



R051-24-10-106265-3/A Ed. 0

<p>RADIO test report</p> <p>according to standard: FCC Part 15 (2010)</p> <p>Equipment under test: FHSS DIGITAL COMMUNICATION TERMINAL VOKKERO EVOLUTION 3</p> <p>FCC ID: U3Z-ARF7672</p> <p>Company: ADEUNIS RF</p>

DISTRIBUTION: Mr SAGUIN

Company: ADEUNIS RF

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			P.O. M. D.			

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PRODUCT: FHSS DIGITAL COMMUNICATION TERMINAL

Trade mark: VOKKERO EVOLUTION 3

Reference / model: ARF7672AA/AN/AS/DA/DN/DS/DT/EA/EF/FA

Serial number: not communicated

MANUFACTURER: ADEUNIS RF

COMPANY SUBMITTING THE PRODUCT:

Company: ADEUNIS RF

Address: 283 rue Louis Néel
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FRANCE

Responsible: Mr SAGUIN

DATE(S) OF TEST: 21, 22 and 23 February 2011

TESTING LOCATION: EMITECH ATLANTIQUE laboratory at ANGERS (49) FRANCE
EMITECH ATLANTIQUE open area test site in LA POUEZE (49)
FRANCE
FCC Registration Number: 101696/FRN: 0006 6490 08

TESTED BY: L. BERTHAUD

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1. INTRODUCTION

This document presents the result of RADIO test carried out on the following equipment: FHSS DIGITAL COMMUNICATION TERMINAL-VOKKERO EVOLUTION 3 in accordance with normative reference.

2. PRODUCT DESCRIPTION

ITU Emission code:	250KF7D
Class:	B (residential environment)
Utilization:	FHSS digital communication terminal
Antenna type and gain:	integrated antenna (0 dBi)
Operating frequency range:	from 902.75 MHz to 927.75 MHz
Number of channels:	25
Channel spacing:	500 kHz
Frequency generation:	synthesizer
Modulation:	GFSK
Power source:	3.7 V rechargeable Li-Polymer battery

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 (2010)	Radio Frequency Devices
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.
KDB Publication 558074 (2005)	Measurement of Digital Transmission Systems Operating under Section 15.247
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:

Subpart B –Unintentional Radiators

Paragraph 107: Conducted limits

Paragraph 109: Radiated emission limits

Paragraph 111: Antenna power conduction limits for receivers

Subpart C – Intentional Radiators

Paragraph 203: Antenna requirement

Paragraph 205: Restricted bands of operation

Paragraph 207: Conducted limits

Paragraph 209: Radiated emission limits; general requirements

Paragraph 212: Modular transmitter

Paragraph 215: Additional provisions to the general radiated emission limitations

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 unintentional radiator (subpart B)

Test procedure	Description of test	Respected criteria?				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

6.2 intentional radiator (subpart C)

Test procedure	Description of test	Respected criteria?				Comment
		Yes	No	NAp	NAs	
FCC Part 15.203	ANTENNA REQUIREMENT	X				<i>Note 1</i>
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				<i>Note 2</i>
FCC Part 15.212	MODULAR TRANSMITTERS			X		
FCC part 15.215	ADDITIONAL PROVISIONS TO THE GENERAL RADIATED EMISSION LIMITATIONS					
	(a) Alternative to general radiated emission limits	X				
	(b) Unwanted emissions outside of §15.247 frequency bands	X				<i>Note 3</i>
	(c) 20 dB bandwidth and band-edge compliance	X				
FCC Part 15.247	OPERATION WITHIN THE BANDS 902-928 MHZ, 2400-2483.5 MHz and 5725-5850 MHz					
	(a) (1) Hopping systems	X				<i>Note 4</i>
	(a) (2) Digital modulation techniques			X		
	(b) Maximum peak output power	X				<i>Note 5</i>
	(c) Operation with directional antenna gains > 6 dBi			X		
	(d) Intentional radiator	X				
	(e) Peak power spectral density			X		
	(f) Hybrid system			X		
	(g) Frequency hopping requirements				X	
	(h) Frequency hopping intelligence				X	
	(i) RF exposure compliance	X				<i>Note 6</i>

NAp: Not Applicable

NAs: Not Asked

Note 1: Integral antenna.

Note 2: See FCC part 15.247 (d).

Note 3: See FCC part 15.209. Unwanted emissions levels are all below the fundamental emission field strength level.

Note 4: 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 (268 kHz; see annex 1).

The frequency hopping system uses 25 channels (see annex 2).

The dwell time by channel is 2 ms (see annex 3).

During 10 s, any channel is used 7 times (see annex 4), then $7 \times 2 \text{ ms} = 14 \text{ ms}$, thus the average time of occupancy on any channel is less than 400 ms within a period of 10 seconds in normal operating mode.

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

Note 6: This equipment uses less than 0.5 W of output power with a high signal transmitting duty factor (section 3 from O et 65c).

Conclusion:

The sample of FHSS DIGITAL COMMUNICATION TERMINAL-VOKKERO EVOLUTION 3 submitted to the tests complies with the regulations of the standard FCC Part 15 (2010) in accordance with the limits or criteria defined in this report.

7. RADIATED EMISSION LIMITS

Standard: FCC Part 15

Test procedure: paragraph 109

Limit class: Class B

Test equipments:

TYPE	BRAND	EMITECH NUMBER
Test receiver	Rohde & Schwarz ESH3	1058
Test receiver	Rohde & Schwarz ESVS10	1219
Spectrum analyzer	Rohde & Schwarz FSP40	4088
Loop antenna	EMCO 6502	1406
Biconical antenna	Hewlett Packard 11966 C	0728
Log periodic antenna	Rohde & Schwarz HL 223	1999
Double ridged guide antenna	Electrometrics EM 6961	1204
Preamplifier 1 to 18 GHz	DBS Microwave DB97-1852	2648
High pass filter	Micro-tronics HPM11630	6609
Open area test site	EMITECH	1274
Multimeter	Fluke 77-2	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 azimuths correspond to the front of the equipment under test.

Frequency range: From 9 kHz to 5000 MHz (highest frequency used: 927.75 MHz).

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

Bandwidth: 120 kHz (F < 1 GHz) 1 MHz (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 standby / reception mode.

Results:

Ambient temperature (°C): 20.5
Relative humidity (%): 52

Power source:

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

Voltage at the beginning of test (V): 4.18
Voltage at the end of test (V): 4.07
Percentage of voltage drop during the test (%): 2.6

Not any spurious has been detected.

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

Test conclusion:

RESPECTED STANDARD

8. ADDITIONAL PROVISIONS TO THE GENERAL RADIATED EMISSION LIMITATIONS

Standard: FCC Part 15

Test procedure: Paragraph 15.215

Test equipments:

TYPE	MANUFACTURER	EMITECH NUMBER
Spectrum analyzer FSP7	Rohde & Schwarz	6796
Multimeter	Fluke 77-2	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 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): 24
 Relative humidity (%): 31

Sample n°1:

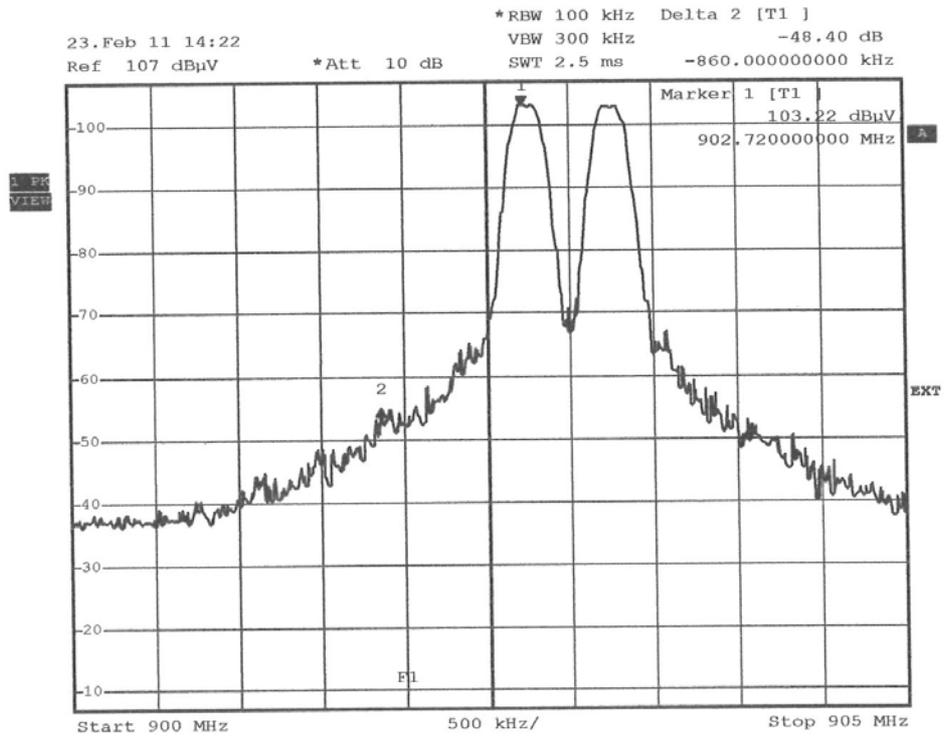
Fundamental frequency (MHz)	Field Strength Level of fundamental (dBµV/m)	Detector (Peak or Average)	Frequency of maximum Band-edges Emission (MHz)	Delta Marker (dB)*	Calculated Max Out-of-Band Emission Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)
902.75	118.7	Peak	901.86	-48.4	70.3	74	3.7
902.75	83.1	Average	901.97	-49.2	33.9	54	20.1
927.75	118.9	Peak	928.05	-44.9	74	74	0
927.5	83	Average	928.01	-42.4	40.6	54	13.4

* *Marker-Delta method*

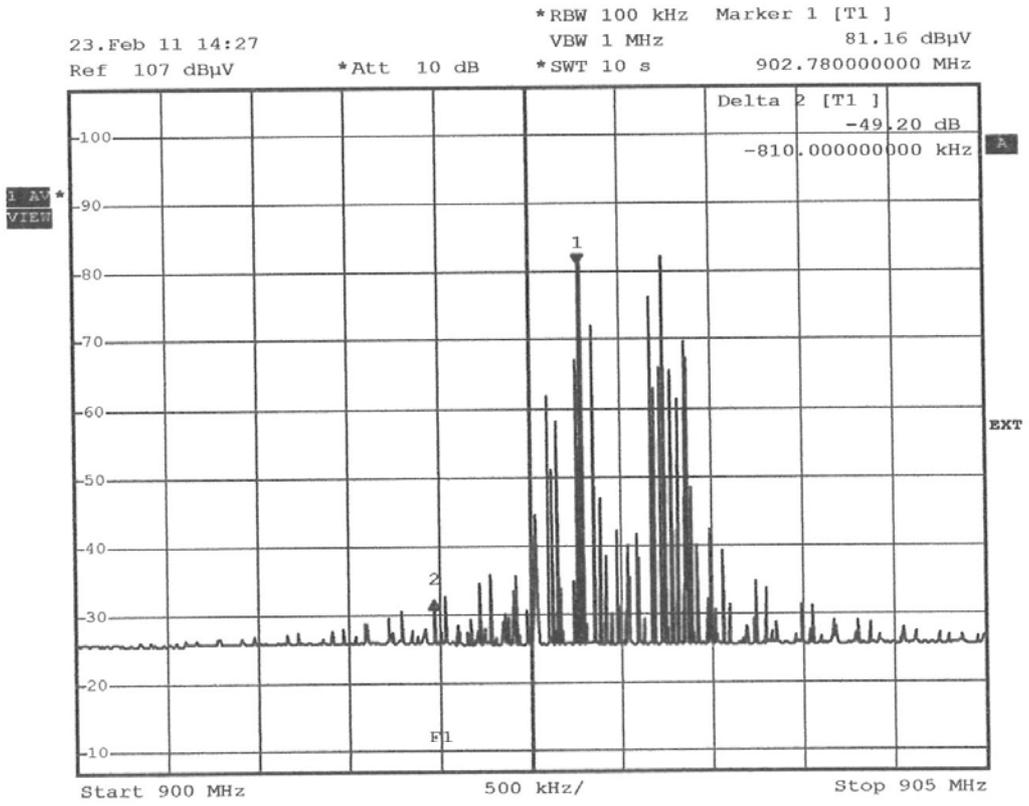
See occupied bandwidth graphs in following pages.

Test conclusion:

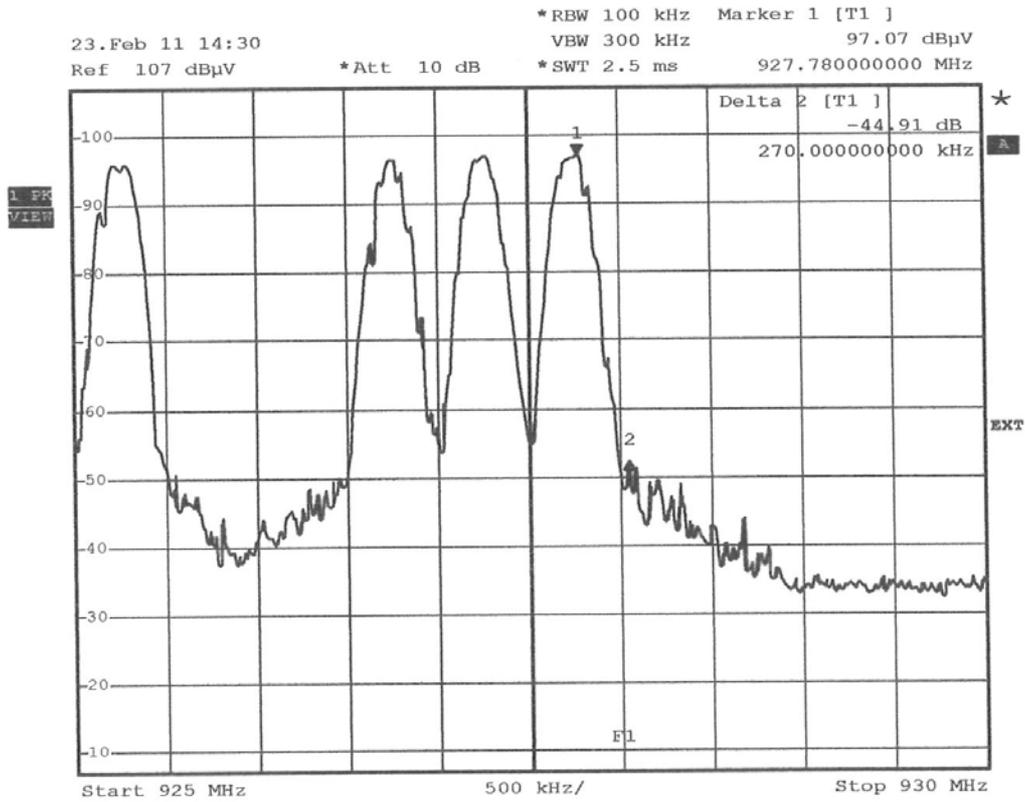
RESPECTED STANDARD



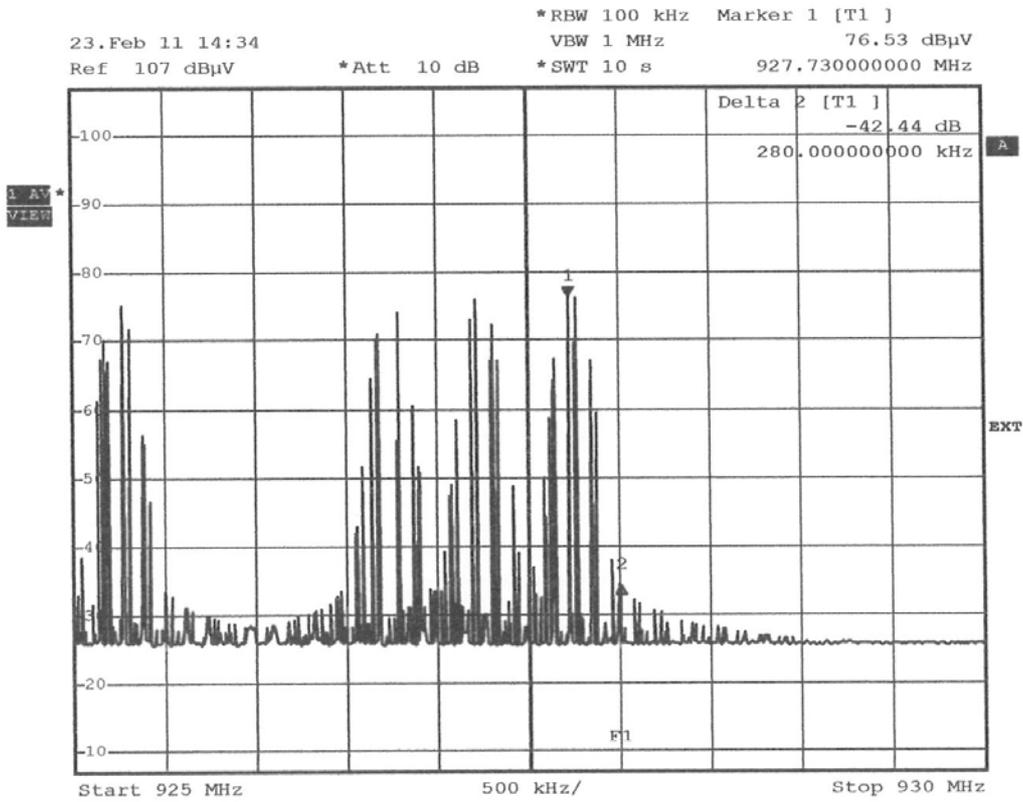
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9. MAXIMUM PEAK OUTPUT POWER**Standard:** FCC Part 15**Test procedure:** paragraph 15.247 (b)**Test equipments:**

TYPE	BRAND	EMITECH NUMBER
Spectrum analyzer	Rohde & Schwarz FSP40	4088
Log periodic antenna	Rohde & Schwarz HL 223	1999
Open area test site	EMITECH	1274
Multimeter	Fluke 77-2	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. 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 adjusted at 100 kHz (detector peak).

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): 20.5
Relative humidity (%): 52

Power source:

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

Voltage at the beginning of test (V): 4.18
Voltage at the end of test (V): 4.07
Percentage of voltage drop during the test (%): 2.6

Sample n° 1 low channel

	Level dB μ V	Cable loss dB	Antenna factor dB	Electro-magnetic field (dB μ V/m):	P* (W)	Limit(W)
Normal test conditions	94.3	3.3	21.1	118.7	222.4 x 10 ⁻³	250 x 10 ⁻³

Polarization of test antenna: vertical (height: 110 cm)

Position of equipment: see annex 6 (azimuth: 20 degrees)

Middle channel

	Level dB μ V	Cable loss dB	Antenna factor dB	Electro-magnetic field (dB μ V/m):	P* (W)	Limit(W)
Normal test conditions	94.5	3.3	21.1	118.9	232.9 x 10 ⁻³	250 x 10 ⁻³

Polarization of test antenna: vertical (height: 110 cm)

Position of equipment: see annex 6 (azimuth: 20 degrees)

High channel

	Level dB μ V	Cable loss dB	Antenna factor dB	Electro-magnetic field (dB μ V/m):	P* (W)	Limit(W)
Normal test conditions	94.5	3.3	21.1	118.9	232.9 x 10 ⁻³	250 x 10 ⁻³

Polarization of test antenna: vertical (height: 110 cm)

Position of equipment: see annex 6 (azimuth: 20 degrees)

* $P = (E \times d)^2 / (30 \times G_p)$ with $d = 3$ m and $G_p = 1$

Test conclusion:

RESPECTED STANDARD

10. INTENTIONAL RADIATOR

Standard: FCC Part 15

Test procedure: paragraph 15.205
paragraph 15.209
paragraph 15.247 (d)

Test equipments:

TYPE	BRAND	EMITECH NUMBER
Test receiver	Rohde & Schwarz ESH3	1058
Test receiver	Rohde & Schwarz ESVS10	1219
Spectrum analyzer	Rohde & Schwarz FSP40	4088
Loop antenna	EMCO 6502	1406
Biconical antenna	Hewlett Packard 11966 C	0728
Log periodic antenna	Rohde & Schwarz HL 223	1999
Double ridged guide antenna	Electrometrics EM 6961	1204
Preamplifier 1 to 18 GHz	DBS Microwave DB97-1852	2648
High pass filter HP12/1200-5AA	Filtek	7310
Open area test site	EMITECH	1274
Multimeter	Fluke 77-2	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 10th harmonic of the highest fundamental frequency (927.75 MHz).

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): 20
 Relative humidity (%): 59

Power source:

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

Voltage at the beginning of test (V): 4.19
 Voltage at the end of test (V): 4.14
 Percentage of voltage drop during the test (%): 1.2

Sample n°1

Low channel

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)	Limits (dBµV/m)	Margin (dB)
1805.6	P	110	0	100	V	66.8	98.9	32.1
2708.2	Av	100	0	1000	V	30.2	54*	23.8
2708.2	P	100	0	1000	V	61.4	74*	12.6
3610.9	Av	110	190	1000	V	31	54*	23
3610.9	P	110	190	1000	V	60.1	74*	13.9

Middle channel

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)	Limits (dBµV/m)	Margin (dB)
1830.4	P	110	0	100	V	64.2	98.9	34.7
2745.7	Av	100	0	1000	V	29.8	54*	24.2
2745.7	P	100	0	1000	V	59.3	74*	14.7
3660.9	Av	135	190	1000	V	28.8	54*	25.2
3660.9	P	135	190	1000	V	57.7	74*	16.3

High channel

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)	Limits (dBµV/m)	Margin (dB)
1855.5	P	110	0	100	V	59.2	98.9	39.7
2783.2	Av	110	0	1000	V	25.6	54*	28.4
2783.2	P	110	0	1000	V	54.6	74*	19.4
3710.9	Av	150	190	1000	V	26.7	54*	27.3
3710.9	P	150	190	1000	V	54.4	74*	19.6

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

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 118.9 dBµV/m.

So the applicable limit is 98.9 dBµV/m.

