RADIO TEST REPORT

No. 0149127R1

EQUIPMENT UNDER TEST

Equipment:	Bluetooth Compact Flash Card
Type / model:	LSE039 R2
Manufacturer:	National Semiconductor Sweden AB
Tested by request of:	National Semiconductor Sweden AB

SUMMARY

The equipment complies with the requirements of radiated emissions according to the following standard:

FCC part 15.247, subpart C (2001)

Date of issue: January 22, 2002

Tested by: Vladimir Bazhanov

Approved by: Björn Rosenquist

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CONTENTS

1. CLIENT INFORMATION

The EUT has been tested by request of

Company:	National Semiconductor Sweden AB Box 2043, Rissneleden 138 SE-174 02 Sundbyberg Sweden
Name of contact:	Mikael Ohlsson mikael.ohlsson@nsc.com

2. EQUIPMENT UNDER TEST (EUT)

2.1 Identification of the EUT

Equipment:	Bluetooth Compact Flash Card
Type/Model:	LSE039 R2
Serial number:	-
Brand name:	National Semiconductor
Manufacturer:	National Semiconductor Sweden AB
Rating:	3,3 V DC and 5,0 V DC
Rating RF output power:	0 dBm (Power class 2)
Operating temperature range:	-20 to +55 °C
Frequency range:	2400 – 2483,5 MHz

2.2 Additional HW information about the EUT

The EUT consists of the following units:

Unit	Type and version
Bluetooth Compact Flash Card	LSE039 R2

2.3 Additional SW information about the EUT

During the tests the EUT supported the following software:

Software	Version	Comment
PPC	1.3	-
BlueSoft	3.1	Used to set the EUT in the test mode

2.4 Peripheral equipment

Peripheral equipment is defined as equipment needed for correct operation of the EUT, but not included as a part of the testing and evaluation of the EUT.

Equipment	Manufacturer / Type	Serial number
Laptop PC	Toshiba / Satellite	2180 CPT

3. TEST SPECIFICATIONS

3.1 Standards

FCC Subpart C – Intentional Radiators (1999) §15.247 for frequency hopping systems operating in the 2400 – 2483.5 MHz and 5725 – 5850 MHz. §15.205 for restricted bands, §15.209 for radiated limits.

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)	Out of band spurious emission, radiated	Pass	
15.247(b)	Peak power	Pass	*
15.247(a)	20dB Bandwidth	Pass	*
15.247(d)	Power spectral density	Pass	*
15.247(a)	Carrier frequency separation	Pass	*
15.247(a)	Number of hopping frequencies	Pass	*
15.247(a)	Time of occupancy (dwell time)	Pass	*
15.247(c)	Band edge compliens	Pass	*
15.247(c)	Out of band spurious emissions conducted	Pass	*

* Test performed at National Semiconductor Sweden AB (see Appendix 1)

5. RADIATED SPURIOUS EMISSIONS, TRANSMITTER AND RECEIVER

5.1 Operating environment

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

5.2 Measurement uncertainty

Radiated disturbance electric field intensity, 30-200 MHz:	± 3,0 dB
Radiated disturbance electric field intensity, 200-1000 MHz:	± 2,5 dB
Radiated disturbance electric field intensity, 1000-26000 MHz:	± 4,0 dB

The measurement uncertainty describes the overall uncertainty of the given measured value during operation of the EUT.

Measurement uncertainty is calculated in accordance with WECC 19-1990.
The measurement uncertainty is given with a confidence of 95%.

5.3 Test equipment

Equipment	Manufacturer	Type	SEMKO No.
Test site: Semi-anechoic shielded chamber, 10 x 20 x 8,5 m (W x L x H)			-
Software:	R&S	ES-K1, V1.60	
Measurement receiver:			
Monitor unit		FSEB	-
RF-unit	R&S	ESVS 30	3302
Antenna amplifier:	SEMKO		7992/7993
Antenna, bilog:	Chase	CBL6111B	12474
Test site: Bluetooth anechoic shielded chamber, 3,68 x 6,98 x 2,35 m (W x L x H)			12285
Software:	R&S	ES-K1, V1.60	
Signal analyser:	R&S	FSIQ 40	9192
Preamplifier:	HP	8449B	6685
Antennas:			
Double Ridge Guide Horn:	EMCO	3115	4936
Horn antenna:	EMCO	3160-08	30099

R&S = Rohde & Schwarz
HP = Hewlett Packard

5.4 Measurement set-up

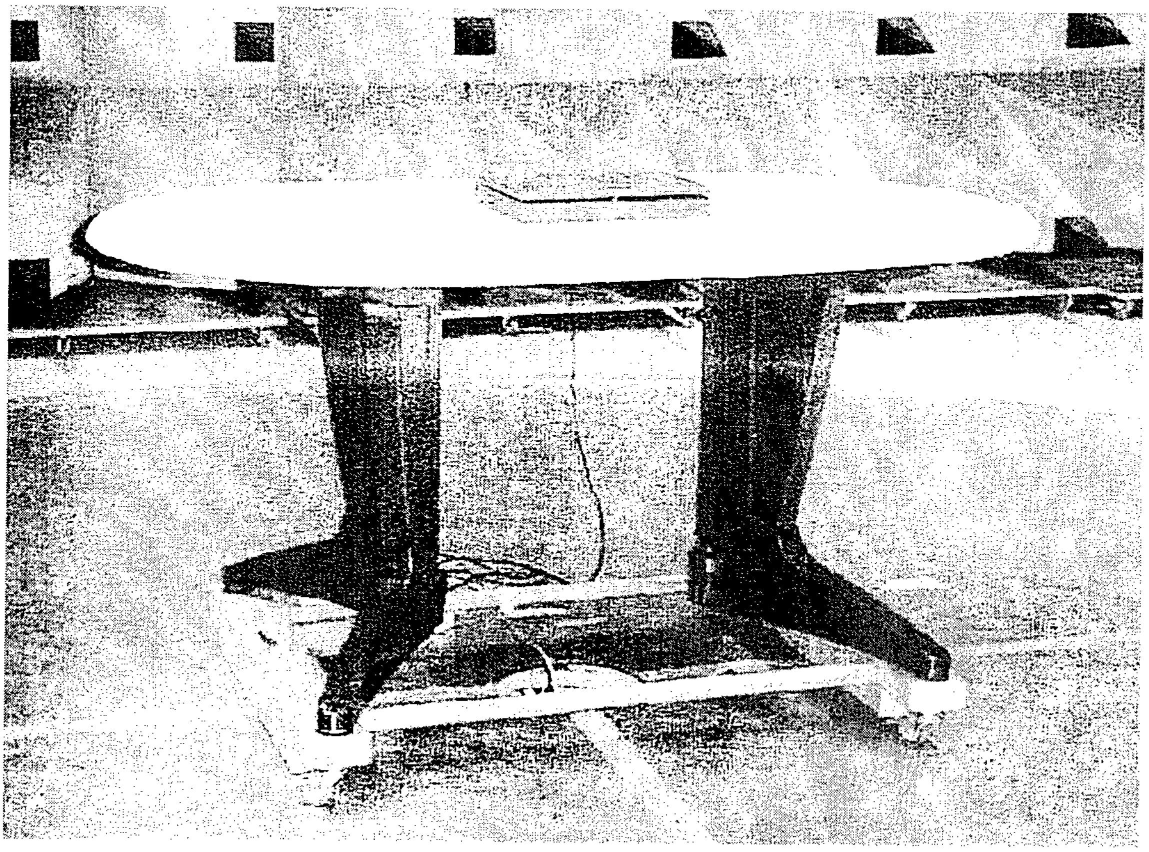
5.4.1 Test site: Semi-anechoic shielded chamber (30 – 1000 MHz)

The radiated disturbance electric field intensity was measured in a semi-anechoic chamber at a distance of 3 m and the EUT was placed on a non-metallic table, 0,8 m above the reference ground plane. The EUT was positioned in order to emit maximum disturbance.

