Table of Contents

1.0 Introduction

1.1 Overview

The instructions in this manual apply to the following Veratus Series Encoders models:

- Model VIA Standard Atmospheric Incremental Encoder

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 Standards Compliance

Veratus Series Encoders are RoHS and RoHS2 compliant; CE compliance pending. *RoHS*

1.4 Related Documentation

- Veratus Series Encoders Data Sheet
- Veratus Series Encoders Interface Drawings
- Veratus Series Encoders Tape and Glass Scales Installation Manual

1.5 Manual Revisions

Version	Date	Notes
Rev. 1	10/20/2015	Initial Release

1.6 Trademarks

Veratus is a registered trademark of MicroE Systems®.

1.7 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

A 5.0Vdc ± 0.25Vdc power supply is recommended at the input connector:

- For cable lengths ≤ 5m, simply strap the 5V_Sense with the 5V and the Com_Sense and Com wires together per paragraph 6.6
- The sense wires can be used to increase the power supply voltage for cable lengths > 5m to accommodate for cable voltage drop either by connecting them directly to the sense terminals on the power supply or by using them to measure the voltage at the encoder end of the cable
    - The encoder will operate and meet all specifications when the voltage at the sense lines is between 4.2Vdc and 5.5Vdc (with the sense lines not strapped to 5V and Com)
    - The sense wires are the same wire gage as the 5V and Com wires and thus will halve the voltage drop when they are strapped together
    - Always strap the sense lines together, to minimize cable drop, if they are not connected directly to the power supply's sense inputs
- The LED will indicate solid red when the power supply voltage is outside the encoder's operating range (4.2Vdc to 5.5Vdc at the encoder end of the cable)

2.2 Installation Considerations

The Veratus 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 Veratus design, allow easy access to the sensor for service and/or replacement. For optimal performance and reliability:

- DO follow standard ESD precautions while handling the sensor.
- DO allow proper clearance for sensor head alignment.
- DO follow setup and alignment 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.

2.3 Items Required for Installation

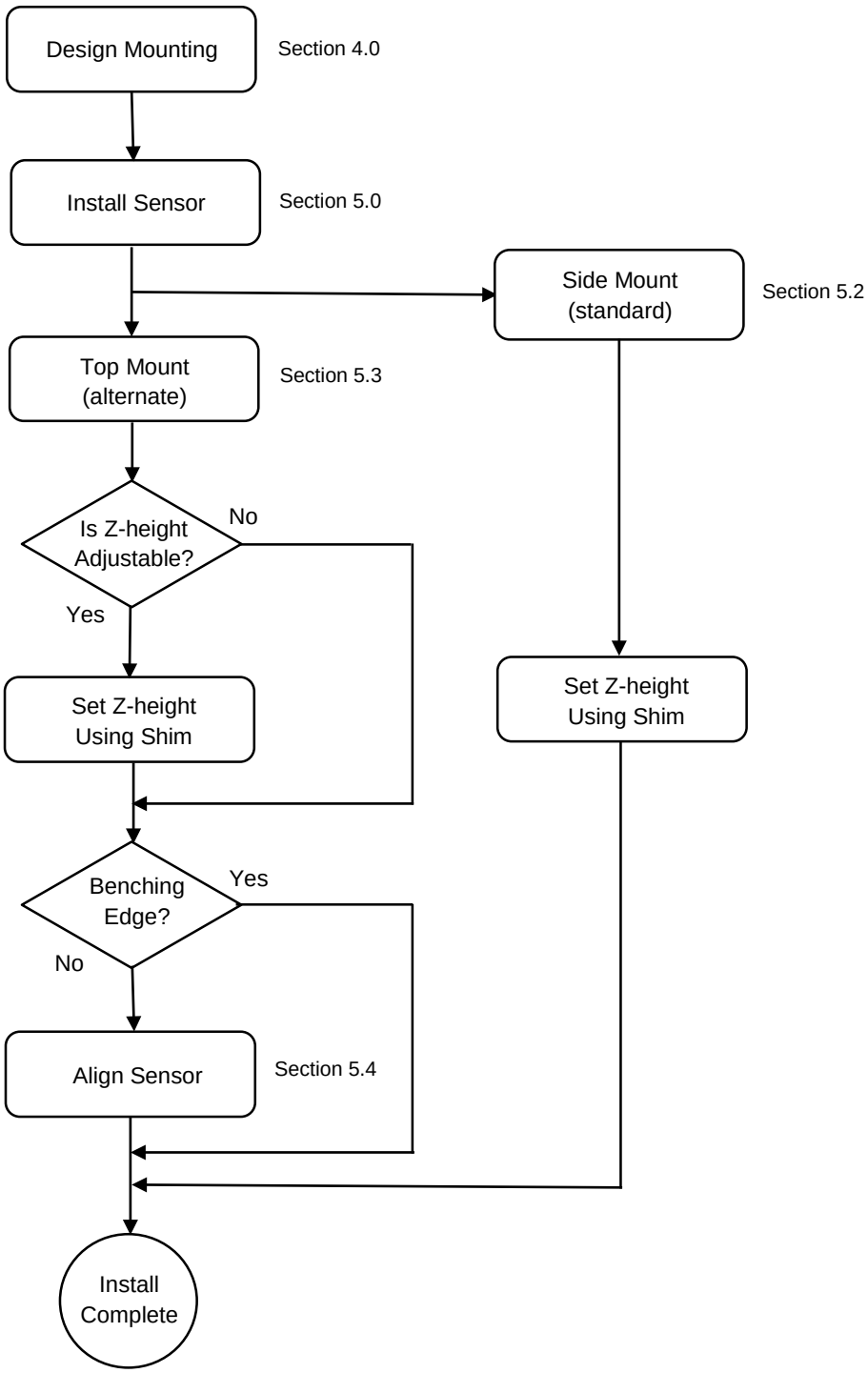
In addition to the items identified in ***Section 3.0 System Overview,*** you will need the following items available for installation:

Item
Z-height spacer shim[1]
Screwdriver
Finger Cots or talc-free gloves
Acetone or isopropyl alcohol
Lint-free cotton cloths or wipes
Epoxy, non-conductive[2]
Stick and disposable surface for stirring epoxy[2]

Notes:
1. Included with sensor.
2. Not required for all installations.

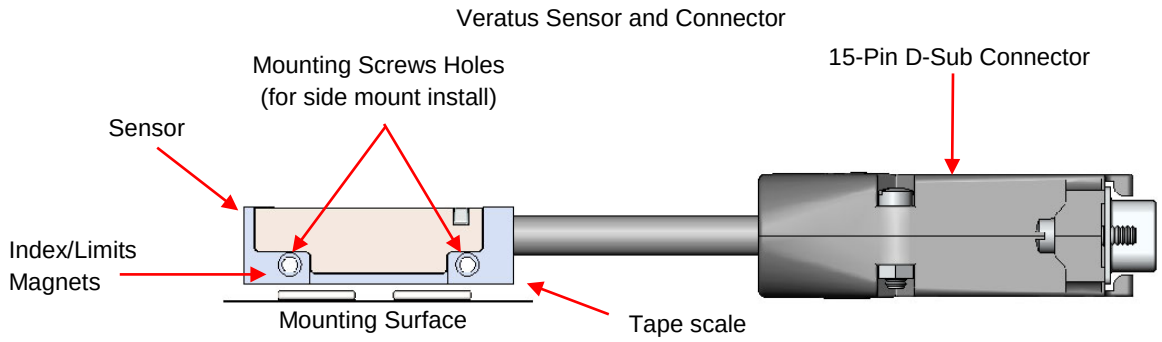
2.4 Installation Flowchart

The following flowchart shows the main steps in sensor installation and alignment.



3.0 System Overview

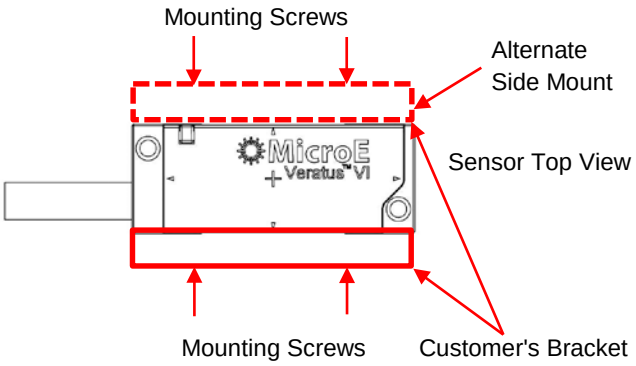
This section identifies parts for the encoder installation. Use the information in this section to design the mounting scheme for the sensor. Refer to the Veratus Series Encoders interface drawings for details.



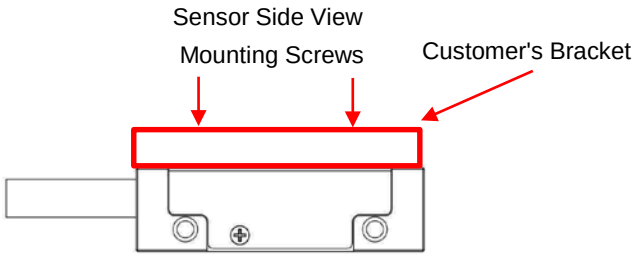
3.1 Top and Side Mountings

The sensor can be mounted in a top mount or side mount orientation directly to customer's bracket or equivalent surface using two mounting screws.

Side Mount Installation



Top Mount Installation



Recommended Customer Required Parts

The following parts or their equivalents are recommended for the top or side mount mechanical mounting of the Veratus sensor.

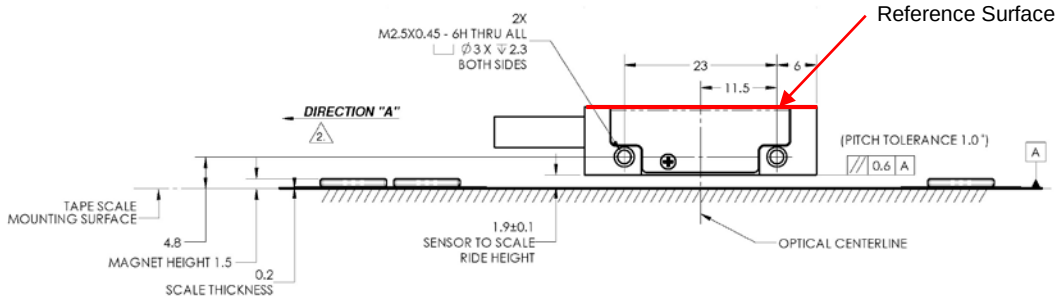
Item	Mounting Scheme
M2.5 Screws (2) M2 Screws (2)	M2.5 tapped holes (side or top mount). Use M2.5 tapped holes as through holes (recommended for side mount only). **Note**: Screw length should extend into the sensor body at least 6 mm. This will accommodate the countersink of 2.3 mm and provide enough threads to make a secure connection without stripping the sensor body.
Z-height Shim Spacers	Two disposable shims for installing sensor (included with sensor) for: • Tape scale install • Glass scale install 

4.0 Design Mounting

This section contains instructions for designing the mounting scheme for installing the sensor in both top and side mountings. A benching edge is recommended to locate the sensor to meet mechanical mounting tolerances. Refer to the interface drawings for recommended location and height of edge.

