

HiCON Mini – pn77E4

**Ethernet Motion Controller
Data Acquisition System
Logic Controller**

User Guide



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Atlanta, GA USA

For more information please visit the product web page:
www.vitalsystem.com/hiconMini

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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. VITAL Systems shall not be liable or responsible for any incidental or consequential damages. By using the HICON motion controller, you agree to the license agreement.

1. Overview



The HiCON Mini is an Ethernet based controller for motion control, data acquisition, and general PID control system applications. Utilizing the latest Microchip technology, the HiCON Mini offers a comprehensive set of features for your demanding applications.

HiCON Mini can be applied in a variety of applications involving PC based Motion Control, Storage and Retrieval Systems and CNC Milling / Lathe Machines. Equipped with a rich set of hardware interfaces, it can also be used for wide variety of applications involving PID control, e.g., speed, oven temperature control and so on.

Key Features

- Up to 4 Differential Quadrature encoder inputs.
- 6Mhz Max Encoder frequency. Encoder resolution multiplied by 4 thru Hardware.
- 4 Step and Direction Channels. Up to 2MHz Step Frequencies
- Optional 1 Isolated Analog Input, Range 0 - 10Volts, 10-bit Resolution
- 10 Digital I/O (6 Inputs & 4 Outputs) NPN Type
- Ethernet 100Mb connectivity using TCP/IP interface.
- Simple UDP Socket Programming Interface.
- VSI Motion Control native API library for Custom Software development (C++, C# and VB.Net).
- Standalone Operation by programming the unit with C or BASIC programming language.

Compatibility Requirements:

- Drives can be stepper or servo types, but they must be able to take Step-Direction (digital) command signals. This is also referred to as “Position mode” in some drive manuals.
- Encoders can be rotary, linear, etc. as long as they use a 5V Differential Quadrature feedback signal. If the encoders use a Single-ended signal, a single-ended to differential signal adapter may be used.

Extremely Important Reminder

Extreme precautions must be observed when operating machinery. Machines are known to have enormous power even with a small motor. Never come within a machine’s path while powered.

Failure to observe caution while operating machines can result in severe injuries or even death.



NOTE: Several notes such as this can be found throughout this document which list key points and comments worth remembering.

2. Software Components

2.1 HiCON Mach3 and Mach4 Plugin Setup

To use the HiCON plugin for Mach3 or Mach4, copy the M3HiCON.dll file to PlugIns folder in the Mach install directory. When you run Mach3 or Mach4, it should provide you with a prompt for multiple plugins detected with the HiCON plugin included in the list.

2.2 VSI Device Manager

In order to change or update the firmware installed on the HiCON Mini, or activate features, you will have to install the VSI Device Manager application. For instructions on using the program, see the provided [manual](#).

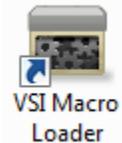


Extended Features:

- Basic Macro – Allows the use of HiCON Basic Programs for standalone operation.
- Closed Loop Encoder Feedback – Allows the use of Encoder Channels 0 – 3 for axis position feedback.
- Torch Height Control – Automatic Torch height positioning for plasma cutting applications
- Synced Outputs – Allows the utilization of the Synced outputs feature in Mach4. This allows digital outputs to be set ON or OFF at a precise position during GCode execution (useful for lasers).
- Rigid Tap – Allows the use of rigid tapping in Mach4.

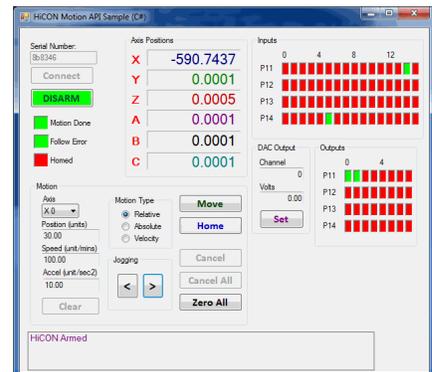
2.3 VSI Macro Loader

VSI Macro Loader is an application that is used to install and debug the HiCON Basic Program on the HiCON controller. The user can select the HiCON Basic file (.bas file) and download it to the controller. After launching the HiCON Basic program, the user can see the print statement outputs on the output window.



2.4 Custom Software Application with HiCON

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. Sample applications and a [user guide](#) may be found [here](#).



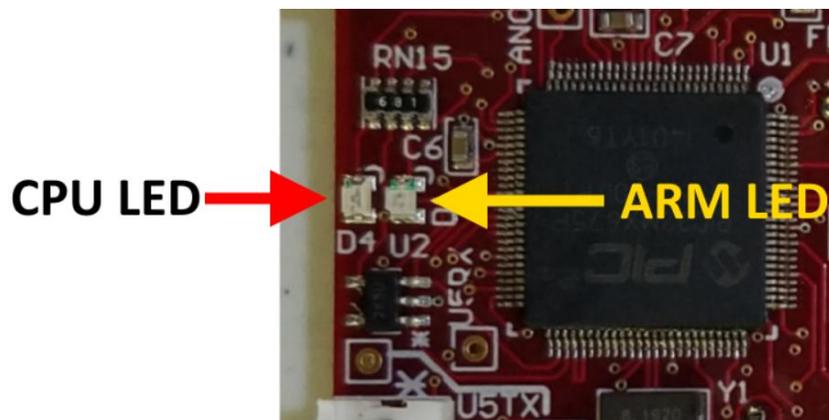
3. Quick Start Guide

The following steps are provided to give the user a basic step-by-step guide for wiring the HiCON Mini on a target machine. These instructions assume that the user has some knowledge about working with electrical wiring, adequate knowledge about the target machine, and has some experience with building or retrofitting CNC machines.

