Start Guide

NPM EC-AD1441A4 EtherCAT Driver CiA402 PP Mode (4-axis) with 86EVA

86Duino Coding IDE 501

EtherCAT Library

(Version 1.0)

Revision

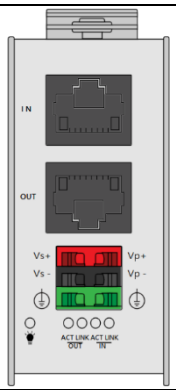
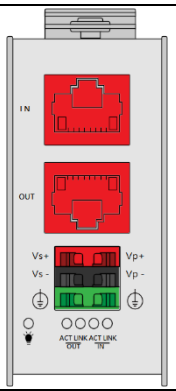
Date	Version	Description
2025/1/24	Version1.0	New Release.

Preface

In this guide, we will show you how to use the EtherCAT MDevice QEC-M-01 and the NPM EC-AD1441A4 (2-phase Bipolar 4-axis stepping motor driver).

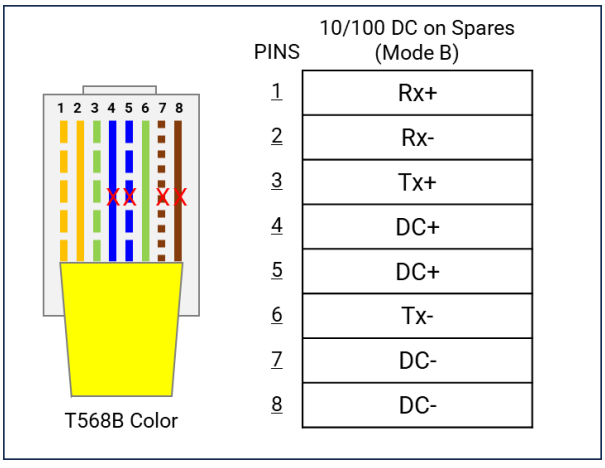
Notes QEC's PoE (Power over Ethernet)

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. 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:



PINS	10/100 DC on Spares (Mode B)
1	Rx+
2	Rx-
3	Tx+
4	DC+
5	DC+
6	Tx-
7	DC-
8	DC-

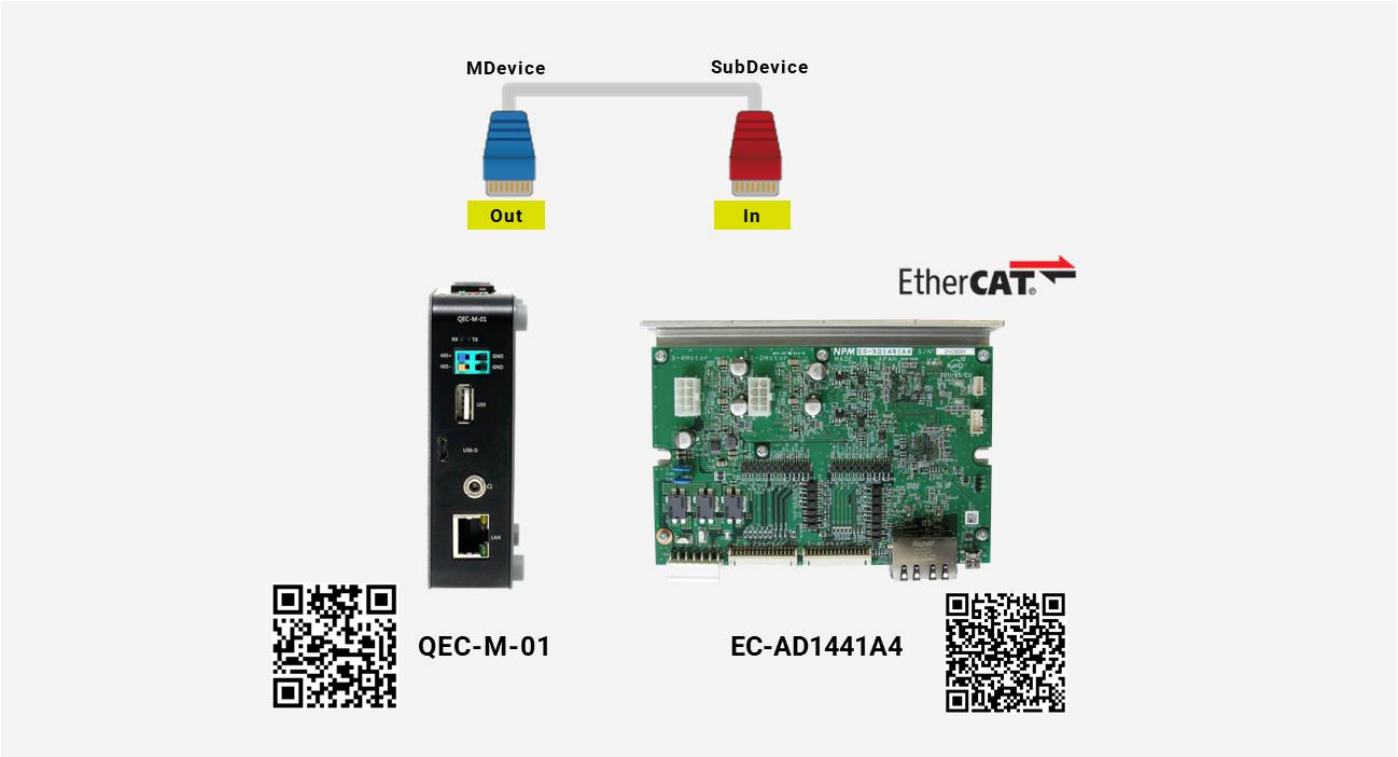
2. When connecting PoE and non-PoE devices, make sure to disconnect Ethernet cables at pins 4, 5, 7, and 8 (e.g., when a PoE-supported QEC EtherCAT MDevice connects with a third-party EtherCAT SubDevice).

