

RADIO TEST REPORT

No. 0047083R.82

EQUIPMENT UNDER TEST

Equipment : Bluetooth PC Card
Type / model : LSE 041 R1B
Manufacturer : Wireless Solutions Sweden AB
Tested by request of : Wireless Solutions Sweden AB

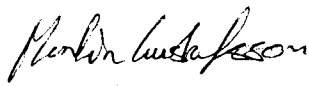
SUMMARY

The equipment complies with the requirements of radiated spurious emission according to the following standard.

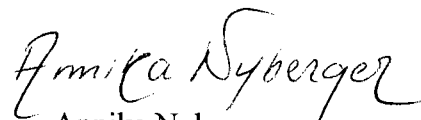
FCC part 15.247

Date of issue: November 29, 2000

Tested by:


Martin Gustafsson

Approved by:


Annika Nyberger

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Appendix I - Conducted measurements performed by Wireless Solutions Sweden AB

Chart A – Radiated emission 30 – 1000 MHz

1. Client information

The EUT has been tested by request of

Company: Wireless Solutions Sweden AB
Box 2043, Rissneleden 138
174 02 Sundbyberg

Name of contact: Mikael Ohlsson

2. EQUIPMENT UNDER TEST (EUT)**2.1 Identification of the EUT**

Equipment: Bluetooth PC Card
Type/Model: LSE 041 R1B
Brand name: Wireless Solutions Sweden AB
Manufacturer: Wireless Solutions Sweden AB
Rating: 5 V DC from PC Card slot

2.2 Additional information about the EUT

The EUT consists of the following units:

Units	Type
Bluetooth PC Card	LSE 041 R1B

The PC Card supports File Transfer and wireless printing (when used in together with the LSE 019 Printer Adapter). The LSE 041 PC Card provides wireless communication for Bluetooth application in the 2,4 GHz ISM band. The PC Card is intended for insert into a PC Card slot in a computer and shall be installed and configured with Windows 98 operation system. During the test the LSE 041 PC Card was installed in a jig, ("Blueboy"). The communication between the computer and Blueboy was performed via RS 232 interface.

2.2.1 Transmitter technical characteristics.

Frequency range:	2402 – 2480 MHz
Supported specification:	Bluetooth 1.0 B

2.2.2 Transmitter RF power characteristics:

Maximum rated transmitter output power:	0 dBm e.i.r.p
Antenna:	Integrated
Transmitter output power is not variable.	

2.2.3 Transmitter modulation

Modulation:	FHSS, GFSK
Bit rate:	1 Mbps

2.2.4 Power source

Power supply:	5 V from PC card slot
Power consumption (peak):	105 mA
Power consumption (stand by):	0,55 mA
Physical interface:	Type II PC card slot

2.3 Peripheral equipment

Defined as equipment needed for correct operation of the EUT, but not included as part of the testing and evaluation of the EUT.

Equipment	Type	Model
Laptop	Toshiba	PS218E-E8180

3. TEST SPECIFICATIONS

3.1 Standards

FCC Subpart C – Intentional Radiators §15.247 for frequency hopping systems operating in the 2400 – 2486.5 MHz and 5725 – 5850 MHz.

3.2 Additions, deviations and exclusions from standards and accreditation

No additions, deviations or exclusions have been made from standards and accreditation.

4. TEST SUMMARY

The results in this report apply only to sample tested:

	Test	Result	Note
15.247(c)	Radiated spurious emission, transmitter	Pass	
15.247(b)	Peak power	Pass	1
15.247(a)	Bandwidth	Pass	1
15.247(a)	Carrier frequency separation	Pass	1
15.247(a)	Number of hopping frequencies	Pass	1
15.247(a)	Time of occupancy	Pass	1
15.247(c)	Band edge compliance	Pass	1
15.247(c)	Out of band spurious emission conducted	Pass	1

Note 1. Measurements performed by the client Wireless Solutions Sweden AB and observed by SEMKO AB – EMC Centre.

5. RADIATED SPURIOUS EMISSION, TRANSMITTER AND RECEIVER

5.1 Operating environment

Temperature: 22 °C (15 - 35 °C)
Relative Humidity: 47 % (30 - 60 %)

5.2 Measurement uncertainty

Measurement uncertainty: ± 4 dB

5.3 Test equipment

Test site: Semi-anechoic shielded chamber.

10 x 20 x 8,5 m (W x L x H)

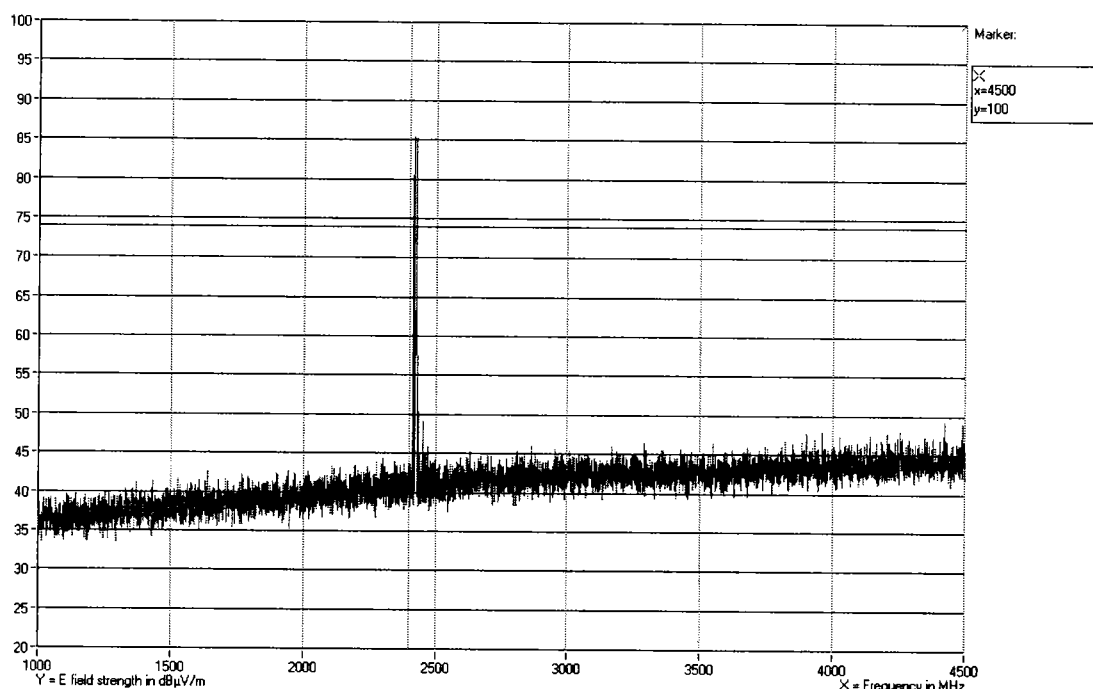
Equipment	Manufacturer	Type	SEMKO No.
Software:	R&S	ES-K1	
Software:	Frank Hoppert	REMI	
Measurement receiver:			
Monitor unit:	R&S	ESAI	2973
RF unit:	R&S	ESAI	2974
Spectrum analyser:	HP	8566B	7091
Antenna amplifier:	SEMKO		7992, 7993
Preamplifier:	HP	8449B	6685
Attenuator:	HP	8491A	2296
High pass filter 4-18GHz:	K&L	4H10-X4500	5133
Antennas:			
Bilog:	Chase	CBL6111A	1550
Double Ridge Waveguide Horn:	EMCO	3115	3006
Pyramidal Horn Antenna:	EMCO	3160-08	9711-1070
Synthesised CW generator:	HP	83712A	3148