An overview sweep with peak detection of the electric field intensity was performed with the measurement receiver in max-hold and with the antenna placed 1,5 m, 2,5 m and 3,5 m above the floor. The polarisation was horizontal and vertical. The measurements were repeated with the EUT rotated in 90-degree steps. The peak overview sweep is found in section 5.5.

For frequencies where high disturbance levels were found a search for max disturbance level was performed. With the EUT and antenna in the worst-case configuration quasi-peak measurements were performed.

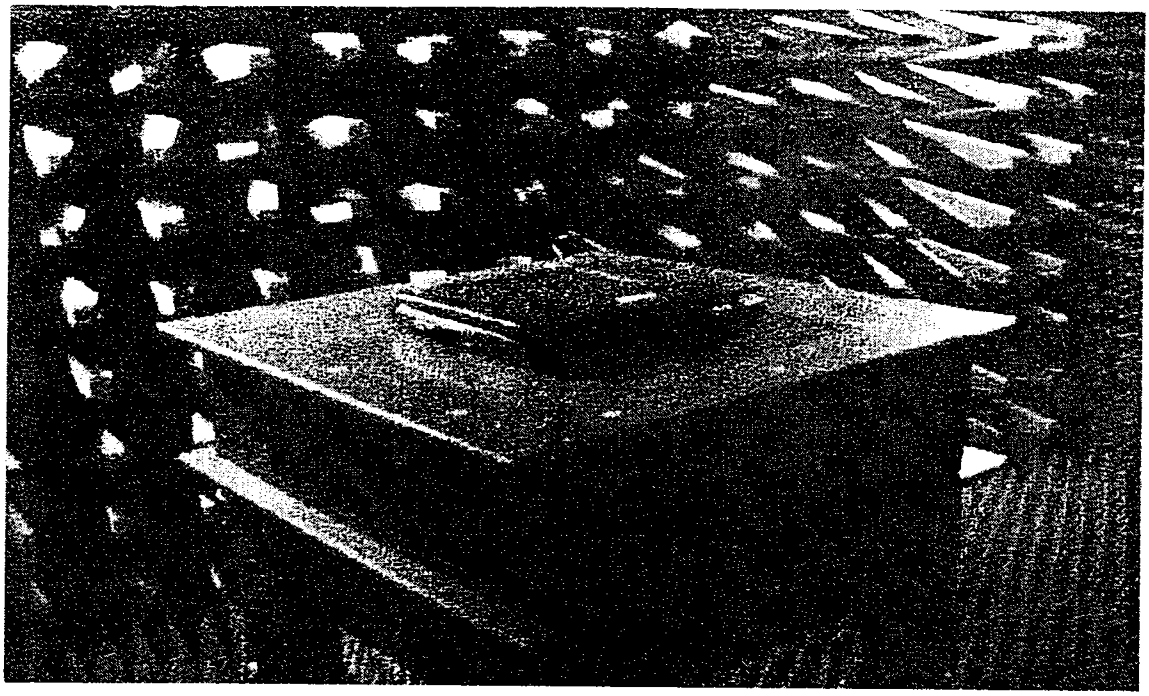
Test set-up photo:



5.4.2 Test site: Bluetooth anechoic shielded chamber (1-26 GHz)

In the Bluetooth anechoic chamber the EUT was placed on a non-metallic table, 1,4 m above the floor. The radiated disturbance electric field intensity was measured at a distance of 3 m. An overview sweep with peak detection of the electric field intensity was performed with the measurement receiver in max-hold and with the antenna placed 1,4 m above the floor. The polarisation was horizontal and vertical. The measurements were repeated with the EUT rotated in 90-degree steps. The specified test mode was enabled.

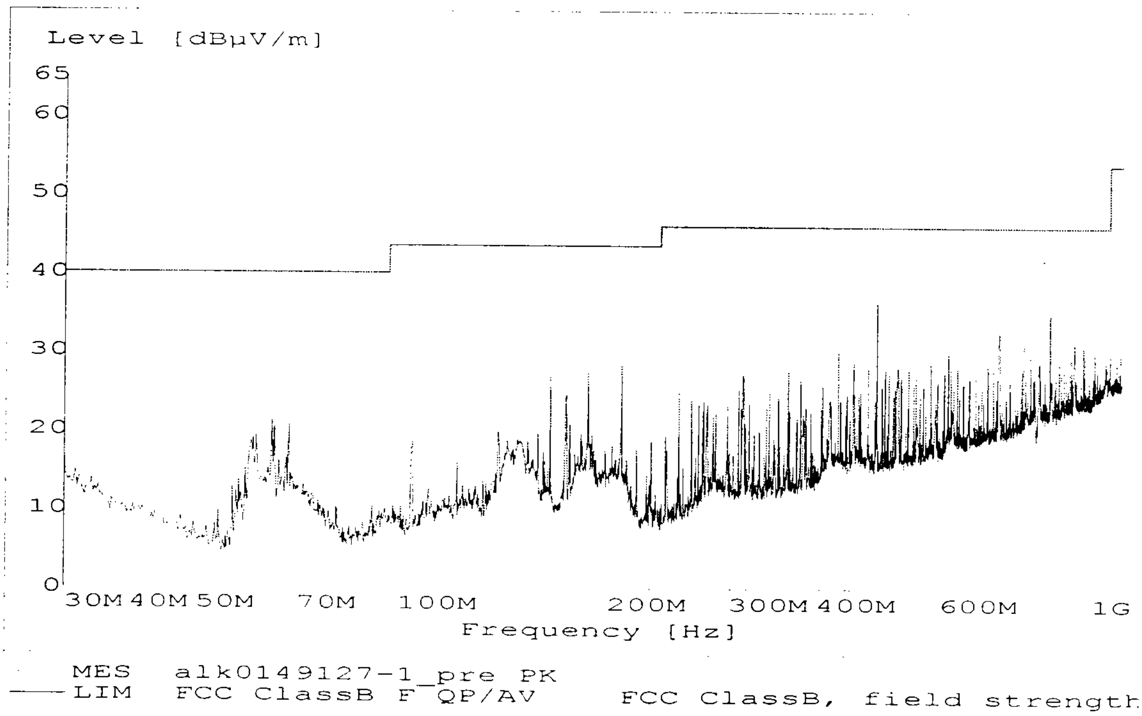
Test set-up photo:



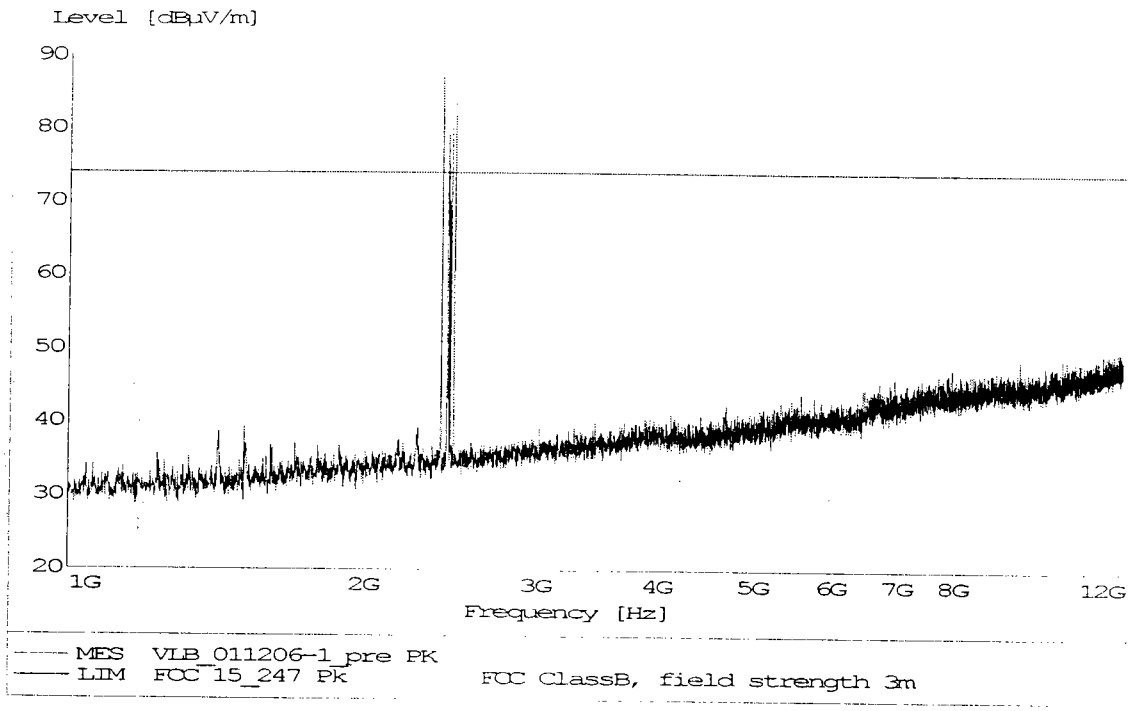
5.5 Test protocol

Date of test: December 06, 2001

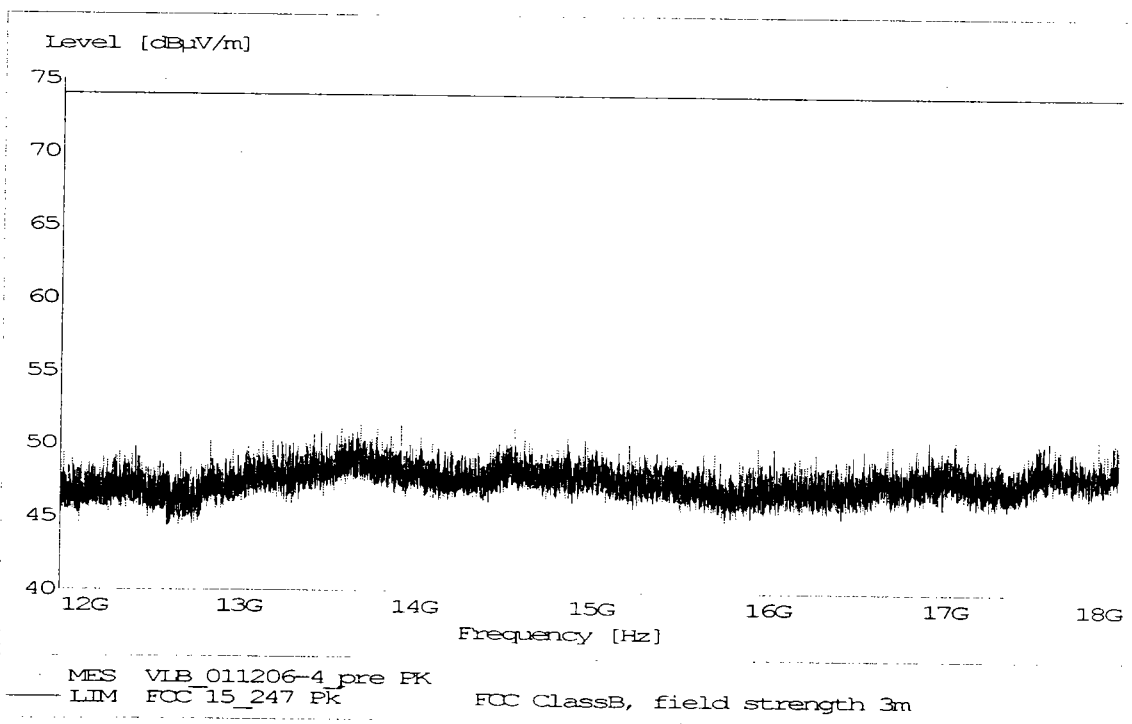
30 – 1000 MHz, peak detection at a distance of 3 m; hopping on all channels



1 – 12 GHz, peak detection at a distance of 3 m; hopping on all channels



12 – 18 GHz, peak detection at a distance of 3 m; hopping on all channels



Field strength of spurious emissions. TX test data sequence						
Frequency	RBW	Measured level		Limit		Note
		Peak	QP/AV	Peak	QP/AV	
[MHz]	[kHz]	[dBµV/m]	[dBµV/m]	[dBµV/m]	[dBµV/m]	
30 – 88	120	<20	-	-	40	
88 – 216	120	<29	-	-	43,5	
216 – 960	120	≤35	-	-	46	
960 – 1000	120	<30	-	-	54	
1000 – 2400	1000	<40	-	74	54	
2483,5 – 4500	1000	<42	-	74	54	
4500 – 12000	1000	<51	-	74	54	
12000 – 18000	1000	<52	-	74	54	

Fulfil requirements: Yes

Appendix 1

Bluetooth RF test report

According to FCC part 15.247

For

Bluetooth CompactFlash Card

Type no. LSE 039/..

Serial no. LSE03901AB001503

GENERAL

Administrative data

Description of EUT

Device	Bluetooth CompactFlash Card
Product type	LSE 039/..
S/N	LSE03901AB001503
HW status	R2A
Date of test started	2001-12-12
Date of test finished	2001-12-13
EUT comments	The LSE 039 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	13
2.1.2	20dB Bandwidth	15.247(a)	Pass	15
2.1.3	Power spectral density	15.247(d)	Pass	16
2.1.4	Carrier frequency separation	15.247(a)	Pass	17
2.1.5	Number of hopping frequencies	15.247(a)	Pass	18
2.1.6	Time of occupancy (dwell time)	15.247(a)	Pass	20
2.1.7	Band edge compliens	15.247(c)	Pass	21
2.1.8	Out of band spurious emissions conducted	15.247(c)	Pass	22

Declaration

All test cases with the regulatory requirement FCC part 15.247 (edition January 8, 2001), are performed according to **FCC DA 00-705, released March 30, 2000.**

The Bluetooth device is regarded as equipment using FHSS modulation.

MEASUREMENTS

For all measurements, a Bluetooth test data sequence DH5, PN9 was used. Modulation is GFSK and the hopping selection is described in the Bluetooth specification, version 1.1 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 CompactFlash-card ± 15% and calibrated multimeter was used to measure the output voltage.

Transmitter

Peak output power

Test conditions and results

Relative humidity:		26%
Attenuation:		4.2dB
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 FSP 30, which is according to clause 15.247(b).

