

## Rotary Encoder (Incremental)

## E6A2

### Compact with an External Diameter of 25 mm

- Various models available in series with supply voltages and output forms adaptable to various input devices.
- Models with zero index function ideal for positioning applications.
- High response frequency and noise immunity make encoders ideal for factory automation applications.
- Ensures higher-than-ever measurement precision.
- An additional series of models with 25 dia. ensuring a resolution of 500 rpm.



### Ordering Information

#### ■ Rotary Encoders

Resolution (pulses/revolution)	Output phase	Output configuration	Supply voltage	Model
10, 20, 60, 100, 200, 300, 360, 500	A	Voltage	5 to 12 VDC	E6A2-CS3E
		Open collector		E6A2-CS3C
			12 to 24 VDC	E6A2-CS5C
100, 200, 360, 500	A, B	Voltage	5 to 12 VDC	E6A2-CW3E
		Open collector		E6A2-CW3C
			12 to 24 VDC	E6A2-CW5C
100, 200, 360, 500	A, B, Z	Voltage	5 to 12 VDC	E6A2-CWZ3E
		Open collector		E6A2-CWZ3C
			12 to 24 VDC	E6A2-CWZ5C

**Note:** When placing an order, specify one of the resolutions (pulses/revolution) listed above in addition to the model number.

#### ■ Accessories (Order Separately)

Product	Model	Remarks
Coupling	E69-C04B	Provided with each E6A2
Servo Mounting Bracket	E69-1	Provided with the E6A2-CWZ□

### Specifications

#### ■ Ratings/Characteristics

Model	E6A2-CS3E	E6A2-CS3C	E6A2-CS5C	E6A2-CW3E	E6A2-CW3C	E6A2-CW5C	E6A2-CWZ3E	E6A2-CWZ3C	E6A2-CWZ5C
<b>Power supply voltage</b>	5 VDC-5% to 12 VDC+10%, ripple (p-p): 5% max.		12 VDC -10% to 24 VDC +15%, ripple (p-p): 5% max.	5 VDC-5% to 12 VDC+10%, ripple (p-p): 5% max.		12 VDC -10% to 24 VDC +15%, ripple (p-p): 5% max.	5 VDC-5% to 12 VDC+10%, ripple (p-p): 5% max.		12 VDC -10% to 24 VDC +15%, ripple (p-p): 5% max.
<b>Current consumption (see note 3)</b>	30 mA max.	20 mA max.		30 mA max.	20 mA max.		50 mA max.	30 mA max.	
<b>Resolution</b>	10, 20, 60, 100, 200, 300, 360, 500			100, 200, 360, 500					

