Mercury II™ 6000 Series Encoders
High Performance Encoders with Digital Output

Mercury II: The Next Generation
High Resolution Digital Output

MicroE Systems revolutionized encoder technology with the original Mercury™ series. Smaller, faster, and smarter than anything before, it set the standard for innovation. Now Mercury II, MicroE Systems newest series of reflective incremental encoders, takes another giant step forward by giving you “best-in-class” performance, unparalleled versatility, superior robustness, and unmatched ease of use. You get all of this from a single encoder system.

Specifications

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Linear: 5μm to 1.22nm</th>
<th>Rotary: 20k to 268M CPR*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linearity</td>
<td>Tape Scale: ± ± 5μm/m**</td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>Glass Scales: Linear: ± 1μm available</td>
<td></td>
</tr>
<tr>
<td></td>
<td>± 1.5μm to ± 5μm standard</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rotary: Up to ± 2.1 arc-sec</td>
<td></td>
</tr>
<tr>
<td>Outputs</td>
<td>A-quad-B, Index Pulse, Dual Limits, and Alarm (MII6500/6700/6800/6000V)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High Speed Serial Word in two serial interfaces (MII6800Si/Pa)</td>
<td></td>
</tr>
<tr>
<td>Scales</td>
<td>Same Sensor for Tape or Glass, Linear or Rotary</td>
<td></td>
</tr>
</tbody>
</table>

* More is possible with custom diameter grating
**Over any one meter of travel after slope correction in customer’s controller

Optional Features

- Tape scale length - up to 30m per dispenser
- Glass scale length or diameter: linear lengths from 10mm to 1m or custom sizes. Rotary diameters from 44mm to 121mm or custom sizes
- Sensor cable length of 1m, 3m, 5m, or custom lengths
- SmartPrecision™ II Software

System Features at a Glance

- Mercury II 6000 Series Encoders consists of:
  - MII6500/6700/6800 - A-quad-B Outputs
  - MII6800Si/Pa (Pa - Panasonic) - High Speed Serial Interfaces
- Serial interface for Panasonic MINAS A4 and A5 series servo drives (for use with linear axes)
- High-resolution interpolated digital output directly from the sensor; resolution from 5μm to 1.2nm
- Extremely low cyclical error - only ± 20nm - provides smooth velocity control
- Small sensor - 8.2 mm tall sensor fits tight spaces (8.1 mm – 6000V)
- Faster - up to 5m/s at 0.1μm resolution (MII6000). Up to 10 m/s at 1.2nm resolution (MII6800Si/Pa)
- Smarter - programmable resolution in integer steps for MII6000; in binary steps for MII6800Si/Pa
- Cut-to-length Marker and Laser tape scale come in dispensers up to 30m
- Linear glass scales for high accuracy
- Built-in and Stick-on optical index and left/right limits
- Bi-directional optical index is repeatable to 1LSB
- Low power consumption, low heat generation at the sensor
- Status LEDs in connector show encoder status at a glance

The Mercury II 6000 (MII6000) Series Encoders represents a breakthrough in performance, offering class-leading resolution and accuracy, digital output, the smallest sensor size, unmatched versatility, robustness, smart programmable features, and easy installation.
Mercury II™ 6000 Series Encoders
High Performance Encoders with Digital Output

System Configurations
Standard and Optional Equipment

Standard Equipment

Encoder Sensor
Same sensor for linear tape, linear glass, or rotary glass scales.

Sensor Cable
The standard high flex life cable is double shielded and available in lengths of 1m, 3m, 5m, or custom.

Connector
RS-422 compliant 15-pin standard D-sub connector.
Built-in status LEDs show the encoder’s operational status at a glance, at all times.

Optional Equipment

SmartPrecision II™ Software
The software performs setup and diagnostics, includes displays for encoder output, multiple data plots, and is used for programmable functions. It is built into the ATMII5000 Alignment Tool; use is optional. See Page 12 for details. Requires Ethernet cable.

Installation Accessories

SmartPrecision™ Alignment Tool for Setup - ATMII5000
- Provides fast and easy sensor alignment, index setup, and limit setup.
- Status and setup LEDs: red/yellow/green signal strength LEDs assist during setup and provide diagnostics at a glance; status LEDs for both limits; power-indicating LED.
- Includes AC/DC power supply (not shown).
- Use pushbutton or software for setup.
- Built-in SmartPrecision II Software for setup and diagnostics; only a web browser is needed (use of software is optional).
- Ethernet software connectivity supports remote connection to the Alignment Tool and MII6000 Series Encoders and multiple encoders/computers.

Note: Alignment Tool and software not for use while in servo control.

Tape Scale Applicator Tool

Tape Scale Shears
Mercury II™ 6000 Series Encoders
High Performance Encoders with Digital Output

Features at a Glance
The Mercury II 6000 Series Encoders is built on the field-proven Mercury technology platform. Known for being smaller, smarter, and faster, Mercury II builds on the original Mercury series and adds increased performance, versatility, robustness, and ease-of-use.

