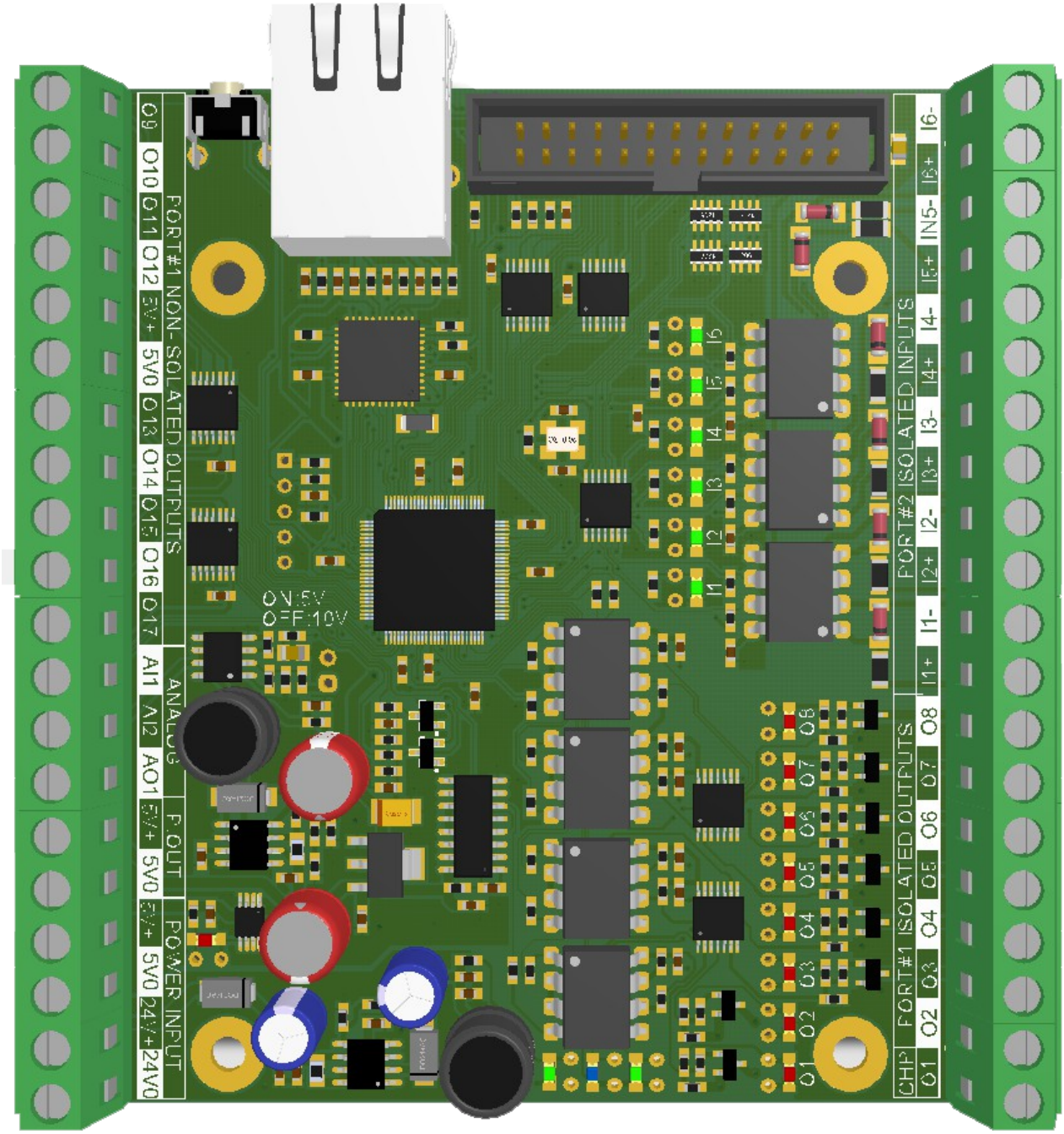
CNCdrive
motion controls

AXBB ethernet motion controller and breakout board
user's guide



Version of this document: 1.0001

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1 .Description of the AXBB device.

For first of all we thank you for your interest in our product and for reading this user's guide.

The AXBB is a motion controller and breakout board combination with ethernet interface.
The device can communicate with a connection to the control computer's network card. The connection can be built with direct connection or via router/switch devices in a local area network (LAN).
The device can be used to control machine tools with stepper or servo motor controls with step and direction interfaces.
The controller can output a maximum of 400kHz stepping frequency and can work with upto 6-axes, however only 8 dedicated step and direction signal pins for 4 axes are wired out on the board, but the I/Os on the software side are freely configurable to any pins making it possible to use all 6 axes if required.
The breakout board functionality is done with the onboard high speed optocouplers, transistors and buffer ICs.
There are 8 non-isolated outputs to be used as step and direction signals.
There are 8 isolated outputs to drive relays, solid state relays, laser controller or anything else which require isolation.
There are 6 isolated inputs to input signals of sensors, switches and pushbuttons.
There is one safety charge pump circuit with isolated output.
In addition to the breakout signals there is one IDC26 port on the board which has standard LPT port pinout. An IDC26 to DSUB25 cable (not included) can be used to connect an additional standard LPT port compatible breakout board to the device to extend the number of I/Os if required.

The board also has 2 analog input channels which can work with externally connected potentiometers (not included). The recommended potentiometer full scale resistance is 1k to 10k Ohms.
The analog input channels can be used to control the feedrate override and the spindle speed override in the software.

There is also one 0-5V or 0-10V (jumper selectable) analog output channel. The analog signal can be used for example to control the speed of a spindle motor with a variable frequency drive (VFD).

This user's guide describes how to establish connection between the device and the control computer, how to setup the LAN network and the device for the communication. This document also describes the electrical parameters and properties of the controller and it shows example connections of different control components like motor drives, relays, switches and sensors.
How to run the device with a CNC control software is not described in this manual and is described in a separate document. Please read the UCCNC control software user's guide for more informations about running the device with the software.

2 .Safety notes.

Moving objects like machine tool axes and automatition equipments can be dangerous. Always make sure to keep all machine safety standards. Always install e-stop switches and the required safety equipments to your control system and make sure that the equipment controlled by our device meets all the safety standards.

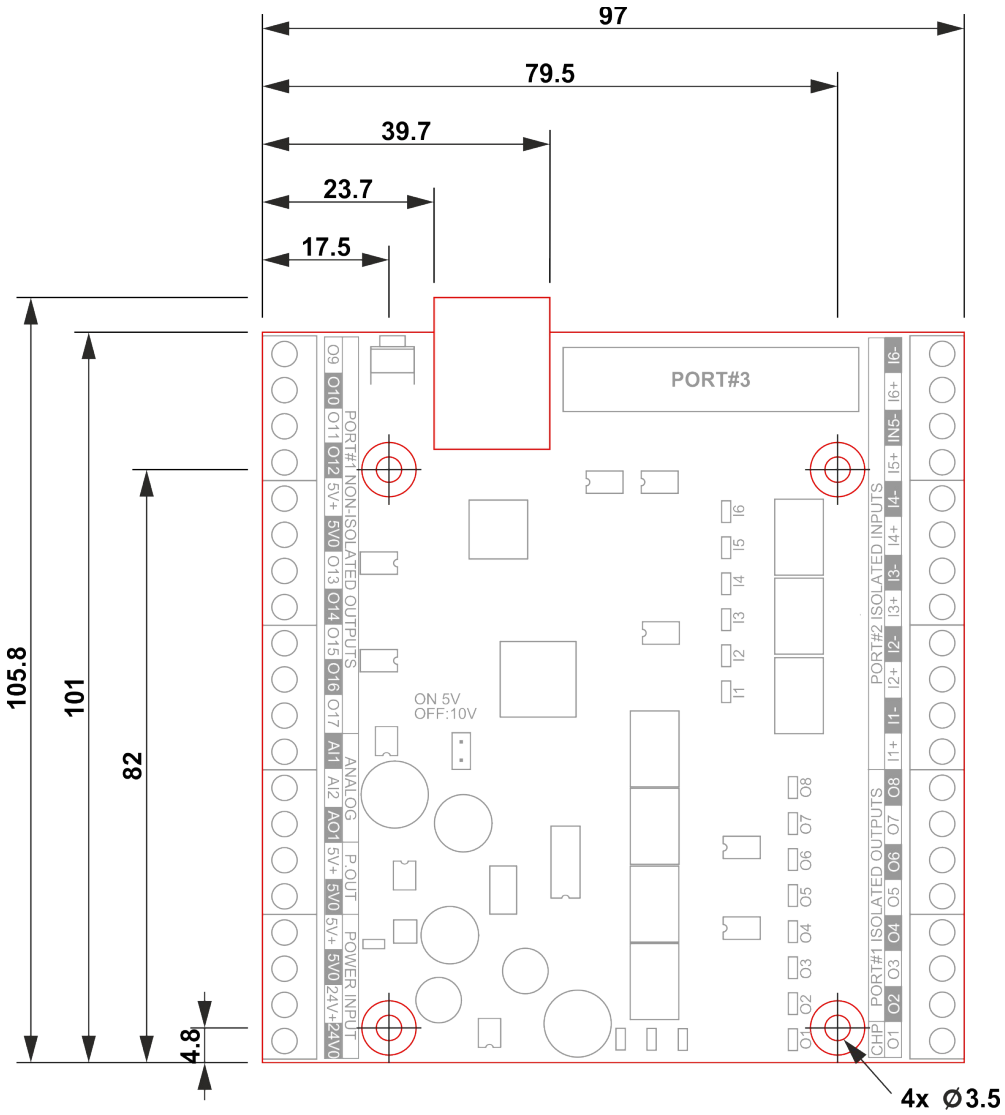
Always keep the board dry and away from falling chips and dust, protect the device from taint damage.
CNCdrive Kft. cannot take responsibility for any personal injury and/or financial loss caused by any device failure or caused by following an error in this documentation.

3 .Physical installation of the device.

The AXBB is a printed circuit board. The board can be mounted in a control box through the 4pcs 3.50mm diameter mounting holes using spacers and bolts.

3.1 .Dimensions and mounting drills.

The following drawings show the outline dimensions of the device and the mounting drills placements.



4 .Systems requirements.

The control computer must have at least one LAN connection, preferably a LAN network card connected to the PCI, PCI-e or PCMCIA port of the PC.
The AXBB controller can be connected to the network card 2 ways, with direct cable connection to the card or via switches/routers.
The different network setup procedures and connections are described in this manual.

The device is compatible with Windows XP, 7., 8, 8.1 and 10 operating systems with all the 32bits and 64bits versions. The communication is done with standard network packets therefor there is no need to install any hardware drivers.

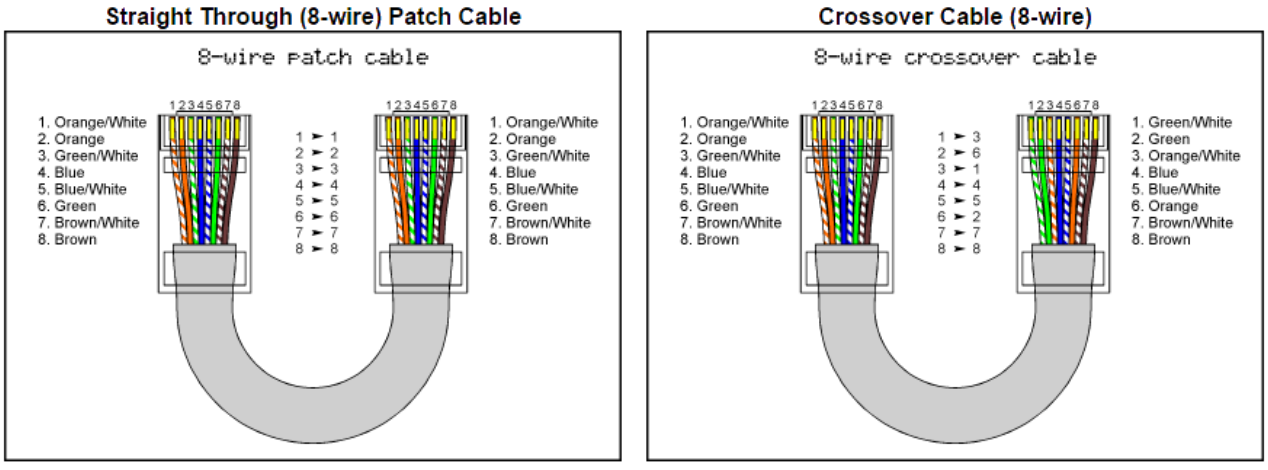
5 .Setting up the network

To setup the network for the device two steps has to be done. The network should be setup on the PC side and also in the AXBB controller. To establish communication between the PC and the device the 2 sides setup must match the connection scheme.

