

Test report for Speed and Distance Sensor

Report Date: June 06, 2007

Signatures:

Tested by:



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Contents approved:



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1 LABORATORY INFORMATION

Test Laboratory	NATLABS OY EMC Laboratory Koneenkatu 12 / K17 05830 Hyvinkää FINLAND Tel: +358 10 424 6200 Fax: +358 10 424 6201 e-mail: firstname.surname@intertek.com
FCC registration number: IC file number:	910391 (January 27, 2003) IC 4616A-1 (May 14, 2003)

2 CUSTOMER INFORMATION

Client	Polar Elektro Oy Professorintie 5 90440 Kempele Finland Tel. +358 8 520 2100 Fax +358 8 520 2200
Contact person:	Juho-Pekka Peltola Polar Elektro Oy Professorintie 5 90440 Kempele Finland Tel: +358 40 711 5939 Fax: +358 8 520 2220
Receipt of EUT:	April 20, 2007
Testing date:	April 23 – June 04, 2007
Report date:	June 04, 2007

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

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	Na
§15.109	7.2.3	5.5	Radiated emissions	Na

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	Speed and distance sensor	Sensor GPS G3	F714M50500017 **	27201
	Speed and distance sensor	Sensor GPS G3	F714M50500021 ***	27202
	Speed and distance sensor	Sensor GPS G3	C717M50400315 ***	27203
Accessories	Battery	LR6 Size AA	-	27204

Notes:

** Modified to transmit continuously

*** Modified with antenna connector for conducted measurements

4.1 EUT description

EUT is a battery powered fixed frequency transmitter, operating in 2471 MHz frequency, for transferring measurement data in short distance.

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), 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	27201		
Accessories	27204		
Temp, Humidity, Air Pressure	22 °C	60 RH%	1004 hPa
Date of measurement	April 26, 2007		
FCC rule part	§15.249 (a)		
RSS-210 section	A2.9 (1)		
Measured by	Päivi Punta		

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	2471 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 (Avg)	94 (Avg) 114 (peak)

6.4 Results

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

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	EUT orientation	Antenna Pol.	Antenna height m	Turntable angle deg
2471	59.5	34	93.5	Pos 3	Ver	1.5	9

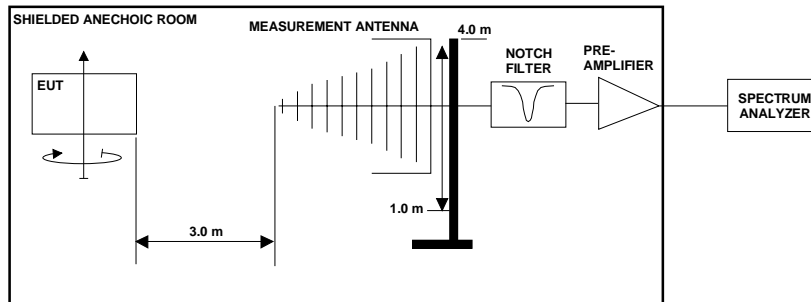
7 RADIATED SPURIOUS EMISSIONS

EUT	27201		
Accessories	27204		
Temp, Humidity, Air Pressure	22 °C	53 RH%	999 hPa
Date of measurement	April 24, 2007		
FCC rule part	§15.249 (a) (d)		
RSS-210 section	2.7, A2.9 (2)		
Measured by	Päivi Punta		

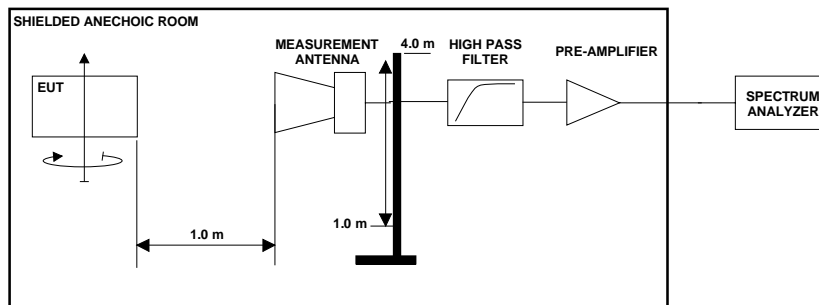
7.1 Test setup

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	2471 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
4942	74.3	-15.3	59.0	-15.0	Pos 1	V	1	12
7413	55.8	-3.1	52.7	-21.3	Pos 1	V	1	306
9884	62.2	-3.5	58.7	-15.3	Pos 1	V	1.3	342
12355	54.5	1.3	55.9	-18.1	Pos 3	V	1.15	177

