RA-24-07103789-1/A Ed. 0

FCC CERTIFICATION
RADIO Measurement
Technical Report

standard to apply:
FCC Part 15.247

Equipment under test:
BLUETOOTH PAYMENT TERMINAL
I7780

FCC ID :
T8D-I7780

Company:
INGENICO BARCELONA SA

DISTRIBUTION: Mr DE LA TORRE **Company: INGENICO BARCELONA SA**

Number of pages: 34 including 5 annexes

Ed.	Date	Modified pages	Written by Name	Visa	Technical Verification Quality Approval Name	Visa
0	2-Nov-07	Creation	L. BERTHAUD	LB	P. BONNENFANT	

PRODUCT:	**BLUETOOTH PAYMENT TERMINAL**
Reference / model:	I7780
Serial number:	not communicated
MANUFACTURER:	not communicated

COMPANY SUBMITTING THE PRODUCT:

Company:	INGENICO BARCELONA SA
Address:	Avda. Via Augusta 71-73 08174 SANT CUGAT DEL VALLES BARCELONA SPAIN
Responsible:	Mr DE LA TORRE
DATE(S) OF TEST:	26 to 29 September 2007
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:	L. BERTHAUD M. DUMESNIL

CONTENTS

TITLE **PAGE**

1. INTRODUCTION

This document presents the result of RADIO test carried out on the following equipment: BLUETOOTH PAYMENT TERMINAL I7780 in accordance with normative reference.

2. PRODUCT DESCRIPTION

ITU Emission code: 1M00F7D

Class: A (commercial, industrial or business environment)

Utilization: payment terminal with Bluetooth function

Antenna type: incorporated antenna

Operating frequency range: from 2402 MHz to 2480 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: Li-Ion battery (1 × 7.4 V)

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 (2006)	Code of Federal Regulations Title 47 - Telecommunication Chapter 1 - Federal Communications Commission Part 15 - Radio frequency devices Subpart C - Intentional Radiators
ANSI C63.4 (2003)	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 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

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 BANDS 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				
	(e) *peak power spectral density*			X		
	(f) *hybrid system*			X		
	(g)	X				
	(h)	X				
	(i) *RF exposure compliance*	X				*Note 7*
DA 00-705	BAND EDGE COMPLIANCE	X				

NAp: Not Applicable NAs: Not Asked

Note 1: dedicated 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: 803.6 kHz (see annex 1).

Note 4: the frequency hopping system uses 79 channels (see annex 3).
The timing by channel is 418.8 µs. During 79 channels x 0.4 s (part 15) = 31.6 s, any channel is used 320 times, then 320 x 418.8 µs = 134.02 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: 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).

Conclusion:

The sample of BLUETOOTH PAYMENT TERMINAL I7780 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. PEAK OUTPUT POWER

Standard: FCC Part 15

Test procedure: paragraph 15.247

Test equipment:

TYPE	BRAND	EMITECH NUMBER
Spectrum analyzer FSEA	Rohde & Schwarz	5071
Diode detector ODZ0004A	Omniyig	2469
Oscilloscope THS 720	Tektronix	0940
Antenna RGA60	Electrometrics	1938
Antenna RGA60	Electrometrics	1204
Open site	EMITECH	1274
Radio frequency generator SME06	Rohde & Schwarz	1669
High pass filter HPM11630	Micro-tronics	1673
Low-noise amplifier 1 to 18 GHz	ALC	2648
Power meter 8541B	Gigatronics	3479
Power sensor 80401A	Gigatronics	3182
Multimeter 77-2	Fluke	0812

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 and substitution method. 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.

The spectrum analyzer is first replaced by a diode detector which is connected to the vertical channel of an oscilloscope.
The equipment under test is then substituted by a signal generator with a calibrated double ridged guide antenna, and its level adjusted such that the deviation of the Y-trace of the oscilloscope reaches the level obtained with the E.U.T.
The output power level of the signal generator is finally measured with a calibrated RF power meter.

Then 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): 23
Relative humidity (%): 65

We used for power source the internal battery of the equipment and we noted:

Voltage at the beginning of test (V): 7.42
Voltage at the end of test (V): 7.36
Percentage of the voltage drop during the test (%): 0.8

Polarization of test antenna: horizontal (height: 216 cm)
Position of equipment: flat position (azimuth: 177 degrees)

Sample n° 1 Hopping mode

		Peak Output Power radiated at these frequencies (W): from 2402 MHz to 2480 MHz	**Limits (W)**
Normal test conditions	Nominal power source (V): 7.4	10.209×10^{-3}	1*

* the frequency hopping system uses at least 75 hopping channels.

Sample n° 1 Channel 1

		Level dBµV	**Cable loss dB**	**Antenna factor dB**	**Electro-magnetic field (dBµV/m):**	**P* (W)**
Normal test conditions	Nominal power source (V): 7.4	70.48	4.62	28.9	104	4.567×10^{-3}

Sample n° 1 Channel 40

		Level dBµV	**Cable loss dB**	**Antenna factor dB**	**Electro-magnetic field (dBµV/m):**	**P* (W)**
Normal test conditions	Nominal power source (V): 7.4	70.87	4.65	29	104.52	5.148×10^{-3}

Sample n° 1 Channel 79

		Level dBµV	**Cable loss dB**	**Antenna factor dB**	**Electro-magnetic field (dBµV/m):**	**P* (W)**
Normal test conditions	Nominal power source (V): 7.4	72.32	4.68	29.14	106.14	7.475×10^{-3}

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

Test conclusion:

RESPECTED STANDARD

8. RADIATED EMISSION OF TRANSMITTER

Standard: FCC Part 15

Test procedure: paragraph 15.205
paragraph 15.209
paragraph 15.247

Test equipment:

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
Low-noise amplifier 18 to 26 GHz	ALC	3036
Multimeter 77-2	Fluke	0812

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

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.

Results:

Ambient temperature (°C): 23
Relative humidity (%): 69

We used for power source the internal battery of the equipment and we noted:

Voltage at the beginning of test (V): 7.44
Voltage at the end of test (V): 7.31
Percentage of the voltage drop during the test (%): 1.7

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

Channel 1

FREQUENCIES (MHz)	Detector QP: Quasi-Peak Avg: Average Pk: Peak	Antenna height (cm)	Azimuth (degree)	Resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m)	Limits (dBµV/m)	Margin (dB)
235.91	QP	100	264	120	H	40.6	85.86	45.26
412.88	QP	107	86	120	H	41.6	85.86	44.26
432	QP	261	255	120	H	35	85.86	50.86
455.99	QP	204	250	120	H	39.6	85.86	46.26
471.87	QP	114	190	120	V	35.2	85.86	50.66
480	QP	215	90	120	H	39	85.86	46.86
589.80	QP	168	40	120	H	41	85.86	44.86
4804	Pk	130	41	1000	H	31.89	73.98*	42.09
4804	Avg	130	41	1000	H	18.76	53.98*	35.22
7206	Pk	196	0	100	V	36.94	85.86	48.92

Channel 40

FREQUENCIES (MHz)	Detector QP: Quasi-Peak Avg: Average Pk: Peak	Antenna height (cm)	Azimuth (degree)	Resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m)	Limits (dBµV/m)	Margin (dB)
235.91	QP	100	264	120	H	40.6	85.86	45.26
412.88	QP	107	86	120	H	41.6	85.86	44.26
432	QP	261	255	120	H	35	85.86	50.86
455.99	QP	204	250	120	H	39.6	85.86	46.26
471.87	QP	114	190	120	V	35.2	85.86	50.66
480	QP	215	90	120	H	39	85.86	46.86
589.80	QP	168	40	120	H	41	85.86	44.86
4882	Pk	100	188	1000	V	34.92	73.98*	39.06
4882	Avg	100	188	1000	V	19.17	53.98*	34.81
7323	Pk	229	0	1000	V	37.5	73.98*	36.48
7323	Avg	229	0	1000	V	21.67	53.98*	32.31

Channel 79

FREQUENCIES (MHz)	Detector QP: Quasi-Peak Avg: Average Pk: Peak	Antenna height (cm)	Azimuth (degree)	Resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m)	Limits (dBµV/m)	Margin (dB)
235.91	QP	100	264	120	H	40.6	85.86	45.26
412.88	QP	107	86	120	H	41.6	85.86	44.26
432	QP	261	255	120	H	35	85.86	50.86
455.99	QP	204	250	120	H	39.6	85.86	46.26
471.87	QP	114	190	120	V	35.2	85.86	50.66
480	QP	215	90	120	H	39	85.86	46.86
589.80	QP	168	40	120	H	41	85.86	44.86
4960	Pk	106	68	1000	V	34.39	73.98*	39.59
4960	Avg	106	68	1000	V	19.11	53.98*	34.87
7440	Pk	242	0	1000	V	35.06	73.98*	38.92
7440	Avg	242	0	1000	V	21.69	53.98*	32.29

* restricted bands of operation.

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 105.86 dBµV/m on channel 79.

So the applicable limit is **85.86 dBµV/m**.

In addition, radiated emissions which fall in 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

9. 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 40	Rohde & Schwarz	4088
Antenna RGA-60	Electrometrics	1204

Test set up:

The measure is realized in near field.
The field strength levels are correlated with the electromagnetic fields measured at 3 m.

Test operating condition of the equipment:

The equipment is blocked in frequency hopping mode.

