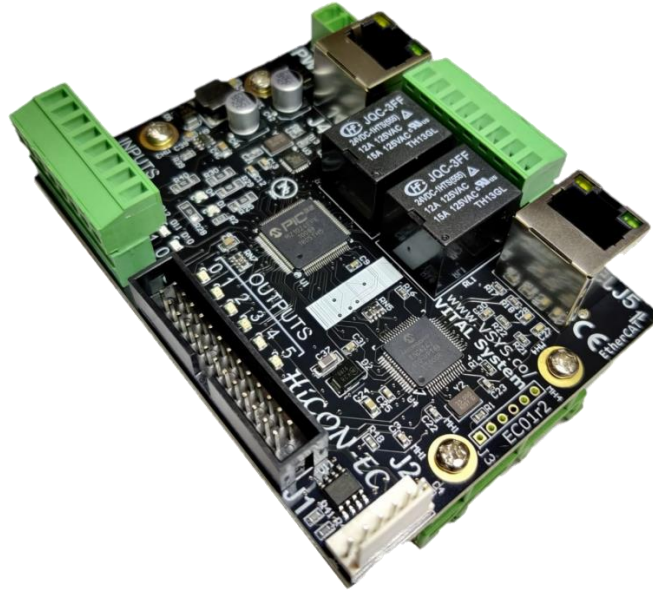


# EtherCAT Motion Controller

Ethernet Motion Controller



## EC01 User Guide

Version 1.3

(Updated Nov 30, 2021)

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## License Agreement

Before using the HiCON and accompanying software tools, please take a moment to go thru this License agreement. Any use of this hardware and software indicate your acceptance to this agreement.

It is the nature of all machine tools that they are dangerous devices. In order to be permitted to use HiCON on any machine you must agree to the following license:

I agree that no-one other than the owner of this machine, will, under any circumstances be responsible, for the operation, safety, and use of this machine. I agree there is no situation under which I would consider Vital Systems, or any of its distributors to be responsible for any losses, damages, or other misfortunes suffered through the use of the HiCON board and its software. I understand that the HiCON board is very complex, and though the engineers make every effort to achieve a bug free environment, that I will hold no-one other than myself responsible for mistakes, errors, material loss, personal damages, secondary damages, faults or errors of any kind, caused by any circumstance, any bugs, or any undesired response by the board and its software while running my machine or device.

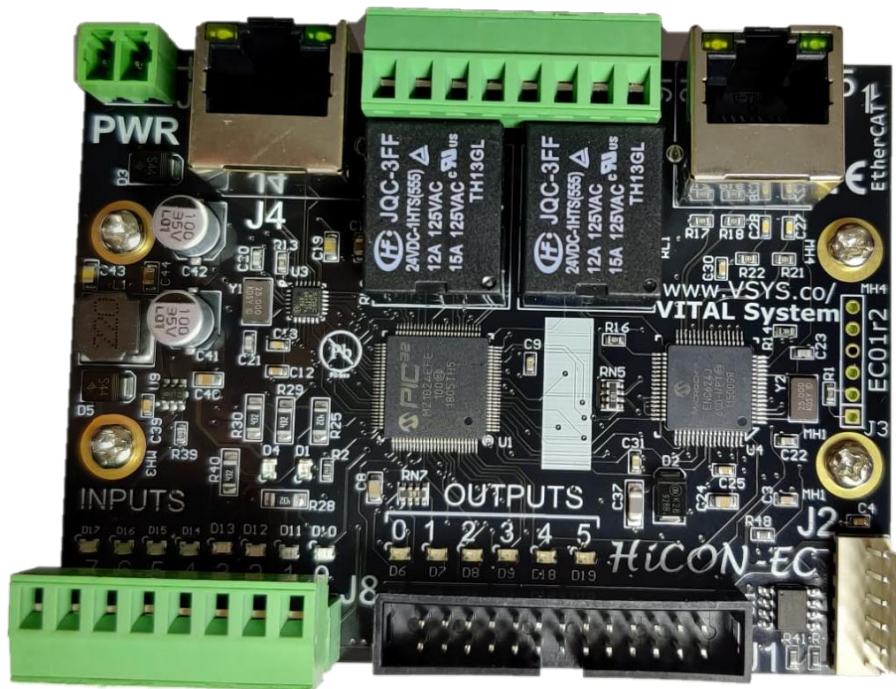
I fully accept all responsibility for the operation of this machine while under the control of HiCON, and for its operation by others who may use the machine. It is my responsibility to warn any others who may operate any device under the control of HiCON board of the limitations so imposed.

