



# RGV100HL-S

## High-Speed, High-Torque Precision Rotation Stage



 **Newport®**

**USER'S MANUAL**

# Warranty

Newport Corporation warrants this product to be free from defects in material and workmanship for a period of 1 year from the date of shipment. If found to be defective during the warranty period, the product will either be repaired or replaced at Newport's discretion.

To exercise this warranty, write or call your local Newport representative, or contact Newport headquarters in Irvine, California. You will be given prompt assistance and return instructions. Send the instrument, transportation prepaid, to the indicated service facility. Repairs will be made and the instrument returned, transportation prepaid. Repaired products are warranted for the balance of the original warranty period, or at least 90 days.

## Limitation of Warranty

This warranty does not apply to defects resulting from modification or misuse of any product or part.

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### CAUTION

**Warranty does not apply to damages resulting from:**

- **Incorrect usage:**
  - **Load on the stage greater than maximum specified load.**
  - **Carriage speed higher than specified speed.**
  - **Improper grounding.**
    - **Connectors must be properly secured.**
    - **When the load on the stage represents an electrical risk, it must be connected to ground.**
  - **Excessive or improper cantilever loads.**
- **Modification of the stage or any part thereof.**

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This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability or fitness for a particular use. Newport Corporation shall not be liable for any indirect, special, or consequential damages.

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Original instructions.

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#### CAUTION

**Please return equipment in the original (or equivalent) packing.**

**You will be responsible for damage incurred from inadequate packaging if the original packaging is not used.**

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# EC Declaration of Conformity

**RGV100HL-S**  **Newport®**

## EU Declaration of Conformity

following Annex II-1A  
of Directive 2006/42/EC on machinery

**The manufacturer:**

MICRO-CONTROLE Spectra-Physics,  
9, rue du Bois Sauvage  
91055 Evry CEDEX, FRANCE

**Hereby declares that the machinery:**

- Description: " RGV100HL-S "
- Function: High-Speed, High-Torque Precision Rotation Stage
- Models: RGV100HL-S

– the technical file of which was compiled by:

Mr Hervé LE COINTE , Quality Director,  
MICRO-CONTROLE Spectra-Physics, Zone Industrielle - B.P.29  
F-45340 Beauce La Rolande France

- complies with all the relevant provisions of the Directive 2006/42/EC on machinery.
- complies with all the relevant provisions of the Directive 2014/30/EU relating to electro-magnetic compatibility.
- complies with all the relevant provisions of the Directive 2011/65/EU relating to RoHS2.

– was designed and built in accordance with the following harmonised standards:

- NF EN 61326-1:2013 « Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements »
- NF EN 55011:2010/A1:2011 Class A
- EN ISO 60204-1 « Safety of machinery – Electrical equipment of machines – Part 1 General requirements »

– was designed and built in accordance with the following other standards:

- NF EN 61000-4-2
- NF EN 61000-4-3
- NF EN 61000-4-4
- NF EN 61000-4-6

### ORIGINAL DECLARATION

Done in Beauce La Rolande on 16 May 2017  
Hervé LE COINTE  
Quality Director



DC1-EN rev:A

# Definitions and Symbols

The following terms and symbols are used in this documentation and also appear on the product where safety-related issues occur.

## General Warning or Caution



The exclamation symbol may appear in warning and caution tables in this document. This symbol designates an area where personal injury or damage to the equipment is possible.

The following are definitions of the Warnings, Cautions and Notes that may be used in this manual to call attention to important information regarding personal safety, safety and preservation of the equipment, or important tips.



### WARNING

**Warning indicates a potentially dangerous situation which can result in bodily harm or death.**



### CAUTION

**Caution indicates a potentially hazardous situation which can result in damage to product or equipment.**

### NOTE

**Note indicates additional information that must be considered by the user or operator.**

## European Union CE Mark



The presence of the CE Mark on Newport Corporation equipment means that it has been designed, tested and certified as complying with all applicable European Union (CE) regulations and recommendations.

## Warnings and Cautions



### ATTENTION

**This stage is a Class A device. In a residential environment, this device can cause electromagnetic interference. In this case, suitable measures must be taken by the user.**

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**WARNING**

When the RGV100HL-S stage is installed or combined with other instruments in a machine, additional testing to directive 2006/42/EC may be required. It is the responsibility of the end-user or integrator to perform a risk-analysis and the necessary tests to conform to the EC directives.

Newport is not liable for damages caused by not executing this responsibility.

