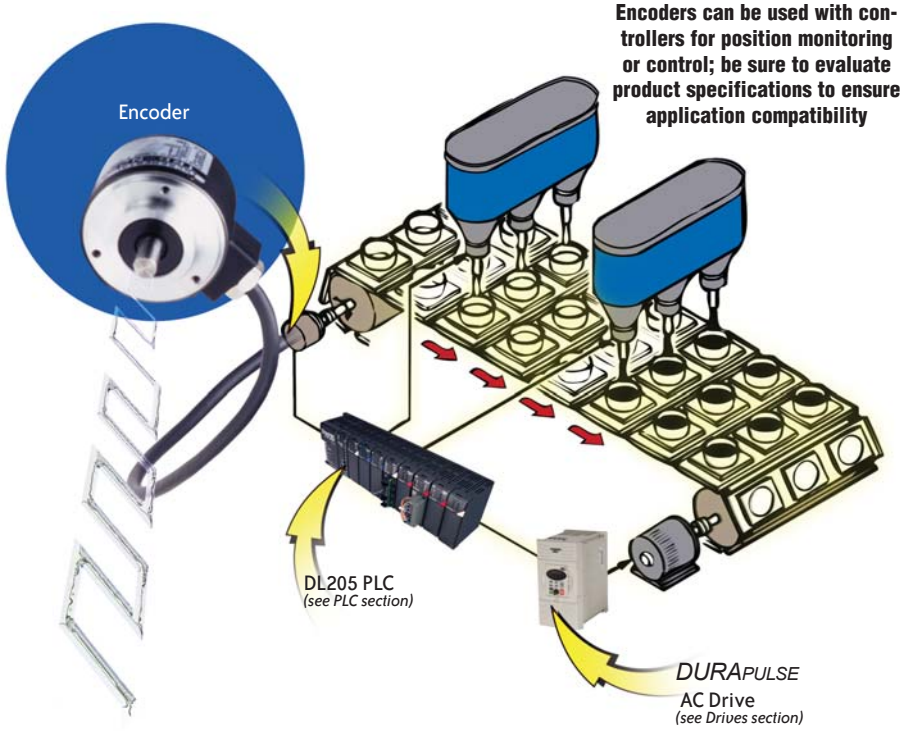
HIGH-QUALITY, RUGGED ENCODERS

Where can I use an encoder?

Encoders are used in all types of motion sensing applications, including machine tooling, semiconductor positioning and multi-axis positioning. All encoders feature a reinforced aluminum diecast casing and come equipped with a two-meter cable exit. Use these encoders with our PLC high-speed counter modules for accurate position monitoring and control.



Encoders can be used with controllers for position monitoring or control; be sure to evaluate product specifications to ensure application compatibility

Why buy an encoder from us?

There are several distinct advantages to purchasing your encoder from AUTOMATIONDIRECT:

Availability

All common encoders are in stock and available to be shipped immediately. (*We also offer non-stock encoders; see Price List or technical sheets for list of part numbers and lead times.)*

Cost

As with all of our product lines, our prices are often 50% below the list prices of traditional automation suppliers. Our direct business model allows us to operate more efficiently than other suppliers and pass the savings on to you.

Quality

All encoders carry a 1-year warranty, and all in-stock models have a 30-day money-back guarantee. If for any reason you are not satisfied with your purchase, send it back and we will refund your money.

What is a light-duty encoder?

A light-duty encoder is a cost-effective encoder for small applications. It offers the following features:

- Small body with 38mm diameter and 30mm depth
- Dustproof (IP40) rating
- 6mm standard shaft or 8mm hollow shaft
- Resolution available from 100 pulses/revolution to 2500 pulses/revolution
- Available with open collector or line driver output
- Up to 200kHz response frequency

What is a medium-duty encoder?

A medium-duty encoder is the most popular encoder we offer. The product line offers the greatest flexibility of choice while maintaining very high quality, all for a very low price. Medium-duty encoders offer:

- Small body with 50mm diameter and 35mm depth
- Splash-proof (IP65) rating
- 8mm standard shaft or 8mm hollow shaft
- Incremental or absolute (gray code) operation
- Incremental resolution available from 60 pulses/revolution to 2500 pulses/revolution
- Absolute resolution available from 256 pulses/revolution to 1024 pulses/revolution
- Available in open collector, push-pull or line driver output versions
- Up to 100kHz response frequency

What is a heavy-duty encoder?

A heavy-duty encoder is the most rugged encoder you can buy. Top-of-the-line bearings help maintain a service life of 12 billion revolutions. A heavy-duty encoder offers:

- Rugged body with 78mm diameter and 60mm depth
- Splash-proof (IP65) rating
- 10mm standard shaft
- Incremental operation from 100 pulses/revolution to 1000 pulses/revolution
- Available with push/pull output
- Up to 100kHz response frequency

Great Selection at Great Prices

Encoder Selection Guide

Type	Incremental	Absolute	Standard Shaft	Hollow Shaft	Output*	Rating
Light-duty	X	(gray code)	X	X	OC, LD	IP40
Medium-duty	X	X	X	X	P/P, LD, OC	IP65
Heavy-duty	X		X		P/P	IP65

* OC=open collector, P/P=push/pull, LD=line driver

Check out the available types:

Incremental light-duty standard shaft (TRD-S)
Incremental light-duty hollow shaft (TRD-SH)
Incremental medium-duty standard shaft (TRD-N)
Incremental medium-duty hollow shaft (TRD-NH)
Incremental heavy-duty standard shaft (TRD-GK)
Absolute medium-duty standard shaft (TRD-NA)

Accessories

Couplings

Aluminum alloy and glass-fiber reinforced plastic couplings, including:
6 mm to 6 mm
8 mm to 8 mm
10 mm to 10 mm

Aluminum alloy couplings, including:
6 mm to 1/4"
8 mm to 1/4", 3/8"
10 mm to 1/4", 3/8"

Mounting brackets

Simplify your installation with a ready-to-use mounting device for your encoder

ENCODERS SELECTION GUIDE



Specification	TRD-S Series	TRD-SH Series	TRD-N Series
Description	Light duty incremental encoder with solid shaft	Light duty incremental encoder with hollow shaft	Medium duty incremental encoder with solid shaft
Size	Body: 38mm diameter and 30mm depth, Shaft: 6mm diameter	Body: 38mm diameter and 30mm depth Shaft: 8mm diameter	Body: 50mm diameter and 35mm depth, Shaft: 8mm diameter
Output Configuration	NPN open collector or line driver	NPN open collector or line driver	Totem pole or line driver
Input Power	NPN open collector: 12-24VDC Line driver: 5VDC	NPN open collector: 12-24VDC Line driver: 5VDC	Totem pole: 5-30VDC Line driver: 5VDC
Resolutions Available	100 to 2500 pulses per revolution	100 to 2500 pulses per revolution	3 to 2500 pulses per revolution
Output Type	Cable (two meter, tinned)	Cable (two meter, tinned)	Cable (two meter, tinned)
Frequency Response	200KHz	200KHz	100KHz max.
Rating	IP40: dust proofed	IP40: dust proofed	IP40: dust proofed; IP65: dust and splash proofed
Accessories Available	Metric-to-metric and metric-to-S.A.E. couplings	Metric-to-metric and metric-to-S.A.E. couplings	Metric-to-metric and metric-to-S.A.E. couplings, mounting bracket
Page Reference	Page 896	Page 896	Page 899




