



# ANGULAR MEASUREMENT SENSOR CATALOG

*J1 Standard Rotary Encoders*  
*Custom Rotary Encoders*



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# Table of Contents

Introduction .....	3
Ordering Information .....	4
J1 Line of Encoders .....	6
J1 Specifications .....	7
Incremental Encoders .....	11
Quadrature	
Step and Direction	
Absolute Encoders .....	14
Analog Output	
Pulse Width Modulation	
J1 Custom Encoders .....	17
Custom Encoder Information .....	18
Customer Support .....	19
Warranty .....	20
Encoder Questions/Answers .....	21

## Introduction

Joral Devices has developed the J1 line of rotary encoders to meet the demanding environment of the hydraulics and power equipment industry. The encoder marries the unique mechanical design with a new advanced digital signal processing technology. **The result is an extremely durable and versatile encoder that can meet a wide range of applications.**

The Joral Devices encoder looks like a simple device, yet is packed full of technology and design innovations. **Higher level encoders contain a microprocessor for the purpose of providing customization for our customers.** By customizing the electronics, software, timing, logic, or input/output features in the encoder, you can save money and design time for your application. See the Custom Encoders section for more details.

The Angular Measurement sensor, AMS, is the heart of the encoder. This technology is comprised of a  magnet precisely pressed into the low inertia encoder shaft located exactly above the “system-on-a-chip” specialized magnetic digital signal processor. All this technology is packed and sealed into the 2” diameter rugged aluminum housing.

**A wide range of standard outputs are possible**, including quadrature, step & direction, PWM or analog output. The device can be supplied as an absolute or incremental encoder. The encoder is easy to use and LED's make installation and diagnostics a breeze. An operating power supply range of 5 to 45 VDC allows the device to fit into various power systems and all the signals have short-circuit and over-temperature protection.

**The encoder has a simple and rugged mechanical design.** The shaft has dual ball bearing support providing protection from impact to the shaft. The electronic circuitry is sealed in high grade potting material making the encoder resistant to water, dirt, grease and other contaminants. The unique design utilizes a minimum of components to provide the most robust encoder available in the industry.



**Joral Devices will custom design encoders to meet specific application requirements. We can design and manufacture a rugged, advanced technology encoder that meets your electrical and mechanical needs.**

# Ordering Information

## **Who to Contact:**

- By contacting your nearest Joral Devices distributor,
- Using the Online Buying section of the web site : [www.JoralDevices.com](http://www.JoralDevices.com) ,
- By calling our sales department directly and placing the order over the phone at 262-951-6725.

## **What to Order:**

- To place an order for a standard J1 encoder you need to determine the part number.
- To place an order for a custom J1 encoder you need to fill out the Custom Encoder Information Sheet and contact Joral Devices Sales department or your distributor.

## **J1 Standard Encoder Part Number:**

The J1 line of Rotary Position Sensors can be configured with many different combinations of features and options. The Item Number for ordering your specific encoder identifies its features. The following specifies the various features available for the J1 line.

### **PART NUMBER IDENTIFICATION**

**Example :** J1-A10404

J1- : J1 product line  
A : Aluminum Body  
1 : Flat On Shaft  
04 : Analog Output Function  
04 : 0 – 10 VDC Output Driver

### **Mechanical Material / Packaging**

Part Number	Description	Details
A	Aluminum Body	Housing Material-Aluminum, Housing-Face Screw, Face Style-Flat, Mount-4 hole, Shaft Length-1.0inch, Shaft Diameter-0.25inch, Connector-Rear, Termination-Plug
B	Plastic Body	Housing Material-Plastic, Housing-Face Screw, Face Style-Flat, Mount-4 hole, Shaft Length-1.0inch, Shaft Diameter-0.25inch, Connector-Rear, Termination-Plug

### **Shaft Type**

Part Number	Description	Details
0	Round	Round shaft, designed to mate with part with set screw.
1	Flat On Shaft	Designed to use with a mating part and set screw, runs entire length of exposed portion of shaft
2	Slotted	Slot runs entire length of exposed portion of shaft

### Output Functions

Part Number	Description	Details
01	Quadrature	Includes Channel A, B and Z' (marker)
02	Step and Direction	Step channel, Direction channel
03	PWM	Pulse duration proportional to absolute position
04	Analog	Analog Output proportional to absolute position
05	Digital Serial	Serial Data Stream representing absolute position
06	Serial Comms	RS-422 Serial Interface proportional to absolute position

### Output Drivers

Part Number	Description	Details
00	None	
01	Push/Pull	Auto-detects sink or source mode
02	Sink	Sinking output – encoder output switches user supplied signal to Ground
03	Source	Sourcing output – encoder output supplies voltage to user circuit, which is typically pulled low
04	0-10VDC	Encoder provides 0 to 10 V DC
05	422 Line	Encoder provides digital signal using bipolar 422 driver circuits
06	PWM	Encoder provides PWM Output as a sinking device

# J1 Line of Encoders

The J1 line of Rotary Position Sensors from Joral Devices provides an extremely durable and versatile encoder that can meet a broad range of applications.

