Slim Incremental 50-mm-dia. Rotary Encoder

E6C2-C

Tough and Easy

- Sealed bearings with IP64 oilproof construction.
- Improved shaft loading performance.
  Radial: 50 N, Thrust: 30 N
- Pre-wired Models with cable connected at an angle.
  Side or back cable connections also possible.
- Improved reliability with reverse connection and load short-circuit protection (except for line-driver outputs).

CE

⚠ Be sure to read *Safety Precautions* on page 4.

Ordering Information

Encoder

Power supply voltage	Output configuration	Resolution (pulses/rotation)	Model
5 to 24 VDC	Open-collector output (NPN)	10, 20, 30, 40, 50, 60, 100, 200, 300, 360, 400, 500, 600	**E6C2-CWZ6C**
		720, 800, 1,000, 1,024, 1,200, 1,500, 1,800, 2,000	
12 to 24 VDC	Open-collector output (PNP)	100, 200, 360, 500, 600	**E6C2-CWZ5B**
		1,000, 2,000	
5 to 12 VDC	Voltage output	10, 20, 30, 40, 50, 60, 100, 200, 300, 360, 400, 500, 600	**E6C2-CWZ3E**
		720, 800, 1,000, 1,024, 1,200, 1,500, 1,800, 2,000	
5 VDC	Line-driver output	10, 20, 30, 40, 50, 60, 100, 200, 300, 360, 400, 500, 600	**E6C2-CWZ1X**
		720, 800, 1,000, 1,024, 1,200, 1,500, 1,800, 2,000	

Note: When ordering, specify the resolution in addition to the model number (example: E6C2-CWZ6C 100 P/R).

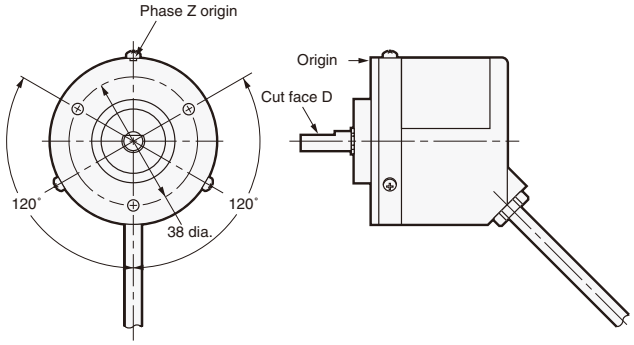
Accessories (Order Separately)

Name	Model	Remarks
Couplings	**E69-C06B**	---
	E69-C68B	Different end diameter
	E69-C610B	Different end diameter
	E69-C06M	Metal construction
Flanges	**E69-FCA**	---
	E69-FCA02	E69-2 Servo Mounting Bracket provided.
Servo Mounting Bracket	**E69-2**	Provided with E69-FCA02 Flange.