Specification	TRD-NH Series	TRD-NA Series	TRD-GK Series	Couplings and Mounting Brackets
Description	Medium duty incremental encoder with hollow shaft	Medium duty absolute encoder with solid shaft	Heavy duty incremental encoder with solid shaft	Couplings for all standard shaft encoders and mounting brackets for medium and heavy duty encoders
Size	Body: 50mm diameter and 35mm depth Shaft: 8mm diameter	Body: 50mm diameter and 35mm depth, Shaft: 8mm diameter	Body: 78mm diameter and 60mm depth, Shaft: 10mm diameter	-
Output Configuration	Totem pole or line driver	NPN open collector	Totem pole	-
Input Power	Totem pole: 5-30VDC Line driver: 5VDC	10-26VDC	10-30VDC	-
Resolutions Available	3 to 2500 pulses per revolution	32 to 1024 pulses per revolution	30 to 5000 pulses per revolution	-
Output Type	Cable (two meter, tinned)	Cable (two meter, tinned)	Cable (two meter, tinned)	-
Frequency Response	100KHz max.	20KHz	100KHz	-
Rating	IP40: dust proofed; IP65: dust and splash proofed	IP65: dust and splash proofed	IP65: dust and splash proofed	-
Accessories Available	Metric-to-metric and metric-to-S.A.E. couplings, mounting bracket	Metric-to-metric and metric-to-S.A.E. couplings, mounting bracket	Metric-to-metric and metric-to-S.A.E. couplings, mounting bracket	-
Page Reference	Page 899	Page 902	Page 902	Page 907 (couplings)

Light Duty Incremental Encoders

Features

A light-duty encoder is a cost-effective encoder for small applications and has the following features:

- Small body with 38mm diameter and 30mm depth
- Dust proof (IP40 rating)
- 6mm standard shaft or 8mm hollow shaft
- Resolution available from 100 pulses per revolution to 2500 pulses per revolution
- Available with open collector or line driver output
- Up to 200kHz response frequency

Standard shaft (TRD-S) model

Hollow shaft (TRD-SH) model

Note: Yellow shaded part numbers are non-stock. Availability may range from four to six weeks.

Light Duty Standard Shaft Incremental Encoders (NPN Open Collector and Line Driver models)

Part Number	Price	Pulses per Revolution	Input Voltage	Output	Body Diameter
TRD-S100-BD	check	100	12-24 VDC	NPN open collector	38mm
TRD-S200BD	check	200			
TRD-S250BD	check	250			
TRD-S300BD	check	300			
TRD-S360-BD	check	360			
TRD-S400BD	check	400			
TRD-S500-BD	check	500			
TRD-S600BD	check	600			
TRD-S800BD	check	800			
TRD-S1000-BD	check	1000			
TRD-S1024-BD	check	1024			
TRD-S1200BD	check	1200			
TRD-S2000BD	check	2000			
TRD-S2500-BD	check	2500			
TRD-S100-VD	check	100	5VDC	Line driver (differential)	
TRD-S200VD	check	200			
TRD-S250VD	check	250			
TRD-S300VD	check	300			
TRD-S360-VD	check	360			
TRD-S400VD	check	400			
TRD-S500-VD	check	500			
TRD-S600VD	check	600			
TRD-S800VD	check	800			
TRD-S1000-VD	check	1000			
TRD-S1024-VD	check	1024			
TRD-S1200VD	check	1200			
TRD-S2000VD	check	2000			
TRD-S2500-VD	check	2500			

Light Duty Hollow Shaft Incremental Encoders (NPN Open Collector and Line Driver models)

Part Number	Price	Pulses per Revolution	Input Voltage	Output	Body Diameter
TRD-SH100-BD	check	100	12-24 VDC	NPN open collector	38mm
TRD-SH200BD	check	200			
TRD-SH250BD	check	250			
TRD-SH300BD	check	300			
TRD-SH360-BD	check	360			
TRD-SH400BD	check	400			
TRD-SH500-BD	check	500			
TRD-SH600BD	check	600			
TRD-SH800BD	check	800			
TRD-SH1000-BD	check	1000			
TRD-SH1024BD	check	1024			
TRD-SH1200BD	check	1200			
TRD-SH2000BD	check	2000			
TRD-SH2500-BD	check	2500			
TRD-SH100-VD	check	100	5VDC	Line driver (differential)	
TRD-SH200VD	check	200			
TRD-SH250VD	check	250			
TRD-SH300VD	check	300			
TRD-SH360-VD	check	360			
TRD-SH400VD	check	400			
TRD-SH500-VD	check	500			
TRD-SH600VD	check	600			
TRD-SH800VD	check	800			
TRD-SH1000-VD	check	1000			
TRD-SH1024VD	check	1024			
TRD-SH1200VD	check	1200			
TRD-SH2000VD	check	2000			
TRD-SH2500-VD	check	2500			

LIGHT DUTY INCREMENTAL ENCODERS

Specifications

Electrical Specifications				
Model			**TRD-Sxxxx-BD TRD-SHxxxxBD (open collector)**	**TRD-Sxxxx-VD TRD-SHxxxxVD (line driver)**
Power Supply	**Operating Voltage**		10.8 - 26.4VDC*	+4.75 - 5.25VDC*
	Allowable Ripple		3% max.	-
	Current Consumption		50 mA max.	
Signal Waveform			Two-phase + home position	
Max. Response Frequency			200KHz	
Duty Ratio			50 ± 25%	
Phase Difference Width			25 ± 12.5%	
Signal Width at Home Position			100 ± 50%	
Output	**Rise/Fall Time**		1µs max. (when cable length is 1m)	-
	Output Type		NPN open collector output	Line driver output (26C31 or equivalent)
	Output Logic		Negative logic (active low)	Negative logic (active high)
	Output Current	**"H"**	-	2.5 V min.
	Output Voltage	**"L"**	0.4 V max.	0.5 V max.
	Influx Current		30mA max.	-
	Load Power Voltage		35 VDC max.	-
	Short-Circuit Protection		Between output and power supply	
* To be supplied by Class II source				

Mechanical Specifications	
Starting Torque	Max. 0.001 Nm (.00074 ft./lbs)
Max. Allowable Shaft Load	Radial: 20N (4.5 lbs) Axial: 10N (2.25 lbs)
Max. Allowable Speed	6000 rpm (highest speed that can support the mechanical integrity of encoder)
Wire Size	AWG26
Weight	Approx. 150g (5.3 oz) with 2m cable

Environmental Specifications	
Ambient Temperature	10 to 70°C; 14 to 158°F
Storage Temperature	-25 to 85°C; -13 to 185°F
Operating Humidity	35-85% RH
Voltage Withstand	500VAC (50/60Hz) for one minute
Insulation Resistance	50MΩ min.
Vibration Resistance	Durable for one hour along three axes at 10 to 55 Hz with 0.75 amplitude
Shock Resistance	11 ms with 490 m/s^2 applied three times along three axes
Protection	IP40: dust proof

Accessories

Couplings

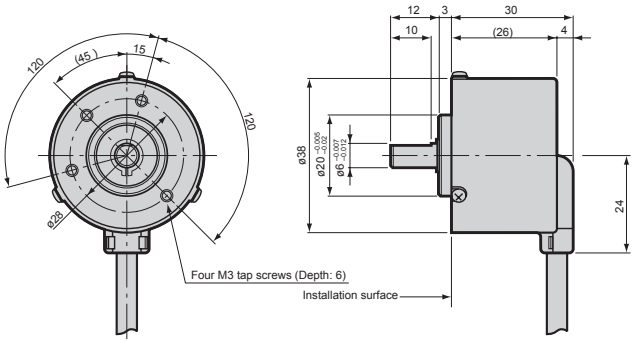
If you selected an encoder with a solid shaft, please select a coupling that fits your encoder. All couplings are in stock, ready to ship.

