

RADIO TEST REPORT

No. 1511922STO-002, Ed. 1

RF Performance

EQUIPMENT UNDER TEST

Equipment: Wireless sensor
Type/Model: VRU
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: 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: 2015-07-15

Tested by:


Matti Virkki

Approved by:


Stefan Andersson

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Revision History

Edition	Date	Description	Changes
1	2015-07-15	First release	

Version 1.00

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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: VRU
Brand name: SCA
ID number: 20-586 / 20-588
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

2.2 Additional information about the EUT

The EUT consists of the following units:

Unit	Type	ID number	Comment
Wireless sensor	VRU	20-586	SMA connector, on/off switch
Wireless sensor	VRU	20-588	Antenna, on/off switch

During the tests the EUT supported following software:

Software	Comment
Wiiking_IR-VRU_reciever_Intertek_PRBS_4dbm.hex	Continuous TX modulated
Wiiking_IR-VRU_reciever_Intertek_Constant_RX.hex	RX mode

2.3 Test signals and operation modes

Continuous signal with O-QPSK modulation.

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.

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

4 TEST SUMMARY

The results in this report apply only to sample tested:

Requirement	Description	Result
FCC §15.203	Antenna requirement	PASS
RSS-GEN, section 8.3	The EUT has integrated non detachable antenna which can't be removed without breaking EUT.	
FCC §15.207	Conducted continuous emission in the frequency range 150 kHz to 30 MHz, AC Power input port	NA
RSS-GEN, section 8.8 table 3	EUT is battery powered.	
FCC §15.247 (b)(4), (d),	Antenna gain	PASS
RSS-247, section 5.4	The EUT complies with the limits. The EUT antenna has 3 dBi gain	
FCC §15.247 (d), 15.209(a)	Radiated emission of electromagnetic fields in the frequency range 30 – 1000 MHz	PASS
RSS-247, section 5.5 RSS-Gen, section 8.9	The EUT complies with the limits. The margin to the limit was at least 20 dB. See clause 5.5.	
FCC §15.247(d), 15.209(a)	Radiated emission of electromagnetic fields in the frequency range above 1 GHz	PASS
RSS-247, section 5.5 RSS-Gen, section 8.9	The EUT complies with the limits. The margin to the limit was at least 3.0 dB at 2399.6 MHz See clause 5.6	
FCC §15.247(a)(2)	Occupied bandwidth	PASS
RSS-GEN, section 6.6 RSS-247, section 5.2(1)	The EUT complies with the limits. The margin to the limit is at least 997 kHz	
FCC §15.247(b)	Conducted output power	PASS
RSS-247, section 5.4	The EUT complies with the limits. The margin to the limit was at least 25.8 dB See clause 9.4.	
FCC §15.247(e)	Power spectral density	PASS
RSS-247, section 5.2(2)	The EUT complies with the limits. The margin to the limit was at least 13.2 dB at 2405.1 MHz See clause 10.4.	

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

Date of test:	2015-07-09	Test location:	Stora Hallen
EUT ID:	20-588	Ambient temp:	22 °C
Tested by:	Matti Virkki	Relative humidity:	46 %
Test result:	Pass	Margin:	3 dB peak to average limit

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 m above the turntable which is a 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.

5.2 Test conditions

Test set-up:

Test receiver set-up:

Preview test:

Final test:

Measuring distance:

Measuring angle:

Antenna

Height above ground plane:

Polarisation:

Type:

30 MHz to 1000 MHz

Peak, RBW 120 kHz. VBW 1 MHz

Peak, RBW 120 kHz. VBW 1 MHz

10 m

0 – 359°

1 – 4 m

Vertical and Horizontal

Bilog

Test set-up:

Test receiver set-up:

Preview test:

Final test:

Measuring distance:

Measuring angle:

Antenna

Height above ground plane:

Polarisation:

Type:

Antenna tilt:

1 GHz – 26.5 GHz

Peak, RBW 1 MHz. VBW 3 MHz

Peak, RBW 1 MHz

Average Peak value + 20 x LOG (Duty cycle)

3 m

0 – 359°

1 – 4 m

Vertical and Horizontal

Horn

Activated

5.3 Radiated Emission requirements

Outside restricted bands

§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 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

