FMS Series

Precision Linear Stages

Newport®
Experience | Solutions

USER'S MANUAL

Precision Motion – *Guaranteed*™

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 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.**

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.

Table of Contents

EC Declaration of Conformity

FMS 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,
9, rue du Bois Sauvage
91055 Évry CEDEX, FRANCE

Hereby declares that the machinery:

- Description: " FMS"
- Function: PRECISION LINEAR STAGES
- Models: FMS100/200/300/CC/PP/PPHA.

– 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 2014/30/EU relating to electro-magnetic compatibility.

– 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

– 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 61000-4-5
- NF EN 61000-4-6

ORIGINAL DECLARATION

Done in Beaune La Rolande on 26 June 2015
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 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.

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 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, steam or high humidity. 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 its end-of-run position, it is strongly recommended not to go beyond this point as this may damage the stage mechanism.

CAUTION

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

Precision Linear Stages
FMS Series

1.0 Introduction

This manual provides operating instructions for the stage that you have purchased in the FMS Series:

- FSMPP
- FSMPPHA
- FSMCC

3 travel ranges of FMS stages.

RECOMMENDATION

We recommend you read carefully the chapter “Connection to electronics” before using the FMS stage.

2.0 Description

The FMS series of precision linear stages is Newport's latest innovation in high precision motion control technology. It addresses the unique needs of surface metrology applications for smooth motion, low noise, high straightness and flatness. The FMS linear stages run highly flat and straight and combined with steel construction, enable higher accuracy performance. Travel options include 100 mm, 200 mm and 300 mm and can be ordered with either a DC or stepper motor. As with all Newport motorized stages, there is a wide choice of integrated controller/driver products, ranging from the single axis SMC100, to the 3-axis ESP301 and high-performance 8-axis XPS Universal Controller.

Featuring steel construction, the FMS linear stages have a very distinct advantage over other stages made with aluminum. It is well known that steel expands less than aluminum when subjected to temperature fluctuations in the operating environment. In addition, a combination of steel and aluminum in the construction of a stage introduces a phenomenon called bi-metallic bending, caused by the different thermal expansion coefficients of metals. Both these reasons led to the use of steel exclusively in the base and other components of the FMS stages. Since all FMS components are made from steel, all these components are expected to expand at the same rate when the operating temperature fluctuates, thereby eliminating bi-metallic bending and the associated inaccuracies and non-flat behavior.

The cross roller bearings in the FMS come standard with an anti-creep feature that ensures high reliability by eliminating bearing cage migration and the need for re-centering the bearings. Moreover, this enables optimum bearing contact that results in superior repeatability of straightness, flatness, pitch and yaw over the life of the FMS.

The FMS stages have a nominal speed of up to 100 mm/s, easily improving throughput compared to other products in the market. Controlling with Newport integrated motion controllers and drivers like the SMC100 and ESP301 (CC and PP versions) or the XPS (all versions), adds more flexibility in gathering metrology data.

The FMS linear stages are exceptional solutions for applications in surface metrology, surface profilometry and tribology.

2.1 Design Details

Base Material	Stainless Steel
Bearings	Crossed Roller Bearings
Drive Mechanism	8 mm, precision ground ball screw
Drive Screw Pitch (mm)	2
Feedback	DC: Screw mounted rotary encoder, 4000 cts/rev, index pulse PP: No feedback PPHA: Steel scale, 50 nm
Origin	PP: optical, located ~9.5 mm from negative software limit CC & PPHA: Optical, located ~10.5 mm from negative software limit
Drive Type	DC Servo Stepper
Cable (m)	3 (included)

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 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.

On-Axis 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:

$$\textit{Absolute Accuracy} = \textit{On-Axis Accuracy} + \textit{Correction Factor}_{x} \textit{Travel}$$

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.

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 test equipment in an air-conditioned room ($20^{\pm 1}$ °C).