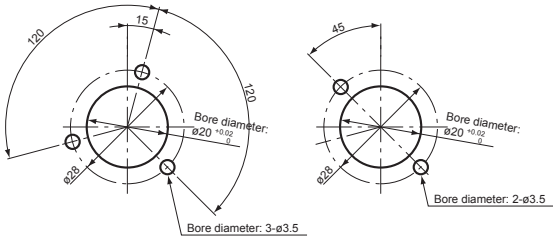
See page 907 for more information on couplings.

Light Duty Incremental Encoders

Dimensions

Standard shaft models

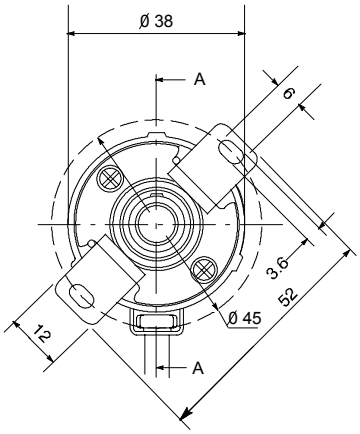


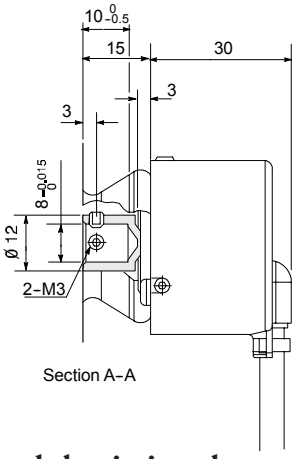


Mounting hole panel cutout (3 holes)

Mounting hole panel cutout (2 holes)

Hollow shaft models



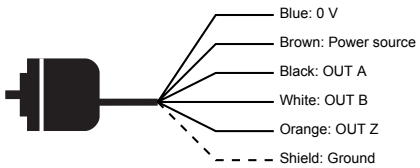


All dimensions in mm
1mm = 0.03937in

Wiring diagrams

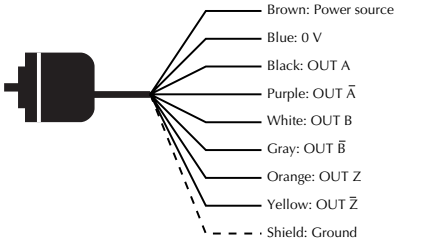
Open Collector Connections

Shielded cable is not connected to the encoder body.



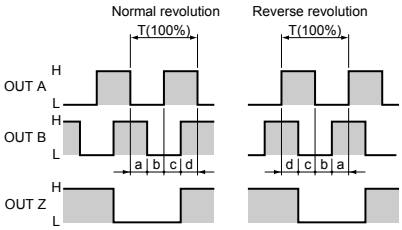
Line driver connections

Shielded cable is not connected to the encoder body.

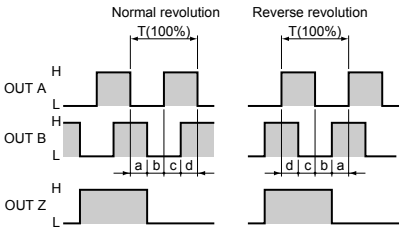


Channel timing charts

Open Collector Models



Line Driver Models



a, b, c, =1/4T±1/8T

"Normal" means clockwise revolution viewed from the shaft.

How to read the timing charts:

Open Collector Models:

Out A and Out B are 90 degrees out of phase. Like any quadrature encoder, four unique logic states are created internally to the encoder. This is based on the rising edge to rising edge (one cycle) on channel A or B that indicates one set of bars on the internal encoder disk has passed by the optical sensor.

For example, looking at the A and A-not channel, the encoder's internal optical sensor compares the two. If the encoder senses more light at A than at A-not, then OUTPUT A goes high. If more light is sensed at A-not than at A, OUT A goes low. The same applies to channel B. This process is called "push-pull."

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

Line Driver Models:

Channel A (OUT A and A-not) and Channel B (OUT B and B-not) are also 90 degrees out of phase on line driver encoders. The quadrature state of channels A and B creates 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. This means that 250 sets of bars would yield 1000 quadrature states (4 x 250 = 1,000).

OUT Z is the same as on open collector models, and is the absolute reference (home position). It signifies one full rotation of the encoder.

Medium Duty Incremental Encoders

Features

The medium duty encoder offers the greatest flexibility of choice in a very high-quality encoder, all for a very low price. Features:

- Small body with 50mm diameter and 35mm depth
- Splash proof (IP65 rating)
- 8mm standard shaft or 8mm hollow shaft
- Incremental resolution available from 60 pulses per revolution to 2500 pulses per revolution
- Available with open collector or push-pull output
- Up to 100kHz response frequency

Standard shaft (TRD-N) model

Hollow shaft (TRD-NH) model

Note: Yellow shaded part numbers are non-stock. Availability may range from four to six weeks.

Incremental Medium Duty Standard Shaft Encoders (Push-Pull Output, TRD-Nxxx-RZVD)

Part Number	Price	Pulses per Revolution	Input Voltage	Output	Body Dia.
TRD-N3-RZWD	check	3	5-30 VDC	Push-pull	50mm
TRD-N4-RZWD	check	4			
TRD-N5-RZWD	check	5			
TRD-N10-RZWD	check	10			
TRD-N30-RZWD	check	30			
TRD-N40-RZWD	check	40			
TRD-N50-RZWD	check	50			
TRD-N60-RZWD	check	60			
TRD-N100-RZWD	check	100			
TRD-N120-RZWD	check	120			
TRD-N200-RZWD	check	200			
TRD-N240-RZWD	check	240			
TRD-N250-RZWD	check	250			
TRD-N300-RZWD	check	300			
TRD-N360-RZWD	check	360			
TRD-N400-RZWD	check	400			
TRD-N480-RZWD	check	480			
TRD-N500-RZWD	check	500			
TRD-N600-RZWD	check	600			
TRD-N750-RZWD	check	750			
TRD-N1000-RZWD	check	1000			
TRD-N1024-RZWD	check	1024			
TRD-N1200-RZWD	check	1200			
TRD-N2000-RZWD	check	2000			
TRD-N2500-RZWD	check	2500			

Incremental Medium Duty Hollow Shaft Encoders (Push-Pull Output, TRD-NHxxx-RZWD)

Part Number	Price	Pulses per Revolution	Input Voltage	Output	Body Dia.
TRD-NH3-RZWD	check	3	5-30 VDC	Push-pull	50mm
TRD-NH4-RZWD	check	4			
TRD-NH5-RZWD	check	5			
TRD-NH10-RZWD	check	10			
TRD-NH30-RZWD	check	30			
TRD-NH40-RZWD	check	40			
TRD-NH50-RZWD	check	50			
TRD-NH60-RZWD	check	60			
TRD-NH100-RZWD	check	100			
TRD-NH120-RZWD	check	120			
TRD-NH200-RZWD	check	200			
TRD-NH240-RZWD	check	240			
TRD-NH250-RZWD	check	250			
TRD-NH300-RZWD	check	300			
TRD-NH360-RZWD	check	360			
TRD-NH400-RZWD	check	400			
TRD-NH480-RZWD	check	480			
TRD-NH500-RZWD	check	500			
TRD-NH600-RZWD	check	600			
TRD-NH750-RZWD	check	750			
TRD-NH1000-RZWD	check	1000			
TRD-NH1200-RZWD	check	1200			
TRD-NH2000-RZWD	check	2000			
TRD-NH2500-RZWD	check	2500			

Medium Duty Incremental Encoders

Note: Yellow shaded part numbers are non-stock. Availability may range from four to six weeks.

