Celera MOTION | MicroE Encoders

Mercury II™ 5000 Series Encoders

Sensor Installation Manual and Reference Guide

>CELERAMOTION

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Table of Contents

1.0 Introduction

1.1 Overview

The instructions in this manual apply to the following Mercury II 5000 Series Encoders:

- MII5500
- MII5700
- MII5800
- MII5800Si
- MII5800Pa

Refer to the Mercury II 5000 Series Encoder data sheet for additional details on ordering parts.

1.2 Precautions

1. Follow standard ESD precautions. Turn **power to off** before connecting the sensor.
2. **Do not touch** electrical pins without static protection such as a grounded wrist strap.

1.3 Laser Safety Information

This product is sold solely for use as a component (or replacement) in an electronic product; therefore, it is not required to, and does not comply with U.S. FDA **21 CFR 1040.10** and **1040.11** which pertain to complete laser products. The manufacturer of the complete system-level electronic product is responsible for complying with 21 CFR.

MicroE Systems encoders contain an infrared laser diode or diodes. Emitted invisible laser radiation levels have been measured to be within the **CDRH Class 1** range, which is not considered hazardous; however, to minimize exposure to the diverging beam, install the **encoder sensor in its operational configuration in close proximity to the encoder scale before applying power**.

- Invisible laser radiation; wavelength: 850 nm.
- Maximum power of 4.8 mW CW for Mercury II.
- **Caution**: The use of optical instruments with this product will increase eye hazard. **Do not** view directly with optical instruments (microscopes, eye loupes, or magnifiers).
- All maintenance procedures such as cleaning must be performed with the MicroE encoder turned **off**.
- **Do not** insert any reflective surface into the beam path when the encoder is powered.
- **Do not** attempt to service the MicroE encoder.

1.4 Standards Compliance

Mercury II models are CE and RoHS compliant.

1.5 Related Documentation

- Mercury II 5000 Series Encoders Data Sheet
- Mercury II 5000 Series Encoders Interface Drawings
- Mercury II PurePrecision Tape and Glass Scales Installation Manual and Reference Guide

1.6 Manual Revisions

Version	Date	Notes
Rev. 1	11/21/2014	Initial Release. Combines coverage for entire series of Mercury II 5000 Series Encoders.
Rev. 1a	11/30/2015	Correction on page 30: changed A6 to A^6 for CRC Bits section. Updated document to Celera Motion standards. Updated Manual Revisions table.

1.7 Trademarks

Mercury II™, PurePrecision™, and SmartPrecision™ are trademarks of MicroE Systems®.

1.8 Special Conventions Used

The following symbols *may* be used in this document.

Symbol	Description
	Warning or caution: potential damage to parts.
	Instructions show correct method.
	Instructions show example of incorrect method.
See Section 2.2	Single click with the mouse on these highlighted references to jump to specified places in instructions.

2.0 Before Installation

Review the items in this section prior to installing the encoder.

2.1 Power Recommendations

- Mercury II encoders require a minimum of 4.75 VDC continuously.
- When designing circuits and extension cables to use Mercury II encoders, be sure to account for voltage loss over distance and tolerances from the nominal supply voltage so that at least 4.75 VDC is available to the Mercury II encoder under all operating conditions.
- The input voltage should not exceed 5.25 VDC.

2.2 Installation Considerations

The Mercury II encoder is a precision electronic instrument. It has been designed to function in a wide range of applications and environments. To take full advantage of the Mercury II modular system design, considerations should be made to allow easy access to the sensor (and interpolator modules where applicable) for service and/or replacement. For optimal performance and reliability:

- DO follow standard ESD precautions while handling the sensor and interpolator.
- DO allow proper clearance for sensor head alignment.
- DO follow setup and calibration instructions for the encoder system.
- DO, where possible, install the scales in an inverted or vertical position to minimize accumulation of dust.
- DO NOT store sensors in an uncontrolled environment.
- DO NOT electrically overstress the sensor (power supply ripple/noise).
- DO NOT intentionally “hot swap” the sensor if the device is energized.
- DO NOT use in high contamination applications (dust, oil, excessive humidity, or other airborne contaminants).

2.3 Items Required for Installation

In addition to the items identified in the ***Section 3.0 System Overview,*** you will need the following items available for installation:

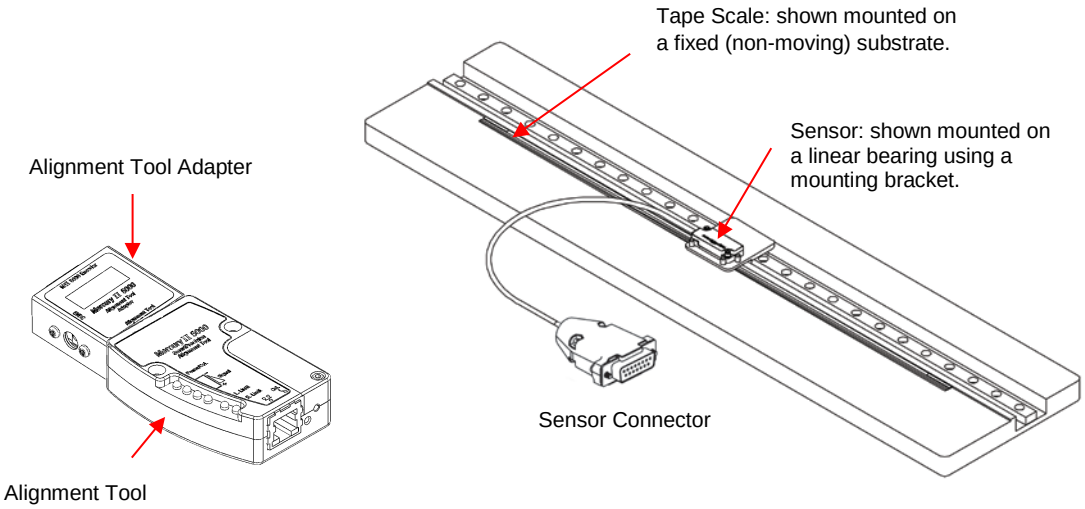
Items Required for Installation		
Item	**Tape Scale**	**Glass Scale**
Index and Limit Marker sheets	√	√
Hex Wrench for Sensor Mounting Screws	√	√
Finger Cots or talc-free gloves	√	√
Acetone or isopropyl alcohol	√	√
Lint-free cotton cloths or wipes	√	√
Two-part epoxy (Tra-Bond 2116 or equivalent)	√	√
Stick and disposable surface for stirring epoxy	√	√
Shears	√	
Tape Applicator Tool*	√	
Silicone adhesive		√

Note*: Not required for some installations.

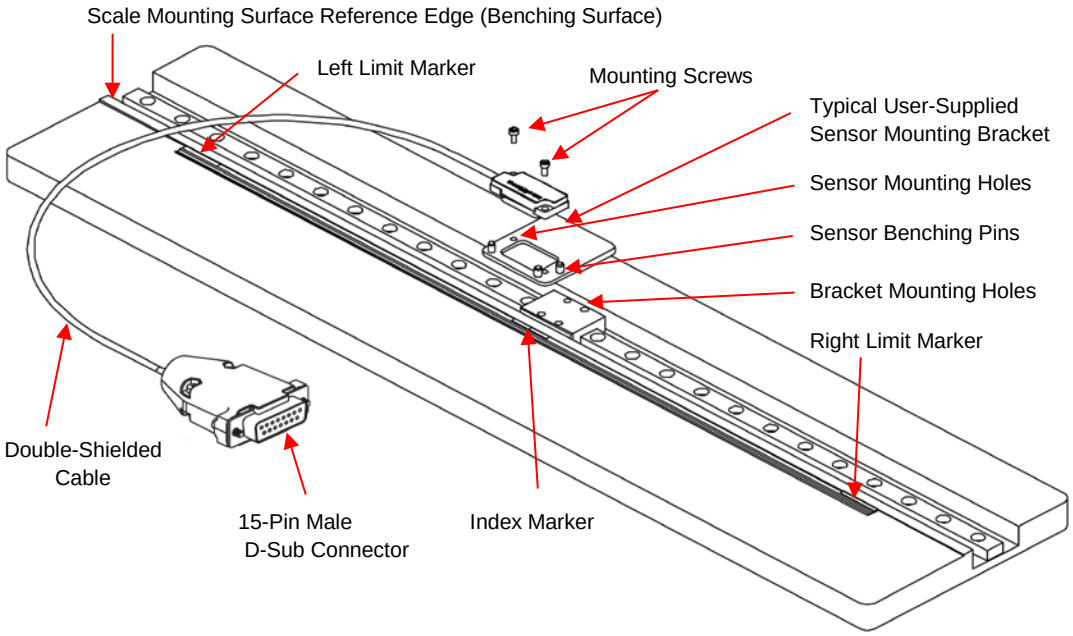
3.0 System Overview

This section identifies parts for the sensor installation.

3.1 System View



3.2 Expanded View

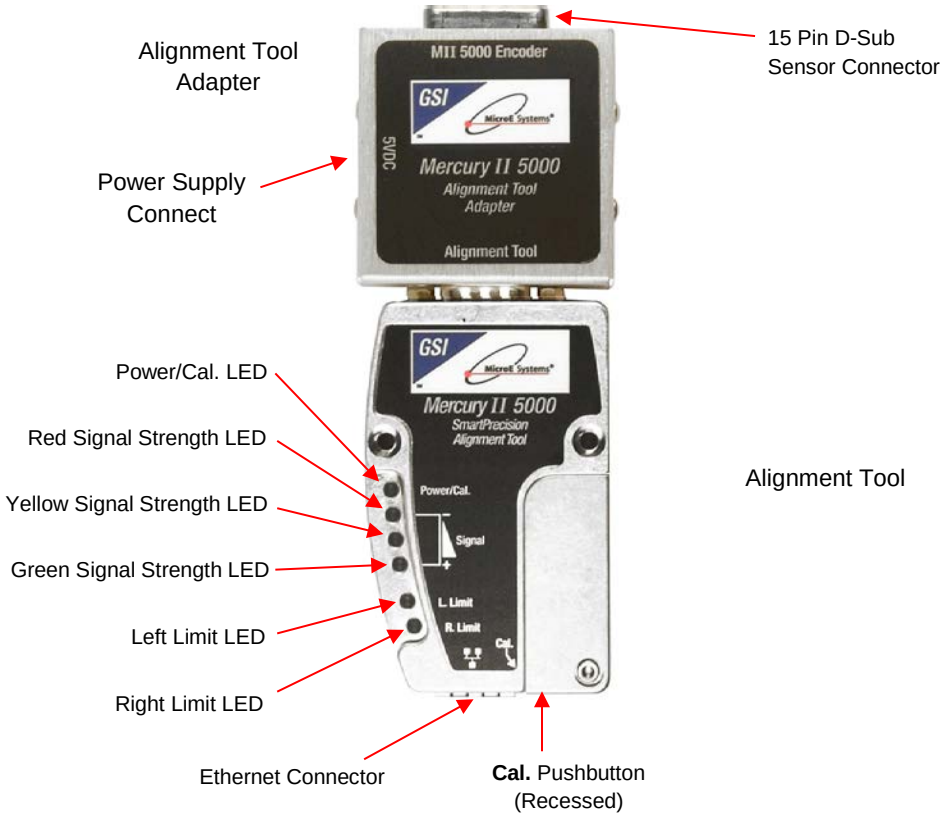


3.3 SmartPrecision Alignment Tool

The Mercury II ATMII5000 SmartPrecision Alignment Tool is required for aligning the Mercury II 5000 Series Encoders. The Alignment Tool includes the following:

- Alignment Tool
- SmartPrecision II Software
- USB Cable
- Power Supply

For more details, see ***Sensor Installation Tools*** in ***Section 7.0 Order Guide*** for more details.



Mercury II 5000 Alignment Tool LEDs	
LED	**Function**
Power/Cal.	Indicates power is on and when encoder is in Alignment Mode
Red Signal Strength	Indicates improper alignment
Yellow Signal Strength	Indicates improved alignment
Green Signal Strength	Indicates proper alignment
Left Limit	Blinks in Alignment Mode and when sensor is located over left limit
Right Limit	Blinks in Alignment Mode and when sensor is located over right limit

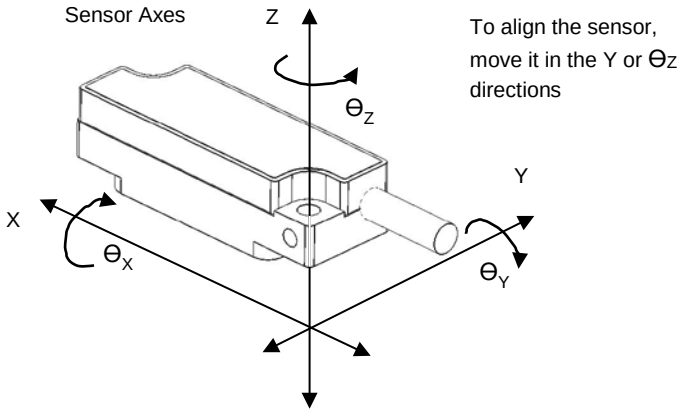
4.0 Sensor Installation

This section contains instructions for installing the sensor.

4.1 Sensor Mounting Orientation and Tolerances

Refer to the following specifications when installing and aligning the Mercury II 5000 encoder.

Orientation



Tolerances

Mercury II 5000 Sensor Alignment Tolerances	
Axis	**Alignment Tolerance**
X	Direction of Motion
Y	± 0.20 mm
Z	± 0.15 mm
θX	± 1.0°
θY	± 1.0°
θZ	± 2.0°

4.2 Verify Sensor Mounting Surface Height

Step	Action
1.	Verify that the vertical distance between the reference surface of the sensor and the top of the scale is as follows: • Tape scale/marker tape after blue protective film is removed: 3.09 mm +/-0.13 • Linear or rotary glass scales: 2.93 mm +/-0.13 **Note**: Use MicroE's Z-axis Height Gauges to easily verify this distance: • Blue Gauge - for use with tape scales (Part Number 409-00196) • White Gauge - for use with linear and rotary glass scales (Part Number 409-00197)
2.	Use the correct gauge to check that there are no gaps between: • The mounting surface of the gauge and the mounting bracket, or • The bottom surface of the gauge and the scale
3.	Check the height at a location on the scale where there are no index or limit markers.

4.3 Install Sensor

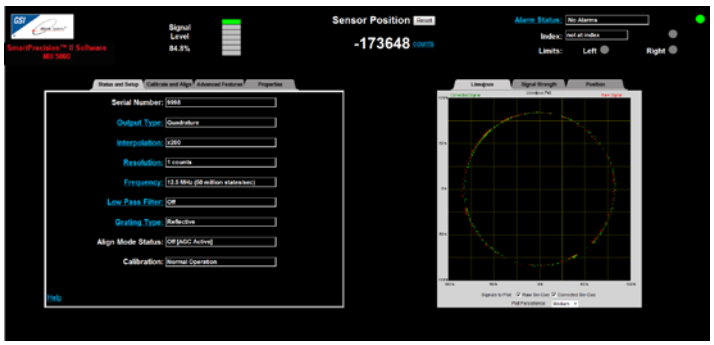
Step	Action
1.	Install the sensor on the mounting surface referencing the appropriate datum surface as shown in the MII5000 Interface Drawings. Use two M-2 screws to **loosely** attach the sensor. **Note**: Do not tighten the two M2 screws at this time.
2.	Use benching pins to locate the sensor if the system's mechanical tolerances are adequate. Refer to MII5000 Interface Drawings for recommended locations and heights of pins.

5.0 Sensor Alignment and Calibration

After installing the MII5000 encoder, use the SmartPrecision Alignment Tool ATMII5000 to align and calibrate the sensor using one of the following methods:

- Calibration (**Cal**) Pushbutton: if you don't have access to a computer or are very experienced at performing encoder alignment and calibration.
- SmartPrecision II Software: if you have access to a computer and either are new at performing encoder alignment and calibration or want to take advantage of the graphic interface.

Select a method:

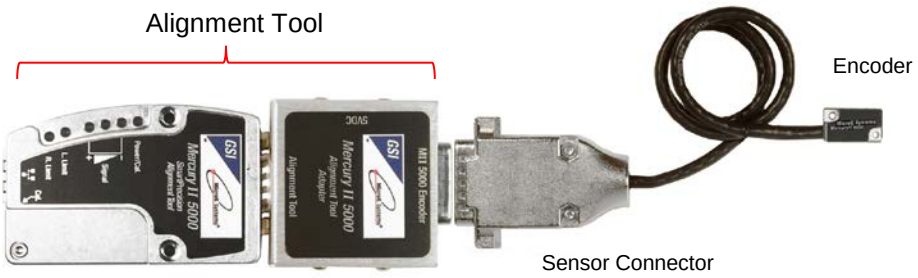
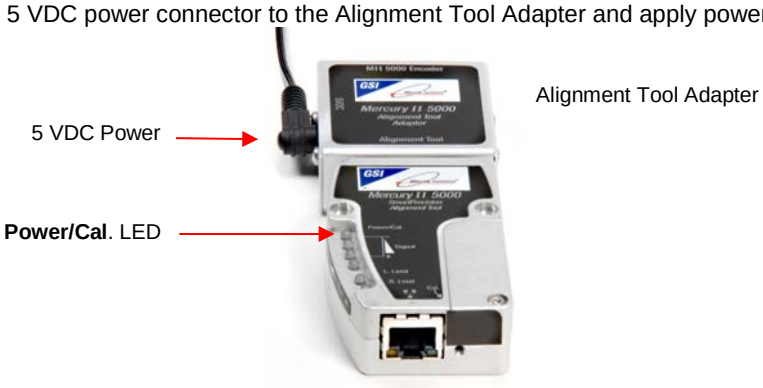
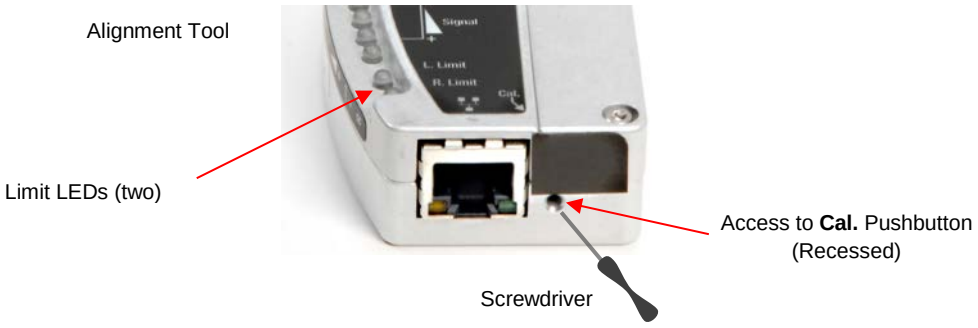
Method	Description
1.	Use the Calibration (**Cal**) Pushbutton: Align and calibrate the sensor head using the Calibration (**Cal**) pushbutton and the LED indicators on the Alignment Tool.  Continue to ***Section 5.1 Using the Cal. Pushbutton.***
2.	Use the SmartPrecision II Software*: Align and calibrate the sensor head using the Alignment Tool and the SmartPrecision II Software.  SmartPrecision II Main Screen Continue to ***Section 5.2 Using the Software.*** **Note*:** The SmartPrecision II Software is built in to the Alignment Tool ATMII5000 for setup and diagnostics; only a web browser is needed (use of software is optional). See ***Sensor Installation Tools*** in ***Section 7.0 Order Guide*** for more details.

