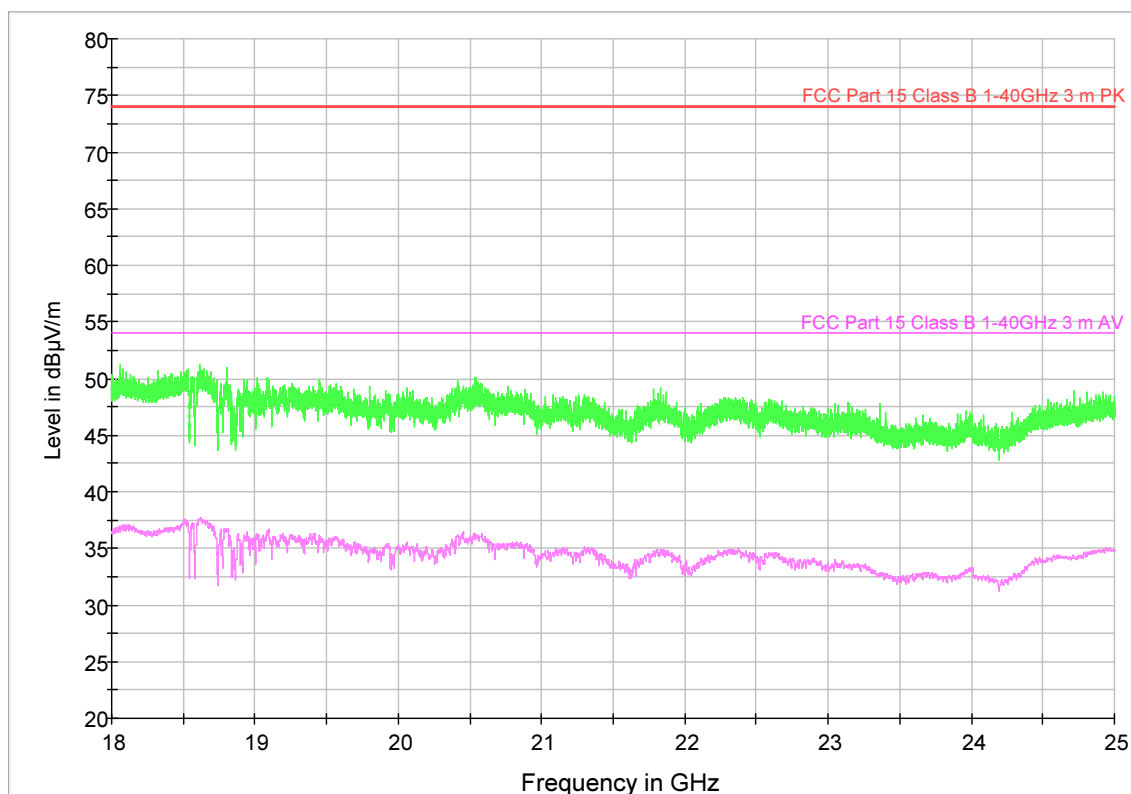
Graphical representation of Radiated Emission Measurement

Operation Mode: #1 – High Channel (2480 MHz) – 2Mbit/s

Frequency: 18GHz – 25GHz

Note: worst case with EUT on X,Y and Z axis

Electric Field Strength 18-26.5GHz





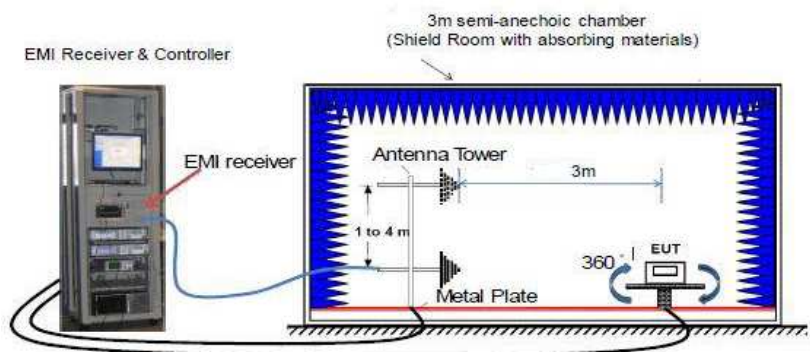
12.3 TEST: 6dB Bandwidth

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	+3,0V dc	Enclosure
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.
For frequencies above 1GHz, the anechoic material is also placed on the metallic floor between EUT and Antenna





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Test Equipment Used

Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
CSSA	ETS Lindgren	FACT3	2926063	05/2017	05/2019
EMI Test Receiver	R&S	ESW 44	2782867	07/2018	07/2019
Antenna Horn with Preamplifier	ETS Lindgren	3117-PA	2782349	04/2017	04/2020

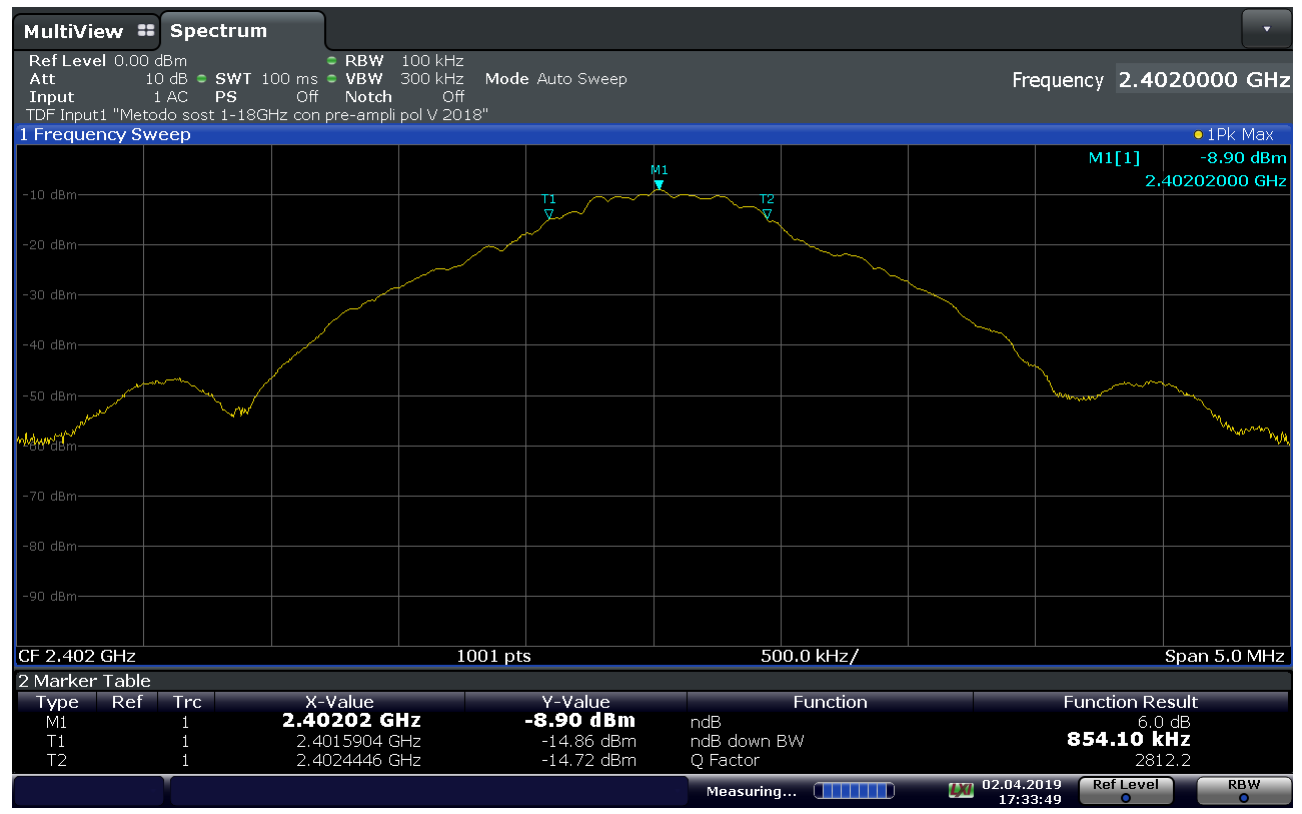
Test Method Used

According to Par. 8.2 of KDB 558074 D01 15.247 Meas Guidance v05 (and par. 11.8.1 Option 2 of ANSI C63.10)



Graphical representation of 6dB Bandwidth

Operation Mode: #1 – Low Channel (2402 MHz)



Graphical representation of 6dB Bandwidth

Operation Mode: #1 – Low Channel (2402 MHz)

