A 5 Days Long

Workshop and Contest on

PCB Design and Fabrication

3rd April to 7th April, 2021

7:30pm to 9:30pm

Platform

zoom

CHIEF GUEST

Engr. Mohammed Abdul Kader

Assistant Professor, Dept of EEE, IIUC

Adviser, IEEE Robotics and Automation Society IIUC Student Branch Chapter

Organized by

IEEE Robotics & Automation Society
IIUC Student Branch Chapter

IEEE IIUC STUDENT BRANCH

Workshop conducted by

Sayed Tanimun Hasan

Chairperson, IEEE Robotics and Automation Society IIUC Student Branch Chapter

Academic Team Member, Bangladesh Robot Olympiad (BDRO)

Sayed Tanimun Hasan

Chairperson, IEEE RAS IIUC SBC

Academic Team Member, Bangladesh Robot Olympiad

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What is PCB

- Printed Circuit Board
- Electronic Board that connects circuit components
- PCB populated with electronic components is a printed circuit assembly(PCA)
- PCBs are rugged, inexpensive, and can be highly reliable

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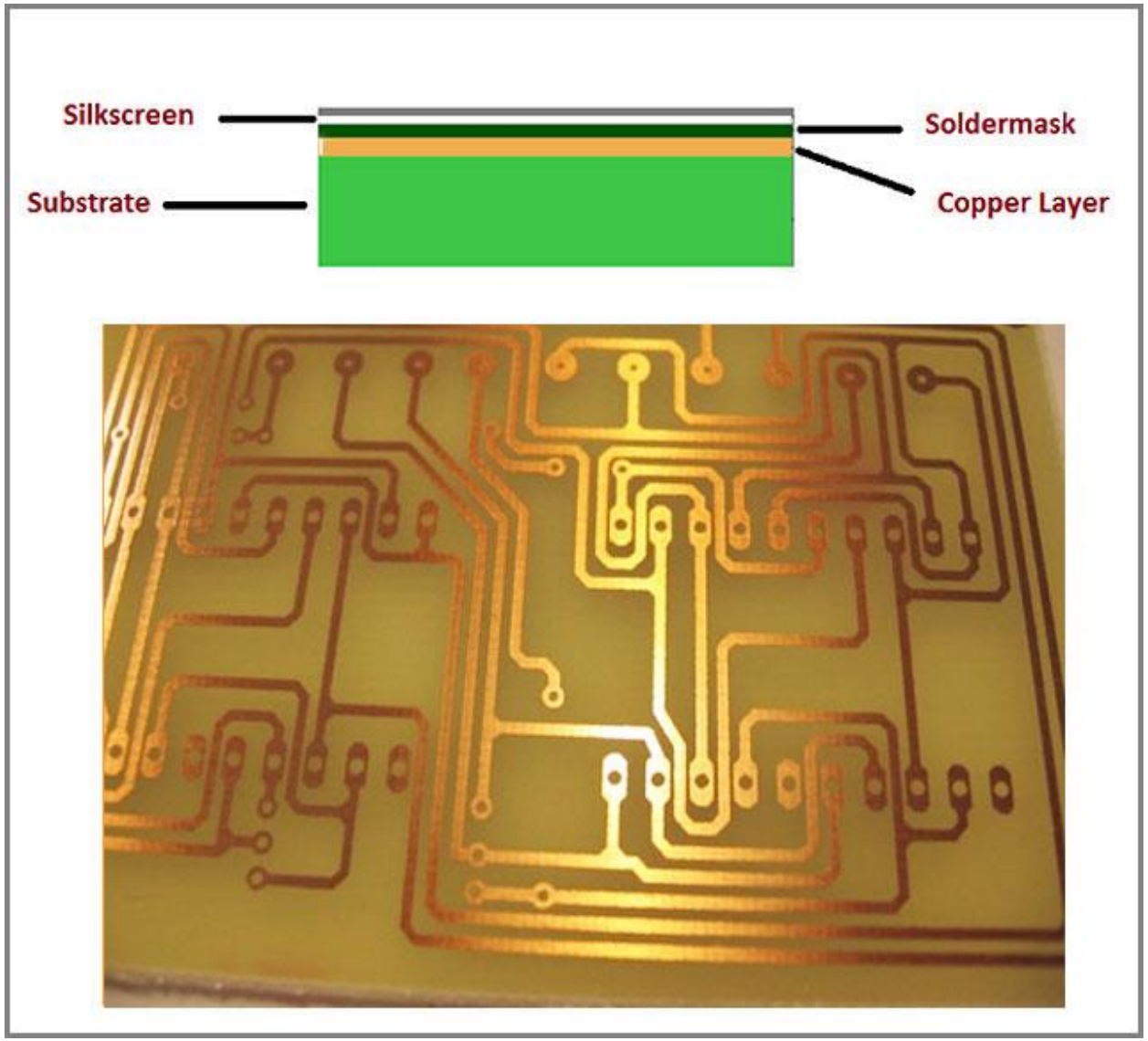
PCB



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Types of PCB

- **Single-Sided PCBs**
- **Double-Sided PCBs**
- **Multilayer PCBs**
- **Rigid PCBs**
- **Flex PCBs**
- **Rigid-Flex PCBs**

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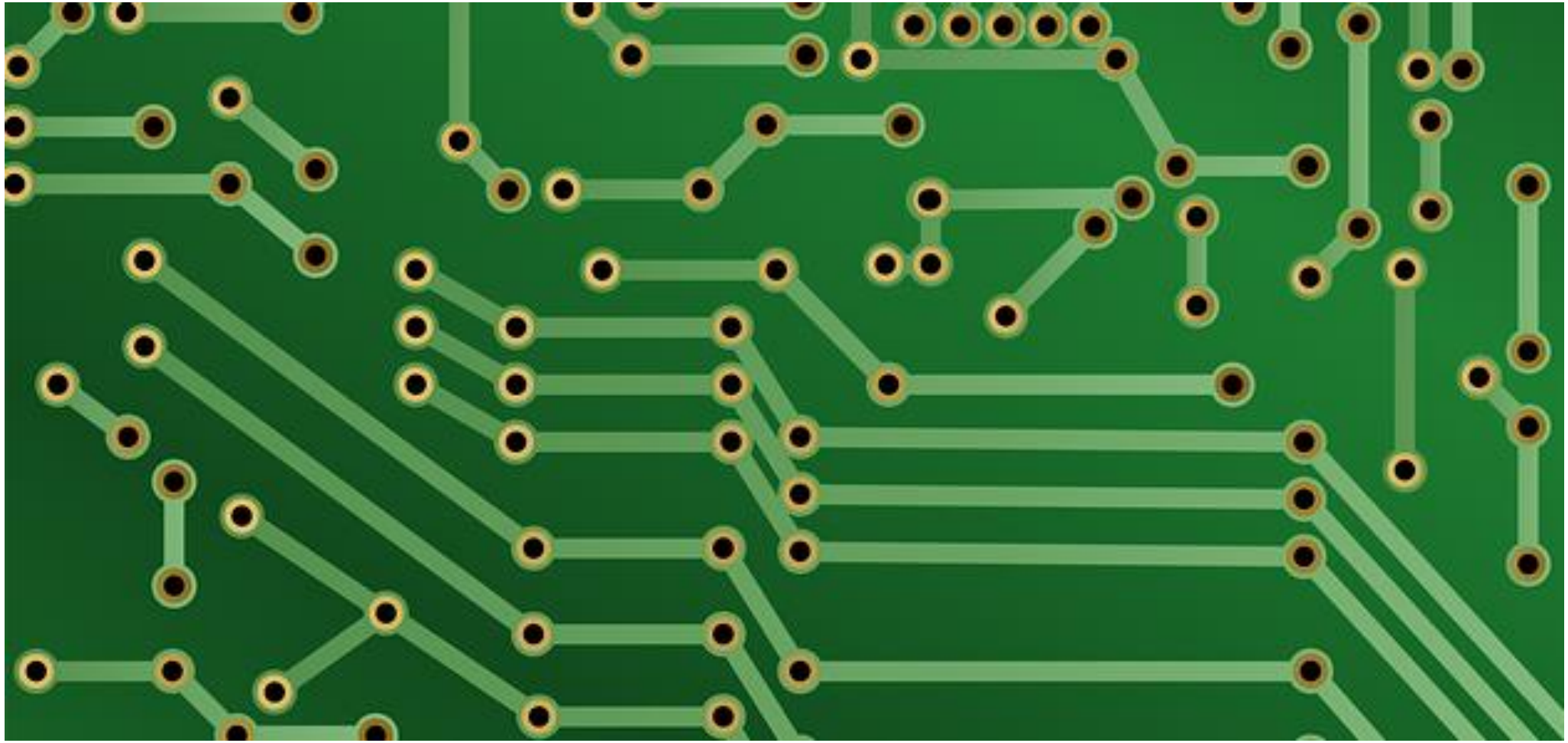
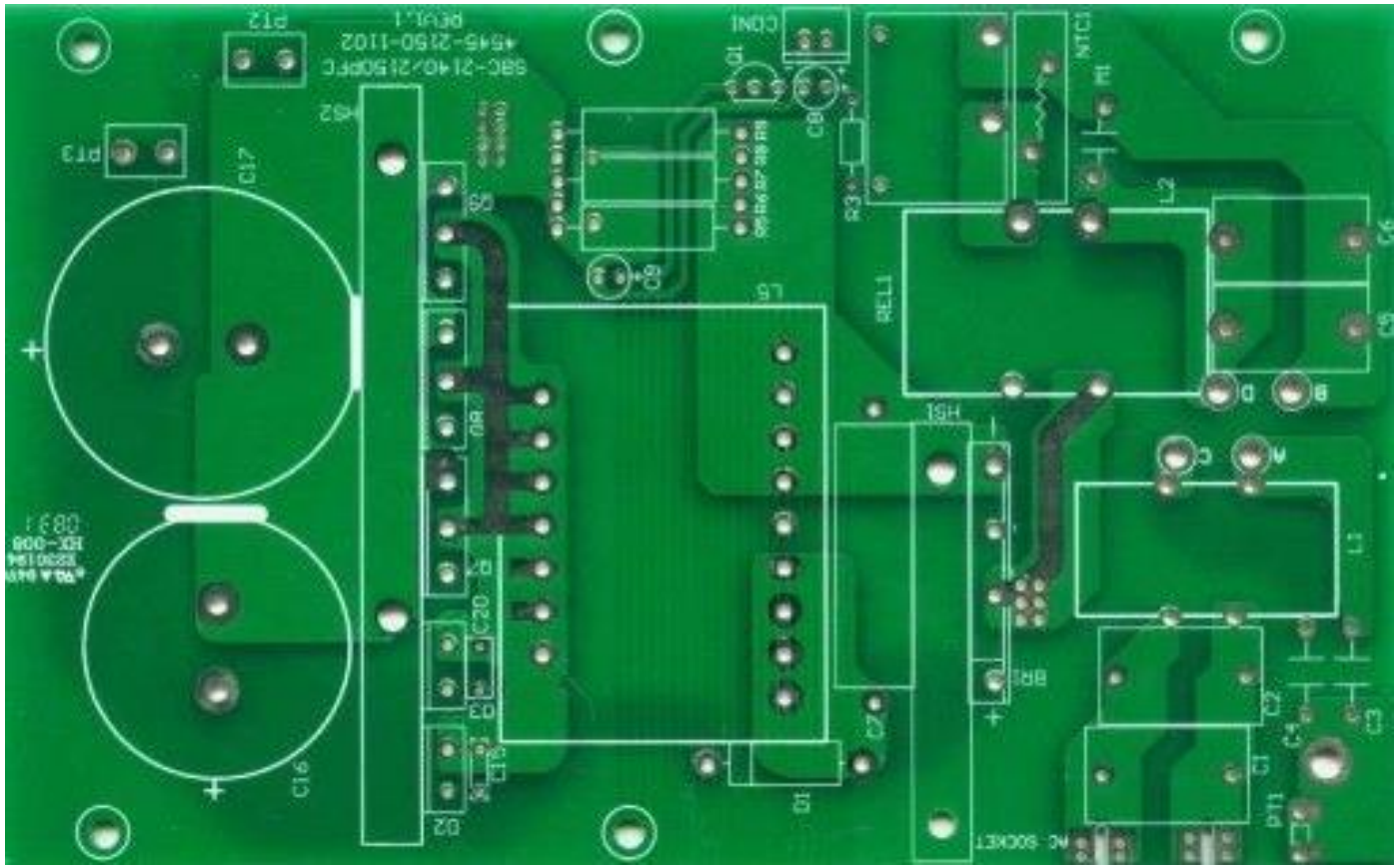
Single Sided PCB



Double Sided PCB



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Multi Layer

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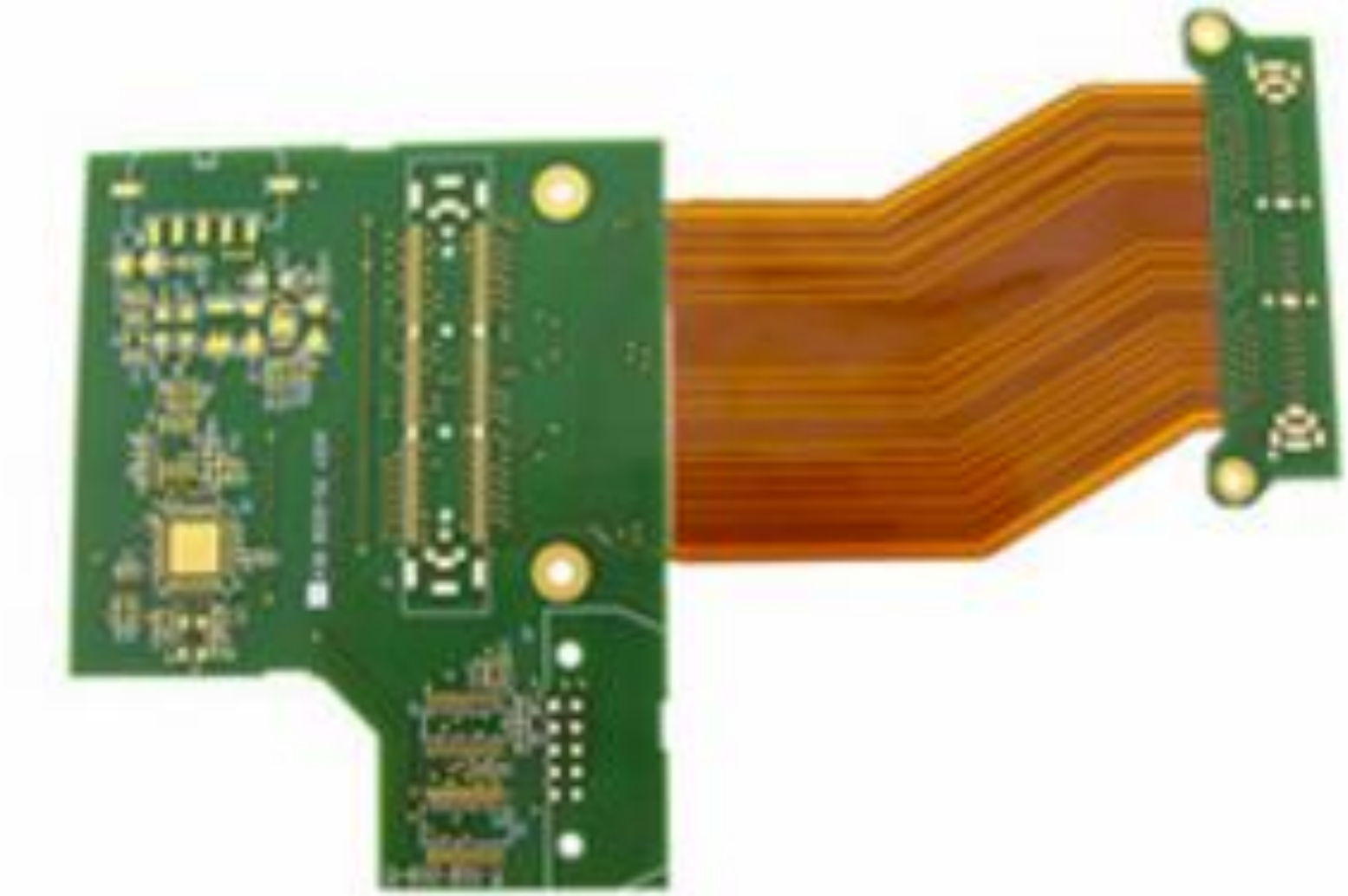
Rigid PCB



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Flex PCB

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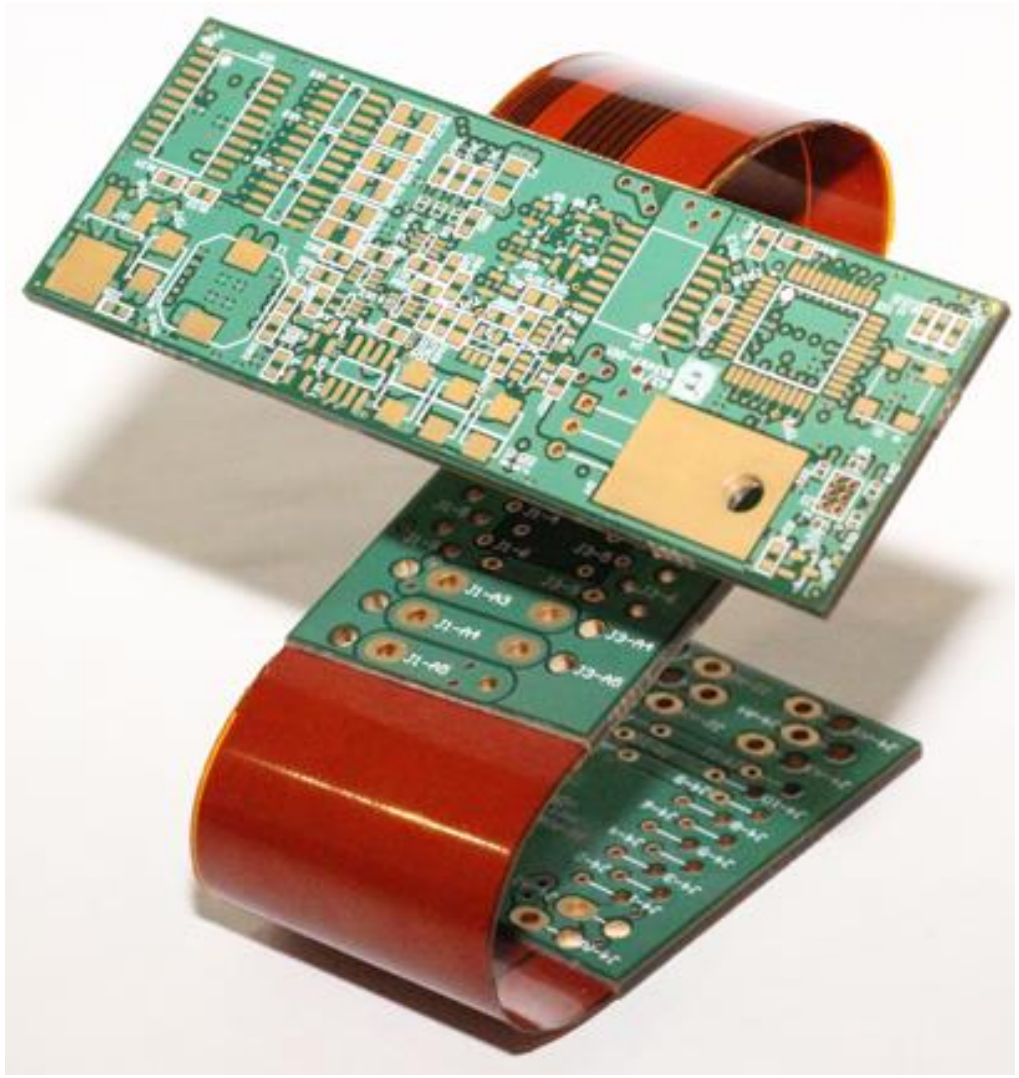
Rigid-Flex PCB



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Materials of PCB

- Conducting layers are typically made of thin copper foil.
- The board is typically coated with a solder mask that is green in color. Other colors that are normally available are blue and red
- Unwanted copper is removed from the substrate after etching leaving only the desired copper traces or pathways

Parts of PCB

- ✓Components
- ✓Pads
- ✓Traces
- ✓Vias
- ✓Top Metal Layer
- ✓Bottom Metal Layer

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Components

Components are the actual devices used in the circuit

This includes input/output connections

I/O ports, including power supply connections are also important in the PCB design.

