



# Scintilla Soldering Course

17 / 18 October 2022



# Planning

## Lecture

- ⚡ What is soldering?
- ⚡ Electronic components
- ⚡ Soldering techniques
- ⚡ Finding and fixing errors
- ⚡ Principles of the audio amplifier

## Practical

- ⚡ Planning your lay-out
- ⚡ Assembling your lay-out
- ⚡ Soldering the components
- ⚡ Testing
- ⚡ Debugging
- ⚡ Testing
- ⚡ Etc.

# What is soldering?

## Breadboard

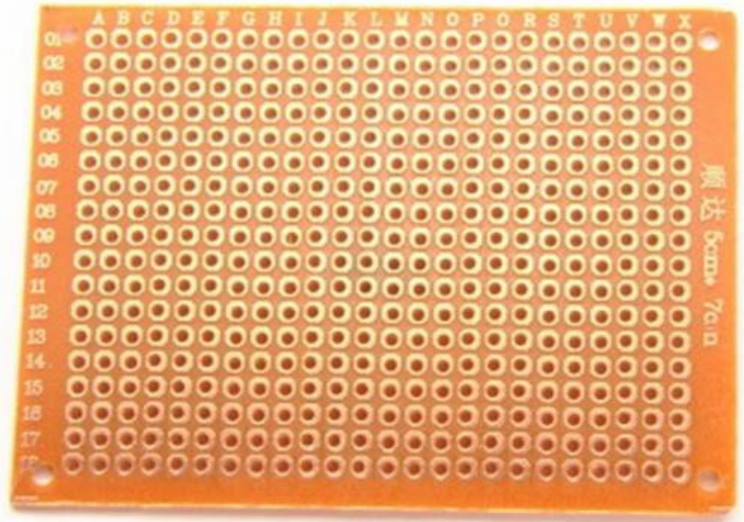
- ⚡ For testing
- ⚡ Temporary
- ⚡ Fragile
- ⚡ Not suitable for high frequencies

## Soldering

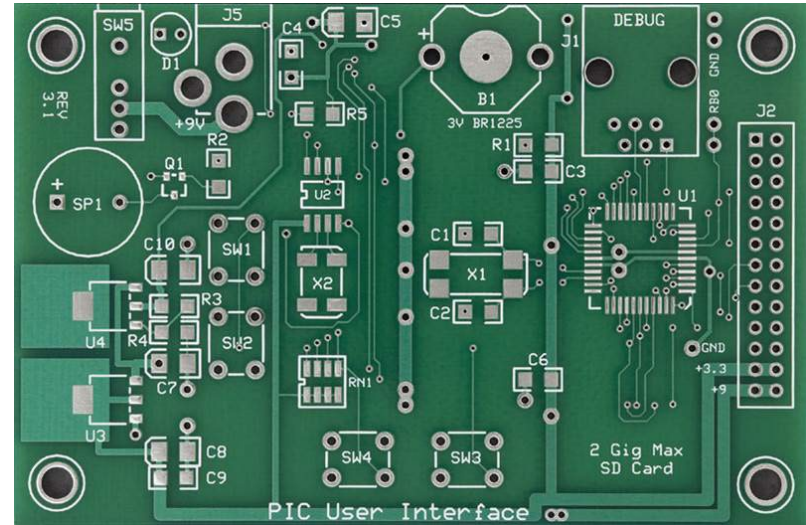
- ⚡ Permanent
- ⚡ Rigid and proper electrical connections
- ⚡ Durable

# What is soldering?

## Through-hole (THT)



## Surface mount (SMD)

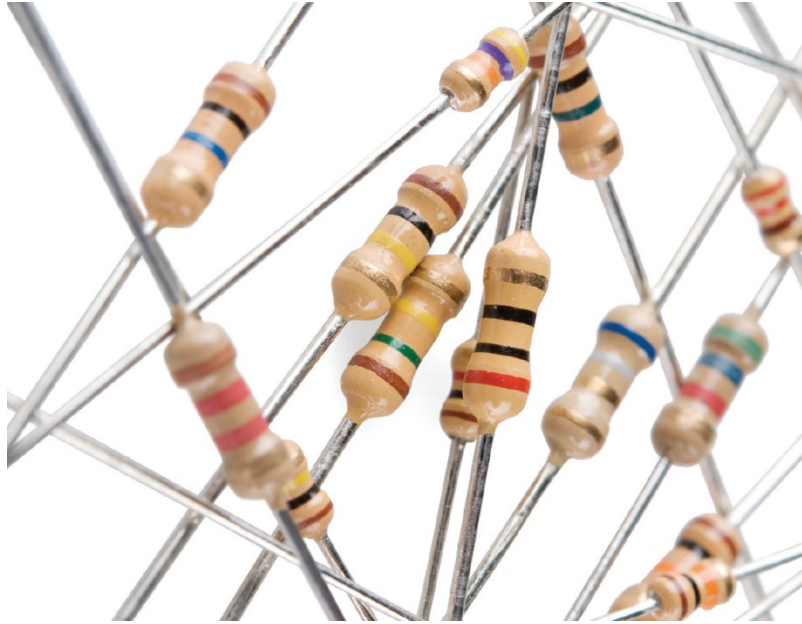




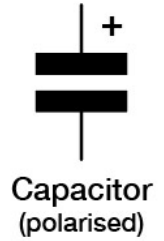
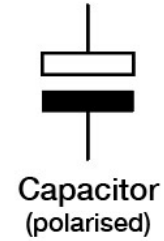
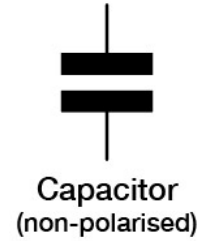
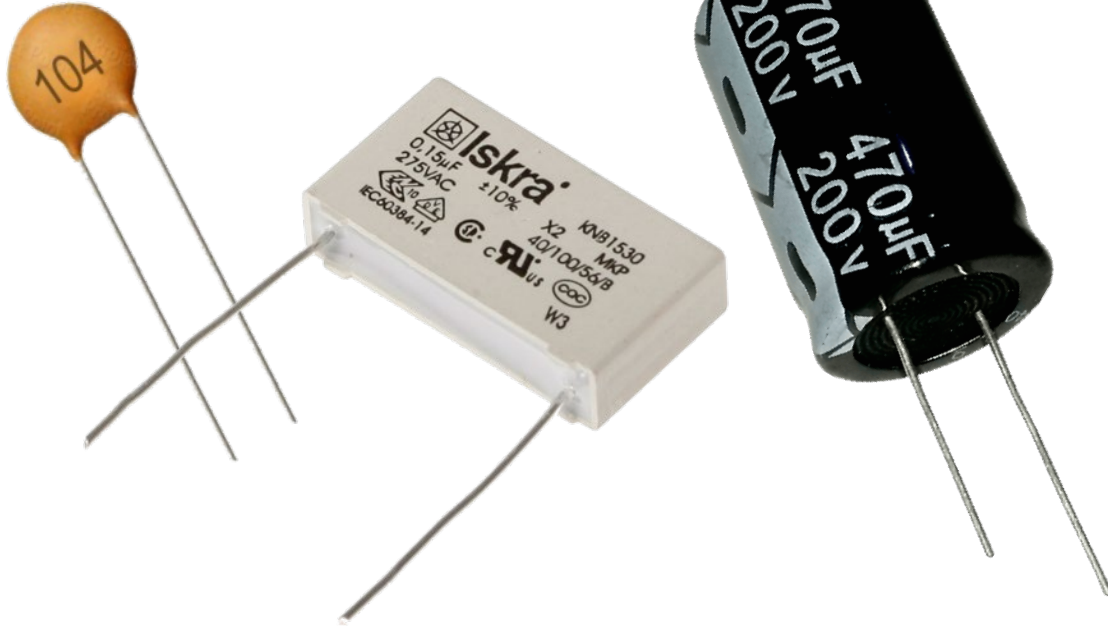
What to take into account?

