ICOP Technology Inc.

Start Guide

NPM PULSERVO II EtherCAT Driver CiA402 PP Mode (1-axis) with 86EVA

86Duino Coding IDE 501

EtherCAT Library

(Version 1.1)

Revision

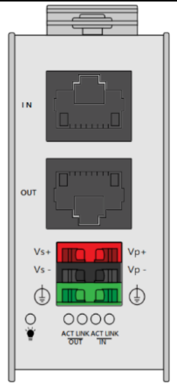
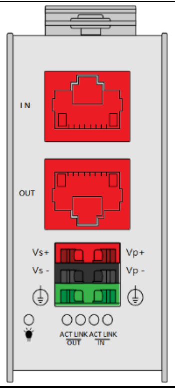
Date	Version	Description
2024/12/31	Version1.0	New Release.
2025/1/23	Version1.1	Change Main-device to MDevice, and Sub-device or Slave to SubDevice

Preface

In this guide, we will show you how to use the EtherCAT MDevice QEC-M-01 and the NPM Pulservo II (Closed-loop stepping motor Driver).

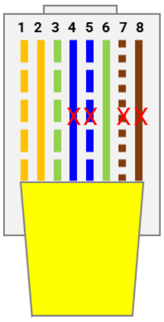
Notes QEC's PoE (Power over Ethernet)

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:



T568B Color

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

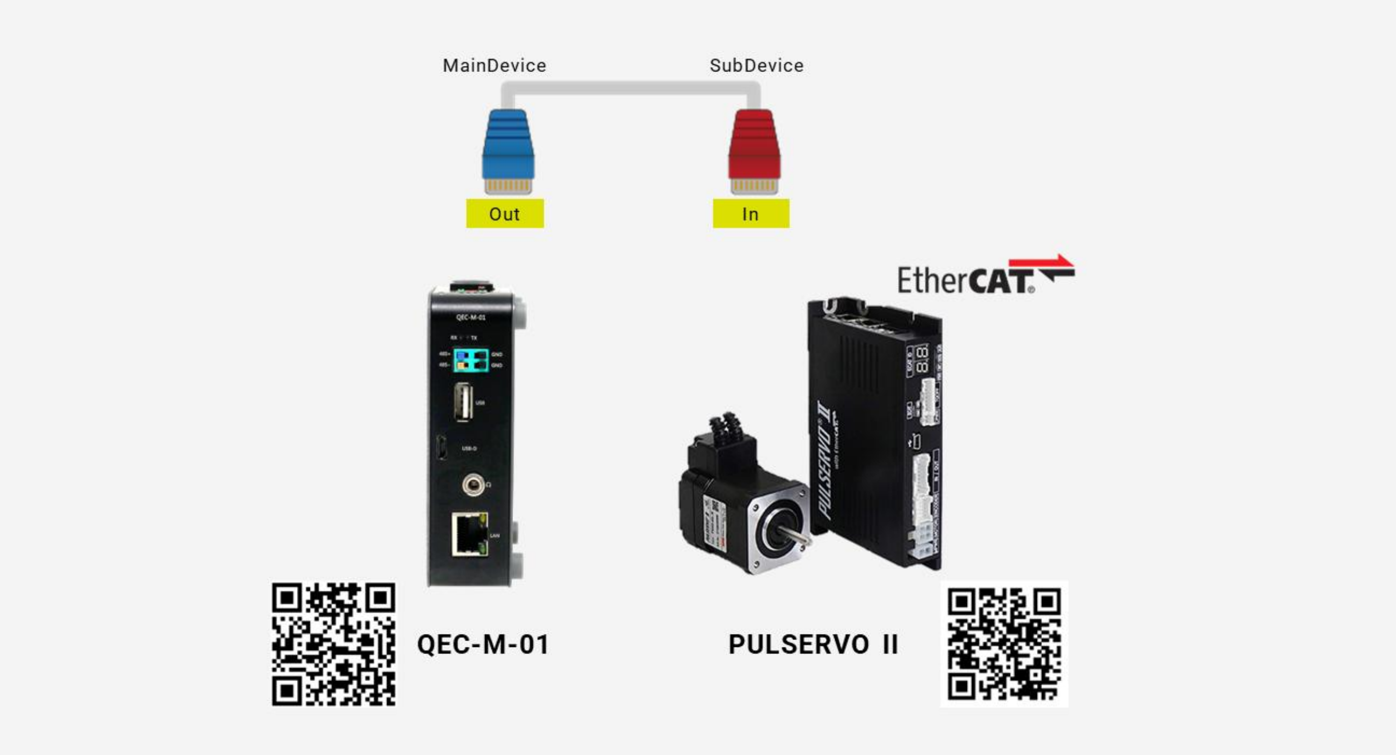
2. When connecting PoE and non-PoE devices, make sure to disconnect Ethernet cables at pins 4, 5, 7, and 8 (e.g., when a PoE-supported QEC EtherCAT MDevice connects with a third-party EtherCAT SubDevice).

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

1. Connection and wiring hardware

The following devices are used here:

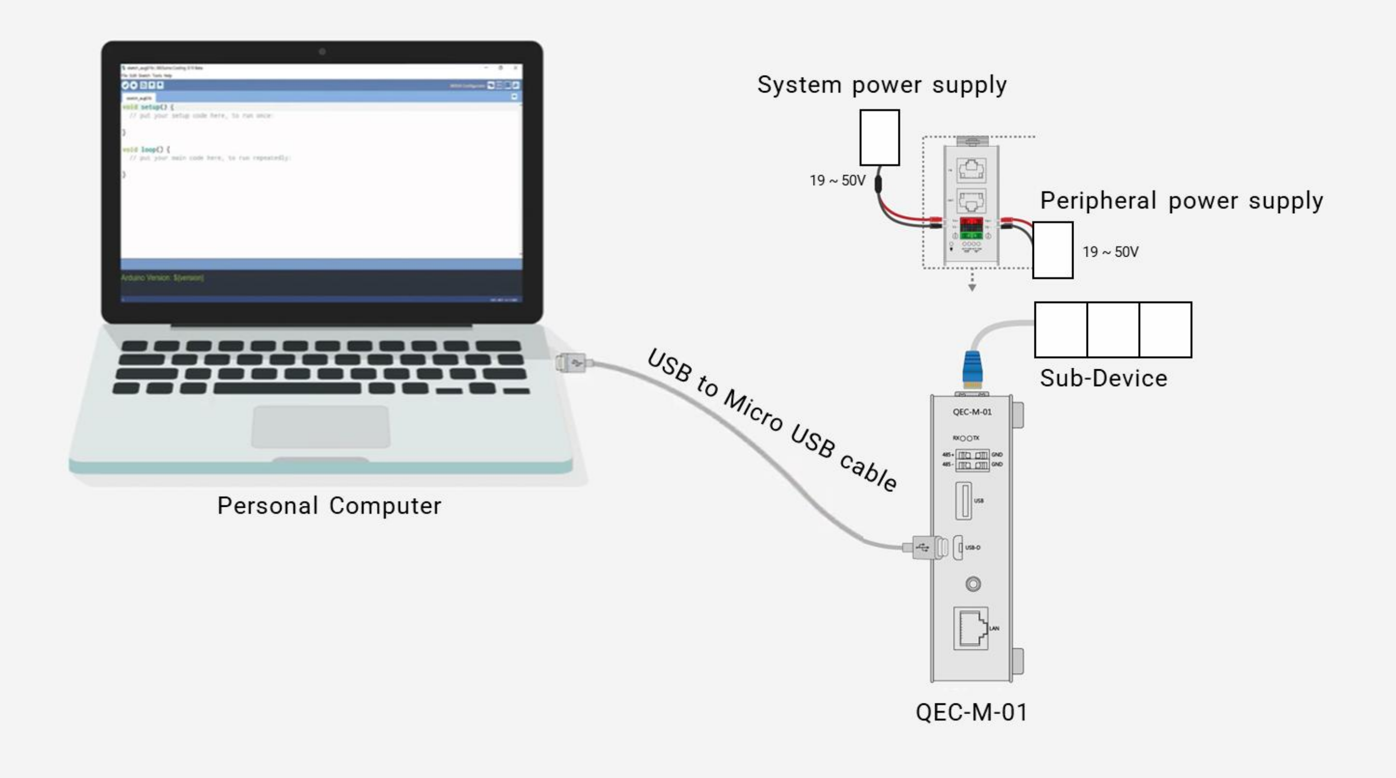
1. QEC-M-01(EtherCAT MDevice）
2. NPM Pulservo II (Closed-loop stepping motor Driver)
3. 24V power supply & EU-type terminal cable & LAN cable
4. PSM2-28 (Standard type Motor, frame size 28 mm square)



