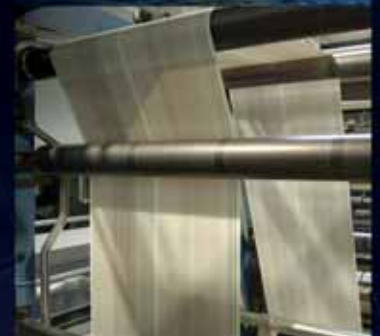


CST BEI
CUSTOM SENSORS & TECHNOLOGIES INDUSTRIAL ENCODERS

**BEI Industrial Encoders
Design and Specifying Guide**





Dear Customer,

You have in your hand a brochure featuring some of the finest position-sensing devices in the world. As an industrial consumer, you demand the highest quality and reliability in the products you purchase. With over 30 years in the industrial encoder business we understand your needs and have designed products of uncompromising quality and performance. BEI has grown to be the leader in the industrial encoder market by keeping promises and standing by our customers. Chances are you heard about us from one of your colleagues. Word of mouth has always been our best advertising.

Please call the factory on our toll free line with any questions regarding our products or your

application. You will find that our professional applications engineers and order specialists are both knowledgeable and easy to talk with. We challenge you to keep us busy helping you find more and better ways to use our products.

Our customers' satisfaction is the key to our growth. So, if you are ever unhappy for any reason with any aspect of our performance and do not receive what you feel is a satisfactory resolution, please contact me directly and I will make every effort to address your concerns. After all, our continued success depends on it.

Sincerely,

Glenn Avolio,
General Manager,
BEI Industrial Encoders
Custom Sensors & Technologies

Committed to Quality



BEI Industrial Encoders was founded more than 30 years ago. Our goal was to produce well-made optical encoders specifically for the industrial marketplace. We also wanted to create a new standard for excellence by providing on-time delivery, customer support and reasonable lead times—all at a fair price. Today, as an ISO registered company, we continue to build on that tradition.

Our products have grown to include electronic interfaces, accessory items and specialized products, like those certified for hazardous area use and wash-down environments. We offer lead times of one to three days on standard Express Encoders®, and two weeks on a wide variety of custom encoders (specialty products can take a little longer). We regularly fulfill our delivery commitments with an average on-time delivery record of better than 99%.

Our custom-designed factory and office facilities near Santa Barbara, California ensure an efficient flow of production, in which all critical manufacturing processes are tightly controlled. High manufacturing standards, certified to ISO9001:2000 include inspection of dozens of individual electrical parameters on every encoder produced, as well as confirming each unit's mechanical compliance with its particular specifications. We stand firmly behind our products with a two-year warranty.

We have five full-time applications specialists to help with your technical needs—whether you want to build a model number or need assistance with an interface issue. Our knowledgeable order entry staff can help you specify and order a unit that will meet your exact requirements. We provide this high level of service to an active customer base of thousands of companies...it's what we do.

Presale service. Guaranteed on-time shipment. Top quality product and technical support. We've preserved the founding ideals of our company and make customer satisfaction our top priority. At BEI, we are proud to be the leader in the industrial encoder marketplace.



From our manufacturing team (top) to our applications engineers and order specialists (above), everyone at BEI works toward a common goal—produce the best products and deliver the best customer service found anywhere.

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Using This Specifying Guide

This guide has been designed to provide you with a wide range of information on the products offered by BEI Industrial Encoders. The Design Guide on pages 8–17 provides assistance for design engineers in specifying the proper encoder for the desired application, including installation tips and frequently asked questions.

Pages 18–47 and 52–53 detail the encoders that comprise our basic product line. Pages 54–63 discuss optional features, wireless interfaces and accessories for encoders.

Pages 48–51 contain hazardous area information, regulatory information, and specialty encoders and accessories for both hazardous and extreme environments. Pages 64–65 contain notes and tables that are referred to throughout the preceding pages.

Ordering Encoders from BEI

The ordering information block that accompanies the description of each of our basic products gives detailed instructions for the construction of a model number. This system allows you to take full advantage of the tremendous diversity of product configurations offered by BEI. If you have questions regarding applications or the construction of a model number, we are always happy to assist you.

Phone: 800-350-ASAP (2727) or 805-968-0782.
Fax: 805-968-3154.

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7230 Hollister Avenue, Goleta, California 93117

Specifications are subject to change without notice.

Count on BEI for the Best Repair and Support

Retrofits and Crossovers



As a leader in the manufacture of optical encoders, BEI Industrial Encoders can also offer expertise in crossing over a wide variety of encoders from other manufacturers, both foreign and domestic. We

maintain a thorough library of encoder specifications and dimensional information covering a wide range of competitive products. If we cannot quote a replacement unit from one of our three encoder divisions, we may be able to guide you to an appropriate manufacturer or repair facility to help solve your problem. We are aware of the importance of time in a machine-down situation and handle crossover requests in the most expeditious manner possible.



Service and Repair



All encoders produced by BEI are backed by our two-year warranty. If anything goes wrong, give us a call. Our trained service personnel can often troubleshoot a problem over the phone and

determine if your encoder needs to be sent in for repair. They will perform a thorough evaluation and recommend a course of action. In emergency situations an evaluation and repair can be underway within minutes after the encoder is received at our dock.



Engineering Support

Our on-site sales and engineering staff is available to help support your engineering needs—from deciding what type of encoder to buy, all the way through helping with the interface to your measurement or control system. In addition, a regional sales manager or manufacturer's representative is available locally to help with your system needs.



Product Specifying Assistance



This Specifying Guide covers most of the requirements of the industrial marketplace. If we can explain some of the available options or you have

some special requirements, please give us a call. Over the years we have developed more than 17 million variations on the basic encoder, and chances are we can answer your specific need.



With BEI's Express Encoder® Program, You Get the Right Encoder...Right Away

Express Encoders® are popular configurations of our standard model encoders that can be built and shipped quickly. With six package styles (four incremental and two absolute) to choose from, over 2000 different configurations—that will meet just about any need—are available as Express Encoders.

Refer to the pages in this catalog for the **Models H25, H20, HS25 and HS35 Incremental Encoders**, and the **Models H25 and HS35 12 bit Absolute Encoders**. In the **Ordering Options** block at the bottom of these pages you will see the blue Express Encoders **highlight bar**. By selecting from the highlighted options when constructing your model number, you will specify an Express Encoder for your particular application.

Express Encoders ship in three days or less. We pay the freight for UPS 2nd Day Delivery when shipping to an address in the continental United States. Certain models in the Express line are kept in stock for **same day shipment (when ordered by 2:00PM pacific time)**.

If you need applications assistance, we are always just a phone call away. Our applications specialists are available to help with your encoder selection. Just call **1-800-ENCODER (800-362-6337)** and ask for technical assistance.



Express Encoders Feature:

- Two-Day Shipping on a Variety of Rotary Optical Encoders
- Same-Day Shipping on Selected Models
- A Broad Range of Resolutions
- Heavy Duty, Environmentally Sealed Models
- Industry Standard 2.0-inch, 2.5-inch, and 3.5-inch packages
- Shafted and Hollow Shaft Styles
- Incremental and Absolute Versions
- Variable Voltage In/Out, up to 28V
- Wide Range of Available Accessories

Incremental Encoders

	Model Number	Resolution (Max)	Output Format	Sealing (Max)	Output Type	Diameter	Mounts	Hazardous Rating Options
PAGE 35	L15	40,640	ABZC	IP53	DLD OC	1.5"	Servo Face	
PAGE 20	H20	4096	ABZC	IP66	DLD OC 5V Reg	2.0"	Square Flange Servo Face	CSA CENELEC/ATEX UL/cUL
PAGE 18	H25	72,000	ABZC	IP66	DLD OC 5V Reg	2.5 "	Square Flange Servo Face	CSA CENELEC/ATEX UL/cUL
PAGE 34	L25	18,000*	ABZC	IP43	DLD OC 5V Reg	2.5 "	Servo Face	UL/cUL CENELEC/ATEX
PAGE 34	E25	18,000*	ABZC	IP43	DLD OC 5V Reg	2.5 "	Face	UL/cUL CENELEC/ATEX
PAGE 28	H38	72,000	ABZC	IP66	DLD OC 5V Reg	3.75"	Square Flange	Explosion Proof CL I, II CENELEC/ATEX UL/cUL, MSHA
PAGE 30	H40	72,000	ABZC	IP66	DLD OC 5V Reg	4.0" Sq.	Foot Mount Face	Explosion Proof CL I UL/cUL
PAGE 22	HS25	2048	ABZC	IP52	DLD OC 5V Reg	2.5"	Shaft Mount with Tether	CENELEC/ATEX UL/cUL
PAGE 24	HS35	80,000	ABZC	IP65	DLD OC 5V Reg	3.5"	Shaft Mount with Tether	CENELEC/ATEX UL/cUL
PAGE 26	HS45	8192	ABZC	IP65	DLD OC 5V Reg	4.7"	Shaft Mount with Tether	CENELEC/ATEX UL/cUL
PAGE 32	HS20	1024	ABZC	IP64	DLD OC 5V Reg	2.0"	Shaft Mount with Tether	CENELEC/ATEX UL/cUL
PAGE 33	HS22	2540	ABZC	IP52	DLD OC 5V Reg	2.2"	Shaft Mount with Tether	
PAGE 35	M58	80,000	ABZC	IP67	DLD 5V Reg	58mm	Pilot Flange Servo	
PAGE 51	ES25	2048	ABZC	IP67+	DLD OC 5V Reg	2.5"	Square Flange Servo Face	CSA CENELEC/ATEX UL/cUL
PAGE 51	ES20	1024	ABZC	IP67+	DLD OC 5V Reg	2.0"	Square Flange Servo Face	CSA CENELEC/ATEX UL/cUL

* For higher resolution options, see H25.

KEY: DLD = Differential Line Driver, OC = Open Collectors

Absolute Encoders

	Model Number	Resolution (Max)	Output Format	Sealing (Max)	Output Type	Diameter	Mounts	Hazardous Rating Options
PAGE 38	H25	13 Bits	GC NB SSI BCD X, A RS422	IP66	LD OC	2.5"	Square Flange Servo Face	
PAGE 39	H25X	15 Bits	GC NB SSI	IP66	LD OC	2.5"	Square Flange Servo Face	
PAGE 40	HMT25	12 X 12 Bits	GC NB SSI A	IP66	LD OC	2.5"	Square Flange Servo Face	
PAGE 43	HS35	13 Bits	GC NB SSI A	IP65	LD OC	3.5"	Shaft Mount	
PAGE 44	H38	13 Bits	GC NB SSI BCD X, A RS422	IP66	LD OC	3.75"	Square Flange	Explosion Proof CL I, II CENELEC/ATEX UL/cUL, MSHA
PAGE 45	H40	13 Bits	GC NB SSI BCD X, A RS422	IP66	LD OC	4.0" Sq.	Foot Mount Face	Explosion Proof CL I UL/cUL
PAGE 42	L18	13 Bits	GC NB SSI	IP66	LD	1.8"	Servo	

KEY: LD = Line Driver, OC = Open Collectors, GC = Gray Code, NB = Natural Binary, SSI = Serial Synchronous Interface, BCD = Binary Coded Decimal, X = Excess Gray Code, A = Analog (4-20 mA, 0-10V)

By Environment

Environment	L15	L18	H20	H25	ES25	ES20	H38	H40	HS25	HS35	HS45
High Electrical Noise	Any Product with 28V/V and Complements										
Wet		IP66 with Shaft Seal	IP66 with Shaft Seal	IP66 with Shaft Seal	IP66 67 + Standard	IP66 67 + Standard	IP66 with Shaft Seal	IP66 with Shaft Seal	IP65 with Shaft Seal	IP65 with Shaft Seal	IP65 with Shaft Seal
Dirty	IP53	IP66 with Shaft Seal	IP66 with Shaft Seal	IP66 with Shaft Seal	IP66 67 + Standard	IP66 67 + Standard	IP66 Shaft Seal	IP66 Shaft Seal	IP65 with Shaft Seal	IP65 with Shaft Seal	IP65 with Shaft Seal
High Temperature	85 C	85 C	85 C	105 C	85 C	85 C	80 C	80 C	85 C	105 C	85 C
Low Temperature	-40 C	-40 C	-40 C	-55 C	-40 C	-40 C	-40 C	-40 C	-40 C	-40 C	-40 C
High Speed				30,000 RPM with Special Spindle							
High Shaft Load				80 lbs. radial with 1/2" Shaft				Up to 300 lbs. Radial			
Caustic/Chemical			with Stainless Steel Option		Note: Most Models Available with Hard Anodize for Chemical Resistance						
Explosion Proof							X	X			
Intrinsically Safe			X	X	X	X			X	X	X
High Shock/Vibration							200 g's Shock 20 g's Vibe				
Small Size/Weight	X	X	X						X		
Dual Outputs				X	X		X	X		X	X

Incremental Encoders

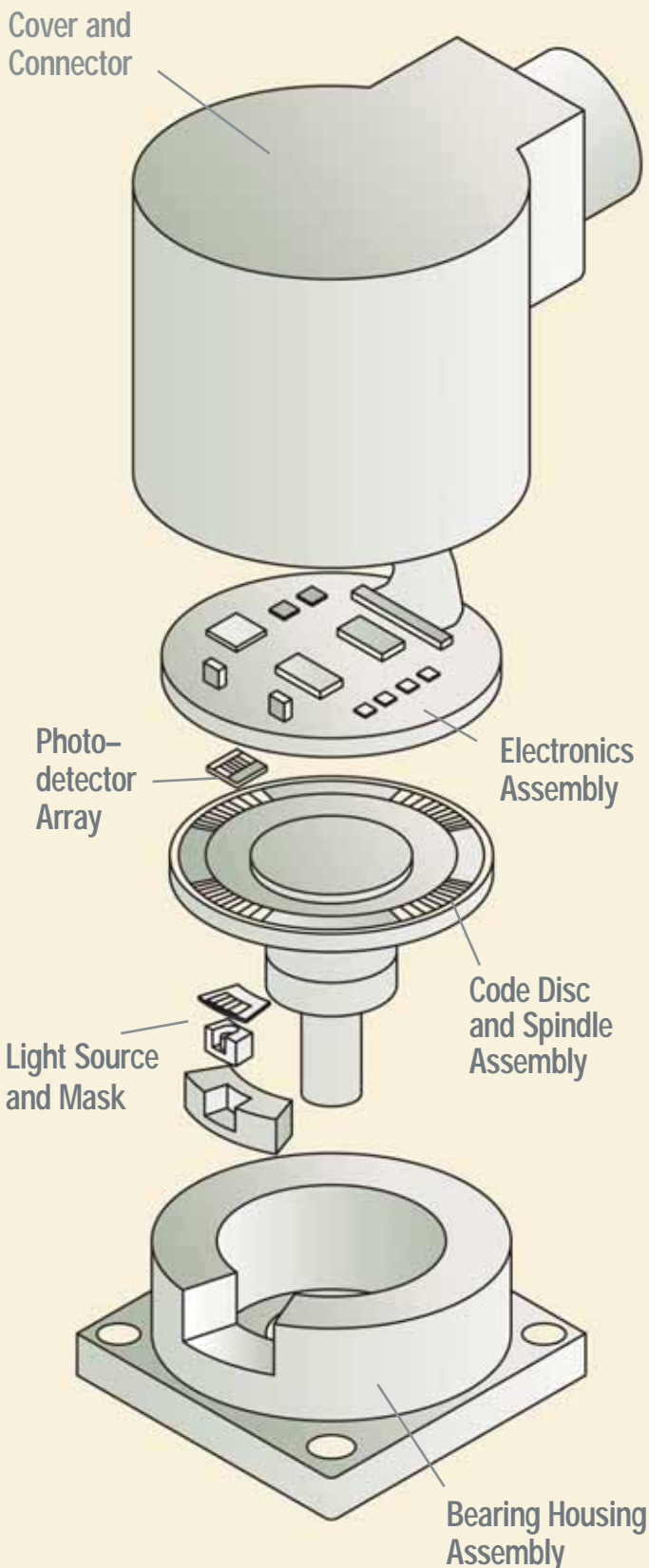
An incremental encoder produces a series of square waves as it rotates. The number of square wave cycles produced per one turn of the shaft is called the encoder resolution. Incremental encoders work by rotating a code disc in the path of a light source (see figure at left); with the code disc acting like a shutter to alternately shut off or transmit the light to a photodetector. Thus, the resolution of the encoder is the same as the number of lines on the code disc. A resolution of 360 means that the encoder code disc will have 360 lines on it and one turn of the encoder shaft will produce 360 complete square wave cycles, each cycle indicating one degree of shaft rotation.

Since the resolution is "hard coded" on the code disc, optical encoders are inherently very repeatable and, when well constructed, very accurate. They also have no error accumulation as you might experience with analog sensors, and the square wave output is inherently easy for digital signal processing techniques to handle.

BEI provides incremental resolutions up to 288,000 counts per turn through a combination of direct read on the code disc and various multiplication techniques (see quadrature detection on next page).

Generally, incremental encoders provide more resolution at a lower cost than their absolute encoder cousins. They also have a simpler interface because they have fewer output lines. In a simple form, an incremental encoder would have 4 lines: 2 quadrature (A & B) signals, and power and ground lines.

A 12 bit absolute encoder, by contrast, would use 12 output wires plus a power and ground line.



Questions?

Call 1-800-ENCODER and ask for Applications Assistance

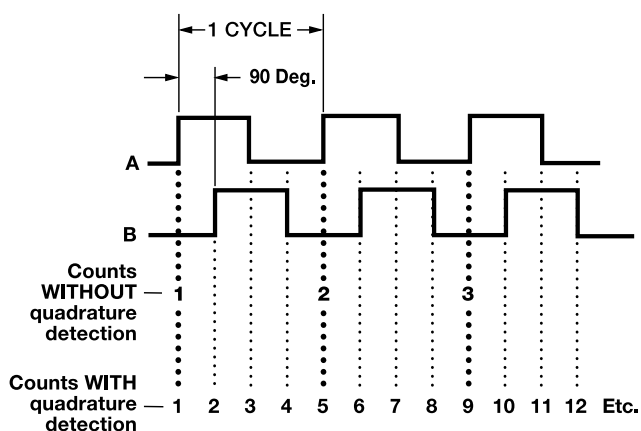
Quadrature Detection (Edge Counting)

Incremental encoders are usually supplied with two channels (A & B) that are offset from one another by 1/4 of a cycle (90 degrees). This signal pattern is referred to as quadrature and allows the user to determine not only the speed of rotation but its direction as well. By examining the phase relationship between the A and B channels, one can determine if the encoder is turning clockwise (B leads A) or counterclockwise (A leads B).

Many counter and controller manufacturers include a quadrature detection circuit as part of their electronics. This allows the use of a two-channel quadrature input without further conditioning.

With quadrature detection the controller can derive 1X, 2X or 4X the basic code disc resolution. 10,000 counts per turn can be generated from a 2500 cycle, two-channel encoder by detecting the Up and Down transitions on both the A and B channels. With a quality disc and properly phased encoder, this 4X signal will be accurate to better than 1/2 count (see diagram below).

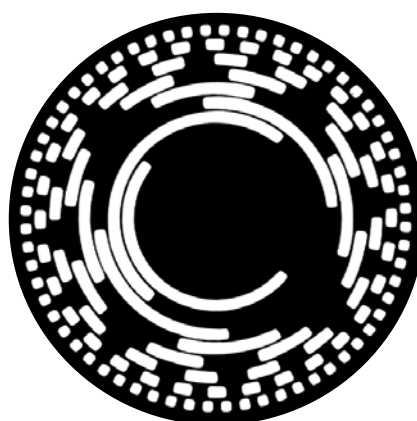
Another means of increasing resolution, interpolation, electronically subdivides the base resolution. Interpolation is achieved through the use of internal electronics acting on the raw encoder signal. This interpolated signal can be further multiplied through the quadrature detection method mentioned above. Interpolative multipliers of 2, 3, 4, 5, 8, 10, 12, 16 and 20 are readily available. More detail is available on pages 36 and 37.



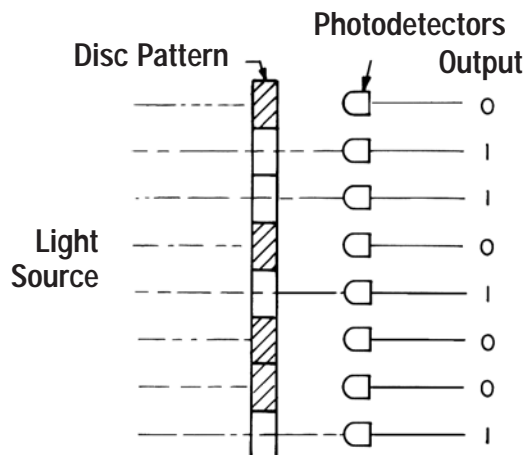
Absolute Encoders

By contrast to incremental encoders, absolute encoders provide a “whole word” output with a unique code pattern representing each position. This code is derived from independent tracks on the encoder disc (one for each “bit” of resolution) corresponding to individual photodetectors. The output from these detectors is HI or LO depending on the code disc pattern for that particular position.

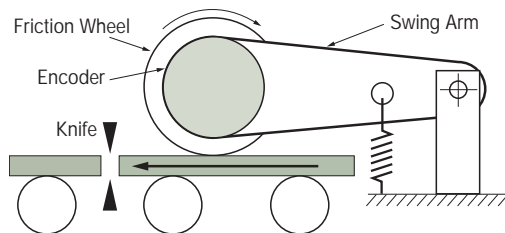
Absolute encoders are used in applications where a device is inactive for long periods of time or moves at a slow rate, such as flood gate control, telescopes, cranes, valves, etc. They are also recommended in systems that must retain position information through a power outage.



8 Bit Gray Code Absolute Disc



Measuring Wheel



Purpose

To measure distance travelled for a cut-to-length operation

Parameters

Speed of Travel: 25 feet per minute

Measuring Wheel Circumference: 12 inches

Desired Resolution: 0.005 inches

Uni-directional measurement only

Manufacturing plant environment, very dusty

50 foot electrical cable run to controller

Integrate to programmable controller

12V power supply available

Resolution Required = $12/0.005 = 2400$ cycles per turn

Output Frequency = $25 \text{ rpm} \times 2400/60 = 1000\text{Hz}$

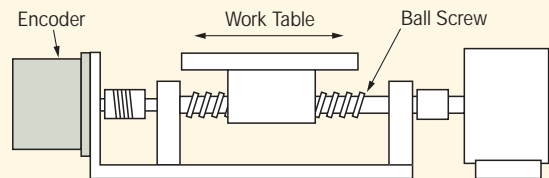
Encoder Specifications

Heavy Duty	H25
Square Flange Mount	D
Shaft Seal	SS
Cycles per Turn	2400
Channels	ABZC
Voltage/Output	Operates from 5-28 Volts
Termination	SM18 (10 pin, side exit)

BEI Model Number

H25D-SS-2400-ABZC-28V/V-SM18

Linear Position with N/C Display



Purpose

To encode the position of a work table through a ball screw

Parameters

Rotational Speed: 500 RPM

Pitch: 1/4

Total Travel: 20 inches

Desired Resolution: 0.0005 inches

20 foot cable run to counter

Oil mist environment

Overtravel protection required

5V power supply available

Resolution required = $\text{Pitch}/\text{resolution} = (0.25/0.0005) = 500$ cycles per turn

Output Frequency = $500 \text{ RPM} \times 500 / 60 = 4167 \text{ Hz}$

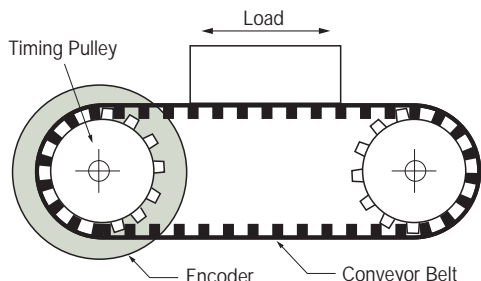
Encoder Specifications

Heavy Duty	H20
Square Flange Mount	D
Pilot (to accept seal)	B
Shaft Diameter	25 (0.25" nominal)
Shaft Seal	SS (protection from oil mist)
Cycles per Turn	500
Channels	ABZC
Note:	Z (generates home pulse with microswitch at end of travel)
Voltage/Output	Operates from 5-28 Volts
Termination	SM18 (10 pin, side exit)

BEI Model Number

H20DB-25-SS-500-ABZC-28V/V-SM18

Belt or Conveyor



Purpose

To determine relative position, direction and speed of travel in a bi-directional conveyor belt

Parameters

Conveyor Speed: 100 feet per minute maximum

Desired Resolution: 0.002 inches

Diameter of Conveyor Belt Drum: 4 inches

Manufacturing Plant: Dust and dirt

100 foot cable run to controller

Programmable controller with high speed counter module requiring 12 volt differential line drivers.

12 V power supply available

Drum speed = $(12 \text{ in/ft}) (100\text{feet/min}) / (\text{PI} \times \text{Diam}) = (12 \times 100) / (\text{PI} \times 4) = 95.5 \text{ RPM}$

Resolution required = $(4 \times \text{PI}) / (0.002) = 6283 \text{ cycles per turn}$

Use the T5 interpolate feature:

$6283/5 = 1256.6 \text{ base resolution, use } 1257$

Output Frequency = $6285 \times 95.5 / 60 = 10,004 \text{ Hz}$

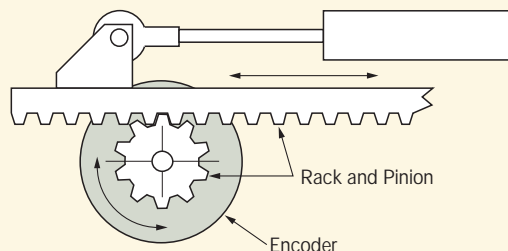
Encoder Specifications

Heavy Duty	H25
Square Flange Mount	D
Shaft Seal	SS
Cycles per Turn	6285-T5
Channels	ABZC
Voltage/Output	Operates from 5-28 Volts
Termination	SM18 (10 pin, side mount)

BEI Model Number

H25D-SS-6285-T5-ABZC-28V/V-SM18

Linear Actuator



Purpose

To encode the position and velocity of a rack and pinion

Parameters

Pinion: 40 Tooth 1/20 pitch = 2 inches per turn

Stroke: 20 inch

Maximum Linear Velocity: 10 inches per second

Desired Resolution: 0.0002 inch

Oil spray environment

10 foot cable length

24 V power supply available

Resolution required = $2 \text{ inches per turn} / 0.0002 \text{ inches} = 10,000 \text{ cycles per turn}$

Use 2500 base cycles per turn with T4 interpolate for 10,000 cycles per turn

Output Frequency = $10,000 \text{ cycles per turn} \times 10 \text{ inches/sec} \times 1 \text{ turn}/2\text{inches} = 50,000 \text{ Hz}$

Encoder Specifications

Heavy Duty	H25
Square Flange Mount	D
Shaft Seal	SS (protection from oil mist)
Cycles per Turn	10,000-T4
Channels	ABZC
Voltage/Output	Operates 5-28 Volts
Termination	SCS120 (side exit with cable seal, 120 inches long—uses shielded/jacketed cable)

BEI Model Number

H25D-SS-10,000-T4-ABZC-28V/V-SCS120

Encoder Quality

Industrial encoders are available for use over a wide range of environmental conditions. A large variety of designs allows the user to customize an encoder to his requirements. This also allows the specifying engineer to select only the options needed without incurring unnecessary additional costs.

There are a number of factors that must be considered to ensure reliable, consistent encoder operation in industrial applications.

In particular, the encoder must have a high degree of mechanical and electrical stability. In order to achieve this stability the encoder must have a solid foundation. The encoder disc, shaft and bearings must be of the highest quality to assure the ultimate accuracy of the device.

The encoder disc interrupts the light as the encoder shaft is rotated, and it is the code pattern etched on the disc which is primarily responsible for the accuracy of the electrical signal generated by the encoder. Should the disc pattern be inaccurate, the resulting signal will reflect that inaccuracy.

BEI has developed some of the most sophisticated and accurate divided circle machines in the world. These machines are capable of accuracies in the sub arc second range. Originally intended for the military and aerospace industries, this quality is automatically incorporated into the industrial products.

The shaft and bearings maintain accurate rotation of the disc and help to eliminate such errors as wobble and eccentricity which would be translated into position errors. The encoder disc must be carefully mounted to avoid eccentricity as the pattern is read. Such eccentricity can cause inaccuracies in the encoder output that will not be apparent to the user during electrical testing but will cause false position information.

In order to eliminate eccentricity errors, BEI has developed electronic centering fixtures capable of centering accuracies up to 40 millionths of an inch.

When selecting an optical encoder for the industrial environment, the following areas may be considered:



Encoders intended for use in harsh or hazardous environments can be subjected to optional tests to ensure they will perform as specified.

Heavy Loads

In applications utilizing gears or drive belts, excessive radial (side) loading on the shaft can shorten bearing life. Encoders should be specified in accordance with the anticipated side loading. Typical maximum loads for industrial encoders are 5, 40, and 100 lbs. Ultra heavy duty encoders are available to withstand heavier loads as well as shocks of up to 200g's.

Corrosive or Washdown

Aluminum encoder housings with a chemical film coating (ex: Iridite or Alodine) finish are sufficient for most applications. However, if the encoder is intended for operation in a corrosive environment, a hard anodize finish with a dichromate seal should be considered. For food or medical grade applications where a washdown may occur, an electroless nickel coating or even stainless steel construction may be required.

Temperature Extremes

The temperature specification of the selected encoder must be consistent with the application. Zero to 70 degrees Celsius is the standard operating temperature on BEI's industrial encoders. Extended temperature testing from as low as -55 and as high as +105 degrees Celsius is available, depending on the model.

Hazardous Environments

Applications in gas and oil production, chemical processing, grain and coal dust, and other hazardous environments may require intrinsically safe or explosion proof encoders. These encoders are approved by recognized certification bodies such as UL, cUL, CSA or DEMKO (for CENELEC/ATEX rating) for turn-key solutions to your hazardous location sensing requirements. For more information see Hazardous Area Usage on page 48.



Industrial environments can really test the integrity of a mechanical design. The encoders shown here have just undergone a leak test in order to ensure that they are properly sealed against wet environments.

Wet or Dirty Environments

If your application requires operation in a liquid or dusty environment, the encoder must be selected accordingly. Adequate sealing is a “must” to ensure against contamination, particularly through the spindle assembly. Contaminants that infiltrate the shaft bearing can rapidly degrade encoder performance. In the encoder interior they can disrupt the optical components or damage the circuit board. A shaft seal is recommended in general, and must be used in applications where liquids are present. If liquid exposure is anticipated, you can specify a leak test.



Precision alignment of sensor arrays is done under high power. Close attention to critical components means robust operation for the finished product.

Electrically Noisy Environments

The increasing use of factory automation systems means industrial environments are rich in electrical signals that can create Electromagnetic Interference (EMI). Some protection can be afforded by shielded cable, especially in conjunction with the use of twisted pair conductors. When this type of cable is used with an encoder, its complements, and a differential line receiver, a significant improvement in noise immunity can be realized.

SPECIAL NOTES

INSTALLATION: Even with the appropriate package, shaft, bearings, and disc, the user must exercise care to avoid undue shock and abuse. In particular, the bearings or code disc can be damaged if the encoder is dropped or a pulley is hammered on the shaft. The typical shock and vibration specification for an industrial encoder is a 50g shock for 11 msec, as well as a vibration of 20g's from 2 to 2000 Hz.

MECHANICAL PROTECTION: To adequately protect optical and electronic components from exposure to the environment, encoder case thickness should be consistent with the severity of expected abuse. In applications where the encoder housing may be struck by tools or debris, a cast housing or protective shroud should be used.

Key Components of Optical Encoders

Shafts

Shafts transmit the rotational movement of the device to be monitored into the encoder either directly (hollow-shaft style encoders) or through a flexible coupling (shafted style of encoders)

Inside Tip: Look for corrosion resistant shafts and a low TIR (Total Indicated Runout), generally 0.001" or less.



Shaft Seals

Without a shaft seal, the bearings and optical path would be subject to contamination due to dust, dirt and moisture in the environment.

Inside Tip: A lubricated rotating lip seal provides the best overall environmental protection over the life of the encoder.



Optics & Electronics

The optics assembly, in conjunction with the electronics, generates a variable amplitude analog signal from the rotation of the code disc and translates it into a digital pulse stream for use by a controller or counter.

Inside Tip: Electronically centered discs are accurate to better than $\pm 1/40$ th of a cycle.



Covers & Connectors



Covers provide mechanical protection for the internal components of the encoder and seal it against dust and moisture intrusion. Connectors carry the signal through the cover of the encoder body while maintaining environmental protection.

Inside Tip: All points of entry, including cover screw holes, should be O-ring sealed for the best environmental protection.



Bearings



Bearings, along with the shaft (or shaft tube in the case of a hollow-shaft style of encoder) combine to provide a stable rotational platform which carries the code disc.

Inside Tip: The most accurate encoders use dual preloaded bearing assemblies.



Environmental & Operational Specifications

The environmental and operational specifications establish the environment under which the manufacturer feels it is prudent to operate the encoder.

Inside Tip: Check bearing and temperature ratings carefully. There is no specification standard in the encoder community for these items. If they are critical to your application, you will want to be sure of what you are getting.



Proper Installation Practices

The mechanical workings of an encoder are straightforward. The rotor portion is coupled to a shaft, so that it will turn without slippage, and the encoder body is prevented from rotating so that it serves as a physical reference for the rotation of the rotor.

Within this framework, certain physical properties associated with mechanical coupling must be observed to ensure a long operating life. The mechanical structure of the encoder shaft, as well as the shaft that is being coupled to are both supported with some form of rotary bearing (typically ball or roller bearings). Mechanical processes are not perfect and no matter how smoothly a rotating shaft may appear to turn, it will wobble when rotated. This small amount of movement is referred to as runout and is usually a few thousandths of an inch (maximum) for most industrial installations. This same principle applies to the encoder shaft as well. And here is where the installer needs to pay special attention.

If you were to hard couple the encoder shaft to a motor shaft and also hard couple the encoder body to the motor casing, the runout of the motor shaft would fight against the smaller, more accurate encoder bearings. This is a perfect "bearing grinding" machine! The motor bearings will "win" this contest and you will be replacing encoders on a regular basis.

The solution, of course, is to ensure that some part of the encoder's mounting assembly is flexible to minimize the stress on the encoder bearings. In the case of a shafted encoder, there is typically a flexible coupling between the encoder shaft and the motor shaft. For hollow shaft encoders, a flexible tether is used between the encoder body and the motor casing, or it may be secured with a block and pin tether. Armed with this knowledge, you are ready to install your encoder.

