



RA-24-07104522-2/A Ed. 0

**FCC CERTIFICATION
RADIO Measurement
Technical Report**

**standard to apply:
FCC Part 15.247**

**Equipment under test:
PROBE RMP40**

**FCC ID :
KQGRMP40**

**Company:
RENISHAW SAS**

DISTRIBUTION: Mr CRESSON

Company: RENISHAW SAS

Number of pages: 34 including 6 annexes

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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: RMP40
Serial number: not communicated

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: 23 and 24 October 2007

TESTING LOCATION: EMITECH ATLANTIQUE laboratory at ANGERS (49) FRANCE
EMITECH ATLANTIQUE open area test site in LA POUZE (49)
FRANCE

Registration Number by FCC: 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: PROBE RMP40 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:	<input type="radio"/> SAW Resonator <input type="radio"/> Crystal <input checked="" type="radio"/> Synthesizer
Modulation: Frequency Hopping Spread Spectrum (FHSS)	<input type="radio"/> Amplitude <input type="radio"/> Digital <input checked="" type="radio"/> Frequency <input type="radio"/> Phase
Power source:	batteries Li-SOCl ₂ (2 × 3.6 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 (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) <i>hopping systems</i>	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) <i>digital modulation techniques</i>			X		
	(b) <i>max output power</i>	X				Note 5
	(c) <i>operation with directional antenna gains > 6 dBi</i>			X		Note 6
	(d) <i>intentional radiator</i>	X				
	(e) <i>peak power spectral density</i>			X		
	(f) <i>hybrid system</i>			X		
	(g)	X				
	(h)	X				
	(i) <i>RF exposure compliance</i>	X				Note 7
DA 00-705	BAND EDGE COMPLIANCE	X				

NAP: Not Applicable

NAs: Not Asked

Note 1: *internal antenna (pcb antenna), see photos in annex 5.*

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 (782 kHz; see annexes 1 and 2).*

Note 4: *the frequency hopping system uses 79 channels (see annex 4).*

The timing by channel is 349 μs. During 79 channels × 0.4 s (part 15) = 31.6 s, any channel is used 416 times, then 416 × 349 μs = 145.18 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 3).

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 PROBE RMP40 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	Omnigig	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): 21.5
 Relative humidity (%): 41

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

Voltage at the beginning of test (V): 7.1
 Voltage at the end of test (V): 7.07

Polarization of test antenna: vertical (height: 119 cm)
 Position of equipment: up right (azimuth: 0 degree)

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): 7.2	0.288×10^{-3}	1*

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

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): 7.2	53.92	4.64	28.86	87.42	0.100×10^{-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): 7.2	54.19	4.69	29.01	87.89	0.112×10^{-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): 7.2	55.62	4.75	29.16	89.53	0.163×10^{-3}

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

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 ($F_{\text{carrier}} \leq 10 \text{ GHz}$)

Bandwidth: 120 kHz ($F < 1 \text{ GHz}$) or 100 kHz, following 15.205 or 15.247
 1 MHz ($F > 1 \text{ GHz}$) 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): 20.5
 Relative humidity (%): 42

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

Voltage at the beginning of test (V): 7.2
 Voltage at the end of test (V): 7.1

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

Channel 1

FREQUENCIES (MHz)	Detector	Antenna height (cm)	Azimuth (degree)	resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m)	Limits (dBµV/m)	Margin (dB)
4806.21	Avg	231	138	1000	V	33.53	53.98*	20.45
4806.21	Peak	231	138	1000	V	56.98	73.98*	17
7209.41	Peak	243	308	100	V	51.9	68.91	17.01

Channel 40

FREQUENCIES (MHz)	Detector	Antenna height (cm)	Azimuth (degree)	resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m)	Limits (dBµV/m)	Margin (dB)
4884.34	Avg	140	150	1000	V	34.98	53.98*	19
4884.34	Peak	140	150	1000	V	62.06	73.98*	11.92
7326.38	Avg	227	309	1000	V	39.53	53.98*	14.45
7326.38	Peak	227	309	1000	V	59.52	73.98*	14.46

Channel 79

FREQUENCIES (MHz)	detector	Antenna height (cm)	Azimuth (degree)	resolution bandwidth (kHz)	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m)	Limits (dBµV/m)	Margin (dB)
4962.21	Avg	150	265	1000	V	35.42	53.98*	18.56
4962.21	Peak	150	265	1000	V	61.57	73.98*	12.41
7443.42	Avg	251	304	1000	V	<35	53.98*	>19
7443.42	Peak	251	304	1000	V	55.68	73.98*	18.3

* 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 88.91 dBµV/m on channel 79.

So the applicable limit is **68.91 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	1204
Multimeter 77-2	Fluke	0812

Test set up:

The measure is realized in near field and the field strength levels are correlated with the peak output power 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 (dB μ V/m)	Detector (Peak or Average)	Frequency of maximum Band-edges Emission (MHz)	Delta Marker (dB)*	Calculated Max Out of Band Emission Level (dB μ V/m)**	Limit (dB μ V/m)	Margin (dB)
2403	87.42	Peak	2338.06	-47.11	40.31 ⁽¹⁾	73.98	33.67
2481	89.53	Peak	2483.7	-38.91	50.62 ⁽¹⁾	73.98	23.36

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

** according to step 3 of Marker-Delta Method:

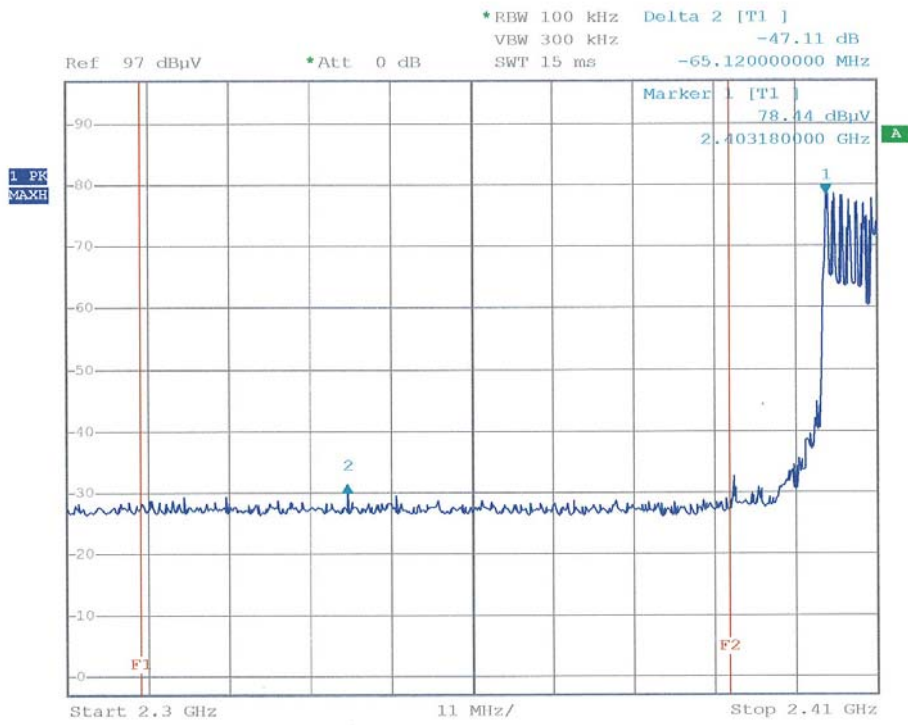
Calculated Emission Level = Field Strength Level – Delta Marker Level

⁽¹⁾ the peak level is lower than the average limit (53.98 dB μ V/m).

