Veratus™ Series Encoders

Compact Precision Encoders for the World’s Machines and Instruments

Built with the new VeraPath™ optical encoder technology from MicroE, the Veratus Series delivers best-in-class reliability, signal stability and dirt immunity in a compact package with unparalleled ease of use.

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Veratus™ Series Encoders
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Smart and Reliable.
Veratus is the only encoder in its class that delivers the reliability, signal stability and dirt immunity required in precision industrial applications with all interpolation, AGC and signal processing performed in the sensor head. No additional PCBs, adapters or dongles are necessary.

Built using new VeraPath™ technology from MicroE, Veratus is engineered with advanced optical filtering and state-of-the-art signal processing and electronics, ensuring low position noise (jitter) and smooth velocity control over a wide range of operating conditions. Veratus is available with up to 20 nm resolution and offers industry standard analog and digital incremental encoder outputs, a phased LSB index, and easy-to-install magnetic limits and index select marks.

Veratus is compatible with MicroE’s wide range of linear gratings and scales, enabling robust performance and easy installation.

Benefits
- Dirt immunity and reliable performance in a wide range of applications and environments; advanced optical filtering and signal processing
- Compact footprint; interpolation and signal processing in sensor head
- Hassle free algorithm-driven automatic calibration; plug and go — no tools or buttons needed
- Multiple mounting configurations
- Built-in limits, flexible index selection
- Multiple linear grating/scale options
- Alignment/Status LED in sensor head

SPECIFICATIONS

Dimensions: 35.0 x 13.5 x 10.2 mm
Interfaces: A-quad-B digital or 1 Vpp Sin/Cos analog
Resolution: 5 µm - 20 nm (linear)
Accuracy Class: +/- 1 µm (linear glass)
+/− 3 µm (linear metal tape)
Input Voltage: 5 VDC
Supply Current: 220 mA with 120 Ω across A, B, I
170 mA with 120 Ω across Sin/Cos, IW
Max Speed: 5 m/s
Index: IW for analog and 5 µm digital
LSB for 2.5 µm digital and above
Outputs: Sin/Cos or A-quad-B, Index, Limits (2), Alarm
Status LED: Yes
Operating Environment: Atmospheric
Scale Pitch: 20 µm
Repeatability: (Hysteresis) ≤ 1 LSB
Typical Sub-Divisional Error (SDE): < 20 nm RMS
Weight: < 1 g sensor head, < 30 g/m cable
Grating Compatibility: Linear

Specifications subject to change.
Veratus™ Series Encoders
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Specifications

<table>
<thead>
<tr>
<th>System</th>
<th>Scales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veratus Series Encoders are compatible with Veratus Tape and Linear Glass</td>
<td></td>
</tr>
</tbody>
</table>

**Scale Pitch**
20 \(\mu m\)

**System Resolution**
- 5 \(\mu m\)
- 2.5 \(\mu m\)
- 1 \(\mu m\)
- 0.5 \(\mu m\)
- 0.2 \(\mu m\)
- 0.1 \(\mu m\)
- 50 nm
- 20 nm
- Analog 1 Vpp
- (specify resolution at time of ordering)

**Accuracy**

<table>
<thead>
<tr>
<th>Tape</th>
<th>SDE: &lt;20 nm RMS²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Linearity: &lt;±3 (\mu m) (max/meter)</td>
</tr>
<tr>
<td></td>
<td>Slope: &lt;±50 (\mu m/m)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Linear Glass</th>
<th>SDE: &lt;20 nm RMS²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Accuracy: &lt;±2 (\mu m/m²)</td>
</tr>
</tbody>
</table>

**Sensor Size and Weight**

<table>
<thead>
<tr>
<th>Dimensions (mm)</th>
<th>Length</th>
<th>Width</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>35.0</td>
<td>13.5</td>
<td>10.2</td>
</tr>
<tr>
<td></td>
<td>&lt;15 g sensor head</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;30 g/m cable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sensor Cable**
- 8 twisted pairs double-shielded, lengths up to 5 m