Incremental Medium Duty Standard Shaft Encoders (Line Driver Output, TRD-Nxxx-RZVWD)

Part Number	Price	Pulses per Revolution	Input Voltage	Output	Body Dia.
TRD-N3-RZVWD	check	3	5VDC	Line driver (differential)	50mm
TRD-N4-RZVWD	check	4			
TRD-N5-RZVWD	check	5			
TRD-N10-RZVWD	check	10			
TRD-N30-RZVWD	check	30			
TRD-N40-RZVWD	check	40			
TRD-N50-RZVWD	check	50			
TRD-N60-RZVWD	check	60			
TRD-N100-RZVWD	check	100			
TRD-N120-RZVWD	check	120			
TRD-N200-RZVWD	check	200			
TRD-N240-RZVWD	check	240			
TRD-N250-RZVWD	check	250			
TRD-N300-RZVWD	check	300			
TRD-N360-RZVWD	check	360			
TRD-N400-RZVWD	check	400			
TRD-N480-RZVWD	check	480			
TRD-N500-RZVWD	check	500			
TRD-N600-RZVWD	check	600			
TRD-N750-RZVWD	check	750			
TRD-N1000-RZVWD	check	1000			
TRD-N1024-RZVWD	check	1024			
TRD-N1200-RZVWD	check	1200			
TRD-N2000-RZVWD	check	2000			
TRD-N2500-RZVWD	check	2500			

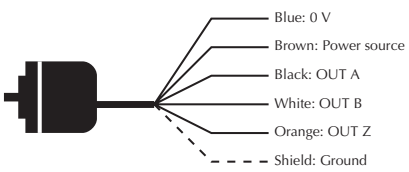
Incremental Medium Duty Hollow Shaft Encoders (Line Driver Output, TRDH-Nxxx-RZVWD)

Part Number	Price	Pulses per Revolution	Input Voltage	Output	Body Dia.
TRD-NH3-RZVWD	check	3	5VDC	Line driver (differential)	50mm
TRD-NH4-RZVWD	check	4			
TRD-NH5-RZVWD	check	5			
TRD-NH10-RZVWD	check	10			
TRD-NH30-RZVWD	check	30			
TRD-NH40-RZVWD	check	40			
TRD-NH50-RZVWD	check	50			
TRD-NH60-RZVWD	check	60			
TRD-NH100-RZVWD	check	100			
TRD-NH120-RZVWD	check	120			
TRD-NH200-RZVWD	check	200			
TRD-NH240-RZVWD	check	240			
TRD-NH250-RZVWD	check	250			
TRD-NH300-RZVWD	check	300			
TRD-NH360-RZVWD	check	360			
TRD-NH400-RZVWD	check	400			
TRD-NH480-RZVWD	check	480			
TRD-NH500-RZVWD	check	500			
TRD-NH600-RZVWD	check	600			
TRD-NH750-RZVWD	check	750			
TRD-NH1000-RZVWD	check	1000			
TRD-NH1024-RZVWD	check	1024			
TRD-NH1200-RZVWD	check	1200			
TRD-NH2000-RZVWD	check	2000			
TRD-NH2500-RZVWD	check	2500			

Wiring diagrams

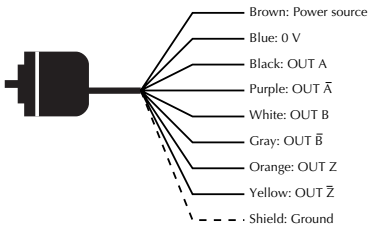
Push-pull connections

Shielded cable is not connected to the encoder body.



Line driver connections

Shielded cable is not connected to the encoder body.



Medium Duty Incremental Encoders

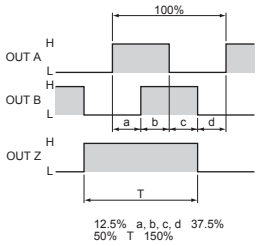
Electrical Specifications				
Model			**TRD-N/NHxxxx-RZWD (Push-Pull)**	**TRD-N/NHxxxx-RZVWD (Line Driver)**
Power Supply	**Operating Voltage**		4.75 - 30VDC*	+4.75 - 5.25VDC*
	Allowable Ripple		3% rms max.	-
	Current Consumption		60 mA max.	
Signal Waveform			Two-phase + home position	
Max. Response Frequency			100KHz max.	
Duty Ratio			50 ± 25% (square wave)	
Signal Width at Home Position			100 ± 50%	
Output	**Rise/Fall Time**		3µs max. (when cable length is 1m)	-
	Output Type		Totem pole	Line driver output (26C31 or equivalent)
	Output Logic		Negative logic (active low)	Negative logic (active high)
	Output Current	**"H"**	10mA max.	-
		"L"	30mA max.	-
	Output Voltage	**"H"**	[(Load power volt) - 2.5V)]	-
		"L"	0.4V max.	-
	Load Power Voltage		35 VDC max.	-

* To be supplied by Class II source

Mechanical Specifications	
Starting Torque	Max. 0.03 Nm (.0022 ft lbs)
Max. Allowable Shaft Load	Radial: 50N (11.24 lbs) Axial: 30N (6.74 lbs)
Max. Allowable Speed	5000 rpm (dust and splash proofed: continuous: 3,000 rpm, instantaneous: 5,000 rpm) (highest speed that can support the mechanical integrity of encoder)
Wire Size	AWG24
Weight	Approx. 250g (8.82 oz) with 2m cable
Environmental Specifications	
Ambient Temperature	10 to 70°C; 14 to 158°F
Storage Temperature	-25 to 85°C; -13 to 185°F
Operating Humidity	35-85% RH
Voltage Withstand	500VAC (50/60Hz) for one minute
Insulation Resistance	50MΩ min. (excluding shield between power supply, signal cable and case)
Vibration Resistance	Durable for one hour along three axes at 10 to 55 Hz with 0.75 mm amplitude (excluding shield between power supply, signal cable and case)
Shock Resistance	11 ms with 490 m/s² applied three times along three axes
Protection	IP50: dust proof; IP65: dust and splash proof

Channel timing chart

Output Signal Timing Chart - Totem Pole Models



The above waveforms apply to normal (clockwise) revolution viewed from the shaft. OUT Z phase is reversed on the RZL and RZWL models.

Accessories

Couplings

If you selected an encoder with a solid shaft, please select a coupling that fits your encoder. All couplings are in stock, ready to ship.

See page 907 for more information.

Mounting bracket

JT-035D metal mounting bracket can be used for all TRD-N/NH/NA encoders.

