RADIO TEST REPORT

No. 0109155R2

EQUIPMENT UNDER TEST

Equipment :	Bluetooth Compact Flash
Type / model :	LSE 039
Manufacturer :	Wireless Solutions Sweden AB
Tested by request of :	Wireless Solutions Sweden AB

SUMMARY

The equipment complies with the requirements according to the following standard.

FCC part 15.247 subpart C (1999)

Date of issue: May 4, 2001

Tested by: Martin Gustafsson

Approved by: Björn Rosenquist

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Appendix. Conducted measurements performed by the manufacturer.

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 Compact Flash
Type/Model:	LSE 039
Brand name:	Wireless Solutions Sweden AB
Manufacturer:	Wireless Solutions Sweden AB
Rating:	3,3 V DC and 5 V DC

2.2 Additional information about the EUT

The EUT consists of the following units:

Units	Type
PC Card	LSE 015 R1A

The Compact Flash supports File Transfer. The LSE 039 Compact Flash provides wireless communication for Bluetooth application in the 2,4 GHz ISM band. The Compact Flash is intended for insert into a Laptop. During the test the LSE 039 Compact Flash was installed in a jigg, ("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

2.2.2 Transmitter RF power characteristics:

Maximum rated transmitter output power:	0 dBm e.i.r.p (power class 2)
Antenna:	Integrated and external RF connector

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:	3,3 V DC and 5 VDC
Physical interface:	Laptop

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	Satelite 2180 CDT

2.4 Equipment included in the test report but not tested

The following equipment is not tested but included in this report. The changes described below will not affect the measurement result. The ".." after the slash in the model designation indicates different customer deliveries and differences are only decorative.

Compact Flash Model number:
LSE 039/..
Differences: The ".." after the slash in the model designation indicates different customer deliveries and differences are only decorative.

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

The conducted measurements were performed by the manufacturer, se note 1 below.
No other 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	Conducted measurements	Pass	1

5. RADIATED SPURIOUS EMISSION, TRANSMITTER AND RECEIVER

5.1 Operating environment

Temperature:	22 °C	(15 - 35 °C)
Relative Humidity:	23 %	(30 - 60 %)

5.2 Measurement uncertainty

Measurement uncertainty: ± 4 dB

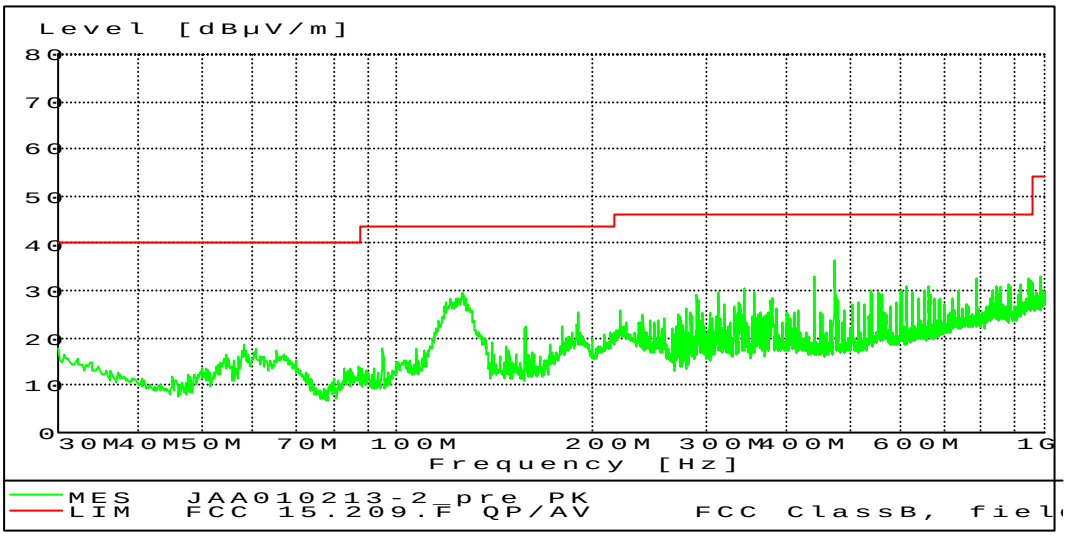
5.3 Test equipment

Test site: Semi-anechoic shielded chamber. 10 x 20 x 8,5 m (W x L x H)

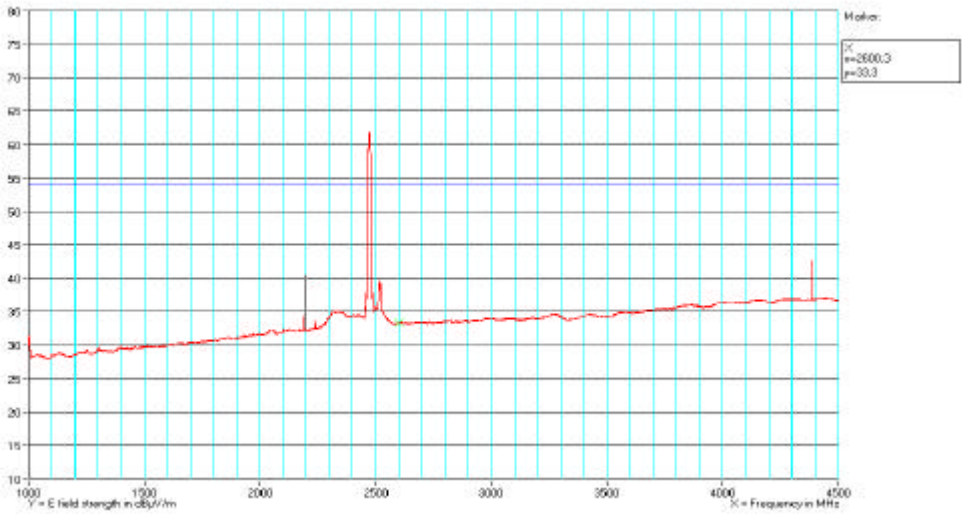
Equipment	Manufacturer	Type	SEMKO No.
Software:	R&S	ES-K1	
Software:	Frank Hoppert	REMI	
Measurement receiver:			
Monitor unit:	R&S	ESAI	2973
RF unit:	R&S	ESAI	2974
Spectrum analyser:	HP	8566B	7091
Antenna amplifier:	SEMKO		7992, 7993
Preamplifier:	HP	8449B	6685
Attenuator:	HP	8491A	2296
High pass filter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