**Operating and Electrical Specifications**

**Power Supply Current**
- AquadB, 5 Vdc +/- 5%: <220 mA with 120Ω across A, B, I
- <160 mA with 0 load
- AquadB, 5 Vdc +/- 5%: <170 mA with 120Ω across Sin/Cos,IW
- <140 mA with 0 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; EN60068-2-7

**Outputs**
- Analog: Sine/Cosine differential
- Digital: AquadB differential
- Index: Index Window (analog and 5 \(\mu m\) digital only), 1 LSB (digital 2.5 \(\mu m\) 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 Vdc, Low<0.2 Vdc
- Sin/Cos: 1 Vpp across 120Ω termination, 2 Vpp no termination, common mode voltage 2.0 Vdc
- Alarm: Pull up to encoder supply voltage maximum
- Limits: Pull up to 24 V maximum

**Maximum Velocity (Digital)**

<table>
<thead>
<tr>
<th>CONTROLLER RECOMMENDED AQB MAXIMUM STATE RATE (MEGASTATES/SEC)</th>
<th>ACTUAL ENCODER AQB MAXIMUM STATE RATE (MEGASTATES/SEC)</th>
<th>5000</th>
<th>2500</th>
<th>1000</th>
<th>500</th>
<th>200</th>
<th>100</th>
<th>50</th>
<th>20</th>
<th>RESOLUTION (NM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>17.50</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>3500</td>
<td>1750</td>
<td>875</td>
<td>350</td>
<td>1750</td>
<td>5830</td>
</tr>
<tr>
<td>10</td>
<td>8.75</td>
<td>5000</td>
<td>5000</td>
<td>4375</td>
<td>1750</td>
<td>875</td>
<td>437</td>
<td>175</td>
<td>437</td>
<td>2950</td>
</tr>
<tr>
<td>5</td>
<td>4.38</td>
<td>5000</td>
<td>5000</td>
<td>4375</td>
<td>2187</td>
<td>875</td>
<td>437</td>
<td>218</td>
<td>875</td>
<td>1950</td>
</tr>
<tr>
<td>2</td>
<td>1.75</td>
<td>5000</td>
<td>4375</td>
<td>1750</td>
<td>875</td>
<td>350</td>
<td>87</td>
<td>35</td>
<td>87</td>
<td>915</td>
</tr>
<tr>
<td>1</td>
<td>0.88</td>
<td>4375</td>
<td>2187</td>
<td>875</td>
<td>437</td>
<td>175</td>
<td>87</td>
<td>43</td>
<td>17</td>
<td>455</td>
</tr>
</tbody>
</table>

Notations:
- 1. 130 mm or less
- 2. Primarily first and second harmonic
- 3. 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.
- 4. 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
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Output Signals

- **Sensor**
- **Align with index anywhere within this area**
- **Direction of positive encoder head motion relative to scale:**
  - Digital: Count up (A leads B)
  - Analog: Cosine leads Sine

- **Negative Limit/Index Magnet**
- **Positive Limit Magnet**
- **Positive Limit Trigger Point**
- **Negative Limit Trigger Point**
- **Optical Centerline**

- **Index Window (IW)**: 20 µm
- **Sin/Cos: 1.0 Vpp differential into 120Ω.**
  - Single-ended signals = 0.5 Vpp on a 2.0 VDC common mode voltage.
- **Index Window is centered on the 45° vector angle of the Sin/Cos signals.**
  - Signal is differential output and RS-422 compatible; available on analog and 5 µm digital resolution.
- **A-quad-B signal are differential outputs and RS-422 compatible.**
- **1 LSB Index: Signal is differential output and RS-422 compatible; available on 2.5 µm digital resolution and above.**
- **Limits are open collector; require external pull-up. Limits are factory programmable: either Active High or Active Low; specify when ordering.**
- **Alarm is factory programmable: either Active Low or Active High; specify when ordering. Signal active for the duration of the event, but not less than 40 msec.**
- **Alarm is open collector; requires external pull-up.**
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Contamination Resistance

With the new VeraPath™ technology, Celera Motion is able to offer the dirt immunity, reliability, and accuracy with metal tape scales required in advanced industrial applications where the encoder is operating in exposed environments. VeraPath filters out signal disturbances caused by scratches on scales and by typical variations of metal scale flatness and achieves high levels of accuracy with both metal scales and glass scales. This is especially beneficial when motion control systems require a precision optical encoder on a long linear stage or actuator where metal tape scales are the preferred solution.