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

Guaranteed 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**

3.2 Mechanical Specifications

	CC	PP	PPHA
Travel Range (mm)		100; 200; 300	
Minimum Incremental Motion (µm)	0.5	0.1 [1]	0.1
Uni-directional Repeatability (µm)	1.5	1.5	0.2
Bi-directional Repeatability [2] (µm)	3 or ±1.5	4.5 or ±2.25	0.5 or ±0.25
Maximum Speed (mm/s)	100	20	50

	FMS100	FMS200	FMS300
On-Axis Accuracy (CC and PP) [2] (µm)	6 or ±3.0	10 or ±5.0	13 or ±6.5
On-Axis Accuracy (-PPHA) [2] (µm)	1 or ±0.5	2 or ±1.0	3 or ±1.5
Straightness, Flatness [2] (µm)	1.5 or ±0.75	3 or ±1.5	6 or ±3.0
Pitch [2] [3] (µrad)	80 or ±40	100 or ±50	120 or ±60
Yaw [2] [3] (µrad)	20 or ±10	30 or ±15	40 or ±20

1) 0.1 µm with XPS; 0.5 µm with SMC100PP and ESP301.

2) Shown are peak to peak, guaranteed specifications or ±half the value as sometimes shown. For the definition of typical specifications which are about 2X better than the guaranteed values, visit www.newport.com for the Motion Control Metrology Primer.

3) To obtain arcsec units, divide µrad value by 4.8.

CAUTION

To reach the specifications stated, stages must be fixed on a plane with a flatness better than the stage flatness guaranteed value or fixed using the 4 washers (Ø 16 mm and thickness 0.1 mm) delivered with the stage. The M6 screws torque to fix the stage must be 5 mn.

3.3 Load Specification Definitions

Normal Load Capacity (Cz)

Maximum load a stage can move while maintaining specifications.

This value is given with speed and acceleration specified for each stage, and with a load perpendicular to bearings.

	FMSPP	PPHA	FMSCC
Specified Speed (mm/s)	20	50	100
Specified Acceleration (mm/s²)	80	200	400

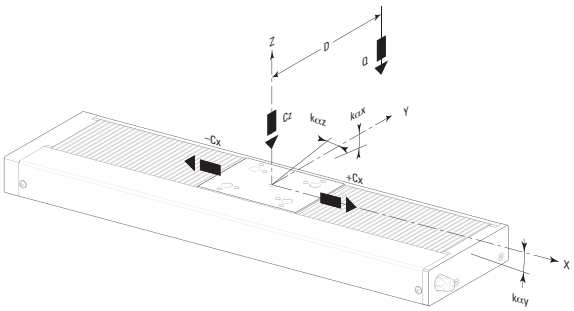
Axial Load Capacity (±Cx)

Maximum load along the direction of the drive train.

Off-Centered Load (Q)

Maximum cantilever-load a stage can move.

3.4 Load Characteristics and Stiffness



Cz, Normal center load capacity on bearings	150 N
±Cx, Axial load capacity	<30 N [1]
kαx, Compliance in roll	3 µrad/Nm
kαy, Compliance in pitch	2 µrad/Nm
kαz, Compliance in yaw	2 µrad/Nm
Q, Off-center load with D = Cantilever distance (mm)	Q ≤Cz ÷ (1 + D/80)

1) Note

Reversible drive chain: Not recommended for vertical use unless counterweighed.

3.5 Stage Weights

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

The stage weight below does not include the cable.

	Weight [lb (kg)]
FMS100	14.3 (6.5)
FMS200	17.0 (7.7)
FMS300	19.6 (8.9)
3-meter MSCABLE-3 Cable	0.66 (0.3)

The weight difference between drive units is not significant.

4.0 Drive

4.1 Stepper Drive Versions

FMSPP: This version is not equipped with an encoder.
The micro-step is equivalent to 1/100 of the full-step.

FMSPPHA: This version is equipped with a steel scale encoder.
For these stages, the micro-step is equivalent to 1/200 of the full-step.

