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RA-03-24216/1/A/ST

FCC CERTIFICATION E.M.C. Measurement Technical Report

**standard to apply:
FCC Part 15**

**Equipment under test:
RADIO INTERFACE FOR MACHINE TOOLS
RMI**

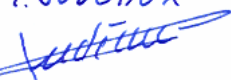
FCC ID: KQGRMI

**Company:
RENISHAW SA**

TRANSMIT TO: Mr CRESSON

Company: RENISHAW SA

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Ed.	Date	Modified pages	Editing		Verification Approval	
			Name	Visa	Name	Visa
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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.

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PRODUCT: **RADIO INTERFACE FOR MACHINE TOOLS**

Reference / model: RMI

Serial number: Y75260

MANUFACTURER: RENISHAW PLC
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COMPANY SUBMITTING THE PRODUCT:

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Responsible: Mr CRESSON

DATE(S) OF TEST: 01 and 02 September 2003

TESTING LOCATION: EMITECH ATLANTIQUE laboratory at ANGERS (49) FRANCE
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EMITECH laboratory at MONTIGNY LE BRETONNEUX (78)
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Registration Number by FCC: 101696/FRN: 0006 6490 08

Registration Number by Industry Canada: IC4379

TESTED BY: D. GRATON
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1.INTRODUCTION

This document presents the result of E.M.C. test carried out on the following equipment:
RADIO INTERFACE FOR MACHINE TOOLS RMI in accordance with normative reference.

2.PRODUCT DESCRIPTION

ITU Emission code: 1M00F7D

Classe: A (paragraph FCC part 15.3)

Utilization: radio interface for machine tools.

Antenna type: incorporated antenna

Operating frequency range: from 2400 MHz to 2483.5 MHz

Number of channels: 80

Channel spacing: 1 MHz

Frequency generation: ☒ SAW Resonator ☐ Crystal ☒ Synthetiser

Modulation: Frequency Hopping Spread Spectrum
☒ Amplitude ☒ Digital ☒ Frequency ☐ Phase

Power source: source power PSU3 Renishaw: 24 Vd.c.

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

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

3.NORMATIVE REFERENCE

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

RSS 210 Low Power Licence - Exempt
Radiocommunication Devices
(All Frequency Bands)

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 207: conducted limits
- Paragraph 205: restricted bands of operation
- Paragraph 209: radiated emission limits; general requirements
- Paragraph 247: operation within the band 2400 – 2483.5 MHz

5.RELATED SUBMITTAL GRANT

This equipment operates with a radio probe for machine tools, RMP60: KQGRMP60.

6.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 “***

7. TESTS AND CONCLUSIONS

Test procedure	Description of test	Criteria respected ?				Comment
		Yes	No	NAp	NAs	
FCC Part 15.205	RESTRICTED BANDS OF OPERATION	X				
FCC Part 15.207	CONDUCTED LIMITS			X		Note 4
FCC Part 15.209	RADIATED EMISSION LIMITS; general requirements			X		Note 5
FCC Part 15.247	OPERATION WITHIN THE BAND 2400-2483.5 MHz					
FCC Part 15.247	(a) (1) <i>hopping mode</i>	X				Note 1
FCC Part 15.247	(a) (1) (iii) <i>hopping timing</i>	X				Note 2
FCC Part 15.247	(b) (1) <i>max output power</i>	X				
FCC Part 15.247	(b) (1) <i>RF exposure compliance</i>			X		Note 3
FCC Part 15.247	(c) <i>intentional radiator</i>	X				

NAp: Not Applicable

NAs: Not Asked

Note 1: see appendix 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.

Note 2: the frequency hopping system use more than 15 non-overlapping channels. The hopping frequency channel is every 20 ms, the timing by channel is 202 μ s (see appendix 2). During 80 channels $\times$ 0.4 s (part 15) = 32 s, any channel is used 32 s $\div$ 1.6 s* = 20 times, then 20 $\times$ 202 μ s = 4.04 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.
* 80 channels $\times$ 20 ms = 1.6 s.

Note 3: this type of equipment use less than 0.5 W of output power with a high signal transmitting duty factor.

Note 4: DC source power.

Note 5: see FCC part 15.247 (c).

