

# GURLEY MODEL 7700 VIRTUAL ABSOLUTE<sup>®</sup> ENCODER

## MOTION TYPE:

ROTARY & \*LINEAR

## USAGE GRADE:

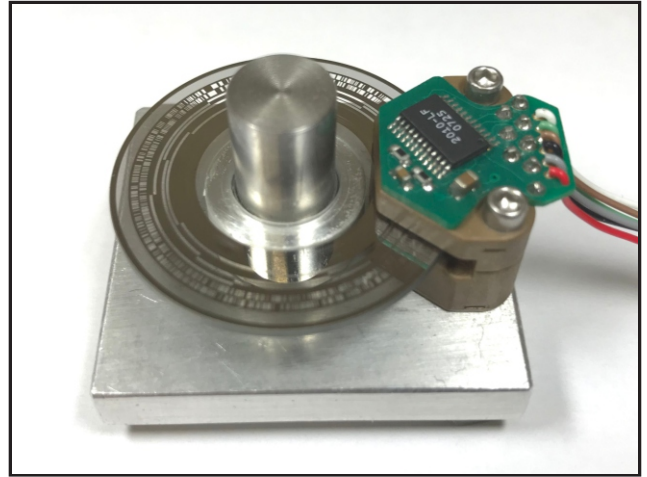
MILITARY, INDUSTRIAL

## OUTPUT:

VIRTUAL ABSOLUTE

## MAX RESOLUTION: W/EXTERNAL DECODING ELECTRONICS

2<sup>24</sup> STEPS/REV.(0.07 ARCSEC)



- ABSOLUTE OUTPUT
- MANY DISC SIZES

- FRICTION-FREE OPERATION
- LOW-COST SOLUTION

The model 7700 Incremental and Virtual Absolute encoder is a compact, non-contact modular encoder with superior performance. Available in many resolutions and configurations, it is easy to install and its optional commutation tracks eliminate hall effect sensors for brushless motors.

Features common to both models include:

- -40C to +100C operating temperature
- Low power consumption
- Single phased-array optoelectronic ASIC
- LED illumination for long service life (>100,000 hours)

Incremental systems (7700 encoder + disc/hub) include:

- Resolutions up to 5000 cycles/rev (20,000 counts/rev, or 0.018degrees/count)
- TTL/CMOS-compatible square wave output, 10mA sink
- Standard once-per-rev zero index signal
- Optional three-phase 2, 4, 6, or 8 pole pair motor commutation

Virtual Absolute systems (7700 encoder + disc/hub + VG, VH or VJ decoder) include:

- Resolutions from 12 bits (4,096 steps) to 24 bits (16,777,216 steps) per turn
- True absolute position after a small initialization, depending on disc diameter - see disc library table for initialization angles
- Compact decoder circuits provide byte-wide parallel (VG), USB (VH), or SSI serial (VJ) outputs. Please refer to individual decoder datasheets for more information
- Built-in patented pseudorandom and quadrature error detection for high reliability

\* Consult factory for information on linear encoder option

ISO  
9001  
CERTIFIED

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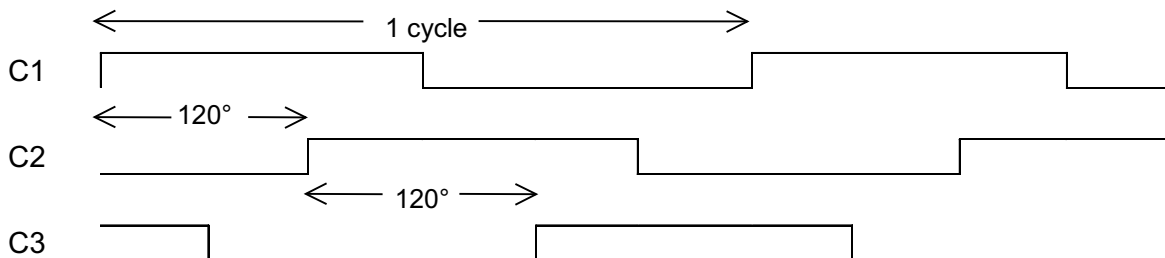
ingenuity<sup>®</sup>@work

