Ezi-IO®

EtherCAT®

Input/Output Module DA

User Manual

CE

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INDEX

Chapter 1. Safety and Installation Precautions

1.1 Before Operation

- Thank you for purchasing FASTECH Ezi-IO EtherCAT DA products.
- Ezi-IO EtherCAT DA is an Analogue Output Module mounted with an EtherCAT Slave Controller chip.
- This manual describes the handling, safety precautions, and specifications of Ezi-IO EtherCAT DA.
- Before starting the operation of Ezi-IO EtherCAT, thoroughly read this manual.
- After reading this manual, keep the manual near Ezi-IO EtherCAT DA, so that any user can read this manual whenever needed.

1.2 Precautions

1.2.1 General Precautions

- Contents of this manual are subject to change without prior notice for functional improvements, change of specifications or user's better understanding. Thoroughly read the manual which is provided with the purchased product.
- In case of manual is damaged or lost, please contact FASTECH or our agents. You can find our contact information on the last page of this manual.
- FASTECH is not responsible for a product breakdown due to the user's dismantling of the product, and such a breakdown is not guaranteed by the warranty.

1.2.2 Installation Precautions

- This product has been designed for indoor use. Use the product in the ambient temperature 0°~ 50°C.
- When installing the products in an enclosed space, keep the ambient temperature of the product at or below 50℃ using a cooling fan.
- Do not install the product under direct rays, near magnetic or radioactive objects.
- When installing more than 2 product units together, keep the distance between two units at least 20mm vertically and 50mm horizontally.

1.2.3 Safety Precautions

- Before installation, operation, or repairing of the products, thoroughly read the manual and fully understand the contents. Before operating the products, please understand the mechanical characteristics of the products and related safety information and precautions.
- Safety precautions are indicated by  Attention and  Warning.

 Attention	**If a user does not properly handle the products, the user may be seriously or lightly injured, and damages may occur to the machine.**
 Warning	**If a user does not properly handle the products, a dangerous situation (such as an electric shock) may occur resulting in deaths or serious injuries.**

- Follow all the safety precautions indicated in this manual. Otherwise, serious damage or injury can be resulted depending on the situation.

◆ **Safety Precautions When Designing**

 Warning	**Design an appropriate protection circuit to protect the entire system from faults in external power or connected devices.** **Protect the system to ensure that the entire system is safe from communication errors (emergency stop, interlock circuit, limit circuit, etc.).**

◆ **Safety Precautions When Installing**

 Attention	**Check if there is any damage on the product and if any part is missing.** Otherwise, the machine may get damaged or the user may get injured. **Carry the product carefully.** Otherwise, the product may get damaged or user's foot may get injured by dropping the product. **Use non-flammable materials such as metal in the place where the product is to be installed.** Otherwise, a fire may occur. **When installing multiple products in an enclosed space, use a cooling fan to keep the ambient temperature of the product at or below 50℃.** Otherwise, a fire or other kinds of accidents may occur due to overheating.
 Warning	**The process of installation, Connection, Operation, Checking and Repairing should be done by qualified personnel.** Otherwise, a fire or other kinds of accidents may occur.

◆ **Safety Precautions When Connecting Cables**

 Attention	**Keep the rated range of input voltage for the drive.** Otherwise, a fire or other kinds of accidents may occur. **Connect cables according to the wiring diagram in this manual.** Otherwise, a fire or malfunction of the machine may occur.
 Warning	**Before connecting cables, make sure the input power is off.** Otherwise, an electric shock or a fire may occur. **When the product is isolated from the ground of the internal circuit by the condenser, ground the product properly.** Otherwise, an electric shock, a fire or a malfunction of the machine may occur.

◆ **Safety Precautions When Operating and Setting**

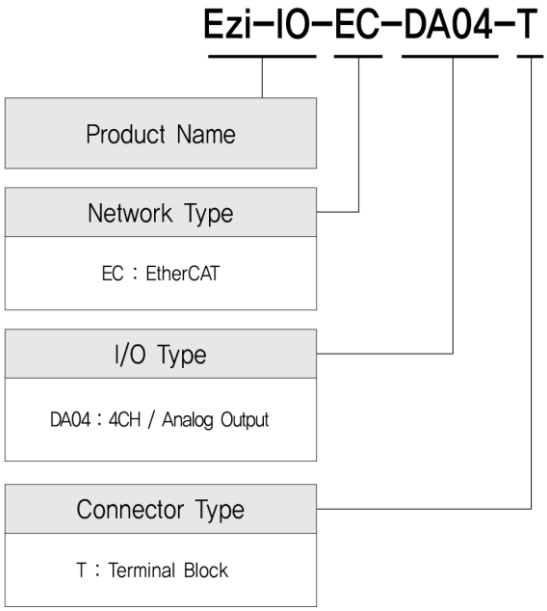
 Attention	**Before changing the settings of the product, thoroughly read this manual and fully understand the contents.** Otherwise, the machine may get damaged or the product may malfunction.

◆ **Safety Precautions When Repairing & Maintaining**

 Warning	**Stop supplying power to the main circuit and wait sufficient time before checking or repairing the product.** Electricity remained in the condenser may cause an electric shock. **Do not change cabling while power is being supplied.** Otherwise, the user may get injured or the product and machine may get damaged. **Do not reconstruct the product.** Otherwise, an electric shock may occur or the product and machine get damaged. And the reconstructed product cannot get after service.

Chapter 2. Configuration

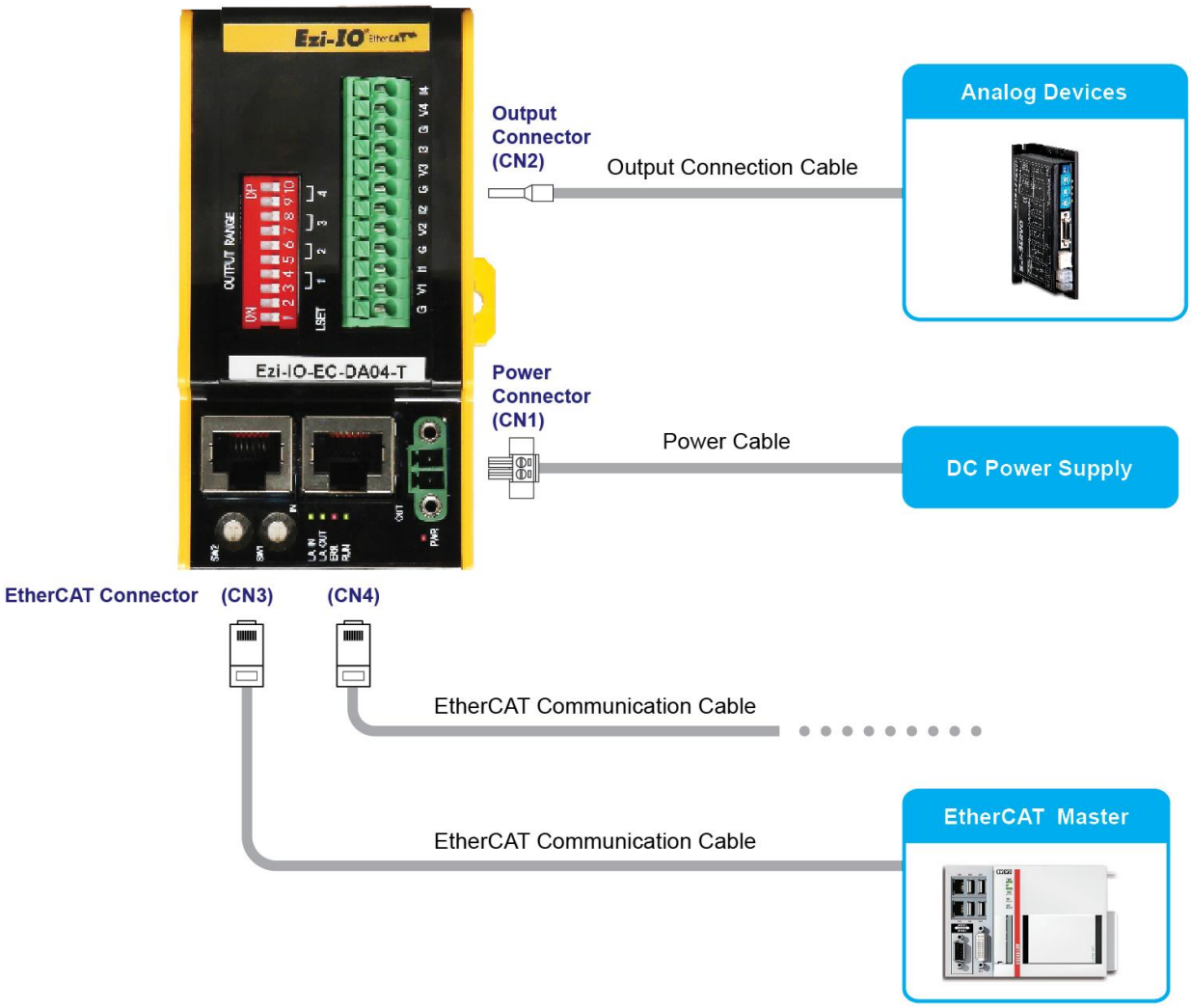
2.1 Ezi-IO EtherCAT DA Part Numbering



2.2 Ezi-IO EtherCAT DA Part Number

Part Number
Ezi-IO-EC-DA04-T

2.3 System Configuration



Chapter 3. Specifications

3.1 EtherCAT Specifications

Communication	EtherCAT
Physical Layer	Ethernet – 100BASE-TX
Connector Type	RJ45 IN: EtherCAT input OUT: EtherCAT output
ECAT Device ID	Configured Station Alias Setting by Rotary Switch : 0 ~ 99 Physical Address Setting in Master Unit : 1 ~ 65535
Topology	Line (Configured by I/O modules only) Tree, Star, Ring (When using a switching hub)
Protocol	CoE (CANopen application protocol over EtherCAT) FoE (File Access over EtherCAT)
Control Profile	CiA 401 Profile
Distributed Clock	Free Run, SM Event, DC SYNC Event (Min. Communication Cycle: 250us)
Processing Data	Fixed PDO Mapping
Cable	STP (Shielded Twisted Pair) Cable, Category 5e or higher / Max. 100m

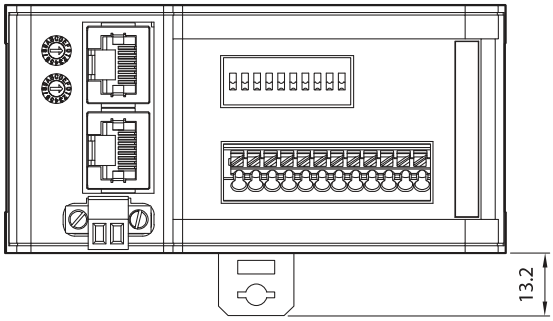
3.2 Module Specifications

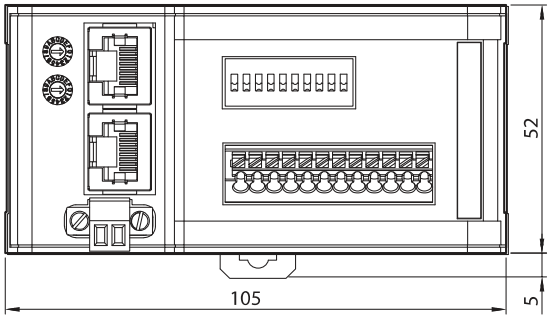
Part Number			Ezi-IO-EC-DA04-T	
Output Mode			Voltage Output	Current Output
Input Voltage			24 [VDC] ±10%	
Current Consumption			Max. 120 [mA]	
Operating Condition	Ambient Temperature		· In Use: 0~50℃ · In Storage: -20~70℃	
	Humidity		· In Use: 35~85% RH (Non-Condensing) · In Storage: 10~90% RH (Non-Condensing)	
	Vib. Resist.		0.5g	
Function	Number of Channels		4CH	
	Output Range		· 0~5 [V] · 1~5 [V] · 0~10 [V] · -10~10 [V]	· 0~20 [mA] · 4~20 [mA]
	Output Range Setting Method		· SDO Communications (Separate setting for each channel) · DIP Switch (Separate setting for each channel)	
	Load Impedance		Min. 1 [kΩ]	Max. 400 [Ω]
	Resolution		Max. 1/50,000	
	Accuracy	25℃	±0.3%(Full Scale)	
		0~50℃	±0.4%(Full Scale)	
	Output Delay		Max. 500 [μs]	
	D/A Converted Data		· -25,000~25,000 (for -10~10 [V] voltage output) · 0~25,000 (for all voltage output except -10~10 [V])	0~25,000 (for current output)
	Signal Isolation Method		Digital isolation between analogue output and communication connections	
LED Indication			· Power Status (PWR) · EtherCAT Communication State (RUN) · Operation Error (ERR) · EtherCAT Link/Activity Status (LA IN, LA OUT)	

