The Series 835S is a family of industrial-grade optical incremental encoders, available in two different models. They have the same mechanical and electrical features, but differ in performance and price.

The following features are common among both models:

- LED illumination for reliability
- Push-pull phototransistors for signal stability
- Optional zero index
- Combination synchro/face mount
- Medium-duty housing, or optional environmentally sealed housing
- Sealed ABEC Class 7 bearings for protection against contaminants
- Precise chrome-on-glass disc

Two Models available:

Model 8135S: Resolution up to 8 times the line count on the disc

Model 8235S: Dual reading heads for improved accuracy. Resolution up to 80 times the line count on the disc.
### NOTES:

1. **Total Optical Encoder Error** is the algebraic sum of **Instrument Error + Quadrature Error + Interpolation Error**. Typically, these error sources sum to a value less than the theoretical maximum. Error is guaranteed at 20°C and is defined at the signal transitions. It does not include quantization error, which is ±1/2 quantum. ("Quantum" is the final resolution of the encoder, after user’s 1x, 2x or 4X quadrature decode.)

2. **Instrument Error** is the sum of disc pattern errors, disc eccentricity, bearing runout and other mechanical imperfections within the encoder. This error tends to vary slowly around a revolution.

3. **Quadrature Error** is the combined effect of phasing and duty cycle tolerances and other variables in the basic analog signals. This error applies to data taken at all four transitions within a cycle; if data are extracted from 1X square waves on a 1X basis (i.e., at only one transition per cycle), this error can be ignored.

4. **Interpolation Error** is present only when the resolution has been electronically increased to more than four data points per optical cycle. It is the sum of all the tolerances in the electronic interpolation circuitry.

5. With external Model HR2A High Resolution Electronics. Frequency response is as stated for output signals, or 50 kHz at the disc, whichever is limiting.

### Specifications

<table>
<thead>
<tr>
<th></th>
<th>SEE NOTE</th>
<th>MODEL 8135S</th>
<th>MODEL 8235S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum line count on disc</td>
<td></td>
<td>11,250</td>
<td></td>
</tr>
<tr>
<td>Max cycles/rev with internal electronics</td>
<td></td>
<td>22,500</td>
<td>90,000</td>
</tr>
<tr>
<td>Max counts/rev (after quad edge detection)</td>
<td></td>
<td>90,000</td>
<td>360,000</td>
</tr>
<tr>
<td>Max cycles/rev with external electronics</td>
<td></td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Max counts/rev with external electronics (after quad edge detection)</td>
<td></td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Instrument error, ± arcsec</td>
<td></td>
<td>1.2</td>
<td>30</td>
</tr>
<tr>
<td>Quadrature error, ± electrical degrees</td>
<td></td>
<td>1.3</td>
<td>30</td>
</tr>
<tr>
<td>Interpolation error, ± quanta</td>
<td></td>
<td>1.4</td>
<td>0.15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FREQUENCY RESPONSE kHz</th>
<th>1x square waves</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2x square waves</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>5x square waves</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>8x square waves</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Up to 20x square waves</td>
<td>5</td>
</tr>
<tr>
<td>Maximum weight, oz (g)</td>
<td></td>
<td>32 (907)</td>
</tr>
<tr>
<td>Starting torque, in-oz (N-m) [at 20°C]</td>
<td></td>
<td>2.0 (14.0 × 10⁻⁶)</td>
</tr>
<tr>
<td>Running torque, in-oz (N-m) [at 20°C]</td>
<td></td>
<td>1.0 (7.0 × 10⁻⁶)</td>
</tr>
<tr>
<td>Moment of inertia, in-oz-s² (g-cm²)</td>
<td></td>
<td>2.3 × 10⁻³ (164)</td>
</tr>
<tr>
<td>Maximum acceleration, rad/s²</td>
<td></td>
<td>1 × 10⁶</td>
</tr>
<tr>
<td>Operating temperature range, °F (°C)</td>
<td></td>
<td>32 to 158 (0 to 70)</td>
</tr>
<tr>
<td>Storage temperature range, °F (°C)</td>
<td></td>
<td>0 to 160 (-18 to 71)</td>
</tr>
<tr>
<td>Humidity, % RH non-condensing</td>
<td></td>
<td>98</td>
</tr>
<tr>
<td>Shock</td>
<td></td>
<td>50 g, 11 ms</td>
</tr>
<tr>
<td>Vibration</td>
<td></td>
<td>15 g, 0-2000 Hz</td>
</tr>
</tbody>
</table>

