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RA-24-07100829-2/A Ed. 0

RADIO test report

according to standard:
FCC Part 15.247

Equipment under test:
PROBE
RMP600

FCC ID:
KQGRMP600

Company:
RENISHAW SAS

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

Number of pages: 35 including 4 annexes

Ed.	Date	Modified pages	Written by Name	Visa	Technical Verification Quality Approval Name	Visa
0	26-Apr-07	Creation	L. BERTHAUD	LB	P. BONNENFANT	

PRODUCT:	**PROBE**
Reference / model:	RMP600
Serial number:	5N9832
MANUFACTURER:	RENISHAW PLC (United Kingdom)

COMPANY SUBMITTING THE PRODUCT:

Company:	RENISHAW SAS
Address:	15, rue Albert Einstein Champs-sur-Marne 77447 MARNE LA VALLEE CEDEX 2 FRANCE
Responsible:	Mr CRESSON
DATE(S) OF TEST:	03 and 06 April 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

CONTENTS

TITLE **PAGE**

1. INTRODUCTION

This document presents the result of RADIO test carried out on the following equipment: PROBE RMP600 in accordance with normative reference.

2. PRODUCT DESCRIPTION

ITU Emission code: 1M00F7D

Class: A (commercial, industrial or business environment)

Utilization: measuring probe for machine tools

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 ⊙ Synthetiser

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

Power source: Alkaline batteries LR6 (2 × 1.5 V) or Lithium batteries LS14500 (2 × 3.6 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 209: radiated emission limits; general requirements
Paragraph 247: operation within the bands 2400-2483.5 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 7*
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 4*
FCC Part 15.247	OPERATION WITHIN THE BAND 2400-2483.5 MHz					
	(a) (1) *hopping systems*	X				*Note 1*
	(a) (1) (i) 902 – 928 MHz			X		
	(a) (1) (ii) 5725 – 5850 MHz			X		
	(a) (1) (iii) 2400 – 2483.5 MHz	X				*Note 2*
	(a) (2) *digital modulation techniques*			X		
	(b) *max output power*	X				*Note 5*
	(c) *operation with directional antenna gains > 6 dBi*			X		*Note 3*
	(d) *intentional radiator*	X				
	(e) *peak power spectral density*			X		
	(f) *hybrid system*			X		
	(g)	X				
	(h)	X				
	(i) *RF exposure compliance*	X				*Note 6*
Public Notice DA 00-705	BAND EDGE COMPLIANCE	X				

NAp: Not Applicable NAs: Not Asked

Note 1: the frequency hopping system have hopping channel carrier frequencies separated by 1 MHz. The system hop 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 (see annex 1).

Note 2: the frequency hopping system use more than 15 channels.
The timing by channel is 606 µs. During 79 channels × 0.4 s (part 15) = 31.6 s, any channel is used 400 times, then 400 x 606 µs = 242.4 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 3: the antenna gain is less than 6 dBi.

Note 4: see FCC part 15.247 (d).

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

Note 6: 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).

Note 7: internal antenna (pcb antenna) (see annex 3).

Conclusion:

The sample of PROBE RMP600 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 FSP 40	Rohde & Schwarz	4088
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 6769B	Wiltron	696
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
Power source E3610A	Hewlett Packard	4195

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, by substitution method. The measuring distance between the equipment and the test antenna is 3 m. The antenna has been oriented in the two polarizations, we have recorded only highest level.

In first the spectrum analyzer is 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 is blocked in continuous modulated transmission mode.

Results:

Ambient temperature (°C): 21.5
Relative humidity (%): 52

Polarization of test antenna: vertical (height: 177 cm)
Position of equipment: up right (azimuth: 277 degrees)

Sample n° 1 Hopping mode

		Peak Output Power radiated at these frequencies (W): from 2403 MHz to 2481 MHz	Limits (W)
Normal test conditions	Nominal power source (V): 3	0.467×10^{-3}	1*

* the frequency hopping systems use at least 75 hopping channel.

Sample n° 1 Channel 1 (2403 MHz)

		Level dBµV	Cable loss dB	Antenna factor dB	Electro-magnetic field (dBµV/m):	P* (W)
Normal test conditions	Nominal power source (V): 3	54.02	4.75	29.16	87.93	0.186×10^{-3}

Sample n° 1 Channel 40 (2442 MHz)

		Level dBµV	Cable loss dB	Antenna factor dB	Electro-magnetic field (dBµV/m):	P* (W)
Normal test conditions	Nominal power source (V): 3	57.63	4.75	29.16	91.54	0.428×10^{-3}

Sample n° 1 Channel 79 (2481 MHz)

		Level dBµV	Cable loss dB	Antenna factor dB	Electro-magnetic field (dBµV/m):	P* (W)
Normal test conditions	Nominal power source (V): 3	57.83	4.75	29.16	91.74	0.448×10^{-3}

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

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
Power source E3610A	Hewlett Packard	4195

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 is blocked in continuous modulated transmission mode.

Results:

Ambient temperature (°C): 19.5
Relative humidity (%): 53

Power source: 3 Vd.c.

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

Channel 1

FREQUENCIES (MHz)	Detector Avg: Average QP: Quasi-Peak Pk: Peak	Antenna height (cm)	Azimuth (degree)	resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m)	Limits (dBµV/m)	Margin (dB)
416	QP	100	50	120	H	38	71.66	33.66
636	QP	100	200	120	V	37.3	71.66	34.36
660	QP	100	210	120	V	38.5	71.66	33.16
788	QP	134	230	120	V	43.5	71.66	28.16
820	QP	134	200	120	V	43.7	71.66	27.96
4806.4	Avg	235	80	1000	H	50.5	53.98*	3.48
4806.4	Pk	235	80	1000	H	62.9	73.98*	11.08

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

Channel 40

FREQUENCIES (MHz)	Detector Avg: Average QP: Quasi-Peak Pk: Peak	Antenna height (cm)	Azimuth (degree)	resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m)	Limits (dBµV/m)	Margin (dB)
416	QP	100	50	120	H	38	71.66	33.66
636	QP	100	200	120	V	37.3	71.66	34.36
660	QP	100	210	120	V	38.5	71.66	33.16
788	QP	134	230	120	V	43.5	71.66	28.16
820	QP	134	200	120	V	43.7	71.66	27.96
4884	Avg	150	348	1000	V	53.8	53.98*	0.18
4884	Pk	150	348	1000	V	67.7	73.98*	6.28

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

Channel 79

FREQUENCIES (MHz)	Detector Avg: Average QP: Quasi-Peak Pk: Peak	Antenna height (cm)	Azimuth (degree)	resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m)	Limits (dBµV/m)	Margin (dB)
416	QP	100	50	120	H	38	71.66	33.66
636	QP	100	200	120	V	37.3	71.66	34.36
660	QP	100	210	120	V	38.5	71.66	33.16
788	QP	134	230	120	V	43.5	71.66	28.16
820	QP	134	200	120	V	43.7	71.66	27.96
4962.48	Avg	148	0	1000	V	53.4	53.98*	0.58
4962.48	Pk	148	0	1000	V	67.8	73.98*	6.18

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

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 91.66 dBµV/m on channel 79.

So the applicable limit is **71.66 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

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	1938
Power source E3610A	Hewlett Packard	4195

Measured condition:

Requirements: Emissions that fall in the restricted bands (part 15.205). These emissions must be less than or equal to 500 µV/m (54 dBµV/m)/ Part 15.35b applies in the restricted bands.

