CNC USB Controller Mk3

User manual

2014-10-22

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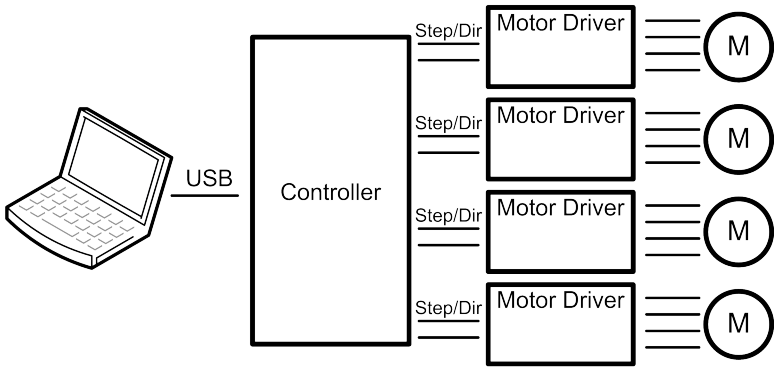
1 Introduction

1.1 Overview



The PlanetCNC series of USB CNC motion controllers is link between a personal computer and motor drivers supporting step/direction control. PlanetCNC series of motion controllers are compatible with most motor drivers. The controllers use the USB port, available on all modern computers and laptops. They can serve as direct replacement or upgrade for many parallel port break-out boards. There are different models available.

PlanetCNC controllers provide a complete, fully integrated software/hardware solution. Additional machine control software is NOT required. The USB CNC Controller software is a dedicated application, designed to fully exploit the features of the purpose-built hardware. It has many advanced features to assist day-to-day CNC machine operation.

1.2 Features and specifications:

- USB (V2.x) from PC/Laptop running Windows XP, Vista, Windows 7, 8 or 8.1 (32 bit or 64bit)
- motor driver connector pin-out is compatible with 10 pin open source interface
- controller works with most step/dir stepper and servo motor drivers available on the market
- buffered IO for maximum performance
- advanced interpolation algorithms
- start, stop, pause and resume execution of program on your machine
- standard RS274/NGC G-code (EMC2 and LinuxCNC compatible)
- advanced G-codes - G40, G41, G42 (Cutter Radius Compensation) supported
- advanced G-codes - G43, G49 (Tool Length Offsets) supported
- advanced G-codes - G54, G59.3 (Coordinate System Origins) supported
- tested with SolidCAM, MasterCAM, ArtCAM, Vectric, CamBam, MeshCAM ... generated G-code
- Profili 4-axes and 3-axes G-code supported
- import toolpath from DXF files
- import toolpath from PLT/HPGL files
- import toolpath from image files
- import toolpath from NC-Drill (Excellon) files
- import toolpath from Gerber (RS-274X) files
- toolpath simulation
- automatic homing procedure
- advanced toolchange procedures
- automatic tool length measuring
- export toolpath to G-code
- export toolpath to DXF
- SDK (software developers kit) is available
- works on MacOS with virtual machine emulating Windows

Mk3 - 9 axes USB CNC controller

- 9 axes controller for stepper and servo motors
- USB and Ethernet connection
- 110 kHz maximum step frequency
- 25 us pulse width, 50% duty cycle at higher frequencies
- 8 digital outputs on board
- 3 PWM capable outputs with selectable frequency (10Hz to 500kHz)
- 3 outputs with support for RC servo motors
- additional outputs with add on boards (currently up to 32)
- jogging keyboard support with speed potentiometer, shift, step and spindle sync feature
- 8 limit switches with shift feature
- 8 digital inputs on board, filtered and protected
- additional inputs with add on boards (currently up to 32)
- 4 analog inputs
- MPG pendant support

- spindle encoder and index signal support for spindle synchronization
- SD card support for running g-code without computer
- control external devices with I2C and UART protocol
- homing procedure
- tool change procedure
- tool length sensor support
- sensor for capturing and measuring
- digitizing probe support
- H-bot kinematics support
- transformation matrix
- soft limits
- slave axes
- backlash compensation
- integrated web server for monitoring state and sending commands
- API

1.3 System Requirements

Minimum system requirements:

- 1 GHz or faster processor
- 512MB RAM
- 500 MB available hard disk space
- Graphics with OpenGL support
- USB 2.0 port
- .NET Framework 3.5 SP1

Recommended system requirements:

- 2 GHz or faster processor
- 2GB RAM
- 500 MB available hard disk space
- Graphics with OpenGL support
- USB 2.0 port
- .NET Framework 3.5 SP1

2 Hardware

2.1 Installation

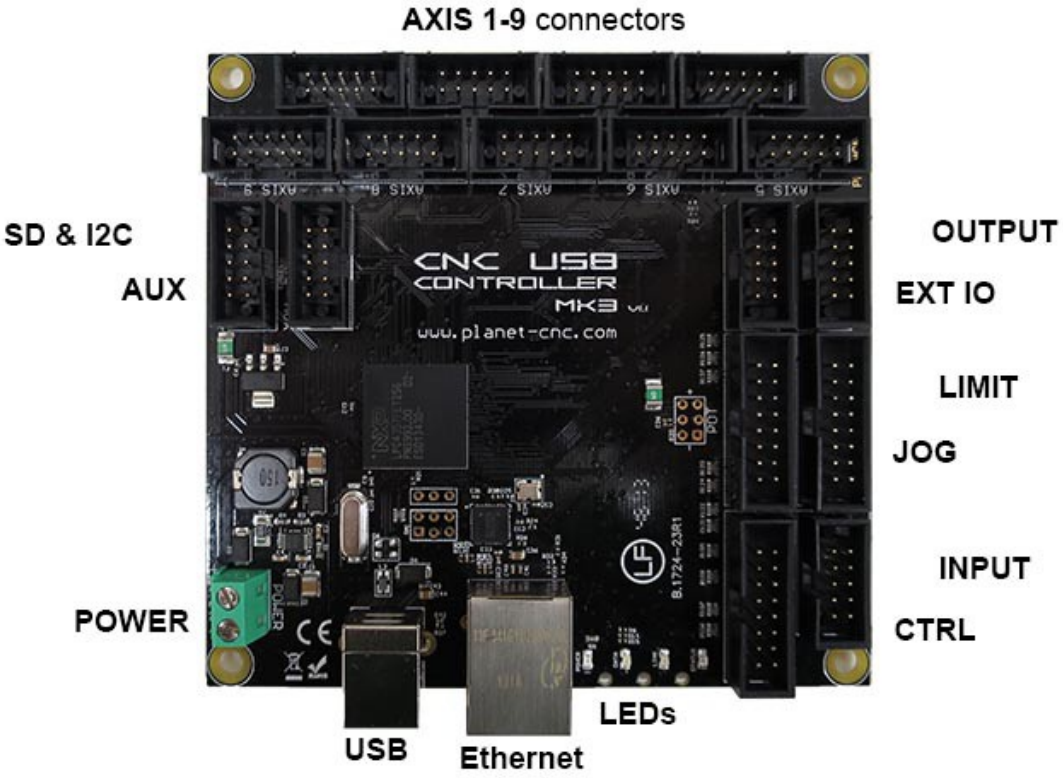
Installation of PlanetCNC CNC USB Controller requires a USB equipped PC or laptop along with motor drivers appropriate to the motors in use. The USB CNC controller is compatible with the vast majority of motor drivers that use step/direction signals.

Optional support hardware can be employed to customize installation to suit user requirement. Use of a screw terminal adapter makes connection to the type of drive in the image much easier. A DB25 adapter is available, for motor drivers requiring this form of input, with male or female DB25 connector.

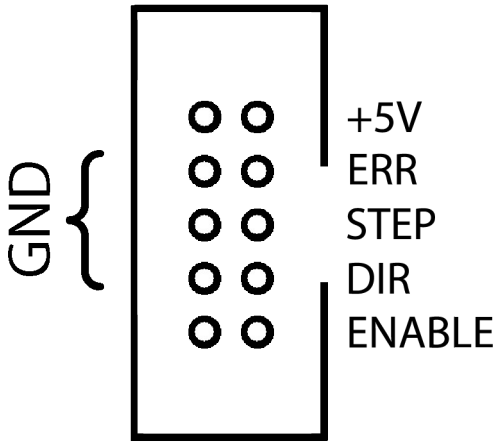
For maximum flexibility in controller layout, a ribbon cable and plug kit is available. This aids the construction of longer cables and ensures plug-in connections correspond to the USB CNC Controller pin outs.

IMPORTANT:
The controller should be powered with an external power supply.
Mk3 - 9 Axis controller hardware requires 8 - 24V DC supply
Power supply should be at least 200mA.

2.2 Mk3 - 9 axis CNC USB controller description



2.2.1 Mk3 *AXIS* connector



Each connector controls one motor driver. Controller has 9 connectors for axes 1-9. This means 9 axes which can all be moved at same time.

Axes are usually named like this: Axis 1=X, Axis 2=Y, Axis 3=Z...
On some machines this can be different. For example Foam cutter uses axis names such as Axis 1=A, Axis 2=Y, Axis 3=U, Axis 4=V. Lathes use Axis 1=Z, Axis 2=X. Configuration of axes, as well as their naming can be set in *File/Settings/Axes.*

CONNECTOR PIN DESCRIPTION:

+5V: +5V power. Motor drivers can take power for logic circuit or common anode connection from the USB controller.

ERR: Error signal from driver to controller.

STEP: Provides a STEP signal of minimum 25 us pulse width or 50% duty cycle at higher frequencies to the motor driver.

