

REPORT: FCC / IC Radio frequency (RF) test report

PRODUCT:

Test item description:	Wrist Computer
Trade Mark:	Suunto
Model/Type reference:	E3c / E5c
Serial number:	P29190025, P29190058 and P29190085
Customer:	Suunto Oy. Valimotie 7 FI-01510 VANTAA FINLAND
Contact person:	Heikki Puuri
Manufacturer:	Suunto Oy. Valimotie 7 FI-01510 VANTAA FINLAND

DATE: 12.6.2009

TESTED BY:



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1 LABORATORY INFORMATION

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FCC registration number: IC file number:	910391 (January 27, 2003) IC 4616A-1 (May 14, 2003)

2 SUMMARY OF TEST RESULTS

The tests listed in this report have been done to demonstrate compliance to the FCC rules section §15.249, §15.209 and IC standard RSS-GEN / RSS-210.

Transmitter measurements

Section in CFR 47	Section in RSS-210	Test	Result
§ 15.249 (a)	A2.9 (1)	Field strength of fundamental	PASS
§ 15.249 (a) (d)	2.7, A2.9 (2)	Spurious radiated emissions	PASS
§ 15.215 (c)		20 dB bandwidth	PASS
§ 15.249 (d)		Band edge compliance	PASS
	RSS-GEN 4.4.1	99% bandwidth	PASS

Receiver measurements

Section in CFR 47	Section in RSS-GEN	Section in ICES-003	Test	Result
§15.109	7.2.3	5.5	Radiated emissions	PASS

PASS Pass
 FAIL Fail
 X Measured, but there is no applicable performance criteria
 Na Not applicable

3 EUT INFORMATION

The EUT and accessories used in the tests are listed below. Later in this report only EUT numbers are used as reference.

	Device	Type	S/N	EUT number
EUT	Wrist Computer	E3c	P29190025	DUT 1 *
	Wrist Computer	E3c	P29190058	DUT 2 **
	Wrist Computer	E3c	P29190085	DUT 3 ***
Accessories	-			

Notes:

- * Modified with antenna for conducted measurement
- ** Modified to receiving active only
- *** Modified to continuous carrier with modulation, max 0 dBm power.

3.1 EUT description

E3c & E5c are wristop computers for athletes. E3c & E5c can receive data from Suunto Heart Rate Belt, Suunto Foot pod , Suunto Bike pod or Suunto GPS pod and view it in real time. It is possible to transmit data to a personal computer using Suunto PC pod as a receiver.

E3c differs from E5c in software settings.

Key features:

- transceiver
- operating frequency 2,465 GHz
- modulation type GFSK
- data rate 520 bps, five 104 bit frames/second, maximum data rate inside of frame 1Mbit/s
- uses ANT-radio protocol
- commercial antenna, Rainsun AN3216, soldered on PCB

The EUT was not modified during the tests.

3.2 EUT TEST SETUPS

For each test the EUT was exercised to find out the worst case of operation modes and device configuration.

Two different test setups were used: one for conducted measurements, another for radiated measurements. One EUT was equipped with an external antenna connector for conductive measurements.

The test setup photographs are in the document referenced in section 12.

4 APPLICABLE STANDARDS

The tests were performed in guidance of CFR 47 Part 15.249, 15.209, 15.107, 15.109 and Part 2, ANSI C63.4 (2003), ICES-003 and RSS-GEN / RSS-210

Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method" for each test case.

5 FIELD STRENGTH OF FUNDAMENTAL

EUT	DUT 3		
Accessories	-		
Temp, Humidity, Air Pressure	23 °C	42 RH%	1000 hPa
Date of measurement	10.6.2009		
FCC rule part	§15.249 (a)		
RSS-210 section	A2.9 (1)		
Measured by	Päivi Punta		

5.1 Test setup and measurement method

The EUT was set on a non-conductive turntable in a semi-anechoic chamber. The EUT was set at 0,8m height. Measuring antenna was scanned 1 – 4 m in height.

The measurements were repeated in three EUT orientations and two antenna polarizations.

The measured signal was routed from the measuring antenna to the spectrum analyzer.

The measurement was made using 1 MHz resolution bandwidth and 1 MHz video bandwidth and maximum hold function to record the maximum peak output power.