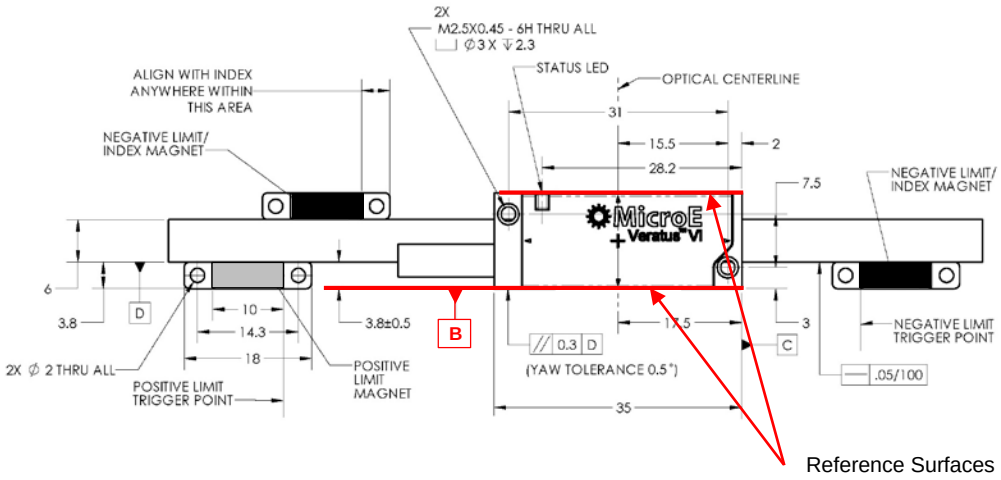
Top Mount Installation

Due to clearances beneath the sensor, use only the top surface (opposite the sensor optic) as reference.



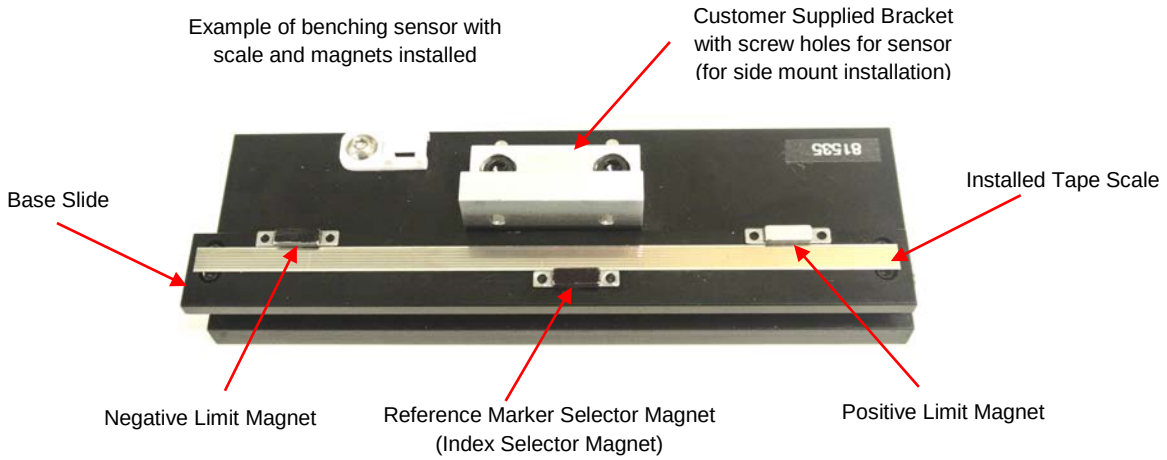
Side Mount Installation

Use Datum B or the opposite long edge as reference.



5.0 Install Sensor

Note: Scale and magnets must be installed before installing the sensor. Refer to the *Veratus Series Encoders Tape and Glass Scales Installation Manual* for instructions.



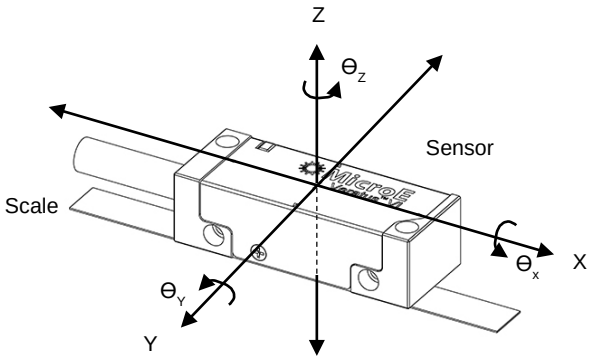
The side mount orientation is the preferred method of installing the sensor since it provides for critical benching and easy access.

5.1 Sensor Mounting Orientation and Tolerances

Refer to the following specifications when installing and aligning the Veratus sensor. Use for both top and side mountings.