Pads

Location that are components connect to

You will solder components to the pads on the PCB

Pads will connect to traces

Pads have an inner diameter and outer diameter

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Vias

Pad with a plated hole connecting traces from one layer of board to other layers.

Attempt to minimize via use in your PCBs

Some component leads can be used as vias

Top Metal Layer

- ✓Most of the components reside on the top layer
- ✓Fewer traces on the top layer
- ✓Components are soldered to the pads on the top layer of PCB
- ✓Higher circuit densities

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Bottom Metal Layer

- ✓Few Components on this layer
- ✓Many traces on the top layer
- ✓Most soldering done on this layer

Solder Mask

- ✓Protect copper traces on outer layers from corrosion
- ✓Areas that shouldn’t be soldered may be covered with polymer resist solder mask coating
- ✓Designed to keep solder only in certain areas
- ✓Prevents solder from binding between conductors and thereby creating short circuits.

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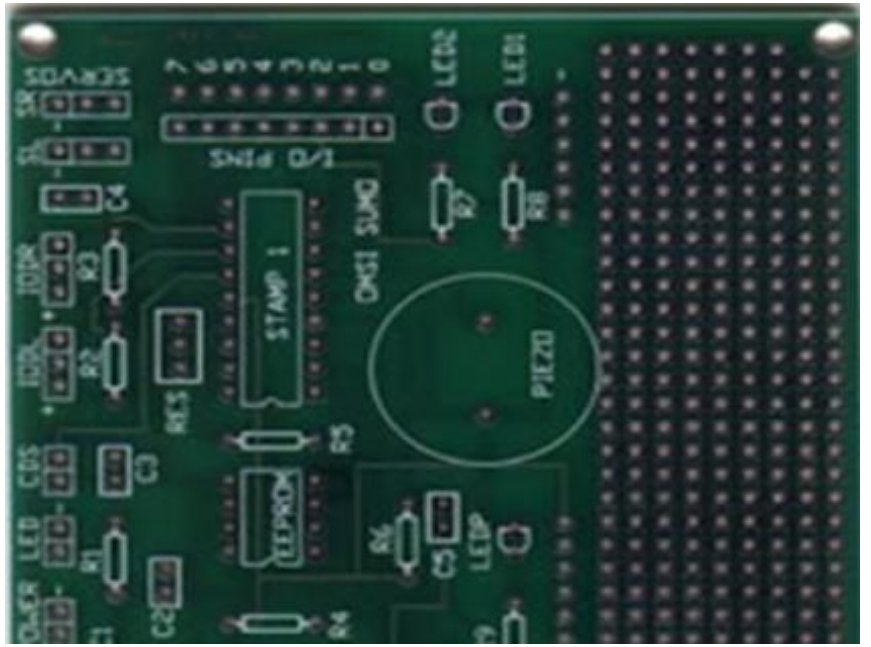
Silkscreen

- ✓Printing on the solder mask to designate component locations
- ✓Readable information about component part numbers and placement
- ✓Helpful in assembling, testing and servicing the circuit board



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Multilayer PCB

- ✓More than top and bottom layer
- ✓Typically there will be a power plane, ground plane, top layer, and bottom layer.
- ✓Sometimes signal layers are added as needed.
- ✓Sometimes RF planes made of more expensive materials are added.

Physical Design Issues

- ✓Components Size
- ✓Heat Dissipation
- ✓Input and Output
- ✓Mounting Points

Components Size*

- ✓Make sure components will actually fit.
- ✓This especially applies for circuits that component densities
- ✓Some components come in multiple sizes. SMT vs Through Hole
- ✓Sometimes you can get tall and narrow caps or short and wide capacitors.

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Mounting Points

- ✓The PCB needs to be mechanically secured to something.
- ✓Could be the chassis-consist of metal frame on which the circuit boards and other electronic components are mounted
- ✓Could be another PCB/socket on PCB
- ✓Could be attachments to a heatsink

Pre-Work*

- ✓Thoroughly simulate your circuit-make sure circuit worked in simulations
- ✓Thoroughly test the prototype-make sure the circuit worked on the bread board
- ✓Have all the data sheets handy for every components
- ✓Play around with the placement of components.

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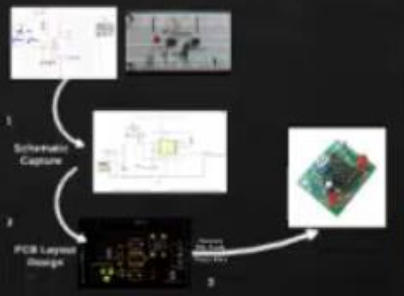
Why Do We Need PCBs?

Elements of a PCB

CAD Tools For PCB Design

CAD: Computer Aided Design

The Main Functionality of PCB CAD Design Tools



The Most Common CAD PCB Design Tools

Paid:

and others...

Free:

it starts with a project or product idea in your mind. Then, you'll move on to create your first prototype to verify it.

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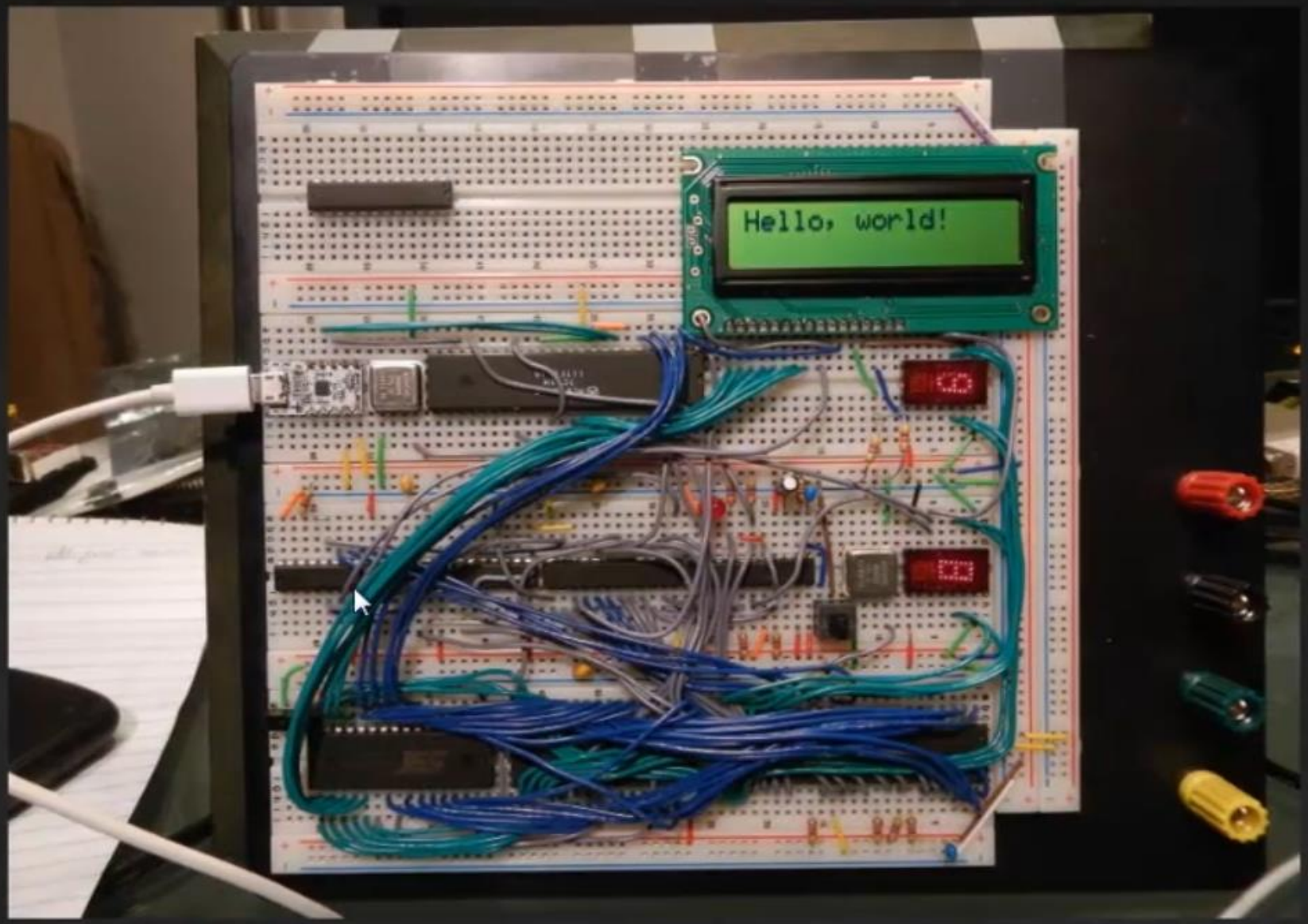
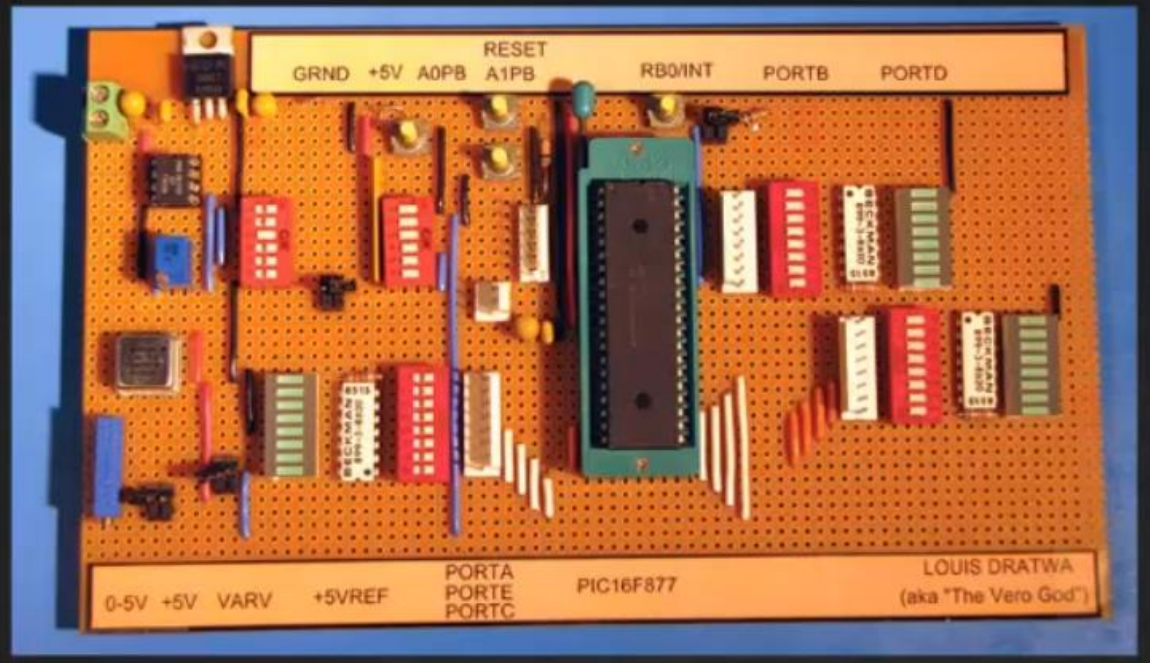

Hello, world!