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

1. Connection and wiring hardware

The following devices are used here:

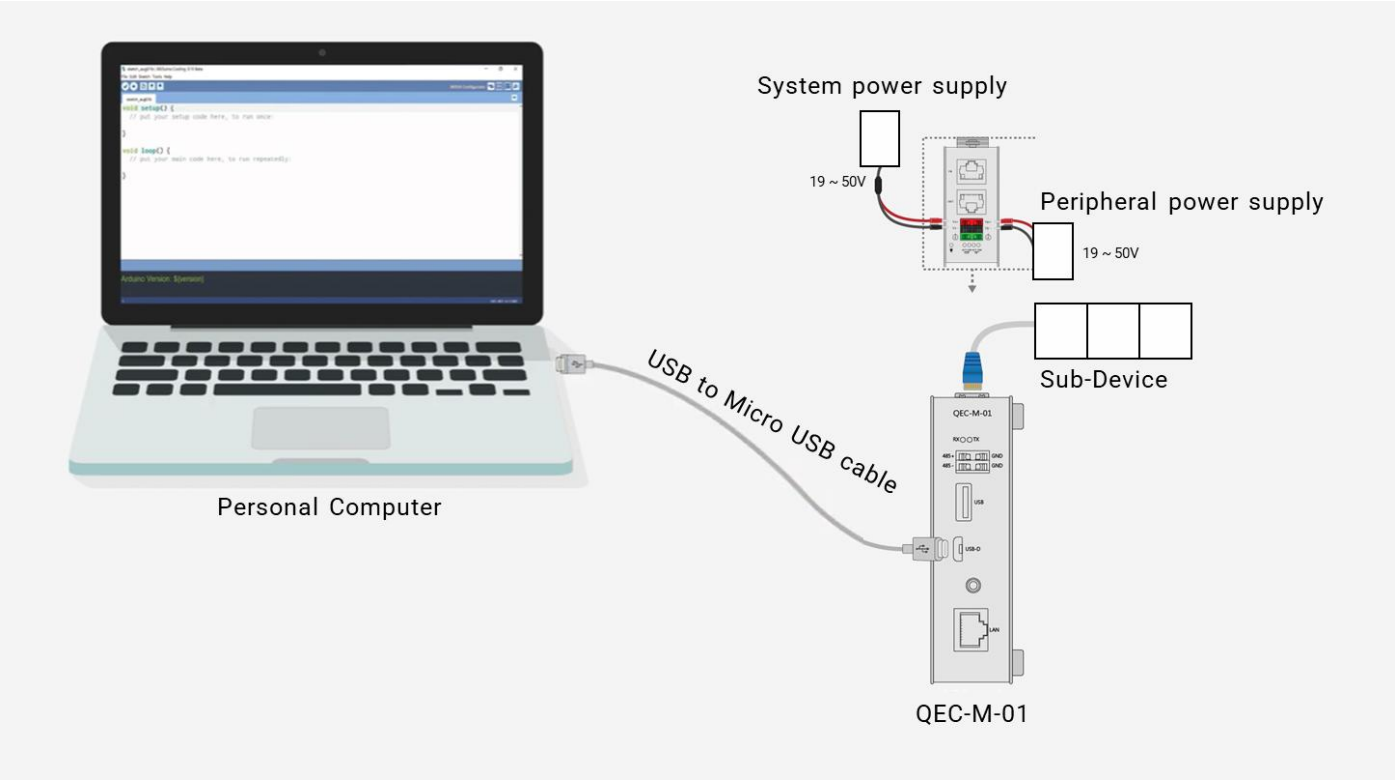
1. QEC-M-01 (EtherCAT MDevice)
2. NPM EC-AD1441A4 (2-phase Bipolar 4-axis stepping motor driver)
3. 24V power supply & EU-type terminal cable & LAN cable
4. 86STEP-42*4 (Encoder in Stepper Motor, size 42 mm square)



1.1 QEC-M-01

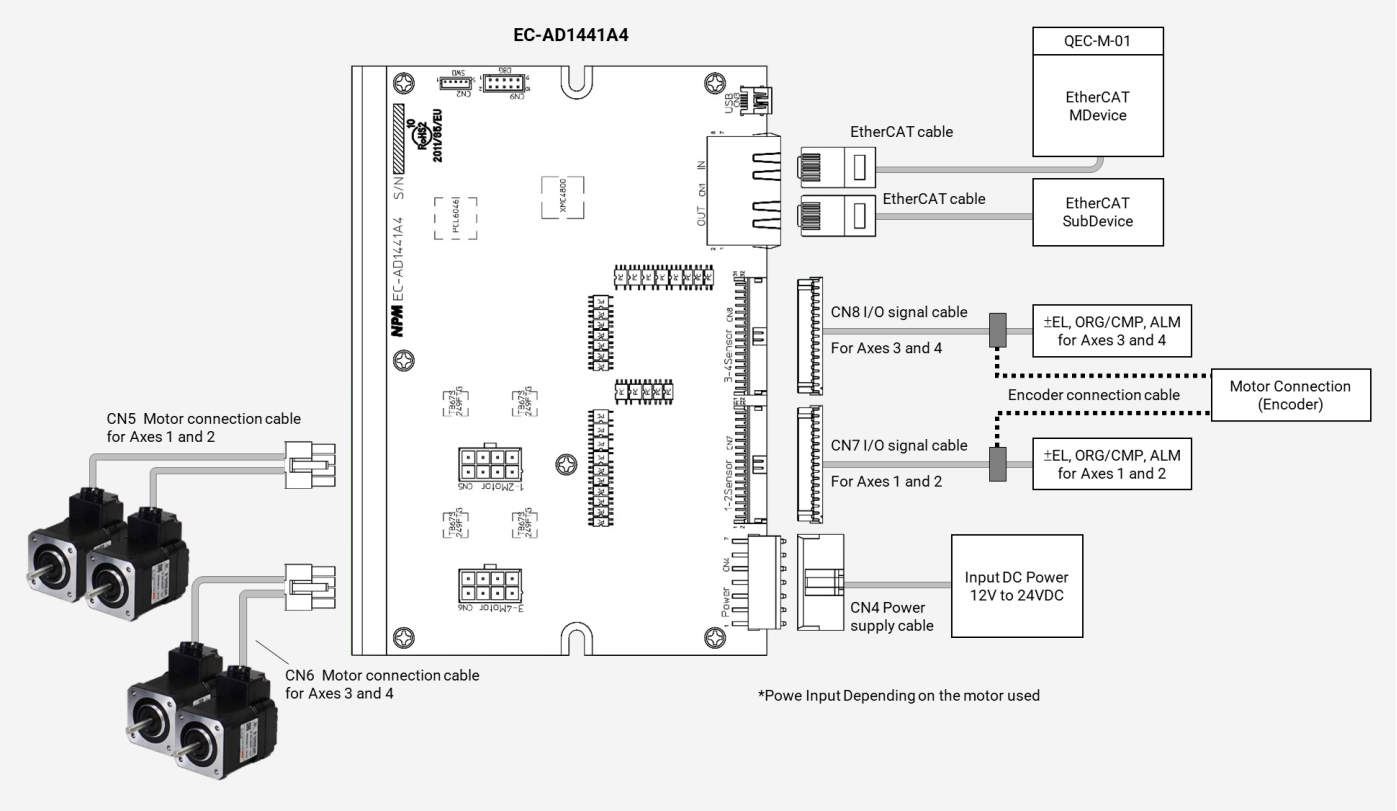
QEC EtherCAT MDevice.