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## Warnings

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**WARNING**

The motion of objects of all types carries potential risks for operators. Ensure the protection of operators by prohibiting access to the dangerous area and by informing the personnel of the potential risks involved.

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**WARNING**

The connection of electrical devices must meet safety and electrical standards. Grounding methods indicated in this manual must be applied.

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**WARNING**

Due to the nature of this stage, the installation, use and maintenance of this stage must be performed by trained personnel who are familiar with safety regulations that are applicable to this product.

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**WARNING**

Do not use this stage when its motor is emitting smoke or is unusually hot to the touch or is emitting any unusual odor or noise or is in any other abnormal state.

Stop using the stage immediately, switch off the motor power and then disconnect the electronics power supply.

After checking that smoke is no longer being emitted contact your Newport service facility and request repairs. Never attempt to repair the stage yourself as this can be dangerous.

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**WARNING**

**Make sure that this stage is not exposed to moisture and that liquid does not get into the stage.**

**Nevertheless, if any liquid has entered the stage, switch off the motor power and then disconnect the electronics from power supply.**

**Contact your Newport service facility and request repairs.**

---

**WARNING**

**Do not insert or drop objects into this stage, this may cause an electric shock, or lock the drive.**

**Do not use this stage if any foreign objects have entered the stage. Switch off the motor power and then disconnect the electronics power supply.**

**Contact your Newport service facility for repairs.**

---

**WARNING**

**Do not place this stage in unstable locations such as on a wobbly table or sloping surface, where it may fall or tip over and cause injury.**

**If this stage has been dropped or the case has been damaged, switch off the motor power and then disconnect the electronics power supply.**

**Contact your Newport service facility and request repairs.**

---

**WARNING**

**Do not attempt to modify this stage; this may cause an electric shock or downgrade its performance.**

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**WARNING**

**Do not exceed the usable depth indicated on the mounting holes (see section “Dimensions”). Longer screws can damage the mechanics or cause a short-circuit.**

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**WARNING**

**Do not exceed speed and load limitations as specified in this manual.**

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# Caution

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**CAUTION**

Do not place this stage in a hostile environment such as X-Rays, hard UV,... or in any vacuum environment.

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**CAUTION**

Do not place this stage in a location affected by dust, oil fumes, steam or high humidity. This may cause an electric shock.

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**CAUTION**

Do not leave this stage in places subject to extremely high temperatures or low temperatures. This may cause an electric shock.

- Operating temperature: +10 to +35 °C
  - Storage/Operating altitude: 1000 m
  - Storage/Operating humidity: 85%
  - Storage temperature: -10 to +40 °C (in its original packaging)
- 

**CAUTION**

Do not move this stage if its motor power is on.

Make sure that the cable to the electronics is disconnected before moving the stage. Failure to do so may damage the cable and cause an electrical shock.

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**CAUTION**

Be careful that the stage is not bumped when it is being carried. This may cause it to malfunction.

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**CAUTION**

When handling this stage, always unplug the equipment from the power source for safety.

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**CAUTION**

When the carriage is in its end-of-run position, it is strongly recommended not to go beyond this point as this may damage the stage mechanism.

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**CAUTION**

Contact your Newport service facility to request cleaning and specification control every year.

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# High-Speed, High-Torque Precision Rotation Stage RGV100HL-S

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## 1.0 Introduction

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This manual provides operating instructions for the RGV100HL-S high-speed, high-torque precision rotation stage.



*RGV100HL-S precision rotation stage.*

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### RECOMMENDATION

**We recommend you read carefully the chapters 4.0 and 6.0 for the connection to an electronics, before using a RGV100HL-S rotation stage.**

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**2.0 Description**

The RGV100HL-S is the high torque version of the RGV100BL, a very compact direct-drive rotation stage that provides ultra-fast rotation with very high resolution and outstanding positioning performance. Applications include semiconductor wafer inspection, micro-robotics, and precision metrology.

The direct-drive technology of the RGV100HL-S eliminates the worm gear of traditional rotation stages. The advantages are higher speeds, superior reliability, and enhanced position sensitivity. Speed, resolution, and repeatability are increased by a factor of up to ten times compared to worm-driven rotation stages of the same size. A high efficiency brushless DC torque motor with rare earth magnets supplies an optimum ratio of torque vs inertia for high acceleration, with minimal stage heating.