Test procedure: An in band field strength measurement of the fundamental Emission using the RBw and detector function required by C63.4-2003 and FCC Rules.

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)
2403.08	87.93	Peak	2372.66	-43.67	44.26(1)	74	29.74
2481.08	91.74	Peak	2484	-42.93	48.81[1)]	74	25.19

* according to step 2 of Marker-Delta Method DA 00-705.

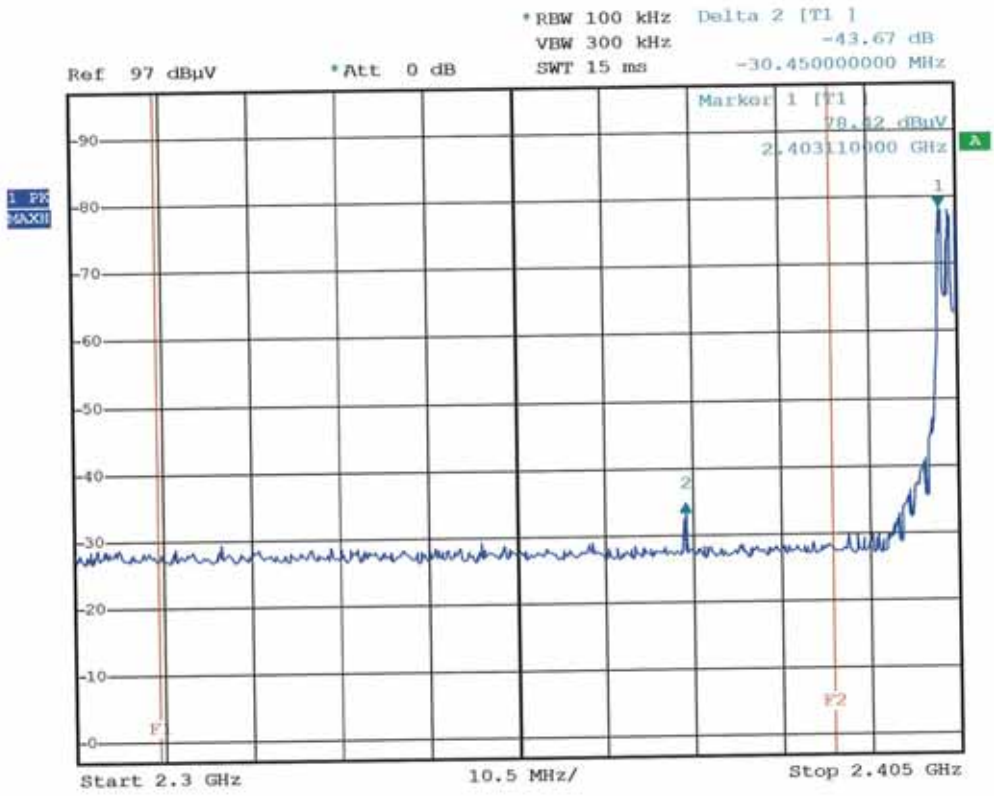
** according to step 3 of Marker-Delta Method:
Calculated Emission Level = Field Strength Level – Delta Marker Level

(1) the level is lower than the average limit (54 dBµV/m).

Test conclusion:

RESPECTED PUBLIC NOTICE

CURVE N°: 1.



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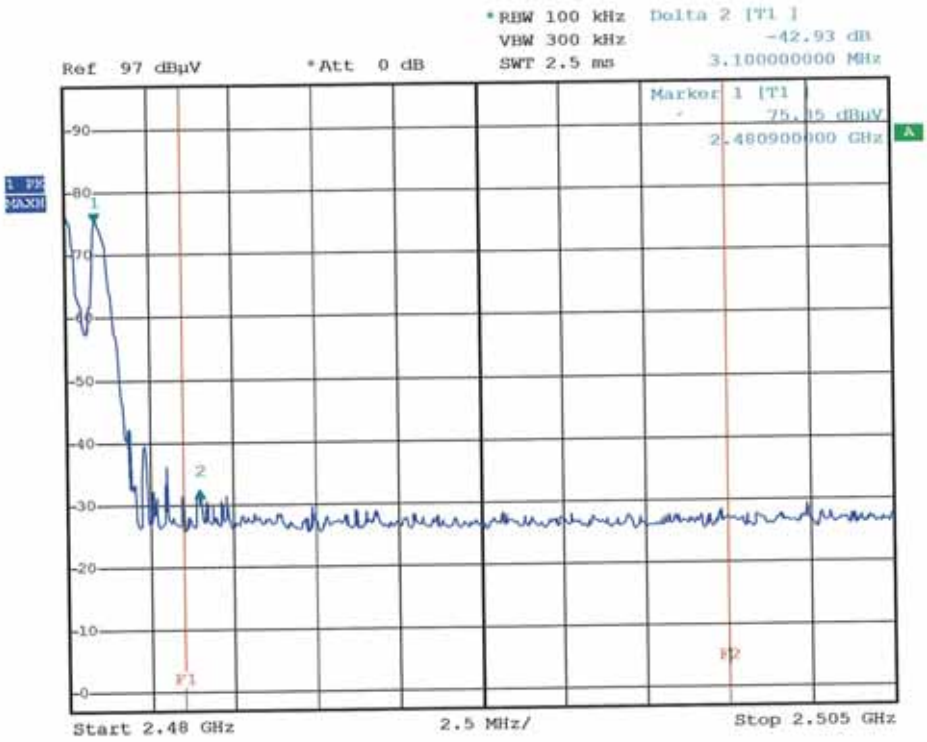
CURVE N°: 2.



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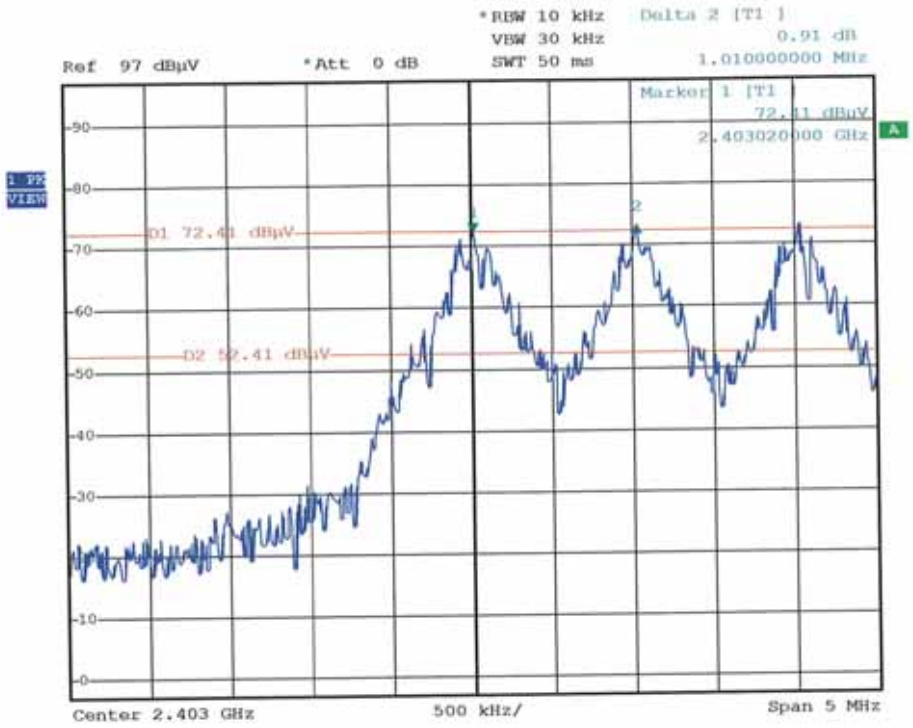
ANNEX 1: CHANNEL SEPARATION AND OCCUPIED POWER BANDWIDTH



