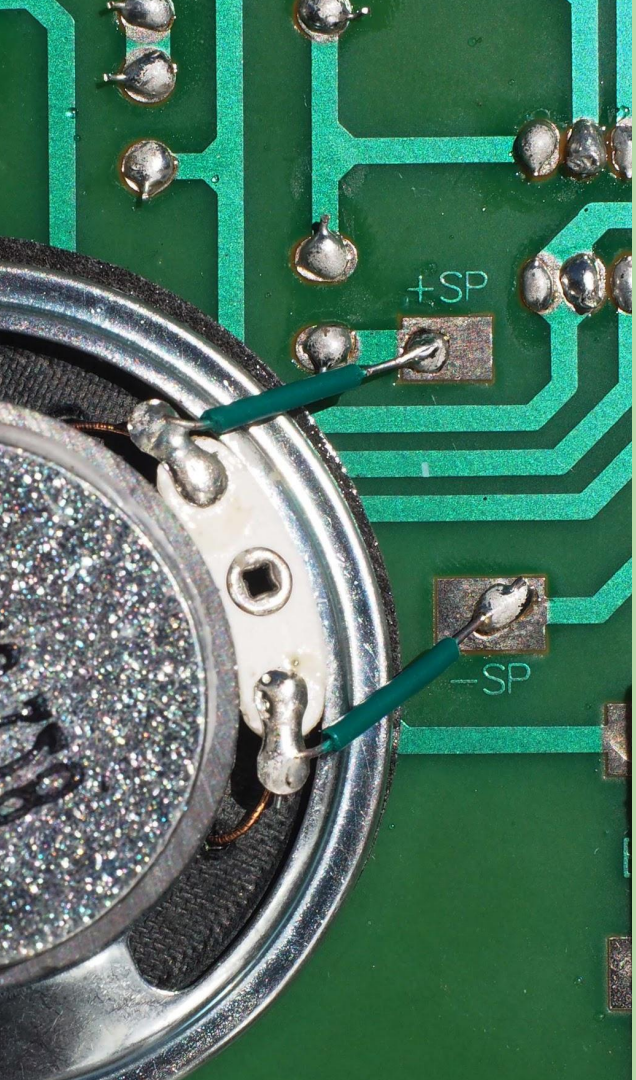


Radios 4 Rhino

Creative Capacity Building for Electronics

Francesca Macchiavello, Isabella Chiurillo, Tanvi Sharma, Tiffany Louie
11.025 D-Lab: Development, Fall 2020

D-Lab Student Team Introductions

Tanvi Sharma
2nd year Masters Candidate in City Planning

Francesca Machiavello,
4th year Undergraduate in Economics and Computer Science

Isabella Chiurillo,
3rd year Undergraduate in Mechanical Engineering

Tiffany Louie
1st year Undergraduate in Engineering

Project Partners

Project Mentors

Amy Smith

Martha Thompson

YSAT

John Jal Dak,

Amuna Vivian

Kulika

Amen Emmanuel

Richard Maliamungu, Chairman Martin, Radio Board Members, and other community members

MIT D-Lab

designing for a more equitable world

D-Lab Students

Peppino Durizzo

Shafira Indah Zata Dini

Nancy Tan

Viviana Rivera

About Rhino Camp

- Refugee settlement since 1980
- Hosts over 100,000 refugees, mainly from South Sudan
- Limited access to electricity
- Misinformation has increased tensions within the community
- Better communications is a high priority for refugees right now → hence, **Radios 4 Rhino**!