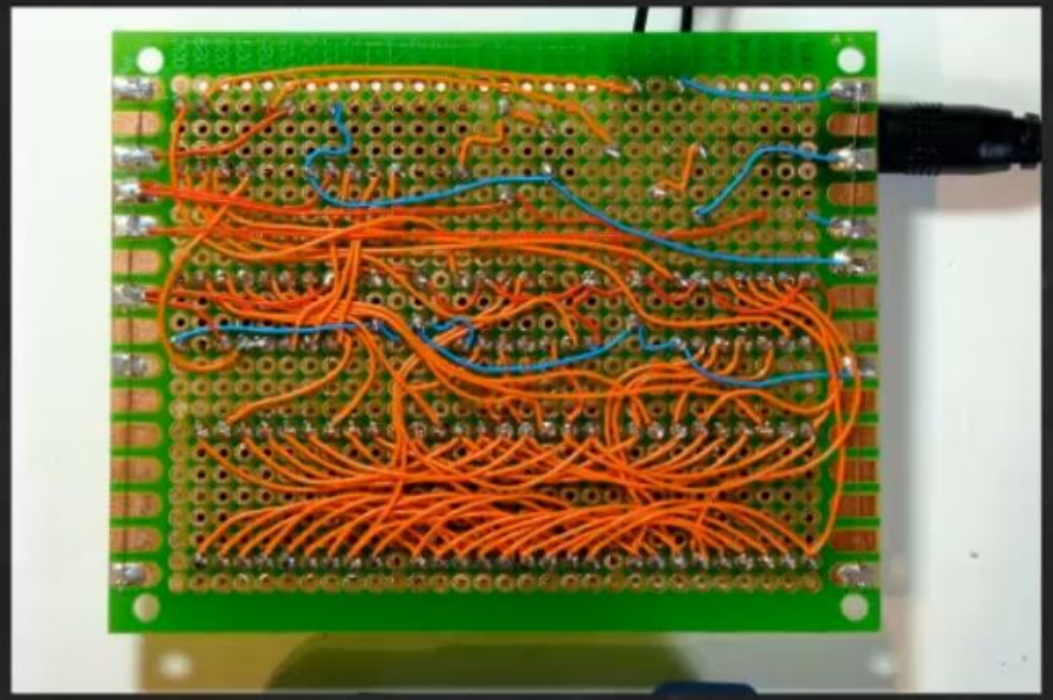
1. Hard To Manufacture

2. Hard To Maintain

3. Hard To Upgrade

4. Extremely Labor Intensive





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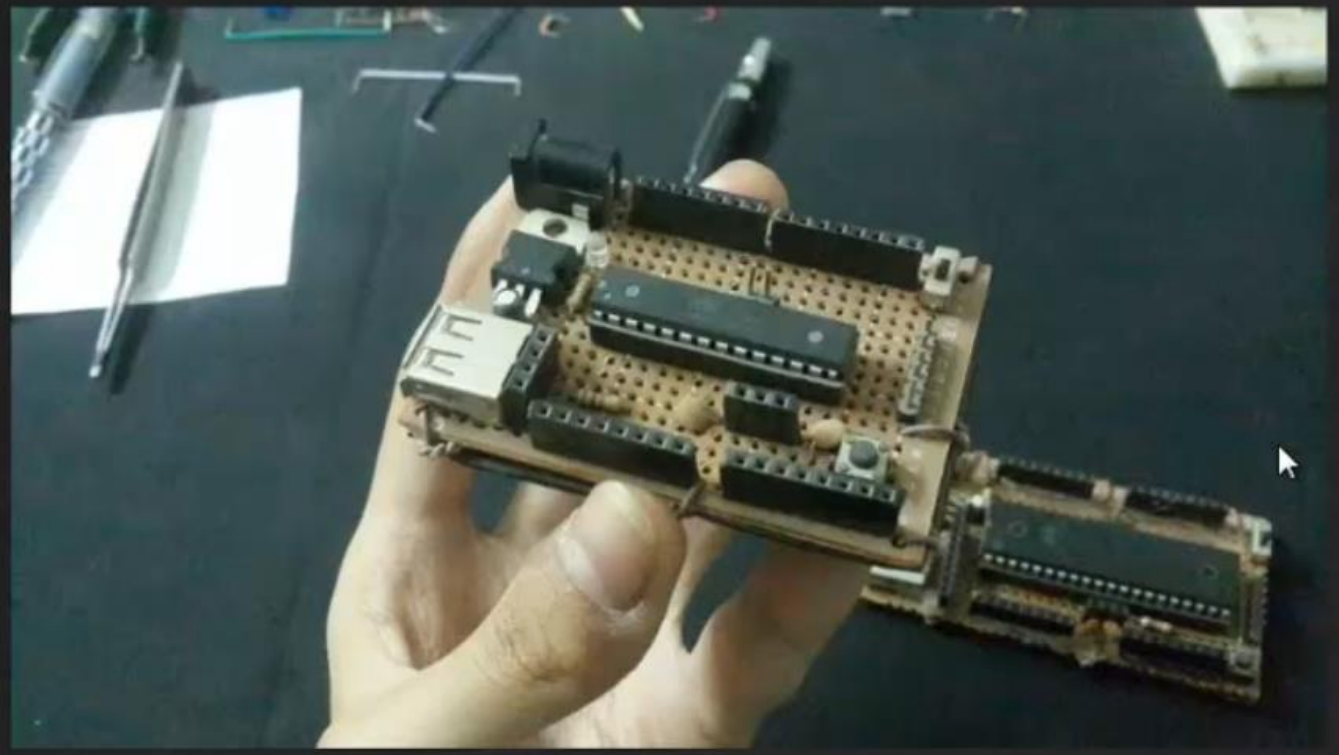
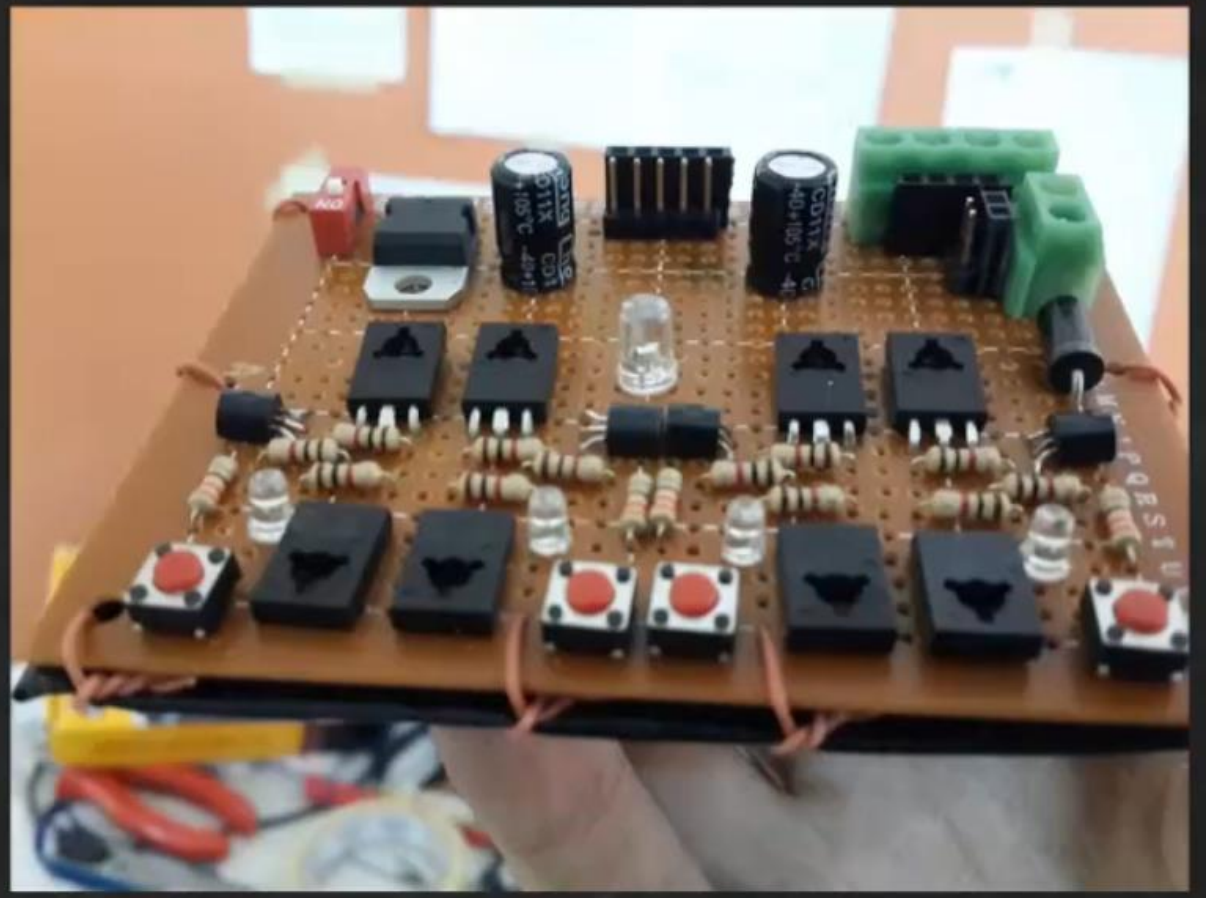
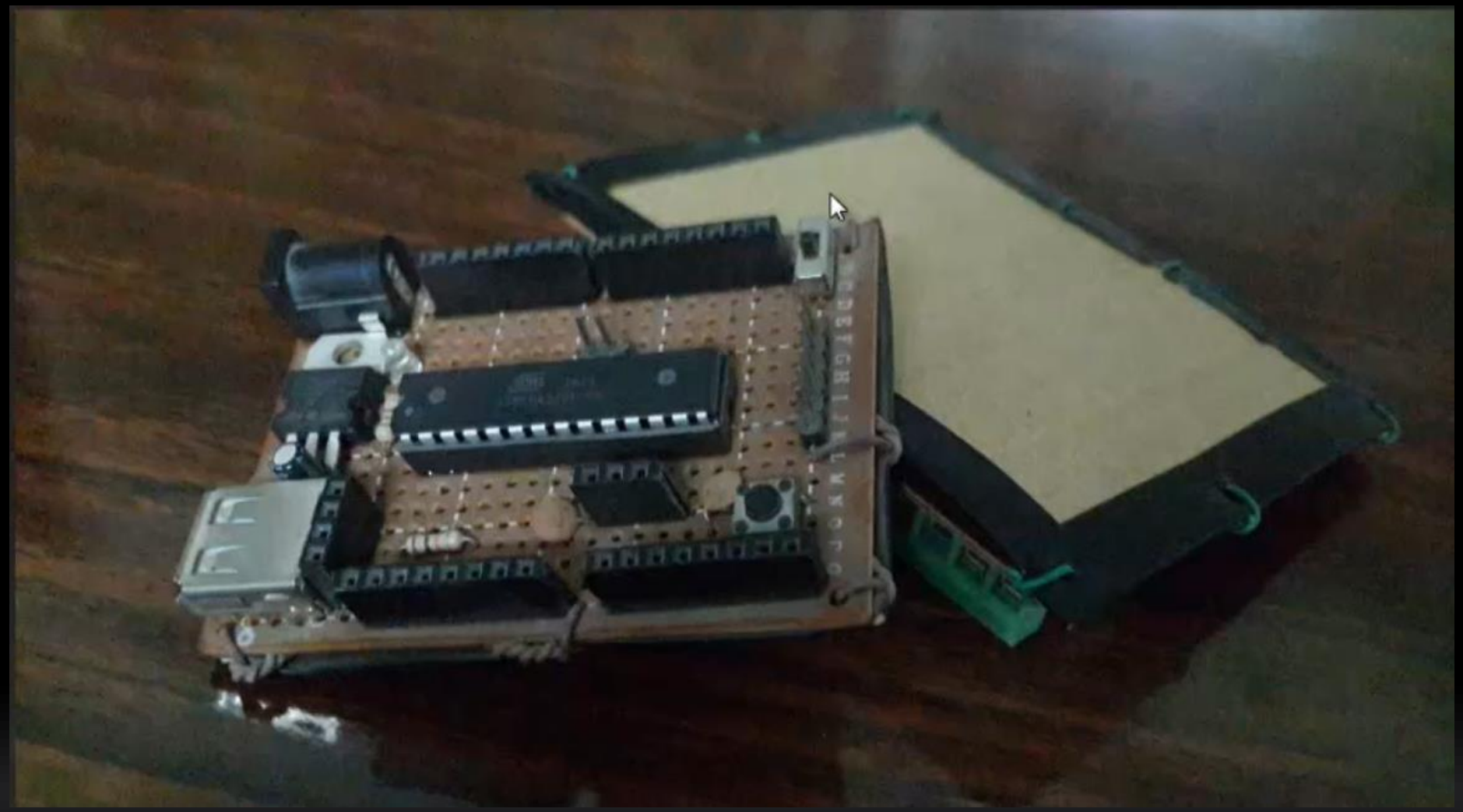
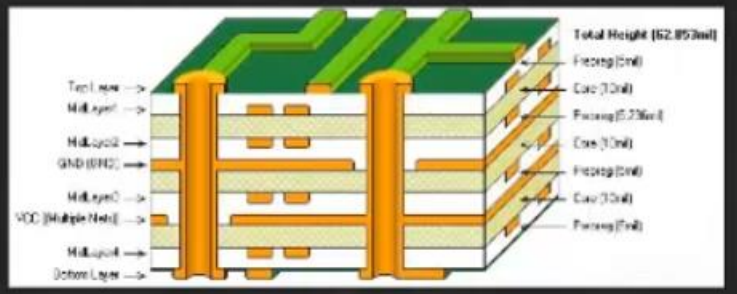


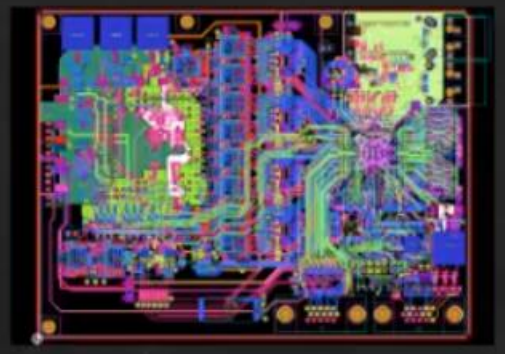




Printed Circuit Board (PCB) Technology Advantages

- Saves Too Much Space
- Very Quick To Manufacture
- Components Can Be Assembled With PnP Machines (Automated)
- You Can Deliver Dozens of Products To Meet The Market's Needs
- Much Easier To Develop/Upgrade and to Maintain As Well
- And more...





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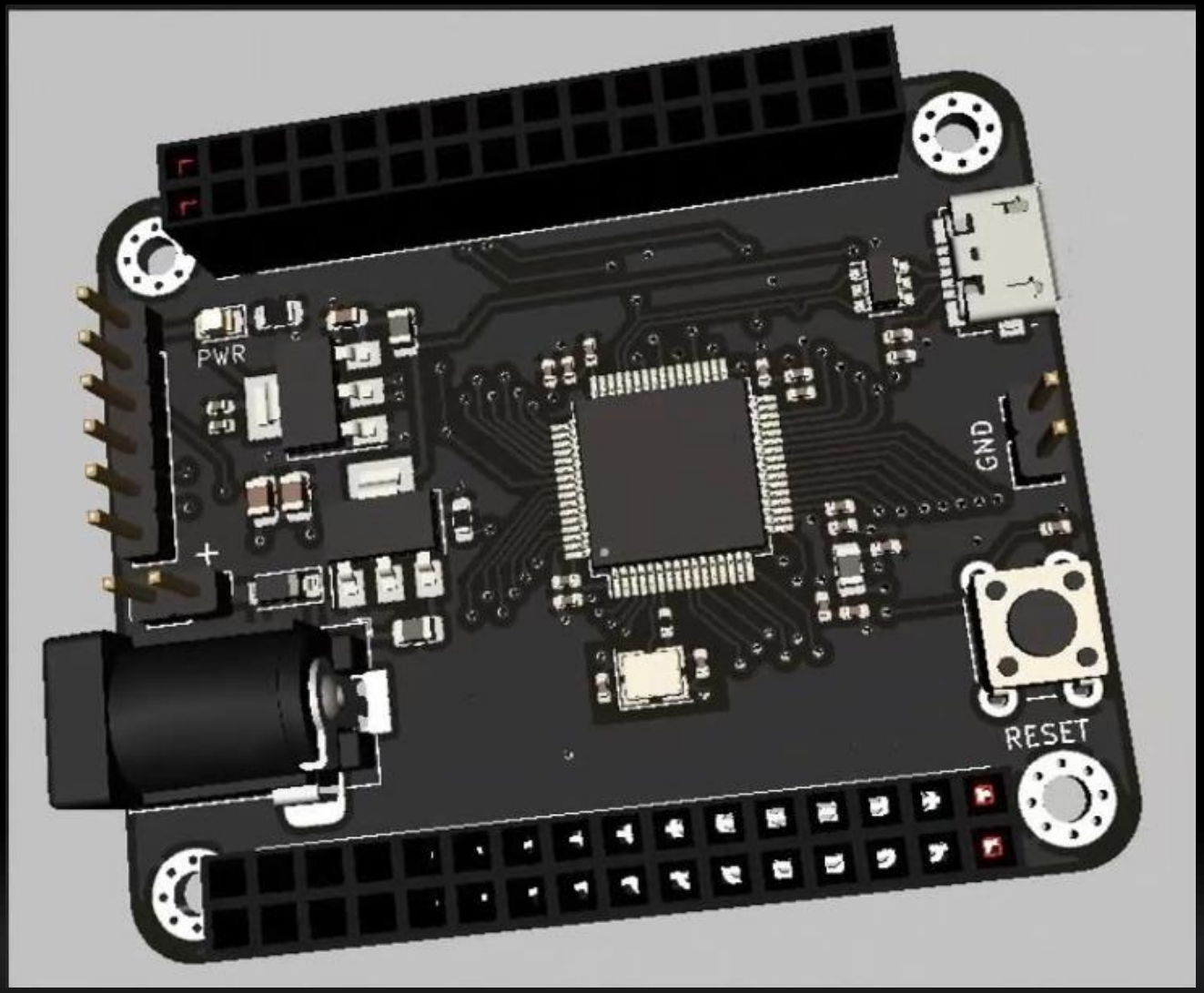
Multilayer



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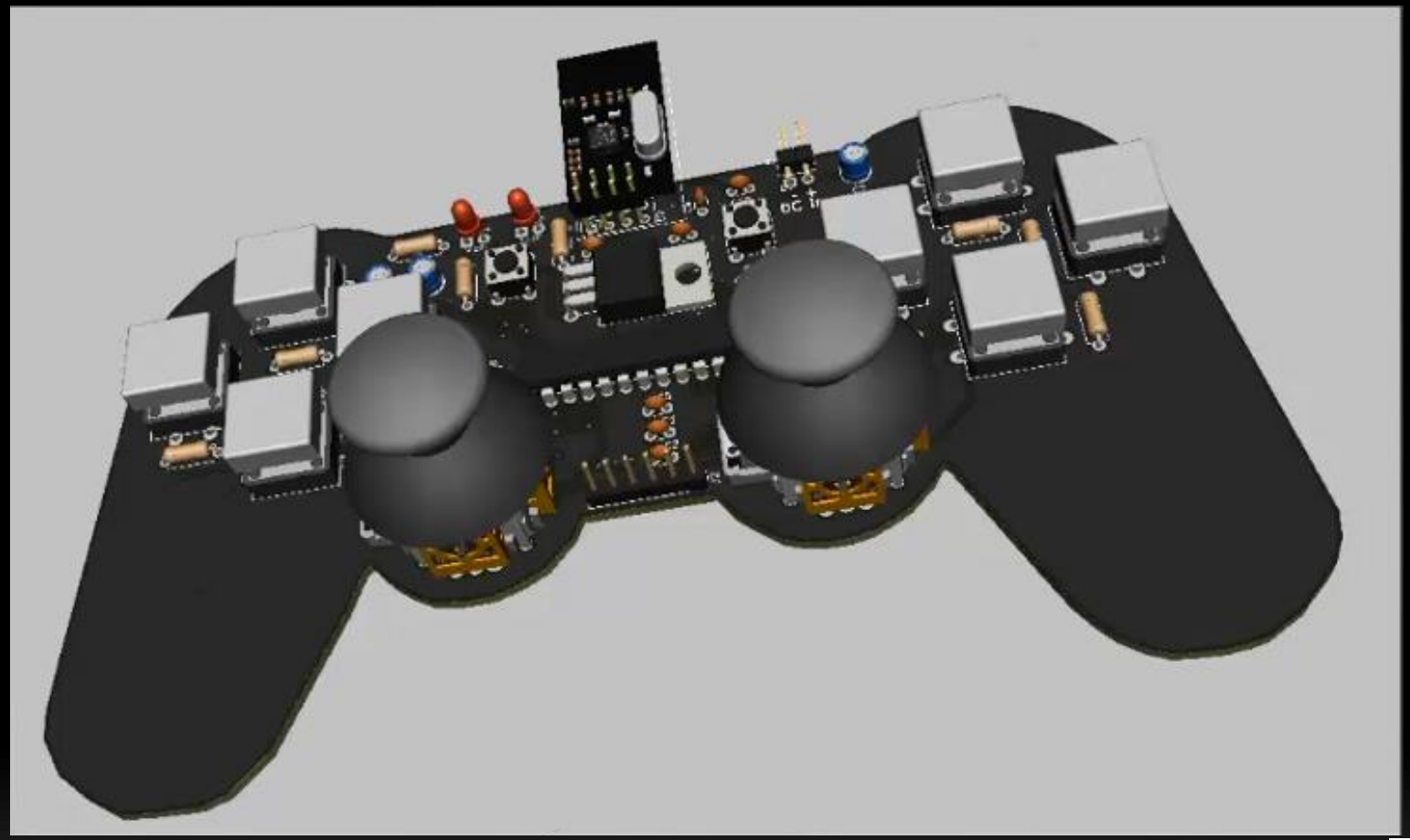
Edge cuts Layer



