ICOP Technology Inc.

User Manual

QEC-RXXDT0/D0T

EtherCAT Slave Digital I/O Module

With 32-ch Digital Input/Output

(Revision 2)

REVISION

DATE	VERSION	DESCRIPTION
2023/11/30	**Version1.0**	**New Release.**
2024/01/11	**Version2.0**	**Update Specification.**

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Ver.2 January, 2024

TRADEMARKS ACKNOWLEDGMENT

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- Japan: www.icop.co.jp
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For technical support or drivers download, please visit our websites at:

- https://www.icop.com.tw/resource_entrance

For EtherCAT solution service, support or tutorials, 86Duino Coding IDE 500+ introduction, functions, languages, libraries, etc. Please visit the QEC website:

- QEC: https://www.qec.tw/

This Manual is for the QEC series.

SAFETY INFORMATION

- Read these safety instructions carefully.
- Please carry the unit with both hands and handle it with caution.
- Power Input voltage +19 to +50VDC Power Input (Typ. +24VDC)
- Make sure the voltage of the power source is appropriate before connecting the equipment to the power outlet.
- To prevent the QEC device from shock or fire hazards, please keep it dry and away from water and humidity.
- Operating temperature between -20 to +70°C/-40 to +85°C (Option).
- When using external storage as the main operating system storage, ensure the device's power is off before connecting and removing it.
- Never touch un-insulated terminals or wire unless your power adaptor is disconnected.
- Locate your QEC device as close as possible to the socket outline for easy access and avoid force caused by the entangling of your arms with surrounding cables from the QEC device.
- If your QEC device will not be used for a period of time, make sure it is disconnected from the power source to avoid transient overvoltage damage.

WARNING!

DO NOT ATTEMPT TO OPEN OR TO DISASSEMBLE THE CHASSIS (ENCASING) OF THIS PRODUCT. PLEASE CONTACT YOUR DEALER FOR SERVICING FROM QUALIFIED TECHNICIAN.

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Ch. 1

General Information

1.1 Introduction

1.2 Specifications

1.3 Dimension

1.4 Mounting Instruction

1.5 Ordering Information

1.1 Introduction

ICOP's QEC-RXXDT0 and QEC-RXXD0T are standard industrial EtherCAT slave digital I/O modules that support 32 channels, which are optional for digital input and output channels. Complying with the EtherCAT Conformance Test Tool (ET9400), the QEC-RXXD_T is qualified and can cooperate with the EtherCAT master systems for quick implementation in industrial applications.

Capable of up to 100 µs EtherCAT cycle time, as well as the Distributed Clock (DC) mode, QEC-RXXD is aimed at high precision and synchronous applications requirements. Designed with up-to-date silicon components, it also reduces heat generation. It extends product life while providing automatic internal status monitoring, including voltage, current, and operating temperature and time, to help provide effective carbon footprint tracking.

The digital input of the QEC-RXXDT0 is equipped with various optional features, including polarity-separated digital input channel pins, input wire break detection lines, and up to 2500Vrms ESD isolation protection. And, the digital output of the QEC-RXXD0T has up to 3750Vrms of ESD isolation protection and can drive up to 56Vdc@20mA.

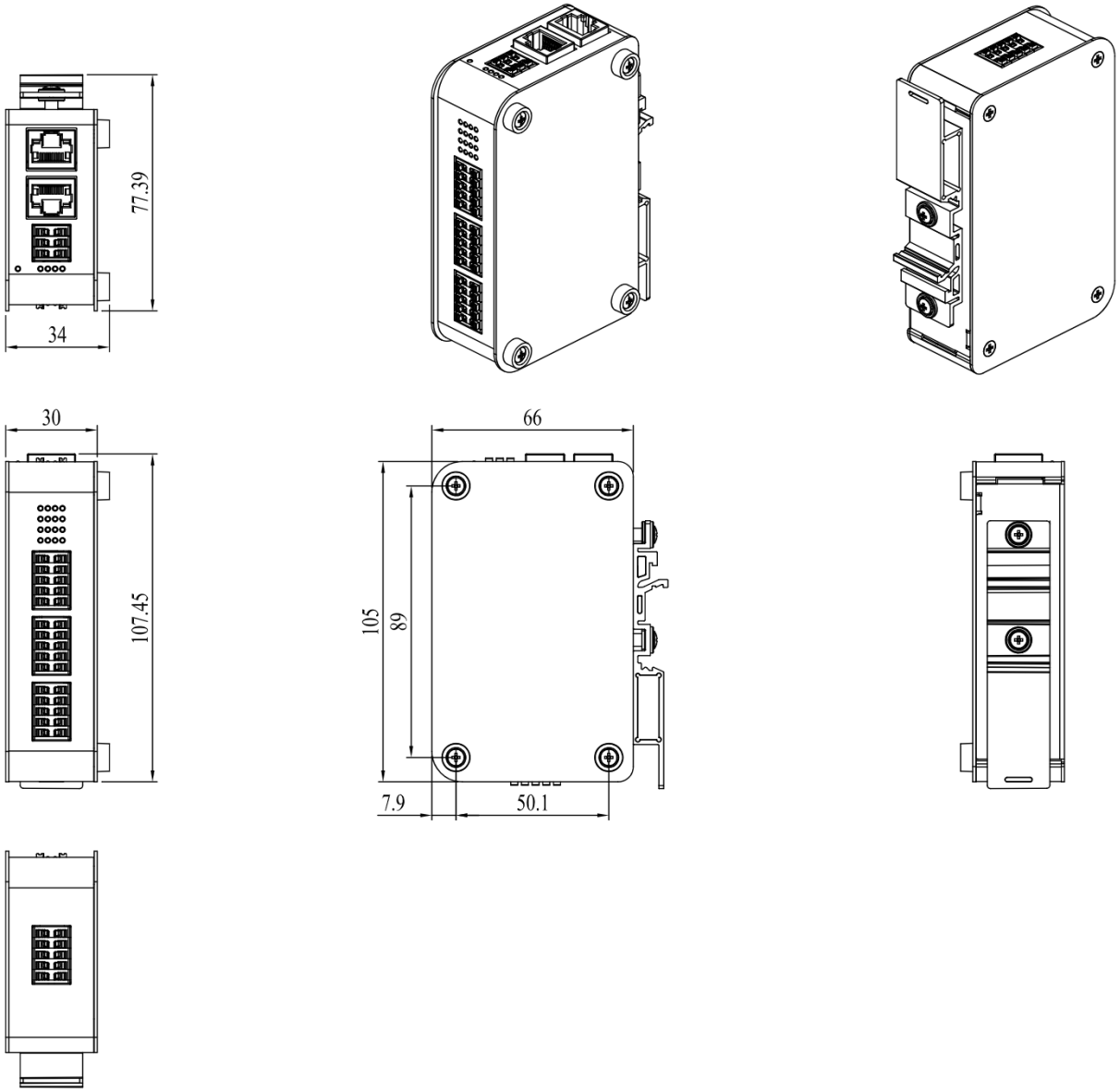
QEC-RXXD series offers users an easy way to update the firmware via FOE and features two networks available for EtherCAT Cable Redundancy. The module status can be indicated by LEDs for troubleshooting and verifying I/O status. It also provides flexible installation and efficient I/O channel configurations for connectivity, reducing infrastructure and operating costs, and can be deployed in network topologies such as star, line, or ring.

QEC-RXXD measures 107.45 x 77.4 x 30 mm and supports standard system operating temperatures from -20 to +70°C and optional -40 to +85°C. It can be easily installed by Din Rail mounting kit and features the European-style terminal block, providing easy installation and removable wiring terminals for easy deployment.

1.2 Specifications

Model Name	QEC-RXXDT0H	QEC-RXXD0TH	QEC-RXXDT0L	QEC-RXXD0TL
Digital Type	Input	Output	Input	Output
I/O Type	Sink			
Channel	32			
I/O Frequency	8KHz	8KHz	-	-
Propagation delay time	150 ns	50 µs	150 ns	50 µs
Mailbox Service	Yes	Yes	No	No
Distributed clocks	Yes	Yes	No	No
Digital Input				
Load Voltage	Max. 56VDC	-	Max. 56VDC	-
Digital Output				
MOSFET	-	MOSFET	-	MOSFET
Load Voltage	-	Max. 56VDC	-	Max. 56VDC
Load Current	-	1A	-	1A
General				
Connector	32-channel Push-in Terminal (Euroblock)			
Connector Color	Positive: Red Negative: Black	Positive: Orange Negative: Black	Positive: Red Negative: Black	Positive: Orange Negative: Black
Protocol	EtherCAT (RJ-45 x 2)			
Ethernet Standard	IEEE 802.3			
Transmission Rate	100Mbps			
Power Connector	4-pin Power Input/Output & 2-pin FGND			
Power Requirement	+19 to +50VDC Power Input (Typ. +24VDC@100-140mA)			
Power Consumption	3W	3W	2.4W	2.4W
LED Indicator	PWR, RUN, LINK, ERROR, DI/O status			
Certifications	CE, FCC, VCCI			
Environment				
Isolation Protection, Optocoupler	2500 Vrms	3750 Vrms	2500 Vrms	3750 Vrms
Operating Temperature	-20 to +70 °C			
Hardware				
Dimension	107.45 x 66 x 34mm (Without DIN-Rail)			
Weight	245 g	265 g	245 g	265 g
Installation	DIN rail			
Internal Monitoring	Yes	Yes	No	No

1.3 Dimension

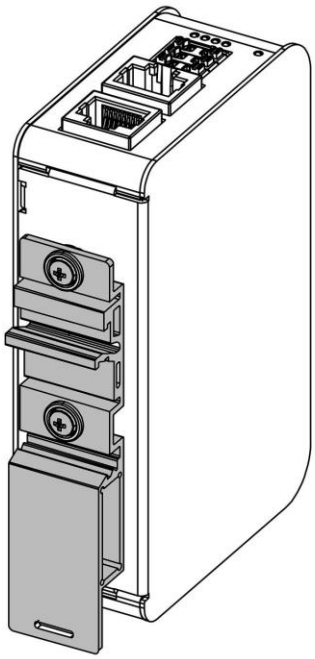


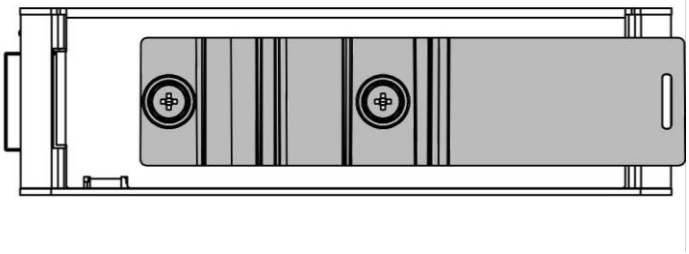
(Unit: mm)

1.4 Mounting Instruction

QEC-RXXDT0 and QEC-RXXD0T are easy-install design to help you set-up your modules easily. Please refer to Ch.3.1 DIN-Rail installation.

- **DIN-Rill**





1.5 Ordering Information

Type	RJ45 power source		Functions			Feature	–	Coating
	Input	Output	Digital	Input	Output	Digital Type		
QEC-R	X	X	D	X	X	X		X

1. Type: Code 1~4

R: EtherCAT Slave.

2. RJ45 Power source: Code 5~6

0: RJ45 In/Out w/o power

1: RJ45 PoE Device, Red Plastic Housing

3. Functions: Code 7~9

D: Digital I/O

X: T (32) input channels

X: T (32) output channels

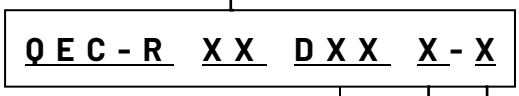
4. Feature: Code 11

H: High-speed Digital Frequency

L: Unsupported Mailbox Service)

5. Coating: Code 13

C: Yes / N: Normal



1.5.1 Reference Ordering Part Number:

Above is the standard Part Number, please contact our sales if you need to order other part number.