I fully accept the above statements, and I will comply at all times with standard operating procedures and safety requirements pertinent to my area or country, and will endeavor to ensure the safety of all operators, as well as anyone near or in the area of my machine.

**WARNING:** Machines in motion can be extremely dangerous! It is the responsibility of the user to design effective error handling and safety protection as part of the system. We shall not be liable or responsible for any incidental or consequential damages. By using the motion controller, you agree to the license agreement.

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## 1. Overview



The EC01 EtherCAT Master is the latest addition to our HiCON series. Designed for use with Mach4 via the HiCON plugin, the EC01 provides a cost effective EtherCAT Master solution that can interface with the PC directly over Ethernet. The EC01 does not require any specialized computer or motherboard to operate.

### Key Features

- EtherCAT Master capable of controlling up to 12 EtherCAT motors concurrently
- EtherCAT configuration software EC-Link for easy configuration
- Mach4 plugin for EtherCAT
- Built on the reliable HiCON Platform
- Cost effective high quality EtherCAT Solution
- 36 Digital IO (24 In/12 Out) and 2 Relays on board

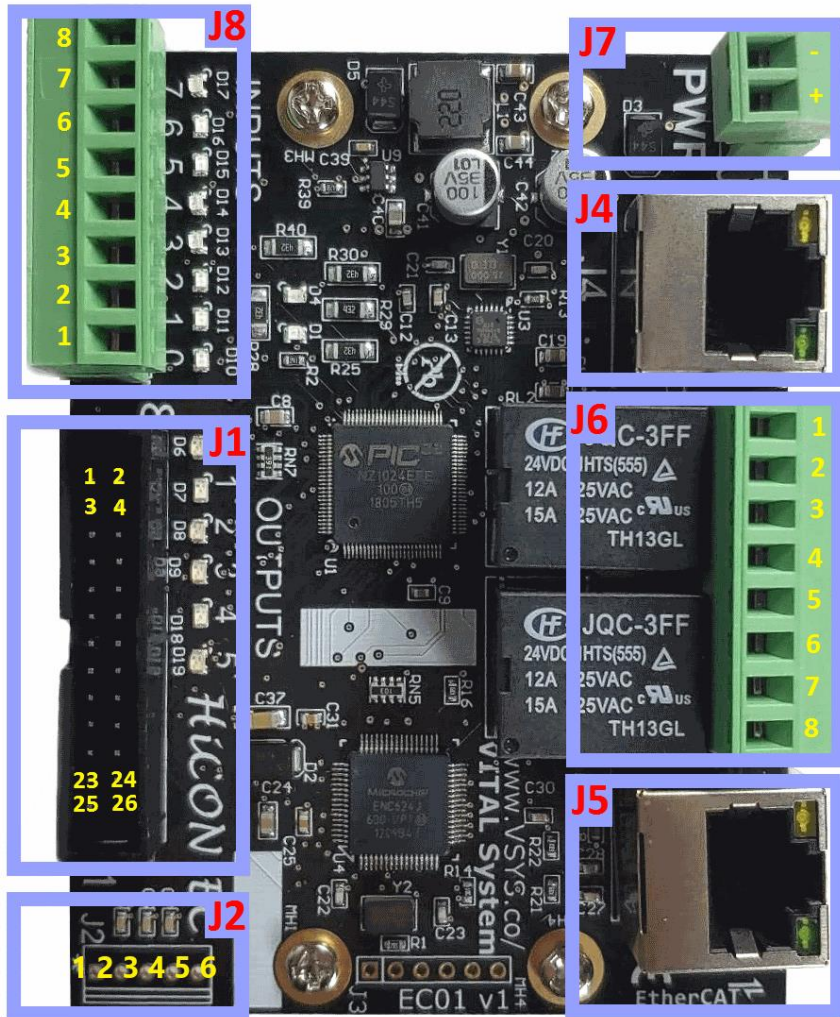
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## 2. EC01 Specifications

