

# Lecture 02 - BASIC COMPONENTS

## Everything on what you put on a PCB

# Outline

- Introduction
- Where do I buy stuff?
- Passive Components
- Transistors & ICs
- Connectors
- Summary

# Capitalism!

Let's go buy some components

Most components you need will be available at DigiKey or Mouser, but if you need something not there it may still exist!



**MOUSER  
ELECTRONICS.**

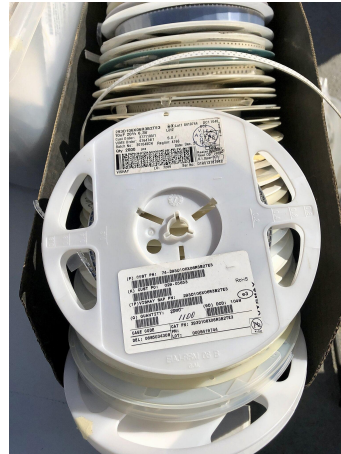
# Packaging

How we get these

## Cut Tape



## Reel

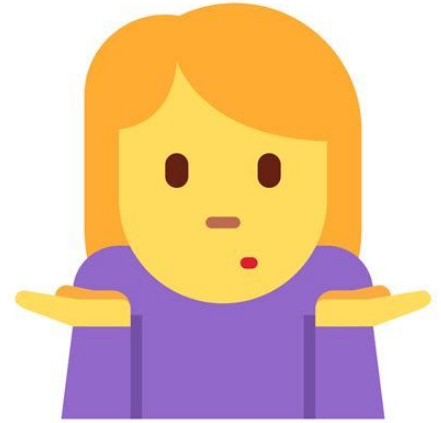


## Tray



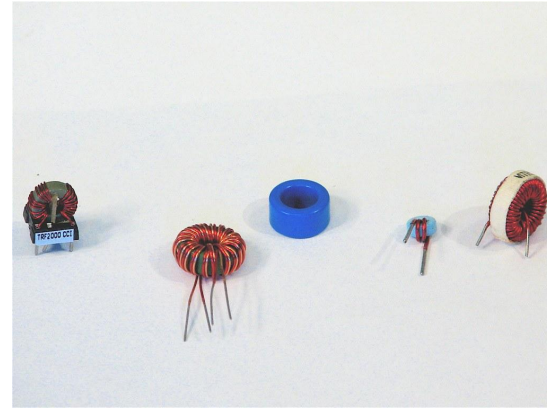
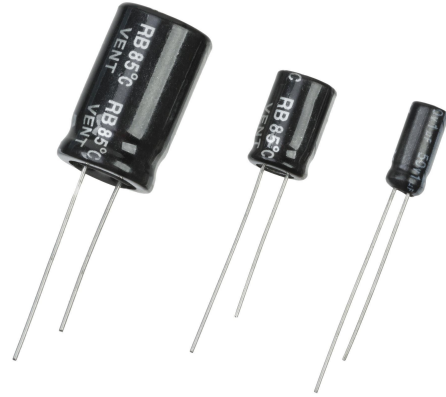
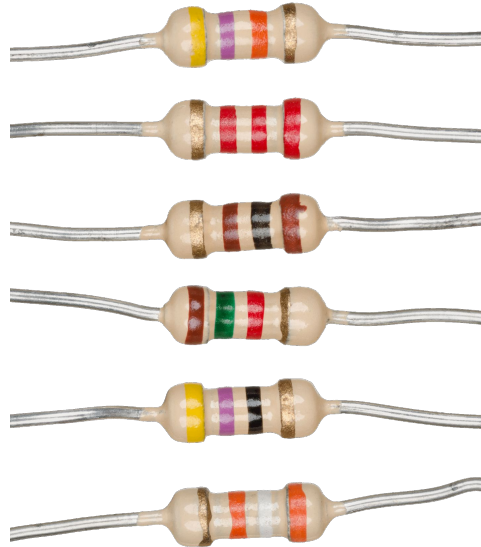
# Passive Components