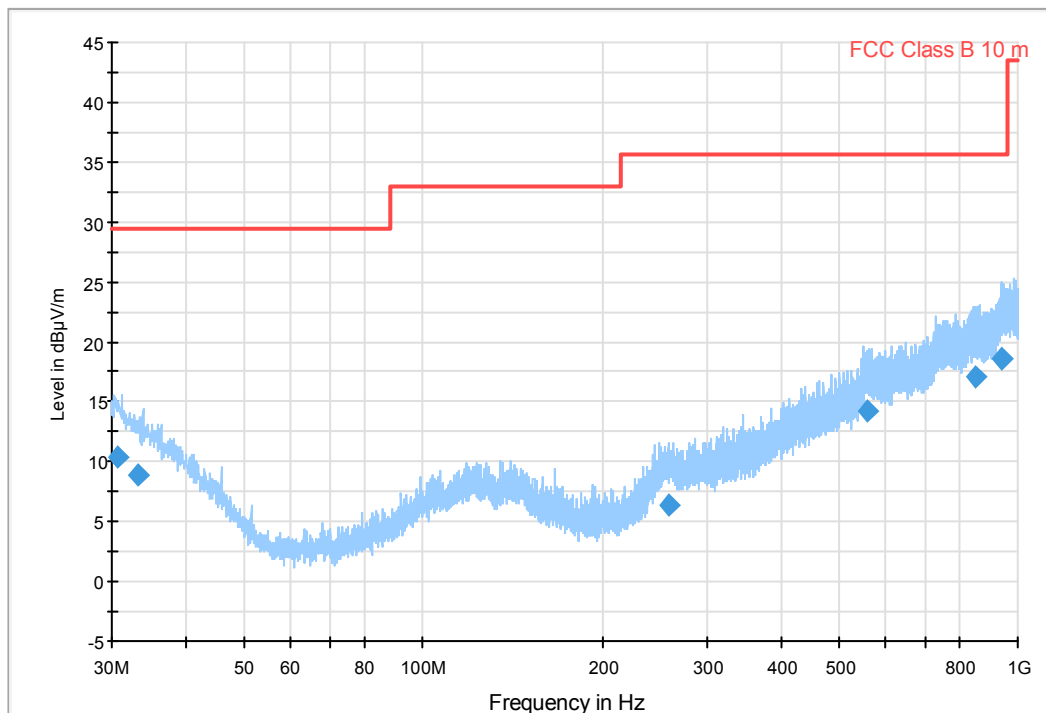
Field strength of emissions must comply with limits shown in table below

Frequency range [MHz]	Field strength at 3 m (dB μ V/m)	Field strength at 10 m (dB μ V/m)	Detector (dB μ V/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.

5.4 Test results 30 MHz – 1000 MHz

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



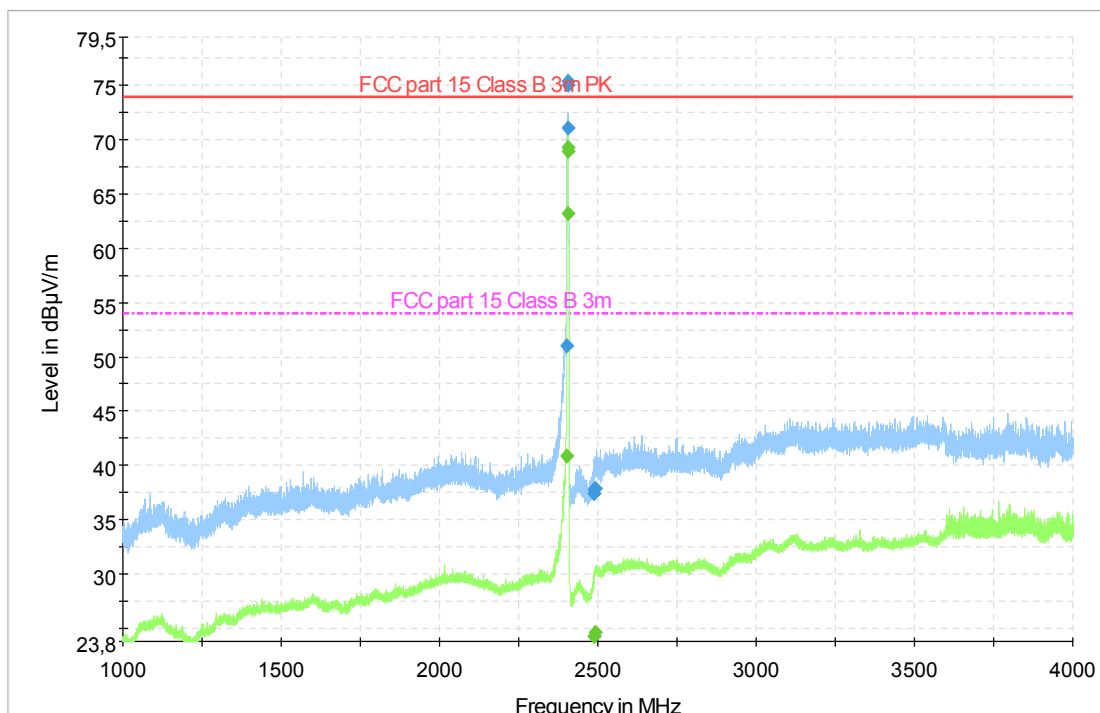
Diagram, Peak overview sweep, 30 – 1000 MHz at 10 m distance.

