

Absolute encoder CAX60 SERIES

CANOPEN protocol (4.0 version)



Encoder introduction

Encoder technology	magneto-electricity
Single-turn resolution	12, 13, or 14 bits can be selected
The number of turns	64turns、256turns、4096turns、16384 turns optional
Multi-turn technique	Mechanical gear set
code system	Binary system

Interface introduce

output signal	CANopen
Interface cycle time	$\geq 2\text{ms}$
transmission rate	Min 20K, Max1M
program function	Single turn resolution, signal count direction, baud rate, address, preset
Profil	DS-406
Output driver	Transceiver (ISO 11898 standard) optocoupler isolation

Electric parameter

working voltage	10-30Vdc (5Vdc dccustomizable)
current consumption	< 50mA (24Vdc)no-load

output signal	CANopen industrial bus
starting time	< 1s
Reverse polarity protection	Yes
short-circuit protection	Yes
Repeated positioning accuracy	less than 2Bits
IP grade	IP65/IP67
Working Temperature	-40℃~85℃
storage temperature	-40℃~85℃
Temperature	98% Relative humidity, no condensation

Mechanical parameter

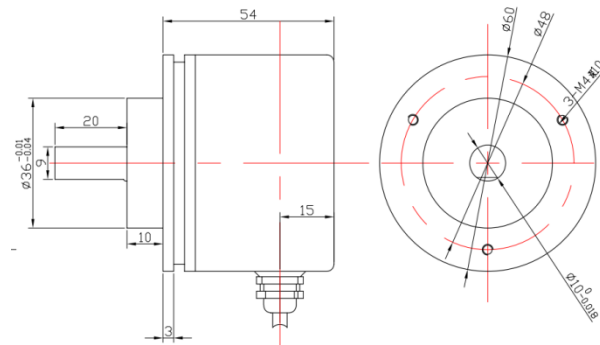
Max Rotate speed	6000r/min
Shaft load	Axial 40N, radial 100N
Main shaft material	stainless steel
shell material	aluminum
shock resistance	1000m/s ² (6ms), =100g
Vibration resistance	200m/s ² (10-2000Hz), =20g
Allowable Axial movement	±1.5mm
Allowable radial runout	±0.2mm
configuration structure	58mmOuter diameter, solid shaft, blind shaft
connecting format	6 core Shielded cable or plug
Flange Material	aluminium
Shaft Material	stainless steel

wiring/connection diagram:

signal	10-30V	GND	CAN High	CAN Low	CAN GND	setting
Colour	Brown	White	Green	Yellow	Blue	Grey

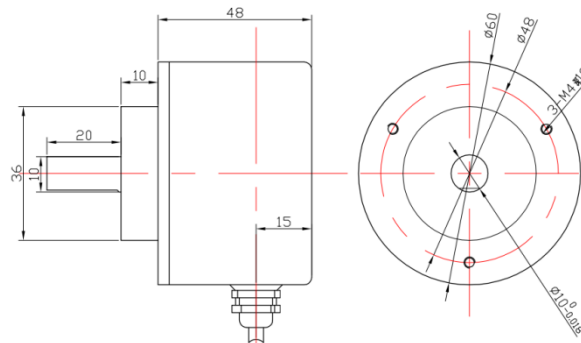
Mechanical dimensional drawing:

Clamp sync flange (cable output or plug output optional)



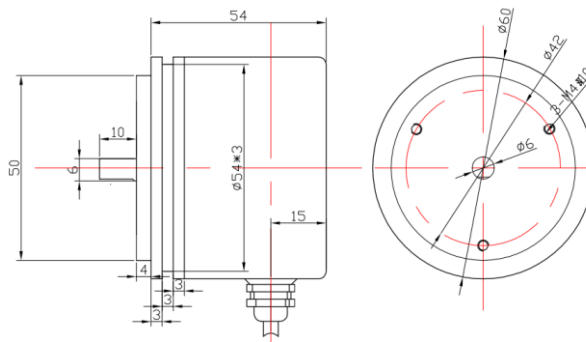
60mm outside diameter 6/8/10mm Axle diameter is optional 20mm axial length Axial outlet is optional

Clamp flange (cable output or plug output optional)