Precision is ensured by a high-resolution glass scale with 15,000 line pairs per revolution that directly measures the position of the rotating platen. The flat encoder is mounted on a precision ground reference surface and is perfectly aligned with the stage’s rotation axis to minimize position errors induced by eccentricity, wobble, or axial runout. The encoder signals are interpolated by Newport’s XPS motion controller with less than 0.1 mdeg resolution for outstanding position sensitivity and stability.

The RGV100HL-S features a proprietary 4-point contact ball bearing. This unique, 2-piece design takes the full benefit of Newport’s excellent capabilities in the design, manufacturing and assembly of precision mechanics and integrates multiple functions, the bearing ways and the direct drive motor into a minimum number of parts. The result is a more compact rotation stage with superior stiffness, high reliability and outstanding wobble and eccentricity.

A 30 mm diameter through-hole allows convenient routing of cables and vacuum lines through the stage. An index pulse, triggered every revolution, permits precision homing to a unique home position. The RGV100HL-S also features two limit switches that can be enabled or disabled by an external switch.

**2.1 Design Details**

Base Material	Aluminum
Bearings	Large diameter steel ball bearings
Motor	High-torque brushless DC-motor with rare earth magnets (no Hall effect sensors)
Motor Initialization	Has to be done by the controller (without using Hall effect sensors)
Motor Commutation	Done by the XPS controller on encoder signals
Feedback	Glass scale encoder with 15,000 line pairs per revolution, 1 V <sub>pp</sub> , 32768-fold signal subdivision when used with XPS controller
Limit Switches	Two optical limit switches at approx. ±168°, disabled by external switch No hard stops included
Origin	Optical, fixed at position 0°, including mechanical zero signal

## 3.0 Characteristics

### 3.1 Definitions

Specifications of our products are established in reference to ISO 230 standard part II “Determination of accuracy and repeatability of positioning numerically controlled axes”.

This standard gives the definition of position uncertainty which depends on the 3 following parameters:

#### **Absolute Accuracy**

Difference between ideal position and real position.

#### **Accuracy**

Difference between ideal position and real position after the compensation of linear errors.

Linear errors include: cosine errors, inaccuracy of screw or linear scale pitch, angular deviation at the measuring point (Abbe error) and thermal expansion effects. All Newport motion electronics can compensate for linear errors.

The relation between absolute accuracy and on-axis accuracy is as follows:

$$\text{Absolute Accuracy} = \text{Accuracy} + \text{Correction Factor} \times \text{Travel}$$

#### **Repeatability**

Ability of a system to achieve a commanded position over many attempts.

#### **Reversal Value (Hysteresis)**

Difference between actual position values obtained for a given target position when approached from opposite directions.

#### **Minimum Incremental Motion (MIM or Sensitivity)**

The smallest increment of motion a device is capable of delivering consistently and reliably.

#### **Resolution**

The smallest increment that a motion device can theoretically move and/or detect. Resolution is not achievable, whereas MIM, is the real output of a motion system.

#### **Eccentricity**

Displacement of the geometric center of a rotation stage from the rotation axis in the plane defined by bearings.

#### **Wobble**

Tilt of rotation axis during rotation of a stage, measured on a reference surface.

The testing of accuracy, repeatability, and reversal error are made systematically with test equipment in controlled environment (20<sup>±1</sup> °C).

A linear cycle with 21 data points on the travel and 4 cycles in each direction gives a total of 168 points.

**Guaranteed and Typical Specifications**

Guaranteed maximum performance values are verified per Newport's A167 metrology test procedure. For more information, please consult the metrology tutorial section in the Newport catalog or at [www.newport.com](http://www.newport.com)

**3.2 Mechanical Specifications**



Travel Range (°)	360 continuous
Minimum Incremental Motion (mdeg)	0.10
Uni-directional Repeatability, Typical (Guaranteed) <sup>(1)</sup> (mdeg)	±0.08 (±0.15)
Bi-directional Repeatability, Typical <sup>(1)</sup> (mdeg)	±0.15
Accuracy, Typical (Guaranteed) <sup>(1)</sup> (mdeg)	±3.0 (±5.0)
Maximum Speed [no load] (°/s)	720
Inertia [no load] (kg.m <sup>2</sup> )	0.00104
Bearing Drag Torque (Nm)	0.3
Wobble, Typical (Guaranteed) <sup>(1)(2)</sup> (µrad)	±5.0 (±10)
Eccentricity, Typical (Guaranteed) <sup>(1)</sup> (µm)	±1.0 (±1.5)
MTBF (h)	20,000 with 5 kg load, 720 °/s speed and a duty cycle of 30%

<sup>1)</sup> For the definition of Typical and Guaranteed specifications see "Motion Basics Terminology & Standards" Tutorial at [www.newport.com](http://www.newport.com)

<sup>2)</sup> To obtain arcsec units, divide µrad value by 4.8.

