The **Series 835H** Hollow-Shaft Optical Encoders are rugged, high-performance devices designed for use where precise motion sensing is critical.

The Series 835H is available in three different models. They have the same mechanical and electrical features, but differ in performance and price.

The following features are common to all models:

- Long-life LED illumination for reliability
- Push-pull phototransistors for signal stability
- Optional zero index
- Fits any size shaft up to 1.2”(30mm) diameter
- Simpler design of user’s shaft: No threads, shoulders, or critical length requirements
- Internal flexible coupling for easier installation
- Combination synchro/face mount or square-flange mount
- Shielded ABEC Class 7 bearings for protection against contaminants
- Precise chrome-on-glass disc

**Three Models available:**

- **Model 8135H:** single reading head; resolution up to 8 times the line count on the disc.
- **Model 8235H:** two reading heads for higher accuracy; resolution up to 80 times the line count on the disc.
- **Model 8435H:** four reading heads for the highest 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.

   \[ \text{Error in arcseconds} = \frac{(3600) \times \text{error in electrical degrees}}{\text{disc line count}} \]

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.

   \[ \text{Error in arcseconds} = \frac{(1296000) \times \text{error in quanta}}{\text{counts/rev}} \]

5. See BEARING LUBRICANTS table

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

As part of our continuing product improvement program, all specifications are subject to change without notice.
EXTENDED RESOLUTION
With internal electronics, the Series 835H generates resolution up to 360,000 counts/rev (3.6 arcsec/count) after 4X quadrature decode. For finer resolution (up to 900,000 counts/rev, or 1.44 arcsec/count), the HR2A external electronics package offers any number of quadrature square waves from 1 to 20 times the line count on the disc, or fixed-duration pulses at 1, 2 or 4 times any integer from 1 to 20. Please refer to the HR2A sheet for full details.

INTERNAL COUPLING
A flexible metal bellows and clamping ring form an accurate coupling that absorbs normal installation misalignments and prevents damage to the encoder bearings. Keeping the misalignments within the following constraints will assure infinite life of the coupling, but will introduce some error. To preserve the encoder’s accuracy, misalignments should be kept as small as possible.

\[ 100P + 14E + 0.125A < 0.5 \]

Where:
- \( P \) = Parallel offset, inches (0.005 max)
- \( E \) = Axial Extension or Compression, inches (0.035 max)
- \( A \) = Angular Misalignment, degrees (4° max)

Parallel offset, \( P \), is equal to the total offset between the centerline of the encoder and the centerline of the user’s shaft, plus half the radial runout of the user’s shaft (TIR/2).

MAXIMUM COUPLING DEFLECTIONS

INTERFERENCE CONSTRAINTS FOR LARGE SHAFTS

<table>
<thead>
<tr>
<th>Shaft Dia., Inches</th>
<th>Max. Angular Misalignment, Degrees</th>
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<tbody>
<tr>
<td>1.250</td>
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<tr>
<td>1.150</td>
<td>1.6</td>
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<td>1.000</td>
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* with zero offset

OUTPUT PIN CONNECTIONS

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<tr>
<th>CONN. CODE</th>
<th>P</th>
<th>Q</th>
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<tr>
<td>CONN. TYPE:</td>
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<td>DA-15P</td>
<td>DE-9P</td>
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<tr>
<td>FUNCTION:</td>
<td>COLOR</td>
<td>PIN #</td>
<td>PIN #</td>
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</table>

Square Wave Output (output codes L, C, T, F)

Buffered Sinusoid Output (output code B)

Pulse Output (output code P)

MATING CONN.

1. Available with RS-422 Differential Line Driver Output (code L) only.
2. The shield is not connected to the case of the encoder.
3. Channel B (cos) leads Channel A (sin) for CW shaft rotation, looking at the mounting face.
POWER SUPPLY OPTIONS:
Vcc = +5.0 VDC ±0.25 V @ 225 mA max, or, Vcc = 7 to 15 VDC @ 225 mA (available with power buffer or line river 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 than sinusoidal.

BUFFERED SINUSOIDS (OUT INTERP = B01)
The output device is an op amp referenced to (50% ±3%) x Vcc. Typical signal values at 1 kHz with 4.7 kΩ load to ground (20°C).

- P-P signal amplitude, data channels: 1.0 ± 0.1 V
- Amplitude ratio, min chan to max chan: .90 to 1.00
- P-P signal amplitude, index channel: 0.7 ± 0.3 V.

