RADIO TEST REPORT

No. 1511922STO-001, Ed. 1

RF Performance

EQUIPMENT UNDER TEST

Equipment:	Wireless sensor
Type/Model:	SCU
Manufacturer:	SCA Hygiene Products AB
Tested by request of:	SCA Hygiene Products AB

SUMMARY

Referring to the emission limits, and the operating mode during the tests specified in this report, the equipment complies with the requirements according to the following standards:

47 CFR Part 15 (2014):, Subpart C: Intentional radiators. Section 15.247

RSS-GEN Issue 4 (2014): General requirements of compliance of radio apparatus (2014)

RSS-247 Issue 1(2015): Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices (2015)

For details, see clause 2 – 4

Date of issue: 2015-07-10

Tested by: Matti Virkki

Approved by: Stefan Andersson

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Revision History

Edition	Date	Description	Changes
1	2015-07-10	First release	

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1 CLIENT INFORMATION

The EUT has been tested by request of

Company	SCA Hygiene Products AB Bäckstensgatan 5 405 03 Göteborg Sweden
Name of contact	Allan Elfström

2 EQUIPMENT UNDER TEST (EUT)

2.1 Identification of the EUT

Equipment:	Wireless sensor
Type/Model:	SCU
Brand name:	SCA
ID number:	10-1322 / 10-1306
Manufacturer:	SCA Hygiene Products AB
Transmitter frequency range:	2405 MHz
Receiver frequency range:	2405 MHz

Frequency agile or hopping:	☐ Yes	☒ No
Antenna:	☒ Internal antenna	☐ External antenna
Antenna connector:	☒ None, internal antenna	☐ Yes
Antenna gain:	3 dBi max	
Rating RF output power:	4 dBm	
Type of modulation:	O-QPSK	
Temperature range:	☐ Category I (General): -20°C to +55°C ☐ Category II (Portable equipment): -10°C to +55°C ☐ Category III (Equipment for normal indoor use): +5°C to +35°C ☒ Other: 0°C to +50°C	
Transmitter stand by mode supported:	☒ Yes	☐ No

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2.2 Additional information about the EUT

The EUT consists of the following units:

Unit	Type	ID number	Comment
Wireless sensor	SCU	10-1322	SMA connector, on/off switch, external power supply
Wireless sensor	SCU	10-1306	Antenna, on/off switch

During the tests the EUT supported following software:

Software	Comment
Wiiking_SCU_Intertek_PRBS_4dbm.hex	Continuous TX modulated
Wiiking_SCU_intertek_Constant_RX.hex	RX mode

2.3 Test signals and operation modes

Continuous signal with O-QPSK modulation.

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3 TEST SPECIFICATIONS

3.1 Standards

Requirements:
47 CFR Part 15: Radio frequency device, Subpart C: Unintentional radiators (2014).

RSS-GEN Issue 4: General requirements of compliance of radio apparatus (2014).

RSS-247 Issue 1: Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices (2015)

Test methods:
ANSI C63.10-2013: American National Standard for testing Unlicensed Wireless Devices

3.2 Additions, deviations and exclusions from standards and accreditation

RSS-GEN Issue 4 (2014) and RSS-247 Issue 1 (2015) and ANSI C63.10(2013) are not within the scope of accreditation.

Radiated emission average values are measured with average detector instead of using the 20 log(tOn/100ms) correction

No other additions, deviations or exclusions have been made from standards and accreditation.

3.3 Test site

Measurements were performed at:

Intertek Semko AB.
Torshamnsgatan 43,
P.O. Box 1103
SE-164 22 Kista

Intertek Semko AB is a FCC listed test site with site registration number 90913
Intertek Semko AB is a FCC accredited conformity assessment body with designation number SE0002
Intertek Semko AB is an Industry Canada listed test facility with IC assigned code 2042G

Measurement chambers

Measurement Chamber	Type of chamber	IC Site filing #
STORA HALLEN	Semi-anechoic 10 m and 3 m	2042G-2

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4 TEST SUMMARY

The results in this report apply only to sample tested:

Requirement	Description	Result
FCC §15.203 **RSS-GEN, section 8.3**	**Antenna requirement** The EUT has integrated non detachable antenna which can't be remove without breaking EUT	**PASS**
FCC §15.207 **RSS-GEN, section 8.8 table 3**	**Conducted continuous emission in the frequency range 150 kHz to 30 MHz, AC Power input port** EUT is battery powered.	**NA**
FCC §15.247 (b)(4), (d), **RSS-247, section 5.4**	**Antenna gain** EUT antenna has 3dBi gain The EUT complies with the limits.	**PASS**
FCC §15.247 (d), 15.209(a) **RSS-247, section 5.5** **RSS-Gen, section 8.9**	**Radiated emission of electromagnetic fields in the frequency range 30 – 1000 MHz** The EUT complies with the limits. The margin to the limit was at least 16.3 dB at 948.861 MHz See clause 5.5.	**PASS**
FCC §15.247(d), 15.209(a) **RSS-247, section 5.5** **RSS-Gen, section 8.9**	**Radiated emission of electromagnetic fields in the frequency range above 1 GHz** The EUT complies with the limits. The margin to the limit was at least 3.7 dB at 7216.5 MHz See clause 6.6	**PASS**
FCC §15.247(a)(2) **RSS-GEN, section 6.6** **RSS-247, section 5.2(1)**	**Occupied bandwidth** The EUT complies with the limits. The margin to the limit is at least 903 kHz	**PASS**
FCC §15.247(b) **RSS-247, section 5.4**	**Conducted output power** The EUT complies with the limits. The margin to the limit was at least 25.9 dBm See clause 9.4.	**PASS**
FCC §15.247(e) **RSS-247, section 5.2(2)**	**Power spectral density** The EUT complies with the limits. The margin to the limit was at least 13.7 dB See clause 10.4.	**PASS**
FCC §15.247(e) **RSS-247, section 5.5**	**Band edge** The EUT complies with the limits. The margin to the limit was at least 18.7 dB at 2.400 MHz	**PASS**

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5 RADIATED RF EMISSION IN THE FREQUENCY-RANGE 30 MHZ TO 26.5 GHZ

Date of test:	2015-07-06 / 2015-07-09	**Test location:**	Stora Hallen
EUT ID:	10-1322	**Ambient temp:**	22°C
Tested by:	Matti Virkki	**Relative humidity:**	46 %
Test result:	Pass	**Margin:**	3.7 dB

5.1 Test set-up and test procedure.

The test method is in accordance with ANSI C63.10. and ANSI C63.4
The EUT was set up in order to emit maximum disturbances.
The EUT was placed on an insulating support 0.8 / 1.5m m above the turntable which is part of the reference ground plane.
Overview sweeps were performed with the measurement receiver in max-hold mode and the peak detector activated in the frequency-range 30 – 1000 MHz.
Above 1 GHz additionally the average detector was activated.
Overview sweeps above 18 GHz are made in anechoic shielded chamber at 3 m distance with EUT and antenna on a height of 1.3 m.

5.2 Test conditions

Test set-up:	**30 MHz to 1000 MHz**	
Test receiver set-up:		
Preview test:	Peak,	RBW 120 kHz. VBW 1 MHz
Final test:	Peak,	RBW 120 kHz. VBW 1 MHz
Measuring distance:	10 m	
Measuring angle:	0 – 359°	
Antenna		
Height above ground plane:	1 – 4 m	
Polarisation:	Vertical and Horizontal	
Type:	Bilog	

Test set-up:	**1 GHz – 26.5 GHz**	
Test receiver set-up:		
Preview test:	Peak,	RBW 1 MHz. VBW 3 MHz
Final test:	Peak,	RBW 1 MHz
	Average	RBW 1MHz
Measuring distance:	3 m	
Measuring angle:	0 – 359°	
Antenna		
Height above ground plane:	1 – 4 m	
Polarisation:	Vertical and Horizontal	
Type:	Horn	
Antenna tilt:	Activated	

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5.3 Radiated Emission requirements

Outside restricted bands

§15.247(d), RSS-210 A8.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits is not required.

Within restricted bands

§15.209, RSS-Gen section 8.9
Field strength of emissions must comply with limits shown in table below

Frequency range [MHz]	Field strength at 3 m (dBµV/m)	Field strength at 10 m (dBµV/m)	Detector (dBµV/m)
30 – 88	40.0	29.5	Quasi Peak
88 – 216	43.5	33.0	Quasi Peak
216 – 960	46.0	35.5	Quasi Peak
960 – 1000	54.0	43.5	Quasi Peak
Above 1000	54.0 / 74.0	43.5 / 63.5	Average / Peak

The values for 10 m measuring distance are calculated by subtracting 10.5 dB from the 3 m limit. (i.e. an extrapolation factor of 20 dB/decade according to §15.31(f)(1)) and RSS-Gen section 6.5.