# Electronic Components

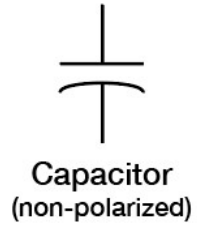
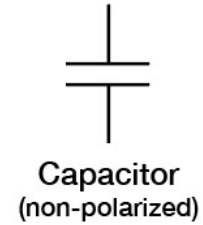
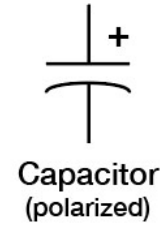
# Resistors



# Capacitors



Alternatives



# Polarized Components

**Only possible to connect in 1 direction**

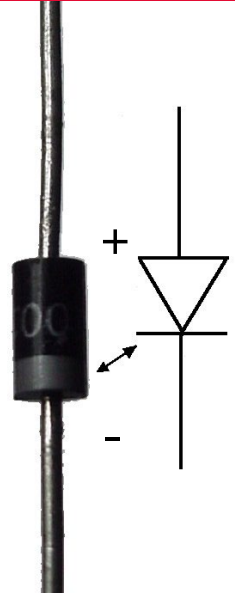
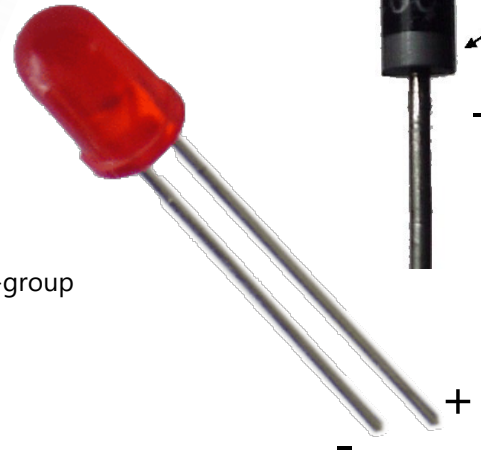
📡 Long side usually '+'

📡 White stripe usually '-'



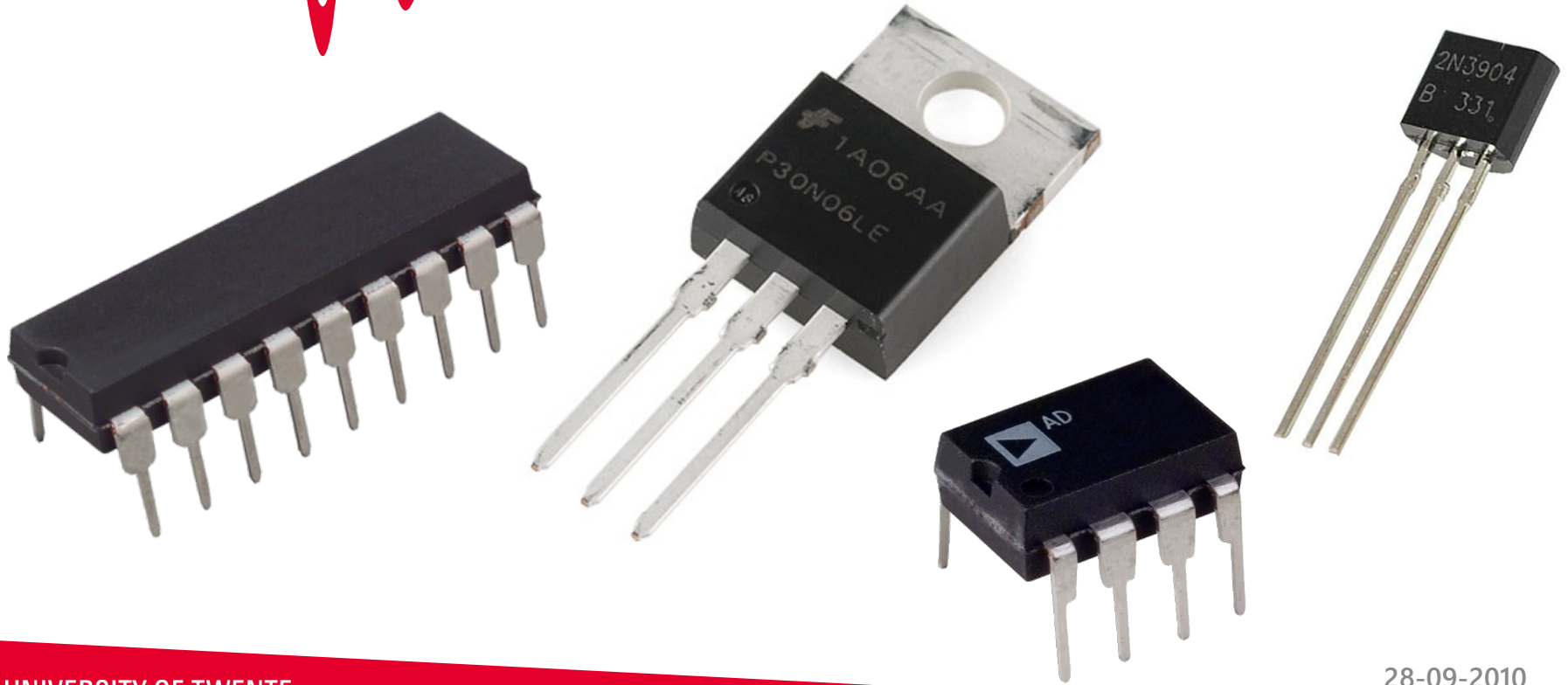
\*Not sponsored

\*\* Not affiliated to Duracell do-group





# Help it has more pins!?



# Reading Datasheets

## What can you find?


- Maximum ratings
- Common applications
- Electrical characteristics
- Pin layout(!)