5.4 Test protocol

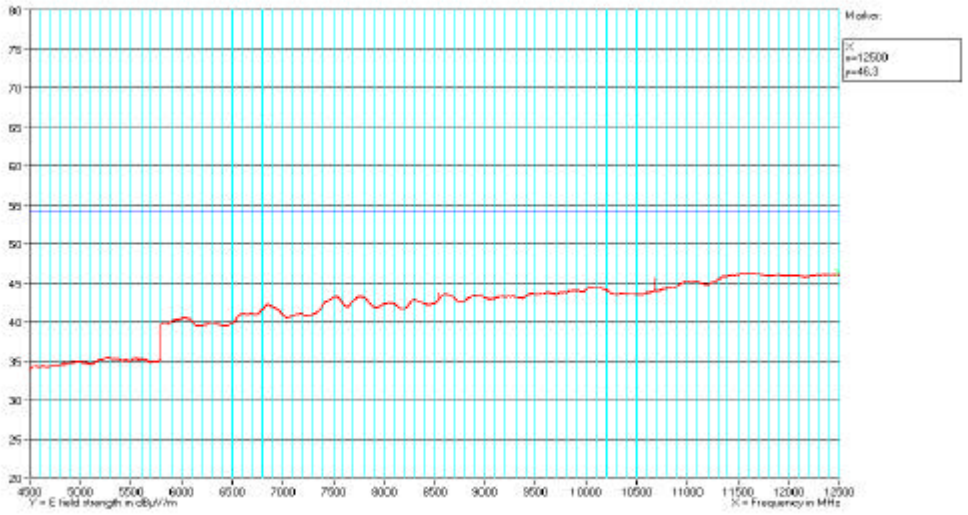
Date of test: February 13, 2001



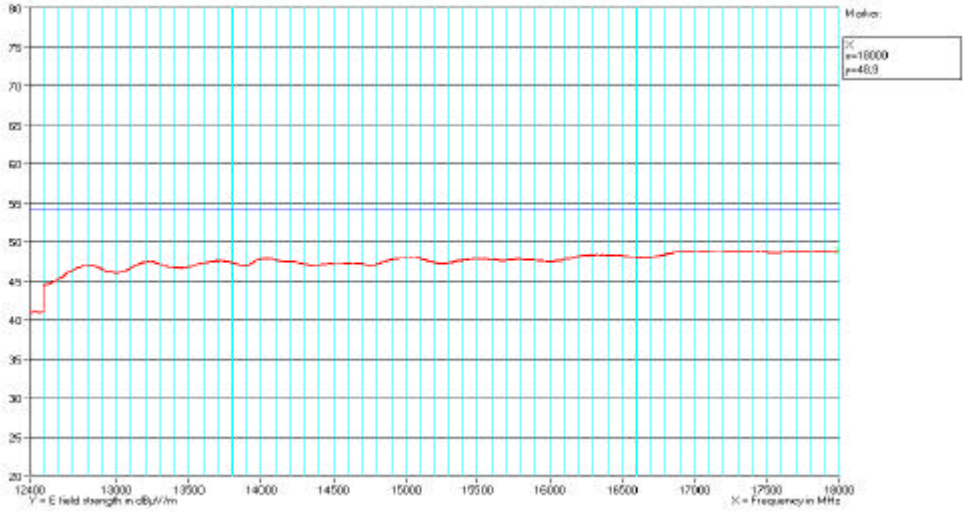
Overview sweep max peek at a distance of 10 m (30 – 1000 MHz):
Duty cycle correction factor = 20 log(dwelltime/100ms) = -44 dB; Dwelltime BT = 625 µs



Overview sweep max peek at a distance of 3 m (1 – 4,5 GHz):
Duty cycle correction factor = 20 log(dwelltime/100ms) = -44 dB; Dwelltime BT = 625 µs



Overview sweep max peek at a distance of 3 m (4,5 – 12,5 GHz):
Duty cycle correction factor = 20 log(dwelltime/100ms) = -44 dB; Dwelltime BT = 625 µs



Overview sweep max peek at a distance of 3 m (12,5 -18 GHz):
Duty cycle correction factor = 20 log(dwelltime/100ms) = -44 dB; Dwelltime BT = 625 µs

Field strength of spurious emission. Tx test data sequence						
Frequency	RBW	Measured level		Limit		Note
[MHz]	[kHz]	Peak [dBµV/m]	QP/AV [dBµV/m]	Peak [dBµV/m]	QP/AV [dBµV/m]	
30 – 88	120	40	-	-	40	1
88 – 216	120	<30	-	-	43,5	1
216 – 960	120	<41	-	-	46	1
960 – 1000	120	<34	-	-	54	1
1000 – 2400	1000	<49	<-8	74	54	2
2483,5 – 4500	1000	<43	<-10	74	54	2
4500 – 12500	1000	<48	<3	74	54	2
12500 – 18000	1000	<42	<5	74	54	2
18000 - 26000	1000	<48	-	74	54	3

Note 1. Calculated from 10 m distance.