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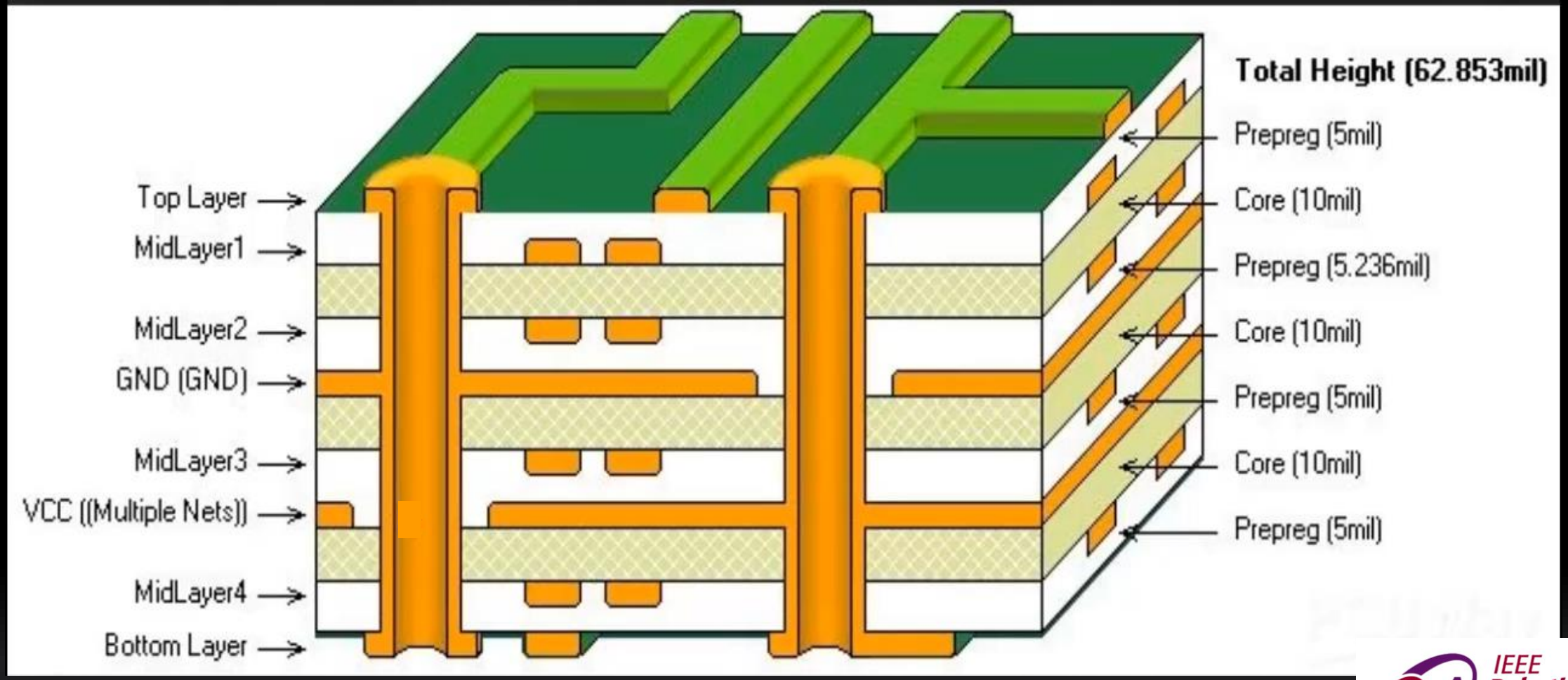

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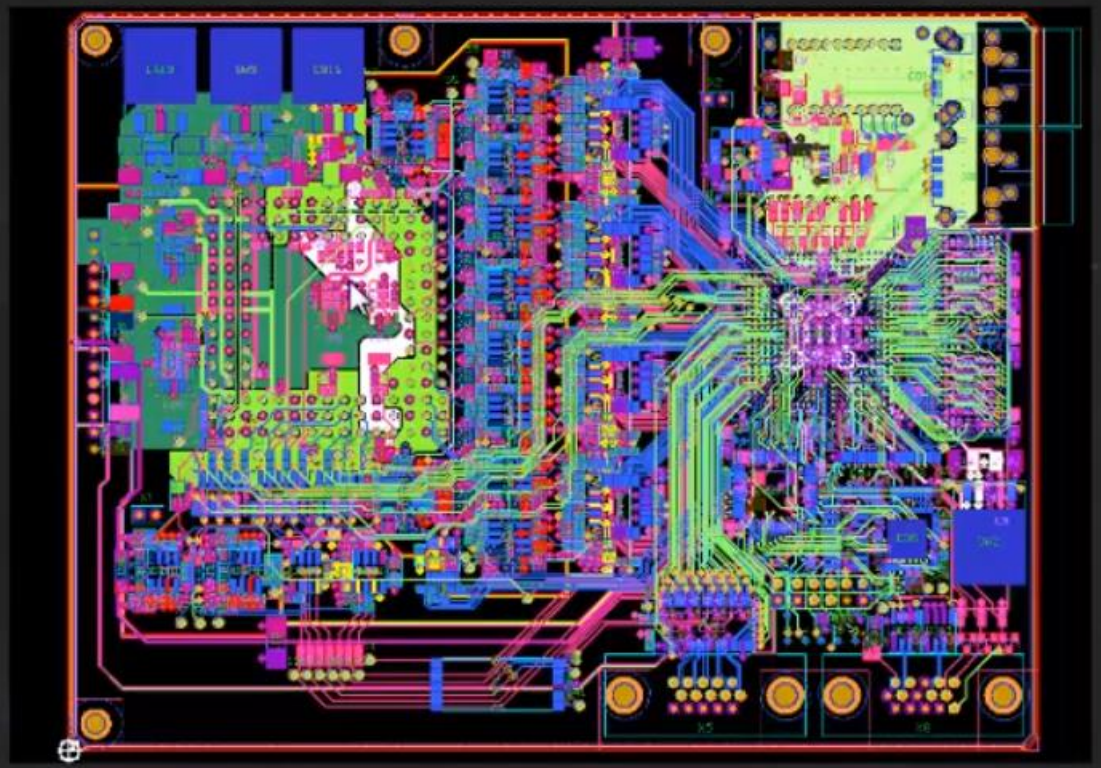

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Elements of PCB

- Electronic Components (BOM), Bill of Materials. "THT or SMD".
- Copper Traces (Tracks).
- Solder Mask (any Color).
- Silkscreen Layer (White).
- Via / Vias.

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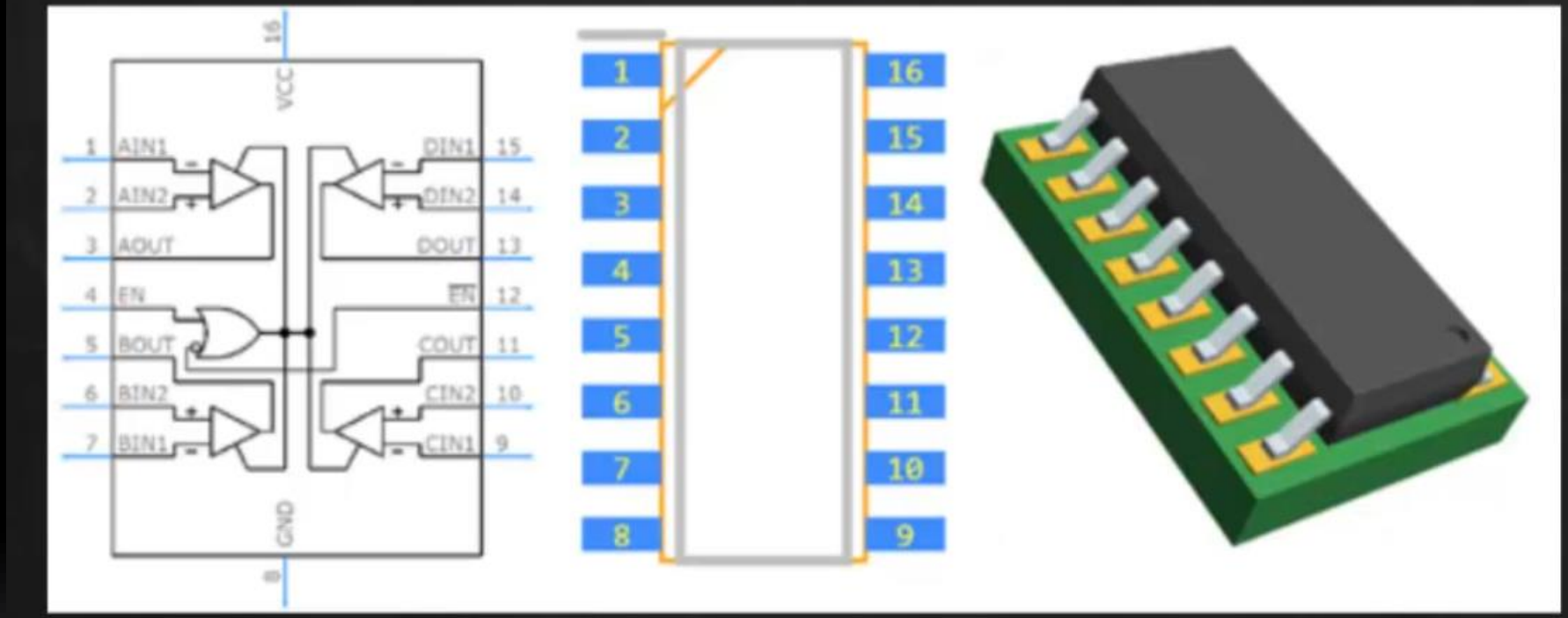
-Footprints



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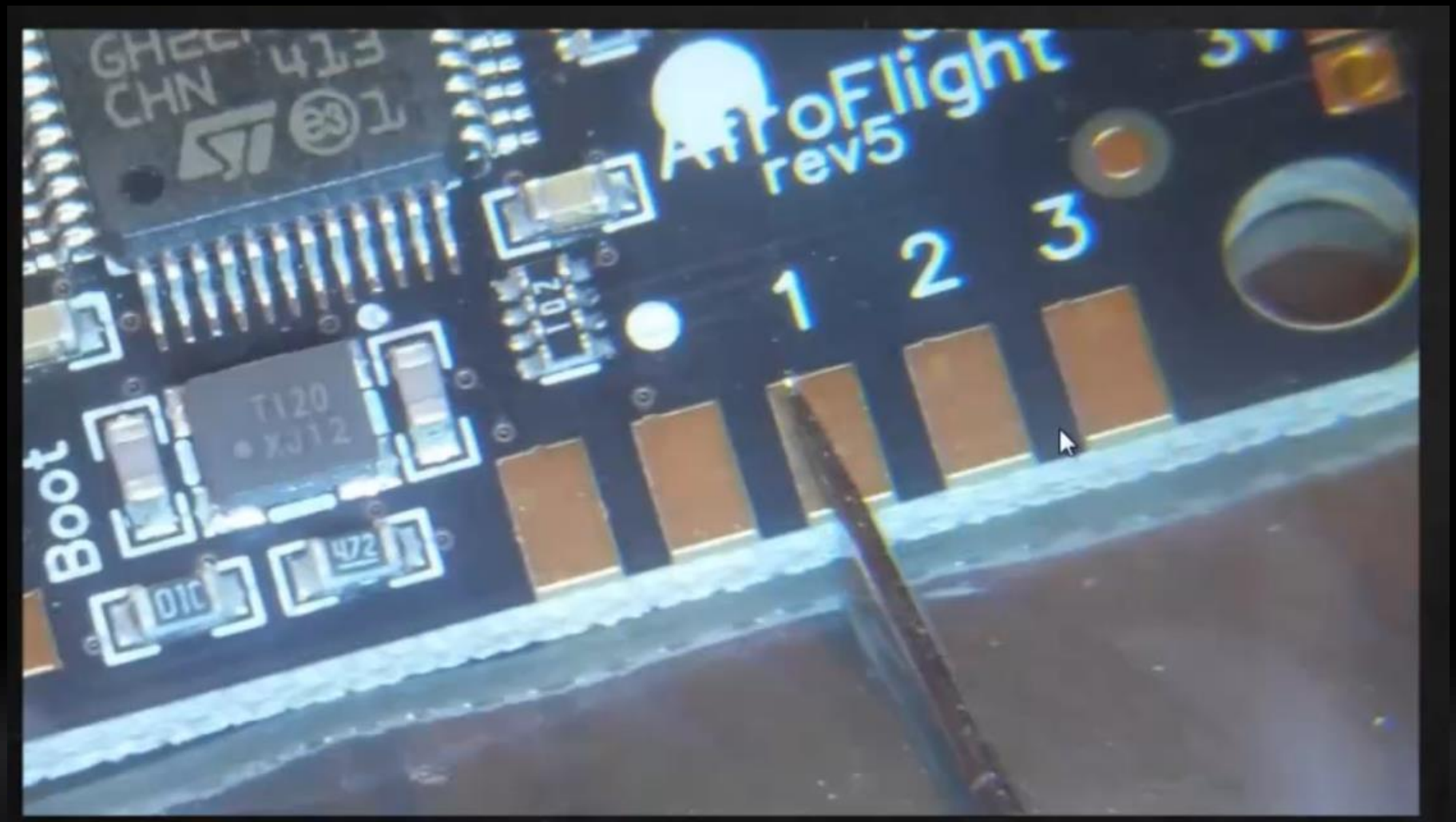
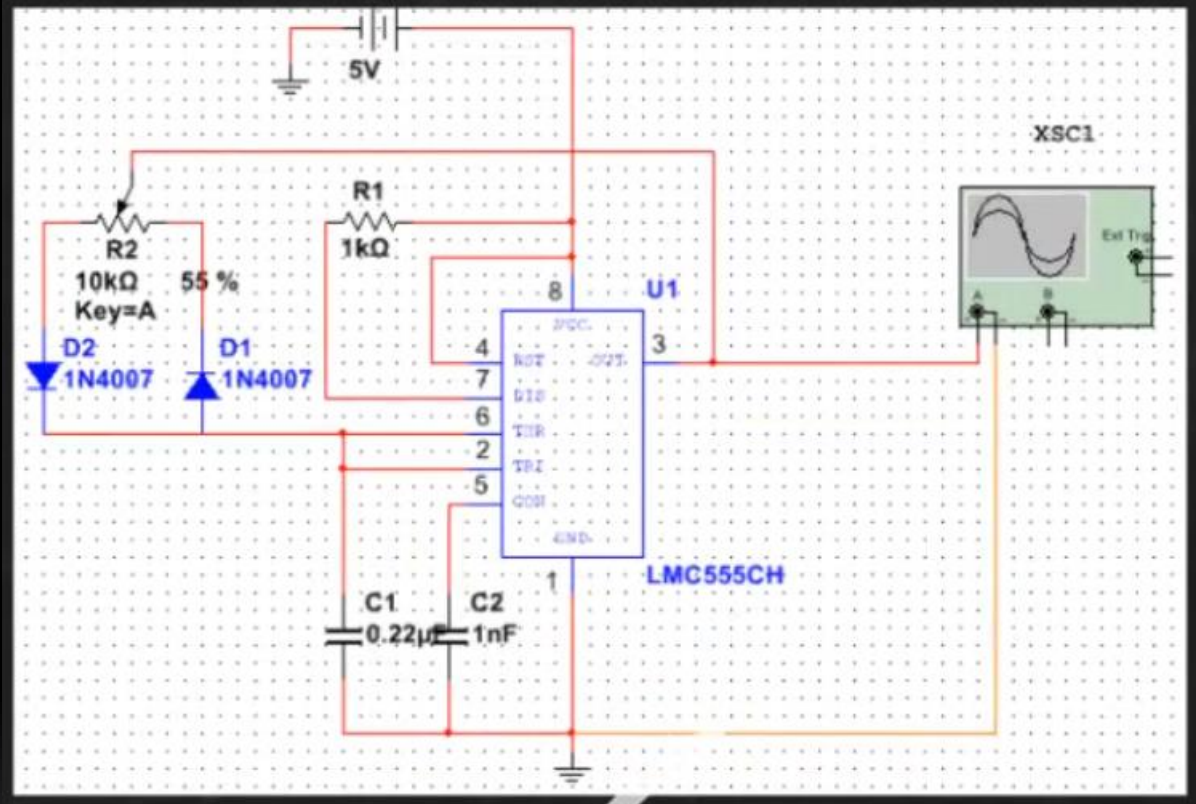
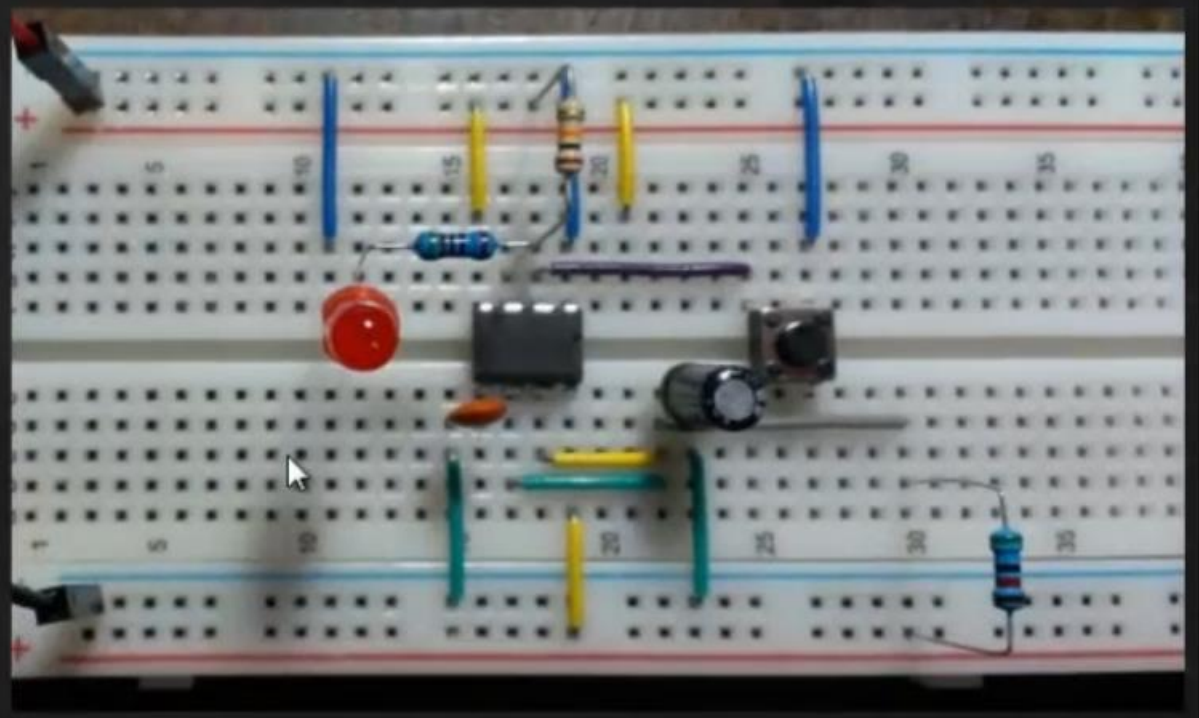
-Solder pad



