YOUR NAME:	YOUR SID:

Lab Score: ___/100

Soldering Practice

Lab 1: Soldering Practice

ELECTRICAL ENGINEERING 40

INTRODUCTION TO MICROELECTRONIC CIRCUITS

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Lab Contents

Lab Objectives

In this lab, you will be soldering a portion of an audio filter board. Soldering is an important technique used to put together and "glue" circuit components permenantly together. This lab is designed to teach and familiarize you with various soldering techniques. Exactly WHAT we will be building will become clearer as you progress through the course.

Since this is your first electronics class, we have already designed and fabricated the **P**rinted **C**ircuit **B**oard (PCB) for you. Your job will be to simply solder the correct components onto the board. The board we designed for you is intended to be completed in modules. We will slowly complete the rest of the board in subsequent labs.

We will first explore the theory behind soldering and then learn the techniques that accompany the art of soldering.

Pre-Lab - README.EE40

Welcome to your first lab in EE 40. It is **very important that you read this section** to get you started with this lab and get you oriented with the structure of all other labs that we will conduct throughout this course.

Each lab will be composed of the following components: pre-lab and lab.

For each lab you must complete the pre-lab before coming into your lab section or it is very possible that you will **not** finish the lab in the allotted time. Because the student per GSI ratio is unreasonably high, you cannot expect your GSI to walk you through the entire lab.

Each lab is designed to feasible in the 3 hours lab section provided that you have completed the pre-lab and familiarized yourself with the document.

If you have not read Lab 0, please do so now before you continue.

A Word of Caution

In this lab we will be using **VERY HOT COMPONENTS, SUPPLIES THAT CONTAIN LEAD, AND LIQUID METAL.** As precautionary measures, it is very important that you are aware of the hot objects such as the soldering iron, molten solder, and hot components so that you don't burn yourself[i].

Be especially careful with the soldering iron. This reaches very high temperatures, and can easily melt plastic and burn through your clothing. Thus, it is imperative that you are keenly aware of this hazard at all times. DO NOT EVER PLAY WITH THE SOLDERING IRON.