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

Note 3. Noise generated in the spectrum analyser.

Fulfil requirements: Yes

Appendix – Conducted measurements by Wireless Solutions Sweden AB

Bluetooth RF test report

According to FCC part 15.247

For

Bluetooth CompactFlash card

Type no. LSE 039/..

Serial no. LSE03901AB000001

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1 GENERAL

1.1 Administrative data

1.2 Description of EUT

Device	Bluetooth CompactFlash card
Product type	LSE 039/..
S/N	LSE03901AB000001
HW status	R1A
Date of test started	2001-04-11
Date of test finished	2001-04-17
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.

1.3 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

1.4 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.

2 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%.

2.1 Transmitter

2.1.1_Peak output power

2.1.1.1 Test conditions and results

Relative humidity:		23%
Attenuation:		5.2dB
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 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:	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	-4.7	-5.4	0.5	-0.2
	Vnom	-4.4	-5.2	0.8	0.0
	Vmax	-4.4	-5.2	0.8	0.0
Tmin	Vmin	-4.3	-4.8	0.9	0.4
	Vnom	-4.1	-4.6	1.1	0.6
	Vmax	-4.1	-4.6	1.1	0.6
Tmax	Vmin	-6.0	-6.7	-0.8	-1.5
	Vnom	-5.7	-6.4	-0.5	-1.2
	Vmax	-5.7	-6.4	-0.5	-1.2

Formula to calculate peak value

P = Pout + attenuator and cable loss (i.e. 5.2dB)

Pout = measured power

2.1.1.2 Limits

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

peak power < 30 dBm

2.1.1.3 Verdict

The equipment passed the test under all test conditions.

2.1.1.4 Test equipment used

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

2.1.1.5 Measurement uncertainty

Amplitude: better than ±1.0dB.

2.1.1.6 Comments

Plots can be seen in Appendix 2.

2.1.2 TX 20dB bandwidth

2.1.2.1 Test conditions and results

Ambient temperature: 25°C

Relative humidity: 23%

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	832	956
	Vnom	840	948
	Vmax	836	956
Tmin	Vmin	828	944
	Vnom	832	948
	Vmax	820	944
Tmax	Vmin	844	960
	Vnom	840	948
	Vmax	840	948

2.1.2.2 Limits

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

2.1.2.3 Verdict

The equipment passed the test under all test conditions.

2.1.2.4 Test equipment used

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

2.1.2.5 Measurement uncertainty

Frequency: ±15kHz

2.1.2.6 Comments

Plots can be seen in Appendix 3.
The measurements where made with marker to peak, and the 20dB-bandwidth is 20dB down from it.

2.1.3 Carrier frequency separation

2.1.3.1 Test conditions and results

Ambient temperature: 25°C

Relative humidity: 23%
Rated output power: 0dBm

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	1008 kHz

2.1.3.2 Limits

Greater than the 20dB bandwidth, which in this case is >948 kHz.

2.1.3.3 Verdict

The equipment passed the test under all test conditions.

2.1.3.4 Test equipment used

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

2.1.3.5 Measurement uncertainty

Frequency: ±20kHz

2.1.3.6 Comments

Plots can be seen in Appendix 7, plot 3.

2.1.4 Number of hopping frequencies

2.1.4.1 Test conditions and results

Ambient temperature: 25°C

Relative humidity: 23%
Rated output power: 0dBm

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 5, it is 79 channels.

2.1.4.2 Limits

≥ 75

2.1.4.3 Verdict

The equipment passed the test under all test conditions.

2.1.4.4 Test equipment used

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

2.1.4.5 Measurement uncertainty

Not applicable.

2.1.4.6 Comments

A plot can be seen in Appendix 5.

2.1.5 Time of occupancy (dwell time)

2.1.5.1 Test conditions and results

Ambient temperature:	25°C
Relative humidity:	23%
Rated output power:	0dBm
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 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 = T * n
S = 2.98ms * 105 = 0.313s

Result:
Channel 1 is active 0.313s under a period of 30 seconds.

2.1.5.2 Limits

0.4s

2.1.5.3 Verdict

The equipment passed the test under all test conditions.

2.1.5.4 Test equipment used

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

2.1.5.5 Measurement uncertainty

Time: ±5.25ms

2.1.5.6 Comments

Plots can be seen in Appendix 6.

2.1.6 Band edge compliance

2.1.6.1 Test conditions and results

Ambient temperature:	25°C
Relative humidity:	23%
Rated output power:	0dBm
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	-56dBc (-54dBc at 2399.856MHz)	-63dBc
Hopping on	-61dBc (-53dBc at 2399.874MHz)	-65dBc

2.1.6.2 Limits

<-20dBc

2.1.6.3 Verdict

The equipment passed the test under all test conditions.

2.1.6.4 Test equipment used

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

2.1.6.5 Measurement uncertainty

Amplitude: better than ±1.2dB.

2.1.6.6 Comments

Plots can be seen in Appendix 7.

2.1.7 Out of band spurious emissions conducted transmit

2.1.7.1 Test conditions and results

Ambient temperature: 25°C

Relative humidity: 23%

Rated output power: 0dBm

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	

2.1.7.2 Limits

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

2.1.7.3 Verdict

The equipment passed the test under all test conditions.

2.1.7.4 Test equipment used

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

2.1.7.5 Measurement uncertainty

Frequency: ±100kHz
Amplitude: ± 3dB

2.1.7.6 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 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 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 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
Network analyser	Agilent	HP8753ES	US39172563	June 2001	For calibration
Multimeter	Agilent	HP34970	US 37031644	May 2001	All
Power supply	Agilent	E3631A	KR01128568	June 2001	All
Hygrometer	THGM	880	-	-	Humidity check
Coaxial cable 1	Suhner	-	-	-	All, except 2.1.7
SMA connector	Male to Male	-	-	-	2.1.7
Attenuator	Suhner 3dB	6603.19	-	-	All, except 2.1.7

Equipment accuracy.