**FAIRCHILD**  
SEMICONDUCTOR

**MJE3055T**

General Purpose and Switching Applications

- DC Current Gain Specified to  $I_C = 10A$
- High Current Gain-Bandwidth Product:  $f_T = 2MHz$  (Min.)



TO-220  
1.Base 2.Collector 3.Emitter

**NPN Silicon Transistor**

**Absolute Maximum Ratings**  $T_C = 25^\circ C$  unless otherwise noted

Symbol	Parameter	Value	Units
$V_{CE0}$	Collector-Base Voltage	70	V
$V_{CE0}$	Collector-Emitter Voltage	60	V
$V_{EB0}$	Emitter-Base Voltage	5	V
$I_C$	Collector Current	10	A
$I_B$	Base Current	6	A
$P_C$	Collector Dissipation ( $T_C = 25^\circ C$ )	75	W
$P_C$	Collector Dissipation ( $T_C = 25^\circ C$ )	0.6	W
$T_J$	Junction Temperature	150	$^\circ C$
$T_{STG}$	Storage Temperature	-55 ~ 150	$^\circ C$

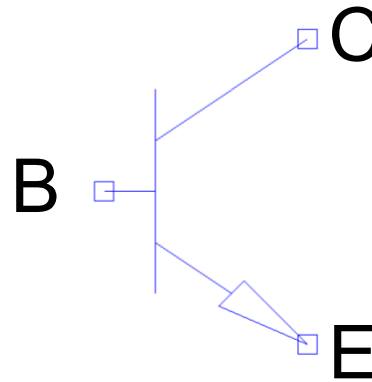
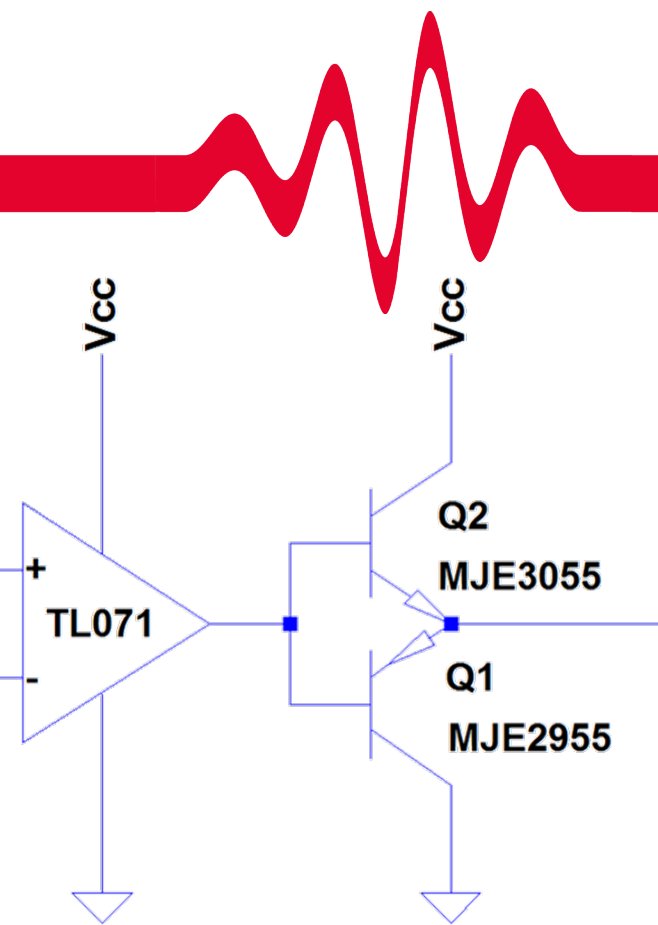
**Electrical Characteristics**  $T_C = 25^\circ C$  unless otherwise noted

Symbol	Parameter	Test Condition	Min.	Max.	Units
$BV_{CE0}$	Collector-Emitter Breakdown Voltage	$I_C = 200mA, I_B = 0$	60		V
$I_{CE0}$	Collector Cut-off Current	$V_{CE} = 30V, I_B = 0$		700	$\mu A$
$I_{CEX1}$	Collector Cut-off Current	$V_{CE} = 70V, V_{BE}(OFF) = -1.5V$		1	mA
$I_{CEX2}$	Collector Cut-off Current	$V_{CE} = 70V, V_{BE}(OFF) = -1.5V$ @ $T_C = 150^\circ C$		5	mA
$I_{EB0}$	Emitter Cut-off Current	$V_{EB} = 5V, I_C = 0$		5	mA
$h_{FE}$	DC Current Gain	$V_{CE} = 4V, I_C = 4A$ $V_{CE} = 4V, I_C = 10A$	20 5	100	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 4A, I_B = 0.4A$ $I_C = 10A, I_B = 3.3A$		1.1 8	V V
$V_{BE(on)}$	Base-Emitter On Voltage	$V_{CE} = 4V, I_C = 4A$		1.6	V
$f_T$	Current Gain Bandwidth Product	$V_{CE} = 10V, I_C = 500mA$	2		MHz

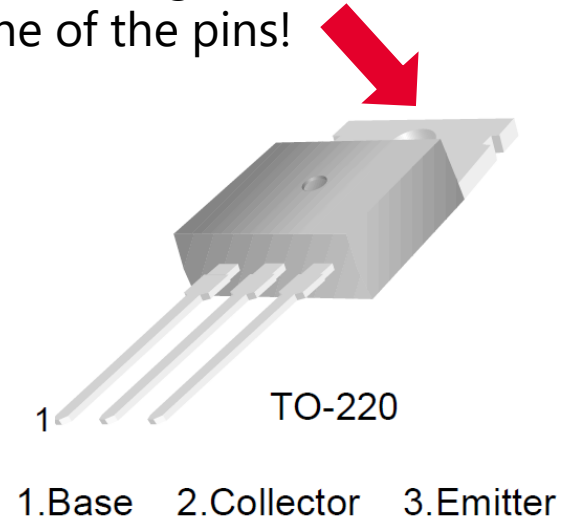
\* Pulse test: PW<300 $\mu s$ , duty cycle<2% Pulse

