

Mercury™ 3500V: Vacuum Rated Smart Encoder

Programmable Interpolation in Integer Steps to 5 nanometers; Rated to 10⁻⁸ Torr

Reflective Linear and Rotary Vacuum Encoder Systems



Resolution

Linear: 5µm to 0.005µm
Rotary: 6,600 to 67.1 M CPR

Accuracy

Linear: ± 1µm available
± 3µm to ± 5µm standard
Rotary: Up to ± 2.1 arc-sec

Output

A-quad-B and Index Pulse

Vacuum

10⁻⁸ Torr

The Mercury 3500V encoder represents the next level of encoder performance. With programmable interpolation, smallest sensor size, easiest alignment, and 10⁻⁸ Torr vacuum rating, the M3500V delivers best-in-class performance. Shown with customer-supplied vacuum-wall connectors.

Imagine what you can do with this!

The Mercury 3500V can reduce the cost and size of your system, and improve its performance all at once! MicroE Systems' Mercury 3500V kit encoders are smaller, higher performance, faster to install, and easier to set up and align than any other encoder. The tiny sensor fits into very tight spaces and works in both linear and rotary applications. The M3500V sensor is vented and constructed with vacuum compatible materials and designed for a 48 hour bake out at 150°C. Color coded bare leads are provided for customer termination.

Standard features

- Smallest sensor- 1/3 the size of other encoders
- Revolutionary bolt-in alignment for many applications
- Advanced SmartPrecision electronics built into shielded D-sub connector
- A-quad-B output with programmable interpolation in integer steps for resolutions to 0.005µm (linear); 67.1M CPR (rotary)
- LED set up indicators for sensor alignment and index location
- Bi-directional index signal is repeatable to encoder resolution
- Best-in-class noise immunity for harsh environments

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Optional features

- Glass scale length or diameter:
Linear lengths from 5mm to 2m
Rotary diameters from 12mm to 108mm
- Cable length of 0.5m, 1m, 2m, or custom
- SmartPrecision Software



System Configurations

Standard and Optional Equipment

M3500V Smart Encoder System Standard Equipment

Encoder Sensor
Same for linear and
rotary scales.



Shielded Vacuum Cable
Supplied with 1.5m standard
length and bare color-coded leads
for customer termination.



SmartPrecision™
Electronics Module
New Metal Enclosure Provides
Best-in-Class Noise Immunity



The standard
cable is double
shielded and
0.5m in length.
The cable
contains color-
coded bare leads
for customer
termination.

A 15 pin high
density D-sub
connector mates
to the customer
controller.

M3500V Optional Equipment

RS 232 Interface Adaptor

The adaptor provides
connections to a
PC, the encoder system
and the controller.



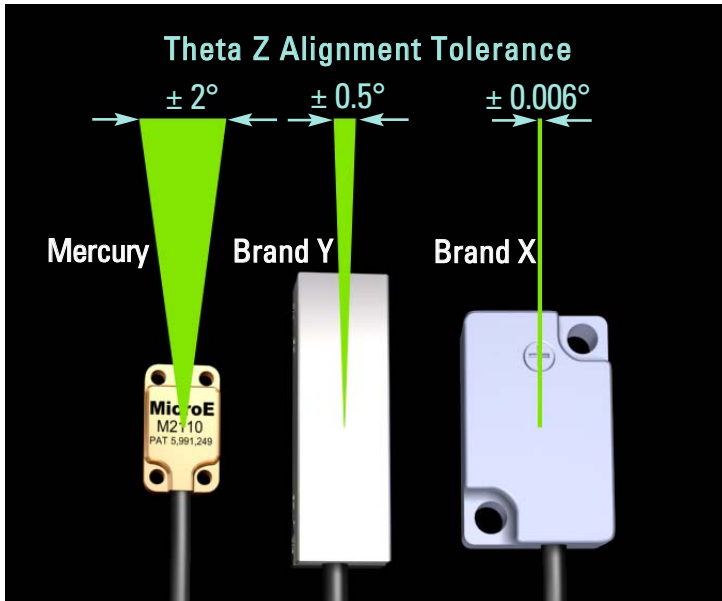
SmartPrecision™ Software

The software module enables all
programmable and diagnostic fea-
tures plus displays encoder output
and signal strength. See page 8 for
details.