Conclusion:

The sample base station of RADIO INTERFACE FOR MACHINE TOOLS RMI 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.

8. PEAK OUTPUT POWER

Standard: FCC Part 15 (03)

Test procedure: paragraph 15.247

Test equipment:

TYPE	BRAND	EMITECH NUMBER
Spectrum analyzer FSEM 30	Rohde & Schwarz	1244
Micro wattmeter 4200 RF	Boonton	2559
Probe micro wattmeter 42004E	Boonton	2560
Source power PSV3	Renishaw	Q04565
Multimeter 8840A	Fluke	1018

Test set up:

The carrier power is the peak power delivered to the artificial antenna.

The artificial antenna is a 50 Ω load connected directly at the power meter on the spectrum analyzer.

The measurement is realized in conducted mode.

Equipment under test operating condition:

The equipment is in continuous transmission mode at the highest power level which the transmitter is intended to operate, the transmitter is locked at the lowest frequency and this trial is repeated at the highest frequency.

Results:

Ambient temperature (°C): 18

Relative humidity (%): 58

Power source (V): 24

Sample N° 1

		Peak Output Power (W) at the frequencies:		Limits
		Channel 1 2402 MHz	Channel 80 2481 MHz	(W)
Normal test conditions	Nominal power source (V): 24	245×10^{-6}	198×10^{-6}	1*

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

Test conclusion:

RESPECTED STANDARD

9.RADIATED EMISSION PORTABLE

Standard: FCC Part 15 (03)

Test procedure: paragraph 15.205
paragraph 15.209
paragraph 15.247

Test equipment:

TYPE	MANUFACTURER	EMITECH NUMBER
Test receiver ESH3	Rohde & Schwarz	1058
Test receiver ESVS 10	Rohde & Schwarz	1219
Spectrum analyzer FSEM 30	Rohde & Schwarz	1244
Loop antenna	EMCO	1406
Biconical antenna HP 11966C	Hewlett Packard	728
Log periodic antenna HL 223	Rohde & Schwarz	1999
Open site	Emitech	1274
Multimeter 8840A	Fluke	1018
Antenna RGA-60	Electrometrics	1204
Low-noise amplifier	Microwave DB	1922
High pass filter HP12/3200-5AA	Filtek	
Antenna WR42	IMC	1939

Test set up:

The system is tested in an open area test site (OATS).

The test unit is placed on a rotating table, 1.5 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 ($F_{\text{carrier}} \leq 10 \text{ GHz}$)

Detection mode: Quasi-peak ($F < 1 \text{ GHz}$)
Average ($F > 1 \text{ GHz}$)

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

Equipment under test operating condition:

The equipment is in continuous transmission mode, is locked at the lowest frequency and this trial is repeated at the highest frequency.

Results:

Ambient temperature (°C): 18

Relative humidity (%): 58

Power source (V): 24

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

Lowest Channel Emission

FREQUENCIES (MHz)	Polarization H: Horizontal V: Vertical	Field strength (dBμV/m)	Limits (dBμV/m)	Margin (dB)
120	H	28.1	43.5**	15.4
160	H	38.5	75*	36.5
200	V	30	75*	45
240	V	35.8	46**	10.2
280	V	41.5	46**	4.5
320	H	26.3	75*	48.7
360	V	32	75*	43
400	V	36.5	46**	9.5
480	V	41.2	75*	33.8
560	H	36	75*	39
680	H	40	75*	35
4804	V	53.85	54**	0.15

Highest Channel Emission

FREQUENCIES (MHz)	Polarization H: Horizontal V: Vertical	Field strength (dBμV/m)	Limits (dBμV/m)	Margin (dB)
120	H	28.1	43.5**	15.4
160	H	38.5	75*	36.5
200	V	30	75*	45
240	V	35.8	46**	10.2
280	V	41.5	46**	4.5
320	H	26.3	75*	48.7
360	V	32	75*	43
400	V	36.5	46**	9.5
480	V	41.2	75*	33.8
560	H	36	75*	39
680	H	40	75*	35
4963	H	53.59	54**	0.41

* limit corresponding at 20 dB below the highest level produced by the intentional radiator, in the assigned band.

