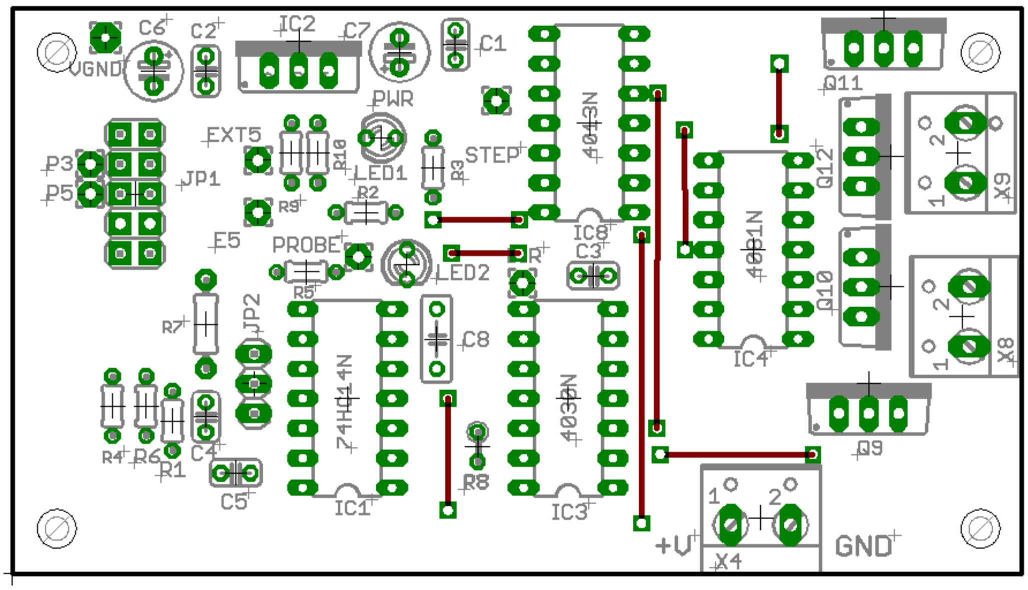
6/20/2006

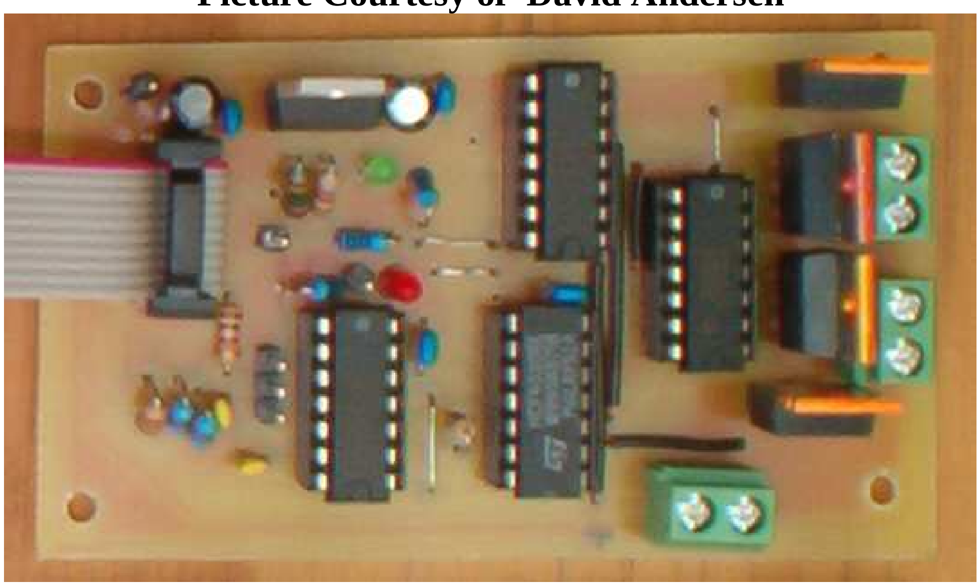
Unipolar Controller Board With Enable

Introduction

This is a simple unipolar stepper board that can control stepper motors rated to 45 VDC. The FET drivers are rated at 50A, but in practicality this board should not be used with motors anywhere near that current for several reasons. The power supply voltage, heat sinks and cooling used for the FET's of your own application play an extremely important part in making that determination. The FET package is designed for 50 Watts of dissipative power. If you're not wise in electronics, the board should be built in stages and tested during each stage to eliminate problems.