5.2 EUT operation mode

EUT operation mode	Continuous transmission
EUT frequency	2465 MHz
EUT TX power level	Max. (Software configuration)

5.3 Limit

Table 1: Field strength of fundamental

Frequency (MHz)	mV/m (@3m)	dBµV/m (@3m)
2400-2483,5	50 (Avg)	94 (Avg) 114 (peak)

5.4 Results

Table 2: Maximum field strength of fundamental (Peak value) EUT orientation Pos1

Freq MHz	Measured Value dBµV	Correction Factor dB	Result dBµV/m	Marginal dB	Antenna Pol.	Antenna height	Turntable angle
2465	62,1	34	96,1	17,9	Ver	3	139

Since the measurements are made with sample that is modified to continuous transmission, average results are calculated from peak results using duty cycle.

$$\text{Average level} \leq \text{Peak level} - 20 \log (\text{duty cycle}).$$

According to manufacturer:

The unit contains a transceiver that transmits a data payload that is at most 450 microseconds in duration using a Gaussian-Frequency-Shift-Keyed modulation scheme. The 450 microsecond message occurs no more quickly than every 0,217 seconds.

Therefore,

$$\begin{aligned} \text{Average level} &\leq \text{Peak level} - 20 \log ((100 \text{ ms} - 450 \mu\text{s}) / 450\mu\text{s}) \\ \text{Average level} &\leq \text{Peak level} - \mathbf{46,9 \text{ dB}} \end{aligned}$$

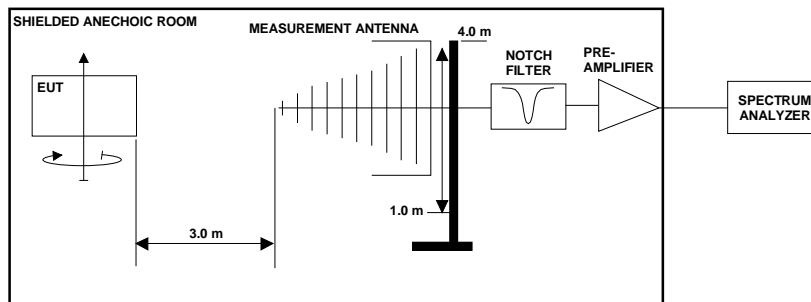
6 RADIATED SPURIOUS EMISSIONS

EUT	DUT 3		
Accessories	-		
Temp, Humidity, Air Pressure	23 °C	42 RH%	1000 hPa
Date of measurement	10.6.2009		
FCC rule part	§15.249 (a) (d)		
RSS-210 section	2.7, A2.9 (2)		
Measured by	Päivi Punta		

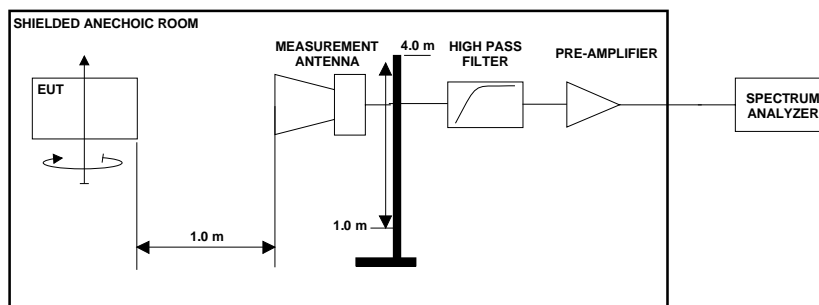
6.1 Test setup

EUT was modified to send constant carrier at nominal frequency.

The test was done using an automated test system, where a computer controlled the measurement equipments.



Picture 1: Test setup for radiated spurious emissions measurement
30 MHz - 3 GHz frequencies



Picture 2: Test setup for radiated spurious emissions measurement
3 GHz – 25 GHz frequencies

6.2 Test method

1. The emissions were searched and maximized by moving the turntable, changing the measuring antenna polarization and height and manipulating the EUT.
2. Levels of suspicious signals and levels of EUT transmitter harmonics were recorded.
3. The recorded levels were corrected in the automated test system with the measurement antenna factor, cable attenuations and filter attenuation.
4. The corrected values, giving the EUT radiated spurious emission levels as dB μ V/m at 3 m distance, are reported.

