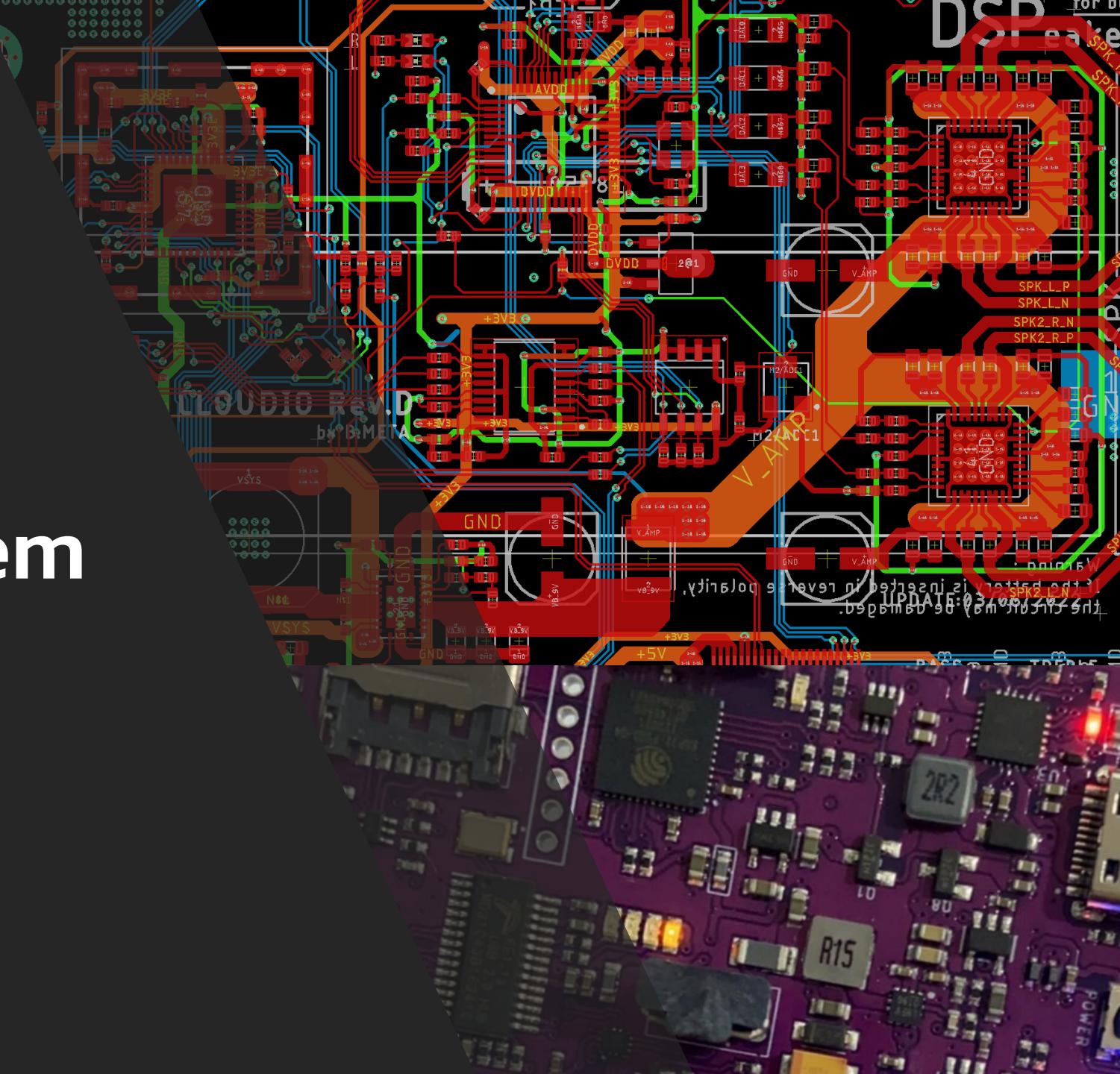




# PCB design for Embedded system

By : Meta Boonma

Embedded Engineer specialist



# ประวัติผู้บรรยาย

## นาย เมรา บุญมา

### ประวัติการทำงาน

2019 – ปัจจุบัน	: IoT & Embedded Engineer Specialist	@ Freewill FX Co.,Ltd.
2018 – 2019	: R&D Engineer	@ Forth Tracking System Co.,Ltd.

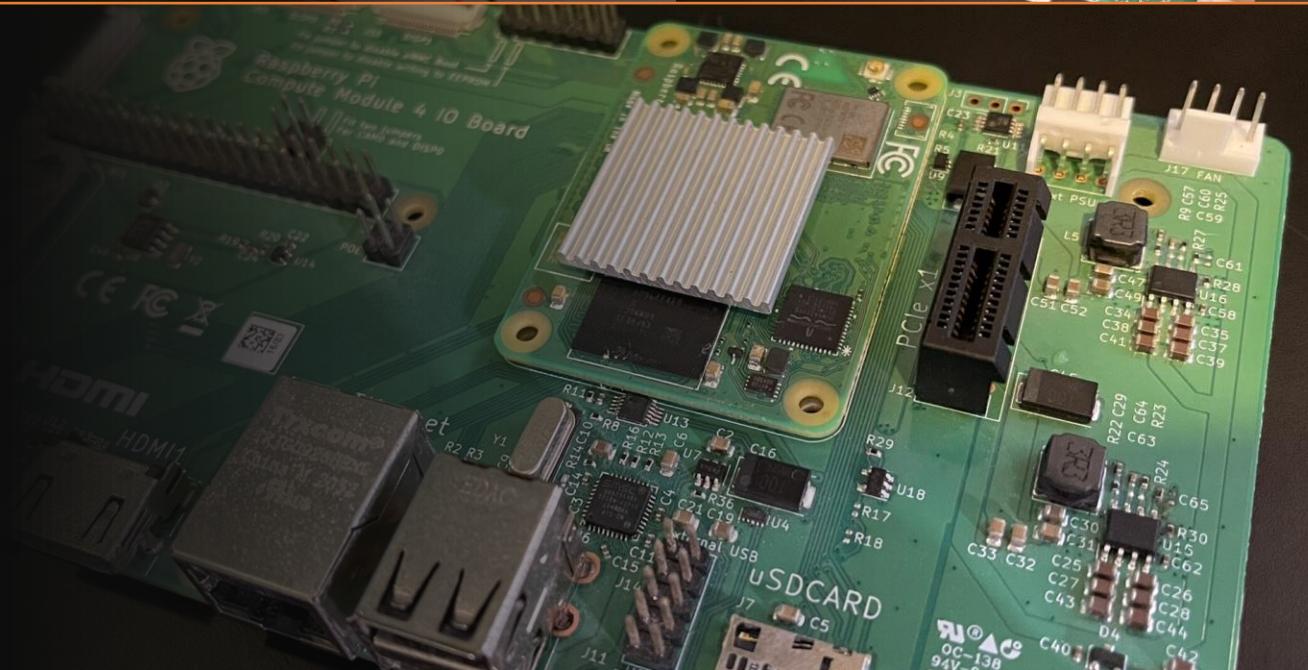
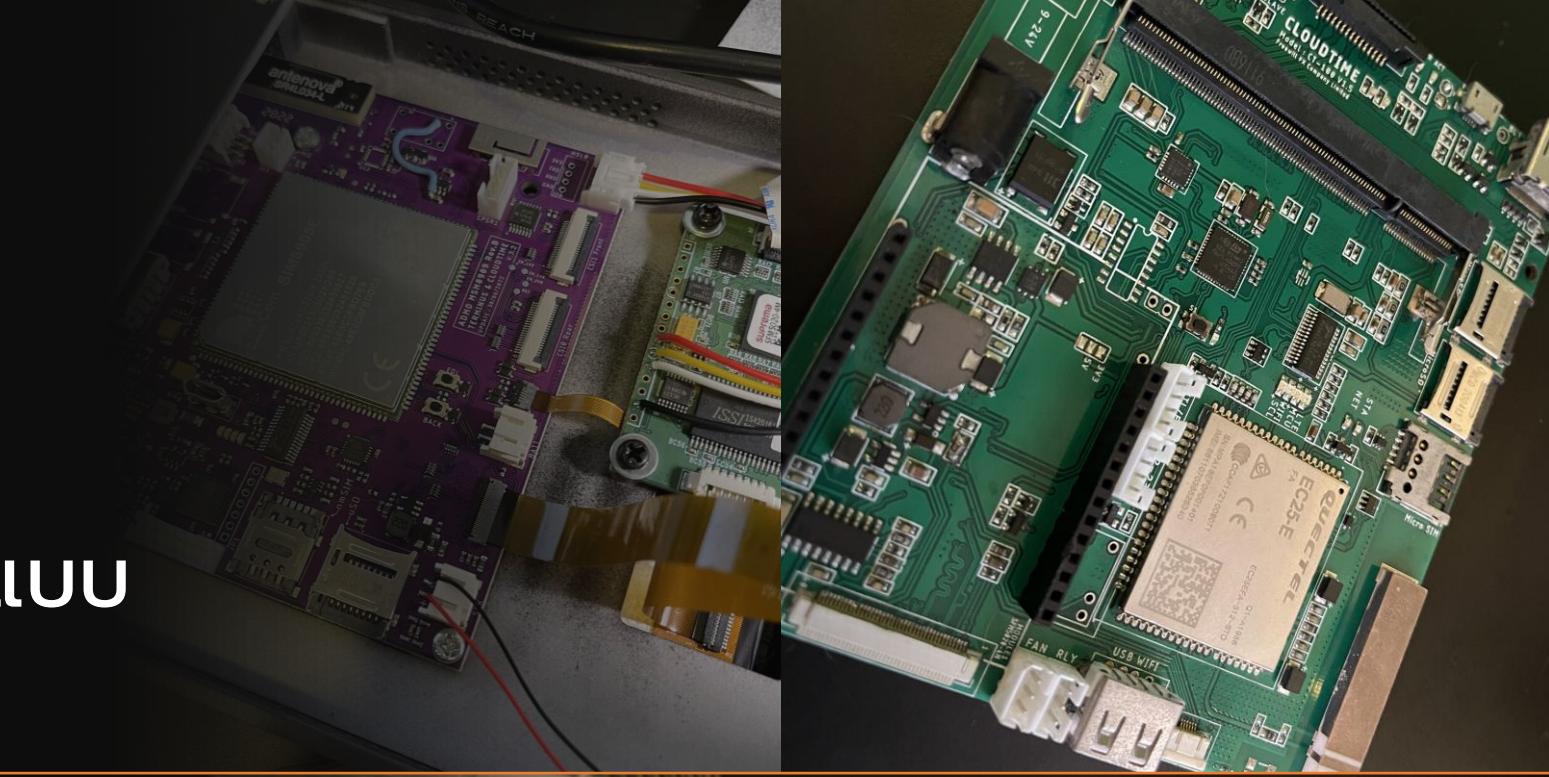
### ประวัติการศึกษา

2018	: ปริญญาตรี : เทคโนโลยีวิศวกรรมอิเล็กทรอนิกส์คอมพิวเตอร์ (ECT)	@ มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าพระนครเหนือ
2016	: ปวส. เทคโนโลยีระบบโทรคมนาคม	@ วิทยาลัยเทคโนโลยีสมุทรสหธรรม
2013	: ปวช. อิเล็กทรอนิกส์	@ วิทยาลัยเทคโนโลยีสมุทรสหธรรม

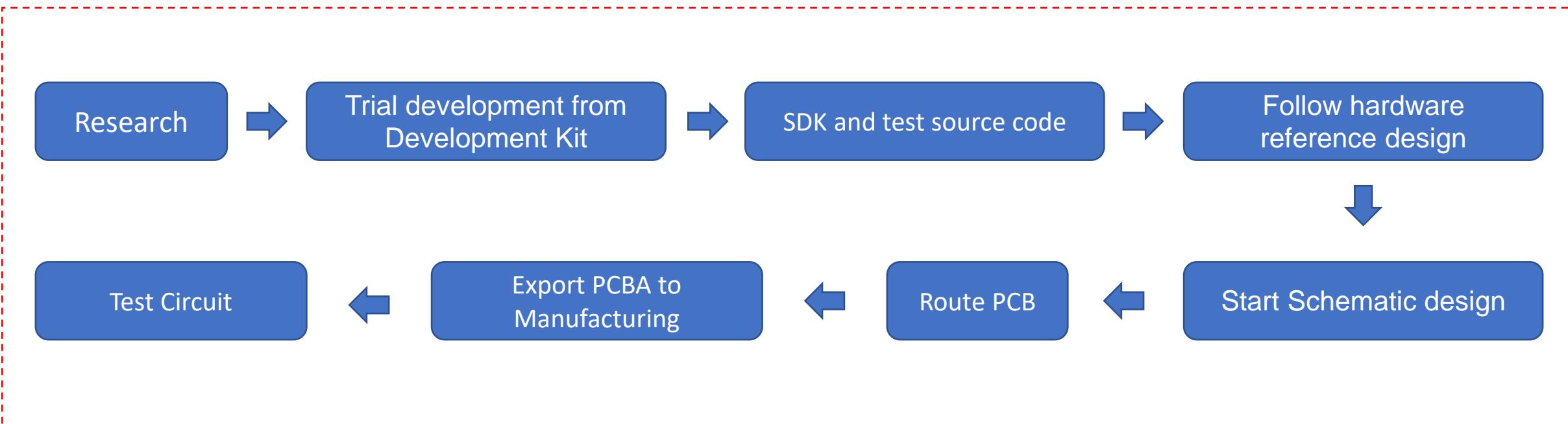
### ผลงานที่ผ่านมาโดยสังเขป

- ออกแบบ Linux Embedded with ARM Cortex-A Processor (Raspi CM3+, CM4) และ Custom Linux Kernel & Driver
- ออกแบบ Android Embedded และ Custom Android Kernel & ROM (Qualcomm Snapdragon 201: MSM8909)
- High Speed Electronic Design
- ออกแบบและสร้างบอร์ดไมโครคอนโทรลเลอร์, IoT จาก MCU : Atmel AVR, ESP32 (WiFi & BT), Nordic NRF (BLE), ARM Cortex-M (ST, NXP, Renesas, Cypress)
- การใช้ซีปประมวลผล DSP เพื่อควบคุมระบบเสียงผ่าน Android
- ปริญญานิพนธ์ : ดิจิทัลมิคเซอร์ควบคุมด้วยอินเทลลิเจนซ์
- โครงงานระดับ ปวส. : ชุดสาธิตหุ่นยนต์อัตโนมัติสั่งงานผ่านสมาร์ทโฟน
- ได้รับรางวัลชนะเลิศการแข่งขัน Smart Home Application ในปี 2014
- ได้รับรางวัลรองชนะเลิศการแข่งขันหุ่นยนต์ ABU Robocon Thailand ในปี 2014

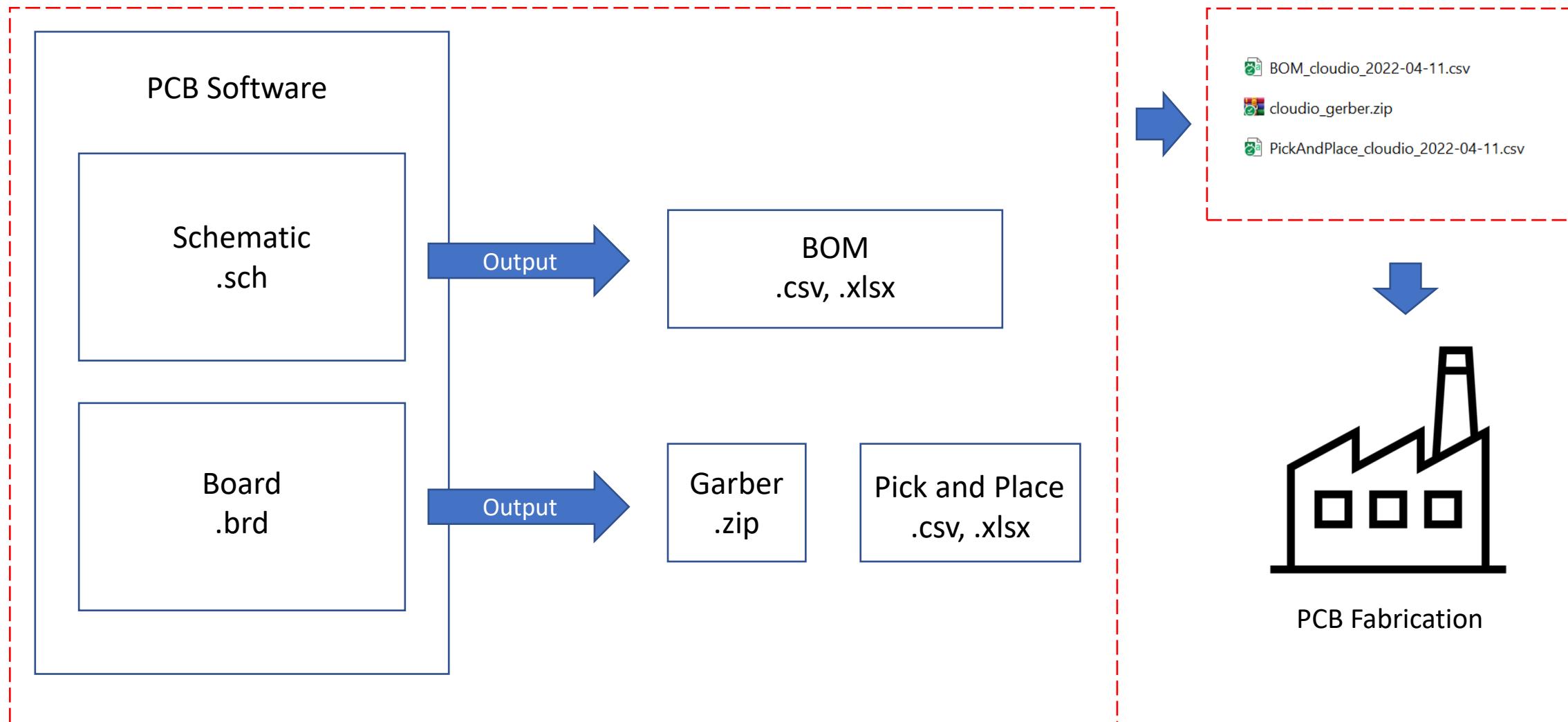
# แนะนำการรวมการอุปกรณ์ ฮาร์ดแวร์



# ແນວກາງການພື້ນທາອາຮົດແວ່ນ



# ໄດ້ແກຣມ



# ตัวอย่างเอกสารกำกับโรงงาน (PCB Assembly)

GerberJob
CannaSens.GBL
CannaSens.GBO
CannaSens.GBP
CannaSens.GBS
CannaSens.GKO
CannaSens.GTL
CannaSens.GTO
CannaSens.GTP
CannaSens.GTS
CannaSens.XLN

565	294	File folder
149,271	40,948	CAMtastic Bottom ...
62,119	18,109	CAMtastic Bottom ...
7,207	1,389	CAMtastic Bottom ...
4,648	1,019	CAMtastic Bottom ...
12,960	4,408	CAMtastic Keepout ...
328,180	90,096	CAMtastic Top Laye...
238,341	66,430	CAMtastic Top Ove...
38,119	7,118	CAMtastic Top Past...
23,634	4,619	CAMtastic Top Sold...
3,114	1,030	XLN File

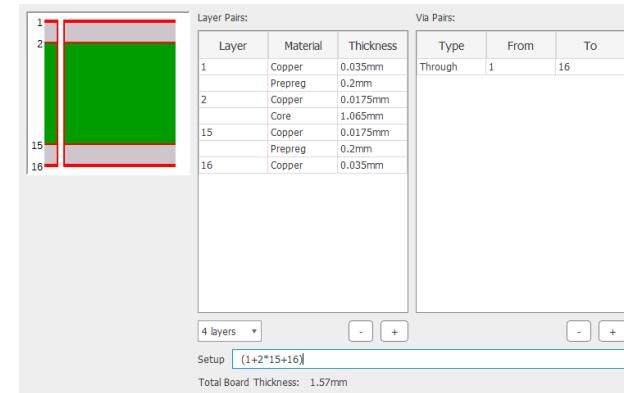
Gerber file

ID	Name	Designator	Footprint	Quantity	Manufacturer Part	Manufacturer	Supplier	Supplier P
1	RS485_MODULE	MODULE1	RS485_MODULE	1				
2	10uF	C1,C19,C3,C8,C9	C0603	5	CL0A106MA8NRNC	SAMSUNG	LCSC	C96446
3	10uF	C111	C0402	1	CL05A106MQ5NUNC	SAMSUNG	LCSC	C15525
4	100nF	C116,C5,C6	C0402	3	CL05B104KB54PNC	Samsung Electro-Mech.	LCSC	C307331
5	10nF	C13	C0603	1	0603B103K500NT	FH	LCSC	C57112
6	10uF	C26,C29	C0805	2	GRM21BR61H106KE43L	Murata Electronics	LCSC	C440198
7	100uF/10V	C27,C28	CT3528	2	TAJB107K006RNJ	AVX	LCSC	C16133
8	SS34	D1,D2	SMA_DO214AC	2	SS34	MDD	LCSC	C8678
9	TPS5430DDAG4	IC2	SOIC127P600X170-9N	1	TPS5430DDAR	TI	LCSC	C9864
10	SPC4078	J11	SPC4078	1	DC-005-2.5A-2.0	XKB Enterprise	LCSC	C319099
11	C146085		IST_PCB_DULK	1	Pulse	Pulse Precision Elec.	LCSC	C146085

BOM (Bill of Materials)

Designator	Footprint	Mid X	Mid Y	Ref X	Ref Y	Pad X	Pad Y	Layer	Rotation	Comment
C1	C0603	922.83mil	1315.36m	922.83mil	1315.35m	922.83mil	1346.85m	T	0	10uF
C3	C0603	922.83mil	1464.17m	922.83mil	1464.17m	922.83mil	1495.67m	T	0	10uF
C5	C0402	456.69mil	2404.72m	456.69mil	2404.72m	456.69mil	2424.4mil	T	0	100nF
C6	C0402	456.69mil	2495.67m	456.69mil	2495.66m	456.69mil	2475.98m	T	180	100nF
C8	C0603	943.7mil	1151.97m	943.7mil	1151.97m	943.7mil	1120.47m	T	180	10uF
C9	C0603	1001.97m	1151.97m	1001.97m	1151.97m	1001.97m	1120.47m	T	180	10uF
C13	C0603	322.44mil	1097.64m	322.44mil	1097.64m	322.44mil	1129.13m	T	0	10nF
C19	C0603	515.35mil	1252.76m	515.35mil	1252.75m	515.35mil	1221.26m	T	180	10uF
C26	C0805	225.59mil	677.56mil	225.59mil	677.56mil	188.19mil	677.56mil	T	90	10uF
C27	CT3528	433.86mil	933.86mil	433.86mil	933.86mil	433.86mil	992.91mil	T	270	100uF/10V
C28	CT3528	247.25mil	1251.18m	247.24mil	1251.18m	306.3mil	1251.18m	T	180	100uF/10V
C29	CT3528	225.59mil	598.42mil	225.59mil	598.42mil	188.19mil	598.42mil	T	90	10uF
C111	C0402	487.4mil	2629.53m	487.4mil	2629.52m	487.4mil	2609.84m	T	180	10uF

Pick and Place



PCB Stackup (optional)

## PCB design software



**OrCAD**<sup>TM</sup>  
CADENCE PCB SOLUTIONS



**KiCad**



## PCB manufacturer



<https://jlpcb.com/>



<https://www.pcbway.com/>



<https://www.seeedstudio.com/>



<https://www.allpcb.com/>

# **Electronic Component Distributor**

- <https://th.mouser.com/>
  - <https://www.digikey.co.th/>
  - <https://th.element14.com/>
  - <https://th.rs-online.com/web/>
  - <https://www.lcsc.com/>
- 
- <http://www.es.co.th/index.asp> (Local Sourcing)

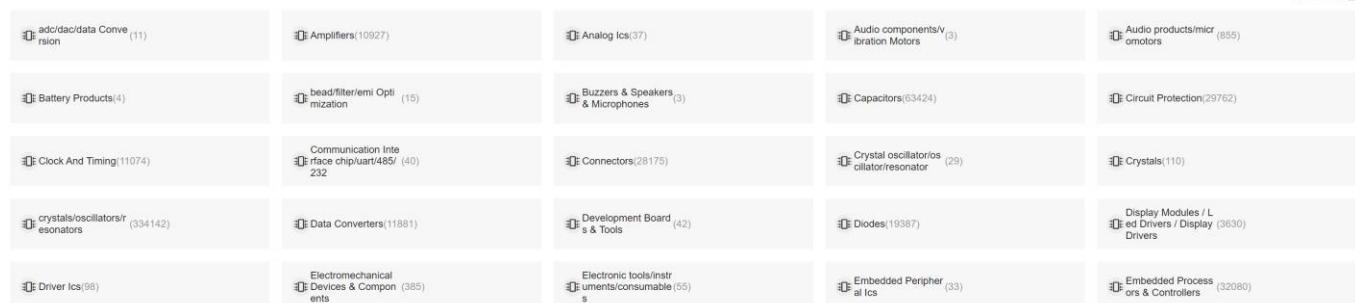
สามารถค้นหา Electronic Part จากหลากหลาย Global Sourcing ได้จาก

- <https://www.findchips.com/>
- <https://octopart.com/>

# PCB Assembly + Part Sourcing



JLCPCB : <https://jlpcpcb.com/>  
LCSC : <https://www.lcsc.com/>  
Part Library : <https://jlpcpcb.com/parts>  
Demo : <https://cart.jlpcpcb.com/quote?fromDemo=yes>



Why JLCPCB? Capabilities Support Resources

PCB      SMT-Stencil      3D-Printing

Only accept zip or rar, Max 20 MB. View example >    All uploads are secure and confidential.