Ratings and Specifications

Item / Model	E6C2-CWZ6C	E6C2-CWZ5B	E6C2-CWZ3E	E6C2-CWZ1X
Power supply voltage	5 VDC −5% to 24 VDC +15%, 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.	5 VDC ±5%, ripple (p-p): 5% max.
Current consumption*1	80 mA max.	100 mA max.		160 mA max.
Resolution (pulses/rotation)	10, 20, 30, 40, 50, 60, 100, 200, 300, 360, 400, 500, 600, 720, 800, 1,000, 1,024, 1,200, 1,500, 1,800, 2,000	100, 200, 360, 500, 600, 1,000, 2,000	10, 20, 30, 40, 50, 60, 100, 200, 300, 360, 400, 500, 600, 720, 800, 1,000, 1,024, 1,200, 1,500, 1,800, 2,000	
Output phases	Phases A, B, and Z			Phases A, $\overline{A}$, B, $\overline{B}$, Z, and $\overline{Z}$
Output configuration	NPN open-collector output	PNP open-collector output	Voltage output (NPN output)	Line driver output*2
Output capacity	Applied voltage: 30 VDC max. Sink current: 35 mA max. Residual voltage: 0.4 V max. (at sink current of 35 mA)	Applied voltage: 30 VDC max. Source current: 35 mA max. Residual voltage: 0.4 V max. (at source current of 35 mA)	Output resistance: 2 kΩ Output current: 20 mA max. Residual voltage: 0.4 V max. (at sink current of 20 mA)	AM26LS31 equivalent Output voltage: High level: I_O = −20 mA Low level: I_S = 20 mA Output voltage: V_O = 2.5 V min. V_S = 0.5 V max.
Maximum response frequency*3	100 kHz	50 kHz	100 kHz	
Phase difference between outputs	90°±45° between A and B (1/4 T ± 1/8 T)			
Rise and fall times of output	1 μs max. (Control output voltage: 5 V, Load resistance: 1 kΩ, Cable length: 2 m)	1 μs max. (Cable length: 2 m, Sink current: 10 mA)		0.1 μs max. (Cable length: 2 m, I_O = −20 mA, I_S = 20 mA)
Starting torque	10 mN·m max.			
Moment of inertia	1×10^{-6} kg·m^2 max.; 3×10^{-7} kg·m^2 max. at 600 P/R max.			
Shaft loading: Radial	50 N			
Shaft loading: Thrust	30 N			
Maximum permissible speed	6,000 r/min			
Protection circuits	Power supply reverse polarity protection, Load short-circuit protection			---
Ambient temperature range	Operating: −10 to 70°C (with no icing), Storage: −25 to 85°C (with no icing)			
Ambient humidity range	Operating/Storage: 35% to 85% (with no condensation)			
Insulation resistance	20 MΩ min. (at 500 VDC) between current-carrying parts and case			
Dielectric strength	500 VAC, 50/60 Hz for 1 min between current-carrying parts and case			
Vibration resistance	Destruction: 10 to 500 Hz, 150 m/s^2 or 2-mm double amplitude for 11 min 3 times each in X, Y, and Z directions			
Shock resistance	Destruction: 1,000 m/s^2 3 times each in X, Y, and Z directions			
Degree of protection	IEC 60529 IP64, in-house standards: oilproof			
Connection method	Pre-wired Models (Standard cable length: 2 m)			
Material	Case: Zinc alloy, Main unit: Aluminum, Shaft: SUS420J2			
Weight (packed state)	Approx. 400 g			
Accessories	Instruction manual			

Note: Origin Indication
The following illustration shows the relationship between phase Z and the origin. Set cut face D to the phase Z origin as shown in the illustration.



*1. An inrush current of approximately 9 A will flow for approximately 0.3 ms when the power is turned ON.
*2. The line driver output is a data transmission circuit compatible with RS-422A and long-distance transmission is possible with a twisted-pair cable.(AM26LS31 equivalent)
*3. The maximum electrical response speed is determined by the resolution and maximum response frequency as follows:

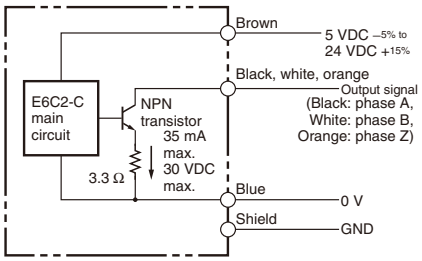
$$\text{Maximum electrical response speed (rpm)} = \frac{\text{Maximum response frequency}}{\text{Resolution}} \times 60$$

This means that the E6C2-C Rotary Encoder will not operate electrically if its speed exceeds the maximum electrical response speed.