**Note:** The following specifications are controller/drive dependent: MIM, Accuracy, Repeatability, Max. Speed and Max. Acceleration.

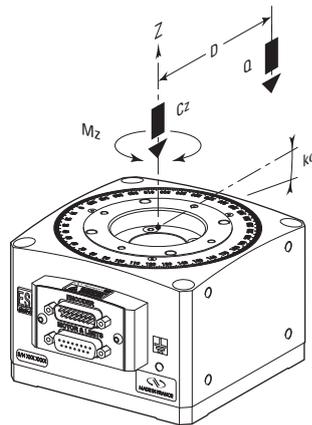
Refer to the RGV100BL-S page on [www.newport.com](http://www.newport.com) for specifications achievable with specific Newport controller/drive combination.



**CAUTION**

To achieve the specifications stated, stages must be fixed on a plane surface with a flatness of 10 µm.

**3.3 Load Characteristics and Stiffness**



Cz, Normal centered load capacity	100 N
Kα, Transversal compliance	15 µrad/Nm
Jz, Maximum Inertia	0.032 kgm <sup>2</sup>
Q, Off-center load	$Q \leq Cz \div (1 + D/35)$ and $Q \leq (Jz - Jq)/D^2$

Where: D = Cantilever distance in mm  
Jq = Inertia of payload



**CAUTION**

When a RGV100HL-S rotation stage is integrated in an assembly or in a system, vibration due to the rotation of an off-center load at a high speed must be taken into account.

These events can affect the RGV100HL-S's performance and the system's performance, or damage the stage and assembly.

**3.4 Stage Weight**

The stage weight indicated below does not include the cables.

	Weight [lb (kg)]
RGV100HL-S	7.7 (3.5)

**4.0 Drive & Motor**

**4.1 Motor Characteristics**

The RGV100HL-S rotation stage is equipped with a brushless DC-motor and a high-resolution glass scale encoder.

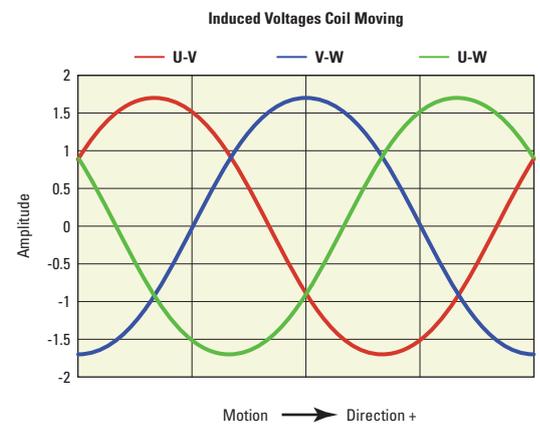
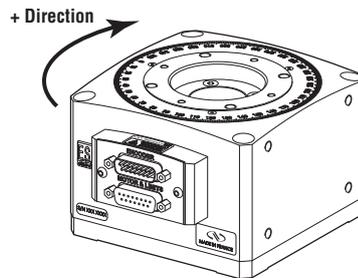
Max. rated torque	16.9 Nm
Design voltage Vp	100 V
Magnet pitch (Commutation period)	30°
Motor constant	0.1185 Nm <sup>2</sup> /W
Torque sensitivity	1.48 Nm/Arms
Back-emf constant	1.22 V/rad/s
Motor resistance	12.61 Ω
Motor inductance	31.4 mH
Thermal resistance	1.5 °C/W
Max. speed @ Vp	81 rad/s
Peak current @ Vp	6.48 Arms
Peak torque @ Vp	9.65 Nm
Max. rms current	1.38 Arms
Max. rms torque	2.05 Nm



**CAUTION**

High RMS current will generate motor heating which will degrade characteristics of the stage, such as repeatability, accuracy, etc...