- **QEC-R00DT0H-N**: EtherCAT Slave High-speed Digital Input 32 channels modules.
- **QEC-R11DT0L-N**: EtherCAT Slave Digital Input 32 channels modules/PoE.
- **QEC-R00D0TH-N**: EtherCAT Slave High-speed Digital Output 32 channels modules.
- **QEC-R11D0TL-C**: EtherCAT Slave Digital Output 32 channels modules (board with coating).

Ch. 2

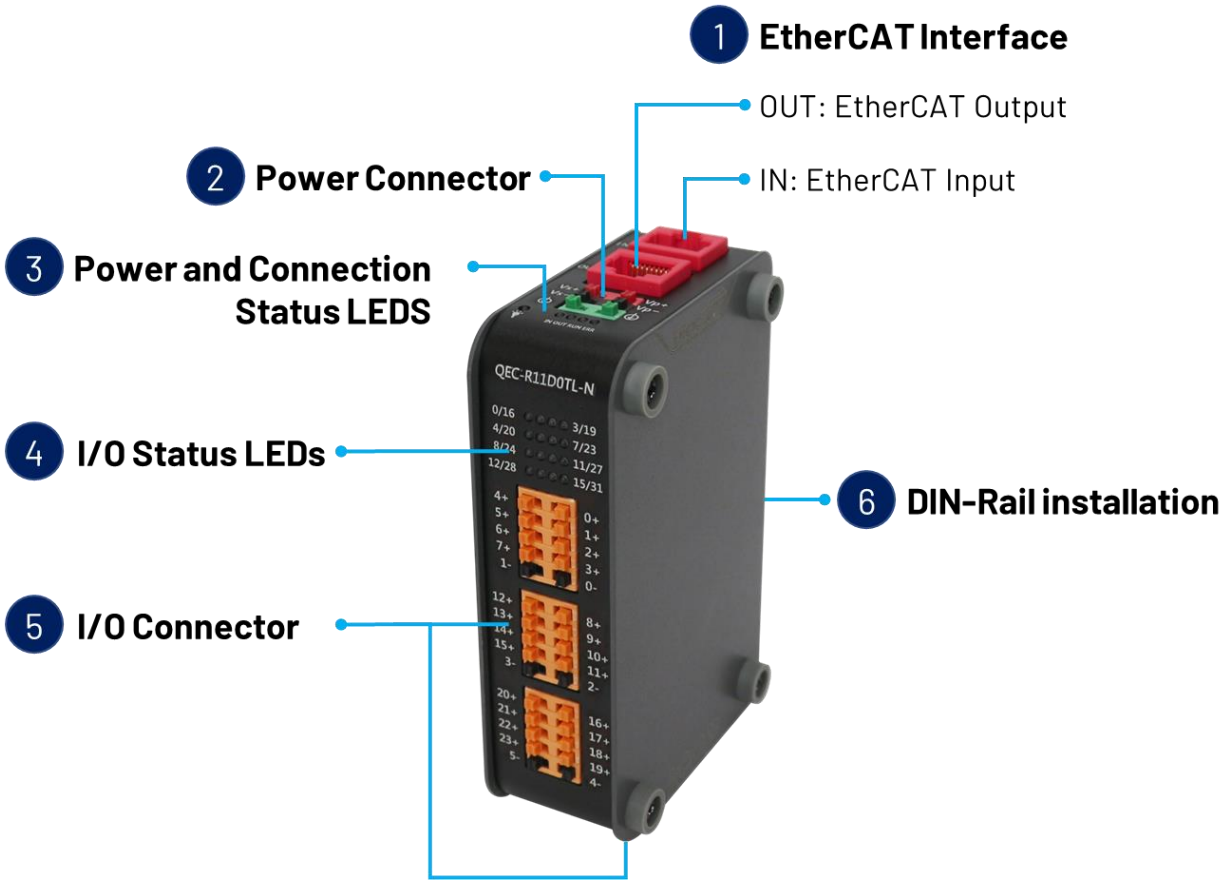
Hardware System

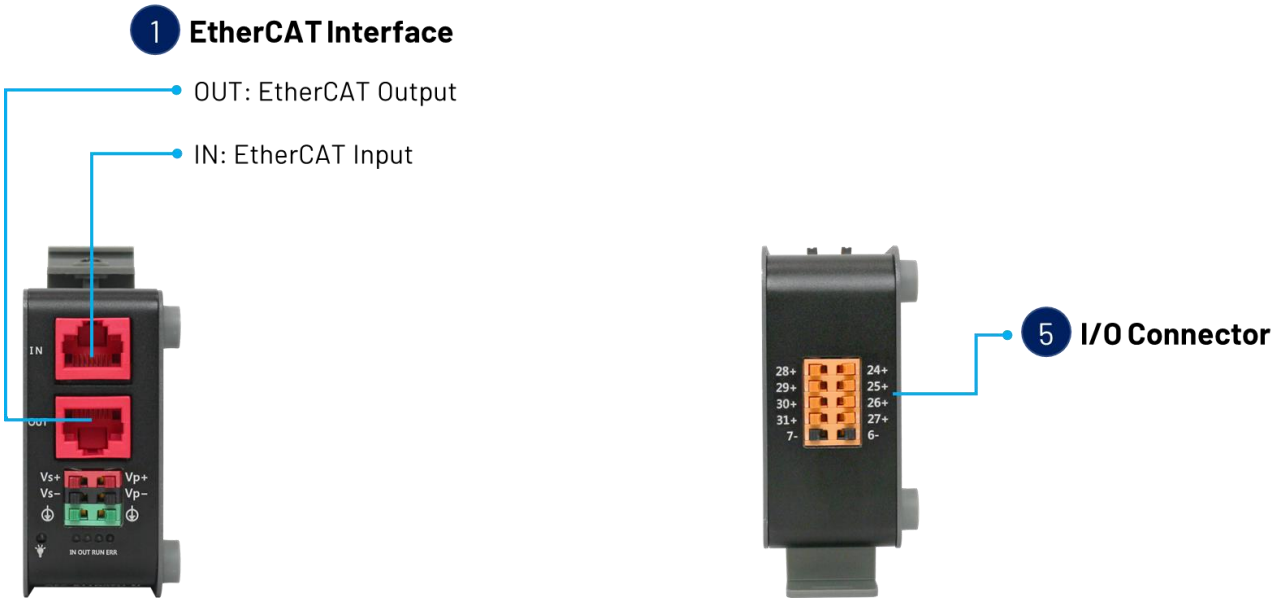
2.1 General Technical Data

2.2 Connector Summary

2.3 Wiring to the Connector

2.1 General Technical Data



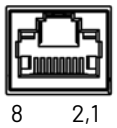


2.2 Connector Summary

No.	Description		Type Narrative	Pin #
1	EtherCAT Interface	OUT	External RJ45 Connector	8-pin
		IN	(Gold finger)	8-pin
2	Power Connector		Terminal Block Interface	6-pin
3	Power and Connection Status LEDs		External Status LEDs	-
4	I/O Status LEDs		External Status LEDs	-
5	I/O Connector		32-ch Push-in Terminal (Euroblock)	40-pin
6	DIN-Rail		-	-

2.2.1 EtherCAT Interface

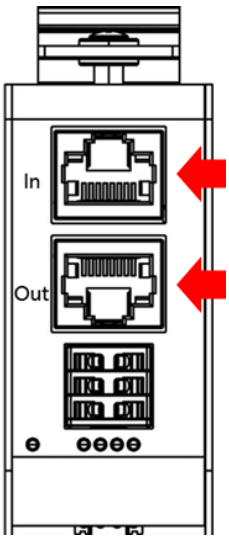
EC IN



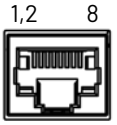
Pin #	Signal Name	Pin #	Signal Name
1	LAN1_TX+	2	LAN1_TX-
3	LAN1_RX+	4	VS+
5	VP+	6	LAN1_RX-
7	VS-(GND)	8	VP-(GND)

* PoE LAN with the Red Housing; Regular LAN with Black Housing.

* L4, L5, L7, L8 pins are option, for RJ45 Power IN/OUT.



EC OUT

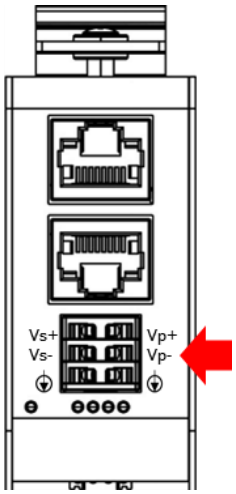


Pin #	Signal Name	Pin #	Signal Name
1	LAN2_TX+	2	LAN2_TX-
3	LAN2_RX+	4	VS+
5	VP+	6	LAN2_RX-
7	VS-(GND)	8	VP-(GND)

* PoE LAN with the Red Housing; Regular LAN with Black Housing.

* L4, L5, L7, L8 pins are option, for RJ45 Power IN/OUT.

2.2.2 Power Connector



Vs for system power; Vp for peripheral power and backup power.

Pin #	Signal Name	Pin #	Signal Name
1	Vs+	2	Vp+
3	Vs-(GND)	4	Vp-(GND)
5	F.G	6	F.G

* Power Input voltage +19 to +50VDC Power Input (Typ. +24VDC)

2.2.3 Power and Connection Status LEDs

Power Status LED

Power input is 24V (typical). The LED status provide high/low voltage warning.

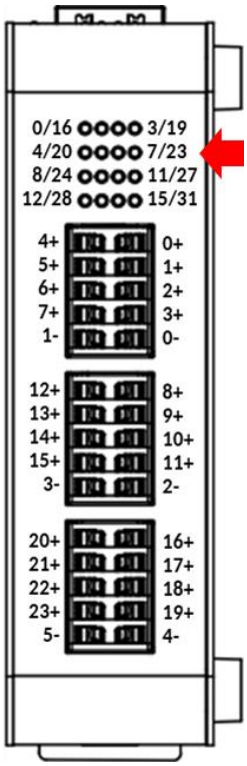
Notation	Color	States	Description
PWR	Green / Red	Green LED On	Voltage <= 48V and Voltage >= 19V
		Green LED On Red LED On	1. Voltage < 50V and Voltage > 48V 2. Voltage < 19V and Voltage < 17V
		Red LED On	Voltage >= 50V and Voltage <= 17V

* Vs power status will be displayed first.