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

Stand by mode

FREQUENCIES (MHz)	Antenna height (cm)	Polarization H: Horizontal V: Vertical	Azimuth (degrees)	Field strength (dBμV/m)	Limits (dBμV/m)	Margin (dB)
2471.55	108	V	0	38.9	75*	36.1

10.APPENDIXES**Appendix 1: "CHANNEL SEPARATION"**

This appendix contains 2 pages.

Appendix 2: "TIMING HOPPING AND TIMING CHANNEL"

This appendix contains 3 pages.

Appendix 3: "PHOTOGRAPHIES OF THE EQUIPEMENT UNDER TEST"

This appendix contains 5 pages.

Appendix 4: "PHOTOGRAPHY OPEN AREA TEST SITE"

This appendix contains 2 pages.

□□□ End of report, 4 appendixes to be forwarded □□□

APPENDIX 1

CHANNEL SEPARATION



Ref Lvl

-20 dBm

Marker 4 [T1]

-56.61 dBm

2.44299599 GHz

RBW

10 kHz

RF Att

0 dB

VBW

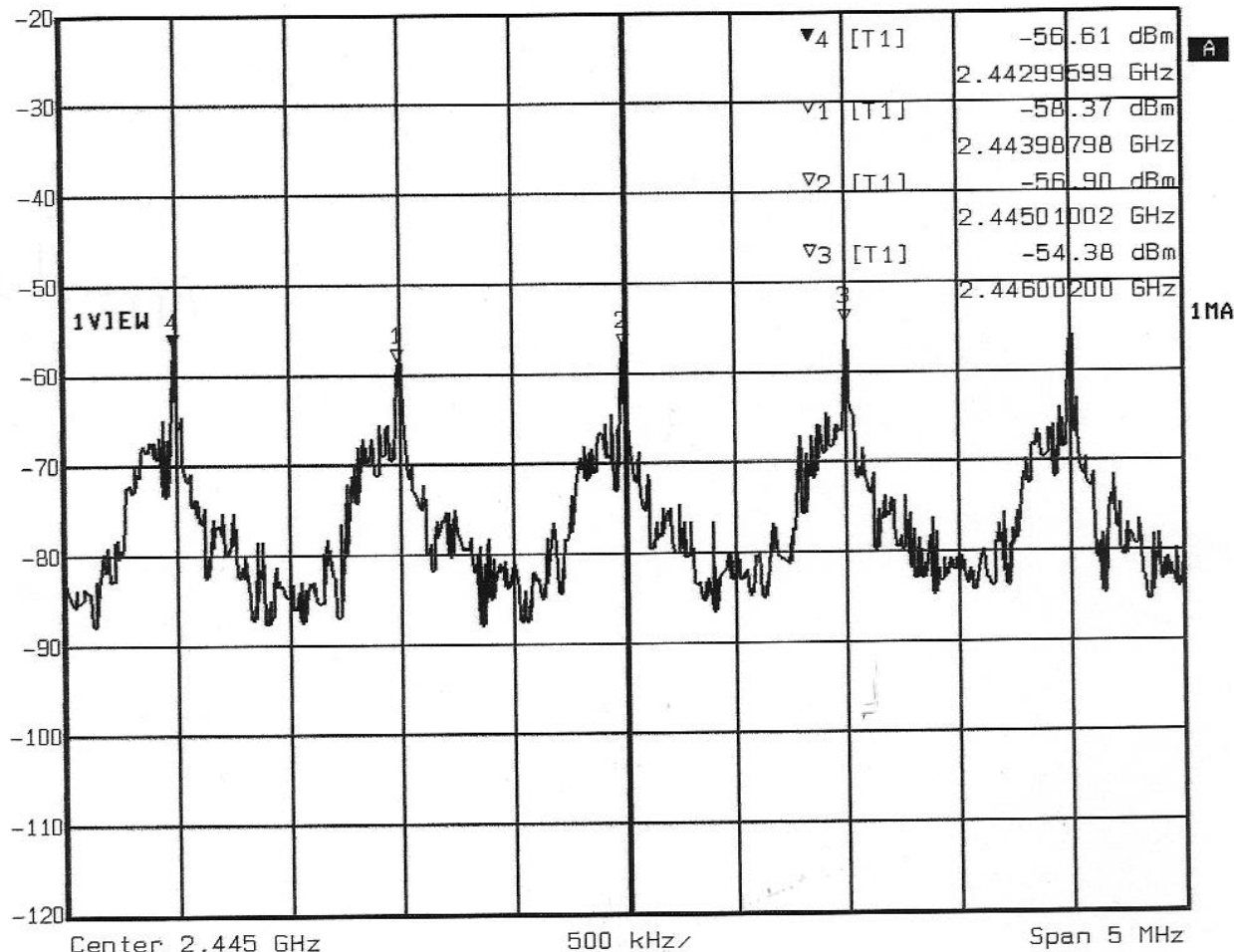
10 kHz

SWT

125 ms

Unit

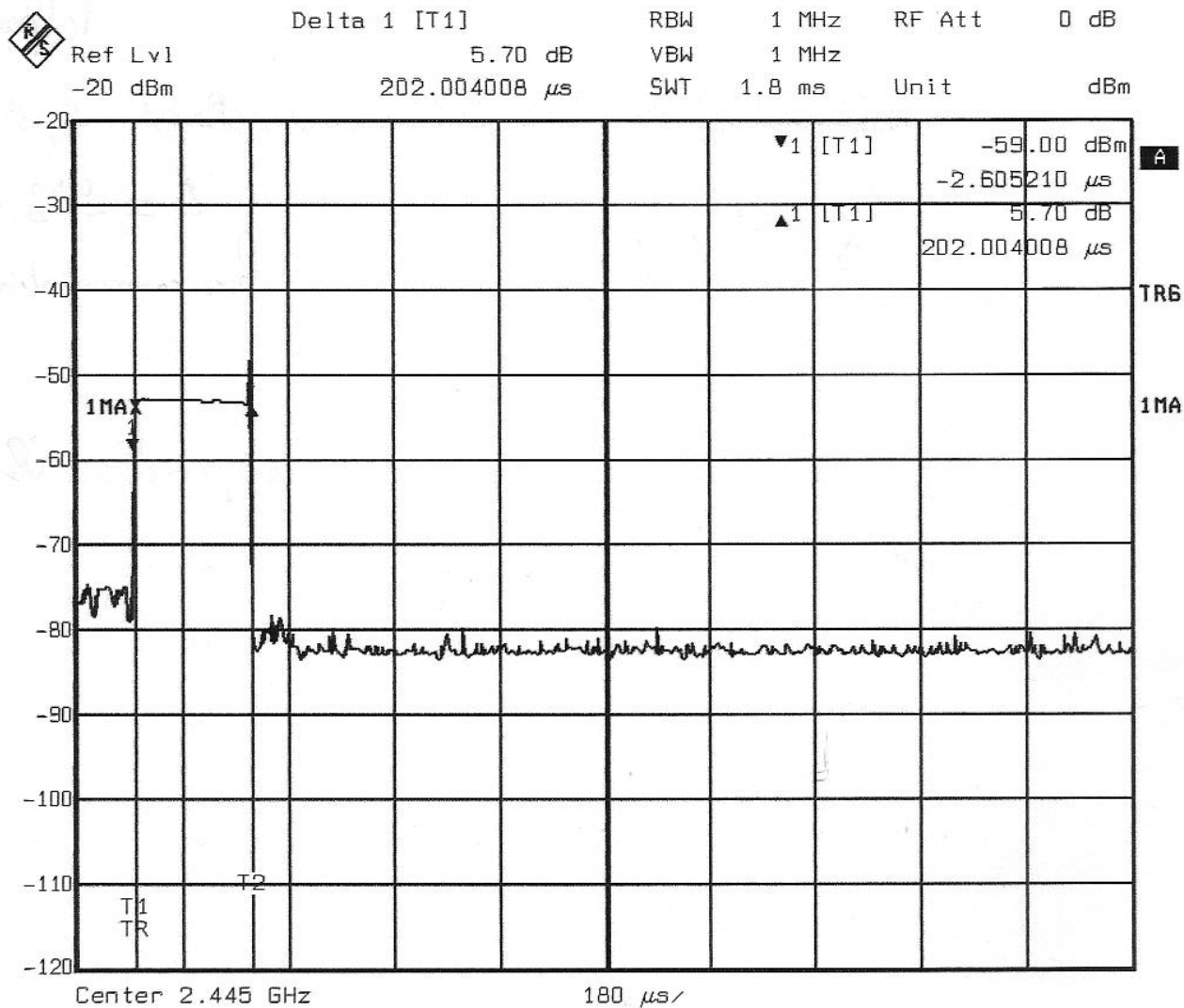
dBm



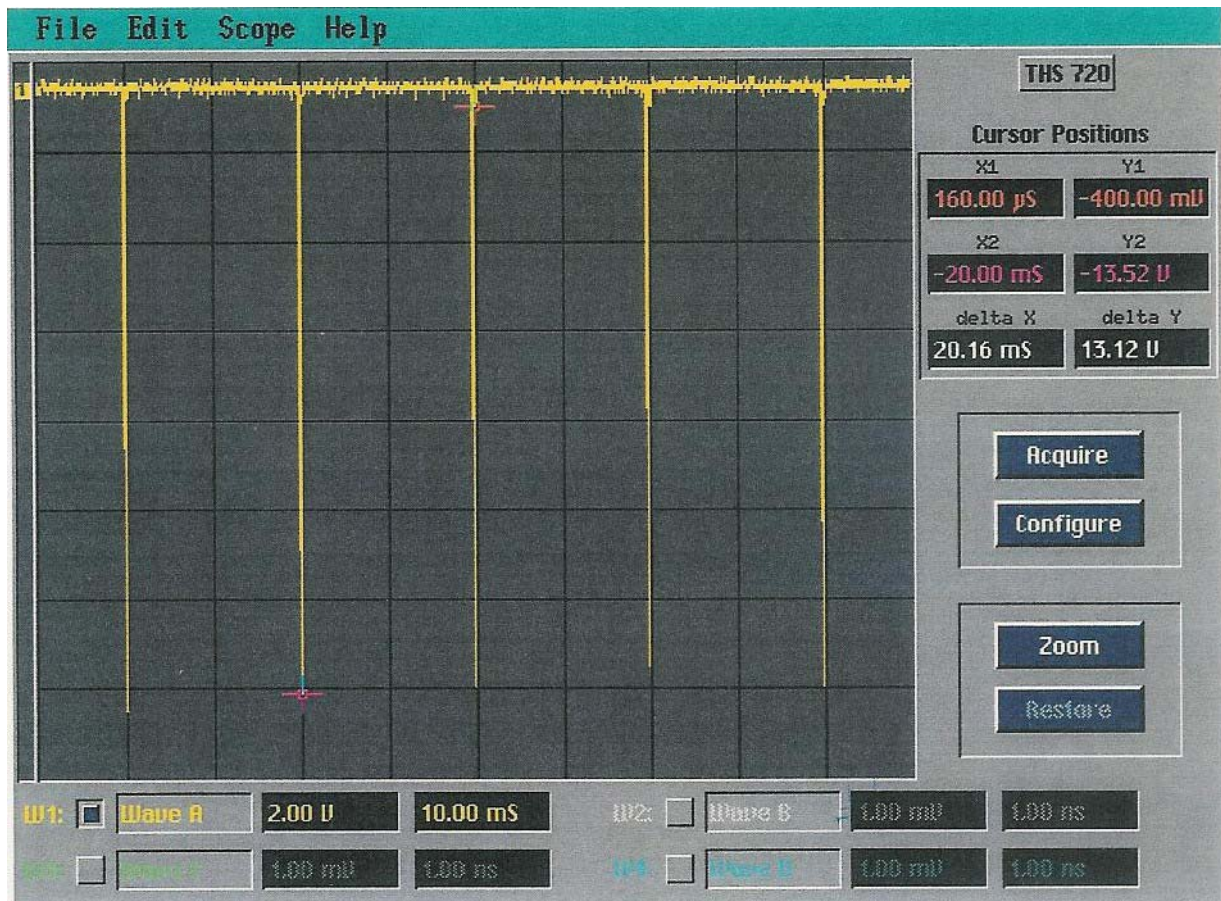
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APPENDIX 2