1. Power Supply: Connect to Vs+/Vs- and Vp+/Vp- power supplies via EU terminals for 24V power.
2. EtherCAT Connection: Using the EtherCAT Out port (On the top side) connected to the EtherCAT In port of EtherCAT SubDevice via RJ45 cable.



1.2 EC-AD1441A4

EC-AD1441A4, an EtherCAT Bipolar constant current, Four axes 2-phase stepping motor driver. This figure shows an example of when the **86STEP-42** motor is connected.



1. EtherCAT Connectivity:
   - Two EtherCAT communication ports (IN and OUT) connect the MDevice (QEC-M01) and the other SubDevices.
2. Signal Connections:
   - CN7: I/O signal interface for Axes 1 and 2 (EL, ORG, CMP, ALM signals).
   - CN8: I/O signal interface for Axes 3 and 4 (EL, ORG, CMP, ALM signals).
   - Encoder Connection: Tracks motor positions for each axes.
3. Motor Connections:
   - CN5: Motor connection cable for Axes 1 and 2.
   - CN6: Motor connection cable for Axes 3 and 4.
4. Power Supply:
   - CN4: Input DC power (12V~24V), powering the device and motors.
5. Safety and Status:
   - Emergency signals (EMG, ALM) are integrated for safety.
   - LED indicators display device and EtherCAT status.

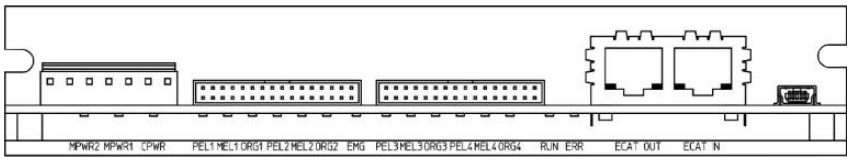
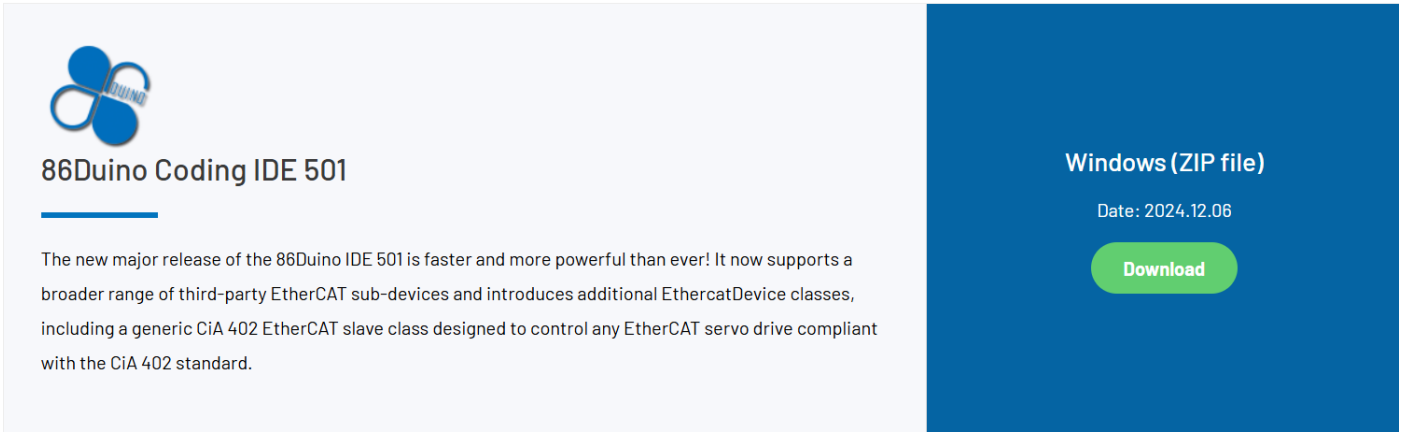


Figure: EC-AD1441A4Side view

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.

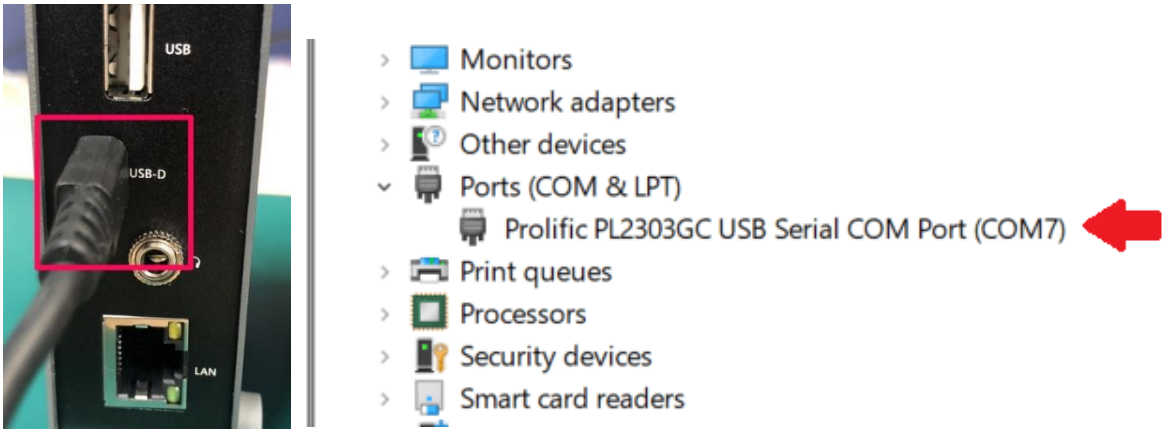
Note:
If Windows displays a warning, click Details once and then click the Continue Run button once.

86Duino Coding IDE 501+ looks like below.