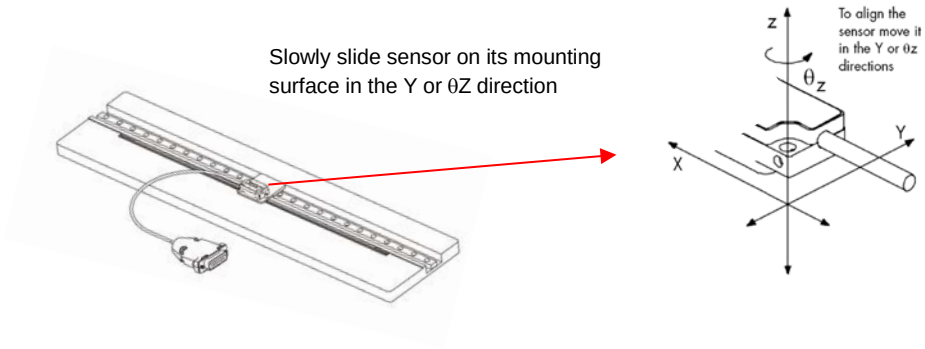
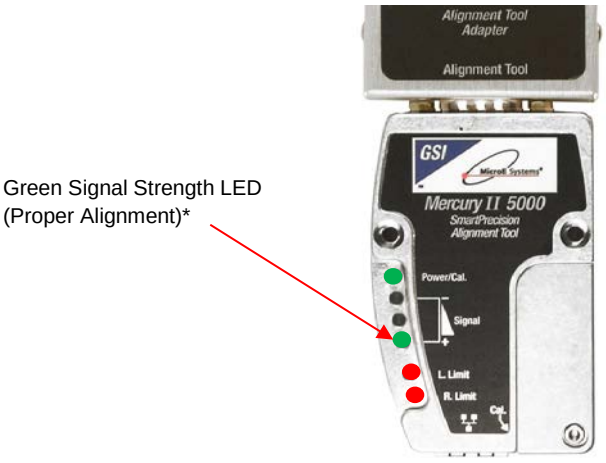
5.1 Using the Cal. Pushbutton

Use the following instructions to perform sensor alignment and calibration by using the **Cal.** Pushbutton located on the ATMII5000 Alignment Tool.

5.1.1 Sensor Alignment

Note: Make sure that the 5 VDC power input is disconnected. Encoder should never be connected to an already energized alignment tool since equipment can be damaged.

Step	Action
1.	Connect the MII5000 encoder to the SmartPrecision Alignment Tool. 
2.	Insert the 5 VDC power connector to the Alignment Tool Adapter and apply power.  **Result**: The **Power/Cal.** LED illuminates a steady green. The sensor is initialized after an approximate 10 second delay.
3.	Enter the Alignment Mode by gently pressing and releasing the **Cal.** pushbutton quickly (within a second) using a small screwdriver or similar tool.  **Result**: The two Limit LEDs will begin to blink in unison (slowly). Automatic Gain Control (AGC) is now inactive. The AGC adjusts gain to maintain a steady signal level.

Step	Action
4.	Align the sensor by slowly sliding the sensor on its mounting surface in the Y or θZ direction until the green Signal Strength LED is illuminated*:  **Note***: Optimal alignment is indicated by Bright Green.
5.	Once the sensor is aligned, tighten the two sensor mounting screws (0.37 Nm [3.3 inch-lbs.] maximum torque).
6.	Move the sensor over the index mark and confirm that the green Signal Strength LED blinks.  **Result:** • If the green Signal Strength LED blinks when the sensor passes over the index, then proceed to the next step. • If the green Signal Strength LED **does not** blink when the sensor passes over the index, then loosen the mounting screws and repeat the alignment procedure (go back to Step 3). **Note***: Optimal alignment is indicated by Bright Green and a blink over the index.
7.	Move the sensor over the entire length of the scale. **Result:** • If the green Signal Strength LED remains illuminated over the entire length of travel (the yellow and red LED's do not illuminate), then proceed to the next step. • Otherwise, clean the scale and try Step 3 again. If cleaning the scale is not successful, loosen the sensor mounting screws and repeat the alignment procedure (go back to Step 3).
8.	Press and release the **Cal** button quickly to exit Alignment Mode. **Result:** The limit LED's will stop blinking and AGC will reactivate.

5.1.2 Sensor Calibration

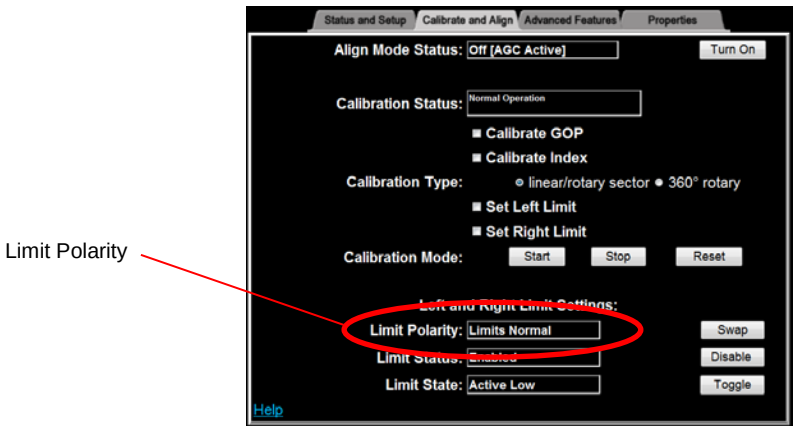
Perform calibration when installing the sensor for first time, or if the sensor is subsequently remounted, or the scale is replaced. This section contains instructions for calibrating the following:

- Linear Scales or Rotary Scales used in applications less than 360°
- Rotary Scales used in applications greater than 360° without Limit Markers

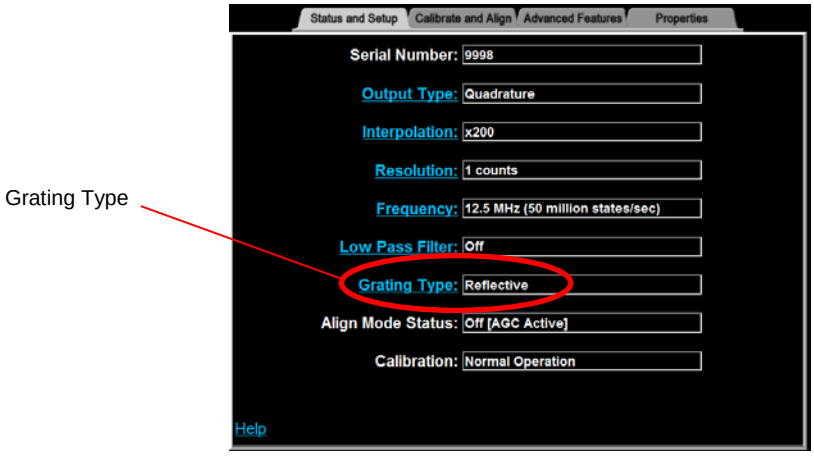
Confirm Settings

Confirm the following before calibration:

- Always perform calibration of the left and right limits while **Limit Polarity** is set to **Limits Normal** mode. See the Left and Right Limits Settings in the **Calibration and Align** tab of the SmartPrecision II Software in ***Section 5.2.3 Sensor Alignment and Calibration***.

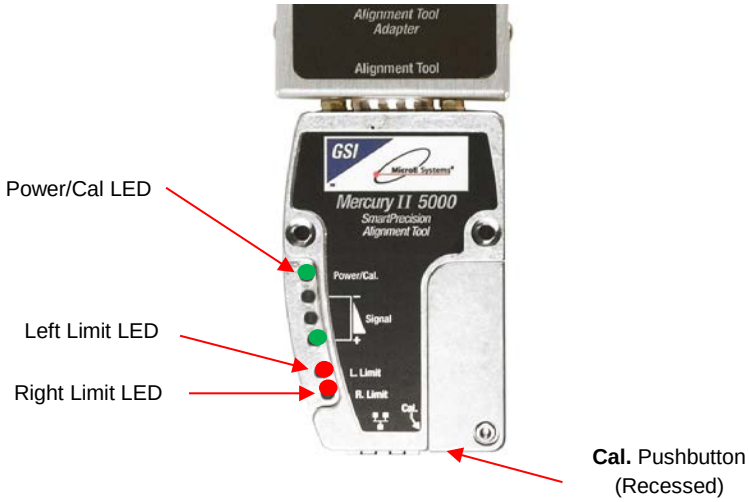


- Select correct Reflective or Non-Reflective Grating Type on **Status and Setup** tab.



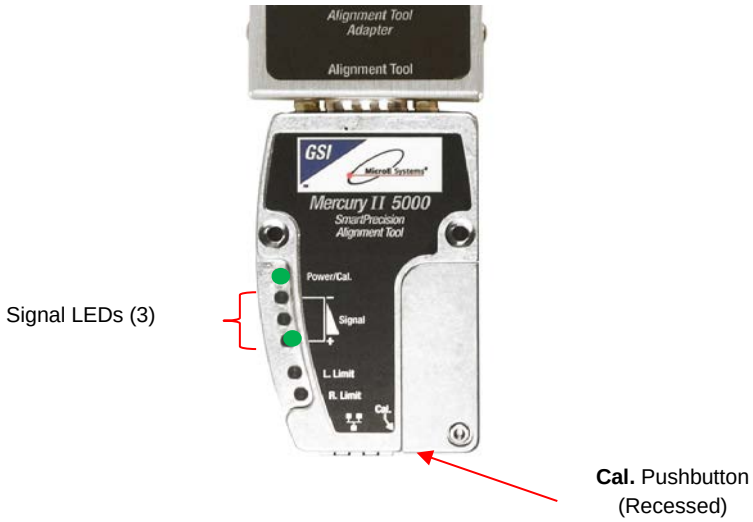
Note: Perform all procedures below at ≤1 meter/second relative motion between the sensor and the scale.

Linear Scales or Rotary Scales used in applications less than 360°

Step	Action
1.	To start calibration, press and hold the **Cal.** button for about two seconds until the **Power/Cal.** LED starts blinking slowly. 
2.	Move the sensor 50 mm to perform **Gain/Offset/Phase calibration**. Move the sensor back and forth if scale has <50 mm of measuring length. **Result**: After calibration both limit LEDs come on steady.
3.	Move the sensor to an area of the scale away from the index and limit markers. Press the **Cal.** button once quickly. **Result**: The **Power/Cal** LED will start blinking quickly.
4.	Move the sensor over the index up to 20 passes (one pass is a single cycle back and forth). **Result**: The Left Limit LED will start blinking quickly. **Note**: If the sensor is positioned over the left limit marker, the Left Limit LED will come on steady.
5.	Move the sensor over the left limit marker and press the **Cal.** button once quickly. **Result**: The Right Limit LED will start blinking. **Note**: if the sensor is positioned over the right limit marker, the Right Limit LED will come on steady.
6.	Move the sensor over the right limit marker and press the **Cal.** button once quickly. **Result**: All LEDs will flash together twice to indicate that setup is completed.
7.	The encoder is now ready for connection to the controller for use in servo control.

Note: To skip any portion of this calibration and move to the next procedure, press and hold the **Cal.** button for two seconds.

Rotary Scales used in applications greater than 360° without Limit Markers

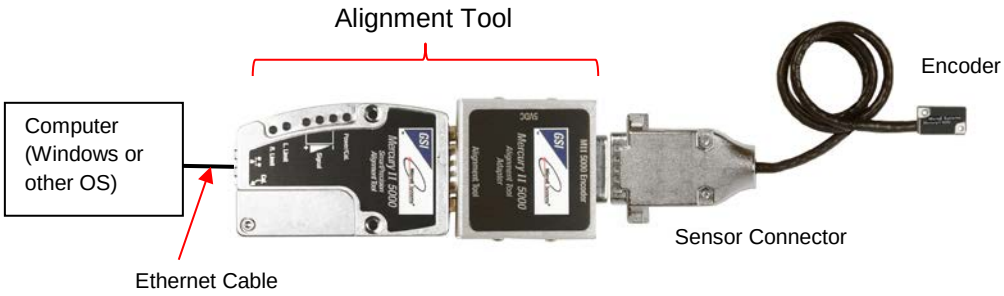
Step	Action
1.	To start calibration, press and hold the **Cal.** button for about 10 seconds: until the three **Signal** LEDs blink twice to indicate that rotary calibration has been activated. 
2.	Move the sensor 50 mm to perform **Gain/Offset /Phase calibration**. After calibration both limit LED's come on steady. Move the sensor back and forth if your scale has a circumference of <50 mm. **Result**: After calibration both limit LEDs come on steady.
3.	Move the sensor to an area of the scale away from the index marker. Press the **Cal.** button once quickly. **Result**: The **Power/Cal.** LED will start blinking quickly.
4.	Move the sensor over the index up to 20 passes (one pass is a single cycle back and forth). **Result**: The **Power/Cal.** LED and both limit LEDs will start to blink in sets of three.
5.	Move the sensor away from the index and press the Cal. button once quickly. **Result**: The **Power/Cal.** LED and both limit LED's will start to blink in sets of two.
6.	Move the sensor over the index once. **Result**: The LEDs will change to **Power/Cal.** LED and both limit LEDs blinking just once.
7.	Make a full revolution of the rotary scale in order to go over the index again in the same direction. The two passes over the index must be at least 1000 20 µm fringes apart (equivalent of 20 mm linear travel), if they are not, the Alignment Tool will wait for another pass that is 1000 fringes from the first.
8.	The encoder is now ready for connection to the controller for use in servo control.

Note: To skip any portion of` this calibration and move on to the next procedure, press and hold the **Cal**. button for two seconds.

5.2 Using the Software

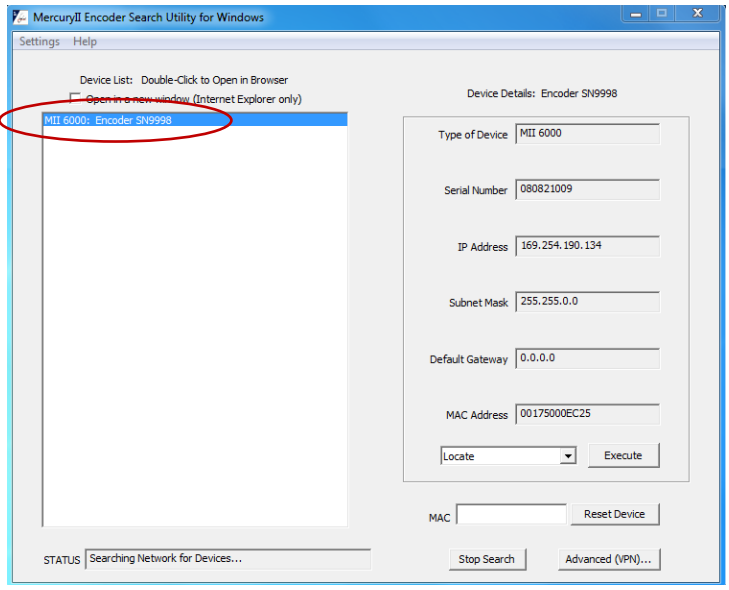
Use the following instructions to perform sensor alignment and calibration using the Alignment Tool and the SmartPrecision II Software.

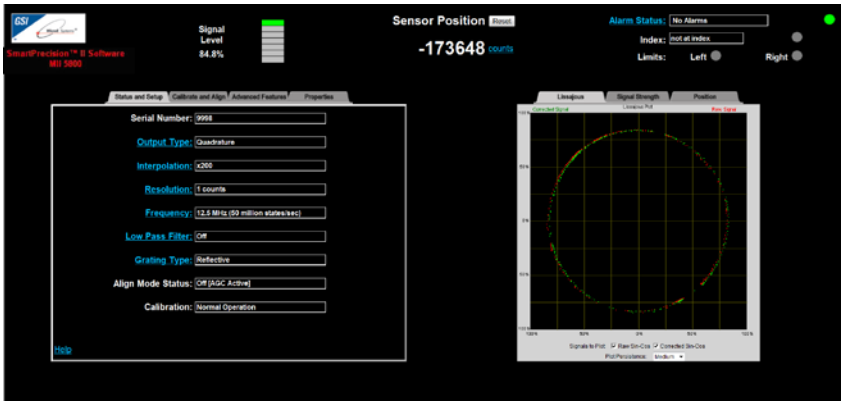
5.2.1 Connect the Alignment Tool and Encoder

Step	Action
1.	Verify that the Alignment Tool Adapter/SmartPrecision II Alignment Tool is not powered on. The **Power/Cal**. LED should be off. 
2.	Connect the MII5000 encoder, Ethernet cable, and computer as shown below. 
3.	Power up the Alignment Tool by plugging in 5 VDC to the Alignment Tool Adapter.  **Result:** The **Power/Cal.** LED illuminates a steady green. The sensor is initialized after an approximate 10 second delay.

5.2.2 Use the FindMII Program to Locate the Encoder

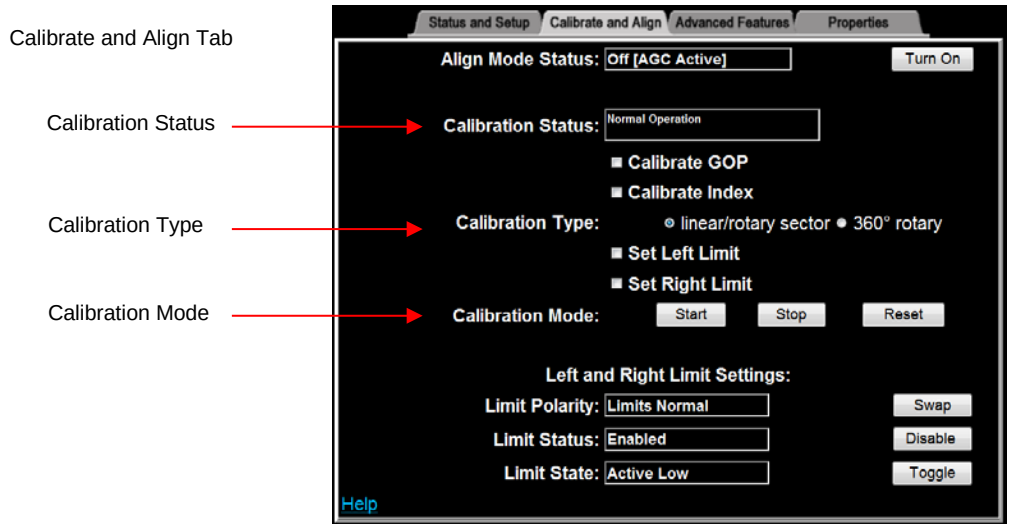
Once the encoder is connected to the computer using an ethernet cable, run the software program **FindMII** (Mercury II Encoder Search Utility) version 1.2.2.1 or higher.