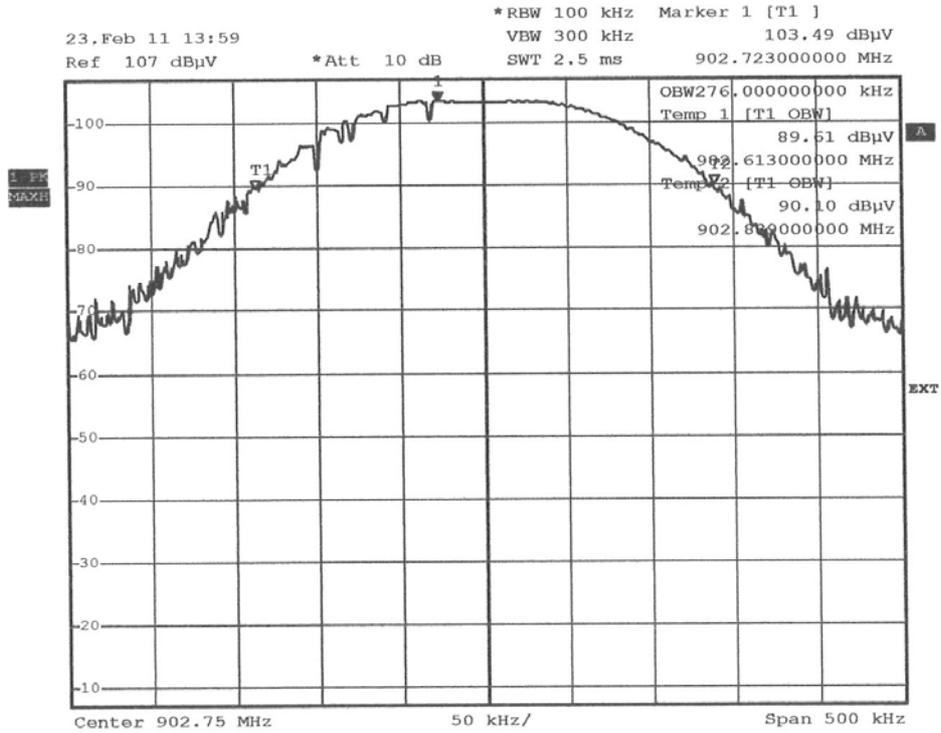
In addition, radiated emissions which fall in the restricted band, as defined in section 15.205 (a), must also comply with the radiated emission limits specified in section 15.209 (a) (see section 15.205 (c)).

Test conclusion:

RESPECTED STANDARD

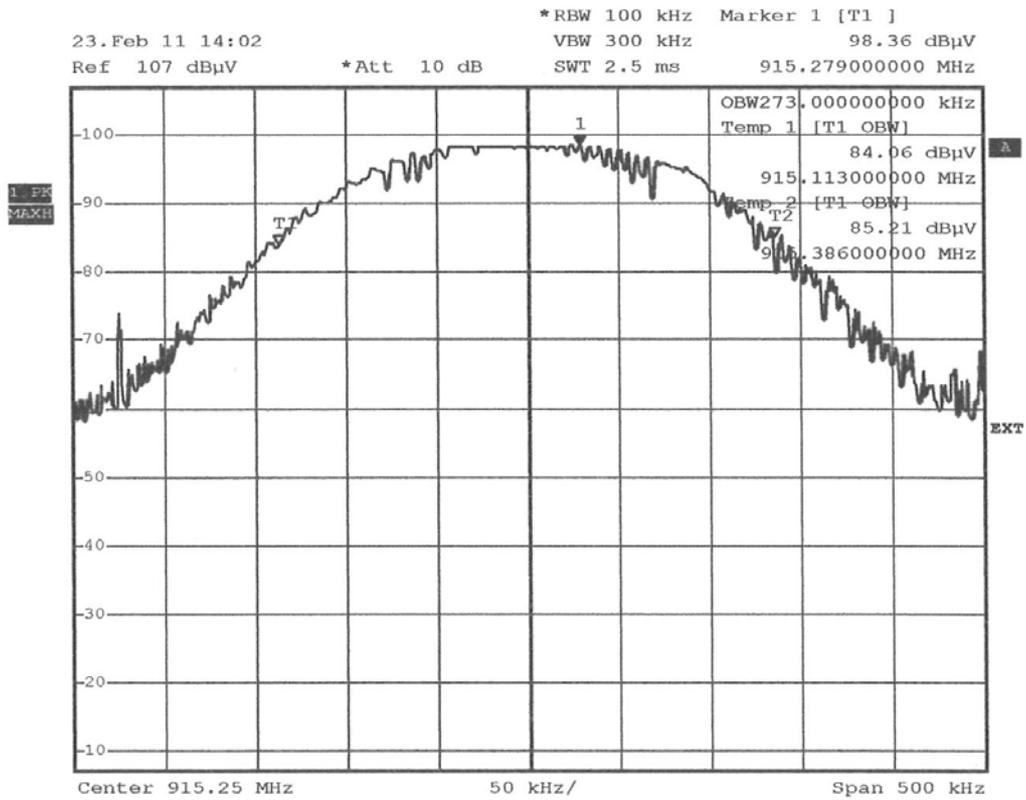
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ANNEX 1: OCCUPIED BANDWIDTH AND CHANNEL SEPARATION



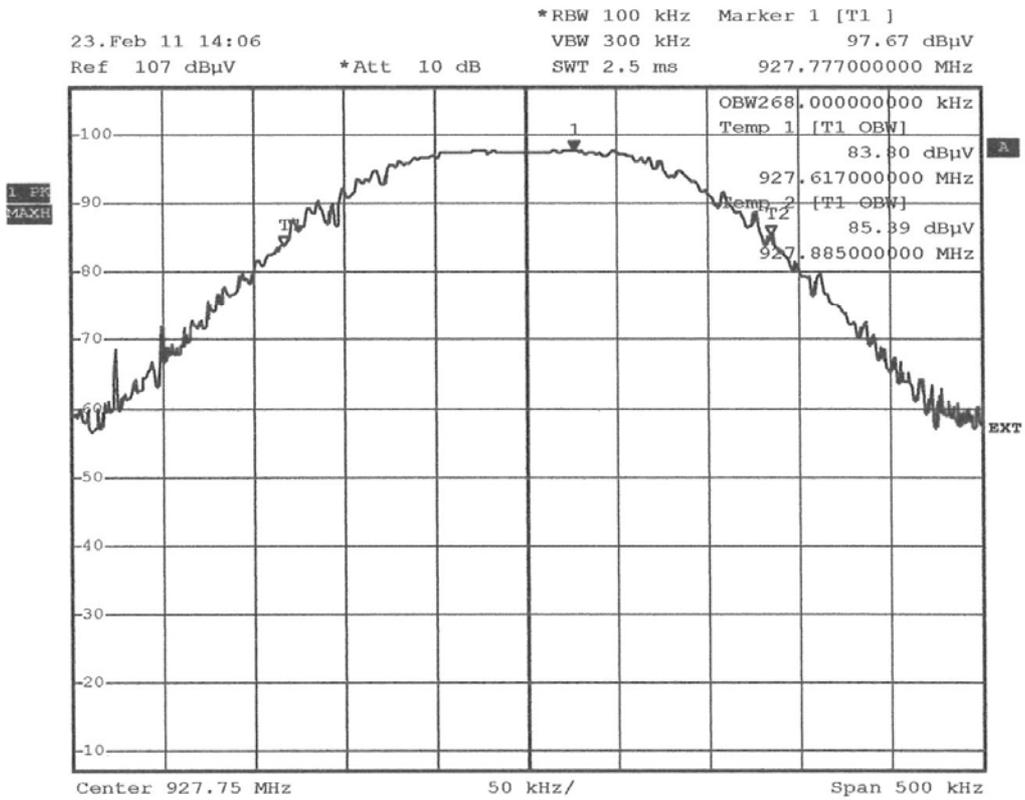
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USA/Canada
 20 dB bandwidth
 low channel



