R051-24-09-104775-1/A Ed. 0

FCC CERTIFICATION
RADIO Measurement
Technical Report

standard to apply:
FCC Part 15.247

Equipment under test:
PROBE RLP40

FCC ID :
KQGRLP40

Company:
RENISHAW SAS

DISTRIBUTION: Mr CRESSON **Company: RENISHAW SAS**

Number of pages: 41 including 5 annexes

Ed.	Date	Modified pages	Written by Name	Visa	Technical Verification Quality Approval Name	Visa
0	1-Dec-09	Creation	M. DUMESNIL	M. D.	P. BONNENFANT	

Duplication of this test report is only permitted for an integral photographic facsimile. It includes the number of pages referenced here above.

This document is the result of testing a specimen or a sample of the product submitted. It does not imply an assessment of the conformity of the whole manufactured products of the tested sample.

PRODUCT:	**PROBE**
Reference / model:	RLP40
Trade mark:	RENISHAW
Serial number:	8U9872
MANUFACTURER:	RENISHAW PLC (United Kingdom)

COMPANY SUBMITTING THE PRODUCT:

Company:	RENISHAW SAS
Address:	15 rue Albert Einstein Champ-sur-Marne 77447 MARNE LA VALLEE Cedex 2 FRANCE
Responsible:	Mr CRESSON
DATE(S) OF TEST:	6, 7 and 24 November 2009 23 December 2009
TESTING LOCATION:	EMITECH ATLANTIQUE laboratory at ANGERS (49) FRANCE EMITECH ATLANTIQUE open area test site in LA POUEZE (49) FRANCE Registration Number by FCC: 101696/FRN: 0006 6490 08
TESTED BY:	M. DUMESNIL
TUTOR:	P. BONNENFANT

CONTENTS

TITLE **PAGE**

1. INTRODUCTION

This document presents the result of RADIO test carried out on the following equipment: PROBE RLP40 in accordance with normative reference.

2. PRODUCT DESCRIPTION

ITU Emission code: 1M00F7D

Class: A (commercial, industrial or business environment)

Utilization: probe for machine tools with Bluetooth function

Antenna type: incorporated antenna

Operating frequency range: from 2403 MHz to 2481 MHz

Number of channels: 79

Channel spacing: 1 MHz

Frequency generation: O SAW Resonator O Crystal ⊙ Synthesizer

Modulation: Frequency Hopping Spread Spectrum (FHSS)
O Amplitude O Digital ⊙ Frequency O Phase

Power source: batteries Li-S0Cl_2 (2x3.6 Vd.c)

Power level, frequency range and channels characteristics are not user adjustable.

The details pictures of the product and the circuit boards are joined with this file.

3. NORMATIVE REFERENCE

The standards and testing methods related throughout this report are those listed below.
They are applied on the whole test report even though the extensions (version, date and amendment) are not repeated.

FCC Part 15 (2007)	Code of Federal Regulations Title 47 - Telecommunication Chapter 1 - Federal Communications Commission Part 15 - Radio frequency devices Subpart C - Intentional Radiators
ANSI C63.10 (2009)	Methods of Measurement of Radio-Noise Emissions from Low-voltage Electrical and Electronics Equipment in the range of 9 kHz to 40 GHz.
Public Notice DA 00-705	Filing and Measurement Guideline for Frequency Hopping Spread Spectrum Systems.

4. TEST METHODOLOGY

Radio performance tests procedures given in part 15:

Paragraph 33: frequency range of radiated measurements
Paragraph 35: measurement detector functions and bandwidths
Paragraph 107: conducted limits
Paragraph 109: radiated emission limits
Paragraph 111: antenna power conducted limits for receivers
Paragraph 203: antenna requirement
Paragraph 205: restricted bands of operation
Paragraph 207: conducted limits
Paragraph 209: radiated emission limits; general requirements
Paragraph 247: operation within the bands 902-928 MHZ, 2400-2483.5 MHz and 5725-5850 MHz

5. ADD ATTACHMENTS FILES

"Synoptic"
"Block diagram"
"External photos and Product labeling"
"Assembly of components"
"Internal photos"
"Layout pcb"
"Bil of materials"
"Schematics"
"Product description"
"User guide"

6. TESTS AND CONCLUSIONS

6.1 intentional radiator (subpart C)

Test procedure	Description of test	Criteria respected ?				Comment
		Yes	No	NAp	NAs	
FCC Part 15.203	ANTENNA REQUIREMENT	X				*Note 1*
FCC Part 15.205	RESTRICTED BANDS OF OPERATION	X				
FCC Part 15.207	CONDUCTED LIMITS			X		
FCC Part 15.209	RADIATED EMISSION LIMITS; general requirements	X				*Note 2*
FCC Part 15.247	OPERATION WITHIN THE BAND 902-928 MHZ, 2400-2483.5 MHz and 5725-5850 MHz					
	(a) (1) *hopping systems*	X				*Note 3*
	(a) (1) (i) 902 – 928 MHz			X		
	(a) (1) (ii) 5725 – 5850 MHz			X		
	(a) (1) (iii) 2400 – 2483.5 MHz	X				*Note 4*
	(a) (2) *digital modulation techniques*			X		
	(b) *max output power*	X				*Note 5*
	(c) *operation with directional antenna gains > 6 dBi*			X		*Note 6*
	(d) *intentional radiator*	X				*Note 7*
	(e) *peak power spectral density*			X		
	(f) *hybrid system*			X		
	(g)	X				
	(h)	X				
	(i) *RF exposure compliance*	X				*Note 8*
DA 00-705	BAND EDGE COMPLIANCE	X				

NAp: Not Applicable NAs: Not Asked

Note 1: internal antenna (pcb antenna), see photos in annex 4.

Note 2: see FCC part 15.247 (d).

Note 3: the system hops to channel frequencies from a pseudo randomly ordered list of hopping frequencies. Each frequency is used equally on the average by the transmitter, and separated by a minimum of 20 dB bandwidth of the hopping channel (762 kHz; see annex 1).

Note 4: the frequency hopping system uses 79 channels (see annex 3). The timing by channel is 666 µs. During 79 channels × 0.4 s (part 15) = 31.6 s, any channel is used 411 times, then 411 × 666 µs = 273.73 ms, thus the average time of occupancy on any channel is less than 400 ms within a period of 0.4 s multiplied by the number of hopping channels employed, in normal operating mode (see annex 2).

Note 5: conducted measurement is not possible (integral antenna), so we used the radiated method in open field.

Note 6: the antenna gain is less than 6 dBi.

Note 7: pulsed modulated devices.
For average measurements a correction duty cycle is calculated.
Equipment during transmit 666 µs twice in a time interval of 100 ms.

So, the duty cycle correction factor is 20 log $\frac{(2\times 666\times 10^{-6})}{100\times 10^{-3}}$ *=-37.51 dB.*

See curves in annex 2.

Note 8: this type of equipment uses less than 0.5 W of output power with a high signal transmitting duty factor (section 3 from Oet 65c).

6.2 unintentional radiator (subpart B)

Test procedure	Description of test	Criteria respected ?				Comment
		Yes	No	NAp	NAs	
FCC Part 15.107	CONDUCTED LIMITS			X		
FCC Part 15.109	RADIATED EMISSION LIMITS	X				
FCC Part 15.111	ANTENNA POWER CONDUCTED LIMITS FOR RECEIVER			X		

NAp: Not Applicable NAs: Not Asked

Conclusion:

The sample of PROBE RLP40 submitted to the tests complies with the regulations of the standard FCC Part 15 in accordance with the limits or criteria defined in this report.

7. RADIATED EMISSION LIMITS

Standard: FCC Part 15 B

Test procedure: paragraph 109

Limit class: Class A

Standard deviation: The measurement is carried out at 3 m, instead of 10 m

Test equipments:

TYPE	BRAND	EMITECH NUMBER
Test receiver	Rohde & Schwarz ESVS 10	1219
Biconical antenna	Hewlett Packard 11966 C	728
Log periodic antenna	Rohde & Schwarz HL 223	1999
Double ridged guide antenna	Electrometrics EM 6961	1204
Spectrum analyzer	Rohde & Schwarz FSP40	4088
Open area test site	EMITECH	1274
Preamplifier 1 to 18 GHz	DBS Microwave DB97-1852	2648
High pass filter	Micro-tronics HPM11630	6609
Multimeter 77-2	Fluke	0812
Meteo station AB 888	Oregon scientific	1539

Test set up:

The system is tested in an open area test site (OATS).
The test unit is placed on a rotating table, 0.8 m from a ground plane. Zero degree azimuths correspond to the front of the equipment under test.

Frequency range: The highest frequency generated in the device is f = 2481 MHz
According the Sec.15.33 of the FCC Part 15 standard, the frequency range measured is indicated in the following table:

For unintentional radiator, including a digital device (Sec.15.33, §(b)(1) of the FCC Part 15standard) :

Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range (MHz)
Above 1000	5th harmonic of the highest frequency or 40GHz, whichever is lower

Bandwidth: 120 kHz (F < 1 GHz)
1 MHz (F > 1 GHz)

Detection mode: Quasi-peak (F < 1 GHz)
Average (F > 1 GHz)

Distance of antenna: 3 meters

Antenna height: 1 to 4 meters

Antenna polarization: vertical and horizontal (only the highest level is recorded)

Equipment under test operating condition:

The equipment is blocked in continuous reception mode.

Results:

Ambient temperature (°C): 19
Relative humidity (%): 61

Power source:
We used for power source the internal battery(ies) of the equipment and we noted:

Voltage at the beginning of test (V): 7.16
Voltage at the end of test (V): 7.14
Percentage of voltage drop during the test (%): 0.28

Not any spurious has been detected during this test.

Note: any spurious which has more than 20 dB of margin compared to the applicable limit is not necessarily reported.