Model	E6A2-CS3E	E6A2-CS3C	E6A2-CS5C	E6A2-CW3E	E6A2-CW3C	E6A2-CW5C	E6A2-CWZ3E	E6A2-CWZ3C	E6A2-CWZ5C
<b>Output phases</b>	A			A, B			A, B, Z		
<b>Output configuration</b>	Voltage output	Open collector output		Voltage output	Open collector output		Voltage output	Open collector output	
<b>Output capacity</b>	Output resistance: 2 k $\Omega$ Output current: 20 mA max. Residual voltage: 0.4 V max. (at output current of 20 mA)	Applied voltage: 30 VDC max. Sink current: 30 mA max. Residual voltage: 0.4 V max. (at sink current of 30 mA)		Output resistance: 2 k $\Omega$ Output current: 20 mA max. Residual voltage: 0.4 V max. (at output current of 20 mA)	Applied voltage: 30 VDC max. Sink current: 30 mA max. Residual voltage: 0.4 V max. (at sink current of 30 mA)		Output resistance: 2 k $\Omega$ Output current: 20 mA max. Residual voltage: 0.4 V max. (at output current of 20 mA)	Applied voltage: 30 VDC max. Sink current: 30 mA max. Residual voltage: 0.4 V max. (at sink current of 30 mA)	
<b>Max. response frequency (see note 1)</b>	30 kHz								
<b>Phase difference on output</b>	---			90°±45° between A and B					
<b>Output duty factor</b>	50±25%			---					
<b>Rise and fall times of output</b>	1.0 $\mu$ s max. (at sink current of 10 mA with 500-mm cable)	1.0 $\mu$ s max. (at control output voltage of 5 V and load resistance of 1 k $\Omega$ with 500-mm cable)		1.0 $\mu$ s max. (at sink current of 10 mA with 500-mm cable)	1.0 $\mu$ s max. (at control output voltage of 5 V and load resistance of 1 k $\Omega$ with 500-mm cable)		1.0 $\mu$ s max. (at sink current of 10 mA with 500-mm cable)	1.0 $\mu$ s max. (at control output voltage of 5 V and load resistance of 1 k $\Omega$ with 500-mm cable)	
<b>Starting torque</b>	1 m N • m max.								
<b>Moment of inertia</b>	1 x 10 <sup>-7</sup> kg • m <sup>2</sup> max.								
<b>Shaft loading</b>	Radial: 10 N Thrust: 5 N								
<b>Max. permissible revolution</b>	5,000 r/min								
<b>Ambient temperature</b>	Operating: -10°C to 55°C (with no icing) Storage: -25°C to 80°C (with no icing)								
<b>Ambient humidity</b>	Operating/Storage: 35% to 85% (with no condensation)								
<b>Insulation resistance</b>	20 M $\Omega$ min. (at 500 VDC) between current carry parts and case								
<b>Dielectric strength</b>	500 VAC, 50/60 Hz for 1 min between current carry parts and case								
<b>Vibration resistance</b>	Destruction: 10 to 55 Hz, 1.5-mm double amplitude for 2 hrs each in X, Y, and Z directions								
<b>Shock resistance</b>	Destruction: 500 m/s <sup>2</sup> 3 times each in X, Y, and Z directions								
<b>Degree of protection (see note 2)</b>	IEC60529 IP50								
<b>Weight (packed state)</b>	Approx. 35 g								
<b>Others</b>	Coupling, Servo Mounting Bracket (provided with the E6A2-CWZ□), hexagonal wrench, and instruction manual								

**Note:** 1. The electrical maximum response rotation is determined with the rotation and maximum response frequency by using the following formula.

$$\text{Electrical maximum response rotation (rpm)} = \frac{\text{Maximum response frequency}}{\text{Resolution}} \times 60$$

Therefore, no signal can follow electrically if the actual rotation exceeds the maximum response rotation.

- The E6A2 is not water or oil-resistive.
- An inrush current of approximately 9 A flows for approximately 0.3 ms when the E6A2 is turned ON.

# Operation

## Output Circuits

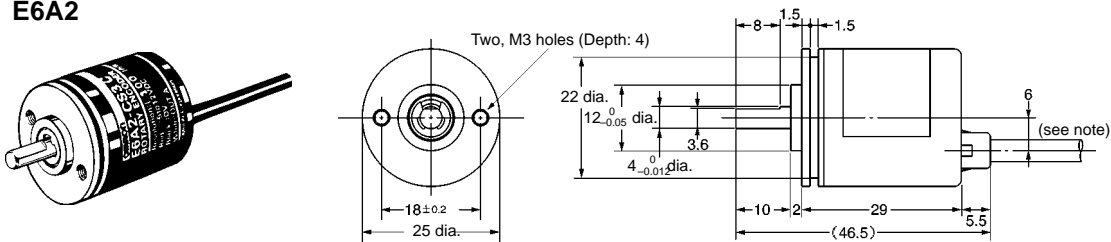
Model	Output circuit	Output mode	Connection												
E6A2-CS3C E6A2-CS5C		<b>Output transistor</b> 	<table border="1"> <thead> <tr> <th>Wire color</th> <th>Signal</th> </tr> </thead> <tbody> <tr> <td>Brown</td> <td>Vcc</td> </tr> <tr> <td>Black</td> <td>A</td> </tr> <tr> <td>White</td> <td>B</td> </tr> <tr> <td>Orange</td> <td>Z</td> </tr> <tr> <td>Blue</td> <td>0 V (common)</td> </tr> </tbody> </table> <p><b>Note:</b> 1. The white and orange wires of the single type (E6A2-CS□□) do not output signals (no connection). 2. The orange wire of the reversible type (E6A2-CW□□) does not output signal (no connection). 3. The voltage output type is capable of sinking a maximum current of 20 mA.</p>	Wire color	Signal	Brown	Vcc	Black	A	White	B	Orange	Z	Blue	0 V (common)
Wire color		Signal													
Brown		Vcc													
Black	A														
White	B														
Orange	Z														
Blue	0 V (common)														
E6A2-CW3C E6A2-CW5C	<b>Direction of resolution: CW (As viewed from end of the shaft)</b> <b>Output transistor</b> 														
E6A2-CWZ3C E6A2-CWZ5C	<b>Direction of resolution: CCW (As viewed from end of the shaft)</b> <b>Output transistor</b> 														
E6A2-CW3E		<b>Direction of resolution: CCW (As viewed from end of the shaft)</b> <b>Output transistor</b> 													
E6A2-CWZ3E		<b>Direction of resolution: CW (As viewed from end of the shaft)</b> <b>Output transistor</b> 													
E6A2-CS3E		<b>Output transistor</b> 													