Mercury II 6000 Series Encoders features include:

- Small, low-mass sensor with ultra-low Z-height fits in compact motion systems.
- Superior resolution and accuracy - resolutions up to 1.2nm (linear), 268M CPR (rotary); cyclic error of ± 20nm typical (linear glass scales); long range accuracy up to ± 1µm (linear glass scales up to 130mm long).
- High-speed operation - 5m/s at 0.1µm resolution (Quadrature Output); 10m/s at 1.2nm resolution (Serial Output).
- Versatility - one sensor works with tape or glass scales, linear or rotary.
- Broad sensor alignment tolerances and the alignment tool’s built-in red/yellow/green setup LEDs and pushbutton setup, make setup fast and eliminate ancillary setup instruments.
- Low sensor power consumption and heat generation – electronics in the sensor are minimized to achieve the lowest possible power consumption and associated heat generation, making the motion stage more thermally stable. Sensor power consumption is just 50mA at 5V DC. Power supply: for quadrature output, 180mA with A, B, I, LL, and RL outputs terminated for the whole encoder system; for serial output, 172mA system total with all outputs terminated.
- Adhesive-mount laser tape scale supplied in continuous lengths for cut-to-length convenience and inventory savings; mounts on virtually any surface - metals, granite, glass, composites, or ceramics.
- Stick-on optical index and limit markers can be placed anywhere required, are easy to apply, and require no adjustment; markers work on both laser tape and linear glass scales.
- Status LEDs in the connector show encoder signal strength and limit status at a glance.
- Robustness features include all differential digital outputs, all digital signals from the sensor, and double-shielded cabling for superior EMI/RFI immunity; scale contamination resistance ensures encoder operation even with fingerprints, oil, dust and other forms of contamination.
- Fail-safe dual optical limits have differential outputs (LVTTL) and reduce motion system cabling; index and limit markers fit right on the 6mm wide tape scale for maximum space savings.
- Optional MIIA-OCL Adapter converts LVTTL limit signals to open-collector.
- Included software makes setup and diagnostics easy; Ethernet connectivity allows you to use any computer.
Smallest Sensor, Lowest System Height, Smallest Tape Scale System, Broader Alignment Tolerances, and More

Why Mercury II Encoders make it Easier to Design High Performance into Your Equipment

Mercury II Can Reduce System Size and Cost
Mercury II 6000 Series system height with tape scale is 28% shorter than competitive encoders, making it easier to fit into your design. This reduction can also cut motion system weight and cost by allowing the use of smaller motors and stages. Mercury II 6000 Series optical index and limit markers are placed within the 6mm width of the tape scale, saving even more space by eliminating external index and limit magnets.

Lowest System Height

Mechanical Dimension Comparison*

<table>
<thead>
<tr>
<th></th>
<th>Mercury II 6000 with Tape Scale</th>
<th>Brand X</th>
<th>Brand Y</th>
<th>Mercury II vs. Best Competitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>System height</td>
<td>9.6mm</td>
<td>12.3mm</td>
<td>18.2mm</td>
<td>28% better</td>
</tr>
<tr>
<td>Sensor Z height</td>
<td>8.2mm</td>
<td>10mm</td>
<td>12.0mm</td>
<td>22% better</td>
</tr>
<tr>
<td>Standoff tolerance</td>
<td>± 0.15mm</td>
<td>± 0.15mm</td>
<td>± 0.1mm</td>
<td></td>
</tr>
<tr>
<td>Tape scale width**</td>
<td>6.0mm</td>
<td>13.5mm</td>
<td>21.0mm</td>
<td>125% better</td>
</tr>
</tbody>
</table>

*Based on published specifications for encoders with digital output
**Tape scale system width including index and limits

Eliminate the Frustration of Touchy Encoder Alignment
With Mercury’s patented PurePrecision™ optics, you can push the sensor against your reference surface, tighten the screws and you’re finished: try that with Brand X or Y.

This performance is possible thanks to relaxed alignment tolerances, particularly in the theta Z axis. Mercury II offers a ± 2° sweet spot – that’s a 300% improvement over the best competitive encoder – that will result in dramatic savings in manufacturing costs.

No other commercially available encoder is easier to align, easier to use, or easier to integrate into your designs.

Alignment Tolerance Comparison*

<table>
<thead>
<tr>
<th></th>
<th>Mercury II **</th>
<th>Brand X</th>
<th>Brand Y</th>
<th>Mercury II vs. Best Competitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>theta Z</td>
<td>± 2.0°</td>
<td>± 0.5°</td>
<td>± 0.006°</td>
<td>300% better</td>
</tr>
<tr>
<td>theta Y</td>
<td>± 1.0°</td>
<td>± 1.0°</td>
<td>± 0.1°</td>
<td></td>
</tr>
</tbody>
</table>

*Based on published specifications for encoders with digital output.
**Measured at a constant temperature for one axis at a time with all other axes at their ideal positions.

The MII6000 Series Encoders use advanced electronics, giving MII6000s the lowest power consumption of any high-performance digital-output encoder:

- Lowest heat generation/dissipation
- Cost and size savings in the controls/drives
- More system design flexibility

Note: MII6800Si shown with all signals terminated. Brands X, Y, and Z shown with A, B, and I terminated.
## Specifications

### Resolution and Maximum Speed Tables - Quadrature Output

Mercury II 6000 systems (models 6000V/6500/6700/6800) have programmable interpolation from x4 to x16384 in integer steps. Below are tables of sample values. For applications requiring up to 10m/s at full resolution, use the MII6800Si/Pa with high speed serial interface.

