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RPMBlue FS SYSTEM ACCEPTANCE AND SPECIFICATIONS

Serial Number : RPM BLUE-0719-0203

Customer : ON SEMI

Approved : Seiichi Kojika Date : 17/Jul/2019

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INTRODUCTION

Thank you for your purchase of the Nanometrics RPMBlue Rapid Photoluminescence Mapper. The following acceptance document is designed as a brief guide outlining the methods used to qualify the RPMBlue tool and to assure the user that the tool is operating to within the manufacturers' specifications.

Accompanying your RPMBlue are the manufacturer's datasheets which contain the original laser test reports obtained within their factory. However outlined below are the results achieved at Nanometrics for each laser fitted.

A- 266nm LASER (Port A)

Laser Type/Model	266nm Q-Switch
Manufacturer	teem photonics
Output Wavelength (nm)	266nm
Serial Numbers	Head: GR1800645 PSU/Controller: 1814-0401
Output Power	Direct from Laser: 7.9mW At sample: 6.5mW
Spot size on RPM entry slit	1.2
Power Stability	0.15% ☐ Stated ☒ Measured ☐ Expected

SECTION 1 - ALIGNMENT

In order to qualify the alignment of a laser, the RPM is submitted to the following tests :

- STAGE HEIGHT OPTIMISATION – This is an automatic function of the RPM software that is designed to set the stage into an optically optimised position by plotting the PL peak intensity versus stage height. This graph is displayed onscreen and indicates the optimised height, which should closely match the thickness of the wafer under scrutiny. The resulting smooth curve not only verifies the thickness of the wafer being examined but ensures that the stage is moving through its full range of travel smoothly. It should be noted though that this test uses the laser only and the results of the height optimisation can be influenced by damage and/or dust particles on the wafer surface and also, in some cases, sub-layers inherent to the structure of the wafer.

- SPATIAL RESOLUTION – The RPM tool allows for very fast data acquisition speeds whilst maintaining a good level of spatial resolution. This is achieved thanks to a rotating stage rather than a X-Y stage (the scanning motion resembles the reading of a record). As a further verification of the alignment quality, a specially designed wafer jig (*see diagram 1*) is scanned by means of a spectral map. The resulting image should be as close as possible to the original jig.

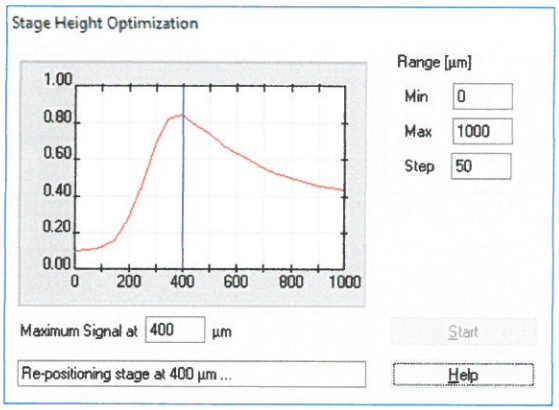
Diagram 1 – Accent Wafer Jig

- WAFER IMAGE TEST – The concept of this third test is to acquire a spectral map of a reference wafer (of which its properties are known) using optimised settings. After the first scan the wafer is then rotated 180° on the chuck and the map is then re-acquired under the same conditions. The scan data is then compared for consistency: first the average intensity and wavelength should be within tolerance and finally, using a simple drawing package, the two spectral images are visually compared to make sure good symmetry is present.

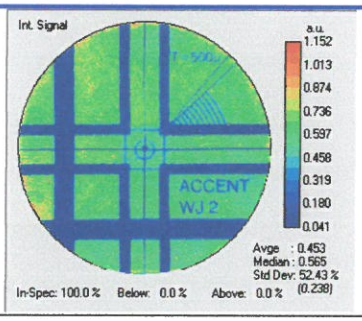
- WAVELENGTH AND INTENSITY CHECKS - The graph shown for each laser fitted to the tool illustrate several key factors which are integral to the tool being aligned accurately. Firstly the signal intensity measured with respect to slit width and secondly, the PL spot size at the slit can be determined from the point on the curve where it reaches peak intensity. Finally the graphs also verify whether the tool reads the wavelength of a given sample to within specification when the slit width is varied.

