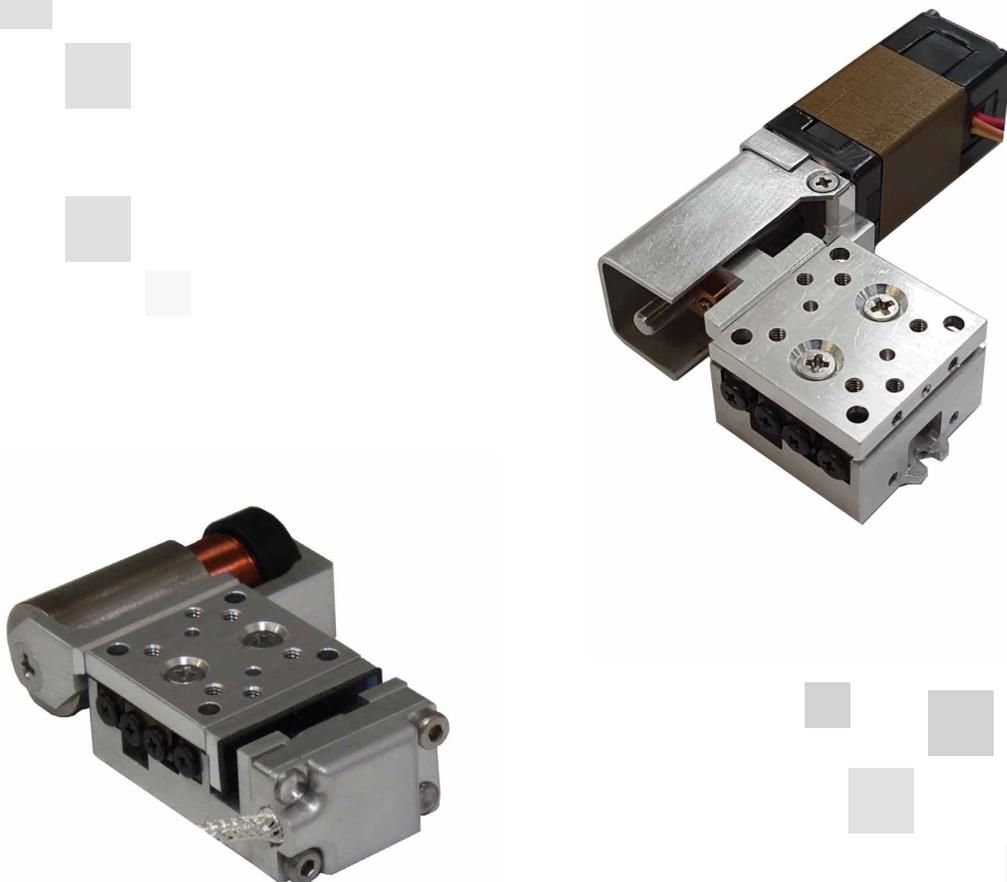


# PPS-20

Series



## Precision Linear Motor / Stepper Motor Stage Reference Manual (Open and Closed Loop Versions)

# **PPS-20**

## **Linear/Stepper Motor Positioner Stage**

### **Reference Manual**

Rev 3.08

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## 1. Introduction

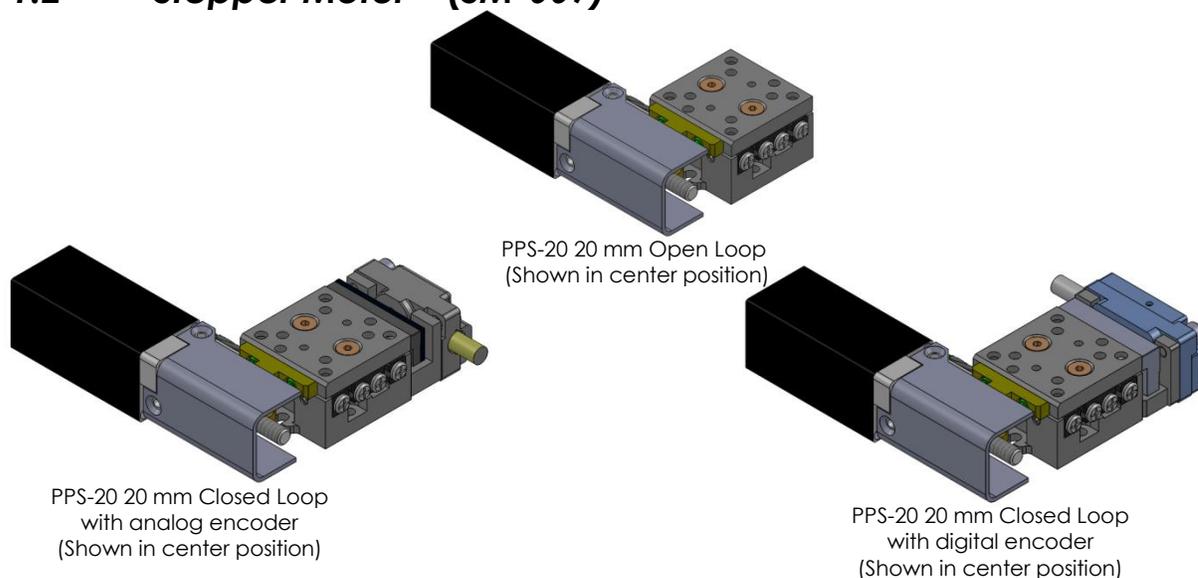
### 1.1 Product Description

The PPS-20 is a low profile, high-precision linear stage outfitted with a linear or stepper motor. Miniature cross-roller bearings assure high stiffness and guiding accuracy for loads up to 20 N (Stepper motor) (horizontal orientation) and 2 N (Linear motor). The PPS-20 LSM is available in travel lengths of up to 51 mm, and an optional linear encoder provides submicron repeatability. High Vacuum ( $10^{-6}$  mbar) compatible versions are available.

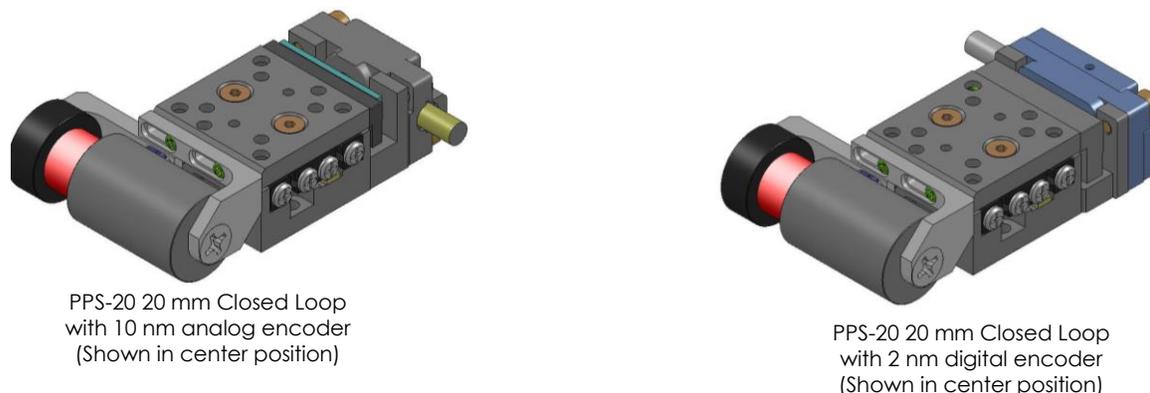
**Features:**

- Stepper Motor travel ranges of 10 mm, 18 mm, 26 mm, and 51 mm
- Linear Motor travel ranges of 11 mm, 18 mm, and 25 mm
- Load capacity up to 20 N (horizontal)
- Optional 2 nm resolution external digital encoder or 10 nm Analog encoder

### 1.2 Stepper Motor – (SM-007)



### 1.3 Linear Motor – (LM-003)



### 1.4 Recommended Controllers

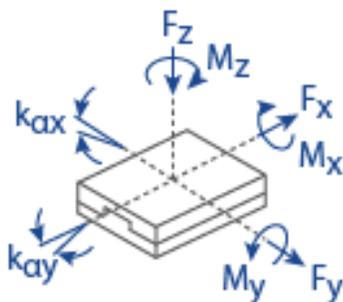
The following controllers are available from MICRONIX USA:

- MMC-200 [Stepper Motor Versions]
- MMC-300 [Linear Motor Versions]

### 1.5 Technical Data

Motor option	SM-007				LM-003		
Speed, max. [mm/sec]	5				100		
Encoder option	Open Loop	Analog (1 V <sub>pp</sub> )	Digital (RS-422)	Digital Low Cost	Analog (1 V <sub>pp</sub> )	Digital (RS-422)	Digital Low Cost (RS-422)
Resolution, typical [μm]	0.1	0.05	0.05	0.5	0.01	0.01	0.5
Repeatability, bi-directional [μm]	± 4	± 0.2	± 0.2	±1	± 0.1	± 0.1	±1
Repeatability, uni-directional [μm]	0.5	0.2	0.2	1	0.1	0.1	1

### 1.6 Load Characteristics



Load Characteristics	F <sub>X(N)</sub>	F <sub>Y(N)</sub>	F <sub>Z(N)</sub>	M <sub>X(Nm)</sub>	M <sub>Y(Nm)</sub>	M <sub>Z(Nm)</sub>	k <sub>ax</sub> [μrad/Nm]	k <sub>ay</sub> [μrad/Nm]
SM-007	5	20	20	0.7	0.7	0.7	-	-
LM-003	1 Peak	2	2	0.7	0.7	0.7	-	-

## 2. Model Configurations

### 2.1 PPS-20 SM Order Numbers

Order No.	PPS-20	2		1	
Stepper Motor SM-007.....	2				
10mm Travel.....	1				
18mm Travel.....	2				
26mm Travel.....	3				
51mm Travel.....	5				
None.....	0				
Analog (1V <sub>pp</sub> ).....	2				
Digital (RS-422).....	3				
Digital Low Cost.....	4				
Magnetic.....	1				
Atmospheric.....	0				
High Vacuum, 10 <sup>-6</sup> mbar.....	6				

Contact MICRONIX USA for custom applications and stacking configurations.