Test conclusion:

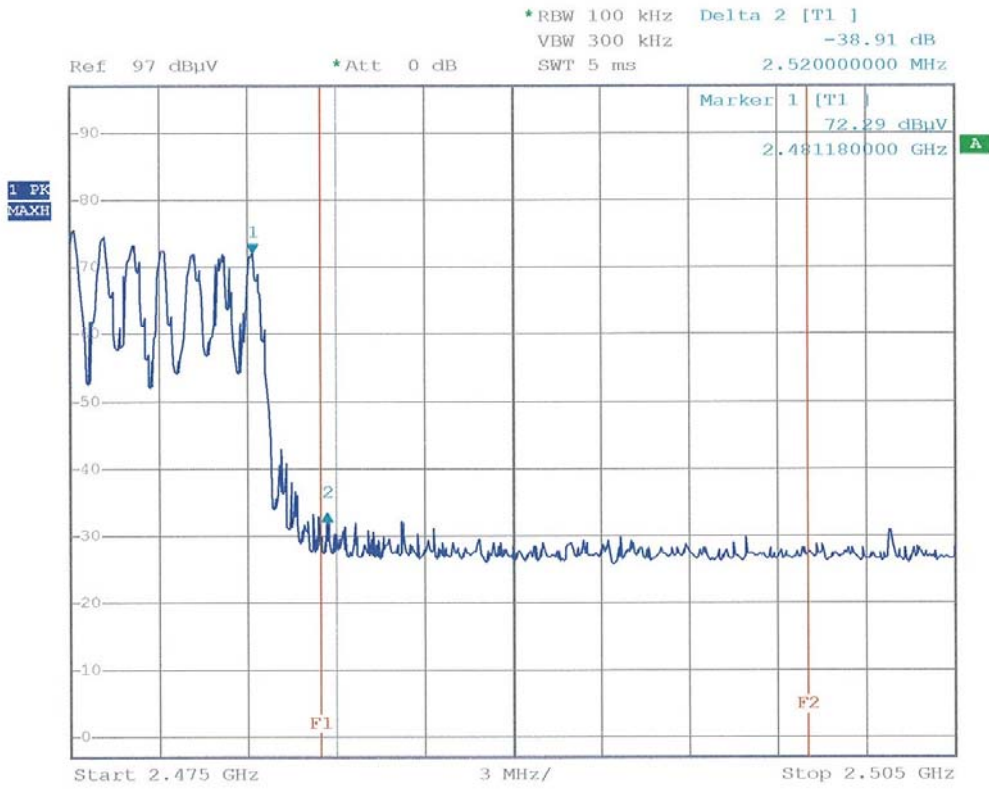
RESPECTED PUBLIC NOTICE

CURVE N°: 1.



Date: 24.OCT.2007 15:07:40

CURVE N°: 2.

