

GURLEY SERIES 9X25 ROTARY INCREMENTAL ENCODERS

MOTION TYPE:

ROTARY

USAGE GRADE:

INDUSTRIAL

OUTPUT:

INCREMENTAL

MAX RESOLUTION:

200,000 COUNTS/REV.



ABOVE - STANDARD PERFORMANCE

The Series **9x25** is a family of optical incremental encoders designed for industrial-grade applications that require high resolution and high accuracy. All 9x25s share these features:

- LED illumination for long life (>100,000 hours)
- Differential photo-detectors for signal stability
- Single-board, surface-mount electronics for reliability
- RS-422 differential line driver output for noise immunity
- Zero index signal
- Sealed ABEC 7 bearings for contamination resistance
- IP65 sealing for harsh environments (IP64 at the shaft exit)

The Series 9x25 is available in three basic models:

Model 9125: Resolutions up to 9000 cycles/rev (36,000 counts/rev); optional index formats; optional input voltage.

Model 9225: Dual read heads for improved accuracy; ASIC for internally interpolated resolutions up to 50,000 cycles/rev (200,000 counts/rev); watchdog circuit.

Model 9425: Same as **9225**, except with four read heads for highest accuracy. Each 9425 includes an accuracy plot.

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9001
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SPECIFICATIONS

Specifications	See Note	9125	9225	9425
Maximum line count on disc	6	9,000	9,000	
Max cycles/rev with internal electronics		9,000	50,000	
Max counts/rev after quad edge detect		36,000	200,000	
Instrument error, ± arcsec	1,2	45	20	10
Quadrature error, ± electrical degrees	1,3	30	24	15
Interpolation error, ± quanta	1,4	N/A	0.10	
Maximum output frequency, kHz				
1X square waves, data only		500	100	
1X square waves, data + index		250	100	
2X square waves, data + index		N/A	150	
5X square waves, data + index		N/A	300	
10X square waves, data + index		N/A	500	
Maximum weight, oz (g)		20 (565)		
Starting torque, in-oz (N-m) @20°C	5	2.0 (14.0 x 10 ⁻³)		
Running torque, in-oz (N-m) @20°C	5	1.0 (7.0 x 10 ⁻³)		
Moment of inertia, in-oz-s ² (g-cm ²)		9.0 x 10 ⁻⁴ (63.2)		
Maximum acceleration, rad/s ²		2 x 10 ⁶		
Operating temperature, °F (°C)		32 to 158 (0 to 70)	32 to 122 (0 to 50)	
Storage temperature, °F (°C)		-4 to 176 (-20 to 80)		
Humidity, % RH, non-condensing		98		
Shock		50g, 11ms		
Sealing		IP65, except IP64 at shaft exit		
Bearings		Grease-lubricated and sealed		
Maximum radial shaft load, lb (N)	5	30 (133)		
Bearing life (with 10-lb radial load)		1.4 x 10 ⁹ rev		

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 defined at the signal transitions and therefore does not include quantization error, which is ±1/2 quantum. ("Quantum" is the final resolution of the encoder, after user's 4X quadrature decode.) Accuracy is guaranteed at 20°C.
2. *Instrument Error* is the sum of disc pattern errors, disc eccentricity, bearing run-out 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.

Error in arcseconds = (3600) x (error in electrical degrees) / (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.

Error in arcseconds = (1296000) x (error in quanta) / (counts/rev)

5. If reduced torque or higher load capacity is required, consult factory.
6. With line counts ≥ 6000, operating temperature range is 32°F to 122°F (0°C to 50°C).

As part of our continuing product improvement program, all specifications are subject to change without notice.



INPUT POWER

9125: Standard: +5 ±0.25 VDC @75 mA max. Optional: +7-15 VDC

9225, 9425: +5 ±0.25 VDC @75 mA max.