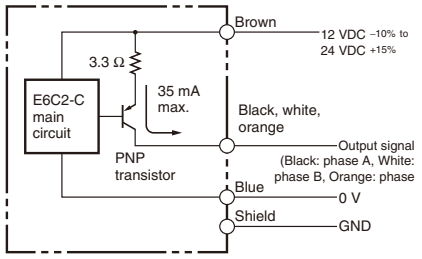
I/O Circuit Diagrams

Model/Output Circuits

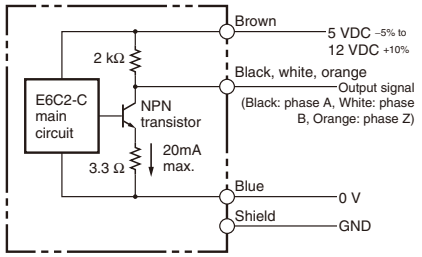
E6C2-CWZ6C



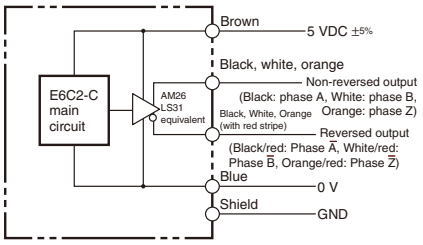
E6C2-CWZ5B



E6C2-CWZ3E



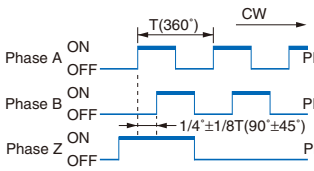
E6C2-CWZ1X



Output mode

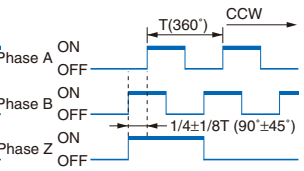
E6C2-CWZ6C NPN Open-collector Output Model
E6C2-CWZ5B PNP Open-collector Output Model

Direction of rotation: CW (as viewed from end of shaft)



Note: Phase A is 1/4 T ± 1/8 T faster than phase B.

Direction of rotation: CCW (as viewed from end of shaft)

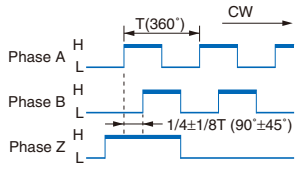


Note: Phase A is 1/4 T ± 1/8 T slower than phase B.

(The ONs in the above timing chart mean that the output transistor is ON and the OFFs mean that the output transistor is OFF.)

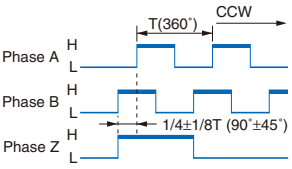
E6C2-CWZ3E Voltage Output Model

Direction of rotation: CW (as viewed from end of shaft)



Note: Phase A is 1/4 T ± 1/8 T faster than phase B.

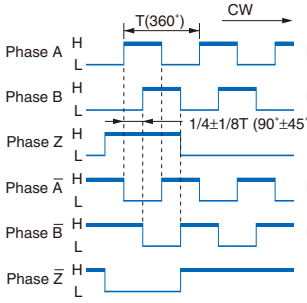
Direction of rotation: CCW (as viewed from end of shaft)



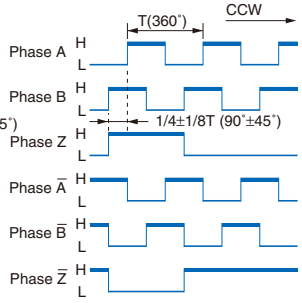
Note: Phase A is 1/4 T ± 1/8 T slower than phase B.

E6C2-CWZ1X Line Driver Output Model

Direction of rotation: CW (as viewed from end of shaft)



Direction of rotation: CCW (as viewed from end of shaft)



Connection

Color	Terminal
Brown	Power supply (+Vcc)
Black	Output phase A
White	Output phase B
Orange	Output phase Z
Blue	0 V (common)

Color	Terminal
Brown	Power supply (+Vcc)
Black	Output phase A
White	Output phase B
Orange	Output phase Z
Black/red stripes	Output phase Ā
White/red stripes	Output phase B̄
Orange/ red stripes	Output phase Z̄
Blue	0 V (common)

Note: Receiver: AM26LS32 equivalent

Note: 1. The shielded cable outer core (shield) is not connected to the inner area or to the case.
2. The phase A, phase B, and phase Z circuits are all identical.
3. Normally, connect GND to 0 V or to an external ground.