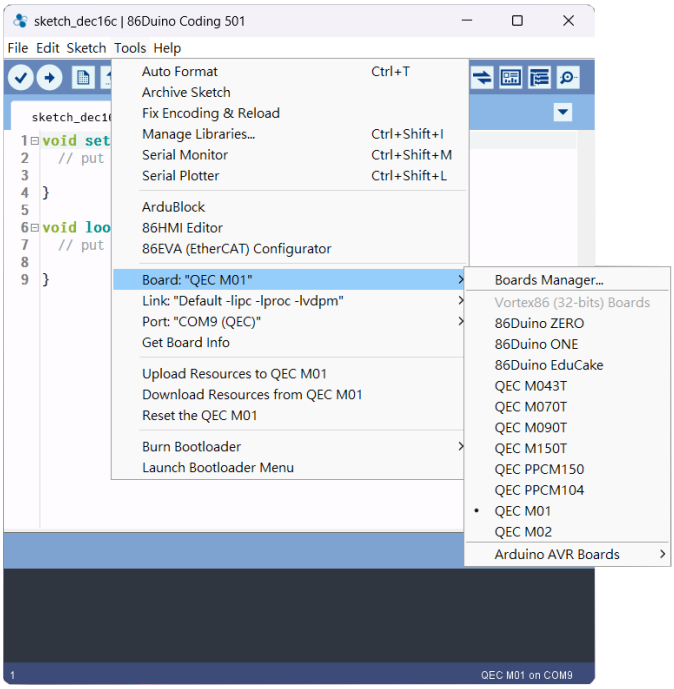
3. Connect to PC and set up the environment

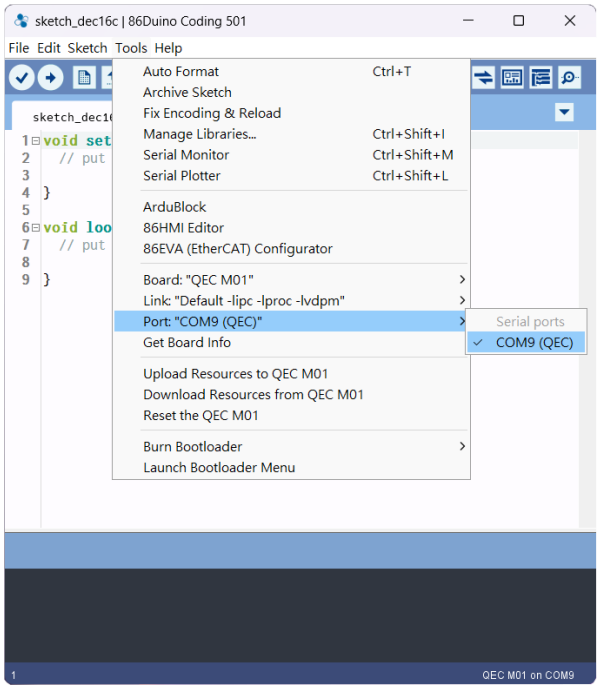
Follow the steps below to set up the environment:

1. Connect the QEC-M-01 to your PC via a Micro USB to USB cable (86Duino IDE installed).
2. Turn on the QEC power.
3. Open “Device Manager” (select in the menu after pressing Win+X) ->” 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 MDevice model you use).
6. Select Port: In the IDE's menu, select Tools > Port and select the USB port to connect to the QEC MDevice (in this case, COM9 (QEC)).





4. Use 86EVA with code

This example shows how to operate the EtherCAT MDevice (QEC-M-01) and the NPM EC-AD1441A4 (2-phase Bipolar 4-axis stepping motor driver) through the 86Duino IDE's graphical low-code programming tool, 86EVA.

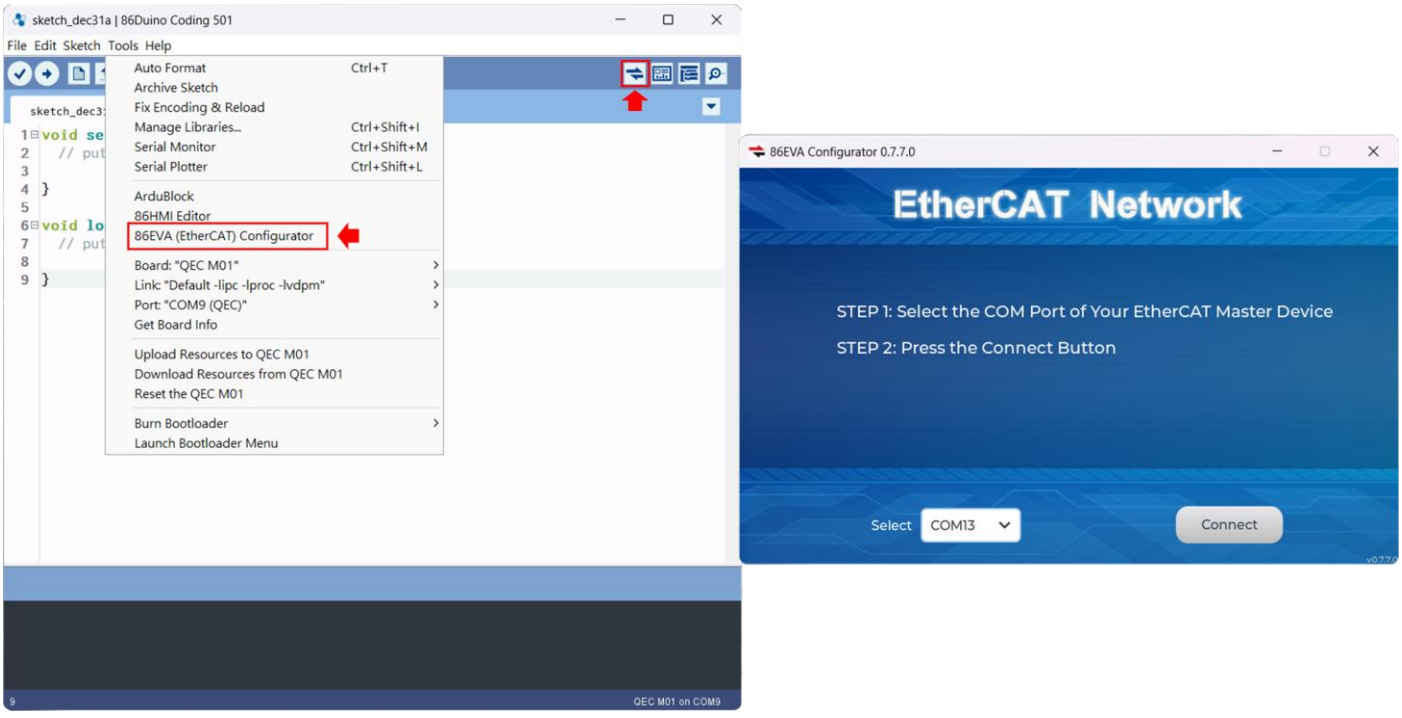
Software Tools Description:

- 86EVA (EVA, EtherCAT-Based Virtual Arduino):
  is a graphical EtherCAT configuration tool based on the EtherCAT Library in the 86Duino IDE and is one of the development kits for 86Duino.

This code establishes EtherCAT communication and controls the NPM AD1442A1 driver in Profile Position (PP) mode. The motor's position is updated cyclically, and the target position alternates between 100,000 and 100,000 units, simulating continuous forward and reverse movements.

