

FCC and ISED Test report for subparts 15C, sections 15.207 and 15.247; RSS-247 and RSS-Gen

Product name : G3 transformer US/C
Applicant : in-lite
FCC ID : 2AU26-SMARTHUB150
IC ID : 25679-SMARTHUB150

Test report No. : 190800656 02 V1.00

Laboratory information

Accreditation

Telefication complies with the accreditation criteria for test laboratories as laid down in ISO/IEC 17025:2005. The accreditation covers the quality system of the laboratory as well as the specific activities as described in the authorized annex bearing the accreditation number L021 and is granted on 30 November 1990 by the Dutch Council For Accreditation (RvA: Raad voor Accreditatie).

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Testing Location

Test Site	Telefication BV
Test Site location	Edisonstraat 12a 6902 PK Zevenaar The Netherlands Tel. +31316583180 Fax. +31316583189
Test Site FCC	NL0001

Revision History

Version	Date	Remarks	By
v0.50	17-11-2019	First draft	PS
v1.00	3-12-2019	First release	PS

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Summary of Test results

FCC	ISED	Description	Section in report	Verdict
15.247(d) 15.209 (a)	RSS-Gen §8.9	Radiated spurious emissions	3.1	Pass
15.205 (a)	RSS Gen §8.10	Spurious emissions in the restricted bands	3.1	Pass
15.247(a) (1)	RSS-247 §5.1(b)	Carrier frequency separation	3.4	Pass
15.247(a) (1) (iii)	RSS-247 §5.1(d)	Average time of occupancy	3.6	Pass
15.247(a) (1) (iii)	RSS-247 §5.1(d)	Number of hopping channels	3.5	Pass
15.247 (a)	RSS-247 §5.1(a)	20 dB bandwidth	3.2	Pass
--	RSS-Gen §6.7	99% bandwidth	3.3	Pass
15.247 (b)	RSS-247 §5.4 (d)	RF output power	3.7	Pass
15.247 (d)	RSS-247 §5.5	Band edge	3.8	Pass
15.207 (c)	RSS-Gen §8.8	Conducted spurious emissions on AC mains	3.9	Pass

1 General Description

1.1 Applicant

Client name:	in-lite design bv
Address	Stephensonweg 18
Zip code:	4207 HB Gorinchem
Telephone:	+31 18 46 88 760
E-mail:	wilbrand.menzo@in-lite.nl
Contact name:	Wilbrand Menzo

1.2 Manufacturer

Manufacturer name:	in-lite design bv
Address:	Stephensonweg 18
Zip code:	4207 HB Gorinchem
Telephone:	+31 18 46 88 760
E-mail:	wilbrand.menzo@in-lite.nl
Contact name:	Wilbrand Menzo

1.3 Tested Equipment Under Test (EUT)

Product name:	G3 transformer US/C
Brand name:	SMART HUB-150
FCC ID:	2AU26-SMARTHUB150
IC ID:	25679-SMARTHUB150
Product type:	Wideband data transmission equipment
Model(s):	SMART HUB-150
Batch and/or serial No.	--
Software version:	--
Hardware version:	--
Date of receipt	4-09-2019
Tests started:	4-09-2019
Testing ended:	7-10-2019

1.4 Product specifications of Equipment under test

Tx Frequency:	BLE: 2400 – 2483.5 MHz
Rx frequency:	BLE: 2400 – 2483.5 MHz
Antenna type	PIFA
Antenna gain	3.3 dBi (max)
Type of modulation:	GFSK
Emission designator	1M25G1D

1.5 Environmental conditions

Test date	5-09-2019	7-10-2019
Ambient temperature	26.3 °C	20.4 °C
Humidity	43.4 %RH	44.9 %RH

1.6 Measurement standards

- ANSI C63.4:2014
- ANSI C63.10:2013
- KDB 558074 D01 V05R02

1.7 Applicable standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- FCC Part 15 Subpart C §15.247
- FCC Part 15 subpart C §15.207
- RSS-Gen Issue 5
- RSS-247 Issue 2

1.8 Observation and remarks

None.

1.9 Conclusions

The sample of the product showed NO NON-COMPLIANCES to the specifications stated in paragraph 1.7 of this report.

The results of the test as stated in this report, are exclusively applicable to the product items as identified in this report. Telefication accepts no responsibility for any properties of product items in this test report, which are not supported by the tests as specified in paragraph 1.7 *"Applicable standards"*.

All conducted tests are performed by:

Name : ing P.A. Suringa

Review of test methods and report by:

Name : ing R. van Barneveld

The above conclusions have been verified by the following signatory:

Date : 10-01-2019

Name : P. van Wanrooij, BASc

Function : Test Engineer

Signature :



2 Test configuration of the Equipment Under Test

2.1 Test mode

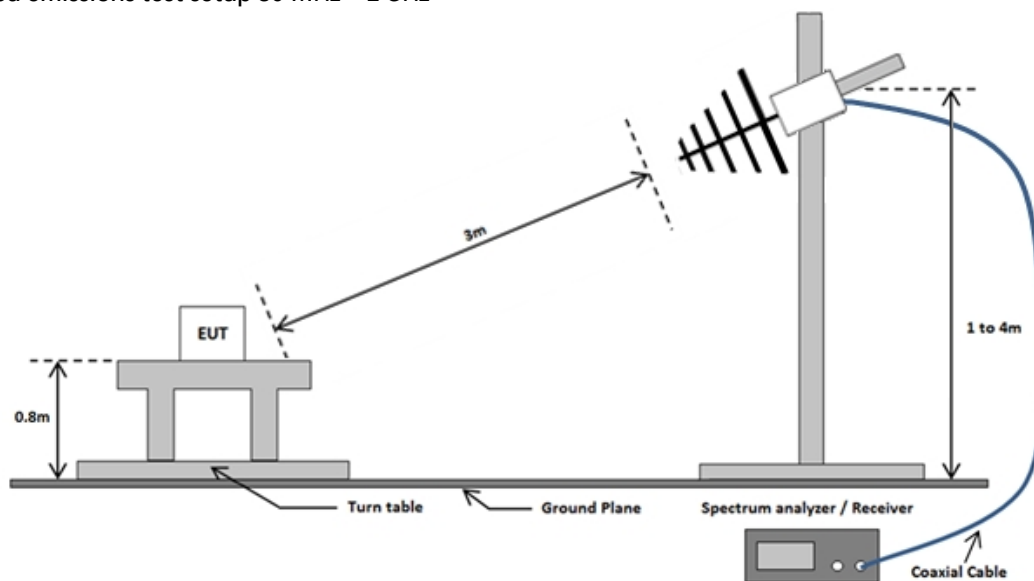
The applicant provided test mode firmware with which it was possible to configure the radio to transmit continuously.