6.3 EUT operation mode

EUT operation mode	Continuous transmission
EUT frequency	2465 MHz
EUT TX power level	Max. (Software configuration)

6.4 Limit

Table 3: Radiated spurious emission limits at measurement distance of 3m

Frequency band (MHz)	3m Limit (μ V/m)	3m Limit (dB μ V/m)	Detector
30 – 88	100	40	QP
88 -216	150	43,5	QP
216 - 960	200	46	QP
960 - 1000	500	54,0	QP
1000 - 25000	500	54,0	AVG
1000 - 25000	5000	74,0	PEAK

As default, all emissions were compared against the general limits. If any emission exceeded that limit, it was further checked, that it complies with the -50dBc requirement.

6.5 Results

Measurement system noise level was at least 20 dB below the spurious emission limit. Only levels of suspicious signals and transmitter harmonic frequencies, which were above the measurement system noise, are reported.

Table 4: Emission levels PEAK detector

Freq MHz	Measured Value dB μ V	Correction Factor dB	Result dB μ V/m	Marginal dB	EUT Position	Ant Pol.	Ant height	TT angle
4930	72,2	-15,9	56,3	-17,7	Pos 1	Hor	1,1	340
7395	59,1	-6,4	52,7	-21,3	Pos 1	Hor	1,1	333
4930	69,3	-15,9	53,4	-20,6	Pos 2	Hor	1,1	111
7395	55,4	-6,4	49,1	-25,0	Pos 2	Hor	1,2	263
4930	66,5	-15,9	50,6	-23,4	Pos 3	Hor	1	335
7395	56,8	-6,4	50,4	-23,6	Pos 3	Hor	1,2	35

Since the measurements are made with sample that is modified to continuous transmission, average results are calculated from peak results using duty cycle.

$$\text{Average level} \leq \text{Peak level} - 20 \log(\text{duty cycle}).$$

According to manufacturer:

The unit contains a transceiver that transmits a data payload that is at most 450 microseconds in duration using a Gaussian-Frequency-Shift-Keyed modulation scheme. The 450 microsecond message occurs no more quickly than every 0,217 seconds.

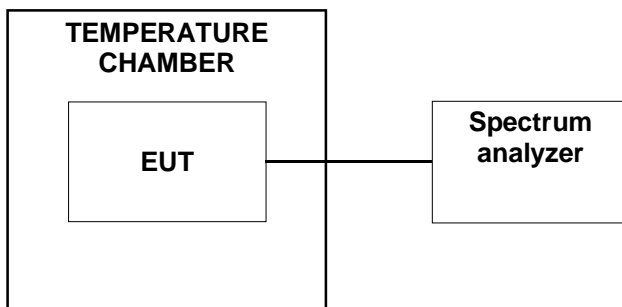
Therefore,

$$\begin{aligned} \text{Average level} &\leq \text{Peak level} - 20 \log((100 \text{ ms} - 450 \mu\text{s}) / 450\mu\text{s}) \\ \text{Average level} &\leq \text{Peak level} - \mathbf{46,9 \text{ dB}} \end{aligned}$$

7 20 dB BANDWIDTH

EUT	DUT 1		
Accessories	-		
Temp, Humidity, Air Pressure	23 °C	43 RH%	1000 hPa
Date of measurement	8.6.2009		
FCC rule part	§15.215 (c)		
RSS-210 section			
Measured by	Matti Virkki		

7.1 Test setup and measurement method



1. The climate chamber temperature was set to the maximum value and the temperature was allowed to stabilize
2. The EUT was placed in the chamber power off
3. The EUT temperature was allowed to stabilize for 30 minutes
4. The EUT was turned on and set to transmit
5. Transmitter peak frequency was measured with spectrum analyzer
6. The steps 3 - 5 were repeated for each temperature

The 20dB bandwidth was measured using 10 kHz resolution bandwidth and maximum hold function of the spectrum analyzer. 20dB bandwidth was defined by measuring the maximum level on the measured channel and by placing delta markers 20 dB below this value.