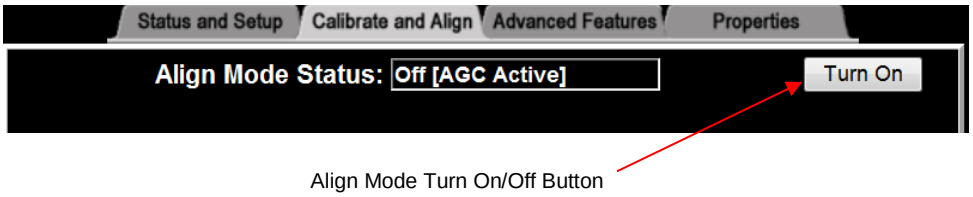
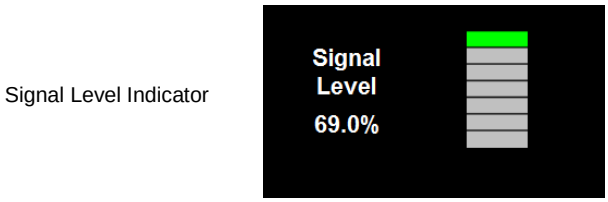
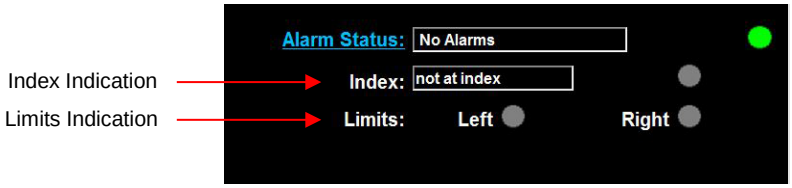
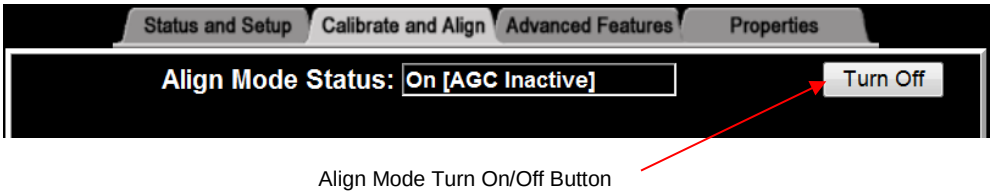
Step	Action
1.	To locate the correct version for your operating system, go to Mercury II Software Downloads at **http://www.microesys.com/products/documentation** or click on one of the following links: For Windows operating systems: FindMII.exe For all other operating systems: FindMII.jar
2.	Double-click on the appropriate link to launch the FindMII program. **Result**: The **FindMII** program locates the encoder and allows you to use the embedded SmartPrecision II Software on your web browser. **Note**: You may receive an **Application Blocked by Security Settings** message when attempting to load the *plotApplet*. Go to the Java applet in your Control Panel and try reducing the Security Level in the Security Tab (covers up to Java 7, versions beyond 7 may require additional steps). **Warning**: Reducing the Security Level in the Security Tab may decrease protection of your computer against malicious software.
3.	Once located, the **FindMII** program displays the **MercuryII Encoder Search Utility** screen. The screen will list all the encoders connected to the network as seen in the following example. Encoder found by the program 

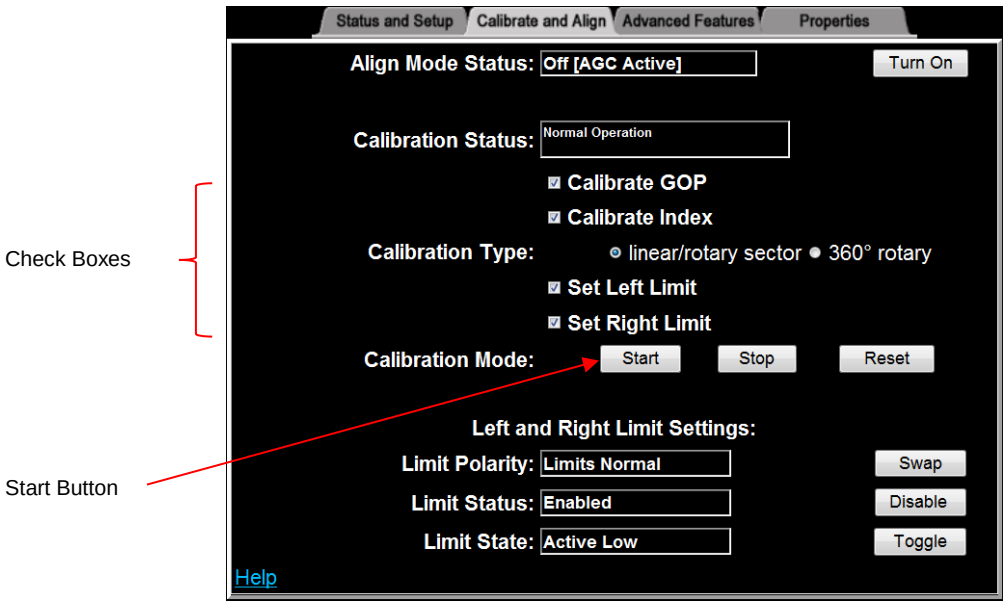
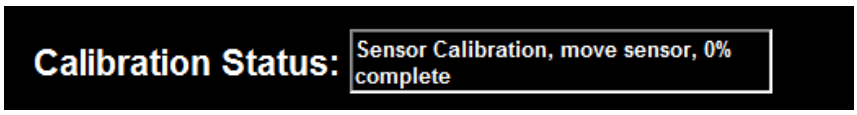
Step	Action
4.	Double-click the name of the encoder to open the SmartPrecision II Software.  **Results:** The SmartPrecision II Software Screen displays.

5.2.3 Sensor Alignment and Calibration

Once the SmartPrecision II Software is open, perform sensor alignment and calibration by using the **Calibrate and Align** tab.

Step	Action
1.	Click on the **Calibrate and Align** tab.  **Results:** The **Calibrate and Align** screen opens.

Step	Action
2.	Turn on Align Mode by clicking on the **Align Mode Turn On** button.  **Results:** The **Turn On** button will change to **Turn Off**. **Align Mode Status** will change to **On (AGC Inactive)**. On the Alignment Tool, both Left and Right Limit LEDS will begin blinking.
3.	Adjust the sensor position until the maximum signal strength is achieved. See the Signal Level Indicator at the top of the SmartPrecision screen. 
4.	Tighten the sensor mounting screws. Check for index indication (using the status display at the top right of the screen).  **Results:** The Index indication is “not at index” when the sensor is not located at the Index marker, and “index crossed” when the sensor has passed over the Index marker.
5.	Turn off Align Mode by clicking on the **Align Mode Turn Off** button.  **Result:** The **Turn Off** button will change to **Turn On**. **Align Mode Status** will change to **Off (AGC Active)**. On the Alignment Tool, both Left and Right Limit LEDS will stop blinking.

Step	Action
6.	Perform setup by checking the **Calibrate GOP, Calibrate Index**, **Set Left Limit**, and **Set Right Limit boxes**.  **Note**: Not all applications require all steps.
7.	Ensure that the **Calibration Type** is correctly selected for your encoder (**linear/rotary sector** is selected above). Press the **Start** button in **Calibration Mode** to begin calibration/setup.  **Results:** Sensor Calibration will begin. Follow the steps in the **Calibration Status** box to complete setup of the MII5000 encoder. For example, in the status box above, the instructions are to move the sensor until reaching 100% complete and then the next calibration step will start.
8.	If there is a failure, turn off the sensor and clean the scale. After cleaning, return to this section.

6.0 Appendix

6.1 Specifications

System

Scales:

- PurePrecision Laser Tape scale - available in continuous lengths up to 30 m.
- Linear glass scales for high accuracy.
- Rotary glass scales for rotary applications.

Grating Period	20 µm
Signal Period	20 µm
System Resolution	5 µm - 0.00122 µm* in integer interpolation steps (factory set or user programmed using included SmartPrecision II Software.

*Value rounded for readability. Use the formula **20 µm/interpolation multiplier** to calculate the exact resolution in units of µm/count.
Note: MII5800Pa resolution is fixed at 1.2 nm.

Accuracy/Linearity

Cyclical Error	
Tape Scales:	± 30 nm typical over any 20 µm movement
Glass Scales:	± 20 nm typical over any 20 µm movement
Tape Scale Linearity:	≤ ± 5 µm/m

Glass Scale Accuracy

High Accuracy Grade:	≤±1 µm for scales up to 130mm ≤±2 µm for scales from130mm to 1m
Standard Accuracy Grade:	≤ ±1.5 µm for scales up to 130 mm ≤ ±5 µm for scales from 130 mm to 1 m

Note: Accuracy is the maximum error over the specified movement when compared to a NIST-traceable laser interferometer standard used at room temperature.

Rotary Accuracy*	Scale O.D.	Micro radians	Arc-Seconds
	44.45 mm	± 38	± 7.8
	63.50 mm	± 19	± 3.9
	120.65 mm	± 10	± 2.1

Note: *Based on ideal scale mounting concentricity.

Index: Built-in or stick-on; bi-directional, full speed.
Note: After power up, the index mark must be passed once at ≤ 1 m/s for proper operation.

Limits: Separate built-in or stick-on left and right limits.
Laser-written embedded index and limits available. Contact MicroE.

Sensor Size

H:	11.03 mm
W:	13.50 mm
L:	38.50 mm

Operating and Electrical Specifications

Agency Standards Conformance: In accordance with Electromagnetic Compatibility Directive 2004/108/EC: EN 55011:2007, EN 61000-4-2, -3, -6

SPI Interface Clock Speed: 25MHz - 50MHz
Max Sample Rate: 227,272 position reads/s - 50MHz clock

Power Supply: 5 VDC ±5%
@ 140 mA (no outputs terminated)
@ 180 mA (A, B, I, and both limits terminated)
@ 172 mA (all serial I/O connections terminated)

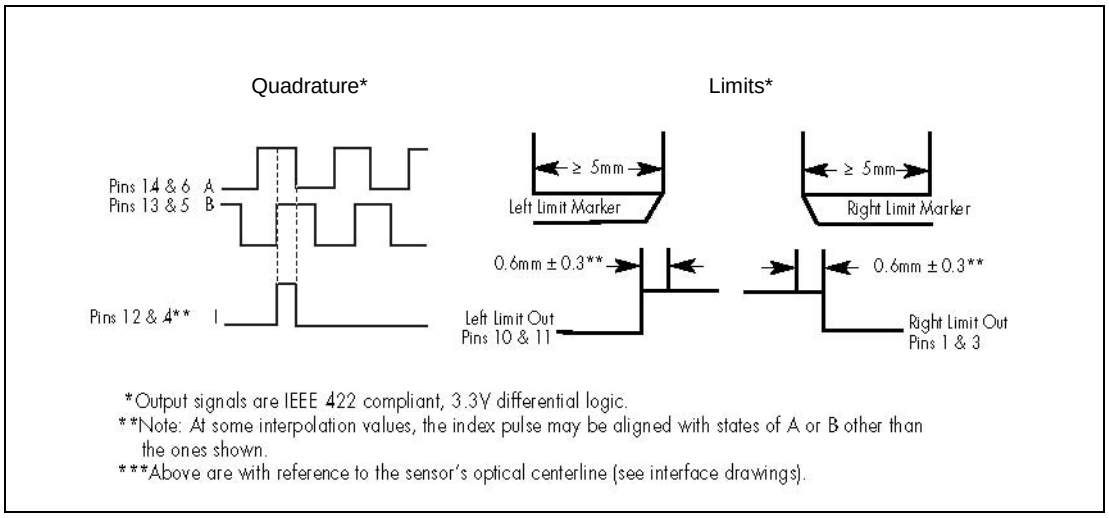
Temperature	
Operating:	0°C to 70°C
Storage:	-20°C to 85°C
Humidity:	10 - 90% RH non-condensing
EMI	CE Compliant
Shock:	300 G 0.5 ms half sine (Sensor)
Vibration:	30 G @ 17Hz
Sensor Weight:	3 g (Sensor without cable)
Cable:	Double Shield Maximum length: 10 m (contact MicroE Systems for applications >5 m) Diameter: 4.2 mm Flex Life: 20 x 10^6 cycles @ 20 mm bending radius

Reliability Information

5 Year Expected Reliability: >99.8% under normal operating conditions.

Note: Refer to the MII5000 Interface Drawings for additional dimensional details and important notes.

MII5000 Output Signals



*Output signals are IEEE 422 compliant, 3.3V differential logic.
**Note: At some interpolation values, the index pulse may be aligned with states of A or B other than the ones shown.
***Above are with reference to the sensor's optical centerline (see interface drawings).

6.2 Resolution and Maximum Speed Tables

Resolution and Maximum Speed Tables - Quadrature Output

Mercury II 5000 systems (MII5500/MII5700/MII5800) have programmable interpolation from x4 to x16384 in integer steps. Below are tables of sample values. For applications requiring up to 10 m/s at full resolution, use the MII5800Si/Pa with high speed serial interface.

Linear – 20 µ Grating Pitch

Maximum Interpolation	Resolution	Maximum Speed*	Applicable Mercury II 5000 Models
x 4	5.000µm/count	10000mm/sec	5500, 5700, 5800
x 10	2.000µm/count	10000mm/sec	5500, 5700, 5800
x 20	1.000µm/count	10000mm/sec	5500, 5700, 5800
x 40	0.500µm/count	10000mm/sec	5500, 5700, 5800
x 80	0.250µm/count	10000mm/sec	5500, 5700, 5800
x 100	0.200µm/count	10000mm/sec	5500, 5700, 5800
x 200	0.100µm/count	5000mm/sec	5500, 5700, 5800
x 400	0.050µm/count	2500mm/sec	5500, 5700, 5800
x 1000	20.0nm/count	1000mm/sec	5700, 5800
x 2000	10.0nm/count	500mm/sec	5700, 5800
x 4000	5.00nm/count	250mm/sec	5700, 5800
x 8000	2.50nm/count	125mm/sec	5800
x 16384	1.22nm/count†	61mm/sec	5800

Note: †Value rounded for readability; use the following formula to calculate the exact resolution in units of µm/count:

$$Resolution = \frac{20\mu}{Interpolation\ Multiplier}$$

Rotary – 20 µ Grating Pitch

Note: Interpolation - the range of available values is x4 to x16384 in integer steps; sample values below.

Rotary Glass Scale Diameter	Fundamental Resolution	Interpolation						
44.45mm	5000 Lines	x4	x20	x40	x400	x1000	x4000	x16384
	interpolated resolution (CPR)	20000	100000	200000	2000000	5000000	20000000	81920000
	interpolated resolution (arc-sec/count)**	64.8	12.96	6.48	0.648	0.259	0.0648	0.01582
	interpolated resolution (µrad/count)**	314	62.8	31.4	3.14	1.257	0.314	0.0767
	maximum speed* (RPM)	6000	6000	6000	1500	600	150	36.6
63.50mm	8192 Lines							
	interpolated resolution (CPR)	32768	163840	327680	3276800	8192000	32768000	134217728
	interpolated resolution (arc-sec/count)**	39.6	7.91	3.96	0.396	0.1582	0.0396	0.00966
	interpolated resolution (µrad/count)**	191.7	38.3	19.17	1.917	0.767	0.1917	0.0468
	maximum speed* (RPM)	3660	3660	3660	915	366	91.5	22.3
120.65mm	16384 Lines							
	interpolated resolution (CPR)	65536	327680	655360	6553600	16384000	65536000	268435456
	interpolated resolution (arc-sec/count)**	19.78	3.96	1.978	0.1978	0.0791	0.01978	0.00483
	interpolated resolution (µrad/count)**	95.9	19.17	9.59	0.959	0.383	0.0959	0.0234
	maximum speed* (RPM)	1830	1830	1830	457	183.1	45.7	11.17
Applicable Mercury II 5000 Models		5500, 5700, 5800	5500, 5700, 5800	5500, 5700, 5800	5700, 5800	5700, 5800	5800	5800

Note: *Maximum speed produces an encoder quadrature output of 50 million states per second (12.5MHz). See Page 24 for additional output frequencies. Maximum speeds shown above will be reduced if a lower quadrature output frequency is selected.

Note: **Resolution values shown are approximate. To calculate exact resolution values, convert from CPR (Counts per Revolution) to the desired units.

Note: To calculate desired rotary interpolation multiplier, use the following equation:

$$Interpolation\ Multiplier = \frac{Desired\ Resolution\ (CPR)}{Fundamental\ Scale\ Resolution\ (Lines)}$$

Note: Specifications assume XOR function which is available in all standard controllers.

Resolution and Maximum Speed Tables - Serial Output

Mercury II 5800Si/Pa systems have programmable interpolation from x4 to x16384 in binary steps. Below is a table of examples. Unlike A-quad-B encoders, the MII5800Si/Pa resolution does not drop off with speed.

Linear – 20µ Grating Pitch

Interpolation Multiplier	Interpolation Bits	Resolution	Maximum Speed
x 4	2	5.000µm/count	10000mm/sec
x 8	3	2.500µm/count	10000mm/sec
x 16	4	1.250µm/count	10000mm/sec
x 32	5	0.6250µm/count	10000mm/sec
x 64	6	0.3125µm/count	10000mm/sec
x 128	7	0.15625µm/count	10000mm/sec
x 256	8	0.078125µm/count	10000mm/sec
x 512	9	0.0390625µm/count	10000mm/sec
x 1024	10	19.53125nm/count	10000mm/sec
x 2048	11	9.765625nm/count	10000mm/sec
x 4096	12	4.8828125nm/count	10000mm/sec
x 8192	13	2.44140625nm/count	10000mm/sec
x 16384	14	1.220703125nm/count	10000mm/sec

Rotary – 20µ Grating Pitch

Note: The range of available values is x4 to x16384 in binary steps; sample values below.

Rotary Glass Scale Diameter	Fundamental Resolution	Interpolation			
44.45mm	5000 Lines	x4	x1024	x4096	x16384
	interpolated resolution (CPR)	20000	5120000	20480000	81920000
	interpolated resolution (arc-sec/count)*	64.8	0.253	0.0630	0.01582
	interpolated resolution (µrad/count)*	314	1.23	0.306	0.0767
	maximum speed (RPM)	6000	6000	6000	6000
63.50mm	8192 Lines	x4	x1024	x4096	x16384
	interpolated resolution (CPR)	32768	8388608	33554432	134217728
	interpolated resolution (arc-sec/count)*	39.6	0.154	0.038	0.00966
	interpolated resolution (µrad/count)*	191.7	0.749	0.187	0.0468
	maximum speed (RPM)	3660	3660	3660	3660
120.65mm	16384 Lines	x4	x1024	x4096	x16384
	interpolated resolution (CPR)	65536	16777216	67108864	268435456
	interpolated resolution (arc-sec/count)*	19.78	0.0772	0.01978	0.00481
	interpolated resolution (µrad/count)*	95.9	0.375	0.0937	0.0234
	maximum speed (RPM)	1830	1830	1830	1830

Note*: Resolution values shown are approximate. To calculate exact resolution values, convert from CPR (Counts per Revolution) to the desired units.

Note: To calculate desired rotary interpolation multiplier, use the following equation:

$$Interpolation\ Multiplier = \frac{Desired\ Resolution\ (CPR)}{Fundamental\ Scale\ Resolution\ (Lines)}$$

Maximum Quadrature Output Frequency

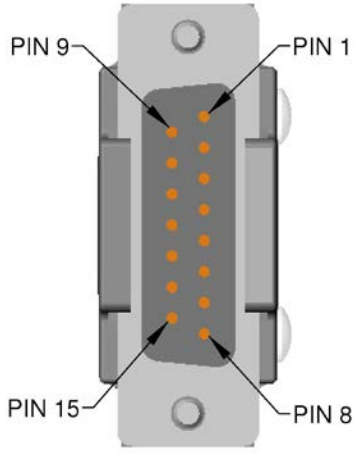
Output Frequency (MHz)	A-Quad-B Output Rate (millions of states/sec)	Dwell Time (or edge separation) (µsec)
12.50	50.00	0.02
6.25	25.00	0.04
3.125	12.50	0.08
1.563	6.25	0.16
0.781	3.125	0.32
0.391	1.5625	0.64
0.195	0.78125	1.28
0.098	0.390625	2.56
0.049	0.1953125	5.12
0.024	0.09765625	10.24

Note: Values shown are approximate. Exact values may be calculated using either of the following equations:

$Output\ Frequency = 12.5MHz/2\text{^}n$ where n = number of steps below 12.5MHz
$Output\ Rate = 50/2\text{^}n$ where n = number of steps below 50 million states per second

6.3 Wiring Diagrams

15-Pin Standard Male D-sub Connector Configuration



Mercury II 15P D-Sub Pin Outs Quad Output	
Pin	**Function**
1	Right Limit+
2	GND
3	Right Limit-
4	Index-
5	B-
6	A-
7	+5V
8	+5V
9	GND
10	Left Limit+
11	Left Limit-
12	Index+
13	B+
14	A+
15	No Connect

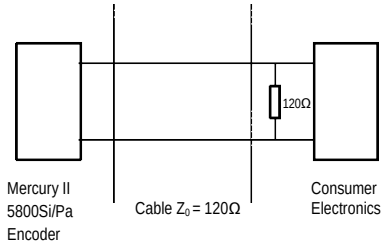
Note: Alarm: A and B are tri-stated if the encoder signal becomes too low for reliable operation.