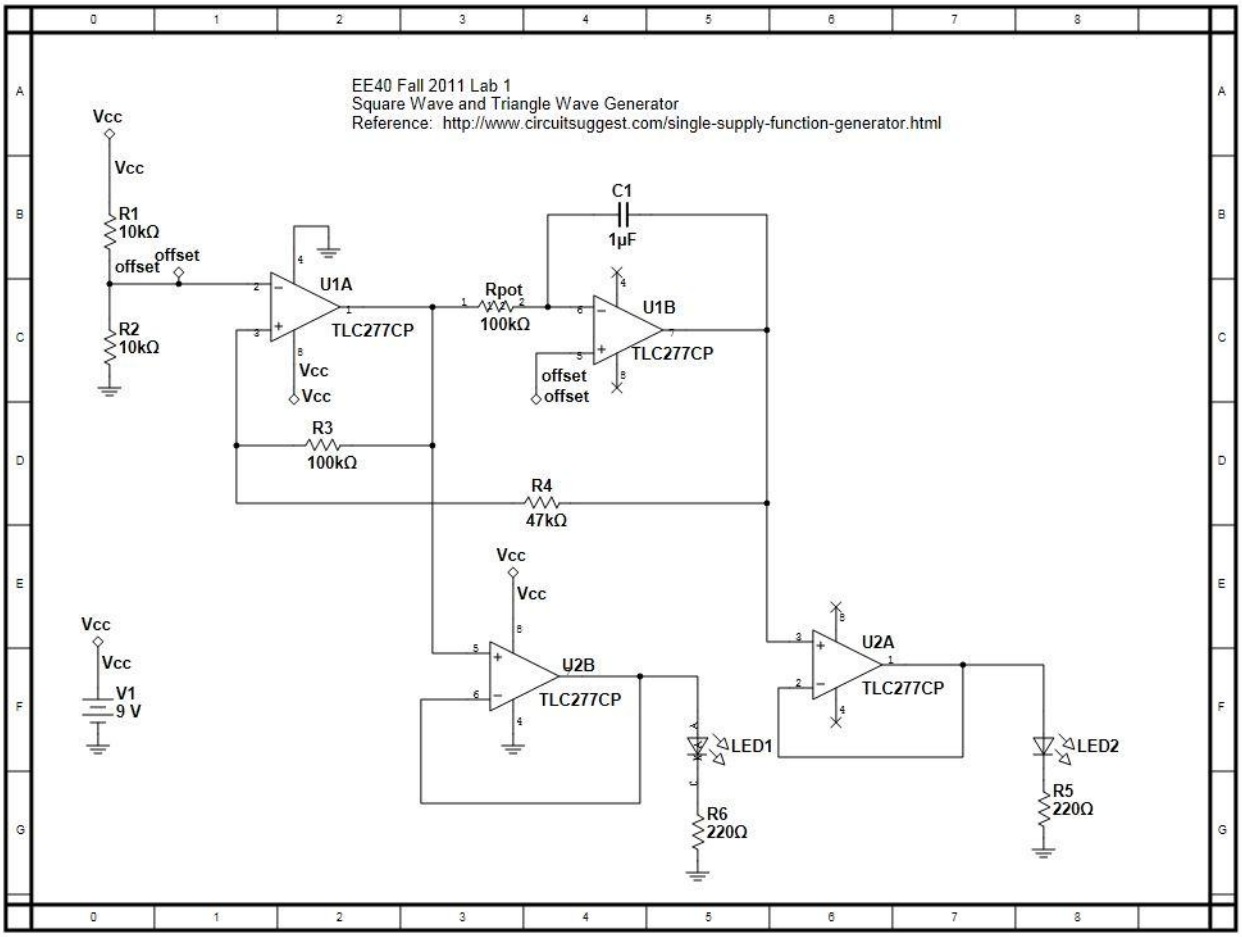
When you solder components, remember that metal conducts heat very easily. Avoid holding the leads that you intend to solder with your fingertips; you will get burned when you apply heat. Also make sure to allow time for your components to cool after you solder them; you can still get burned even after you remove the soldering iron.

Finally, we are working with liquid metal so be careful not to allow it to let it splatter or splash around. Any molten solder that lands on your skin will burn you instantly.

About the Board

For this solder lab we will be assembling a relaxation oscillator with a rail splitter to drive an LED. Don't worry about what this actually means, you will learn more about the circuit that you built in later labs and lectures. In a nutshell, a relaxation oscillator outputs a square wave and the triangle wave generator outputs… well… a triangle wave. We will provide for you all of the necessary instructions and guidelines for assembly of the board.

Below is a schematic of what we will be implementing…



The board that we will be soldering has already been prepared for you with all the necessary components in a kit. You should receive a kit with the board and all of the components when you arrive in the lab. Remember, this lab is one board per **person** so every student must complete their own board. All you have to do is stuff the components and solder them. Once you finish, you should end up with a blinking LED which you will demonstrate to you TA for check off.

Lab Component - Soldering the PCB

Soldering Theory

What exactly is soldering anyways?

Soldering is defined as "the joining of metals by a fusion of alloys which have relatively low melting points". In other words, you use a metal that has a low melting point to adhere the surfaces to be soldered together. Soldering is more like gluing with molten metal than anything else. Soldering is also a must have skill for all sorts of electrical and electronics work. **It is also a skill that can only be developed with practice**. The steps involved with soldering will be explained later in the document.

Soldering Equipment

Soldering requires two main things: a soldering iron and solder. Soldering irons are the heat source used to melt solder. Irons of the 15W to 30W range are good for most electronics/printed circuit board work. Anything higher in wattage and you risk damaging either the component or the board. Note that you should not use so-called soldering guns. These are very high wattage and generate most of their heat by passing an electrical current through a wire. Because of this, the wire carries a stray voltage that could damage circuits and components. The choice of solder is also important. One of the things to remember is to never use acid core solder. Acid core solder will corrode component leads, board traces and form conductive paths between components. The best solder for electronics work is a thin rosin core solder[1]

A Typical Weller Soldering Station[ii]

Remember that when soldering, the rosin in the solder releases fumes. These fumes are harmful to your eyes and lungs. Therefore, always work in a well ventilated area. Hot solder is also dangerous. Be sure not to let it splash around because it will burn you almost instantly.[2]

[1] After you are done soldering, you must wash your hands thoroughly since the solder contains lead

[2] The fumes do not contain lead but contain solder flux which is still hazardous to your health so avoid ingesting them

Soldering Procedure

Surface Preparation

A clean surface is very important if you want a strong, low resistive solder joint. Since you already have a PCB design, you don't have to worry about your board being clean. But, make sure that your component leads are clean.