1.1 QEC-M-01

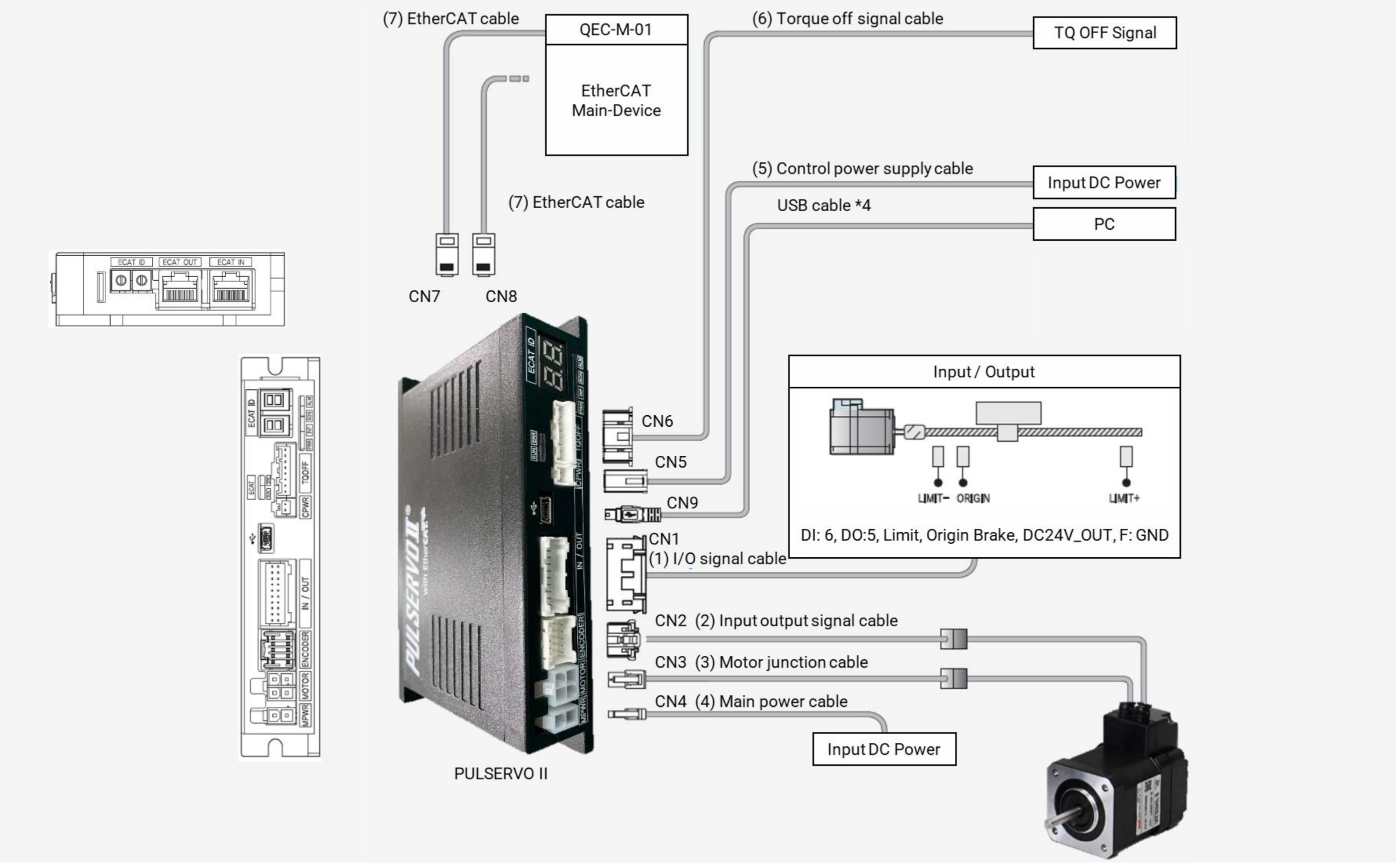
QEC EtherCAT MDevice.

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.



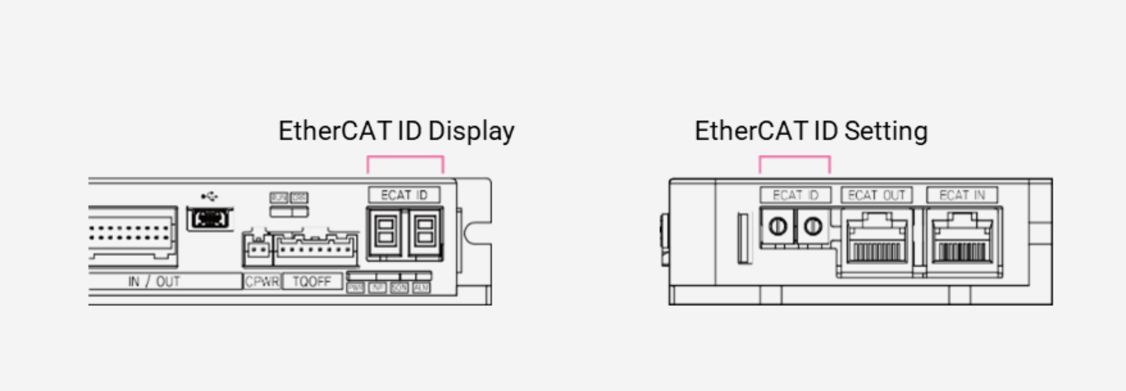
1.2 NPM Pulservo II

NPM Pulservo II, a PLS2-EC series EtherCAT interface closed-loop stepping motor driver (NPM Step-Servo Driver). This figure shows an example of when the **PSM2-28** motor is connected.



1. EtherCAT Connectivity:
   - Two EtherCAT ports (CN7, CN8) for network communication.
   - EtherCAT ID setting switches (SW1, SW2) for device identification.
2. Signal Connections:
   - Input/output signal interface (CN1) for digital inputs and outputs.
   - Encoder connection (CN2) to track motor position.
   - Motor connection (CN3) for power and control.
3. Power Supply:
   - Main power input (CN4) for operating the motor.
   - Control power input (CN5) for driver control circuitry.
4. Safety and Status:
   - Torque-Off signal input (CN6) for emergency stop functionality.
   - LED indicators for driver status, EtherCAT status, and EtherCAT ID display.
5. USB Port:
   - USB interface (CN9) for configuration and monitoring.

ID setting for Pulservo II Driver:



Change the EtherCAT ID (Configured Alias ID) value by configuring the rotary switch. The switch on the left shows 10 digits and the switch on the right shows 1 digit.
The setting range is 0 to 99.