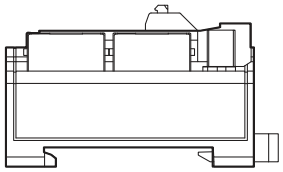
3.3 Module Dimensions

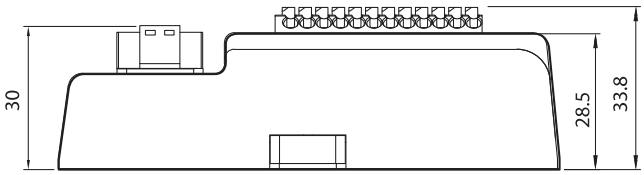
[Unit: mm]

* Can be installed on 35mm DIN Rail.





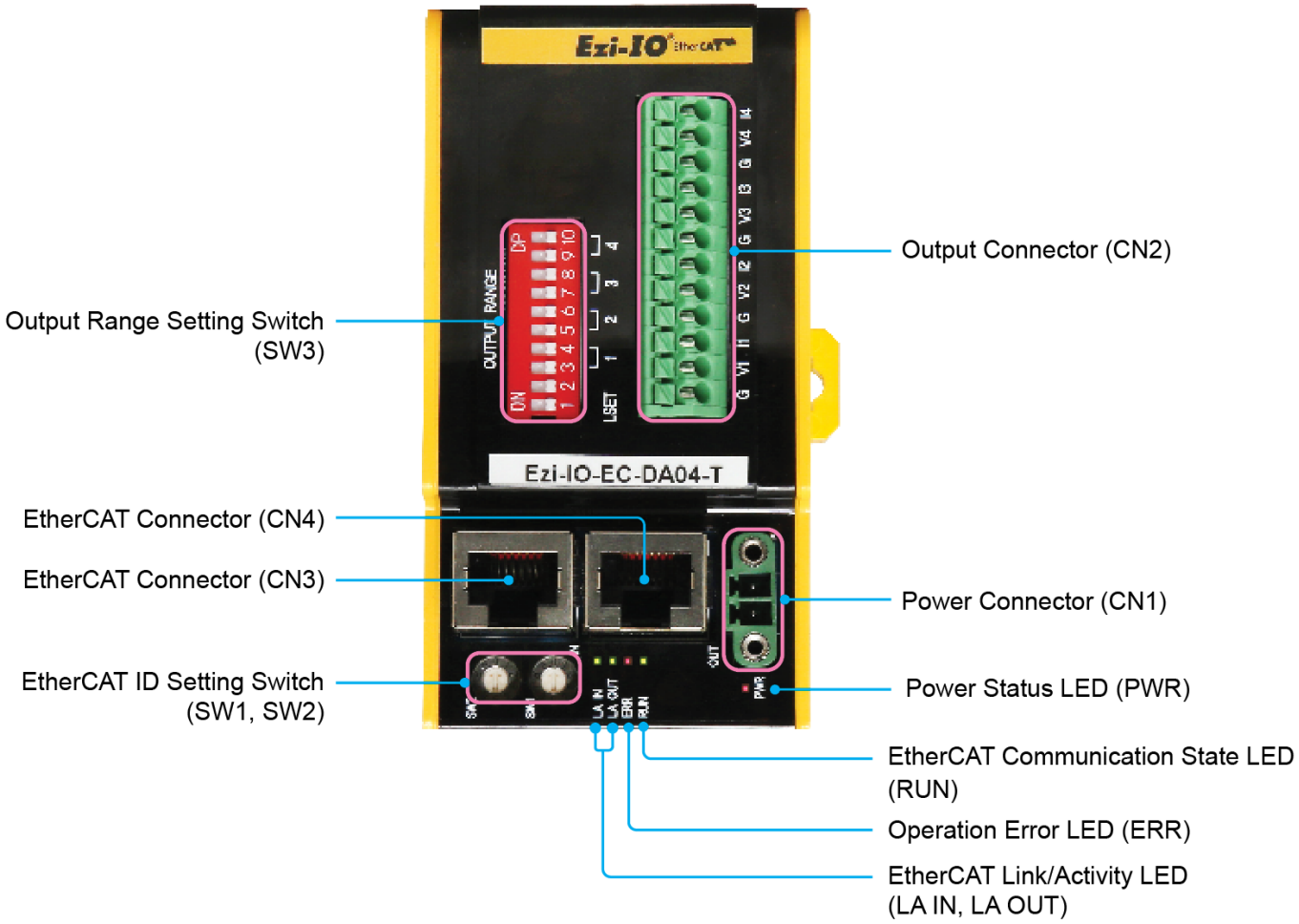




* Can be installed on 35mm DIN Rail.

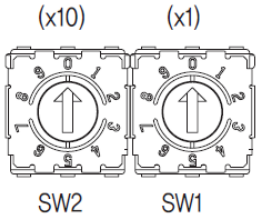
Chapter 4. Connection Panel View

4.1 Names and Functions (Ezi-IO-EC-DA04-T)



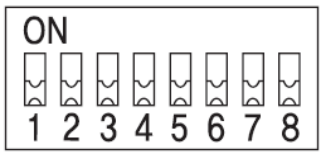
4.1.1 EtherCAT ID Setting Switches (SW1, SW2)

Use two rotary switches to set EtherCAT ID (ECAT Device ID). Set ones digit (x1) of EtherCAT ID on the right rotary switch (SW1), and set tens digit (x10) of EtherCAT ID on the left rotary switch (SW2).
Setting Range is 0 ~ 99.



* The Configured Alias ID set by the rotary switches is applied when the power is supplied to the I/O module.

4.1.2 Output Range Setting Switch (SW3)



Select the output range by SW3 referring to the chart.

① Selecting Output Setting Method

Select the output setting method with LSET switch (SW3.1).

Switch / Setting Method	LSET SW3.1	Description
DIP Switch	ON	Setting output range with DIP switches (SW3.3~SW3.10)
SDO Communication	OFF	Setting voltage/current output range through EtherCAT SDO communication

* Set SW3.1 before supply power to the module.

* SW3.2 is not used.

② Selecting Output Range

When using the DIP Switch for the setting method (SW3.1=ON), select output range referring to the chart.

Switch / Output Range	CH1		CH2		CH3		CH4	
	SW3.3	SW3.4	SW3.5	SW3.6	SW3.7	SW3.8	SW3.9	SW3.10
0~5 [V]	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
-10~10 [V]	OFF	ON	OFF	ON	OFF	ON	OFF	ON
0~20 [mA]	ON	OFF	ON	OFF	ON	OFF	ON	OFF
4~20 [mA]	ON	ON	ON	ON	ON	ON	ON	ON

* 1~5 [V], 0~10 [V] voltage output range can be set by the SDO communication ONLY.

4.1.3 LED Indications

LED	Color	Status	Description
PWR	Red	OFF	Power OFF
		ON	Power ON

LED	Color	Status	Description
RUN	Green	OFF	INIT State or Power OFF
		Blinking	PRE-OPERATIONAL State
		Single Flash	SAFE-OPERATIONAL State
		ON	OPERATIONAL State
		Flickering	BOOTSTRAP State

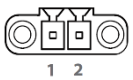
LED	Color	Status	Description
ERR	Red	OFF	No Error or Power OFF
		Blinking	Invalid Configuration
		Single Flash	Local Error
		Double Flash	Watchdog Time Out

LED	Color	Status	Description
Link/ Activity	Green	OFF	Link is not established physically.
		ON	Link is established physically.
		Flickering	Link is active in operation.

* Refer to 7.3.2 EtherCAT Communication State Indication

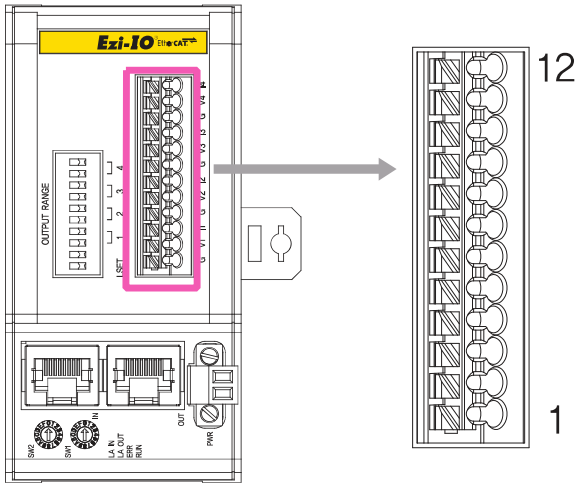
4.1.4 Power Connector (CN1)

NO.	Function
1	24 [VDC]
2	GND



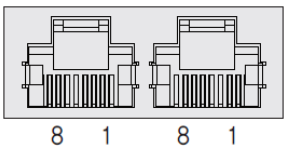
4.1.5 Output Connector (CN2)

NO.	Label	Function	I/O
1	G	GND	—
2	V1	Voltage Out 1	Output
3	I1	Current Out 1	Output
4	G	GND	—
5	V2	Voltage Out 2	Output
6	I2	Current Out 2	Output
7	G	GND	—
8	V3	Voltage Out 3	Output
9	I3	Current Out 3	Output
10	G	GND	—
11	V4	Voltage Out 4	Output
12	I4	Current Out 4	Output



4.1.6 EtherCAT Connectors (CN3, CN4)

NO.	Function	NO.	Function
1	TD+	6	RD-
2	TD-	7	—
3	RD+	8	—
4	—	Connector Hood	F.GND
5	—		



4.1.7 Parts Included

- **Power Connector**

Function	Item	Part Number	Manufacturer
Power Connector (CN1)	Terminal Block	MC421-38102	DECA

* The connector above is the most suitable model for Ezi-IO EtherCAT DA. Another equivalent connector can be used.

4.1.8 Accessories (Sold Separately)

- **EtherCAT Cable**

Function	Part Number	Cable Length [m]	Remarks
EtherCAT Connector (CN3, CN4)	CGNR-EC-001F	1	• STP (Shielded Twisted Pair) cable • Category 5e or higher • Maximum cable length: 100m • For fixed installation
	CGNR-EC-002F	2	
	CGNR-EC-003F	3	
	CGNR-EC-005F	5	

* If you need another length of cable (in unit of m), please contact FASTECH.

Chapter 5. IO Connector Wiring

Ezi-IO EtherCAT DA is supplied with push-in spring type terminal blocks which are connected with wires in simple and easy way using ferrule connectors. Connections of Ezi-IO EtherCAT DA to analogue devices are also simplified.