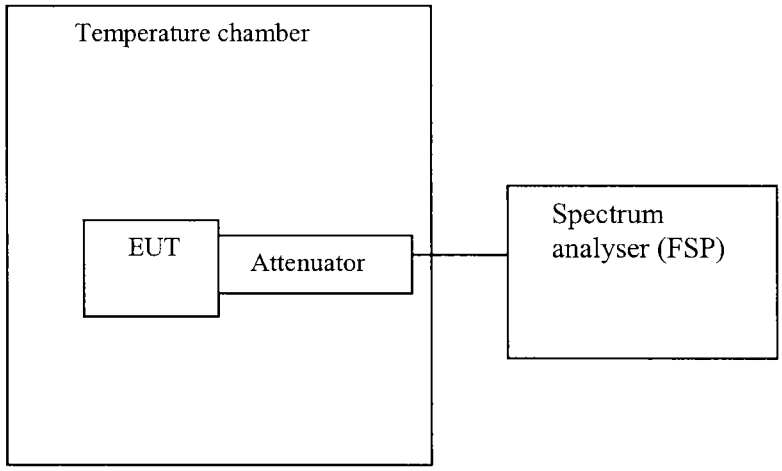
Instrument	Manufacturer	Type	Accuracy
Spectrum analyser	Rohde & Schwarz	FSP 30	± 0.5 dB (amplitude) @ f<3000MHz ± 2 dB (amplitude) @ f<7000MHz ± 2.5 dB (amplitude) @ f<13600MHz ± 3 dB (amplitude) @ f<30000MHz max ±2.5 ppm (frequency) ±1% max deviation (sweep time) at zero span
Network analyser	Agilent	HP8753ES	± 0.1 dB
Power supply	Agilent	E3631A	± 2 %
Multimeter	Agilent	HP34970	± 1 °C
Coaxial cable 1 + Attenuator SMA connector			5.2 ± 0.1dB 0.1dB
Hygrometer	THGM	880	± 7 %

4 APPENDIX

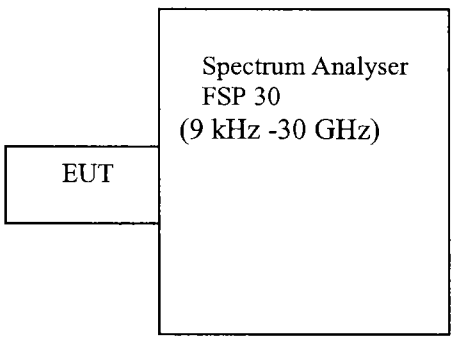
1. Measurement set-up
2. Peak power
3. 20dB Bandwidth
4. Spurious emission
5. Number of hopping channels
6. Dwell time
7. Band edge

Appendix 1 – Measurement set-up

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

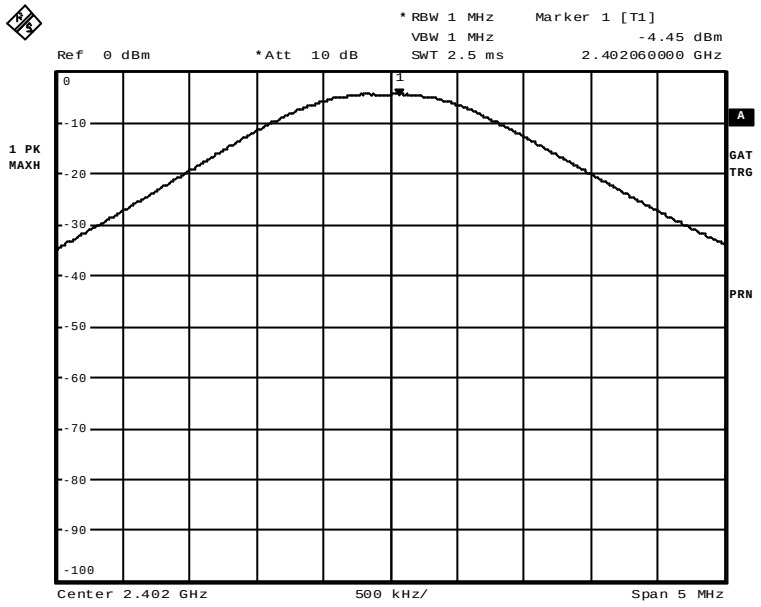


A1.2 Spurious measurements with spectrum analyser from Rohde & Schwarz.