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:	3.3 V
Vmin:	2.8 V
Vmax:	3.8 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	
Temperature	**Voltage**	**Fmin**	**Fmax**	**Fmin**	**Fmax**
Tnom	Vmin	-3.3	-4.0	0.9	0.2
	Vnom	-3.1	-3.7	1.1	0.5
	Vmax	-3.1	-3.7	1.1	0.5
Tmin	Vmin	-2.9	-3.4	1.3	0.8
	Vnom	-2.8	-3.1	1.4	1.1
	Vmax	-2.8	-3.1	1.4	1.1
Tmax	Vmin	-4.6	-5.3	-0.4	-1.1
	Vnom	-4.4	-4.9	-0.2	-0.7
	Vmax	-4.4	-4.9	-0.2	-0.7

Formula to calculate peak value

P = Pout + cable loss (i.e. 4.2dB)

Pout = measured power

Limits

The limits, according to FCC 15.247(b) is, average power < 30 dBm

peak power < 30 dBm

Verdict

The equipment passed the test under all test conditions.

Test equipment used

Spectrum analyser	Rohde & Schwarz	FSP 30
Power supply	Agilent	E3631A
Coaxial cable 1	Suhner	Sucoflex 100
Attenuator	Suhner 3dB	6603.19

Measurement uncertainty

Amplitude: better than ±1.0dB.

Comments

Plots can be seen in Appendix 1.2.

TX 20dB bandwidth

Test conditions and results

Ambient temperature:		25°C
Relative humidity:		26%
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

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

Tnom:	+25 °C
Tmin:	-30 °C
Tmax:	+55 °C
Vnom:	3.3 V
Vmin:	2.8 V
Vmax:	3.8 V

Readings from the spectrum analyser:

Test conditions		**Frequency Range (kHz)**	
Temperature	**Voltage**	**f(L)**	**f(H)**
Tnom	Vmin	932	980
	Vnom	932	960
	Vmax	932	964
Tmin	Vmin	928	968
	Vnom	924	960
	Vmax	916	952
Tmax	Vmin	944	984
	Vnom	932	960
	Vmax	936	956

Limits

The limit according to clause 15.247(a)(ii) is: 20dB bandwidth <1MHz.

Verdict

The equipment passed the test under all test conditions.

Test equipment used

Spectrum analyser	Rohde & Schwarz	FSP 30
Coaxial cable 1	Suhner	Sucoflex 100
Attenuator	Suhner 3dB	6603.19

Measurement uncertainty

Frequency: ±15kHz

Comments

Plots can be seen in Appendix 1.3.
The measurement where made with marker to peak, and the 20dB-bandwidth is 20dB down from it.

Power spectral density

Test conditions and result

Ambient temperature:	***+26 °C***
Relative humidity:	25%
Rated output power:	0 dBm
TX mode:	sending Paging-mode sequence
Vnom:	3.3 volt
Frequency:	2441 MHz (middle channel)

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

Spectrum analyser settings:
RBW = 3 kHz
VBW = 10 kHz
Span = 300 kHz
Sweep time = 100 sec.
Detector = max peak
Trace = max hold

The RBW is set to 3 kHz and the sweep time is calculated to (Span/RBW) = 300/3 = 100 seconds.

Readings from the spectrum analyser:

Test condition		Power spectral density			
Tempera-ture	Voltage	Frequency Peak (MHz)	Measured value (dBm)	Calculated value (dBm)	FCC limit
Tnom	Vnom	2440.986	-11.95	-7.8	+8dBm

Attenuation = 4.2 dB
Calculated value = measured value + attenuation

Limits

The limit according to FCC 15.247(d) is: < +8 dBm.

Verdict

The equipment passed the test.

Test equipment used

Spectrum Analyser	Rhode & Schwarz	FSP 30
Power supply	Agilent	E3631A
Coaxial cable 1	Suhner	Sucoflex 100
Attenuator	Suhner 3dB	6603.19

Measurement uncertainty

Amplitude: better than ±1.0dB

Comments

A plot can be seen in Appendix 1.8.

Carrier frequency separation

Test conditions and results

Ambient temperature: 26°C
Relative humidity: 25%
Rated output power: 0 dBm
TX mode: Hopping on

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

Spectrum Analyser 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	990 kHz

Limits

Greater than the 20dB bandwidth, which in this case is > 960 kHz.

Verdict

The equipment passed the test under all test conditions.

Test equipment used

Spectrum analyser	Rohde & Schwarz	FSP 30
Coaxial cable 1	Suhner	Sucoflex 100
Attenuator	Suhner 3dB	6603.19

Measurement uncertainty

Frequency: ±20kHz

Comments

Plots can be seen in Appendix 1.7, Plot 3.

Number of hopping frequencies

Test conditions and results

Ambient temperature: 26°C
Relative humidity: 25%
Rated output power: 0 dBm
TX mode: Hopping on

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

Spectrum Analyser settings:
RBW = 100 kHz
VBW = 100 kHz
Span = 102MHz
Detector = max peak
Trace = max hold

Result:

According to the plot in Appendix 1.5, it is 79 channels.

Limits

≥ 75

Verdict

The equipment passed the test under all test conditions.

Test equipment used

Spectrum analyser	Rohde & Schwarz	FSP 30
Coaxial cable 1	Suhner	Sucoflex 100
Attenuator	Suhner 3dB	6603.19

Measurement uncertainty

Not applicable.

Comments

A plot can be seen in Appendix 1.5.

Time of occupancy (dwell time)

Test conditions and results

Ambient temperature:	26°C
Relative humidity:	25%
Rated output power:	0 dBm
TX mode:	Hopping on

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

Spectrum analyser settings:
RBW = 1MHz
VBW = 1MHz
Span = 0Hz
Sweep time = 5ms
Detector = max peak
Trace = max hold

Transmit time = 2.98ms = T (see Plot 1, Appendix 1.6)
Number of times that channel 1 occurred in 30s = 106 = n (see Plot 2, Appendix 1.6)
How long time for channel 1 to be active in 30s = S

Formula:
S = T * n
S = 2.981ms * 106 = 0.316s

Result:

Channel 1 is active 0.316s under a period of 30 seconds.

Limits

0.4s

Verdict

The equipment passed the test under all test conditions.

Test equipment used

Spectrum analyser	Rohde & Schwarz	FSP 30
Coaxial cable 1	Suhner	Sucoflex 100
Attenuator	Suhner 3dB	6603.19

Measurement uncertainty

Time: ±5.25ms

Comments

Plots can be seen in Appendix 1.6.

Band edge compliance

Test conditions and results

Ambient temperature:	26°C
Relative humidity:	25%
Rated output power:	0 dBm
TX mode:	Hopping off and hopping on

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

Spectrum Analyser settings:
RBW = 100kHz
VBW = 100kHz
Span = 9MHz
Detector = max peak
Trace = max hold

Result:

Test conditions	**Frequency Range**	
(Tnom, Vnom)	**2400 MHz**	**2483.5 MHz**
Hopping off	-57 dBc	-62 dBc
Hopping on	-61 dBc	-63 dBc

Limits

<-20dBc

Verdict

The equipment passed the test under all test conditions.

Test equipment used

Spectrum analyser	Rohde & Schwarz	FSP 30
Coaxial cable 1	Suhner	Sucoflex 100
Attenuator	Suhner 3dB	6603.19

Measurement uncertainty

Amplitude: better than ±1.2dB.

Comments

Plots can be seen in Appendix 1.7.

Out of band spurious emissions conducted transmit

Test conditions and results

Ambient temperature:	26°C
Relative humidity:	25%
Rated output power:	0 dBm
TX mode:	Hopping on

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

Spectrum Analyser 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:	3.3 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 dBm	None were found	

Limits

According to section 15.247(c), it should be ≤ -20dBc.

Verdict

The equipment passed the test under all test conditions.