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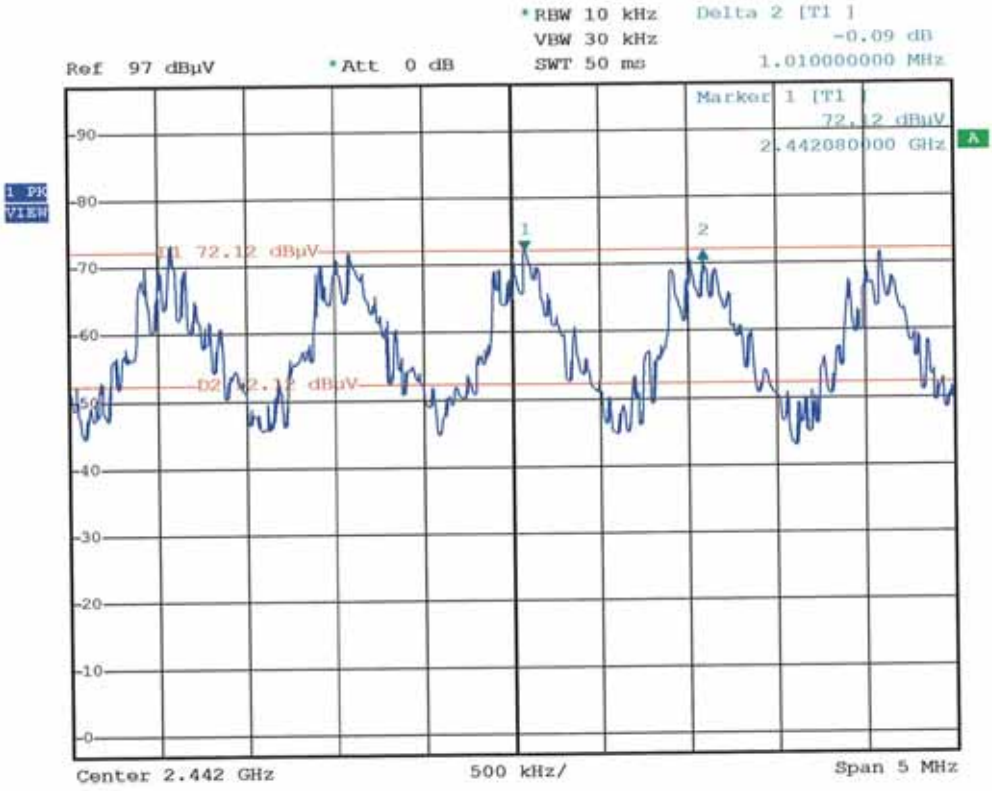

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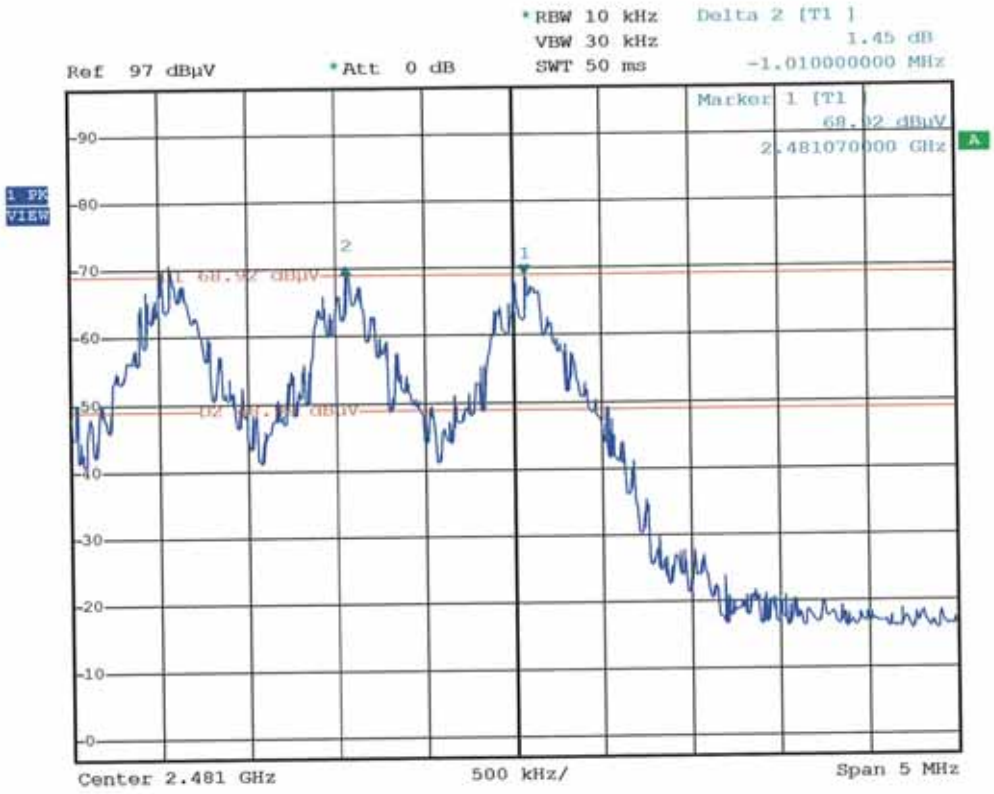

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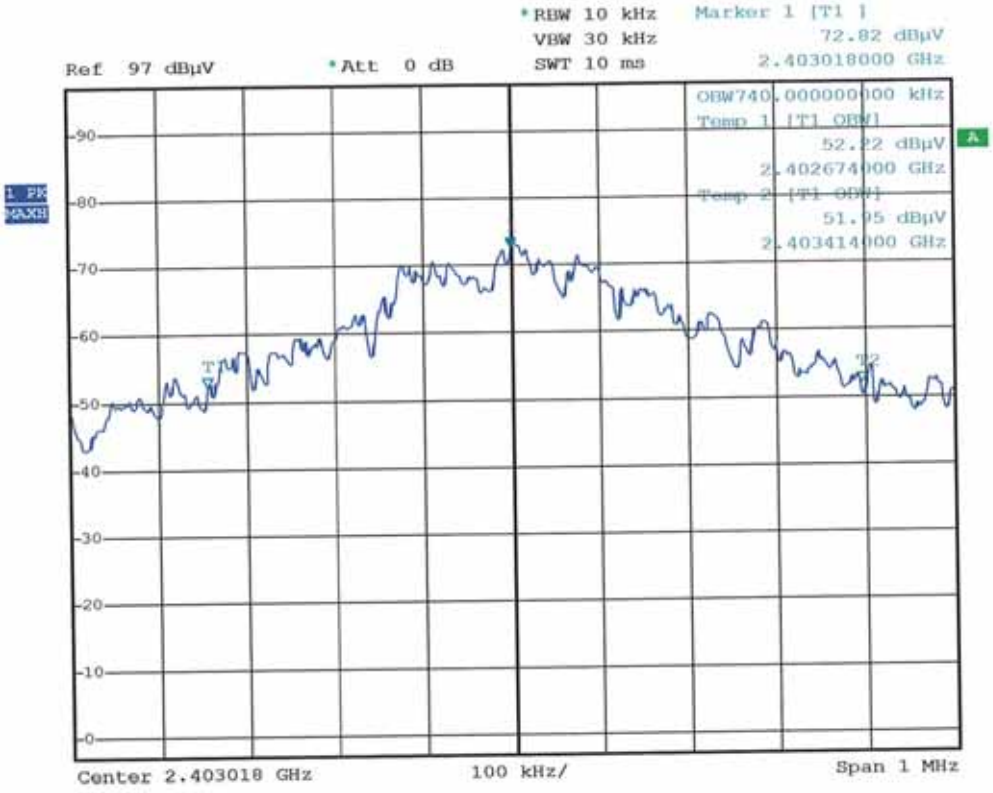