2.2 Test setups

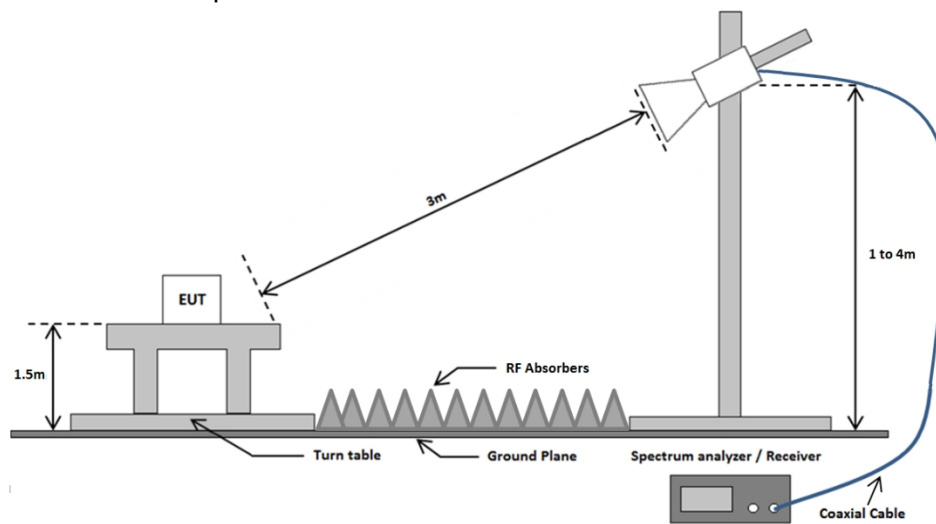
Conducted test setup



Radiated emissions test setup 30 MHz – 1 GHz

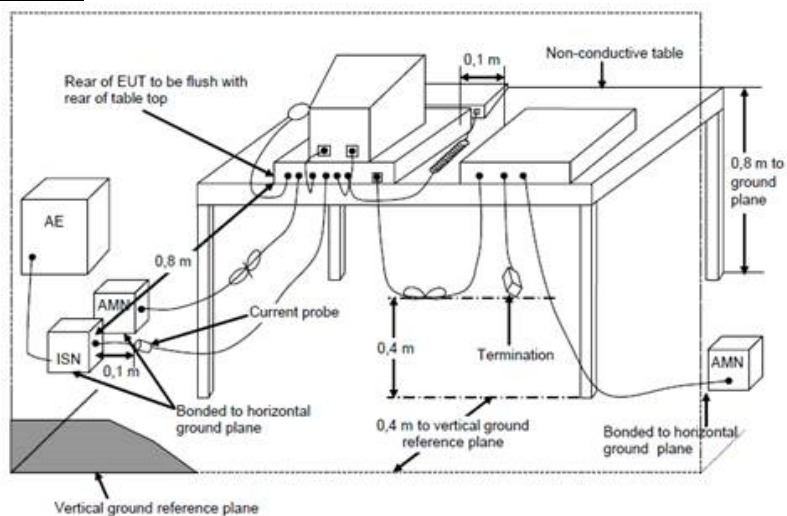


Radiated emissions test setup above 1 GHz



Conducted emissions test setup

Emissions test at AC mains



2.3 Equipment used in the test configuration

Description	Manufacturer	Model	ID	Used at Par.
Spectrum Analyzer	Rohde & Schwarz	FSP40	TE11125	3.1
Spectrum Analyzer	Rohde & Schwarz	ESR7	TE01220	3.2 – 3.9
Software	D.A.R.E Instruments	Radimation	2019.1.8	3.1
Biconilog Antenna	Chase	CBL6112A	TE00967	3.1
Horn Antenna	EMCO The Electro – Mechanics Co	3115	TE00531	3.1
Semi Anechoic Chamber	Comtest Engineering BV	-	TE00861	3.1
Artificial Mains Network (AMN)	Rohde & Schwarz	ESH3-Z5	TE00208	3.9
Pulse limiter	Rohde & Schwarz	ESH3-Z2	TE00756	3.9
AC source	Croma	61601	TE02001	3.9
High pass filter	Wainwright instruments	WHK10-2520-3000-18000	TE01146	3.1

2.4 Sample calculations

Field Strength Measurement example(see chapter 3.3):

Frequency (MHz)	Polarization	Height(m)	Quasi-Peak (dB μ V/m)
135,6	Horizontal	1	40,4

The following relation applies:

$$E \text{ (dB}\mu\text{V/m)} = U \text{ (dB}\mu\text{V)} + AF \text{ (dB/m)} + CL \text{ (dB)}$$

Where:

E = Electric field strength

U = Measuring receiver voltage

AF = Antenna factor

CL = Cable loss

$$(40.4 = 27.23 + 11.8 + 1.37)$$

3 Test results

3.1 Spurious emissions (incl. spurious emissions in the restricted bands)

3.1.1 Limit

§ 15.247(d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the RF power shall be at least 20 dB attenuation below that in the 100 kHz bandwidth within the band that contains the highest level of desired power, based on either a conducted or radiated measurement.

§15.205(c)

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).