Instructions For Ordering      Upload History >

Base Material: FR-4      Aluminum

Layers: 1      2      4      6

Dimensions: 100 \* 100 mm

PCB Qty: 5

Product Type: Industrial/Consumer electronics      Aerospace      Medical

Different Design: 1      2      3      4

Delivery Format: Single PCB      Panel by Customer      Panel by JLCPCB

PCB Thickness: 0.4      0.6      0.8      1.0      1.2      1.6      2.0

PCB Color: Green      Purple      Red      Yellow      Blue      White      Black

Silkscreen: White

Silkscreen Technology: Ink-jet/Screen Printing Silkscreen      High-definition Exposure Silkscreen

Surface Finish: HASL(with lead)      LeadFree HASL-RoHS      ENIG-RoHS

Outer Copper Weight: 1 oz      2 oz

Gold Fingers: No      Yes

Confirm Production file: No      Yes

# ສະເປັກ PCB ທີ່ JLCPBCB ສາມາຄພລິຕໄດ້



ສາມາຄດຮາຍລະເອີ້ນໄດ້ຈາກ : <https://jlcpcb.com/capabilities/Eagle%20PCB%20to%20gerber%20files>

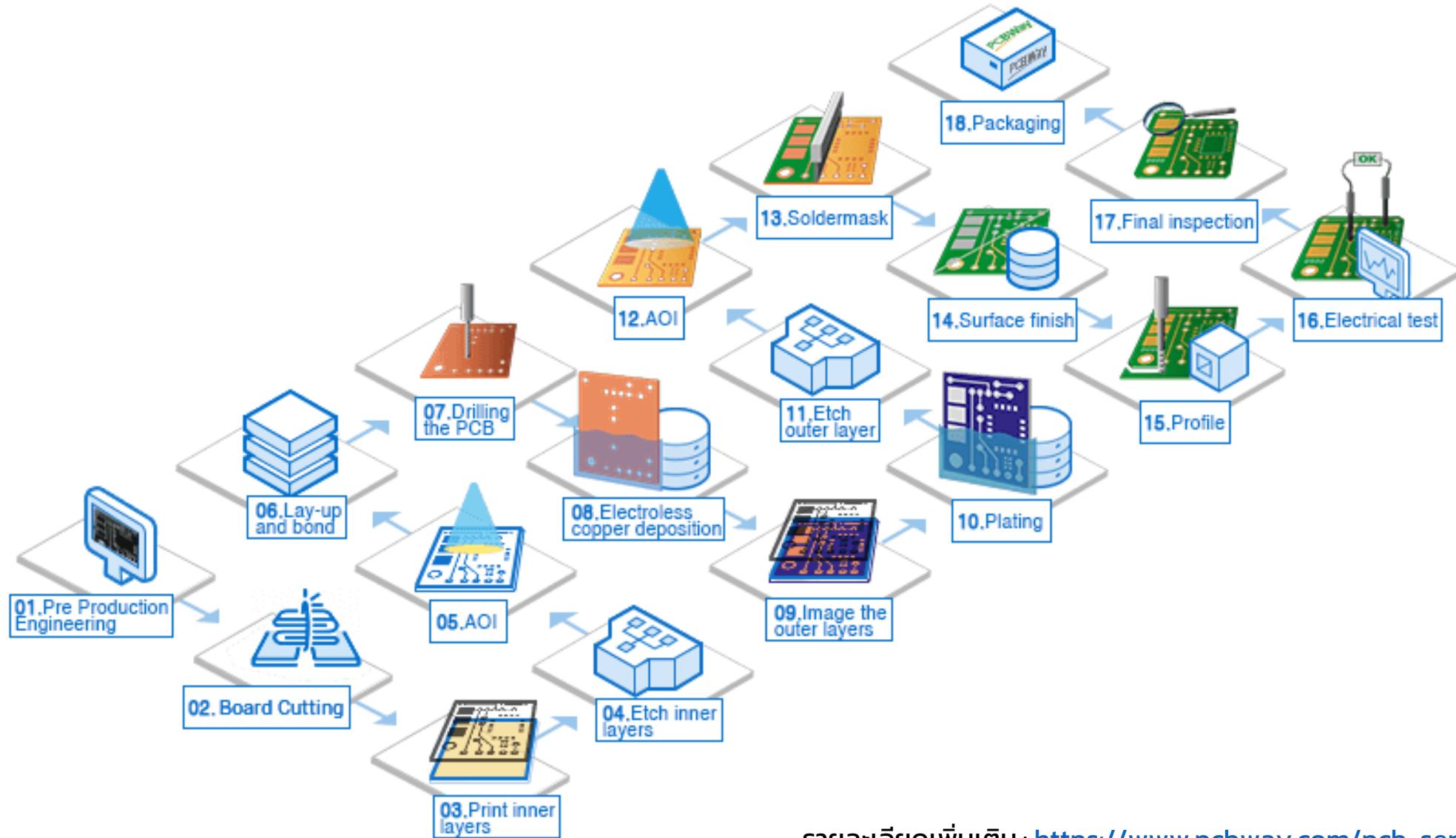
PCB Specifications		
Features	Capability	Notes
Layer count	1,2,4,6 layers	The number of copper layers in the board.
Controlled Impedance	4/6 layer, default layer stack-up	<a href="#">Controlled Impedance PCB Layer Stackup JLCPCB Impedance Calculator</a>
Material	FR-4	FR-4 Standard Tg 130-140/ Tg 155
Dielectric constant	4.5(double-sided PCB)	7628 Prepreg 4.6 2313 Prepreg 4.05 2116 Prepreg 4.25
Max. Dimension	400x500mm	The maximum dimension JLCPCB can accept
Dimension Tolerance	±0.2mm	±0.2mm for CNC routing, and ±0.4mm for V-scoring
Board Thickness	0.4/0.6/0.8/1.0/1.2/1.6/2.0mm	The thickness of finished board.
Thickness Tolerance ( Thickness≥1.0mm)	± 10%	e.g. For the 1.6mm board thickness, the finished board thickness ranges from 1.44mm(T-1.6×10%) to 1.76mm(T+1.6×10%)
Thickness Tolerance ( Thickness<1.0mm)	± 0.1mm	e.g. For the 0.8mm board thickness, the finished board thickness ranges from 0.7mm(T-0.1) to 0.9mm(T+0.1).
Finished Outer Layer Copper	1 oz/2 oz (35um/70um)	Finished copper weight of outer layer is 1oz or 2oz.
Finished Inner Layer Copper	0.5 oz (17.5um)	Finished copper weight of inner layer is 0.5oz by default. 2 oz inner copper weight is available for 4-layer PCBs with 1.6mm thickness/JLC2313 stackup/2oz outer copper weight.

## Minimum trace width and spacing

	Min. Trace width	Min. Spacing
1-2 Layers	5mil (0.127mm)	5mil (0.127mm)
4-6 Layers	3.5mil (0.09mm)	3.5mil (0.09mm)
2oz Copper weight	8mil (0.2mm)	8mil (0.2mm)

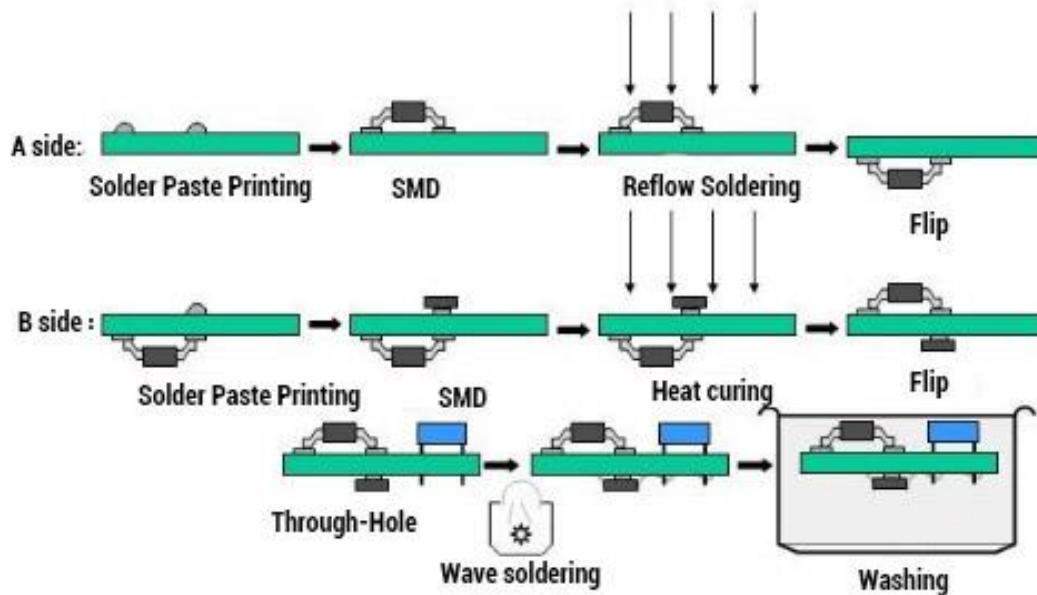
Features	Capabilities
Hole to hole clearance(Different nets)	0.5mm
Via to Via clearance(Same nets)	0.254mm
Pad to Pad clearance(Pad without hole, Different nets)	0.127mm
Pad to Pad clearance(Pad with hole, Different nets)	0.5mm
Via to Track	0.254mm
PTH to Track	0.33mm
NPTH to Track	0.254mm
Pad to Track	0.2mm

# กระบวนการผลิต PCB และ Multi Layer



รายละเอียดเพิ่มเติม : <https://www.pcbway.com/pcb-service.html>

# ขั้นตอนการประกอบ (PCB Assembly)



2 layers board Mixed Assembly



# ขั้นตอนการประกอบ (PCB Assembly)

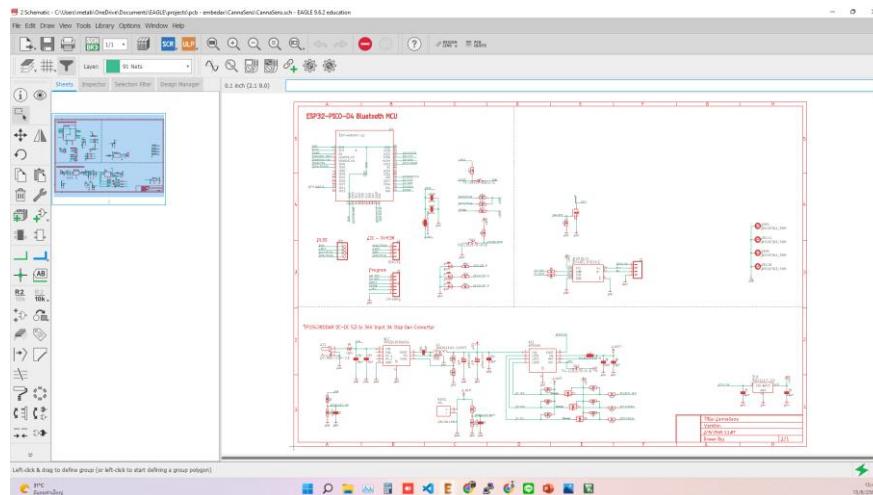


<https://www.youtube.com/watch?v=usmDfGM2KmU&t=1s>

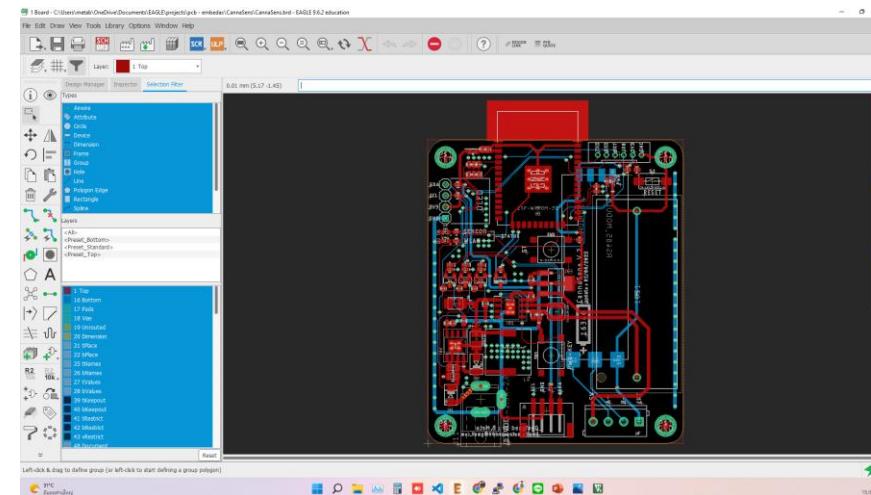
# ຕົວຢ່າງການອຳນວຍ PCB ດ້ວຍໄປແກຣມ Eagle ເພື່ອພັດຕະປິນຊັ້ນງານຈິງ



[Download Link](#)



1. ອຳນວຍບົງຈර (Schematic design)



2. ອຳນວຍລາຍງານ (PCB Routing)

BOM\_claudio\_2022-04-11.csv

claudio\_gerber.zip

PickAndPlace\_cludio\_2022-04-11.csv

3. Export PCBA file

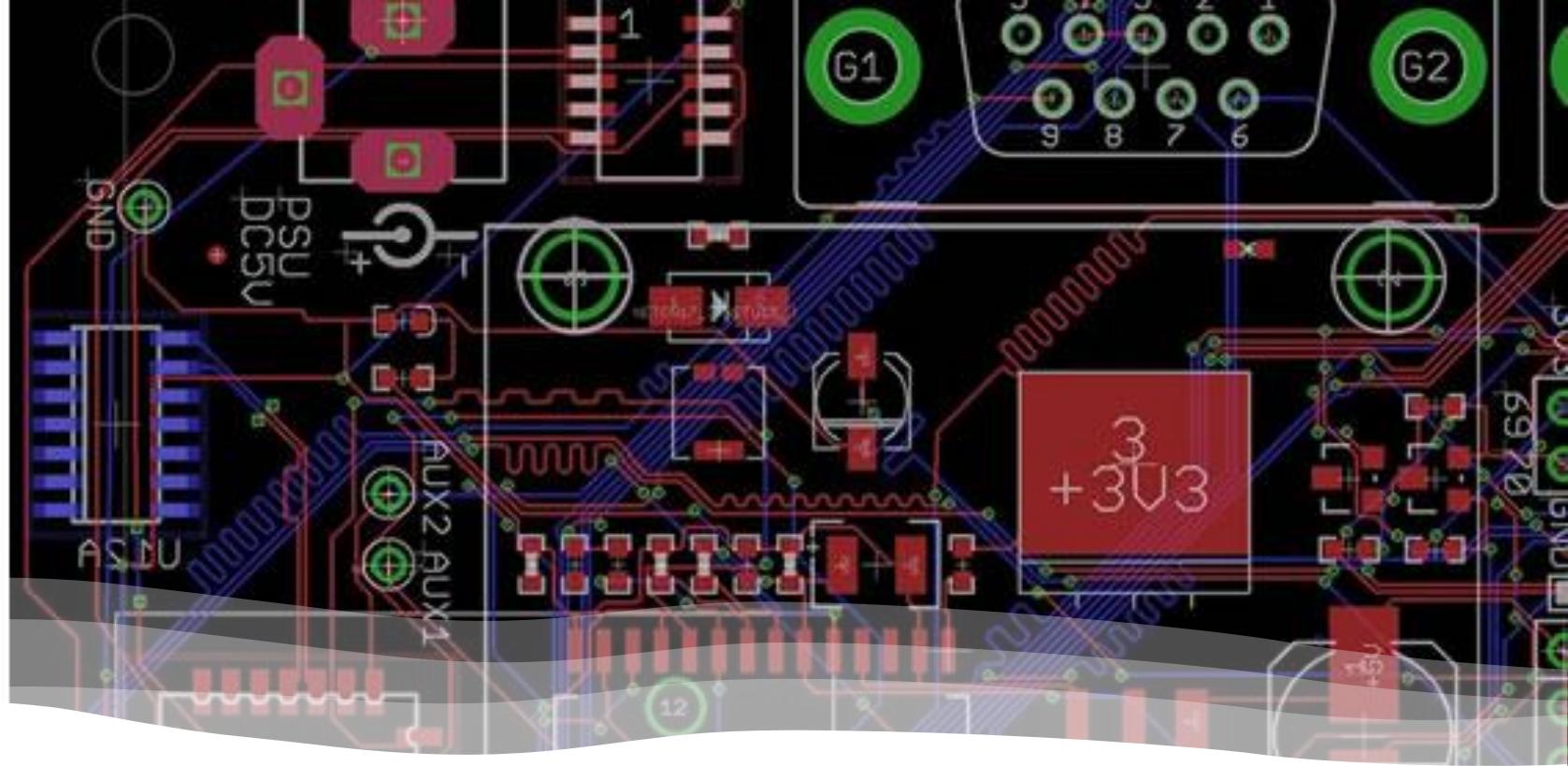
The screenshot shows the JLCPCB website's PCB upload interface. It displays two versions of the PCB design: a top-side view and a bottom-side view. To the right, there are sections for 'Charge Details' (Special Offer \$0.00, Special Process Fee \$17.69), 'Build Time' (PCB: 4 days, note: build time increased by 2 days), 'Calculated Price' (\$25.69), and shipping information (DHL Express Worldwide, 2-4 business days). A 'SAVE TO CART' button is visible.

4. Upload PCBA file JLCPCB.com



4. PCB ກໍາພັດຕາຈາກ JLCPCB.com

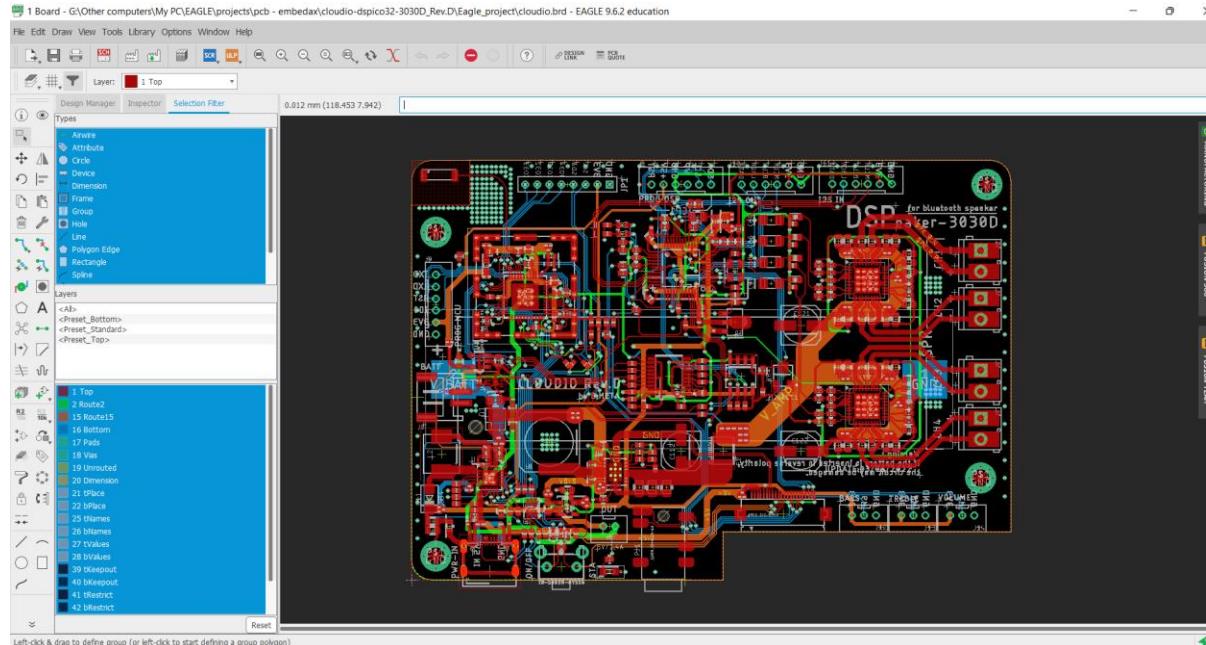
AUTODESK®  
EAGLE



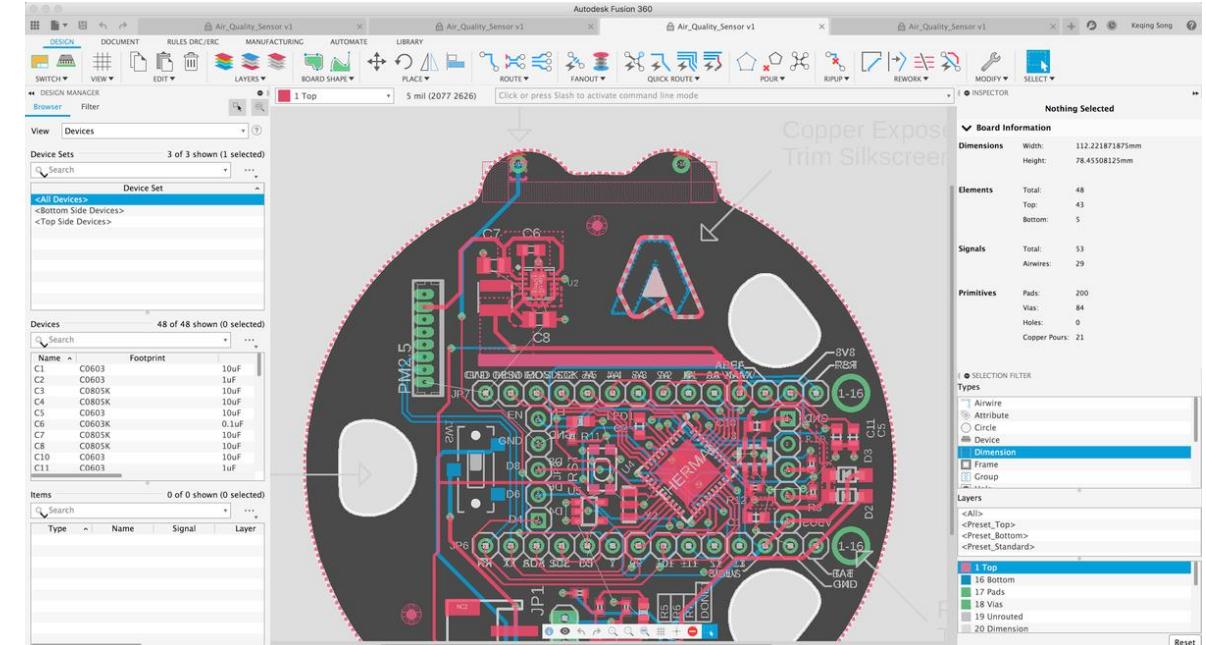
အသေးစိတ်များ  
အသေးစိတ်များ

# Introduction

โปรแกรม Eagle เป็นโปรแกรมที่พัฒนาโดยบริษัท Autodesk ปัจจุบันเป็นเวอร์ชัน 9.6.2 และทาง Autodesk ได้หยุดอัพเดตเวอร์ชันไปในปี 2020 เนื่องจากมีการเพิ่ม feature Electronics Design เข้าไปในโปรแกรม Fusion360

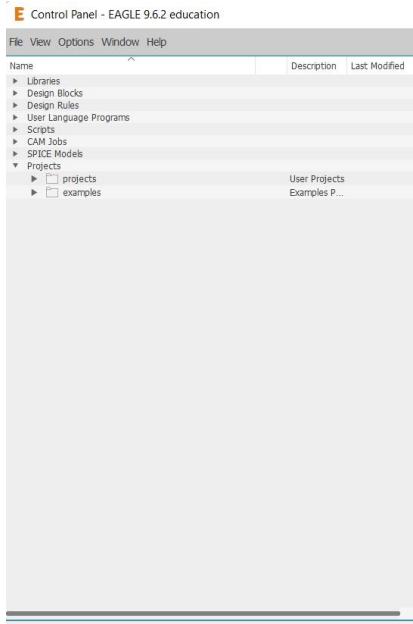
[Download](#)[Download](#)

