FLASHCUT CNC

CONTROL MADE SIMPLE ®

8 Amp Micro Stepping Pro Series CNC Controller Hardware Guide

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1. Getting Started

About This Manual

FlashCut CNC is a unique application involving hardware and software. We recommend that you read all of these instructions before using the product.

Since automated machining is potentially dangerous, please take the time to completely read through this manual and the software User's Guide to understand the operation of the electronics, software and machine before cutting a part.

Turning Off The Controller

Always turn off the CNC Controller when it is not in use.

Safety and Usage Guidelines

When running an automated machine tool, safety is of the utmost importance. For proper and safe use of the FlashCut CNC program and your CNC machine, the following safety guidelines must be followed:

1. **Never let the machine tool run unattended.**
2. **Require any person in the same room as a running machine tool to wear safety goggles, and to stay a safe distance from the machine.**
3. **Allow only trained operators to run the machine tool. Any operator must have:**

   Knowledge of machine tool operation.

   Knowledge of personal computer operation.

   Knowledge of Microsoft Windows.

   Good common sense.
4. **Place safety guards around the machine to prevent injury from flying objects. It is highly recommended that you build a safety shield around the entire tool envelope.**
5. **Never place any part of your body within the tool envelope while the machine is online, since unexpected machine movement can occur at any time.**
6. **Always keep the tool envelope tidy and free of any loose objects.**
7. **Be on alert for computer crashes at all times.**

FlashCut CNC, Inc. is not responsible for the safe installation and use of this product. You and only you are responsible for the safety of yourself and others during the operation of your CNC machine tool. FlashCut CNC supplies this product but has no control over how it is installed or used. Always be careful!

FlashCut CNC, Inc. or its affiliates are not responsible for damage to any equipment or workpiece resulting from use of this product.

If you do not understand and agree with all of the above safety guidelines, do not use this product.

2. Stepper CNC Controller

Front Panel

The front panel of the CNC controller has the power switch, the fan and 7 LED's with the following functions:

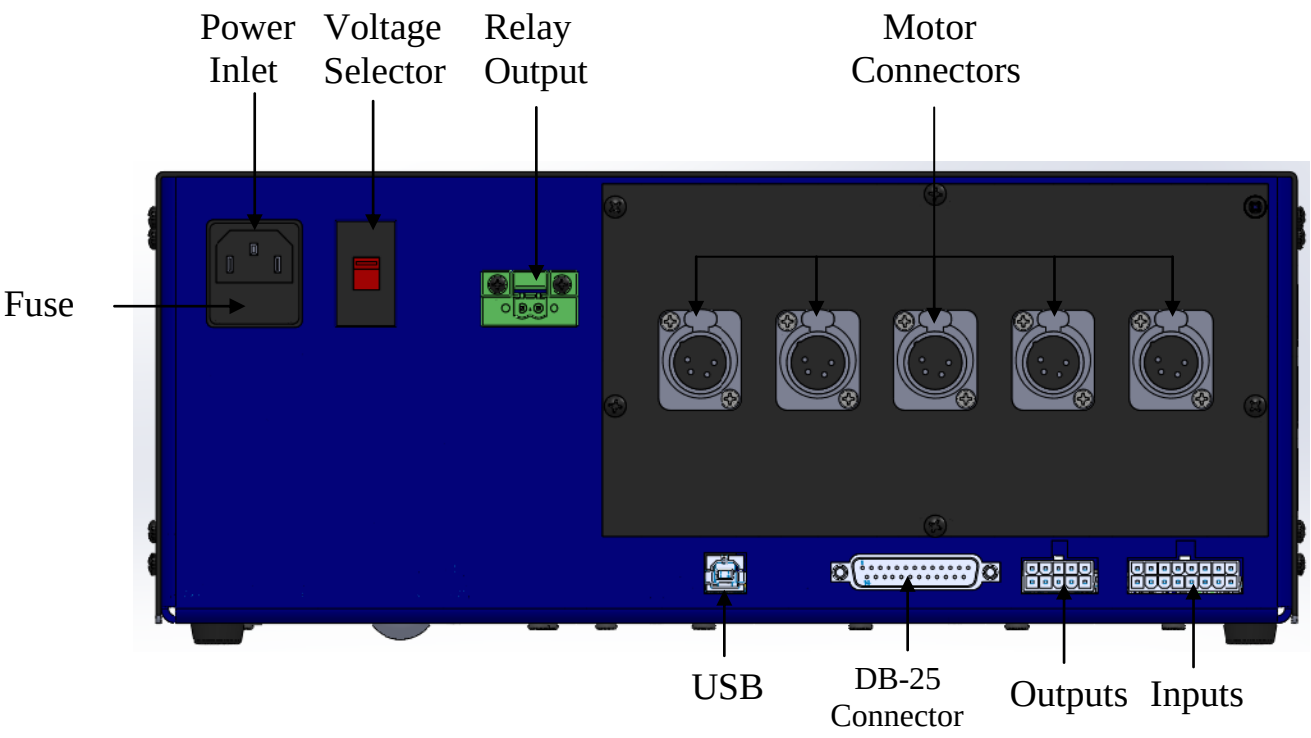
AXIS LED's 1, 2, 3, 4, 5 – Turns green when the respective axis is moving.

USB LED– Turns yellow when connected to the host PC USB port.

POWER LED– Turns green when the power switch is turned on.

POWER SWITCH – Turns the unit on and off. "I" is on and "O" is off. If there is ever a communications error while running FlashCut CNC, turn the switch off and on to reset the internal microprocessor.

Rear Panel



The rear panel has connectors for input and output signals as described below.

POWER INLET – Receptacle for the power supply. The unit is shipped with a standard grounded power cable for use with a 115VAC wall outlet.

USB – USB connector for communication with the USB port on the host PC. Use a USB-A to B cable with a maximum length of 3 meters to make the connection. For the most robust communication, plug the cable directly into PC, as opposed to a USB repeater or a hub. If the FlashCut software loses communication with the Signal Generator, electrical noise may be the cause. To reduce electrical noise problems, try using a shorter USB cable, or attach one or more ferrite chokes to the USB cable. Toroid-shaped chokes are more effective than snap-on cylindrical chokes. If you need more than 3m of USB cable length, you can use an active extension cable which comes in 4.5m lengths. Note that when running an active extension cable, the USB will run in Full Speed mode.

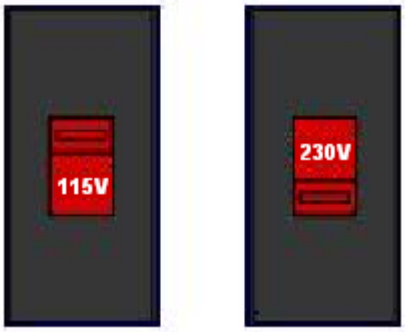
INPUT – The connector for up to 8 input lines. The most common use of the input lines is for limit or safety switches. These lines are all TTL- and CMOS-compatible optically isolated inputs. When a switch is open, its input signal is high (+5V). When the switch is closed, its input signal is grounded low (0V). If you need more than 8 input lines, an I/O extension board is available.

OUTPUT – The connector for up to 8 output lines. These lines are all compatible with TTL/CMOS level outputs. The Output ports are not setup to drive a 24V external system unless it accepts TTL/CMOS levels. They are all driven by HCT family logic. Output logic high is normally 5V and can go down to 3.9V at full load. Output logic low is normally 0V and can go up to 0.3V at full load. Each of these signals can provide up to 20mA of current. If you need more than 8 output lines, an I/O extension board is available.

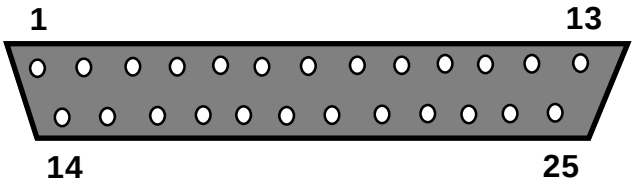
FUSE – In this drawer is a 250V/ 10Amp slow blow fuse. If you have chronic fuse problems, please call FlashCut CNC or your distributor for assistance.

RELAY OUTPUT – This connector is a back compatible relay output. Connection should be made in pins 7 and 8 of the 10 pin Phoenix terminal block. Output provides an optically isolated switch closure for controlling both AC and DC devices. Max current loading is 0.5 Amps for this non-polarity sensitive connection.

115-230 VAC SELECTION SWITCH– This switch allows you to use an external power source of 115 or 230 VAC. If your building is wired for 230VAC, then simply flip the switch with a flat-head screwdriver so that "230V" is clearly visible. If your building is wired for 115 VAC, then flip the switch until "115V" is clearly visible. **Note that severe damage can occur if you have 115 selected and your building is wired for 230VAC.**



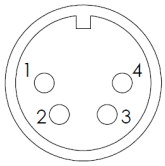
DB-25 CONNECTOR FOR MOTOR SIGNALS – This uses a DB-25 Cable to send step and direction signals from the FlashCut CNC Signal Generator to an additional external drive box. The pin assignments are as follows:



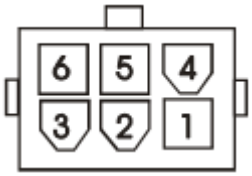
DB25 Pin No.	Signal	DB25 Pin No.	Signal
1	OUTPUT 1	14	ENABLE ALL
2	OUTPUT 2	15	INPUT 1
3	STEP AXIS 5	16	INPUT 2
4	DIRECTION AXIS 5	17	INPUT 3
5	INPUT 5	18	INPUT 4
6	INPUT 6	19	DIRECTION AXIS 4
7	INPUT 7	20	DIRECTION AXIS 3
8	INPUT 8	21	DIRECTION AXIS 2
9	DIRECTION AXIS 1	22	Internal VCC +5V
10	STEP AXIS 4	23	OPT VCC (INPUT)
11	STEP AXIS 3	24	Internal GND
12	STEP AXIS 2	25	OPT GND (INPUT)
13	STEP AXIS 1		

POWER CONNECTOR TO MOTORS – The motors for axes 1-5 plug into these connectors. The motor lines 1-5 are correlated to any combination of the X, Y, Z, A and/or B axes in the Motor Signal Setup menu in the FlashCut CNC software. A dummy plug as installed on any unused motor connector for units with less than 5 axes. Each motor connector is a Molex Mini Fit Jr. 6 Pin Receptacle with Male Pins (See Section on Motor Cabling for Mating Connector Information). The pin assignments for the Motor Connector are as follows (looking from the rear of the unit):

XLR Pin	Wire
1	B-
2	B+
3	A+
4	A-



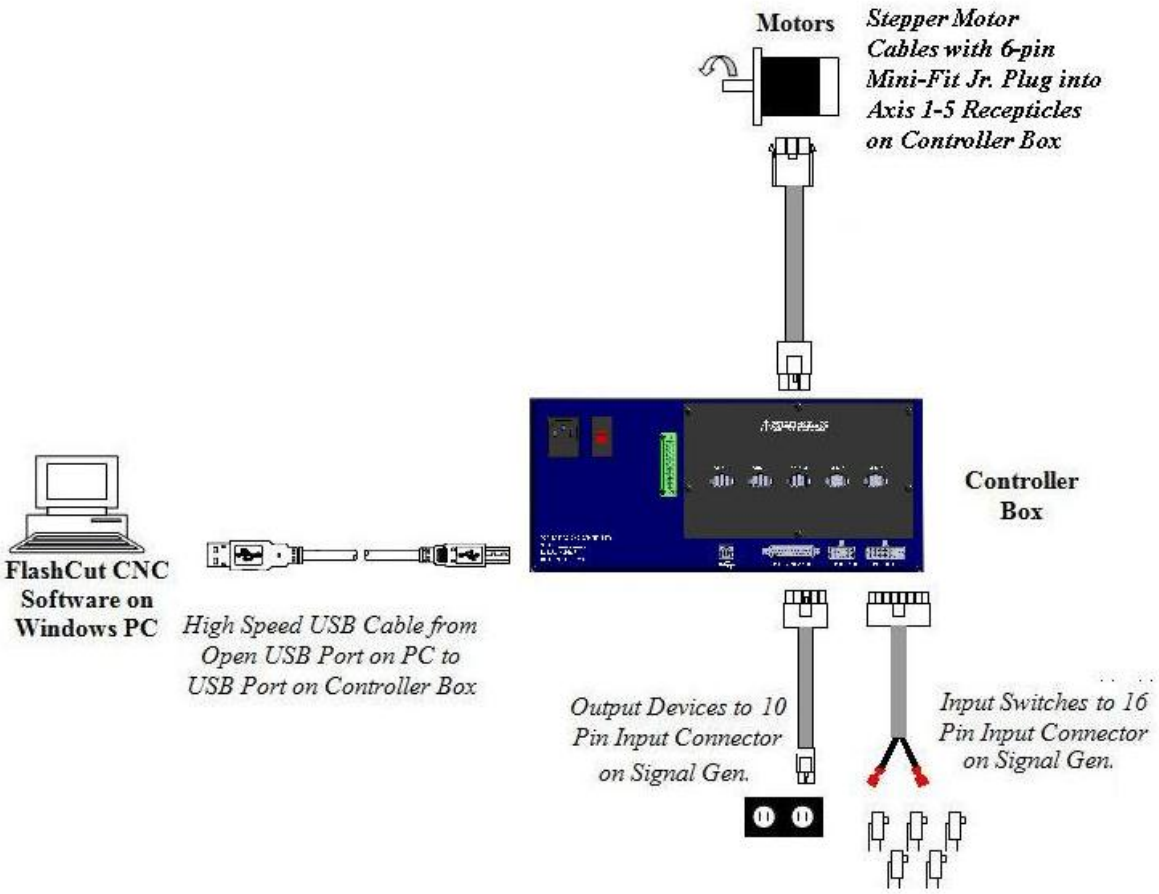
Molex Pin	Wire
1	B+
2	Cable Ground Shield
3	A+
4	B-
5	No Connection
6	A-



Never connect or disconnect motor cables while the power is on. This will result in damage to the driver box.

The mating motor cable connector is a Molex - Waldom 6-Pin Mini-Fit Jr. Receptacle Housing Part # 39-01-2060 with Female Pins Part # 39-00-0039 or 39-00-0047. Please see the section on Stepper Motor Cabling later in this manual for more information.

3. System Connections



4. Removing the Top Cover

To remove the cover from the unit remove the 8 total screws located on the left and right sides of the unit. There are 4 screws on either side. Then lift the top cover off.

5. Signal Generator

Input

The default setting for each of the input lines is normally closed (NC). The input line settings can be individually changed between normally closed (NC) or normally open (NO) input lines using FlashCut CNC software. Please refer to the FlashCut CNC User's Guide under "Input Line Settings" for further information.

In the FlashCut CNC software, the Input Line Status dialog displays "OPEN" for a high-level input voltage, or open switch, and "CLOSED" for a low-level input voltage or closed switch.

The input lines are all optically isolated. Jumpers J84 and J85 enable you to choose between the internal power of the Signal Generator and isolated power from an external source. Both jumpers must be set on the same pair of pins (either both must be on pins 1 and 2 or both must be on pins 2 and 3).

Internal Power- This is the most convenient option and works well for most applications, but negates some of the signal isolation. When JP84 shorts pins 1 and 2, OPT VCC gets its power from the Internal 5V power source. When JP85 shorts pins 1 and 2, OPT GND is directly connected to the Internal GND.

External Isolated Power

For the best noise immunity, connect an external 5V-24V power supply to the LED side of the optical couplers. When JP84 shorts pins 2 and 3, OPT VCC gets its optically isolated power from the TB-VCC. When JP85 shorts pins 2 and 3, OPT GND is directly connected to the TB-GND.

Choose **only one** of the following methods to supply power:

1. Connect a power source to the TB 40 screw terminal.
2. Connect a power source through pins 23 and 25 of the DB-25 connector.

If you are providing an external voltage through pins 23 and 25 of the DB25 Motor Signal connector or via TB-40, then you must have both JP84 and JP85 jump pins 2 and 3, OTHERWISE SEVERE DAMAGE COULD RESULT.

BE VERY CAREFUL WHEN DOING ANY WIRING. IMPROPER WIRING WILL DAMAGE THE SIGNAL GENERATOR.

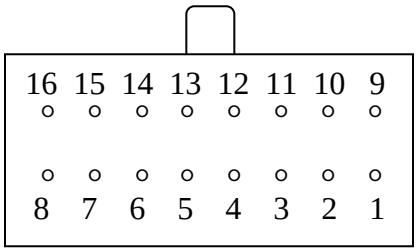
Input lines 1, 2, 3 & 4 are also connected through pins 15, 16, 17 & 18 respectively of the Motor Signal connector, and input lines 5, 6, 7 & 8 are also connected through pins 5, 6, 7 & 8 respectively of the Motor Signal connector. This makes it convenient to send any signals from an external motor driver box, such as limit lines or servo position error signal, back to the Signal Generator through the DB25 cable without

using a separate input cable. Note that if an input line is being used through the Motor Signal connector, that line must remain open in the Input connector.

The receptacle that plugs into this connector is a Molex-Waldom Mini-Fit Jr. Series 16 pin receptacle (part number 39-01-2160), with female pins (part number 39-00-0039 or 39-00-0047 for 22 gauge or thinner wires).

The Molex 63811-1000 for 14-24 AWG universal or Molex 11-01-0197 Crimp Tools are recommended for installing the pins. Kits containing connectors and pins are available through FlashCut CNC or an electronics distributor.

The input lines as seen from the back of the box are arranged as follows (all connections denoted by "OPT-GND" are optically isolated ground.):



Mini-Fit Jr. Pin No.	Signal	Mini-Fit Jr. Pin No.	Signal
1	OPT-GND	9	INPUT 1
2	OPT-GND	10	INPUT 2
3	OPT-GND	11	INPUT 3
4	OPT-GND	12	INPUT 4
5	OPT-GND	13	INPUT 5
6	OPT-GND	14	INPUT 6
7	OPT-GND	15	INPUT 7
8	OPT-GND	16	INPUT 8

Output

This connector is for up to 8 output lines. These lines are all compatible with TTL/CMOS level outputs. The Output ports are not setup to drive a 24V external system unless it accepts TTL/CMOS levels. They are all driven by HCT family logic. Output logic high is normally 5V and can go down to 3.9V at full load. Output logic low is normally 0V and can go up to 0.3V at full load. Each of these signals can provide up to 20mA of current.

Two additional pins on this connector are provided for your output lines: ground and +5V. These are connected to GND and +5V and are not optically isolated. This 5V circuit can source up to 100 mA. Any larger current demand would require a larger power source.