5.1 .Setting up the network on the PC side

To setup the network on the computer side first connect the AXBB device to the network and power it up with connecting an external power supply to the power input screw terminals. For direct cable connection to the LAN card use a crossover cable (crossed wiring.) and if connecting the device to a switch or router use an ethernet patch cable (straight wiring). The cable length for the direct connection can be a maximum of 100meters (330feet).
It also must be noted here that if the LAN network card or the router where the AXBB is connected to supports MDI/MDIX auto cross functionality then it does not matter if the cable used is a Patch cable or a Crossover cable, because the MDI/MDIX function will detect the cable type.

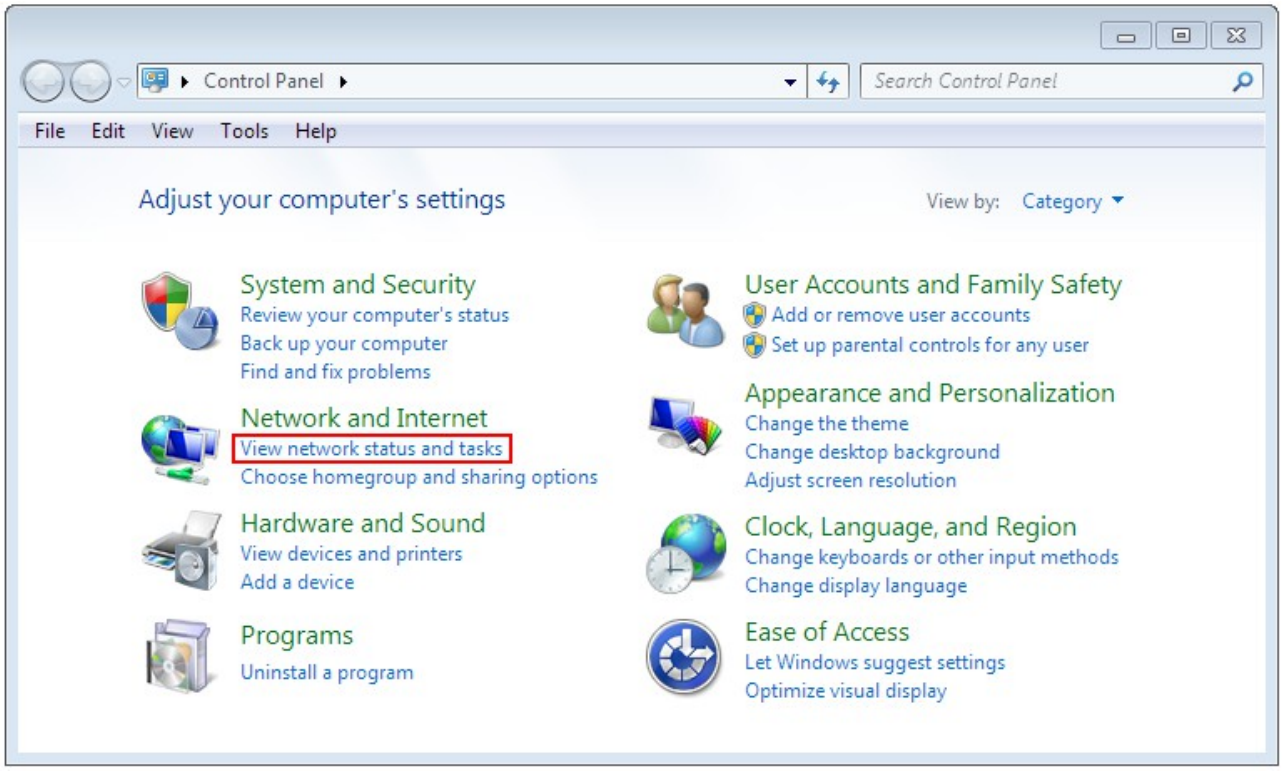
The following image shows the wiring of the different cables.



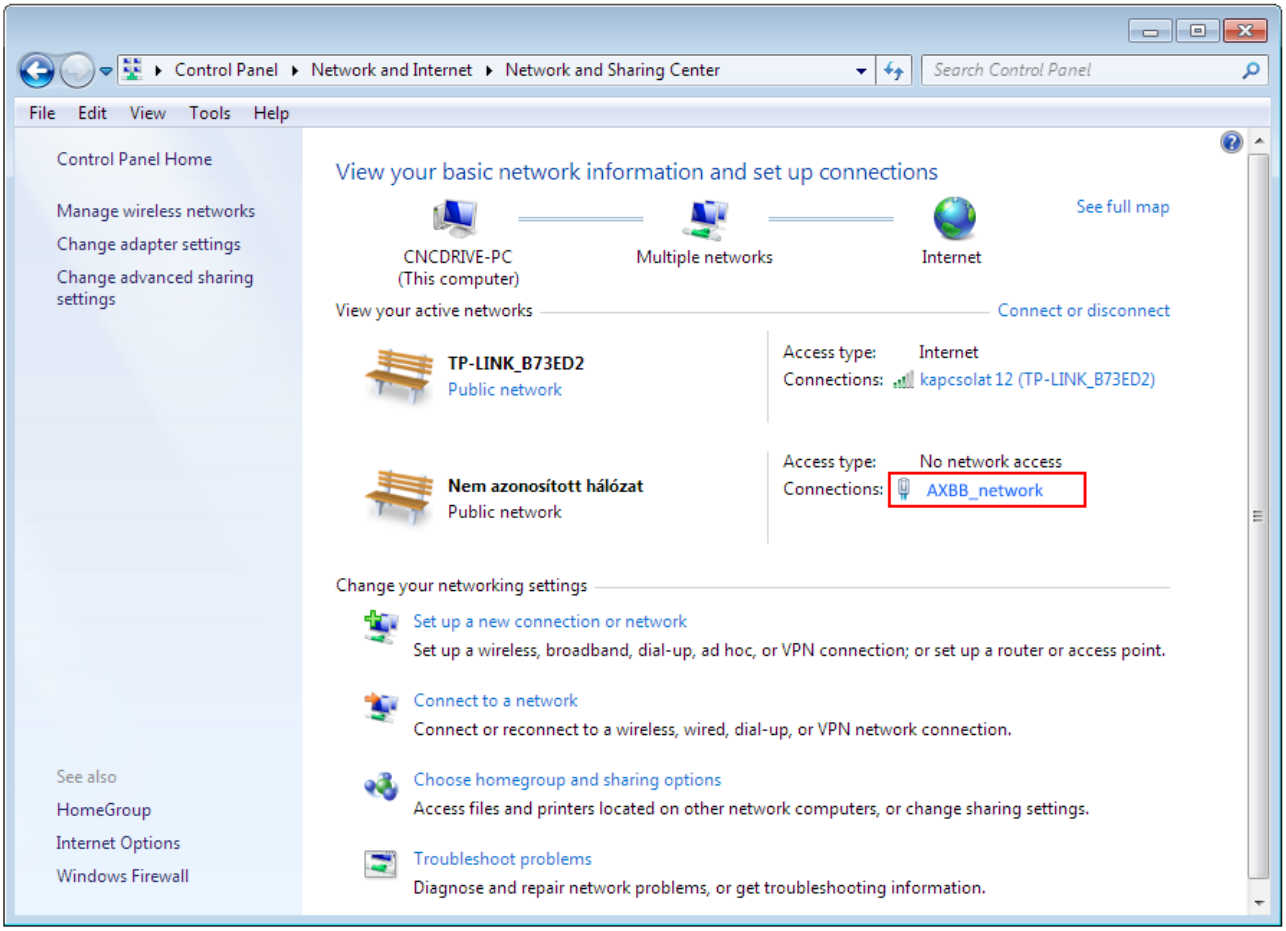
Use this cable for connection via router(s). **Use this cable for direct connection.**

After creating the connection and powering the AXBB up wait a few seconds to let the board power up and to let the device identify itself on the network and in Windows click the

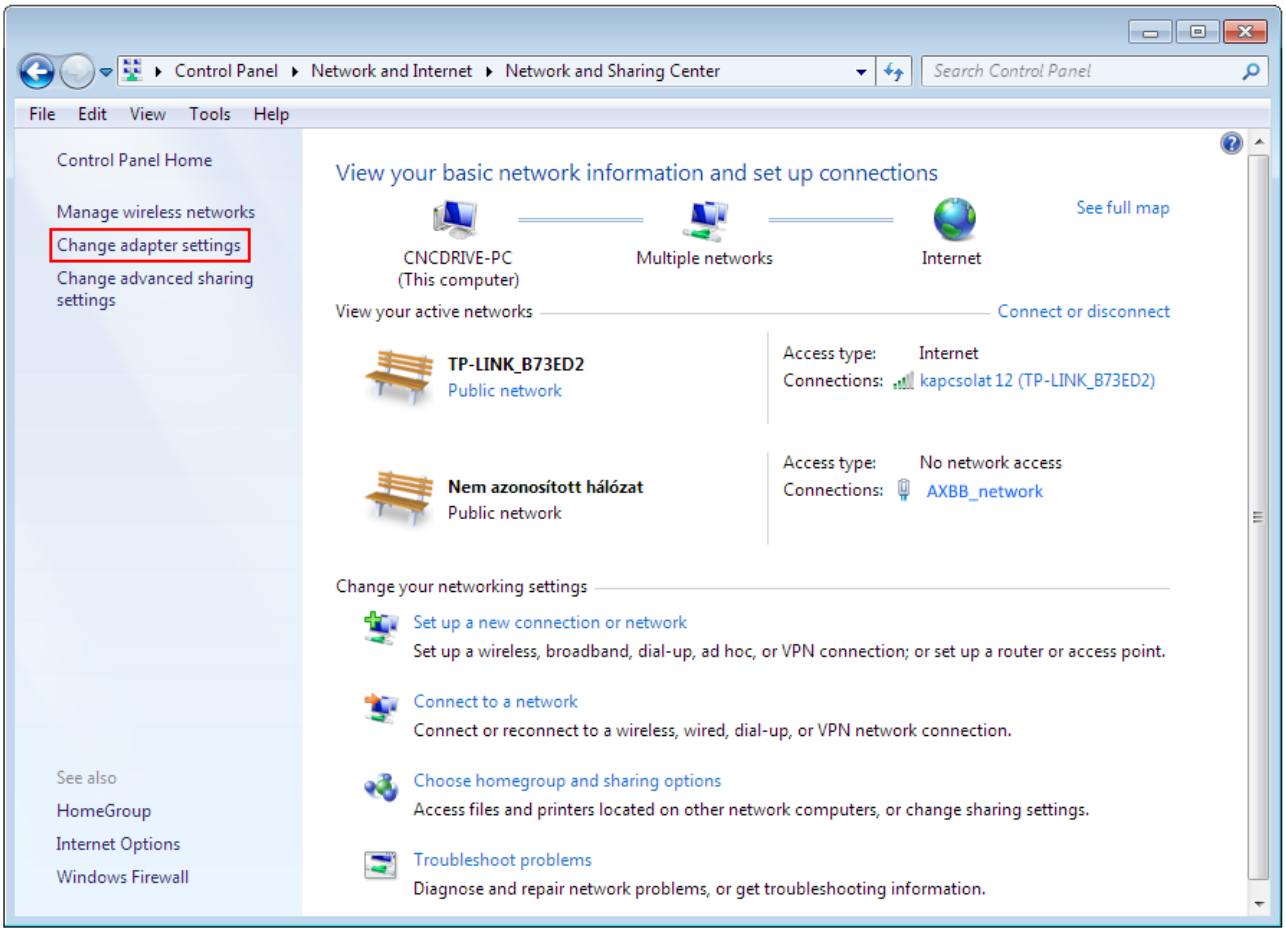
Start menu and the Control panel and open the Network and Sharing center.