Note: GND and Inner Shield are internally connected.

Recommended Interface Termination

Customer Differential Line Receiver – RS 422: The following diagram shows the recommended signal termination for a-quad-b, serial, index, and limits signals for the Mercury II 5000 Series Encoders.

Standard RS-422 Line Receiver Circuitry:



Grounding Considerations

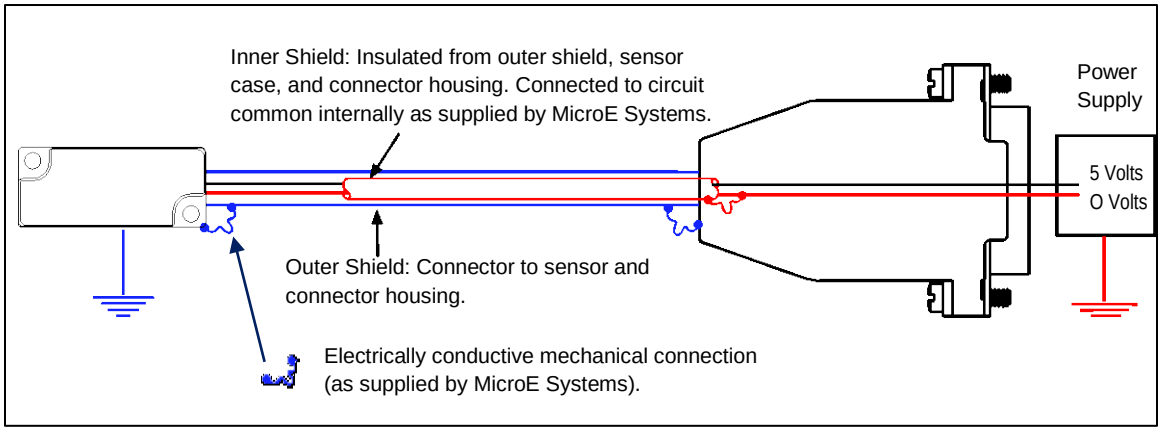
The diagrams below show how to make the connections when the encoder's connector is plugged into the customer's controller chassis. If a customer-supplied extension cable is used, it should be a double-shielded cable with conductive connector shells and must provide complete shielding over the conductors contained within it over its entire length. Furthermore, the shields should be grounded at the connection to the controller chassis the same way as the encoder connectors in the diagrams below.

Note: For best performance, isolate the encoder outer shield from motor cable shields and separate the encoder cable as far possible from motor cables.

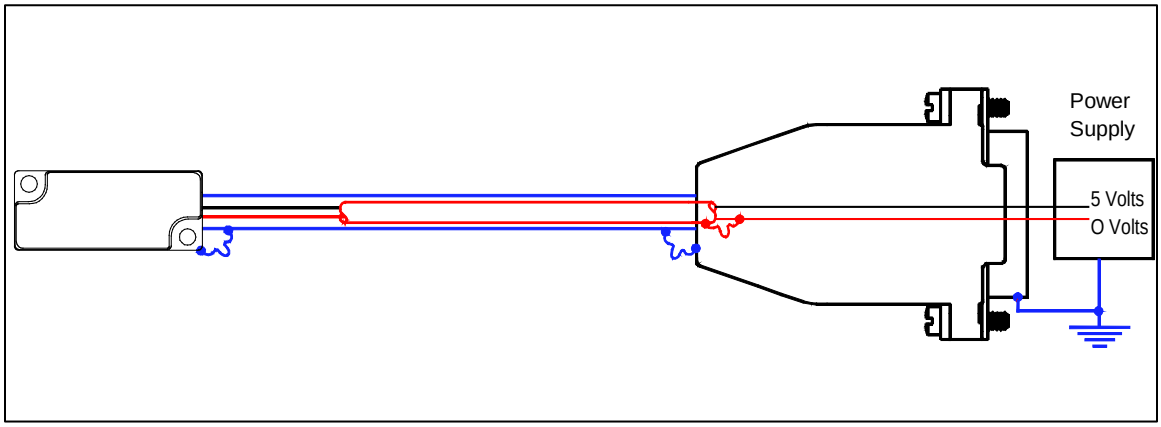
Sensor mounted with good electrical contact to a well-grounded surface (preferred)

The encoder's connector shell must be in close, electrically-conductive contact with the customer-supplied mating connector, which must be isolated from the controller's ground. If a customer-supplied shielded cable connects the encoder to the controller, then the outer shield on the customer-supplied cable must be isolated from the controller's ground.

The sensor mounting surface must have a low-impedance (DC/AC) connection to ground. The encoder sensor mounting surface may have to be masked during painting or anodizing to ensure good electrical contact with the sensor.



Sensor mounted to poorly-grounded or non-conducting surface



6.4 Customer Interface

Cable Requirements

Customer cables that interface to Mercury II 5000 Series Encoders must have the following characteristics:

- Twisted pair signals wiring.
- Characteristic impedance of 100-120 ohms.
- Sufficient wire gauge to meet the minimum voltage requirement at the encoder. For example: 24AWG gauge wire for a 2 m length cable. Recommended cables are 24AWG gauge wire with 6 twisted pairs.
- Single shield cable with a minimum of 90% coverage. Note that a double shielded cable may be required in high-noise applications.

Signal Wiring for A-quad-B

Each differential signal should be connected to a corresponding twisted pair as follows for the 15-pin standard male D-sub connector:

Mercury II 5000		
Signal	**Twisted Pair**	**Pin**
A+	Pair 1	14
A-		6
B+	Pair 2	13
B-		5
Index+	Pair 3	12
Index-		4
Left Limit+	Pair 4	10
Left Limit-		11
Right Limit+	Pair 5	1
Right Limit-		3
+5V	Pair 6	7, 8
GND		2, 9

Note: The Alarm signal on pin 15 is not differential and is not part of a pair.

Signal Wiring for Serial Interface

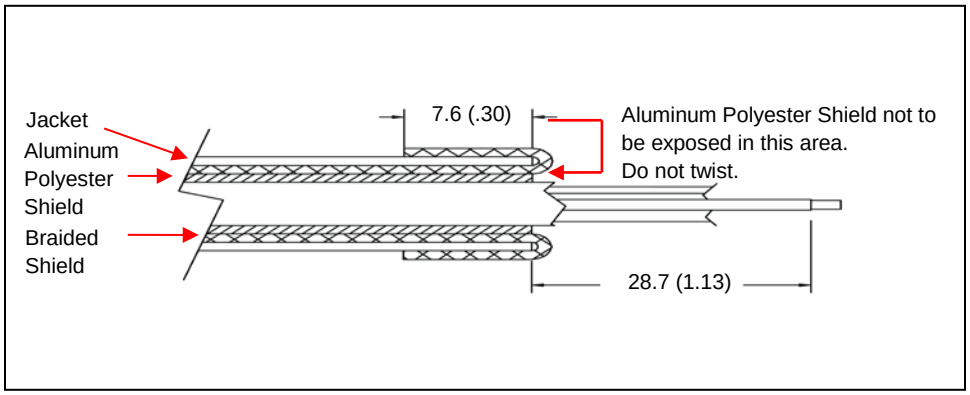
Each differential signal should be connected to a corresponding twisted pair as follows:

Mercury II 5800Si/Pa Signals			
Twisted Pair	**DB15 Pins**	**5800Si Signals**	**5800Pa Signals**
Pair 1	14	SDATA_OUT+	NC*
	6	SDATA_OUT-	NC
Pair 2	13	SCLOCK_OUT+	NC
	5	SCLOCK_OUT-	NC
Pair 3	10	SCLOCK_IN+	REQ_SD+
	11	SCLOCK_IN-	REQ_SD-
Pair 4	1	nCS+	NC
	3	nCS-	NC
Pair 5	7	+5V	NC
	8	+5V	NC
Pair 6	2	GND	NC
	9	GND	NC

Note: NC - No Connect

Shield Termination

- The customer's cable shield must be in 360° contact with the connector shroud and the connector shell to provide complete shielding.
- The connector shell should be metal with conductive surfaces. Suggested metal connector shells for use with Mercury II encoders: AMP 748676-1 or equivalent; where the dash number is dependent on the customer's outside cable diameter.
- Terminate the shield as illustrated in the following diagram.



Note: Fold braided shield back over jacket. Example shows double-shielded cable. Dimensions shown are for purpose of illustration only.

6.5 Serial Interface Specifications

Introduction

The serial interface to the Mercury II 5800Si/Pa allows a serial host (controller) to receive position and status information serially from the sensor. Serial communications between the encoder and controller permit high speed motion system operation with high encoder resolution: up to 10 m/s at resolution of 1.22 nm. The serial data word consists of the following sequence:

- Position word of four start bits
- Four to thirty-five position bits
- Nine bits of status
- Six-bit Cyclic Redundancy Check (CRC) to provide error detection
- Four stop bits

The encoder's position is sampled by the MII5800Si at the moment the host commands a sample (falling edge of nCS); the only latency in the system is the time required for the host to receive the position word. This architecture minimizes latency and eliminates jitter due to sampling uncertainty.

Serial Interface Input/Output

MII5800Si (Serial Interface)

Pin	Name	Direction	Description
14	SDATA_OUT+	OUTPUT	Serial Data from Sensor to Host
6	SDATA_OUT-	OUTPUT	Serial Data from Sensor to Host
13	SCLOCK_OUT+	OUTPUT	Serial Clock from Sensor to Host
5	SCLOCK_OUT-	OUTPUT	Serial Clock from Sensor to Host
10	SCLOCK_IN+	INPUT	Serial Clock from Host to Sensor
11	SCLOCK_IN-	INPUT	Serial Clock from Host to Sensor
1	nCS+	INPUT	Chip Select from Host to Sensor
3	nCS-	INPUT	Chip Select from Host to Sensor (Negative True to start capture)
7,8	+5V		
2,9	GND		
15	Alarm	OUTPUT	For low level or saturated signal
4	Reserved		Do Not Connect
12	Reserved		Do Not Connect

MII5800Pa (Panasonic)

The following are the pins used by the MII5800Pa Panasonic serial interface.

- Pins 2, 7, 8, 9 are the same for both MII5800Si and Panasonic
- Pins 10 and 11 are different for Panasonic
- All other pins for Pa are not connected (NC)

Pin	Name	Direction	Description
10	REQ_SD+	Input/Output	Request for Serial Data from Host to Sensor
11	REQ_SD-	Input/Output	Request for Serial Data from Host to Sensor
7,8	+5V	Input	
2,9	GND	Input	

Output Signal Specifications

- SDATA_OUT
- SCLOCK_OUT

Parameter	Minimum	Typical	Maximum
Differential Output Voltage	500 mv	2v	2.5v
Common Mode Output Voltage	500 mv	2v	2.5v
Termination	120 ohms across each differential pair		

Input Signal Specifications

- SLOCK_IN
- nCS

Parameter	Minimum	Typical	Maximum
Differential Output Voltage			150 mV
Common Mode Output Voltage	1.1v	1.6v	1.9v
Absolute Maximum Single-Ended Voltage	-0.3V	2v	1.9V
Recommended Common Mode Voltage	1.2v	2v	2.5v
Recommended Differential Input Voltage	250 mv	2v	2.5v
Impedance	120 ohm		

Signal Definitions

Signal	Definition
SDATA_OUT	The serial data output to the host. The data word consists of 4 start bits, a position word of 4 to 35 bits, 9 bits of status, a 6-bit CRC to provide error detection capability, followed by 4 stop bits.
SCLOCK_OUT	The output clock is synchronous to the input clock with a phase delay. It is used by the host as the clock for the serial data output.
SCLOCK_IN	Provided by the host to the sensor and used by the encoder as the system clock. **Note**: An interruption in the input clock could cause a loss of encoder position. • Clock frequency requirements: 30MHz to 50MHz
nCS	The host uses this line to initiate a position sample. The nCS logic is “negative true”. Each time the sensor detects a falling edge on this signal, a position sample is sent to the host. • Maximum position sample frequency (falling edge to falling edge): 220 clock cycles • Minimum Pulse Width (high or low): 2 clock cycles

Power-Up Sequence

Power is supplied from the host to the sensor. After power is supplied, the following sequence is performed:

- The sensor waits for the serial clock to be provided by the host on the signal SCLOCK_IN for 100ms.
- If a clock is not provided, the sensor switches to operate in the final mode (quadrature or serial).
- Upon detecting a serial clock on SCLOCK_IN, the sensor returns the clock to the host on SCLOCK_OUT.

- Within the first 500 ms after the serial clock is provided by the host, SCLOCK_OUT may be unstable.
- Once it remains on continuously for at least 500 ms, the sensor is ready for data transfers and SCLOCK_OUT will remain stable.

Data Word Format

First Bit ---------- Last Bit

Start Bits				Position Word	Status Bits									CRC Word	Stop Bits			
1	0	1	1	4 – 35 Bits	IW	RL	LL	Y	R	S	C	Sp	Ø	6 Bits	1	0	1	1

MSB----------LSB

Start Bits

The data word will always start with bits one, zero, one, one.

Position Word

The 2's complement position word has two sections and is user adjustable. The Inter-Fringe bits which determine encoder resolution are adjustable between 14 bits (1.22 nm resolution) and 2 bits (5 µm resolution). The Fringe-Counter bits are increments of 20 µm which determine the total travel and are adjustable between 21 bits (±21 meters) and 0 bits (±10 microns). The total number of bits (inter-fringe + fringe-counter) must be at least 4 and no more than 35. Position word length is edited via the SmartPrecision II software in the Status and Setup tab. The position word is always transmitted most significant bit (MSB) first.

Status Bits

The encoder status bits are all active high with the exception of the Right and Left Limits. Limit status is user programmable (active high or active low) by using the SmartPrecision II software in the Calibrate and Align tab.

The nine status bits are defined as follows:

Status Bit	ID	Definition
IW	Index Window	Active when the sensor is over the optical index mark
RL	Right Limit	Active when the sensor is over the right limit marker
LL	Left Limit	Active when the sensor is over the left limit marker
Y	Yellow Alarm	Active during marginal alignment to the main track
R	Red Alarm	Active during poor or bad alignment to the main track
S	Saturation Alarm	Active if the main track signal is too large
C	Communication Error	Active if there is a communication error internal to the encoder
Sp	Over-Speed Alarm	Active if the encoder exceeds 10m/s (the speed alarm threshold)*
Ø	Reserved bit is always zero	

Example: ØØØØ_ØØØØ_Ø = normal operation, not at the index mark.

Note*: The encoder maximum operational speed is 10 meters/second, regardless of the speed alarm setting. The alarm is a user configured feature, to be set for specific application requirements, or the bit may be ignored if desired. The speed alarm is dependent on the

clock frequency, the sample rate, and the desired speed where the user would like the bit to assert high. The speed alarm register is defaulted to 3604, and may be changed using the alignment tool and Smart Precision software. The register must be set using the following formula:

Register value = (8.19E108 x ST x NC)/CF
ST = the desired speed alarm threshold in m/s
NC = number of clocks between samples
CF = clock frequency in Hz

Register value should be rounded to the nearest integer and entered into the settings screen in the SmartPrecision software.

The speed alarm may also be disabled in the SmartPrecision software.

CRC Bits

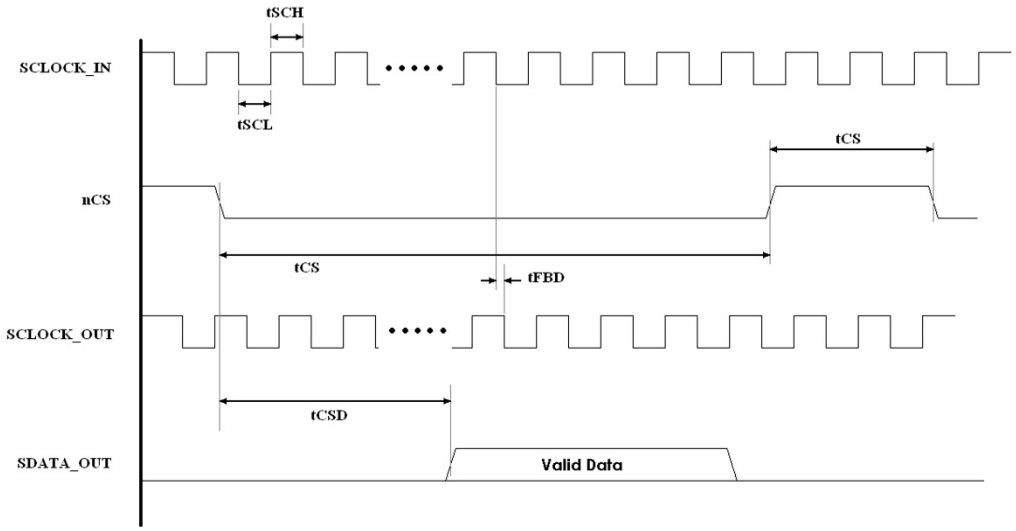
The cyclic redundancy check or CRC includes only the position and status bits. The CRC format is 6-bit polynomial:

$X^6 + X + 1$, MSB first after preloading the CRC register with all 1's

Stop Bits

The data word will always end with bits one, zero, one, one (1011).

