

GURLEY SERIES 835H HOLLOW-SHAFT ENCODERS

MOTION TYPE:

ROTARY

USAGE GRADE:

INDUSTRIAL

OUTPUT:

INCREMENTAL

MAX RESOLUTION:

INTERNAL ELECTRONICS
360,00 COUNTS/REV
EXTERNAL ELECTRONICS
900,000 COUNTS/REV



HIGH PERFORMANCE - INDUSTRIAL RUGGEDNESS

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.

ISO
9001
CERTIFIED

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SPECIFICATIONS

	SEE NOTE	MODEL 8135H	MODEL 8235H	MODEL 8435H
Maximum line count on disc		11,250		
Max cycles/rev with internal electronics		22,500	56,250	90,000
Max counts/rev (after quad edge detection)		90,000	225,000	360,000
Max cycles/rev with external electronics	5	N/A	225,000	
Max counts/rev with external electronics (after quad edge detection)	5	N/A	900,000	
Instrument error, ± arcsec	1,2	30	15	5
Quadrature error, ± electrical degrees	1,3	30	24	15
Interpolation error, ± quanta	1,4	0.15	0.10	0.05
FREQUENCY RESPONSE kHz	1x square waves	5	100	
	2x square waves	5	150	
	5x square waves	5	N/A	300
	8x square waves	5	N/A	500
	Up to 20x square waves	5,6	N/A	1000
Maximum weight, oz (g)		25 (715)		
Starting torque, in-oz (N-m) [at 20°C]		2.0 (0.014)		
Running torque, in-oz (N-m) [at 20°C]		1.0 (0.007)		
Moment of inertia, in-oz-s ² (g-cm ²)		0.022 (1600)		
Maximum acceleration, rad/s ²		74 x 10 ³		
Operating temperature range, °F (°C)		41 to 158 (5 to 70)		
Storage temperature range, °F (°C)		0 to 160 (-18 to 71)		
Humidity, % RH non-condensing		98		
Shock		50 g, 11 ms		
Vibration		15 g, 0-2000 Hz		
Maximum slew speed, rpm		See BEARING LUBRICANTS table		

NOTES:

- 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.)
- 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.
- 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.

$$\text{Error in arcseconds} = (3600) \times (\text{error in electrical degrees}) / (\text{disc line count})$$
- 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.

$$\text{Error in arcseconds} = (1296000) \times (\text{error in quanta}) / (\text{counts/rev})$$
- See BEARING LUBRICANTS table
- 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.



SPECIFICATIONS

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.

$$100P + 14E + 0.125A \leq 0.5$$

Where:

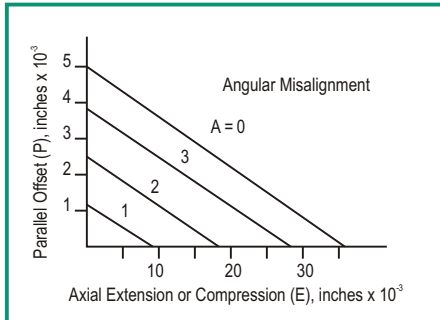
P = Parallel offset, inches (0.005 max)

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).

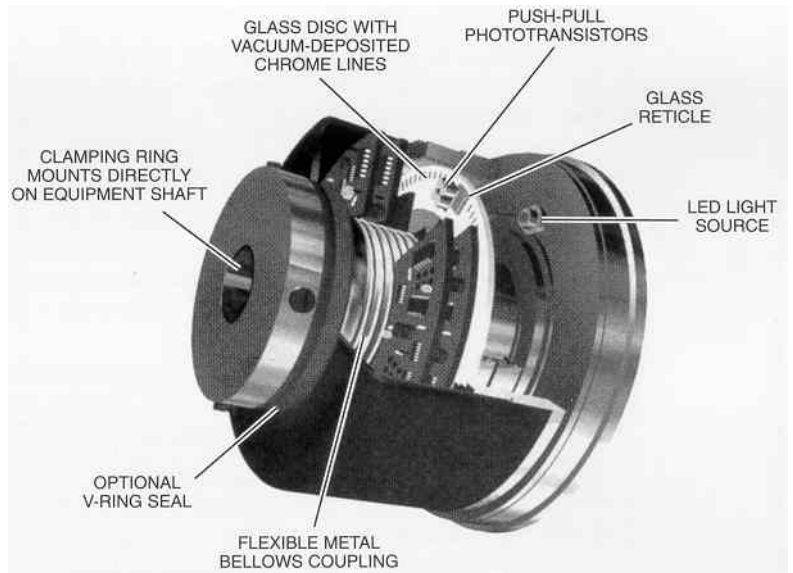
MAXIMUM COUPLING DEFLECTIONS



INTERFERENCE CONSTRAINTS FOR LARGE SHAFTS

Shaft Dia., Inches	Max. Angular Mis-Alignment, Degrees
1.250	0.25*
1.150	1.6
1.000	3.2