LASER PORT A – A

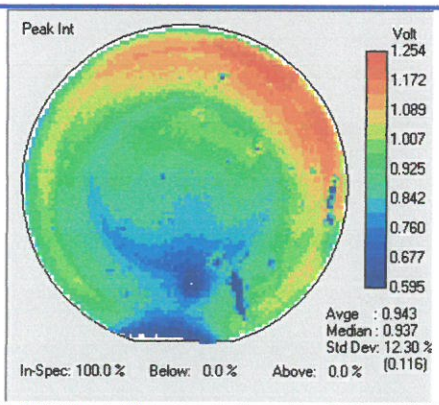
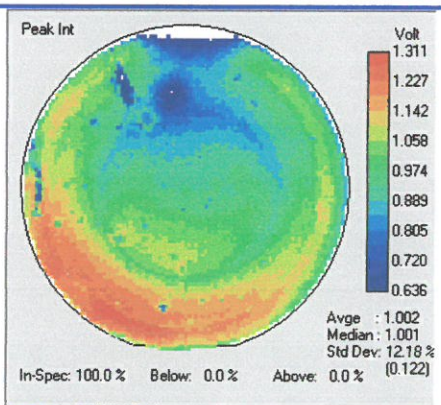
- STAGE HEIGHT OPTIMISATION – Tests performed using a GaN reference wafer with a thickness of 400µm.



- SPATIAL RESOLUTION – Test performed using the Accent wafer jig as shown in diagram 1. The resulting map is shown below.

ACCENT WAFER JIG	SPECTRAL MAP
	

- WAFER IMAGE TEST – Tests performed using a GaN reference wafer which has a peak wavelength around 470nm and a thickness of 400µm.

WAFER MAP (0 Degrees)		WAFER IMAGE (180 Degrees)	
			
Wavelength (nm)	462.9	Wavelength (nm)	462.9
Peak Intensity (V)	0.943	Peak Intensity (V)	1.002

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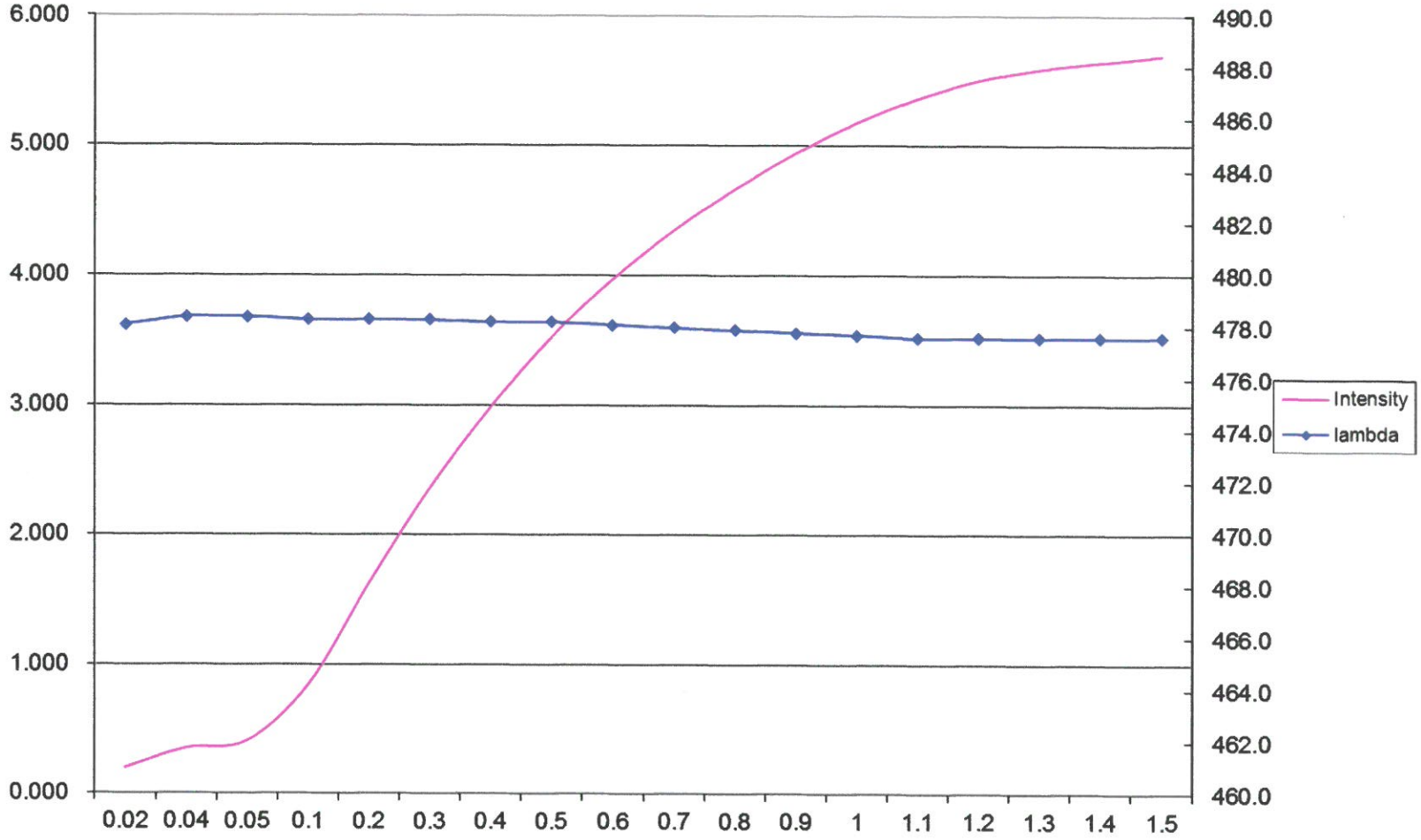
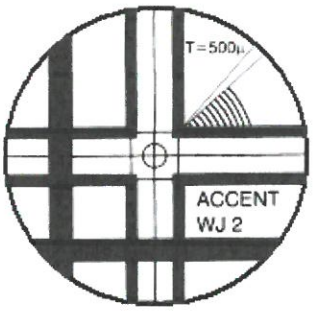
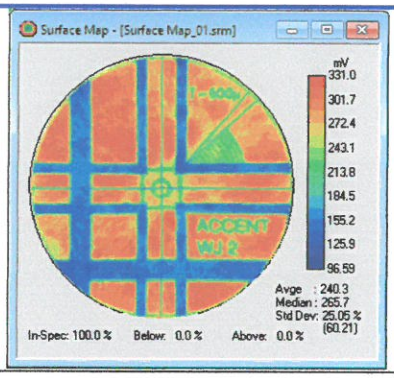
Slit Width Variations - 266nm Q-Switch laser