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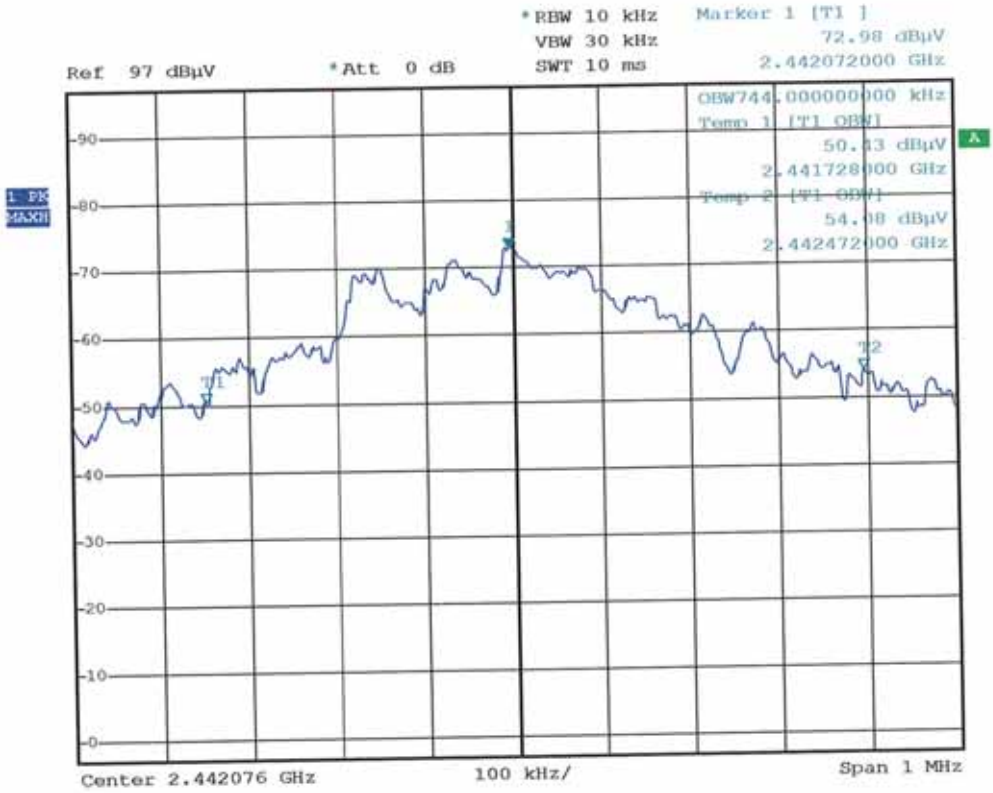

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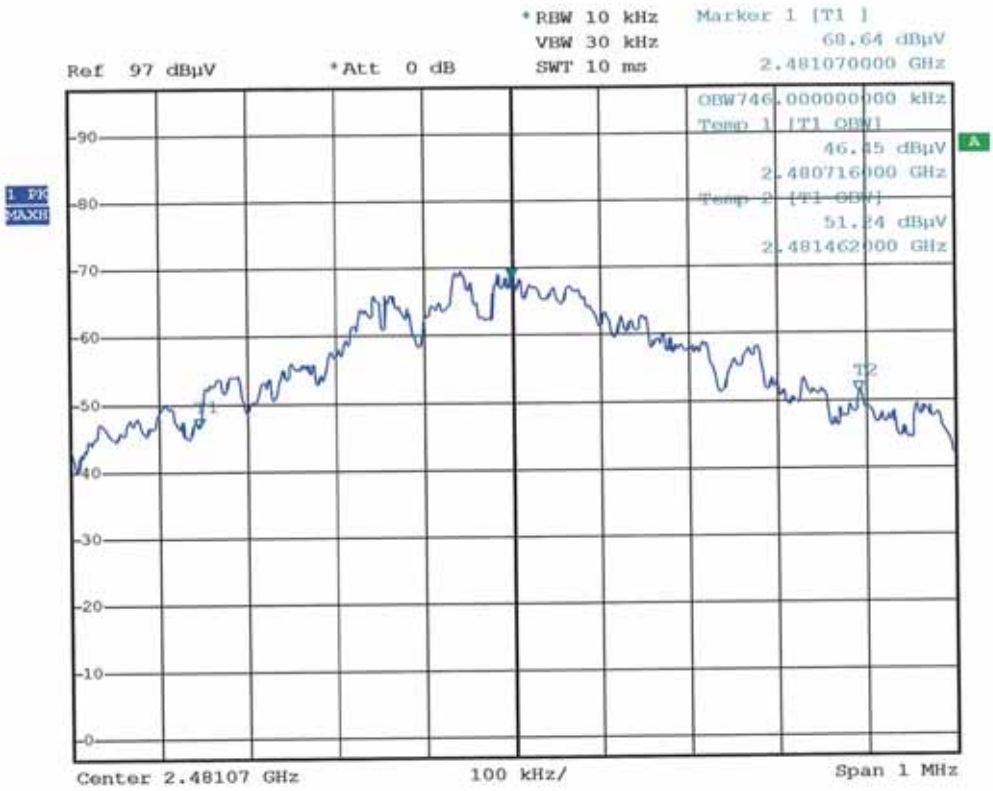

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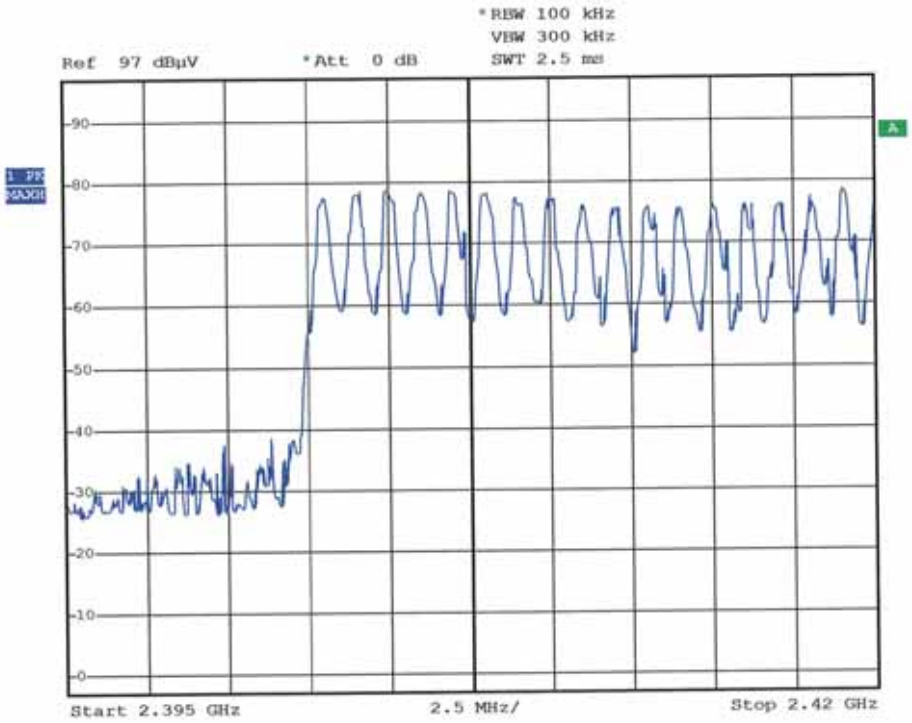
ANNEX 2: NUMBER OF HOPPING CHANNELS AND AVERAGE TIME OF OCCUPANCY ON ANY FREQUENCY