JT-035D

How to read the timing charts:

Open Collector Models:

Out A and Out B are 90 degrees out of phase. Like any quadrature encoder, four unique logic states are created internal to the encoder. This is based on the rising edge to rising edge (one cycle) on channel A or B that indicates that one set of bars on the internal encoder disk has passed by the optical sensor.

For example, looking at the A and A-not channel, the encoder's internal optical sensor compares the two. If the encoder senses more light at A than at A-not, then OUTPUT A goes high. If more light is sensed at A-not than at A, OUT A goes low. The same applies to channel B. This process is called "push-pull."

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

Line Driver Models:

Channel A (OUT A and A-not) and Channel B (OUT B and B-not) are also 90 degrees out of phase on line driver encoders. The quadrature state of channels A and B creates 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. This means that 250 sets of bars would yield 1000 quadrature states (4 x 250 = 1,000).

OUT Z is the same as on open collector models, and is the absolute reference (home position). It signifies one full rotation of the encoder.

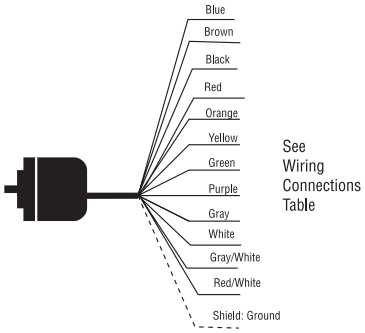
Medium Duty Absolute Encoders

Features

Why use an absolute encoder? When power is cycled using an incremental encoder, any positioning information is lost until "home" position is triggered. An absolute encoder uses gray code to describe each position, so position data is not lost when power is cycled. Features include:

- Small body with 50mm diameter and 35mm depth
- Splash proof (IP65 rating)
- 8mm standard shaft
- Absolute resolution available from 32 pulses per revolution to 1024 pulses per revolution
- Open collector output
- Up to 100kHz response frequency

Standard shaft (TRD-NA) model



Note: Yellow shaded part numbers are non-stock. Availability may range from four to six weeks.

Absolute Medium Duty Standard Shaft Encoders

Part Number	Price	Resolution	Input Voltage	Output	Body Dia.
TRD-NA32NWD	check	5 bit gray code, 32 pulses per revolution	10-26 VDC	NPN open collector	50mm
TRD-NA64NWD	check	6 bit gray code, 64 pulses per revolution			
TRD-NA128NWD	check	7 bit gray code, 128 pulses per revolution			
TRD-NA180NWD	check	8 bit gray code, 180 pulses per revolution			
TRD-NA256NWD	check	8 bit gray code, 256 pulses per revolution			
TRD-NA360NWD	check	9 bit gray code, 360 pulses per revolution			
TRD-NA512NWD	check	9 bit gray code, 512 pulses per revolution			
TRD-NA720NWD	check	10 bit gray code, 720 pulses per revolution			
TRD-NA1024NWD	check	10 bit gray code, 1024 pulses per revolution			

Wiring Connections

Wire color	Connector Pin No.	1024/720 Resolution	512/360 Resolution	256/180 Resolution	128 Resolution	64 Resolution	32 Resolution
Blue	1	0V	0V	0V	0V	0V	0V
Brown	2	12/24V	12/24V	12/24V	12/24V	12/24V	12/24V
Black	3	bit 1 (2^0)	No connection	No connection	No connection	No connection	No connection
Red	4	bit 2 (2^1)	bit 1 (2^0)	No connection	No connection	No connection	No connection
Orange	5	bit 3 (2^2)	bit 2 (2^1)	bit 1 (2^0)	No connection	No connection	No connection
Yellow	6	bit 4 (2^3)	bit 3 (2^2)	bit 2 (2^1)	bit 1 (2^0)	No connection	No connection
Green	7	bit 5 (2^4)	bit 4 (2^3)	bit 3 (2^2)	bit 2 (2^1)	bit 1 (2^0)	No connection
Purple	8	bit 6 (2^5)	bit 5 (2^4)	bit 4 (2^3)	bit 3 (2^2)	bit 2 (2^1)	bit 1 (2^0)
Gray	9	bit 7 (2^6)	bit 6 (2^5)	bit 5 (2^4)	bit 4 (2^3)	bit 3 (2^2)	bit 2 (2^1)
White	10	bit 8 (2^7)	bit 7 (2^6)	bit 6 (2^5)	bit 5 (2^4)	bit 4 (2^3)	bit 3 (2^2)
Black/ white	11	bit 9 (2^8)	bit 8 (2^7)	bit 7 (2^7)	bit 6 (2^5)	bit 5 (2^4)	bit 4 (2^3)
Red/ white	12	bit 10 (2^9) (MSB)	bit 9 (2^8) (MSB)	bit 8 (2^7) (MSB)	bit 7 (2^6) (MSB)	bit 6 (2^5) (MSB)	bit 5 (2^4) (MSB)
-	13	Not connected	Not connected	Not connected	Not connected	Not connected	Not connected
Shield*	-	GND	GND	GND	GND	GND	GND

Note: Numbers in parenthesis () are the bits corresponding to binary code.

* GND (shielded cable) is not connected to encoder body, the enclosure is grounded through the 0VDC line.

Medium Duty Absolute Encoders

Electrical Specifications		
Model		**TRD-NAxxxx-NWD**
Power Supply	**Operating Voltage**	10.8 - 26.4VDC*
	Allowable Ripple	3% rms max.
	Current Consumption	70 mA max.
Output Code		Gray binary (38 gray codes at 180 resolution, 76 at 360 resolution, and 152 at 720 resolution)
Max. Response Frequency		20KHz (Maximum revolution speed = (max. response frequency / resolution) x 60. The encoder does not respond to revolution faster than the maximum speed.)
Accuracy		(360 / resolution x 2)°
Direction of Rotation		Normal (CW) or reversed (CCW) (When viewed from the shaft, CW is clockwise direction, and CCW is counterclockwise direction)
Rise/Fall Time		2µs max. (at 1kW load resistance and when cable length is 2m or less)
Output	**Output Type**	NPN open collector
	Output Logic	Negative logic (active low)
	Sinking Current	16mA
	Residual Voltage	0.4V max.
	Load Power Voltage	30VDC max.
* To be supplied by Class II source		
Mechanical Specifications		
Starting Torque	Max. 0.03 Nm (.0022 ft lbs) max. at 20°C (68°F)	
Max. Allowable Shaft Load	Radial: 50N (11.24 lbs) Axial: 30N (6.74 lbs)	
Max. Allowable Speed	Continuous: 3,000 rpm, instantaneous: 5,000 rpm; (highest speed that can support the mechanical integrity of encoder)	
Wire Size	AWG26	
Weight	Approx. 300g (10.58 oz) with 2m cable	
Environmental Specifications		
Ambient Temperature	10 to 60°C; 14 to 140°F	
Storage Temperature	-25 to 85°C; -13 to 185°F	
Operating Humidity	25-85% RH (with no condensation)	
Insulation Resistance	10MΩ min.	
Vibration Resistance	Durable for one hour along three axes at 10 to 55 Hz with 0.75 mm amplitude	
Shock Resistance	11 ms with 980 m/s² applied three times along three axes	
Protection	IP65: dust and splash proof	

Accessories

Couplings

If you selected an encoder with a solid shaft, please select a coupling that fits your encoder. All couplings are in stock, ready to ship.

See page 907 for more information.

Mounting bracket

JT-035D metal mounting bracket can be used for all TRD-N/NH/NA encoders.