Connection Status LEDs

Notation	Color	States	Description
In	Green	Off	No link
		Blinking	Link and activity
		On	Link without activity
Out	Green	Off	No link
		Blinking	Link and activity
		On	Link without activity
Run	Green	Off	The device is in state INIT
		Blinking	The device is in state Pre-Operation
		Single Flash	The device is in state Safe-Operation
		On	The device is in state Operation
Err	Red	Off	No error
		Blinking	Invalid Configuration
		Single Flash	Local Error
		Double Flash	Process Data Watchdog Timeout EtherCAT Watchdog Timeout
		On	The device is in state Error

2.2.4 I/O Status LEDs



Notation	States	Color	Description
DI	Off	-	Digital input status is “Off”
	On	Orange	From 0 to 15 channel, Digital input status is "On"
		Blue	From 16 to 32 channel, Digital input status is "On"
		Purple	Both Digital input from 0 to 15 and 16 to 32 channels are "On"
DO	Off	-	Digital output status is “Off”
	On	Green	From 0 to 15 channel, Digital output status is "On"
		Blue	From 16 to 32 channel, Digital output status is "On"
		Purple	Both Digital output from 0 to 15 and 16 to 32 channels are "On"

LED Color Comparison:

Orange	Blue	Purple
		

2.2.5 I/O Connector

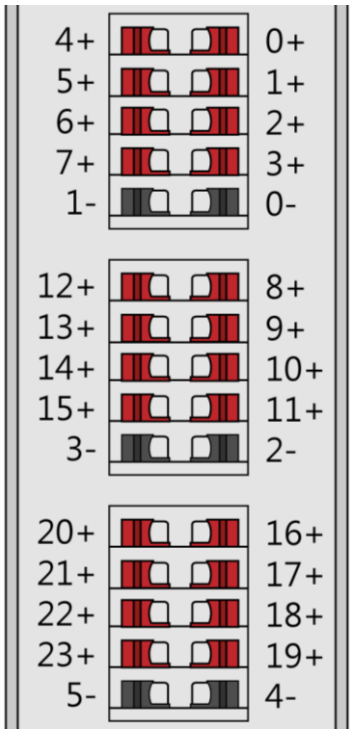
For EtherCAT Slave index assignments, refer to 4.2.3 Especial Objects (0x6000-0xFFFF).

Digital Input (QEC-RXXDT0H/ QEC-RXXDT0L)

Digital Input Connector Color: Positive (Red), Negative (Black).

Front side:

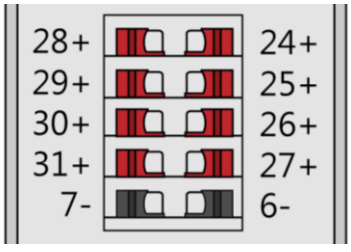
Pin #	Signal Name
4+	DI04
5+	DI05
6+	DI06
7+	DI07
1-	COM
12+	DI12
13+	DI13
14+	DI14
15+	DI15
3-	COM
20+	DI20
21+	DI21
22+	DI22
23+	DI23
5-	COM



Pin #	Signal Name
0+	DI00
1+	DI01
2+	DI02
3+	DI03
0-	COM
8+	DI08
9+	DI09
10+	DI10
11+	DI11
2-	COM
16+	DI16
17+	DI17
18+	DI18
19+	DI19
5-	COM

Bottom side:

Pin #	Signal Name
28+	DI28
29+	DI29
30+	DI30
31+	DI31
7-	COM



Pin #	Signal Name
24+	DI24
25+	DI25
26+	DI26
27+	DI27
6-	COM

Digital Input Load Voltage:

- Maximum Load Voltage: 56VDC
  Our modules are designed to handle the load voltage range from 24 to 56VDC.

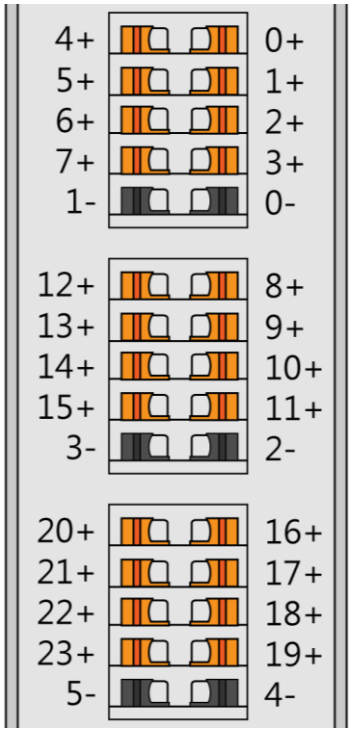
I/O Type: Sink Type.

Digital Output (QEC-RXXD0TH/ QEC-RXXD0TL)

Digital Output Connector Color: Positive (Orange), Negative (Black).

Front side:

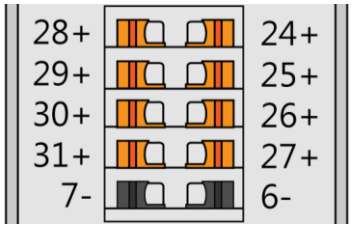
Pin #	Signal Name
4+	DO04
5+	DO05
6+	DO06
7+	DO07
1-	COM
12+	DO12
13+	DO13
14+	DO14
15+	DO15
3-	COM
20+	DO20
21+	DO21
22+	DO22
23+	DO23
5-	COM



Pin #	Signal Name
0+	DO00
1+	DO01
2+	DO02
3+	DO03
0-	COM
8+	DO08
9+	DO09
10+	DO10
11+	DO11
2-	COM
16+	DO16
17+	DO17
18+	DO18
19+	DO19
5-	COM

Bottom side:

Pin #	Signal Name
28+	DO28
29+	DO29
30+	DO30
31+	DO31
7-	COM



Pin #	Signal Name
24+	DO24
25+	DO25
26+	DO26
27+	DO27
6-	COM

Digital Output can handle a load current of up to 1 A.

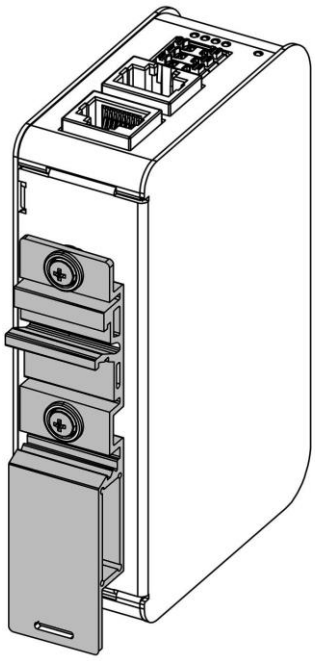
Digital Output Load Voltage:

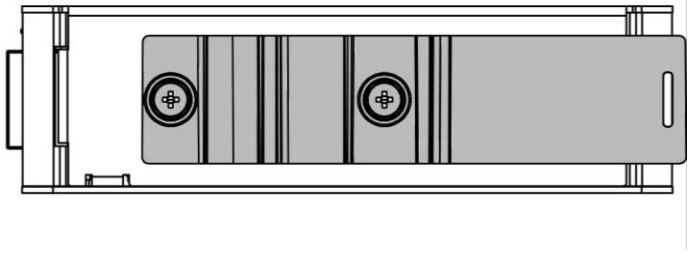
- Maximum Load Voltage: 56VDC
  Our modules are designed to handle the load voltage range from 24 to 56VDC.

I/O Type: Sink Type.

2.2.6 DIN-Rail installation

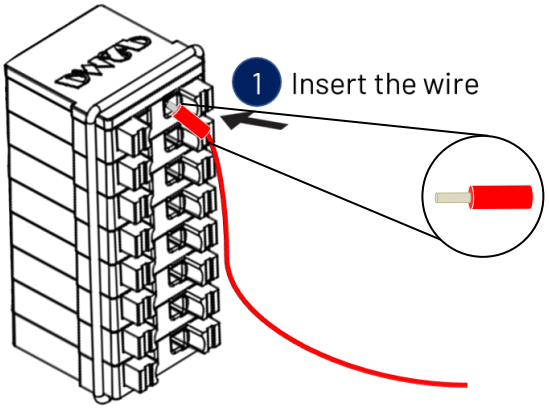
Please refer to Ch.3.1 DIN-Rail installation.

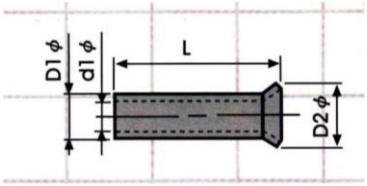




2.3 Wiring to the Connector

2.3.1 Connecting the wire to the connector

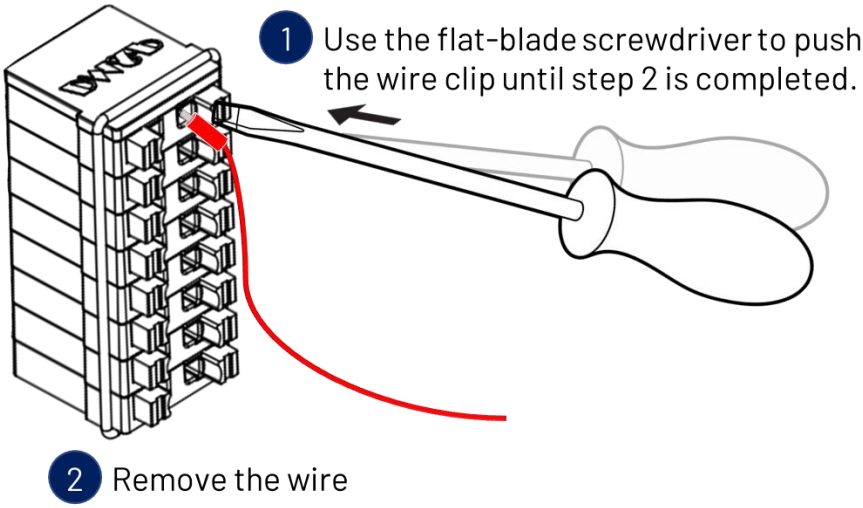




Insulated Terminals Dimensions (mm)

Position	L	ØD1	Ød1	ØD2
CN 0.5-6	6.0	1.3	1.0	1.9
CN 0.5-8	8.0	1.3	1.0	1.9
CN 0.5-10	10.0	1.3	1.0	1.9

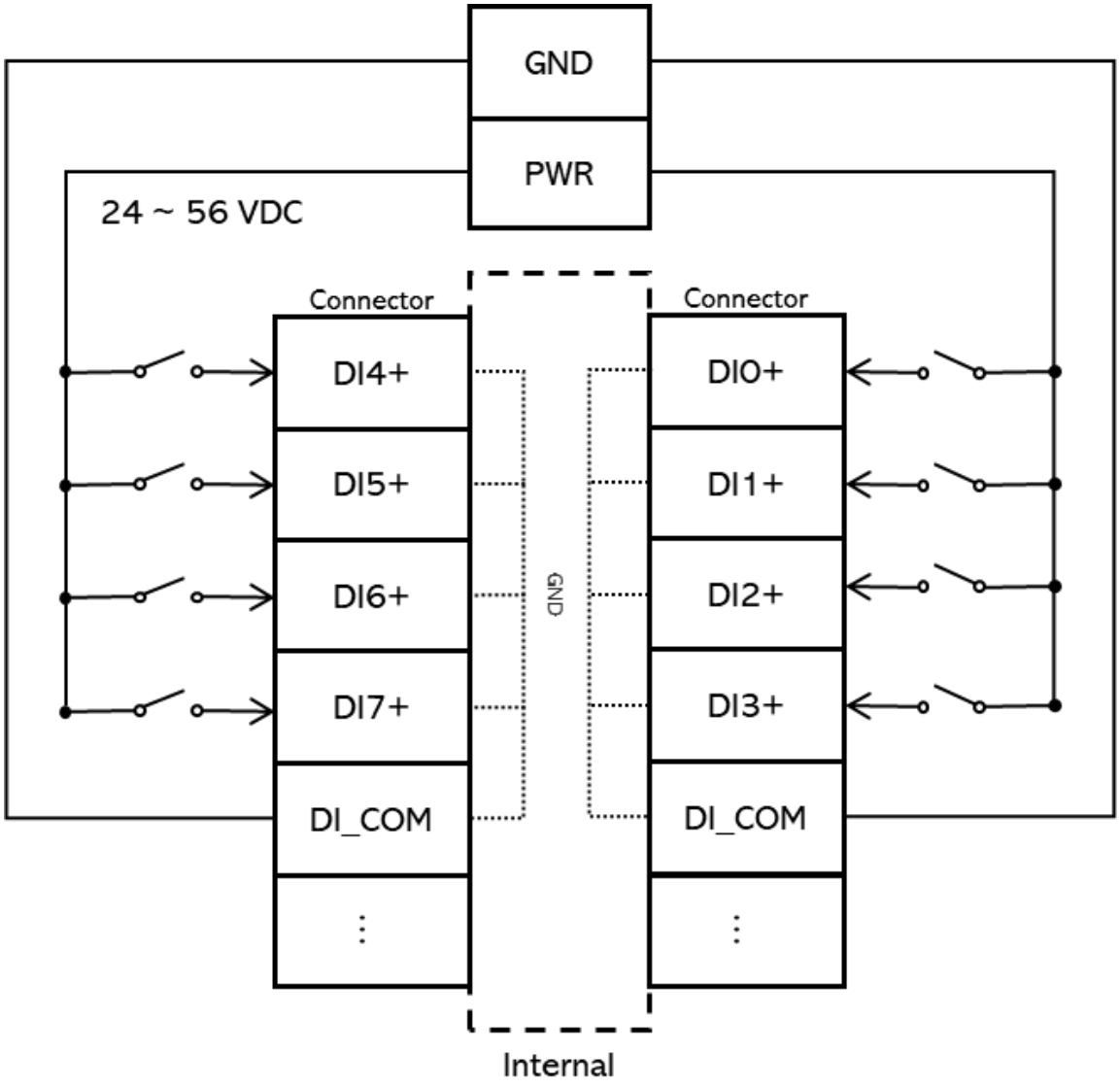
2.3.2 Removing the wire from the connector