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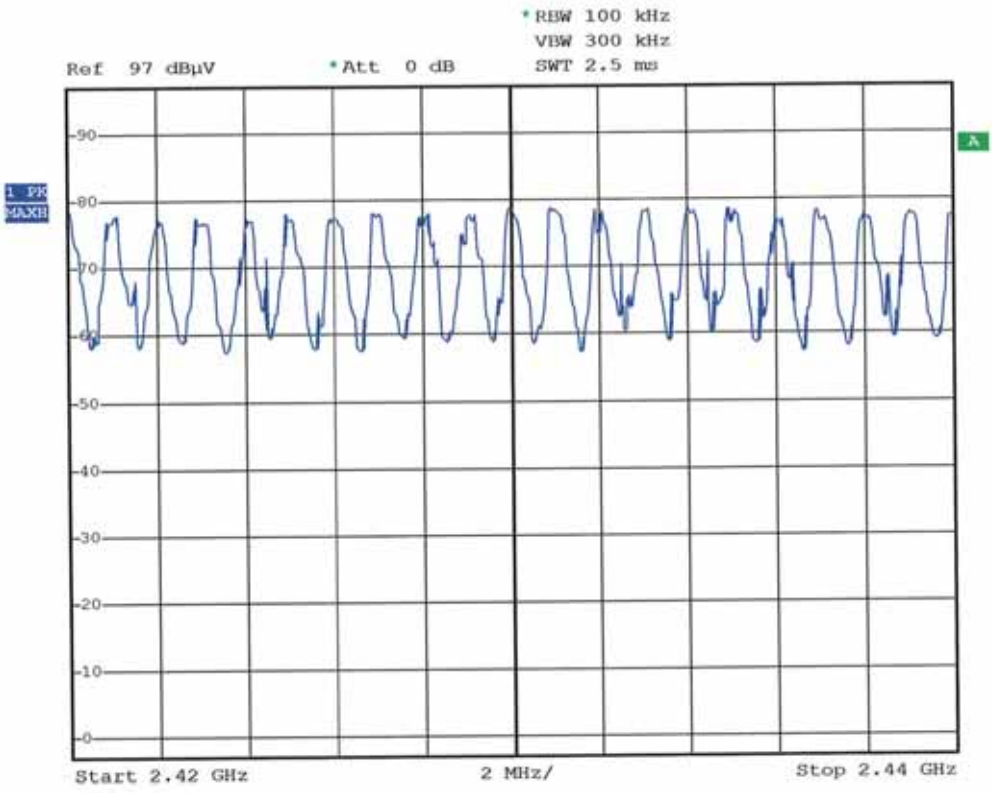

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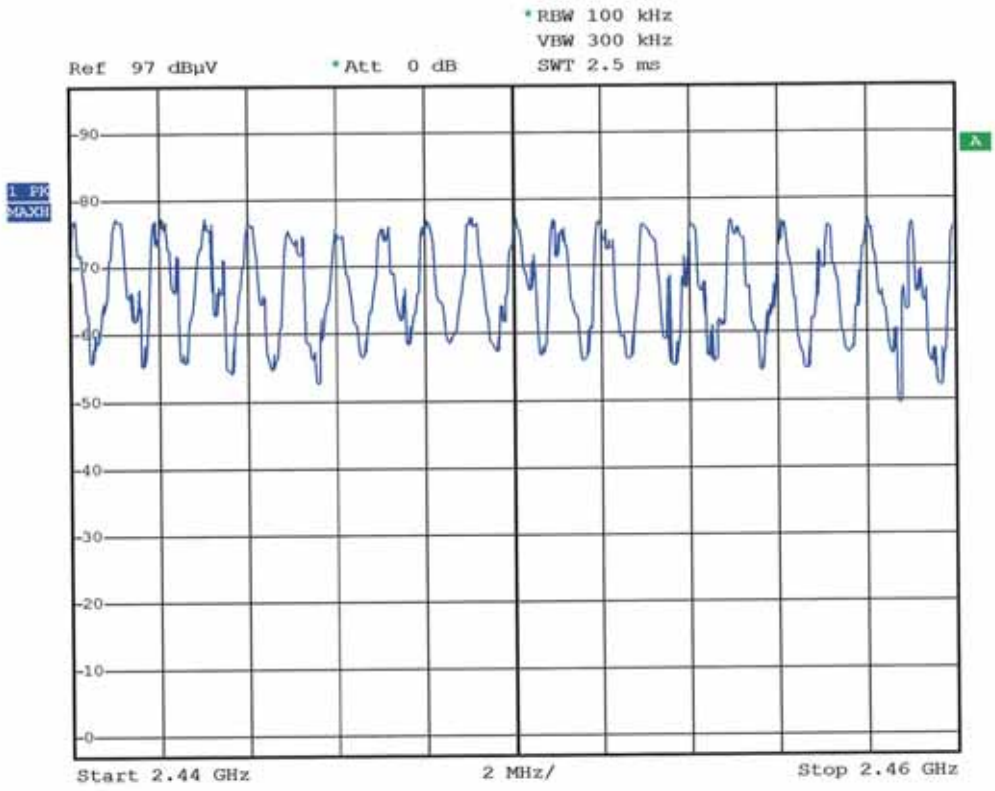