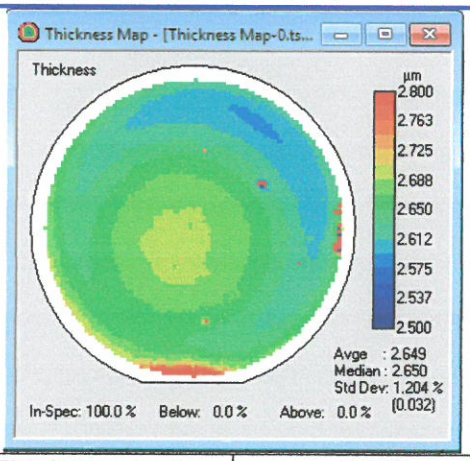
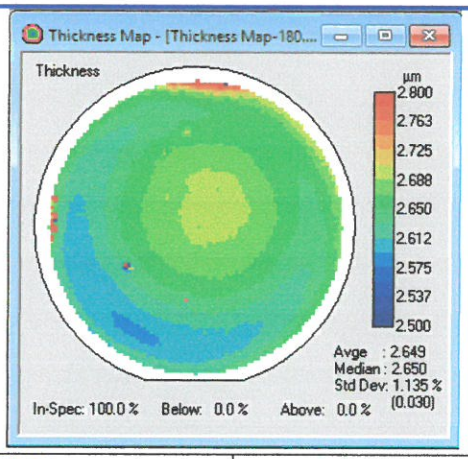


WHITE LIGHT SOURCE

- SPATIAL RESOLUTION – Test performed using the Accent wafer jig as shown. The resulting map is shown below.

ACCENT WAFER JIG	SPECTRAL MAP
	

- WAFER IMAGE TEST – Tests performed using a GaN reference wafer.

WAFER MAP (0 Degree)		WAFER IMAGE (180 Degrees)	
			