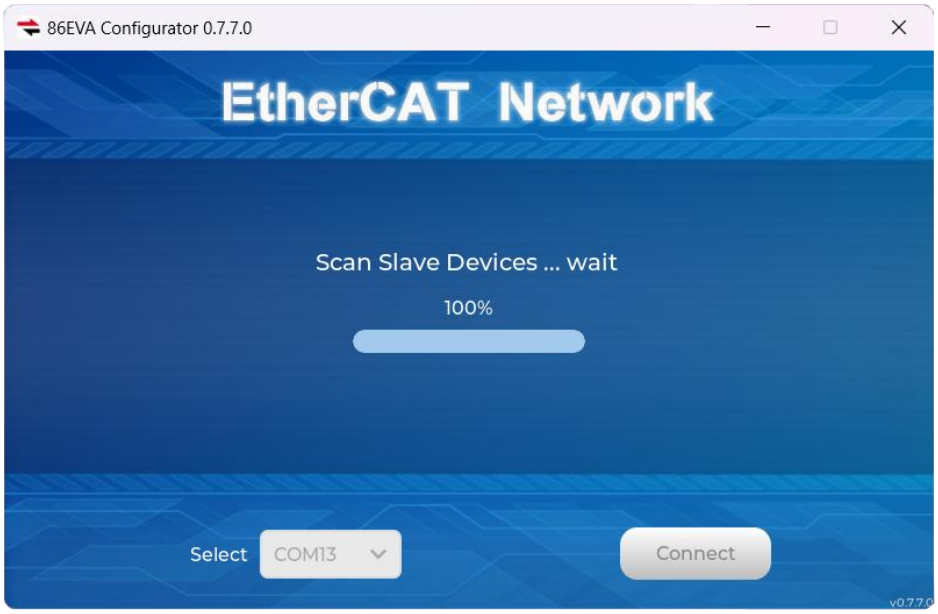
Step 1: Turn on 86EVA and scan

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



Please select the correct COM port and then click the "Connect" button.

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



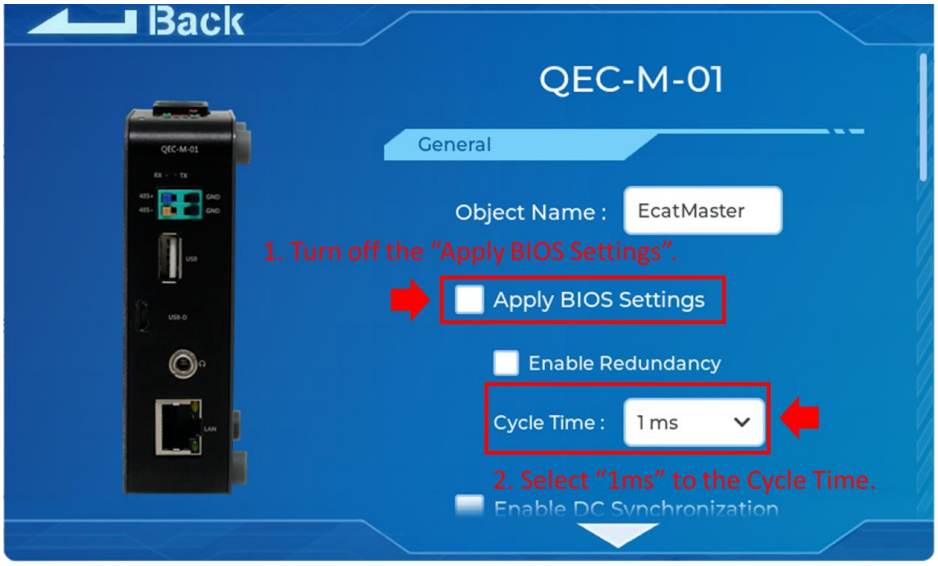
The connected devices will be displayed after the EtherCAT network has been scanned.

Step 2: Set the parameters

Press twice on the scanned device image to enter the corresponding parameter setting screen.

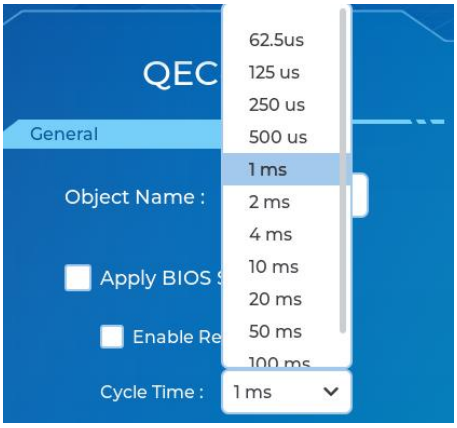
QEC-M-01

Press twice on the image of the QEC-M-01 to see the parameter settings.

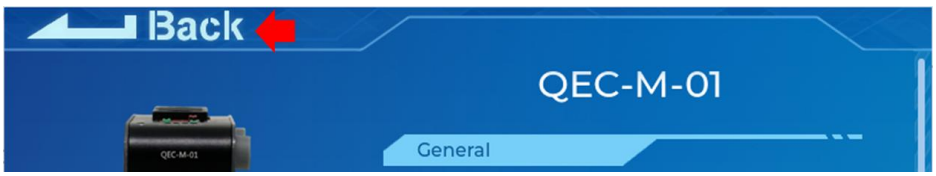


Please check the following configures.

1. Turn off the “Apply BIOS Settings”.
2. Select “1ms” to the Cycle Time.



Click "Back" in the upper left corner to return.