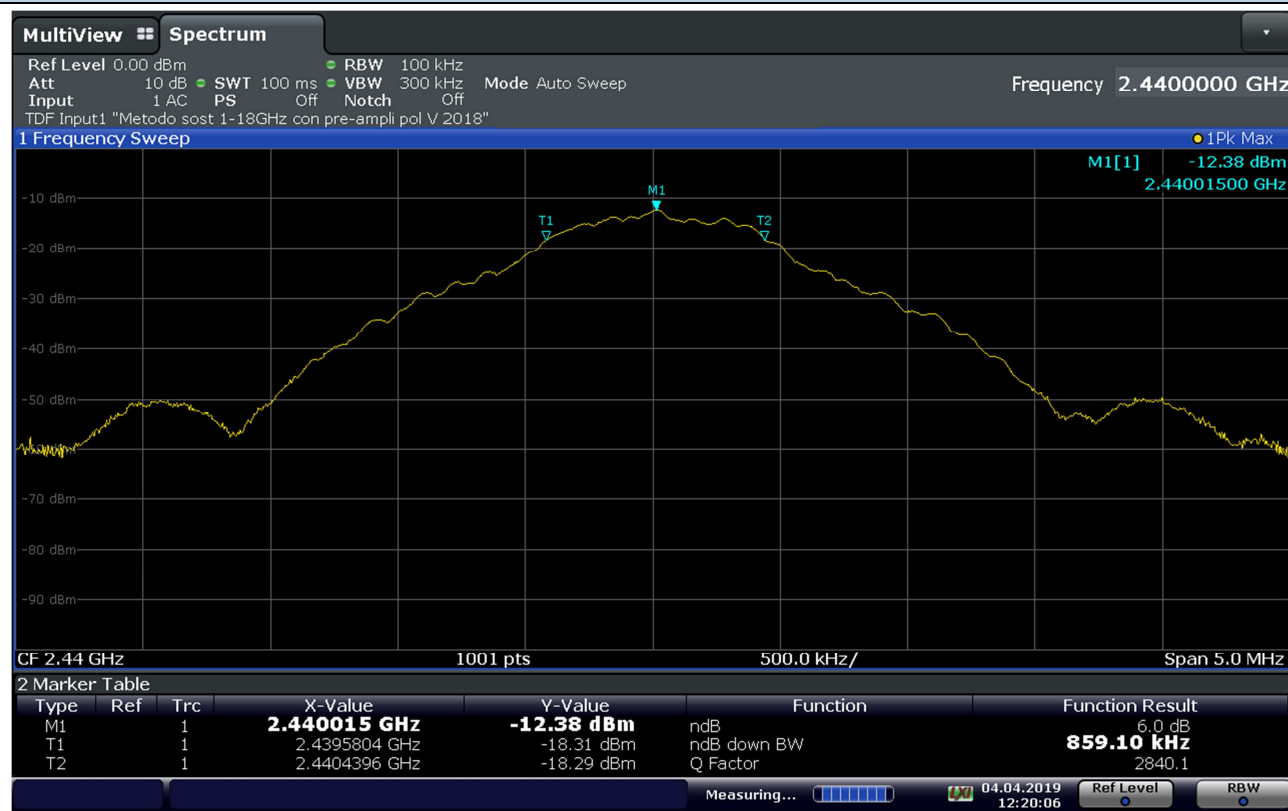
Channel (No.)	Frequency (MHz)	Data rate	Channel Bandwidth at -6dB (kHz)
Low	2402	2Mbit/s	854,10

Bandwidth at -6dB (Fmin and Fmax)				
2Mbit/s	Fmin	2401,590 MHz	Fmax	2402,444 MHz



Graphical representation of 6dB Bandwidth

Operation Mode: #1 – Middle Channel (2440 MHz)



Graphical representation of 6dB Bandwidth

Operation Mode: #1 – Middle Channel (2440 MHz)

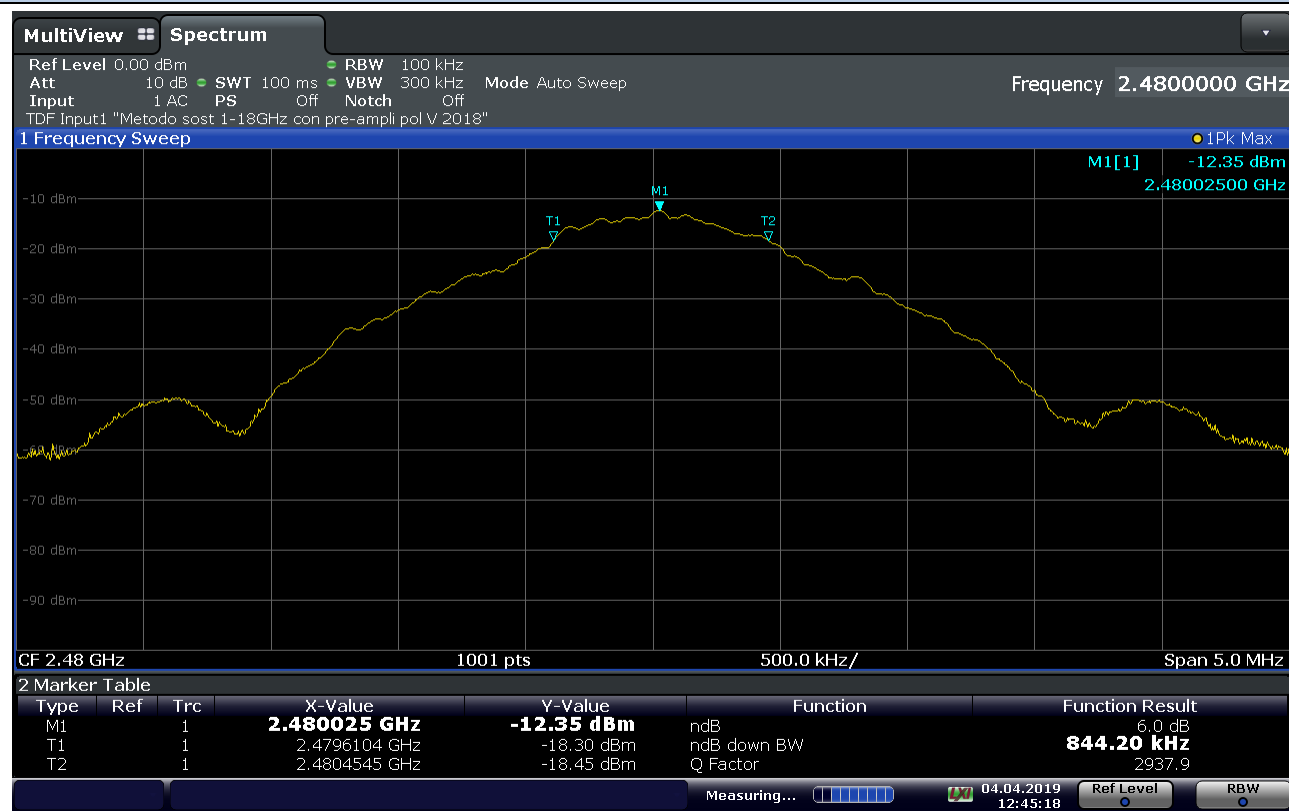
Channel (No.)	Frequency (MHz)	Data rate	Channel Bandwidth at -6dB (kHz)
Middle	2440	2Mbit/s	859,10

Bandwidth at -6dB (Fmin and Fmax)				
2Mbit/s	Fmin	2439,580 MHz	Fmax	2440,439 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)	Data rate	Channel Bandwidth at -6dB (kHz)
High	2480	2Mbit/s	844,20

Bandwidth at -6dB (Fmin and Fmax)				
2Mbit/s	Fmin	2479,610 MHz	Fmax	2480,454 MHz

**11.4 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	+3,0V dc	Enclosure
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.

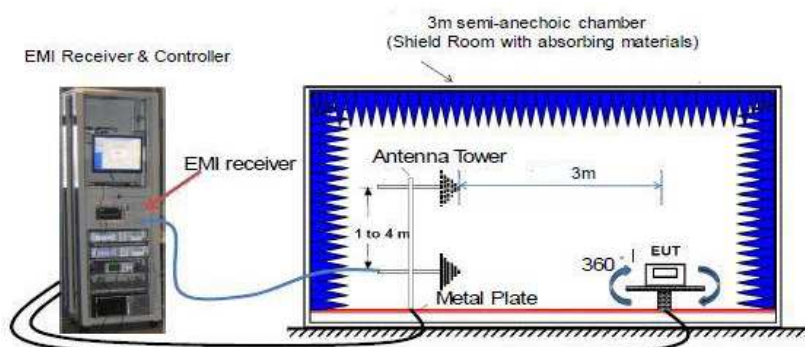
(2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

(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.