- All devices like I/O modules and Drives must have Distributed Clock support with 1ms cycle time DC can be 32bit/64bit (recommended)
- EtherCAT drives must have support for Cyclic Synchronous Position (CSP) and CiA402 protocol
- Maximum of 12 slaves on the network (Visit the product page for latest skew information)
- Maximum of 16 PDO mappings per slave (8 per direction: Rx & Tx PDO)
- Maximum of 32 objects per PDO mapping
- Maximum of 128 Inputs and 128 Outputs per slave
- All PDO mappings must be **byte** aligned. In case of digital I/O they can be **nibble** aligned and placed at the end of the network if they are not byte aligned.
- Maximum of 20 SDO per slave
- SDO data types supported INT8, INT16, INT32, INT64, UINT8, UINT16, UINT32, UINT64, FLOAT/REAL32, DOUBLE/REAL64
- LRW commands are used for communication.

### 3. EC01 Hardware Interface

The EC01 has several interface ports and indicator LEDs. The figure below shows a top view of the EC01 board with interface ports and other components:



J1	Digital I/O (8 Output, 16 Input) (Extended I/O Only)
J2	Analog output 0-10V and Encoder (A,B,Z)
J4	LAN Ethernet Connection to PC (Mach4)
J5	EtherCAT Network to Slave Devices
J6	Four Digital Outputs 0..3 (NPN Sinking) and two Relay N.O. Dry contacts
J7	Power Input, +24VDC, 500mA
J8	Eight Digital Inputs (NPN Sinking)

### 3.1. Power Supply (J7)

J9 Pin#	Function
+	+12 - 28VDC (Polarity Protected)
-	Ground

- Unit requires at least 15W power input.
- If more devices are connected to the unit, a bigger power supply may be required.

### 3.2. Ethernet Ports (J4, J5)

#### J4 LAN Ethernet Port:

The EC01 controller has an Ethernet Port that allows the user to make a PC connection using an Ethernet cable. Connect to PC directly or via an Ethernet Hub or switch. For more detailed information see section [3. Network Connection Setup](#). The EC01 supports both 10 MBit and 100 Mbit network speeds. TCP/IP network protocol in UDP mode is used for PC communications.

#### J5 Ethercat Interface Ethernet Port:

The EC01 controller has an Ethernet Port that which it uses to connect to a slave group using EtherCAT protocol. The EC01 supports both 10 MBit and 100 Mbit network speeds.

### 3.3. Digital I/O 3.3V TTL Port (J1, J2, J6, J8)

#### J1 Digital I/O (3.3V TTL) Pin Assignments:

\*This port is only available when Extended I/O activation is enabled on the controller.

J1 Pin#	Function	J1 Pin#	Function
1	Ground	2	Digital Output Mach4 Port 12, Pin 0
3	Digital Output Mach4 Port 12, Pin 1	4	Digital Output Mach4 Port 12, Pin 2
5	Digital Output Mach4 Port 12, Pin 3	6	Digital Output Mach4 Port 12, Pin 4
7	Digital Output Mach4 Port 12, Pin 5	8	Digital Output Mach4 Port 12, Pin 6
9	Digital Output Mach4 Port 12, Pin 7	10	Digital Input Mach 4 Port 12, Pin 0
11	Digital Input Mach 4 Port 12, Pin 1	12	Digital Input Mach 4 Port 12, Pin 2
13	Digital Input Mach 4 Port 12, Pin 3	14	Digital Input Mach 4 Port 12, Pin 4
15	Digital Input Mach 4 Port 12, Pin 5	16	Digital Input Mach 4 Port 12, Pin 6
17	Digital Input Mach 4 Port 12, Pin 7	18	Digital Input Mach 4 Port 12, Pin 8
19	Digital Input Mach 4 Port 12, Pin 9	20	Digital Input Mach 4 Port 12, Pin 10
21	Digital Input Mach 4 Port 12, Pin 11	22	Digital Input Mach 4 Port 12, Pin 12
23	Digital Input Mach 4 Port 12, Pin 13	24	Digital Input Mach 4 Port 12, Pin 14
25	Digital Input Mach 4 Port 12, Pin 15	26	+5V