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

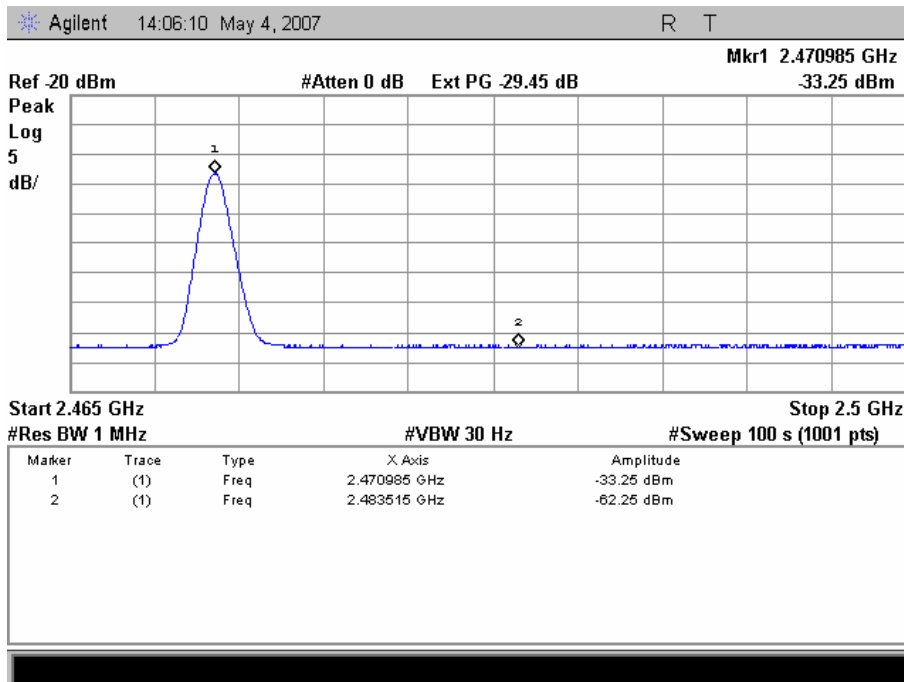
$$\text{Average level} \leq \text{Peak level} - 20 \log(\text{duty cycle})$$

According to manufacturer the worst case duty cycle for this product is 144µs + 265 µs long transmissions every 0.437s.