Component Placement

Bend the leads as necessary and insert the component through the proper holes on the board. To hold the part in place while you are soldering, you may want to bend the leads on the bottom of the board at a 45 degree angle, refer to figure 3 below.

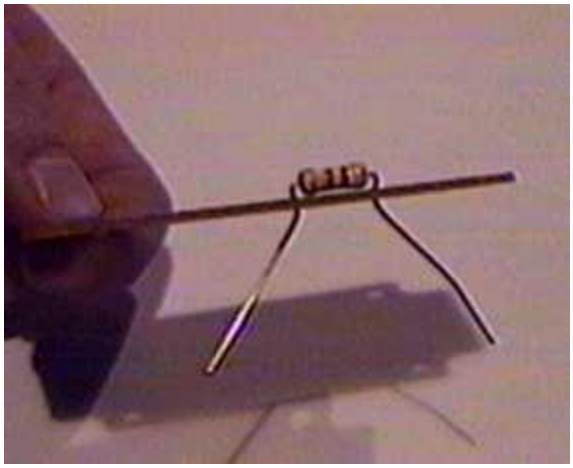


Figure 3. Resistor ready to be soldered

Apply Heat

Apply a very small amount of solder to the tip of the iron. This helps conduct the heat to the component and board, but it is **NOT** the solder that will make up the joint. Now you are ready to actually heat the component and board. Lay the iron tip so that it rests against both the component lead and the board. Normally, it takes one or two seconds to heat the component up enough to solder, but larger components and larger soldering pads on the board can increase the time. Refer to figure 4 for a picture [1].

As a general rule of thumb, you should solder passive components (resistors, capacitors, diodes etc.) first. The reason is that passives can be more easily mounted as compared to transistors and integrated circuits (ICs). Make sure you solder polarized capacitors and diodes correctly. You should also use sockets for ICs when available.

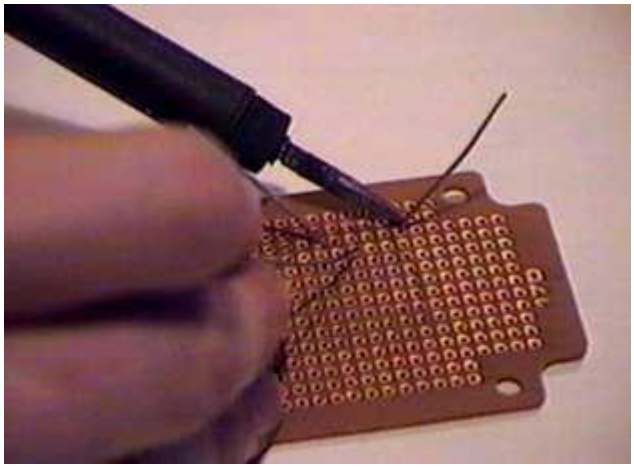


Figure 4. Applying heat

Apply Solder and Remove Heat

Once the component lead and solder pad has heated up, you are ready to apply solder. Touch the tip of the strand of solder to the component lead and solder pad, but **NOT** the tip of the iron. If everything is hot enough, the solder should flow freely around the lead and pad. Once the surface of the pad is completely coated, you can stop adding solder and remove the soldering iron (in that order).

Don't move the joint for a few seconds to allow the solder to cool. If you do move the joint, you will get what's called a "cold joint". A cold joint is a joint in which the solder does not make good contact with the component lead or printed circuit board pad. Cold joints occur when the component lead or solder pad moves before the solder is completely cooled. Cold joints make a really bad electrical connection and can prevent your circuit from working.