7.2 EUT operation mode

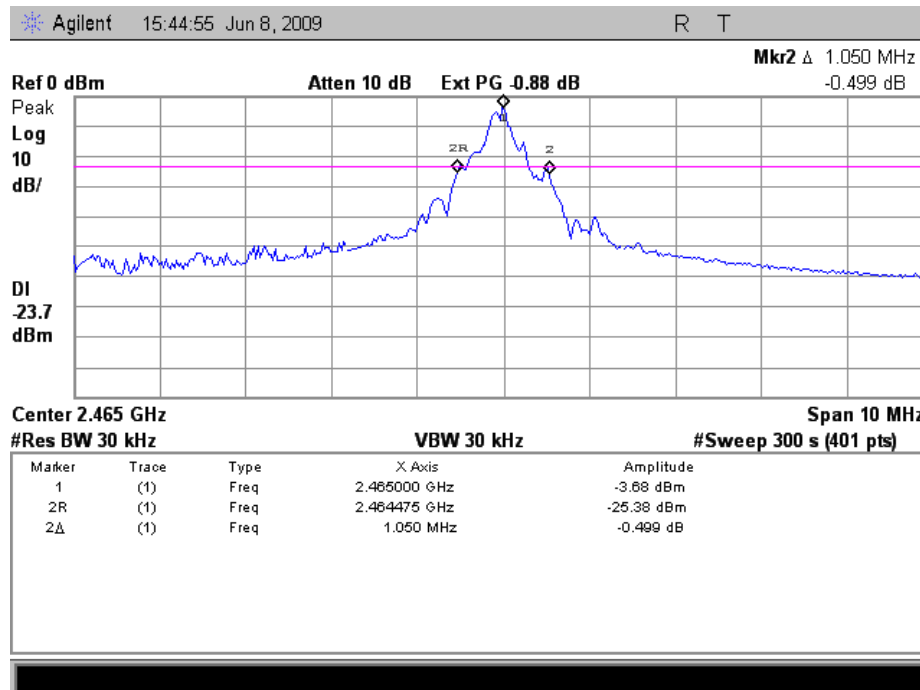
EUT operation mode	Continuous transmission
EUT frequency	2465 MHz
EUT TX power level	Max. (Software configuration)

7.3 Results

Table 5: 20dB bandwidth measurement results

EUT Frequency MHz	Temp °C	Operating voltage	Limit MHz	Measured value MHz
2465	23	Nominal	-	1,050

7.4 Screen shots



Picture 3: 20dB Bandwidth measurement result @ 23 °C and nominal operating voltage.

8 BAND EDGE COMPLIANCE

EUT	DUT 1		
Accessories	-		
Temp, Humidity, Air Pressure	23 °C	27 RH%	993 hPa
Date of measurement	8.6. 2009		
FCC rule part	§ 15.249 (d)		
RSS-GEN section			
Measured by	Matti Virkki		

8.1 Test setup and measurement method

Band edge compliance of RF-conducted emissions was measured by setting the span of the spectrum analyzer so that band edge frequency and the carrier frequency can be seen in same display. The measured carrier power and power on the band edge frequency was then compared.

8.2 EUT operation mode

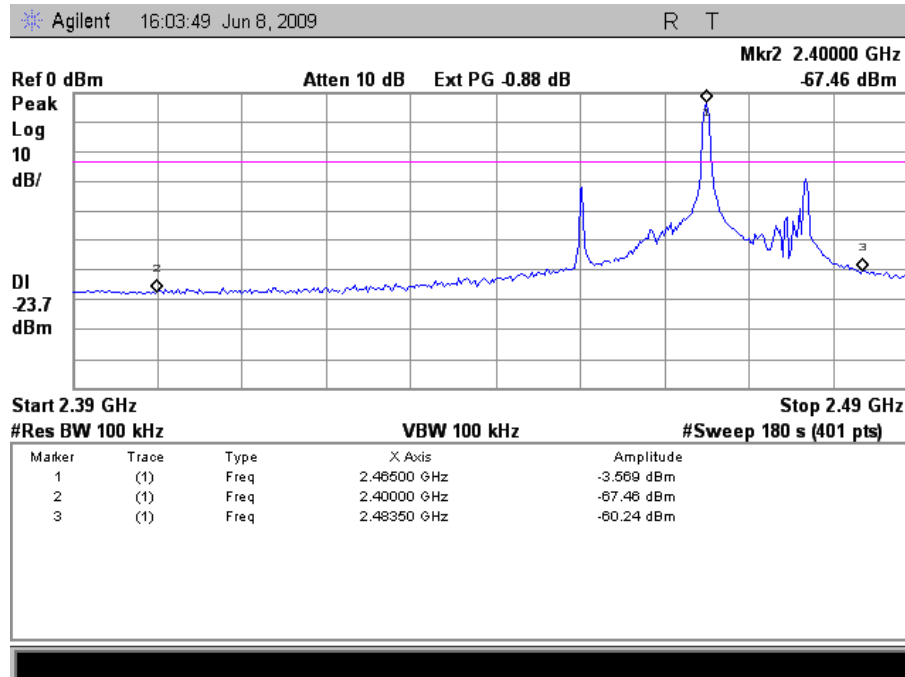
EUT operation mode	Continuous transmission
EUT frequency	2465 MHz
EUT TX power level	Max. (Software configuration)