MJE3055T

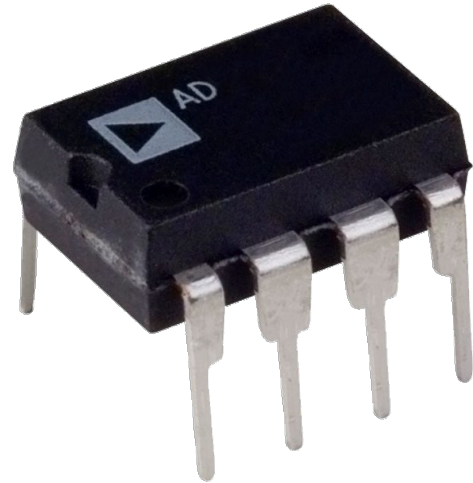
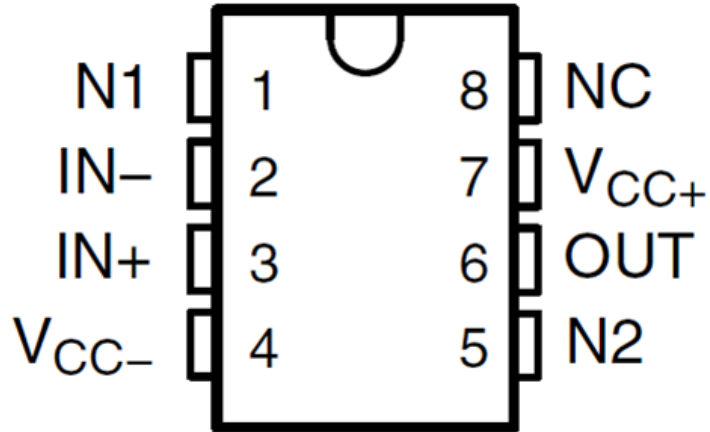
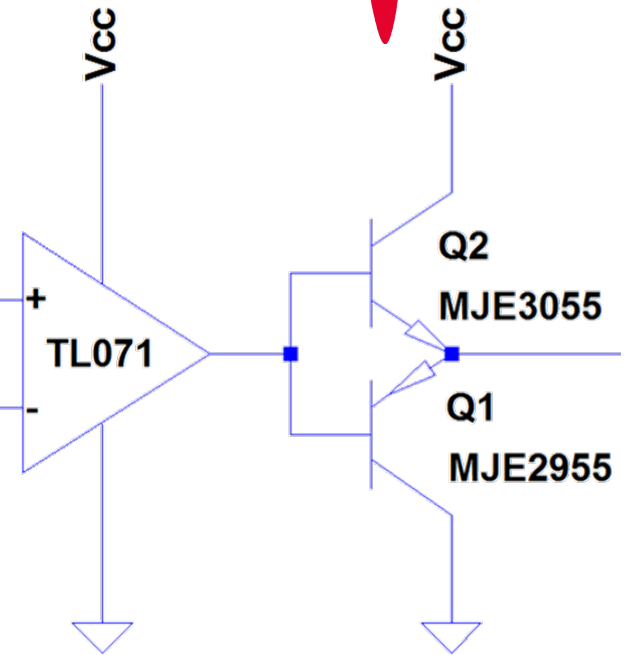
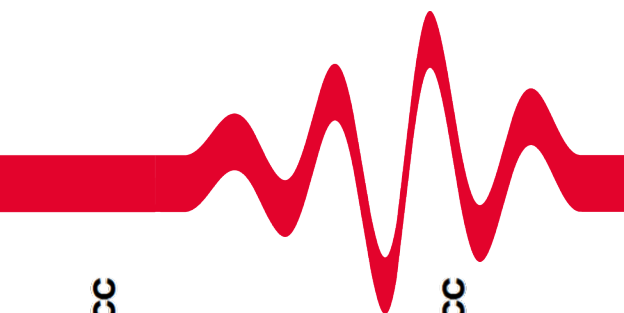
# Transistor



Heat sink might be connected to one of the pins!



# Op-Amp



# IC Sockets

## What are they used for?

- Easy to replace components
- Prevents overheating during soldering





Do's and don'ts

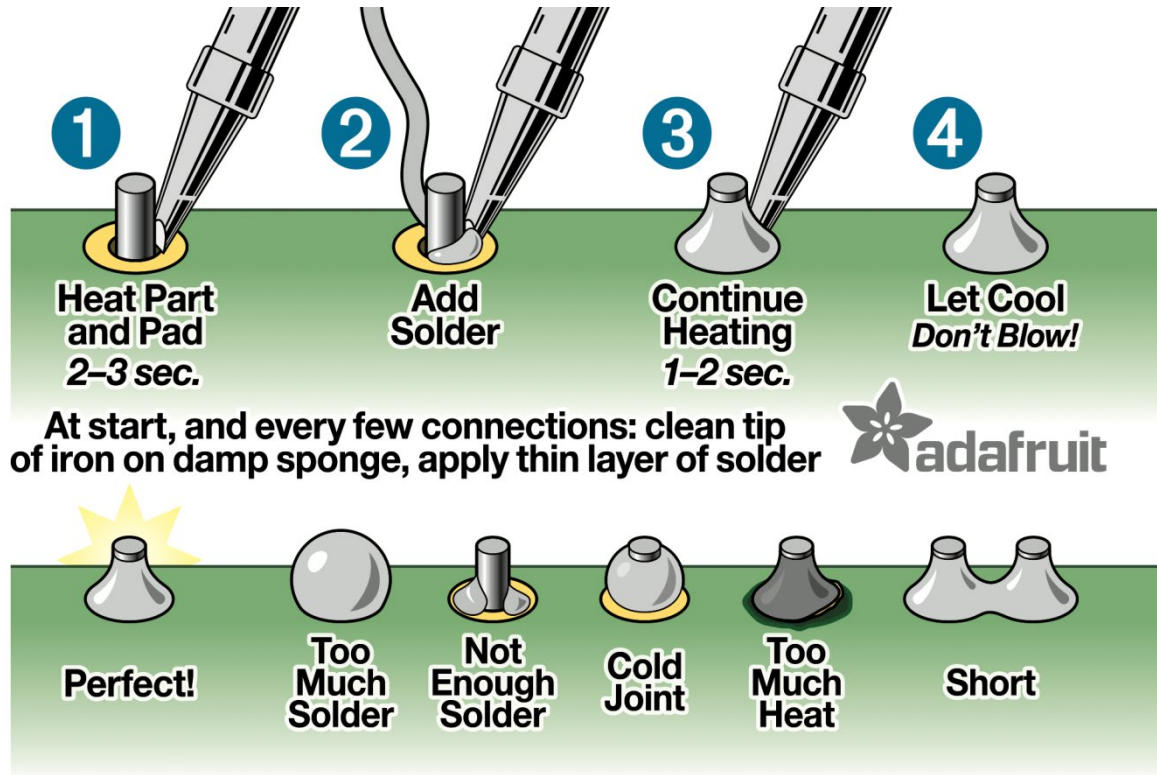
# Soldering techniques

# Sorts of tin

- 📡 Unleaded solder ~330°C
  - Has an expiration date
  - Uses flux core
- 📡 Leaded solder ~230°C
  - Higher melting point
  - Toxic fumes
  - Easier to solder
- 📡 Flux
  - 'Repairs' oxidized metals