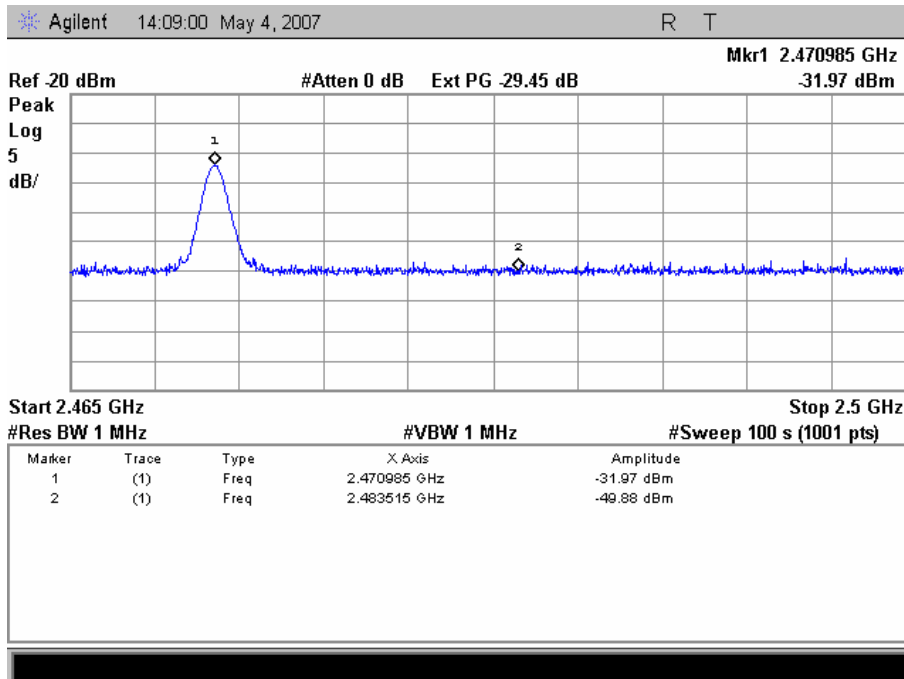
Therefore,

$$\begin{aligned} \text{Average level} &\leq \text{Peak level} - 20 \log((100 \text{ ms} - 409 \mu\text{s}) / 409\mu\text{s}) \\ \text{Average level} &\leq \text{Peak level} - \mathbf{47.7 \text{ dB}} \end{aligned}$$

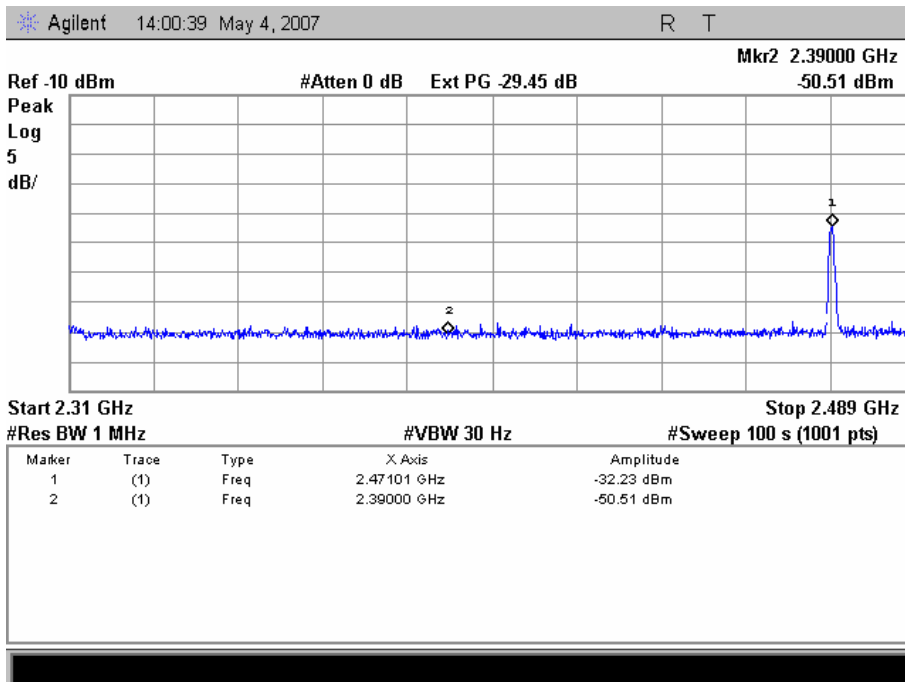
Spurious emissions on band edge restricted bands



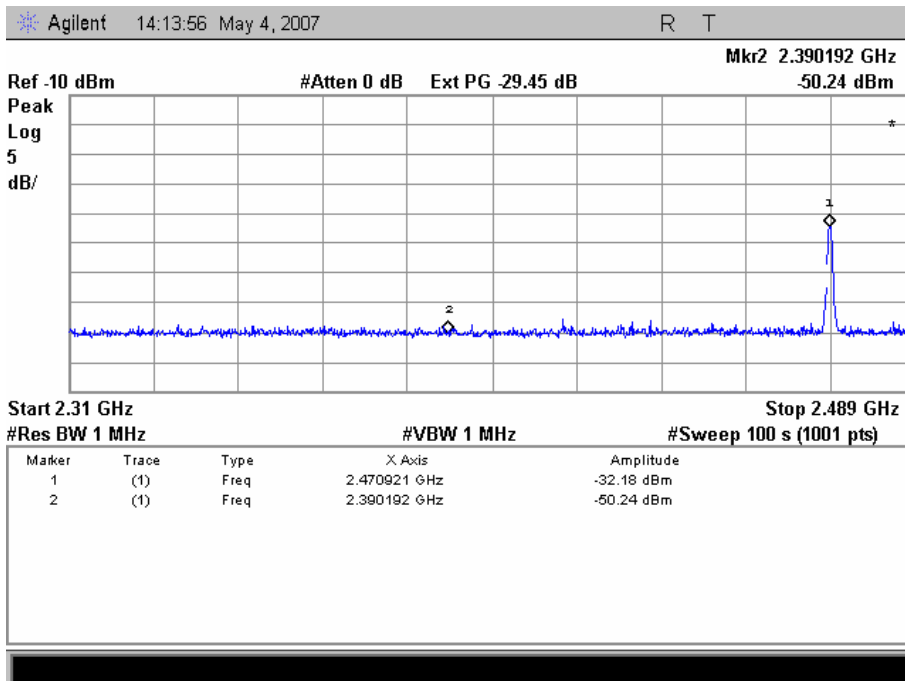
Picture 3: Band edge measurement, Average