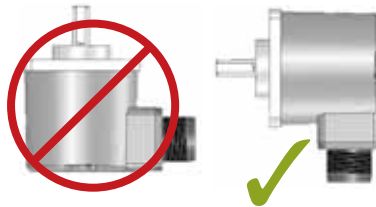
Before You Install an Encoder

First, ensure that you have the correct hardware for your installation and that it all fits properly. Mating parts should line up, bolt thread pitches and lengths should be appropriate, and all the tools should be the correct type and size and should be at hand. Have the manufacturer's installation instructions handy because there may be some critical measurements or pieces of hardware required.

Check that there are no burrs on the mating shaft and that the shaft length is correct for the encoder. Also, if the flexible coupling has setscrews, ensure that the setscrews are backed off so that they don't bind when slipped on the shaft.

Encoder Installation Do's and Don'ts

DON'T install with the shaft upright



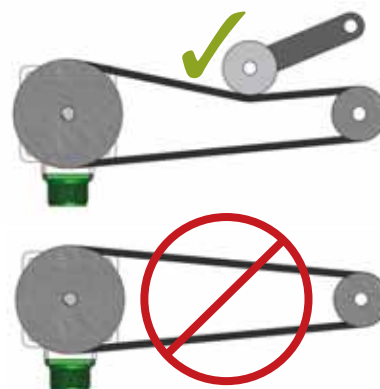
Liquids or dust could pool around the shaft seal. If any liquid is present (dew, process liquids, oil, etc), then the natural breathing process in cooling and heating the encoder may cause it to aspirate contaminants, which could get into the bearings or optics assembly and result in premature failure. Instead, install the encoder with the shaft horizontal or down so contaminants do not accumulate.

DO install with the connector facing downward



This will minimize the cable bend radius and prevent possible cable failure. If you install the connector upright, the weight of the cable may make the bend radius too small, leading to cable failure.

DO use a spring-loaded idler wheel to limit stress on encoder bearings



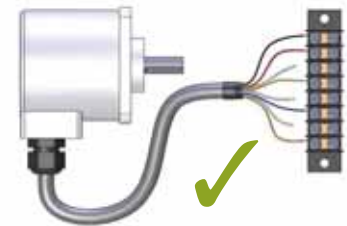
Visit www.beiied.com/installation for step-by-step installation instructions for shafted and hollow shaft encoders.

DON'T hammer a pulley or wheel onto the encoder shaft



This will damage the shaft, bearings or other internal components and will lead to feedback errors, vibration and/or overheating.

DO allow any unused encoder outputs to float electrically, instead of grounding them



If you ground these unused outputs, it will unnecessarily stress encoder drivers.

DON'T install encoders in high-traffic areas or near floor level

They may be subject to damage from traffic such as a forklift vehicle, or may be perceived as a useful step. A cage or shield is recommended to provide proper protection if the physical location cannot be changed.

DO use flexible couplings to minimize stress on encoder bearings



If you hard couple an encoder to a motor shaft, it will put stress on the bearings and may lead to bearing failure. (See proper installation practices at left)

Is there a difference between encoder accuracy and encoder resolution?

Resolution refers to the number of bits or words contained in the complete code. For incremental encoders, resolution is defined as cycles per revolution. For absolute single turn encoders, it is called counts per turn.

Accuracy is the difference between the actual position and the theoretical “perfect” position of each bit edge. The base accuracy of an encoder is traceable to the encoding disc and the mounting technique of that disc on its spindle. Accuracy is different from and is not directly related to resolution. It is possible to have a high-resolution encoder that is very inaccurate. Shaft and bearings are also responsible for the accurate rotation of the disc. Poor quality discs, shafts, bearings or the method of building the encoder can all contribute to an inaccurate encoder, regardless of its resolution.

What is the difference between single-ended and differential encoder signals?

Single-ended signals do not contain the signal complements or wires for those complements, which can mean a cheaper, simpler installation. However, single-ended configurations rely on a fixed reference and are therefore more susceptible to electrical noise interference. Environmental noise can cause the single-ended signal to jump above or below the reference. The controller cannot tell the difference between this type of signal change and the true encoder signal, resulting in possible feedback errors. Single-ended signals are best used in short runs in relatively low noise environments with a stable reference. Differential signals supply the signal complements, which means one additional wire per data channel. The benefit of this approach is that differential signals have superior noise immunity over single-ended since they do not rely on a fixed reference. This also gives them better performance in low voltage situations. Differential is the better choice for an electrically noisy environment and long cable runs of around 25 feet or more. A single-ended encoder can be converted to differential drive type with use of an optical isolator (page 59).

What are the different types of encoder outputs?

Incremental encoders generally use quadrature output, where two incremental data channels are deliberately out of phase by 90 electrical degrees. The relationship between the two channels is set within the encoder. A typical quadrature relationship would be described as: A leads B for counterclockwise (CCW) rotation of the input shaft. Quadrature allows

for discrimination between direction of movement (CW versus CCW), error detection in high vibration environments and higher resolution by using edge detection.

Absolute encoders generally use either Parallel or Serial Synchronous Interface (SSI) output. Parallel output uses a separate data line for every bit of the data word. SSI sends encoder position data on one pair of conductors instead of one conductor per bit. Parallel and SSI outputs typically use either Natural Binary Code or Gray Code format. Natural binary code counts up using the natural sequence of binary counting (000, 001, 010, 011, etc). Gray code uses binary counting as well, but only one bit can transition at a time. This eliminates the problem of multiple simultaneous transitions found in tradition binary counting. See pages 46–47 for more information on absolute encoder options.

My encoder is in an electrically noisy environment and my controller is receiving feedback errors from it. How can I minimize the effects this noise?

First, make sure the encoder cable you are using is a low capacitance, twisted pair cable with an overall shield. Also, make sure you route the encoder cable away from motor leads—a common and prevalent noise source. If you are using a single-ended encoder, try to limit the cable run to 25 feet or less. An encoder with a differential signal would be the best choice in this application, as it has superior noise immunity over single-ended encoders.

I don't use encoders very often. Can I get some guidance in designing my encoder mechanical and electrical interface?

Yes, you can always call us and ask for application assistance. We can evaluate your requirements and recommend the appropriate products for your application. You can also send us your input schematics and we will review them. If you are looking for general information on encoders, the first part of this catalog is an Encoder Specifying and Design Guide. It provides an overview of encoders, their applications and environments.

You can also request a copy of *BEI Industrial Encoders for Dummies* at www.beiied.com/dummies. This guide provides a comprehensive review of industrial encoders including how they work, how to choose the right one for your application, what makes a high quality encoder and how to assess environmental and electrical concerns before they become an issue in your system.

Throughout the catalog, you refer to “see Note x” but I cannot seem to locate them. Where are the notes located?

All notes are located in the back of the catalog on page 64.

What is the difference between BEI part numbers and model numbers?

Part numbers have a numerical format of 924-xxxx-xxxx and identify the exact electrical, mechanical and environmental configurations of the encoder. A part number is assigned for every new encoder configuration and that part number is now permanently associated with that exact encoder. It becomes a shorthand way to refer to a specific configuration and allows us to search quickly for a specific part when providing applications assistance, or when ordering.

Model numbers are a general description of the encoder and indicate the type of product and its broad mechanical and electrical configurations. An example of the H25 model number would be H25D-SS-1000-ABZC-28V/V-SM18. Many BEI encoders are ordered with a -S at the end of the model number, which indicates a special feature. When a model number has a -S, then the part number is needed to find out the exact special features. There can be many different part numbers that have the same model number with a -S designation. When contacting BEI for tech support or reorders, it is best to reference the encoder's part number.

Do you repair encoders?

Yes, we repair what we build. If something goes wrong with your BEI encoder, give us a call and we can help determine if it needs to be sent in for repair. If the encoder does need repair, our in-house repair facility will ensure it is brought up to its original performance standards. See page 4 for further repair information.

I have a non-BEI encoder and the manufacturer has gone out of business. Can I get a replacement from BEI?

Yes. For over 30 years, we have maintained a thorough library of encoder specification information covering a wide range of encoders from other manufacturers, both foreign and domestic. Just give us a call at 800-ENCODER and we will help you find the right replacement encoder. Our web site also lists some of the more common manufacturers and models we crossover at www.beiied.com/crossover.

H25 Incremental Optical Encoder

Mechanical Specifications

Shaft Diameter: 3/8" (1/2" as special feature)

Flat On Shaft: 3/8" Shaft: 0.80 long X 0.03" deep;
1/2" Shaft: 0.80 long X 0.04" deep

Shaft Loading: 3/8" shaft: Up to 40 pounds axial and 35 pounds radial;
1/2" shaft: Up to 90 pounds axial and 80 pounds radial

Shaft Runout: 0.0005 T.I.R. at midpoint regardless of shaft diameter

Starting Torque at 25°C: Without shaft seal 1.0 in-oz (max);
With shaft seal 2.5 in-oz (max); 1/2" shaft with shaft seal:
3.5 in-oz (max)

Bearings: Class ABEC 7 standard, ABEC 5 for 1/2" shaft

Shaft Material: 416 stainless steel

Bearing Housing: Die cast aluminum with protective finish;
stainless steel (special feature)

Cover: Die cast aluminum; stainless steel (special feature)

Bearing Life: 2 X 10⁸ revs (1300 hrs at 2500 RPM)
at rated load 1 X 10¹⁰ revs (67,000 hrs at 2500 RPM) at
10% of rated load

Maximum RPM: 12,000 RPM nominal, 8000 RPM with
1/2" shaft (see Frequency Response, below) 30,000 RPM
available on units with 3/8" shaft—consult with factory

Moment of Inertia: 4.1 X 10⁻⁴ oz-in-sec²; 5.2 X 10⁻⁴
oz-in-sec² with 1/2" shaft

Weight: 13 oz typical, 14.5 oz typical with 1/2" shaft

Electrical Specifications

Code: Incremental

Output Format: 2 channels in quadrature, 1/2 cycle index
gated with negative B channel

Cycles Per Shaft Turn: 1 to 72,000 (see table 2) For resolu-
tions above 3,600 see interpolation options on pages 36 and 37

Supply Voltage: 5 to 28 VDC available

Current Requirements: 100 mA typical + output load, 250 mA (max)

Voltage/Output: (see note 5)

15V/V: Line Driver, 5–15 VDC in, V_{out} = V_{in}

28V/V: Line Driver, 5–28 VDC in, V_{out} = V_{in}

28V/5: Line Driver, 5–28 VDC in, V_{out} = 5 VDC

28V/OC: Open Collector, 5–28 VDC in, OC_{out}

Protection Level: Reverse, overvoltage and output short circuit
(see note 5)

Frequency Response: 100 kHz, up to 1MHz with interpolation
option (see note 7)

Output Terminations: (See table 1, page 65)

Note: Consult factory for other electrical options

Environmental Specifications

Enclosure Rating: NEMA 4 & 13 (IP 66) when ordered with
shaft seal (on units with an MS connector) or a cable gland
(on units with cable termination).

Temperature: Operating, 0° to 70° C; extended temperature
testing available (see note 8); Storage, -25° to 90° C unless
extended temperature option called out.

Shock: 50 g's for 11 msec duration

Vibration: 5 to 2000 Hz @ 20 g's

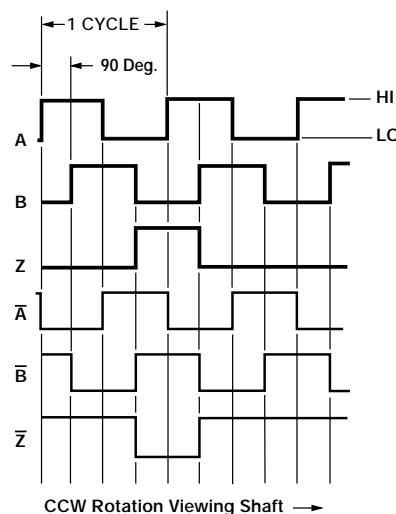
Humidity: 98% RH without condensation

NOTES & TABLES: All notes and tables referred to in the text can
be found on pages 64–65.



The H25 is the flagship of the BEI Industrial Encoders product line. It was designed from the ground up for the industrial marketplace. The H25 offers features such as EMI shielding, 40 lb. ABEC 7 bearings, matched thermal coefficients on critical components, and custom high-efficiency optics. The encoder meets NEMA 4 and 13 requirements when ordered with the shaft seal. Typical applications include machine control, process control, the wood processing industry, oil well logging, industrial weighing, agricultural machinery, textile equipment, web process control, robotics, and food processing.

Figure 1 Output Waveform



Certifications

The H25 Incremental Encoder is available with the following certifications:



EN 55011 and EN 61000-6-2



CENELEC EEX ia IIC T4



U.S. Standards Class I, Group A,B,C & D;
Class II Group E,F & G



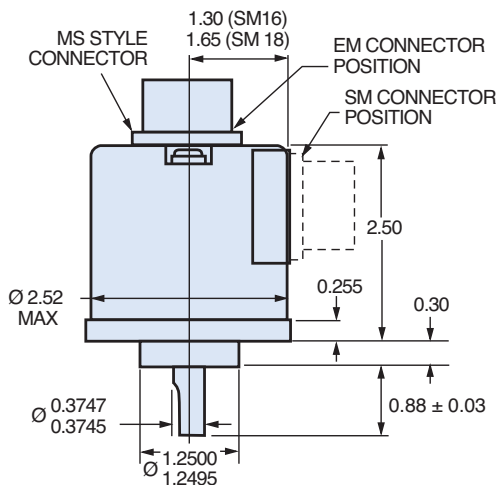
Canadian Standards
Class I, Zone 0, Group IIC



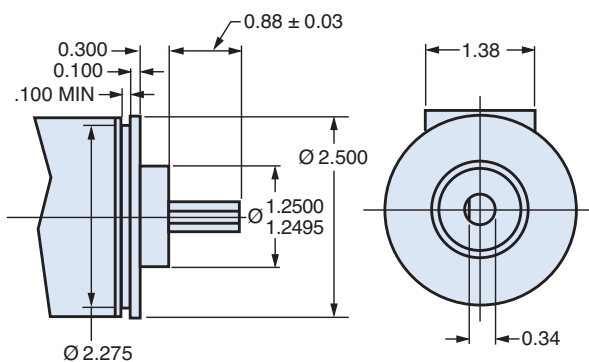
CSA Class I, Div 1 Group C&D

See Regulatory Information on page 48
for further certification details.

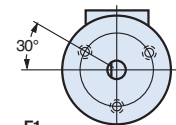
H25D - Square Flange



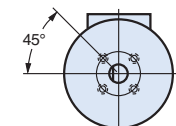
H25E - 2.50 Servo Mount



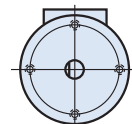
Optional Face Mounts



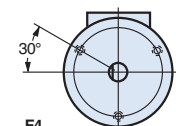
F1
10-32 UNF-2B
0.188 Min. Deep
3 places equally spaced
on a Ø 1.875 bolt circle.



F2 (H25G Only)
4-40 UNC-2B
0.250 Min. Deep
4 places equally spaced
on a Ø 1.272 bolt circle.
(0.900 square, Ref.)

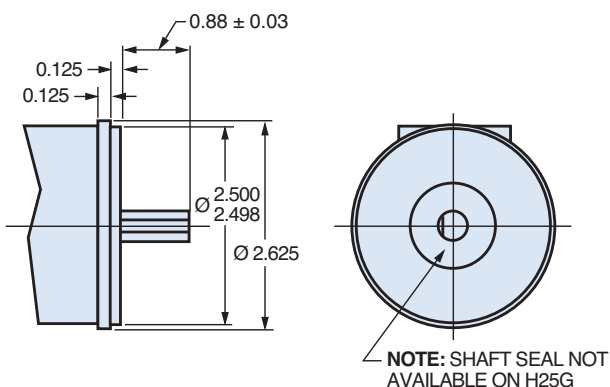


F3
4-40 UNC-2B
0.250 Min. Deep
4 places equally spaced
on a Ø 2.00 bolt circle.



F4
6-32 UNC-2B
0.250 Min. Deep
3 places equally spaced
on a Ø 2.00 bolt circle.

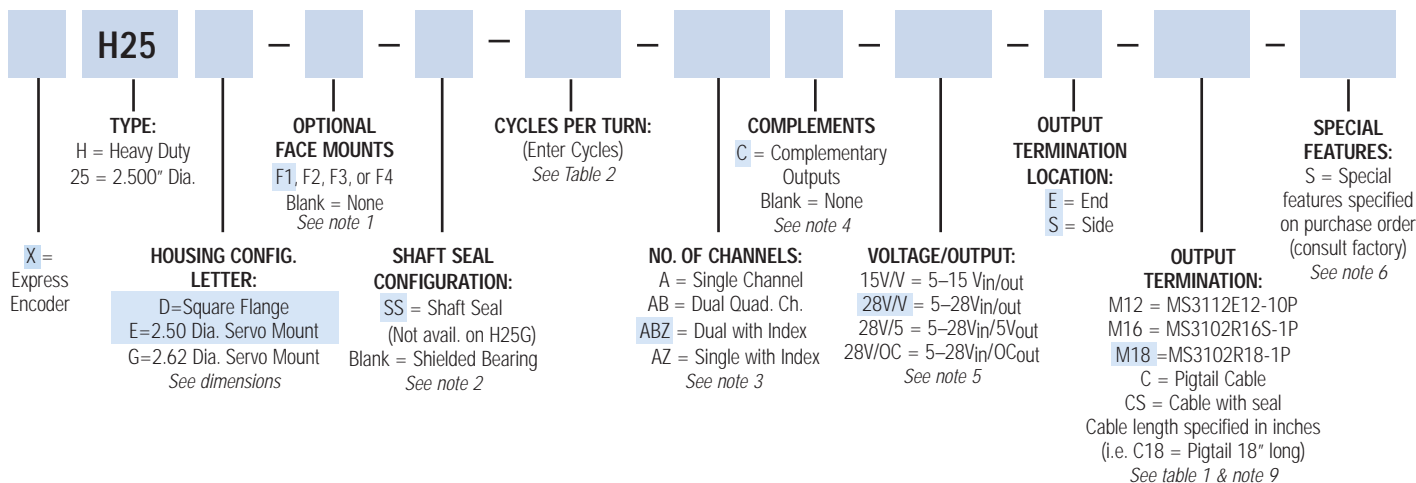
H25G - 2.62 Dia Servo Mount



H25 Incremental Ordering Options for assistance call 800-350-2727

Use this diagram, working from left to right to construct your model number (example: H25D-SS-2000-ABZC-28V/V-SM18).

All notes and tables referred to can be found on pages 64–65.



EXPRESS ENCODERS® Items highlighted with are standard Express Encoders and ship in one to three days.

T2 and T5 options are available as standard H25 Express Encoders. See page 36–37.

H20 Incremental Optical Encoder

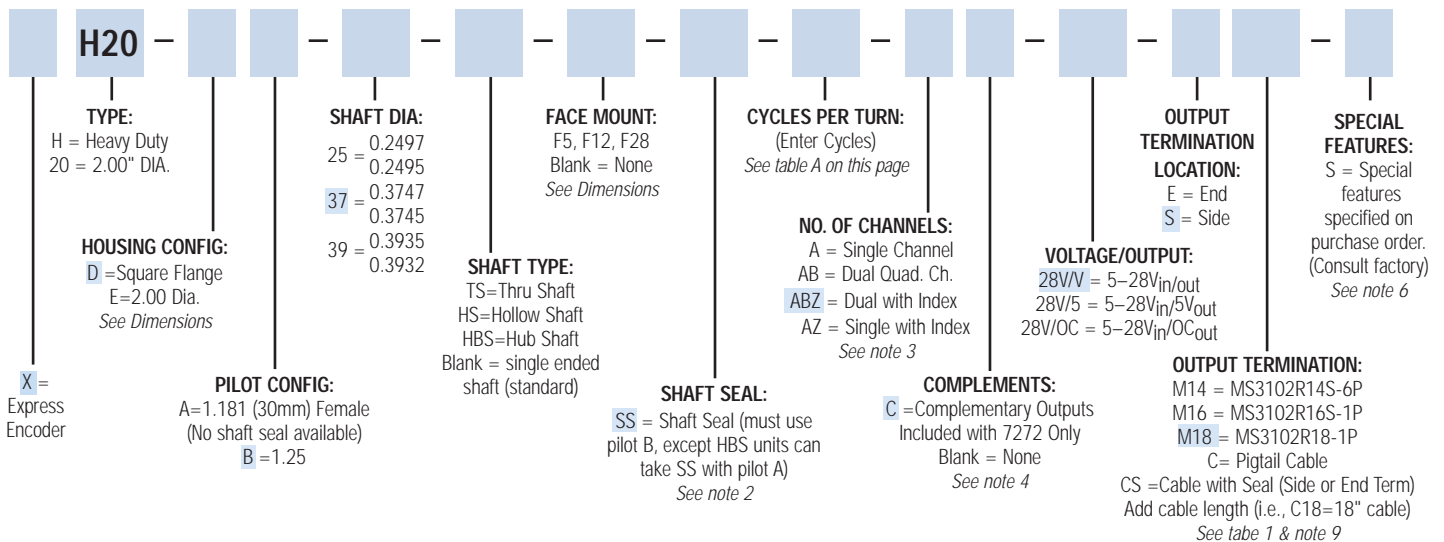


The H20 is an extremely rugged encoder designed to economically fill the resolution range up to 4096 cycles per turn. This compact unit features a shock resistant disc, heavy duty bearings, and EMI shielding. The H20 conforms to NEMA 4 and 13 requirements. The H20 is also available in a hub shaft style with a flexmount (inset) for easy mounting directly to small motors. Typical applications of the H20 include machine control, process control, agricultural machinery, textile equipment, robotics, food processing, and mete



H20 Incremental Ordering Options FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: H20DB-37-SS-500-ABZC-28V/V-SM18). All notes and tables referred to can be found on pages 64–65.



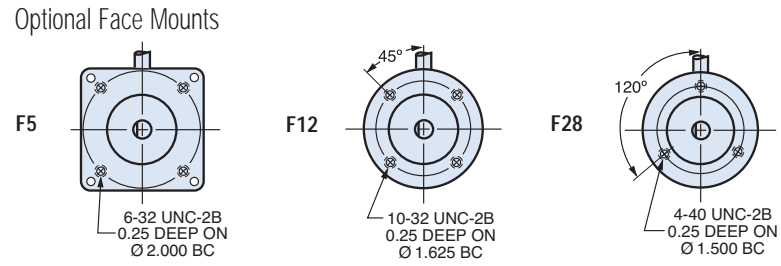
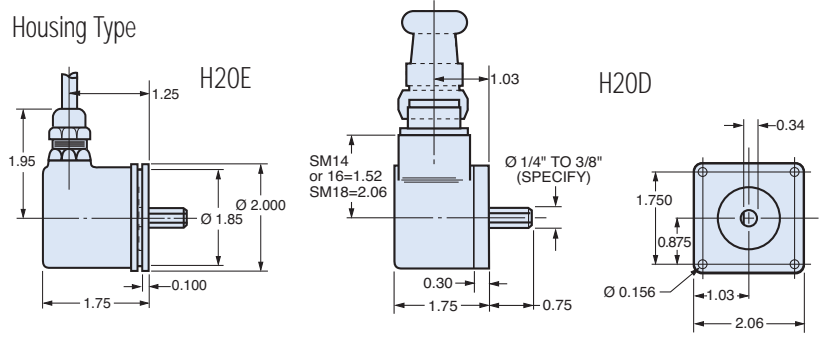
EXPRESS ENCODERS® Items highlighted with are standard Express Encoders and ship in one to three days.

T2 option is available as a standard H20 Express Encoder. See page 36–37.

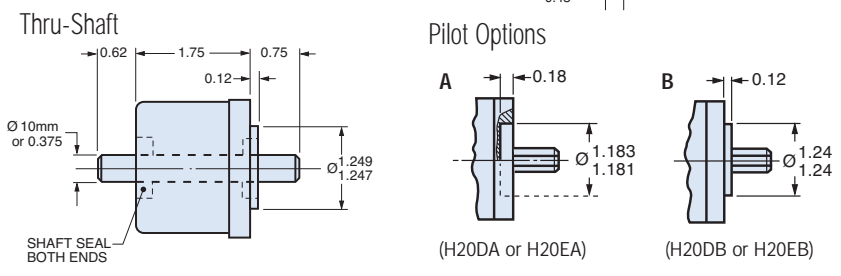
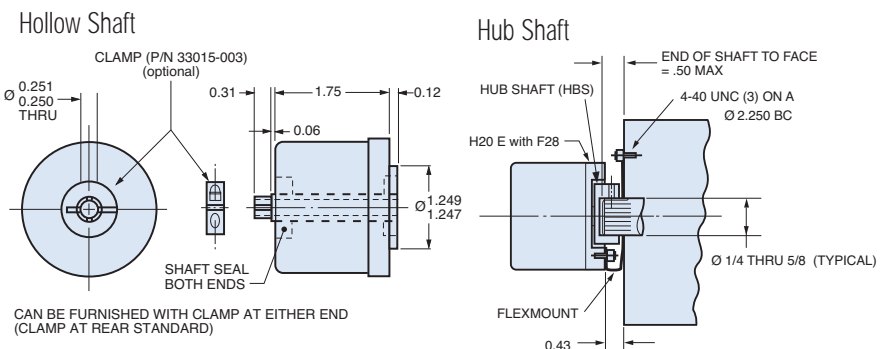
Table A H20 Disc Resolutions

1*	2	3	5	6	8	10	11	12	24	25	30	32	40	50	60	64	70	75	80	100	105	112	115	120	125	150	192	200	240	250
256	300	336	360	400	410	500	510	512	600	720	785	1000	1024	Resolutions Shown in RED are not available as Express Encoders																

*No index. For interpolation please specify the multiplied output (up to 4,096 for H20) in the model number, i.e. 4,096-T4.



Special Shaft Options



Mechanical Specifications

Shaft Diameter: 1/4" thru 3/8" and metric versions. Hollow shaft, hub shaft or thru-shaft versions available.

Flat On Shaft: 0.75 x 0.03 deep

Shaft Loading: up to 40 lbs. axial and 40 lbs. radial

Shaft Runout: .001 T.I.R. maximum

Starting Torque at 25°C: 1.0 in-oz maximum without shaft seal; 2.5 in-oz maximum with shaft seal; 4.0 in-oz thru-shaft

Bearings: 52100 bearing steel

Shaft material: 303 stainless steel

Bearing Housing: Die cast aluminum with iridite finish; stainless steel (special feature)

Cover: Die cast aluminum with protective finish (For MS or CS terminations), otherwise drawn aluminum with protective finish; stainless steel (special feature)

Bearing Life: 1.5 X 10⁹ revs at rated load (10,000 hrs at 2500 RPM)

Maximum RPM: 8,000 (see Frequency Response)

Moment of Inertia: 2.0 x 10⁻⁴ oz-in-sec²

Weight: 9 oz. typical

Electrical Specifications

Code: Incremental

Output Format: 2 channels in quadrature, 1/2 cycle index gated with negative B channel as standard. Ungated index when 3904 is specified as the output device

Cycles per Shaft Turn: 1 to 4096 (see table A page 20) For resolutions above 1024 see interpolation options on pages 36 and 37

Supply Voltage: 5 to 28 VDC available

Current Requirements: 100 mA typical + output load, 250 mA (max)

Voltage/Output: (see note 5)
 28V/V: Line Driver, 5–28 VDC in, V_{out} = Vin
 28V/5: Line Driver, 5–28 VDC in, V_{out} = 5 VDC
 28V/OC: Open Collector, 5–28 VDC in, OC_{out}

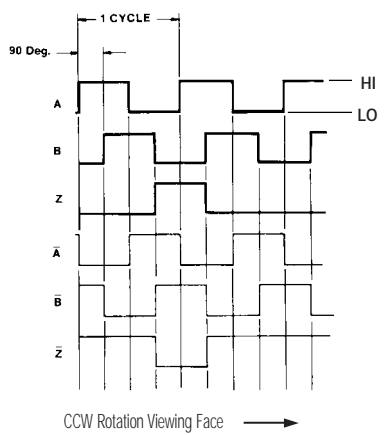
Protection Level: reverse, overvoltage and output short circuit (see note 5)

Frequency Response: 100 KHz (up to 1024 cpt; 400 KHz with interpolation option (see note 7)

Output Terminations: See Table 1, page 65

Note: Consult factory for other electrical options

Figure 1 Output Waveform



Certifications

The H20 Incremental Encoder is available with the following certifications:

EN 55011 and EN 61000-6-2

CSA Class I, Div 1 Group A, B, C, & D (3904, 3904R only)

See Regulatory Information on page 48 for further certification details.

Environmental Specifications

Enclosure Rating: NEMA 4 & 13 (IP66) when ordered with shaft seal (on units with an MS connector) and a cable gland (on units with cable termination)

Temperature: Operating, 0° to 70°C; extended temperature testing available (see note 8); Storage, -25° to 90°C unless extended temperature option called out

Shock: 50 g's for 11 msec duration

Vibration: 5 to 2000 Hz @ 20 g's

Humidity: 98% RH without condensation

NOTES & TABLES: All notes and tables referred to in the text can be found on pages 64 and 65.

HS25 Incremental Optical Encoder

Mechanical Specifications

Shaft Bore: 0.375", 0.750", 0.625", 0.500", dia. 0.625" and under are supplied with insulating sleeves.

Allowable Misalignment: 0.005: T.I.R. on mating shaft 0.75" from shaft end

Bore Runout: 0.001" T.I.R.

Starting Torque at 25° C: Through shaft version (SS) = 7 in-oz (max); Blind shaft version (BS) = 4 in-oz (max)

Bearings: 52100 SAE high carbon steel

Shaft Material: 6061-T6 aluminum alloy

Bearing Housing: Die cast aluminum with protective finish

Cover: Die cast aluminum with protective finish

Bearing Life: 7.5×10^9 revs (25,000 hrs at 2500 RPM)

Maximum RPM: 6,000 RPM

(see Frequency Response, below)

Moment of Inertia: 17×10^{-4} oz-in-sec²

Weight: 9 oz typical

Electrical Specifications

Code: Incremental

Output Format: 2 channels in quadrature, 1/2 cycle index gated with negative B channel

Cycles per Shaft Turn: up to 2048 (see table A, this page)

Supply Voltage: 5 to 28 VDC available (see note 5)

Current Requirements: 100 mA typical + output load, 250 mA (max)

Voltage/Output: (see note 5)

15V/V: Line Driver, 5–15 VDC in, $V_{out} = V_{in}$

28V/V: Line Driver, 5–28 VDC in, $V_{out} = V_{in}$

28V/5: Line Driver, 5–28 VDC in, $V_{out} = 5$ VDC

28V/OC: Open Collector, 5–28 VDC in, OCout

Protection Level: Reverse, overvoltage and output short circuit

Frequency Response: 100 kHz (see note 7)

Output Terminations: (see table 1, page 65)

Note: Consult factory for other electrical options

Environmental Specifications

Enclosure rating: NEMA 4 & 13 (IP65) when ordered with shaft seal and a cable gland.

Temperature: Operating, 0° to 70°C; extended temperature testing up to 85°C available (see note 8); Storage, -25° to 90° C unless extended temperature option called out

Shock: 50 g's for 11 msec duration

Vibration: 5 to 2000 Hz @ 20 g's

Humidity: 98% RH non-condensing

NOTES & TABLES: All notes and tables referred to in the text can be found on pages 64 and 65.

Table A HS25 Disc Resolutions

10	12	60	88	100	250	360	500
512	1000	1024	2000	2048			

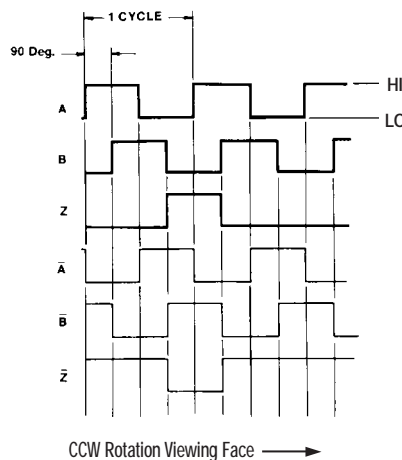
Other resolutions available—consult factory.



The HS25 combines the rugged, heavy-duty features usually associated with shafted encoders into a hollow-shaft style. Its design includes dual bearings and shaft seals for NEMA 4, 13 and IP65 environmental ratings, a rugged metal housing, and a cable gland.

This low-profile design, just 2" deep, is easily mounted on a through shaft. Securing the encoder to the shaft is simple with a collet-style single screw clamp. The optional anti-rotation tether block maintains housing stability during operation. The HS25 is designed to accommodate shafts up to 3/4" in diameter. With optional insulating inserts, it can be mounted on smaller diameter shafts. Applications include motor feedback and vector control, paper converting and printing industries, robotic control, web process control along with many other applications.

Figure 1 Output Waveform



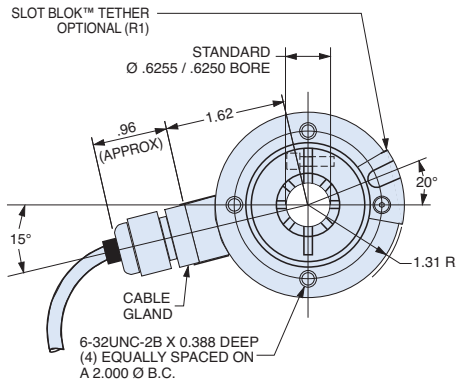
Certifications

The HS25 Incremental Encoder is available with the following certifications:

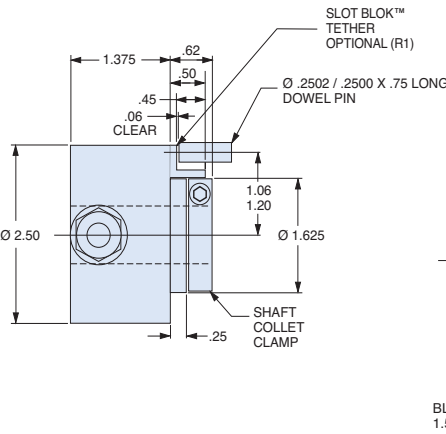
-  EN 55011 and EN 61000-6-2
-  CENELEC EEX ia IIC T4
-  U.S. Standards Class I, Group A, B, C & D; Class II Group E, F & G
-  Canadian Standards Class I, Zone 0, Group IIC

See Regulatory Information on page 48 for further certification details.