For frequencies above 1GHz, the anechoic material is also placed on the metallic floor between EUT and Antenna





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Test Equipment Used

Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
CSSA	ETS Lindgren	FACT3	2926063	05/2017	05/2019
EMI Test Receiver	R&S	ESW 44	2782867	07/2018	07/2019
Antenna Horn with Preamplifier	ETS Lindgren	3117-PA	2782349	04/2017	04/2020

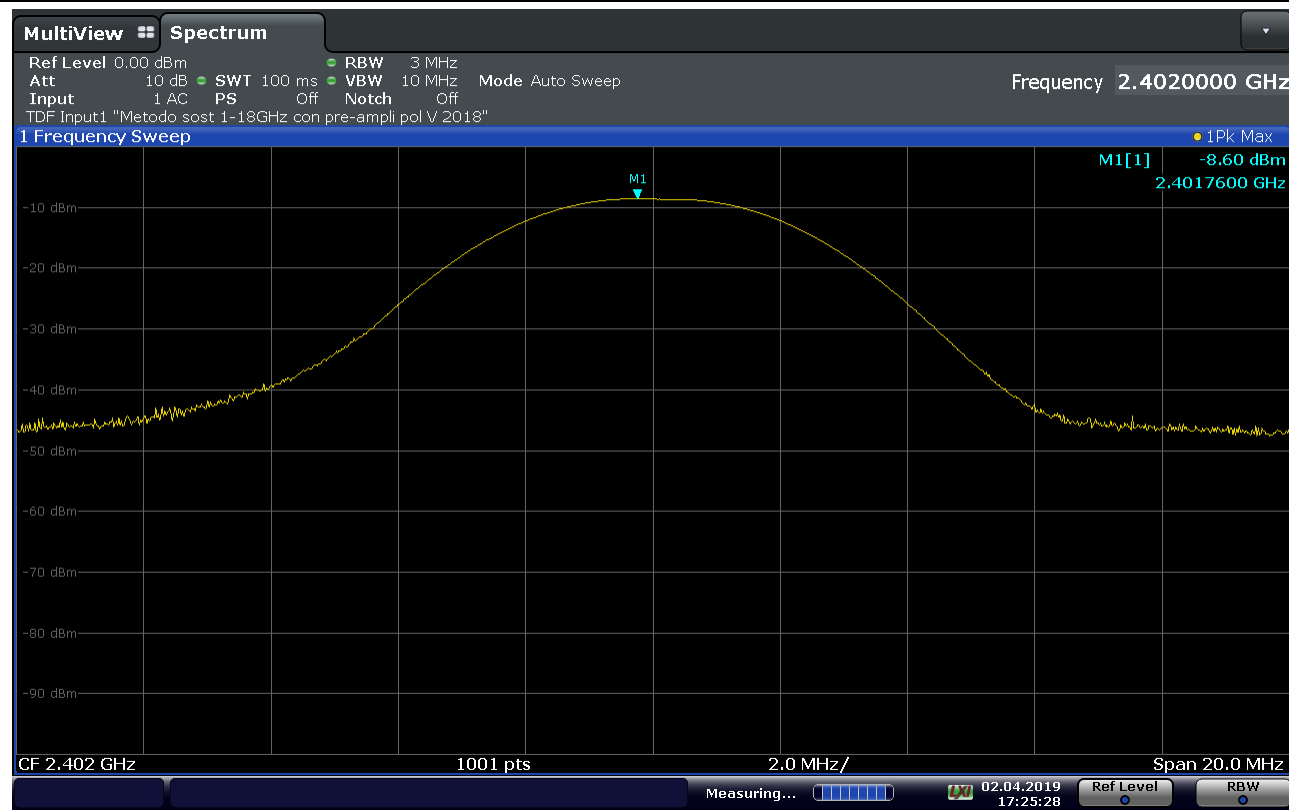
Test Method Used

Note: since it was not possible to put in an antenna connector, test was carried out in a radiated manner according to Par. 2.3 of KDB 412172 D01 Determining ERP and EIRP v01r01



RF power output (Radiated)

Operation Mode: #1 – Low Channel (2402 MHz)

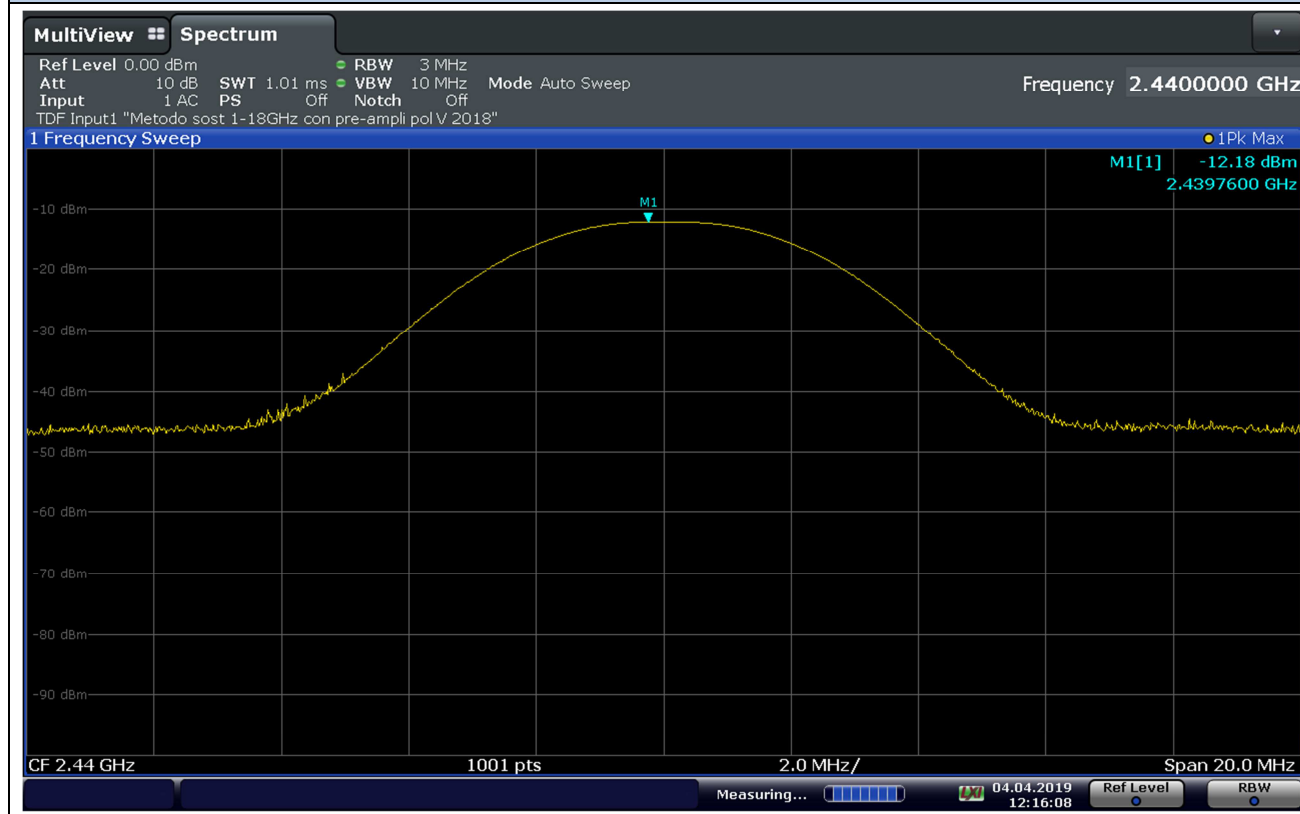


Channel (No.)	Frequency (MHz)	Data rate (Mbit/s)	Radiated Output Power (Eirp)		Limit (W)	
			(dBm)	(mW)	Conducted	Radiated
Low	2402	2	-8,60	0,138	1	4



RF power output (Radiated)

Operation Mode: #1 – Middle Channel (2440 MHz)