#### Linear – 20μ Grating Pitch

<table>
<thead>
<tr>
<th>Maximum Interpolation</th>
<th>Resolution</th>
<th>Maximum Speed</th>
<th>Applicable Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>x 4</td>
<td>5.000µm/count</td>
<td>10000mm/sec</td>
<td>6000V, 6500, 6700, 6800</td>
</tr>
<tr>
<td>x 10</td>
<td>2.000µm/count</td>
<td>10000mm/sec</td>
<td>6000V, 6500, 6700, 6800</td>
</tr>
<tr>
<td>x 20</td>
<td>1.000µm/count</td>
<td>10000mm/sec</td>
<td>6000V, 6500, 6700, 6800</td>
</tr>
<tr>
<td>x 40</td>
<td>0.500µm/count</td>
<td>10000mm/sec</td>
<td>6000V, 6500, 6700, 6800</td>
</tr>
<tr>
<td>x 80</td>
<td>0.250µm/count</td>
<td>10000mm/sec</td>
<td>6000V, 6500, 6700, 6800</td>
</tr>
<tr>
<td>x 100</td>
<td>0.125µm/count</td>
<td>10000mm/sec</td>
<td>6000V, 6500, 6700, 6800</td>
</tr>
<tr>
<td>x 200</td>
<td>0.0625µm/count</td>
<td>10000mm/sec</td>
<td>6000V, 6500, 6700, 6800</td>
</tr>
<tr>
<td>x 400</td>
<td>0.03125µm/count</td>
<td>2500mm/sec</td>
<td>6000V, 6500, 6700, 6800</td>
</tr>
<tr>
<td>x 1000</td>
<td>0.015625µm/count</td>
<td>1000mm/sec</td>
<td>6000V, 6500, 6700, 6800</td>
</tr>
<tr>
<td>x 2000</td>
<td>0.0078125µm/count</td>
<td>500mm/sec</td>
<td>6000V, 6500, 6700, 6800</td>
</tr>
<tr>
<td>x 4000</td>
<td>0.00390625µm/count</td>
<td>250mm/sec</td>
<td>6000V, 6500, 6700, 6800</td>
</tr>
<tr>
<td>x 8000</td>
<td>0.001953125µm/count</td>
<td>125mm/sec</td>
<td>6000V, 6800</td>
</tr>
<tr>
<td>x 16384</td>
<td>0.0009765625µm/count</td>
<td>61mm/sec</td>
<td>6000V, 6800</td>
</tr>
</tbody>
</table>

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

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

#### Rotary – 20μ Grating Pitch

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

<table>
<thead>
<tr>
<th>Rotary Glass Scale Diameter</th>
<th>Fundamental Resolution</th>
<th>Interpolation</th>
</tr>
</thead>
<tbody>
<tr>
<td>44.45mm 5000 Lines</td>
<td></td>
<td>x4 x10 x20 x40 x400 x1000 x4000 x16384</td>
</tr>
<tr>
<td>interpolated resolution</td>
<td>20000</td>
<td>20000</td>
</tr>
<tr>
<td>(CPR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>interpolated resolution</td>
<td>20</td>
<td>12.96</td>
</tr>
<tr>
<td>(arc-sec/count)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>interpolated resolution</td>
<td>314</td>
<td>62.8</td>
</tr>
<tr>
<td>(µrad/count)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>maximum speed* (RPM)</td>
<td>6000</td>
<td>6000</td>
</tr>
<tr>
<td>63.50mm 8192 Lines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>interpolated resolution</td>
<td>32768</td>
<td>163840</td>
</tr>
<tr>
<td>(CPR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>interpolated resolution</td>
<td>19.17</td>
<td>38.3</td>
</tr>
<tr>
<td>(arc-sec/count)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>interpolated resolution</td>
<td>3660</td>
<td>3660</td>
</tr>
<tr>
<td>(µrad/count)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>maximum speed* (RPM)</td>
<td>16384</td>
<td>16384</td>
</tr>
<tr>
<td>120.65mm 16384 Lines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>interpolated resolution</td>
<td>65536</td>
<td>327680</td>
</tr>
<tr>
<td>(CPR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>interpolated resolution</td>
<td>19.78</td>
<td>9.59</td>
</tr>
<tr>
<td>(arc-sec/count)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>interpolated resolution</td>
<td>1830</td>
<td>1830</td>
</tr>
<tr>
<td>(µrad/count)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>maximum speed* (RPM)</td>
<td>1830</td>
<td>1830</td>
</tr>
</tbody>
</table>

**Note:** Maximum speed produces an encoder quadrature output of 50 million states per second (12.5MHz). See page 9 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:

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

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

### Resolution and Maximum Speed Tables - Serial Output

Mercury II 6800Si/Pa systems have programmable interpolation from x4 to x16384 in binary steps. Below is a table of examples. Unlike A-quad-B encoders, the MII6800Si/Pa resolution does not drop off with speed.

#### Linear – 20µ Grating Pitch

<table>
<thead>
<tr>
<th>Interpolation Multiplier</th>
<th>Interpolation Bits</th>
<th>Resolution</th>
<th>Maximum Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>x 4</td>
<td>2</td>
<td>5.000µm/count</td>
<td>10000mm/sec</td>
</tr>
<tr>
<td>x 8</td>
<td>3</td>
<td>2.500µm/count</td>
<td>10000mm/sec</td>
</tr>
<tr>
<td>x 16</td>
<td>4</td>
<td>1.250µm/count</td>
<td>10000mm/sec</td>
</tr>
<tr>
<td>x 32</td>
<td>5</td>
<td>0.6250µm/count</td>
<td>10000mm/sec</td>
</tr>
<tr>
<td>x 64</td>
<td>6</td>
<td>0.3125µm/count</td>
<td>10000mm/sec</td>
</tr>
<tr>
<td>x 128</td>
<td>7</td>
<td>0.15625µm/count</td>
<td>10000mm/sec</td>
</tr>
<tr>
<td>x 256</td>
<td>8</td>
<td>0.078125µm/count</td>
<td>10000mm/sec</td>
</tr>
<tr>
<td>x 512</td>
<td>9</td>
<td>0.0390625µm/count</td>
<td>10000mm/sec</td>
</tr>
<tr>
<td>x 1024</td>
<td>10</td>
<td>0.01953125µm/count</td>
<td>10000mm/sec</td>
</tr>
<tr>
<td>x 2048</td>
<td>11</td>
<td>0.009765625µm/count</td>
<td>10000mm/sec</td>
</tr>
<tr>
<td>x 4096</td>
<td>12</td>
<td>0.0048828125µm/count</td>
<td>10000mm/sec</td>
</tr>
<tr>
<td>x 8192</td>
<td>13</td>
<td>0.00244140625µm/count</td>
<td>10000mm/sec</td>
</tr>
<tr>
<td>x 16384</td>
<td>14</td>
<td>0.001220703125µm/count</td>
<td>10000mm/sec</td>
</tr>
</tbody>
</table>

#### Rotary – 20µ Grating Pitch

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

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

**Note**: Resolution values 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:

\[
\text{Interpolation Multiplier} = \frac{\text{Desired Resolution (CPR)}}{\text{Fundamental Scale Resolution (Lines)}}
\]
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Specifications

System

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

Grating Period: 20µm

Signal Period: 20µm

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

*Value rounded for readability. Use the formula 20µm/interpolation multiplier to calculate the exact resolution in units of µm/count.