Results:

Lower Band Edge: from 2310 MHz to 2390 MHz, CURVE n° 1
Upper Band Edge: from 2483.5 MHz to 2500 MHz, CURVE n° 2

Sample n°1:

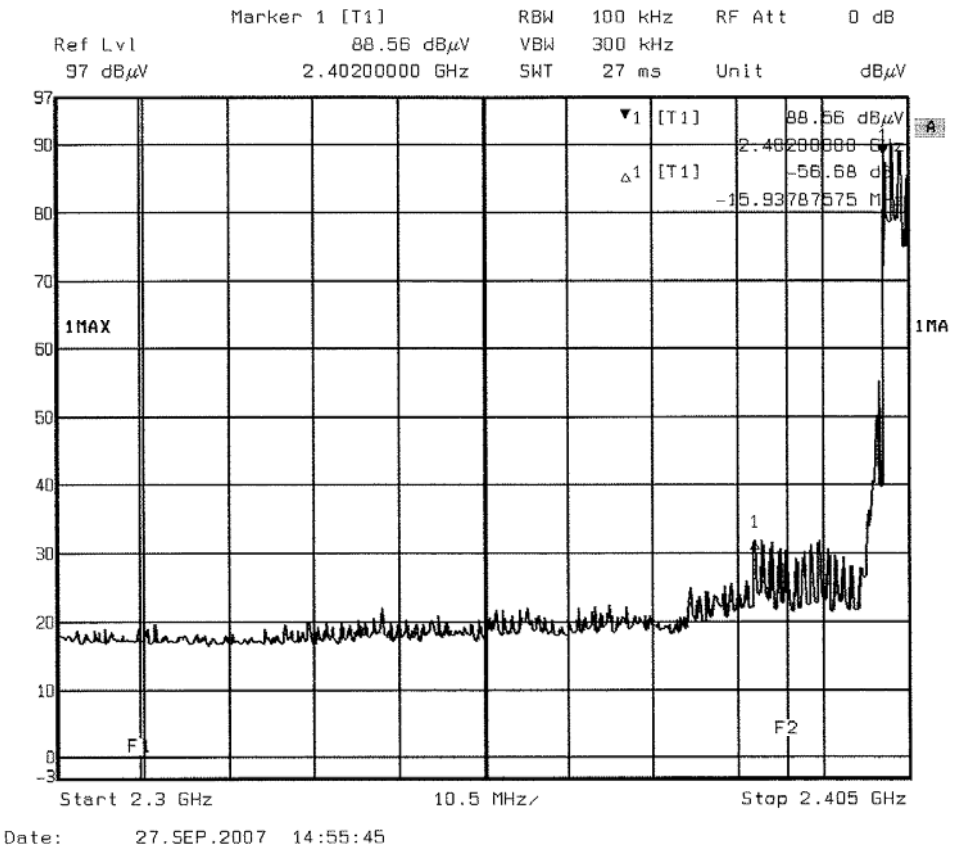
Fundamental frequency (MHz)	Field Strength Level of fundamental (dBµV/m)	Detector (Peak or Average)	Frequency of maximum Band-edges Emission (MHz)	Delta Marker (dB)*	Calculated Max Out of Band Emission Level (dBµV/m)**	Limit (dBµV/m)	Margin (dB)
2402	104	Peak	2386.06	-56.68	47.32(1)	73.98	26.66
2480	106.14	Peak	2487.75	-61.9	44.24(1)	73.98	29.74

* 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 peak level is lower than the average limit (53.98 dBµV/m).

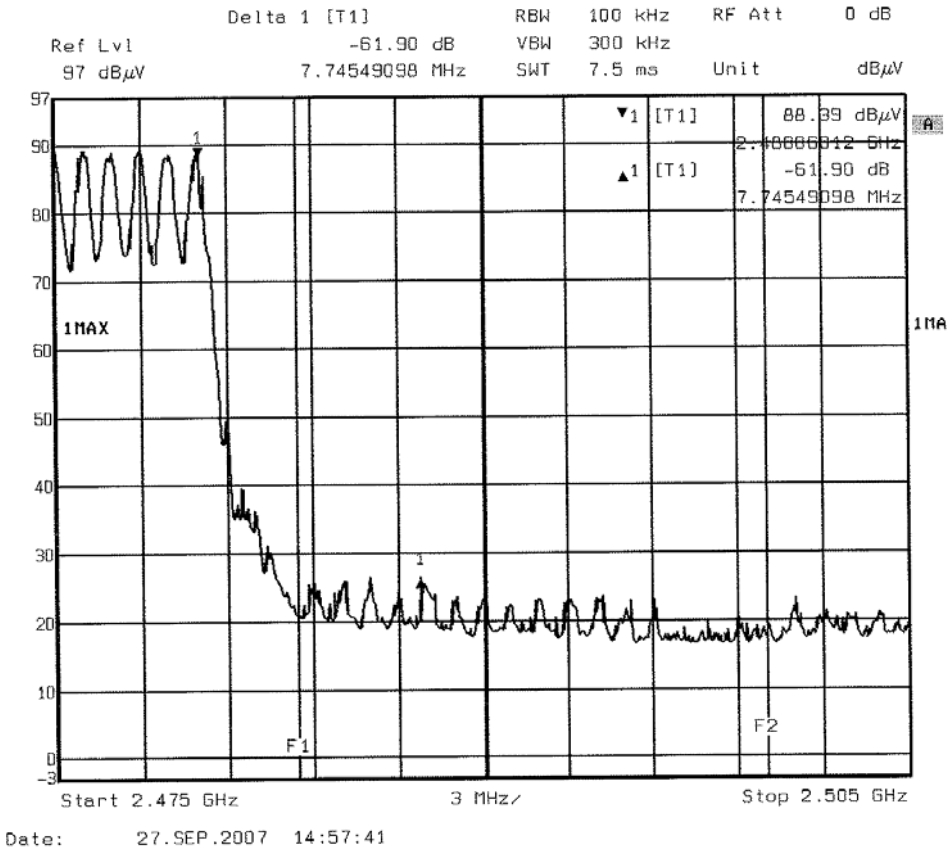
Test conclusion:

RESPECTED PUBLIC NOTICE

CURVE N° 1.

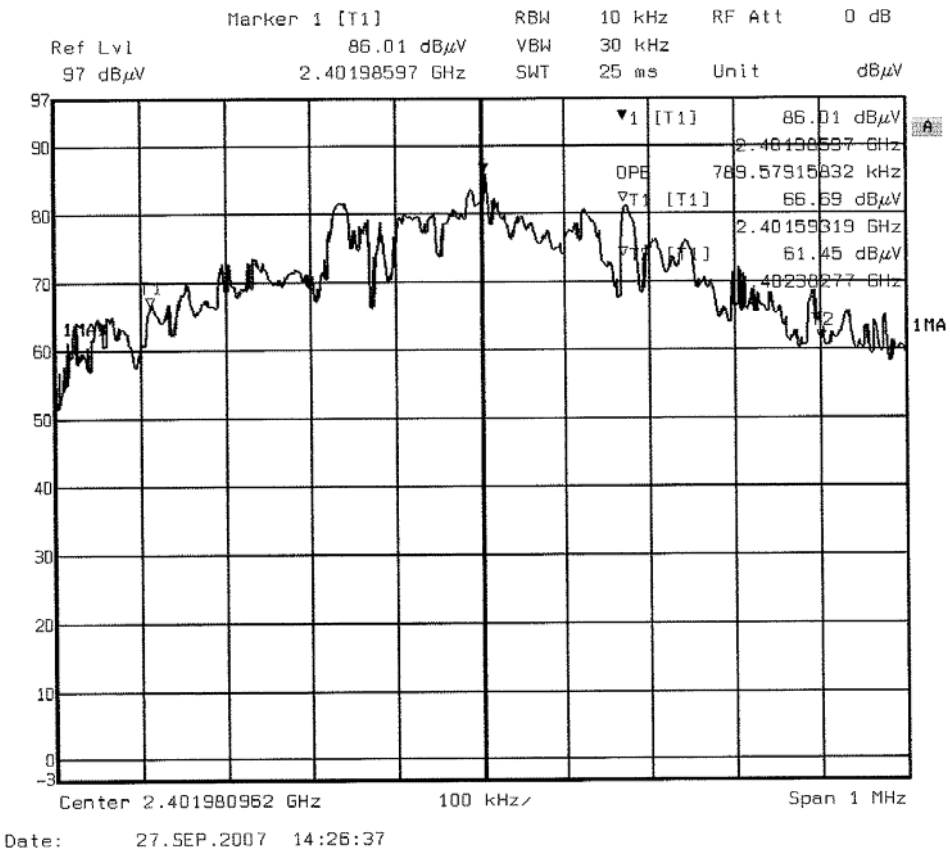

Marker 1 [T1]
RBW 100 kHz
RF Att 0 dB
Ref Lvl
88.56 dBµV
VBW 300 kHz
97 dBµV
2.40200000 GHz
SWT 27 ms
Unit dBµV
1 [T1]
88.56 dBµV
2.40200000 GHz
Δ1 [T1]
-56.68 dB
-15.93787575 MHz
1MAX
1MA
F1
F2
Start 2.3 GHz
10.5 MHz/
Stop 2.405 GHz
Date: 27.SEP.2007 14:55:45