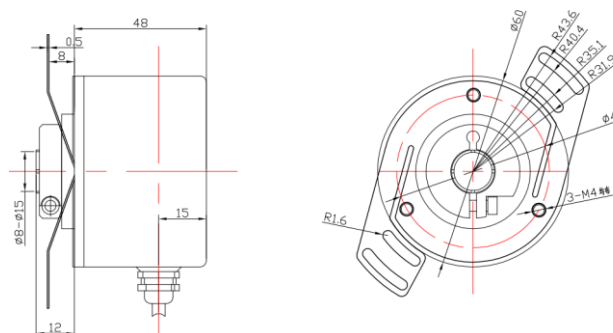
60mm outside diameter 6/8/10mm Axle diameter is optional 20mm axial length Axial outlet is optional

Synchronous flange/servo flange (cable output or plug output optional)



60mm outside diameter 6 Axle diameter 10mm axial length Axial outlet is optional

Blind/half-through flange (cable output or plug output optional)



60mm outside diameter 8-15 mm Axle diameter is optional 20mm axial length Axial outlet is optional

1: CANopen instructions

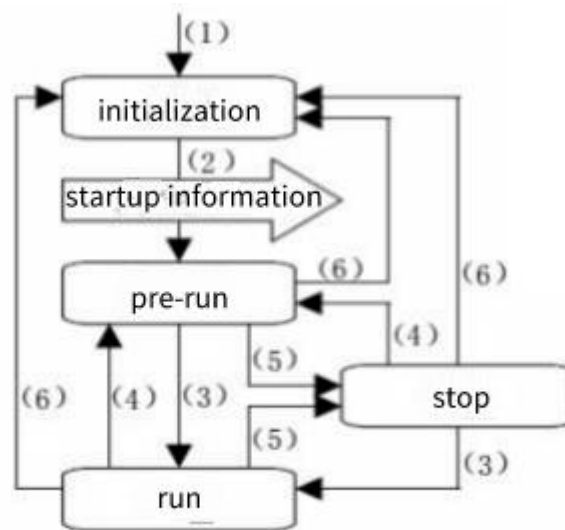
This type of encoder follows the "encoder Device Industry rule Class2" and is generally used as a slave device. For details not covered in this manual, please refer to the relevant part of Documents "CiA Standard Specification 301" and "CiA Standard Specification 406".

2: EDS file

EDS files will be provided to clients with the CANopen encoder, please install EDS files on the CANopen main controller before trying the CANopen encoder.

3: state machine

The CANopen working state:



The state machine is switched between different states. The state diagram is shown below.

serial number	description
(1)	power on
(2)	After finish the initialization, the startup information is automatically sent
(3)	NMT Message "Start Remote Node"
(4)	NMT Message "prerun"
(5)	NMT Message "Shut down the remote node"
(6)	NMTMessage "Reset Node" or "Reset Communication"

3.1 Initialization

This is the state that the CANopen device enters for the first time after power-on or hardware reset. After reading the parameter information stored in the EPROM and finish the basic device initialization, the CANopen device (encoder) automatically sends startup information to the host controller to enter the "pre-run" state.

3.2 pre-run

In this state you can communicate via SDO. Because PDO does not yet exist, you cannot communicate via PDO. Through the configuration program, you can complete the configuration and parameter configuration of PDO. The encoder can be directly put into operating state by sending "Start remote Node".

3.3 run the program

In this state, all communication objects are available. The slave device can send Process data via PDO according to the parameters set in the object dictionary. The host controller can access the object dictionary through the PDO.

The host controller sends a prerun message to make it to enter the prerun state.

3.4 stopping

In this state, the slave device is forced to stop all communication (except the monitoring node). Nor can you communicate with SDO via PDO. The host controller can bring the encoder directly into a pre-run or operating state by sending specific NMT messages.

4: Object dictionary

Each object is represented as follows:

Index – Subindex object name [data type, attribute]

- Indexes and sub-indexes are identified in hexadecimal.
- Properties: ro= read-only, rw= read-write. -Unsigned16 Data type:

Procedure data byte	
Byte 4	Byte 5
low byte	high type

-Unsigned32 data type:

Procedure data byte			
Byte 4	Byte 5	Byte 6	Byte 7
low byte	...	...	high type

4.1Standard Objects (DS 301)

Index – Subindex	Object name	[Data type, attribute]
1000-00	device type default: 0001 0196h=Single-turn encoder, DS 406 0002 0196h=Multiturn encoder, DS 406	[Unsigned32, ro]
1001-00	Error register If a bit of this register is set to "1", the corresponding error has occurred. Default value: 00h	[Unsigned8, ro]