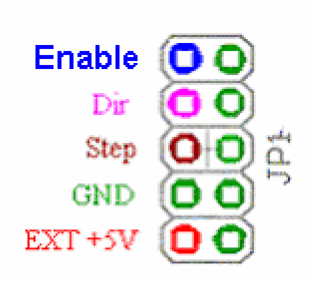


Picture Courtesy of David Andersen



JP1 Inputs

Same orientation as the board layout above.



Using the onboard 5.5VDC

By installing IC2 (LM317HV 5VDC on board regulator) an external DC supply form 8VDC to 45VDC can be used. That power supply is connected via the X4 Wago connector. Observe polarity when connecting.

Using the board

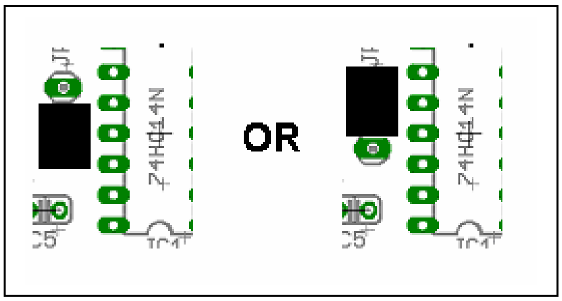
The board was designed with a high noise immunity environment in mind. Switching heavy currents and inductive loads are prone to noise. For that very reason, IC1 is utilized to provide excellent noise rejection. There are two options for IC1. Either a 40106 or 74HC14 Schmitt Trigger Inverter can be installed. The 40106 is older slower technology is preferred for the best noise immunity, but can't be relied to be driven directly by a PC's parallel port. If driving from a PC parallel port with no active conditioning logic, a 74HC14 must be used.

Current Limiting Resistors (IMPORTANT)

Anytime a power supply for the stepper motor is used that is greater than the rated voltage of the motor, current limiting resistors are required. This board does not contain room for them on the board, as they can be quite large sometimes. The coil resistance of the motor can be computed by dividing the rated voltage by the rated current. For example a motor rated at 5.2 volts @ 1.6 A (5.2/1.6) has a coil resistance of 3.25 ohms. To compute the size of the current limiting resistor subtract the motor voltage rating from the power supply voltage and divide it by the current rating. For example using a 12v power supply with the above motor (12-5.2/1.6),
You would need a 4.25 ohm resistor. The wattage rating of that resistor is the current squared times the resistor value (1.6 * 1.6 *4.25) or in this case 10.88 watts minimum. Power resistors come in standard wattage ratings or 1, 5, 10, 25, 50 watts.

Setting the Step Direction

A jumper must be installed in the Direction jumper. JP2 Pin 2 must be jumper to either pin 3 or pin 1, depending on your hardware setup. Leaving this jumper off, will not allow the motor to switch rotation directions, and give intermittent direction information if not installed.



Optional Logic Probe

Many times getting a board running a simple logic probe that visually gives an indication of a high or low logic state is helpful. Components R5, R2, R4, Q1, and LED2 make up the logic probe along with a spare gate from IC1. By installing a wire in the probe pad to use as a test lead with those components installed the LED will illuminate when the test lead is left open or connected to a logic hi, it will not illuminate when touched to a logic low. One you are finished with the logic probe, wire the probe input to gnd to keep the LED off.

Simple Initial Checkout

After build verify your circuit is working correctly prior to hooking up the stepper motor. Start by only hooking up a DC power source between 8VDC and 30VDC to the X4 terminal. A simple 9-volt alkaline cell will work for checkout. Applying power both LED's should illuminate.

If you have a means of measuring DC voltages, measure from ground VGND pad to the E5 pad for 5VDC. It should be within the range of 5.3 to 5.8 VDC.