Stepper Motor Performance Specifications

	Resolution (µm)	Speed (mm/s)	Motor
FMSPP	0.1	20	UE34PP
FMSPPHA	0.05	50	

4.2 DC-Servo Drive Version

One DC-motor configurations is available: FMSCC.

This version is equipped with a 4000 cts/rev. rotary encoder located directly on the screw.

DC-Motor Performance Specifications

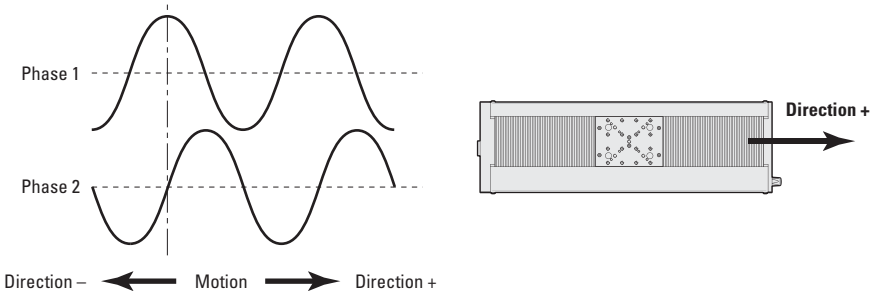
	Resolution (µm)	Speed (mm/s)	Motor
FMSCC	0.5	100	UE34CC

5.0 Motor

5.1 UE34PP Motor Characteristics

Motor	Angle by Step (°)	RMS Current per Phase (A)	Resistance (Ω)	Inductance (mH)	Newport Utilization
UE34PP	1.8	0.71	1.7	2.8	Micro-Step

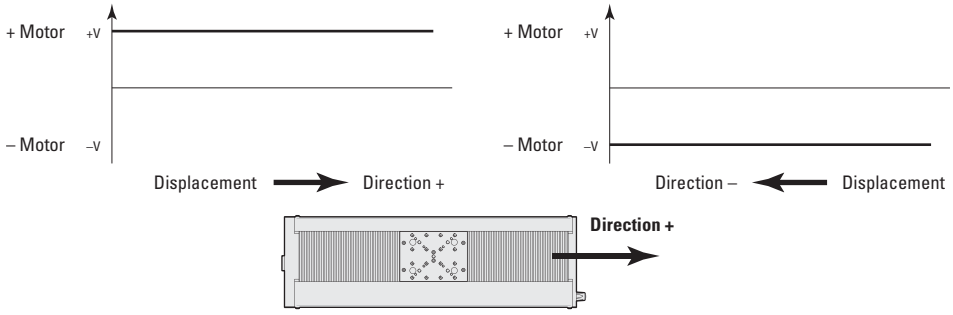
5.2 Command Signals for the Stepper Motors



5.3 UE34CC Motor Characteristics

Motor	Nominal Voltage (V)	Max. RMS Current (A)	Max. Peak Current (A)	Resistance (Ω)	Inductance (mH)
UE34CC	48	0.9	1.6	2.52	0.51