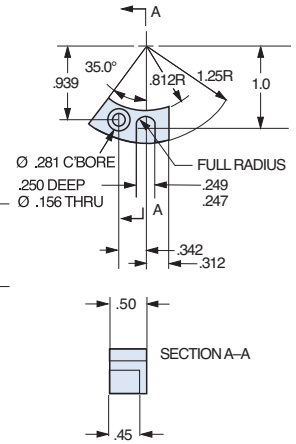
Thru Shaft Version



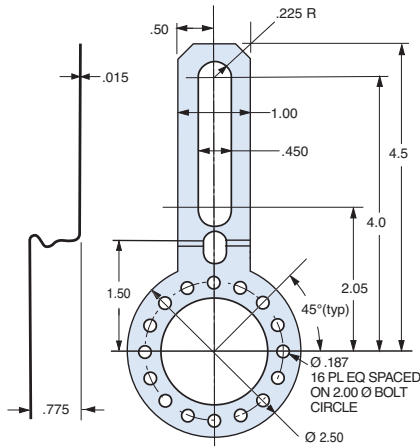
Blind Shaft Version



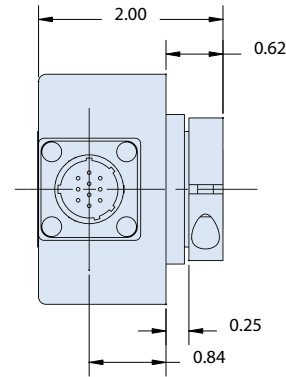
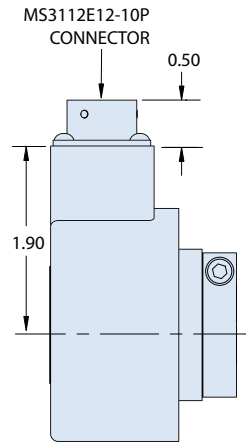
R1 Tether Block and Pin



R2 Tether Arm



M12



TOLERANCES:
 .XX=±0.01, .XXX=±0.005

HS25 Incremental Ordering Options

FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: HS25F-62-R1-SS-1024-ABZC-28V/V-SCS18). All notes and tables referred to can be found on pages 64–65.

HS25										
TYPE: HS = Hollow Shaft 25 = 2.5" Encoder Diameter	SHAFT BORE: 75 = 0.750" 62 = 0.625" 50 = 0.50" 37 = 0.375"	SHAFT SEAL CONFIGURATION: SS = Dual Shaft Seals BS = Blind Shaft <i>See note 2</i>	NO. OF CHANNELS: A = Single Channel AB = Dual Quad. Ch. ABZ = Dual with Index AZ = Single with Index <i>See note 3</i>	VOLTAGE/OUTPUT: 15V/V = 5–15 V _{in} /out 28V/V = 5–28V _{in} /out 28V/5 = 5–28V _{in} /5V _{out} 28V/OC = 5–28V _{in} /OC _{out} <i>See note 5</i>	SPECIAL FEATURES: S = Special features specified on purchase order (consult factory) <i>See note 6</i>	HOUSING CONFIG: F = Standard	TETHER: Blank = None R1 = Tether Block and Pin R2 = Tether Arm	CYCLES PER TURN: (Enter Cycles) <i>See table A, previous page</i>	COMPLEMENTS: C = Complementary Outputs <i>See note 4</i>	OUTPUT TERMINATION: M12 = MS3112E12-10P SCS = Shielded, Jacketed Cable with Cable gland seal and cable length in inches, (i.e. SCS18 = 18 inches) SCS18-M18 = SM18 connector on end of cable with length specified in inches (i.e. SCS18-M18) M18 = MS3101F18-1P <i>See table 1 and note 9</i>

EXPRESS ENCODERS® Items highlighted with are standard Express Encoders and ship in one to three days.

HS35 Incremental Optical Encoder

Mechanical Specifications

Shaft Bore: 1.00", 0.875", 0.750", 0.625", 0.500".

All are supplied with insulating sleeves.

Allowable Misalignment: 0.005" T.I.R. on mating shaft 0.75" from shaft end

Bore Runout: 0.001" T.I.R maximum

Starting Torque at 25°C: Through shaft version (SS) = 7 in-oz (max); Blind shaft version (BS) = 4 in-oz (max)

Bearings: 52100 SAE High carbon steel

Shaft Material: 416 stainless steel

Bearing Housing: Die cast aluminum with protective finish

Cover: Die cast aluminum with protective finish

Bearing Life: 7.5×10^9 revs (50,000 hrs at 2500 RPM)

Maximum RPM: 6,000 RPM (see Frequency Response below)

Moment of Inertia: 0.019 oz-in-sec²

Weight: 18 oz typical

Electrical Specifications

Code: Incremental

Output Format: 2 channels in quadrature, 1/2 cycle index gated with negative B channel

Cycles Per Shaft Turn: 1 to 80,000 (see table A, page 25). For resolutions above 5000 see interpolation options on pages 36 and 37

Supply Voltage: 5 to 28 VDC available (see note 5)

Current Requirements: 100 mA typical + output load, 250 mA (max)

Voltage/Output: (see note 5)

15V/V: Line Driver, 5–15 VDC in, $V_{out} = V_{in}$

28V/V: Line Driver, 5–28 VDC in, $V_{out} = V_{in}$

28V/5: Line Driver, 5–28 VDC in, $V_{out} = 5$ VDC

28V/OC: Open Collector, 5–28 VDC in, OC_{out}

Protection Level: Reverse, overvoltage and output short circuit (See note 5)

Frequency Response: 150 kHz (up to 5000 cpt resolution; 300 KHz above 5000 cpt, also see note 7)

Output Terminations: See table 1 page 65

Note: Consult factory for other electrical options

Environmental Specifications

Enclosure Rating: NEMA 4 & 13 (IP65) when ordered with shaft seal (on units with an MS connector) or a cable gland (on units with cable termination)

Temperature: Operating, 0° to 70° C; extended temperature testing up to 105° C available (see note 8); Storage, -25° to 90° C unless extended temperature option called out

Shock: 50 g's for 11 msec duration

Vibration: 5 to 2000 Hz @ 20 g's

Humidity: 98% RH without condensation

NOTES & TABLES: All notes and tables referred to in the text can be found on pages 64 and 65.

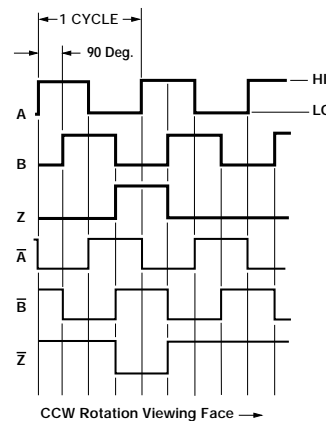


The HS35 combines the rugged, heavy-duty features usually associated with shafted encoders into a hollow shaft style. Its design includes dual bearings and shaft seals for NEMA 4, 13 and IP65 environmental ratings, a rugged metal housing, and a sealed connector or cable gland. The HS35 accommodates shafts up to 1" in diameter. With optional insulating inserts, it can be mounted on smaller diameter shafts. It can be mounted on a through shaft or a blind shaft with a closed cover to maintain its environmental rating. The HS35 is also available with a dual output option (inset) to provide redundant encoder signals, dual resolutions, or to supply two separate controllers from a single encoder. Applications include motor feedback and vector control, printing industries, robotic control, oil service industries, and web process control.



The HS35 Dual Output Encoder





Figure 1 Output Waveform



NOTE: Index location is displaced 180° (mechanical) on second output with dual output option.

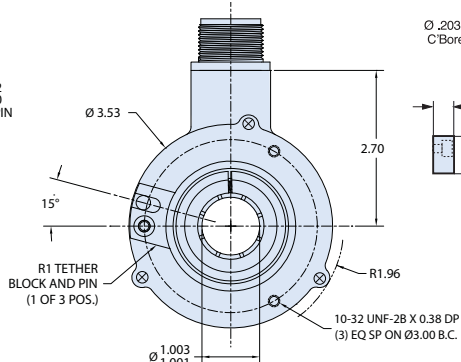
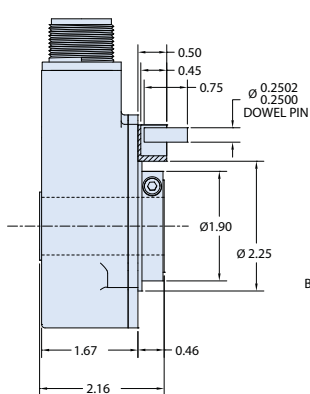
Certifications

The HS35 Incremental Encoder is available with the following certifications:

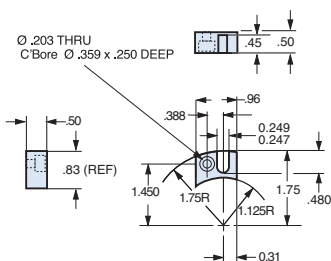
-  EN 55011 and EN 61000-6-2
-  CENELEC EEX ia IIC T4
-  U.S. Standards Class I, Group A,B,C & D; Class II Group E,F & G
-  Canadian Standards Class I, Zone 0, Group IIC

See Regulatory Information on page 48 for further certification details.

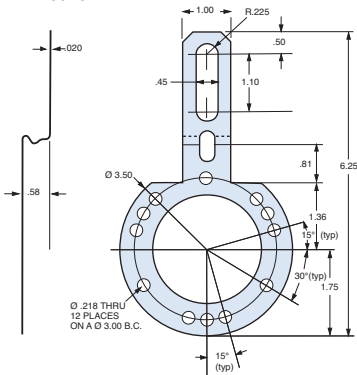
MS Connector Termination



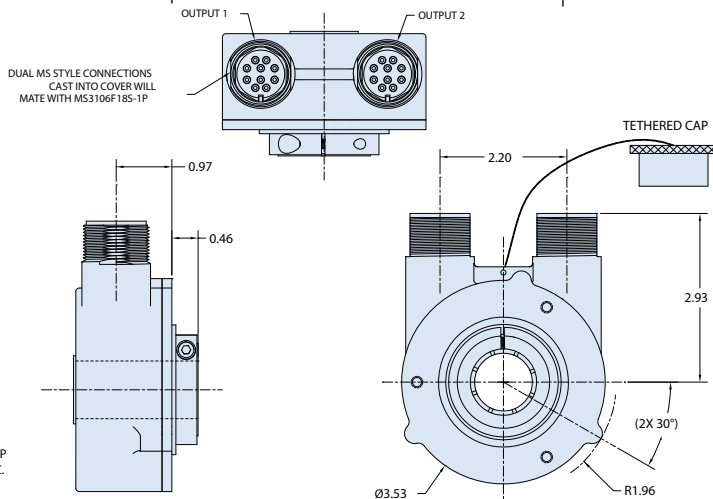
R1 Tether Block and Pin



R2 Tether Arm



Dual Output



Cable Termination

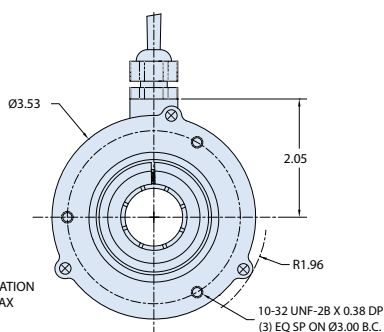
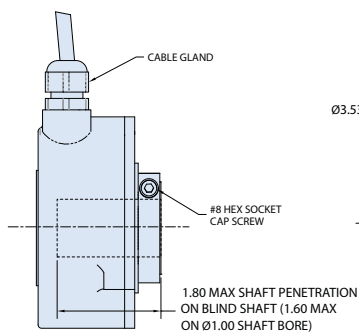


Table A HS35 Disc Resolutions

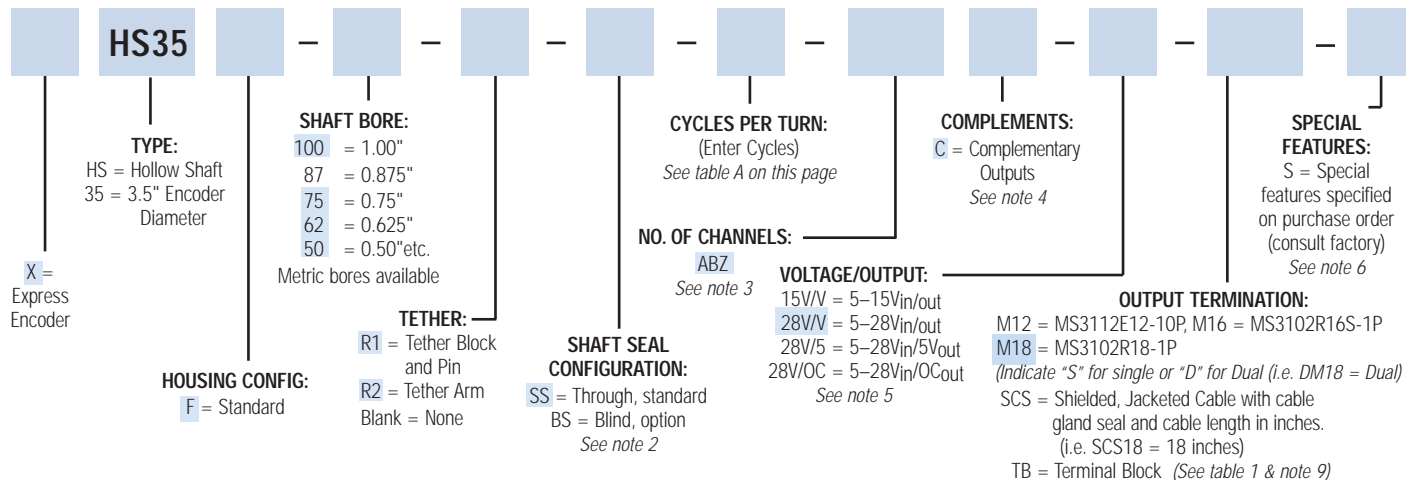
32 100 250 360 420 500 512 600 720 1000 1024 1200 1500 1650 1800 2000 2100 2048 2500 2881 2884 3600 3710 4096 5000

For interpolation please specify the multiplied output (up to 80,000 for the HS35) in the model number, i.e. 80,000-T16. Other resolutions available—consult factory.

NOTE: Dual resolutions available, consult factory.

HS35 Incremental Ordering Options FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: HS35F-100- R1-SS-2048-ABZC-28V/V-SM18). All notes and tables referred to can be found on pages 64–65.



EXPRESS ENCODERS® Items highlighted with are standard Express Encoders and ship in one to three days.

T2 option is available as a standard HS35 Express Encoder. See page 36–37.

HS45 Incremental Optical Encoder

Mechanical Specifications

Shaft Bore: 1.750" max

Allowable Misalignment: Axial: ± 0.030 (with R2), ± 0.050 (with R1), Radial: 0.005 T.I.R.

Bore Runout: 0.002" T.I.R.

Running Torque at 25° C: Dual seals (SS) = 30 in-oz (max); Single seal (BS) = 18 in-oz (max)

Bearings: 52100 dual preloaded bearings

Shaft Material: Stainless Steel

Bearing Housing: Die cast aluminum with protective finish

Cover: Die cast aluminum with protective finish

Bearing Life: 5×10^{12} revs

Maximum RPM: 5,000 RPM
(see Frequency Response, below)

Moment of Inertia: 0.063 oz-in-sec² max

Weight: Approximately 2.3 lbs single output, 2.6 lbs dual output

Electrical Specifications

Code: Incremental

Output Format: Incremental output format, 2 channels with complements, in quadrature, 1/2 cycle index gated with negative B channel

Cycles per Shaft Turn: Up to 8192

Supply Voltage: 5–28 VDC ($\pm 5\%$)

Current Requirements: 100 mA (typical) per side + output load, 250 mA (max)

Voltage/Output: (see note 5)

28V/V: Line Driver, 5–28 VDC in, $V_{out} = V_{in}$

28V/5: Line Driver, 5–28 VDC in, $V_{out} = 5$ VDC

28V/OC: Open Collector, 5–28 VDC in, OC_{out}

Protection Level: Reverse, overvoltage and output short circuit (see note 5)

Frequency Response: 150kHz

Output Terminations: see Table 1

Environmental Specifications

Enclosure Rating: IP65 (NEMA 4 & 13)

Temperature: Operating 0° to 70°C standard, -40° to 85° C optional, storage -40 to 90° C

Shock: 50 g's for 11 msec

Vibration: 10–2000 Hz @ 20 g's

Humidity: 98% RH non-condensing

NOTES & TABLES: All notes and tables referred to in the text can be found on pages 64 and 65.



The HS45 is a large bore, heavy duty, rugged encoder designed to operate in very demanding environments. It is available in both single

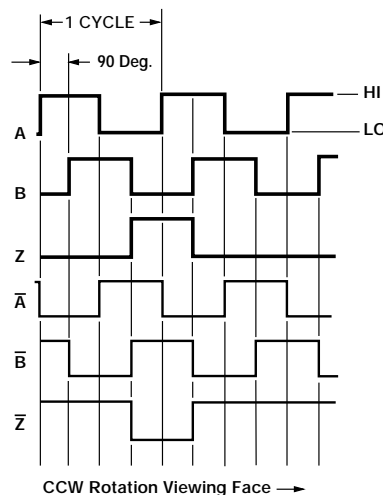
and dual output versions as shown above. These encoders use a preloaded bearing set for mechanical stability and a long service life.

The dual output version has redundant electronics internal to the encoder simplifying signal distribution to multiple controllers.



The HS45 Dual Output Encoder


Figure 1 Output Waveform



NOTE: Index location is displaced 180° (mechanical) on 2nd output with dual output option

Certifications

The HS45 Incremental Encoder is available with the following certifications:

 EN 55011 and EN 61000-6-2

 CENELEC EEX ia IIC T4

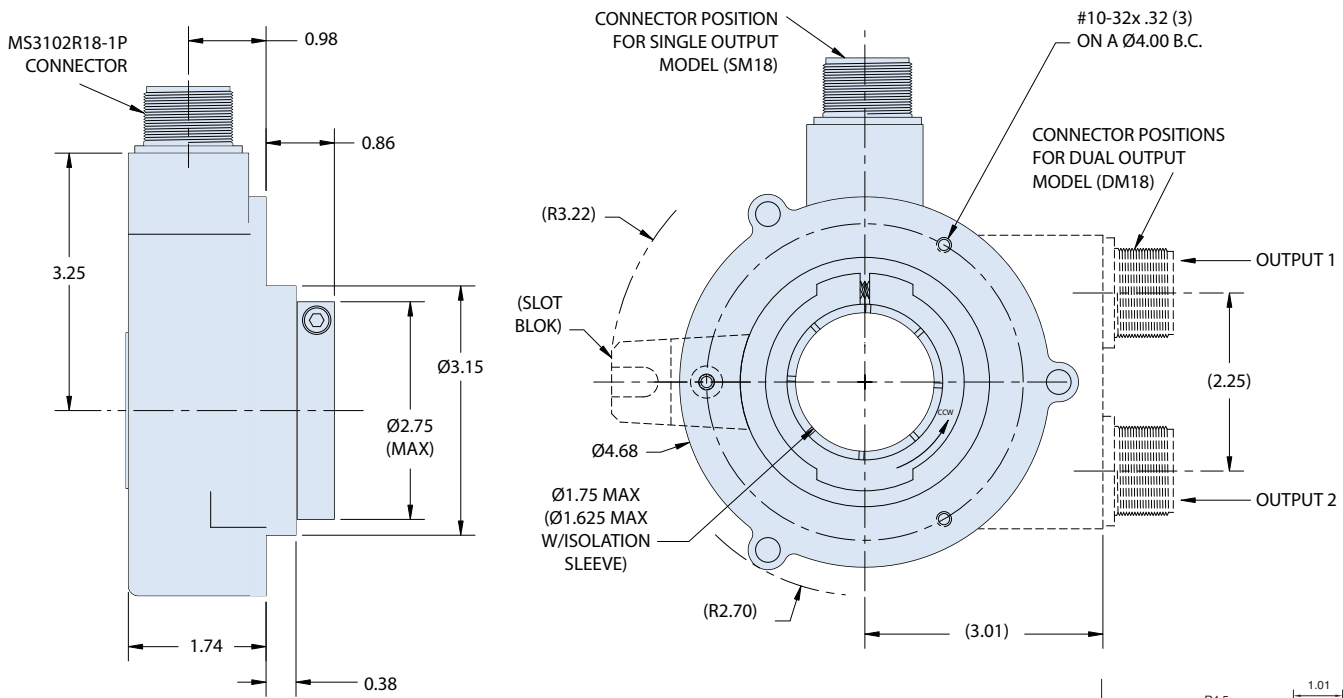
 U.S. Standards Class I, Group A,B,C & D; Class II Group E,F & G

 Canadian Standards Class I, Zone 0, Group IIC

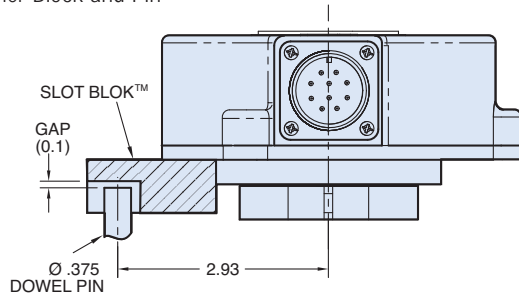
See Regulatory Information on page 48 for further certification details.

MS Connector Termination

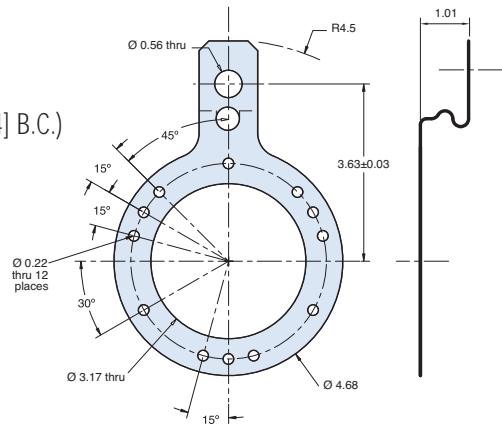
MAXIMUM BORE PENETRATION ON BLIND SHAFT IS 2.00"



R1 Tether Block and Pin



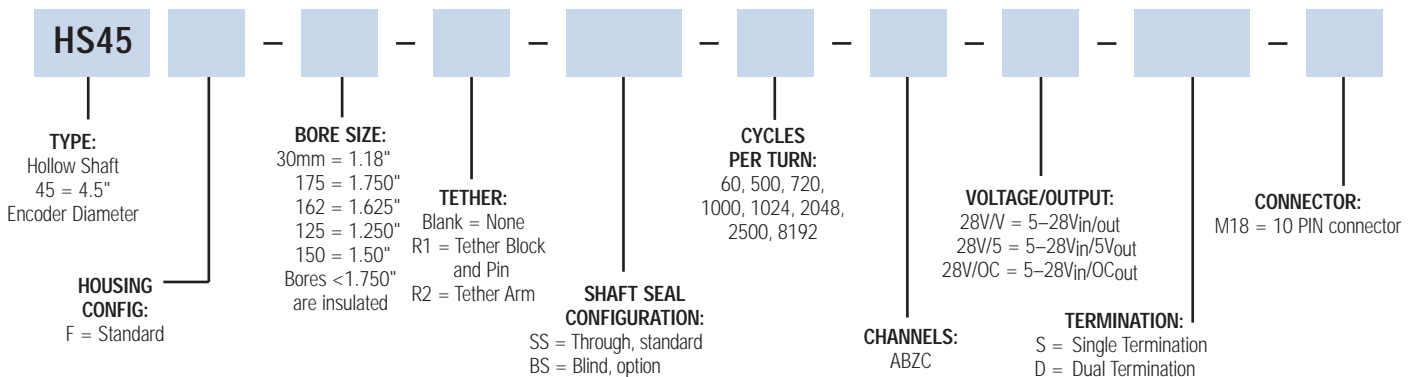
R2 Tether Arm
(Fits Ø 7.25 [184] B.C.)



HS45 Incremental Ordering Options

FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: HS45F-175-R2-SS-8192-ABZC-28V/V-SM18).



H38 Explosion Proof Optical Encoder



TERMINAL PIN NO.	INCREMENTAL OUTPUT	8 BIT GRAY CODE OUTPUT*
1	CASE GRND.	CASE GRND.
2	OV	OV
3	+V	+V
4	A	G0
5	B	G1
6	Z	G2
7	\bar{A}	G3
8	\bar{B}	G4
9	\bar{Z}	G5
10	SPARE	G6
11	SPARE	G7

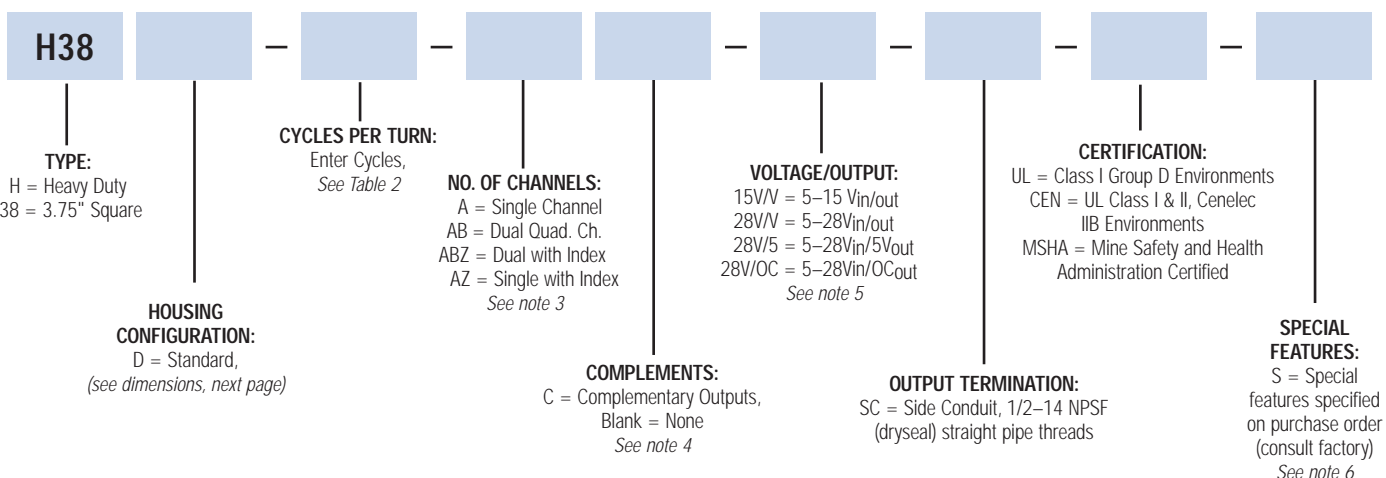
*For higher resolutions, see Absolute Encoder Options on pages 46–47.

The H38 is an explosion proof version of the field-proven H25 encoder series. The H38 is UL certified for NEMA Class 4X and 6 (outdoor non-hazardous locations) and Class 4X and 13 (indoor non-hazardous locations). It is available with Class 1, Group D, Division 1 or Class 2, Division 1 Group E, F, and G rating for use in hazardous locations. It features a standard shaft seal, double bearing seals, and a cast aluminum housing with hard anodized and dichromate sealed finish. The H38 is suitable for use in petroleum service industries, solvent refining operations, spray painting applications, and explosive dust environments.

H38 Explosion Proof Ordering Options FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: H38D-2000-ABZC-28V/V-SC-CEN).

All notes and tables referred to can be found on pages 64–65.



Mechanical Specifications

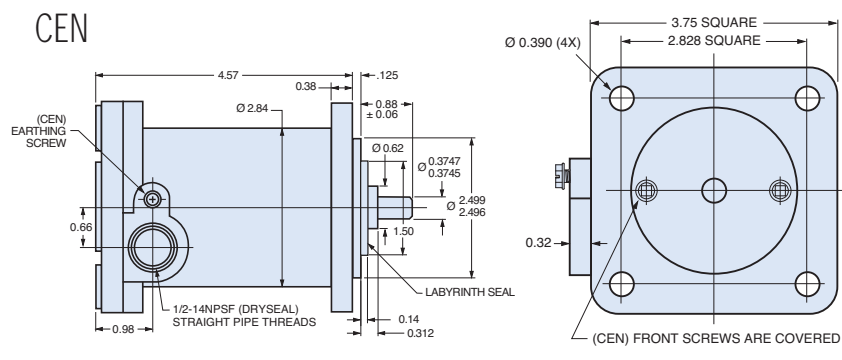
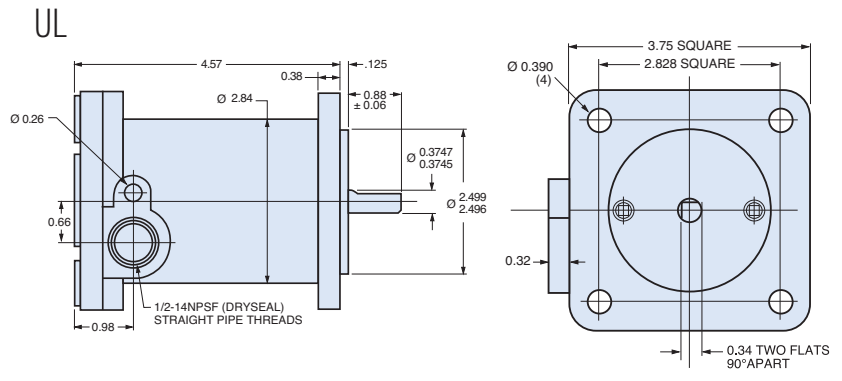
- Shaft Diameter:** 3/8" nominal
- Shaft Loading:** Up to 40 pounds axial and 20 pounds radial applied 1/4" from housing
- Shaft Runout:** 0.0005 T.I.R.
- Starting Torque at 25° C:** 4.0 in-oz (max)
- Bearings:** Class ABEC 7 standard
- Shaft Material:** 303 stainless steel
- Enclosure:** Die cast aluminum, hard anodized with dichromate sealed finish. Shaft seals and sealed bearings are standard to achieve environmental ratings.
- Bearing Life:** 2 X 10⁸ revs (1300 hrs at 2500 RPM) at rated load; 1 X 10¹⁰ revs (67,000 hrs at 2500 RPM) at 10% of rated load
- Maximum RPM:** 10,000 RPM (see Frequency Response, below)
- Moment of Inertia:** 4.1 X 10⁻⁴ oz-in-sec²
- Weight:** 64 oz typical (approx 4 lbs)

Electrical Specifications

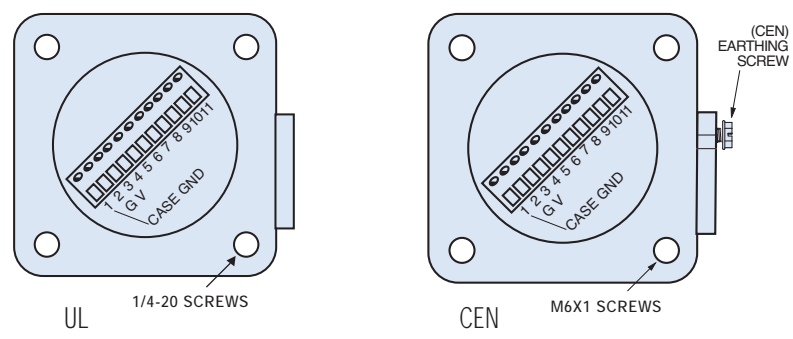
- Code:** Incremental or Absolute (see Absolute version, pg 44)
- Output Format:** 2 channels in quadrature, 1/2 cycle index gated with negative B channel, or Absolute to 13 bits
- Cycles per Shaft Turn:** 1 to 72,000 (see table 2, page 65). For resolutions above 3,600 see interpolation options on pages 36 and 37); Absolute to 8192 counts per turn
- Supply Voltage:** 5 to 28 VDC available
- Current Requirements:** 100 mA typical +output load, 250 mA (max)
- Voltage/Output:** (see note 5)
 15V/V: Line Driver, 5–15 VDC in, V_{out} = V_{in}
 28V/V: Line Driver, 5–28 VDC in, V_{out} = V_{in}
 28V/5: Line Driver, 5–28 VDC in, V_{out} = 5 VDC
 28V/OC: Open Collector, 5–28 VDC in, OC_{out}
- Protection Level:** Reverse, overvoltage and output short circuit (See note 5)
- Frequency Response:** 100 KHz, Up to 1MHz with interpolation option (see note 7)
- Output Terminations:** See table 1, opposite page
- Termination Type:** Compression type, UL recognized. Accepts AWG 14 to 22, stranded wire, strip 1/4"
- Note:** Consult factory for other electrical options

Environmental Specifications

- Enclosure Rating:** NEMA 4X & 6 (IP66), outdoor Non-Hazardous locations, NEMA 4X & 13 (IP66), indoor Non-Hazardous locations
- Temperature:** Operating, 0° to 70° C; extended temperature testing available (see note 8, pg 50); 80° C max for UL and CEN approved units; storage; -25° to 90° C.
- Shock:** 50 g's at 11 msec
- Vibration:** 5 to 2000 Hz @ 20 g's
- Humidity:** 100% RH
- Hazardous Area Rating:** Underwriters Laboratories listed for use in hazardous locations; NEMA Enclosure 7. Class 1, Group C & D, Division 1, NEC Class 2 circuits only, or Class 2, Groups E, F, and G
- NOTES & TABLES:** All notes and tables referred to in the text can be found on pages 64 and 65.



Rear View



Certifications

The H38 Explosion Proof Encoder is available with the following certifications (see page 48, Table 2.2):

- EN 55011 and EN 61000-6-2
- CENELEC EExd IIB T4
- U.S. Standards Class I, Group C & D, Division 1; Class II, Group E, F & G
- Canadian Standards Class I, Division 1, Group C & D; Class II, Group E, F & G



The Mine Safety and Health Administration (MSHA) is an organization that operates in the United States and enforces compliance with safety and health standards in the Nation's mines. Consult factory for MSHA rated product.

H40 Shock Proof Optical Encoder

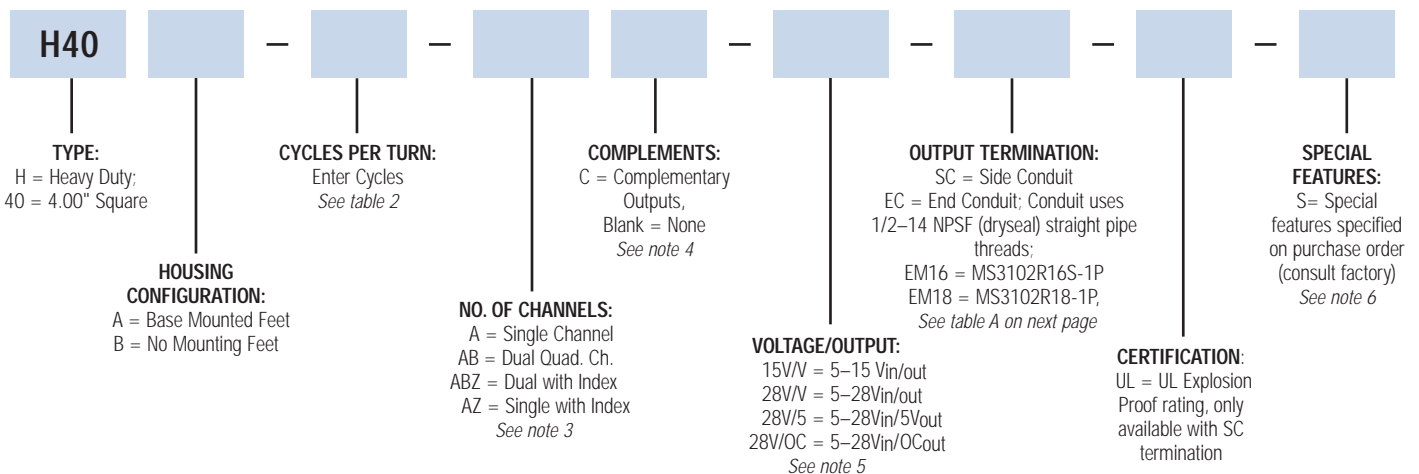


The H40 is an ultra heavy duty encoder whose internal structure is totally isolated from severe shock and shaft loading conditions. The optics and electronics are supported in shock absorbing material within the heavy cast outer housing. The encoder shaft is flexibly coupled to the high load capacity bearings and shaft assembly, which is carried in the outer housing. The entire bearing assembly is field-removable to permit proper shaft support while pressing pulleys, gears, etc. onto the shaft. An Underwriters Laboratories listed version of this model is available.