Timing Diagram



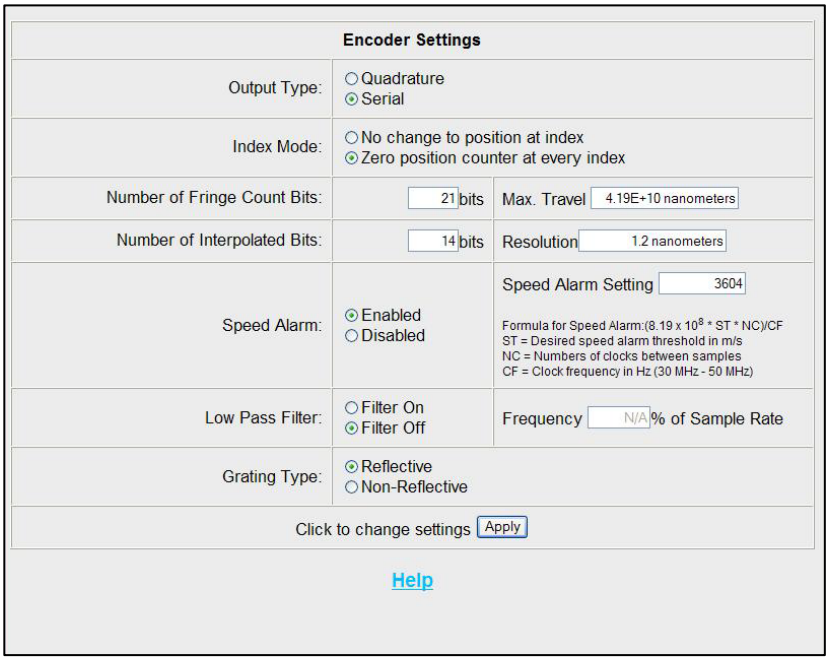
Symbol	Parameter	Min	Max
tSCL	SCLOCK_IN low time	20ns	33.3ns
tSCH	SCLOCK_IN high time	20ns	33.3ns
tCS	nCS pulse width	2 clock cycles	
tCSD	nCS to valid data	108 clock cycles	
tFBD	SCLOCK feedback delay	0ns	Dependent on total cable length

Configurable Settings

There are a number of settings that may be configured for serial output operation:

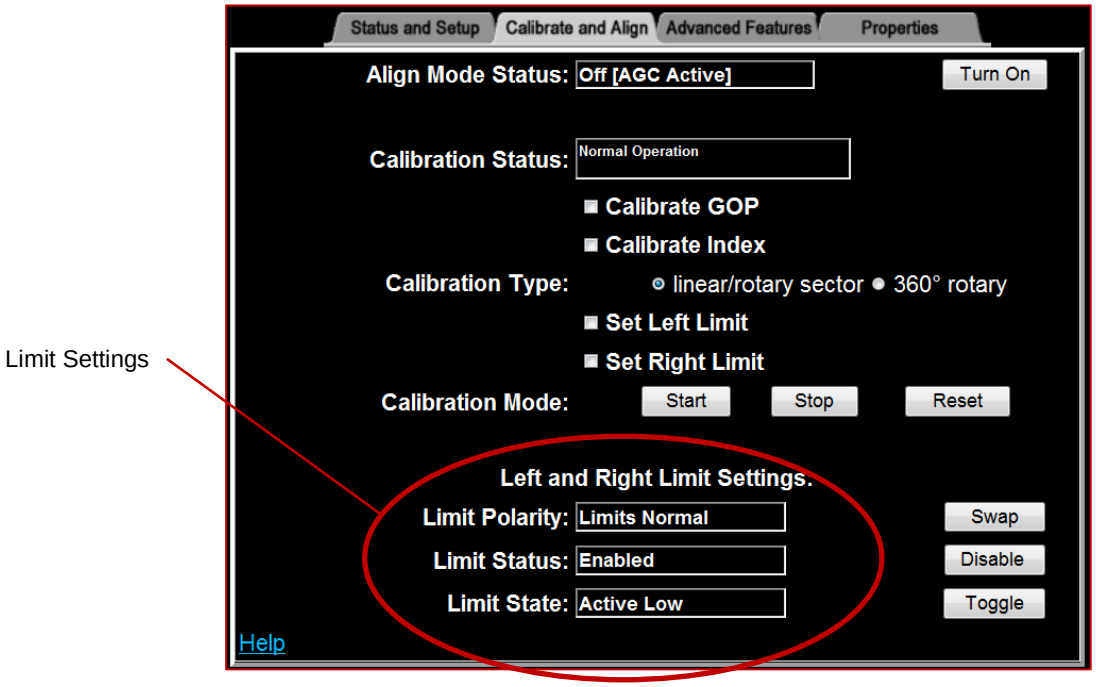
- **Index Mode**: The encoder can be set to reset the position to 0 every time the index is crossed (“Index Mode 1”) or to use the position at power up as the 0 position (“Index Mode 0”).
- **Number of Fringe Count Bits**: Each fringe is 20 µm long on the encoder’s scale. The number of fringe count bits can be set from 0 bits (no fringes) to 21 bits (2,097,152 fringes). Use enough fringe count bits to ensure that the position word is large enough for the expected range of motions. For example, 18 fringe count bits will make the range of position values from -2.62144 m to +2.62144 m (total travel of 5.24288 m). The total travel in meters is calculated as follows: travel = 0.00002 m * 2n, where n = the number of interpolation bits.
- **Number of Interpolated Bits**: The number of bits to calculate the position within a fringe, and thus the encoder’s resolution. The number of interpolated bits can be set from 2 bits (x4 interpolation; 5 µm resolution) to 14 bits (x16, 384 interpolation; approximately 1.22 nm resolution). Using fewer fringe count and interpolation bits than the maximums can increase the sample rate to the controller. The encoder’s resolution, in µm, is calculated as follows: Resolution = 20 µm/2n, where n = the number of interpolation bits.
- **Low Pass Filter**: The digital low pass filter is used to limit the bandwidth of the encoder system if desired. It is set in terms of % of sample rates and can be set from 0.01% to 40% in 0.01% increments.

Note: Fringe count bits + interpolated bits must be ≥ 4 bits total.



- **Left and Right Limit Settings** can be changed by clicking on the associated controls (Swap, Enable/Disable, and Toggle):
    - **Limit Polarity:** Normal - left limit marker triggers left limit signal; right limit marker triggers right limit signal. Reversed - left limit marker triggers right limit signal; right limit marker triggers left limit signal.
    - **Limit Status**: The limits may also be enabled or disabled.
    - **Limit State**: Active High - status bit = 1 when limits is active; Active Low - status bit = 0 when limit is active.

    See examples in **Calibrate and Align** screen below.



Performance Specifications

- Resolution: 5 µm to approximately 1.22 nm
- Maximum travel before position counter rollover, with fringe count bits set to 21: 41.94304 meters
- Maximum speed: 10 m/s
- Maximum cable length: 10 m

6.6 Index Speed Considerations

MII5000

Maximum Speed for MII5000 Index after Power-up (MII5800, MII5700 and MII5500 Models):

Each time an MII5800, MII5700, or MII5500 encoder is powered up, the first pass over the index mark must occur at a speed ≤1 m/s. Once the index is initially detected, the index will function at all speeds (up to 10 m/s) until the next power cycle.

MII5800Si/Pa

Controller Sample Rate and Maximum Encoder Speed for MII5800Si/Pa Index:

The Index Window is part of the MII5800Si's serial word and does not latch. To detect the index mark, the controller must issue a sample command while the sensor is over the index mark on the scale. When this happens, the Index Window bit will be high. If the sensor is not over the index mark, the IW bit will be low. Consequently, the sample rate must be at least as fast as the output from the following equation to ensure that a sample command occurs when the sensor is over the index mark:

- Index Window duration (µs) = Index Window width (µm) / encoder speed (m/s)
- The Index Window's width can be in the range from 5 µm to 30 µm. It is typically 20 µm after calibration. To ensure reliable index sampling, a value of 5 µm can be used in the above equation for all systems.

The maximum position sample rate is 4.4 µs; there is no minimum sample rate.

For example:

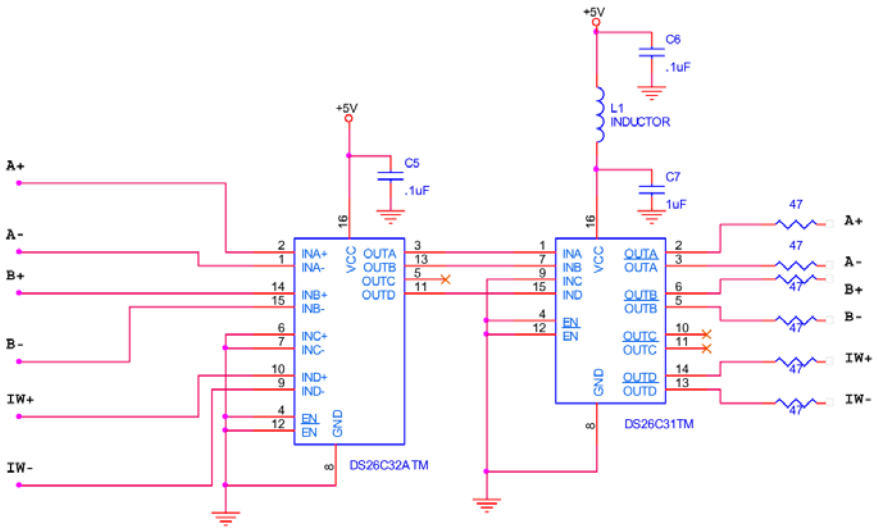
- Index Window width = 5 µm.
- Speed = up to 1.1 m/s.
- Index Window duration = 4.55 µs.
- Therefore, the controller's position sample rate must be 4.55 µs or faster to read the Index Window (at least one position word with the IW bit high).

6.7 RS-422 Compliance

Mercury II 5000 Series Encoders are RS-422 compatible. Encoder signals are "sending end terminated" and customer receiving terminations are not required.

For more details, see the following Tech Note:
Proper Termination of Digital Incremental Encoder Signals.

Optional RS-422 compliant circuitry for long cable runs in harsh electronic environments is illustrated below:



6.8 Troubleshooting

Problem	Solution
The Power/Calibration indicator will not come on.	• Make sure that the SmartPrecision II Electronics 15-pin D-sub connector is fully seated and connected. • Confirm that +5 Volts DC is being applied to pin 7 and 8 on the SmartPrecision II electronics 15-pin connector and that pins 2 and 9 are connected to ground.
Can't get the SmartPrecision II Electronics "Signal" LEDs better than red or yellow; or the green “Proper Alignment” indicator doesn't stay illuminated over the full length of the scale.	• Verify that the sensor is mounted in the correct orientation with reference to the scale and scale mounting reference edge. Refer to the Interface Drawing. • Verify that the sensor has been aligned to the scale and that the mounting screws are tight. Check the dimensions for the mechanical mounting holes (and clamps if any) to make sure that the sensor is correctly located over the scale in the Y and Z dimensions. Refer to the Interface Drawing. • Check that the scale is firmly mounted and can't jiggle or move in any direction other than the axis of motion. • Make sure that the scale is clean over its entire length or circumference.
The green Power/Calibration indicator LED or limit LEDs are flashing unexpectedly.	• Part of the normal setup procedure is to activate the SmartPrecision II Electronics Calibration/Setup process by pressing the recessed button in the electronics module. • The Power/Cal. LED or limit LEDs will begin to flash until the relevant setup process is complete. See the instructions beginning at ***Section 5.1.1 Sensor Alignment***.
Can't complete the Calibration/Setup process - the green Power/Calibration indicator doesn't stop flashing.	• Verify that the sensor is mounted in the correct orientation to the scale for the desired index mark. Refer to the Interface Drawing. • Refer to ***Section 4.2 Verify Sensor Mounting Surface Height*** to ensure proper sensor alignment and index marker operation.
Signal Plots in Smart Precision II Software not displaying in browser window.	• Reduce the Security Level setting for Java to “Medium” by going to the Windows Start Menu/Control Panel/Java and selecting the Security tab (covers up to Java 7, versions beyond 7 may require different steps). • You may receive an **Application Blocked by Security Settings** message when attempting to load the *plotApplet*. **Warning**: Reducing the Security Level in the Security Tab may decrease protection of your computer against malicious software.

7.0 Order Guide

How to Order

Sensors

MII5800, A-quad-B Output, with Resolution* from 5µm to 1.22nm

MII5810-AB-16384-1-1-0

- Low Pass Filter Roll Off Frequency (kHz)
  0=Off (full bandwidth)
  1=1khz
  2=2khz
  ↓
  100=100kHz
- Limit Logic
  1=Active Low (fail safe) 2=Active High
- Maximum Output Frequency
  1=12.50 MHz
  2=6.25 MHz
  3=3.125 MHz
  4=1.563 MHz
  5=0.781 MHz
  6=0.391 MHz
  7=0.195 MHz
  8=0.098 MHz
  9=0.049 MHz
  10=0.024 MHz
- Interpolation (Integer Steps)
  4=x4
  5=x5
  ↓
  16384=x16384
- AB
  AB=A-quad-B output
- MII58XX (Cable Length)
  MII5810=1m cable
  MII5830=3m cable
  MII5850=5m cable

MII5700, A-quad-B Output, with Resolution* from 5µm to 5nm

MII5710-AB-4000-1-1-0

- Low Pass Filter Roll Off Frequency (kHz)
  0=Off (full bandwidth)
  1=1khz
  2=2khz
  ↓
  100=100kHz
- Limit Logic
  1=Active Low (fail safe)
  2=Active High
- Maximum Output Frequency
  1=12.50 MHz
  2=6.25 MHz
  3=3.125 MHz
  4=1.563 MHz
  5=0.781 MHz
  6=0.391 MHz
  7=0.195 MHz
  8=0.098 MHz
  9=0.049 MHz
  10=0.024 MHz
- Interpolation (Integer Steps)
  4=x4
  5=x5
  ↓
  4000=x4000
- AB
  AB=A-quad-B output
- MII57XX (Cable Length)
  MII5710=1m cable
  MII5730=3m cable
  MII5750=5m cable

Note*: Resolution = 20 µm/interpolation
(see ***Section 6.2 Resolution and Maximum Speed Tables***)
Note: All specifications are subject to change.

How to Order

Sensors

MII5500, A-quad-B Output, with Resolution* from 5µm to 50nm

MII5510-AB-400-1-1-0

- Low Pass Filter Roll Off Frequency (kHz)
  0=Off (full bandwidth)
  1=1khz
  2=2khz
  ↓
  100=100kHz
- Limit Logic
  1=Active Low (fail safe)
  2=Active high
- Maximum Output Frequency
  1=12.50 MHz
  2=6.25 MHz
  3=3.125 MHz
  4=1.563 MHz
  5=0.781 MHz
  6=0.391 MHz
  7=0.195 MHz
  8=0.098 MHz
  9=0.049 MHz
  10=0.024 MHz
- Interpolation (Integer Steps)
  4=x4
  5=x5
  ↓
  400=x400
- AB
  AB=A-quad-B output
- MII55XX (Cable Length)
  MII5510=1m cable
  MII5530=3m cable
  MII5550=5m cable

MII5800Si, Serial Output, with Resolution* up to 1.22nm

MII5810-Si-14-21-1-0

- Low Pass Filter Roll Off Frequency
  (% of Sample Rate)
  0=Off (full bandwidth)
  1=1% of sample rate
  2=2% of sample rate
  ↓
  40=40% of sample rate
- Index Mode
  0=No change to position of index
  1=Position reset at every index
- Number of Fringe Count Bits*
  2=2
  3=3
  ↓
  21=21
- Interpolation Bits*
  2=2
  3=3
  ↓
  14=14
- Si
  Si=Serial Interface
- MII58XX (Cable Length)
  MII5810=1m cable
  MII5830=3m cable
  MII5850=5m cable

Note*: Interpolation bits plus fringe bits must be ≤35 bits.

Note*: Resolution = 20 µm/interpolation
(see ***Section 6.2 Resolution and Maximum Speed Tables***)
Note: All specifications are subject to change.

How to Order

Sensors

MII5800Pa, Serial Output, with Resolution* up to 1.22nm

MII5810-Pa-14-10-1-0

- Low Pass Filter Roll Off Frequency (kHz)
  0=Off (full bandwidth)
  1=1% of sample rate
  2=2% of sample rate
  ↓
  40=40% of sample rate
- Index Mode
  0=Default (no option)
- Number of Fringe Count Bits
  2=2
  3=3
  ↓
  21=21
- Interpolation Bits
  2=2
  3=3
  ↓
  14=14
- Pa
  Pa=Panasonic
- MII58XX (Cable Length)
  MII5810=1m cable
  MII5830=3m cable
  MII5850=5m cable

Sensor Installation Tools

ATMII5000	*Alignment Tool Kit for MII5000 encoders includes: - Alignment Tool - SmartPrecision II Software - USB Cable - Power Supply (100V- 240VAC/50-60Hz)
-US	US=Power supply with US standard 2-prong plug
-EU	EU=Power supply with European standard 2-prong plug
ZG-PP2	Z-Height Gauge, PurePrecision Tape Scales
ZG-GS2	Z-Height Gauge, Glass Scales

Note*: Required for MII5000/MII6000 setup.

Adapter for Open Collector Limit Outputs

MIIA-OCL	Small DB15 adaptor to convert 3.3V left and right limit output signals to open collector type (7407)

End Cap Kit, PurePrecision Tape Scales

EC	Optional Tape Scale End Caps

Tape Scale Applicator Tools (use for lengths > 300mm)

TSAT-PPT	Tape Applicator Tool for applying tape scale

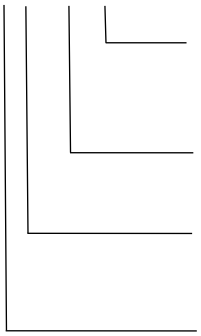
Note*: Resolution = 20 µm/interpolation
(see ***Section 6.2 Resolution and Maximum Speed Tables***)
Note: Interpolation bits plus fringe bits must be ≤24
Note: All specifications are subject to change.

How to Order

Scales

PurePrecision Marker Tape II

MT-N-A-L-9999-I



I = Individual Lengths
C = Continuous reel with index and cut marks (unless otherwise specified)

Length in mm (40mm – 9,999mm)
For lengths >10,000mm, contact MicroE for custom part number

L=Center Index and Limits
I=Center Index Only
C=Custom

A=Adhesive

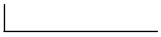
PurePrecision Laser Tape II

TS-3000

Length in mm (40mm – 30,000 mm)

PurePrecision Linear Glass Scales

(Standard accuracy grade)
MIIL-100



Length in mm (10mm – 1,000 mm)

For high accuracy grade scales, contact MicroE.

Note: Index and limit markers must be ordered separately.

Stick-On Index and Limit Markers

(for Laser Tape II and Performance and Value Linear Glass Scales)

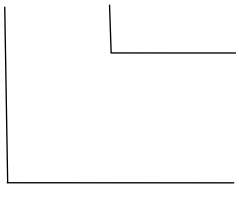
RIMS Qty of 8 Stick-On Index Markers
RLMS Qty of 4 Stick-On Left Limit Markers and
Qty of 4 Stick-On Right Limit Markers

Note: To use RIMS/RLMS, MII5000 must be configured for Reflective Grating Type.

PurePrecision Rotary Glass Scales

(For example: 44.45mm OD Rotary Glass Scale with Hub: MIIR4513-HI)

MIIRxxxx* - Hub



NH=Without Hub
HI=for R4513
HJ=for R6425
HK= for R12151

MIIR4513
MIIR6425
MIIR12151

Note*: Custom Versions are available.
Note: Rotary glass scales are shipped not mounted to hub. Hub mounting is available, contact MicroE Systems for information.
Note: All specifications are subject to change.

8.0 Contacting Celera Motion

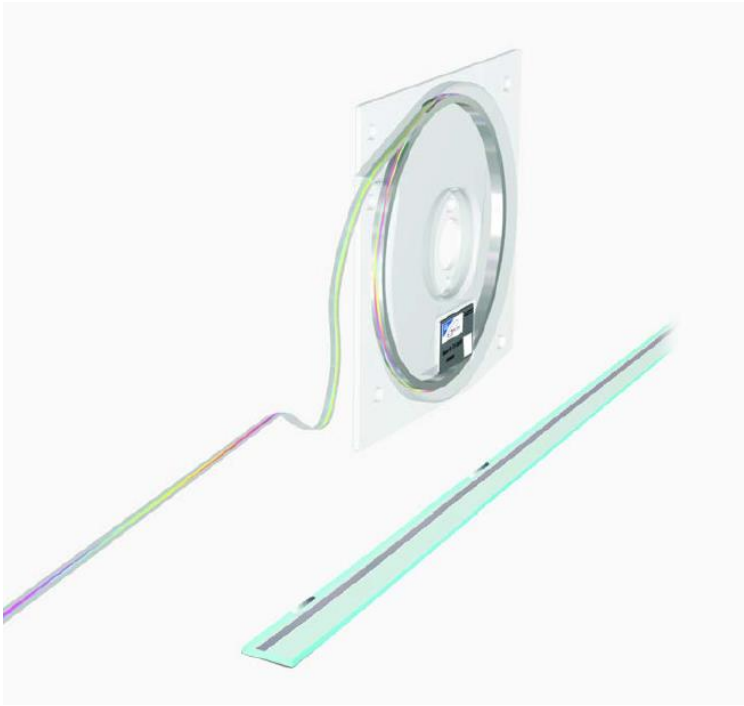
Celera Motion is a world leader in optical encoder technology with offices in major industrial centers around the globe. We deliver enabling technology that brings advanced applications to life in the motion control, medical, semiconductor, electronics, and industrial markets.