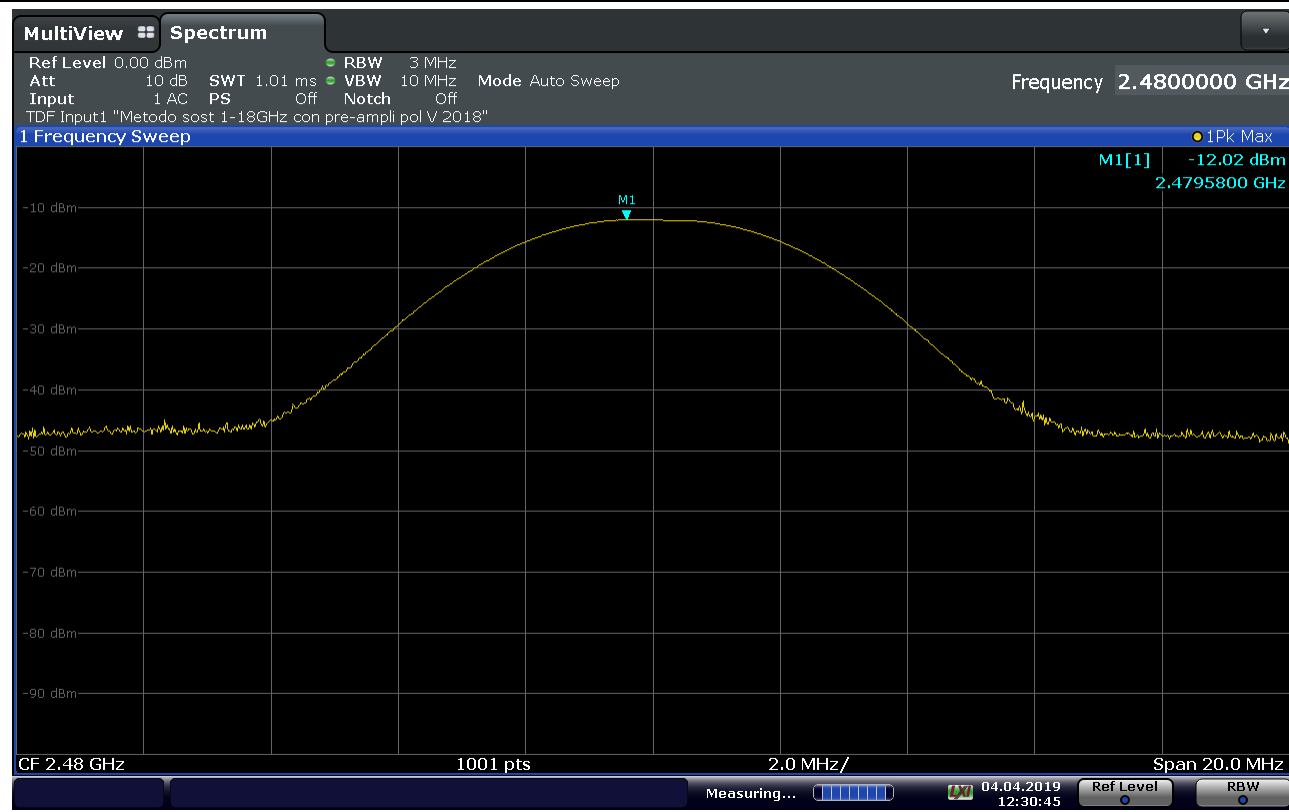


Channel (No.)	Frequency (MHz)	Data rate (Mbit/s)	Radiated Output Power (Eirp)		Limit (W)	
			(dBm)	(mW)	Conducted	Radiated
Middle	2440	2	-12,18	0,060	1	4



RF power output (Radiated)

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



Channel (No.)	Frequency (MHz)	Data rate (Mbit/s)	Radiated Output Power (Eirp)		Limit (W)	
			(dBm)	(mW)	Conducted	Radiated
High	2480	2	-12,02	0,062	1	4



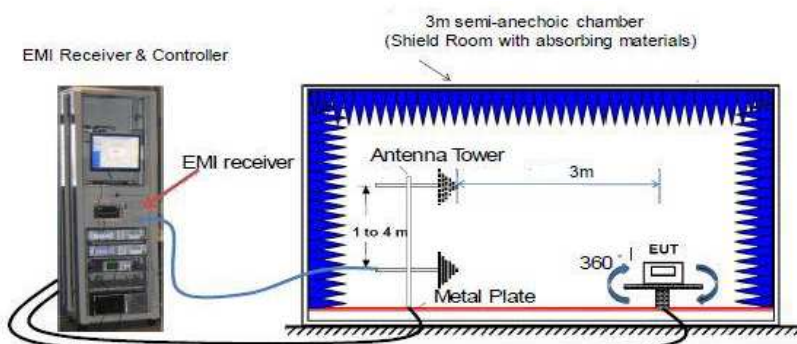
11.5 TEST: Out-of-band emissions

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	+3,0V dc	Enclosure
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.
For frequencies above 1GHz, the anechoic material is also placed on the metallic floor between EUT and Antenna





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Test Equipment Used

Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
CSSA	ETS Lindgren	FACT3	2926063	05/2017	05/2019
EMI Test Receiver	R&S	ESW 44	2782867	07/2018	07/2019
Antenna BiConiLog	ETS Lindgren	3124E-PA	2782348	04/2017	04/2020
Antenna Horn with Preamplifier	ETS Lindgren	3117-PA	2782349	04/2017	04/2020
Antenna Horn	ETS Lindgren	114514	2782350	05/2017	05/2020

Test Method Used

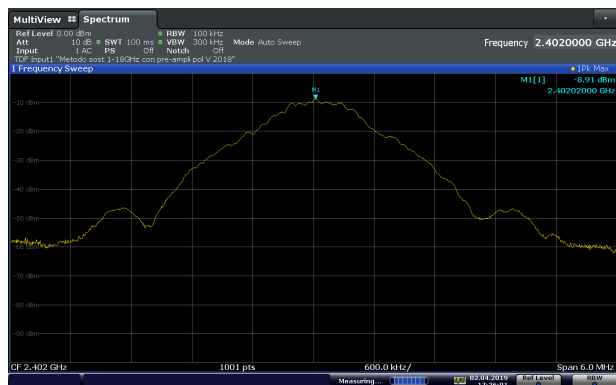
Note: since it was not possible to put in an antenna connector, test was carried out in a radiated manner, according to Par. 8.5 of KDB 558074 D01 15.247 Meas Guidance v05 (and par. 11.11 of ANSI C63.10 – radiated mode)