Measurement results, Quasi Peak

All measured disturbances have a margin of more than 20 dB to the limits.

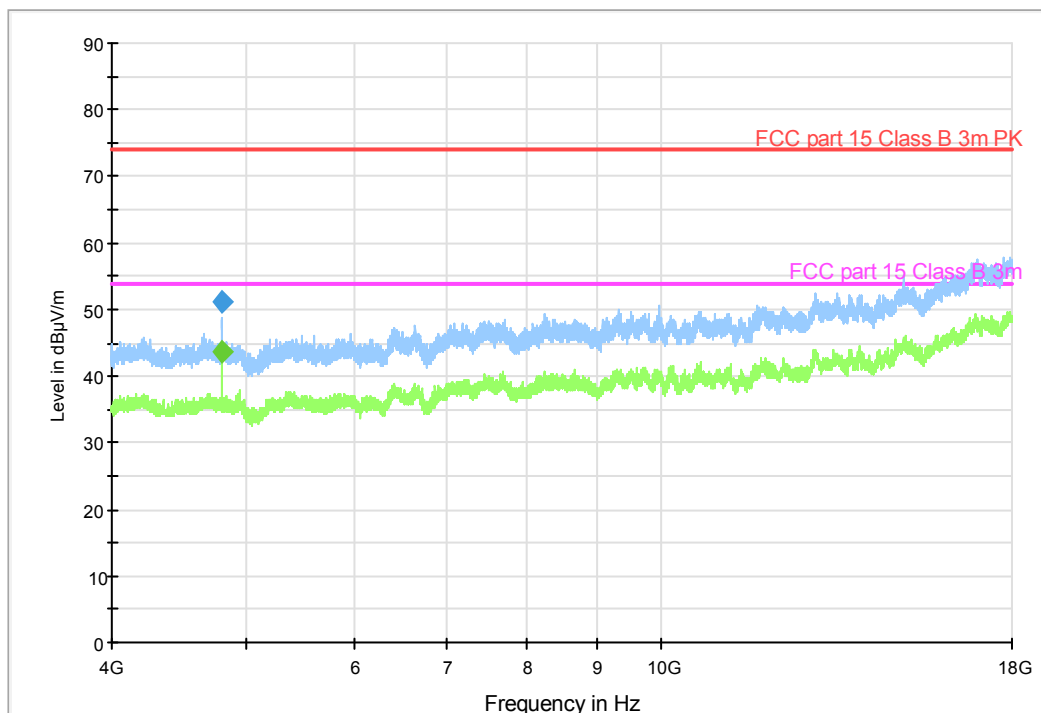
Result [dBµV/m] = Analyser reading [dBµV] + Antenna factor [1/m] - Amplifier gain [dB] + Cable loss [dB]

