EE459 Lab Assignment 1
Power Connections

1 Introduction

The purpose of this assignment is to install the necessary components on the project board so that power is available for running the other components that will be installed on the board later. There is no point in installing other items on the board until there is reliable and stable power for them.

2 Components

Each team will be provided with the following components:

- $8'' \times 5.5''$ prototyping board
- 3 position terminal block
- Red and black banana plugs
- Red and black wire for power connection
- Single-pole, double-throw (SPDT) panel-mount toggle switch.
- 10μF electrolytic capacitor
- LED
- 270Ω resistor
- Two header strips (or one long one that can be cut in half)

Teams will also receive their toolkit containing a collection of tools that can be used throughout the semester. Please try to keep the tools together and not leave them lying around in the lab.

- Needle-nose pliers
- Wire strippers
- Diagonal cutters
- Unwrapping tool for wire-wrap connections
- IC removal tool
- Small screwdriver
- Set of 5 micro-hook clip leads
- Key to the EE459 storage locker
- Padlock for the team locker
- USBtiny programming module and USB cable

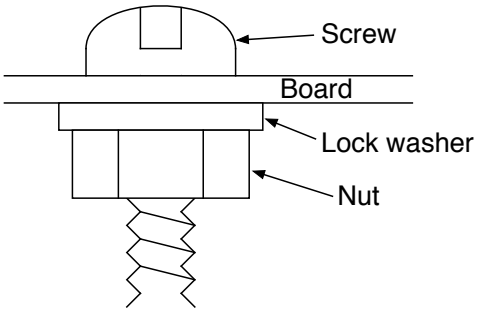

Figure 1: Installation of screws

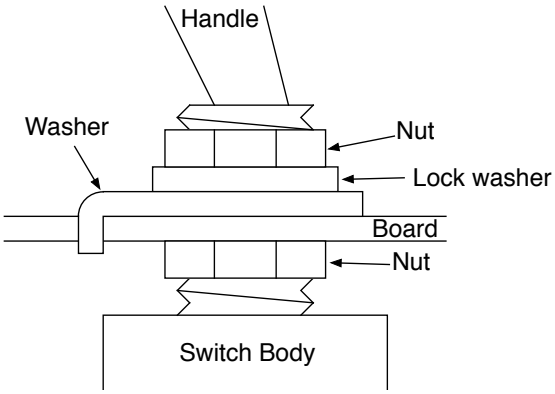

Figure 2: Toggle switches

3 Assembly

The first thing you want to do with your project board is to identify the component side and the wiring side of the board. The wiring side has little metal pads around each hole, the component side has none of these. All the components (modules, IC's, resistors, capacitors, etc.) will be mounted on the component side with their pins or leads poking through holes to the wiring side. All the wiring connections between pins and leads is done on the wiring side. Some components like the toggle switch used in this assignment are mounted so part of it is on the component side and part is on the wiring side.

3.1 Legs

The next thing to do is to install screws in the holes in the corners of the board to act as legs for the board. The screws, nuts and lock washers are in a plastic box in the supply cabinet. Install a 3/4" long #6 screw with the top of the screw on the component side and most of it extending out on the wiring side. Place a lock washer and nut on each screw as shown in Fig. 1 and use a 5/16″ nutdriver from the tool chest to tighten it.

3.2 Header Pins

Before installing any of the components on the board, do some planning to make sure they are installed where you don't think they will interfere with other stuff that will be installed later. The power components should probably be installed near an edge of board so to leave as much room free as possible in the middle of the board.

Examine your board and note that while most of the board consists of individual metal pads around each hole, there are several places where multiple holes are all in the same metal strip as shown in Fig. 3 and Fig. 4 depending on which type of board you received.

On the newer boards there is one on each short edge, one on each long edge, and one shaped like a sideway "H" across the top and bottom and down the center. On the older boards there are three along one long side and two along both the short sides. These create "bus strips" where connections can be made the same voltage. The header pins can be installed in these bus strips to create sets of wire-wrap pins that are all connected to power and ground.

For the newer boards, the recommended place for installing the headers is along one of the long sides of the board where there are two bus strips running parallel along the edge of the board. One strip for power can be installed in the strip closest to the edge, and the other for ground can be installed in the strip that connects to the center bus strip.

