DANAK
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Telelaboratoriet

TEST REPORT

An Accredited Technical Test Executed under the Danish Accreditation Scheme

Prøvningsrapport

for akkrediteret prøvning i henhold til Dansk Akkrediterings Ordning

No. of annexes 29
Antal bilag

Test-report No *Prøvningsrapport Nr.*	UPRR020008-02	**Our reference** *Vor reference*	Martin Arndt	**Copy No** *Eksemplar Nr.*	1
Equipment *Udstyr*	Medical Bluetooth device				
Manufacture *Fabrikat*	GN Otometrics A/S				
Type *Type*	NOAHlink				
Serial No *Serie Nr.*	-	**Equipment received** *Udstyr modtaget*	31.01.2002		
Client *Rekvirent*	GN Otometrics A/S				
Address *Adresse*	Dybendalsvænget 2,				
Postal code *Post Nr.*	2630	**City** *By*	Tåstrup	**Country** *Land*	Danmark
The testing has been carried out in accordance with *Prøvningen er udført i henhold til*	CFR47 Part 15C (2001 edition). Clause 15.209 and 15.247				
Remarks *Bemærkninger*	All the tested parameters fulfil the requirements				
Date and signature *Dato og underskrift*	26. June 2002	Martin Bülow Arndt			

Martin Bülow Arndt
B.Sc.(E.E.)

The test result is only valid for the equipment tested.
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The requirements to be met by accredited laboratories are laid down in the "Danish Agency for Trade and Industry's" ("Erhvervsfremme Styrelsen´s") Statutory Order on accreditation of laboratories to perform testing etc., and GLP-inspection. The Statutory order refers to other documents where the criteria for accreditation are specified further.

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In order for a laboratory to be accredited it is, among other things, required:

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- that the laboratory operates a documented quality system.
- that the laboratory has at its disposal all items of equipment, facilities and premises required for correct performance of the service that it is accredited to perform.
- that the laboratory management and personnel have technical competence and practical experience in performing the service that they are accredited to perform.
- that the laboratory has procedures for traceability and uncertainty calculations.
- that accredited testing is performed in accordance with fully validated and documented methods.
- that the laboratory keeps records which contain sufficient information to permit repetition of the test.
- that the laboratory is subject to surveillance by DANAK on a regular basis.
- that the accredited laboratory shall take out an insurance, which covers liability in connection with the performance of accredited services.

Reports carrying DANAK´s logo are used when reporting accredited services and show that these have been performed in accordance with the rules of accreditation.

Title: Test on GN Otometrics A/S, NOAHlink, to FCC Part 15 C clause 15.209 and 15.247.

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Title: Test on GN Otometrics A/S, NOAHlink, to FCC Part 15 C clause 15.209 and 15.247.

Annexes:

Normal mode

1	:	Separation of channels
2	:	Number of hopping channels
3 - 5	:	20 dB bandwidth
6 - 7	:	Occupancy of individual frequencies
8 - 16	:	Radiated emission (Pre-scan)
17	:	Radiated emission (Final measurement)
18-19	:	Radiated emission at TX band edges

Acquisition mode

20	:	Channels used in inquiry mode
21 – 23	:	Bandwidths, Inquiry mode
24	:	Channels used in Page mode
25 – 27	:	Bandwidths, Page mode
28	:	Spectral power density, inquiry mode
29	:	Spectral power density, page mode

Title: Test on GN Otometrics A/S, NOAHlink, to FCC Part 15 C clause 15.209 and 15.247.

1. Test Specification and Methods

Purpose of Test: The tests are performed in order to demonstrate compliance with the FCC requirements for frequency hopping intentional transmitters operating in the freq. range 2400MHz to 2483,5MHz.

Test Specifications:

Limits:

[1] **CFR 47 Part 15 : 2001**, Code of Federal Regulation 47 (Telecommunication), Part 15 (Radio Frequency Devices), Subpart C (Intentional Radiators)
Clause 15.209 and 15.247

Methods and Procedures:

The Test methods and procedures are defined in the following standard(s) (for undated references the latest edition applies):

[2] **ANSI C63.4 : 2000**, American National Standard for Methods of Measurement of Radio-Noise Emissions form Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

2. Location of Test Site

Test are performed at the test site of Tele Danmark A/S (Telelaboratoriet) at the address:

Tele Danmark A/S (Telelaboratoriet)
Telegade 2
DK-2630 Taastrup
Denmark

This site is listed at the FCC under the Registration Number 92797 since December 19, 2001. The FRN number for Telelaboratoriet is 0005-0898-67.