Broader Alignment Tolerances, Increased Standoff Clearance, Smallest Sensor and More

Why Mercury Encoders Make It Easier To Design High Performance Into Your Equipment



Eliminate the Frustration of Touchy Encoder Alignment

Mercury Solves this Problem for Good

Fussy alignment is no longer a concern. With Mercury's patented PurePrecision™ optics, advanced SmartPrecision™ electronics and LED alignment indicators, 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 offers a ± 2° sweet spot— that's a 300% improvement over the best competitive encoder. And 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**

	Mercury*	Brand X	Brand Y	Mercury vs. Best Competitor
Z Standoff	± 0.15mm	± 0.1mm	± 0.1mm	Mercury is 50% better
Y	± 0.20mm for linear ± 0.10mm for rotary ≥19mm dia.	± 0.1mm	unspecified	Mercury is 100% better
theta X	± 1.0°	unspecified	± 1.0°	
theta Y	± 2.0°	± 0.1°	± 1.0°	Mercury is 100% better
theta Z	± 2.0°	± 0.006°	± 0.5°	Mercury is 300% better

*Measured at a constant temperature for one axis at a time with all other axes at their ideal positions.

**Based on published specifications

Mercury Can Reduce System Size and Cost

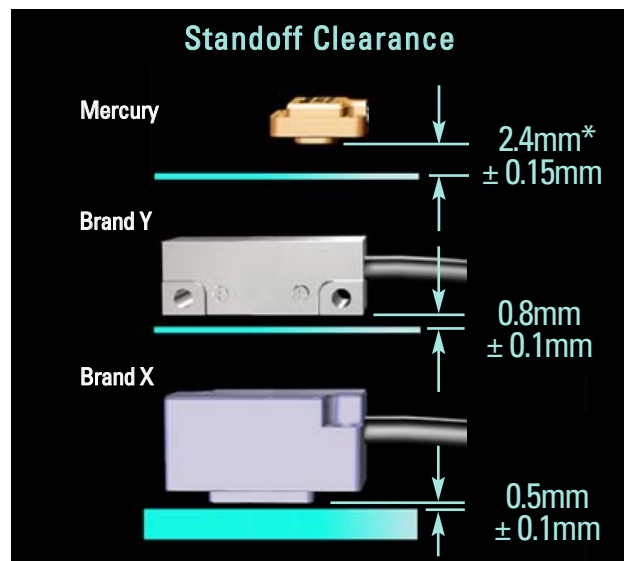
Mercury's sensor height is 44% shorter than competitive encoders, making it easy to fit into your design. This reduction can also cut total system weight and cost by allowing the use of smaller motors and stages. Safe system operation is also enhanced thanks to Mercury's generous standoff clearance— 200% greater than other encoders. And its standoff tolerance is 50% greater than the best alternative.

This significantly relaxes mechanical system tolerances, while reducing system costs.

Mechanical Dimension Comparison**

	Mercury	Brand X	Brand Y	Mercury vs. Best Competitor
Sensor Z height	8.4mm	23mm	15mm	44% better
Standoff clearance	2.4mm	0.5mm	0.8mm	200% better
Standoff tolerance	± 0.15mm	± 0.1mm	± 0.1mm	50% better
System height	11.7mm	28.5mm	15.8mm	26% better

**Based on published specifications



* Dimensions shown illustrate encoder system standoff clearance; see Mercury Encoder Interface Drawings for correct design reference surfaces.

* Dimensions shown illustrate encoder system standoff clearance; see Mercury Encoder Interface Drawings for correct design reference surfaces.

System Specifications

Resolution and Maximum Speed

Mercury 3500V systems have programmable interpolation from x4 to x4096 in integer steps. Below is a table of sample values.

