

Date: ESPOO 21.03.2014

Page: 1 (22)

Appendices

Number:
No. 1 / 1

254779A

Date of handing in: 24.02.2014

Tested by:



Pekka Kälviäinen, Test Engineer

Reviewed by:



Timo Leismala, Test Manager

SORT OF EQUIPMENT:

2.4 GHz Transceiver

IC NUMBER:
SAVOX PRODUCT CODE:
FCC ID:
SAVOX PRODUCT CODE:
TYPE:
MANUFACTURER:

6574A-TUFWPTT
K16214/A C555 WPTT PCBA
TUFWPTT
K16214/A C555 WPTT PCBA
CC2530F32RHAT
Texas Instruments

CLIENT:

Savox Communications Ltd.

ADDRESS:

Sinikalliontie 3B, FI-02630 Espoo, Finland

TELEPHONE:

+358 (0)9 417 411 00

TEST LABORATORY:

Nemko Oy

FCC REG. NO.

359859 October 25, 2013

IC FILE NO.

2040F-1 November 22, 2012

SUMMARY:

In regard to the performed tests the equipment under test fulfils the requirements defined in the test specifications, see page 2 for details

The test results are valid for the tested unit only. Without a written permission of SGS Fimko EMC Oy it is allowed to copy this report as a whole, but not partially.

Summary of performed tests and test results

<i>Section in CFR 47</i>	<i>Section in RSS-GEN or RSS-210, Issue 8</i>		<i>Result</i>
15.249 (a)	A2.9	Field strength of fundamental	PASS
15.249 (d)(e), 15.209	A2.9	Band-edge compliance of RF emissions	PASS
15.249 (d)(e), 15.209	A2.9	Spurious radiated emissions	PASS
15.215		20 dB bandwidth	-
15.207	7.2.2	AC power line conducted emissions	PASS

Explanations:

- PASS The EUT passed that particular test.
 FAIL The EUT failed that particular test.
 N.A. The test not applicable, battery operated equipment
 X The measurement was done, but there is no applicable performance criteria.

Disclaimer

This test report is issued under SGS Fimko general terms of delivery (available on request and accessible at www.fi.sgs.com). Attention is drawn to the limitations of liability, indemnification and jurisdictional issues defined therein. Unless otherwise stated: (a) the results shown in this document refer only to the sample(s) tested and (b) such sample(s) are retained for three months. This document cannot be reproduced except in full, without prior approval of SGS Fimko.

Any unauthorized alteration, forgery or falsification of the content or appearance of this report is unlawful and offenders may be prosecuted to the fullest extent of the law.

Contents

Summary of performed tests and test results	2
1. EUT and Accessory Information	4
1.1 EUT description	4
1.2 EUT and accessories.....	4
1.3 Additional information related to testing	4
2. Test setups.....	5
3. Standards and measurement methods.....	6
4. Test results.....	6
4.1 Field strength of fundamental	6
4.1.1 EUT operation mode.....	6
4.1.2 Test method and limit	6
4.1.3 Test results	7
4.2 Band-edge compliance of RF emissions	9
4.2.1 EUT operation mode.....	9
4.2.2 Test method and limit	9
4.2.3 Test results	10
4.3 Spurious radiated emission	12
4.3.1 EUT operation mode.....	12
4.3.2 Test method and limit	12
4.3.3 Test results	14
4.4 20 dB bandwidth	15
4.4.1 EUT operation mode.....	15
4.4.2 Test method and limit	15
4.4.3 Test results	15
4.1 AC power line conducted emissions.....	17
4.1.1 Test method and limit	17
4.1.2 EUT operation mode.....	17
4.1.3 Test results	18
4.2 Duty cycle correction factor, Transmit time in 100 ms.....	20
4.2.1 Test data	20
5. List of test equipment.....	21
6. Photographs.....	22

1. EUT and Accessory Information

1.1 EUT description

2.4 GHz transceiver, Digital modulated, 16 channels

1.2 EUT and accessories

	<i>unit</i>	<i>type</i>	<i>s/n</i>
<i>EUT</i>	Transceiver	CC2530F32RHAT	152064301
<i>EUT</i>	Antenna	Molex 479500001	-
<i>AE</i>	AC power supply	HG Power PS3010	-

Operating voltages

transceiver: 3.0V

AC power supply: 230V 50Hz AC

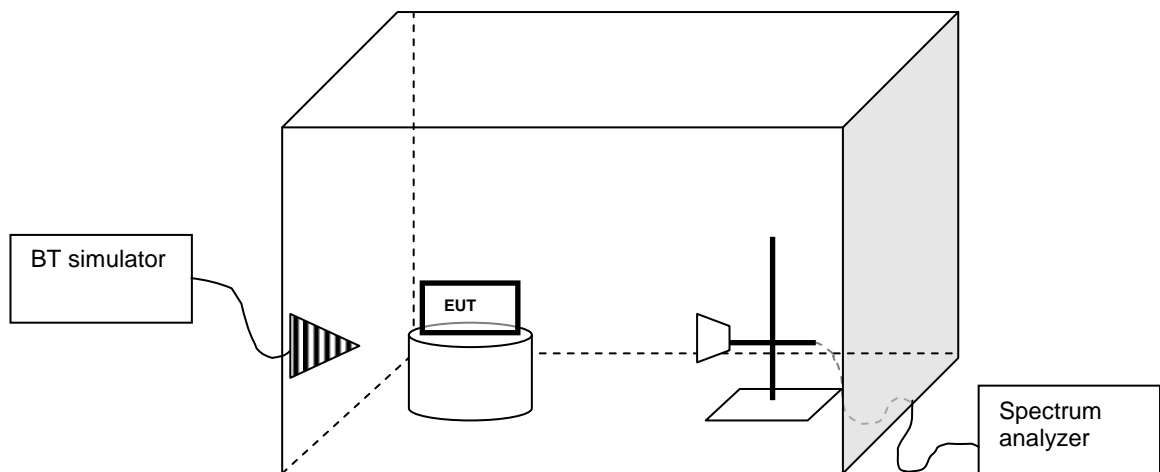
1.3 Additional information related to testing

Tested Technology:	Digital modulated, 16 channels	
Antenna:	Integral	
Type of Unit	Transmitter	
Modulation:	DSSS	
Power Supply Requirement:	Nominal	3.0VDC
Transmit Frequency Range	2400 MHz to 2483.5 MHz	
Transmit Channels Tested:	Channel Frequency (MHz)	
	2405	
	2440	
	2480	

2. Test setups

Setup (Radiated measurements)

The test was performed inside a semi anechoic shielded room. For the duration of the test the EUT was placed on a non-conductive support 0.8 m high standing on the turntable. The tower and turn table were remotely controlled to turn the EUT and change the antenna polarization. The measured signal was routed from the measuring antenna to the spectrum analyzer. A BT simulator was not used.