OUTPUT DEVICE

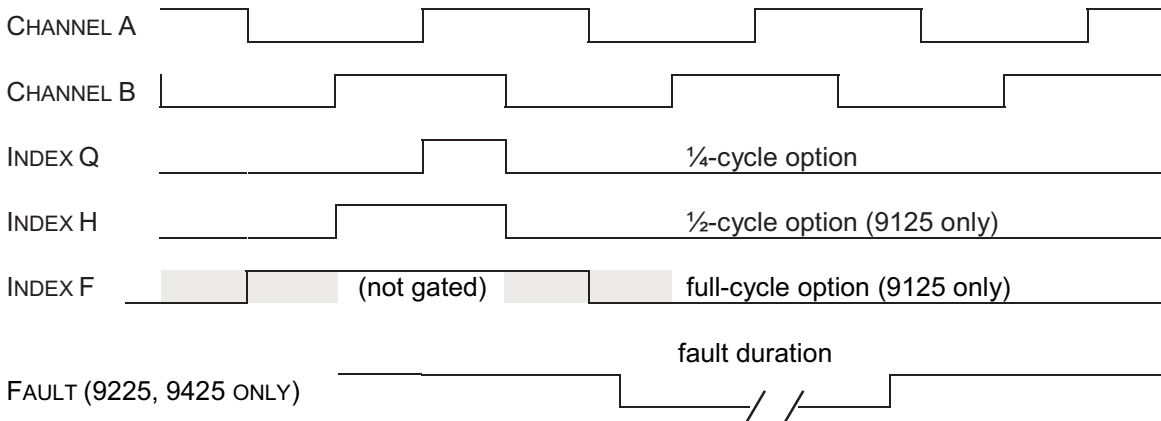
EIA/RS-422 balanced differential line driver, protected to survive an extended-duration short circuit across its output. May be used single-ended for TTL-compatible inputs.

INDEX OPTIONS

9125: Index is available in one of three formats: ungated full cycle wide ±180° elect; half-cycle wide, gated with high state of B; or quarter-cycle wide, gated with high states of A and B.

9225, 9425: Index is quarter-cycle wide, gated with high states of A and B.

OUTPUT WAVEFORMS (Clockwise shaft rotation shown. Complements omitted for clarity)



WATCHDOG CIRCUIT (MODEL 9225 AND 9425 ONLY)

If the 9225 or 9425 photo-detector outputs deviate beyond prescribed limits, an active-low FAULT signal is issued whose duration will be for as long as the fault condition lasts.

Fault conditions detectable by this method include operation outside the specified encoder temperature range; broken or high-impedance wiring to the encoder; LED failure; low supply voltage; badly damaged bearings; defective photo-detectors; operation beyond the rated speed; and localized code disc defects such as chips, cracks or contamination.

The watchdog output provides advance warning of gradual performance degradation in cases where the failure is not catastrophic. This gives the user an opportunity to schedule replacement of the encoder while continuing to use it, as long as it functions correctly otherwise.

INTERPOLATION CONSTRAINTS (9225 AND 9425 ONLY)

Interpolation factor	Allowable line counts	Output cycles/rev	Max. output frequency
1X	200-9000	200-9000	100 kHz
2X	200-8192	400-16384	150 kHz
5X	200-6000	1000-30000	300 kHz
10X	200-5000	2000-50000	500 kHz

ELECTRICAL CONNECTIONS

Output Functions	Wire Colors Conn. Code P	Pin #, Dx-15P Conn. Code Q or R	Pin #, DE-9P Conn. Code S	Pin #, MS3102E-18-1P	
				Conn. Code A	Conn. Code M
A	Yellow	8	4	A	A
/ A	Brown	7	8	H	B
B	Green	5	3	B	C
/ B	Orange	4	7	I	D
IND	Blue	2	2	C	E
/ IND	White	1	6	J	F
FLT	Violet	12			
/ FLT	Gray	11			
+V	Red	10	5	D	I
COMMON	Black	13	9	F	J
CASE	Bare (shield)	9	1	G	H

NOTES:

1. Channel B leads Channel A for clockwise shaft rotation, viewed from the shaft end.
2. FLT and /FLT signals are available with **9225** and **9425**, but only with connector codes **P**, **Q** or **R**.