**J2 Pin Assignments:**

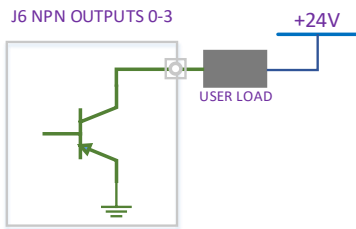
J2 Pin#	Function
1	Ground
2	Analog Output (0V - 10V)
3	Encoder – A
4	Encoder – B
5	Encoder – C
6	+5V

**J6 Pin Assignments:**

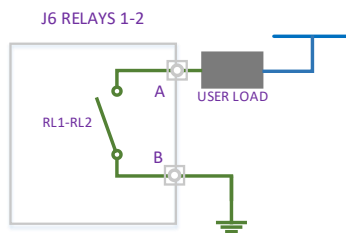
J6 Pin#	Function
1	Digital Output 0, Mach4 Port 11 Pin 0
2	Digital Output 1, Mach4 Port 11 Pin 1
3	Digital Output 2, Mach4 Port 11 Pin 2
4	Digital Output 3, Mach4 Port 11 Pin 3
5	Relay N.O. 1 – Mach4 Port 11 Pin 4
6	
7	Relay N.O. 2 – Mach4 Port 11 Pin 5
8	

**J6 Outputs and Relay Circuit Diagrams**

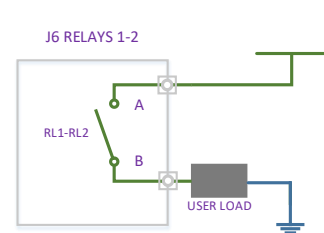
NPN Output Diagram (PIN 1-4)



