

Test report for Smart Belt

Report Date: June 12, 2006

Signatures:

Tested by:



Marko Turkkila

Test Engineer

Contents approved:



Tuomo Hahl

Test Engineer

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1 LABORATORY INFORMATION

Test Laboratory	NATLABS OY EMC Laboratory Koneenkatu 12 / K17 05830 Hyvinkää FINLAND Tel: +358 20 475 2600 Fax: +358 20 475 2719 e-mail: firstname.surname@ette.com
FCC registration number: IC file number:	910391 (January 27, 2003) IC 4616 (May 14, 2003)

2 CUSTOMER INFORMATION

Client	Suunto Oy Valimotie 7 01510 Vantaa Finland Tel. +358 9 875 870 Fax +358 9 875 87301
Contact person:	Heikki Puuri Suunto Oy Valimotie 7 01510 Vantaa Finland Tel. +358 9 875 870 Fax: +358 9 875 87301
Receipt of EUT:	March 30, 2006
Testing date:	April 19 – June 09, 2006
Report date:	June 12, 2006

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

3 SUMMARY OF TEST RESULTS

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
	RSS-GEN 4.4.1	99% bandwidth	PASS
§ 15.215 (c)	RSS-GEN 7.2.4	Frequency stability	PASS

Receiver measurements

Section in CFR 47	Section in RSS-GEN	Section in ICES-003	Test	Result
§15.107	7.2.2	5.3	Conducted emissions to AC-power lines	PASS
§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

4 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	Heart rate transmitter	Smart Belt		06401 **
	Heart rate transmitter	Smart Belt		06402 ***
	Heart rate transmitter	Smart Belt		06403 ** / ***
	Heart rate transmitter	Smart Belt		06404
Accessories	Battery	Sony 2032		06405
	Laptop computer	Dell PR04S	0J7316-36521 -55K-0548	06406
	Serial mouse	Logitech	LZB83902452	06407
	Printer	HP Deskjet 890C	SG78I19082	06408
	Docking unit (USB connector)	-	-	06409

Notes:

** Modified to transmit continuously

*** Modified with antenna connector for conducted measurements

4.1 EUT description

EUT is battery powered heart rate measuring equipment. It's primary function is to transmit heart rate data to receiver via radio link that operates in 2.4 GHz frequency band and uses GFSK modulation. It is also possible to collect heart rate data to internal memory and download it to computer via USB connection.

The EUT was not modified during the tests.

4.2 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. Two EUT were equipped with an external antenna connector for conductive measurements.

The test setup photographs are in the document referenced in section 14.

5 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.

6 FIELD STRENGTH OF FUNDAMENTAL

EUT	06401		
Accessories	06405		
Temp, Humidity, Air Pressure	21 °C	49 RH%	988 hPa
Date of measurement	April 09-27, 2006		
FCC rule part	§15.249 (a)		
RSS-210 section	A2.9 (1)		
Measured by	Tuomo Eloranta		

6.1 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.

6.2 EUT operation mode

EUT operation mode	Continuous transmission
EUT frequency	2465 MHz
EUT TX power level	0 dBm (Software configuration)

6.3 Limit

Table 1: Field strength of fundamental

Frequency (MHz)	mV/m (@3m)	dBuV/m (@3m)
2400-2483.5	50	94

6.4 Results

Table 2: Maximum field strength of fundamental

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	EUT orientation	Antenna Pol.	Antenna height	Turntable angle
2465	59.8	34.0	93.8	Pos 1	Ver	2.55	25