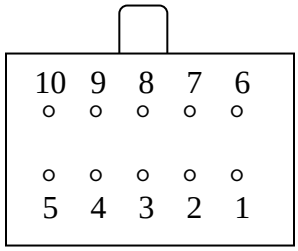
BE VERY CAREFUL WHEN DOING ANY WIRING. IMPROPER WIRING WILL DAMAGE THE SIGNAL GENERATOR.

The output lines are all initialized to low (0V) when you turn on the Signal Generator. Output lines 1 and 2 are also connected through pins 1 and 2 respectively of the Motor Signal connector. This makes it convenient to connect up to 2 output signals to an external motor driver box to drive devices such as solid-state relays that might be in an external motor driver box.

The receptacle that plugs into this connector is a Molex-Waldom Mini-Fit Jr. Series 10 pin receptacle (part number 39-01-2100), with female pins (part number 39-00-0039 or 39-00-0047 for 22 gauge or thinner wires).

The Molex 63811-1000 for 14-24 AWG universal or Molex 11-01-0197 Crimp Tools are recommended for installing the pins. Kits containing connectors and pins are available through FlashCut CNC or an electronics distributor.

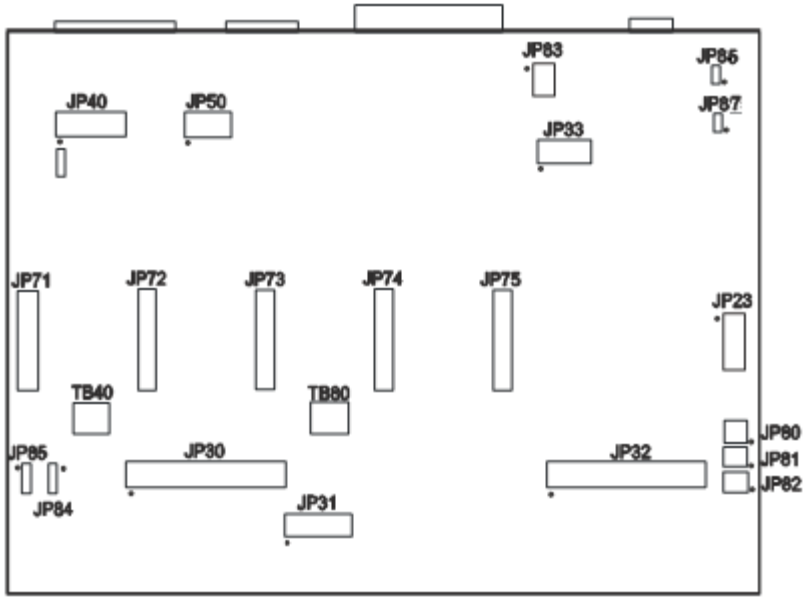
The output lines as seen from the back of the box are arranged as follows:



Mini-Fit Jr. Pin No.	Signal	Mini-Fit Jr. Pin No.	Signal
1	OUTPUT 1	6	OUTPUT 2
2	OUTPUT 3	7	OUTPUT 4
3	OUTPUT 5	8	OUTPUT 6
4	OUTPUT 7	9	OUTPUT 8
5	+5V	10	GROUND

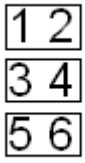
Jumper Settings

Pin 1 of all jumpers is indicated by a small white dot printed on the PCB.



JP83 – DB to USB Ground

This connects the DB 25 ground to the USB ground. By default pins 1 and 2, 3 and 4, and 5 and 6 are jumped as pairs. In order to isolate only the USB shield only jumper pins 3 and 5 as well as removing JP 86. In order to isolate only the chassis jumper pins 1 and 2, 3 and 5, and 4 and 6 as well as removing JP 86 and JP 87.



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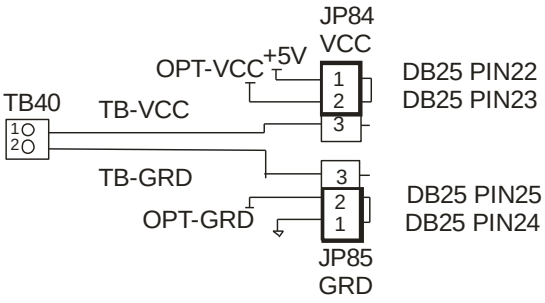
JP84/JP85 – Input Power Select

These two jumpers enable you to choose between the internal power of the Signal Generator and isolated power from an external source. Both jumpers must be set on the same pair of pins (either both must be on pins 1 and 2 or both must be on pins 2 and 3).

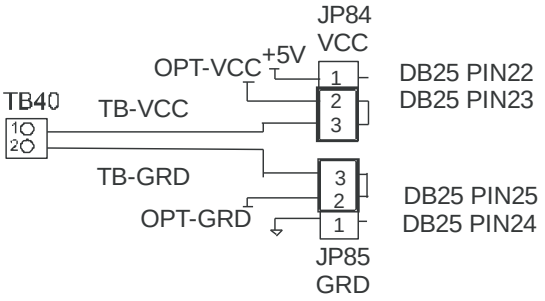
Internal Power

This is the most convenient option and works well for most applications, but negates some of the signal isolation. When JP84 shorts pins 1 and 2, OPT VCC gets its power from the Internal 5V power source. When JP85 shorts pins 1 and 2, OPT GND is directly connected to the Internal GND.



External Isolated Power

For the best noise immunity, connect an external 5V-24V power supply to the LED side of the optical couplers. When JP84 shorts pins 2 and 3, OPT VCC gets its optically isolated power from the TB-VCC. When JP85 shorts pins 2 and 3, OPT GND is directly connected to the TB-GND.



Choose **only one** of the following methods to supply power:

1. Connect a power source to the TB 40 screw terminal.
2. Connect a power source through pins 23 and 25 of the DB-25 connector.
3. Check the resistor value in RP41 to make sure it matches the voltage in TB40.

TB40 Voltage	RP41 Value (10 pin 9 Resistor SIP)
5V	3.9kΩ (Default)
12V	11kΩ
24V	22kΩ

If you are providing an external voltage through pins 23 and 25 of the DB25 Motor Signal connector or via TB-40, then you must have both JP84 and JP85 jump pins 2 and 3, OTHERWISE SEVERE DAMAGE COULD OCCUR.

JP 86 – USB to Chassis Ground

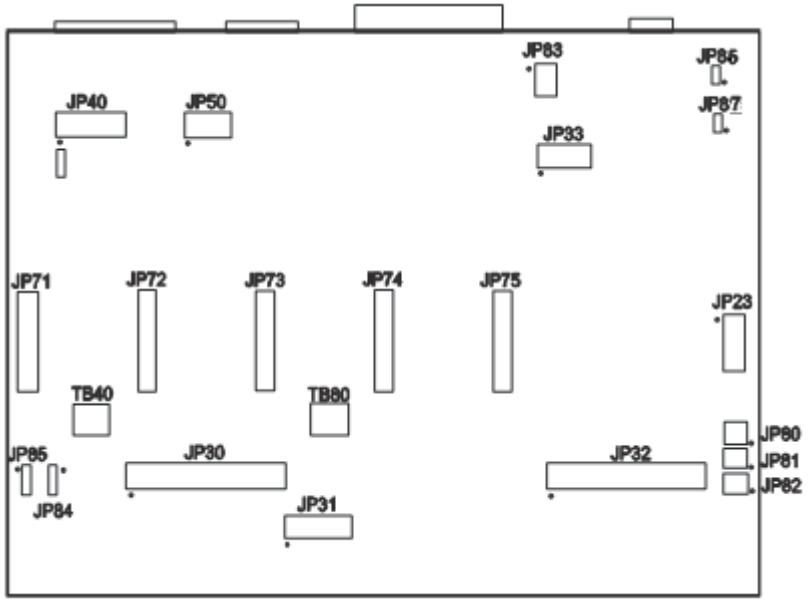
This jumper connects the USB shield to the chassis ground of the Signal Generator when jumped. In order to isolate the USB shield remove this jumper and make sure only pins 3 and 5 are jumper on JP 83. In order to isolate the DB 25 shield and the USB shield remove this jumper. In order to isolate the DB 25 shield, the USB shield, and the chassis remove this jumper as well as JP87.

JP 87 – Internal Signal to Chassis Ground

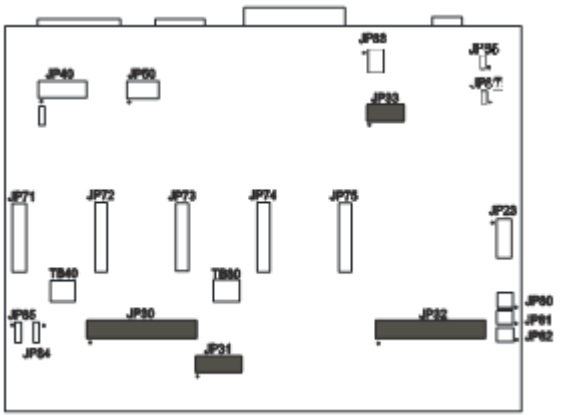
This jumper connects the internal signal ground to the chassis ground of the Signal Generator when jumped. In order to isolate the chassis ground remove this jumper in addition to JP 86 as well as jumping pin 3 and 5, and 4 and 6 on JP 83. In order to isolate the DB 25 shield, the USB shield, and the chassis remove this jumper as well as JP86.

Internal Connections

The diagram below shows the locations of the internal connectors. The top of the diagram corresponds to the back side of the signal generator (where the external connectors are located). The small dot next to some of the connectors designates the number 1 pin position.



On the following diagrams, the positions of the connectors will be highlighted in black.**Connectors JP30, JP31, JP32, JP33**



JP30 – Auxiliary Inputs

This contains all of the Input Signals 1-8 which come out of the 501A board and Input Signals 9-32 which come out of the I/O Expansion board.

+3.3V	1	2	+3.3V
GPI32	3	4	GPI1
GPI31	5	6	GPI2
GPI30	7	8	GPI3
GPI29	9	10	GPI4
GPI28	11	12	GPI5
GPI27	13	14	GPI6
GPI26	15	16	GPI7
GPI25	17	18	GPI8
GND	19	20	GND
GPI24	21	22	GPI9
GPI23	23	24	GPI10
GPI22	25	26	GPI11
GPI21	27	28	GPI12
GPI20	29	30	GPI13
GPI19	31	32	GPI14
GPI18	33	34	GPI15
GPI17	35	36	GPI16
+3.3V	37	38	+3.3V
GND	39	40	GND

JP31 – Status LEDs

This is for connecting wired LEDs from a custom chassis to the 501A LED signals.

+5V	1	2	N/C
LED-DIR1	3	4	LED-STEP1
LED-DIR2	5	6	LED-STEP2
LED-DIR3	7	8	LED-STEP3
LED-DIR4	9	10	LED-STEP4
LED-DIR5	11	12	LED-STEP5
LED-AUX	13	14	LED-USB
GND	15	16	LED-PWR

JP32 – Bus Expansion

This contains signal and address lines for the I/O Expansion board.

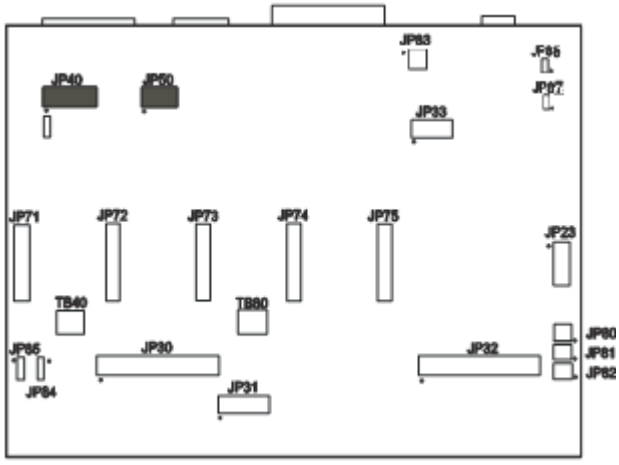
+3.3V	1	2	GND
CS6	3	4	STATUS6
TXD2	5	6	FAULT6
RXD2	7	8	AUX1-STB
OUT-ENA	9	10	AUX2-STB
OUT2-STB	11	12	OUT1-STB
OUT4-STB	13	14	OUT3-STB
+5V	15	16	+5V
GND	17	18	GND
A0	19	20	A1
DATA1	21	22	DATA2
DATA3	23	24	DATA4
DATA8	25	26	DATA7
DATA6	27	28	DATA5
+7V	29	30	+7V
SPHOME	31	32	ENC CLK
+3.3V	33	34	ENC DIR
AGND	35	36	AV+
DAC2	37	38	DAC1
ADC1	39	40	AGND

JP33 – Step & Direction

This contains all of the step and direction signals for 5 axes of motion.

STEP5	1	2	ENA
STEP4	3	4	DIR5
STEP3	5	6	DIR4
STEP2	7	8	DIR3
STEP1	9	10	DIR2
GND	11	12	DIR1

Connectors JP40, JP50



JP40 – Input Aux Header

This contains the same signals as the Mini-Fit Jr. Input Connector. It is provided for the convenience of using a different input connector or an external input connector on a custom chassis.

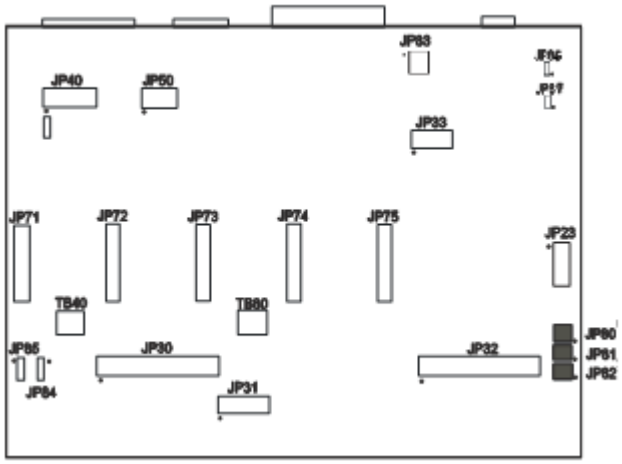
GPI1	1	2	OPT-GND
GPI2	3	4	OPT-GND
GPI3	5	6	OPT-GND
GPI4	7	8	OPT-GND
GPI5	9	10	OPT-GND
GPI6	11	12	OPT-GND
GPI7	13	14	OPT-GND
GPI8	15	16	OPT-GND

JP50 – Output Aux Header

This contains the same signals as the Mini-Fit Jr. Input Connector. It is provided for the convenience of using a different input connector or an external input connector on a custom chassis.

GPO2	1	2	GPO1
GPO4	3	4	GPO3
GPO6	5	6	GPO5
GPO8	7	8	GPO7
GND	9	10	VCC

Connectors JP80, JP81, JP82



JP80 – Rear Panel Power

Connect the main power here. It can be 8.5V – 16V DC or AC. See current draw chart for power requirements.

JP81 – Rear Panel Fuse

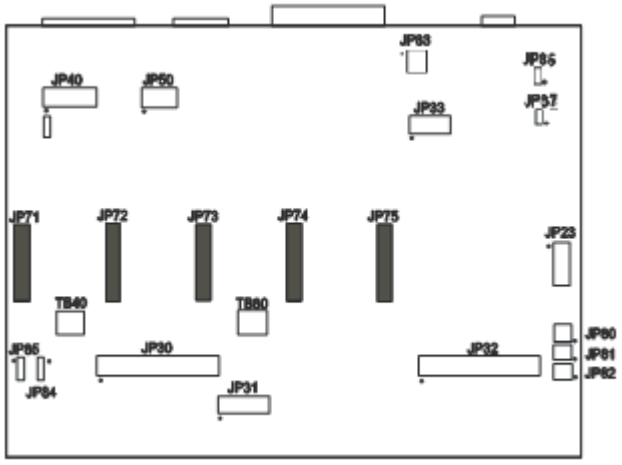
This is for an optional power fuse. The unit is shipped with a shunt instead of a fuse. If you replace the shunt with a fuse, it should be sized according to your power requirements.

JP82 – Front Panel Switch

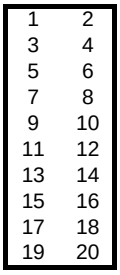
Connect the main power switch here.

Axis Plug-In Interfaces

Axis Plug-Ins JP71 – JP75



The Axis plug-in interfaces are used to add additional functions to the main signal generator board. For example, a stepper drive plug-in card or cable will enable you to drive a stepper motor directly from the signal generator box.



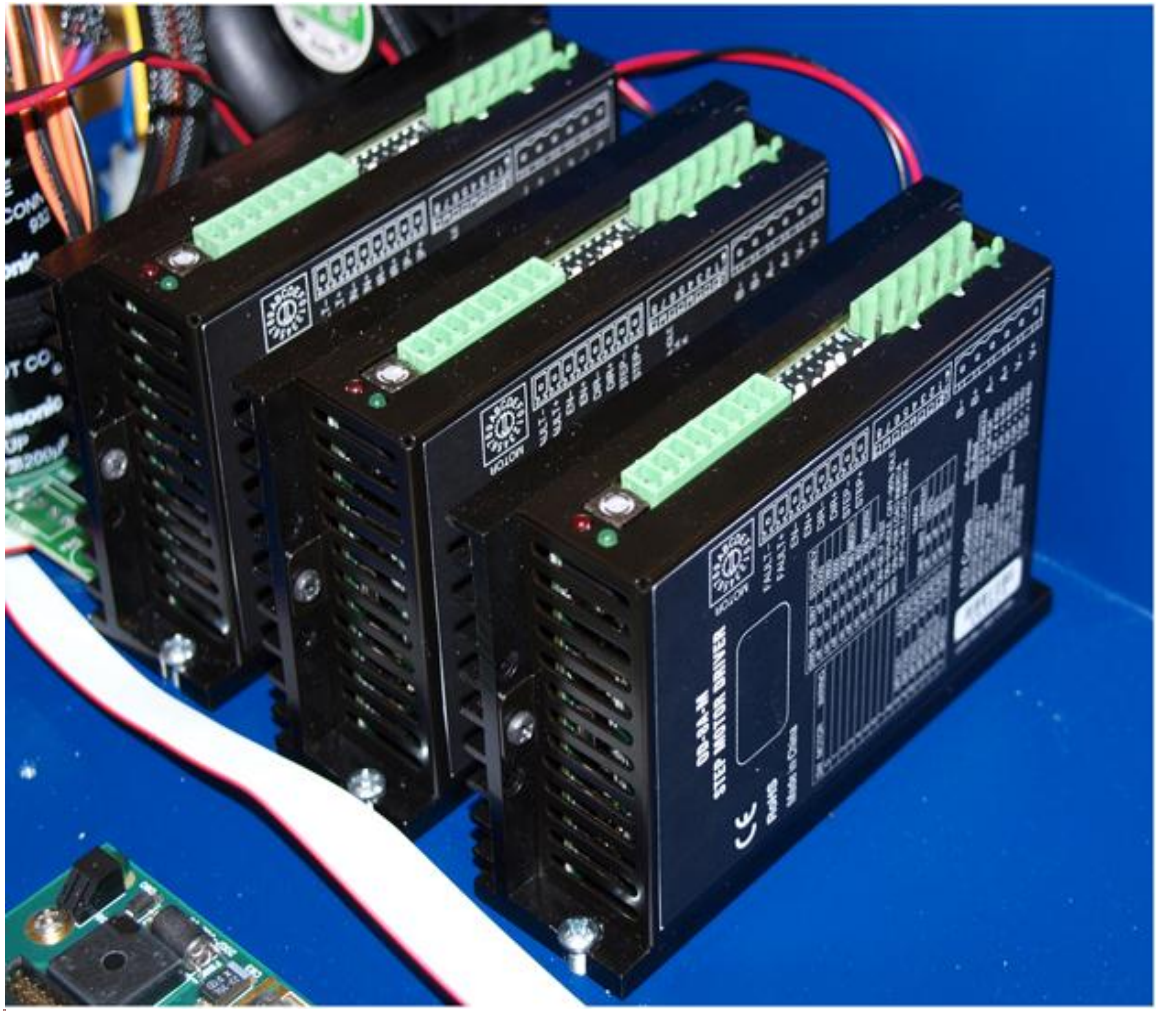
Each of these plug-in cards is a SKT10X2 connector, with the pin configuration on the left. Pin numbers 1-5, 7, 13, 15 and 17-20 perform the same function on each jumper.