3. Standards and measurement methods

The test were performed in guidance of the CFR 47, FCC Rules Part 15 Subpart C, ANSI C63.4 (2003), CISPR 22 Ed. 6.0, Public notice DA 00-705, ANSI C63.10 (2009), IC standards RSS-GEN (Issue 3, December 2010) and RSS-210 (Issue 8, December 2010).

4. Test results

4.1 Field strength of fundamental

The test was performed as a compliance test. The test parameters concerned were as follows:

<i>EUT</i>	EUT
<i>Site name</i>	Perkkaa
<i>FCC rule part</i>	§ 15.249 (a)
<i>Section in RSS-210</i>	A2.9
<i>Date of testing</i>	24.02.2014
<i>Test equipment</i>	566, 525, 350
<i>Test conditions</i>	22 °C, 30 % RH

4.1.1 EUT operation mode

<i>EUT frequency (MHz)</i>	2405, 2440 and 2480
----------------------------	----------------------------

4.1.2 Test method and limit

<i>Frequency range (MHz)</i>	Limit Average (dB μ V/m)	Limit Peak (dB μ V/m)
2400 – 2483.5	≤ 94	≤ 114

The measurement results were obtained as described below.

$$E [\text{dB}(\mu\text{V}/\text{m})] = U_{RX} + A_{CABLE} + AF$$

Where

U_{RX} receiver reading

A_{CABLE} attenuation of the cable

AF antenna factor

Duty Cycle correction factor(dB) -44.11 dB was used. (RFon 0.6233ms/100ms)

4.1.3 Test results

frequency (MHz)	E Average (dBμV/m)	E Peak (dBμV/m)	Result
2405	55.81	99.91	PASS
2440	55.20	99.31	PASS
2480	53.46	97.57	PASS