CAD Tools for PCB Design

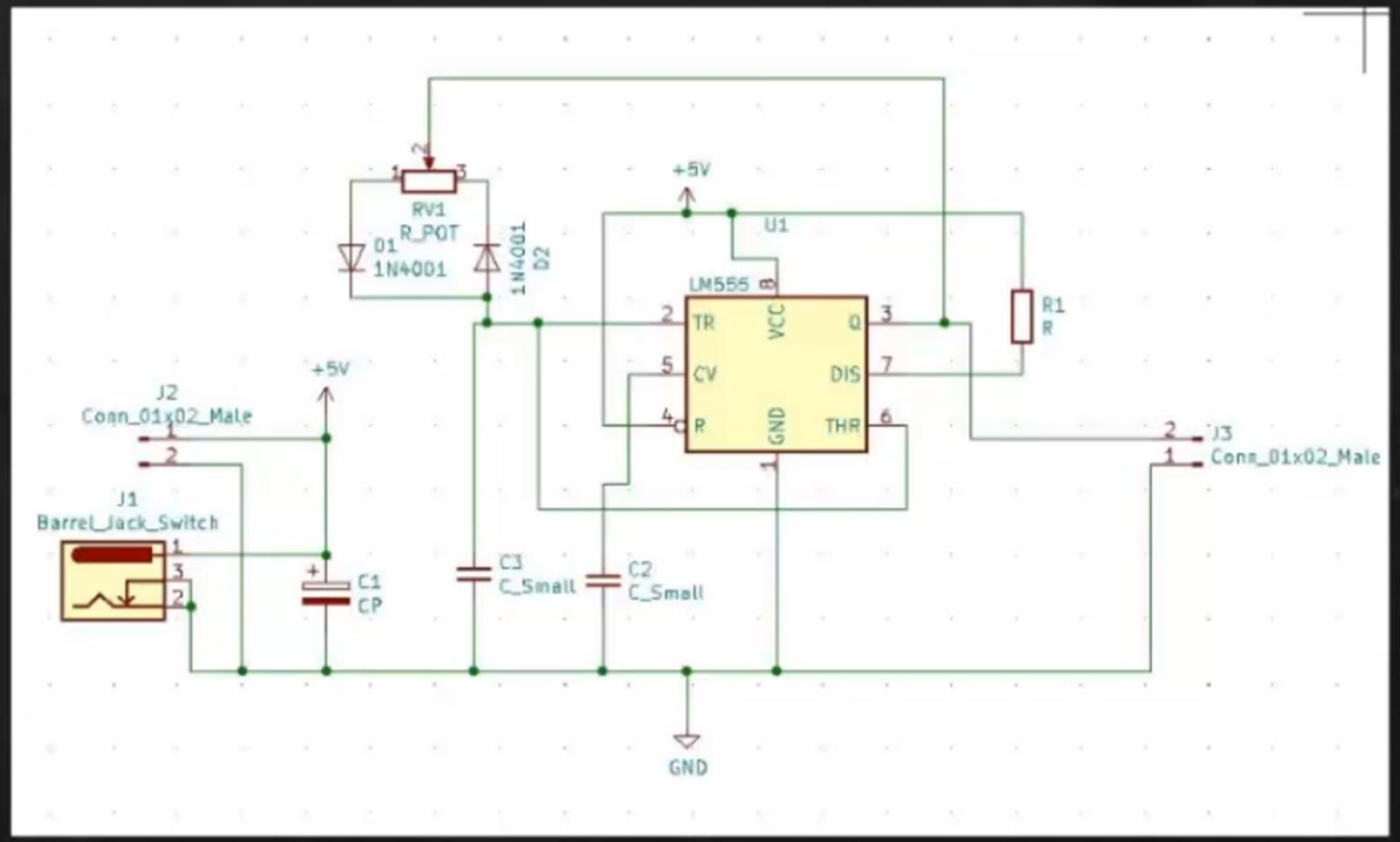
1. Schematic Capture





1

Schematic Capture



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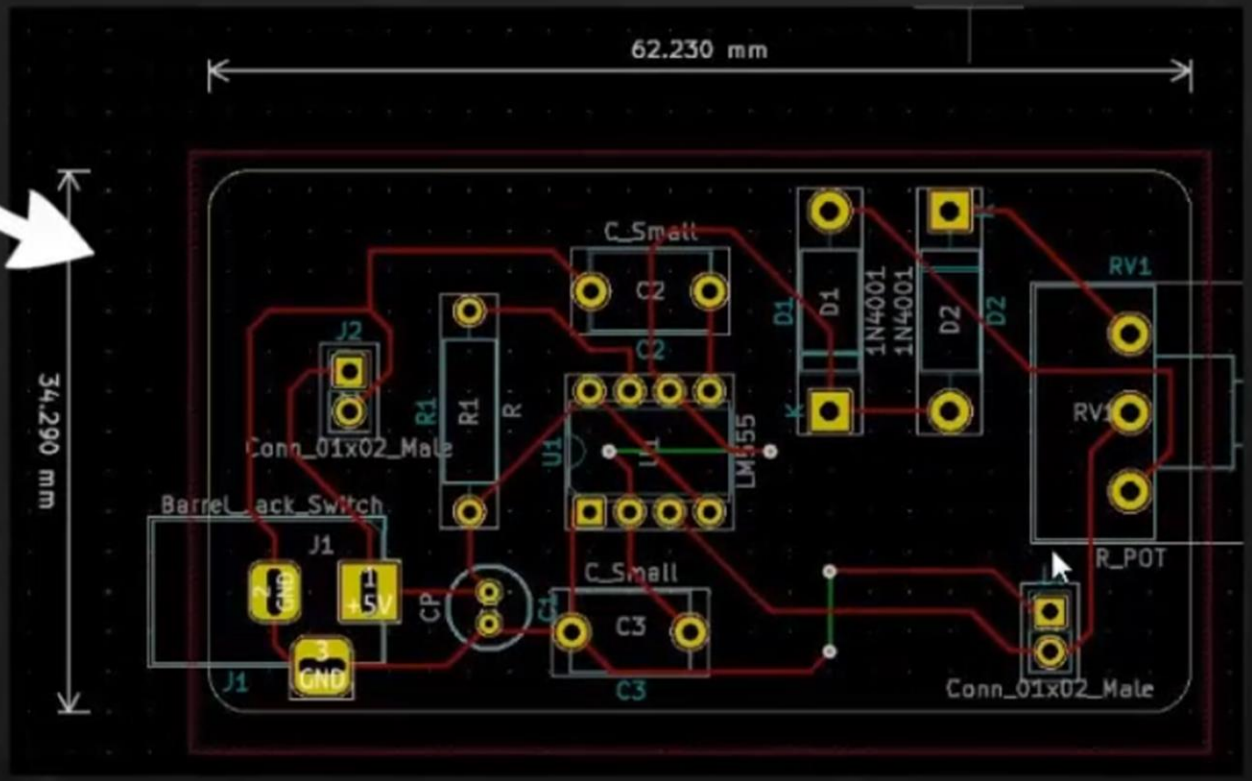
2

PCB Layout Design



Generate Fab.-Ready Output Files

3

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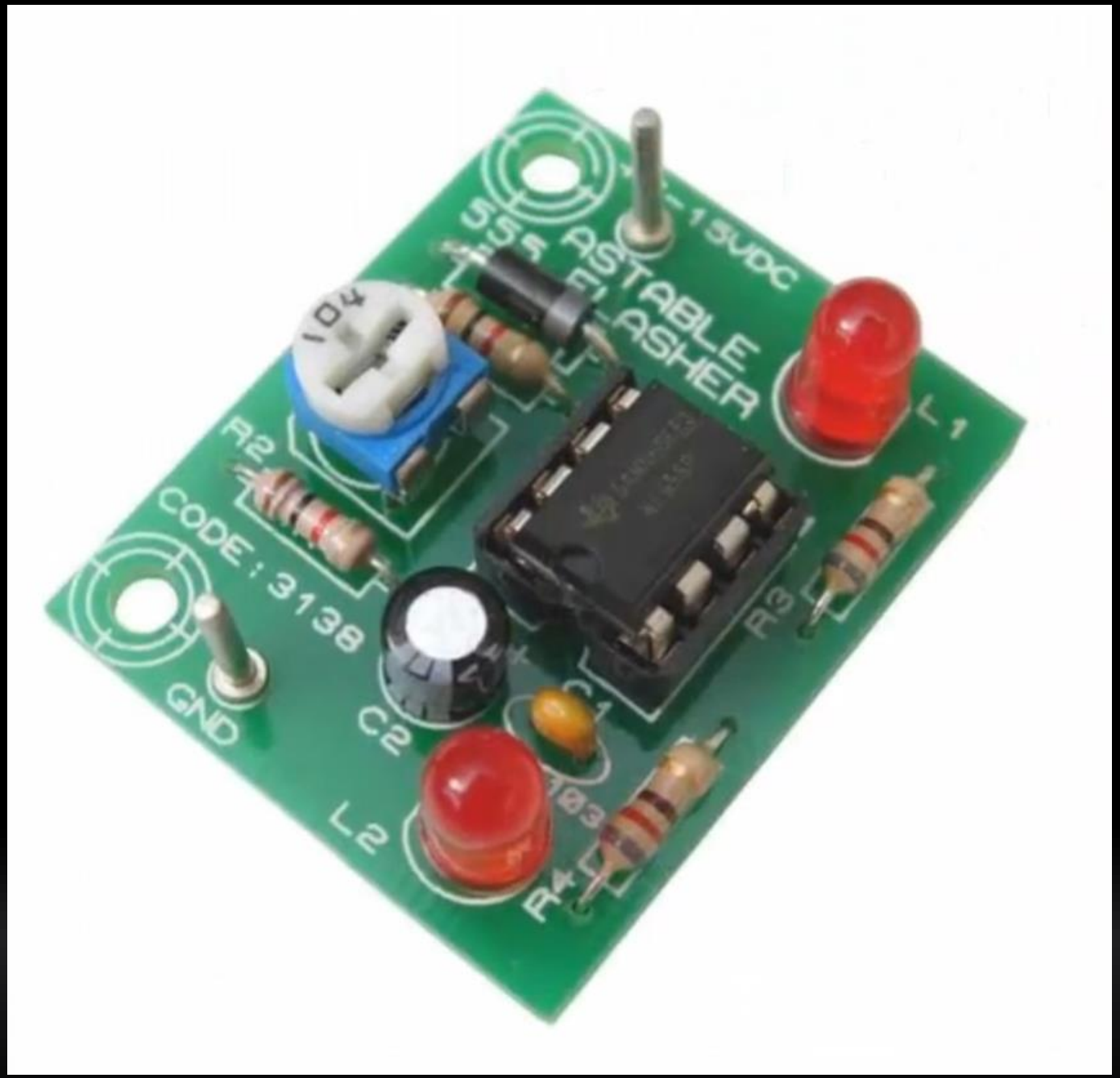

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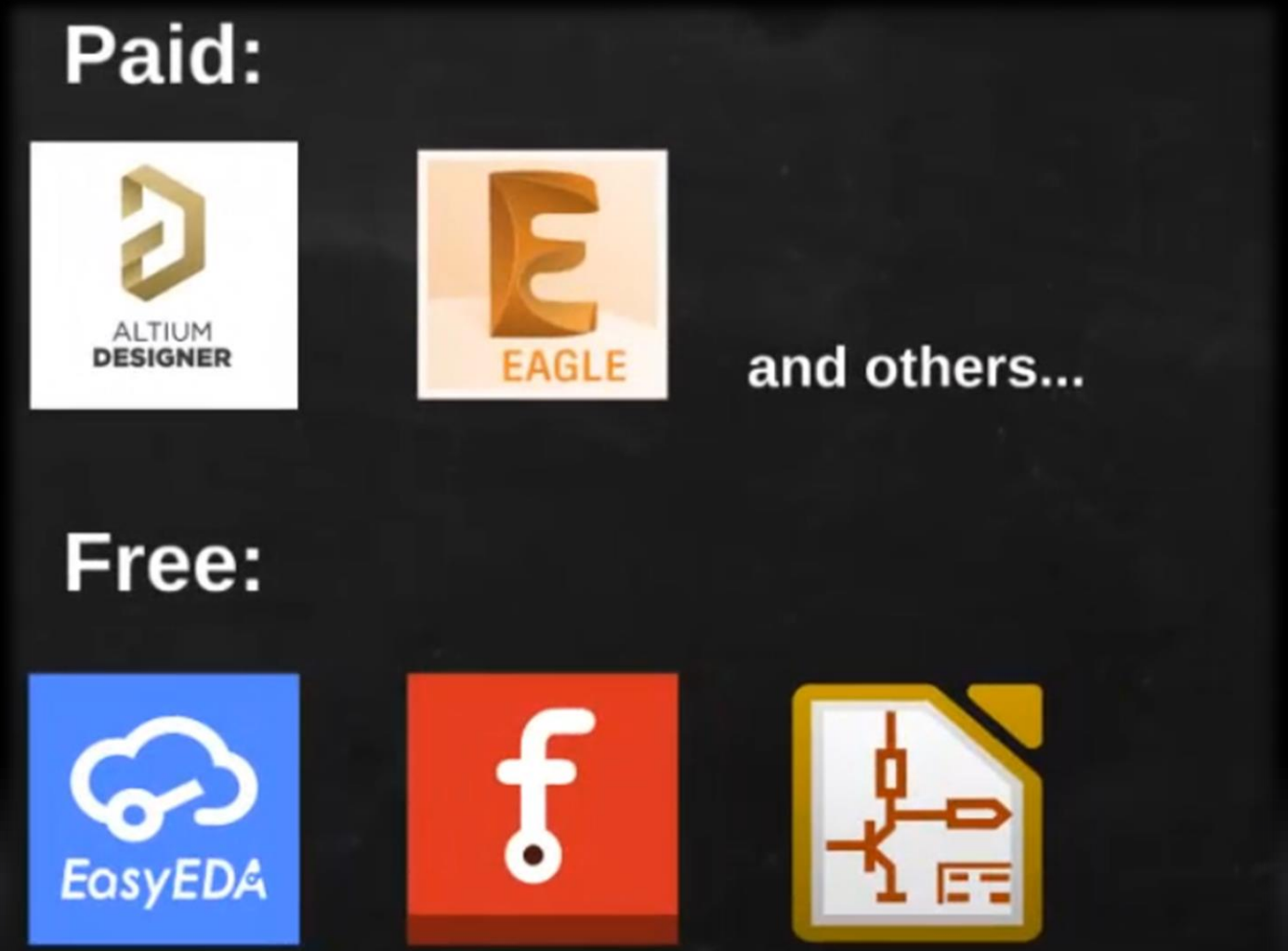
The Most Common CAD PCB Design Tools



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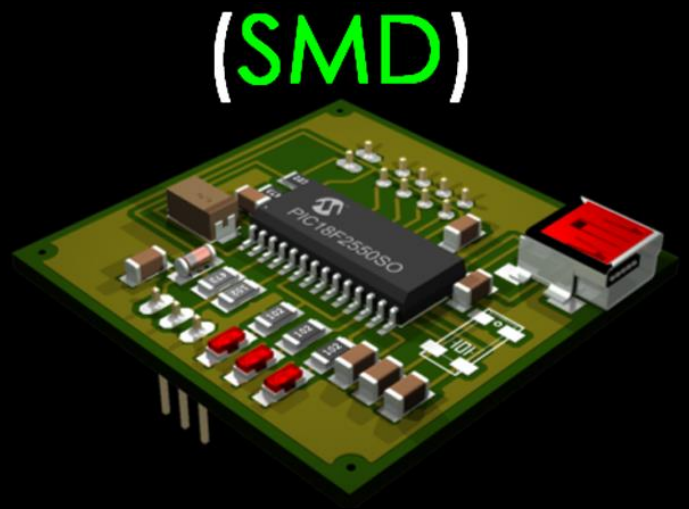
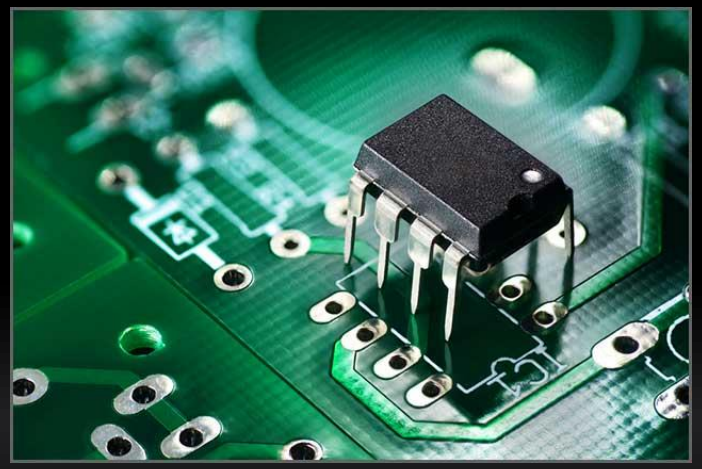
THT and SMD/SMT