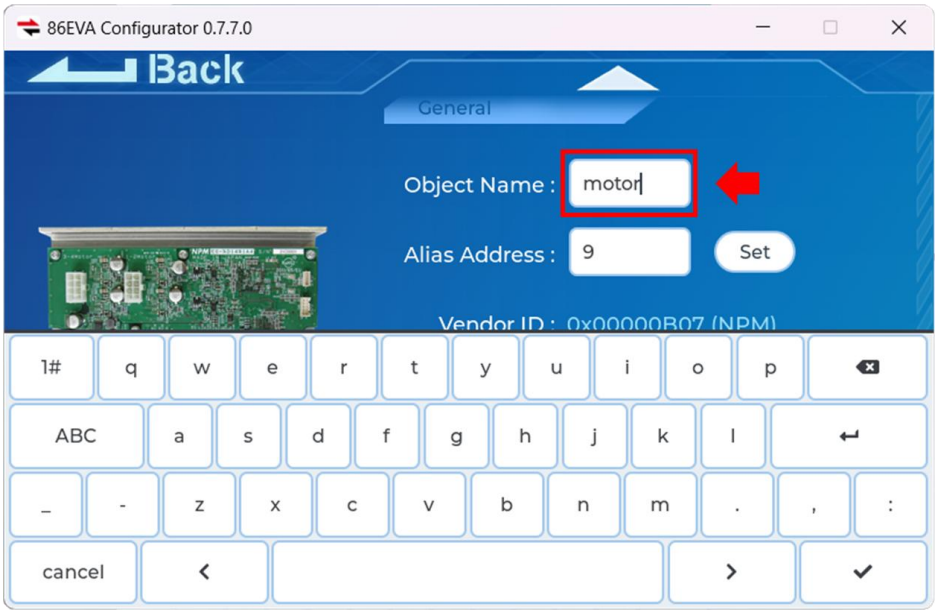


EC-AD1441A4

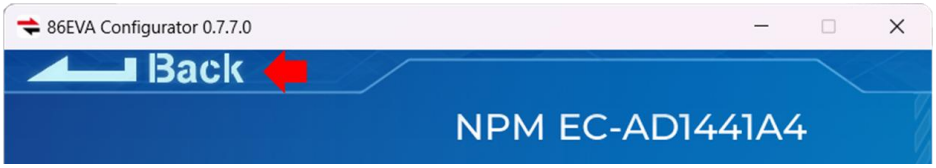
Press twice on the image of the NPM EC-AD1441A4 Driver to see the parameter settings.

The page will show the Object Name, Alias Address, Vendor ID, Product Code, Virtual Arduino Mapping, and Virtual Servo Configuration parameters.

Please change the Object Name to “motor”.
It’ll appear a keyboard after you click the Object Name.



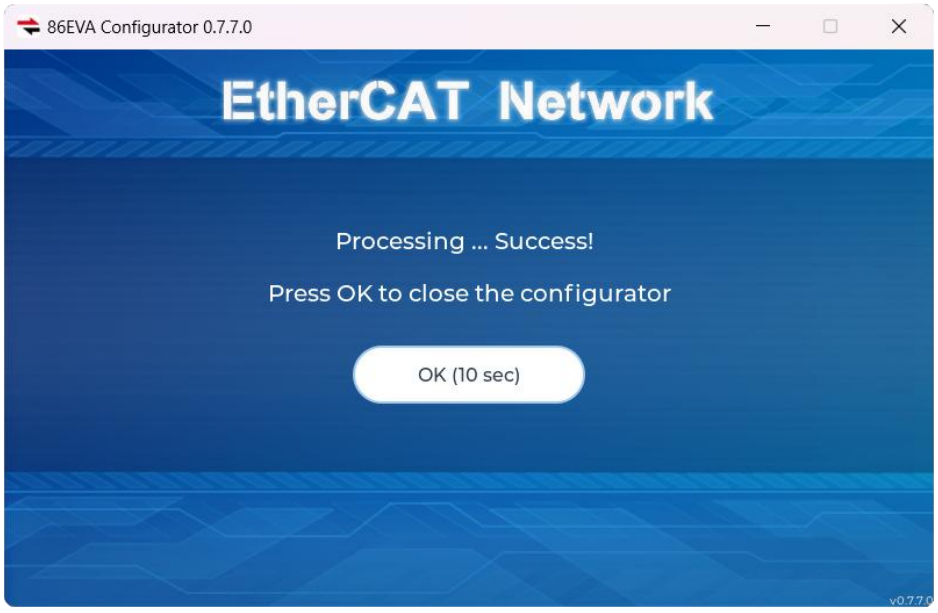
Click "Back" in the upper left corner to return.



Step 3: Generate the code

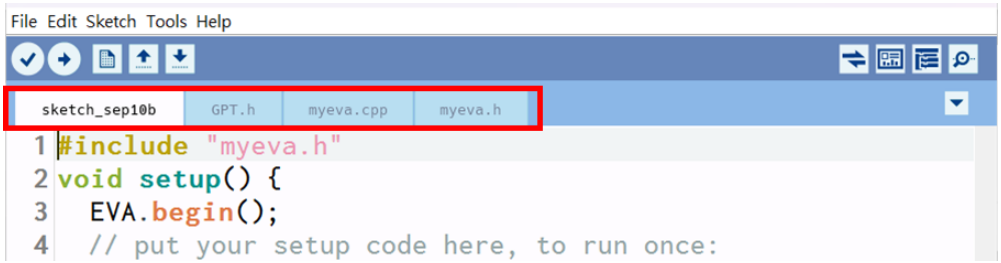
Once you've set your device's parameters, go back to the home screen and press the "Code Generation" button in the bottom right corner.

When you're done, double-click the OK button to turn off 86EVA, or it will close in 10 seconds.



The generated code and files are as follows:

- sketch_sep10b: Main Project (.ino, depending on your project name)
- GPT.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 missing 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: Write the code

The programming code from 86EVA are set as the following by default:

- NPM EC-AD1441A4: Total 4 EthercatDevice_CiA402 objects, represent 4 axes on the EC-AD1441A4 stepper motor driver.
- CiA402 mode: Profile Position (PP) mode.
- EtherCAT mode: ECAT_SYNC.
- Distributed Clock: Open. Follow the EtherCAT cycle time.

And here is the setting by users:

- EtherCAT Cycle time: 1 millisecond.
- Device Object Name: QEC-M-01 is “EcatMaster”, and NPM EC-AD1441A4 is “motor”.

This code establishes EtherCAT communication and controls the NPM EC-AD1441A4 driver in Profile Position (PP) mode. Four motors' positions are updated cyclically, and the target position alternates between 100,000 and 100,000 units, simulating continuous forward and reverse movements.

A. In Setup Function:

In the setup() function initializes communication and configures the motor for CiA402 Profile Position (PP) mode. Follow the steps below:

1. Initialize Serial Communication
    - Start serial communication at a baud rate of 115200.
2. Start the 86EVA
    - Use the EVA.begin() function to start and initialize the EtherCAT network.
3. Set Profile Position (PP) Mode
    - Configure the motor to PP mode using setCiA402Mode(CIA402_PP_MODE).
4. Enable the Motor
    - Use the enable() function to enable the motor and transition it to CIA402_OPERATION_ENABLED.
5. Configure Profile Parameters
    - Motion Profile Type: Linear Ramp, Profile Velocity: 50,000, Acceleration: 3,000, Deceleration: 3,000.

B. In Loop Function:

In the loop() function, the motor's current position is displayed on the Serial Monitor, and the motor alternates its movement back and forth.

1. State Machine Logic
    - case 0: Start the motor and move to the target position (100,000 units). Once the command is successfully executed, transition to the next state.

