# PCB Design Guidelines and Tips

PCB Design Guidelines and Tips

- Every project must have a custom PCB
- Think carefully about <u>your project</u> and its <u>PCB design</u> and ask the following questions:
  - What PCB components are necessary to meet requirements?
  - Prototype your idea before designing your PCB (**Breadboard Demos**).
  - How much time would be required to <u>design</u>, <u>fabricate</u>, <u>solder</u>, <u>test</u> and <u>redesign</u> the PCB?
    - This course orders PCBs in waves
    - It takes about 7-10 days to go from PCB wave deadline to delivery
  - Every PCB must have a processor
    - Typical projects have microcontrollers (ESP, ATmega, STM, etc).
    - Raspberry Pi board okay but needs to interface with your custom PCB that also has a microcontroller
    - FPGA board okay but needs to interface with your custom PCB that also has a microcontroller
  - Consider assembly before choosing PCB components
    - Size and soldering leads (through hole pins preferred, surface mounts components okay but we careful)

Prototyping Stage (Breadboard Demos)

- Before designing your PCB, test your idea with discrete components and development boards.

- Validate the functionality of your design before designing your PCB.

- If your first PCB does not work, debug it!
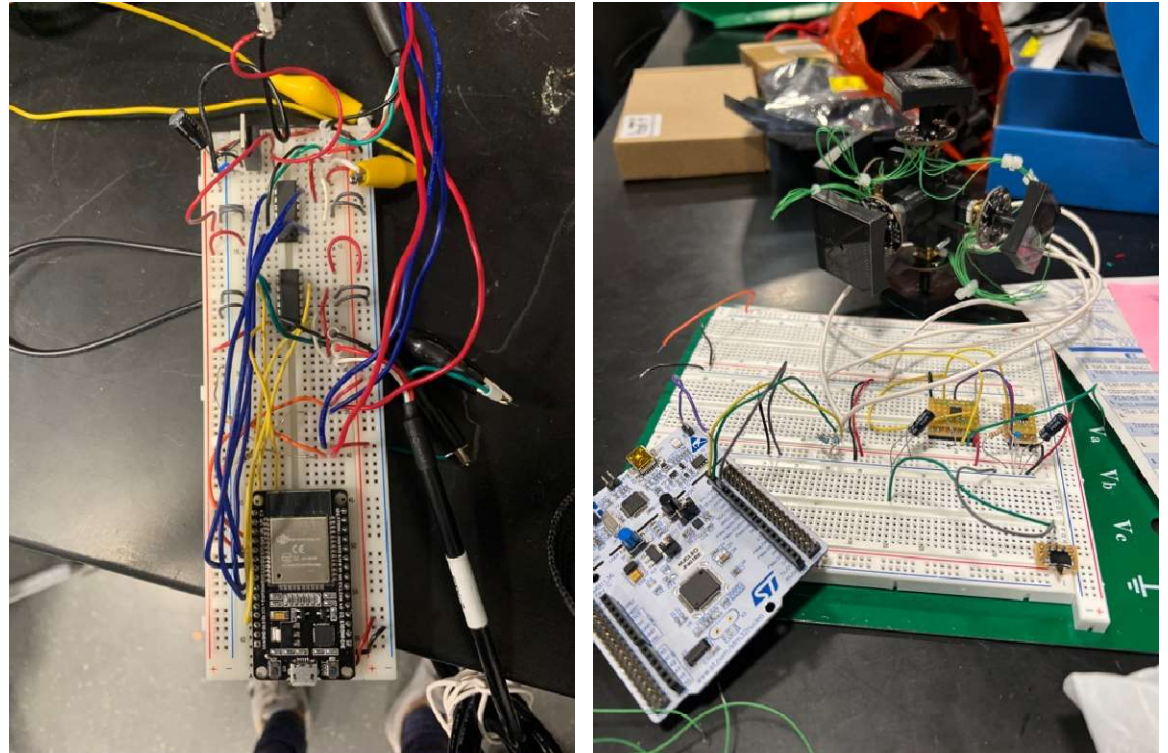
Examples of Breadboard Demos