3.1.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.1.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.1.4 Test procedure

According to ANSI C63.10: 2013; sections 5.6, 6.6

IRN 026_14.1 Radiated electrical disturbance (V per m); methods 1, 2, 3

3.1.5 Test results of the radiated spurious emission measurements

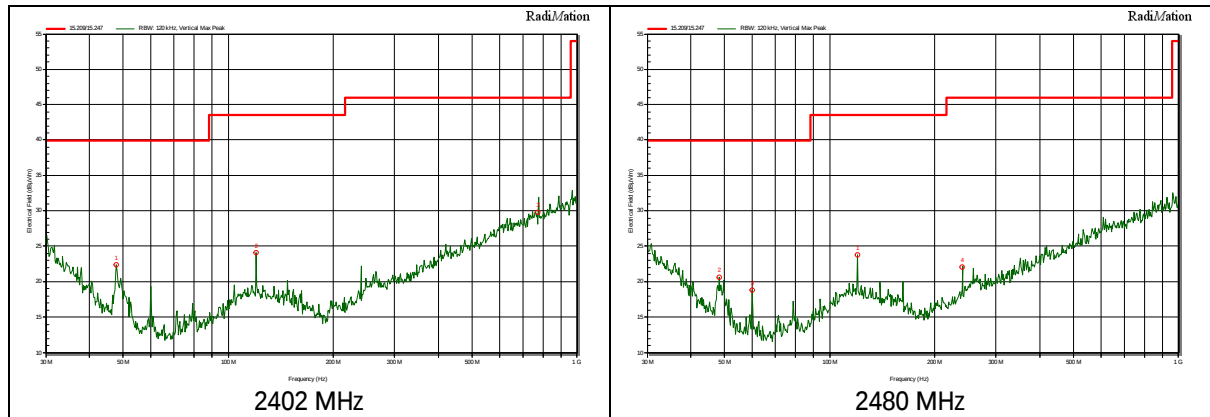
See next pages.

3.1.6 Measurement uncertainty

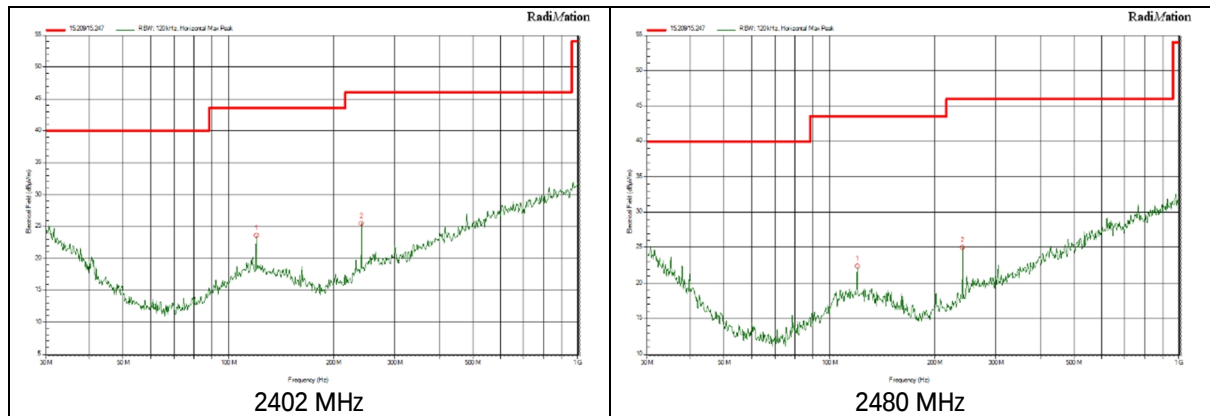
Horizontal polarization	
30 – 200 MHz	4.5 dB
200 – 1000 MHz	3.6 dB
1000 – 18000 MHz	5.7 dB
18000 – 26000 MHz	4.9 dB
Vertical polarization	
30 – 200 MHz	5.4 dB
200 – 1000 MHz	4.6 dB
1000 – 18000 MHz	5.7 dB
18000 – 26000 MHz	4.9 dB

