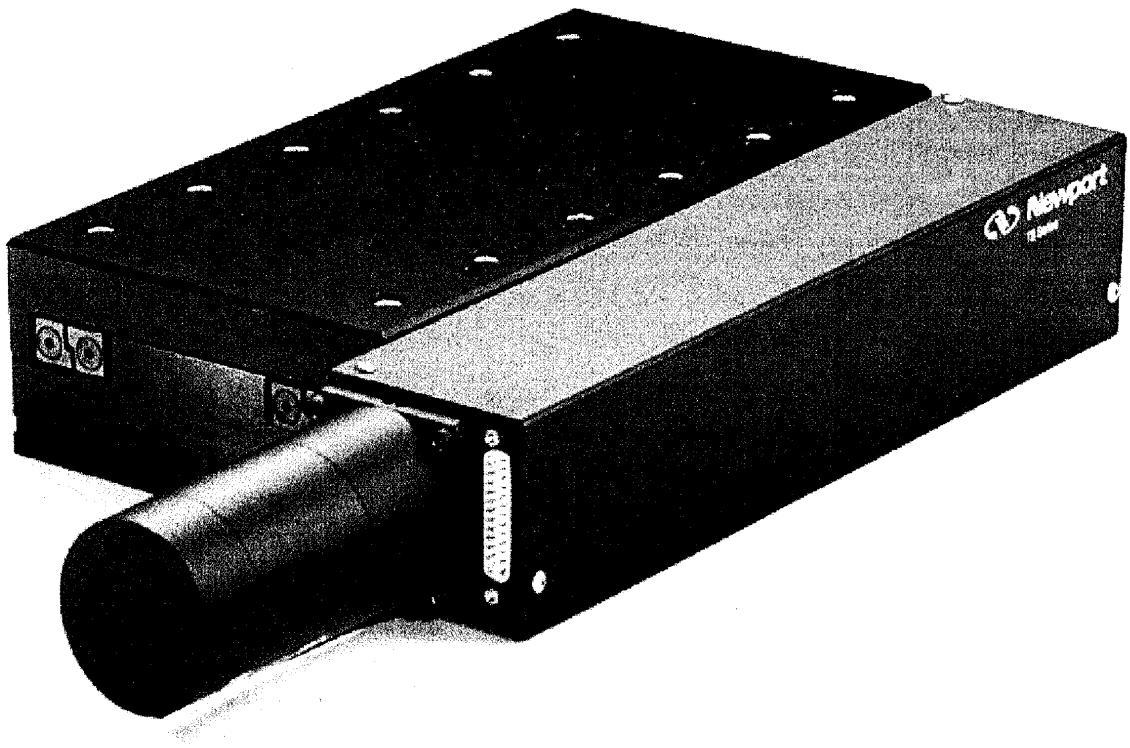
TS Series

Precision Linear Stages



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Warranty

Newport Corp warrants its product to be free of defects in material and workmanship for a period of twelve (12) months from the date of shipment. During the warranty period, Newport will repair or replace (at Newport's discretion) any component within its product that fails to adhere to published specifications (for standard product) or specifications in the quotation (for custom/special product).

For warranty service requiring return of a product to Newport, the item(s) must be returned to our Service Center, with all shipping, taxes, or duty charges prepaid unless special arrangements have been approved beforehand by Newport. The location of services performed under warranty will be determined by Newport.

If using controller electronics other than Newport's, the liability of the product rests with the customer if upon performance evaluation of the stage there are no anomalies exhibited with Newport's electronics.

Warranty Limitations

The foregoing warranty shall not apply to defects resulting from:

a. Components and accessories manufactured by companies other than Newport, which causes damage to Newport's products, nor does Newport's warranty cover the cost of the customer's time and expenses incurred in diagnosing, repairing and handling Newport's warranty related issues.

b. Improper or inadequate maintenance by the buyer not in adherence with Newport's guidelines.

c. Customer-supplied interfacing.

d. Operation outside the environmental specifications of the product.

e. System malfunctions that are related to or caused by software misuse.

f. Improper site preparation and mainenance of unauthorized product modification or misuse.

g. Warranty is not valid outside of the United States.

h. Newport assumes no liability for customer-supplied material. The obligations of Newport are limited to repairing or replacing, without charge, equipment which proves to be defective during the warranty period only. The warranty on parts purchased after the expiration of the original warranty is ninety (90) days. Our warranty does not cover damages due to misuse, negligence or accidents, or damages due to installation, repairs or adjustments not specifically authorized by Newport Corp.

STATEMENT OF CALIBRATION

This instrument has been inspected and tested in accordance with specifications published by Newport Corp.

The accuracy and calibration of this instrument (where applicable) is traceable to the National Institute for Standards and Technology through equipment which is calibrated at planned intervals by comparison to the certified standards maintained at Newport Corp.

ACCURACY AND REVISIONS

The information in this document has been checked and is believed to be entirely reliable. However, no responsibility is assumed for inaccuracies or inadvertent omissions. Furthermore, Newport Corp. reserves the right to make changes to any product herin to improve reliability, function or design.

USE OF THIS MANUAL

Please read through this manual carefully before using the equipment provided. It should be noted that if the equipment is used in a manner other than that specified by this manual, personal injury or damage to the equipment may be incurred.

SAFETY CONSIDERATIONS

Hazard Warning Labels

The hazard warning labels pictured below are affixed to some Newport equipment. In Figure 1 below, is a Pinch Point warning label. This indicates that injury could occur if extremities are placed between moving components.

Figure 1

Abbildung 1. Quetschgefahr

Figura 1. Riesgo de Aplastamiento

Figue 1. Risque d'écrasement

In Figure 2 below, is the Electrical Hazard warning label. This is to indicate that injury, such as electric shock, burns or permanent damage to the equipment could occur if the component comes into contact with other objects or with the user.