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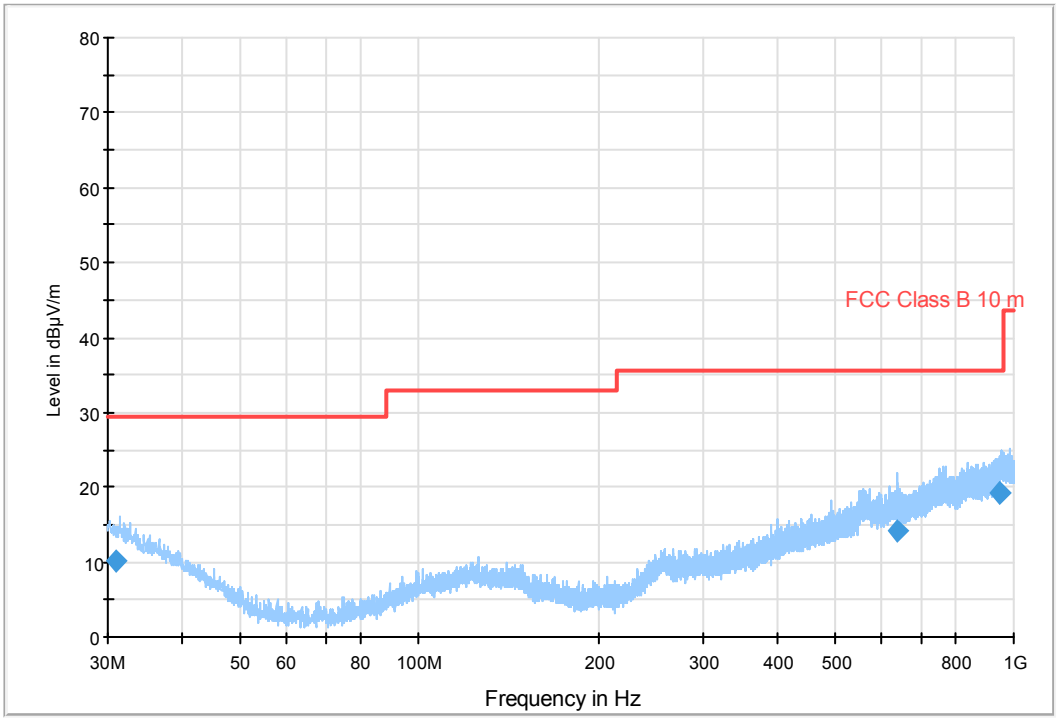
5.4 Test results 30 MHz – 1000 MHz

Radio FCC 30 - 1000 MHz FCC class B 10m continuous TT rotation



Diagram, Peak overview sweep, 30 – 1000 MHz at 10 m distance.

Measurement results, Quasi Peak

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]
30.895	10.2	29.5	H	19.3
637.080	14.2	35.6	V	21.4
948.861	19.3	35.6	H	16.3

Result [dBµV/m] = Analyser reading [dBµV] + Antenna factor [1/m] - Amplifier gain [dB] + Cable loss [dB]

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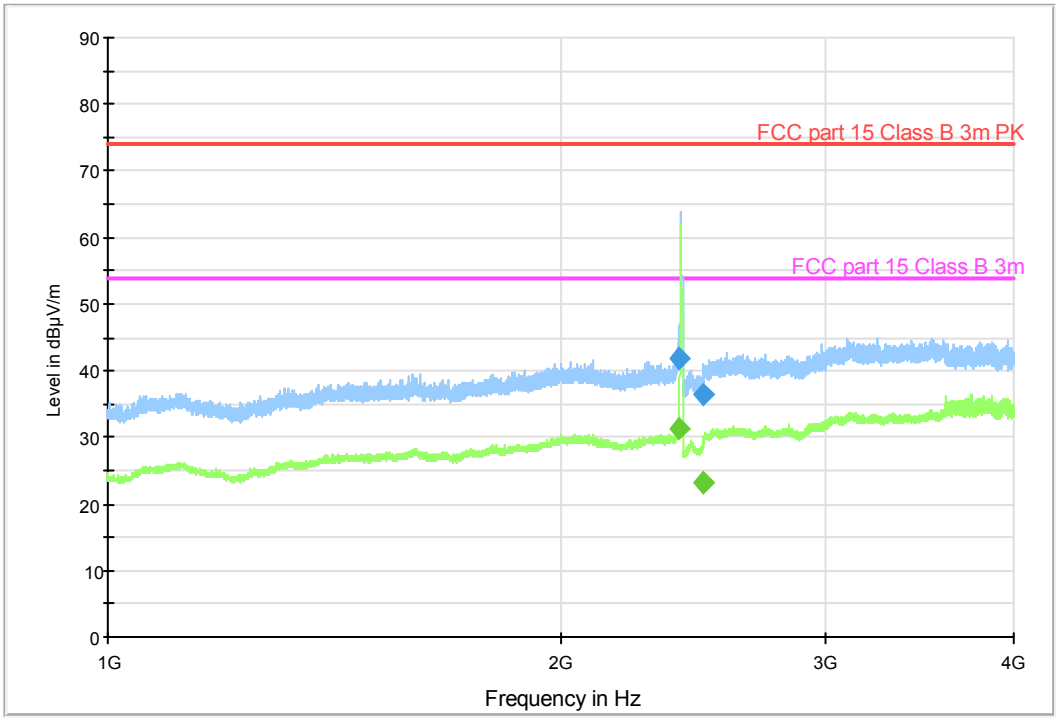
5.5 Test results 1 GHz – 4 GHz

FCC 1 G - 4 G class B 3m ESU40 Continuous TT rotation



Diagram, Peak overview sweep, 1 – 4 GHz at 3 m distance.

Measurement results, Peak

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]
2400.0	41.9	74	H	32.1
2483.5	36.5	74	H	37.5

Measurement results, Average

Not measured. Peak levels are under the average limit.