2.2 PPS-20 LM Order Numbers

Order No.	PPS-20	3			
Linear Motor LM-003.....	3				
11mm Travel.....	1				
18mm Travel.....	2				
25mm Travel.....	3				
Analog (1V <sub>pp</sub> ).....	2				
Digital (RS-422).....	3				
Digital Low Cost.....	4				
None.....	0				
Magnetic.....	1				
Atmospheric.....	0				

Contact MICRONIX USA for custom applications and stacking configurations.

## 3. Preparing to Install the PPS-20 LMSM Stage

### 3.1 Installation Preparation

When mounting the stage, it is important to consider the flatness of the mounting surface, as the stage will conform to the shape of that surface. A surface that is not flat can adversely affect the performance and structural integrity of the stage.

The stage is calibrated and guaranteed to be within specification at 20°C ±5°C, unless otherwise specified. Be sure to use the stage under the following conditions:

- Mount to a clean and flat surface which is free of debris, burrs or dings
- An indoor atmosphere free of corrosive gases, excessive dust, and condensation
- Temperature range of 0-40°C
- Relative humidity between 20-80%
- Locate away from water, heat, and electrical noise

### 3.2 Package Contents

If product is damaged or there are missing components, contact MICRONIX USA immediately. Do not discard product packaging in case of return shipment.

**Package Should Contain:**

- PPS-20 Linear Stage
- Reference Manual
- Any other previously agreed upon components such as a controller

## 4. Installing the PPS-20 LMSM Stage

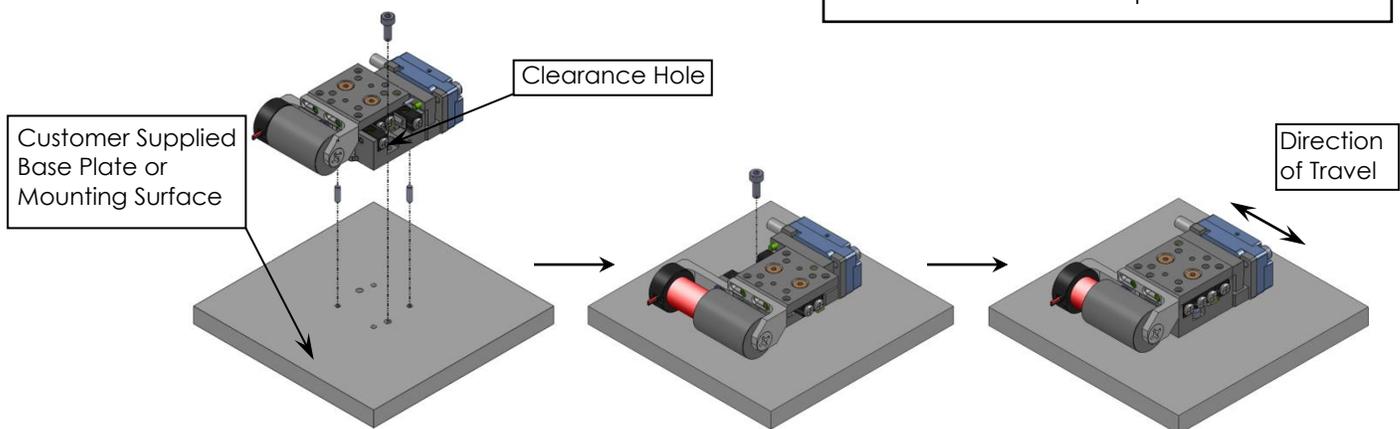
Mounting patterns require M2 screws for mounting and M1.5 x 5mm dowel pins for precision alignment. Additional brackets and screws may be required for custom applications.

### 4.1 PPS-20 LMSM Installation

#### 4.1.1 General Mounting

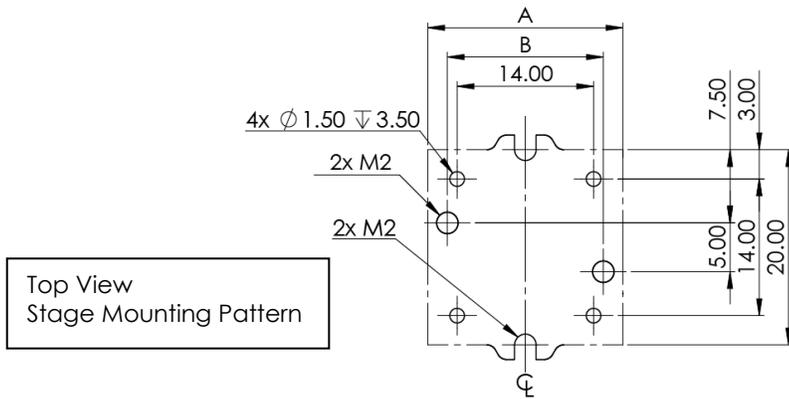
For general mounting configurations, mount the base to the mounting surface using the thru holes. Move the carriage to access base mounting pattern. (Please note, it is possible to move the carriage of the linear motor configurations manually without damaging the stage, however, for \*stepper versions the motor must be driven by a controller to reposition the carriage.)

Requires:  
 2x M1.5 x 5mm Dowel Pins  
 2x M2 Socket Head Cap Screws



1. Move carriage via controller\*, if necessary, to access mounting hole. Insert Pins and M2 SHCS as shown.

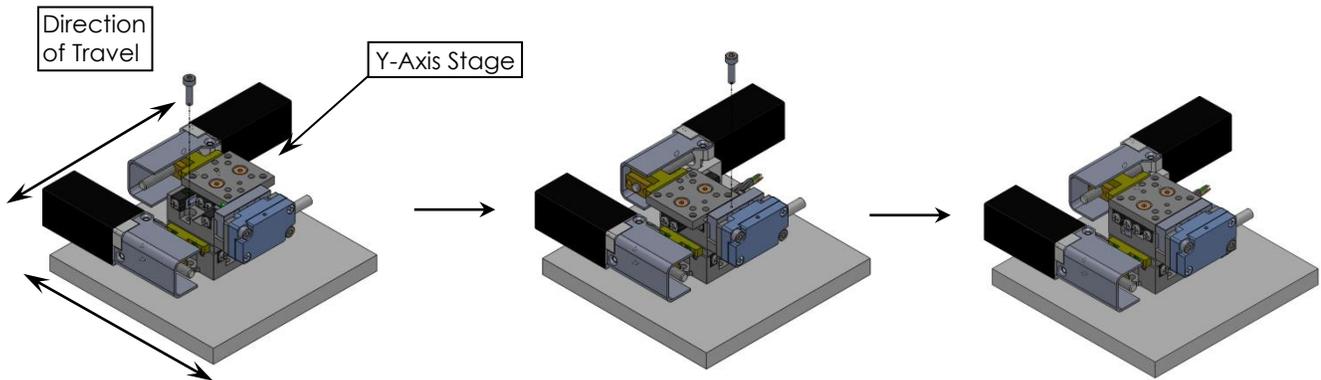
2. Move carriage via controller\*, if necessary, to access remaining mounting hole. Install M2 SHCS as shown.



4.1.2 X-Y Mounting

For X-Y mounting, follow the instructions for mounting the X-axis stage, outlined in section 4.1.1 *General Mounting*, then proceed to mount the Y-axis stage, as shown below. X-Y mounting of longer travel length stages may require them to be mounted base to base (note shown). Please note, it is possible to move the carriage of the linear motor configurations manually without damaging the stage, however, for stepper versions the motor must be driven by a controller to reposition the carriage

- Requires:  
 2x M1.5 x 5 mm Dowel Pins  
 4x M2 Socket Head Cap Screws  
 (For stacking screws, use M2 x 5 mm SHCS)



1. Move Y-Axis Stage carriage via controller\*, if necessary, to access mounting hole. Install M2 SHCS as shown.

2. Move carriage via controller\*, if necessary, to access remaining mounting hole. Install M2 SHCS as shown.

Stepper Motor			
Travel	A	B	
10mm	20	16	
18mm	30	16	
26mm	40	36	
51mm	80	50	

Linear Motor		
Travel	A	B
11mm	20	16
18mm	30	16
25mm	40	36

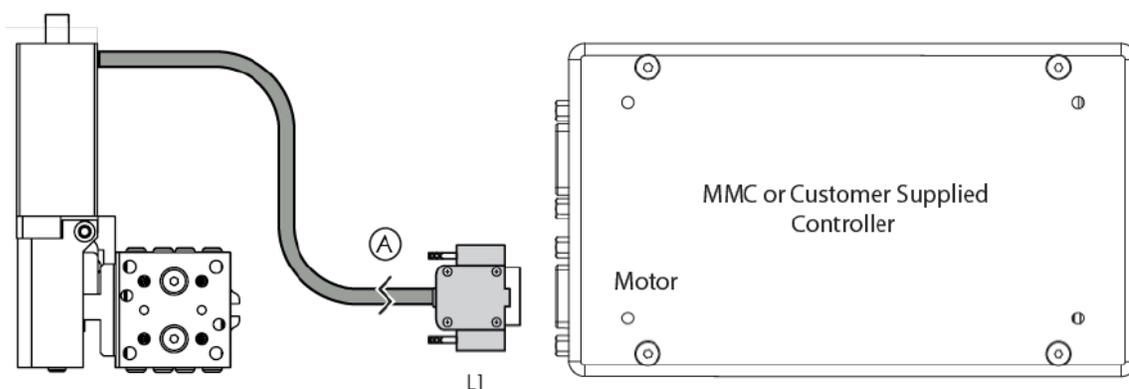
## 5. Connecting the PPS-20 LMSM Stage

### 5.1 Atmospheric Environments

For controller information refer to the appropriate MMC controller manual.