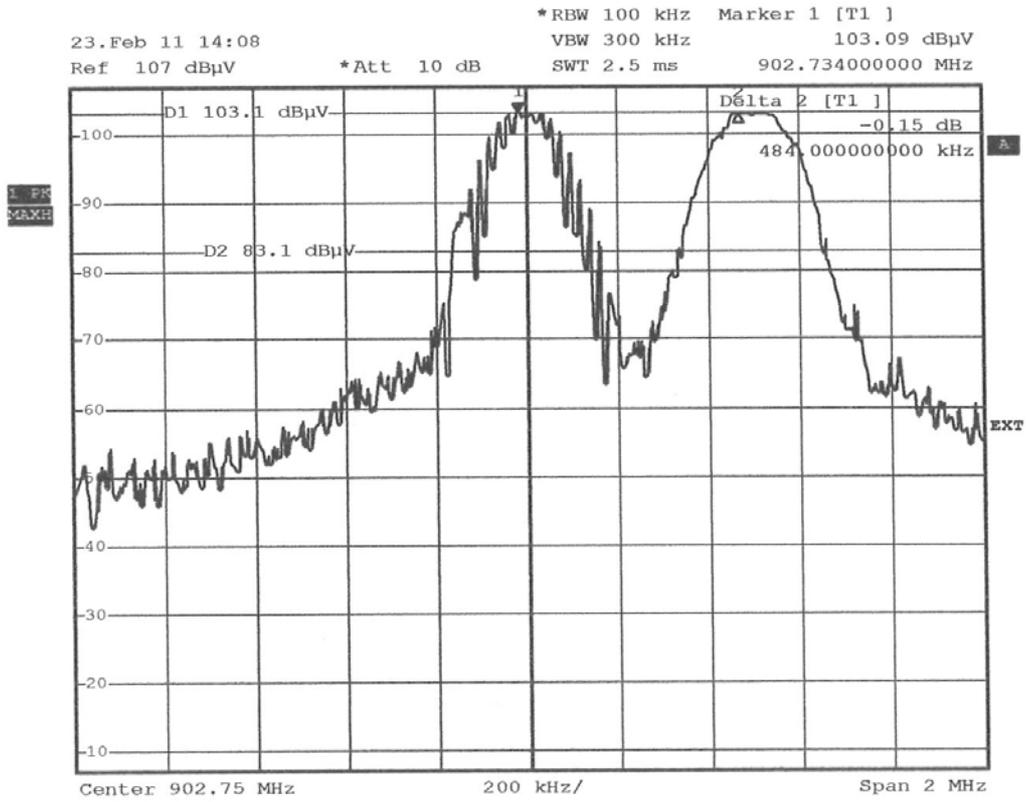
Date: 23.FEB.2011 14:02:11

USA/Cereda
 20 dB bandwidth
 Middle channel



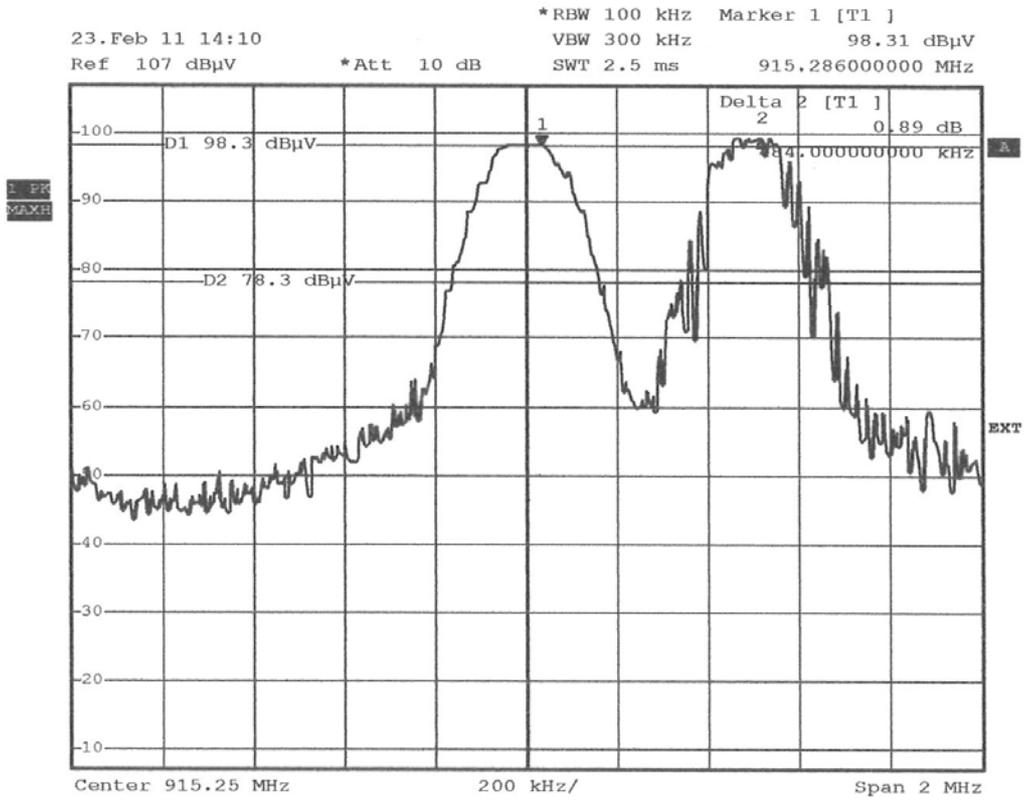
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USA/Cesda
 20dB bandwidth
 High channel



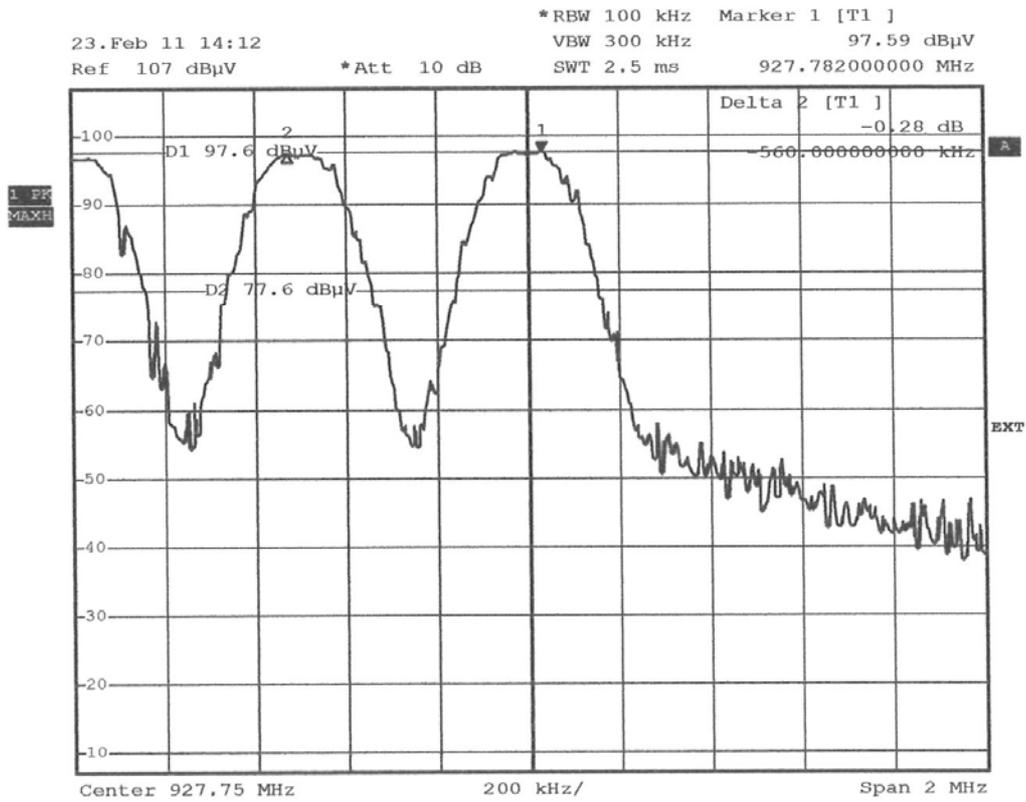
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USA/Canada
 Channel separation
 Low channel