5.4 Command Signals for the DC-Motor

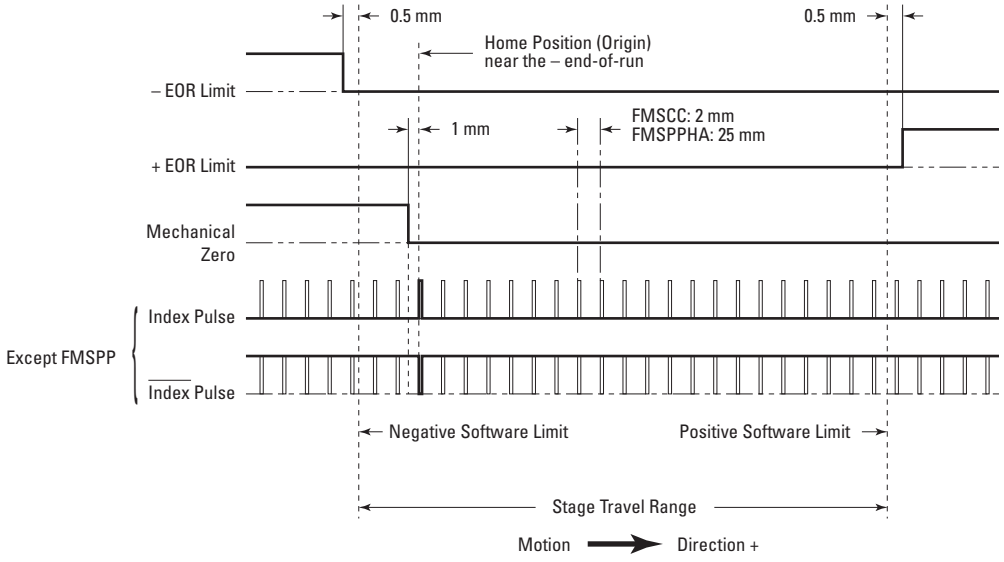


In the above drawings, + Motor signal is referred to – Motor signal.

① When the stage moves in + Direction, the + Motor voltage is higher than – Motor voltage.

② When the stage moves in – Direction, the + Motor voltage is lower than – Motor voltage.

5.5 Sensor Position



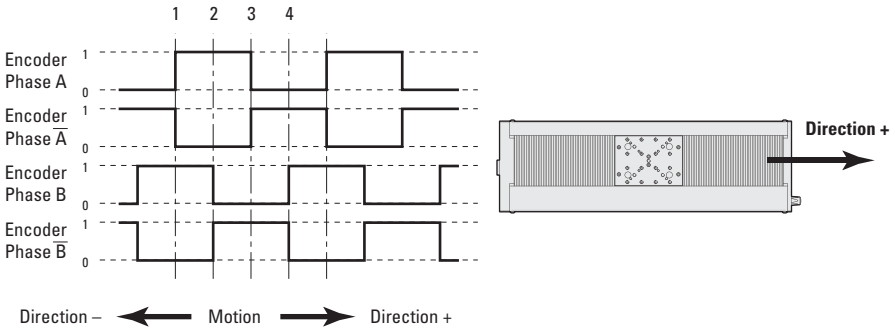
NOTES

- **End-of-Run and Mechanical Zero are 5 V open collector type.**
- **Use of the Index Pulse provides a repeatable Home Position at ±1 step.**
- **There is no index pulse on the FMSPP.**
- **On the FMSCC, there is one index pulse every 2 mm and homing will use the first pulse to the right of the Mechanical Zero. It is adjusted to about 1 mm.**
- **There is one index pulse every 25 mm on FMSPPHA. Homing will use the first pulse to the right of the Mechanical Zero and is adjusted to about 1 mm.**

CAUTION

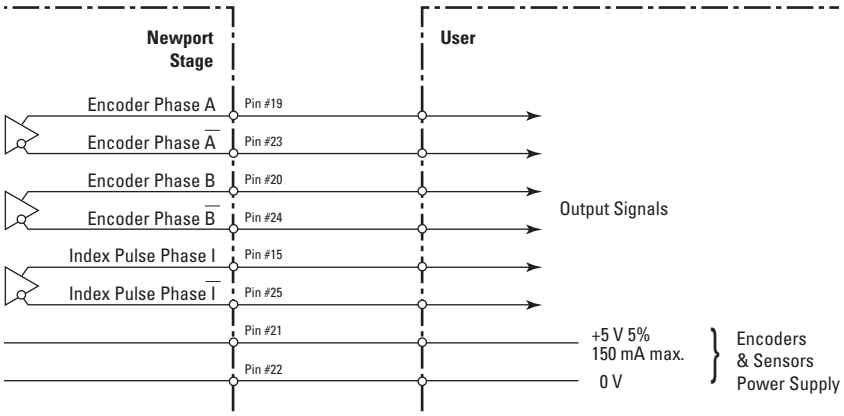
"End-of-Run" and "Mechanical Zero" are active signals and should not be connected to any other source.