#### 5.1.1 Open Loop Installation & Wiring Diagram

Connecting the PPS-20 LMSM stage in an open loop configuration only requires that the D-sub 9 Pin male Motor Cable be connected to a compatible controller. No other cables or components are required. Note: Open loop configurations are not available for linear motor versions.

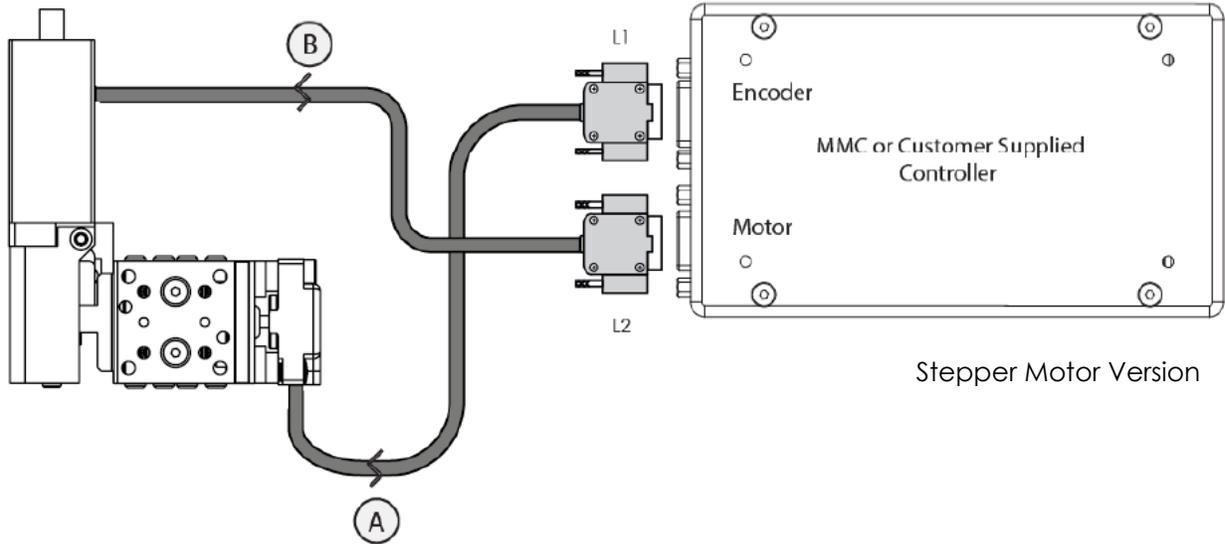


Stepper Motor Version

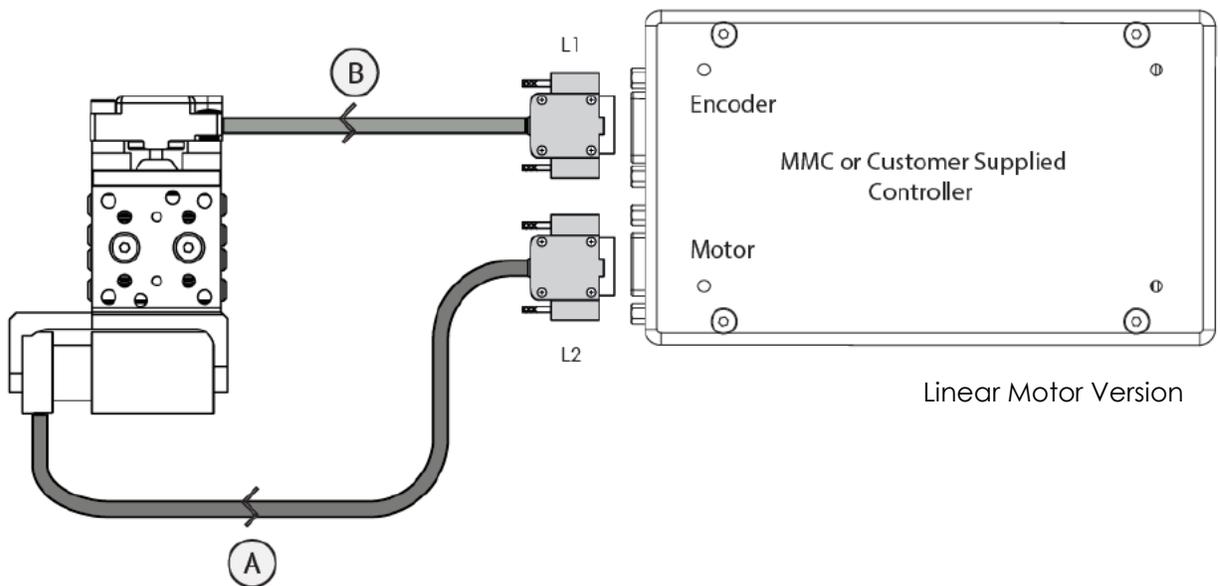
5.1.2 Closed Loop/Encoder Installation & Wiring Diagram

Using the PPS-20 LSM stage with an encoder requires a closed loop compatible controller that recognizes encoder feedback. Connect the stage as shown below.