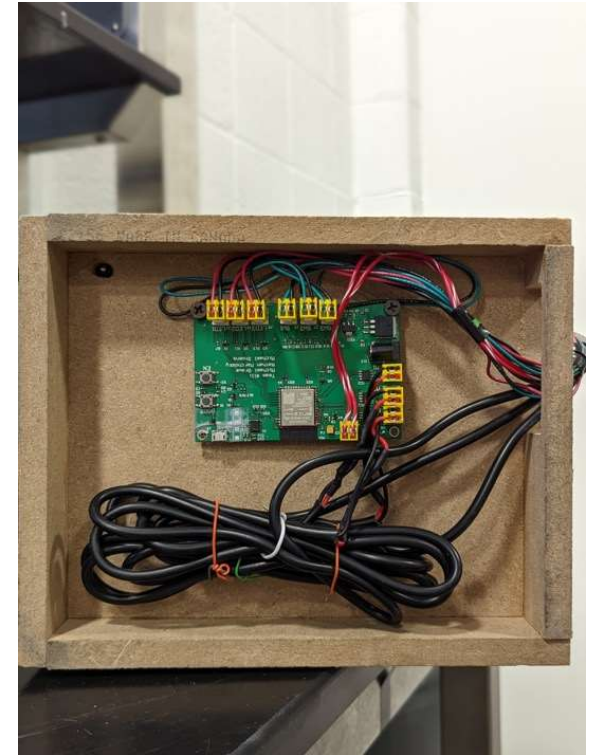# Designing your project with a custom PCB

Final Project Demo

Motors and Sensors in each drawer

Custom PCB

Senior design project #11, Fall 2022

PCB Design

Senior design project #11, Fall 2022

- PCB board has the following parts:
  - Microcontroller
  - Microcontroller programmer (don't forget it)
  - Power regulator circuits
  - Sensor (on a separate PCB)
  - Motor controller (h-bridge)
  - Buttons and LEDs
  - Pay attention to the size of the components (**print your PCB on a paper**)
  - Pay attention on the types of surface mounts pads

PCB Design: Do's and Don'ts

Very small resistors are very difficult to solder. Avoid them

Creative debugging. You can remove (cut) and add wires on your PCB

Do not forget the programming circuit for your microcontroller

Voltage regulator – large size which will be easy to solder

Large connectors and wide wires are necessary for large current drives

Microcontroller. Pins are on the side and about 1mm in size which will be easier to solder.

Senior design project #11, Fall 2022
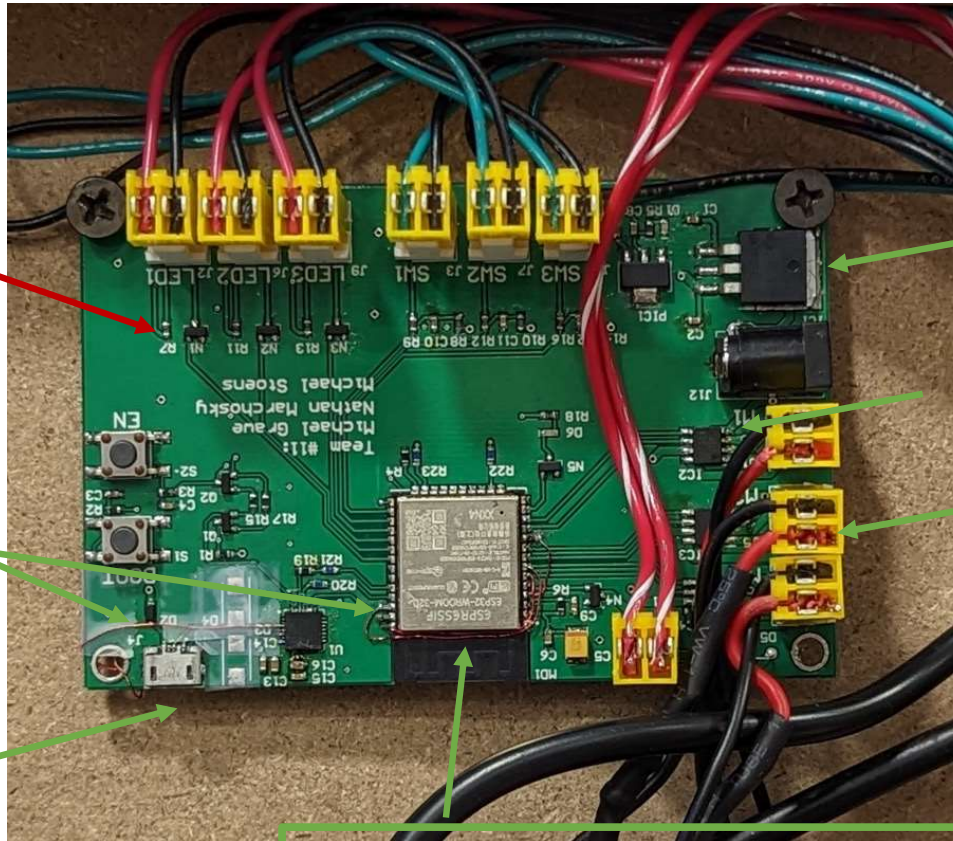
PCB Design: Common IC Packages