# SPECIFICATIONS

<b>ELECTRICAL</b>	
Input power	V <sub>CC</sub> : +5VDC ±0.5 VDC @ 60 mA
Light source	Infra-red LED; rated for long service life >100,000 hours
Output Signals	TTL-compatible square waves or micro-current sine waves
<b>MECHANICAL</b>	
Materials Encoder body Disc Hub	Molded Ryton PPS Vacuum-deposited chrome pattern on glass Aluminum (stainless steel optional)
Weight Read head	0.25 oz (7 g) max without cable
<b>PERFORMANCE</b>	
Frequency response	Incremental: 125 kHz, all channels; VA: 2 kHz disc rate
Endplay	± 0.010 inches (0.254 mm)
<b>ENVIRONMENTAL</b>	
Operating temperature	-40°F to +212°F (-40°C to +100°C)
Storage temperature	-40°F to +212°F (-40°C to +100°C)

## Commutation Tracks (Incremental Encoder options only)

If your motor has P poles, you need a disc with N cycles/rev commutation tracks, where  $N = P/2$ . The three commutation signals are phase-shifted 120° electrical from each other within each cycle.



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

## Virtual Absolute (VA) Encoders

VA discs and scales are similar to incremental discs and scales in that they contain a cyclic track and an index track. In an incremental encoder, the index occurs at one place in the full travel, but in a VA encoder, the index track is a continuous serial code similar to a bar code. Although speed and direction are known upon start-up, position is not immediately known as in a conventional absolute. After a very short travel, *in either direction and starting from anywhere*, you know exactly where you are. For example, a 1.75" disc diameter with 2048-lines, this initialization angle is 1.92°. From then on, the encoder output is truly absolute.

Gurley offers several different interpolating decoders depending on the final resolution and output format desired. Please refer to the **VG** (Parallel), **VH** (USB), **VJ** (SSI), **VK** (dual-axis) datasheets for detailed information. Each model contains a patented high-speed absolute position decoder for the pseudorandom index track, and adds from 2 to 10 bits of resolution beyond the optical resolution (10, 11, 12 or 13-bits) of the disc. In addition to the final natural binary position output, a **status** bit tells when the encoder is initialized. This bit is at a logic high whenever the initializing motion is not yet complete, or when some other problem such as damage or fouling of the disc, supply voltage interruption, or electrical noise disrupts the proper code sequence from the index track. When these self-tests are all satisfied, the **status** bit is low, indicating the position output is valid.

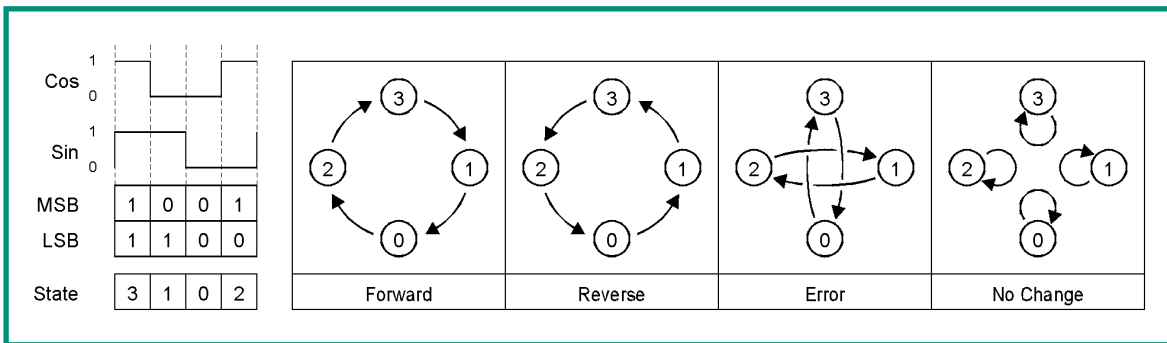


# SPECIFICATIONS

## Built-in Error Detection (*Virtual Absolute* options only)

With the addition of a patented Gurley *Virtual Absolute* pseudorandom tag decoder, the encoding system continuously monitors signal integrity in two important ways to improve system reliability. The first way is actually a well-known test that can be applied to any incremental encoder, where the timing track signals from the encoder are inspected for disallowed quadrature sequence. If a quadrature sequence fault is detected, the tag decoder will immediately be reset into Wait mode, the **status** bit will be set to a logic high indicating "data not valid", and the electronics package will automatically start accumulating a new code tag with any further motion of the disk or scale.

