

# MI Encoder System Datasheet

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## Table Of Contents

1	General Information .....	3
1.1	Revision History.....	3
1.2	Disclaimers and Limitations of Liability .....	3
2	Overview .....	4
3	Specifications.....	5
4	Electrical Interface .....	9
4.1	Interpolator Pinout.....	9
4.2	ABZ Signal Termination .....	10
5	Position Interface .....	11
5.1	ABZ Timing.....	11
6	Installation & Handling .....	12
7	Optional Software .....	13
7.1	Installation & Operation .....	13
7.2	Functionality.....	13
7.2.1	Program Interpolator .....	13
7.2.2	Install Mercury Encoder System .....	13
7.2.3	Monitor and Diagnose .....	13
7.3	Using the Lissajous Display .....	14
8	Ordering Information .....	15
8.1	Readhead .....	15
8.2	Interpolator .....	15
8.3	Rotary Scales.....	16
8.4	Rotary Scales on Hubs .....	16
8.5	Linear Scales .....	16
8.6	Accessories .....	17

# 1 General Information

## 1.1 Revision History

Revision	Release Date	Changes
Beta 0.2	July 16 2021	Initial Release
Beta 0.3	July 23 2021	2 quad frequencies added: Overview, Specs, Ordering Guide
Beta 0.4	July 28 2021	Ordering Information correction
Beta 0.5	July 30 2021	RoHS Compliance Information Updated
Beta 0.6	August 09 2021	CE Compliance Information Updated
Beta 0.7	September 17 2021	Minor rewording in Overview.
Beta 0.8	November 22 2021	Corrected Model Number associated with Part Number 195-00296 in Ordering Information.

## 1.2 Disclaimers and Limitations of Liability

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## 2 Overview

The advanced optical design of Mercury I delivers high performance, small size and ease of installation. Broad alignment tolerances reduce setup time and cost. Coupled with Mercury I interpolators, quadrature signals with resolutions up to 5 nm are possible. Gain, offset and phase calibration of readhead signals optimizes accuracy. The entire Mercury Encoder System is EMI shielded for reliable, consistent performance.

The new generation of Mercury I interpolators allows faster quadrature output frequencies with more configuration options for interfacing to your drive or controller. If the run speed exceeds the clock frequency, an alarm is generated (SS200x now has Alarm output). Alarm generation supersedes count buffering which inevitably caused problems in servo control. The new interpolators also incorporate a USB interface eliminating the need for a Computer Interface Adapter (CIA), power supply and RS232-to-USB converter.

Mercury I System readhead alignment is a simple process using built-in LEDs. Optionally, SmartPrecision™ configuration software can be used. Download SmartPrecision™ from the Celera Motion website and connect via USB. As well as providing a visual display of signal strength, position and index, SmartPrecision™ can be used to configure and calibrate the Mercury I interpolator.

Celera Motion offers a wide array of rotary and linear chrome on glass scales for the highest accuracy and thermal stability. All scales include an optical index. Easy to install, standard scales meet most application requirements. Customized scales are available as needed. Rotary scales can also be pre-mounted on hubs, further simplifying installation.

A vacuum rated "V" version of the Mercury I Encoder System is also available. The V version features a stainless steel readhead with engraved serial number and braided cable. The cable has flying leads for connection to a bulkhead pass-through connector. A second cable with flying leads connects to the interpolator outside the bulkhead.

## 3 Specifications

Interpolator Operating Data			
Model	SS200x	SS300x	SS350x
Interpolation Depth	4X to 256X <sup>1</sup>	4X to 1024X <sup>1</sup>	4X to 4096X <sup>1</sup>
Position Output	ABZ (AqB and Index)		
Maximum Output Frequency	12.5 MHz (50 M counts/sec) <sup>2</sup>		
Configurable Output Frequencies	12.5, 6.25, 4.17, 3.125, 1.8, 0.9, 0.45, 0.225 MHz		
Latency	2.2 $\mu$ sec		
Maximum Input Rate	760,000 Scale_Periods/sec		
Index Width	1 LSB		
Calibration	Gain, Offset, Phase compensation & Index centering		
Status Output	Alarm - weak signal, input/output overspeed		
LED Indicators (4)	1:Power/Calibration, 3:Alignment Status (See Installation Manual)		
Communications	USB 2.0 Mini-B		

1. Available in integer steps
2. An encoder count is a transition on either of the A or B quadrature signals. A count is sometimes referred to as a “quadrature state” or “megastate”. The frequency of counts/sec is 4x the frequency of a quadrature channel

Rotary System Data	
Scale Period	0.02 mm



Rotary System Data					
Scale OD	12.00 mm	19.05 mm	31.75 mm	57.15 mm	107.95 mm
Optical Diameter	10.50 mm	15.92 mm	26.08 mm	52.15 mm	104.30
Accuracy	± 21 arcsec	± 13 arcsec	± 7.8 arcsec	± 3.9 arcsec	± 2.1 arcsec
Max. Resolution <sup>1,2</sup>	0.192 arcsec	0.127 arcsec	0.077 arcsec	0.039 arcsec	0.0193 arcsec
Max. Speed <sup>3</sup>	13,090 rpm	8,640 rpm	5,275 rpm	2,637 rpm	1,318 rpm
Alignment Tolerance TAN, RAD, Z	± 0.08, ± 0.05, ± 0.15 mm				
Substrate Material	Soda lime glass				