5.4 Test protocol

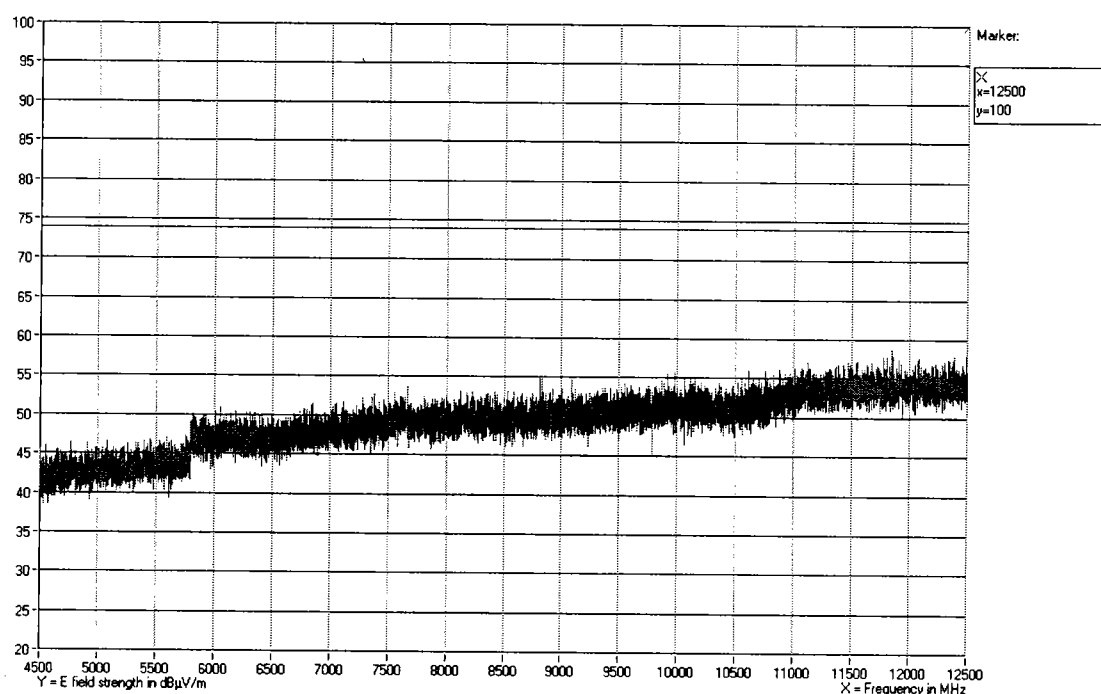
Date of test: Oktober 25, 2000

Overview sweep max peak at a distance of 10 m (30 – 1000 MHz): See chart B

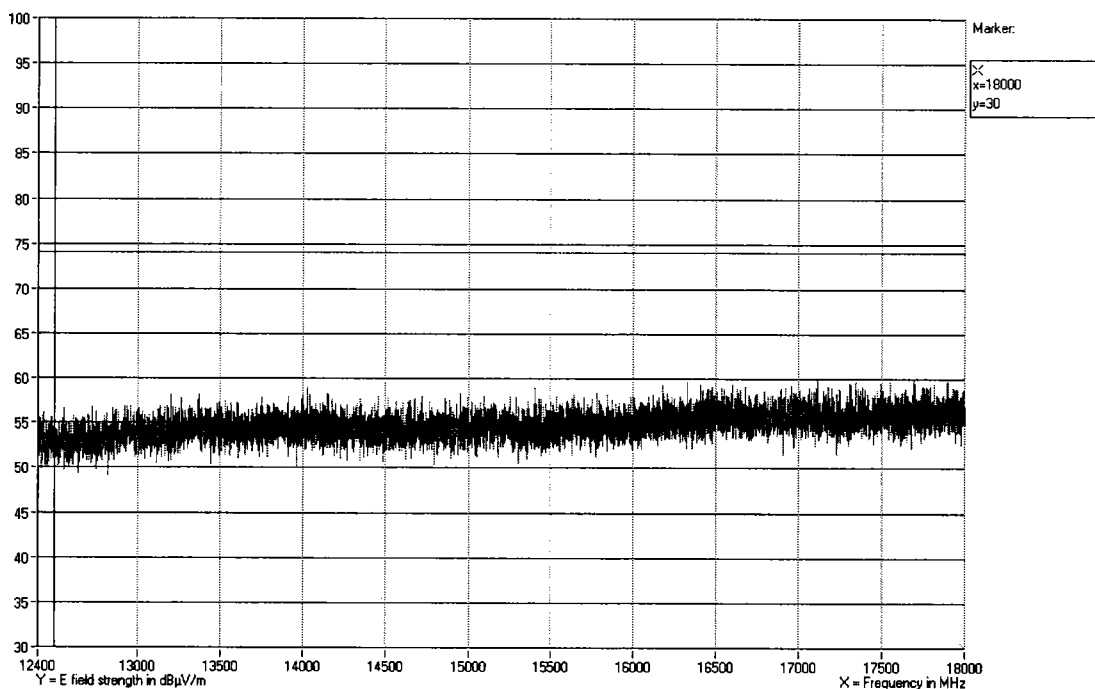
Overview sweep max peak (RBW = 1 MHz, VBW = RBW) at a distance of 3 m (1 – 4,5 GHz):



Overview sweep max peak (RBW = 1 MHz, VBW = RBW) at a distance of 3 m (4,5 – 12,5 GHz):

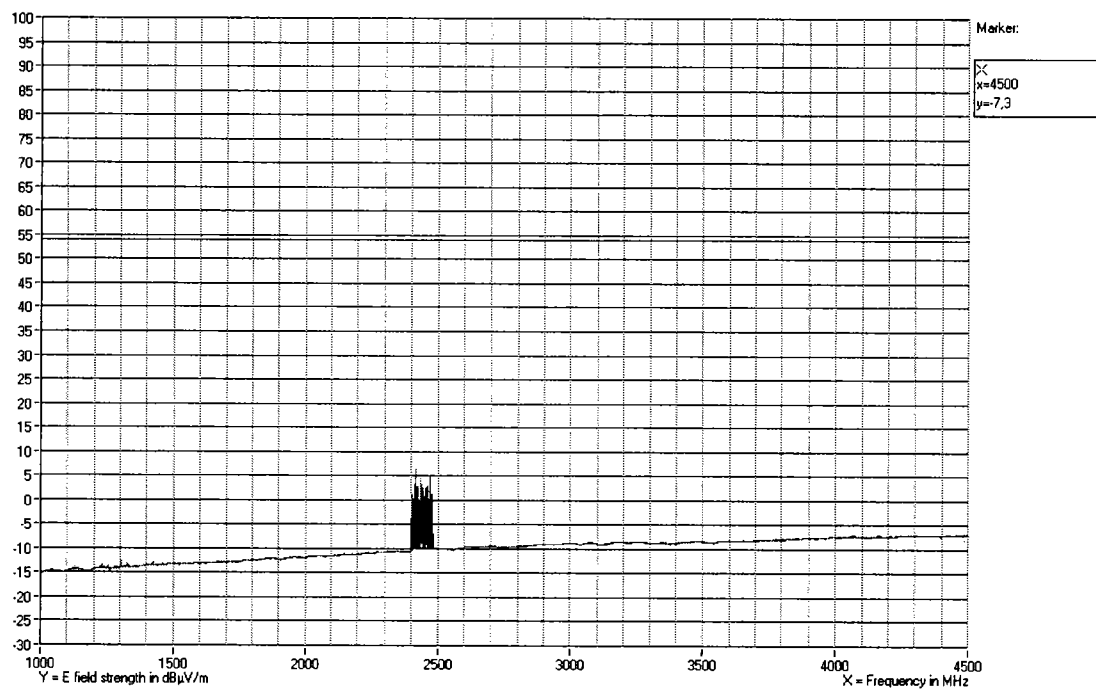


Overview sweep max peak (RBW = 1 MHz, VBW = RBW) at a distance of 3 m (12,5 -18 GHz):