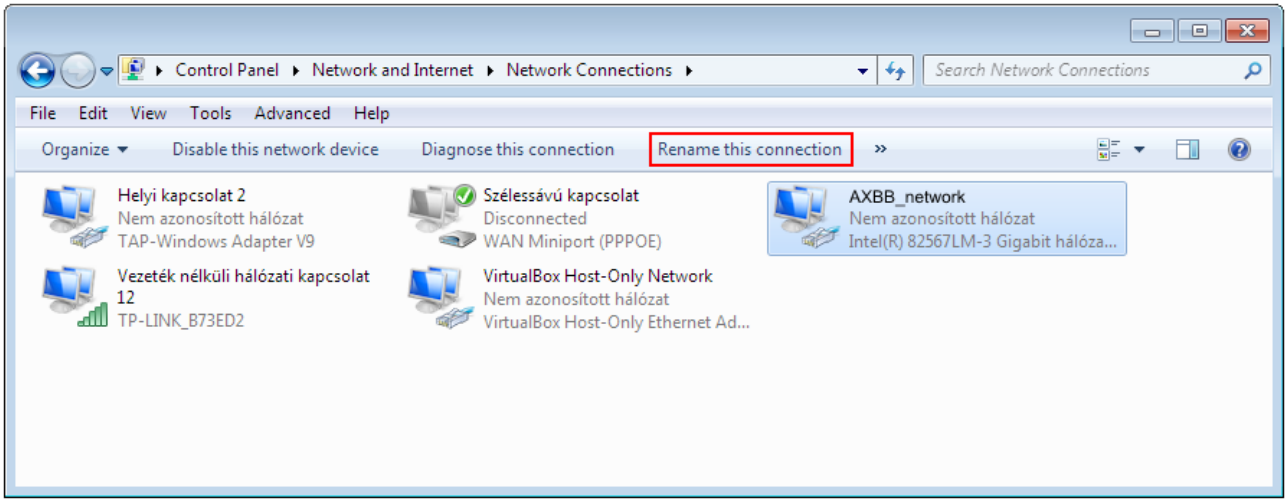
Find the network connection in the non identified connections list and click on it's name.



Please note that the network on the above printsceen is already renamed to AXBB. By default the network will have a name localconnection or similar. To rename the connection click the change adapter settings on the left side of the window.



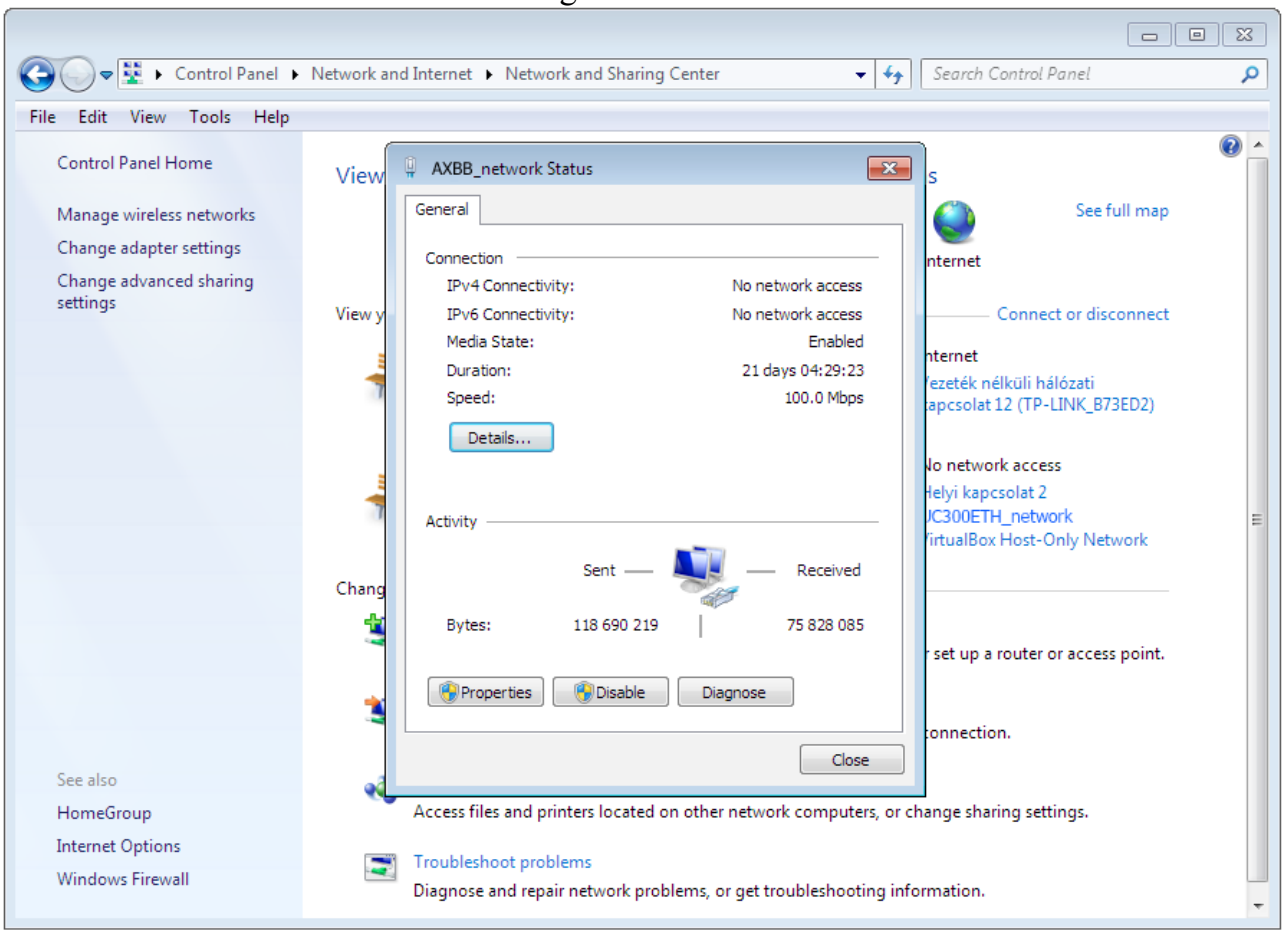
And left click the name of the adapter and click 'Rename this connection' and enter the new name of the connection.

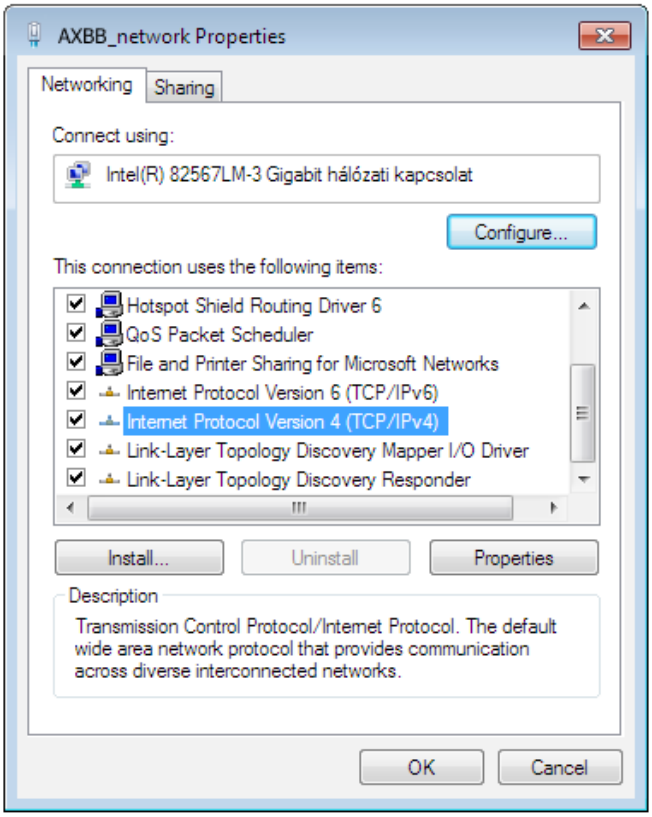


After finding and optionally renaming the connection it is time to setup the network parameters.

5.1.1 .Setup with direct connection to a LAN network card.

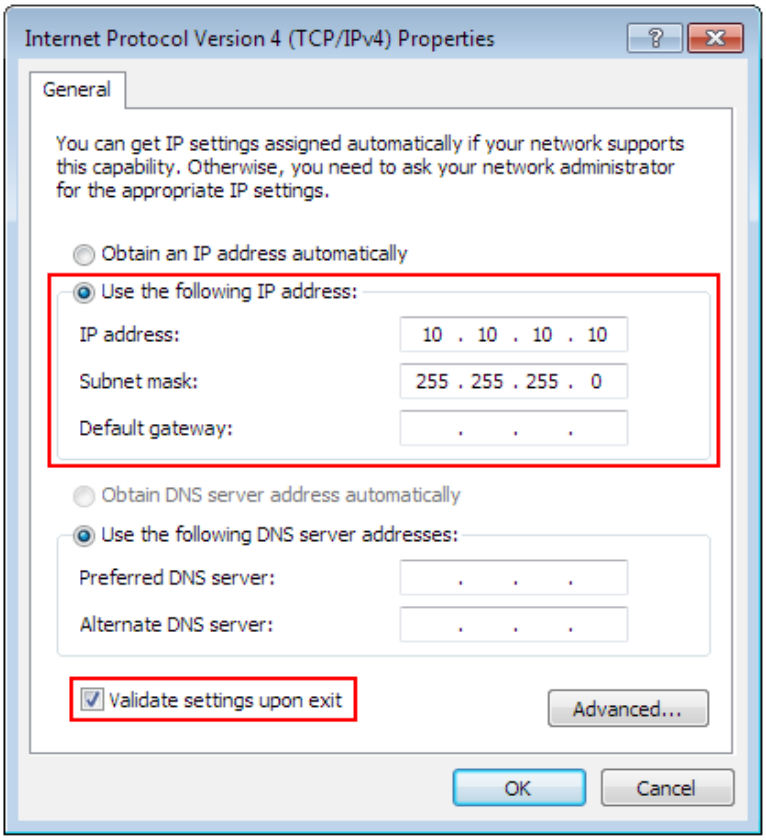
To setup the connection with direct cable connection click on the name of the connection and on the pop-up window press the Properties button. Please note that for this action to work the user must have administrator rights in the Windows account.