Single function components that don't really think



# What are passives?

- Resistors
- Capacitors
- Inductors



# Resistors on a PCB

- Facilitates a voltage drop
- Consumes power
  - Limited resource on your PCB!

$$P = V^2/R$$

$$V = IR$$

# Capacitors on a PCB

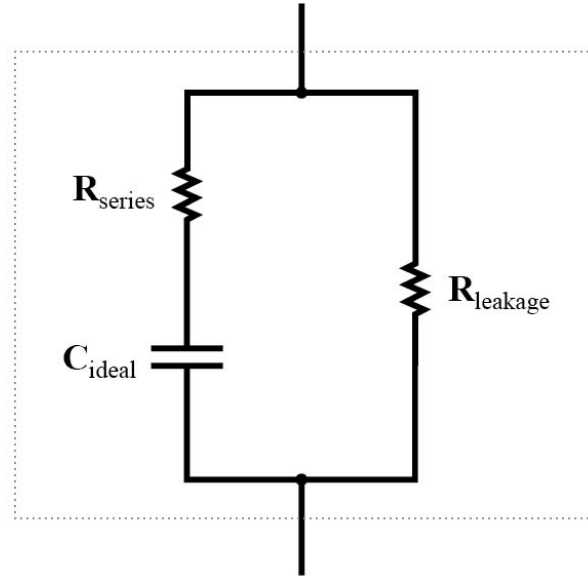
- **Help maintain steady power supply to vulnerable components**
  - **Bypass capacitors**
- **Resists changes in *voltage***
- **Tantalum or Ceramic**
  - **Ceramic: better ESR & ESL, can handle higher ripple**
    - **Typically the standard currently**
  - **Tantalum: less degradation over time**



# Tangent: Parasitics

- **ESR = Equivalent Series Resistance**
  - Contributes to total power consumption
- **ESL = Equivalent Series Inductance**
  - Can mess with high power or high frequency applications

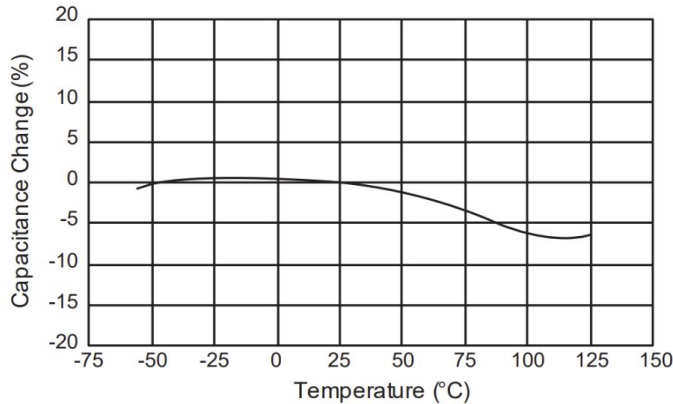
Capacitor equivalent circuit



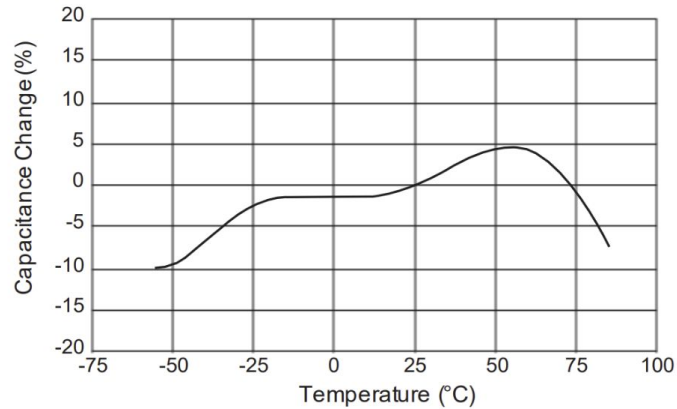
allaboutcircuits.com

# Tangent: Temperature Dependence

[Example of Temperature Characteristics X7R(R7)]  
Sample: 0.1 $\mu$ F, Rated Voltage 50VDC



[Example of Temperature Characteristics X5R(R6)]  
Sample: 22 $\mu$ F, Rated Voltage 4VDC