5.5 Test results 1 GHz – 26.5 GHz



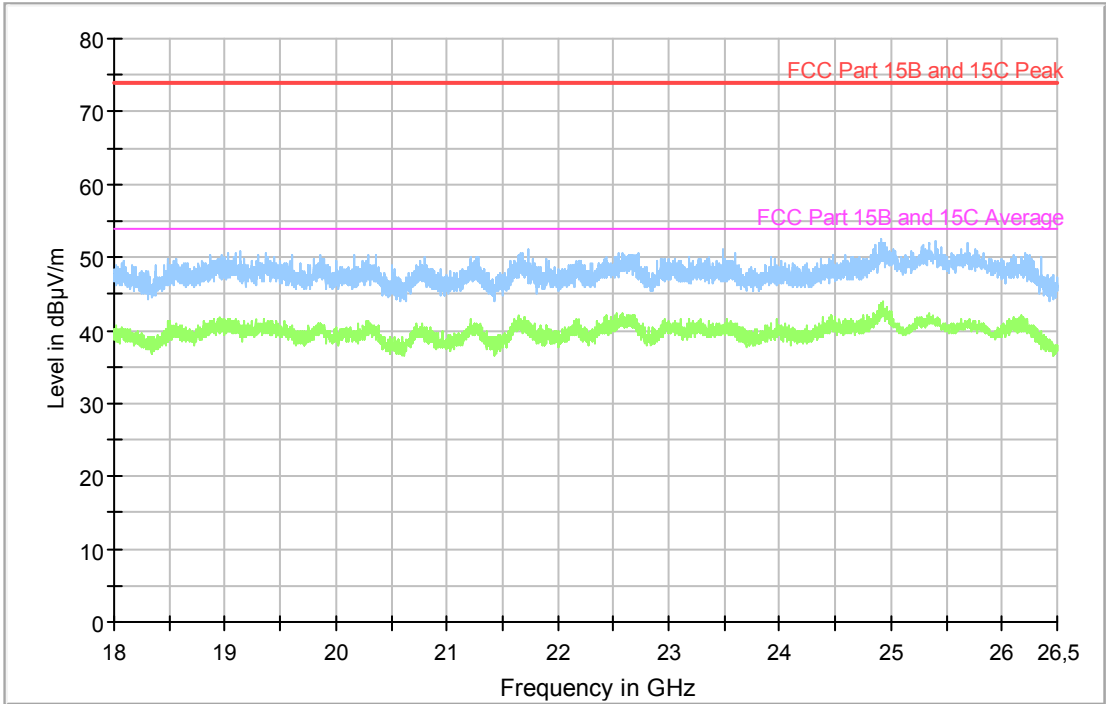
Diagram, Peak overview sweep: 1 – 4 GHz at 3 m distance.

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



Diagram, Peak overview sweep: 4 - 18 GHz at 3 m distance.

Full Spectrum



Diagram, Peak overview sweep: 18 – 26.5 GHz at 3 m distance.

Measurement results, Peak

Frequency [MHz]	Level [dBµV/m]	Limit [dBµV/m]	Polarization H/V	Margin [dB]
2399.6	51.0	74	V	14.5
2488.7	37.7	74	H	36.3
4810.8	51.3	74	H	22.7

Measurement results, Average

All peak values meet average limit average results are not measured

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

6 99 % BANDWIDTH

Date of test:	2015-06-09	Test location:	Wireless Center
EUT ID:	20-586	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.