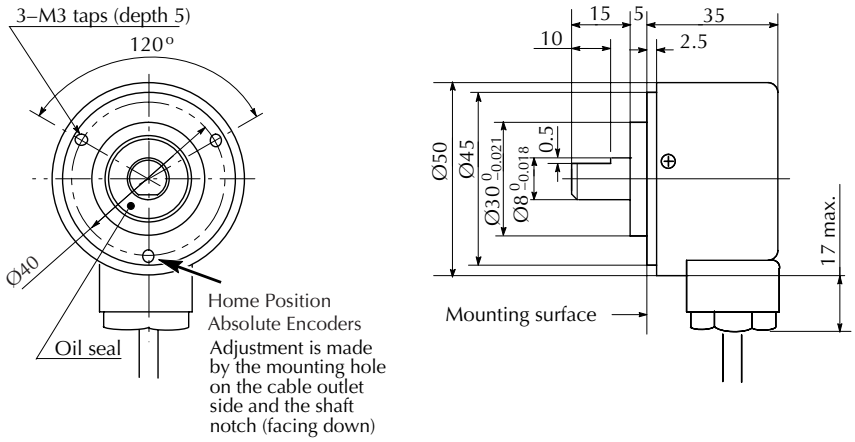
JT-035D

Medium Duty Absolute and Incremental

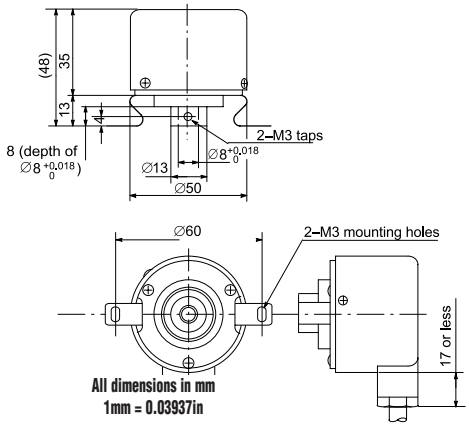
Dimensions

The following are the external dimensions of both incremental and absolute medium duty encoders and the optional mounting bracket.

Standard shaft incremental and absolute encoders (TRD-N, TRD-NA)

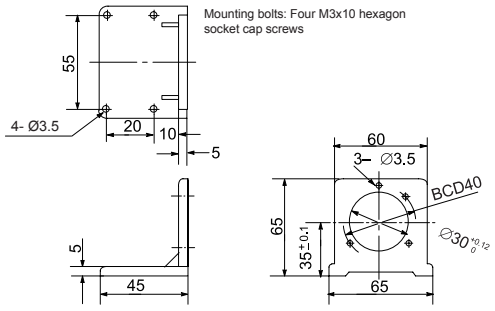


Hollow shaft incremental encoders only (TRD-NH)



Optional mounting bracket for all medium duty encoders

JT-035D



Heavy Duty Incremental Encoders

Features

A heavy-duty encoder is the most rugged encoder you can buy. Top-of-the-line bearings allow a service life of 12 billion revolutions. Features include:

- 10mm standard shaft
- Rugged body with 78mm diameter and 60mm depth
- Splash proof IP65 rating
- Incremental operation from 30 pulses per revolution to 5,000 pulses per revolution
- 100KHz maximum response frequency
- 10-30 VDC, push-pull output

Standard shaft (TRD-GK) model

Dimensions and wiring diagram on page 906.

Note: Yellow shaded part numbers are non-stock. Availability may range from four to six weeks.

Heavy Duty Standard Shaft Incremental Encoders

Model	Price	Pulses per Revolution	Input Voltage	Output	Body Diameter
TRD-GK30-RZD	check	30	10-30 VDC	Push-pull	78mm
TRD-GK100-RZD	check	100			
TRD-GK120-RZD	check	120			
TRD-GK200-RZD	check	200			
TRD-GK240-RZD	check	240			
TRD-GK250-RZD	check	250			
TRD-GK300-RZD	check	300			
TRD-GK360-RZD	check	360			
TRD-GK400-RZD	check	400			
TRD-GK500-RZD	check	500			
TRD-GK600-RZD	check	600			
TRD-GK800-RZD	check	800			
TRD-GK1000-RZD	check	1000			
TRD-GK1200-RZD	check	1000			
TRD-GK1500-RZD	check	1500			
TRD-GK1800-RZD	check	1800			
TRD-GK2000-RZD	check	2000			
TRD-GK2500-RZD	check	2500			
TRD-GK3600-RZD	check	3600			
TRD-GK5000-RZD	check	5000			

Electrical Specifications

Model		TRD-GKxxxx-RZD
Power Supply	Operating Voltage	10 - 30VDC*
	Allowable Ripple	3% rms max.
	Current Consumption	At less than 16VDC: 50 mA max. / at 16VDC or more: 70mA max.
Output Waveform	Output Signal	Two phase + home position
	Duty Ratio	50 ± 25%
	Max. Frequency Response	100KHZ max.
	Signal Width at Home Position	At 400P or less: 25 to 150%; at 500P or more: 1° at 30'
	Rise/Fall Time	2µs max. (when cable length is 2m or less)
Output	Output Type	Totem pole
	Current: Outflow "H"	30mA max.
	Voltage: "H"	(power source voltage - 4V) min.
	Voltage: "L"	2V max.
	Load Power Voltage	35VDC max.

* To be supplied by Class II source

Mechanical Specifications

Starting Torque	Max. 0.1 Nm (.074 ft lbs) max. at 20°C (68°F)
Max. Allowable Shaft Load	Radial: 100N (22.48 lbs) Axial: 50N (11.24 lbs)
Max. Allowable Speed	5,000 rpm
Sevice Life of Bearing	12 billion revolutions (at max. allowable speed)
Wire Size	AWG24
Weight	Approx. 600g (21.16 oz) with 2m cable

Environmental Specifications

Ambient Temperature	10 to 70°C; 14 to 158°F
Storage Temperature	-25 to 85°C; -13 to 185°F
Operating Humidity	35-85% RH (with no condensation)
Insulation Resistance	50MΩ min.
Vibration Resistance	At 500P or less: Durable for one hour along three axes at 10 to 55 Hz with 0.75 mm amplitude At 600P or more: Durable for one hour along three axes at 10 to 55 Hz with 0.35 mm amplitude
Shock Resistance	At 500P or less: 11 ms with 980 m/s² applied three times along three axes At 600P or more: 11 ms with 294 m/s² applied three times along three axes
Protection	IP65: dust and splash proof

Heavy Duty Incremental Encoders

Accessories

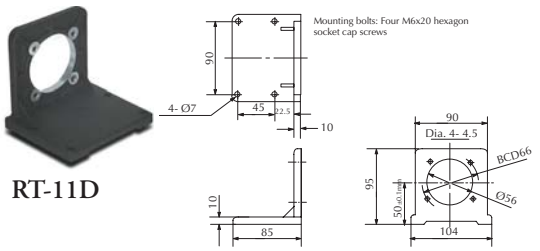
Couplings

Select a coupling that fits your encoder.
All couplings are in stock, ready to ship.

See page 18-16 for more information.

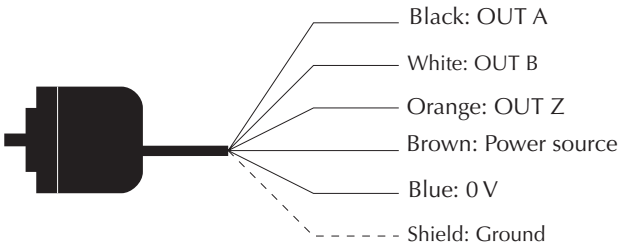
Mounting bracket

RT-11D metal mounting bracket for all TRD-GK encoders.