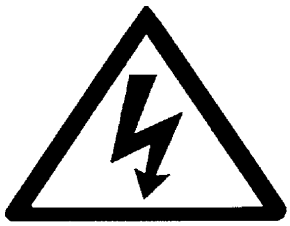


Figure 2

Abbildung 2. Elektroshockgefahr

Figura 2. Riesgo Eléctrico

Figue 2. Risque électrique

General Safety Precautions

Disconnect power to motorized equipment under the following circumstances:

If the unit has been exposed to rain or excessive moisture, or if liquids are spilled on it.

If the unit has been dropped or the case is damaged.

If you suspect service or repair is required.

Whenever you clean the case.

Achtung

Die Stromversorgung motorbetriebener Geräte is in folgenden Situationen zu unterbrechen:

- **Wenn das Gerät Regen oder übermäßigerFeuchtigkeit ausgesetzt ist, oder wenn Flüssigkeiten in das Gerät geraten sind.**
- **Wenn das Gerät fallengelassen wurde oder das Gehäuse beschädigt ist.**
- **Wenn dasangenommen wird, daß Service - oder Reparaturarbeiten erforderlich sind**
- **Wenn das Gerät gereinigt wird.**

Advertencia

Desconecte el equipo motorizado de la alimentación CC bajo las siguientes circunstancias:

- **Si se expone la unidad alluvia, humedad excesiva o si le cae encim algún líquido.**
- **Si la unidad se ha caído o se ha dañado su alojamiento.**
- **Si se sospecha que requiere mantenimiento o reparción.**
- **Cada vez que se limpie el alojamiento.**

Attention

Débranchez l'alimentation secteur de l'appareil de pilotage dans les cas suivants:

- **Si l'équipement a été exposé à la pluie, à une humidité excessive ou à des projec tions de liquide.**
- **Si l'équipement a subit un dommage durant le transport (chute ou emballage abîmé).**
- **Si vous estimez que l'équipement a besoin d'une réparation.**
- **Chaque fois que vous nettoyez l'équipement.**

To avoid hazardous situations and to protect the equipment from danger, observe the following recommendations:

Do not make any modifications or parts substitutions to the units.

Do not touch, directly or with other objects, live circuits inside motorized units.

Do not operate the units in an explosive atmosphere.

Do not expose the units to excessive moisture (>85% relative humidity).

UNPACKING AND INSPECTION

All Newport products are carefully assembled, tested and inspected before shipment. Upon receiving this product, please check for any obvious signs of physical damage that might have occurred during shipment. Report any such damage to the shipping agent immediately. Retain the original packaging materials in case reshipment becomes necessary.

If a Newport product must be returned, the following information is needed for proper shipment back to Newport:

a. Unit Model Number

b. Unit Serial Number

c. Reason for return.

A Return Material Authorization number (RMA) will be issued, which should be referenced on your shipping documents. Please fill out the included service form.and return it with the unit. Use the proper precautions when shipping the unit. Damage incurred during shipping may invalidate your warranty.

SET UP

Removing Shipping Tabs (See Figure 3)

To prevent damage during shipping, the top plate of the stage has been locked with red anodized tabs. Orange warning tags indicate the position of each tab. To remove the tabs, undertake the following steps:

1. Use a 4mm hex wrench to remove the two sockethead cap screws from each lock tab.

2. Remove the lock tab and warning tag and retain for future relocation.

Figure 3

Environmental Considerations

Temperature

For optimum performance, the stage should be maintained at a temperature of 20° C (68° F +/- 2°F). A mean room air temperature of 20° C should also be maintained.

Vibration

The stage should not be set up within the vicinity of vibration or shock. Outside forces, such as forklifts, compressors and other machinery, can induce unwanted motion in the stages via the floor on which the whole system is resting. Resulting vibrations can lead to measurement errors.

Surface Plate Flatness

To ensure accuracy, the surface plate on which the stage is mounted should be flat to within 2.5um (0.0001 inch) over all. Granite is the preferred mounting surface.

Fastener Kit

A fastener kit containing eight bolts, eight flat washers and eight anti-pinch caps (TS 50 kit, contains 4 of each, not eight) is provided for bolting the stage to a surface plate. The fastener sizes vary depending on whether the stage is metric or English (See Table 1 below). The kit also includes a jumper for stage compatibility with Newport MM4005™ controllers.

	METRIC	ENGLISH
BOLT	M6-1 x 35mm	1/4-20 x 1 3/8inch
WASHER	6mm inside diameter	1/4 inch inside diameter

Table 1

Stage Installation

Allow clearance for the 25 pin connector.

Bolting the Stage to the Surface Plate

1. Clean the surface plate prior to mounting the stage.

2. The stage should be attached at all four corners to the surface plate. To allow access to the counter bores, move the stage alternately to one end-of-travel limit and then to the other. Bolt the stage to the surface plate using a hex wrench, eight washers and eight sockethead cap screws (See Figure 4). The screws should be torqued to between 13-14.7 N-m (115-130 in-lbs).

3. After torquing the fasteners, place the supplied anti-pinch caps into the mounting holes. Ensure that the caps do not protrude above the surface of the bottom stage plate. Use of these caps is manditory to ensure CE compliance.