Relay Setup Method 1

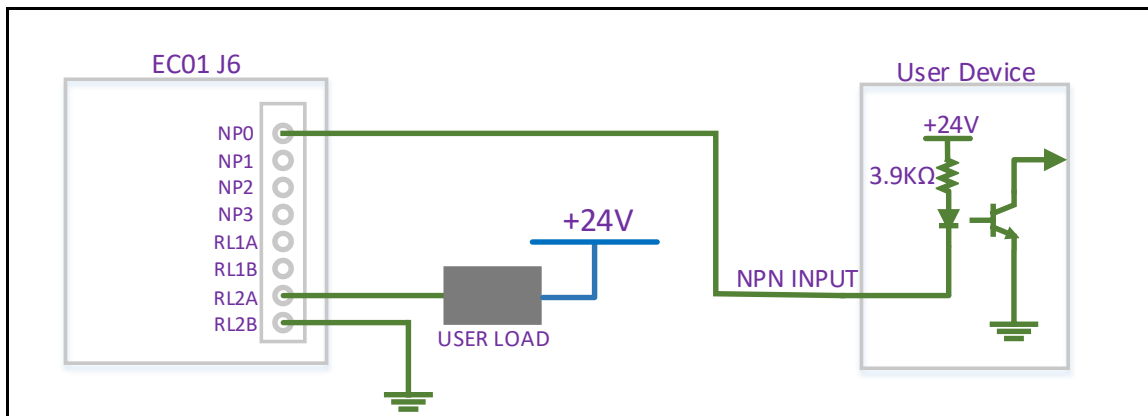


Relay Setup Method 2





## J6 Example Setup

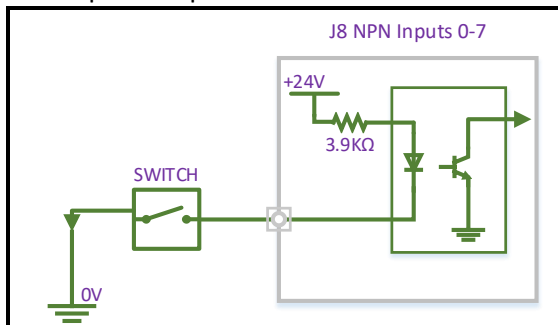


## J8 (24V) NPN Digital Inputs Pin Assignments:

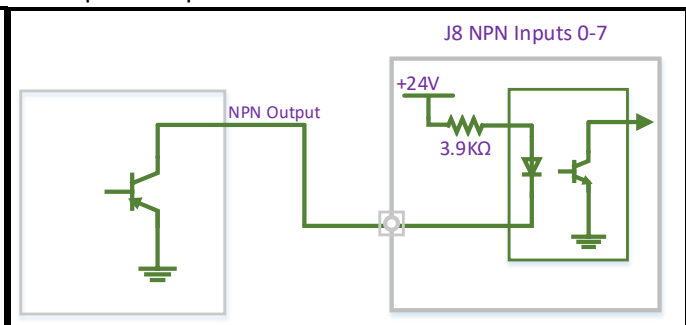
J8 Pin#	Function
1	Digital Input 0, Mach4 Port 11 Pin 0
2	Digital Input 1, Mach4 Port 11 Pin 1
3	Digital Input 2, Mach4 Port 11, Pin 2
4	Digital Input 3, Mach4 Port 11, Pin 3
5	Digital Input 4, Mach4 Port 11, Pin 4
6	Digital Input 5, Mach4 Port 11, Pin 5
7	Digital Input 6, Mach4 Port 11, Pin 6
8	Digital Input 7, Mach4 Port 11, Pin 7

## J8 Circuit Diagrams

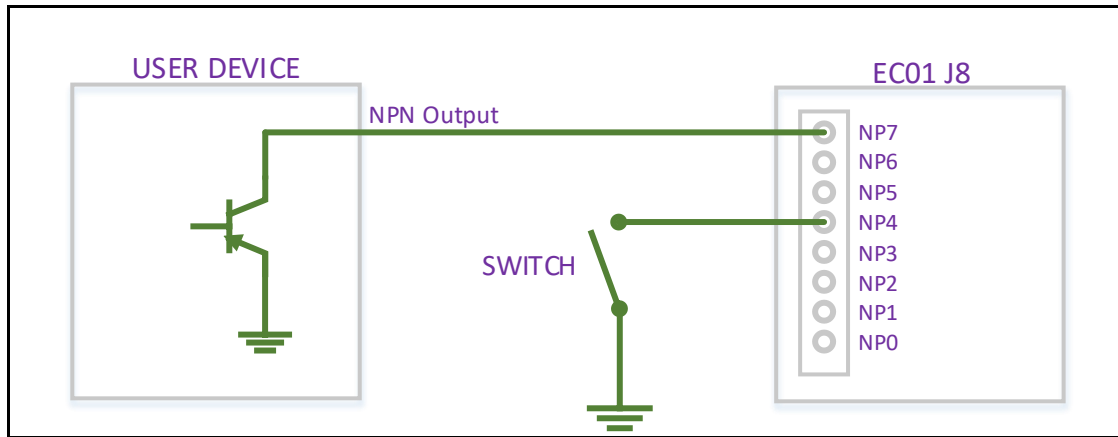
NPN Input Setup Method 1



NPN Input Setup Method 2



## J8 Example Setup



### 3.4. Electrical Characteristics

	Type	Current Rating	Voltage Rating
J7 Power		500 mA	24V (20 to 28V)
J8 Inputs	NPN (Sinking)	10 mA	3 to 24V
J6 Outputs (Pin 1-4)	NPN (Sinking)	500 mA Max per output pin	30V Max
J6 Relays (Pin 5-8)		1 Amp	24V