Quadrature square waves are two square waves that are phase shifted with respect to each other by 90 electrical or one quarter of the optical cycle. The quadrature pair may be thought of as being a series of two-digit binary numbers, also given decimal state names for convenience below. Four groups of state transitions are possible depending on the direction of encoder motion. The figure below shows the digital quadrature square waves, binary representations, and state diagrams for each of the four quadrature state transition groups. The state diagrams show how a rapidly sampled pair of square waves is perceived to change from state to state by the decoder. "Forward" and "Reverse" motion are self-explanatory. The "No Change" group shows how the states are perceived not to have changed within a sampling period. The "Error" group illustrates illegal state transitions: those with simultaneous edges, or edges close enough to fall within the same sampling period. This signifies a loss of quadrature, which in turn makes it impossible to determine proper direction sensing and renders the serial data sampled from the pseudorandom *Virtual Absolute* code track untrustworthy. Possible causes of an illegal quadrature sequence include incorrect or shorted wiring from the encoder read head, damaged disk or scale, or overwhelming noise interference. The decoder's quadrature state transition test helps guarantee position data integrity at all times.



The pseudorandom serial position data may be corrupted from causes other than quadrature error. Gurley's unique decoder architecture tests the pseudorandom data for the correct sequence, even as it is decoding it into a usable natural binary output. If a sequence error occurs due to electrical noise, broken or intermittent wires, interruption of the power supply, or various optical defects such as cracks, chips, or contamination of the code disc, the decoder resets itself the same as described above for quadrature errors. These built-in self tests are a major improvement of *Virtual Absolute* encoding technology over conventional incremental and absolute encoders, which do not detect their own malfunctions.

O.D.	Max. I.D.	Thickness	VA Initialization Angle (degrees)	Disc Line Count
1.300 (33.020)	0.410 (10.41)	0.0394 (1.00)	3.52	<b>00100, 00200, 00250, 00256, 00300, 00360, 00500 00512, 00600, 00720, 01000, 01024, 01200, 01250 01440, 02000, 02048, 02500, 02540, 03600</b>
1.750 (44.450)	0.888 (22.565)	0.0394 (1.00)	1.93	<b>01000, 01024, 02000, 02048, 03600, 04096, 05000</b>
2.072 (52.629)	1.202 (30.531)	0.0394 (1.00)	1.93	<b>02048</b>
2.504 (63.602)	1.598 (40.589)	0.0394 (1.00)	1.93	<b>02048</b>
2.748 (69.799)	1.842 (46.787)	0.0394 (1.00)	1.93	<b>02048</b>
3.200 (81.280)	2.294 (58.268)	0.0394 (1.00)	1.05	<b>04096</b>
3.424 (86.970)	2.518 (63.957)	0.0394 (1.00)	1.05	<b>04096</b>
3.748 (95.199)	2.842 (72.187)	0.0394 (1.00)	1.05	<b>04096</b>
4.048 (102.819)	3.142 (79.807)	0.0394 (1.00)	1.05	<b>04096</b>
4.912 (124.765)	4.006 (101.752)	0.0394 (1.00)	1.05	<b>04096</b>
5.400 (137.160)	4.494 (114.148)	0.0394 (1.00)	1.05	<b>04096</b>
6.304 (160.122)	5.398 (137.109)	0.0394 (1.00)	0.57	<b>08192</b>
6.752 (171.501)	5.846 (148.488)	0.0394 (1.00)	0.57	<b>08192</b>
7.400 (187.960)	6.494 (164.948)	0.0394 (1.00)	0.57	<b>08192</b>
8.000 (203.200)	7.094 (180.188)	0.0394 (1.00)	0.57	<b>08192</b>

