ILS-LM Series

High-Performance Linear Motor Stages

Newport®
Experience | Solutions

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.

CAUTION

Warranty does not apply to damages resulting from:

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

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.

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.

This manual has been provided for information only and product specifications are subject to change without notice. Any changes will be reflected in future printings.

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EC Declaration of Conformity

ILS-LM Series

EC Declaration of Conformity

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

Newport
Experience | Solutions

The manufacturer:

MICRO-CONTROLE Spectra-Physics,
1 rue Jules Guesde ZI. Bois de l'Epine - BP189
F-91006 Evry FRANCE

Hereby declares that the machinery:

- Description: " ILS-LM "
- Function: High Performance Linear Stage
- Models: M-/ILS100/200/300/LM .

– the technical file of which was compiled by:

Mr Dominique DEVIDAL, Quality Director,
MICRO-CONTROLE Spectra-Physics, Zone Industrielle - B.P.29
F-45340 Beaune 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 2004/108/EC relating to electro-magnetic compatibility.

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

- NF EN 61326-1:2006 « Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements »
- NF EN 55011:2007 Class A

– 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
- NF EN 61000-4-8

ORIGINAL DECLARATION

Done in Beaune La Rolande on 09 June 2011
Dominique DEVIDAL
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.

Warnings

WARNING

The translation 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.

WARNING

The magnetic channel included into this device could be the source of disruption for pacemakers. Consequently, as precautionary measure it is better to avoid the exposure less than 1 meter for each implanted person.

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.

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.

WARNING

Do not exceed speed and load limitations as specified in chapter 3.3.

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.

Cautions

CAUTION

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

CAUTION

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

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 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.

CAUTION

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

CAUTION

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

CAUTION

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

CAUTION

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

High-Performance Linear Motor Stages ILS-LM Series

1.0 Introduction

This manual provides operating instructions for the stage that you have purchased in the ILS-LM Series.

(M-)ILS300LM Stage.

RECOMMENDATION

We recommend you read carefully the chapter “Connection to electronics” before using the (M-)ILS-LM stage.

2.0 Description

The ILS-LM Series linear stages are designed for self-supporting applications with travel ranges from 100 mm to 300 mm. The stages feature a robust design with high performance but with low cost, making them cost-effective solutions for precision industrial applications such as semiconductor wafer inspection, micro-electronics test and assembly, pick and place, DNA sequencing, or laser machining,

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Based on industry proven technology of the ILS, the ILS-LM series utilizes an FEM-optimized extruded aluminum body that is extremely stiff, while minimizing the bending effect caused by the different thermal expansion coefficients of the aluminum body and the steel rails. The rails' position relative to the profile's neutral fiber minimize the effect due to bi-metal thermal expansion. The body's rigidity minimizes the deflection under load.

Unlike screw driven stages, the ILS-LM employs a centered, high efficiency 3-phase, synchronous ironless, linear motor as the driving element. This drive system is absolutely noise-free and has the advantage of higher speed, high acceleration and high system responsiveness without wear associated with motor brushes or drive screws. And because of the fully integrated linear motor, the ILS-LM is more than 150 mm shorter than a comparable screw driven stage. Thus, the ILS-LM is the optimum solution for space constrained applications that require high-throughput, high reliability, and ultra-quiet operation.

Recirculating ball bearing slides provide excellent payload capabilities and long life. The movement is smooth with low noise.

Precision position feedback is supplied by a very repeatable linear scale mounted in the stage. The encoder signals are interpolated by Newport's XPS motion controller with nanometer resolution for outstanding position sensitivity, repeatability, and stability. A home position is incorporated on the same scale, avoiding the use of additional electronics or mechanics for improved reliability and accuracy.

2.1 Design Details

Base Material	Extruded Aluminum
Bearings	Recirculating bearings
Drive System	3-phase synchronous ironless linear motor (without Hall effect sensors)
Motor Initialization	Has to be done by the controller. The XPS controller uses an initialization routine to limit the stochastic motions of stages.
Motor Commutation	Done by the controller on encoder feedback
Feedback	Linear steel scale, 20 µm signal period, 1 Vpp
Limit	Switches Optical
Home Switch	Optical, on encoder's fiducial track, located at center of travel
Controller Compatibility	ESP
Cable	5 m long cables included
MTBF	20,000 hours

RoHS Compliant

NOTE

This product complies with the RoHS directive (Restriction of Hazardous Substances).