H40 Shock Proof Ordering Options for assistance call 800-350-2727

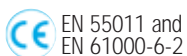
Use this diagram, working from left to right to construct your model number (example: H40A-2000-ABZC-28V/V-SC-UL).

All notes and tables referred to can be found on pages 64–65.



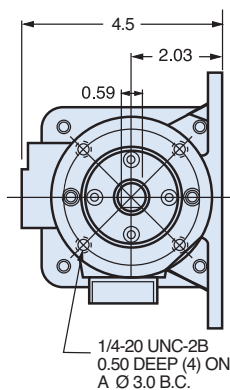
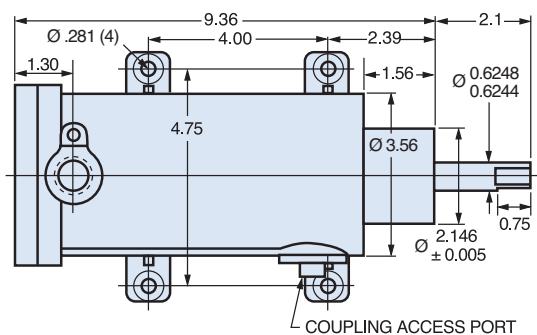
Certifications

The H40 Shock Proof Encoder is available with the following certifications:

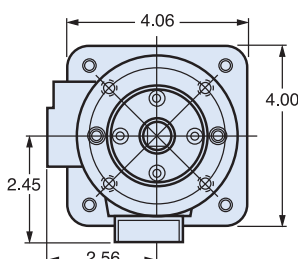
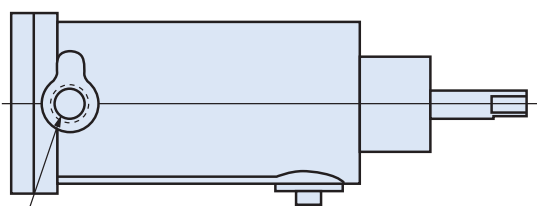


See Regulatory Information on page 48 for further certification details.

H40A

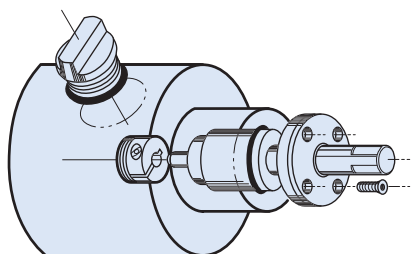


H40B

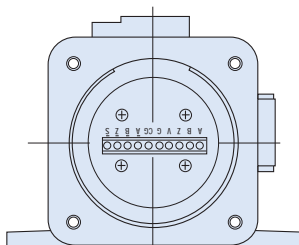


1/2 - NPSF (DRYSEAL) STRAIGHT PIPE THREADS
NOTE: THIS WIRING PORT WILL BE SEALED WITH A PIPE PLUG IF THE EM OR EC OPTION IS SPECIFIED

Field Replaceable Coupling & Bearing Assembly



Rear View



Mechanical Specifications

- Shaft Diameter:** 5/8" nominal
- Flats On Shaft:** Two flats, 0.75" long X 0.30" deep at 90°
- Shaft Loading/Bearing Life:** Refer to figure 1
- Shaft Runout:** 0.001" T.I.R. at mid-point of shaft
- Starting Torque at 25° C:** 10.0 in-oz (max)
- Bearings:** Class 52100 SAE high carbon steel, stainless steel option
- Shaft Material:** 1070 carbon steel, 303 and 316 stainless steel optional
- Enclosure:** Die cast aluminum, hard anodized with dichromate sealed finish (optional). Shaft seals and sealed bearings are standard to achieve environmental ratings.
- Maximum RPM:** 10,000 RPM (see frequency response, below)
- Coupling Windup:** The H40 uses an internal coupling. Windup error (degrees) = $a \times 7.5 \times 10^{-4} \text{ rad/sec}^2$ where a = angular acceleration in rad/sec^2
- Weight:** Approx 9 lbs

Electrical Specifications

- Output Format:** 2 channels in quadrature, 1/2 cycle index gated with negative B channel
- Cycles per Shaft Turn:** 1 to 72,000 (see table 2). For resolutions above 3,600 see interpolation options on pages 36 and 37.
- Supply Voltage:** 5 to 28 VDC available
- Current Requirements:** 100 mA typical + output load, 250 mA (max)
- Voltage/Output:** (see note 5)
15V/V: Line Driver, 5–15 VDC in, $V_{out} = V_{in}$
28V/V: Line Driver, 5–28 VDC in, $V_{out} = V_{in}$
28V/5: Line Driver, 5–28 VDC in, $V_{out} = 5 \text{ VDC}$
28V/OC: Open Collector, 5 – 28 VDC in, OC_{out}
- Protection Level:** Reverse, overvoltage and output short circuit (see note 5)
- Frequency Response:** 100 KHz, up to 1 MHz with interpolation option (see note 7)
- Output Terminations:** See Table A, this page
- Termination Type:** Compression type, UL recognized. Accepts AWG 14 to 22, stranded wire, strip 1/4"
- Note:** Consult factory for other electrical options

Environmental Specifications

- Enclosure Rating:** NEMA 4 X & 6 (IP66), outdoor Non-Hazardous locations, NEMA 4 X & 13 (IP66), indoor Non-Hazardous locations
- Hazardous Area Rating:** The optional Underwriters Laboratories listed version is for use in hazardous locations; NEMA Enclosure 7. Class 1, Group D, Division 1, NEC Class 2 circuits only
- Temperature:** Operating, 0° to 70° C; extended temperature testing available (see note 8, pg 50); 80° C max for UL and CEN approved units; storage; -25° to 90° C
- Shock:** 200 g's at 11msec
- Vibration:** 5 to 2000 Hz @ 20 g's
- Humidity:** 100% RH

NOTES & TABLES: All notes and tables referred to in the text can be found on pages 64 and 65.

Table A Output Functions

Incremental		8-Bit Absolute*		
TERMINAL	FUNCTION	GRAY CODE	NATURAL BINARY	TERMINAL NUMBER
A	CHANNEL A	G0	2 ⁰	1
B	B	G1	2 ¹	2
Z	Z	G2	2 ²	3
V	+VDC	G3	2 ³	4
G	GROUND (OV)	G4	2 ⁴	5
CG	CASE GROUND	G5	2 ⁵	6
A̅	A̅	G6	2 ⁶	7
B̅	B̅	G7	2 ⁷	8
Z̅	Z̅			9
S	SPARE*			10
				11
				12
				13
				14
				15
				16

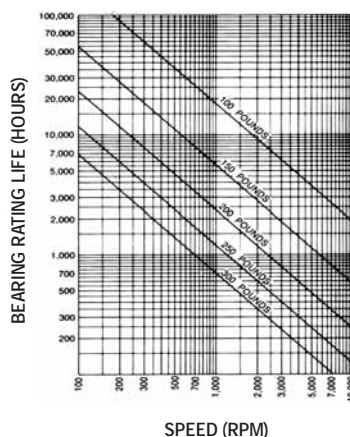
*or SELECT on Dual Count encoders

Latch and Interrogate are optional

*For higher resolutions, see Absolute Options pages 46–47

Figure 1

Bearing Life vs. Speed at Various Radial Loads



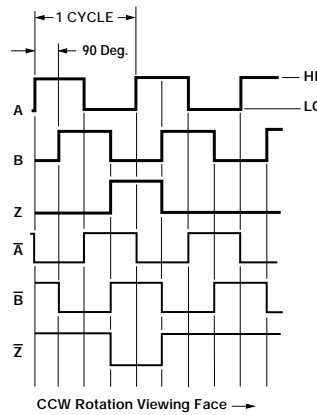
HS20 Incremental Encoder



The HS20 is a compact, rugged encoder designed with the needs of the small motor market in mind. It can be used where lighter duty encoders are not suitable or cost effective. Its bearing design and simple interface translate to ease of installation and field reliability.

PIN (K8)	WIRE	FUNCTION
1	YEL	A
4	BLU	B
6	ORN	Z
2	RED	+V (SUPPLY)
7	BLK	OV (CIRCUIT COMMON)
N/C	GRN	CASE GROUND
3	W/YEL	\bar{A}
5	W/BLU	\bar{B}
8	W/ORN	\bar{Z}

Figure 1 Output Waveform



Mechanical Specifications

Shaft Bore: 5/8", 1/2", 1/4", metric available
Allowable Misalignment: 0.005 TIR, 0.010 Axial using R2 Tether
Bore Runout: 0.001 TIR
Starting Torque at 25°C: 3.5 in-oz (max)
Bearings: 52100 dual preloaded bearings
Shaft Material: Aluminum
Bearing Housing: Aluminum with protective finish
Cover: Aluminum with protective finish
Bearing Life: 7.5 X 10⁹ revs
Maximum RPM: 6000 (see frequency response)
Moment of Inertia: 3.4 X 10⁻⁴ oz-in²
Weight: 8 ounces, maximum

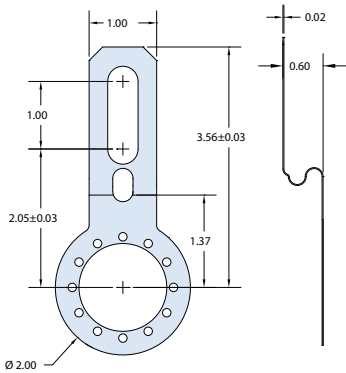
Electrical Specifications

Code: Incremental output format; 2 channels in quadrature, with complements; 1/2 cycle index gated with negative B channel
Cycles Per Shaft Turn: 2 through 1024
Supply Voltage: 5–28 VDC ± 5%
Current Requirements: 100mA typical + output load, 250mA (max)
Voltage/Output: (see note 5)
 28V/V: Line Driver, 5–28 VDC in, V_{out} = V_{in}
 28V/5: Line Driver, 5–28 VDC in, V_{out} = 5 VDC
 28V/OC: Open Collector, 5–28 VDC in, OC_{out}
Protection Level: Overvoltage, reverse voltage. Outputs short-circuit protected (1 minute max)
Frequency Response: 100kHz
Output Termination Pinouts: See Table 1, this page

Environmental Specifications

Enclosure Rating: IP64
Temperature: 0–70° Standard
Shock: 50 g's for 11 msec duration
Vibration: 5–2000 Hz @ 20 g's
Humidity: 98% RH non-condensing

R2 Tether Arm



HS20 Diagram

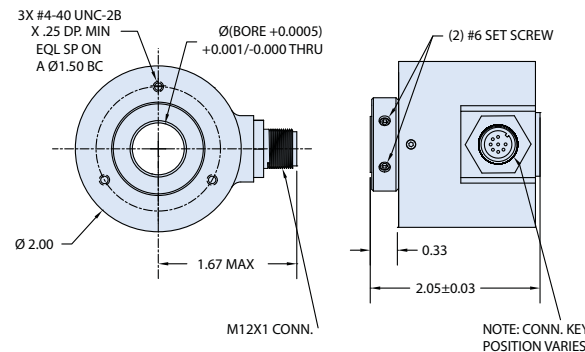
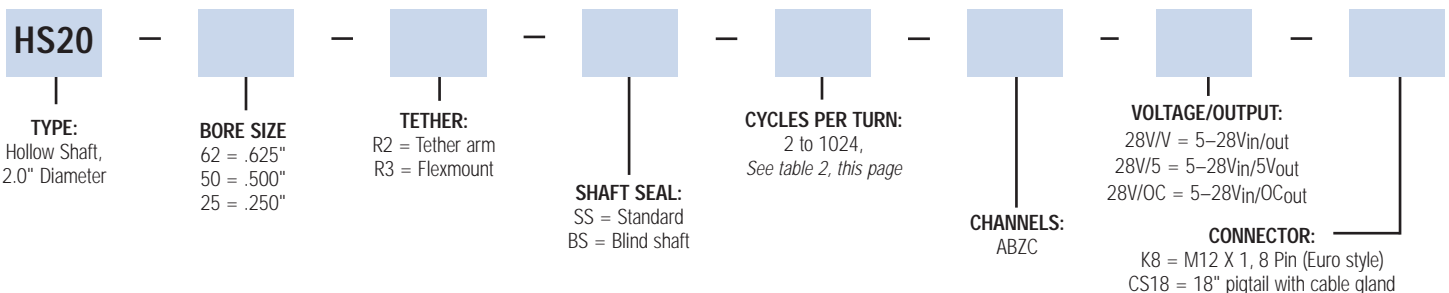


Table 2 HS20 Disc Resolutions

2	3	5	6	8	10	11	12	24	25	30	32	40	50	60	64
70	75	80	100	105	115	120	125	150	192	200	240	250	256	300	336
400	410	500	512	600	720	785	1000	1024							

HS20 Incremental Ordering Options FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: HS20-50-R2-SS-1024-ABZC-28V/V-K8). All notes and tables referred to can be found on pages 64–65.



HS22 Incremental Encoder



The HS22 series of hollow shaft incremental encoder offers application advantages over conventional optical encoders. This heavy duty unit is designed for ease of installation to a servo motor, the encoder's flexible coupling fits over the driven motor shaft to provide an accurate, backlash-free method of attachment.

The mounting method eliminates the need for couplings, sprockets, or gearing. The integral flex mount provides for a 20-degree angular adjustment. Through-shaft or blind shaft configurations of the HS22 encoder are available.

Through-shaft units allow for applications where the center of the encoder must be used for transmission of fluids, cabling, or optics. Blind shaft units are designed to mate with shaft lengths of 0.50 to 1.50 inch. Standard outputs for both configurations include: A and B in quadrature with index and optional commutation signals for brushless motor control.

Mechanical Specifications

- Shaft Bore:** 0.500" (standard) 0.375", 0.250", 10mm, 8mm and 6mm available
- Allowable Misalignment:** 0.010 T.I.R. on mating shaft
- Bore Runout:** 0.001" T.I.R.
- Starting Torque at 25°C:** 5-in-oz (max)
- Bearings:** 52100 SAE high carbon steel
- Shaft Material:** 303 stainless steel
- Bearing Housing:** Die cast aluminum with protective finish
- Cover:** Drawn aluminum with protective finish
- Bearing Life:** 7.5 X 10⁹ revs (50,000 hrs at 2500 RPM)
- Maximum RPM:** 5,000 RPM
- Moment of Inertia:** 10 X 10⁻⁴ oz-in-sec²
- Weight:** 10 oz (max)

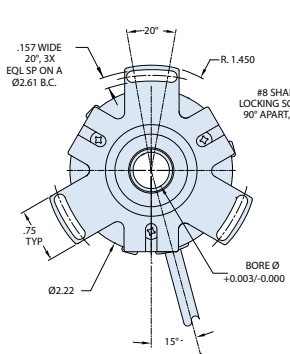
Electrical Specifications

- Code:** Incremental Output Format, 2 channels in quadrature, one cycle (nominal) ungated index (other index options and commutation channels available—consult factory).
- Cycles Per Shaft Turn:** 100 to 2540 (see table 2, this page)
- Supply Voltage:** 5, 12–15, 24–28 VDC
- Current Requirements:** 120 mA typical, 175 mA max
- Voltage/Output:** (see note 5)
28V/V: Line Driver, 5–28 VDC in, V_{out} = V_{in}
28V/5: Line Driver, 5–28 VDC in, V_{out} = 5 VDC
28V/OC: Open Collector, 5–28 VDC in, OCout
- Protection Level:** Output short circuit
- Frequency Response:** 100kHz allowable operating speed (RPM) = (100kHz/Resolution) x 60
- Output Termination Pinouts:** See table 1, this page

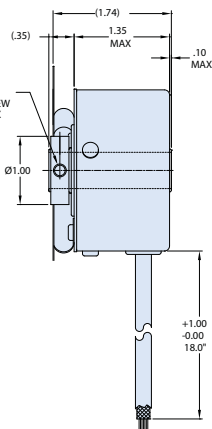
Environmental Specifications

- Enclosure Rating:** NEMA 5 (IP50) for through shaft versions (TS) and NEMA 12 (IP52) for blind shaft (BS) versions
- Temperature:** Operating, 0° to 70° C; extended temperature testing available, -40° to 85° ; storage, -20° to 90° C.
- Shock:** 50 g's for 11 msec duration
- Vibration:** 5 to 2000 Hz @ 10 g's
- Humidity:** 98% RH non-condensing

HS22 Diagram



Thru Shaft



Blind Shaft

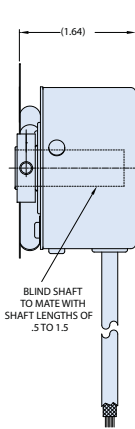


Figure 1 Output Waveform

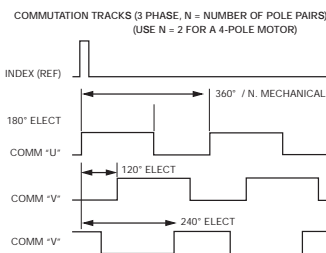
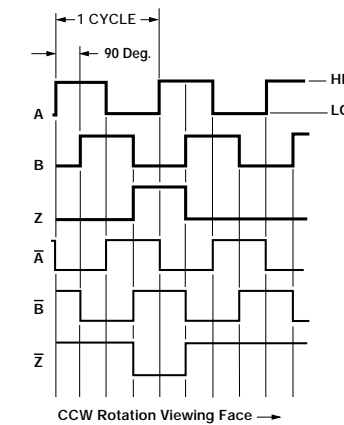


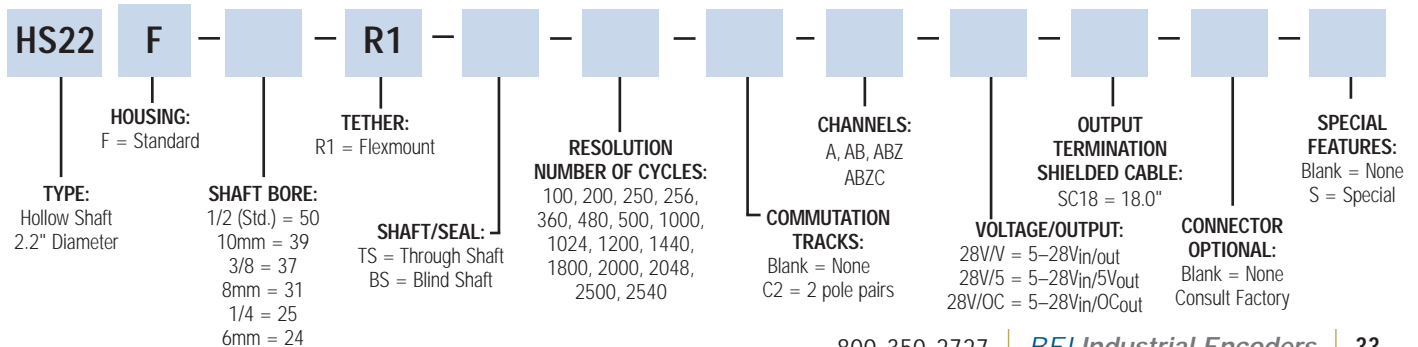
Table 1—Output Termination Pinouts

STANDARD INCREMENTAL OUTPUTS		OPTION COMMUTATION OUTPUTS	
COLOR	FUNCTION	COLOR	FUNCTION
YEL	A	GRY	U
WHT/YEL	A̅	WHT/YGRY	U̅
BLU	B	BRN	V
WHT/BLU	B̅	WHT/BRN	V̅
ORN	Z	VIO	W
WHT/ORN	Z̅	WHT/VIO	W̅
RED	+V (SUPPLY)		
BLK	0 V (GROUND)		
BARE	SHIELD DRAIN		

HS22 Incremental Ordering Options FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: HS22F-50-R1-TS-256-ABZC-28V/V-SC18).

All notes and tables referred to can be found on pages 64–65.



E25 Incremental Optical Encoders

The E25 has been designed as a light duty encoder for applications such as robotics, precision computer peripherals and OEM motors and controls. It is designed with an integrated mounting ring and shaft coupling. In most instances, the E25 encoder can be replaced with an equivalent H25 model. For example,

E25BA-4R-SB-1024-ABZC-28V/V-SM18 would become:
H25E-F45-SB-1024-ABZC-28V/V-SM18-S

-S=short shaft

Include 31170-001 adapter kit and 39074-12-8 coupling on your order.

Please call our Applications Assistance Hotline at 1-800-ENCODER for help in crossing your E25 over to an H25 equivalent.

Coupling Bore: 1/4" and 3/8" nominal, standard

Starting Torque at 25° C: 0.07 in-oz typical

Bearings: Class ABEC 5

Coupling Material: Aluminum with protective finish

Bearing Housing: Die cast aluminum with protective finish

Cover: Drawn aluminum, 0.060" wall, protective finish standard. Die cast aluminum with protective finish for EM, SM, ECS and SCS terminations

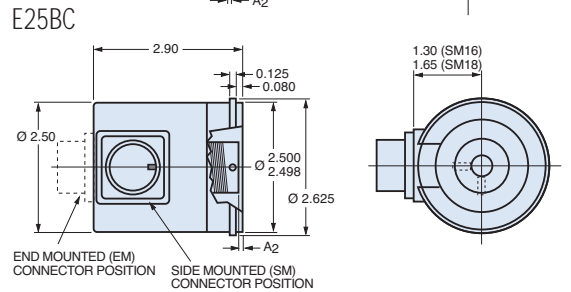
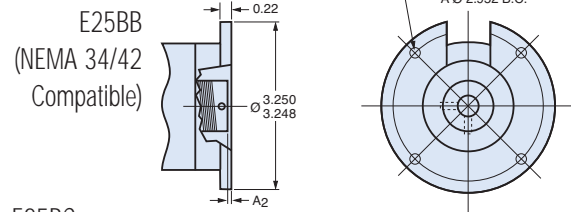
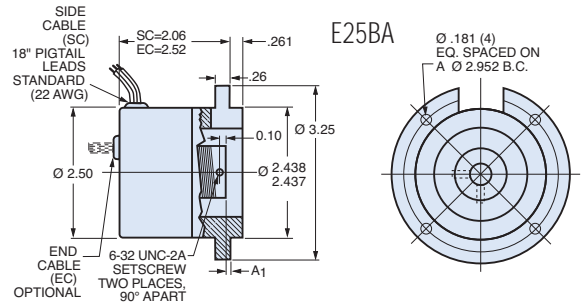
Bearing Life: 1 X 10⁹ revs (6,700 hrs at 2500 RPM) at rated load

Maximum RPM: 10,000

Weight: 13 oz., typical

Enclosure Rating: NEMA 2 (IP43)

Temperature, Shock, Vibration, Humidity and Electrical Specifications:
Refer to H25 Incremental, pages 18-19



Installation Note:
To prevent damage, the coupling must be operated without excessive axial compression or extension. For proper installation, rotate the coupling on the mating shaft prior to tightening the set screws.

COUPLING DATA	STANDARD COUPLING	HIGH - PERFORMANCE COUPLING	
	TYPE 4H	TYPE 4R	TYPE 6R
Coupling Bore	.250/.251	.2500/.2505	.3750/.3755
Dimension A1 (E25BA only)	.16	.08	.08
Dimension A2 (E25BB & BC)	.10	.02	.02
Axial Motion (Inches Max.)	±.010	±.020	±.030
Parallel Offset (Inches Max.)	.010	.010	.010
Angular Misalignment (Degrees Max.)	2	2	2
Torsional Spring Rate (arc-sec/oz-in)	52	15	21

L25 Incremental Optical Encoders



The L25 is a lighter duty version of the H25. With low starting torque, a 1/4" diameter stainless steel shaft and a drawn aluminum cover.

In most instances, the L25 encoder can be replaced with an equivalent H25 model. For example,

L25G-SB-1024-ABZC-28V/V-SM18-S would become:
H25G-SB-1024-ABZC-28V/V-SM18-S

-S=1/4" dia. shaft

Please Call our Applications Assistance hotline at 1-800-ENCODER for help in crossing your L25 over to an H25 equivalent.

Shaft Diameter: 1/4" nominal

Flat On Shaft: 0.80 long x 0.03 deep

Shaft Loading: up to 5 lbs. axial and 8 lbs. radial

Shaft Runout: .0005 T.I.R. maximum

Starting Torque at 25°C: 0.07 in-oz typical, 0.12 in-oz maximum without sealed bearings; 0.50 in-oz typical, 1.0 in-oz maximum with sealed bearings

Bearings: Class ABEC 5

Shaft material: 416 stainless steel

Bearing Housing: Die cast aluminum with protective finish

Cover: Drawn aluminum, 0.060" wall, protective finish standard. Die cast aluminum with protective finish for EM, SM, ECS and SCS terminations

Bearing Life: 1 X 10⁹ revs (6,700 hrs at 2500 RPM)

Maximum RPM: 10,000

Moment of Inertia: 4.1 x 10⁻⁴ oz-in-sec²

Weight: 13 oz. typical

Electrical Specifications: Refer to H25 Incremental, pages 18-19 for typical electrical specifications

Enclosure Rating: NEMA 2 (IP43)

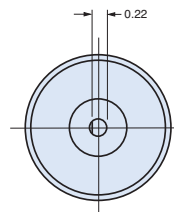
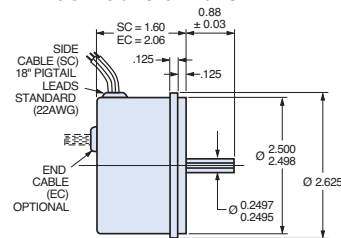
Temperature: Operating, 0° to 70° C; extended temperature testing available (see note 8); storage: -25° to 90° C

Shock: 50 g's for 11 msec duration

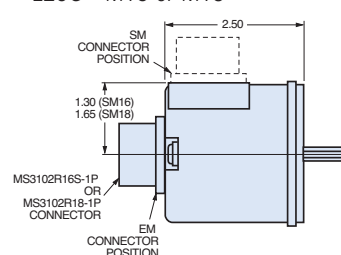
Vibration: 5 to 2000 Hz @ 20 g's

Humidity: 98% RH without condensation

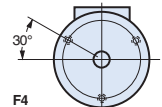
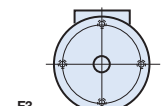
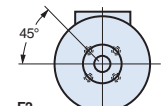
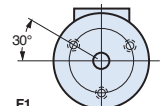
L25G - SC18 or EC18



L25G - M16 or M18



Optional Face Mounts



L15 Incremental Optical Encoders

The L15 provides the industrial marketplace with a rugged high-resolution encoder in a compact size 15 servo package. Engineered with robust interpolative electronics, the L15 offers up to 40,640 cycles per turn. Ideal for space or weight limited applications, these compact encoders discount size without compromising performance.

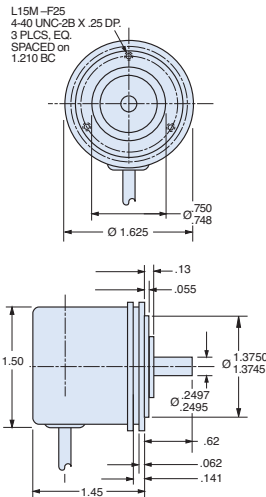


The L15 encoder features 1/4-inch diameter stainless steel shaft and can accommodate up to 5 pounds radial or axial load. The L15 encoder package has field-proven ASIC electronics, sealed dual bearings and BEI's accurate code disk in an all metal housing to ensure ruggedness and reliability.

Table 1 L15 Disc Resolutions

(Other resolutions and interpolation options available—see pages 36–37.)

24	50	100	200	256	300	360	400	500
512	625	900	1000	1024	1200	1250	1440	
1800	2000	2048	2500	2540				



Shaft Runout: 0.002 T.I.R. at midpoint of shaft

Starting Torque at 25°C: 0.20 in-oz (max)

Bearing Housing: Aluminum with protective finish

Cover: Drawn aluminum

Bearing Life: 1 X 10⁹ revs (10,000 hrs at 1500 RPM)

Maximum RPM: 5,000 RPM nominal (see Frequency Response, below)

Moment of Inertia: 1.0 X 10⁻⁴ oz-in-sec²

Weight: 6 oz (max)

Output Format: 2 channels in quadrature, 1/2 cycle index gated with negative B channel

Cycles Per Shaft Turn: 24 to 40,640 (see Table 1 this page)

Current Requirements:
100mA typical + output load
150mA (max) with 28V/5
250mA (max) otherwise

Protection Level: Reverse, overvoltage and output short circuit

Supply Voltage: 5–28 VDC

Voltage/Output:

28V/V: Line Driver, 5–28VDCin, Vout = Vin
28V/5: Line Driver, 5–28VDCin, Vout = 5VDC

28V/OC: Open Collector, 5–28VDCin, OCout

Frequency Response: 100kHz (non-interpolated), up to 1 MHz interpolated

Output Termination Pinouts:

See Table 1, on page 65

Enclosure Rating: NEMA 3. (IP53)

Temperature: Operating, 0° to 70° C; extended temperature testing available, -40° to 85°; storage, -40° to 90° C

Shock: 50 g's for 11 msec duration (1/2 Sine)

Vibration: 20 to 2000 Hz @ 20 g's

Humidity: 98% RH non-condensing

L15 Incremental Ordering Options FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: L15M-F25-256-ABZC-28V/V-SCS18).

L15M-F25

CYCLES/TURN:
See table 1, this page

CHANNELS:
ABZ, ABZC

VOLTAGE/OUTPUT:
28V/V, 28V/OC,
28V/5

OUTPUT/TERMINATION:
SCS = Shielded,
jacketed cable with cable
gland seal and cable length
in inches (SCS18=18")

SPECIAL FEATURES:
Consult Factory

M58 Incremental Optical Encoders

The M58 is a rugged industrial grade metric incremental encoder with a unique combination of performance and flexibility. It features resolutions up to 80,000 cycles per turn. The robust design has excellent resistance to shock and vibration. IP65 environmental protection is standard. The M58 is an ideal replacement encoder for metric equipment.



Shaft Diameter: 10mm, (0.39") Standard, 6mm (0.24") Option

Shaft Material: Stainless Steel

Bearings: Series 6000

Cover: Zinc Alloy

Shaft Loading: up to 50 N (11 lbs.) axial and 100 N, (22 lbs.) radial

Starting Torque at 25 C: 0.004 Nm (0.6 in-oz) max

Enclosure: Aluminum

Maximum RPM: 9,000 RPM

Moment of Inertia: 0.7 x 10⁻⁶ kgm² (1.0 X 10⁻⁴ oz-in-sec²)

Weight: Approximately .285 Kg (10 oz.)

Voltage/Output:

28V/V: Line Driver, 5–28 VDCin, Vout = Vin
28V/5: Line Driver, 5–28 VDCin, Vout = 5VDC

Current Requirements:
75mA typical + output load

Protection Level: Reverse, overvoltage and output short circuit

Output Format: 2 Incremental Channels in quadrature, with gated index and complements.

Cycles per Shaft Turn: 256–80,000 (see Table 3 this page)

Frequency Response: to 300kHz

Output Terminations: (See Table 2 this page)

Temperature: Operating, -0° to 70°C; storage (non-operating), -40° to 80°C. Consult factory for extended temperature ratings.

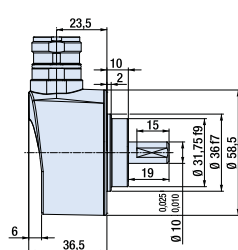
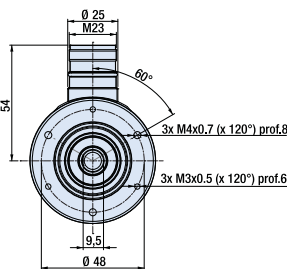
Shock: 50 g's for 6 msec duration

Vibration: 55 to 2000 Hz @ 10 g's

Humidity: 98% RH without condensation

Enclosure Rating: IP65, NEMA 4X & 13

Pilot Flange,
10mm Shaft
Diameter



Servo,
6mm Shaft
Diameter

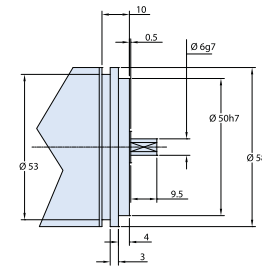
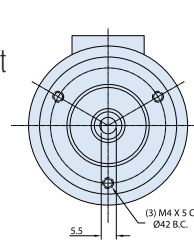


Table 2—Output Termination

SM23 12 PIN CONNECTOR, CCW	
PIN	CHANNELS
10 + 11	OV (Circuit Common)
2 + 12	+V (Supply)
8	A
5	B
3	Z
1	A
6	B
4	Z
Connector Body	Case Ground
9	N/C

Table 3 M58 Disc Resolutions

Resolutions in **RED** are interpolated and will be noted by (example T2 or other value). Additional resolutions are available, please consult factory.

256	360	500	512	720	768	1000	1024	1080	1280	1440	1500	1800	2000	2048	2500	2560	2880	3072	3600	4000	4096	4320
5000	5120	5760	6000	8000	8192	10000	10240	12288	15000	16384	20000	25000	40000	50000	60000	80000						

M58 Incremental Ordering Options FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: M58-1024-ABZC-28V/V-SM23).

M58

FACE MOUNT:

Blank = pilot flange (std),
E = Servo (opt)

CYCLES/TURN:
See table 3, this page

CHANNELS:
ABZC

VOLTAGE/OUTPUT:
28V/V, 28V/5

OUTPUT TERMINATION:
SM23=Side M23 Conn.

