EMITECH ATLANTIQUE

15, rue de la Claie
Z.I. Angers-Beaucouzé
49070 BEAUCOUZÉ
Tél. 02 41 73 26 27
Fax 02 41 73 26 40
e-mail : atlantique@emitech.fr
R.C.S. ANGERS 95 B 543
SIRET 344 545 645 00055

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FCC CERTIFICATION
RADIO Measurement
Technical Report

standard to apply:
FCC Part 15.247

Equipment under test:
SENSOR FOR MACHINE TOOLS
RMP60 and RMP60M

FCC ID :
KQGRMP60V2

Company:
RENISHAW SAS

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

Number of pages: 26 including 4 annexes

Ed.	Date	Modified pages	Editing Name	Editing Visa	Verification Approval Name	Verification Approval Visa
0	18-Jan-06	Creation	L. BERTHAUD	LB	P. BONNENFANT	

PRODUCT:	**SENSOR FOR MACHINE TOOLS**
Reference / model:	RMP60 and RMP60M
Serial number:	not communicated
MANUFACTURER:	RENISHAW METROLOGY LTD (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
DATES OF TEST:	14 December 2005
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: SENSOR FOR MACHINE TOOLS RMP60 and RMP60M in accordance with normative reference. The two equipments are strictly identical. Only the mechanical housing where the probe is fixed differs (see annex 3).

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: I.S.M. band from 2400 MHz to 2483.5 MHz

Number of channels: 79

Channel spacing: 1 MHz

Frequency generation: O SAW Resonator O Crystal ⊙ Synthetiser

Modulation: Frequency Hopping Spread Spectrum
O Amplitude O Digital ⊙ Frequency O Phase

Power source: Alkaline batteries LR6 (2 x 1.5 V) or Lithium batteries LS14500 (2 x 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 (2005)	Code of Federal Regulations Title 47 - Telecommunication Chapter 1 - Federal Communications Commission Part 15 - Radio frequency devices Subpart C - Intentional Radiators
ANCI C63.4 (2003)	Methods of Measurement of radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz

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 205: restricted bands of operation
Paragraph 207: conducted limits
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 15.205	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) *hopping mode*	X				*Note 1*
FCC Part 15.247	(a) (1) (iii) *hopping timing*	X				*Note 2*
FCC Part 15.247	(b) (1) *max output power*	X				*Note 6*
FCC Part 15.247	(c) *operation with directional antenna*			X		*Note 3*
FCC Part 15.247	(d) *intentional radiator*	X				
FCC Part 15.247	(e) *peak power spectral density*	X				*Note 6*
FCC Part 15.247	(f) *hybrid system*			X		
FCC Part 15.247	(g)	X				
FCC Part 15.247	(h)	X				
FCC Part 15.247	(i) *RF exposure compliance*	X				*Note 7*

NAp: Not Applicable NAs: Not Asked

Note 1: see annex 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.

Note 2: the frequency hopping system use more than 15 channels.
The timing by channel is 595.8 µs (see annex 2).
During 79 channels × 0.4 s (part 15) = 31.6 s, any channel is used 448 times, then
448 × 595.8 µs = 266.9 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.

Note 3: the antenna gain is less than 6 dBi.

Note 4: battery source power.

Note 5: see FCC part 15.247 (d).

Note 6: for information only, conducted measurement is not possible (integral antenna), so we used the substitution method in open field.

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 SENSOR FOR MACHINE TOOLS RMP60 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 OD20004A	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	812

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 have 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 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 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 (≥ 20 dB bandwidth of the emission).

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 transmission mode, modulated by internal data signal.

Results:

Ambient temperature (°C): 20
Relative humidity (%): 50

Polarization of test antenna: vertical (height: 165 cm)
Position of equipment: up right (azimuth: 317 degrees)

Sample N° 1

		Peak Output Power radiated at these frequencies (W): from 2403 MHz to 2481 MHz	**Limits (W)**
Normal test conditions	Nominal power source (V): 3	1.306×10^{-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	61.97	4.75	27.71	94.43	0.832×10^{-3}

* P = (E×d) squared / (30×G) with G = 1 d = 3 m

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	61.89	4.75	27.71	94.35	0.817×10^{-3}

* P = (E×d) squared / (30×G) with G = 1 d = 3 m

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	59.73	4.75	27.71	92.19	0.497×10^{-3}