5.6 Feedback Signal Position



On FMSCC stages, the incremental sensor operates following the photoelectric measurement principle, with a disk including slides.

When the sensor shaft turns, the sensor generates square signals in quadrature, sent to pins #19, #20, #23 and #24 of the 25-pin Sub-D connector.

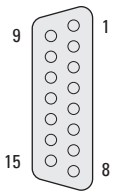


"Encoder" and "Index Pulse" are "differential pair" (type RS-422) type output signals. Using these signals permits a high immunity to noise. Emission circuits generally used by Newport are 26LS31 or MC3487. Reception circuits to use are 26LS32 or MC3486.

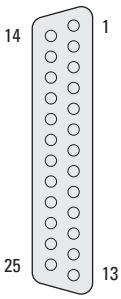
5.7 Pinouts

The SUB-D connection for FMS Series translation stages is given in the following table:

SUB-D15M



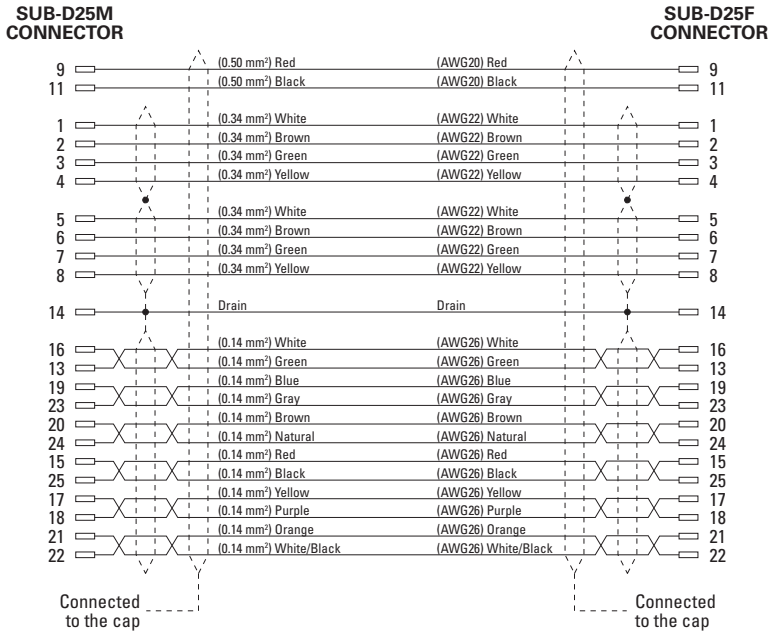
SUB-D25M



	FMSPP UE34PP		FMSPPHA UE34PP		FMSCC UE34CC
1	+ Phase 1	**1**	+ Phase 1	**1**	N.C.
2	+ Phase 2	**2**	+ Phase 1	**2**	+ Motor
3	Mechanical Zero	**3**	– Phase 1	**3**	Mechanical Zero
4	– End-of-Run	**4**	– Phase 1	**4**	– End-of-Run
5	Ground	**5**	+ Phase 2	**5**	Ground
6	N.C.	**6**	+ Phase 2	**6**	Encoder Phase /A
7	N.C.	**7**	– Phase 2	**7**	Encoder Phase /B
8	N.C.	**8**	– Phase 2	**8**	Index Pulse /I
9	– Phase 1	**9**	N.C.	**9**	N.C.
10	– Phase 2	**10**	N.C.	**10**	– Motor
11	+ End-of-Run	**11**	N.C.	**11**	+ End-of-Run
12	+5 V	**12**	N.C.	**12**	+5 V
13	N.C.	**13**	Mechanical Zero	**13**	Encoder Phase A
14	N.C.	**14**	Ground	**14**	Encoder Phase B
15	N.C.	**15**	Index Pulse I	**15**	Index Pulse I
		16	Ground		
		17	+ End-of-Run		
		18	– End-of-Run		
		19	Encoder Phase A		
		20	Encoder Phase B		
		21	+5 V		
		22	Ground		
		23	Encoder Phase /A		
		24	Encoder Phase /B		
		25	Index Pulse /I		