Per the chart below, pins 6, 8-12, 14 and 16 have different values of Status, Fault, InputA, Dir, InputB, Step, SCOM and CS respectively for each plug-in card.

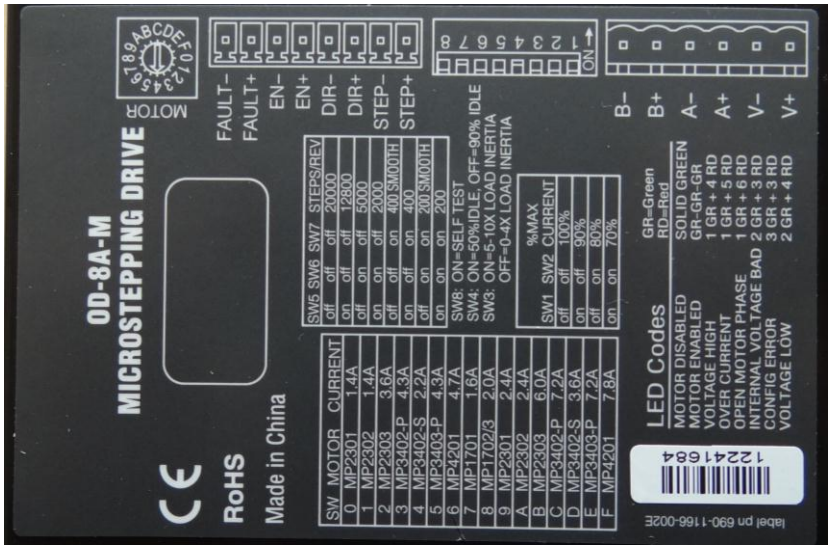
Pin No.	Label	Function	JP-71	JP-72	JP-73	JP-74	JP-75
1	HV-PWR	High Voltage Power	HV-PWR	HV-PWR	HV-PWR	HV-PWR	HV-PWR
2	HV-PWR	High Voltage Power	HV-PWR	HV-PWR	HV-PWR	HV-PWR	HV-PWR
3	GND	Ground	GND	GND	GND	GND	GND
4	GND	Ground	GND	GND	GND	GND	GND
5	RxD2	Serial Com. Receive	RxD2	RxD2	RxD2	RxD2	RxD2
6	STATUS	Status	**STATUS1**	**STATUS2**	**STATUS3**	**STATUS4**	**STATUS5**
7	TxD2	Serial Com. Transmit	TxD2	TxD2	TxD2	TxD2	TxD2
8	FAULT	Fault Indicator	**FAULT1**	**FAULT2**	**FAULT3**	**FAULT4**	**FAULT5**
9	INPUTA	Input A	**IN8**	**IN10**	**IN12**	**IN14**	**IN16**
10	DR	Direction	**DR1**	**DR2**	**DR3**	**DR4**	**DR5**
11	INPUTB	Input B	**IN9**	**IN11**	**IN13**	**IN15**	**IN17**
12	ST	Step	**ST1**	**ST2**	**ST3**	**ST4**	**ST5**
13	SM0	SM0	SM0	SM0	SM0	SM0	SM0
14	SCOM	SCOM	**SCOM1**	**SCOM2**	**SCOM3**	**SCOM4**	**SCOM5**
15	SM1	SM1	SM1	SM1	SM1	SM1	SM1
16	CS	Chip Select	**CS1**	**CS2**	**CS3**	**CS4**	**CS5**
17	ENA	Enable	ENA	ENA	ENA	ENA	ENA
18	+5V	+5V	+5V	+5V	+5V	+5V	+5V
19	GND	GND	GND	GND	GND	GND	GND
20	GND	Ground	GND	GND	GND	GND	GND

6. Drive Settings

Inside of the controller box are the individual drive modules for axes 1-5.



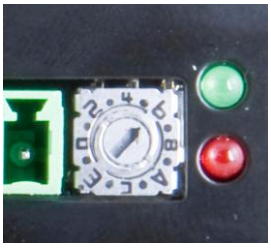
Each drive module has Logic Connector for the Step, Direction, COM and Enable signals coming from the Axis Plug-in connector on the Signal generator, a Motor Connector for the A and B Coils of the motor, a Power Connector, and a group of DIP Switches for configuring the drive for your specific requirements. The configuration of the DIP switches vary depending on your application.



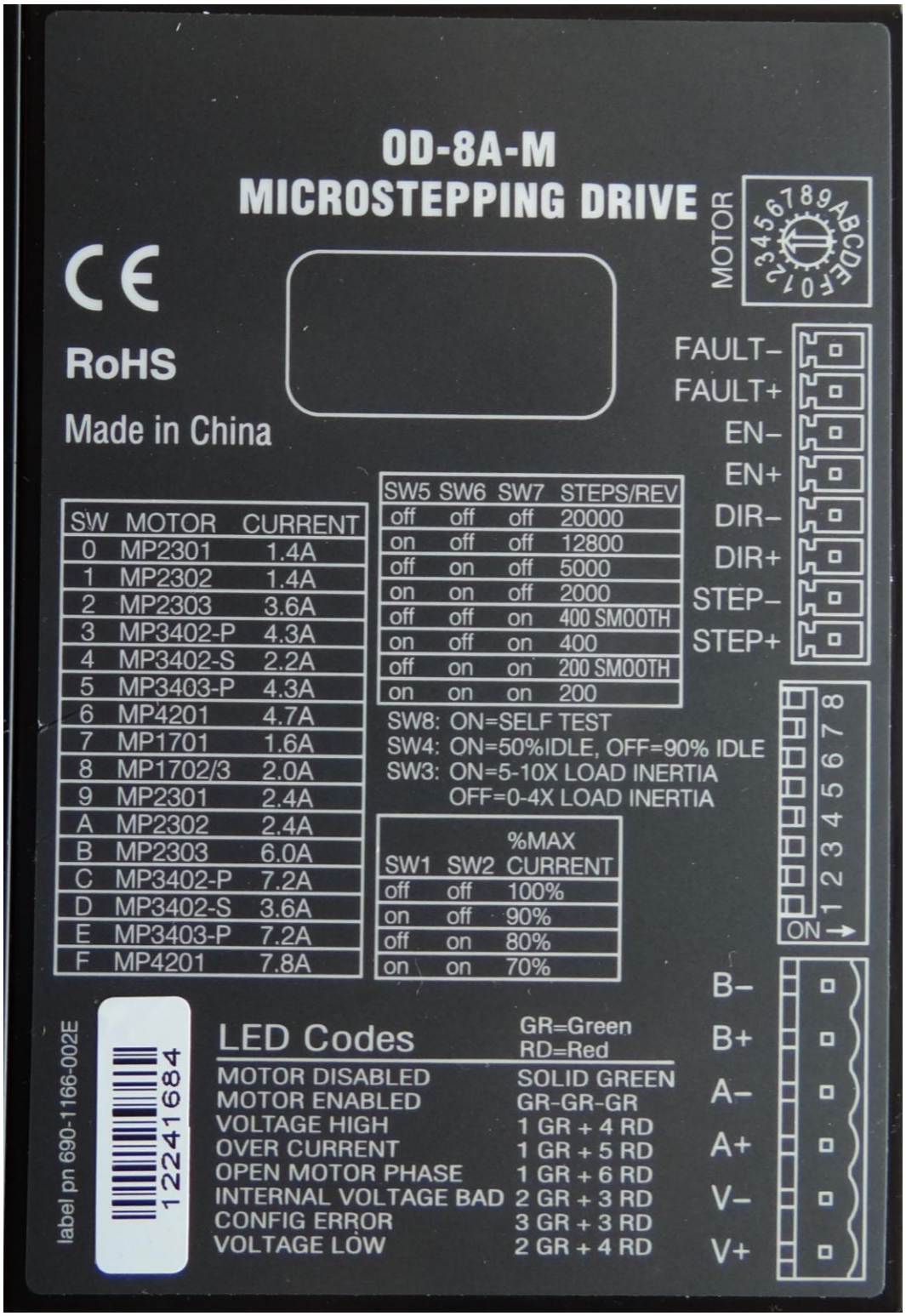
Configuring the Drives

Selecting a Motor

The drives are optimized for use with selected variety of stepper motors. Each setting matches the current and inertia of a given motor providing the most power with minimum resonance. To select a motor, simply move the rotary switch to the letter or number that corresponds to the motor of your choice. Make sure the power is off before changing this setting, or damage could occur to your motor or drive.



If your motor is not on the list please set the switch to a selection whose rotor inertia, holding torque and current are within 10% of your motor.



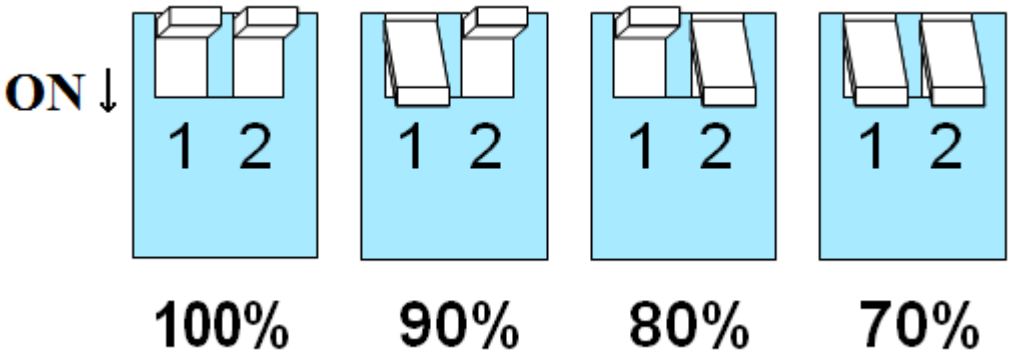
Setting the Current

The maximum current for the motor you have selected is set automatically when you set the rotary switch. But you may want to reduce the current to save power or lower motor temperature. This is important if the motor is not

mounted to a surface that will help it dissipate heat or if the ambient temperature is expected to be high.

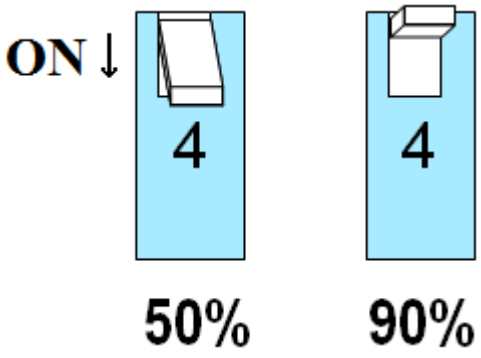
Step motors produce torque in direct proportion to current, but the amount of heat generated is roughly proportional to the square of the current. If you operate the motor at 90% of rated current, you'll get 90% of the rated torque. But the motor will produce approximately 81% as much heat. At 70% current, the torque is reduced to 70% and the heating to about 50%.

Two of the small switches on the front of the drive are used to set the percent of rated current that will be applied to the motor: SW1 and SW2. Please set them according to the illustration below. The factory default setting is 70%.



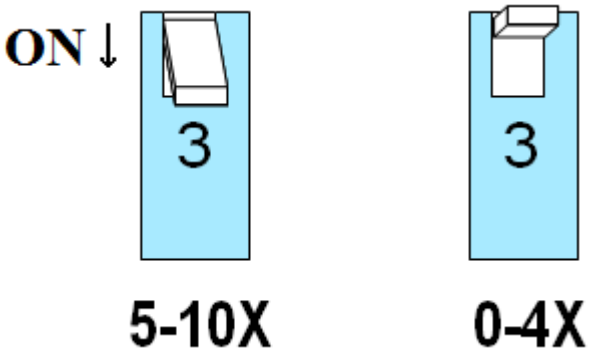
Setting Idle Current

Motor heating and power consumption can also be reduced by lowering the motor current when it is not moving. The drive will automatically lower the motor current when it is idle to either 50% or 90% of the running current. The 50% idle current setting will lower the holding torque to 59%, which is enough to prevent the load from moving in most applications. This reduced motor heating by 75%. In some applications such as those supporting a vertical load, it is necessary to provide a high holding torque. In such cases, the idle current can be set to 90% as shown below. The default setting is for 50% idle current.



Load Inertia

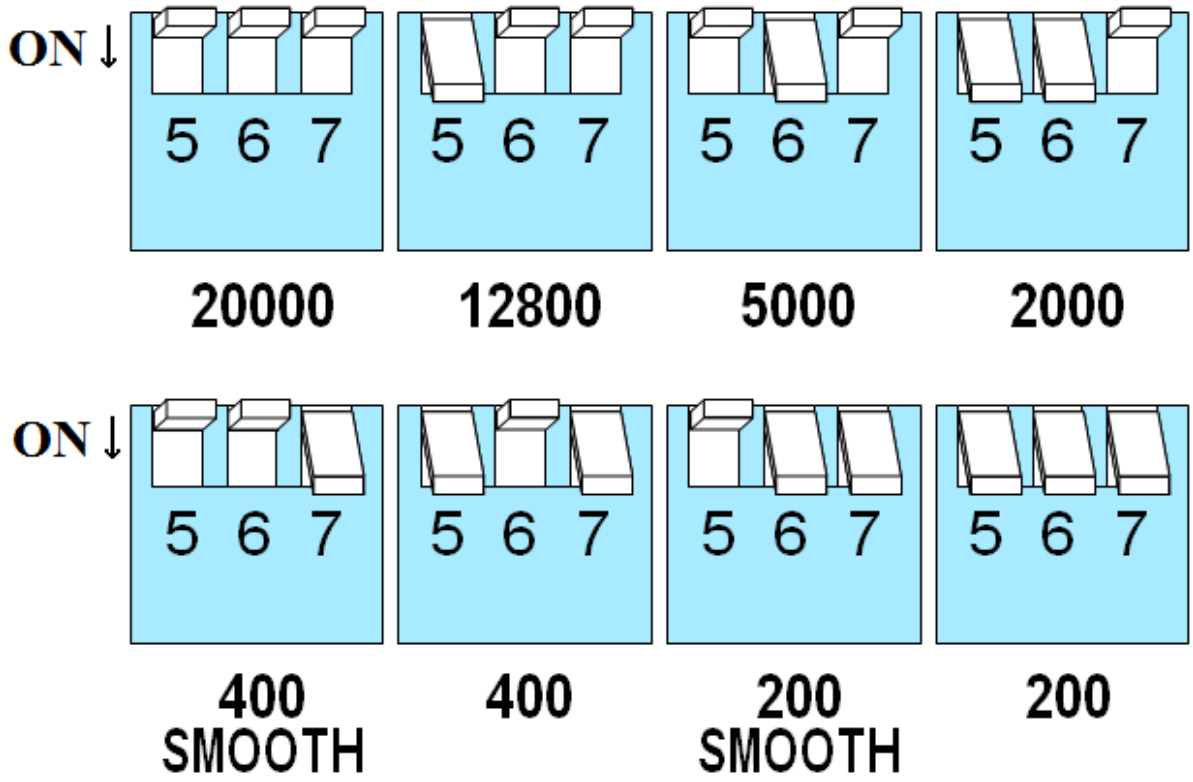
The drives include anti-resonance and electronic damping features which greatly improve motor performance. To perform optimally, the drive must understand the electromechanical characteristics of the motor and load. Most of this is done automatically when you select the motor by setting the rotary switch. To further enhance performance you must set a switch to indicate the appropriate inertia ratio of the load and motor. The ranges are 0 to 4X and 5 to 10X. Simply divide the load inertia by the rotor inertia to determine the ratio, then set switch 3 accordingly, as shown.



Step Size

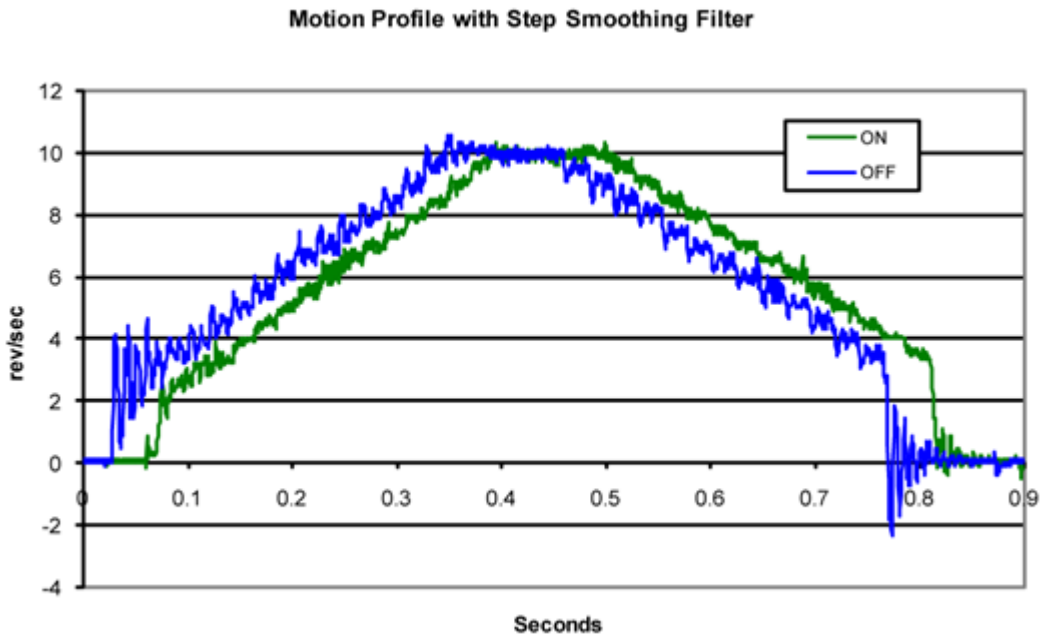
The drive module requires a source of step pulses to command motion. This may be a PLC, an indexer, a motion controller or another type of device. The only requirement is that the device be able to produce step pulses whose frequency is in proportion to the desired motor speed, and be able to smoothly ramp the step speed up and down to produce smooth motor acceleration and deceleration.