SPECIAL FEATURES:
Consult Factory

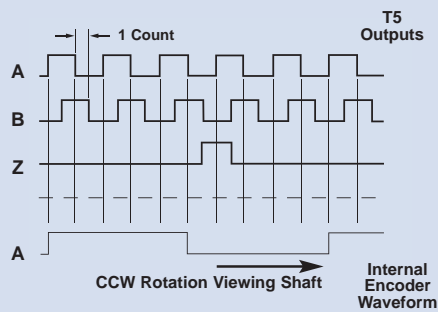
Interpolation Options

Electronically Multiplied Squarewave Output

Interpolate encoders provide a higher degree of angular resolution. These encoders are ideal for position readouts and position servo applications. The major specifications of interest for this type of encoder are transition accuracy and frequency response. In position readout situations the system usually doesn't know where it is within a particular count, so tight transition accuracy specs tend to be wasted. What is desired in these applications is the ability to subdivide a "count" into smaller divisions to improve system resolution. Interpolation provides this ability without any sacrifice in mechanical integrity or internal electrical signal strength.

Typical Waveform Pattern

Option T-5 Shown



Ordering Interpolation Options

The factory will be pleased to assist you in construction of the model number.

Call toll free: **800-350-2727**

When constructing the model number for any one of BEI's standard encoders, insert the desired number of Cycles Per Turn, after multiplication and the correct interpolation designator, in the model number between Shaft Seal Configuration and Number of Channels.

Example:

H25D-SS-7200-T2-ABZC-28V/V-SM18

(one possible encoder configuration with Interpolation Option T2.)

NOTES & TABLES: All notes and tables referred to in the text can be found on pages 64 and 65.

	Option T-2	Option T-3	Option T-4
	Available on all models, except HS25, HS45, HS20, HS22	Available on all models, except HS25, HS45, HS20, HS22	Available on all models, except HS25, HS45, HS20, HS22
Multiplication Factor	X 2 (T2)	X 3 (T3)	X 4 (T4)
Cycles Per Turn	All Models, except L15, H20, HS35 and HS25: Up to 7200 (3600 X 2) Model H20: Up to 2048 (1024 X 2) Model HS35: Up to 10,000 (5000 X 2) Model L15: Up to 5,080 (2540 X 2)	Up to 10,600 (3600 X 3) Model HS35: Up to 15,000 (5000 X 3) Model H20: Up to 3072 (1024 X 3) Model L15: Up to 7,620 (2540 X 3)	Up to 14,400 (3600 X 4) Model HS35: Up to 20,000 (5000 X 4) Model H20: Up to 4096 (1024 X 4) Model L15: Up to 10,160 (2540 X 4)
Supply Voltages Available	5–28 VDC ± 5%; see note 5	5–28 VDC ± 5%; see note 5	5–28 VDC ± 5%; see note 5
Output Options	Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC	Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC	Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC
Current Requirements	TTL: 100 mA + load current maximum, see note 5	TTL: 100 mA + load current maximum, see note 5	TTL: 100 mA + load current maximum, see note 5
Transition Accuracy	± 27° quadrature transition accuracy, measured at 1/5 maximum frequency response.	± 1 Count, measured at 1/5 maximum frequency response	± 1 Count, measured at 1/5 maximum frequency response
Frequency Response	250 kHz, minimum count width = 1/10 base count.	300 kHz, minimum count width = 1/10 base count.	400 kHz, minimum count width = 1/10 base count.
Output Termination			
Mechanical Specifications	See standard specifications for the encoder of interest.	See standard specifications for the encoder of interest.	See standard specifications for the encoder of interest.



Model H25



Model E25



Model L25



Model H40

Option T-5 Available on all models except H20, HS25, HS45, HS20, HS22	Option T-8 Available on all models except H20, HS25, HS45, HS20, HS22	Option T-10 Available on models L15, H25, HS35, H38, H40	Option T-12 Available on models L15, H25, HS35, H38, H40	Option T-16 Available on models L15 H25, HS35, H38, H40	Option T-20 Available on models H25, H38, H40
X 5 (T5)	X 8 (T8)	X 10 (T10)	X 12 (T12)	X 16 (T16)	X 20 (T20)
Up to 18,000 (3600 X 5) Model HS35: Up to 25,000 (5000 X 5) Model L15: Up to 12,700 (2540 X 5)	Up to 28,800 (3600 X 8) Model HS35: Up to 40,000 (5000 X 8) Model L15: Up to 20,320 (2540 X 8)	Up to 36,000 (3600 X 10) Model HS35: Up to 50,000 (5000 X 10) Model L15: Up to 25,400 (2540 X 10)	Up to 43,200 (3600 X 12) Model HS35: Up to 60,000 (5000 X 12) Model L15: Up to 30,480 (2540 X 12)	Up to 57,600 (3600 X 16) Model HS35: Up to 80,000 (5000 X 16) Model L15: Up to 40,640 (2540 X 16)	Up to 72,000 (3600 X 20)
5–28 VDC ± 5% see note 5	5–28 VDC ± 5% see note 5	5–28 VDC ± 5% see note 5	5–28 VDC ± 5% see note 5	5–28 VDC ± 5% see note 5	5–28 VDC ± 5% see note 5
Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC	Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC	Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC	Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC	Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC	Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC
TTL: 100 mA + load current maximum, see note 5	TTL: 100 mA + load current maximum, see note 5	TTL: 100 mA + load current maximum, see note 5	TTL: 100 mA + load current maximum, see note 5	TTL: 100 mA + load current maximum, see note 5	TTL: 200 mA + load current maximum, see note 5
± 1 Count, measured at 1/5 maximum frequency response	± 2 Counts, measured at 1/5 maximum frequency response	± 2 Counts	± 4 Counts	± 4 Counts	± 4 Counts
500 kHz, minimum count width = 1/10 base count.	800 kHz, minimum count width = 1/10 base count.	1 MHz, minimum. count width = 1/10 base count.	1 MHz, minimum. count width = 1/10 base count.	1 MHz, minimum. count width = 1/10 base count.	1 MHz, minimum. count width = 1/10 base count.

See Table 1

See standard specifications for the encoder of interest. .	See standard specifications for the encoder of interest.	See standard specifications for the encoder of interest.	See standard specifications for the encoder of interest.	See standard specifications for the encoder of interest.	Overall Length may increase up to 1.67" depending on options. Consult Factory.
--	--	--	--	--	--



Model H38



Model H20



Model HS25



Model HS35



Model L15



Model HS45

H25 Absolute Optical Encoder

Electrical Specifications

Code: 12 or 13 bits NB or GC; excess gray and BCD available

Counts Per Shaft Turn: 4096 or 8192

Count Transition Accuracy: ± 1/2 bit maximum

Supply Voltage: 5–28 VDC

Current Requirements: 120 mA typical

Output Formats: Parallel: Gray Code, Natural Binary and Binary Coded Decimal; Serial: Serial Synchronous Interface (SSI) compatible; Analog: 4–20 mA, 0–10V

Voltage/Output: (see note 5)

28V/V: Line Driver, 5–28 VDC in, $V_{out} = V_{in}$

28V/5: Line Driver, 5–28 VDC in, $V_{out} = 5$ VDC

28V/OC: Open Collector, 5–28 VDC in OC_{out}

SSI: 5–28 VDC In/5Vout (see page 46)

Protection Level: Reverse, overvoltage and output short circuit protection

Frequency Response: 100kHz (1200 RPM for 12-bits, 600 RPM for 13-bits)

Output Termination Pinouts: See table page 47

Mechanical & Environmental Specs

Reference the H25 Incremental Encoder, pages 18–19

Connector

MS3112E14-19P, 19-pin connector on encoder body, mates to MS3116J14-19S (or equivalent)

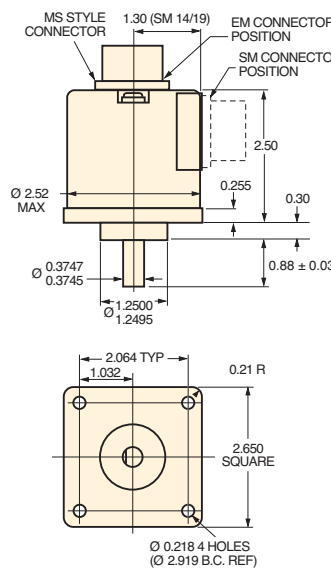
NOTES & TABLES: All notes and tables referred to in the text can be found on pages 64 and 65.



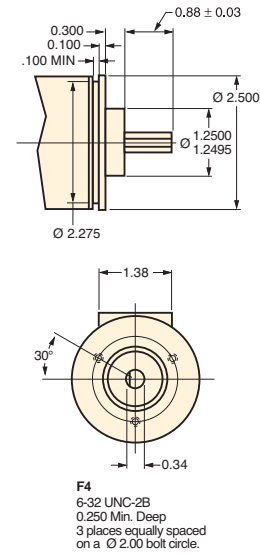
Long considered the industry standard for shafted incremental encoders, the Model H25 is now available in an absolute version with up to 13 Bits of resolution. It incorporates many of the great standard features of the incremental version, including: EMI shielding, 40-lb ABEC 7 bearings, matched thermal coefficients on critical components, and custom optics. This encoder features a 12 or 13 Bit absolute parallel gray code output, a selection line for count direction, and an output latch as standard. Output is standard gray code with options for natural binary or SSI compatible signals. Signals can be provided in either a single-ended multi-voltage line driver (TTL compatible when provided with 5 volts) or as an open-collector style of output. Typical applications include dam gate control, cranes, telescopes, tool changers, and robotics.

Certifications EN 55011 and EN 61000-6-2

H25D - Square Flange



H25E - 2.50 Servo Mount



H25G - 2.62 Dia Servo Mount

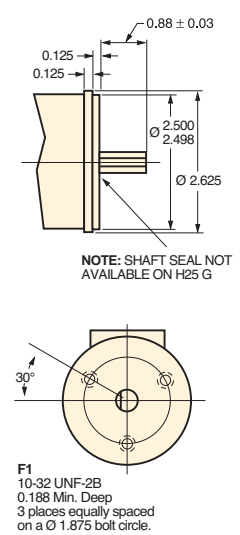


Figure 1 Gray Code

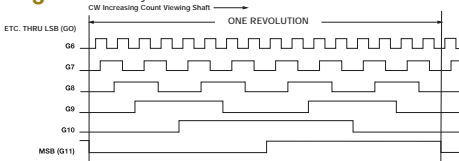
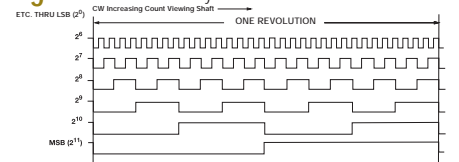


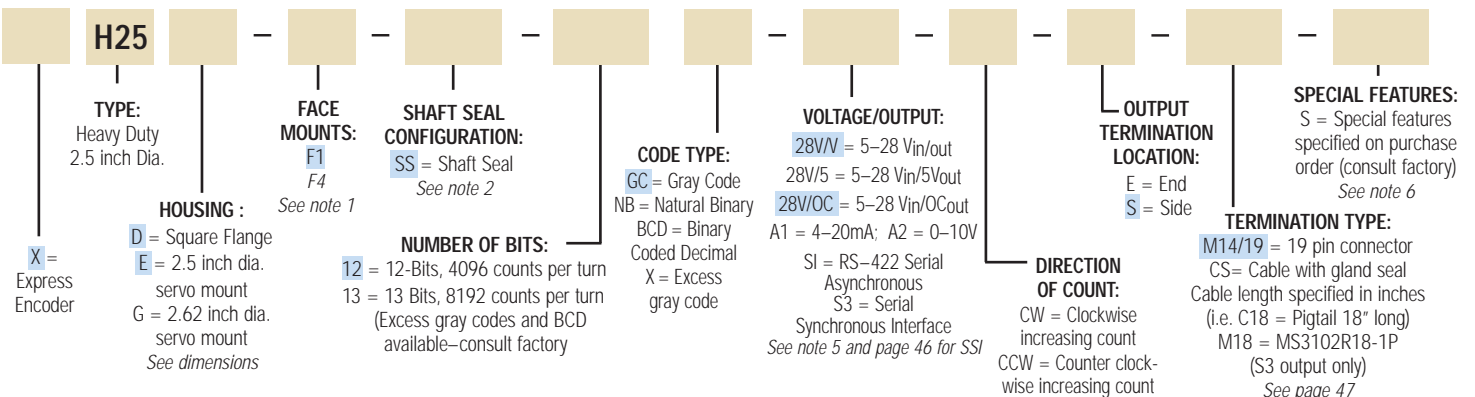
Figure 2 Natural Binary



H25 Absolute Encoder Ordering Options for assistance call 800-350-2727

Use this diagram, working from left to right to construct your model number (example: H25E-F4-SS-12GC-28V/V-CW-SM14/19).

All notes and tables referred to can be found on pages 64–65.



EXPRESS ENCODERS® Items highlighted with are standard Express Encoders and ship in one to three days.

H25X Absolute Optical Encoder

Mechanical Specifications

- Shaft Diameter:** 3/8"
- Shaft Loading:** Up to 25 pounds axial and radial
- Shaft Runout:** 0.0005 T.I.R. at midpoint regardless of shaft diameter
- Starting Torque at 25°C:** With shaft seal 2.5 in-oz
- Bearings:** Class ABEC 7 standard, ABEC 5 for 1/2" shaft
- Shaft Material:** 416 stainless steel
- Bearing Housing:** Die cast aluminum with iridite finish
- Cover:** Die cast aluminum
- Bearing Life:** 2 X 10⁹ revs (1300 hrs at 2500 RPM) at rated load 1 X 10¹⁰ revs (67,000 hrs at 2500 RPM) at 10% of rated load
- Maximum RPM:** 12,000 RPM mechanical,
- Moment of Inertia:** 4.1 X 10⁻⁴ oz-in-sec²
- Weight:** 13 oz typical

Electrical Specifications

- Code:** 14 or 15 bits NB or GC
- Counts Per Shaft Turn:** 16,384 or 32,768
- Count Transition Accuracy:** ± 1/2 bit maximum
- Supply Voltage:** 5–28 VDC
- Current Requirements:** 120 mA typical

Output Formats:

- Parallel: Gray Code, Natural Binary
- Serial: Serial Synchronous Interface (SSI) compatible

Voltage/Output:

- 28V/V: Line Driver, 5–28 VDC in, V_{out} = V_{in}
- 28V/5: Line Driver, 5–28 VDC in, V_{out} = 5 VDC
- 28V/OC: Open Collector, 5–28 VDC in, OC_{out}
- SSI: 5–28 VDC I_{in}/5V_{out} (see page 46)

Protection Level:

- Reverse, overvoltage and output short circuit protection (see note 5)

Frequency Response:

- 500kHz

Output Termination Pinouts:

- See table page 47

Environmental Specs

Reference the H25 Incremental Encoder, pgs. 18–19

Connector

MS3112E14-19P, 19-pin connector on encoder body, mates to MS3116J14-19S (or equivalent)

NOTES & TABLES: All notes and tables referred to in the text can be found on pages 64–65.



The H25X series single turn encoder is designed for those applications that require 14 or 15 bits of resolution in a compact, easy-to-integrate package. Gray Code and Natural Binary outputs are available for installations using a parallel input with the controller. For simplicity of data transmission, ease of cabling and better noise immunity, an SSI (Serial Synchronous Interface) is also offered. This encoder works with the BEI Serial-to-Parallel converter, allowing for system upgrades from parallel output to SSI.

The H25X is built to the exacting mechanical standards used with the H25 design, including: dual preloaded ABEC 7 bearings; matched thermal coefficients on critical components and electronically centered code disks for high accuracy and stability over a range of environments. Specify the H25X when you need high pointing accuracy and ruggedness in a 14 or 15 bit absolute encoder for your telescope, antenna, robotics, material handling or general industrial automation.

Certifications



H25XD - Square Flange

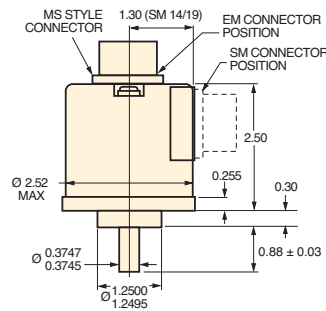
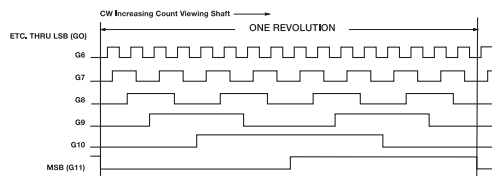


Figure 1 Gray Code



H25XE - 2.50 Servo Mount

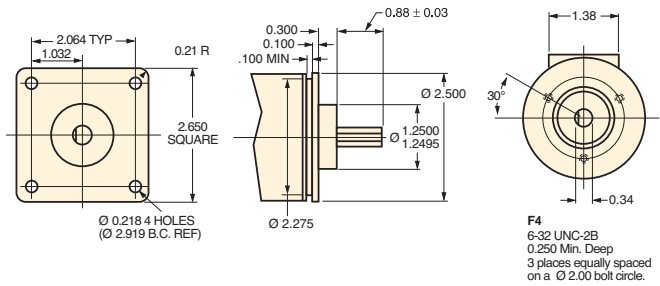
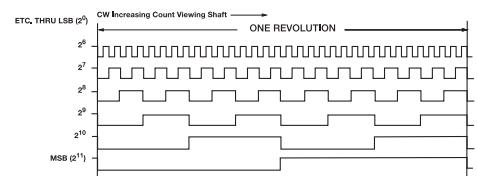


Figure 2 Natural Binary

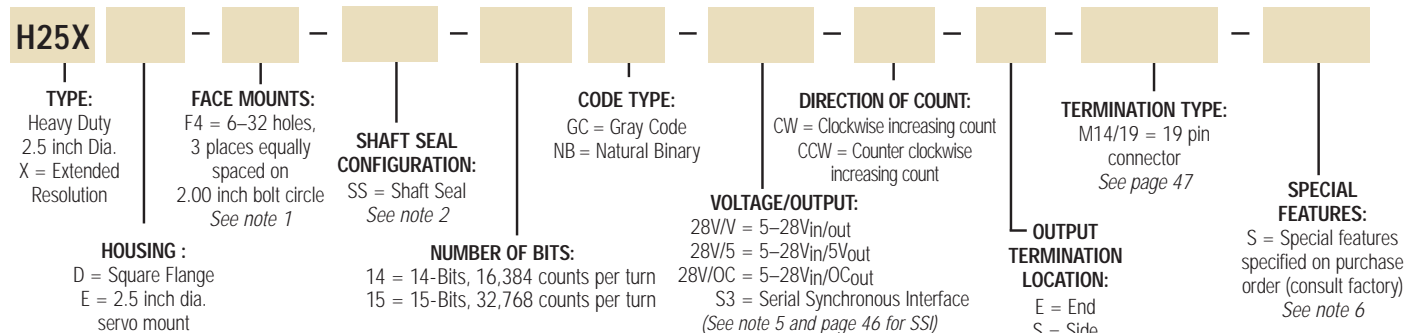


H25X Absolute Encoder Ordering Options

FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: H25XD-F4-SS-14GC-28V/V-CW-SM14/19).

All notes and tables referred to can be found on pages 64–65.



HMT25 Absolute Multi-Turn Encoder



The HMT25 geared multi-turn encoder provides absolute position information over multiple turns of the input shaft. It keeps track of the exact position even during periods of power loss without the need for a battery backup. The HMT25 series is capable of outputs up to 4096 counts per turn and can count up to 4096 turns—a total of 24 bits or 16,777,216 positions. Units are enclosed in a 2.5-inch diameter sealed package to withstand rugged environments and they carry an IP 66 environmental rating. These encoders meet the long travel and high resolution requirements of robotics, rolling mills, rotary tables, cable winding, printing, converting and material handling systems.

Mechanical Specifications

- Shaft Diameter:** 0.375" (0.5" optional)
- Flat on Shaft:** 0.80" long x 0.030" deep
- Shaft Loading:** 40 lbs axial, 36 lbs radial (90 lbs axial and 80 lbs radial with 0.5" shaft)
- Shaft Runout:** 0.0005 TIR at midpoint of shaft
- Starting Torque at 25°C:** 2.5 in-oz (max)
- Bearings:** Dual, preloaded, Class ABEC 7
- Shaft Material:** 416 stainless steel
- Bearing Housing:** Die cast aluminum with protective finish
- Cover:** Die cast aluminum
- Bearing Life:** 1×10^{10} at 10% rated load
- Maximum RPM:** 6,000 (see frequency response, below)
- Moment of Inertia:** 4.3×10^{-4} oz-in-sec²
- Weight:** 16 oz nominal

Electrical Specifications

- Code:** Natural binary, gray code or SSI
- Counts per Shaft Turn:** 4096, 12 bits
- Number of Turns:** up to 4096, 12 bits
- Supply Voltage:** 5–28 VDC
- Current Requirements:** 130 mA typical + load, 250mA (max)
- Voltage/Output:** (See note 5)
- 28V/V: Line Driver, 5–28 VDC in, $V_{out} = V_{in}$
- 28V/5: Line Driver, 5–28 VDC in, $V_{out} = 5$ VDC
- 28V/OC: Open Collector, 5–28 VDC in, OCout
- SSI: 5–28 VDCin/5Vout (see page 41)
- Frequency Response:** 100 kHz
- Protection Level:** Overvoltage, reverse voltage. Outputs short-circuit protected (1 minute max)
- Output Termination Pinouts:** See Tables, page 41

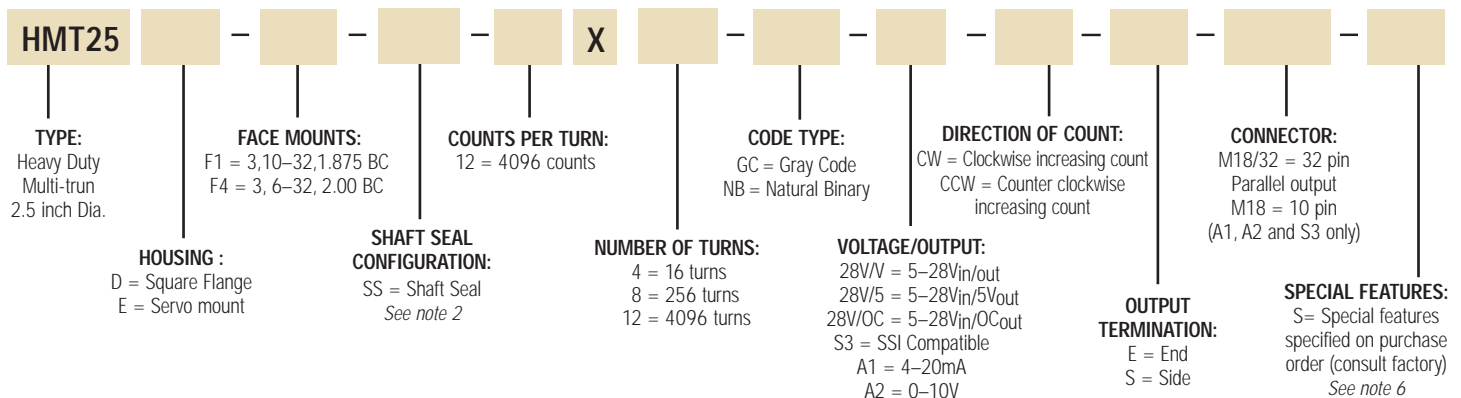
Environmental Specifications

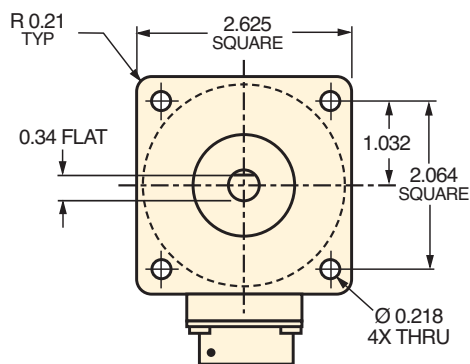
- Enclosure Rating:** IP66
- Temperature:** Operating, 0° to 70° C; Extended, -40° to +85° C; Storage, -20° to 90° C (to -40° if extended range is called out)
- Shock:** 50 g's 11 msec
- Vibration:** 5 to 2000 Hz @ 20 g's (see special note page 41)
- Humidity:** 98% Non-condensing

HMT25 Multi-Turn Encoder Ordering Options FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: HMT25D-SS-12X12GC-28V/V-CW-SM18/32).

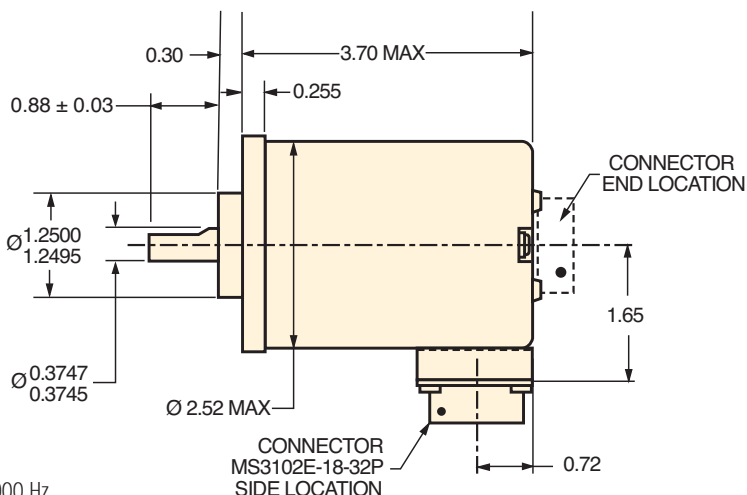
All notes and tables referred to can be found on pages 64–65.





Special note on vibration testing:

Test profile is 0.3 g's ramp to 20 g's from 5 to 40 Hz and 20 g's from 40 Hz to 2000 Hz.



HMT25 Output Terminations for Parallel Output¹

PIN	FUNCTION (2)	PIN	FUNCTION (2)
A	T11 (MSB)	T	F7
B	T10	U	F6
C	T9	V	F5
D	T8	W	F4
E	T7	X	F3
F	T6	Y	F2
G	T5	Z	F1
H	T4	a	F0 (LSB)
J	T3	b	N/C
K	T2	c	LATCH
L	T1	d	DIR CONTROL
M	T0 (LSB)	e	ENABLE (Option)
N	F11 (MSB)	f	N/C
P	F10	g	0 V
R	F9	h	+V
S	F8	j	CASE GND

(1) Parallel output uses a MS3112E18-32P, 32 Pin connector on the encoder body (2) TXX = Turns counts, FXX = Fine resolution counts

Direction of Count: The HMT25 comes standard with a Direction of Count bit. Normal operation is CW increasing count when viewed from the shaft end. This pin is normally pulled HI internally. To reverse the count direction, this pin must be pulled LO (Circuit Common). Optionally this can be designated as CCW increasing count when HI, in which case LO will be CW increasing count.

Latch: Outputs are active and provide continuous information when this pin is HI. When this pin is pulled LO (Circuit Common) the outputs are latched at the logic state that is present when the latch is applied and will stay latched until this pin is no longer LO. This pin is pulled HI internally.

Enable (optional): This option allows the operator to momentarily deactivate the outputs from the encoder. This may be useful in instances where the outputs from several different encoders must be sampled independently. Output is active when this pin is HI. When pulled LO (Circuit Common) all outputs go to high impedance state (Tri-state) and are inactive until the LO state is removed. This pin is pulled HI internally. To order this option on the HMT25 make sure the model number has -S on the end, followed by the description, -S = output enable.

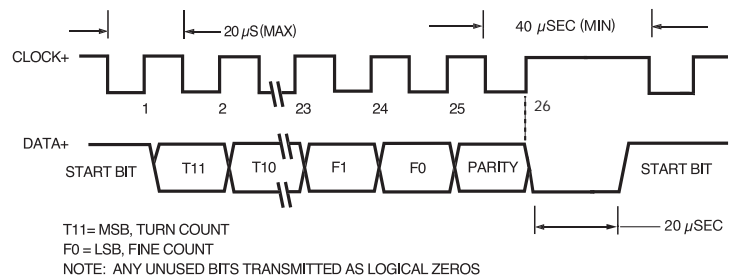
HMT25 Output Terminations for Optional 24 Bit SSI Output

FUNCTION	CABLE	CONNECTOR*	TERM BOARD (H38 & H40 ONLY)	
			H38	H40
DATA+	YEL	A	4	1
DATA-	WHT/YEL	H	7	7
CLOCK+	BLU	B	5	2
CLOCK-	WHT/BLU	I	8	8
DIRECTION OF COUNT	ORN	C	6	3
ENABLE (Optional)	VIOLET	E	9	—
RESET (Optional)	WHT/ORN	J	10	9
+V (SUPPLY VOLTAGE)	RED	D	3	4
0 V (CIRCUIT COMMON)	BLK	F	2	5
CASE GROUND	GRN	G	1	6

*Connector is an MS3102E18-1P, 10-pin connector on the encoder body and mates to an MS3106F18-1S connector or can be used with a standard cable/ connector assembly, BEI part 924-31186-18XX. (Where XX = 10, 20, or 30 for a 10, 20 or 30 foot cable length.)

RESET (Optional): The Reset pin (Pin J) is normally HI and is pulled up internally to the positive supply voltage. To activate the Reset function, Pin J must be pulled LO by connecting it to signal common for 1 second or greater. This causes the present encoder position to be stored into non-volatile memory as an offset value and the output of the encoder is then set to the value of "0". The encoder will retain this offset even if the power is turned off and on again. A new "0" position can be set by rotating the encoder shaft to a new position and then activating the Reset pin again. To order this option for the HMT25, make sure the model number has -S on the end followed by the description, -S = Reset.

24 Bit, SSI Compatible Output Timing



L18 Absolute Encoder



The L18 absolute encoder provides system designers with high precision in a small, lightweight package. This small industrial encoder features a 13-bit absolute SSI output in a 1.8-inch servo package. The L18 encoder contains field-proven ASIC electronics, sealed bearings and BEI's accurate code disk in an all metal housing to ensure its ruggedness and reliability. Ideal for space or weight limited applications requiring high accuracy, including semiconductor fabrication, mobile platforms and industrial robotics.

Mechanical Specifications

Shaft Diameter: 1/4"
Shaft Loading: 2 lbs axial and radial max
Shaft Runout: .002: max
Starting torque at 25° C: 1 oz-in max.
Bearings: Shielded
Shaft Material: Stainless steel
Bearing Housing: Aluminum
Cover: Aluminum
Bearing Life @2 lbs max. Radial Shaft Loading: 1.2 x 10⁶ revs
Maximum RPM: 500 (mechanical)
Moment of Inertia: 0.5 x 10⁻⁴ in-oz-sec²
Weight: 6 oz max

Electrical Specifications

Code: 13 Bits Natural Binary or Gray Code
Counts per Shaft Turn: 8192
Supply Voltage: 5–28 VDC
Current Requirements: 120 mA typical
Voltage/Output: SSI: 5–28 VDC in/5Vout
Frequency Response: 100 kHz
Protection Level: Reverse, overvoltage and output short circuit protection (see note 5)
Output Termination Pinouts: See table 1, this page

Environmental Specifications

Enclosure: IP66
Temperature: 0° C to +70° C; extended range testing available (see note 8); Storage, -25° to 90°
Shock: 50 g's for 11 msec (1/2 sine)
Vibration: 20 to 2000 Hz @ 20 g's
Humidity: 98% RH non-condensing

NOTES & TABLES: All notes and tables referred to in the text can be found on pages 64–65.

Certifications EN 55011 and EN 61000-6-2

Figure 1 Gray Code

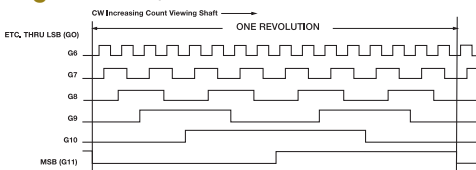
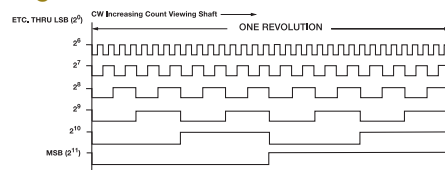
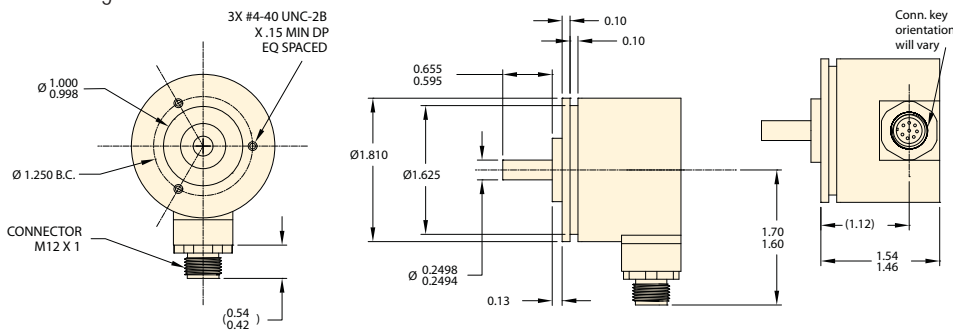


Figure 2 Natural Binary



L18 Diagram



CONN. PIN	FUNCTION
1	DATA +
2	+V
3	DATA -
4	CLOCK +
5	CLOCK -
6	N/C
7	OV
8	N/C

L18 Absolute Encoder Ordering Options

FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: L18E-F71-SS-13NB-S3-CW-SK8).

All notes and tables referred to can be found on pages 64–65.

L18	–	E	–	F71	–	SS	–	13	–		–	S3	–	CW	–	SK8	–		
TYPE: L = Light Duty 18 = 1.8" diameter		HOUSING: E = Standard		FACE MOUNT: F71 = Standard		SHAFT SEAL CONFIGURATION: SS = Shaft Seal (See note 2)		NUMBER OF BITS: 13 = 13 bits, 8192 counts		CODE TYPE: GC = Gray Code NB = Natural Binary		VOLTAGE/OUTPUT: S3 = Serial Synchronous Interface (See note 5 and page 46 for SSI)		DIRECTION OF COUNT: CW = Clockwise increasing count		TERMINATION TYPE: SK8 = Side mounted, M12x1, 8 Pin (Euro style)		SPECIAL FEATURES: S = Special feature specified on purchase order (consult factory) See note 6	

HS35 Absolute Encoder

Electrical Specifications

Code: 12 or 13 bits NB or GC
Counts Per Shaft Turn: 4096 or 8192
Count Transition Accuracy: $\pm 1/2$ bit maximum
Supply Voltage: 5–28 VDC
Current Requirements: 120 mA typical
Output Formats: Parallel: Gray Code, Natural Binary
Voltage/Output: (see note 5)
 15V/V: Line Driver, 5–15 VDC in, $V_{out} = V_{in}$
 28V/V: Line Driver, 5–28 VDC in, $V_{out} = V_{in}$
 28V/5: Line Driver, 5–28 VDC in, $V_{out} = 5$ VDC
 28V/OC: Open Collector, 5–28 VDC in, OC_{out}
 SSI: 5–28 VDC in/ $5V_{out}$ (See page 46)
Protection Level: Reverse, overvoltage and output short circuit protection
Frequency Response: 100kHz (1200 RPM for 12-bits)
Output Termination Pinouts: See table page 47

Mechanical & Environmental Specs

Shaft Bore: 1.000, 0.875, 0.750, 0.625, 0.500.
 Diameters under 0.875 are supplied with insulated sleeves.
Allowable Misalignment: 0.005" T.I.R. on mating shaft 0.75" from shaft end
Bore Runout: 0.001 T.I.R. maximum
Starting Torque at 25°C: Through shaft version (SS) = 7 in-oz (max); Blind shaft version (BS) = 4 in-oz max
Bearings: 52100 SAE High carbon steel
Shaft Material: 416 Stainless Steel
Bearing Housing: Die cast aluminum with protective finish
Cover: Die cast aluminum with protective finish
Bearing Life: 7.5×10^9 revs (50,000 hours @ 2500 RPM)
Maximum RPM: 6,000 mechanical (see frequency response, above)
Moment of Inertia: 0.019 oz-in-sec²
Weight: 18oz typical
Connector
 MS3112E14-19P, 19-pin connector on encoder body, mates to MS3116J14-19S (or equivalent)

NOTES & TABLES: All notes and tables referred to in the text can be found on pages 64–65.