TIMING HOPPING AND TIMING CHANNEL



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APPENDIX 3

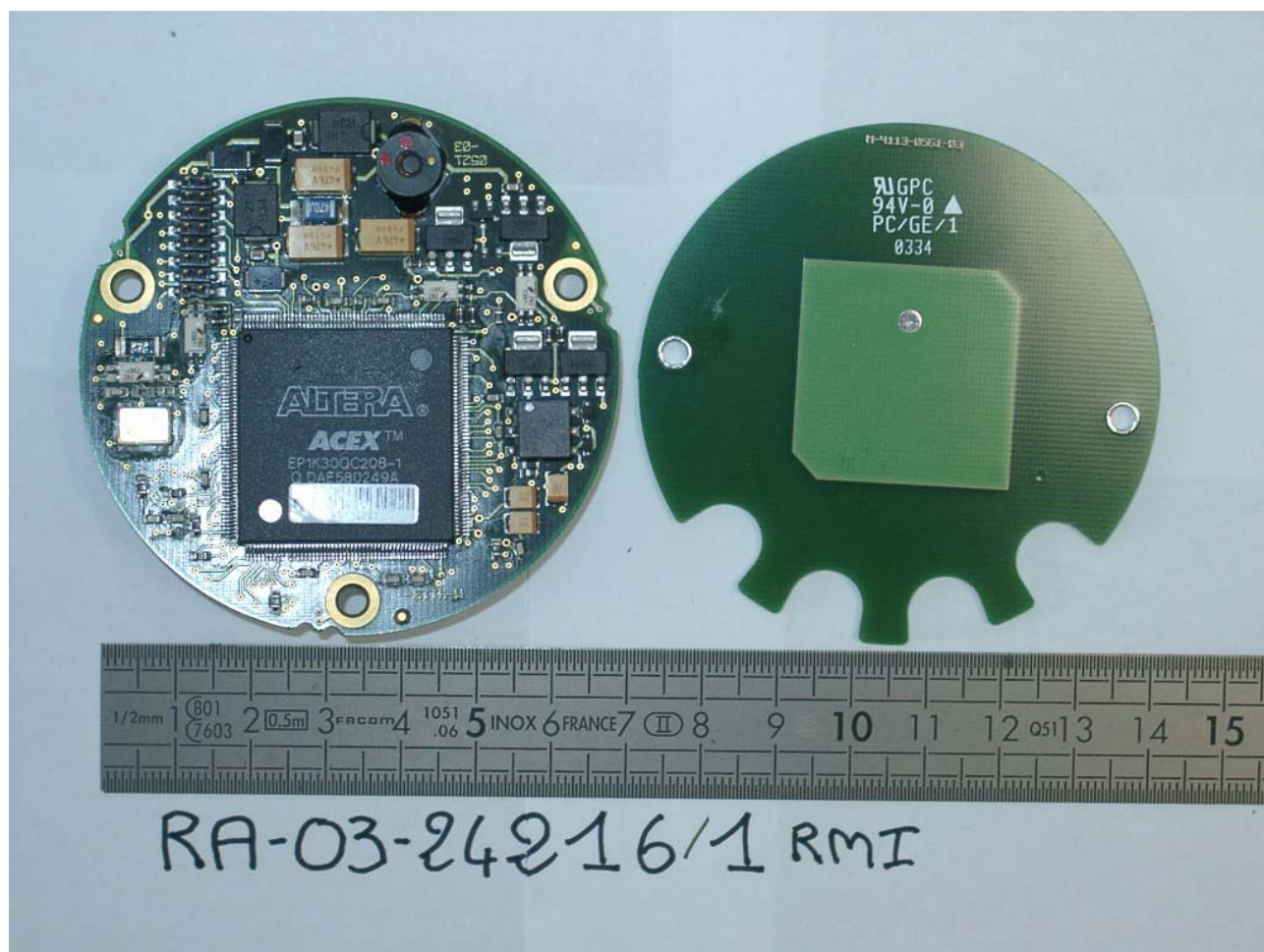
PHOTOGRAPHIES OF THE EQUIPMENT UNDER TEST