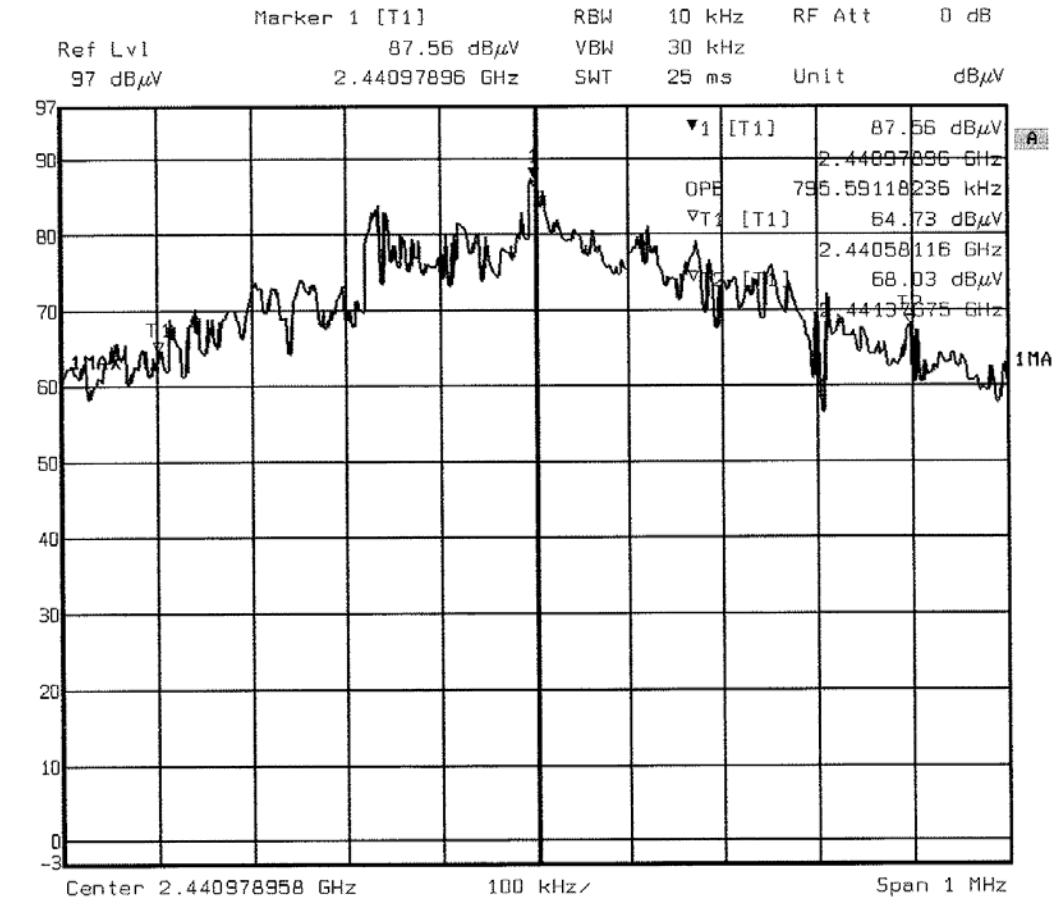
CURVE N° 2.

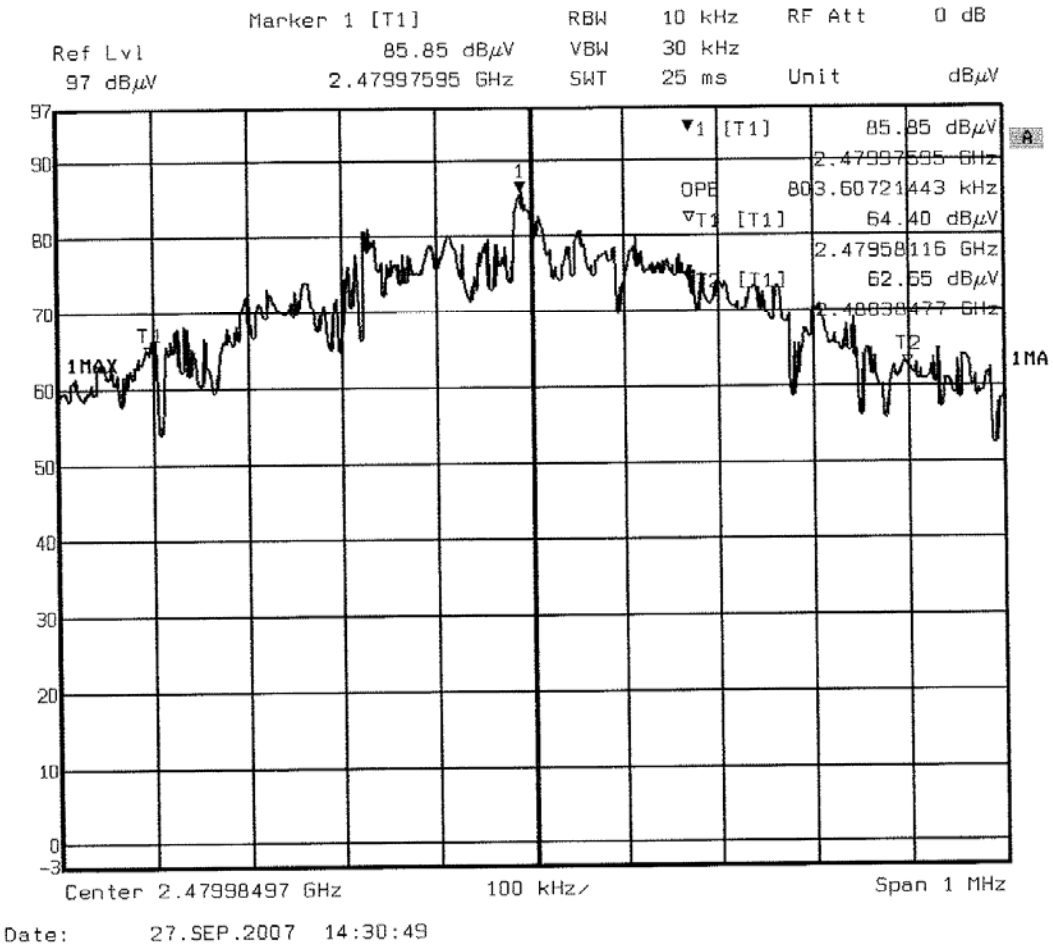


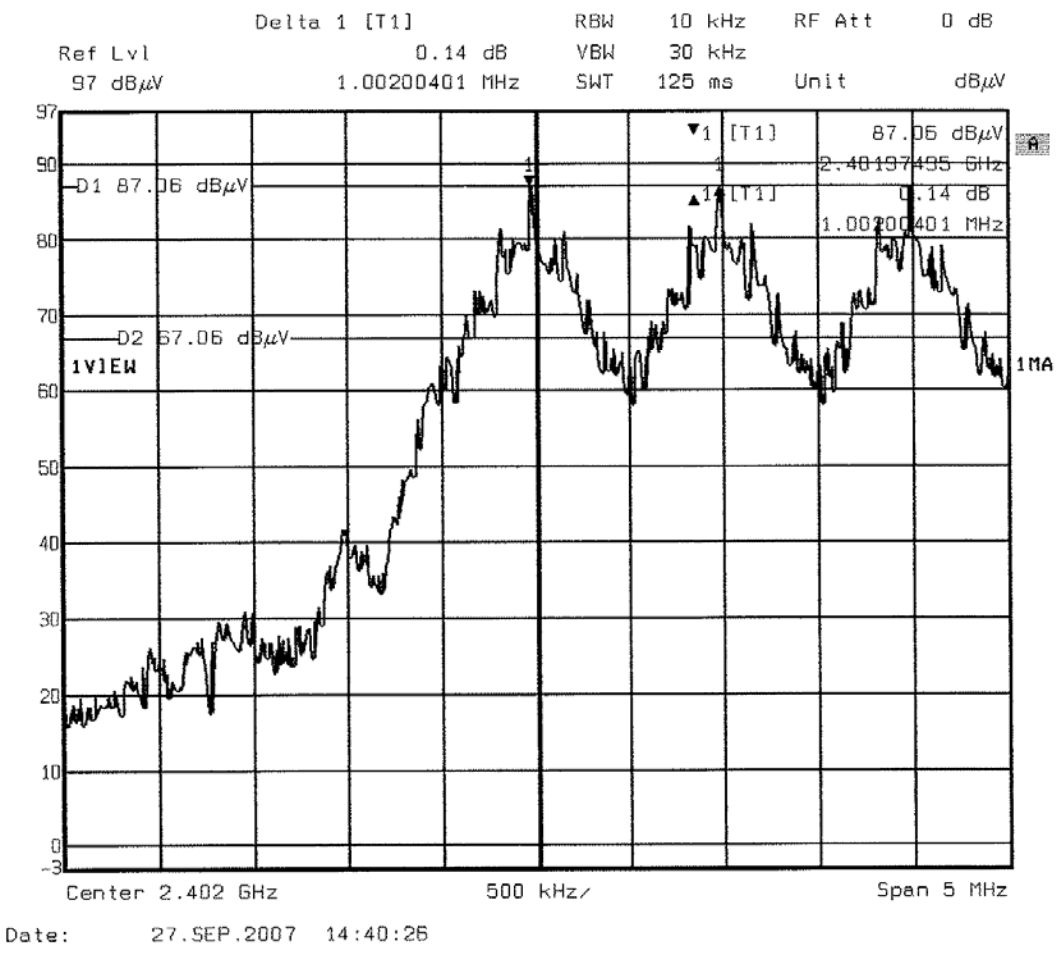
□□□ End of report, 5 annexes to be forwarded □□□

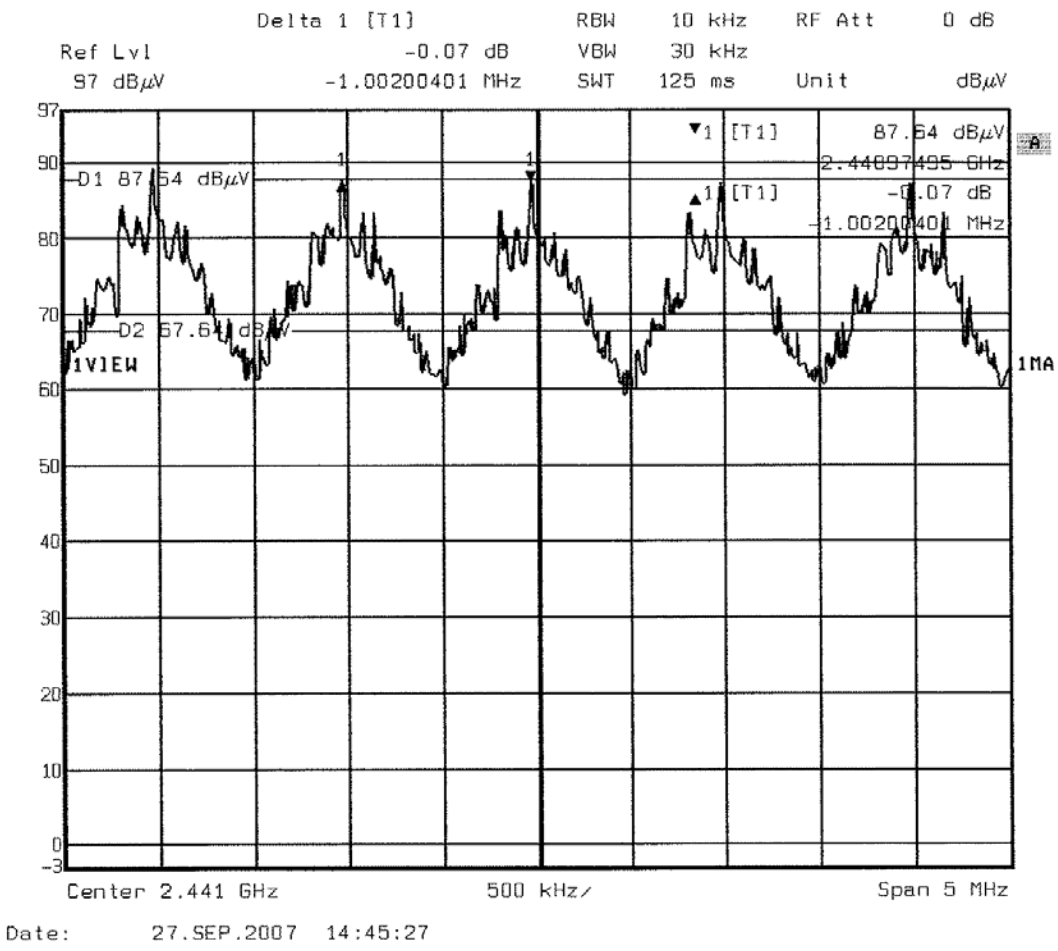
ANNEX 1: OCCUPIED POWER BANDWIDTH AND CHANNEL SEPARATION