Built on the same rugged design as the incremental model, the HS35 Absolute Encoder is available with various output options including Gray Code and Natural Binary. Designed with a cast aluminum housing, a sealed connector and shaft seals, it carries an IP65 environmental rating. With the optional insulating inserts, it can be mounted on smaller diameter shafts. It is designed for either a through shaft mounting or blind shaft mounting with a closed cover to maintain its environmental rating.

Certifications EN 55011 and EN 61000-6-2

Figure 1 Gray Code

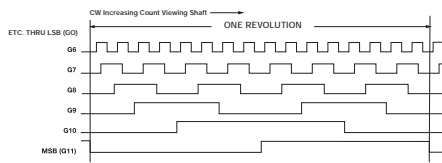
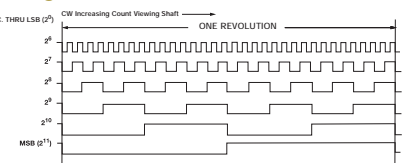
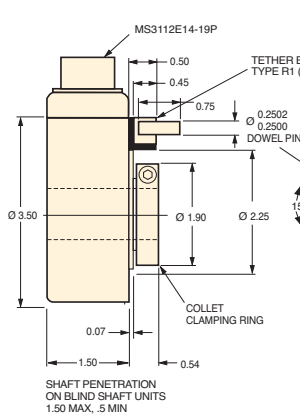


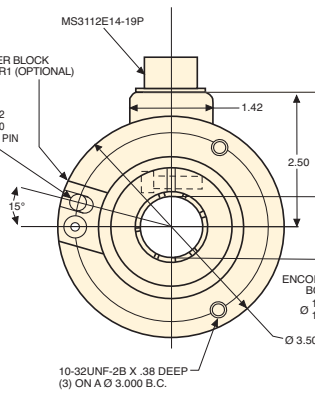
Figure 2 Natural Binary



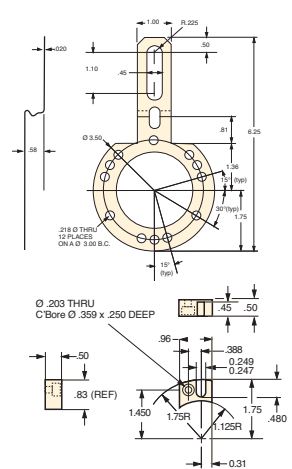
MS Connector Termination



R1 Tether Block and Pin



R2 Tether Arm



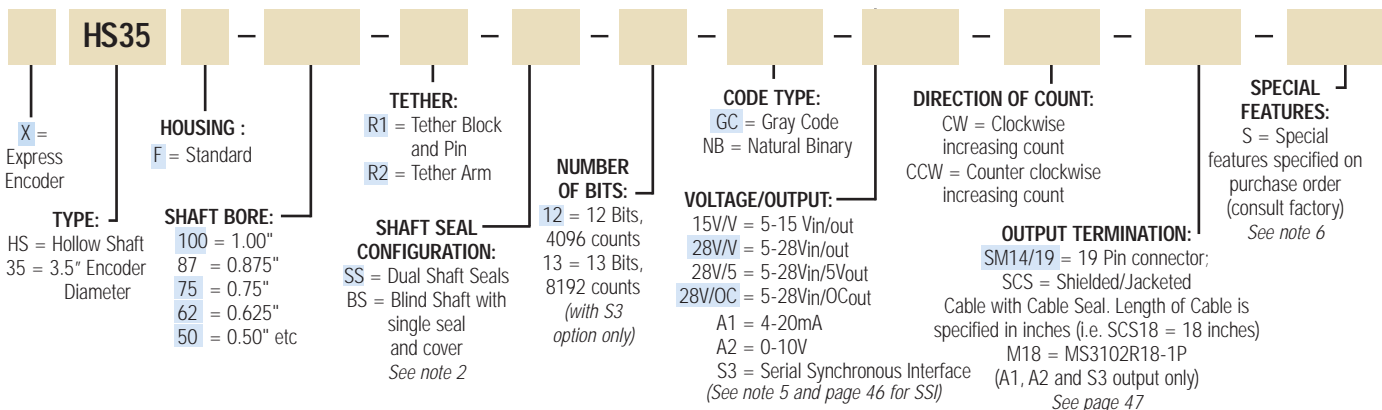
TOLERANCES: .XX=±0.01, .XXX=±0.005
 For M18 Connector, See Drawing on Page 25.

HS35 Absolute Encoder Ordering Options

FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: HS35F-100-R1-SS-12GC-28V/V-CW-SM14/19).

All notes and tables referred to can be found on pages 64–65.



EXPRESS ENCODERS® Items highlighted with are standard Express Encoders and ship in one to three days.

H38 Absolute Explosion-Proof Encoder



This is the same Explosion Proof rated encoder as the H38 Incremental, in an absolute encoder version with output up to 13 bits of resolution. When your application needs the ability to recover position information quickly after a power loss and you are operating in a hazardous area—the H38 may be the answer to your needs.

Electrical Specifications

Code: 12 or 13 bits NB or GC; excess gray and BCD available

Counts Per Shaft Turn: 4096 or 8192

Count Transition Accuracy: ± 1/2 bit maximum

Supply Voltage: 5–28 VDC

Current Requirements: 120 mA typical

Output Formats: Parallel: Gray Code, Natural Binary and Binary Coded Decimal; Serial: Serial Synchronous Interface (SSI); Analog: 4–20 mA, 0–10V

Voltage/Output: (see note 5)
 28V/V: Line Driver, 5–28 VDC in, $V_{out} = V_{in}$
 28V/5: Line Driver, 5–28 VDC in, $V_{out} = 5$ VDC
 28V/OC: Open Collector, 5–28 VDC in OC_{out}
 SSI: 5–28 VDC in/5V $_{out}$ (see page 46)

Protection Level: Reverse, overvoltage and output short circuit protection

Frequency Response: 100kHz (1200 RPM for 12-bits, 600 RPM for 13-bits)

Output Termination Pinouts: See table page 47

Mechanical Specifications

Shaft Diameter: 3/8" nominal

Flats On Shaft: Two flats, 0.80" long X 0.30" deep at 90°

Shaft Loading: Up to 40 pounds axial and 20 pounds radial applied 1/4" from housing

Shaft Runout: 0.0005 T.I.R.

Starting Torque at 25° C: 4.0 in-oz (max)

Bearings: Class ABEC 7 standard

Shaft Material: 303 stainless steel

Enclosure: Die cast aluminum, hard anodized with dichromate sealed finish. Shaft seals and sealed bearings are standard to achieve environmental ratings.

Bearing Life: 2 X 10⁸ revs (1300 hrs at 2500 RPM) at rated load; 1 X 10¹⁰ revs (67,000 hrs at 2500 RPM) at 10% of rated load

Maximum RPM: 10,000 RPM (see frequency response, below)

Moment of Inertia: 4.1 X 10⁻⁴ oz-in-sec²

Weight: 64 oz typical (approx 4 lbs)

Environmental Specifications

Enclosure Rating: NEMA 4 X & 6 (IP66), outdoor Non-Hazardous locations, NEMA 4 X & 13 (IP66), indoor Non-Hazardous locations

Temperature: Operating, 0° to 70° C; extended temperature testing available (see note 8, pg 64); 80° C max for UL and CEN approved units; storage; -25° to 90° C.

Shock: 50 g's at 11 msec

Vibration: 5 to 2000 Hz @ 20 g's

Humidity: 100% RH

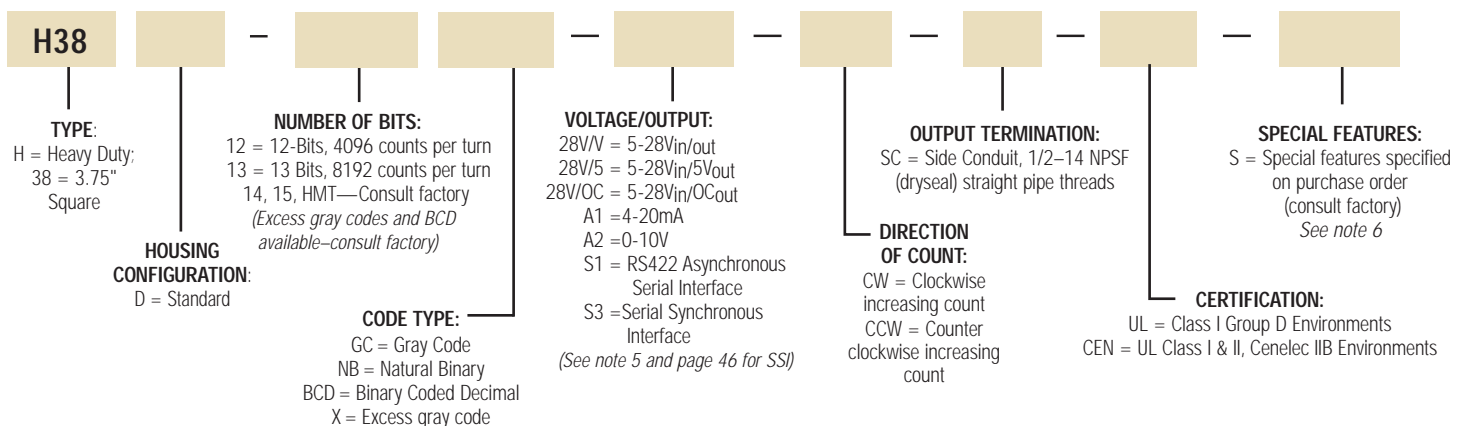
Hazardous Area Rating: Underwriters Laboratories listed for use in hazardous locations; NEMA Enclosure 7. Class 1, Group C & D, Division 1, NEC Class 2 circuits only, or Class 2, Groups E, F, and G (see page 48, Table 2.2)

NOTES & TABLES: All notes and tables referred to in the text can be found on pages 64–65.

H38 Absolute Encoder Ordering Options FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: H38D-12GC-28V/V-CW-SC-UL).

All notes and tables referred to can be found on pages 64–65.



H40 Absolute Shock-Proof Encoder



Built to the same rugged standards as the H40 Incremental Heavy Duty encoder, this unit features an absolute encoder output up to 13 bits of resolution. Designed to take the rigors of physically demanding environments, the H40 has a heavy-duty housing, a 100+ pound bearing, and internal shock absorbers. When you need absolute position in a really tough environment—the H40 absolute is what you need.

Electrical Specifications

Code: 12 or 13 bits NB or GC; excess gray and BCD available

Counts Per Shaft Turn: 4096 or 8192

Count Transition Accuracy:
± 1/2 bit maximum

Supply Voltage: 5–28 VDC

Current Requirements: 120 mA typical

Output Formats: Parallel: Gray Code, Natural Binary and Binary Coded Decimal; Serial: Serial Synchronous Interface (SSI) compatible; Analog: 4–20 mA, 0–10V

Voltage/Output: (see note 5)

28V/V: Line Driver, 5–28 VDC in, $V_{out} = V_{in}$

28V/5: Line Driver, 5–28 VDC in, $V_{out} = 5$ VDC

28V/OC: Open Collector, 5–28 VDC in OCout

SSI: 5–28 VDC in/5Vout (see page 46)

Protection Level: Reverse, overvoltage and output short circuit protection

Frequency Response: 100kHz

(1200 RPM for 12-bits, 600 RPM for 13-bits)

Output Termination Pinouts: See table page 47

Mechanical Specifications

Shaft Diameter: 5/8" nominal

Flats On Shaft:

Two flats, 0.75" long X 0.30" deep at 90°

Shaft Loading/Bearing Life:

Refer to Figure 1, page 31

Shaft Runout: 0.001" T.I.R. at mid-point of shaft

Starting Torque at 25° C: 10.0 in-oz (max)

Bearings: Class 52100 SAE high carbon steel

Shaft Material:

1070 carbon steel, 303 stainless steel optional

Enclosure: Die cast aluminum, hard anodized with optional sealed finish. Shaft seals and sealed bearings are standard to achieve environmental ratings.

Maximum RPM: 10,000 RPM

(see Frequency Response)

Coupling Windup: The H40 uses an internal coupling. Windup error (degrees) = $a \times 7.5 \times 10^{-4}$ rad/sec² where a = angular acceleration in rad/sec²

Weight: Approx 9 lbs

Environmental Specifications

Enclosure Rating: NEMA 4 X & 6 (IP66), outdoor Non-Hazardous locations, NEMA 4 X & 13 (IP66), indoor Non-Hazardous locations

Hazardous Area Rating: The optional Underwriters Laboratories listed version is for use in hazardous locations; NEMA Enclosure 7, Class 1, Group D, Division 1, NEC Class 2 circuits only (see page 48, Table 2.2)

Temperature: Operating, 0° to 70° C; extended temperature testing available (see note 8, pg 64); 80° C max for UL and CEN approved units; storage; -25° to 90° C

Shock: 200 g's at 11msec

Vibration: 5 to 2000 Hz @ 20 g's

Humidity: 100% RH

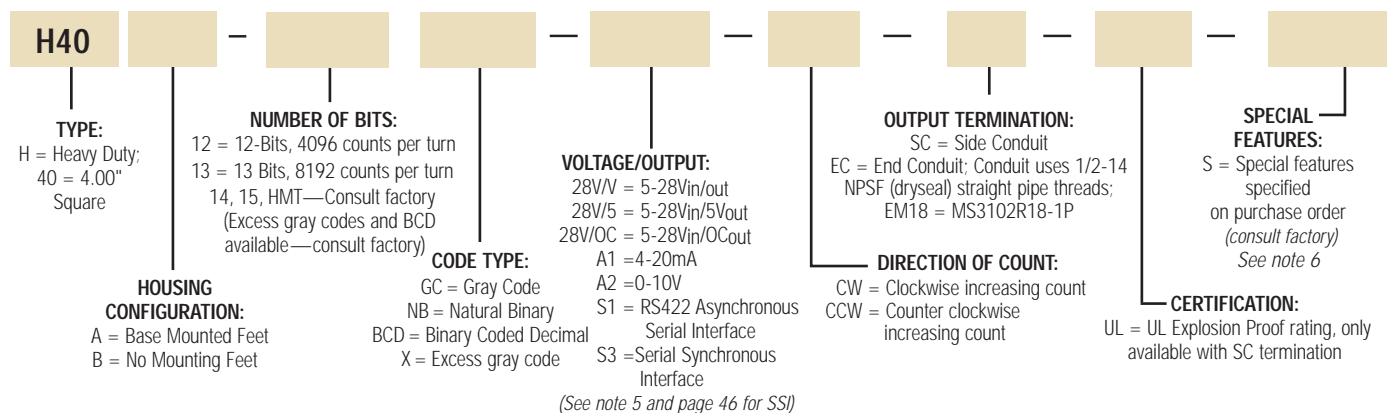
NOTES & TABLES: All notes and tables referred to in the text can be found on pages 64 and 65.

H40 Absolute Encoder Ordering Options

FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: H40A-12GC-28V/V-CW-SC-UL).

All notes and tables referred to can be found on pages 64–65.



Parallel Absolute Output

The two most common types of absolute outputs are the Gray Code and the Natural Binary. Resolution for absolute encoders is expressed in "bits" where each successive bit increases the resolution by a factor of two. For example, 10 bits = $2^{10} = 1024$ counts per revolution.

Natural binary code (Figure 1) is constructed so that the code counts up using the natural sequence of binary counting, i.e. 000, 001, 010, 011, 100 . . . etc. The drawback to using this code sequence is that at several count positions the code will have transitions on multiple bits simultaneously. Due to the normal variations caused by gate delays, line impedances, etc. the actual transitions will not occur simultaneously. Reading data during one of these times could result in an erroneous reading. This can be overcome by taking multiple readings.

Gray code (Figure 2), by contrast, is designed to avoid the multiple transition problem entirely. It is specifically constructed so that only one bit will transition at a time. This ensures that state changes are much less ambiguous to the controller and is generally considered to be a more robust type of absolute code.

Regardless of the code type, one of the characteristics of absolute encoders is that they can readily be used for any resolution up to and including their maximum resolution. For example, a 12 bit encoder can be used at only 8 bits by ignoring (or disconnecting) the four lowest significant bits (LSB). This enables an installation that uses multiple absolute encoders to use the same encoder throughout with each controller using only the bits that it needs.

Figure 1 Natural Binary

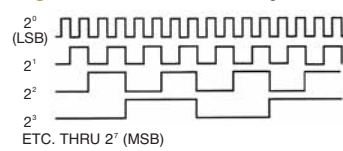
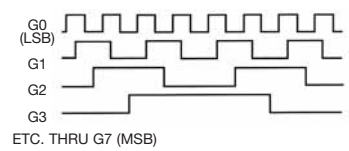


Figure 2 Gray Code



Ordering 8-Bit Absolutes

For years, we produced encoders with a maximum resolution of 8 bits. Lots of those old 8 bit encoders are still around. We update them to newer 12 bit designs on a case-by-case basis. If you have an 8 bit encoder, here is how that model number was constructed: **Direction of Rotation, Count, Code** and **Latch** designators were inserted between **Shaft Seal Configuration** and **Voltage/Output** as shown below. To specify an equivalent encoder based on the 12 bit design, please call our Applications Specialists at **800-ENCODER** (800-362-6337) or check our website at www.beiied.com.

Direction of Rotation: CCW or CW

Count: 8

Code: GC = Gray Code or NB = Natural Binary

Latch: L = Latch or Blank=None

Output Terminations: EM20=MS3102R20-29P or ED25=DB25P; SM18 = MS3102R18-1P; C18 = Cable, with length specified in inches. Specify ED25 for Line Driver Outputs.

Example: H25E-F1-SS-CCW-8GC-28V/V-EM20

(one possible encoder configuration with the 8-Bit Absolute Option.)

Serial Synchronous Interface (SSI)

SSI output provides effective synchronization in a closed-loop control system. A clock pulse train from a controller is used to clock out sensor data: one bit of position data is transmitted to the controller per one clock pulse received by the sensor. The use of a differential driver permits reliable transmission of data over long distances in environments that may be electrically noisy. The encoder utilizes a clock signal, provided by the user interface, to time the data transmission. Receiving electronics must include an appropriate receiver as well as line terminating resistors.

Features

- Synchronous transmission
- Transmission lengths to 1000 feet
- Accepts clock rates from 100 KHz to 1.8 MHz

Data Transmission Sequence

1. Output driver of the encoder is a MAX 491 transceiver in transmit mode. The recommended receiver is a MAX 491 transceiver in receive mode.
2. Controller provides a series of pulses (or differential pulse pairs) on the CLOCK input lines.
3. On the first HIGH-to-LOW CLOCK transition, the encoder latches its data at the current position and prepares to transmit.
4. Controller reads data on the falling edge of the next 15 clock cycles.
5. The first bit is a START bit and is always HIGH.
6. Next comes 13 data bits beginning with the most significant bit (MSB) and ending with the parity bit. On 12 bit encoders, bit 13 is LOW. When parity is not ordered, parity is LOW.
7. After the DATA bits, the DATA line goes LOW and remains LOW for a minimum of 20 microseconds between the end of the DATA bits and the beginning of the next CLOCK series.

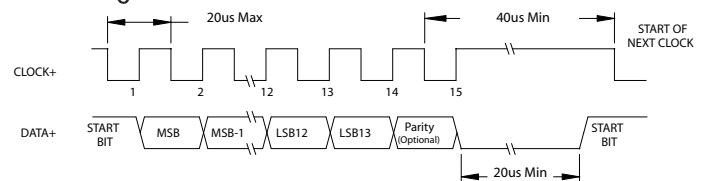
Interfacing Long Data Lines

Cable impedance can create a transmission delay, in effect, shifting the phase relationship between the clock pulse and the data. If this phase shift exceeds 180°, then the wrong bit position will be sampled by the receiver. As a result, the maximum allowable clock frequency is a function of the cable length. For 24 AWG, stranded, 3 pair cable (BEI part number 37048-003 or equivalent) the group delay is 1.36ns/ft. The table below shows the maximum transmission rate allowable as a function of cable length to ensure a phase shift of less than 90°.

CLOCK, Maximum (kHz) = 92,000 / Cable Length (ft)CW

Cable Length (ft)	50	100	200	300	500	1000
Max Freq (kHz)	1800	900	500	300	200	100

SSI Timing



Ordering SSI

HOW TO SPECIFY SSI OUTPUT IN THE ENCODER MODEL NUMBER:

Use the designation, S3 between the **Code Format** designation and the **Connector** designation.

Example: H25D-SS-12GC-S3-CW-SM18



Single Turn Absolute Encoder Options

The tables below are reference for pinouts, connections and operation of BEI's single turn absolute encoders. These absolute options are available in a wide range of package styles with a variety of outputs. The applicability table below shows which combinations are currently available. As always, you can call us at **800-350-ASAP (2727)** for immediate applications assistance should you have any questions.

Output Code and Terminations (12 & 13 Bit)								
PARALLEL CODE					TERMINATION TYPE			
	Gray Code		Natural Binary		Binary Coded Decimal	Cable	M14/19 Conn	Term Board H38 & H40
	12 Bit	13 Bit	12 Bit	13 Bit				
MSB	G ₁₁	G ₁₂	2 ¹¹	2 ¹²	A ₀	WHT/BLK	A	1
	G ₁₀	G ₁₁	2 ¹⁰	2 ¹¹	B ₀	WHT/BRN	B	2
	G ₉	G ₁₀	2 ⁹	2 ¹⁰	C ₀	WHT/RED	C	3
	G ₈	G ₉	2 ⁸	2 ⁹	D ₀	WHT/ORN	D	4
	G ₇	G ₈	2 ⁷	2 ⁸	A ₁	WHT/YEL	E	5
	G ₆	G ₇	2 ⁶	2 ⁷	B ₁	WHT/GRN	F	6
	G ₅	G ₆	2 ⁵	2 ⁶	C ₁	WHT/BLU	G	7
	G ₄	G ₅	2 ⁴	2 ⁵	D ₁	WHT/VIO	H	8
	G ₃	G ₄	2 ³	2 ⁴	A ₂	WHT/GRY	J	9
	G ₂	G ₃	2 ²	2 ³	B ₂	WHT	K	10
	G ₁	G ₂	2 ¹	2 ²	C ₂	GRY/BLK	L	11
LSB ₁₂	G ₀	G ₁	2 ⁰	2 ¹	D ₂	GRY/BRN	M	12
LSB ₁₃		G ₀		2 ⁰	A ₃	GRY/RED	N	13
	0V (CIRCUIT COMMON) ¹				B ₃	GRY/ORN	P	
	DIRECTION OF COUNT					ORN	R	18
	CASE GROUND					GRN	S	16
	0 V (CIRCUIT COMMON)					BLK	T	15
	LATCH CONTROL					YEL	U	17
	+V (SUPPLY VOLTAGE)					RED	V	14
	SHIELD DRAIN					BARE	—	

¹Pin P is available for a tri-state option

Output Applicability Table								
	12 BITS PARALLEL	13 BITS PARALLEL	14/15 BITS	12x12 BITS	S3 SSI	S1 RS422	A1 4-20mA	A2 0-10 V
H25	•	•			•	•	•	•
H25X			•		•			
HS35	•				•		•	•
H38	•	•		•	•	•	•	•
H40	•	•		•	•	•	•	•
HMT25				•	•		•	•

Direction of Count: Standard is CW increasing when viewed from the shaft end. Pin R is normally HI (or N/C) and is pulled up internally to +V. To reverse the count direction, Pin R must be pulled LO (COMMON).

Latch control: Encoder outputs are active and provide continuous parallel position information when Pin U is HI (or N/C). Pin U is pulled up internally to +V. When Pin U is LO (COMMON) the encoder outputs are latched at the logic state that is present when the latch is applied and will stay latched until Pin U is no longer grounded.

Parallel Code (14 & 15 Bit) ²					
	Gray Code		Natural Binary		M14/19 Connector
	14 BIT	15 Bit	14 BIT	15 Bit	
MSB	G ₁₃	G ₁₄	2 ¹³	2 ¹⁴	A
	G ₁₂	G ₁₃	2 ¹²	2 ¹³	B
	G ₁₁	G ₁₂	2 ¹¹	2 ¹²	C
	G ₁₀	G ₁₁	2 ¹⁰	2 ¹¹	D
	G ₉	G ₁₀	2 ⁹	2 ¹⁰	E
	G ₈	G ₉	2 ⁸	2 ⁹	F
	G ₇	G ₈	2 ⁷	2 ⁸	G
	G ₆	G ₇	2 ⁶	2 ⁷	H
	G ₅	G ₆	2 ⁵	2 ⁶	J
	G ₄	G ₅	2 ⁴	2 ⁵	K
	G ₃	G ₄	2 ³	2 ⁴	L
	G ₂	G ₃	2 ²	2 ³	M
	G ₁	G ₂	2 ¹	2 ²	N
LSB14	G ₀	G ₁	2 ⁰	2 ¹	P
LSB15	DIR CONTROL	G ₀	DIR CONTROL	2 ⁰	R
	CASE GROUND				S
	OV (CIRCUIT COMMON)				T
	LATCH	DIR/LATCH	LATCH	DIR/LATCH	U
	+V (SUPPLY VOLTAGE)	+V (SUPPLY VOLTAGE)	+V (SUPPLY VOLTAGE)	+V (SUPPLY VOLTAGE)	V

²Units Manufactured before April 2007 are LSB Justified.

SSI Output Termination Table					
	M18 CONN	M14/19 CONN	CABLE CONN	TERM. BOARD	
				H38	H40
DATA +	A	A	YEL	4	1
DATA-	H	B	WHT/YEL	7	7
CLOCK+	B	C	BLU	5	2
CLOCK-	I	D	WHT/BLU	8	8
DIR CONTROL	C	R	ORN	6	3
CASE GROUND	G	S	GRN	1	6
CIRCUIT COMMON	F	T	BLK	2	5
+V SUPPLY VOLTAGE	D	V	RED	3	4
SHIELD DRAIN	—	—	BARE	—	—

Dir/Latch on 15-Bit Encoders: Due to a limited number of connector pins, either direction of count or latch is available on pin U.

M18 Connector is a MS3102R18-1P, 10-pin connector on the encoder body and mates to an MS3106F18-1S connector or can be used with a standard cable/connector assembly, BEI P/N 924-31186-18XX (Where XX = 10, 20 30 or 50 for a 10, 20, 30, or 50 foot length). This is the preferred connector for SSI output.

M14/19 Connector is a MS3112E14-19P, 19-pin connector on the encoder body and mates to an MS3116J14-19S or equivalent.

Hazardous Location Information

Do you need encoders designed for hazardous environments? To keep pace with the growth of complex industrial processes, BEI has developed rugged, quality encoders that meet high standards and certifications for use in potentially explosive environments. There are a variety of protection methods available depending on the circumstance of a particular installation. For optical encoders, the most commonly used methods are explosion proof construction and intrinsic safety, detailed below:

Explosion Proof Construction Method





In this encoder protection technique the equipment is contained in an enclosure that can withstand an internal explosion of the most volatile gas-to-air mixture that can penetrate into the interior of the encoder enclosure. The enclosure must contain the explosion without damage

and without allowing the flame to leave the enclosure through any joints or other openings.

Intrinsic Safety Method

This encoder protection technique uses an apparatus that limits the maximum level of current and voltage (usually measured as energy in millijoules) that can be delivered into the hazardous location. This equipment ensures that even in a double fault condition, there will not be enough energy to ignite the gas or vapor in that area. Note that encoders that use this method of protection, must use energy limiting devices (commonly called Barriers) in their installation. An Intrinsically Safe encoder, installed without an Intrinsic Safety Barrier is not an Intrinsically Safe system.

Table 2.1—European and N. American Intrinsic Safety Approvals

Encoder Type	Output Driver	Input VDC	 CENELEC/ATEX	 U.S. Standards	 Canadian U.S. Standards Class I, Div. I, Group	 c U.S. Standards Class II, Div I, Group	System Diagram Class I, Div I, Zone 0
H25, L25, E25, HS25 ¹ , H35, HS35, H37, H38, or H40	4469	5	EEx ia IIC T4	A, B, C, D	E, F, G	Group IIC	924-08062-001, 002, or 003
	3904R	5	EEx ia IIC T4	A, B, C, D	E, F, G	Group IIC	924-08063-001 or 002
	3904	5	EEx ia IIC T4	A, B, C, D	E, F, G	Group IIC	924-08064-001 or 002
	3904	9	EEx ia IIB T4	C, D	E, F, G	Group IIB	924-08064-001 or 002
H20 ² , H25 ³ , HS20 ⁴ , HS25 ⁴ , HS35 ^{2,3} , HS45 ²	5V/V	5	EEx ia IIC T4	A, B, C, D	E, F, G	Group IIC	924-08172-001, or 002
	5V/OCR	5	EEx ia IIC T4	A, B, C, D	E, F, G	Group IIC	924-08173,-001, or 002
	5V/OC	5	EEx ia IIC T4	A, B, C, D	E, F, G	Group IIC	924-08174-001, or 002
	9V/OC	9	EEx ia IIB T4	C, D	E, F, G	Group IIB	924-08174-001, or 002

¹ Rating only available with 4469 output driver

² Single and dual output versions available

³ Line driver version available with interpolation T2, T3, T4, T5, T8, T12, T16

⁴ Rating only available with 5V/V

Table 2.2 – Europe and North American “Explosion Proof” Approvals




Encoder Type	 CENELEC/ATEX	 c US NEMA 7 U.S. Standards Class I, Div I, Group:	 c US NEMA 7 U.S. Standards Class II, Div I, Group:
H38 (Standard)		D	
H38 (w/ Labyrinth Seal)	EExd IIB T4	C, D	E, F, G
H40		D	

Table 3 – Hazardous Environment Groups

GAS GROUPS		DUST GROUPS
Class I		Class II
Division 1 & 2	Zone 0,1 & 2	Division 1 & 2
A (acetylene)	IIC (acetylene & hydrogen)	E (metals)
B (hydrogen)		F (coal)
C (ethylene)	IIB (ethylene)	G (grain)
D (propane)	IIA (propane)	



Encoders with metal connector or conduit terminations are rated to EN 55011 and EN 61000-6-2. For plastic connector, pigtail or shielded/jacketed cable terminations, consult factory

Model HS35 Drawworks Optical Hollow-Shaft Encoder

Single and Dual Output Options

This specifically configured drawworks Model HS35 encoder combines rugged, heavy-duty features into a unique through-shaft style for use as a winch-turns counter in the drawworks system of oil rigs. It is supplied with a standard 1"-14 diameter threaded connection and a convertible adapter that allows its use in systems with a 5/8"-18" threaded connection.



Dual Output Drawworks Encoder

The dual output option of the HS35 drawworks encoder can supply simultaneous position feedback to two separate systems from a single encoder.

Shaft Bore: 0.375" diameter through with convertible adapter for 1" or 5/8" air coupler.

Bearing Housing: Die cast aluminum, hard anodized with dichromate sealed finish

Output Format: 2 channels (A and B) in quadrature, with index and complements (see Figure 1, page 24)

Cycles Per Shaft Turn: Up to 80,000 (See table A, page 25)

Supply Voltage: 5 or 9V (Supplied through IS barrier)

Current Requirements: 120mA (typical)

Output Termination: See table 1, page 65

Temperature: -40° to +85°C standard

NOTE: Reference HS35 Incremental Encoder for further electrical, mechanical and environmental specs, pages 24-25

Certifications

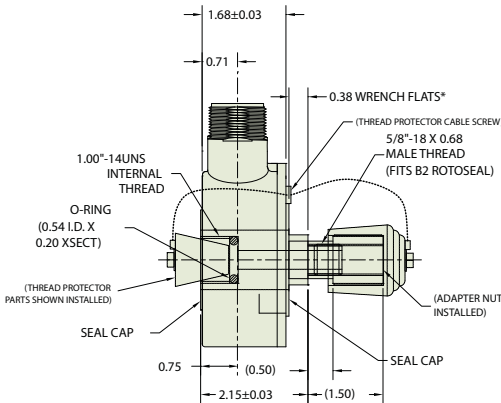
EN 55011 and EN 61000-6-2

CENELEC EEX ia IIC T4

U.S. Standards Class I, Group A,B,C & D; Class II Group E, F & G

Canadian Standards Class I, Zone O, Group IIC

HS35 MS Connector Termination

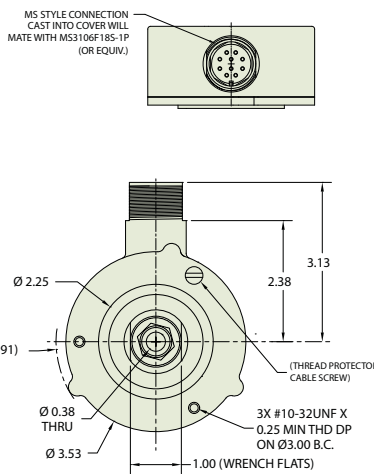


Model number

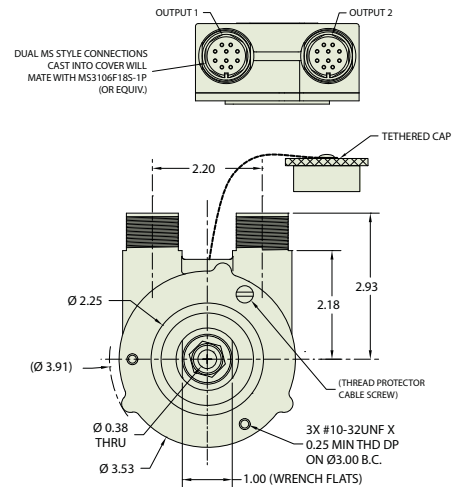
HS35F-1-14-SS-100-ABZC-5V/V-SM18-EX-S

-S = Threaded shaft (convertible), hard anodized, gross leak test, wrench 40203 included, shaft seal caps

*Extended tool face available. Adds 0.38 to shaft length.