Linear - 20µm grating pitch

Interpolation	Resolution	Maximum Speed*
x4	5.000µm/count	7200mm/s
x10	2.000µm/count	7200mm/s
x20	1.000µm/count	7200mm/s
x40	0.500µm/count	7200mm/s
x80	0.250µm/count	7200mm/s
x100	0.200µm/count	5760mm/s
x200	0.100µm/count	2880mm/s
x400	0.050µm/count	1440mm/s
x1000	0.020µm/count	576mm/s
x2000	0.010µm/count	288mm/s
x4000	0.005µm/count	144mm/s

To calculate desired linear interpolation multiplier, use the following equation
 $Interpolation\ Multiplier = Grating\ Period\ (20\mu m) / Desired\ Resolution\ (\mu m/count)$

Rotary - 20µm grating pitch

Rotary Glass Scale Diameter	Fundamental Resolution	Interpolation			
		Note: The range of available values is x4 to x4096 in integer steps; example values below.			
0.472" [12.00mm]	1650 CPR	x4	x100	x256	x4096
	interpolated resolution (CPR)	6,600	165,000	422,400	6,758,400
	interpolated resolution (arc-sec/count)**	196.4	7.85	3.08	0.192
	interpolated resolution (µrad/count)**	952	38.0	14.86	0.930
	maximum speed* (RPM)	13090	10470	4090	256
0.750" [19.05mm]	2500 CPR	x4	x100	x256	x4096
	interpolated resolution (CPR)	10,000	250,000	640,000	10,240,000
	interpolated resolution (arc-sec/count)**	129.6	5.18	2.03	0.127
	interpolated resolution (µrad/count)**	628.3	25.1	9.8	0.614
	maximum speed* (RPM)	8640	6912	2700	169
1.250" [31.75mm]	4096 CPR	x4	x100	x256	x4096
	interpolated resolution (CPR)	16,384	409,600	1,048,576	16,777,216
	interpolated resolution (arc-sec/count)**	79.1	3.16	1.24	0.077
	interpolated resolution (µrad/count)**	383.5	15.3	6.0	0.375
	maximum speed* (RPM)	5273	4219	1648	103
2.250" [57.15mm]	8192 CPR	x4	x100	x256	x4096
	interpolated resolution (CPR)	32,768	819,200	2,097,152	33,554,432
	interpolated resolution (arc-sec/count)**	39.6	1.58	0.618	0.039
	interpolated resolution (µrad/count)**	191.7	7.7	3.0	0.187
	maximum speed* (RPM)	2637	2109	824	52
4.250" [107.95mm]	16384 CPR	x4	x100	x256	x4096
	interpolated resolution (CPR)	65,536	1,638,400	4,194,304	67,108,864
	interpolated resolution (arc-sec/count)**	19.7	0.791	0.309	0.0193
	interpolated resolution (µrad/count)**	95.9	3.83	1.5	0.0937
	maximum speed* (RPM)	1318	1054	412	26

*Maximum speed produces an encoder quadrature output of up to 28.8 million states per second.

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

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

To calculate desired rotary interpolation multiplier, use the following equation

$Interpolation\ Multiplier = Desired\ Resolution\ (CPR) / Fundamental\ Scale\ Resolution\ (CPR)$

All Specifications are subject to change. All data is accurate to the best of our knowledge. MicroE Systems is not responsible for errors.

System Specifications

System

Grating Period	20µm
Signal Period	20µm
System Resolution	5µm - 0.005µm in integer interpolation steps (factory set or user programmed using MicroE SmartPrecision Software)

Linear accuracy*

Interpolation accuracy: Better than ± 0.12µm over any 20µm movement

Long-travel accuracy: ±1µm accuracy available - consult MicroE
 Better than ± 3µm for scales up to 130mm
 Better than ±5µm for scales 155mm to 1m
 Better than ±5µm per meter for scales 1m or more

*Maximum peak to peak error over the specified movement when compared to a NIST-traceable laser interferometer standard, used at room temperature and with MicroE interpolation electronics.