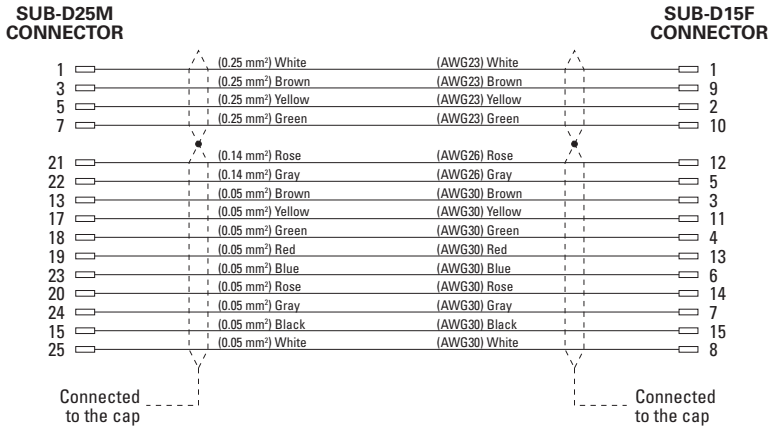
5.8 MCAB-3 Cable

This cable is supplied with FMSPPHA stages.



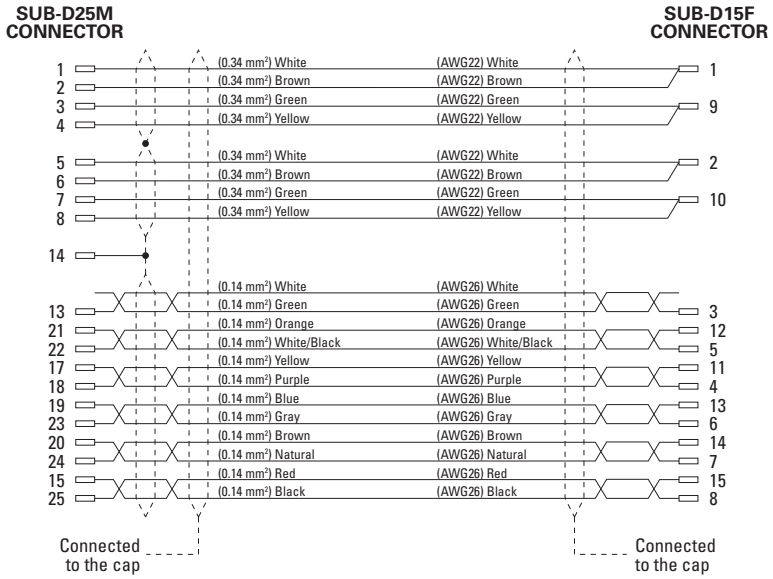
5.9 MSCABLE-3 Cable

This cable is supplied with FMSPP and FMSCC stages.



5.10 MSCABLE-10 Cable

Optional 10-meter cable for FMSPP or FMSCC stages.



6.0 Connection to Newport Controllers

NOTE

Visit www.newport.com for compatible Newport controllers.

6.1 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 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.

6.2 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 any time prior to power-up with the supplied cable assemblies.

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.

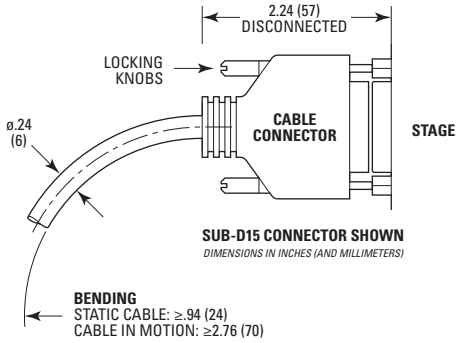
6.3 Cables

Our FMS stages are delivered with a **MCAB-3** or **MSCABLE-3** 3-meter cable according to the stage you bought. This cable is equipped with a SUB-D25M connector so it can be directly connected to our controllers/drivers.