Note: MI6800Pa resolution is fixed at 1.2nm.

Accuracy/Linearity

Cyclical Error
Tape Scales: ±30nm typical over any 20µm movement
Glass Scales: ±20nm typical over any 20µm movement

Tape Scale Linearity: ≤±5µm/m

Glass Scale Accuracy

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

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

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*

<table>
<thead>
<tr>
<th>Scale O.D.</th>
<th>Microradians</th>
<th>Arc-Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>44.45mm</td>
<td>±38</td>
<td>±7.8</td>
</tr>
<tr>
<td>63.50mm</td>
<td>±19</td>
<td>±3.9</td>
</tr>
<tr>
<td>120.65mm</td>
<td>±10</td>
<td>±2.1</td>
</tr>
</tbody>
</table>

Note*: Based on ideal scale mounting concentricity.

Index: Built-in or stick-on; bi-directional, full speed.

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

Note: Sensor below shown with tape scale. Refer to the MI66000 interface drawings for additional details and important notes.

Sensor Size

H: 8.23mm
W: 12.70mm
L: 22.61mm

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

Signal Period: 20µm

SPI Interface Clock Speed: 25MHz - 50MHz

Max Sample Rate: 227,272 position reads/s - 50MHz clock

Power Supply: 5VDC ±5%

@ 140mA (no outputs terminated)
@ 160mA (A, B, I, and both limits terminated); 50mA at the sensor (MI6500/MI6700/MI6800)
@ 172mA (all serial I/O connections terminated); 50mA at the sensor (MI6800Su/Pa)

Temperature

Operating: 0°C to 70°C
Storage: -20°C to 85°C

Humidity: 10 - 90% RH non-condensing

EMI: CE Compliant

Shock: 300G 0.5 ms half sine (Sensor)
Vibration: 3G @ 17Hz
Sensor Weight: 3g (Sensor without cable)

Cable: Double Shield
Maximum length: 10m (contact MicroE Systems for applications >5m)
 Diameter: 4.2mm
Flex Life: 20 x 10^6 cycles @ 20mm bending radius.

Reliability Information

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

The Mercury II 6000 Series Encoders is optimized to achieve the smallest sensor with the lowest power consumption, while delivering high resolution and accuracy. This compact, versatile system includes the following features:

- Programmable interpolation level and low-pass filter
- Accuracy optimization - sensor signals are automatically optimized to improve system accuracy and maximize repeatability
- Bi-directional index with repeatability of 1 LSB
- A-quad-B tri-state output alarm for low signal. Alarm on output pin (and bit in serial word) for low signal
- All settings and setup parameters are stored in non-volatile memory
- Superior EMI/RFI immunity - CE compliant, and all outputs are differential and RS422 compatible
- Status LEDs in the connector show the encoder’s operational status at a glance

Programmable Interpolation
For the Mercury II 6000 Series Encoders, the sensor has programmable interpolation that is selectable over the range 4x to x16384 in integer steps (depending on model), providing output resolutions that can be matched to your application requirements. This feature allows reduced inventory and field spare parts costs since one electronics module can be programmed for many different resolution requirements and different motion axes. Motion system development engineers also benefit from the flexibility of programmable interpolation by allowing them to vary the encoder's resolution during motion system loop tuning and optimization. Linear resolutions can range from 5µm to 1.2nm in convenient increments and rotary resolutions from 20k CPR to 268 million CPR. Specify the interpolation value at the time of ordering or select the interpolation at your site using SmartPrecision II Software.

Programmable Maximum Output Frequency
For the Mercury II 6000 Series Encoders applications combining high resolution and high speed, the sensor supports up to 50 million quadrature state changes per second. By specifying the maximum output frequency to match your controller's capability - ranging from approximately 0.098 to 50 million quadrature state changes per second - the Mercury II encoder system will never produce encoder counts faster than your controller can read them. Specify the encoder's maximum output frequency at the time of ordering or select the setting at your site using MicroE's SmartPrecision II Software.

Note*: “Quadrature state changes per second” is the reciprocal of “dwell time” or “edge separation.” For example, 50 million states per second = 0.02 µsec dwell time.

High Speed Serial Interface*
Motion system engineers who are optimizing their system can boost its performance by interfacing their SPI-compatible controller with the Mercury II 6800Si. Its industry standard SPI high-speed serial data interface is supported by multiple DSP chip manufacturers, including TI, Motorola, and Analog Devices, and provides a robust connection that is ideal for encoder interfacing. With the Mercury II 6800Si, encoder position values are sent directly into the controller's DSP. Limitations of encoders with A-quad-B output are completely eliminated. Standard features include:

- Very high motion speed with high encoder resolution - up to 10m/s movements with 1.2nm** resolution.
- 50MHz maximum input clock frequency/Sample rate of 227,272 position reads/sec with 50MHz clock.
- RS422 voltage levels are resistant to electromagnetic interference and support long cable runs.
- Two index modes:
  - Mode 0: Zeros the position value at power up, without reference to the index mark. No changes are made to the position word at the index mark.
  - Mode 1: Zeros the position value at every encounter with the index mark.

The index mode can be factory set or selected by the customer using SmartPrecision II Software - see page 11 for software features.

Note*: Mercury II 6000 Series Encoders supports Panasonic serial interface (MII6800Pa).
Note**: Resolution values shown are approximate - see pages 5 and 6 for exact values.