Rotary Accuracy*	Scale O.D.	Microradians	Arc-Seconds
	12.00mm	±100	±21
	19.05mm	±63	±13
	31.75mm	±38	±7.8
	57.15mm	±19	±3.9
	107.95mm	±10	±2.1

*Based on ideal scale mounting concentricity

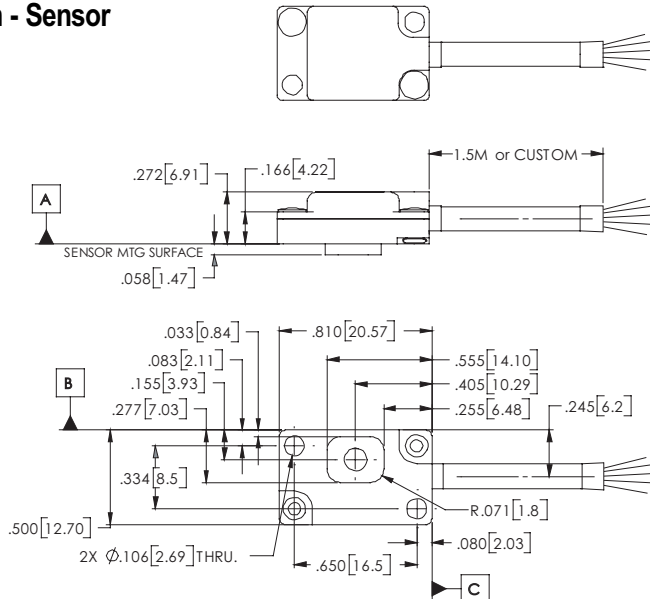
Sensor Size

W:	12.70mm	0.500"
L:	20.57mm	0.810"
H:	8.38mm	0.330"

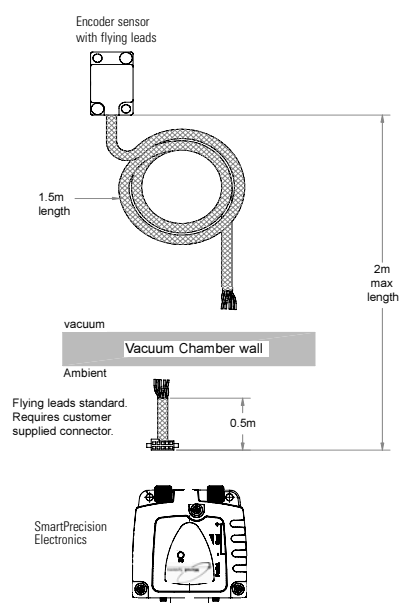
Operating and Electrical Specifications

Vacuum	10 ⁻⁸ Torr, negligible outgassing
Bake Out	Up to 150°C; up to 48 hours, non-operating
Power Supply	5VDC ±5% @ 330mA (30mA for sensor)
Temperature	
Operating:	0 to 70°C
Storage:	-20 to 70°C
Humidity:	10 - 90% RH non-condensing
EMI:	CE Compliance pending
Shock:	1500G 0.5 ms half sine (Sensor)
Sensor Weight:	2.7g (Sensor without cable)
Cable:	The 1.5m vacuum-compatible cable is EMI shielded and comes standard with color coded bare leads for customer termination within the vacuum bulkhead. Custom cable lengths and connectors are available.

Mechanical Information - Sensor



Vacuum Encoder System



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SmartPrecision™ Electronics Module

The Mercury 3500V encoder system includes a SmartPrecision electronics module. This compact, fully-featured signal processing system performs the following functions:

- Interpolation - up to 4096X with 28.8 million quadrature states/sec.
- Programmable interpolation level and output bandwidth
- Accuracy optimization - sensor signals are automatically optimized to improve system accuracy and maximize repeatability
- Signal strength indication - red / yellow / green LEDs assist during setup and provide diagnostics at a glance
- Index centering - centers the bi-directional index output pulse for repeatability to +/-1LSB
- Low Signal alarm
- Power-indicating LED
- Computer interface - for programming and data acquisition using SmartPrecision software
- Superior EMI / RFI immunity - CE compliance pending
- Mounting options - all electronics are within the EMI-shielded connector housing and can be screwed directly into a mating connector that is bulkhead mounted, or the module may be mounted to the frame of your motion system and connected using an extension cable

Programmable Interpolation

The electronics module has programmable interpolation that is selectable over the range x4 to x4096 in integer steps, providing output resolutions that can be matched to your application requirements. This feature provides linear resolutions from 5µm to 5nm in convenient increments and rotary resolutions from 6,600 CPR to 67.2M CPR. Specify the interpolation value at the time of ordering or select the interpolation at your site using SmartPrecision Software.