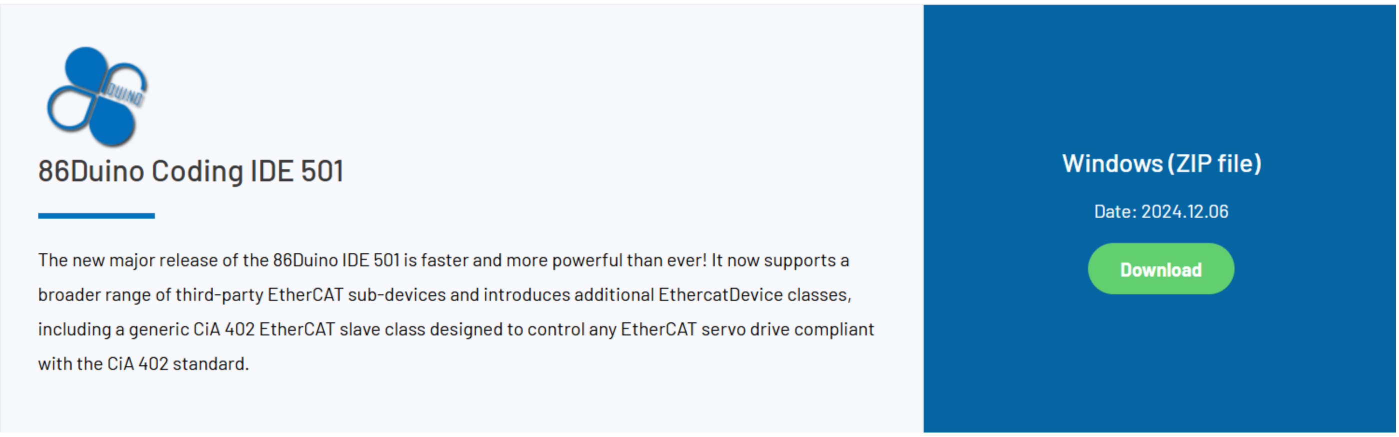
Note: The ID Value (Configured Alias ID) set on the rotary switch is applied when the product is turned ON.

ID Settings:

- The 7-segment LED indicates the Physical Address or EtherCAT ID (EtherCAT Configured Alias) value. The display value conditions are as follows:
- When all rotary switches are set to "0", the 7-segment LED indicates the EtherCAT Physical Address. Since there is no connection between the SubDevice (this product) and the MDevice, it indicates 0 (zero) until the Physical Address is assigned. When the MDevice assigns a physical address to each SubDevice (this product), its value is displayed.
- If the rotary switch is set to any other value other than "0", the 7-segment LED indicates the corresponding set value (EtherCAT Configured Alias).
- If the 7-segment LED of the ID is blinking, it indicates that the ID value is not set. It is set when the power is turned ON.

2. Software/Development Environment

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



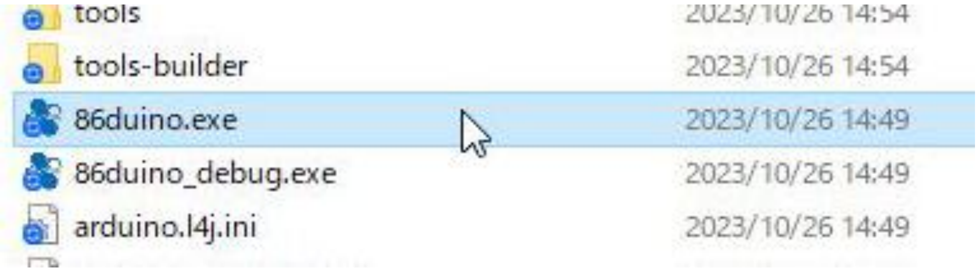
86Duino Coding IDE 501

The new major release of the 86Duino IDE 501 is faster and more powerful than ever! It now supports a broader range of third-party EtherCAT sub-devices and introduces additional EthercatDevice classes, including a generic CiA 402 EtherCAT slave class designed to control any EtherCAT servo drive compliant with the CiA 402 standard.

Windows (ZIP file)

Date: 2024.12.06

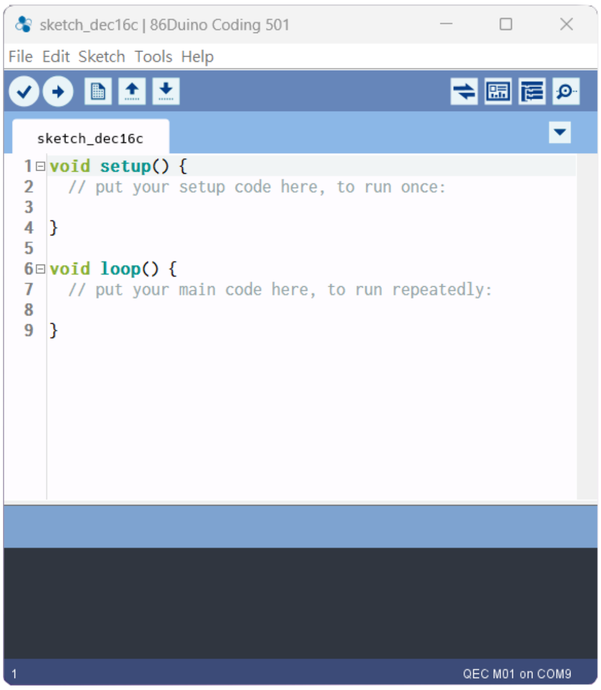
After downloading, please unzip the downloaded zip file, no additional software installation is required, just double-click 86duino.exe to start the IDE.



tools	2023/10/26 14:54
tools-builder	2023/10/26 14:54
86duino.exe	2023/10/26 14:49
86duino_debug.exe	2023/10/26 14:49
arduino.l4j.ini	2023/10/26 14:49

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

86Duino Coding IDE 501+ looks like below.



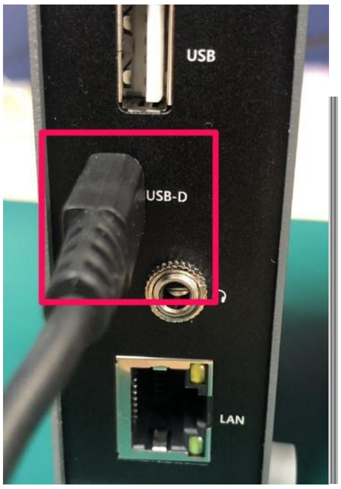
sketch_dec16c | 86Duino Coding 501
File Edit Sketch Tools Help
sketch_dec16c

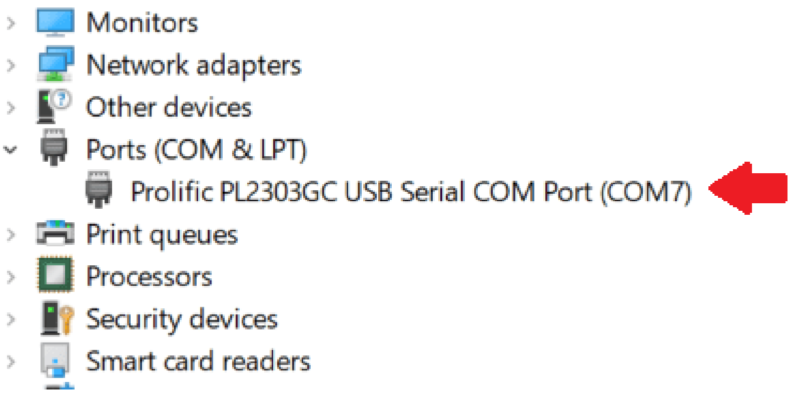
```
void setup() {
  // put your setup code here, to run once:

}

void loop() {
  // put your main code here, to run repeatedly:

}
```