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Online at www.gurley.com, e-mail: info@gurley.com
EXTENDED RESOLUTION
The series 835S offers resolution up to 360,000 counts/rev (3.6 arcsec/count) after 4x quadrature edge detection. If finer resolution is required (up to 900,000 counts/rev, or 1.44 arcsec/count), the HR2A external electronics package provides a wide range of options that ensures compatibility with virtually all commercially available counter circuits, dedicated encoder interface cards and programmable logic controllers:

- Any number of quadrature square waves from 1 to 20 times the line count on the disc
- Fixed-duration pulses at 1, 2 or 4 times any integer from 1 to 20
- A choice of CW/CCW or PULSE/DIRECTION output pulse format
- A zero-index (reference) signal in either gated ½ cycle, gated ¼ cycle, or fixed duration pulse format
- EIA/RS-422 or open collector line drivers
- On-board low-dropout voltage regulator

Refer to the HR2A data sheet for full details.

### Electrical Connections

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>A</td>
<td>A</td>
<td>CW</td>
<td></td>
</tr>
<tr>
<td>Brown</td>
<td>B</td>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>C</td>
<td>Cos</td>
<td>IND</td>
<td>CCW</td>
</tr>
<tr>
<td>Orange</td>
<td>D</td>
<td>Index</td>
<td>+V</td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td>E</td>
<td>Index</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>F</td>
<td>TRD Common</td>
<td>IND</td>
<td></td>
</tr>
<tr>
<td>Gray</td>
<td>H</td>
<td>Case</td>
<td>Case</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>I</td>
<td>+V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>J</td>
<td>Common</td>
<td>IND</td>
<td></td>
</tr>
</tbody>
</table>

### Bearing Life Ratings/Hours

The table gives bearing life as a function of speed and radial load at the end of the shaft, based on fatigue failure criteria. In many long-duration applications, lubrication retention becomes the determining factor.

When high radial shaft loads are applied to an encoder with a high line count on the disc, the encoder may not meet the stated quadrature tolerance. Please consult the factory if your application requires this combination.
**Encoder Length**

<table>
<thead>
<tr>
<th>L1</th>
<th>L2</th>
<th>Output Interp. Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.30 [58.4]</td>
<td>2.45 [62.2]</td>
<td>B01, C01, F01, F02, L01, L02 T01, T02, P01, P02, P04, P08</td>
</tr>
<tr>
<td>2.65 [67.3]</td>
<td>2.80 [71.1]</td>
<td>L05, L08 P05, P10, P20</td>
</tr>
</tbody>
</table>

**Notes:**

1. Mating connector is optional. Order M01 to mate with connector code Q, M02 for connector code A or M, or M06 for connector code S.

2. With connector codes P, Q and S, the cover is drawn aluminum can. With connector code M and A, the cover is a rugged aluminum extrusion with an O-ring between the cover and the base.
**POWER SUPPLY OPTIONS**

\[ V_{cc} = +5.0 \text{ VDC} \pm 0.25 \text{ V} \] at 225 mA max, or \[ V_{cc} = 7 \text{ to 15 VDC} \] at 225 mA (available with power buffer or line driver options).

**SINUSOIDAL OUTPUT**

This option provides quadrature sinusoids at the same spatial frequency (cycles/rev) as the line count on the disc. At lower line counts, the signals tend to be more trapezoidal.

**BUFFERED SINUSOIDS**

(OUT INTERP = B01)

- P-P signal amplitude, data channels: \( 1.0 \pm 0.1 \text{ V} \)
- Amplitude ratio, min chan to max chan: \( 0.90 \) to \( 1.00 \)
- P-P signal amplitude, index channel: \( 0.7 \pm 0.3 \text{ V} \)

Typical signal values at 1 kHz with 4.7 kΩ load to ground (20°C).