Quad Flat Package (QFP)

wikipedia.com

- Easy to solder
- Joints are inspectable
- Easy to fix bridging with flux and wick

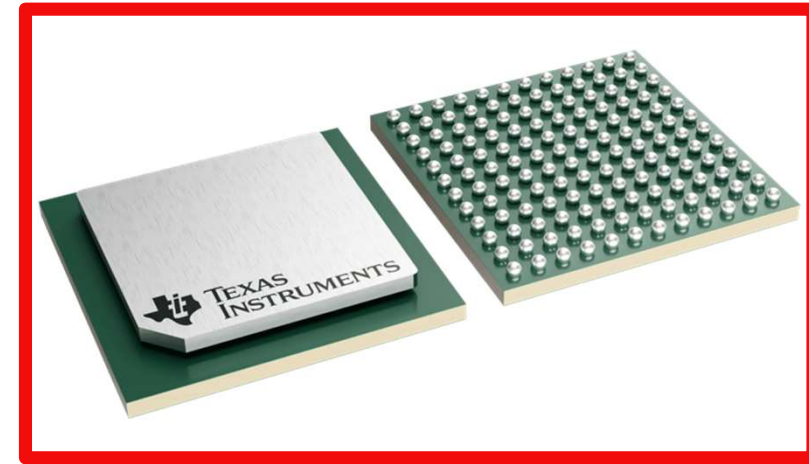**Quad Flat No-lead (QFN)**
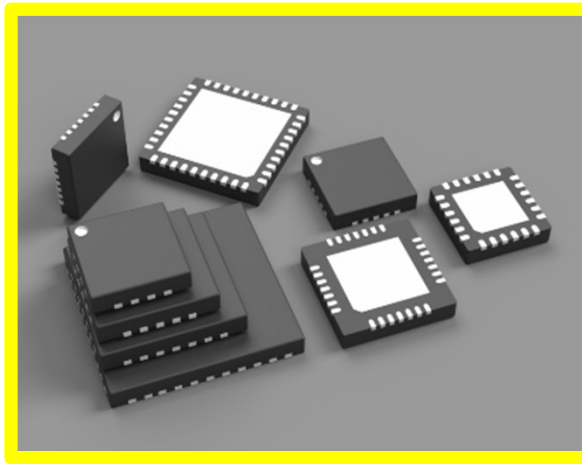
pcbway.com

- Stencil required for soldering
- Joints are difficult or impossible to inspect
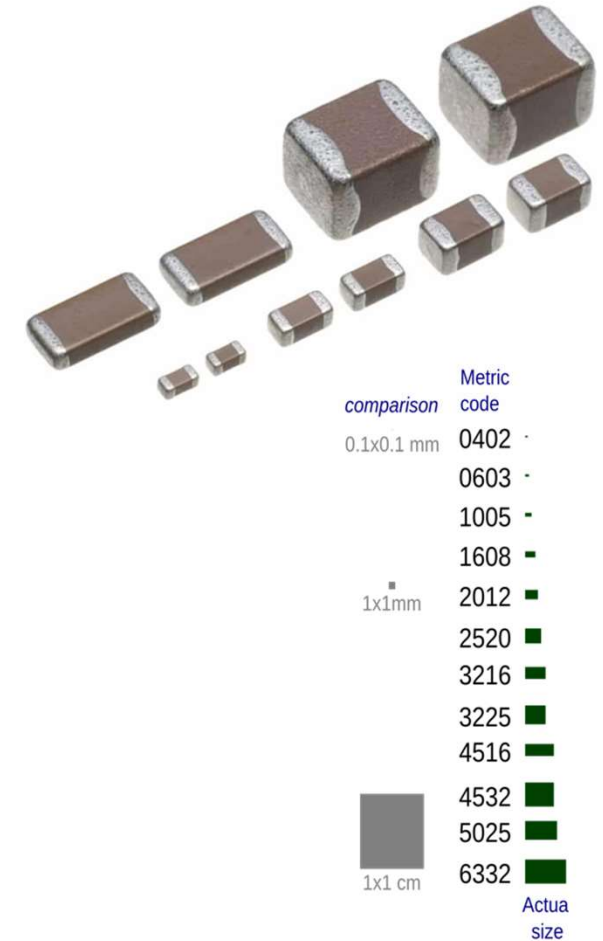- Hard to fix mistakes