Thickness (µm)	2.649	**Thickness** (µm)	2.649

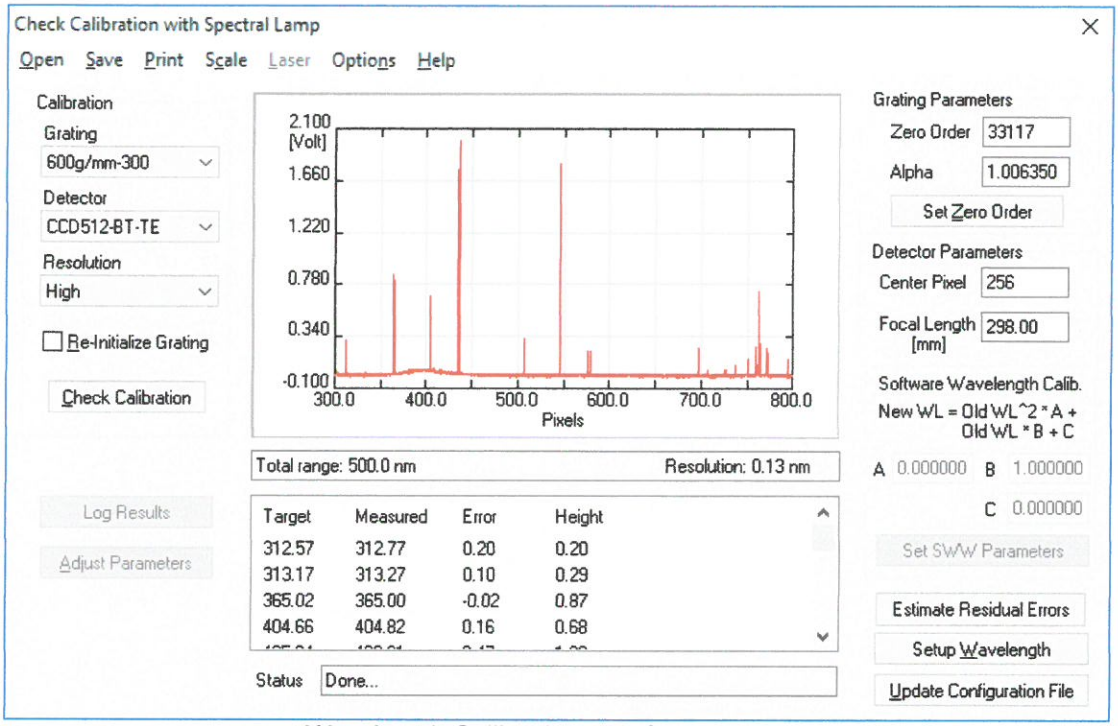
SECTION 2 – WAVELENGTH CALIBRATION

The wavelength calibration of the RPMBlue FS is based on measuring a very sharp, accurate and stable signal with a known wavelength. Depending on the system's configuration, the laser which best matches the above criteria will be used, most commonly a 532nm Nd:YAG DPSS Laser. Usually, the first, second and third orders (from the grating) are measured. This calibration can be verified easily by following the directions in the User Manual or in the help file

GRATING	DETECTOR	ZERO ORDER 266nm		1nd HARMONIC 532nm		2nd HARMONIC 798nm	
		SPEC from 266nm	Actual (nm)	SPEC from 532nm	Actual (nm)	SPEC from 798nm	Actual (nm)
600 g.mm-1	CCD	± 0.26	**266.2**	± 0.26	**531.8**	± 0.26	**798.1**
λ_b =300	InGaAs						
300 g.mm-1	CCD	± 0.52	**266.1**	± 0.52	**532.1**	± 0.52	**798.4**
λ_b =300	InGaAs						
150 g.mm-1	CCD	± 1.04	**265.7**	± 1.04	**533.0**	± 1.04	**797.0**
λ_b =500	InGaAs						

Note: λ_b = Blaze Angle (peak response wavelength)

After the initial wavelength calibration has been completed the calibration is further refined by measuring the spectral lines of an Hg pencil lamp. These lines give a very sharp, accurate and stable signal with a known wavelength. This calibration can be verified easily by following the directions in the User Manual or in the help file.



Wavelength Calibration with Spectra Lamp

Hg Line (nm)	Measured (nm)	Error (nm)
313.17	313.27	0.10
365.02	365.00	-0.02
404.66	404.82	0.16
435.84	436.31	0.47
546.07	545.98	-0.09
576.96	576.99	0.03
579.07	579.21	0.14

GRATING	DETECTOR	SPEC
150 g.mm^{-1} λ_b = 500	CCD	± 1.04
	InGaAs	± 1.04
300 g.mm^{-1} λ_b = 300	CCD	± 0.52
	InGaAs	± 0.52
600 g.mm^{-1} λ_b = 300	CCD	± 0.26
	InGaAs	± 0.26
1200 g.mm^{-1} λ_b =	CCD	± 0.13
	InGaAs	± 0.13

Note: λ_b = Blaze Angle (peak response wavelength)