1003	Predefined error fields
-00	This object save the errors that the device has already made. The number of times an error occurred [Unsigned8, rw]
-01	Write 00H to clear the error
-02	history. Last error [Unsigned32, ro]
.	
.	
.	
-08	earlier errors [Unsigned32, ro]
1004	Numbe of PDOs Supported
-00	
-01	Number of Entries [Unsigned32, ro]
-02	Number of ynchronous PDOs [Unsigned32, ro]
	Number of asynchronous PDOs [Unsigned32, ro]
1005-00	COB-ID ynchronous message [Unsigned32, rw] default: 0000 0080h

1008-00	Name of the device manufacturer default : “MAGA”	[String, ro]																		
1009-00	hardware version	[String, ro]																		
100A-00	software version	[String, ro]																		
1010-01	storage parameter This object stores all parameters to non-volatile memory. The write signal is “save”. Controller → Encoder (write)	[Unsigned32, rw]																		
<table><tr><td>COB-ID</td><td>order</td><td colspan="2">index</td><td>sub-index</td><td colspan="4">data byte</td></tr><tr><td>600+ID</td><td>22</td><td>10</td><td>10</td><td>01</td><td>73</td><td>61</td><td>76</td><td>65</td></tr></table>			COB-ID	order	index		sub-index	data byte				600+ID	22	10	10	01	73	61	76	65
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Encoder → Controller (Confirm)																				
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COB-ID	command	index		sub-index	data byte															
580+ID	60	10	10	01	00	00	00	00												

1011-01	Restore default parameters [Unsigned32, rw] This object is used to restore the default values of all parameters. If the write signal is load, the restored default value takes effect after setting reset. Controller → Encoder (write) <table><tr><td>COB-ID</td><td>command</td><td colspan="2">index</td><td>sub-index</td><td colspan="4">data byte</td></tr><tr><td>600+ID</td><td>22</td><td>11</td><td>10</td><td>01</td><td>6C</td><td>6F</td><td>61</td><td>64</td></tr></table> Encoder → Controller (Confirm) <table><tr><td>COB-ID</td><td>command</td><td colspan="2">index</td><td>sub-index</td><td colspan="4">data byte</td></tr><tr><td>580+ID</td><td>60</td><td>11</td><td>10</td><td>01</td><td>00</td><td>00</td><td>00</td><td>00</td></tr></table> To save the default values, performing the “Store parameters” function is needed(see Object 1010h) Default parameter list: <table><tr><td>Baud rate</td><td>distinguishability</td><td>direction</td><td>Node ID</td><td>positional value</td></tr><tr><td>125K</td><td>4096</td><td>clockwise</td><td>1</td><td>0</td></tr></table>	COB-ID	command	index		sub-index	data byte				600+ID	22	11	10	01	6C	6F	61	64	COB-ID	command	index		sub-index	data byte				580+ID	60	11	10	01	00	00	00	00	Baud rate	distinguishability	direction	Node ID	positional value	125K	4096	clockwise	1	0
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125K	4096	clockwise	1	0																																											
1014-00	EMCY COB-ID [Unsigned32, rw] Default value: 80h+Node ID This object defines the EMCY write service COB-ID.																																														
1017-00	Producer Heartbeat Time [Unsigned16, rw]																																														

1018	Identification object -01 Manufacturer code [Unsigned32, ro] -02 Product code [Unsigned32, ro] -03 Revision number [Unsigned32, ro] -04 Serial number [Unsigned32, ro]
1800	PD01 Communication parameters -00 Import quantity [Unsigned8, ro] Default value: 5H -01 COB-ID of PD01 [Unsigned32, rw] 0180h+ Node ID Transmission type [Unsigned8, rw] -02 Default: FEH (Asynchronous transfer) [Unsigned16, rw] -03 InhibitTime unit: 0.1ms [Unsigned16, rw] -05 interval Time unit: ms

1801		PD02 communication parameters	
	-00	Import quantity	[Unsigned8, ro]
		Default value: 5H	
	-01	The COB-ID of the PD02	[Unsigned32, rw]
		0280h+ Node ID	
	-02	Transmission type	[Unsigned8, rw]
		Default value: 01H (Synchronous transmission)	
For n values that require n synchronization signals, they can be set in subindex 2 of object 1801h.			
	-03	Inhibit Time	[Unsigned16, rw]
		unit: 0.1ms	
	-05	Event Time (Sending interval time)	[Unsigned16, rw]
		unit: ms	
1A00			
	-00	Number of Inputs	[Unsigned8, rw]
		Default value: 1	
	-01	PD01 Mapping parameter	[Unsigned32, rw]
		Default value: 6004h	
This object follows the device row rule DS406 and contains the position value of the encoder.			
1A01			
	-00	Import quantity	[Unsigned8, rw]
		Default value: 1	
	-01	PD02 mapping parameters	[Unsigned32, rw]
		Default value: 6004h	

