EtherCAT Slave Unit

Two-channel Incremental Encoder Counter

with Latch and Reset function

XSC-ECAT-CNT2D

User's Manual

NEXT ROBOT

VAS CORPORATION

WARRANTY

- **Warranty Period**

The product is warranted against defective materials for a period of one year from date of delivery to the original purchaser.

- **Warranty Coverage**

Warranty is extended to operating in conditions described in this handling manual and all malfunctions occurred during the warranty period are serviced at no cost.
However, following conditions even during the warranty period will be serviced at cost.

① Improper use and inappropriate repairs or contributed to modifications.

② Cause is contributed to dropping the product after purchase and caused during transport.

③ Usage outside of the scope of the product specification.

④ Caused by fire earthquakes, lightning, storm and flood damages, salt damage, abnormal voltage, other natural disasters.

⑤ Caused by water, oil, metal pieces, other foreign substance penetration.

Scope of warranty is extended only to the main body of the product sold and damages caused by sold product failure are excluded from the warranty coverage.

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Contents

1. EtherCAT Network

1.1. Overview of EtherCAT Networks

EtherCAT (Ethernet Control Automation Technology) is a high-performance industrial network system based on Ethernet system and can realize faster and more efficient communications. Each node achieves a short communications cycle time by transmitting Ethernet frames at high speed. Furthermore, even though EtherCAT is a unique protocol, it offers excellent general-purpose applicability. For example, you can use Ethernet cables because EtherCAT utilizes standard Ethernet technology for the physical layer. And the effectiveness of EtherCAT can be fully utilized not only in large control systems that require high processing speeds and system integrity, but also in small and medium control systems.

1.1.1. Features of EtherCAT

EtherCAT has the following features.

- **Extremely high-speed communications with speed of 100 Mbps**

It dramatically shortens the I/O response time from generation of input signals to transmission of output signals. By fully utilizing the optimized Ethernet frame bandwidth to transfer data using a high-speed repeat method, it is possible to efficiently transmit a wide variety of data.

- **Extremely High Compatibility with Ethernet**

EtherCAT is an open network with extremely high compatibility with conventional Ethernet systems.

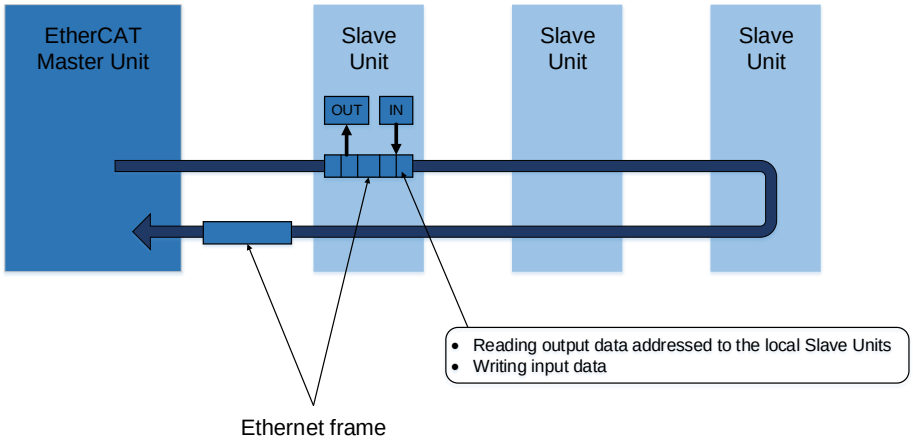
1.1.2. Structure of EtherCAT

EtherCAT does not send data to individual slave nodes on the network, instead, it passes Ethernet frames through all of the slave nodes.

When frame passes through a slave node, the slave node reads and writes data in the areas allocated to it in the frames in a few nanoseconds.

Ethernet frames sent from the EtherCAT Master Unit go through all the EtherCAT Slave Units without stopping on the way. Once they reach the final Slave Unit, they are sent back from the final Slave Unit, pass through all Slave Units again, and return to the EtherCAT Master Unit.

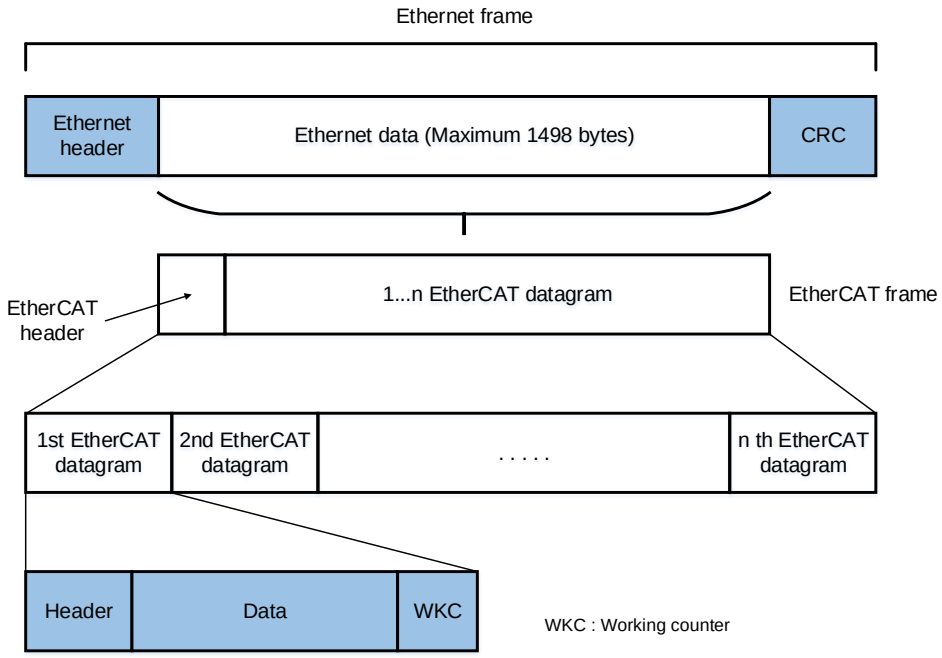
With this structure, EtherCAT secures high-speed and real-time data transmission.



It is the "EtherCAT datagram" stored directly in an Ethernet frame that exchanges data regularly between the EtherCAT Master Unit and Slave Units.

Each "EtherCAT datagram" is configured with header (data length, including address of one or more Slave Units, etc.), data, working counter (check bit).

When an Ethernet frame is compared to a "train", an EtherCAT datagram can be considered as "railway car."



1.1.3. Communications types of EtherCAT

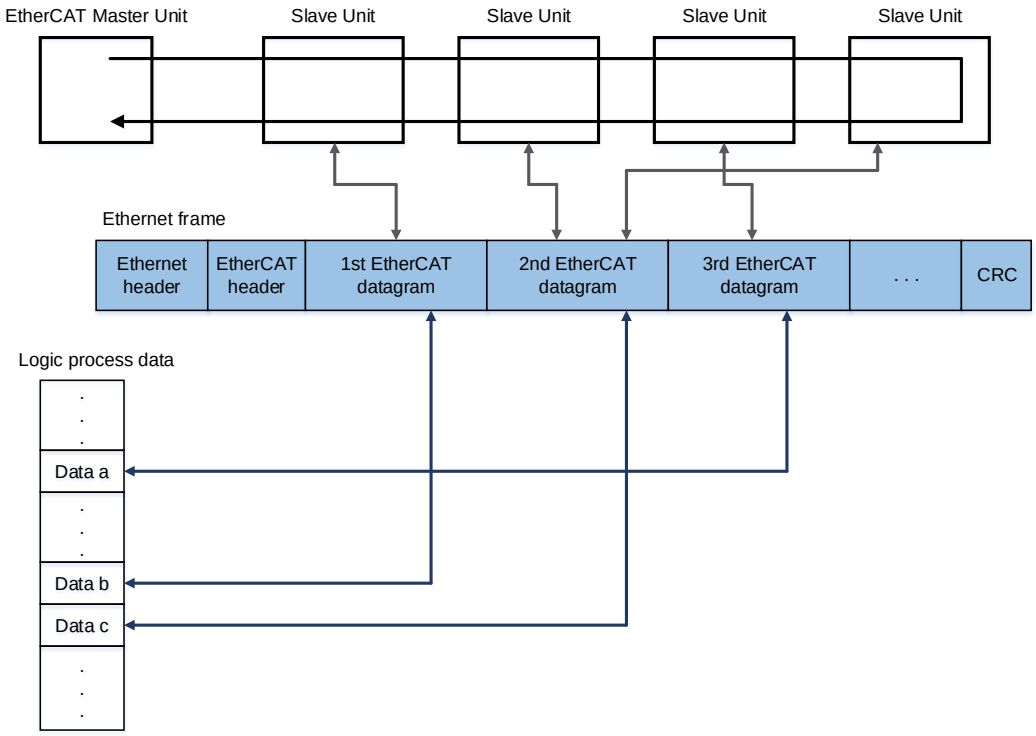
EtherCAT provides the following two types of communication functions.

PDO communications are always updating data per communication cycle on EtherCAT, while SDO communications are processed in between those updates.

- **Process data communications functions (PDO communications)**

This communication function is used to transfer process data in real time in a fixed-cycle.

By mapping logical process data space to each node by the EtherCAT Master Unit, it achieves fixed-cycle communications among the EtherCAT Master Unit and Slave Units.



- **Mailbox communications functions (SDO communications)**

It refers to message communications.

At any timing, the EtherCAT Master Unit transmits commands to Slave Units and the Slave Units return responses to the EtherCAT Master Unit.