Eagle 9.6.2

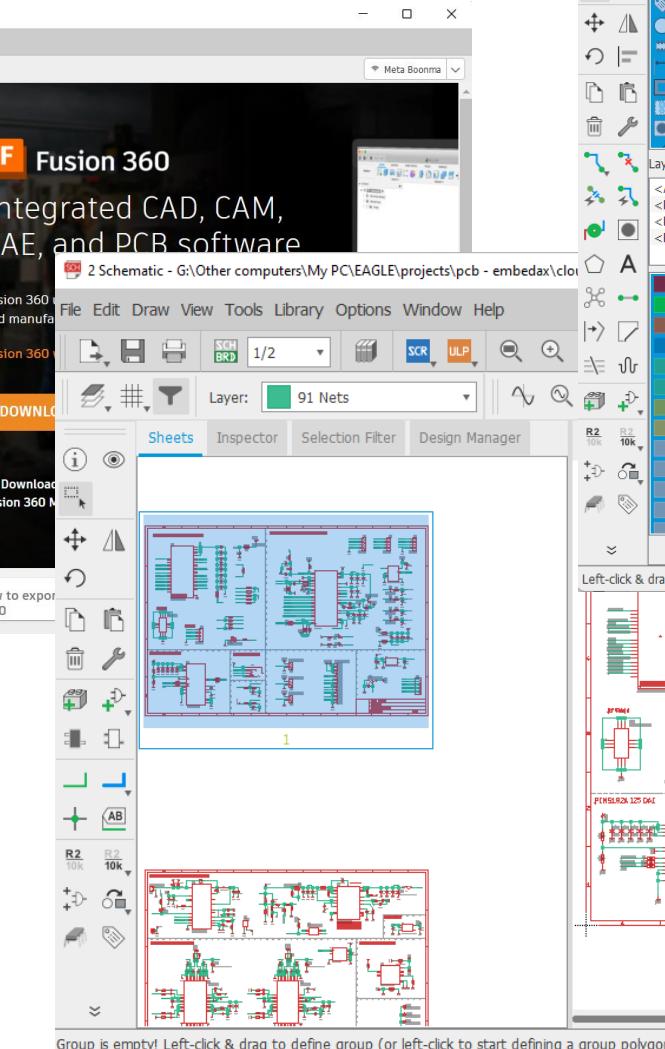


Fusion360 : Electronics Design

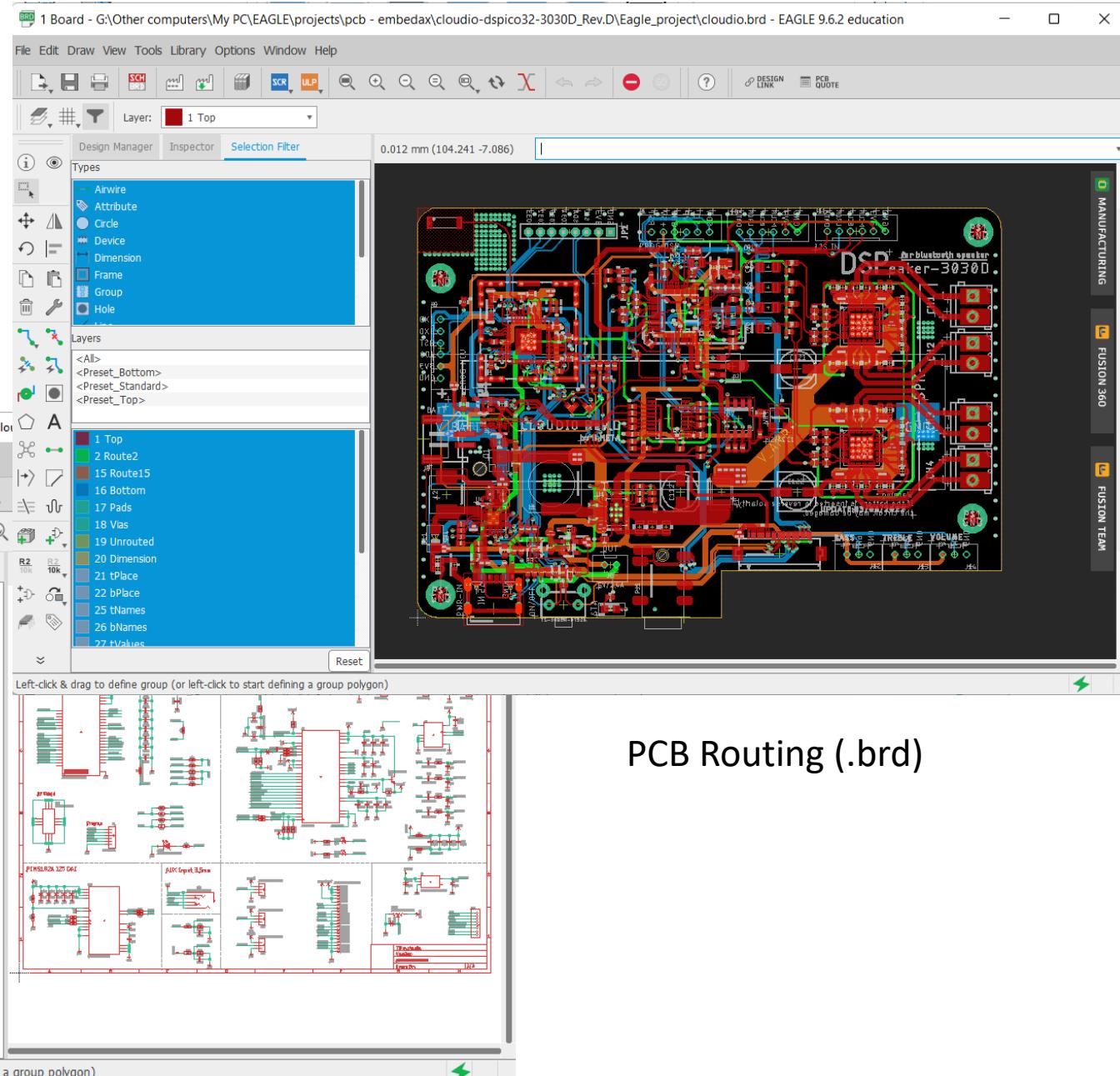
# Introduction



Control Panel



Schematics Design (.sch)



PCB Routing (.brd)

# EAGLE & Fusion360 Subscription

<https://www.autodesk.com/products/eagle/overview?term=1-YEAR&tab=subscription>



Eagle  
PCB design made easy for every engineer  
Available only with a Fusion 360 subscription  
[Buy Fusion 360](#)  
Talk to our sales team. Financing options available. 1-833-843-3437

Buy Fusion 360

OPTIONS

\$1,555 /paid every 3 years	BEST VALUE
\$545 /paid annually	
\$70 /paid monthly	

TOTAL  
**\$545 /year**  
Savings of 35% compared to monthly price

[ADD TO CART](#)

Payment methods: VISA, MasterCard, AMEX, PayPal, DISCOVER, ACH

## Free Version

Limited electronics and PCB design:

- 2 schematics
- 2 layers
- 80cm<sup>2</sup> board area

## Pro Version **\$545 per Year**

Unified electronics and PCB design:

- 999 schematics
- 16 layers
- Unlimited board area

# Register Autodesk education license

ลงทะเบียน Education license เพื่อใช้งาน Version สำหรับ นักศึกษา, อาจารย์, นักพัฒนา, R&D ฯลฯ  
<https://www.autodesk.com/education/edu-software/overview?sorting=featured&filters=individual>

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Educational role: Student

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Date of Birth: Month Day Year

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Email: boonma.meta@gmail.com ✓

Confirm email: boonma.meta@gmail.com ✓

Password:

I agree to the [Autodesk Terms of Use](#) and to the use of my personal information in accordance with the [Privacy Statement](#) (including cross-border transfers as described in the statement).

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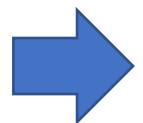
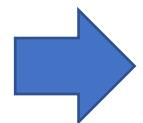
boonma.meta@gmail.com



DIDN'T GET AN EMAIL? [RESEND](#)

OR ALREADY VERIFIED? [CONTINUE](#)

Trouble with verification?  
[SHOW HELP OPTIONS](#)



[DONE](#)

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Name of educational institution

มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าพระนครธนี (มจพ.)

Enrolled from date

August 2021

Expected graduation date

August 2024

[NEXT](#)

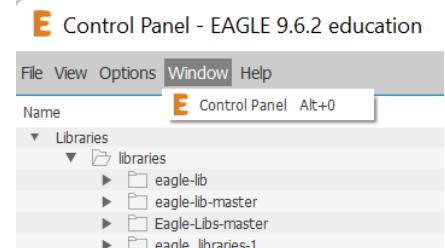
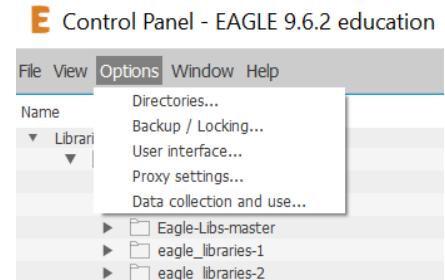
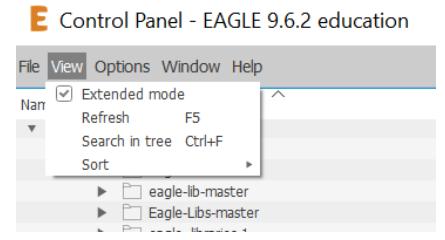
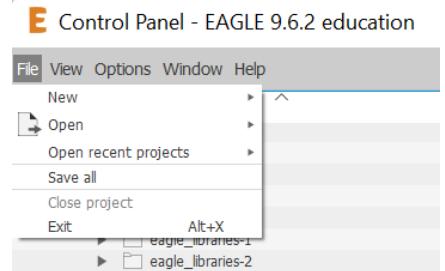
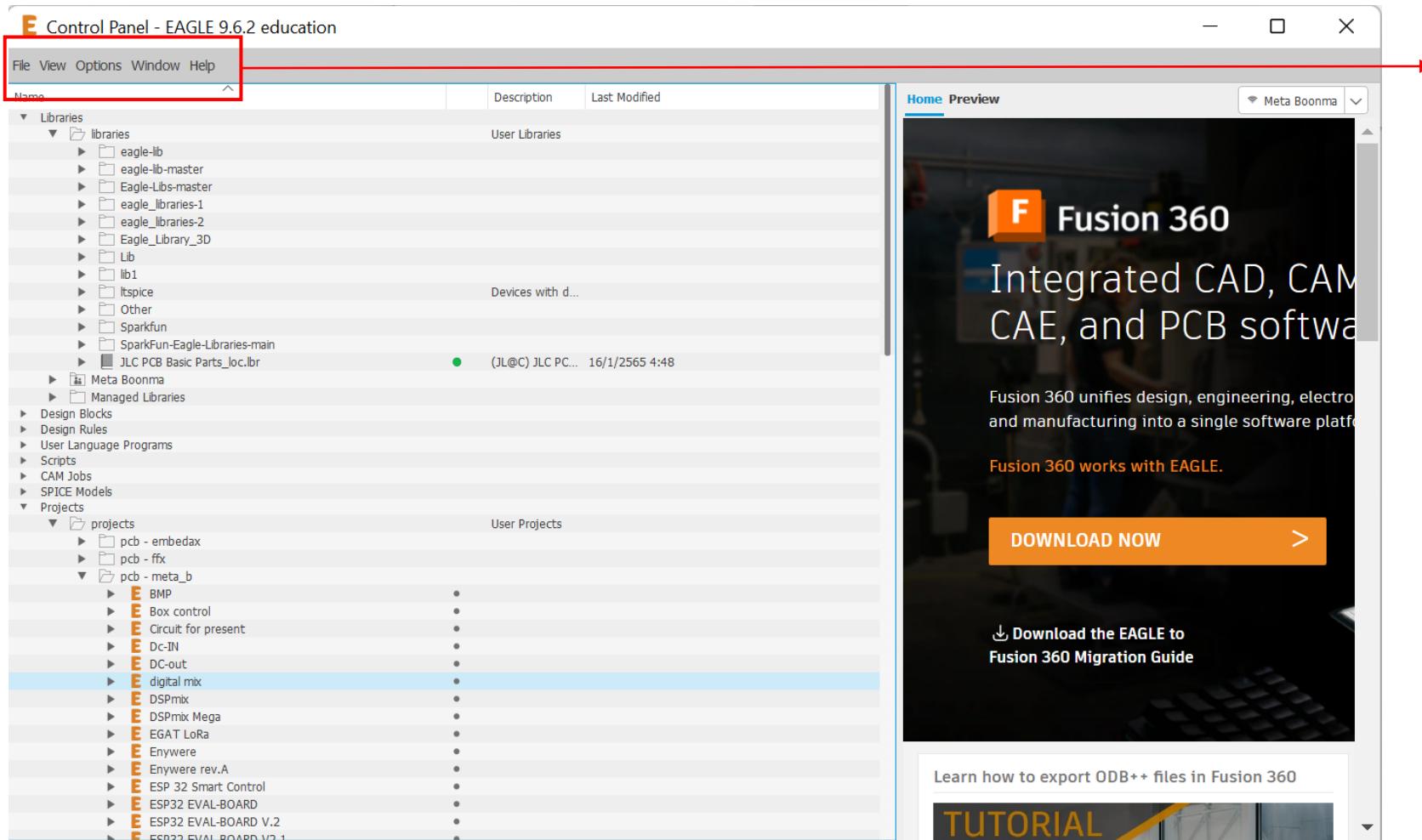
## Account set

Your account is now updated to access the Autodesk education community



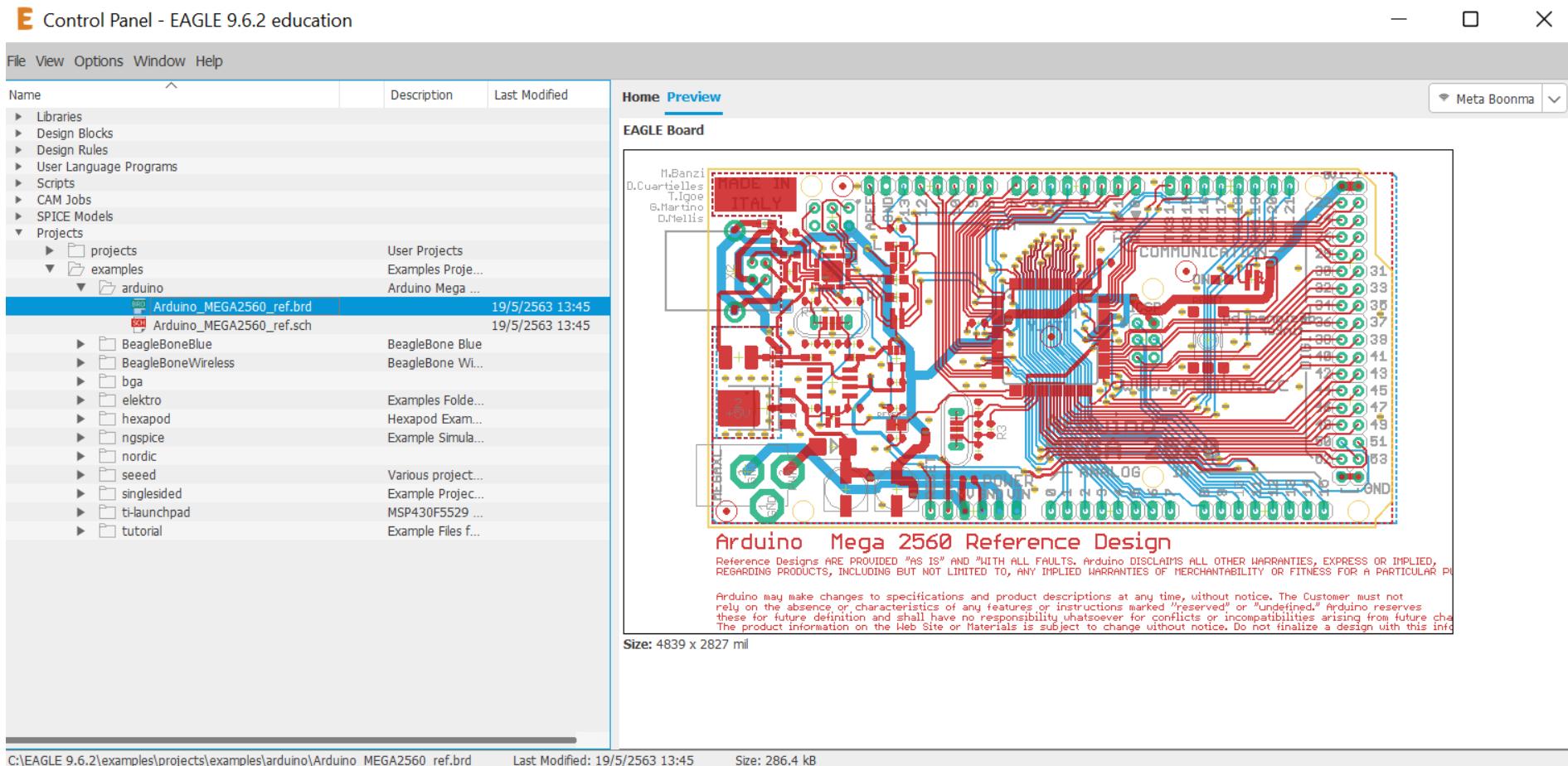
[CONTINUE](#)

# Eagle Control Panel Menu

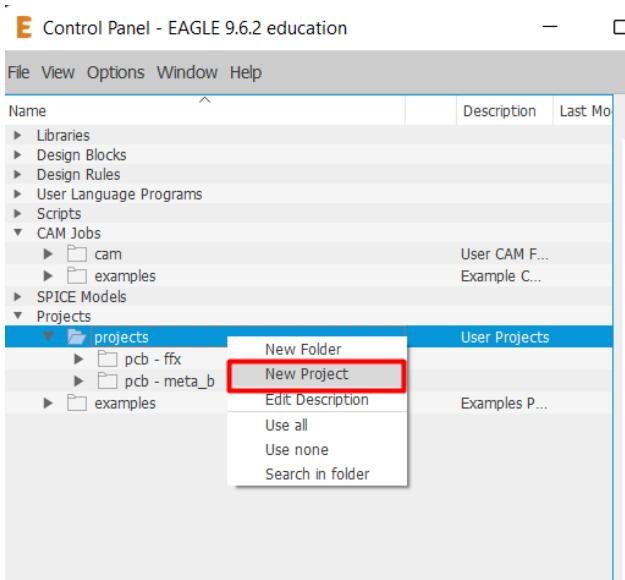


Eagle Folder : C:\Users\admin\Documents\EAGLE (Folder สำหรับเก็บไฟล์ Project และ Library)