Smaller step sizes result in smoother motion and more precise speed, but also require a higher step pulse frequency to achieve maximum speed. The smallest step size of the drives is 1/20,000th of a motor turn while the maximum step rate of the signal generator is typically between 50,000 and 100,000 steps/sec.Six different settings are provided in the drive module, as shown in the table below. Please choose the one that best matches the capabilities for your system.



At lower step resolutions such as 200 steps/revolution (full step) and 400 steps/revolution (half step), motors run a little rough and produce more audible noise than when they are microstepped (2000 steps/revolution and beyond). The drives include a feature called “microstep emulation”, also called “step smoothing”, that can provide smooth motion from coarse command signals. If you select “200 SMOOTH or 400 SMOOTH”, this feature is automatically employed to provide the smoothest possible motion from a less than ideal signal source.

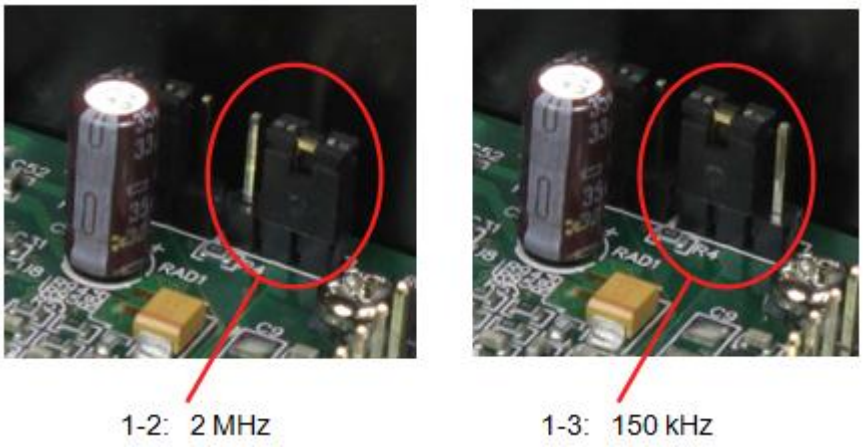
Because a command filter is used as part of the step smoothing process, there will be a slight delay, or “lag” in the motion. If this delay is objectionable for your application, please choose the non-filtered setting “200” or “400”. The chart on the next page shows an example of the delay that can occur from using the step smoothing filter. If you are using the smoothing feature, you must have all axis in the same smoothing mode, otherwise there will be a timing problem with multi-axis interpolation.



Step Pulse Noise Filtering

Electrical noise can affect the STEP signal in a negative way, causing the drive to think that one step pulse is two or more pulses. This results in extra motion and inaccurate motor and load positioning. To combat this problem the drives include a digital noise filter on the STEP and DIR inputs. The default factory setting of this filter is 150 kHz, which works well for most applications.

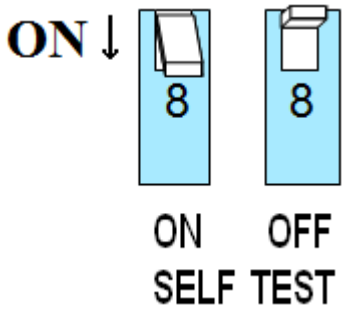
However as discussed in "Step Size" of this section, if you are operating the drive module at a high number of steps/revolution and at high motor speeds you will be commanding the drive at step rates above 150 kHz. In such cases you should remove the cover and move jumper S4 from the 150 kHz position (1-3) to the 2 MHz position (1-2) as shown below.



Your maximum pulse rate will be the highest motor speed times the steps/revolution. For example, 40 revolutions/second at 20,000 steps/revolution is 40 X 20,000 = 800 kHz. Please consider this when deciding if you must increase the filter frequency,

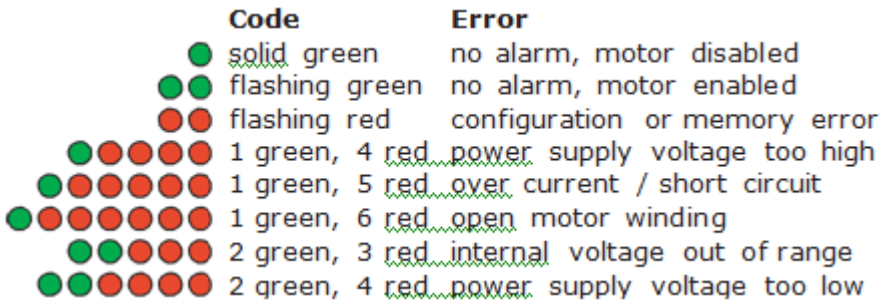
Self-Test

If you are having trouble getting your motor to turn you may want to try the built-in self-test. Anytime switch 8 is moved to the ON position, the drive will automatically rotate the motor back and forth, two turns in each direction. This feature can be used to confirm that is correctly wired, selected and otherwise operational.



Alarm Codes

In the event of a drive fault or alarm, the green LED will flash one or two time, followed by a series of red flashes. The pattern repeats until the alarm is cleared.



7. Motor Signal Settings

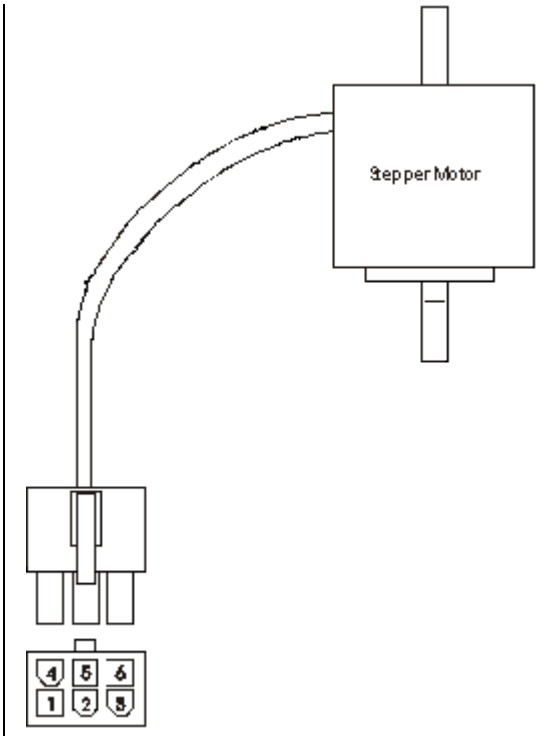
The motor settings in the Motor Signal Setup Screen in the FlashCut CNC software need to be properly set according to the driver box that you have. Please refer to Motor Signal Setup section of the User's Guide for the best way to set up your drive for your software version.
For this drive, the best signals are as follows:

Driver Model: 8A Pro Micro Stepper (6501-X-080-M
Step Pulse: High
Step Pulse Width: 5
Min. Time Between Steps: 5
Direction-Step Setup: 5
Min. Step-Direction Lag: 5
Enable Signal Polarity: High

8. Stepper Motor Cabling

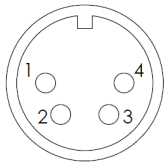
Motor Cable - 2 Twisted pair (one pair for A coil and one pair for B Coil) 22 gauge and shielded (18 gauge for 6A motors). Shield is only connected to noted pin on Molex-Waldom connector and should not be connected to motor end. Use Belden - M 8723 CM 2PR22 Shielded Cable or equivalent.

Connector - Molex - Waldom 6-Pin Mini-Fit Jr.
Receptacle Housing Part # 39-01-2060.
Female Pins Part # 39-00-0039 or 39-00-0047



Molex Pin	Motor Wire
1	B
2	Cable Ground Shield
3	A
4	B~
5	No Connection
6	A~

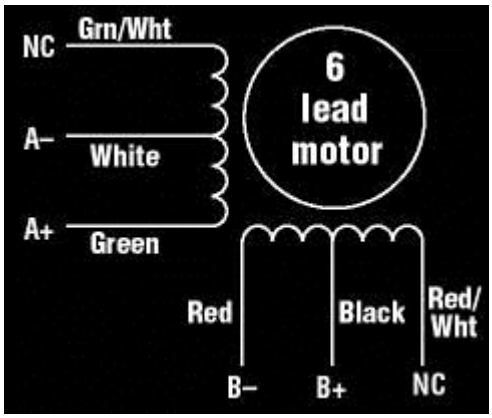
XLR Pin	Wire
1	B-
2	B+
3	A+
4	A-



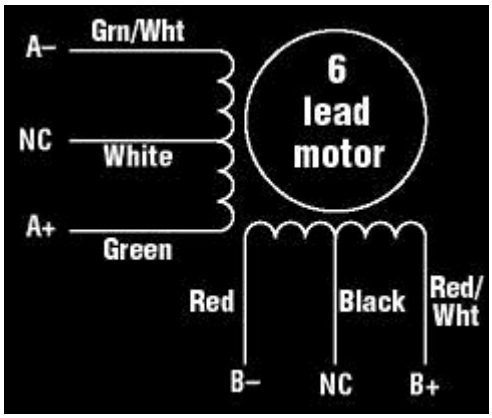
Motor Wiring for Other Stepper Motors

If you have your own stepper motor, you can use the following charts for your wiring. Note that the motor wire colors will vary.

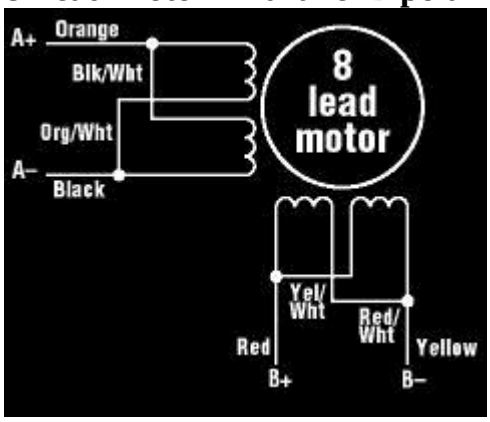
6 Lead Motor – ½ Coil Bipolar



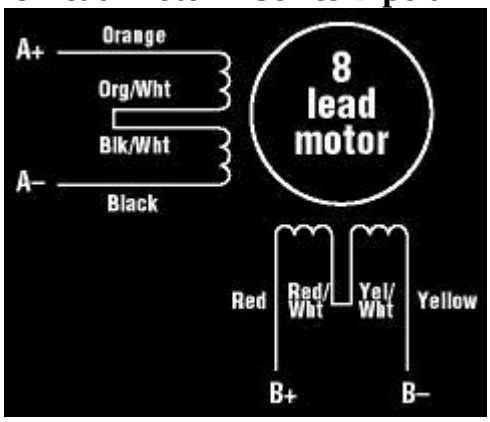
6 Lead Motor – Series Bipolar



8 Lead Motor – Parallel Bipolar



8 Lead Motor – Series Bipolar



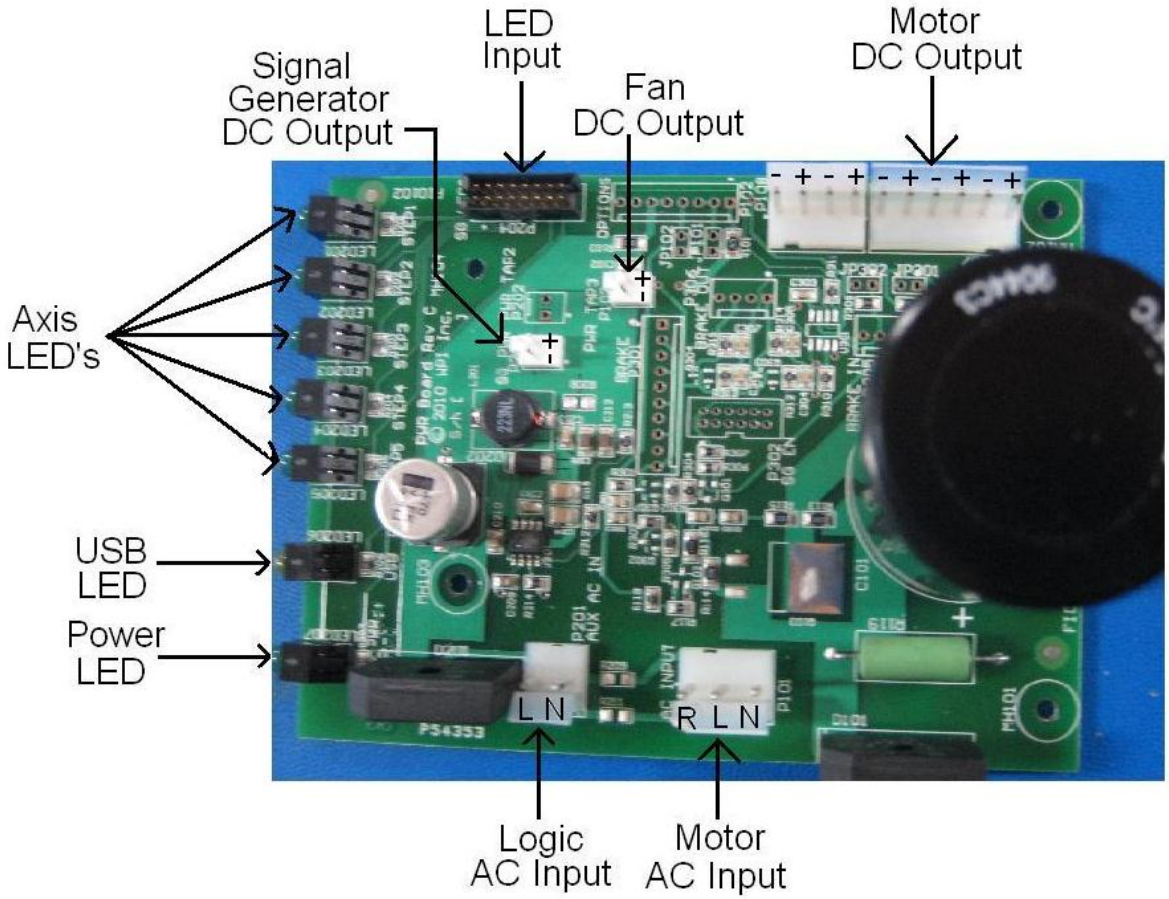
Unknown Motor Wiring

If you are uncertain which is the A pair and which is the B pair, you can use an ohm meter and the following chart to determine the pairs (and the center taps on a 6- wire motor)

A to A~	About 1-10 ohms (Equal to B to B~)
B to B~	About 1-10 ohms (Equal to A to A~)
A or A~ to B or B~	No Continuity
A Center to A or A~	½ the resistance of A to A~
B Center to B or B~	½ the resistance of B to B~
B Center to A or A~	No Continuity
A Center to B or B~	No Continuity

If the A and A~ or the B and B~ are reversed, the motor will spin the opposite direction. This can easily be corrected by changing the motor polarity in the Setup…Motor Settings menu in the FlashCut CNC software.

9. Power Board



The function of the Power Board is to supply DC voltage to the drive modules as well as to the cooling fan and logic signals to the Signal Generator. The power enters the board in the form AC voltage from a transformer; the AC voltage is then converted to DC voltage. The Power Board also contains the indication LED's:

AXIS LED's 1, 2, 3, 4, 5 – Turns green when the respective axis is moving.

USB LED– Turns yellow when connected to the host PC USB port.

POWER LED– Turns green when the power switch is turned on.

LOGIC AC INPUT- This connector takes in the power from the transformer for the logic signals. The AC voltage from the transformer is then converted to a DC voltage to be used for logic signals. The two contacts are labeled as follows: L is the hot, N is the neutral.

MOTOR AC INPUT- This connector takes in the power from the transformer for the drive modules. The AC voltage from the transformer is then converted to a DC voltage of 40-80V, depending on the connection configuration, to be used for powering the drive

modules. The three contacts are labeled as follows: R is the reserve, L is the hot, N is the neutral. The reserve and the hot may be switched to vary the voltage. For example if R is red and L is purple the resulting DC voltage is approximately 67 VDC, where if R is purple and L is red the resulting DC voltage is approximately 80 VDC.

SIGNAL GENERATOR DC OUTPUT- This output sends a 9 VDC signal to power the Signal Generator. When viewing the power board in the configuration above the top contact of the signal generator DC output is positive and the bottom contact is negative.

FAN DC OUTPUT- This output sends a 24 VDC signal to power the fan for cooling the box. When viewing the power board in the configuration above the top contact of the fan DC output is positive and the bottom contact is negative.

MOTOR DC OUTPUT- This output sends a 40-80 VDC, depending on the connection configuration, DC signal to power the drive modules. Power for up to 5 individually powered drive modules. The contacts alternate positive and negative starting with positive on the contact nearest the large capacitor.