Outline

- Introductions
- Solar Panel Design
- Discussion- Solar Panel Questions
- Radio Creative Capacity Building Manual
- Discussion- Curriculum Design

Solar System Design

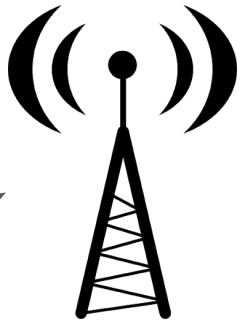
Radios 4 Rhino, Project Leads: Isa and Fran

Radio System Equipment

1. **Transmitter** - transmits signals that can be picked up by radios
2. **Antenna** - sends and receives radio signals
3. **Studio Equipment**
    a. Speakers, Microphones, Headphones

Station Equipment

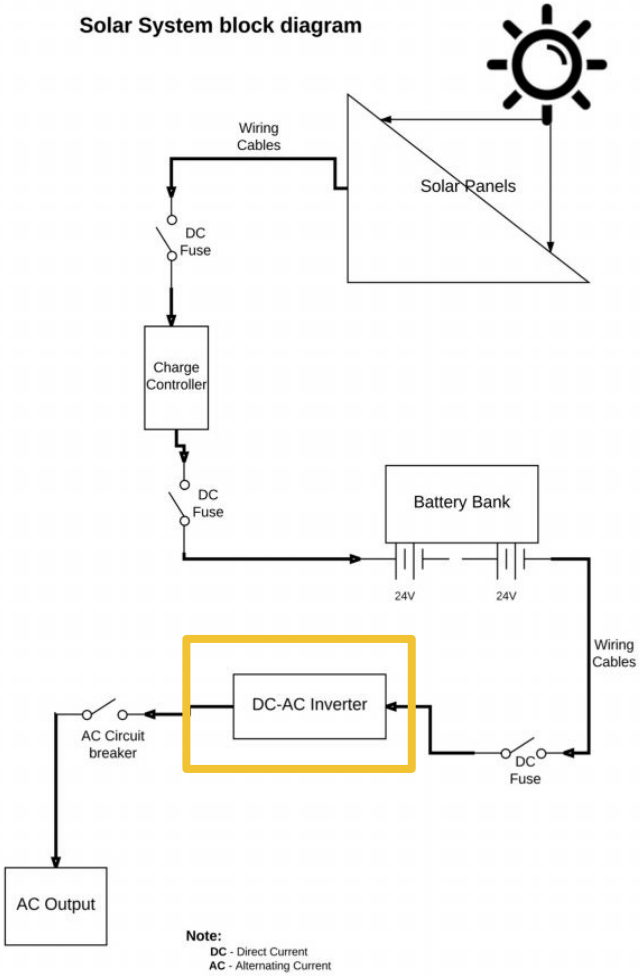
Transmitter



Antenna

Solar System Components

1. Solar Panels
2. Back-up generation (Diesel generator)
3. Inverter - converts DC (solar energy) to AC (usable power)
4. Battery - stores energy so energy can be used when there is no sunlight (5-15 yr lifetime)



Radio Station Planning Stages

Stage 1: Planning

- Funding
- Licensing and permits
- Solar system design for Stage 2

Stage 2: Small scale pilot

- A few hours of broadcasting
- Moderate coverage
- Finalizing broadcast content

Stage 3: Expansion

- Station is a separate building with room for staff
- Additional office equipment
- Longer hours
- More coverage

Solar System: Stage 3 Goal

This is our **end-goal** for the Radio Station:

1. Building Structure:
    - Radio station will be a separate building within the YSAT area including 2 rooms to accommodate staff
2. Weather Pattern
    - Rainy season: August-November; Rain can last for 7 days in a row, but not the whole day
3. Broadcasting Hours:
    - 5am-11pm everyday
4. Area Coverage
    - ~85 square km (Rhino Camp)
5. Additional Equipment
    - Office equipment: Internet system, 3 laptop computers, 1 desktop, 1 printer
    - Building appliances: Lighting, 1 refrigerator, 1 television set

Questions: Stage 1

Area Coverage

Rhino Camp area: ~85 square km

Other nearby areas/communities?

Different languages? Multiple radio stations to address this?

Rhino Camp Weather

How hot does it get in the summertime? Ie. Would AC be necessary or fans sufficient?

Broadcasting hours

How many hours should we start at?

Morning and night shifts for broadcasting? Breaks between shifts?