Measure the following points for voltages:
IC1 Pin 7 should be 0 volts, Pin 14 should be the same voltage as the E5 pad.
IC3 Pin 7 should be 0 volts, Pin 14 should be the same voltage as the E5 pad.
IC4 Pin 7 should be 0 volts, Pin 14 should be the same voltage as the E5 pad.
IC8 Pin 7 should be 0 volts, Pin 14 should be the same voltage as the E5 pad.

Utilize the onboard logic probe by soldering one end of a short (4 to 8 inches) wire to the probe pad. Strip the other end so it exposes a short amount of wire. That end will be used to probe (touch) parts of the board to verify logic states.

With the board connected to nothing but the power supply, and the direction jumper between pins 2 and 3 of that jumper, using the probe, IC1 pins should give you the following indications:
Pin 1 ON, Pin 2 OFF, Pin 3 ON, Pin 4 OFF, Pin 5 OFF, Pin 6 ON, Pin 7 OFF (GND),
Pin 10 ON, Pin 11 Off, Pin 12 Off, Pin 13 ON
Next IC2 pins should give you the following indications:
Pin 8 ON,
Pin 2 ON
Next IC8 pins should give you the following indications:
Pin 11 ON,
Pin 3 ON

Using a jumper wire, connect JP1 pin 3 to Gnd, Probe IC1
Pin 13 Off,
Pin 12 On,
Pin 11 ON,
Pin 10 Off
Next IC2 pins should give you the following indications:
Pin 8 Off,
Pin 2 Off

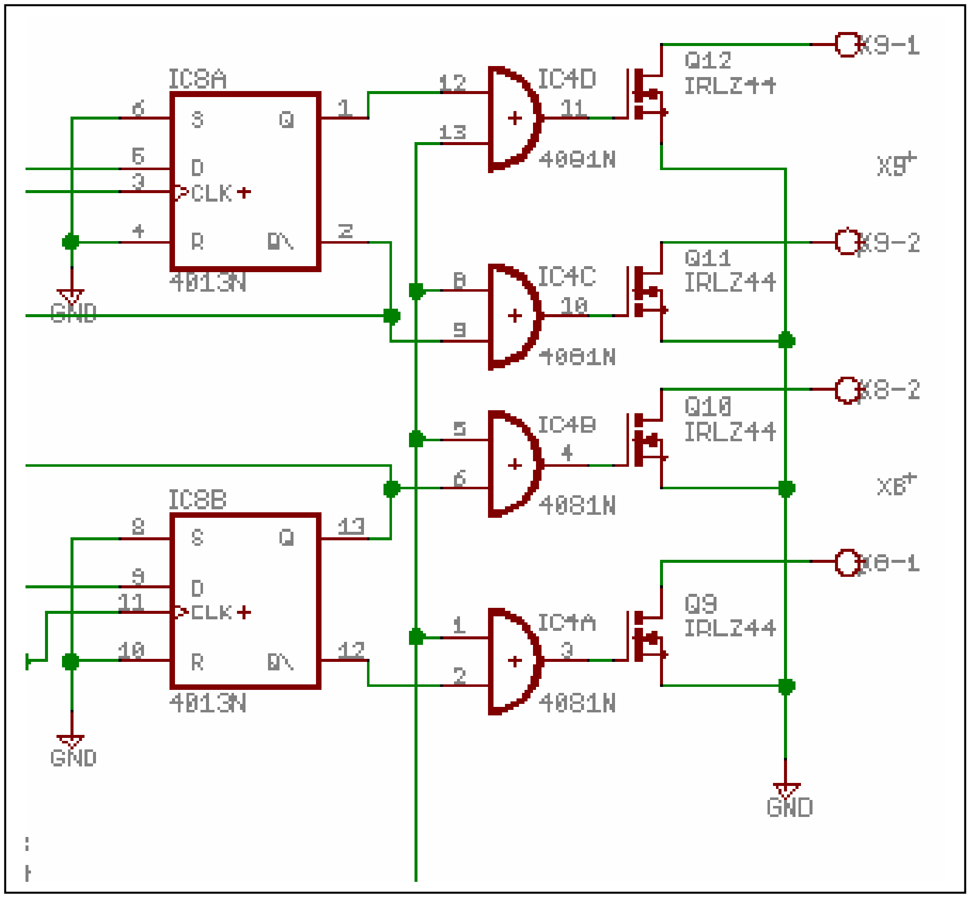
Using a jumper wire, connect JP1 pin 5 to Gnd, Probe IC1
Pin 1 Off,
Pin 2 On,
Pin 5 ON,
Pin 6 Off
Next IC8 pins should give you the following indications:
Pin 11 Off,
Pin 3 Off