2.3.3 Application Wiring

- **Digital Input**

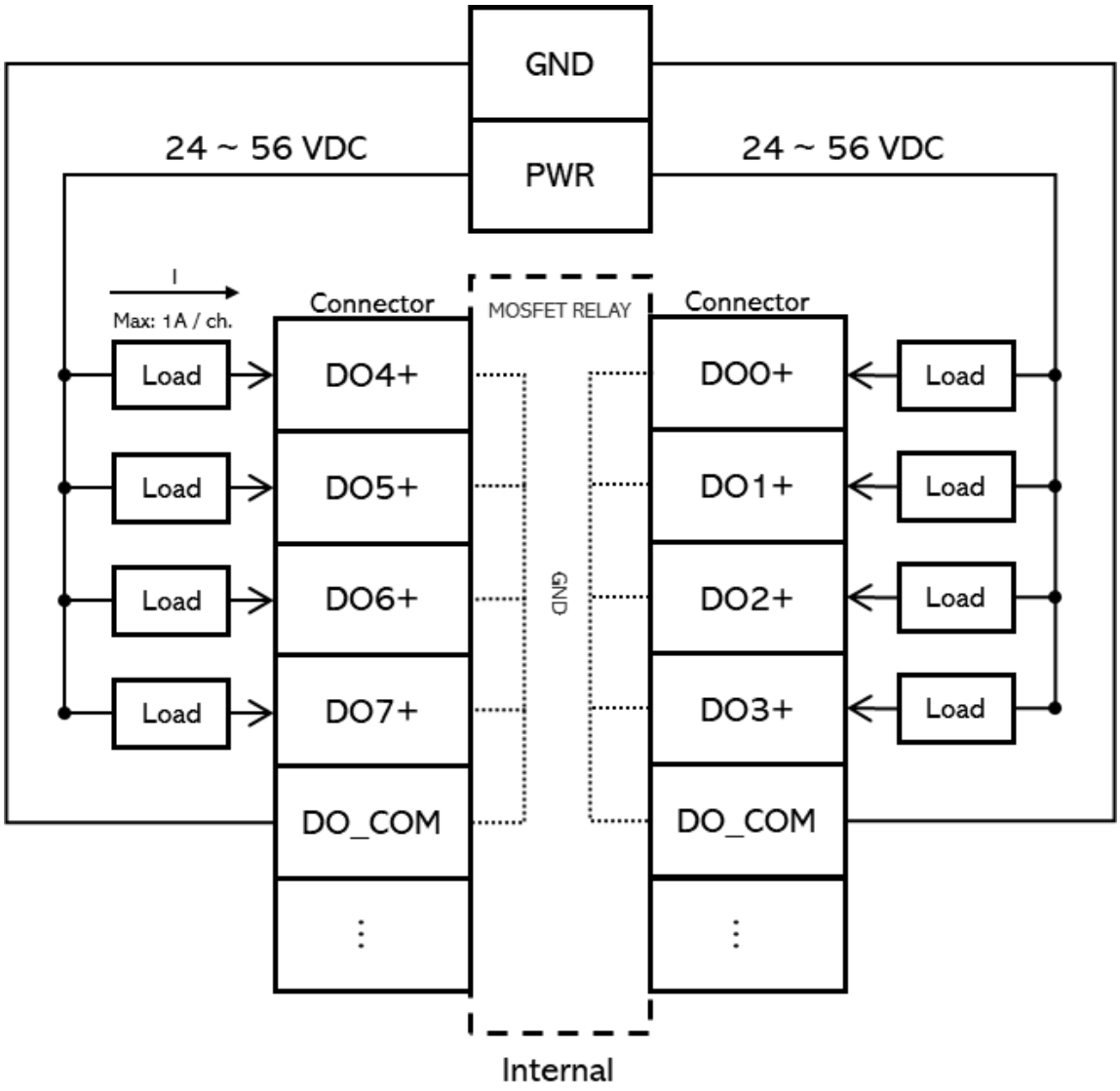
Example for 32-ch Digital Input Operation. (QEC-RXXDT0H/QEC-RXXDT0L)



The wiring diagram shows a setup where four digital input pins are grouped with one ground (GND) pin (For example, DI0+ to DI3+ pins' ground is 0-). Its load voltage is from 24 to 56VDC, and the ISO1212 chips inside the module help to receive the signals safely and reliably.

- **Digital Output**

Example for 32-ch Digital Output Operation. (QEC-RXXD0TH/QEC-RXXD0TL)



The wiring diagram shows a setup where four digital output pins are grouped with one ground (GND) pin (For example, DO0+ to DO3+ pins' ground is 0-).
Each channel is outfitted with a Photocoupler and a MOSFET in the Digital Output modules, ensuring enhanced protection and dependable performance. These modules are designed to accommodate a load voltage range of 24V to 56VDC, with loading currents up to 1A.

Ch. 3

Hardware Installation

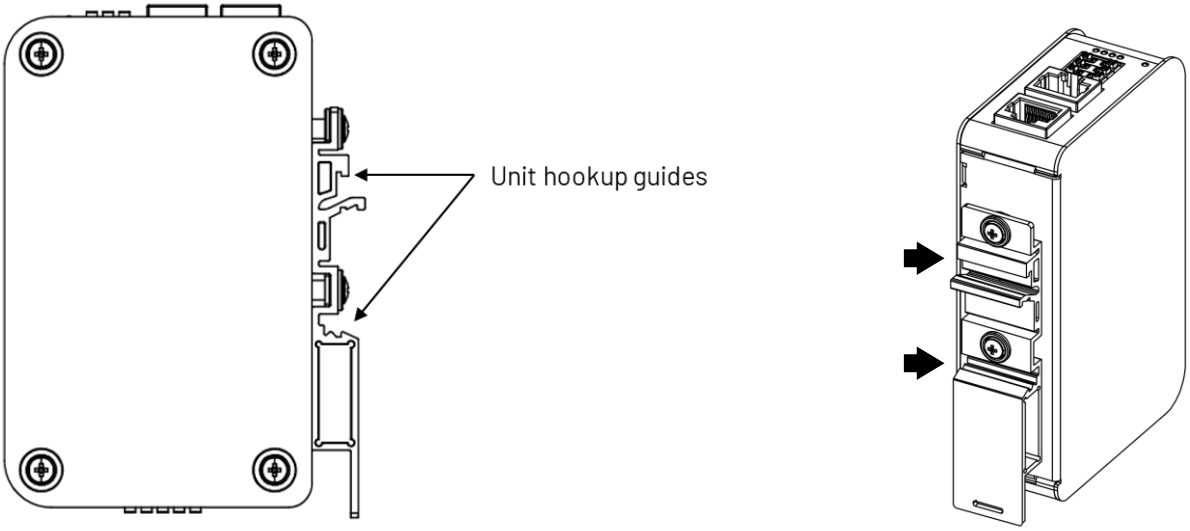
3.1 DIN-Rail installation

3.2 Removing QEC-RXXD Unit

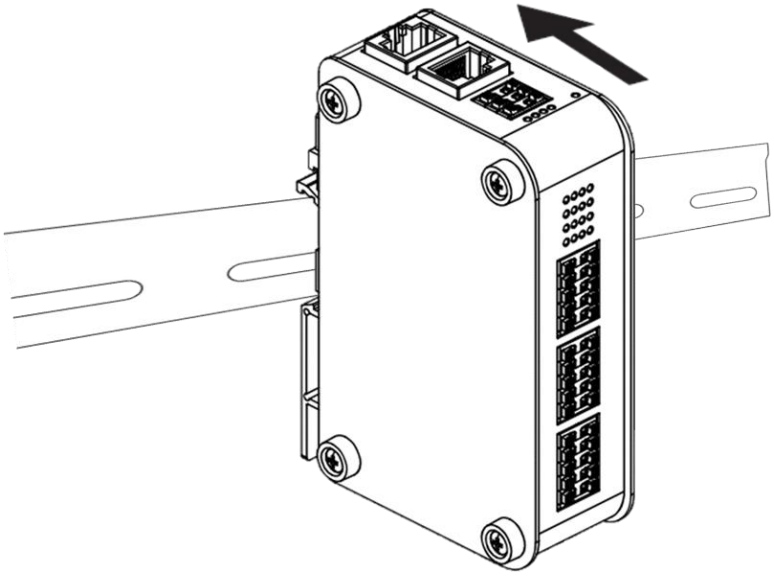
This section describes how to install QEC-RXXD. Please turn OFF the power supply before you mount QEC-RXXD. Always mount QEC-RXXD one at a time.

3.1 DIN-Rail installation

Slide in the QEC-RXXD on the hookup guides and press the QEC-RXXD with a certain amount of force against the DIN track until the DIN Track mounting hook lock into place.



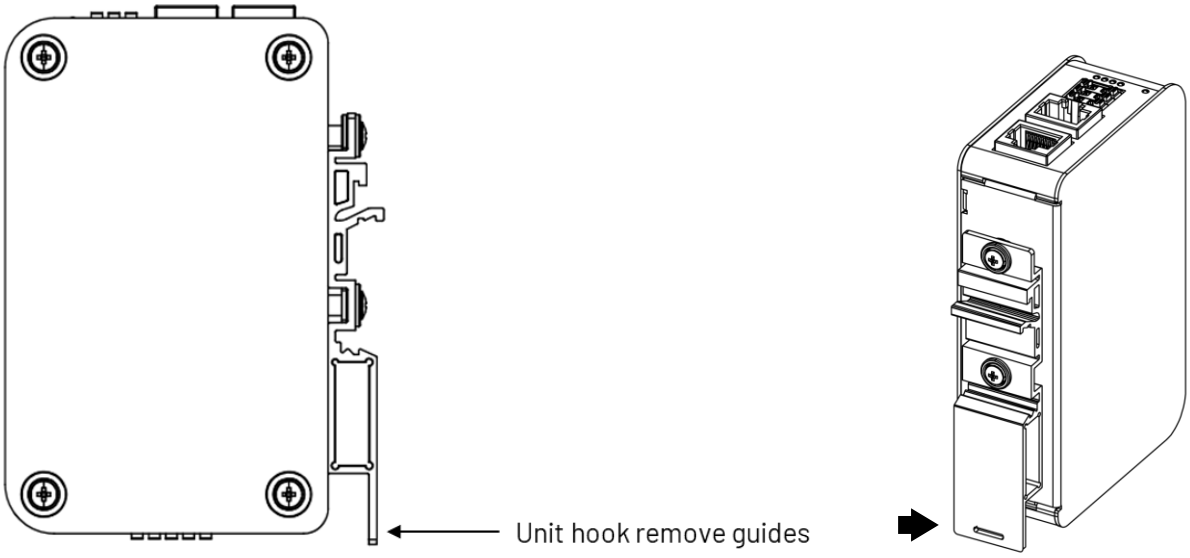
When you mount the QEC-RXXD, releasing the DIN track mounting hook on the QEC-RXXD is unnecessary. After you mount the QEC-RXXD, make sure it is locked to the DIN Track.