<https://search.murata.co.jp/Ceramy/image/img/A01X/G101/ENG/GRM21BR61E106KA73-01.pdf>

# Inductors on a PCB

- Resists changes in *current*
- Common in power converters
- Used for oscillators and filters
- Also used for electromagnetics
  - Think motors

# Packaging Passives

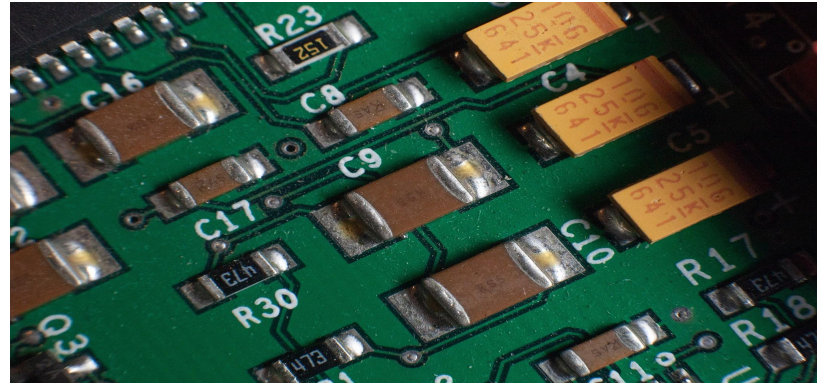
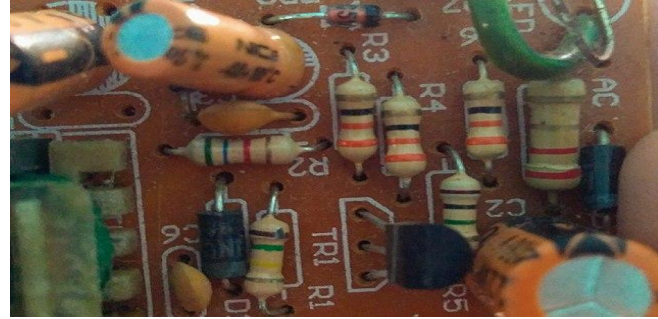
## Surface Mount vs. Through Hole

### Through Hole

- Mostly hand soldered
- Require holes in PCB

### Surface Mount

- Better for pick and place
- Typically take less space



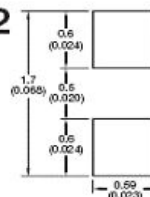
# Surface Mount Packages

- Anything smaller than 0402 should be machine soldered
- You will solder 0402s in lab and decide if they're too small for you
- Largest benefit of larger packages is ease of soldering

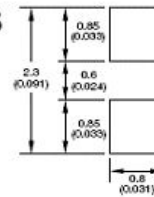
## REFLOW SOLDERING

Dimensions: millimeters (inches)

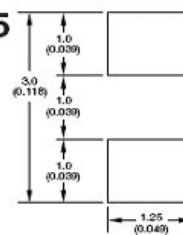
0402



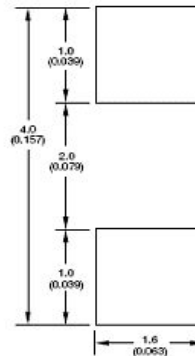
0603



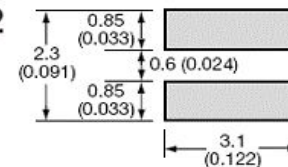
0805



1206



0612



# Ratings

Category	Significance
Tolerance	Amount of over/under-voltage a component can handle for short periods
Voltage	Voltage the component should generally operate at
Power	Maximum power the component can handle
Temperature	Mostly important to high reliability applications