A wide range of outputs are possible, including quadrature, step & direction, PWM, serial, or analog. The device can be supplied as an absolute or incremental encoder. It is easy to use and LED's make installation and diagnostics a breeze. An operating power supply range of 6 to 36 VDC allows the device to fit into various power systems and all the signals have short-circuit and over-temperature protection.



The encoder has a simple and rugged mechanical design. The shaft has dual ball bearing support providing protection from impact to the shaft. The electronic circuitry is sealed in high grade potting material making the encoder resistant to water, dirt, grease and other contaminants. The unique design utilizes a minimum of components to provide the most robust encoder available in the industry.



The Angular Measurement sensor, AMS, is the heart of the encoder. This technology is comprised of a magnet precisely pressed into the low inertia encoder shaft located exactly above the “system-on-a-chip” specialized magnetic digital signal processor.

All this technology is packed and sealed into the 2” diameter rugged aluminum housing.

## **Key Features**

- Rugged design
- Easy to use
- Completely potted electronics
- Dual ball bearing shaft support
- Low rotational mass
- Non-magnetic stainless steel shaft
- Installation and diagnostic LEDs
- Absolute or incremental encoder / Digital or Analog output
  - Quadrature (A, B and Marker)
  - Step and Direction
  - Pulse Width Modulation (PWM)
  - Analog 0 to 10VDC
  - Sink, source, or push/pull (auto-sensing) output drivers
- Short-circuit and Over-temperature protection
- Wide operating voltage of 6 to 36 VDC
- 32 to 4096 pulse per revolution (PPR)



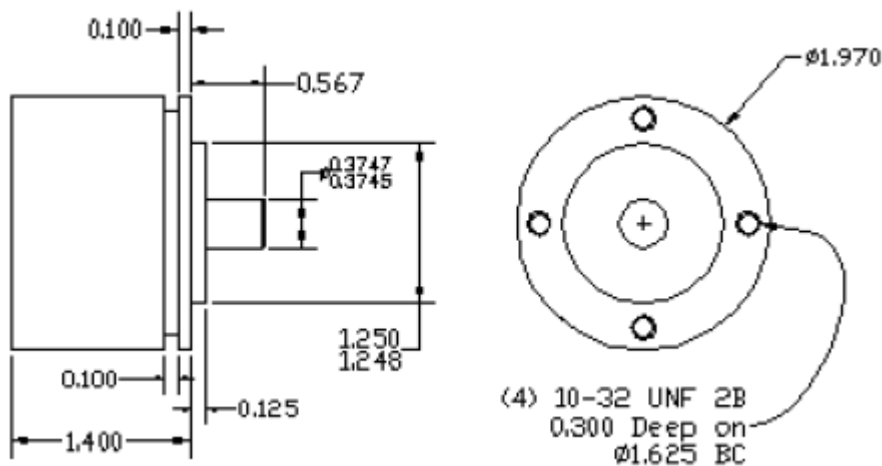
# J1 Specifications

## General

Power Supply Voltage	6 to 36 Volts DC	
Operating Current	100mA typical	
Maximum RPM	8000 RPM	
Operating Temperature Limits	-40C to +125C	
Approximate Weight	8 Oz	
Enclosure Rating	Nema 4, IP67 (encoder electronics)	

## Body

Aluminum Body Material	Billet 6160 Aluminum	
Outside Diameter	1.970"	
Height	1.400"	Does not include exposed shaft length
Mounting Holes	1.625" hole center	4 x 10-32 UNF 2B x .30 deep



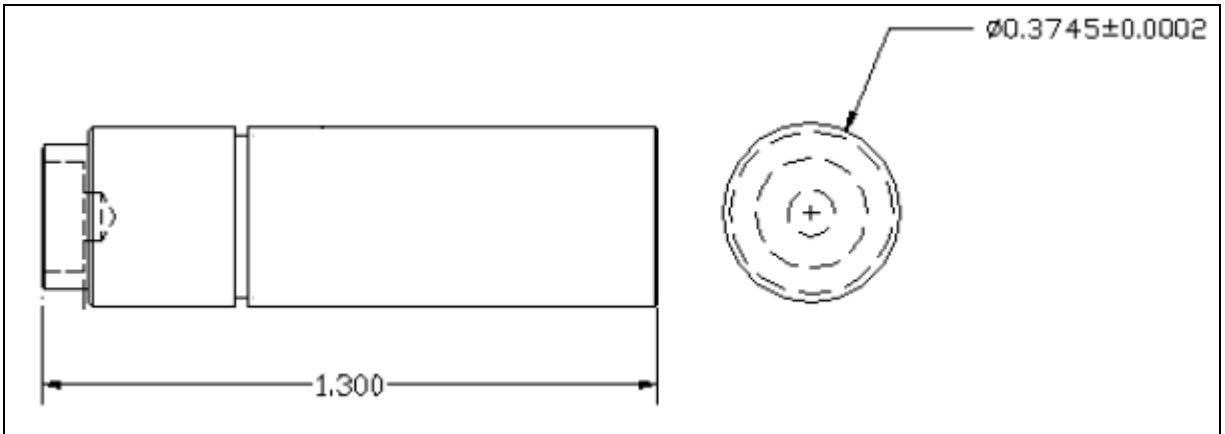
## Bearings

Design	Dual set of ball bearings	
Material	Chrome Steel	
Outer Diameter	22.225 mm	
Inner Diameter	9.525 mm	