30 -1000 MHz

Vertical polarization

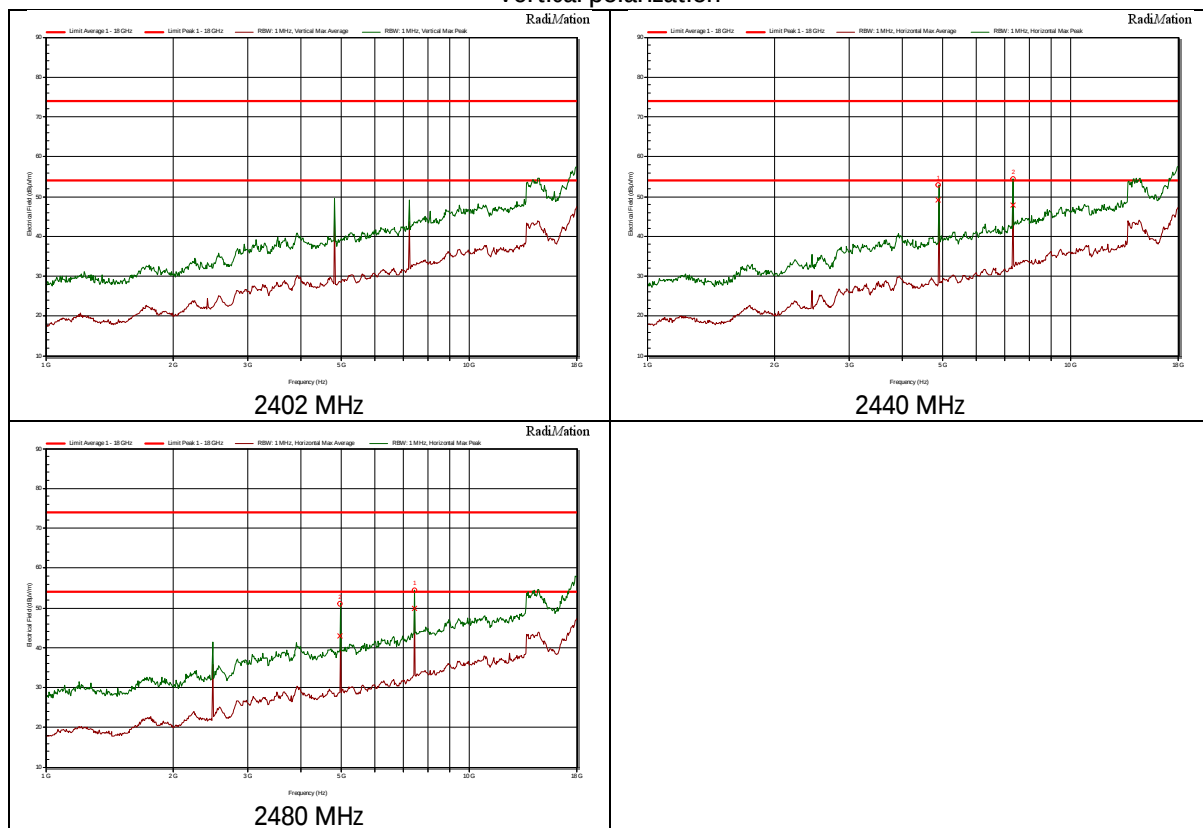


Horizontal polarization

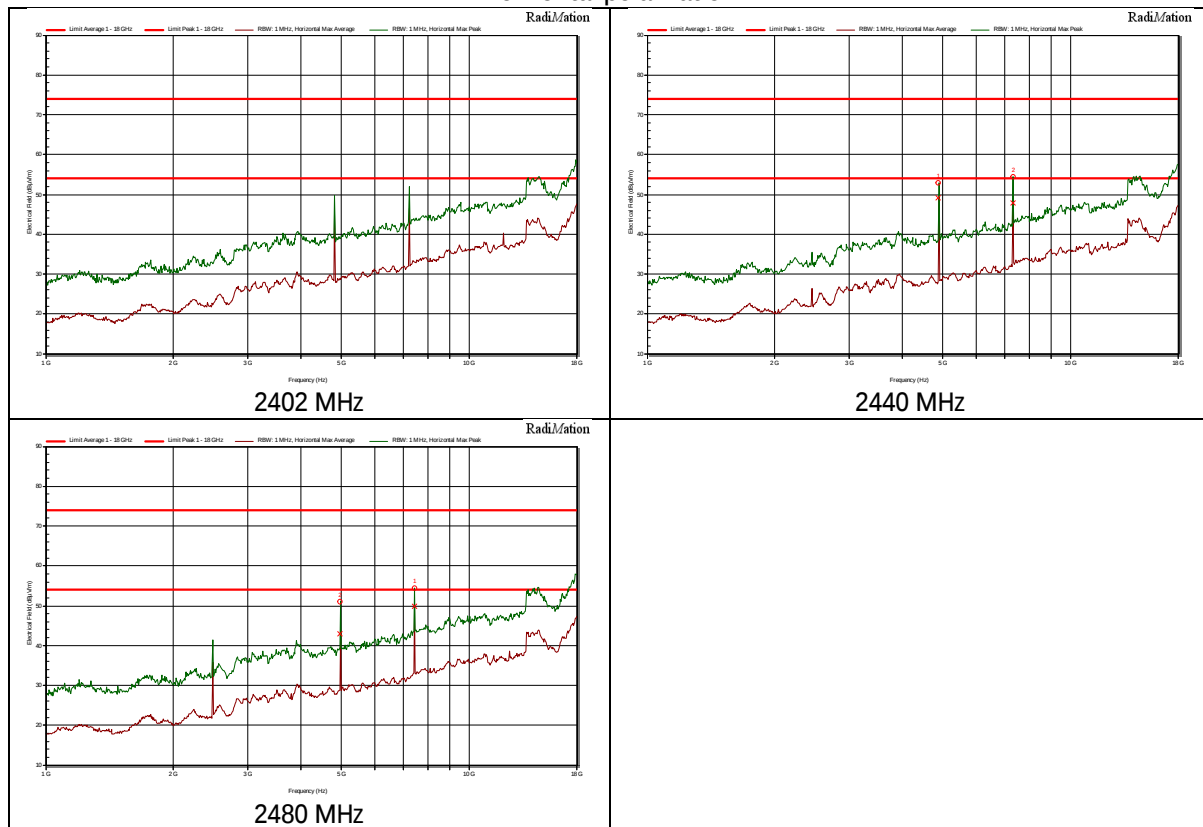


1 – 18 GHz

Vertical polarization

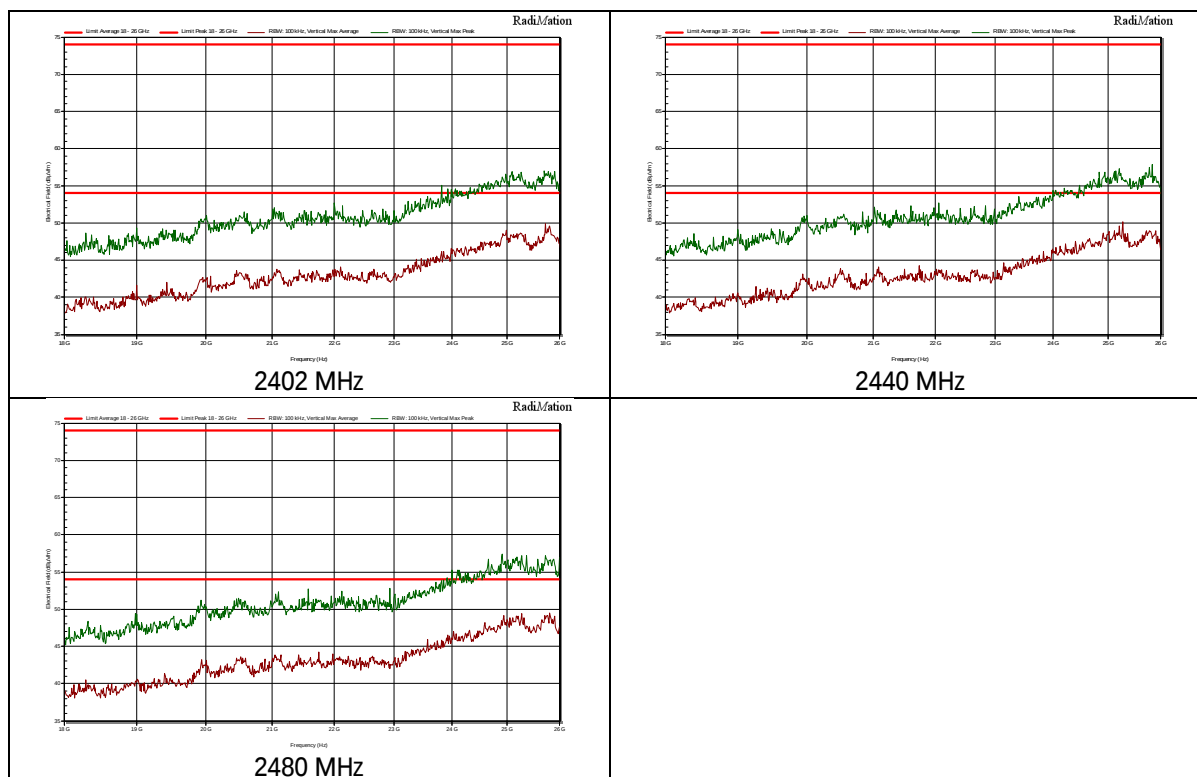


Horizontal polarization

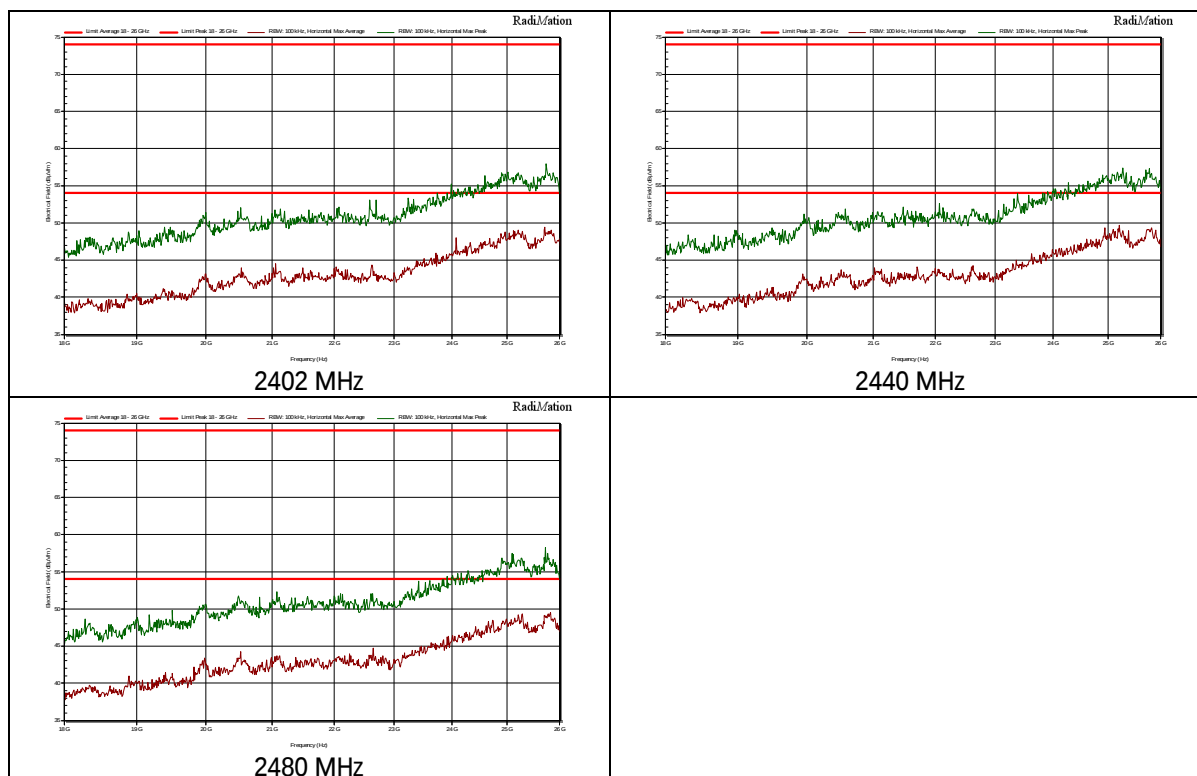


18 – 26 GHz

Vertical polarization



Horizontal polarization