3.0 Characteristics

3.1 Definitions

Specifications of our products are established in reference to ISO 230 standard part II “Determination of the position, precision and repeatability of the machine tools with CNC”.

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

(Absolute) Accuracy

Difference between ideal position and real position.

On-Axis Accuracy

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

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 follow:

Absolute Accuracy = On-Axis Accuracy + Correction Factor x 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 (Sensitivity)

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

Resolution

The smallest increment that a motion device can be commanded to move and/or detect.

Yaw, Pitch

Rotation of carriage around the Z axis (Yaw) or Y axis (Pitch), when it moves.

The testing of on-axis accuracy, repeatability, and reversal error are made systematically with our test equipment in an air-conditioned room (20 °C ±1 °C).

Each rotation stage is tested with a precision optical encoder.

A linear cycle with 21 measures on the travel and 4 cycles in each direction gives a total of 164 points.

3.2 Mechanical Specifications

Travel Range (mm)	100, 200, 300
Minimum Incremental Motion, Linear (µm)	0.01
Uni-directional Repeatability, Guaranteed [1] (µm)	0.45
Bi-directional Repeatability, Guaranteed [1] (µm)	0.7 or ±0.35
On-Axis Accuracy, Guaranteed [1] [2] (µm)	5 or ±2.5
Maximum Speed (mm/s) [See chapters 3.3 to 3.6]	500 [3]
Maximum Acceleration, No Load (m/s²) [See chapters 3.3 to 3.6]	20
Max. Force (Cont.) (N)	15
Max Force (Peak) 4 s (N)	30
Pitch, Yaw, guaranteed [1] [2] [4] (µrad)	300 or ±150
Load Capacity (N)	250

[1] Shown are peak to peak, guaranteed specifications or ± half the value. The typical specifications are about 2X better than the guaranteed values.
[2] For a travel of 300 mm.
[3] With a 44 V driver (such as the XPS-DRV02 board of the XPS controller).
[4] To obtain arcsec units, divide µrad value by 4.8.

CAUTION

To reach specifications stated, stages must be fixed on a plane surface with a flatness of 5 µm.

3.3 Hard Stoppers: Speed Limitation Versus Load

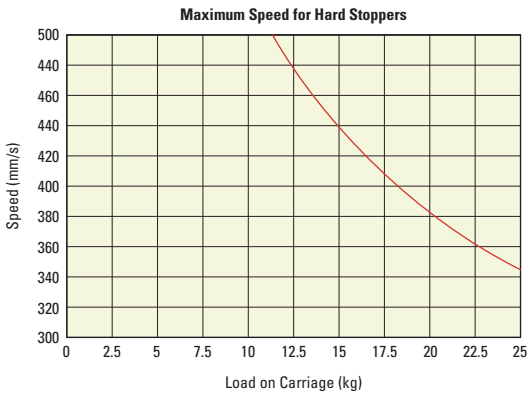
(M-)ILS-LM stage uses electrical end-of-run and rubber bumper hard stoppers to stop as smoothly as possible the carriage at travel end. The overtravel allowed by the rubber bumpers is 3.5 mm.

When the stage is used with Newport controllers, the factory settings of "software limit" forbid any commanded motion out of travel range.

Nevertheless, for security issue, we recommend to follow the recommendations above to minimize risks of mechanical damage in case of failure or bad adjustment of parameters.

The maximum speed of the stage must be limited so that the rubber bumpers will always stop the carriage in 3.5 mm or less, to avoid any chock between carriage and stage body.

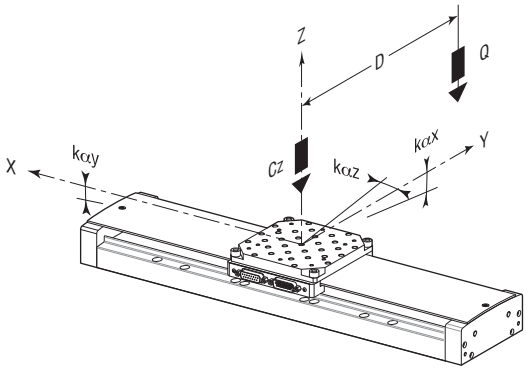
The graph opposite indicates the maximum speed that hard stopper can stop in 8 mm as a function of the load. This graph assumes that a correct wiring of the electrical end of runs will cut motor power before the contact with the rubber bumpers.