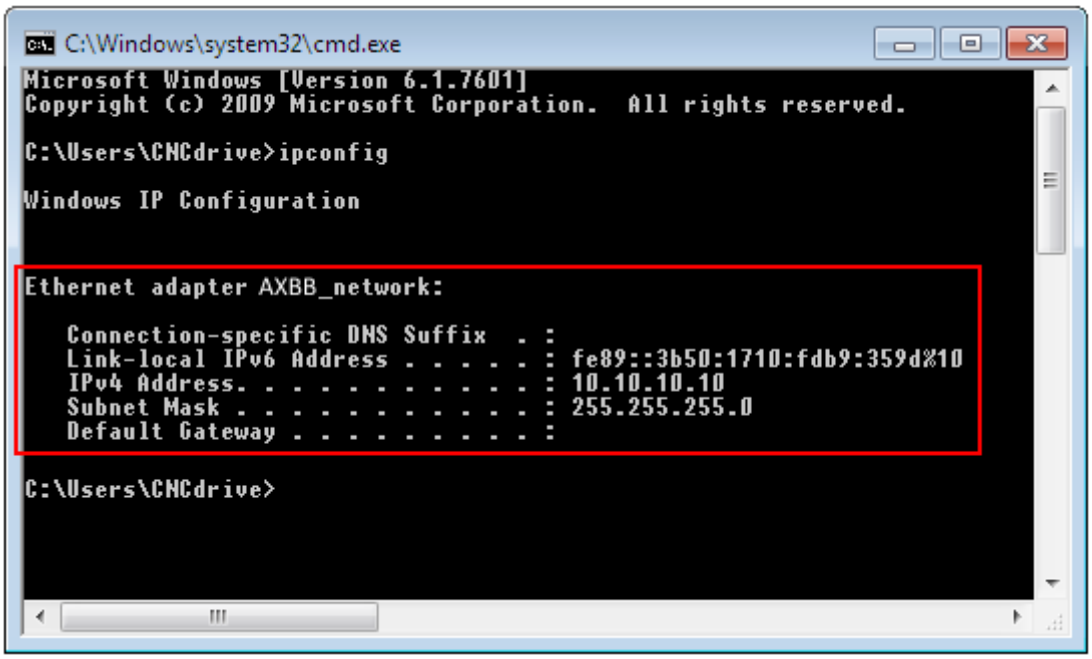


On the popup window find and select the 'Internet Protocol Version 4(TCP/IPv4)' row and click the Properties button.
On the pop up Internet Protocol Version 4((TCP/IPv4) Properties window select the Use the following IP address option and fill in the IP address of the AXBB device and set the Subnet mask. The default IP address of the AXBB is 10.10.10.10 (this can be changed and this will be described in a later section of this manual.) and set the subnet mask to 255.255.255.0 value.

Note that on Windows XP only the TCP/IPv4 protocol exists and because TCP/IPv6 protocol did not exist the time XP was released the protocol is simply named TCP/IP on XP.

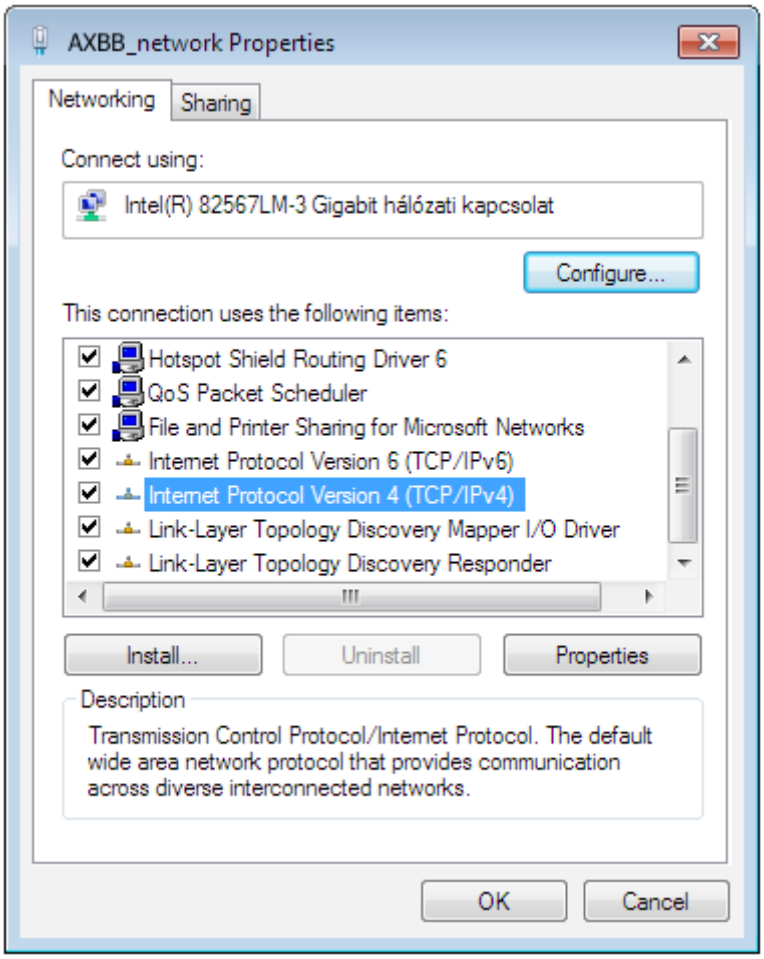


After filling the values don't forget to set the 'Validate settings upon exit' checkbox to let the parameters validate automaticaly when closing the setup. Finally press OK to all the pop up windows to exit the setup.
Wait a few seconds to let Windows to update the settings in the LAN card.
To verify that the settings got validated open up a command window with typing 'cmd' into the start menu and in the command window type 'ipconfig'.
The result should look like as on the following image. Please note that the Ipv4 address of our adapter got the 10.10.10.10 value with a subnet mask of 255.255.255.0 value.

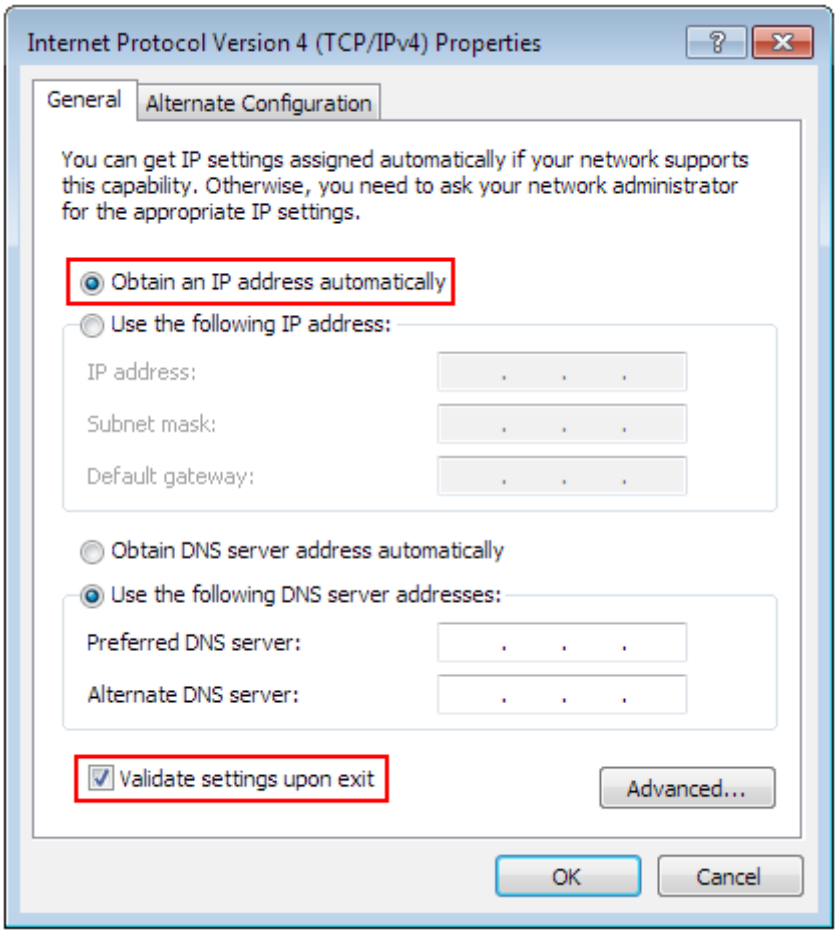


5.1.2 .Setup with connection via switch/router.

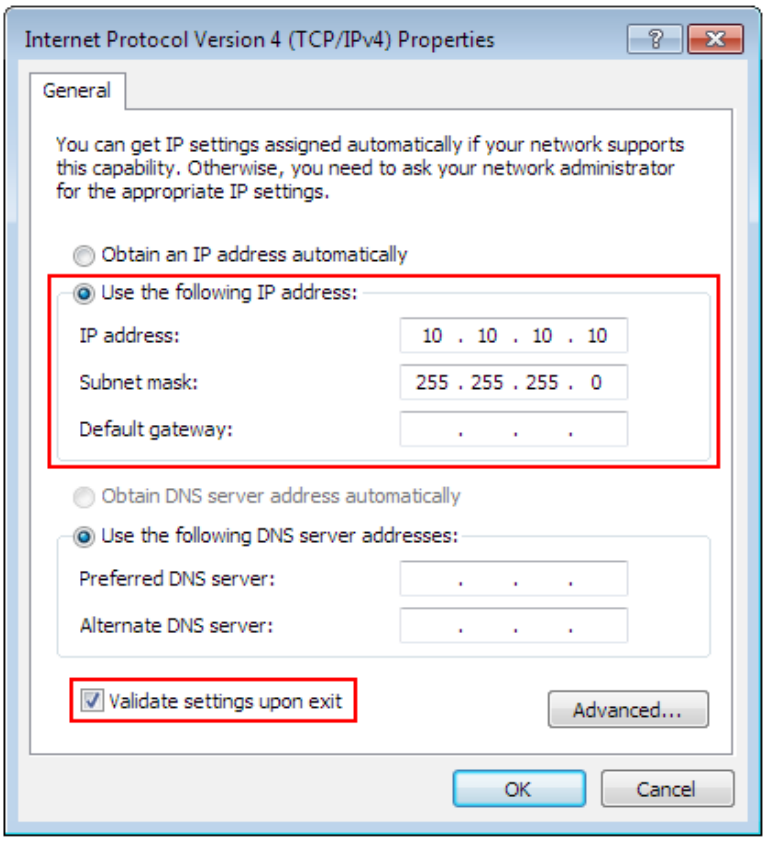
To setup the connection with connection via a switch or router device click on the name of the connection and on the pop-up window press the Properties button.
Please note that for this action to work the user must have administrator rights in the Windows account.



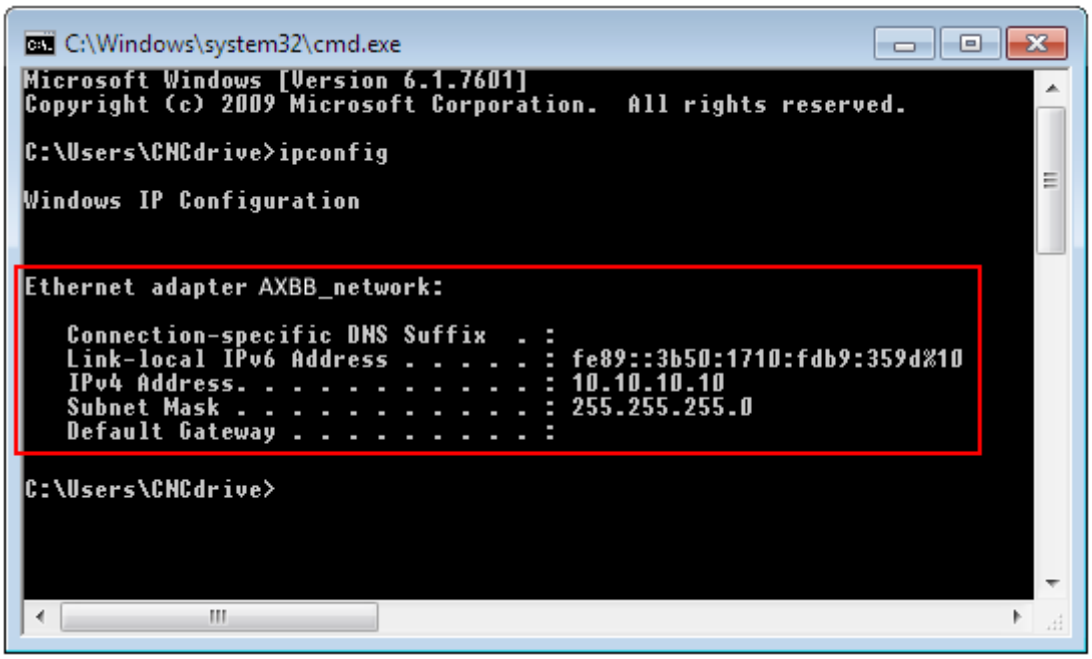
On the popup window find and select the 'Internet Protocol Version 4(TCP/IPv4)' row and click the Properties button.
If the DHCP is enabled in the router and in the AXBB then set the Obtain an IP address autoatically setting, because this way the DHCP server will provide an IP address to the AXBB device, no need to set a fixed IP address.