3.2 20 dB bandwidth Measurement

3.2.1 Limit

No limit applies.

3.2.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.2.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.2.4 Test procedure

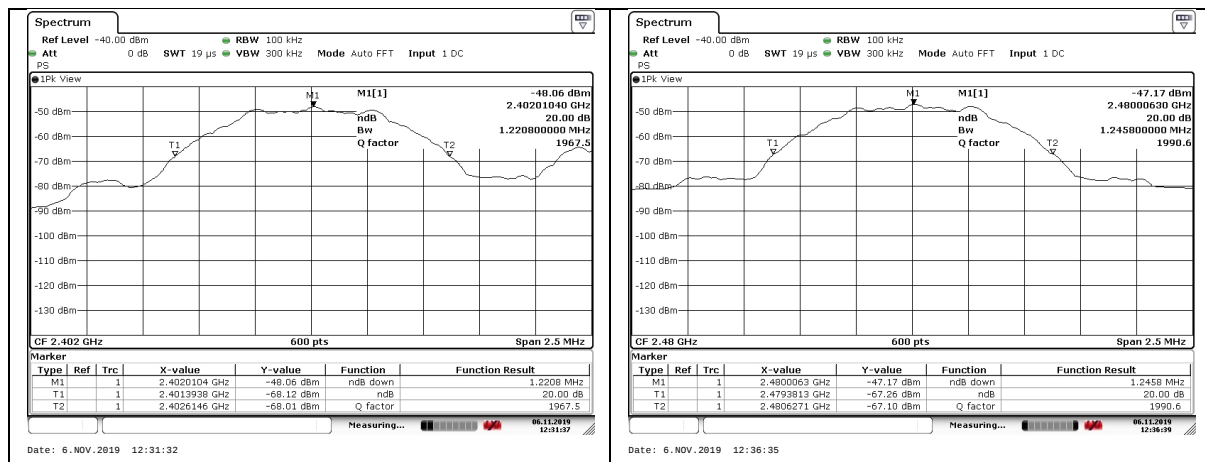
According to ANSI C63.10: 2013, section 6.9.2

IRN 017 - Occupied bandwidth (Hz) Method 2 – Relative method.