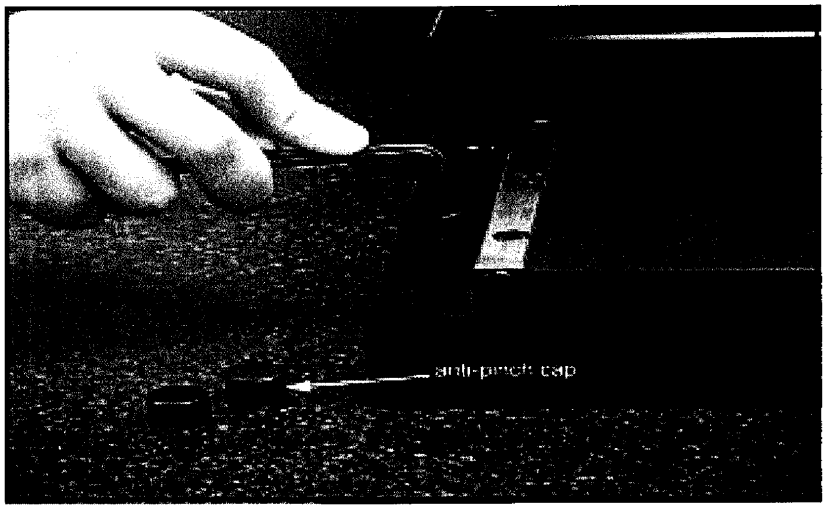


Figure 4

4. Connect the cable from the stage to the motion contoller using the 25 pin interconnect cable supplied.

Installing the Jumper

The jumper is not installed at the factory. If the stage is being used in conjunction with a Newport MM4005™ controller, install the jumper for compatibility of the stage and controller. Complete the following steps:

1. Use a 2 mm hex wrench to remove the four buttonhead cap screws from the drive cover. Remove the drive cover.

2. Find the two pins marked JP1 in the upper corner of the circuit board adjacent to the 25 pin connector.

3. Place the shorting jumper across the two pins and push it gently into place (See Figure 5).

4. Replace the drive cover.

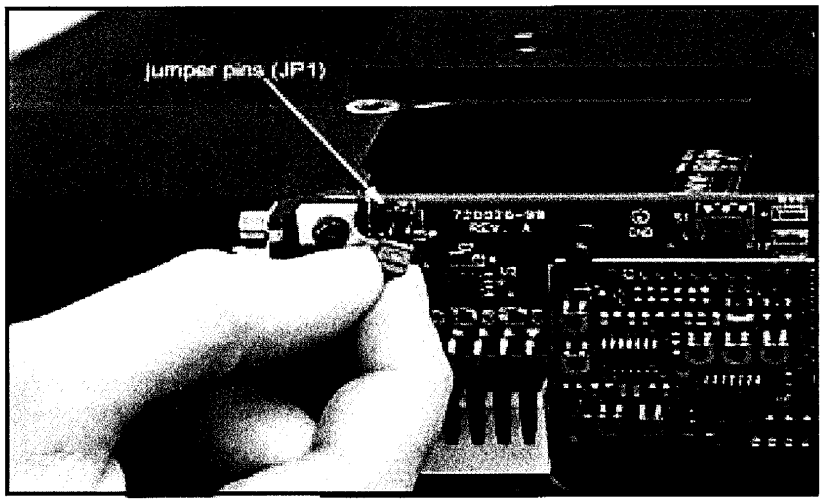


Figure 5

Initial Operation

The TS Stage has been adjusted and calibrated at the factory, prior to shipment. Under normal circumstances, no calibrations or adjustments are required after the equipment has been set up. However, it is highly recommended that initial verifications of proper limit switch operation and of proper configuration of the controller are performed.

Note: If using a controller other than a Newport controller, the stage may not work properly. Contact the factory for modification instructions.

Verification of Proper Limit Switch Operation

The cable needs to be connected and the controller under power to perform this test. When the controller is referenced below, refer to the manufacturer's manual for the controller (and controller software, if in use) to find the relevant procedures.

1. Disconnect power to the motor via the controller.

2. Using the manual knob, move the stage to the counterclockwise end-of-travel limit.

3. Check the status of the limit via the controller.

4. If the controller does not indicate arrival at the limit, refer to the Home and Limit Switches Troubleshooting guide.

5. Repeat steps 3 to 5 for the clockwise end-of-travel limit.

Verification of Proper Controller Configuration

Before using the stage for any application, the controller should be specifically configured and programmed for operation with the TS stage. Refer to the manufacturer's manual for the controller to find the relevant procedures. Fine tuning of the controller may also be required.

1. Program the controller so that the first move of the stage is a short distance, low velocity move. The move should be a distance of less than a quarter of full travel at a velocity of less than 2 mm/sec (.01 in/sec).

2. Perform the first move. Use a suitable indicator to check that the stage has travelled the required distance.

3. If the stage has not travelled the required distance, refer to the Stage and Controller Troubleshooting Guide.

Adjusting the Travel Limits

The end-of-travel limits are factory adjusted to provide the specified travel (See Specifications). If a specific application requires travel limits other than the factory settings, please contact the factory. Adjustments of +/- 3mm (+/- 0.125 inch) can be made to the limit positions by undertaking the following steps:

Note: Upon triggering a travel limit, the actual stopping position of the stage will depend on several factors. Those include the performace of the controller, stage velocity, stage decelleration and load mass.

1. Move the stage to the center of travel. Set the position readout to zero.

2. While the stage is powered, disable motor power via the controller. Refer to the manufacturer's manual for the controller to find the relevant procedure.

3. Verify that the motor is unpowered by turning the manual operation knob. There should be little resistance.

4. Remove the four buttonhead cap screws that hold the drive cover in place. Remove the dirve cover.

5. Manually move the stage toward the motor end. Stop when the counterclockwise green lamp (labelled CCW) turns off. Note the position reading. Loosen the screw on the upper flag assembly and reposition the flag to add or subtract motion as required. Repeat the procedure until the limit is set where needed. Tighten the flag retaining the screw.

6. Move the stage to the opposite end until the clockwise red lamp beside the limit sensor turns off. Repeat the steps outlined under step 5 above to adjust the flag.

