Test Report

DANAK
Reg. no. 19

Emission tests to FCC requirements of OEM Bluetooth Module 0005-01

Performed for connectBlue AB

DANAK-195875
Project no.: K222161-1
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12 annexes

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The PDF-version consists of 3 parts. This is part 1.

Title	Emission tests to FCC requirements of OEM Bluetooth Module 0005-01
Test object	OEM Bluetooth Module 0005-01 in two versions, one with internal antenna and one with external antenna.
Report no.	DANAK-195875
Project no.	K222161-1
Test period	2001-09-13 to 2001-11-09
Client	connectBlue AB Stora Varvsgatan 11 N:1 SE-211 19 Malmö Sweden Telephone: +46 40 237 100 Fax: +46 40 237 137
Contact person	Mr. Olof Viklund
Manufacturer	connectBlue AB
Specifications	47 CFR Part 15, Subpart C – Intentional Radiators
Results	The equipment under test was in compliance with the requirements
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Date	2001-11-28
Project manager	 Vagn Sylvest B.Sc.E.E. - EMC DELTA

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1. Summaries

1.1 Technical report summary

The tests reported in this document have been performed to demonstrate compliance with the requirements of FCC for Frequency Hopping Transmitters operating within the frequency band 2400 - 2483.5 MHz.

This report contains measurement data from tests performed at DELTA, Denmark, a FCC listed and DANAK accredited test laboratory.

1.1.1 Applicable FCC rules for test

47 CFR Part 15, Subpart C – Intentional Radiators

§15.207 Conducted limits
§15.209 Radiated emission limits, general requirements
§15.247 Operation within the bands 902 – 928 MHz, 2400 – 2583.5 MHz, and 5725 – 5850 MHz.

The methods and procedures have been applied as specified in:

ANSI C63.4:1992 Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz.

Note

This report, DANAK no. 195875, is a consolidated report that includes updates and additions to initial report DANAK 195768. Updates and additions are based on the relevant points of a seven point technical request from MET Lab, forwarded as e-mail to DELTA on 26 October 2001. The initial report, DANAK-195768, is therefore no longer relevant.

1.2 Summary of tests

The results of the emission tests can be summarised as follows:

Tests of Intentional Radiator	**Key references to requirement**	**FCC Part 15 Subpart C**
Conducted emission, AC mains	§ 15.207	Passed
Radiated electromagnetic field emission	§15.209	Passed
Number of Hopping Frequencies	§ 15.247(a)1)ii)	Passed
20 dB Bandwidth	§ 15.247(a)1)ii)	Passed
Time of occupancy	§ 15.247(a)1)ii)	Passed
Carrier Frequency Separation	§ 15.247(a)1)	Passed
Occupied Bandwidth	§ 15.247	Passed
Peak Power Output	§ 15.247(b)1)	Passed
Relative power in 100 kHz bandwidth	§ 15.247(c)	Passed
Peak power spectral density	§ 15.247(d)	Passed

Abbreviations
Passed : The requirements are met.
Failed : The requirements are not met.
Not done : No test was performed.
N/A : Not applicable.
Not relevant : The test was not relevant for the test object.

The test results relate only to the specimen tested.

2. Test specimen(s)

The test object OEM Bluetooth Module 0005-01 is a serial interface to air interface converter module. It houses an Ericsson Bluetooth module type ROK 10 1007, which is a Modular Transmitter with **FCC Identifier CGK8001001** or **PNI8001001**. The Grantee is Ericsson.

The OEM Bluetooth Module 0005-01 is a **Mobile Modular Transmitter** with a nominal 0 dBm output. The module exists in two versions. One version has an internal antenna mounted on the PCB. The other version has permanently connected an external antenna. The printed circuit board and mounted parts are identical, except for the antenna.

Two objects were tested and reported here. One unit using Intenna's "Bluetooth SMD antenna", mounted on the PCB. The other unit was mounted with Intenna's "Inside2 antenna", which is an external antenna connected through a 30 cm RC 174/U coaxial cable.

Both antennas will be permanently connected to the circuit board. If connectors are used, they will be made permanently connected.

The output power of the modular transmitter, and the power fed to the antenna, is nominal 0 dBm.