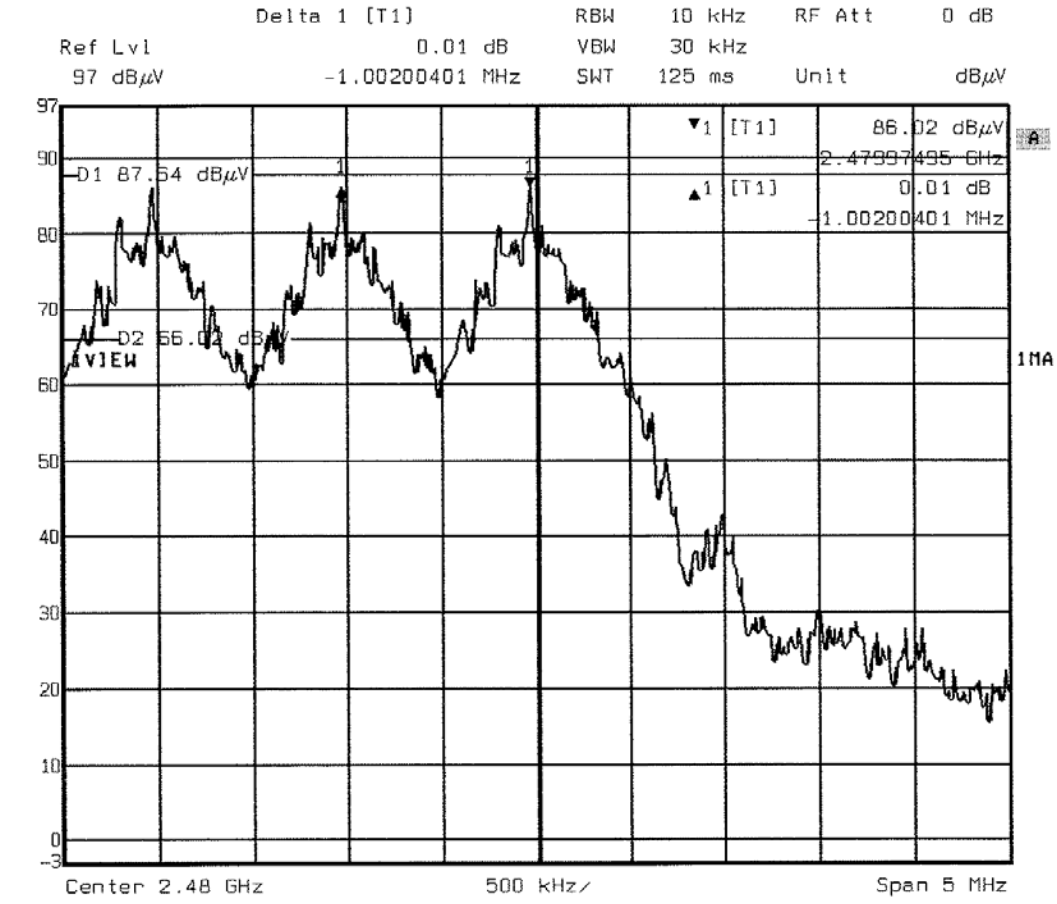



Marker 1 [T1]
RBW 10 kHz
RF Att 0 dB
Ref Lvl
87.56 dBµV
VBW 30 kHz
97 dBµV
2.44097896 GHz
SWT 25 ms
Unit dBµV
1 [T1] 87.56 dBµV
2.44097896 GHz
OPB 795.59118236 kHz
T1 [T1] 64.73 dBµV
2.44058116 GHz
68.03 dBµV
1MA
97
90
80
70
60
50
40
30
20
10
0
-3
Center 2.440978958 GHz
100 kHz/
Span 1 MHz
Date: 27.SEP.2007 14:28:31

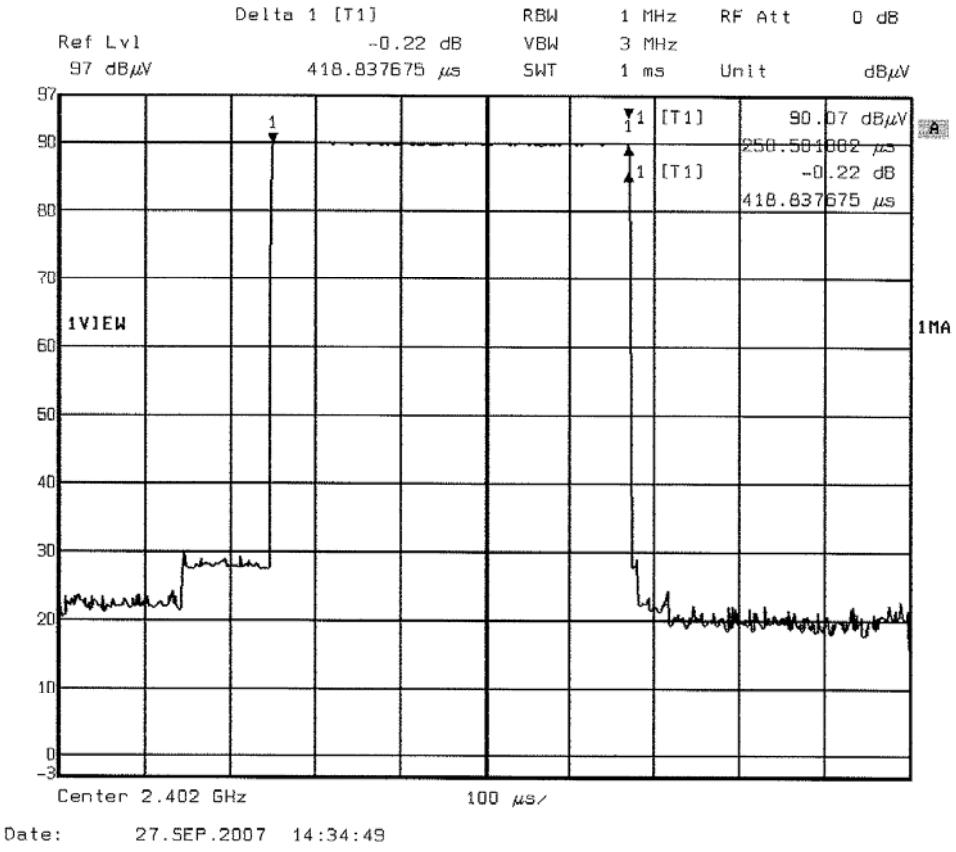

Marker 1 [T1]
85.85 dBµV
2.47997595 GHz
RBW 10 kHz
VBW 30 kHz
SWT 25 ms
RF Att 0 dB
Unit dBµV
Ref Lvl
97 dBµV
▼1 [T1] 85.85 dBµV
2.47997595 GHz
OBW 803.60721443 kHz
▽T1 [T1] 64.40 dBµV
2.47958116 GHz
▽T2 [T1] 62.55 dBµV
2.48038477 GHz
1MAX
1MA
Center 2.47998497 GHz
100 kHz/
Span 1 MHz
Date: 27.SEP.2007 14:30:49