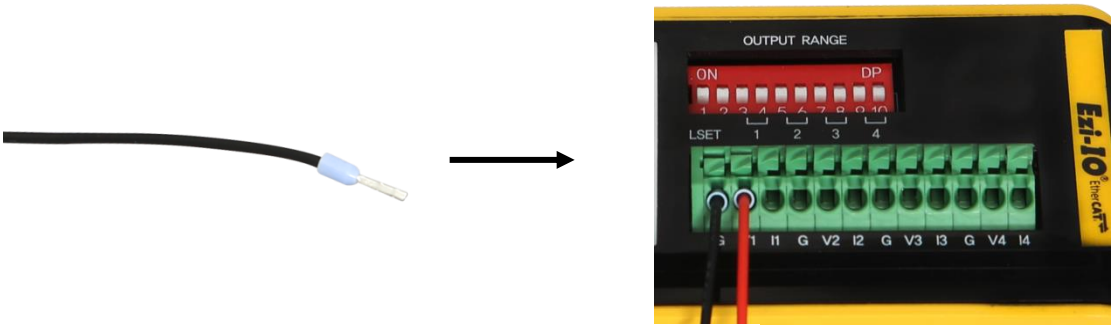


Figure 5-1. Ferrule Connection

5.1 Signal Wiring

Each output channel of Ezi-IO EtherCAT DA has separate voltage output and current output pins.
Refer to the **Figure 5-2** and **Figure 5-3** for wire connections of your applications.

5.1.1 Wiring of Voltage Outputs

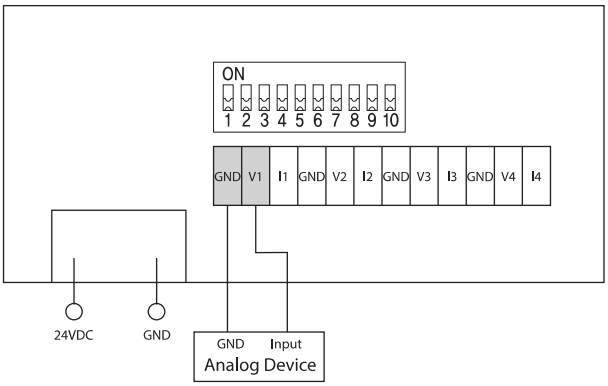


Figure 5-2. Wiring of Voltage Outputs (Example: Channel 1)

5.1.2 Wiring of Current Outputs

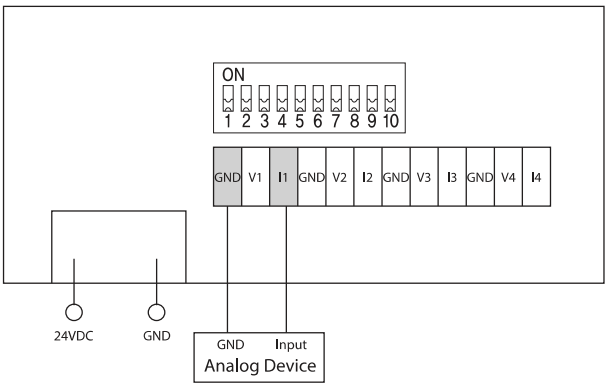


Figure 5-3. Wiring of Current Outputs (Example: Channel 1)

5.2 Internal Circuit Diagram

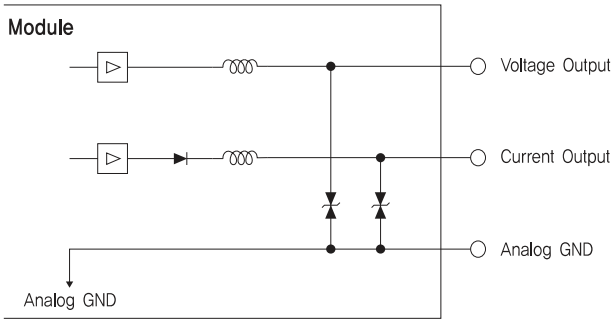


Figure 5-4. Internal Circuit Diagram

Chapter 6. Setting Output Range

To set voltage range, use either SDO communication or DIP switch setting method. The setting methods are following.

6.1 Setting Voltage Output Range

6.1.1 Setting Voltage Output Range through SDO Communication

(Example) Setting Channel 2

① Set LSET switch (SW3.1) of Output Range Setting Switch (SW3) to OFF before supplying power.

② On the Output Connector (CN2), wire GND pin (G) and voltage output pin (V2) of Channel 2 to the analogue device. Then, supply power to the module.

③ Enter the value of the Analogue Output Range Object (2301h) through the Master unit to set the voltage output range.

④ Supply power to the module again, and complete the setting.

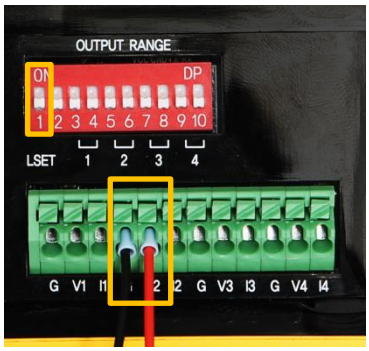


Figure 6-1. Setting Voltage Output Range through SDO Communication

6.1.2 Setting Voltage Output Range with DIP Switches

(Example) Setting Channel 2 to -10~10V Output Range

① Set LSET switch (SW3.1) of Output Range Setting Switch (SW3) to ON before supplying power to the module. Set the voltage output range of Channel 2 with SW3.5~SW3.6 switches (SW3.5=OFF, SW3.6=ON).

② On the Output Connector (CN2), wire GND pin (G) and voltage output pin (V2) of Channel 2 to the analogue device. Then, supply power to the module.

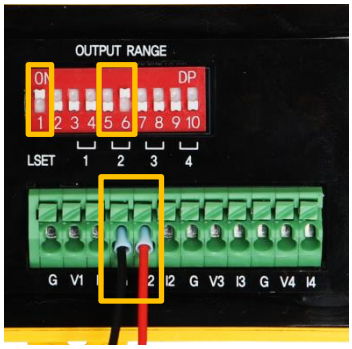


Figure 6-2. Setting Voltage Output Range with DIP Switches

6.2 Setting Current Output Range

6.2.1 Setting Current Output Range through SDO Communication

(Example) Setting Channel 2

① Set LSET switch (SW3.1) of Output Range Setting Switch (SW3) to OFF before supplying power to the module.

② On the Output Connector (CN2), wire GND pin (G) and current output pin (I2) of Channel 2 to the analogue device. Then, supply power to the module.

③ Enter the value of the Analogue Output Range Object (2301h) through the Master unit to set the Current output range.

④ Supply power to the module again, and complete the setting.

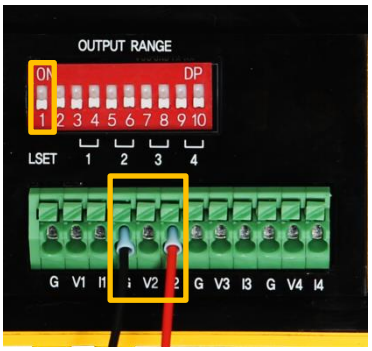


Figure 6-3. Setting Current Output Range through SDO Communication

6.2.2 Setting Current Output Range with DIP Switches

(Example) Setting Channel 2 to 4~20[mA] Output Range

① Set LSET switch (SW3.1) of Output Range Setting Switch (SW3) to ON before supplying power to the module. Set the current output range of Channel 2 with SW3.5~SW3.6 switches (SW3.5=ON, SW3.6=ON).

② On the Output Connector (CN2), wire GND pin (G) and current output pin (I2) of Channel 2 to the analogue device. Then, supply power to the module.

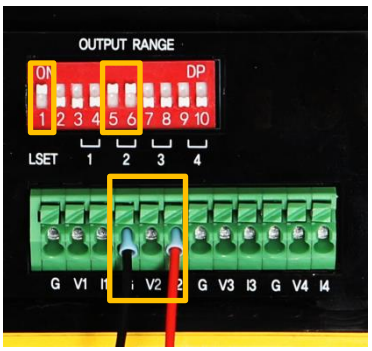


Figure 6-4. Setting Current Output Range with DIP Switches

Chapter 7. EtherCAT Communication

7.1 CAN Application Protocol Over EtherCAT

Ezi-IO EtherCAT DA is an analogue output module that supports CAN application protocol over EtherCAT (CoE). Ezi-IO EtherCAT DA has the following network structure.

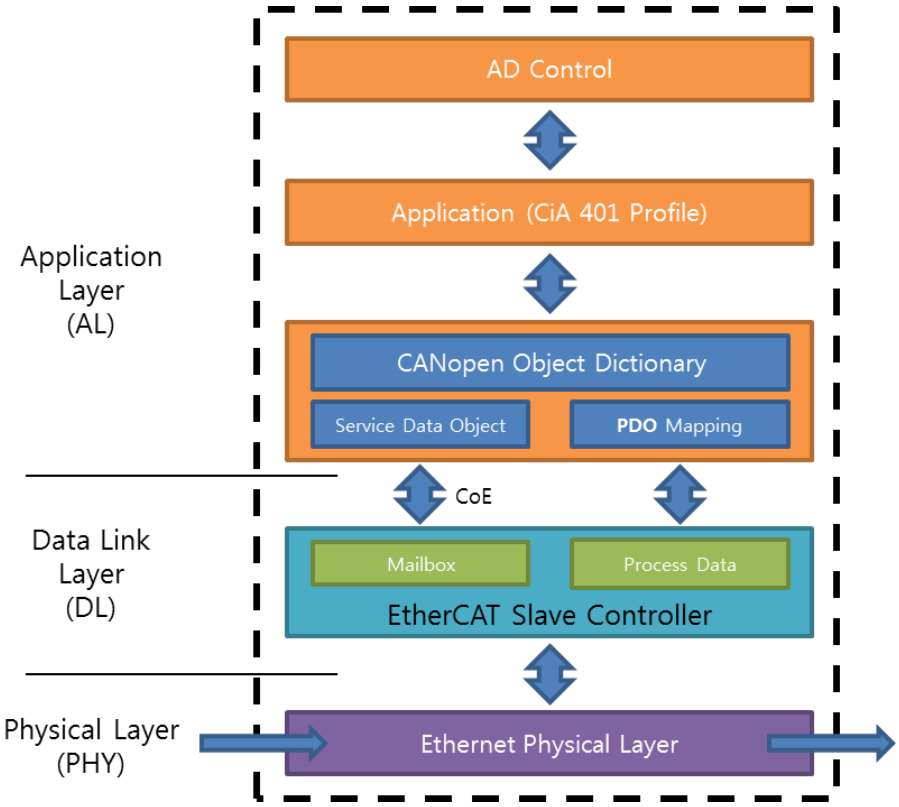


Figure 7-1. Communication Structure of Ezi-IO EtherCAT DA

7.1.1 Object Dictionary

The Object Dictionary is the group of data objects which are saved in an EtherCAT slave unit. EtherCAT masters can read and write data through the index or sub-index of objects.

7.1.2 Mailbox Communication

In the Mailbox (SDO) communication, a master and a slave exchange the service data object (SDO). It is a message transmission and reception method. If the master sends a command, the slave Ezi-IO EtherCAT DA answers to it.

The SDO communication is used for setting or checking objects in the Object Dictionary when the Ezi-IO EtherCAT DA is in Pre-Operational, Safe-Operational, or Operational state.

7.1.3 Process Data Communication

In Process Data (PDO) communication, a slave exchanges the process data object (PDO) with a master every cycle. The data to be exchanged is pre-determined by PDO Mapping in the communication initialization state. The PDO communication of Ezi-IO EtherCAT DA is classified into a Receive PDO (RxPDO) which receives data from the master and is used when the Ezi-IO EtherCAT DA is in Operational state.

Figure 7-2. EtherCAT PDO Communication

7.2 PDO Mapping

Through the PDO Mapping, sets the application objects to be exchanged through the PDO communication.

7.2.1 PDO Mapping

The mapping information of RxPDO, which receives the master command, is set in Object 1600h. In the mapping table, it records the object IDs, sub-index values and data length (in bit) of exchanging data.