Test equipment used

Power supply	Agilent	E3631A	
Spectrum analyser	Rohde & Schwartz	FSP 30	9 kHz - 30 GHz
SMA connector	Male to male		

Measurement uncertainty

Frequency: ±100kHz
Amplitude: ± 3dB

Comments

Plot can be seen in Appendix 1.4.

TEST EQUIPMENT AND ANCILLARIES USED

A computer was used both to ensure the correct test sequence for the EUT and to collect data from the spectrum analyser in the spurious emission measurement. The other plots in the Appendix are generated from the "Hardcopy" -> "Print screen" function on the spectrum analyser.
The Rohde & Schwarz FSP 30 Spectrum Analyser was used for all measurements.
The signal generator and the power meter were used to calibrate the cables, connectors and the attenuator.
A calibrated multimeter (34401A) was used to measure the output voltage from the power supply (E3631A).
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 multimeter. 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.

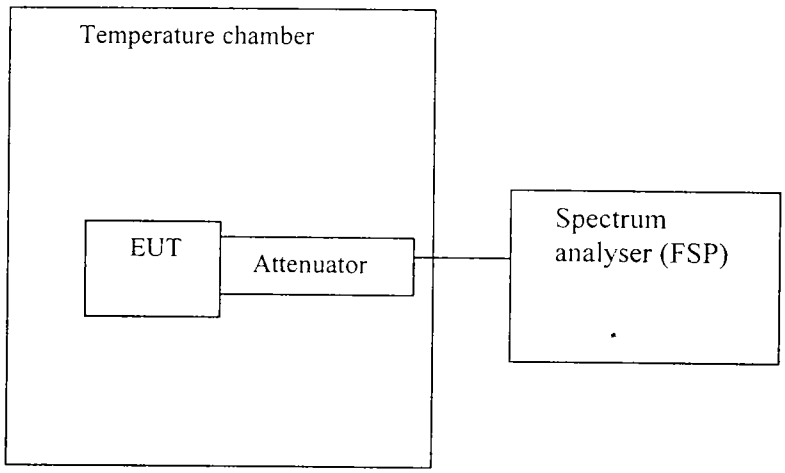
Instrument	**Manufacturer**	**Type**	**S/N**	**Calibration due**	**Used in test case**
Spectrum analyser	Rohde & Schwarz	FSP 30	837866/014	Jan 2002	All
Signal generator	Agilent	E4433B	GB39340649	Oct 2002	For calibration
Multimeter – acquisition unit	Agilent	HP34970	US37044664	Feb 2002	All
Power supply	Agilent	E3631A	KR01128568	-	All
6½ Digit Multimeter	Agilent	34401A	US36108956	Jan 2002	All
Hygrometer	THGM	880	-	-	Humidity check
Coaxial cable 1	Suhner	-	-	-	All, except 2.1.7
SMA connector	Male to Male	-	-	-	2.1.7

Equipment accuracy

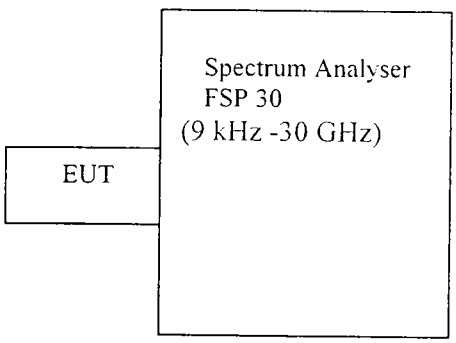
Instrument	Manufacturer	Type	Accuracy
Spectrum analyser	Rohde & Schwarz	FSP 30	± 0.5 dB (amplitude) @ f<3000MHz ± 2 dB (amplitude) @ f<7000MHz ± 2.5 dB (amplitude) @ f<13600MHz ± 3 dB (amplitude) @ f<30000MHz max ±2.5 ppm (frequency) ±1% max deviation (sweep time) at zero span
6½ Digit Multimeter	Agilent	34401A	±0.25mV
Power supply	Agilent	E3631A	± 2 %
Multimeter	Agilent	HP34970	± 1 °C
Coaxial cable 1 + attenuator SMA connector			4.2 ± 0.1dB 0.1dB
Hygrometer	THGM	880	± 7 %

Appendix 1.1 – Measurement set-up

A1.1 Power measurements with spectrum analyser from Rohde & Schwarz.

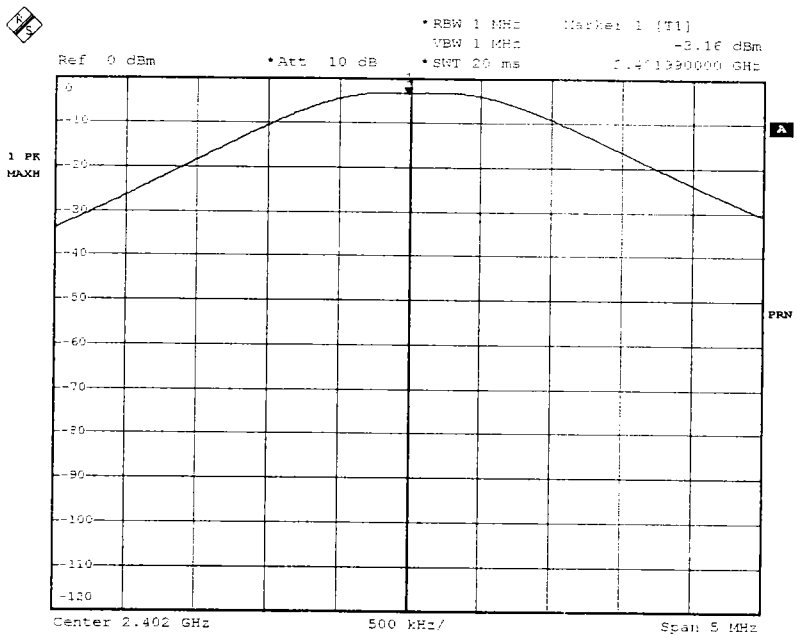


A1.2 Spurious measurements with spectrum analyser from Rohde & Schwarz.

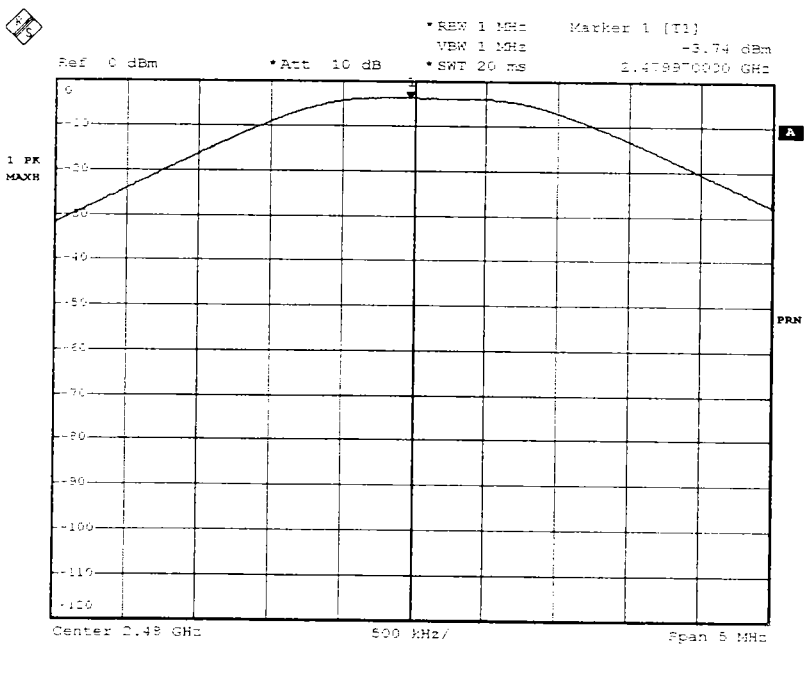


Appendix 1.2 – Peak power

Plot 1 – Peak power on lowest channel, Vnom and Tnom.