To learn more about MicroE encoders, visit www.celeramotion.com.

Celera Motion
World Headquarters & Encoder Center of Excellence
125 Middlesex Turnpike
Bedford, MA 01730-1409 USA
Tel: 781-266-5700
Email: celera_support@celeramotion.com

Mercury II™ PurePrecision™ Tape and Glass Scales

Installation Manual



>CELERAMOTION

IM-MII_PurePrecision_Scales Rev. 1a.docx

125 Middlesex Turnpike | Bedford, MA 01730-1409 USA
Tel: 781-266-5700 | celeramotion@gsig.com

Table of Contents

1.0 Introduction

1.1 Overview

The instructions in this manual apply to the following scales for Mercury II Series Encoders:

- PurePrecision Marker Tape II, Model MT
- PurePrecision Laser Tape II, Model TS
- PurePrecision Linear Glass Scales, Model MIIL
- PurePrecision Rotary Glass Scales, Model MIIR
- Stick-On Index and Limit Markers, Models RIMS/RLMS

Refer to the encoder data sheet or installation manual for details on ordering parts.

1.2 Applicable Encoders

Use PurePrecision Tape and Glass Scales for the following Mercury II Series Encoders:

MII5500	MII5700	MII5800	MII5800Si
MII5800Pa	MII6500	MII6700	MII6800
MII6800Si	MII6800Pa		

1.3 Related Documents

- Mercury II 5000/6000 Series Encoders Data Sheets
- Mercury II 5000/6000 Series Encoders Installation Manual and Reference Guide
- Mercury II 5000/6000 Series Encoders Interface Drawings

1.4 Manual Revisions

Version	Date	Notes
Rev. 1	11/21/2014	Combined PurePrecision Tape and Glass Scales into one installation manual and updated procedures.
Rev. 1a	11/25/2015	Updated document to Celera Motion standards. Updated Manual Revisions table.

1.5 Trademarks

Mercury II™ and PurePrecision™ are trademarks of MicroE Systems®.

1.6 Standards Compliance

Mercury II models are CE and RoHS compliant. *RoHS* CE

1.1 Special Conventions Used

The following symbols *may* be used in this document.

Symbol	Description
	Warning or caution: potential damage to parts.
	Instructions show correct method.
	Instructions show example of incorrect method.
See Section 2.2	Single click with the mouse on these highlighted references to jump to specified places in instructions.

2.0 PurePrecision Rotary Scales

For details on rotary scales, see the following:

- Encoder data sheets
- Encoder interface drawings

The following Tech Notes documents also contain information for using rotary scales.

Tech Note	Description
Design Guidelines for Customer-Supplied Hubs	MicroE Systems offers standard hubs for each of our standard rotary scales. Should customers want to design a hub themselves, this document describes the key factors that should be incorporated into the hubs.
Alignment of Rotary Scales	This document describes two different methods of aligning rotary scales: (1) optically centering the grating pattern track using a CCD camera; and (2) using two sensors to “electrically” center the grating.
Design Guidelines for Customer-Supplied Segment Holders	This document provides design guidelines for customers who want to design their own holders for rotary scale segments.

Go to the following MicroE Systems website to locate the listed Tech Notes:
http://www.microesystems.com/resource/technical-notes.

3.0 PurePrecision Laser Tape II Scale Installation

Use the steps in this section to mount and install PurePrecision Laser Tape II Scales.

3.1 Before Installation

Review the information in this section prior to installing tape scales.

3.1.1 Items Required for Tape Scale Installation

You will need the following items available for PurePrecision Tape Scale installation.

Item	Notes
Index and limit marker strips	1
Finger Cots or talc-free gloves	
Acetone or isopropyl alcohol	
Lint-free cotton cloths or wipes	
Two-part epoxy (Tra-Bond 2116 or equivalent)	
Stick and disposable surface for stirring epoxy	
Shears	2
Tape Applicator Tool	3
End Caps	4

Notes:

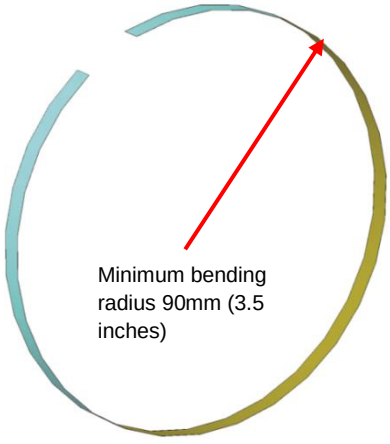
1. Optional for tape and glass scales: limit marker strips, model RLMS; index marker strips, model RIMS.
2. Recommended: Clauss Part Number 18003.
3. Model TSAT-PPT. required for applications >300mm (not required for installations <300mm).
4. Optional for tape scales.

Refer to encoder data sheets or installation manuals for details on ordering parts.

3.1.2 Pre-Installation Information and Precautions

Read all instructions completely before beginning the installation process and follow the instruction sequence throughout the installation process. The PurePrecision Tape Scale is a precision metrological device. Handle it with the utmost care at all times.

- Avoid bending the tape scale to a radius less than 90mm (3.5 inches).
- Avoid twisting the PurePrecision Tape Scale.
- Do not let any sharp object touch the tape scale after the blue protective film is removed.
- The PurePrecision Tape Scale is protected by a blue film on the top that prevents contamination and damage to the grating pattern during installation.
- Once the adhesive on the tape scale is exposed (by removing the adhesive backing), do not touch the adhesive or allow any contamination to come into contact with it.



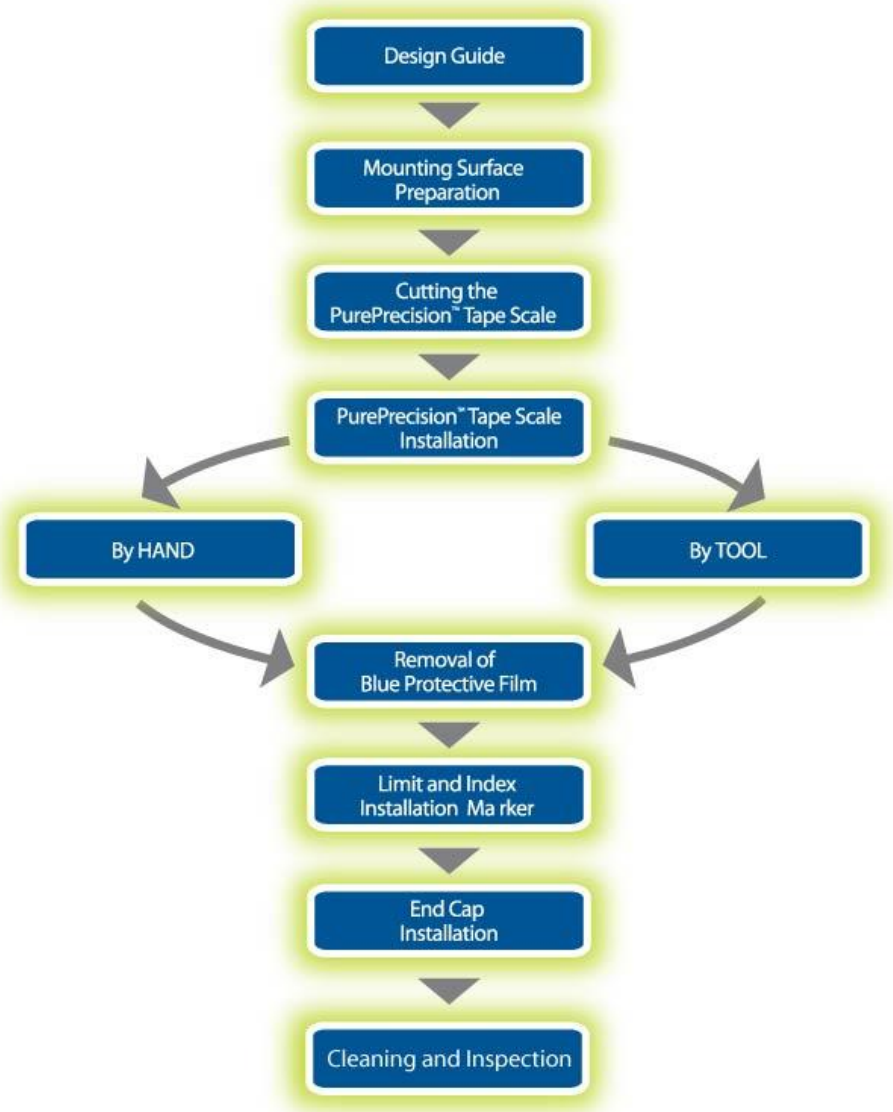
- PurePrecision Tape Scale, Index and Limit Markers are designed for one time installation only.

- If removed from the mounting surface for any reason, they should not be used for any kind of reapplication. This will affect the performance and reliability of the encoder system.

The adhesive on the PurePrecision Tape Scale is permanent:

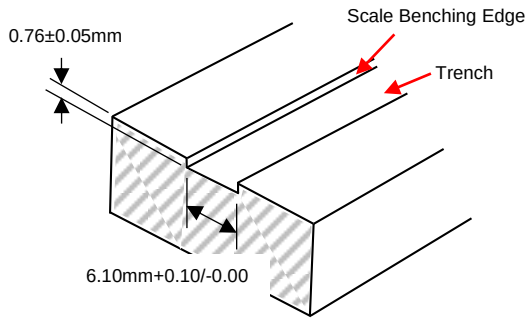
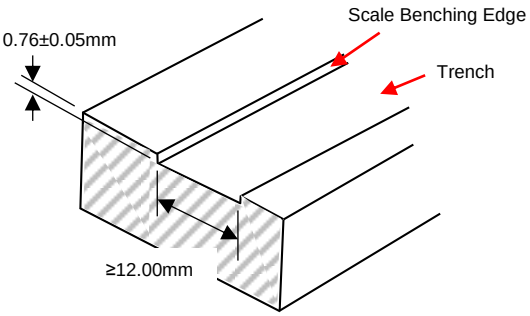
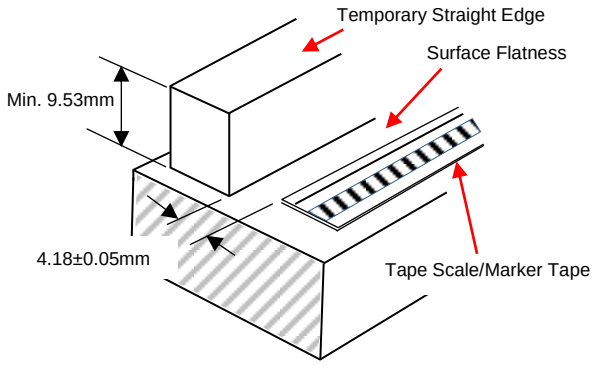
- Do not touch the adhesive once the adhesive backing is removed.
- Do not remove the tape scale from the mounting surface once it has been installed.
- Do not reinstall the tape scale if it has already been installed once. If the tape scale is removed and reinstalled again, the encoder performance will be degraded.
- Avoid any contamination to the adhesive. Any particulate matter or contamination trapped between the scale and the mounting surface will affect encoder performance.

3.1.3 Flowchart for PurePrecision Tape Scale Installation



3.1.4 Design Guide

The following table describes the three basic mounting configurations for tape scale installation. Also, see all guidelines that follow the table.

#	Type of Installation	Example
1	Machined Edge: Trench - Hand Application Only Trench: • 6.1 mm trench: applicator tool is not compatible with 6.1 mm trench, and end caps cannot be used. • Max radius of 0.13 mm required between scale benching edge and bottom of trench. • Benching edge must be parallel to axis of motion to within .05/100 mm. • Trench surface flatness to within .003/10 mm.	
2	Machined Edge: Trench - Use with Tape Applicator Tool Trench: • 12 mm trench. • Max radius of 0.13 mm required between scale benching edge and bottom of trench. • Benching edge must be parallel to axis of motion to within .05/100 mm. • Trench surface flatness to within .003/10 mm.	
3	Temprary Straight Edge – Use with Tape Applicator Tool Temporary straight edge: • Use either your hands or the applicator tool to install the tape scale against a straight edge. • Minimum height of 9.53 mm. • Benching edge must be parallel to axis of motion to within .05/100 mm. • Trench surface flatness to within .003/10 mm. • 4.18±0.05 mm: offset from tape scale to temporary straight edge.	

Guidelines:

- MicroE Systems recommends using an edge as a guide to maintain straightness of the scale during mounting. The edge can be temporary or permanent but must follow above guidelines.
- Use the applicator tool for installation of scales, especially longer than 250 mm, and for all installations against a straight edge. For shorter scales, install by hand or use the applicator tool.

- In #3 above, the outside reference surface of the applicator tool slides against the temporary edge and the tape scale is offset from the edge as shown (4.18 ±0.05 mm). If this offset is too small for the application, create a spacer than can attach to the outside of the tool.
- To ensure successful tape installation: verify all tolerances listed for your installation, and verify the dimensions of the scale benching edge (permanent or temporary).
- Calculate the length of the PurePrecision Tape Scale required for your application using the following formula:

  ML + 40 mm = Length of Tape Scale

  ML - Measuring Length (refer to the encoder interface drawings)

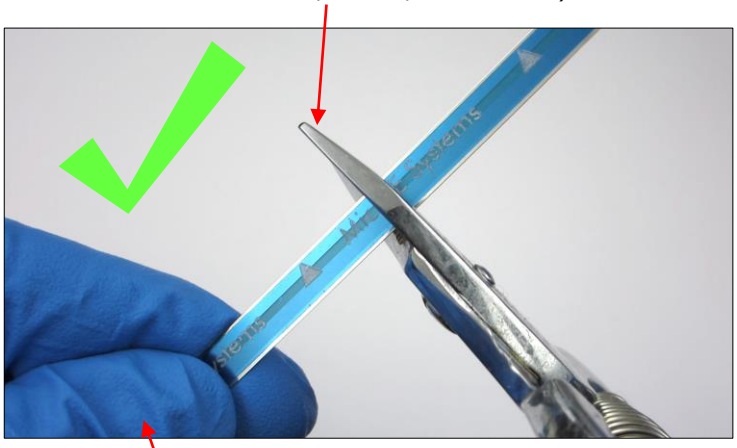
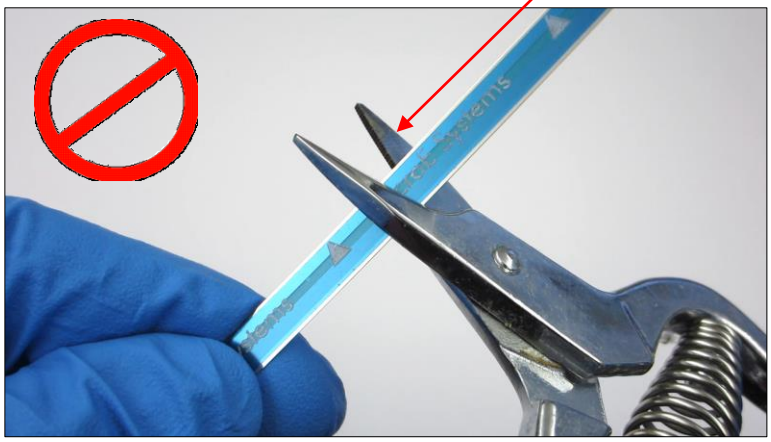
3.1.5 Mounting Surface Preparation

Perform the following steps prior to tape scale installation.

Step	Action
1.	Inspect the mounting surface for any machining irregularities. MicroE Systems recommends a surface finish of better than 3.2 micrometers Ra.
2.	The straight edge (permanent or temporary) must be sharp on the benching side in order for the applicator tool to use it as a guide. In order for the tape scale to be mounted close to the straight edge, use a maximum radius of 0.13 mm (0.005 inches) where the edge meets the bottom of the mounting surface.
3.	Thoroughly clean the scale mounting surface and reference edge using a cotton swab or lint-free cloth dampened with isopropyl alcohol or acetone. Remove all dust and particles.
4.	Mark the starting location on the mounting surface where the tape scale will be applied (the left edge of where the scale will be applied when the scale reference edge is away from you). Also mark the locations where the index and limit markers will be applied. Refer to the encoder interface drawings to identify the reference points of the markers.

3.2 Cut the Tape Scale

Note: When working with any encoder scale, it is important to use finger cots or talc-free gloves.

Step	Action
1.	Uncoil the tape scale and cut it to the required length using the shears provided in the installation kit. **Note**: Check the interface drawing to make sure that the scale is cut to the correct length.
2. 	Securely hold the tape scale close to the shears (at an approximate distance of 40 mm [1½ inches]) near the point of cutting. Orient the tape scale perpendicular to the shear. Shear held perpendicular to the tape scale (NOT INCLINED)  Hand approximately at a distance of 40 mm - 50 mm (1 1/2 inches to 2 inches) from the cutting point
3.	Cut the tape scale in a smooth, continuous motion. Shears held inclined, not perpendicular, to the tape scale 

3.3 Install Tape Scale

When installing tape scale, always perform the following steps to ensure best system performance:

- Wear talc-free gloves or finger cots during all steps of tape scale installation.
- Thoroughly clean the scale mounting surface and reference edge using a cotton swab or lint-free cloth dampened with isopropyl alcohol or acetone.
- Remove all dust and particles.

The tape scale can be installed using one of the following methods:

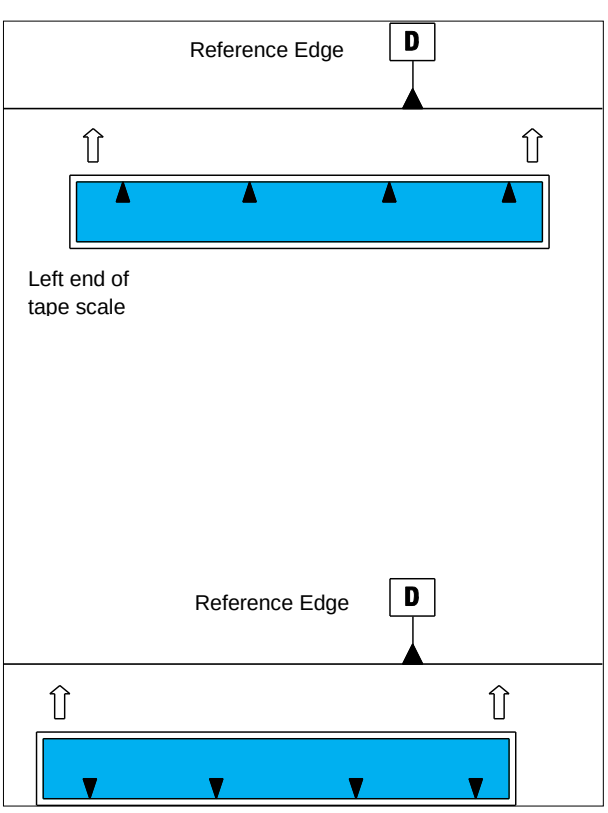
- Manually by hand (see ***Section 3.3.1)***
- Using the Applicator Tool (see ***Section 3.3.2***)

Use ***Section 3.1.4 Design Guide*** to help select the method of installation.