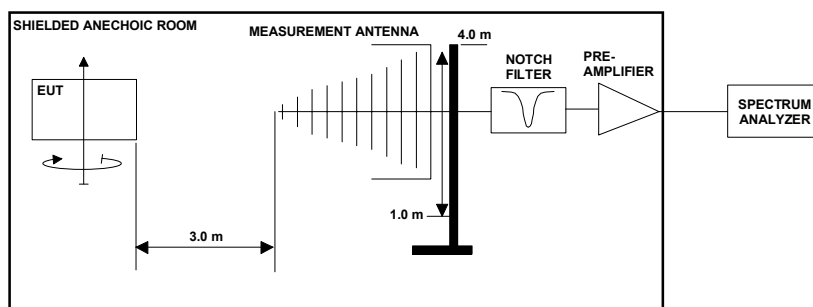
7 RADIATED SPURIOUS EMISSIONS

EUT	06401		
Accessories	06405		
Temp, Humidity, Air Pressure	24 °C	40 RH%	1008 hPa
Date of measurement	April 27, 2006		
FCC rule part	§15.249 (a) (d)		
RSS-210 section	2.7, A2.9 (2)		
Measured by	Marko Turkkila		

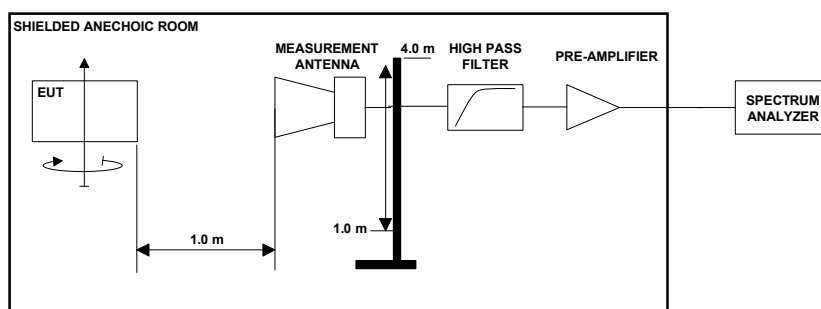
7.1 Test setup

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

7.2 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.

7.3 EUT operation mode

EUT operation mode	Continuous transmission
EUT frequency	2465 MHz
EUT TX power level	0 dBm (Software configuration)

7.4 Limit

Table 3: Radiated spurious emission limits at measurement distance of 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 - 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.

7.5 Results

Measurement system noise level was 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 dBuV	Correction Factor dB	Result dBuV/m	Marginal dBuV/m	EUT Position	Ant Pol.	Ant height	TT angle
3697.5	54.5	-18.6	35.9	-38.1	Pos 1	Ver	1.1	100
4930.5	62.1	-15.3	46.8	-27.2	Pos 2	Ver	1.3	267
7395	65.3	-3.1	62.2	-11.8	Pos 1	Ver	1.15	97
9860.5	51.1	-3.6	47.5	-26.6	Pos 2	Ver	1.05	165

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 Duty cycle for this product is 150µs long transmission at 5Hz frequency. The average is calculated over 100 ms period as required in §15.35(c)

Therefore,

$$\begin{aligned} \text{Average level} &\leq \text{Peak level} - 20 \log ((100 \text{ ms} - 150 \mu\text{s}) / 150\mu\text{s}) \\ \text{Average level} &\leq \text{Peak level} - \mathbf{56.5 \text{ dB}} \end{aligned}$$

8 20 dB BANDWIDTH

EUT	06403		
Accessories	06405		
Temp, Humidity, Air Pressure	22 °C	46 RH%	997 hPa
Date of measurement	May 11, 2006		
FCC rule part	§15.215 (c)		
RSS-210 section			
Measured by	Marko Turkkila		

8.1 Test setup and measurement method

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 display line 20 dB below this value and by reading the bandwidth from the intersection of the measured trace and display line.