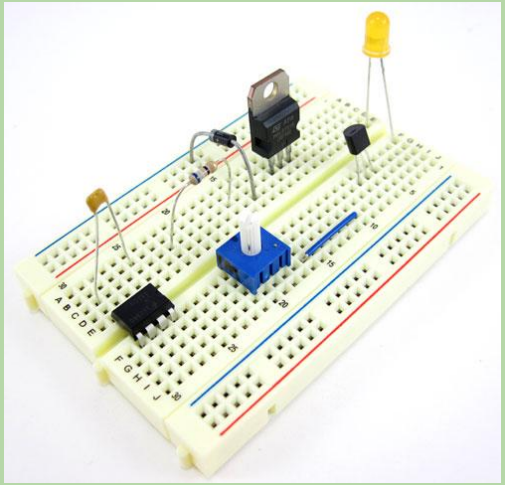
How many people working inside at the same time?

Creative Capacity Building (CCB)

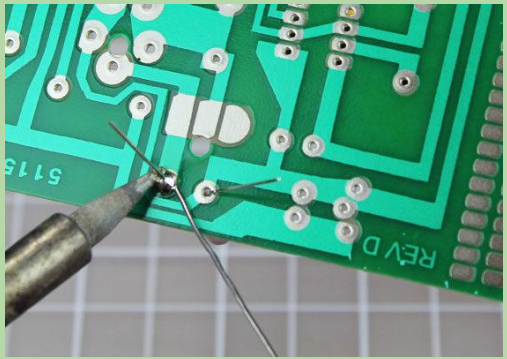
Radios 4 Rhino, Project Leads: Tiffany and Tanvi

CCB Learning Modules

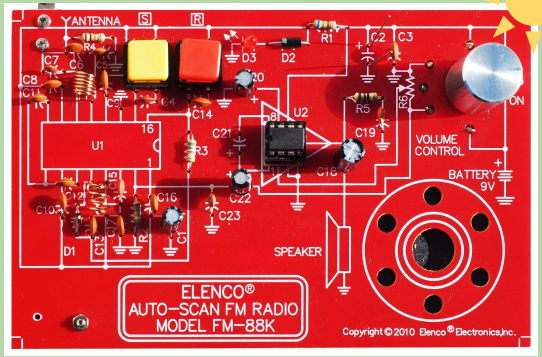
Basic electronics using a breadboard and basic components