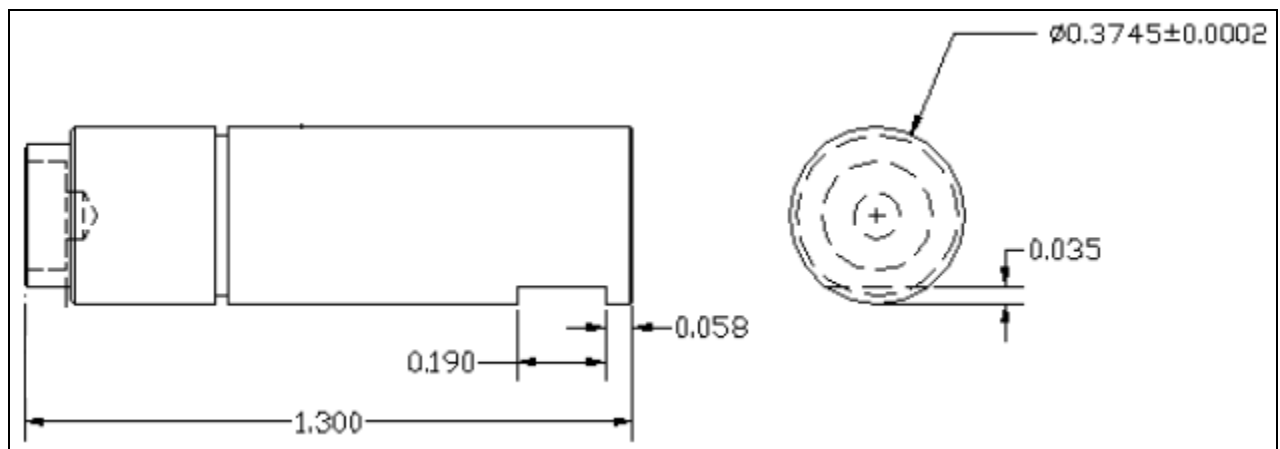
## Shaft

Shaft Material	Stainless Steel	
Shaft Diameter	0.375"	
Shaft Overall Length	1.300"	Part of the shaft is within the body of the encoder and part is exposed
Shaft Exposed Length	0.440"	
Slotted Shaft Slot Width	0.125"	