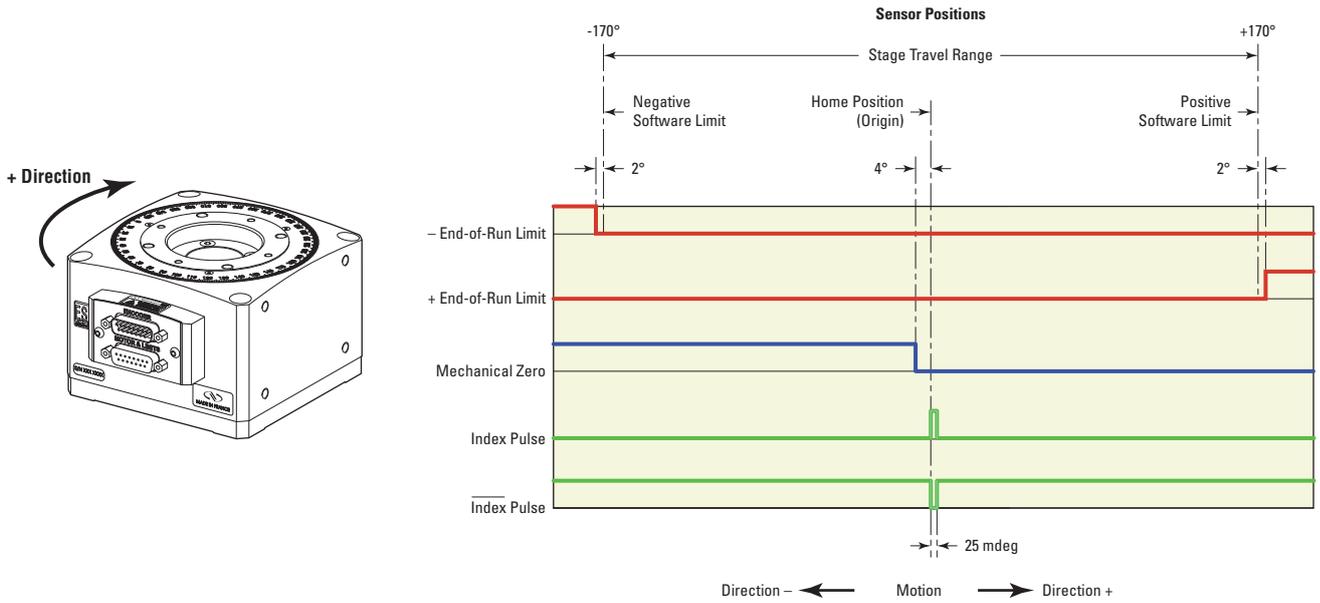
**4.2 Command Signals**



**NOTE**

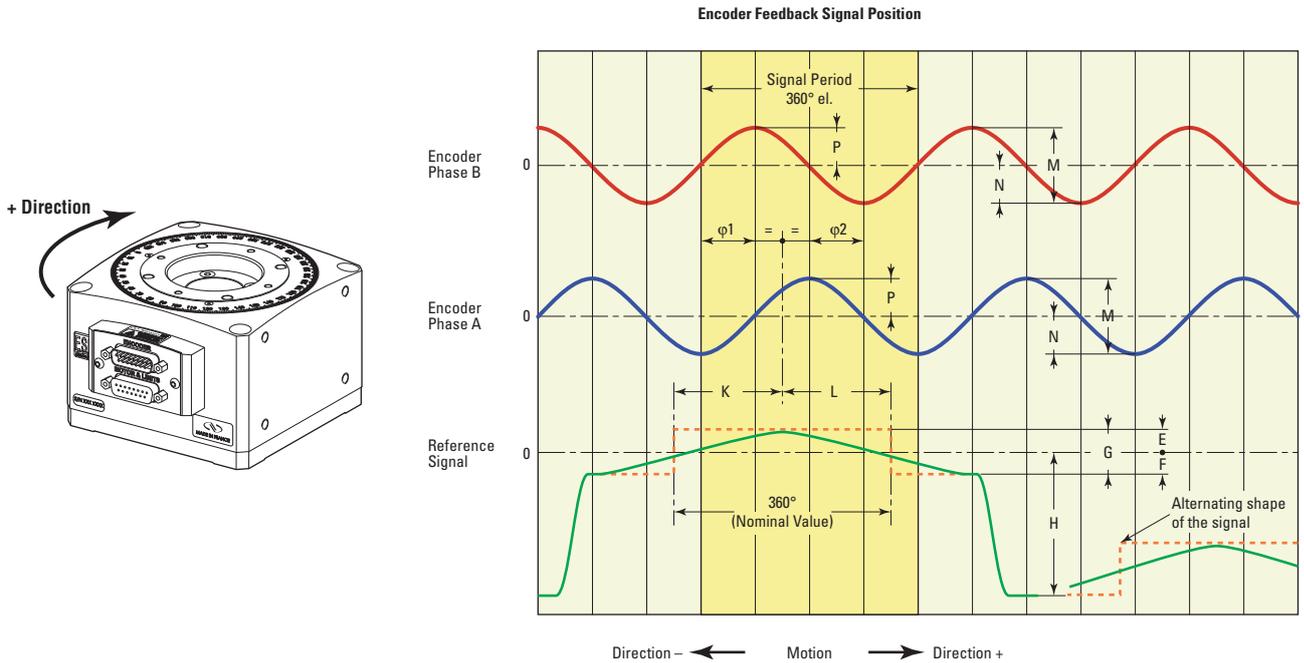
The values above indicate induced voltage between coils. A positive value for U-V would indicate a higher voltage on U relative to V.