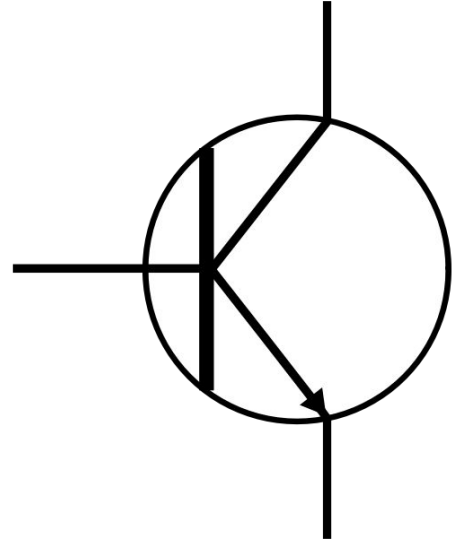
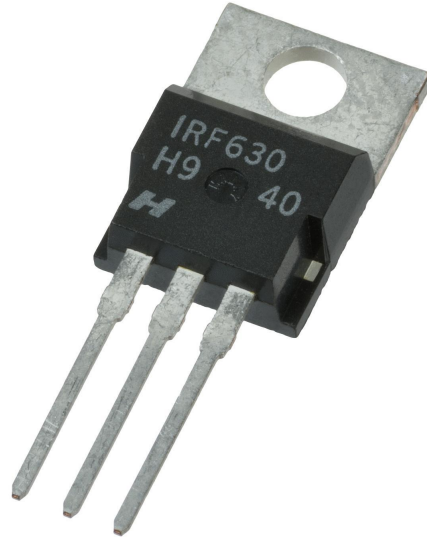
# **Transistors & ICs**

**MOSFETs, BJTs, ICs, oh my!**

# What is a transistor?

Fancy switches!

- In 6.2000 there are ideal switches. Those get replaced with these (or human controlled buttons) on a PCB
- Typically Bipolar Junction Transistors (BJTs) or Field Effect Transistors (FETs)

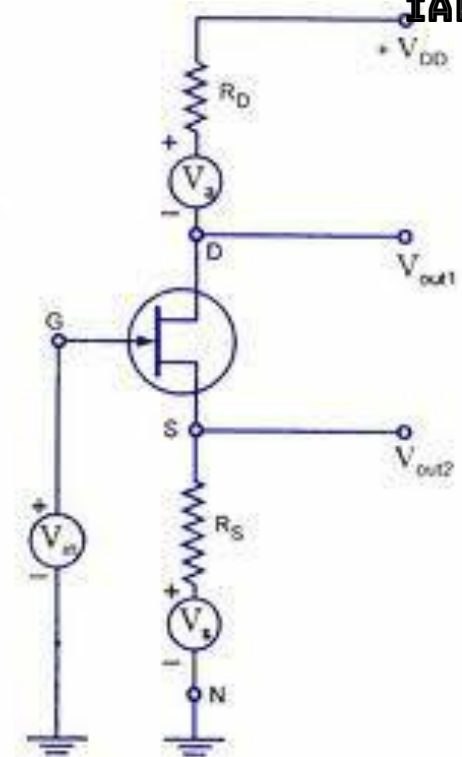
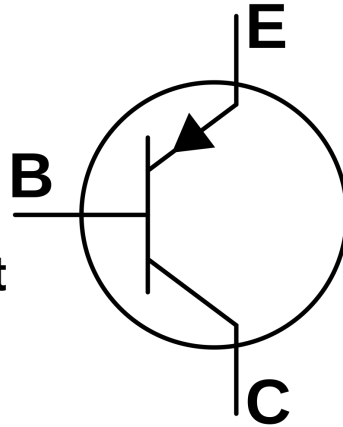




# Using transistors

## Fancy switches!

- The datasheet will tell you how to connect to your circuit
- Require that very fairly specific voltages be put into them
- Directional components!