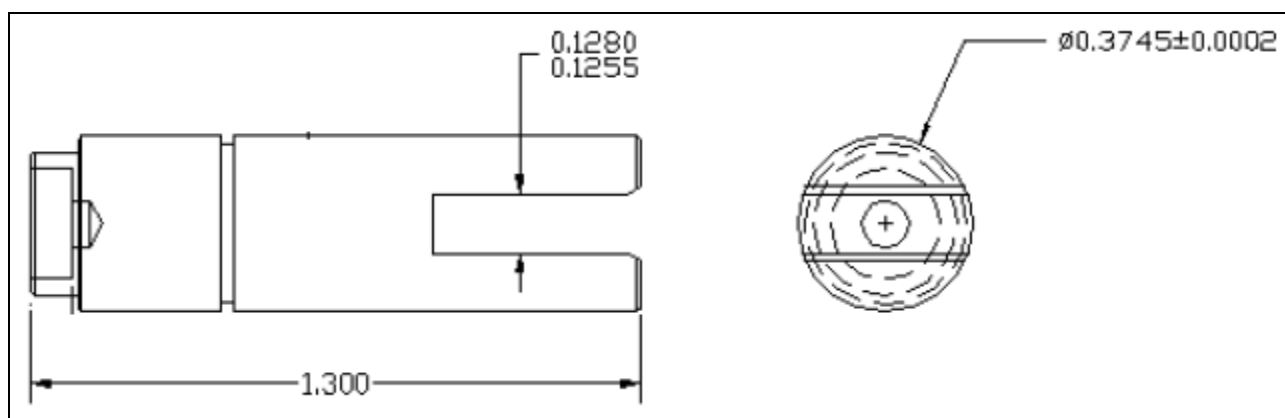
### Round Shaft Detail



### Shaft with Flat Detail

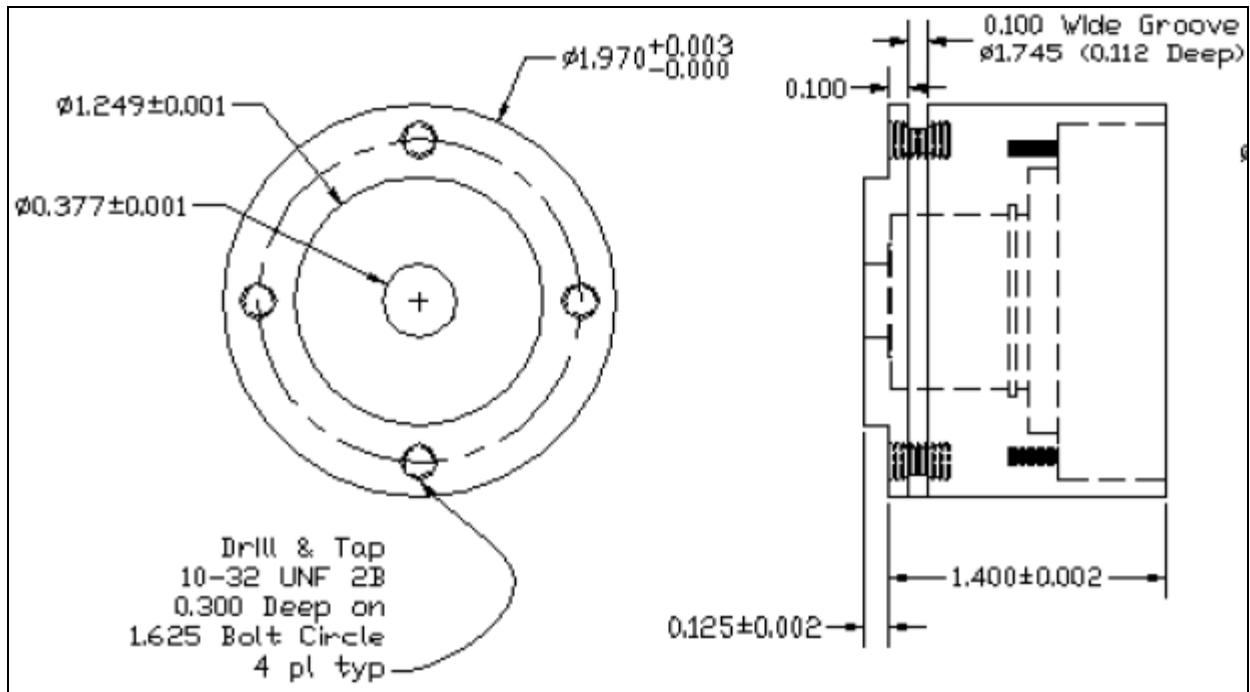


### Shaft with Slot Detail



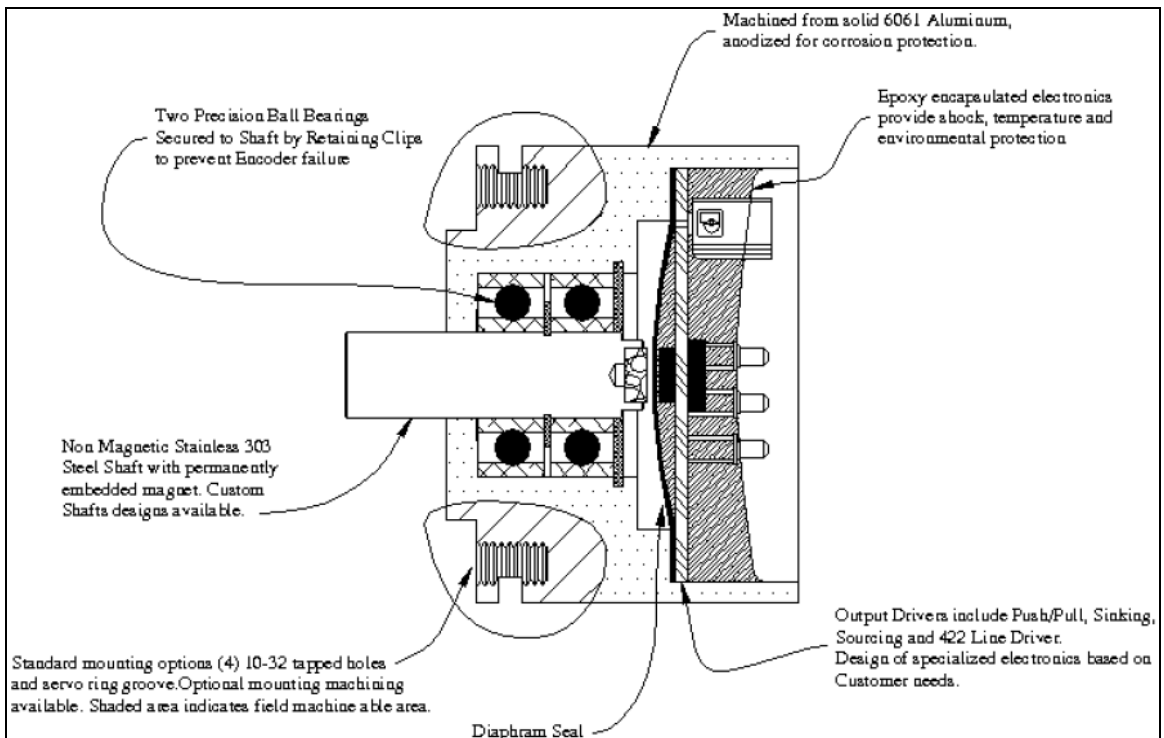


## Housing Details



## Construction

The following diagram highlights the construction features of the Joral Devices encoder.



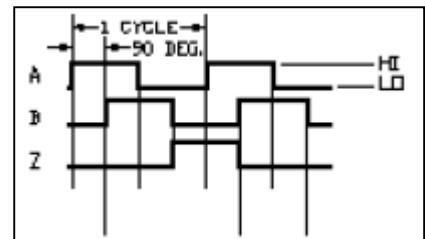
# Incremental Encoders

*An Incremental Encoder outputs a digital pulse for each rotational position of the shaft.*

Joral Devices offers two types of standard incremental encoders, Quadrature or Step and Direction. Incremental encoders produce a repeatable pattern of digital outputs that can be used by a computer, controller, or counter to determine the position component in a position control loop. Joral Devices incremental encoders also include an output channel called a Marker (zero or index or reference signal) which supplies a single pulse per revolution. This single pulse is used for precise determination of a reference position.