BEARING LUBRICANTS

The standard lubricant, *Andok® C*, is specifically formulated for severe service, high speed, long life, low torque and low temperature rise; it is suitable for most applications. *Braycote® 601EF* is a low-vapor-pressure lubricant for use in vacuum and clean-room applications at the expense of slightly higher torque.*

Base code	Mounting	Lubricant
A	Synchro/face	Andok C
C	Square-flange	Andok C
E	Synchro/face	Braycote 601EF
F	Square-flange	Braycote 601EF

PINION SHAFTS

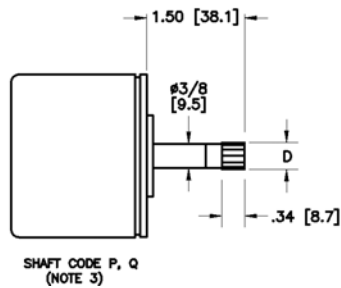
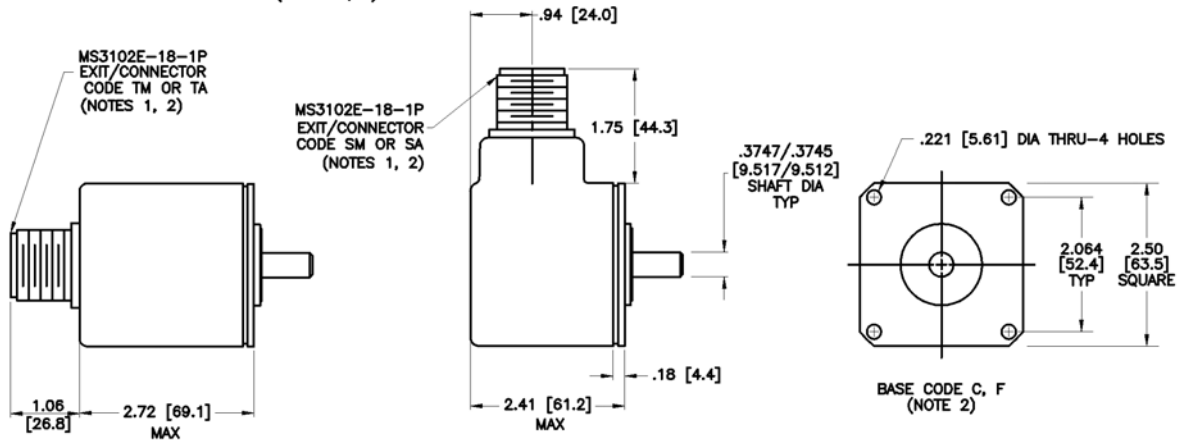
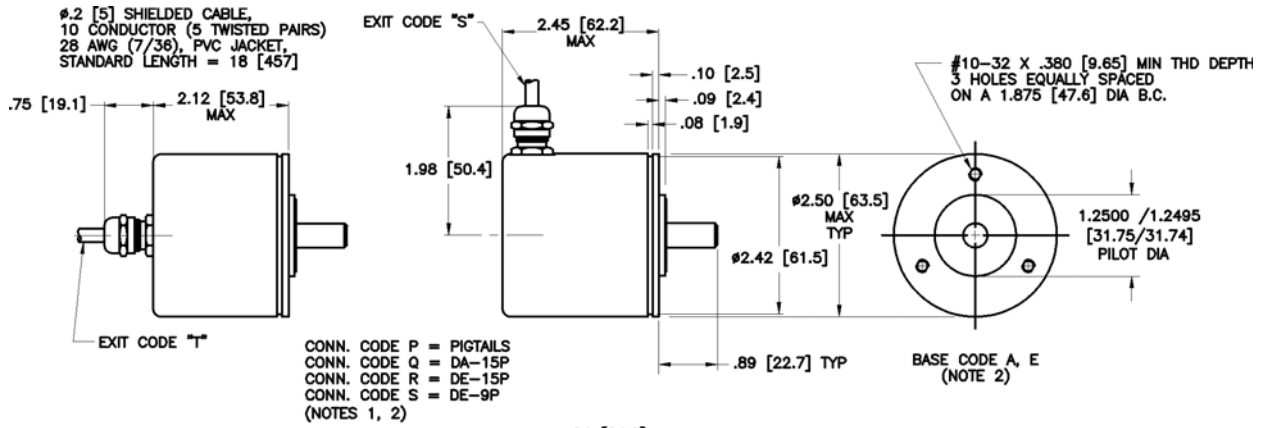
The Series **9x25P** and **9x25Q** incorporate a precision-hobbed pinion as an integral part of the encoder shaft. Because this eliminates assembly eccentricity, it is more accurate than attaching a separate pinion. The pinion shaft is made from hardened 416 stainless steel to minimize wear. The pinion mates with a 10-tooth-per-inch rack, and traverses exactly one inch per revolution (**9x25P**) or two inches per revolution (**9x25Q**). An optional flex-mount bracket keeps the pinion spring-loaded into the rack to virtually eliminate backlash.

