EE 2010/2011 Circuit Analysis
Lab 03: Soldering School and an Astable Circuit

Lab Section: **Printed Name (Last, First):**

Learning Objectives:

- Understand the basics of soldering
- Understand soldering safety
- Understand the necessary soldering equipment
- Use Multisim to simulate and understand the functionality of the soldering practice kit
- Use a soldering practice kit to gain hands on understanding of soldering

1 Before coming to lab:

1.1 What is Soldering?

Definition: *Soldering* is a process in which two or more metals are joined together by melting and putting a filler metal (an alloy also known as solder) into the joint, the filler metal having a melting point lower than the metals being adjoined.

In other words: You are using a metal that has a low melting point to adhere pieces of metal to each other. It can be thought of as "hot-gluing with metal."

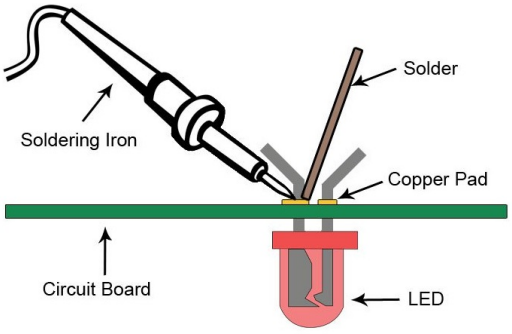


Figure 1: Soldering Example

Very useful soldering kits are readily available for under $20.

Become familiar with the *what*, *why*, *how to* and the *how not to* of soldering by reading/watching the following:

1.1.1 View the first 3 minutes of ShopJimmy.com's *How to Solder* Tutorial.

1.1.2 View the more general video on *How to solder*

1.1.3 Read the *Soldering Equipment* document on Pilot for this Lab. **Its mostly pictures!**

1.1.4 View *this video* on how NOT to solder – and other things.

1.1.5 Add this Soldering guide to your document library.

1.2 Soldering Safety

1.2.1 **Make sure the workspace is well ventilated to avoid:**

1.2.2 Lead Exposure: Many solders contain lead to aid in the soldering process. Exposure to lead can lead to chronic health issues. Lead-free solder is recommended for health reasons, but if leaded solder is used, make sure that the workspace is very well ventilated.

1.2.3 Rosin Exposure: Rosin is contained in solder flux to help reduce oxide formation, providing a better connection for the solder. Rosin is typically obtained from pine and confiner trees and is a potential eye, throat, lung, and nose irritant and can cause headaches. Repeated exposure can lead to chronic health issues. Caution should be exercised when using Rosin flux. Again, make sure your workspace is very well ventilated.

1.2.4 Electrical Safety: Do not use a soldering iron that has obvious damage to the body, cable, or plug. While the iron is in use, keep the workspace as free as possible of electrical cables, including the iron's own electrical cable.

1.2.5 Burn/Fire Prevention: The iron gets extremely hot (∼400°C). The iron tip should never be touched.

1.2.6 When heated, solder can "spit" or "pop."

1.2.7 Standard Operating Procedures for use of Soldering Iron:

- Hot solder can splatter, always wear safety glasses or goggles.
- Never touch the element or tip of the soldering iron.
- Always return the soldering iron to its stand when not in use.
- Work in well ventilated area.
- Use lead-free solder.
- Keep the sponge wet during use.
- Allow joints and components to cool before touching them.
- Turn soldering iron/oven off and unplug it when not in use.
- Wash your hands after using solder.
- If you have not soldered before or if you have questions ask for help!
- If you burn yourself immediately run cold water over the burn for 15 minutes
- Report burns to the EE Office

Be prepared to attest to: "I have read the above and agree to follow this procedure. I acknowledge that failure to follow this procedure and safe lab practices or failure to use required PPE in the lab can result in loss of lab privileges and/or invocation of university disciplinary procedures."