RxPDO Mapping

PDO Map Object		Object Contents		
Index	Sub	Object	Sub	Size
0x1600	1	0x6411	0x01	0x10
0x1600	2	0x6411	0x02	0x10
0x1600	3	0x6411	0x03	0x10
0x1600	4	0x6411	0x04	0x10

Application Object List

Object	Sub	Name
0x6411	0x01	Analogue output CH01
0x6411	0x02	Analogue output CH02
0x6411	0x03	Analogue output CH03
0x6411	0x04	Analogue output CH04
0x0000	0x00	

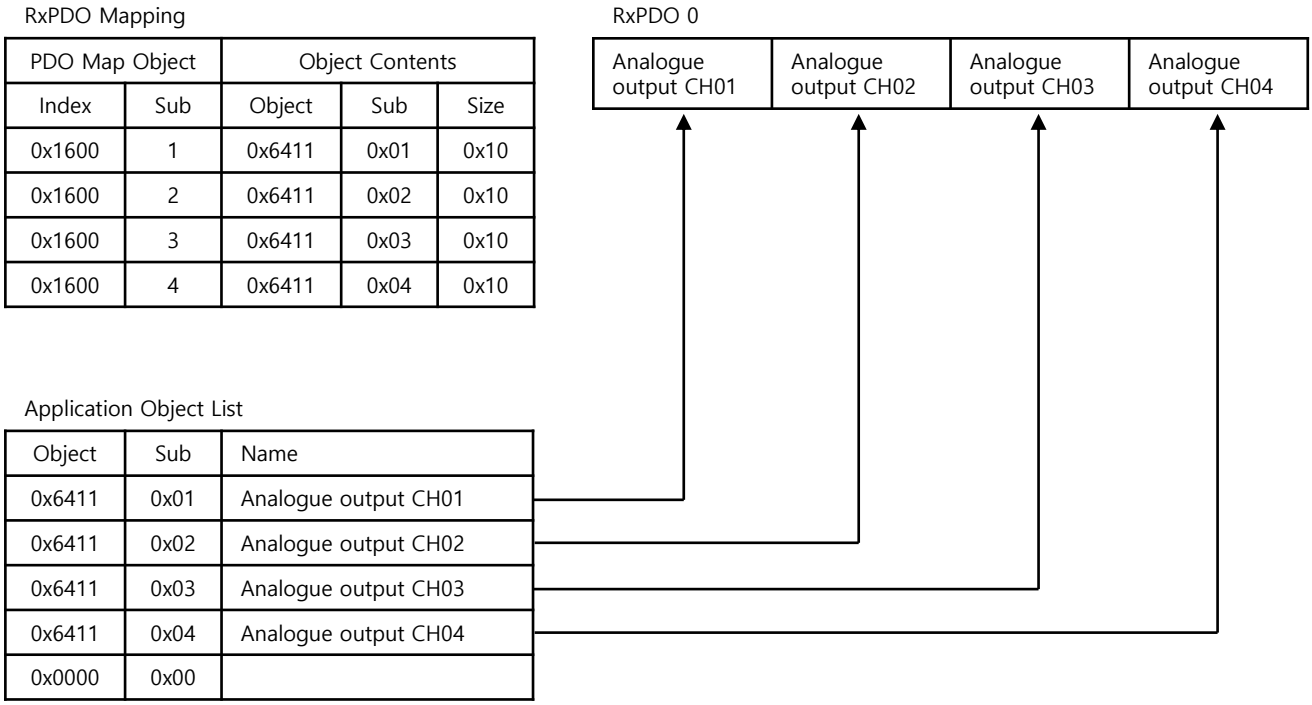


Figure 7-3. PDO Mapping

7.2.2 PDO Assign

By the PDO Assign, sets the PDO Mapping Object which is assigned to the SyncManager.
Object 1C12h assigns RxPDO, and it also assigns an object for the RxPDO Object, 1600h.

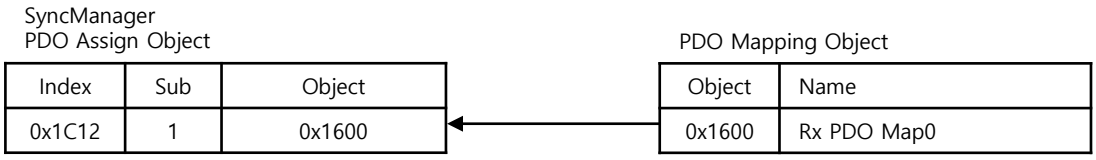


Figure 7-4. PDO Assign

7.3 EtherCAT Communication State

7.3.1 EtherCAT State Machine

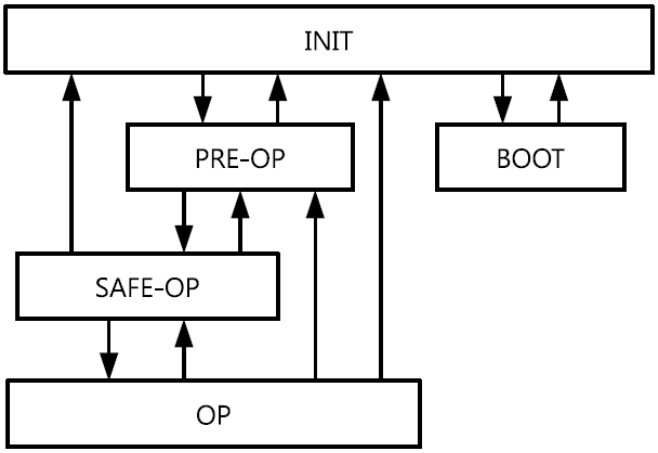


Figure 7-5. EtherCAT State Machine

The operational states of EtherCAT products are controlled by EtherCAT masters.

State	SDO	Rx PDO	Description
INIT	Disabled	Disabled	EtherCAT communication is initialized. Communication is disabled.
PRE-OP	Enabled	Disabled	After the communication initialization is done, this state begins. Communication settings are initialized. Only Mailbox communication is enabled.
SAFE-OP	Enabled	Enabled	Rx PDO communication is enabled.
OP	Enabled	Enabled	All the communications are enabled.
BOOT	Enabled	Disabled	Only Mailbox communication is enabled. FoE is enabled, and the product firmware can be updated via FoE protocol.

Table 7-1. EtherCAT Operational State

* FoE = File over EtherCAT. It is an EtherCAT slave node through which the product firmware can be updated.

7.3.2 EtherCAT Communication State Indication

The RUN LED indicates EtherCAT network state of the product.

LED	Color	Status	Description
RUN	Green	OFF	INIT State or Power OFF
		Blinking	PRE-OPERATIONAL State
		Single Flash	SAFE-OPERATIONAL State
		ON	OPERATIONAL State
		Flickering	BOOTSTRAP State

Table 7-2. EtherCAT Communication State LED

The ERR LED indicates operational errors of the product.

LED	Color	Status	Description
ERR	Red	OFF	No Error or Power OFF
		Blinking	Invalid Configuration
		Single Flash	Local Error
		Double Flash	Watchdog Time Out

Table 7-3. Operational Error LED

Refer to **Figure 7-6** to see the indication pattern of RUN LED and ERR LED.

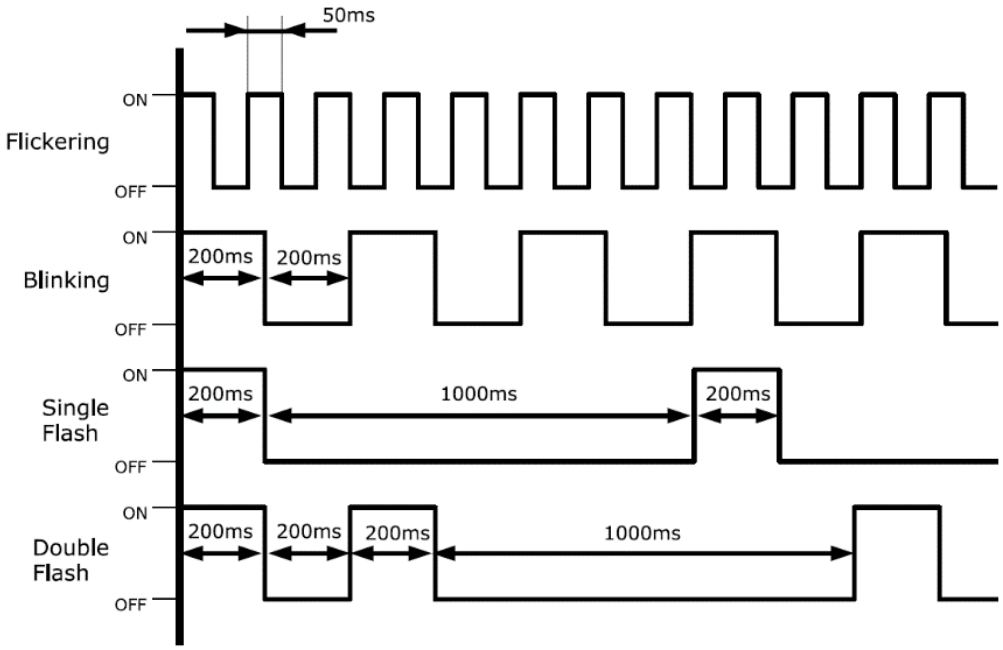


Figure 7-6. EtherCAT LED Indication Pattern

7.4 Synchronization

Ezi-IO EtherCAT DA provides the following synchronization modes.

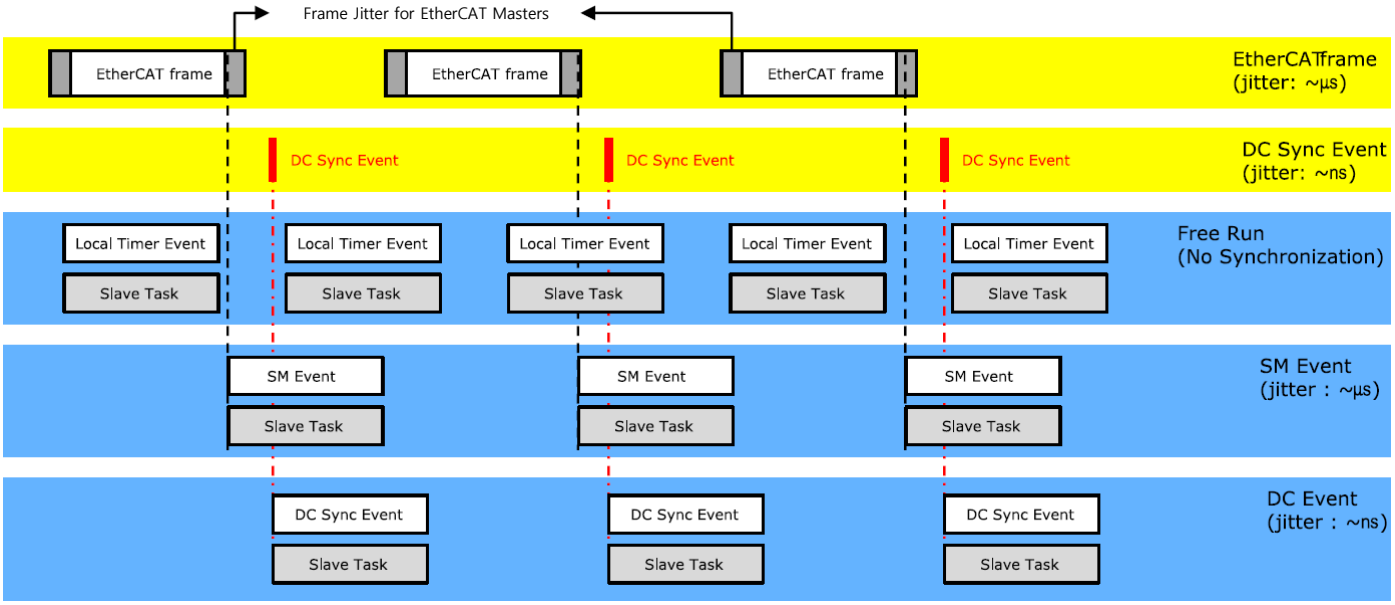


Figure 7-7. Types of EtherCAT Synchronization

7.4.1 Free Run

The I/O module operates without being synchronized with the master. In Free Run mode, the master and I/O module operate in their own cycles independently.