It performs the following data communications:

• Read and write process data

• Make Slave Unit setting

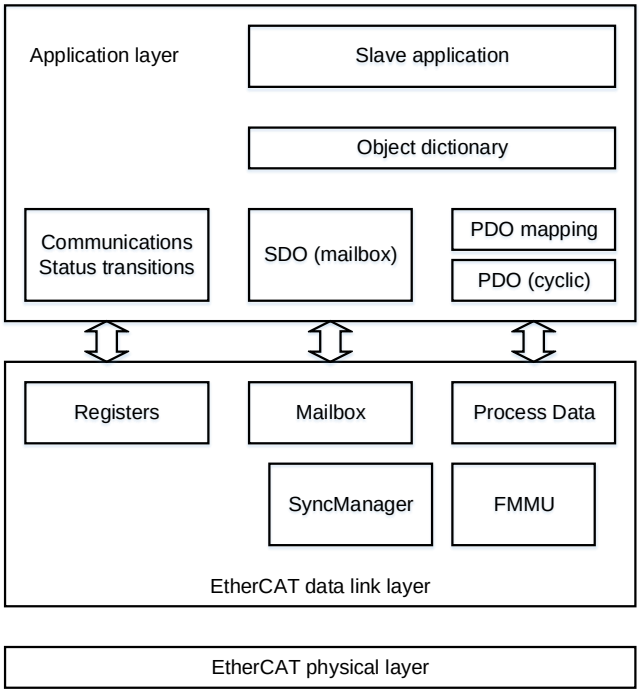
• Monitor Slave Unit state

2. EtherCAT Communications

2.1. Structure of CAN application protocol over EtherCAT (CoE)

Normally, multiple protocols can be transferred by EtherCAT. But NR-series EtherCAT Slave Units use "CAN application protocol over EtherCAT (CoE)", a communication interface to be applied for EtherCAT devices, as the device profile of the open network standard "CAN application protocol."

The figure below shows the structure of CoE in NR EtherCAT Slave Units.



CAN application protocol has two types of object dictionaries, PDO (Process Data Object) and SDO (Service Data Object).

PDO is composed of object dictionaries that can be mapped. The process data is defined by PDO mapping. PDO is primarily used in PDO communications for regularly exchanging process data.

Moreover, SDO is able to read and write all object dictionaries and is used in non-fixed-cycle type SDO (event type messages) communications.

By using the CoE interface to set object SDO and PDO dictionaries, EtherCAT can provide EtherCAT devices with the same device profile as CAN application protocol.

2.2. EtherCAT Slave Information File (ESI File)

An EtherCAT Slave Information (ESI) file contains the setting information of an EtherCAT Slave Unit. Various EtherCAT communications setting can be defined from the ESI files of connected Slave Units and the network connection information.

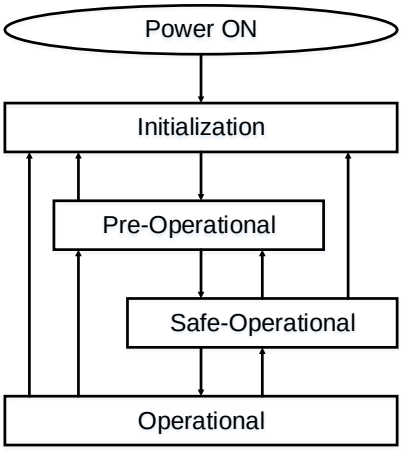
ESI files are installed in the configuration tool to create network configuration information.

You can download the network configuration information to the EtherCAT Master Unit to configure the EtherCAT network.

2.3. Communications State Transitions

The EtherCAT State Machine (ESM) indicates the state transition model of EtherCAT Slave Unit communications control. It is controlled by EtherCAT Master Unit.

The following figure shows the communications state transitions from power ON.



State	SDO Communications	PDO transmission	PDO reception	Contents
Initialization (**Init**)	Not possible.	Not possible.	Not possible.	Communications are being initialized. Communications are not possible.
Pre-Operational (**Pre-Op**)	Possible	Not possible.	Not possible.	SDO (message) communications are possible in this state. This state is entered after initialization has been completed. It is used to initialize network settings.
Safe-Operational (**Safe-Op**)	Possible	Possible	Not possible.	In this state, PDO transmissions are possible in addition to SDO (message) communications. PDO sendings can be used to send information such as status from the Slave Unit.
Operational (**Op**)	Possible	Possible	Possible.	Normal communication state PDO communications can be used to control the I/O data.

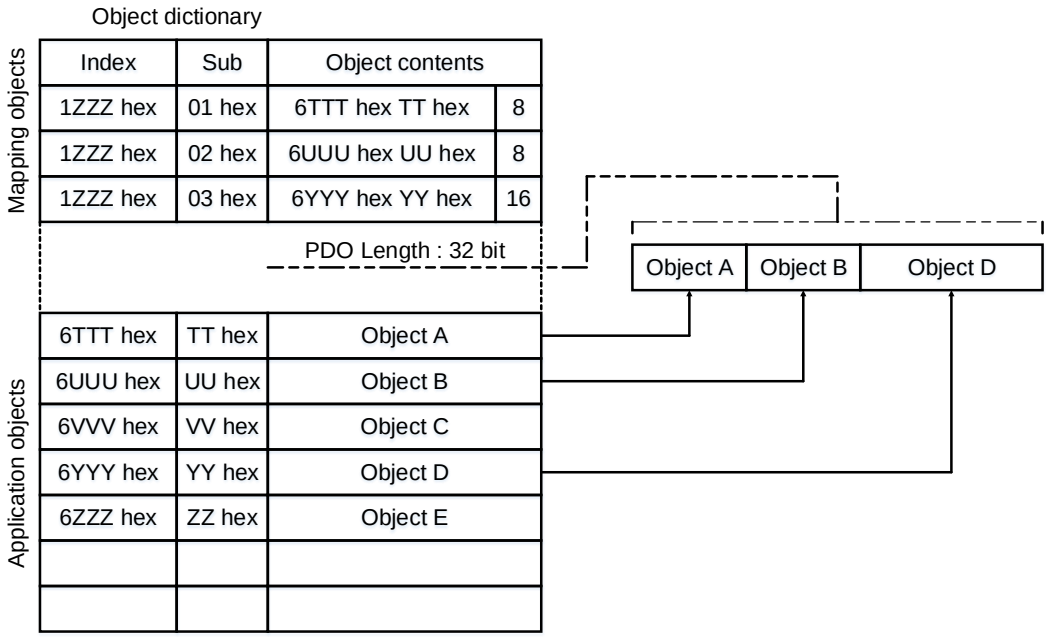
2.4. Process Data Objects (PDO)

2.4.1. Overview

The process data objects (PDO) are used for real-time data transfer via cyclic communications.
There are two types in PDO: RxPDO that receives data from the EtherCAT Master Unit and TxPDO that sends the present value from a EtherCAT Slave Unit to the EtherCAT Master Unit.
It is possible to hold multiple objects in the EtherCAT application layer so that various process data of EtherCAT Slave Units can be transferred. The details of process data are described in PDO Mapping Objects and Sync Manager PDO Assignment Objects.
NR EtherCAT Slave Units support PDO mapping for I/O control.

2.4.2. PDO Mapping Settings

The PDO mapping indicates the mapping for application objects (realtime process data) between the object dictionary and PDO.
The number of mapped objects is described in sub-index 0 of the mapping table. In this mapping table, indexes 1600 hex to 17FF hex are used for RxPDO and 1A00 hex to 1BFF hex are used for TxPDO.
The figure below shows an example of PDO mapping.



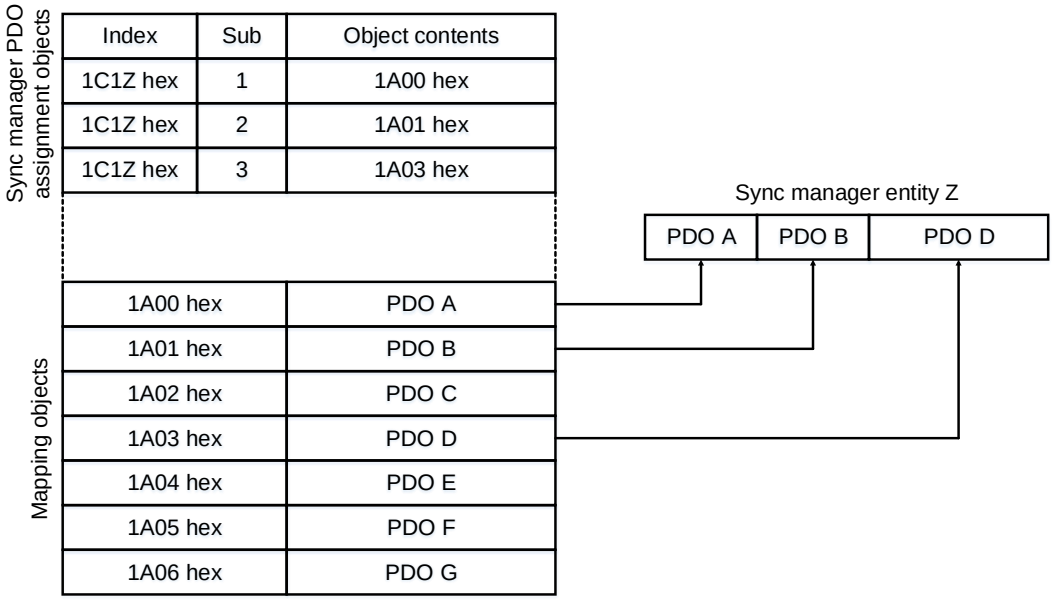
2.4.3. Sync Manager PDO Assignment Settings

A sync manager channel consists of several PDOs. The sync manager PDO assignment objects describe how these PDOs are related to the Sync Manager.