5.1.2.1 Analog Encoder Wiring Diagram

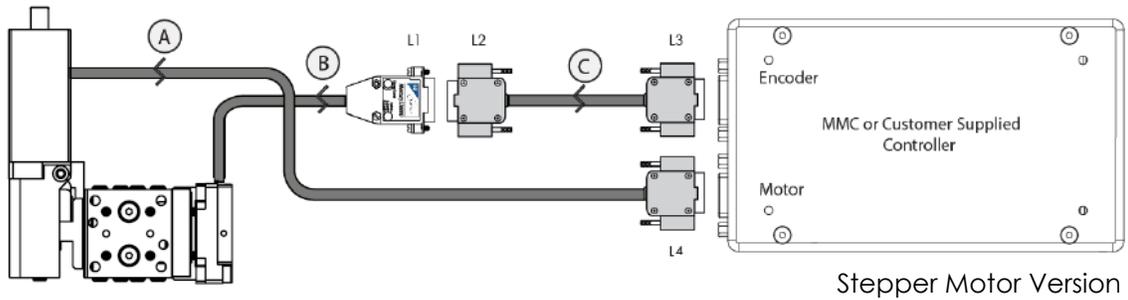


Stepper Motor Version

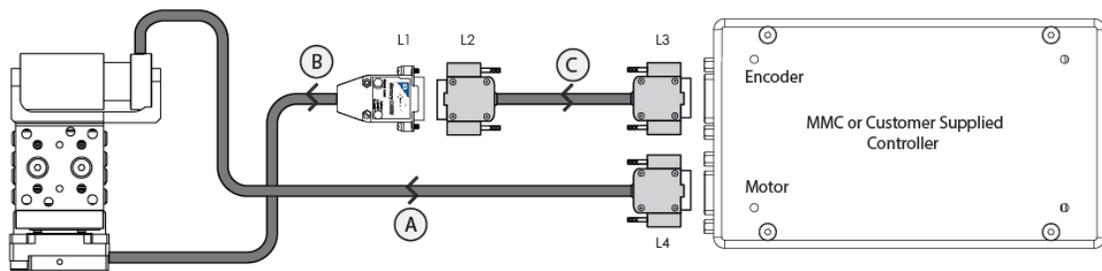


Linear Motor Version

5.1.2.2 MII 6000 Digital Encoder Wiring Diagram



Stepper Motor Version



Linear Motor Version

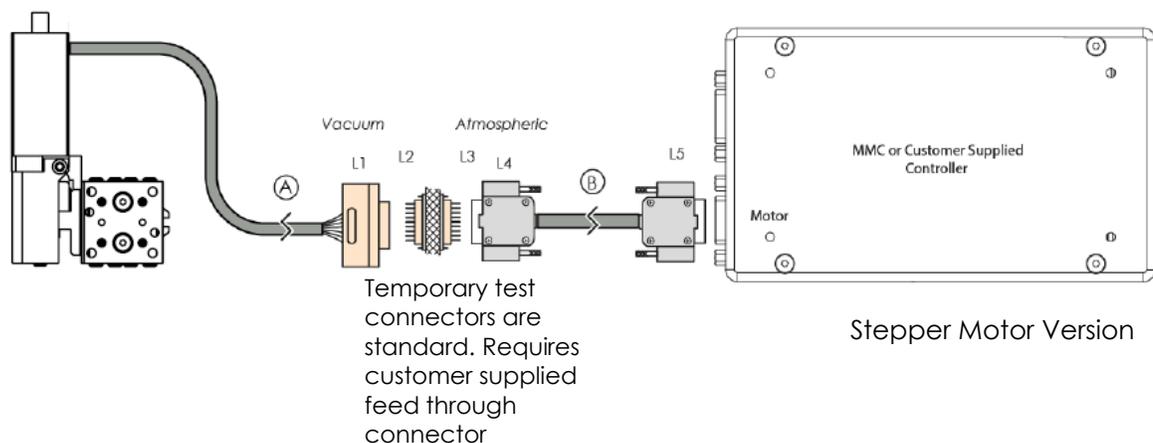
## 5.2 Vacuum Environments

### 5.2.1 Handling and Preparation

When preparing the stage for vacuum environments, take the necessary precautions (such as wearing gloves, clean room, clothing, etc.) when handling the stage as to avoid any contaminants. Maximum Bake-out temperature is 100°C. MICRONIX USA can supply the stage with vacuum compatible connectors: 9-pin female PEEK connector for open loop, 15-Pin female PEEK connector for closed loop with analog encoder, 25-pin female PEEK connector for closed loop with MII 6000 digital encoder.

### 5.2.2 Open loop Installation & Wiring Diagram

Connecting an open loop PPS-20 LMSM stage in a vacuum chamber requires the use of a feed through connector at the vacuum chamber wall. The vacuum compatible PPS-20 LMSM will be supplied with wiring for a straight through feed through, not a cross over gender changer. MICRONIX USA supplies test connectors that simulate the vacuum feed through to allow for functionality testing prior to installation in a vacuum chamber. For details regarding the pin-out and feed through specifications see the Appendix A.4. Note: Linear motor versions are not available for vacuum environments.

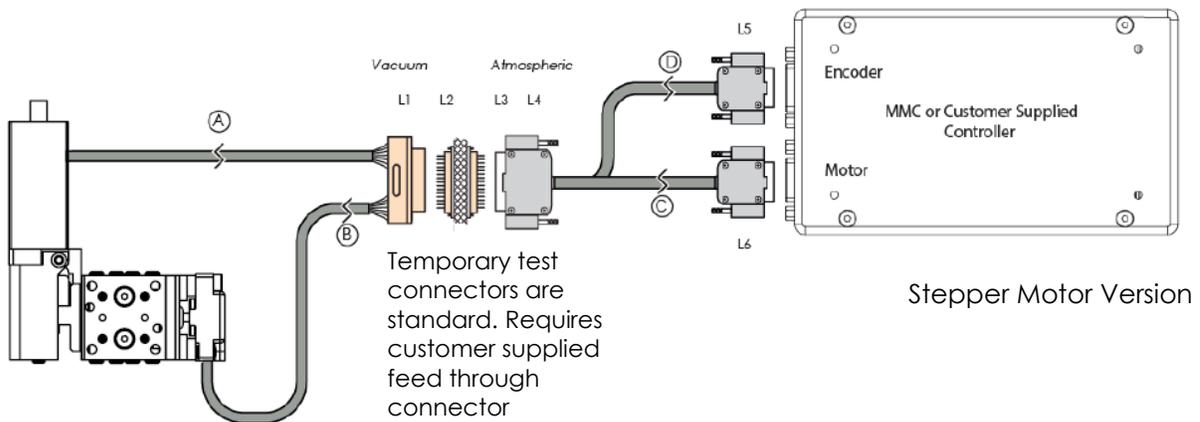


5.2.3 Closed Loop/Encoder Installation & Wiring Diagram

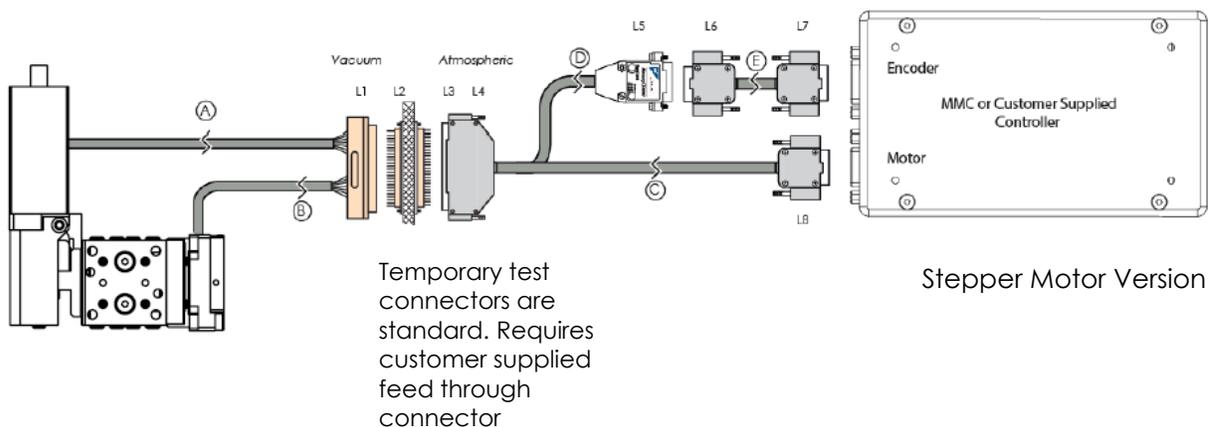
Closed loop installation of the PPS-20 LSM stage in vacuum environments requires an intermediate feed through connector at the vacuum chamber wall that can accommodate both the motor cable, and the encoder cable.

The vacuum compatible PPS-20 LSM stage will be supplied with wiring for a straight through feed through, not a cross over gender bender. MICRONIX USA supplies test connectors that simulate the vacuum feed through to allow for functionality testing prior to installation in a vacuum chamber. For details regarding the pin-out and feed through specifications see the Appendix A.5.7, A.6.5.

5.2.3.1 Analog Encoder Wiring Diagram



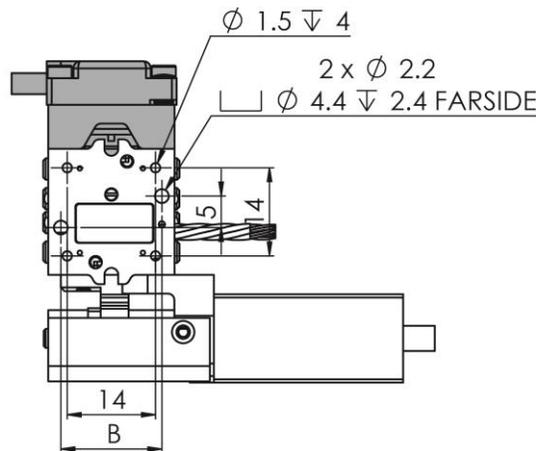
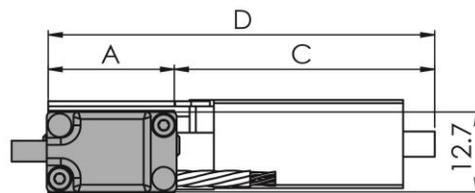
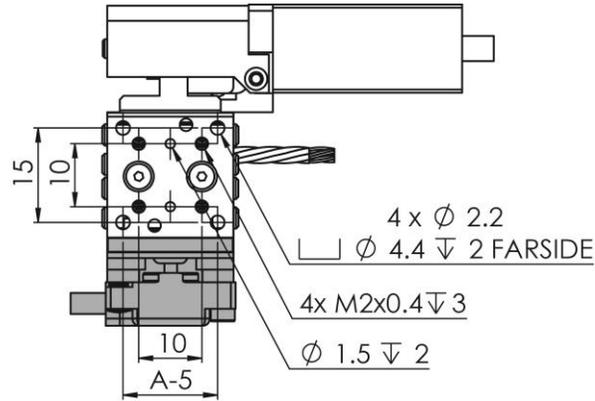
5.2.3.2 MII 6000 Digital Encoder Wiring Diagram