- Note:** 1. \*(H) and (L) indicate the output levels of the voltage output type.  
2. Output A leads B by  $1/4 T \pm 1/8 T$  when the shaft revolves clockwise, while A lags behind B by  $1/4 T \pm 1/8 T$  when the shaft revolves counterclockwise.

## Dimensions

**Note:** All units are in millimeters unless otherwise indicated.

### E6A2

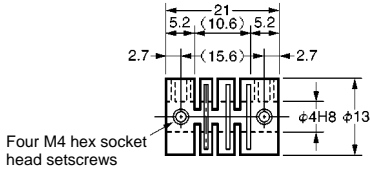


**Note:** Vinyl-insulated round cable with five cores, 4 dia. (0.16 dia. x 7), standard length: 500 mm

# Accessories (Order Separately)

Numbers in parentheses are reference values.

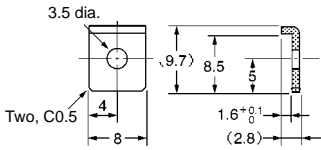
## Coupling E69-C04B



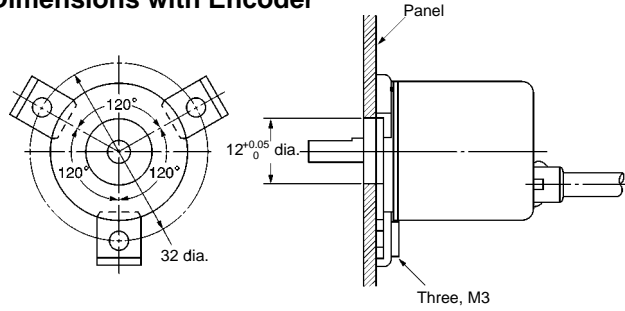
- Note:**
1. Material: Glass-filled polyacetal resin (PBT).
  2. One Coupling is supplied with E6A2.

## Mounting Bracket

(Supplied with E6A2-CWZ□□)



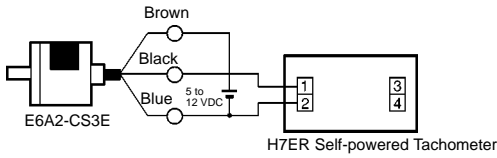
## Dimensions with Encoder



# Connection Examples

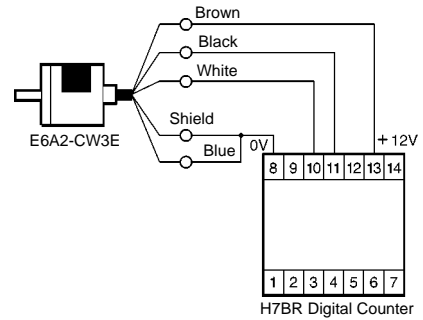
## Connection to H7ER Self-powered Tachometer