8.2 EUT operation mode

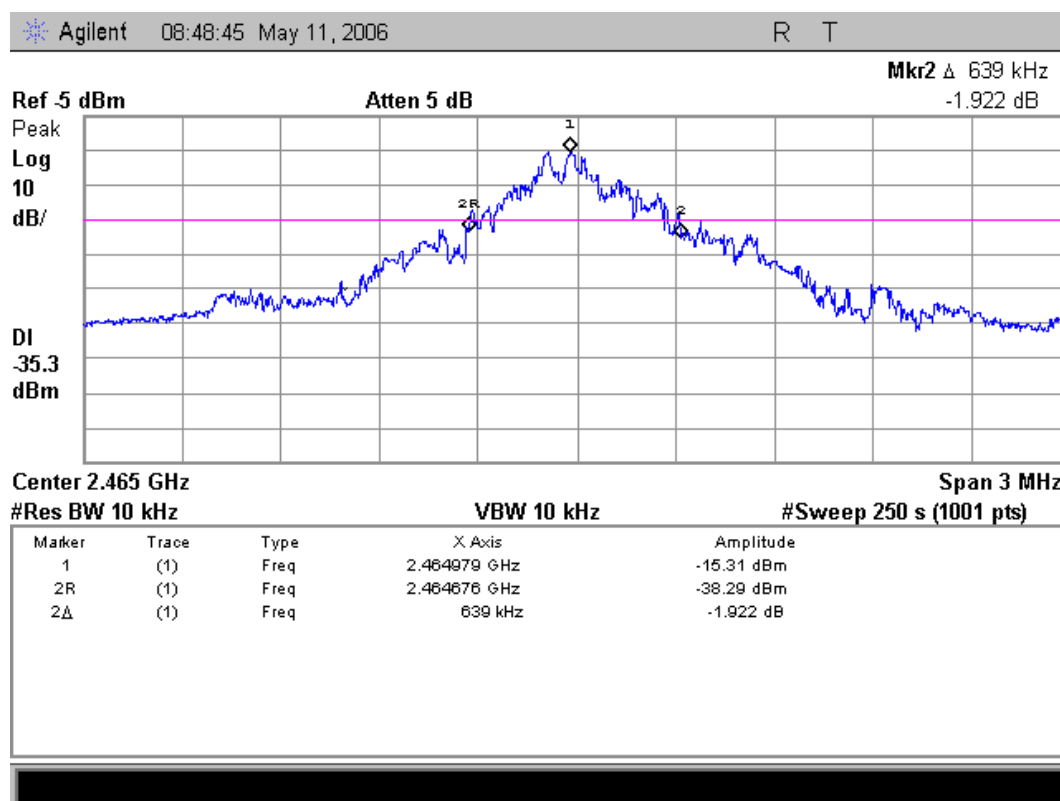
EUT operation mode	Normal modulation
EUT frequency	2465 MHz
EUT TX power level	0 dBm (Software configuration)

8.3 Results

Table 5: 20dB bandwidth measurement results

EUT Frequency MHz	Limit MHz	Measured value MHz
2465	-	0.639

8.4 Screen shots



Picture 3: 20dB Bandwidth measurement result

9 99 % BANDWIDTH

EUT	06403		
Accessories	06405		
Temp, Humidity, Air Pressure	22 °C	46 RH%	997 hPa
Date of measurement	May 11, 2006		
FCC rule part			
RSS-GEN section	4.4.1		
Measured by	Marko Turkkila		