8.3 Results

Table 6: Band edge compliance measurement results

Frequency MHz	Limit (dBc)	Test result (dBc peak)
2465	≤ -20	-56,7

8.4 Screen shots



Picture 4: Band edge measurement, Peak

9 99 % BANDWIDTH

EUT	DUT 1		
Accessories	-		
Temp, Humidity, Air Pressure	23 °C	27 RH%	993 hPa
Date of measurement	12.6.2009		
FCC rule part			
RSS-GEN section	4.4.1		
Measured by	Matti Virkki		

9.1 Test setup and measurement method

The 99% occupied bandwidth was calculated from spectrum analyzer measurements.

The measurement data was read from the analyzer to computer.

Software in computer calculated the total power from the measurement data and defined the frequency band containing 99% of the total power.

Markers in the spectrum analyzer were then placed between the calculated frequencies to show the calculated 99% power band in the screenshots.

9.2 EUT operation mode

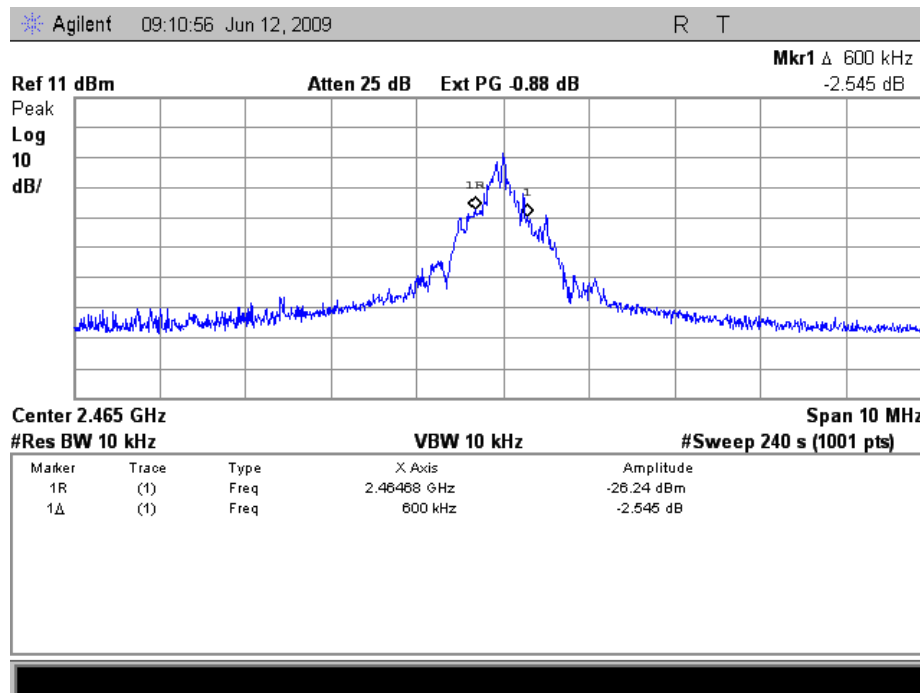
EUT operation mode	Continuous transmission
EUT frequency	2465 MHz
EUT TX power level	Max. (Software configuration)