Dual limits
Mercury II includes electrically fail-safe independent left and right limits with differential outputs. The limit outputs are non-latching. The output for limits is active-low, making them electrically fail-safe. Limit outputs can be configured for active-low or active-high at the time of ordering, or by the customer using SmartPrecision II Software, to match your controller's requirement.

Programmable Low Pass Filter
The Mercury II 6000 Series Encoders have a programmable low-pass input filter for enhanced performance in low speed applications. The filter can be disabled for full bandwidth or set from 0.01 – 100 kHz in steps of 0.01 kHz for MII6500/6700/6800 (from 0.01% - 40% of the sample rate in steps of 0.01% for MII6800Si/Pa) where the frequency is -3dB output roll-off.
# Mercury II™ 6000 Series Encoders

High Performance Encoders with Digital Output

## Quadrature Inputs/Outputs

15-Pin Standard Male D-sub Connector Configuration

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Right Limit+</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
</tr>
<tr>
<td>3</td>
<td>Right Limit-</td>
</tr>
<tr>
<td>4</td>
<td>Index</td>
</tr>
<tr>
<td>5</td>
<td>B-</td>
</tr>
<tr>
<td>6</td>
<td>A-</td>
</tr>
<tr>
<td>7</td>
<td>+5V</td>
</tr>
<tr>
<td>8</td>
<td>+5V</td>
</tr>
<tr>
<td>9</td>
<td>GND</td>
</tr>
<tr>
<td>10</td>
<td>Left Limit+</td>
</tr>
<tr>
<td>11</td>
<td>Left Limit-</td>
</tr>
<tr>
<td>12</td>
<td>Index+</td>
</tr>
<tr>
<td>13</td>
<td>B+</td>
</tr>
<tr>
<td>14</td>
<td>A+</td>
</tr>
<tr>
<td>15</td>
<td>Alarm</td>
</tr>
</tbody>
</table>

**Note:** Tri-state 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.

## Mechanical Information – 15-Pin Connector

![Mechanical Diagram]

## Maximum Quadrature Output Frequency

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

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

- Output Frequency = 12.5MHz/2^n
- Output Rate = 50/2^n

where n = number of steps below 12.5MHz

where n = number of steps below 50 million states per second

## Output Signals

- **Quadrature**
  - Rev 14.0.5 A
  - Rev 10.0.5 B
  - Rev 13.4.0*

- **Limits**
  - Left Limit Indicator
  - Right Limit Indicator

*Output signals are IEEE 422 compliant; 3.3V differential logic.

**Note:** At some interpolations rates, the index pulse may be aligned with states of A or B other than those shown.

**Note:** Above are with reference to the sensor’s optical cabling (see interface drawings).

## Signal Termination for A-quad-B, Index, and Limits

- **Mercury II 6000 Series Encoder**
- **Cable Z0: 120 Ω**
- **Customer Electronics**
Serial Inputs/Outputs

15-pin standard Male D-sub connector

<table>
<thead>
<tr>
<th>Pin</th>
<th>Name</th>
<th>Direction</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>nCS+</td>
<td>Input</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>nCS-</td>
<td>Input</td>
<td>Negative True</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chip Select</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Capture Start)</td>
</tr>
<tr>
<td>4</td>
<td>Reserved - do not connect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>SCLOCK_OUT</td>
<td>Output</td>
<td>Must be floating at host</td>
</tr>
<tr>
<td>6</td>
<td>SDATA_OUT-</td>
<td>Output</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>+5V*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>+5V*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>GND</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>SCLOCK_IN+*</td>
<td>Input</td>
<td>Serial Clock from Host to Sensor</td>
</tr>
<tr>
<td>11</td>
<td>SCLOCK_IN-</td>
<td>Input</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Reserved - do not connect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>SCLOCK_OUT+</td>
<td>Output</td>
<td>Serial Clock from Sensor to Host</td>
</tr>
<tr>
<td>14</td>
<td>SDATA_OUT+</td>
<td>Output</td>
<td>Serial Data from Sensor to Host</td>
</tr>
<tr>
<td>15</td>
<td>Alarm</td>
<td>Output</td>
<td></td>
</tr>
</tbody>
</table>

Note*: The following are pin outs for MII6800Si (Panasonic): Pins 2,7,8,9 are same for both MII6800Si/Pa, Pin 10 = REQ_SD+, Pin 11 = QEQ_SD-, (REQ = Request, SD = Serial Data), All other pins are NC (no connect)

Signal Termination for Serial I/O Connections

Limit Marker Positioning

Serial Word Data Format*

The SPI serial interface to the MII6800Si allows a serial host to receive position and status information from the sensor at up to 250,000 position reads/sec. This supports applications up to 10m/s with 1.2nm resolution in servo control, and applications where a device such as a laser or camera must be triggered from the encoder at a particular position.

Note*: For Mercury II 6800Si only. MII6800Pa Panasonic serial interface supported.

58 Bit Data Word

<table>
<thead>
<tr>
<th>Start</th>
<th>Position 4 - 35 Bits</th>
<th>Status 9 Bits</th>
<th>CRC 6 Bits</th>
<th>Stop 4 Bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Bits</td>
<td>4 - 35 Bits</td>
<td>9 Bits</td>
<td>6 Bits</td>
<td>4 Bits</td>
</tr>
</tbody>
</table>

The data word length is up to 58 bits. The data word consists of four start bits, a position word of 4 to 35 bits (35 bits is full interpolation depth), nine bits of status, a 6-bit cyclic redundancy check (CRC) to provide data communication error detection, and four stop bits. This position word is large enough to keep track of a measurement length of 41.9 meters.