Applicable limits: For 30 MHz ≤ F < 88 MHz: 49.54 dBµv/m at 3 m
For 88 MHz ≤ F < 216 MHz: 53.98 dBµv/m at 3 m
For 216 MHz ≤ F < 960 MHz: 56.90 dBµv/m at 3 m
Above 960 MHz: 60 dBµv/m at 3 m

TEST CONCLUSION:

RESPECTED STANDARD

8. MAXIMUM PEAK OUTPUT POWER

Standard: FCC Part 15 C

Test procedure: paragraph 15.247

Test equipments:

TYPE	BRAND	EMITECH NUMBER
Spectrum analyzer FSP 40	Rohde & Schwarz	4088
Antenna RGA60	Electrometrics	1204
Open site	EMITECH	1274
Multimeter 77-2	Fluke	0812
Meteo station AB888	Oregon scientific	1539

Test set up:

The system is tested in an open area test site (OATS).
The test unit is placed on a rotating table, 0.8 m from a ground plane. Zero degree azimuth corresponds to the front of the equipment under test.
We use for this measure outdoor test site. The measuring distance between the equipment and the test antenna is 3 m. The test antenna has been oriented in the two polarizations, we have recorded only the highest level.

A measurement of the electro-magnetic field is realized, with a resolution bandwidth and video bandwidth adjusted at 1 MHz.

Distance of antenna: 3 meters

Antenna height: 1 to 4 meters

Antenna polarization: vertical and horizontal

Equipment under test operating condition:

The equipment under test is blocked in continuous transmission mode, modulated by internal data signal, at the highest output power level which the transmitter is intended to operate.

Results:

Ambient temperature (°C): 19.5
Relative humidity (%): 74

Power source:
We used for power source the internal battery(ies) of the equipment and we noted:

Voltage at the beginning of test (V): 7.32
Voltage at the end of test (V): 7.16
Percentage of voltage drop during the test (%): 2.19

Sample n° 1 Channel 1

		Level dBµV	Cable loss dB	Antenna factor dB	Electro-magnetic field (dBµV/m):	P* (W)	Limit (W)
Normal test conditions	Nominal power source (V): 7.2	56.61	4.97	28.61	90.19	$0.190x10^{-3}$	1

Polarization of test antenna: vertical (height: 223 cm)
Position of equipment: vertical position (azimuth: 180 degrees)

Sample n° 1 Channel 40

		Level dBµV	Cable loss dB	Antenna factor dB	Electro-magnetic field (dBµV/m):	P* (W)	Limit (W)
Normal test conditions	Nominal power source (V): 7.2	55.22	5.01	28.73	88.96	$0.143x10^{-3}$	1

Polarization of test antenna: vertical (height: 214 cm)
Position of equipment: vertical position (azimuth: 26 degrees)

Sample n° 1 Channel 79

		Level dBµV	Cable loss dB	Antenna factor dB	Electro-magnetic field (dBµV/m):	P* (W)	Limit (W)
Normal test conditions	Nominal power source (V): 7.2	55.03	5.06	28.84	88.93	$0.142x10^{-3}$	1

Polarization of test antenna: vertical (height: 148 cm)
Position of equipment: vertical position (azimuth: 50 degrees)

* $P = (E \times d)^2 / (30 \times Gp)$ with d = 3 m and Gp = 1.65

Test conclusion:

RESPECTED STANDARD

9. INTENTIONAL RADIATOR

Standard: FCC Part 15 C

Test procedure: paragraph 15.205
paragraph 15.209
paragraph 15.247

Test equipments:

TYPE	BRAND	EMITECH NUMBER
Test receiver ESH3	Rohde & Schwarz	1058
Test receiver ESVS 10	Rohde & Schwarz	1219
Spectrum analyzer FSP 40	Rohde & Schwarz	4088
Loop antenna	EMCO	1406
Biconical antenna HP 11966C	Hewlett Packard	728
Log periodic antenna HL 223	Rohde & Schwarz	1999
Open site	Emitech	1274
Antenna RGA-60	Electrometrics	1204
Low-noise amplifier 2 to 18 GHz	Microwave DB	1922
High pass filter HP12/3200-5AA	Filtek	
Antenna WR42	IMC	1939
Power source E3610A	Hewlett Packard	4195
Low-noise amplifier 18 to 26 GHz	ALC	3036
Multimeter 77-2	Fluke	0812
Meteo station AB 888	Oregon scientific	1539

Test set up:

The system is tested in an open area test site (OATS).
The test unit is placed on a rotating table, 0.8 m from a ground plane. Zero degree azimuth corresponds to the front of the equipment under test.

Frequency range: from 9 kHz to harmonic 10 ($F_{carrier} \leq 10$ GHz)

Bandwidth: 120 kHz (F < 1 GHz) or 100 kHz, following 15.205 or 15.247
1 MHz (F > 1 GHz) or 100 kHz, following 15.205 or 15.247

Detection mode: Quasi-Peak (F< 1GHz)
Average (F> 1 GHz)

Distance of antenna: between 30 m and 3 m according the frequencies and the limits.

Antenna height: 1 to 4 meters

Antenna polarization: vertical and horizontal, only the highest level is recorded.

Equipment under test operating condition:

The equipment under test is blocked in continuous transmission mode, modulated by internal data signal, at the highest output power level which the transmitter is intended to operate.
The equipment is fitted with an internal antenna, without connector.

Results:

Ambient temperature (°C): 20
Relative humidity (%): 56

Power source:
We used for power source the internal battery(ies) of the equipment and we noted:

Voltage at the beginning of test (V): 7.17
Voltage at the end of test (V): 7.16
Percentage of voltage drop during the test (%): 0.14

The polarity column refers to the antenna polarity at which the maximum emissions level is measured.

Channel 1

FREQUENCIES (MHz)	Detector P: Peak QP: Quasi-Peak Av: Average	Antenna height (cm)	Azimuth (degree)	resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m) Note 1	Limits (dBµV/m)	Margin (dB)
4806	P	148	117	1000	V	65.26	73.98*	8.72
4806	Av	148	117	1000	V	15.33	53.98*	38.65
7209	P	137	297	100	V	61.53	69.87	8.34

Channel 40

FREQUENCIES (MHz)	Detector P: Peak QP: Quasi-Peak Av: Average	Antenna height (cm)	Azimuth (degree)	resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m) Note 1	Limits (dBµV/m)	Margin (dB)
4884	P	145	129	1000	V	69.06	73.98*	4.92
4884	Av	145	129	1000	V	18.38	53.98*	35.60
7326	P	222	326	1000	V	66.47	73.98*	7.51
7326	Av	222	326	1000	V	17.40	53.98*	36.58

Channel 79

FREQUENCIES (MHz)	Detector P: Peak QP: Quasi-Peak Av: Average	Antenna height (cm)	Azimuth (degree)	resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m) Note 1	Limits (dBµV/m)	Margin (dB)
4962	P	113	322	1000	V	68.48	73.98*	5.50
4962	Av	113	322	1000	V	16.88	53.98*	37.10
7443	P	138	308	1000	V	72.21	73.98*	1.77
7443	Av	138	308	1000	V	21.06	53.98*	32.92

* restricted bands of operation in 15.205, this limit corresponding at the 15.209 section.

Note 1: All average value were taken using peak detector function with VBW= 10 Hz and the duty cycle correction factor.(see § 15.35; pulsed modulated device)

For average measurements a correction duty cycle is calculated.

Equipment during transmit 666 µs twice in a time interval of 100 ms.

So, the duty cycle correction factor is 20 log $\frac{(2\times 666\times 10^{-6})}{100\times 10^{-3}}$ *=-37.51 dB.*

See curves in annex 2.

Note: any spurious which has more than 20 dB of margin compared to the applicable limit is not necessarily reported.

Applicable limits : In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator 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.

The highest level recorded in a 100 kHz bandwidth is 89.87 dBµV/m on channel 1.
So the applicable limit is 69.87 dBµV/m.
In addition, radiated emissions which fall in the restricted band, as defined in section 15.205 (a), must also comply with the radiated emission limits specified in section 15.209 (a) (see section 15.205 (c)).

TEST CONCLUSION:

RESPECTED STANDARD

10. BAND EDGE COMPLIANCE

Standard: FCC part 15.247

Test procedure: Public Notice DA 00-705, Delta Marker method.

Test equipment used:

TYPE	MANUFACTURER	EMITECH NUMBER
Spectrum analyzer FSP 7	Rohde & Schwarz	6796
Antenna RGA-60	Electrometrics	1204
Multimeter 77-2	Fluke	0812

Test set up:

Test realized in near field. All field strength measurements are correlated with the radiated maximum peak output power.

Test operating condition of the equipment:

The equipment is locked in frequency hopping mode.

Results:

Lower Band Edge: from 2398 MHz to 2400 MHz, Curve N° 1
Upper Band Edge: from 2483.5 MHz to 2485.5 MHz, Curve N° 2

Sample n° 1:

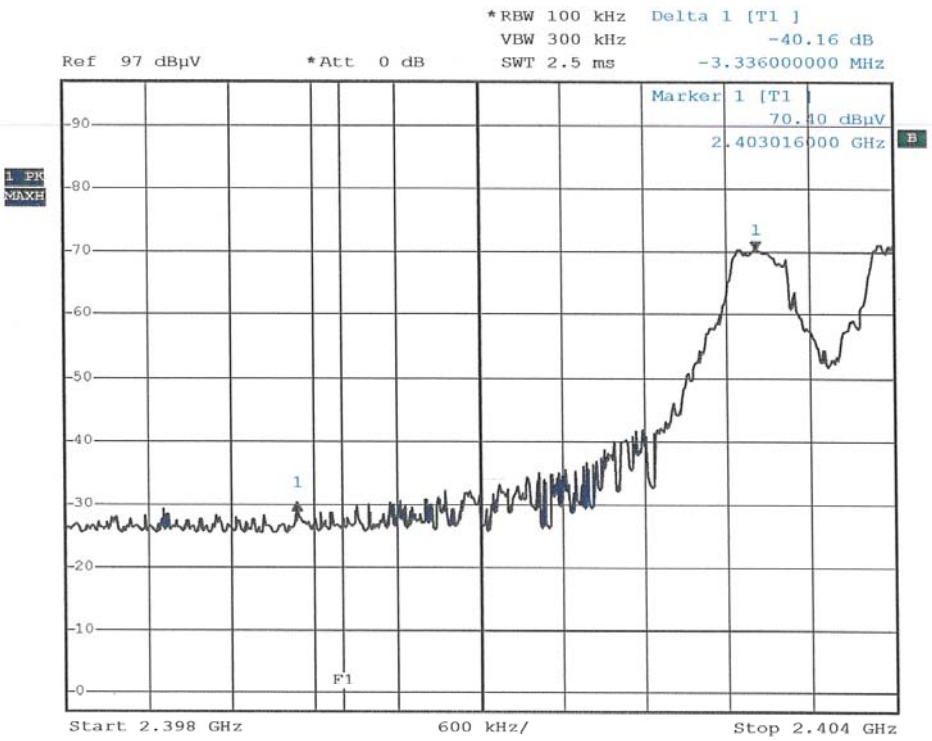
Fundamental Frequency (MHz)	Field Strength Level of fundamental (dBµV/m)	Peak Or Average	Frequency of maximum Band-edges Emission (MHz)	Delta Marker (dB)*	Calculated Max Out of Band Emission Level (dBµV/m)**	Limit (dBµV/m)	Margin (dB)
2403.016	90.19	Peak	2399.680	-40.16	50.03 (1)	73.98	23.95
2480.913	88.93	Peak	2483.881	-37.16	51.77 (1)	73.98	22.21

* According to step 2 of Marker-Delta Method DA 00-705
** According to step 3 of Marker-Delta Method:
Calculated Emission Level = Field Strength Level – Delta Marker Level
(1) the peal level is lower than the average limit (53.98 dBµV/m).

Test conclusion:

RESPECTED PUBLIC NOTICE

CURVE N°: 1.


*RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Delta 1 [T1]
-40.16 dB
-3.336000000 MHz
Ref 97 dBµV
*Att 0 dB
Marker 1 [T1]
70.40 dBµV
2.403016000 GHz
1 PK
MAXH
B
90
80
70
60
50
40
30
20
10
0
1
1
F1
Start 2.398 GHz
600 kHz/
Stop 2.404 GHz
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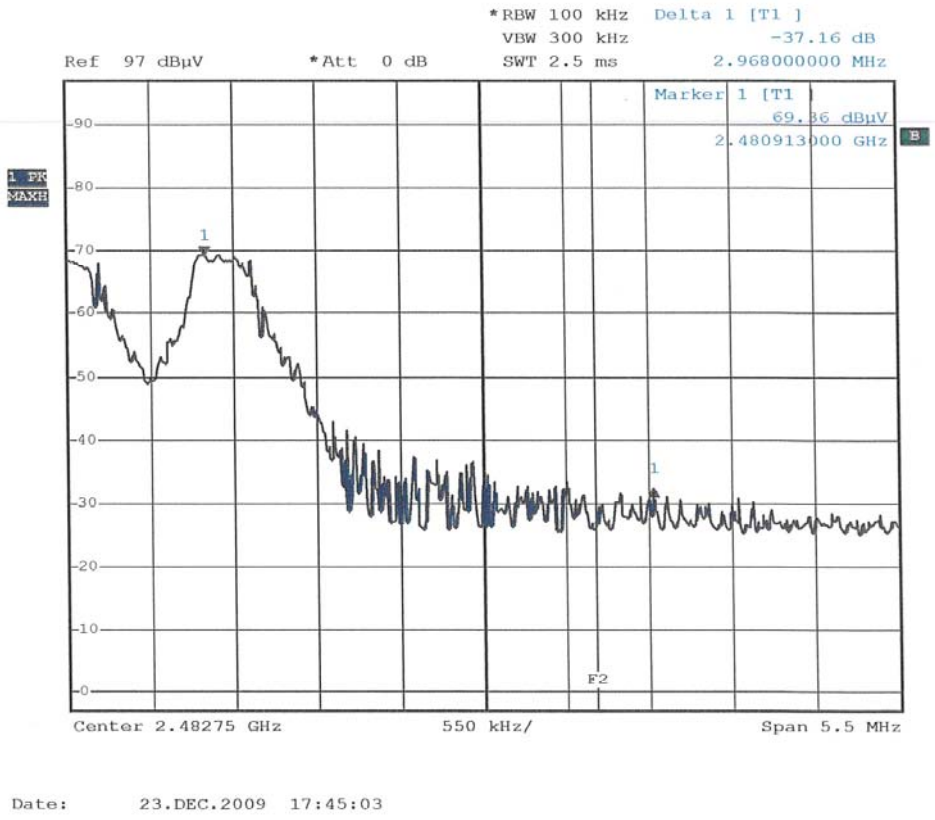
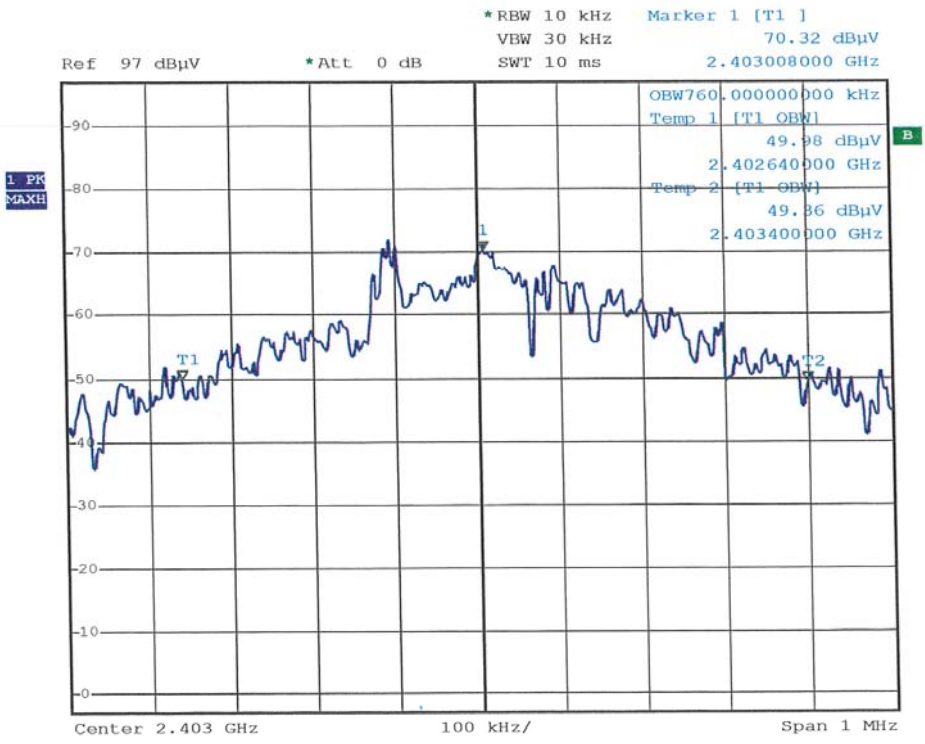
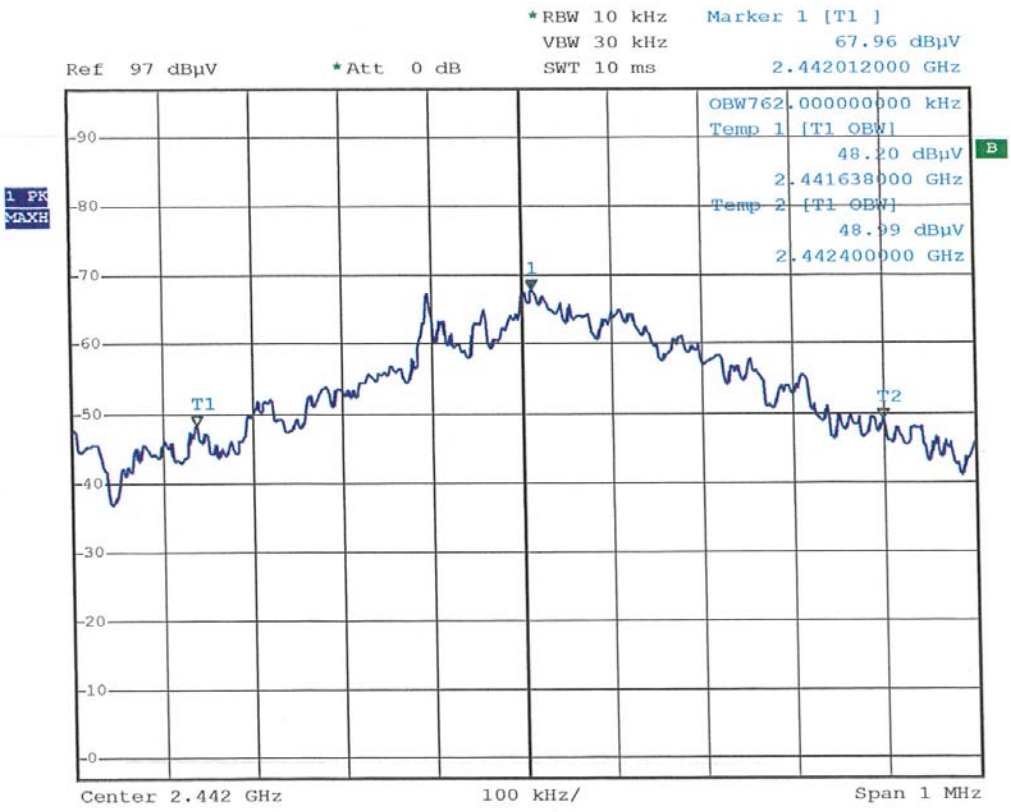
CURVE N°: 2.