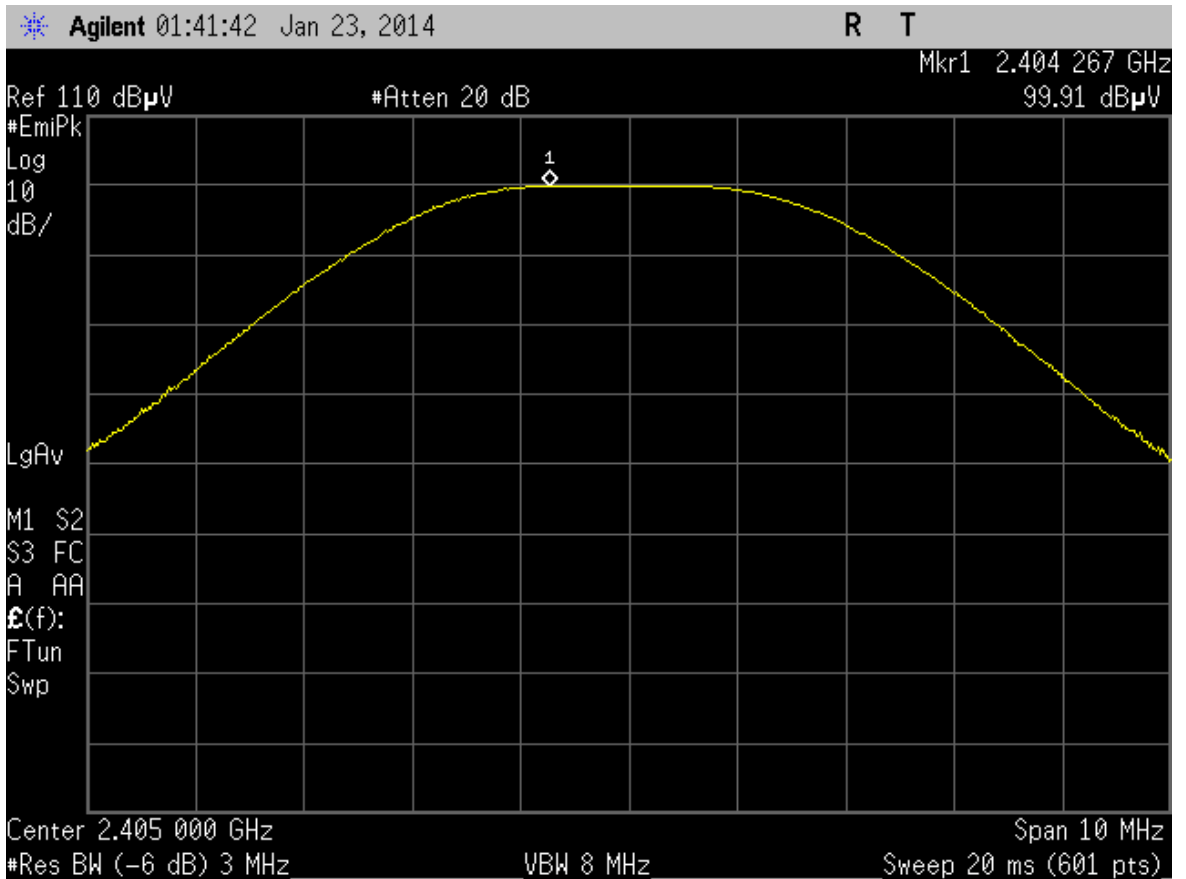


Figure 1. 2405MHz, Field strength of fundamental

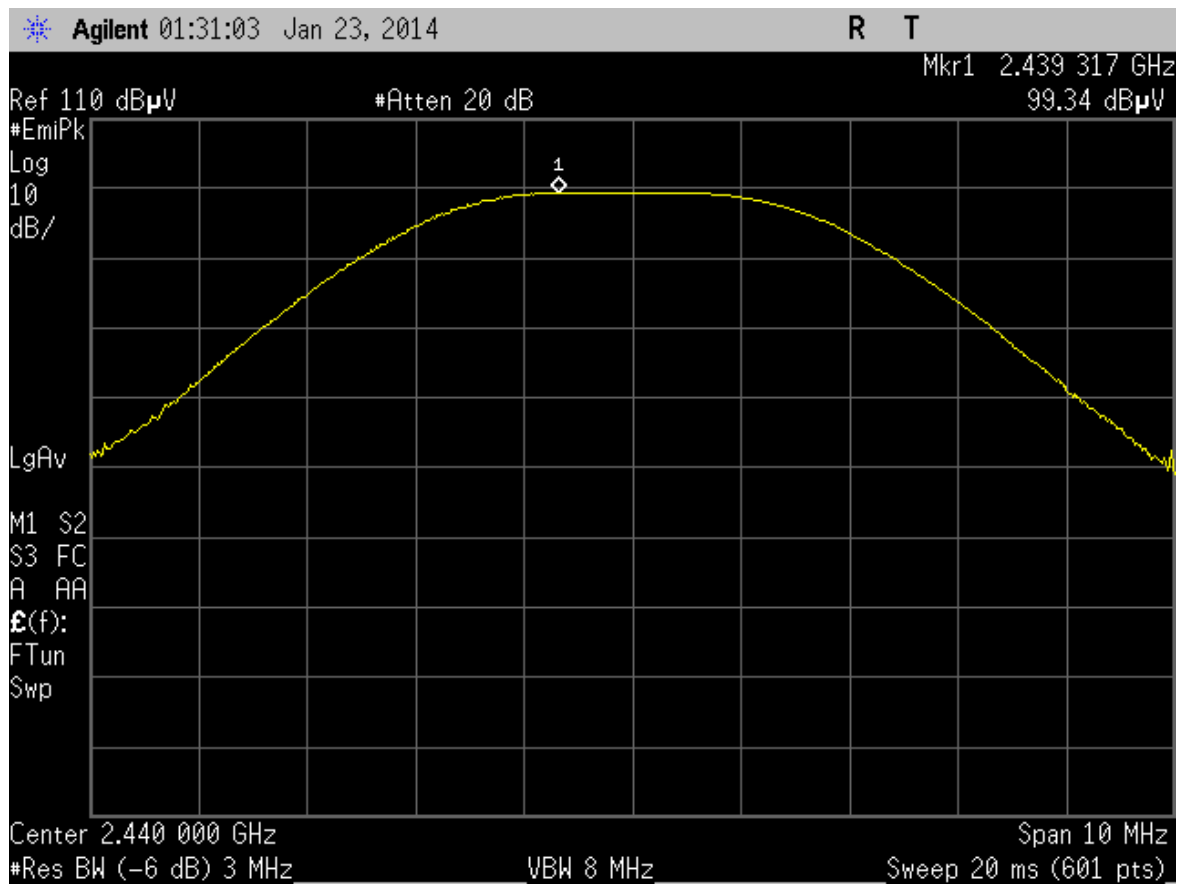


Figure 2. 2440MHz, Field strength of fundamental

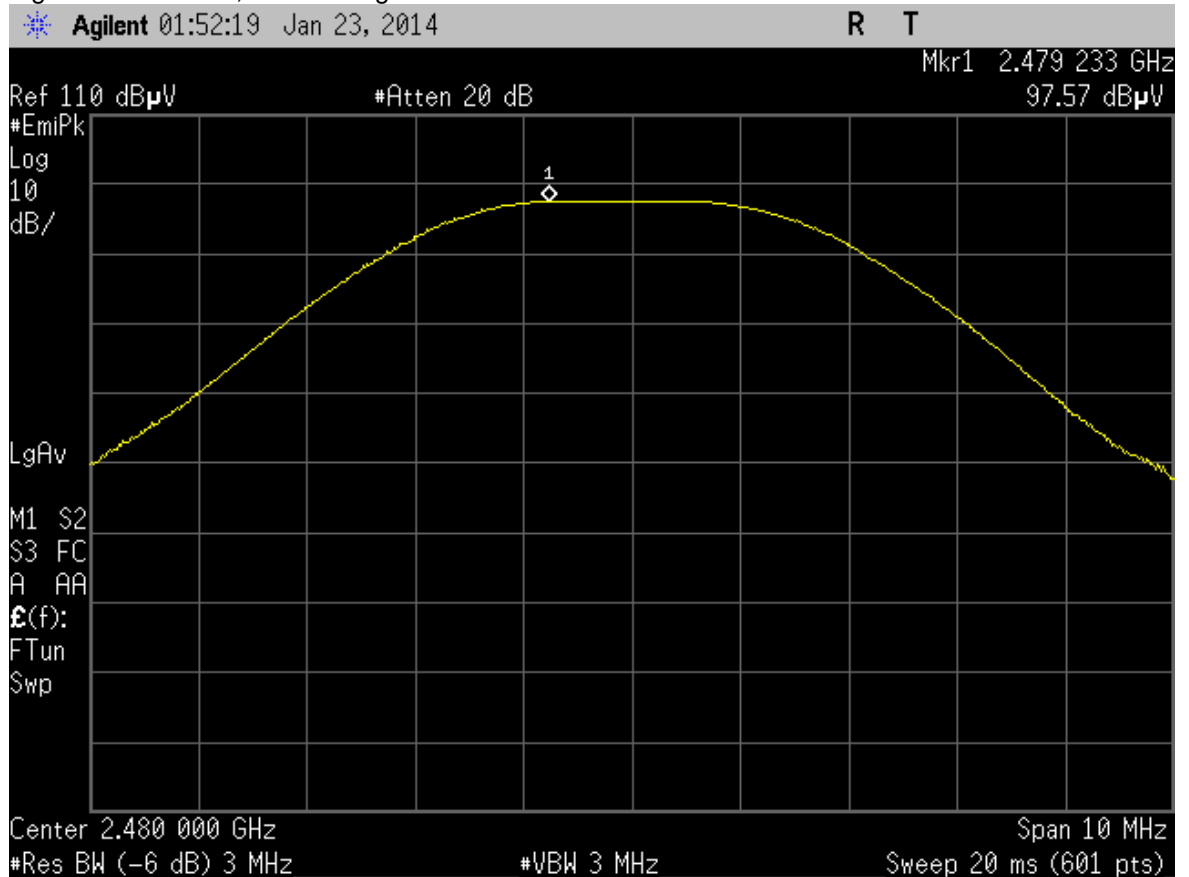


Figure 3. 2480MHz, Field strength of fundamental

4.2 Band-edge compliance of RF emissions

The test was performed as a compliance test. The test parameters concerned were as follows:

<i>EUT</i>	EUT
<i>Site name</i>	Perkkaa
<i>FCC rule part</i>	§ 15.249 (d)(e), § 15.209
<i>Section in RSS-210</i>	A2.9
<i>Date of testing</i>	24.02.2014
<i>Test equipment</i>	566, 525, 350
<i>Test conditions</i>	24 °C, 51 % RH
<i>Test result</i>	PASS

4.2.1 EUT operation mode

<i>EUT frequency (MHz)</i>	2405 and 2480
----------------------------	----------------------

4.2.2 Test method and limit

The measurement is made according to Public notice DA 00-705 and IC standard RSS-210.