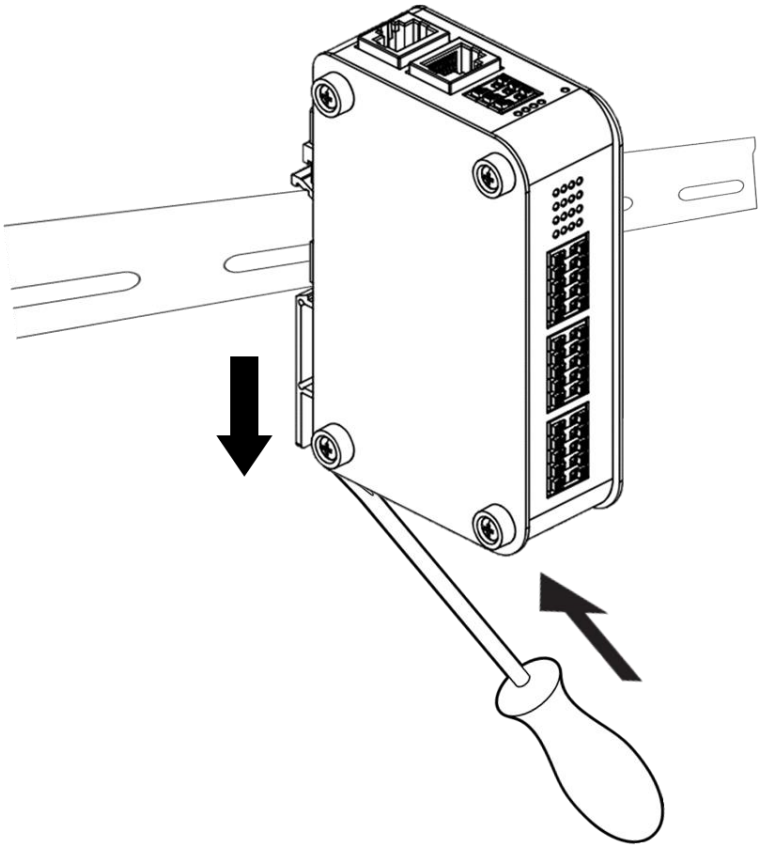
Note: Always turn OFF the Unit power supply and I/O power supply before connecting and removing the QEC-RXXD.

3.2 Removing QEC-RXXD Unit

Use a flat-blade screwdriver to remove the DIN Track mounting hook on the unit.



Pull down and out the flat-blade screwdriver with force against the DIN track until you hear the DIN Track remove the hook.



Ch. 4

Getting Started

4.1 Hardware Preparation and Connection

4.2 Software/Development Environment

4.3 Connect to your PC and set up the environment

4.4 Configuration and Operation

4.5 Access Further Documentation

This chapter explains how to access the QEC-RXXDT0 and QEC-RXXD0T modules through the QEC-M-01 (EtherCAT Master) and its software, 86Duino Coding IDE. The parameter settings are easy to configure, shortening the system installation and evaluation time.

Note. QEC's PoE (Power over Ethernet)

In QEC product installations, users can easily distinguish between PoE and non-PoE: if the RJ45 house is red, it is PoE type, and if the RJ45 house is black, it is non-PoE type.

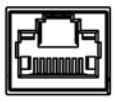
Non-PoE type

PoE type

PoE (Power over Ethernet) is a function that delivers power over the network. QEC can be equipped with an optional PoE function to reduce cabling. In practice, PoE is selected based on system equipment, so please pay attention to the following points while evaluating and testing:

1. When connecting PoE and non-PoE devices, make sure to disconnect Ethernet cables at pins 4, 5, 7, and 8 (e.g., when a PoE-supported QEC EtherCAT master connects with a third-party EtherCAT slave).

2. The PoE function of QEC is different and incompatible with EtherCAT P, and the PoE function of QEC is based on PoE Type B, and the pin functions are as follows:



Pin #	Signal Name	Pin #	Signal Name
1	LAN1_TX+	2	LAN1_TX-
3	LAN1_RX+	4	VS+
5	VP+	6	LAN1_RX-
7	VS- (GND)	8	VP- (GND)

* PoE LAN with the Red Housing; Regular LAN with Black Housing.
* L4, L5, L7, L8 pins are option, for RJ45 Power IN/OUT.

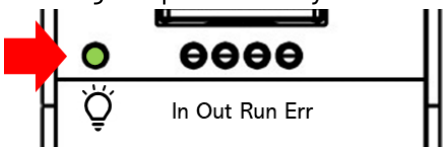
3. QEC's PoE power supply is up to 24V/3A.

4.1 Hardware Preparation and Connection

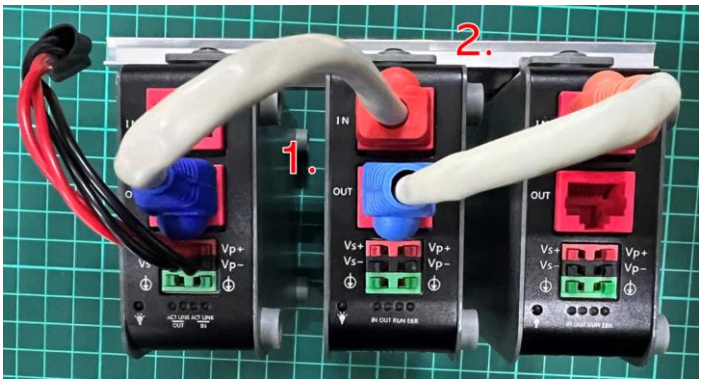
The following devices are used here:

1. QEC-M-01P (EtherCAT Master/PoE)
2. QEC-R11D0TH-N (EtherCAT Slave High-speed 32-ch digital input/PoE)
3. QEC-R11DT0H-N (EtherCAT Slave High-speed 32-ch digital input/PoE)
4. RJ45 cable
5. 24V power supplier

All QEC devices have PoE functions, so we only need to connect to Vs+/Vs and Vp+/Vp power pins (EU terminals) supplies for 19 to 50VDC power on QEC-M-01P, and then other devices will be powered by PoE. After powering on, you'll see the power LED light up and verify that the "PWR" LED indicators are ON (green).

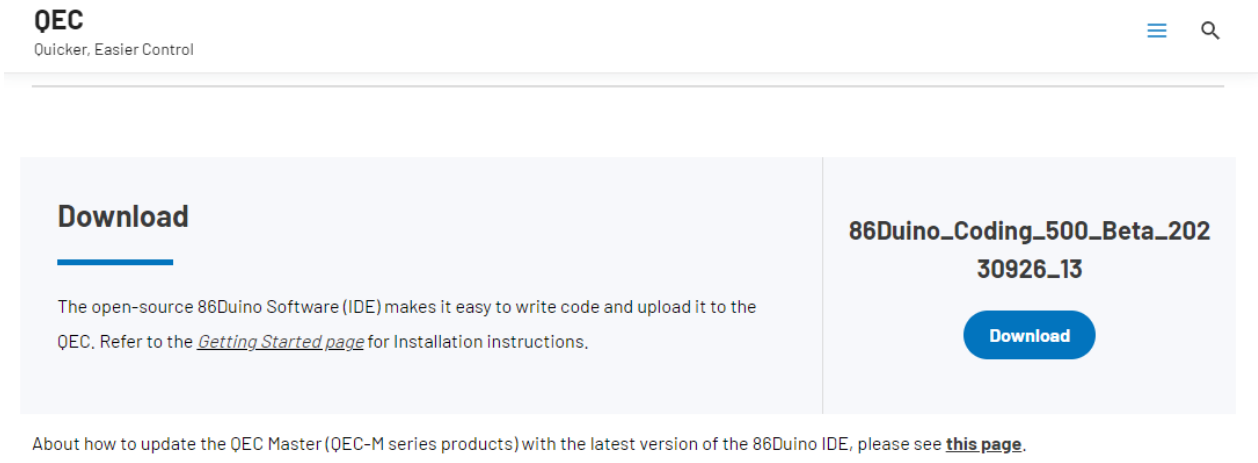


1. Using the EtherCAT Out port (top side) of QEC-M-01P connected to the EtherCAT In port of QEC-R11DT0H-N via RJ45 cable (powered by PoE).
2. Using the EtherCAT Out port (top side) of QEC-R11DT0H-N connected to the EtherCAT In port of QEC-R11D0TH-N via RJ45 cable (powered by PoE).



4.2 Software/Development Environment

Download 86duino IDE from https://www.qec.tw/software/.



After downloading, please unzip the downloaded zip file, no additional software installation is required, just double-click **86duino.exe** to start the IDE.

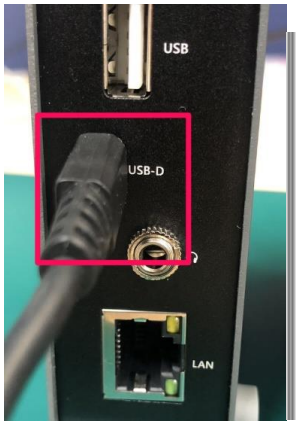
*Note: If Windows displays a warning, click Details once and then click the Continue Run button once.

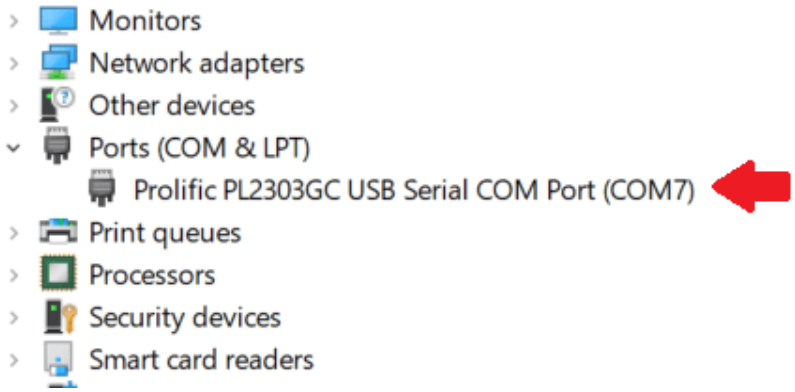
86Duino Coding IDE 500+ looks like below.