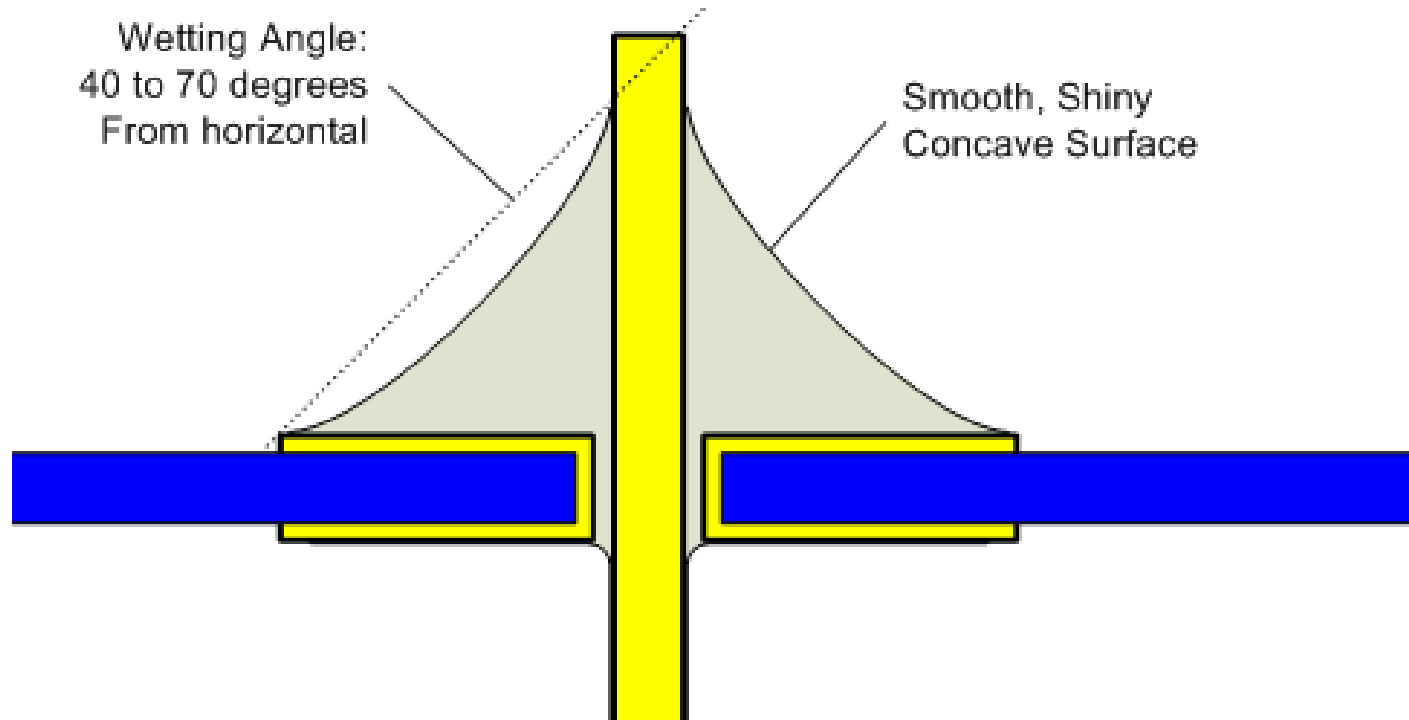


# How to do it correctly





# Correct Joint



# Cold Joint

**Cause: cold metal**

Solution: Reheat (and add new solder/flux)