THT- Through Hole Technology



SMD/SMT- Surface Mounted Device/Technology



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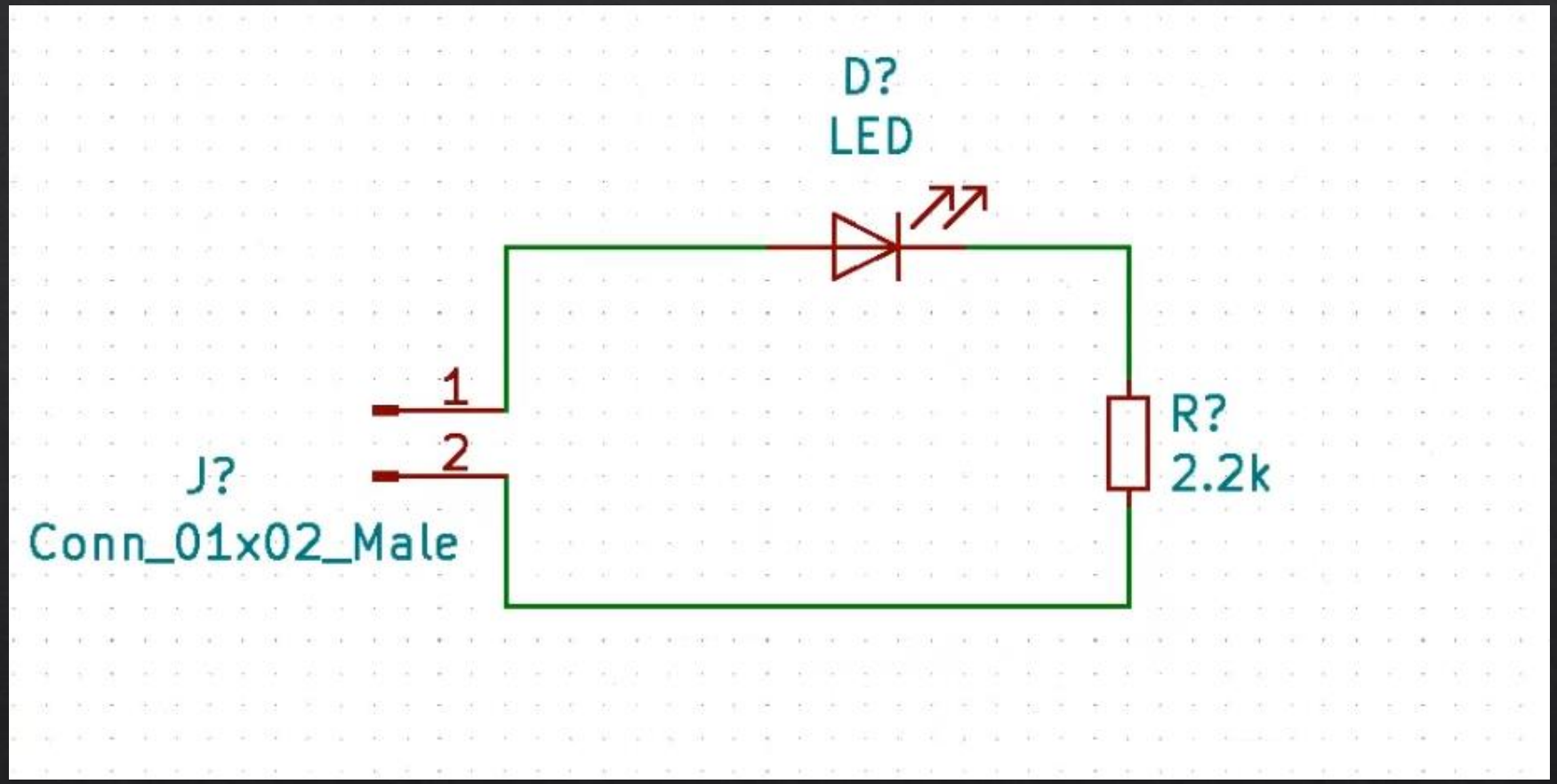
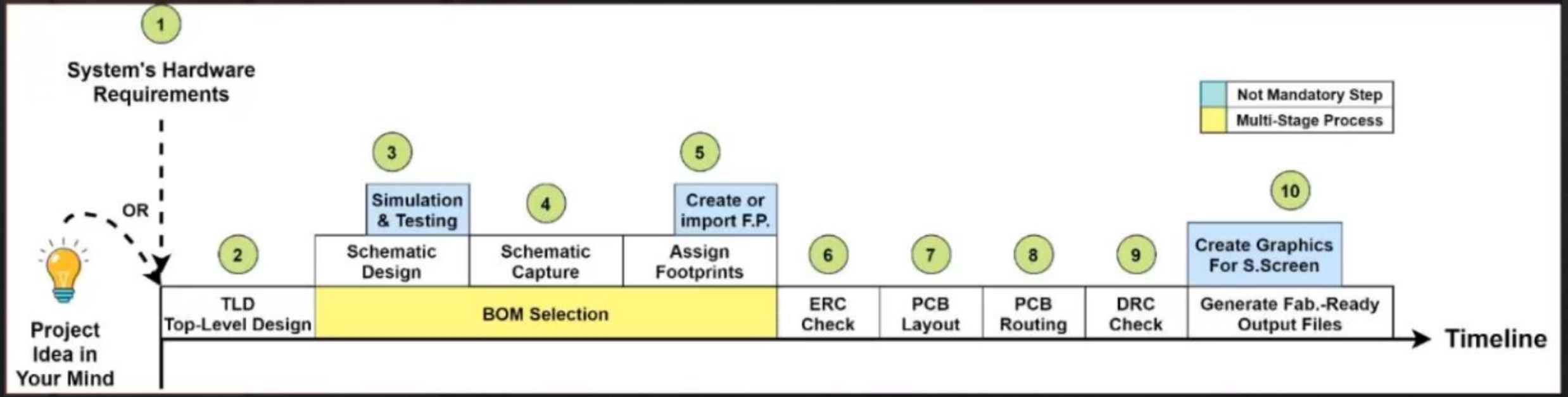
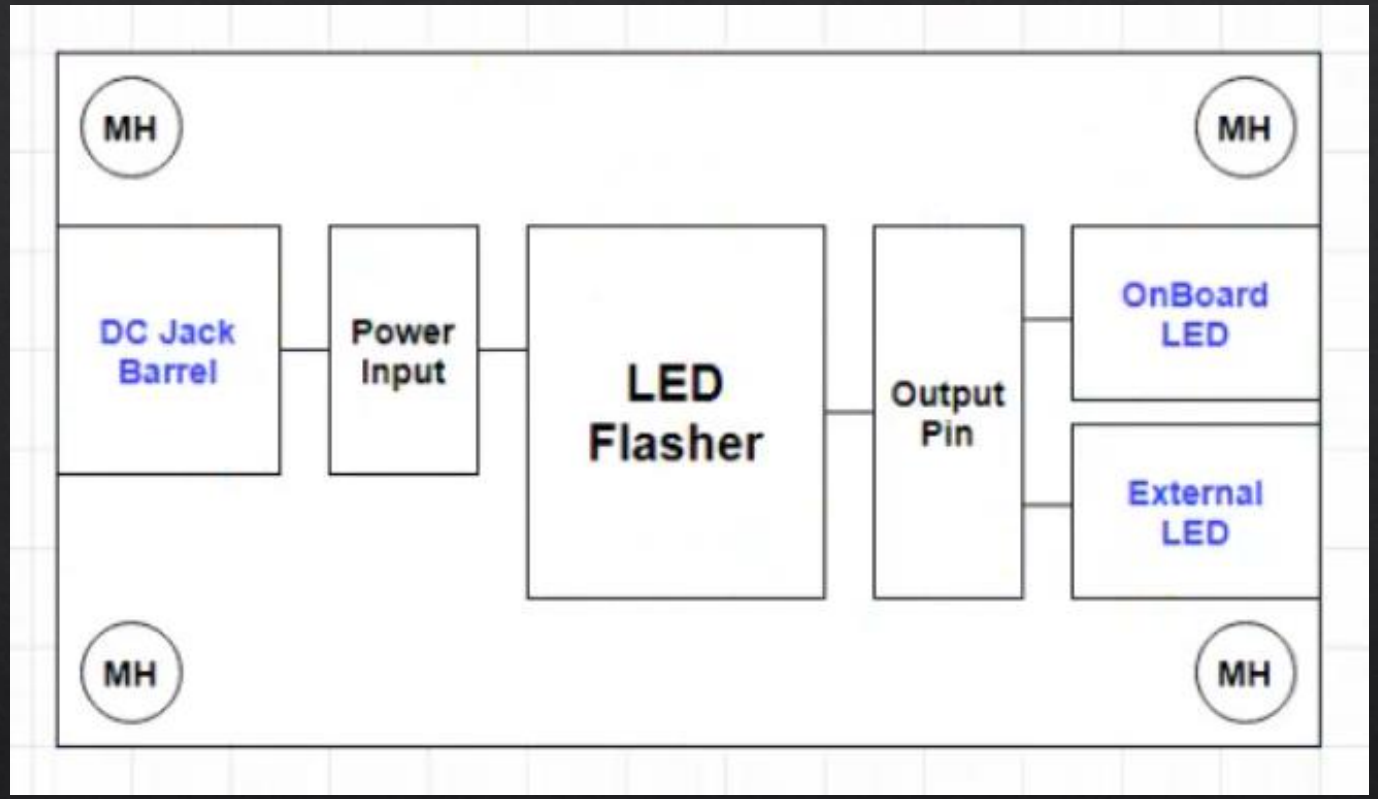

D?
LED
1
2
J?
Conn_01x02_Male
R?
2.2k

PCB Design Methodology

The way I approach hardware (PCB) design projects



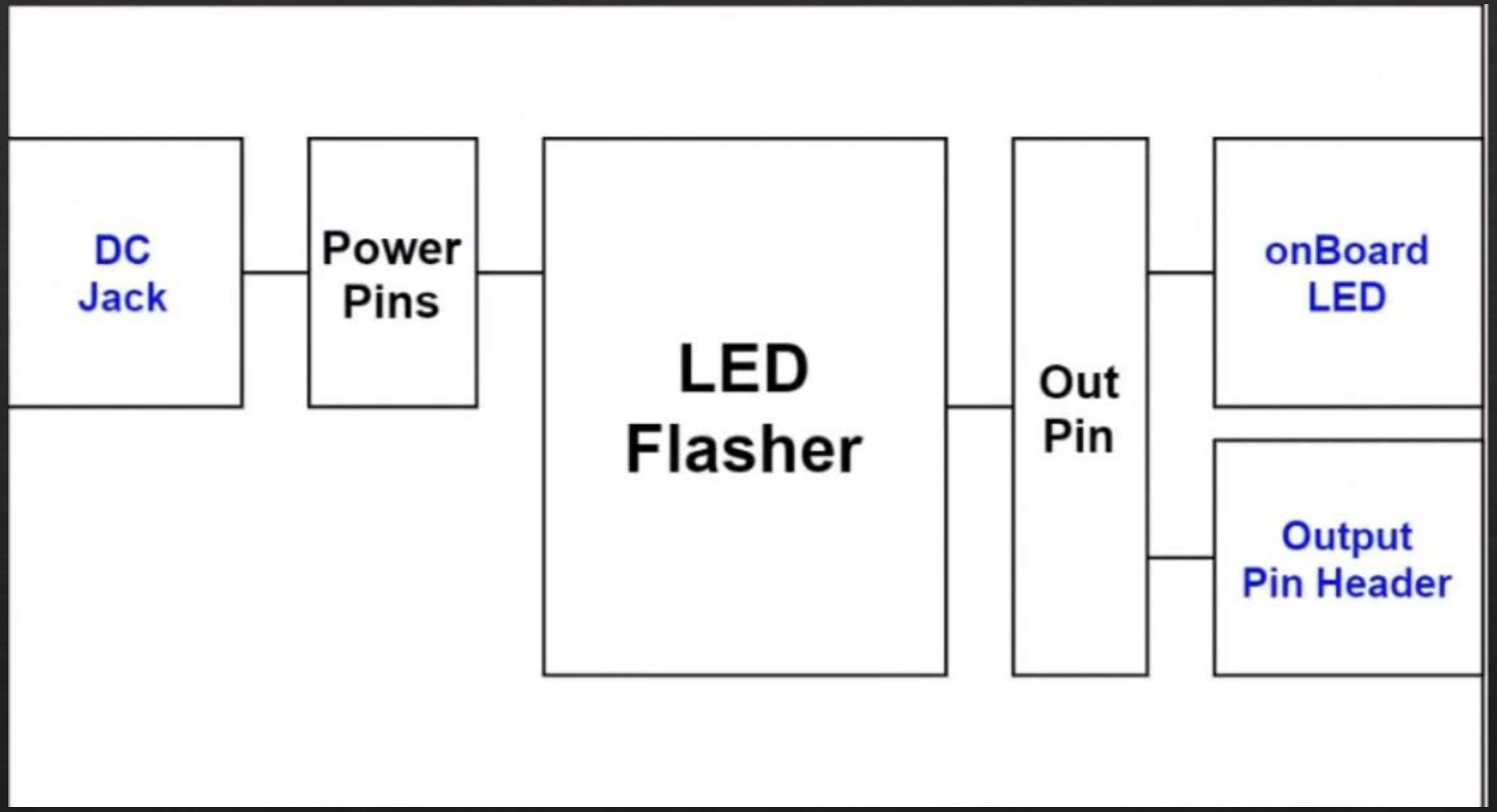

MH
MH
DC Jack Barrel
Power Input
LED Flasher
Output Pin
OnBoard LED
External LED
MH
MH

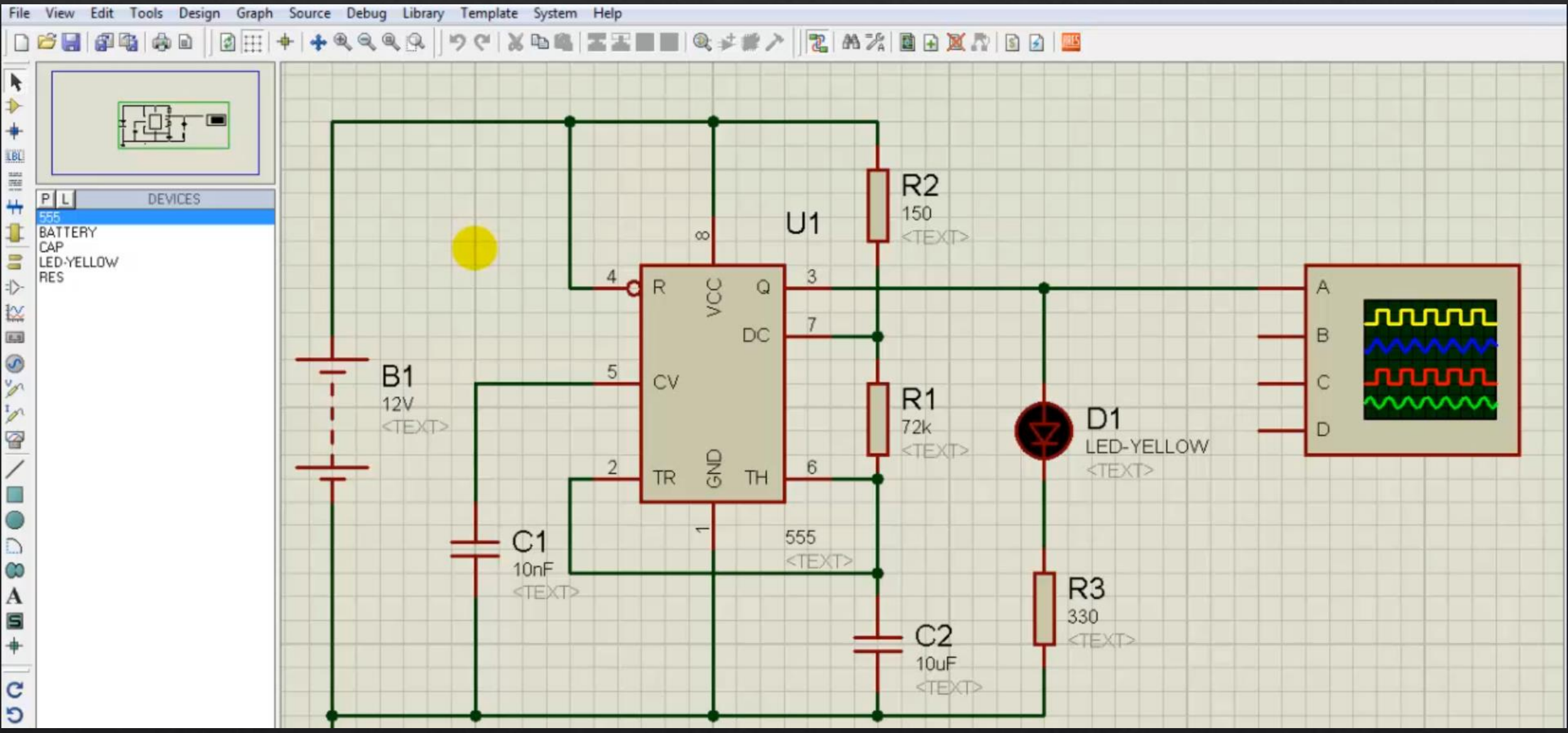
Pre-Design Stage

PCB Project1 Hardware Requirements (LED Flasher)

- Inputs:
  - NA
- Outputs:
  - Small LED (On Board)
  - Small LED (Off-Board) "Solder PADs or Screw Terminal"
- In/Out:
  - NA
- Power:
  - DC 5-12v From Adapter with Barrel Jack
- PCB Size or Dimensions:
  - NA
- Functionality Description:
  - The PCB **Shall** Blink an LED once a second always after power-up.
- Other Notes For The Designer:
  - Add Open-Source Graphics to The Silkscreen Layer
  - Add Project's Name "LED Flasher" to The Silkscreen
  - Add 4 Mounting Holes (M2 size)

Pre-Design Stage

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P L DEVICES
555
BATTERY
CAP
LED-YELLOW
RES
U1
R
VCC
Q
DC
CV
TR
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TH
8
4
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7
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C1
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C2
10uF
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D1
LED-YELLOW
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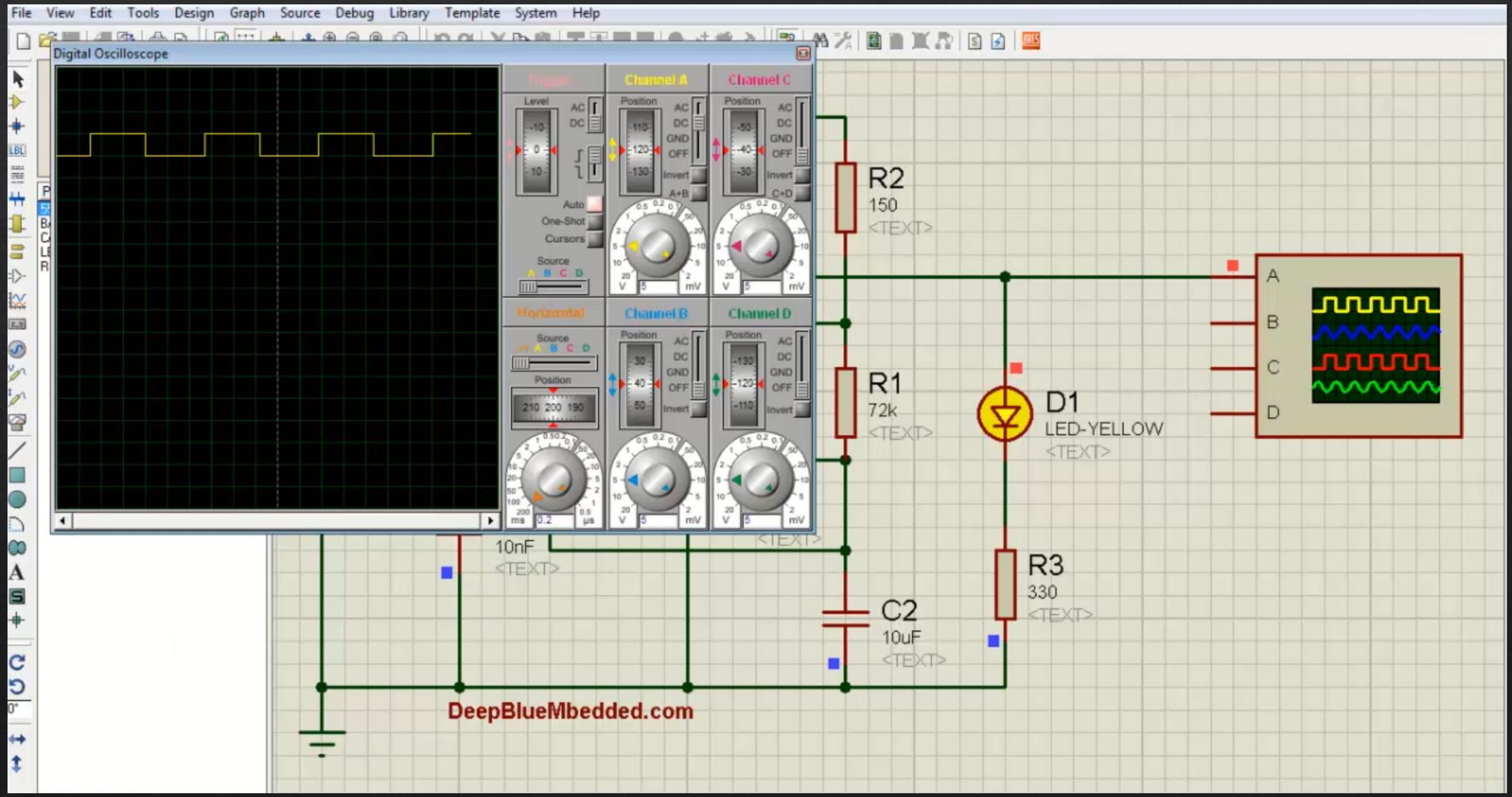
A
B
C
D