3.4 Load Characteristics and Stiffness

Normal Load Capacity (Cz)

Maximum load a stage can move while maintaining specifications.



Cz	250 N
kαx	15 µrad/Nm
kαy	10 µrad/Nm
kαz	10 µrad/Nm

Q	Off-center load, Q ≤ Cz/(1 + D/60)
D	Cantilever distance in mm
Cz	Normal center load capacity on bearings
kαx	Angular stiffness (Roll)
kαy	Angular stiffness (Pitch)
kαz	Angular stiffness (Yaw)

3.5 Example of Parameters “ScalingAcceleration” & “AccelerationLimit”

This example is based on Newport XPS controller and XPS-DRV02 driver.

Two parameters have to be updated in the parameter file, according to the payload put onto the (M-)ILS-LM stage:

- The parameter "ScalingAcceleration" is used by the controller to scale the output voltage sent to the driver.

  It indicates the theoretical maximum acceleration (friction not taken in account) of the ILS-LM carriage when the maximum voltage (10 volts) is applied to the driver.
- The parameter "AccelerationLimit" indicates the theoretical maximum acceleration that the controller will be able to require from the (M-)ILS-LM carriage. It correspond to the (M-)ILS-LM peak force.

For XPS controller and XPS-DRV02 driver, these parameters can be calculated using the following formulas, where the payload must be entered in kg:

$$\text{ScalingAcceleration(Payload)} = 40305 \frac{\text{mm/s}^2}{(\text{Payload} + 0.9)}$$

Examples: ScalingAcceleration(**0**) = 44800 mm/s²
ScalingAcceleration(**25**) = 1556 mm/s²

$$\text{AccelerationLimit(Payload)} = \frac{\text{ScalingAcceleration(Payload)}}{1.1}$$

Examples: AccelerationLimit(**0**) = 40.727 mm/s²
AccelerationLimit(**25**) = 1712 mm/s²

These formulas are explained below:

Inputs from the system

- Motor:
  - Motor force constant: $\text{MotorForceConstant} = 11.4 \text{ N/Amp. rms}$
  - Motor thermal resistance: $\text{MotorRth} = 1.8 \frac{K}{\text{Watt}}$
  - Motor constant at 300 K: $\text{MotorK} = 18.3 \frac{\text{Newton}^2}{\text{Watt}}$

- Driver:

  XPS-DRV02 driver is using sine/cosine commutation on its input. Its maximum current of 5 A is obtained for a 10 V input, so:

  $$MaxDriverCurrent = 5\ Amp.$$

  $$TransImpedenceDriver = 0.5\ Amp./V$$

- Mechanics:
  - (M-)ILS-LM carriage mass: $Mcar = 0.4\ kg$
  - Interface plate mass: $Mint = 0.5\ kg$
- System:

  (M-)ILS-LM rms force is defined to keep motor heating below 25 °C:

  $$ILS\_RmsForce = \sqrt{\frac{25\ :MotorK}{MotorRth}}$$
  $$ILS\_RmsForce = 15\ Newtons$$

  (M-)ILS-LM peak force is defined to allow two time the rms force. This value is lower than the theoretical peak force of the motor:

  $$ILS\_PeakForce = 30\ Newtons$$

  The rms current limitation of the driver is set according to (M-)ILS-LM rms force:

  $$DriverMaximumRMSCurrent = \frac{ILS\_RmsForce}{MotorForceConstant}$$
  $$DriverMaximumRMSCurrent = 1.32\ A\ rms$$

  The peak current limitation of the driver is set according to ILS-LM peak force:

  $$DriverMaximumPeakCurrent = \min\left(\frac{ILS\_PeakForce}{MotorForceConstant}\sqrt{2}\cdot 1.05\ ,\ MaxDriverConstant\right)$$
  $$DriverMaximumPeakCurrent = 3.9\ A$$

  The integration time of the driver I^2t limitation is set to allow to apply the peak current for 4 seconds. This is obtained with an integration time of 10 s, which is lower than the motor thermal time constant.

  $$DriverRMSIntegrationTime = 10\ s$$

Inputs from the user

- Load on the carriage: $Load = 0\ kg$

Calculation

- **MovingMass**:

  $$MovingMass = Mcar + Mint + Load$$

- **ScalingAcceleration**:

  $$ScalingAcceleration = \frac{MotorForceConstant\ :10\ Volts\ :TransImpedenceDriver}{\sqrt{2}\ :MovingMass}$$
  $$ScalingAcceleration = \mathbf{44800}\ mm/s^2$$