Result [dBµV/m] = Analyser reading [dBµV] + Antenna factor [1/m] - Amplifier gain [dB] + Cable loss [dB

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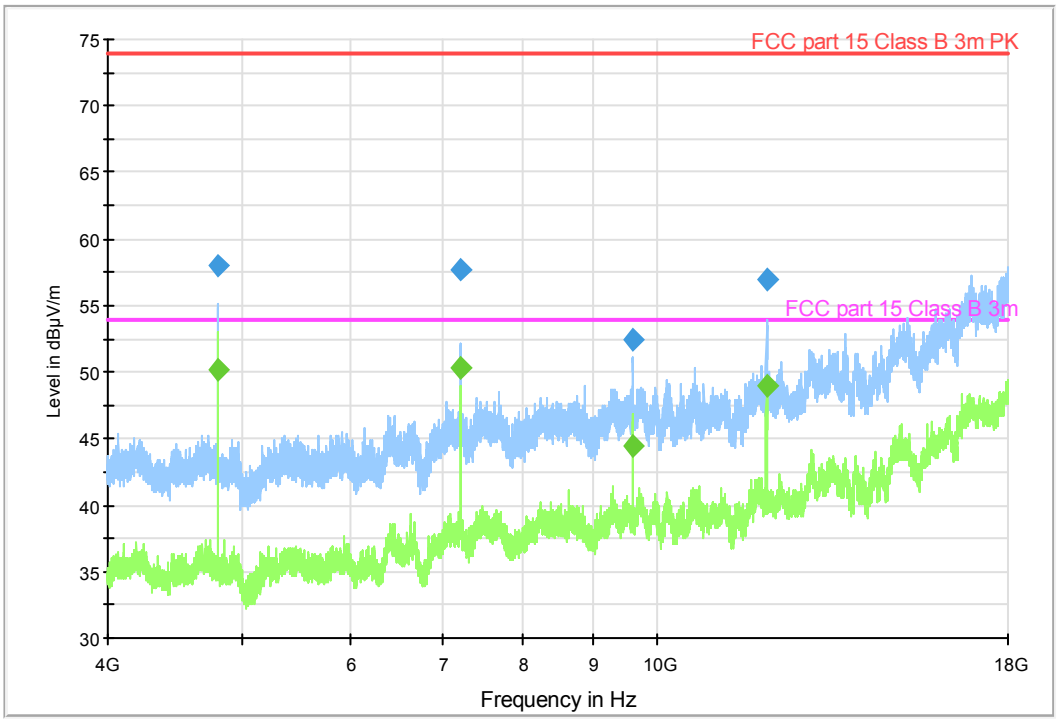
5.6 Test results 4 GHz – 18 GHz

FCC 4 G - 18 G class B 3m ESU40 Continuous TT rotation



Measurement results, Peak

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)
4809. 0	58.0	1000.0	1000	100.0	H	192.0	-4.6	16.0
7213.7	57.7	1000.0	1000	205.0	V	338.0	-0.2	16.3
9618.0	52.4	1000.0	1000	234.0	V	-33.0	1.4	21.6
12022.9	56.9	1000.0	1000	238.0	V	11.0	4.1	17.1

Measurement results, Average

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)
4811.0	50.2	1000.0	1000	100.0	H	191.0	-4.6	3.8
7216.5	50.3	1000.0	1000	205.0	V	-26.0	-0.3	3.7
9622.1	44.5	1000.0	1000	223.0	V	-26.0	1.5	9.5
12027.4	49.0	1000.0	1000	259.0	V	17.0	4.2	5.0

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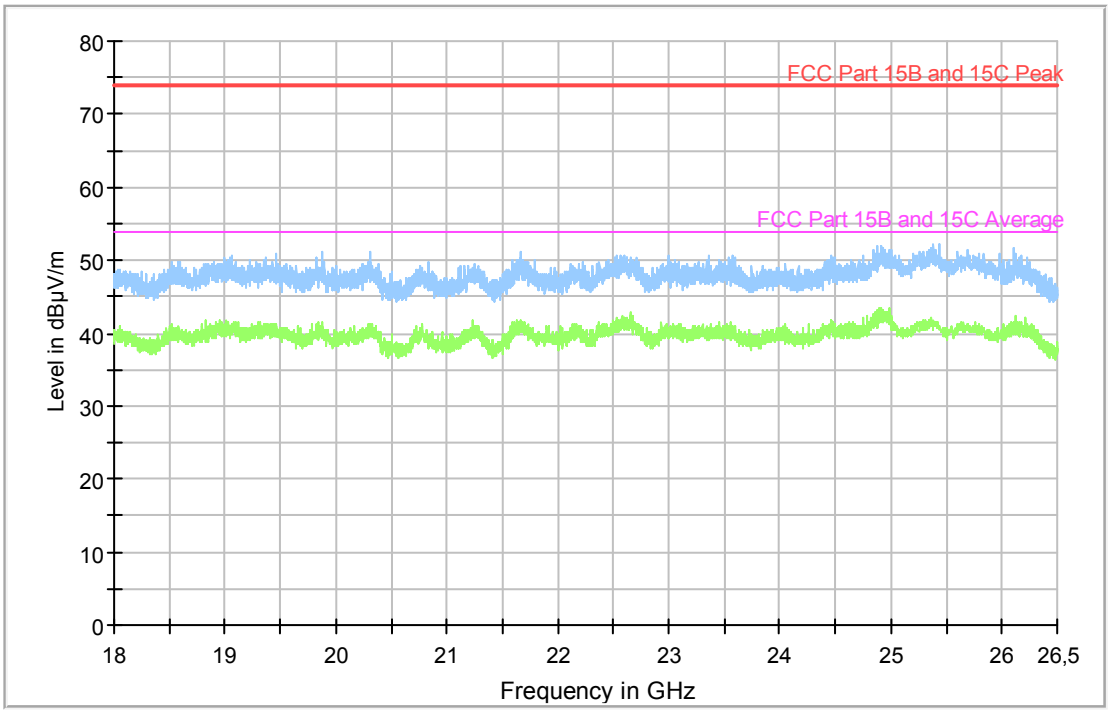
5.7 Test results 18 G – 26.5 Hz