Safety Precautions

Refer to *Warranty and Limitations of Liability*.

⚠ WARNING

This product is not designed or rated for ensuring safety of persons either directly or indirectly. Do not use it for such purposes.

Precautions for Correct Use

Do not use the Encoder under ambient conditions that exceed the ratings.

● Wiring

Cable Extension Characteristics

- When the cable length is extended, the output waveform startup time is lengthened and it affects the phase difference characteristics of phases A and B. Conditions will change according to frequency, noise, and other factors. As a guideline, use a cable length of 10 m* or less. If the cable must be more than 2 m, use a Model with a Line-driver Output (max. length for line-driver output: 100 m).

* Recommended Cable
Conductor cross section: 0.2 mm^2
Spiral shield
Conductor resistance: 92 Ω/km max. (20°C)
Insulation resistance: 5 Ω/km min. (20°C)

- The output waveform startup time changes not only according to the length of the cable, but also according to the load resistance and the cable type.
- Extending the cable length not only changes the startup time, but also increases the output residual voltage.

● Connection

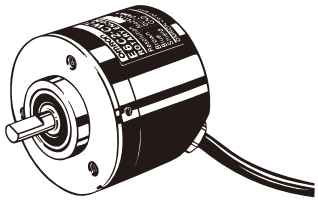
Spurious pulses may be generated when power is turned ON and OFF. Wait at least 0.1 s after turning ON the power to the Encoder before using the connected device, and stop using the connected device at least 0.1 s before turning OFF the power to the Encoder. Also, turn ON the power to the load only after turning ON the power to the Encoder.

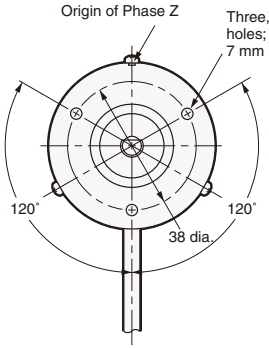
Dimensions

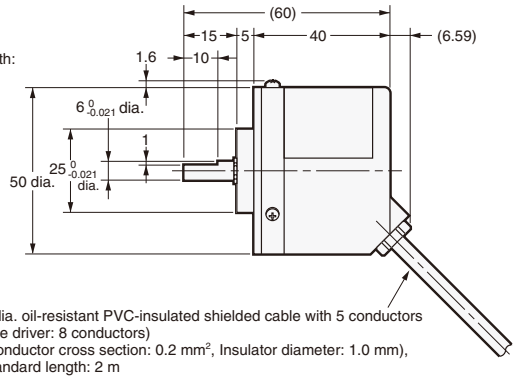
(Unit: mm)

Encoder

E6C2-CWZ□□







Accessories (Order Separately)

Couplings

E69-C06B
E69-C68B
E69-C610B
E69-C06M

Flanges

E69-FCA
E69-FCA02

Servo Mounting Bracket

E69-2 (Three brackets in a set.)

General Precautions

For precautions on individual products, refer to *Safety Precautions* in individual product information.

⚠ WARNING

These products cannot be used in safety devices for presses or other safety devices used to protect human life. These products are designed for use in applications for sensing workpieces and workers that do not affect safety.

Precautions for Correct Use

- Do not use a voltage that exceeds the rated voltage range. Applying a voltage that is higher than the rated voltage range may cause explosion or burning.
- Be sure that the power supply polarity and other wiring is correct. Incorrect wiring may explosion or burning.
- Do not short-circuit the load. Doing so may cause explosion or burning.
- Make sure the power is OFF before performing wiring work. If the power is ON and an output wire contacts the power supply, the output circuit may be damaged.
- Wire high-voltage lines or power lines separately from Encoder wiring. If high-voltage lines are wired in parallel with Encoder wiring, induction may cause malfunction or damage.

Precautions for Correct Use

●Mounting

Mounting Procedure

1. Fit the coupling onto the shaft. — **Do not secure the coupling to the shaft with screws.**
2. Secure the Encoder.

Do not insert the shaft into the coupling beyond the value indicated at right.