SECTION 3 - PERFORMANCE

The final section of this report covers the RPMBlue's ability to produce consistent results under apparently similar test conditions. For the duration of these final tests it is assumed that the following conditions are met:

- The laser intensity stability is better than 2% over the duration of the test
- Maximum room temperature does not deviate by more than ± 1 ℃
- Test results do not take into account long term drift from a laser as this characteristic is highly laser dependant and is defined by the laser manufacturer

A- PL REPRODUCIBILITY – In the qualification of the RPMBlue we acquire a spectral map for a 20cm diameter section of a reference wafer. Once the first map is completed the system is then powered down completely and then powered back up after a cooling down time. Once the tool is back up, the scan is repeated using identical parameters and the results recorded. This procedure is repeated 10 times in order to show that the system is capable of accurately reproducing measurements from preset analysis conditions.

Sample Type: GaN
Laser: 266nm Q-Switch
Detector: CCD512-BT-TE
Slit Width: 0.1
Grating: 600g/mm-300

RAW DATA

Test Number	Wavelength (nm)	Intensity (V)		Test Number	Wavelength (nm)	Intensity (V)
1	461.3	0.443		6	461.3	0.461
2	461.3	0.427		7	461.2	0.436
3	461.3	0.487		8	461.2	0.434
4	461.3	0.427		9	461.3	0.431
5	461.3	0.427		10	461.3	0.438

REPRODUCIBILITY STATISTICS

	Grating	Specifications	Actual
Wavelength (nm - Peak to Peak)	150 g.mm^{-1}	± 2.08	
	300 g.mm^{-1}	± 1.04	
	600 g.mm^{-1}	± 0.75	*0.1*
	1200 g.mm^{-1}	± 0.52	
Intensity (% - 3σ)	ALL	± 15	**13.005**

B – ROBOT IRONMAN TEST

Robot is exercised for 1000 cycles continuously to verify its performance. The each circle includes:

- Load wafer to pre-aligner
- Pre-align wafer
- Open laser safety shutter
- Load wafer to RPM stage
- RPM stage moves to measurement position
- Close laser safety shutter
- RPM stage moves to load position
- Open laser safety shutter
- Load wafer to cassette

N/A

Robot Ironman Test

C – THROUGHPUT

Throughput is an important benchmark of measurement speed. RPMBlue is currently the fastest commercially available PL mapper. For this test the robot is utilised for wafer handling, the cassette is audited and the measurement parameters are:

- 48mm spectral map
- 2mm resolution
- 80 pt/s scan rate

One cassette with a few samples is measured in "Process Cassette" mode. The average time between the generations of data files of two successive wafers is used to calculate the throughput.

File Name	Created Time	Modified Time	Size
Measurement Time(s)			
Time on each wafer (s)			
Throughtput(WPH)			

MEASURED THROUGHPUT **N/A** WPH

D – WAFER BOW

Wafer bow is a new feature introduced to RPMBlue and VerteX. For this test two calibration mirrors (Nanometrics PN: 9700-7-000007 and 9700-7-000008) are used.

The measurement conditions and software/fitting settings are listed in 'RPM Align, Test and Calibration Procedure of Bow Kits'.

Measurement	9700-7-000007 (PAV200)	9700-7-000008 (PAV1000)
No.1		
No.2		
No.3		
No.4		
No.5		
AVE (µm)		
StDev (µm)		
Target (µm)	136.9	27.4
Difference (µm)		
Specification (µm)	136.9± 6	27.4± 6
Pass/Fail		

CONCLUSION – This concludes the report. The data included in this document indicates the tool is operating within specification at the Nanometrics factory. If you have any further queries regarding the data in the report please don't hesitate to contact Accent and we will be happy to deal with your queries.

CONTACT DETAILS

Please contact us if you have any further questions or comments.

+1 408 545 6000
+44 1904 529 700

Nanometrics Inc. (www.nanometrics.com) is a leading supplier of process control systems for silicon and compound semiconductor manufacturers worldwide. The company's legacy dates back over 300 years to its optical instrument manufacturing roots in York, England. Nanometrics specialises in photolithography process control tools, providing industry-leading performance of overlay, critical dimensions, and profile metrology to top-tier device manufacturers. Nanometrics is also a major provider of lattice metrology tools, supplying process characterization and control to advanced semiconductor industries including those using strained silicon, SOI, or advanced epitaxial layers for high performance logic, wireless communications, opto-electronics, and high brightness LEDs.