3. Connect to PC and set up the environment

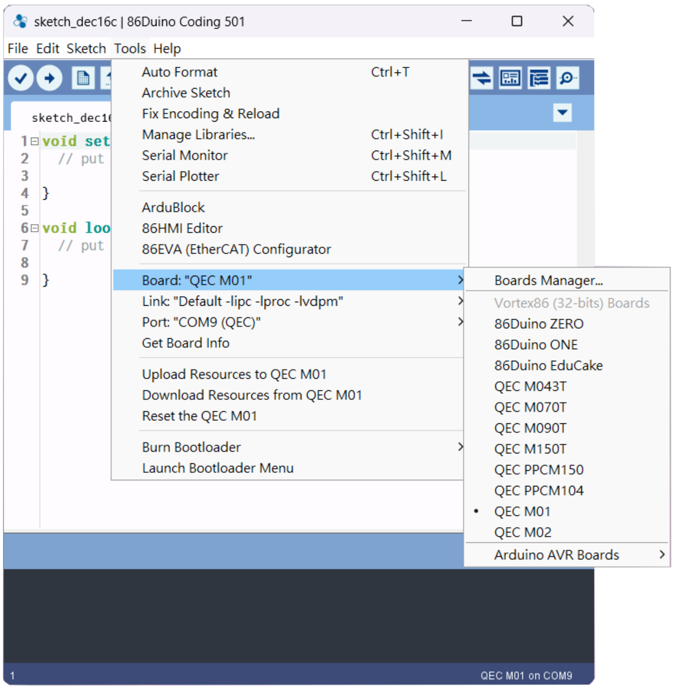
Follow the steps below to set up the environment:

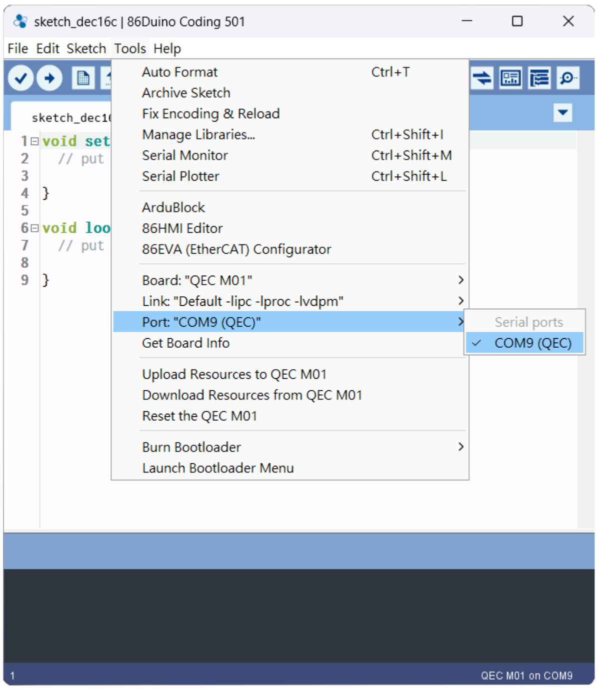
1. Connect the QEC-M-01P to your PC via a Micro USB to USB cable (86Duino IDE installed).
2. Turn on the QEC power.
3. Open “Device Manager” (select in the menu after pressing Win+X) ->” Ports (COM & LPT)” in your PC and expand the ports; you should see that the “Prolific PL2303GC USB Serial COM Port (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)).




sketch_dec16c | 86Duino Coding 501
File Edit Sketch Tools Help
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Manage Libraries... Ctrl+Shift+I
Serial Monitor Ctrl+Shift+M
Serial Plotter Ctrl+Shift+L
ArduBlock
86HMI Editor
86EVA (EtherCAT) Configurator
Board: "QEC M01"
Link: "Default -lipc -lproc -lvdpm"
Port: "COM9 (QEC)"
Get Board Info
Upload Resources to QEC M01
Download Resources from QEC M01
Reset the QEC M01
Burn Bootloader
Launch Bootloader Menu
Serial ports
✓ COM9 (QEC)
QEC M01 on COM9

4. Use 86EVA with code

This example shows how to operate the EtherCAT MDevice (QEC-M-01) and the NPM Pulservo II (Closed-loop stepping motor Driver) through the 86Duino IDE's graphical low-code programming tool, 86EVA.

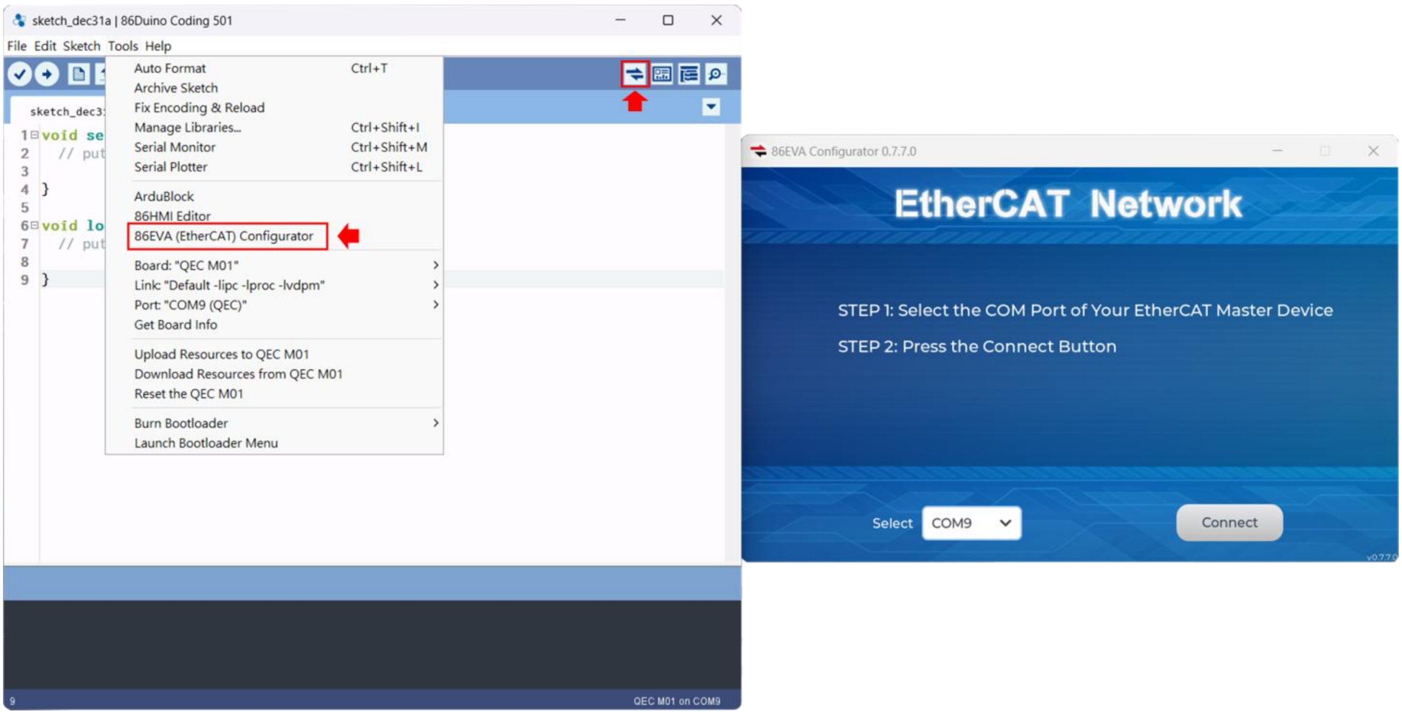
Software Tools Description:

- 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 Pulservo II 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.