4.3 Connect to your PC and set up the environment

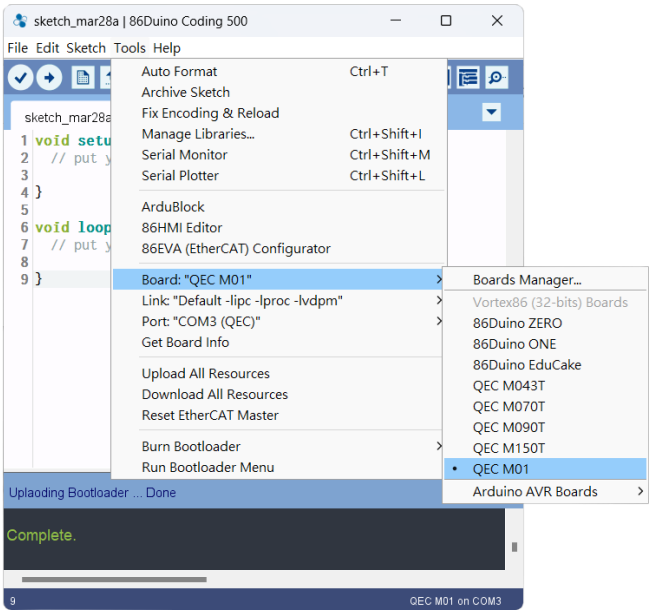
Follow the steps below to set up the environment:

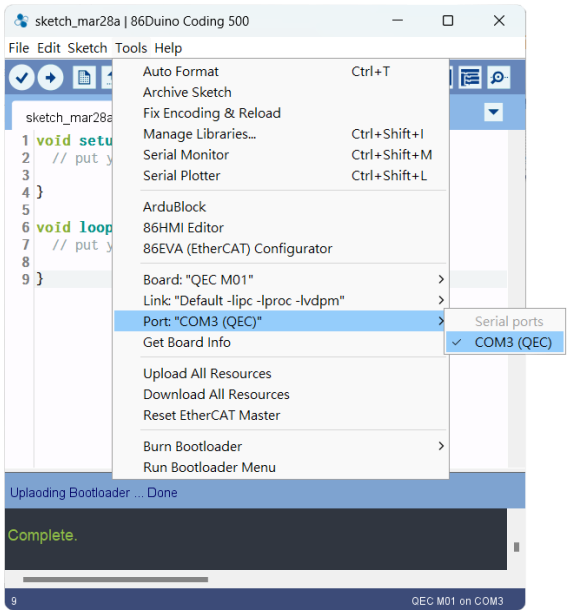
1. Connect the QEC-M-01P to your PC via a Micro USB to USB cable (86Duino IDE installed).
2. Turn on the QEC power.
3. Open "Device Manager" -> "Ports (COM & LPT)" in your PC and expand the ports; you should see that the "Prolific PL2303GC USB Serial COM Port (COMx)" is detected; if not, you will need to install the required drivers.
   (For Windows PL2303 driver, you can download here)





4. Open the 86Duino IDE.
5. Select the correct board: In the IDE's menu, select "Tools" ->" Board"- > QEC-M-01 (or the QEC-M master model you use).
6. Select Port: In the IDE's menu, select "Tools"- >" Port" and select the USB port to connect to the QEC-M master (in this case, COM3 (QEC)).



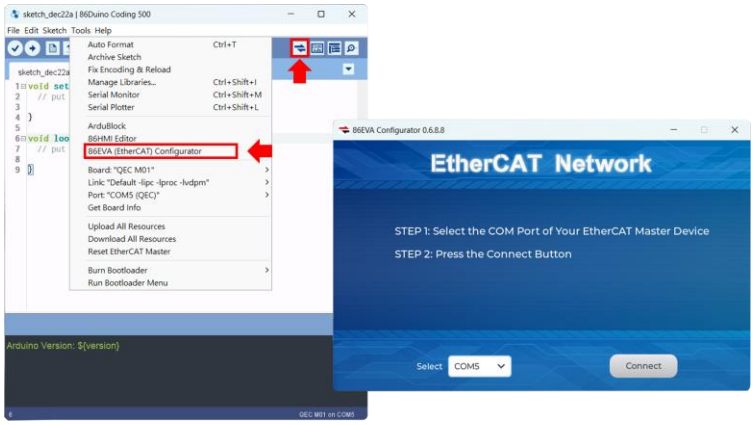


4.4 Configuration and Operation

86EVA is a graphical EtherCAT configurator based on the EtherCAT Library in the 86Duino IDE and is one of the development kits for 86Duino. The user can use it to configure the EtherCAT network quickly and start programming.

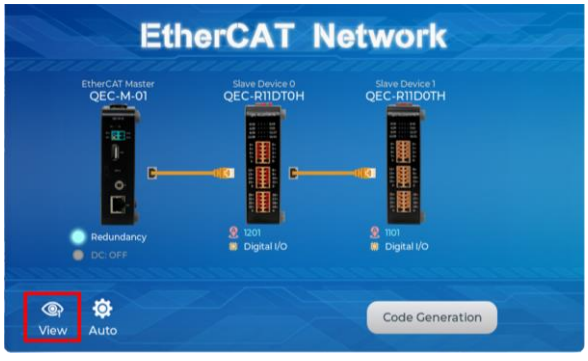
Step 1: Turn on 86EVA and scan

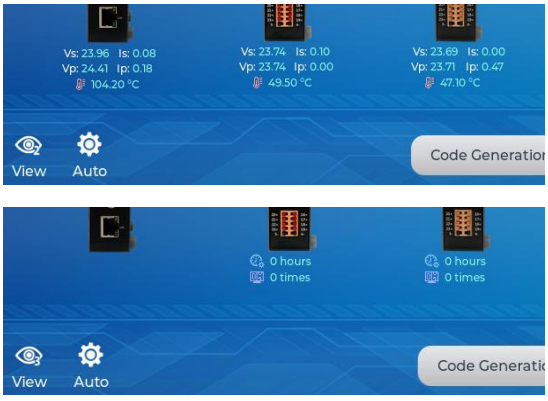
The 86EVA tool can be opened via the following buttons.



Once you have confirmed that the correct COM port has been selected of QEC-M-01P, press the “Connect” button to start scanning the EtherCAT network.

The connected devices will be displayed after the EtherCAT network has been scanned. Press the "View" button to check the device's status and operation time.





Step 2: Set the parameters

You can press twice on the scanned device image to enter the corresponding parameter setting screen. There are including the Device Name, Object Name, Alias Address, Vendor ID, and Product Code of the QEC slave.

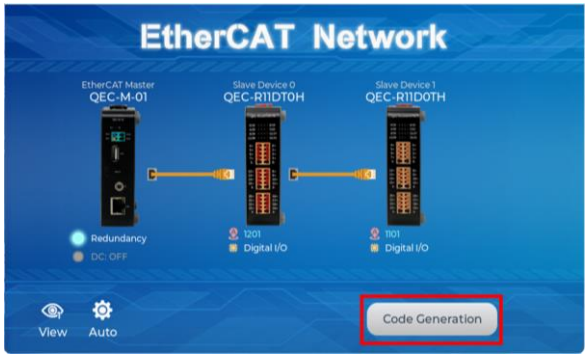
QEC-R11DT0H

QEC-R11D0TH

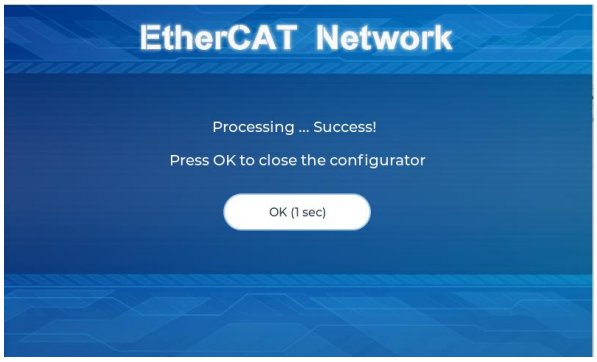
For the Device Information, you can refer to 5.2.1 Standard Objects (0x1000-0x1FFF) and 5.2.2 Manufacturer Objects (0x5000-0x5FFF).

Step 3: Generation the code

After configuring all settings, click the "Code Generation" button.

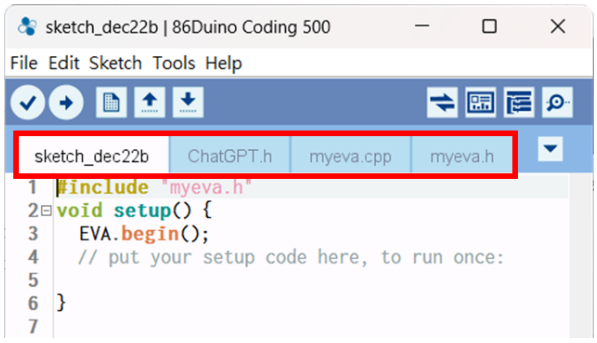


After clicking, the result and completion screen will appear, click OK to leave the program; If you do not click OK, you will leave the program after 10 seconds.



The generated code and files are as follows:

- sketch_dec22b: Main Project (depends on your project name)
- ChatGPT.h: Parameters to provide to ChatGPT referred
- myeva.cpp: C++ program code of 86EVA
- myeva.h: Header file of 86EVA

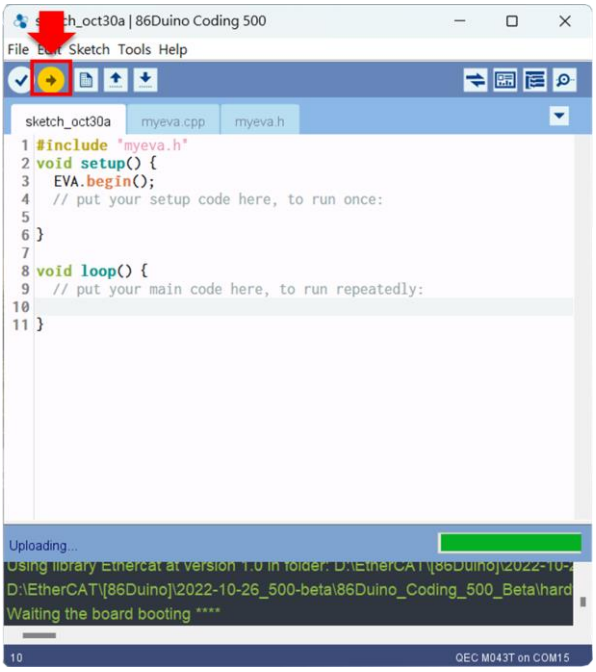


Additional note: After 86EVA generates code, the following code will be automatically generated in the main program (.ino), and any of them will cause 86EVA not to work.

1. #include “myeva.h” : Include EVA Header file
2. EVA.begin() in setup(); : Initialize the EVA function

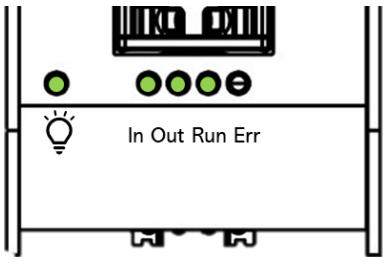
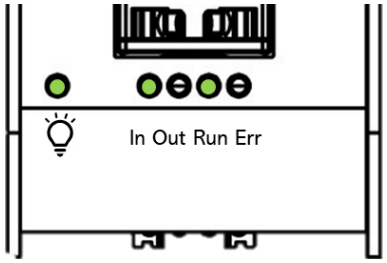
Step 4: Upload the code

Once the code is generated, click on the toolbar to compile, and to confirm that the compilation is complete and error-free, you can click to upload. The program will run when the upload is complete.



After the upload, if the EtherCAT Network is running successfully, it will enter OPERATION mode.

You can confirm this by the RUN LED on your QEC slave device, which should light up. Additionally, the LED on the EtherCAT LAN ports will start blinking, indicating active operation.

QEC-R11DT0H (Node 0)	QEC-R11D0TH (Node 1)
	

EthercatDevice_QECRXXD Class

This class within the EtherCAT Library specifically caters to QEC EtherCAT Slave Digital IO Modules. For comprehensive details on the *EthercatDevice_QECRXXD Class*, please refer to EthercatDevice_QECRXXD Class - QEC.