The number of PDOs is given in sub-index 0 of the sync manager PDO assignment table.

In this table, index 1C12 hex is for RxPDOs and 1C13 hex is for TxPDOs.

The figure below shows an example of sync manager PDO mapping.


Sync manager PDO assignment objects
Index
Sub
Object contents
1C1Z hex
1
1A00 hex
1C1Z hex
2
1A01 hex
1C1Z hex
3
1A03 hex
Mapping objects
1A00 hex
PDO A
1A01 hex
PDO B
1A02 hex
PDO C
1A03 hex
PDO D
1A04 hex
PDO E
1A05 hex
PDO F
1A06 hex
PDO G
Sync manager entity Z
PDO A
PDO B
PDO D

2.5. EtherCAT Master Unit - Slave Unit

This section explains the communication modes between the Master Unit and NR EtherCAT Slave Unit.

2.5.1 Free Run Mode

In the FREE RUN mode, a Slave Unit operates asynchronously with the EtherCAT Master Unit.

The Digital I/O Slave Units and Analog I/O Slave Units operate in the FREE RUN mode.

Note that Slave Unit's internal processing time varies by the Slave Unit type, refer to the explanation on each Slave Unit in Chapter 7 to Chapter 8.

(Digital I/O Slave Units: ON delay, OFF delay, Analog I/O Slave Units: Cycle time)

To calculate the input and output response time* of the entire system, refer to the relevant values in the manual of the host system (EtherCAT Master or CPU Unit) to be used.

* This is the time which takes for an input signal from an Input Slave Unit to be processed by the PLC of the Master Unit and output to an Output Slave Unit

2.5.2 DC Mode

In the DC mode, a Slave Unit operates synchronously with the EtherCAT Master Unit.

A mechanism called distributed clock (DC), where the EtherCAT Master Unit and Slave Units share the same clock, is used for synchronization.

Each of DC mode-ready Slave Units connected to EtherCAT shares the clock information.

By generating interrupt signals and executing input/output processing inside each Slave Unit according to the clock, it becomes possible to synchronize the input/output timing with other Slave Units.

The DC mode supported by Encoder Input Slave Units is DC mode 1.

- **Communications cycle**

The communications cycle is determined by setting output frequency of Sync0 signal (interrupt signal in DC mode 1): 500 μs, 1 ms, 2 ms, 4 ms

The settings are performed on the EtherCAT Master Unit side. For the setting method, refer to the manual of the EtherCAT Master Unit to be used.

3. Basic Specifications of Slave Units

3.1 – EtherCAT Communications Specifications

Item	Specification
Communication protocol	Dedicated protocol for EtherCAT
Baud rate	100 Mbps
Physical layer	100BASE-TX (IEEE802.3)
Connectors	RJ45 × 2 (Shielded) CN IN: EtherCAT input CN OUT: EtherCAT output
Topology	Daisy chain
Communications cable	CAT5e or higher
Communications distance	Distance between nodes (Slave Units): 100 m max.
Indicator	PWR x 1 L/A IN (Link/Activity IN) x 1 L/A OUT (Link/Activity OUT) x 1 RUN x 1 ERR x 1
Process data	Fixed PDO mapping
Mailbox	SDO requests, SDO responses and SDO information
Synchronization mode	Free Run Mode, Distributed Clock mode

3.2 – General Specifications

Item	Specification
Unit power supply voltage	10 to 30 VDC
Sensor power supply voltage	10 to 30 VDC

4. Encoder Input Slave Unit

4.1 – I/O Data Allocation

4.1.1 Input Data Allocation

Encoder Input Slave Unit stores the counter present value, external latch value A, external latch value B and the counter status as input data, and can allocate required data to Input area.

The details of each data type are as follows.

Data	Size	Detail
Counter present value	8 bytes	Used to monitor counter data.
External latch value A	8 bytes	Stores the counter value (latch value A) latched by external latch A.
External latch value B	8 bytes	Stores the counter value (latch value B) latched by external latch B.
Counter status	2 bytes	Status flag to check the counter status.

Offset (byte)	D07	D06	D05	D04	D03	D02	D01	D00
0	CRUN1	CERR1	Reserved	EXLB1	EXLA1	EXRES1	RACK1	PACK1
+1	CRUN2	CERR2	Reserved	EXLB2	EXLA2	EXRES2	RACK2	PACK2
+2	CH1 Present value data							(LL)
+3								(LH)
+4								(HL)
+5								(HH)
+6	CH2 Present value data							(LL)
+7								(LH)
+8								(HL)
+9								(HH)
+10	CH1 Latch A data							(LL)
+11								(LH)
+12								(HL)
+13								(HH)
+14	CH2 Latch A data							(LL)
+15								(LH)
+16								(HL)
+17								(HH)
+18	CH1 Latch B data							(LL)
+19								(LH)
+20								(HL)
+21								(HH)
+22	CH2 Latch B data							(LL)
+23								(LH)
+24								(HL)
+25								(HH)

Abbreviations used for the counter status information description have the following meanings.

Abbreviation	Status name	Operation
PACKn	Present value preset execution completed	Soft switch "Present value preset execution" completion flag 0→1: Preset execution completed 1→0: Soft switch "Present value preset execution" is set to 0
RACKn	Present value internal reset execution completed	Soft switch "Present value internal reset execution" completion flag 0→1: Reset execution completed 1→0: Soft switch "Present value reset execution" is set to 0
EXRESn	External reset generation flag	1: Turned ON at reset generation by external input/phase Z 0: Soft switch "present value external reset generation flag clear" is changed from 0 to 1
EXLAn	External latch A generation flag	1: Turned ON with external latch A event generation 0: Soft switch "external latch A generation flag clear" is changed from 0 to 1
EXLBn	External latch B generation flag	1: Turned ON with external latch B event generation 0: Soft switch "external latch B generation flag clear" is changed from 0 to 1
CERRn	Present value preset set value error	0: No setting error 1: Setting error generation
CRUNn	Counter operation state	0: Counter stopped 1: Counter operating

4.1.2 Output Data Allocation

Encoder Input Slave Unit stores the soft switch and the preset command value as output data, and can allocate required data to Output area.

The details of each data type are as follows.

Data	Size	Detail
Soft switch	4 bytes	Used to control the Encoder Input Slave Unit.
Preset command value	8 bytes	Specifies the value to be written over the counter present value data at preset execution.

Offset (byte)	D07	D06	D05	D04	D03	D02	D01	D00
0	Reserved	Reserved	Reserved	Reserved	Reserved	INPRES1	PSET1	CENB1
+1	Reserved	EXLBC1	EXLAC1	EXRESC1	Reserved	EXLBE1	EXLAE1	EXRESE1
+2	Reserved	Reserved	Reserved	Reserved	Reserved	INPRES2	PSET2	CENB2
+3	Reserved	EXLBC2	EXLAC2	EXRESC2	Reserved	EXLBE2	EXLAE2	EXRESE2
+4	CH1 Preset command value							(LL)
+5								(LH)
+6								(HL)
+7								(HH)
+8	CH2 Preset command value							(LL)
+9								(LH)
+10								(HL)
+11								(HH)

The data allocation is as follows when using the default settings.

Abbreviation	Status name	Operation	Detection
CENBn	Count possible/not possible	1: Count possible command 0: Count not possible command	Level
PSETn	Present value preset execution	0→1: Start preset of present value 1→0: Clear present value preset execution completion flag	Edge
INPRESn	Present value internal reset execution	0 -> 1: Start resetting present value 1→0: Clear present value internal reset execution completion flag	Edge
EXRESEn	Present value external reset enabled	1: Enabled 0: Disabled	Level
EXLAEn	External latch A enabled	1: Enabled 0: Disabled	Level
EXLBEn	External latch B enabled	1: Enabled 0: Disabled	Level
EXRESCn	Clear present value external reset generation flag	0→1: Clear flag	Edge
EXLACn	Clear external latch A generation flag	0→1: Clear flag	Edge
EXLBCn	Clear external latch B generation flag	0→1: Clear flag	Edge

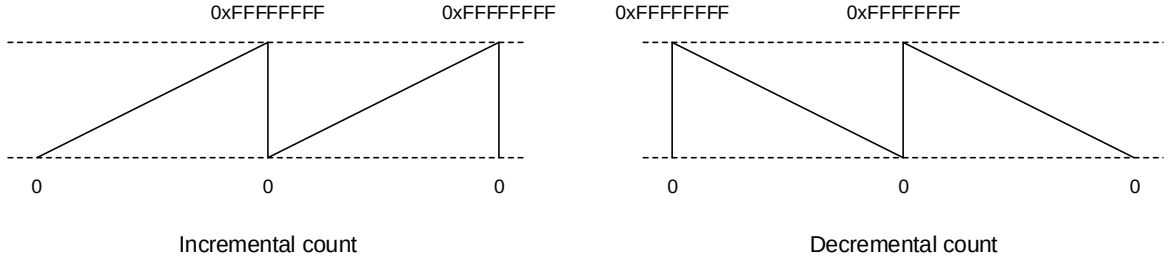
4.2 Function of the Encoder Input Slave Units

4.2.1 Count Mode

The Count Mode is run by the Circular counter

4.2.2 Circular Counter

The maximum counter value is 4,294,967,295 (FFFFFFFF hex).



If the counter value exceeds the maximum value, the counter value returns to 0 to continue count operation.

If the counter value becomes less than 0, the counter value returns to the maximum value to continue count operation.

4.2.3 Input Signal Types

The input method of Encoder Input Slave Units is explained below.