For more details, see Tech Note TN-1002 VeraPath™ Optical Encoder Technology.

Features of VeraPath

Veratus Series Encoders utilize the following features of VeraPath to minimize the impact of scale contamination:

• LED light source
• Advanced filtering optics
• Large detector area
• State-of-the-art signal processing

Causes of Contamination

VeraPath minimizes optical scanning errors caused by contamination such as:

• Oil film
• Dust
• Water
• Fingerprints

Advanced Signal Processing

Sensor optics and internal control loops make a robust position detector capable of high contamination resistance. Veratus internal control loops generate corrections:

• Automatic Vector Magnitude Control (AVMC) adjusts Lissajous diameter to a constant 1 Vpp through debris and over time
• Automatic Offset Control (AOffC) adjusts Lissajous origin to 0.0 volts to minimize SDE error
• Automatic Gain Tracking Control (AGainTC) balances the amplitude of Sine/Cosine so that the Lissajous is round minimizing SDE error
• Automatic Common Mode Output Voltage Control (ACMOV) adjusts the common mode output voltage of Sine/Cosine to 2.0 VDC independent of encoder alignment
**Veratus Sensor**

System Status LED

Veratus Series Encoders have a built-in Status LED that displays alignment quality, index/limits detection, and alarms.

### Indications for Index/Limits Detection

- **Index**: very bright at the index
- **Positive Limit**: flashes between normal and very bright at 4 Hz when passing over positive limit
- **Negative Limit**: flashes between normal and very bright at 2 Hz when passing over negative limit

### Interface Drawing

- **Direction “A”**
  - Digital: Count up (A leads B)
  - Analog: Cosine leads Sine

### 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
Veratus™ Series Encoders
Compact Precision Encoders for the World’s Machines and Instruments

Veratus Sensor
Wide Alignment Tolerances

Veratus Series Encoders
Sensor Alignment Tolerances

<table>
<thead>
<tr>
<th>AXIS</th>
<th>ALIGNMENT TOLERANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Direction of Motion</td>
</tr>
<tr>
<td>Y</td>
<td>+/- 0.5 mm</td>
</tr>
<tr>
<td>Z</td>
<td>+/- 0.1 mm</td>
</tr>
<tr>
<td>Θx</td>
<td>+/- 1.0°</td>
</tr>
<tr>
<td>Θy</td>
<td>+/- 1.0°</td>
</tr>
<tr>
<td>Θz</td>
<td>+/- 0.5°</td>
</tr>
</tbody>
</table>

Sensor Mounting Options

There are two options for mounting the Veratus sensor:

1. Top Mount

2. Side Mount

Recommended Customer Required Parts

Use the following parts or equivalents to mount the Veratus sensor:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>MOUNTING SCHEME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting Screws (2)</td>
<td>Two tapped M2.5 holes on the side and two tapped M2.5 holes on top</td>
</tr>
<tr>
<td>Magnets</td>
<td>Two 0-80 or M1.6 pan head screws or adhesive backing (epoxy recommended for adhesive mounting)</td>
</tr>
<tr>
<td>Z-Height Shim Spacer</td>
<td>Disposable shim for installing sensor (included with sensor)</td>
</tr>
<tr>
<td>Applicator Tool</td>
<td>For tape scale installation: side mount</td>
</tr>
</tbody>
</table>

Wide Alignment Tolerances

Veratus Series Encoders
Sensor Alignment Tolerances

<table>
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<tr>
<td>Z</td>
<td>+/- 0.1 mm</td>
</tr>
<tr>
<td>Θx</td>
<td>+/- 1.0°</td>
</tr>
<tr>
<td>Θy</td>
<td>+/- 1.0°</td>
</tr>
<tr>
<td>Θz</td>
<td>+/- 0.5°</td>
</tr>
</tbody>
</table>
Veratus™ Series Encoders
Compact Precision Encoders for the World’s Machines and Instruments