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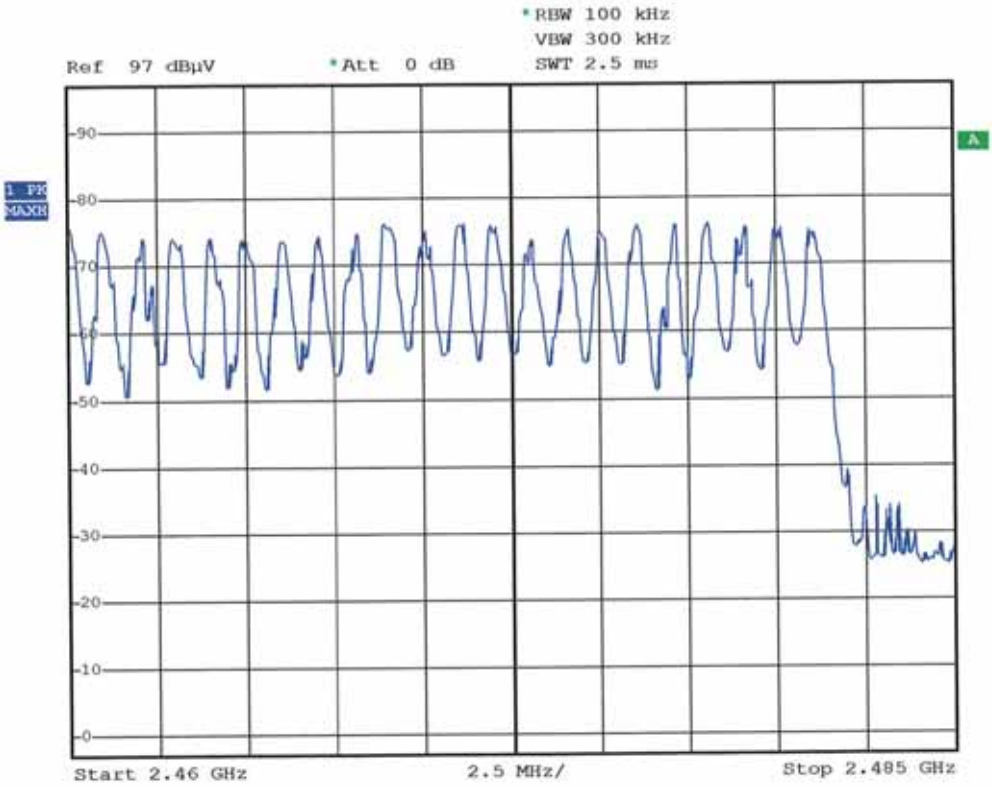

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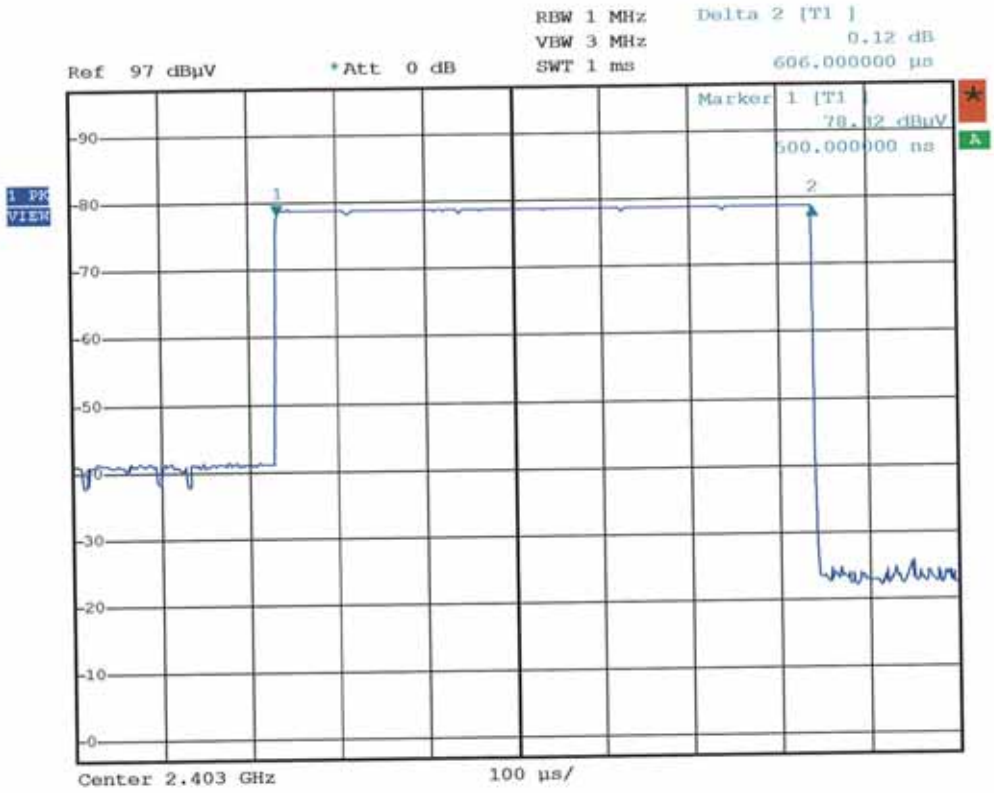

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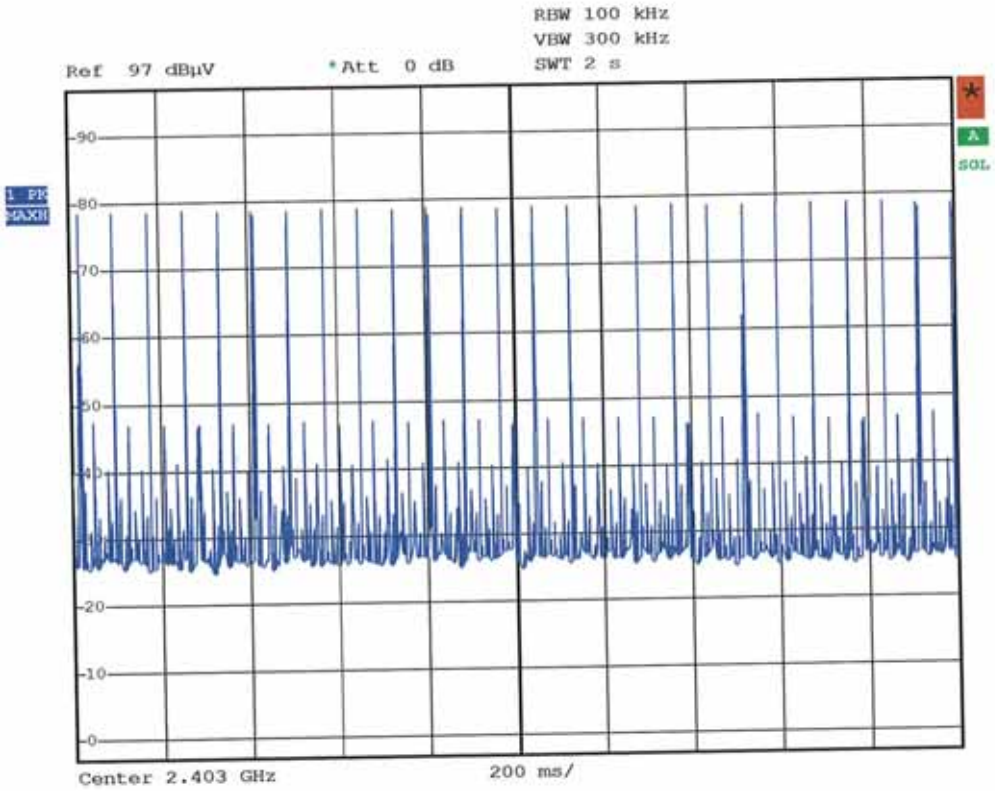