3.3.1 Install Tape Scale Manually

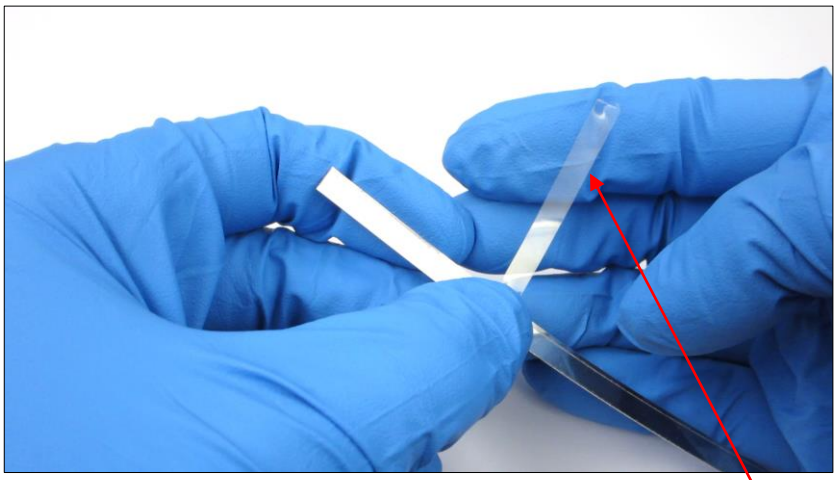
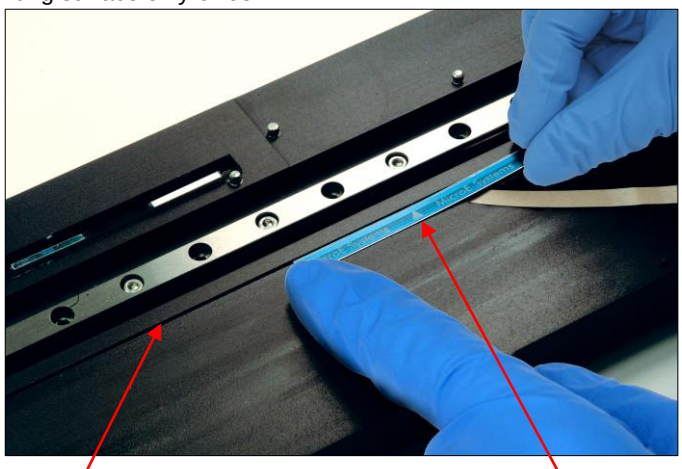
Use the steps in this section to install PurePrecision Laser Tape II Scales manually by hand.

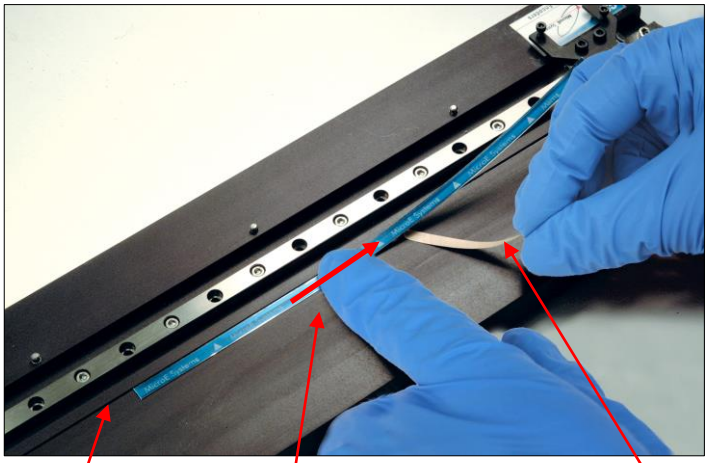
Step	Action
1.	Orient the scale such that the arrowheads on the blue protective film are pointing towards the mounting surface reference edge “D” as shown in the interface drawing for your sensor model. Refer to the correct model number interface drawing for reference edge “D” dimensions and sensor orientation.

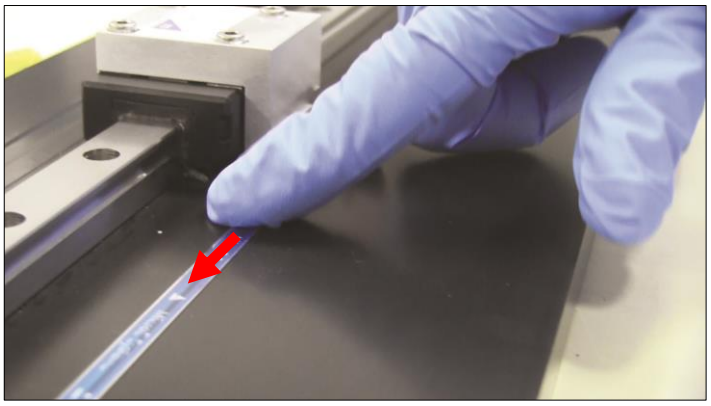
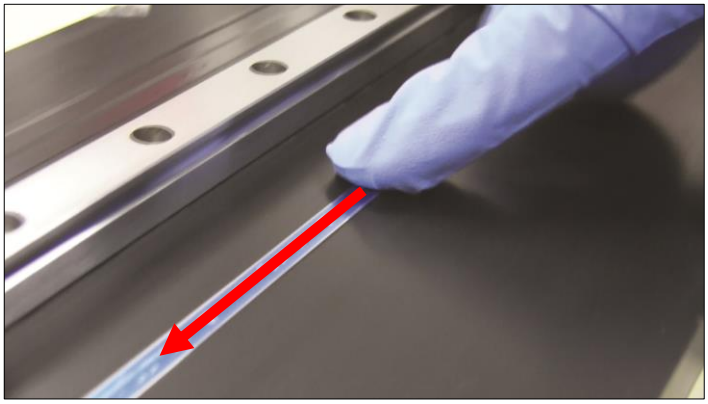


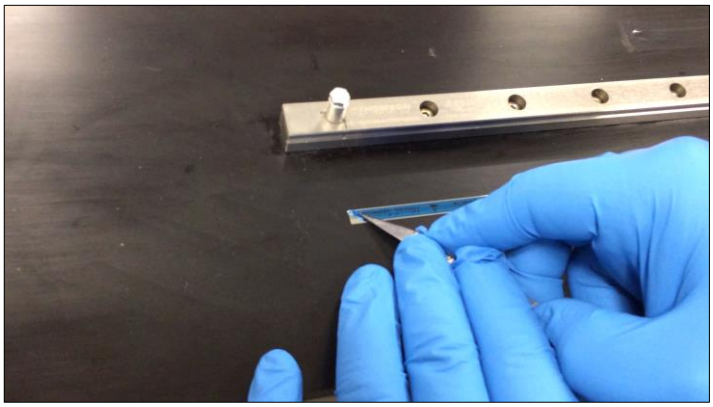
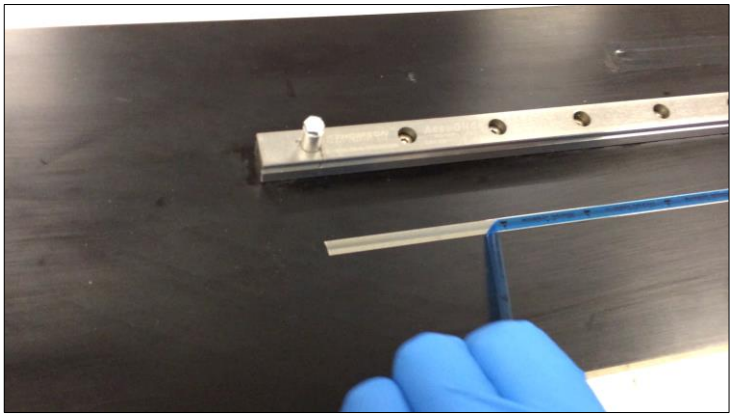
Correct: Arrowheads on the blue protective film are **pointing towards** the mounting surface reference edge.

Incorrect: Arrowheads on the blue protective film are **pointing away** from the mounting surface reference edge.

Step	Action
2.	Remove/peel the bottom adhesive backing: 1. Use a sharp tool or fingernails to start peeling the adhesive backing from the left end of the tape scale. 2. Remove and peel back approximately 25 mm (1 inch) of the bottom adhesive backing, taking care not to touch the adhesive or allow any particulate contamination.  Adhesive backing peeled off about 25 mm (1 inch) from the left end **Note**: Be careful not to expose the adhesive backing more than 50 mm (2 inches). Do not peel the blue protective film off at this time.
3.	Flip the tape over such that exposed adhesive surface of the tape scale (surface from which the adhesive backing was removed) faces the desired location where the tape needs to be attached.
4.	Place the tape scale on the mounting surface reference edge: Place the 25 mm (1 inch) exposed adhesive left end of the tape scale against the mounting surface "D" reference edge at the desired starting location and press firmly on the end. **Note**: Adhesive exposed by removing the adhesive bottom backing can touch the mounting surface only **once**.  "D" reference edge as shown in the encoder interface drawing Tape scale orientation arrow

Step	Action
5.	Install the PurePrecision Tape Scale along the remaining length of the mounting surface: 1. With one hand pull the adhesive backing progressively away from the scale while the other hand slides evenly along the scale. 2. During the sliding motion, press the remaining tape on to the mounting surface and pull the adhesive backing out of the way. **TIP**: Maintain a gap of approximately 25 mm – 35 mm (1 – 1½ inches) between the two hands as you progress along the length of the tape scale. **Note**: Be sure to keep the blue top protective film in place. Make sure that the tape scale is tight against the "D" reference edge.  "D" reference edge as shown in the encoder interface drawing Sliding motion of finger progressively along the length of the tape Pull adhesive backing out of the way during sliding. No obstruction between tape scale and mounting surface. Once the tape has been installed, discard the adhesive backing.

Step	Action
6.	Once the scale is applied to the mounting surface and before the blue protective film is removed, apply even pressure over the entire tape scale length by sliding a glove or cot-protected finger across the scale. The applied pressure will ensure that the adhesive is set evenly and permanently.  Slide across scale to apply even pressure  Performing this operation more than once is not necessary but will not have an adverse effect.

Step	Action
7. 	Peel off the blue protective film: Start the peeling process using a sharp tool, being careful not to damage the scale. Pull off the remaining blue protective film.  Pull off remaining blue film 
8.	After removing the blue protective film, the scale is ready for use and will perform to specification. The encoder will not function properly with the blue protective film installed. It must be removed for proper encoder operation.

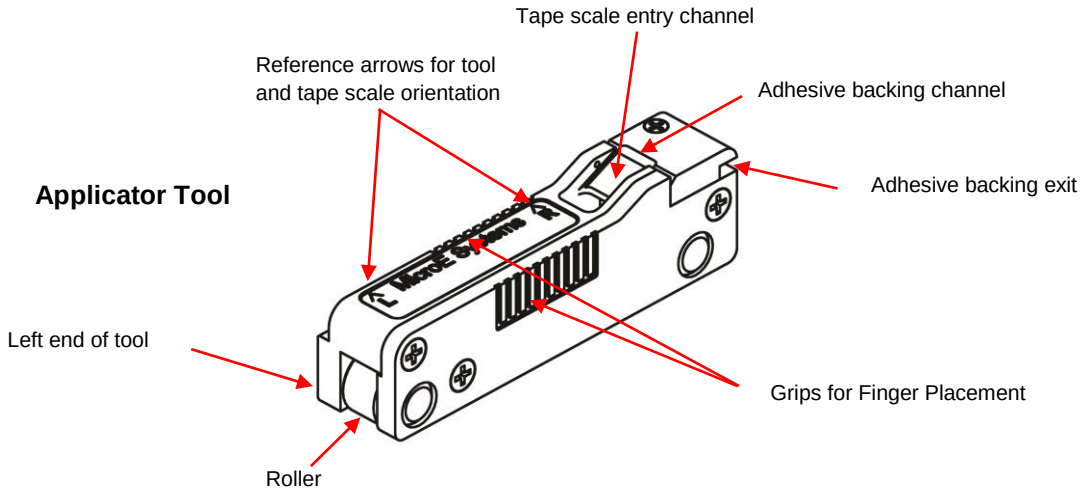
If installing Laser Tape II index/limits, go to ***Section 5.0 Stick-On Index and Limit Markers Installation.***

3.3.2 Install Tape Scale Using the Applicator Tool

Use the steps in this section to install PurePrecision Laser Tape II Scales using the hand-held Applicator Tool. (See ***Section 3.1.4 Design Guide*** for details on scale mounting.)

The Applicator Tool

The Hand-Grip Applicator Tool (Model TSAT-PPT) is needed for tape scale lengths greater than 300 mm and recommended for lengths of 250 mm. It is designed to be handheld and to slide along either a permanent or temporary mounting edge while the tape scale is supplied.



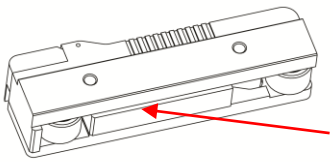
Applicator Tool Mounting Surface Guide Edges

The applicator tool has two guide edges:

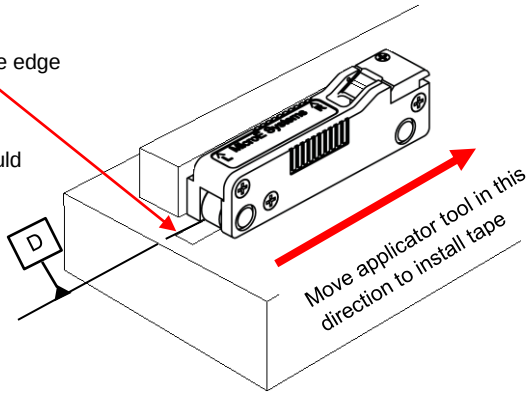
- Low guide edge for configurations of thickness 0.76 mm (0.030 inches)
- High guide edge for configurations of thickness greater than 9.5 mm (.375 inches)

Refer to the encoder Interface Drawings for tape scale reference edge "D."

Low Guide Edge

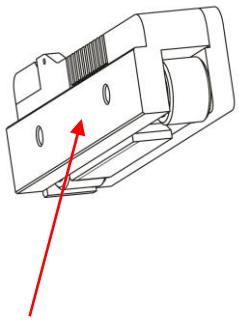


Low guide edge of tool should be in contact with mounting surface edge of thickness 0.76 mm (0.030 inches)

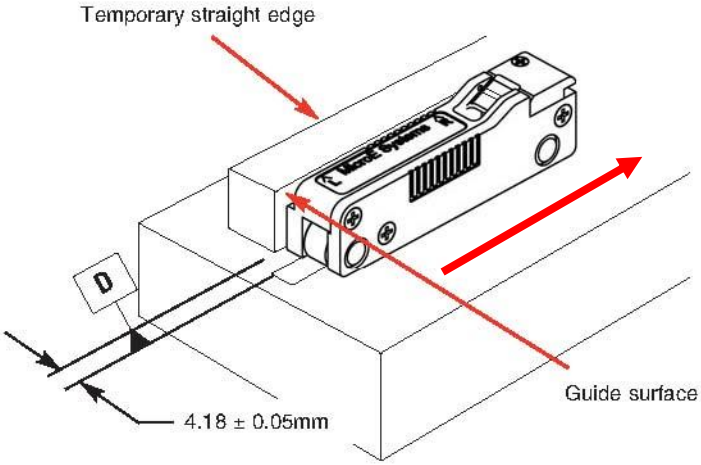


Note: The low guide edge also corresponds to the "D" tape scale reference edge in the interface drawing.

High Guide Edge Surface

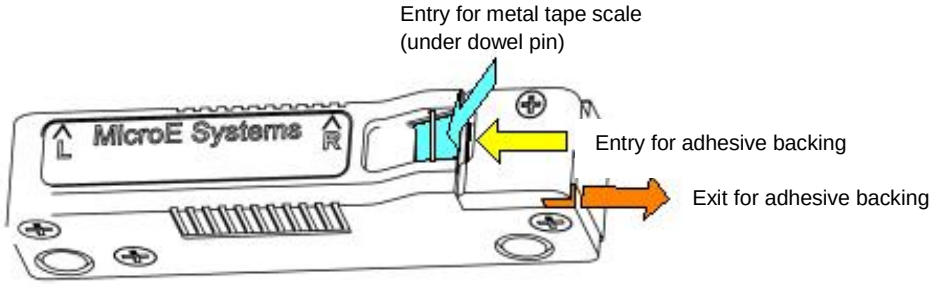


High guide surface of tool. Mounting surface reference edge higher than 9.5 mm (0.375 inches)



Tape Travel Path

The path for the tape scale through the Applicator Tool is shown in the following diagram.

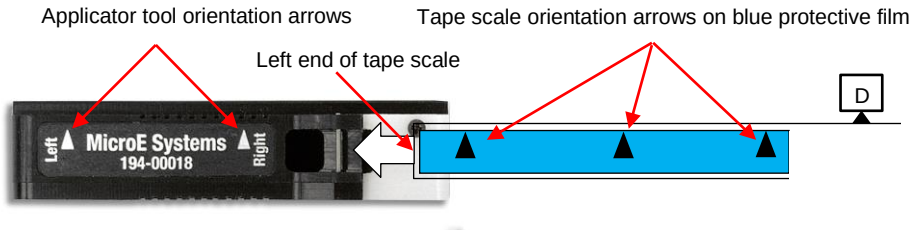
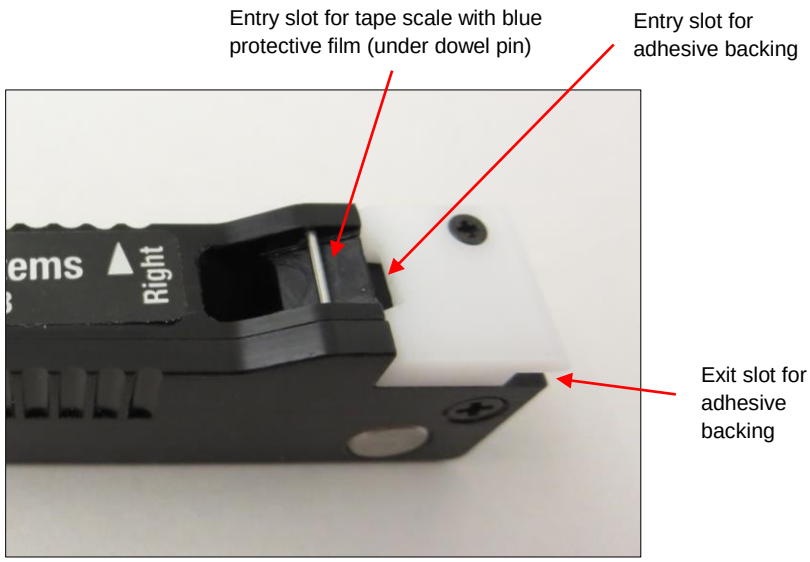


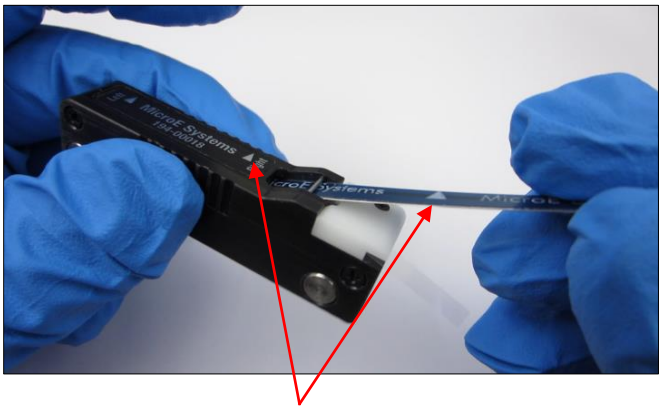
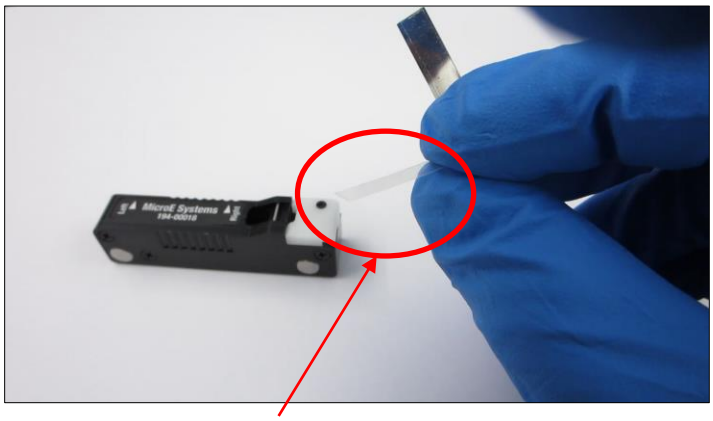
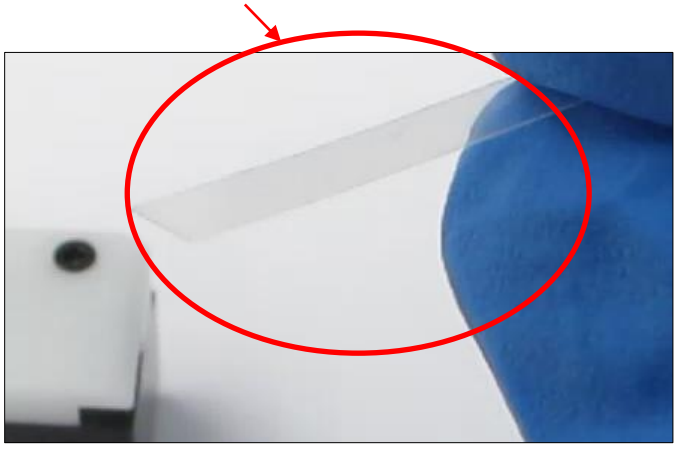
Install Tape Scale

When orienting the tape, both tape scale arrows and applicator tool orientation arrows need to point in the **same direction** for proper orientation.