Graphical representation of Spurious Emission - Radiated

Operation Mode: #1 – Low Channel (2402 MHz) – 2Mbit/s

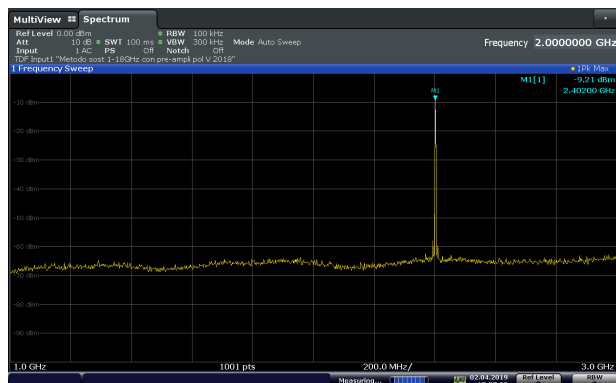
Fundamental



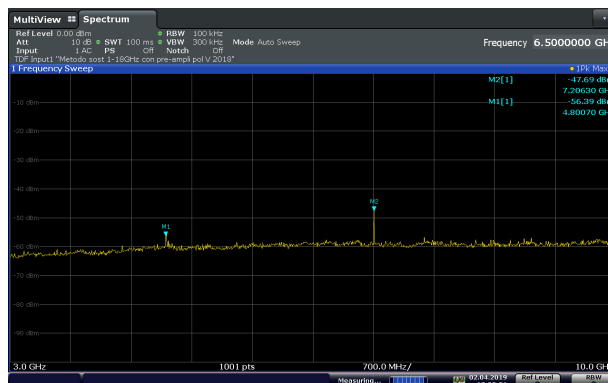
Frequency: 30MHz – 1000MHz

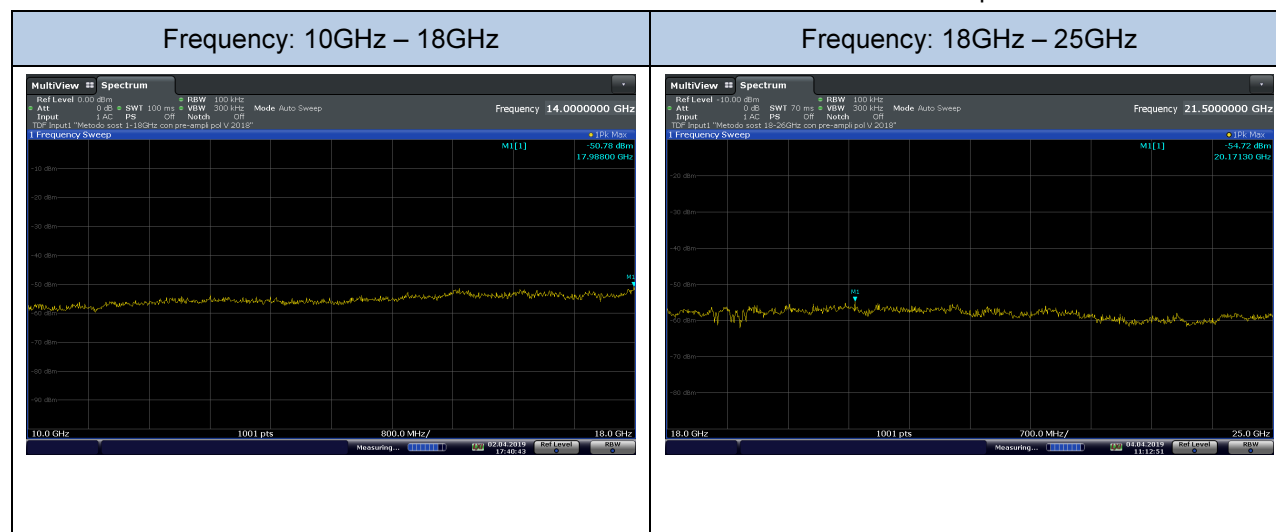


Frequency: 1GHz – 3GHz



Frequency: 3GHz – 10GHz





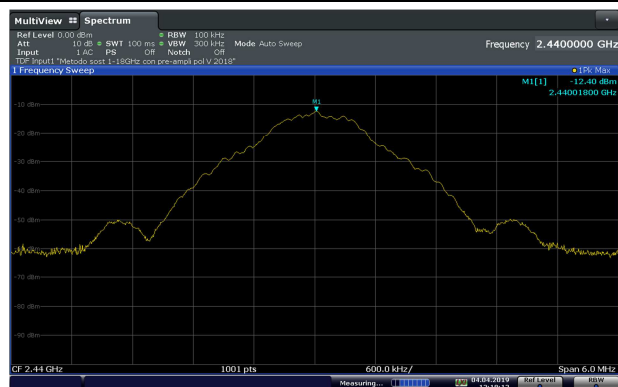
Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power -20dB (dBm)	Margin (dB)
942,13	-55,53	-8,91	46,62	-28,91	26,62
4800,70	-56,39		47,48		27,48
7206,30	-47,69		38,78		18,78
17988,0	-50,78		41,87		21,87
20131,3	-54,72		45,81		25,81



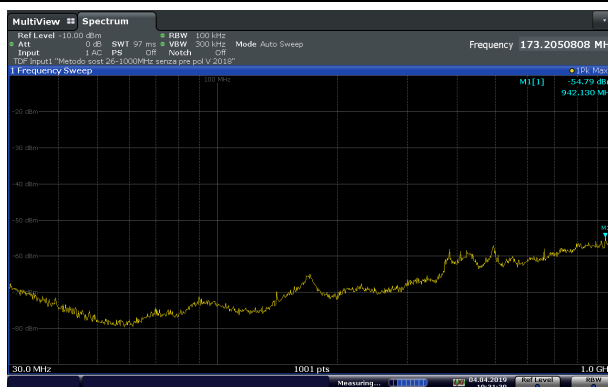
Graphical representation of Spurious Emission - Radiated

Operation Mode: #1 – Middle Channel (2440 MHz) – 2Mbit/s

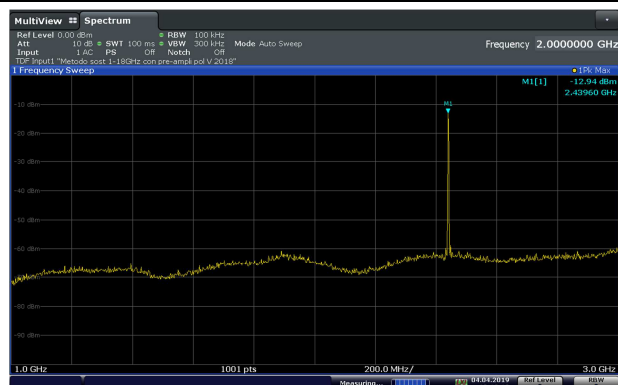
Fundamental



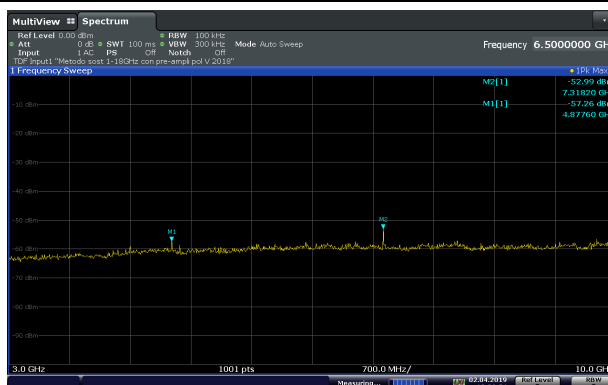
Frequency: 30MHz – 1000MHz

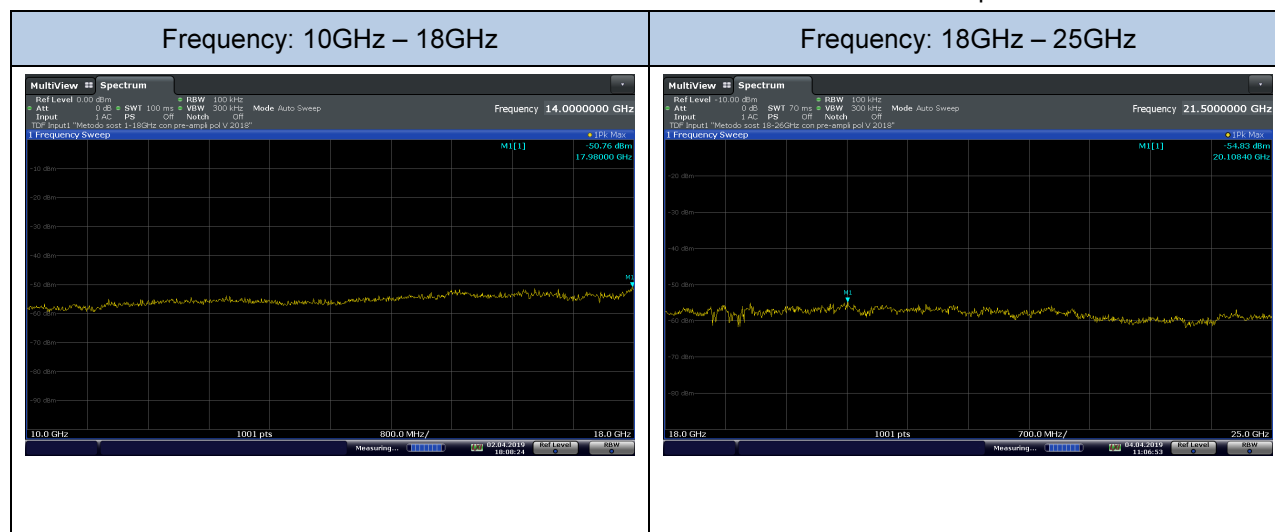


Frequency: 1GHz – 3GHz



Frequency: 3GHz – 10GHz





Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power -20dB (dBm)	Margin (dB)
942,13	-54,79	-12,40	42,39	-32,40	22,39
4877,60	-57,26		44,86		24,86
7318,20	-52,99		40,59		20,59
17980,0	-50,76		38,36		18,36
20108,4	-54,83		42,43		22,43



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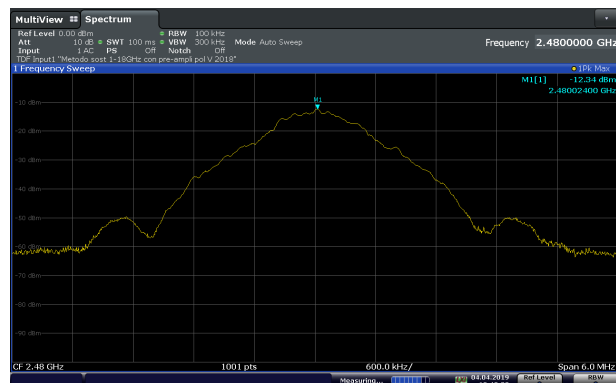
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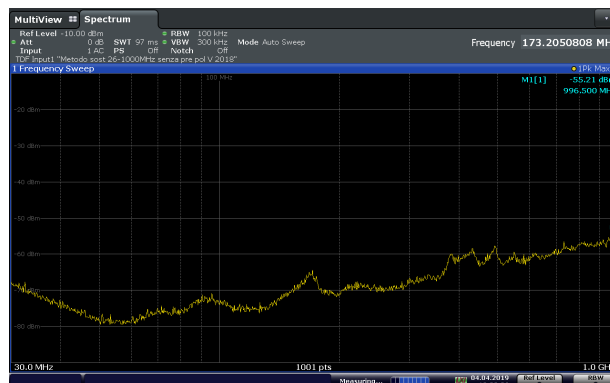
Graphical representation of Spurious Emission - Radiated