# Dry Joint

**Cause: Movement  
during cooling**

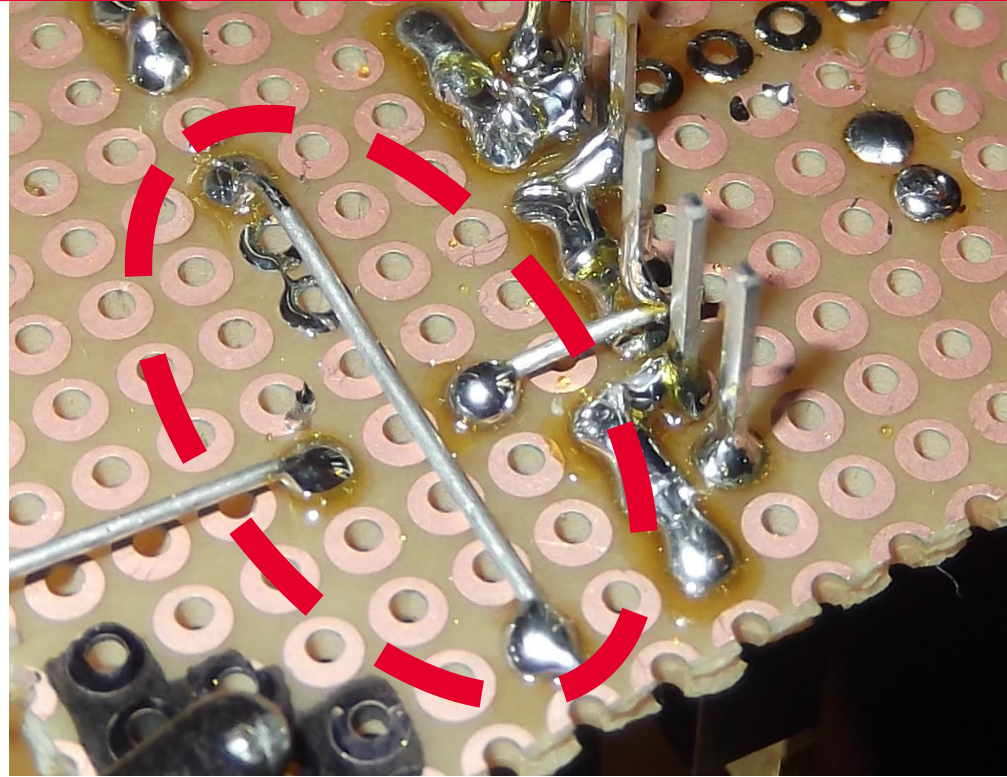
Solution: Reheat



# Connections

## Using Component Legs

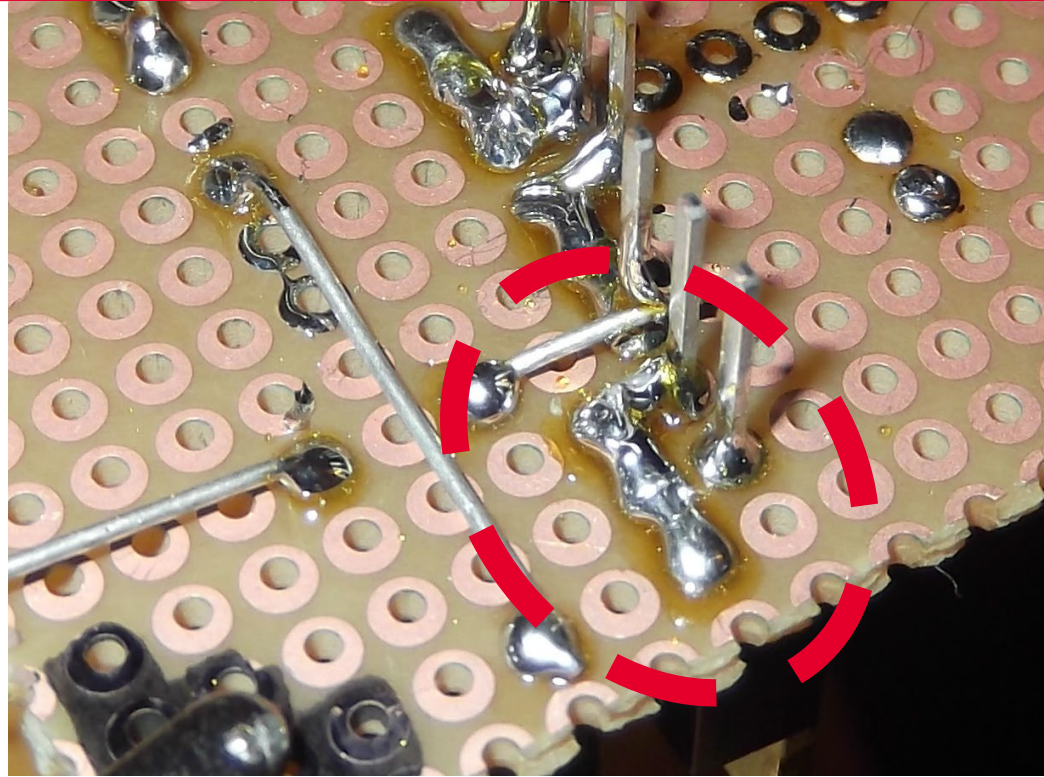
- ⚡ Saves effort and solder
- ⚡ Use the components to make a bridge



# Connections

## Using Solder Bridges

- Connects nearby components
- Use tin to make the connection





# Connections

## Using Wire Bridges

- 📡 Covers large distances
- 📡 Makes circuit chaotic
- 📡 Try to avoid these!



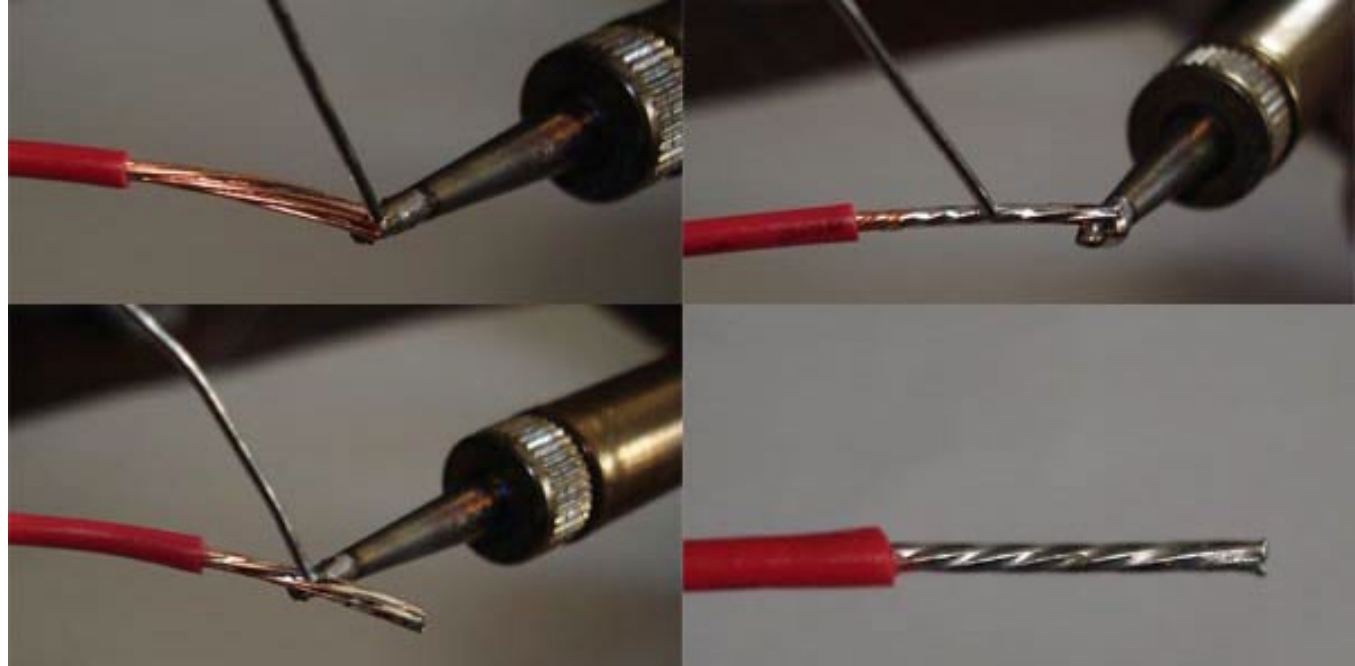
# Fitting Components

## Keep it tidy!

- Make sure components are flush with the PCB
- Avoid using wires
- Do not connect the IC until after soldering



# Soft Core Wires







And fixing them!