If the DHCP option is not enabled then the fix IP address set in the AXBB has to be set.
If the DHCP option is not enabled then on the pop up Internet Protocol Version 4((TCP/IPv4) Properties window select the Use the following IP address option and fill in the IP address of the AXBB device and set the Subnet mask. The default IP address of the AXBB is 10.10.10.10 (this can be changed and this will be described in a later section of this manual.) and set the subnet mask to 255.255.255.0 value.



After filling the values don't forget to set the 'Validate settings upon exit' checkbox to let the parameters validate automaticaly when closing the setup. Finally press OK to all the pop up windows to exit the setup.
Wait a few seconds to let Windows to update the settings in the LAN card.
To verify that the settings got validated open up a command window with typing 'cmd' into the start menu and in the command window type 'ipconfig'.
The result should look like as on the following image. Please note that the Ipv4 address of our adapter got the 10.10.10.10 value with a subnet mask of 255.255.255.0 value.

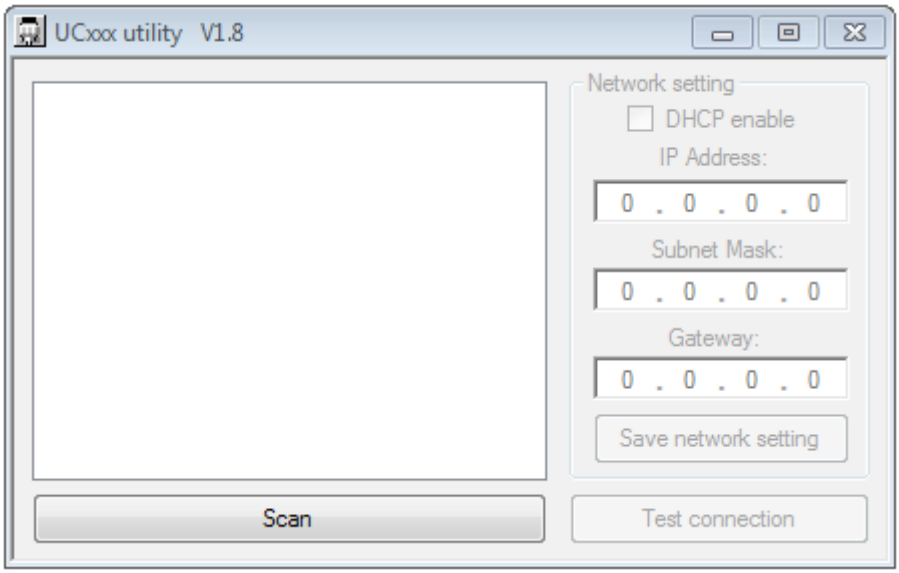


5.2 .Network settings on the AXBB.

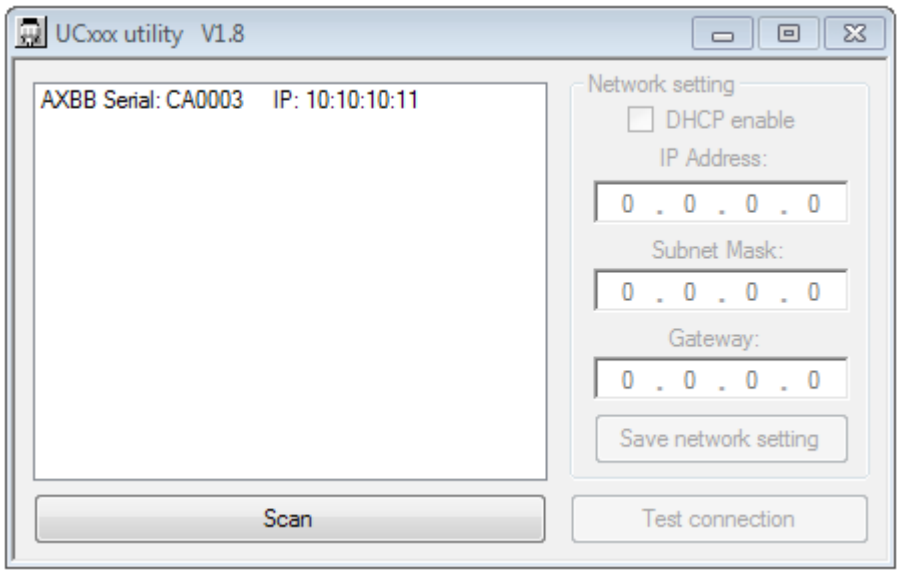
The AXBB network settings should be setup to fit the network settings on the PC side. To do the setup run the UCxxx_utility.exe application which file can be found in the UCCNC software installation folder.

5.2.1 .The UCxxx_utility.exe utility.

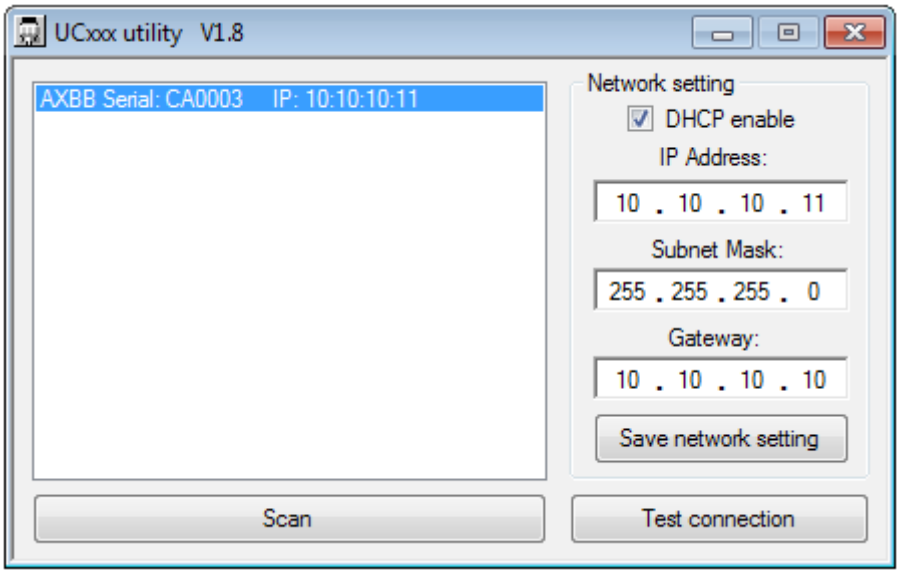
The UCxxx_utility.exe software can be used to list our USB and ethernet motion controllers and to check and configure the network parameters of the connected ethernet motion controllers.
The setup utility software looks the following on startup:



Press the 'scan' button to list the motion controller devices connected to the network. Doing so the software will send a broadcast massege to the network and will map all the available motion controller devices connected and running and will list the devices serial numbers in the listbox on the application form like this:

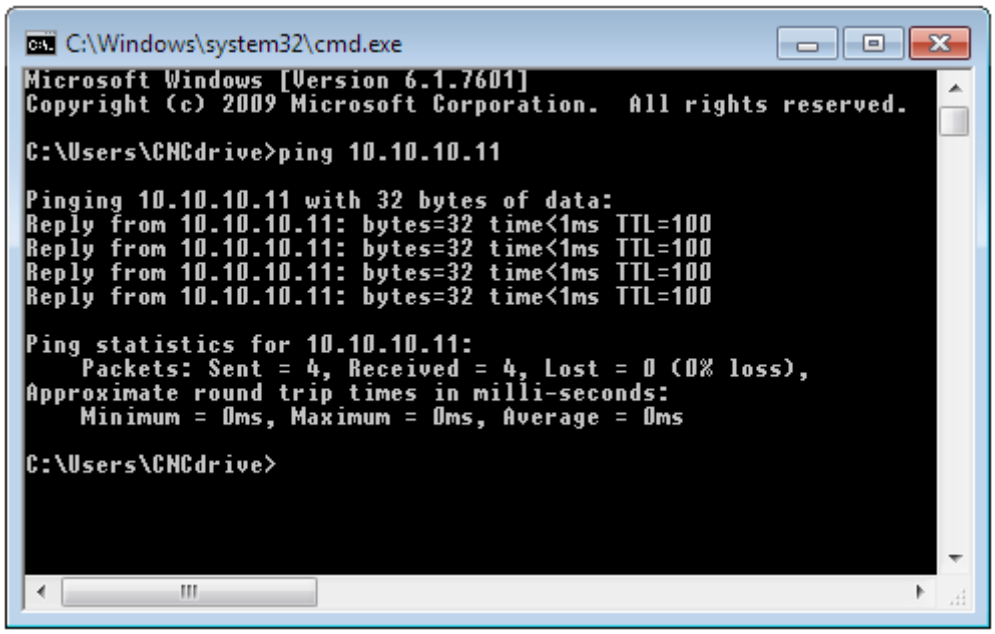


If the device of interest does not show up in the list then check the network cable connections and the router/switch device if there is any. Also check if the PC side network parameters are correct.
If the device serial number shows up in the list then click it's row to configure it.



Selecting the device in the list will enable the network settings area on the screen.
Now the network parameters can be changed with typing in the new values.
The default parameter values are shown on the above picture and in the PC side network setup topic we setup the connection for these parameters.
The default IP address value is 10.10.10.11, the Subnet mask is 255.255.255.0 and the gateway is 10.10.10.0.
Ofcourse if the PC side setup values were different then the AXBB side setup should follow those different network settings.
If the AXBB is connected via a direct cable then the DHCP option should be left unchecked, because in this case the device will be called directly with a fixed IP address.
If the AXBB is connected via a router/switch then the DHCP option can be enabled depending on if the DHCP is enabled and setup in the router device.
A router could be also setup to provide a fix IP address to the AXBB device, in this case the DHCP option in the UCxxx_utility software should be not set.
With the DHCP enabled and working the router will give a dynamic IP address to the AXBB device and the PC will get connected to the AXBB via the router using the routing informations provided by the router.
To save all parameters press the 'Save network settings' button and this will save the parameters to the AXBB non volatile memory.

The network connection can be tested with a command line pinging, like on the below picture:

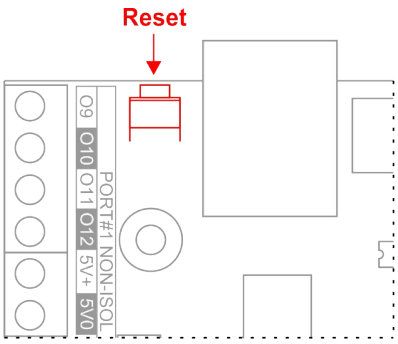


Another way to ping the device is to ping the device's alias on the network. For example the AXBB device which having a serial number of 123456 can be pinged via the command line with the following command 'ping AXBB-123456' , executing this command will ping the device just like when the IP address of the device was pinged. Please note that the command parameter is case sensitive, the AXBB and the letters in the serial number (if any) has to be typed with upper case characters.

The connection can be also tested with pressing the 'test connection' button on the utility program window. The connection testing algorithm will check the connection to the AXBB device and will show a success message or an error depending on the correctness of the settings.