1. Download and install the VSI Device Manager application. If you haven't already.
 - [VSI Device Manager](#)
 - [VSI Device Manager manual](#)
2. Connect power to the HiCON Mini. The image below shows the necessary wiring connections for this part of the setup. Only turn on the power supply once all the connections below are made.



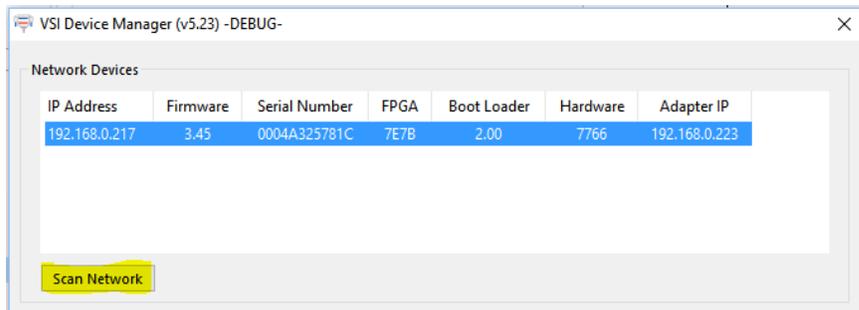
3. If the HiCON Mini is correctly powered up, the 24V LED at D9 should be lit up to indicate that the voltage is present on the unit, and the CPU LED at D4 should blink in a constant time.



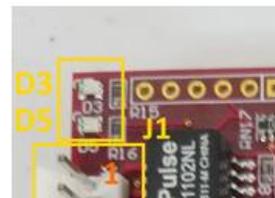
Troubleshoot Issue	Solution
The 24V LED is not lit up	Make sure that the wires are adequately stripped, and use a voltmeter to verify that 24V is present on the connection. If not, then the power supply may be the issue.
The CPU LED does not light up	If the 24V LED is lit up, but the CPU LED is not, try cycling the power. If that still doesn't work, please email support@vitalsystem.com for assistance.
The CPU LED blinks very rapidly	Try cycling the power on the unit. If the blinking is still rapid, after a couple of tries, please email support@vitalsystem.com for assistance.

- Establish a network connection to the HiCON Mini. Follow the “[Network Connection Setup](#)” Section. If a direct connection to the PC is used, make sure to carefully follow the steps for setting the PC IP address.

If all instructions were followed correctly, you should be able to scan the HiCON Mini using the “VSI Device Manager” application. If the unit does not show up, then try some of the solutions in the “Troubleshoot” table below.



Troubleshoot Issue	Solution
The device does not show up in VSI Device Manager	<ul style="list-style-type: none"> Make sure that a good quality CAT5e (or better) Ethernet cable is used between the HiCON Mini and the PC. The HiCON Mini has Auto-MDIX, so cross-over or straight-through cables can be used. 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 wifi connection and Ethernet port). Try disabling the other network adapter. Check the D3 and D5 LED lights on the HiCON Mini and make sure the orange LED is lit and green LED is blinking. If not, try using a different cable



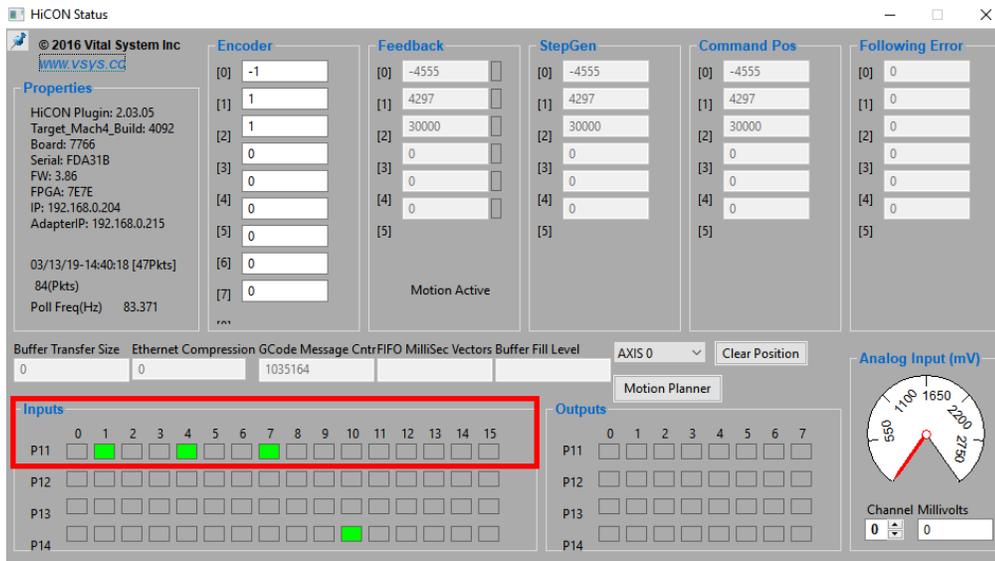
- After getting the HiCON Mini on the network, you may then proceed to turn off the power and wire the machine sensors and switches to the Digital I/O on the unit.

NOTE: For safety reasons, It is highly recommended to first set up the ESTOP and limit switches before attempting any motion on the machine.

The HiCON Mini uses NPN circuits for the Digital I/O (sinking type, or the ground wire has the switch). All Digital I/O on the HiCON Mini have no built-in functionality. Input and Output functions will depend on how they are mapped or scripted within Mach3 or Mach4 (or in custom software). As such, the sensors can be wired now, or later after mapping the I/O signals in Mach.

Wiring sensors and switches to the pins can be found on the [“Digital I/O 24V Ports”](#) section and wiring examples are provided on the [“Wiring Examples”](#) section.