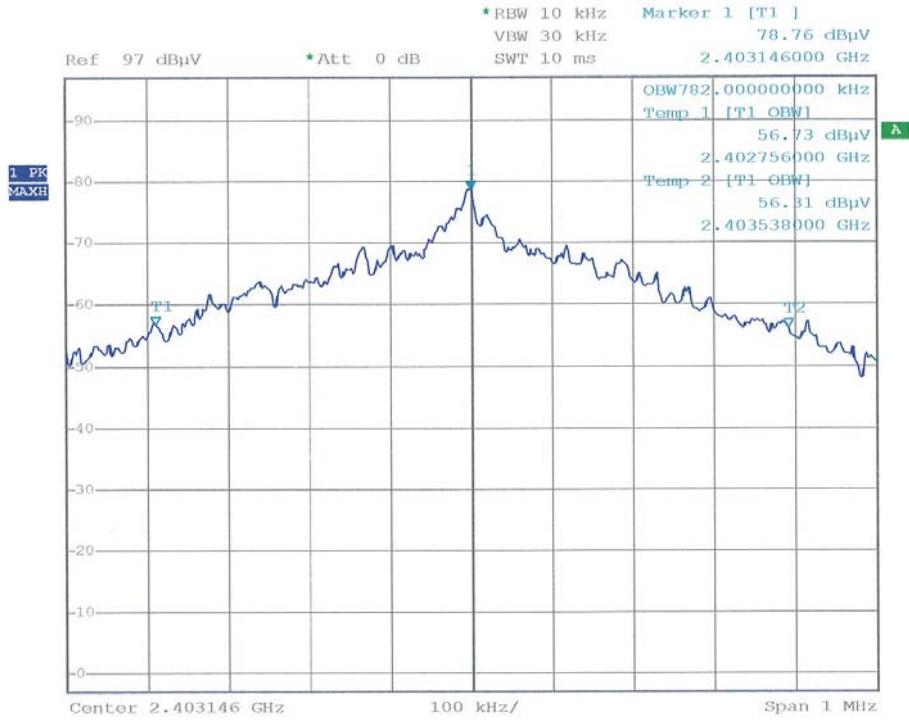


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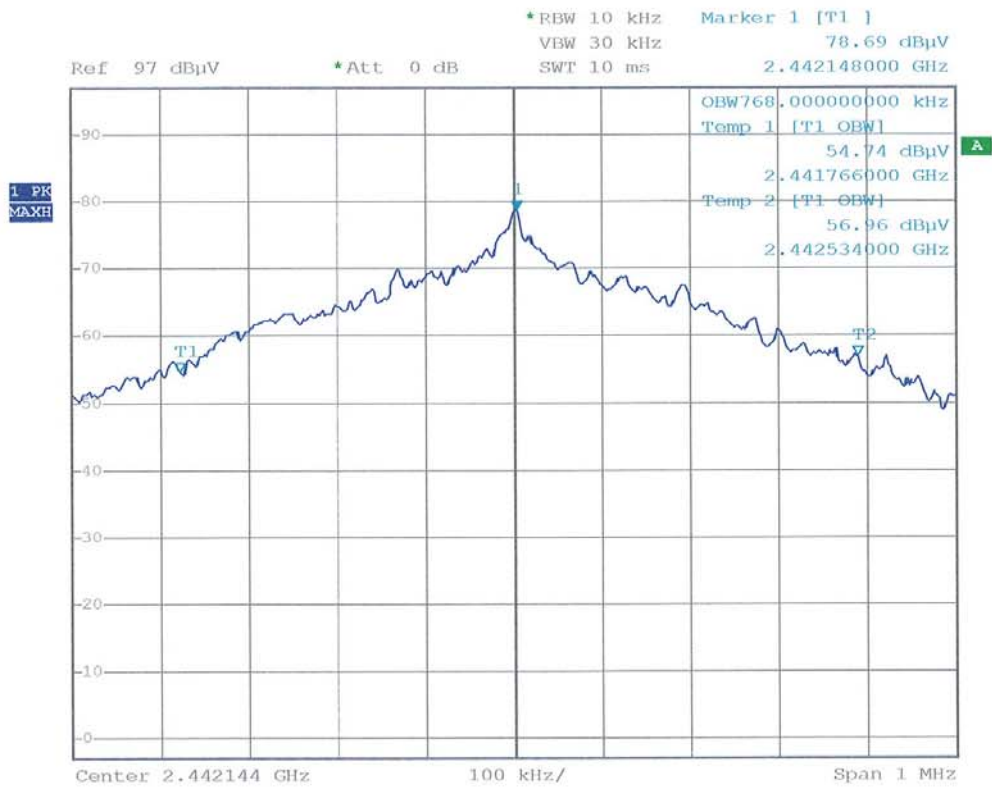
EMITECH

□□□ End of report, 6 annexes to be forwarded □□□

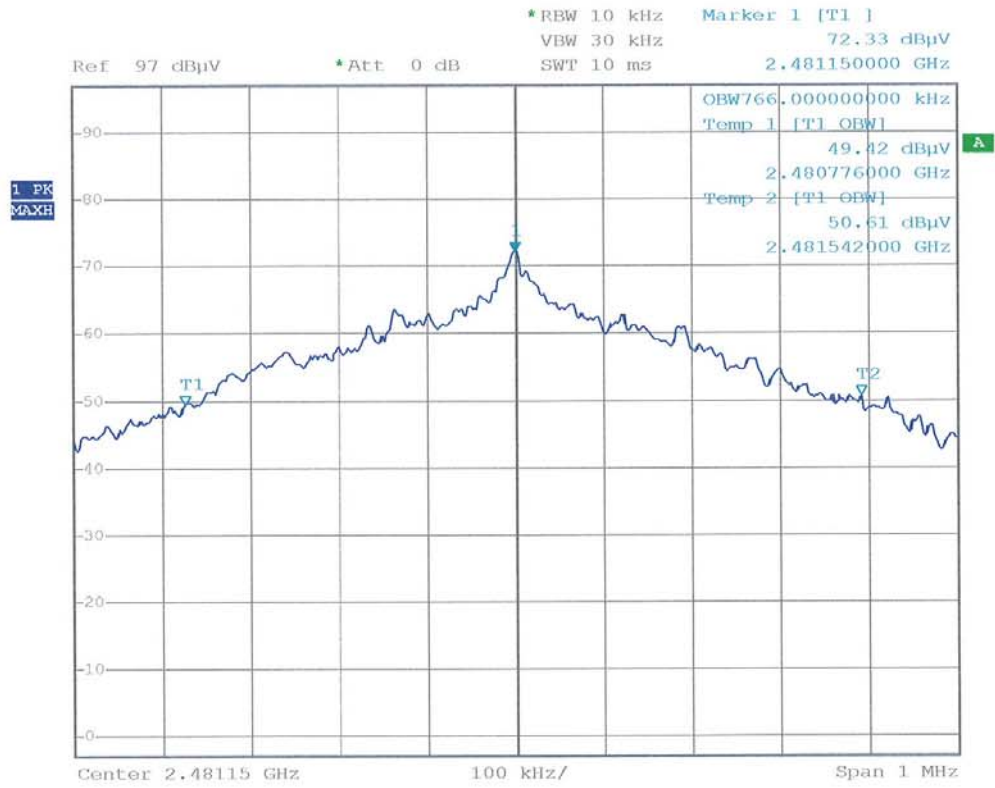
ANNEX 1: OCCUPIED POWER BANDWIDTH



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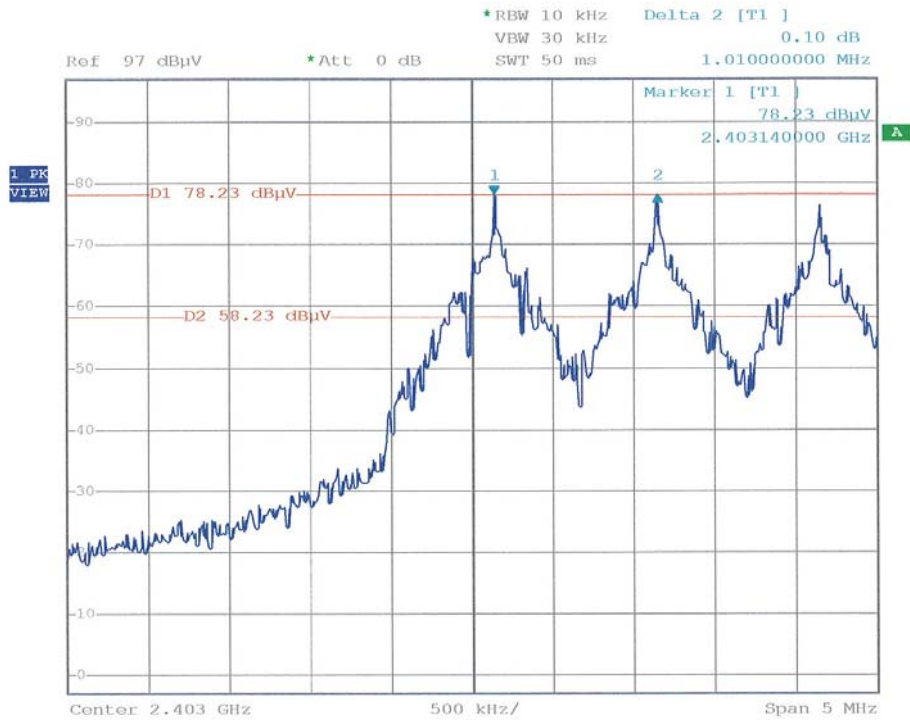