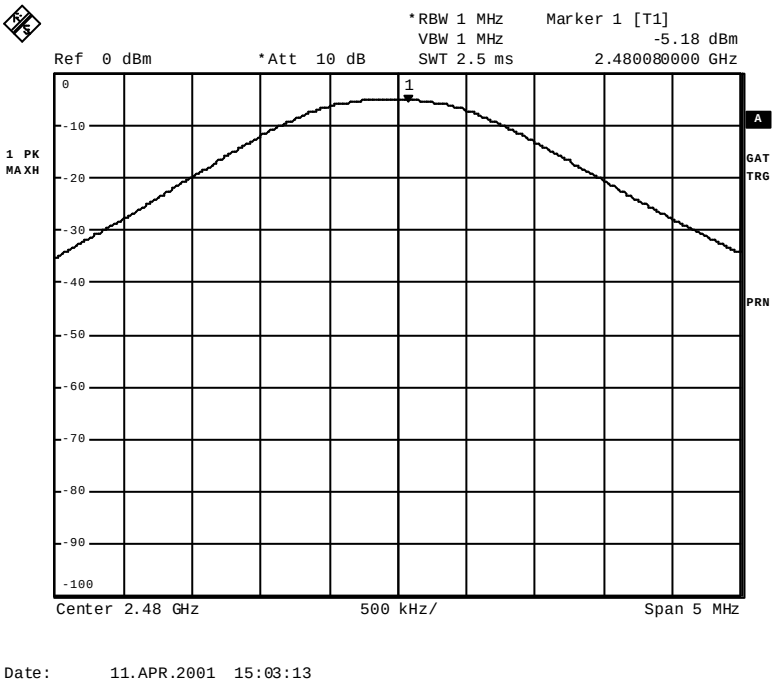


Appendix 2 – Peak power

Plot 1 – Peak power on lowest channel with 3.3V and at +25°C.

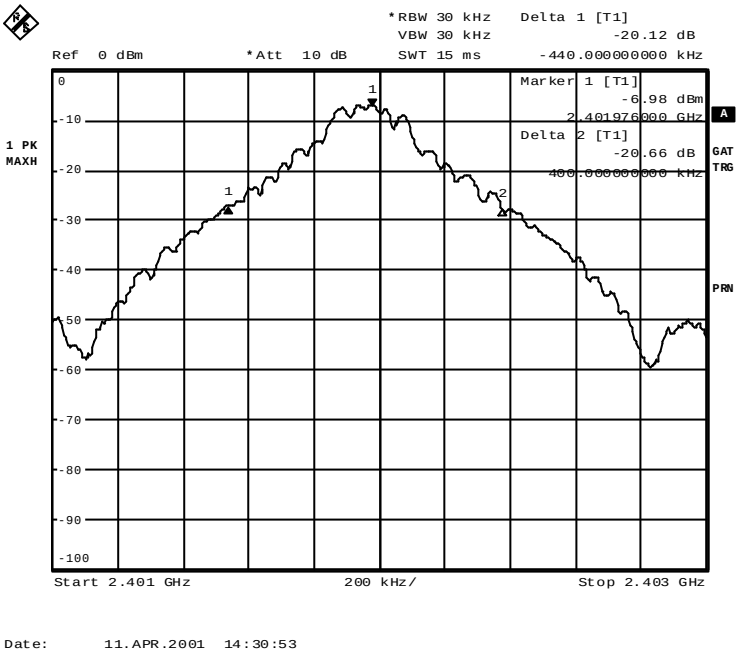


Plot 2 – Peak power on highest channel with 3.3V and at +25°C.