Coupling	Amount of insertion
E69-C02B	3.2mm
E69-C04B	5.2mm
E69-C06B	5.5mm
E69-C08B	6.8mm
E69-C10B	7.1mm
E69-C68B	6.8mm
E69-C610B	7.1mm
E69-C06M	8.5mm
E69-C10M	10.5mm

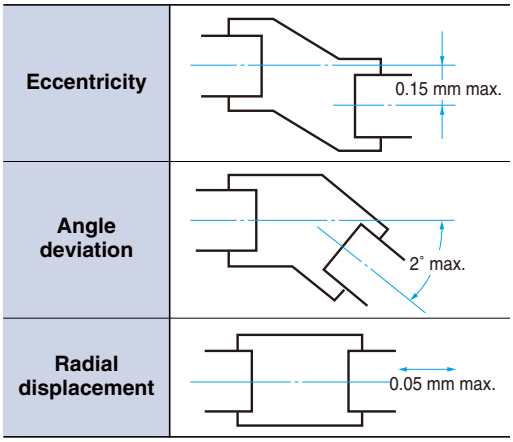
3. Secure the coupling.

Coupling	Tightening torque
E69-C02B	0.08N•m
E69-C04B	0.2N•m
E69-C06B	0.25N•m
E69-C08B	0.44N•m
E69-C10B	
E69-C68B	
E69-C610B	
E69-C06M	0.7N•m
E69-C10M	3.5N•m

4. Connect the power supply and I/O wires. — **Always turn OFF the power supply before wiring.**
5. Turn ON power and check output.

Mounting

- Do not allow water or oil to splash on the Encoder.
- The Rotary Encoder consists of high-precision components. Dropping the Encoder may damage it. Exercise sufficient caution when handling the Encoder.
- When using reverse rotation, check the Encoder mounting direction and the increment/decrement directions before mounting.
- When aligning phase Z of the Encoder with the origin of the machine in which the Encoder is installed, be sure to verify phase Z output while mounting the Encoder.
- Make sure that an excessive load is not placed on the shaft when the gears engage.
- When securing the Rotary Encoder with screws, tighten the screws to a torque of 0.49 N•m.
- When using a coupling, do not exceed the following permitted values.

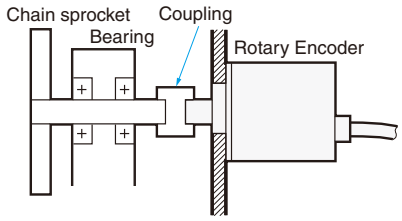


- If there are large mounting errors (eccentricity or angle deviation), an excessive load will be placed on the shaft, causing damage and an extremely shortened life.

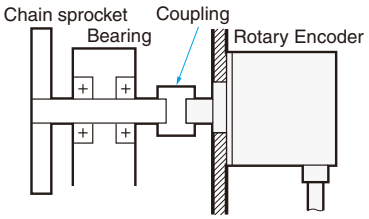
Mounting

- When connecting with a chain timing belt and gears, hold the shaft with a bearing and use a coupling to join to the Encoder.