Note that SDO communications are used for setting an input method. (Default setting: Phase A/B phase difference pulse input (Multiplication × 4))

The target index is 4002 hex.

For the set values, refer to the information in the corresponding index of "Object Dictionary".

- **Phase A/B phase difference pulse input (Multiplication × 1/2/4)**

(1) Multiplication × 1

Count at signal change of phase A when phase B signal is turned OFF.

The count is incremented at rise of phase A and decremented at fall of phase A.

(2) Multiplication × 2

It is used to heighten resolution of encoder input compared to Multiplication × 1.

The counter operation is performed at rise and fall of phase A signals.

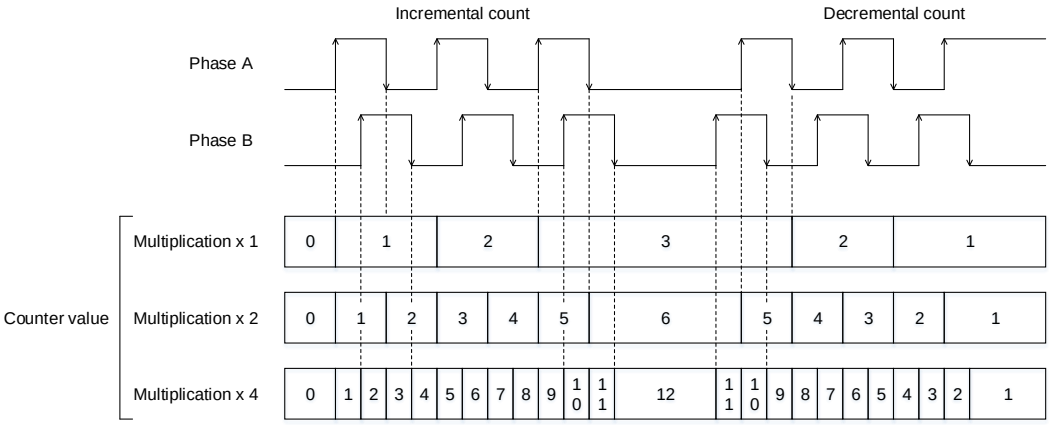
The count is incremented if phase A is advanced from phase B and decremented if phase A is delayed from phase B.

(3) Multiplication × 4

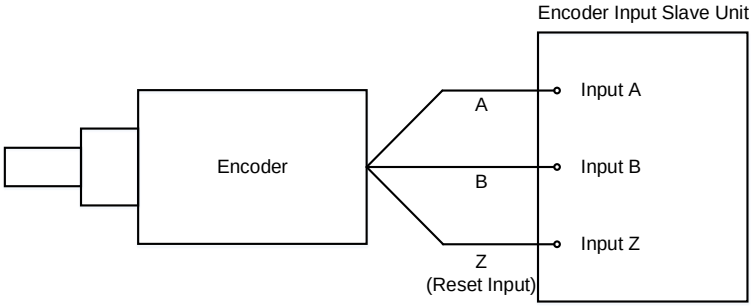
It is used to further heighten resolution of encoder input from Multiplication × 2.

The counter operation is performed at rise and fall of phase A/B signals.

The count is incremented if phase A is advanced from phase B and decremented if phase A is delayed from phase B.



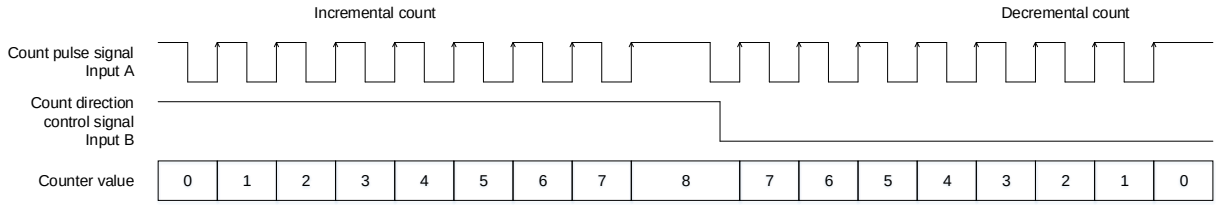
When phase A/B phase difference pulse is input, the connection with external input devices becomes as follows.



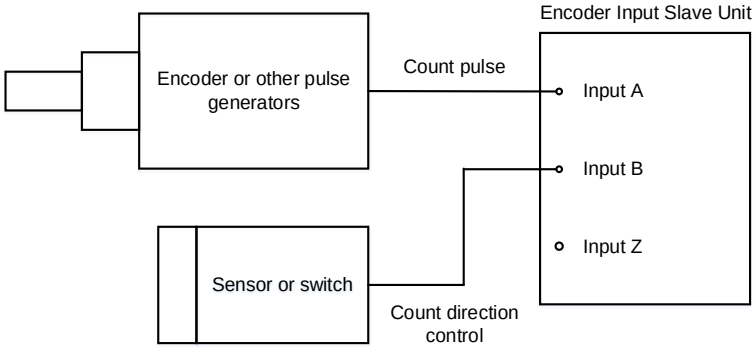
- **Pulse/Dir input**

Input A is count pulse signal and input B is count direction control signal.

The count is incremented at rise of phase A when input B is ON and decremented at rise of phase A when input B is OFF.

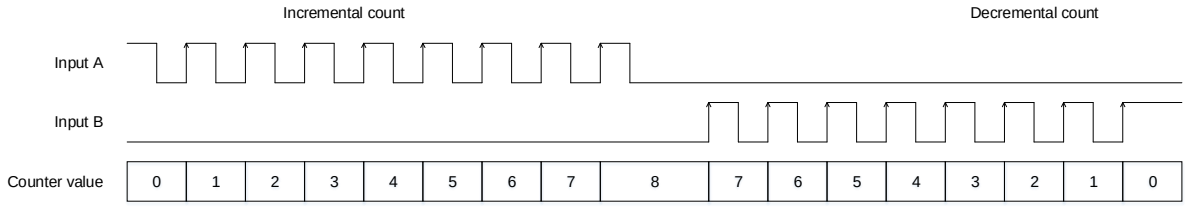


When code and pulses are input, the connection with external input devices becomes as follows.

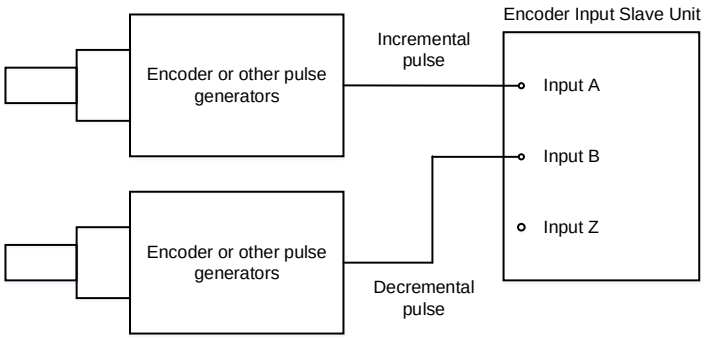


- **Incremental/decremental pulse input**

The count is incremented at rise of input A pulse and decremented at rise of input B pulse.



When incremental/decremental pulses are input, the connection with external input devices becomes as follows.

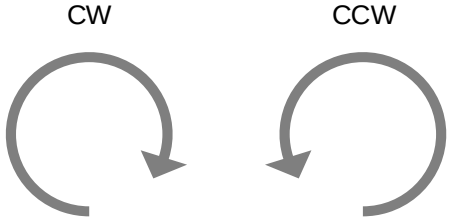


4.2.4 Encoder Direction Setting

There are two following types for the encoder directions of an Encoder Input Slave Unit.

• Forward direction at CW (clockwise rotation seen from the shaft of the connected encoder)

• Forward direction at CCW (counterclockwise rotation seen from the shaft of the connected encoder)



Note that SDO communications are used to set encoder direction. (Default setting: Forward direction at CW)

The target index is 4001 hex.

For the set values, refer to the information in the corresponding index of "Object Dictionary".

4.2.5 Counter Reset

It is possible to reset counter value for each channel using the elements shown below.

- **Counter reset bit**

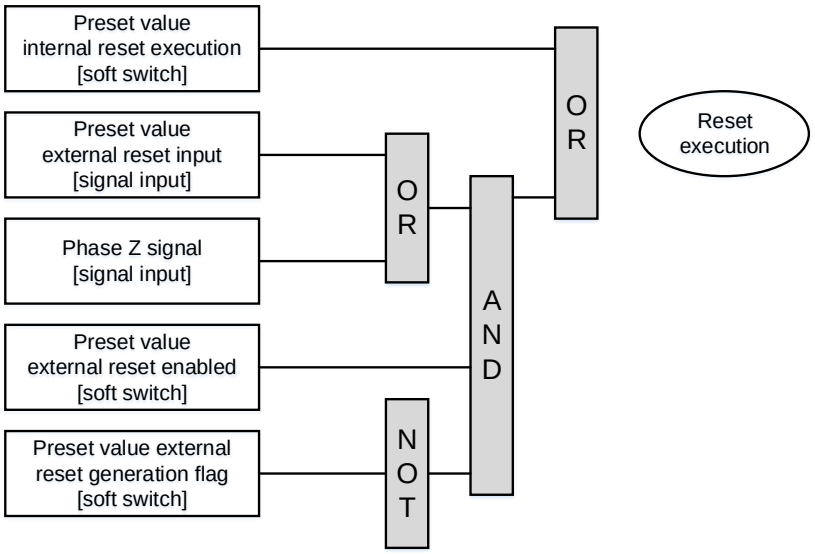
The counter of each channel is reset to 0 by changing soft switch "present value internal reset execution" allocated to each channel from 0 to 1 in the output data (Slave Unit → EtherCAT Master Unit) area.