4.3 Sensor Positions



4.4 Position Feedback Signals

Power supply	5 V <sub>DC</sub> ±5% @ 33 mA
Output signal	Sine/Cosine
Resolution	15000 lines/rev.

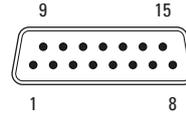


Interface	Sinusoidal voltage signals	1 V <sub>DC</sub>
Incremental signals	2 signals with sinusoidal shape, A and B	
	Signal range, M:	0.6 to 1.2 V <sub>DC</sub> ; 1 V <sub>DC</sub> typical
	Gap of symmetry $ P - N /2M$	≤0.065
	Signal ratio $M_A/M_B$ :	0.8 to 1.25
	Phase difference $ \phi_1 + \phi_2 /2$ :	90° ±10° el.
Reference signal	1 or several peaks of signal, R	
	Usable range, G:	≥0.2 V
	Sleeping value, H:	≥1.7 V
	Signal/Noise ratio, E and F:	0.04 to 0.68 V
	Zero crossing, K and L	180° ±90° el.

**4.5 Pinouts**

The pinout diagrams for RGV100HL-S stage connectors are shown below.

**4.5.1 Motor & Limits Connector**



SUBD15F	
1	N.C.
2	Phase M Motor
3	Mechanical Zero
4	- End-of-Run
5	Ground
6	N.C.
7	N.C.
8	N.C.
9	Phase N Motor
10	Phase L Motor
11	+ End-of-Run
12	N.C.
13	N.C.
14	N.C.
15	N.C.

- Max. voltage: 96 V
- Max. rms Current: 1.38 A

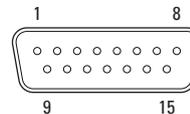
**WARNING**



**GROUNDING:** The stage's protective ground is located on pin #5 of the motor power connector.

If you are using grounds other than those provided by Newport, you must connect pin #5 to a ground connection.

**4.5.2 Encoder Connector**



SUBD15M	
1	Encoder Phase B
2	Ground
3	Encoder Phase A
4	+5 V
5	N.C.
6	N.C.
7	Index Pulse /I
8	N.C.
9	Encoder Phase /B
10	N.C.
11	Encoder Phase /A
12	N.C.
13	N.C.
14	Index Pulse I
15	N.C.

#### 4.6 Cables

The RGV100HL-S rotation stage is supplied without cables.

The appropriate cable kit must be ordered separately, in accordance with the XPS controller configuration used. Please refer to our website for ordering information.



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**WARNING**

**The RGV100HL-S rotation stage operates only with 5-meter max. cables.**

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**WARNING**

**Cables of the kits are shielded correctly. For a correct operation, make sure to lock connectors (ground continuity provided by the cable).**

---

**WARNING**

**Keep these cables at a safe distance from other electrical cables in your environment to avoid potential cross talk.**

---

## 5.0 Stage Installation

### 5.1 Unpacking

The RGV100HL-S stage is delivered in packaging designed for safe transport. Carefully lift the stage from packaging and handle with care.



The stage comes with a test report that shows the stage performs within the guaranteed specifications. These measurements were taken in a controlled environment under flat mounting conditions.

### 5.2 Mounting Conditions

The RGV100HL-S stage features a four-point mounting surface. The compactness of its body provides good stiffness, however it is recommended that the mounting conditions below be followed for best performance.

<b>Installation Considerations</b>	
Mounting surface flatness	10 $\mu$ m
Payload surface flatness	10 $\mu$ m
Max. M6 mounting screw torque	7 Nm
Max. M5 mounting screw torque	4 Nm

## 6.0 Connection to Newport Controllers

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### NOTE

Visit [www.newport.com](http://www.newport.com) for compatible Newport controllers.