Picture 4: Band edge measurement, Peak



Picture 5: Band edge measurement, Average



Picture 6: Band edge measurement, Peak

8 20 dB BANDWIDTH

EUT	27203		
Accessories	27204		
Temp, Humidity, Air Pressure	23 °C	53 RH%	1007 hPa
Date of measurement	June 04, 2007		
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

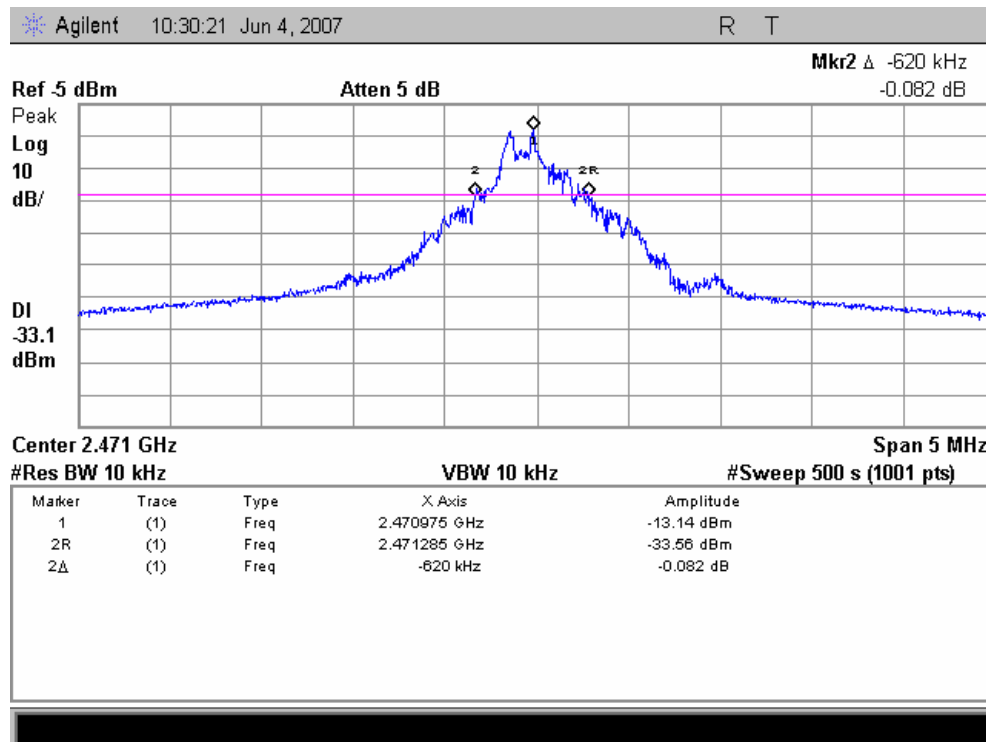
EUT operation mode	Normal modulation
EUT frequency	2471 MHz
EUT TX power level	0 dBm (Software configuration)

8.3 Results

Table 5: 20dB bandwidth measurement results

EUT Frequency MHz	Limit MHz	Measured value MHz
2471	-	0.620

8.4 Screen shots



Picture 7: 20dB Bandwidth measurement result

9 99 % BANDWIDTH

EUT	27203		
Accessories	27204		
Temp, Humidity, Air Pressure	23 °C	53 RH%	1007 hPa
Date of measurement	June 04, 2007		
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