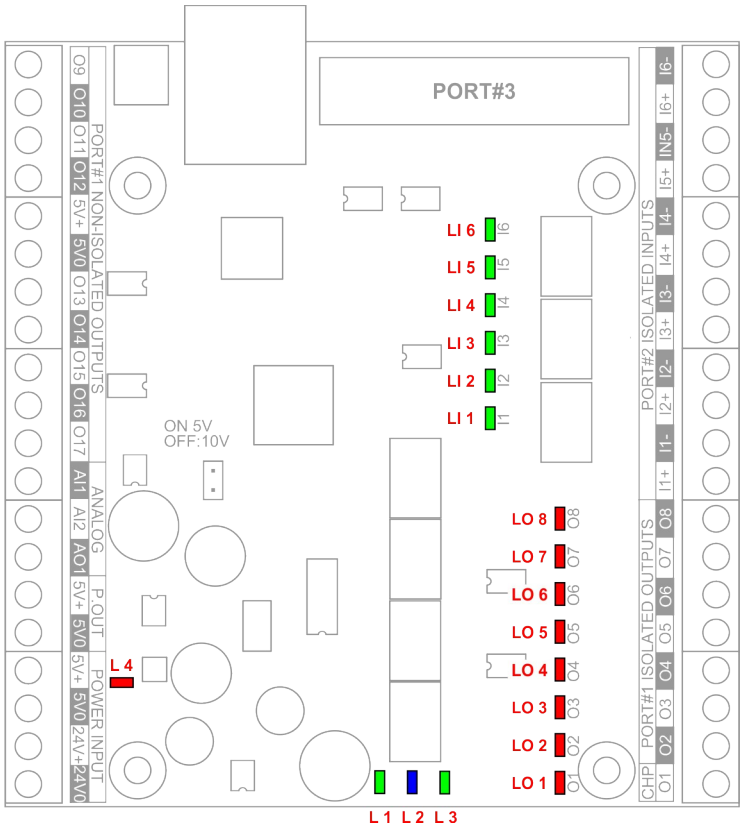
5.2.2 .Resetting the network settings

The UCxxx_utility software explores the AXBB on the network with broadcast packages, so theoritically the device should remain always detectable with any settings, but if something goes really wrong with the settings the network parameters in the AXBB can be reset.
To reset the settings unpower the device with disconnecting the 5VDC power source from the power input terminal and push the reset button on the top of the AXBB board and keep the button down while powering the device up. Both the green and the blue LEDs will be blinking rapidly. Keep the button pressed for 5 more seconds until both LEDs will show a solid light which indicates that the device reset the settings to the factory defaults.
The following picture shows the reset button on the board:



6 .LEDs signs.

There are 6 status LEDs in total on the AXBB board. Two of these LEDs are inside the RJ45 jack. The following image shows the onboard LEDs:



The green LED in the RJ45 connector is the 'Link' Led which lights when there is an active connection to the computer or switch/router. If the green LED is off when the LAN cable is connected to the computer and the AXBB board is powered then there is a physical connection problem, the cable might be broken or has the wrong pinout.

The orange LED is the 'Activity' LED which lights when packets being received or transmitted by the device.

The other 3 LEDs are on the opposite side of the board. The green LED (L3) is the digital power LED. This LED has a few different signs indicated with different blinking sequences. There are 2 execution states in the AXBB processor with different green LED sequences, one state is when the device is executing the bootloader in the processor of the AXBB board and the other state is when the DSP is executing the firmware.
The DSP is executing the bootloader when the device resets and starting up and when the firmware code has an error and when a new firmware is being downloaded from the host computer to the AXBB device.

The possible LED blink sequences when the device is in the bootloader:

00001111**00**000 - No valid IP address (DCHP request in progress), Firmware OK.
00001111**01**000 - The IP address is valid, Firmware OK.
00001111**00**0**1**0 - No valid IP address, Firmare has error.

0000111101010 - The IP address is valid, Firmware has error.

The possible blinking sequences when the device is executing the firmware:

11110 - No vaid IP address.
11111 - IP address is valid.

Notes:
0 – means the green LED is off.
1 – means the green LED is on.
One 0 and 1 character state has a 200milliseconds execution time interval.
The blue LED (L2) on the board is the communication LED and this LED lights when there is a connection to the software on the host PC and there is an active communication ongoing.
The third LED (L1) is the 24 Volts power LED.

There is one more LED (L4) which shows power failures and short circuits on the digital power. When there is a short circuit on the 5V side of the circuit then the AXBB protects itself and first limits the current, but if the voltage drops to an unwanted low level then it switches the 5V power input off and unpowers itself and the LED L4 turns on indicating the fault. To remove this fault condition the 5V power connected to the board has to be toggled.

The LEDs marked with 'LO' indicating the output terminals logic states and the LEDs marked with 'LI' indicating the input terminal logic states.

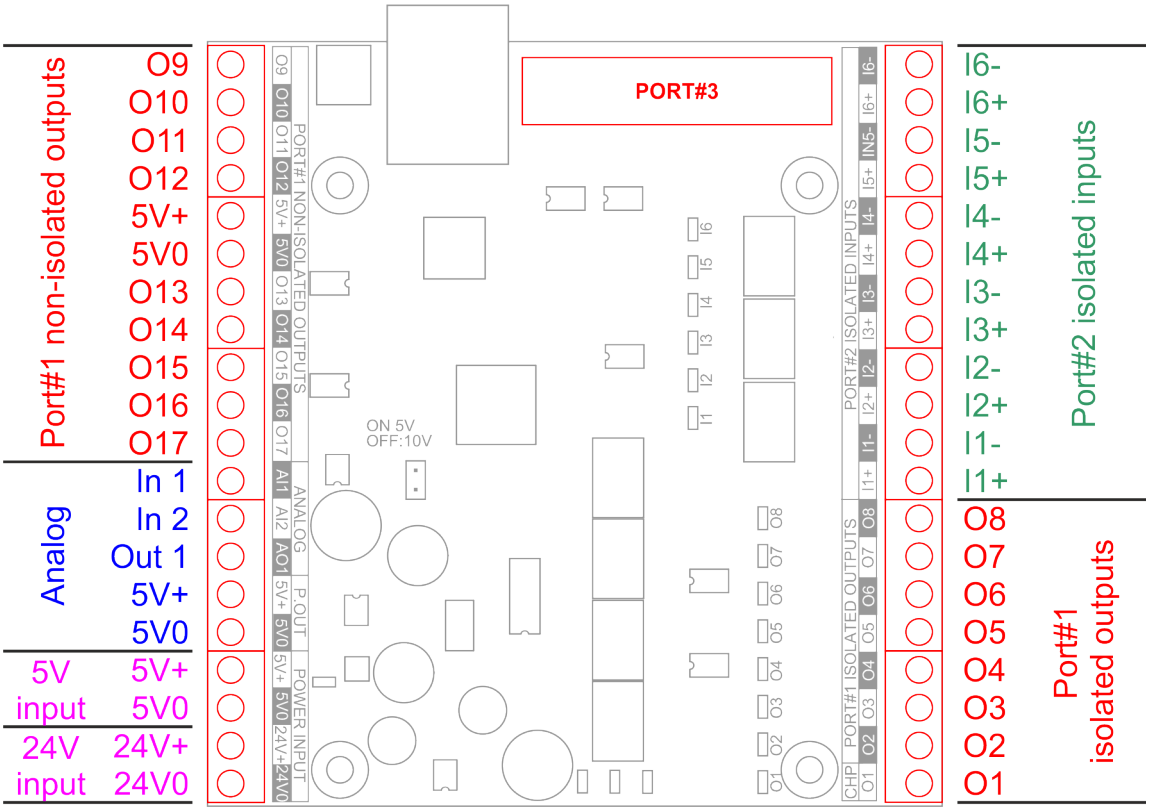
7 .External power supply connection.

The AXBB board requires 2 power supply, one power supply is called the digital power and it powers the internal logic of the device as well as the IDC26 extension port, the unisolated I/O port and the analog ports.
Make sure to not use higher input Voltage than 5Volts DC because it can cause permanent damage to the device!
We recommend to use a power supply with at least 500mAmps of current capability of the power supply. More current may be required if more I/Os are used on the unisolated port and on the IDC26 port.

The second power supply has to have a voltage of 12 to 24Volts. This power supply powers the isolated ports and the devices connected to it, the home and limit switches, buttons, probe sensor, etc. connected to the inputs and the relays etc. connected to the outputs.

8 .I/O connections of the device.

The I/Os of the board are separated to 3 digital ports and 1 analog port.
Port#1 and port#2 and the analog port are all wired to screw terminals while port#3 is an IDC26 extension port with standard LPT port pinout.
The following image shows the connectors and terminal pinouts:



8.1 .Digital ports.

There are 3 digital ports on the board.
Port#1 contains 17 outputs.
Port#2 contains 6 inputs.
Port#3 contains 12 outputs and 5 inputs.

8.1.1 .Digital isolated ports.

Port#1 pins 2. to 8. are isolated outputs. These outputs contain high speed 10Mbit/sec optocouplers and an N-channel Mosfet transistors.
The outputs can drive upto 500mAmps of current upto 24Volts voltage levels.
The high current capability of the output transistors makes these outputs ideal to drive relays, solid state relays and other signals which require isolation.

Port#2 contains 6 isolated inputs. These inputs are built with high speed 10Mbit/sec optocouplers and both the anode and cathode side connections are wired out making it possible to interface NPN, PNP and push pull sensors as well as switches and pushbuttons. There is a serial 2.2kOhm resistor on each inputs which limits the current into the optocoupler making the optocoupler to function between 10 and 30Volts input voltage levels.

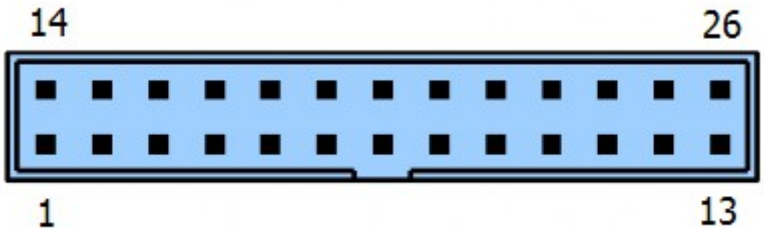
8.1.2 .Digital non-isolated ports.

Port#1 pins 9. to 17. are non isolated outputs.
These outputs are referenced to the 0Volt (ground) of the 5V power supply.
The outputs can push/pull 20mAmps current maximum with TTL (0/5V) voltage level.
The purpose of these pins are to output step and direction or other high frequency signals

which require no isolation.

8.1.3 .Port#3 extension port pinout

The following image and table show the pinout of port#3:



Pin number	Signal type
1	Output 1.
2	Output 2.
3	Output 3.
4	Output 4.
5	Output 5.
6	Output 6.
7	Output 7.
8	Output 8.
9	Output 9.
10	Input 10.
11	Input 11.
12	Input 12.
13	Input 13.
14	Output 14.
15	Input 15.
16	Output 16.
17	Output 17.
18-25	Ground
26	5 Volt output

8.2 .Analog port.

The analog port contains 2 analog inputs and 1 analog output.

8.2.1 .Analog output.

There is one analog output on the board (marked with A01) which can output 0-10V voltage levels or 0-5V voltage levels. The voltage range is selectable between the 0-10V or 0-5V with the J1 jumper on the board. If the jumper is removed then the range is 0-5V and if the

jumper is on then the voltage is 0-10V. The analog output can be used for example to control the speed of a spindle motor using a variable frequency drive with analog voltage input interface.

8.2.2 .Analog inputs.

There are 2 analog inputs (marked with AI1 and AI2) on the board. The input voltage range is 0-5Volts.
External potentiometers can be connected to these inputs to control for example the spindle speed override and the feedrate override in the CNC control software.

8.3 .Charge pump safety circuit port

There is one charge pump safety circuit integrated on the board in port#1 O1 CHP output. The charge pump circuit senses the charge pump pulse stream signal from the controller and if the signal exists then the output is switched on and if it cuts then the output switches off. The charge pump can be used to control a safety relay to cut power when the software is not running on the computer.