3m measurement distance

<i>Frequency range (MHz)</i>	<i>Limit Average (dBμV/m)</i>	<i>Limit Peak (dBμV/m)</i>
Below 2390 and above 2483.5	≤ 54	≤ 74

The measurement results were obtained as described below.

$$E \text{ [dB}(\mu\text{V/m)}] = U_{RX} + A_{CABLE} + AF$$

Where

U_{RX} receiver reading

A_{CABLE} attenuation of the cable

AF antenna factor

Duty Cycle correction factor(dB) -44.11dB was used. (RFon 0.6233ms/100ms)

4.2.3 Test results

2405 MHz:

Below 2400 MHz:

<i>Detector (RBW: 1MHz)</i>	<i>E (dBμV/m)</i>	<i>Result</i>
Peak	54.67	PASS
Average	10.56	PASS

2480 MHz:

Above 2483.5 MHz:

<i>Detector (RBW: 1MHz)</i>	<i>E (dBμV/m)</i>	<i>Result</i>
Peak	58.92	PASS
Average	14.81	PASS

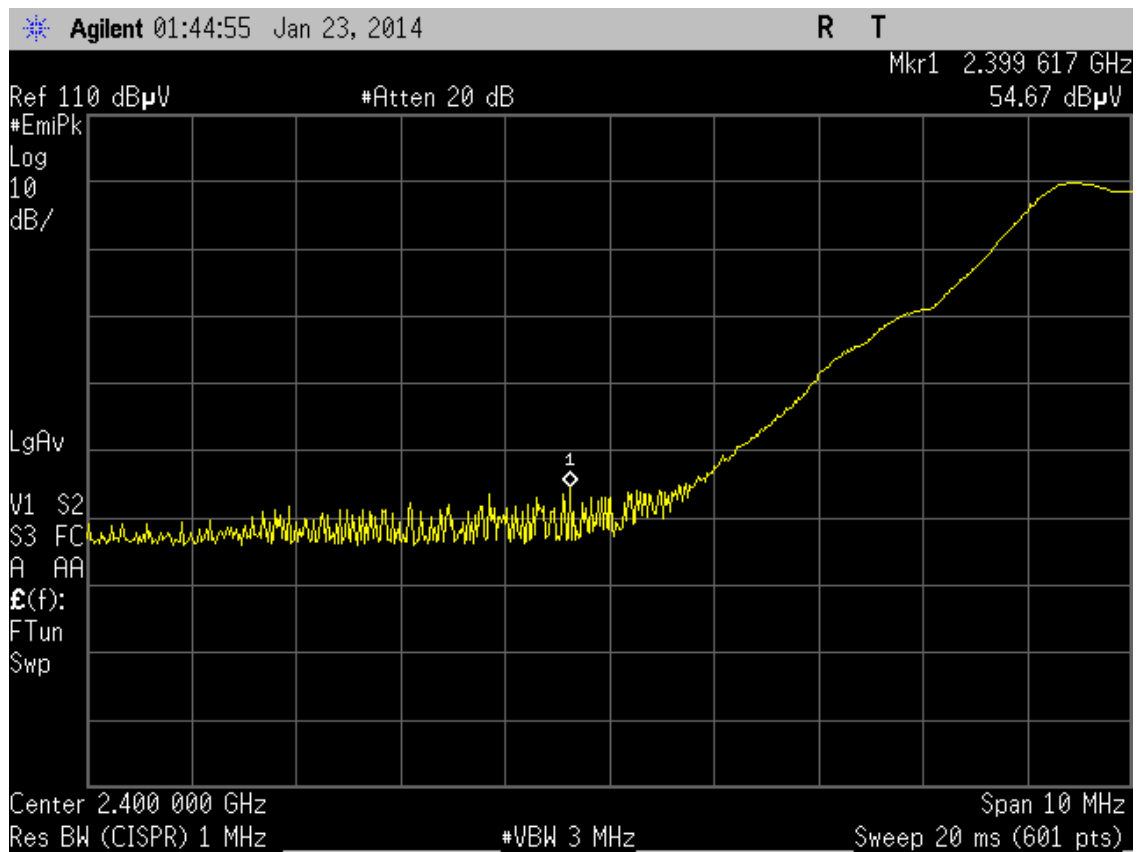


Figure 1. 2405MHz, Band-edge compliance, low end

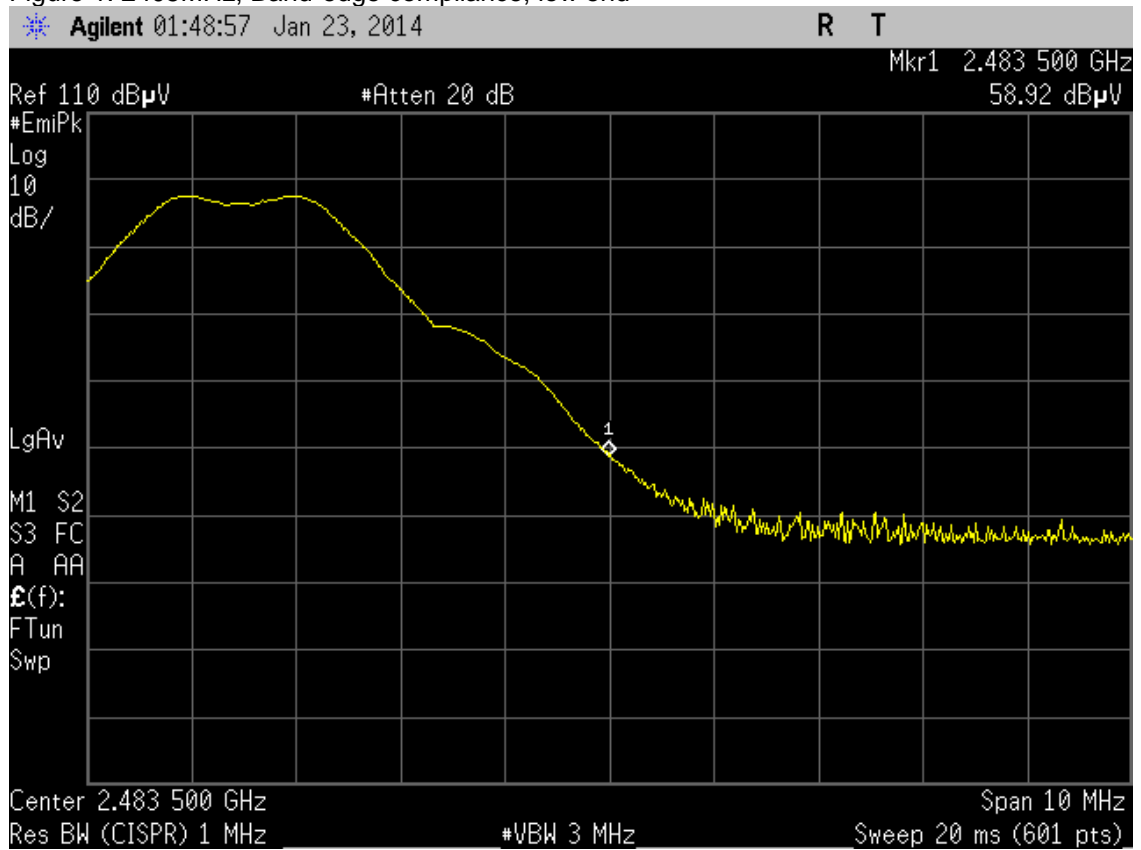


Figure 5. 2480MHz, Band-edge compliance, high end

4.3 Spurious radiated emission

The test was performed as a compliance test. The test parameters concerned were as follows:

<i>EUT</i>	EUT
<i>Site name</i>	Perkkaa
<i>FCC rule part</i>	§ 15.249 (d)(e), § 15.209
<i>Section in RSS-210</i>	A2.9
<i>Date of testing</i>	24.02.2014
<i>Test equipment</i>	566, 709, 564, 559, 525, 319, 544, 350, 88
<i>Test conditions</i>	24 °C, 52 % RH

4.3.1 EUT operation mode

<i>EUT frequency (MHz)</i>	2405, 2440 and 2480
----------------------------	----------------------------

4.3.2 Test method and limit

The test was performed in a semi-anechoic shielded room. The EUT was placed on a non-conductive 0.8 m high table standing on the turntable. During the test the distance from the EUT to the measuring antenna was 3 m. The excess length of the cables of the EUT was made into bundles 30-40 cm in length (see photograph 1). In order to find the maximum levels of the disturbance radiation the angle of the turntable, the height of the measuring antenna and the lay-out of the EUT cables were varied during the tests. The test was performed with the measuring antenna being both in horizontal and vertical polarizations.

Vertical and horizontal polarizations in the frequency range 30 – 1000 MHz was measured by using the peak detector. During the peak detector scan, the turntable was rotated from 0° to 360° with 30° step with the antenna heights 1.0 m and 3.0 m. The highest levels of the radiated interference field strength measured by using the quasi-peak detector were recorded.

Vertical and horizontal polarizations in the frequency range 1000 – 25000 MHz was measured by using the peak detector. During the peak detector scan, the turntable was rotated from 0° to 360° with 15° step with the antenna heights 1.0 m, 1,5m, 2.0m, 2,5m and 3.0 m. The highest levels of the radiated interference field strength measured by using the average and peak detectors were recorded.

Minimum Standard: Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.

Emissions falling in the restricted bands of 15.205 shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions.

3m measuring distance, FCC Part 15.209

<i>Frequency band MHz</i>	<i>limit, Quasi peak detector dB(μV/m)</i>
30 - 88	40
88 - 216	43.5
216 - 960	46
960 - 1000	54

<i>Frequency band MHz</i>	<i>limit, average detector dB(μV/m)</i>	<i>limit, peak detector dB(μV/m)</i>
1000 - 25000	54	74

The EUT was tested on three orthogonal axes.

The device was tested from 30 MHz to the tenth harmonic of the highest fundamental frequency per 15.33.

The device was tested on three channels per 15.31(l).

The CFR 47 Part 15. Subpart B. Class B limit of 500 μV/m has been calculated to correspond 54 dB(μV/m) as follows: $[dB(\mu V/m)] = 20 \log[\mu V/m]$.

The measurement results were obtained as described below.

$$E [dB(\mu V/m)] = U_{RX} + A_{CABLE} + AF - G_{PREAMP}$$

Where

U_{RX} receiver reading

A_{CABLE} attenuation of the cable

AF antenna factor

G_{PREAMP} gain of the preamplifier

Duty Cycle correction factor(dB) -44.11 dB was used. (RFon 0.6233ms/100ms)

4.3.3 Test results

below 1GHz: RBW 120kHz
above 1GHz: peak, RBW 1MHz, VBW 3MHz

2405MHz

<i>Frequency MHz</i>	<i>Peak dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
4810	56.7	74	17.3	PASS
7215	52.0	74	22.0	PASS

<i>Frequency MHz</i>	<i>Average dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
4810	12.6	54	41.4	PASS
7215	7.9	54	46.1	PASS

2440MHz

<i>Frequency MHz</i>	<i>Peak dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
4880	56.3	74	17.7	PASS
7320	52.8	74	21.2	PASS

<i>Frequency MHz</i>	<i>Average dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
7320	12.2	54	41.8	PASS
	8.7	54	45.3	PASS

2480MHz

<i>Frequency MHz</i>	<i>Peak dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
4960	55.8	74	18.2	PASS
7440	52.4	74	21.6	PASS

<i>Frequency MHz</i>	<i>Average dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
4960	11.7	54	42.3	PASS
7440	8.3	54	45.7	PASS

4.4 20 dB bandwidth

The test was performed as a compliance test. The test parameters concerned were as follows:

<i>EUT</i>	EUT
<i>Site name</i>	Perkkaa
<i>FCC rule part</i>	§ 15.215
<i>Date of testing</i>	24.02.2014
<i>Test equipment</i>	566, 525, 350
<i>Test conditions</i>	22 °C, 30 % RH

4.4.1 EUT operation mode

<i>EUT frequency (MHz)</i>	2405, 2440 and 2480
----------------------------	----------------------------

4.4.2 Test method and limit

The measurement is made according to Public notice DA 00-705 and IC standard RSS-210.

<i>Limit (MHz)</i>	N/A
--------------------	------------

4.4.3 Test results

<i>EUT frequency (MHz)</i>	<i>20 dB bandwidth (MHz)</i>
2405	2.881
2440	2.908
2480	2.912