## 6. Technical Specifications

### 6.1 Dimensions

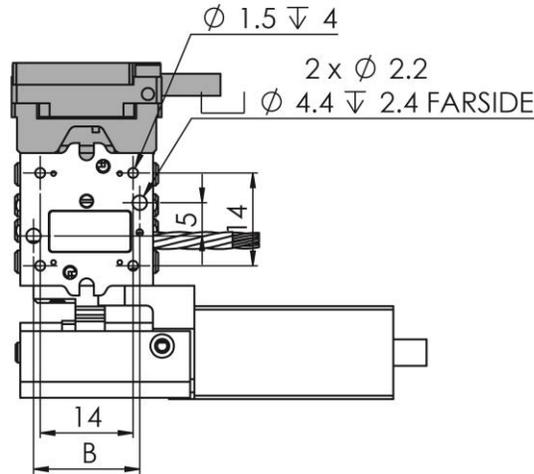
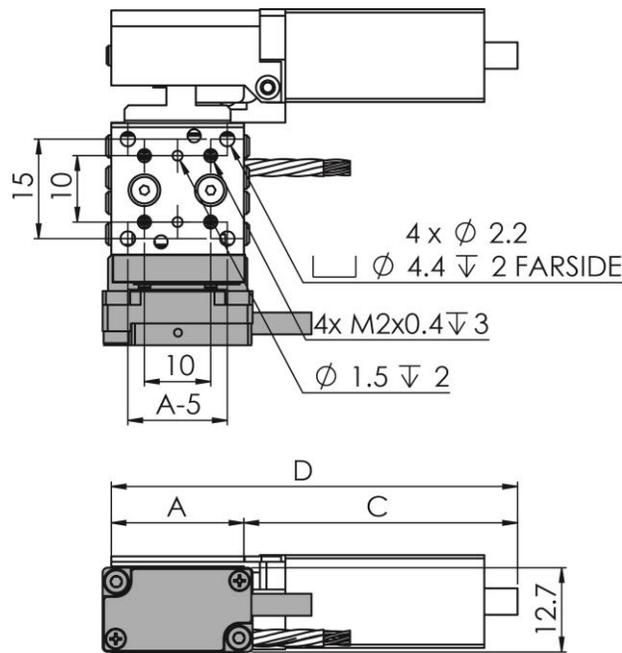
#### 6.1.1 PPS-20 Stepper Motor Analog Encoder



TRAVEL	A	B	C	D
12	20	16	41.3	61.3
18	30	16	41.3	72.1
26	40	36	35.7	75.8
51	80	50	32.1	110.7

\* Grey parts for external closed loop only

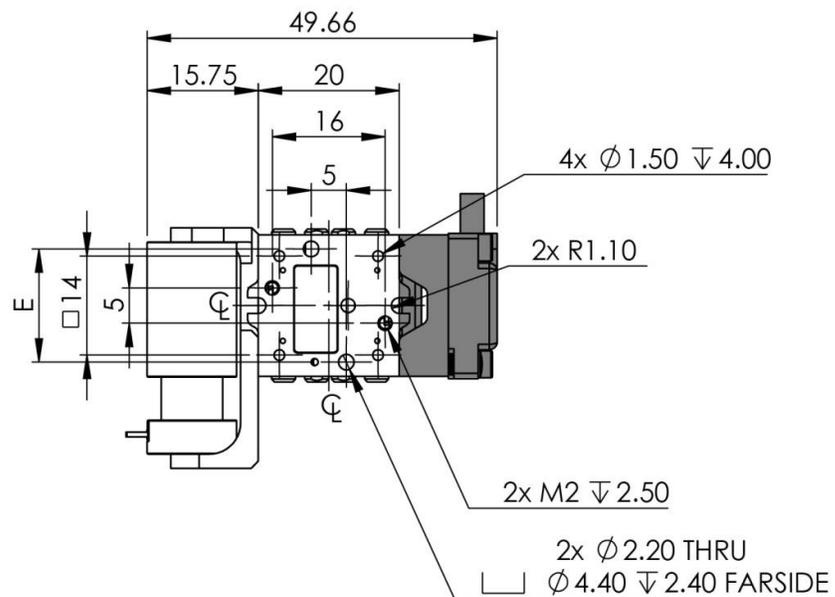
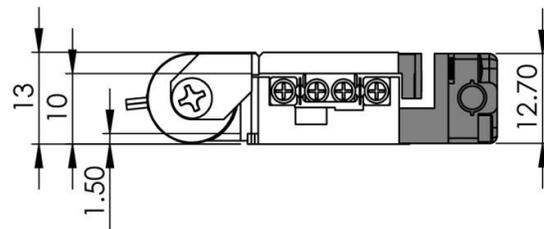
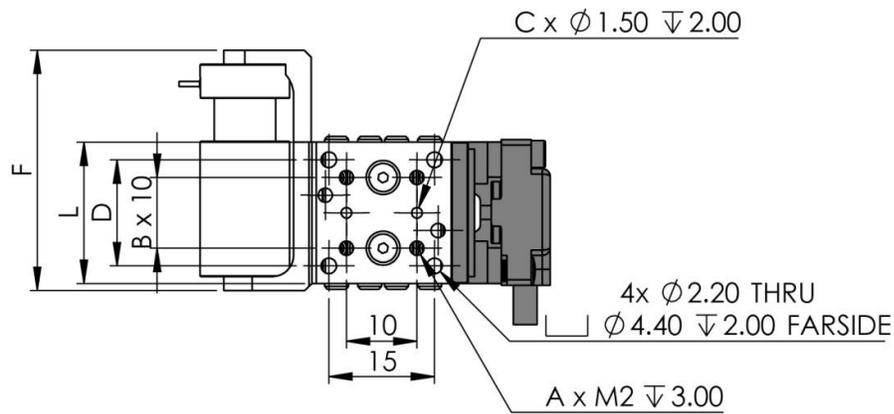
6.1.2 PPS-20 Stepper Motor MII 6000 Digital Encoder



TRAVEL	A	B	C	D
10	20	16	41.3	61.3
18	30	16	41.3	72.1
26	40	36	35.7	75.8
51	80	50	32.1	110.7

\* Grey parts for external closed loop only

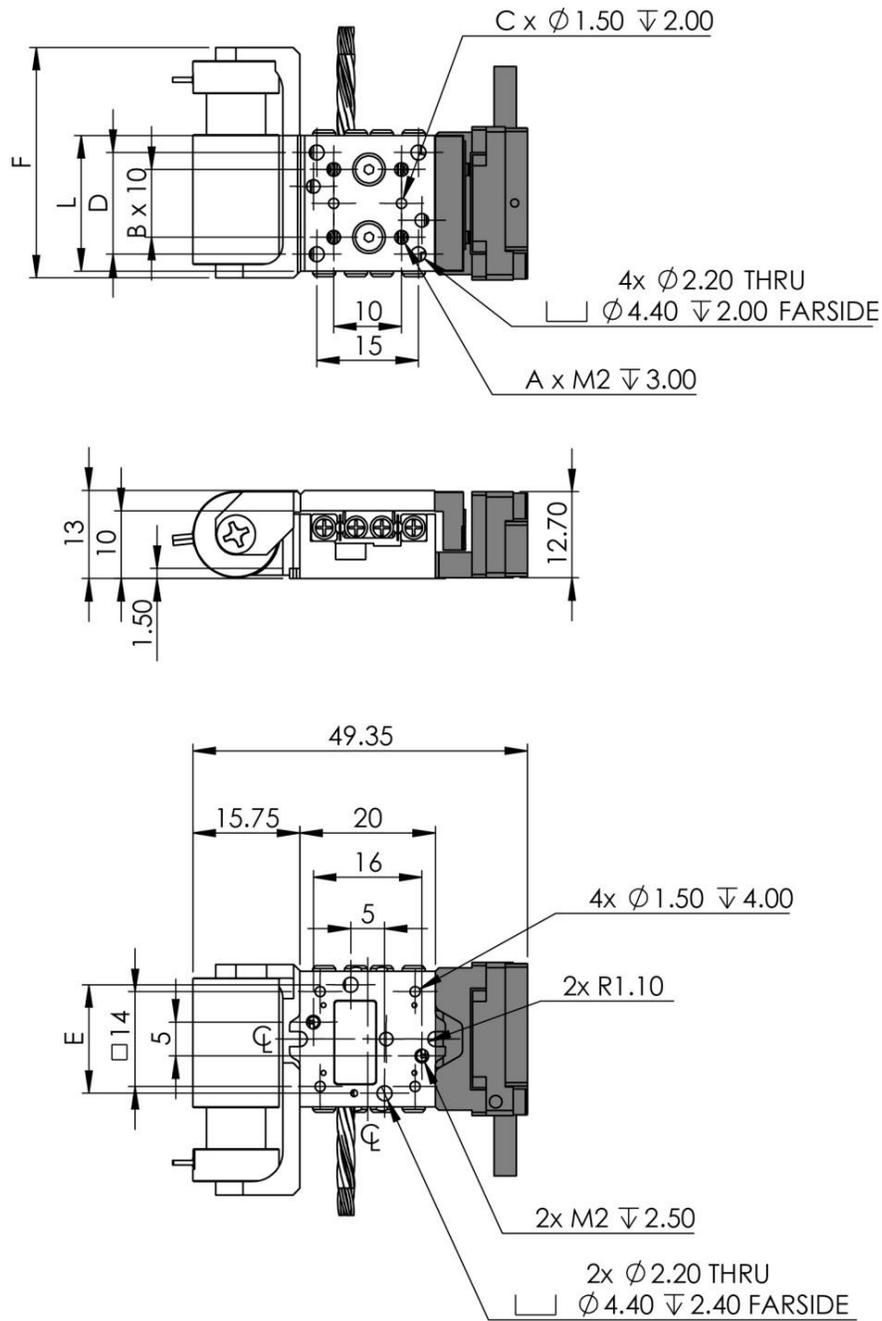
6.1.3 PPS-20 Linear Motor Analog Encoder



L	TRAVEL	A	B	C	D	E	F
20	11	6	1	2	15	16	40
30	18	6	1	2	25	16	54.5
40	25	10	3	6	35	36	66.8

\* Grey parts for external closed loop only

6.1.4 PPS-20 Linear Motor MII 6000 Digital Encoder



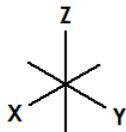
L	TRAVEL	A	B	C	D	E	F
20	11	6	1	2	15	16	40
30	18	6	1	2	25	16	54.5
40	25	10	3	6	35	36	66.8