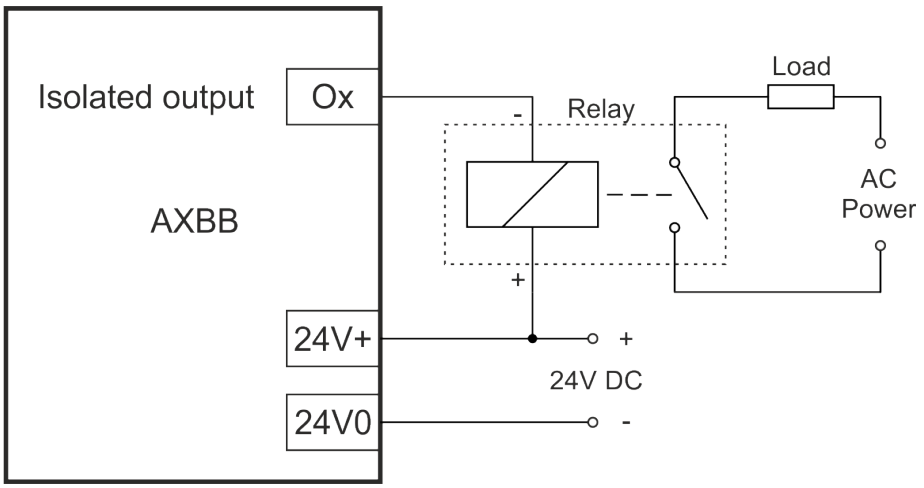
9 .Example connections

9.1 .Connecting different devices to the isolated outputs

9.1.1 .Connecting a mechanical relay

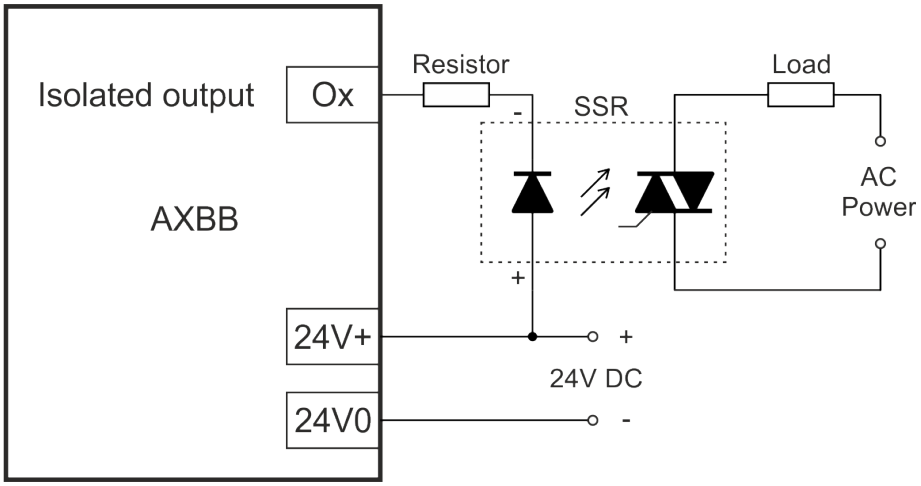
To connect a mechanical relay to the isolated outputs is simple. When the mechanical relay coil rated voltage is 24Volts DC then the 24V powersupply powering the AXBB board can be used to power the relay.
Connect the 24Volts of the power supply to the positive side of the relay coil and connect the negative side of the relay coil to the screw terminal of the output.

If the relay coil is rated to a different voltage not 24Volts then a second powersupply is required to power it. Common the 0Volts output of the second power supply with the 0Volts (24V0) output of the 24V powersupply which powers the AXBB board to have the second powersupply referenced to the same 0Volts potential. Connect the positive powersupply voltage to the positive side of the relay coil and connect the negative side of the relay coil to the output screw terminal of the output.
The following image shows how to connect a mechanical relay:



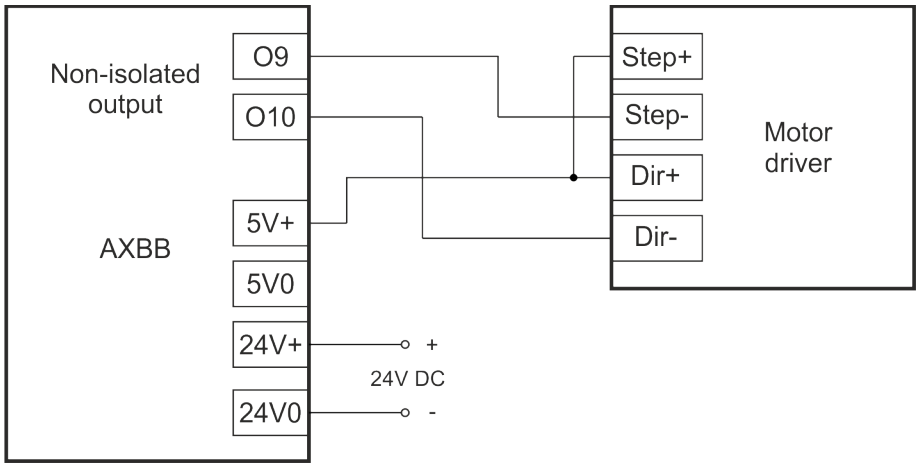
9.1.2 .Connecting a solid state relay (SSR)

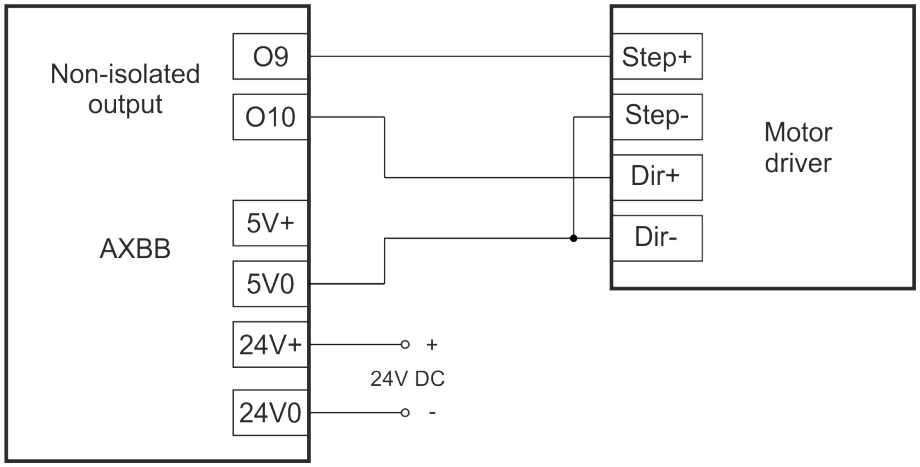
Solid state relays (SSR) are non-mechanical type relays where the switching circuit inside the relay is an electric circuit mostly with a Mosfet or IGBT or Triak.
These kind of relays having an optocoupler with LED on their inputs and they can be driven similar way as a standard LED. A series resistor often has to be connected in series with the LED anode of the SSR. This series resistor is used to limit the LED current to a value adviced in the SSR's datasheet. If a series resistor is required and for the recommended value of the series resistor please see the used SSR's product manual.
The shematics of the SSR connection to the AXBB board is shown below:



9.2 .Connecting step and direction signals to the non-isolated outputs.

To connect the step and direction signals to stepper or servo drives any of the 8 non-isolated outputs (O9 to O17) can be used. Most stepper drives have an optocoupler on these signals with a series resistor fitted in series with the LED of the optocoupler. Mostly the series resistor's value fits a certain voltage level or voltage range, usually it is around 5Volts. With these drives the 5Volts from the P.OUT screw terminals 5V+ and 5V0 can be used to drive the step and direction lines of the drives. The following 2 pictures show the possible connection schemas:

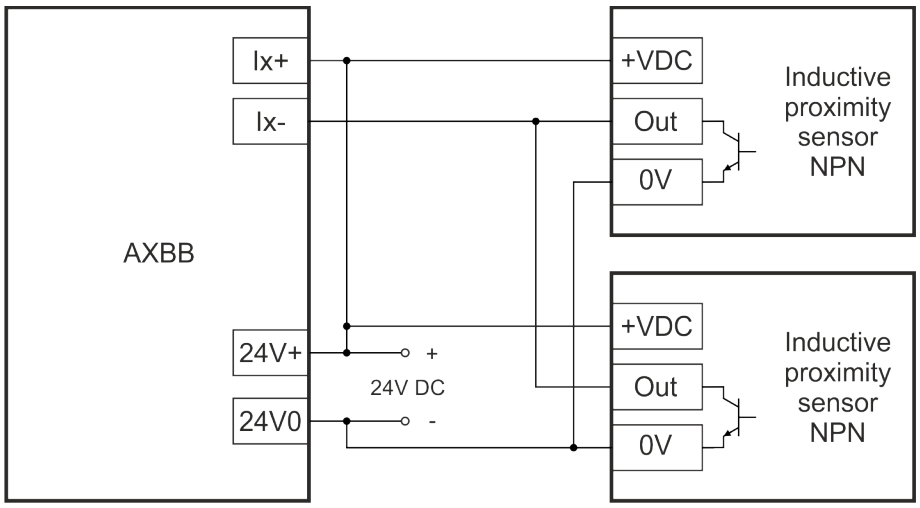




9.3 .Connecting switches and sensors to inputs

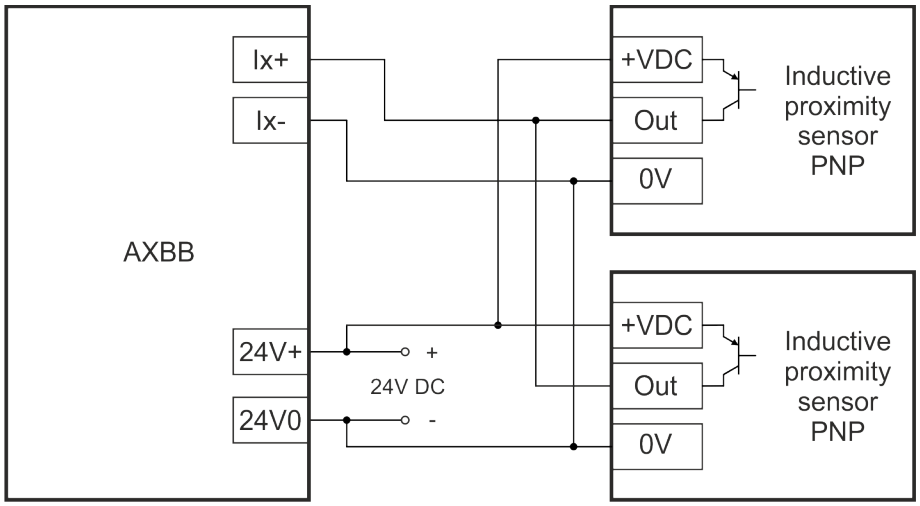
9.3.1 .Connecting NPN switches

Any number of NPN type outputs can be wired in parallel to a single input as shown on the below schematics drawing:



9.3.2 .Connecting PNP switches

Any number of PNP outputs can be wired in parallel to a single input as shown on the below shematics drawing:

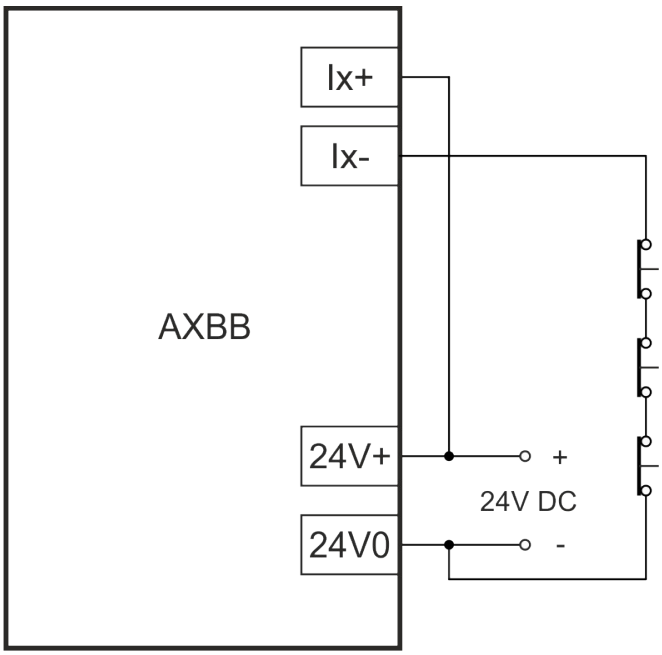


9.3.3 .Connecting mechanical switches

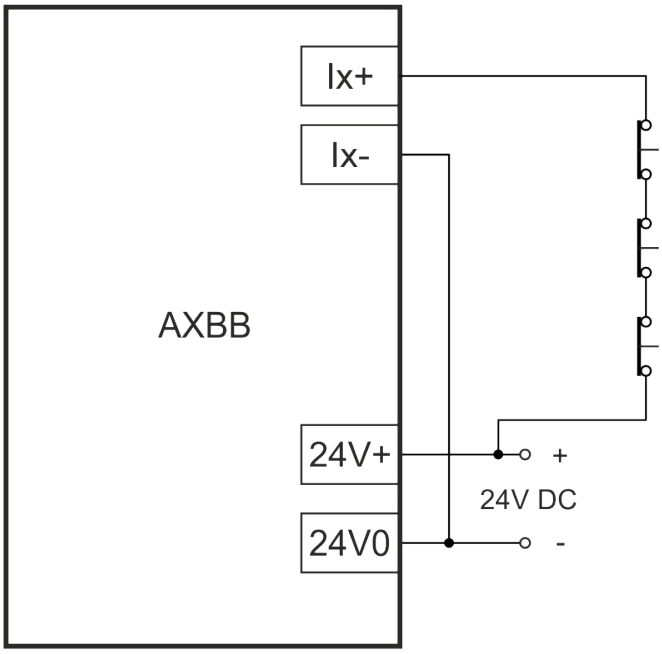
Normally open switches can be connected to the input in a series connection and normally closed switches can be connected to the input in a parallel connection.
It should be noted that for safety signals like the limit and e-stop switches it is recommended to use NC type switches, because with the NC switches if there is an accidental wire cut or a contactor failure of the switch is detected as an open circuit which triggers the safety function, because it is the same action as if the switch is pressed in and the contactor releases.
If NO switches are used then a wire cut or a contactor failure is not causing the safety function to trigger, but instead it causes the switch not to trigger the input when pressed and the safety function can't be triggered which is a safety hazard.

9.3.3.1 Connecting normally closed (NC) switches

Any number of mechanical NC contact switches can be wired in series to a single input. There are two ways of connecting mechanical NC type switches to the inputs. One way is to connect the positive power supply rail +24V to the positive input screw terminal and connect the 0Volts (24V0) to one side of the NC switch and connect the other side of the switch to the negative input screw terminal of the AXBB. The following image shows the connection:

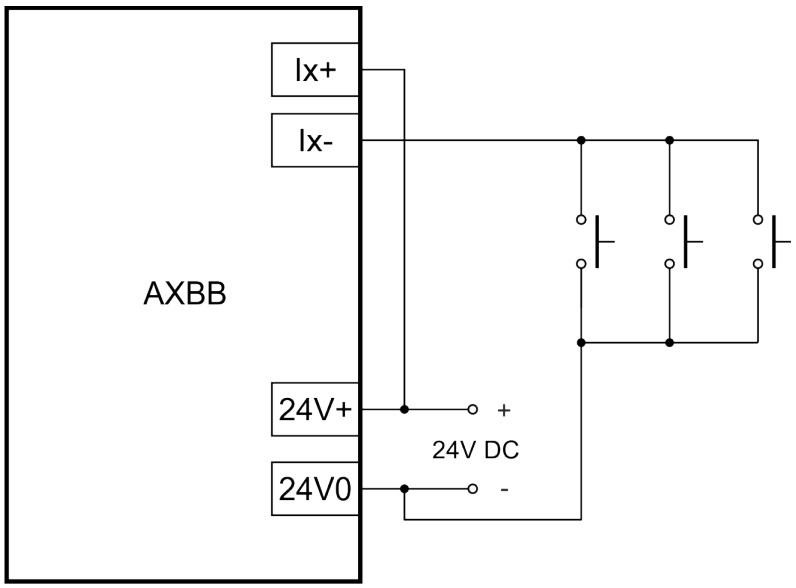


The other way is to connect the positive power supply rail +24V to one side of the NC switch and connect the other side of the NC switch to the positive input screw terminal of the AXBB and connect the 0V (24V0) to the negative input screw terminal of the AXBB.
The following image shows the connection:

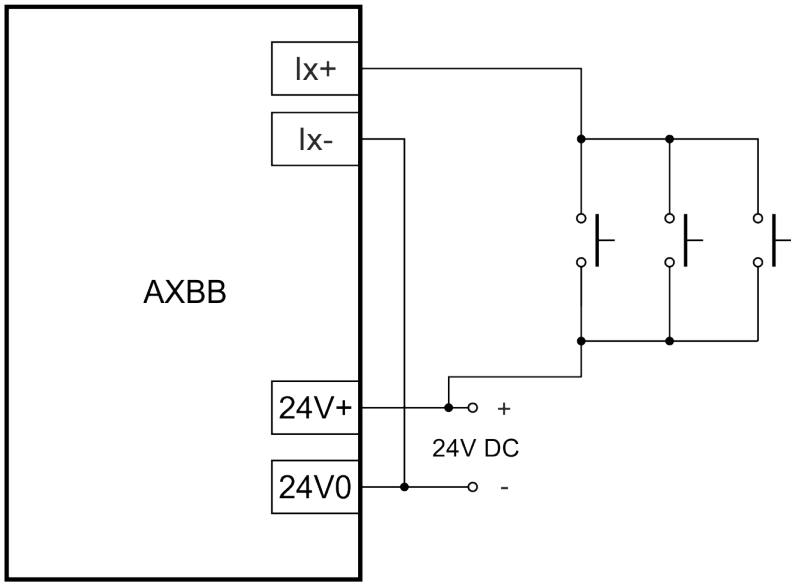


9.3.3.2 Connecting normally open (NO) switches

Any number of mechanical NO contact switches can be wired in parallel to a single input. There are two ways of connecting mechanical NO type switches to the inputs. One way is to connect the positive power supply rail 24V to the positive input screw terminal and connect the 0Volts (24V0) to one side of the NO switch and connect the other side of the switch to the negative input screw terminal of the AXBB.
The following image shows the connection:

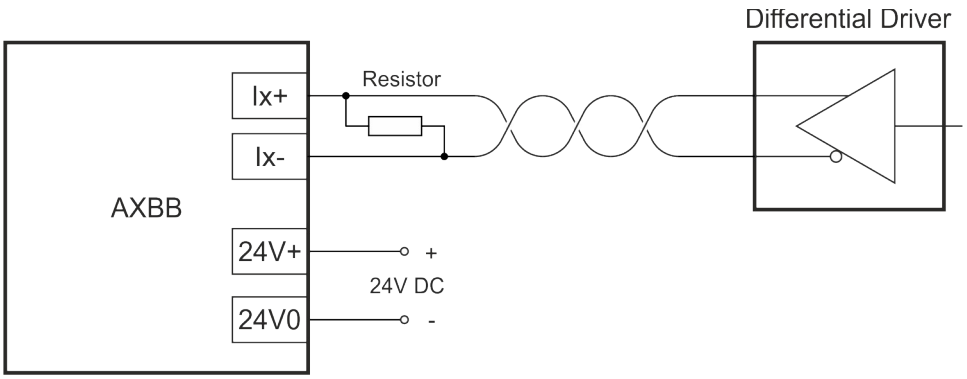


The other way is to connect the positive power supply rail 24V to one side of the NO switch and connect the other side of the NO switch to the positive input screw terminal of the AXBB and connect the 0Volts (24V0) to the negative input screw terminal of the AXBB.
The following image shows the connection:



9.3.4 .Connecting line drivers

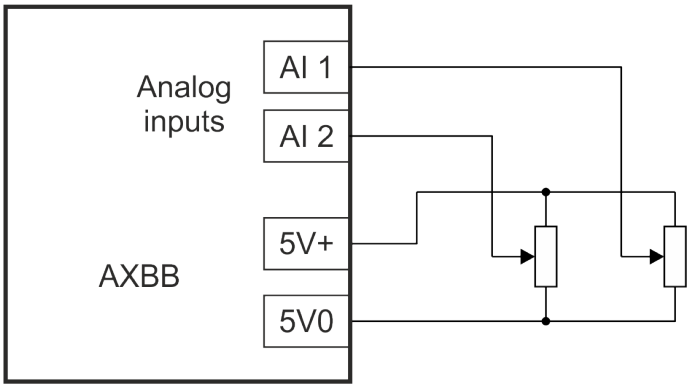
Connecting line driver transmitters to inputs of the AXBB board is possible because there is a reverse polarity connected diode with the series resistor on each input.
This diode opens and protects the LED when the line driver's channels switches to the reverse polarity to the LED's driving polarity.
To connect a line driver like a 26LS31 or similar there is a need to connect a terminating resistor or snubber close to receiver which is the input of the AXBB board. For exact resistor and/or snubber values please refer to the line driver IC or sensor's manual. Usually a 100 to 120 Ohms resistor is adequate.



9.4 .Connections to the analog port

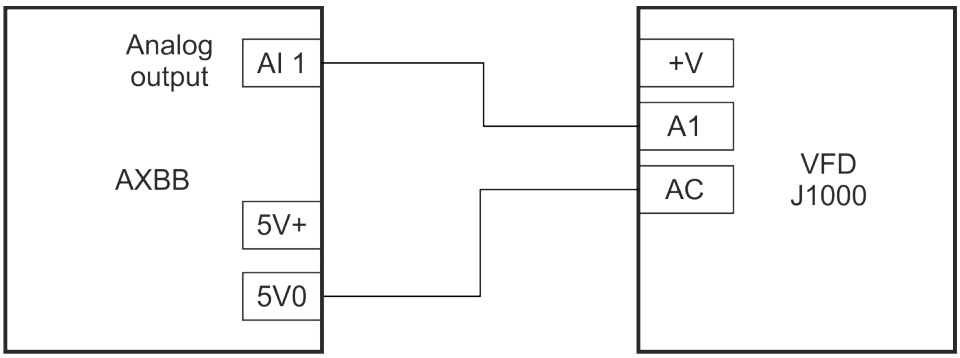
9.4.1 .Connecting potentiometers to the analog inputs

The 2 analog inputs (AI1 and AI2) are non-isolated and are referenced to the 5V0 ground potential of the board. To connect a potentiometer connect one side of the potentiometer to the 5V0 screw terminal and the other side to the +5V screw terminal and connect the wiper of the potentiometer to the AI1 or AI2 analog input terminals of the AXBB board.
The recommended potentiometer full scale resistance value is 1k to 10kOhms.
If linear scaling of the signal is required then use a linearly scaled potentiometer.
The following image shows the connection of an external potentiometer:



9.4.2 .Connecting a VFD to the analog output

There is one analog output on the board. The analog output is non-isolated and is referenced to the 5V0 ground potential of the board. The signal full scale voltage range is selectable between 0-5 Volts when the J1 jumper is off and 0-10 Volts when J1 jumper is on.
Usually the analog output is used to control the speed of a spindle motor using a variable frequency drive (VFD) which has an analog voltage input interface.
To connect the analog output signal to the VFD's analog input common the ground 5V0 with the VFD's analog ground and connect the output signal AO1 to the analog input of the VFD. Please note that this connection is only recommended if the analog input circuitry of the VFD is isolated from the high voltage part of the VFD.
The following image shows an example VFD analog signal connection:



10 .Running the AXBB with the UCCNC software.

After the network for the AXBB got setup it is time to run the device with the UCCNC software, but before doing so make sure to copy the license key file for the device to the UCCNC installation directory.
The AXBB hardware is compatible with the UCCNC software versions starting from 1.2105.
To use the software first power the AXBB and connect it to the LAN network and run the software. In case of a successful connection the blue LED on the AXBB will light up as soon as starting the software and will remain on while the software is running.
For more informations about the software licensing and the usage of the UCCNC software please read the UCCNC software user's guide which is available on the software product page at: http://www.cncdrive.com/AXBB .