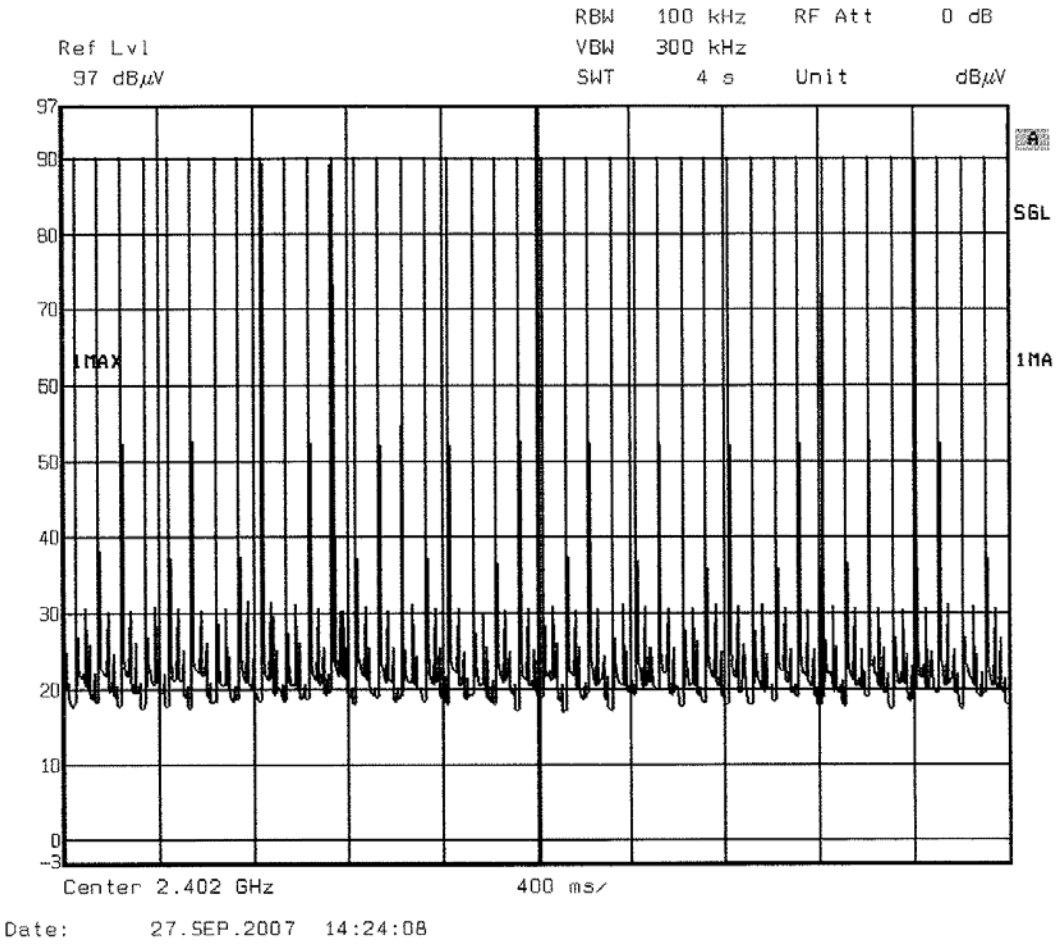

Delta 1 [T1]
RBW 10 kHz
RF Att 0 dB
Ref Lvl
0.14 dB
VBW 30 kHz
97 dBµV
1.00200401 MHz
SWT 125 ms
Unit dBµV
1 [T1] 87.06 dBµV
2.40197495 GHz
1 [T1] 0.14 dB
1.00200401 MHz
D1 87.06 dBµV
D2 67.06 dBµV
1VIEW
1MA
97
90
80
70
60
50
40
30
20
10
0
-3
Center 2.402 GHz
500 kHz/
Span 5 MHz
Date: 27.SEP.2007 14:40:26

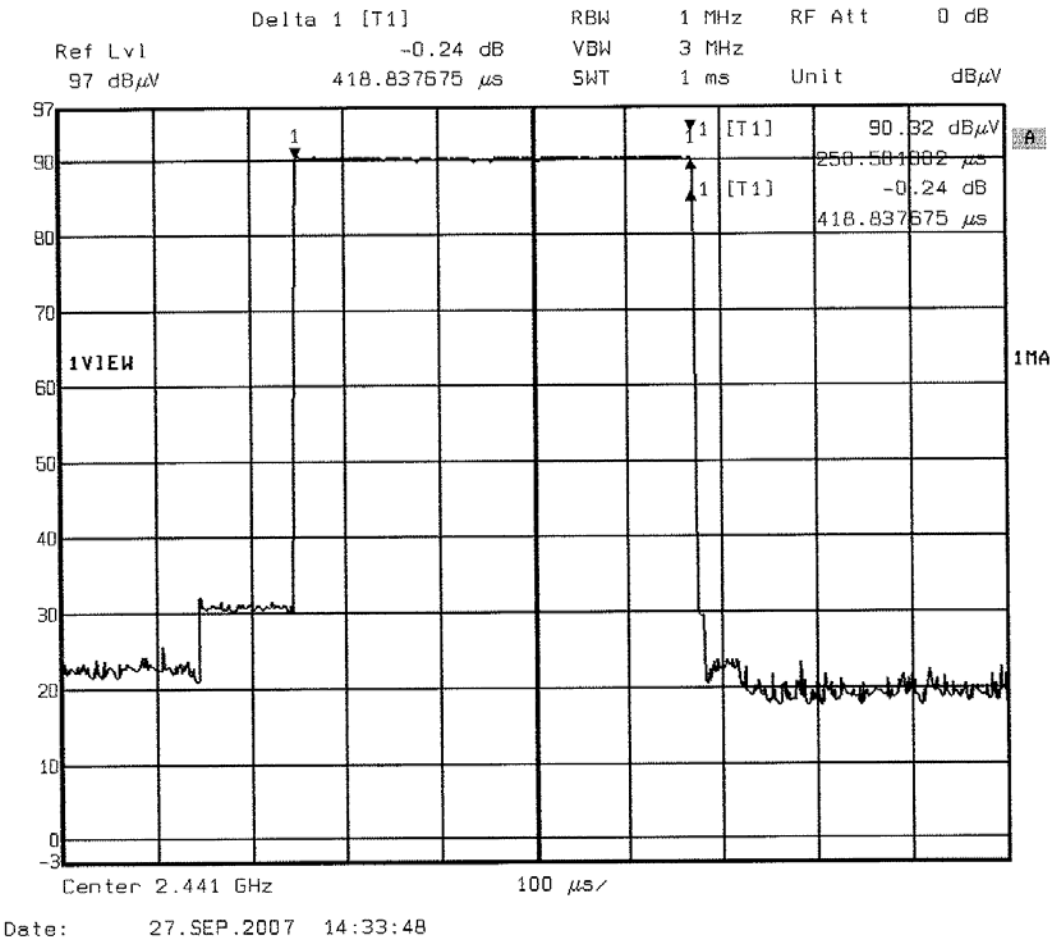

Delta 1 [T1]
RBW 10 kHz
RF Att 0 dB
Ref Lvl
-0.07 dB
VBW 30 kHz
97 dBµV
-1.00200401 MHz
SWT 125 ms
Unit dBµV
1 [T1] 87.64 dBµV
2.44097495 GHz
1 [T1] -0.07 dB
-1.00200401 MHz
D1 87.64 dBµV
D2 67.64 dBµV
1VIEW
1MA
A
97
90
80
70
60
50
40
30
20
10
0
-3
Center 2.441 GHz
500 kHz/
Span 5 MHz
Date: 27.SEP.2007 14:45:27

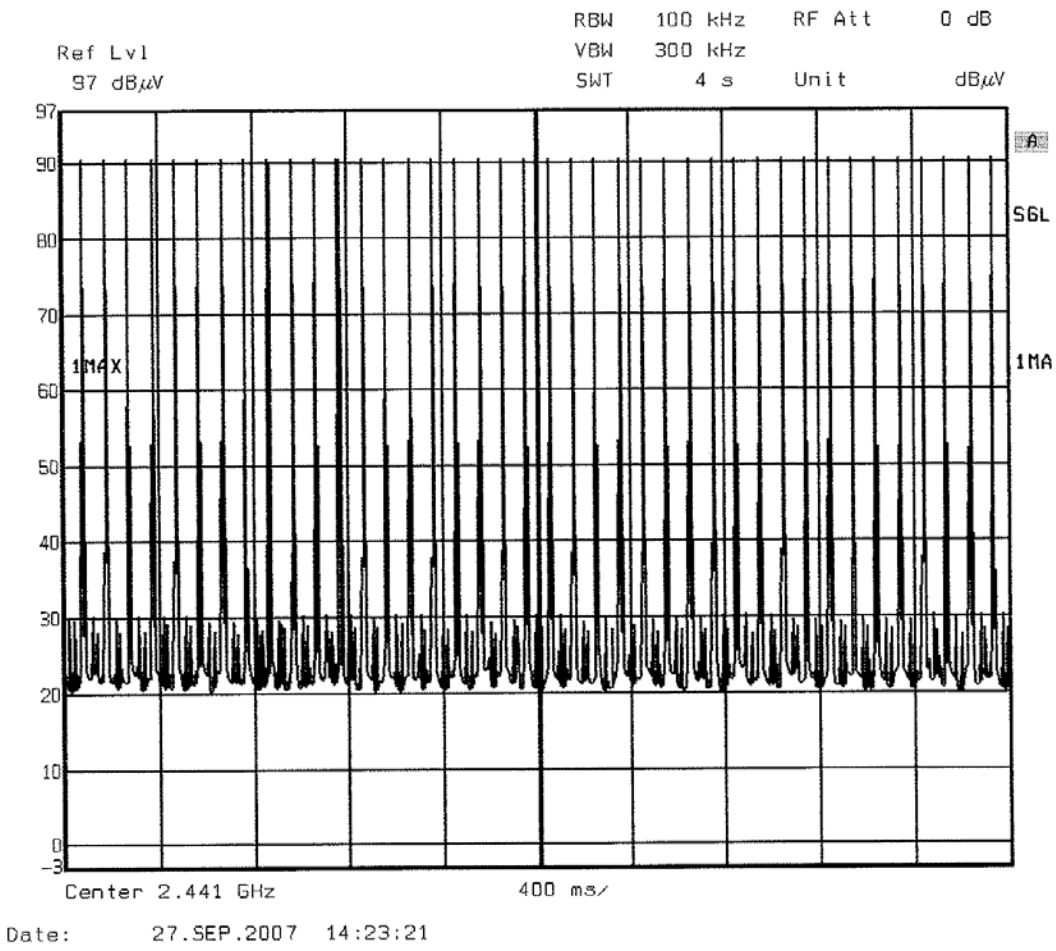

Delta 1 [T1]
0.01 dB
-1.00200401 MHz
RBW 10 kHz
VBW 30 kHz
SWT 125 ms
RF Att 0 dB
Unit dBµV
Ref Lvl
97 dBµV
D1 87.64 dBµV
D2 66.02 dBµV
VIEW
1 [T1] 86.02 dBµV
2.47997495 GHz
1 [T1] 0.01 dB
-1.00200401 MHz
1MA
Center 2.48 GHz
500 kHz/
Span 5 MHz
Date: 27.SEP.2007 14:50:54