7. Replace the drive cover and four screws before enabling motor power.

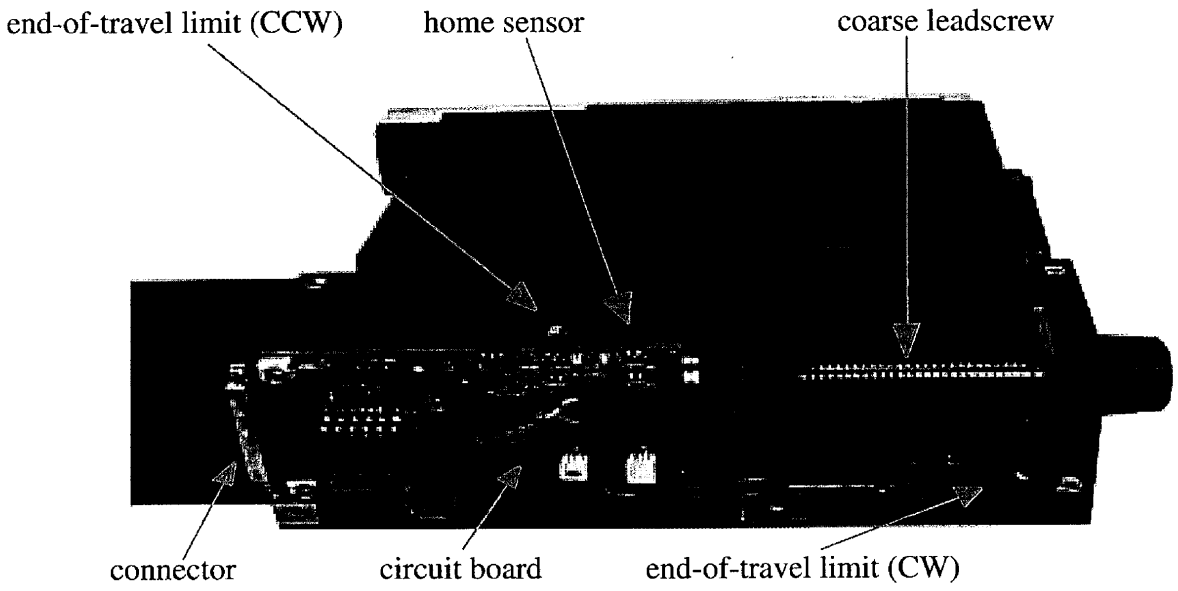
Attaching to the Stage

Components Surface Flatness
The mating surfaces of components being attached to the stage should be flat to within 2.5um (0.0001 inch) overall.

Screw Specifications
Use an M6 x 1 or 1/4-20 x 1-1/2 inch screw, depending on whether the mounting holes are English or metric. to attach other components. The length of the screw protruding into the stage should be no more than 12mm (1/2 inch).

Torque
Components being attached to the stage should be torqued in an alternating pattern. The maximum torque should not exceed 11.3 N-m (100 in-lbs).

Moment
Components being attached to the stage should not induce a moment of greater than 22.6 N-m (200 in-lbs).



Locations of the connector, end-of-travel (CCW) and (CW), circuit board, home sensor, and coarse leadscrew.

MAINTENANCE

The frequency of required cleaning, lubrication and testing is highly user dependent. Refer to Table 2 below to establish a maintenance schedule for your unit.

ENVIRONMENT	DUTY CYCLE		
	High	**Medium**	**Low**
Clean Room	3 months	6 months	1 year
Laboratory	3 months	3 months	6 months
Manufacturing	3 months	3 months	3 months

Table 2

Cleaning

Clean the stage surfaces by first dusting with a lint-free cloth and then wiping off any stains with an unsoiled napping cloth. Isopropyl alcohol may be used as a solvent.

Home Sensor Cleaning

Stages Using Contact Type Linear Encoders
Under normal circumstances, the home sensor does not need cleaning because it is protected by the drive cover.

Stages Using Non-contact Type Linear Encoders
The home sensor is unprotected. Exposure to dirt or dust may impair its proper functioning. If this happens, follow the procedure on the next page for cleaning.

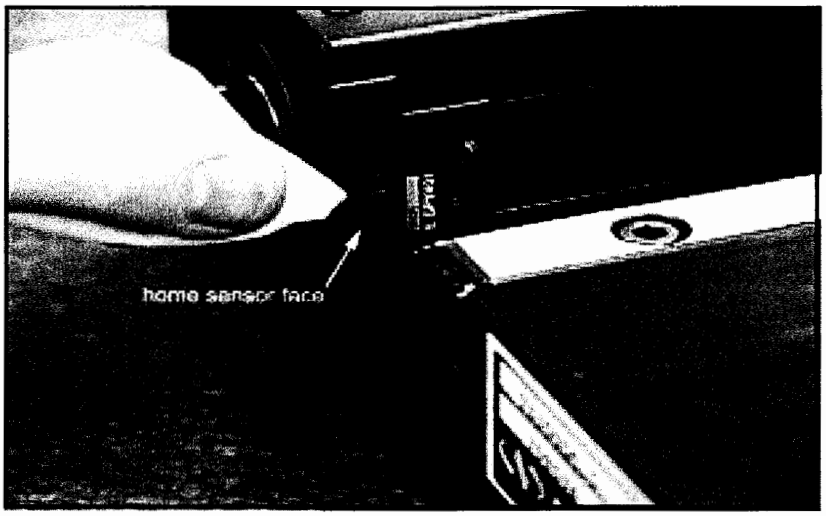


Figure 8

1. Using the manual knob, move the stage to allow access to the home sensor.

2. Wipe the sensor face with a lint free cloth or lens tissue (Figure 8). Use isopropyl alcohol as a solvent only as required.