7.4.2 SM Event

The I/O module operates synchronously with the SyncManager (SM) Event of EtherCAT communication.
SM Event occurs when an EtherCAT Frame is received by the module, and each SM Event synchronized module has a range of jitter in μs or less.

7.4.3 DC Sync Event

The I/O module operates synchronously with the Sync-Interrupt generated according to Distributed Clock (DC). DC is a synchronized time clock that is shared by the master and I/O module. Using DC, it generates perfectly synchronized interrupts so that the I/O module executes commands in exact timing. Each product has a range of jitter in ns or less.

7.5 EtherCAT Slave Information

To connect the I/O module to an EtherCAT master, an ESI (EtherCAT Slave Information) file is required. In the file, the information of slave device which is developed based on the EtherCAT specification is included in XML format. The Slave device can set up the PDO and SDO simply as it writes the ESI file to the EtherCAT master through the EtherCAT setting device.

Information
Download ESI files from the DOWNLOADS page on the FASTECH website.

7.6 EtherCAT Device ID

To use the EtherCAT communication, you must configure a master and all slaves. The master must assign the EtherCAT Device IDs to the slaves to identify them and to send messages to each node. The EtherCAT Device ID is either Configured Station Alias or Physical Address. Configured Station Alias is set by rotary switches or the master, and it can be changed flexibly by user. Physical Address is automatically assigned by the master according to the connected order of slaves.

Chapter 8. Setting and Operation

Operate the product according to the following procedure.

1. Install the product according to installation conditions with no power connected. Refer to Chapter 1. Safety and Installation Precautions.
2. Make sure to connect the power cable, I/O connector, EtherCAT communication cable, etc. to the module correctly. Refer to the System Configuration.
3. Turn ON the power of module. Then, check the following.
   - Check the power status LED (PWR) turns Red.
   - After connecting the communication, check EtherCAT Link/Activity LED (LA IN, LA OUT) turns Green.
4. Run the software of EtherCAT Master. (Example of Master Software: Beckhoff TwinCAT)
5. Run the TwinCAT in the following sequence.
   ① Click 'New TwinCAT Project'.
   ② Go to 'New Project'→ 'TwinCAT XAE Project'.
   ③ Select the project name or path, and then click 'OK'.

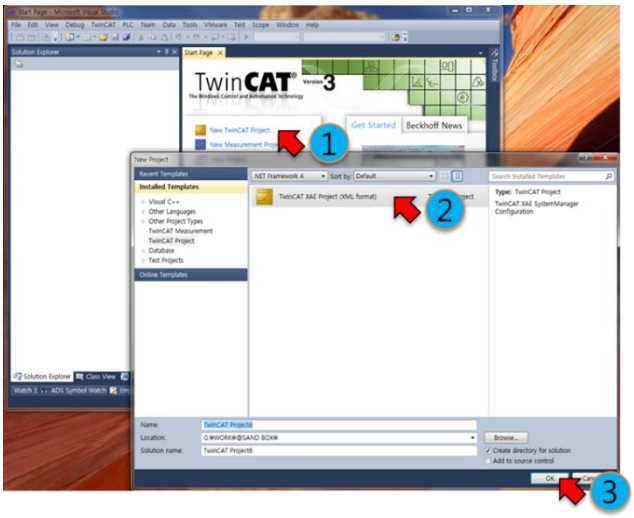


Figure 8-1. Running TwinCAT

6. If TwinCAT is in 'Run Mode', new connection and setting may be disabled. Set TwinCAT to 'Config Mode'.
   -  Stop Mode: Indicated in Red
   -  Config Mode: Indicated in Blue
   -  Run Mode: Indicated in Green (Unable to connect)

7. After creating a project,

① Go to 'Solution Explorer'→ 'I/O'. Right-click on the 'Device', and open the menu.

② Select 'Scan' on the menu.

③ When a 'Hint' pops up, click 'OK'.

④ On the 'new I/O devices founds' window, check correct devices and click 'OK'.

(If no device is found on the 'new I/O devices founds' window, check the power and cable connection for the product and try again.)

⑤ When 'Scan for boxes' pops up, click 'Yes'.

⑥ Make sure a device or box is added under the 'Device'. When 'Activate Free Run' pops up, click 'Yes'.

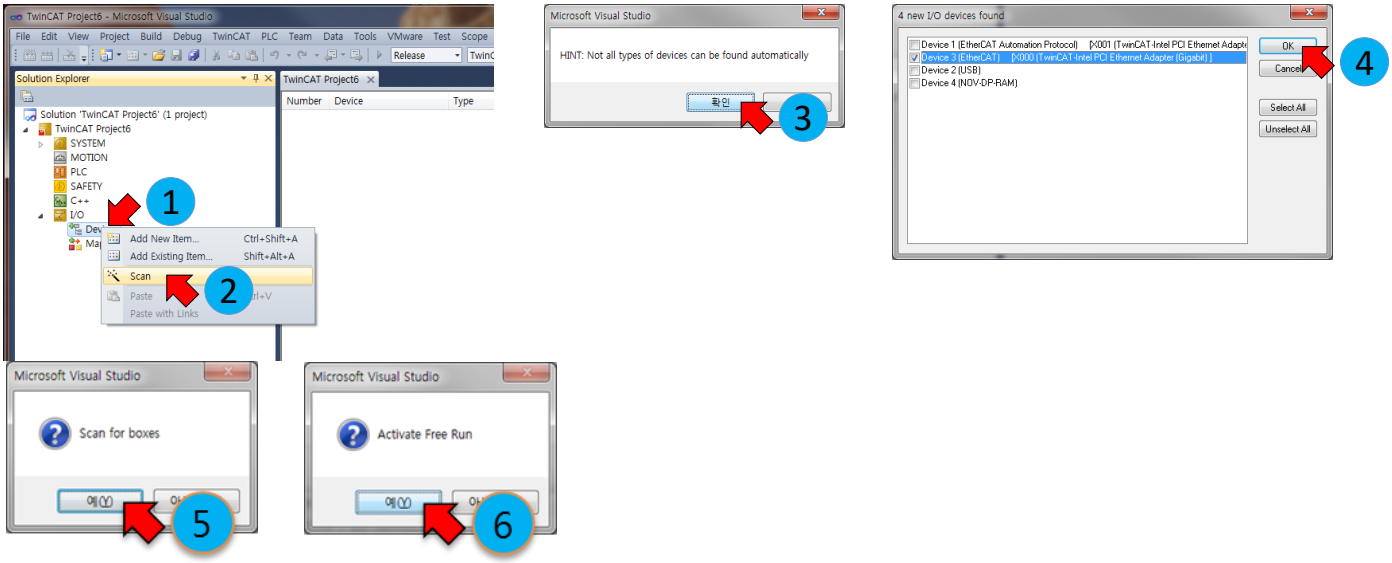


Figure 8-2. Order of Product Scanning

8. Check the followings.

① Check the EtherCAT network is in 'OP' state as shown in **Figure 8-3**.

② Check the EtherCAT Communication State LED (RUN) turns Green.

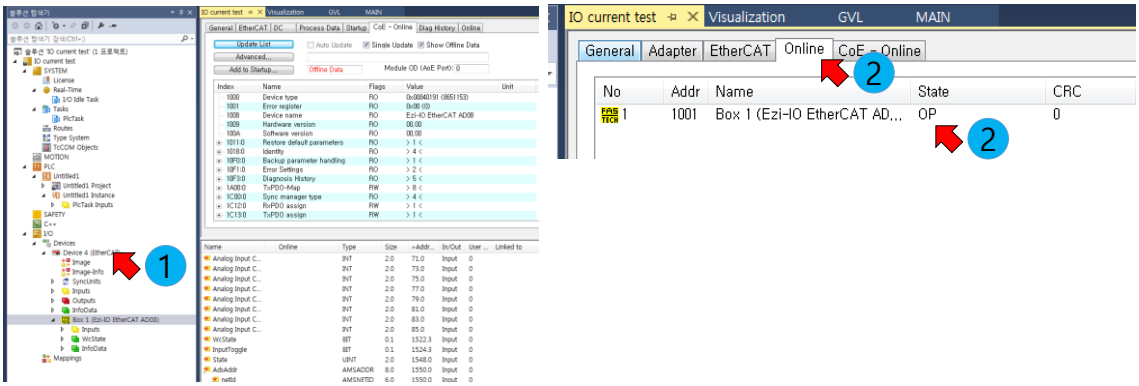


Figure 8-3. Checking EtherCAT Communication State

9. Then, you can configure and control local devices with EtherCAT network by setting and programming in your preferences.

Chapter 9. Functions

9.1 Activating Channels

You can select the channels of Ezi-IO EtherCAT DA to use and activate them.
Deactivated channels ouput 0 [V] through the voltage output pins and 0 [mA] through the current otuput pins.
* Change in the setting for each channel is updated after the reboot.
To activate a channel to use, set the value of Analogue Output Available Channel Choice Object (2300h). Refer to 10.6.1 Object 2300h: Analogue Output Available Channel Choice for detailed information.

9.2 Output Ranges

Ezi-IO EtherCAT DA supports 4 different ranges of voltage output (0~5 [V], 1~5 [V], 0~10 [V], and -10~10 [V]) and two different ranges of current output (0~20 [mA] and 4~20 [mA]). For each output range, you can use max. 5% extended range of output with the user calibration function.
If the digital data is out of range, it is converted to the minimum or maximum analogue signal.
* Change in the setting for each channel is updated after the reboot.

9.2.1 Data Conversions for Output Ranges

9.2.1.1. 0~5 [V] Voltage Output

In the voltage output range, the digital data 0~25,000 is converted to 0~5 [V] output. Actually, the digital data -1,250~26,250 is converted to -0.25~5.25 [V].
If the digital data is greater than 26,250, it outputs 5.25 [V]. Or if the digital data is less than -1,250, it outputs -0.25 [V].
The following formula is used when converting digital data to analogue signals.

$$\text{Analogue Output}[\text{V}] = \frac{5}{25000} \times \text{Digital Data}$$

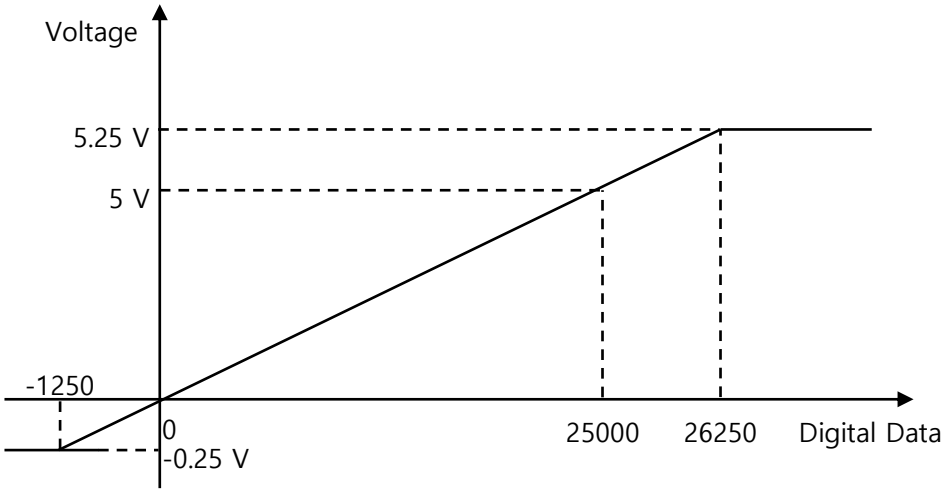


Figure 9-1. Data Conversion for Output Range 0 ~ 5 [V]

9.2.1.2. 1~5 [V] Voltage Output

In the voltage output range, the digital data 0~25,000 is convereted to 1~5 [V] output. Actually, the digital data -1,250~26,250 is converted to 0.8~5.2 [V].