Title: Test on GN Otometrics A/S, NOAHlink, to FCC Part 15 C clause 15.209 and 15.247.

3. EUT Description

3.1. General

The EUT is a medical device providing a wireless link to hearing aids to be used during their individual calibration. The EUT operates in the 2.4GHz band and the RF and protocols used are based on the Bluetooth technology.

Product:	Medical Bluetooth Device
Manufacture:	GN Otometrics A/S
Type No:	NOAHlink

The RF interface is provided by a Ericsson Bluetooth module, ROK 101 007 / 21, previously approved by the FCC and is listed under FCC ID number PNI8001001.

3.2. Technical specifications

Frequency	:	2400,0 – 2483,5 MHz
Number of channels	:	79 (2402 – 2480)
Type of modulation	:	GFSK, FHSS (TDD)
Output power	:	0dBm / 1 mW
Antenna type	:	Internal
Antenna gain	:	1,2dBi (max)
Power supply	:	1,5VDC (Alkaline battery) or 1.2VDC (rechargeable NiMH battery)
Type of equipment	:	Bluetooth Transceiver class 2
Temperature range	:	5 – 45 deg. C.

4. Tests and test conditions

4.1. EUT ports to be examined

Following port was examined during the tests:

1. Enclosure port

4.2. Operation of the EUT

The EUT was during all tests operated at its maximum output power (0dBm) and powered by a 1,5V alkaline battery (except during extreme conditions where power were supplied by power supply).
EUT was set-up by a by a lab-top PC with a Bluetooth interface to operate in TX test mode and based upon the parameters given after the test mode command, package size, hopping on/off, TX frequency could be selected.
All tests are performed with the internal antenna replaced with a 50 ohm connector (conduced measurement) with the exception of the radiated emission test (radiated measurement) which is performed with the actual antenna in place.

4.3. Limits and frequency ranges used

4.3.1. Enclosure port measurements

Compliance is checked according to §15.209 general limits and § 15.247 covering frequency-hopping transmitters using the 2400,0 - 2483,5 MHz ISM band.

According to [1] §15.33, spurious and RF emission is measured up to the 10. harmonic of the maximum TX channel frequency. This give a measuring range of 30 MHz to 25 GHz as the highest TX channel is at 2480 MHz.

5. Measurements, Examinations and Derived Results

General Comments
The measurement uncertainties stated below are calculated according with the requirements of the Danish Institute of Fundamental Metrology.

Title: Test on GN Otometrics A/S, NOAHlink, to FCC Part 15 C clause 15.209 and 15.247.

5.1. §15.247 (a) (1) – Separation of channels

The frequency spectrum is measured using a spectrum analyser with a max-hold function. This is done in order to measure the channel separation. Measurement is performed with EUT in active mode (transfer of DH5 packages) hopping on all 79 channels.

Measurement uncertainty:

Amplitude: **+/- 2,5dB** (k=2)
Frequency **+/- 80kHz** (k=2)

Measurement results:

The measurement shows that the channel carrier frequencies is separated by more than 20dB (20dB bandwidth)

The measurement results are plotted in annex 1.

Limit:

Separation shall be minimum 25kHz or the 20dB bandwidth of the hopping channel.

Conclusion:

The EUT complies with the given limit.

Test performed by: FBOLL Date: 21. May 2002

Title: Test on GN Otometrics A/S, NOAHlink, to FCC Part 15 C clause 15.209 and 15.247.

5.2. §15.247 (a) (1) – Number of hopping channels

The number of channels used by the EUT was measured using a spectrum analyser with a max hold function. Measurement was performed with the EUT in active mode (transfer of DH5 packages).

Measurement uncertainty:

N/A

Measurement results:

In annex 2 the number of channels used by the EUT is shown. Lowest channel is 2402MHz and highest channel is 2480. Number of channels used is 79.

Limit:

Frequency hopping systems operating in the 2400,0 – 2483,5MHz band shall use at least 75 hopping channels.

Conclusion:

The EUT complies with the given limit.

Test performed by: MBAR Date: 21. May 2002

Title: Test on GN Otometrics A/S, NOAHlink, to FCC Part 15 C clause 15.209 and 15.247.