9.3 Results

Table 7: 99% bandwidth measurement results

EUT Frequency MHz	Limit MHz	Measured value MHz
2465	-	0,600

9.4 Screen shots



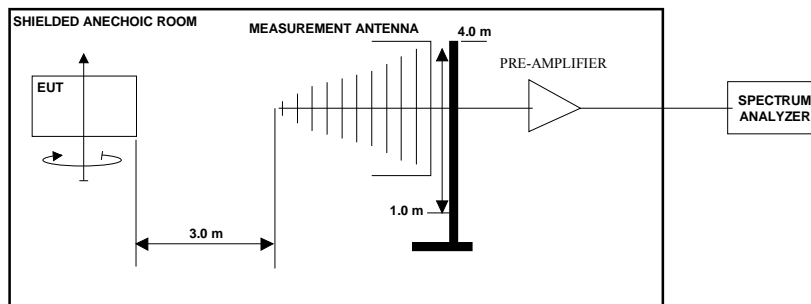
Picture 5: 99% Bandwidth measurement result

10 RECEIVER RADIATED EMISSION

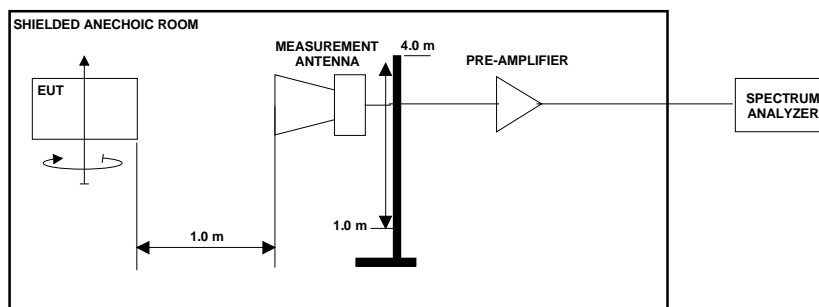
EUT	DUT 3		
Accessories	-		
Temp, Humidity, Air Pressure	23 °C	42 RH%	1000 hPa
Date of measurement	10.6.2009		
FCC rule part	§15.109		
RSS-GEN section	7.2.3		
ICES-003 section	5.5		
Measured by	Päivi Punta		

10.1 Test setup

The test was done using an automated test system, where a computer controlled the measurement equipments.



Picture 6: Test setup for radiated spurious emissions measurement
30 MHz - 1 GHz frequencies



Picture 7: Test setup for radiated spurious emissions measurement
1 GHz – 12,5 GHz frequencies

10.2 Test method

1. The emissions were searched and maximized by moving the turntable, changing the measuring antenna polarization and height and manipulating the EUT.
2. Levels of suspicious signals and levels of EUT transmitter harmonics were recorded.
3. The recorded levels were corrected in the automated test system with the measurement antenna factor, cable attenuations and filter attenuation.
4. The corrected values, giving the EUT radiated spurious emission levels as dB μ V/m at 3 m distance, are reported.

10.3 EUT operation mode

EUT was modified to receiver active mode by customer.

EUT operation mode	Receiver mode
EUT frequency	2465 MHz
EUT TX power level	Na

10.4 Limit

Table 8: Radiated spurious emission limits at measurement distance 3m

Frequency band (MHz)	3m Limit (μV/m)	3m Limit (dBμV/m)	Detector
30 – 88	100	40	QP
88 -216	150	43,5	QP
216 - 960	200	46	QP
960 - 1000	500	54,0	QP
1000 - 12400	500	54,0	AVG
1000 - 12400	5000	74,0	PEAK

As default, all emissions were compared against the general limits. If any emission exceeded that limit, it was further checked, if it was outside the restricted band thus complying with the -20dBc requirement.

10.5 Results

The measured interference values using Quasi peak and average detectors are shown in the pictures below.

All signals closer than 6 dB to the limit below 1 GHz have been measured using quasi peak or average detector and reported in the table 9, 10 and 11.