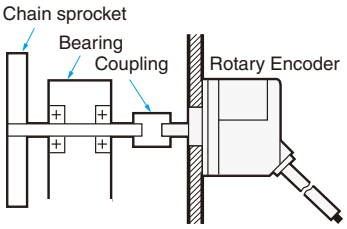
E6A2-C



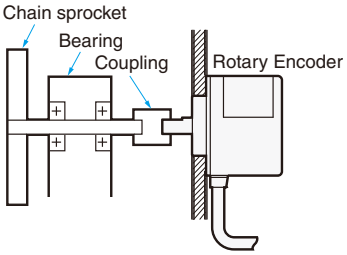
E6B2-C
E6D-C
E6C-N



E6C2-C



E6C3-C□H
E6C3-A

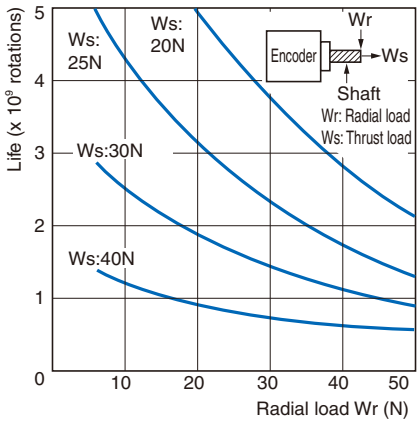


- When inserting the coupling into the shaft, do not tap it with a hammer or apply any other type of shock.
- When attaching or detaching the coupling, do not bend, compress, or pull excessively on the coupling.

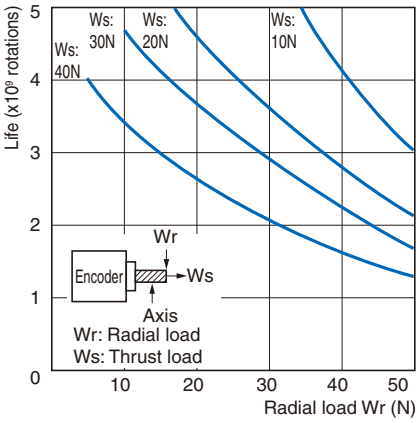
Life of Rotary Encoder Bearings

The life of bearings when a radial load and thrust load are applied are shown in the following graphs (theoretical value).

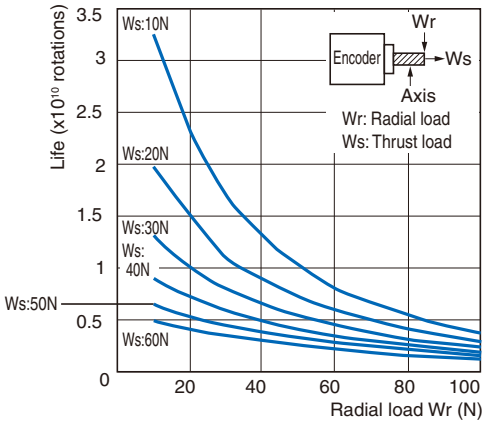
E6B2-C



E6C2-C□



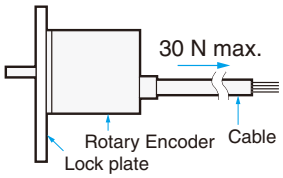
E6C3-C□H



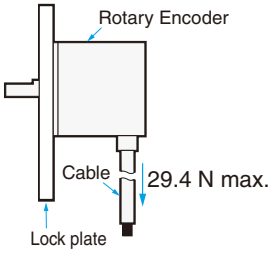
●Wiring

- If connecting the cable after securing the Encoder, do not pull on the cable with a force of 29.4 N or greater.

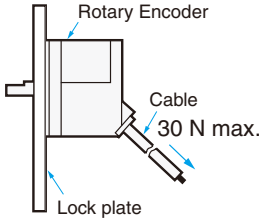
E6A2-C
E6J-A/C



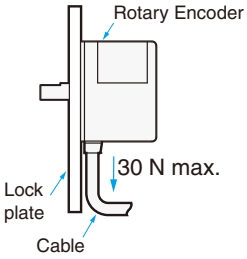
E6B2-C
E6D-C
E6C-N



E6C2-C



E6C3-C□H
E6C3-A



- If connecting the cable after securing the Encoder, do not pull on the cable. Also do not apply shock to the Encoder or shaft.