\* Grey parts for external closed loop only

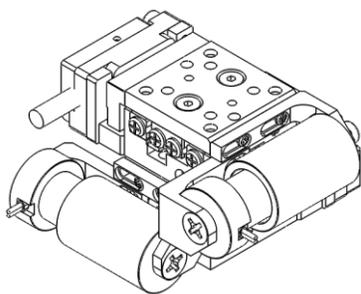
## 7. Stacking Configurations

### 7.1 Configuration Examples (Additional Configurations available upon request)

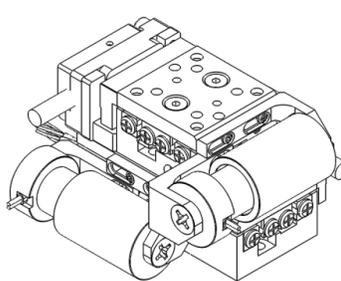
- Additional configurations available upon request
- Note: Stacking compatibility for all motor configurations.
- Positioning according to:



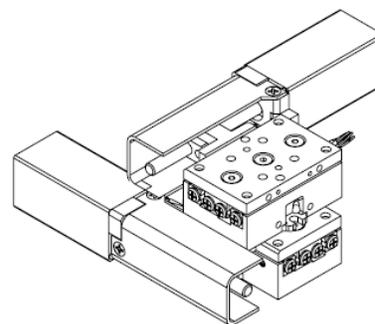
#### No Adapters



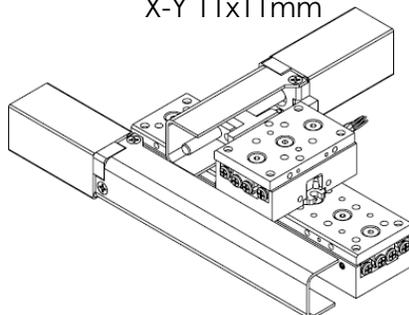
X-Y 11x11mm



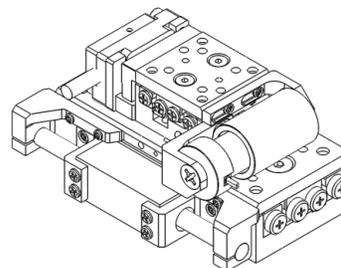
X-Y 11x25mm



X-Y 18x18mm

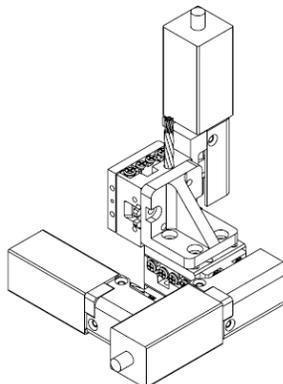


X-Y 51x18mm



X-Y 26x11mm  
[with PPS-28 Linear Stage]

#### Using Adapter Plate (P/N: 430509)



X-Y-Z 12x12x12mm  
[3 PPS-20 SM Stages]

## 8. Supplementary Information

### 8.1 Maintenance

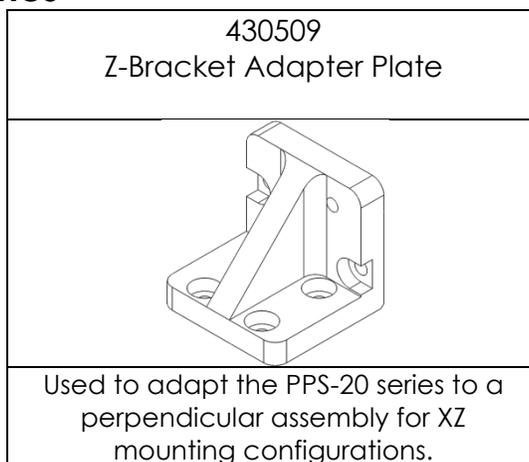
- The PPS-20 LMSM stage is a precision mechanical device and should be handled with care. Do not drop or mishandle the stage.
- Do not touch the bearings, as this will contaminate the lubrication and jeopardize the longevity of the stage.
- Follow the *Installation Preparation* requirements and use proper cable management to ensure a clean and safe operating environment.
- Allow for easy access to the stage in case of servicing.

### 8.2 Units and Conventions

All measurements in this document are in the metric system of units.

Metric Unit	English Unit
1 millimeter	0.0394 inches
1 micron	0.0000394 inches
1 Newton	0.2248 lbs
1 Newton-meter	8.85 in-lbs

### 8.3 Accessories



## A. Appendix

### A.1 Stepper Motor

#### A.1.1 Standard Atmospheric DB-9 Male Motor Connector

Stepper Motor		
Pin	Function	Wire Color
1	Motor A+	Yellow
2	Motor A-	Green
3	Motor B+	Black
4	Motor B-	Red
5	N/A	N/A
6	Limit Switch+	Violet
7	Limit Switch-	Blue
8	+5V	Orange
9	Ground	Brown

#### A.1.2 Stepper Motor Specifications

Stepper Motor	
Motor Type	2 Phase Bipolar
Phase Current	0.3 A Max
Step Angle	1.8°
Full steps per Rev	200
Coil-Resistance	21 Ohms
Coil-Inductance	4.2 mH
Holding Torque	6.5 mHm
Pitch	0.5 mm/rev
Resolution/Full step	2.5 μm

## A.2 Linear Voice-Coil Motor

### A.2.1 Standard Atmospheric DB-9 Male Motor Connector

Linear Motor		
Pin	Function	Wire Color
1	Negative (-)	Black
2	Positive (+)	Red
3	N/A	N/A
4	N/A	N/A
5	N/A	N/A
6	Limit Switch+	Violet
7	Limit Switch-	Blue
8	+5V	Orange
9	Ground	Brown

### A.2.2 Linear Motor Specifications

#### Linear Motor - 11mm Version

Intermittent Force @10% Duty Cycle	2.55 N	9.2 oz
Continuous Force	0.81 N	2.9 oz
Force Constant	0.77 N/A	2.8 oz/A
Back EMF Constant	0.77 V/m/s	0.020 V/in/s
Stroke	12.7 mm	0.50 in
Coil Clearance Per Side	0.33 mm	0.013 in
Coil Assy Mass	6.4 gr	0.23 oz
Body Mass	10.6 gr	0.37 oz
Coil Resistance	3.2 Ohms	
Coil Inductance @120 Hz	0.5 mH	
Max Continuous Power	3.5 W	

#### Linear Motor - 18mm Version

Intermittent Force @10% Duty Cycle	2.51 N	9.0 oz
Continuous Force	0.79 N	2.9 oz
Force Constant	0.80 N/A	2.9 oz/A
Back EMF Constant	0.80 V/m/s	0.020 V/in/s
Stroke	19.1 mm	0.75 in
Coil Clearance Per Side	0.33 mm	0.013 in
Coil Assy Mass	9.0 gr	0.32 oz
Body Mass	13.8 gr	0.49 oz
Coil Resistance	4.6 Ohms	
Coil Inductance @120 Hz	0.7 mH	
Max Continuous Power	4.5 W	

**Linear Motor - 25mm Version**

Intermittent Force @10% Duty Cycle	2.20 N	7.9 oz
Continuous Force	0.70 N	2.5 oz
Force Constant	0.76 N/A	2.7 oz/A
Back EMF Constant	0.76 V/m/s	0.019 V/in/s
Stroke	25.4 mm	1.000 in
Coil Clearance Per Side	0.33 mm	0.013 in
Coil Assy Mass	10.8 gr	0.38 oz
Body Mass	17 gr	0.60 oz
Coil Resistance	5.9 Ohms	
Coil Inductance @120 Hz	1.0 mH	
Max Continuous Power	5.0 W	

### A.3 Magnetic (Hall Effect) Limit Switches

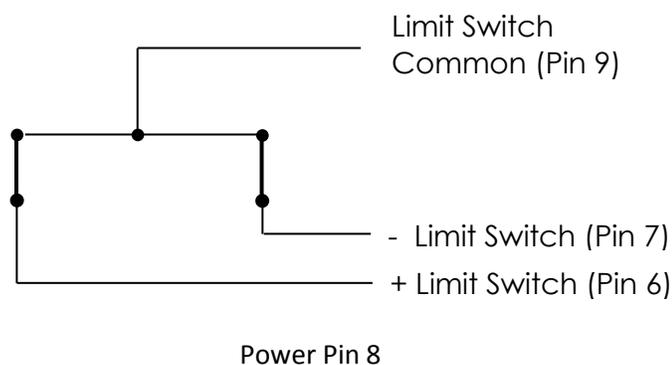
Hall Effect transistor switches are activated in the presence of a magnetic field. These switches feature a highly repeatable operation, remote sensing non-contacting operation, broad temperature range (-40 to +150°C), and exceptionally long life.

The hall effect limit switches are factory calibrated to ensure advertised travel length and cannot be adjusted by the customer.