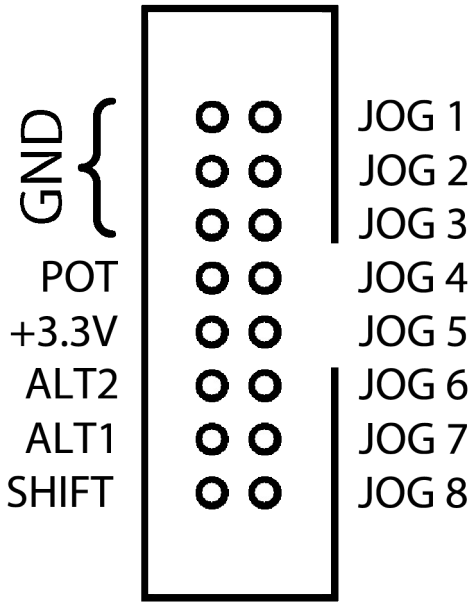
DIR: Provides DIR or DIRECTION signal to the motor driver.

ENABLE: Provides an ENABLE signal for motor drivers. When the ENABLE signal is lost, due to output command, E-Stop or limit switch activation, motor drivers will deactivate.

A dedicated E-Stop switch connected to the CTRL or INPUT connector can control the signal. It can also be operated by limit switch activation, software command or on shutdown of the control software.
This arrangement provides a useful safety feature that can be user-configured to operate under manual and/or computer control.

GND: Ground connections.

2.2.2 Mk3 *JOG* connector



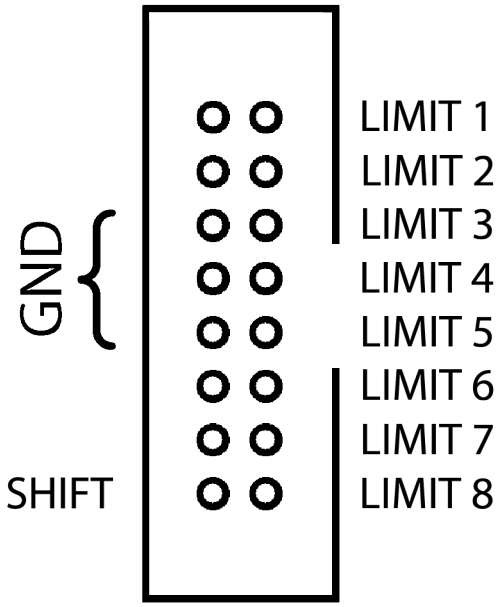
Switched operation of JOG 1-8 controls manual jogging.
Jogging keyboards can use a ‘SHIFT’ key, allowing Mk3 controller users to jog additional axes or toggle the option of jog ‘step’ mode. ‘SHIFT’ key function is defined in settings, as is the ‘step’ value for each key press.
Jogging keyboards can use two ‘ALT’ keys. Function is defined in 'settings'.
Jogging directions and axis assignment can be defined in 'settings'.

CONNECTOR PIN DESCRIPTION:

A typical use might be as below.

JOG 1: Jog Axis 1 in negative direction.
JOG 2: Jog Axis 1 in positive direction.
JOG 3: Jog Axis 2 in negative direction.
JOG 4: Jog Axis 2 in positive direction.
JOG 5: Jog Axis 3 in negative direction.
JOG 6: Jog Axis 3 in positive direction.
JOG 7: Jog Axis 4 in negative direction.
JOG 8: Jog Axis 4 in positive direction.
SHIFT: Jogging for additional axes or selects 'step' jog mode.
ALT1: Selects different jog mode
ALT2: Selects different jog mode
+3.3V: Power for jogging speed POT
POT: Jogging speed POT
GND: Ground connections

2.2.3 Mk3 *LIMIT* connector



LIMIT 1-8 connects limit switches. It's recommended that a 100nF capacitor is connected directly across switch terminals.

The 'SHIFT' key toggles limit options using one of two possible configurations. The chosen configuration determines hardware connections.

Limit switches can be connected in 'Normal' method or 'Single input' method. In software, you can set this in *File/Settings/Limit*. If you are using 'Normal' method, 'Single Input' feature must be disabled.

To pause all axes, if certain axes limit switch has been activated, you enable 'Lock Other Axes'.

NORMAL: Each switch is connected to its own pin.

LIMIT 1: Axis 1 negative limit
LIMIT 2: Axis 1 positive limit
LIMIT 3: Axis 2 negative limit
LIMIT 4: Axis 2 positive limit
LIMIT 5: Axis 3 negative limit
LIMIT 6: Axis 3 positive limit
LIMIT 7: Axis 4 negative limit
LIMIT 8: Axis 4 positive limit
SHIFT: Toggle Limit switch options
GND: Ground connections

SHIFT OFF: Axes 1 to 4 limits are selected
SHIFT ON: Axes 5 to 8 limits are selected

SINGLE INPUT: Both axis limit switches are connected to one pin.

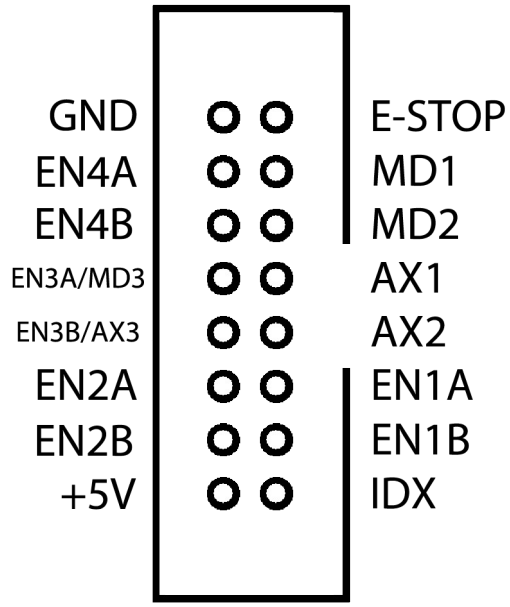
Direction of travel determines if positive or negative switch is triggered.

LIMIT 1:	Axis 1 negative and positive limit
LIMIT 2:	Axis 2 negative and positive limit
LIMIT 3:	Axis 3 negative and positive limit
LIMIT 4:	Axis 4 negative and positive limit
LIMIT 5:	Axis 5 negative and positive limit
LIMIT 6:	Axis 6 negative and positive limit
LIMIT 7:	Axis 7 negative and positive limit
LIMIT 8:	Axis 8 negative and positive limit
SHIFT:	Axis 9 negative and positive limit
GND:	Ground connections

NOTE: If 'normally open' (NO) type switches are used, wiring must be done in parallel method, if 'normally closed' (NC) type switches are used, wiring must be done in serial method.

Software 'Invert' options allow use of ‘normally closed’ or ‘normally open’ switch hardware. This feature can be set in *File/Settings/Limit/Invert*

2.2.4 Mk3 *CTRL* connector



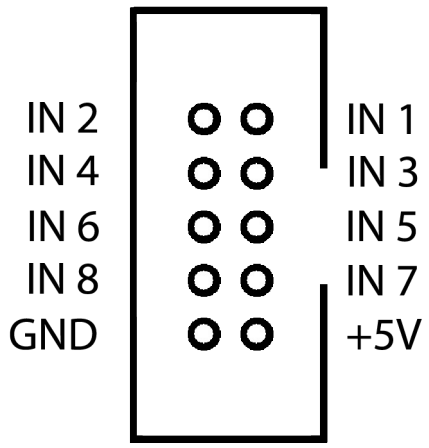
This connector provides inputs for use of MPG pendant devices and E-Stop.
Spindle speed encoder for spindle synchronization can also be connected.
GND pin provides ‘Ground’ or common connections.

An E-Stop switch attached to this connector can be configured in software to activate/deactivate E-Stop.
E-Stop switch hardware for use with this connector can be NC (Normally Closed) or NO (Normally Open). If NC is used, 'Invert' feature must be enabled in 'settings'. Locking switch is recommended.

CONNECTOR PIN DESCRIPTION:

E-STOP: E-Stop
MD1: Mode switch
MD2: Mode switch
AX1: Axis switch
AX2: Axis switch
EN1A: Encoder for MPG
EN1B: Encoder for MPG
IDX: Index signal for spindle synchronization
+5V: Power supply for encoder
EN2B: Additional encoder
EN2A: Additional encoder
EN3B/AX3: Axis switch for additional axes or encoder
EN3A/AX3: Axis switch for additional axes or encoder
EN4B: Encoder for spindle synchronization
EN4A: Encoder for spindle synchronization
GND: Ground

2.2.5 Mk3 *INPUT* connector

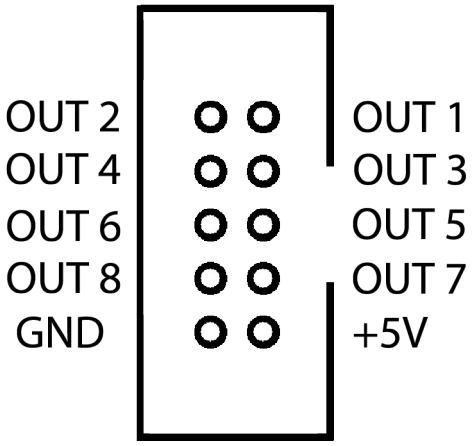


This connector provides input for user-assigned functions.