File View Edit Tools Design Graph Source Debug Library Template System Help
Digital Oscilloscope
Trigger
Channel A
Channel C
Horizontal
Channel B
Channel D
Level
Position
AC
DC
GND
OFF
Invert
A+B
C+D
Auto
One-Shot
Cursors
Source
A B C D
210 200 190
R2
150
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R1
72k
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A
B
C
D
10nF
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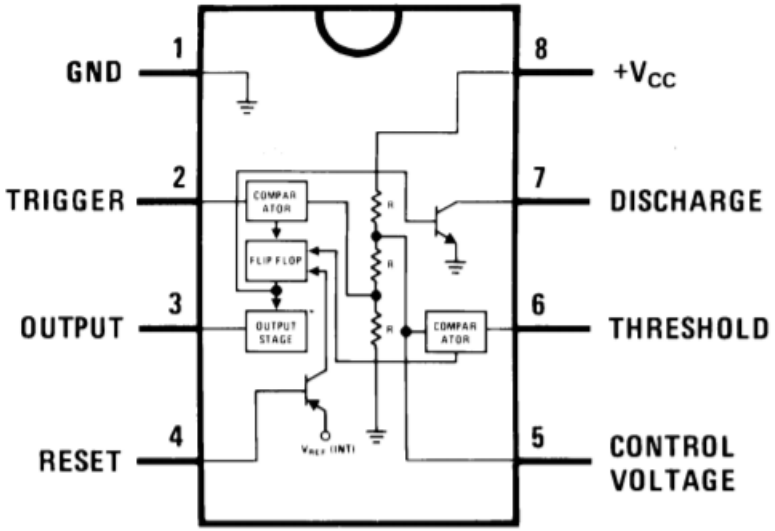
C2
10uF
<TEXT>
R3
330
<TEXT>
DeepBlueMbedded.com

Connection Diagram

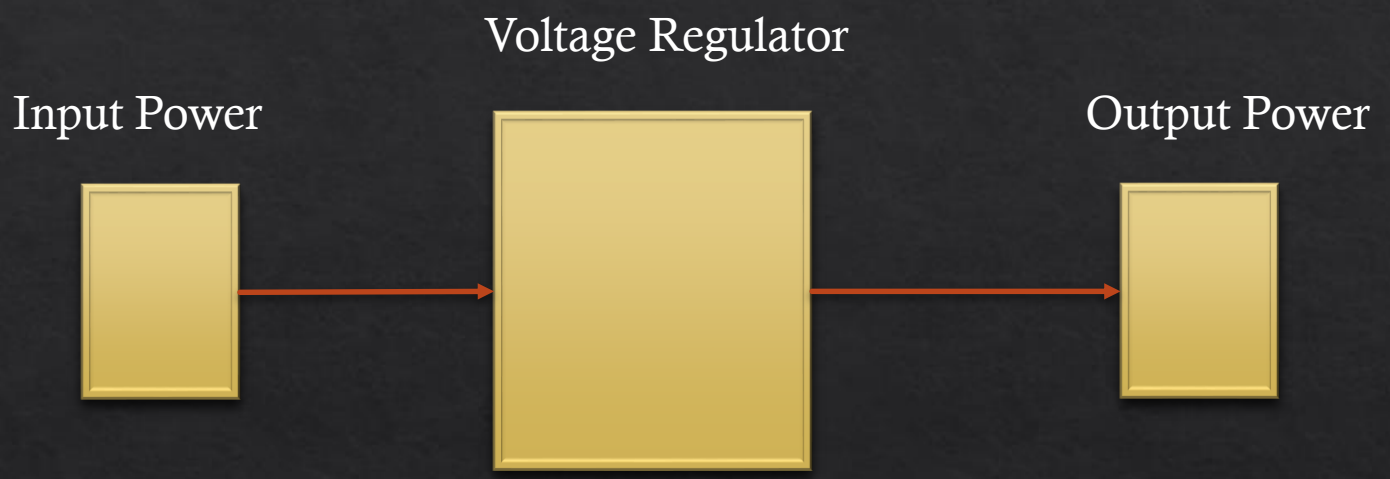
Dual-In-Line, Small Outline
and Molded Mini Small Outline Packages