If the digital data is greater than 26,250, it outputs 5.2 [V]. Or if the digital data is less than -1,250, it outputs 0.8 [V].

The following formula is used when converting digital data to analogue signals.

$$\text{Analogue Output}[\text{V}] = \frac{4}{25000} \times \text{Digital Data} + 1$$

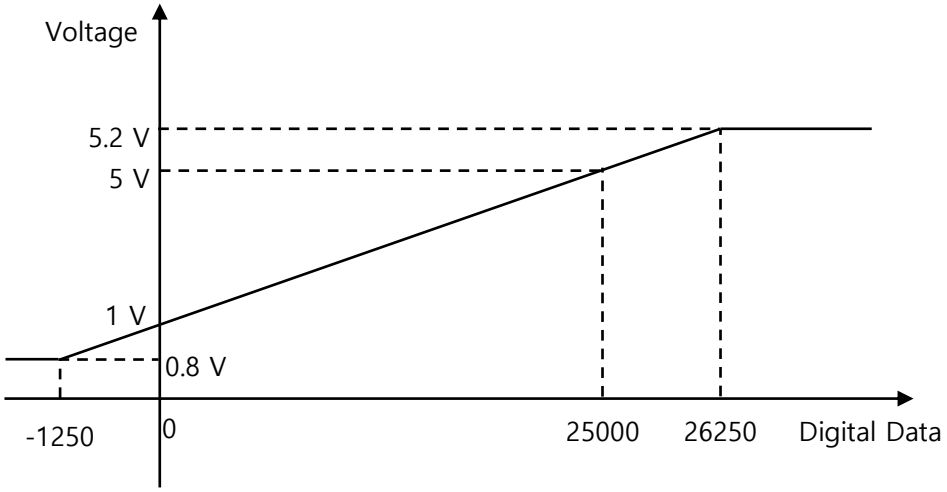


Figure 9-2. Data Conversion for Output Range 1 ~ 5 [V]

9.2.1.3. 0~10 [V] Voltage Output

In the voltage output range, the digital data 0~25,000 is converted to 0~10 [V] output. Actually, the digital data -1,250~26,250 is converted to -0.5~10.5 [V].

If the digital data is greater than 26,250, it outputs 10.5 [V]. Or if the digital data is less than -1,250, it outputs -0.5 [V].

The following formula is used when converting digital data to analogue signals.

$$\text{Analogue Output}[\text{V}] = \frac{10}{25000} \times \text{Digital Data}$$

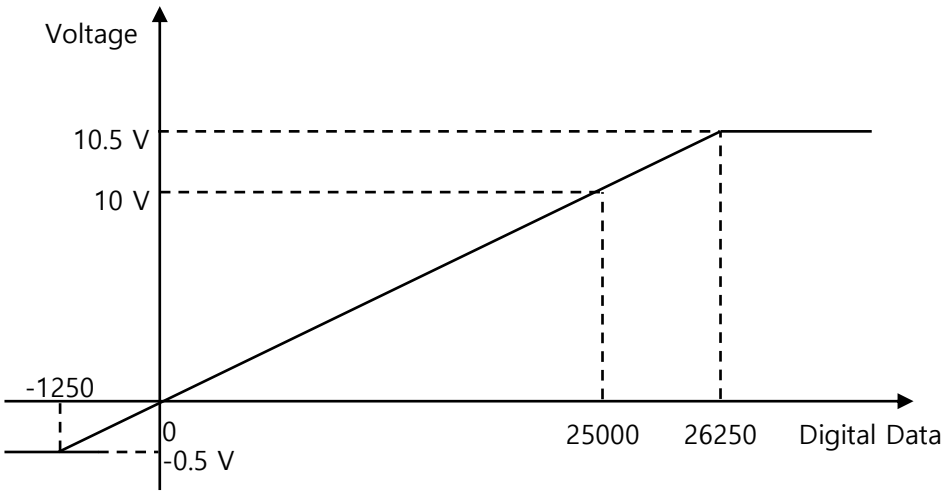


Figure 9-3. Data Conversion for Output Range 0 ~ 10 [V]

9.2.1.4. -10~10 [V] Voltage Output

In the voltage output range, the digital data -25,000~25,000 is converted to -10~10 [V] output. Actually, the digital data -26,250~26,250 is converted to -10.5~10.5 [V].
If the digital data is greater than 26,250, it outputs 10.5 [V]. Or if the digital data is less than -26,250, it outputs -10.5 [V].
The following formula is used when converting digital data to analogue signals.

$$\text{Analogue Output}[\text{V}] = \frac{20}{50000} \times \text{Digital Data}$$

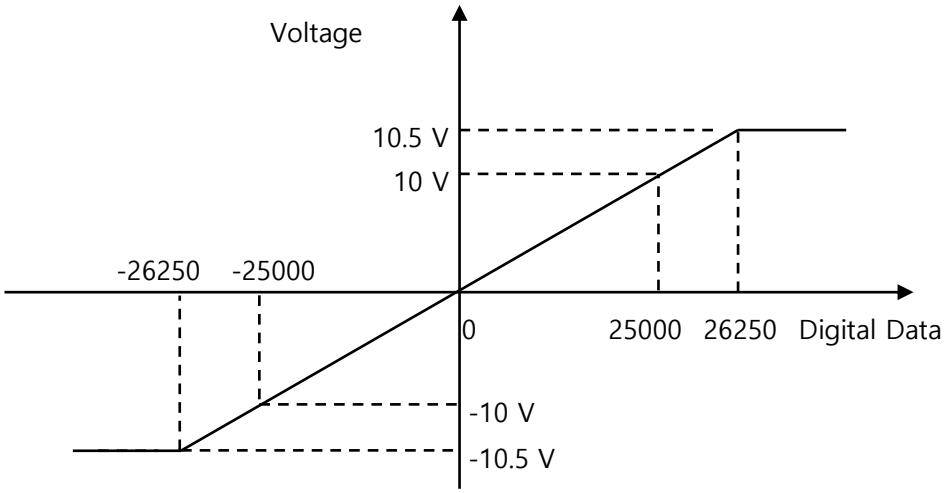


Figure 9-4. Data Conversion for Output Range -10 ~ 10 [V]

9.2.1.5. 0~20 [mA] Current Output

In the voltage output range, the digital data 0~25,000 is converted to 0~20 [mA] output. Actually, the digital data 0~26,250 is converted to 0~21 [mA].
If the digital data is greater than 26,250, it outputs 21 [mA]. Or if the digital data is less than 0, it outputs 0 [mA].
The following formula is used when converting digital data to analogue signals.

$$\text{Analogue Output}[\text{mA}] = \frac{20}{25000} \times \text{Digital Data}$$

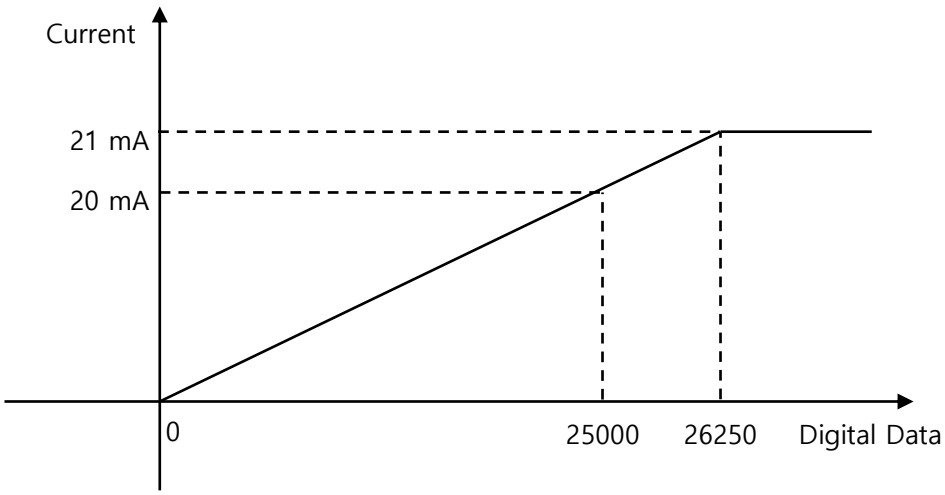


Figure 9-5. Data Conversion for Output Range 0 ~ 20 [mA]

9.2.1.6. 4~20 [mA] Current Output

In the voltage output range, the digital data 0~25,000 is converted to 4~20 [mA] output. Actually, the digital data -1,250~26,250 is converted to 3.2~20.8 [mA].
If the digital data is greater than 26,250, it outputs 20.8 [mA]. Or if the digital data is less than -1,250, it outputs 3.2 [mA].
The following formula is used when converting digital data to analogue signals.

$$\text{Analogue Output[mA]} = \frac{16}{25000} \times \text{Digital Data} + 4$$

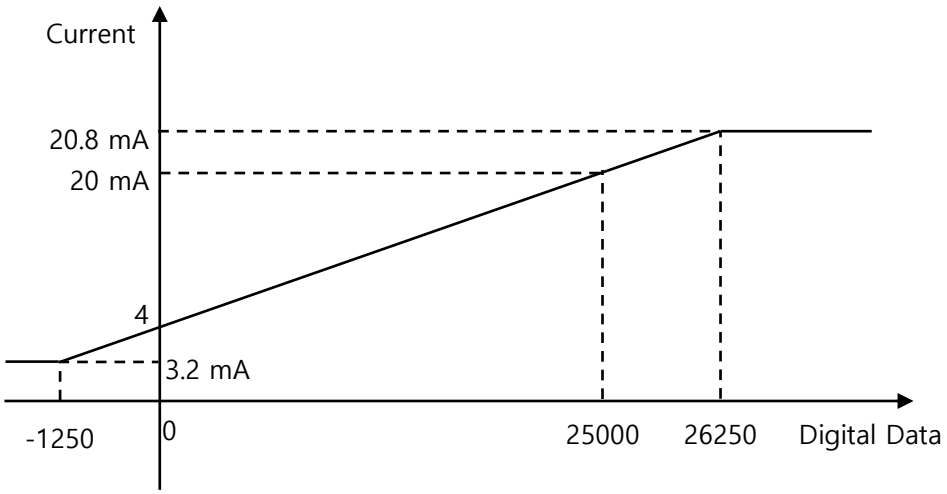


Figure 9-6. Data Conversion for Output Range 4 ~ 20 [mA]

9.2.2 Output Range Setting Methods

9.2.2.1. Setting Output Range through SDO Communication

Set LSET switch (SW3.1) of Output Range Setting Switch (SW3) to set the output range through the SDO communication. Enter the value of the Analogue Output Range Object (2301h) through the Master unit to set the output range. Refer to 10.6.2 Object 2301h: Analogue Output Range for the object values.

9.2.2.2. Setting Current Output Range with DIP Switches

Set LSET switch (SW3.1) of Output Range Setting Switch (SW3) to ON to set the output range with dip switches. Refer to the 4.1.2 Output Range Setting Switch (SW3) for more details.

9.3 Analogue Output Fault Action

9.3.1 Output Patterns When Error Occurs

When an EtherCAT network error occurs, the output value changes according to the following output patterns listed on the **Table 9-1**.

Output Pattern when Error Occurs	Description
Hold Last State	Holds the values of the output voltage or current just before the error occurred.
Low Limit	Outputs the minimum value of voltage or current which the specific channel can output. Refer to the **Table 9-2** for details.
High Limit	Outputs the maximum value of voltage or current which the specific channel can output. Refer to the **Table 9-2** for details.
User Value	Outputs the voltage or current specified by users.
Zero Value	Outputs the voltage or current converted from the digital data value 0 in the specific channel.