## **Quadrature**

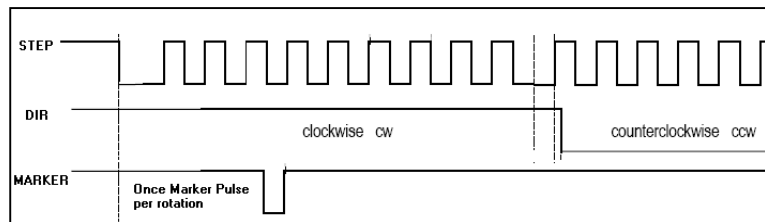
The most common type of incremental encoder is called a Quadrature encoder. It uses two output channels (A and B) to sense position. Using two code tracks with sectors positioned 90 degrees out of phase, the two output channels of the quadrature encoder indicate both position and direction of rotation. If A leads B, for example, the disk is rotating in a clockwise direction. If B leads A, then the disk is rotating in a counter-clockwise direction.



By monitoring both the number of pulses and the relative phase of signals A and B, you can track both the position and direction of rotation.

## **Step and Direction**

The Step and Direction encoder provides a Step output, and Direction output and a Marker pulse output. The Step output signal pulses at every rotational position. The Direction output indicates the current direction of rotation.



# Quadrature Encoder Specifications

## J1 Quadrature Encoder - Most Common Standard Product Part Numbers

Part Number	Description
J1-A00101	Aluminum Body, Round Shaft, Quadrature Output and Push/Pull Driver
J1-A00102	Aluminum Body, Round Shaft, Quadrature Output and Sink Driver
J1-A10103	Aluminum Body, Flat On Shaft, Quadrature Output and Source Driver

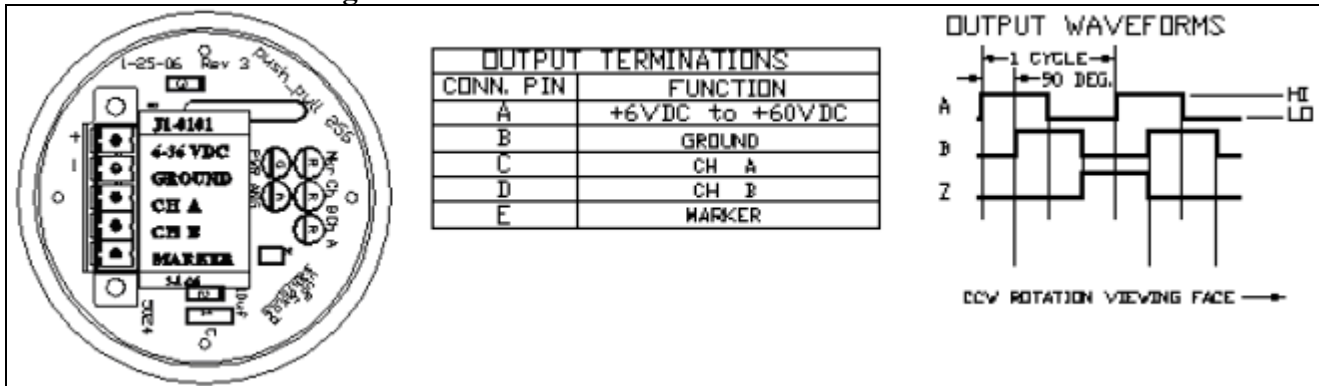
## Quadrature Output

Code	Incremental	
Quadrature	Channel A and in quadrature format, Z' marker pulse once per revolution	
PPR	256 Pulses per revolution per channel	256 cycles per revolution. 1 Z' marker pulse per revolution. See figure below.
Output Drivers Available	Push / Pull Sink Source RS422	- Auto detects - Encoder connects circuit to ground - Encoder drives circuit voltage - Differential pair per signal line (A, B, Z')

## Output Drivers

Driver	Maximum Output Current	Maximum Voltage
Push/Pull (L293)	600 mA	36 volts
Sink (A2557)	500 mA	60 volts
Source (VNQ860)	250 mA	36 volts
RS422 (OL7272)	100 mA	36 volts

## Connector Pinout and Signal Waveform



# Step and Direction Encoder Specifications

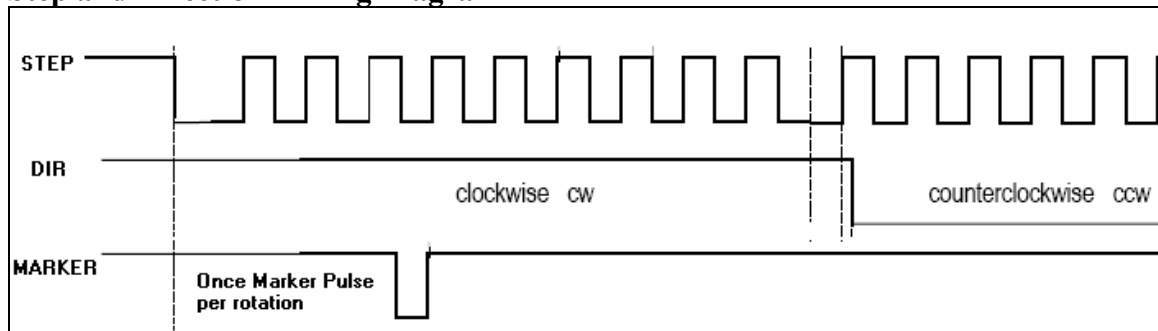
## J1 Step and Direction Encoder - Most Common Standard Product Part Numbers