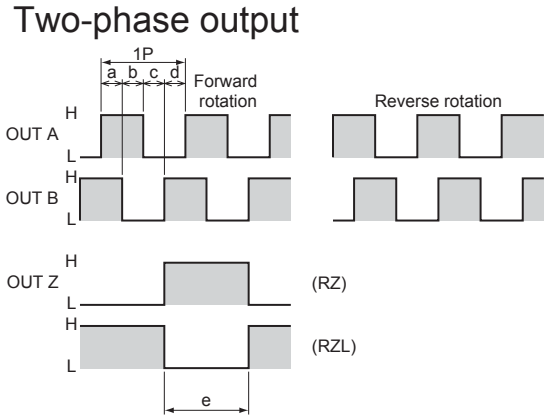


RT-11D

Wiring diagram



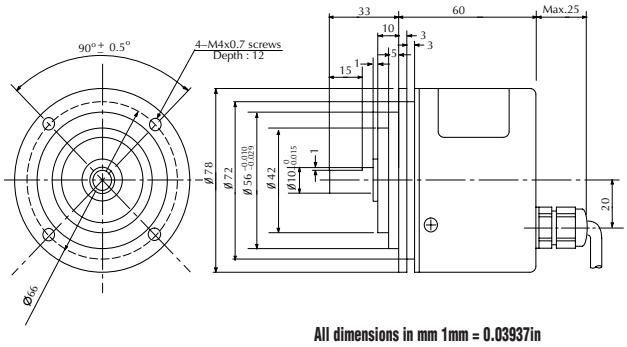
Channel timing chart



a, b, c, d = (1/4±1/8) P
e: 400 P or less: 25 to 150%
500 P or more: 1 ±30'
(At 1,800, 3,600, 5000 pulses only: 50 to 150%)
OUT Z generates home position in both directions.

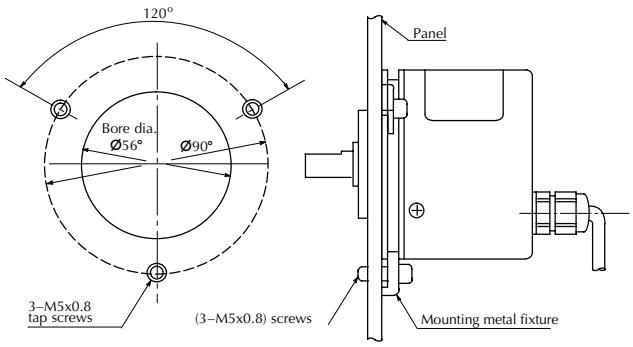
Dimensions

External dimensions



All dimensions in mm 1mm = 0.03937in

Servo mounting



How to read the timing charts:

Open Collector Models:

Out A and Out B are 90 degrees out of phase. Like any quadrature encoder, four unique logic states are created internal to the encoder. This is based on the rising edge to rising edge (one cycle) on channel A or B that indicates that one set of bars on the internal encoder disk has passed by the optical sensor.

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

ENCODER COUPLINGS

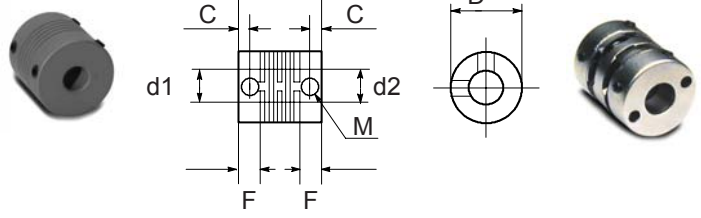
Couplings provide a connection between encoders and solid shafts. We offer fiberglass and aluminum metric-to-metric couplings and aluminum metric-to-S.A.E. couplings. Use the selection guide below to help select your coupling.

Couplings Selection Guide and Dimensions

Type	Part No.	Price	Applicable Encoders	Material	d1	d2	D	L	F	C	M	a	E	S
					mm*									
Fiberglass (metric)	GJ-6D	check	TRD-S	Glass-fiber reinforced polyacetal	6	6	15	21.6	5.2	2.8	M3 set screw	6° max.	0.5mm max.	0.12mm max.
	GJ-8D	check	TRD-N,-NA		8	8	19	24	6.8	3.5	M4 set screw	5° max.	0.5mm max.	0.12mm max.
	GJ-10D	check	TRD-GK		10	10	22	26.2	7.1	3.6	M4 set screw	5° max.	0.5mm max.	0.12mm max.
Aluminum (metric)	RU-075D	check	TRD-S	Aluminum alloy	6	6	19.1	19.1	4.8	9.5	M3 set screw	5° max.	0.25mm max.	0.12mm max.
	JU-100D	check	TRD-N,-NA		8	8	25.4	25.4	6.9	3.8	M5 set screw	5° max.	0.25mm max.	0.12mm max.
	RU-100D	check	TRD-GK		10	10	25.4	25.4	6.9	3.8	M5 set screw	5° max.	0.25mm max.	0.12mm max.
Aluminum (metric to SAE)	MCGL16-6-635	check	TRD-S	Aluminum alloy (Bent plate: Polyimide)	6	6.35 (0.25")	16	23.2	7	3	M3 set screw	3.5° max.	0.3mm max.	0.3mm max.
	MCGL20-8-635	check	TRD-N,-NA		8	6.35 (0.25")	20	26	7.5	3.7	M3 set screw	3.5° max.	0.3mm max.	0.4mm max.
	MCGL20-8-952	check	TRD-N,-NA		8	9.52 (0.375")	20	26	7.5	3.7	M3 set screw	3.5° max.	0.3mm max.	0.4mm max.
	MCGL25-10-635	check	TRD-GK		10	6.35 (0.25")	25	30.2	9	4	M4 set screw	3.5° max.	0.3mm max.	0.5mm max.
	MCGL25-10-952	check	TRD-GK		10	9.52 (0.375")	25	30.2	9	4	M4 set screw	3.5° max.	0.3mm max.	0.5mm max.

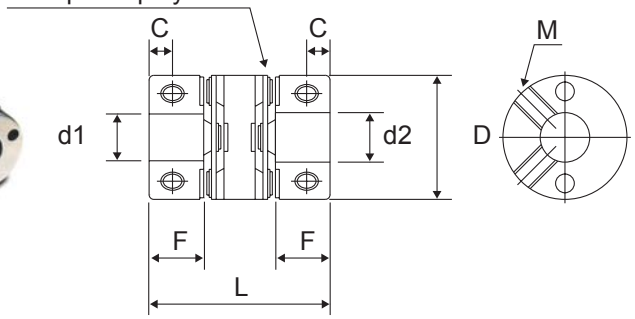
* mm÷25.4 = inches

GJ-6D, GJ-8D, and GJ-10D fiberglass couplings

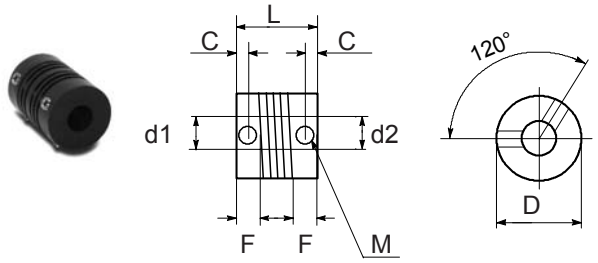


MCGLxx aluminum couplings

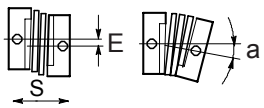
Bent plate: polyimide



RS-075D, RS-100D, and JU-100D aluminum couplings



Misalignment compensation



Encoders Frequently Asked Questions

Q: What is a differential line output?
A: A differential output refers to the fact that each channel has a complement channel, i.e. Channel A and Channel A not. A differential line driver is used to help increase noise immunity. It also allows you to sink or source more current then a push pull output. A differential line driver will work both with a sinking or sourcing circuit. It can also help in increasing the distance that a signal is transmitted.