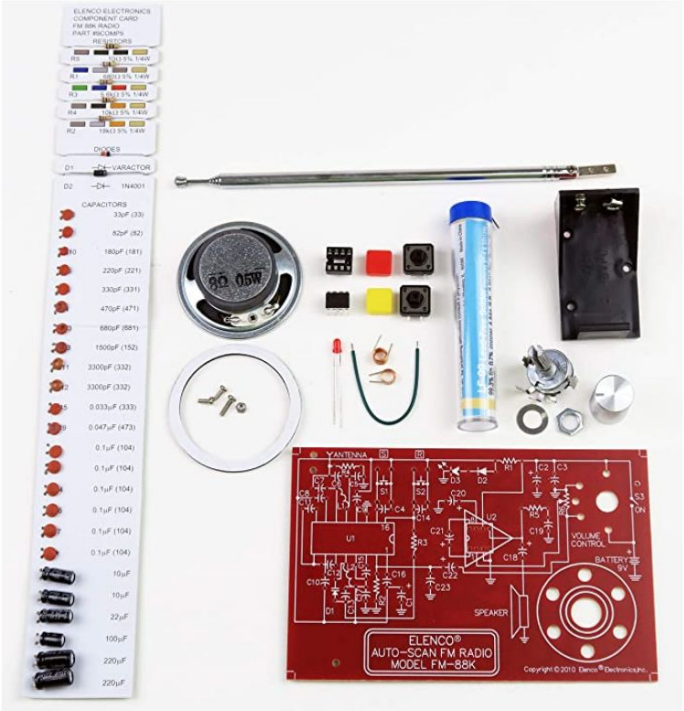
Soldering and desoldering practice

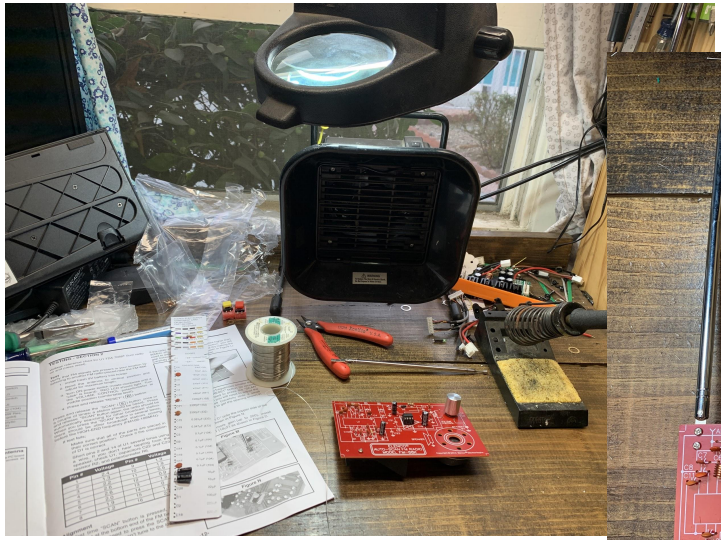


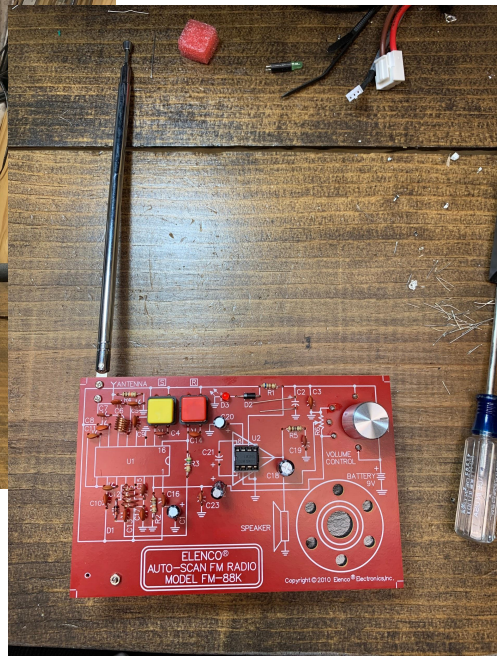
Basic radio theory and assembly



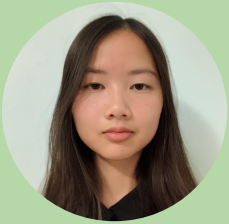
Radio Building

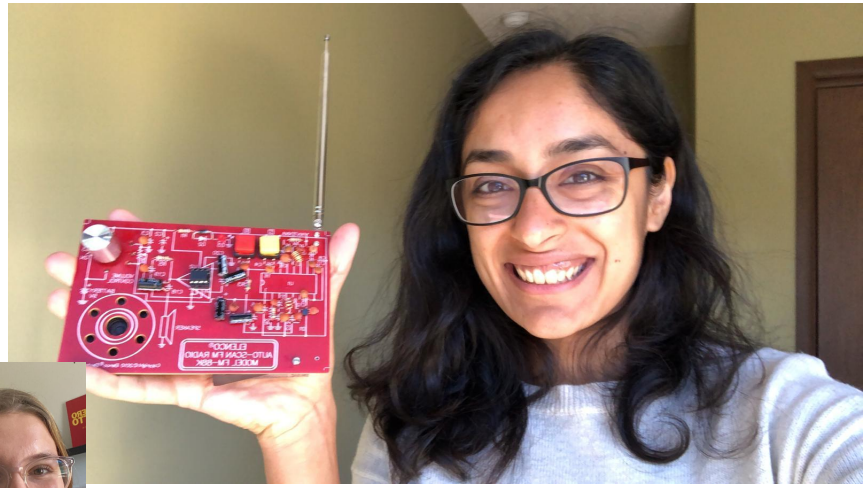


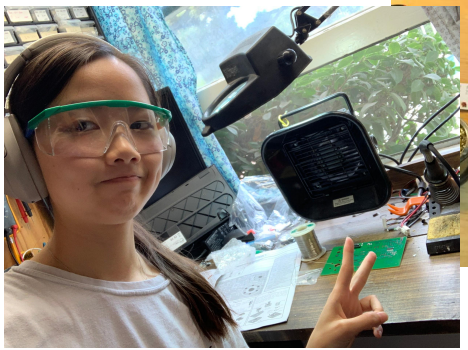




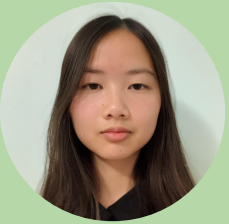
Radio Building

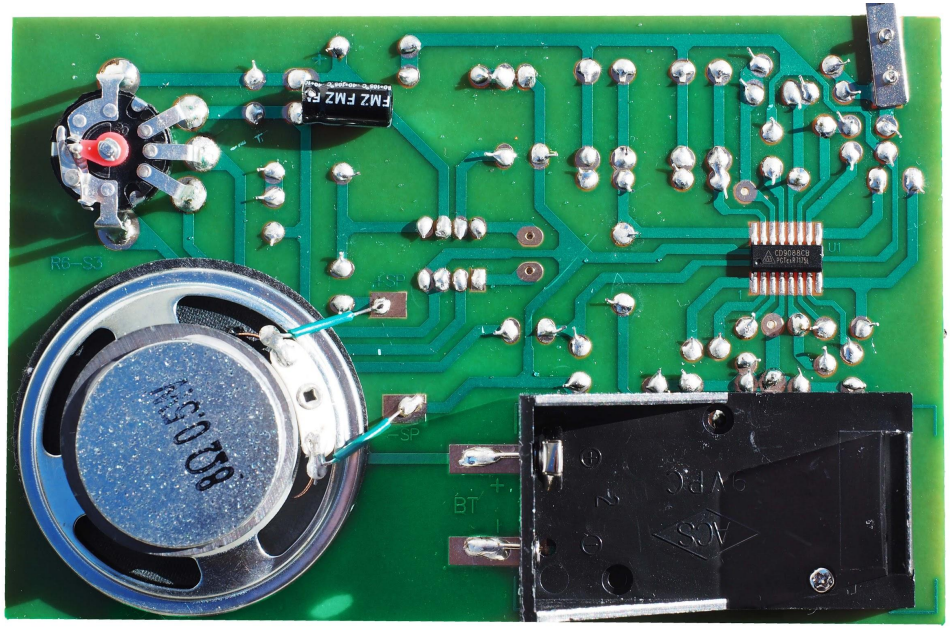