PHOTOGRAPHY OF THE EQUIPMENT UNDER TEST RMI

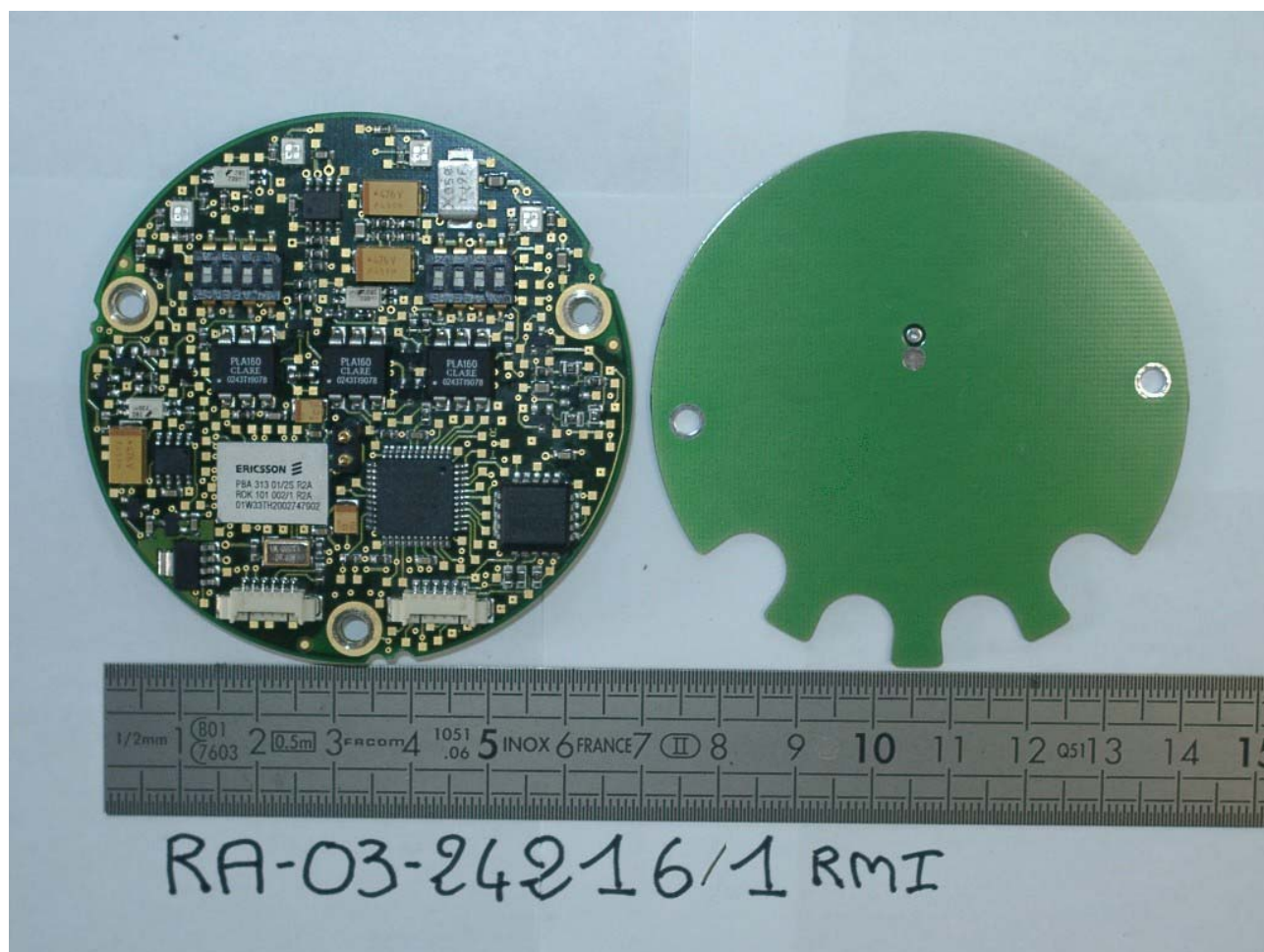
PHOTOGRAPHY OF THE EQUIPMENT UNDER TEST, WITH PSU3 (optional D.C. source power)



Printed circuit board transmitter: face 1



Printed circuit board transmitter: face 2



APPENDIX 4

PHOTOGRAPHY OPEN AREA TEST SITE

PHOTOGRAPHY OPEN AREA TEST SITE