Assembling the Printed Circuit Boards for the LabPro Robot

Each board will be controlled by one of the two DIG/SONIC ports on the LabPro. Each port can then operate a stepper motor, plus either a servo motor or a 12-V output.

Step 1 -- Orientation to the Printed Circuit Board

Look at the printed circuit board (PCB) and be sure you understand how it should be oriented. Most of the components will be placed on top of the board while it is oriented as shown. This is the side of the board which will face downward, under the robot platform. The last component you will solder--the LED--will be fastened on the opposite side of the board, so it will show through the robot platform as a power-on indicator.

Step 2 -- Identify the Components

Identify each component listed below, and lay them out where you can keep track of them. The letters indicate the recommended order of assembly.

Order	Component	#
A	Circuit Board	1
B	Resistor, 10 kohm, 1/8 W, 5%, Carbon Film	1
C	Resistor, 220 ohm, 1/4 W, 5%, Carbon Film	1
D	Diode, 1N4001	1
E	Sockets, DIP 14 pin	2
F	Socket, DIP 16 pin	1
G	Terminal Blocks, 2 position	3
H	Terminal Block, 6 position	1
I	Fuse, Resettable, 1.1A	1
J	Fuse, Resettable, 0.30A	1
K	Header, right angle, 3 Pos	1
L	Modular Jack, 6P6C, side entry with stops	1
M	Voltage Regulator, 7805	1
N	LED, green, 0.5"	1
O	IC, 74HC08, Quad "AND" gate	1
P	IC, 74HC04, Hex Inverter	1
Q	IC, ULN2003A, Darlington Array	1
R	Standoff and Screw	4

Step 3 -- Add Resistors and Diode

- Be sure that you and all the people near you are wearing eye protection.
- Be very alert to the fact that the soldering iron is hot.

Insert the small 10-kohm (brown, black, orange) resistor from the top of the PCB in the designated location, and solder it into place. Repeat with the 220-ohm (red, red, brown) resistor. Also solder the diode into place BEING VERY CAREFUL TO ORIENT IT CORRECTLY WITH THE SILVER BAND TO THE RIGHT.

Step 4 -- Put in the Sockets

Carefully align the 3 sockets as shown on the board. The notches on the two 14-pin sockets should go to the left, and the notch on the 16-pin socket should go up. Solder all of the pins on the sockets, being careful to avoid solder bridges (where solder provides a path from one pin to the next) and cold solder joints (where the solder fails to stick to either the pin or the pad).

Be sure to give your soldering a visual inspection before you go on. Use desoldering braid or another desoldering tool to remove any solder bridges and use more solder to redo any cold joints.

Step 5 – Add the Terminal Blocks

Carefully align the 3 2-position terminal blocks and the 1 6-position block, being careful to keep the openings towards the outside of the board. Solder them into place.

Step 6 – Fuses and Servo-Motor Header

Solder the 2 fuses and the 3-pin header into place, as shown.

Step 7 -- Add the Phone Jack and the Voltage Regulator

Very carefully insert the 6 terminal wires of the phone jack into the board, and then snap the plastic holders into place. Be careful as you solder to avoid "solder bridges."

Insert the voltage regulator. It must be oriented with the printing toward the front and the metal heat sink toward the back. Once you have soldered the voltage regulator into place, trim off the excess leads and bend the voltage regulator backwards to about a 45° angle.

Step 9 -- LED

Turn the board over. The last soldered component should be attached on the opposite side. Insert the LED, being careful to keep its negative terminal (the shorter wire, and the flat or notched side of the LED itself) on the side away from the 220-ohm resistor. Solder the two leads from the top of the board and trim them.

Step 10 -- Insert the Integrated Circuits

Insert the 3 integrated circuits as shown. Location and orientation are important, and it's also very important that you not bend any of the pins as you put them in.

The top left IC is a 7408 AND gate, which combines multiple signals from the CBL to turn on the correct lines to the stepper motor.

The lower left IC is a 7404 INVERTER, needed to convert some signals from high to low before they go to the AND gate.

The right, vertical IC is the ULN2003A, the workhorse of the circuit. It takes the weak information from the rest of the system and uses it to control the much stronger currents that operate the motor.

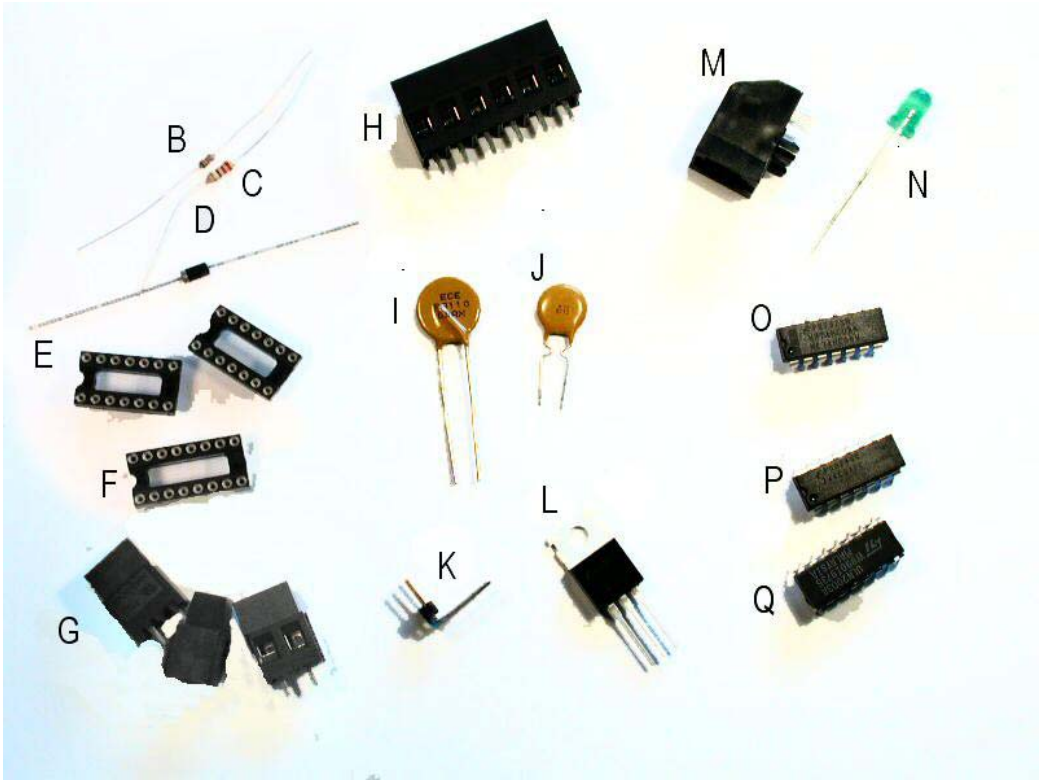
Be sure the notch on each IC matches the notch on its socket. Also be sure you get all of the pins started before you "seat" each IC by pushing it firmly into the socket.