- case 1: Wait for the motor to reach the target position. Once the target is reached, proceed to the next state.
- case 2: Start the motor and move back to the original position (-100,000 units). Once the command is successfully executed, transition to the next state.
- case 3: Wait for the motor to return to the original position. Once the target is reached, reset the state machine back to case 0 to repeat the movement cycle.

2. Tracks the number of completed cycles using pp_done. When all motors complete their cycles, resets all state machines (pp_state[]) and the pp_done counter.

Code Logic Summary

- Use the pp_Run() function to initiate position movement.
- Use the pp_IsTargetReached() function to confirm whether the target position has been reached.
- The state machine starts at case 0 and resets after completing case 3.

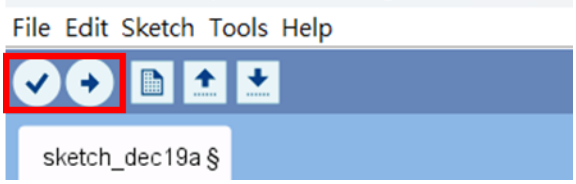
The example code is as follows:

```
#include "myeva.h"

#define NUM 4

int pp_state[NUM]; // State machine for PP
int pp_done = 0;

void setup() {
  Serial.begin(115200);
  EVA.begin();

  for (int i = 0; i < NUM; i++)  motor[i].setCiA402Mode(CIA402_PP_MODE);

  for (int i = 0; i < NUM; i++) {
    delay(100);
    Serial.print("Enable"); Serial.print(i);
    Serial.print(": "); Serial.println(motor[i].enable());
    motor[i].pp_SetMotionProfileType(0);
    motor[i].pp_SetVelocity(50000);
    motor[i].pp_SetAcceleration(3000);
    motor[i].pp_SetDeceleration(3000);
  }
}

void loop() {
```

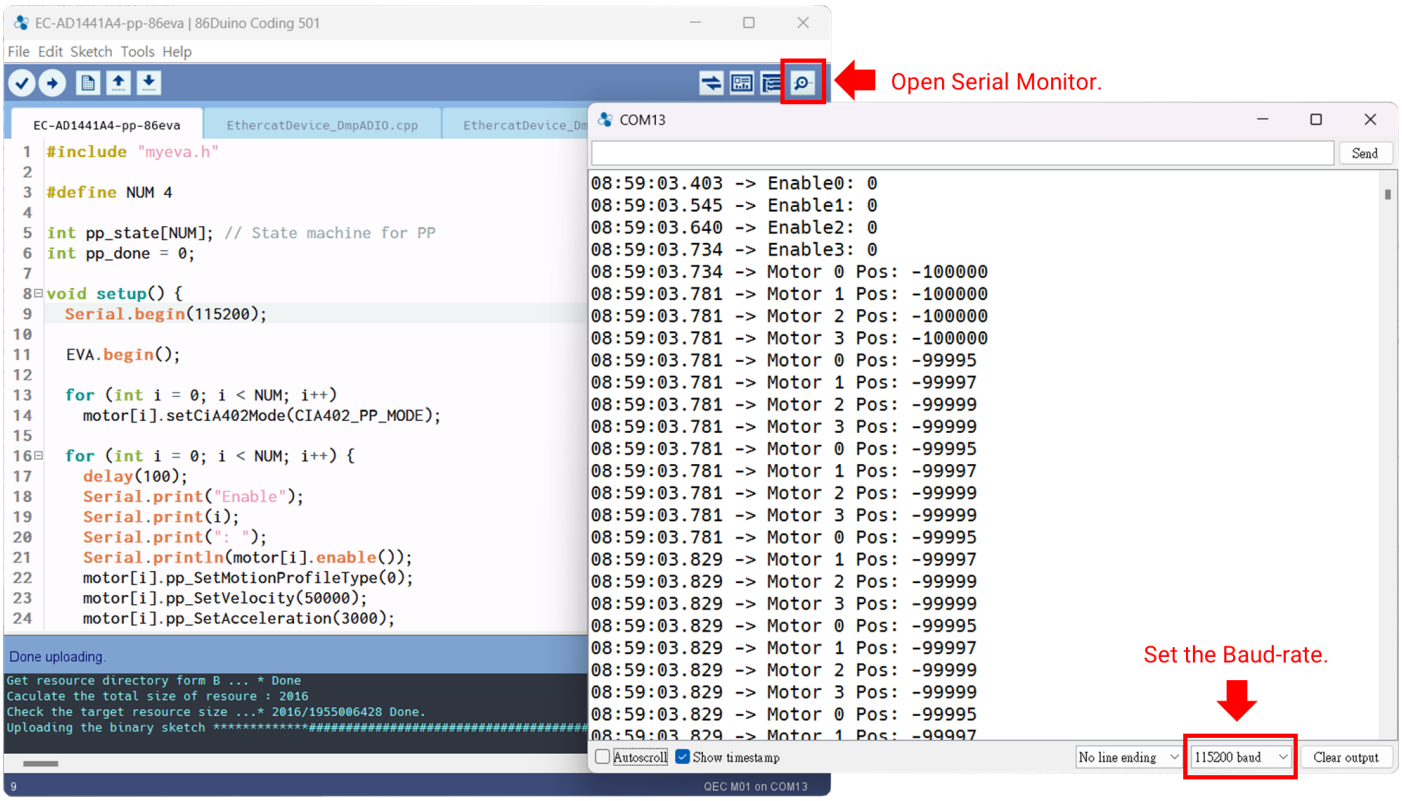
```
  for (int i = 0; i < NUM; i++) {
    Serial.print("Motor "); Serial.print(i);
    Serial.print(" Pos: "); Serial.println(motor[i].getPositionActualValue());

    switch (pp_state[i]) {
      case 0:
        if (motor[i].pp_Run(100000) == 0)
          pp_state[i]++;
        break;
      case 1:
        if (motor[i].pp_IsTargetReached())
          pp_state[i]++;
        break;
      case 2:
        if (motor[i].pp_Run(-100000) == 0)
          pp_state[i]++;
        break;
      case 3:
        if (motor[i].pp_IsTargetReached())
          pp_state[i] = 0;
        pp_done++;
        break;
    }
  }

  // Once all motors are done, reset states
  if (pp_done == NUM) {
    pp_done = 0;
    for (int i = 0; i < NUM; i++)
      pp_state[i] = 0;
  }
}
```

Note:

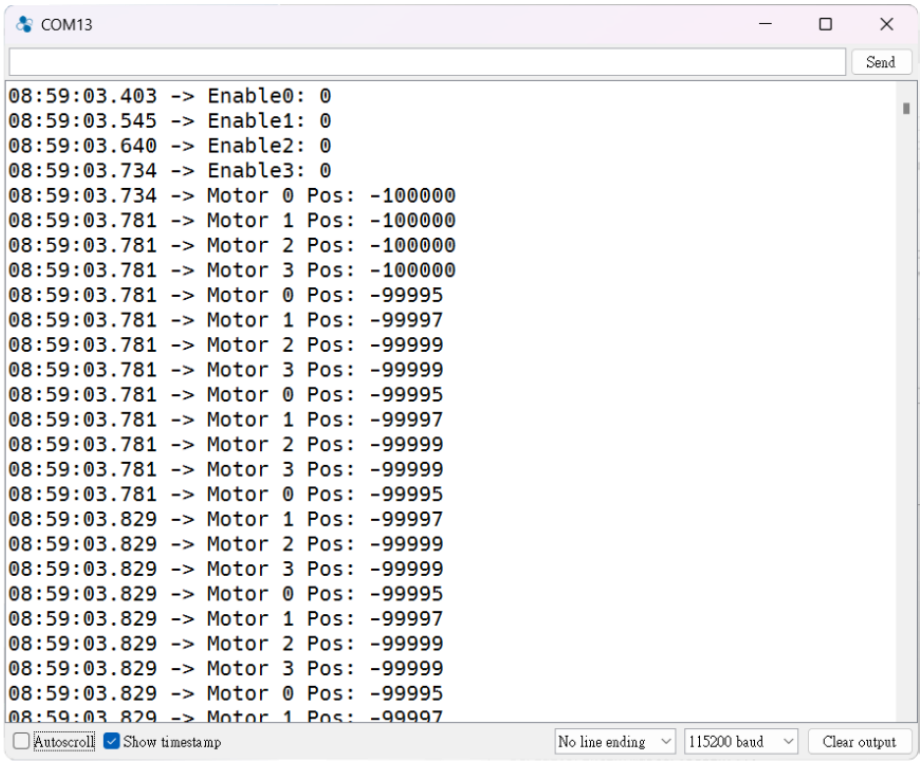
Once the code is written, click on the toolbar to  compile, and to confirm that the compilation is complete and error-free, you can click  to upload.



After you successfully upload the program to the QEC-M-01, you can open the Serial Monitor on 86Duino IDE. Please check the Serial baud rate is same as your setting.



If the EtherCAT communication config successful, Serial Monitor will print “Enable: 0”.
And it will print the motor’s current position to the serial monitor.



Troubleshooting

QEC-M-01 cannot successfully upload code

When you are unable to successfully upload code, please open 86EVA to check if your QEC EtherCAT MDevice's environment is abnormal. As shown in the figure below, please try updating your QEC EtherCAT MDevice's environment, which will include the following three items: Bootloader, EtherCAT firmware, and EtherCAT tool.

Now, we will further explain how to proceed with the update:

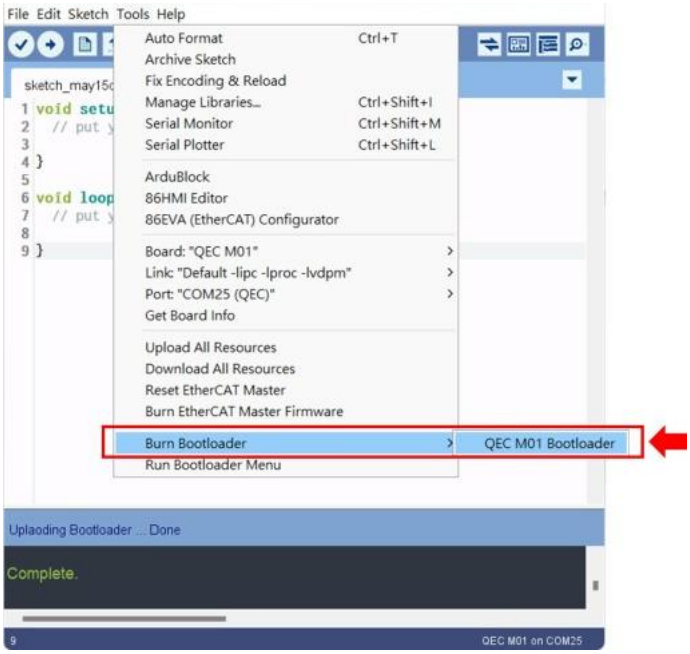
Step 1: Setting up QEC-M

1. Download and install 86Duino IDE 500+ (or a newer version): You can download it from Software.
2. Connect the QEC-M: Use a USB cable to connect the QEC-M to your computer.
3. Open 86Duino IDE: After the installation is complete, open the 86Duino IDE software.
4. Select Board: From the IDE menu, choose "Tools" > "Board" > "QEC-M-01" (or the specific model of QEC-M you are using).
5. Select Port: From the IDE menu, choose "Tools" > "Port" and select the USB port to which the QEC-M is connected.

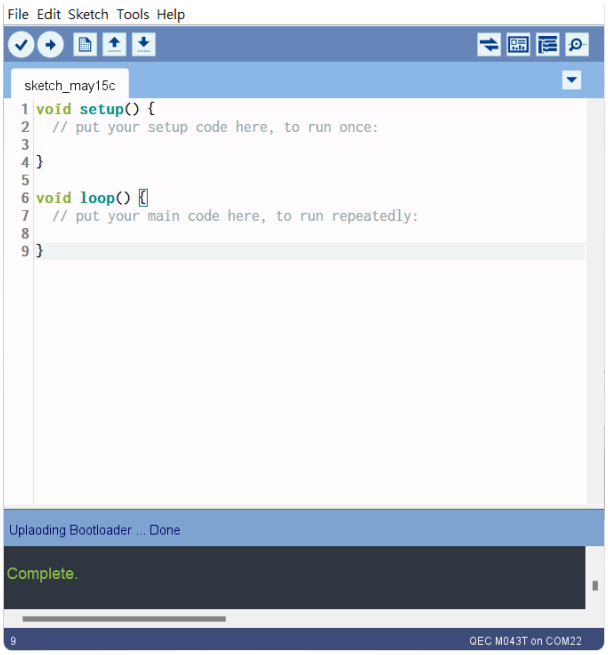
Step 2: Click “Burn Bootloader” button

After connecting to your QEC-M product, go to “Tools”> “Burn Bootloader”. The currently selected QEC-M name will appear. Clicking on it will start the update process, which will take approximately 5-20 minutes.

QEC-M-01:



Step 3: Complete the Update



After completing the above steps, your QEC-M has been successfully updated to the latest version of the development environment.

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.