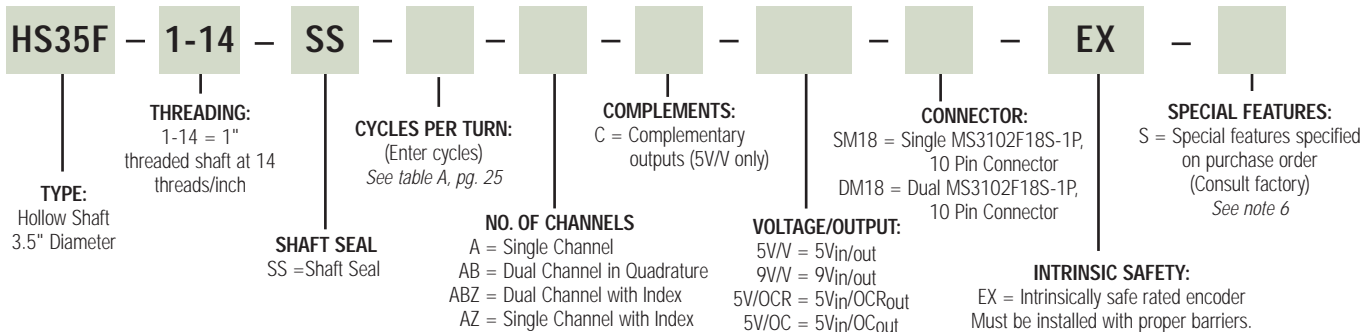
HS35 Dual Output



Drawworks Ordering Options

FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number.



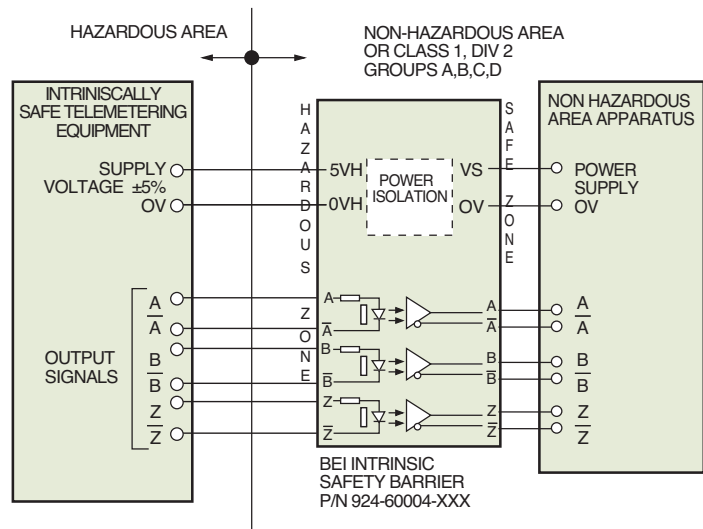
Intrinsic Safety Barrier



This Galvanically Isolated Electronic Module is the perfect complement to our Intrinsically Safe Encoders. Together with our cable assemblies they constitute a completely engineered solution to operation in Class I and Class II Division 1 Hazardous Environments. This single barrier provides both power and signal isolation for an incremental encoder with differential quadrature outputs and an index. This all-in-one approach saves the cost and inconvenience of buying separate power and signal barriers as required by other systems. This barrier is galvanically isolated and saves the added cost of maintaining a high integrity earth ground. With differential line driver outputs, this barrier can be used to carry signals up to 500 feet with a bandwidth of up to 250 kHz.

The Intrinsic Safety Barrier Module is designed around a standard DIN Rail mounting (Type EN 50 022, 35 mm X 7.5 mm) for easy installation in standard enclosures.

Intrinsic Safety Barrier Specifications				
POWER SUPPLY/OUTPUT TYPE				
Part Number:	Barrier Supply Vs +/-5%	Output logic to Non-Hazardous Area Apparatus:		
924-60004-002	12-24 Volts	V _{out} = 5V Line Driver 100mA Source/Sink		
924-60004-003	12-24 Volts	V _{out} = V _{in} (Nominal) Line Driver 100mA Source/Sink		
924-60004-004	12-24 Volts	Open Collector NPN 80mA Sink		
BARRIER PARAMETERS				
Voltage Supply	Voc (Uo) Isc (Io)	Class I, Group D Class II, Groups E,F,G Group IIA	Class I, Group C Group IIB	Class I, Groups A,B Group IIC
+5V DC±5%	8.9V 345mA	Ca(Co) La(Io) 560 µF 2.0 mH	Ca(Co) La(Io) 40 µF 0.80 mH	Ca(Co) La(Io) 5.2 µF 0.4 mH

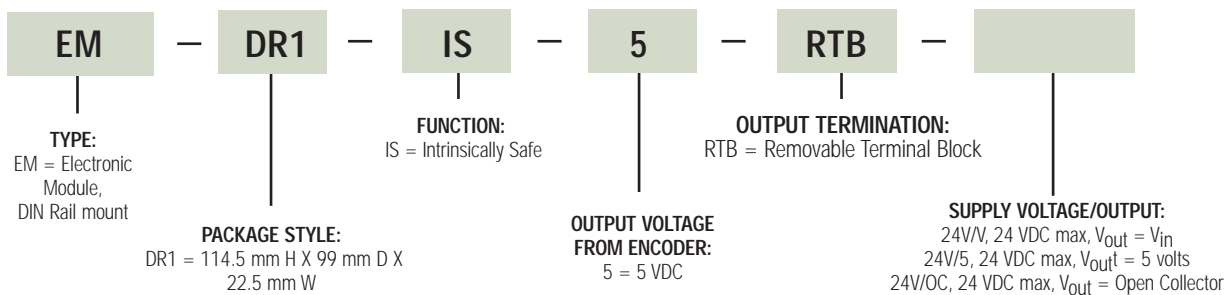


Note: This system diagram is for general information only. Installation must be consistent with BEI Installation Drawing 924-08067-001.

Intrinsic Safety Barrier Ordering Options for assistance call 800-350-2727

Use this diagram, working from left to right to construct your model number (example: EM-DR1-IS-5-RTB-24V/V).

All notes and tables referred to can be found on pages 64-65.



Encoders for Extreme Environments

These specialty encoders have been designed for use in extreme environments such as wash down, water immersion, chemical or other wet or dirty environments.

Environmentally Sealed Encoders

Through the use of a magnetic shaft coupling connection, Model ES is completely sealed with an IP67+ environmental rating. This coupling connection isolates the encoder from high shock and vibration, and makes it dust tight and impervious to debris or liquid in the environment. Model ES encoders can even operate while fully immersed in one meter of water. Since the Model ES is not physically coupled to external equipment, it is much more tolerant of shaft misalignment. Ideal for applications with heavy wash-downs, temporary water immersions, excessive environmental debris.

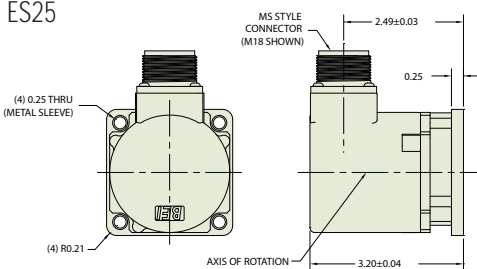


Maximum RPM: 5,000 RPM
Enclosure: Aluminum (sealed aluminum castings)
Weight: 18 oz
Supply Voltage: 5 to 28 VDC
Enclosure Ratings: IP67/IP68 (consult factory for IP68 applications)
Model ES25 Cycles per Shaft Turn: 1 to 2,048 (see Table 1, this page)
Model ES20 Cycles per Shaft Turn: 1 to 1,024 (see H20 Resolutions Table A, page 20)

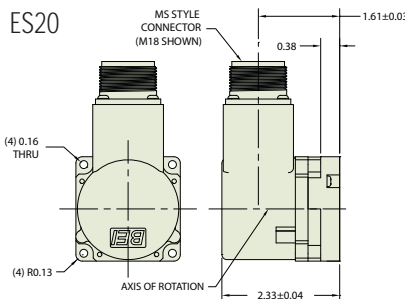
Table 1 ES25 Resolutions

1	2	3	5	6	8	10	11	13	16	20	24	25
26	30	32	33	34	36	37	40	45	48	50		
51	60	64	66	72	75	80	86	88	90	100		
102	120	122	125	127	128	132	144	148				
150	158	160	175	176	180	187	192	200				
202	217	220	240	250	254	255	256	274				
280	283	288	292	300	312	320	321	325				
360	366	372	375	377	380	381	384	385				
393	400	430	432	450	462	480	490	500				
502	508	512	522	530	550	576	598	600				
604	625	628	635	638	640	660	687	690				
700	720	725	735	740	744	748	750	762				
768	780	785	800	812	825	850	864	878				
888	900	912	914	938	942	955	960					
1000	1016	1024	1030	1035	1036	1040						
1054	1056	1074	1076	1080	1088	1100						
1101	1125	1136	1200	1237	1250	1257						
1270	1280	1300	1314	1332	1333	1390						
1400	1414	1427	1440	1484	1500	1562						
1570	1596	1600	1650	1666	1718	1745						
1774	1800	1850	1855	1875	1894	1920						
1952	1968	1979	1995	2000	2048							

ES25



ES20



Environmentally Sealed Incremental Encoder Ordering Options FOR ASSISTANCE CALL 800-350-2727

[]	-	[D]	-	[]	-	[]	-	[ABZC]	-	[]	-	[S]	-	[M18]	-	[S]
TYPE: ES25 = 2.50" Diameter Housing ES20 = 2.0" Diameter Housing		HOUSING CONFIG: D = Square Flange		MAGNETIC HUB BORE: 25 = 0.250" 37 = 0.375" Blank = None		CYCLES PER TURN: For ES25 = 1 to 2048 (see table this page) For ES20 = 1 to 1024 (see H20 resolutions table A, page 20)		CHANNELS ABZC = Dual with index and complements		VOLTAGE/OUTPUT: 28V/V = 5-28V _{in} /out 28V/5 = 5-28V _{in} /5V _{out} 28V/OCR = 5-28V _{in} /OC _{out} See note 5		OUTPUT LOCATION S = Side		OUTPUT TERMINATION M18 = MS3102R18-1P		SPECIAL FEATURES: Consult Factory

Stainless Steel Encoders



Harsh industrial applications often expose plant equipment to caustic chemical materials, resulting in premature deterioration and failure. Now you can prevent costly equipment downtime and replacement by ordering your Model H25 or Model H20 encoders with a 304 series stainless steel encoder body and bearing housing. This provides exceptional resistance to the corrosive agents often found in wash-down, salt water and chemical environments.

Stainless steel encoders are ideal for use in chemical, petrochemical, oilfield, food, and medical industries.

Note: When ordering stainless steel encoders, add a -S to the end of the H25 or H20 model number and specify this feature on the purchase order. See page 19 for Model H25 ordering options and page 20 for Model H20 ordering options.



A Linear Encoder with a Unique Stainless Steel Scale

IP 67 Rated

The BEI linear encoder combines the advantages of inductive sensing with the versatility of differential quadrature outputs. Its design includes a sealed stainless steel scale and a potted read head for an IP67 environmental rating, allowing it to operate even while submerged. This rugged construction gives the LN encoder shock and vibration tolerances far surpassing those of glass scales. Harnessing the power of digital signal processing (DSP) technology, the LN provides industry standard differential quadrature outputs in 5 to 28 VDC line driver, 5 volt regulated or open collector style outputs at traverse rates nearly twice that of typical linear encoders. Repeatable to ± 1 count and available in resolutions as fine as $0.5\mu\text{m}$, the LN encoder is a tough, dependable and highly adaptable solution to a wide variety of positioning challenges. Applications include process control, robotics and pick-and-place operations.

Mechanical Specifications

- Accuracy:** $\pm .0004"$ ($\pm 10\mu\text{m}$)
- Repeatability:** \pm one count
- Resolutions:** $.00002"$ to $.0004"$ ($0.5\mu\text{m}$ to $10\mu\text{m}$)
- Maximum Traverse Rate:** Up to 20m /sec @ $10\mu\text{m}$ resolution (dependent on resolution)
- Index:** every 1/2 inch (12.7mm)
- Max Scale Length, Single End Mount:** 14" (35.6cm)
- Max Scale Length Between Supports:** 59" (150 cm)
- Maximum Scale Length:** 433" (11 M)

Electrical Specifications

- Operating Voltage:** 5–28V +/-5%
- Output Format:** 2 channels in quadrature, reference marker every 1/2 inch
- Output Options:**
 - Differential Line Driver: 5-28 VDC, $V_{\text{out}} = V_{\text{in}}$
 - Line Driver: 5–28 VDC, $V_{\text{out}} = 5\text{VDC}$
 - Open collector, accepts 5–28 VDC

Cable Length: 40"

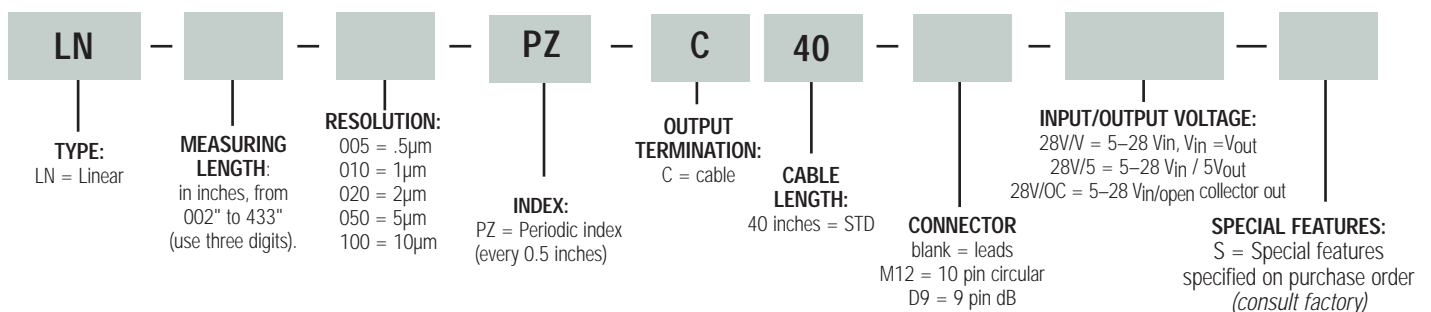
Electrical Connection: flying leads, M12 or DB9

Environmental Specifications

- Operating Temperature:** 0° to 70°C
- Storage Temperature:** -20° to 70°C
- Ingress Protection:** IP67 (> NEMA 6)
- Shock (11 msec):** 100g (IEC 68-2-6)
- Vibration (55 to 2000 Hz):** 30g (IEC 68-2-27)
- Magnetic Field Susceptibility:** 1000 gauss

Linear Encoder Ordering Options FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: LN-030-050-PZ-C40-28V/V).



LN Linear Encoder Features

IP67 Environmental Rating:

The system resists contamination and can operate even when completely submerged. No costly air purging system is required.

Universal Mounting Adapters:

Installation is quick and simple. It is not necessary to machine a flat surface for mounting.

Shock Tolerance of 100g's:

The scale is 30 times more shock resistant than glass scales. The risk of breakage and lost productivity is greatly reduced.

Non-contacting Design:

No parts to wear out, eliminating costly maintenance.

Industry-leading Traverse Times:

The mechanical advantages of a wrap-around read head combine with the processing power of an onboard DSP to allow traverse speeds of up to 20 meters per second.

All Steel Scale:

Offering a thermal expansion coefficient that matches the workpiece more closely than a glass scale, resulting in greater accuracy and repeatability shift-to-shift, day-to-day, year-to-year.

Variety of Standard Electrical Interfaces:

The encoder is compatible with standard counters, controllers, PLC's and computer interfaces, allowing it to be easily integrated into existing systems.

Temperature Range of 0° to 70° C:

Offering reduced thermal errors and dependable operation in a wide variety of industrial environments.

Vibration Tolerance of 30g's:

50% more vibration tolerant than glass, for a reduced risk of breakage, even in tough conditions.



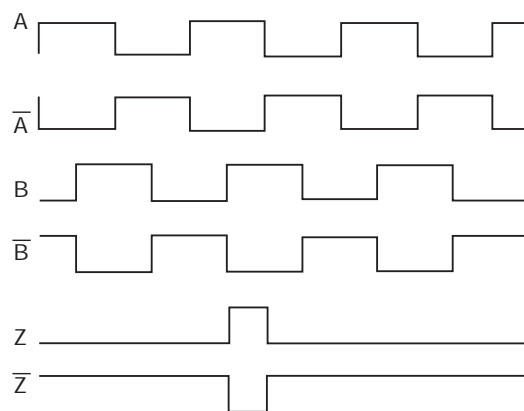
Compatible digital displays are available (See page 58)

Mounting brackets are included with the Linear Incremental Encoder



Manufactured by Newall Measurement Systems LTD., U.K., a Division of Custom Sensors & Technologies

Figure 1 Output Waveform



A leads B for → travel of scale through read head when viewing front face

Table 1—LN Linear Encoder Connections

WIRE COLOR		D9	M12	FUNCTION
28V/5	28V/V OR 28V/OC			
Dk Green	Lt Green	2	A	A
Blue	Brown	4	B	B
Violet	Pink	8	C	Z
Black	Black	7	D	+V, 5-28VDC
-	-	1	E	N/C
White	White	6	F	0V
bare	bare	-	G	Case Ground
Yellow	Wh/Lt Green	3	H	A̅
Red	Wh/Brown	5	J	B̅
Gray	Wh/Pink	9	K	Z̅

BEI's SwiftComm wireless sensor interface ushers in a whole new era of wireless industrial control



Now the machine designer is free to install sensor equipment without the expense and constraints of a hard-wired system. Encoder installations in difficult applications like cranes, rotating tables or mobile applications, are greatly simplified. The SwiftComm system includes the transmitter-receiver pair, which communicates using a point-to-point frequency-hopping 2.4 GHz RF protocol. Because of its flexible input/output electronics, it can interface with many different industrial sensors and control systems. Simply connect the SwiftComm transmitter to the sensor and the SwiftComm receiver to your control system and apply power. That's it! No complicated cabling required.

SwiftComm's proprietary radio protocols include a broad security code range, data encryption, handshaking, interference recovery, and error checking that together provides a secure and robust wireless interface system. Ruggedness and flexibility are further enhanced with SwiftComm's NEMA 4 weatherproof enclosures, panel mounting options, antenna choices and wide-range DC power inputs.



A Wide Variety of Industrial Applications

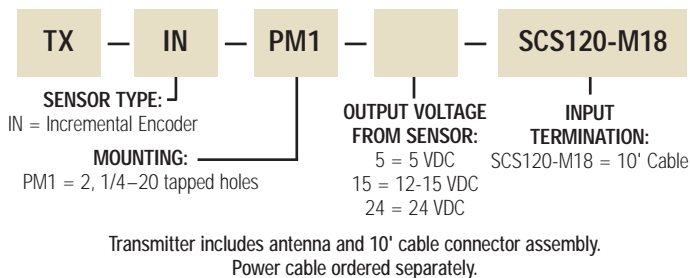
SwiftComm is suitable for use in many different industrial applications. However, certain conditions allow the user to receive the most benefit from its use. In applications where long, expensive cable lengths are needed, SwiftComm can provide a very cost effective alternative to hard wiring. If cabling of any length is damaged often in a system and needs constant replacement, SwiftComm can be a viable solution. A wireless interface is ideal for use in applications with a clear line-of-sight between the transmitter and receiver. Although SwiftComm can work around some obstructions, the best performance will be achieved where the radios have a clear line-of-sight. This is a very robust and reliable wireless interface system, and will work in many different kinds of industrial applications. Here are just a few examples:

- Crane & Hoist
- Dam Control
- Printing Press
- Drawbridge
- Irrigation
- Factory Automation
- Drawworks
- Mining
- Top Drives

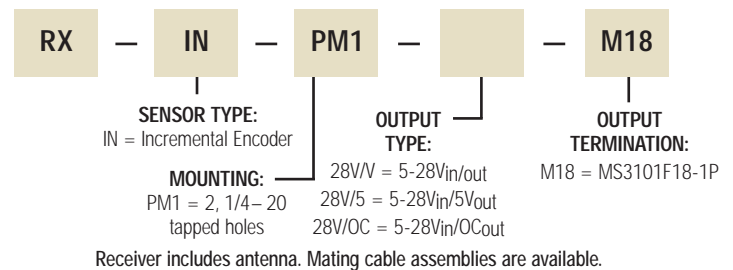
SwiftComm Ordering Options for assistance call 800-350-2727

Order Note: The Transmitter and Receiver are sold as pairs. Sensor type must be the same for Transmitter and Receiver modules

TRANSMITTER MODEL NUMBER



RECEIVER MODEL NUMBER



SwiftComm's Unique Advantages

Robust Signal

BEI's SwiftComm operates on the 2.4 GHz ISM radio band and uses Adaptive Frequency Hopping Protocol (AFH). This helps avoid data interruptions due to frequency interference. If a particular radio channel encounters interference, SwiftComm seamlessly hops to another open channel. This technology decreases the susceptibility to interference thereby increasing overall reliability. The SwiftComm hopping algorithm uses 77 ISM channels in a pseudo-random sequence. To enhance RF link reliability even more, when SwiftComm detects interference on a channel, that channel is dropped from the hop sequence and SwiftComm will avoid using that channel in the future. If the available channels list ever becomes exhausted, previous dropped channels are retested to see if they are clear.

SwiftComm's patent pending technology can even overcome data loss due to link interruption. Internally and transparent to the user, SwiftComm keeps track of the encoder's output signal. If SwiftComm encounters packet loss from temporary link interruption, it fills in the encoder's output information based on the historical data trend. It then processes this information in place of the lost packet. SwiftComm corrects for any accumulated error and seam-

lessly sends the corrected data to the controller. So, even in environments where occasional packets are lost, SwiftComm will transmit a continuous stream of data to the control system.

Real-Time Control

It is critical in any motion control applications to have minimum lag time in signal transmission. Delays in data to the controller can cause major problems. SwiftComm is one of the fastest wireless sensor interfaces available. Data is relayed between the transmitter and receiver every 600 microseconds (μ s). Because SwiftComm is a point-to-point configuration, there is no inherent latency.

Secure Transmission

SwiftComm provides a very secure system for your data to travel wirelessly. The transmitter and receiver each have a 40-bit hard coded security code. These codes are programmed at the factory and give the system a range of over 500 billion possible unique codes. BEI has developed its own proprietary protocol for SwiftComm, which is not available to the public. Additionally, the data is transmitted with a high-level encryption algorithm and pseudo-random frequency hopping. This provides additional levels of data security to assure that your data is protected.

Long Range

Because motion control applications can vary widely, SwiftComm was designed with a 50 mW radio. This provides SwiftComm with reliable long-range communication. In most open situations, a reliable link distance of up to 1,000 feet is possible. Inside buildings, a reliable link distance on the order of 300 feet can be expected.



United States FCC ID: VSR-SWIFTCOMM07

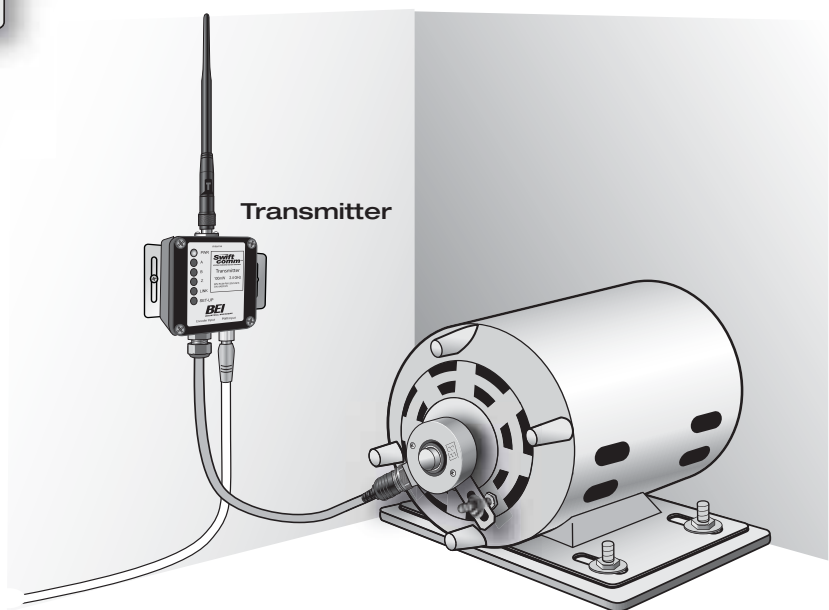
Canadian IC: 7445A-SWIFTCOMM07

Licensed in US and Canada only

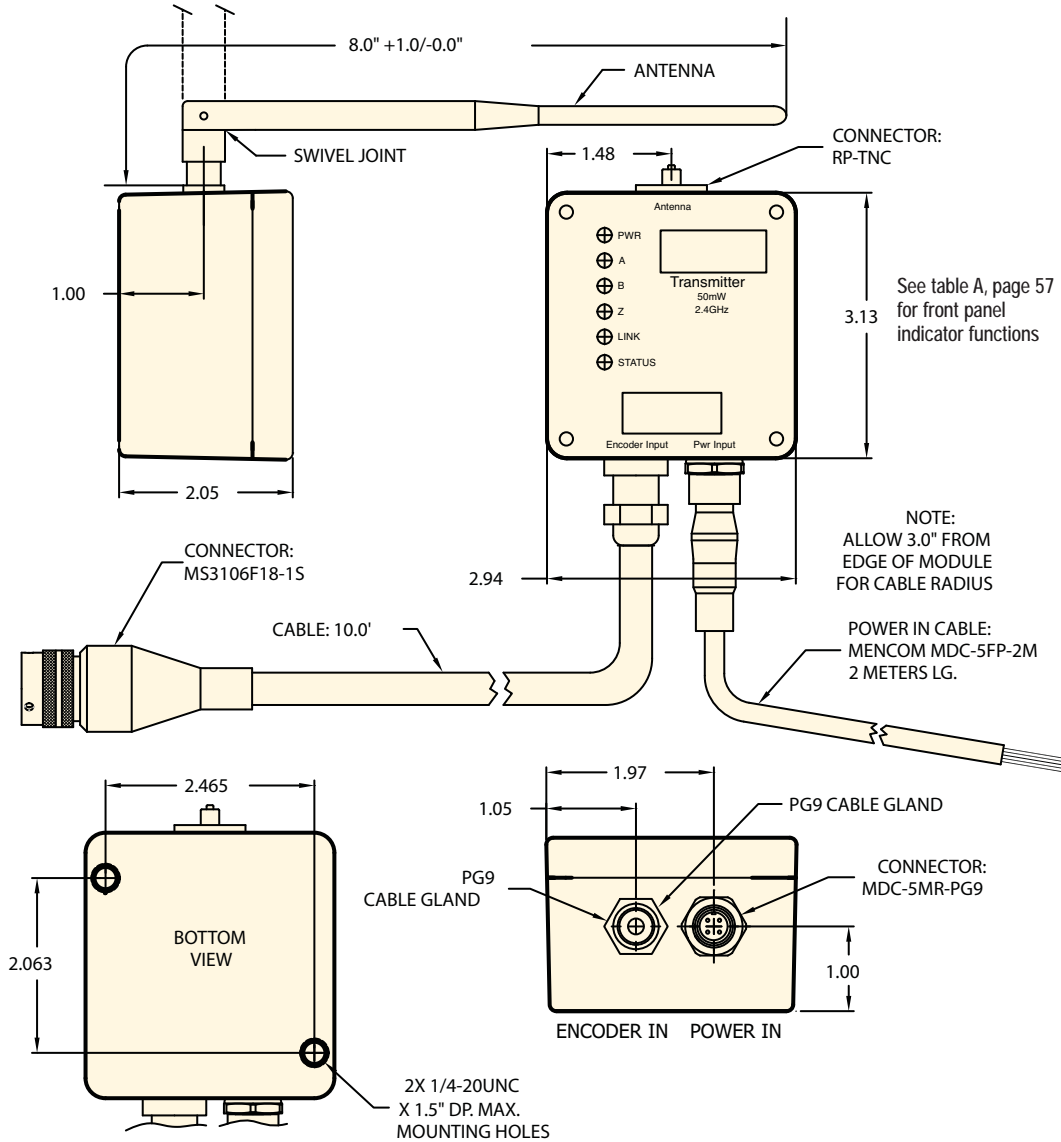
To satisfy RF exposure requirements, this device and its antenna must operate with a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

This device has been designed to operate with an antenna having a maximum gain of 5.5dBi. Antenna having a higher gain is strictly prohibited per regulations of Industry Canada. The required antenna impedance is 50 ohms.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than the required for successful communication.



SwiftComm Transmitter Module



Transmitter: Pwr Input & BIT Output (5 Pin Connector)

PIN	FUNCTION
1	+V (Supply Voltage)
2	B.I.T Output*
3	0V (Circuit Common)
4	—
5	Case Ground

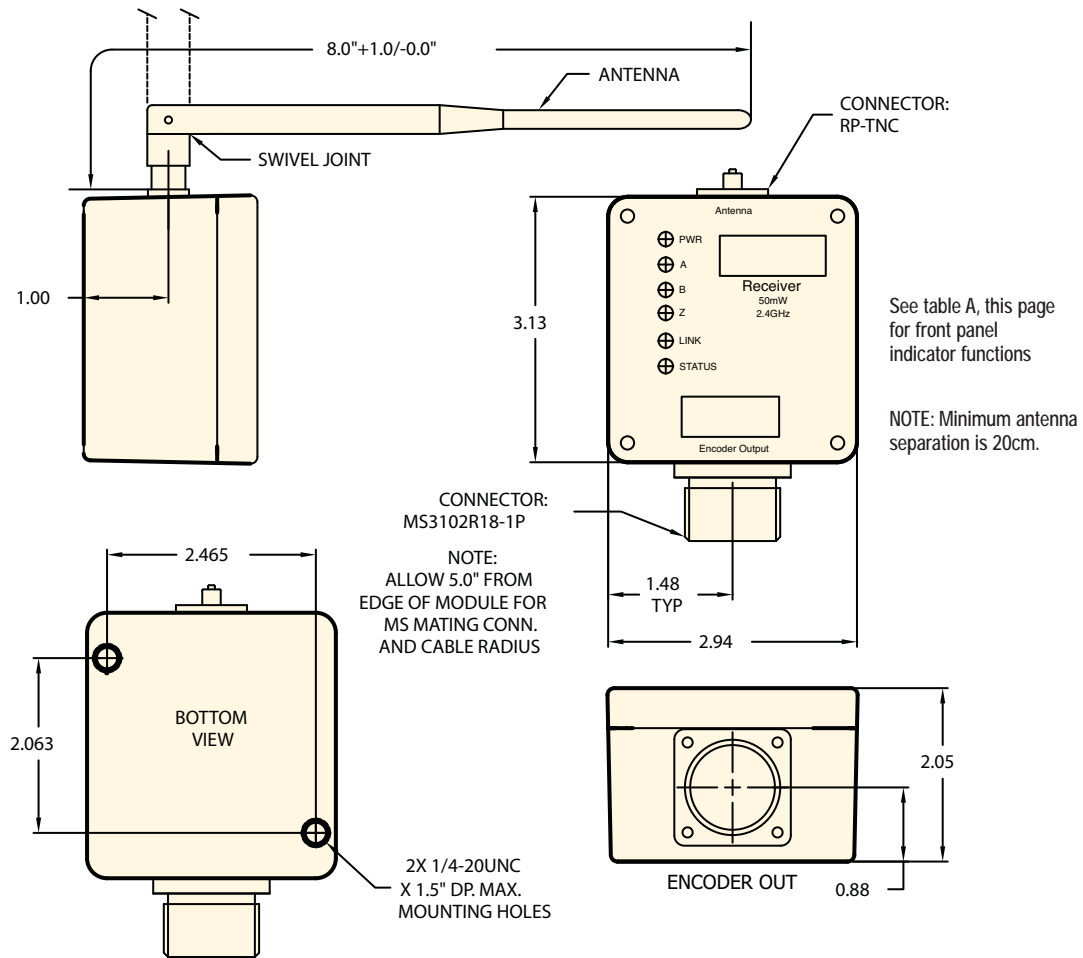
*If transmission is interrupted for longer than 0.13 seconds the status of this pin will change from LO to HI. B.I.T. is HI at +V level.

The SwiftComm Transmitter Module has two connector plugs: a 5-pin connector for power input, B.I.T output and chassis ground; and a 3-meter (10 foot) cable with a 10-pin MS connector attached to the end.

Transmitter: Encoder Input (MS3106F18-1S or 10 ft pigtail)

PIN	FUNCTION	PIN	FUNCTION
A	A	F	0V (Supply to Encoder)
B	B	G	Case Gnd
C	Z	H	\bar{A}
D	+V (Supply to Encoder)	I	\bar{B}
E	—	J	\bar{Z}

SwiftComm Receiver Module



The SwiftComm Receiver Module has an MS connector that provides the same output signals as a standard BEI encoder. Input power can be from 5 to 28 VDC. Quadrature output signals (specified at time of ordering) can be 5 VDC or V in. The B.I.T output signals indicate the RF Link Status.

Case ground is connected to earth ground. Circuit ground is electrically isolated from the case ground. Both of these grounds are typically connected together at the power supply.

Receiver Pinouts: Encoder Output (MS3102R18-1P)

PIN	FUNCTION
A	A
B	B
C	Z
D	+V (Supply Voltage)
E	B.I.T Output*
F	0V (Circuit Common)
G	Case Gnd
H	\bar{A}
I	\bar{B}
J	\bar{Z}

*If transmission is interrupted for longer than 0.13 seconds the status of this pin will change from LO to HI. B.I.T. is HI at +V level.

Table A – Front Panel Indicators

FUNCTION	COLOR	DESCRIPTION
POWER	GREEN	ON Indicates input power is supplied to the Module
A	RED	Indicates quadrature Phase A status
B	RED	Indicates quadrature Phase B status
Z	RED	Indicates index status
LINK	GREEN	ON Indicates SwiftComm Modules have established a reliable RF link. OFF Indicates the RF link has been lost and an B.I.T. signal is active
SET-UP	RED	Blinks ON each time RF packets are lost. Rate of blinking indicates relative quality of the RF link. Useful when setting up antennas and troubleshooting interference problems.