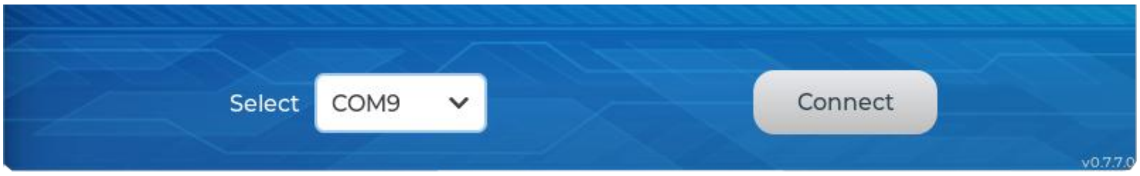


STEP 1: Select the COM Port of Your EtherCAT Master Device

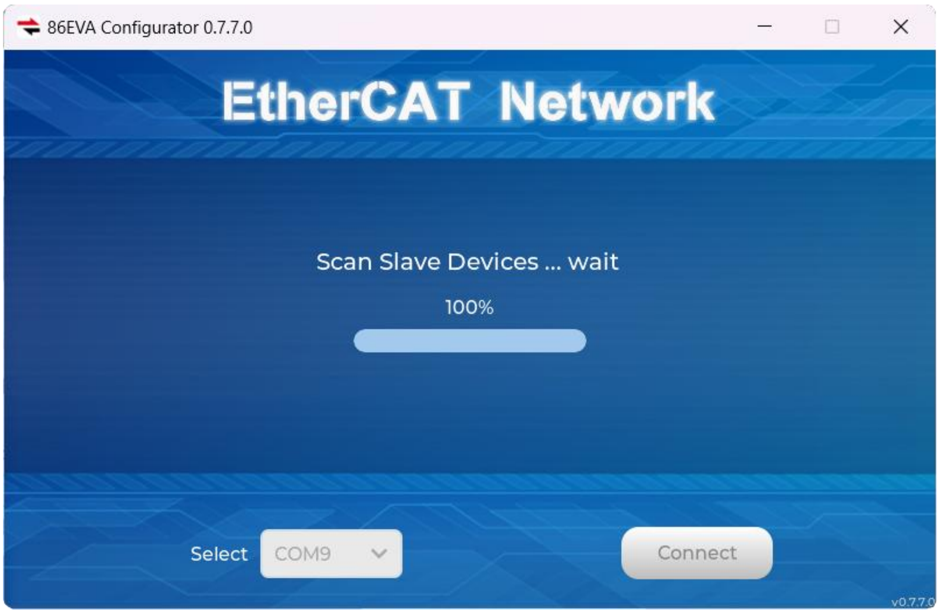
STEP 2: Press the Connect Button

sketch_dec31a | 86Duino Coding 501
File Edit Sketch Tools Help
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Manage Libraries... Ctrl+Shift+I
Serial Monitor Ctrl+Shift+M
Serial Plotter Ctrl+Shift+L
ArduBlock
86HMI Editor
86EVA (EtherCAT) Configurator
Board: "QEC M01"
Link: "Default -lipc -lproc -lvdpm"
Port: "COM9 (QEC)"
Get Board Info
Upload Resources to QEC M01
Download Resources from QEC M01
Reset the QEC M01
Burn Bootloader
Launch Bootloader Menu
QEC M01 on COM9
86EVA Configurator 0.7.7.0
EtherCAT Network
Select
COM9
Connect
v0.7.7.0

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.



86EVA Configurator 0.7.7.0

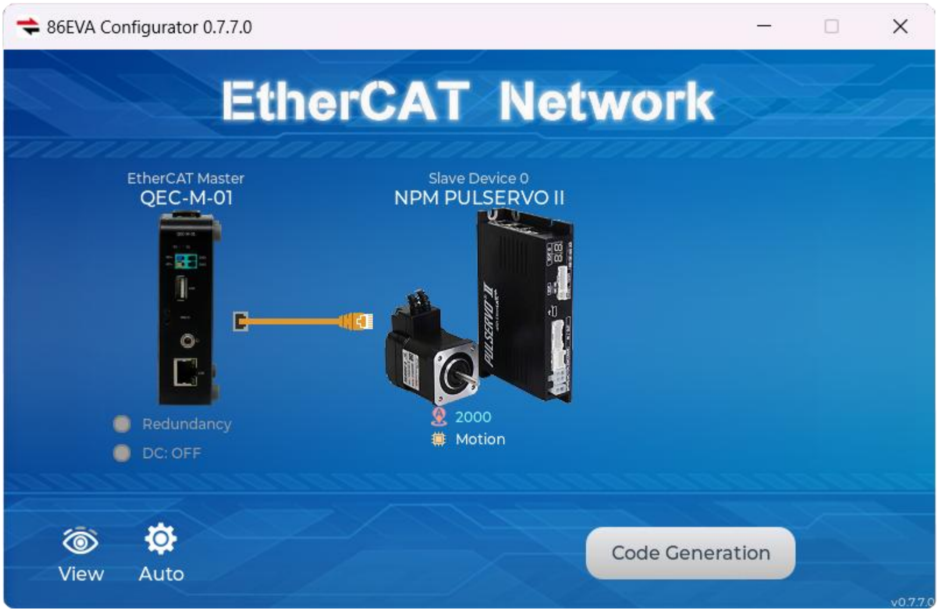
EtherCAT Network

Scan Slave Devices ... wait

100%

Select COM9

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



86EVA Configurator 0.7.7.0

EtherCAT Network

EtherCAT Master
QEC-M-01

Slave Device 0
NPM PULSERVO II

Redundancy

DC: OFF

2000

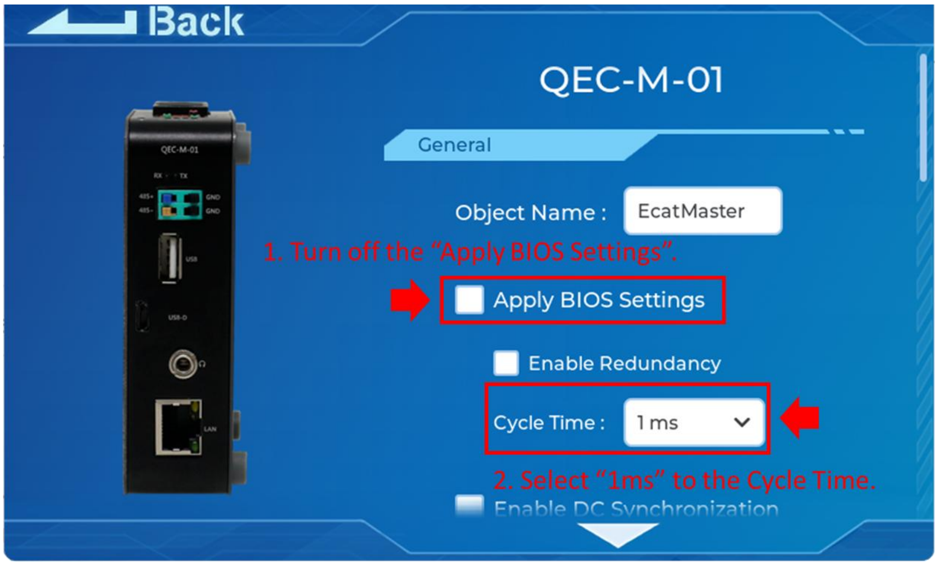
Motion

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.



Object Name : EcatMaster

1. Turn off the "Apply BIOS Settings".

□ Apply BIOS Settings

□ Enable Redundancy

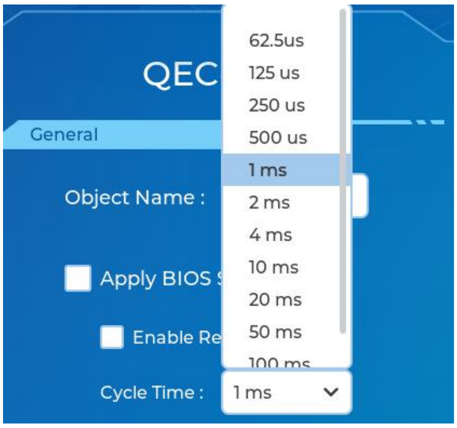
Cycle Time : 1 ms

2. Select "1ms" to the Cycle Time.

□ Enable DC Synchronization

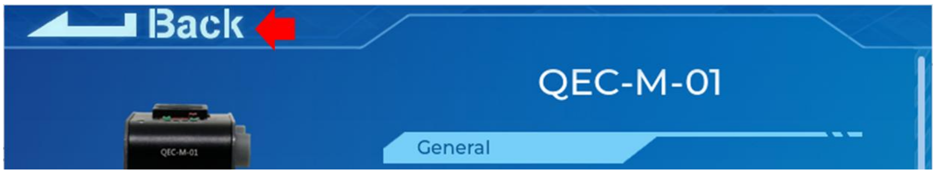
Please check the following configures.