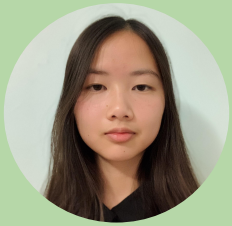


Completed Radio

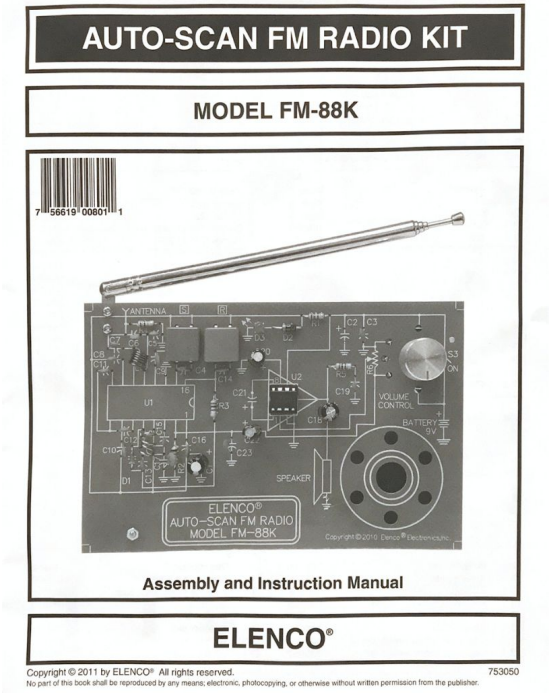




Demo



An Easier-to-Follow Manual



CONSTRUCTION

Introduction

The most important factor in assembling your FM-88K Auto-scan FM Radio Kit is good soldering techniques. Using the proper soldering iron is of prime importance. A small pencil type soldering iron of 25 - 40 watts is recommended. **The tip of the iron must be kept clean at all times and well-tinned.**