Date: 23.FEB.2011 14:10:18

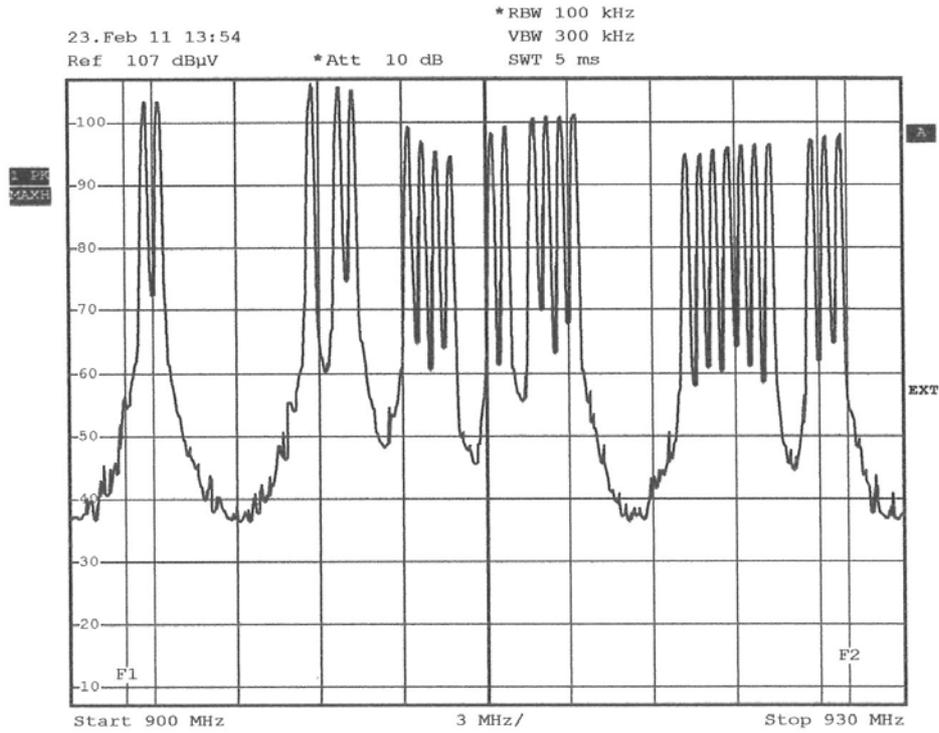
USA/Canada
 Channel separation
 Middle channel



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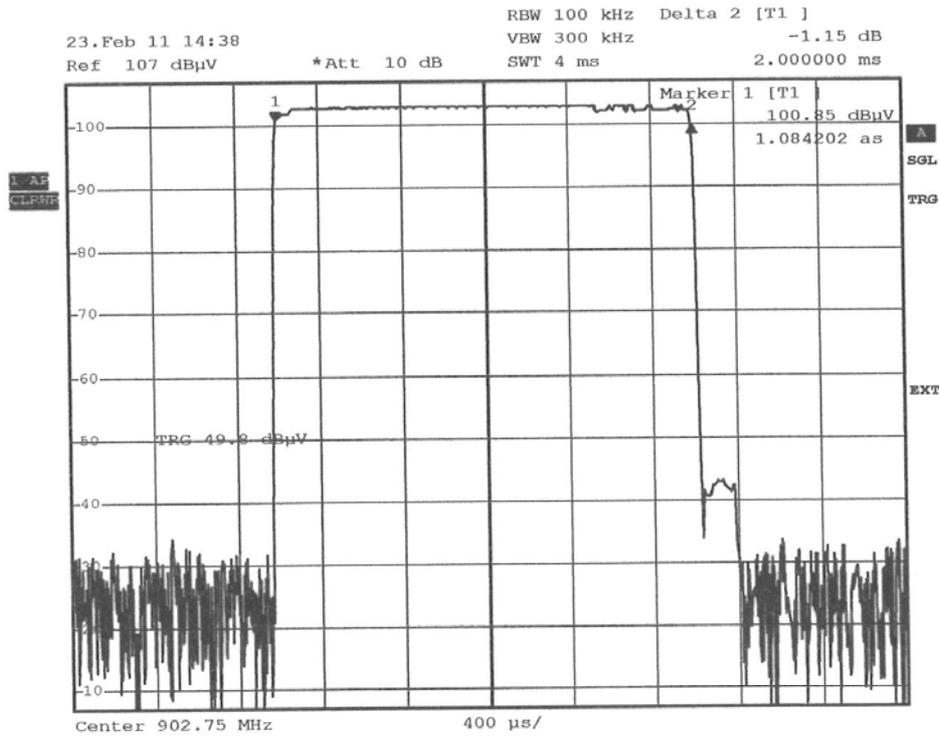
USA / Canada
 Channel separation
 High channel

ANNEX 2: NUMBER OF HOPPING CHANNELS



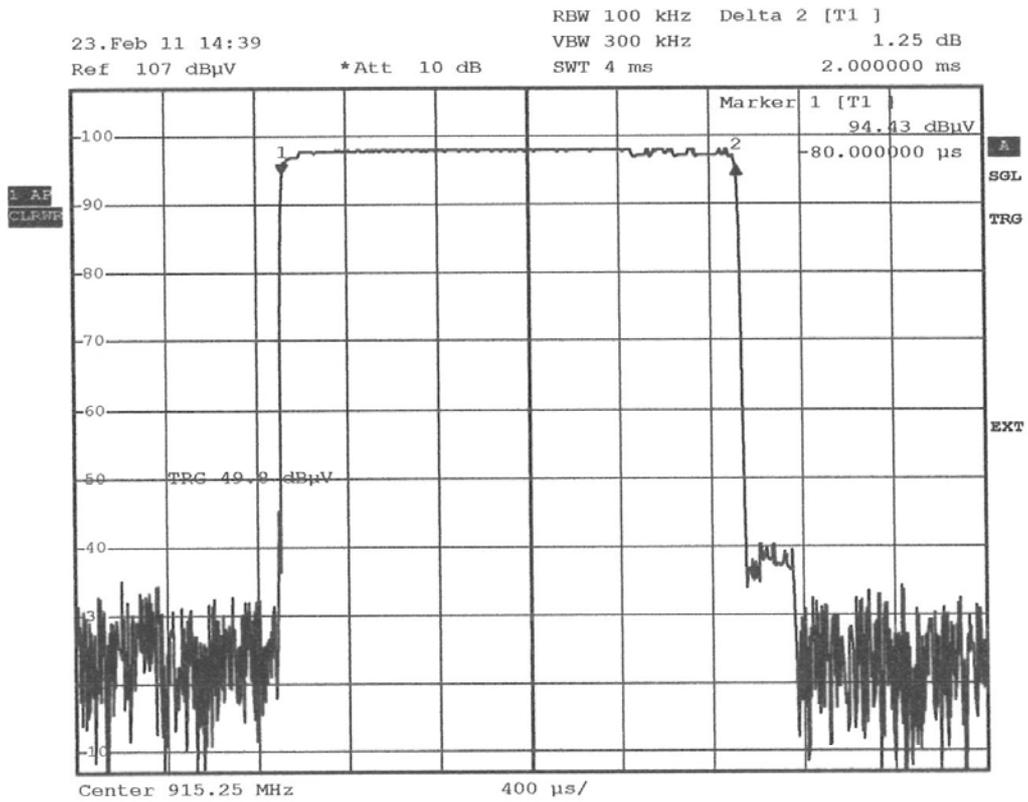
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USA/Canada
25 channels