For the older boards, the recommended location is in the bus strips on either side of the gap where the power block is shown to be installed as shown in Fig. 4

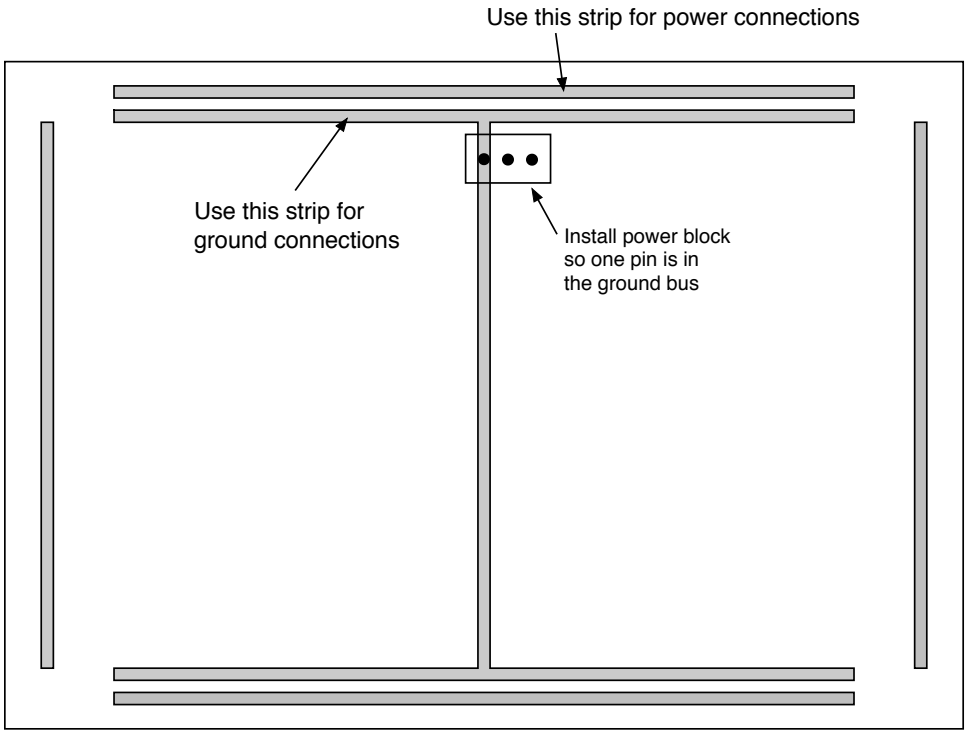

Figure 3: Location of bus strips on newer protoboards

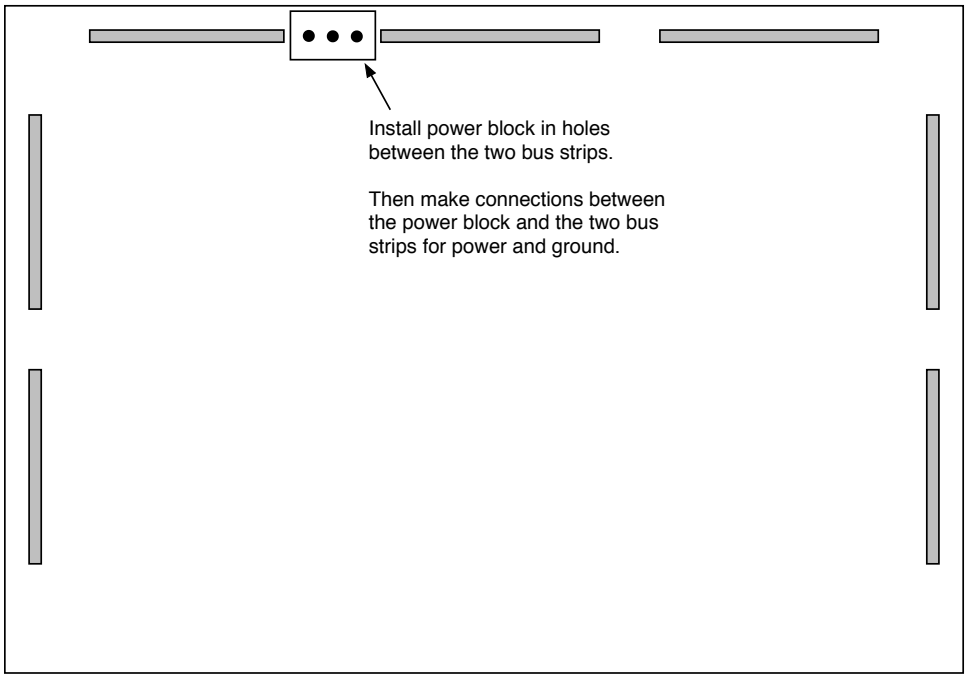

Figure 4: Location of bus strips on older protoboards

The rest of the power supply components can be installed nearby. If necessary use the wire cutters to cut the header to the length needed. Insert it through the holes in the board so the plastic part that holds the pins together is on the component side and the long part of the pin is going through the hole so it sticks out on the wiring side. Solder **all** the pins of the header to the bus strip. The Lab Notes handout has more information on installing the header strips.

3.3 Power Terminals

The blue 3 position terminal block for connecting power cables can be installed anywhere but the recommended place is near one side of the board close to the two header strips that you just installed. On the newer protoboards, to reduce having to run a wire from the power terminal to the ground bus, the terminal can be installed with one of the three pins in the ground bus strip as shown in Fig. 3

> **Note:** Sometimes the pins on the terminal block are too big to fit through the holes on the board but the instructor may have drilled three holes to be wider to accommodate the terminal block. Look closely at the possible mounting position and see if there are some holes that have been expanded so you can mount the terminal block at that position.

In the terminal block the three openings for wire to be inserted should be facing out from the center of the board. Press the block against the component side of the board when soldering it to make sure is flush against the board.

3.4 Toggle Switch

The toggle switch is installed in a hole with the body of the switch on the wiring side of the board and the lever on the component side. If you examine the switch and its associated hardware you will see that there are two nuts, a lock washer and a flat washer on the shaft as shown in Fig. 2. The bottom nut can be adjusted to make the top of the shaft flush with the surface of the board when the top nut is tightened down. Look closely at the washer and