Orientation

Alignment Axes



Tolerances

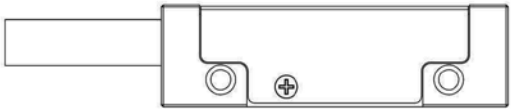
Veratus Series Encoders Sensor Alignment Tolerances	
Axis	**Alignment Tolerance**
X	Direction of Motion
Y	± 500 µm
Z	± 100 µm
θX	± 0.5°
θY	± 1.0°
θZ	± 0.5°

Note: Tolerance for each axis is specified independently, assuming nominal alignment in other axes.

5.2 Side Mount Installation

(Standard mounting orientation)

Refer to the Veratus Series Encoders interface drawings for details for sensor installation. Refer to sensor information in ***Section 3.0 System Overview***.

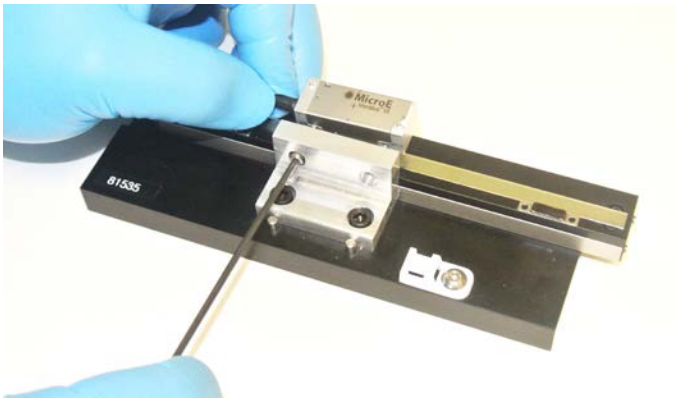


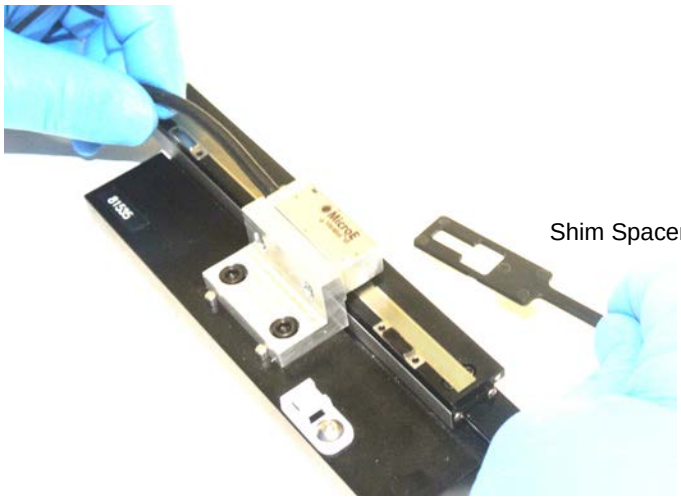
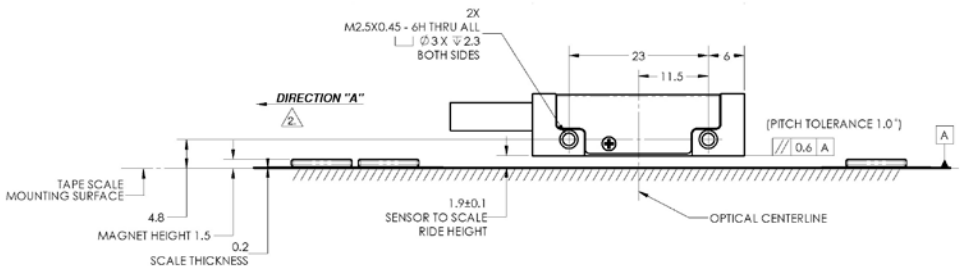
Side View of Sensor

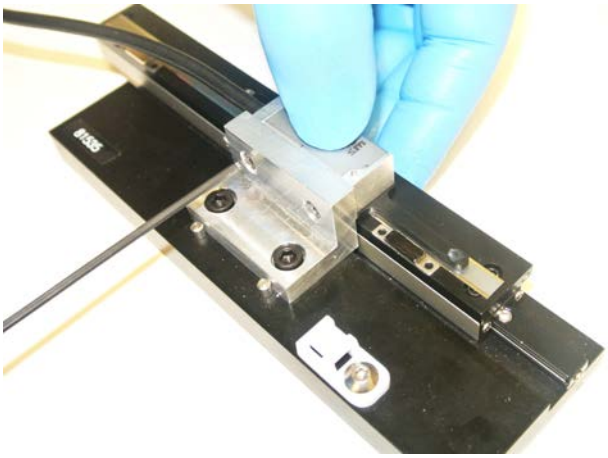
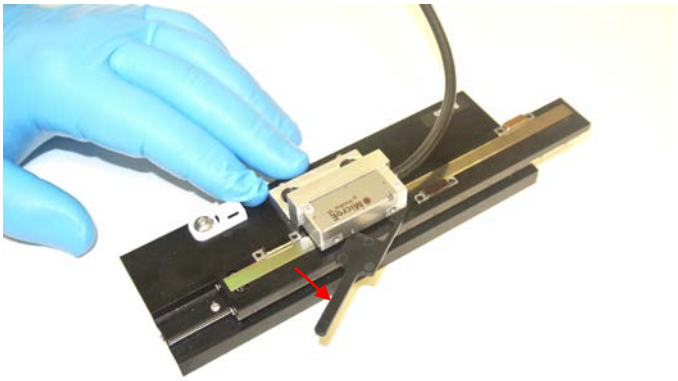
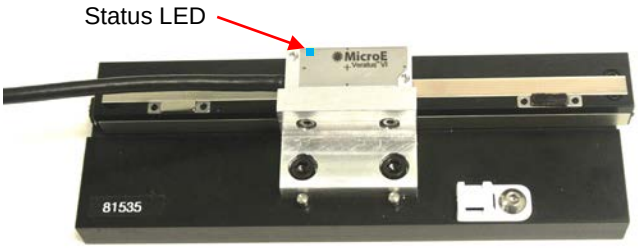
Note: A scale must be installed before installing the sensor. Refer to the *Veratus Series Encoders Tape and Glass Scales Installation Manual*.