3.2.5 Test Results of the 20 dB bandwidth Measurement

Technology Std.	Channel	Frequency (MHz)	Data rate	20dB bandwidth (kHz)
Bluetooth Low energy	37	2402	1 Mbps	1221
	--	--	--	--
	39	2480	1 Mbps	1246
Uncertainty	± 26 kHz			

3.2.6 Plots of the 20 dB bandwidth measurement



3.3 99% Occupied Bandwidth

3.3.1 Limit

No limit, according to RSS-Gen 6.7

3.3.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.3.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.3.4 Test procedure

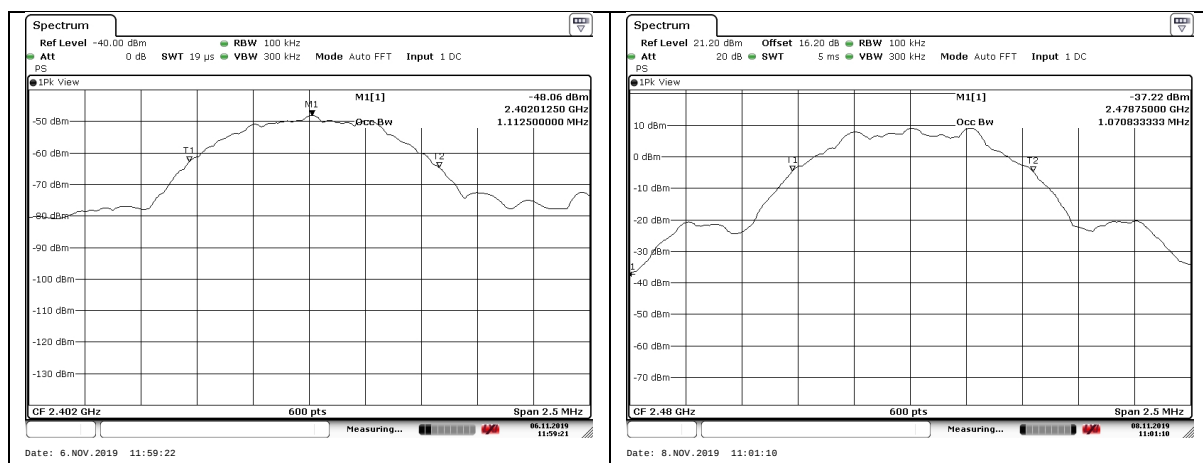
RSS-GEN section 6.7

IRN 017 - Occupied bandwidth (Hz) Method 1 – XX % power bandwidth.

3.3.5 Test results of the 99% occupied bandwidth measurement

Technology Std.	Channel	Frequency (MHz)	Data rate	99% bandwidth (kHz)
Bluetooth Low energy	37	2402	1 Mbps	1113
	--	--	--	--
	39	2480	1 Mbps	1071
Uncertainty	± 26 kHz			

3.3.6 Plots of the 99% occupied bandwidth measurement



3.4 Carrier frequency separation

3.4.1 Limit

Frequency hopping systems shall have hopping channel frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

3.4.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.4.3 Test setup

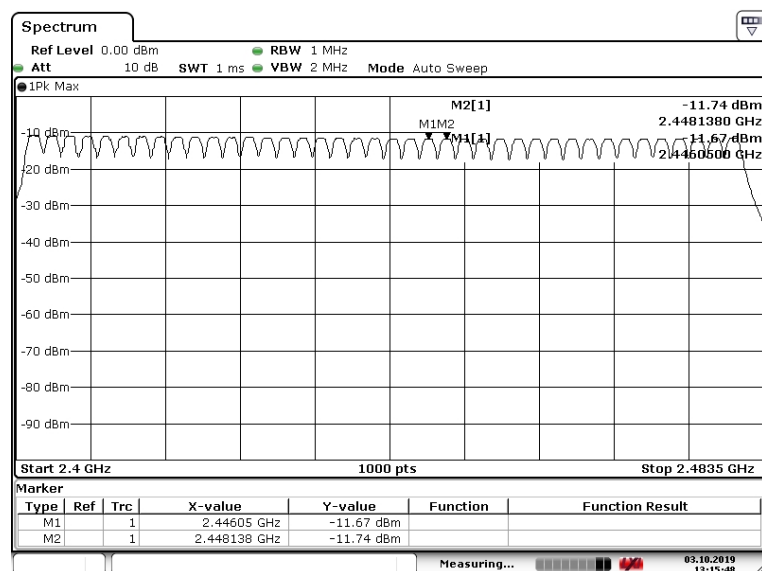
The test setup is as shown in chapter 2.2 of this report.

3.4.4 Test procedure

According to ANSI C63.10: 2013, Section 7.8.2

IRN 005_12.1 Frequency (Hz) – Method 4

3.4.4.1 Plot of the carrier frequency separation measurement



Date: 3.OCT.2019 13:15:48

From the plot above:

Separation is: $M2 - M1 = 2448 - 2446 = 2 \text{ MHz}$

3.4.5 Measurement uncertainty

+/- 1 MHz

3.5 Number of hopping frequencies

3.5.1 Limit

Frequency hopping systems in the 2400 – 2483.5 MHz band shall use at least 15 channels.