Once wired onto the pins, the sensors may be tested by triggering them manually and watching the Input LEDs in the HiCON diagnostic window in Mach4.



<u>Troubleshoot Issue</u>	<u>Solution</u>
<p>The Input LEDs in the HiCON diagnostic window do not light up when the sensor/switch is triggered</p>	<ul style="list-style-type: none"> Ensure that the 24V LED is lit up and that the CPU LED is blinking but not rapidly. If the CPU LED is blinking rapidly, the controller is in bootloader mode and needs to be reset. If the 24V LED is not lit, go back to step1. Make sure that the wires are adequately stripped, and use a logic probe to verify that the sensor/switch is triggered.

<p>Some Input LEDs in the HiCON diagnostic window are turned ON, or their states are not following the sensor/switch</p>	<ul style="list-style-type: none">• Using the “Example I/O Connections” diagram as a reference, ensure that solid earth ground connections are present, because electrical noise accumulation can disrupt the microcontroller operation in the HiCON Mini.• Disconnect the device that is connected to the input and replace it with a momentary switch where the other side is connected to ground. If the input still does not switch then there may be a problem with the hardware.
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6. Connect the stepper/servo drives to the HiCON Mini. Connect the motor drives to the stepper output channels located on J6, J8, J10 and J12. Information on pin layouts can be found on the “[Step and Direction Signals](#)” section.

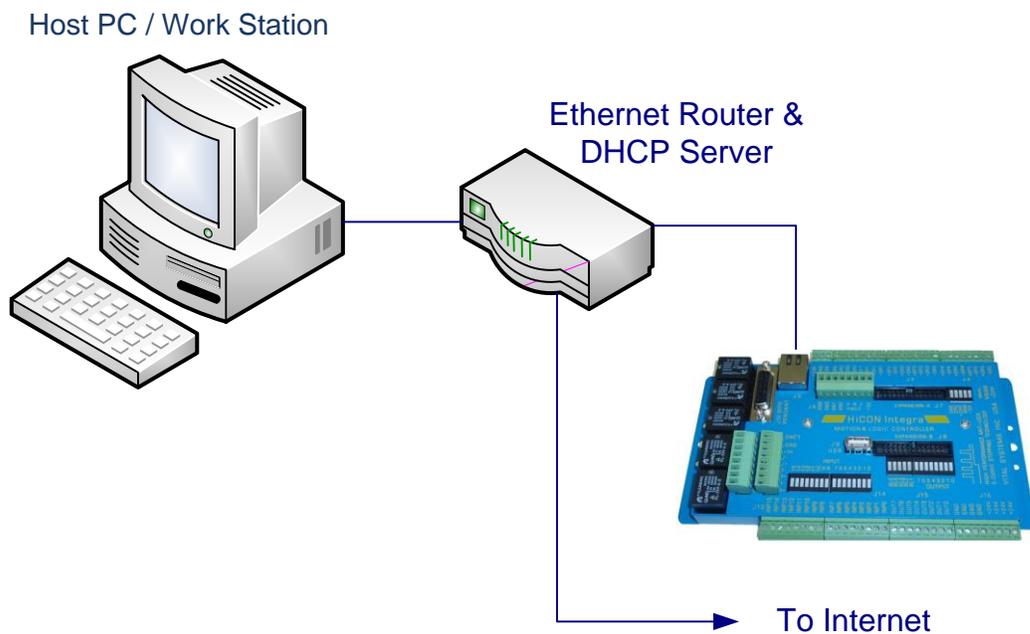
Once the drives are wired up correctly, you are now ready for the software configuration and testing. Further setup procedures can be found on either:

- [HiCON Mach3 Software Integration manual](#)
- [HiCON Mach4 Software Integration manual](#)

4. Network Connection Setup

You can connect the HiCON Mini directly to your PC or connect via an Ethernet switch. The HiCON board can use the DHCP server on the network or a fixed IP address (firmware pre-assigned IP address is 192.168.0.35). The default IP address of the device can be manually changed via the VSI Device Manager Software.