Cold joints can be recognized by a characteristic grainy, dull gray color, and can be easily fixed. This is done by first removing the old solder with a desoldering tool or simply by heating it up and flicking it off with the iron. Once the old solder is off, you can resolder the joint, making sure to keep it still as it cools. Refer to figure 5 for a picture of correctly applying solder.

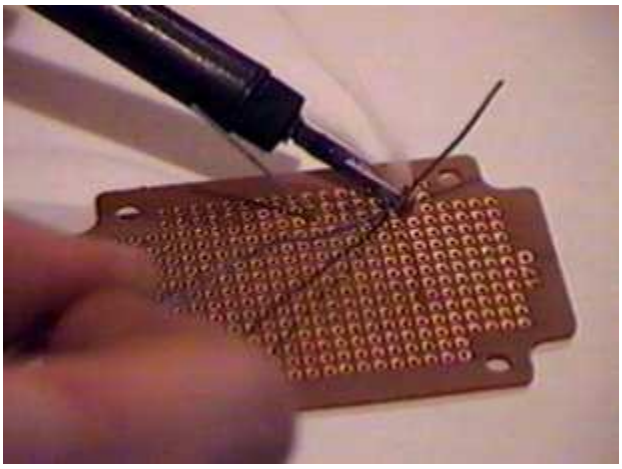


Figure 5. Applying solder

Some Words of Wisdom

DO NOT try to solder all the components and then test the circuit. This will not work; moreover, this approach is **NOT** a systematic. One of the fundamental approaches to engineering design is to decompose a system into subsystems and then design/debug each individual subsystem. For example this project is subdivided into the power circuitry, and the circuitry surrounding the IC chip.

DO NOT forget to insert components with the correct polarity. If you insert a component with the wrong polarity your circuit will not work. Usually positive polarity is indicated by the longer lead on a polarized component. The polarity of the component should also be marked on the PCB with a plus and minus sign, or by a dotted outline around the pad.

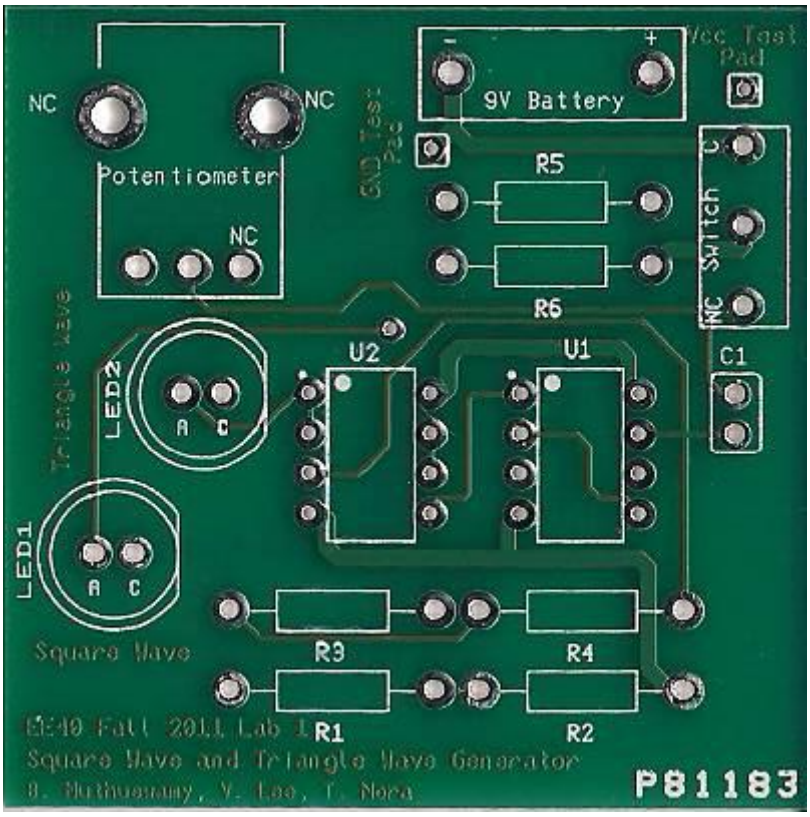
You should NEVER have to touch the solder and the iron together to get the solder to flow. If you can't get the solder flowing, ask your lab GSI for assistance.