Lubrication

When applying lubricant, do not use either a harsh applicator which may scratch or damage the stage surfaces, or a fragile applicator, which may generate particles to contaminate the component. The recommended lubricant is Lubriplate® FM0-500-AW (Mineral Oil)

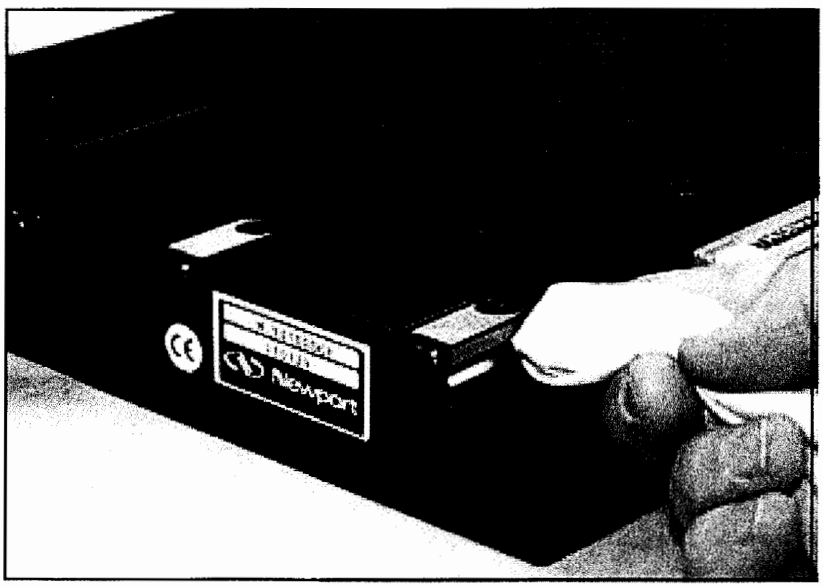


Figure 9

1. Inspect the bearing rails for signs of damage or corrosion. Consult Newport's factory if damage or corrosion has occured.

2. Use the manual knob to move the stage to one end-of-travel limit.

3. Clean the exposed bearing rail v-grooves on both upper and lower rails with Isopropyl alcohol and a lint free cloth.

4. Apply a light film of lubricant to the exposed v-grooves and to the top of the rail (See Figure 9).

5. Move the stage to the other end-of-travel limit and repeat steps 2 and 3.

6. Run the stage from one end-of-travel limit to the other to distribute the lubricant evenly along the rails.

Leadscrew Lubrication

The recommended lubricant for the leadscrew is KS46 LeadScrew Lubricant®.

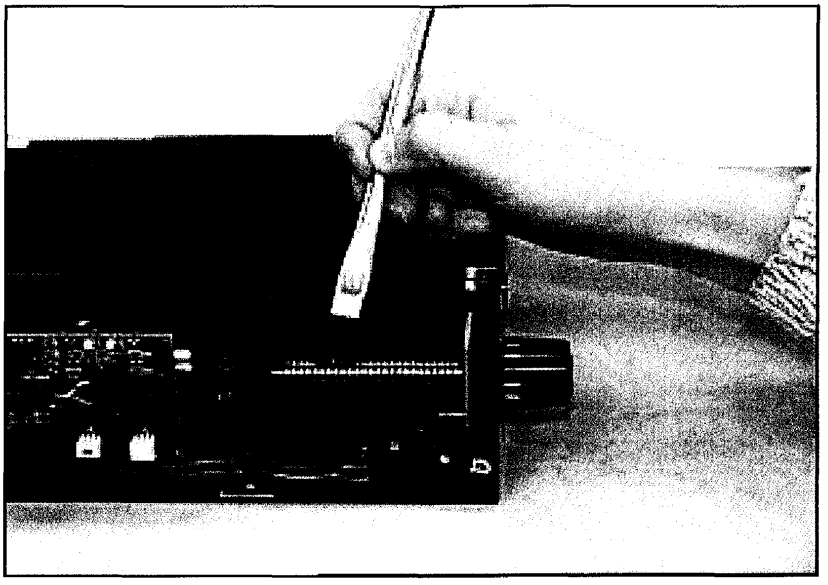


Figure 10

1. Use a 12 mm hex wrench to remove the four buttonhead cap screws from the drive cover. Remove the drive cover.

2. Inspect the leadscrew for signs of damage or wear.

3. Clean the leadscrew. Manually move the stage as required to gain access to all of the leadscrew.

4. Apply a light film of the lubricant to the exposed part of the leadscrew (Figure 10).

5. Manually run the stage from one end-of-travel limit to the other to distribute the lubricant evenly along the leadscrew.

6. Wipe off any excess lubricant.

7. Replace the drive cover.

SPECIFICATIONS

Travel Range	All	50 mm	100 mm	150 mm	200 mm	250 mm	300 mm
Bi-directional Repeatability	+/-1.0, +/- 0.5 um						
Minimum Incremental Motion	1.0, 0.5 um						
Normal Load Capacity	45kg						
Accuracy with 1.0 um encoder with 0.5 um encoder	per 25 mm +/- 4.0 um +/- 2.5 um	max +/- 5.0 um +/- 3.0 um	max +/- 7.0 um +/- 4.5 um	max +/- 8.0 um +/- 6.0 um	max +/- 10.0 um +/- 7.5 um	max +/- 11.0 um +/- 9.0 um	max +/- 13.0um +/- 10.5 um
Maximum Speed	75 mm/sec						
Origin Repeatability	1.0, 0.5 um						
Straightness	per 25 mm +/- 0.5 um	max +/- 1.0 um	max +/- 1.5 um	max +/- 2.0 um	max +/- 2.5 um	max +/- 3.0 um	max +/- 3.5 um
Flatness	per 25 mm +/- 1.0 um	max +/- 1.0 um	max +/- 2.0 um	max +/- 3.0 um	max +/- 4.0 um	max +/- 5.0 um	max +/- 6.0 um
Pitch		+/- 19 urad	+/- 24 urad	+/- 29 urad	+/- 34 urad	+/- 39 urad	+/- 44 urad
Yaw	+/- 15 urad						
Motor (See Charts Below)	UE611CC						