Programmable Maximum Output Frequency

For encoder applications combining high resolution and high speed, the SmartPrecision electronics module supports up to 28.8 million quadrature state changes per second**. By specifying the maximum output frequency to match your controller's capability - ranging from 900,000 to 28.8 million quadrature state changes per second - the Mercury 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 Software.

* The electronics module's serial computer programming interface can be translated to be RS-232 compatible using the MicroE SmartPrecision Computer Interface Adapter or a voltage translation circuit of your own design.

** "Quadrature state changes per second" is the reciprocal of "dwell time" or "edge separation". For example, 28.8 million states per second = 0.035µsec dwell time.

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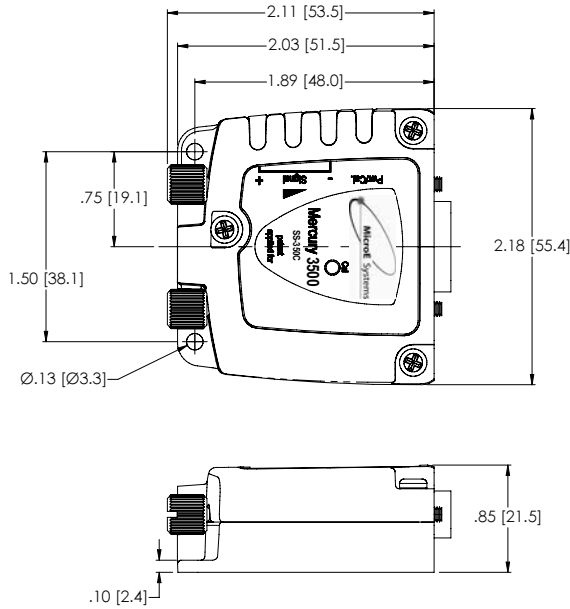
SmartPrecision module enclosure provides "Best-in-Class" noise immunity for high noise environments.

Mercury 3500V Outputs:

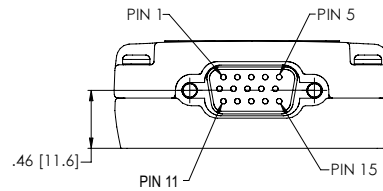
15-pin high density Male D-sub connector

PIN	FUNCTION
1	Reserved - Do not connect
2	Serial programming interface -transmit*
3	Serial programming interface -receive*
4	A- quadrature
5	A+ quadrature
6	Reserved - Do not connect
7	Reserved - Do not connect
8	Reserved - Do not connect
9	B- quadrature
10	B+ quadrature
11	Alarm
12	+5VDC
13	Ground
14	I+ index
15	I- index

Mechanical Information - electronics module



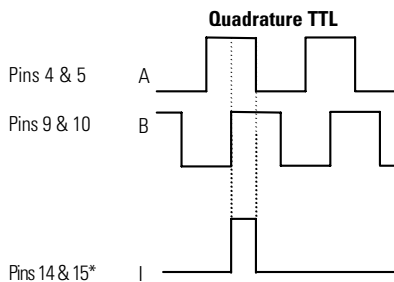
Male D-sub connector



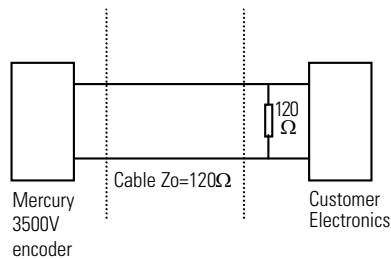
Maximum Quadrature Output Frequency:

Output Frequency	A-Quad-B Output Rate	Dwell Time (or edge separation)
7.2MHz	28.8 Million Quadrature states/sec	0.035µsec.
3.6MHz	14.4 Million Quadrature states/sec	0.069µsec.
1.8MHz	7.2 Million Quadrature states/sec	0.139µsec.
900KHz	3.6 Million Quadrature states/sec	0.239µsec.
450KHz	1.8 Million Quadrature states/sec	0.555µsec.
225KHz	900K Quadrature states/sec	1.111µsec.