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



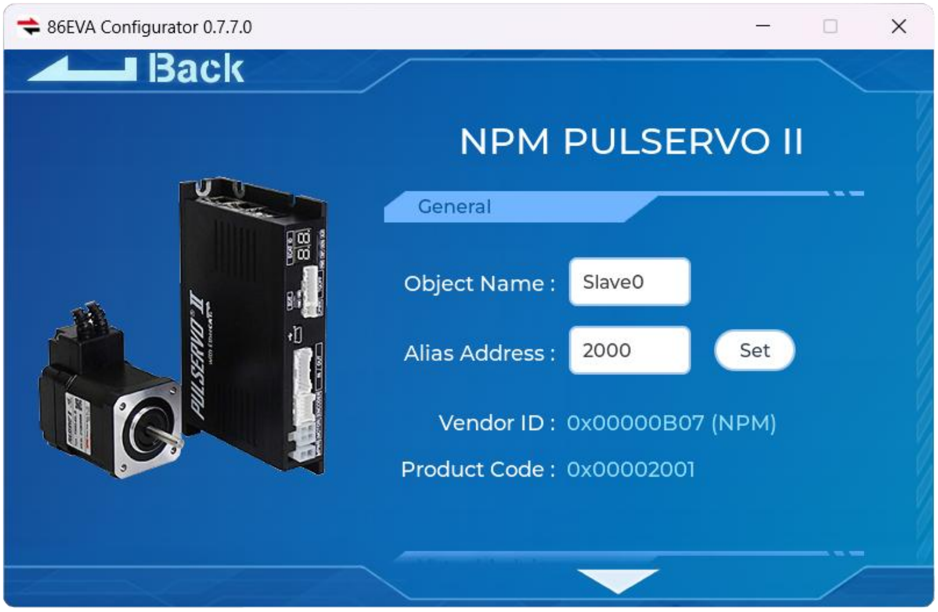
Cycle Time : 1 ms

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



NPM Pulservo II

Press twice on the image of the NPM Pulservo II Driver to see the parameter settings.



Object Name : Slave0

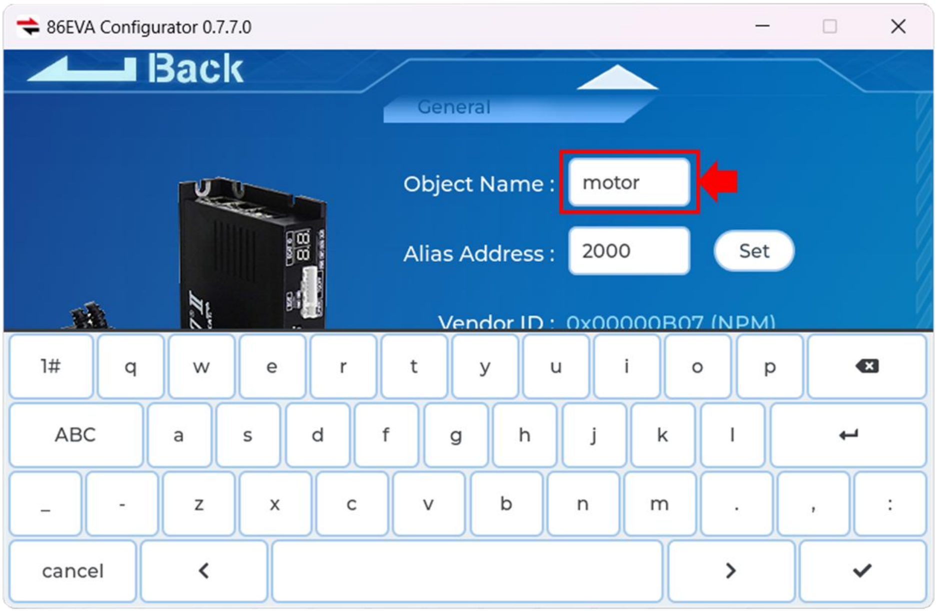
Alias Address : 2000 Set

Vendor ID : 0x00000B07 (NPM)

Product Code : 0x00002001

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.

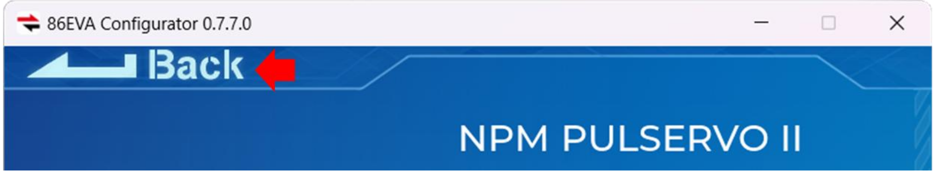


Object Name : motor

Alias Address : 2000 Set

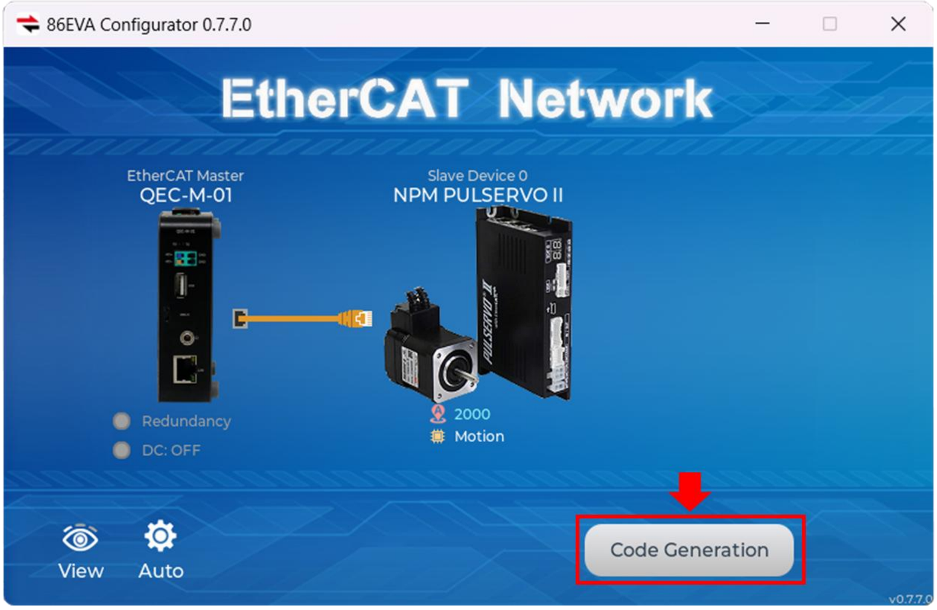
Vendor ID : 0x00000B07 (NPM)

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

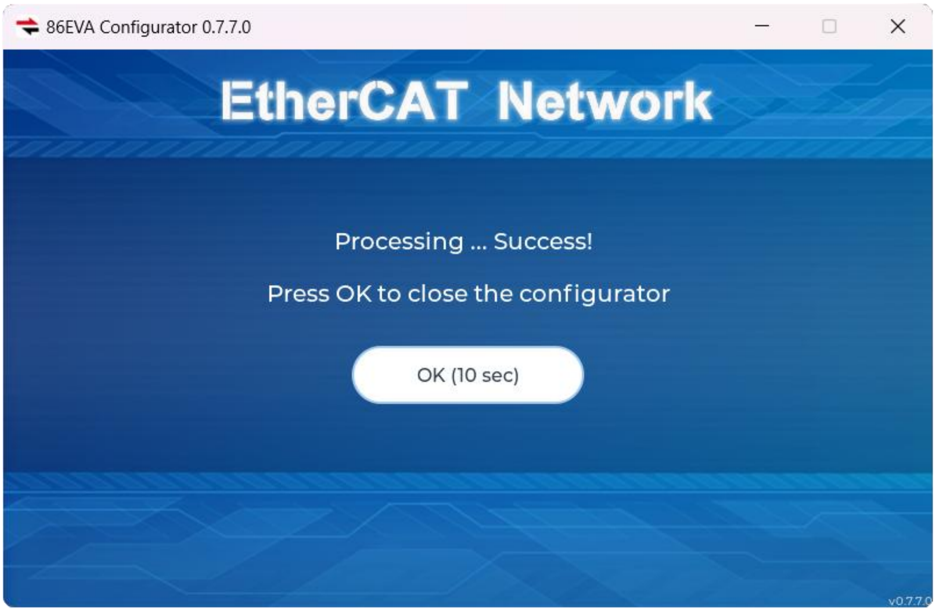


Step 3: Generate the code

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.