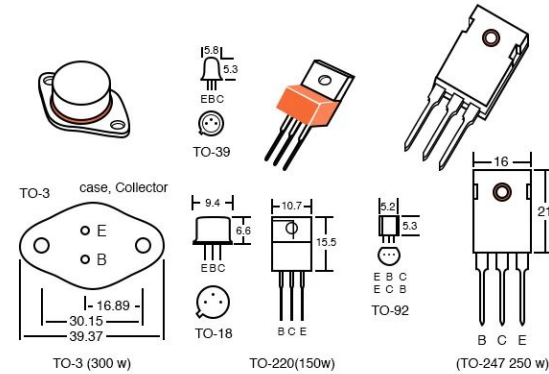
# Transistor Packaging

## 3-Prong Through Holes

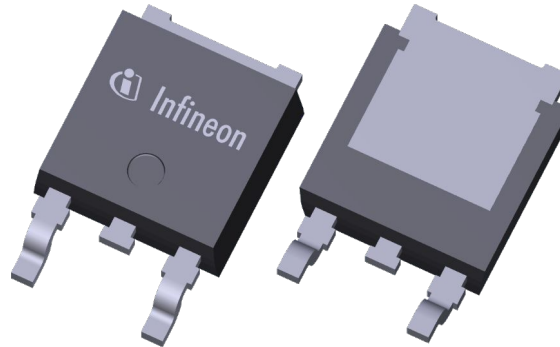
- TO-\_\_\_\_
- Number refers to space between prongs

DPAK

SOT-\_\_



allaboutcircuits.com



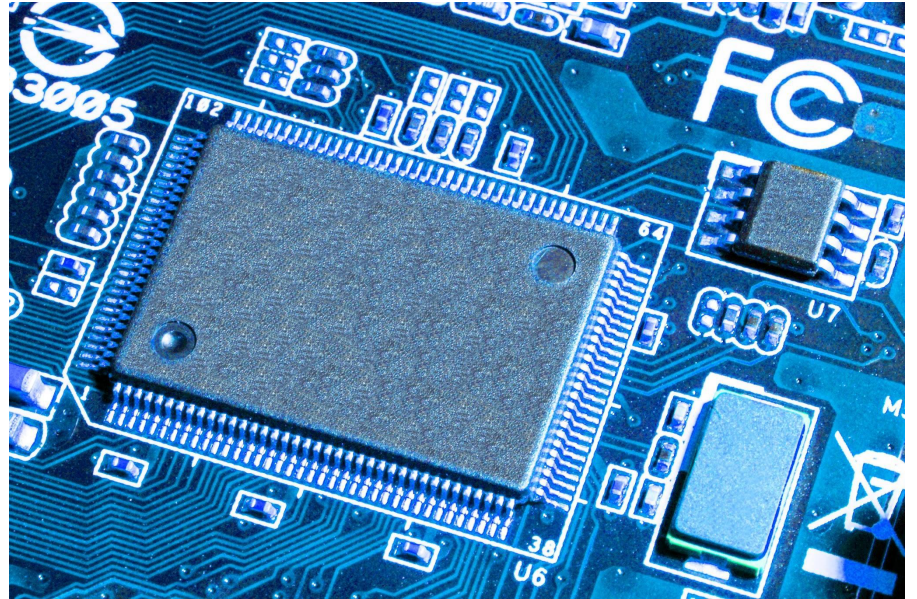
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# Integrated Circuits (ICs)

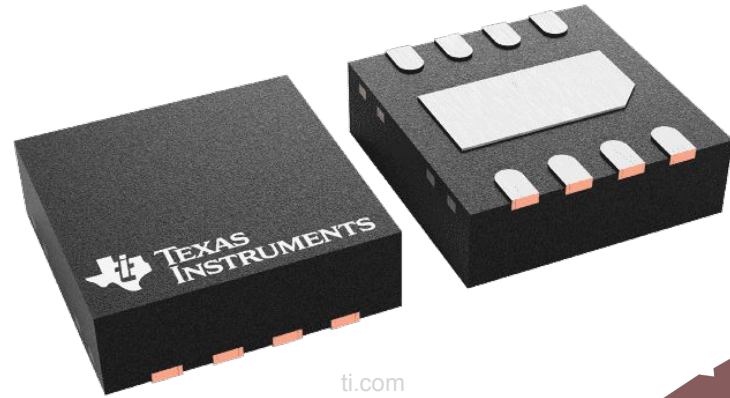
- Many typical circuits can be found in IC form
- Will help save space on board
- Typically most expensive components