#### A.3.1 Hall Effect Limit Switches

Supply Voltage	3 - 12 VDC
Supply Current	< 5 mA
Output Configuration	Open Collector
Max Sink Current	20 mA
Contact Rating	100 mA @ 30 V
Contact Type	Open Collector (NPN) Normally Closed
Operating Temperature	-40 to +150 °C

#### A.3.2 Limit Switch Schematic



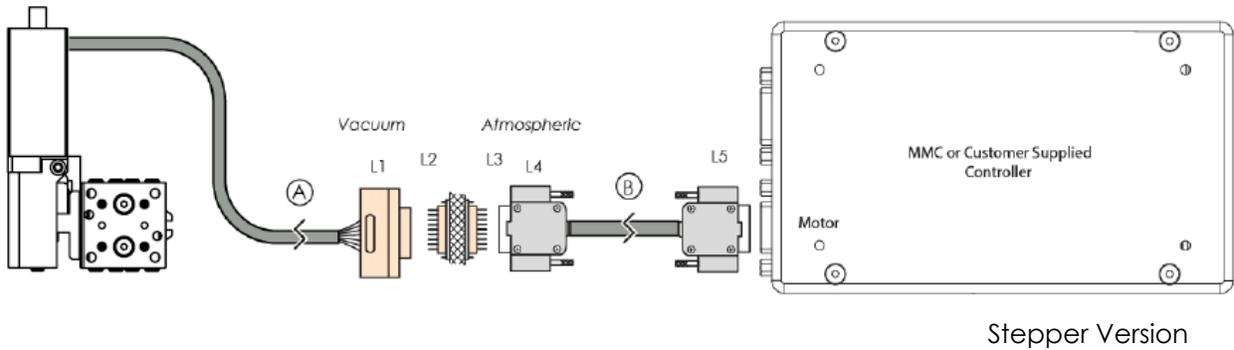
### A.4 Open Loop Vacuum Wiring Diagram

**Standard Cable Descriptions:**

A. PPS-20 Motor Cable - Vacuum Side (Female Dsub 9 Pin Peek Connector, 1.5m)

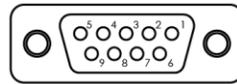
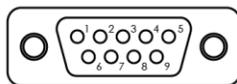
B. Atmospheric Motor Connector (Female Dsub 9 Pin to Male Dsub 9 Pin, 1.5m)

**Wiring Diagram:**



**Stepper Motor Connector Pinout**

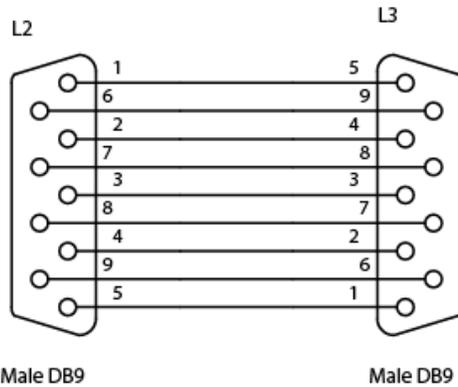
Description	Color	L1	L2	L3	L4	L5
Motor Phase A+	Yellow	5	5	1	1	1
Motor Phase A-	Red	4	4	2	2	2
Motor Phase B+	Blue	3	3	3	3	3
Motor Phase B-	Orange	2	2	4	4	4
Shield	-	1	1	5	5	5
Limit Switch +	Violet	9	9	6	6	6
Limit Switch -	Blue	8	8	7	7	7
+5V	Orange	7	7	8	8	8
Limit Ground	Brown	6	6	9	9	9



Female Dsub9 Connector - Rear View      Male Dsub9 Connector - Rear View

#### A.4.1 Straight Through 9-Pin Feed Through

**A.5 Using**



**an Analog Encoder**

**A.5.1 Analog Encoder Overview**

A PPS-20 LMSM stage with Analog encoder will need to be paired with an appropriate controller. MMC controllers has an Analog option. The PPS-20 LMSM stage with internal Analog encoder will be supplied with a 15-pin connector that incorporates both motor and encoder signals.

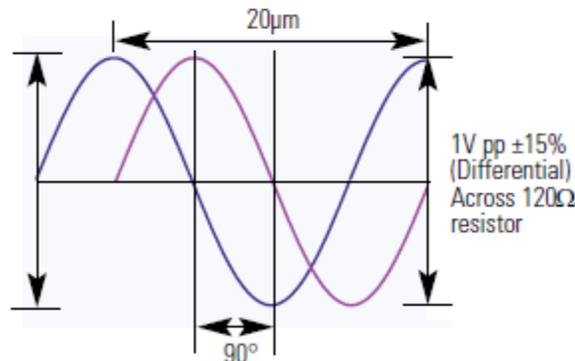
**A.5.2 Encoder Pin-Out**

Pin	Color	Description
1	Brown	Cos+
2	Yellow	Sin+
3	Violet	Index +
4	Black	Ground
5	Red	+5V
6	Orange	Cos-
7	Green	Sin-
8	Blue	Index -
9	Not in Use	Not in Use

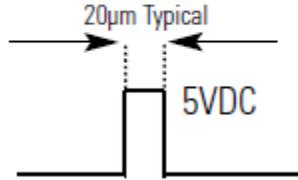
**A.5.3 Operating and Electrical Specifications**

Power Supply	5VDC $\pm$ 5% @ 330mA (60mA for sensor)
Operating Temperature	0 to 70°C
Humidity	10 - 90% RH non-condensing

**A.5.4 Analog Output (Pins 1,2,6 and 7)**



**A.5.5 Index Window (Pins 3)**



**A.5.6 Resolution**

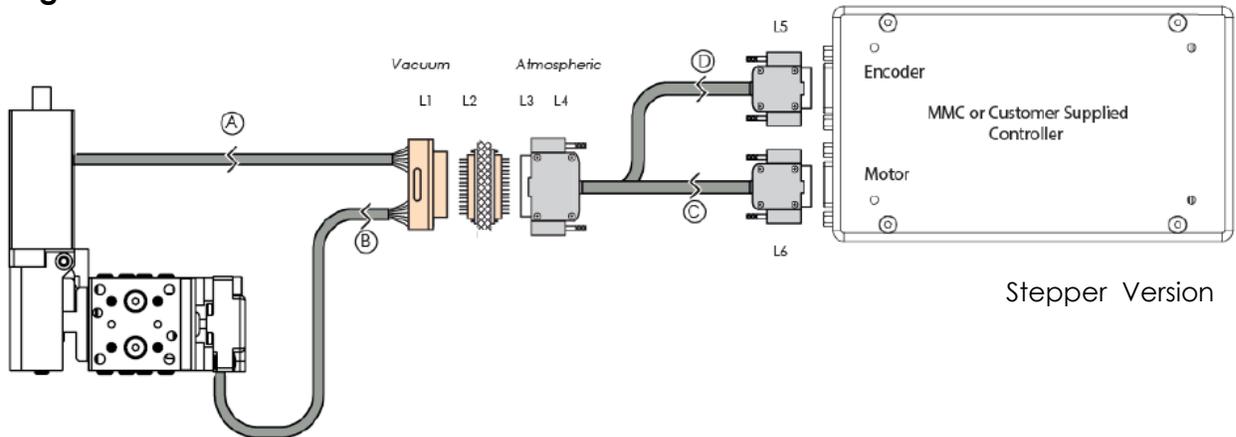
All closed loop stages are supplied with 20µm scales. The interpolation is done in an MMC controller to a higher resolution as specified in the order. With an analog encoder the MMC controller has an achievable resolution of 10nm.

**A.5.7 Analog Encoder Wiring Diagram**

**Standard Cable Descriptions:**

- A. PPS-20 Motor Cable - Vacuum Side
  - B. PPS-20 Encoder Cable - Vacuum Side
  - C. Atmospheric Motor Connector (Female Dsub 25 Pin to Male Dsub 9 Pin)
  - D. Atmospheric Encoder Module (Female Dsub 25 Pin to Female Dsub 9 Pin)
- (Female Dsub 25 Pin Peek Connector)

**Wiring Diagram:**

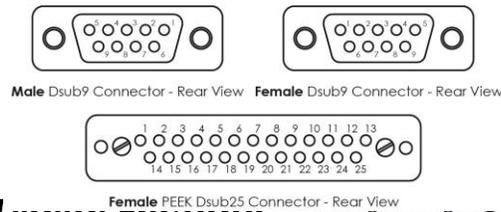


Stepper Version

**Stepper Motor Connector Pinout**

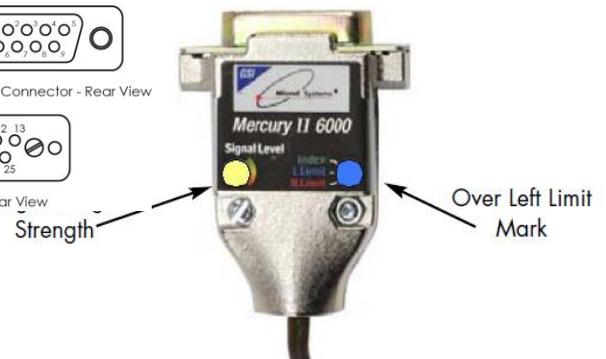
Description	Color	L1	L2	L3	L4	L5	L6
Motor B-	Orange	1	1	13	13 (Brown)		4
Ground	Brown	14	14	25	25 (Black)		9
Motor B+	Blue	2	2	12	12 (White - Brown TP)		3
+5V	Orange	15	15	24	24 (Red)		8
Motor A-	Red	3	3	11	11 (Green)		2
Limit +	Blue	16	16	23	23 (White - Violet TP)		7
Motor A+	Yellow	4	4	10	10 (White - Green TP)		1
Limit -	Violet	17	17	22	22 (Violet)		6
Shield	-	5	5	9	9 (Shield)		Casing
Enc Shield	-	8	8	6	6 (Shield)	Casing	
+5V	Red	10	10	4	4 (Red)	5	
Ground	Black	22	22	17	17 (Black)	4	
Cos+	Brown	11	11	3	3 (Brown)	1	
Cos-	Orange	23	23	16	16 (White - Brown TP)	6	
Sin+	Yellow	12	12	2	2 (Yellow)	2	
Sin-	Green	24	24	15	15 (White - Yellow TP)	7	
Index+	Violet	13	13	1	1 (Violet)	3	