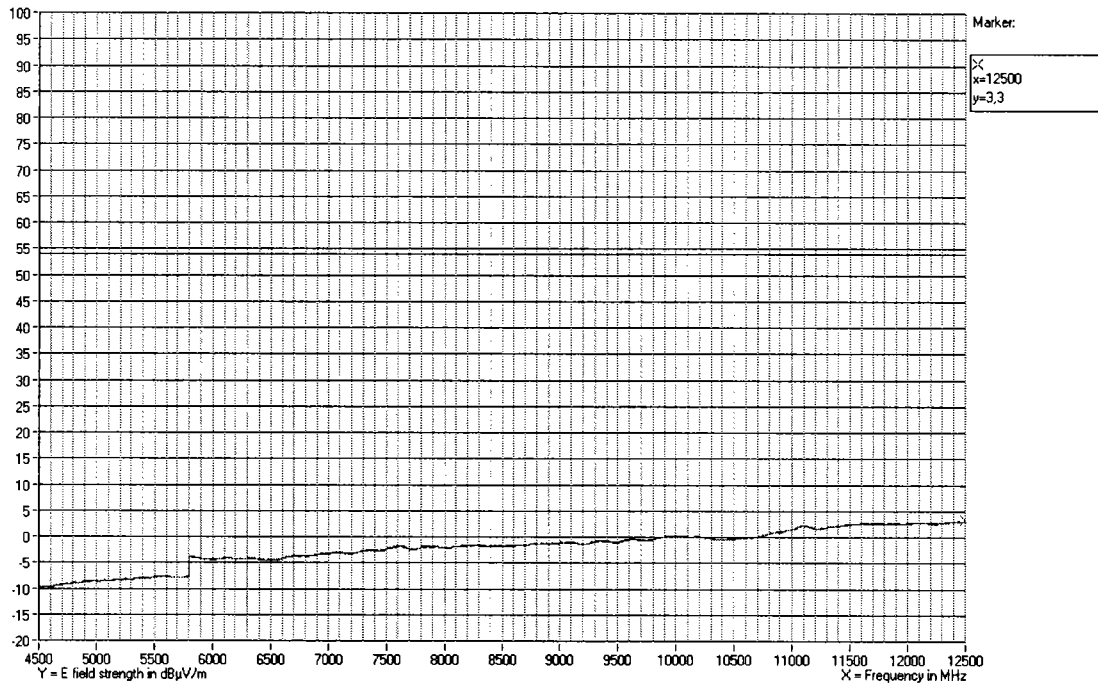


Overview sweep max peak (RBW = 1 MHz, VBW = 10 Hz) at a distance of 3 m (12,5 -18 GHz):

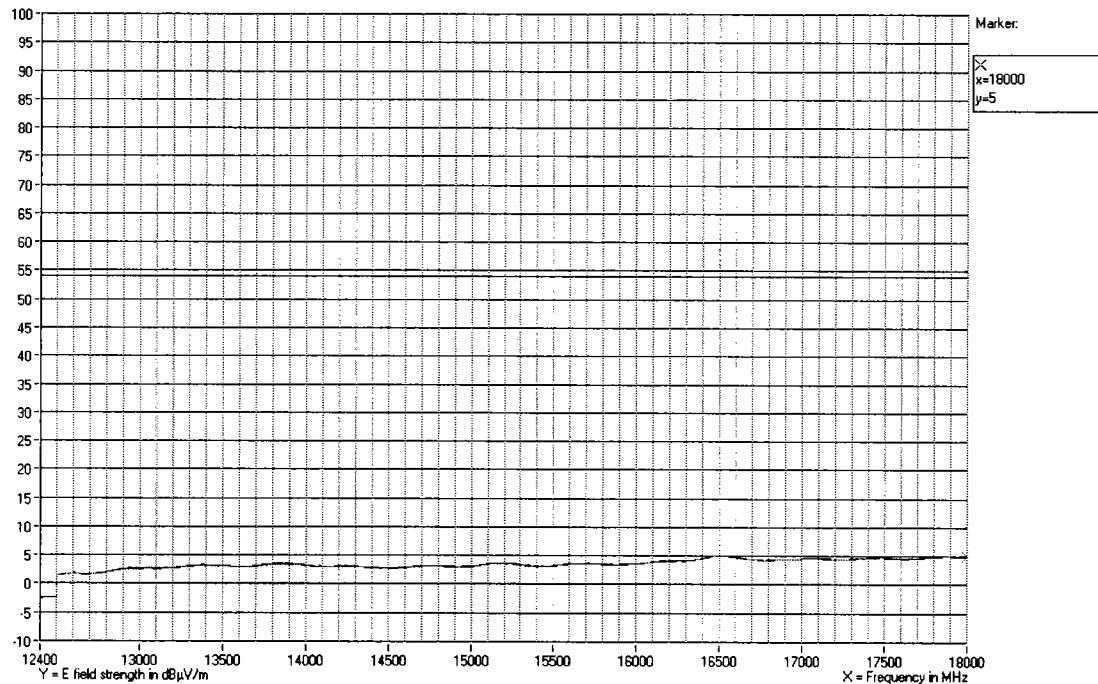
Duty cycle correction factor = $20 \log(\text{dwelltime}/100\text{ms}) = -44 \text{ dB}$; Dwelltime BT = 625 μs



Overview sweep max peek (RBW = 1 MHz, VBW = 10 Hz) at a distance of 3 m (12,5 -18 GHz):
Duty cycle correction factor = $20 \log(\text{dwelltime}/100\text{ms}) = -44 \text{ dB}$; Dwelltime BT = 625 μs



Overview sweep max peek (RBW = 1 MHz, VBW = 10 Hz) at a distance of 3 m (12,5 -18 GHz):
Duty cycle correction factor = $20 \log(\text{dwelltime}/100\text{ms}) = -44 \text{ dB}$; Dwelltime BT = 625 μs



Field strength of spurious emission. Tx test data sequence, hopping on						
Frequency [MHz]	RBW [kHz]	Measured level		Limit		Note
		Peak [dB μ V/m]	QP/AV [dB μ V/m]	Peak [dB μ V/m]	QP/AV [dB μ V/m]	
30 – 88	120	<18	-	-	40	1
88 – 216	120	<27	-	-	43,5	1
216 – 473,9	120	<33	-	-	46	1
474	120	38	-	-	46	1
474,2 – 960	120	<33	-	-	46	1
960 – 1000	120	<33	-	-	54	1
1000 – 2400	1000	<45	<-8	74	54	2
2483,5 – 4500	1000	<48	<-10	74	54	2
4500 – 12500	1000	<58	<3	74	54	2
12500 – 18000	1000	<60	<5	74	54	2
18000 - 25000	1000	<64	<8	74	54	3

Note 1. Calculated from 10 m distance.

Note 2. Adjusted by duty cycle correction factor of -44 dB

Note 3. No spurious emissions were found above the spectrum analyser noise floor in the frequency range 18000 – 25000 MHz.

Fulfil requirements: Yes

Appendix I – Conducted measurements performed by Wireless Solutions Sweden AB

**Bluetooth RF test report
According to FCC part 15.247
For
Bluetooth pccard
Type no. LSE 041
Serial no. WSS00001A**

1 General

Administrative data

Description of EUT

Device	Bluetooth PC Card
Product type	LSE 041
S/N	WSS00001A
HW status pc card	R1A
Date of test started	2000-11-27
Date of test finished	2000-11-30
EUT comments	The LSE 041 has a built in antenna with 0dB gain.
Measurement comments	To make conducted measurements a semi-rigid cable with SMA connector was connected instead of the antenna.