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

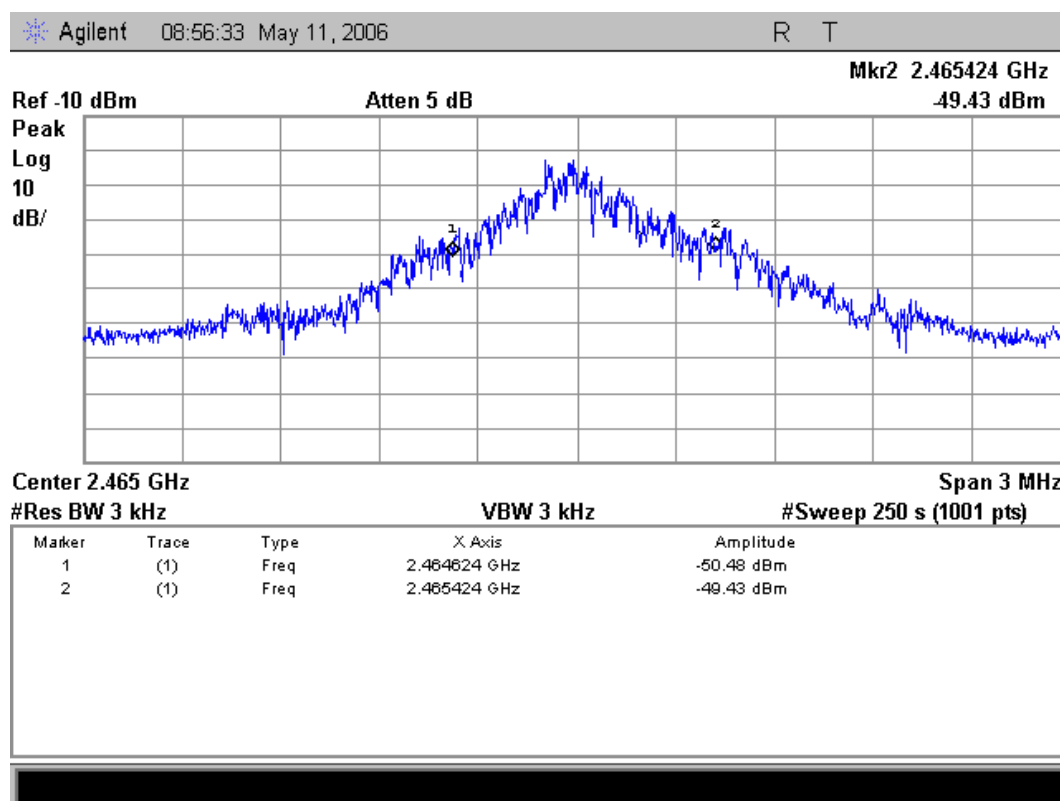
EUT operation mode	Normal modulation
EUT frequency	2465 MHz
EUT TX power level	0 dBm (Software configuration)

9.3 Results

Table 6: 99% bandwidth measurement results

EUT Frequency MHz	Limit MHz	Measured value MHz
2465	-	0.800

9.4 Screen shots

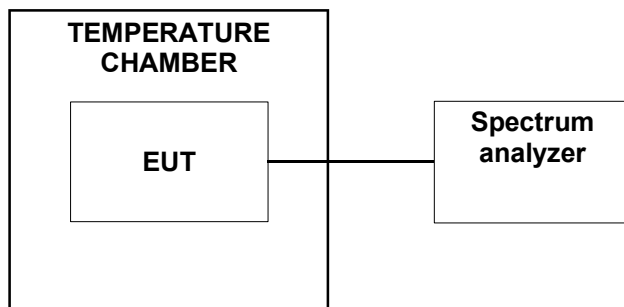


Picture 4: 99% Bandwidth measurement result

10 FREQUENCY STABILITY

EUT	06402		
Accessories	06405		
Temp, Humidity, Air Pressure	- °C	- RH%	- hPa
Date of measurement	April 26, 2006		
FCC rule part	§15.215 (c)		
RSS-GEN section	7.2.4		
Measured by	Marko Turkkila		

10.1 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

10.2 EUT operation mode

EUT operation mode	Continuous transmission
EUT channel	2465 MHz
EUT TX power level	0 dBm (Software configuration)

10.3 Results

Table 7: Frequency stability measurement results

Temperature (°C)	Transmitter frequency (MHz)
50	2464.982
40	2464.984
30	2464.987
20	2464.990
10	2464.992
0	2464.992
-10	2464.986
-20	2464.976
-30	2464.961

11 CONDUCTED EMISSIONS TO AC-MAINS

EUT	06404		
Accessories	06405, 06406, 06407, 06408, 06409		
Temp, Humidity, Air Pressure	22 °C	49 RH%	997 hPa
Date of measurement	June 09, 2006		
FCC rule part	§15.107		
RSS-GEN section	7.2.2		
ICES-003 section	5.3		
Measured by	Marko Turkkila		

11.1 Test setup

Charger was connected to line impedance stabilization network and conducted emissions to AC-mains were measured using measurement receiver.

11.2 EUT operation mode

EUT was connected to Laptop pc USB connector.

11.3 Limits

Frequency of emission [MHz]	FCC / IC	
	Limit [dBμV] Quasi peak	Limit [dBμV] Average
0,15 – 0,50	66 – 56*	56 – 46*
0,50 – 5	56	46
5 – 30	60	50

* The limit decreases linearly with the logarithm of the frequency

11.4 Results

The measured interference values using peak and average detectors are shown in the pictures 3 and 4 below.