Operation Mode: #1 – High Channel (2480 MHz) – 2Mbit/s

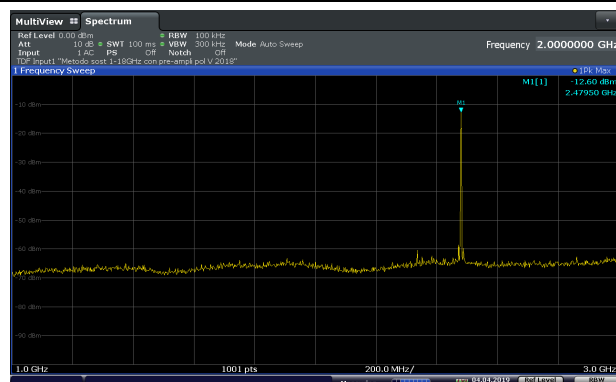
Fundamental



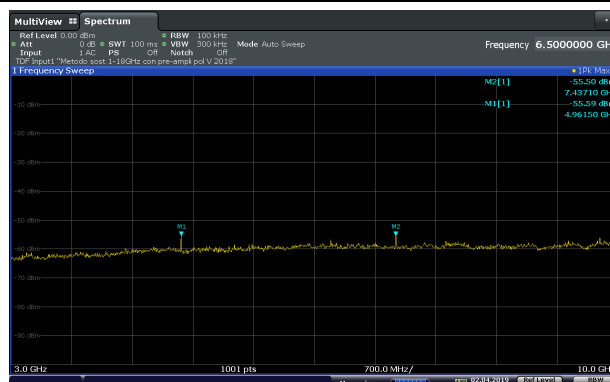
Frequency: 30MHz – 1000MHz

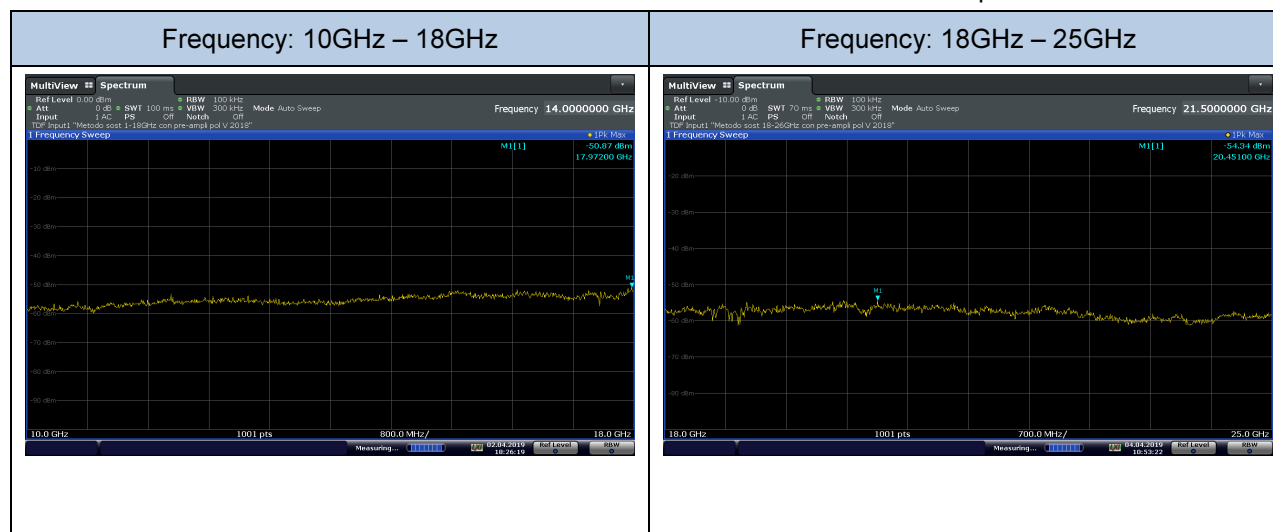


Frequency: 1GHz – 3GHz



Frequency: 3GHz – 10GHz





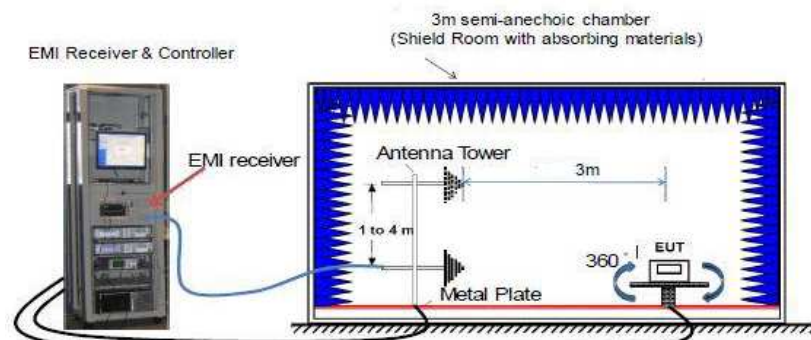
Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power -20dB (dBm)	Margin (dB)
996,50	-55,21	-12,34	42,87	-32,34	22,87
4961,50	-55,59		43,25		23,25
7437,10	-55,50		43,16		23,16
17972,0	-50,87		38,53		18,53
20451,0	-54,34		42,00		22,00

**11.6 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	+3,0V dc	Enclosure
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
(Radiated)





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LAB N° 1356

Report No. 28113143 001

Test Equipment Used

Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
CSSA	ETS Lindgren	FACT3	2926063	05/2017	05/2019
EMI Test Receiver	R&S	ESW 44	2782867	07/2018	07/2019
Antenna Horn with Preamplifier	ETS Lindgren	3117-PA	2782349	04/2017	04/2020

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)

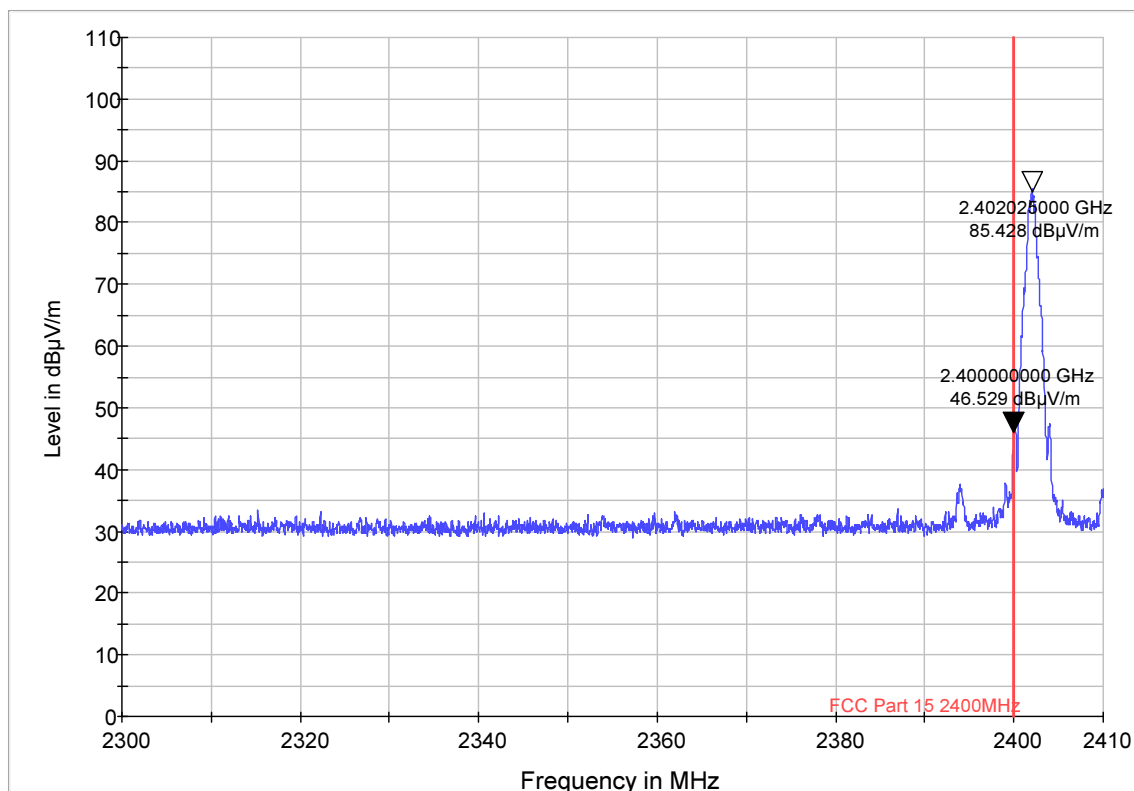


Graphical representation of 100 kHz Bandwidth of Frequency Band Edges - Radiated

Operation Mode: #1 – Low Channel (2402 MHz) – 2Mbit/s

Note: worst case with EUT on X,Y and Z axis

BandEdge 2.4 GHz FCC radiato



PEAK					
Frequency (MHz)	Measured power at the band edge (dBμV/m)	Measured power at fundamental frequency (dBμV/m)	Difference Peak / band edge (dB)	Peak Limit at PK power -20 dB (dBμV/m)	Margin (dB)
2400	46,53	85,42	38,89	65,42	18,89