Example of applicable model E6A2-CS3E 10P/R, 60P/R



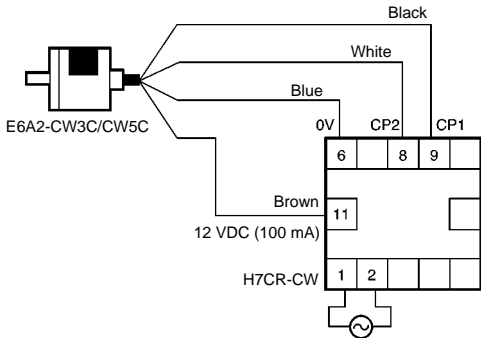
## Connection to H7BR Digital Counter

Example of applicable model E6A2-CW3E



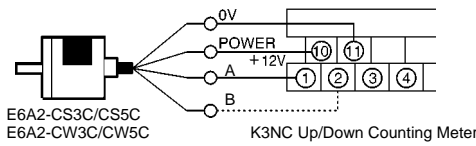
## Connection to H7CR-CW Counter

Example of applicable model E6A2-CW3C, E6A2-CW5C



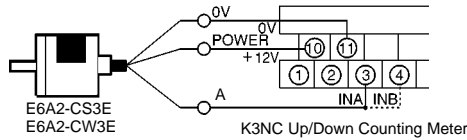
**Connection to K3NC Up/Down Counting Meter  
NPN Open Collector Output**

<b>Example of applicable model</b>	E6A2-CS3C, E6A2-CS5C, E6A2-CW3C, E6A2-CW5C
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**Voltage Output**

<b>Example of applicable model</b>	E6A2-CS3E, E6A2-CW3E
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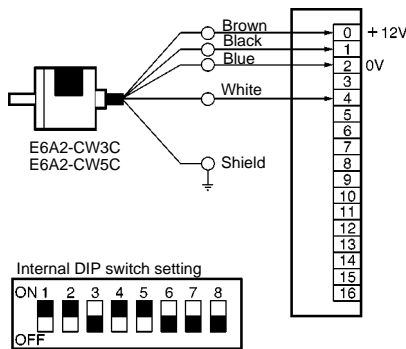


**Connection to C500-CT001 or C500-CT012  
High-speed Counter Unit**

For CW and CCW Detection  
(Incremental/Decremental Counting)

Internal DIP switch settings

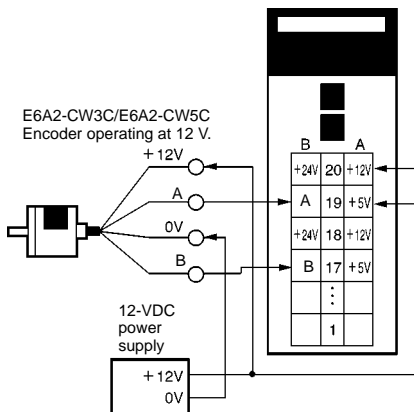
<b>Example of applicable model</b>	E6A2-CW3C, E6A2-CW5C
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**Connection to C200H-CT□□ High-speed  
Counter Unit**

Typical example: C200H-CT001-V1

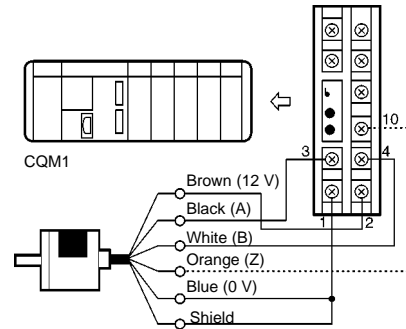
<b>Example of applicable model</b>	E6A2-CW3C, E6A2-CW5C
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- Note:**
1. Connect the phase-A output and phase-B output of the Encoder to terminals A19 and A17 respectively when the power supply voltage to the E6A2-CW3C is 5 VDC.
  2. Connect the phase-A output and phase-B output to B20 and B18 respectively when the power supply voltage to the E6A2-CW5C is 24 VDC.