5.3. §15.247 (a) (1) – 20 dB bandwidth

The used RF bandwidths were measured at the lowest, highest and centre frequency in active mode (transfer of DH5 packages).

Measurement uncertainty:

Amplitude: **+/-1 dB**
Frequency **+/- 40 kHz**

Measurement results:

Channel / TX freq.	Lowest / 2402MHz	Centre 2441MHz	Highest 2480MHz
Bandwidth [MHz]	0,556	0,538	0,538

The measurement results are plotted in annex 3-5.

Limit:

The occupied bandwidth shall not exceed 1MHz.

Conclusion:

The EUT complies with the given limit.

Test performed by: FBOLL Date: 21. May 2002

Title: Test on GN Otometrics A/S, NOAHlink, to FCC Part 15 C clause 15.209 and 15.247.

5.4. §15.247 (a) (1) – Occupancy of individual frequencies

The maximum TX slot length and the number of times a particular hopping frequency is (re)used is measured. These measurements are performed in order to establish the TX time on this channel within a 30-second period.

Measurement uncertainty:

Time : +/- 0.1mS

Measurement results:

The maximum TX slot length is measured to 2,85msec.The (re)use of a single hopping frequency within a 10 second period is 32 giving a calculated (re)use of 96times within a 30 second period.

Use of a single frequency is: 96 * 0,00285 = 0,2736 second over a 30 second period.

The measured (re)use of a frequency is plotted in annex 6.
The measured TX slot length is plotted in annex 7.

Limit:

The average time of occupancy on any frequency shall not be greater than 0,4 second within a 30 second period.

Conclusion:

The EUT complies with the given limit.

Test performed by: MBAR Date: 24 and 29. May 2002

Title: Test on GN Otometrics A/S, NOAHlink, to FCC Part 15 C clause 15.209 and 15.247.

5.5. §15.247 (b) (1) – Maximum peak output power

The maximum RF output power were measured at the lowest, highest and centre frequency in active mode (transfer of DH5 packages). The output values are measured using a 1MHz BW, at the temporary antenna connector. The EIRP values are calculated by using the peak gain of the used antenna e.g. 1.2 dBi.

Measurement uncertainty:

Amplitude: **+1,3 / -1,2 dB**

Measurement results:

Measured with peak detector.

	Lowest / 2402MHz	Centre 2441MHz	Highest 2480MHz
Transmitter power [dBm]	0,67	0,33	0,00

Highest measured peak power: 0,67dBm ⇔ 1.17mW
Highest possible EIRP (peak gain = 1,2dB) = 1,54mW

Limit:

The maximum peak output power shall not exceed 1Watt.

Conclusion:

The EUT complies with the given limit under normal and extreme conditions.

Test performed by: MBAR **Date:** **20. June 2002**

Title: Test on GN Otometrics A/S, NOAHlink, to FCC Part 15 C clause 15.209 and 15.247.

5.6. §15.247 (c) – RF power, conducted measurement

The maximum RF power (carrier and spurious products) that is produced by the EUT is measured conducted with a spectrum analyser using a 100kHz BW. The temporary RF connector of the EUT is connected directly to the input of the spectrum analyser.

Measurement uncertainty:

Amplitude: **+1,3 / -1,2 dB**

Measurement results:

The maximised carrier signal and highest level of spurious with TX locked at 2402, 2441 and 2480MHz is shown below.

TX locked at 2402MHz
In-band level = 0,23dBm
Maximum out of band level = -56,1dBm

TX locked at 2441MHz
In-band level = 0,23dBuV/m
Maximum out of band level = -58,27dBm

TX locked at 2480MHz
In-band level = -0,43dBuV/m
Maximum out of band level = -59,1dBm

Limit:

All RF power values measured outside the frequency band in which the spread spectrum intentional radiator is operated must be at least 20 dB less than the maximum value found in the frequency band in which the spread spectrum intentional radiator is operated. Both measurements performed with 100kHz BW.

Conclusion:

The EUT complies with the given limit.

Test performed by: **MBAR** **Date:** **19. June 2002**

Title: Test on GN Otometrics A/S, NOAHlink, to FCC Part 15 C clause 15.209 and 15.247.

5.7. §15.209 (a) – Radiated emission

The maximum radiated emission that is produced by the EUT is measured in a GTEM (pre-scan) and in an anechoic room in 3-meter distance (final measurement). The measurement is made with the EUT positioned in 3 orthogonal planes.
Detailed plot of the emission at the TX band edges are made to show compliance with the requirements in the restricted bands just below 2402 MHz and just above 2480 MHz.