LED INPUT- This input receives logic signal from the signal generator in order to illuminate any of the 7 LED's indicating axis movement, power or USB connectivity. The contact connections for the LED input are as follows:

JP31 – STATUS LEDS

2 X 8 - 2MM SPACING

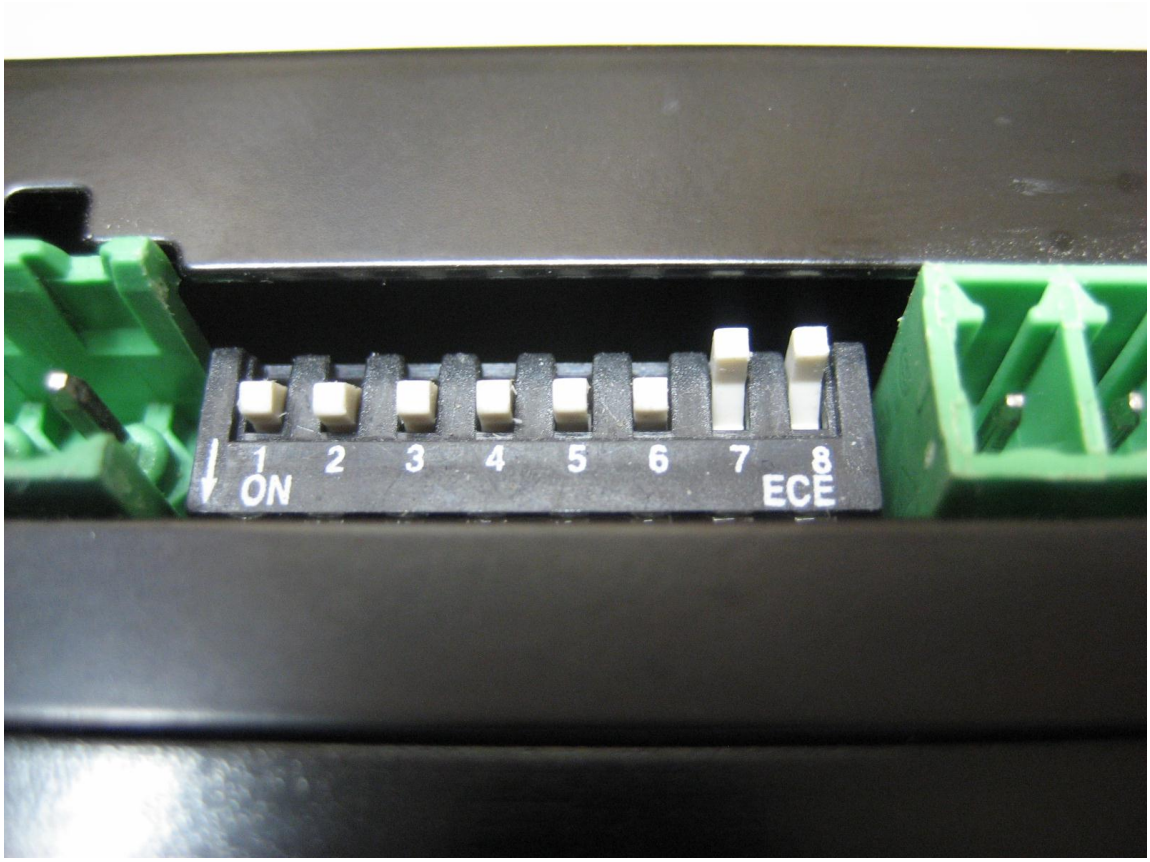
+5V	1	2	N/C
LED-DIR1	3	4	LED-STEP1
LED-DIR2	5	6	LED-STEP2
LED-DIR3	7	8	LED-STEP3
LED-DIR4	9	10	LED-STEP4
LED-DIR5	11	12	LED-STEP5
LED-AUX	13	14	LED-USB
GND	15	16	LED-PWR

10. Driver Module Upgrades

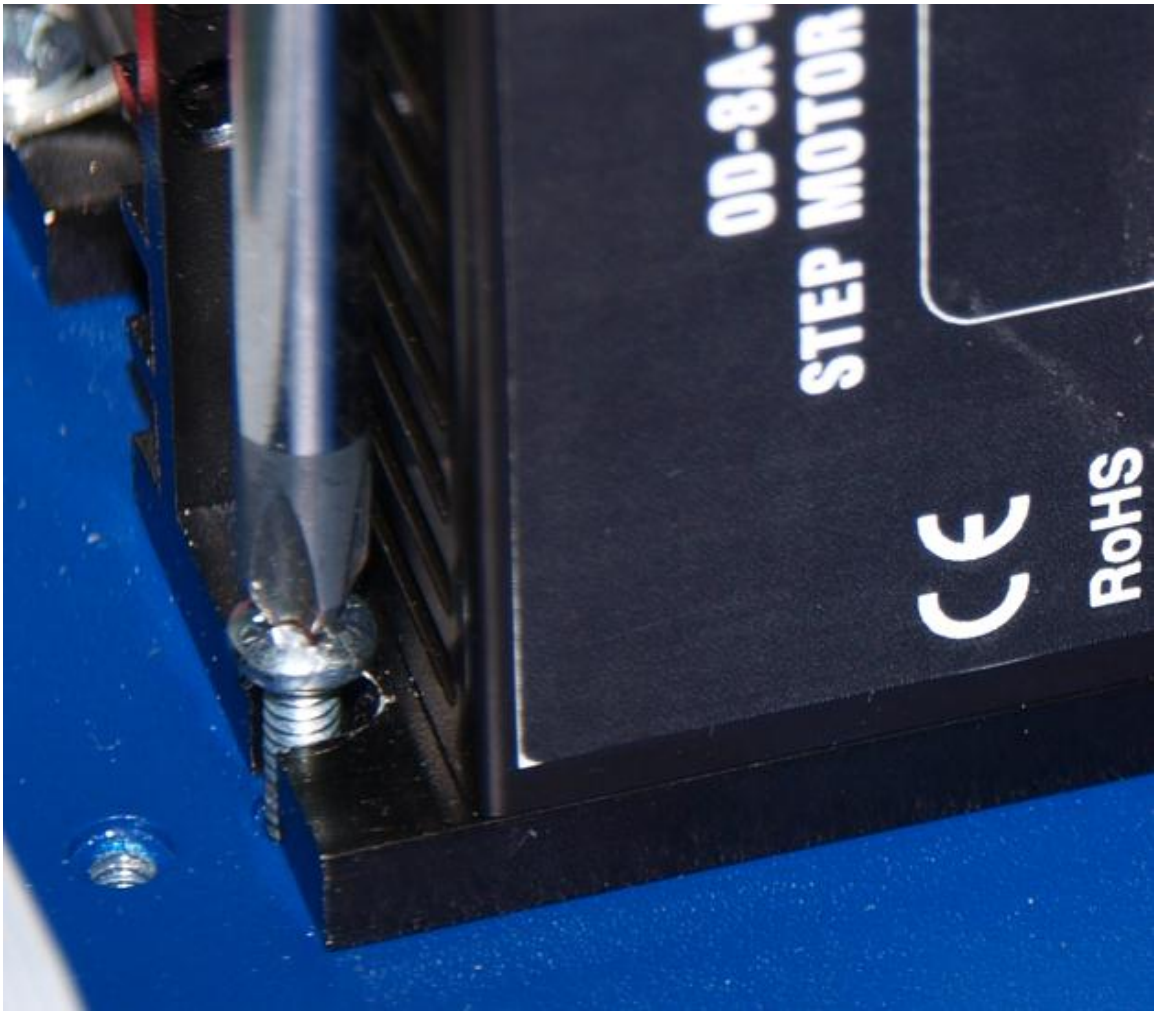
To upgrade your CNC controller such as adding a 4th or 5th axis you should install the new drive module(s) using the following instructions.

Improper wiring can cause damage to your driver box and/or motors. Please take care in following these instructions properly. Please refer to the drawings below for the correct logic connectors.

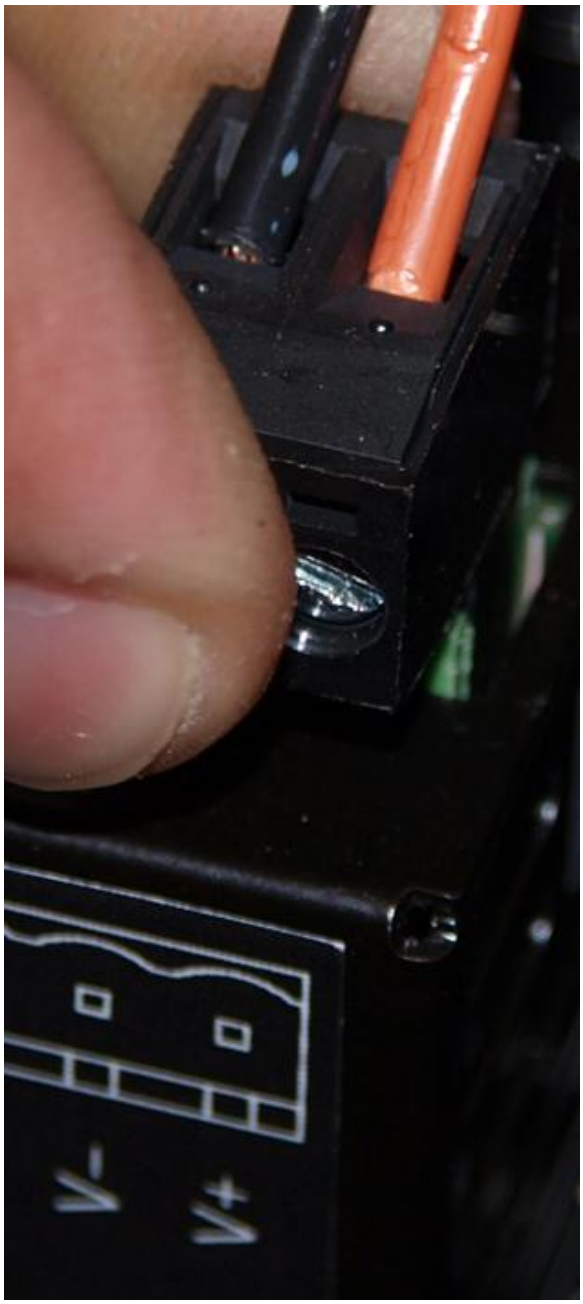
1. Set the Dip Switches to the appropriate settings for your application (default settings pictured).



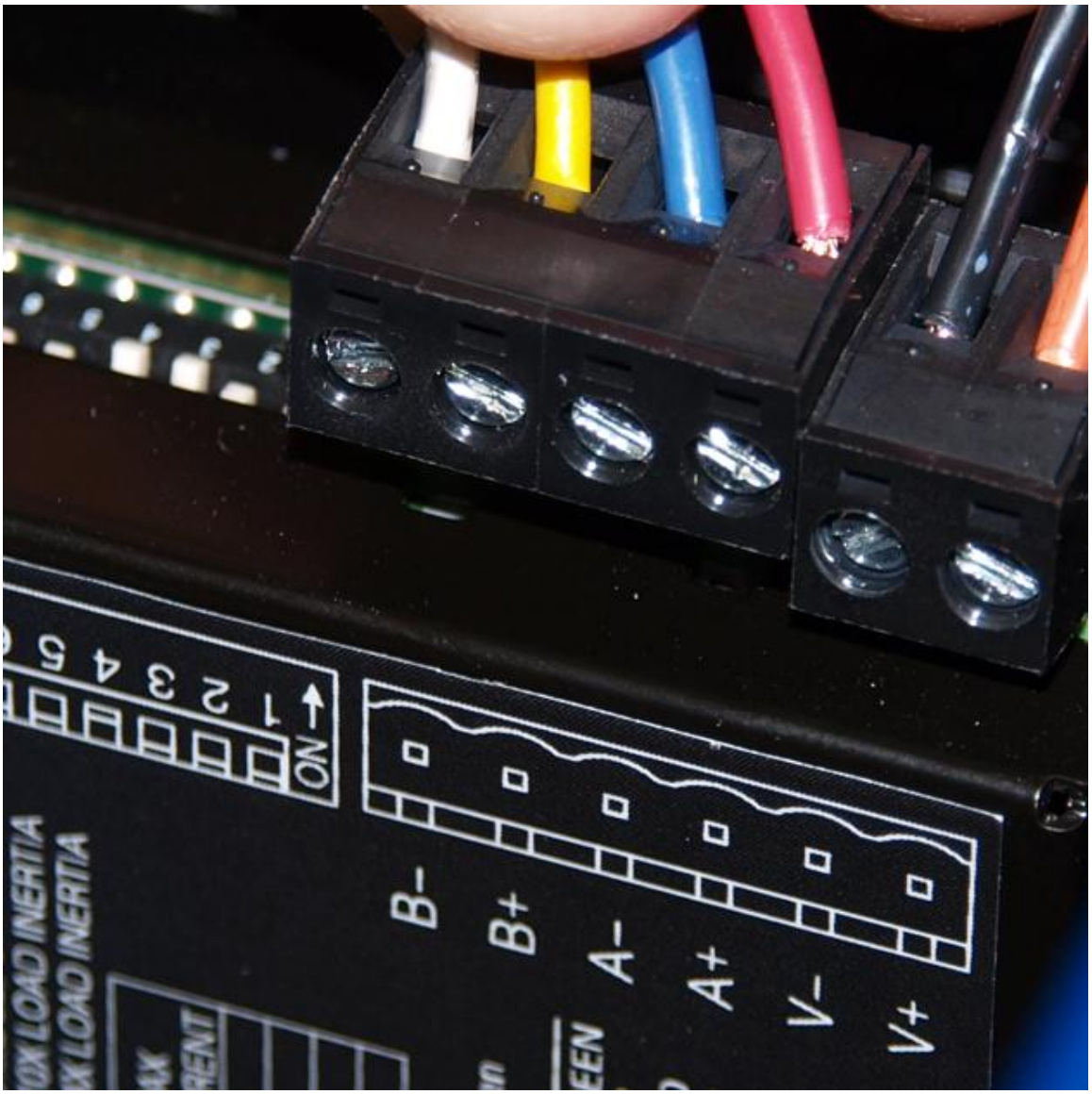
2. Mount the drive module to the driver box chassis using (2) 6-32 conducting screws.



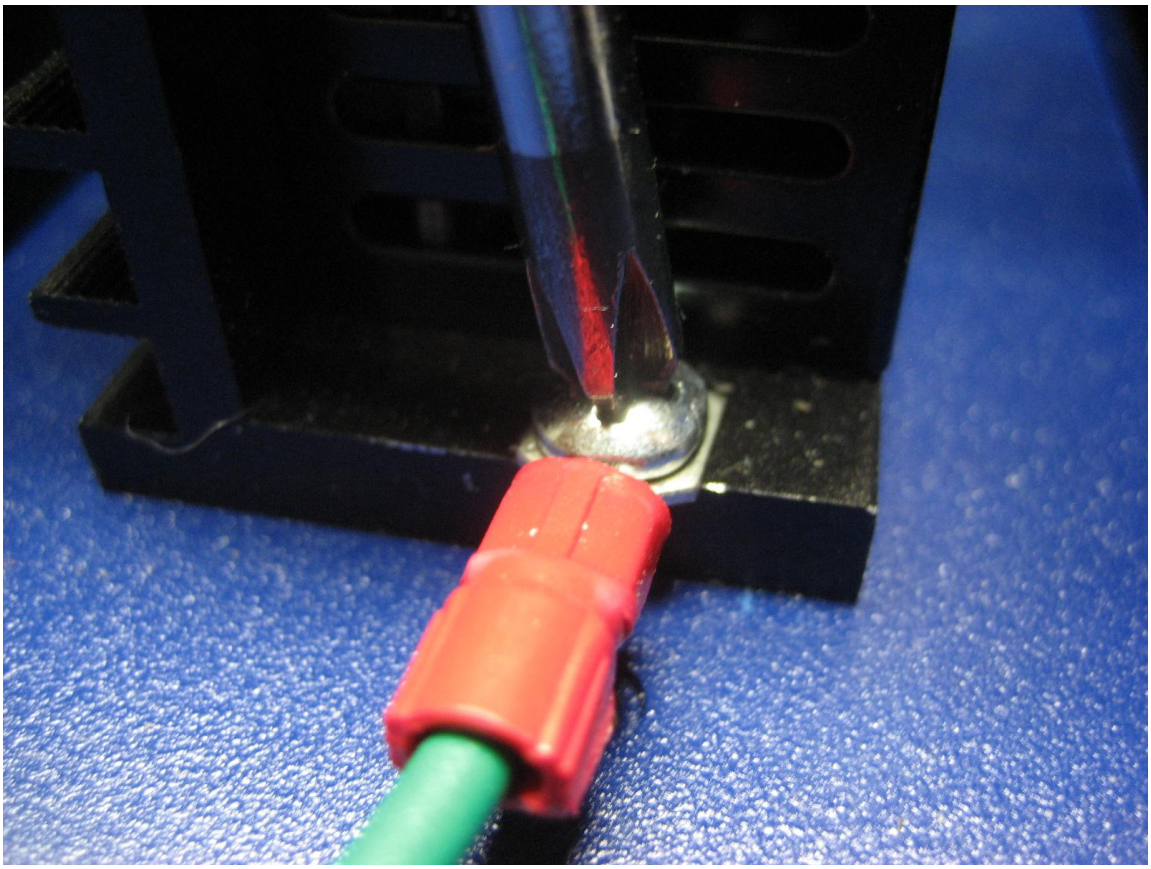
3. Connect the power cable from the power board into V- and V+ on the drive making sure to note polarity.



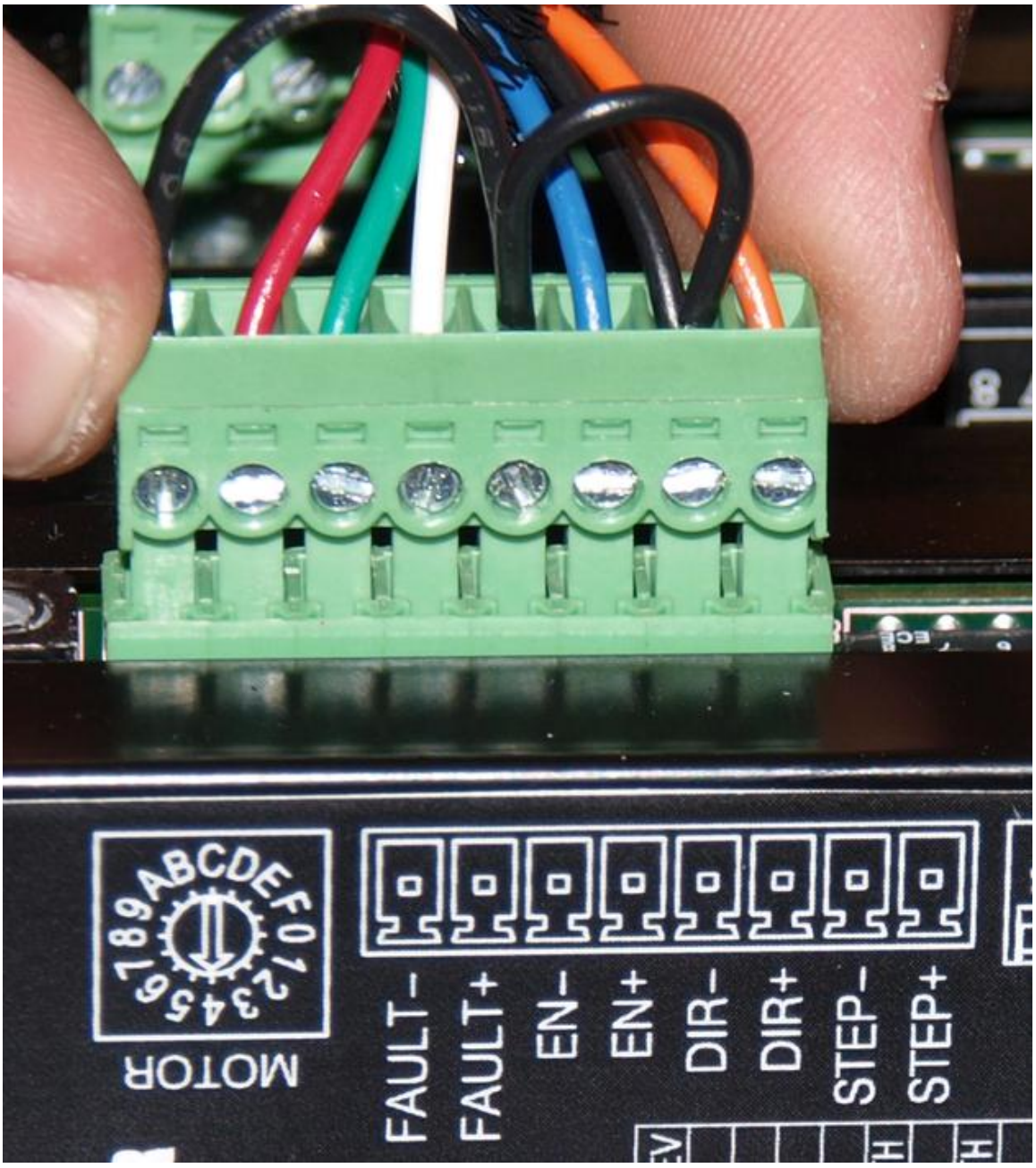
4. Connect the wires from the motor receptacle to the drive module motor connector labeled B-, B+,A- and A+ on the drive module.