# Finding Errors

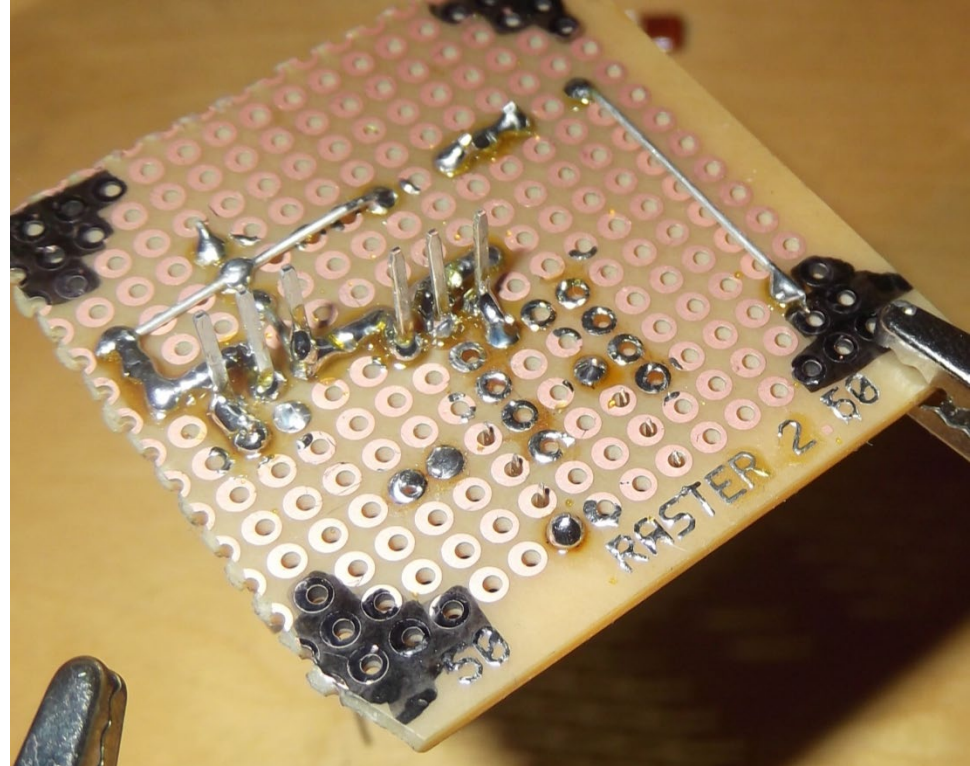
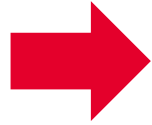
# Finding errors

- 📡 Visual inspection
- 📡 Voltage measurements at critical points
- 📡 Follow the signal
- 📡 Common errors:
  - Missing connections
  - Short circuits
  - Cold joints
  - Dry joints

# Visual Inspection

## Clearly not finished

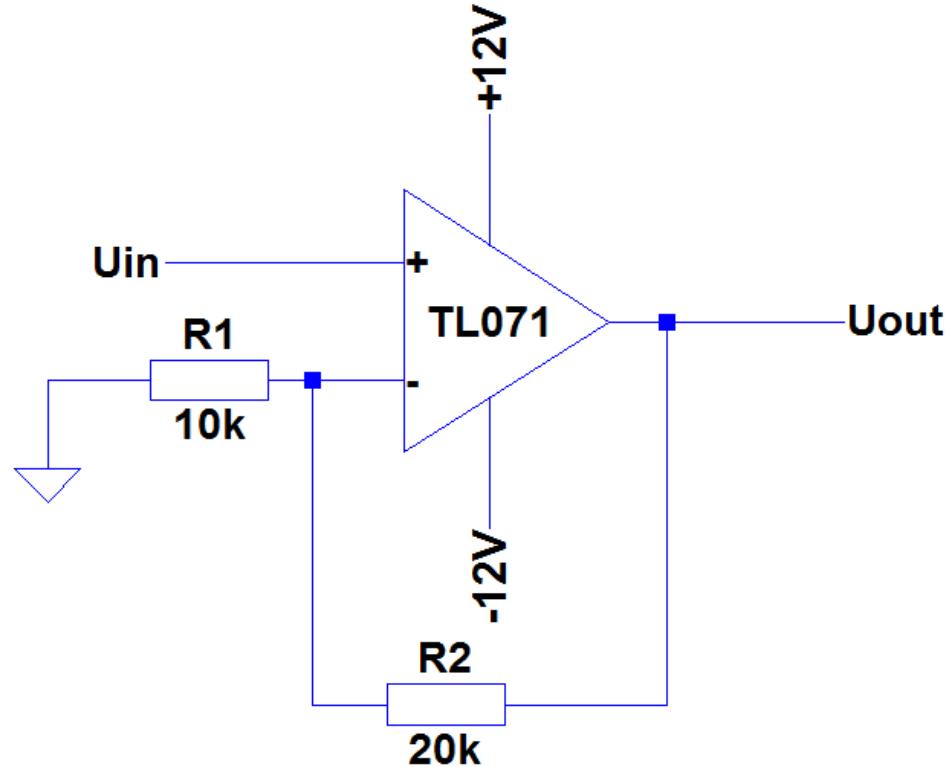
Fast and simple method to find faulty or missing connections