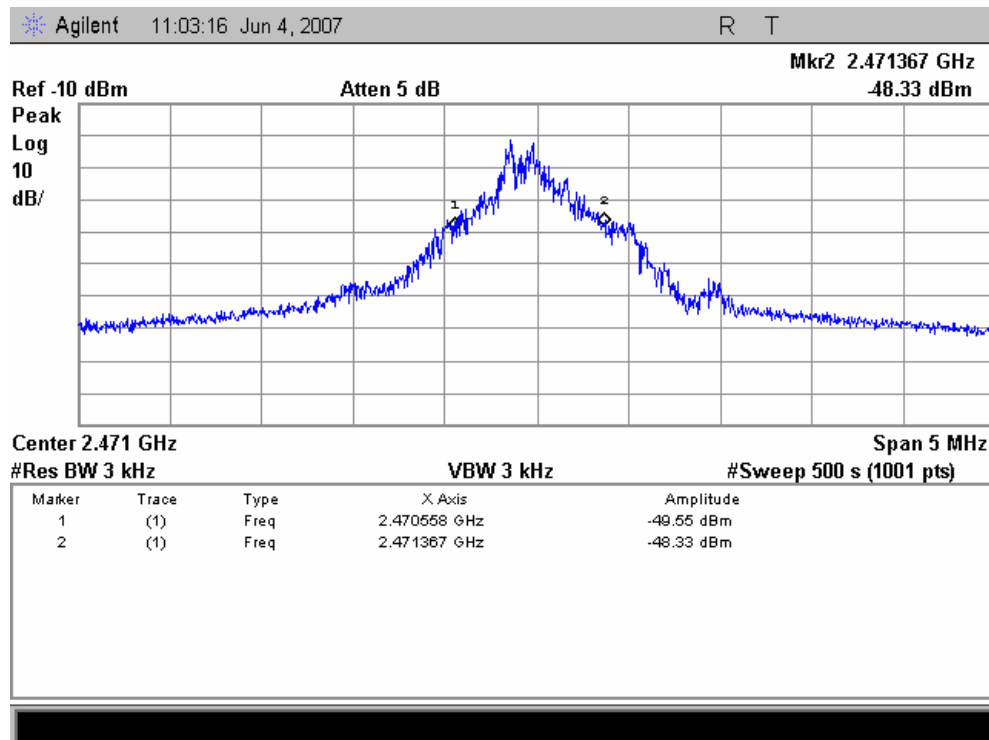
EUT operation mode	Normal modulation
EUT frequency	2471 MHz
EUT TX power level	0 dBm (Software configuration)

9.3 Results

Table 6: 99% bandwidth measurement results

EUT Frequency MHz	Limit MHz	Measured value MHz
2471	-	0.779

9.4 Screen shots

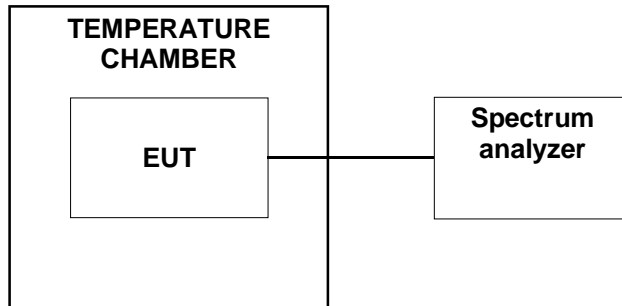


Picture 8: 99% Bandwidth measurement result

10 FREQUENCY STABILITY

EUT	27202		
Accessories	-		
Temp, Humidity, Air Pressure	- °C	- RH%	- hPa
Date of measurement	May 09, 2007		
FCC rule part	§15.215 (c)		
RSS-GEN section	7.2.4		
Measured by	Matti Virkki		

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	2471 MHz
EUT TX power level	0 dBm (Software configuration)

10.3 Results

Table 7: Frequency stability measurement results

Temperature (°C)	Transmitter frequency (MHz)
50	2470.977
40	2470.975
30	2470.976
20	2470.977
10	2470.978
0	2470.976
-10	2470.972
-20	2470.962
-30	2470.947

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
Attenuator 3 dB	Narda	779-3
Power splitter	Mini Circuits	ZFSC-2-4
Power splitter	Narda	4426-2

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

T07-272C-EMC_PHOTOS.doc