□□□ End of report, 5 annexes to be forwarded □□□

ANNEX 1: OCCUPIED POWER BANDWIDTH AND CHANNEL SEPARATION





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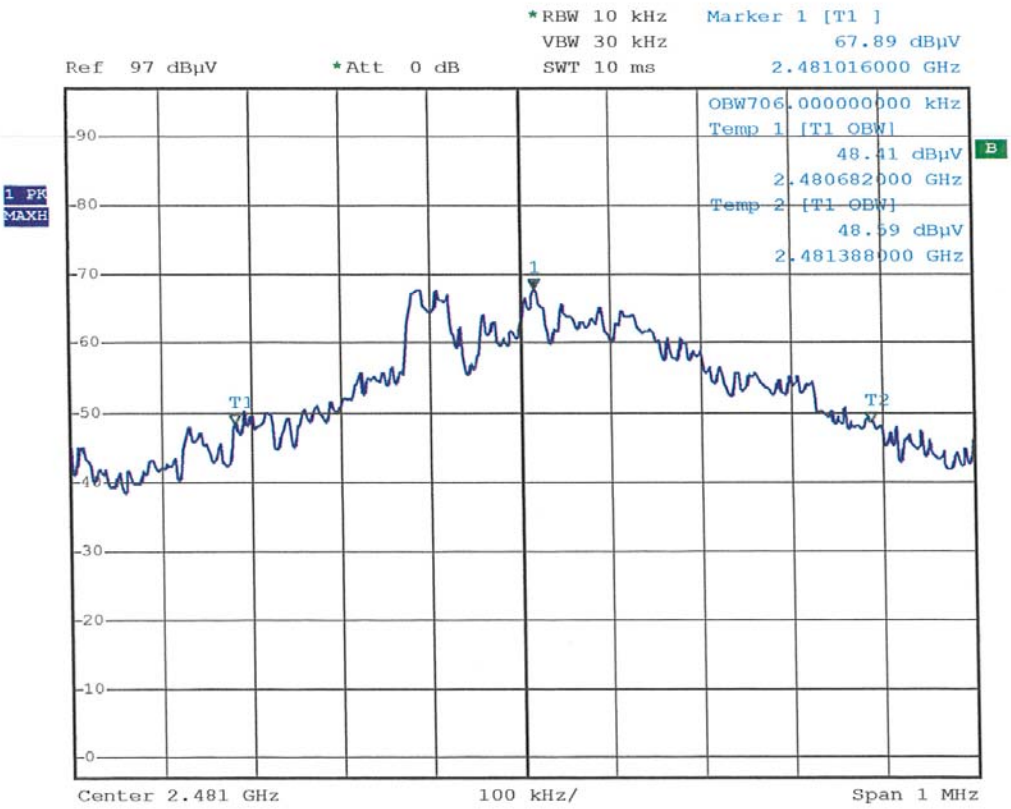

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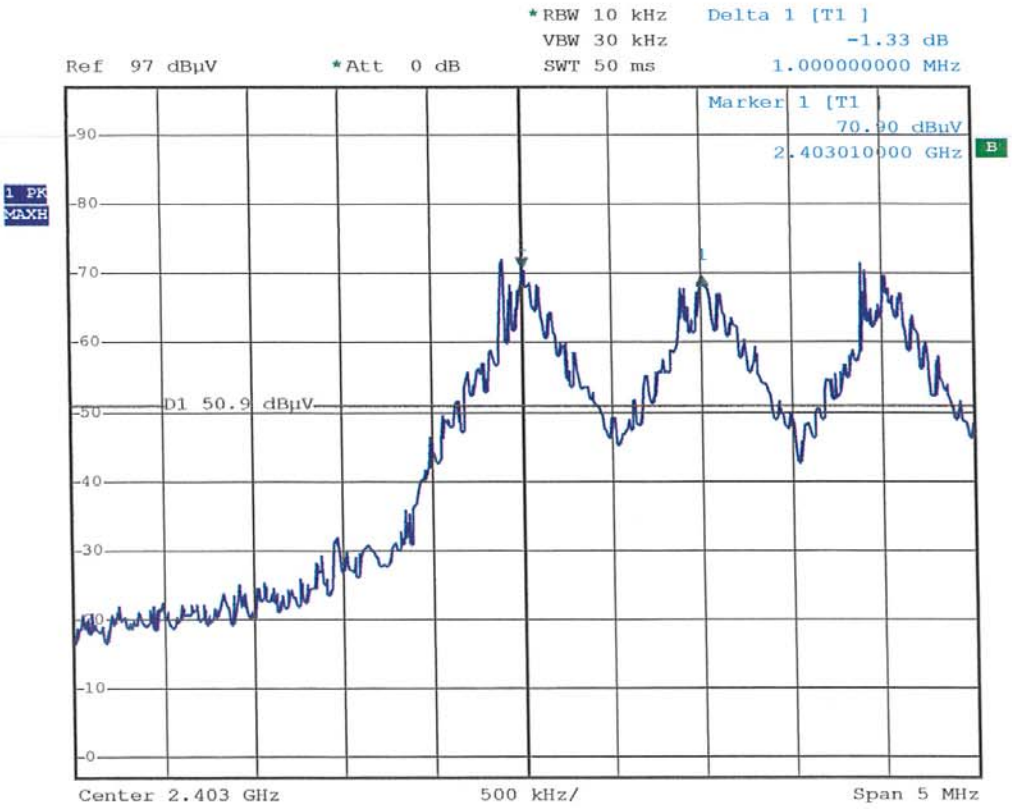

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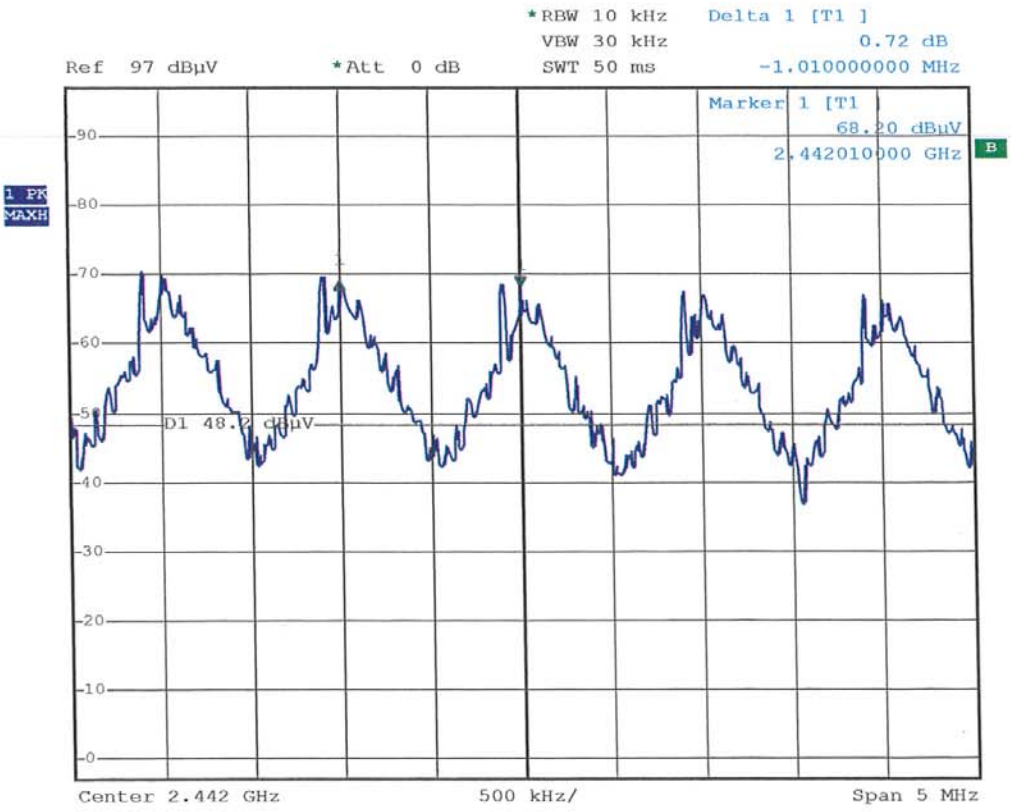