* with zero offset



OUTPUT PIN CONNECTIONS

	CONN. CODE	P	Q	S
	CONN. TYPE:	NONE	DA-15P	DE-9P
	FUNCTION:	COLOR	PIN #	PIN #
Square Wave Output (output codes L, C, T, F)	A	Yellow	8	4
	/A ⁽¹⁾	Brown	7	8
	B	Green	5	3
	/B ⁽¹⁾	Orange	4	7
	IND	Blue	2	2
	/IND ⁽¹⁾	White	1	6
	+V	Red	10	5
Buffered Sinusoid Output (output code B)	COMM	Black	13	9
	CASE	Gray	9	1
	SHIELD	Bare ⁽²⁾	14	1
	SIN	Yellow	9	
	COS	Green	11	
	IND	Blue	5	
	+V	Red	4	
Pulse Output (output code P)	COMM	Black	15	
	CASE	Gray	8	
	SHIELD	Bare ⁽²⁾	8	
	CW	Yellow	5	3
	/CW	Brown	4	7
	CCW	Green	8	4
	/CCW	Orange	7	8
IND	Blue	2	2	
/IND	White	1	6	
+V	Red	10	5	
COMM	Black	13	9	
CASE	Gray	9	1	
SHIELD	Bare ⁽²⁾	14	1	
MATING CONN.	-	M01	M06	

1. Available with RS-422 Differential Line Driver Output (code L) only.

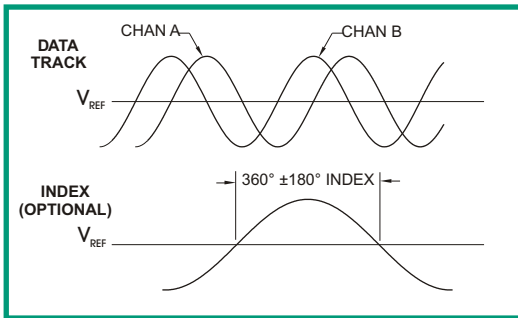
2. The shield is not connected to the case of the encoder.

3. Channel B (cos) leads Channel A (sin) for CW shaft rotation, looking at the mounting face.

POWER SUPPLY OPTIONS:

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

SINUSOIDAL OUTPUT



SINUSOIDAL OUTPUT OPTION

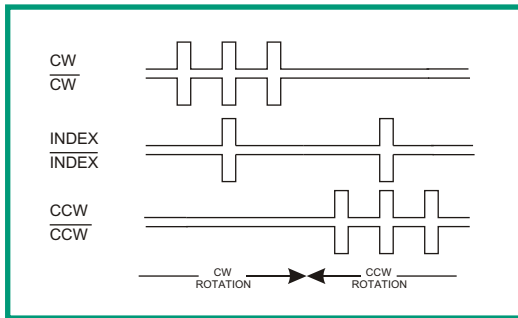
This option provides quadrature sinusoids at the same spatial frequency (cycles/rev) as the line count on the disc. At lower line counts, the signals tend to be more trapezoidal than sinusoidal.

BUFFERED SINUSOIDS (OUT INTERP = B01)

The output device is an op amp referenced to $(50\% \pm 3\%) \times V_{cc}$. Typical signal values at 1 kHz with 4.7 k load to ground (20°C).

- P-P signal amplitude, data channels: $1.0 \pm 0.1 \text{ V}$
- Amplitude ratio, min chan to max chan: .90 to 1.00
- P-P signal amplitude, index channel: $0.7 \pm 0.3 \text{ V}$.

PULSE OUTPUT



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 $0.4 \pm 0.1 \text{ s}$. 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.