Part Number	Description
J1-A00201	Aluminum Body, Round Shaft, Step and Direction Output and Push/Pull Driver
J1-A10202	Aluminum Body, Flat On Shaft, Step and Direction Output and Sink Driver
J1-A10203	Aluminum Body, Flat On Shaft, Step and Direction Output and Source Driver

## Step and Direction Output

Code	Incremental	
Step & Direction	Channel A is the STEP output, Channel B is the DIRECTION output	
PPR	256 Pulses per revolution per channel	256 cycles per revolution. 1 Z' marker pulse per revolution. See figure below.
Output Drivers Available	Push / Pull Sink Source RS422	- Auto detects - Encoder connects circuit to ground - Encoder drives circuit voltage - Differential pair per signal line (A, B, Z')

## Step and Direction Timing Diagram



## Output Drivers

Driver	Maximum Output Current	Maximum Voltage
Push/Pull (L293)	600 mA	36 volts
Sink (A2557)	500 mA	60 volts
Source (VNQ860)	250 mA	36 volts
RS422 (OL7272)	100 mA	36 volts

## Connector Pinout

Pin 1	Vcc (6 to 36 VDC)
Pin 2	Gnd
Pin 3	A / STEP output
Pin 4	B / DIRECTION output
Pin 5	Z' (Marker Pulse active Low)

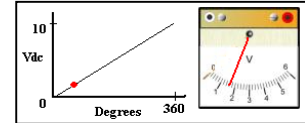
# Absolute Encoders

*An Absolute Encoder outputs a unique value for each rotational position of the shaft.*

Joral Devices offers two types of standard absolute encoders, Analog output or Pulse Width Modulation (PWM). Both types of output provide the absolute position of the shaft.

## **Analog Output**

The Analog Output encoder has a single channel that outputs a **0 to 10vdc analog** signal proportional to the 0 to 360 degree position of the shaft. As the shaft rotates the output is continually updated. The Analog output type connects to an analog input on a PLC or computer.



## **PWM**

The PWM encoders have a digital output that is pulsed on for a length of time proportional to the 0 to 360 degree position of the shaft. The PWM output connects to a digital input on a PLC or computer capable of measuring pulse width.



# Analog Output Encoder Specifications

## **J1 0 to 10VDC Analog Output Encoder - Most Common Standard Product Part Numbers**

Part Number	Description
J1-A10404	Aluminum Body, Flat On Shaft, Analog Output and 0-10VDC Driver

### **ANALOG OUTPUT**

Code	Absolute	
0-10VDC Analog Output	Voltage Output is proportional to absolute position	Encoder provides 0 to 10 VDC analog voltage level representing 0 to 360 degrees
Output Driver Available	0 – 10 VDC	- High Current Driver (OPA548)

### **Output Drivers**

Driver	Maximum Output Current	Maximum Voltage
High Current Driver (OPA548)	2000 mA	8 - 36 volts

### **CONNECTOR PINOUT**

Pin 1	Vcc (6 to 36 VDC)
Pin 2	Gnd
Pin 3	0-10VDC (Absolute Position)
Pin 4	
Pin 5	

# PWM Output Encoder Specifications

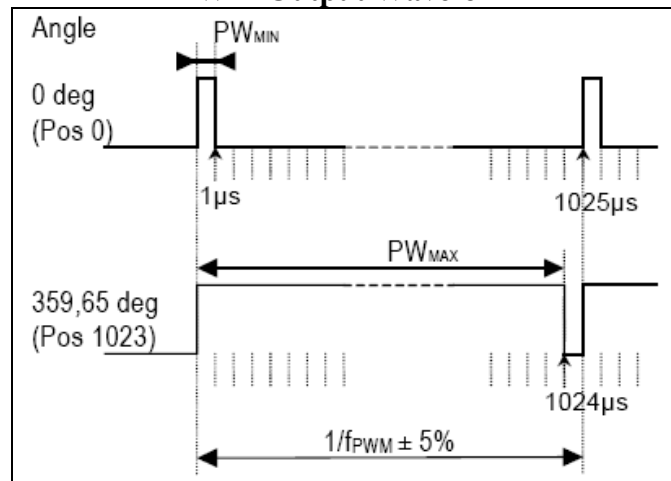
## J1 PWM Output Encoder - Most Common Standard Product Part Numbers

Part Number	Description
J1-A10306	Aluminum Body, Flat On Shaft, PWM Output and PWM Driver