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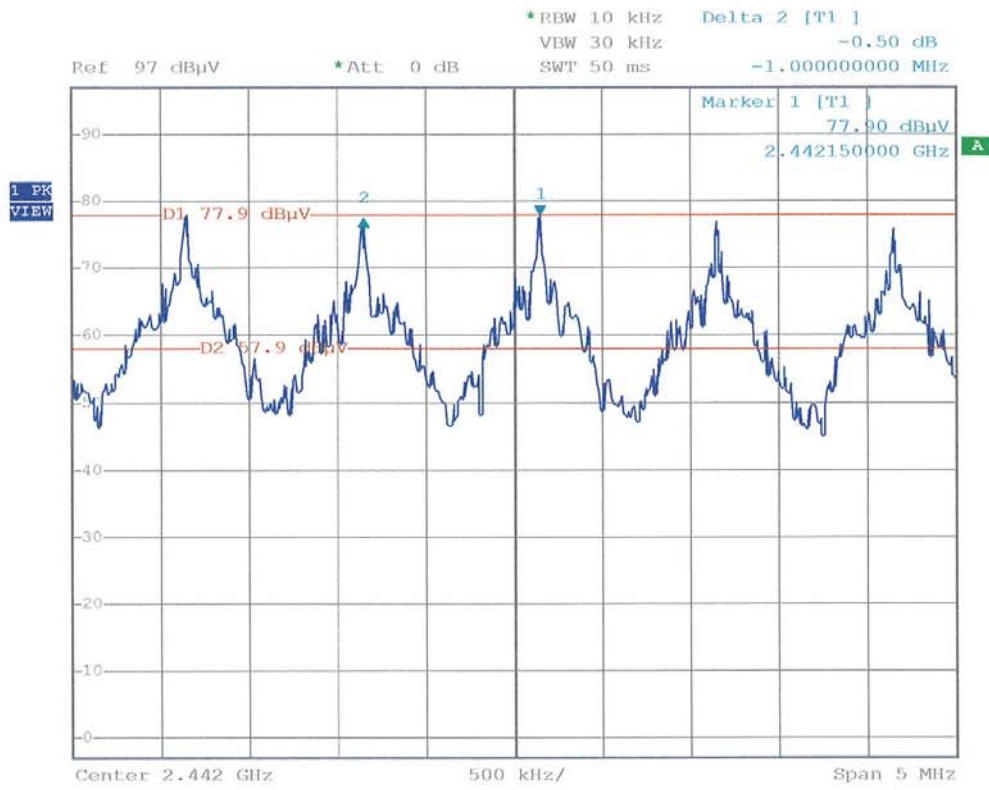


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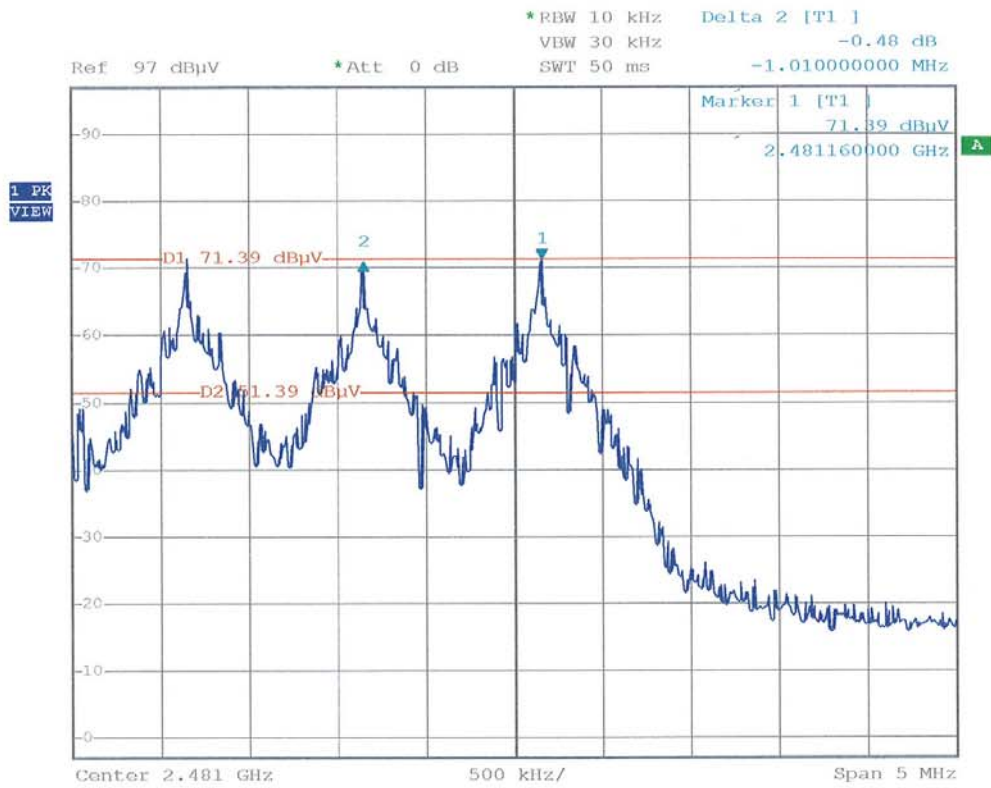
ANNEX 2: CHANNEL SEPARATION



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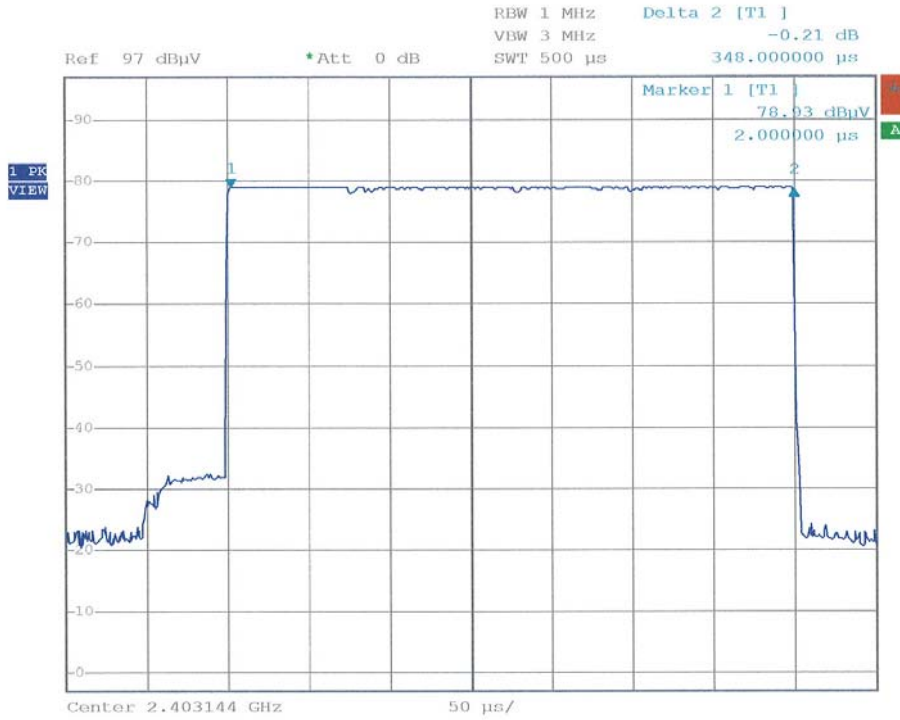