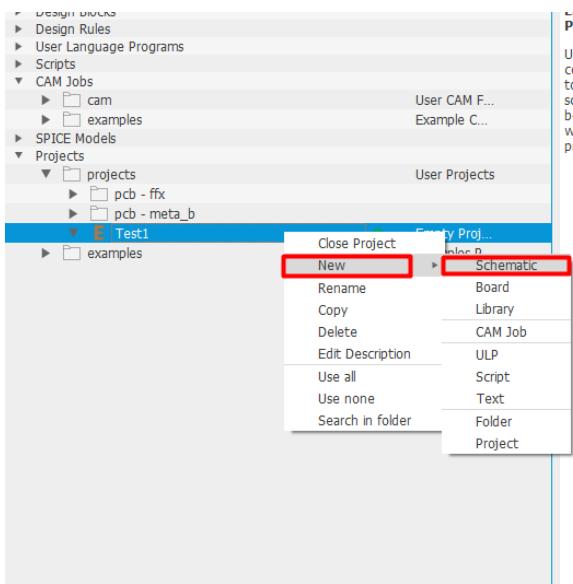
# Eagle Project Examples



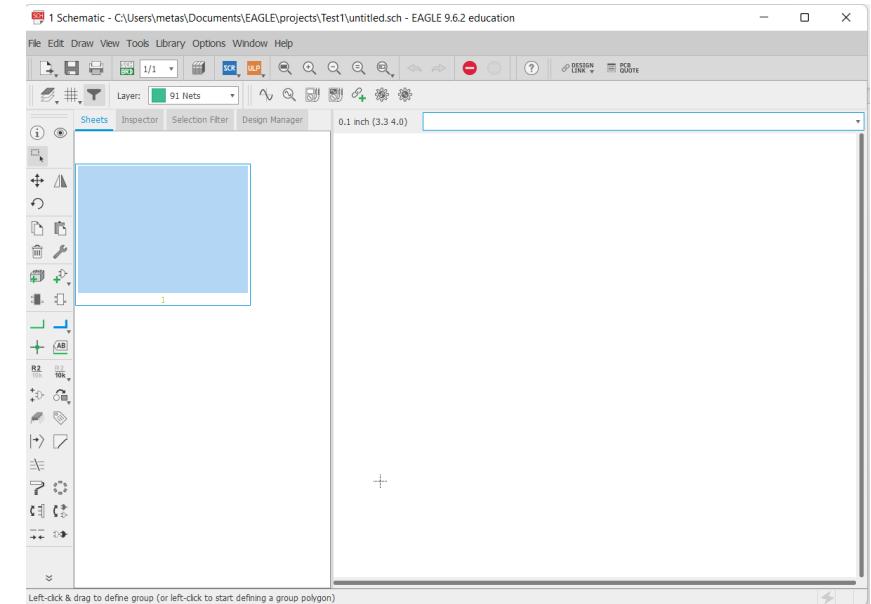
# การสร้างโปรเจ็ค



1. Click ขวา New Project

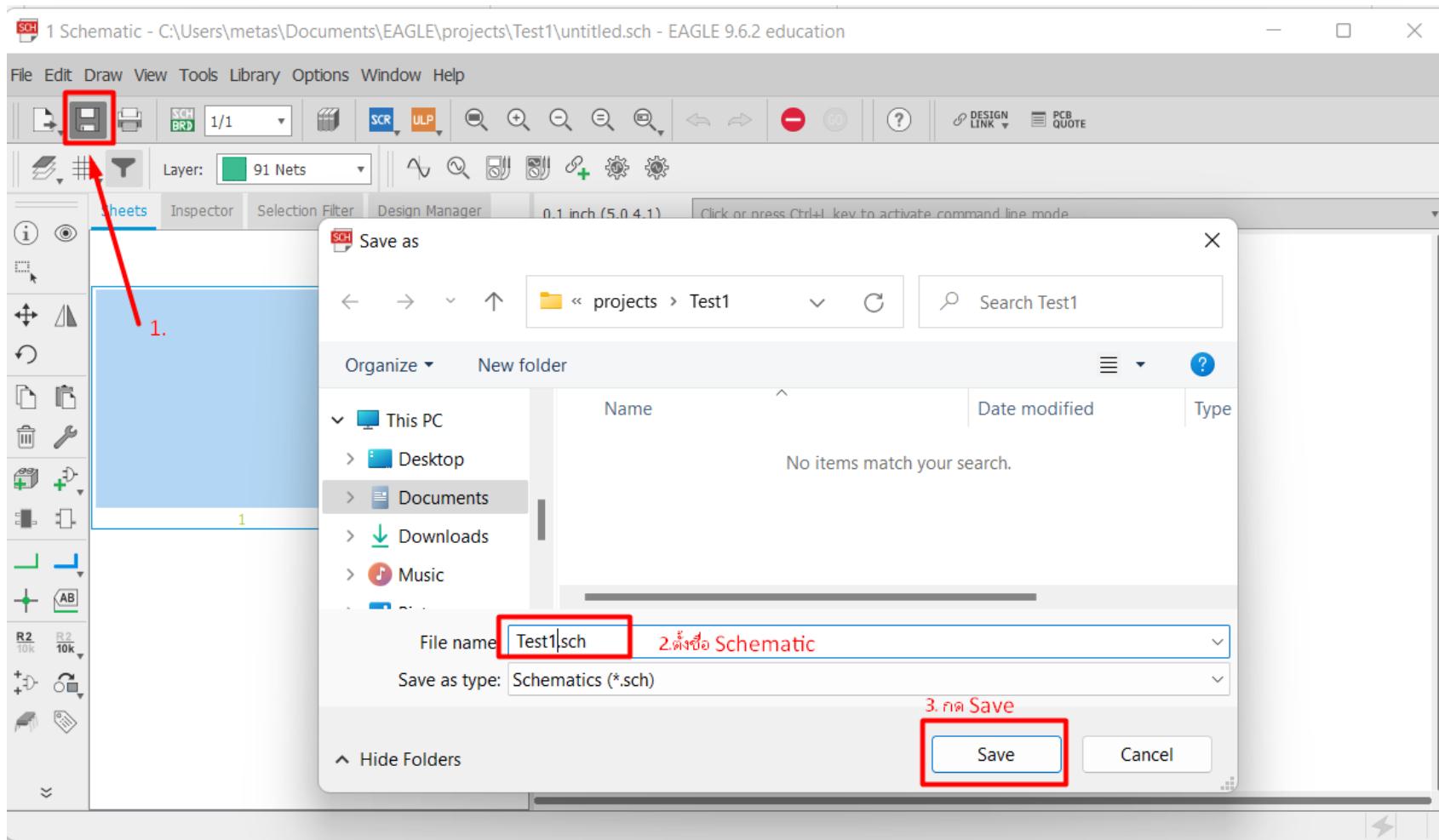


2. Click ขวา New -> Schematic

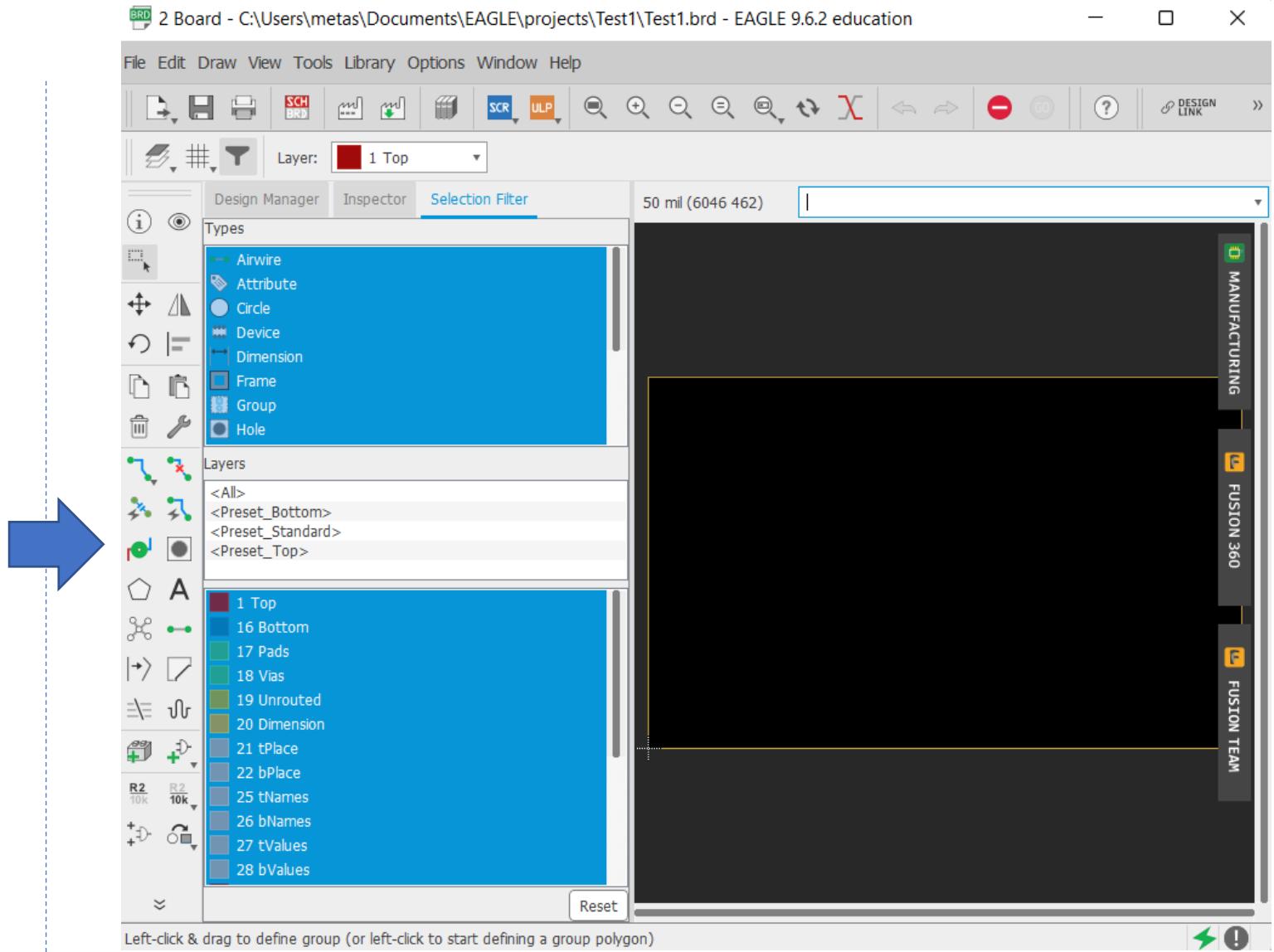
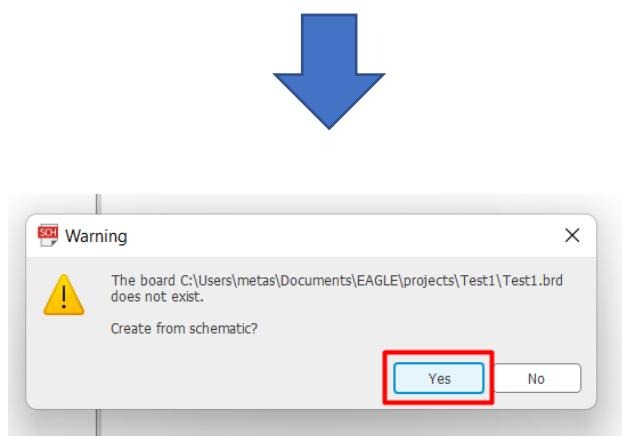
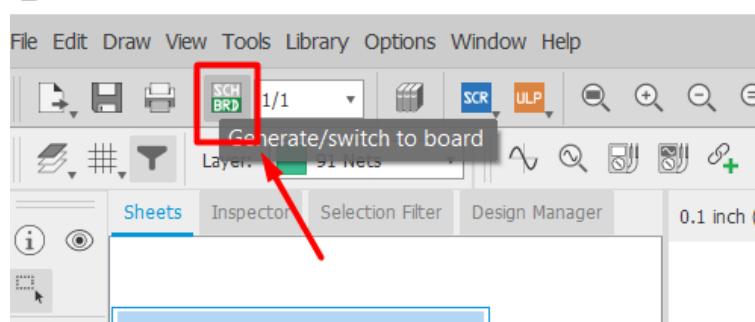


3. ได้หน้าสำหรับวาด Schematic

# Save schematic

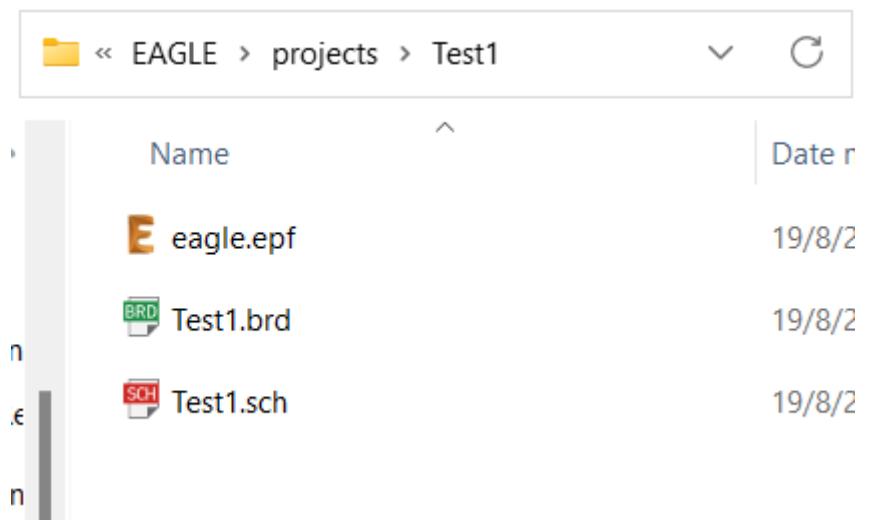
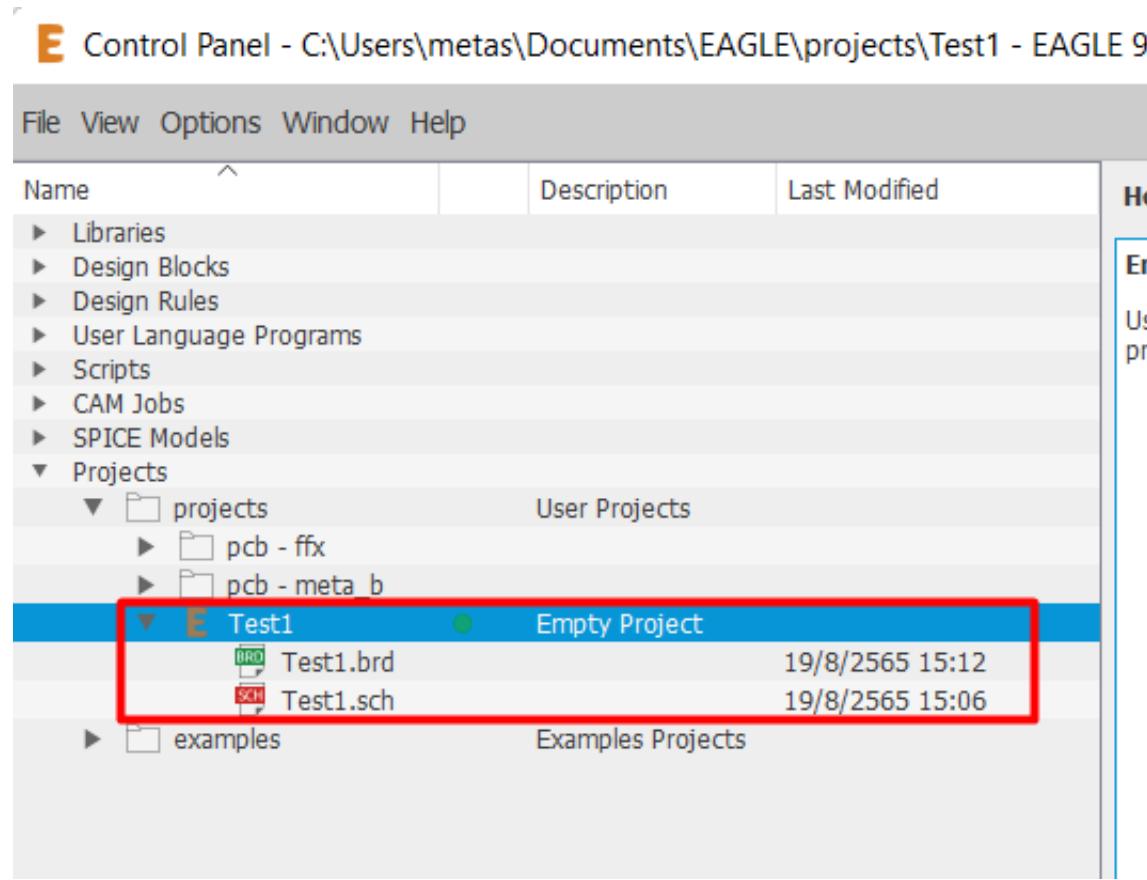


# การสร้าง Board



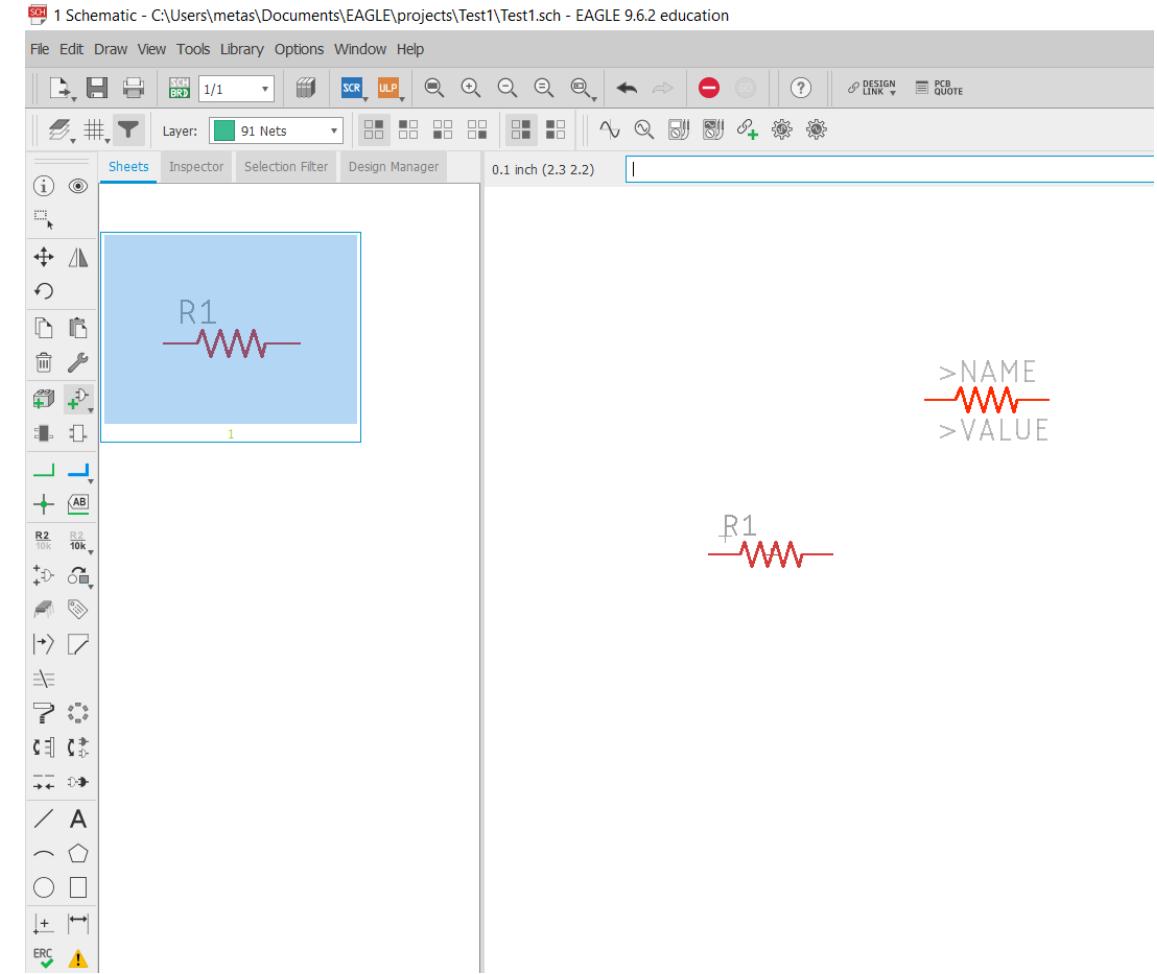
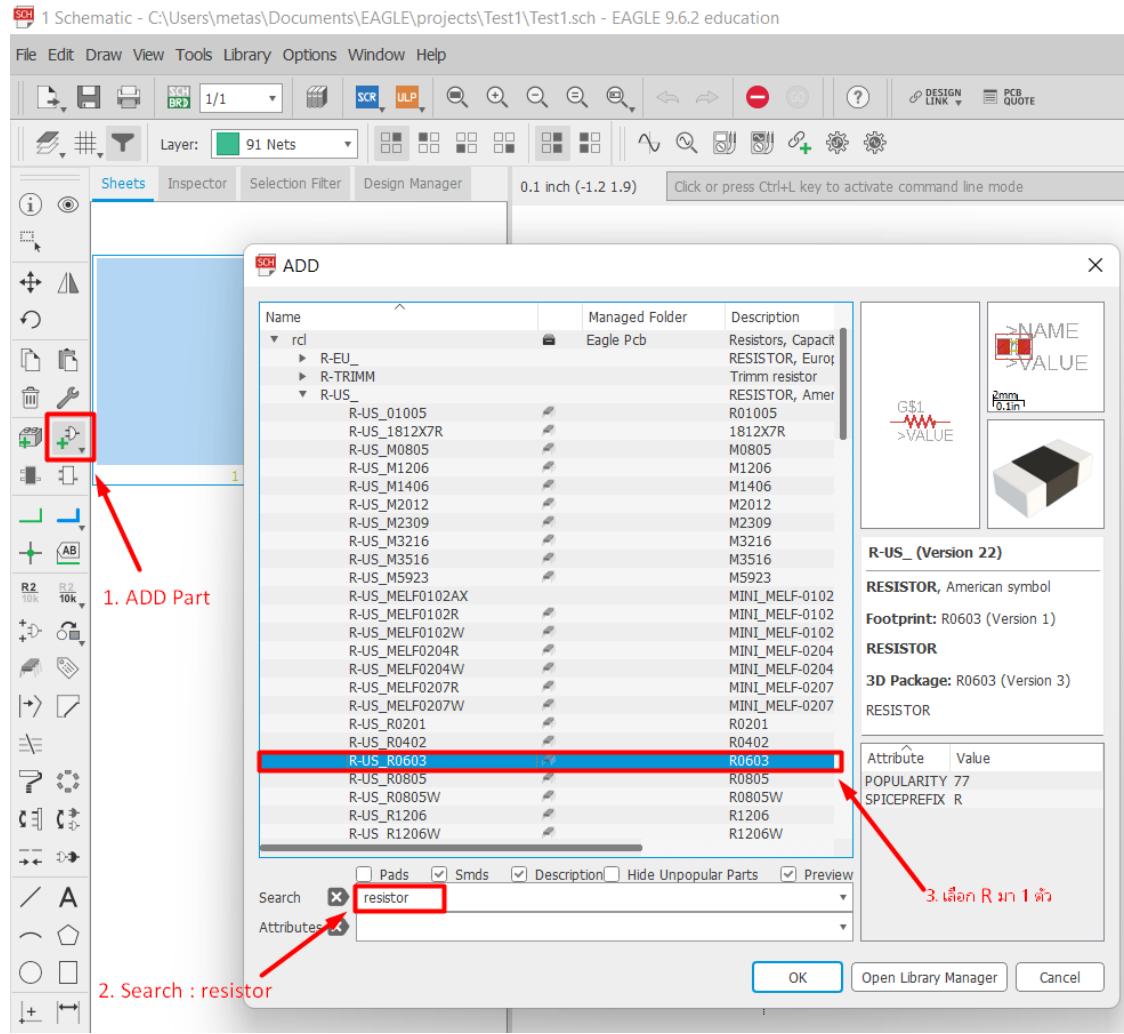
# Project, brd, sch

Schematic และ Board จะถูกสร้างไว้ภายในตัว Folder เดียวกันและซื้อไฟล์เหมือนกัน



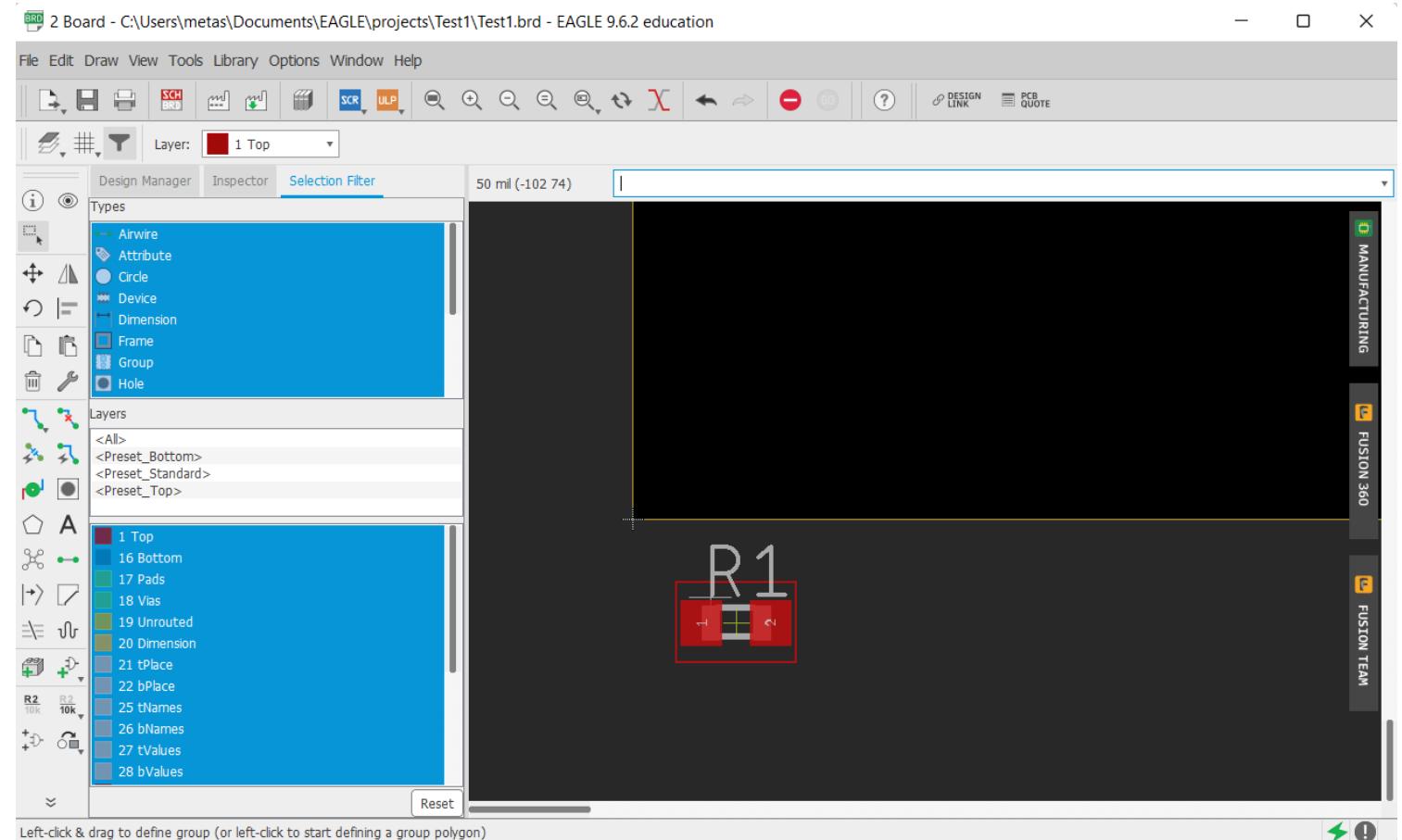
เราสามารถเปิดไฟล์โปรเจ็คได้ผ่านหน้า Control panel และ จาก Folder โดยตรง

# การเพิ่มอุปกรณ์ลงใน Schematic และ Board



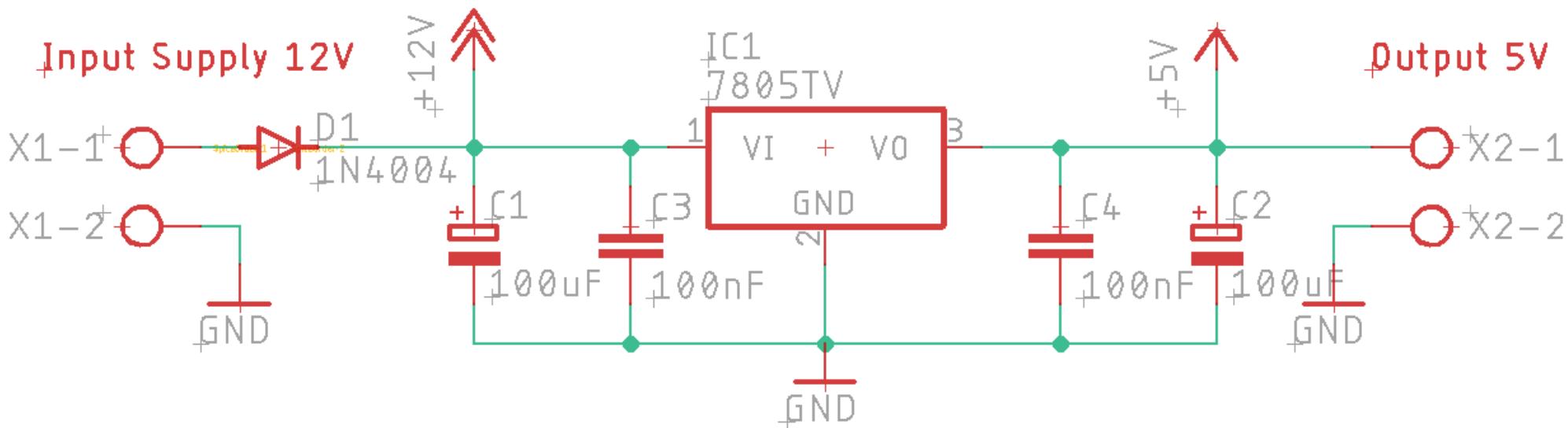
# การเพิ่มอุปกรณ์ลงใน Schematic และ Board

อุปกรณ์ที่เราเพิ่มจาก Schematic ก็จะถูกเพิ่มเข้ามาใน Board ด้วยตาม Footprint ที่เราเลือกจากตัวอย่างเป็น Resistor แบบ SMD chip ขนาด Footprint 0603 (6mm x 3mm)



# Lab 1: กดลองอุปกรณ์แบบวงจร Regulator 5V

- ลากเส้นเชื่อมต่อวงจรโดยใช้ Net 
- เปลี่ยนค่าความต้านทาน, เบอร์ IC, ค่าความจุ, ... โดยใช้ Value 

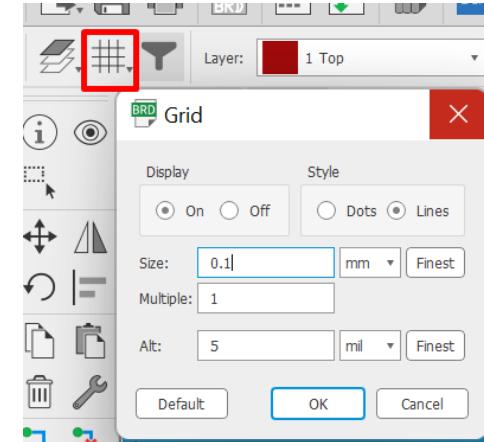
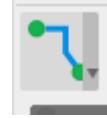