Veratus Sensor

Sensor Connectors

<table>
<thead>
<tr>
<th>PIN NUMBER</th>
<th>SIGNAL</th>
<th>DIGITAL</th>
<th>ANALOG</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NC</td>
<td>Cos-</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Com</td>
<td>Sin-</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Alarm</td>
<td>Index+</td>
<td>5V</td>
</tr>
<tr>
<td>4</td>
<td>Index-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>B-</td>
<td>5V_Sense</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>A-</td>
<td>Alarm</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>5V</td>
<td>Positive Limit</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>5V_Sense</td>
<td>Negative Limit</td>
<td></td>
</tr>
</tbody>
</table>

Recommended Signal Termination

Digital/Analog Outputs

Alarm and Limit Controls

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.

Cable Shield Termination

For cable lengths \( M \leq 5 \) m, straps (as shown) connecting \( 5V \) and \( \text{Com} \) on DB15 connector to respective sense lines are recommended (see Sensor Connector).

Recommended Signal Termination

Digital/Analog Outputs

Veratus Series Encoder  
Cable \( Z_c = 100 \Omega \)  
Customer Electronics

Alarm Output

\[ V_{CC} \]

\[ R > 2K \Omega \]

Limit Output

\[ V_{AA} \]

\[ R > V_{AA} \]

20mA

Customer Chassis

<table>
<thead>
<tr>
<th>PIN NUMBER</th>
<th>SIGNAL</th>
<th>DIGITAL</th>
<th>ANALOG</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Com_Sense</td>
<td>Cos+</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Negative Limit</td>
<td>Sin+</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Positive Limit</td>
<td>Index-</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Index+</td>
<td>Com</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>B+</td>
<td>Com_Sense</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>A+</td>
<td>NC</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>NC</td>
<td>NC</td>
<td></td>
</tr>
</tbody>
</table>
**Veratus™ Series Encoders**
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**Veratus Tape Scales**

Model: VILT

Veratus Linear Tape Scales are adhesive-backed metal tape scales, which are only 6 mm wide and easily installed on virtually any surface with standard adhesive backing while achieving industry-leading price/performance. Veratus tape scales provide linearity of $\pm 43 \mu m$ (max/meter) and are easily cut to length in the field. Customer-specified lengths up to 20 m can be ordered.

**Limits/Index Magnets**

There are two magnet types that are used for limits and index selection:
- Negative Limit/Index Magnet
- Positive Limit Magnet

The Negative Limit/Index Magnet can serve as both the Negative Limit or as the Index Selector depending on location. For index selection, place the magnet on the top side of the tape scale. For assigning a negative limit, place the magnet on the bottom side of the tape scale. Magnet size (mm) is 18 (l) × 3.75 (w) × 1.56 (h) with adhesive backing.

Standard index marks are located every 50 mm. The index selection magnet is used to select a single index mark at the desired location. Magnets and scales have an adhesive backing for securing to surfaces and magnets can also be fastened using two mounting screws. Custom tape scales can be ordered with an optical index mark in any location.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linearity</td>
<td>$\pm 3 \mu m$ (max/meter)</td>
</tr>
<tr>
<td>Material</td>
<td>Inconel 625</td>
</tr>
<tr>
<td>Typical CTE</td>
<td>12.8 ppm/°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>

**Tape Scale Applicator Tool for Veratus Series Encoders**

- Use the Tape Scale Applicator Tool Model VILT-AT for scale lengths greater than 0.3 meters; side mount only.
- The Applicator Tool enables fast and accurate installation of long scale lengths, which ensures optimal encoder performance.
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How to Order

Sensor

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

Scales — Veratus Tape Scale

VILT-05000I-A-A (example)

Accessories

Reference Marker Selector Magnet

Positive Limit Magnet

Negative Limit Magnet

Tape Scale Applicator Tool (used for lengths >0.3 m)

Note

5. Scales Availability: linear glass scales are available; contact MicroE for more details: Linear Glass Scales: Model VILG, lengths up to 130 mm