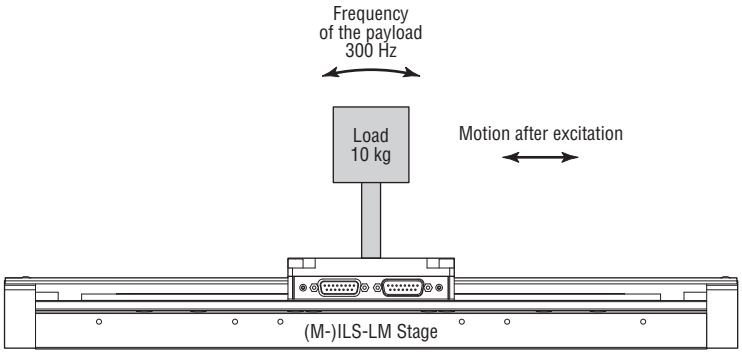
- **LimitAcceleration**:

  $$LimitAcceleration = ScalingAcceleration\ :\frac{DriverMaximumPeakCurrent}{MaxDriverCurrent}\ :\frac{1}{1.05}$$
  $$LimitAcceleration = \mathbf{23670}\ mm/s^2$$

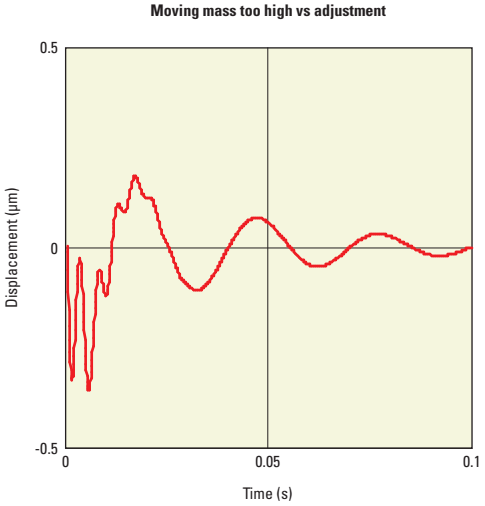
3.6 Estimated Moving Mass for (M-)ILS-LM Stages

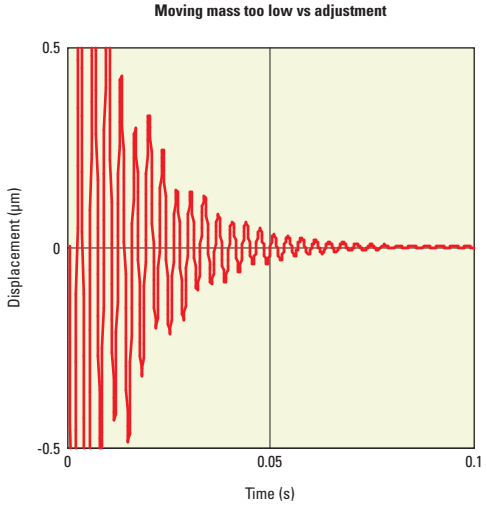
CAUTION

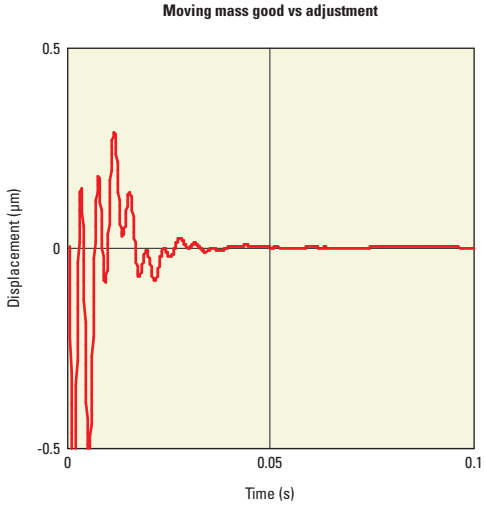
(M-)ILS-LM stages with linear motor are sensitive to the load variation and its stiffness. The example below shows the behavior of the displacement in accordance with the underestimated/overestimated moving mass.



Driving in force requires a good adjustment of the controller/driver theoretical acceleration parameter (ScalingAcceleration) which depends on the moving mass.







3.7 Stage Weights

Weights indicated into the below table are average values for stages with a typical drive unit installed.