* P = (E×d) squared / (30×G) with G = 1 d = 3 m

Test conclusion:

RESPECTED STANDARD

8.PEAK POWER DENSITY

Standard: FCC Part 15

Test procedure: paragraph 15.247

Test equipment used:

TYPE	MANUFACTURER	EMITECH NUMBER
Spectrum analyzer FSP 40	Rohde & Schwarz	4088
Open site	Emitech	1274
Radiofrequency generator SME06	Rohde & Schwarz	1669
Antenna RGA-60	Electrometrics	1938
Antenna RGA-60	Electrometrics	1204
Power meter 8541B	Gigatronics	3479
Power sensor 80401A	Gigatronics	3182
Multimeter 77-2	Fluke	812

Measured condition:

We used the same method of the peak output power, but the oscilloscope and the diode is replaced by a spectrum analyzer used in combination with an RF power meter.
Resolution bandwidth: 3 kHz
Video bandwidth: 10 kHz

Test operating condition of the equipment:

The equipment is blocked in continuous transmission mode, modulated by internal data signal.

Results:

Ambient temperature (°C): 20
Relative humidity (%): 50

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

Voltage at the beginning of test (V): 3.20
Voltage at the end of test (V): 3.14
Percentage of the voltage drop during the test (%): -1.9
Limits (%): ± 5

Sample n° 1 Channel 1

	Peak power density at frequency: 2403.39 MHz
Normal test conditions	-10.68 dBm
Limits	+8 dBm

Sample n° 1 Channel 40

	Peak power density at frequency: 2442.14 MHz
Normal test conditions	-10.34 dBm
Limits	+8 dBm

Sample n° 1 Channel 79

	Peak power density at frequency: 2480.88 MHz
Normal test conditions	-11.6 dBm
Limits	+8 dBm

Test conclusion:

RESPECTED STANDARD

9.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
Multimeter 77-2	Fluke	812
Low-noise amplifier to 18 to 26 GHz	ALC	3036

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)

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

Equipment under test operating condition:

The equipment is blocked in continuous transmission mode, modulated by internal data signal.

Results:

Ambient temperature (°C): 20
Relative humidity (%): 50

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

Voltage at the beginning of test (V): 3.14
Voltage at the end of test (V): 3.02
Percentage of the voltage drop during the test (%): -3.8
Limits (%): ± 5

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

As the dwell time per channel of the hopping signal is less than 100 ms (see annex 2), the reading may be adjusted by a "duty cycle correction factor" derived from 20 log ($\frac{dwelltime}{100\,ms}$) according the public Notice DA 00-705.

We have noted:
* dwell time = 595.8 µs (see annex 2)
* correction factor = 20 log ($\frac{595{,}8\times10^{-3}}{100}$): -44.5 dB

So with the duty cycle correction factor, we noted:

Sample n°1

Channel 1

FREQUENCIES (MHz)	Antenna height (cm)	Azimuth (degree)	RBW (kHz)	VBW (Hz)	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m) without correction	Field strength (dBµV/m) corrected	Limits (dBµV/m)	Margin (dB)
4806.11	188	35	1000	10	V	50.64	6.14	54*	47.86

Channel 40

FREQUENCIES (MHz)	Antenna height (cm)	Azimuth (degree)	RBW (kHz)	VBW (Hz)	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m) without correction	Field strength (dBµV/m) corrected	Limits (dBµV/m)	Margin (dB)
4884.10	144	32	1000	10	V	53.35	8.85	54*	45.15

Channel 79

FREQUENCIES (MHz)	Antenna height (cm)	Azimuth (degree)	RBW (kHz)	VBW (Hz)	Polarization H: Horizontal V: Vertical	Field strength (dBµV/m) without correction	Field strength (dBµV/m) corrected	Limits (dBµV/m)	Margin (dB)
4962.06	141	154	1000	10	V	52.84	8.34	54*	45.66

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

Applicable limits: 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the power produced by the equipment, in 100 kHz bandwidth outside the frequency band in which the spread spectrum is operating. In addition radiated emissions which fall in the restricted band, as defined in section 15.205 (c), must also comply with the radiated emission limits specified in section 15.209 (a).

TEST CONCLUSION: RESPECTED STANDARD

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