## PWM OUTPUT

Code	Absolute	
Pulse Width Modulation	PWM Output is proportional to absolute position	Encoder provides 0 to 1024 microsecond pulse width representing 0 to 359.65 degrees
Output Driver Available	PWM	- High Current Driver (OPA548)

### PWM Output Waveform



Parameter	Symbol	Typ	Unit	Note
PWM frequency	$f_{PWM}$	0.9756	kHz	Signal period: $1025 \mu s$
MIN pulse width	$PW_{MIN}$	1	$\mu s$	- Position 0d - Angle 0 deg
MAX pulse width	$PW_{MAX}$	1024	$\mu s$	- Position 1023d - Angle 359,65 deg

## Output Drivers

Driver	Maximum Output Current	Maximum Voltage
PWM (OPA548)	2000 mA	8 – 36 volts

## CONNECTOR PINOUT

Pin 1	Vcc (6 to 36 VDC)
Pin 2	Gnd
Pin 3	PWM
Pin 4	
Pin 5	

## Joral Custom Encoders

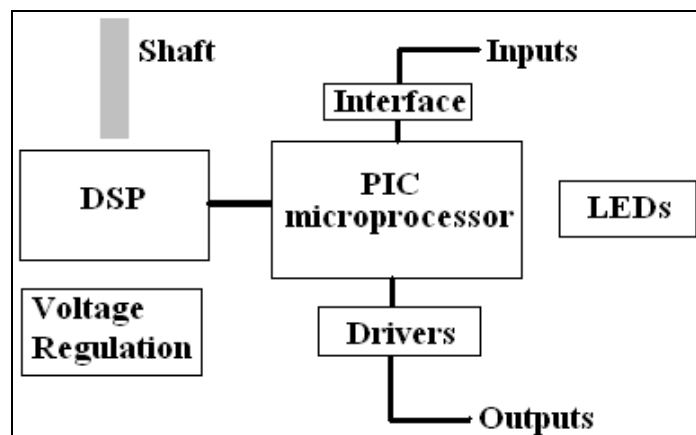
Joral Devices will custom design encoders to meet specific application requirements or to duplicate another manufacturer's encoder in our rugged design. Custom Encoders offer the same outstanding features that our Standard Products provide. Customizations are usually intended to make the encoder easier to integrate into your system, to save money by reducing other hardware, or by combining features from other devices.



Please use the Custom Encoder Information Sheet to describe the requirements of your application and special needs for your encoder.

## Custom Encoder Technology

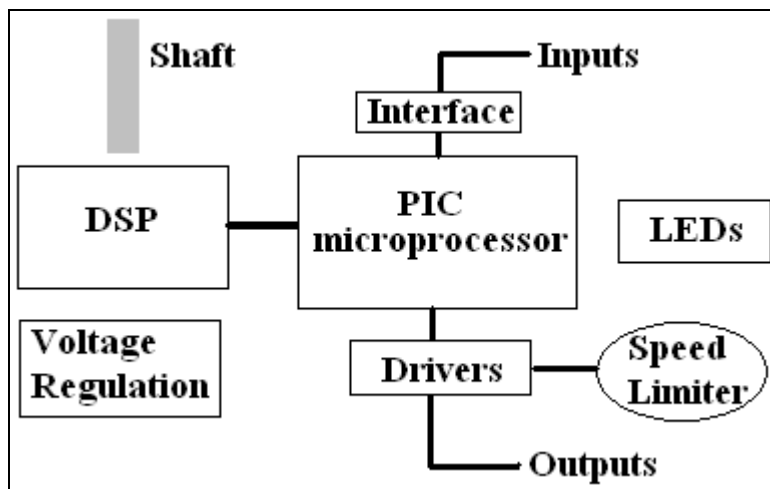
The following block diagram shows the major elements of the higher level Joral Devices Encoder. Of particular importance is the 'PIC' microprocessor located between the encoder Digital Signal Processor (DSP) and the physical Inputs and Output (I/O) of the encoder. This processor allows substantial customizations to the encoder for your specific application without having to redesign the encoder from the ground up. Changes in timing, additions of logic, and additional input and output functions are all possible. The example that follows highlights one customer's use of customization at the encoder level to simplify their overall design and reduce costs.



## Customization Example

In this example a software modification was made to the PIC microprocessor program to examine the current rotational speed and turn ON a digital output, called Speed Limiter, when the speed was above the setpoint. This simple enhancement allowed the customer to eliminate external hardware and software in his system to accomplish this task. The high capacity drivers already built into the encoder were able to interface directly to his limiting control system.

**Speed Limit Control Built into the Encoder**



# Custom Encoder Information Sheet

Joral Devices will custom design encoders to meet specific application requirements or to replace another manufacturers encoder. Custom Encoders offer the same rugged duty features that our Standard Products provide.

Use this sheet to describe the requirements of the encoder so engineering can determine the best way to meet those requirements. Call 262-951-6725 or Fax 262-364-2661 or email sales@JoralDevices.com.