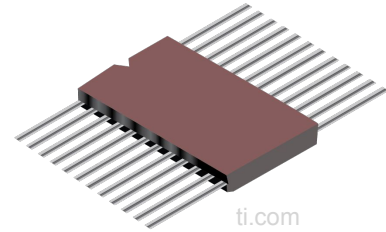
# IC Packaging

## Flatpacks

- Will typically include how many leads there are in the package name
- Lead vs. Leadless



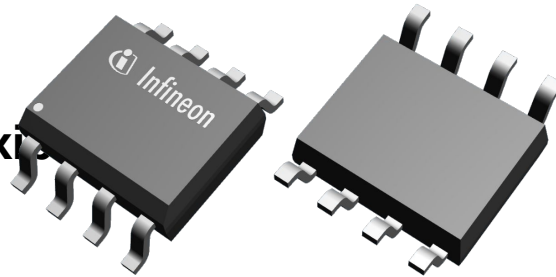
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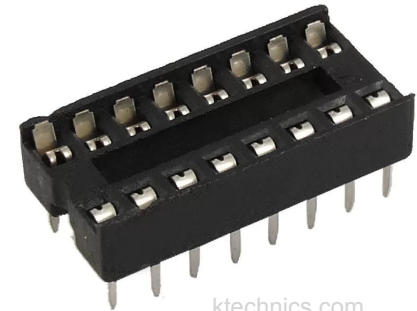
ti.com

## DIP

- Dual In-Line Package
- Good for testing and flexibility



infineon.com



ktechnics.com

# IC Schematic Note!!!

- Most ICs have suggested topologies in their datasheets, use them!

## EMC RECOMMENDED CIRCUITS

EN50155 (EN50121-3-2) (EN55011 Class A)

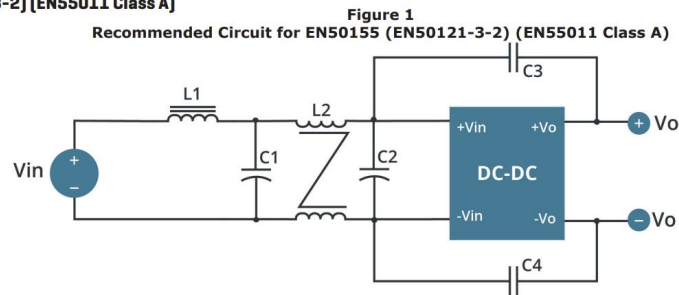


Table 1

Recommended External Circuit Components							
Model	D1	C1	C2	C3	C4	L1	L2
VHB150R-T110-S5	1.5KE180A Littelfuse	220uF/200V YXF	220uF/200V YXF	2200 pF	2200 pF	5 μH	0.33 mH
VHB150R-T110-S12	1.5KE180A Littelfuse	220uF/200V YXF	220uF/200V YXF	2200 pF	2200 pF	5 μH	0.33 mH
VHB150R-T110-S24	1.5KE180A Littelfuse	220uF/200V YXF	220uF/200V YXF	2200 pF	2200 pF	5 μH	0.33 mH

Note: C1, C2 Aluminum Capacitors and C3, C4 Ceramic Capacitors

<https://www.cui.com/product/resource/vhb150r.pdf>

# Connectors

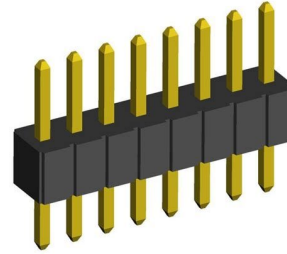
**Come together, right now!**



# Connectors

## Headers

- Can have many pins
- Low Voltage, Signal
- Connect to other connector



bentex.com.hk

## Terminal Block

- AKA Screw Terminal
- Power or Signal
- Connect to wires



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newark.com

## Test Points

- Connect to probe or alligator clips



resources.altium.com

# To Consider



# Considerations for all components

## Power

- Can it handle enough?
- Does it match the voltage and current throughout the circuit?

## Size

- Will this component fit on my board?
- Will a person or pick and place machine be able to work with this component?

## Familiarity

- Do you trust this component? Will you need to test it first?

# Questions?