Next the outputs of the 4013N (IC8) should be in opposites states. If pin 1 is off, pin 2 should be on, or if pin 1 is on pin 2 should be off. If pin 12 is off pin 13 should be on, or if pin 12 is on pin 13 should be off.

Next is to check the enable signal. IC4 is a four gate “and” gate. The way an and gate works is it that both input to be a logic high to get a logic hi out. To turn a FET on the output of the associate “and” gate has to be high. You can see, one input on each of the and gates is wired together to the output of the one inverter IC1B pin 4. When IC1B pin 4 is a logic high, each of the 4 outputs coming from the flip flops of IC8 will be passed to the output of the and gate. I.e. if the output of pin 1 of IC8 is high, then pin 12 of IC4 is high and with pin 13 high, pin 11 of IC4 will be high and Q 12 will turn on, effectively connecting K9-1 to ground. If the output of pin 1 of IC8 is low, pin 12 of IC4 is high and with pin 13 low, pin 11 of IC4 will be low and Q 12 will turn off, effectively making K9-1 open (no current flow).

A method to simply determine if the fets are switching appropriately is to take a resistor, value is not important but would advise no lower than 100 ohms no higher than 1K initially. By hooking one end of the resistor to the 5 VDC logic power (pad E5 on the pcb layout) and the other end to the FET motor connection, you can use the logic probe to determine if the FET is switching under a minimal load. Pin 1 (enable) of JP1 must be jumpered to ground for this test. If pin one s not jumpered to ground all the FETs should be in the off state. In the example below if pin 1 of IC8 is a logic high, the X9-1 terminal should indicate a logic 0 with the resistor hooked up. If pin 1 is a logic low then X9-1 should be a logic high. That can test can be repeated as below

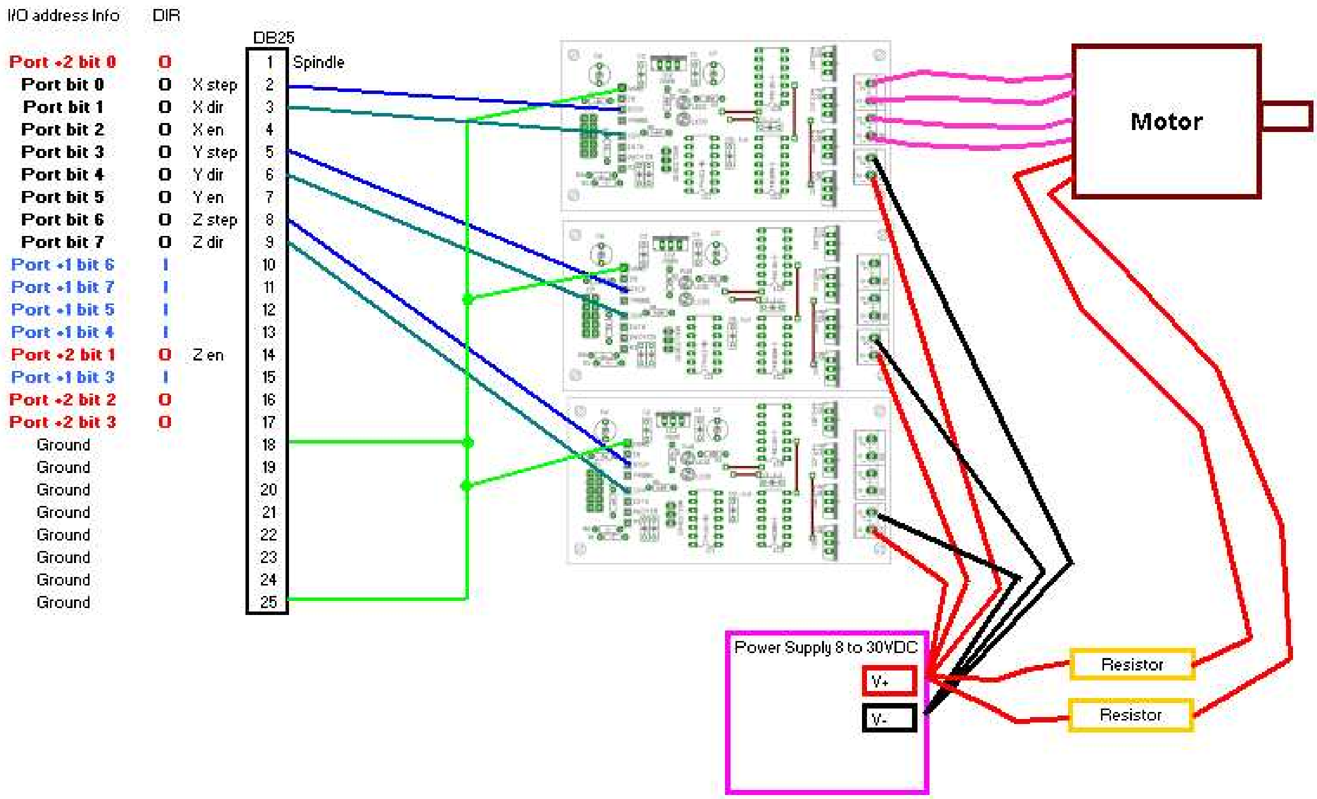
IC8 Pin	Output		
1	Low	X9-1	High
1	High	X9-1	Low
2	Low	X9-2	High
2	High	X9-2	Low
13	Low	X8-2	High
13	High	X8-2	Low
12	Low	X8-1	High
12	High	X8-1	Low