The number of position bits is determined by adding the number of interpolation bits (valid range: 2-14) and the number of fringe count bits (valid range: 2-21). Interpolation bits determine the interpolation multiplier (for example: 14 bits = x16384 interpolation; see pages 5 and 6 for tables of output resolutions). Fringe count bits determine the maximum number of 20µm fringes that can be counted in the position word (for example: 21 bits = 2097152 fringes = 41.9 meters). Most applications can use 14 interpolation bits and 21 fringe count bits. Use fewer interpolation or fringe count bits if your motion controller requires a shorter data word for faster transfer rates than can be achieved with the maximum data word of 58 bits. The number of interpolation and fringe count bits is specified at the time of ordering, but may be changed using SmartPrecision II Software.

The status bits include index window, left limit, right limit, and signal level alarms.

Important controller interfacing information such as a timing diagram, signal descriptions, and the CRC formula are in the Mercury II 6000 Installation Manual.
**SmartPrecision II™ Software**

Why use software with an encoder?
Mercury II 6000 Series Encoders Alignment Tool includes built-in SmartPrecision II Software. The Alignment Tool’s pushbutton setup process does not require use of the software; however, SmartPrecision II Software adds unique functionality:

- Observe encoder operation using digital readouts and data plots such as Lissajous.
- Get support from trained MicroE Systems’ support personnel for diagnosing customer equipment, no matter where the equipment is located throughout the world.
- Use Mercury II’s programmable features for more rapid integration and motion system optimization.
- Perform encoder setup with the convenience and step-by-step prompts of a software interface.

Included with every Mercury II 6000 Series Encoder Alignment Tool, SmartPrecision II Software can perform setup and diagnostic functions locally or remotely across a LAN or WAN. It operates from the encoder using simple Java commands and thus does not require any software to be installed on the computer other than a standard web browser (such as Internet Explorer). Compatible with numerous web browsers and operating systems, its features include simultaneous displays of:

- Position in engineering units
- Lissajous plot
- Encoder signal level
- Status of software alarms, index and limits
- Status of programmable encoder settings
- Encoder serial number
SmartPrecision II™ Software

Program Mercury II 6000 Series Encoders

Electronics
- Set interpolation in integer steps and filter roll-off frequency (quadrature output frequency) for MII8000 or in binary steps from x4 to x16,384 for MII8800Si/Pa
- Set maximum output frequency to match your controller
- Disable/enable low-pass filter and set filter roll-off frequency
- Set limit logic when necessary to match your controller’s requirements
- Set grating type
- Set index mode

Install Mercury II 6000 Series Encoders
- Align sensor using Signal Level display and Lissajous data plot
- Locate index and see when sensor is over the scale’s index mark
- Verify sensor output over length of scale using the Signal Strength plot
- Calibration

Verify Mercury II 6000 Series Encoders

Operation
- Read encoder position in engineering units of your choice
- View data plots (software not for use while using encoder in servo control)
- Check software alarms and programmable settings

Diagnose Mercury II 6000 Series Encoders

Performance
- Capture signal data and email it to MicroE for rapid diagnostic support
- View software alarms and programmable settings

Ethernet Connectivity Features

The software resides in the ATMII5000 Alignment Tool as a ‘web server’ and is accessed using an Ethernet connection. The computer does not need any special software to be installed, so virtually any computer can connect instantly to an ATMII5000 Alignment Tool. Ethernet connectivity advantages include:

- High speed, network data connection supports many configurations:
  - One encoder with one computer
  - Many encoders with one computer
  - Several computers and one encoder
  - Multiple encoders and multiple computers
  - One-to-one (no network), LAN, WAN, or router
- Securely connect to the encoder remotely for field support through your company’s Virtual Private Network.
- The software’s web server architecture can respond to a variety of requests:
  - Html pages, data requests, Java plots, etc.
  - Take requests from most operating systems
  - Take requests from a variety of sources (user with web browser, user-software, scripts, controller, etc.)
- Program your controller to communicate with the encoder using simple HTML web commands for ‘observer’ position data feedback or encoder status, including calibration, alarms, and limits.
- Computer operating system independence and flexibility of interfacing to your own software without needing any DLLs, drivers, or any specific hardware or software configuration.

Computer Requirements

- Any computer with a web browser (such as Internet Explorer) and Java Runtime Environment installed and enabled
- Ethernet connection to a computer, LAN, WAN or router

How to Order

SmartPrecision II Software is included with all ATMII5000 Alignment Tools and does not require any installation - just access it using your computer’s web browser.
PurePrecision™ Marker and Laser Tape Scales

The Best Tape Scale Solutions Available

Mercury II PurePrecision Marker Tape and Laser Tape scales are fast and easy to install, provide excellent accuracy and take up less space than any encoder in this class because index and limit marks are contained within the tape’s 6mm width. They mount using permanent pressure-sensitive adhesive. Thermal expansion of the substrate is matched by anchoring the ends of the tape scale using epoxy.

Marker Tape and Laser Tape scales are supplied in dispensers of lengths up to 30m so that they can be cut to any length required for your application, minimizing inventory costs. They may also be ordered pre-cut to any length you specify for high-volume OEM applications.

Installation for a wide range of lengths is fast and easy using MicroE Systems’ tape applicator tool, or without a tool by hand. When using the installation tool, released paper is automatically removed from the tape. The tape’s location on the mounting surface is set by a reference edge that is either machined into the substrate or is put in place temporarily.

PurePrecision Marker Tape

PurePrecision Marker Tape has built-in index and limit marks to speed installation. Manufactured into the tape scale to your specifications using a laser etch process. Installation of the tape scale is reduced to one simple step: just apply the adhesive-mount tape scale to your system’s mounting surface and you are done. There is no need to mount index or limit markers or magnets. The laser-written marks are placed in the exact locations you specify – index location, number of index marks, and limit mark lengths can be specified at the time of ordering. PurePrecision Marker Tape may be ordered in pre-cut lengths for the fastest installation, or in continuous form for cutting at your site.