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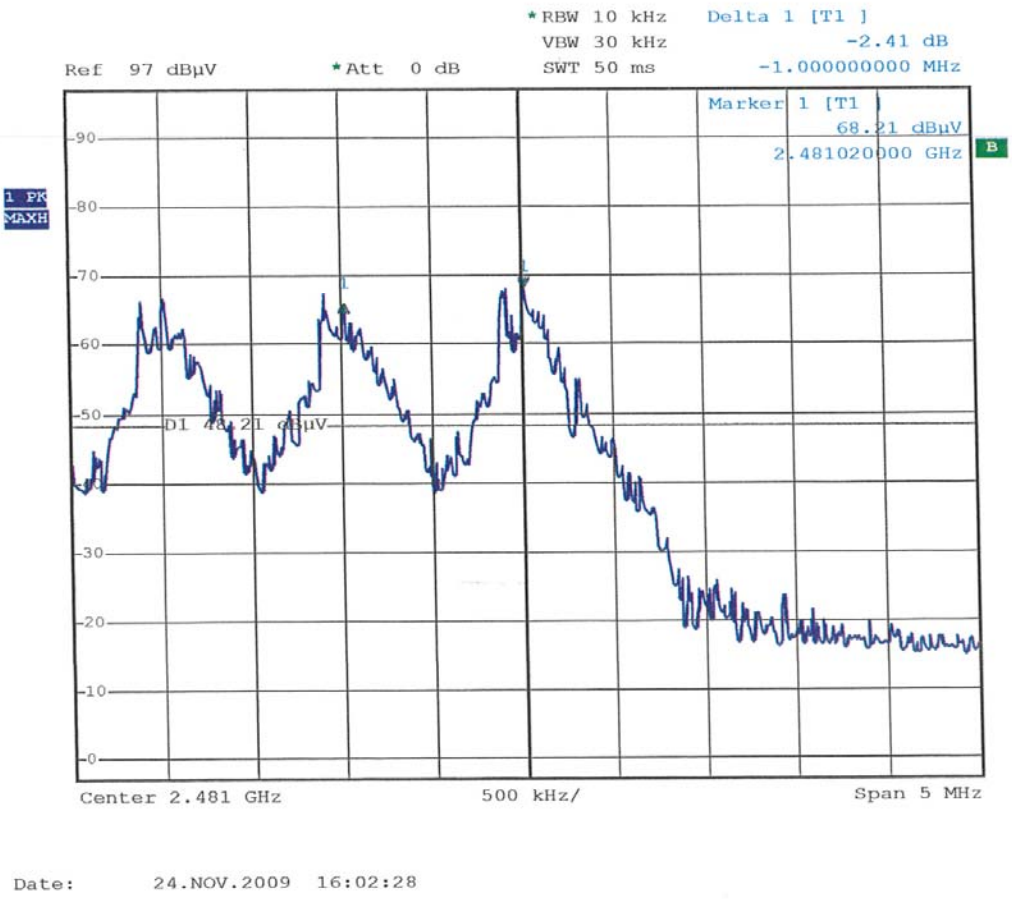
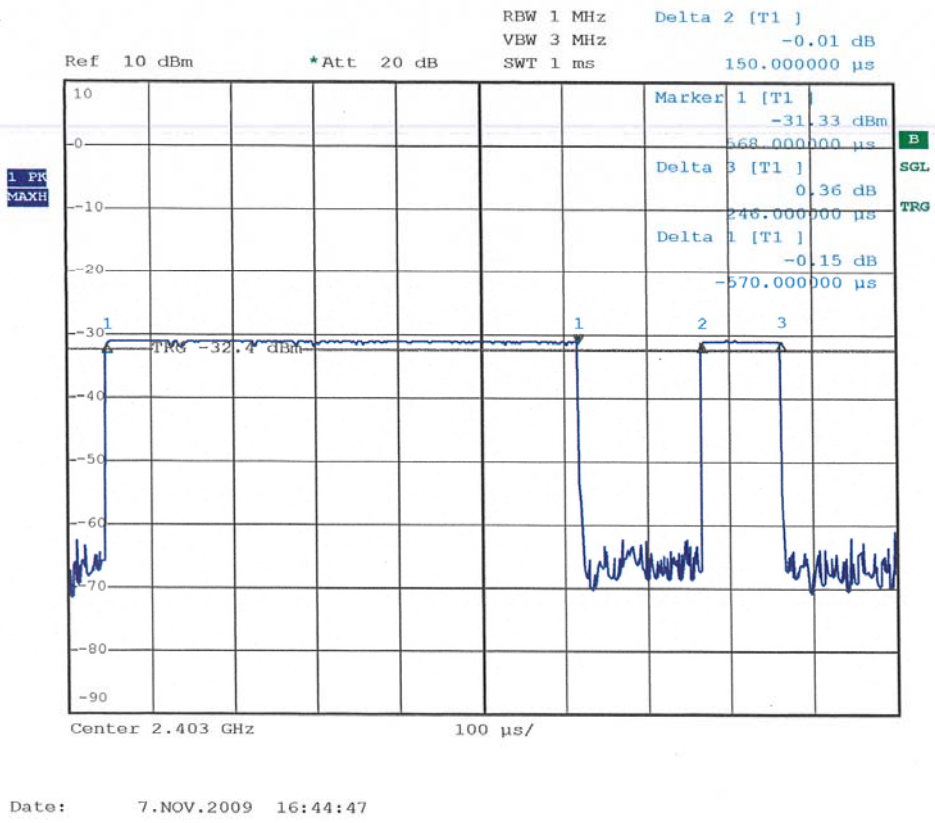
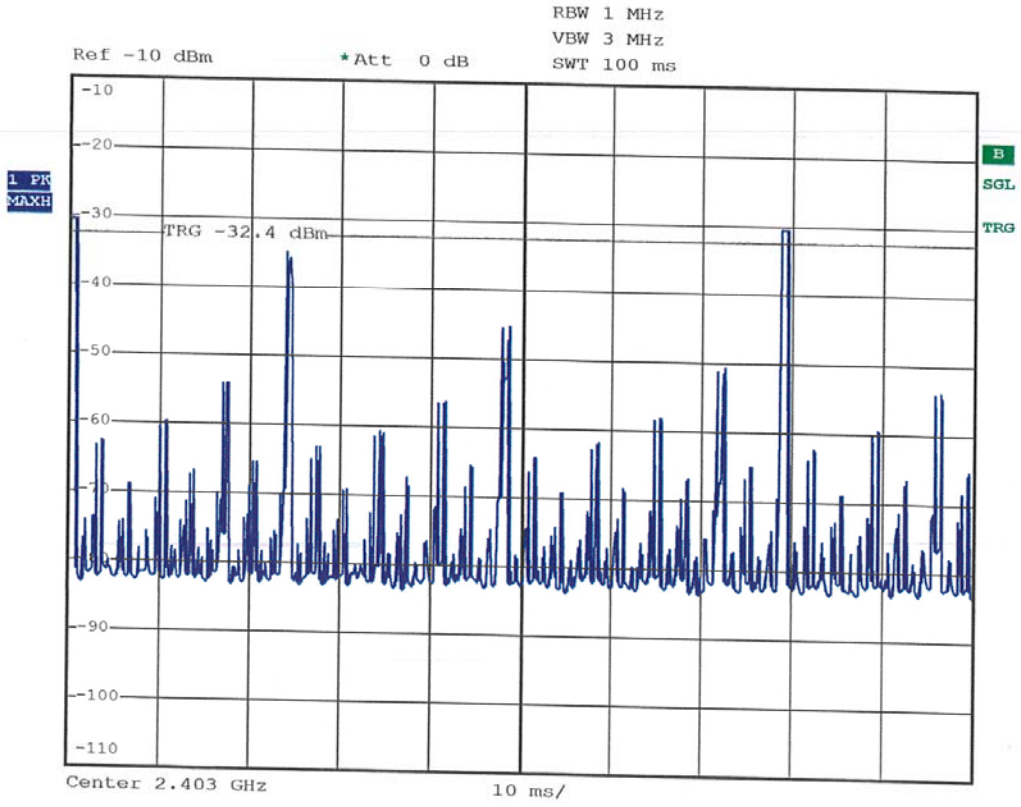

*RBW 10 kHz
VBW 30 kHz
SWT 50 ms
Delta 1 [T1]
-2.41 dB
-1.000000000 MHz
Ref 97 dBµV
*Att 0 dB
Marker 1 [T1]
68.21 dBµV
2.481020000 GHz
B
1 PK
MAXH
90
80
70
60
50
D1 68.21 dBµV
30
20
10
0
Center 2.481 GHz
500 kHz/
Span 5 MHz
Date: 24.NOV.2009 16:02:28

ANNEX 2: AVERAGE TIME OF OCCUPANCY ON ANY FREQUENCY





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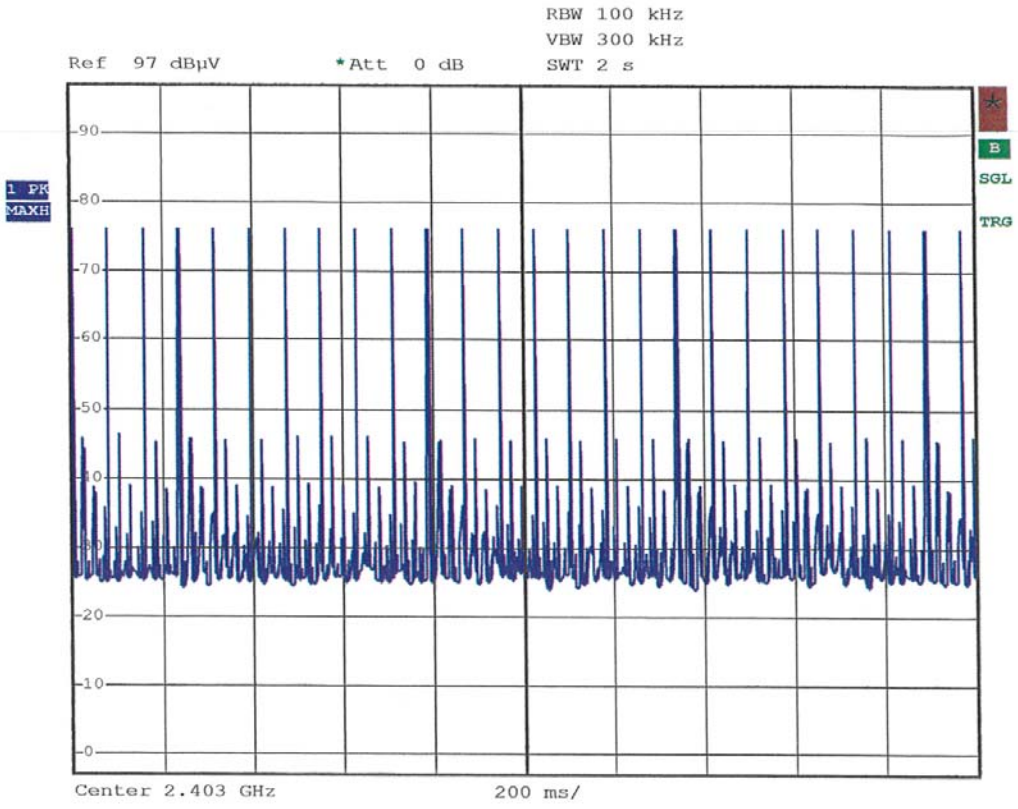