Table 9: Radiated emissions using Quasi peak detector

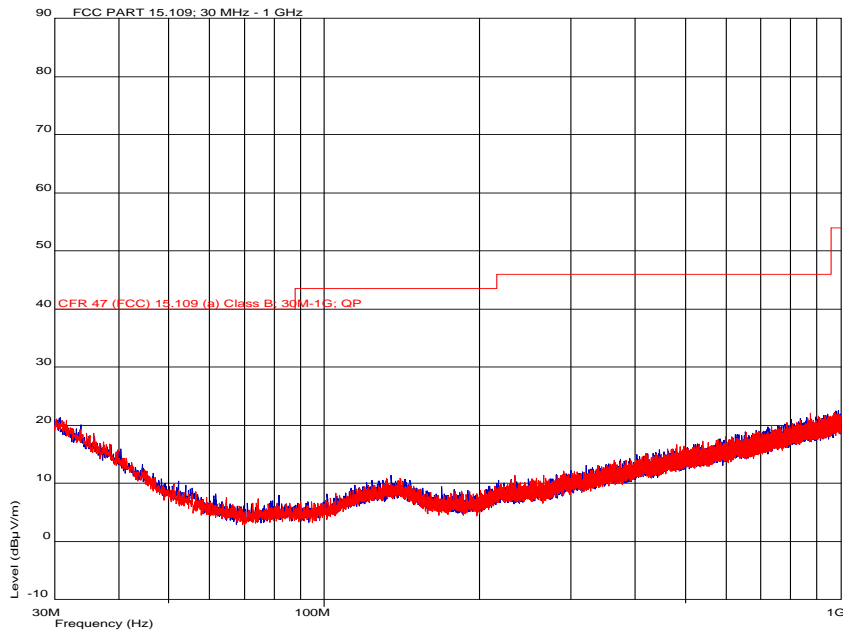
Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height	TT angle
N/A								

Table 10: Radiated emissions using Peak detector

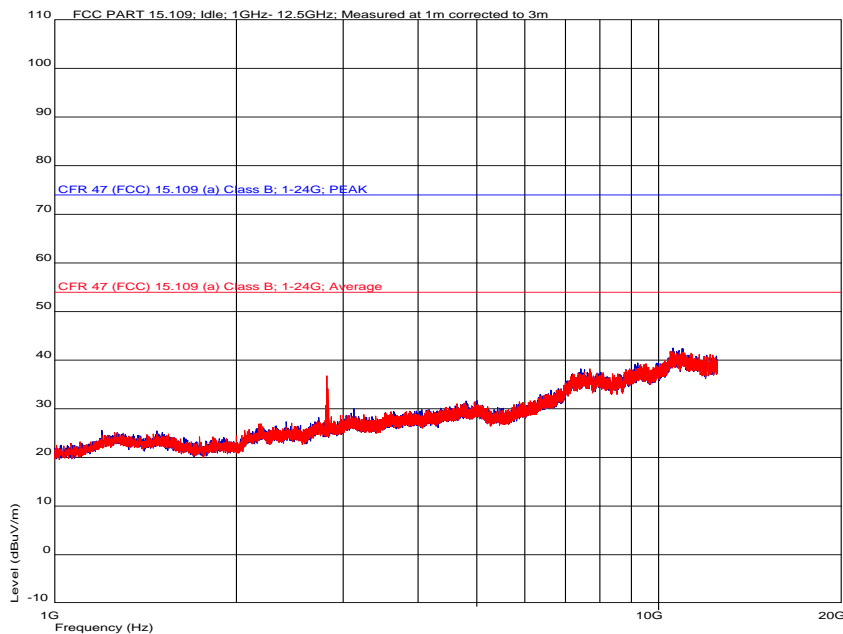
Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height	TT angle
N/A								

Table 11: Radiated emissions using Average detector

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height	TT angle
N/A								



Picture 8: radiated emission results, 30 – 1000 MHz,
Red= horizontal polarization, blue = vertical polarization



Picture 9: radiated emission results, 1 – 12,5 GHz,
Red= horizontal polarization, blue = vertical polarization

11 TEST EQUIPMENT

All testing and measurement equipment has been calibrated once a year, except the antennas that are calibrated every two years.

11.1 Conducted measurements

Equipment	Manufacturer	Model
Spectrum Analyzer	Agilent	E7405A
Power supply	Delta Elektronika	SM120-13

11.2 Radiated measurements

Equipment	Manufacturer	Model
Spectrum Analyzer	Agilent	E7405A
Antenna	Chase	CBL 6141
Antenna	Schwarzbeck	BBHA 9120D
Antenna	Schwarzbeck	BBHA 9170
Band reject filter	Wainwright Instruments	WRCT2400/2483
High pass filter	Wainwright Instruments	WHK3.0/18GST
Pre-amplifier	Agilent	87405B
Pre-amplifier	JCA	118-400
Pre-amplifier	Miteq	AMF-6F-18002650-25-10P
Turn table / antenna mast controller	EMCO	2090

12 TEST SETUP PHOTOGRAPHS

Test setup photograph can be found in a separate document

T09-241A-RF_PHOTOS.doc