Note: The sensor may be powered during this procedure.

Perform the following steps to install sensor in a side mount orientation.

Step	Action
1.	Insert two M2.5 screws to attach sensor and secure loosely. Refer to the interface drawings to ensure that the sensor is oriented correctly to the scale. **Note**: Screw length should extend into the sensor body at least 6 mm. This will accommodate the countersink of 2.3 mm and provide enough threads to make a secure connection without stripping the sensor body. Insert mounting screws (2).  Attach screws loosely. Do not tighten. 

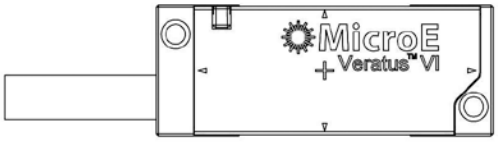
Step	Action
2.	Z-height: • If Z-height is adjustable, then use the Z-height Shim Spacer to verify proper Z-height distance between the bottom surface of the sensor and the top of the scale is as follows: ▪ For tape scales: 1.9 mm +/- 0.1 mm ▪ For linear or rotary glass scales: see interface drawing for glass scales  Shim Spacer • If Z-height is not adjustable, then go to Step 6.
3.	Place shim between the bottom of the sensor head and the top of the scale and press down in the Z-axis. Make sure to choose a location where the magnets do not interfere with the shim. Gently press the sensor and the shim against the top of the tape scale in the Z-axis.  Shim can be inserted either parallel or perpendicular to the scale. The shim features cut-outs that allow the signal level to be monitored during sensor mounting.

Step	Action
4.	Tighten the sensor mounting screws. 
5.	Carefully remove the shim by rotating it off the scale using the shim's handle.  Rotate to remove shim
6.	Connect sensor's 15-pin connector to customer's electronics.  Status LED Installed sensor **Result**: Blue LED should light.
7.	Move sensor to confirm blue LED lights for optimal alignment (see ***Section 5.4 Sensor Head Alignment***.) **Result**: If blue LED lights, then sensor installation is complete for top mount installation. If LED does not indicate optimal alignment, go to *Sensor Head Alignment*.

5.3 Top Mount Installation

(Alternate mounting orientation)

Refer to the Veratus interface drawings for details for sensor installation. Also refer to sensor information in ***Section 3.0 System Overview*** and see ***Section 5.2 Side Mount Installation*** for some related details.

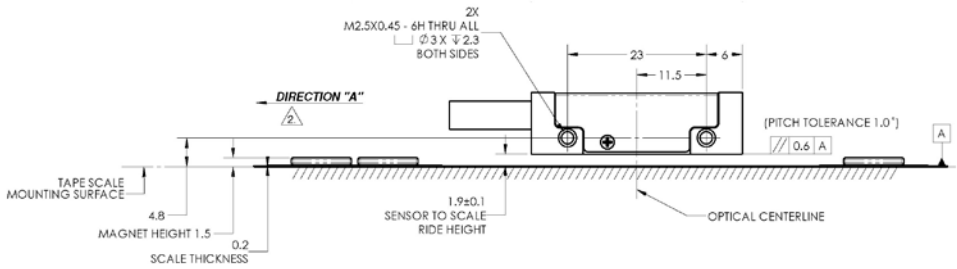


Top view of sensor

Note: A scale must be installed before installing the sensor. Refer to the *Veratus Series Encoders Tape and Glass Scales Installation Manual*.

Note: The sensor may be powered during this procedure.

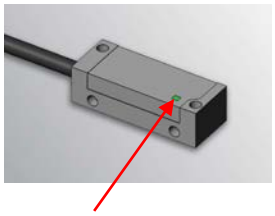
Perform the following steps to install sensor in top mount orientation.

Step	Action
1.	Insert two M2.5 screws to attach sensor and secure loosely. Do not tighten. Refer to the interface drawings to ensure that the sensor is oriented correctly to the scale. **Note**: Screw length should extend into the sensor body at least 6 mm. This will accommodate the countersink of 2.3 mm and provide enough threads to make a secure connection without stripping the sensor body.
2.	Z-height: • If Z-height is adjustable, then use the Z-height Shim Spacer to verify proper Z-height distance between the bottom surface of the sensor and the top of the scale is as follows: ▪ For tape scales: 1.9 mm +/- 0.1 mm ▪ For linear or rotary glass scales: see interface drawing for glass scales • If Z-height is not adjustable, then go to Step 6.
3.	Place shim between the bottom of the sensor head and the top of the scale and press down in the Z-axis. Gently press the sensor and the mounting against the top of the tape scale in the Z-axis.  Shim can be inserted either parallel or perpendicular to the scale. The shim features cut-outs to allow the signal level to be monitored during sensor mounting.
4.	Tighten the sensor bracket in the Z-axis.
5.	Carefully remove the shim by rotating it off the scale using the shim's handle.
6.	Connect sensor's 15-pin connector to customer's electronics.
7.	Move sensor to confirm blue LED lights for optimal alignment (see *Section 5.4 Sensor Head Alignment).* **Result**: If blue LED lights, then sensor installation is complete for top mount installation. If LED does not indicate optimal alignment, go to ***Section 5.4 Sensor Head Alignment***