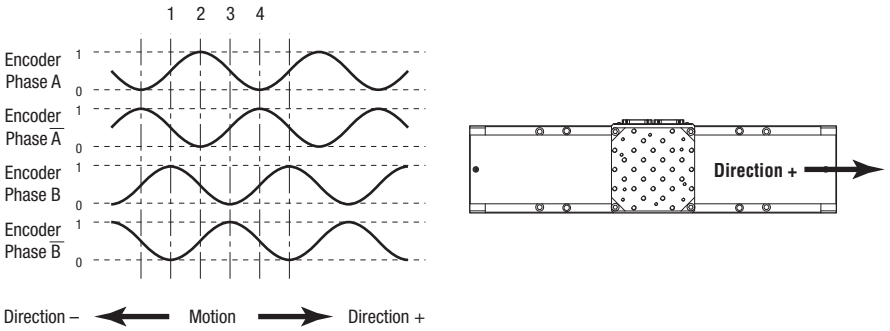
	Weight [lb (kg)]
(M-)ILS100LM	6.4 (2.9)
(M-)ILS200LM	8.2 (3.7)
(M-)ILS300LM	9.9 (4.5)

4.0 Motor

4.1 Brushless Motor Characteristics

Motor	Motor Constant (N^2/W)	Magnet Pitch (mm)	Nominal Voltage (V)	Max. RMS Current (A)	Max. Peak Current (A)	Resistance per Phase (Ω)	Inductance per Phase (mH)
UC6	18.3	16.5	48	1.3	3.9	2.4	0.38

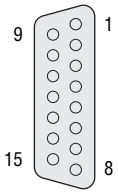
4.2 Feedback Signal Position



4.3 Pinouts

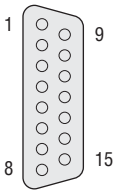
Sub-D connections for (M-)ILS-LM stages are given in the following tables:

Motor Connector (Sub-D15 Male)



1	Shield Ground
2	V Motor
3	Mechanical Zero
4	- End-of-Run
5	Shield Ground
6	N.C.
7	N.C.
8	N.C.
9	W Motor
10	U Motor
11	+ End-of-Run
12	+5 V
13	N.C.
14	N.C.
15	N.C.

Encoder Connector (Sub-D15 Female)



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

5.0 Connection to Newport Controllers

5.1 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.

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 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.

5.2 Connection

On each stage is represented a label which indicates its name and its serial number.

WARNING

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

Stages may be connected to the rear panel motor connectors labeled “Motor…” any time prior to power-up with the supplied cable assemblies.

NOTE

(M-)ILS-LM are ESP compatible stages. Enhanced System Performance is Newport's exclusive technology that enables Newport ESP compatible 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.

5.3 Cables

Our (M-)ILS-LM stages are delivered equipped with a set of two 5-meter cables. They can be directly connected to our XPS controller.

WARNING

ILS-LM Series translation stages operate only with 5-meter max. cables.

WARNING

These cables are shielded correctly. For a correct operation, make sure to lock connectors (ground continuity provided by cables).