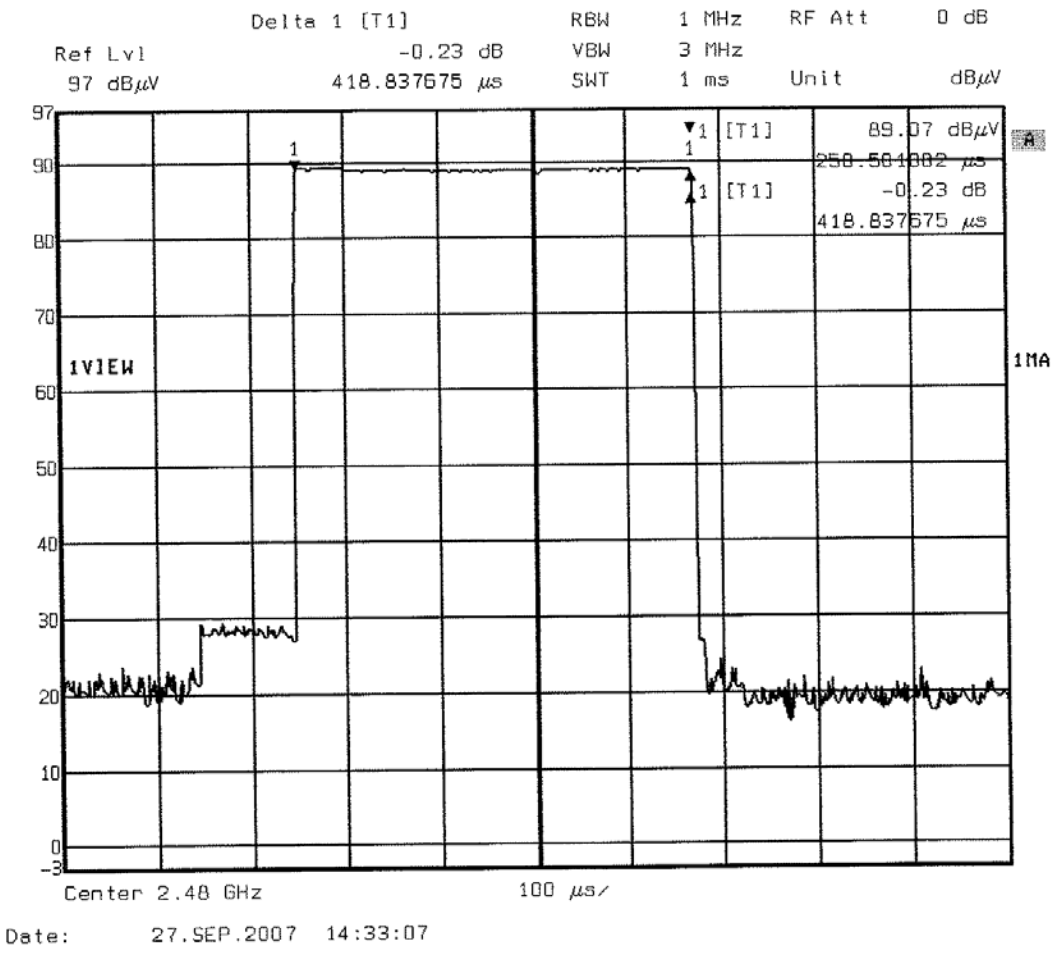
ANNEX 2: AVERAGE TIME OF OCCUPANCY ON ANY FREQUENCY

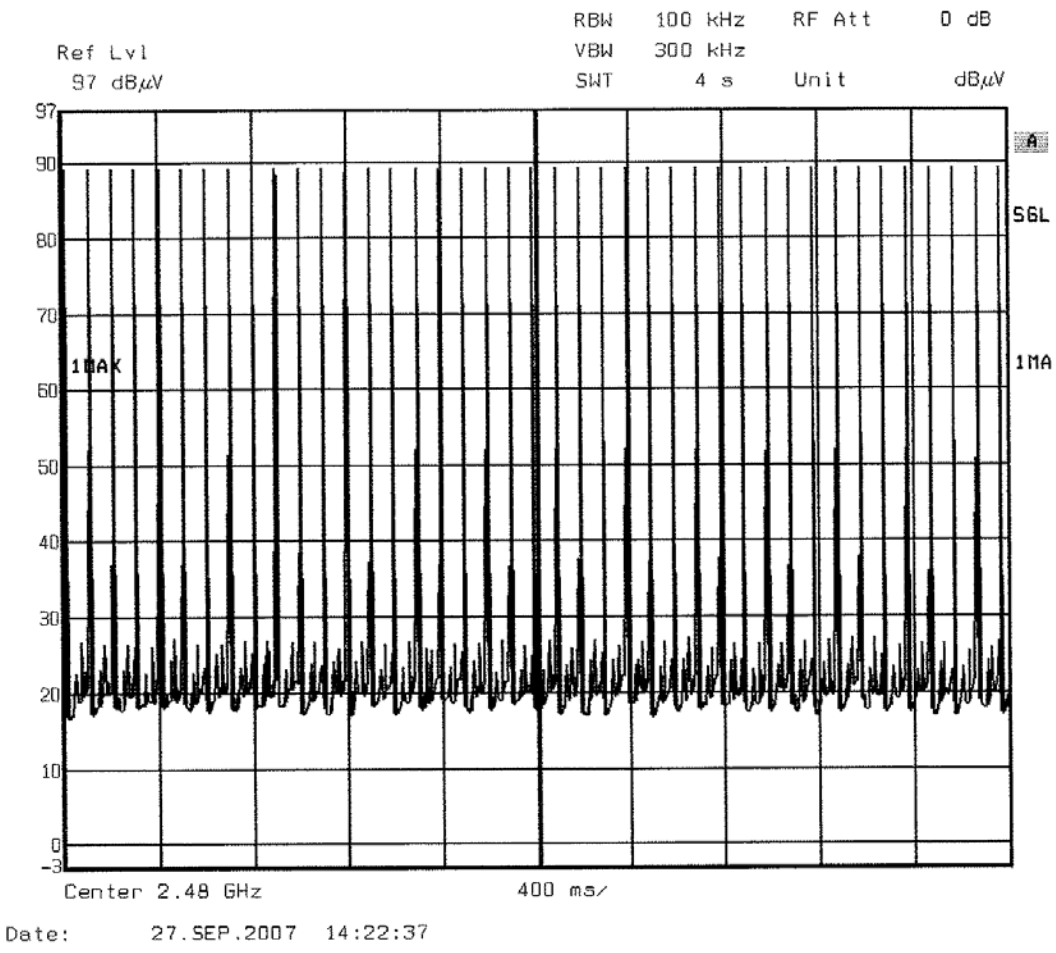



RBW 100 kHz
RF Att 0 dB
Ref Lvl
VBW 300 kHz
97 dBµV
SWT 4 s
Unit dBµV
97
90
80
70
60
50
40
30
20
10
0
-3
1MAX
A
SGL
1MA
Center 2.402 GHz
400 ms/
Date: 27.SEP.2007 14:24:08

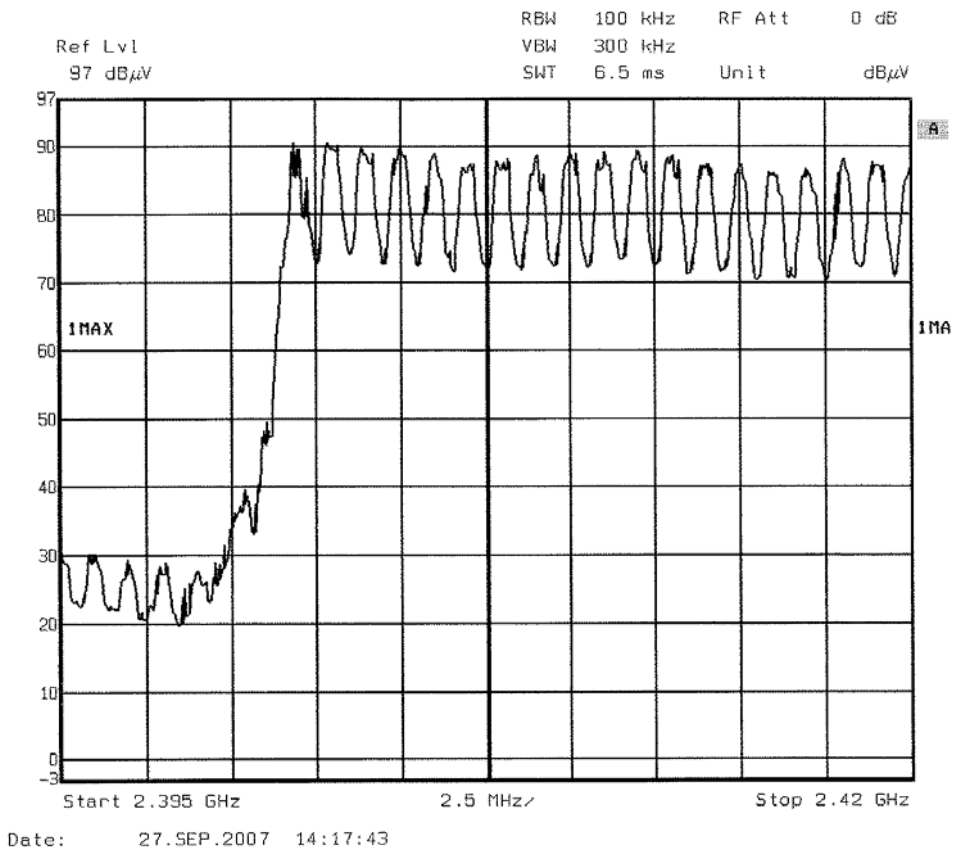

Delta 1 [T1]
RBW 1 MHz
RF Att 0 dB
Ref Lvl
-0.24 dB
VBW 3 MHz
97 dBµV
418.837675 µs
SWT 1 ms
Unit dBµV
1 [T1]
90.32 dBµV
250.581082 µs
1 [T1]
-0.24 dB
418.837675 µs
A
1VIEW
1MA
97
90
80
70
60
50
40
30
20
10
0
-3
Center 2.441 GHz
100 µs/
Date: 27.SEP.2007 14:33:48