note that it has a small prong in the inside of the washer's hole, and on the outside of the washer a small tab is bent at a 90° angle. The switch will be mounted with the right-angle tab poking into a hole on the board. The combination of the tab and the groove in the shaft of the switch that engages the prong on the washer is used to prevent the switch from rotating in case it comes loose.

Drill a $1/4''$ diameter hole for the toggle switch shaft and then using a smaller drill bit, make a small hole next to the first one for the tab on the washer. Insert the toggle switch through from the wiring side of the board and place the washer on the shaft on the component side so the tab goes into the small hole. Put the lock washer and nut on the switch and use a $5/16''$ nutdriver to tighten them down. If the shaft is sticking up too far, loosen the top nut and adjust the bottom nut to make it fit better.

4 Wiring the Electronic Components

The components on the board are wired up as shown in the schematic in Fig. 5. Figures 6 and 7 show both sides of a newer protoboard that has had the various components installed. If you are using one of the older protoboards, the components will be in a slightly different position.

The electrical connections between the components can be made using wire from the spools in the lab. All wiring between capacitors, resistors and LEDs should be made using wire-wrapping as shown in Fig. 7. Wire-wrapping connections should be done with the thinner 30-gauge wire available in the lab. Connections that go to a solder terminal on a switch or power connector can be made using the 22-gauge hook-up wire. If some of the components are close together you can just bend their leads together and solder them without using any additional wire.

If you installed the terminal block with one of its pins in the center bus strip then that connector on the terminal block will be the ground connector. One of the other two connectors can be used for the $+5V$ connection.

The toggle switch is a double-throw switch. Depending on which position the lever is in, the center terminal is connected to one of the two outside terminals. Use the center terminal and one of the outside terminals to make a power switch for the board. Make a connection from the $+5V$ position on the terminal