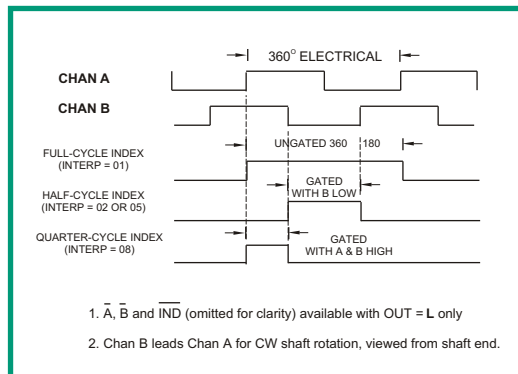
1x, 2x, 4x or 8x PULSES (OUT INTERP = P01, P02, P04 or P08)

Available on all 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 8235H and 8435H only. Pulses are at 5, 10 or 20 times the line count on the disc.

SQUARE WAVE OUTPUT



1x SQUARE WAVES, TTL COMPATIBLE (OUT INTERP = T01)

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

$$V_{OH} = V_{CC} - 0.25 \text{ V}$$

$$I_{SINK} = -8 \text{ mA} \quad V_{OL} = 0.8 \text{ V}$$

2x SQUARE WAVES, TTL COMPATIBLE (OUT INTERP = T02)

Output device is high-speed CMOS logic gate.

Max rating:
 $I_o = \pm 25 \text{ mA} (V_o = 0 \text{ to } V_{cc})$

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 LM 339 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.

$$V_{COH} = +36 \text{ V}$$

$$I_{COL} = 16 \text{ mA}$$

1x, 2x SQUARE WAVES, POWER BUFFER (OUT INTERP = F01 or F02)

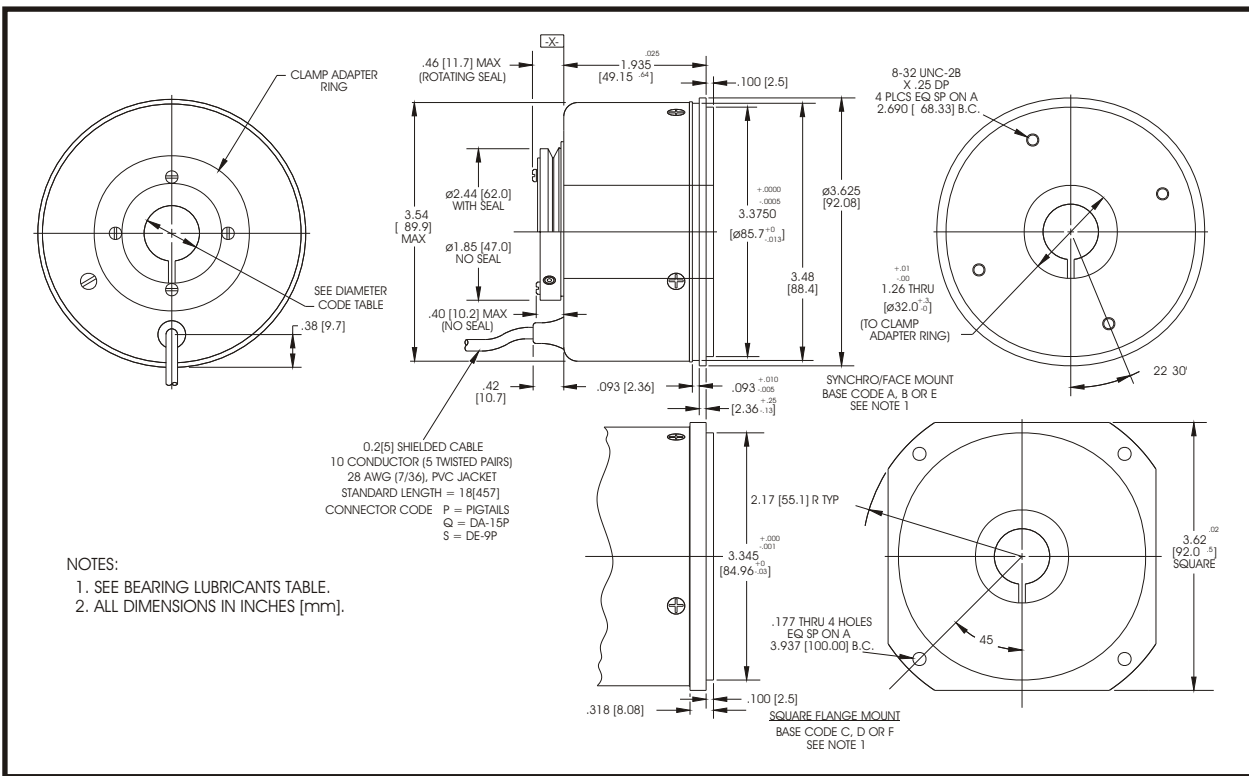
Output device is 2N3725 driver transistor. Outputs are pulled up to supply voltage with an internal 10 kΩ resistor. Customer may provide external pull-up as desired, within the range of the output device.