Ball Grid Arary (BGA)

ti.com

- Stencil required for soldering
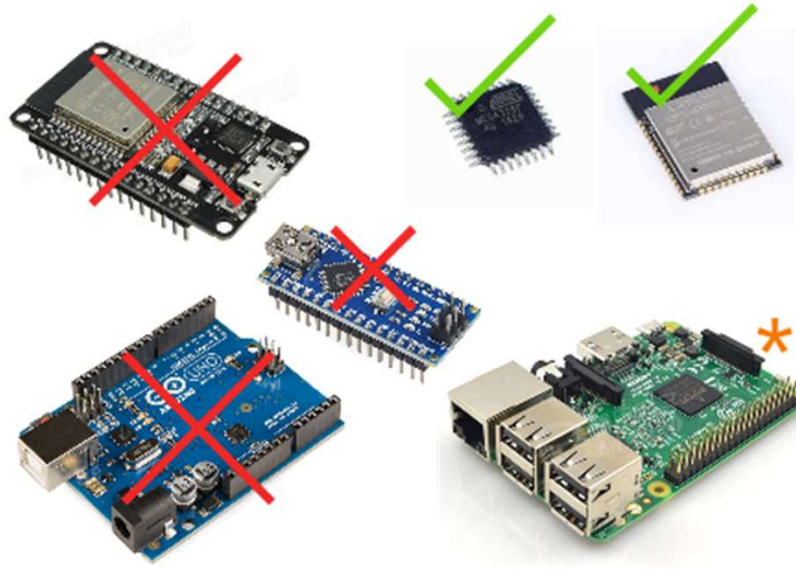- Impossible to inspect joints

PCB Design: Other Packages

- There are many kinds of packages available
- When you import a footprint into KiCAD, <u>compare it to a part you know the size of</u> (like your microcontroller)
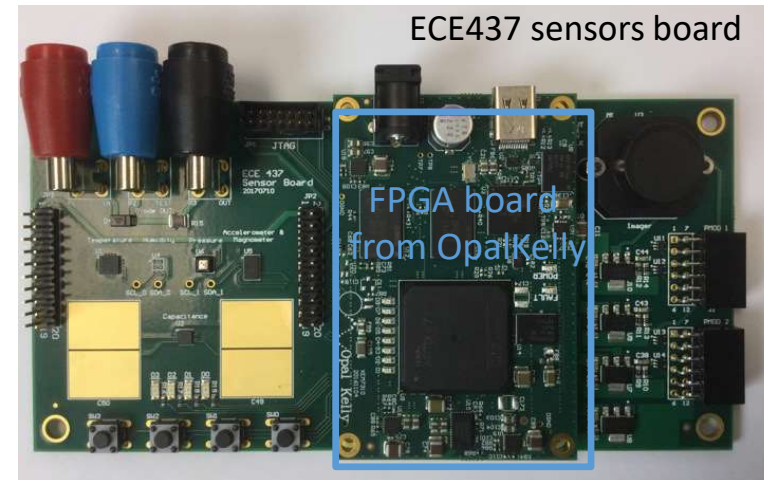- Print out your PCB design to get a sense of component size

Processor Policy

- Microcontroller ICs and modules are permitted
- Development boards are not allowed
- Single board computers (e.g. Raspberry Pi, Nvidia Jetson, etc.) are allowed under certain circumstances

Processor Policy: Example

- Main PCB contains many components (sensors, camera, LEDs, buttons).
- Main PCB should also contain a <u>microcontroller</u>
- Main PCB has to interface with your development board
  - In this example, FPGA dev board from OpalKelly is interface with a custom PCB.
  - The development can be used for image processing or more complex signal processing (for example, machine learning algorithms on FPGA such as mobile net.)

Design Resources
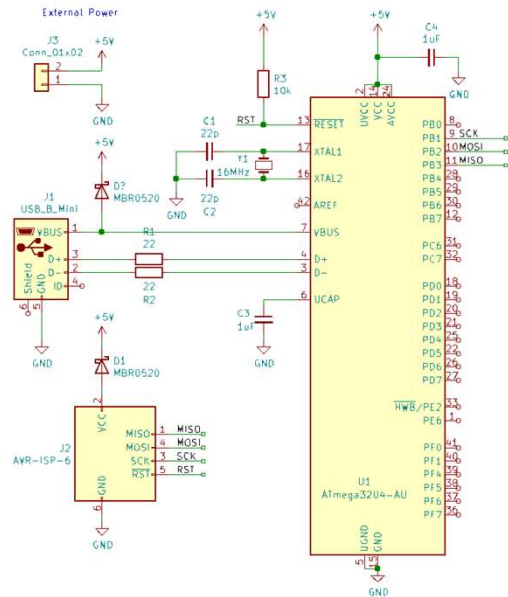
ATMega
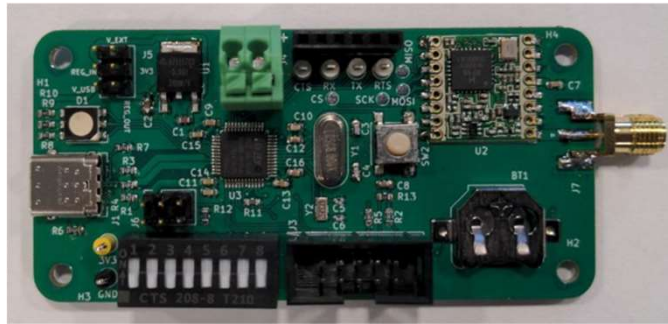
STM32