Note :

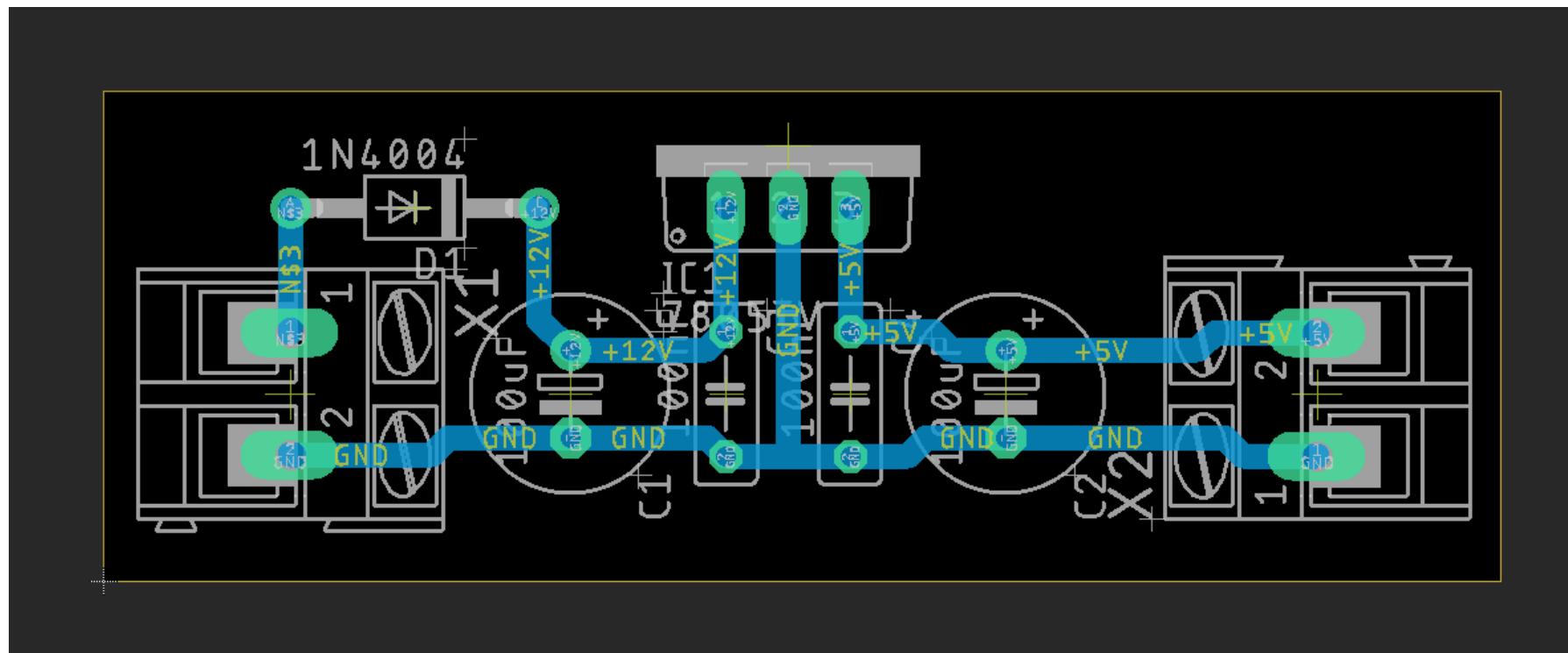
Connector = AK300/2

## Lab2 : ทดลองลากสายทองแดง

- ลากเส้นเชื่อมต่อสายทองแดงโดยใช้ Route Airwire
- ลบเส้นโดยใช้ Ripup



สามารถปรับ Grid ให้ละเอียดขึ้นได้  
และเปลี่ยนหน่วยวัดได้ทั้ง mil และ mm

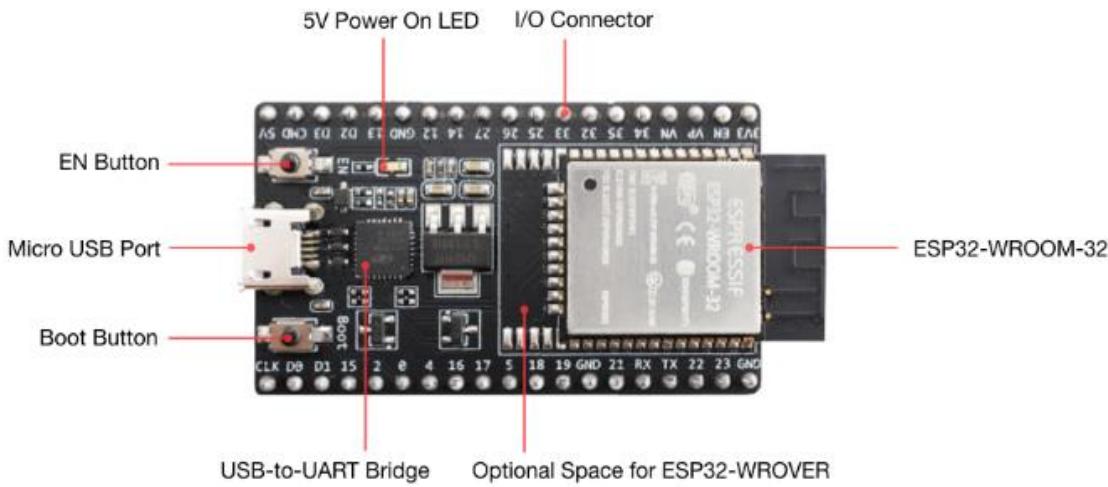


**Break 10 ນາທີ**

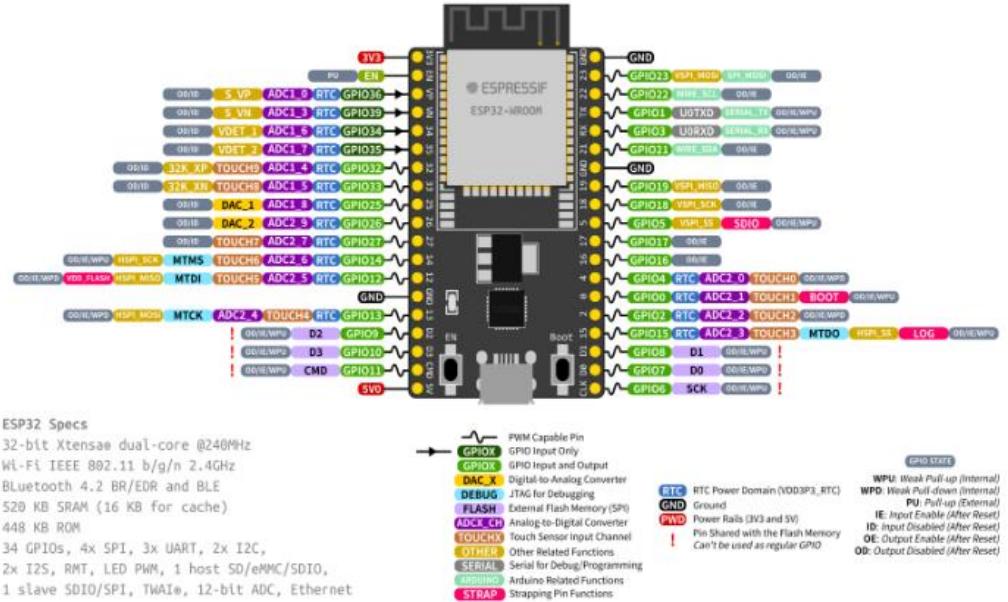
**การอ่านแบบวงจรโดยอ้างอิงจาก  
Datasheet, Application Notes,  
Reference Design**

# เริ่มจาก Development Kit

<https://docs.espressif.com/projects/esp-idf/en/latest/esp32/hw-reference/esp32/get-started-devkitc.html>



ESP32-DevKitC



ESP32-DevKitC Pin Layout (click to enlarge)

# ESP32-DevKitC Reference Design

- <https://www.espressif.com/en/products/devkits/esp32-devkitc/resources>

The screenshot shows the ESPRESSIF website's product page for the ESP32-DevKitC. The top navigation bar includes links for Products, Solutions, Support, Ecosystem, Company, Join Us, Contact Us, a search icon, Chinese language selection, and a subscribe button. Below the navigation, the breadcrumb path indicates the current location: Products > DevKits > ESP32-DevKitC. A secondary navigation bar below the breadcrumb shows 'Overview' and 'Resources', with 'Resources' being the active tab. The main content area displays two sections: 'AT' (with a downward arrow) and 'Documentation' (with an upward arrow). Under 'Documentation', there is a table with columns for Title, Format, Version, Release Date, and Download. Two rows are listed: 'ESP32-DevKitC Getting Started Guide' (HTML, latest, 2017.07.28, download icon) and 'ESP32-DevKitC-V4 Reference Design r2.1' (ZIP, V4-r2.1, 2020.01.15, download icon). The second row is highlighted with a red border.

Title	Format	Version	Release Date	Download
ESP32-DevKitC Getting Started Guide	HTML	latest	2017.07.28	
ESP32-DevKitC-V4 Reference Design r2.1	ZIP	V4-r2.1	2020.01.15	

# Reference Design Files

« ESP32-DevKitC-V4_Reference_Design > 01_Schematic				
Name	Date modified	Type	Size	
ESP32-DevKitC-V4_20180607A.DSN	13/6/2561 13:45	Data Source Name	13,474 KB	
ESP32-DevKitC-V4_SCH_20180607A.pdf	12/6/2561 20:02	Foxit PDF Editor Doc...	73 KB	
« ESP32-DevKitC-V4_Reference_Design > 02_PCB Layout				
Name	Date modified	Type	Size	
ESP32_DevKitc_V4-ForPADS9.5_20171206A.asc	6/12/2560 14:38	ASC File	521 KB	
ESP32-DevKitC-V4_20171206A.pcb	6/12/2560 14:39	PCB File	547 KB	
ESP32-DevKitC-V4_PCB_20171206A.pdf	6/12/2560 14:37	Foxit PDF Editor Doc...	769 KB	
« ESP32-DevKitC-V4_Reference_Design > 05_BOM List				
Name	Date modified	Type	Size	
ESP32-DevKitC-V4-(ESP32-SOLO-1)-BOMList(V...	28/6/2561 15:40	Microsoft Excel Work...	11 KB	
ESP32-DevKitC-V4-(ESP32-WROOM-32)-BOMLi...	28/6/2561 15:41	Microsoft Excel Work...	11 KB	
ESP32-DevKitC-V4-(ESP32-WROOM-32D)-BOM...	28/6/2561 15:44	Microsoft Excel Work...	11 KB	
ESP32-DevKitC-V4-(ESP32-WROOM-32U)-BOM...	28/6/2561 15:45	Microsoft Excel Work...	11 KB	

01\_Schematic

02\_PCB Layout

03\_Gerber

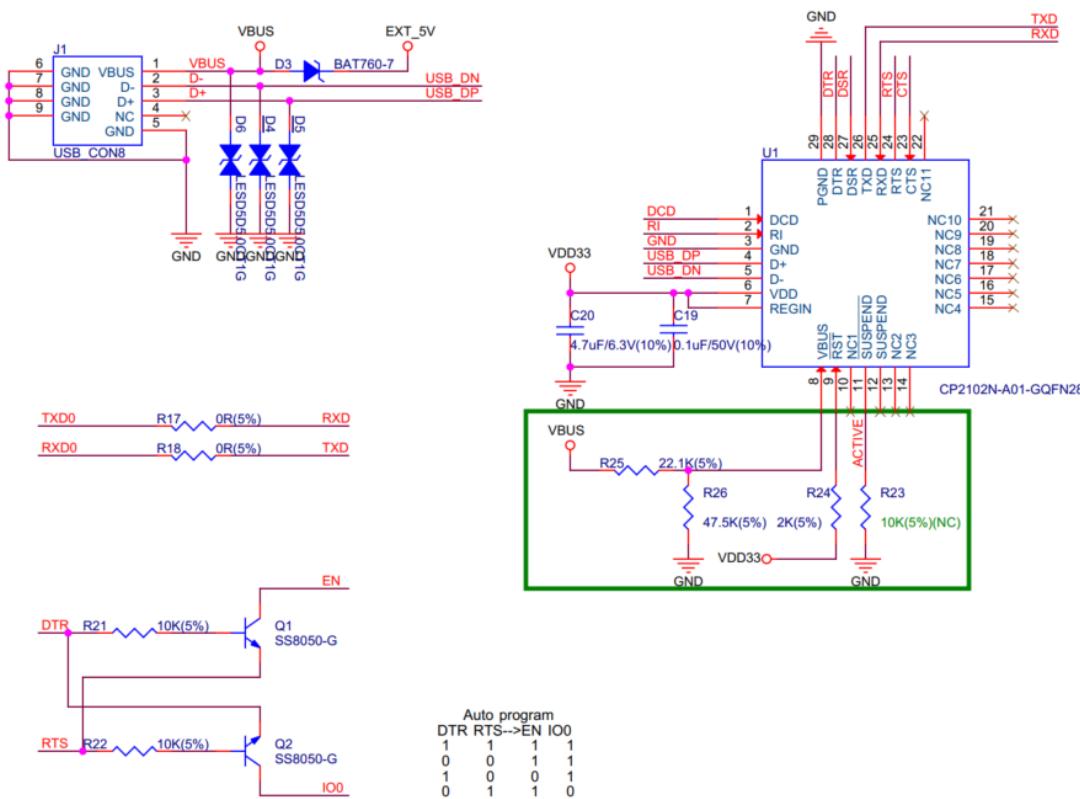
05\_BOM List

README.pdf

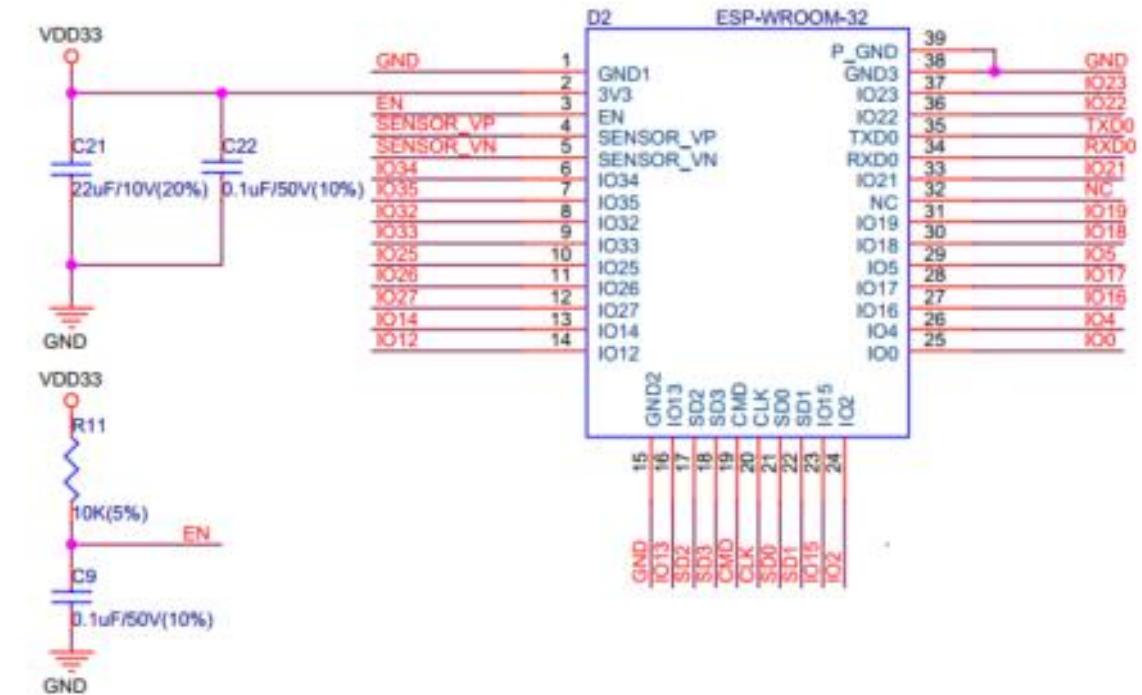
SCH: Cadence/OrCAD Capture V16.6

# ESP32-DevKitC Reference Schematic

Micro USB 5V&USB-UART



ESP32 Module



# Hardware Design Guidelines

[https://www.espressif.com/sites/default/files/documentation/esp32\\_hardware\\_design\\_guidelines\\_en.pdf](https://www.espressif.com/sites/default/files/documentation/esp32_hardware_design_guidelines_en.pdf)

## 2. Schematic Checklist

ESP32's integrated circuitry requires only 20 resistors, capacitors and inductors, one crystal and one SPI flash chip. ESP32 integrates the complete transmit/receive RF functionality including antenna switches, RF balun, power amplifier, low noise receive amplifier, filters, power management module, and advanced calibration circuitries.

ESP32's high integration allows for simple peripheral circuit design. This chapter details ESP32 schematics and PCB layout design. ESP32 schematic is shown in Figure 1.

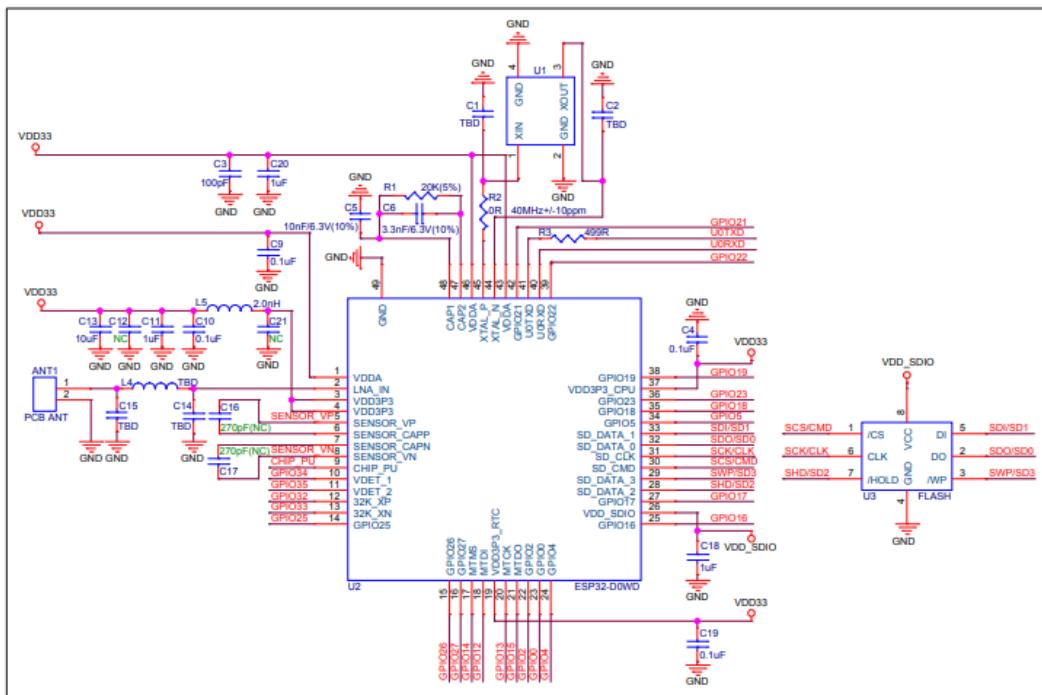


Figure 1: ESP32 Schematics (ESP32-D0WD used as an example for all illustrations in this section)



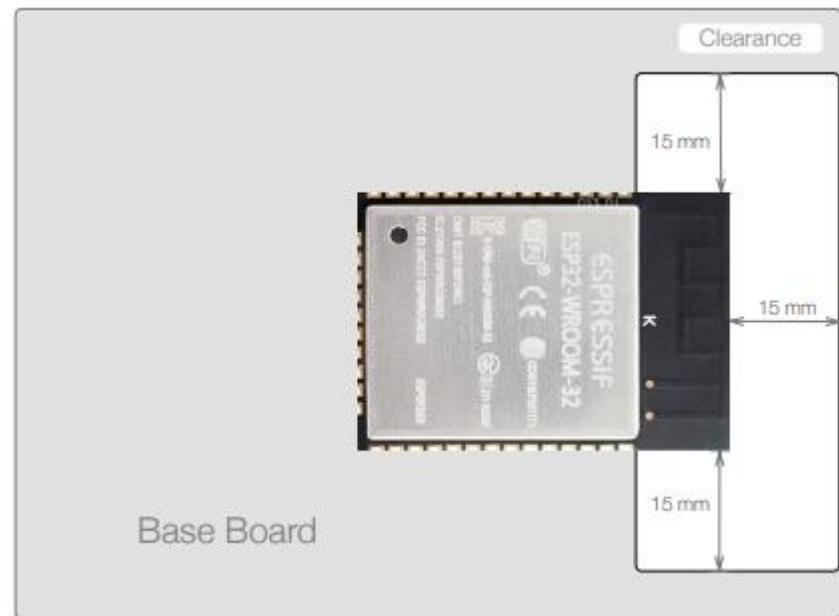
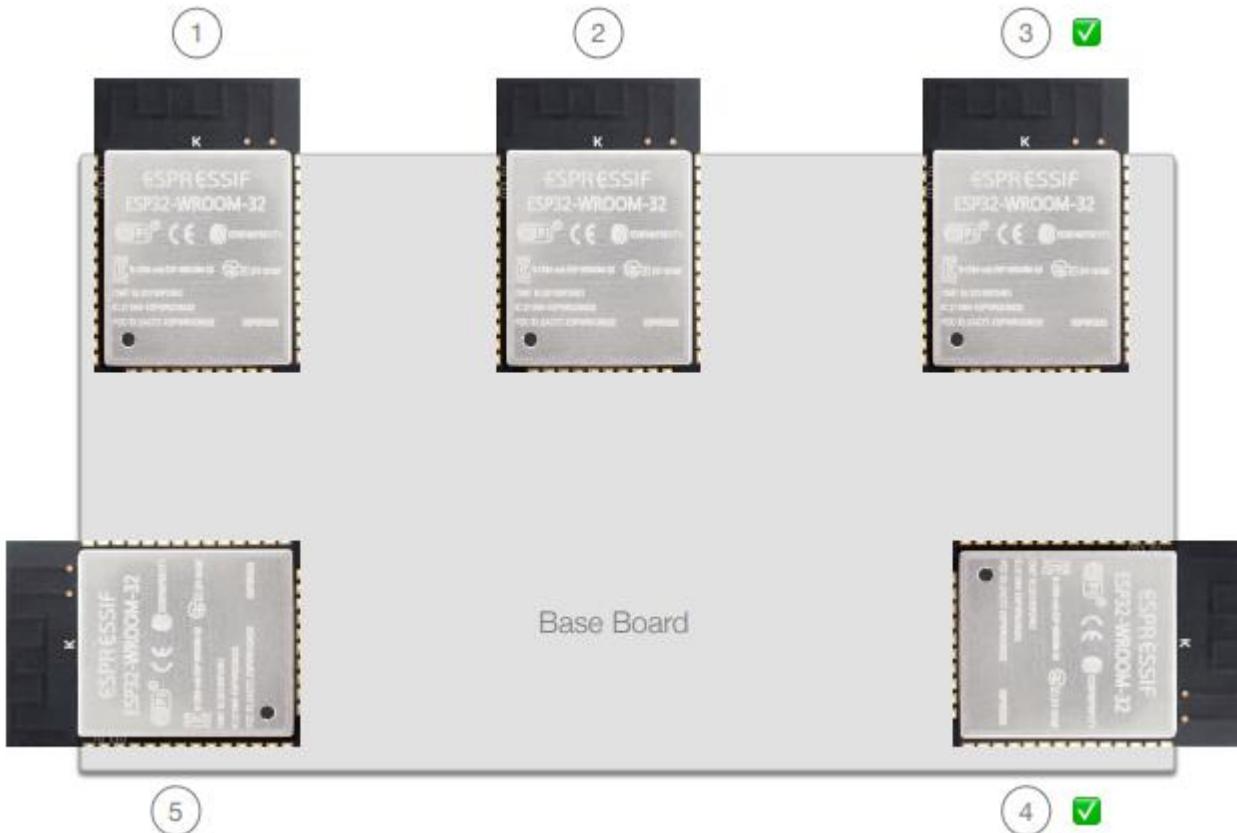
<http://www.es.co.th/af.asp?keyword=esp32&catc=018001&mfc=>

[https://lcsc.com/product-detail/WiFi-Modules\\_Espressif-Systems-ESP32-WROOM-32-N4\\_C82899.html](https://lcsc.com/product-detail/WiFi-Modules_Espressif-Systems-ESP32-WROOM-32-N4_C82899.html)