Wiring the board

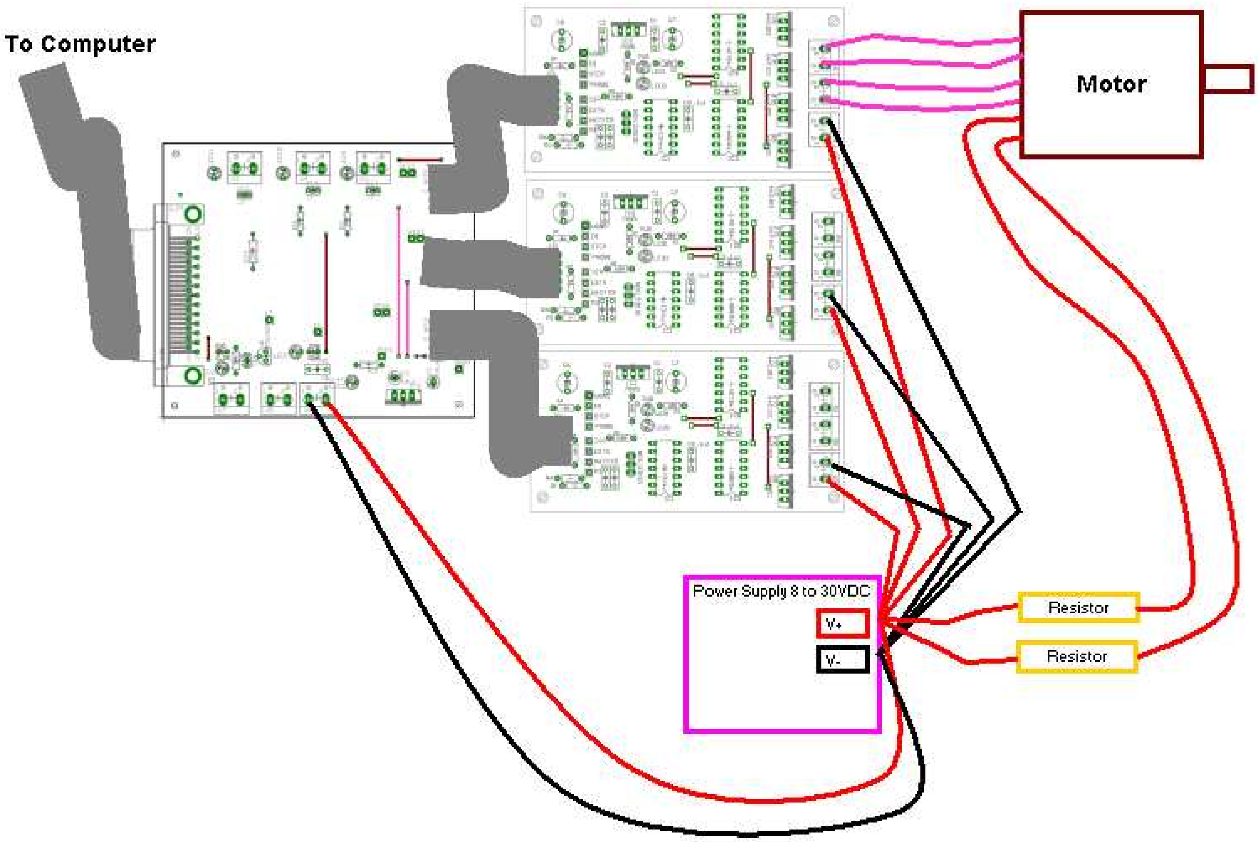
A unipolar stepping motor also requires a connection to a power supply, and depending on rating of the motor and the voltage of the power supply, sometimes current limiting resistors are required. These are often referred as "ballast" resistors. These current limiting resistors and power supply connection are not installed on this board.