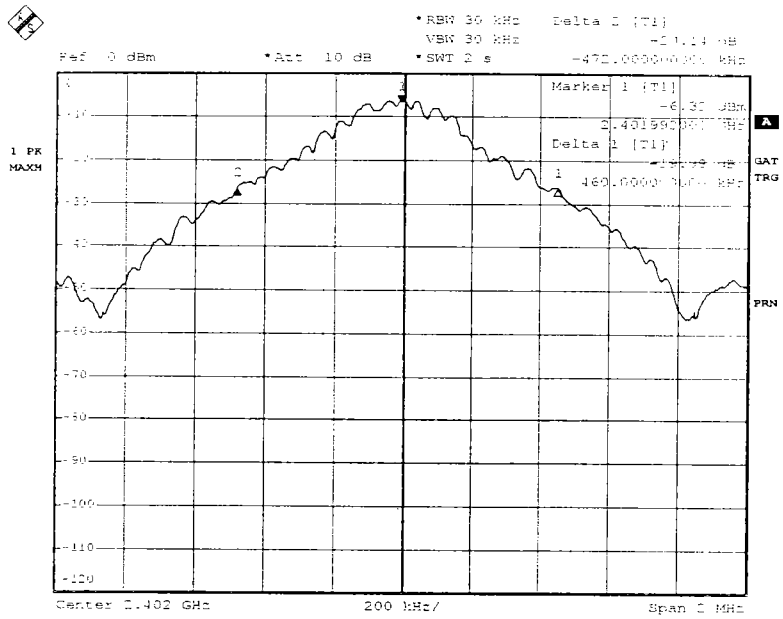


Plot 2 – Peak power on highest channel, Vnom and Tnom.



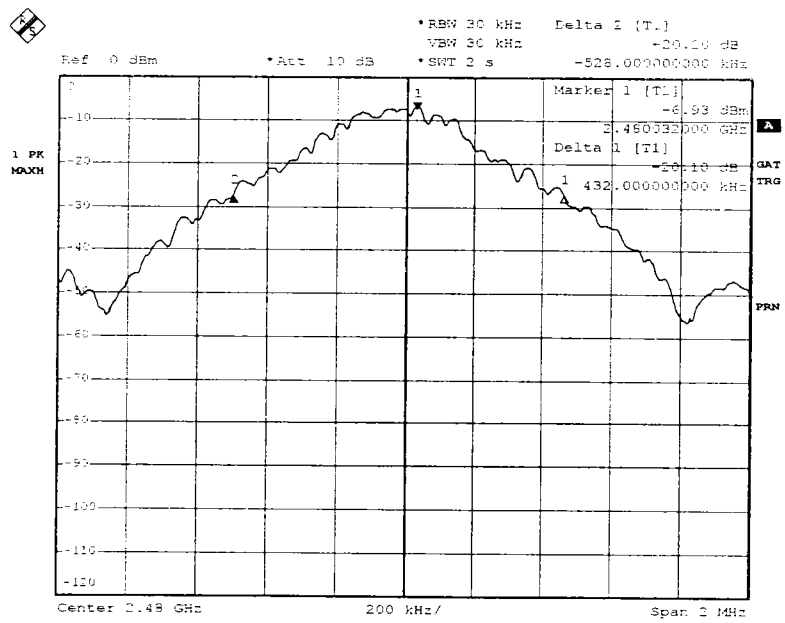
Appendix 1.3 – 20dB bandwidth

Plot 1 – The 20dB bandwidth on the lowest channel, Vnom and Tnom.



Date: 12.DEC.2001 16:10:27

Plot 2 – The 20dB bandwidth on the highest channel, Vnom and Tnom.



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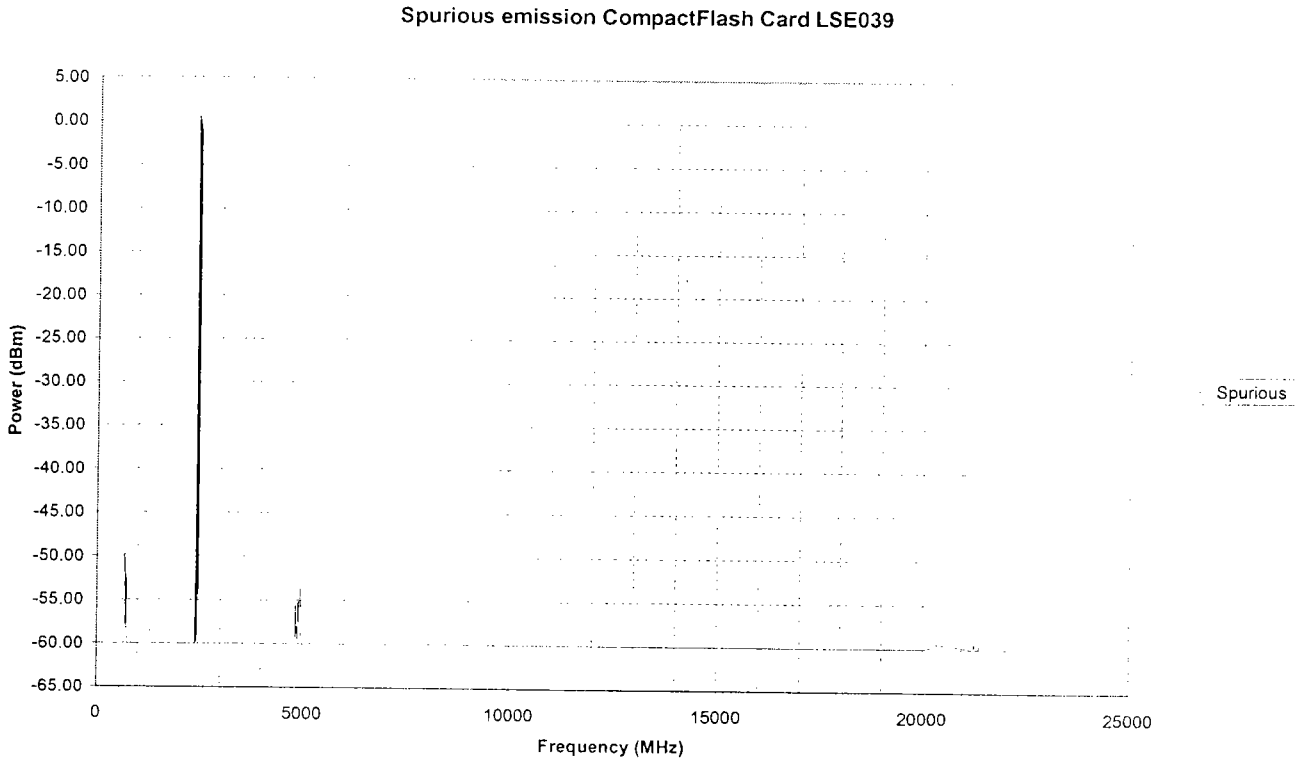
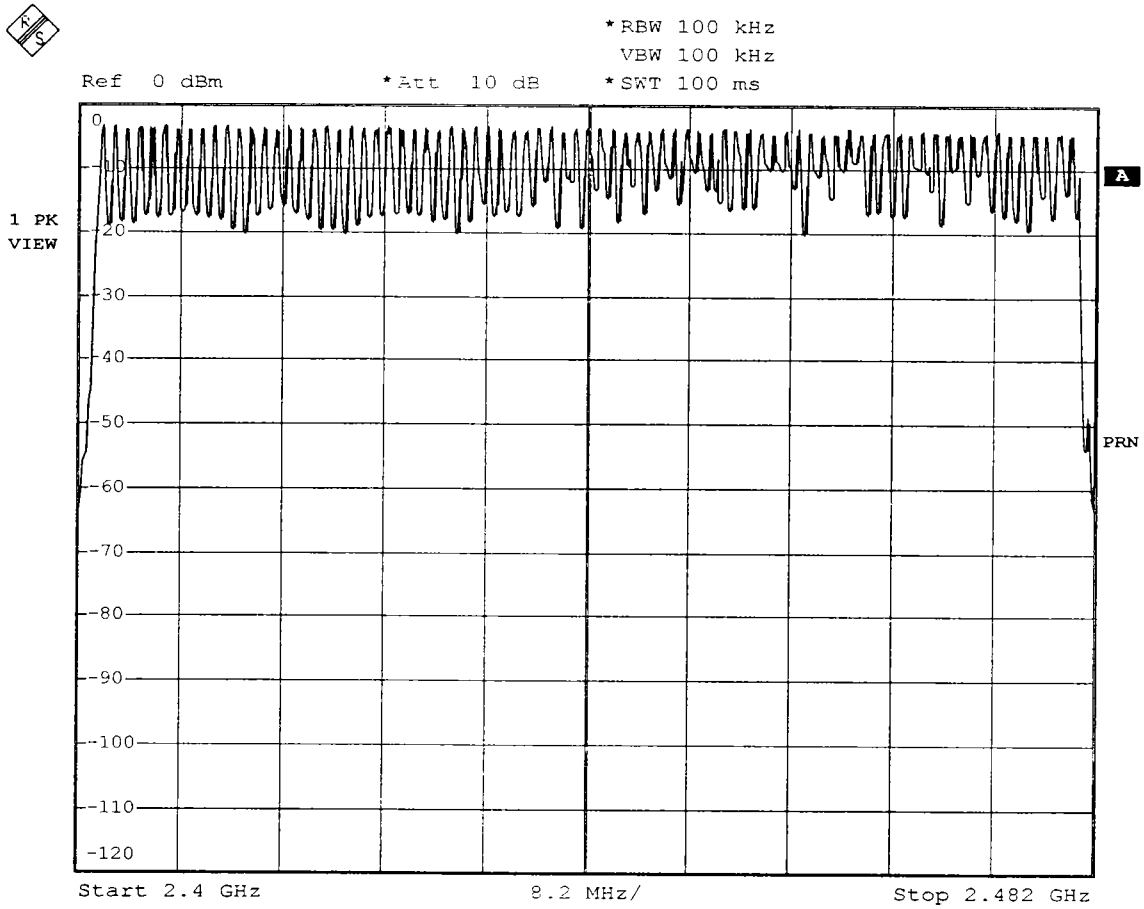
Appendix 1.4 - Spurious emission