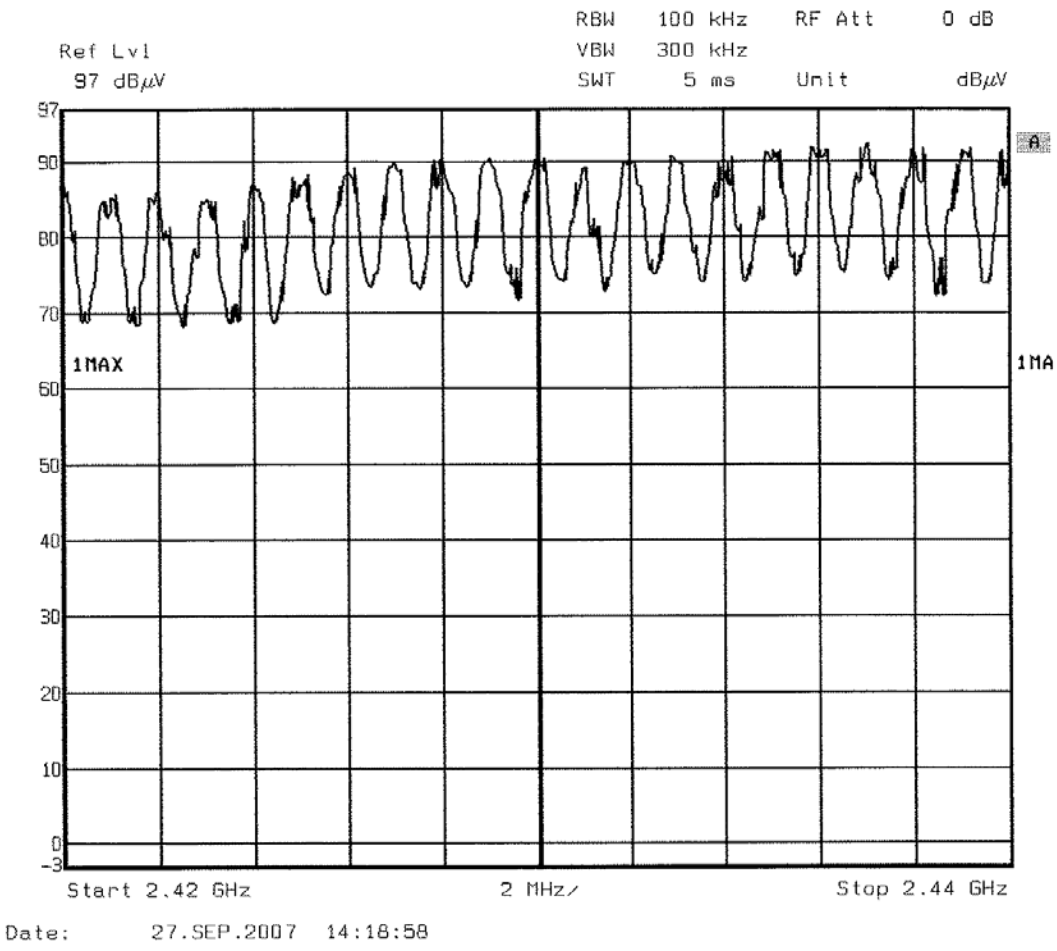

RBW 100 kHz
RF Att 0 dB
VBW 300 kHz
SWT 4 s
Unit dBµV
Ref Lvl
97 dBµV
97
90
80
70
60
50
40
30
20
10
0
-3
1MAX
SGL
1MA
Center 2.441 GHz
400 ms/
Date: 27.SEP.2007 14:23:21

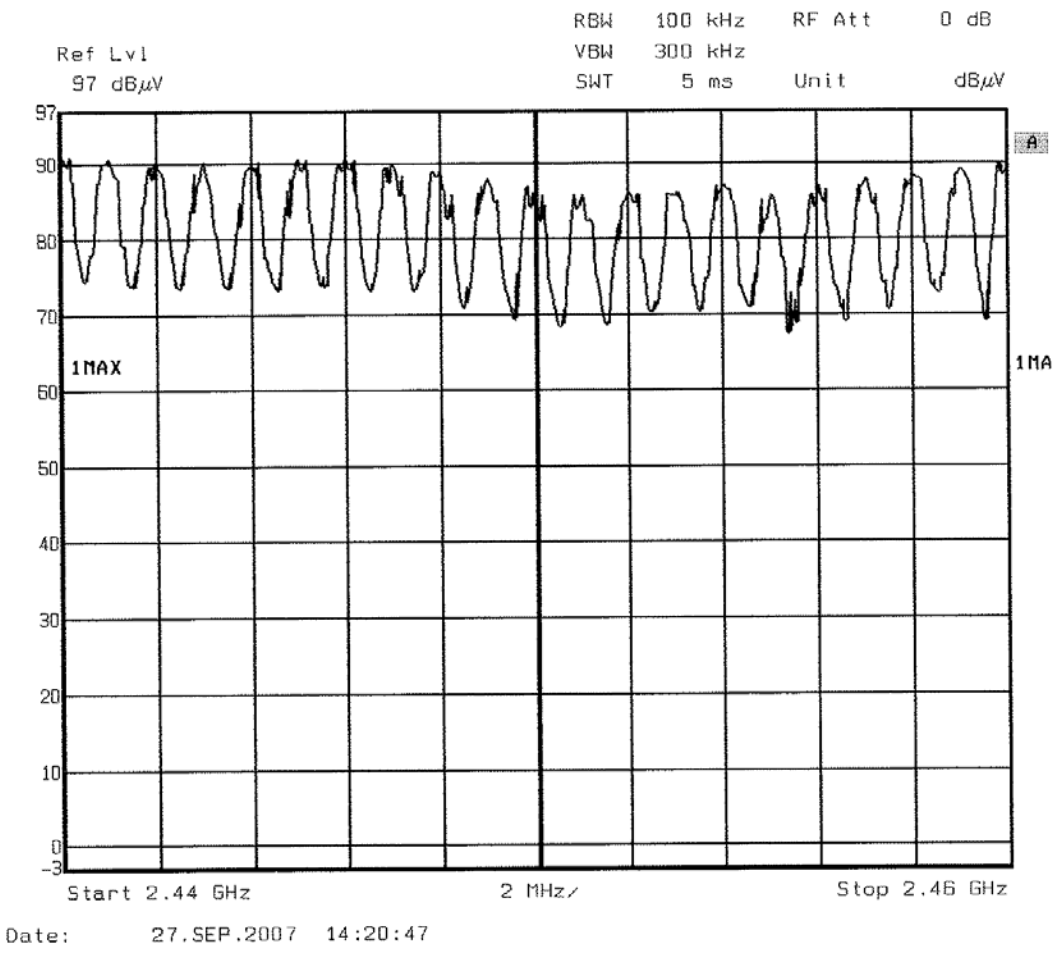

Delta 1 [T1]
RBW 1 MHz
RF Att 0 dB
Ref Lvl
-0.23 dB
VBW 3 MHz
97 dBµV
418.837675 µs
SWT 1 ms
Unit dBµV
1 [T1]
89.07 dBµV
250.501002 µs
1 [T1]
-0.23 dB
418.837675 µs
1VIEW
1MA
97
90
80
70
60
50
40
30
20
10
0
-3
Center 2.48 GHz
100 µs/
Date: 27.SEP.2007 14:33:07

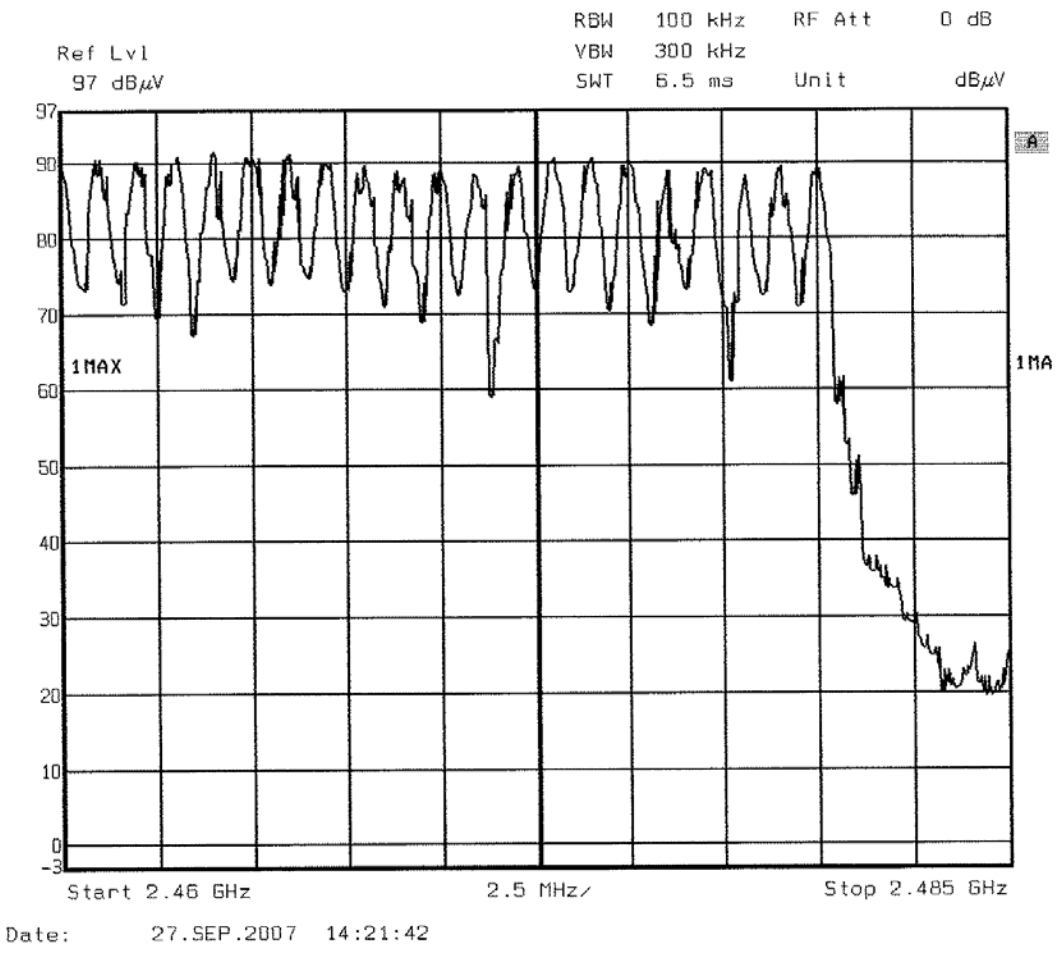

RBW 100 kHz
RF Att 0 dB
Ref Lvl
VBW 300 kHz
97 dBµV
SWT 4 s
Unit dBµV
97
90
80
70
60
50
40
30
20
10
0
-3
A
SGL
1MA
1MAK
Center 2.48 GHz
400 ms/
Date: 27.SEP.2007 14:22:37