All signals closer than 6 dB to the limit have been measured using quasi peak and average detectors and reported in the table 8 and 9.

Table 8: Quasi peak detector measurement results, AC live

Frequency [MHz]	Measured value [dB μ V]	Limit [dB μ V]	Margin to limit [dB]
-			

Table 9: Average detector measurement results, AC live

Frequency [MHz]	Measured value [dB μ V]	Limit [dB μ V]	Margin to limit [dB]
-			

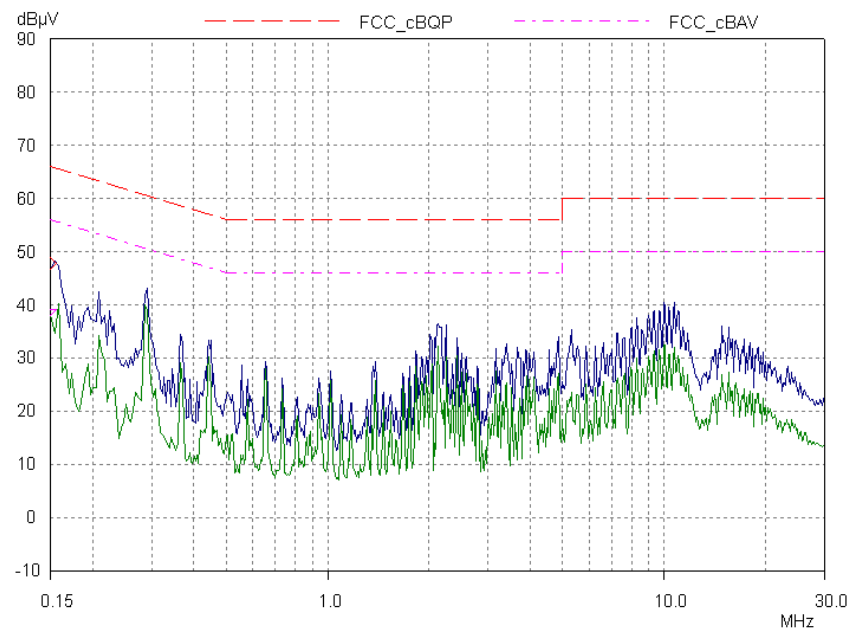
Table 10: Quasi peak detector measurement results, AC neutral

Frequency [MHz]	Measured value [dB μ V]	Limit [dB μ V]	Margin to limit [dB]
-			

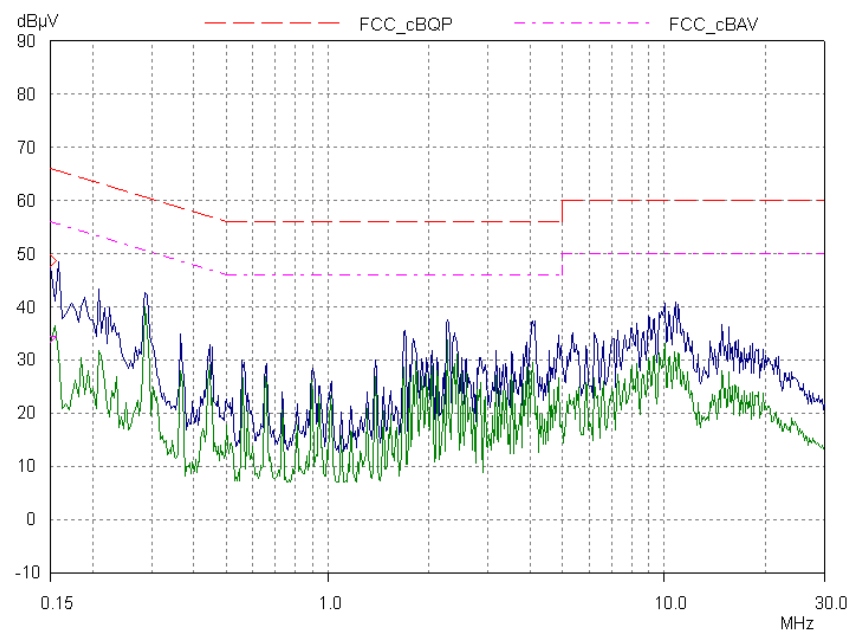
Table 11: Average detector measurement results, AC neutral