Ambient temperature		Non- operating: -50°C to +80 °C
Operating temperature:		-40 °C to +70 °C (-40 °F to 160 °F)
Temperature shock		-40 °C to +70 °C (-40 °F to 160 °F) within 3 min
Maximum humidity	Non- operating:	up to 95% relative humidity non-condensing at 35 °C (95 °F)
	Operating:	up to 95% relative humidity non-condensing at 25 °C (77 °F) up to 90% relative humidity non-condensing at 42 °C (108 °F)

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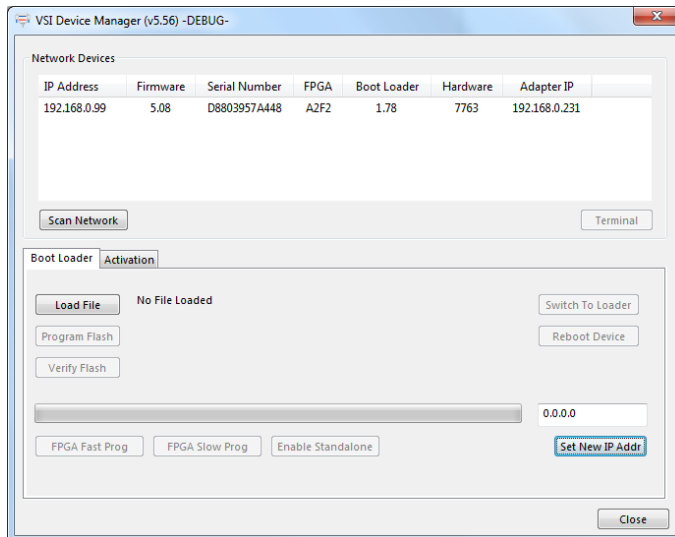
## 4. Software Components

### 4.1. HiCON Mach4 Plugin Setup

To use the HiCON plugin for Mach4, copy the M4HiCON.m4pw and M4HiCON.sig files to the “Plugins” folder in the Mach4 install directory, and enabling the plugin from within the “Plugins” tab of the Mach4 Configuration window.

### 4.2. VSI Device Manager

In order to change or update the firmware installed on the EC01, or activate features, you will have to install the VSI Device Manager application.



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### 4.3. [EC-Link](#)

EC-Link is our custom designed EtherCAT configuration software. Easily setup and configure your EtherCAT master using a streamlined, reliable, and user-friendly interface.

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## 5. Additional Features

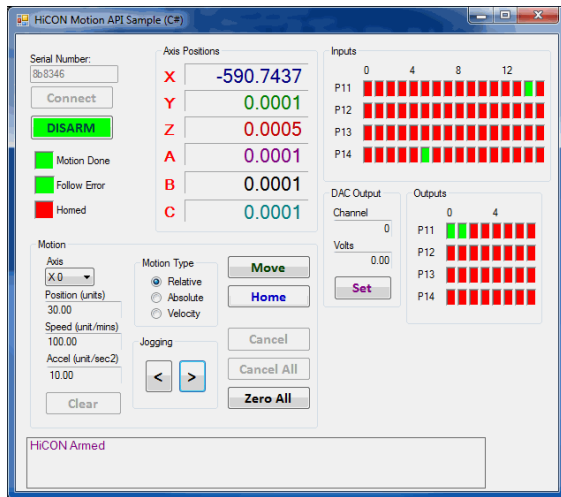
### 5.1. Extended Features

Extended features can be purchased for additional non-standard functionality. If these are purchased alongside the EC01 then it will ship with the activations already present. However, they can also be purchased later and activated via an activation code.