List of measurements

Test case no.	Transmitter parameters	Regulatory reference	Result	Page no.
2.1.1	Peak power	15.247(b)	Pass	6
2.1.2	Bandwidth	15.247(a)	Pass	8
2.1.3	Carrier frequency separation	15.247(a)	Pass	10
2.1.4	Number of hopping frequencies	15.247(a)	Pass	11
2.1.5	Time of occupancy (dwell time)	15.247(a)	Pass	12
2.1.6	Band edge compliens	15.247(c)	Pass	14
2.1.7	Out of band spurious emissions conducted	15.247(c)	Pass	15

Declaration

All test cases with the regulatory requirement FCC part 15.247, are performed according to FCC DA 00-705, released March 30, 2000

The Bluetooth device is regarded as equipment using FHSS modulation.

2 MEASUREMENTS

For all measurements, a Bluetooth test data sequence DH5, PN9 was used. Modulation is GFSK and the hopping selection is described in Bluetooth specification version 1.0 B chapter 11 (see appendix A in product documentation). Maximum data rate (1Mbps) is always used.

The humidity and the temperature were measured according to chapter 3. The Agilent E3631A power supply was used to vary the supply voltage to the pccard $\pm 15\%$.

Transmitter

Peak output power

Test conditions and results

Relative humidity: 31%

Attenuation 7.9dB

TX mode Hopping off

Peak power settings

Test procedure: Fc: Fmin, Fmax

Span: 5 MHz

RBW: 1 MHz

VBW: 1 MHz

Detector: Peak

Trace: Max hold

The peak power was measured with spectrum analyser FSEB 20, which is according to clause 15.247(b).
The voltage was supplied and measured by E3631A.
The measurement is performed on the lowest (2402 MHz) and the highest (2480 MHz) channels only.

Tnom: +25 °C
Tmin: -30 °C
Tmax: +55 °C
Vnom: 5.0 V
Vmin: 4.25V
Vmax: 5.75 V
Fmin: 2402 MHz
Fmax: 2480 MHz

Readings from the spectrum analyser:

Test conditions		Transmitter output power peak (dBm) instrument readings		Transmitter output power (dBm) calculated values	
		Fmin	Fmax	Fmin	Fmax
Tnom	Vmin	-7.8	-8.1	0.1	-0.1
	Vnom				
	Vmax				
Tmin	Vmin	-6.8	-6.6	1.1	1.3
	Vnom				
	Vmax				
Tmax	Vmin	-9	-9.5	-1.1	-1.6
	Vnom				
	Vmax				

Formula to calculate peak value

$P = P_{out} + \text{attenuator and cable loss (i.e. 7.9dB)}$

P_{out} = measured power

Limits

The limits according to FCC 15.247(b) is:

< 30 dBm average
< 30 dBm peak

Verdict

The equipment passed the test under all test conditions.

Test equipment used

Spectrum analyser	Rohde & Schwarz	FSEB 20
Power supply	Agilent	E3631A
Coaxial cable 1	Suhner	Sucoflex 100
Coaxial cable 2	Suhner	Sucoflex 100
SMA connector	Female to Female	
Attenuator	Weinschell Associates	WA4

Measurement uncertainty

Better than ± 1.5 dB.

Comments

Plots can be seen in Appendix 2

TX 20dB bandwidth

Test conditions and results

Ambient temperature: 25 °C
 Relative humidity: 31 %
 Rated output power: 0 dBm
 TX mode Hopping off

Test procedure: Fc: Fmin, Fmax
 Span: 2401-2403 MHz (Fmin),
 2479-2481 MHz (Fmax)
 RBW: 30 kHz
 VBW: 30 kHz
 Detector: Peak
 Trace: Max hold

Which is according to clause 15.247a

Tnom: +25 °C
 Tmin: -30 °C
 Tmax: +55 °C
 Vnom: 5.0 V
 Vmin: 4.25 V
 Vmax: 5.75 V

Readings from the spectrum analyser:

Test conditions		Frequency Range	
		f(L)	f(H)
Tnom	Vnom	874 kHz	958 kHz
	Vmin		
	Vmax		
Tmin	Vnom	877 kHz	894 kHz
	Vmin		
	Vmax		
Tmax	Vnom	874 kHz	958 kHz
	Vmin		
	Vmax		

Limits

The defined bandwidth is according to FCC clause 15.247(a) 20dB bandwidth.

The limits according to clause 15.247(a)(ii) is:

The limit is a bandwidth <1MHz.

Verdict

The equipment passed the test under all test conditions.

Test equipment used

Spectrum analyser	Rohde & Schwarz	FSEB 20
Coaxial cable 1	Suhner	Sucoflex 100
Coaxial cable 2	Suhner	Sucoflex 100
Attenuator	Weinschell Associates	WA4-6

Measurement uncertainty

±15kHz

Comments

Plots can be seen in Appendix 3

The measurements were made with marker to peak, and the 20 dB bandwidth is 20 dB down from it.

Carrier frequency separation

Test conditions and results

Ambient temperature: 25°C
 Relative humidity: 24%
 Rated output power: 0dBm
 TX mode: Hopping on

The test is performed according to clause 15.247(a)

Settings:

RBW=100 kHz
VBW=100 kHz

Span=9MHz
Detector = max peak
Trace = max hold

Result:

Test conditions		Separation channel 1 and channel 2
Tnom	Vnom	1010 kHz

Limits

>958 kHz

Verdict

The equipment passed the test under all test conditions.

Test equipment used

Spectrum analyser	Rohde & Schwarz	FSEB 20
Coaxial cable 1	Suhner	Sucoflex 100
Coaxial cable 2	Suhner	Sucoflex 100
Attenuator	Weinschell Associates	WA4-6

Comments

Plots can be seen in Appendix 7 plot 3

Number of hopping frequencies

Test conditions and results

Ambient temperature: 25°C
Relative humidity: 24%
Rated output power: 0dBm
TX mode Hopping on

The test is performed according to clause 15.247(a)

Settings:

RBW=100 kHz
VBW=100 kHz
Span=102MHz
Detector = max peak
Trace = max hold

Result:

According to plot in appendix 5 it is 79 channels.

Limits

> 75

Verdict

The equipment passed the test under all test conditions.

Test equipment used

Spectrum analyser	Rohde & Schwarz	FSEB 20
Coaxial cable 1	Suhner	Sucoflex 100
Coaxial cable 2	Suhner	Sucoflex 100
Attenuator	Weinschell Associates	WA4-6

Comments

Plots can be seen in Appendix 5

Time of occupancy (dwell time)

Test conditions and results

Ambient temperature: 25°C
 Relative humidity: 24%
 Rated output power: 0dBm
 TX mode Hopping on

The test is performed according to clause 15.247(a)

Settings:

RBW=1MHz

VBW=1MHz

Span=0Hz

Sweep time=5ms

Detector = max peak

Trace = max hold

Duty cycle=82%=T

Transmit time=3ms (see plot 1 in appendix 6)=D (see plot 1 appendix 6)

Number of times that channel 1 occurred in 30s=105=n (see plot 2 appendix 6)

How long time for channel 1 to be active in 30s=S

Formula:

$S = (D \cdot n) / T$

$S = (0.003 \cdot 105) / 0.82 = 0.384s$

Result:

Channel 1 is active 0.384s under a 30s period of time.

Limits

0.4s

Verdict

The equipment passed the test under all test conditions.

Test equipment used

Spectrum analyser	Rohde & Schwarz	FSEB 20
Coaxial cable 1	Suhner	Sucoflex 100
Coaxial cable 2	Suhner	Sucoflex 100
Attenuator	Weinschell Associates	WA4-6

Comments

Plots can be seen in Appendix 6

Band edge compliens

Test conditions and results

Ambient temperature: 25°C
 Relative humidity: 24%
 Rated output power: 0dBm
 TX mode Hopping off and hopping on

The test is performed according to clause 15.247(c)

Settings:

RBW=100kHz

VBW=100kHz

Span=9MHz

Detector = max peak

Trace = max hold

Result:

Test conditions	Frequency Range	
	2400MHz	2483.5MHz
Hopping off	-39dBc	-45dBc
Hopping on	-39dBc	-44dBc

Limits

<-20dBc

Verdict

The equipment passed the test under all test conditions.