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 ± 0.1 μs. 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 = T01, T02, T04 or T08)
Available on all models. Pulses are at 1, 2, 4 or 8 times the line count on the disc.

1x or 2x Square Waves
Available on all models. Square waves are at the same or twice the spatial frequency (cycles/rev) as the disc line count.

1x, 2x, 5x OR 8x SQUARE WAVES, LINE DRIVER (OUT INTERP = L01, L02, L05 or L08)
The output device is an EIA/RS-422 balanced differential line driver protected to survive an extended-duration short circuit across its output.

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.

1x, 2x SQUARE WAVES, POWER BUFFER (OUT INTERP = F01 or F02)
Output device is 2N3725 driver transistor. Outputs are pulled up to supply voltage with an internal 10 kΩ resistor. Customer may provide external pull-up as desired, within the range of the output device.

1x SQUARE WAVES, TTL COMPATIBLE (OUT INTERP = T01)
Output device is LM339 voltage comparator with internal 2.2 kΩ pull-up resistor. TTL Fanout = 5 Vcc ≥ Vcc - 0.25V
Iout = -8 mA VOL ≤ 0.8 V

2x SQUARE WAVES, TTL COMPATIBLE (OUT INTERP = T02)
Output device is high-speed CMOS logic gate. Max rating:
Ii ± 25 mA (Vci = 0 to Vcc)

5x, 10x, or 20x PULSES (OUT INTERP = P05, P10, or P20)
Available on Models 8235H and 8435H only. Pulses are at 5, 10 or 20 times the line count on the disc.

5x or 8x Square Waves
Available on Model 8235H and 8435H only. Square wave spatial frequency is five or eight times the disc line count.
SEALS

When ordered with optional shaft seals, the encoder has a magnetic-liquid seal at the base end and a V-ring seal at the clamp end. The magnetic liquid seal consists of an oil film with suspended magnetic particles. The medium, which is held in place magnetically, forms an effective seal against airborne particulates. The nitrile rubber V-ring seal comprises a flexible lip attached to the seal body with an integral resilient "hinge". It rotates with the shaft and seals axially against a stationary surface. The flexible lip and hinge provide effective sealing even with end play or shaft misalignment. With seals, the maximum recommended shaft speed is 4400 rpm.

BEARING LUBRICANTS

There are two standard bearing lubricants. \textit{Andok C} is specifically designed for severe service, high speed, long life, low torque and low temperature rise, and is suitable for most applications. \textit{Braycote 601} is a low vapor pressure lubricant which is suitable for vacuum and clean room applications at the expense of reduced speed and service life and slightly higher torque.

Bearings which are subjected to oscillatory motion, i.e., partial revolutions and frequent reversals, or very low speed operation (<100 RPM) may exhibit reduced service life, rotational torque variations, and other undesirable behavior. Consult the factory if your application requires either oscillatory or very low speed operation.
### 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.

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### ORDERING INFORMATION

<table>
<thead>
<tr>
<th>MODEL</th>
<th>LINES</th>
<th>IND</th>
<th>V</th>
<th>OUT</th>
<th>INTERP</th>
<th>BASE</th>
<th>CAB</th>
<th>T</th>
<th>DIA</th>
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**LINES** - Disc line count

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</table>

**INTERP** - Interpolation factor

- 01: With buff. sinusoid output
- 01, 02, 05, 08: With square wave output
- 01, 02, 04, 05, 08, 10, 20: With pulse output

**BASE** - Base type

- A: Synchro/face mount, no shaft seals, Andok
- B: Synchro/face mount, with shaft seals, Andok
- C: Square flange mount, no shaft seals, Andok
- D: Square flange mount, with shaft seals, Andok
- E: Synchro/face mount, no seals, Braycote
- F: Synchro flange mount, no seals, Braycote

**CAB** - Cable length, inches (04-99)

- 18: Standard

**CONN** - Connector

- P: Pigtauls (no connector)
- Q: DA-15P
- S: DE-9P

**DIA** - Shaft Diameter

<table>
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<th>Shaft Dia.</th>
<th>20E*</th>
<th>18E</th>
<th>16E</th>
<th>14E</th>
<th>12E</th>
<th>10E</th>
<th>08E</th>
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<td>0.200mm</td>
<td>0.100mm</td>
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</table>

**SPEC** - Special code

- X: To define non-standard features
- N: No special features

**Accessories** (order separately)

- AX06399: Synchro cleats (see separate data sheet)
- M01: Mating connector for DA-15P
- M06: Mating connector for DE-9P
- ISC3N: Interface card for IBM® PC

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