3.1. Connect using an Internet Router (DHCP Server)



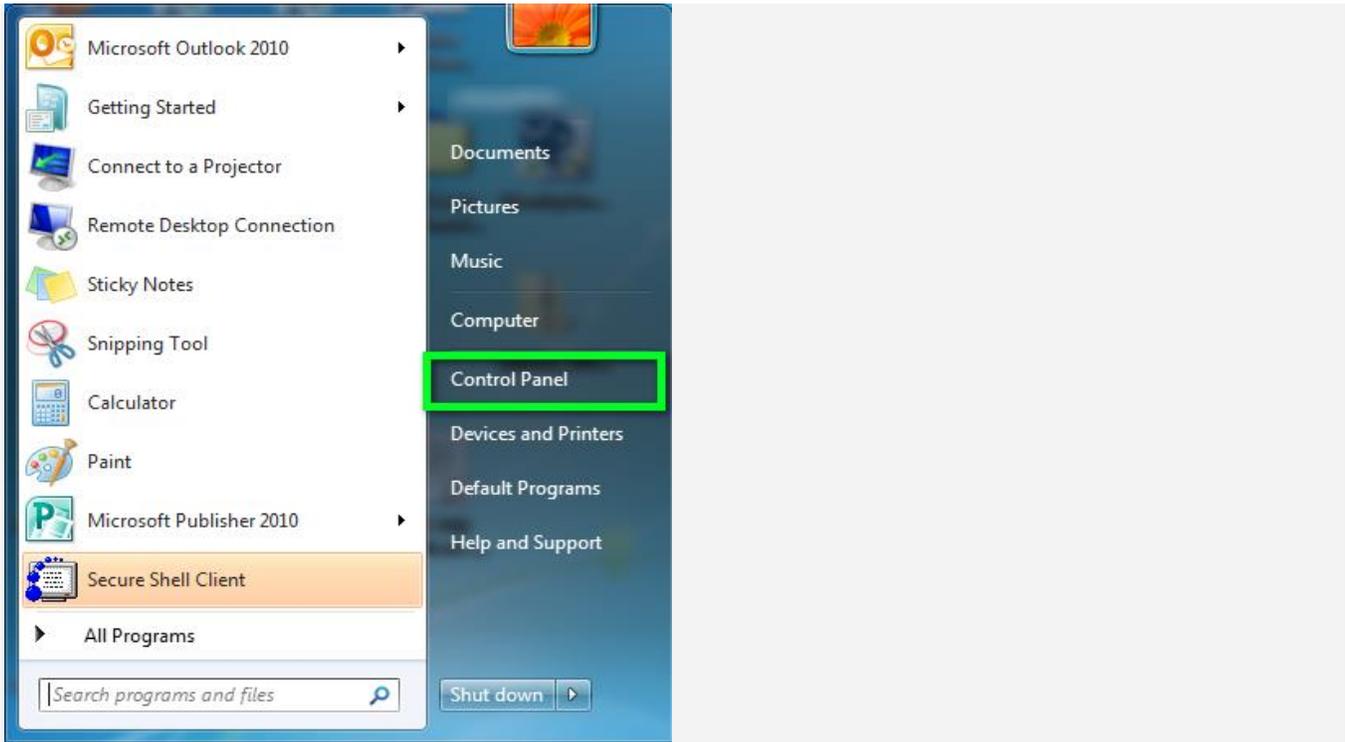
This is the simplest method to connect Mach software to the controller. The figure above shows a basic setup using an Internet router on your network. Connect the Ethernet cable from the J5 Ethernet port of the HiCON to the router. Connect another Ethernet cable from the router to your PC. The router dynamically assigns unique IP address both to the PC as well as to the HiCON Mini, and therefore completes the network setup without requiring any intervention from the user.

3.2. Direct Connection to the PC

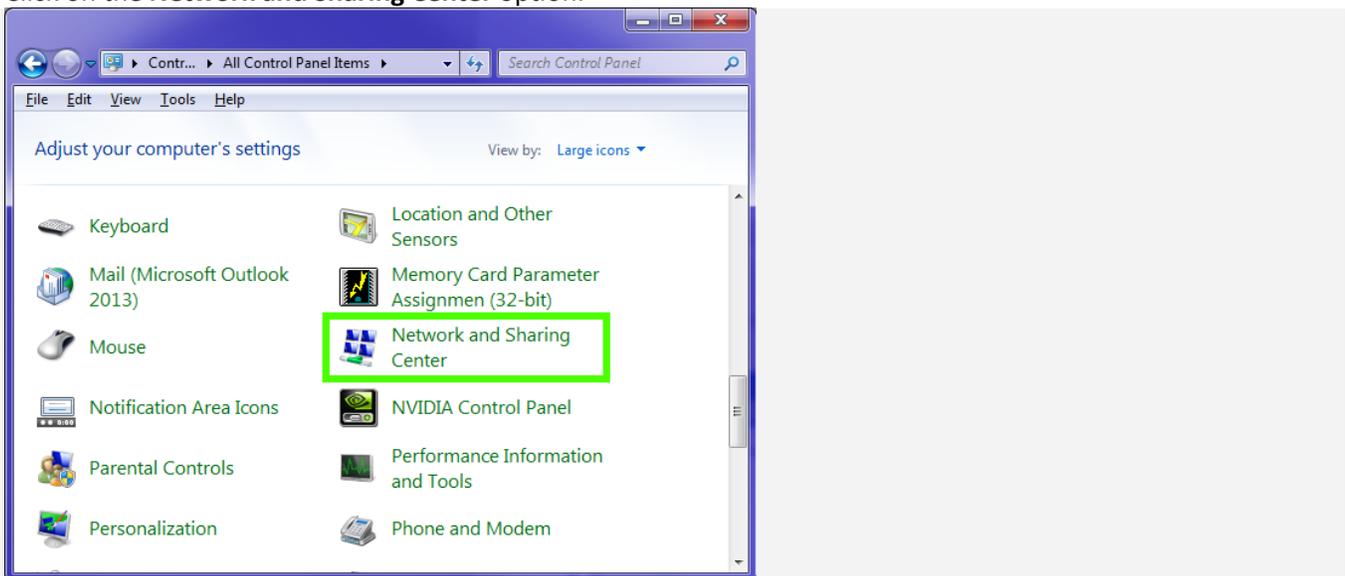
When connecting the PC directly to the HiCON, you will need to manually assign IP address 192.168.0.10 in Windows XP, 7 or newer. The HiCON board will use its firmware default IP address, i.e., 192.168.0.35. Do not use VSI Device Manager Software to change the HiCON IP address, unless you know exactly what you are doing. If you are not sure, please email VSI for more information (support@vitalsystem.com). Network setup is a pretty simple task, but wrong settings can get you stuck for many hours.