Full Spectrum



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6 99 % BANDWIDTH

Date of test:	2015-06-09	**Test location:**	Wireless Center
EUT ID:	10-1322	**Ambient temp:**	22 °C
Tested by:	Kajsa From	**Relative humidity:**	29 %
Test result:	Pass	**Margin:**	-

6.1 Test set-up and test procedure

The test method is in accordance with RSS-GEN.

Spectrum analyser with occupied bandwidth measurement function is used to determine the occupied bandwidth.

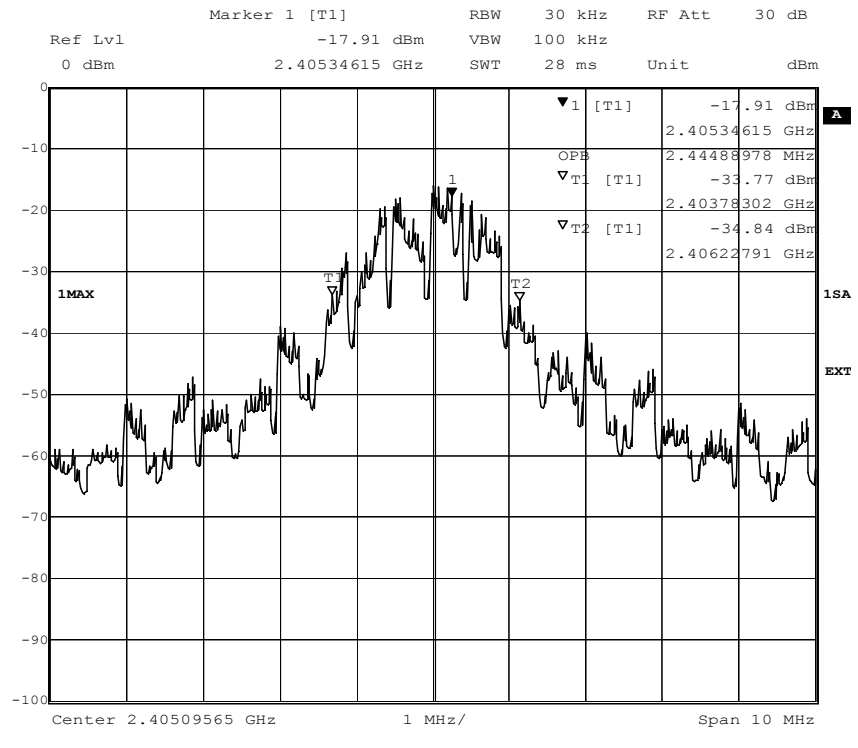
6.2 Test conditions

Detector Sample,
RBW 1 – 5 % of OBW
VBW 3 x RBW
Span 10 MHz

The EUT was set up in order to emit maximum disturbances.

6.3 Test results

99 % band width = 2.44 MHz



Screenshot: Occupied bandwidth Measurement

7 6 DB BANDWIDTH

Date of test:	2015-07-10	**Test location:**	Wireless Center
EUT ID:	10-1322	**Ambient temp:**	22 °C
Tested by:	Matti Virkki	**Relative humidity:**	46 %
Test result:	Pass	**Margin:**	993 kHz

7.1 Test set-up and test procedure

The test method is in accordance with ANSI C63.10.

Spectrum analyser is used to determine the occupied bandwidth.

7.2 Test conditions

Detector	Peak
RBW	100 kHz
VBW	3 x RBW
Span	5 MHz

The EUT was set up in order to emit maximum disturbances.

7.3 Requirement

§15.247 (a)(2) RSS-247, section 5.2(1)

The minimum 6 dB bandwidth shall be at least 500 kHz.