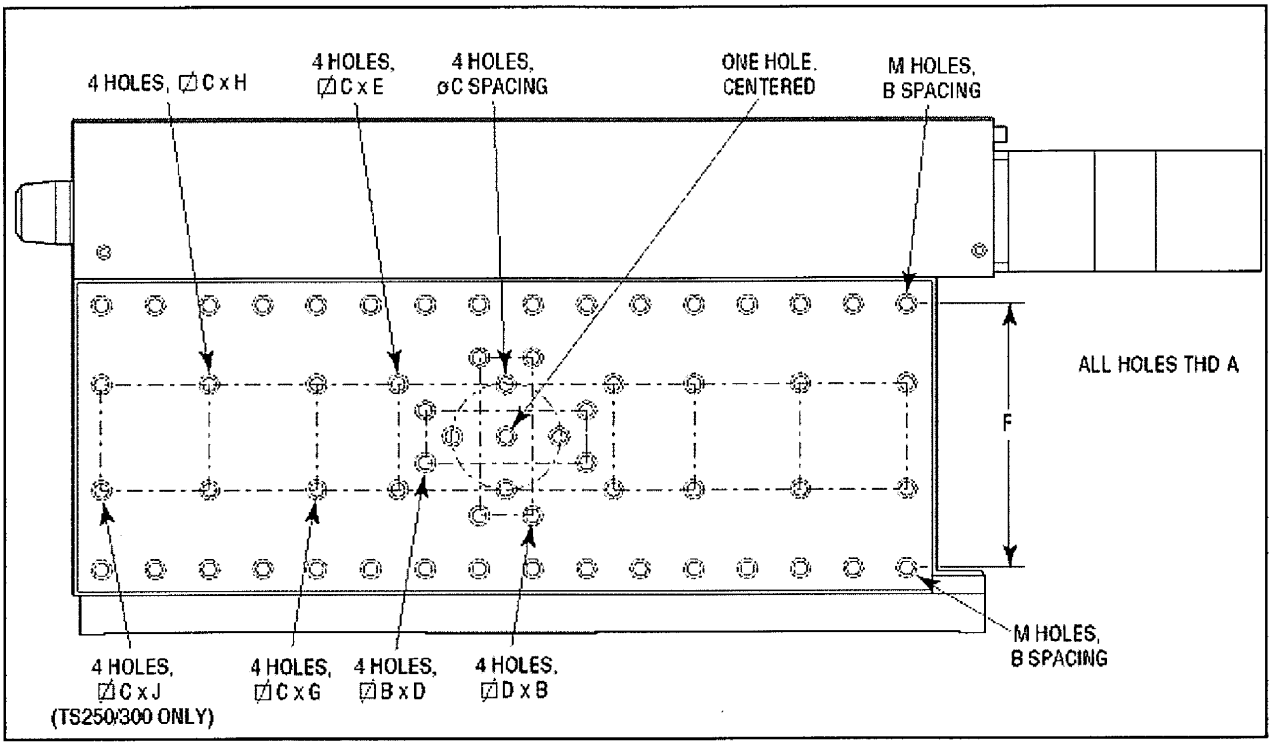
Motor Parameters

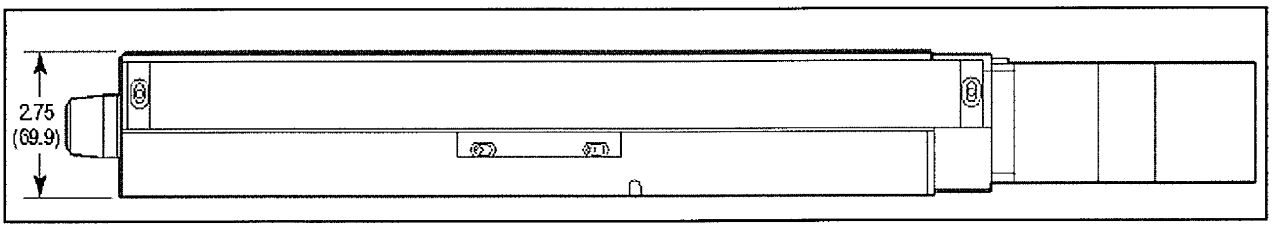
	Tolerance	Units	Value
Operating Speed	Max.	R.P.M	6000
Continuous Torque (Tc)	Max.	OZ-IN	35
Peak Torque (Tp)	Max.	OZ-IN	210
Torque Sensitivity (Kt)	+/- 10%	OZ-IN/AMPS	20.19
Back EMF Constant (Ke)	+/- 10%	V/K R.P.M.	14.93
D.C. Resistance (Rt)	+/- 10%	OHMS	5.0
Inductance (L)	+/- 30%	mH	3.5
Rotor Inertia (Ja)	Nom.	OZ-IN-SEC^2	0.0045
Friction Torque (Tf)	Nom.	OZ-IN	7.5
Damping Torque (Td)	Nom.	OZ-IN/KRPM	0.8
Winding Temperature	Max.	°C	155
Weight	Nom.	LBS	2.6