The Ethernet cable is connected from the J5 Ethernet port of the HiCON board to the PC as shown below:

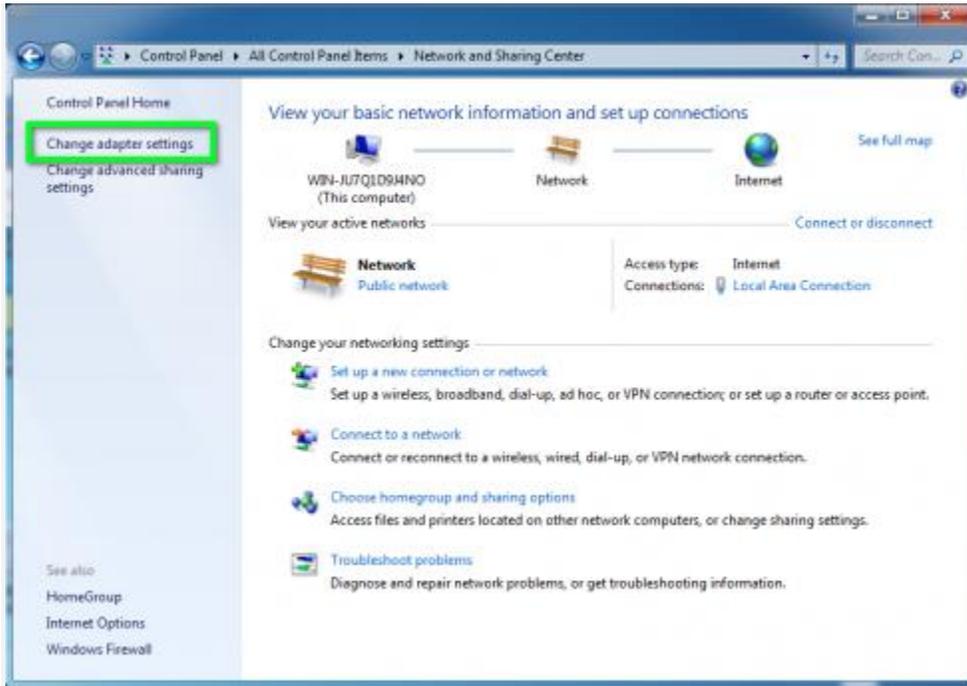
Click the **Start** menu. Next, click on the **Control Panel** option.



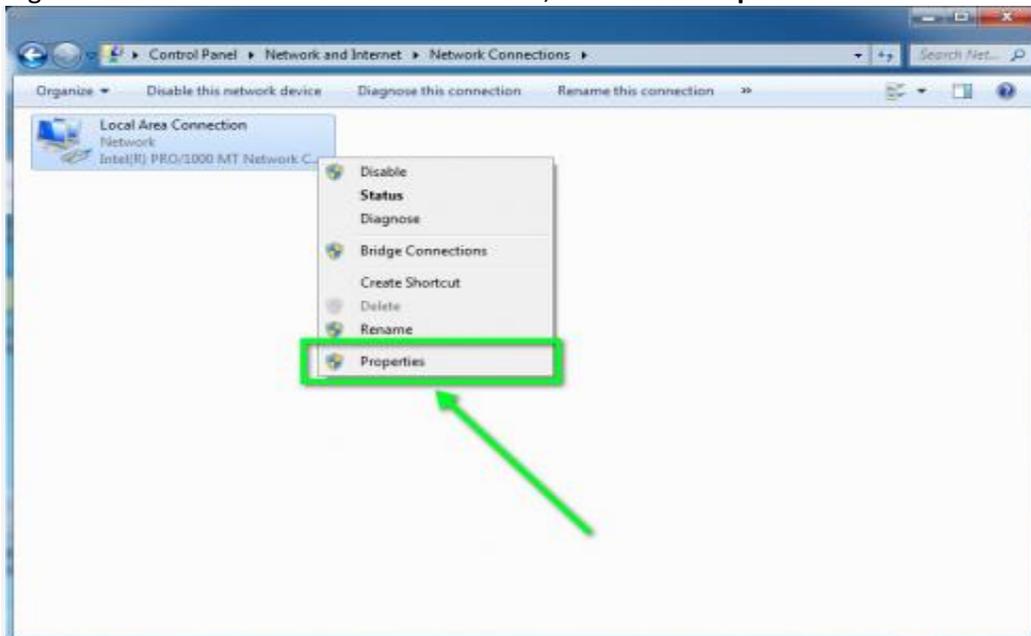
Click on the **Network and Sharing Center** option.



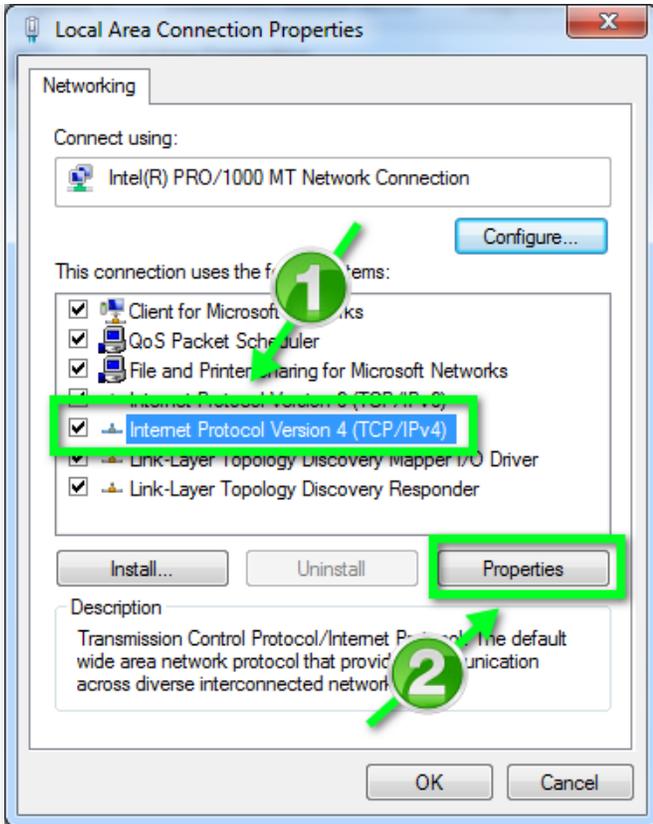
Click on **Change adapter settings** from the left side menu.