1. Resolution\_Counts = Optical\_Diameter \* pi \* Interpolation\_Depth / Scale\_Period counts/rev

2. Resolution\_Angle = 1,296,000 / Resolution\_Counts arcsec

3. Maximum\_Speed = Output\_Frequency \* 4 \* 60 / Resolution\_Counts rpm

Linear System Data	
Scale Period	0.02 mm
Short Scale Lengths <sup>1</sup>	18, 30, 55, 80, 105 mm
Long Scale Lengths <sup>1</sup>	155, 325, 425 mm
Short Scale W,H	6.35, 0.9 mm
Long Scale W,H	20.0, 2.5 mm
Accuracy (Short Scale)	± 3 μm



Linear System Data	
Accuracy (Long Scale)	± 5 μm
Max. Resolution <sup>2,3</sup>	5 nm
Max. Speed <sup>4,5</sup>	7.2 m/sec
Alignment Tolerance Y,Z	± 0.20, ± 0.15 mm
Substrate Material	Soda lime glass
CTE (typical)	8 ppm/°C

1. Measuring length is 5 mm shorter than total scale length (see Interface Drawing)
2.  $Resolution\_Counts = 1000 * Interpolation\_Depth / Scale\_Period\ counts/m$
3.  $Resolution\_Distance = 10^9 / Resolution\_Counts\ nm$
4.  $Maximum\_Speed\ (Interpolation\_Depth > 80x) = Output\_Frequency * 4 / Resolution\_Counts\ m/sec$
5.  $Maximum\_Speed\ (Interpolation\_Depth \leq 80x) = 7.2\ m/sec$

Electrical Data	
Supply Voltage	5 VDC ± 5%
Supply Current	190 mA (160 mA Interpolator, 30 mA Readhead)
ABZ Signals	RS-422 Compliant
Alarm	Single ended LVTTTL
Mechanical Data	
Size Readhead	20.6 x 12.7 x 8.4 mm
Size Interpolator	53.5 x 55.4 x 21.5 mm

Mechanical Data	
Fly Height	1.75 mm
Weight Readhead	5.0 g
Cable Flex Life	20 x 10 <sup>6</sup> cycles @ 20 mm bend radius
Environmental Data	
Operating Temperature	0°C to 70°C
Storage Temperature	-20°C to 70°C
Humidity	10-90% RH non-condensing
Shock (Readhead)	1500 G, 0.5 msec half sine
Vacuum (V Option)	10 <sup>-8</sup> Torr, negligible outgassing
Bake Out (V Option)	48 hours @ 150°C
Compliance & Approvals	
RoHS	RoHS 3 Compliant
CE	EN55011 Radiated Emissions EN55022 Class A and B Emissions EN61000-4-2 ESD Immunity EN61000-4-3 Radiated Immunity EN61000-4-4 EFT Immunity EN61000-4-6 Conducted Immunity EN61000-4-8 Magnetic Immunity



## 4 Electrical Interface

### 4.1 Interpolator Pinout

15-pin, high density, male, D-sub connector

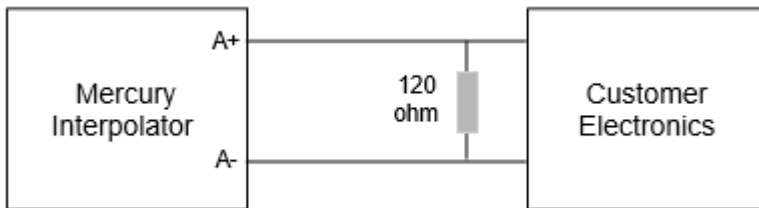
Pin	SS200x, SS300x, SS350x
1	Reserved - do not connect
2	Serial programming interface - transmit <sup>1</sup>
3	Serial programming interface - receive <sup>1</sup>
4	A-
4	A+
6	Reserved - do not connect
7	Reserved - do not connect
8	Reserved - do not connect
9	B-
10	B+
11	Alarm
12	+5 VDC
13	Ground

Pin	SS200x, SS300x, SS350x
14	Z+
15	Z-

1. Signals used for legacy Computer Interface Adapter, do not connect

## 4.2 ABZ Signal Termination

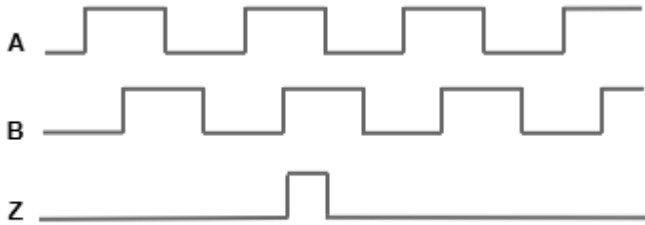
Differential A, B and Z signals should be connected via 120 ohm impedance cable and terminated at the customer electronics with a 120 ohm resistor. The example below shows the A quadrature signal.