Test equipment used

Spectrum analyser	Rohde & Schwarz	FSEB 20
Coaxial cable 1	Suhner	Sucoflex 100
Coaxial cable 2	Suhner	Sucoflex 100
Attenuator	Weinschell Associates	WA4-6

Comments

Plots can be seen in Appendix 7

Out of band spurious emissions conducted transmit

Test conditions and results

Ambient temperature: 25°C
 Relative humidity: 31%
 Rated output power: 0dBm
 TX mode: Hopping on

The test is performed according to clause 15.247(c).

Settings:
 RBW=100 kHz
 VBW=100 kHz
 Span=100 MHz
 Range 0-25 GHz

With the equipment used as described in chapter 3, the loss from the EUT to the spectrum analyser is none.

Tnom: +25 °C
 Vnom: 5 V

Readings from the spectrum analyser:

Test conditions: Tnom, Vnom		Spurious emission (dBm)	
Range	Limit	Spurious level (dBm)	Spurious frequency (GHz)
0-25 GHz	-20 dBc	None were found	

According to section 15.247(c)

Verdict

The equipment passed the test under all test conditions.

Test equipment used

Power supply	Agilent	E3631A	
Spectrum analyser	Rohde & Schwartz	FSP 30	0-25 GHz

Measurement uncertainty

±100kHz

Comments

Plot can be seen in appendix 4

3 TEST EQUIPMENT AND ANCILLARIES USED

A computer was used both to ensure the correct test sequence for the EUT and to collect the data from the spectrum analysers.

The Rohde & Schwarz FSP 30 spectrum analyser was used for spurious emission from 0 Hz up to 25 GHz.

The network analyser was used for calibrating the cables, connectors and the attenuator.

The attenuator was used together with a 1m SMA cable for all measurements except for the spurious, where the spectrum analyser was connected directly through a SMA connector.

The accurate temperature was ensured by the temperature sensor and the multi meter. The sensor in the Heraeus temperature chamber was not used.

The humidity was measured with a hygrometer.

A torque wrench (Rosenberg 50 Ncm) was used to ensure good RF connections.

Instrument	Manufacturer	Type	S/N	Calibration due	Used in test case
Spectrum analyser	Rohde & Schwarz	FSEB 20	835146/001	May 2001	All except 2.1.7
Spectrum analyser	Rohde & Schwarz	FSP 30	837866/014	Oct 2001	2.1.7
Network analyser	Agilent	HP8753ES	US39172563	June 2001	For calibration
Multi meter	Agilent	HP34970	US 37031644	May 2001	all
Hygrometer	THGM	880		-	
Coaxial cable 1	Suhner	Sucoflex 100	SN0213/1PE		
Coaxial cable 2	Suhner	Sucoflex 100	SN0214/1PE		
SMA connector	Female to Female				
Attenuator	Weinschell Associates	WA4-6		-	

Equipment accuracy.

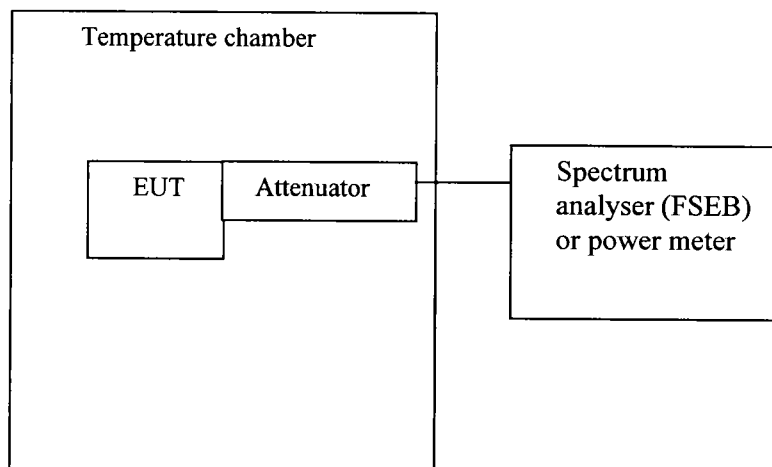
Instrument	Manufacturer	Type	Accuracy
Spectrum analyser	Rohde & Schwarz	FSP 30	± 0.5 dB (amplitude) @ f<3000MHz ± 2 dB (amplitude) @ f<7000MHz ± 2.5 dB (amplitude) @ f<13600MHz ± 3 dB (amplitude) @ f<30000MHz ± 1 ppm (frequency)
Spectrum analyser	Rohde & Schwarz	FSEB 20	± 1 dB (amplitude) ± 2.5 ppm (frequency)
Network analyser	Agilent	HP8753ES	± 0.1 dB
Power supply	Agilent	E3631A	± 2 %
Multimeter	Agilent	HP34970	± 1 °C
Coaxial cable 1+ Coaxial cable 2+ SMA connector+ Attenuator			7.9 ± 0.1dB
Hygrometer	THGM	880	± 7 %

APPENDIX

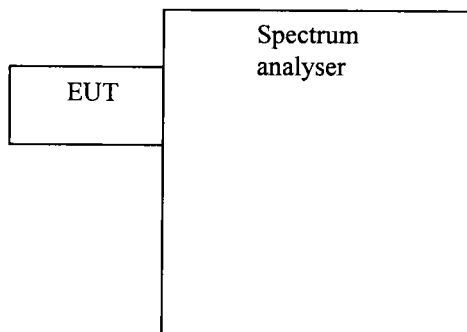
1. Measurement set-up
2. Peak power
3. Bandwidth
4. Spurious
5. Number of hopping channels
6. Dwell time
7. Band edge

Appendix 1

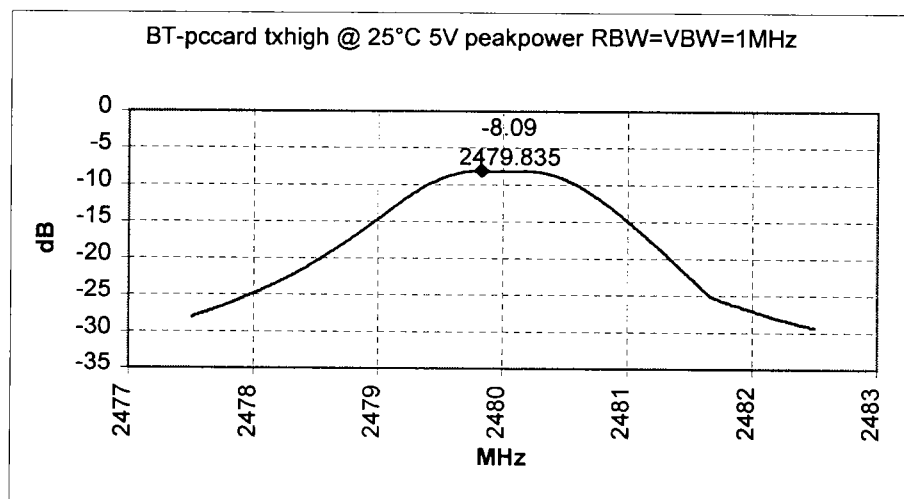
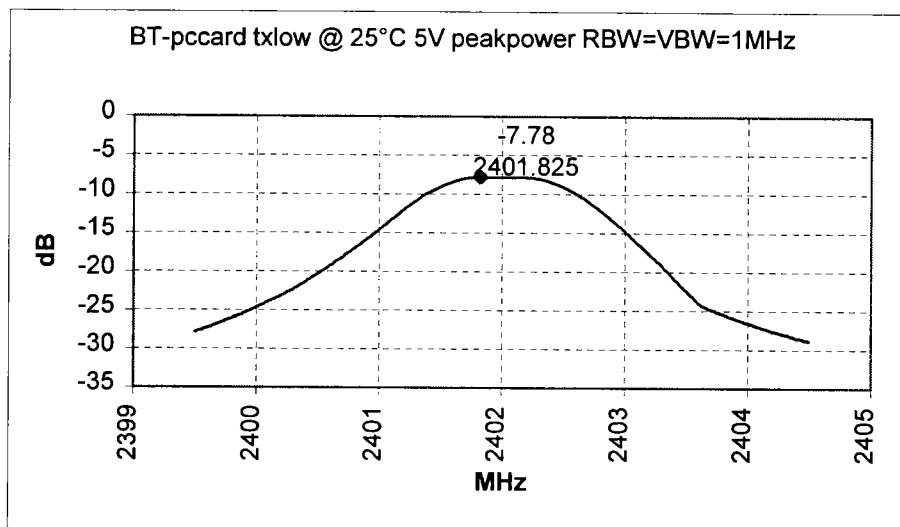
Spurious and power measurements with spectrum analyser from Rohde & Schwarz