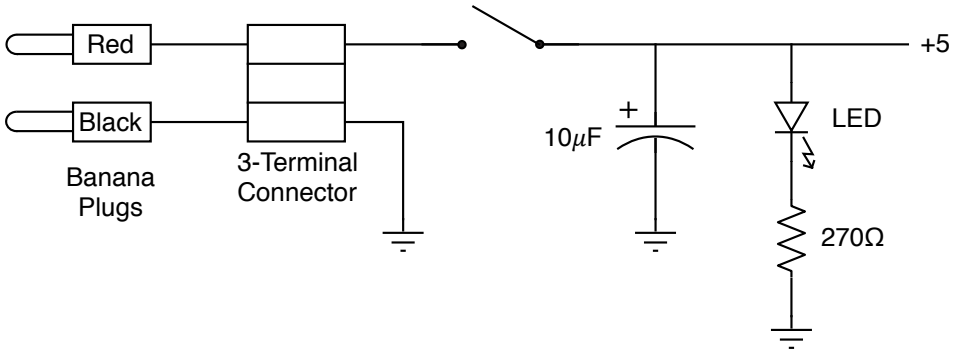

Figure 5: Wiring diagram for power components

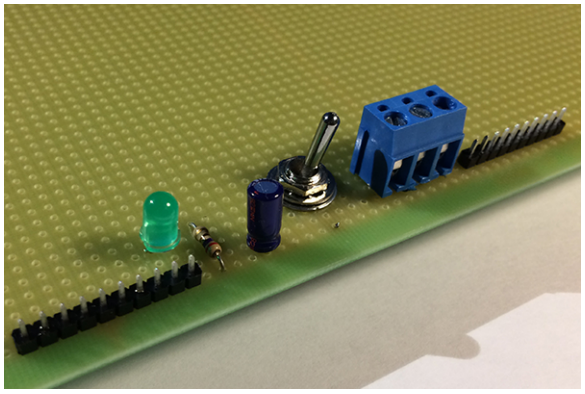

Figure 6: Component side of board

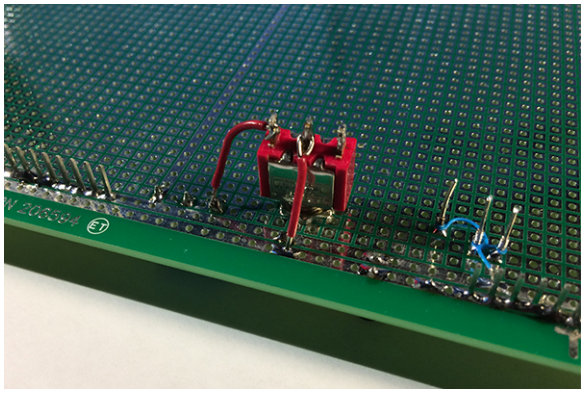

Figure 7: Wiring side of board

block to one of the outside terminals on the switch. Connect the center terminal of the switch to your $+5V$ bus strip.

Install the capacitor, resistor and LED on the board as shown in the schematic. The capacitor is used to help filter out noise on the $+5V$ line coming from either the power supply or from components that will be added later to the board. The capacitor provided can be inserted into the board so its leads come out holes in the ground and $+5V$ bus strip and then these leads can be soldered to the bus strip. The capacitor is polarized so it is a good idea to mount it on the board in such a way that you can read the polarization marking after it's installed.

The leads of the resistor should be bent 90°, pushed through two holes of the board and then soldered to the pads to keep it in place.

The LED can be installed sticking straight up. The anode (+) lead of the LED is slightly longer than the cathode (−) lead. In addition the cathode of the LED is marked by a flat spot on the edge of the LED and this side should go towards ground.

The banana plugs are installed on the ends of the power wires using the small screw in the side of the banana plug. Strip about $1/4''$ of the insulation from both ends of the wire. To make a more solid connection, the stripped wire on both ends should be "tinned" by melting some solder into the strands of the wire to make a single solid wire. This will allow the screws that holds the wire into the banana plug and terminal block to hold the wire more securely. On the banana plug, loosen the screw, insert the wire into the barrel of the plug as far as it will go and then tighten the screw. For the blue terminal strip, use the screwdriver to open up the terminal block connector so the wire can be inserted. Insert the wire and tighten the screw. Give a tug on the wires to make sure they are securely fastened.

There should be no bare wire exposed. If you can see bare wire, either where the wire goes into the banana plug or where it goes into the power block, remove the wire and cut off enough of the wire so no

bare wire is exposed when the wires are inserted into the plug or block.

5 Testing

Once all the components are installed on the board and wired together, plug it in to the bench power supply and turn on the power supply. Turning the switch on the board on and off should make the LED go on and off. Use the multimeter to confirm that there is 5 Volts present when the switch is on.

While the board is turned on and the multimeter is measuring the voltage level, bang the board on the bench top a few times (not too hard) and watch to make sure the power stays on. If the power flicks off and back on at all then something is loose on the board and you'll need to find the loose connection and fix it. You want the power connections to be rock solid so you don't have to worry about getting stable power to the rest of the circuit.