The plot below shows the spurious emission when the EUT is transmitting in frequency hopping mode (values below –60dBm was not recorded). Vnom and Tnom.



Appendix 1.5 – Number of hopping channels

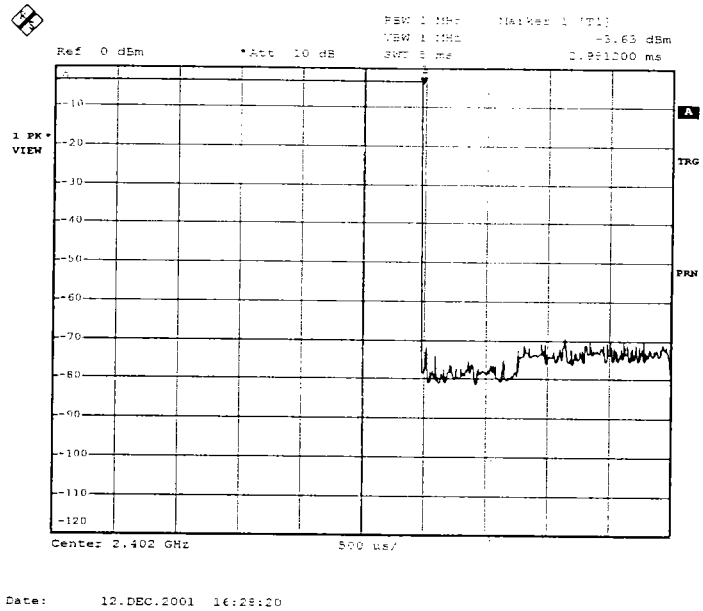
The plot below shows the number of hopping channels that the EUT is using (=79 channels), Vnom and Tnom.



Date: 12.DEC.2001 16:20:04

Appendix 1.6 – Dwell time

Plot 1 – The dwell time for the EUT on the lowest channel, Vnom and Tnom.



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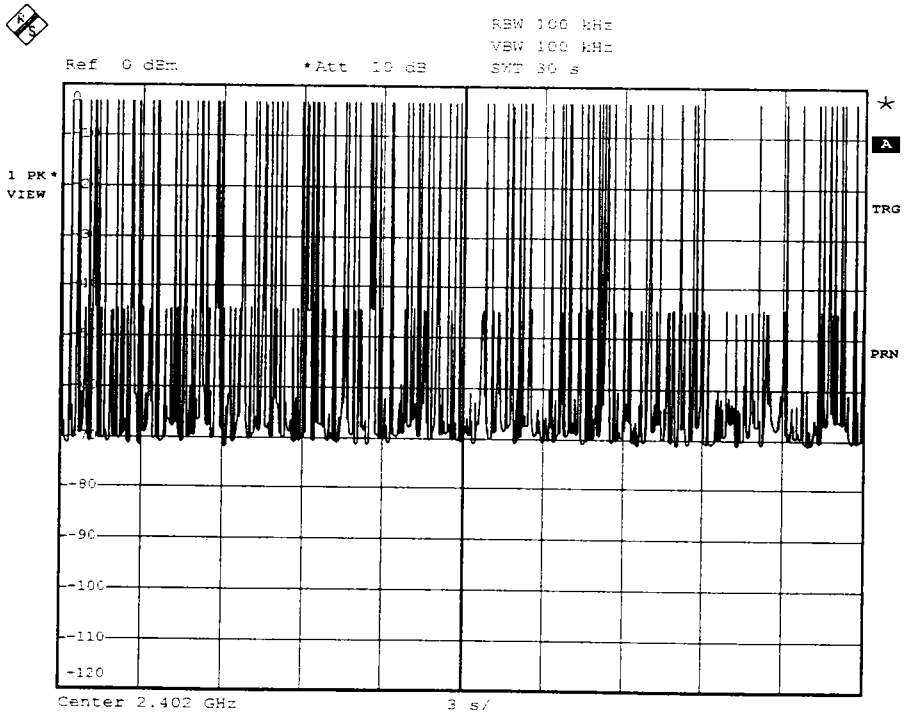
Plot 2 – 30 seconds sweep time on the lowest channel, Vnom and Tnom.