## 5 Position Interface

### 5.1 ABZ Timing

- A leads/lags B depending on direction of motion (see Interface Drawing)
- Index occurs when quadrature signals A and B are both high



## 6 Installation & Handling



Please refer to Installation Manual, Interface Drawing and CAD Files available here:

[Installation Documents](#)<sup>1</sup>

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<sup>1</sup> <https://www.celeramotion.com/resources/legacy-products/>

## 7 Optional Software

SmartPrecision™ Software is an optional tool for configuration, alignment and monitoring.

Prerequisites: Win10 computer, USB cable

### 7.1 Installation & Operation

1. Download from [Get SmartPrecision<sup>2</sup>](#)
2. Run installer
3. Connect to interpolator via USB cable
4. Run SmartPrecision™

### 7.2 Functionality

#### 7.2.1 Program Interpolator

- Set interpolation depth in integer steps
- Set maximum interpolator output frequency

#### 7.2.2 Install Mercury Encoder System

- Align the sensor using the Signal Level display and the Encoder Signal data plot
- Verify the sensor's output over the length of the scale using the Signal Strength plot
- Locate the index and see when sensor is over the scale's index mark

#### 7.2.3 Monitor and Diagnose

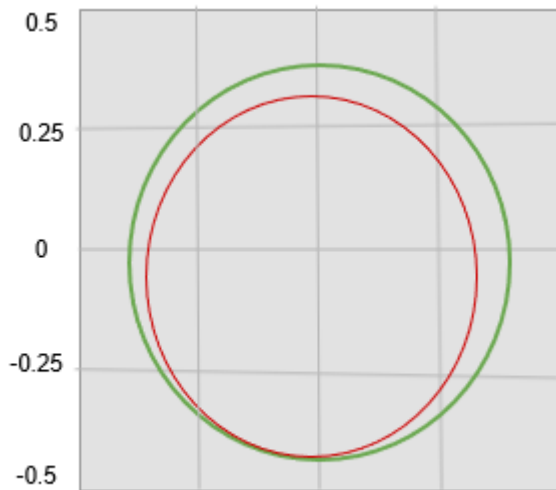
- Capture alarms and view the alarm log
- Read the encoder position in engineering units of your choice
- Read the encoder's hour meter to monitor system usage

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<sup>2</sup> <https://www.celeramotion.com/resources/software-downloads/>

## 7.3 Using the Lissajous Display

- Lissajous displays readhead SIN and COS signals on orthogonal axes
- Plot should be a perfect circle centered at origin of graph
- Red circle is raw signal showing small Gain imbalance and small Offset
- It is unusual to see a significant Phase shift - angled elliptical shape
- Green circle shows signal after Gain, Offset and Phase compensation
- Lissajous should maintain shape and size over range of travel (small variations are acceptable)



## 8 Ordering Information

### 8.1 Readhead

Model Number	Part Number	Description
M05	195-00294	Mercury I Readhead 0.5 m Cable
M10	195-00295	Mercury I Readhead 1.0 m Cable
M20	195-00296	Mercury I Readhead 2.0 m Cable
MV	195-00338	Mercury I Vacuum Readhead 1.5 m Vacuum Cable

### 8.2 Interpolator

Interpolator	Interpolation Depth	Maximum Output Frequency
SS200x	4 = 4X	1= 12.5 MHz
SS300x	5 = 5X	2= 4.17 MHz
SS350X	...	3= 1.8 MHz
	256 = 256X (SS200x Max)	4= 900 kHz
	...	5= 450 kHz
	1024 = 1024X (SS300x Max)	6= 225 kHz
	...	7= 6.25 MHz
	4096 = 4096X (SS350x Max)	8= 3.125 MHz

Example:

SS300x, 512 Interpolation Depth, 1.8 MHz Output Frequency: SS300x-512-3

## 8.3 Rotary Scales

Model Number	Part Number	Description
R1206	301-00073	Model number indicates approximate scale OD and ID
R1910	301-00055	
R3213	301-00056	
R5725	301-00057	
R10851	301-00058	

## 8.4 Rotary Scales on Hubs

Model Number	Part Number	Description
R1206-HE	190-00051	Model number indicates approximate scale OD and ID
R1910-HA	190-00036	
R3213-HB	190-00037	
R5725-HC	190-00038	
R10851-HD	190-00039	

## 8.5 Linear Scales

Prefix	Length	Adhesive Tape Option
L	18, 30, 55, 80, 105, 155, 325, 425	T

Examples:



55 mm scale, clamp mounting: L55

105 mm scale, adhesive tape option: L105-T

## 8.6 Accessories

Model Number	Part Number	Description
C1	160-00001	Scale clamps (3) L30 - L105
C2	160-00002	Scale clamps (10) L155 - L425
ZG-CET	409-0000	Z Height gauge