5.4 Sensor Head Alignment

Alignment is positioning of the sensor with respect to the scale to achieve proper signal strength from the count track and the index track. Proper sensor alignment may require minor adjustments to the sensor position with respect to the scale.

Sensor alignment can be performed easily using the sensor's Status LED indicator, which displays sensor alignment status as follows:

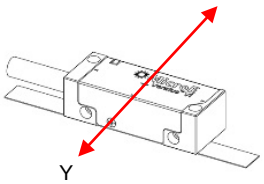


Status LED

LED Color	System Status
Blue	Optimal alignment: Optimal position signal with minimum power consumption Encoder system meets specification
Green	Good alignment: Optimal position signal at specified power consumption Encoder system meets specification.
Yellow	Alignment could be improved but fully operational: Sensor is reading position with marginal signal strength. Encoder system functions but vector magnitude may not be 1 Vpp and SDE may exceed specification.
Red	Sensor fault: Sensor is reading position with weak signal strength, or Power supply is less than 4.2 V, or Power supply is greater than 5.5 V, or Sensor moving faster than 5.8 m/s. Encoder system may not function properly. Alarm signal will be asserted.

Align Sensor (only if no benching edge)

Perform the following steps to align the sensor:

Step	Action
1.	Apply power to sensor if not already powered on.
2.	Optimal alignment: • Ensure that the sensor's mounting screws are loosely tightened. • Slowly move the sensor by allowing it to slide on the mounting surface until the Status LED illuminates blue, which indicates optimal alignment. • Check LED through full range of motion of the sensor (see System Status table above). • Tighten the mounting screws when optimal alignment is achieved.
3.	If optimal alignment is not achieved (blue LED illuminates), re-check Z-height: • For a side mount installation, go to Steps 2 through 5 on pages 8 and 9. • For a top mount installation, go to Steps 2 through 5 on page 10. After Z-height is re-adjusted, confirm optimal alignment and continue to Step 4.
4.	Confirm that the blue LED flashes brightly when passing over the index. If not, readjust the sensor in the Y direction and repeat the above procedure starting at Step 2 above.  Y
5.	Confirm limit magnets: • Confirm that blue LED blinks at a regular interval (4 Hz) over the Positive Limit Magnet. • Confirm that blue LED blinks at a regular interval (2 Hz) over the Negative Limit Magnet.
6.	When alignment is completed, tighten the two sensor mounting screws.
7.	Confirm that the LED remains blue over the full range of motion.
8.	If the sensor is not aligned over the entire range of motion: • Loosen the sensor mounting screws and repeat this procedure starting at Step 1.

Step	Action
	• Confirm that the scale has been installed parallel to the motion axis and that the LED remains blue through the full range of motion. **Result**: The LED remains blue throughout travel and flashes over the Index.

6.0 Appendix

6.1 Specifications

System

Scales

Veratus Series Encoders are compatible with Veratus Tape, Linear Glass, and Rotary Glass scales.

Scale Pitch	20 µm
System Resolution	5 µm, 2.5 µm, 1 µm, 0.5 µm, 0.2 µm, 0.1 µm, 50 nm, 20 nm. Analog 1 Vpp 2,000 CPR – 75M CPR (rotary) (specify resolution at time of ordering)

Accuracy

Tape	SDE:	<20 nm RMS[3]
	Linearity:	≤±3 µm (max/meter)
	Slope:	<±50 µm/m
Linear Glass	SDE:	<20 nm RMS[3]
	Total Accuracy:	<±2 µm/m[1]
Rotary Glass	Total Accuracy:	±2 arc-seconds[2]

Sensor Size and Weight

	Length	Width	Height
Dimensions (mm)	35.0	13.5	10.2
Weight	<15 g sensor head <30 g/m cable		
Sensor Cable	8 twisted pairs double-shielded, length up to 5 m		

Operating and Electrical Specifications

Power Supply Current

AquadB, 5 V_{DC} ±5%:		<220 mA with 120Ω across A, B, I <160 mA with no load
Analog,	5 V_{DC} ±5%:	<170 mA with 120Ω across Sin/Cos, IW <140 mA with no load
	Ready Time:	<0.5 s once power >4.5 V

Temperature	
Operating	-20°C to 70°C
Storage	-20°C to 85°C
Humidity	
Operating	10% to 90% RH, non-condensing
Storage	Up to 85% RH, non-condensing
Vibration	10 g, 55 Hz to 2 KHz; EN60068-2-6
Acceleration	50 g; EN 60068-2-7

Outputs

Analog: Sine/Cosine differential
Digital: A-quad-B differential
Index: Index Window (analog and 5 µm digital only),1 LSB (digital 2.5 µm and above)

Right and Left Limits single-ended, open collector 24 V compliant
Alarm is single-ended open collector