- **External control input**

The counter is reset to 0 at rise of the present value external reset input signal or phase Z input signal. However, it is necessary to set the soft switch "present value external reset enabled" to 1.

If the counter value is reset via input of the present value external reset or phase Z, the "external reset generation flag" is turned ON. By changing "clear present value external reset generation flag" from 0 to 1, "external reset generation flag" is cleared, enabling the next reset reception.

The counter reset conditions are shown in the figure below.



4.2.6 Counter Preset

It is possible to preset counter value for each channel using the elements shown below.

- **Counter preset bit**

The counter present value is overwritten by "preset command value" by changing soft switch "present value preset execution" allocated to each channel from 0 to 1 in the output data (Slave Unit → EtherCAT Master Unit) area.

- **Preset command value**

Set "preset command value" allocated to each channel in output data (Slave Unit → EtherCAT Master Unit) area or via SDO communications. (Default setting: 0)

When SDO communications are used, the target index is 4011 hex.

For the details, refer to the information in the corresponding index of "Object Dictionary".

4.2.7 Counter value latch

The counter value is latched for each channel using the elements shown below.

It is possible to latch two values at the same time.

- **External control input (latch A)**

The present counter value is acquired/stored at the rise of latch A of external control input.

However, it is necessary to set the soft switch "external latch A enabled" to "enabled." *

- **External control input (latch B)**

The present counter value is acquired/stored at the rise of latch B of external control input.

However, it is necessary to set the soft switch "external latch B enabled" to “enabled”.*

For both latch A and B inputs, when latch is generated via latch input, the "external latch generation flag" changes from 0 to 1 and the counter value is stored in objects (latch value A/latch value B) as latch A/latch B data.

By changing "clear external latch generation flag" from 0 to 1, it is possible to clear the "external latch generation flag."

When the "external latch generation flag" is cleared, the next latch input becomes enabled.

If it is desired to use latched counter values (latch values) in a ladder program, select PDO mapping to which latch data is allocated.

* To use SDO communications, acquire/store the present counter value at the rise of latch A/B of external control input, regardless of the status of the soft switch "external latch A/B enabled."

4.3 Specifications of Encoder Input Slave Units

4.3.1 Line Driver Input Type ECAT-CNT2D

- **Slave Unit Specifications**

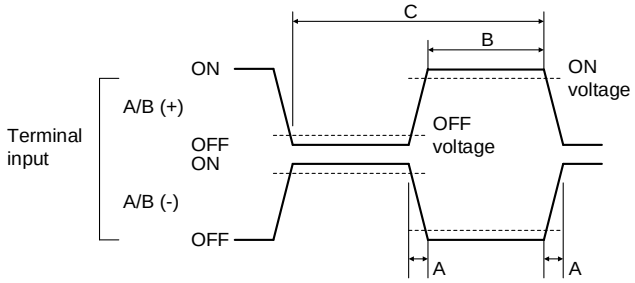
Item	Specification
Counter channel	2 channel
Input signal	Counter phase A
	Counter phase B
	Counter phase Z
	Latch input (A/B)
	Counter reset input
Counter enabled status display	LED display (green)
Input indicators	LED display (yellow)
Unit power supply current consumption	100 mA max (for 10 to 30VDC power supply voltage)

- **Pulse input specifications**

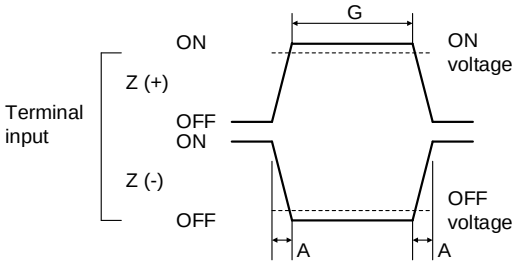
Item	Specification	
	Counter phase A/B	Counter phase Z
Input voltage	TIA/EIA-422-B standard line driver level, input -14V to 14V	
Input impedance	120 Ω ±5%	
Positive-going input threshold voltage, differential input	0.2V	
Negative-going input threshold voltage, differential input	-0.2V	
Maximum input frequency	Single phase 4MHz (phase difference Multiplication x 4, 1MHz)	1MHz

- **Pulse input timing specifications**

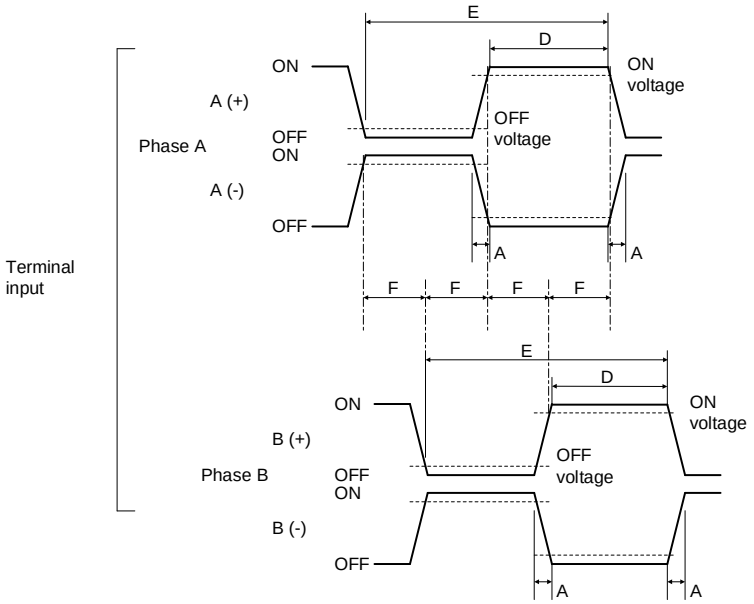
Counter input phase A/B
Input pulse duty: 50%



Counter input phase Z



Relationship between phase A and phase B at phase difference pulse input

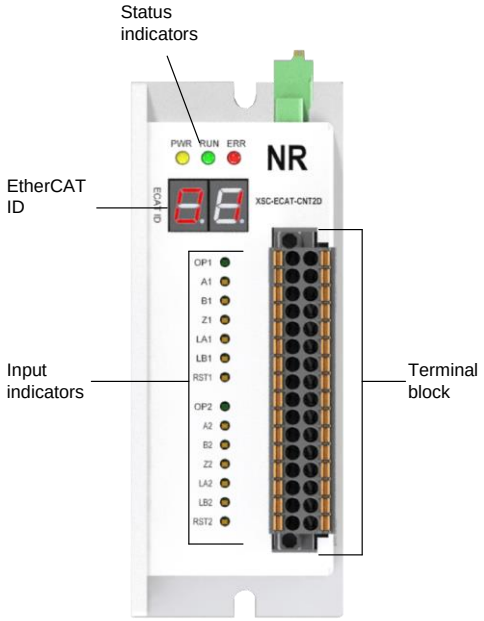


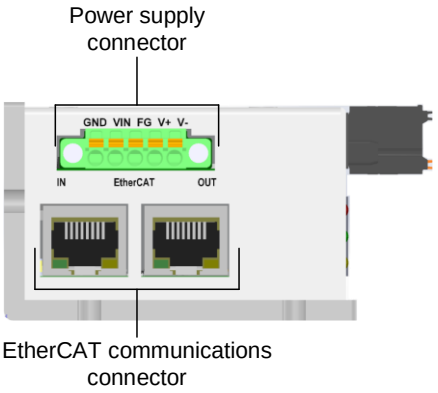
Timing conditions						
A	**B**	**C**	**D**	**E**	**F**	**G**
<25ns	>125ns	>250µs	>0.5µs	>1µs	>0.25µs	>0.5µs

- **Latch/reset input specifications**

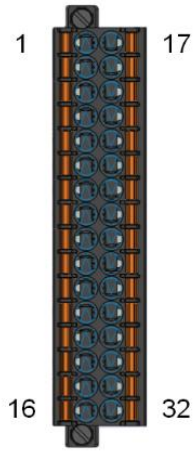
Item	Specification	
	Latch input (A/B)	Reset input
Internal I/O common	NPN	
Input voltage	10 to 30 VDC	10 to 30 VDC
input impedance	4.7 kΩ	3.3 kΩ
input current	4.8 mA (at 24 VDC)	6.9 mA (at 24 VDC)

- **Terminal/input display LED layout diagram**





Terminal block				
1	A1-		A1+	17
2	B1-		B1+	18
3	Z1-		Z1+	19
4	0V		5V	20
5	V-		V+	21
6	V-		V+	22
7	LB1		LA1	23
8	FG		RST1	24
9	A2-		A2+	25
10	B2-		B2+	26
11	Z2-		Z2+	27
12	0V		5V	28
13	V-		V+	29
14	V-		V+	30
15	LB2		LA2	31
16	FG		RST2	32



Power supply connector				
1	2	3	4	5
GND	VIN	FG	V+	V-

- **LED status indicator**

Name	Color	State	Contents
PWR	Yellow	Off	Device is not powered
		On	Device is powered
RUN	Green	Off	Device is in INIT state
		Blinking	Device is in PREOP state
		Single Flash	Device is in SAFEOP state
		On	Device is in OP state
ERR	Red	OFF	No error
		Toggle	An error occurred

- **EtherCAT ID indicator**

Name	Color	Contents
ECAT ID	Red	Show the node ID of the Slave in the network, range 0 to 99