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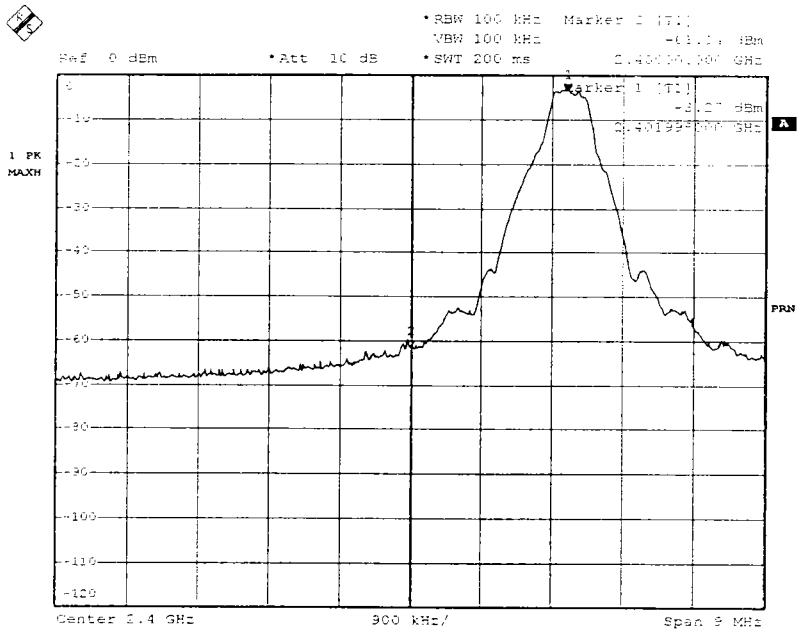
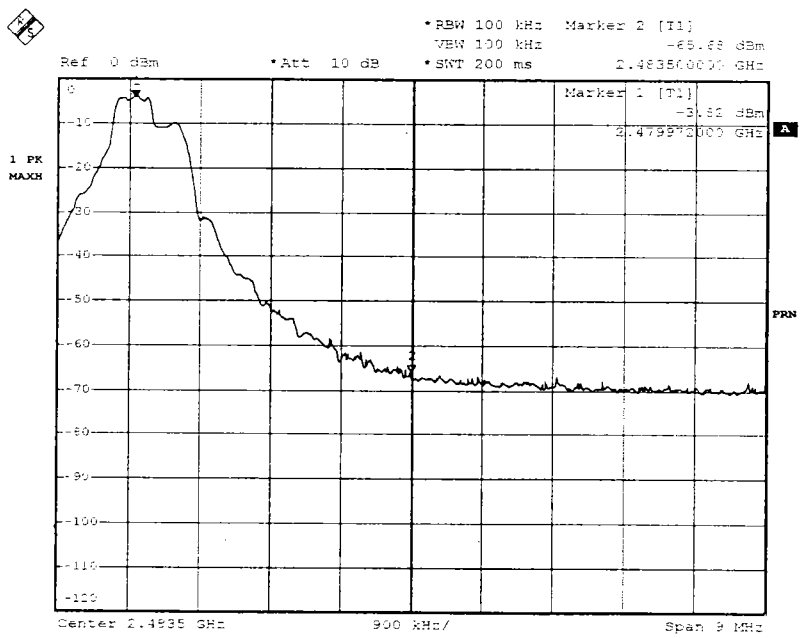
Appendix 1.7 – Band edge

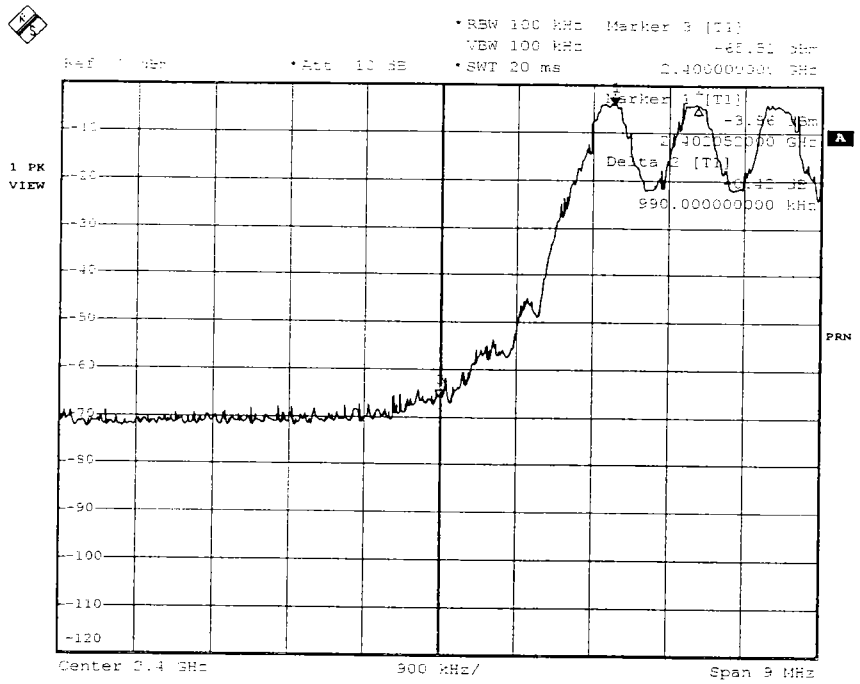
Plot 1 – Lowest channel hopping off, Vnom and Tnom.



Plot 2 - Highest channel hopping off, Vnom and Tnom.



Plot 3 - Lowest channel hopping on, Vnom and Tnom.



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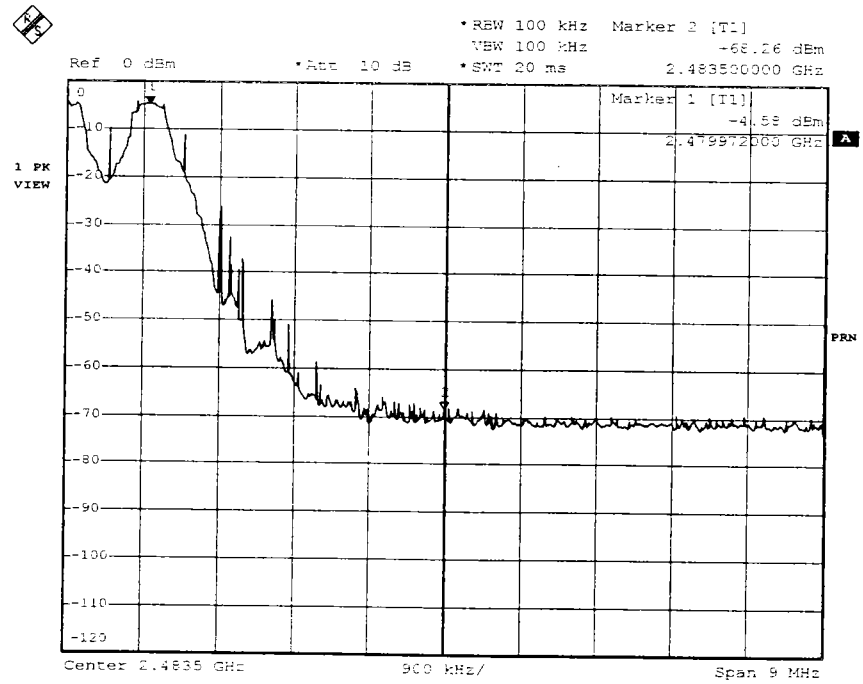
Plot 4 - Highest channel hopping on, Vnom and Tnom.



Date: 12.DEC.2001 16:46:48

Appendix 1.8 – Power spectral density

The power spectral density plot for Tnom and Vnom.