Hard wiring a simple 3 axis system

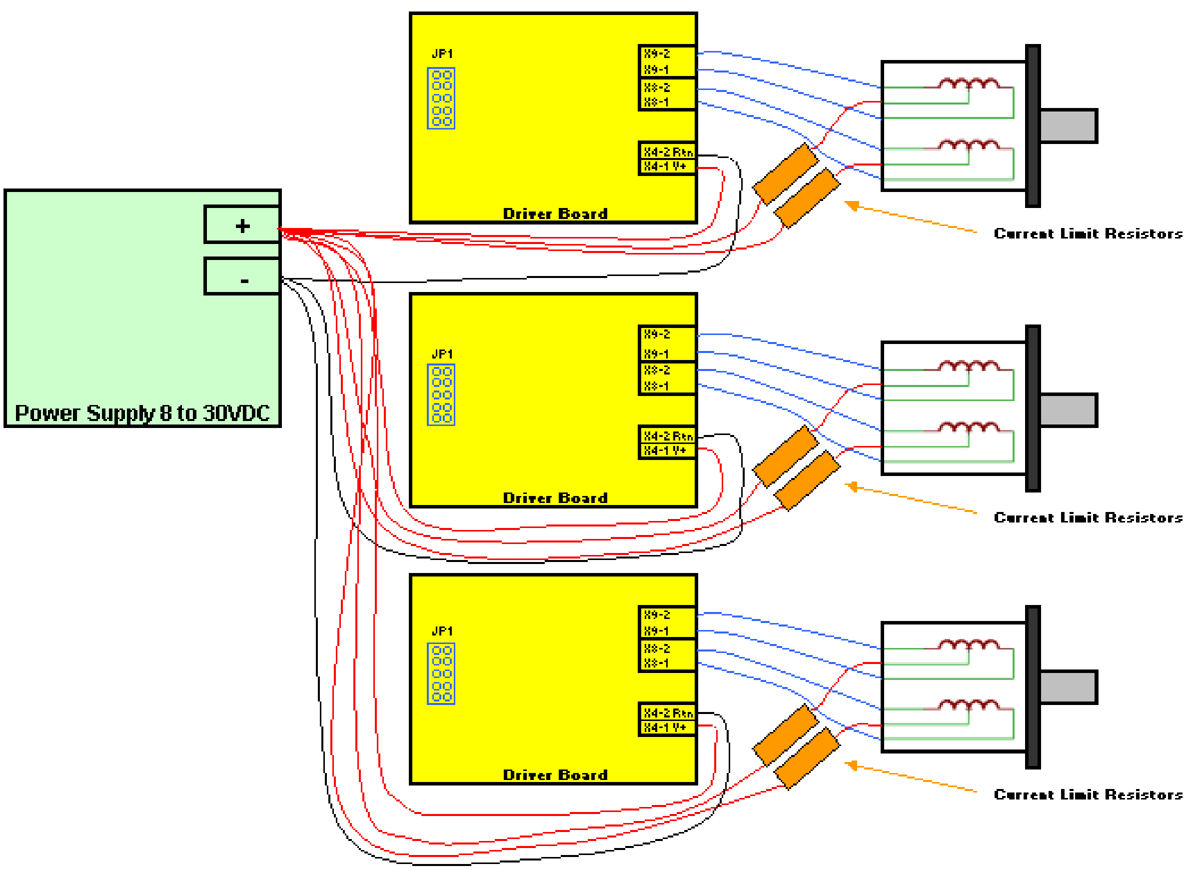


Only one Motor hookup is shown for clarity. The other two axis are wired the same as the one illustrated With the exception it would wire to the associate second and third driver boards. As depicted above the power supply wiring is done with the power supply as the common point. In other words there are three wires on each of the positive and negative terminals each wire running independently to the associated driver board. Wiring in this method helps to eliminate potential problems that can manifest it wired sequentially. When wiring the electronics to control your motors, the wires should be neatly routed and separated. By this I mean the wiring from the X axis driver to the x axis motor should not be routed with any other wiring. Same for Y and Z axis's. Board power wiring should