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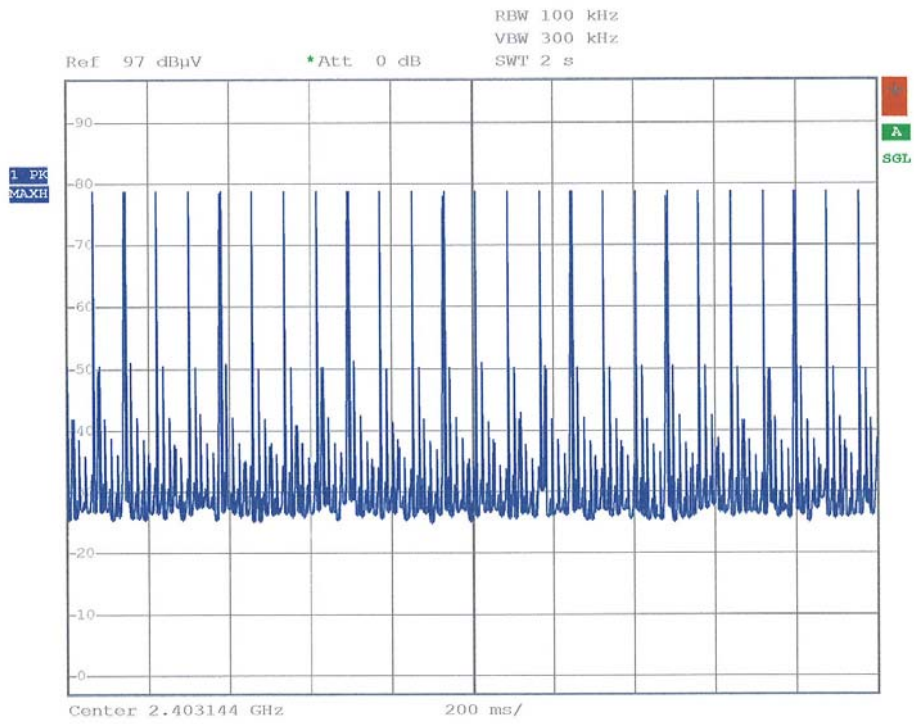


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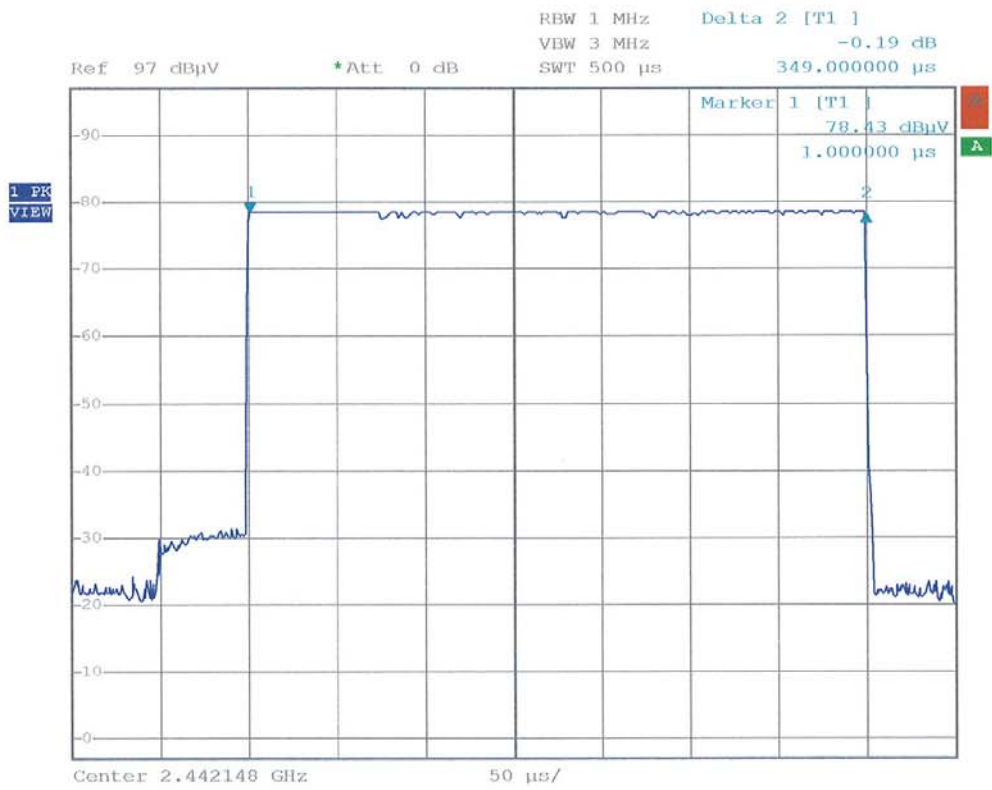
ANNEX 3: AVERAGE TIME OF OCCUPANCY ON ANY FREQUENCY