PurePrecision Laser Tape with Stick-On Index and Limits

PurePrecision Laser Tape has the same high performance Inconel scale as PurePrecision Marker Tape, but without the factory written index/limit markers. Laser Tape provides the ultimate in flexibility and productivity by using stick-on index and limit markers so that you can cut the tape scale to any length you need.

The stick-on (adhesive-mount) optical index and limit markers are mounted on the tape in seconds using the same reference edge as for the tape scale. This space-saving design keeps the index and limit markers within the 6mm width of the tape, ideal for space-constrained motion systems. The index is bi-directional, operates at all encoder speeds, and is repeatable to 1LSB.

Mercury II PurePrecision Marker and Laser Tape scale may also be installed using scale applicator tools for 6mm-wide tape from other manufacturers.
PurePrecision™ Marker Tape Scale

The Marker Tape scale length that you specify for your application must be calculated as follows. This calculation applies when using 20mm end limits. Note that 5mm at each end of the tape scale is not to be used for encoder feedback.

Tape Scale Length = Measuring Length + 40mm*

For Example: Measuring Length of 800mm is required, limits will be used at the end of the tape scale and end caps will not be used. The Tape Scale Length = 800mm + 40mm = 840mm.

*See Interface Drawings for other configurations.

Index and Limit Marker Locations

Note: Configurations above are only examples. For other limit lengths or index configurations, contact MicroE Systems.

Specifications

Accuracy ≤ ±5µm over any one meter of travel after slope correction in the customer’s controller

Material Inconel 625

Typical CTE 13ppm/°C; thermal behavior of the tape scale is typically matched to the substrate using epoxy at the ends of the tape scale

Available Lengths

Order as much tape scale as you will require for your production and cut it to length for each job, or order pre-cut lengths to match your application requirements. Note that the Measuring Length for each axis in your equipment will be less than the Tape Scale Length.

PurePrecision Marker Tape scale is shipped in tubes for lengths from 40mm - 500mm and in dispensers for lengths greater than 500mm.

Order the required Tape Scale Length using the model number configuration in the How to Order section at the end of this document.
PurePrecision™ Laser Tape Scale with Stick-On Index and Limits

The laser scale length that you specify for your application must be calculated as follows. This calculation applies whether your application requires end limits or not. 20mm at each end of the tape scale are not to be used for encoder feedback.

**Tape Scale Length = Measuring Length + 40mm**

*For Example:* Measuring Length of 800mm is required, and limits will be used at the end of the tape scale. The Tape Scale Length = 800mm + 40mm = 840mm.

*When the end limits are at the ends of the tape scale and end caps are not used. The Tape Scale Length must be increased further if the limit markers are applied at a distance from the ends of the tape scale.*

Index and Limit Marker Locations

Specifications

<table>
<thead>
<tr>
<th>Linearity</th>
<th>≤ ±5µm after two-point linearization in the customer’s controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Inconel 625</td>
</tr>
<tr>
<td>Typical CTE</td>
<td>13ppm/°C; thermal behavior of the tape scale is typically matched to the substrate using epoxy at the ends of the tape scale</td>
</tr>
</tbody>
</table>

Available Lengths

Order as much tape scale as you will require for your production and cut it to length for each job, or order pre-cut lengths to match your application requirements. Note that the Measuring Length for each axis in your equipment will be less than the Tape Scale Length depending on limits and use of end caps. PurePrecision laser tape is shipped in tubes for lengths from 40mm – 500mm and in dispensers for lengths greater than 500mm.

Contact MicroE Systems for lengths greater than 30m.
Linear and Rotary Glass Scales

MicroE Systems offers a wide array of chrome on glass scales. Easy to install, choose from standard linear and rotary scales, or customized linear, rotary, and rotary segment scales where needed. Use linear glass scales for the highest accuracy.

Glass Scale Options
- Standard linear: 10mm - 1m (contact MicroE for longer lengths)
- Standard rotary: 44mm - 121mm diameter, with or without hubs
- Custom linear*: special lengths, widths, thickness, index mark locations, pre-printed index and limits, and special low CTE materials
- Custom rotary*: special IDs, ODs (up to 304.8mm), index mark inside the main track, and special low CTE materials
- Mounting of hubs for rotary scales: MicroE Systems can mount and align standard, custom, or customer-supplied hubs
- Rotary segments*: any angle range; wide range of radius values

Note*: Custom scales or rotary segments are available in OEM quantities. Contact your local MicroE Systems sales office.

Mercury II linear glass scales 130mm or shorter are only 6mm wide, enabling drop-in replacement of existing 6mm wide tape scale encoders for dramatic improvements in motion system resolution and accuracy.

Standard Short Linear Scales
130mm and Shorter (dimensions in mm)

Specifications

<table>
<thead>
<tr>
<th></th>
<th>MIIO18</th>
<th>MIIO30</th>
<th>MIIO55</th>
<th>MIIO80</th>
<th>MIIL105</th>
<th>MIIL130</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale Length</td>
<td>18mm</td>
<td>30mm</td>
<td>55mm</td>
<td>80mm</td>
<td>105mm</td>
<td>130mm</td>
</tr>
<tr>
<td>Measuring Length Without Limits</td>
<td>13mm</td>
<td>25mm</td>
<td>50mm</td>
<td>75mm</td>
<td>100mm</td>
<td>125mm</td>
</tr>
<tr>
<td>Measuring Length With Limits</td>
<td>N/A</td>
<td>N/A</td>
<td>15mm</td>
<td>40mm</td>
<td>65mm</td>
<td>90mm</td>
</tr>
</tbody>
</table>

Order the required Scale Length using model number MIILxxxx where xxxx = Scale length in mm (10mm - 1000mm). For example: (30mm Linear Glass Scale): MIIL030.
Mercury II™ 6000 Series Encoders
High Performance Encoders with Digital Output

Linear Glass Scales with Stick-on Index and Limits

Standard Long Linear Scales
131mm and Longer (dimensions in mm)

Specifications

<table>
<thead>
<tr>
<th>Accuracy</th>
<th>±5µm standard accuracy grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>±2µm available (high accuracy grade)</td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td>Soda lime glass</td>
</tr>
<tr>
<td>Typical CTE</td>
<td>8ppm/°C (Ultra-low CTE glass available)</td>
</tr>
</tbody>
</table>

Order the required Scale Length using model number MIILxxxx where xxxx = Scale length in mm (10mm - 1000mm).