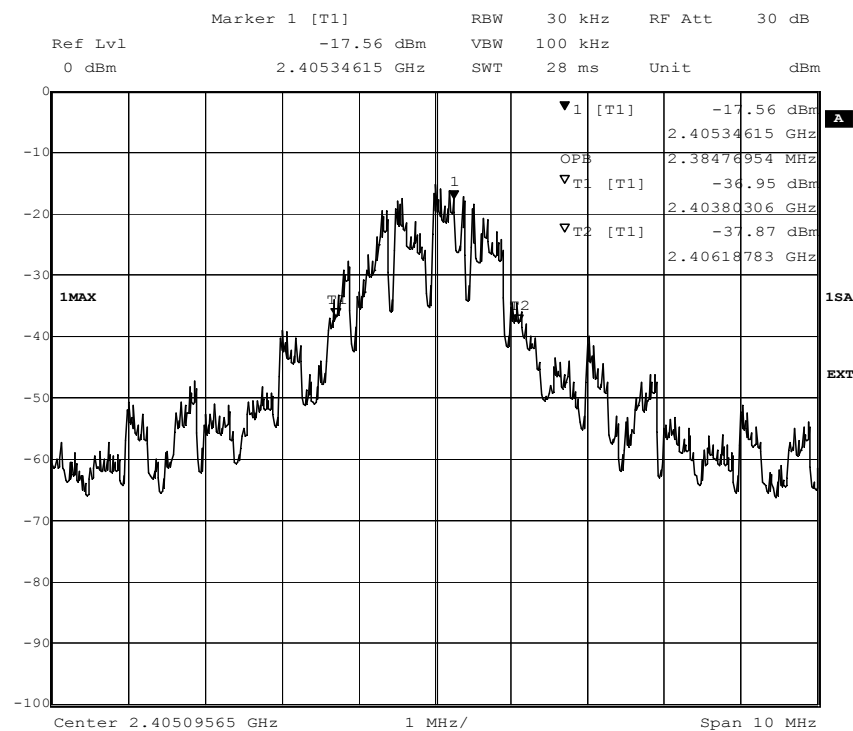
6.2 Test conditions

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 = 2.38 MHz



Date: 9 JUN 2015 09:09:45

Screenshot: Occupied bandwidth Measurement

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7 6 DB BANDWIDTH

Date of test:	2015-07-10	Test location:	Wireless Center
EUT ID:	20-586	Ambient temp:	22 °C
Tested by:	Matti Virkki	Relative humidity:	29 %
Test result:	Pass	Margin:	997 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.