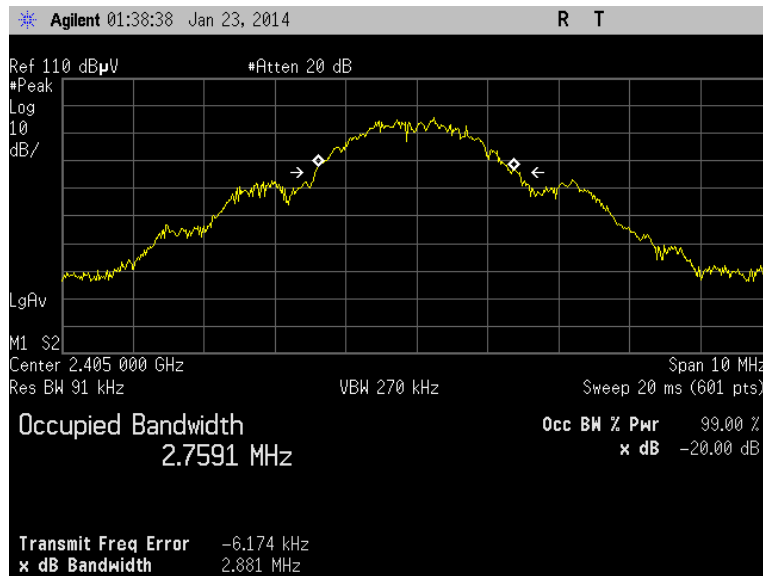


Figure 6. 2405MHz, 20 dB bandwidth

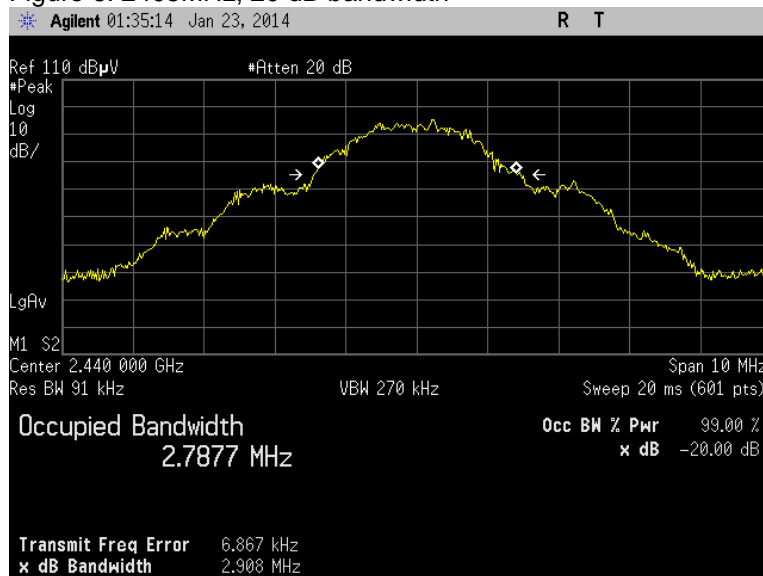


Figure 7. 2440MHz, 20 dB bandwidth

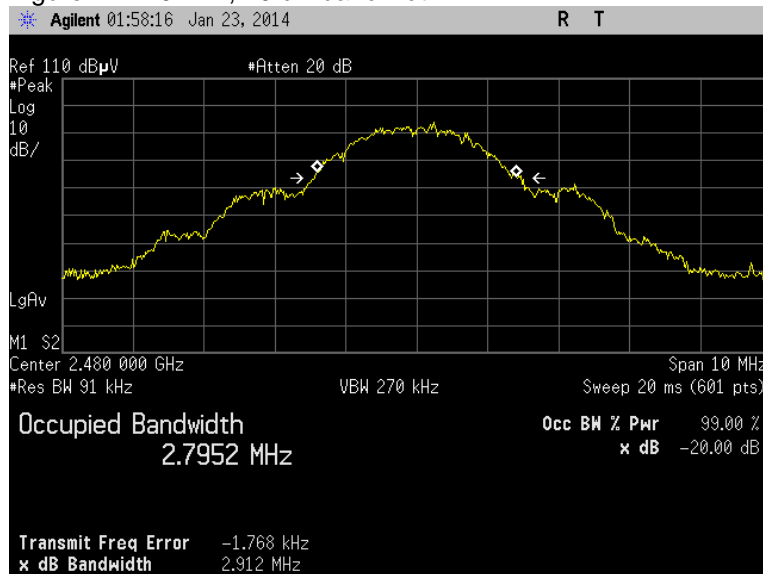


Figure 8. 2480MHz, 20 dB bandwidth

4.1 AC power line conducted emissions

The test was performed as a compliance test. The test parameters concerned were as follows:

<i>EUT</i>	<i>EUT</i>
<i>Site name</i>	Perkkaa
<i>FCC rule part</i>	§ 15.207
<i>Section in RSS-210</i>	7.2.2
<i>Date of testing</i>	25.02.2014
<i>Test equipment</i>	745, 348, 694
<i>Test conditions</i>	22 °C, 30 % RH
<i>Test result</i>	PASS

4.1.1 Test method and limit

The test was performed inside a shielded room where the floor and one of the walls of the test site comprised the reference ground plane (RGP). For the duration of the test the EUT was placed on a non-conductive table 0.8 m high standing on the reference ground plane (see photograph 2). The excess length of the cables of the EUT were made into bundles 30-40 cm in length. The power input cable of the EUT was connected to an artificial mains network. The test was performed separately on the phase and also on the neutral wire.

The disturbances were first examined by performing a spectrum scan by using a peak detector. The general procedure in the conducted disturbance emission test is that no further measurements are necessary if the disturbance levels measured by using the peak detector are below the limit value defined for the measurement performed by using an average detector.

If not, then at the test frequencies concerned the measurement is performed also by using a quasi-peak detector. If the disturbance levels measured by using the quasi-peak detector are below the limit value defined for the measurement performed by using an average detector, then measurements by using the average detector are not necessary.

<i>Frequency band MHz</i>	<i>Quasi-peak dB(μV)</i>	<i>Average limit dB(μV)</i>
0.15 – 0.5	66 – 56	56 – 46
0.5 – 5	56	46
5 - 30	60	50

4.1.2 EUT operation mode

<i>EUT Frequency (MHz)</i>	2440
----------------------------	-------------

4.1.3 Test results

Line N

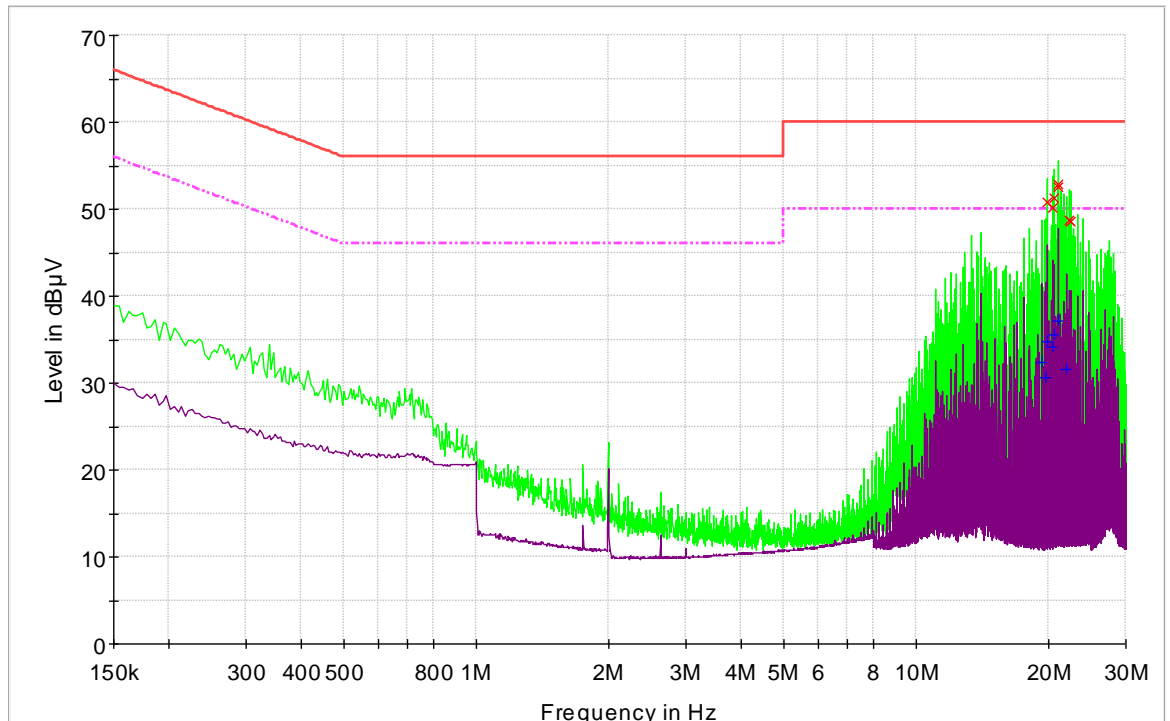


Figure 9. AC powerline emissions, Line N

Highest emissions:

Frequency MHz	Quasi-peak dB(µV)	Limit value dB(µV)	Margin dB	Result
19.944	50.8	60.0	9.2	PASS
20.423	50.2	60.0	9.8	PASS
20.571	51.3	60.0	8.7	PASS
21.031	52.6	60.0	7.4	PASS
21.032	52.8	60.0	7.2	PASS
22.286	48.7	60.0	11.3	PASS
22.410	48.6	60.0	11.4	PASS

Frequency MHz	Average dB(µV)	Limit value dB(µV)	Margin dB	Result
19.319	32.4	50.0	17.6	PASS
19.795	30.7	50.0	19.3	PASS
19.945	34.7	50.0	15.3	PASS
20.420	34.2	50.0	15.8	PASS
20.572	35.5	50.0	14.5	PASS
21.032	37.1	50.0	12.9	PASS
21.930	31.5	50.0	18.5	PASS

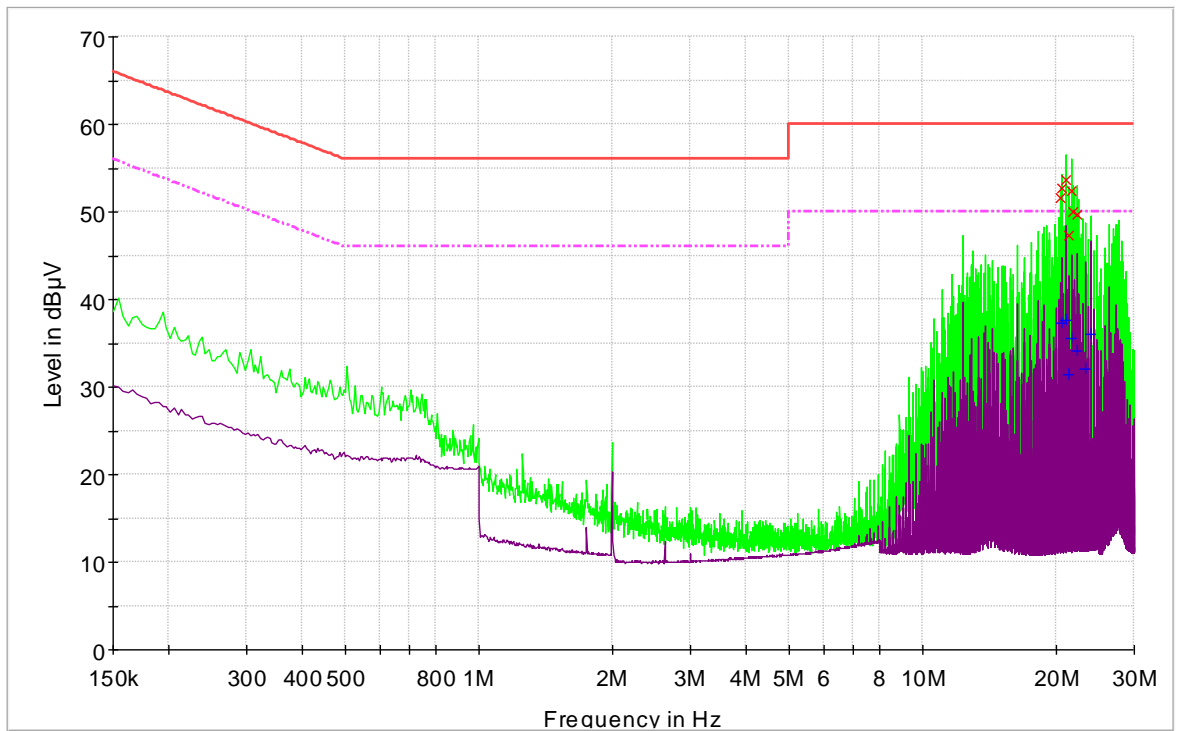
Line L


Figure 10. AC powerline emissions, Line L

Highest emissions:

Frequency MHz	Quasi-peak dB(µV)	Limit value dB(µV)	Margin dB	Result
20.423	51.5	60.0	8.5	PASS
20.571	52.7	60.0	7.3	PASS
21.032	53.7	60.0	6.3	PASS
21.349	47.3	60.0	12.7	PASS
21.658	52.3	60.0	7.7	PASS
21.776	50.0	60.0	10.0	PASS
22.285	49.7	60.0	10.3	PASS

Frequency MHz	Average dB(µV)	Limit value dB(µV)	Margin dB	Result
20.570	37.4	50.0	12.6	PASS
21.034	37.6	50.0	12.4	PASS
21.298	31.4	50.0	18.6	PASS
21.661	35.6	50.0	14.4	PASS
22.285	34.1	50.0	15.9	PASS
23.368	32.0	50.0	18.0	PASS
24.000	36.0	50.0	14.0	PASS

4.2 Duty cycle correction factor, Transmit time in 100 ms

Spectrum analyzer with zero span was used to investigate spectrum.

15.35(c) Unless otherwise specified, e.g. § 15.255(b), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