Signal Levels

A/B/I (differential): RS-422 compatible
A/B/I (single-ended, no termination): High>4.2 V_{DC}, Low <0.2 V_{DC}
Sine/Cosine: 1 Vpp across 120 ohm termination, 2 Vpp no termination, Common mode voltage 2.0 V_{DC}
Alarm: Pull up to encoder supply voltage maximum
Limits: Pull up to 24 V maximum

Notes:

1. 130 mm or less
2. 125 mm diameter, excludes eccentricity
3. Primarily first and second harmonic

Maximum Velocity (Digital)

Maximum Velocity (before Overspeed Buffer Protection[4]) vs. Interpolation Depth

Controller Recommended AqB Maximum State Rate (MegaStates/Sec)	Actual Encoder AqB Maximum State Rate (MegaStates/Sec)	5000	2500	1000	500	200	100	50	20	Resolution (nm)
		4	8	20	40	100	200	400	1000	Interpolation Depth
20	17.50	5000	5000	5000	5000	3500	1750	875	350	Maximum Velocity (mm/s)
10	8.75	5000	5000	5000	4375	1750	875	437	175	
5	4.38	5000	5000	4375	2187	875	437	218	87	
2	1.75	5000	4375	1750	875	350	175	87	35	
1	0.88	4375	2187	875	437	175	87	43	17	

Notes[4]:

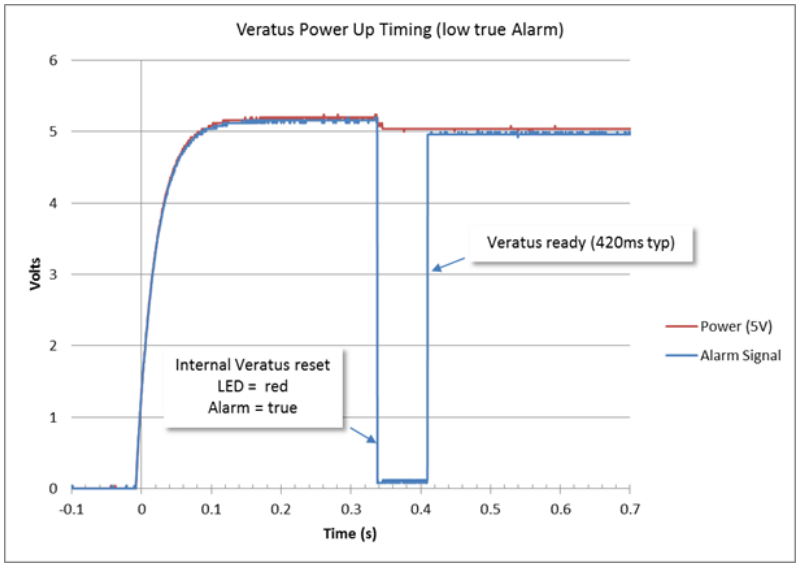
1. Veratus implements Overspeed Buffer Protection (OBP). No AqB counts are lost for velocities below 5830 mm/s even if the maximum specified state rate is exceeded.
2. The ALARM bit sets TRUE at 5.83 m/s, however, Veratus will continue to produce valid AqB outputs up to 7 m/s although accuracy specifications are no longer guaranteed.

Maximum Velocity (Analog)

Sine/Cosine Vector Magnitude: > 0.5 Vpp at 5 m/s

6.2 Power-Up Timing

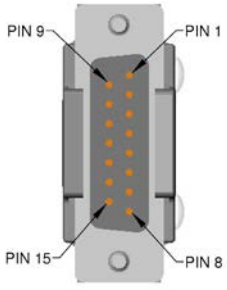
The Veratus encoder will be ready 420 ms after the 5 V supply rises, during which the LED will flash red and the Alarm signal will transition true. The encoder will be ready once the Alarm transitions false per the following chart:



6.3 Sensor Connector Pinouts

15-Pin Standard Male D-sub Connector Configuration

Manufacturer's Part Number: 15 Pin D-sub Connector



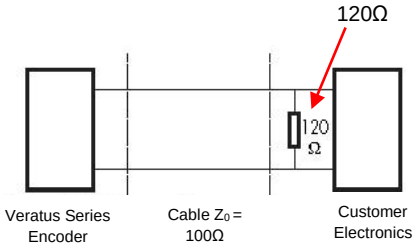
Pin Numbers	Signals	
	Digital	Analog
1	NC	Cos-
2	Com	Sin-
3	Alarm	Index+
4	Index-	5V
5	B-	5V_Sense
6	A-	Alarm
7	5V	Positive Limit
8	5V_Sense	Negative Limit
9	Com_Sense	Cos+
10	Negative Limit	Sin+
11	Positive Limit	Index-
12	Index+	Com
13	B+	Com_Sense
14	A+	NC
15	NC	NC

NC – No Connect

Note: GND and Inner Shield are internally connected.