Q: What is an open collector output?
A: An open collector output is an NPN transistor. An NPN transistor allows the sinking of current to common. It can be thought of as a switch that allows the circuit to be connected to common after the load. This means that a source is required for the output to work. A supply through a load must be connected to the output, otherwise the NPN transistor is simply creating a path to common, (i.e., a dry contact). Therefore, if you were to measure the voltage at the output of an open collector that is not connected to some supply, you would not see a change in voltage. The voltage should be measured across the output load to determine if the open collector is working properly.

Q: What is a push-pull output?
A: A push-pull output is an output that allows you to connect either a sinking or sourcing circuit. This type of an output allows you to sink more current than a totem pole output and follow the input voltage. A push pull output is chosen when an open collector output will not work with the controller that is connected to the encoder.

Q: What is a quadrature output?
A: Quadrature output refers to the fact that the signals A and B are separated by 90 degrees of phase shift with A leading B or B leading A depending on the direction of rotation. It does not mean that the output will be four times the amount of the pulses per revolution of the encoder. The fact that the signals are 90 degrees out of phase enables the controller to determine the direction that the encoder is spinning. You must use both the A and B signal to have a quadrature output and to get X2 or X4 logic.

Q: Why do I need a pull-up resistor?
A: A pull-up resistor is used to "pull" the logic high voltage level up to the level of the operating voltage. This is useful when the output of the open collector is not reaching the voltage level needed to indicate a logic high signal or when noise is present on the signal line. When a logic high signal is present, its voltage level will be approximately that of the operating voltage for an open circuit. The difference is due to the voltage drop across the pull up resistor. This is not necessarily true if the load is referenced to ground.

Q: What is the difference between quadrature and 4X logic?
A: Quadrature output refers to the phasing of the output signals. When the output signals, signal A and B, are 90 degrees out of phase with each other, the output is said to be in quadrature.

4X logic denotes how the controller will interpret the signal that it is receiving. This is done by translating each edge of the pulse detected for the A and B channel into its own pulse. This translation takes place in the controller and not at the encoder.

This means if you order a quadrature encoder with 120 pulses per revolution, the output of signal A and B will be out of phase by 90 degrees. It does not mean that for every one revolution that the encoder makes you will get 480 pulses. The multiplication of the pulses only occurs at the controller.

Q: Is shielded cable needed?
A: YES. The use of shielded cable is highly recommended. This is especially true for areas in which large amounts of electrical noise exist. If you are having any noise problems, or suspect that you might, then use a shielded cable.

Q: How do I set my calibration constant?
A: The calibration constant can be simplified by simply selecting the correct pulses per revolution (PPR). When choosing your calibration constant remember the closer to 1, the better. The value of the calibration constant is your best resolution per pulse of the encoder.

Q: How do I choose the pulses per revolution (PPR)?
A: When choosing the PPR value of the encoder, please keep a few simple rules in mind. Make sure that you do not choose a PPR that will cause you to exceed the maximum frequency of your controller or encoder. Try to choose a PPR that is close to the value you wish to display. This eliminates or reduces the need for a calibration constant. For example, if you wish to display 12 inches, choose 1200 PPR. However, do not make the mistake of forgetting the multiplication of the controller's input. Most controllers have X2 or X4 logic. If it is X2 logic, this would change your PPR to 600 for a 12.00 display and the PPR would be 300 for X4 logic. These choices give you one pulse for every one unit of measurement desired. It is important to remember the frequency that your PPR will create. When choosing the PPR, do not choose one that will result in a higher frequency than the encoder can handle at your maximum speed. The reverse is also true: do not choose too low of a PPR so that your controller cannot recognize the signal. Try to choose your PPR so that you calibration constant is between .5 and 1.

ENCODERS FREQUENTLY ASKED QUESTIONS

Q: How far away can I place my encoder from my system?

A: There is no set answer to this question. Many factors play a role in determining the maximum length of cable that can be used to connect the units together. The largest problem with running long lengths of cable is that the cable becomes more susceptible to noise. This is due to the capacitance of the cable, the cable acting as an antenna, and the loss of power through the cable. The maximum distance of cable can be achieved by following some basic wiring principles. Do not run the cable near objects that create a lot of electrical noise. This includes AC motors, arc welders, AC power lines, and transformers. Use twisted pair cabling when using the signal and its compliment, and shielded cabling when running any type of signal. Use the highest voltage available for the output voltage. For example, if the encoder will output 5 to 24 volts, then use 24 volts. Use an open collector or differential line driver output with a differential receiver so that the maximum amount of current can be sinked/sourced. If you are using the encoder as an input to more than one controller, use a signal amplifier. This is also a good way to help increase the distance a signal can travel. Typical maximum distances for a differential line driver are around 100ft., or more when using a differential input, and for an open collector the distance is around 35 ft.

Q: Why use an absolute encoder?

A: An absolute encoder has each position of the revolution uniquely numbered. This means that instead of an output of pulses, you get an output that is a specific value in a binary format. This is very useful when exact positioning is a must. Since each location in an absolute encoder's revolution is a unique binary value, if the power should be lost, the actual value of the position will be known when power is restored. The exact position will be known even if the controller loses power and the process is moved.

Q: What is gray code?

A: Gray code is a form of binary. The difference between gray code and binary is the method of incrementing to the next number. In gray code, only one digit may change states for every increment. This means the count sequence would look something like this: 0, 1, 3, 2, 6, and 7. This is different than standard binary, where the sequence would be 0,1, 2, 3, 4, and 5.

Gray code is used to prevent errors as transitions to the next state occur. An example of how an error could occur would be when both values in the sequence were true. This can occur due to the timing sequence and the capacitance of the cable. The transition from 0011 to 0100 could cause 0111 to be generated. With gray code this is not possible.

Q: How do I convert gray code to binary?

A: The conversion from gray code to binary is simple.

Step 1: Write the number down and copy the left most digit under itself.

Step 2: Add the highlighted binary digit to the gray code immediately up and to the right of it. So, 1 plus 1 is 0 dropping the carried digit. Write the result next to the binary digit just added. Drop all of the carried digits.

Step 3: Repeat Step 2 until the number is completed.

Q: What is a sinking or sourcing Input?

A: Sinking and sourcing inputs simply refer to the current flow in a transistor. This means that they require a voltage and a load to operate. A sinking input requires the voltage and load to be present before connecting it to the circuit. This means that it is "sinking" the current to ground for the circuit. A sourcing input must be before the load in the circuit. This means that it is "sourcing" the current to the circuit. Voltage and a load must be present in either case to detect a voltage change at the input. The same is true for sinking or sourcing outputs.