- Activated Motors – Specifies how many motors the EC01 is able to control over the EtherCAT network. The default EC01 comes with 2 activated motors, but it is also available in variations of 2, 3, 4, 6, 8, and 12 activated motors.
- Custom DRO Support - This software feature allows the user to map PDOs to Mach4 Registers. For example, Torque can be mapped and viewed in Mach4 as a DRO. This Software feature is only available on 6 or more activated motor EC01.
- Extended IO – Enables the J1 digital IO port for additional 16 digital inputs and 8 digital outputs. Recommended to be used with the [7535 I/O termination board](#). It also enables Synced outputs feature in Mach4.
- Analog Input with 77ISO adapter board – Gives the EC01 a 0-10V analog input using the 77ISO Analog Voltage sensor plugged into the J1 port. This is useful for plasma application requiring isolated analog input.
- Analog Output and Encoder Input - Enables J2 to provide 0-10 analog output for spindle VFD speed, as well as encoder input channel (A, B, Z) for spindle RPM and Lathe threading. (Coming soon).
- ArcPro Plasma Screen – Enables the logic with [ArcPro Plasma Screen](#) for Torch Height Control on Plasma Tables. Requires 77ISO Analog Voltage Sensor adapter board.
- Macro Programming – For advanced users this optional software feature allows the writing of custom programs (In C language) that can be downloaded to the controller for fast execution. It allows the system to run in standalone mode as well as manipulate I/O at extremely high speeds. Most Mach4 CNC installations do not require this feature.

## 5.2. Custom Software Application

Optional Custom Windows applications can be created using the **VSI Motion Control API** library. The Library is an API designed to allow communication (via Ethernet) using commands to arm/disarm, control and read I/O, and command motion among others.



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## 6. Troubleshooting

**Category:** Hardware

**Problem:** The green LED is not lit up

**Solution:** Make sure that the power wires are adequately stripped, and use a voltmeter to verify that 24V is present on the connection. If not, then the power supply may be the issue.

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**Category:** Hardware

**Problem:** The CPU blue LED does not light up

**Solution:** If the green LED is lit up and the CPU LED is not, try cycling the power. If that still doesn't work it could indicate either a hardware fault or missing or corrupt bootloader. Please email us for assistance.

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**Category:** Hardware

**Problem:** The CPU LED blinks very rapidly and Mach cannot connect

**Solution:** In boot-loader mode or Software Exception the CPU LED blinks fast. Try cycling the power on the unit. If the blinking is still rapid, after a couple of tries, please email us for assistance.

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**Category:** Communication

**Problem:** The device does not show up in VSI Device Manager

**Solution:**

- Make sure that a good quality CAT5e (or better) Ethernet cable is used between the controller and the PC. The EC01 supports Auto-MDIX, so cross-over or straight-through cables can be used.
- IP Address conflict. Make sure PC is set to 192.168.0.10 and the controller is set to something other than that, e.g., 192.168.0.95.
- Try disabling windows firewall temporarily to see if it interferes with the connection.
- If more than one network adapter is present (for example, a laptop with a Wi-Fi connection and Ethernet port). Try disabling the other network adapter.
- Check the RJ45 port on the controller and make sure the orange LED is lit and green LED is blinking. If not, try using a different cable.



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**Category:** Communication  
**Problem:** Device Manager can see controller but Mach4 can't  
**Solution:** Update the plugin and/or the firmware so they are latest

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**Category:** Communication  
**Problem:** I/O is shifted or I/O is not correct  
**Solution:** The I/O PDO should be byte aligned if not must be placed at the end of the network. (Beckhoff modules have 4 bits each hence they must be either used in pairs or placed at the end of the network.

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**Category:** Mach4  
**Problem:** EC01 frequently errors out with the message "ERROR: Disarmed Drives unexpectedly..." on Mach4  
**Solution:** Reduce the counts per unit(Also known as Gear Ratio) on the drives typical values are 10000 - 20000

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**Category:** Mach4  
**Problem:** Frequent following error reported on Mach4  
**Solution:** If there is no error reported on the drive and the Debug window on Mach4 says following error then it could any of these reasons

1. The counts (Gear Ratio) on the drive is high (Typical value should be 10000 – 20000 or recommended by the device manufacturer)
2. The following error in HiCON Config is low

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**Category:** General  
**Problem:** The gantry oscillate/vibrates when cutting  
**Solution:** The drives need to be tuned for the application. The Drives are underpowered.

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**Problem:** The gantry oscillate/vibrates when cutting  
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