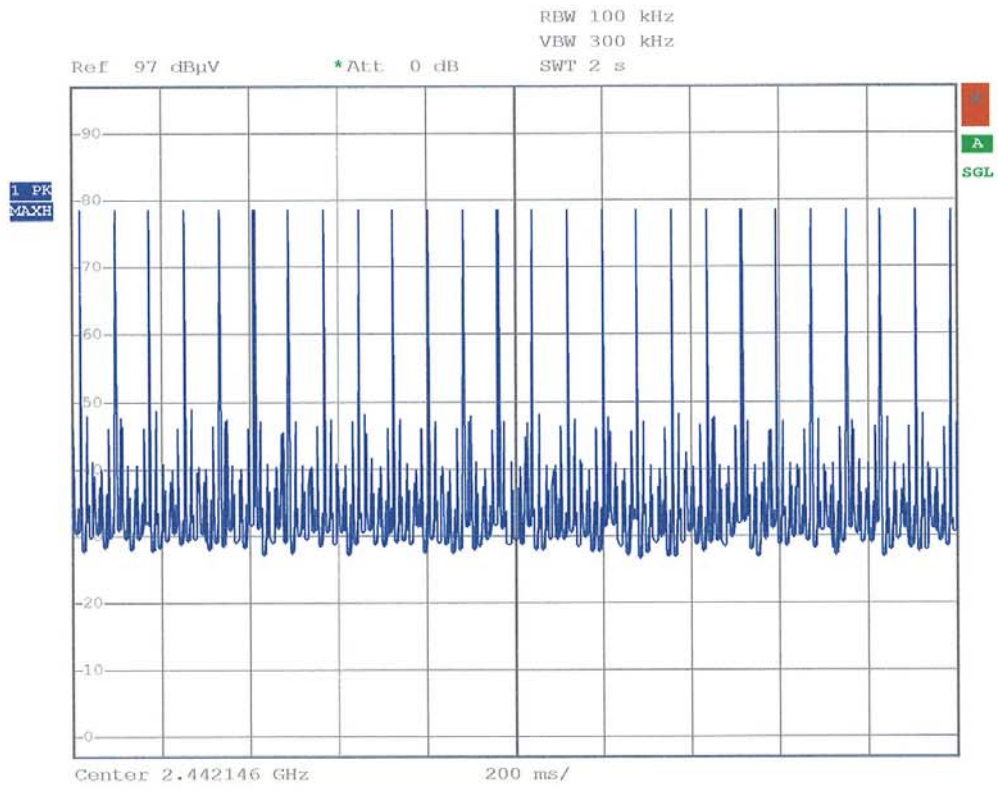
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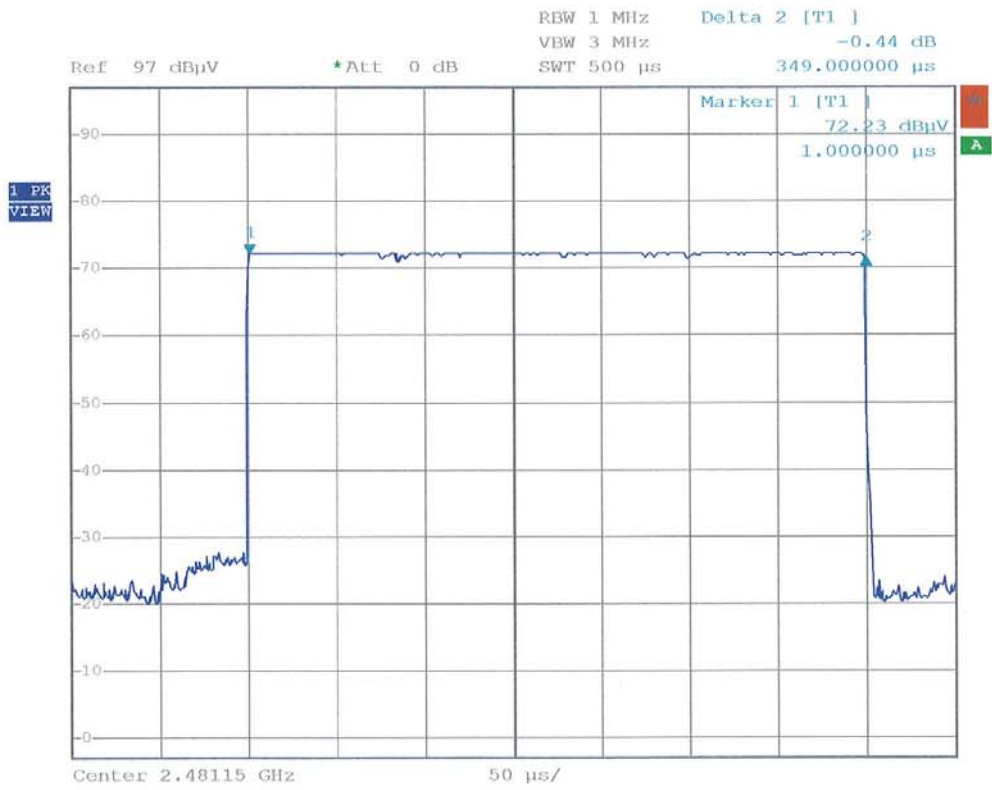
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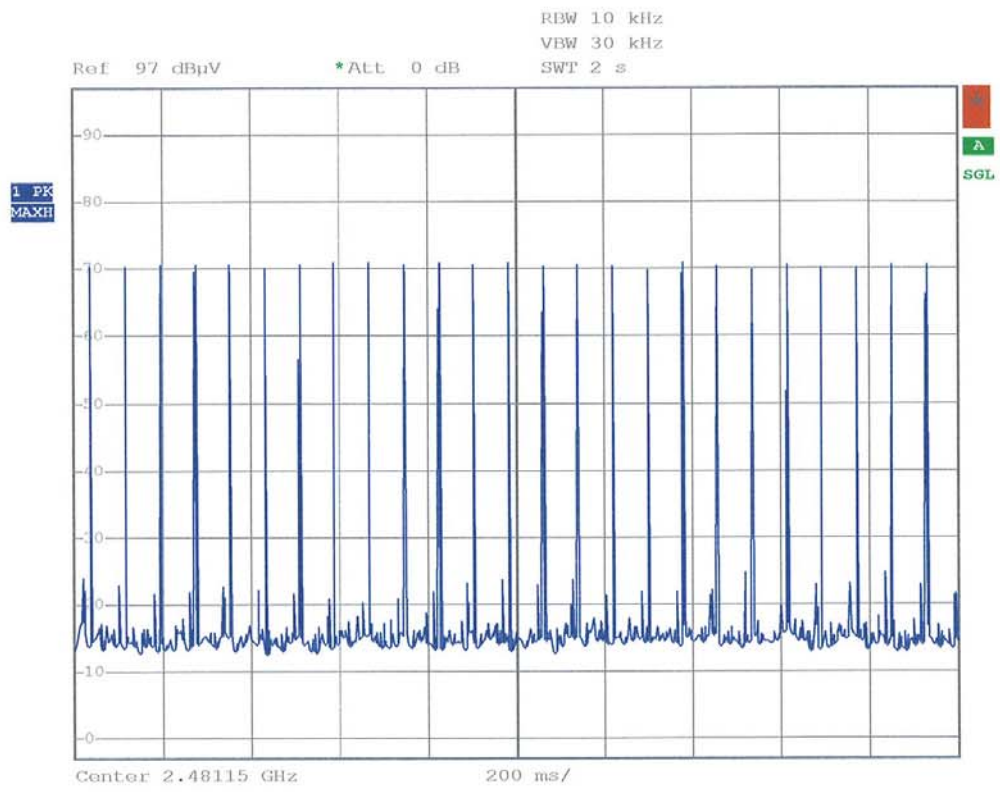
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Date: 24.OCT.2007 14:51:52