ANNEX 3: DWELL TIME



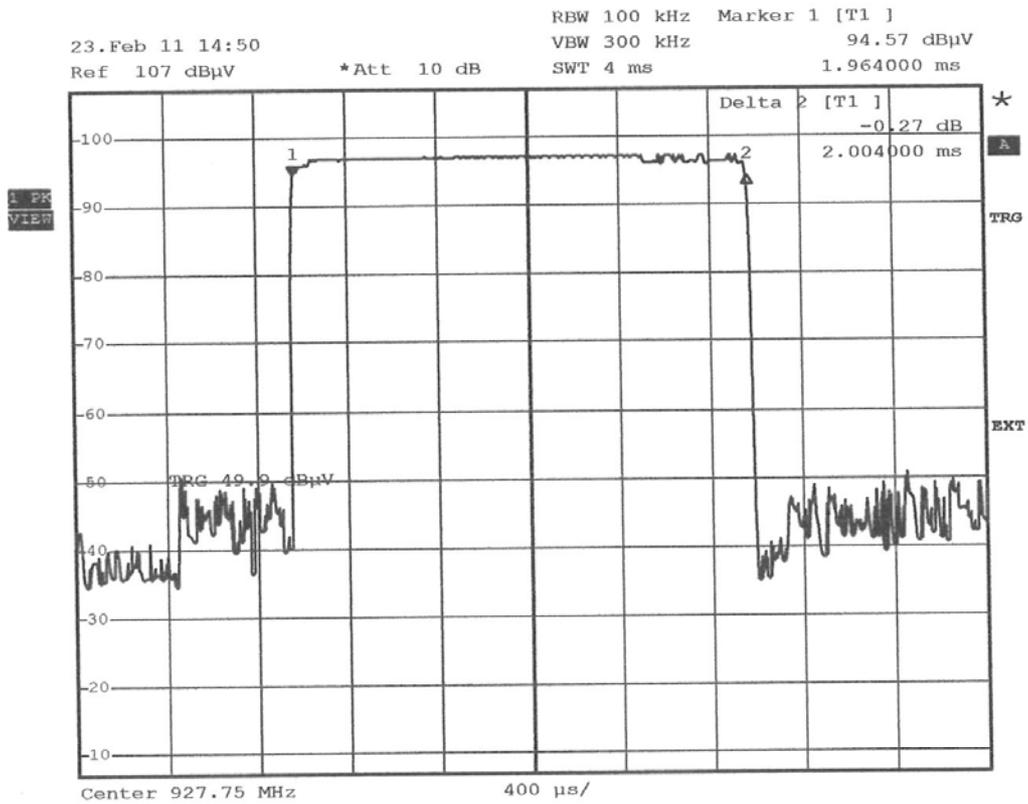
Date: 23.FEB.2011 14:38:59

USA/Canada
 Dwell time
 Low channel



Date: 23.FEB.2011 14:39:33

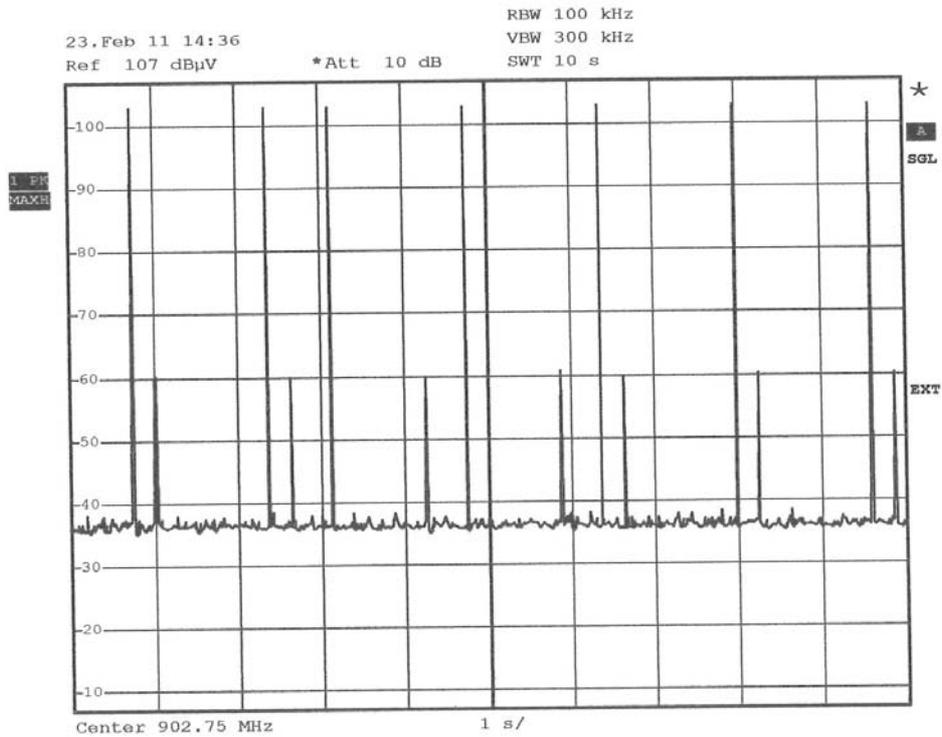
*USA/Canada
 Dwell time
 Middle channel*