ANNEX 3: NUMBER OF HOPPING FREQUENCIES




RBW 100 kHz
RF Att 0 dB
VBW 300 kHz
Ref Lvl
97 dBµV
SWT 5 ms
Unit dBµV
97
90
80
70
1MAX
1MA
60
50
40
30
20
10
0
-3
Start 2.42 GHz
2 MHz/
Stop 2.44 GHz
Date: 27.SEP.2007 14:18:58

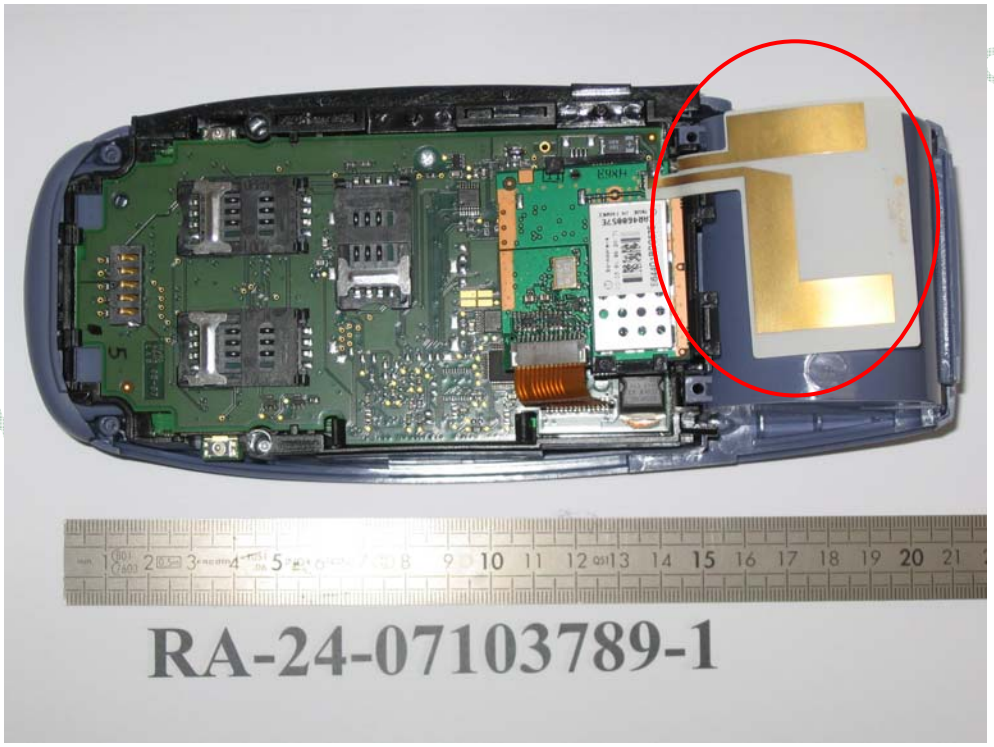

RBW 100 kHz
RF Att 0 dB
VBW 300 kHz
Ref Lvl
97 dBµV
SWT 5 ms
Unit dBµV
97
90
80
70
60
50
40
30
20
10
0
-3
A
1MAX
1MA
Start 2.44 GHz
2 MHz/
Stop 2.46 GHz
Date: 27.SEP.2007 14:20:47


RBW 100 kHz
RF Att 0 dB
VBW 300 kHz
Ref Lvl
97 dBµV
SWT 6.5 ms
Unit dBµV
97
90
80
70
60
50
40
30
20
10
0
-3
1MAX
1MA
A
Start 2.46 GHz
2.5 MHz/
Stop 2.485 GHz
Date: 27.SEP.2007 14:21:42

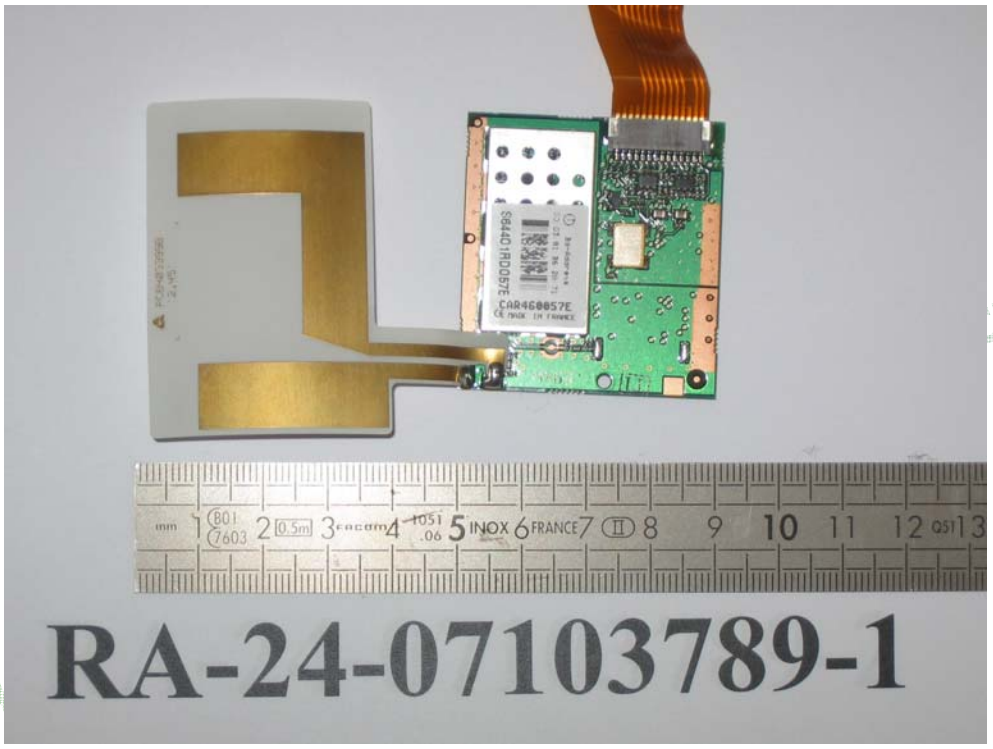
ANNEX 4: PHOTOS OF THE EQUIPMENT UNDER TEST

GENERAL VIEW

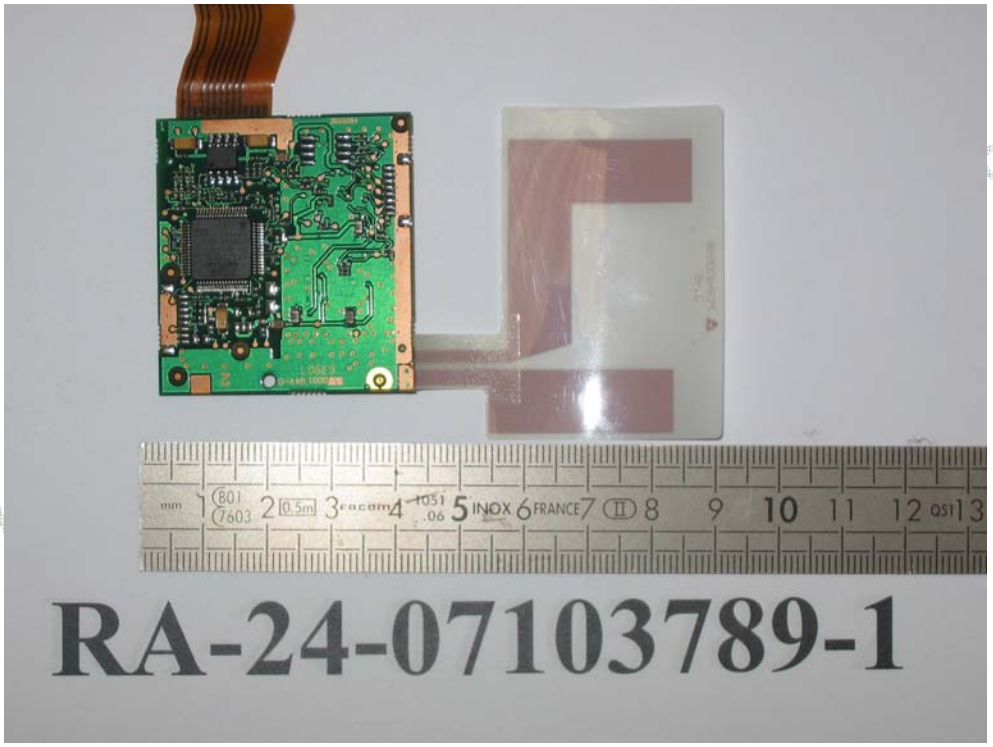
INTERNAL VIEW + ANTENNA



Printed circuit board: face 1



Printed circuit board: face 2



ANNEX 5: TEST SET UP AND OPEN AREA TEST SITE

TEST SET UP

OPEN AREA TEST SITE