3.5.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.5.3 Test setup

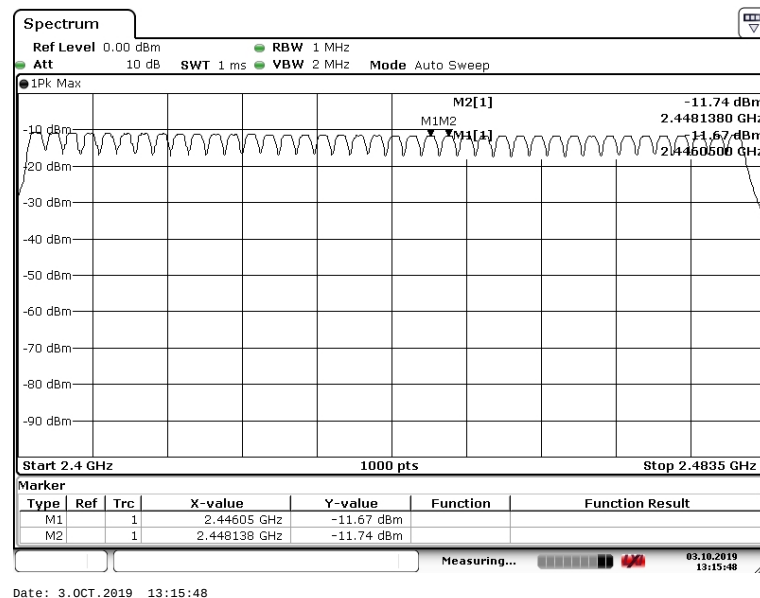
The test setup is as shown in chapter 2.2 of this report.

3.5.4 Test procedure

According to ANSI C63.10: 2013, Section 7.8.3

IRN 005_12.1 Frequency (Hz) – Method 4

3.5.4.1 Plot of the number of hopping frequencies



The number of hopping frequencies is: 40

3.5.5 Measurement uncertainty

Not applicable.

3.6 Average time of occupancy

3.6.1 Limit

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of channels employed.

3.6.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.6.3 Test setup

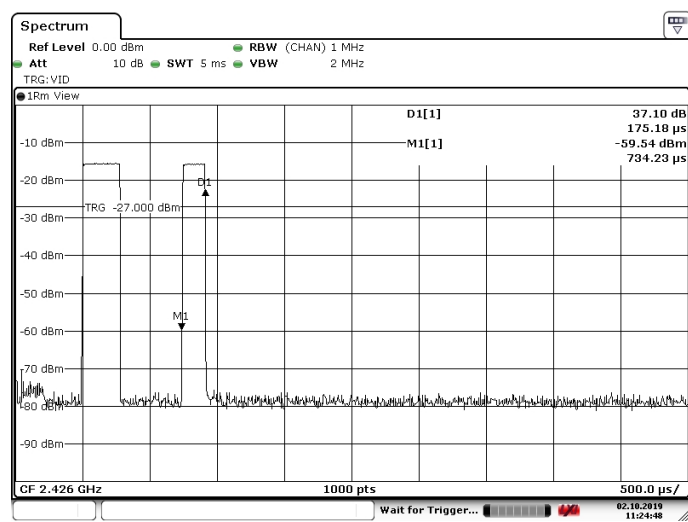
The test setup is as shown in chapter 2.2 of this report.

3.6.4 Test procedure

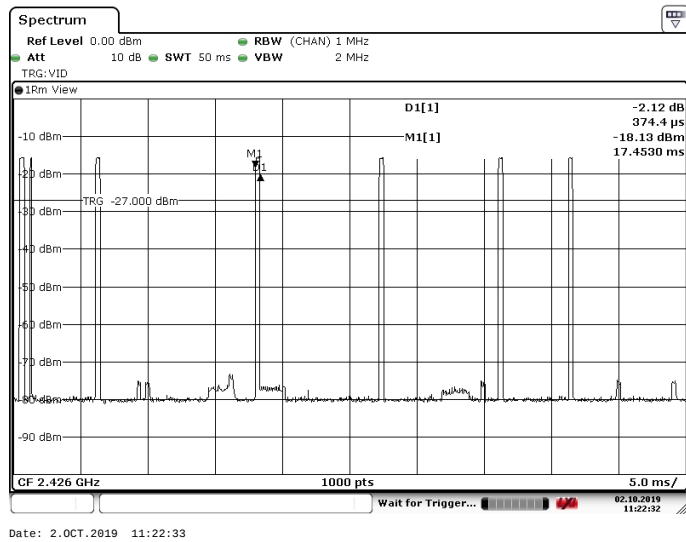
According to ANSI C63.10: 2013, Section 7.8.4

IRN 013_08.1 Duty cycle (%) - Method 2

3.6.4.1 Plots of the average time of occupancy measurement



Note: the first pulse a control signal



From the plots above:

Each 50 milliseconds six 175 μsec data pulses occur.

The average time of occupancy in 0.4x40 = 16 seconds: $16000/50 \times 0.175 \text{ msec} = 56 \text{ msec}$

3.6.5 Measurement uncertainty

+/- 0.1%

3.7 Output Power Measurement

3.7.1 Limit

The maximum conducted output power of the intentional radiator shall not exceed 125 mW for frequency hopping systems in the 2400 – 2483.5 MHz band employing less than 75 non-overlapping channels.

If transmitting antenna of directional gain greater than 6 dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point to point operation, the limit has to be reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

3.7.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.7.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.7.4 Test procedure

ANSI C63.10: 2013, section 7.8.5

IRN 014 - RF power (W) - Method 1 – AVGSA (DTS) according to ANSI C63.10.

3.7.5 Test results of Output Power Measurement

Technology Std.	Channel	Peak method		Peak output power (dBm) ^{*)}
		Frequency (MHz)	Data rate	
Bluetooth Low Energy	37	2402	1 Mbps	22.3
	17	2440	1 Mbps	20.5
	39	2480	1 Mbps	21.9
Uncertainty	±0.71 dB			

^{*)} including antenna gain (3.3 dBi max)

3.8 Band edge Measurement

3.8.1 Limit

At the edge of the authorized band the RF power shall be at least 20 dB down.