**Connection to CQM1 Programmable Controller**

<b>Example of applicable model</b>	E6A2-CWZ3C, E6A2-CWZ5C
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- The pulse input of the E6A2 can be directly input into IN04, IN05, and IN06 of the CPU Unit to use these three points as a built-in high-speed counter.
- The single-phase response speed is 5 kHz and the two-phase response speed is 2.5 kHz. The count value is within a range between 0 and 65,535 in increment mode and -32,767 and 32,767 in decrement mode.
- The operation mode of the high-speed counter is set in the PC Setup area in the DM area.

**Count Mode**

<b>Increment/Decrement mode</b>	Increment/Decrement counter uses phases A and B.
<b>Increment mode</b>	Increment counter uses phase A only.
<b>Normal mode</b>	IN04 to IN06 used as normal input points

**Reset Method**

The present count value can be reset with the soft-reset function or the AND of soft-reset and phase-Z input.

**Output Method**

<b>Target value conformance</b>	When the count value reaches the target value, the specified subroutine is executed. A maximum of 16 target values can be set.
<b>Band comparison</b>	When the count value reaches the band, the specified subroutine is executed. A maximum of eight bands can be set with upper and lower limits.

## Precautions

Do not apply voltage exceeding the rated voltage range to the E6A2, otherwise the E6A2 may be damaged.

Do not wire power lines or high-tension lines in parallel to the lines of the E6A2. Doing so may result in damage or malfunction of the E6A2 due to induction. Be sure to wire the lines of the E6A2 separated from the power lines or high-tension lines.

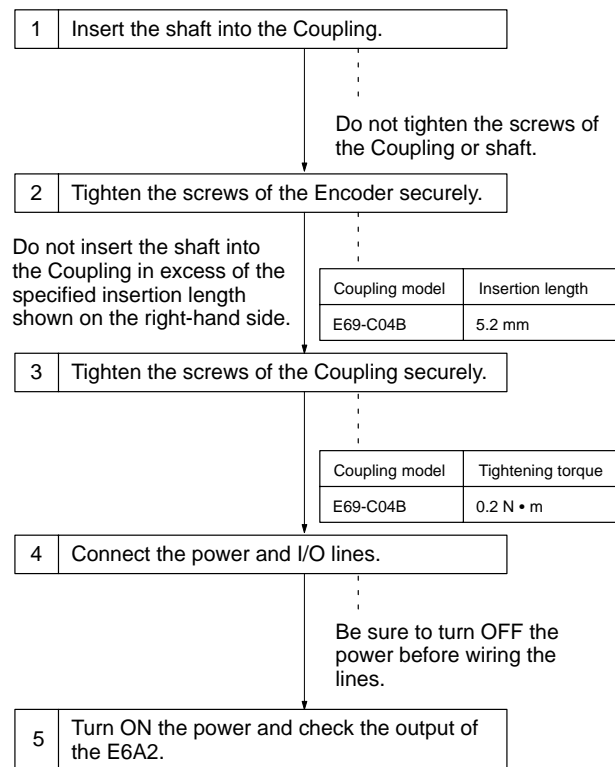
If the power supply has a surge voltage, connect a surge absorber between the positive and negative terminals of the power supply to absorb the surge voltage. Also, shorten the wires connected to the E6A2 as much as possible in order to reduce noise.

Unnecessary pulses are output when the E6A2 is turned ON or OFF. Be sure to turn ON the peripheral devices connected to the E6A2 0.1 s after turning ON the E6A2 and turn OFF the peripheral devices 0.1 s before turning OFF the E6A2.

### ■ Correct Use

#### Mounting

##### Mounting Procedure



#### Mounting

Make sure that the E6A2 is free of water or oil drops.

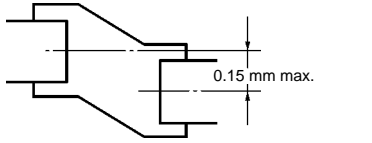
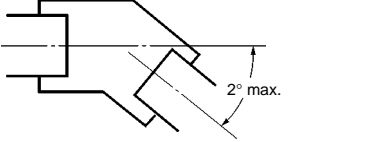
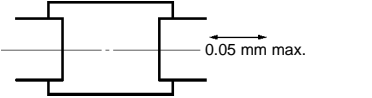
The E6A2 consists of high-precision parts. Be sure to handle the E6A2 with utmost care in order not to drop the E6A2. Not doing so may result in malfunction of the E6A2.