1.3 The 555 Timer-driven "Blinking LED" Kit

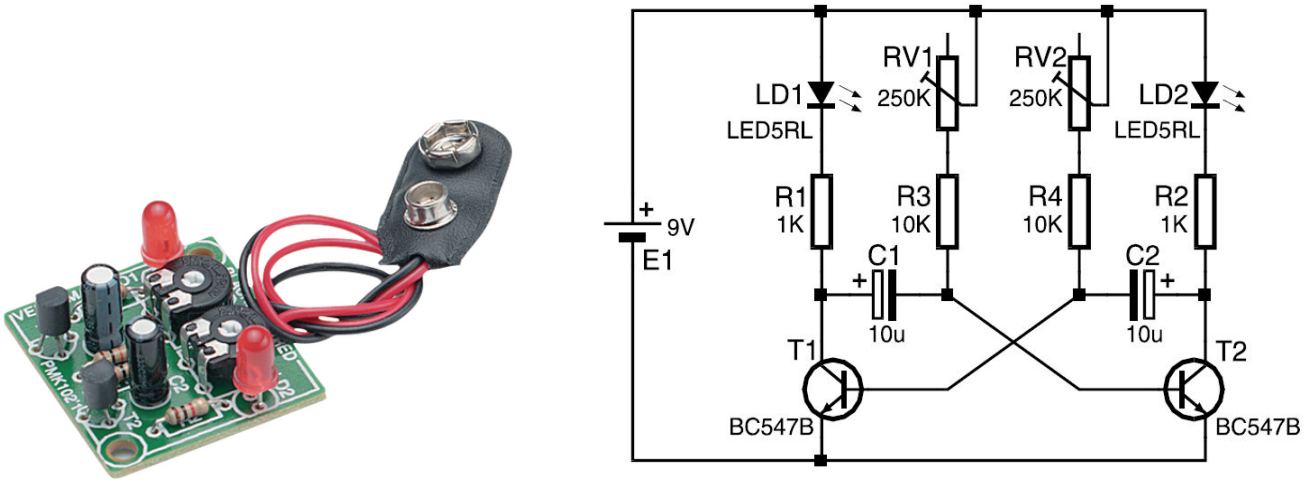
The kit we are using sells on All Electronics for under $5.00.

To walk through a soldering practice, we first employ a simulation for a simpler astable circuit shown below.

The circuit is designed to alternatively flash the two LEDs (LD1 and LD2). This sequence is enabled by the two electrolytic capacitors (C1 and C2) charging and discharging through the gates of the transistors (T1 and T2). This is an example of an *astable circuit.*

Operation Sequence: Say capacitor C1 is at full charge. Because it is connected to the gate of T2, T2 is in an "on state" which allows the flow of current through transistor T2, turning LD2 on. Meanwhile, capacitor C2 is charging. Once C2 is at full charge, transistor T1 turns on, allowing current through transistor T1 turning on LD1.

Once current flow begins through T1, C1 begins to discharge through T1. Once C1 discharges, T2 turns off, turning LD2 off as well. With current flowing through T1, LD1 is turned on. Meanwhile, capacitor C1 is recharging and so on.



(a) (b)

Figure 2: MK102 and Schematic

The schematic in Figure 2b shows the layout of the desired circuit with:

- E1, a 9V battery.
- R1 - R4 are standard valued resistors.
- C1 and C2 are electrolytic capacitors (polar capacitors).
- LD1 and LD2 are the LEDs (these light up ONLY with the correct polarity)
- RV1 and RV2 are "trimmers" - a kind of variable resistor suitable for long-term use
- T1 and T2 are Bipolar Junction Transistors (BJTs).

1.4 Multisim Simulation:

Creating the design in Multisim will help you understand the functionality of the circuit and make it easier to visualize how it is constructed, making you less likely to make an error in the lab. An example of the schematic in Multisim can be found in Figure 3.

1.4.1 Construct the MK102 schematic from Figure 3 in Multisim.

i. The 9V battery can be simulated with a DC Source set to 9V.

ii. The BJTs can be found under the **Transistor** Group. Select the "NPN Folder" and select the **2N2222A**.

iii. The capacitors can be found under the **Passive** Group.

iv. The LEDs can be found under the **Diodes** Group.

Note: The LEDs are polar components. this means that if you put them in to the circuit the wrong way the circuit will not function properly. Pay attention to the direction of the component when wiring the circuit.

1.4.2 Run the simulation. It will take a few seconds for the circuit to display the expected behavior. If you have constructed the circuit properly, you will notice the LEDs flashing back and forth after you start the simulation.