Table 9-1. Output Patterns when Error Occurs

The value of output signal on the error is the following.

Output Pattern when Error Occurs	Output Range					
	0~5 V	1~5 [V]	0~10 [V]	-10~10 [V]	0~20 [mA]	4~20 [mA]
Hold Last State	Holds the output values just before the error occurred.					
Low Limit	-0.25 [V]	0.8 [V]	-0.5 [V]	-10.5 [V]	0 [mA]	3.2 [mA]
High Limit	5.25 [V]	5.2 [V]	10.5 [V]	10.5 [V]	21 [mA]	20.8 [mA]
User Value	-0.25~5.25 [V]	0.8~5.2 [V]	-0.5~10.5 [V]	-10.5~10.5 [V]	0~21 [mA]	3.2~20.8 [mA]
Zero Value	0 [V]	1 [V]	0 [V]	0 [V]	0 [mA]	4 [mA]

Table 9-2. Output Values when Error Occurs

9.3.2 Setting Output Patterns for When Error Occurs

The output pattern when error occurs for each channel can be set with Analogue Output Fault Action Object (2304h). Refer to 10.6.5 Object 2304h: Analogue Output Fault Action for more information.
When you select the User Value for the output pattern, user can specify a value for the output voltage or current when an error occurs.

9.4 User Calibration for Output Deviation

Deviation in output signals can be occurred due to the various conditions such as connected devices, cables and connection methods. Users can calibrate the deviation values of output signals.

9.4.1 Terms Used

- Low End and High End: Minimum and maximum values of the selected output range.
- Low Limit and High Limit: Minimum and maximum values of output signal which the specific channel can output in selected output range.
- Low Value and High Value: Digital data when it outputs the Low End and High End values.

(Example) With 0~5 [V] Output Range

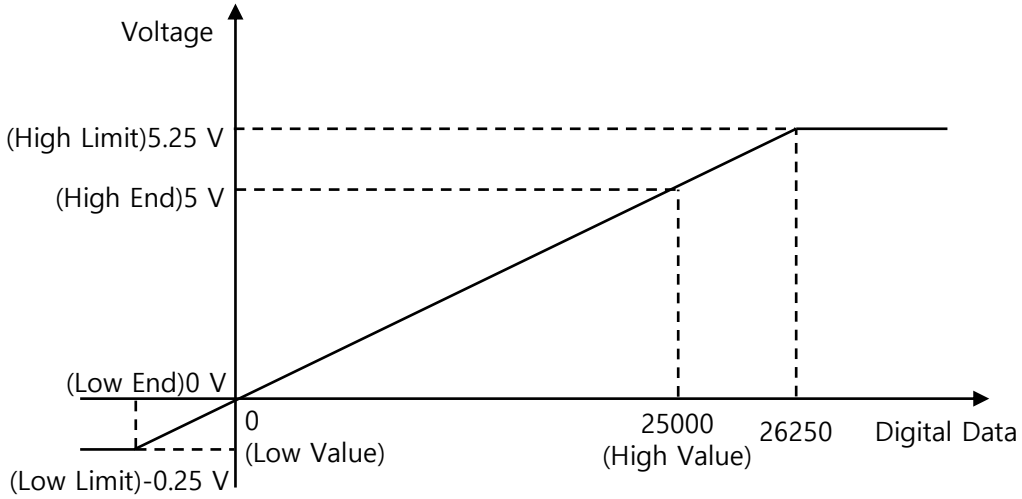


Figure 9-7. Values When Output Range is 0~5 [V]

9.4.2 Example of Using User Calibration

(Example) Output Deviations and User Calibration Function when output range is 0~5 [V]

In the Figure 9-8, it does not output 0~5 [V] exactly for 0~25,000 digital data, and there is output deviations.

Digital Data 0 ⇒ 0.2 [V] Output

Digital Data 25,000 ⇒ 5.2 [V] Output

First, to use the user calibration function, reset the Low Value and High Value for Low End (0 V) and High End (5 V). Refer to the Figure 9-8 for the reset.

For Low End (0 V): Reset the Low Value to -1,000.

For High End (5 V): Reset the Low Value to 24,000.

Then, the reset values are used for the user calibration converting the digital data. Finally, it outputs correct analogue output signals corresponding to the digital data.

Digital Data 0 ⇒ Converted to -1,000 by the user calibration ⇒ 0 [V] Output

Digital Data 10,000 ⇒ Converted to 9,000 by the user calibration ⇒ 2 [V] Output

Digital Data 25,000 ⇒ Converted to 24,000 by the user calibration ⇒ 5 [V] Output

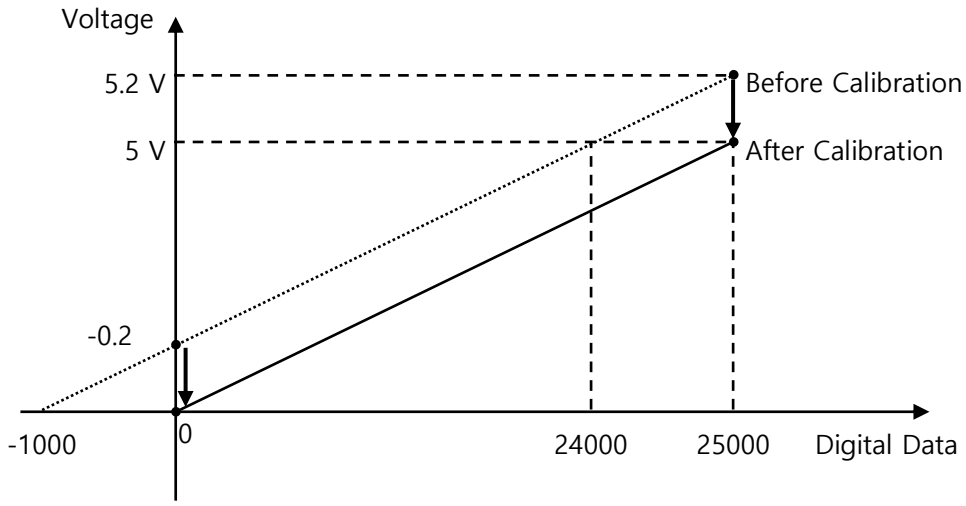


Figure 9-8. Example of User Calibration When Output Range is 0~5 [V]

Low and High Values for each output range are listed in the **Table 9-3**.

Output Range	Low Value	High Value
0~5 [V]	-1,250~1,250	23,750~26,250
1~5 [V]	-1,250~1,250	23,750~26,250
0~10 [V]	-1,250~1,250	23,750~26,250
-10~10 [V]	-26,250~-23,750	23,750~26,250
0~20 [mA]	0~1,250	23,750~26,250
4~20 [mA]	-1,250~1,250	23,750~26,250

Table 9-3. Low and High Values for Each Output Range

9.4.3 User Calibration Method

Perform the user calibration of output deviation according to the following procedure.

1. Set the Low Value and High Value to the default values.
   - Analogue Output Calibration Low Value (2302h): Sets Low Value to the default value
   - Analogue Output Calibration High Value (2302h): Sets High Value to the default value
   - Refer to the following table for the default values of Low Value and High Value for each Output Range.

Output Range	Default Low Value	Default High Value
0~5 [V]	0	25,000
1~5 [V]	0	25,000
0~10 [V]	0	25,000
-10~10 [V]	-25,000	25,000
0~20 [mA]	0	25,000
4~20 [mA]	0	25,000

Table 9-4. Default Low and High Values for Each Output Range

2. Adjust the Write Analogue Output 16bit (6411h) value to output the Low End value. Record the digital data when it reaches the Low End output.

3. Adjust the Write Analogue Output 16bit (6411h) value to output the High End value. Record the digital data when it reaches the High End output.
4. Enter the digital data recorded at Low End output and High End output into the following objects.
   - Analogue Output Calibration Low Value (2302h): Enter the digital data recorded at Low End output.
   - Analogue Output Calibration High Value (2302h): Enter the digital data recorded at High End output.

Chapter 10. EtherCAT Object Dictionary

10.1 Object Description Format

The following table shows the format of the Object description.

Index	Sub Index	Name	Type	Access	SAVE	PDO Mapping	Value Range	Default Value
2301h	0	Number of Entries	U8	RO	No	No	—	4
	1	CH1 Output Range	U8	RW	Yes	No	—	0
	2	CH2 Output Range	U8	RW	Yes	No	—	0
	3	CH3 Output Range	U8	RW	Yes	No	—	0
	4	CH4 Output Range	U8	RW	Yes	No	—	0

The Objects which stores fixed data such as Device Name (1008h) is described in the following format.

Index	Sub Index	Name	Type	Access	Constant Value
1008h	0	Device Name	STR(20)	RO	Ezi-IO EtherCAT DA04

10.1.1 Index and Sub-Index

All the Objects are assigned with Object Index of four-digit hexadecimal numbers.

Index	Area	Description
0000h ~ 0FFFh	Data Type Area	Definitions of data types
1000h ~ 1FFFh	CoE Communication Area	Definitions of variables for dedicated communications used by all servers
2000h ~ 5FFFh	Manufacturer Specified Area	Definitions of variables dedicated for FASTECH modules
6000h ~ 9FFFh	Device Profile Area	Definitions of variables for CiA 401 module profile
A000h ~ FFFFh	Reserved Area	Other variables

Table 10-1. Index of Objects

If an Object is combined with multiple variables, use sub-Index.

Refer to the Sub-Index 0: 'Number of Entries' to set the maximum number of sub-Index.

10.1.2 Name

Name of Object describes the Object.

10.1.3 Data Types

Data types for Objects.

Data Type	Length of Data	Range
U8	1 byte	0 ~ 255
U16	2 bytes	0 ~ 65,535
U32	4 bytes	0 ~ 4,294,967,295
I8	1 byte	-128 ~ 127
I16	2 bytes	-32,768 ~ 32,767
I32	4 bytes	-2,147,483,648 ~ 2,147,483,647
BOOL	1 bit	0 ~ 1
STR(n)	n bytes	n-byte long string

Table 10-2. Data Types

10.1.4 Access

The following table shows access types for each Object.

Access	Description
RO	Read Only / Variables for read-only.
RW	Read/Write / Variables for read or write

Table 10-3. Access Type of Object

10.1.5 SAVE

The Object values are automatically saved in EEPROM.

10.1.6 PDO Mapping

Indicates whether the Object is valid for the PDO communication of EtherCAT or not.

PDO Type	Description
No	The Object is NOT valid for PDO Mapping.
Tx PDO	The Object is valid for Tx PDO Mapping.
Rx PDO	The Object is valid for Rx PDO Mapping.

Table 10-4. PDO Mapping

10.1.7 Constant Value

Constant Value is a fixed value stored in the Object. The value varies depending on the product model and version.

10.1.8 Value Range

Value Range indicates the range of input signal stored in the Object. The range can have a random range or a range of Data Type.

10.1.9 Default Value

Default value of the Object. Default values can be restored using the Restore Default Parameters (1011h).

10.2 Communication Object

10.2.1 Object 1000h: Device Type

Index	Sub Index	Name	Type	Access	Constant Value
1000h	0	Device Type	U32	RO	0088 0191h

This Object includes the data about device type.

Bit	Name	Value	Description
0 ~ 15	Device Profile Number	0191h	CiA 401 Profile
16 ~ 22	I/O Function	04h	Analogue Output
23	M (PDO Applied)	1h	Supported PDO Mapping for each device
24 ~ 31	Special Function	00h	

Table 10-5. Object for Device Type

10.2.2 Object 1001h: Error Register

Index	Sub Index	Name	Type	Access	SAVE	PDO Mapping	Value Range	Default Value
1001h	0	Error Register	U8	RO	No	No	—	00h

This Object indicates types of error that occurred in the product.