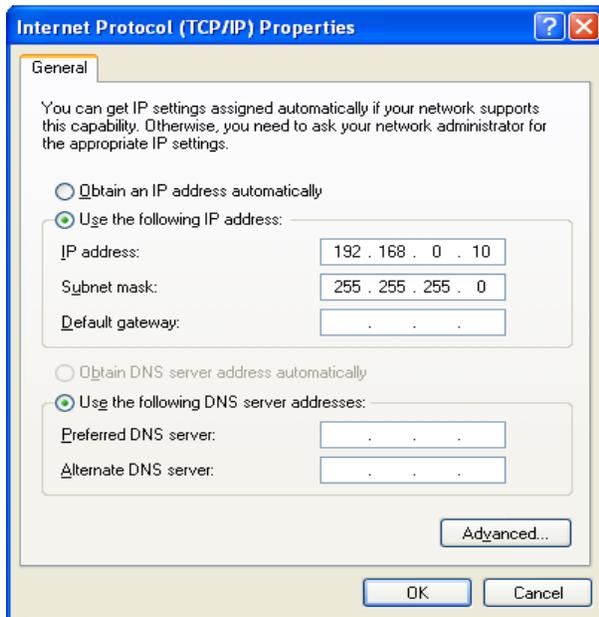
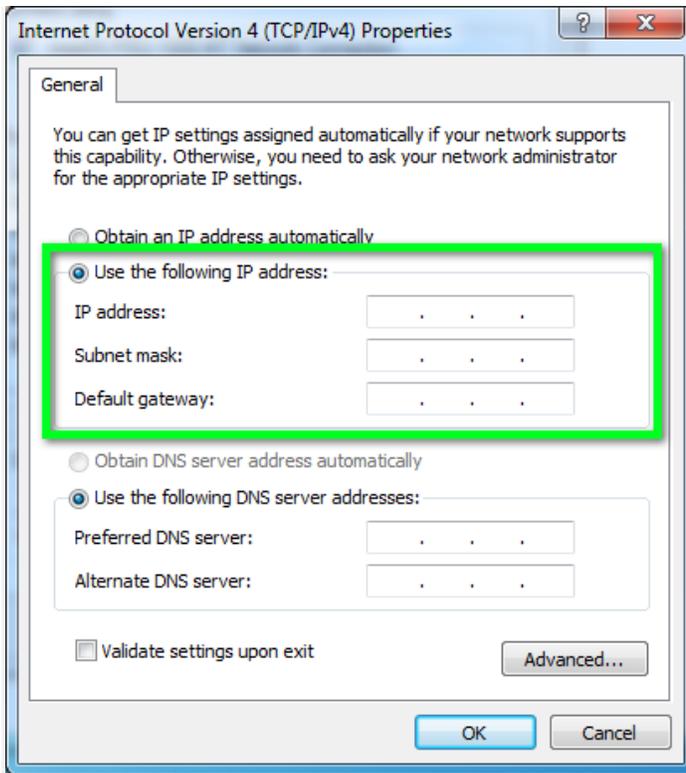
Right-click on the **Local Area Connection** icon, then select **Properties**.



In the window that opens, click on the **Internet Protocol Version 4 (TCP/IPv4)** (you may need to scroll down to find it). Next, click on the **Properties** button.



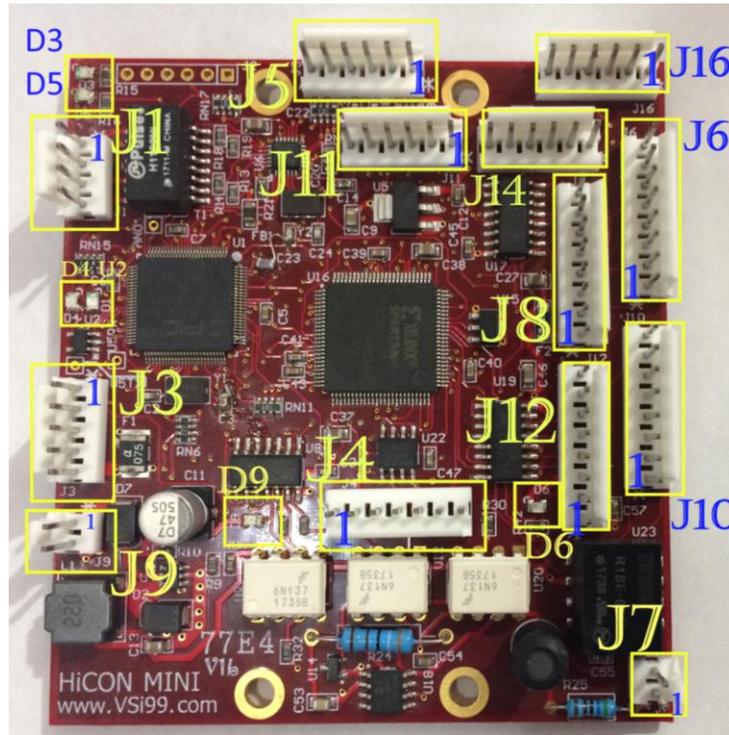
In the window that opens, click the Use the following IP address: radio button. In the IP address:, type **192.168.0.10**, Subnet mask: **255.255.255.0**, and Default gateway: leave blank. For the DNS server settings, leave both of them blank.



Click OK to save the setting. After a few seconds, you should be able to connect HiCON from Mach software.