# Voltage measurement

**What voltages do you expect at every node?**

- 📡 Check DC first
- 📡 Then follow the signal through the circuit

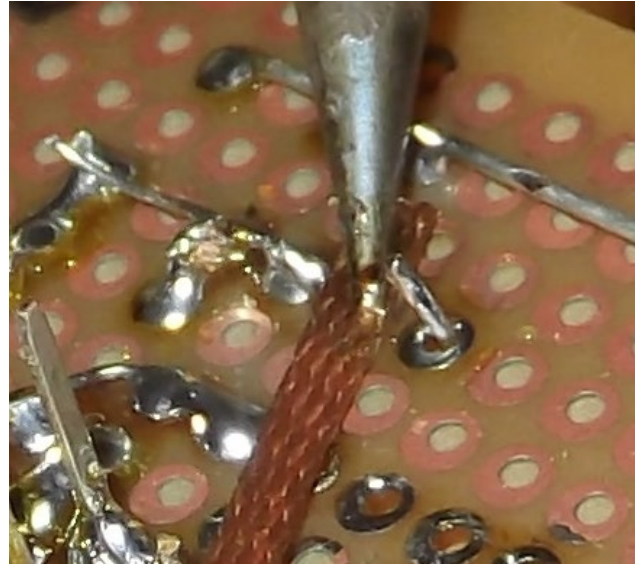


# Fixing errors

## Desoldering Pump



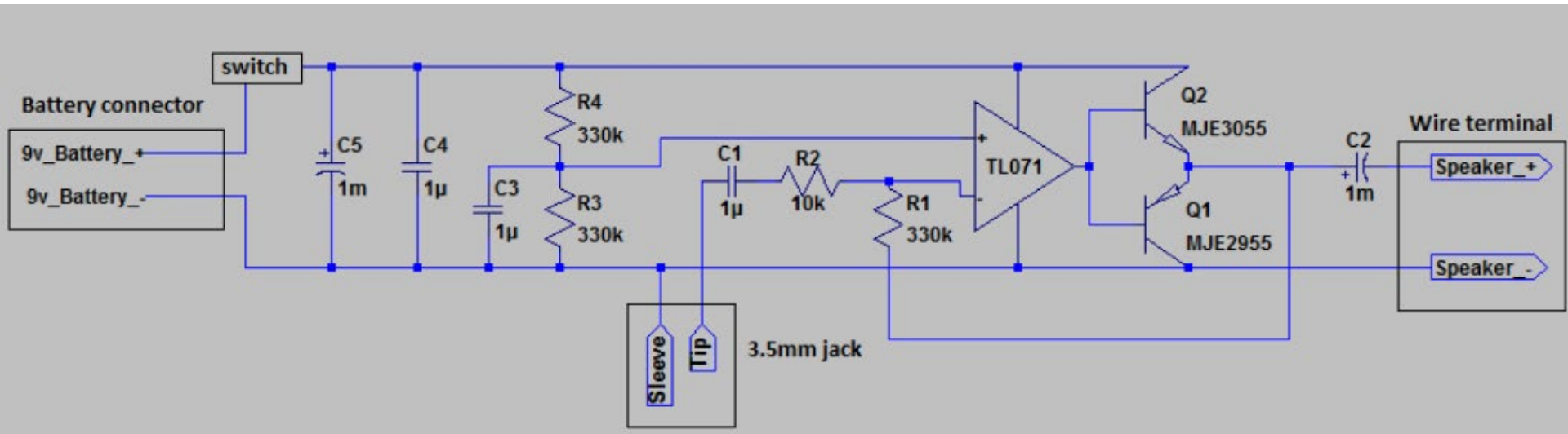
## Desoldering Wick





# Audio Amplifier

# The Practical



# Jack Plug

Mono amplifiers only  
use the **left** channel



Right channel

Ring



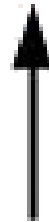
Sleeve

Ground



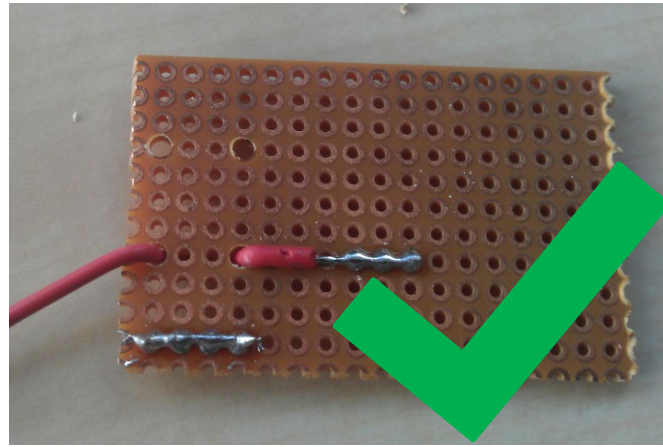
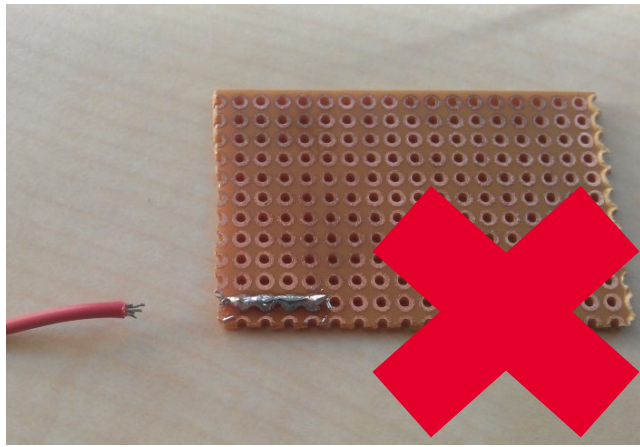
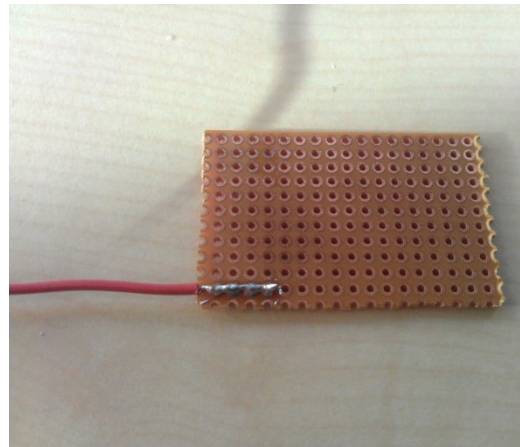
Tip

Left channel





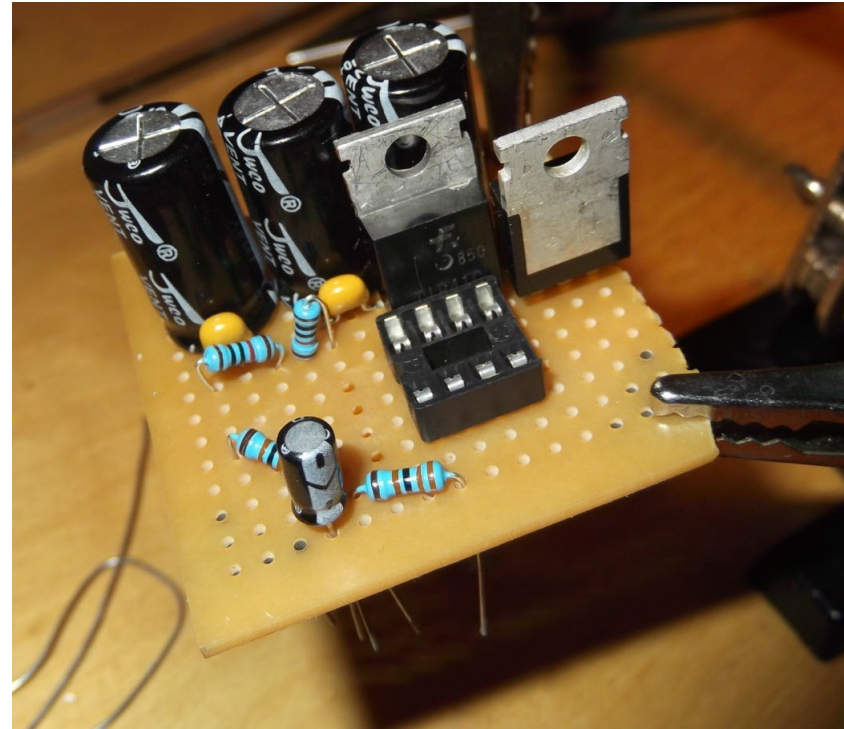
# Connecting the Jack



# Final Product

## How to get here?

- 📡 Analyse the circuit diagram
- 📡 Make a layout on the PCB
- 📡 Insert the components and solder them





# Final Product

- 📡 Taking the schematic and placing the components on the PCB is very time consuming
- 📡 **This process might take (most of) the first evening!**



**Good luck and happy soldering!**

You can ask the MasterCLASS members  
for an example on how to solder a  
component.