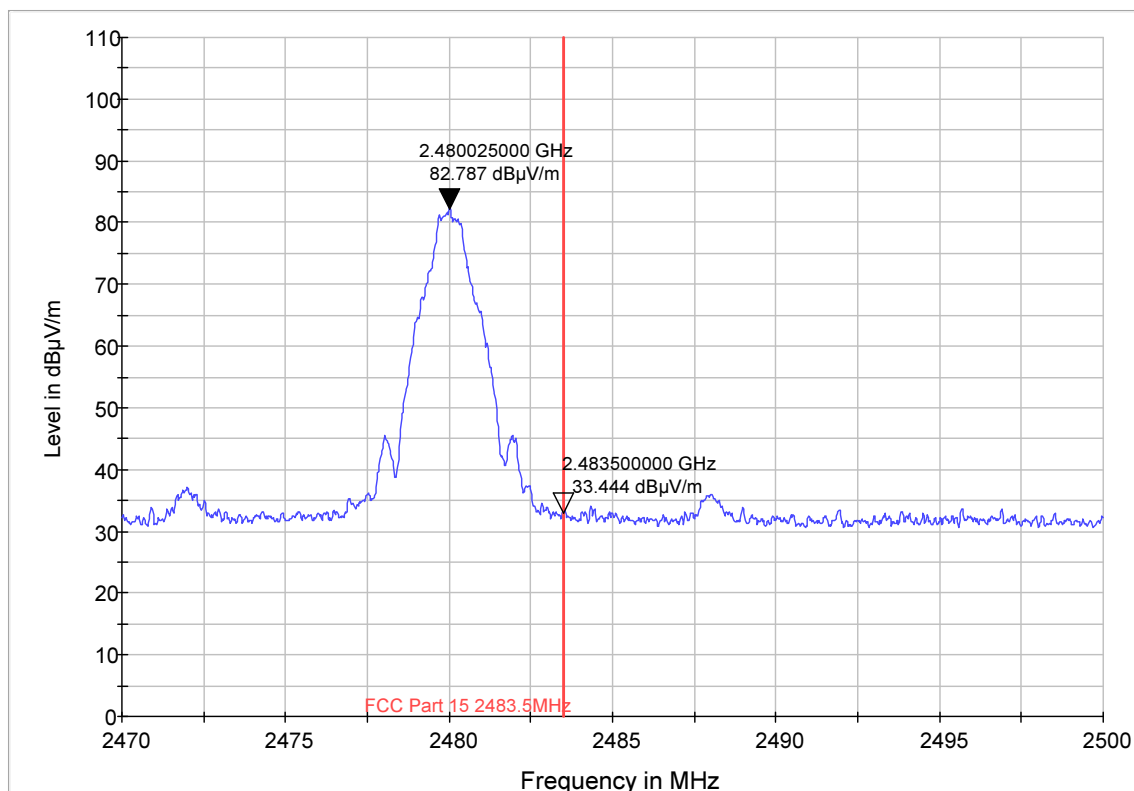


Graphical representation of 100 kHz Bandwidth of Frequency Band Edges - Radiated

Operation Mode: #1 – High Channel (2480 MHz) – 2Mbit/s

Note: worst case with EUT on X,Y and Z axis

BandEdge 2.4 GHz FCC radiato



PEAK					
Frequency (MHz)	Measured power at the band edge (dBµV/m)	Measured power at fundamental frequency (dBµV/m)	Difference Peak / band edge (dB)	Peak Limit at PK power -20 dB (dBµV/m)	Margin (dB)
2483,5	33,44	82,78	49,34	62,78	29,34



11.7 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	+3,0V 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	



11.8 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	+3,0V dc	Enclosure	
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 (Radiated)	<div><div>EMI Receiver & Controller</div><div><div>EMI receiver</div><div>Antenna Tower</div><div>3m</div><div>1 to 4 m</div><div>Metal Plate</div><div>360°</div><div>EUT</div><div>3m semi-anechoic chamber (Shield Room with absorbing materials)</div></div></div>		



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Test Equipment Used

Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
CSSA	ETS Lindgren	FACT3	2926063	05/2017	05/2019
EMI Test Receiver	R&S	ESW 44	2782867	07/2018	07/2019
Antenna Horn with Preamplifier	ETS Lindgren	3117-PA	2782349	04/2017	04/2020

Test Method Used

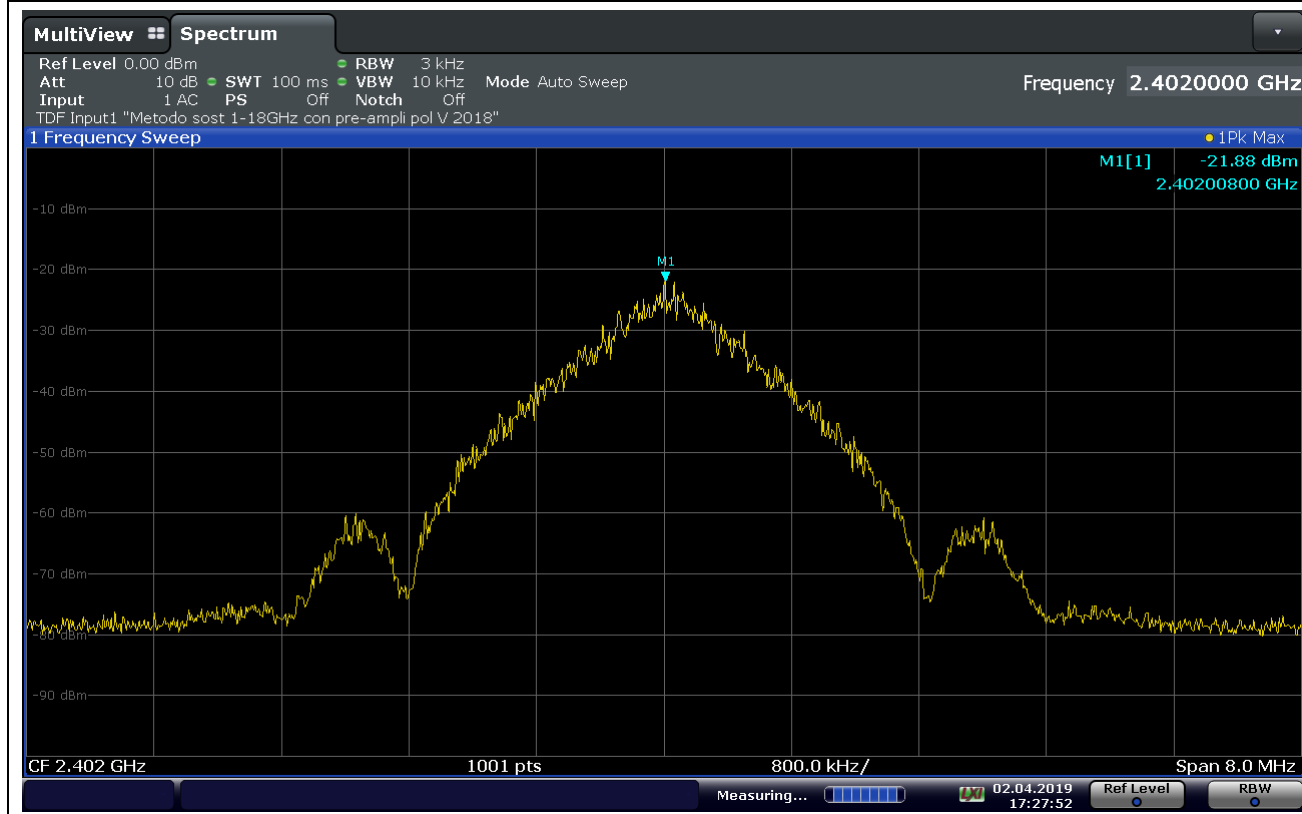
Note: since it was not possible to put in an antenna connector, test was carried out in a radiated manner with a Substitution Method and according to Par. 8.4 of KDB 558074 D01 15.247 Meas Guidance v05 (and par. 11.10.2 Method PK PSD of ANSI C63.10)



