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 120Ω across A, B, I |
|              | 170 mA with 120Ω 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: | < 15 g sensor head, < 30 g/m cable |
| Grating Compatibility: | Linear |

Specifications subject to change.
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Specifications

**System**

**Scales**
Veratus Series Encoders are compatible with Veratus Tape and Linear Glass
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 (specify resolution at time of ordering)

**Accuracy**

**Tape**
- SDE: <20 nm RMS²
- Linearity: ±0.43 µm/(max/meter)
- Slope: ±0.450 µm/m

**Linear Glass**
- SDE: <20 nm RMS²
- Total Accuracy: <42 µm/m²

**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></td>
<td>35.0</td>
<td>13.5</td>
<td>10.2</td>
</tr>
</tbody>
</table>

| Weight          | <15 g sensor head | <30 g/m cable |

**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 120Q across A, B, I
- <160 mA with no load
- AquadB, 5 Vdc +/- 5%: <170 mA with 120Q across Sin/Cos, I/W
- <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; EN60068-2-7

**Outputs**
- Analog: Sine/Cosine differential
- Digital: AquadB 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 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)**

Maximum Velocity (before Overspeed Buffer Protection³) vs. Interpolation Depth

<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>
<th>INTERPOLATION DEPTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>17.50</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>4375</td>
<td>2187</td>
<td>875</td>
<td>437</td>
<td>175</td>
<td>875</td>
<td>Maximum Velocity (mm/s)</td>
</tr>
<tr>
<td>10</td>
<td>8.75</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>4375</td>
<td>2187</td>
<td>875</td>
<td>437</td>
<td>175</td>
<td>875</td>
<td>Maximum Velocity (mm/s)</td>
</tr>
<tr>
<td>5</td>
<td>4.38</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>4375</td>
<td>2187</td>
<td>875</td>
<td>437</td>
<td>175</td>
<td>875</td>
<td>Maximum Velocity (mm/s)</td>
</tr>
<tr>
<td>2</td>
<td>1.75</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>4375</td>
<td>2187</td>
<td>875</td>
<td>437</td>
<td>175</td>
<td>875</td>
<td>Maximum Velocity (mm/s)</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>875</td>
<td>Maximum Velocity (mm/s)</td>
</tr>
</tbody>
</table>

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

Output Signals

- **Negative Limit/Index Magnet (used as Index Selector)**
  - Align with index anywhere within this area

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

**Direction of positive encoder head motion relative to scale:**
- **Digital:** Count up (A leads B)
- **Analog:** Cosine leads Sine

**Sensor**
- Align with index anywhere within this area

**Analog**
- **Sine**
- **Cosine**

- **Index Window (IW)**
  - 20 µm

**Digital**
- **A**
- **B**

- **1 LSB Index**

**Positive Limit**

**Negative Limit**

**Alarm**
- **Alarm is open collector; requires external pull-up.**

**Limits**
- Open collector; require external pull-up.
- Limits are factory programmable: either Active High or Active Low; specify when ordering.

**Alarm**
- **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.

**Sin/Cos:** 1.0 Vpp differential into 120 Ω.
- 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 is differential output 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**
- Factory programmable: either Active High or Active Low; specify when ordering.
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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.

<table>
<thead>
<tr>
<th>LED COLOR</th>
<th>SYSTEM STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td><strong>Optimal alignment</strong></td>
</tr>
<tr>
<td></td>
<td>• Optimal position signal with minimum power consumption</td>
</tr>
<tr>
<td></td>
<td>• Encoder system meets specification</td>
</tr>
<tr>
<td>Green</td>
<td><strong>Good alignment</strong></td>
</tr>
<tr>
<td></td>
<td>• Optimal position signal at specified power consumption</td>
</tr>
<tr>
<td></td>
<td>• Encoder system meets specification</td>
</tr>
<tr>
<td>Yellow</td>
<td><strong>Alignment could be improved but fully operational</strong></td>
</tr>
<tr>
<td></td>
<td>• Sensor is reading position with marginal signal strength</td>
</tr>
<tr>
<td></td>
<td>• Encoder system functions but vector magnitude may not be 1 Vpp and SDE may exceed specification</td>
</tr>
<tr>
<td>Red</td>
<td><strong>Sensor fault</strong></td>
</tr>
<tr>
<td></td>
<td>• Sensor is reading position with weak signal strength, or</td>
</tr>
<tr>
<td></td>
<td>• Power supply is less than 4.2 V, or</td>
</tr>
<tr>
<td></td>
<td>• Power supply is greater than 5.5 V, or</td>
</tr>
<tr>
<td></td>
<td>• Sensor moving faster than 5.8 m/s.</td>
</tr>
<tr>
<td></td>
<td>• Encoder system may not function properly</td>
</tr>
<tr>
<td></td>
<td>• Alarm signal will be asserted</td>
</tr>
</tbody>
</table>

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”

Direction of positive encoder head motion relative to scale:
- Digital: Count up (A leads B)
- Analog: Cosine leads Sine
**Veratus Sensor**

Wide 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>

**Z-Height Shim Spacer**

**Applicator Tool**
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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></td>
</tr>
<tr>
<td>4</td>
<td>Index-</td>
<td>5V</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>

<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>

NC — No Connect

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 ≤ M, straps (as shown) connecting 5V and Com on DB15 connector to respective sense lines are recommended (see Sensor Connector)
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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>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linearity</td>
<td>( \pm 3 \mu m / \text{(max/meter)} )</td>
</tr>
<tr>
<td>Material</td>
<td>Inconel 625</td>
</tr>
<tr>
<td>Typical CTE</td>
<td>12.8ppm/°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.
Veratus™ Series Encoders
Compact Precision Encoders for the World’s Machines and Instruments

How to Order

**Sensor**

VIA-5000-AA1-20-05A (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

- **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 Linear

- **Model**
  - VI = Veratus Incremental

**Scales — Veratus Tape Scale**

VILT-050001-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 and E)

- **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**

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