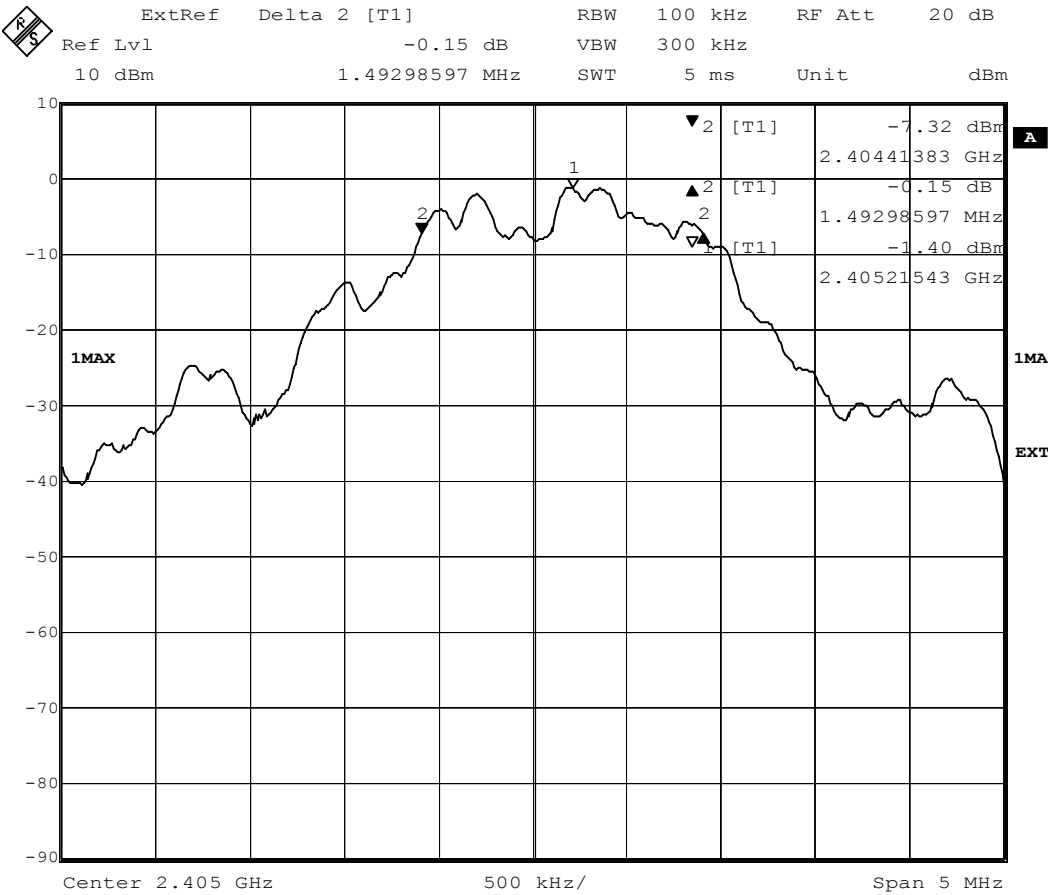
7.3 Requirement

§15.247 (a)(2) RSS-247 A8.2.a

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

7.4 Test results

6 dB band width = 1493 kHz



Date: 10.JUL.2015 12:22:50
Screenshot: Occupied bandwidth Measurement

8 MAXIMUM PEAK CONDUCTED OUTPUT POWER

Date of test:	2015-06-09	Test location:	Wireless Center
EUT ID:	20-586	Ambient temp:	22 °C
Tested by:	Kajsa From	Relative humidity:	29 %
Test result:	Pass	Margin:	25.8 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)

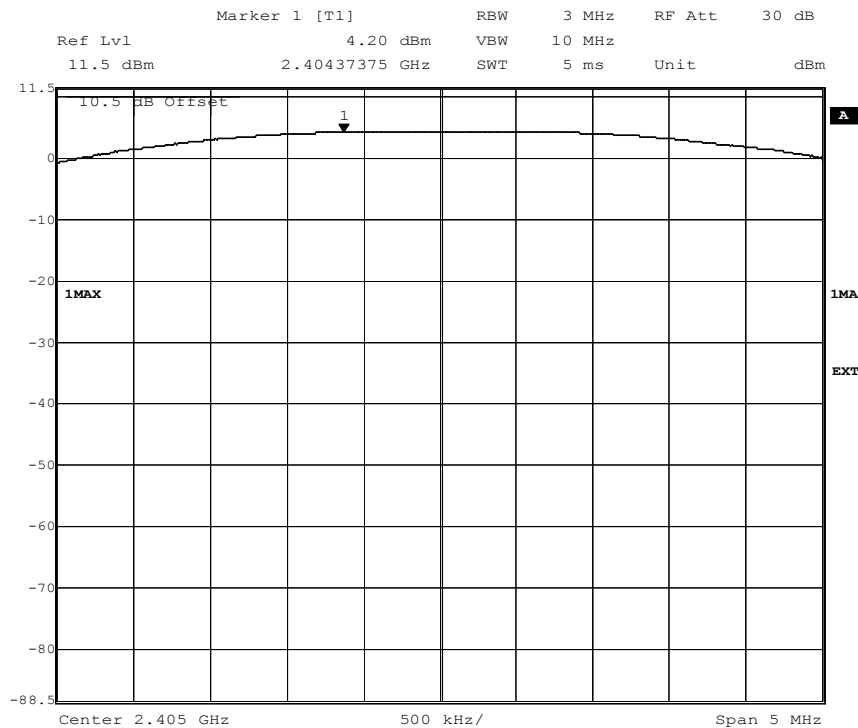
For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as 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.

8.4 Test results

Peak conducted output power = 4.2 dBm



Date: 9.JUN.2015 09:32:37

Screenshot: maximum peak conducted output power Measurement

9 POWER SPECTRAL DENSITY

Date of test:	2015-06-09	Test location:	Wireless Center
EUT ID:	20-586	Ambient temp:	22 °C
Tested by:	Kajsa From	Relative humidity:	29 %
Test result:	Pass	Margin:	13.2 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.