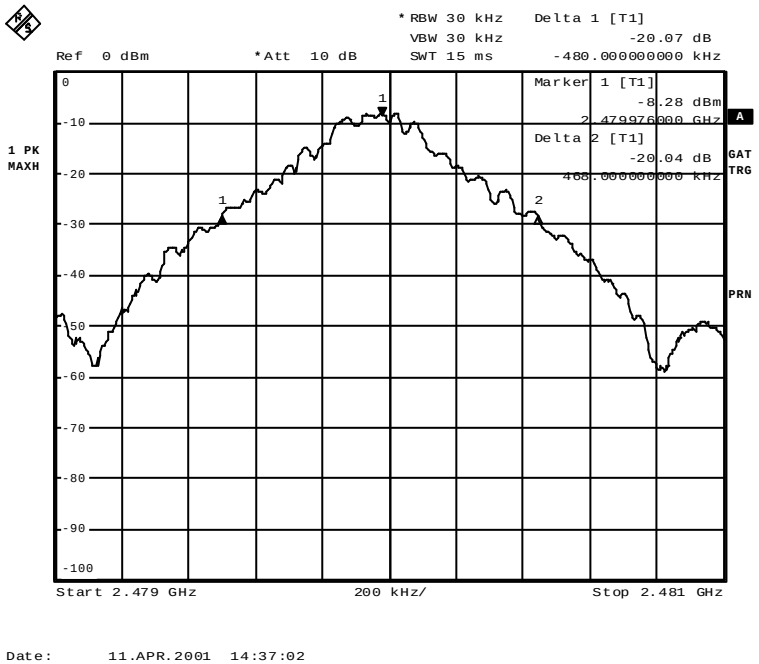


Appendix 3 – 20dB bandwidth

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

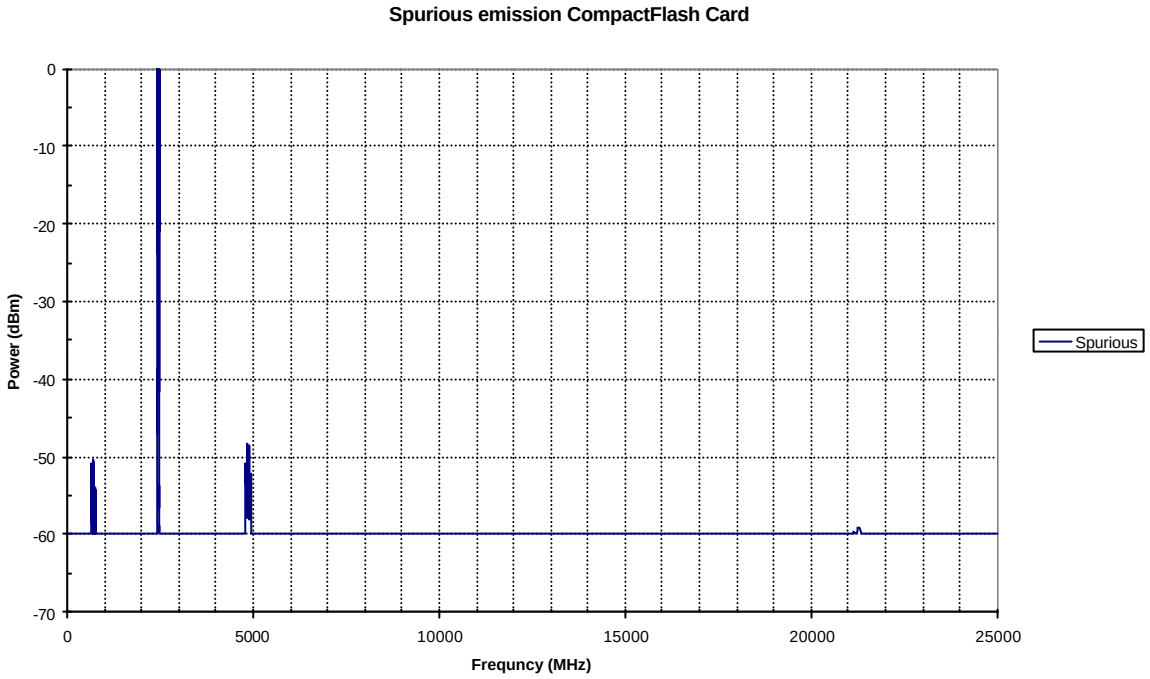


Plot 2 – The 20dB bandwidth on the highest channel, Vnom and Tnom.



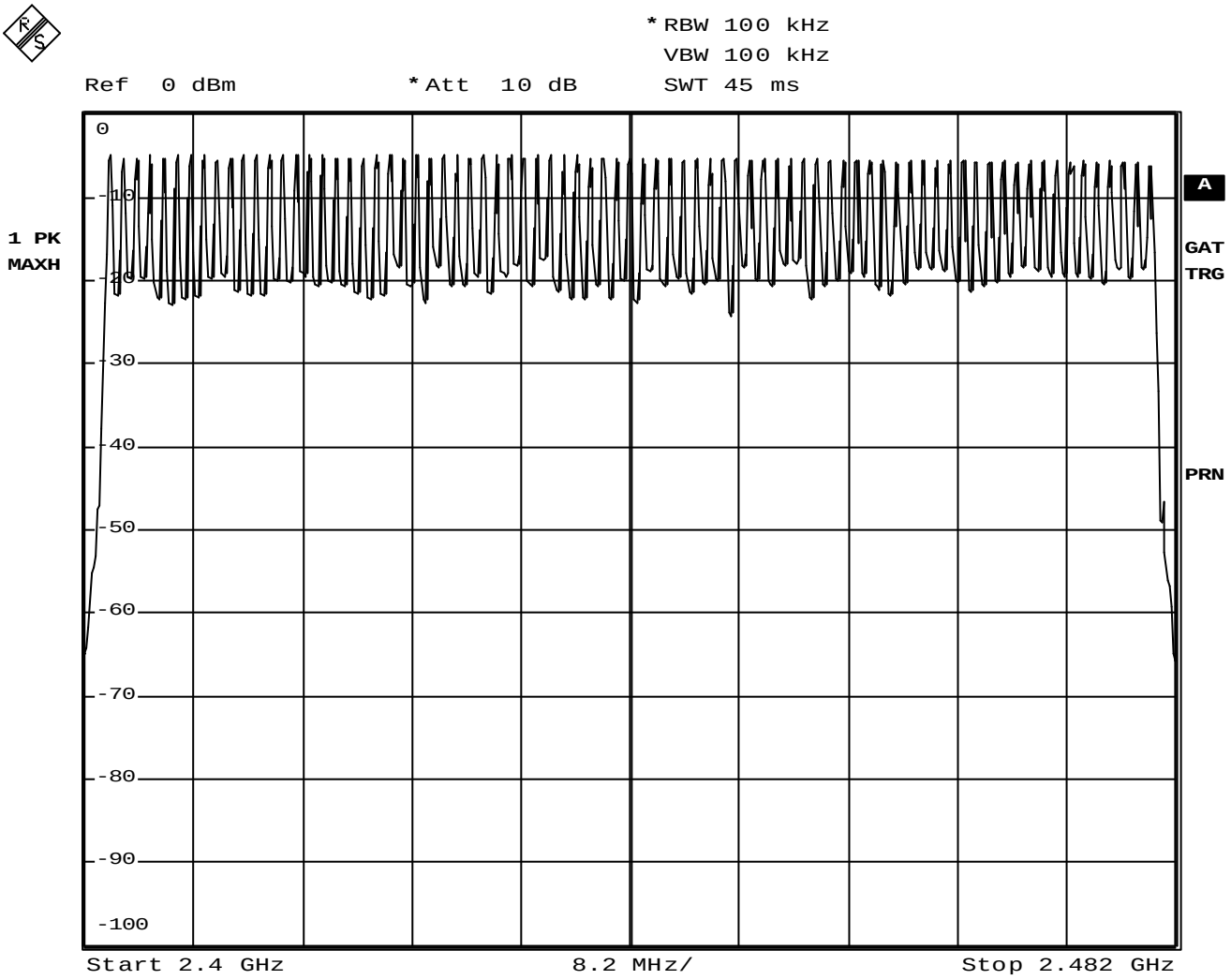
Appendix 4 - Spurious emission

The plot below shows the spurious emission when the EUT is transmitting in frequency hopping mode (no values was recorded below –60dBm), Vnom and Tnom.