Step 11 – Standoffs

Four nylon standoffs must be attached to the bottom of the PC board (on the same side as the LED). Later, you will turn the PCB over and use these standoffs to hold it in place beneath the robot platform. The standoffs should be snug, but don't over tighten the screws or you may strip the threads.

Step 12 – Testing the Board

- Apply 14 to 15 V DC at the power input terminals. The LED should light and the current input should be about 60 mA. Turn off the power.
- If necessary, load the appropriate POINTER program group into your calculator. Connect your calculator to the LabPro and connect the interface to your board. Run the program DCUINIT to verify that the calculator and LabPro are connected properly. If the batteries in the LabPro have not been changed recently, consider replacing them or using the DC adapter.
- Attach a servo motor to the servo header, with the black ground wire to the right. Turn the power back on to the board and use the POIPUT (*Pointer Put*) program to verify that the servo responds. Before running each program, you must store an angle in degrees (between -90 and +90) as the variable “A” (for example, 45→A) and then run the program. After the motor moves to position A, it should remain in or close to the same position, until you change the value for “A” and run the program again.
- Use the POISWF (*Pointer Switch For*) program and a buzzer, laser pointer or another 12-V device to verify that the programmable switch is functioning properly. Before running the program, you must store a time (in seconds) to the variable “T” (for example, 3→T). The programmable switch will then provide about 12 V for the time specified. Turn off the power and disconnect the device motor after the test.
- Attach the 6 wires of a stepper motor. The two bicolored wires must be attached to the top terminals, both marked “+.” (It doesn’t matter which one goes in which of the two “+” terminals.”) To work on the left side of the robot, the wires below the positive terminals should be connected in the sequence red, blue, black and white. Store a value such as 40 to the variable A, then run POIPIV (*Pointer Pivot*). A positive value for A should make the pointer pivot counterclockwise. Store a negative value for A (such as -20) and run POIPIV again. The motor should reverse direction. Turn off the power when finished.
- To work on the right side of the robot, the wires below the positive terminals should be connected in the opposite sequence--white, black, blue and red. The instructions above should make this motor turn opposite the direction for the left-side motor.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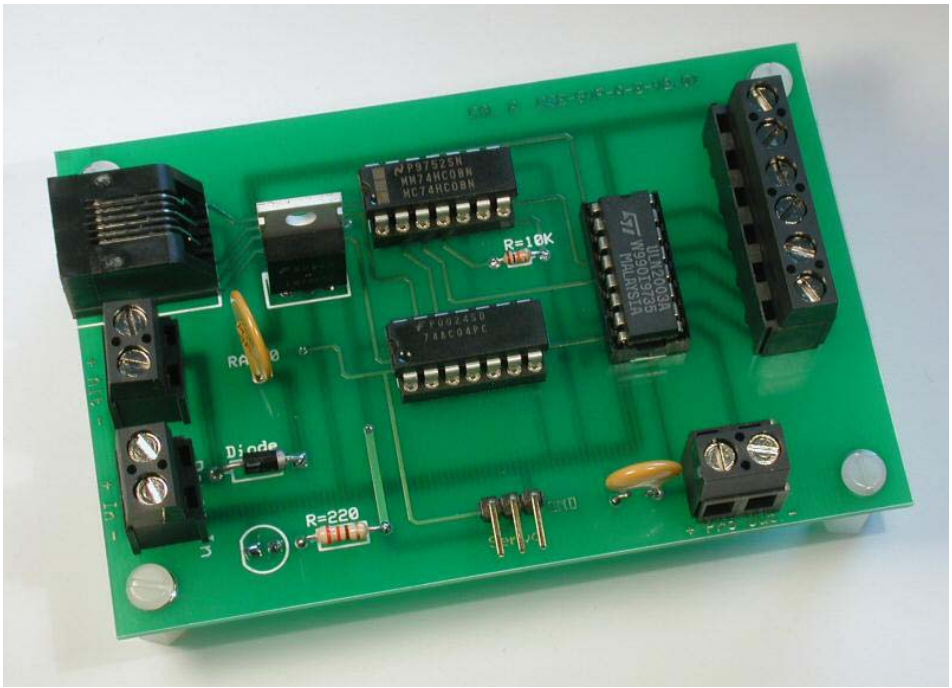
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