To properly ground your motor cable shield, connect Pin 2 of the motor cable directly to the base of the drive module using the 6-32 hold down screw.



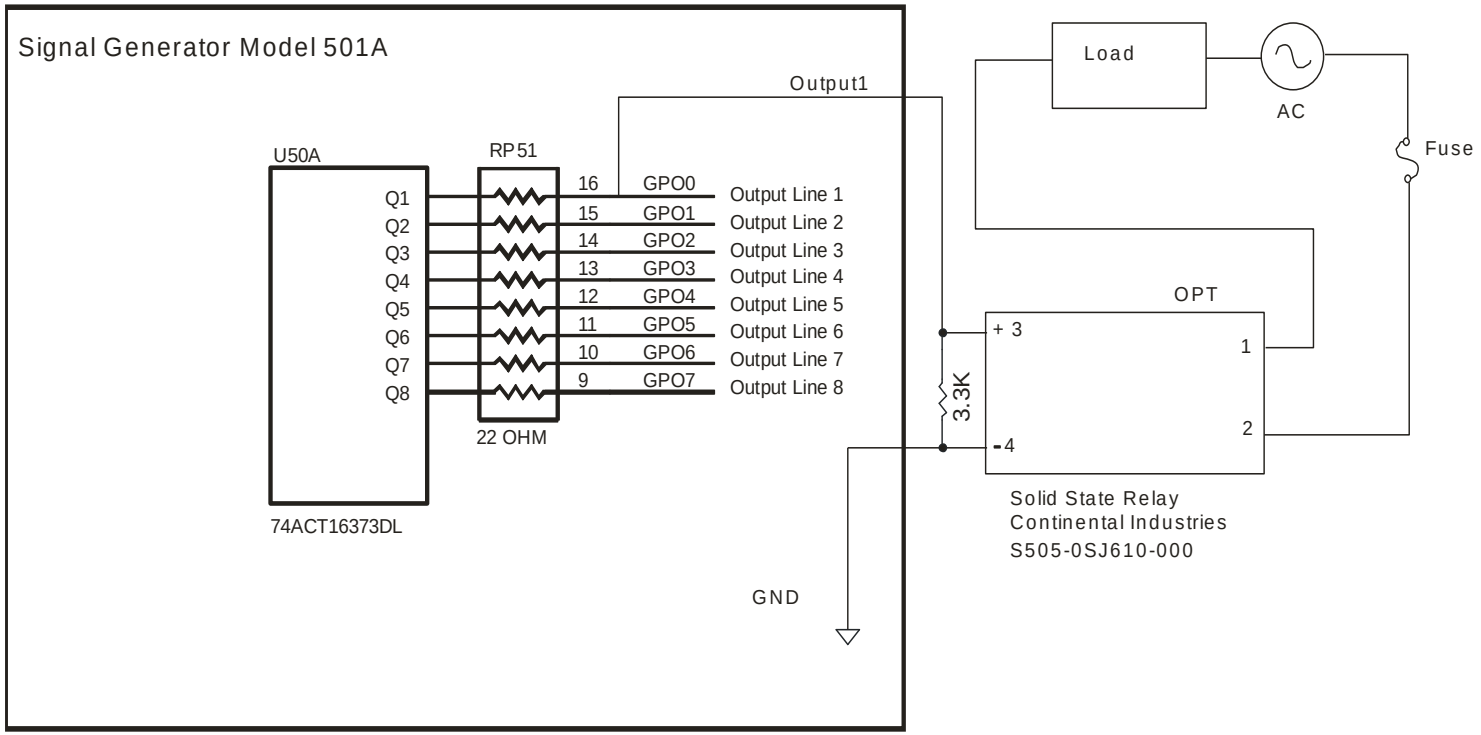
5. Connect the step, direction, enable and fault lines from the drive module to the signal generator via the axis plug-in interface located on the PCB.



11. Appendix

Sample Wiring Diagrams

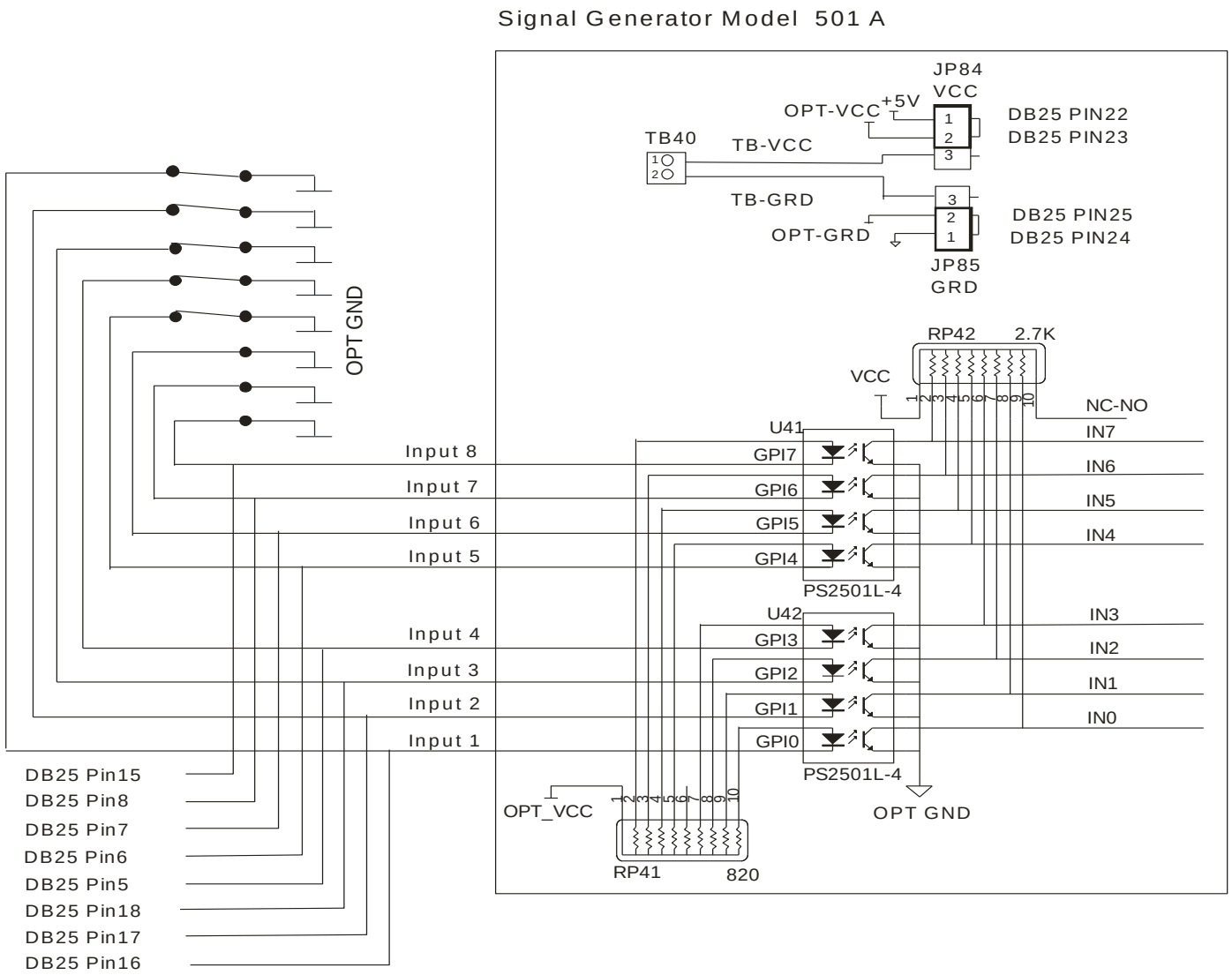
Typical Output Line Circuit



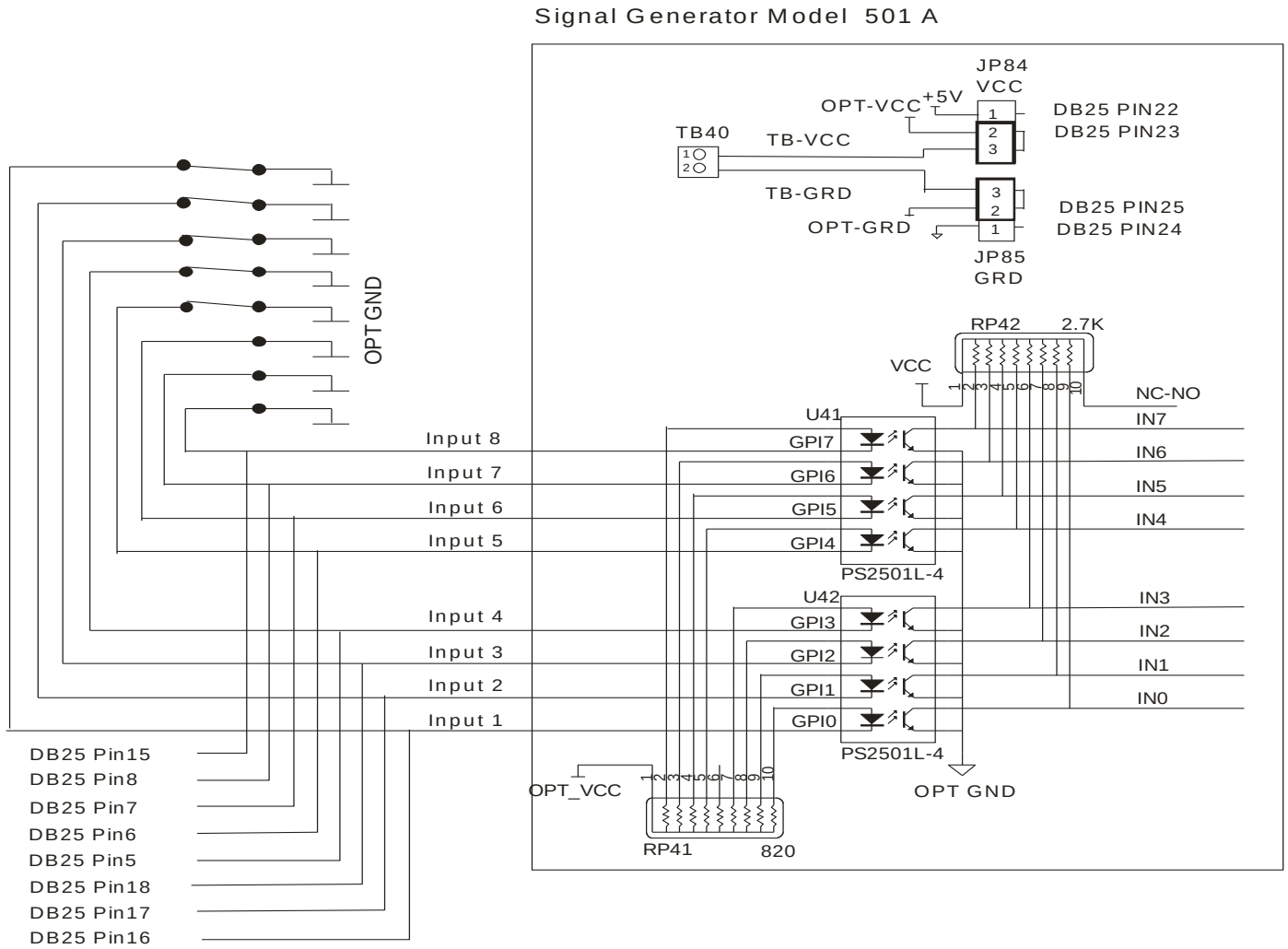
The above schematic shows a typical connection of one solid state relay controlled by output line 1 of the Signal Generator. A typical load would be a spindle, a vacuum, a laser, etc. In this example, the solid-state relay used is a Continental Industries model S505-0SJ610-000. It takes a 3 to 32VDC input and has an output of 24-330VAC.

Each of the output signals has a 22-ohm resistor in series with their outputs. This is to reduce any "ringing" at the transient switching points. Ground and 5V are provided on this connector for your convenience. The FlashCut Spindle On/Off Relay Box is wired as shown in the above schematic.

Typical Input Line Circuit – Internal Power



Typical Input Line Circuit – External Power

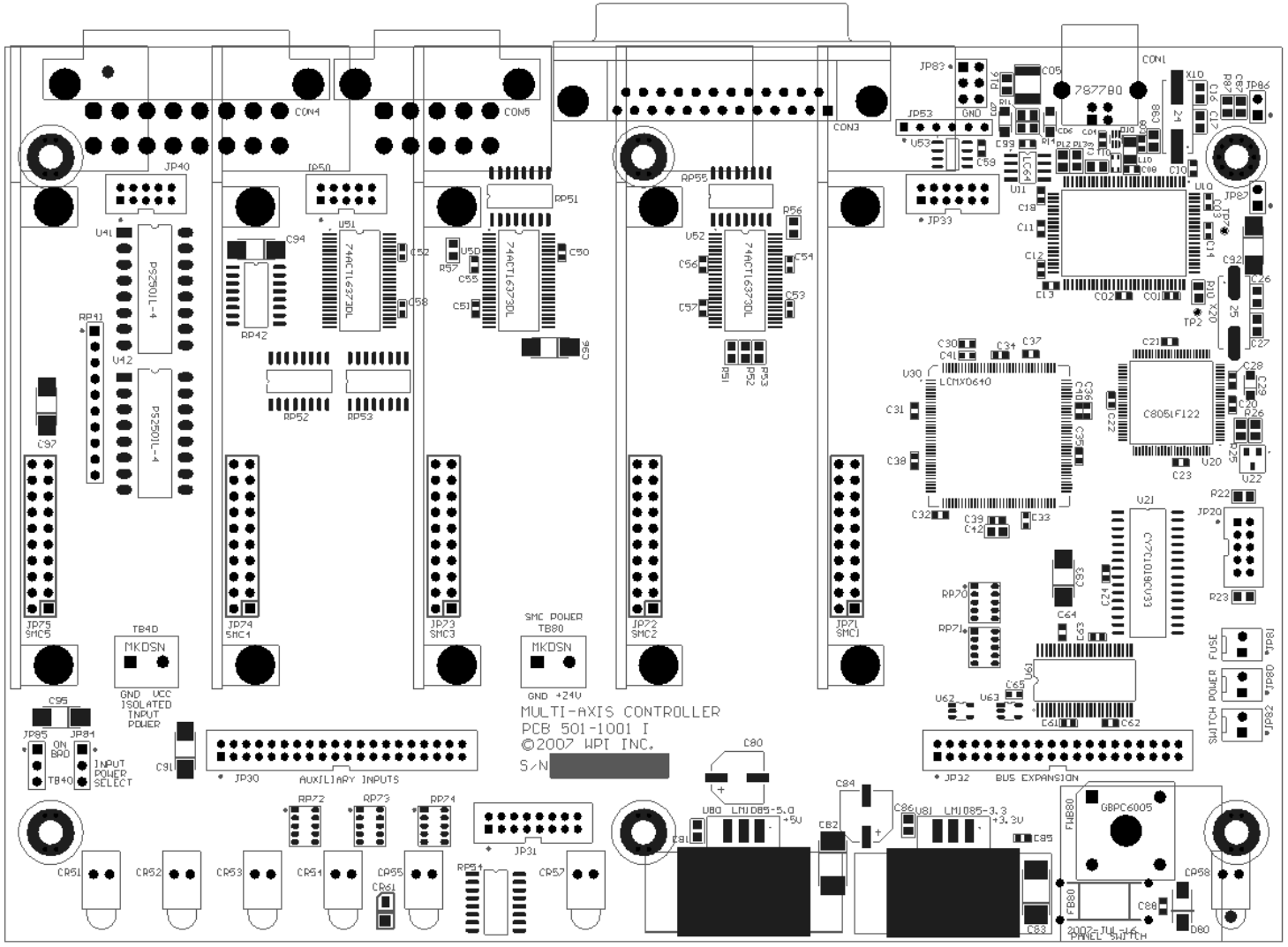


The above schematic shows a typical connection of 5 normally closed switches. These switches are connected between input lines 1-5 and ground. Lines 6-8 are connected directly to ground with jumper wires. All external connections shown are made through the Input connector on the back of the Signal Generator. This resistor pack (RP41) is socketed so that you can change the value if needed for your application.

The input lines are all optically isolated. In this example, JP84 and JP85 are shorted using the internal power to source the external side of the optical couplers. However, for the best isolation, JP84 and JP85 should be open, and power should be provided through pins 23 and 25 of the DB25 Motor Signal connector. Input lines 1-4 and 5- 8 are internally connected to pins 15-18 and 5-8 respectively of the DB25 Motor Signal connector.

Note that the FlashCut CNC limit switch kit has the same wiring as shown in this example.