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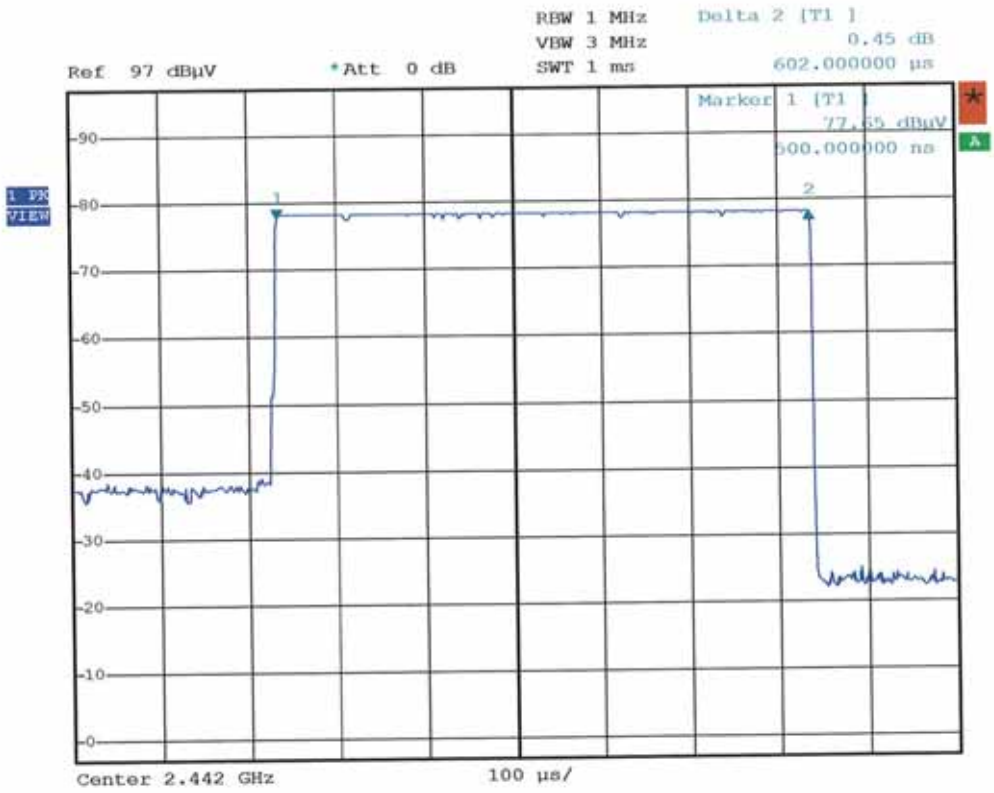

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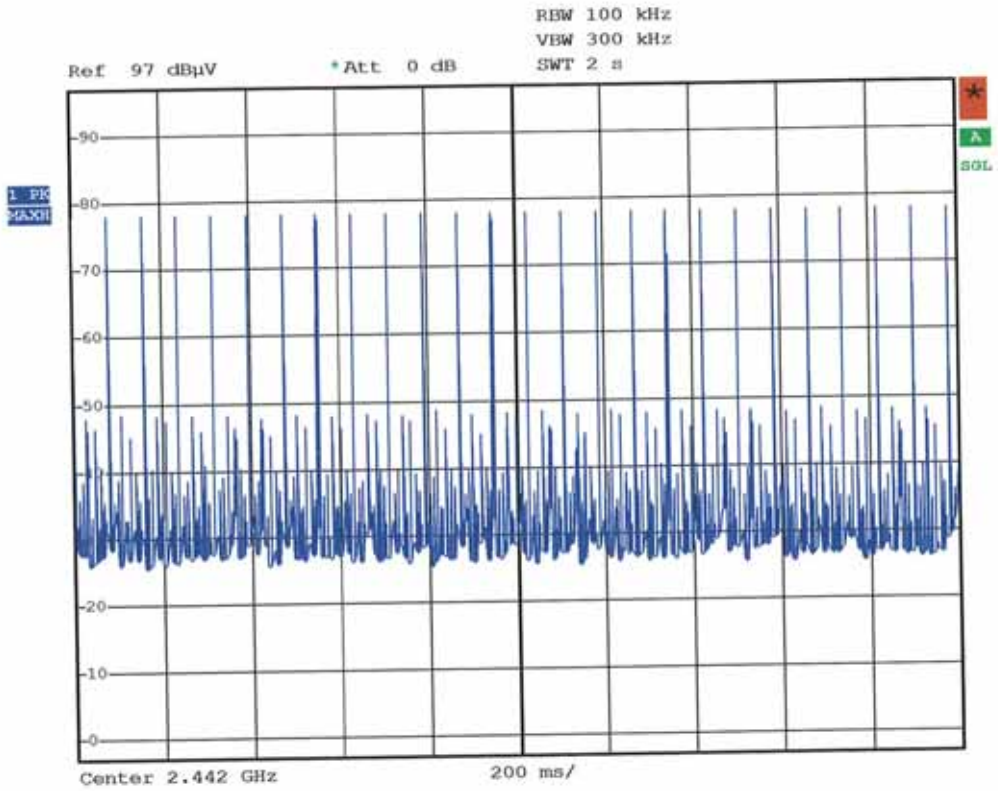

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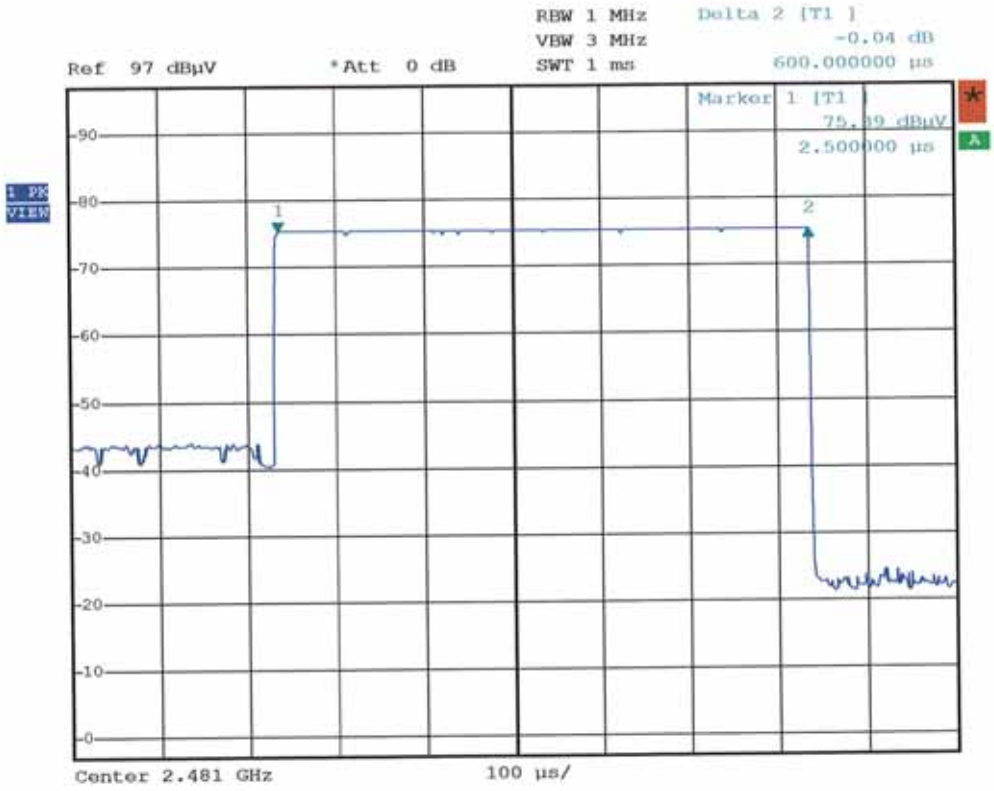