7700 Virtual Absolute binary discs are in **red bold italics**

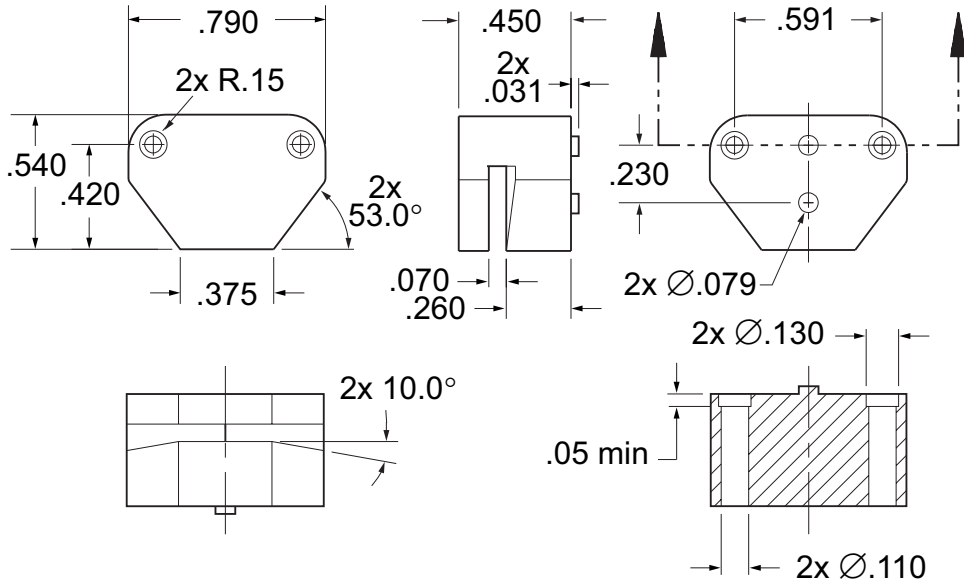
**Need a disc diameter not called out in our library?**

GPI can manufacture disc diameters ranging from 1.30" through 8.00". In many cases, a binary (2<sup>n</sup>) resolution is achievable at or near the diameter you need. If a particular diameter is more important than having a binary number of counts/rev, the count can be adjusted to realize the desired diameter. Or other resolutions like 36,000 counts/rev are possible at different diameters.



# 7700 READHEAD DIMENSIONS

## Module Outline Dimensions



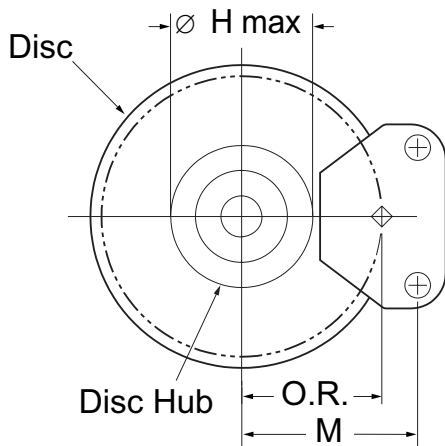
## Module Interface

### Module 0130

O.R. - Optical Radius . . . . .0.602 in  
M - Mounting dimension . . . .0.756 in  
H - Hub Maximum O.D. . . . .0.61 in

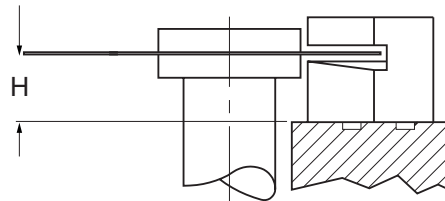
### Module 0175

O.R. - Optical Radius . . . . .0.832 in  
M - Mounting dimension . . .0.986 in  
H - Hub maximum O.D. . . . .1.07 in



### DISC MOUNTING

same for rotary disc or linear scale



Disc Material	H $\pm$ -.005
Glass 0.04" [1 mm] thick (standard)	0.280
Plastic 0.02" [0.5 mm]	0.300

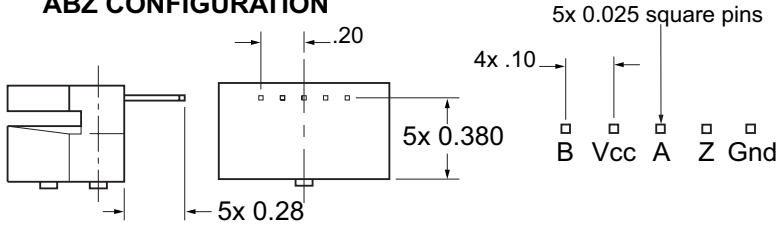
# 7700 READHEAD & DISC DIMENSIONS

## Side Pin Layout

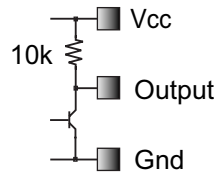
## Output Format

The Optical Encoder Module with side exit pins comes standard with A, B and Z (Index) channels.