4.2 Objects related to the manufacturer

Index - Subindex	Object name	[Data type, attribute]
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3001-00	Baud rate [Unsigned8, rw] This object defines the bit rate of the device, as listed in the following table <table><tr><td>data</td><td colspan="5">Represents the baud rate</td></tr><tr><td>00h</td><td colspan="5">20Kbit/s</td></tr><tr><td>01h</td><td colspan="5">50Kbit/s</td></tr><tr><td>02h</td><td colspan="5">100Kbit/s</td></tr><tr><td>03h</td><td colspan="5">125Kbit/s</td></tr><tr><td>04h</td><td colspan="5">250Kbit/s</td></tr><tr><td>05h</td><td colspan="5">500Kbit/s(default)</td></tr><tr><td>06h</td><td colspan="5">800Kbit/s</td></tr><tr><td>07h</td><td colspan="5">1000Kbit/s</td></tr></table> Steps to change the baud rate: set the object 3001h, then send the command "Reset node" (or "reset communication"), and finally store the parameters Controller → Encoder <table><tr><td>COB-ID</td><td>demand</td><td colspan="2">index</td><td>Sub-index</td><td>data</td></tr><tr><td>600+ID</td><td>22</td><td>01</td><td>30</td><td>00</td><td>04 00 00 00</td></tr></table> Encoder → Controller (Confirm) <table><tr><td>COB-ID</td><td>demand</td><td colspan="2">index</td><td>Sub-index</td><td>data</td></tr><tr><td>580+ID</td><td>60</td><td>01</td><td>30</td><td>00</td><td>00 00 00 00</td></tr></table> Storage parameters (refer to Object 1010h). If not stored, the original baud rate will be used after the device is powered on again.	data	Represents the baud rate					00h	20Kbit/s					01h	50Kbit/s					02h	100Kbit/s					03h	125Kbit/s					04h	250Kbit/s					05h	500Kbit/s(default)					06h	800Kbit/s					07h	1000Kbit/s					COB-ID	demand	index		Sub-index	data	600+ID	22	01	30	00	04 00 00 00	COB-ID	demand	index		Sub-index	data	580+ID	60	01	30	00	00 00 00 00
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580+ID	60	01	30	00	00 00 00 00																																																																										
3000-00	nodeID [Unsigned8, rw] This object defines the node identifier of the device. Default value: 01h steps to change the node address: Set object 3000h, send the Reset Node command, and store parameters. Encoder → Controller (write) <table><tr><td>COB-ID</td><td>demand</td><td colspan="2">index</td><td>Sub-index</td><td>data</td></tr><tr><td>600+ID</td><td>22</td><td>00</td><td>30</td><td>00</td><td>01 00 00 00</td></tr></table> Encoder → Controller (Confirm) <table><tr><td>COB-ID</td><td>demand</td><td colspan="2">index</td><td>Sub-index</td><td>data</td></tr><tr><td>580+ID</td><td>60</td><td>00</td><td>30</td><td>00</td><td>00 00 00 00</td></tr></table> Storage parameters (refer to Object 1010h). If not stored, the original nodeID will be used after the device is powered on again.	COB-ID	demand	index		Sub-index	data	600+ID	22	00	30	00	01 00 00 00	COB-ID	demand	index		Sub-index	data	580+ID	60	00	30	00	00 00 00 00																																																						
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4.3 The object specified by the device trade rules (DS 406)