When using the E6A2 in reverse operation, be sure to consider the mounting direction of the E6A2 and the increment/decrement directions.

When the phase-Z output of the E6A2 must coincide with the origin of the installed equipment, be sure to mount the Encoder while monitoring the phase-Z output.

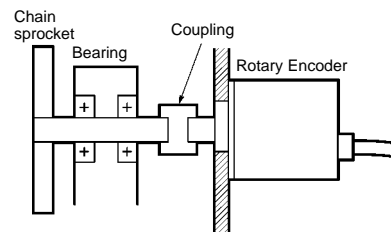
When mounting the E6A2 with screws, be sure to tighten each screw to a maximum torque of 0.5 N • m.

Make sure that the Coupling is connected within the following tolerance ranges.

<b>Decentering tolerance</b>	
<b>Declination tolerance</b>	
<b>Displacement tolerance in the shaft direction</b>	

If there is a difference in angle or position between the shaft and the other shaft connected, an excessive load that may damage the shaft will be imposed on the shaft. Make sure that the shaft is connected properly.

Do not impose excessive loads on the shaft, otherwise the shaft may be damaged. Do not directly connect the shaft to chains, timing belts, or gears. Be sure to connect the shaft to them through an appropriate bearing and Coupling.



When inserting the shaft into a Coupling, do not strike the shaft or the Coupling with a hammer or subject any other shock to the shaft or Coupling.

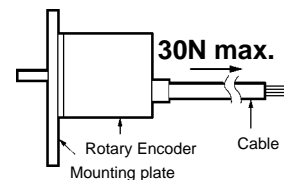
When connecting or disconnecting the Coupling to or from the shaft, do not excessively bend, press, or pull the Coupling.

#### Wiring

Do not make mistakes in the polarity of the power supply, otherwise the E6A2 may be damaged.

Be sure to connect each wire of the E6A2 with the power turned OFF.

When wiring the cable with the E6A2 mounted securely, do not pull the cable with 30N or more.



Do not pull the cable. Make sure that the E6A2 including its shaft is free of any shock.

#### Connections

An increase in the residual voltage and the distortion of output waveform may result due to the resistance or capacity between lines if the cable is extended. Be sure to check the cable type and response frequency before extending the cable.

### Cable Extension Characteristics

When the cable is extended, the output waveform takes a longer time to rise, which adversely affects the phase difference characteristics of phases A and B.

The rise time of the output waveform varies with the load resistance and cable type as well as the cable length.

In addition, there will be an increase in the output residual voltage when the cable is extended.

### Prevention of Counting Errors

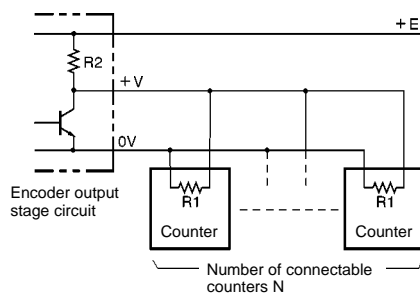
When the operation of E6A2 is stopped in close proximity to the rising or falling edge of the signal, an incorrect pulse may be output due to vibration. As a result, the counter may miscount. In such cases, use an increment/decrement counter so that incorrect pulses will not be counted or accumulated.

### Others

#### Voltage Output of Encoder Input into Multiple Counters

Obtain the number of connectable counters per Rotary Encoder from the following formula.

$$\text{Number of connectable counters } N = \frac{R1 (E-V)}{V \cdot R2}$$



E: Encoder supply voltage

V: Counter minimum input voltage

R1: Counter input resistance

R2: Encoder output resistance

**ALL DIMENSIONS SHOWN ARE IN MILLIMETERS.**

To convert millimeters into inches, multiply by 0.03937. To convert grams into ounces, multiply by 0.03527.

Cat. No. Q018-E1-3 **In the interest of product improvement, specifications are subject to change without notice.**

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