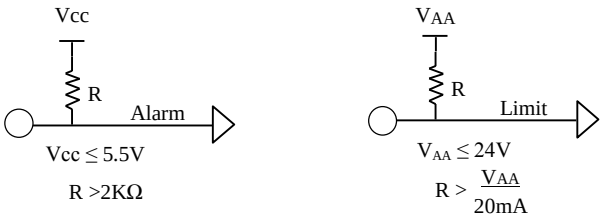
6.4 Recommended Signal Termination

Digital/Analog Outputs

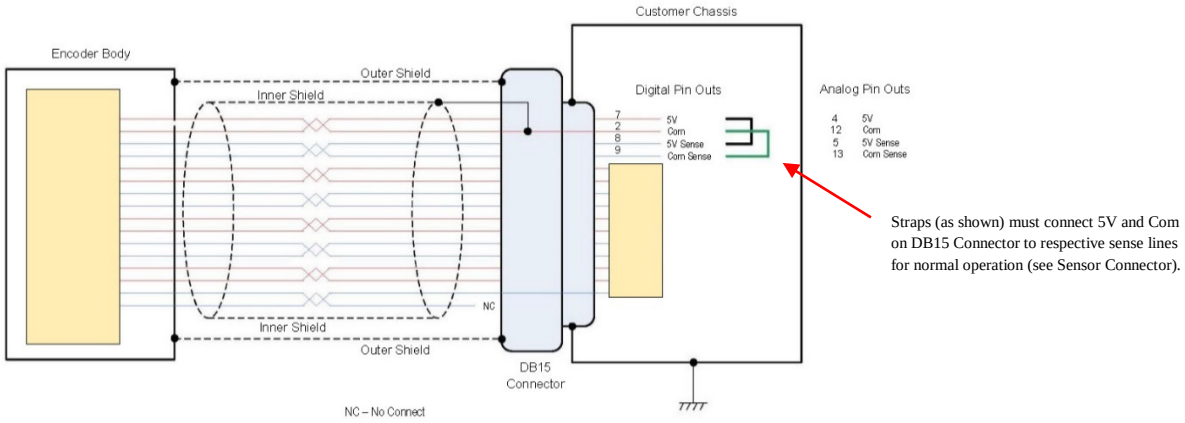


Alarm and Limit Outputs

Alarm and limit outputs are open collector circuits that are factory programmable: either Active High or Active Low; specify when ordering. Each circuit requires an external pull-up resistor. See customer-supplied circuit examples below.



Note: Maximum cable length is
5 m. Contact MicroE Applications Engineering if longer lengths are required.



6.5 Customer Interface

Cable Requirements

Customer cables that interface to the Veratus Series Encoders must have the following characteristics:

- Twisted pairs with 120 ohm characteristic impedance.
- Shielding connected to the sensor's outer shield.

6.6 Sense Lines

Veratus is equipped with a 5V_Sense and Com_Sense twisted pair. For systems where the total distance between the sensor head and the receiving electronics (sensor cable and customer's extension cable) does not exceed 5 meters, simply tie 5V and Com to their respective sense lines as shown above in ***Section 6.3 Sensor Connector Pinouts***. For cable runs ≥5 meters, the sense lines provide a means to check the voltage drop with a DVM and make the necessary adjustment to the supply output to achieve the voltage specified in ***Section 2.1 Power Recommendations***.

6.7 RS-422 Compatibility

Veratus Series Encoders are RS-422 compatible. Encoder AqB and Index signals are back matched with 60Ω in each leg and therefore terminations at the receiving end are not strictly required unless the cable runs are long or in harsh electronic environments.

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

Troubleshooting

Problem	Solution
The LED on the sensor does not light.	• Confirm power connection is correct. • Confirm sensor configuration.
The LED on the sensor displays steady red.	• Confirm sensor alignment. • Confirm scale cleanliness.

7.0 Order Guide

Sensor

VIA-5000-AA1-20-05-A (example)

- Cable Termination
  A=15-pin D-sub
- Cable Length
  05=0.5 m
  10=1.0 m
  15=1.5 m
  30=3.0 m
  50=5.0 m
- AquadB Output Rate
  20=20 MegaStates/sec
  10=10 MegaStates/sec
  05=5 MegaStates/sec
  02=2 MegaStates/sec
  01=1 MegaStates/sec
  00=Analog 1 Vpp/sec
- Index Selector
  1=Enabled (requires selector magnet to trigger index)
  0=Disabled (all indexes trigger signal)
- Limits
  A=Open Collector, Active High
  B=Open Collector, Active Low
- Alarm
  A=Open Collector, Active High
  B=Open Collector, Active Low
- Resolution
  5000=5 µm
  2500=2.5 µm
  1000=1 µm
  0500=0.5 µm
  0200=0.2 µm
  0100=0.1 µm
  0050=50 nm
  0020=20 nm
  0000=Analog 1 Vpp
- Sensor Type
  A=Standard
- Model
  VI = Veratus Incremental

Scales[1] - Veratus Tape Scale

VILT-05000I-A-A (example)

- Mounting
  A=Adhesive
- Index Mark
  A=Every 50 mm
  B=Center of measuring length
  C=Customer specified
  E=None
- Continuous or Individual
  C=Continuous lengths with cut marks
  I=Individual length (default selection for Index Mark types A & E)
- Tape Scale Length
  XXXXX=Length in mm
- Model
  VILT=Veratus Tape Scale, Standard

Accessories

VI-RM	Reference Marker Selector Magnet
VI-PL	Positive Limit Magnet
VI-NL	Negative Limit Magnet
VILT-AT	Tape Scale Applicator Tool (used for lengths >0.3 m)

Note[1]: Scales Availability: linear glass and rotary glass scales are available; contact MicroE for more details:
- Linear Glass Scales - Model VILG, lengths up to 130 mm
- Rotary Glass Scales - Model VIRG, diameters up to 130 mm

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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