2.1 Test object *OEM Bluetooth Module 0005-01*

Category	Intentional radiator with Bluetooth Transmitter
Manufacturer	connectBlue AB
Model/type	0005-01 - Internal antenna
Serial no.	000016
FCC ID	(PVH000501)
Antenna type	Intenna's Bluetooth SMD Antenna - Max gain 2 dBi
Antenna part no.	4170001
Supply voltage	3.6 - 6,5 VDC. Nominal 5 VDC
Operational mode	Transmitting in HCI-mode

2.2 Test object *OEM Bluetooth Module 0005-01*

Category	Intentional radiator with Bluetooth Transmitter
Manufacturer	connectBlue AB
Model/type	0005-01 - External antenna
Serial no.	000017
FCC ID	(PVH000501)
Antenna type	Intenna's Inside2 Antenna - Max gain 2.41 dBi
Antenna part no.	4130001
Antenna cable	30 cm Huber+Suhner RG 174/U. Attenuation 1.65 dB/m
Supply voltage	3.6 - 6,5 VDC. Nominal 5 VDC
Operational mode	Transmitting in HCI-mode

2.3 AUX equipment Interface module with DC/DC converter

Manufacturer	connectBlue AB
Model/type	0006-01
Serial no.	0000176
Supply voltage	Input 12 VDC. Output 5 VDC
Remark	Converts DB9 connector flat cable

2.4 AUX equipment Test PC

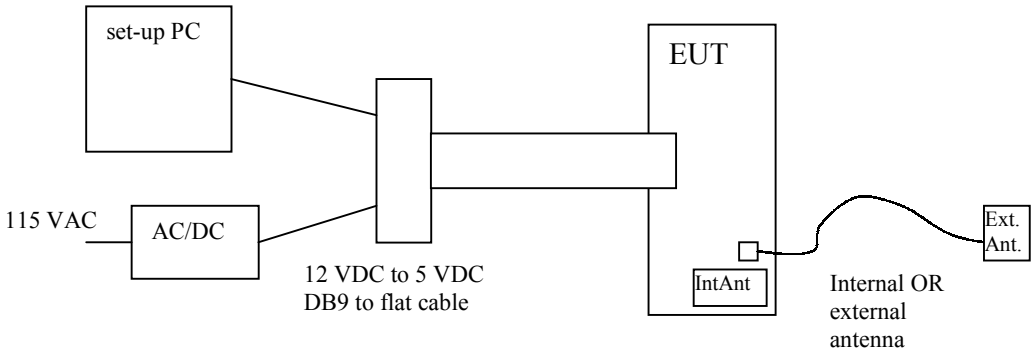
Manufacturer	Acer
Model/type	Travelmate 525TXV PC
Part no.	-
Serial no.	9141H0120W0320139DT
FCC ID	-
Remark	Used only for configuration of OEM Bluetooth Module

2.5 AUX equipment Power supply

Manufacturer	Powerbox
Model/type	3000
Part no.	-
Serial no.	3228
connectBlue inventory	No. 007670
Remark	115 VAC to 12 VDC converter. Supplying the interface module.

3. General test conditions

3.1 Test set-up



The system is configured as a serial interface to air interface.

The EUT has a build-in DC/DC converter. Power and serial data are fed to the EUT via a flat cable. Connection to the flat cable is made using a connectBlue interface module type 0006-01. This module houses a DC/DC converter and performs a direct galvanic connection from the signal wires of the DB9 connector to the flat cable.

The function of the set-up PC is only to configure the Bluetooth module, when changing between hopping mode and fixed frequency transmission.

The AC/DC power supply was powered from 115 VAC 50 Hz during the tests.

4. Test and results

4.1 Conducted emission, AC mains (FCC Part 15, Subpart C)

	Requirements
Specification	FCC Rules and Regulations Part 15, Subpart C
Test set-up	ANSI C63.4:1992
Frequency range	0.45-30 MHz
Limit: (quasi-peak)	0.45-30 MHz: 48 dBµV
Test record sheets	*Annex 3*

Results:

The emission was within the specified limits.

Comments:

Supply voltage: 115 VAC.