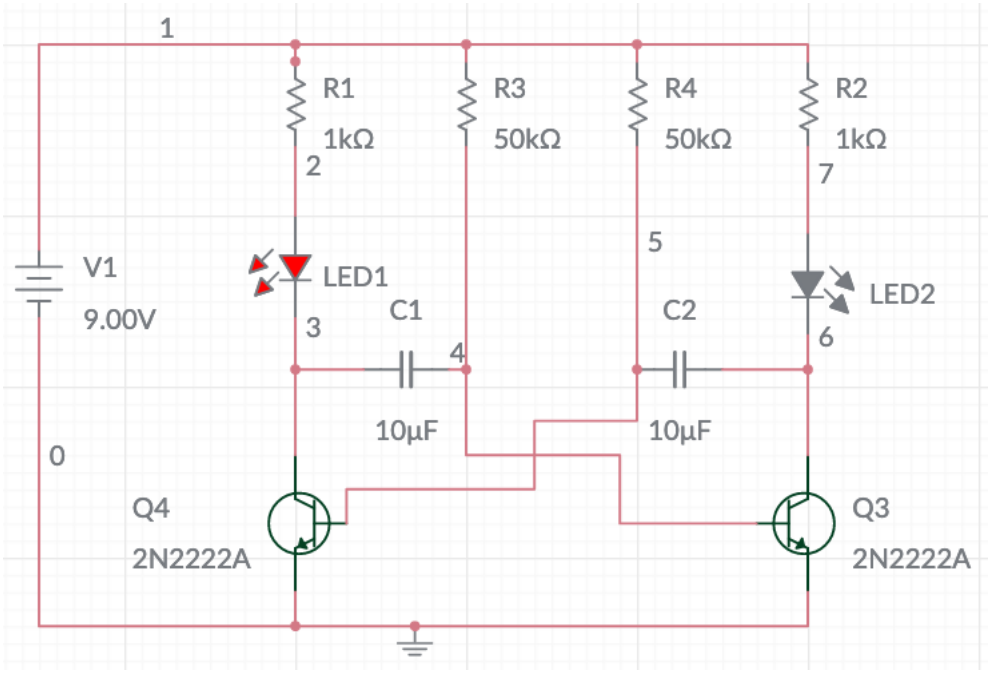


Figure 3: Multisim Schematic of the MK102

1.4.3 Take a screenshot of your Schematic and upload it to the dropbox on Pilot. If you do not see the dropbox on Pilot or are not able to find it, please contact your TA.

2 In Lab Procedures

In this lab session you will construct and test the MK102 circuit.

Safety is Critical

- Do not touch the soldering iron element, even if the iron is unplugged and does not look hot.
- Be sure that the soldering iron is not damaged in any way.
- Be sure that the workspace is as clear as possible of electrical cables.

2.1 Gathering Equipment

Before soldering, check that all components are at your station. Open up the *Soldering Equipment* document on Pilot to do a component checklist.

Soldering Equipment

☐ Soldering Iron	☐ Wire Cutters/Strippers
☐ Solder	☐ Sponge
☐ Safety Glasses	☐ Solder Sucker

2.2 Soldering

Since you are working in groups, share the soldering iron as evenly as possible. Have each person in the group do one component and then switch so that each person completes their board. The manufacturer instructions and tips for properly soldering to the MK102 board can be found on the last page.

View the ShopJimmy.com's *How to Solder* Tutorial from the 1 minute point to the 3 minute point, if you are not already familiar with how to solder to a PCB board (This is the second video from the Pre-Lab but please watch it again to refresh your memory). Pay special attention to:

- ☐ 1:00 - 1:40, How to remove a component.
- ☐ 1:40 - 2:15, How to solder a component.
- ☐ 2:15 - 3:00, Proper soldering joint examples.

A short summary of the steps from the video for reference:

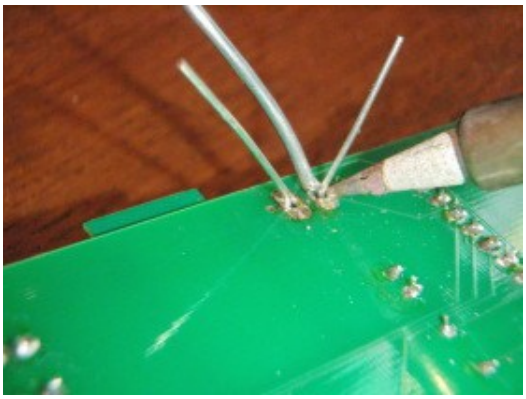
2.2.1 Place the component through the holes and bend the leads away from each other so that the component stays in place for soldering (**Remember** The capacitors and the LEDs are polar and can only be inserted in one direction for proper functionality).

2.2.2 Leave a small amount of room between the component and the board.

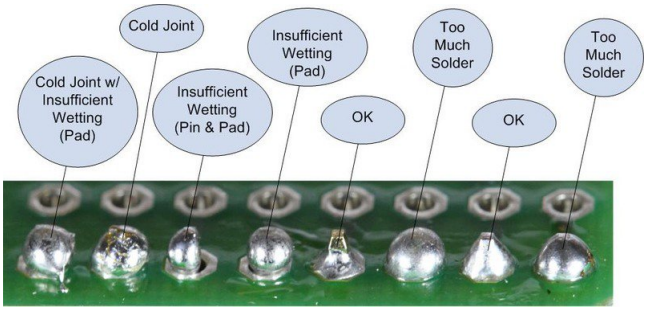
2.2.3 Place the tip of the soldering iron to the pad so that the pad and the lead gets hot. Hold the tip of the iron here for a second or two.

2.2.4 Apply the solder to the joint and inspect the joint to make sure it looks OK. If not, remove the solder and repeat the process.