Signal Generator Board Layout



Connector Pin-Out Table

EXTERNAL CONNECTORS (RED)

CON1: STANDARD USB TYPE-A

CON3 – DB25F

GPO1	1	14	ENA
GP02	2	15	GPI1
STEP5	3	16	GPI2
DIR5	4	17	GPI3
GPI5	5	18	GPI4
GPI6	6	19	DIR4
GPI7	7	20	DIR3
GPI8	8	21	DIR2
DIR1	9	22	VCC
STEP4	10	23	OPT-VCC
STEP3	11	24	GND
STEP2	12	25	OPT-GND
STEP1	13		SHIELD

CON4 - INPUTS

OPT-GND	1	9	GPI1
OPT-GND	2	10	GPI2
OPT-GND	3	11	GPI3
OPT-GND	4	12	GPI4
OPT-GND	5	13	GPI5
OPT-GND	6	14	GPI6
OPT-GND	7	15	GPI7
OPT-GND	8	16	GPI8

CON5 - OUTPUTS

GPO1	1	6	GPO2
GPO3	2	7	GPO4
GPO5	3	8	GPO6
GPO7	4	9	GPO8
VCC	5	10	GND

INTERNAL CONNECTORS (ORANGE)

PIN 1 OF ALL HEADERS IS INDICATED BY A SMALL WHITE DOT PRINTED ON THE PCB.

JP30 – AUXILIARY INPUTS

2 X 20 - 2MM SPACING

+3.3V	1	2	+3.3V
GPI32	3	4	GPI1
GPI31	5	6	GPI2
GPI30	7	8	GPI3
GPI29	9	10	GPI4
GPI28	11	12	GPI5
GPI27	13	14	GPI6
GPI26	15	16	GPI7
GPI25	17	18	GPI8
GND	19	20	GND
GPI24	21	22	GPI9
GPI23	23	24	GPI10
GPI22	25	26	GPI11
GPI21	27	28	GPI12
GPI20	29	30	GPI13
GPI19	31	32	GPI14
GPI18	33	34	GPI15
GPI17	35	36	GPI16
+3.3V	37	38	+3.3V
GND	39	40	GND

JP31 – STATUS LEDS

2 X 8 - 2MM SPACING

+5V	1	2	N/C
LED-DIR1	3	4	LED-STEP1
LED-DIR2	5	6	LED-STEP2
LED-DIR3	7	8	LED-STEP3
LED-DIR4	9	10	LED-STEP4
LED-DIR5	11	12	LED-STEP5
LED-AUX	13	14	LED-USB
GND	15	16	LED-PWR

INTERNAL CONNECTORS (ORANGE)

JP32 – BUS EXPANSION

2 X 20 - 2MM SPACING

+3.3V	1	2	GND
CS6	3	4	STATUS6
TXD2	5	6	FAULT6
RXD2	7	8	AUX1-STB
OUT-ENA	9	10	AUX2-STB
OUT2-STB	11	12	OUT1-STB
OUT4-STB	13	14	OUT3-STB
+5V	15	16	+5V
GND	17	18	GND
A0	19	20	A1
DATA1	21	22	DATA2
DATA3	23	24	DATA4
DATA8	25	26	DATA7
DATA6	27	28	DATA5
+7V	29	30	+7V
SPHOME	31	32	ENC CLK
+3.3V	33	34	ENC DIR
AGND	35	36	AV+
DAC2	37	38	DAC1
ADC1	39	40	AGND

JP33 – STEP & DIRECTION

2 X 6 - 2MM SPACING

STEP5	1	2	ENA
STEP4	3	4	DIR5
STEP3	5	6	DIR4
STEP2	7	8	DIR3
STEP1	9	10	DIR2
GND	11	12	DIR1

INTERNAL CONNECTORS (ORANGE)

JP40 – INPUT AUX HEADER

2 X 8 - 2MM SPACING

GPI1	1	2	OPT-GND
GPI2	3	4	OPT-GND
GPI3	5	6	OPT-GND
GPI4	7	8	OPT-GND
GPI5	9	10	OPT-GND
GPI6	11	12	OPT-GND
GPI7	13	14	OPT-GND
GPI8	15	16	OPT-GND

JP50 – OUTPUT AUX HEADER

2 X 5 - 2MM SPACING

GPO2	1	2	GPO1
GPO4	3	4	GPO3
GPO6	5	6	GPO5
GPO8	7	8	GPO7
GND	9	10	VCC

JP53 – OUT 1&2 LOW SIDE DRIVER

1 X 6 - 2MM SPACING

+5V VCC	1
CLAMP for GP02	2
GPO2 Low Side Driver	3
GPO1 Low Side Driver	4
CLAMP for GP01	5
LOGIC GND	6

JP80 - REAR PANEL POWER

JP81 - REAR PANEL FUSE

JP82 - FRONT PANEL SWITCH

CONFIGURATION JUMPERS (BLUE)

PIN 1 OF ALL JUMPERS IS INDICATED BY A SMALL WHITE DOT PRINTED ON THE PCB.

JP83: DB TO USB GROUND

ALWAYS LEAVE PIN 1 JUMPED TO PIN 2, PIN3 JUMPED TO PIN 4 AND PIN 5 JUMPED TO PIN 6 UNLESS DIRECTED OTHERWISE BY FLASHCUT TECH SUPPORT.

JP84/JP85: INPUT POWER SELECT

SHOULD BE JUMPERED THE SAME WAY…
1-2: INPUTS DRIVEN BY ON-BOARD VCC
2-3: INPUTS BIASED BY VOLTAGE ON TB40

JP86: USB GROUND

SHOULD BE JUMPED TO PULL USB GROUND TO CHASSIS GROUND

JP87: CHASSIS GROUND

SHOULD BE JUMPED TO PULL INTERNAL SIGNAL GROUND OF THE SIGNAL GENERATOR TO CHASSIS GROUND.

TERMINAL BLOCKS (GREEN)

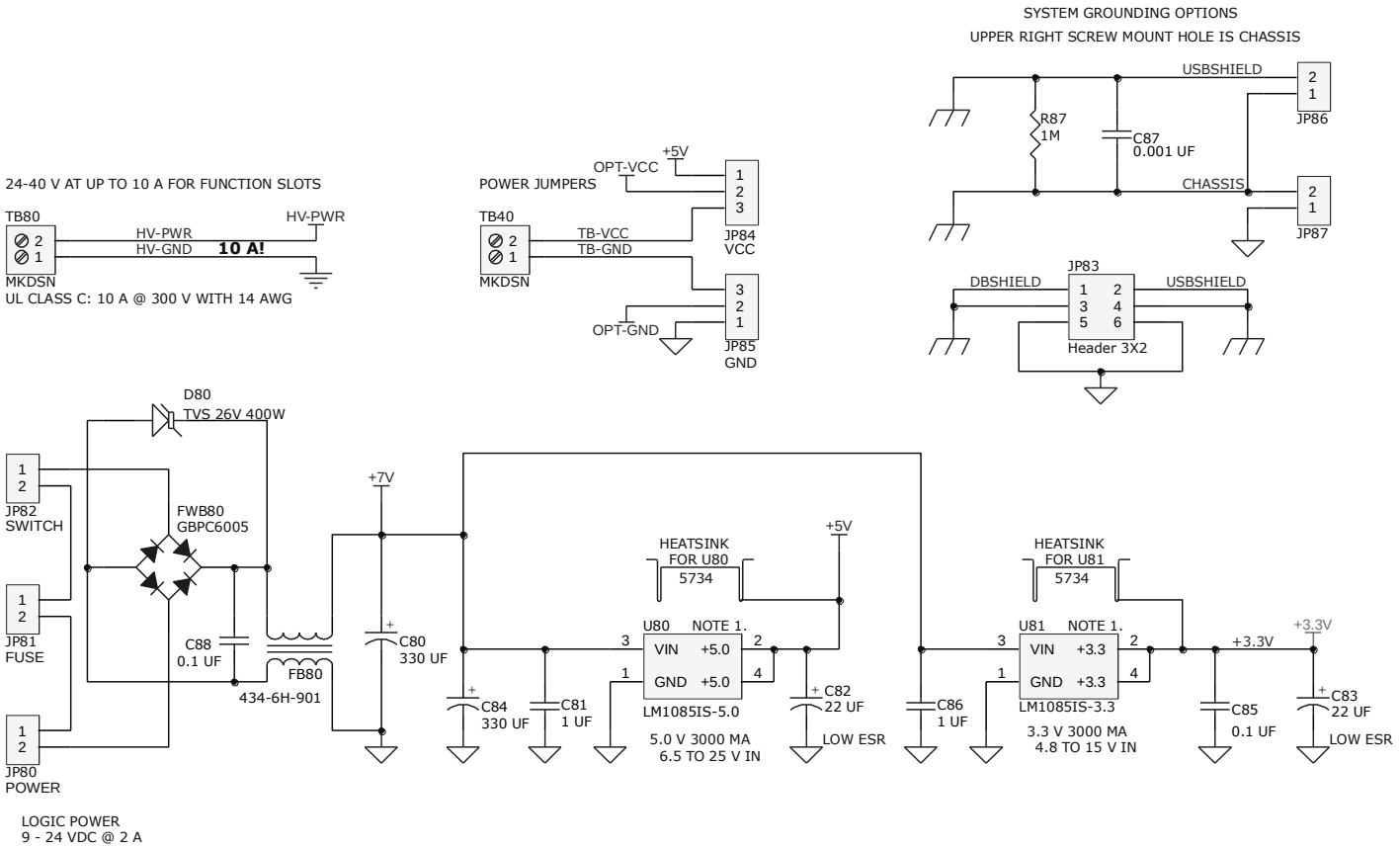
TB40: ISOLATED INPUT POWER

VOLTAGE APPLIED HERE BIASES INPUTS IF JP84/JP85 ARE SHORTED PINS 2-3; DO NOT
EXCEED 5V ON THIS TERMINAL UNLESS SPECIFICALLY ARRANGED WITH FLASHCUT TECH SUPPORT.

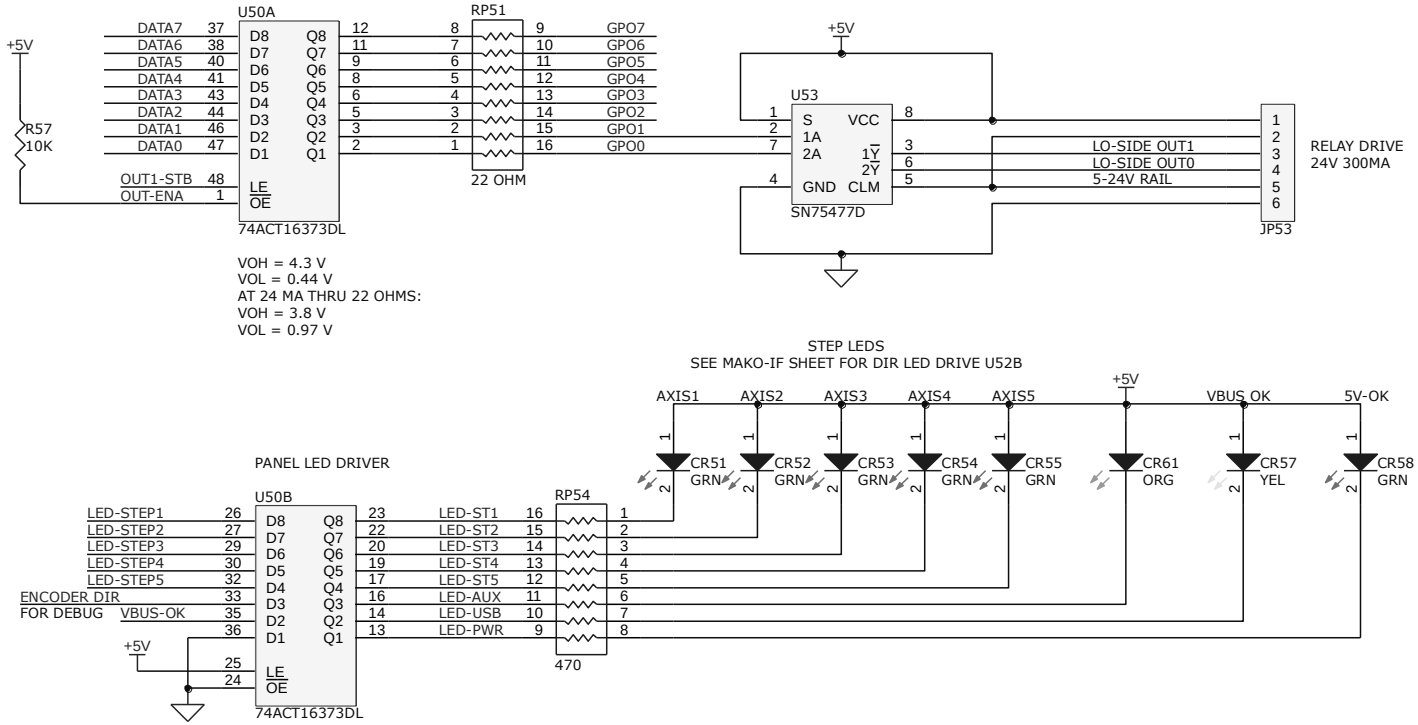
TB80: SMC POWER (24V)

APPLY 24 VDC HERE TO BIAS THE STEPPER MOTOR CONTROLLER BOARD(S) PLUGGED INTO SLOTS SMC1-SMC5

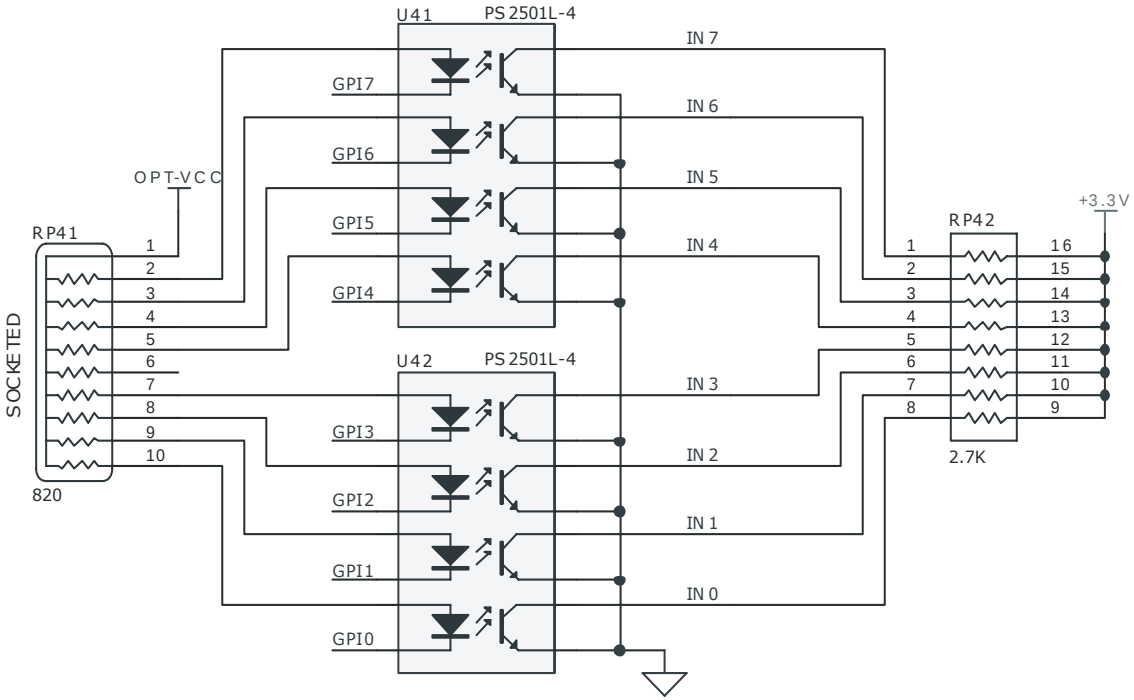
Power


SYSTEM GROUNDING OPTIONS
UPPER RIGHT SCREW MOUNT HOLE IS CHASSIS
USBSHIELD
JP86
R87
1M
C87
0.001 UF
CHASSIS
JP87
JP83
DBSHIELD
USBSHIELD
Header 3X2
24-40 V AT UP TO 10 A FOR FUNCTION SLOTS
TB80
HV-PWR
HV-GND
10 A!
MKDSN
UL CLASS C: 10 A @ 300 V WITH 14 AWG
POWER JUMPERS
+5V
OPT-VCC
TB40
TB-VCC
TB-GND
JP84
VCC
OPT-GND
JP85
GND
D80
TVS 26V 400W
JP82
SWITCH
FWB80
GBPC6005
JP81
FUSE
C88
0.1 UF
FB80
434-6H-901
C80
330 UF
+7V
JP80
POWER
LOGIC POWER
9 - 24 VDC @ 2 A
HEATSINK
FOR U80
5734
U80 NOTE 1.
VIN +5.0
GND +5.0
LM1085IS-5.0
5.0 V 3000 MA
6.5 TO 25 V IN
C84
330 UF
C81
1 UF
C82
22 UF
LOW ESR
HEATSINK
FOR U81
5734
U81 NOTE 1.
VIN +3.3
GND +3.3
LM1085IS-3.3
3.3 V 3000 MA
4.8 TO 15 V IN
C86
1 UF
C85
0.1 UF
C83
22 UF
LOW ESR
+3.3V