4. HiCON Mini Hardware Interface

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



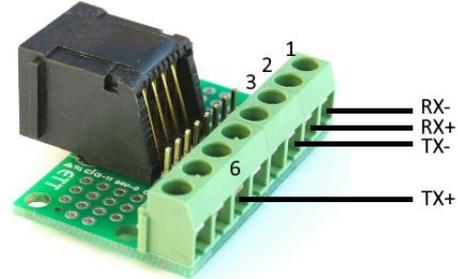
J9	+24V 1Amp for powering board.
J6	Step and Direction Outputs 0.
J8	Step and Direction Outputs 1.
J10	Step and Direction Outputs 2.
J12	Step and Direction Outputs 3.
J1	Ethernet connection
J5	Differential Encoder Input 0
J11	Differential Encoder Input 1
J14	Differential Encoder Input 2
J16	Differential Encoder Input 3
J11	Differential Encoder Input #1
J3	Digital Outputs Port#11, Pins 0 – 3.
J4	Digital Inputs Port#11, Pins 0 – 5.
J7	0-10V isolated analog voltage input
D3, D5	Ethernet Status LED's. D3 glows steadily when a 100mbps Ethernet connection is up. D5 blinks rapidly to indicate data transmission.
D6	Blue colored LED. Indicates the drive enable signal is on or off.
D9	Green colored LED. Indicates power is being supplied to the device.
D4	Blue colored LED for operation indication. It blinks at a constant rate when Power is on and running normally. It has a heartbeat blink when Mach4 is enabled. It blinks rapidly if it is in Boot-Loader mode.

4.1. Ethernet Port

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

J1 Ethernet Pin Assignments:

Pin#	Function
1	RJ45 Pin 6 TX+ (Green)
2	RJ45 Pin 3 TX- (Green/White)
3	RJ45 Pin 2 RX+ (Orange)
4	RJ45 Pin 1 RX- (Orange/White)

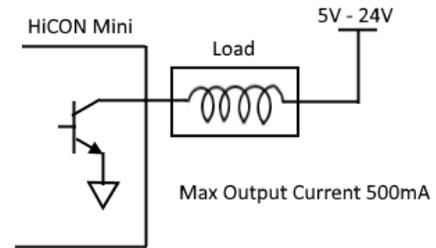


NOTE: RJ45 pin assignments are compatible with the T-568B standard.

4.2. Digital I/O Ports (J3, J4)

J3 (0V) NPN Digital Output Pin Assignments:

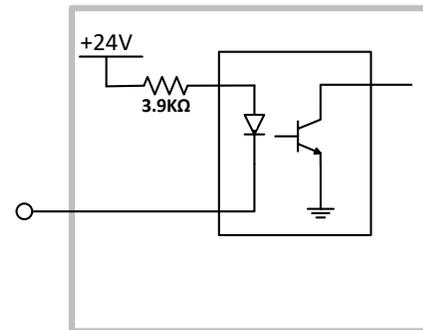
Pin#	Function
1	Output 0 – Mach4 Port 11, Pin 0
2	Output 1 – Mach4 Port 11, Pin 1
3	Output 2 – Mach4 Port 11, Pin 2
4	Output 3 – Mach4 Port 11, Pin 3
5	Ground



J4 (0V) NPN Digital Inputs Pin Assignments:

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	Ground

HiCON Mini Typical Input



4.3. Step and Direction Signals

HiCON Mini provides 5volts differential step and direction signals. You can also connect them in single ended mode by using either just the + or – signals.

J6 Pin Assignments:

Pin#	Function
1	+5V Output
2	+Direction 0
3	Drive Enable (NPN Output)
4	GND
5	-Direction 0
6	+Step 0
7	-Step 0
8	Drive Error Input (NPN Input)

NOTE: For Drive Enable and Drive Error Input, refer to [input/output Wiring section](#)

J8 Pin Assignments:

Pin#	Function
1	+5V Output
2	+Direction 0
3	Drive Enable (NPN Output)
4	GND
5	-Direction 0
6	+Step 0
7	-Step 0
8	Drive Error Input (NPN Input)

J10 Pin Assignments:

Pin#	Function
1	+5V Output
2	+Direction 0
3	Drive Enable (NPN Output)
4	GND
5	-Direction 0
6	+Step 0
7	-Step 0
8	Drive Error Input (NPN Input)

J12 Pin Assignments:

Pin#	Function
1	+5V Output
2	+Direction 0
3	Drive Enable (NPN Output)
4	GND
5	-Direction 0
6	+Step 0
7	-Step 0
8	Drive Error Input (NPN Input)

NOTE: *The Drive Error signal has no built-in functionality and will not do anything in Mach by default. This is because handling the Drive Error signal varies across several models (e.g. warning or disarm). A custom script may be used to perform any necessary actions when this signal is activated.*

4.4. Encoders on J5, J11, J14, and J16

J5 Pin Assignments:

Pin#	Function
1	+5 Volts, max 200mA
2	Differential Encoder (Enc 0) A+
3	Differential Encoder (Enc 0) A-
4	Ground
5	Differential Encoder (Enc 0) B+
6	Differential Encoder (Enc 0) B-

J11 Pin Assignments:

Pin#	Function
1	+5 Volts, max 200mA
2	Differential Encoder (Enc 1) A+
3	Differential Encoder (Enc 1) A-
4	Ground
5	Differential Encoder (Enc 1) B+
6	Differential Encoder (Enc 1) B-

J14 Pin Assignments:

Pin#	Function
1	+5 Volts, max 200mA
2	Differential Encoder (Enc 2) A+
3	Differential Encoder (Enc 2) A-
4	Ground
5	Differential Encoder (Enc 2) B+
6	Differential Encoder (Enc 2) B-

J16 Pin Assignments:

Pin#	Function
1	+5 Volts, max 200mA
2	Differential Encoder (Enc 3) A+
3	Differential Encoder (Enc 3) A-
4	Ground
5	Differential Encoder (Enc 3) B+
6	Differential Encoder (Enc 3) B-

NOTE: The use of Encoder Channels 0-3 requires the “Closed Loop” Feature to be activated.