Output Signals



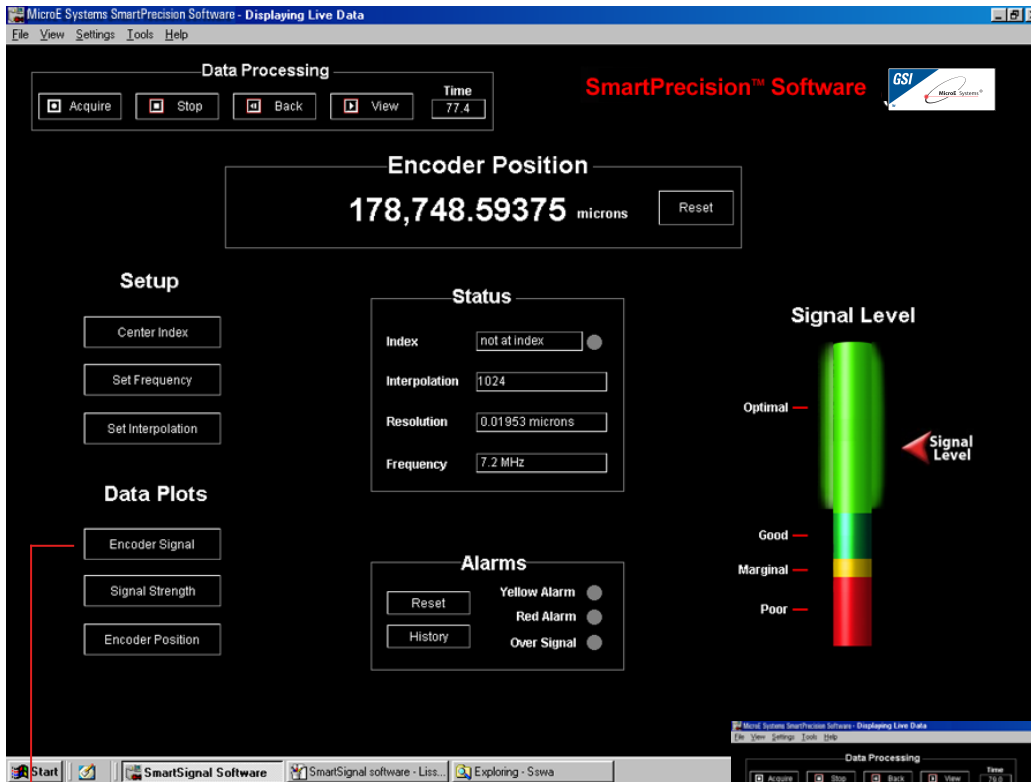
Signal Termination for A-Quad-B and Index



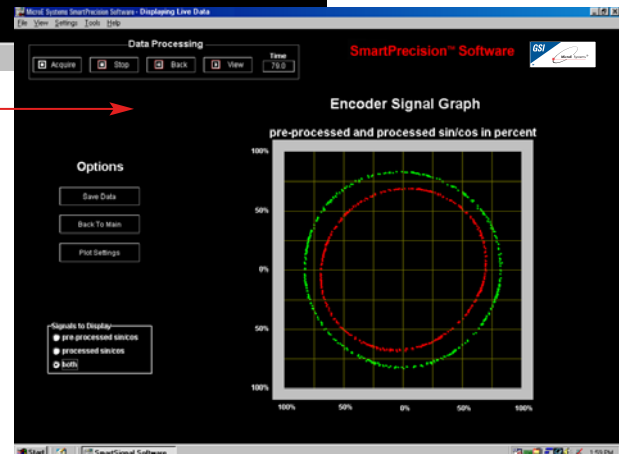
*Note: The index pulse may be aligned with A or B at some interpolation values.

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SmartPrecision Software for Mercury 2000, 3000 and 3500V Encoder Systems



SmartPrecision Software makes Mercury the industry's easiest to use encoder. It helps you program, set up, use, and diagnose Mercury 2000, 3000 and 3500V encoders with the click of a mouse. Compatible with Windows 95, 98, ME, NT, 2000, and XP.



The encoder signal plot, or Lissajous plot, reveals the underlying strength and uniformity of the sensor's output.