- **LED input indicators**

CH1			CH2		
Name	**State**	**Contents**	**Name**	**State**	**Contents**
OP1	Lit green	Counter operating	OP2	Lit green	Counter operating
	OFF	Counter Stopped		OFF	Counter Stopped
A1	Lit yellow	Input A (phase A signal/count pulse signal/incremental count signal) available	A2	Lit yellow	Input A (phase A signal/count pulse signal/incremental count signal) available
	OFF	Input A (phase A signal/count pulse signal/incremental count signal) not available		OFF	Input A (phase A signal/count pulse signal/incremental count signal) not available
B1	Lit yellow	Input B (phase B signal/count pulse signal/incremental count signal) available	B2	Lit yellow	Input B (phase B signal/count pulse signal/incremental count signal) available
	OFF	Input B (phase B signal/count pulse signal/incremental count signal) not available		OFF	Input B (phase B signal/count pulse signal/incremental count signal) not available
Z1	Lit yellow	Phase Z input available	Z2	Lit yellow	Phase Z input available
	OFF	Phase Z input not available		OFF	Phase Z input not available
LA1	Lit yellow	External latch input A available	LA2	Lit yellow	External latch input A available
	OFF	External latch input A not available		OFF	External latch input A not available
LB1	Lit yellow	External latch input B available	LB2	Lit yellow	External latch input B available
	OFF	External latch input B not available		OFF	External latch input B not available
RST1	Lit yellow	External reset input available	RST2	Lit yellow	External reset input available
	OFF	External reset input not available		OFF	External reset input not available

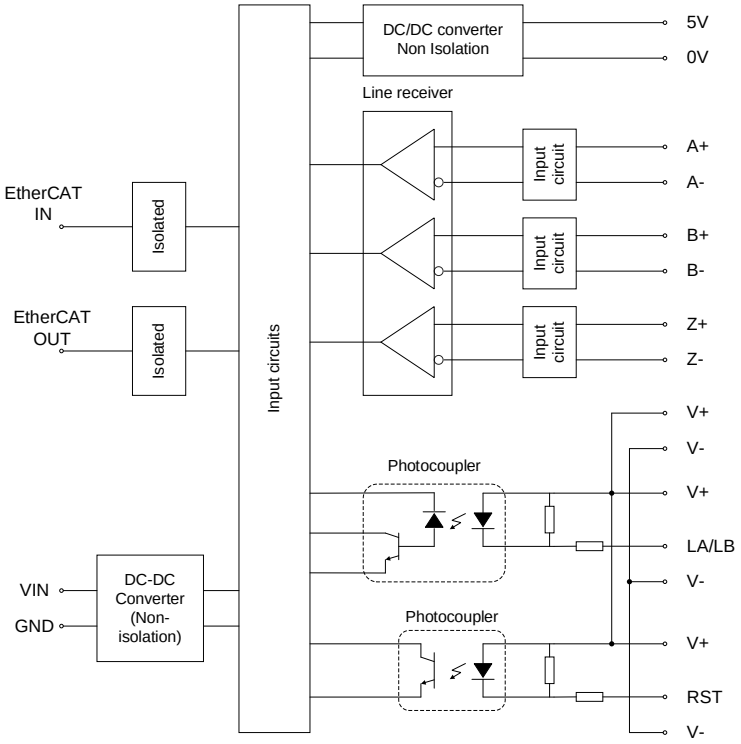
- **Power connector**

Connector number	Terminal name	Contents
1	VIN	Unit power supply
2	GND	Unit power supply
3	FG	Frame ground
4	V+	Sensor power supply output
5	V-	Sensor power supply output

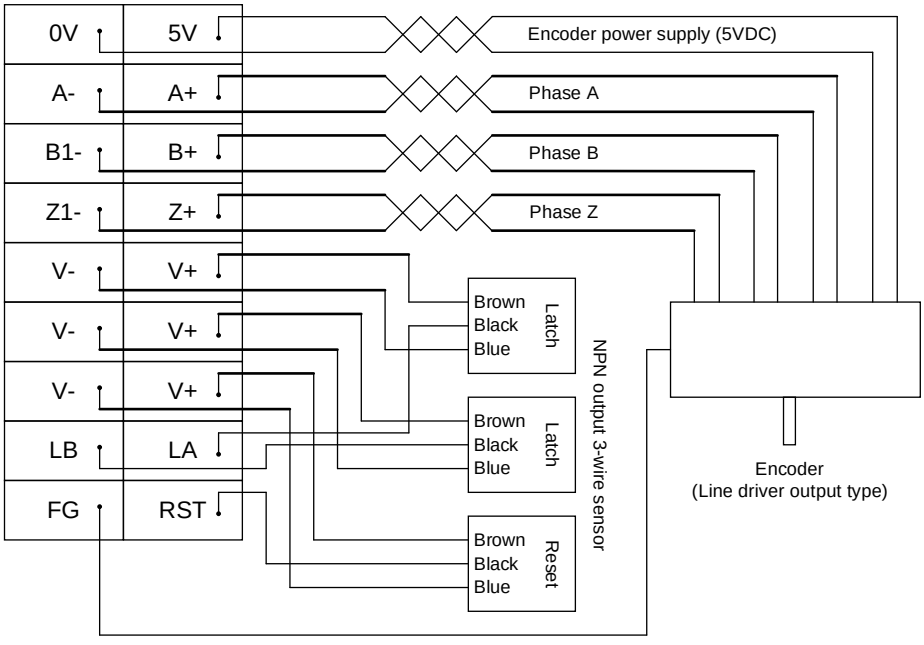
- **Terminal block**

CH	Terminal block number	Terminal name	Contents
CH1 CH2	1	A1-	Phase A input (-) channel 1
	2	B1-	Phase B input (-) channel 1
	3	Z1-	Phase Z input (-) channel 1
	4	0V	Encoder negative power supply
	5	V-	Sensor power supply output
	6	V-	Sensor power supply output
	7	LB1	Latch B input channel 1
	8	FG	Frame ground
	9	A2-	Phase A input (-) channel 2
	10	B2-	Phase B input (-) channel 2
	11	Z2-	Phase Z input (-) channel 2
	12	0V	Encoder negative power supply
	13	V-	Sensor power supply output
	14	V-	Sensor power supply output
	15	LB2	Latch B input channel 2
	16	FG	Frame ground
	17	A1+	Phase A input (+) channel 1
	18	B1+	Phase B input (+) channel 1
	19	Z1+	Phase Z input (+) channel 1
	20	5V	Encoder positive power supply
	21	V+	Sensor power supply output
	22	V+	Sensor power supply output
	23	LA1	Latch A input channel 1
	24	RST1	Reset input channel 1
	25	A2+	Phase A input (+) channel 2
	26	B2+	Phase B input (+) channel 2
	27	Z2+	Phase Z input (+) channel 2
	28	5V	Encoder positive power supply
	29	V+	Sensor power supply output
	30	V+	Sensor power supply output
	31	LA2	Latch A input channel 2
	32	RST2	Reset input channel 2

- **Internal circuits diagram**

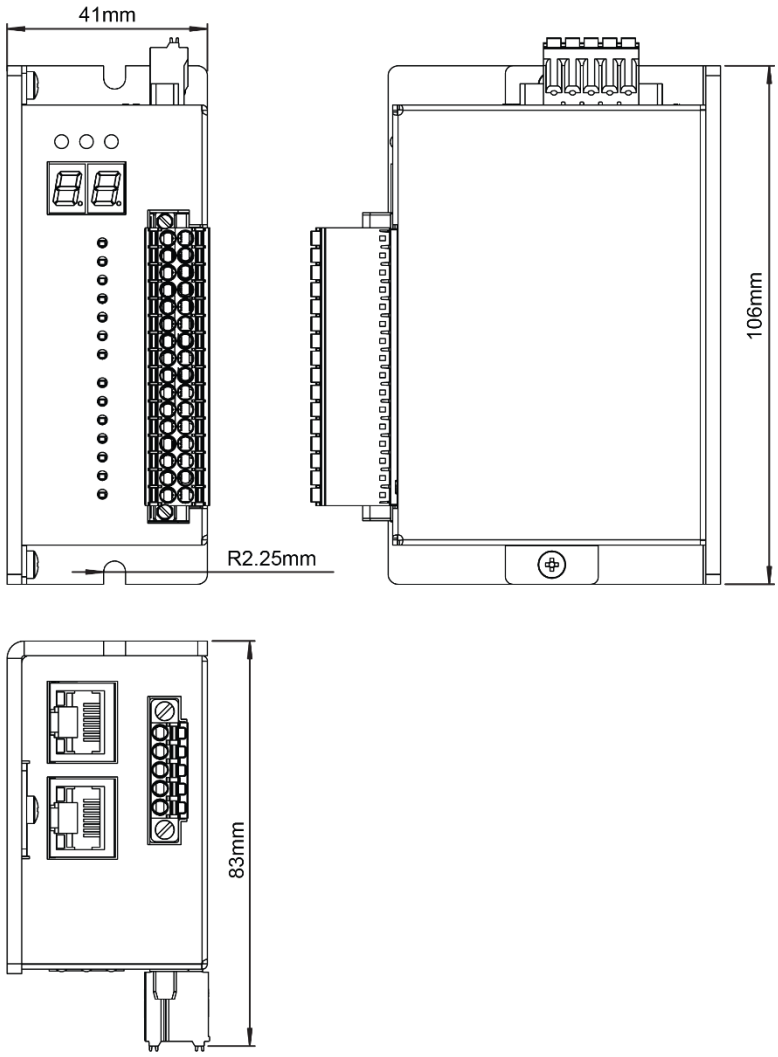


- **Wiring diagram**



4.4. Mounting Dimensions

The mounting dimensions [mm] of an Encoder Input Slave Unit are shown below.



5. Object Dictionary

5.1. Data Types

This profile uses the following data types.