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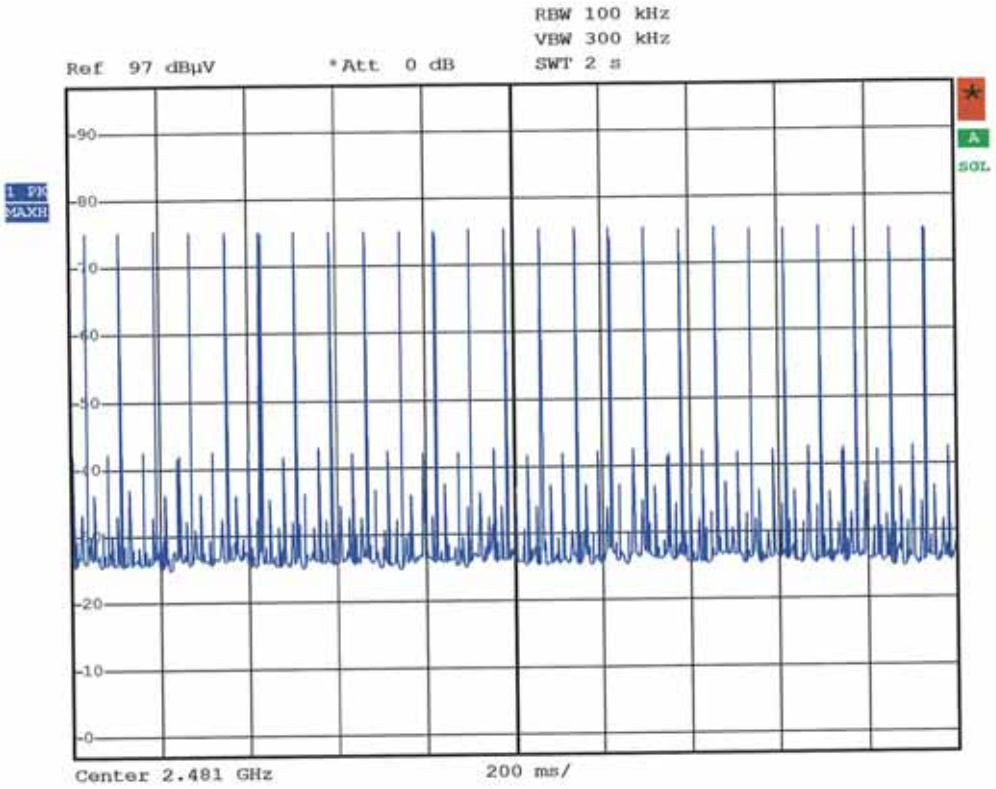

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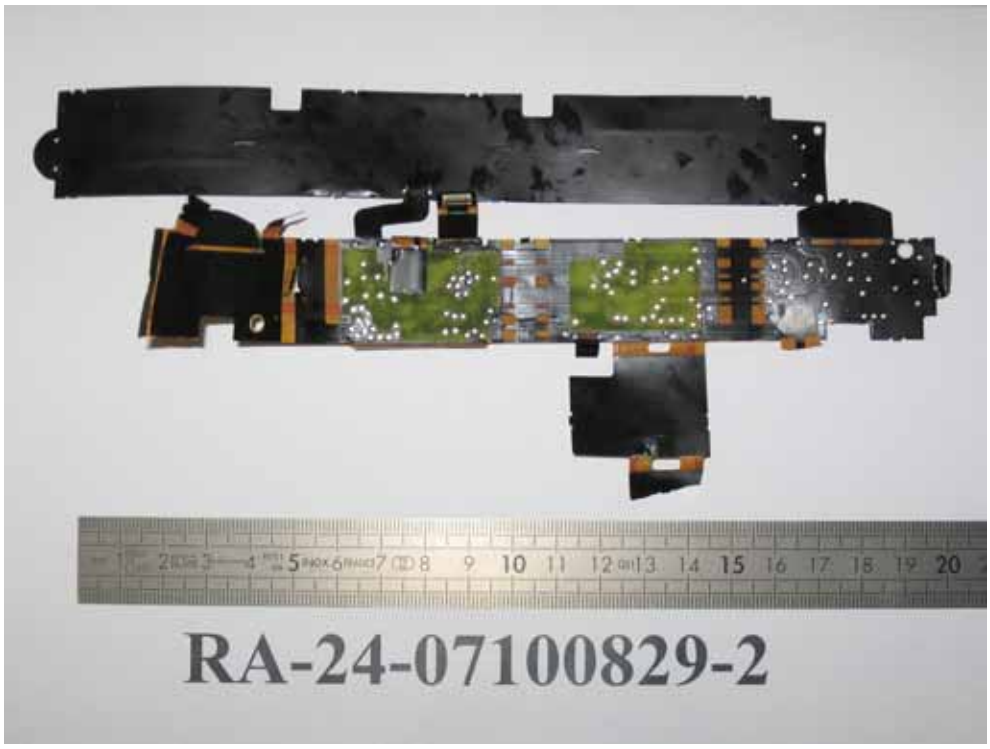
ANNEX 3: PHOTOS OF THE EQUIPMENT UNDER TEST

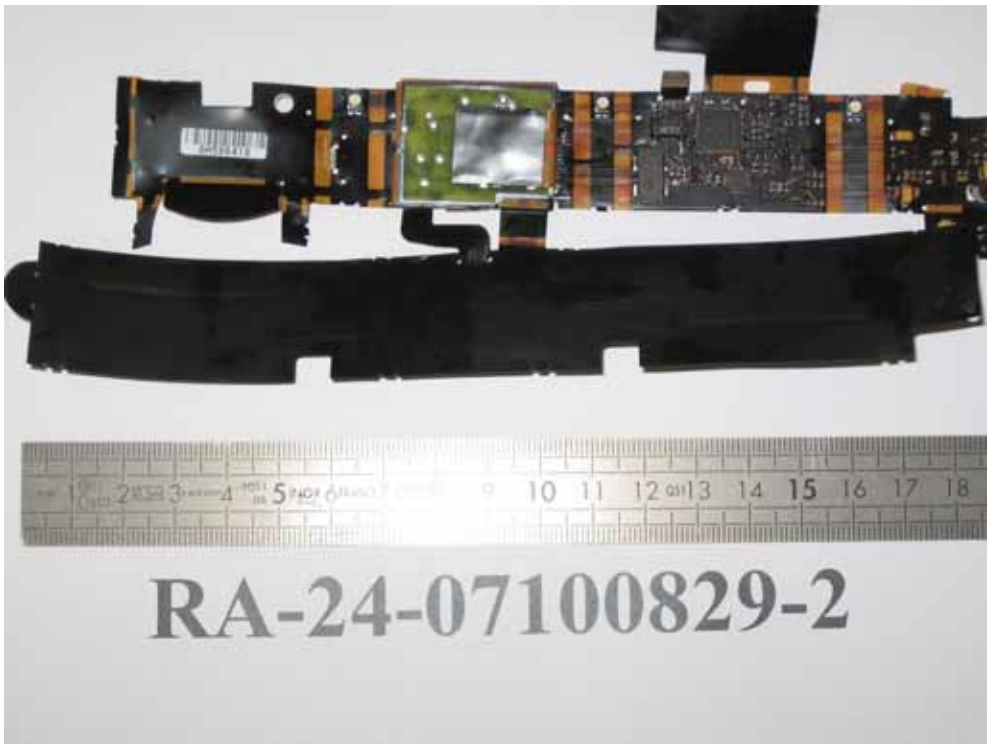
GENERAL VIEW

Printed circuit board: face 1



Printed circuit board: face 2

Antenna



ANNEX 4: TEST SET UP