## **General Information**

What is the Application? \_\_\_\_\_  
\_\_\_\_\_

If replacing an existing encoder:

Who is the Manufacturer? \_\_\_\_\_

What is the Model Number? \_\_\_\_\_

## **Mechanical**

Body Diameter: \_\_\_\_\_ Shaft Size/Shape: \_\_\_\_\_

Special Mounting: \_\_\_\_\_

Special Connector: \_\_\_\_\_

Connector Location: \_\_\_\_\_

## **Electrical**

Operating Voltage: \_\_\_\_\_

## **Environmental**

Temperature Range: \_\_\_\_\_

## **Other Information**

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# CUSTOMER SUPPORT

Joral Devices strongly supports our products. Most issues can be handled over the phone or email.

If a product was purchase directly thorough Joral Devices then all customer support is handled directly.

Distributors are the customer's first line of support for the encoder products purchase through them.

Distributors are typically specialists in particular sectors of industry and can assist customers in their immediate applications. Of course Joral Devices is available to help wherever possible to discuss applications, how standard or custom products may be applied or provide technical support.

All support is through the main Joral Devices phone number : 262-951-6725.

If you are aware of a specific cell phone number for a Joral Devices employee, feel free to use that number for support as well.

## **Sales Support**

Distributors are the first contact a customer should make when considering an encoder application or to discuss a product related problem.

## **Technical Support**

Distributors are the first level of technical support for their customers. All our encoder have LED's for installation and troubleshooting. Most problems can be isolated to either the field devices or wiring, or the encoder itself. If it appears that the encoder is at fault, call or email Joral Devices for additional support or information. Technical support is available during standard business hours.

If on-site service is required, the individual situation will be evaluated in regard to costs or possible charges.

# WARRANTY

## **Product Warranty**

JORAL DEVICES, LLC warrants that all equipment manufactured by it will be free from defects, under normal use, in materials and workmanship for a period of 12 months. Within this *warranty* period, JORAL DEVICES, LLC shall, at its option, repair or replace, free of charge, any equipment covered by this warranty which is returned, shipping charges prepaid, within 12 months from date of invoice, and which upon examination proves to be defective in material or workmanship and not caused by accident, misuse, neglect, alteration, improper installation, or improper testing.

The provisions of the "STANDARD WARRANTY" are the sole obligations of JORAL DEVICES, LLC and excludes all other warranties expressed or implied. In no event shall JORAL DEVICES, LLC be liable for incidental or consequential damages or for delay in performance of this warranty.

# Encoder Questions and Answers

## **Question: What is the basic definition of an encoder?**

Answer: An encoder is an electrical mechanical device that can monitor motion or position. A typical encoder uses sensors to provide a series of pulses that can be translated into motion, position, or direction. An encoder comes in two architectures. The first architecture is linear. The second architecture is rotary. Both types sense mechanical motion and translates the information (velocity, position, acceleration) into useful electrical data.

## **Question: What is the difference between an absolute and an incremental encoder?**

Answer: There are a few subtle differences between absolute and incremental rotary encoders. Incremental encoders have output signals that repeat over the full range of motion. It is important to understand that each mechanical position is not uniquely defined. When the incremental encoder is turned on, the position of an incremental encoder is not known since the output signals are not unique to any singular position. Absolute encoders have a unique value (voltage, binary count, etc) for each mechanical position. When an absolute encoder is turned on, the position of an absolute encoder is known (this function resembles a resolver, although the principles of operation have no similarity.) The similarities of both absolute and incremental encoders are form factor and the issues of count and directional information. They can be obtained from both absolute and incremental encoders equally.

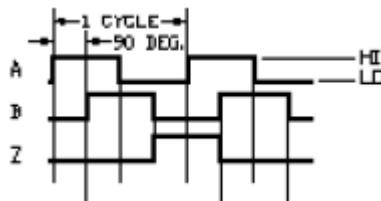
## **Question: What is a channel?**

Answer: A channel is an electrical output signal from an encoder. Typical incremental encoders have either two or three channels. An example would be: A, A not, B, B not, and Z, Z not (sometimes referred to as I or I not.). The most common configuration is A, B and Z not.

## **Question: What is quadrature encoding?**

Answer: quadrature is a description of the 90 degrees out of phase between channel A and B. The rising edge to rising edge (referred as the Cycle) on channel A or B indicates that one set of bars (on the internal encoder disk) have passed by the optical sensor. The quadrature state of channels A and B create four unique logic states. When these four unique logic states are decoded, the resolution obtained is 4 times (4X) the resolution of the encoder disk. So with this in mind 256 sets of bars would yield 1024 quadrature states.

### **Representative Output from a Quadrature Encoder show channels A and B and Marker Pulse**



## **Question: What is the Marker pulse (index, strobe, Z, and I)?**

Answer: It is the absolute reference added to an incremental encoder. It is also known as home position. It signifies a full rotation of the encoder disk

**Question: What is PWM (Pulse Width Modulation)?**

Answer: In a nutshell, PWM is a way of digitally encoding analog signal levels. Through the use of high-resolution counters, the *duty cycle* of a square wave is modulated to encode a specific analog signal level. The PWM signal is still digital because, at any given instant of time, output is either on or off. The voltage or current source is supplied to the analog load by means of a repeating series of on and off pulses. The *on-time* is the time during which the DC supply is applied to the load, and the *off-time* is the period during which that supply is switched off. Given a sufficient bandwidth, any analog value can be encoded with PWM.

**Three PWM waveforms showing 10%, 50% and 90% on-time.**