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RPMBlue Packing List

Tool Serial Number RPM BLUE-0719-0203 Date 17/Jul/2019

Sales Order Number Customer ON SEMI

Item Description	Comments	✓ Checked	✓ Checked
Hardware			
RPMBlue		✓	✓
Wafer Handler		N/A	N/A
External Laser		N/A	N/A
Ext. Laser Fibre	To Be Shipped With Endcaps	N/A	N/A
Ext Laser Control Cable		N/A	N/A
Ext Laser Power Cable		N/A	N/A
Cassette Station Cable(s)	Cable	N/A	N/A
Vacuum Hose	1 cable	✓	✓
Power Lead	CZE Type 2 cables (RPMBlue, VACUUM PUMP)	✓	✓
Wafer Holders	Standard, 7300-7-000047, 7300-7-000051	✓	✓
Keyboard		✓	✓
Trackerball		✓	✓
Vacuum Pump		✓	✓
Manuals			
User Manual	CD	✓	✓
Laser Datasheet(s)	266nm Q-Switch	✓	✓
Monochromator Datasheet		✓	✓
Detectors Datasheet(s)	CCD512-BT-TE	✓	✓
Robot User Manual		N/A	N/A
Software			
RPMBlue System Software	V9.17.0	✓	✓
System Configuration Files		✓	✓
Gencobot Firmware Backup		N/A	N/A
Spares			
Spare Fuses	2 off T1.6A	✓	✓
Reflection Option	Spare Bulb + Mirror	✓	✓
Panel Key		N/A	N/A
Labels			
Electrical Safety Label		✓	✓
Serial Number Sticker		✓	✓
Voltage Rating Sticker		✓	✓
Warning Labels		✓	✓
Certificates			
CE Certificate		✓	✓
Laser Safety Certificate		✓	✓
Acceptance Documents		✓	✓

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RPMBlue Packing List

General			
Cleaned		✓	✓
Remarks			

This document certifies that the above instrument(s) and associated accessories have been successfully tested and packed in the factory. Upon receipt of the delivery, please check the quantity of units and parts on the packing list and inspect them for any signs of damage.

Checked by : Seiichi Kojika Signature : 小鹿 誠一 Date : 17/Jul/2019

Checked by : Kenji Suzuki Signature : 鈴木 憲司 Date : 17/Jul/2019

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Product Electrical Safety Test

Doc No.	094-9289	Rev	A

REVISION / AUTHOR	DATE OF REVISION	SECTION(S) EFFECTED	REASONS FOR REVISION
REVISION A	06-02-2007	ALL	FIRST EDITION

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Instrument	***RPM BLUE***	**Voltage**	***240V***
Serial Number	*RPM BLUE-0719-0203*		
Test Engineer	*Seiichi Kojika*	**Date**	*16/Jul/2019*
Electrical Classification	*Class1*		
Test Equipment Used	*EASY PAT2100*		

Tests Specified:

1. Visual Inspection
2. Earth Bond Test
3. Insulation Test
4. Flash Test (optional)
5. Function / Earth Leakage Test (optional)

1. Visual Inspection (internal / external)		
PASSED	Signature	S. Kojika

2. Earth Bond Test (Measured at 25 Amps)		
Note: pass range <0.1Ω Note: pass range <0.5Ω (for low current instruments)		
Test to ALL exposed metalwork / tool panels		
Record Highest Measured Value (Ω)		0.11 Ω
PASSED	Signature	S. Kojika

3. Insulation Test (Measured at 500VDC)		
Note: pass range >2MΩ, class 1 product		
Note: pass range >7MΩ, class 2 product		
Record Measured Value (MΩ)		>20 MΩ
PASSED	Signature	S. Kojika

4. Flash Test (optional)
Note: If performing this test, record the method and results in the box below
N/A

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5. Function / Earth Leakage Test		
Note: pass range <3.5 mA class 1 product		
Note: pass range <0.75 mA class 2 product		
Power Consumption (KVA)		0.5 A 240 VAC
Earth Leakage N-E (mA)		1.0 mA
Earth Leakage L-E (mA)		1.0 mA
PASSED	Signature	S. Kojika

Comments
N/A

Test Complete Signature	Seiichi Kojika 16/Jul/2019

nanometrics RPMBlue Laser Safety Test Certificate

Date	16/Jul/2019		
Engineer	Seiichi Kojika	Signature	Seiichi Kojika
Instrument Serial Number	RPM BLUE-0719-0203		
Customer / Order Number	ON SEMI		
Software version	9.17.0		

Perform the tests in the stated order. Initial the checkbox and record any comments before carrying out the next test. Fill out the comment section if any problems are encountered.