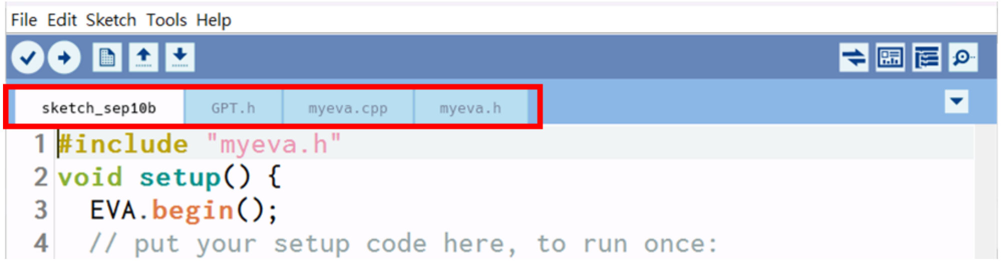


Processing ... Success!

Press OK to close the configurator

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



```
#include "myeva.h"
void setup() {
  EVA.begin();
  // put your setup code here, to run once:
```

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 Pulservo II: EthercatDevice_CiA402 object.
- 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 Pulservo II is “motor”.

This code establishes EtherCAT communication and controls the NPM Pulservo II 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.

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: 100,000, Acceleration: 5,000, Deceleration: 5,000.

B. In Loop Function:

In the loop() function, the current position of the motor is displayed on the Serial Monitor, and the motor alternates its movement back and forth in a repeating cycle:

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. 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.

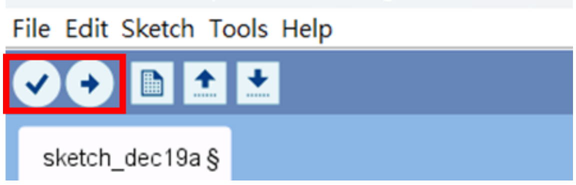
The example code is as follows:

```
#include "myeva.h"

int pp_state = 0;

void setup() {
  Serial.begin(115200);
  while (!Serial);

  EVA.begin();
  motor.setCiA402Mode(CIA402_PP_MODE);
  Serial.print("Enable: "); Serial.println(motor.enable());
  motor.pp_SetMotionProfileType(0); // Linear ramp (trapezoidal profile)
  motor.pp_SetVelocity(100000);
  motor.pp_SetAcceleration(5000);
  motor.pp_SetDeceleration(5000);
}

void loop() {
  Serial.print("Pos: "); Serial.println(motor.getPositionActualValue());
  switch (pp_state)
  {
    case 0:
      if (motor.pp_Run(100000) == 0)
        pp_state++;
      break;
    case 1:
      if (motor.pp_IsTargetReached())
        pp_state++;
      break;
    case 2:
      if (motor.pp_Run(-100000) == 0)
```

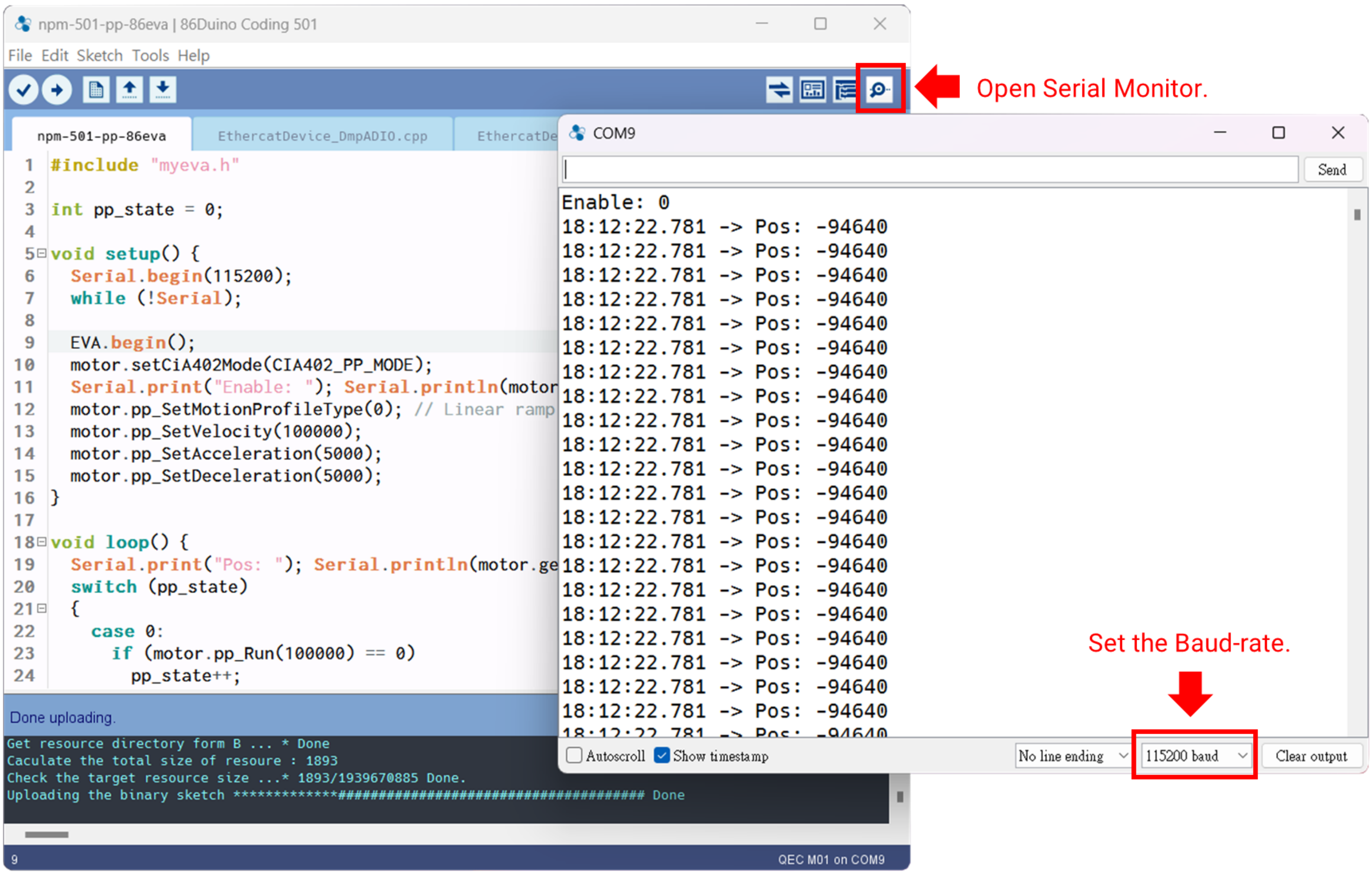
```
        pp_state++;
      break;
    case 3:
      if (motor.pp_IsTargetReached())
        pp_state = 0;
      break;
  }
}
```

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.


npm-501-pp-86eva | 86Duino Coding 501
File Edit Sketch Tools Help
npm-501-pp-86eva
EthercatDevice_DmpADIO.cpp
EthercatDe
COM9
Send
Autoscroll
Clear output
9
QEC M01 on COM9