For example: (225mm Linear Glass Scale): MIIL225. Contact MicroE Systems for lengths greater than 1m.

Note: The following are only examples; you can order any size.

<table>
<thead>
<tr>
<th>Model</th>
<th>MIIL155</th>
<th>MIIL225</th>
<th>MIIL325</th>
<th>MIIL425</th>
<th>MIIL525</th>
<th>MIIL1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale Length</td>
<td>155mm</td>
<td>225mm</td>
<td>325mm</td>
<td>425mm</td>
<td>525mm</td>
<td>1000mm</td>
</tr>
<tr>
<td>Measuring Length Without Limits</td>
<td>150mm</td>
<td>220mm</td>
<td>320mm</td>
<td>420mm</td>
<td>520mm</td>
<td>995mm</td>
</tr>
<tr>
<td>Measuring Length With Limits</td>
<td>115mm</td>
<td>185mm</td>
<td>285mm</td>
<td>385mm</td>
<td>485mm</td>
<td>960mm</td>
</tr>
</tbody>
</table>

Rotary Glass Scales with Built-In Index

Standard Rotary Scales
Specifications

| Material       | Soda lime glass               |
| Typical CTE    | 8ppm/°C                       |

Dimensions in MM

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Fundamental CPR</th>
<th>Scale Outer Diameter</th>
<th>Scale Inner Diameter</th>
<th>Optical Diameter</th>
<th>Hub Inner Diameter +0.013mm/-0.0000</th>
<th>Hub Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIIR4513</td>
<td>500</td>
<td>44.45mm</td>
<td>12.70mm</td>
<td>31.83mm</td>
<td>6.358mm</td>
<td>1.27mm</td>
</tr>
<tr>
<td>MIIR6425</td>
<td>8192</td>
<td>63.50mm</td>
<td>25.40mm</td>
<td>52.15mm</td>
<td>12.708mm</td>
<td>1.52mm</td>
</tr>
<tr>
<td>MIIR12121</td>
<td>16384</td>
<td>120.65mm</td>
<td>50.80mm</td>
<td>104.30mm</td>
<td>25.408mm</td>
<td>2.03mm</td>
</tr>
</tbody>
</table>

Custom scales are available including larger diameters.

Note: MIIL800Pa is for linear axes only.
How to Order

Sensors

MII6800, A-quad-B Output, with Resolution from 5µm to 1.2nm

MII6810-AB-16384-1-1-0 (example)

- 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

MII68XX (Cable Length)
- MII6810=1m cable
- MII6830=3m cable
- MII6850=5m cable

MII6700, A-quad-B Output, with Resolution from 5µm to 5nm

MII6710-AB-4000-1-1-0 (example)

- 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

MII67XX (Cable Length)
- MII6710=1m cable
- MII6730=3m cable
- MII6750=5m cable

Note: All specifications are subject to change.
# Mercury II™ 6000 Series Encoders

High Performance Encoders with Digital Output

## How to Order

### Sensors

**MII6500, A-quad-B Output, with Resolution from 5µm to 50nm**

**MII6510-AB-400-1-1-0 (example)**

- **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

**MII6800Si, Serial Output, with Resolution up to 1.2nm**

**MII6810-Si-14-21-1-0 (example)**

- **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

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

### Note

- **MII65XX (Cable Length)**
  - MII6510 = 1m cable
  - MII6530 = 3m cable
  - MII6550 = 5m cable

- **MII68XX (Cable Length)**
  - MII6810 = 1m cable
  - MII6830 = 3m cable
  - MII6850 = 5m cable

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**Note**: All specifications are subject to change.

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How to Order

Sensors

MII6800Pa, Serial Output, with Output Resolution up to 1.2nm
MII6810-Pa-14-10-1-0 (example)

Sensor Installation Tools

ATMII5000  *Alignment Tool Kit for MII6000 encoders includes:
- Alignment Tool
- SmartPrecision II Software
- USB Cable
- Power Supply (100V-240VAC/50-60Hz)

-US Power supply with US standard 2-prong plug
-EU Power supply with European standard 2-prong plug

ZG-PP3 Z-Height Gauge, PurePrecision Tape Scales
ZG-GS3 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: Interpolation bits plus fringe bits must be ≤24 bits.
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)

Total Segment Lengths in mm (up to 5,000)
Customs (Sequential # 0001, 0002, .......9999)
L=Center Index and 20mm 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, MII6000 must be configured for Reflective Grating Type.

PurePrecision Rotary Glass Scales

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.
Mercury II Encoders are Fully RoHS Compliant

Mercury II is fully compliant with European Directive 2002/95/EC (Restriction of use of Hazardous Substances, “RoHS”).
A Document of Compliance is available upon request. “Mercury™” is a brand name of MicroE Systems; Mercury and Mercury II encoders do not contain any mercury metal.

Vacuum-Rated and Small Diameter Rotary Encoders

Vacuum-Rated and Small Diameter Rotary Encoders

Visit CeleraMotion.com for Mercury linear and rotary encoders that are vacuum rated up to $10^{-8}$ torr, small-diameter rotary encoders with scale outside diameters from 32mm to 12mm, and low-cost PCB mount encoders.