$$V_{COH} = +40 \text{ V}$$

$$I_{COL} = 200 \text{ mA}$$



DIMENSIONS



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. *Andok C* is specifically designed for severe service, high speed, long life, low torque and low temperature rise, and is suitable for most applications. *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.

Base Code	Mounting	Lube	Shaft Seals	Max. Slew Speed
A	Synchro/face	Andok C	No	12,000 rpm
B	Synchro/face	Andok C	Yes	4,400
C	Square flange	Andok C	No	12,000
D	Square flange	Andok C	Yes	4,400
E	Synchro/face	Braycote 601	No	8,000
F	Square flange	Braycote 601	No	8,000

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.

DIAMETER CODE

User's Shaft Outside Dia. ⁽¹⁾	Diameter Code	Adapter Ring Inside Dia.
+0.000/-0.001 in		
1.250"	20E ⁽²⁾	1.250" NOM
1.125"	18E	1.125" NOM
1.000"	16E	1.000" NOM
0.875"	14E	0.875" NOM
0.750"	12E	0.750" NOM
0.625"	10E	0.625" NOM
0.500"	08E	0.500" NOM
0.375"	06E	0.375" NOM
0.3125"	05E	0.3125" NOM
0.250"	04E	0.250" NOM
+0.000/-0.028 mm		
30.000 mm	30M	30.00 mm NOM
25.000 mm	25M	25.00 mm NOM
20.000 mm	20M	20.00 mm NOM
10.000 mm	10M	10.00 mm NOM

1. Consult Gurley Precision Instruments for other sizes.
2. Not recommended; consult factory.



ORDERING INFORMATION

MODEL	LINES	IND	V	OUT	INTERP	BASE	CAB	T	CONN	DIA	SPEC

MODEL

- 8135H** Standard accuracy
- 8235H** High accuracy
- 8435H** Highest Accuracy

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

LINES - Disc line count

00360	00500	00512	00600	00900
01000	01024	01575	01800	02000
02048	02500	02540	02700	03000
03175	03300	03600	04000	04050
04096	04200	04302	04310	04500
05000	05400	06000	06400	06480
07000	07200	07640	08000	08192
09000	09550	09900	10000	10800
11250				

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

Consult factory for other line counts

IND - Index format

- F** Full cycle ungated (INTERP = **01**)
- H** Half cycle gated (INTERP = **02, 05**)
- Q** Quarter cycle gated (INTERP = **08**)
- P** Pulse index (OUT = **P**)
- N** None

CONN - Connector

- P** Pigtails (no connector)
- Q** DA-15P
- S** DE-9P

DIA - Shaft Diameter

CODE	Nominal Shaft Dia.	CODE	Nominal Shaft Dia.
20E*	1.250"	06E	0.375"
18E	1.125"	05E	0.3125"
16E	1.000"	04E	0.250"
14E	0.875"	30M	30.00mm
12E	0.750"	25M	25.00mm
10E	0.625"	20M	20.00mm
08E	0.500"	10M	10.00mm

V - Input voltage

- 5** 5 volts dc
- R** 7-15 volts dc (OUT = **F, L** or **P**)

* Not recommended - consult factory

OUT output format

- B** Buffered sinusoids (INTERP = **01**)
- C** Open collector (single-ended sq. Waves) (INTERP = **01**)
- F** Power Buffer (single-ended sq. waves) (INTERP = **01, 02**)
- L** RS-422 differential line driver (INTERP = **01, 02, 05, 08**)
- T** Single-ended TTL (INTERP = **01, 02**)
- P** Pulses (cw and ccw) (INTERP = **01, 02, 04, 05, 08, 10, 20**)

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

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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V3.1

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