Functionality Overview

To effectively utilize your QEC-RXXD device, it's important to understand which functions are compatible with different modules (For EtherCAT Slave index assignments, please refer to 4.2.3 Especial Objects (0x6000-0xFFFF)).

Below is a breakdown of the functions and their corresponding module applicability:

Initialization Functions: (All)

- attach(): Specify the EC-Slave number and mount it on the EC-Master.

DMP Slave Device Specific Functions: (QEC-RXXDT0H/QEC-RXXD0TH)

- getSystemTemperature()
- getSystemPowerVoltage()
- getSystemPowerCurrent()
- getPeripheralPowerVoltage()
- getPeripheralPowerCurrent()

Digital Input Modules: (QEC-RXXDT0H/QEC-RXXDT0L)

- digitalRead() : Read the digital input value.
- digitalReadAll(): Read HIGH or LOW values from all digital input pins.

Digital Output Modules: (QEC-RXXD0TH/QEC-RXXD0TL)

- digitalWrite(): Write a digital output value.
- digitalWriteAll(): Write HIGH or LOW value to all digital output pins.

High-Speed QEC Slave DIO (DC Mode): (QEC-RXXDXXH)

- setDC(): Configures Distributed Clock (DC) parameters.

To obtain the full EtherCAT Master API User Manual, we encourage you to reach out to our sales team or email us directly at info@icop.com.tw. Our team is dedicated to providing you with comprehensive support and detailed information to enhance your experience with our products.

Practical Application Examples

When using these functions, reference the object name of your QEC-RXXD device as set in the 86EVA or from your code object definition.

1. digitalRead

Example for basic digital input operations.
Suppose your device is named **Slave0**. In this case, the code to read would be implemented as follows:

- To read the digital input from the all pins: **Slave0.digitalRead();**
- To print out as the serial monitor: **Serial.println(Slave0.digitalRead());**

86EVA Object Definition:

Your code:

```
#include "myeva.h" // 86EVA

void setup() {
  EVA.begin(); // Initialize the EVA
  // put your setup code here, to run once:
  Serial.begin(115200); // Start serial communication at 115200 baud rate
}

void loop() {
  // put your main code here, to run repeatedly:
  for (int i = 0; i < 32; i++) {
    // Read and print the digital state of each pin from 0 to 31 on Slave0
    Serial.print(Slave0.digitalRead(i));
    // Add a newline character after printing the last pin's state
    if (i == 31) Serial.println(Slave0.digitalRead(i));
  }
}
```

When the code runs, it prints all the digital pins (0 to 31) of Slave0 on the Serial monitor in 86Duino IDE.

2. digitalWrite

Example for basic digital output operations.
Suppose your device is named **Slave1**. In this case, the code to set digital output pin would be implemented as follows:

- To set the all digital out pins to HIGH: **Slave1.digitalWrite(pins, HIGH);**
- To set the all digital out pins to LOW: **Slave1.digitalWrite(pins, LOW);**

86EVA Object Definition:

Your code:

```
#include "myeva.h" // 86EVA

void setup() {
  EVA.begin(); // Initialize the EVA
}

void loop() {
  // Loop to set all pins from 0 to 31 on Slave1
  for (int i = 0; i < 32; i++) {
    // Set the all digital output pin on Slave1 to HIGH
    Slave1.digitalWrite(i, HIGH);
  }
  delay(1000); // Wait for 1 second

  for (int i = 0; i < 32; i++) {
    // Set the all digital output pin on Slave1 to LOW
    Slave1.digitalWrite(i, LOW);
  }
  delay(1000); // Wait for 1 second
}
```

When the code runs, it turns on all the digital pins (0 to 31) on Slave1 at the same time. They stay on for 1 second. Then, all the pins are turned off and stay off for another second. This pattern of turning all pins on and then off again repeats continuously.

3. Distributed Clock (DC)

For high-speed QEC Slave DIO modules, you might need to configure the DC mode. For instance, to set the DC mode on a device named Slave0: **Slave0.setDc(cycletime0_ns);**
In this example code, we also attach the cyclic Callback function and set the EtherCAT SYNC mode.

```
#include "Ethercat.h" // Include the EtherCAT library

EthercatMaster EcatMaster; // Create an EtherCAT Master Object
EthercatDevice_QECR11DT0H Slave0; // Create an EtherCAT Slave Object for QEC-R11DT0H
EthercatDevice_QECR11D0TH Slave1; // Create an EtherCAT Slave Object for QEC-R11D0TH

// Define a callback function for cyclic tasks
void myCallback() {
  // put your cyclic Callback function here.
  // This function is called cyclically by the EtherCAT master
}

void setup() {
  // Initialize the EtherCAT Master. If successful, all slaves enter PRE-OPERATIONAL state
  EcatMaster.begin();

  // Attach Slave0 to the EtherCAT Master at position 0 and set its Distributed Clock (DC)
  Slave0.attach(0, EcatMaster);
  Slave0.setDc(1000000); // Set DC cycle time to 1ms

  // Attach Slave1 to the EtherCAT Master at position 1 and set its DC
  Slave1.attach(1, EcatMaster);
  Slave1.setDc(1000000); // Set DC cycle time to 1ms

  // Attach the cyclic callback function to the EtherCAT Master
  EcatMaster.attachCyclicCallback(myCallback);

  // Start the EtherCAT Master with a cycle time of 1ms, using ECAT_SYNC mode
  EcatMaster.start(1000000, ECAT_SYNC);
}

void loop() {
  // put your main code here, to run repeatedly:
  // This loop remains empty as EtherCAT communication is handled in the callback
}
```

Further Information on Distributed Clock (DC): To gain a deeper understanding of the Distributed Clock (DC) functionality in the EtherCAT protocol, consider visiting the EtherCAT Device Protocol Poster provided by the EtherCAT Technology Group, ETG.

Additional Guidance

It's essential to ensure consistency in the object names used in your code and the names assigned to your QEC-RXXD device. For further examples and a more detailed explanation, please visit the EthercatDevice_QECRXXD Class - QEC.

4.5 Access Further Documentation

For those seeking comprehensive details about the EtherCAT Master API, we recommend referring to the EtherCAT Master API User Manual.This manual provides an in-depth exploration of the API, offering insights into more advanced features and capabilities.

Additionally, if you're interested in expanding your knowledge and exploring programming functions beyond the basic setup, the Language Reference Home and Libraries Reference Home are excellent resources. These sections contain valuable information and guides that cover a wide range of programming topics and libraries relevant to the EtherCAT technology.

For more info and sample request, please write to info@icop.com.tw, call your nearest ICOP Branch, or contact our Worldwide Official Distributor.

Ch. 5

Slave Information

5.1 ESI (EtherCAT Slave Information) file

5.2 Object Dictionary

5.1 ESI (EtherCAT Slave Information) file

The ESI files contain information unique to the EtherCAT Slave Terminals in XML format. You can load an ESI file into the Support Software to easily allocate Slave Terminal process data and other settings. The ESI files for QEC EtherCAT slaves are already installed in the Support Software.

Note. Ensuring Up-to-date Installation of the XML Device Description File (ESI)

To ensure smooth functioning, it is important to install the latest version of the XML device description file in the EtherCAT Master software. The latest version of the XML device description file can be downloaded from the QEC website.

https://www.qec.tw/

5.2 Object Dictionary

The object dictionary defined here shall be used complementary with ETG.5001 and ETG.1000.

- Device Profile: 5001
- Modul Profile: 0
- Modular Device Profile
- Usage Notes:
  - The PDO mapping object and SyncManager assignment object doesn't need to be defined. In that case they are created automatically.
  - The following objects are fixed included in the SSC and shall not be defined in the file: 0x1000, 0x1001, 0x1008, 0x1009, 0x100a, 0x1010, 0x1011, 0x1018, 0x10F0, 0x10F1, 0x10F3, 0x1c00, 0x1c32, 0x1c33.
  - Entries less or equal one 8Bit shall not overlap byte borders.
  - Entries greater 8Bit shall always start at an exact word border.

Note. All descriptions in the object dictionary are only for High-speed Digital Modules (QEC-RXXDT0H and QEC-RXX0TH)

5.2.1 Standard Objects (0x1000-0x1FFF)

Index 1000 Device type

Index	Name	Data type	Flags	Default
1000	Device type	UINT32	RO	0x00001389 (5001)

Index 1001 Error register

Index	Name	Data type	Flags	Default
1001	Error register	UINT8	RO	0x00 (0)

Index 1008 Device name

Index	Name	Data type	Flags	Default
1008	Device name	STRING	RO	Refer to following table.

Table 4-1: Device Name

Type	Device Name
Digital Input	QEC-R00DT0H
	QEC-R11D0TH
Digital Output	QEC-R00D0TH
	QEC-R11D0TH

Index 1009 Hardware version

Index	Name	Data type	Flags	Default
1009	Hardware version	STRING	RO	Depending by model.

Index 100A

Index	Name	Data type	Flags	Default
100A	Software version	STRING	RO	1.00

Index 1018 Identity

Index	Name	Data type	Flags	Default
1018:0	Identity	UINT8	RO	> 4 <
1018:01	Vendor ID	UINT32	RO	0x00000BC3 (3011)
1018:02	Product code	UINT32	RO	Refer to following table.
1018:03	Revision	UINT32	RO	Depending by model.
1018:04	Serial number	UINT32	RO	0x00000000 (0)

Table 4-2: Product code & Revision Number

Model Name	Product code
QEC-R11DT0H	0x0086d700
QEC-R00DT0H	0x0086d701
QEC-R11D0TH	0x0086d800
QEC-R00D0TH	0x0086d801

Index 10F1 Error Settings

Index	Name	Data type	Flags	Default
10F1:0	Error Settings	UINT8	RO	> 2 <
10F1:01	Local Error Reaction	UINT32	RW	0x00000001 (1)
10F1:02	Sync Error Counter Limit	UINT32	RW	0x0004 (4)

Index 10F8 Timestamp Object

Index	Name	Data type	Flags	Default
10F8	Timestamp Object	UINT8	RW P	-

Index 1600 DigitalOutput process data mapping

Index	Name	Data type	Flags	Default
1600:0	DigitalOutput process data mapping	UINT8	RO	Maximum of 32, by model.
1600:01	SubIndex 001	UINT32	RO	0x7000:01, 1
1600:02	SubIndex 002	UINT32	RO	0x7000:02, 1
1600:03	SubIndex 003	UINT32	RO	0x7000:03, 1
1600:04	SubIndex 004	UINT32	RO	0x7000:04, 1
1600:05	SubIndex 005	UINT32	RO	0x7000:05, 1
1600:06	SubIndex 006	UINT32	RO	0x7000:06, 1
1600:07	SubIndex 007	UINT32	RO	0x7000:07, 1
1600:08	SubIndex 008	UINT32	RO	0x7000:08, 1
1600:09	SubIndex 009	UINT32	RO	0x7000:09, 1
1600:0A	SubIndex 010	UINT32	RO	0x7000:0A, 1
1600:0B	SubIndex 011	UINT32	RO	0x7000:0B, 1
1600:0C	SubIndex 012	UINT32	RO	0x7000:0C, 1
1600:0D	SubIndex 013	UINT32	RO	0x7000:0D, 1
1600:0E	SubIndex 014	UINT32	RO	0x7000:0E, 1
1600:0F	SubIndex 015	UINT32	RO	0x7000:0F, 1
1600:10	SubIndex 016	UINT32	RO	0x7000:10, 1
1600:11	SubIndex 017	UINT32	RO	0x7000:11, 1
1600:12	SubIndex 018	UINT32	RO	0x7000:12, 1
1600:13	SubIndex 019	UINT32	RO	0x7000:13, 1
1600:14	SubIndex 020	UINT32	RO	0x7000:14, 1
1600:15	SubIndex 021	UINT32	RO	0x7000:15, 1
1600:16	SubIndex 022	UINT32	RO	0x7000:16, 1
1600:17	SubIndex 023	UINT32	RO	0x7000:17, 1
1600:18	SubIndex 024	UINT32	RO	0x7000:18, 1
1600:19	SubIndex 025	UINT32	RO	0x7000:19, 1
1600:1A	SubIndex 026	UINT32	RO	0x7000:1A, 1
1600:1B	SubIndex 027	UINT32	RO	0x7000:1B, 1
1600:1C	SubIndex 028	UINT32	RO	0x7000:1C, 1
1600:1D	SubIndex 029	UINT32	RO	0x7000:1D, 1
1600:1E	SubIndex 030	UINT32	RO	0x7000:1E, 1
1600:1F	SubIndex 031	UINT32	RO	0x7000:1F, 1
1600:20	SubIndex 032	UINT32	RO	0x7000:20, 1