Date: 23.FEB.2011 14:50:21

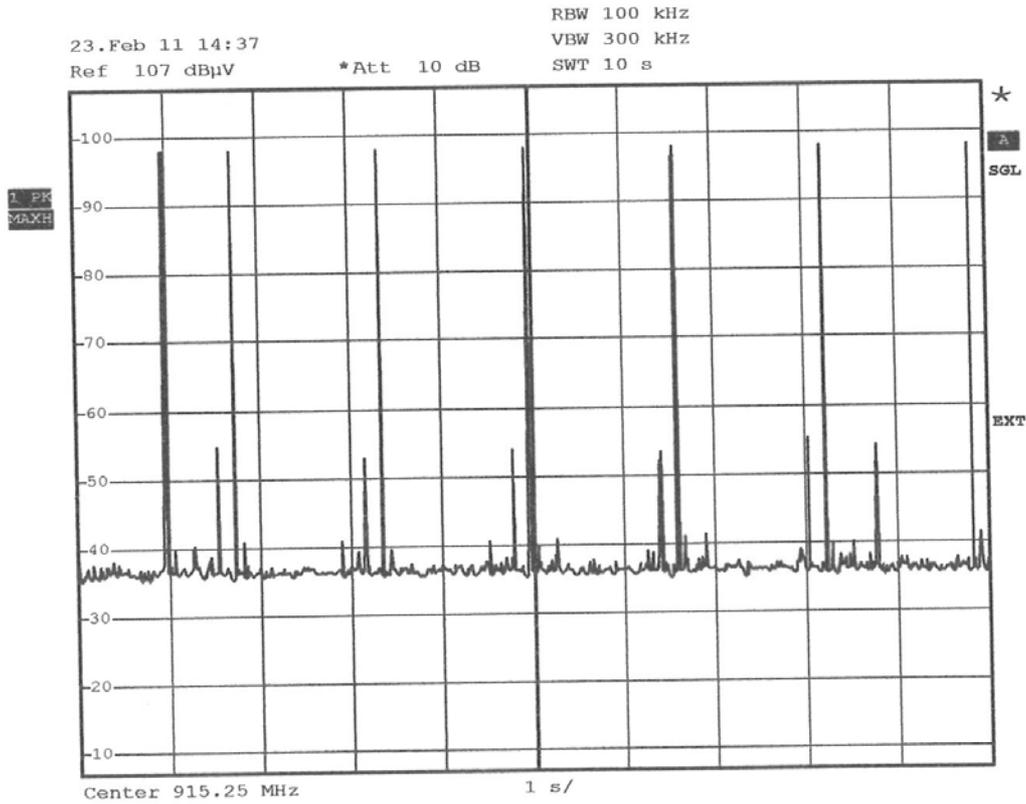
USA / Canada
 Dwell time
 High channel

ANNEX 4: AVERAGE TIME OF OCCUPANCY



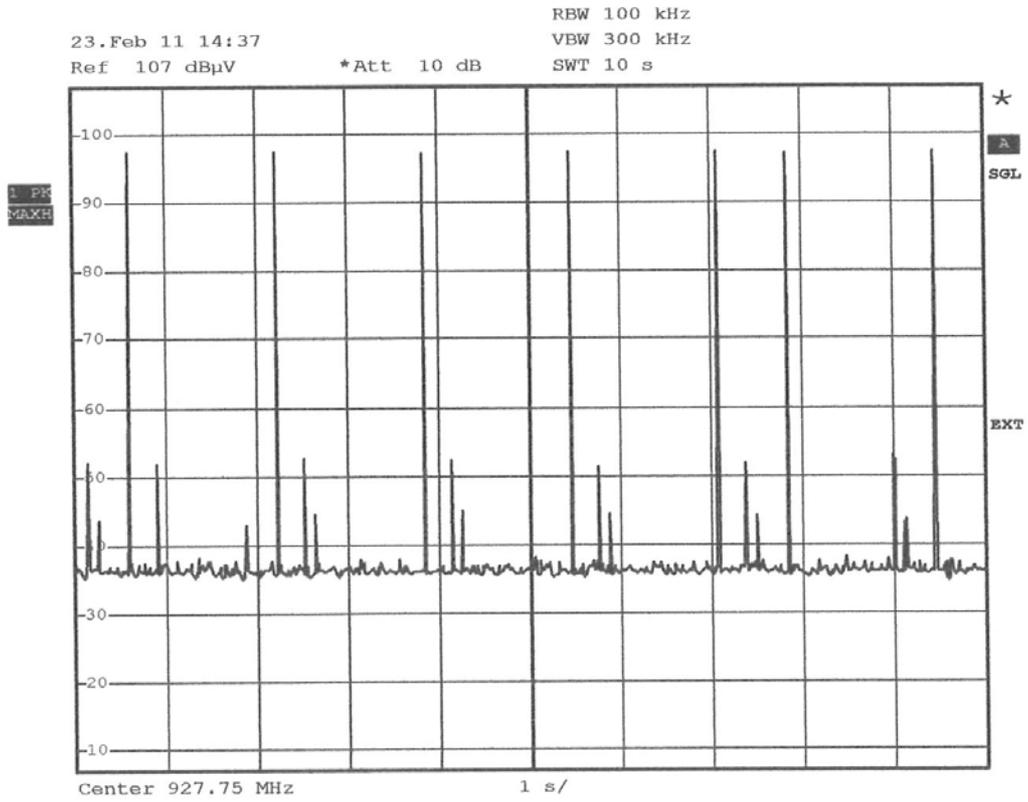
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USA / Canada
 Average time of occupancy
 low channel



Date: 23.FEB.2011 14:37:21

USA/Canada
Average time of occupancy
middle channel



Date: 23.FEB.2011 14:37:42

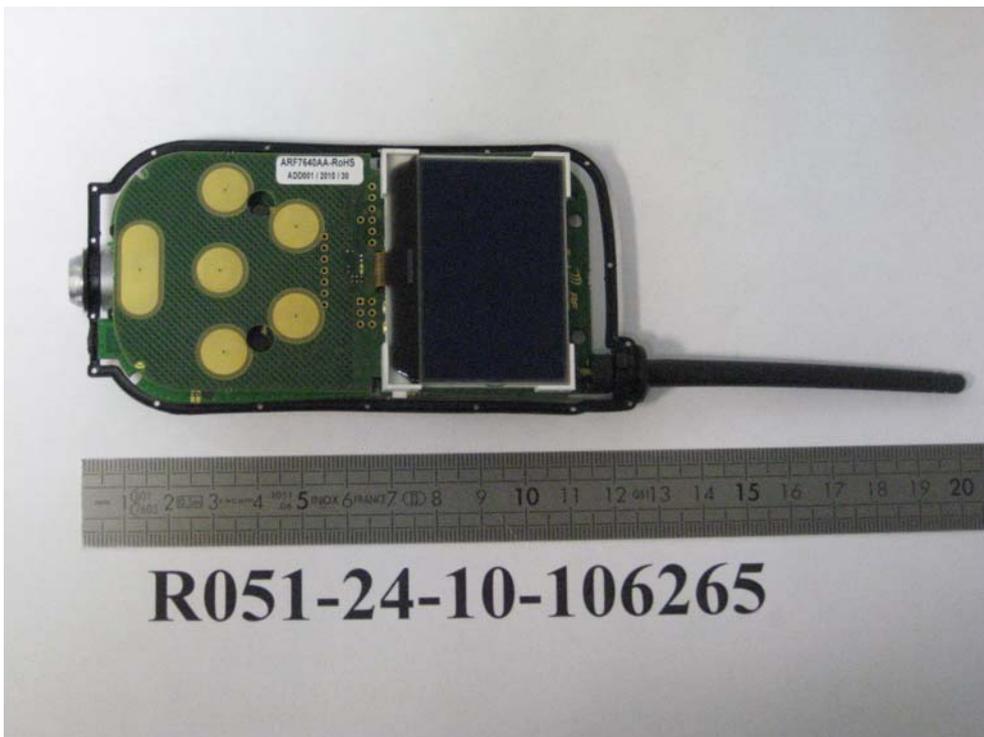
USA/Canada
Average time of occupancy
High channel

ANNEX 5: PHOTOS OF THE EQUIPMENT UNDER TEST

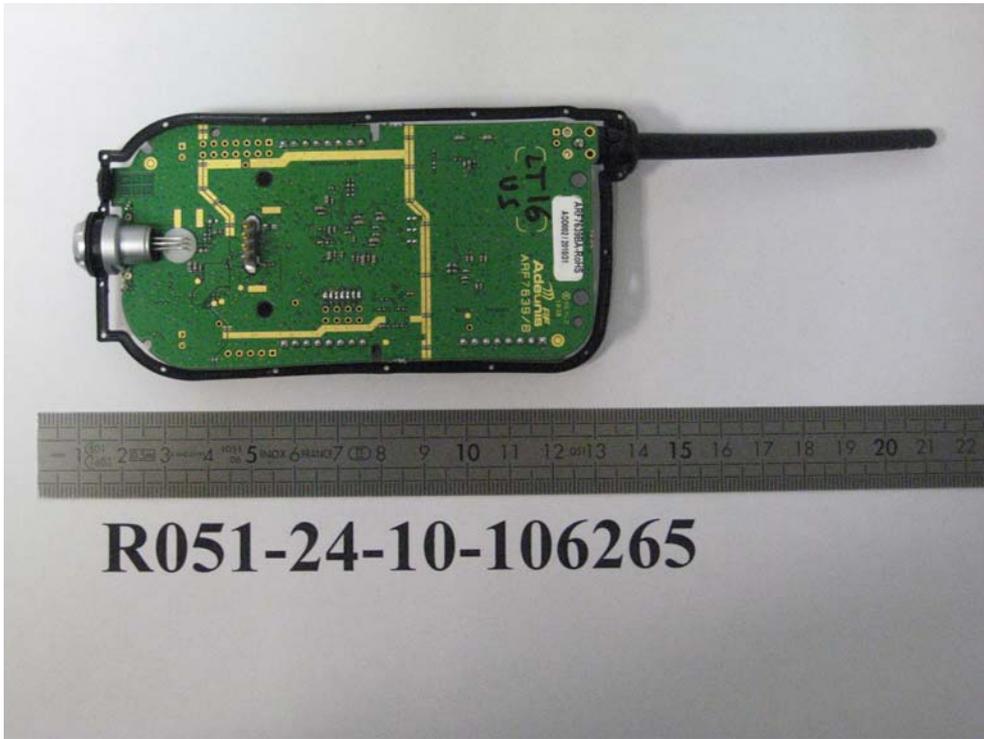
GENERAL VIEW



PRINTED CIRCUIT BOARD: FACE 1



PRINTED CIRCUIT BOARD: FACE 2



ANNEX 6: TEST SET UP AND OPEN AREA TEST SITE

RADIATED MEASUREMENTS



OPEN AREA TEST SITE