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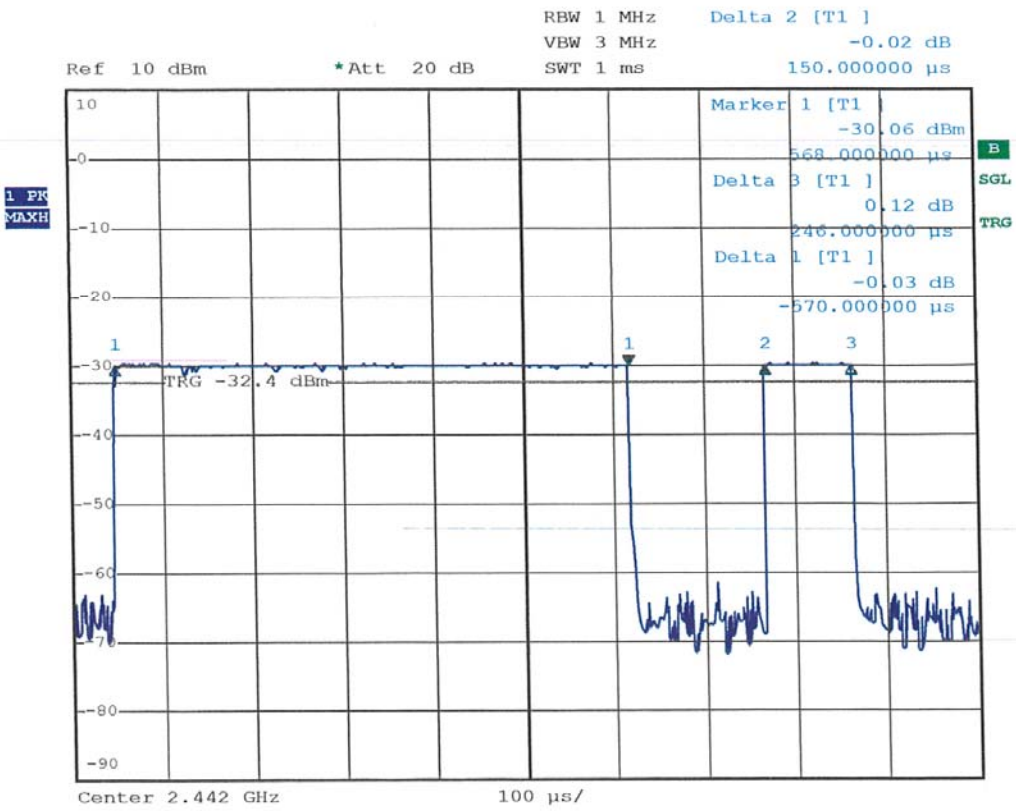
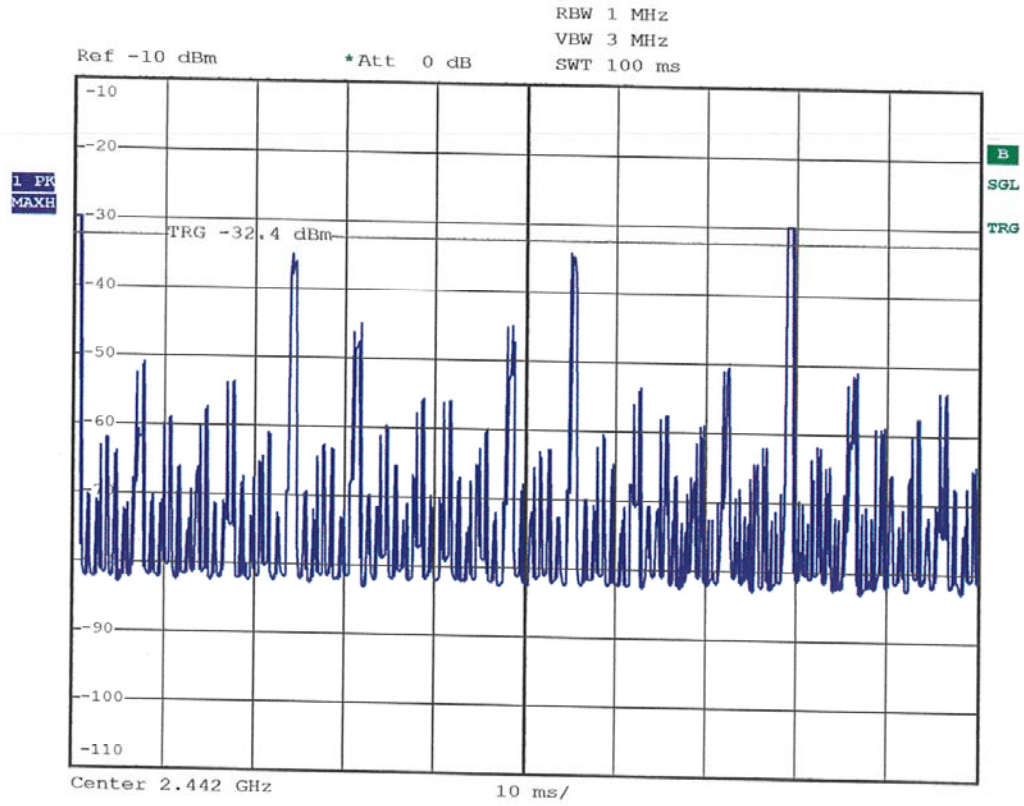

RBW 1 MHz
VBW 3 MHz
SWT 1 ms
Delta 2 [T1]
-0.02 dB
150.000000 µs
Ref 10 dBm
*Att 20 dB
Marker 1 [T1]
-30.06 dBm
568.000000 µs
Delta 3 [T1]
0.12 dB
246.000000 µs
Delta 1 [T1]
-0.03 dB
-570.000000 µs
1 PK
MAXH
B
SGL
TRG
TRG -32.4 dBm
Center 2.442 GHz
100 µs/
Date: 7.NOV.2009 16:42:53