# Schematic Checklist

<b>2 Schematic Checklist</b>	2
2.1 Power Supply	3
2.1.1 Digital Power Supply	3
2.1.2 Analog Power Supply	4
2.2 Power-on Sequence and System Reset	4
2.2.1 Power-on Sequence	4
2.2.2 Reset	5
2.3 Flash (compulsory) and PSRAM (optional)	5
2.4 Crystal Oscillator	6
2.4.1 External Clock Source (compulsory)	6
2.4.2 RTC (optional)	7
2.5 RF	8
2.6 ADC	8
2.7 External Capacitor	9
2.8 UART	9
2.9 SDIO	10
2.10 Touch Sensor	10

# การจัดวางตำแหน่งของไมดูล



# PCB Layout Design



Figure 11: ESP32 PCB Layout

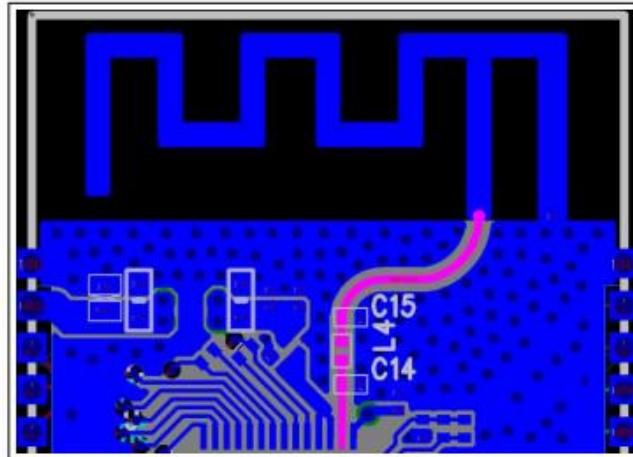


Figure 18: ESP32 RF Layout in a Four-layer PCB Design

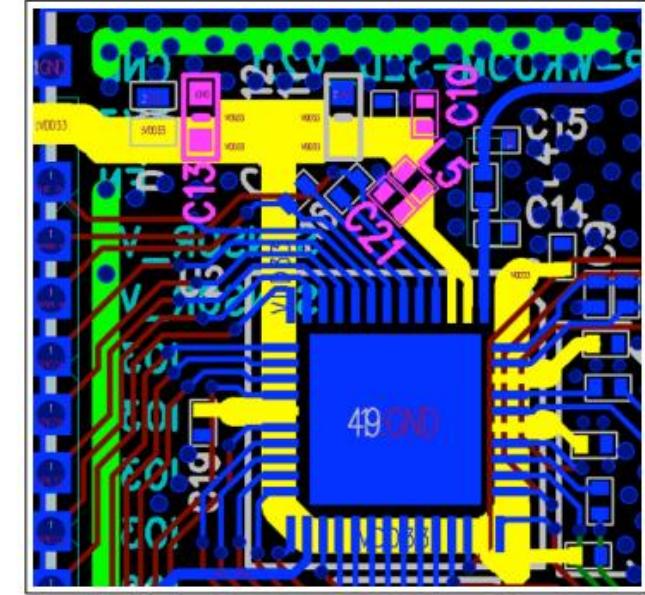
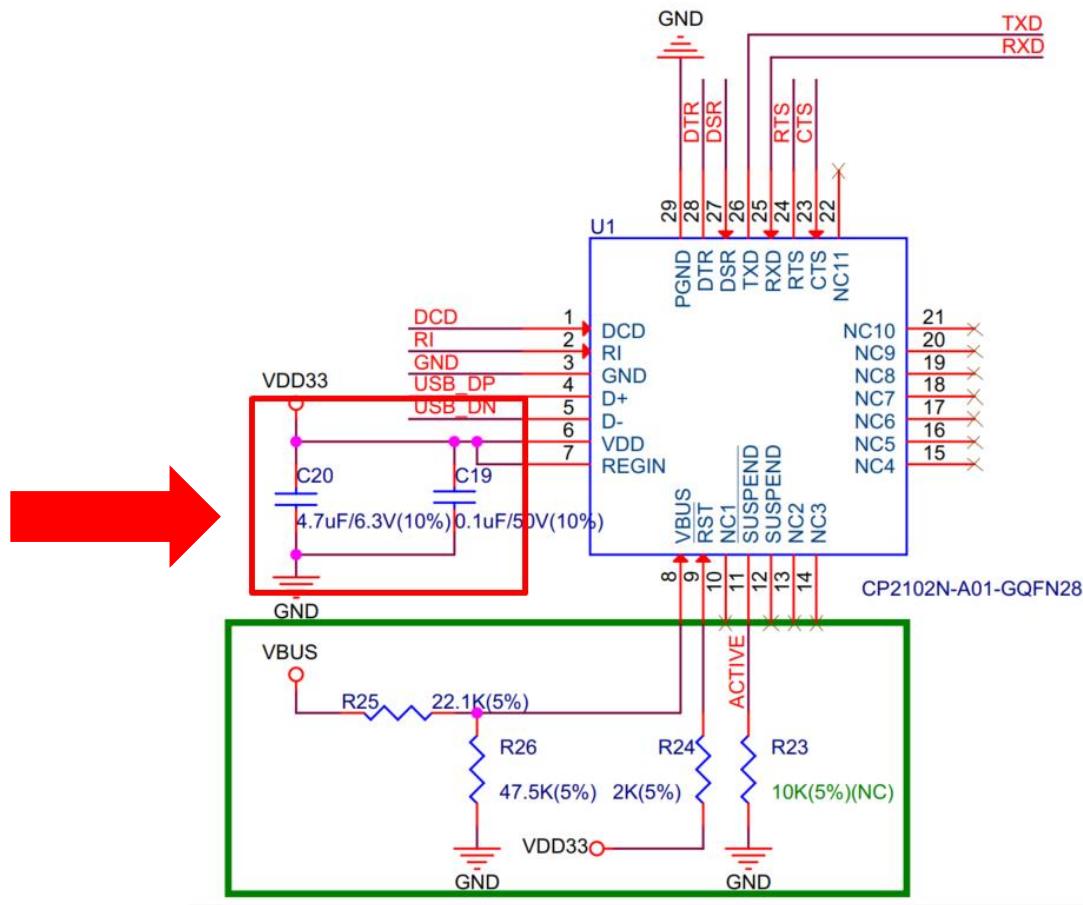


Figure 14: ESP32 Power Traces in a Four-layer PCB Design

# ทำไมต้องใส่ C ไว้ใกล้กับขา VDD

C20 = 4.7uF, C19= 0.1uF



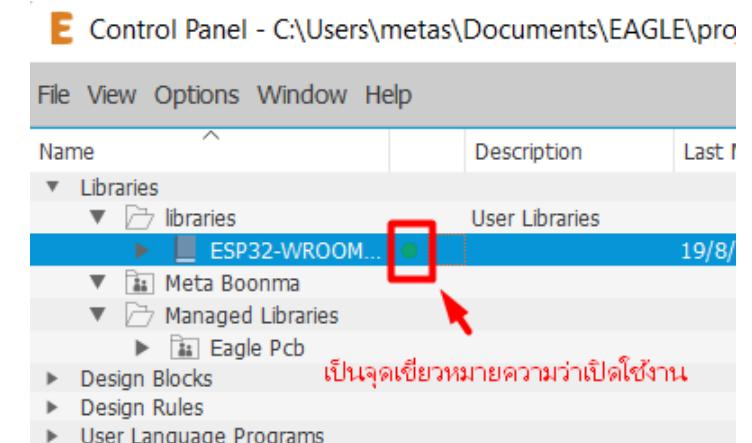
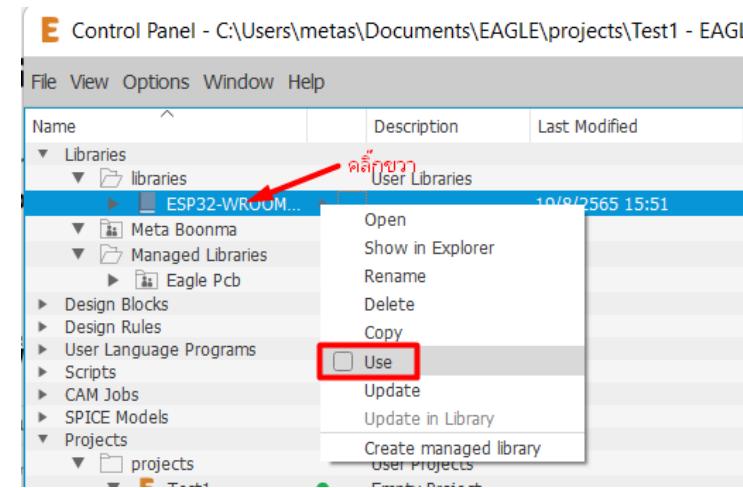
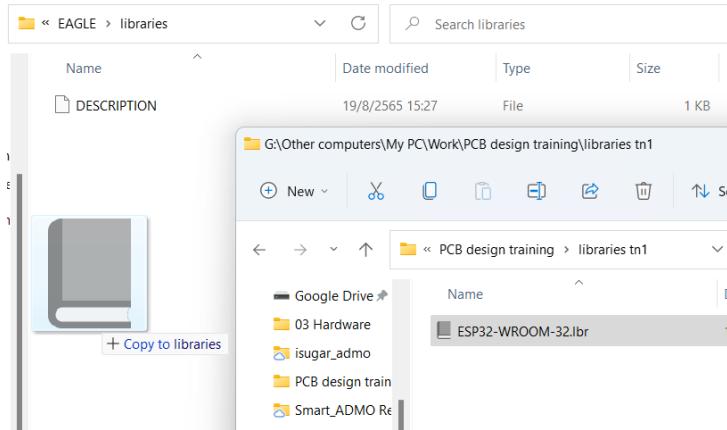
ตอบ :

# การเพิ่ม Library ใน Eagle

หากเราต้องการใช้อุปกรณ์อื่นๆ นอกเหนือจาก Standard Library ของ Eagle เราสามารถเพิ่ม Library ทั้ง Symbol และ Footprint ได้ 2 รูปแบบคือ

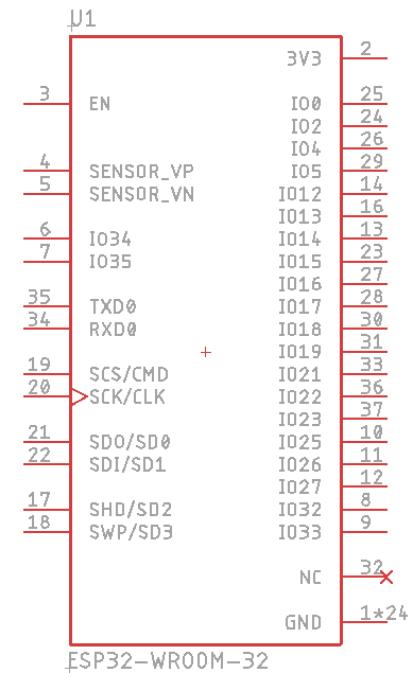
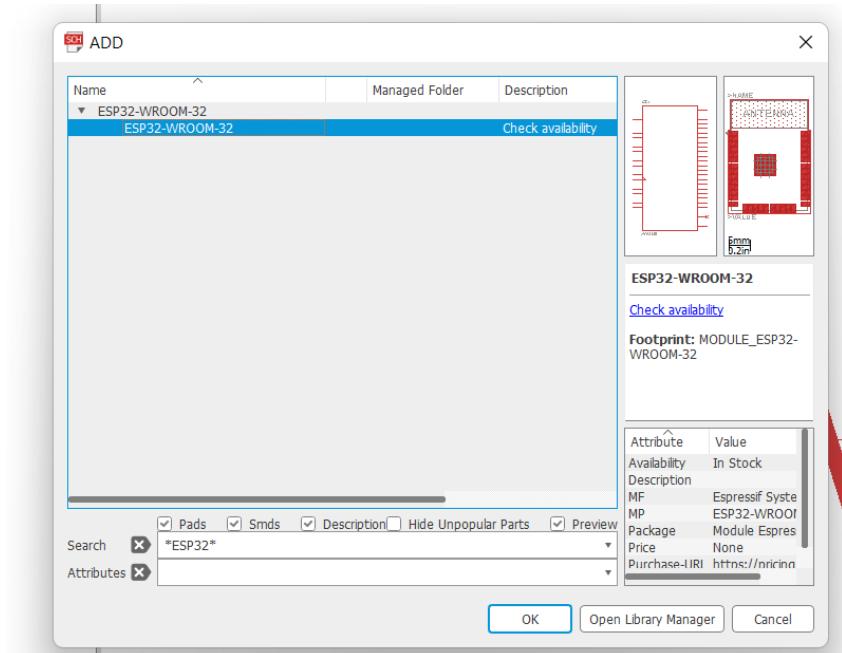
- สร้างขึ้นมาเองโดยอ้างอิงจาก datasheet
- ใช้ Library สำเร็จรูปที่ทำการดาวน์โหลดแล้ว

การเพิ่ม Library ทำได้โดยการ Copy ไฟล์ Library.lbr ไปวางไว้ที่ Folder \Documents\EAGLE\libraries

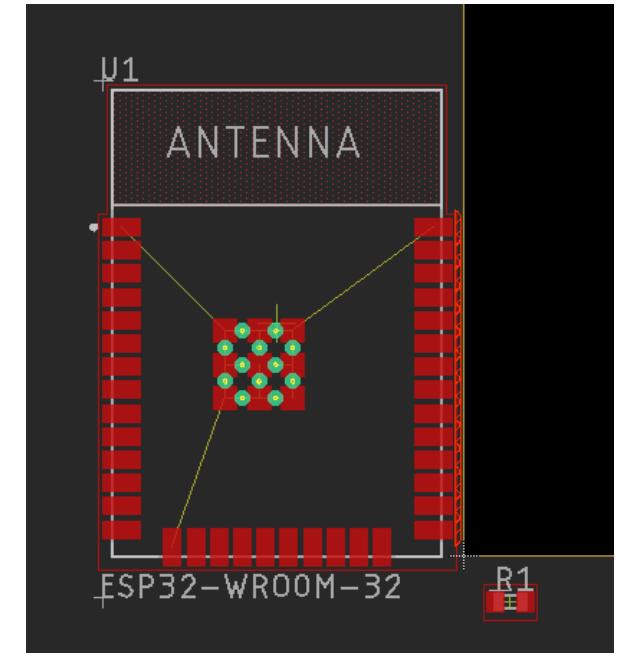


# ลองค้นหา part จาก library ที่เราเพิ่มไป

การค้นหา Part หากค้นหาไม่เจอหรือไม่รู้ว่าคำค้นหาครบทรึอไม่ ให้เราใช้เครื่องหมาย \*คำค้นหา\* จะช่วยให้เราค้นหาได้ดียิ่งขึ้น เช่น \*ESP32\*



Symbol ใน Schematic



Footprint ใน Board

# SnapEDA.com

<https://www.snapeda.com/>

 **TPS5430DDAR**

5.5V to 36V Input, 3A, 500kHz Step-Down Converter

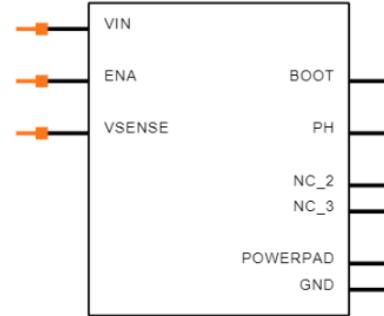
Availability:  In Stock  
Package Type: [HSOIC-8](#)  
CAD Models: [Symbol](#), [Footprint](#), [3D Model](#)

 Get this part  
Unlimited production quantities

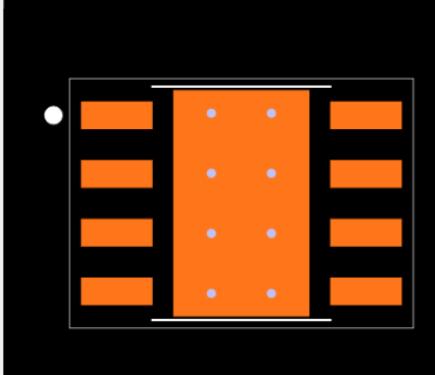
[Buy on TI.com](#)

**Symbol and Footprint** [3D Model](#) [Simulation Models](#) [Buy on TI.com](#) 

**Symbol**



**Footprint**



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**3D Model**



 Help  Fullscreen [Download 3D Model](#)

# SamacSyc.com

<https://www.samacsy.com/>

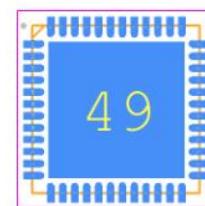
The screenshot shows the SamacSyc.com website interface. At the top left is the logo 'COMPONENT SEARCH ENGINE'. A search bar at the top center contains the placeholder text 'Search by keyword, technical specification or part number'. To the right of the search bar are buttons for 'Search', 'What's New', 'ENG ▾', 'Sign In', and 'Register'. The main content area features a background illustration of electronic components like chips and capacitors. In the center, the product 'STM32F411CEU6TR - STMicroelectronics' is displayed. Below the product name is a brief description: 'Description: ARM Microcontrollers - MCU High-performance access line, ARM Cortex-M4 core with DSP and FPU, 512 Kbytes Flash, 100 MHz CPU, ART Accelerator'. Below the description are several download options: 'Download ECAD Model' (highlighted in blue), 'Schematic symbols', 'PCB footprints', and '3D models'. There is also a checkbox for 'Alert me if there are changes to this model' with the note 'Email notifications will be applied after download.' At the bottom of this section are three preview images: a symbol (circuit diagram), PCB footprints (blue square with yellow numbers), and a 3D model (black cube).

Symbol



click to zoom

PCB Footprints



click to zoom

3D Models



click to zoom

# Octopart.com

<https://www.samacsy.com/>

Octopart Categories

Integrated Circuits (ICs) · RF Semiconductors and Devices · RF Receivers, Transceivers

Espressif Systems  
**ESP32-PICO-D4**

Rx Txrx Mod Wifi Surface Mount

USD 4.950



Jump to: [Price & Stock](#) [Inventory History](#) [CAD Models](#)

## Price & Stock

Espressif Systems ESP32-PICO-D4 pricing and available inventory.

## Authorized Distributors

Seller	SKU	Stock	Visit site	USD
★ Digi-Key	<a href="#">1904-1029-1-ND</a>	9,599	<input type="button" value="Visit site"/>	USD
	<a href="#">1904-1029-6-ND</a>	9,599	<input type="button" value="Visit site"/>	USD
	<a href="#">1904-1029-2-ND</a>	8,000	<input type="button" value="Visit site"/>	USD
★ Mouser	<a href="#">356-ESP32-PICO-D4</a>	2,366	<input type="button" value="Visit site"/>	USD

## Non-Authorized Stocking Distributors

Seller	SKU	Stock	Visit site	USD
LCSC	<a href="#">C193707</a>	3,512	<input type="button" value="Visit site"/>	USD
Ampacity Systems	<a href="#">ESP32-PICO-D4</a>	800	<input type="button" value="Visit site"/>	USD

Espressif Systems **ESP32-PICO-D4** Rx Txrx Mod Wifi Surface Mount USD 4.950

Jump to: [Price & Stock](#) [Inventory History](#) [CAD Models](#) [Tech Specs](#) [Documents](#) [Descriptions](#) [Images](#)

1 ye

Invent

## CAD Models

Download Espressif Systems ESP32-PICO-D4 symbol, footprint, and 3D STEP models from our trusted partners.

SOURCE	eCAD	mCAD	FILES
Component Search Engine	<input type="button" value="Symbol"/> <input type="button" value="Footprint"/>		<input type="button" value="Download"/> <input type="button" value="Preview"/>
EE Concierge	<input type="button" value="Symbol"/> <input type="button" value="Footprint"/>	3D	<input type="button" value="Download"/> <input type="button" value="Preview"/>
SnapEDA	<input type="button" value="Symbol"/> <input type="button" value="Footprint"/>	3D	<input type="button" value="Download"/> <input type="button" value="Preview"/>
Ultra Librarian	<input type="button" value="Symbol"/> <input type="button" value="Footprint"/>	3D	<input type="button" value="Download"/> <input type="button" value="Preview"/>

The partner site will open in a new tab when downloading their CAD models.

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## Technical Specifications

Espressif Systems ESP32-PICO-D4 technical specifications, attributes, and parameters.

### Technical

Bandwidth	72 MHz
Data Rate	150 mbps
Interface	I2C, I2S, SPI, UART
Max Frequency	2.484 GHz
Max Operating Temperature	85 °C
Max Supply Voltage	3.6 V

# UltraLibrarian.com

<https://www.ultralibrarian.com/>

Symbol	Footprint	3D Model

Normal View    Basic View

ESP32-PICO-D4\_1    ESP32-PICO-D4\_EXP

[Download Now](#)

## Additional Info



Datasheets



Pricing & Availability



Tech Specs

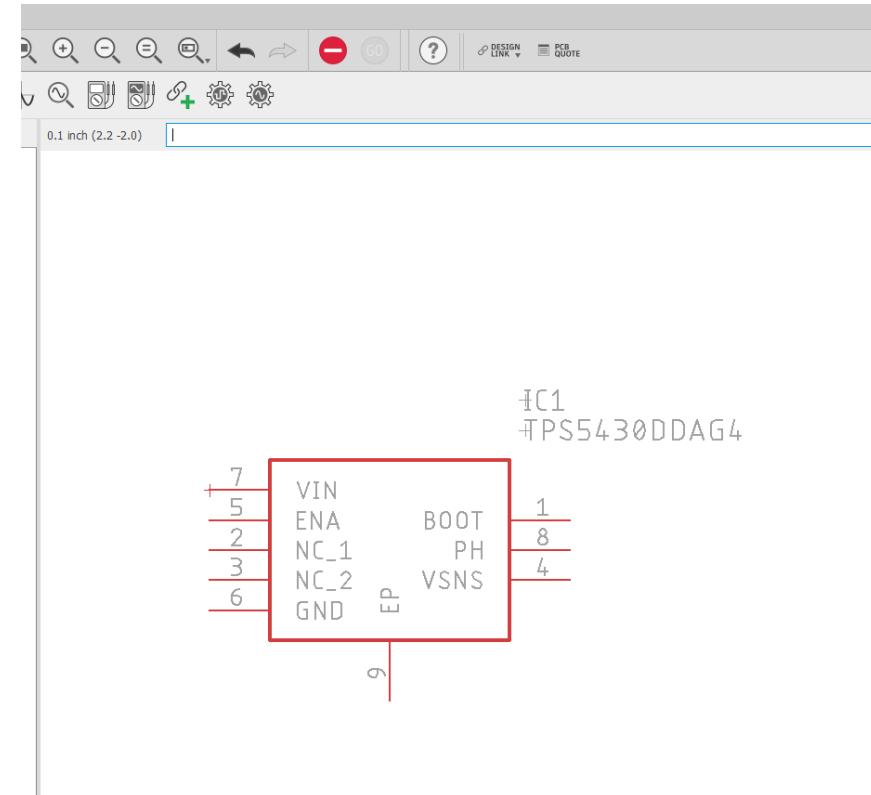
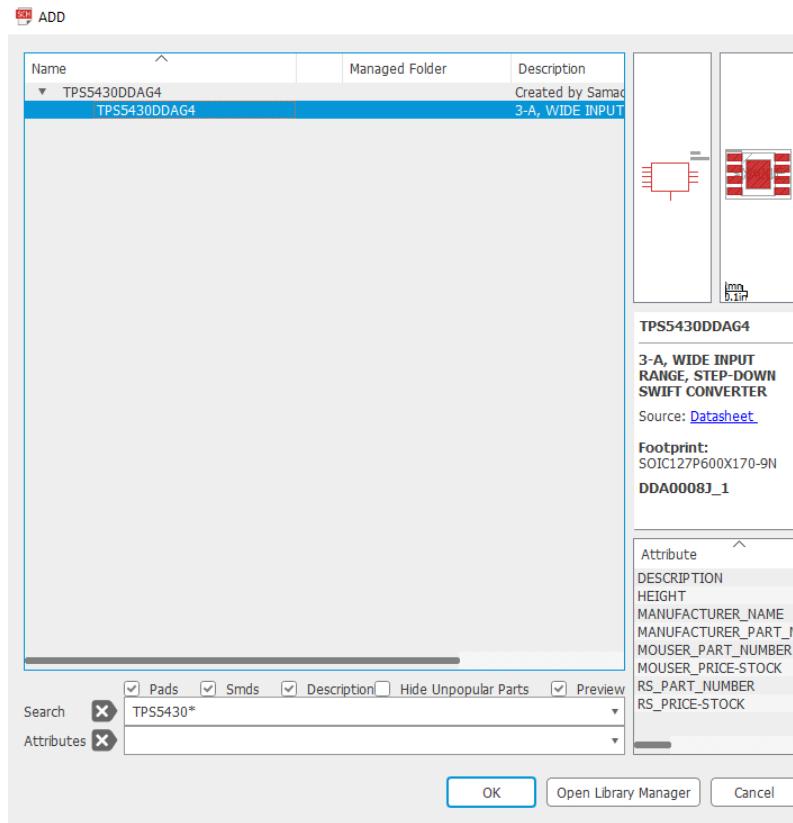


Welcome to the worlds largest verified [Feedback](#)