Data Types	Code	Size	Range
Boolean	BOOL	1 bit	TRUE (1), FALSE (0)
Unsigned8	USINT	1 byte	0 to 255
Unsigned16	UINT	2 byte	0 to 65535
Unsigned32	UDINT	4 byte	0 to 4294967295
Visible string	STRING	-	-

5.2. Object Dictionary List

The following table lists the dictionary objects.

Functional Classification	Object Name	Index	Refer to
General Objects	Device type	1000h	5.3
	Error register	1001h	5.3
	Device name	1008h	5.3
	Manufacturer hardware version	1009h	5.3
	Manufacturer software version	100Ah	5.3
	Identify object	1018h	5.3
PDO Mapping Objects	Receive PDO mapping	1600h to 1601h	5.4
	Transmit PDO mapping	1A00h to 1A01h	5.4
Sync Manager Communication Objects	Sync manager communication type	1C00h	5.5
	Sync manager PDO assignment	1C12h and 1C13h	5.5
	Sync manager synchronization	1C32h and 1C33h	5.5
	Sync error setting	10F1h	5.5
Manufacturer Specific Objects	Count mode	4000h	5.6
	Encoder direction	4001h	5.6
	Encoder input setting	4002h	5.6
	Max count setting	4003h	5.6
	Position value	4010h	5.6
	Preset value	4011h	5.6
	Latch value A	4012h	5.6
	Latch value B	4013h	5.6
	Instruction flag	4021h	5.6
	Status Flag	4030h	5.6

5.3. General Objects

Device type (1000h)

This object contains the device type and functionality.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1000h	0	Device type	UDINT	RO	No	00010000h	No

Error register (1001h)

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1001h	0	Error register	USINT	RO	No	00h	No

Data Description

Bit	Data	Description
0	Generic error	0: No error, 1: error
1 to 7	Reversed	0: Always 0

Device name (1008h)

This object contains the EtherCAT Slave model name.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1008h	0	Device name	STRING	RO	No	00h	No

Manufacturer hardware version (1009h)

The object contains the software version of the EthetCAT Slave

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1009h	0	Manufacturer hardware version	STRING	RO	No	00h	No

Manufacturer software version (100Ah)

The object contains the software version of the EthetCAT Slave

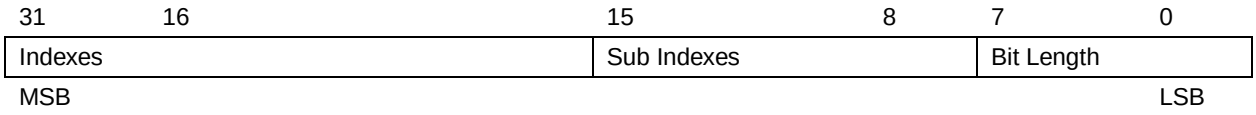
Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
100Ah	0	Manufacturer software version	STRING	RO	No	00	No

Identify object (1018h)

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1018h	0	Number of entries	USINT	RO	No	04h	No
	1	Vendor ID	UDINT	RO	No	00000B9Eh	No
	2	Product code	UDINT	RO	No	00000004h	No
	3	Revision number	UDINT	RO	No	00000001h	No
	4	Serial number	UDINT	RO	No	00000001h	No

5.4. PDO Mapping Objects

Indexes 1600 hex to 17FF hex are used for Receive PDO mapping, and indexes 1A00 hex to 1BFF hex are used for Transmit PDO mapping. Sub-indexes after sub-index 1 provide information about the application object being mapped.



Bits 0 to 7 : Bit length of the mapped object.

(For example, for 32 bits, 20 hex is given.)

Bits 8 to 15 : Sub-index of the mapped object.

Bits 16 to 31 : Index of the mapped object.

The following indexes describes the specific objects by Slave Unit types.

Receive PDO Mapping (1600h to 1601h)

- 1st Receive PDO Mapping - Command Setting Channel 1

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1600h	0	Number of objects	USINT	RO	No	02h	Yes
	1	Mapping entry 1	UDINT	RO	No	40200110h	Yes
	2	Mapping entry 2	UDINT	RO	No	40110120h	Yes

- 2nd Receive PDO Mapping - Command Setting Channel 2

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1601h	0	Number of objects	USINT	RO	No	02h	Yes
	1	Mapping entry 1	UDINT	RO	No	40200210h	Yes
	2	Mapping entry 2	UDINT	RO	No	40110220h	Yes

Transmit PDO Mapping (1A00h to 1A01h)

- 1st Transmit PDO Mapping - Actual Status Channel 1

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1A00h	0	Number of objects	USINT	RO	No	02h	Yes
	1	Mapping entry 1	UDINT	RO	No	40100120h	Yes
	2	Mapping entry 2	UDINT	RO	No	40120120h	Yes
	3	Mapping entry 3	UDINT	RO	No	40130120h	Yes
	4	Mapping entry 4	UDINT	RO	No	40300108h	Yes

- 2nd Transmit PDO Mapping - Actual Status Channel 2

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1A01h	0	Number of objects	USINT	RO	No	02h	Yes
	1	Mapping entry 1	UDINT	RO	No	40100220h	Yes
	2	Mapping entry 2	UDINT	RO	No	40120220h	Yes
	3	Mapping entry 3	UDINT	RO	No	40130220h	Yes
	4	Mapping entry 4	UDINT	RO	No	40300208h	Yes

5.5. Sync Manager Communication Objects

Sync manager communication type (1C00h)

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1C00h	0	Number of used Sync Manager channels	USINT	RO	No	04h	Yes
	1	Communication type sync manager 0	USINT	RO	No	1: Mailbox reception (master to slave)	Yes
	2	Communication type sync manager 1	USINT	RO	No	2: Mailbox send (slave to master)	Yes
	3	Communication type sync manager 2	USINT	RO	No	3: Process data output (master to slave)	Yes
	4	Communication type sync manager 3	USINT	RO	No	4: Process data input (slave to master)	Yes

Sync manager PDO assignment (1C12h and 1C13h)

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1C12h	0	Number of objects	USINT	RO	No	02h	Yes
	1	Index of assigned RxPDO 1	UINT	RO	No	1600h	Yes
	2	Index of assigned RxPDO 2	UINT	RO	No	1601h	Yes
1C13h	0	Number of objects	USINT	RO	No	02h	Yes
	1	Index of assigned TxPDO 1	UINT	RO	No	1A00h	Yes
	2	Index of assigned TxPDO 2	UINT	RO	No	1A01h	Yes

Sync Manager Synchronization (1C32h and 1C33h)

- Sync Manager 2 (Process Data Output) Synchronization

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1C32h	0	Number of synchronization parameters	USINT	RO	No	20h	No
	1	Synchronization type	UINT	RW	No	0: Free-Run 2: DC Sync0	No
	2	Cycle time	UDINT	RO	No	Sync0 event cycle [ns]	No
	4	Synchronization types supported	UINT	RO	No	40300208h	No
	5	Minimum cycle time	UDINT	RO	No	150000 [ns]	No
	6	Calc and copy time	UDINT	RO	No	0 [ns]	No
	8	Get cycle time	UINT	RW	No		No
	9	Delay time	UDINT	RO	No	0 [ns]	No
	10	Sync0 cycle time	UDINT	RW	No	Same as 1C32h:02	No
	11	SM-Event Missed	UINT	RO	No		No
	12	Cycle Time Too Small	UINT	RO	No		No
	31	Sync Error	BOOL	RO	No		No

- Sync Manager 3 (Process Data Input) Synchronization

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1C33h	0	Number of synchronization parameters	USINT	RO	No	20h	No
	1	Synchronization type	UINT	RW	No	Same as 1C32h:01	No
	2	Cycle time	UDINT	RO	No	Same as 1C32h:02	No
	4	Synchronization types supported	UINT	RO	No	40300208h	No
	5	Minimum cycle time	UDINT	RO	No	Same as 1C32h:05	No
	6	Calc and copy time	UDINT	RO	No	0 [ns]	No
	8	Get cycle time	UINT	RW	No		No
	9	Delay time	UDINT	RO	No	0 [ns]	No
	10	Sync0 cycle time	UDINT	RW	No	Same as 1C32h:10	No
	11	SM-Event Missed	UINT	RO	No		No
	12	Cycle Time Too Small	UINT	RO	No		No
	31	Sync Error	BOOL	RO	No		No

Sync error setting (10F1h)

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
10F1h	0	Number of objects	USINT	RO	No	02h	No
	1	Local error Reaction	UDINT	RW	No	01h	No
	2	Sync Error Counter Limit	UINT	RW	No	04h	Yes

5.6. Manufacturer Specific Objects

Count Mode

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
4000h	0	Number of channel	USINT	RO	No	02h	No
	1	CH1 Count mode	USINT	RW	No	00h	No
	2	CH2 Count mode	USINT	RW	No	00h	Yes

- It stores the Count Mode.
- The Count Mode is fixed to 00 hex (Circular Counter).

Encoder Direction

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Default Value	Saving to EEPROM
4001h	0	Number of channel	USINT	RO	No	02h	No
	1	CH1 Pulse direction	BOOL	RW	No	FALSE	No
	2	CH2 Pulse direction	BOOL	RW	No	FALSE	No

- Set the count direction.

Bit	Count direction
0 (FALSE)	Forward direction at CW (clockwise rotation seen from the shaft of the connected encoder)
1 (TRUE)	Forward direction at CCW (counterclockwise rotation seen from the shaft of the connected encoder)

Encoder Input Setting

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Default Value	Saving to EEPROM
4002h	0	Number of channel	USINT	RO	No	02h	No
	1	CH1 Pulse Input Setting	USINT	RW	No	02h	No
	2	CH2 Pulse Input Setting	USINT	RW	No	02h	No

- Set the input method.