Connecting

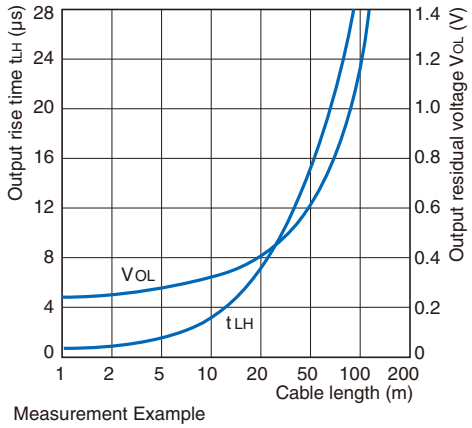
Connection

- When extending the cable, check the cable type and response frequency. Wire resistance and capacitance between wires may amplify residual voltage and cause waveform distortions. If the cable is extended, it is recommended to use a line-driver output. Regardless of the output type, only lengths of 30 m or less comply with the EMC Directive.
  To avoid inductive noise, keep the cabling as short as possible (particularly when inputting to an IC).
- If surges occur in the power supply, connect a surge absorber between the power supply and the Encoder. To reduce noise, keep the wiring as short as possible.
- Spurious pulses may be generated when the power is turned ON or OFF. Wait 0.1 s after turning ON the power before using the connected device, and stop using the connected device 0.1 s (1 s for E6CP-A) before turning OFF the power to the Encoder.
- Inrush current will flow when the power is turned ON. Take the value of the inrush current into consideration before using the power supply.

Cable Extension Characteristics

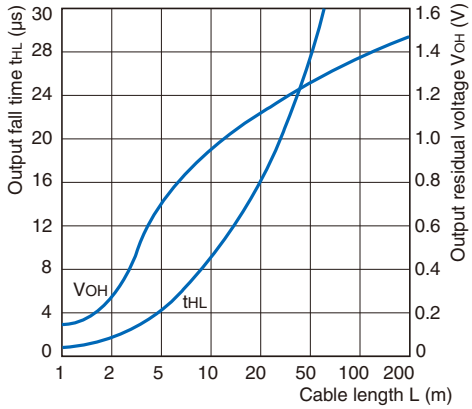
- When the cable length is extended, the output waveform startup time is lengthened and it affects the phase difference characteristics of phases A and B.
- The output waveform startup time changes not only according to the length of the cable, but also according to the load resistance and the cable type.
- Extending the cable length not only changes the startup time, but also increases the output residual voltage.

<E6B2-CWZ6C>



Measurement Example
Power supply voltage: 5 VDC
Load resistance: 1 kΩ (Output residual voltage is measured at a 35 mA load current.)
Cable: Special Cable

<E6C2-CWZ5B>



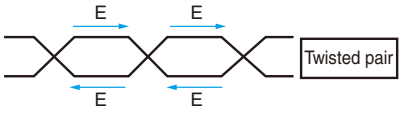
Measurement Example
Power supply voltage: 12 VDC
Load resistance: 5 mA (Output residual voltage is measured at a 35-mA load current.)
Cable: Special Cable

Preventing Counting Errors

Spurious pulses due to vibration may cause counting errors if the shaft is stationary near the rise or fall of the signal. Using an up/down counter can prevent the counting of error pulses.

Extending the Cable When Using a Line-driver Output

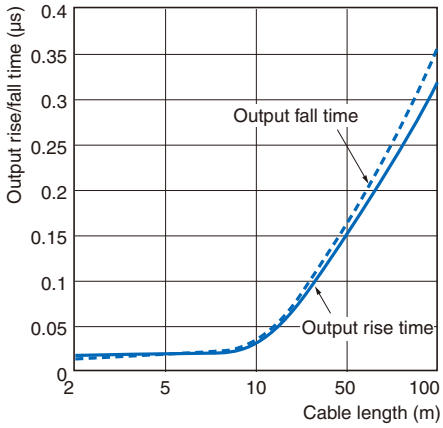
- Be sure to use shielded twisted-pair cable when extending the cable for a line-driver output. (Recommended Cable: TKVVBS4P-02T from Tachii Electric Wire Co.)
  Use an RS-422A Receiver for the receiver side.
- The structure of twisted-pair cable is suitable for RS-422A transmission. By twisting the two outputs as shown in the following diagram, electromotive force occurring in the wires is reciprocally canceled, and the noise element of normal mode is eliminated.