# Lab 3: ทดลองค้นหา IC จากเว็บไซต์แล้วเพิ่มเข้า Eagle libraries

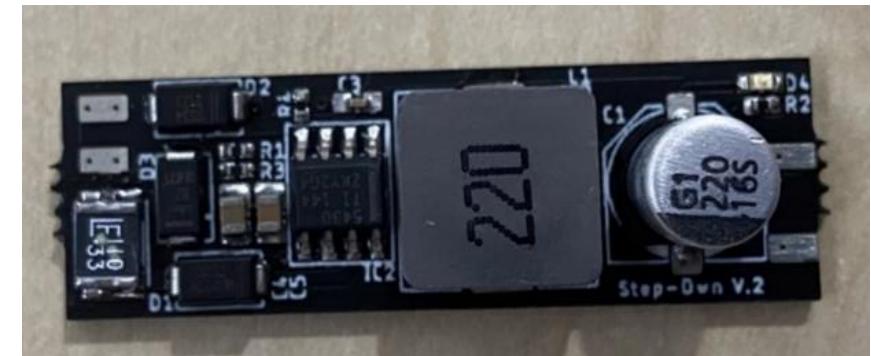
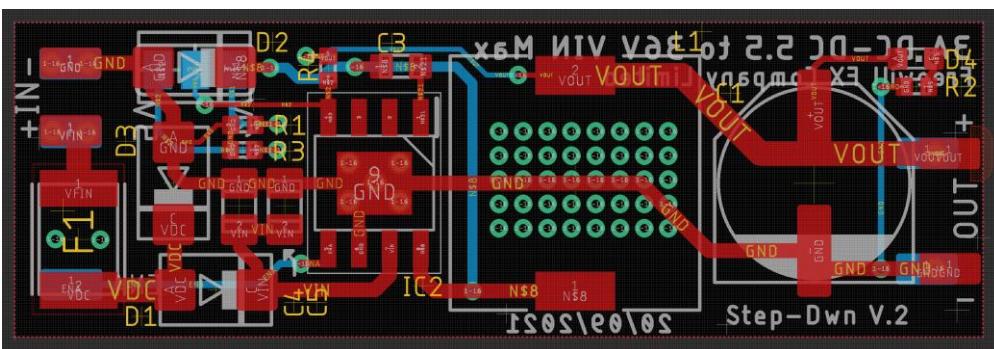
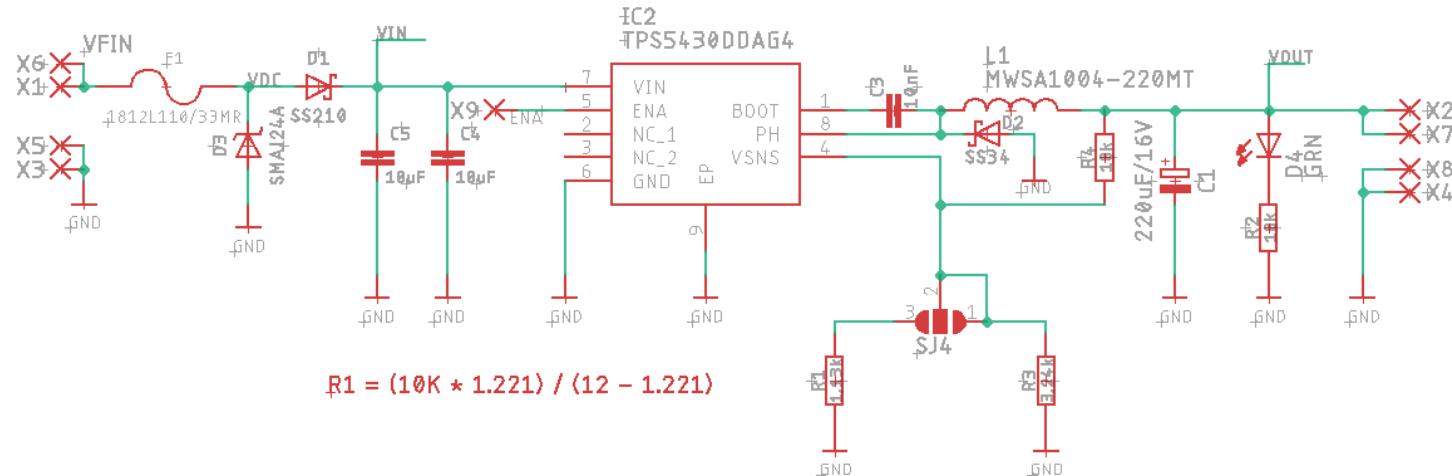
TPS5430DDAR 3-A, Wide Input Range, Step-Down Converter

[https://lcsc.com/product-detail/DC-DC-Converters\\_Texas-Instruments-TPS5430DDAR\\_C9864.html](https://lcsc.com/product-detail/DC-DC-Converters_Texas-Instruments-TPS5430DDAR_C9864.html)



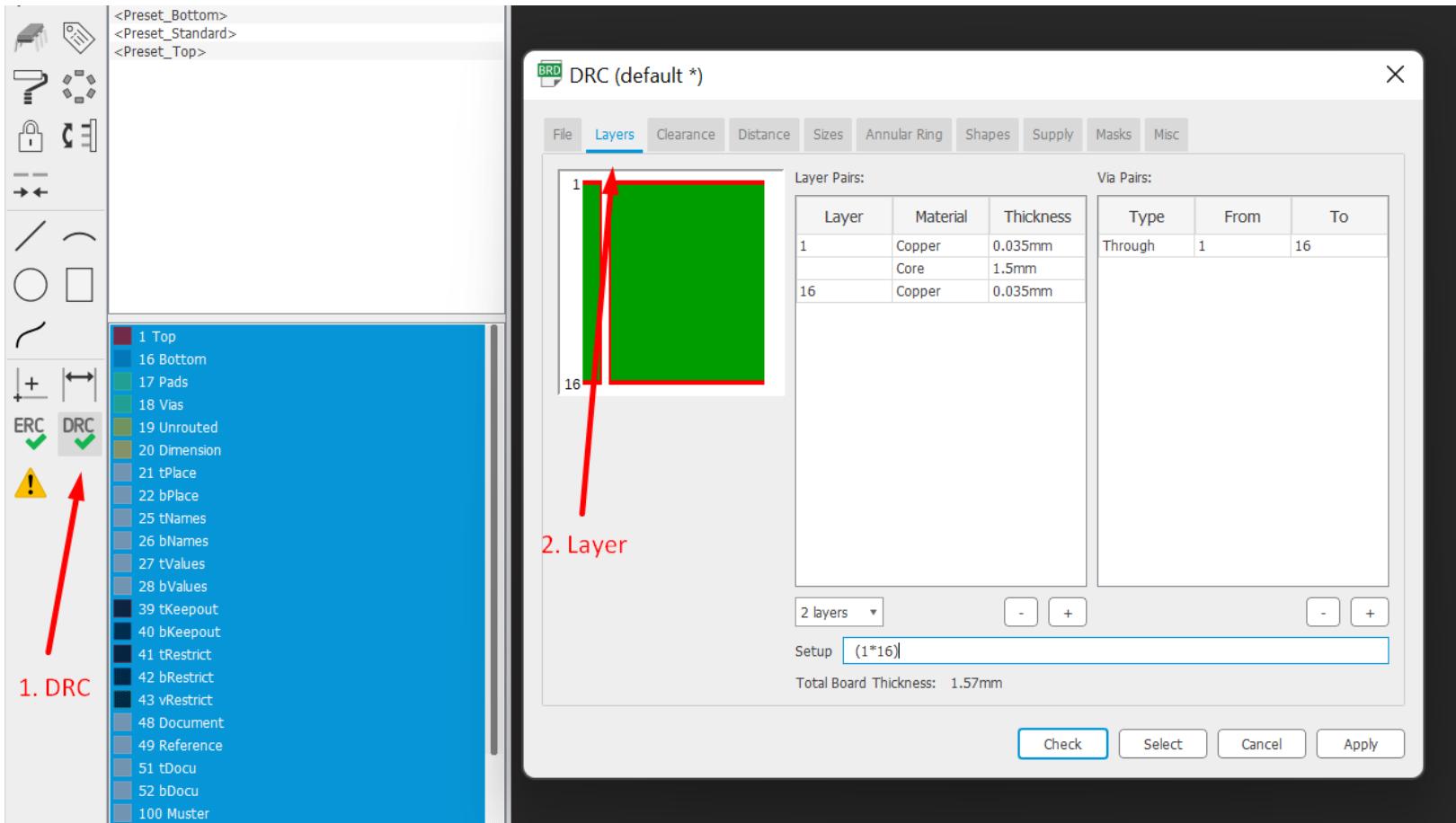
# ตัวอย่างการต่อวงจรใช้งานจริง

TPS5430DDAR DC-DC 5.5 to 36V Input 3A Step Dwn Converter



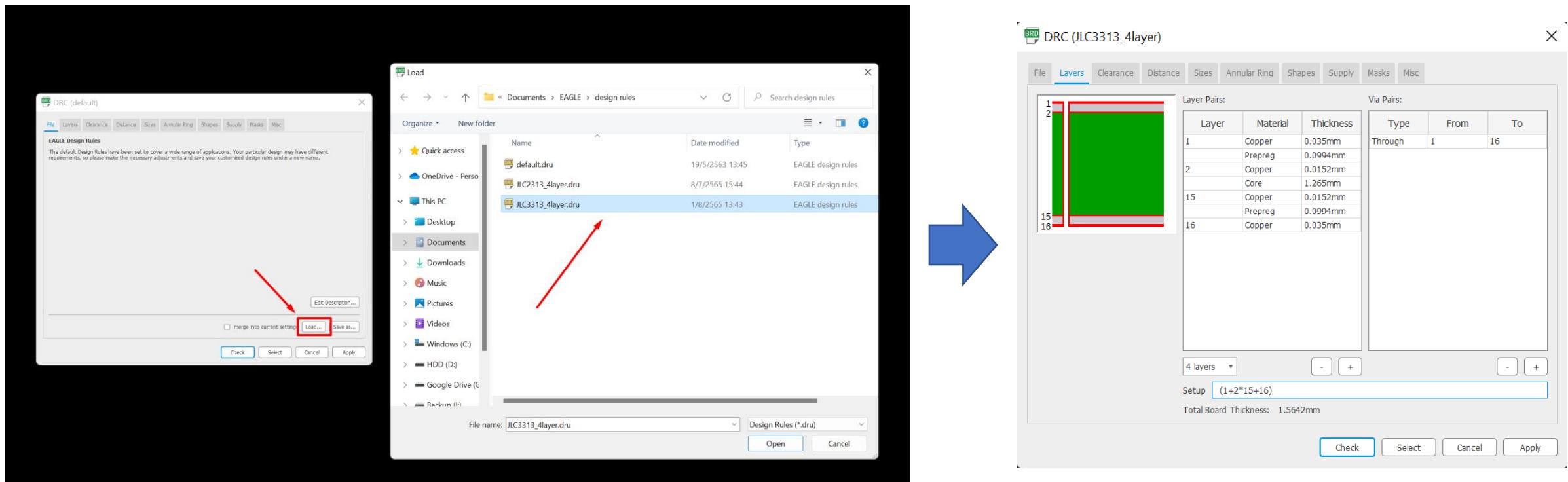
# **Stackup PCB Layer**

# การตั้งค่า PCB Layer (default 2 layer)



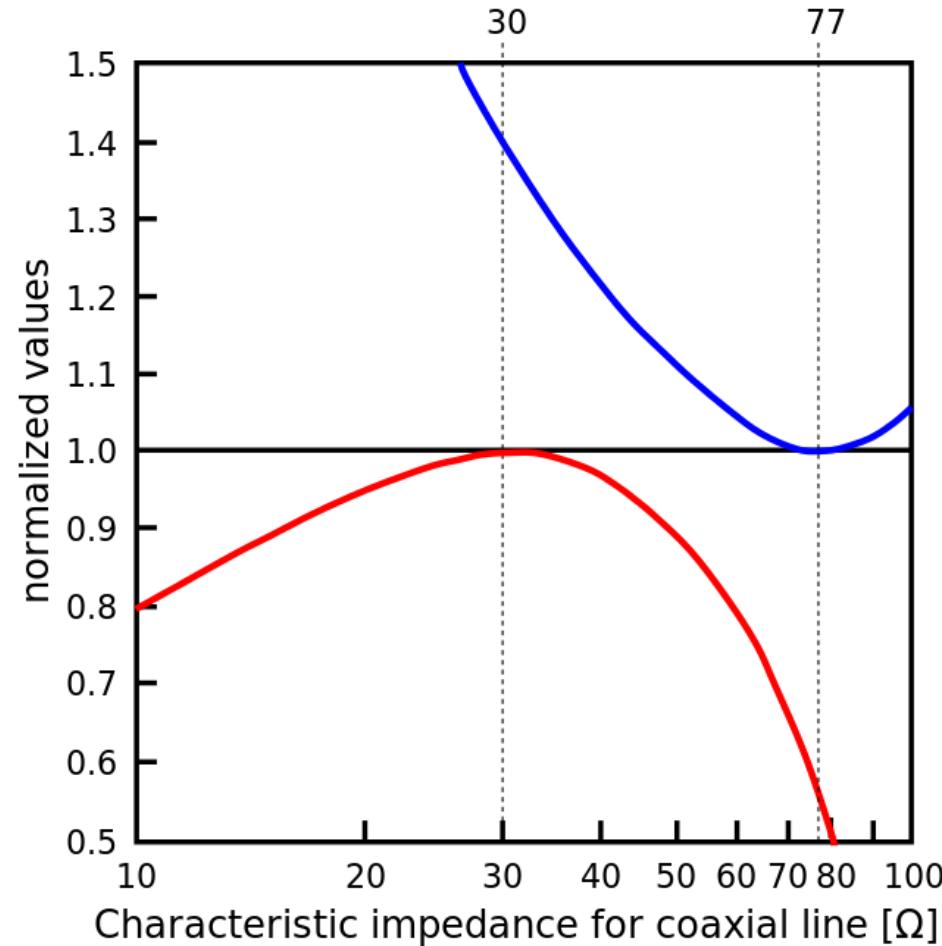
# การเพิ่ม DRC ที่มีการตั้งค่าไว้แล้ว

ลอง load : JLC3313\_4layer.drc



# 50 Ohm Impedance : มาจากไหน

- Lowest loss
- Highest voltage
- Highest power transfer



Attenuation (blue) is lowest at  $77 \Omega$  (for  $\epsilon_r = 1$ )

Maximum power capacity (red) peaks at  $30 \Omega$

# JLCPCB 4layer Impedance control Stack-up

<https://cart.jlcpcb.com/impedance>

## Controlled Impedance PCB Parameters and Stackup

1. Prepreg dielectric constant:

Prepreg type	Dielectric constant
7628	4.6
3313	4.05
2116	4.25

# JLC3313 Stackup Thickness = 1.6mm

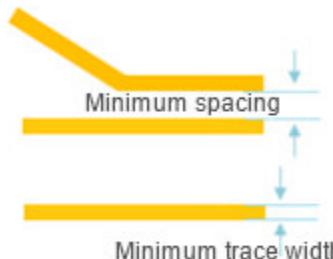
b) JLC3313 Stackup:

Layer	Material Type	Thickness	
Top Layer1	Copper	0.035 mm	
Prepreg	3313*1	0.0994 mm	
Inner Layer2	Copper	0.0152 mm	1.3 mm (with copper core)
Core	Core	1.265 mm	
Inner Layer3	Copper	0.0152 mm	
Prepreg	3313*1	0.0994 mm	
Bottom Layer4	Copper	0.035 mm	

0.1mm (3.94 mil) is nominal thickness of 3313 prepreg. Use 3.5 mil as the thickness when the controlled impedance tracks are on top/bottom, use 4.5 mil when tracks are inside.

# JLCPCB Trace/Gap Capability

## Minimum trace width and spacing

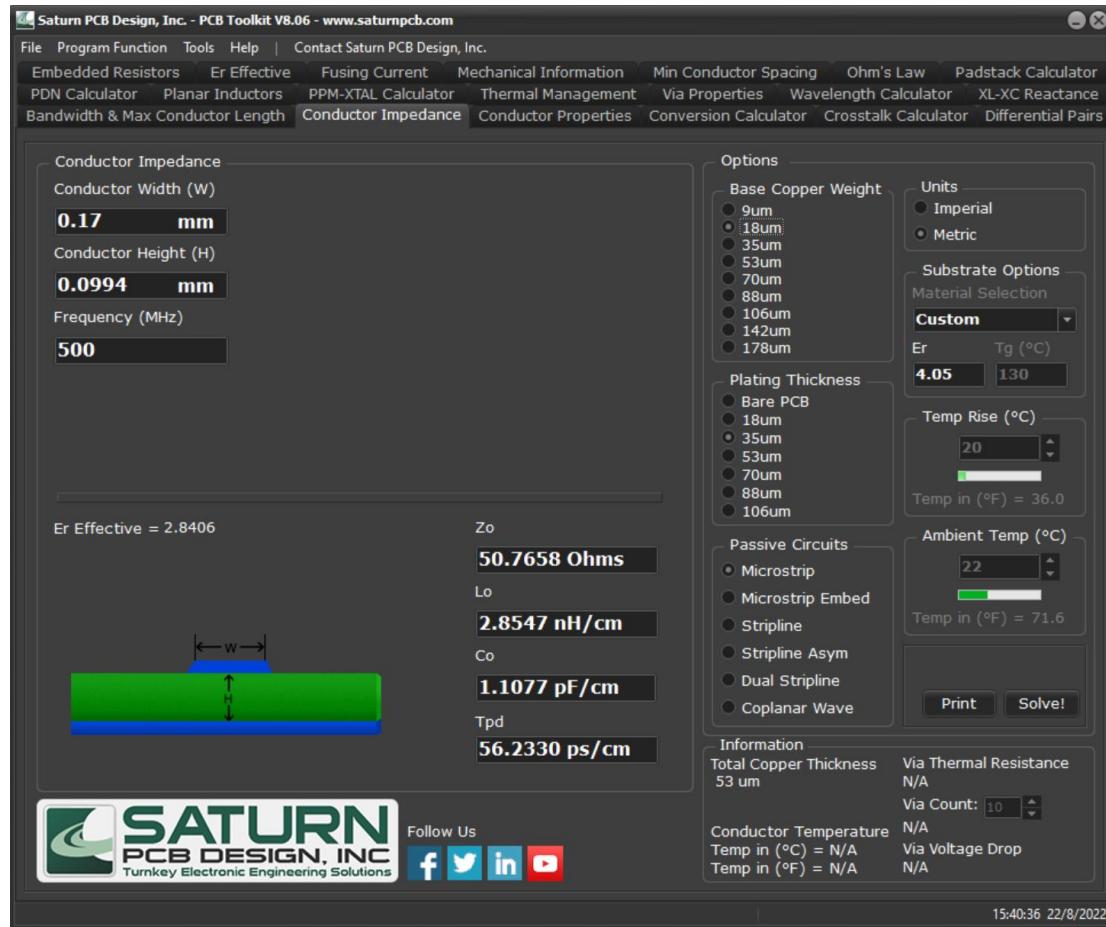
	Min. Trace width	Min. Spacing	Patterns
1-2 Layers	5mil (0.127mm)	5mil (0.127mm)	
4-6 Layers	3.5mil (0.09mm)	3.5mil (0.09mm)	
2oz Copper weight	8mil (0.2mm)	8mil (0.2mm)	

# การคำนวณ Impedance

- ใช้โปรแกรม <https://saturnpcb.com/saturn-pcb-toolkit/>
- ให้ลองคำนวณที่ 50 ohm ที่ 4 Layer JLC3313

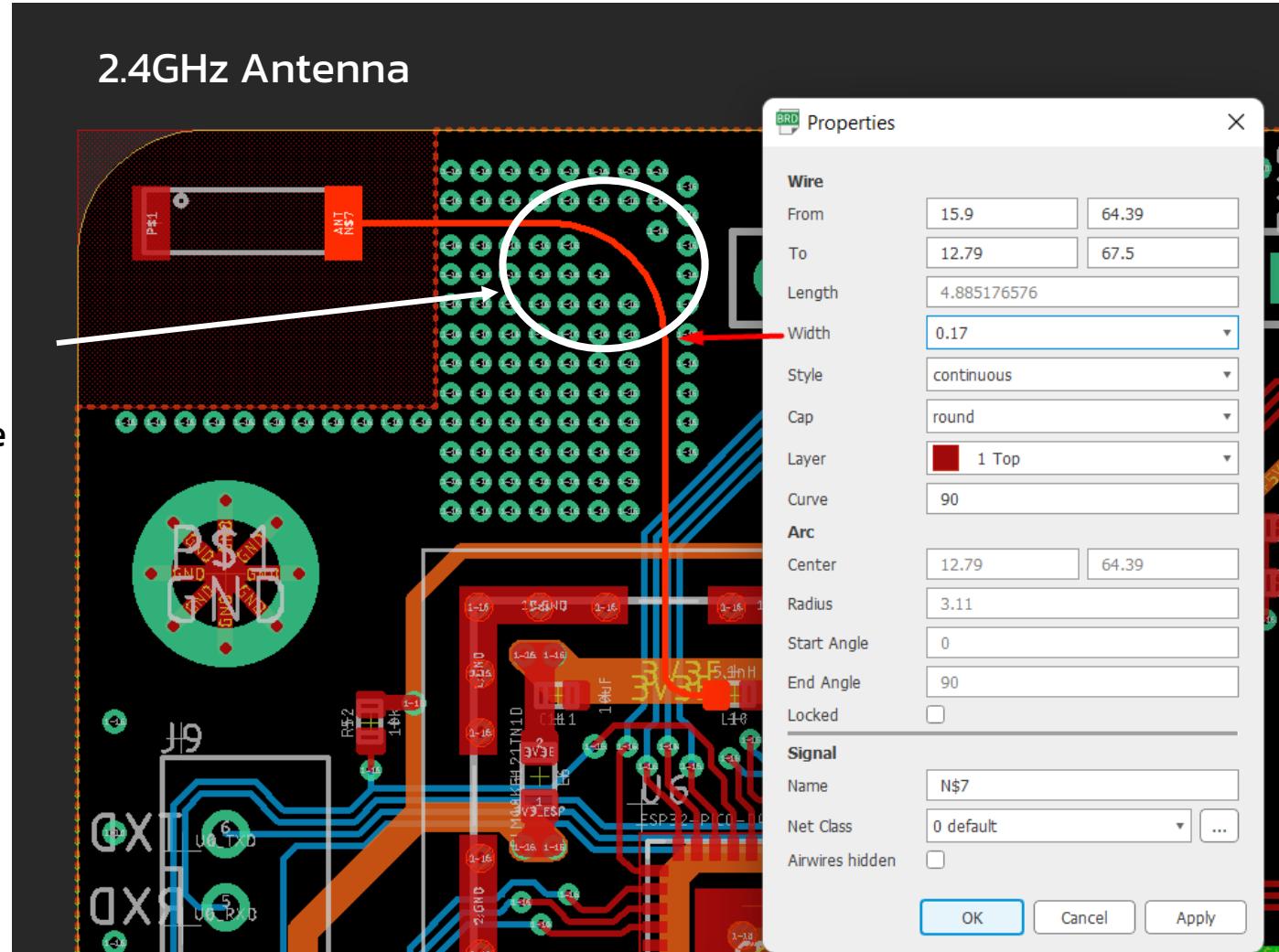
## Parameter

Er	: 4.05
Conductor H	: 0.0994 mm
Base Copper	: 18um (0.5oz)
Plating	: 35um (1oz)