Power Supply for Encoders & Controllers



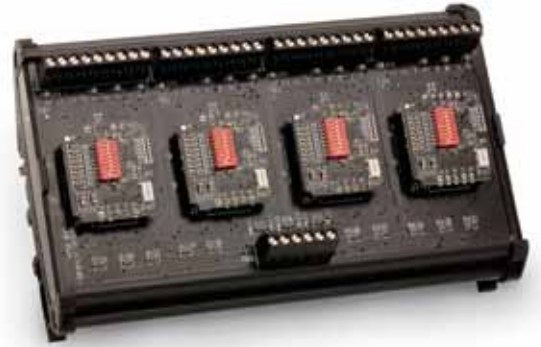
With a wide range of acceptable input voltages (AC and DC) this DIN Rail mountable power supply is usable in virtually all industrial applications worldwide. It has built in surge protection to reduce faults due to transients and it has 100% reserve capacity for startup and overload conditions. This power supply is CE rated and internationally rated by UL for IT equipment (60950) and industrial controls (508). It also conforms to EMC directive 89/336/EEC and 73/23/EEC for low voltage.

Power Supply Specifications	
INPUT	
Voltage range	85 – 264 V AC 110 – 350 V DC
Frequency (AC)	45 – 65 Hz
Transient surge protection	Varistor
Internal fuse	1.25 Amps to protect power supply
OUTPUT	
Voltage tolerance	± 1 %
Nominal output current	4.0 Amps (5 volt supply) 1.5 Amps (24 volt supply)
ENVIRONMENTAL	
Operating temperature	0 to +55 °C
Storage temperature	-40 to +85 °C

5 VOLTS: PART# 924-60008-001
24 VOLTS: PART# 924-60008-002

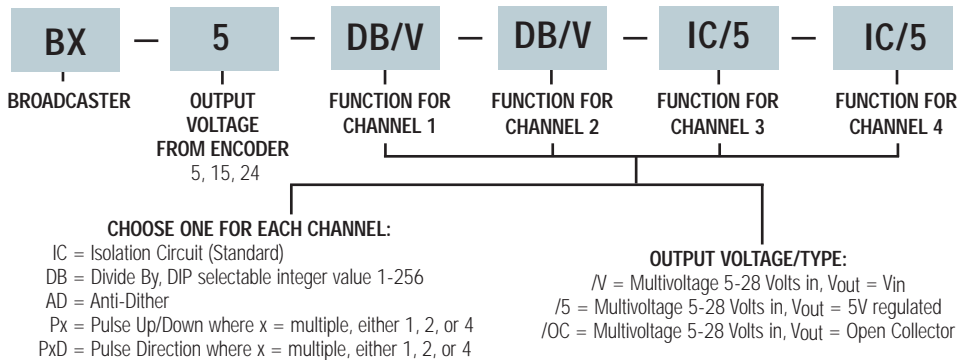
Encoder Signal Broadcaster

The Encoder Signal Broadcaster accepts standard incremental encoder inputs, (two channels in quadrature plus an index and complements) and can broadcast up to four encoder signals to four independent devices. Each of the broadcast signals is optically isolated eliminating ground loops. This compact package also allows for signal processing options, such as anti-dither filter, integer divide-by or pulse and direction outputs, to be incorporated into each of the four broadcast signals independently. The broadcaster is ideal for driving multiple receivers from a single encoder in applications like electronic line shafting or synchronization of multiple devices to a single operation.



Signal Broadcaster Ordering Options

FOR ASSISTANCE CALL 800-350-2727 (ASAP)
Use this diagram, working from left to right to construct your model number (i.e.: BX-5-DB/V-DB/V-IC/5-IC/5).
All notes and tables referred to can be found on pages 64–65.



SA100/SA100R Digital Display

This versatile 7-digit display comes in two versions. The SA100R Rotary Display reads out in degrees/minutes/seconds (DMS) or decimal degrees. Resolutions up to 0.001 degree are selectable from the front panel. The SA100 Linear Display reads out in inches or millimeters. Resolutions from 0.1 micron to 1mm or 5 micro inches to 0.01 inch are selectable from the front panel. The SA100/SA100R accepts a 5VDC standard differential quadrature signal from either linear or rotary incremental encoders. Incremental and absolute operating modes are available. The SA100/SA100R also features an auxiliary reference input, allowing integration of an independent reference marker from a remote switch. The SA100/SA100R comes with its own 12VDC power supply which operates on 115 VAC line Voltage.



Technical Specifications

Construction: 1/16" sheet metal
Dimensions: Height: 2.835", Width: 5.878", Depth: 2.756", Weight: 1.07 lbs
Operating Voltage: 12–27 VDC ±10% (power supply 60012-003 included)
Maximum Power Consumption: 6 watts

Rotary SA100R: BEI Part# 924-60012-005
Linear SA100: BEI Part# 924-60012-004

Maximum Data Rate: 2MHz
Operating Temperature: 0 to 45°C
Storage Temperature: -20 to 60°C
Inputs: Two channels in quadrature. Differential or single ended (user selectable)
Environment: Indoor use, IP20



Divide-By Module

This module accepts single ended or differential inputs and divides the signal by a factory set number from 2 to 256. The resulting output signal is a reduced resolution of the input signal. Ideal for use in machine retrofitting and for applications where a different resolution output is needed from the same encoder source. When ordering, make sure to specify the divide-by amount in the model number (see ordering options below).



Dual Encoder USB Interface

The Encoder USB Interface translates encoder position to industry standard USB 2.0 format that can be read by a computer. Each module can handle signals from two encoders. Modules are available for SSI absolute encoders, as well as quadrature incremental encoders. The module can be programmed through the USB interface for number of bits, clock speed and position offset for absolute SSI encoders. For incremental encoders, count mode (X1, X2, X4), reset, preset, and preset/reset on index are programmable through the USB input. The Encoder USB interface is ideal for system setup and debugging, data acquisition and PC based control applications.



Optical Isolator Module

This is a versatile interface between an incremental encoder and any receiving electronics. It accepts single ended or differential inputs and provides single ended or differential outputs in either an open collector or line driver configuration. It accommodates all standard operating voltages from 5 to 28 VDC. Up to eight Optical Isolator Modules can be daisy-chained to provide multiple, simultaneous outputs to controllers or PLC's. This Optical Isolator can help clean up noisy signals by converting to a differential line driver output. It has a 1 MHz throughput capability and can be used wherever a fast, optically isolated interface is required.



Anti-Dither Module

This module performs a specialized yet critical function for applications that may be subject to position errors due to stop/start cycles or vibration environments that are not using the direction-detection functions provided by a quadrature signal. The Anti-Dither module accepts A and B signals and, through internal discrimination circuitry, passes the signals through only when there has been true movement of the encoder. This acts like 1/4 cycle of hysteresis and avoids encoder signal transition dithering due to mechanical vibration. This is especially useful in web processes, handling and inspection systems that use conveyors and simple speed control in applications that are subject to vibration.



Encoder Tester Module

This test module accepts input from any type of incremental optical encoder. It tests for two channels in quadrature, an index pulse, and power to the module. It features a simple and intuitive LED indicator scheme: lights are on to indicate that a signal is HI and off when the signal goes LO. Through combinations of terminal connections and dropping resistors (supplied), it can test open collector outputs, and both single ended and differential outputs at all standard voltages: 5VDC, 12-15 VDC, and 24 VDC. This tester can also be used for machine set-up (by locating the index pulse) and incoming inspection and diagnostics of encoded motors.



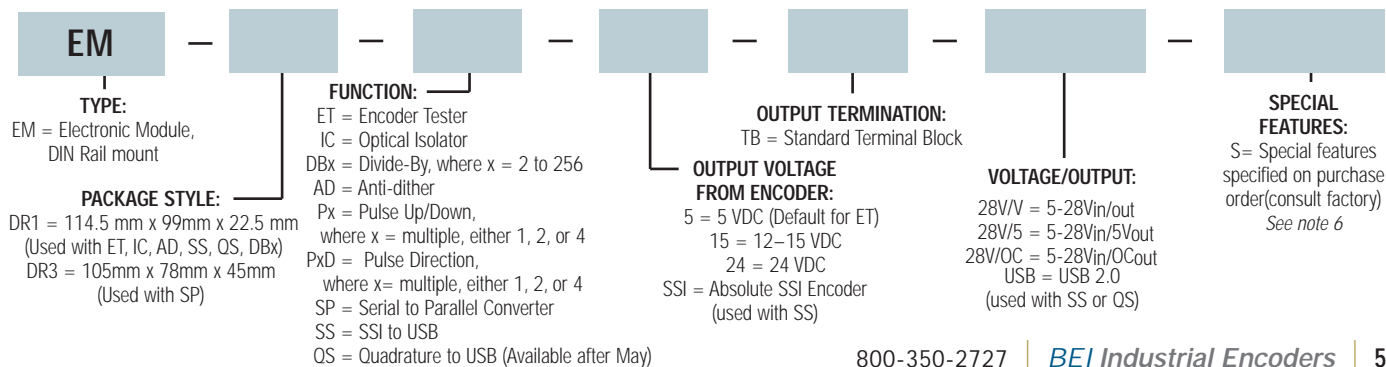
Serial-to-Parallel Converter Module

The serial to parallel converter takes serial data from either a SSI or RS-422 source and converts it to a 15 bit parallel output. This replaces the high cost and noise susceptibility of long, parallel cable runs with the simplicity of a low cost twisted pair cable to interface to a parallel-input PLC or controller. Serial input type is selectable along with clock speed (for SSI) or baud (for RS422). This module accepts inputs from 5 to 28 VDC and has output options of $V_{out}=V_{in}$, $V_{out}=5V$ regulated or $V_{out} = \text{Open Collector}$.

Electronic Modules Ordering Options FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: EM-DR1-IC-24-TB-28V/V).

All notes and tables referred to can be found on pages 64–65.



Adapters

All adapter assemblies can be ordered as a completed assembly with an encoder or separately as a kit. All adapter kits will be provided with the necessary hardware to assemble the adapter onto the encoder only.

Please contact the factory for applications assistance in determining the proper adapter configuration for your system.

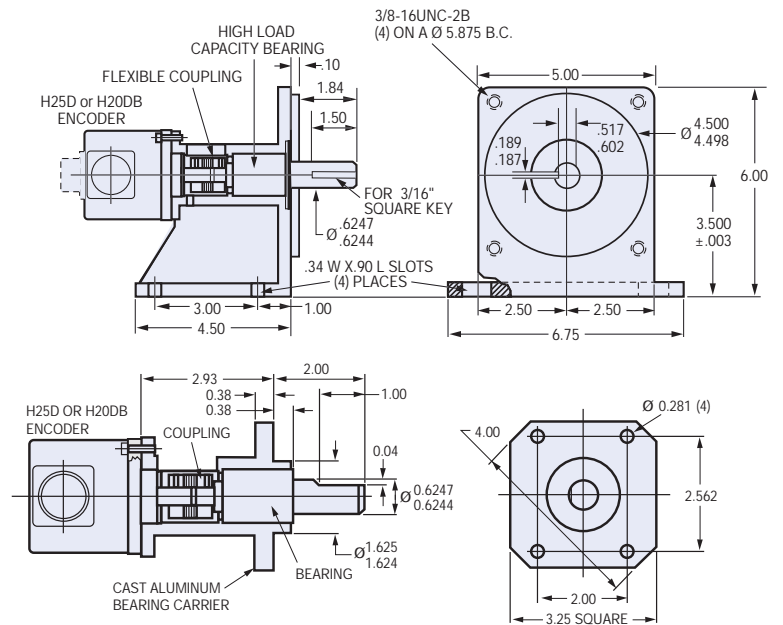
Hi-Load Bearing Assemblies

The high load bearing assemblies come in two styles: foot-mounted and flange-mounted. The foot-mounted version mates to a 56C motor face while the flange-mounted version features a standard 4-hole flange mount. The high load bearing assemblies accommodate the H20D, H25D and H38D square flange series encoders. Optional shaft configurations are available upon request. Consult the factory.

Foot-mounted

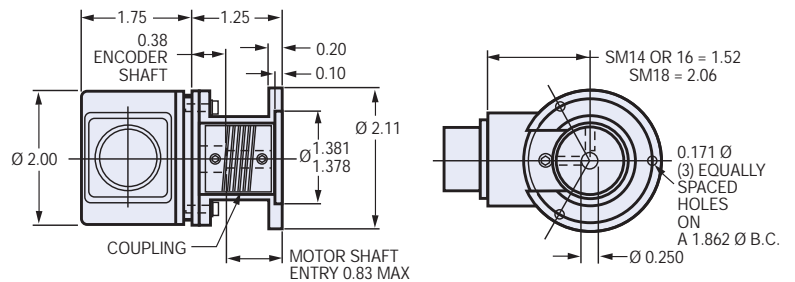


Square Flange-mounted



NEMA 23

The NEMA 23 flange mount adapter allows for mating a Model H20E with an F28 face mount encoder to a standard NEMA 23 motor frame.

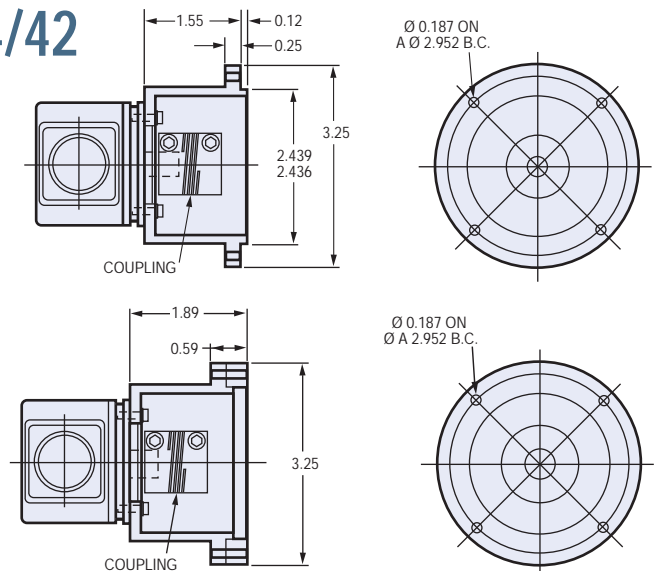


Thermoplastic Adapter & NEMA 34/42

This thermoplastic adapter allows easy mounting of either an H20E with an F12 face mount or an H25E with an F45 face mount. Thermoplastic material provides thermal and electrical isolation. With the addition of the aluminum NEMA 34/42 mounting ring, the encoder will mount directly to a NEMA 34/42 motor housing. Regular or insulated couplings are available. Consult the factory.

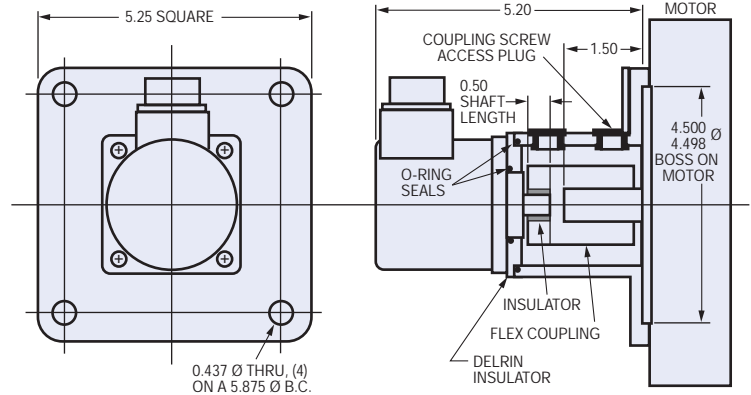


Adapter with NEMA 34/42 Mounting Ring



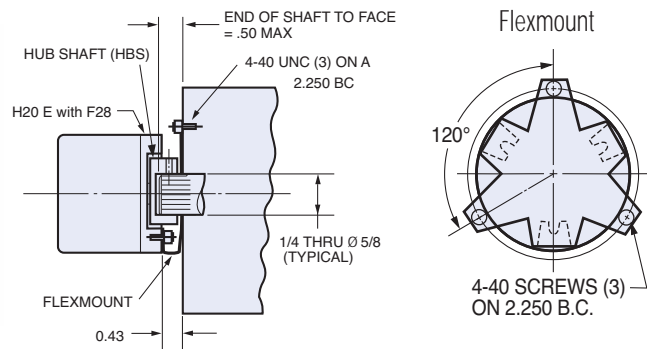
NEMA 56

This adapter can be used to mount an H25E with F1 face mount, H25D, or H38D square flange series encoder to a size 56 motor frame. The assembly is provided with a flexible coupling to accommodate a 5/8" diameter shaft.



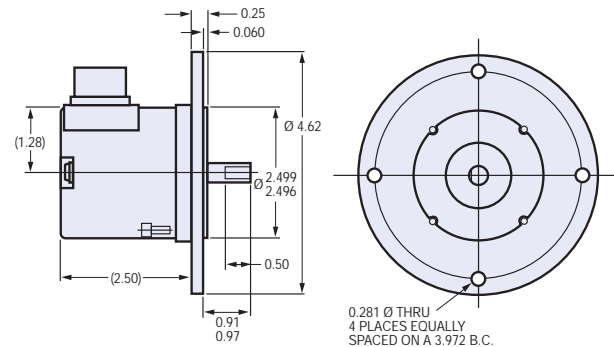
H20 Hub Shaft

This is also shown under the H20 model description in the Specifying Guide portion of this manual. The Hub Shaft with flexmount is a versatile, general purpose mounting that can accommodate shafts from 1/4" up to 5/8" readily in a compact package. The flexmount kit includes mounting hardware to assemble the flexmount to the encoder only.



5PY

This is a standard 5PY style motor adapter. It comes in aluminum or Delrin plastic versions and can accommodate a Model H20D, H25D square flange encoder, or H25E with three synchro-clamps (page 63).



Encoder Adapter Ordering Information

HI-LOAD BEARING ASSEMBLIES Foot-mounted NEMA 56C

H25D series part number 11009-001
H20D series part number 11009-002
H38D series part number 11009-003

Square-flange mount

H25D series part number 11008-000
H20D series part number 11008-003
H38D series part number 11008-004

NEMA 23 ADAPTER

H20 Series: Part Number 38229-001

Note: The NEMA 23 adapter kit can be ordered with either a 1/4" or 3/8" inside diameter coupling, please specify when ordering. Couplings are ordered separately.

THERMOPLASTIC ADAPTER & NEMA 34/42

H20/H25 series part number 31170-001
H20/H25, NEMA 34/42 Kit 31170-003

Note: Includes adapter and mounting hardware only. Couplings are available for shaft diameters from 1/4 to 1/2 inch. Couplings are ordered separately.

NEMA 56 ADAPTER

H25E Series (incl. Delrin Insul.): Part No. 11012-002
H25D Series (no Delrin Insul.): Part No. 11012-006
NOTE: H25 kits must specify 0.5" long shaft
H38D Series (incl. Delrin Insul.): Part No. 11012-003

H20 HUB SHAFT WITH FLEXMOUNT

Flexmount Kit: Part Number 31134-001

5PY ADAPTER

Aluminum Adapter: Part Number 38228-001
Delrin Adapter: Part Number 38228-002

Mating Connectors for Incremental Encoders



These have sealed conductors and are screw-on, military-style connectors with solder cups on the back of the pins (can accept up to 16 gage wire) and a built-in clamping strain relief. The environmentally sealed backshell is waterproof.

MS3116 Mating Connector for 12–15 Bit Absolute Encoders

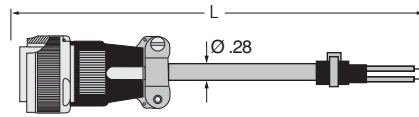
These have sealed conductors and use a bayonet (push and turn) shell. Pins have solder cups on the back for 20 gage wire and a built-in clamping strain relief. The environmentally sealed backshell is waterproof.

Cable Assemblies for Incremental and Absolute Encoders

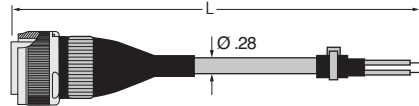
Cable assemblies are built using high quality custom BEI standard cable (P/N 37048-003) consisting of four, low capacitance twisted pairs (13 x 24 AWG data pair) with an overall shield, low resistance power conductors all within an abrasion-resistant PVC jacket. Size 16 and 18 cable assemblies utilize a waterproof and UV resistant over-molded backshell.



Drawing A
SIZE 12 AND 14 CABLE ASSEMBLIES



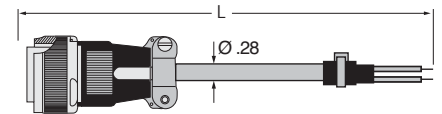
Drawing B
SIZE 16 AND 18 CABLE ASSEMBLIES



Cable Assemblies for 8 Bit Absolute Encoders

Cable assemblies for 8 Bit absolute encoders are built using high quality custom BEI Standard Cable (P/N 37059) consisting of 12, 22 gage conductors, an overall shield, and an abrasion-resistant PVC jacket.

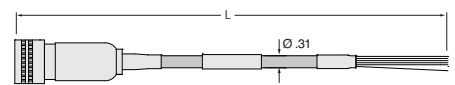
Drawing C



Cable Assemblies for 12–15 Bit Absolute Encoders

Cable assemblies for absolute encoders are built using high quality custom BEI standard cable (P/N 37063) consisting of 18, 26 gage conductors and uses larger, 22 gage conductors for power and ground. This cable has an overall shield and an abrasion-resistant PVC jacket.

Drawing D



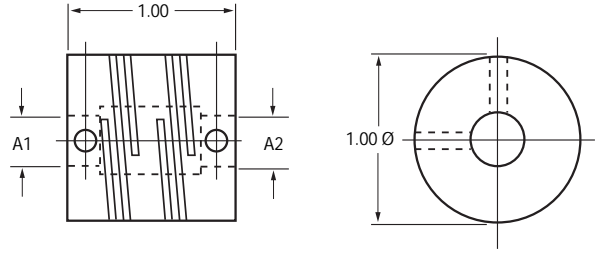
Mating Connector and Cable Assembly Selection

Find your encoder model number and output termination to select the appropriate mating connector and cable assembly. If you do not see your configuration, please contact factory for assistance. Table for standard pinouts only.

Encoder Model	Terminations	Output Format	Mating Connector Length	Connector P/N:	Use Cable Assembly P/N	Drawing
H25, HS35, HS45	M16	ABZ or ABC	2.19"	MS3106F16S-1S	31186-16XX XX = 10, 20, 30'	B
	M18	ABZC	2.66"	MS3106F18-1S	31186-18XX XX = 10, 20, 30, 50'	B
H20	M14	ABZ or ABC	2.13"	MS3106F14S-6S	31186-14XX X = 10, 20, 30'	A
	M16	ABZ or ABC	2.19"	MS3106F16S-1S	31186-16XX XX = 10, 20, 30'	B
	M18	ABZC	2.66"	MS3106F18-1S	31186-18XX XX = 10, 20, 30, 50'	B
HS25	M12	ABZC	1.81"	MS3116F12-10S	31186-12XX XX = 10, 20, 30'	A
H25, HS35, H25X Absolute	M14/19	Parallel GC, NB, XS, BCD	1.80"	MS3116J14-19S	31219-14XX XX = 10, 20, 30'	D
	M20	Parallel	2.66"	MS3106F20-29S	31204-20XX XX = 10, 20, 30	C
H25, HS35 Absolute, HMT25	M18	SSI, A1	2.66"	MS3106F18-1S	31186-18XX XX = 10, 20, 30, 50'	B
HMT25 Absolute	M18/32	Parallel GC, NB, XS, BCD	1.85"	MS3116F18-32S	Not Available	—

Couplings

Couplings are high performance, helical-cut beam style providing the best combination of torsional rigidity and compensation for shaft misalignment. They are made of aluminum and are iridite coated to resist chemical attack.



Part No.	Bore Dia $+.002/-0.000$ A1 Dia	Bore Dia $+.002/-0.000$ A2 Dia	Torsional Flexibility	Non-Reversing	Torques (Lbs-inch) Shock or Reversing	Momentary
39074-8-8	.250	.250	.165 min/in-oz	19	9.3	37
39074-12-8	.375	.250	.315 min/in-oz	15	7.5	30
39074-12-12	.375	.375	.315 min/in-oz	15	7.5	30

Notes:

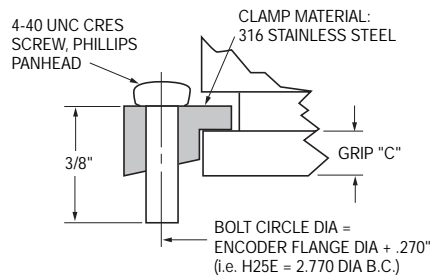
1. Bore is relieved to allow shafts to nearly butt
2. Setscrews: Cup point, hex socket, #6-32, two at each end, 90° apart.
3. Permitted axial motion from free length: $\pm .020$

4. Permissible shaft misalignment: Angular up to 5°; Parallel up to .010".

Installation note: To avoid coupling failure, be sure the shafts fit freely in the coupling bores and that the coupling is not compressed or subjected to greater deflections than specified above.

Synchro-Clamps

Synchro clamps are used with servo-style bearing housings ("E" or "G" style housings on the encoder model number designation) to hold the face of the encoder against a mounting plate. Clamps are placed at a radius slightly larger than the encoder mounting flange, (see illustration below) and allow for rotational alignment of the encoder during installation for machine set-up.



Grip "C"	Encoder Type	Part No. (3-Piece Kit)
.093	H25E or H20E	924-31165-001
.125	H25G	924-31165-002

Measuring Wheel

This measuring wheel uses an 80 durometer urethane rolling surface vulcanized to an aluminum hub and then machined to a circumference of 12 inches. It is designed to be used with shafts of a nominal 3/8" diameter and should be installed with the hub side facing away from the encoder housing. Maximum recommended load in service is 15 pounds. **Part Number 31196-001**



Cable Reels



Both 100' and 500' reels of encoder cable are available for your own custom wiring requirements. This high quality custom BEI standard cable consisting of four, low capacitance twisted pairs with an overall shield, extra large conductors for power, and signal ground; all within an abrasion-resistant PVC jacket.

100 ft. reel	Part No. 37048-003-100
500 ft. reel	Part No. 37048-003-500

Protective Cover for Hollow-Shaft Encoders

This cage protects hollow-shaft style encoders from mechanical damage during handling and installation. It is used with either the HS25 or the HS35 encoder and has a side cutout to allow for tether arm placement. It accepts a NEMA56 standard motor face mount and can be used with either through-shaft or blind shaft styles of encoders. Protective cover kits come with installation hardware.



Part Number 26068-001

1. Mounting is usually done either using the D-style square flange mount, E- or G-style servo mounts, or one of the standard face mounts, F1 for example. Consult factory for additional face mount options.
2. The shaft seal is recommended in virtually all installations. The most common exceptions are applications requiring a very low starting torque or those requiring operation at both high temperature and high speed.
3. Non-standard index widths and multiple indices are available by special order. Consult factory.
4. Complementary outputs are recommended for use with line driver type (source/sink) outputs. When used with differential receivers, this combination provides a high degree of noise immunity.

5. Output IC's

Output IC's are available as either Line Driver (LD) or NPN Open Collector (OC) types. Open Collectors require pull-up resistors, resulting in higher output source impedance (sink impedance is similar to that of line drivers). In general, use of a Line Driver style output is recommended. Line Drivers source or sink current and their lower impedance mean better noise immunity and faster switching times.

Warning: Do not connect any line driver outputs directly to circuit common/OV, which may damage the driver. Unused outputs should be isolated and left floating. Our applications specialists would be pleased to discuss your system requirements and the compatibility of your receiving electronics with Line Driver type outputs.

28V/V

Multi-voltage Line Driver (7272*): 100 mA source/sink. Input voltage 5 to 28 VDC +/- 5% standard (Note: $V_{out} = V_{in}$). This driver is TTL compatible when used with 5 volt supply. Supply lines are protected against overvoltage to 60 volts and reverse voltage. Outputs are short circuit protected for one minute. Supply current is 120 mA typical (plus load current). This is the recommended replacement for 3904R and 7406R open collector outputs with internal pullup resistors. It is also a direct replacement for any 4469, 88C30, 8830 or 26LS31 line driver

28V/5

Multi-voltage Line Driver (7272*): 100 mA source/sink. Input voltage 5 to 28 VDC +/- 5% standard, internally regulated with 5V (TTL compatible) logic out. Supply lines are protected against overvoltage to 60 volts and reverse voltage. Outputs are short circuit protected for one minute. Supply current is 90 mA typical (plus load current).

* Products manufactured prior to April 2007 used the line driver IC number instead of voltage output in model number.

15V/V

Multi-voltage Line Driver (4469*): 100 mA source/sink. Input voltage 5 to 15 VDC +/- 5% standard (Note: $V_{out} = V_{in}$). TTL compatible when used with 5 volt supply. Supply lines are protected against overvoltage to 60 volts and reverse voltage. Outputs are short circuit protected for one minute. Supply current is 90 mA typical (plus load current). This is a direct replacement for the 4469 Line Driver.

28V/OC

NPN Open Collector (3904*, 7273*). Current sink of 80 mA max. Current sourced by external pull-up resistor. Output can be pulled up to voltage other than supply voltage (30 V max). Input voltage 5 to 28 VDC +/- 5% standard. Supply current is 120 mA typical. This replaces prior IC's with designations of 3904, 7406, 3302, 681 and 689.

5V/OCR, 15V/OCR, 24V/OCR

Open Collector (3904R*, 7406R*, 7273R*): Current sink of 70 mA max. Includes internal pull-ups sized at approximately 100 ohms/volt. Max current source is 10 mA. Supply current is 100 mA typical, 120 mA with internal pull-ups. The 5V/OCR, 15V/OCR and 24V/OCR are often replaced by the 28V/V in system upgrades.

3904, 3904R, 4469, 5V/V, 5V/OC, 5V/OCR, 9V/OC

Intrinsically safe line driver and open collector outputs. These drivers are specific to intrinsically safe encoders, and are installed per the appropriate control drawings listed in Table 2.1 on page 48.

6. Special -S at the end of the model number is used to define a variety of non-standard features such as special shaft lengths, voltage options, or special testing. Please consult the factory to discuss your special requirements.
7. Higher frequency response may be available. Please consult with the factory.
8. Extended temperature ratings are available in the following ranges: -40 to 70°C, -40 to 85°C, -20 to 105°C and -40 to 105°C depending on the particular model. Some models can operate down to -55°C. Extended temperature ranges can affect other performance factors. Consult with factory for more specific information.
9. Mating straight plug receptacles may be ordered from the factory:
 - For M12 use MS3116F12-10S
 - For M14 use MS3106F14S-6S
 - For M14/19 use MS3116J14-19S
 - For M16 use MS3106F16S-1S
 - For M18 use MS3106F18-1S
 - For M20 use MS3106F20-29S

For additional Accessories refer to page 62-63.

For standard pinouts, refer to the facing page.

Table 1: Incremental Output Terminations

The connector style will determine pinouts. For example, an encoder with ABC channels and an M18 connector uses the table to the right.

M14 CONNECTOR PIN	M16 CONNECTOR PIN	CHANNELS DESIGNATED IN MODEL NO.	
		ABZ	ABC
E	A	A	A
D	B	B	B
C	C	Z	\overline{A}
B	D	+V (SUPPLY VOLTAGE)	
F	E	—	\overline{B}
A	F	0 V (CIRCUIT COMMON)	
	G	CASE GROUND (CG) (except H20)	

M18 CONNECTOR	
PIN	CHANNEL
A	A
B	B
C	Z
D	+V
E	—
F	0V
G	CG
H	\overline{A}
I	\overline{B}
J	\overline{Z}

WIRE COLOR (22AWG)	DA 15P CONNECTOR	CHANNELS DESIGNATED IN MODEL NO.		
		ABZ	ABC	ABZC
YEL	13	A	A	A
BLUE	14	B	B	B
ORN	15	Z	—	Z
W-Yel	10	—	\overline{A}	\overline{A}
W-Blu	11	—	\overline{B}	\overline{B}
W-Orn	12	—	—	\overline{Z}
RED	6	+V (SUPPLY VOLTAGE)		
BLK	1	0 V (CIRCUIT COMMON)		
GRN	9	CASE GROUND (CG) (except H20)		
WHITE		SHIELD DRAIN (Shielded Cable Only)		

M12 CONNECTOR	
PIN	CHANNEL
A	A
B	B
C	Z
D	+V
E	—
F	0V
G	CG
H	\overline{A}
J	\overline{B}
K	\overline{Z}

Table 2: Disc Resolutions for Incremental Encoder Models H25, H38, H40, L 25, E25

Resolutions highlighted with are available as standard **Model H25 EXPRESS ENCODERS**[®] that ship in one to three days.

1, 2, 3, 5, 6, 7, 8, 10, 13, 16, 20, 24, 25, 26, 30, 32, 33, 34, 36, 37, 40, 45, 48, 50, 51, 56*, 60, 64, 66, 72, 75, 80, 86, 88, 90, 100, 102, 120, 122, 125, 127, 128, 132, 144, 148, 150, 158, 160, 175, 176, 180, 187, 192, 200, 202, 204*, 217, 220, 240, 250, 254, 255, 256, 264*, 274, 280, 283, 288, 292, 300, 312, 320, 321, 325, 360, 366, 372, 375, 377, 380, 381, 384, 385, 393, 400, 430, 432, 450, 462, 480, 490, 500, 502, 508, 512, 522, 530, 550, 560*, 576, 598, 600, 604, 625, 628, 635, 638, 640, 660, 672, 676, 680, 687, 690, 700, 720, 725, 735, 740, 744, 748, 750, 762, 768, 780, 785, 800, 812, 825, 850, 864, 878, 888, 900, 912, 914, 938, 942, 955, 960, 1000, 1016, 1024, 1030, 1035, 1036, 1040, 1054, 1056, 1074, 1076, 1080, 1088, 1100, 1101, 1125, 1136, 1200, 1237, 1250, 1257, 1270, 1280, 1300, 1314, 1332, 1333, 1390, 1400, 1414, 1427, 1440, 1484, 1500, 1562, 1570, 1596, 1600, 1650, 1666, 1718, 1745, 1774, 1800, 1840*, 1850, 1855, 1875, 1894, 1920, 1952, 1968, 1979, 1995, 2000, 2048, 2080, 2094, 2100, 2160, 2164, 2199, 2200, 2250, 2356, 2400, 2485, 2500, 2514, 2519, 2540, 3000, 3125, 3600, 4000, 4096, 5000

*AB or ABC output only. NOTE: Resolutions up to 72,000 are available.

For Model L15 Resolutions See Table 1 on Page 35.

For Model H20 Resolutions See Table A on Page 20.

For Model HS20 Resolutions See Table 2 on Page 32.

For Model HS22 Resolutions See Table 2 on Page 33.

For Model HS25 Resolutions See Table A on Page 22.

For Model HS35 Resolutions See Table A on Page 25.

For Model HS45 Resolutions See "Cycles per Turn" in Ordering Information on Page 27.

For Model M58 Resolutions See Table 3 on Page 35.

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