4.5. Isolated Analog Voltage

The HiCON Mini is equipped with an onboard optically isolated 0-10V analog input at J7. The intended use is for reading the tip voltage from a plasma machine.

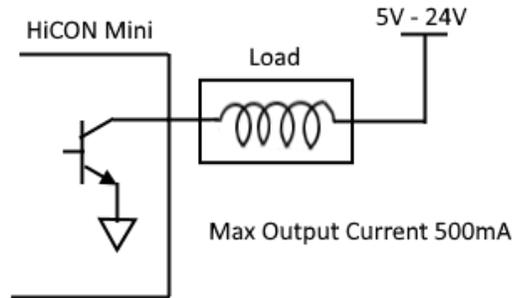
J7 Pin Assignments:

Pin#	Function
1	+V (0-10V Max)
2	-V (Ground)

5. Wiring Examples

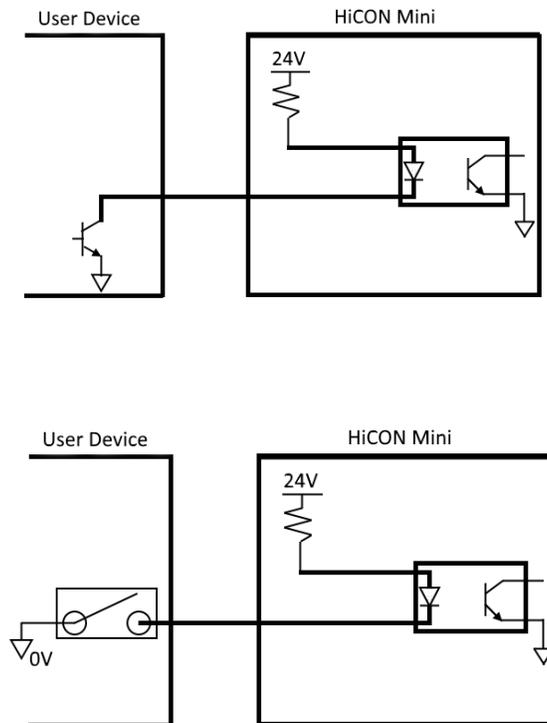
5.1 Example I/O Connections

Outputs connected to J3



**The above circuit also applies to Drive Enable outputs.*

Inputs connected to J4



**The above circuit also applies to Drive Error Inputs.*

NOTE: It is required to make solid earth ground connections to 24v power supply negative. Failure to do so may cause electrical noise that will disrupt the microcontroller operation and other low-voltage circuits.

6. Add-ons and Optional Features

Most CNC applications will only require the HiCON Mini base unit, pn7734. However, advanced and production applications can benefit from these add-ons:

NOTE: [*] - These items may be purchased any time before or after shipping as they are software features and are acquired via activation codes.

HiCON-MACRO^[*]

This software feature allows the user to write custom programs (in vb/BASIC language) which can be downloaded to the controller for fast execution. Advantages of the HiCON-Macro feature include:

- Real-time program execution on the firmware
- Ultra-fast I/O control and response
- C or BASIC language may be used
- Extends Mach3/Mach4 Functionality

HiCON-ADC^[*]

This software feature allows the use of the 0-10V analog input located on J7.

INTG-CLOOP^[*]

Enables the HiCON Mini Closed Loop Options. This software feature allows the use of Encoder channels [0 – 3] on J5, J11, J14, and J16. Advantages of this feature include:

- Closed loop operation accounts for any missing steps during transmission, and will automatically apply the necessary correction at the start of the next move. This prevents following errors from accumulating.
- The machine will only need to be homed (referenced) once on system power up. Axis position is preserved during ESTOP due to out of band axes even if Mach is closed or stopped.
- Allows Mach to display the physical machine coordinates based from encoder feedback on the Mach display DROs. Open loop operation only displays the position based from the outputted step signals.
- Closed Loop feedback is a requisite for switching to and from Manual mode operation.
- Enables 4 Encoder Channels on the HiCON Mini. The pins are differential type and available on J5, J11, J14 and J16.
- Feedback from rotary, linear (or glass scale) encoders may be used. Feedback gain may be configured to match step resolution.

Torch Height Control^[*]

Allows the use of Automatic Torch Height Control where the Z axis height is regulated at a distance over the cutting surface based off the voltage changes read from the 0-10V analog input sensor. This feature is almost always a requisite for Plasma cutting machines.

Synced Outputs^[*]

Allows the use of the Synced Outputs feature of Mach4. Synced outputs allows an output to be triggered ON or OFF at a precise real-time position which can be indicated in a GCode file. Unlike MCodes, the Synced outputs feature will not halt motion to trigger an output, but rather, only trigger it at a precise position value while keeping motion continuous. Extremely useful for applications that make use of laser cutting.

Rigid Tap^[*]

Allows the use of Rigid Tapping in Mach4. This feature makes use of the actual spindleRPM to regulate the feedrate of a tapping head (usually the Z axis).

7. Further Reading

1. [HiCON Mach3 Software Integration](#)
2. [HiCON Mach4 Software Integration](#)
3. [HiCON Basic User Guide](#)
4. [HiCON CMacro User Guide](#)
5. [VSI Device Manager manual](#)