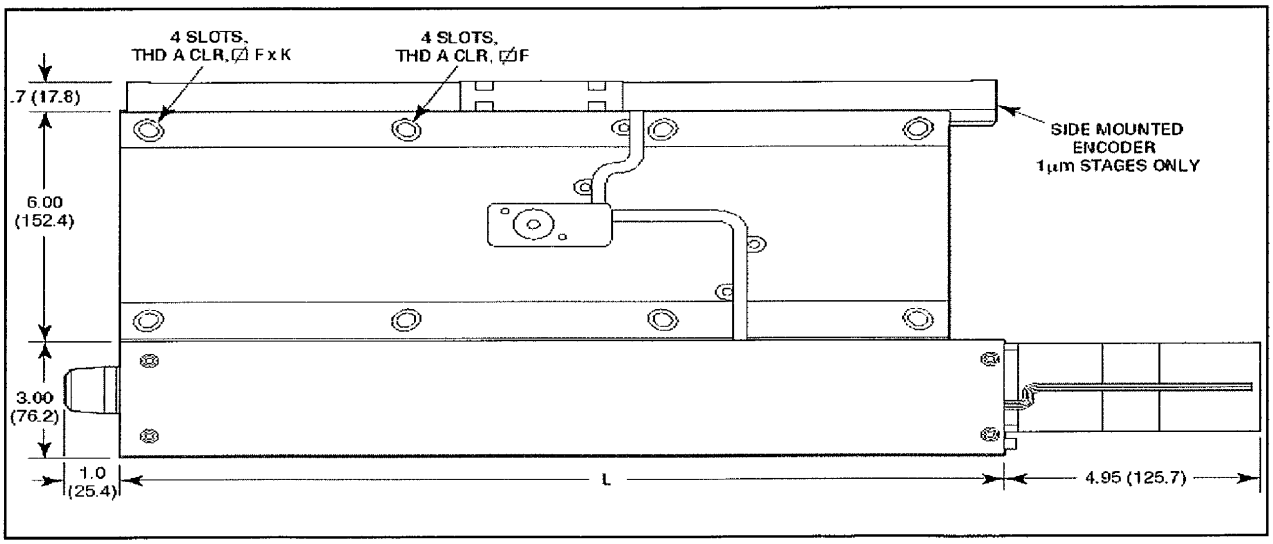
Tachometer Parameters

	Tolerance	Value
Voltage Sensitivity (V/1000 RPM)	+/- 10%	7
Voltage Ripple @ 11 CY/REV(% AVG-PK)	Max.	2
D.C. Resistance (Ohms)	+/- 10%	72
Load Resistance (Ohms)	Nom.	5K
Inductance (mH)	+/-30%	43.8

DIMENSIONS







Dimension chart on next page.

	Thread	Dimensions										# Holes
Model	A	B	C	D	E	F	G	H	J	K	L	M
	English	Inches										
TS50	1/4-20	1.000	2.000	3.000	4.000	5.000	NA	NA	NA	NA	7.1	6
TS100	1/4-20	1.000	2.000	3.000	4.000	5.000	7.000	NA	NA	7.00	9.1	8
TS150	1/4-20	1.000	2.000	3.000	4.000	5.000	7.000	9.000	NA	9.00	11.1	10
TS200	1/4-20	1.000	2.000	3.000	4.000	5.000	7.000	11.000	NA	11.00	13.1	12
TS250	1/4-20	1.000	2.000	3.000	4.000	5.000	7.000	11.000	13.000	13.00	15.1	14
TS300	1/4-20	1.000	2.000	3.000	4.000	5.000	7.000	11.000	15.000	15.00	17.1	16
	Metric	Millimeters										
M-TS50	M6	25.0	50.0	75.0	100.0	125.0	NA	NA	NA	NA	180.3	6
M-TS100	M6	25.0	50.0	75.0	100.0	125.0	175.0	NA	NA	175.0	231.1	8
M-TS150	M6	25.0	50.0	75.0	100.0	125.0	175.0	225.0	NA	225.0	281.9	10
M-TS200	M6	25.0	50.0	75.0	100.0	125.0	175.0	275.0	NA	275.0	332.7	12
M-TS250	M6	25.0	50.0	75.0	100.0	125.0	175.0	275.0	325.0	325.0	383.5	14
M-TS300	M6	25.0	50.0	75.0	100.0	125.0	175.0	275.0	375.0	375.0	434.3	16

Linear Encoders

Contact Encoder

0.5, 1.0 um Resolution
TTL Quad AB Output (Differential)
20 um Grating
Home (Origin) 25 mm from CCW end of travel

Non-Contact Encoder

0.5, 1.0 um Resolution
TTL Quad AB Output (Differential)
4 um Signal Period
Home (Origin) at center

STAGE AND CONTROLLER TROUBLESHOOTING GUIDE

This section may help you to troubleshoot common problems with operating the equipment provided. The various problems along with the possible causes and corrective actions required are outlined below.

Problem	Cause	Corrective Action
Stage does not function	Loose connector at stage	Tighten connector.
	Stage incorrectly connected to controller	Check that cables are correctly connected and wired.
	Controller incorrectly programmed. Limits not enabled via software	Refer to the manufacturer's manual for the controller
	Controller not connected to power source	Refer to the manufacturer's manual for the controller
Stage moves a short distance and stops. Controller reports "Following Error" or other motion error.	Obstruction to motion	Check for and remove all obstructions
	Loose motor coupling	Tighten coupling
	Loose connectors at stage or controller	Tighten connector
	Incorrectly wired cabling	Motor plus/minus leads reversed and/or tachometer plus/minus leads reversed
	Stage incorrectly tuned	Contact Newport's factory for service
	Load too large for motion profile used	Lower velocity and/or acceleration
Stage motion unsteady or jerky	Obstrucion or freign object on rails	Check for and remove all obstructions. Clean rails according to the procedures outlined in this manual
	Loose connections or faulty cabling	Tighten connectors. Check cabling and replace or repoair as necessary
	Stage incorrectly tuned	Contact Newport's factory for service
	Controller incorrectly programmed	Refer to the manufacturer's manual for the controller
Stage travels less than specifications	Obstruction to motion	Check for and remove all obstructions
	Entangled cables	Ensure that all cables are clear of the moving equipment
	Roller creep	If roller creep is suspected, consult Newport's factory
	Misadjusted travel limits	Refer to the procedure outlined under Travel Limits Adjustment in this manual
Stage does not meet specifications	Improper mounting	Refer to Setup, Environmental considerations in this manual
	Improper attachment	Refer to Setup, Environmental considerations in this manual
	Stage outside of environmental specifi-cations	Refer to the specifications in this manual and consult Newport's factory
	Stage incorrectly tuned	Contact Newport's factory for service
	Improper handling and/or transport	Consult Newport's factory for recalibration or certification