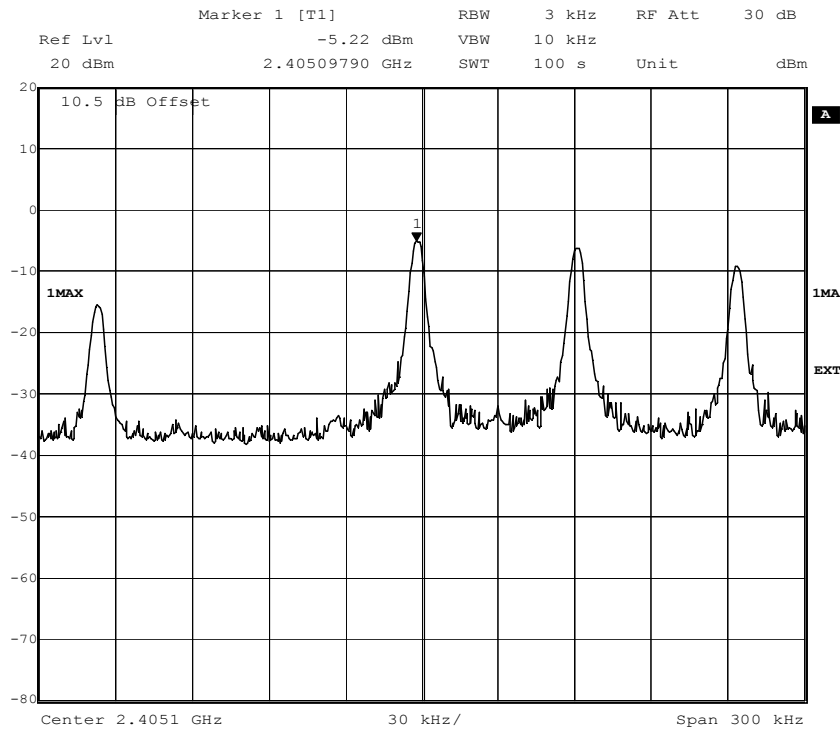
9.3 Requirement

§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.

9.4 Test results

Max power spectral density = -5.2 dBm



Date: 9.JUN.2015 11:05:15

Screenshot: maximum peak conducted output power Measurement

10 BAND EDGE

Date of test:	2015-06-09	Test location:	Wireless Center
EUT ID:	20-586	Ambient temp:	22 °C
Tested by:	Kajsa From	Relative humidity:	29 %
Test result:	Pass	Margin:	19.2 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

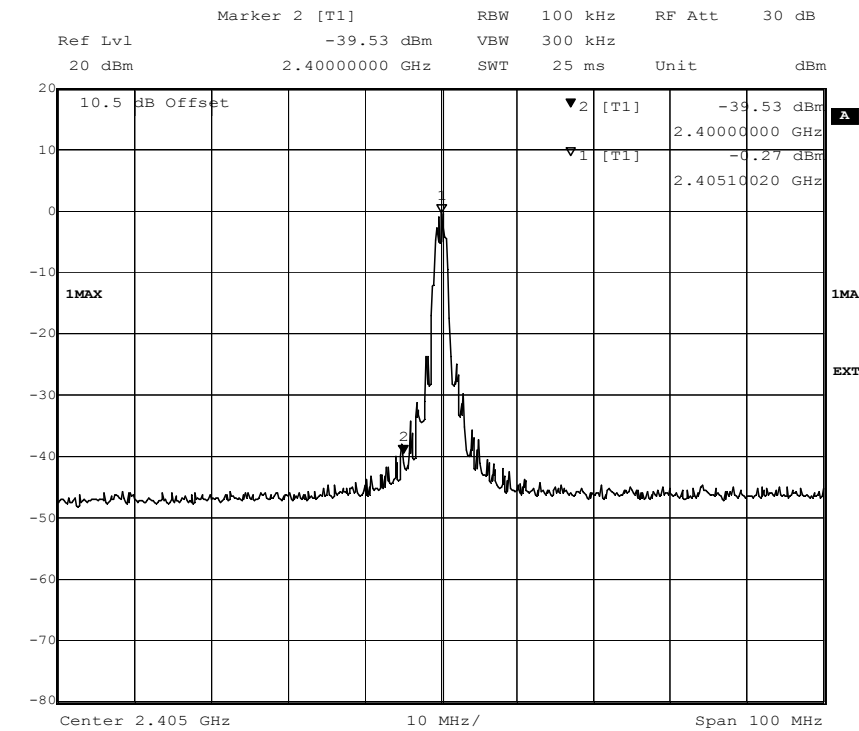
The EUT was set up in order to emit maximum disturbances.

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)).

10.4 Test results



Date: 9.JUN.2015 12:04:56
Screenshot: Lower band edge

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

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-002, Annex 1, Ed. 1.