The salient benefits of a rack-and-pinion system include good tolerance to misalignments, virtually unlimited measuring length, high resolution, long life and relative insensitivity to contamination. Please refer to the Rack-and-Pinion data sheet for system specifications.

*Andok and Braycote are brand names of Exxon Corp and Castrol Industrial North America, respectively. GPI reserves the right to change to equivalent lubricants without notice.



DIMENSIONS



0.1" PITCH PINION		
SHAFT CODE	TEETH	D
P	10	.40 [10.2]
Q	20	.70 [17.8]

Notes:

- Mating connector is optional.

Connector Code	P	Q	R	S	M	A
Optional mating connector	N/A	M01	M05	M06	M02	M02

- Any connector code can be used with any base code.
- See Rack-and-Pinion data sheet for rack details.
- All dimensions are in inches [mm]



ORDERING INFORMATION

MODEL	SHAFT	LINES	IND	V	OUT	INTERP	BASE	CAB	EXIT	CONN	DIA	SPEC

MODEL

- 9125** Standard accuracy
- 9225** High accuracy
- 9425** Highest accuracy

SHAFT - Shaft type

- S** Solid shaft
- P** 10-tooth pinion shaft (1" per rev.)
- Q** 20-tooth pinion shaft (2" per rev.)

LINES - Disc line count

- 00200, 00250, 00300, 00360, 00500,**
 - 00600, 00635, 00900, 01000, 01200,**
 - 01250, 01720, 01800, 02048, 02400,**
 - 02500, 02540, 03000, 03125, 03600,**
 - 04096, 05000, 06000, 06282, 08192,**
 - 09000**
- Consult factory for other line counts.

IND - Index format

- F** Full cycle ungated (**9125** only)
- H** Half cycle gated (**9125** only)
- Q** Quarter cycle gated (any model)

V - Input voltage

- 5** 5 volts dc
- R** 7-15 volts dc (**9125** only)

OUT - Output format

- L** RS-422 Differential line driver

INTERP - Interpolation factor

- 01** 1X square waves
- 02, 05, 10** 2, 5 or 10X square waves available with **9225** or **9425**

Accessories (order separately)

- M01** DA-15S (mates with CONN code **Q**)
- M05** DE-15S (mates with CONN code **R**)
- M06** DE-9S (mates with CONN code **S**)
- M02** MS3106E-18-1S (mates with CONN code **A** or **M**)

BASE - Base & lubricant type

- A** Synchro/face mount, Andok
- C** Square-flange mount, Andok
- E** Synchro/face mount, Braycote
- F** Square-flange mount, Braycote

CAB - Cable length, inches

- 18** Standard
- 00** With CONN code **A, M** or **T**

EXIT - Cable exit or connector location

- S** Side
- T** Top

CONN - Connector

- P** Pigtails (no connector)
- Q** DA-15P
- R** DE-15P
- S** DE-9P
- A** MS3102E-18-1P (see wiring table)
- M** MS3102E-18-1P (see wiring table)
- T** Terminals; available only when used with HDT enclosure

DIA - Shaft diameter

- 06E** 3/8" shaft dia

SPEC - Special features

- X** Issued at time of order to cover special customer requirements
- N** No special features

- AX06399** Synchro mounting cleats
- ISC3N** Interface card for IBM® PC
- HDT** Heavy-duty enclosure

SPECIAL CAPABILITIES

For special situations, we can customize encoders to provide higher frequency response, greater accuracy, wider temperature range, reduced torque, non-standard line counts, or other modified characteristics. 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 high-performance, high-reliability conditions. We welcome the opportunity to help you with your special 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.