Solder

For many years leaded solder was the most common type of solder used by the electronics industry, but it is now being replaced by lead-free solder for health reasons. This kit contains lead-free solder, which contains 99.3% tin, 0.7% copper, and has a rosin-flux core.

Lead-free solder is different from lead solder: It has a higher melting point than lead solder, so you need higher temperature for the solder to flow properly. Recommended tip temperature is approximately 700°F; higher temperatures improve solder flow but accelerate tip decay. An increase in soldering time may be required to achieve good results. Soldering iron tips wear out faster since lead-free solders are more corrosive and the higher soldering temperatures accelerate corrosion, so proper tip care is important. The solder joint finish will look slightly duller with lead-free solders.

Use these procedures to increase the life of your soldering iron tip when using lead-free solder:

- Keep the iron tinned at all times.
- Use the correct tip size for best heat transfer. The conical tip is the most commonly used.
- Turn off iron when not in use or reduce temperature setting when using a soldering station.
- Tips should be cleaned frequently to remove oxidation before it becomes impossible to remove. Use Dry Tip Cleaner (Elenco® #SH-1025) or Tip Cleaner (Elenco® #TTC1). If you use a sponge to clean your tip, then use distilled water (tap water has impurities that accelerate corrosion).

Safety Procedures

- **Always wear safety glasses or safety goggles to protect your eyes when working with tools or soldering iron, and during all phases of testing.**
- Be sure there is **adequate ventilation** when soldering.
- Locate soldering iron in an area where you do not have to go around it or reach over it. Keep it in a safe area away from the reach of children.
- **Do not hold solder in your mouth.** Solder is a toxic substance. Wash hands thoroughly after handling solder.

Assemble Components

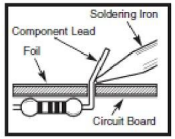
In all of the following assembly steps, the components must be installed on the top side of the PC board unless otherwise indicated. The top legend shows where each component goes. The leads pass through the corresponding holes in the board and are soldered on the foil side.
Use only rosin core solder.

DO NOT USE ACID CORE SOLDER!

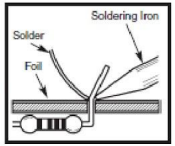
What Good Soldering Looks Like

A good solder connection should be bright, shiny, smooth, and uniformly flowed over all surfaces.

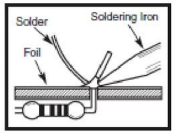
1. Solder all components from the copper foil side only. Push the soldering iron tip against both the lead and the circuit board foil.



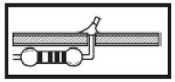
2. Apply a small amount of solder to the iron tip. This allows the heat to leave the iron and onto the foil. Immediately apply solder to the opposite side of the connection, away from the iron. Allow the heated component and the circuit foil to melt the solder.



3. Allow the solder to flow around the connection. Then, remove the solder and the iron and let the connection cool. The solder should have flowed smoothly and not lump around the wire lead.

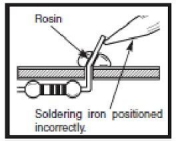


4. Here is what a good solder connection looks like.

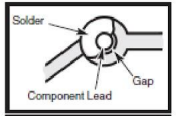


Types of Poor Soldering Connections

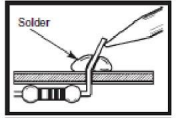
1. **Insufficient heat** - the solder will not flow onto the lead as shown.



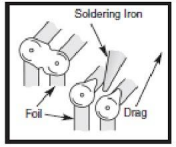
2. **Insufficient solder** - let the solder flow over the connection until it is covered.
Use just enough solder to cover the connection.



