

# Test report for WearLink(R) W.I.N.D.

This report replaces the old test report: T06-098C-EMC.

Report Date: July 27, 2006

Signatures:

Tested by:



Marko Turkkila Test Engineer

Contents approved:



Tuomo Hahl Test Engineer

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## 1 LABORATORY INFORMATION

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

## 2 CUSTOMER INFORMATION

|                        |  |
|------------------------|--|
| <b>Client</b>          | Polar Electro Oy<br>Professorintie 5<br>90440 Kempele<br>Finland<br><br>Tel. +358 9 875 870<br>Fax. +358 9 875 87301                         |
| <b>Contact person:</b> | Kari Parkkisenniemi<br>Polar Electro Oy<br>Professorintie 5<br>90440 Kempele<br>Finland<br><br>Tel. +35840-574 0869<br>Fax. +35888- 520 2220 |
| <b>Receipt of EUT:</b> | May 13, 2006   |
| <b>Testing date:</b>   | May 15 – July 5, 2006  |
| <b>Report date:</b>    | July 6, 2006   |

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-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   |

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 |
|--------------------|-------------------------|----------------------|------------------|------------|
| <b>EUT</b>         | WearLink(R)<br>W.I.N.D. | Wearlink<br>W.I.N.D. | F614K20800291 ** | 09801      |
|                    | WearLink(R)<br>W.I.N.D. | Wearlink<br>W.I.N.D. | F614K20800293 ** | 09802 ***  |
|                    | WearLink(R)<br>W.I.N.D. | Wearlink<br>W.I.N.D. | F617K20900030    | 09803 ***  |
| <b>Accessories</b> | Battery                 | CR2025               |                  | 09804      |

Notes:

\*\* Modified to transmit continuously

\*\*\* Modified with antenna connector for conducted measurements

##### 4.1 EUT description

EUT is battery powered heart rate sensor that transmits its measurement data to a computer via radio link. Radio link uses fixed frequency (2473 MHz) and GFSK modulation.

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 12.

## 5 APPLICABLE STANDARDS

The tests were performed in guidance of CFR 47 Part 15.249, 15.209, and Part 2, ANSI C63.4 (2003), 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

|                                     |              |        |         |
|-------------------------------------|--------------|--------|---------|
| <b>EUT</b>                          | 09801        |        |         |
| <b>Accessories</b>                  | 09804        |        |         |
| <b>Temp, Humidity, Air Pressure</b> | 22 °C        | 39 RH% | 993 hPa |
| <b>Date of measurement</b>          | May 22, 2006 |        |         |
| <b>FCC rule part</b>                | §15.249 (a)  |        |         |
| <b>RSS-210 section</b>              | A2.9 (1)     |        |         |
| <b>Measured by</b>                  | Matti Virkki |        |         |

### 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

|                           |                                |
|---------------------------|--------------------------------|
| <b>EUT operation mode</b> | Continuous transmission        |
| <b>EUT frequency</b>      | 2473 MHz                       |
| <b>EUT TX power level</b> | 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 |
|----------|---------------------|----------------------|---------------|-----------------|--------------|----------------|-----------------|
| 2473     | 59.1                | 27.6                 | <b>86.7</b>   | Pos 3           | Hor          | 1.1            | 216             |

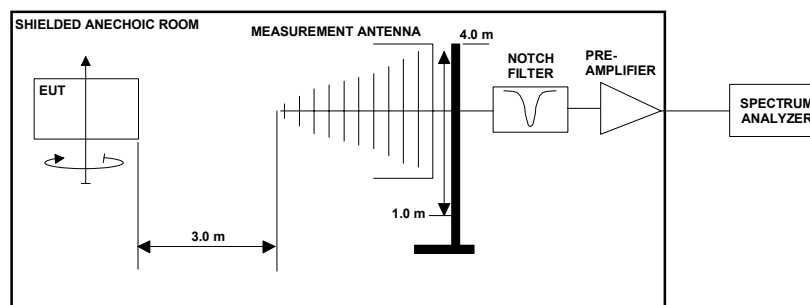
## 7 RADIATED SPURIOUS EMISSIONS

|                                     |                        |        |         |
|-------------------------------------|------------------------|--------|---------|
| <b>EUT</b>                          | 09801                  |        |         |
| <b>Accessories</b>                  | 09804                  |        |         |
| <b>Temp, Humidity, Air Pressure</b> | 22 °C                  | 39 RH% | 993 hPa |
| <b>Date of measurement</b>          | May 24 – June 09, 2006 |        |         |
| <b>FCC rule part</b>                | §15.249 (a) (d)        |        |         |
| <b>RSS-210 section</b>              | 2.7, A2.9 (2)          |        |         |
| <b>Measured by</b>                  | Matti Virkki           |        |         |

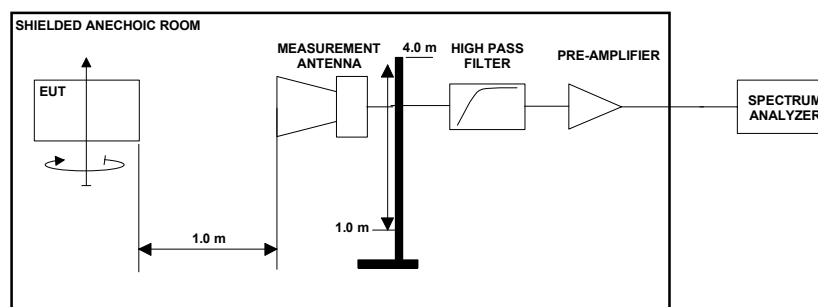
### 7.1 Test setup

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 $\mu$ V/m at 3 m distance, are reported.