CONNECTOR PIN DESCRIPTION:

INPUT1: Assignable input 1
INPUT2: Assignable input 2
INPUT3: Assignable input 3
INPUT4: Assignable input 4
INPUT5: Assignable input 5
INPUT6: Assignable input 6
INPUT7: Assignable input 7
INPUT8: Assignable input 8
+5V: Power supply
GND: Ground

2.2.6 Mk3 *OUTPUT* connector



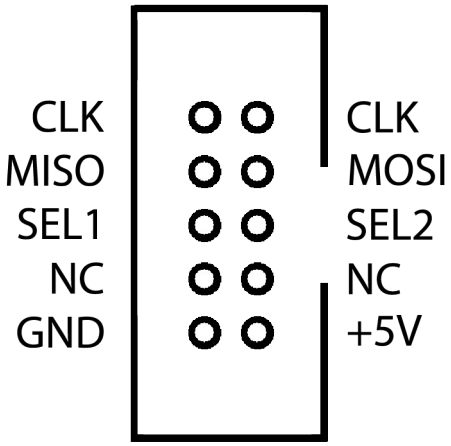
This connector provides 7 digital outputs for control of external devices.
The optional 'Output board' links to the Mk3 controller using this connector.
Output assignment is controlled in software.

CONNECTOR PIN DESCRIPTION:

OUT 1 - 8: Digital Output
GND: Ground
+5V: +5V supply.

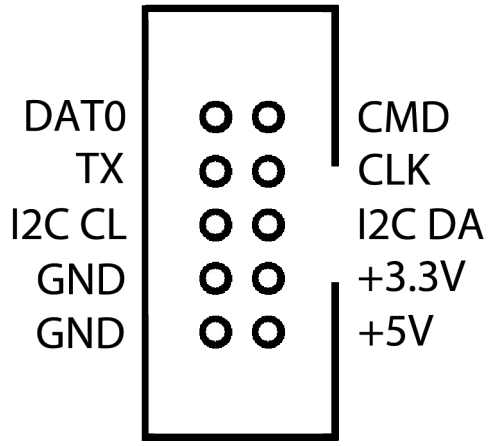
OUT 1, 2 and 6 can generate PWM signal, RC servo signal or frequency modulation.

2.2.7 Mk3 IO EXT connector



Connector for additional IO extension boards.

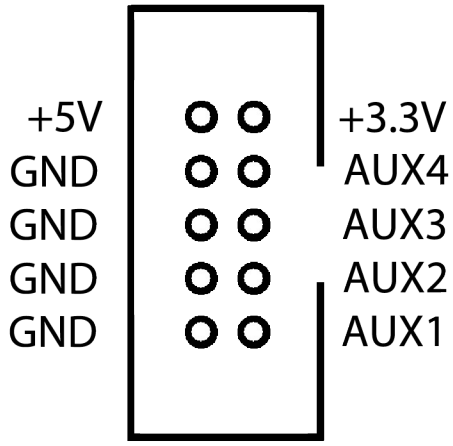
2.2.8 Mk3 *SD&I2C* connector



This connector allows use of SD Card with PlanetCNC SD card adapter, I2C and UART protocol devices.

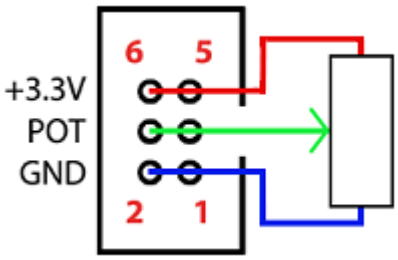
DAT0: SD card signal
CMD: SD card signal
CLK: SD card signal
TX: UART signal
I2C CL: I2C signal
I2C DA: I2C signal
GND: Ground
+3.3V: +3.3V supply
GND: Ground
+5V: +5.0V supply

2.2.9 Mk3 *AUX* connector



Reserved for future use.

2.2.10 Mk3 *POT* connector



A potentiometer attached to this connector provides a manual jog speed control when using jogging keyboard connected to *JOG* connector. Mk3 controller also has this pins on jogging connector.

+3.3V: +3.3V power supply for use with potentiometers.
POT: 5k or 10k ohm, logarithmic taper potentiometer can be connected to provide a jog speed control.
GND: Ground

2.2.11 Mk3 *USB* connector

The Mk3 USB CNC controller connects to computer via the USB port. The port uses the USB 2.x standard.

2.2.12 Mk3 *Ethernet* connector

The Mk3 USB CNC controller connects to computers via the Ethernet port.

2.2.13 Mk3 *Power* terminal

The controller should be powered with an external power supply.
Mk3 - 9 Axis controller hardware requires 8 - 24V DC supply
Power supply should be at least 200mA.

2.2.14 Mk3 *LED* indicators

The user is provided with helpful feedback and live ‘status’ information via on-board LED indicators. There are four indicators.

Power: Lights when the controller is powered.
Data: Indicates controller functions.
Link: Indicates controller communication.
Status: Blinks to indicate controller function is ‘good’.

3 Connection diagrams

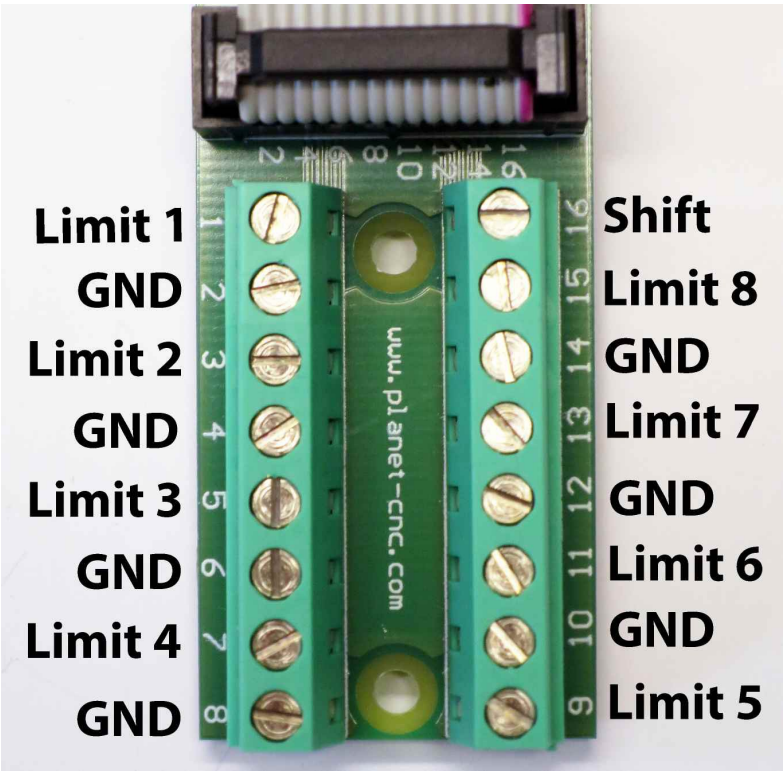
3.1 Wiring of limit switches

Mk3 controller has 8 designated limit switch inputs. In software you can set which wiring method is used. You can use 'Normal' or 'Single Input' method of wiring.

-When 'Normal' method is used, each axis limit switch has its designated limit pin.
-When 'Single input' method is used both limit switches are connected to one limit pin.

Since Mk3 controller does not have screw type connector mounted on the board, you can use Planet-CNC 16-pin adapter which comes in great help when wiring limit switches:

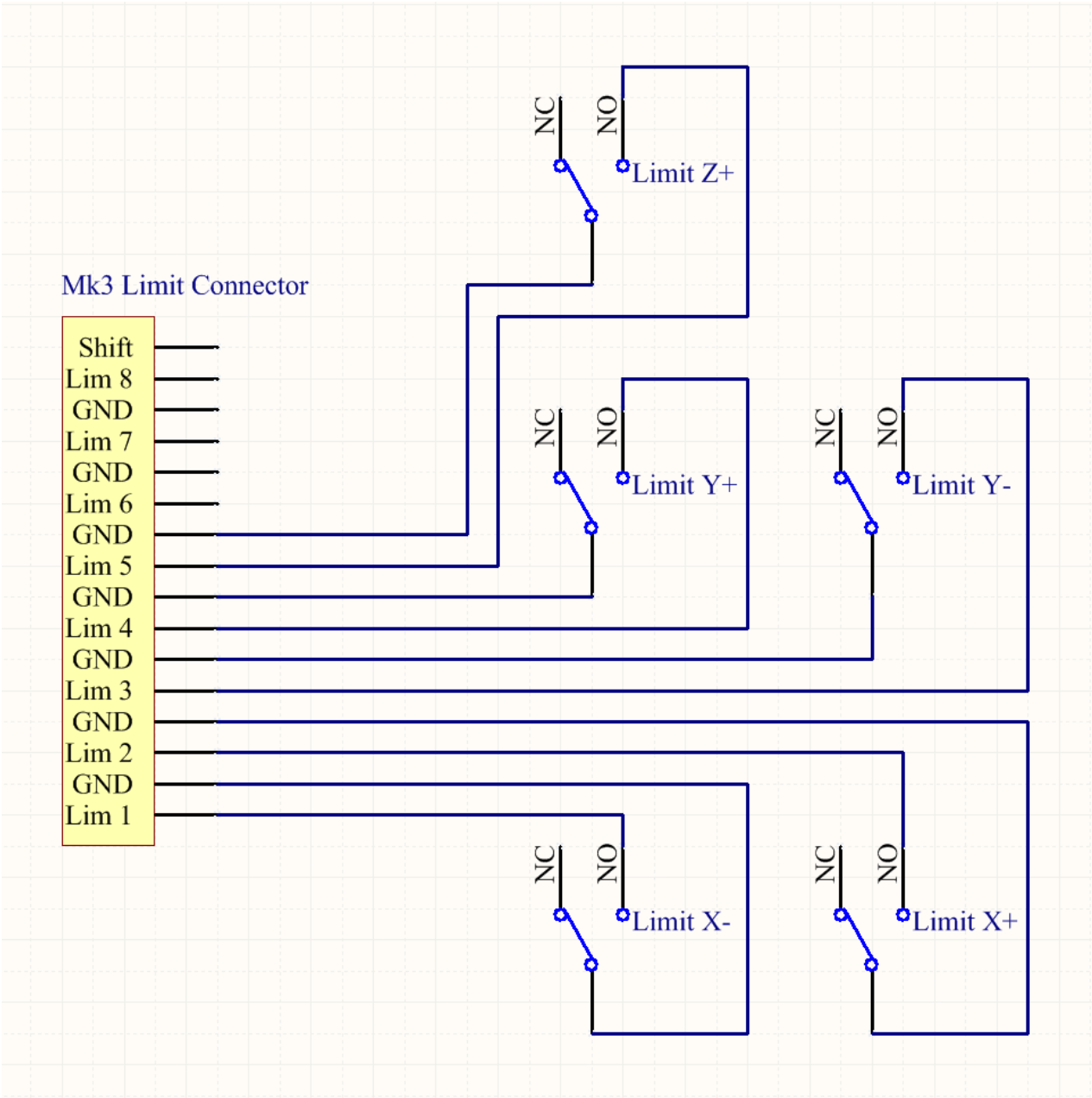
Pin description of 16-pin adapter board when connected to Mk3 Limit connector:



Bellow are wiring plans and pictures that demonstrate wiring of limit switches when 'Normal' or 'Single input' method is used.

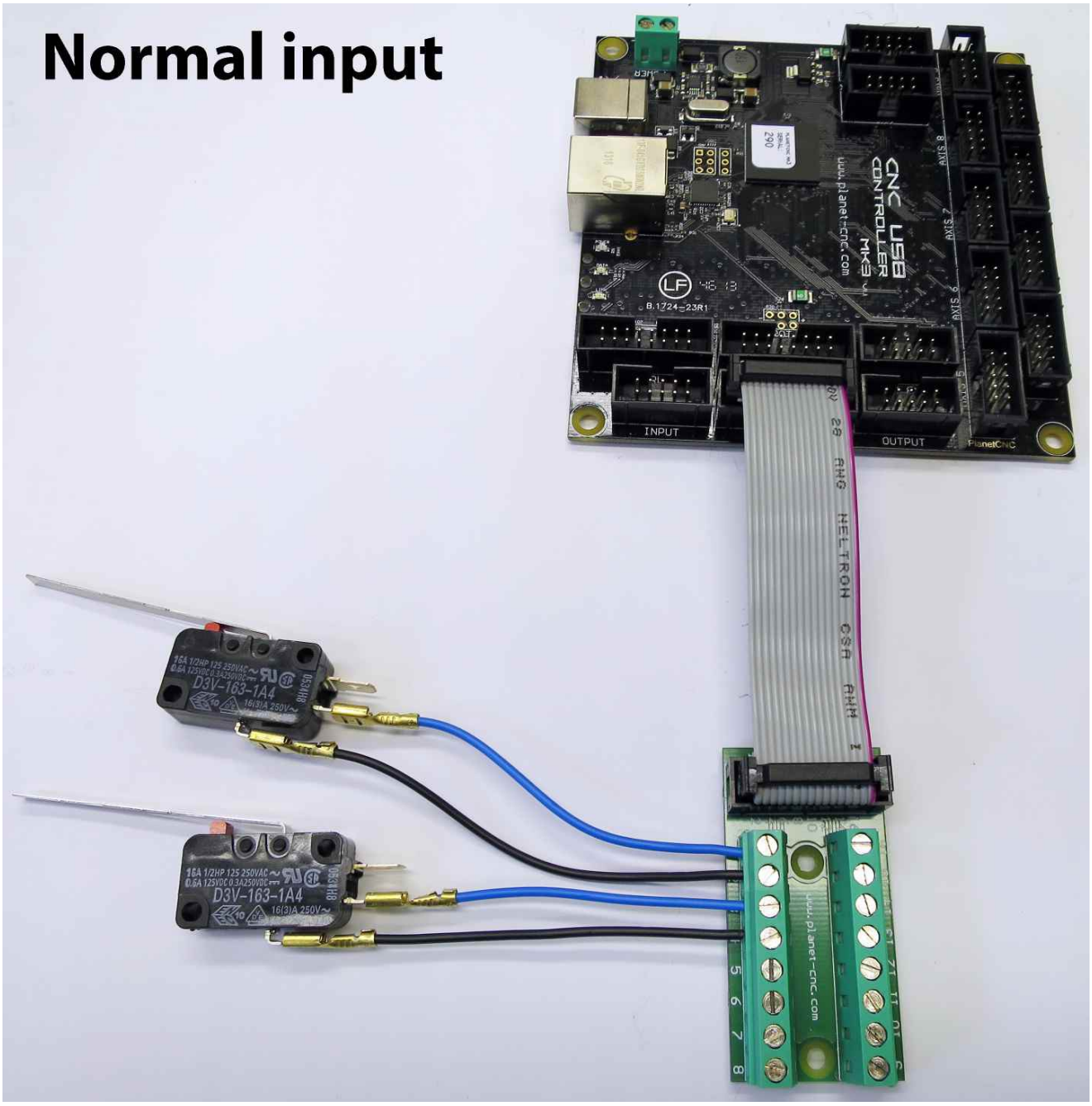
3.1.1 'Normal' wiring method

NO or NC type switches can be used. When NC type switches are used, 'Invert Limit' function must be enabled in software.



Each limit switch is connected to its own limit input pin.

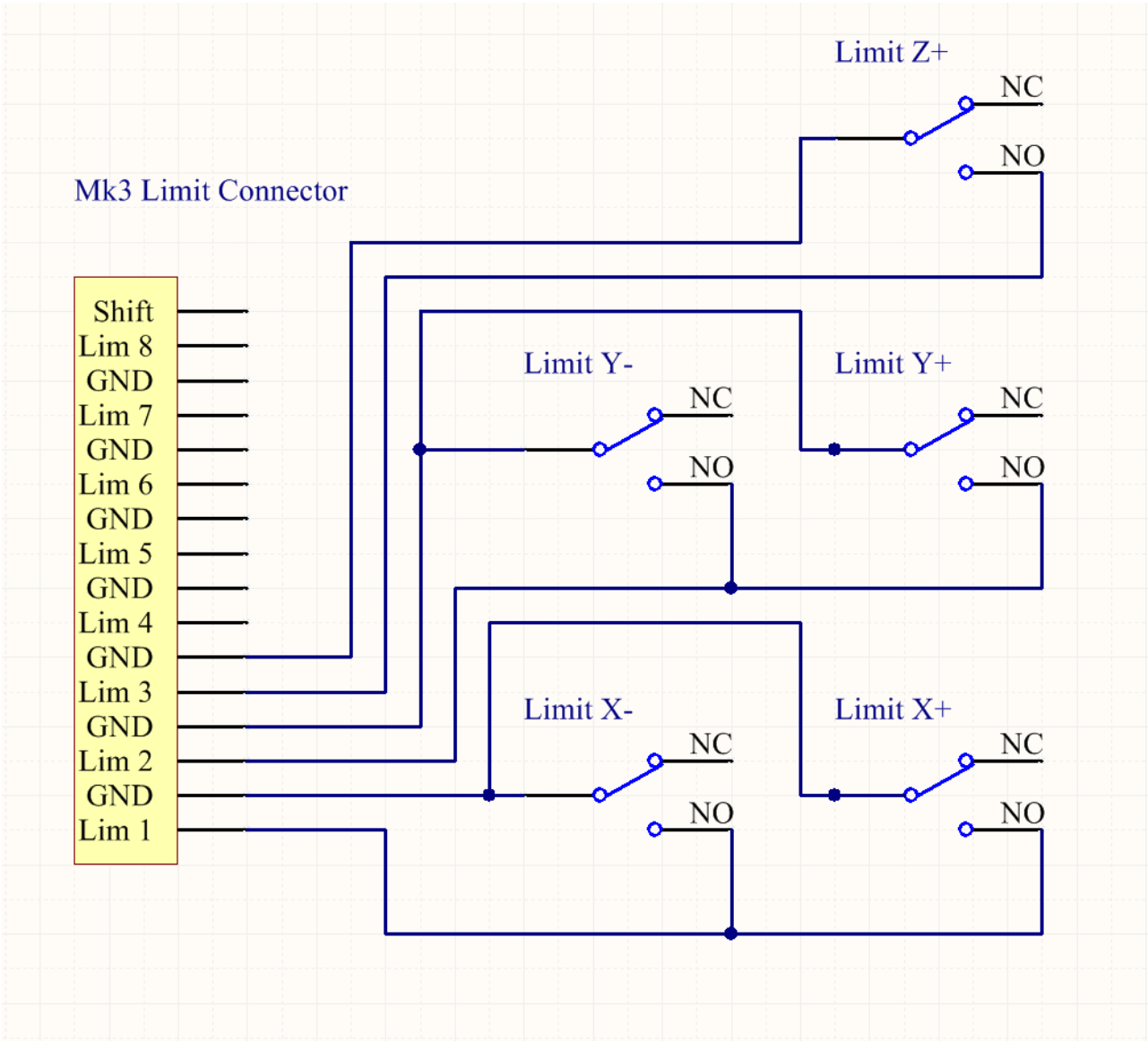
'Normal' wiring method of limit switches* using Planet-CNC 16-pin adapter board:



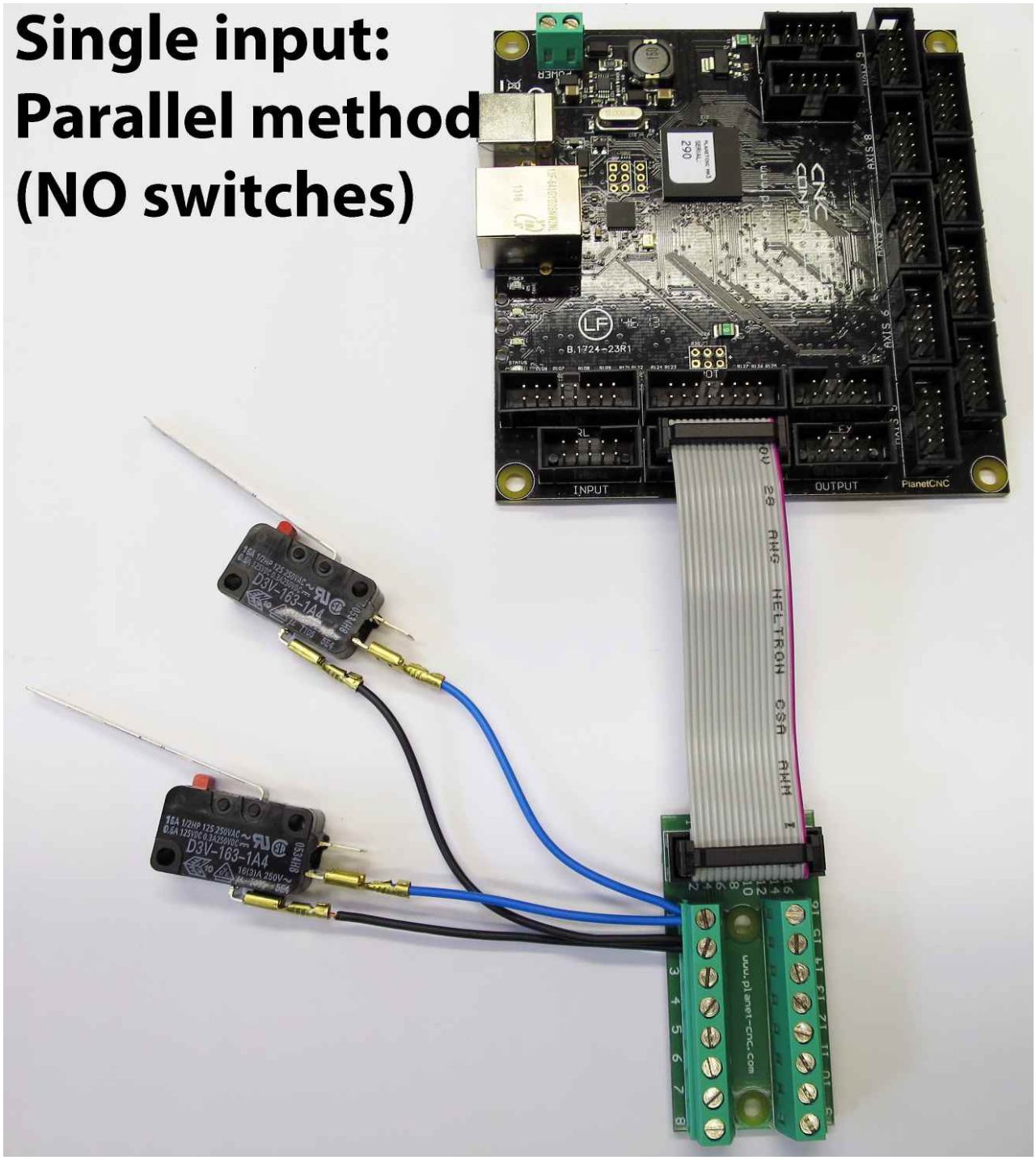
*On this picture only for axis one.

3.1.2 'Single input' wiring method

3.1.2.1 Parallel wiring of NO type switches:

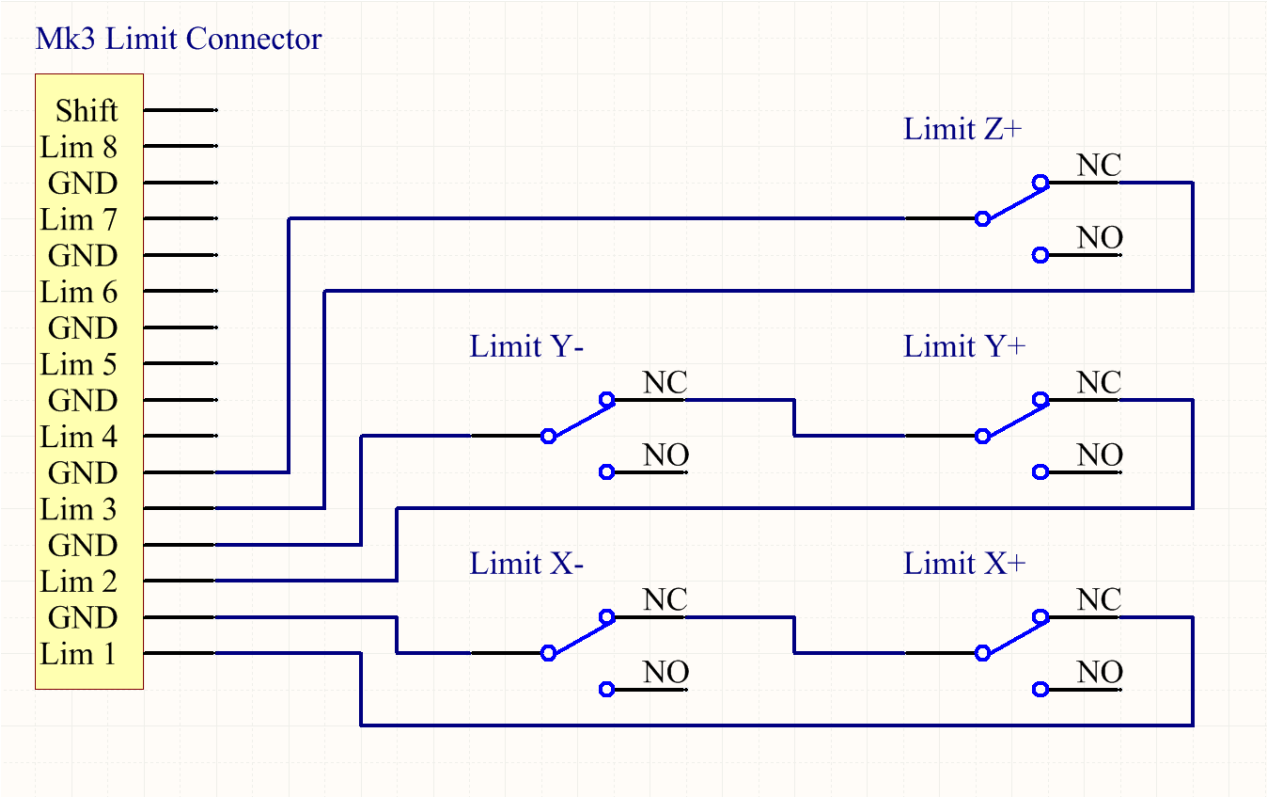


Parallel wiring of NO type limit switches* using Planet-CNC 16-pin adapter board:

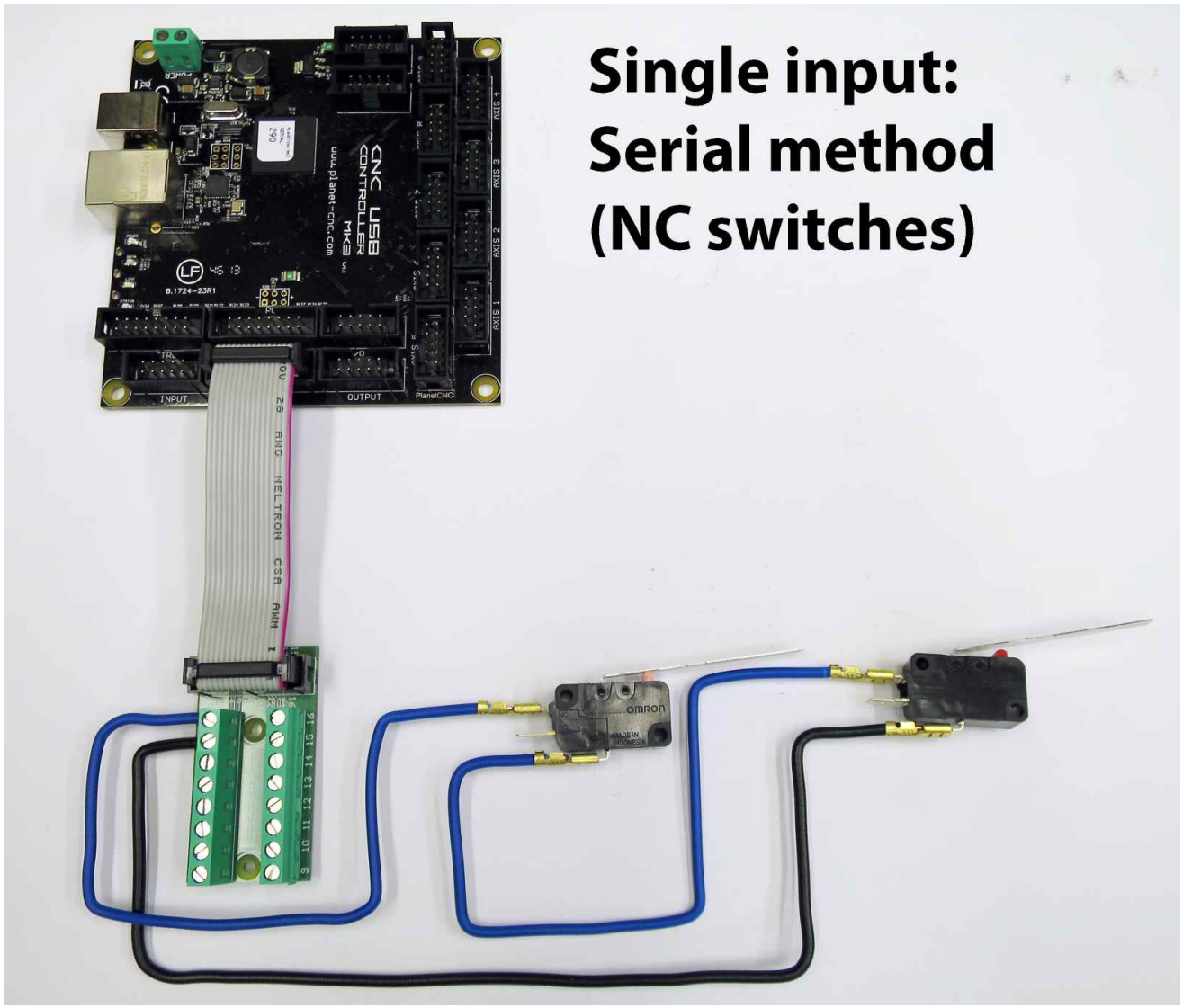


* On this picture only for axis one.

3.1.2.2 Serial wiring of NC type limit switches:



Serial wiring of NC type limit switches* using Planet-CNC 16-pin adapter board:

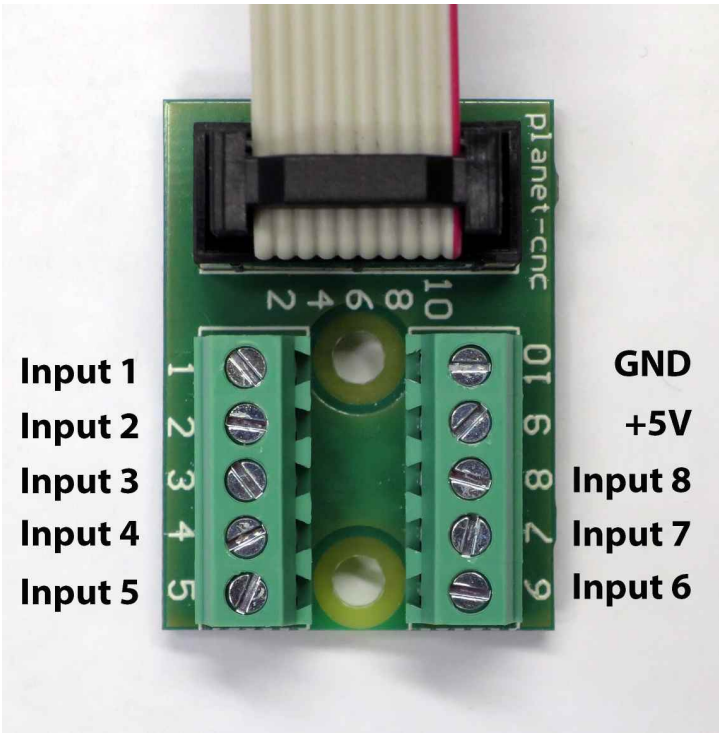


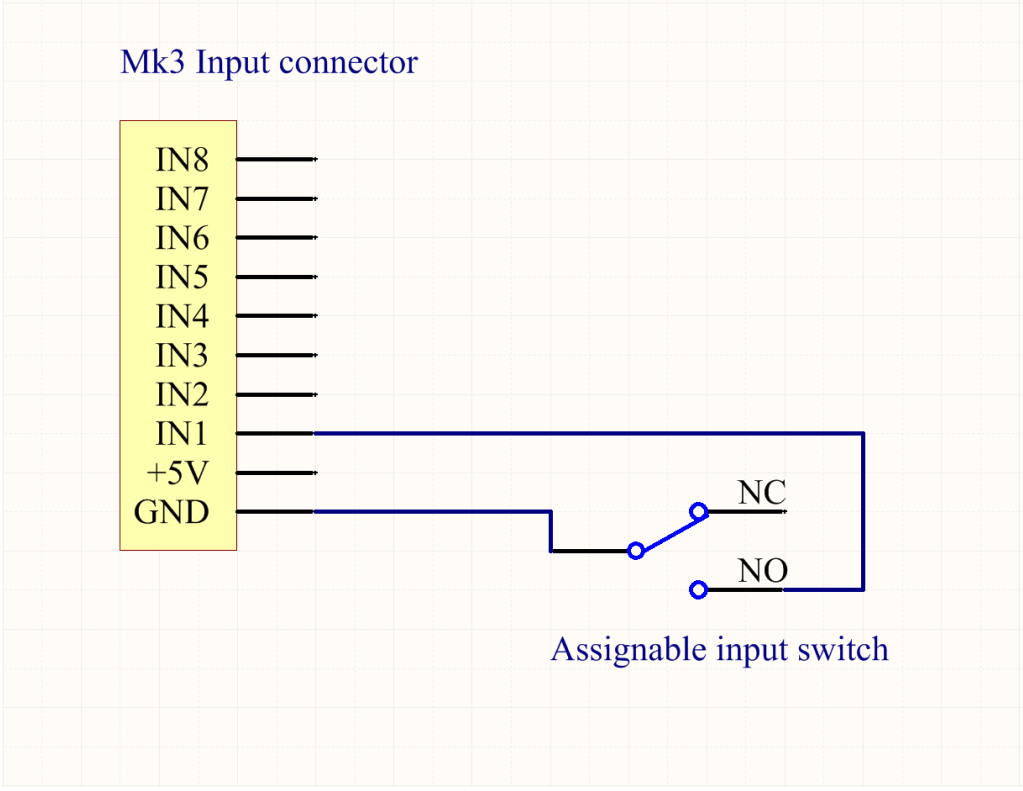
*On this picture only for axis one.

3.2 Wiring inputs of Mk3 controller

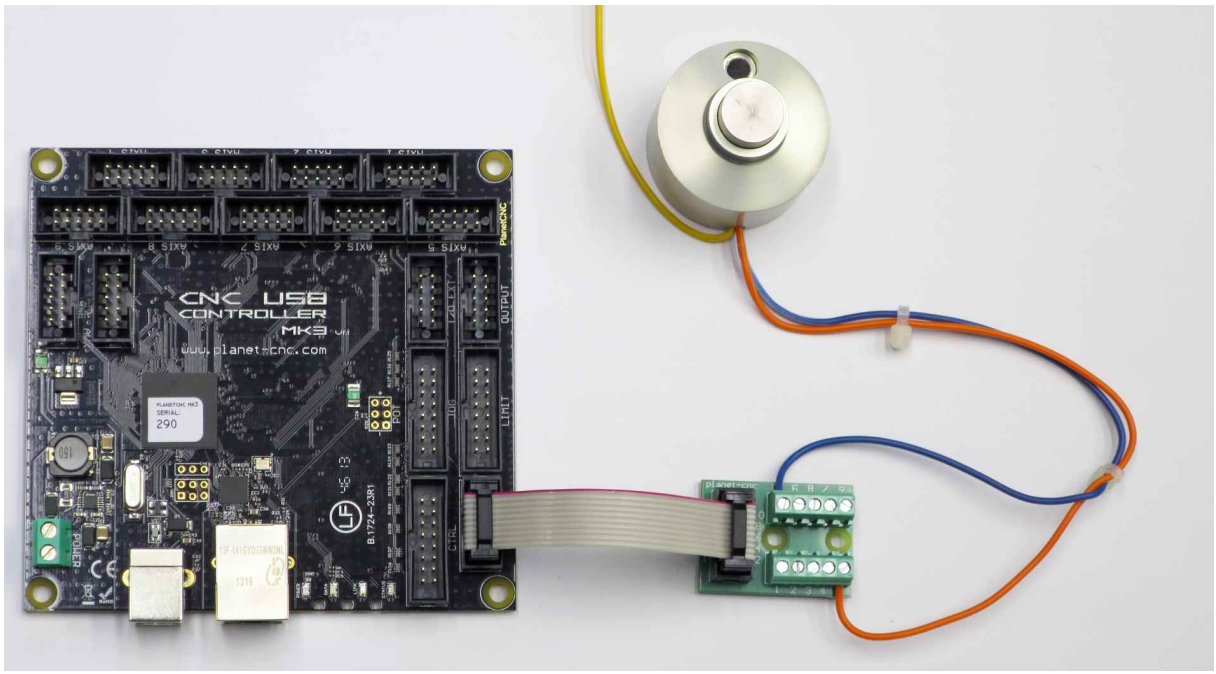
Mk2 has eight assignable inputs. Bellow is wiring diagram and picture of connected tool sensor to Mk3 controller using Planet-CNC 10-pin adapter board.