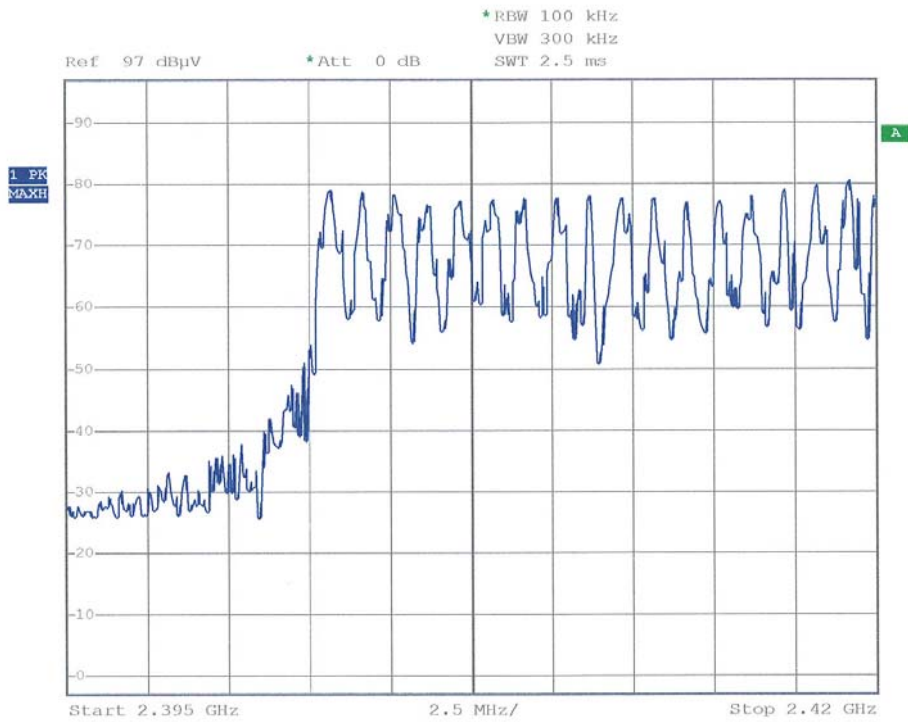


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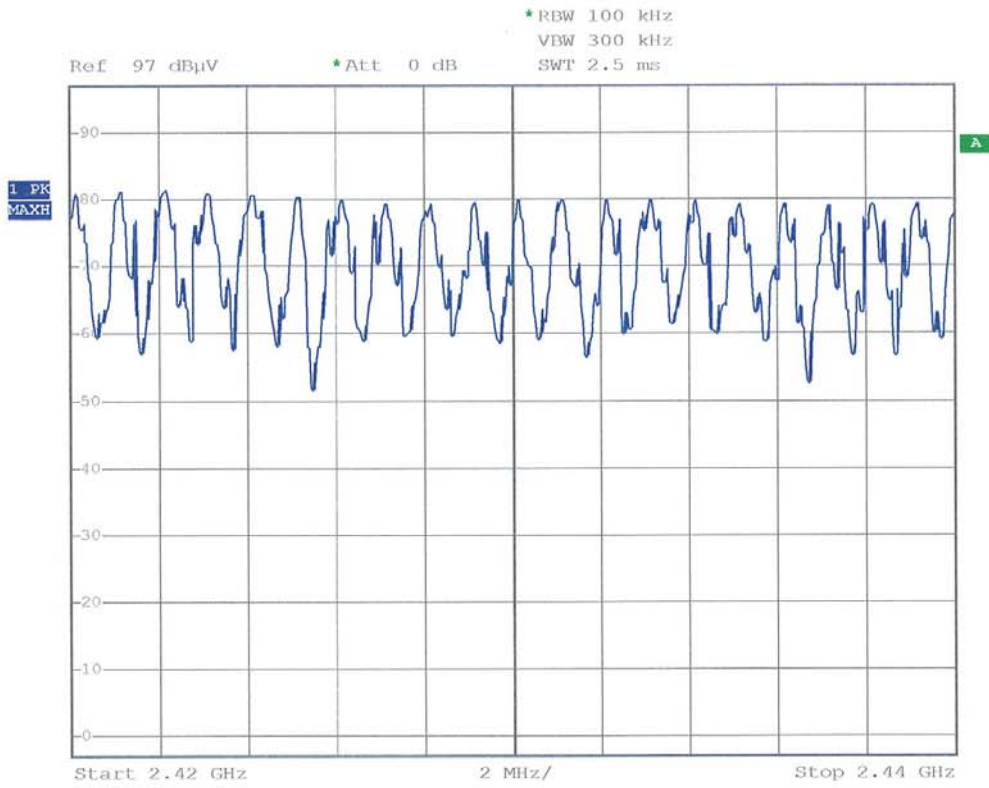


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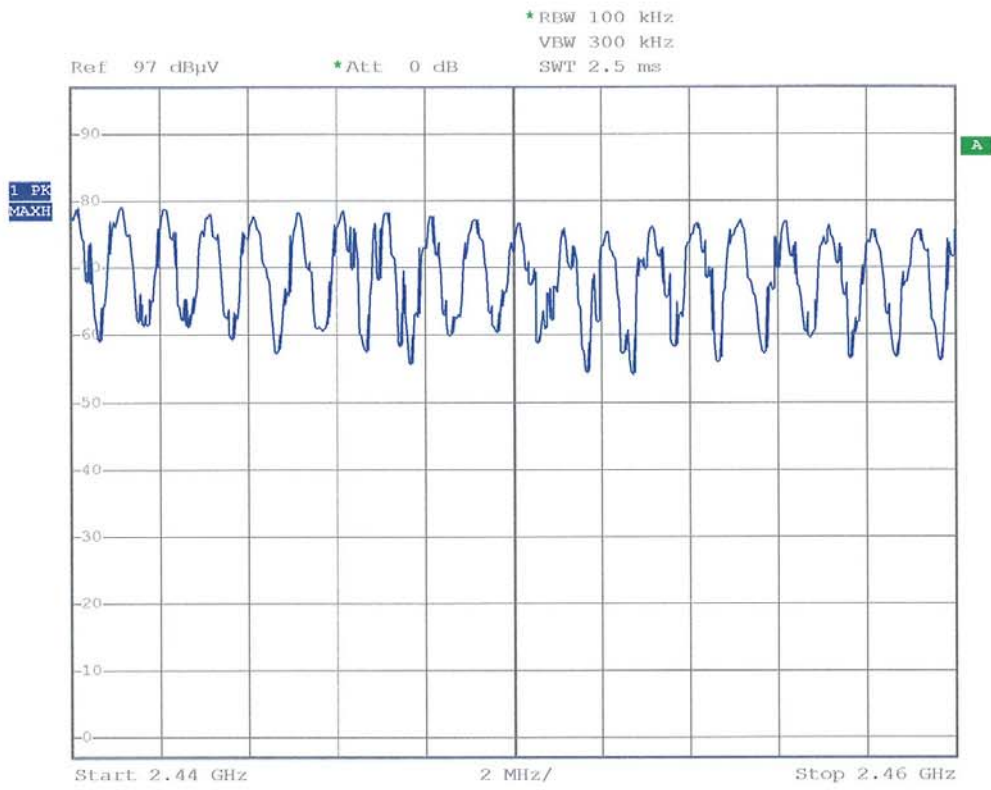
ANNEX 4: NUMBER OF HOPPING FREQUENCIES