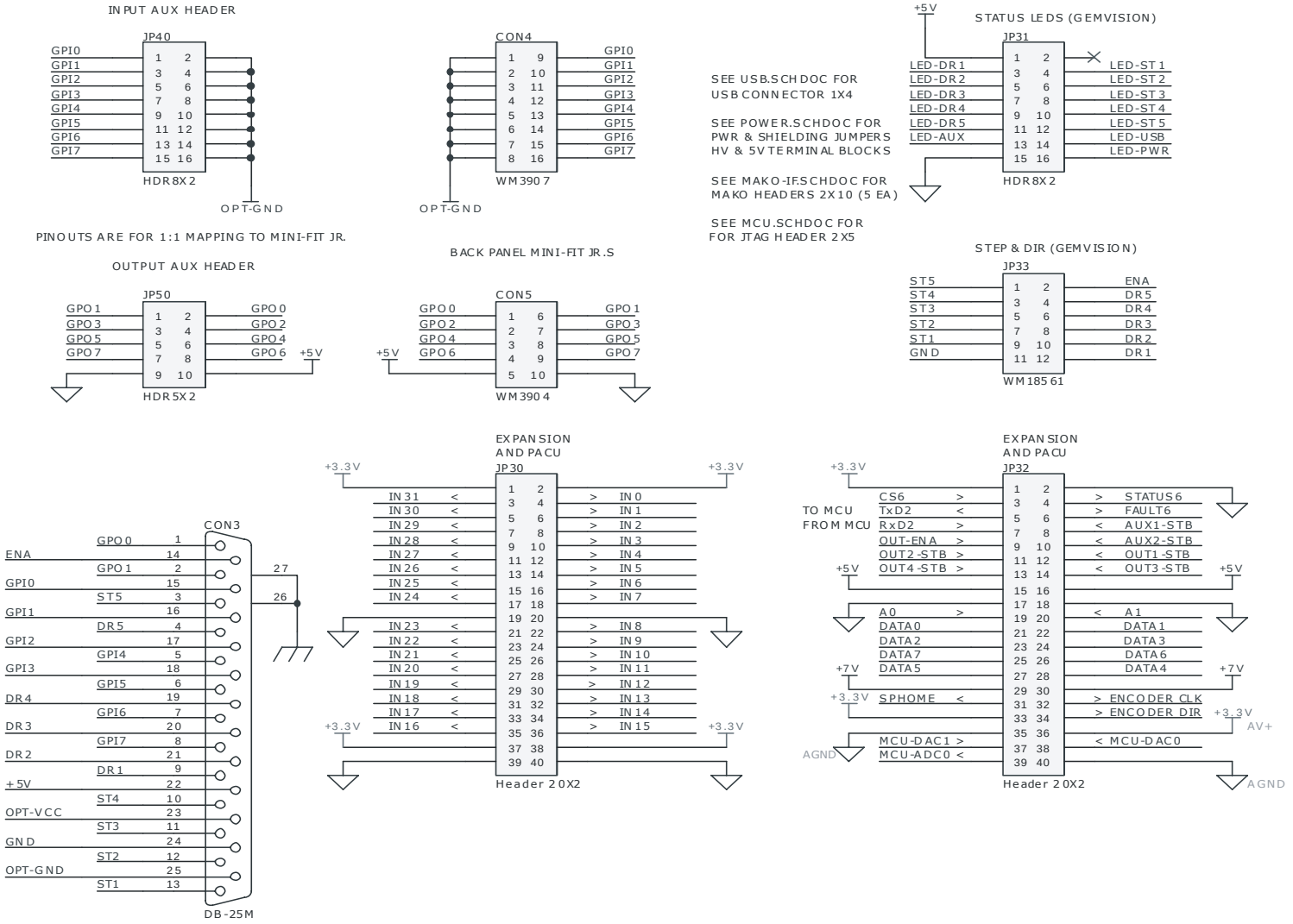
Outputs


U50A
RP51
+5V
R57
10K
DATA7 37
DATA6 38
DATA5 40
DATA4 41
DATA3 43
DATA2 44
DATA1 46
DATA0 47
OUT1-STB 48
OUT-ENA 1
D8 Q8
D7 Q7
D6 Q6
D5 Q5
D4 Q4
D3 Q3
D2 Q2
D1 Q1
LE
OE
74ACT16373DL
12 11 9 8 6 5 3 2
8 7 6 5 4 3 2 1
9 10 11 12 13 14 15 16
GPO7 GPO6 GPO5 GPO4 GPO3 GPO2 GPO1 GPO0
22 OHM
VOH = 4.3 V
VOL = 0.44 V
AT 24 MA THRU 22 OHMS:
VOH = 3.8 V
VOL = 0.97 V
+5V
U53
S VCC
1A
2A 1Y
2Y
GND CLM
SN75477D
1 2 7 4
8 3 6 5
LO-SIDE OUT1
LO-SIDE OUT0
5-24V RAIL
1 2 3 4 5 6
JP53
RELAY DRIVE
24V 300MA
STEP LEDS
SEE MAKO-IF SHEET FOR DIR LED DRIVE U52B
AXIS1 AXIS2 AXIS3 AXIS4 AXIS5 +5V VBUS OK 5V-OK
CR51 GRN
CR52 GRN
CR53 GRN
CR54 GRN
CR55 GRN
CR61 ORG
CR57 YEL
CR58 GRN
PANEL LED DRIVER
U50B
RP54
LED-STEP1 26
LED-STEP2 27
LED-STEP3 29
LED-STEP4 30
LED-STEP5 32
ENCODER DIR 33
FOR DEBUG VBUS-OK 35
36
+5V
25
24
LE
OE
74ACT16373DL
23 22 20 19 17 16 14 13
LED-ST1 16
LED-ST2 15
LED-ST3 14
LED-ST4 13
LED-ST5 12
LED-AUX 11
LED-USB 10
LED-PWR 9
1 2 3 4 5 6 7 8
470

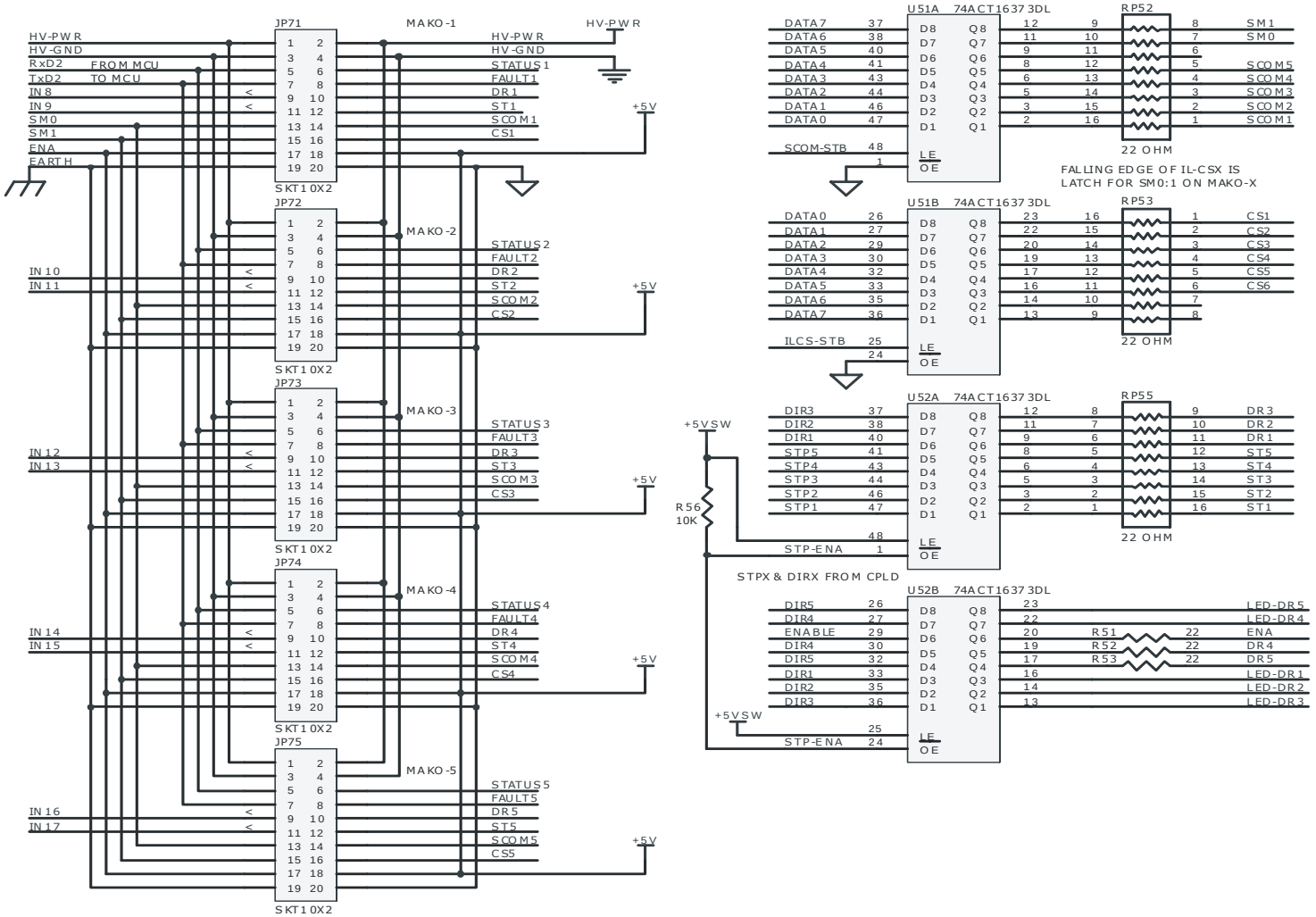
Inputs


U41
PS2501L-4
U42
PS2501L-4
GPI7
GPI6
GPI5
GPI4
GPI3
GPI2
GPI1
GPI0
IN 7
IN 6
IN 5
IN 4
IN 3
IN 2
IN 1
IN 0
OPT-VCC
+3.3V
RP41
SOCKETED
820
RP42
2.7K

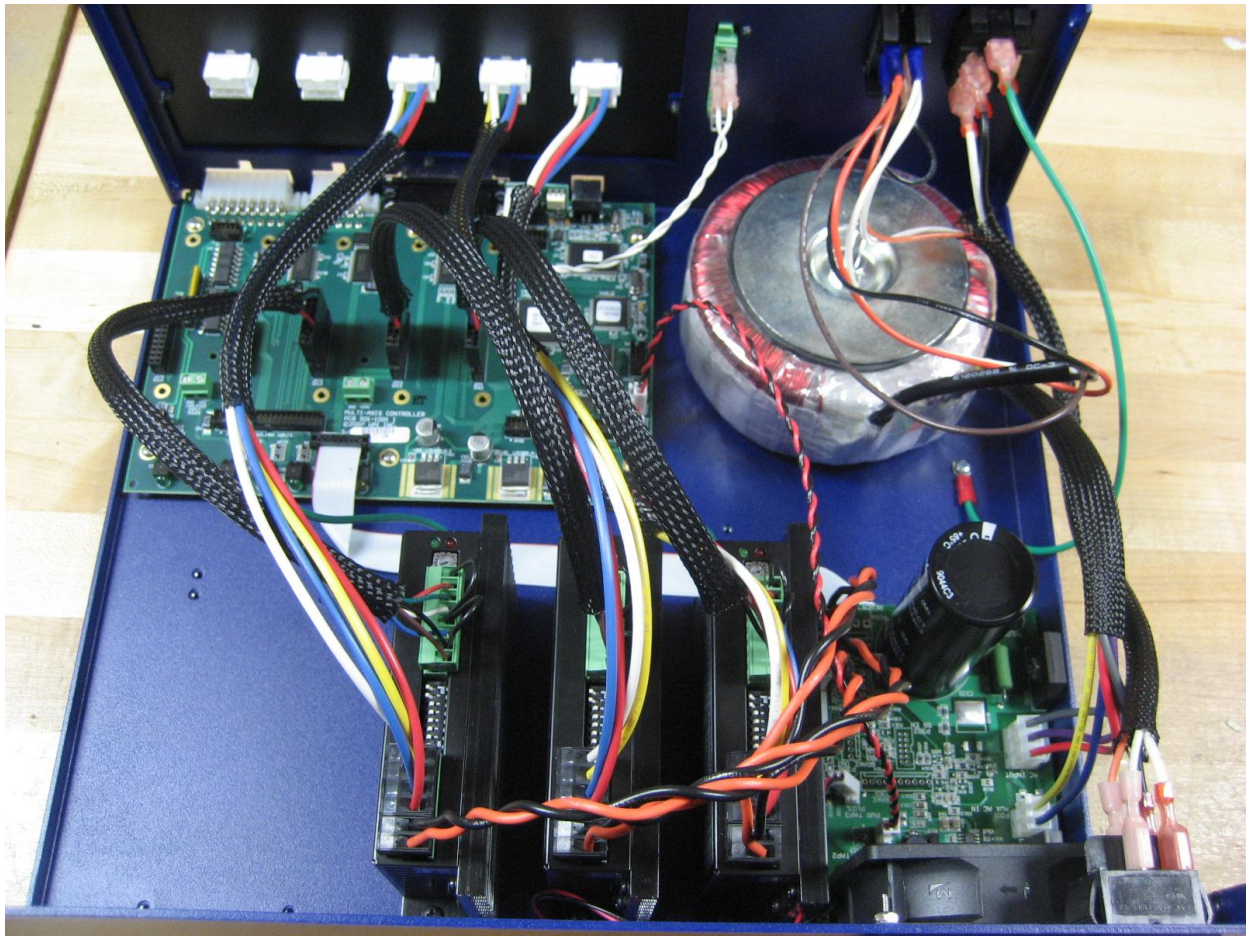
Connectors


INPUT AUX HEADER
JP40
GPI0
GPI1
GPI2
GPI3
GPI4
GPI5
GPI6
GPI7
1 2
3 4
5 6
7 8
9 10
11 12
13 14
15 16
HDR8X2
OPT-GND
CON4
1 9
2 10
3 11
4 12
5 13
6 14
7 15
8 16
WM3907
OPT-GND
PINOUTS ARE FOR 1:1 MAPPING TO MINI-FIT JR.
SEE USB.SCHDOC FOR
USB CONNECTOR 1X4
SEE POWER.SCHDOC FOR
PWR & SHIELDING JUMPERS
HV & 5V TERMINAL BLOCKS
SEE MAKO-IF.SCHDOC FOR
MAKO HEADERS 2X10 (5 EA)
SEE MCU.SCHDOC FOR
FOR JTAG HEADER 2X5
+5V
STATUS LEDS (GEMVISION)
JP31
LED-DR1
LED-DR2
LED-DR3
LED-DR4
LED-DR5
LED-AUX
LED-ST1
LED-ST2
LED-ST3
LED-ST4
LED-ST5
LED-USB
LED-PWR
HDR8X2
OUTPUT AUX HEADER
JP50
GPO1
GPO3
GPO5
GPO7
GPO0
GPO2
GPO4
GPO6
+5V
HDR5X2
BACK PANEL MINI-FIT JR.S
CON5
WM3904
STEP & DIR (GEMVISION)
JP33
ST5
ST4
ST3
ST2
ST1
GND
ENA
DR5
DR4
DR3
DR2
DR1
WM18561
EXPANSION
AND PACU
JP30
+3.3V
IN31 < > IN0
IN30 < > IN1
IN29 < > IN2
IN28 < > IN3
IN27 < > IN4
IN26 < > IN5
IN25 < > IN6
IN24 < > IN7
IN23 < > IN8
IN22 < > IN9
IN21 < > IN10
IN20 < > IN11
IN19 < > IN12
IN18 < > IN13
IN17 < > IN14
IN16 < > IN15
Header 20X2
CON3
ENA
GPI0
GPI1
GPI2
GPI3
DR4
DR3
DR2
+5V
OPT-VCC
GND
OPT-GND
GPO0
GPO1
ST5
DR5
GPI4
GPI5
GPI6
GPI7
ST4
ST3
ST2
ST1
27
26
DB-25M
EXPANSION
AND PACU
JP32
TO MCU
FROM MCU
CS6
TxD2
RxD2
OUT-ENA
OUT2-STB
OUT4-STB
A0
DATA0
DATA2
DATA7
DATA5
SPHOME
MCU-DAC1
MCU-ADC0
STATUS6
FAULT6
AUX1-STB
AUX2-STB
OUT1-STB
OUT3-STB
A1
DATA1
DATA3
DATA6
DATA4
ENCODER CLK
ENCODER DIR
MCU-DAC0
+7V
AV+
AGND
Header 20X2

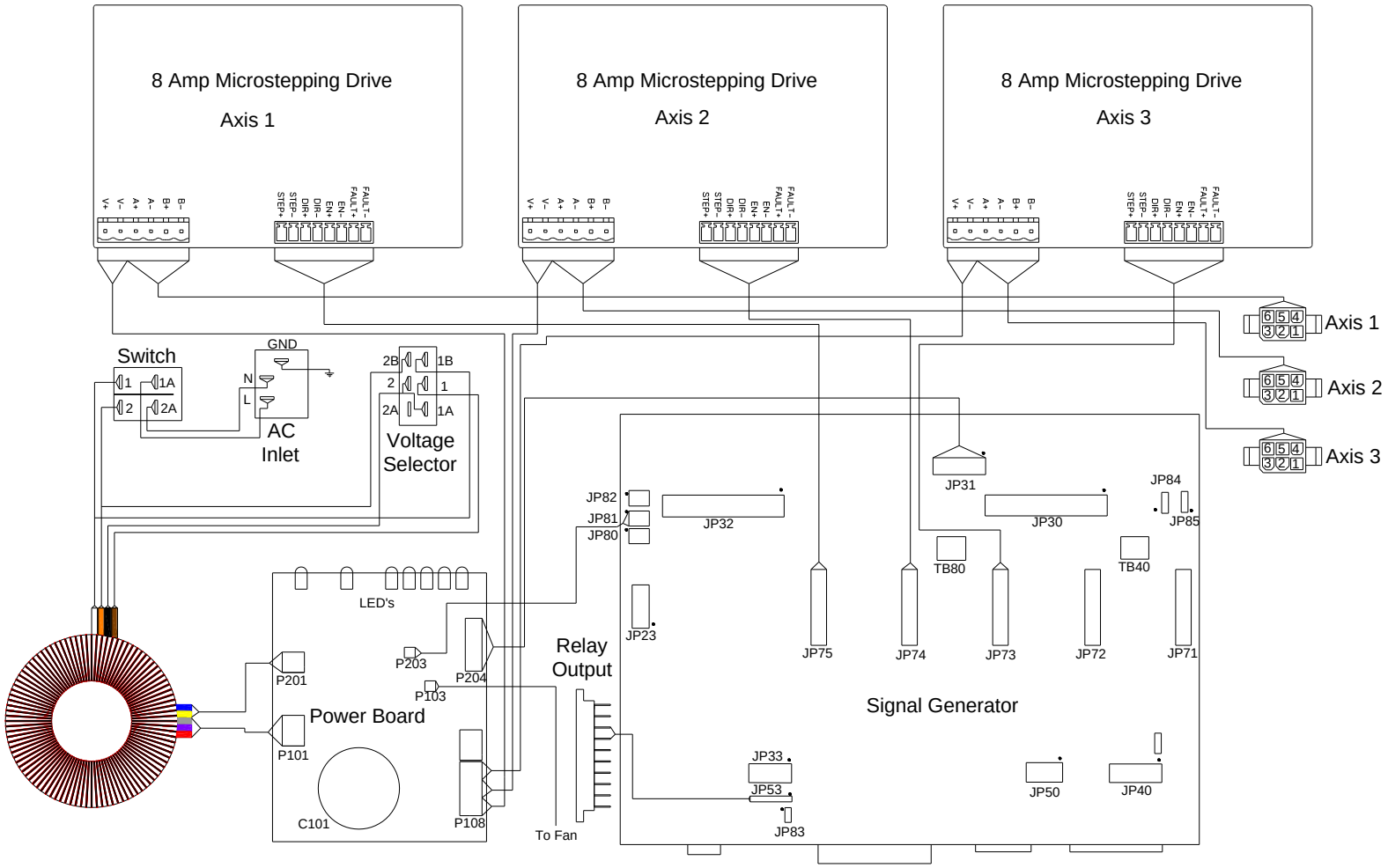
Axis Plug-In Interface



12. Internal Connections



Connection Schematic



Revision History

Revision	Date	Description of Revision
A	2/26/10	Initial write up
B	5/3/10	1st Edit
C	5/7/10	1st Revision
D	8/17/10	2nd Revision
E	11/03/10	3rd Revision
F	03/14/13	Motor Connector updates (XLR)