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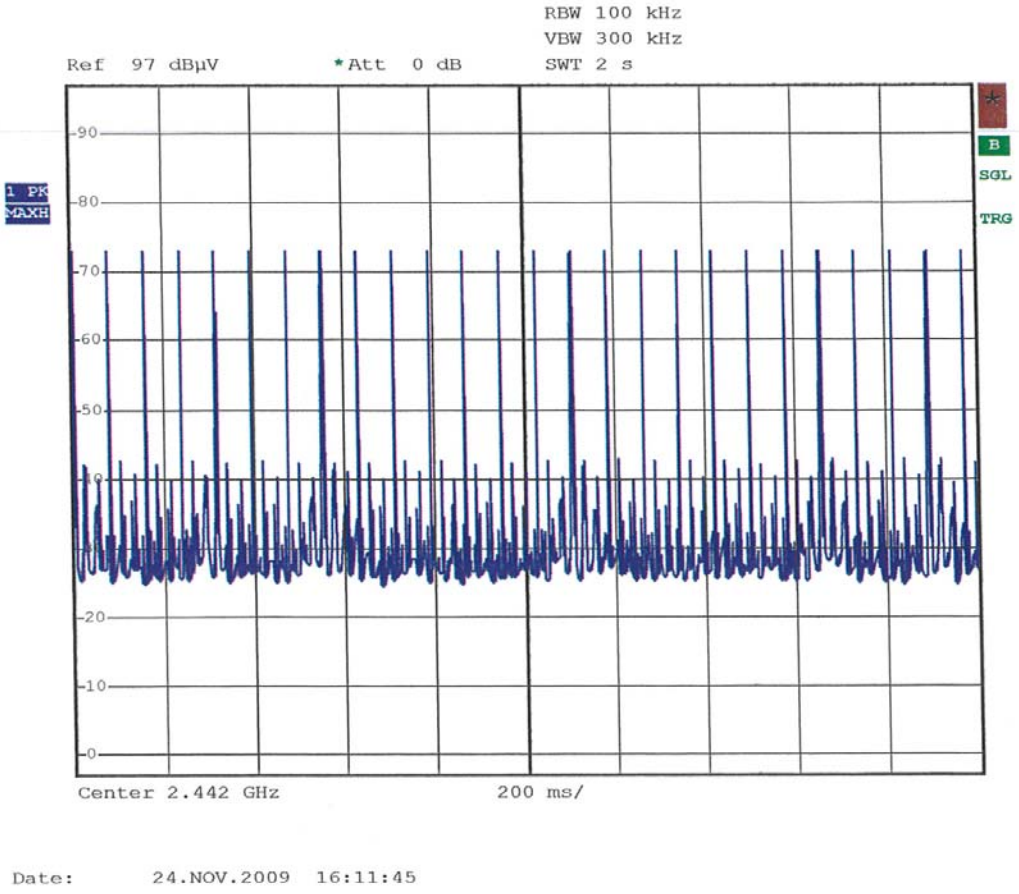
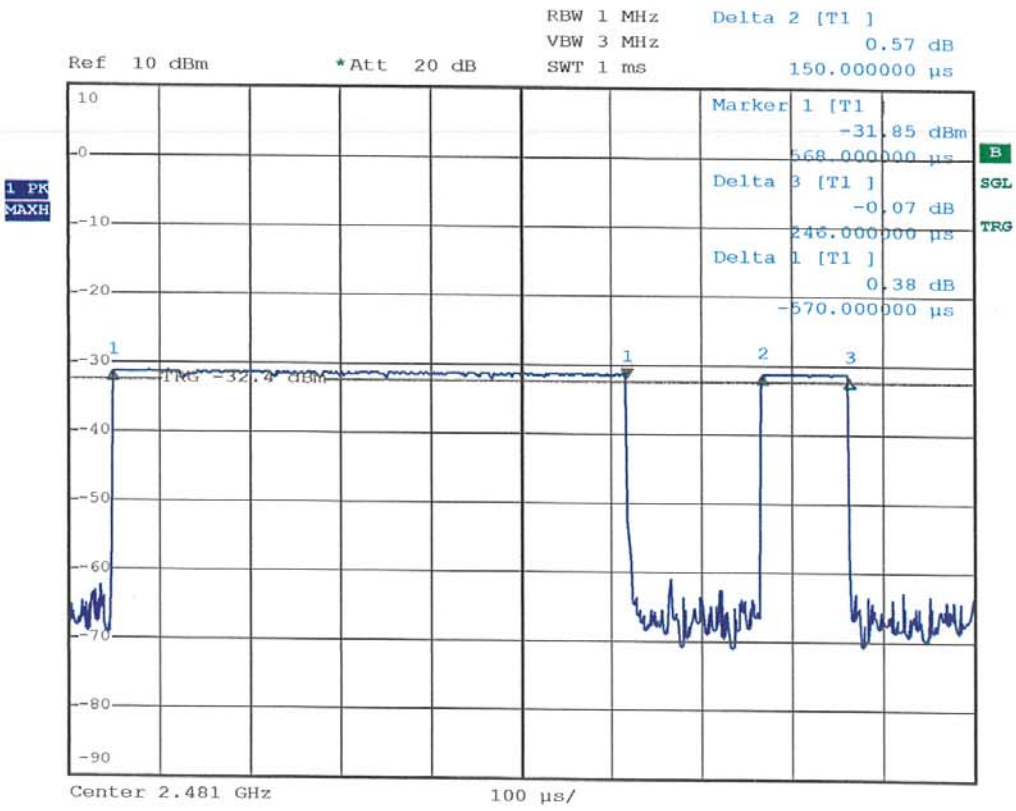
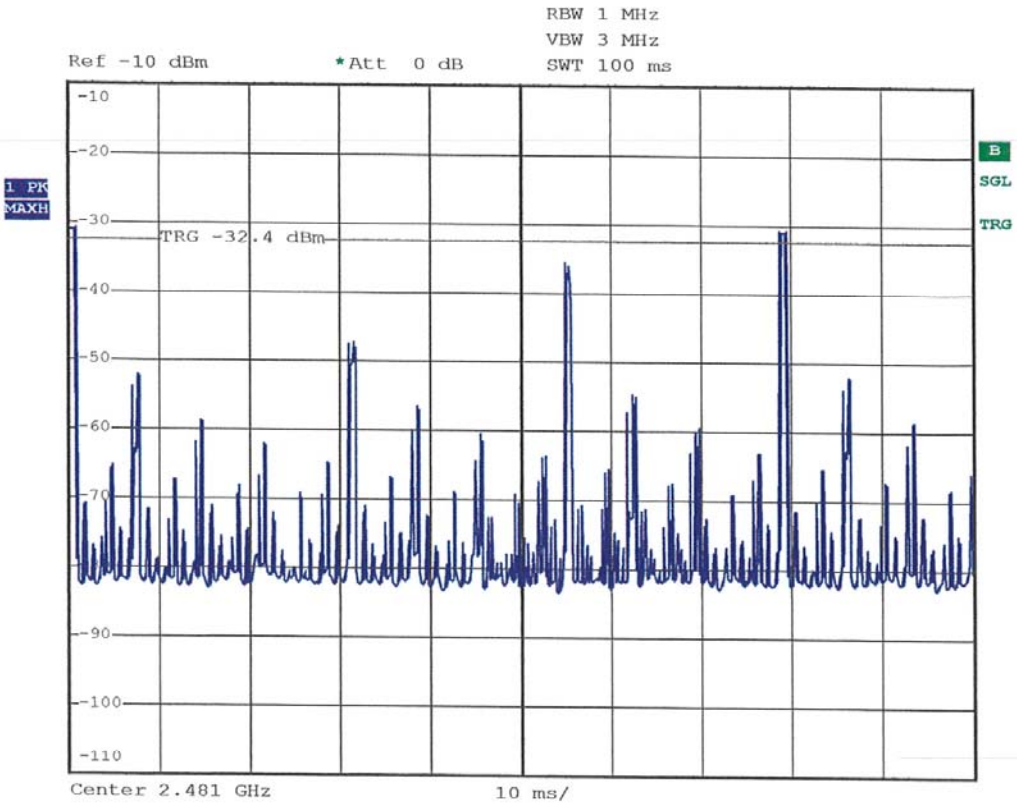
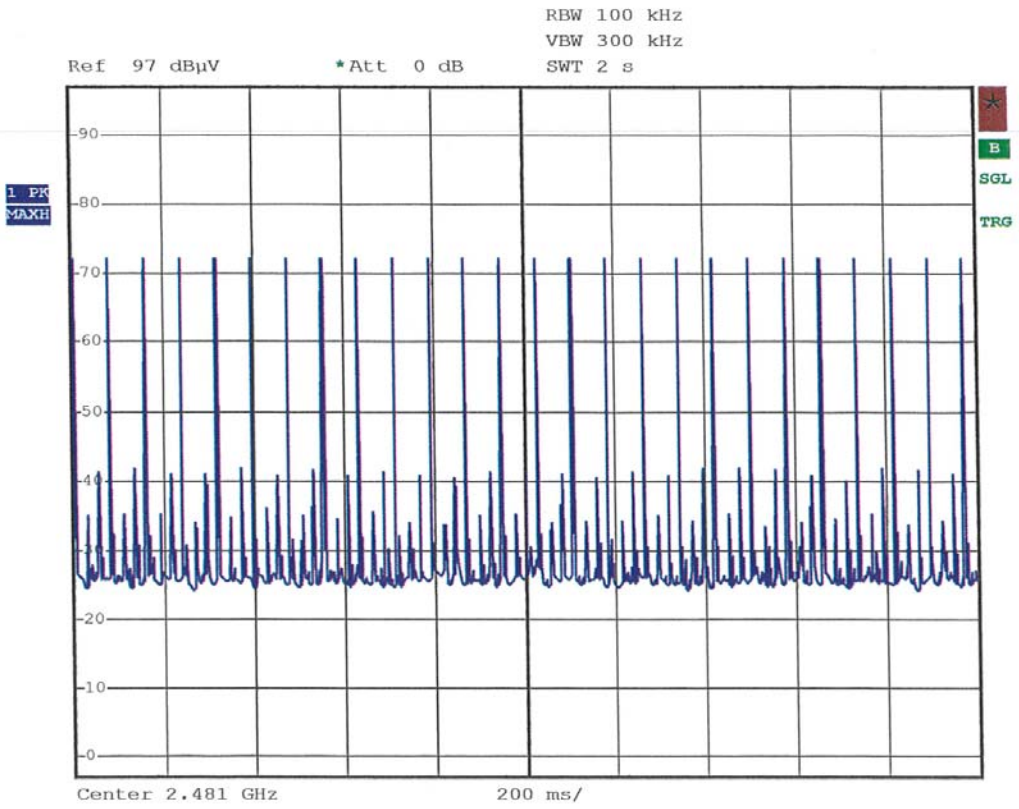

RBW 100 kHz
VBW 300 kHz
Ref 97 dBµV
*Att 0 dB
SWT 2 s
1 PK
MAXH
B
SGL
TRG
-90
-80
-70
-60
-50
-40
-30
-20
-10
-0
Center 2.442 GHz
200 ms/
Date: 24.NOV.2009 16:11:45


RBW 1 MHz
VBW 3 MHz
SWT 1 ms
Delta 2 [T1]
0.57 dB
150.000000 µs
Ref 10 dBm
*Att 20 dB
Marker 1 [T1
-31.85 dBm
568.000000 µs
Delta 3 [T1]
-0.07 dB
246.000000 µs
Delta 1 [T1]
0.38 dB
-570.000000 µs
1 PK
MAXH
B
SGL
TRG
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
TRG -32.4 dBm
Center 2.481 GHz
100 µs/
Date: 7.NOV.2009 16:46:38