Program Mercury Encoder Electronics

- Set interpolation in integer steps from x4 to x256 (Mercury 2000), x4 to x1024 (Mercury 3000) or x4 to x4096 (Mercury 3500V)
- Set maximum output frequency to match your controller

Install Mercury Encoder System

- Align sensor using Signal Level display and Encoder Signal 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

Monitor Mercury Encoder Operation

- Read encoder position in engineering units of your choice
- Read the encoder's hour meter to monitor system usage
- Capture alarms while system operates unattended

Diagnose Mercury Encoder Performance

- Capture signal data and email it to MicroE for rapid diagnostic support
- Monitor alarms, view the alarm history log

System Description

The SmartPrecision Software system includes Software on CD, a computer interface adapter, computer cable, and a power adapter.

How to Order SmartPrecision Software

To Purchase the SmartPrecision Software system, use this Model Number: SSWA120 for 120 VAC, 60Hz US Standard 2-prong plug or SSWA220 for 220 VAC, 50 Hz European Std. 2-prong plug

Scale Specifications

Standard and Customized Scales

MicroE Systems offers a wide array of chrome on glass scales for the highest accuracy and best thermal stability. Easy to install, standard linear and rotary scales meet most application requirements. Customized linear, rotary, and rotary segment scales are available where needed. All scales include an optical index. Mercury's glass scales save time by eliminating motion system calibrations or linearity corrections required by other encoders, and provide better thermal stability than metal tape scales.

Options include:

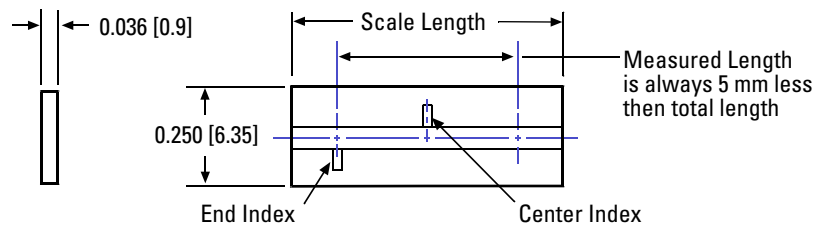
- *Standard linear*: 18mm - 2m
- *Standard rotary*: 12mm - 107.95mm diameter, with or without hubs
- *Custom linear**: special lengths, widths, thickness, index mark locations and special low CTE materials
- *Custom rotary**: special ID's, OD's (up to 304.8mm), index mark outside the main track and special 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

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

Standard Short Linear Scales

130mm and Shorter

Key: inches[mm]



Specifications

Accuracy	±3µm standard ±1µm available
Material	Soda lime glass
Typical CTE	8ppm/°C
Index	Center or End

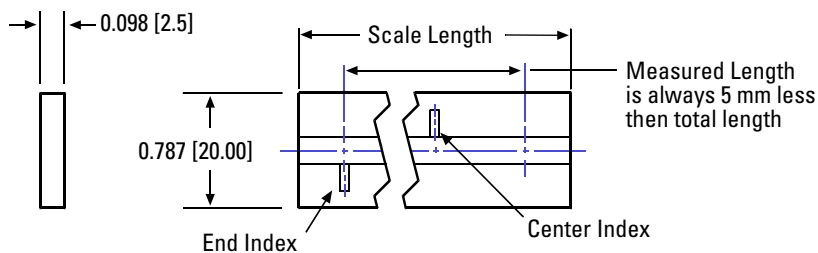
Model	L18	L30	L55	L80	L105	L130
Scale Length	0.709 [18]	1.181 [30]	2.165 [55]	3.150 [80]	4.134 [105]	5.118 [130]
Measured Length	0.512 [13]	0.984 [25]	1.969 [50]	2.953 [75]	3.937 [100]	4.921 [125]

Custom scales available

Standard Long Linear Scales

155mm and Longer

Key: inches[mm]



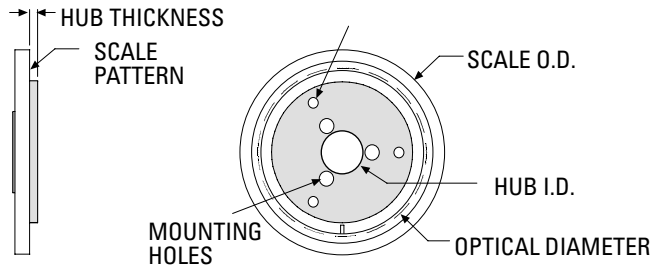
Specifications

Accuracy	±5 µm <1m ±5 µm/m >1m
Material	Soda lime glass
Typical CTE	8ppm/°C
Index	Center or End