2.2.5 Remember that you don't want to apply the solder to the tip of the iron, but directly to the component lead and the pad on the PCB.



(a) Soldering Example



(b) Soldering Joints

Figure 4

Once you have finished soldering the circuit, verify with your TA that the circuit works properly. Have your TA sign below. You will not receive credit if they have not verified that the circuit functions properly.

TA Signature: owen RIEMER

Takeaways:

1. Soldering is a mechanically-secure and electrically-conductive means for connecting elements

PARTS LIST AND INSTRUCTION FOR LEDKIT

READ ALL INSTRUCTION BEFORE STARTING THE PROJECT!

Your kit should include the following parts:

1 each - P.C. BOARD
1 each - 555 timer I.C.
1 each - 33K ohm resistor (orange, orange, orange)
1 each - 120K ohm resistor (brown, red, yellow)
1 each - 4.7 MFD capacitor with radial (P.C. leads)
2 each - L.E.D. (assorted colors)
1 each - 9 volt battery snap (battery not included)

• STEP 1 (see figure 1)

Insert and solder the **555 I.C.** to P.C. Board paying close attention to the notch edge. Notch edge indicates pin one on the I.C. and should match with pin one on the P.C. board trace. Insert and solder the **120K ohm resistor** so that the resistor faces the notch edge of the 555 timer. Insert and solder the **33K ohm resistor** as indicated.

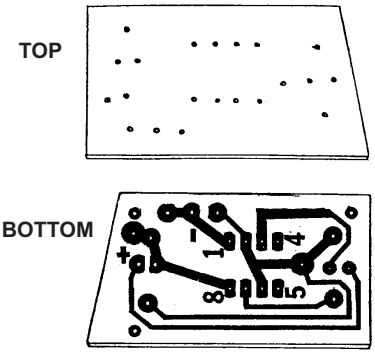


FIGURE 1

• STEP 2 (see figure 2)

Insert and solder the **1 mfd capactior** paying close attention to polarity.

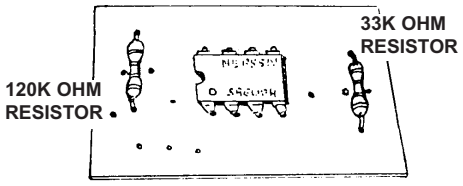
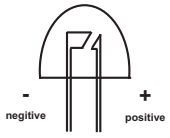


FIGURE 2

• STEP 3 (see figure 3)

Locate the flat side of the RED **L.E.D**. From the top of the L.E.D. look down around the edge or run you finger along the edge of the L.E.D. until you feel the flat part. This is the negative side of the L.E.D. Insert and solder this L.E.D. over the 120K ohm resistor with the flat side of the L.E.D. facing the outside of the board (not facing the 555 timer).
Remove the 2nd **L.E.D** from the black holder.
Look at the LED.
It should look something like this. ⟶
Insert and solder this L.E.D. over the 33K ohm resistor with the negitive side facing the inside of the board (facing the 555 timer).



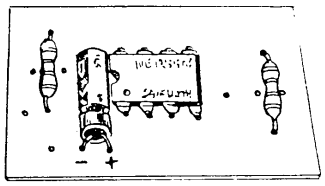


FIGURE 3

• STEP 4 (see figure 4)

Insert and solder the battery snap paying close attention to the RED and BLACK wire as per figure 4. Connect a 9 volt battery (not supplied with this kit) and the L.E.D.s should start to flash.

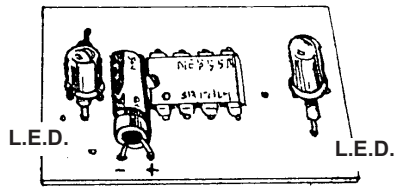


FIGURE 4

IF THE PROJECT DOES NOT FUNCTION

Check the following ...

• Is the 555 I.C. inserted correctly? Check the location of pin 1 ...
• Is the 1 mfd capacitor inserted correctly? Check plus and minus ...
• Are both L.E.D.'s inserted correctly? Check the notch position ...
• Is the battery snap inserted correctly? Check the plus and minus ...
• Are the solder connections well done? Check to see none overlap traces on the P.C. board and that you do not have any cold solder jounts.
• Is your battery good?

*** * * REVIEW STEPS 1 THRU 4 * * ***

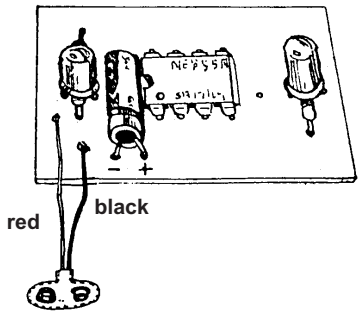


Figure 5: LED kit description