3. **Excessive solder** - could make connections that you did not intend to between adjacent foil areas or terminals.



4. **Solder bridges** - occur when solder runs between circuit paths and creates a short circuit. This is usually caused by using too much solder.
To correct this, simply drag your soldering iron across the solder bridge as shown.



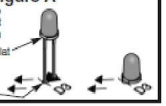
SECTION 1

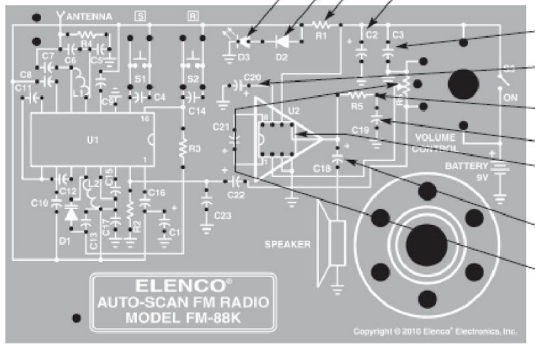
ASSEMBLE COMPONENTS TO THE PC BOARD

Place a check mark ☑in the box provided next to each step to indicate that the step is completed.

Figure A

Mount the LED flush to the PC board with the flat side in the same direction as marked.





- ☐ D3 - Red LED (see Figure A)
- ☐ D2 - 1N4001 Diode (see Figure B)
- ☐ R1 - 680Ω 5% 1/4W Res. (blue-gray-brown-gold)
- ☐ C2 - 220µF, Electrolytic (see Figure C)
- ☐ C3 - 0.1µF Discap (104)
- ☐ C20 - 22µF, Electrolytic (see Figure D)
- ☐ R5 - 10Ω 5% 1/4W Res. (brown-black-black-gold)
- ☐ C19 - 0.047µF Discap (473)
- ☐ U2 - 8-pin IC Socket
- ☐ U2 - LM-386 IC (see Figure E)
- ☐ C18 - 220µF, Electrolytic (see Figure D)
- ☐ R6/S3 - Potentiometer
- ☐ Nut & Washer
- ☐ Knob (see Figure F)

Figure B

Mount the diode flush to the PC board with the printed band in the same direction as marked.

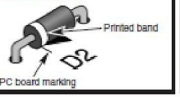


Figure C

Mount capacitor C2 on the back of the PC board in the location shown. Make sure the lead with the polarity marking is in the correct hole as shown.

Figure D

Electrolytics have a polarity marking indicating the (–) lead. The PC board is marked to show the lead position.

Warning:

If the capacitor is connected with incorrect polarity, or if it is subjected to voltage exceeding its working voltage, it may heat up and either leak or cause the capacitor to explode.

Figure E

Insert the IC socket into the PC board with the notch in the direction shown on the top legend. Solder the IC socket into place. Insert the IC into the socket with the notch in the same direction as the notch on the socket.

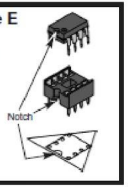
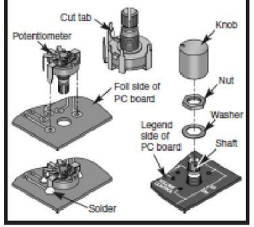


Figure F

Cut the tab off of the potentiometer as shown. Insert the potentiometer into the PC board holes, from the foil side, as shown. Place the washer over the shaft and tighten the nut. Solder the potentiometer into place and then insert the knob onto the shaft.



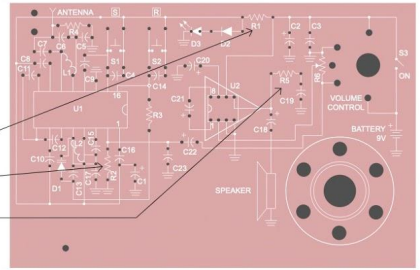
1. Resistors

Step 1 (Front)

Solder the following resistors to the board.