ESP32

- The ECE 445 wiki has <u>example projects</u> available for microcontrollers kept in stock by the electronics service shop

- The wiki contains information on:
  - Regulator selection
  - Connectors
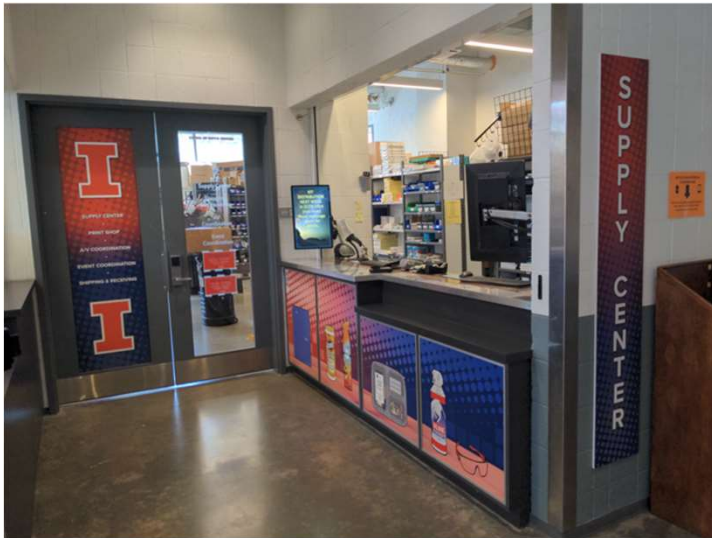 - Importing parts into KiCAD
  - Microcontroller programming

Getting Parts: Senior Design Lab

- You may borrow development boards, programmers, autotransformers, sensors, etc. from the white cabinets

- These items should be returned at the end of the semester

- Any TA can check out parts to a student

Getting Parts: Supply Center and E-Shop

ECE Supply Center

- Near the loading dock

- Stocks through-hole components, project boxes, sensors, etc.

- Not free

- **Electronic Services Shop**

- Near the north exit to Wright Street

- Stocks connectors, potentiometers, through-hole components, etc.

- Also stocks surface-mount components deliverable by your TA

- Surface mount components include microcontrollers, passive components, and oscillators

Getting Parts: my.ECE Ordering

- You may use your budget of $50 per student to order parts from Digikey, Mouser, etc. through the business office

- A CFOP number for this course will be shared shortly

- Note that Digikey is short staffed at the moment so they are slow to send out orders

- During the middle of the semester, orders may take many days to be placed
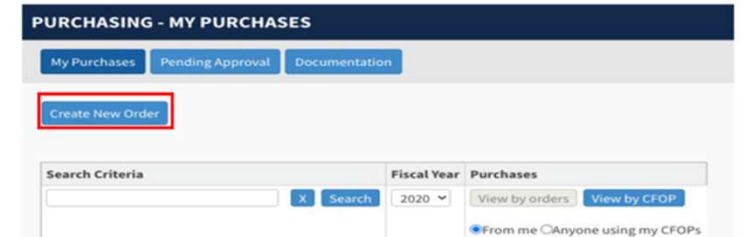
LAB   RESOURCES   PAC

General Information

Bench Equipment

Getting Parts

Ordering a PCB

Reserve Bench Time

Clean Your Lab Bench!

- Please keep the lab benches and the soldering stations clean
- When you finish working:
  - Remove any bits of solder, wick, or wire clippings on the table
  - Turn off equipment (e.g. soldering irons, extraction fans)
- Untangle cables that tie tools down
- Wind up unspooled solder and wick
- We will have to <u>shut down the lab</u> if it gets too messy

PCB Design : Final Remarks

- PCB Success is a practice of being thorough in understanding documentation
- Utilize
- Take advantage of the following resources
  - Course Wiki
  - Application Notes
- Consider how you will assemble your PCB before doing layout
- Give yourself test points:
  - How are you going to figure out the issue when things go wrong?

- Time is your biggest constraint in this class!