4.2.1 Test data

Pulses/100ms=1

Length of one pulse = 0.6233ms

*DutyCycleCorrectionFactor=20*log(Tocc/100)=20*log(1*0.6233/100)=-44.11dB*

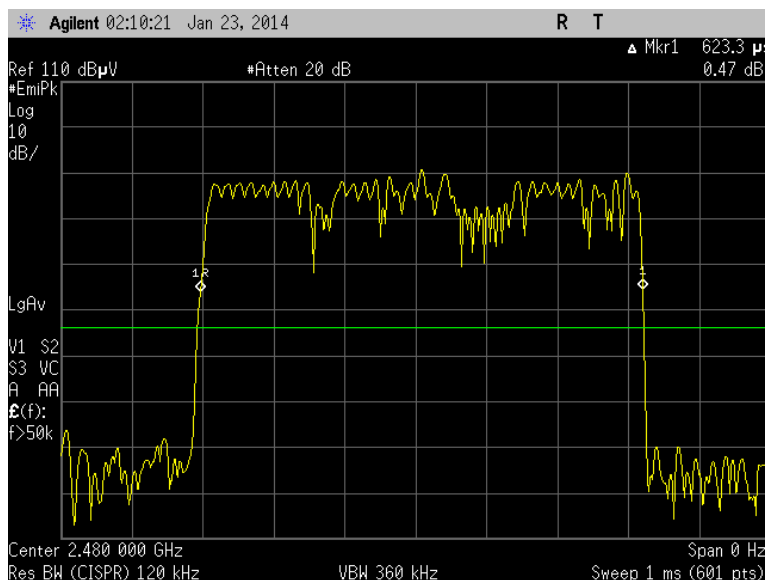


Figure 11. Duration of one transmission, 2480MHz

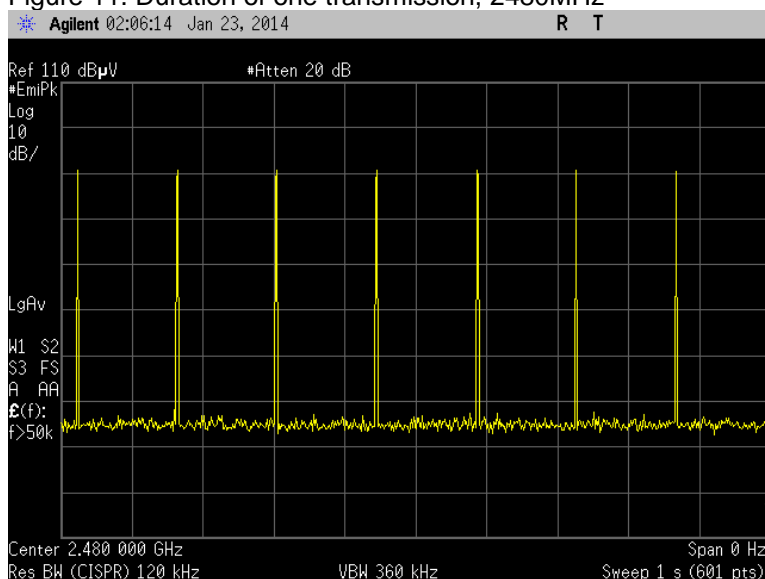


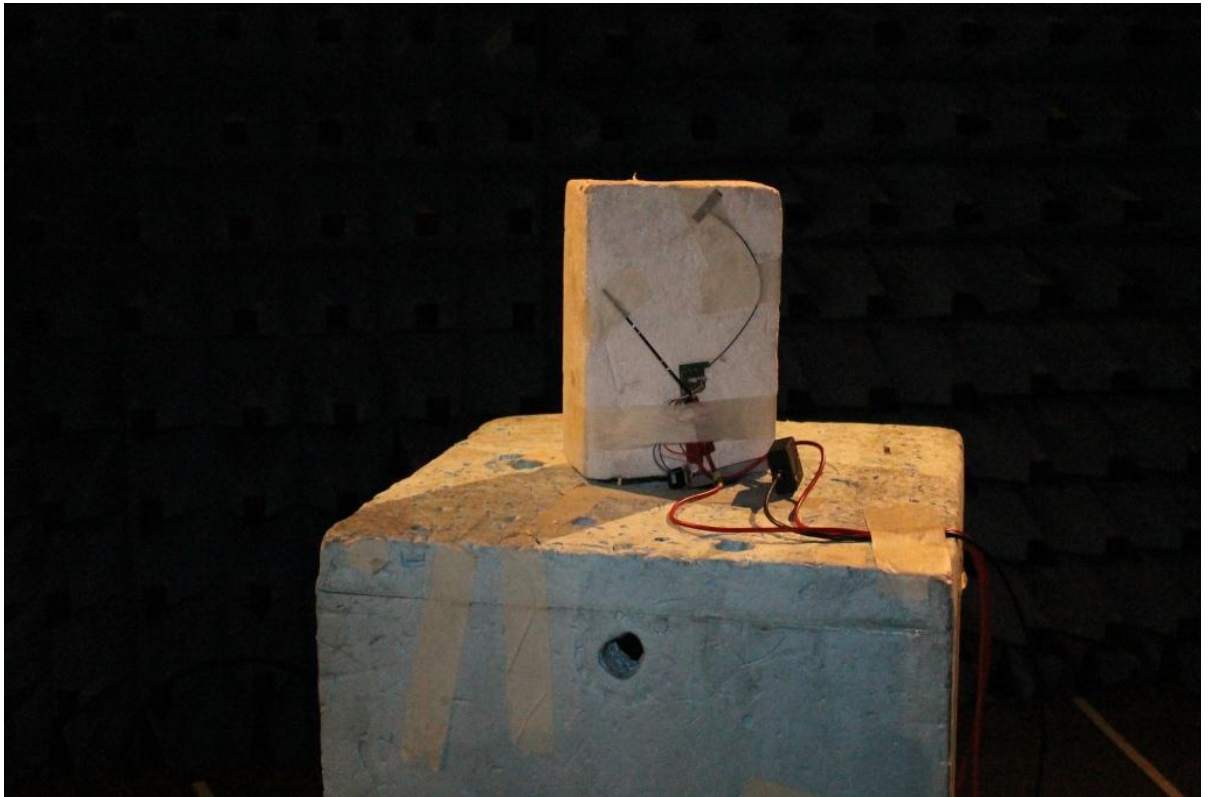
Figure 12. Duration of 1 s, 2480MHz

5. List of test equipment

Each active test equipment is calibrated once a year, antennas every 18 months and other passive equipment every 24 months.

Nr.	Equipment	Type	Manufacturer	Serial number	Cal date	Cal due
338	Test receiver	ESS	Rohde & Schwarz	847151/009	24.11.2013	11.2014
566	Spectrum analyzer	E4448A	Agilent	US42510236	17.4.2013	4.2014
709	EMI test receiver	ESU8	Rohde & Schwarz	100297	24.07.2013	7.2014
567	RF generator	E8257C	Agilent	MY43320736	25.2.2013	2.2014
544	RF-amplifier	ZFL-2000VH2	Mini-Circuits	QA0749010	29.1.2014	1.2015
564	RF amplifier	CA018-4010	CIAO Wireless	132	3.2.2014	2.2015
745	2-Line V-Network	ENV216	Rohde & Schwarz	101466	11.6.2013	06.2014
319	Antenna	CBL6112	Chase	2018	12.7.2012	1.2014
525	Double-Ridged Horn	3115	Emco	6691	10.10.2012	4.2014
542	Double-Ridged Horn	3115	Emco	00023905	10.10.2012	4.2014
559	Highpass Filter	WHKX3.0/18G-10SS	Wainwright Instruments	1	3.2.2014	2.2016
88	Waveguide horn	638	Narda	8003	-	-
350	Semianechoic shielded room	RFD-F-100	Euroshield Oy	1327	26.10.2012	10.2014
348	Shielded room	RFSD-100	Euroshield Oy	1320	-	-

6. Photographs



Photograph 1. Spurious radiated emissions test setup



Photograph 2. AC power line conducted emissions test setup