Appendix 5 – Number of hopping channels

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



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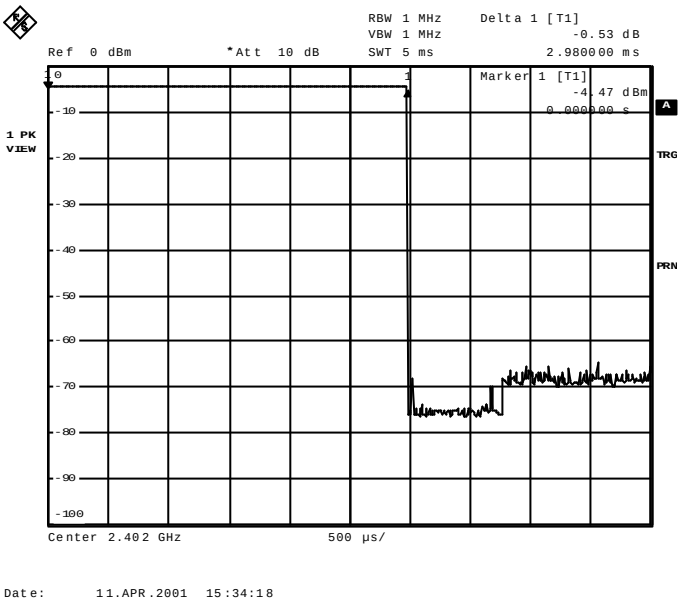
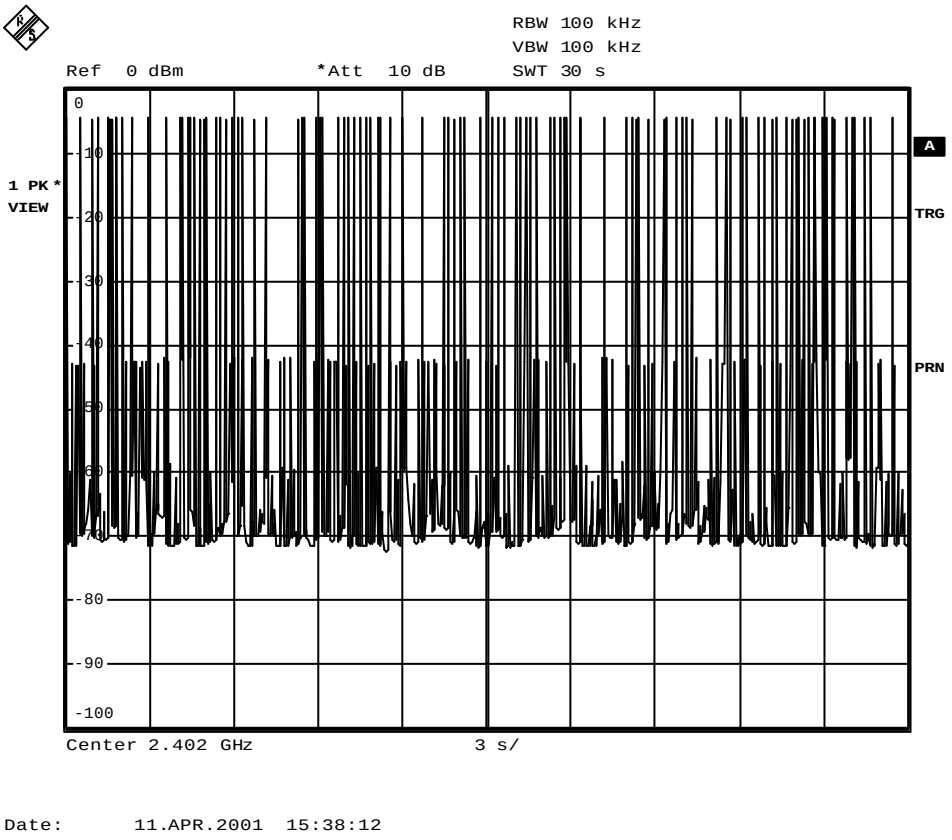
Appendix 6 – Dwell time

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

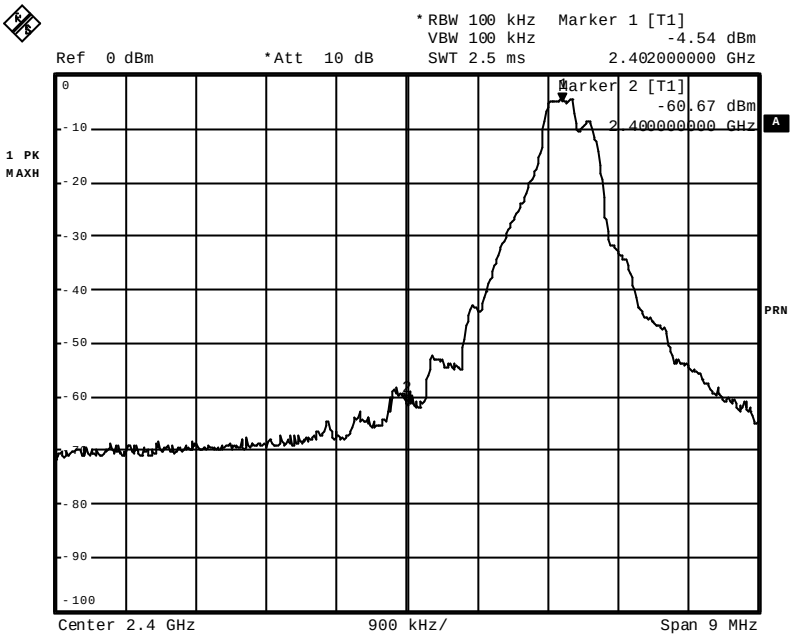


Plot 2 – 30 seconds sweep time on the lowest channel, Vnom and Tnom.