## 7.3 EUT operation mode

|                           |                                |
|---------------------------|--------------------------------|
| <b>EUT operation mode</b> | Continuous transmission        |
| <b>EUT frequency</b>      | 2473 MHz                       |
| <b>EUT TX power level</b> | 0 dBm (Software configuration) |

## 7.4 Limit

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

| Frequency band (MHz) | 3m Limit ( $\mu$ V/m) | 3m Limit (dB $\mu$ 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.

## 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 |
|----------|---------------------|----------------------|---------------|-----------------|--------------|----------|------------|----------|
| 4948     | 78.4                | -15.3                | 63.1          | -10.9           | Pos 2        | Hor      | 1          | 357      |
| 7422     | 60.0                | -3.0                 | 57.0          | -17.0           | Pos 2        | Hor      | 1.15       | 335      |
| 9896     | 58.1                | -3.5                 | 54.6          | -19.4           | Pos 2        | Hor      | 1          | 52       |

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 150 $\mu$ s long transmission at 5Hz frequency.

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

|   |                |        |          |
|---|----------------|--------|----------|
| <b>EUT</b>                              | 09803          |        |          |
| <b>Accessories</b>                      | 09805          |        |          |
| <b>Temp, Humidity,<br/>Air Pressure</b> | 22 °C          | 54 RH% | 1003 hPa |
| <b>Date of measurement</b>              | June 12, 2006  |        |          |
| <b>FCC rule part</b>                    | §15.215 (c)    |        |          |
| <b>RSS-210 section</b>                  |                |        |          |
| <b>Measured by</b>                      | 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

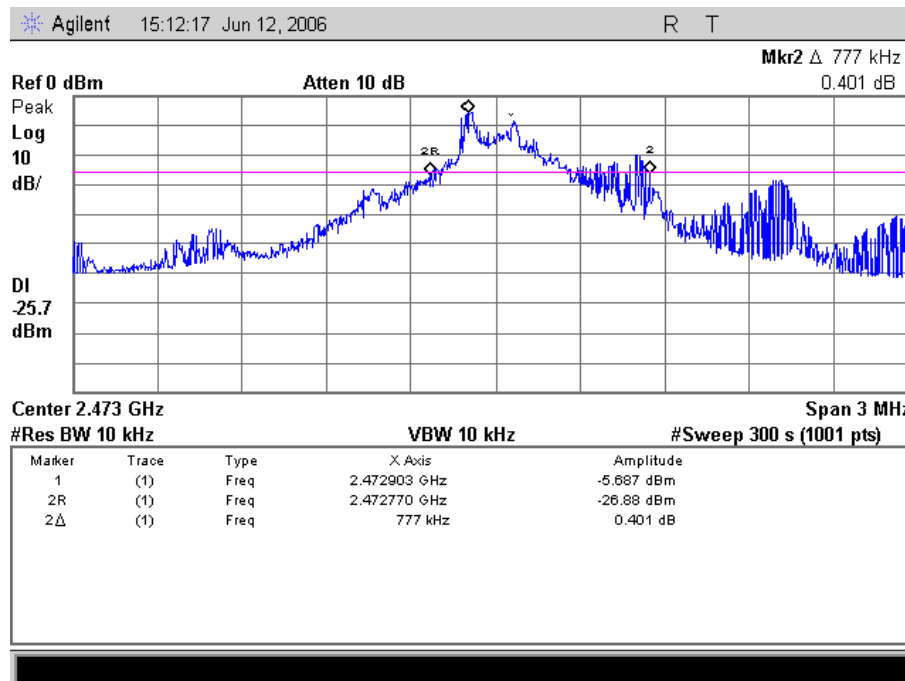
|                           |                                |
|---------------------------|--------------------------------|
| <b>EUT operation mode</b> | Normal modulation              |
| <b>EUT frequency</b>      | 2473 MHz                       |
| <b>EUT TX power level</b> | 0 dBm (Software configuration) |

### 8.3 Results

Table 5: 20dB bandwidth measurement results

| EUT Frequency MHz | Limit MHz | Measured value MHz |
|-------------------|-----------|--------------------|
| 2473              | -         | 0.777              |

### 8.4 Screen shots



Picture 3: 20dB Bandwidth measurement result

## 9 99 % BANDWIDTH

|                                     |                |        |          |
|-------------------------------------|----------------|--------|----------|
| <b>EUT</b>                          | 09803          |        |          |
| <b>Accessories</b>                  | 09805          |        |          |
| <b>Temp, Humidity, Air Pressure</b> | 22 °C          | 54 RH% | 1003 hPa |
| <b>Date of measurement</b>          | June 12, 2006  |        |          |
| <b>FCC rule part</b>                |                |        |          |
| <b>RSS-GEN section</b>              | 4.4.1          |        |          |
| <b>Measured by</b>                  | 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