Model	L155	L225	L325	L425	L525	L1025	L2025
Scale length	6.102 [155]	8.858 [225]	12.795 [325]	16.732 [425]	20.669 [525]	40.354 [1025]	79.724 [2025]
Measured length	5.906 [150]	8.661 [220]	12.598 [320]	16.535 [420]	20.472 [520]	40.157 [1020]	79.528 [2020]

Custom scales available

Standard Rotary Scales



Specifications

Material	Soda lime glass
Typical CTE	8ppm/°C

Key: inches[mm]

Model No.	Scale Outer Diameter	Scale Inner Diameter	Optical Diameter	Hub Inner Diameter +0.0005/-0.0000	Hub Thickness	Fundamental CPR
R1206	0.472 [12.00]	0.250 [6.35]	0.413 [10.50]	0.1253 [3.18]	0.040 [1.02]	1650
R1910	0.750 [19.05]	0.375 [9.52]	0.627 [15.92]	0.1253 [3.183]	0.040 [1.02]	2500
R3213	1.250 [31.75]	0.500 [12.70]	1.027 [26.08]	0.2503 [6.358]	0.050 [1.27]	4096
R5725	2.250 [57.15]	1.000 [25.40]	2.053 [52.15]	0.5003 [12.708]	0.060 [1.52]	8192
R10851	4.250 [107.95]	2.000 [50.80]	4.106 [104.30]	1.0003 [25.408]	0.080 [2.03]	16384

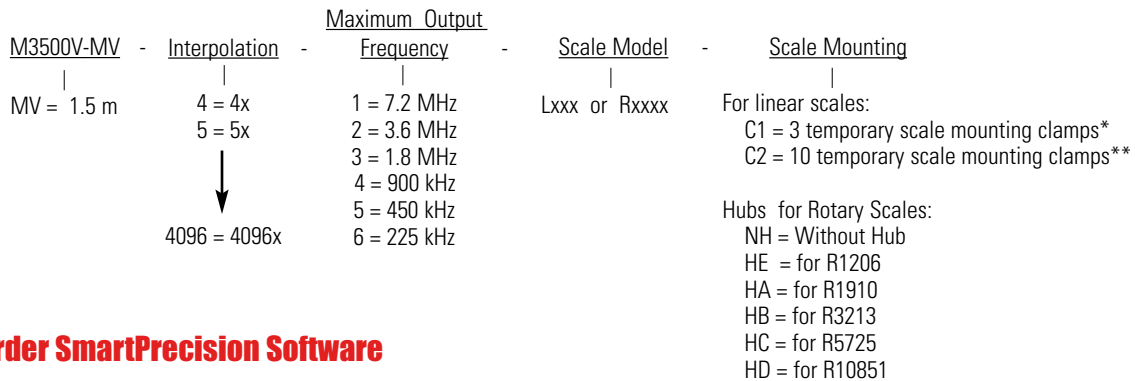
Custom scales available

How to Order Mercury 3500V Encoder Systems

To specify your Mercury encoder with the desired scale, level of interpolation, maximum output frequency, cable length and software, consult the chart below to create the correct part number for your order. Call MicroE Systems' Rapid Customer Response team for more information [508] 903-5000.

Example (Linear Encoder): M3500V-MV-4096-1-L55-C1

Example (Rotary Encoder): M3500V-MV-4096-1-R1910-HA

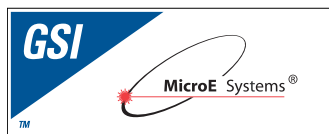


How to Order SmartPrecision Software

SmartPrecision Software

SSWA120 for 120 VAC, 60Hz
US Standard 2-prong plug
or
SSWA220 for 220 VAC,
50 Hz European Std. 2-prong plug

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* 3 clamps for linear scales up to 130mm

** 10 clamps for linear scales 155mm or longer

Note: Scale mounting clamps are not vacuum rated.