WARNING

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

6.0 Connection to Non-Newport Controllers

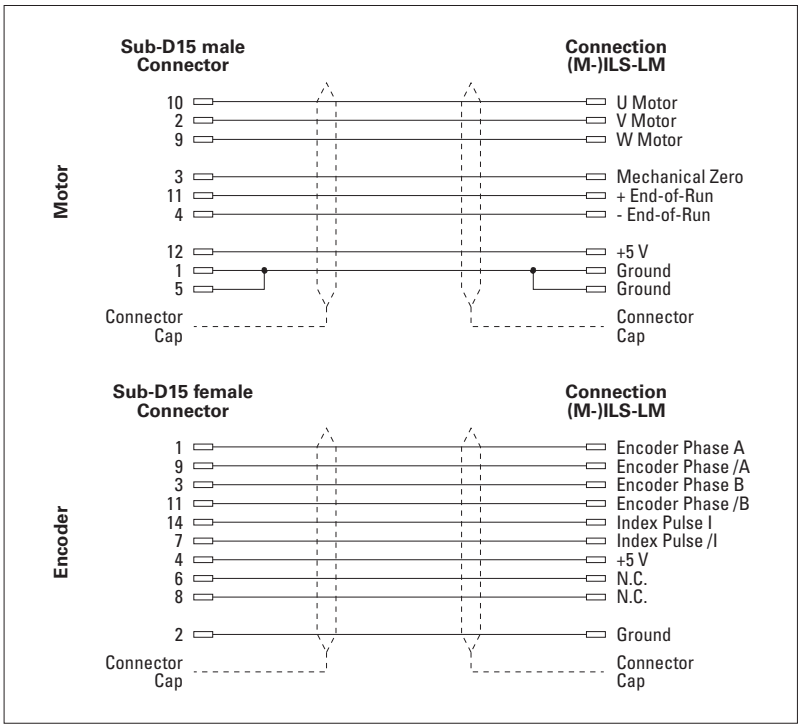
WARNING

Newport takes no responsibility for improper functioning or damage of a stage when it is used with any non- Newport controllers.

WARNING

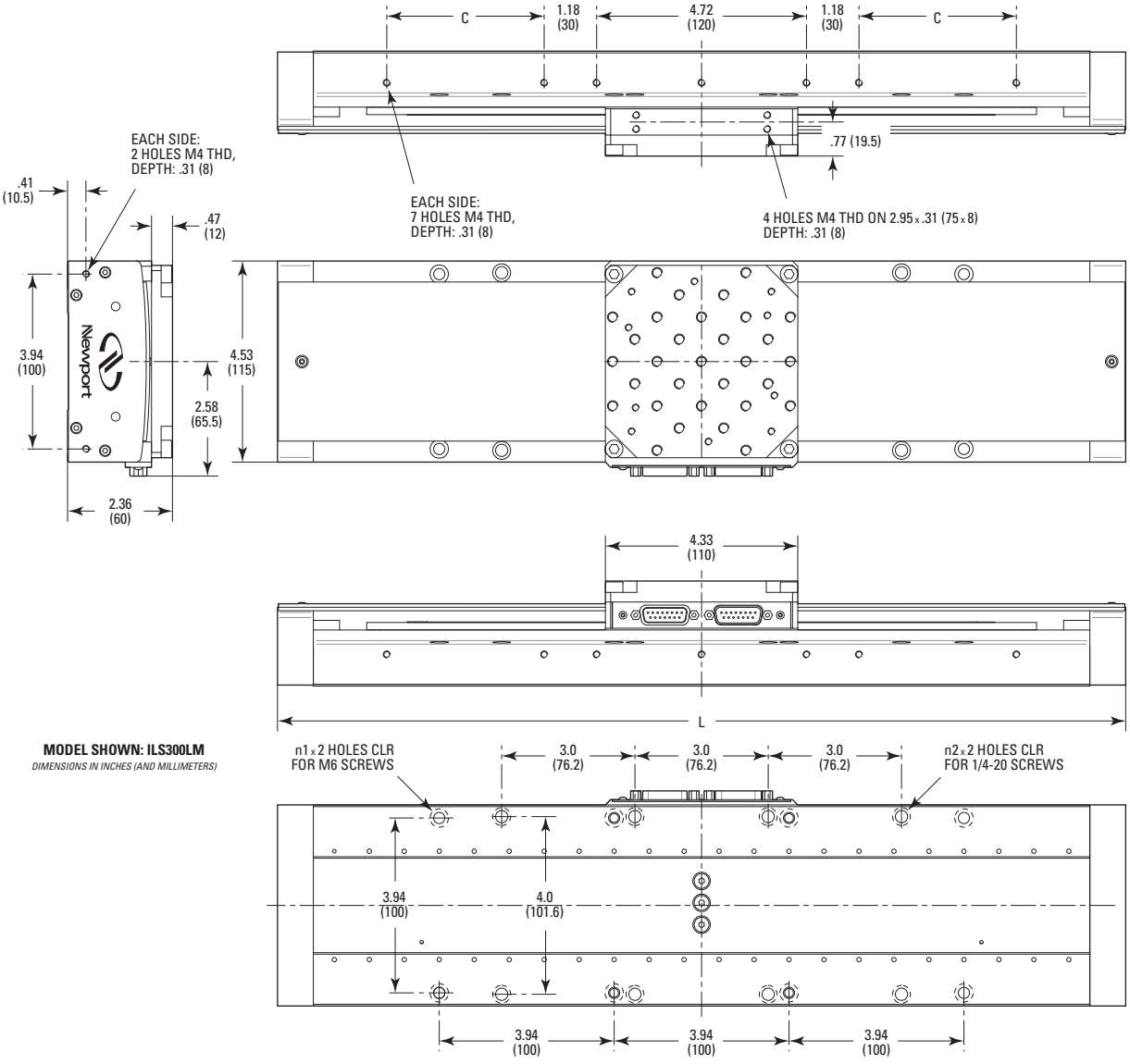
Newport guarantees the "CE" compliance of the (M-)ILS-LM translation stages only if they are used with Newport cables and controllers.