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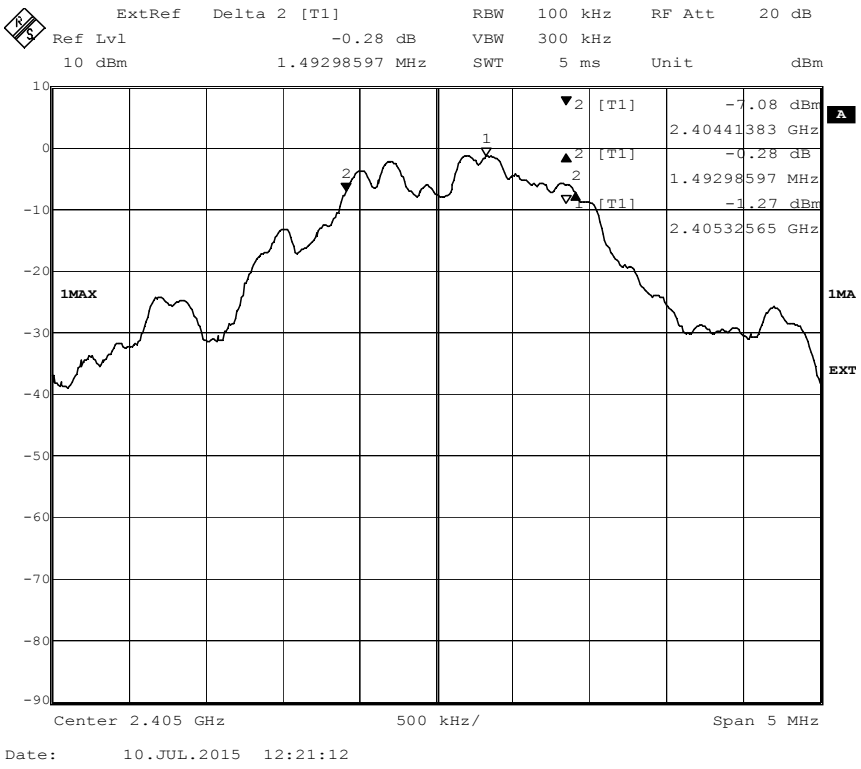
7.4 Test results

6 dB band width = 1493 kHz



Screenshot: Occupied bandwidth Measurement

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8 MAXIMUM PEAK CONDUCTED OUTPUT POWER

Date of test:	2015-06-09	**Test location:**	Wireless Center
EUT ID:	10-1322	**Ambient temp:**	22 °C
Tested by:	Kajsa From	**Relative humidity:**	29 %
Test result:	Pass	**Margin:**	25.9 dB

8.1 Test set-up and test procedure

The test method is in accordance with ANSI C63.10 and RSS-GEN

Spectrum analyser is used to determine the peak conducted output power.

8.2 Test conditions

Detector Peak,
Trace Max hold
RBW > OBW
VBW 3 x RBW
Span 1,5 x OBW
Marker was used to detect peak power.

The EUT was set up in order to emit maximum disturbances.

8.3 Requirement

§15.247 (b)(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.

RSS-247, section 5.4
For systems employing digital modulation techniques operating in the bands 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz, the maximum peak conducted output power shall not exceed 1 W. Except as provided in Section A8.4 (5), the e.i.r.p. shall not exceed 4 W.

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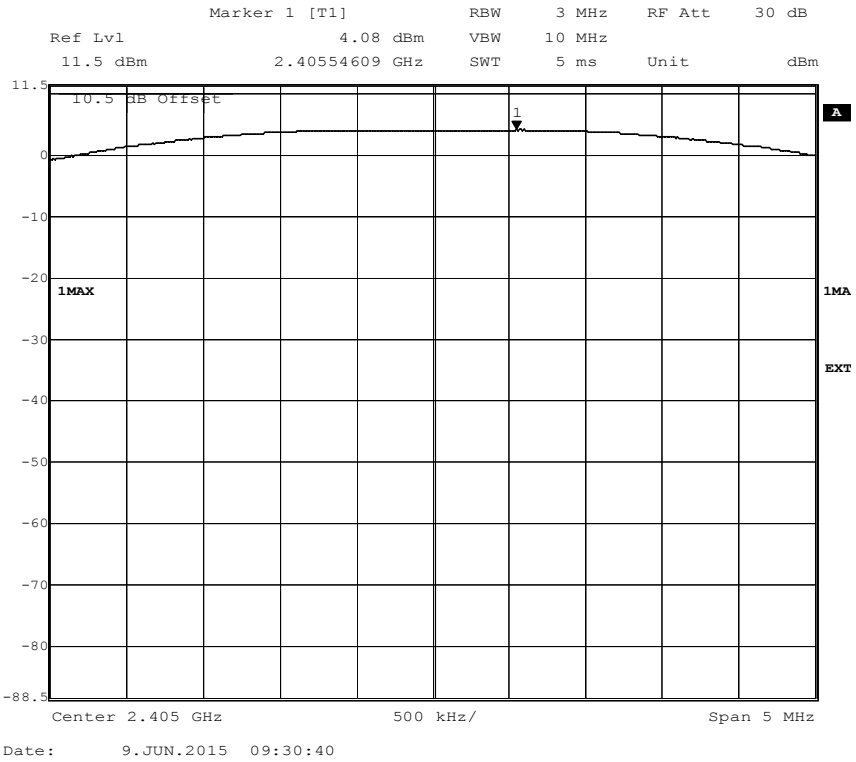
8.4 Test results

Peak conducted output power = 4.1 dBm



Screenshot: maximum peak conducted output power Measurement

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9 POWER SPECTRAL DENSITY

Date of test:	2015-06-09	**Test location:**	Wireless Center
EUT ID:	10-1322	**Ambient temp:**	22 °C
Tested by:	Kajsa From	**Relative humidity:**	29 %
Test result:	Pass	**Margin:**	13.7 dB

9.1 Test set-up and test procedure

The test method is in accordance with ANSI C63.10 and RSS-GEN.