The cable supplied with your FMS stage is given in the following table:

Stages	Supplied Cable
FMSPP	MSCABLE-3
FMSPPHA	MCAB-3
FMSCC	MSCABLE-3

6.4 MSCABLE-3 Cable



WARNING

This cable is shielded correctly. For a correct operation, make sure to lock connectors (ground continuity provided by the cable).

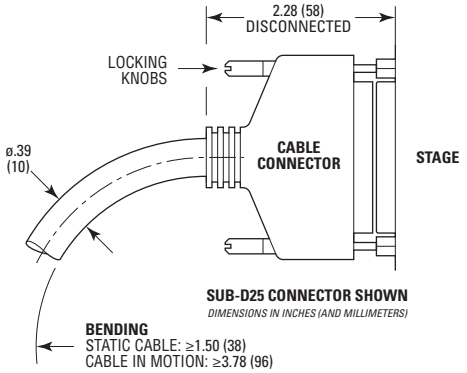
For applications where the standard 3-meter cable (**MSCABLE-3**) included with your stage is not adequate, Newport offers a 10-m longer length cable (**MSCABLE-10**) designed to ensure the integrity of your positioning application.

These cables are specially shielded and terminated with Newport's standard SUB-D15 and SUB-D25 connectors.

WARNING

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

6.5 MCAB-3 Cable



WARNING

This cable is shielded correctly. For a correct operation, make sure to lock connectors (ground continuity provided by the cable).

For applications where the standard 3-meter cable (**MCAB-3**) included with your stage is not adequate, Newport offers longer length cables designed to ensure the integrity of your positioning application.

These cables are specially shielded and terminated with Newport's standard SUB-D25 connectors. They are available in 5-m (**MCAB-5**), 7-m (**MCAB-7**) or 10-m (**MCAB-10**) lengths.

WARNING

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

7.0 Connection to Non-Newport Electronics

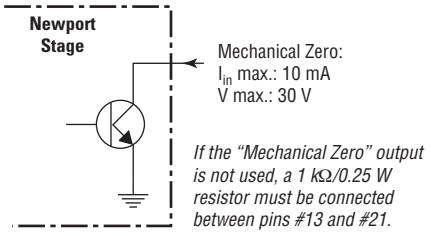
7.1 Connections

WARNING

Newport is not responsible for malfunction or damage to a FMS stage when it is used with non- Newport controllers.