Pin description of 10-pin adapter board when connected to Mk3 Input connector:



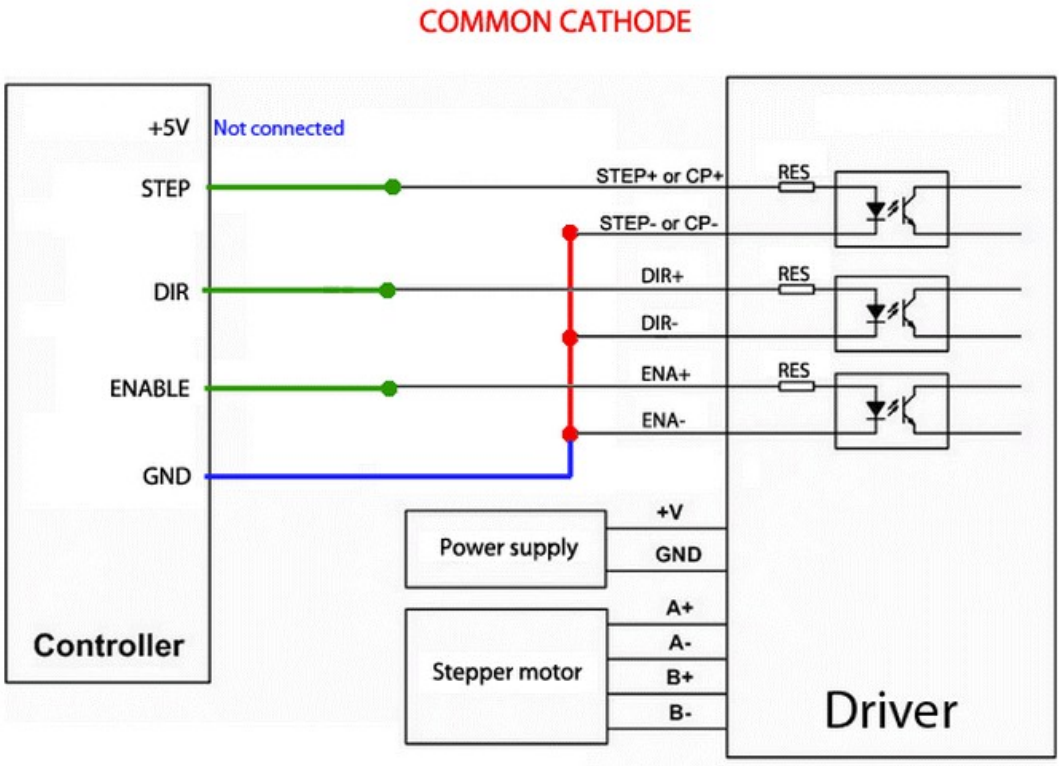


Example: Connecting tool sensor to input 5 of Mk3 input connector:

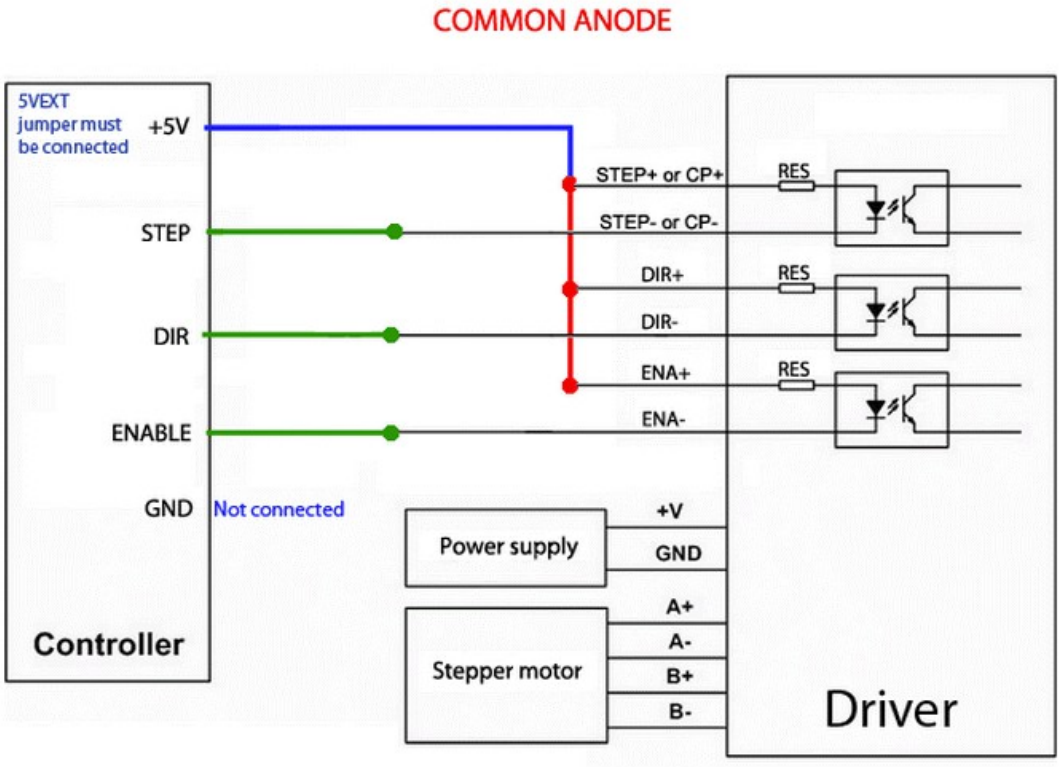


3.3 Connecting motor driver to Mk3 controller

Wiring diagrams for COMMON CATHODE and COMMON ANODE connection of motor driver:

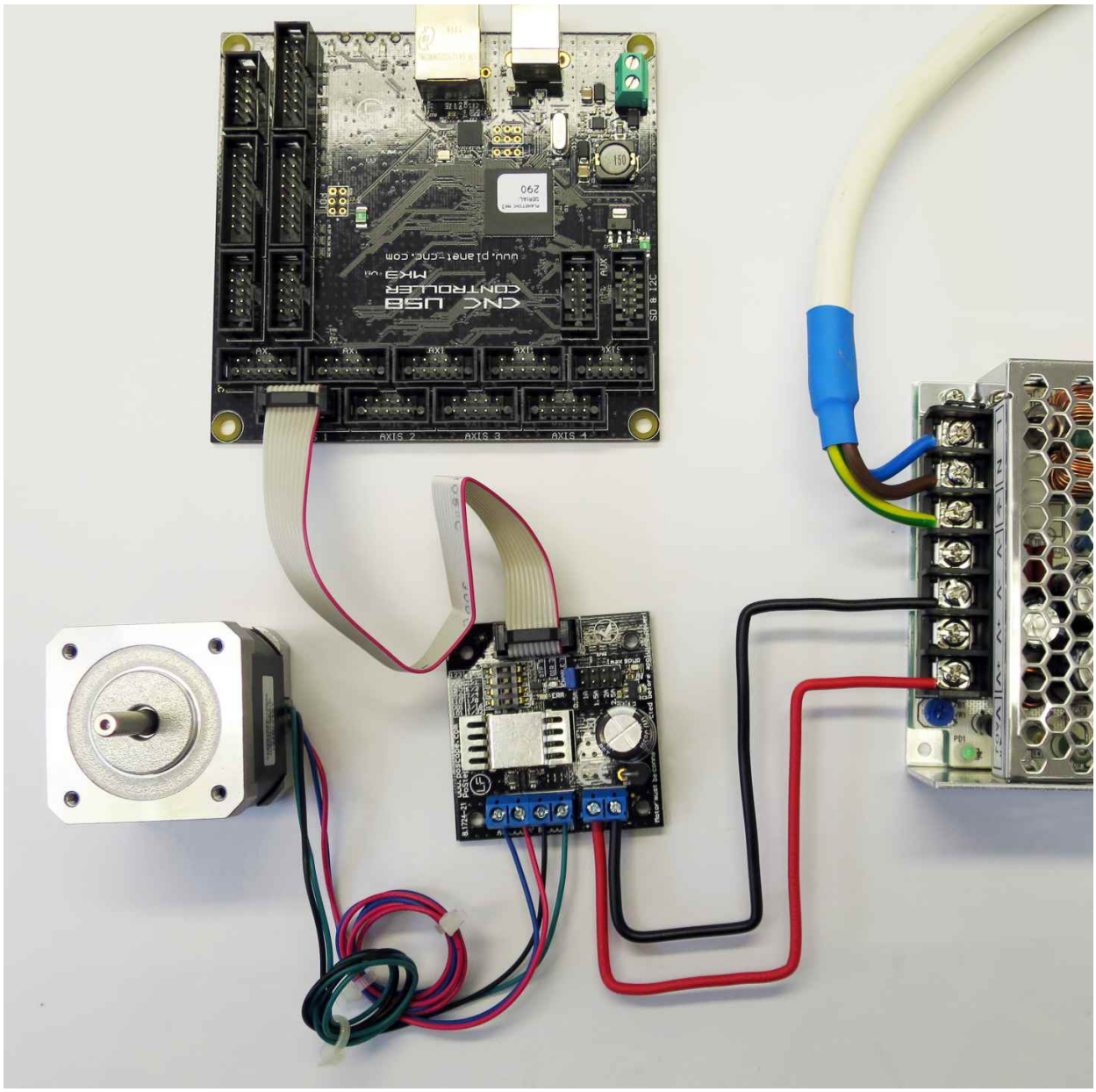


2. Common anode

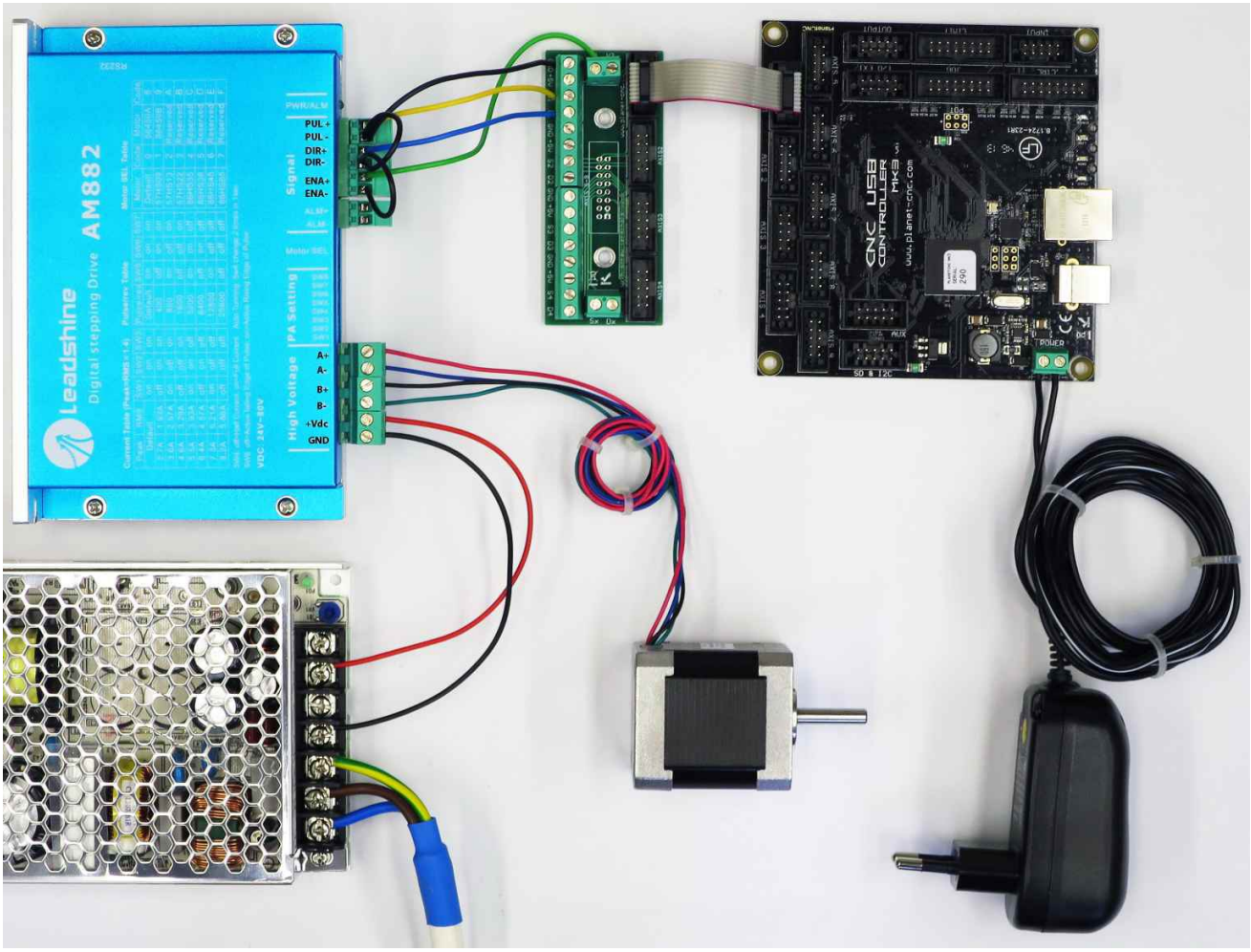


*STEP input on motor drivers can be also labeled as PUL or CLK.

Picture bellow demonstrates the connection of 2.5A Motor driver to Mk2 controller and connection of stepper motor and power supply to 2.5A motor driver. Since this motor driver uses 10-pin header and ribbon cable, connection is pretty much trivial:



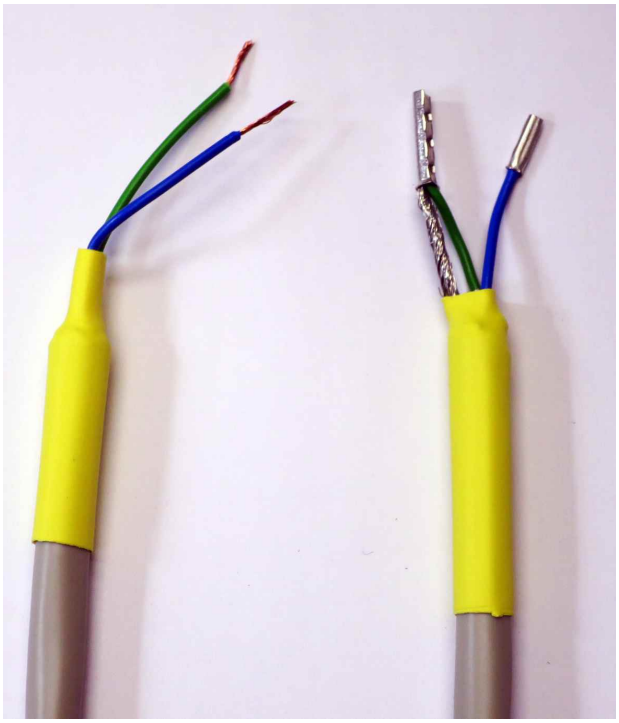
Picture bellow demonstrates connection of motor driver to Mk2 controller with screw type adapter and connection of controllers external power supply:



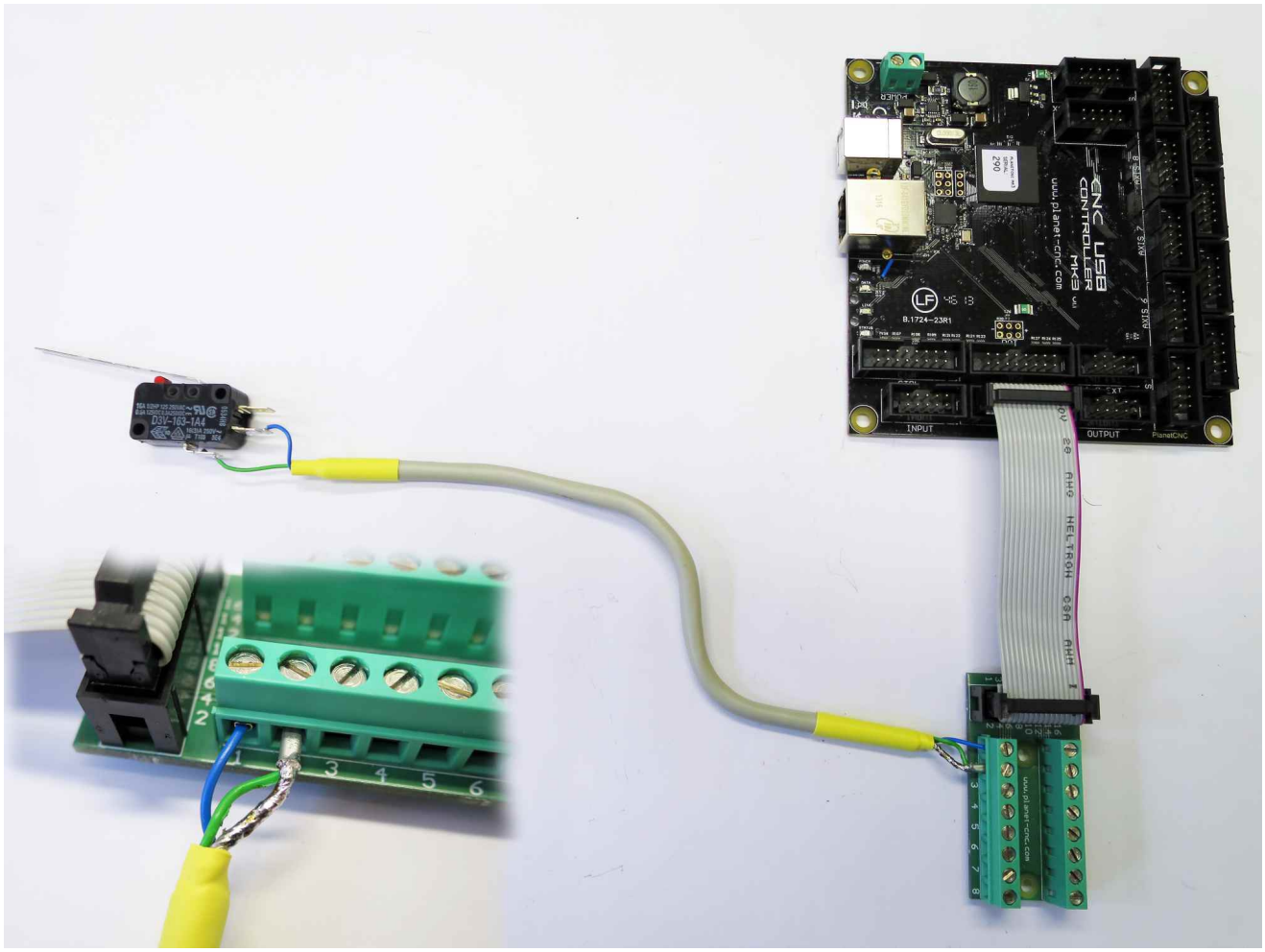
3.4 Shielded cables

We always recommend the use of shielded cables for wiring. Whether you are connecting limit switches, input switches, output devices, motor drivers or motors etc... The shielded cables should be properly maintained and set with insulated ferrules or crimp terminals.

Picture bellow demonstrates both ends of one shielded cable. Shield and GND are connected with ferrule only at that end of the cable which will be later connected to controllers input. Other end of the cable which will be connected to limit switch, does not have shield and GND connected.



Shield of the cable should be connected to GND only at the end which is connected to controllers input:



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