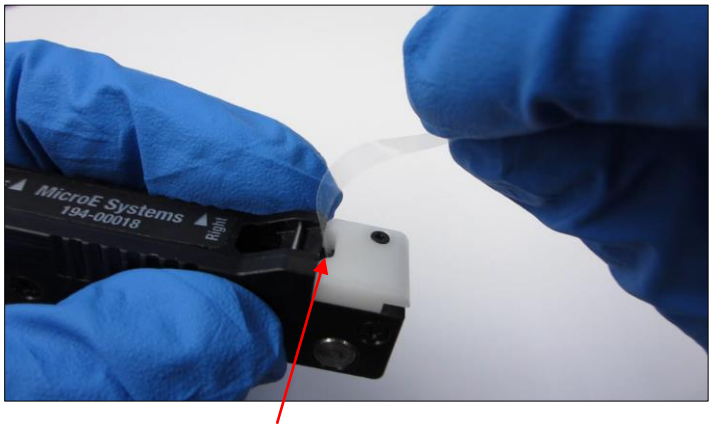
Note: The tape scale orientation arrows always point to the "D" reference edge in the interface drawing.

Make sure that the applicator tool is free of any particulate contamination.

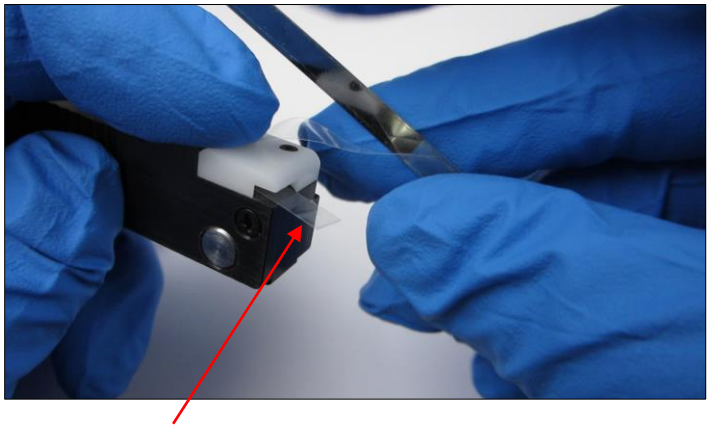
Step	Action
1.	Orient the applicator tool and tape scale: With the mounting surfaces reference edge away from you, insert the tape scale in the applicator tool so that arrowheads are pointing away from you as shown. The arrowheads on the applicator tool should also point away from you. In the example shown below, the left end of the tape scale will go into the applicator tool entry channel first. Correct orientation of the applicator tool is the "MicroE Systems" label to the left and the white-colored end to the right.  D = Tape Scale Mounting Surface Reference Edge (See encoder interface drawings)
2.	PurePrecision tape scales have 4 layers: blue protective film, Inconel (metal) scale, adhesive, and adhesive backing. The top two layers fit under the dowel pin, while the bottom adhesive backing fits into the backing slot as shown below. 

Step	Action
3.	Determine the correct end of the tape scale to insert into the applicator tool entry slot. The correct end is determined by the direction of the orientation arrows on both the tape scale blue protective film and the applicator tool arrows. Both sets of arrows have to point in the same direction.  Correct orientation – all arrows point in same direction
4.	From the left end (arrows are pointing away) of the tape scale, peel and curl back 50-75 mm (2-3 inches) of the adhesive backing as shown. Take care not to touch the adhesive on the bottom of the tape scale or allow any particle contamination. **Note**: **Do not** peel the blue protective film off at this time.  Peel and cut back 50-75 mm (2-3 inches) of the adhesive backing 

Step	Action
5.	Feed the adhesive backing into the applicator tool.

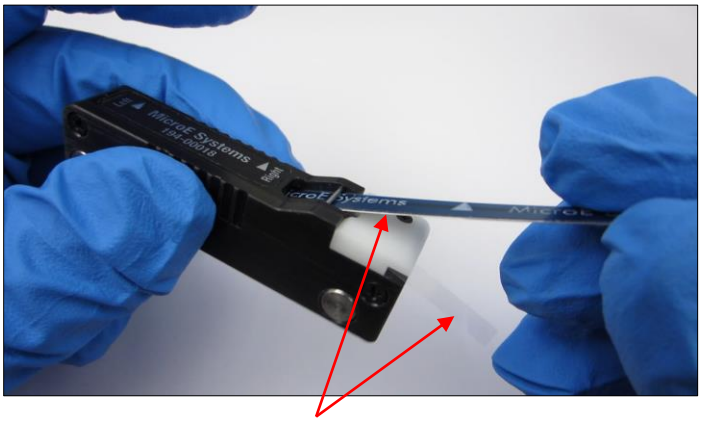


Adhesive backing inserted into backer slot



Adhesive backing exiting from backer slot

Step	Action
6.	Insert the tape scale (with blue protective film) under the dowel pin and into the entry slot.  Dowel pin and entry slot  Tape inserted

Step	Action
7.	Feed tape scale into the applicator tool until the end of the tape is past the front roller.  Tape inserted with adhesive backing exiting  Tape scale fed past front tool roller.
8.	Apply tape scale with the hand grip applicator tool: Once the applicator tool is configured with the adhesive backer exiting from the exit slot and steel tape extending past the front tool roller, the scale is ready to be installed on the mounting surface.  Applicator tool correctly configured for installation

Step	Action
9.	Place applicator tool along reference edge and firmly press down on mounting surface.  High guide edge face Applicator tool pressed down and against high guide edge
10.	Slide tool along guide edge face (in direction shown) with a slow and even pressure motion until all of the tape is installed on the mounting surface. Be sure the adhesive backing film does not bunch up and jam inside the tool and exits freely from the exit slot.  Applicator tool in motion against guide edge face
11.	Once the scale is applied to the mounting surface, and before the blue protective film is removed, it is recommended that even pressure be applied over the entire tape scale length by sliding a glove-protected finger or the applicator tool across the scale. The applied pressure will ensure that the adhesive is evenly and permanently set.
12.	Peel off the blue protective film: Start the peeling process using a sharp tool, being careful not to damage the scale. Pull off the remaining blue protective film. Clean the tape scale using alcohol or acetone and a lint-free cotton cloth.
13.	Precautions: • If scale damage has occurred, the tape scale may need to be replaced. • The ends of the tape scale can be covered and secured with an end cap. • Clean the tape scale using alcohol or acetone and a lint-free cotton cloth. • Tape scales cannot be reused if removed from mounting surface.

If installing Laser Tape II index/limits, go to ***Section 5.0 Stick-On Index and Limit Markers Installation.***

4.0 PurePrecision Linear Glass Scales Installation

Use the steps in this section to mount and install PurePrecision Linear Glass Scales.

4.1 Before Installation

Review the information in this section prior to installing PurePrecision Linear Glass Scales.

4.1.1 Items Required for Glass Scale Installation

You will need the following items available for PurePrecision Glass Scales installation.

Item	Notes
Index and limit marker strips	1
Finger Cots or talc-free gloves	
Acetone or isopropyl alcohol	
Lint-free cotton cloths or wipes	
Two-part epoxy (Tra-Bond 2116 or equivalent)	
Stick and disposable surface for stirring epoxy	
Silicone adhesive	

Notes:

1. Optional for tape and glass scales: limit marker strips, model RLMS; index marker strips, model RIMS.

Refer to encoder data sheets or installation manuals for details on ordering parts.

4.1.2 Mounting Surface Preparation

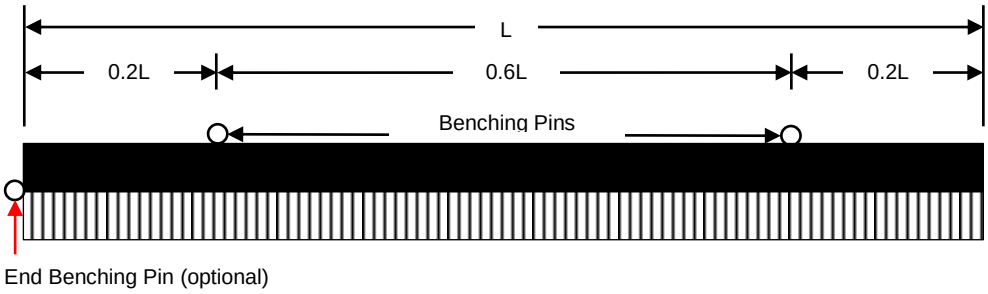
Perform the following steps prior to mounting the glass scales (for non-adhesive backed glass scales).

Step	Action
1.	Inspect the mounting surface for any machining irregularities. MicroE Systems recommends a surface finish of better than 3.2 micrometers Ra.
2.	MicroE Systems recommends a mounting surface flatness of 0.0001 inch/inch.
3.	Thoroughly clean the scale mounting surface and reference edge using a cotton swab or lint-free cloth dampened with isopropyl alcohol or acetone. Remove all dust and particles.

4.2 Mount Linear Glass Scales

Note: Use talc-free gloves or finger cots to handle the scales.

Step	Action
1.	Permanently attach MicroE Systems linear glass scales to the mounting surface using epoxy and silicone adhesive.

Step	Action
2.	Two benching pins are recommended on the long side of the scale and one at the end as shown below. “Benching" the scale to the system means aligning the scale by means of benching pins. 
3.	Position the benching pins inward from either end of the scale. 20% of the overall scale length is the recommended location from the edge.
4.	Be sure the benching pins do not exceed the height of the scale to prevent mechanical interference with the sensor or sensor mount.

4.3 Install Linear Glass Scales

Use the following instructions to install linear glass scales.

Step	Action
1.	Make sure that the mounting surface is dry and clean.
2.	Align the scale by placing the edges against the benching pins. Optionally, scale clamps may be used to secure the scale while the adhesive cures.
3.	Apply a hard epoxy, such as Tra-Bond 2116, at one point on the scale. If no end benching pin is used, epoxy at the index mark is suggested. If an end benching pin is used, epoxy at the end of the scale where the pin is located is suggested. Then apply 100% Silicone RTV adhesive around the edges of the scale. **Caution**: Do not allow epoxy to seep under the scale as this will affect scale flatness and therefore, encoder accuracy.
4.	After adhesive curing, remove the scale mounting clamps.

If installing Laser Tape II index/limits, go to ***Section 5.0 Stick-On Index and Limit Markers Installation.***

5.0 Stick-On Index and Limit Markers Installation

This section provides instructions for installing stick-on index and limit markers for PurePrecision Laser Tape II Scales and Linear Glass Scales. The markers come in strips with the following models names:

- RIMS - Reflective Index Markers
- RLMS - Reflective Limit Markers

Note: For tape scale, make sure the blue protective film is removed before installing markers.

5.1 Stick-On Marker Strips

Stick-On Index and Limit Markers for PurePrecision Laser Tape II (HPTS):

Index Marker Strips, Model RIMS

Index Strip: 8 Index Markers

Limit Marker Strips, Model RLMS

Limits Strip: 4-Left and 4-Right*

Note*: Limit markers have different reflectivity values for left and right markers.

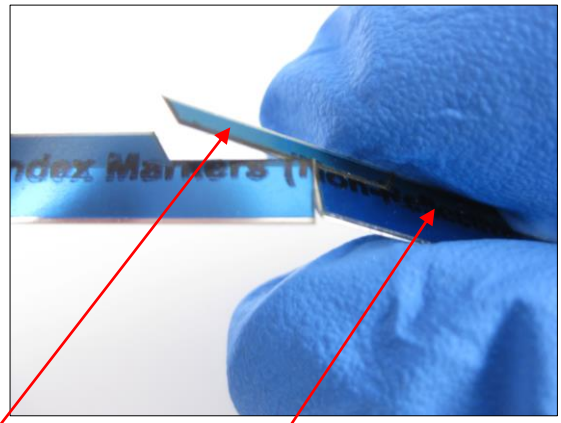
5.2 Remove Markers from Strip

Index/limit markers must first be removed from the stick-on marker strip.

Note: Index marker is used in this procedure, but the procedure is the same for limit markers.

Note: Put on finger cots before starting the index and limit markers installation.

Step	Action
1.	Begin by holding the Limit and Index Marker strip so that the blue protective film is on top and the reflective surface is on the bottom.

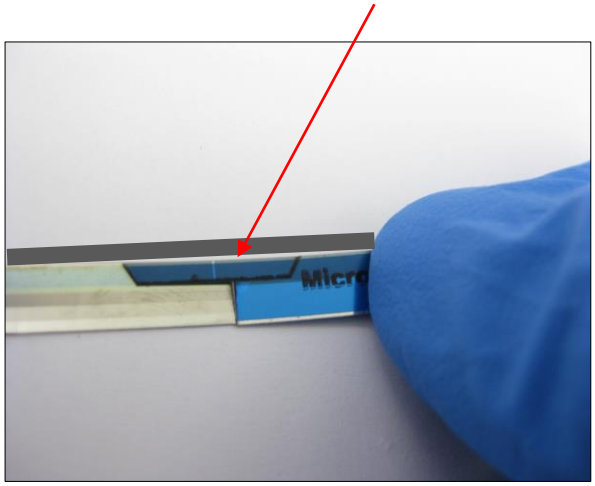
Step	Action
2.	Starting from the handle, slowly remove the index marker from the strip by gently twisting the strip in the area of the marker.  Stick-On Index Handle Section **Note**: Be sure to hold the index and limit markers by the **handle only.** The adhesive on the handle can be touched, however be careful not to touch the adhesive on the areas of the markers that will be applied to the scale. **Result**: The marker will pull away from the transparent adhesive backing. Holding only the handle, slowly pull the index marker from the strip.

5.3 Attach Markers to Scale

Once marker is removed from strip, attach the marker to the tape or glass scale.

Note: For tape scales, remove the blue protective film before installation of markers.

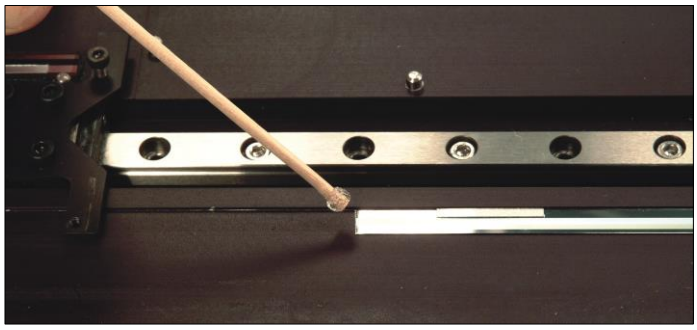
Note: For benching requirement, see the encoder interface drawings. The benching edge corresponds to the “D” reference edge in the interface drawings.

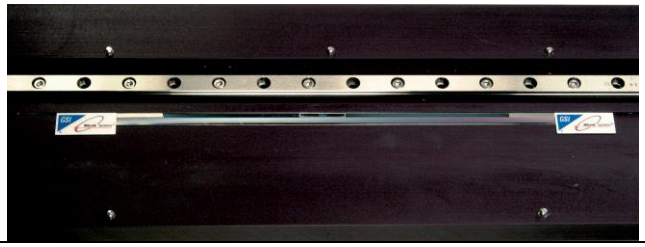
Step	Action
1.	Place the top edge of the marker at the top against the benching edge, holding it at a 45° angle as shown below. This keeps the adhesive away from the scale until the marker is in the correct position and you press it into place. **Note**: The scale is installed with an offset from its reference edge, a temporary reference edge surface such as a small metal block must be used for the index and limit markers. Benching Edge (“D” reference edge) 
2.	When the marker is tight against the reference edge, press the marker onto the scale with your finger.
3.	Press your finger on the marker close to the edge of the handle. Then, with your other hand, pull up on the handle to detach it from the marker. The handle will break away from the marker. 

Step	Action
4.	Carefully remove the blue protective film from the marker surface. **TIP**: Use fingernails or plastic tweezers to remove blue protective film, but do not use a hard metal object. Using a hard metal object might damage the grating on the scale or the marker.  Attached Marker with Handle Removed
5.	To apply left and right limit markers, repeat steps 1 through 4.

6.0 End Caps Installation

Perform the following steps to install optional End Caps on tape scale.

Step	Action
1.	Epoxy Setup: 1. Mix the two-part epoxy and place it in a syringe or on the end of a stick. Do not use a cotton swab to apply the epoxy. 2. Put epoxy on the end of the scale. Make sure that the epoxy touches both the mounting surface and the scale across the width of the scale. **Note**: Only apply epoxy at the ends of the tape scale. Do not get any epoxy on the tape scale in the measuring area.  Perform the next step **immediately** while the epoxy is still in a liquid state.

Step	Action
2.	Install the End Caps on the Mounting Surface: 1. Remove the adhesive backing from end cap. 2. Place the end cap on the top of the scale and epoxy so that the end of the scale is in the middle of the end cap. 3. Press down lightly to ensure adhesion and let cure for 24 hours.  

7.0 Final Cleaning, Inspection, and Cure Time

Before using the encoder for servo control, clean the scale, index marker, and limit markers using alcohol or acetone and a lint-free cotton cloth or swab. Finally, inspect the scale's surface for scratches, adhesive spots or smears in the measuring length.

For tape scales, a cure time of 12 hours is required for the scale's pressure-sensitive adhesive to achieve the best performance and reliability.

7.1 Reworking to Correct Mistakes

Once installed, the scale, index marker, and limit markers cannot be moved or removed and reinstalled. Reworking will require removal and discarding of the old scale or markers, and installation of new ones.

If only the index or limit markers have to be replaced, the scale can remain in place and be reused so long as there is no damage to the scale's surface. Do not use a tool made of metal or other hard material to remove the markers. Clean the scale's surface completely of any adhesive residue before applying new markers.

7.2 Cleaning Scales

Step	Action
1.	General Particle Removal: Blow off any contamination with nitrogen, clean air, or a similar gas.
2.	Contamination Removal: Use a lint-free cleanroom wipe or cotton swab dampened with isopropyl alcohol or acetone to wipe the surface clean. Handle the scale by the edges. **Do not** scrub the scale.

8.0 Contacting Celera Motion

Celera Motion is a world leader in optical encoder technology with offices in major industrial centers around the globe. We deliver enabling technology that brings advanced applications to life in the motion control, medical, semiconductor, electronics, and industrial markets.

To learn more about MicroE encoders, visit www.celeramotion.com.

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