The components (especially components with heat sinks) may get hot during operation or may heat up due to a short or poor connection. Usually a heat sink is used to remove this heat but we won't be using one for our purposes because we don't expect you to overheat any of the components used for this lab.

When you insert the **I**ntegrated **C**hips (ICs), remember the pin numbering! For the pin numbering, consult the datasheet for each respective IC.

Your Assignment

Your job is to solder the specified modules on the PCB. You can find the board and schematic can be accessed from the bspace. A copy of the board you will be working with is shown below.



The modules that you will solder in this lab are indicated below in the bill of materials. Match up the component label or designation with the part listed in the table below. If you end up with cold joints, you may want to reapply heat to re-melt the solder. If this doesn't solve the problem, it is best that you unsolder the component and try again.

You will notice that each component has an outline on the board indicating where the component goes. The components can be identified by matching the component label on the board (e.g. R2, C7, U3, etc.) with the component on the bill of materials list below. Your kit should come with the specified number of each component. If your kit is missing something, let your GSI know immediately and we will get them for you.

Make sure that you use the correct components and put them in the correct holes. Your GSI will show you how to read resistor and capacitor values, and use the multimeter to verify them.

Furthermore, make sure that you insert components with correct polarity. If you are unsure of which way to insert a component, ask your GSI or consult the example board. All holes on the board, except for the test pads should have components associated with them.

You may have to bend and clip some of the leads for the potentiometer to make it fit. For the larger leads of the potentiometer, you do not have to worry too much since they are mounts and are not connected to the rest of the circuit. Also we recommend you tin the leads for the battery clip before soldering and tape it down after soldering since the wires break easily.

Component	Value	Designator	Notes
Capacitor	1uF	C1	The blue component
Resistor	10kOhm	R1,R2	Color band: Brown, Black, Orange, Gold
Resistor	47kOhm	R4	Color band: Yellow, Purple, Orange, Gold
Resistor	100kOhm	R3	Color band: Brown, Black, Yellow, Gold
Resistor	220Ohm	R5,R6	Color band: Red, Red, Brown, Gold
9V Battery	9V	9V Battery	
Green LED	Green LED	LED2	Longer lead indicates positive side of diode
Yellow LED	Yellow LED	LED1	Longer lead indicates positive side of diode
Potentiometer	100kOhm	POT1	
Switch		Switch	Check C and NC indicators marked on side of part
TLC277 Dual Operational Amplifier		U1,U2	Use LMC6482 if you can't find these

Make sure you have READ the procedures before you begin soldering your components. You will NOT be provided with an extra board so please try to understand the procedure BEFORE you start soldering.

Once you finish soldering the components, verify that your circuit is working and demonstrate it to your lab TA.

To test if your PCB works or not, first make sure that you circuit is turned on. You should observe a flashing LED on your board. If you do, than congratulations, your circuit works and you have completed your first lab!

If your board doesn't work, take a quick look at your soldering and make sure that it's clean.

If your board still isn't working, ask your GSI to provide assistance. We'll get it to work eventually…

Finally, you will have one lab section to complete this assignment so please be prepared to come to lab and solder away.

Once you finish, you can leave early or familiarize yourself with the other lab equipment.

Oh, and one more thing, have fun and enjoy! ☺

Regards,

Your teaching staff

Lab Check-Off

Your GSI Signs Here if you attempted the lab **(50 pts)** | |

Your GSI Signs Here if your circuit works **(50 pts)** | |

Lab Report Submissions

This lab is **due at the beginning** of the lab section. Make sure you have **completed all questions** and **drawn all the diagrams** for this lab. In addition, attach any loose papers specified by the lab and submit them with this document.

These labs are designed to be completed **individually**. In future labs, all laboratory reports will be done in pairs. Make sure your name is on this document (preferably on the front).

Image Citations

[i] www.labelident.com
[ii] www.elexp.com