Description	N/A	Initial	Comment
Optical Head			
Optical head secure		S.K	
Optical head alignment correct		S.K	
Channel A laser secure		S.K	266nm Q-Switch Laser secure
Channel A laser beam steering unit secure		S.K	
Channel A filter wheel function correct		S.K	
Port 2 diode laser/optical fibre collimator secure	S.K		
Port 2 light shield present		S.K	
Port 2 blanking plug present		S.K	
UV port optical fibre assembly secure	S.K		
UV port optical fibre secure	S.K		
UV port optical fibre security tie secure	S.K		
UV port light shield present & aligned	S.K		
UV port optical fibre secure throughout route	S.K		
UV blanking plate fitted		S.K	
Port 4 diode laser/optical fibre collimator secure	S.K		
Port 5 diode laser/optical fibre collimator secure	S.K		
Beamsplitter assembly secure		S.K	
Beamsplitter assembly alignment correct		S.K	
Beamsplitter blanking plate fitted	S.K		
Beamsplitter function correct		S.K	
SAM assembly secure		S.K	
SAM assembly alignment correct		S.K	
SAM blanking plate fitted	S.K		
SAM function correct		S.K	
Hg lamp assembly secure		S.K	
White Light Source secure		S.K	
White Light Source aligned		S.K	
White Light Source blanking plate fitted	S.K		
Stage/Safety Interlocks			
Laser shutter function correct		S.K	
Loading Door latch function correct		S.K	
Loading Door interlock function correct		S.K	
Identification Label			
Identification label fitted		S.K	
Identification label details correct		S.K	
Emergency Off Switch			
Emergency Off Switch function correct		S.K	
Robot Shutter			
Shutter Vane operation correct		S.K	
Cylinder aperture orientation correct		S.K	
Shutter sequence correct		S.K	

Description	N/A	Initial	Comment
Warning Labels			
Warning labels (laser) on upper covers (7-off)		S.K	
Warning labels on cassette apertures (3-off)*	S.K		
Exterior Panels & Covers			
Upper panels fit		S.K	
Upper Loadside panel fit		S.K	
Robot covers fit	S.K		
Blanking plates on unused cassette apertures	S.K		
Prealigner cover fit	S.K		
Robot Perspex cover fit	S.K		
External laser			
Optical Fibre entry correct	S.K		
Optical Fibre secure on route and at terminations	S.K		
Laser shutter function correct	S.K		
Filter wheel function correct	S.K		
Contactor function correct re. Primary Interlock	S.K		
Contactor function correct re. EMO switch	S.K		
External cover present and secure	S.K		
External cover warning labels present	S.K		
Software Version			
Latest version installed		S.K	9.17.0
Documents (or appropriate record)			
Mechanical Build	S.K		
Electrical/Electronic Build	S.K		
Calibration/data Sheets/Manuals	S.K		
Monochromator		S.K	
CCD Detector 1		S.K	CCD512-BT-TE
CCD Detector 2	S.K		
Dual Wavelength Detector	S.K		
266nm Laser		S.K	Q-Switch
325nm Laser	S.K		
355nm Laser	S.K		
375nm Laser	S.K		
405nm Laser	S.K		
532nm Laser	S.K		
660nm Diode Laser	S.K		
785nm Diode Laser	S.K		
980nm Diode Laser	S.K		
Other Laser	S.K		
Robot Service Manual	S.K		
Robot Test & Calibration check list	S.K		
Robot Prealigner Test & Calibration check list	S.K		
Robot Shipping check list	S.K		

Additional comments, notes or non compliance's
N/A

ACCENT®

Accent Optical Technologies (U.K.) Ltd

RPM STAGE ASSEMBLY
FINAL TESTS CHECKLIST

Type	RPM BLUE	Serial Number	RPM BLUE-0719-0203

ELECTRONICS *Voltage Check*

Stage Interface PCB	TP1/TP2	5.090			
Stage Rotation Sensor PCB	TP1/TP2	5.090	TP3/TP4	4.850	
Vacuum Switch	Status	S.K			
Vacuum Sensor	Status	S.K			
Override Switch	Status	S.K			
Linear Opto-Sensor	Status	S.K			
Rotation Opto-Sensor	Status	S.K			