Problem	Cause	Corrective Action
Stage makes unusual noise	Object contacting the manual operation knob	Remove object
	Loose covers	Tighten screws
	Entangled cables	Ensure that all cables are clear of the moving equipment
	Stage incorrectly tuned	Consult Newport's factory for service
Controller reports that both end limits are active	Loose connector	Tighten all connectors
	Faulty or miswired cables	Check cabling and rewire or repair as necessary
	Controller incorrectly programmed	Refer to the manufacturer's manual for the controller
	Encoder requires cleaning	Refer to the procedure outlined in this manual
	Encoder requires realignment	Contact Newport's factory for service
	Failed encoder	Contact Newport's factory for service

Controller

Problem	Cause	Corrective Action
Light remains on when limit is flagged	Possible bad switch	Consult Newport's factory
Light does not illuminate	Possible bad switch	Consult Newport's factory
	Faulty or miswired cables	Check cabling and rewire or repair as necessary
	Improper configuration or programming of the controller	Refer to the manufacturer's manual for the controller
Activation of the clockwise switch (CW) causes the counterclockwise (CCW) light to illuminate and visa versa	Faulty or miswired cables Improper configuration or programming of the controller	Check cabling and rewire or repair as necessary Refer to the manufacturer's manual for the controller
Lights indicate proper functioning of the limit switch but stage hits a hard stop before the switch is activated	Misadjusted travel limits	Refer to the procedure outlined under Travel Limits Adjustment in this manual
Lights indicate proper operation of the limit switches but controller does not respond to switch activation	Faulty or miswired cables	Check cabling and rewire or repair as necessary
	Improper configuration or programming of the controller	Refer to the manufacturer's manual for the controller

HOME & LIMIT SWITCHES TROUBLESHOOTING GUIDE

Transmissive Sensor Testing

Perform this procedure for the following sensors:
-- the clockwise and coutnerclockwise limit sensors
-- for stages using contact type encoders, the home sensor

1. Find a thin strip of flexible material, such as heavy paper or thin cardboard, to use as a flag.

2. Disconnect power to the stage.

3. Remove the four buttonhead cap screws from the drive cover. Remove the drive cover.

4. Manually position the stage to allow access to the sensor under test.

5. Command the controller to disable motor power. Refer to the manufacturer's manual for the controller to find the relevant procedure.

6. Reconnect power to the stage.

7. Insert the flag between the two upright posts of the sensor. The sensor lamp should switch off when the strip is inserted and illuminate again when the strip is removed.

Sensor	Lamp
Clockwise limit	Red
Counterclockwise limit	Green
Home	Green

8. If the lamp does not switch off when flagged, refer to the limit switch troubleshooting chart.

Reflective Sensor Testing

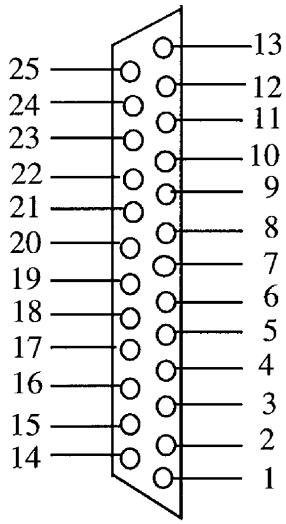
Perform this procedure for stages with non-contact type encoders, the home sensor.

1. Move the stage to allow access to the home sensor.

2. Place a target of reflective material about 1mm from the sensor face.

3. The sensor red lamp should illuminate when the target is put in position. If the sensor lamp does not illuminate, consult the sensor troubleshooting chart.

PINOUT CONNECTIONS



The circuit board connector interfaces to the motion controller. Refer to the below pinout chart for pinout numbers. Depending on whether the stage uses a DC servo or Stepper type motor, the pinout connections may vary.

Pin #	Stepper Motor	DC Servo Motor
1	Phase 1	+ Tachometer Generator
2	Phase 1	+ Tachometer Generator
3	Phase 2	-- Tachometer Generator
4	Phase 2	-- Tachometer Generator
5	Phase 3	+ Motor Phase
6	Phase 3	+ Motor Phase
7	Phase 4	-- Motor Phase
8	Phase 4	-- Motor Phase
9	Common Ph. 3-4	No Connection
10	Common Ph. 3-4	No Connection
11	Common Ph. 3-4	No Connection
12	Common Ph. 1-2	No Connection
13	Home Switch Signal	Home Switch Signal
14	Shield Ground	Shield Ground
15	Encoder Index Pulse I	Encoder Index Pulse I
16	Limit Ground	Limit Ground
17	+ Travel Limit	+ Travel Limit
18	-- Travel Limit	-- Travel Limit
19	Encoder Channel A	Encoder Channel A
20	Encoder Channel B	Encoder Channel B
21	Encoder Power +5V	Encoder Power +5V
22	Encoder Ground	Encoder Ground
23	Encoder Channel/A	Encoder Channel/A
24	Encoder Channel/B	Encoder Channel/B
25	Encoder Index Pulse/I	Encoder Index Pulse/I