Graphical representation of Power Spectral Density (Radiated)

Operation Mode: #1 – Low Channel (2402 MHz) – 2Mbit/s

Note: worst case with EUT on X,Y and Z axis



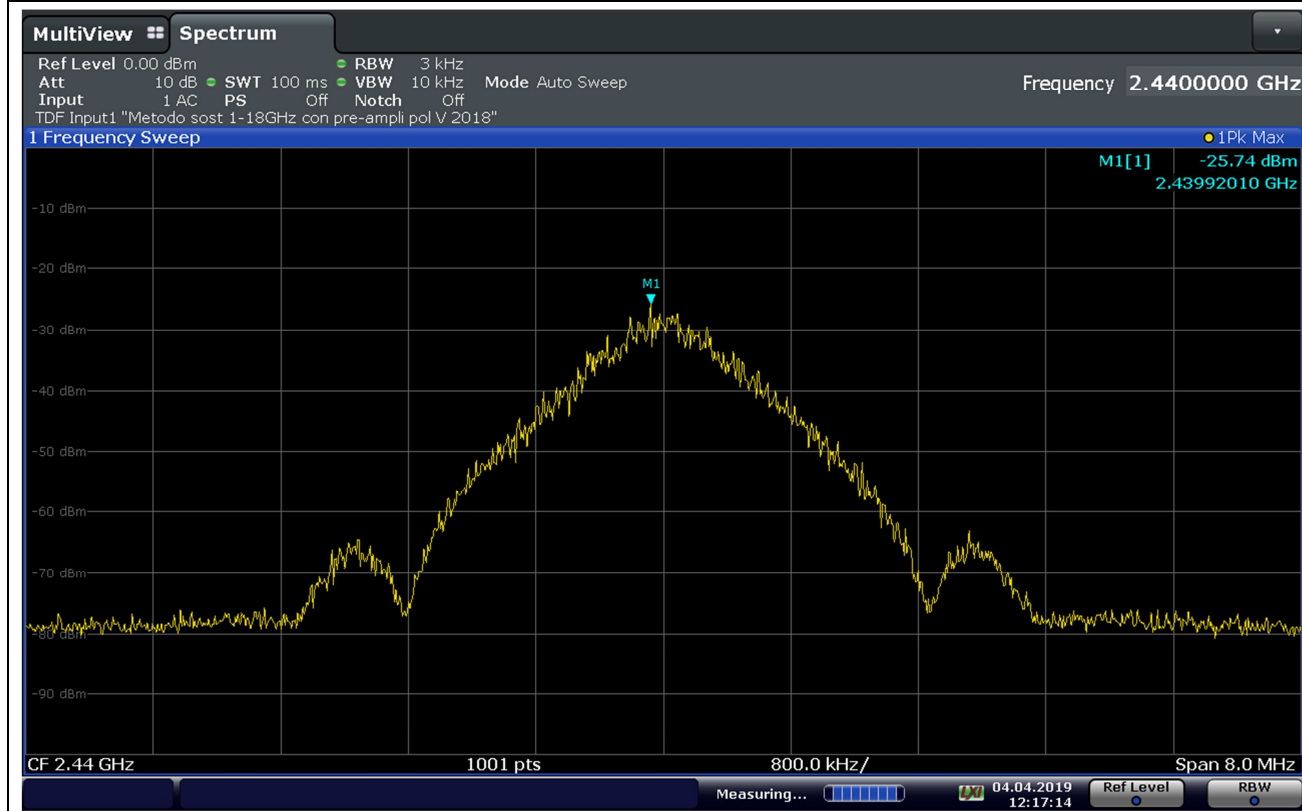
Channel (No.)	Frequency (MHz)	Radiated Power Spectral Density	Limit (dBm)
		Measured (dBm)	
Low	2402	-21,88	8



Graphical representation of Power Spectral Density (Radiated)

Operation Mode: #1 – Middle Channel (2440 MHz) – 2Mbit/s

Note: worst case with EUT on X,Y and Z axis



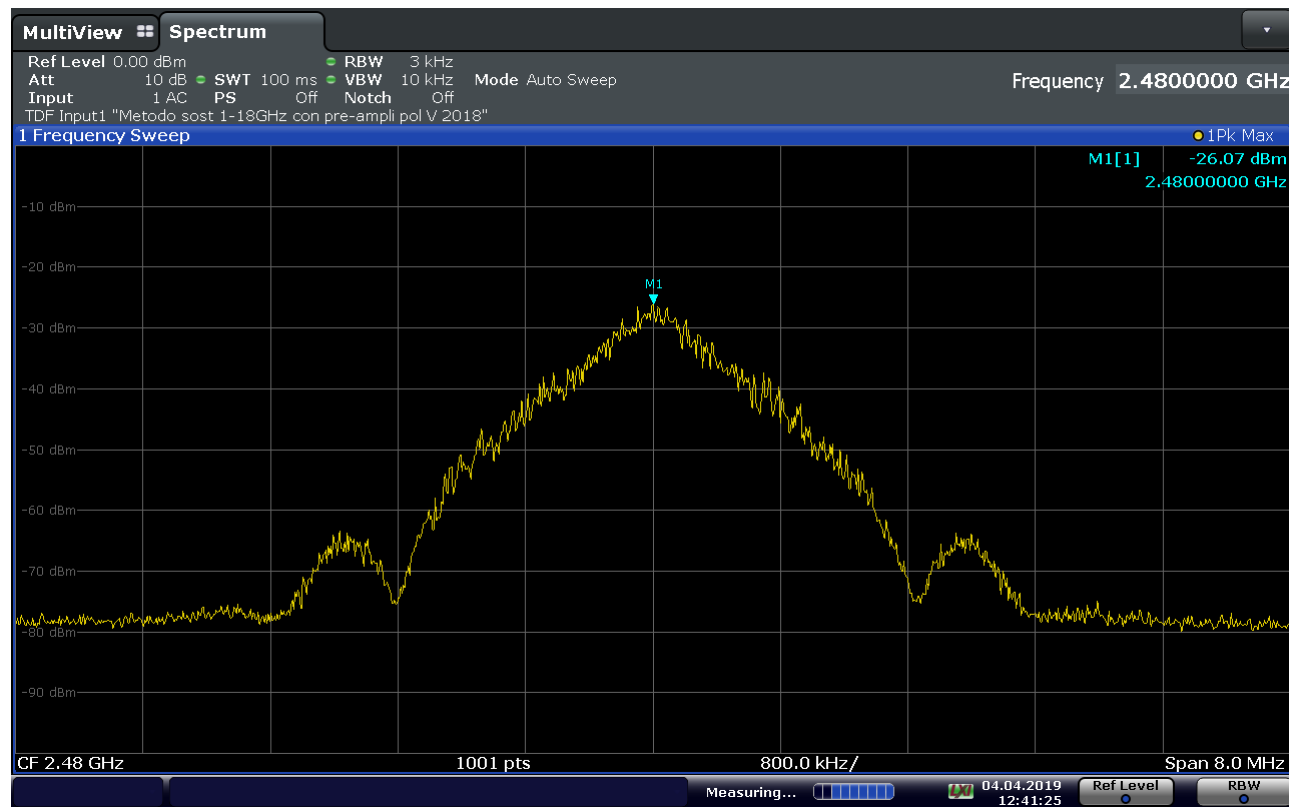
Channel (No.)	Frequency (MHz)	Radiated Power Spectral Density	Limit (dBm)
		Measured (dBm)	
Middle	2440	-25,74	8



Graphical representation of Power Spectral Density (Radiated)

Operation Mode: #1 – High Channel (2480 MHz) – 2Mbit/s

Note: worst case with EUT on X,Y and Z axis



Channel (No.)	Frequency (MHz)	Radiated Power Spectral Density	Limit (dBm)
		Measured (dBm)	
High	2480	-26,07	8



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11.9 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	+3,0V 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)	Portable equipment	
Limits Freq. Range 2402÷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.



Operating Condition #1					
CH	Frequency	Max Radiated Output Power (P)	Max Radiated Output Power (P)	Separation distance	Exemption Limit (obtained by linear interpolation) (mW)
	(MHz)	(dBm)	(mW)	(mm)	
Low	2402	-8,60	0,138	≥5	10,08
Middle	2440	-12,18	0,060	≥5	10,01
High	2480	-12,02	0,062	≥5	9,94
VERDICT					
SAR evaluation is not required because the output power value is less than exemption limit (separation distance ≥5mm)					



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12. ANNEX

Photographic Documentation

External photo	See Report n° 28113143 001 Annex1
Internal photo	See Report n° 28113143 001 Annex2
Set-up photo	See Report n° 28113143 001 Annex3

END OF TEST REPORT