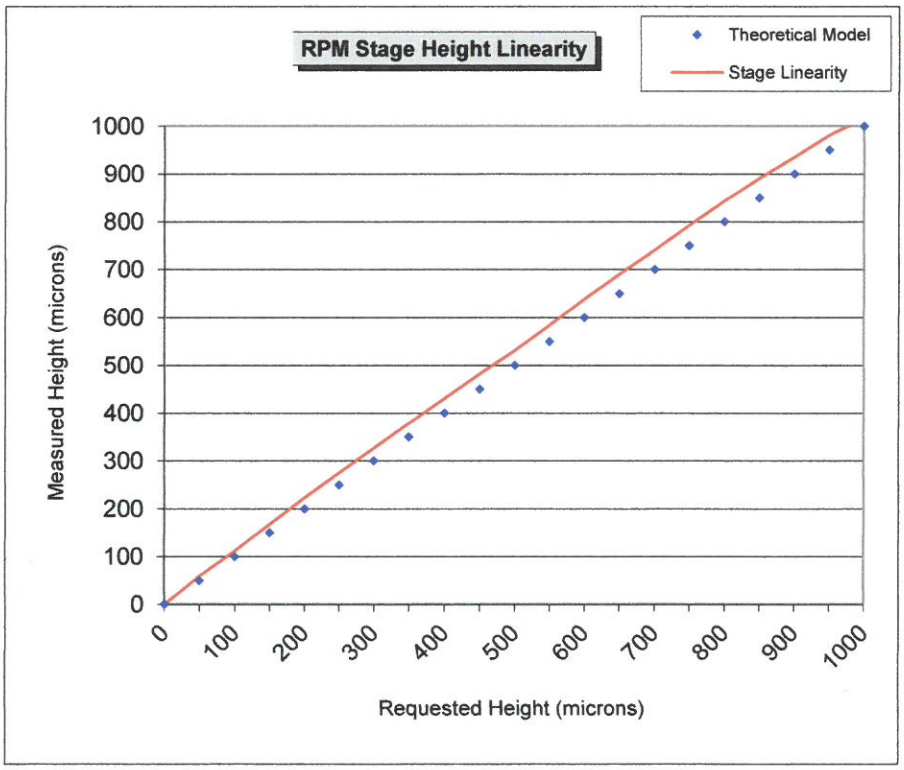
MECHANICAL *Visual Inspection*

Drive Motor Belt	Status	S.K	
Linear Motor Belt	Status	S.K	
Rotation Belt	Status	S.K	
Flatness	Clocked at	20	μm

FINAL TESTS

Linear Repeatability	Cycles	1000
Height Linearity		

Requested Height	Measured Height
0	0
50	59
100	112
150	168
200	223
250	275
300	327
350	379
400	431
450	482
500	531
550	584
600	639
650	690
700	741
750	793
800	844
850	891
900	935
950	981
1000	1016



Approved by : Seiichi Kojika *Date :* 11/Jul/2019

Declaration of Conformity

CE

Manufacturer: **Nanometrics**
Model Name: **RPM Blue**
Date: **June 2010**

Application of Council Directives:
Low Voltage Directive (LVD) 2006/95/EC
Standards to which Conformity is Declared: IEC 60204-1 2005-10

Standards to which Conformity is Declared:
IEC 60825-1 (Ed.2.0) Safety of Laser Products 2007-03-30 –
Part 1: Equipment classification and requirements

Application of Council Directives:
Electromagnetic Compatibility Directive (EMC) 2004/108/EC
Conformity is declared to Annex II (EMC) 2004/108/EC

Application of Council Directives:
Machinery Directive 2006/42/EC - 1st Edition - December 2009
Conformity is declared to Essential Requirements of the Directive

The equipment and information provided and listed above has been evaluated and found conforming based on the directives and standards listed based on evaluation, assessment, technical construction file and risk assessment.

The Technical Construction file is maintained at;
Nanometrics, Inc.
1320 Southeast Armour Road
Bend, OR 97702-4405

Authorized Representative in the EU;
Nanometrics (UK) Ltd.
3-7 Rose Avenue
Nether Poppleton, York YO26 6RU, United Kingdom
01904 529700

Name: Steve Barcik
Title: Third Party Evaluator
Signature:

Steve Barcik

High Tech Design Safety, LLC
Austin, Texas, USA
512-266-0222
www.hightechdesignsafety.com
Date: March 24, 2010

Name: Christopher Raymond
Title: Director of Technology Development
Signature:

Nanometrics
Bend, Oregon, USA
(541) 322-2500
www.nanometrics.com
Date: March 24, 2010