**PULSE OUTPUT OPTIONS**

All pulse outputs are direction-sensed (CW pulses and CCW pulses are on different terminals). The output device is an EIA/RS-422 balanced differential line driver protected to survive an extended-duration short circuit across its output. Pulse width is \( 0.4 \pm 0.1 \mu s \).

The index pulse is gated so that it always occurs simultaneously with a specific data pulse. The maximum output pulse rate is 650 kHz, based on maintaining adequate separation between pulses; however, the frequency response of the square waves from which the pulses are generated is often the limiting factor in determining maximum encoder speed.

Available with either 5 V or 7-15 V encoder power input.

**1x, 2x, 4x or 8x PULSES**

(OUT INTERP = P01, P02, P04 or P08)

Available on both models. Pulses are at 1, 2, 4 or 8 times the line count on the disc.

**5x, 10x, or 20x PULSES**

(OUT INTERP = P05, P10, or P20)

Available on Models 8235S only.

**QUADRATURE SQUARE WAVE OUTPUT OPTIONS**

1x or 2x Square Waves

Available on both models. Square waves are at the same or twice the spatial frequency (cycles/rev) as the disc line count.

5x or 8x Square Waves

Available on Model 8235S only. Square wave spatial frequency is five or eight times the disc line count.

**PULSE OUTPUT OPTIONS**

All pulse outputs are direction-sensed (CW pulses and CCW pulses are on different terminals). The output device is an EIA/RS-422 balanced differential line driver protected to survive an extended-duration short circuit across its output. Pulse width is \( 0.4 \pm 0.1 \mu s \). The index pulse is gated so that it always occurs simultaneously with a specific data pulse. The maximum output pulse rate is 650 kHz, based on maintaining adequate separation between pulses; however, the frequency response of the square waves from which the pulses are generated is often the limiting factor in determining maximum encoder speed. Available with either 5 V or 7-15 V encoder power input.

1x, 2x, 4x or 8x PULSES

(OUT INTERP = P01, P02, P04 or P08)

Available on both models. Pulses are at 1, 2, 4 or 8 times the line count on the disc.

5x, 10x, or 20x PULSES

(OUT INTERP = P05, P10, or P20)

Available on Models 8235S only.

**1x SQUARE WAVES, TTL COMPATIBLE**

(OUT INTERP = T01)

Output device is LM339 voltage comparator with internal 2.2kΩ pull-up resistor.

\[ \begin{align*}
    \text{TTL Fanout} &= 5 \\
    V_{CR} &= V_{CC} \cdot 0.25V \\
    I_{L_{min}} &= -8 \text{ mA} \\
    V_{CL} &\leq 0.8 \text{ V}
\end{align*} \]

**2x SQUARE WAVES, TTL COMPATIBLE**

(OUT INTERP = T02)

Output device is high-speed CMOS logic gate. Max rating:

\[ \begin{align*}
    I_{L} &\leq 25 \text{ mA} (V_{cc} = 0 \text{ to } V_{cc}) \\
    V_{CC} &\leq +36 \text{ V} \\
    I_{COL} &\leq 16 \text{ mA}
\end{align*} \]

1x SQUARE WAVES, OPEN COLLECTOR

(OUT INTERP = C01)

Output device is LM339 voltage comparator with open collector output transistor. Outputs are pulled up to +5 VDC with internal 10 kΩ resistor. Customer may provide external pull-up as desired, within rating of LM339.

\[ \begin{align*}
    V_{CC} &\leq +40 \text{ V} \\
    I_{COL} &\leq 200 \text{ mA}
\end{align*} \]
## SPECIAL CAPABILITIES
For special situations, we can optimize catalog encoders to provide higher frequency response, greater accuracy, wider temperature range, reduced torque, non-standard line counts, or other modified parameters. In addition, we regularly design and manufacture custom encoders for user-specific requirements. These range from high-volume, low-cost, limited-performance commercial applications to encoders for military, aerospace and similar high-performance, high-reliability conditions. We would welcome the opportunity to help you with your encoder needs.

## WARRANTY
Gurley Precision Instruments offers a limited warranty against defects in material and workmanship for a period of one year from the date of shipment.