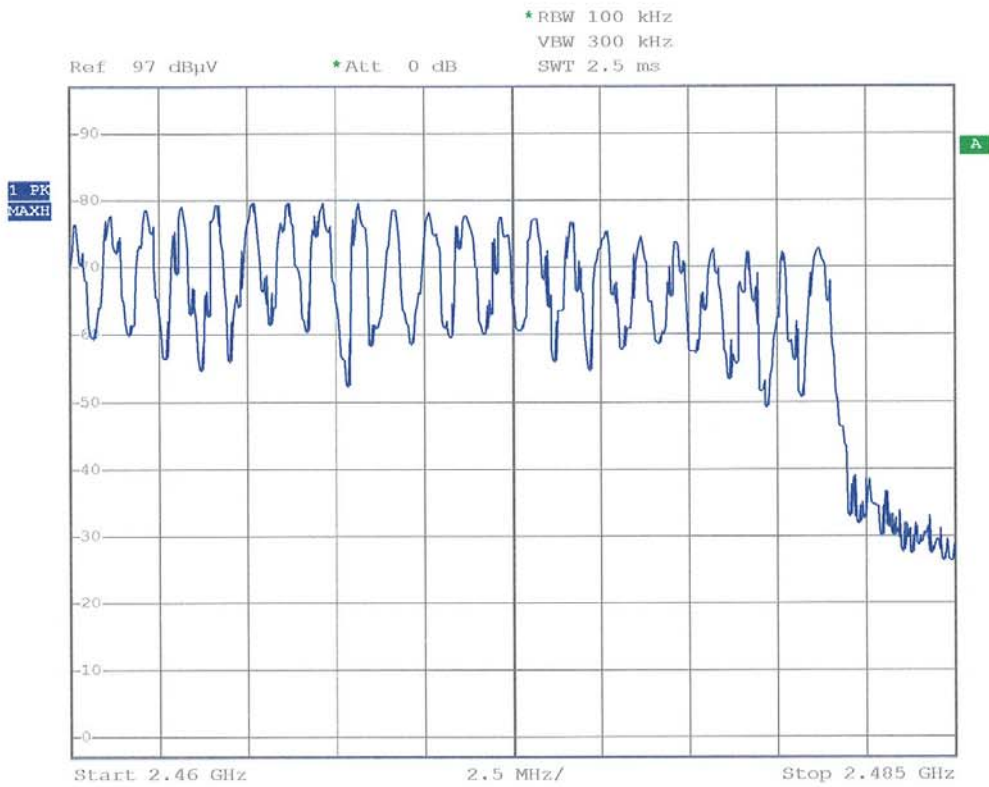
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Date: 24.OCT.2007 14:45:38



Date: 24.OCT.2007 14:47:31



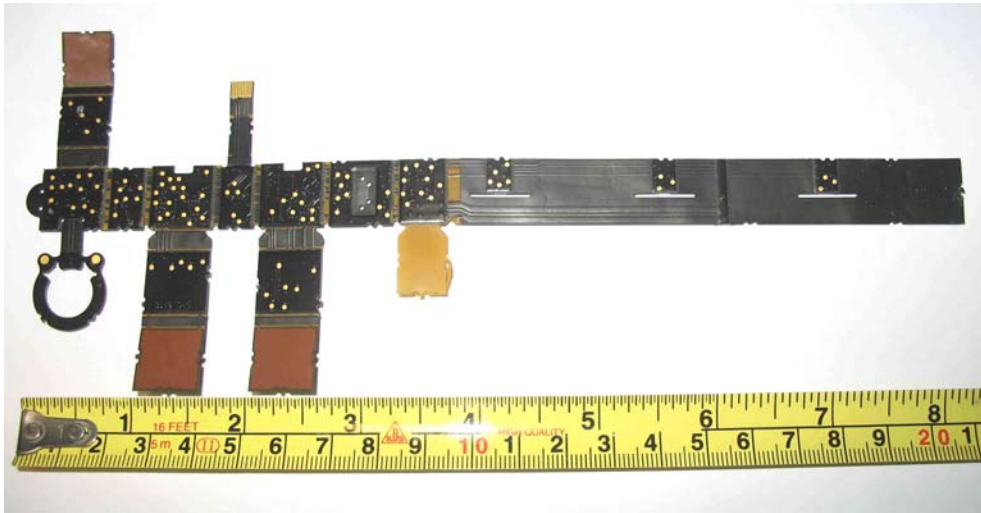
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ANNEX 5: PHOTOS OF THE EQUIPMENT UNDER TEST

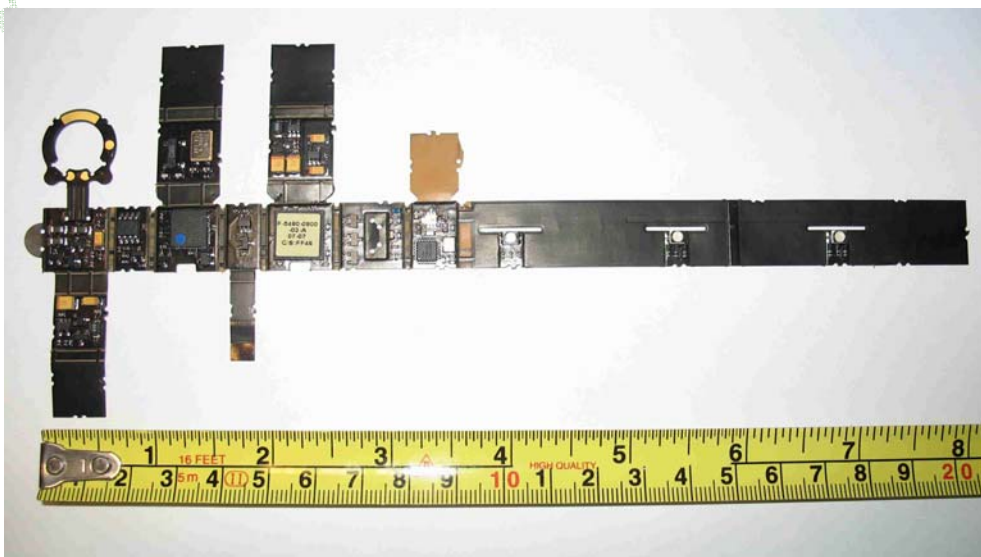
GENERAL VIEW



Printed circuit board: face 1



Printed circuit board: face 2



Antenna



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ANNEX 6: TEST SET UP AND OPEN AREA TEST SITE

TEST SET UP



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OPEN AREA TEST SITE