Measurement uncertainty:

Field strength: **-4.2/+3.4 dB** (k = 2)

Measurement results:

The plots of the pre-scans (lowest, middle and highest channel) are shown in annex 8 – 16. The result of the final measurement is listed in annex 17. These represents the maximum obtained for the EUT placed in the 3 different planes. A summary is shown below. Sweeps at TX band edges are shown in annex 18+19.

Frequency	Values @ 3 meter	Limit @ 3 meter
30 – 88 MHz	No critical peaks	40dBuV/m (QP)
88 – 216 MHz	No critical peaks	43,52dBuV/m (QP)
216 –1 GHz	below 39,19dBuV/m (peak)	46dBuV/m (QP)
1-25 GHz Excluding TX band	below 68,93dBuV/m (peak)	74dBuV/m (peak) / 54 dBuV (avg.)

Note: During normal operation the duty cycle will be maximum 1% (0,27-sec. TX in 30-sec. period) giving a peak to avg. relation of –40dB. E.g. max avg. of carrier related peaks above 1GHz <28,93dBuV/m

Limit:

All Radiated emission that falls in the restricted bands as defined in 15.205 (a) must comply with the radiated emission limits specified in 15.209.

Conclusion:

The EUT complies with the given limit.

Test performed by: MBAR Date: 10. April 2002

Title: Test on GN Otometrics A/S, NOAHlink, to FCC Part 15 C clause 15.209 and 15.247.

5.8. §15.247 (a) (2) – 6 dB bandwidth, acquisition (inquiry / page)

The used RF bandwidths were measured at the lowest, highest and centre frequency in both inquiry and page mode.

Measurement uncertainty:

Amplitude: **+/-1 dB**
Frequency **+/- 40 kHz**

Measurement results:

Inquiry mode

Channel / TX freq.	Lowest / 2402MHz	Centre 2441MHz	Highest 2479MHz
Bandwidth [kHz]	1150	983	1035

Centre frequency of highest channel is 2479 in inquiry mode

Page mode

Channel / TX freq.	Lowest / 2403MHz	Centre 2440MHz	Highest 2479MHz
Bandwidth [kHz]	1120	1005	980

Centre frequency of lowest channel is 2403 in page mode

Channels used in inquiry mode can be found in annex 20.
Bandwidths in inquiry mode can be found in annex 21 – 23
Channels used in page mode can be found in annex 24.
Bandwidths in page mode can be found in annex 25 - 27

Limit:

For direct sequence systems the minimum 6dB bandwidth shall be at least 500kHz.

Conclusion:
The EUT complies with the given limit.

Test performed by: FBOLL **Date: 13. May 2002**

Title: Test on GN Otometrics A/S, NOAHlink, to FCC Part 15 C clause 15.209 and 15.247.

5.9. §15.247 (d) – Spectral power density, acquisition (inquiry / page)

The maximum spectral power density is performed as a conducted measurement. The power is measured at the point where the antenna normally is connected. Measurements are performed with a bandwidth of 3kHz.

Measurement uncertainty:

Amplitude: **+/-1 dB**

Measurement results:

To find the highest power density a scan over the full TX band was performed in both page and inquiry mode.
For maximum peak power in inquiry mode is shown in annex 28.
Maximum peak power in page mode is shown in annex 29.

Measurement shall be corrected for cable losses by adding 1.3dB to the values shown.

Corrected max. peak power density value in inquiry and page mode is found to be < -11dBm.

Limit:

For direct sequence systems, the peak power spectral power density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3kHz band during any time.

Conclusion:

The EUT complies with the given limit.

Test performed by:FBOLL Date: 13. May 2002

Title: Test on GN Otometrics A/S, NOAHlink, to FCC Part 15 C clause 15.209 and 15.247.

6. List of instruments

Radiated emission Prescan :

Test receiver	R&S ESMI	14853
GTEM	EMCO 5302	Ser. No. 9410-1118

Radiated emission Final:

Test receiver	R&S ESMI	14853
Antenna 1	Schwarzbeck VHA	17094
Antenna 2	Schwarzbeck UHALP	17380
Antenna 3	EMCO 3115	15781

RF conducted measurements:

Test receiver	R&S ESMI-RF	17643
Test receiver	HP 71210C	15358

Support Equipment:

Laptop PC with Bluetooth interface card :