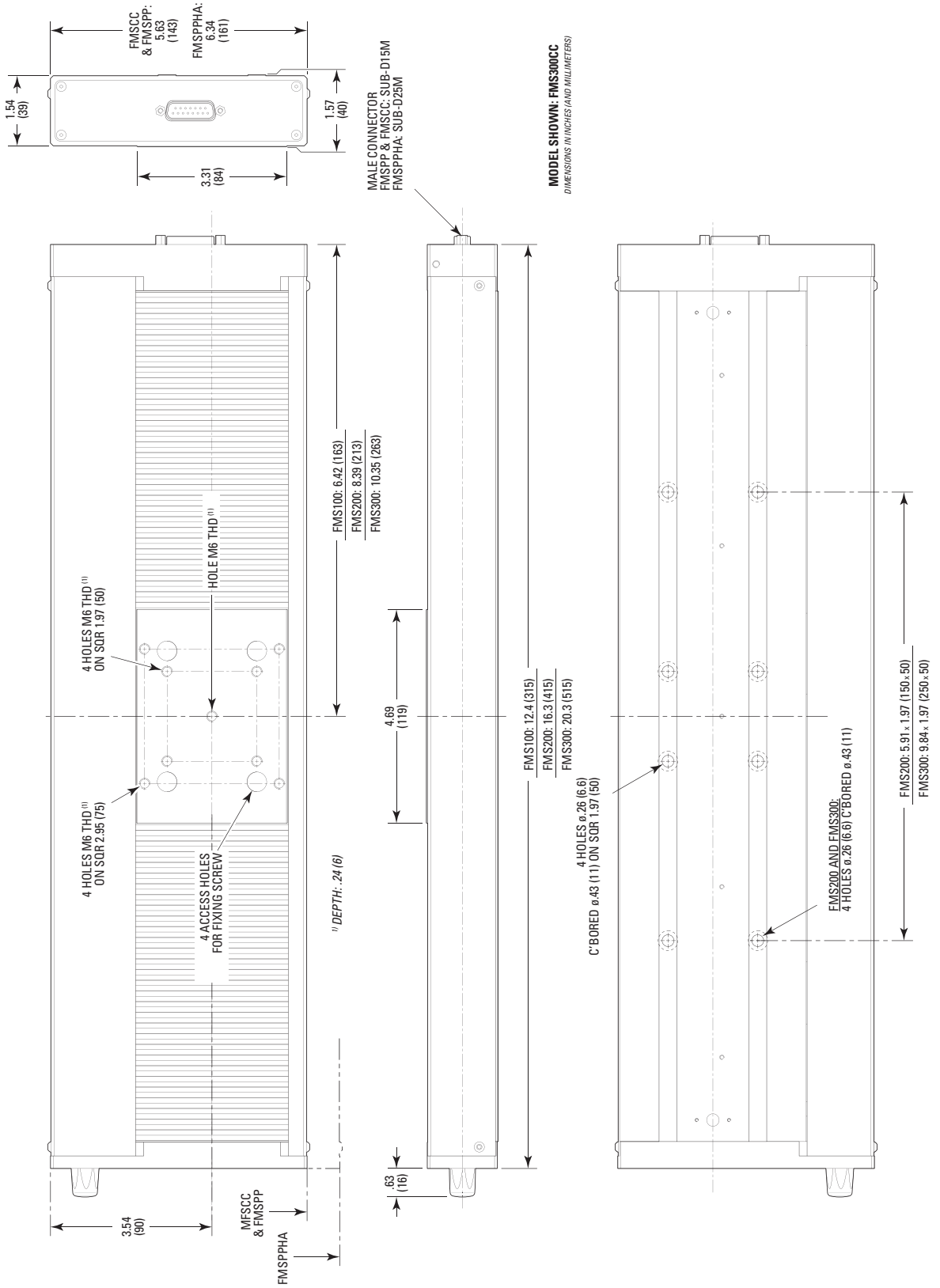
WARNING

Newport guarantees "CE" compliance of the FMS stage only if they are used with Newport cables and controllers.



"Encoder" and "Index Pulse" are "differential pair" (type RS-422) type output signals. Using these signals permits a high immunity to noise. Emission circuits generally used by Newport are 26LS31 or MC3487. Reception circuits to use are 26LS32 or MC3486.

8.0 Dimensions



9.0 Maintenance

RECOMMENDATION

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

9.1 Maintenance

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

PRECAUTIONS

The FMS stage must be used or stocked in a clean environment, without dust, humidity, solvents or other substances.

RECOMMENDATION

It is recommended to return your FMS stage to Newport's After Sales Service after every 2000 hours of use for lubrication.

If your 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 FMS stage to Newport once a year for 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: _____

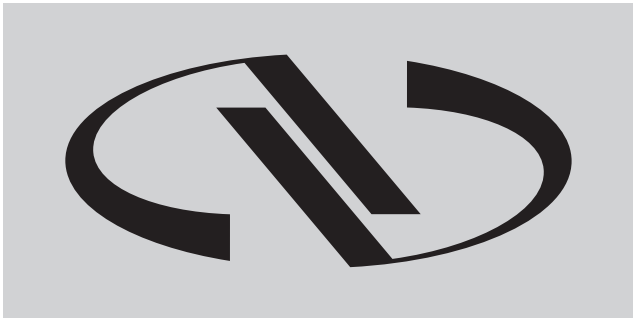
P.O. Number: _____ Fax Number: _____

Item(s) Being Returned:

Model #: _____ Serial #: _____

Description: _____

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



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