Nevertheless, the figure below indicates the recommended wiring when a (M-)ILS-LM stage is used with non-Newport controllers.



7.0 Dimensions

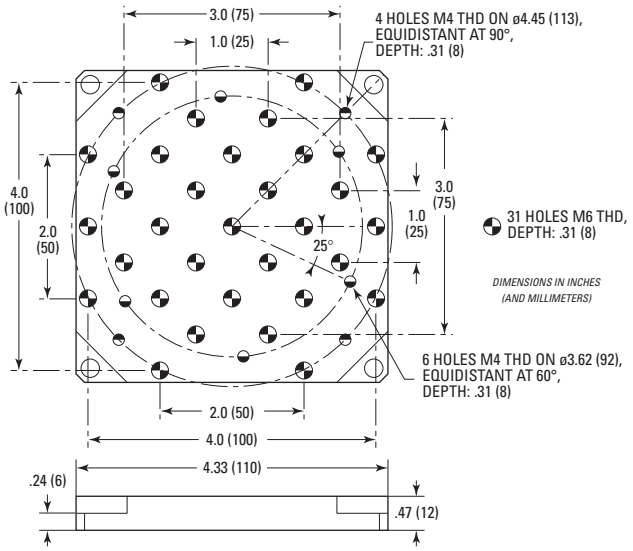
7.1 (M-)ILS-LM Stages



MODEL SHOWN: ILS300LM
DIMENSIONS IN INCHES (AND MILLIMETERS)

MODEL (METRIC)	n1	n2	C	TRAVEL	L
(M-)ILS100LM	2	2	1.08 (27.5)	3.94 (100)	11.22 (285)
(M-)ILS200LM	4	4	2.76 (70)	7.87 (200)	15.16 (385)
(M-)ILS300LM	4	4	3.54 (90)	11.8 (300)	19.09 (485)

7.2 (M-)ILS-LM Stages Top Plate Interface



8.0 Maintenance

RECOMMENDATION

It is recommended to contact our After Sales Service which will know to define the appropriate maintenance for your application.

8.1 Maintenance

The (M-)ILS-LM stage requires no particular maintenance. Nevertheless, this is a precision mechanical device that must be kept and manipulated with precaution.

PRECAUTIONS

The (M-)ILS-LM stage must operate, and be stocked in a clean environment, without dust, humidity, solvents or other substances.

RECOMMENDATION

It is recommended to return your stage to our After Sales Service after every 2000 hours of use for lubrication.

If your (M-)ILS-LM stage is mounted on a workstation and cannot be easily dismantled, please contact our After Sales Service for further instructions.

8.2 Repairing

CAUTION

Never attempt to disassemble an element of the stage that has not been specified in this manual.

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

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

CAUTION

All disassembly attempts or repair of stage without authorization will void your warranty.

8.3 Calibration

CAUTION

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

Service Form

Your Local Representative
Tel.: _____
Fax: _____

Name: _____ Return authorization #: _____
(Please obtain prior to return of item)

Company: _____

Address: _____ Date: _____

Country: _____ Phone Number: _____

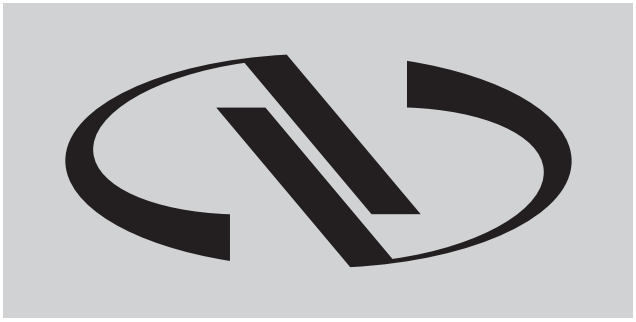
P.O. Number: _____ Fax Number: _____

Item(s) Being Returned:

Model #: _____ Serial #: _____

Description: _____

Reasons of return of goods (please list any specific problems): _____



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