Appendix 7 – Band edge

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



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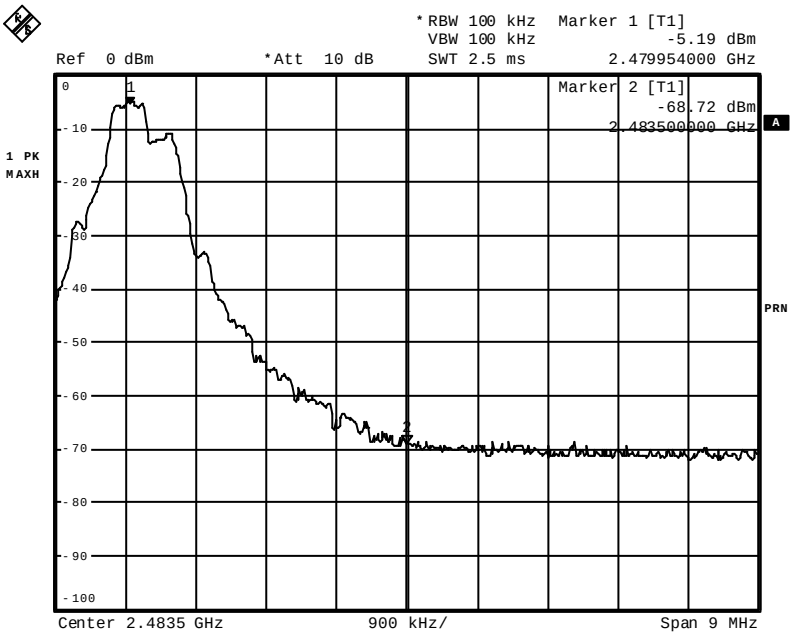
Plot 2 - Highest channel hopping off, Vnom and Tnom.



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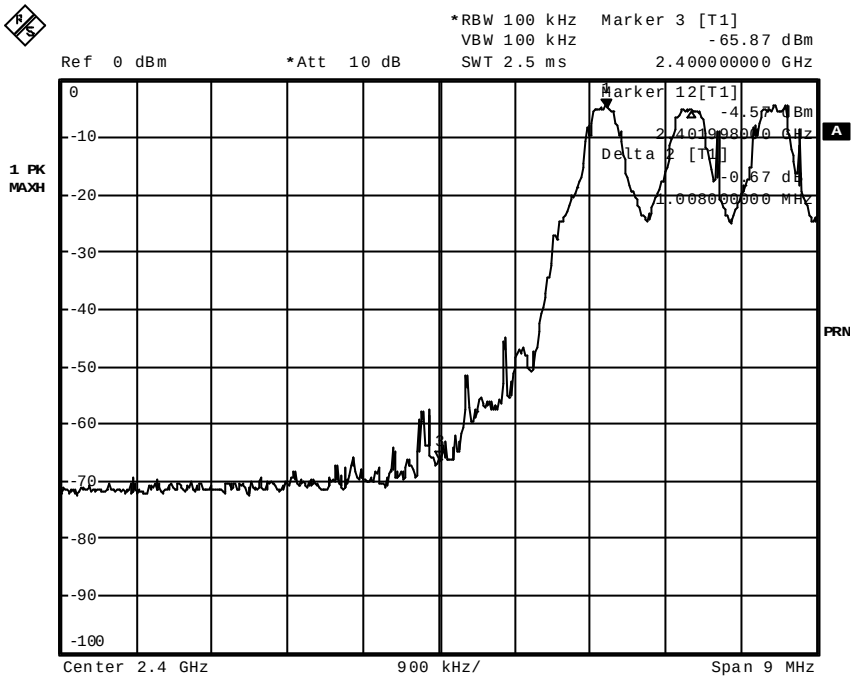
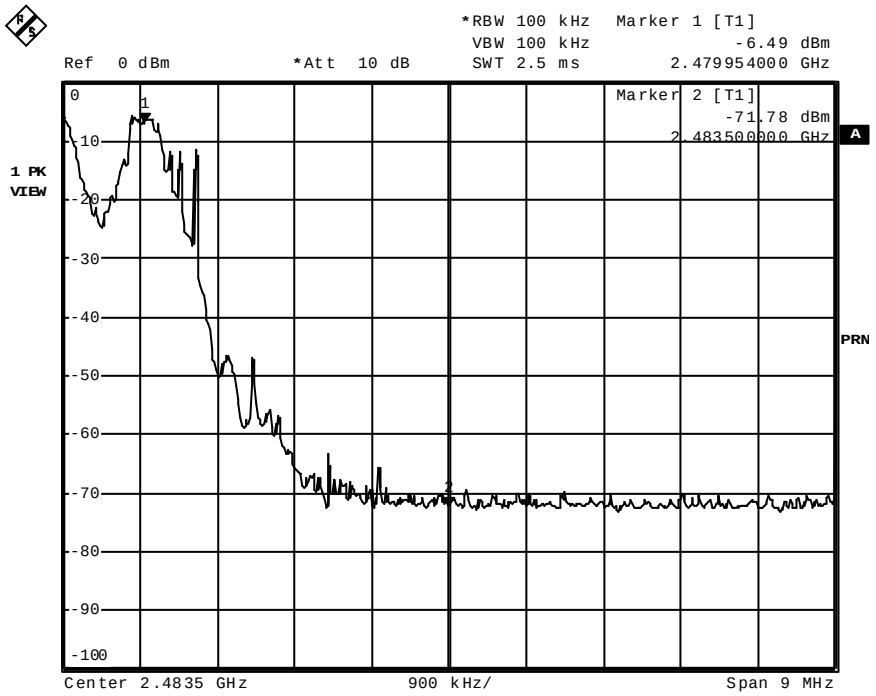
Plot 3 - Lowest channel hopping on, Vnom and Tnom.



Date: 19.APR.2001 17:03:21

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



Date: 19.APR.2001 16:32:41