Checklist

- ☐ R1 - 680 Ω 5% 1/4W (blue-gray-brown-gold)
- ☐ R2 - 18 Ω 5% 1/4W (brown-gray-orange-gold)
- ☐ R5 - 10 Ω 5% 1/4W (brown-black-black-gold)



Helpful Tips

Resistors can be inserted in any direction.

Check their colored bands to verify the correct resistance.

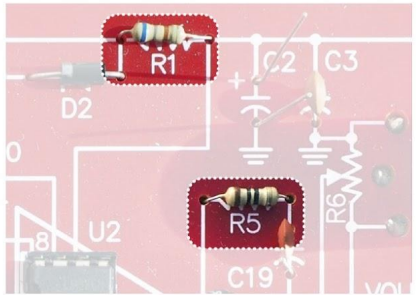
Resistor Symbol

About Resistors

Resistors reduce current flow through a circuit. They can also be commonly used to adjust signal levels and divide voltages.

They are made of an insulator, a material that limits electrons flowing through a circuit.

They come in a range of values, depending on how much resistance is needed.



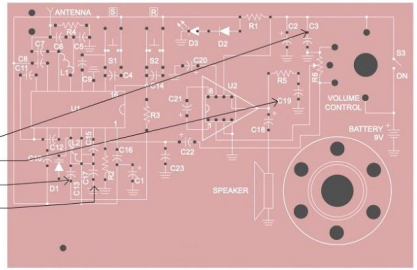
2. Non-Polarized Capacitors

Step 2 (Front)

Solder the following capacitors to the board.

Checklist

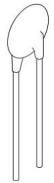
- ☐ C3 - 0.1µF (104)
- ☐ C19 - 0.047µF (473)
- ☐ C13 - 680pF (681)
- ☐ C17 - 0.1µF (104)

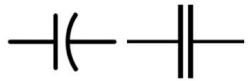


Helpful Tips

Nonpolarized capacitors can be inserted in any direction.

Check their printed numbers to verify the correct capacitance.



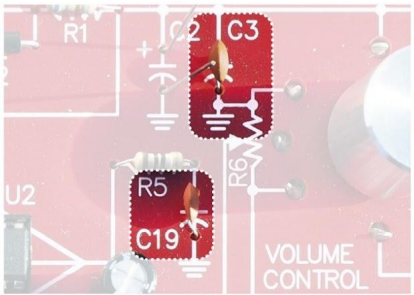


Capacitor Symbols

About Capacitors

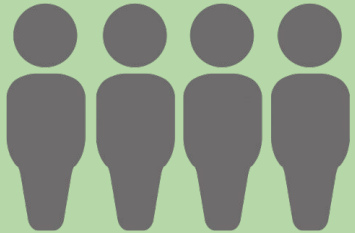
Capacitors store electrical energy like a small battery. They can smooth out signals (like a battery that cuts on and off) and track signals (if it is charged or discharged).

It is made of two metal plates with an insulator, a material that does not allow electricity to pass, in between. As you run power through the capacitor, the electrical charge builds up on the plate and stays stuck there. If you cut off the power, then there is still some energy left.

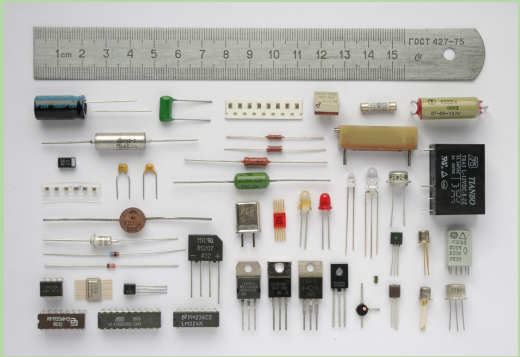


Questions

Who would be a potential point of contact(s) in the community for content creation and for the CCB training?



What is the availability of basic electronic components in the area?



What type of electronics training is already happening? Is there additional electronics you would like to learn?

Next Steps: January

- Radio Licensing
- Content development by Board
- Crowdsourcing for project funds
- CCB Content Creation

  Educational modules for electronics pre-radio building
- Finalize load calculations for solar panel system



Thank You!

Questions and Comments?