Bit	Description
0	General Error
1	Current Error
2	Voltage Error
3	Temperature Error
4	Communication Error
5	Device Profile Error
6	Reserved
7	Manufacturer Specified Error

Table 10-6. Object for Errors

When an error occurs, the corresponding bit is set from 0 to 1.

10.2.3 Object 1008h: Device Name

Index	Sub Index	Name	Type	Access	Constant Value
1008h	0	Device Name	STR(20)	RO	Ezi-IO EtherCAT DA04

This Object indicates the device name.

10.2.4 Object 1009h: Hardware Version

Index	Sub Index	Name	Type	Access	Constant Value
1009h	0	Hardware Version	STR(5)	RO	01.00

This Object indicates the hardware version of the product. The data varies depending on the product version.

10.2.5 Object 100Ah: Software Version

Index	Sub Index	Name	Type	Access	Constant Value
100Ah	0	Software Version	STR(5)	RO	01.00

This Object indicates the software version. The data varies depending on the product version.

10.2.6 Object 1011h: Restore Default Parameters

Index	Sub Index	Name	Type	Access	SAVE	PDO Mapping	Value Range	Default Value
1011h	0	Number of Entries	U8	RO	No	No	—	1
	1	Restore Default Parameters	U32	RW	No	No	—	

It commands that the Object values saved in EEPROM are restored with default values.
To reset the Objects with the factory default values, enter '64616F6Ch' to the Sub-Index 01h.

	MSB			LSB
ASCII	'd'	'a'	'o'	'l'
Hex	64h	61h	6Fh	6Ch

Table 10-7. Restore Parameters

Information
Object values are reset to default values when the product is restarted.

10.2.7 Object 1018h: Identity

Index	Sub Index	Name	Type	Access	Constant Value
1018h	0	Number of Entries	U8	RO	4
	1	Vendor ID	U32	RO	0FA0 0000h
	2	Product Code	U32	RO	0000 2203h
	3	Revision Number	U32	RO	0001 0000h
	4	Serial Number	U32	RO	0000 0000h

This Object indicates the device information.

* Each data for the Identity varies depending on the product version.

10.2.8 Object 10F1h: Error Setting

Index	Sub Index	Name	Type	Access	SAVE	PDO Mapping	Value Range	Default Value
10F1h	0	Number of Entries	U8	RO	No	No	—	2
	1	Local Error Reaction	U32	RO	No	No	—	0000 0000h
	2	Sync Error Counter Limit	U32	RW	No	No	—	0000 000Ch

10.3 PDO Mapping Object

10.3.1 Object 1600h: RxPDO-Map

Index	Sub Index	Name	Type	Access	SAVE	PDO Mapping	Value Range	Default Value
1600h	0	Number of Entries	U8	RO	No	No	0 ~ 10	4
	1	1st PDO Object	U32	RW	Yes	No	—	6411 0110h
	2	2nd PDO Object	U32	RW	Yes	No	—	6411 0210h
	3	3rd PDO Object	U32	RW	Yes	No	—	6411 0310h
	4	4th PDO Object	U32	RW	Yes	No	—	6411 0410h
	5	5th PDO Object	U32	RW	Yes	No	—	0000 0000h
	6	6th PDO Object	U32	RW	Yes	No	—	0000 0000h
	7	7th PDO Object	U32	RW	Yes	No	—	0000 0000h
	8	8th PDO Object	U32	RW	Yes	No	—	0000 0000h
	9	9th PDO Object	U32	RW	Yes	No	—	0000 0000h

This Object indicates the RxPDO-Map setting.

Write Analogue Output 16bit (6411h) Object is mapped.

RxPDO-Map is NOT editable.

10.3.2 Object 1C12h: RxPDO Assign

Index	Sub Index	Name	Type	Access	SAVE	PDO Mapping	Value Range	Default Value
1C12h	0	Number of Entries	U8	RO	No	No	—	1
	1	RxPDO Assign	U16	RW	No	No	—	1600h

10.3.3 Object 1C13h: TxPDO Assign

Index	Sub Index	Name	Type	Access	SAVE	PDO Mapping	Value Range	Default Value
1C13h	0	Number of Entries	U8	RO	No	No	—	1
	1	TxPDO Assign	U16	RW	No	No	—	0000h

10.4 Sync Manager Object

10.4.1 Object 1C00h: Sync Manager Type

Index	Sub Index	Name	Type	Access	SAVE	PDO Mapping	Value Range	Default Value
1C00h	0	Number of Entries	U8	RO	No	No	—	4
	1	SM0	U8	RO	No	No	—	01h
	2	SM1	U8	RO	No	No	—	02h
	3	SM2	U8	RO	No	No	—	03h
	4	SM3	U8	RO	No	No	—	04h

Sync Manager Type	Description
1	Mailbox Out
2	Mailbox In
3	PDO Output
4	PDO Input

Table 10-8. Sync Manager Type Value

10.4.2 Object 1C32h: SM Output Parameter

Index	Sub Index	Name	Type	Access	SAVE	PDO Mapping	Value Range	Default Value
1C32h	0	Number of Entries	U8	RO	No	No	—	32
	1	Synchronization Type	U16	RW	No	No	—	0002h
	2	Cycle Time	U32	RO	No	No	—	0000 0000h
	4	Synchronization Type Supported	U16	RO	No	No	—	401Fh
	5	Minimum Cycle Time	U32	RO	No	No	—	0003 D090h
	6	Calc And Copy Time	U32	RO	No	No	—	0000 2710h
	8	Get Cycle Time	U16	RW	No	No	—	0000h
	9	Delay Time	U32	RO	No	No	—	0000 0000h
	10	Sync0 Cycle Time	U32	RW	No	No	—	0000 0000h
	11	SM-Event Missed	U16	RO	No	No	—	0000h
	12	Cycle Time Too Small	U16	RO	No	No	—	0000h
	32	Sync Error	BOOL	RO	No	No	—	0000h

10.4.3 Object 1C33h: SM Input Parameter

Index	Sub Index	Name	Type	Access	SAVE	PDO Mapping	Value Range	Default Value
1C33h	0	Number of Entries	U8	RO	No	No	—	32
	1	Synchronization Type	U16	RW	No	No	—	0002h
	2	Cycle Time	U32	RO	No	No	—	0000 0000h
	4	Synchronization Type Supported	U16	RO	No	No	—	401Fh
	5	Minimum Cycle Time	U32	RO	No	No	—	0003 D090h
	6	Calc And Copy Time	U32	RO	No	No	—	0000 2710h
	8	Get Cycle Time	U16	RW	No	No	—	0000h
	9	Delay Time	U32	RO	No	No	—	0000 0000h
	10	Sync0 Cycle Time	U32	RW	No	No	—	0000 0000h
	11	SM-Event Missed	U16	RO	No	No	—	0000h
	12	Cycle Time Too Small	U16	RO	No	No	—	0000h
	32	Sync Error	BOOL	RO	No	No	—	0000h

10.5 IO Module Profile Object

10.5.1 Object 6411h: Write Analogue Output 16 bit

Index	Sub Index	Name	Type	Access	SAVE	PDO Mapping	Value Range	Default Value
6411h	0	Number of Entries	U8	RO	No	No	—	4
	1	Analogue Output CH1	I16	RW	No	Rx PDO	-32,768~32,767	0
	2	Analogue Output CH2	I16	RW	No	Rx PDO	-32,768~32,767	0
	3	Analogue Output CH3	I16	RW	No	Rx PDO	-32,768~32,767	0
	4	Analogue Output CH4	I16	RW	No	Rx PDO	-32,768~32,767	0

This Object receives digital data from the master.

10.6 Manufacturer Specific Object

10.6.1 Object 2300h: Analogue Output Available Channel Choice

Index	Sub Index	Name	Type	Access	SAVE	PDO Mapping	Value Range	Default Value
2300h	0	Analogue Output Available Channel Choice	U8	RW	Yes	No	—	0

This Object can activate the DA channels.

Each bit of the object has the following functions.

Bit	Description
0	1: Activate CH1 / 0: Deactivate CH1
1	1: Activate CH2 / 0: Deactivate CH2
2	1: Activate CH3 / 0: Deactivate CH3
3	1: Activate CH4 / 0: Deactivate CH4
4~255	Reserved

Table 10-9. Analogue Output Available Channel Choice

10.6.2 Object 2301h: Analogue Output Range

Index	Sub Index	Name	Type	Access	SAVE	PDO Mapping	Value Range	Default Value
2301h	0	Number of Entries	U8	RO	No	No	—	4
	1	CH1 Output Range	U8	RW	Yes	No	—	0
	2	CH2 Output Range	U8	RW	Yes	No	—	0
	3	CH3 Output Range	U8	RW	Yes	No	—	0
	4	CH4 Output Range	U8	RW	Yes	No	—	0

This Object sets the output range of each channel.

Output range is selected according to the following values.

Value	Output Range
0	0~5 [V]
1	1~5 [V]
2	0~10 [V]
3	-10~10 [V]
4~15	Reserved
16	0~20 [mA]
17	4~20 [mA]
18~255	Reserved

Table 10-10. Analogue Output Ranges

10.6.3 Object 2302h: Analogue Output Calibration Low Value

Index	Sub Index	Name	Type	Access	SAVE	PDO Mapping	Value Range	Default Value
2302h	0	Number of Entries	U8	RO	No	No	-	4
	1	CH1 Calibration Low Value	I16	RW	Yes	No	-	0
	2	CH2 Calibration Low Value	I16	RW	Yes	No	-	0
	3	CH3 Calibration Low Value	I16	RW	Yes	No	-	0
	4	CH4 Calibration Low Value	I16	RW	Yes	No	-	0

When the user calibration function is used, this Object re-defines the digital data for the Low End output in the selected output range.

10.6.4 Object 2303h: Analogue Output Calibration High Value

Index	Sub Index	Name	Type	Access	SAVE	PDO Mapping	Value Range	Default Value
2303h	0	Number of Entries	U8	RO	No	No	-	4
	1	CH1 Calibration High Value	I16	RW	Yes	No	-	0
	2	CH2 Calibration High Value	I16	RW	Yes	No	-	0
	3	CH3 Calibration High Value	I16	RW	Yes	No	-	0
	4	CH4 Calibration High Value	I16	RW	Yes	No	-	0

When the user calibration function is used, this Object re-defines the digital data for the High End output in the selected output range.

10.6.5 Object 2304h: Analogue Output Fault Action

Index	Sub Index	Name	Type	Access	SAVE	PDO Mapping	Value Range	Default Value
2304h	0	Number of Entries	U8	RO	No	No	-	4
	1	CH1 Fault Action Mode	U8	RW	Yes	No	0~4	0
	2	CH2 Fault Action Mode	U8	RW	Yes	No	0~4	0
	3	CH3 Fault Action Mode	U8	RW	Yes	No	0~4	0
	4	CH4 Fault Action Mode	U8	RW	Yes	No	0~4	0

This Object sets the output for when a communication error occurs.

Value	Output Range
0	Hold Last Value
1	Low Limit
2	High Limit
3	User Value
4	Zero Value
5~255	Reserved

Table 10-11. Analogue Output Fault Action

10.6.6 Object 2305h: Analogue Output Fault Value

Index	Sub Index	Name	Type	Access	SAVE	PDO Mapping	Value Range	Default Value
2305h	0	Number of Entries	U8	RO	No	No	-	4
	1	CH1 Fault Value	I16	RW	Yes	No	-32,768~32,767	0
	2	CH2 Fault Value	I16	RW	Yes	No	-32,768~32,767	0
	3	CH3 Fault Value	I16	RW	Yes	No	-32,768~32,767	0
	4	CH4 Fault Value	I16	RW	Yes	No	-32,768~32,767	0

When the User Value mode is selected for the Analogue Output Fault Action, this Object sets the value of voltage or current for the output when error occurs.

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