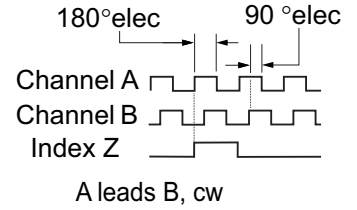
### ABZ CONFIGURATION



### OUTPUT STAGE



### WAVEFORMS

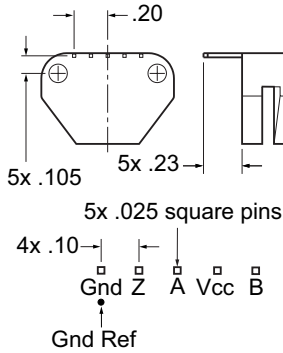


## Top Pin Layouts

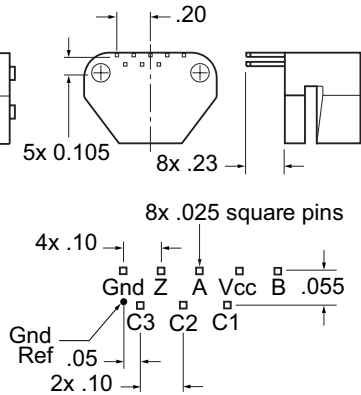
## Disc and Hub Dimensions

The Optical Encoder Module with top exit pins comes standard with A, B, and Index channels. Commutation channels are optional.

### ABZ CONFIGURATION



### ABZ + COMS CONFIGURATION



### Module 130 Disc and Hub

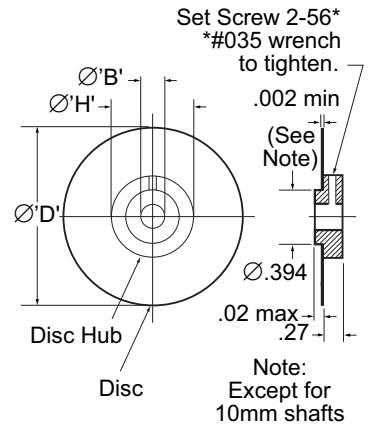
D - Disc O.D. . . . . . 1.30 in.  
H - Hub O.D. . . . . . 0.61 in.

### Module 175 Disc and Hub

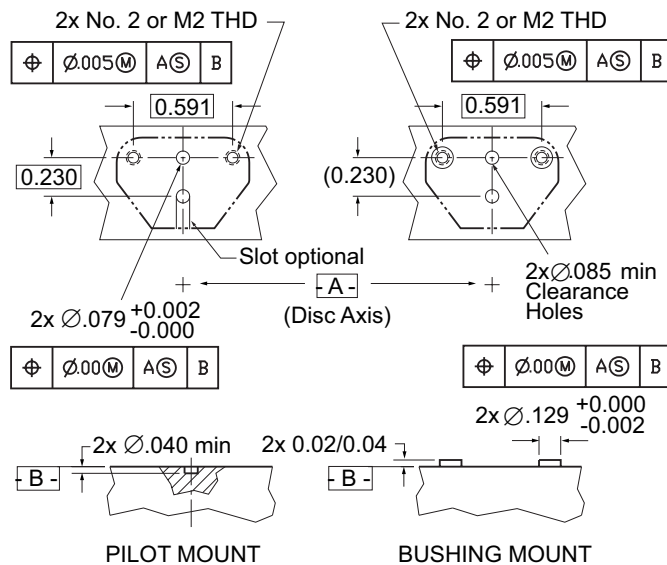
D - Disc O.D. . . . . . 1.75 in.  
H - Hub O.D. . . . . . 1.00 in.

### Shaft Size Hub Bore Sizes

Shaft Size	Hub Bore Sizes	Ø B in.	Ø B mm
		+0.005 -0.000	+0.13 -0.000
1/4 in.	.2500		6.350
3/8 in.	.3750		9.525
6 mm	.2362		6.000
8 mm	.3150		8.000
10 mm	.3937		10.000