- When using a line-driver output, a power supply of 5 VDC is needed for the Encoder. The voltage will drop approximately 1 V per 100 m of cable.

<Using a Line Receiver IC>

Recommended IC: ICs from Texas Instruments Incorporated
AM26LS32, AM26C32

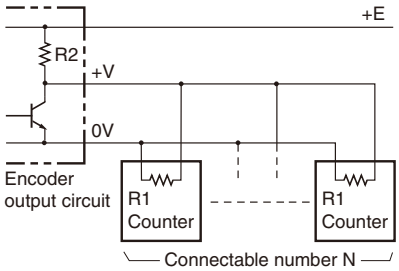


●Others

Input to More than One Counter from Encoder (with Voltage Output)

To connect multiple identical counters to one Encoder, use the following equation to determine the number of counters that can be connected.

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



E : Power supply voltage of Encoder
V : Input voltage of counter (min. value)
R1 : Input resistance of counter
R2 : Output resistance of Encoder

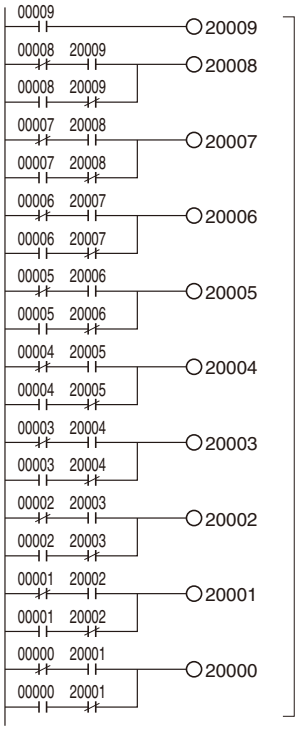
Gray Code → Binary Code Conversion

- This section explains how to convert gray code into binary values using PLC (Programmable Controller) ladder programming when the resolution is 720.

First, the following table shows a wiring example.

Encoder output signal	PLC input signal
Brown (2^0)	00000
Orange (2^1)	00001
Yellow (2^2)	00002
Green (2^3)	00003
Blue (2^4)	00004
Violet (2^5)	00005
Gray (2^6)	00006
White (2^7)	00007
Pink (2^8)	00008
Empty (2^9)	00009

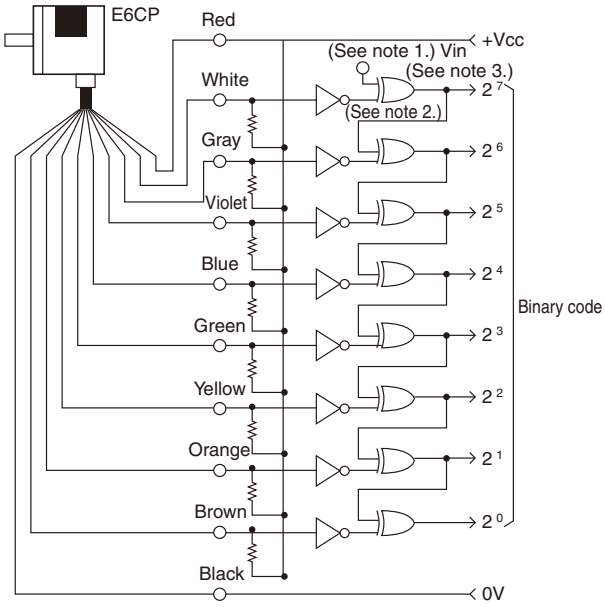
The following diagram shows converting gray code to binary using programming.
<Ladder Program Example>



The gray code is converted to binary and placed in IR 200. Bits 10 to 15 of IR200 are set to 0. (These bits are not used.)

Note: The ladder program example above is for a CPM1A or CQM1H PLC. Check the ladder programming with the model being considered for use.

- To convert gray code to binary code, refer to the circuits in the following diagram.



Note: 1. Vin can be connected to 0 V to convert to positive logic binary code.
2. Inverter
3. Exclusive OR

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