be routed independently of all motor wiring. Computer signal wire routing should be independent of power and motor wiring. Physical placement of the wire

Wiring a 3 axis system with the compatible BOB



Motor Wiring 3 Axis

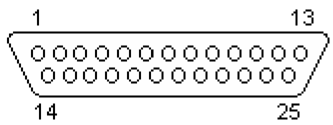


Parts

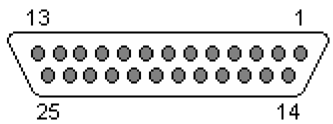
Qty	Value	Device	Parts
1	JP1	PINHD-2X5	JP1
3	.1uf		C1, C2, C3, C8
2	1k		R4, R7
1	2.2K		R5
3	10K		R1, R6, R8
2	10uf	CPOL-USE2.5-5	C6, C7
1	74HC14N	DIP	IC1
1	220K		R11
2	220pf		C4, C5
1	240		R9
2	270		R2, R3
1	820		R10
1	4013N	DIP	IC8
1	4030N	DIP	IC3
1	4081N	DIP	IC4
4	IRLZ44	IRF512	Q9, Q10, Q11, Q12
1	JP2	PINHD-1X3	JP2
1	LM317HV	LM317TS	IC2
2	PWR	LED3MM	LED1, LED2
3	X4	W237-02P	X4, X8, X9

PC Parallel Port

The DB25 subminiature D connector has been a defacto standard from original IBM PC for the parallel port historically used for a printer interface.