Open Serial Monitor.

```
#include "myeva.h"

int pp_state = 0;

void setup() {
  Serial.begin(115200);
  while (!Serial);

  EVA.begin();
  motor.setCiA402Mode(CIA402_PP_MODE);
  Serial.print("Enable: "); Serial.println(motor
  motor.pp_SetMotionProfileType(0); // Linear ramp
  motor.pp_SetVelocity(100000);
  motor.pp_SetAcceleration(5000);
  motor.pp_SetDeceleration(5000);
}

void loop() {
  Serial.print("Pos: "); Serial.println(motor.ge
  switch (pp_state)
  {
    case 0:
      if (motor.pp_Run(100000) == 0)
        pp_state++;
```

Done uploading.

```
Get resource directory form B ... * Done
Caculate the total size of resource : 1893
Check the target resource size ...* 1893/1939670885 Done.
Uploading the binary sketch ************######################################## Done
```

```
Enable: 0
18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
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18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
```
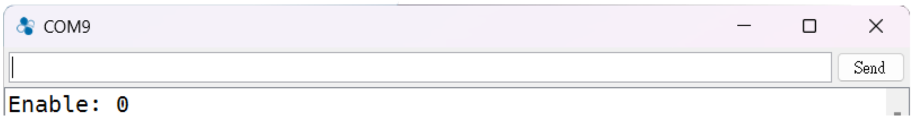

☐ Autoscroll ☑ Show timestamp | No line ending | 115200 baud

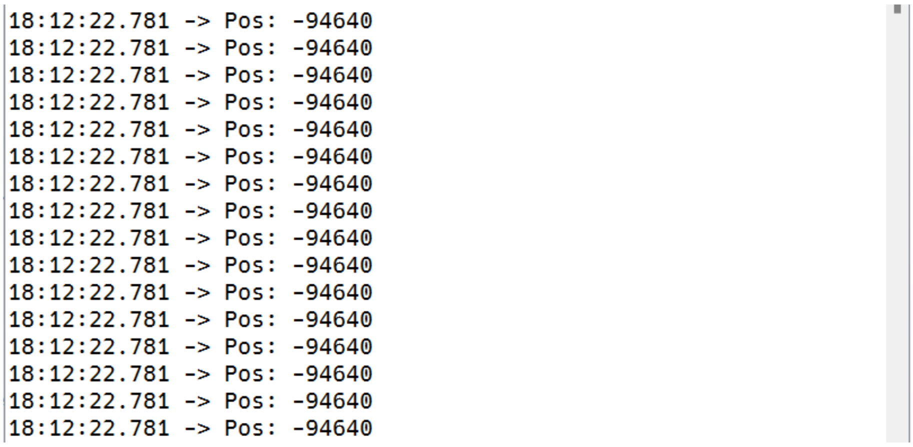
Set the Baud-rate.

If the EtherCAT communication config successful, Serial Monitor will print “Enable: 0”.



```
Enable: 0
```

It will print the motor’s current position to the serial monitor.



```
18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
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18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
18:12:22.781 -> Pos: -94640
```
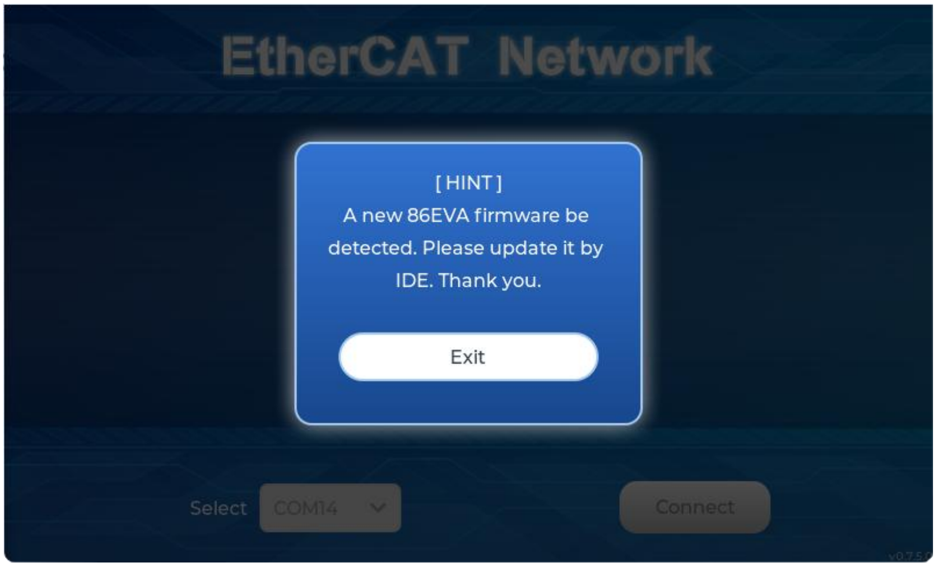

Troubleshooting

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.



[HINT]
A new 86EVA firmware be detected. Please update it by IDE. Thank you.

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

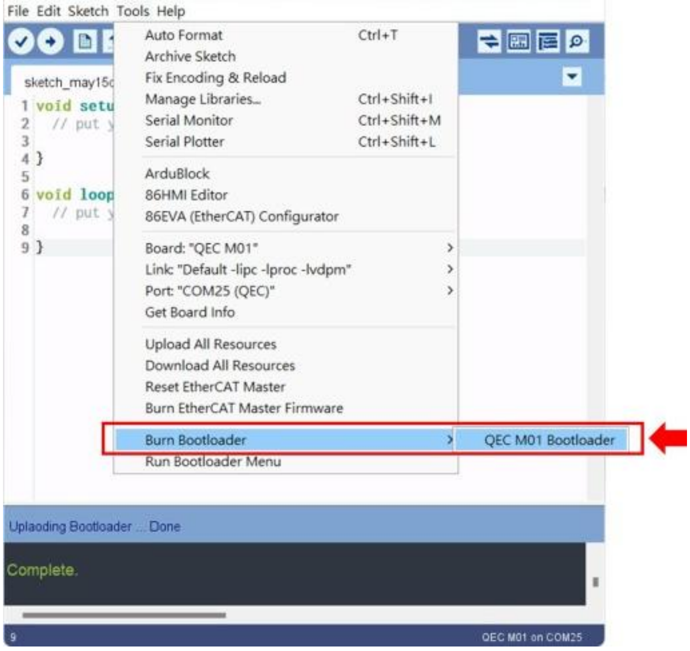
Step 1: Setting up QEC-M

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

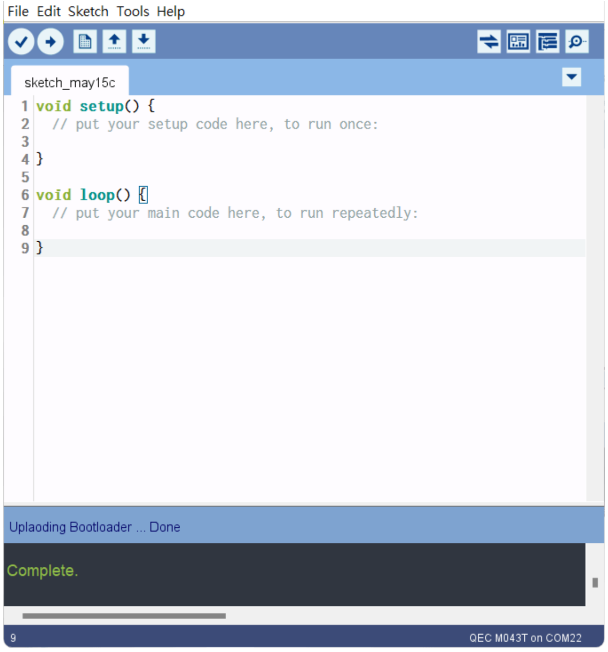
After connecting to your QEC-M product, go to “Tools”> “Burn Bootloader”. The currently selected QEC-M name will appear. Clicking on it will start the update process, which will take approximately 5-20 minutes.

QEC-M-01:



```
Uplaoding Bootloader ... Done
Complete.
```

Step 3: Complete the Update



```
void setup() {
  // put your setup code here, to run once:

}

void loop() {
  // put your main code here, to run repeatedly:

}
```

```
Uplaoding Bootloader ... Done
Complete.
```

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.