Frequency [MHz]	Measured value [dB μ V]	Limit [dB μ V]	Margin to limit [dB]
-			

11.5 Screen shots



Picture 5: AC-mains conducted emission measurement results, AC live



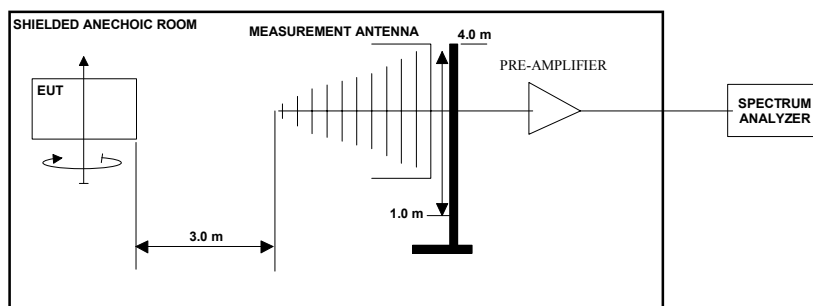
Picture 6: AC-mains conducted emission measurement results, AC neutral

12 RECEIVER RADIATED EMISSION

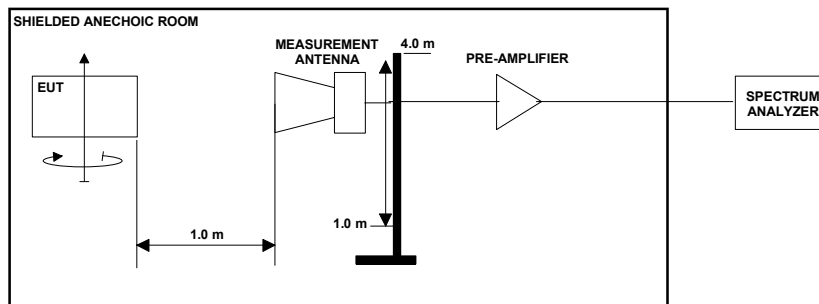
EUT	06404		
Accessories	06405, 06406, 06407, 06408, 06409		
Temp, Humidity, Air Pressure	22 °C	46 RH%	994 hPa
Date of measurement	May 15 – 29, 2006		
FCC rule part	§15.109		
RSS-GEN section	7.2.3		
ICES-003 section	5.5		
Measured by	Tuomo Eloranta		

12.1 Test setup

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



Picture 7: Test setup for radiated spurious emissions measurement
30 MHz – 1 GHz frequencies



Picture 8: Test setup for radiated spurious emissions measurement
1 GHz – 12.4 GHz frequencies

12.2 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.

12.3 EUT operation mode

EUT was connected to Laptop pc USB connector. Suunto Team Monitor program was used to set EUT to receiver active mode.

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

12.4 Limit

Table 12: 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

12.5 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 13, 14 and 15.