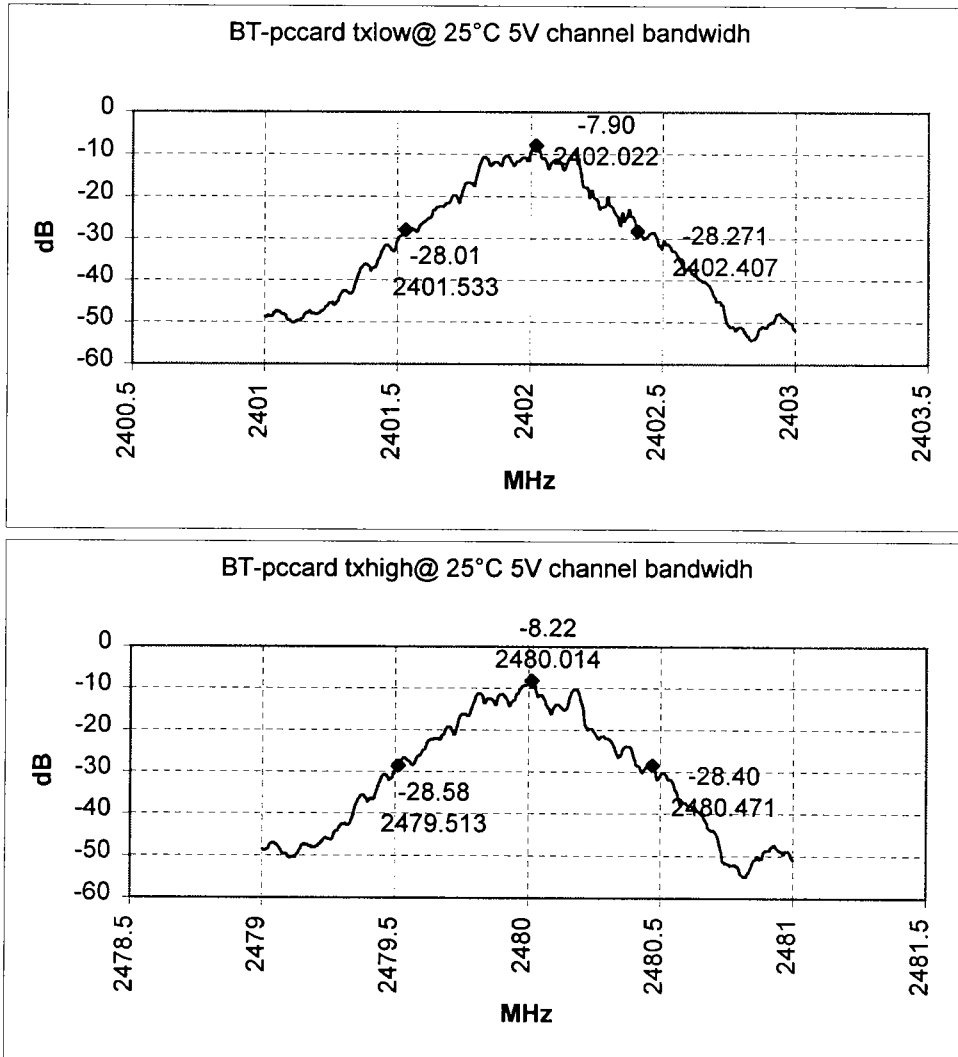
Spurious measurements with spectrum analyser from Rohde & Schwarz FSP



Appendix 2
Peak power

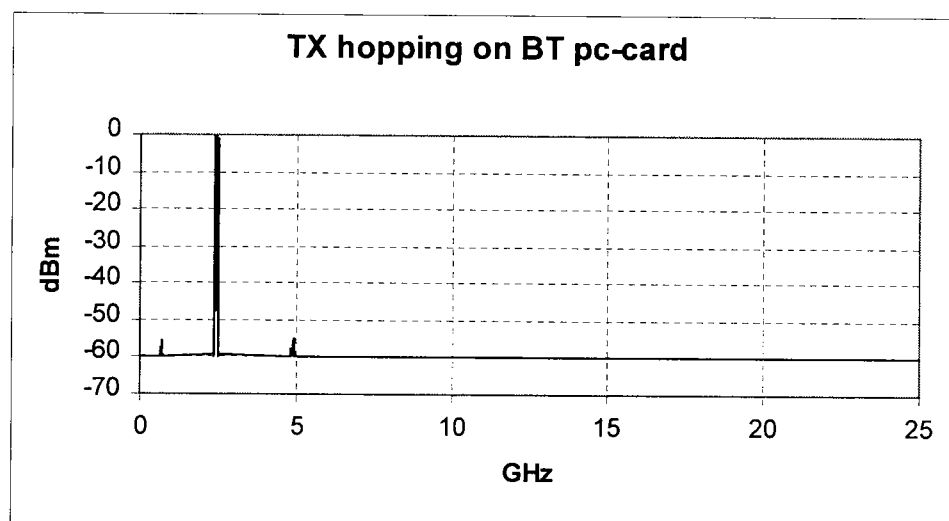


Appendix 3
20dB bandwidth

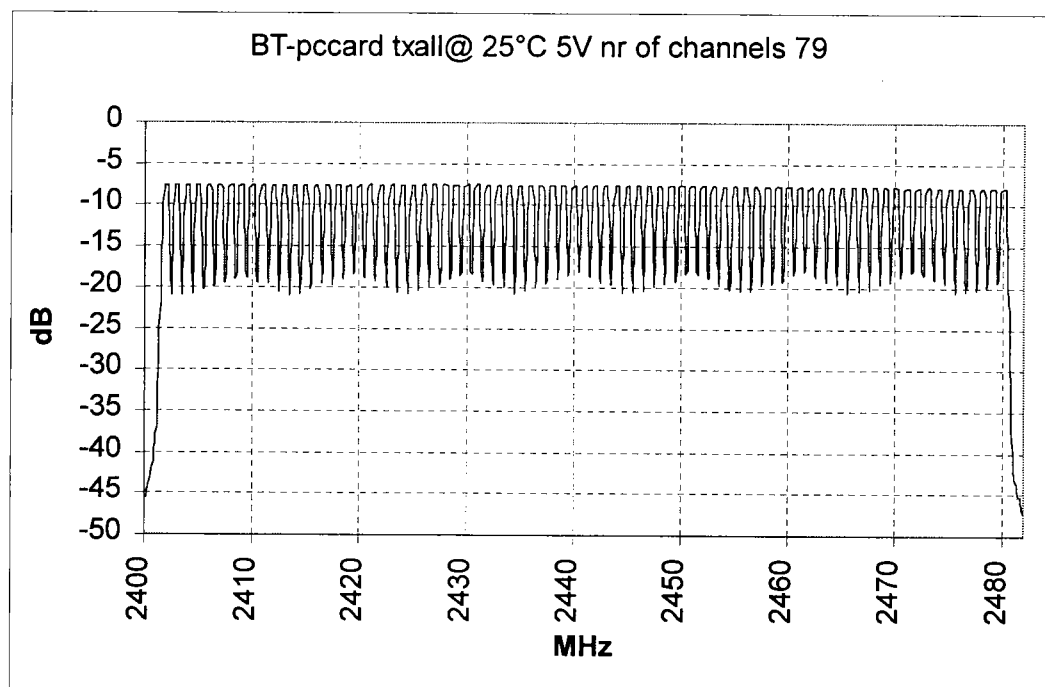


Appendix 4

Spurious emission (no values was recorded below -60dBm)