Index 1A00 DigitalInput process data mapping

Index	Name	Data type	Flags	Default
1A00:0	DigitalInput process data mapping	UINT8	RO	Maximum of 32, by model.
1A00:01	SubIndex 001	UINT32	RO	0x6000:01, 1
1A00:02	SubIndex 002	UINT32	RO	0x6000:02, 1
1A00:03	SubIndex 003	UINT32	RO	0x6000:03, 1
1A00:04	SubIndex 004	UINT32	RO	0x6000:04, 1
1A00:05	SubIndex 005	UINT32	RO	0x6000:05, 1
1A00:06	SubIndex 006	UINT32	RO	0x6000:06, 1
1A00:07	SubIndex 007	UINT32	RO	0x6000:07, 1
1A00:08	SubIndex 008	UINT32	RO	0x6000:08, 1
1A00:09	SubIndex 009	UINT32	RO	0x6000:09, 1
1A00:0A	SubIndex 010	UINT32	RO	0x6000:0A, 1
1A00:0B	SubIndex 011	UINT32	RO	0x6000:0B, 1
1A00:0C	SubIndex 012	UINT32	RO	0x6000:0C, 1
1A00:0D	SubIndex 013	UINT32	RO	0x6000:0D, 1
1A00:0E	SubIndex 014	UINT32	RO	0x6000:0E, 1
1A00:0F	SubIndex 015	UINT32	RO	0x6000:0F, 1
1A00:10	SubIndex 016	UINT32	RO	0x6000:10, 1
1A00:11	SubIndex 017	UINT32	RO	0x6000:11, 1
1A00:12	SubIndex 018	UINT32	RO	0x6000:12, 1
1A00:13	SubIndex 019	UINT32	RO	0x6000:13, 1
1A00:14	SubIndex 020	UINT32	RO	0x6000:14, 1
1A00:15	SubIndex 021	UINT32	RO	0x6000:15, 1
1A00:16	SubIndex 022	UINT32	RO	0x6000:16, 1
1A00:17	SubIndex 023	UINT32	RO	0x6000:17, 1
1A00:18	SubIndex 024	UINT32	RO	0x6000:18, 1
1A00:19	SubIndex 025	UINT32	RO	0x6000:19, 1
1A00:1A	SubIndex 026	UINT32	RO	0x6000:1A, 1
1A00:1B	SubIndex 027	UINT32	RO	0x6000:1B, 1
1A00:1C	SubIndex 028	UINT32	RO	0x6000:1C, 1
1A00:1D	SubIndex 029	UINT32	RO	0x6000:1D, 1
1A00:1E	SubIndex 030	UINT32	RO	0x6000:1E, 1
1A00:1F	SubIndex 031	UINT32	RO	0x6000:1F, 1
1A00:20	SubIndex 032	UINT32	RO	0x6000:20, 1

Index 1C00 Sync manager type

Index	Name	Data type	Flags	Default
1C00:0	Sync manager type	UINT8	RO	> 4 <
1C00:01	SubIndex 001	UINT8	RO	0x01 (1)
1C00:02	SubIndex 002	UINT8	RO	0x02 (2)
1C00:03	SubIndex 003	UINT8	RO	0x03 (3)
1C00:04	SubIndex 004	UINT8	RO	0x04 (4)

Index 1C12 SyncManager 2 assignment

Index	Name	Data type	Flags	Default
1C12:0	SyncManager 2 assignment	UINT8	RO	> 1 <
1C12:01	SubIndex 001	UINT16	RO	0x1600 (5632)

Index 1C13 SyncManager 3 assignment

Index	Name	Data type	Flags	Default
1C13:0	SyncManager 3 assignment	UINT8	RO	> 1 <
1C13:01	SubIndex 001	UINT16	RO	0x1A00 (6656)

Index 1C32 SM output parameter

Index	Name	Data type	Flags	Default
1C32:0	SM output parameter	UINT8	RO	> 32 <
1C32:01	Synchronization Type	UINT16	RW	0x0001 (1)
1C32:02	Cycle Time	UINT32	RO	0x00000000 (0)
1C32:04	Synchronization Types supported	UINT16	RO	0x401F (16415)
1C32:05	Minimum Cycle Time	UINT32	RO	0x000186A0 (100000)
1C32:06	Calc and Copy Time	UINT32	RO	0x00000000 (0)
1C32:08	Get Cycle Time	UINT16	RW	0x0000 (0)
1C32:09	Delay Time	UINT32	RO	0x00000000 (0)
1C32:0A	Sync0 Cycle Time	UINT32	RW	0xC811E15B (-938352293)
1C32:0B	SM-Event Missed	UINT16	RO	0x0000 (0)
1C32:0C	Cycle Time Too Small	UINT16	RO	0x010D (269)
1C32:0D	Shift Time Too Short Counter	UINT16	RO	0xCAD3 (51923)
1C32:20	Sync Error	BOOL	RO	TRUE

Index 1C33 SM input parameter

Index	Name	Data type	Flags	Default
1C33:0	SM input parameter	UINT8	RO	> 32 <
1C33:01	Synchronization Type	UINT16	RW	0x0001 (1)
1C33:02	Cycle Time	UINT32	RO	0x00000000 (0)
1C33:04	Synchronization Types supported	UINT16	RO	0x405F (16479)
1C33:05	Minimum Cycle Time	UINT32	RO	0x000186A0 (100000)
1C33:06	Calc and Copy Time	UINT32	RO	0x00000000 (0)
1C33:08	Get Cycle Time	UINT16	RW	0x0000 (0)
1C33:09	Delay Time	UINT32	RO	0x00000000 (0)
1C33:0A	Sync0 Cycle Time	UINT32	RW	0x00000000 (0)
1C33:0B	SM-Event Missed	UINT16	RO	0x0000 (0)
1C33:0C	Cycle Time Too Small	UINT16	RO	0x0709 (1801)
1C33:0D	Shift Time Too Short Counter	UINT16	RO	0x0000 (0)
1C33:20	Sync Error	BOOL	RO	TRUE

5.2.2 Manufacturer Objects (0x5000-0x5FFF)

Index 0x5xxn Manufacturer Objects

Index	Object Code	DataType	Name	Default	Description
0x5000	VARIABLE	UINT16	SP_Voltage	0	Read SP Voltage
0x5001	VARIABLE	UINT16	SP_Current	0	Read SP Current
0x5002	VARIABLE	UINT16	PP_Voltage	0	Read PP Voltage
0x5003	VARIABLE	UINT16	PP_Current	0	Read PP Current
0x5004	VARIABLE	INT16	Temperature	0	Read Temperature
0x5005	VARIABLE	UINT8	BoxStatus	0	NormalOperation 0 ESC_3p3_Power_NG 3 DIO_3p3_Power_NG 4 EXT_Xtal_Stop 5 EXT_Xtal_OverRang 6 PowerVoltageLowOrHigh 0x10 PowerVoltageTooLowOrTooOVer 0x11
0x5006	RECORD	UINT8	OrderInformation	> 4 <	OrderInformation
0x5006:01		STRING(6)	customerID	000000	Customer ID
0x5006:02		STRING(8)	poNumber	00000000	Po Number
0x5006:03		STRING(11)	orderNumber	00000000000	Order Number
0x5006:04		STRING(4)	preDeliveryDate	0000	Pre-Delivery Date
0x5007	VARIABLE	UINT32	MTBF		Record machine operating time. (Counter will push 1 for the Device on/off and per hour)

5.2.3 Especial Objects (0x6000-0xFFFF)

Index 0x6nnx Input Data of the Module (0x6000 - 0x6FFF)

Digital input index data. (QEC-RXXDT0H)
Users can use it according to the number of digital input pins.

Index	Object Code	DataType	Name	Default	Description
0x6000	RECORD		DigitalInput	RO P	Digital Input (tx).
		BOOL	DI00		
		BOOL	DI01		
		BOOL	DI02		
		BOOL	DI03		
		BOOL	DI04		
		BOOL	DI05		
		BOOL	DI06		
		BOOL	DI07		
		BOOL	DI08		
		BOOL	DI09		
		BOOL	DI10		
		BOOL	DI11		
		BOOL	DI12		
		BOOL	DI13		
		BOOL	DI14		
		BOOL	DI15		
		BOOL	DI16		
		BOOL	DI17		
		BOOL	DI18		
		BOOL	DI19		
		BOOL	DI20		
		BOOL	DI21		
		BOOL	DI22		
		BOOL	DI23		
		BOOL	DI24		
		BOOL	DI25		
		BOOL	DI26		
		BOOL	DI27		
		BOOL	DI28		

		BOOL	DI29		
		BOOL	DI30		
		BOOL	DI31		

Index 0x7nnx Output Data of the Module (0x7000 - 0x7FFF)

Digital output index data. (QEC-RXXD0TH)

Users can use it according to the number of digital output pins.

Index	Object Code	DataType	Name	Default	Description
0x7000	RECORD		DigitalOutput	RO P	Digital Output (rx).
		BOOL	D000	0	
		BOOL	D001	0	
		BOOL	D002	0	
		BOOL	D003	0	
		BOOL	D004	0	
		BOOL	D005	0	
		BOOL	D006	0	
		BOOL	D007	0	
		BOOL	D008	0	
		BOOL	D009	0	
		BOOL	D010	0	
		BOOL	D011	0	
		BOOL	D012	0	
		BOOL	D013	0	
		BOOL	D014	0	
		BOOL	D015	0	
		BOOL	D016		
		BOOL	D017		
		BOOL	D018		
		BOOL	D019		
		BOOL	D020		
		BOOL	D021		
		BOOL	D022		
		BOOL	D023		
		BOOL	D024		
		BOOL	D025		
		BOOL	D026		
		BOOL	D027		

		BOOL	DO28		
		BOOL	DO29		
		BOOL	DO30		
		BOOL	DO31		

If this is your first time running EtherCAT and using a QEC-M master, we recommend that you read Set up the QEC-M-043T for 86Duino to get your project started.

Warranty

This product is warranted to be in good working order for a period of one year from the date of purchase. Should this product fail to be in good working order at any time during this period, we will, at our option, replace or repair it at no additional charge except as set forth in the following terms. This warranty does not apply to products damaged by misuse, modifications, accident or disaster. Vendor assumes no liability for any damages, lost profits, lost savings or any other incidental or consequential damage resulting from the use, misuse of, originality to use this product. Vendor will not be liable for any claim made by any other related party. Return authorization must be obtained from the vendor before returned merchandise will be accepted. Authorization can be obtained by calling or faxing the vendor and requesting a Return Merchandise Authorization (RMA) number. Returned goods should always be accompanied by a clear problem description.