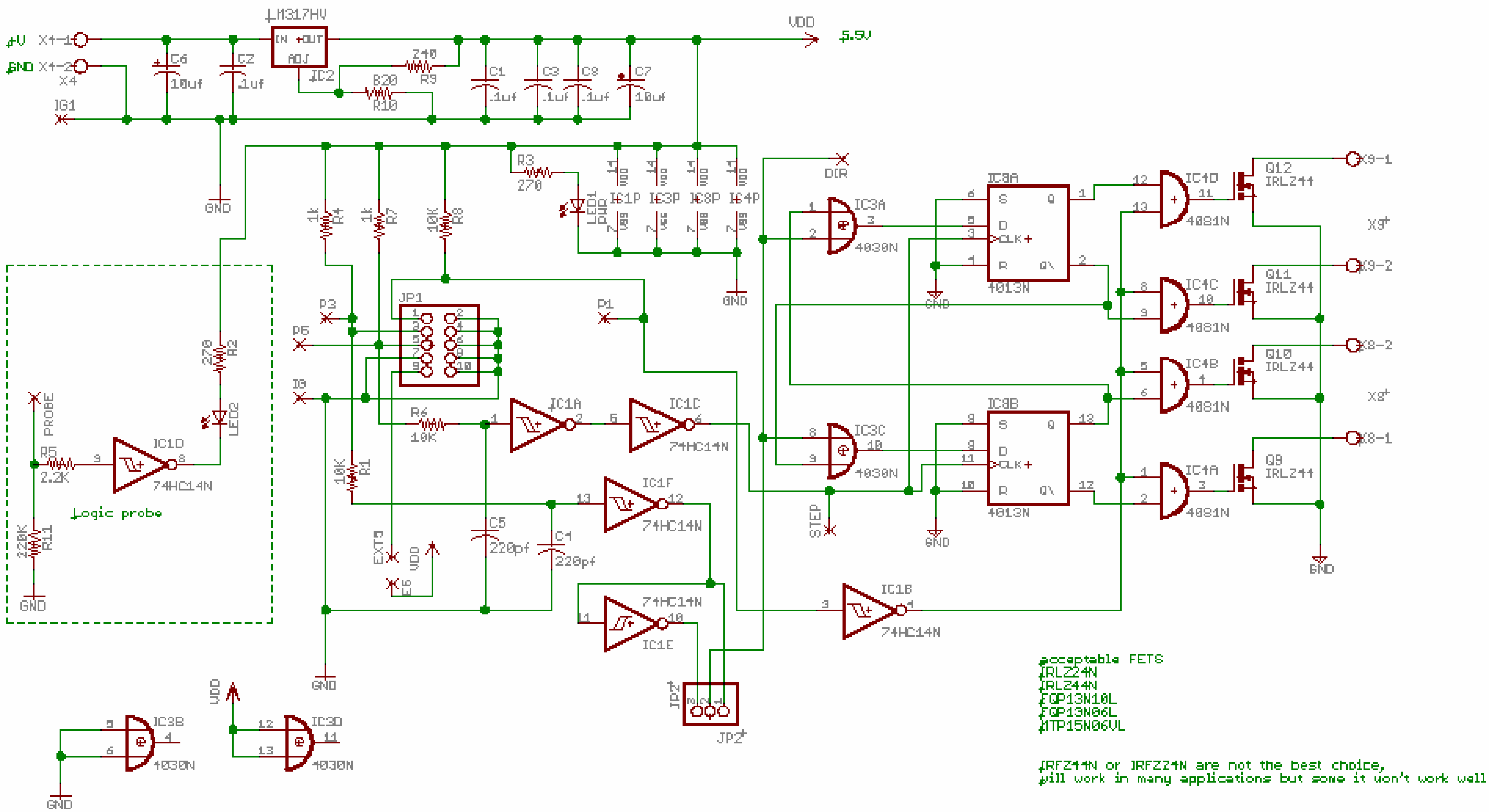


DB-25 Male



DB-25 Female

Many breakout boards utilize a DB-25 Female connector.


+V X4-1
GND X4-2
X4
JG1
LM317HV
IN +OUT
ADJ
IC2
240
R9
820
R10
C6
10uf
C2
.1uf
C1
.1uf
C3
.1uf
C8
.1uf
C7
10uf
VDD
5.5V
GND
R3
270
LED1
PWR
IC1P
IC3P
IC8P
IC4P
VDD
VSS
1k
R4
1k
R7
10K
R8
JP1
P3
P5
P1
I0
R6
10K
IC1A
IC1C
74HC14N
IC1F
IC1E
IC1B
R1
10K
C5
220pf
C4
220pf
EXT5
E6
VDD
JP2
DIR
STEP
IC3A
4030N
IC3C
IC3B
IC3D
IC8A
IC8B
S
D
CLK
R
Q
Q\
4013N
IC4D
IC4C
IC4B
IC4A
4081N
Q12
Q11
Q10
Q9
IRLZ44
X9-1
X9-2
X9
X8-2
X8-1
X8
PROBE
R5
2.2K
IC1D
R2
270
LED2
R11
220K
Logic probe
acceptable FETS
IRLZ24N
IRLZ44N
FQP13N10L
FQP13N06L
MTP15N06VL
IRFZ44N or IRFZZ4N are not the best choice,
will work in many applications but some it won't work well