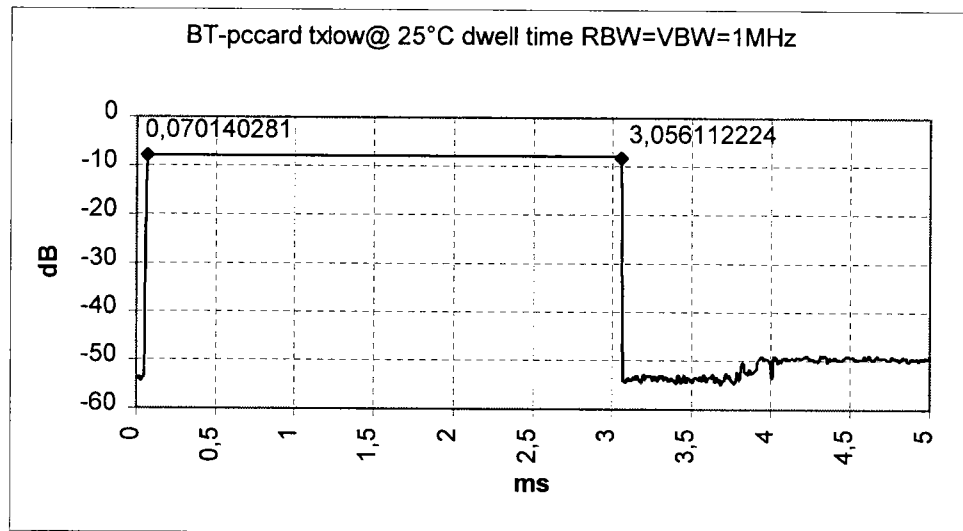


Appendix 5

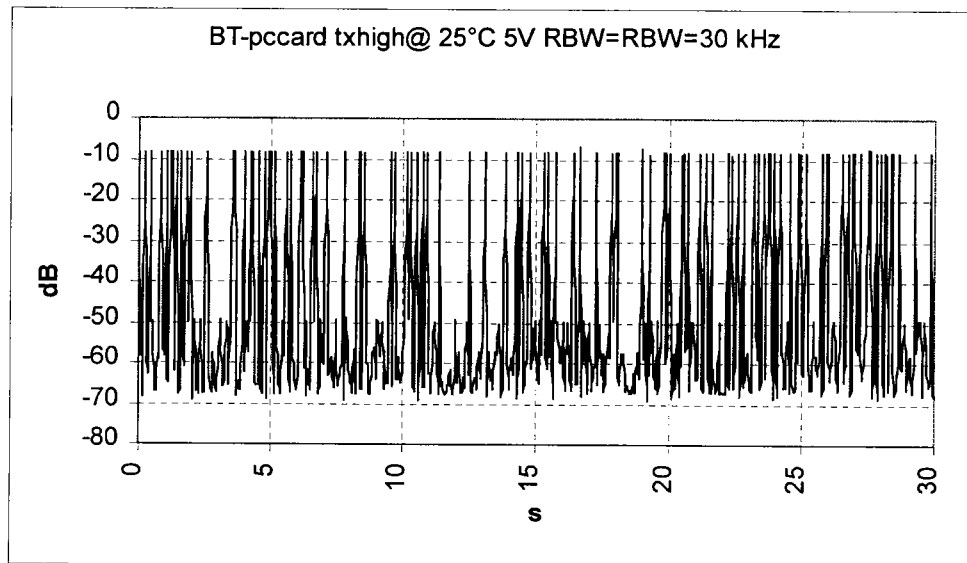


Appendix 6

Plot 1

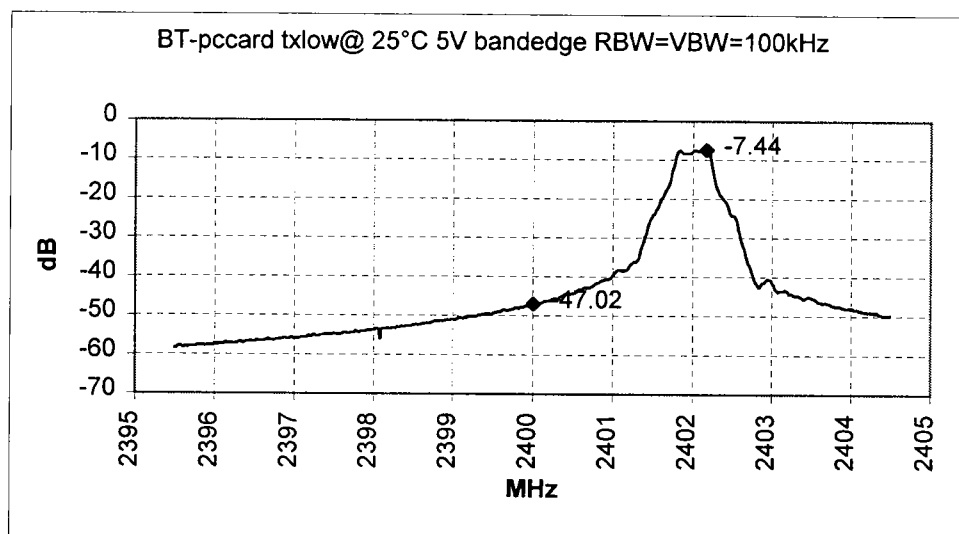


Plot 2

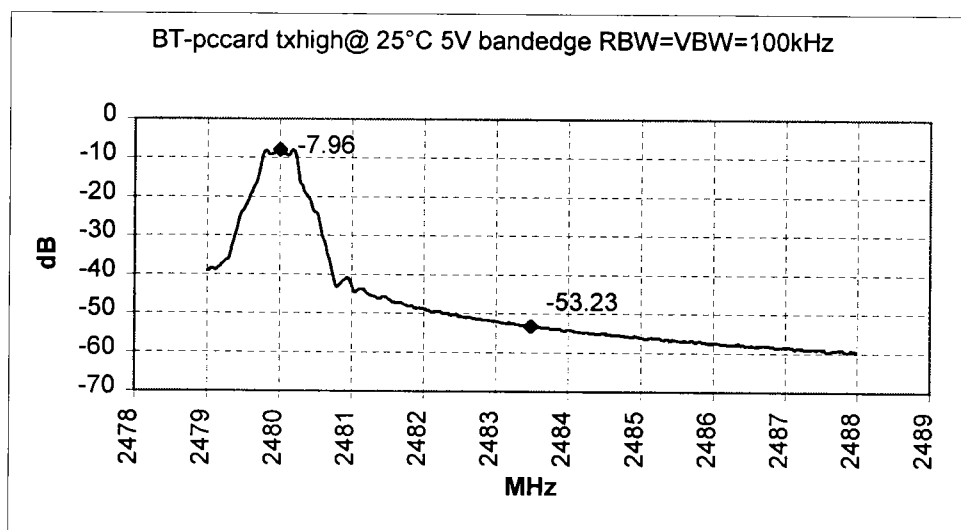


Appendix 7

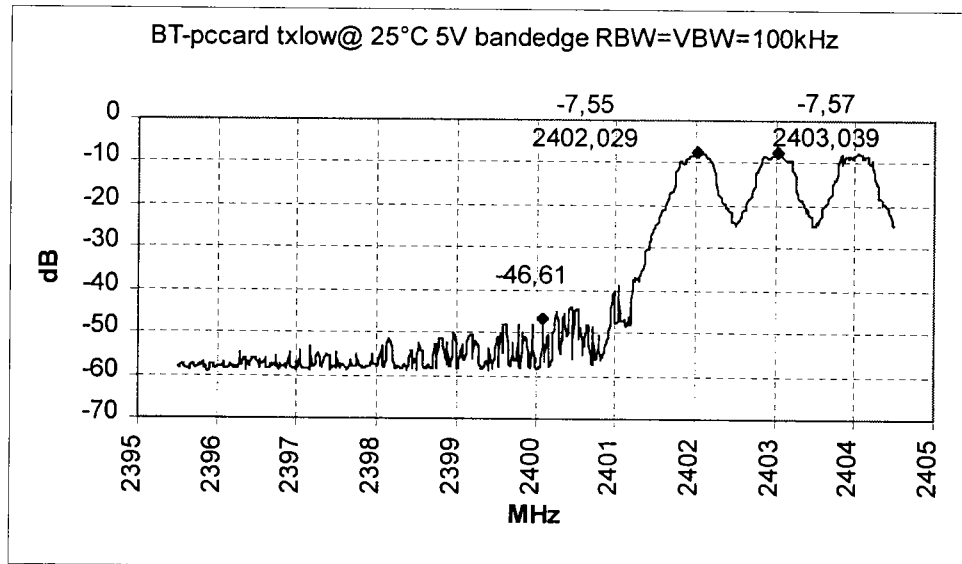
Plot 1 hopping off



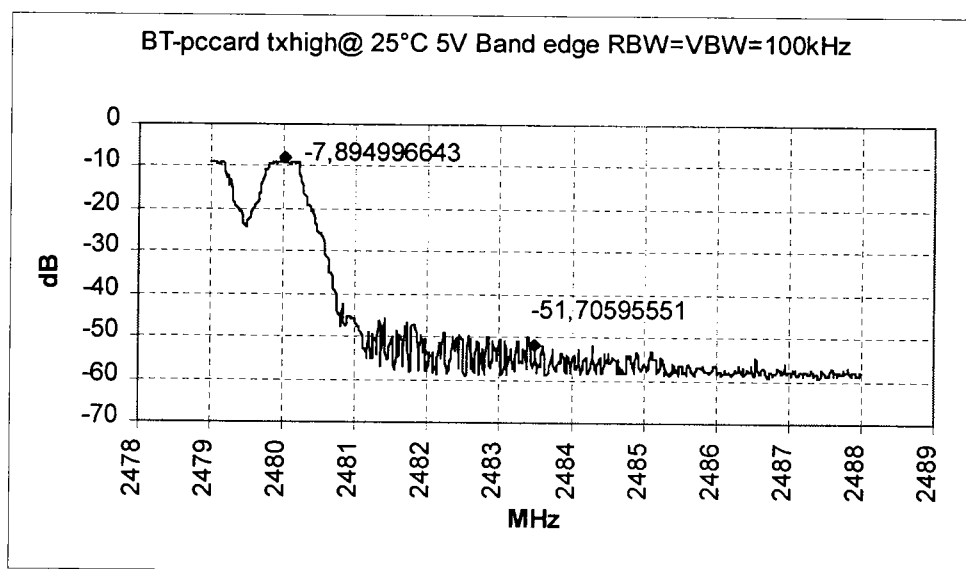
Plot 2 hopping off



Plot 3 hopping on



Plot 4 hopping on



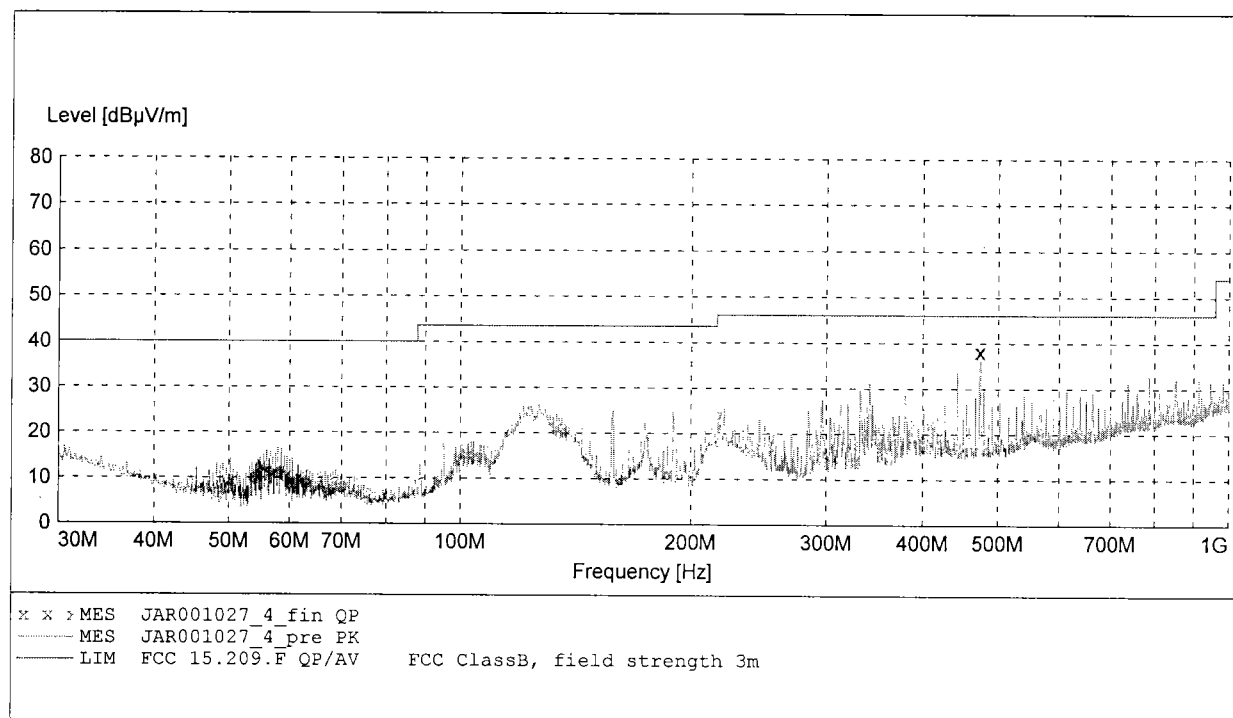
Radiated Emission

MAQ

EUT: Bluetooth PC-card, LSE 041, TX-mode, R1A
 Manufacturer: Wireless Solutions Sweden AB
 Operating Condition: Norm. op. Tx-mode
 Test Site: Semi anechoic chamber, 3 m
 Operator: JAR
 Test Specification: FCC part 15.209.F QP/AV
 Comment: i Toshiba dator i pcmciaslot.
 Temp 21 C, Hum 31%

SCAN TABLE: "FCC 15.247 F 3mceLNA"

Short Description:		FCC Part 15 Class B Field LNA				
Start	Stop	Step	Detector	Meas. Time	IF Bandw.	Transducer
Frequency	Frequency	Width				
30.0 MHz	100.0 MHz	80.0 kHz	MaxPeak	1.0 s	120 kHz	CBL 6111A S-971
100.0 MHz	200.0 MHz	80.0 kHz	MaxPeak	1.0 s	120 kHz	CBL 6111A S-971
200.0 MHz	300.0 MHz	80.0 kHz	MaxPeak	1.0 s	120 kHz	CBL 6111A S-971
300.0 MHz	400.0 MHz	80.0 kHz	MaxPeak	1.0 s	120 kHz	CBL 6111A S-971



MEASUREMENT RESULT: "JAR001027_4_fin QP"

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Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Height cm	Azimuth deg	Polarisation
474.080000	38.20	-12.5	46.0	7.8	239.0	290.00	VERTICAL
474.160000	38.30	-12.5	46.0	7.7	239.0	293.00	VERTICAL