Set value	Range
00h	Phase A/B pulse (Multiplication x 1 cycle)
01h	Phase A/B pulse (Multiplication x 2 cycle)
02h	Phase A/B pulse (Multiplication x 4 cycle)
03h	Pulse/Dir input
04h	Incremental/decremental pulse

Max Count Setting

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Default Value	Saving to EEPROM
4003h	0	Number of channel	USINT	RO	No	02h	No
	1	CH1 Max Count Setting	UDINT	RW	No	FFFFFFFFh	No
	2	CH2 Max Count Setting	UDINT	RW	No	FFFFFFFFh	No

- This object is used to specify the maximum value of the counter.

Position value

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Default Value	Saving to EEPROM
4010h	0	Number of channel	USINT	RO	No	02h	No
	1	CH1 Position Value	UDINT	RO	No	00000000h	No
	2	CH2 Position Value	UDINT	RO	No	00000000h	No

- The present counter value is stored.

Preset value

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Default Value	Saving to EEPROM
4011h	0	Number of channel	USINT	RO	No	02h	No
	1	CH1 Preset Value	UDINT	RW	No	00000000h	No
	2	CH2 Preset Value	UDINT	RW	No	00000000h	No

- This object is used to specify the preset command value.

Latch Value A

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Default Value	Saving to EEPROM
4012h	0	Number of channel	USINT	RO	No	02h	No
	1	CH1 Latch Value A	UDINT	RO	No	00000000h	No
	2	CH2 Latch Value A	UDINT	RO	No	00000000h	No

- The value of latch A is stored.

Latch Value B

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Default Value	Saving to EEPROM
4013h	0	Number of channel	USINT	RO	No	02h	No
	1	CH1 Latch Value B	UDINT	RO	No	00000000h	No
	2	CH2 Latch Value B	UDINT	RO	No	00000000h	No

- The value of latch B is stored.

Instructions Bits

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Default Value	Saving to EEPROM
4020h	0	Number of channel	USINT	RO	No	02h	No
	1	CH1 Instruction Bits	UINT	RW	No	0000h	No
	2	CH2 Instruction Bits	UINT	RW	No	0000h	No

- The soft switch setting is specified.

Status Bits

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Default Value	Saving to EEPROM
4030h	0	Number of channel	USINT	RO	No	02h	No
	1	CH1 Status Bits	USINT	RO	No	0000h	No
	2	CH2 Status Bits	USINT	RO	No	0000h	No

- Status bit is stored.

6. Troubleshooting

Errors can be notified by status indicators on Slave Units.

In this section, the states of status indicator are indicated using the following abbreviations.

Abbreviation	Definition
On	ON
Off	OFF
F	Flickering (ON (50 ms) - OFF (50 ms) flashing)
B	Blinking (ON (200 ms) - OFF (200 ms) flashing)
SF	Single flash (ON (200 ms) - OFF (1000 ms) flashing)
DF	Double flash (ON (200 ms) - OFF (200 ms) - ON (200 ms) - OFF (1000 ms) flashing)
-	Unknown

- **Errors of Slave Unit**

[PWR] indicator	[L/A IN] [L/A OUT] LED	[RUN] indicator	[ERR] indicator	Description	Cause	Actions
On	F	On	Off	EtherCAT communication is in progress.	EtherCAT communication is being executed.	PDO communications or both PDO and SDO communications are being executed. State is normal.
Off	Off	Off	Off	Power supply error	The power is not properly supplied to the Slave Unit.	After removing the following factors of power supply shutdown, restart the Slave Unit according to the specification of connected EtherCAT Master Unit. • Are the power supply cables wired correctly? • Are the power supply cables disconnected? • Is the power supply voltage within the specification range? • Is the power supply capacity sufficient? • Is the power supply malfunctioning?
On	On	-	-	Link established in physical layer	Operation standby status after establishing link in physical layer.	-

[PWR] indicator	[L/A IN] [L/A OUT] LED	[RUN] indicator	[ERR] indicator	Description	Cause	Actions
On	Off	-	-	Link not established in physical layer	A link in physical layer has not been established.	After checking the following items, restart the Slave Unit according to the specification of connected EtherCAT Master Unit. • Is the communications cable wired correctly? • Are any cables disconnected or loose in the part that connects to the connector? • Is the cable length appropriate? • Is the communications cable of the recommended specification?
					The host master has not been started.	Check that EtherCAT Master Unit is operating correctly.
					A hardware failure occurred.	If the problem is not resolved even after the measures described above are taken, the Slave Unit hardware may be damaged. Replace the applicable Slave Unit.
On	-	-	DF	Process data communications timeout	A communications error occurred.	After checking the following items, restart the Slave Unit according to the specification of connected EtherCAT Master Unit. [Item about communication cable] • Is the communications cable wired correctly? • Are any cables disconnected or loose in the part that connects to the connector? • Is the cable length appropriate? • Is the communications cable of the recommended specification? [Item about power supply] • Is the power supply voltage within the specification range? • Is the power supply capacity sufficient?
				Link in physical later OFF	Communications cable disconnection occurred.	Check to see if the cable is disconnected or loose in the part that connects to the connector.

[PWR] indicator	[L/A IN] [L/A OUT] LED	[RUN] indicator	[ERR] indicator	Description	Cause	Actions
On	-	SF	-	Safe- Operational state	It is commanded from the EtherCAT Master Unit to shift to the Safe-Operational state.	If the trouble occurred during operating the system, check the state of the connected EtherCAT Master Unit.
On	-	B	-	Pre- Operational state	It is commanded from the EtherCAT Master Unit to shift to the Pre-Operational state.	
On	-	Off	-	Init state	It is commanded from the EtherCAT Master Unit to shift to the Init state.	
On	-	B	SF	Synchronization error (at synchronization start)		After checking the following items, restart the Slave Unit according to the specification of connected EtherCAT Master Unit. • Is the communications cable wired correctly? • Is the communications cable exposed to excessive noise? • Review set time of Sync Not Received Timeout Setting (synchronization error setting).
On	-	SF	SF	Communications synchronization error		After checking the following items, restart the Slave Unit according to the specification of connected EtherCAT Master Unit. • Is the communications cable wired correctly? • Is the communications cable exposed to excessive noise? • Review set time of Communication Error Setting.

[PWR] indicator	[L/A IN] [L/A OUT] LED	[RUN] indicator	[ERR] indicator	Description	Cause	Actions
On	-	SF	SF	Synchronization error (in operation)		After checking the following items, restart the Slave Unit according to the specification of connected EtherCAT Master Unit. • Is the communications cable wired correctly? • Is the communications cable exposed to excessive noise? • Review set time of Communication Error Setting. If this does not improve, the Slave Unit hardware may be damaged. Replace the applicable Slave Unit.

- **Error of Counter Unit**

Symptom	Cause	Measures
The count pulse cannot be detected.	Input wiring is wrong.	Check wiring of input A and input B.
	The I/O power is not supplied.	Check that the I/O power is supplied.
	I/O power supply voltage is outside the rated range.	Set the I/O power supply voltage within the rated voltage.
	A connected device is disconnected.	Check the wiring with the connected device.
	A connected device is defective.	Replace the connected device.
	The setting of counter input method is wrong.	Set the correct counter input method and restart the Slave Unit.
The pulse is not counted accurately.	The pulse frequency exceeds the maximum frequency of the Slave Unit specification. Or, the frequency exceeds the maximum value of set mode.	Set the pulse frequency within the Slave Unit specification or the mode maximum value.
	The setting of counter input method is wrong.	Set the correct counter input method.
The counter value is not reset even the present value external reset signal or phase Z pulse are input.	Input wiring is wrong.	Check input wiring.
	The soft switch "present value external reset enabled" is set to 0 (disabled).	Set the soft switch "present value external reset enabled" to 1 (enabled).
	Counting is not possible. (The count value cannot be reset with external input when counting is not possible.)	Change to count possible status. If it is necessary to reset because counting is not possible, reset with the soft switch "present value internal reset execution."
Although the soft switch "present value external reset enabled" is enabled, the counter value cannot be reset even if signals are input.	After resetting the counter value externally, the "external reset generation flag" changes from 0 to 1. After that, external reset cannot be performed until the flag is cleared.	Change the soft switch "clear present value external reset generation flag" from 0 to 1. At the rise from 0 to 1, the "external reset generation flag" changes from 1 to 0 and external reset is enabled.
The counter value cannot be latched even if external control input (latch A/B) signals are input.	The soft switch "external latch A/B enabled" is set to 0 (disabled).	Set the soft switch "external latch A/B enabled" to 1 (enabled).
Although the soft switch" external latch A/B enabled" is enabled, the counter value cannot be latched even if signals are input.	After latching the counter value, the "external latch A/B generation flag" changes from 0 to 1. After that, it is not possible to latch until the flag is cleared.	Change the soft switch "clear external latch A/B generation flag" from 0 to 1. At the rise from 0 to 1, the "external latch A/B generation flag" changes from 1 to 0 and latch is enabled.
Some functions are not reflected even after parameters have been set.	Parameters that are enabled at the timing that the count status changes from disabled to enabled were changed.	When the count is enabled, execute the count enable command after the count disable command. When the count is disabled, execute the count enable command.

Revision History

Revision	Date	Descriptions	Author
REVA.001	25.01.2021	Initial version	V.N.D
REVB.001	10.10.2021	Update model part number	V.N.D
REVE.001	01.12.2022	Change encoder connector pinout Change Housing dimension	V.N.D