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#### 6.1 Operating with Newport Controllers/Drives

Newport provides detailed documentation for connecting and configuring RGV100HL-S stages with compatible Newport controllers/drives. Newport controllers proprietary plug-and-play ESP technology will automatically load configuration parameters for the stage based on best factory settings in a no load condition. These configurations can be adjusted for optimal operation under various applications and load conditions. Refer to documentation available on the RGV100HL-S Page for additional information.

#### 6.2 Warnings on Controllers

Controllers are intended for use by qualified personnel who recognize shock hazards and are familiar with safety precautions required to avoid possible injury. Read the controller user's manual carefully before operating the instrument and pay attention to all written warnings and cautions.

Specifications listed in this guide are based on operation with Newport Control and Drive Electronics. The Newport controllers with ESP technology are delivered with a configuration file that has been developed at the factory for operation in a no-load condition for immediate plug-and-play operation.

---

### WARNING

**Disconnect the power plug under the following circumstances:**

- If the power cord or any attached cables are frayed or damaged in any way.
- If the power plug is damaged in any way.
- If the unit is exposed to rain, excessive moisture, or liquids are spilled on the unit.
- If the unit has been dropped or the case is damaged.
- If you suspect service or repair is required.
- Whenever you clean the electronics unit.




---

### CAUTION

**To protect the unit from damage, be sure to:**

- Keep all air vents free of dirt and dust.
  - Keep all liquids away from the unit.
  - Do not expose the unit to excessive moisture (85% humidity).
  - Read this manual before using the unit for the first time.
-

**WARNING**

All attachment plug receptacles in the vicinity of this unit are to be of the grounding type and properly polarized.

Contact your electrician to check your receptacles.

**WARNING**



This product is equipped with a 3-wire grounding type plug.

Any interruption of the grounding connection can create an electric shock hazard.

If you are unable to insert the plug into your wall plug receptacle, contact your electrician to perform the necessary alterations to ensure that the green (green-yellow) wire is attached to earth ground.

**WARNING**

This product operates with voltages that can be lethal.

Pushing objects of any kind into cabinet slots or holes, or spilling any liquid on the product, may touch hazardous voltage points or short out parts.

**6.3 Connection**

There is a label on every stage indicating its part and serial numbers.



**WARNING**

Always turn the controller's power OFF before connecting to a stage.

**WARNING**

Ensure the stage is stopped before connecting or disconnecting. The rotation can generate voltages and currents dangerous for workers and for the equipment.

**NOTE**



These stages are ESP compatible. Enhanced System Performance is Newport's exclusive technology that enables Newport ESP motion controllers to recognize the connected Newport ESP stage and upload the stage parameters. This ensures that the user can operate the motion system quickly and safely.

**6.4 Wiring**

The RGV100HL-S rotation stage is supplied without cables (see chapter 4.6: "Cables").

## 7.0 Connection to Non-Newport Electronics

Newport stages can be operated with Non-Newport controllers. However, under such operational conditions Newport makes no guarantee regarding achievable specifications. To aid Newport customers using non-Newport Controllers with RGV100HL-S stages we have provided wiring conventions and motor characteristics below. It should be noted, damage caused by improper configuration or operation while in use with non-Newport controllers is not covered by the warranty.

Please refer to Design Details and Specifications for more information to help configure the stage with your controller. Newport also provides a tech note on configuring third party stages with Newport controllers on the RGV100HL-S website, which may be useful as a reference.

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### WARNING

**Newport is not responsible for malfunction or damage of RGV100HL-S stage when used with non-Newport controllers.**

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### WARNING



**Newport guarantees “C” compliance of RGV100HL-S stage only if used with the appropriate Newport cable kit and a XPS series controller.**