3.8.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.8.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

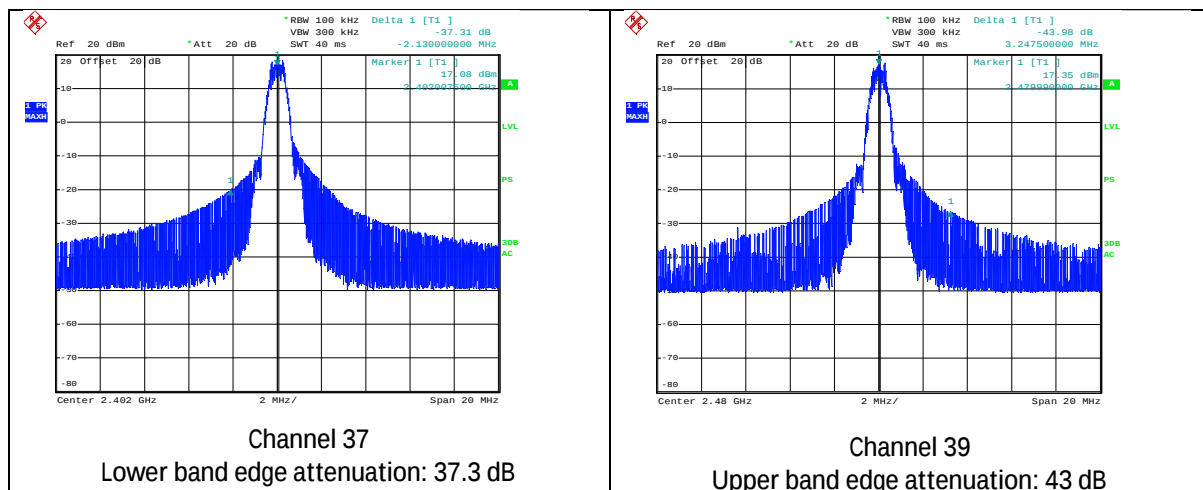
3.8.4 Test procedure

According to ANSI C63.10, section 6.10

3.8.5 Measurement Uncertainty

± 2.5 dB.

3.8.6 Test results of the Band edge Measurements



3.9 Conducted emissions

3.9.1 Limit

According to 15.207 (a)

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table.

Frequency of emission (MHz)	Conducted limit (dB μ V)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases with the logarithm of the frequency.

3.9.2 Measurement instruments

The measurement instruments are listed in chapter 2.3 of this report.

3.9.3 Test setup

The test setup is as shown in chapter 2.2 of this report.

3.9.4 Test procedure

According to ANSI C63.4: 2014, section 13.3
IRN 029 – Method 1

3.9.5 Test results and plots of the AC mains conducted measurement

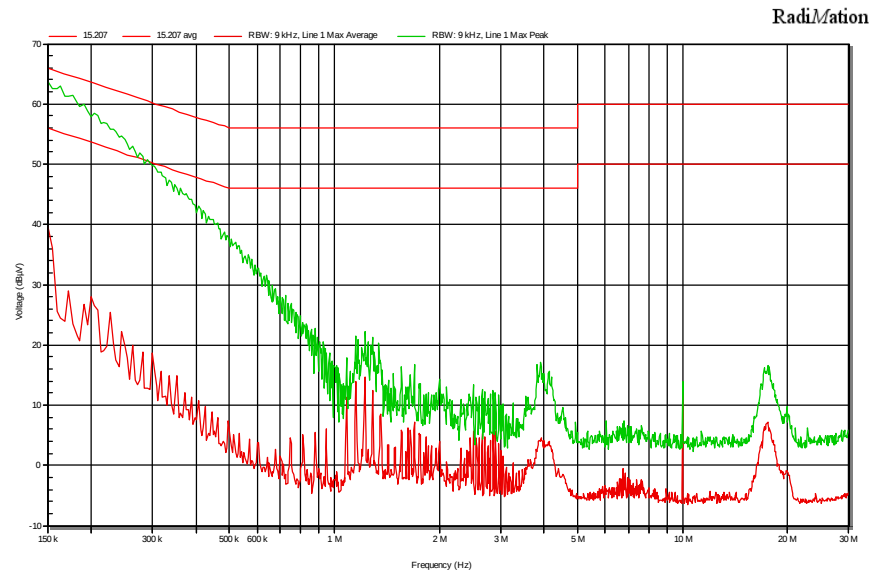
See next page.

3.9.6 Measurement uncertainty

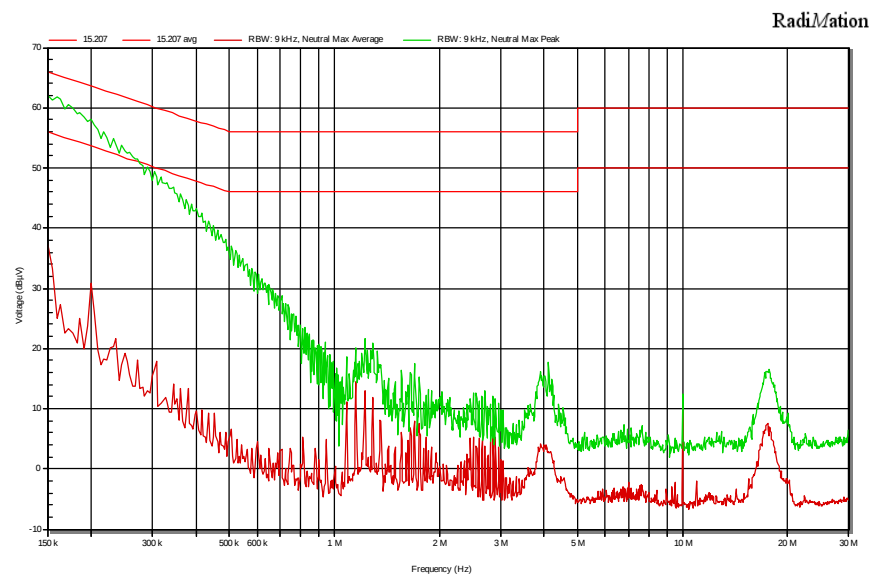
+/- 3.6 dB

3.9.7 Plots of the AC mains conducted spurious measurement

110 Vac Phase



110 Vac Neutral



Note: the upper trace is to be compared with the upper limit line and the lower trace with the lower limit line.