4.2 Radiated electromagnetic field (FCC Part 15, Subpart C)

	Requirements
Specification	FCC Rules and Regulations Part 15, Subpart C
Test set-up	ANSI C63.4:1992
Measuring distance	To 18 GHz: 3 m. Above 18 GHz: 0.2 m
Frequency range	30-25.000 MHz
Limits: As specified in 15.209(a)	30-88 MHz: 40 dBµV/m 88-216 MHz: 43.5 dBµV/m 216-960 MHz: 46 dBµV/m Above 960 MHz: 54 dBµV/m
Measurement uncertainty (2 σ) <1 GHz Measurement uncertainty (2 σ) >1 GHz	2.6 dB 4.9 dB
Below 1 GHz the limits apply to measurements performed using a quasi-peak detector. Above 1 GHz the limits apply to measurements of spurious emission performed with an average detector. Furthermore, the peak level must be no higher than 20 dB above the average limit.	
Test record sheets	*Annex 4*

Results:

The emission was within the specified limits when using internal antenna and when using external antenna.

For spurious emission in tabular form for the band 30-1000 MHz, see *annex 4*.

Spurious emission 1000 MHz to 25 GHz. Data from the external antenna which has the highest emissions:

TX frequency	**Polarisation**	**Spurious freq.**	**Peak dBµV/m**	**Average dBµV/m**	**dB below peak limit**	**dB below average limit**
2442	Horizontal	4882 MHz (R)	54	45,9	20	8.1
2480	Horizontal	4960 MHz (R)	58.7	50	15.3	4
2480	Horizontal	7440 MHz (R)	58	47.8	16	6.2
2402	Vertical	1989 MHz	58	47.8	16	6.2

(R) means frequency in restricted band.
Average limit is 500 µV/m or 54 dBµV/m.
Peak limit is 20 dB above average limit or 74 dBµV/m.

Comments:

Test record sheets are marked in their upper right hand corner with EXT for external antenna and INT for internal antenna.

Measurements above 1 GHz are performed using a spectrum analyzer in peak hold mode. Average measurements are performed on spurious emission exceeding the limit, when measured in peak hold mode.

Using RBW 1 MHz and VBW 10 Hz should perform average measurements. On the HP 7000 spectrum analyser system used, it is however not possible to set this combination of bandwidths. Therefore the following procedure is used:

On HP 7000 set RBW and VBW to 1 MHz. From the IF section used the 21,4 MHz IF signal is fed to a HP 8594EM spectrum analyser. The frequency of maximum spurious level is found on the HP 7000 system. This frequency is set to CF and a span of zero Hz is selected. The level [A] in dBµV is recorded.

The HP 8594EM spectrum is set using RBW of 1 MHz, CF of 21,4 MHz and zero span. The attenuation and reference level is set to allow for at least 30 dB dynamic range.

The measured levels at VBW 1 MHz [B]dBµV and VBW 10 Hz [C]dBµV are recorded. The level difference [B]- [C] = [D] in dB is recorded.

The change in level [D] is the same as would have been recorded on the HP 7000 system, if the combination 1 MHz/10 Hz could have been selected.

Therefore, the spurious emission level, using an average detector equals [A] - [D] in dBµV, where [A] was the level found on the HP 7000 using RBW and VBW of 1 MHz.

Spurious emission with peak values close to the average limit are examined using the average measurement set-up. The results are noted.

Reporting

- Record frequency and amplitude of the highest fundamental emission (see *section 4.8*).
- Record frequency and amplitude of the three highest harmonic or spurious emissions.
- Record frequency and amplitude of the three highest restricted band emissions.

Polarisation is noted at each frequency.

4.3 Number of hopping frequencies

The number of hopping frequencies is 79.

The first channel is centred on 2.402 GHz and the last one on 2.480 GHz.

See plot in *annex 5*.

During Inquiry mode and Page mode, used when establishing contact between two devices, 32 channels only are used.

The EUT is in compliance with the requirement(s).

4.4 20 dB bandwidth

The 20 dB bandwidth of the hopping channels is less than 1 MHz.

See plot in *annex 6*.

The requirements of 15.247(a)1)ii) is maximum 1 MHz.

The EUT is in compliance with the requirement(s).

4.5 Time of occupancy

The time of occupancy is demonstrated during two measurements, found in *annex 7*.

Sheet 105 shows how many times one frequency is used, here 2441 MHz, during a 30 s period.