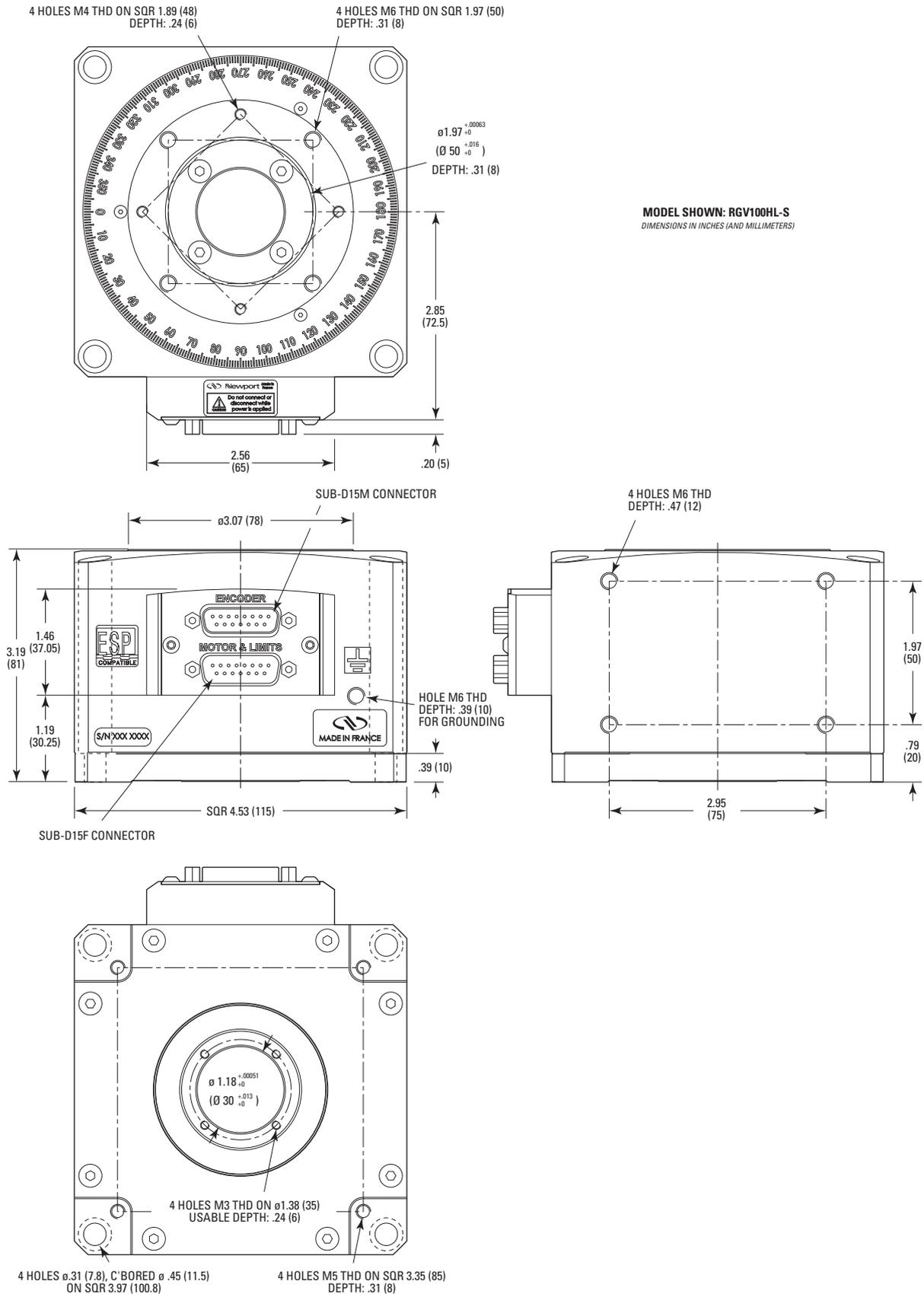
**It is the customer's responsibility to modify the cables and take care of sensor signal connections, when using the stage with non-Newport controllers.**

---

### WARNING

- **Maximum peak voltage: 100 V<sub>peak</sub>**
  - **Maximum rms current: 1.38 Arms.**
-

8.0 Dimensions



**9.0 Maintenance**

**RECOMMENDATION**

**Please contact Technical Sales Support team for recommendations on application specific maintenance.**

**9.1 Maintenance**

The RGV100HL-S stage requires no particular maintenance. Nevertheless, this is a precision mechanical device that must be kept and operated with caution.

**PRECAUTIONS**

**The RGV100HL-S stage must be used or stocked in a clean environment, without dust, humidity, solvents or other substances.**

**RECOMMENDATION**

**It is recommended to return the stage to Newport for re-lubriaction after 2000 hours of use.**

**If the RGV100HL-S stage is mounted on a workstation and cannot be easily removed, please contact Newport's After Sales Service for further instructions.**

**9.2 Repair**

**CAUTION**



**Never attempt to disassemble a component of the stage that has not been covered in this manual.**

**To disassemble a non specified component can cause a malfunction of the stage.**

If you observe a malfunction in your stage, please contact us immediately to arrange for a repair.

**CAUTION**



**Any attempt to disassemble or repair a stage without prior authorization will void your warranty.**

**9.3 Calibration**

**CAUTION**



**It is recommended to return your RGV100HL-S stage to Newport once a year for recalibration to its original specifications.**





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