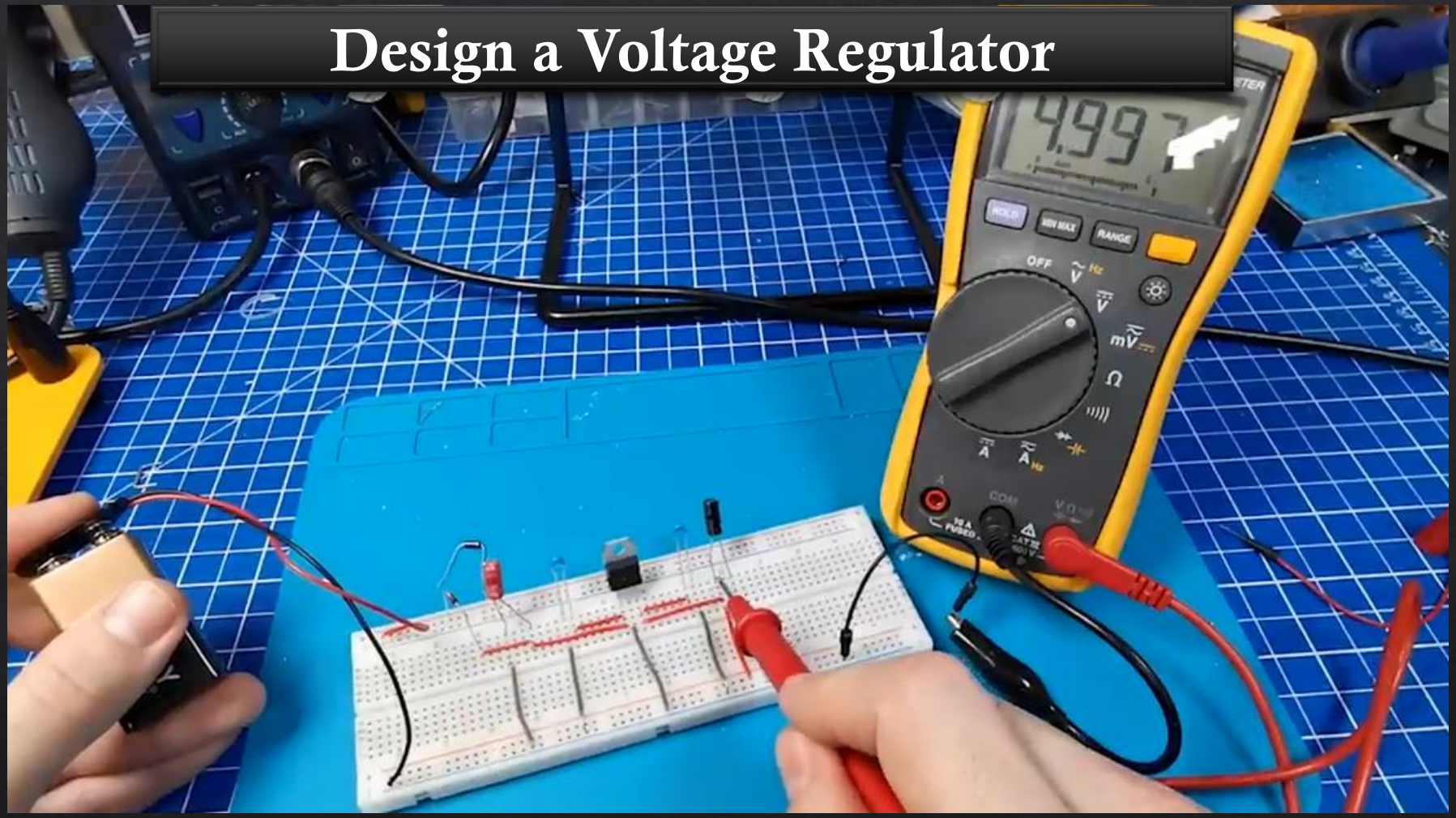
00785103

Top View

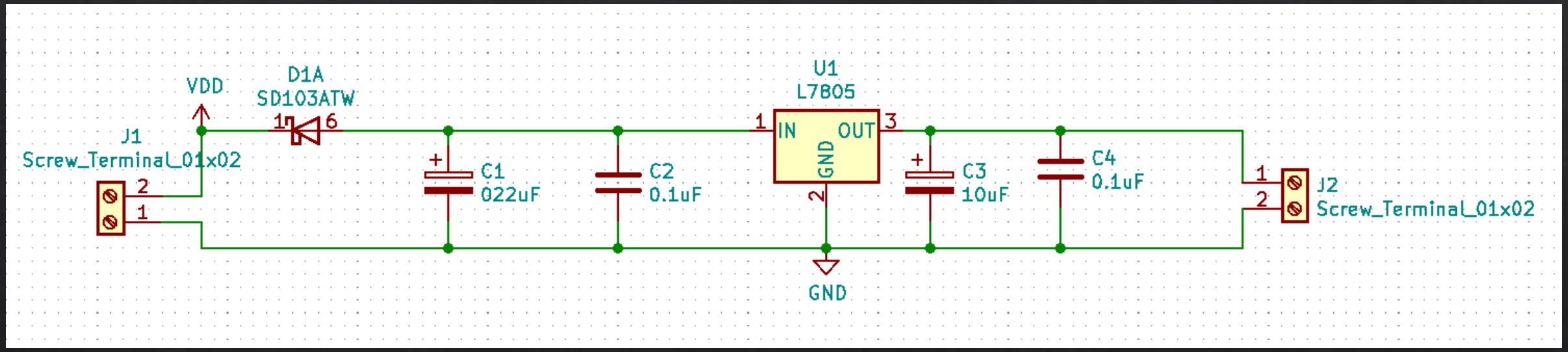
Project 3



Project 3



Schematic Capture

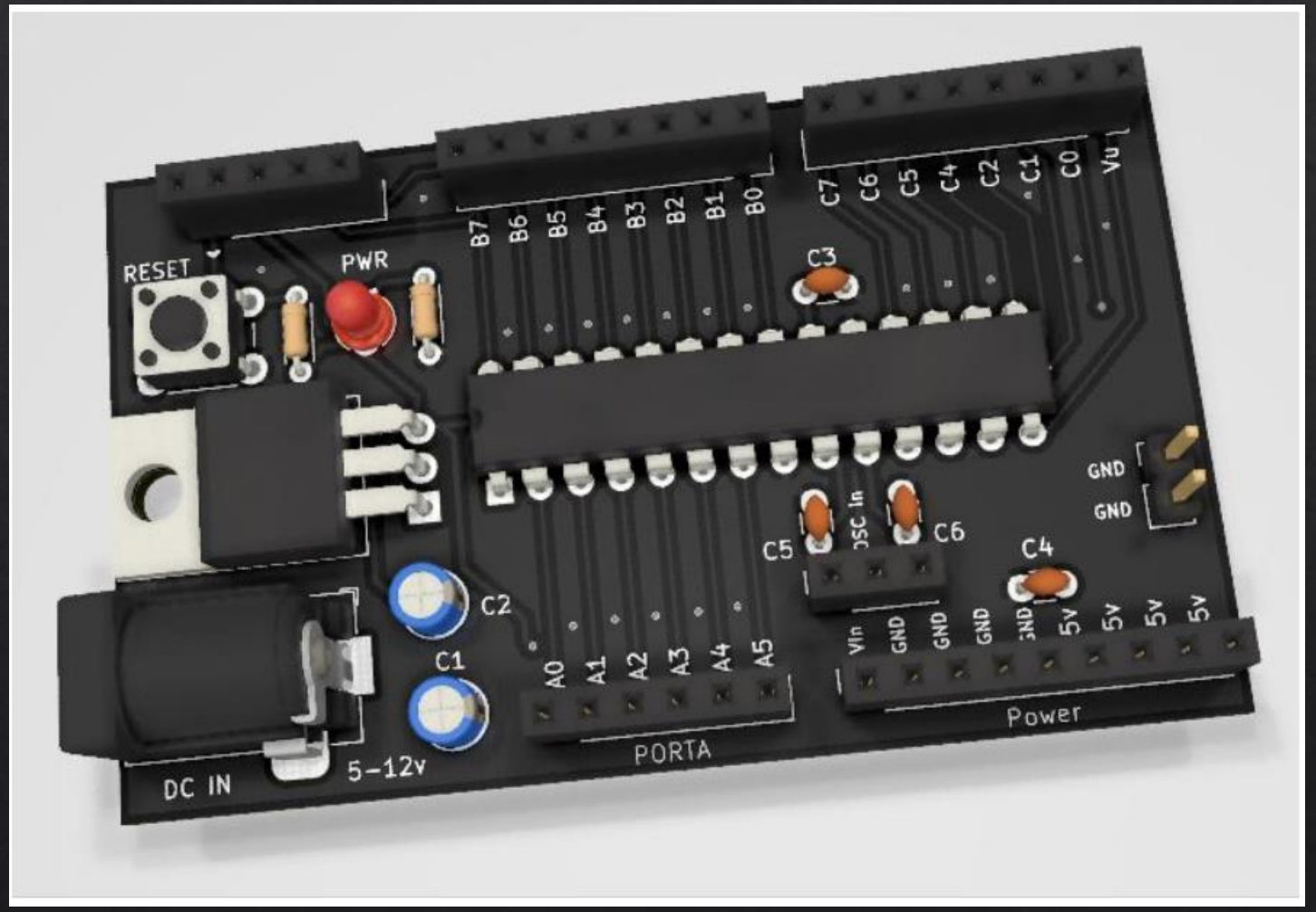


Assignment Footprint

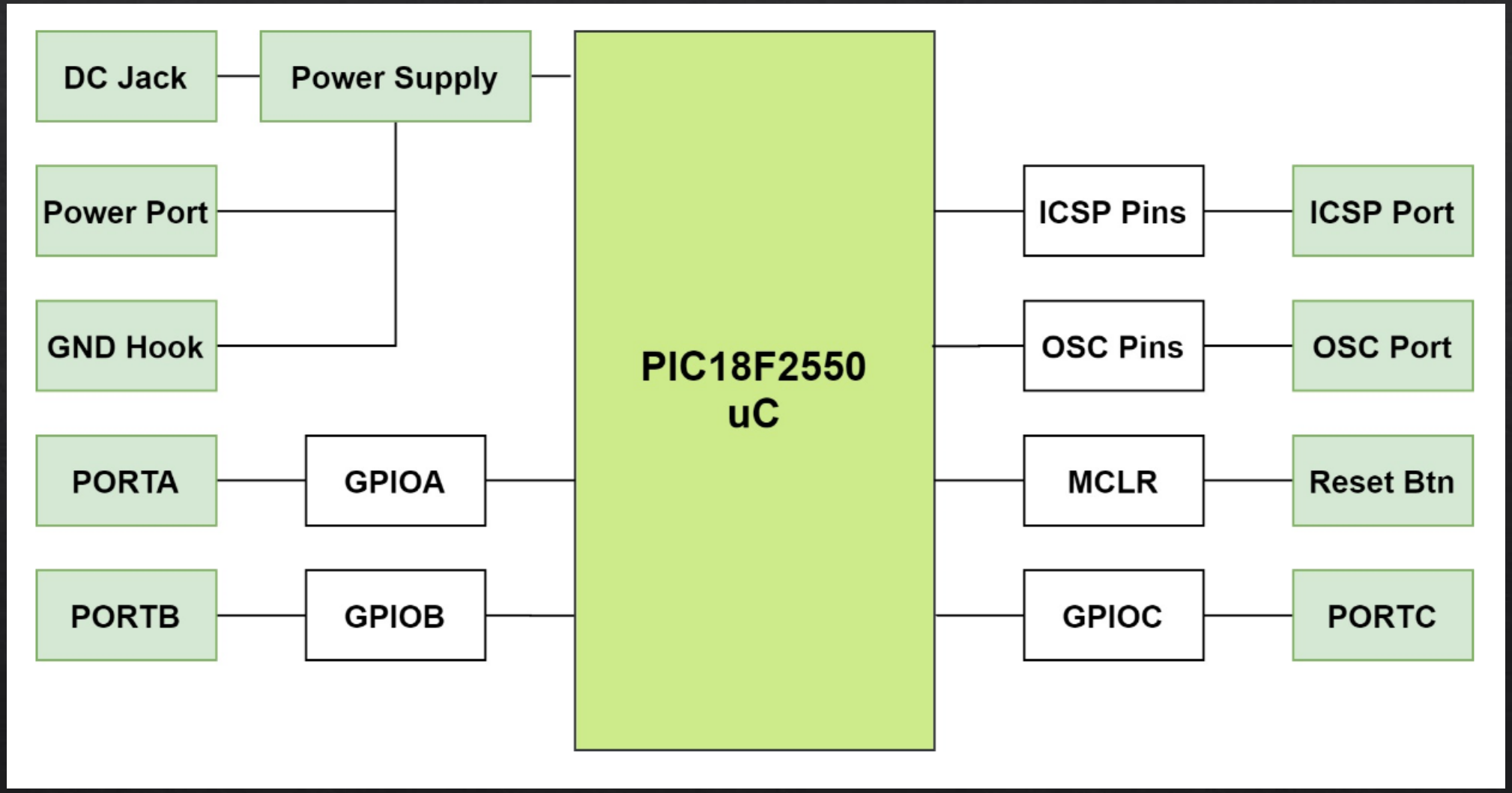
Symbol	Footprint Assignments
1	C1 - CP1 : Capacitor_THT:C_Radial_D5.0mm_H5.0mm_P2.00mm
2	C2 - CP1 : Capacitor_THT:C_Radial_D5.0mm_H5.0mm_P2.00mm
3	D1 - D : Diode_THT:Diode_Bridge_DIP-4_W5.08mm_P2.54mm
4	D2 - D : Diode_THT:Diode_Bridge_DIP-4_W5.08mm_P2.54mm
5	D3 - D : Diode_THT:Diode_Bridge_DIP-4_W5.08mm_P2.54mm
6	D4 - D : Diode_THT:Diode_Bridge_DIP-4_W5.08mm_P2.54mm
7	D5 - LED : LED_THT:LED_D3.0mm
8	D6 - LED : LED_THT:LED_D3.0mm
9	J1 - Barrel_Jack_Switch : Connector_BarrelJack:BarrelJack_CUI_PJ-036AH-SMT_Horizontal
10	J2 - Conn_02x02_Odd_Even : Connector_PinHeader_1.00mm:PinHeader_2x02_P1.00mm_Vertical
11	J3 - Conn_02x02_Odd_Even : Connector_PinHeader_1.00mm:PinHeader_2x02_P1.00mm_Vertical
12	R1 - R_Small : Resistor_THT:R_Axial_DIN0204_L3.6mm_D1.6mm_P5.08mm_Horizontal
13	R2 - R_Small : Resistor_THT:R_Axial_DIN0204_L3.6mm_D1.6mm_P5.08mm_Horizontal
14	SW1 - SW_SPDT : Button_Switch_THT:SW_DIP_SPSTx01_Slide_9.78x4.72mm_W7.62mm_P2.54mm
15	U1 - LM7805_TO220 : Package_TO_SOT_THT:TO-220-3_Vertical

Project 4

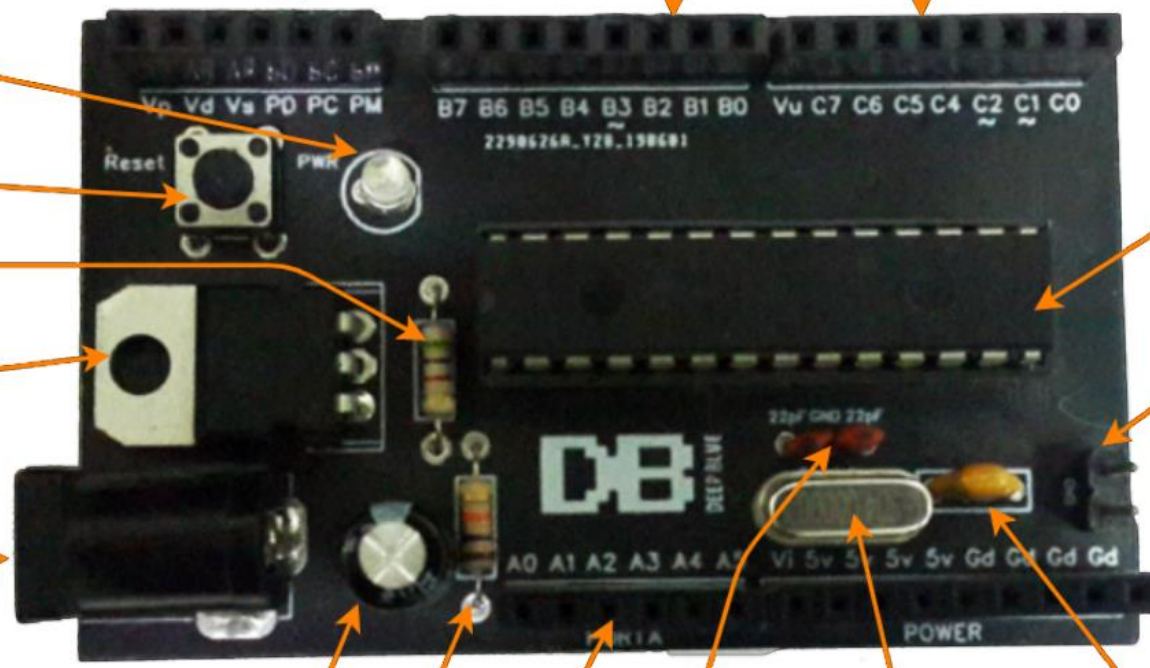
PIC18F Development Board



Project 4


DC Jack
Power Supply
Power Port
GND Hook
PORTA
GPIOA
PORTB
GPIOB
PIC18F2550
uC
ICSP Pins
ICSP Port
OSC Pins
OSC Port
MCLR
Reset Btn
GPIOC
PORTC

Project 4



1x PinHeader (1x6)

2x PinHeader (1x8)

Power LED

IC Base + PIC18F2550

Reset Switch

330 ohm

1x PinHeader (1x2) GND Hook For Oscilloscope or Logic Analyzer

LM7805 Regulator

DC Power In Jack (5v to 12v)

1x PinHeader (1x9) Power Port

104 Ceramic Cap (C2)

10k ohm

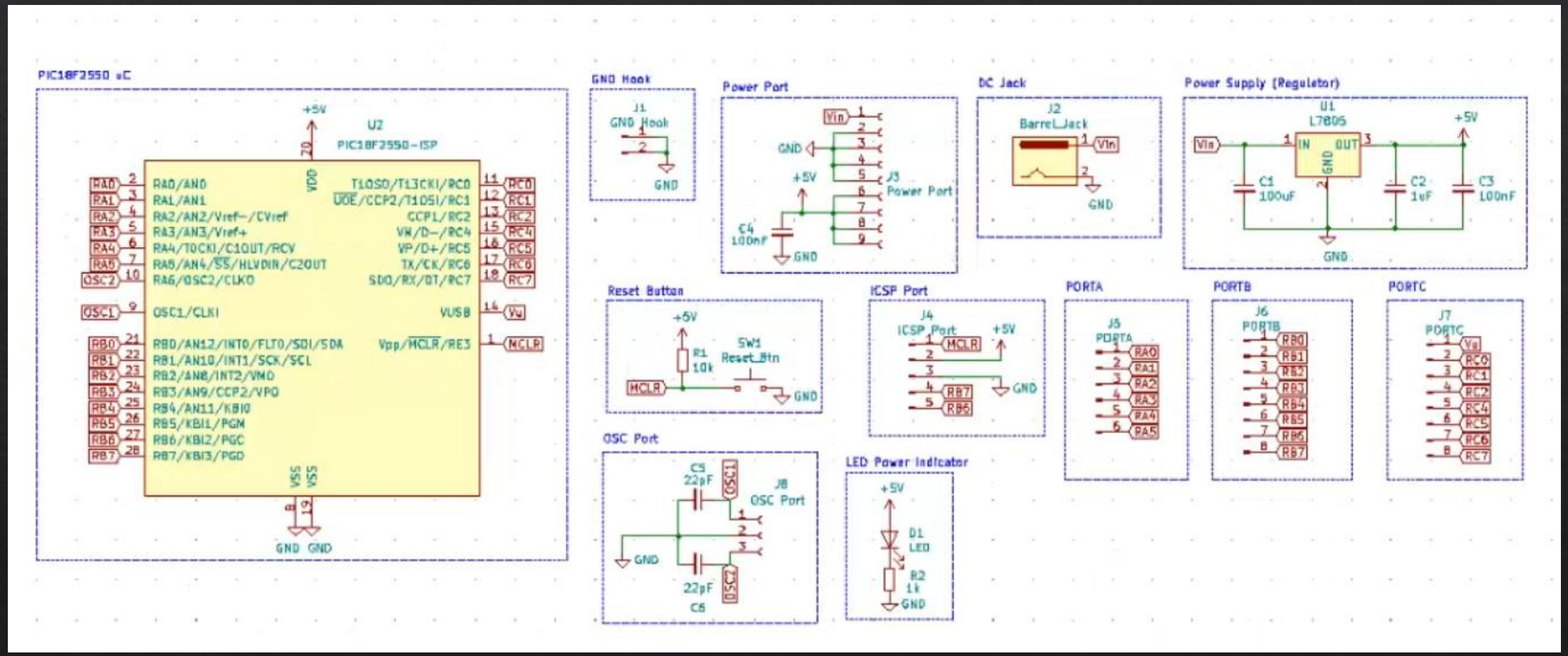
3Pin Connector For Crystal or Resonator

100uF Cap

2x 22pF Caps

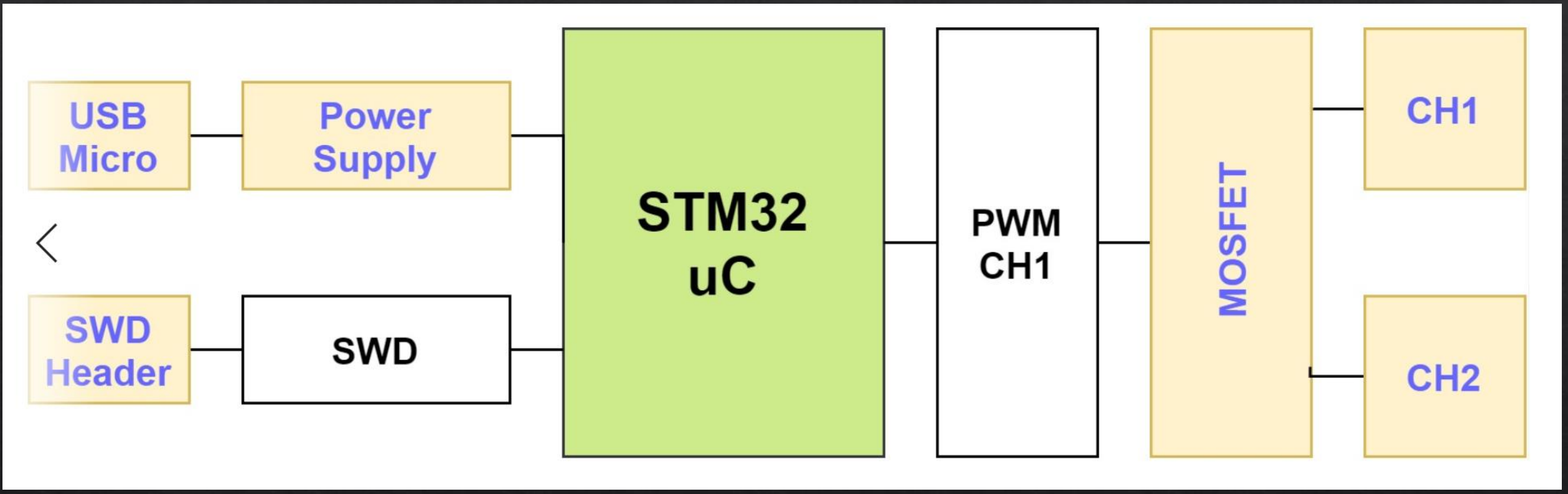
1x PinHeader (1x6)

Schematic


PIC18F2550 uC
U2
PIC18F2550-ISP
+5V
VDD
VSS
GND GND
RA0/AN0
RA1/AN1
RA2/AN2/Vref-/CVref
RA3/AN3/Vref+
RA4/T0CKI/C1OUT/RCV
RA5/AN4/SS/HLVDIN/C2OUT
RA6/OSC2/CLKO
OSC1/CLKI
RB0/AN12/INT0/FLT0/SDI/SDA
RB1/AN10/INT1/SCK/SCL
RB2/AN8/INT2/VMO
RB3/AN9/CCP2/VPO
RB4/AN11/KBI0
RB5/KBI1/PGM
RB6/KBI2/PGC
RB7/KBI3/PGD
T1OSO/T13CKI/RC0
UOE/CCP2/T1OSI/RC1
CCP1/RC2
VM/D-/RC4
VP/D+/RC5
TX/CK/RC6
SDO/RX/DT/RC7
VUSB
Vpp/MCLR/RE3
GND Hook
J1
GND Hook
GND
Power Port
Vin
GND
+5V
J3
Power Port
C4
100nF
DC Jack
J2
BarrelJack
Vin
GND
Power Supply (Regulator)
U1
L7805
IN
OUT
GND
Vin
+5V
C1
100uF
C2
1uF
C3
100nF
Reset Button
+5V
R1
10k
SW1
Reset_Btn
MCLR
GND
ICSP Port
J4
ICSP_Port
MCLR
+5V
RB7
RB6
GND
PORTA
J5
PORTA
PORTB
J6
PORTB
PORTC
J7
PORTC
OSC Port
C5
22pF
OSC1
J8
OSC Port
GND
22pF
C6
OSC2
LED Power Indicator
+5V
D1
LED
R2
1k
GND

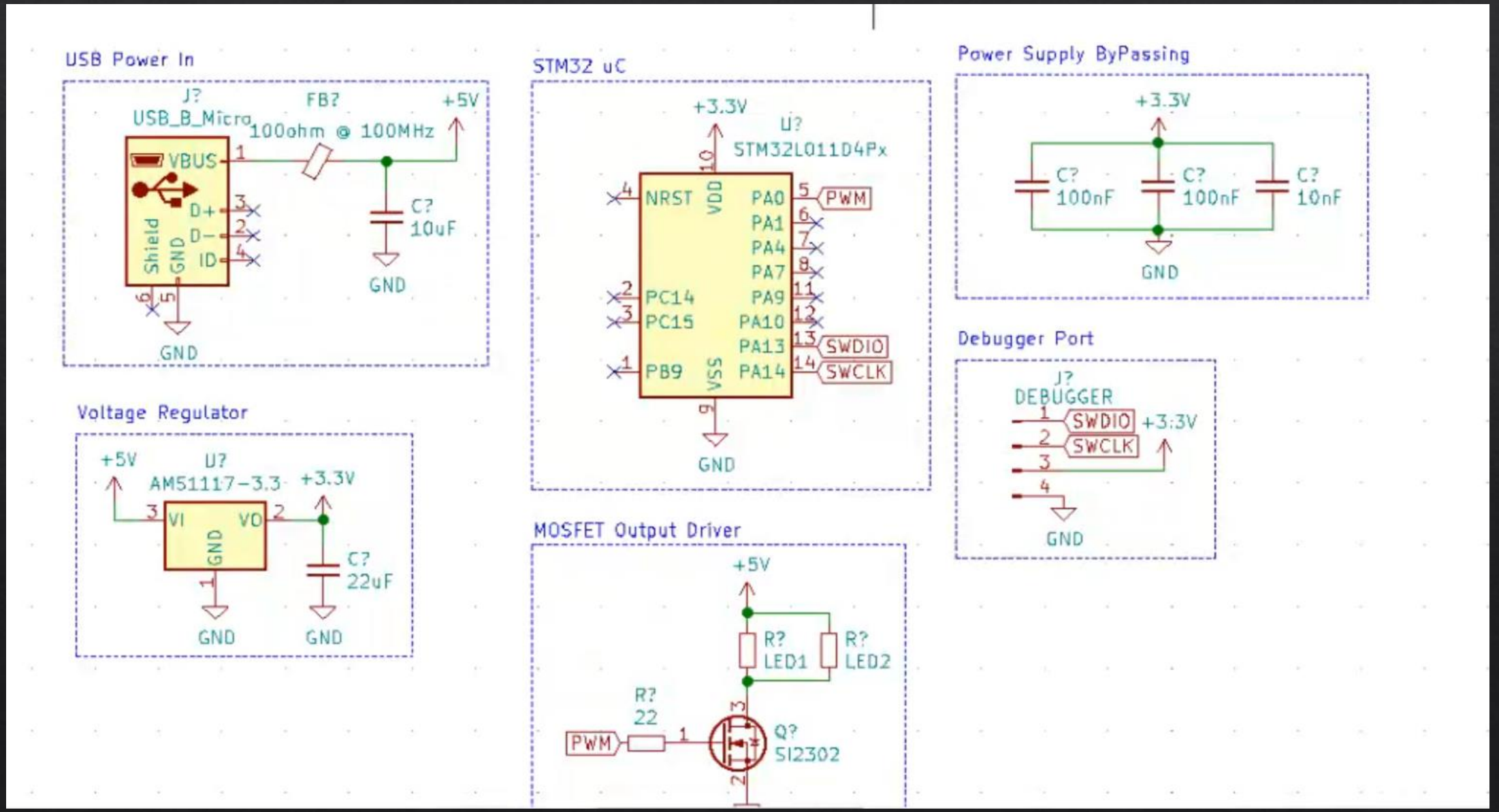
Project 5

Top Level Design



Functionality

Schematic


USB Power In
J?
USB_B_Micro
FB?
100ohm @ 100MHz
+5V
VBUS
D+
D-
ID
Shield
GND
C?
10uF
GND
GND
STM32 uC
+3.3V
U?
STM32L011D4Px
NRST
VDD
PA0
PWM
PA1
PA4
PA7
PC14
PA9
PC15
PA10
PA13
SWDIO
PB9
VSS
PA14
SWCLK
GND
Power Supply ByPassing
+3.3V
C?
100nF
C?
100nF
C?
10nF
GND
Debugger Port
J?
DEBUGGER
SWDIO
+3.3V
SWCLK
GND
Voltage Regulator
+5V
U?
AM51117-3.3
+3.3V
VI
VO
GND
C?
22uF
GND
GND
MOSFET Output Driver
+5V
R?
LED1
R?
LED2
R?
22
PWM
Q?
SI2302