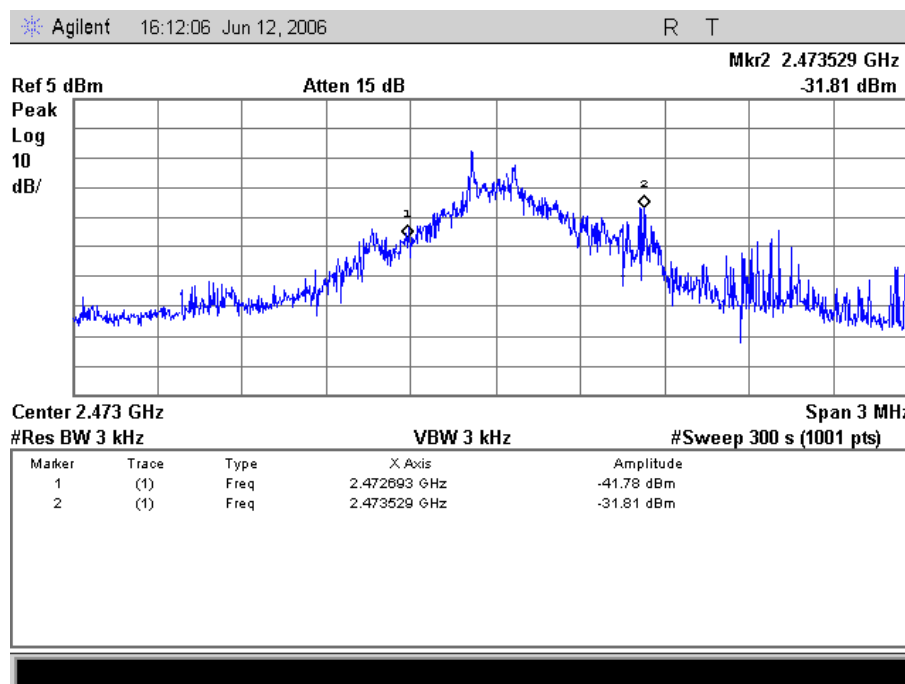
|                           |                                |
|---------------------------|--------------------------------|
| <b>EUT operation mode</b> | Normal modulation              |
| <b>EUT frequency</b>      | 2473 MHz                       |
| <b>EUT TX power level</b> | 0 dBm (Software configuration) |

### 9.3 Results

Table 6: 99% bandwidth measurement results

| EUT Frequency MHz | Limit MHz | Measured value MHz |
|-------------------|-----------|--------------------|
| 2473              | -         | 0.836              |

### 9.4 Screen shots

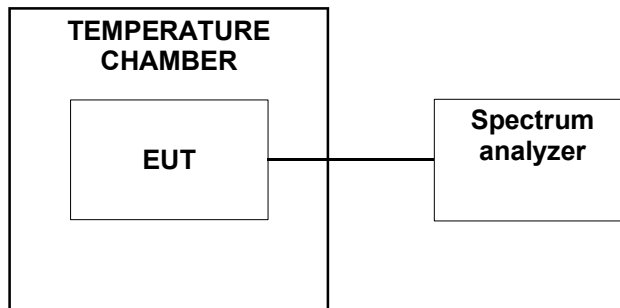


Picture 4: 99% Bandwidth measurement result

## 10 FREQUENCY STABILITY

|                                     |              |       |       |
|-------------------------------------|--------------|-------|-------|
| <b>EUT</b>                          | 09802        |       |       |
| <b>Accessories</b>                  | 09805        |       |       |
| <b>Temp, Humidity, Air Pressure</b> | - °C         | - RH% | - hPa |
| <b>Date of measurement</b>          | July 5, 2006 |       |       |
| <b>FCC rule part</b>                | §15.215 (c)  |       |       |
| <b>RSS-GEN section</b>              | 7.2.4        |       |       |
| <b>Measured by</b>                  | Jani Kiiski  |       |       |

### 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

|                           |                                |
|---------------------------|--------------------------------|
| <b>EUT operation mode</b> | Continuous transmission        |
| <b>EUT channel</b>        | 2473 MHz                       |
| <b>EUT TX power level</b> | 0 dBm (Software configuration) |

## 10.3 Results

Table 7: Frequency stability measurement results

| Temperature<br>(°C) | Transmitter frequency<br>(MHz) |
|---------------------|--------------------------------|
| 50                  | 2474,065                       |
| 40                  | 2474,069                       |
| 30                  | 2474,074                       |
| 20                  | 2474,078                       |
| 10                  | 2474,082                       |
| 0                   | 2474,082                       |
| -10                 | 2474,078                       |
| -20                 | 2474,069                       |
| -30                 | 2474,054                       |



## 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 Radiated measurements

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

## 12 TEST SETUP PHOTOGRAPHS

Test setup photograph can be found in a separate document

T06-098F-EMC\_PHOTOS.doc