Spectrum analyser is used to determine the power spectral density.

9.2 Test conditions

Detector	Peak
Trace	Max hold
RBW	3 kHz
VBW	3 x RBW
Span	300 kHz
Sweep time	100 s

The EUT was set up in order to emit maximum disturbances.

9.3 Requirement

§15.247 (e**),** RSS-247, section 5.2(2)
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.

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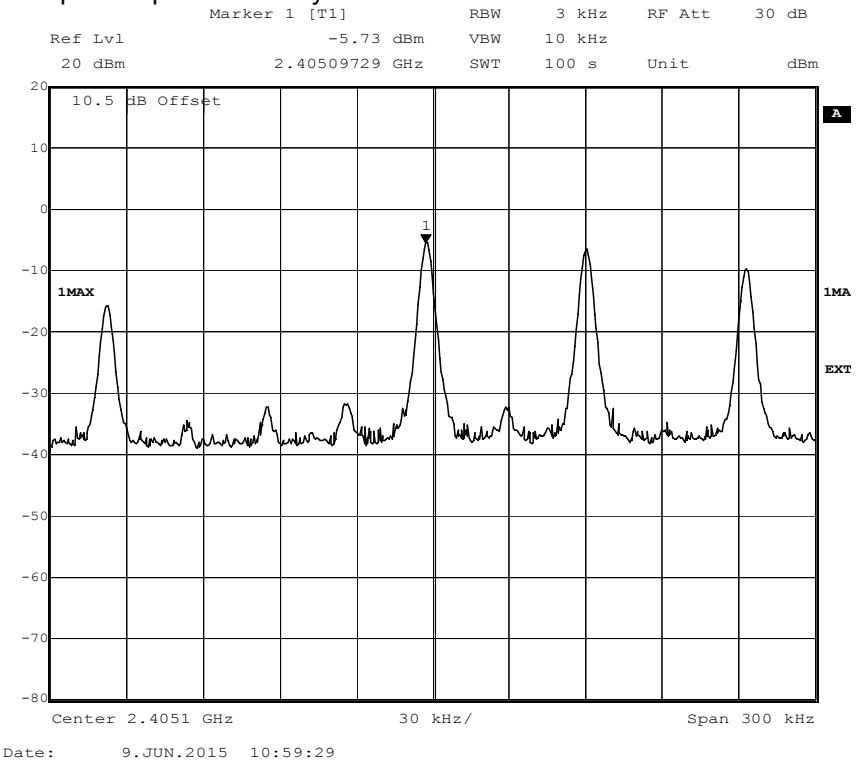
9.4 Test results

Max power spectral density = -5.7 dBm



Screenshot: maximum peak conducted output power Measurement

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10 BAND EDGE

Date of test:	2015-06-09	**Test location:**	Wireless Center
EUT ID:	10-1322	**Ambient temp:**	22 °C
Tested by:	Kajsa From	**Relative humidity:**	29 %
Test result:	Pass	**Margin:**	18.7 dB

10.1 Test set-up and test procedure

The test method is in accordance with ANSI C63.10 and RSS-GEN

Spectrum analyser with occupied bandwidth measurement function is used to determine the occupied bandwidth.

10.2 Test conditions

Detector: Peak
Trace Max hold
RBW 100 kHz
VBW 3 x RBW
Span 100 MHz

The EUT was set up in order to emit maximum disturbances.

10.3 Requirement

§15.247 (d) RSS-247 section 5.5

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)).