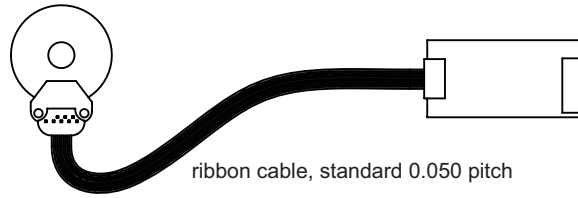


## Recommended Mounting Configurations

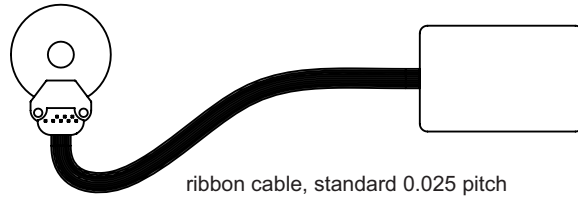


# 7700 VIRTUAL ABSOLUTE CONFIGURATIONS

## 7700 with VG Multiplexed decoding electronics



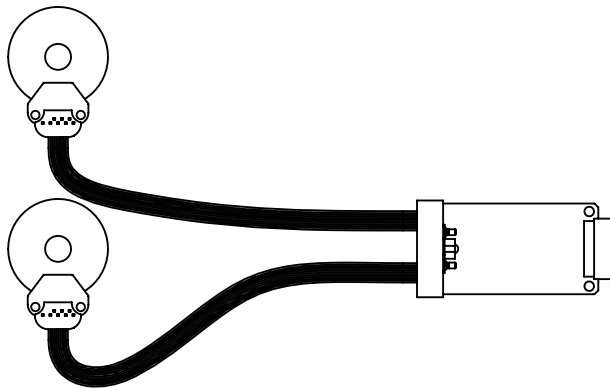
## 7700 with VH USB decoding electronics



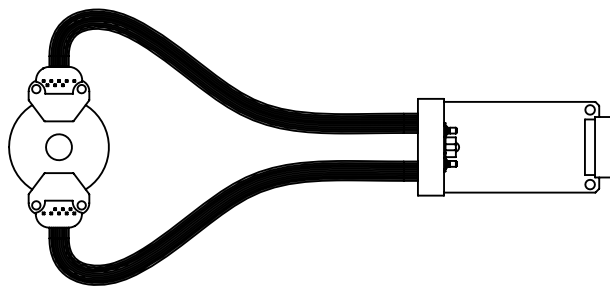
## 7700 with VJ SSI decoding electronics



## 7700 with VK SSI dual input decoding electronics



Reading two separate readheads & disc/hub assemblies into one VK decoder. Good for Az & El gimbal applications



Reading two readheads on one common disc/hub assembly into one VK decoder. Good for applications where high accuracy is required.

# ORDERING INFORMATION

<b>Module</b>	<b>MDL</b>	<b>OUT</b>	<b>RES</b>	<b>TYPE</b>	<b>CABLE</b>	<b>CONN</b>	<b>DIA</b>	<b>SF</b>
	<b>7700</b>	<input type="text"/>	<input type="text"/>	<input type="text" value="R"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text" value="N"/>

**OUTPUT**

- A** analog micro-currents for VH & VJ decoders
- B** analog buffered differential for VK decoder
- C** TTL with commutation
- D** TTL with internal doubler circuit
- T** TTL-compatible square waves

**CONNECTOR**

- T** Top pins
- S** Side pins
- V** Mates with VG decoder
- U** Mates with VH or VJ decoders
- M** Mates with VK decoder

**RESOLUTION**

5-digit resolution code; see page 4

**DIAMETER**

- 0130** 1.30" disc
- 0175** 1.75" disc

**TYPE**

- R** Rotary; consult factory for Linear

**SPECIAL FEATURES**

- N** No Special Features

**CABLE**

- 00** for Top or Side pins
- 12** for **V, U, M** decoders (standard in inches)

<b>Disc/hub</b>	<b>MDL</b>	<b>LINES</b>	<b>DIA</b>	<b>IND</b>	<b>MATL</b>	<b>COMM</b>	<b>ID</b>	<b>SF</b>
	<b>DH</b>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text" value="N"/>

**LINES**

5-digit resolution; see page 4

**COMMUTATION TRACKS**

- 0** (none)
- 2, 4, 6, 8** with 1.30" disc at 500 & 512 lines and 1.75" discs at 1000 & 1024

**DIAMETER**

- 0130** 1.30" disc
- 0175** 1.75" disc

**ID (hub)**

- 04E** 0.250"
- 06E** 0.375"
- 06M** 6mm
- 08M** 8mm
- 10M** 10mm

**INDEX**

- S** Standard once-per-rev
- V** Virtual Absolute

**SPECIAL FEATURES**

- N** No special features – other letter codes for special custom requirements issues at time of order

**MATERIAL**

- G** Glass at 0.040" (1mm) thick (**standard**)

**SPECIAL CAPABILITIES**

For special situations, we can optimize catalog encoders to provide higher frequency response, greater accuracy, wider temperature range, 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 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.