Table 13: Radiated emissions using Quasi peak detector

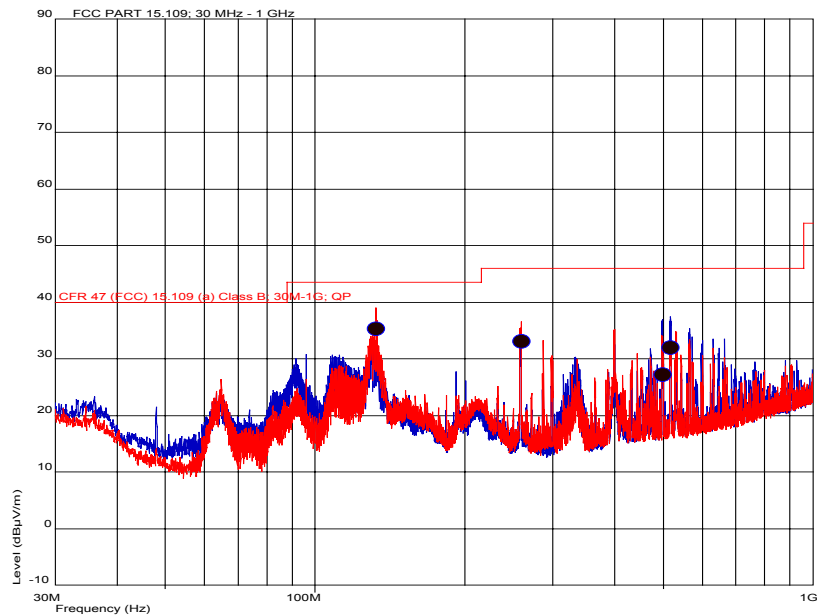
Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dBuV/m	EUT Position	Ant Pol.	Ant height	TT angle
132.6	45.2	-9.9	35.3	-8.2	Pos 1	Hor	1.5	272
259.44	42.3	-9.1	33.2	-12.9	Pos 1	Hor	1	259
499.38	30.0	-2.8	27.2	-18.8	Pos 1	Ver	1	181
518.28	34.6	-2.5	32.1	-13.9	Pos 1	Ver	1	357

Table 14: Radiated emissions using Peak detector

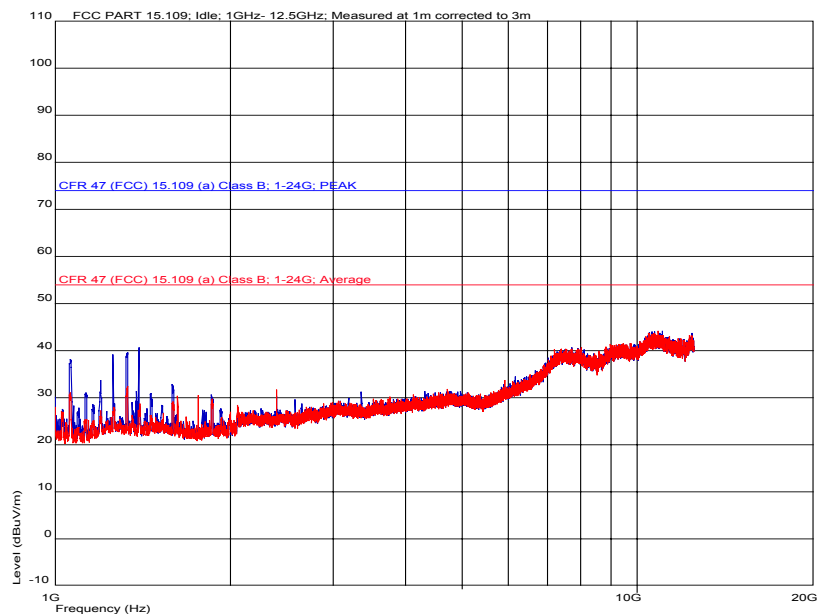
Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dBuV/m	EUT Position	Ant Pol.	Ant height	TT angle

Table 15: Radiated emissions using Average detector

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



Picture 9: radiated emission results, 30 – 1000 MHz,
Red= horizontal polarization, blue = vertical polarization



Picture 10: radiated emission results, 1 – 12.4 GHz,
Red= horizontal polarization, blue = vertical polarization

13 TEST EQUIPMENT

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

13.1 Conducted measurements

Equipment	Manufacturer	Model
Measurement receiver	Rohde & Schwarz	ESCS 30
Transient limiter / 10 dB attenuator	Chase	CFL 9206
Line Impedance Stabilization Network (LISN)	Rohde & Schwarz	ESH 3-Z5
Line Impedance Stabilization Network (LISN)	Schwarzbeck	NNLK8121

13.2 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

14 TEST SETUP PHOTOGRAPHS

Test setup photograph can be found in a separate document

T06-064A-EMC_PHOTOS.doc