Index - Subindex	Object name	[Data type, attribute]	
6000-00	operating parameter		
	Bit	function	Bit=0Bit=1
	0	Encoder count direction	clockwiseanticlockwise
	1	Hardware self-test	closeenabled
	2	zoom	closeenabled
	Default value: 0000h The encoder count direction defines whether the count value increases or decreases when the axis of rotation is rotated clockwise or counterclockwise as seen from the encoder axis -- Zoom function: If this function is disabled, the physical resolution is used (see objects 6501h and 6502h)		
6001-00	Resolution per revolution [Unsigned32, rw] default: 2000H. If the 6000 parameter bit2=1, it can be used to change the single-turn resolution, but it should not be greater than the 6501 parameter.		
6002-00	Total measuring range [Unsigned32, rw] default: 20000000H. If the 6000 parameter bit2=1, it can be used to change the total resolution of the multiturn, but it should not be greater than the 6502 parameter		
6003-00	Default value The default value is the set position value, in order to prevent running errors, the default value must not exceed the "total hardware resolution"		
6004-00	Current location value [Unsigned32, ro]		
6200-00	cycle time [Unsigned16, ro] In asynchronous communication, it is used to adjust the PD001 transmission interval.		
6500-00	operation status [Unsigned16, ro]		
6501-00	Resolution per revolution [Unsigned32, ro] This object is used to define the number of discernible steps per revolution on the hardware. To use other values, refer to Object 6001h.		
6502-00	Total turns number of hardware [Unsigned32, ro] This object defines the maximum number of turns that can be measured on the hardware. For other values, refer to 6001h and 6002h		
6503-00	alarm value [Unsigned16, ro]		

6504-00	Alarm support default: 1H	[Unsigned16, ro]
6505-00	Warning value	[Unsigned16, ro]
6506-00	Warning support default: 4H	[Unsigned16, ro]
6507-00	Appearance and software version default: 01000100H.	[Unsigned32, ro]
6508-00	run time default=FFFF FFFFh (don' t use) unit: 0.1h.	[Unsigned32, ro]
6509-00	offset This object contains the offset value, which is calculated from the preset value and the position value.	[Integer32, ro]
650B-00	serial number default=FFFF FFFFh (don' t use)	[Unsigned32, ro]

Attention:

To make the changed parameters take effect, you need to Save Parameters (see Object 1010h). The parameters will be lost when the Reset communication command or power is turned off.

5: set up parameters

Here are some examples of data exchange between the master controller and the encoder when parameters are set. "ID" is used to represent the address of the encoder. The value is in hexadecimal notation.

- Set run and pre-run status

Controller → Encoder

COB-ID	command	node
000	01	ID
000	80	ID

- Set the single-turn resolution (2^{12} =0000 1000h)

Controller → Encoder (Setup request)

COB-ID	command	index		Sub-index	process data			
600+ID	22	01	60	00	00	10	00	00

Encoder → Controller (Setting confirmation)

COB-ID	command	index		Sub-index	process data			
580+ID	60	01	60	00	00	00	00	00

Set running parameters (counting direction: clockwise -00: anticlockwise -01)

Controller → Encoder (Setup request)

COB-ID	command	index		Sub-index	process data			
600+ID	22	00	21	00	01	00	00	00

Encoder → Controller (Setting confirmation)

COB-ID	command	index		Sub-index	process data			
580+ID	60	00	21	00	00	00	00	00

Set preset values (Preset value is 1000=03E8h)

Controller → Encoder (Setup request)

COB-ID	command	index		Sub-index	process data			
600+ID	22	03	60	00	E8	03	00	00

Encoder → Controller (Setting confirmation)

COB-ID	command	index		Sub-index	process data			
580+ID	60	03	60	00	00	00	00	00

Setting the heartbeat Time (500ms=01F4h)

Controller → Encoder (Setup request)

COB-ID	command	index		Sub-index	process data			
600+ID	2B	17	10	00	F4	01	00	00

Encoder → Controller (Setting confirmation)

COB-ID	command	index		Sub-index	process data			
580+ID	60	17	10	00	00	00	00	00

Set cycle time (100ms=64h)

Controller → Encoder (Setup request)

COB-ID	command	index		Sub-index	process data			
600+ID	2B	00	18	05	64	00	00	00

Encoder → Controller (Setting confirmation)

COB-ID	command	index		Sub-index	process data			
580+ID	60	00	18	05	00	00	00	00

To make the changed parameters take effect, you need to Save Parameters (refer to Object 1010h). The parameters will be lost when the Reset communication command or power is turned off.

6: Alert Objects

If you want to understand the meaning of the warning message, Please refer to the "SD0 Exception Interrupt Code" section of my "CIA Draft Standard 301" at www.can-cia.org.

7: Emergency object

An emergency object will be triggered when an error occurs inside the device.

Emergency object structure:

identification	CAN data			
COB-ID(hex)	0	1	2	3 • • • 7
Refer to object 1014h	error code		Error register	specific-code
	Lowest bits	Highest bits	1001	00 • • • 00