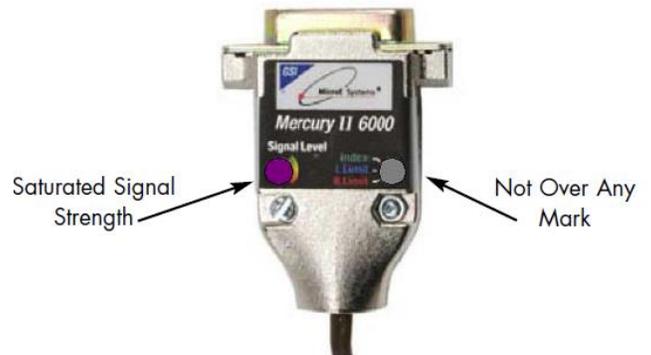
### A.6 Using the Digital Encoder Module

When using the digital external encoder configuration, the Encoder Module should display two green LED's indicating a power source and proper encoder alignment. A Red or Yellow Signal Level LED indicates misalignment of the Encoder Head, if this occurs contact MICRONIX USA. Do not adjust the Encoder Head or scale. For more information refer to MicroE Systems Mercury Encoders.



#### A.6.1 Encoder Module Pin-out

Pin	Description	Pin	Description
1	*Right Limit+	9	Ground
2	Ground	10	*Left Limit+
3	*Right Limit-	11	*Left Limit-
4	Index-	12	Index+
5	B-	13	B+
6	A-	14	A+
7	+5V	15	(not used)
8	+5V		



\*Limits must be specified at the time of order and calibrated at the factory.

Note: Tri-state alarm: A and B are tri-stated if the encoder signal becomes too low for reliable operation.

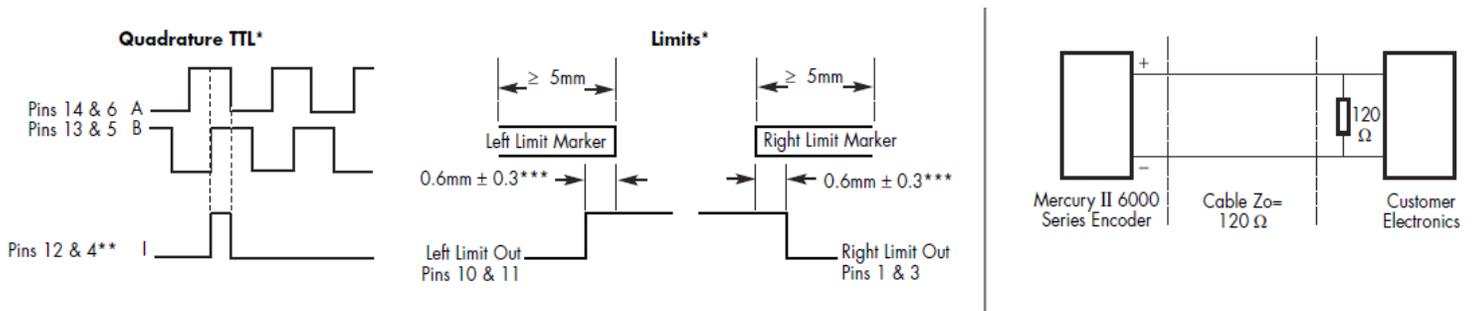
### Normal Operation



### A.6.2 Operating and Electrical Specifications

Power Supply	5VDC $\pm 5\%$ @ 140mA (No outputs terminated) @ 180mA (A, B, I, and both limits terminated); 50mA at the sensor
Operating Temperature	0 to 70°C
Humidity	10 - 90% RH non-condensing

### A.6.3 Output Signals & Signal Termination for A quad B, Index and limits



\*Output signals are differential. Inverse signals are not shown for clarity.

\*\*Note: At some interpolations values the index pulse may be aligned with other states of A or B than the ones shown.

\*\*\*Above are with reference to the sensor's optical centerline

### A.6.4 Resolution

All closed loop stages are supplied with 20 $\mu$ m scales. The digital encoder module interpolates to a higher resolution as specified in the order. With a digital encoder an MMC controller has an achievable resolution of 2nm.

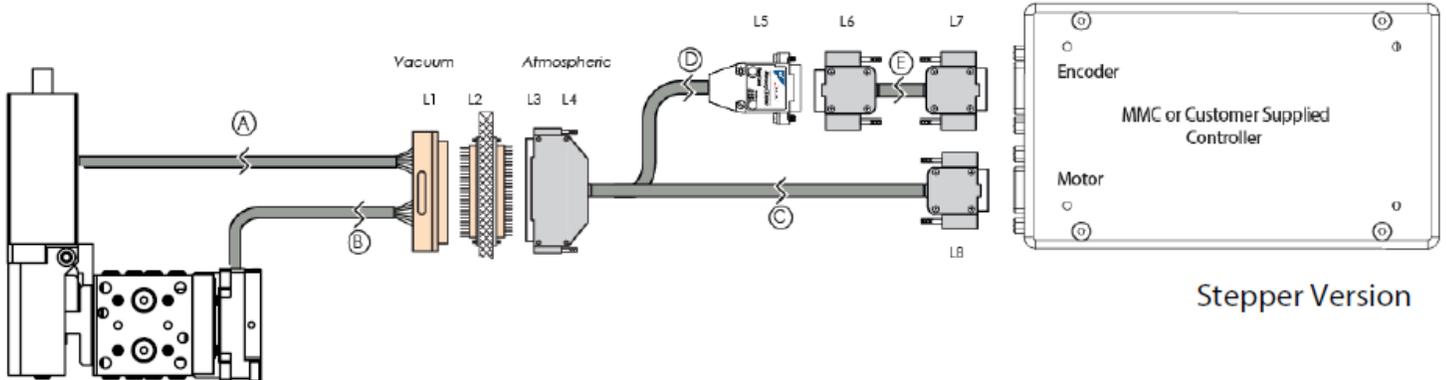


### A.6.5 MII 6000 Digital Encoder Wiring Diagram

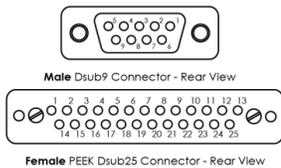
#### Standard Cable Descriptions:

- A. PPS-20 Motor Cable - Vacuum Side > (Female Dsub 25 Pin Peek Connector, 1.5m)
- B. PPS-20 Encoder Cable - Vacuum Side >
- C. Atmospheric Motor Cable (Female Dsub 25 Pin to Male Dsub 9 Pin, 1.5m)
- D. Atmospheric Encoder Module Cable (Female Dsub 25 Pin to MII 6000 Interpolator Module, 1m)
- E. Encoder Module Adapter Cable (Female Dsub 15 to Female Dsub 9 Pin, 0.5m)

#### Wiring Diagram:



Stepper Version



Description	Color	L1	L2	L3	L4	L8
Motor B-	Orange	1	1	13	13 (Brown)	4
Ground	Brown	14	14	25	25 (Black)	9
Motor B+	Blue	2	2	12	12 (White - Brown TP)	3
+5V	Orange	15	15	24	24 (Red)	8
Motor A-	Red	3	3	11	11 (Green)	2
Limit +	Blue	16	16	23	23 (White - Violet TP)	7
Motor A+	Yellow	4	4	10	10 (White - Green TP)	1
Limit -	Violet	17	17	22	22 (Violet)	6
Shield	-	5	5	9	9 (Shield)	Casing
+5V DC	Red	8	8	6	6 (Red)	
GND	Black	20	20	19	19 (Black)	
DCLK-	Gray	9	9	5	5 (Gray)	
DCLK+	White - Gray TP	21	21	18	18 (White - Gray TP)	
MISO-	Violet	10	10	4	4 (Violet)	
MISO+	White - Violet TP	22	22	17	17 (White - Violet TP)	
MOSI-	Blue	11	11	3	3 (Blue)	
MOSI+	White - Blue TP	23	23	16	16 (White - Blue TP)	
nSS-	Green	12	12	2	2 (Green)	
nSS+	White - Green TP	24	24	15	15 (White - Green TP)	
CLK-	Brown	13	13	1	1 (Brown)	
CLK+	White - Brown TP	25	25	14	14 (White - Brown TP)	
Shield	-	7	7	7	7 (Shield)	



◆ Note: For the pinout of cable E, refer to the appropriate MMC manual.

A.6.6 Straight Through 25-Pin Feed Through