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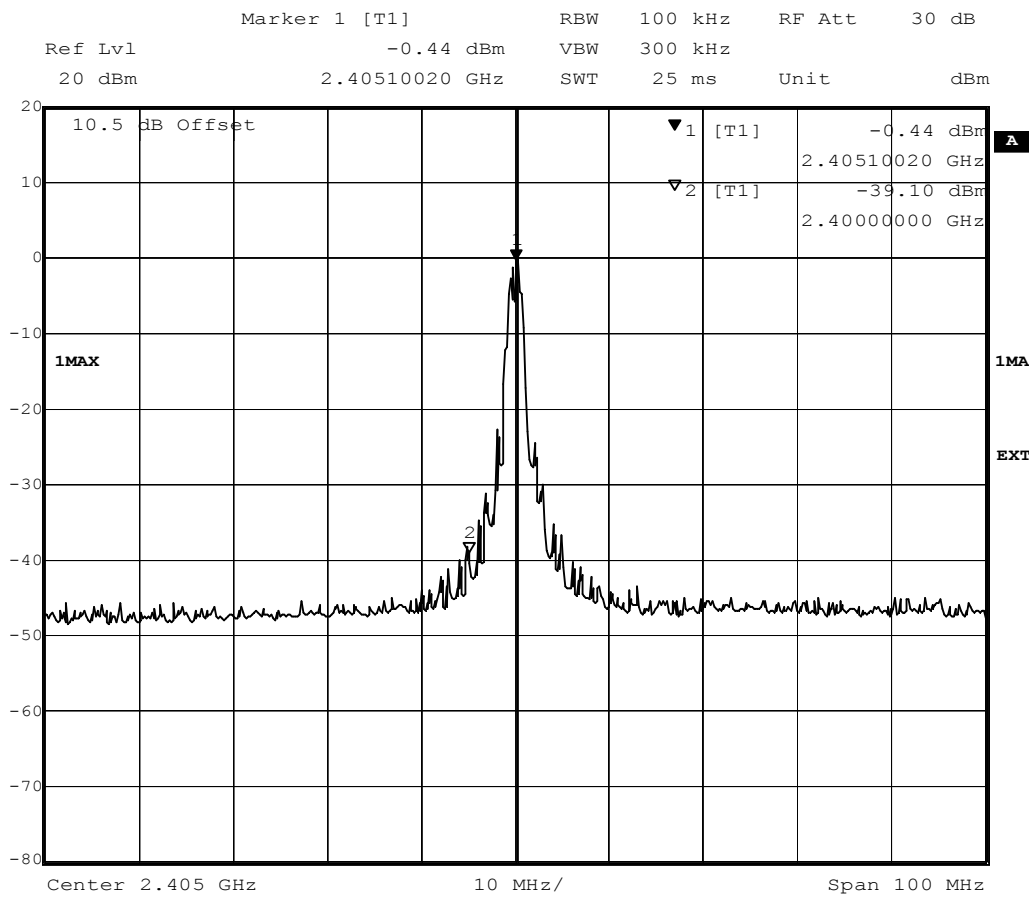
10.4 Test results



Screenshot: Lower band edge

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11 TEST EQUIPMENT

Stora Hallen

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 - 8.51	--	--	--
Receiver	Rohde & Schwarz	ESU 8	12866	7/2014	1 year
Receiver	Rohde & Schwarz	ESU 40	13178	7/2014	1 year
BiLog antenna	Chase	CBL6110A	971	8/2012	3 years
Preamplifier	Semko	AM1331	30366	7/2014	1 year
Horn antenna	Rohde & SChwarz	HF907	31245	7/2013	3 years
Preamplifier	Bonn elektronik	BLMA 0118-M	31246	11/2014	1 year
2,4 GHz band reject filter:	K&L MICROWAVE INC	6N45-2450/T100-0/0	12389	7/2014	1 year
4 GHz high pass filter	K&L MICROWAVE INC	4410-X4500/18000-0/0	5133	7/2014	1 year

Wireless Center and 3m FAC

Equipment type	Manufacturer	Model	Inv. No.	Last Cal. date	Cal. interval
Measurement software	Rohde & Schwarz	EMC32 - V9.15.0	--	--	--
Signal analyzer	Rohde & Schwarz	FSIQ 40	12793	7/2015	1 year
10 dB Attenuator	HP	8491A	7967	7/2014	1 year
Preamplifier	Sangus	AFS6-00101400-23-10P -6-S ; AFS44-12002400-32-10P -44	12335	7/2014	1 year
Measurement cable	HUBER + SUHNER	SUCOFLEX 104 1,5m	5191	7/2014	1 year
Measurement cable	HUBER + SUHNER	SUCOFLEX 104 1,5m	9192	7/2014	1 year
Measurement cable	HUBER + SUHNER	Sucoflex 104 PE	39070	7/2014	1 year
Horn antenna	EMCO	3115	4936	4/2014	3 years
Horn antenna	EMCO	3160-08	30099	10/2013	3 years
Horn antenna	EMCO	3160-09	30101	10/2013	3 years

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12 MEASUREMENT UNCERTAINTY

Continuous conducted disturbances with AMN in the frequency range 9 kHz to 30 MHz ± 3.6 dB

Measurement uncertainty for radiated disturbance

Uncertainty for the frequency range 30 to 1000 MHz at 3 m	± 4.9 dB
Uncertainty for the frequency range 30 to 1000 MHz at 10 m	± 4.8 dB
Uncertainty for the frequency range 1.0 to 18 GHz at 3 m	± 5.4 dB
Uncertainty for the frequency range 18 to 26 GHz at 3 m	± 5.5 dB
Uncertainty for the frequency range 26 to 40 GHz at 3 m	± 5.6 dB

Measurement uncertainty is calculated in accordance with CISPR 16-4-2:2011.
The measurement uncertainty is given with a confidence of 95 %.

13 TEST SET UP AND EUT PHOTOS

Test set up photos are in separate document 1511922STO-001, Annex 1, Ed. 1.

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