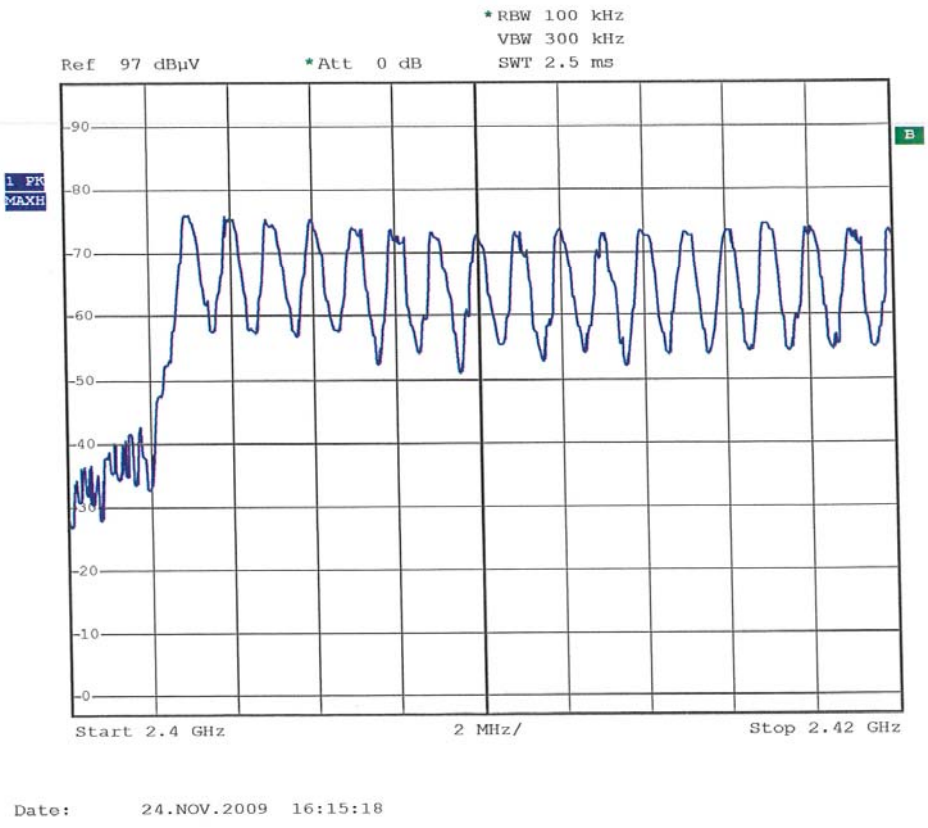


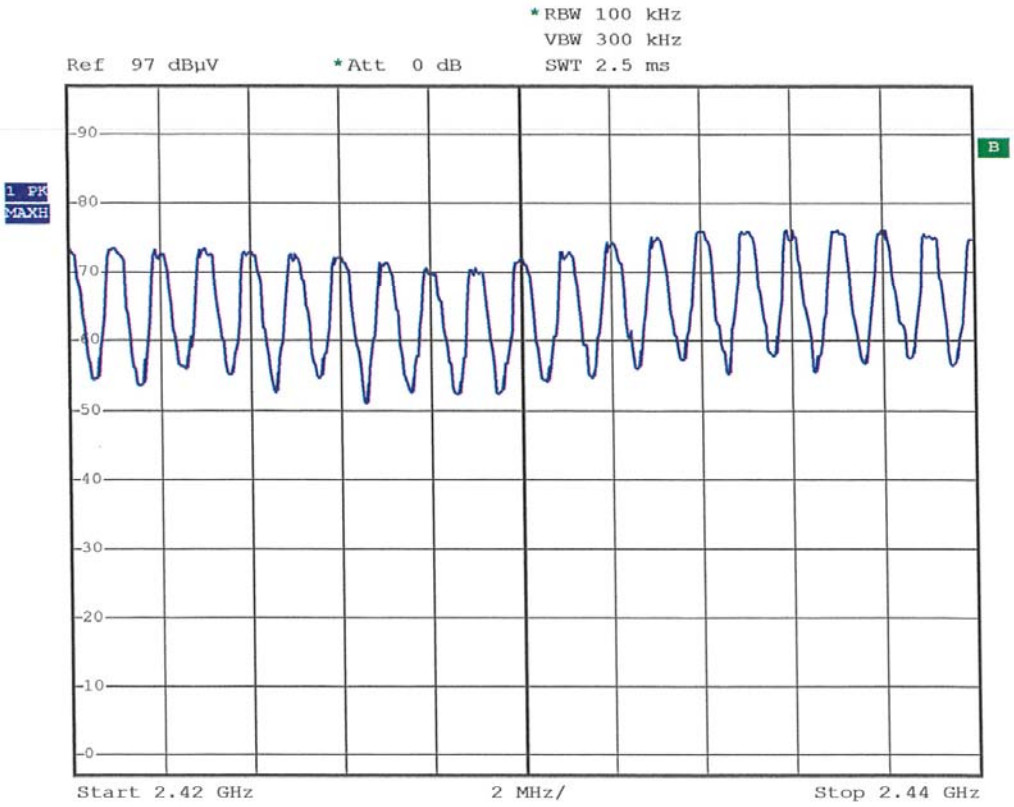
Date: 7.NOV.2009 16:48:38



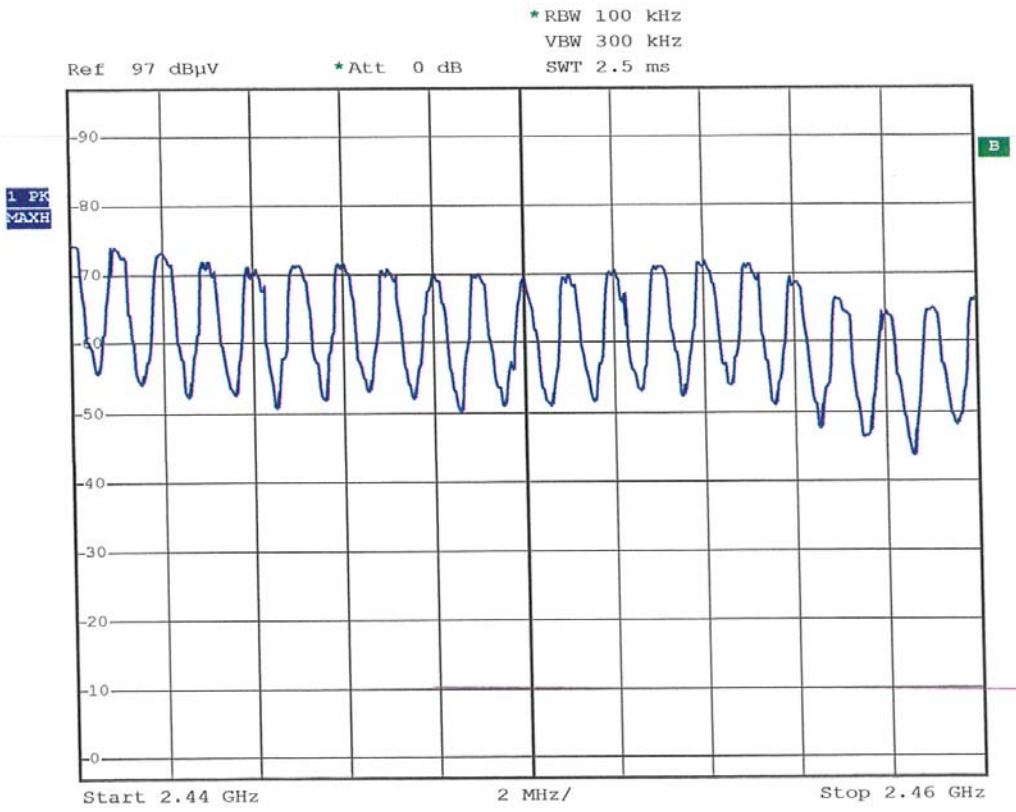
Date: 24.NOV.2009 16:13:18

ANNEX 3: NUMBER OF HOPPING FREQUENCIES

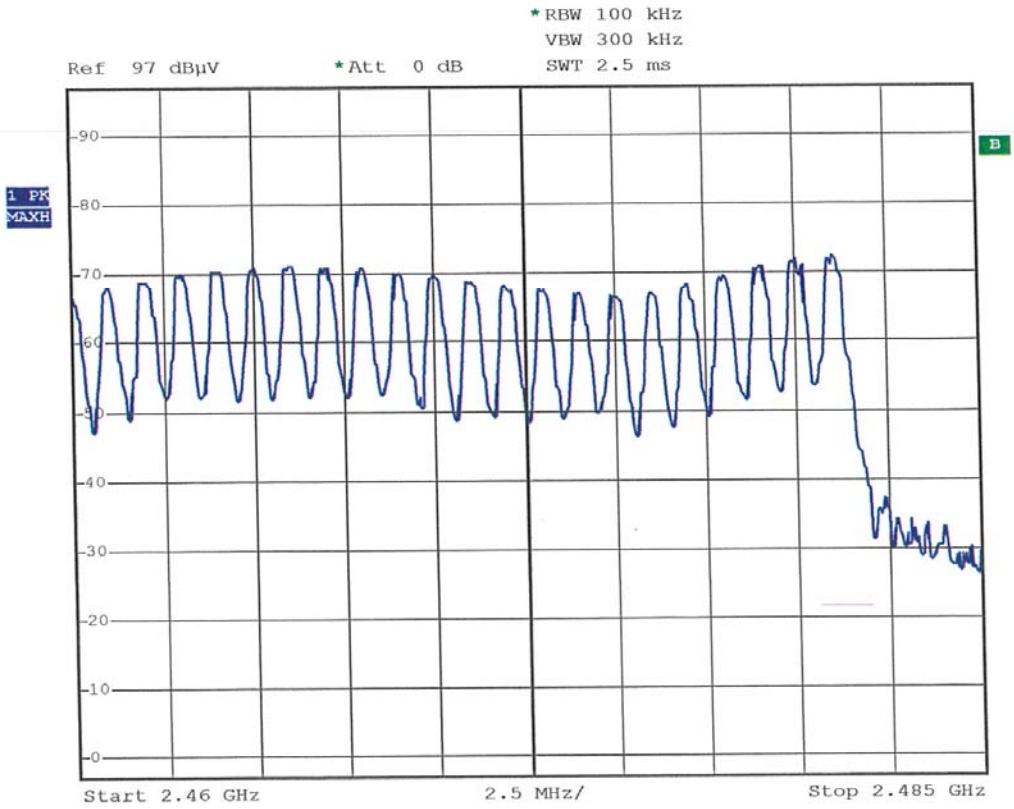




Date: 24.NOV.2009 16:16:50



Date: 24.NOV.2009 16:18:19

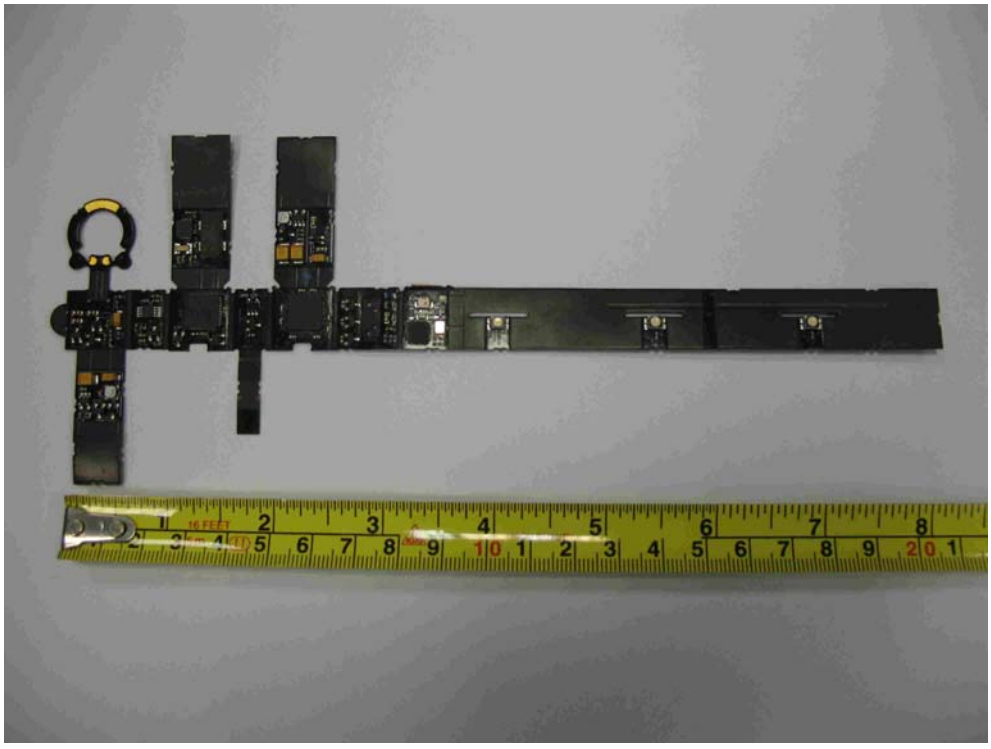


Date: 24.NOV.2009 16:19:54

ANNEX 4: PHOTOS OF THE EQUIPMENT UNDER TEST

GENERAL VIEW

Printed circuit board: face 1



Printed circuit board: face 2

ANNEX 5: TEST SET UP AND OPEN AREA TEST SITE