Sheet 106 shows the length of each connection, which is 3 ms. The frequency 2441 is therefore occupied in 108 times 3 ms equals 324 ms during a 30 s period.

The limit according to 15.247(a)1)ii) is 400 ms in a 30 s period.

The EUT is in compliance with the requirement(s).

4.6 Carrier frequency separation

The carrier frequency separation is 1 MHz. See plot in *annex 8*.

The requirement of 15.247(1) says that the carrier frequencies shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

The EUT is in compliance with the requirement(s).

4.7 Occupied bandwidth

The limits of the transmission band are reached when only spurious emission can be measured.

The lower band limit is 2.4 GHz and the upper band limit is 2.4835 GHz.

On the plots in *annex 9* is indicated that carriers and high spurious are above 2.4 GHz and well below 2.4835 GHz (indicated by the markers).

The EUT is in compliance with the requirement(s).

4.8 Peak output power

The nominal peak output power of the unit is 0 dBm. Measurements using the two specified antennas show:

EIRP using external antenna: + 0.7 dBm.

EIRP using internal antenna: - 3.7 dBm.

See plots in *annex 10.*

A calibration has been performed over this frequency band using the substitution method. It is therefore possible to calculate directly the effective radiated power.

The 0 dBm line is drawn round the carrier frequencies.

As stated in 15.247(b)1) the maximum peak output power shall not exceed 125 mW or +21 dBm, because in some instances less than 75 hopping channels are used.

The EUT is in compliance with the requirement(s).

4.9 Relative power in 100 kHz bandwidth

As specified in 15.247 (c): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. Attenuation below the general limits specified in Section 15.209(a) is not required.

Measurements, showing worst case emissions, are shown in *annex 11*.

The EUT is in compliance with the requirement(s).

4.10 Peak power spectral density

As specified in 15.247(d): For direct sequence systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

The Bluetooth transmitter has to be tested against this requirement when operating in Page mode and operating in Inquiry mode.

The unit with external antenna had the highest emission values and is reported here.

Operational mode	Peak power spectral density	Measured at frequency
Page mode	-10.5 dBm	2442 MHz
Inquiry mode	-6.7 dBm	2441 MHz

For plots of measured values, see *annex 12*.

Measurement procedure used:

The plots of Page and Inquiry mode has been captured using RBW = VBW = 3 kHz. Centre frequency as stated in the table. Span equals 2 MHz with a sweep time of 0,67 s. The Bluetooth transmitter is transmitting continuously and traces were accumulated using peak max hold, until no changes in the trace could be observed.

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- in cases where such loss or damage results from a property of a product or of a use, to which such product is put, which either has not been tested or examined and described in the present report or differs from DELTA's description in that report of the properties of the product or of uses to which it might be put.

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DANAK was established in 1991 in pursuance of the Industry and Trade Promotion Act No. 394 of 13 June 1990. The scheme is a continuation of the accreditation scheme established in 1973 under the auspices of the former Danish National Testing Board (STP).

The requirements to the accredited testing laboratories are laid down in the Danish Agency for Development of Trade and Industry Statutory Order No. 258 of 11 April 1994 on accreditation of laboratories to perform technical testing etc.

The standards DS/EN 45001 „General criteria for the operation of testing laboratories" and DS/EN 45002 „General criteria for the assessment of testing laboratories" are integrated parts of the statutory order.

In order to obtain accreditation to perform technical testing it is, among other things, required:

- that the testing laboratory and its personnel are free from any commercial, financial and other pressures which might influence their technical judgement.
- that the testing laboratory operates a quality system which is documented.
- that the testing laboratory is furnished with items of equipment required for correct performance of the tests and measurements which the laboratory is accredited to perform.
- that the testing laboratory has sufficient personnel, having the necessary education, training, technical knowledge and experience for their assigned functions.
- that the testing laboratory has procedures for traceable calibration of equipment used for accredited testing.
- that accredited testing is performed after fully documented methods.
- that the testing laboratory has records which contain sufficient information to permit repetition of the test.
- that the testing laboratory is assessed and surveyed by DANAK on a regular basis.
- that the accredited laboratory shall take out an insurance which will cover liability in connection with accredited testing

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