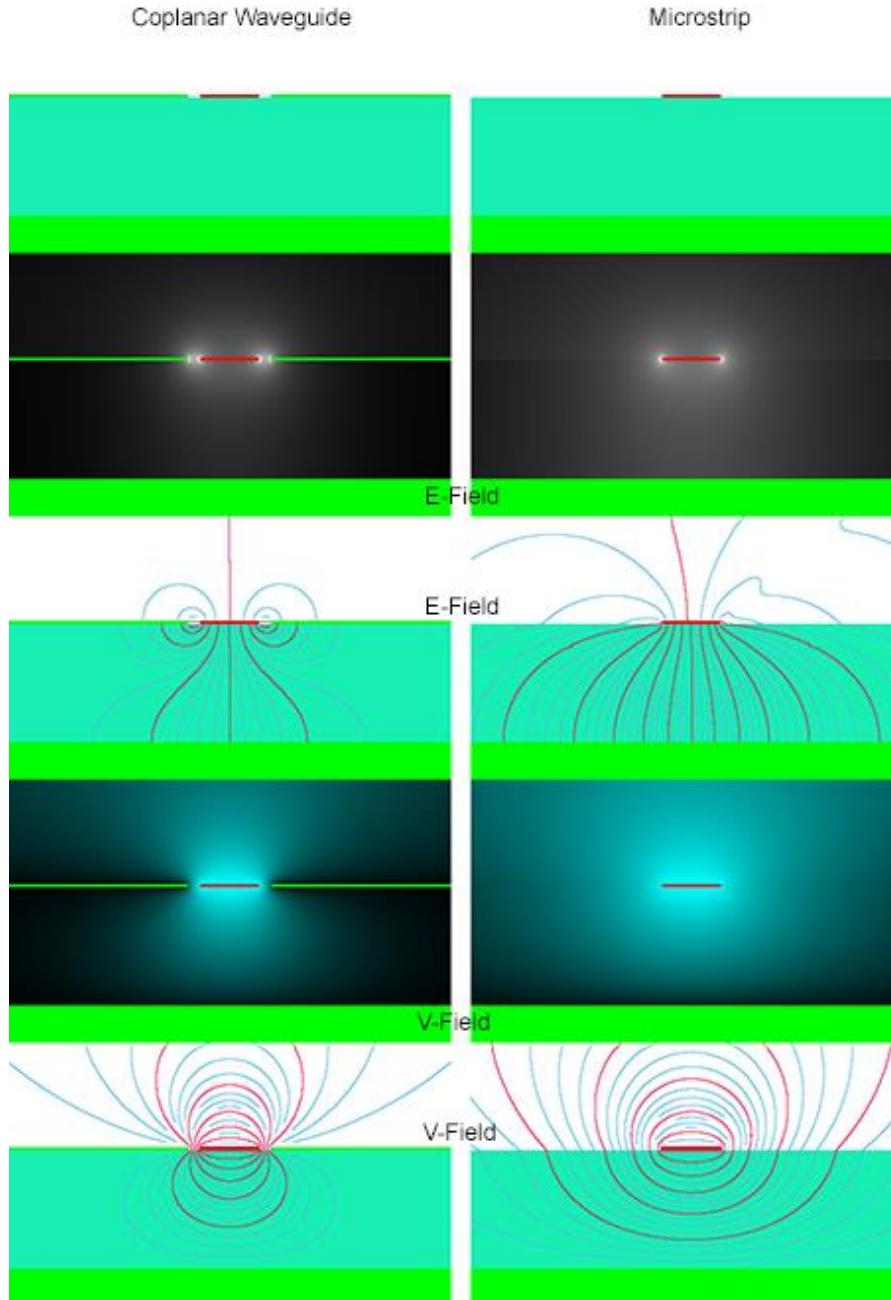
# ตัวอย่างการเดินเส้นสาย 50 ohm (Antenna trace width 0.17mm)

ต้องมีส่วนหักมุมให้น้อยที่สุด  
จึงใช้เป็นเส้นโค้งแทนเพื่อลด  
การเปลี่ยนแปลง Impedance  
ภายในเส้นสายวงจร



# Single Coplanar (SEC)vs Single (SE)

<https://electronics.stackexchange.com/questions/570008/trace-impedance-calculation-in-altium-for-rf>

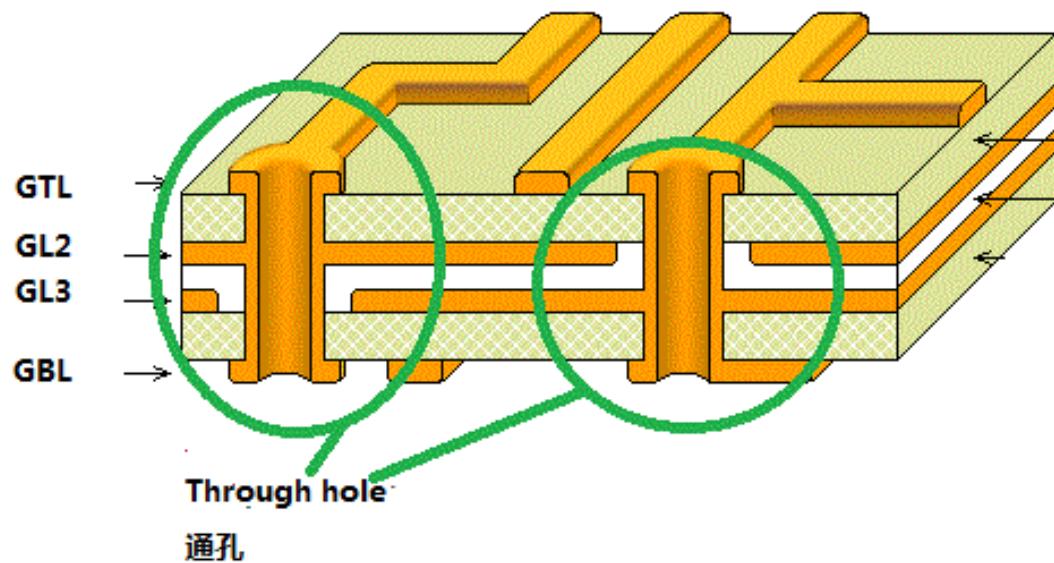
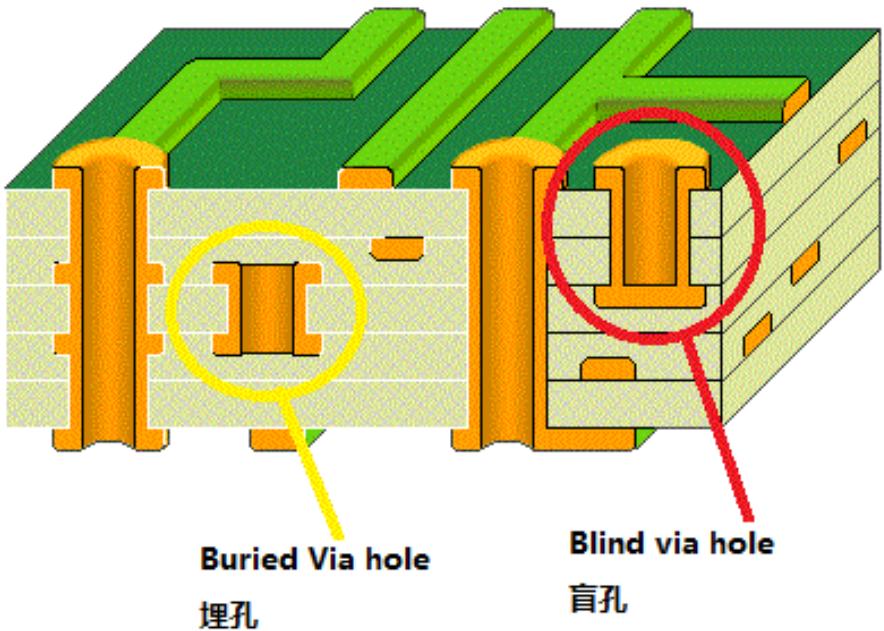


# Online Calculators Tool

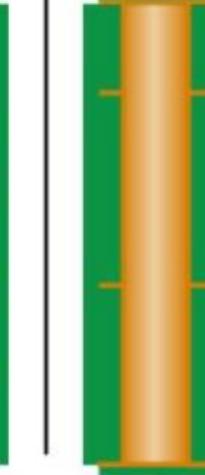
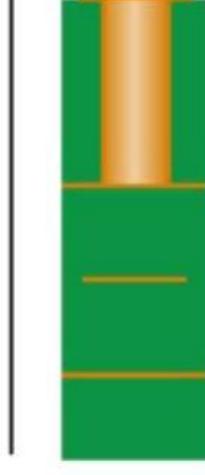
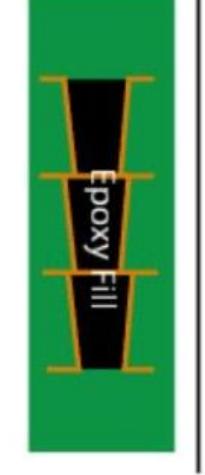
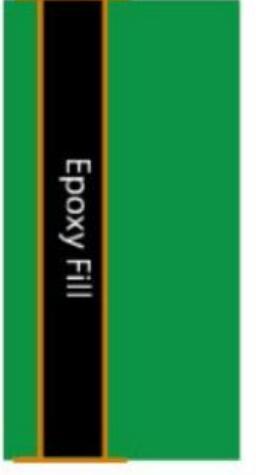
- <https://chemandy.com/calculators/microstrip-transmission-line-calculator-hartley27.htm>
- <https://chemandy.com/calculators/coplanar-waveguide-with-ground-calculator.htm>
- <https://cart.jlcpcb.com/impedanceCalculation>

# **การใช้งาน VIA**

# Via Type



# Via Type

Cost	Standard	Standard	+\$	+\$	+\$	+\$
Duration	Standard	Standard	+🕒	+🕒	+🕒🕒	+🕒🕒
Type	Through Via	Tented Via	Blind Via	Buried Via	Stacked Via	Via in Pad
						

<https://www.tempoautomation.com/blog/the-essentials-of-annular-ring-pcb-design/>

# Common Via Hole/Pads size

VIA PADSTACK TECHNOLOGY							
HOLE SIZE		PAD SIZE		PLANE CLEARANCE		SOLDER MASK	
INCH	METRIC	INCH	METRIC	INCH	METRIC	INCH	METRIC
0.006"	0.15 mm	0.016"	0.40 mm	0.024"	0.60 mm	0.000"	0.00 mm
0.008"	0.20 mm	0.018"	0.45 mm	0.026"	0.65 mm	0.000"	0.00 mm
0.010"	0.25 mm	0.020"	0.50 mm	0.028"	0.70 mm	0.000"	0.00 mm
0.012"	0.30 mm	0.024"	0.65 mm	0.030"	0.75 mm	0.000"	0.00 mm
0.014"	0.35 mm	0.028"	0.70 mm	0.032"	0.80 mm	0.000"	0.00 mm
0.016"	0.40 mm	0.030"	0.75 mm	0.034"	0.85 mm	0.016"	0.40 mm
0.018"	0.45 mm	0.033"	0.85 mm	0.036"	0.90 mm	0.018"	0.45 mm
0.020"	0.50 mm	0.035"	0.90 mm	0.038"	0.95 mm	0.020"	0.50 mm
0.022"	0.55 mm	0.040"	1.00 mm	0.040"	1.00 mm	0.022"	0.55 mm
0.024"	0.60 mm	0.043"	1.10 mm	0.042"	1.05 mm	0.024"	0.60 mm

# Example: Via Characteristics

Hole/Pad= 0.2mm/0.45mm

Via Current =1.8A

Via Impedance=66 Ohm

Via Characteristics

Via Hole Diameter  
**0.2 mm**

Internal Pad Diameter  
**0.45 mm**

Ref Plane Opening Diam  
**1.016 mm**

Via Height  
**1.575 mm**

Via Plating Thickness  
**0.0254 mm**

Options

Base Copper Weight  
 9um  
 18um  
 35um  
 53um  
 70um  
 88um  
 106um  
 142um  
 178um

Units  
 Imperial  
 Metric

Substrate Options  
Material Selection  
**Custom**

Er      Tg (°C)  
**4.58**    **155**

Temp Rise (°C)  
**20**

Temp in (°F) = 36.0

Ambient Temp (°C)  
**22**

Temp in (°F) = 71.6

Property Selection  
 Via Properties  
 Differential Vias

Layer Set  
 2 Layer  
 Multi Layer  
 Microvia

Information  
Power Dissipation (dBm) 7.9706 dBm  
Via Thermal Resistance 222.2 °C/W  
Aspect Ratio 7.88:1  
Via Count: 10  
Via Temperature 22.2 °C/W per via  
Temp in (°C) = 42.0  
Temp in (°F) = 107.6  
Via Voltage Drop 3.4482 mV

Via Capacitance  
**0.3184 pF**

Via DC Resistance  
**0.00190 Ohms**

Power Dissipation  
**0.00627 Watts**

Via Inductance  
**1.4017 nH**

Resonant Frequency  
**7533.938 MHz**

Conductor Cross Section  
**0.0180 Sq.mm**

Via Impedance  
**66.355 Ohms**

Step Response  
**23.2376 ps**

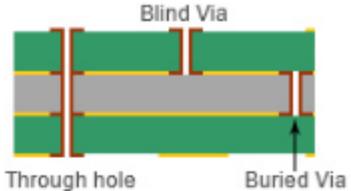
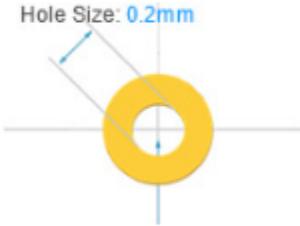
Via Current  
**1.8175 Amps**

SATURN PCB DESIGN, INC  
Turnkey Electronic Engineering Solutions

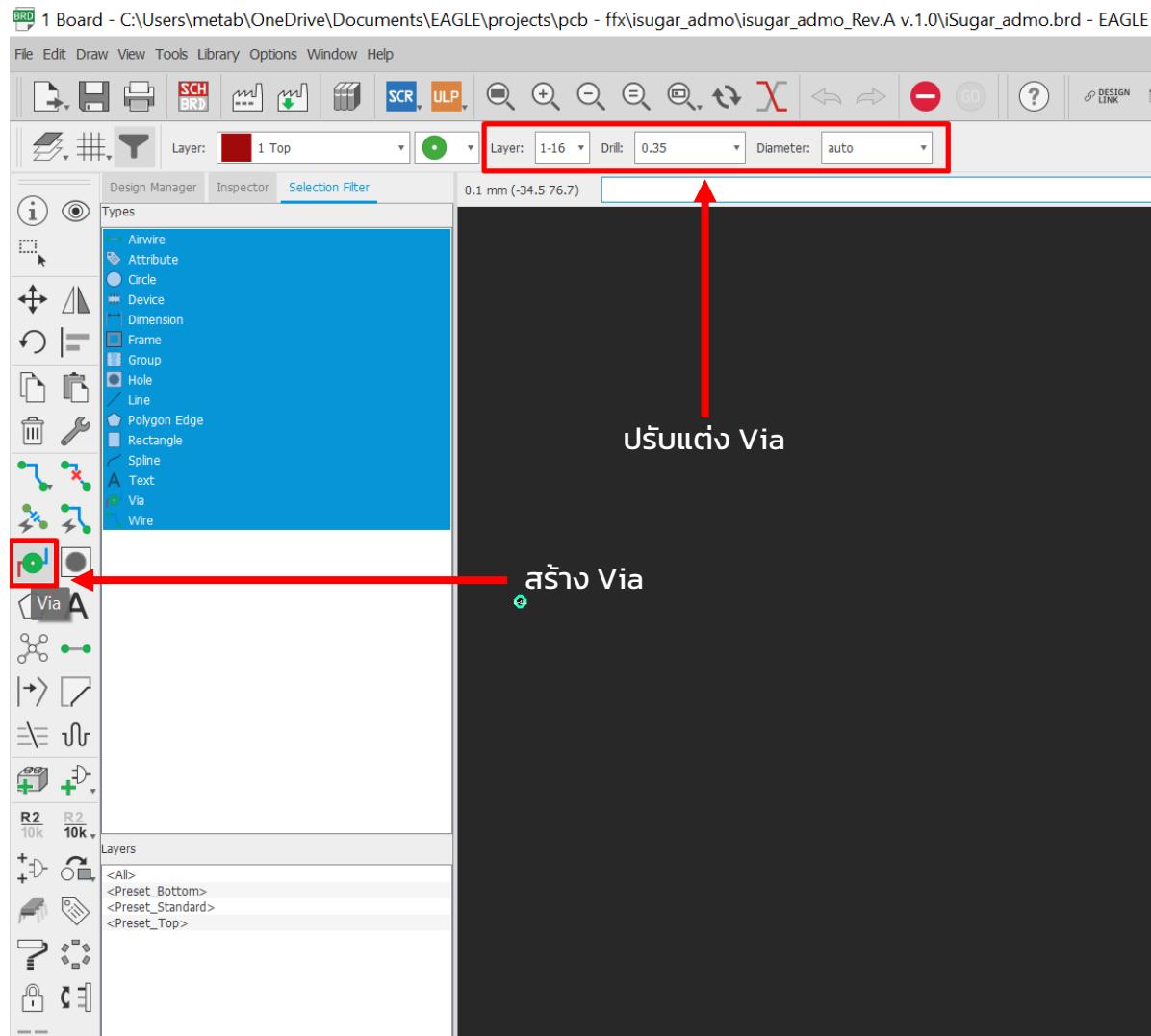
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# JLCPCB Via Capability

Blind/Buried Vias	Don't support	Currently we don't support Blind/Buried Vias, only make through holes.	
Min. Via hole size	0.2mm	For Single&Double Layer PCB, the minimum via hole size is 0.3mm; For Multi Layer PCB, the minimum via hole size is 0.2mm	
Min. Via diameter	0.4mm	For Single&Double Layer PCB, the minimum Via diameter is 0.5mm; For Multi Layer PCB, the minimum via diameter is 0.45mm(Limitation 0.4mm).	

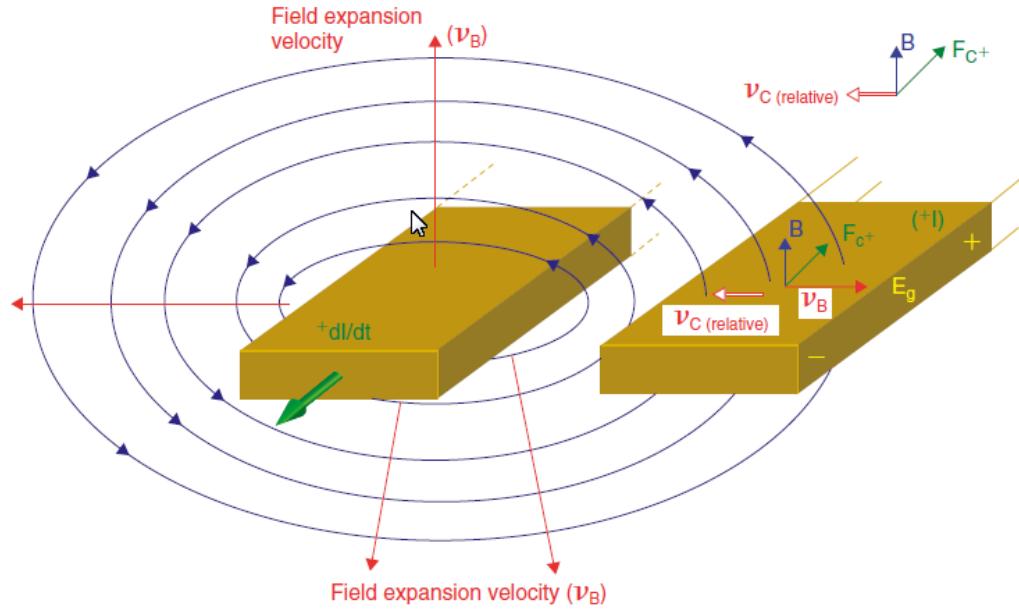
# Via ใน Eagle



# **វិវេលធនស័ិក្សានរបកវនាំអរុបការអកແប់ PCB**

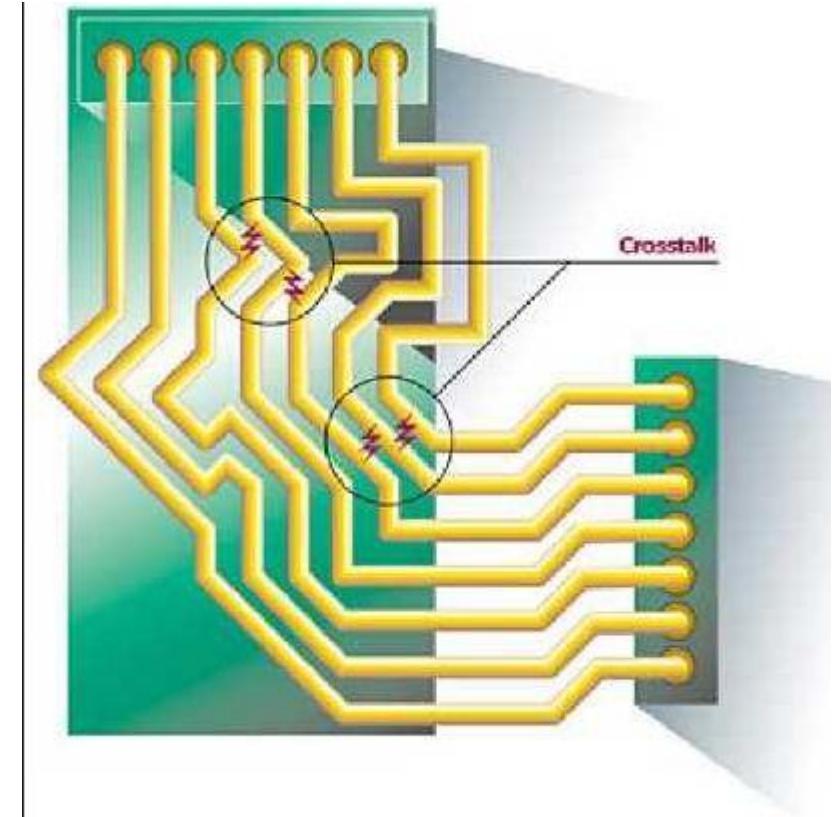
អាយុងឱ៉ែនៅទាំង : <https://ndrsolution.com/2022/07/12/how-to-noise-reduction-for-pcb-design-part-1-3/>

# Crosstalk



- Coupling of energy between conductor
- **Faster rise time** increased levels of crosstalk
- Shorter rise time -> higher frequencies

- Increase space between traces
- Reduce parallel trace length
- Place conductor close to ground



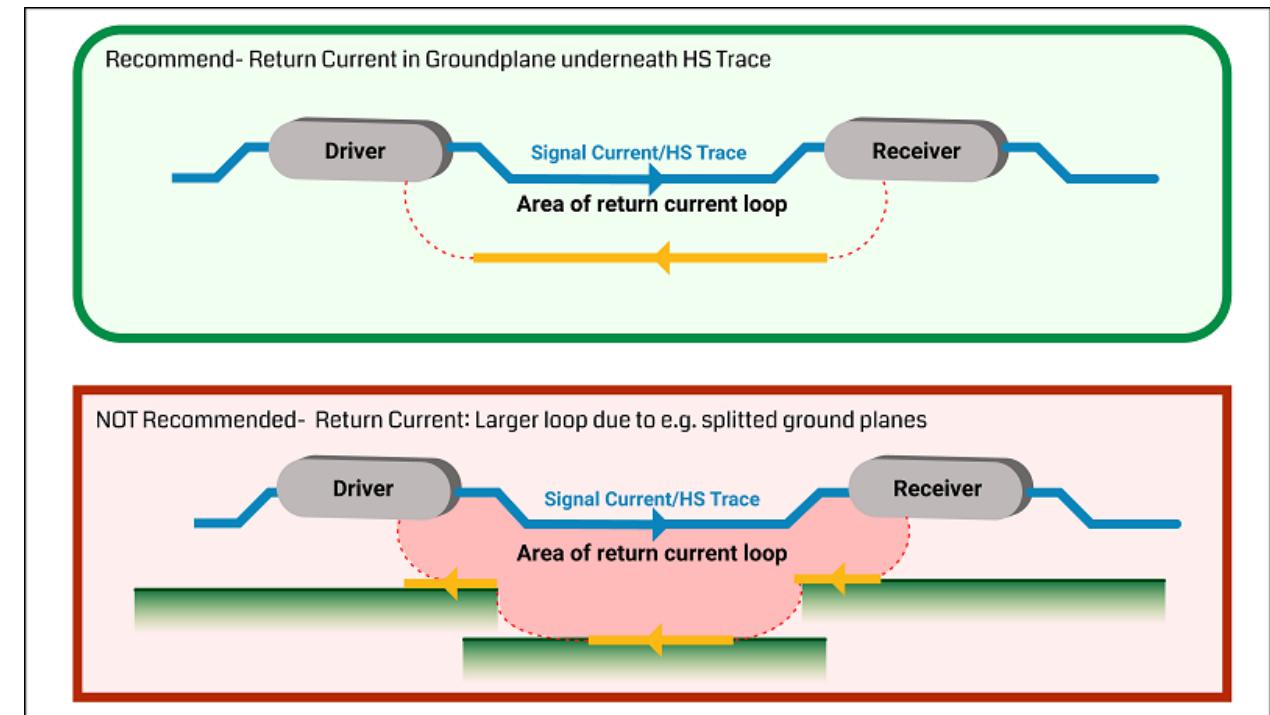
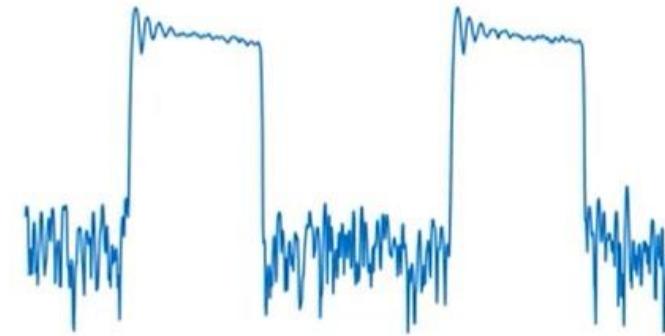
<https://www.eeestudy.com/what-is-crosstalk-in-pcb-design/>

อ้างอิง : HW-A01\_Trainin By Q-wave System Co.,Ltd

# Noise

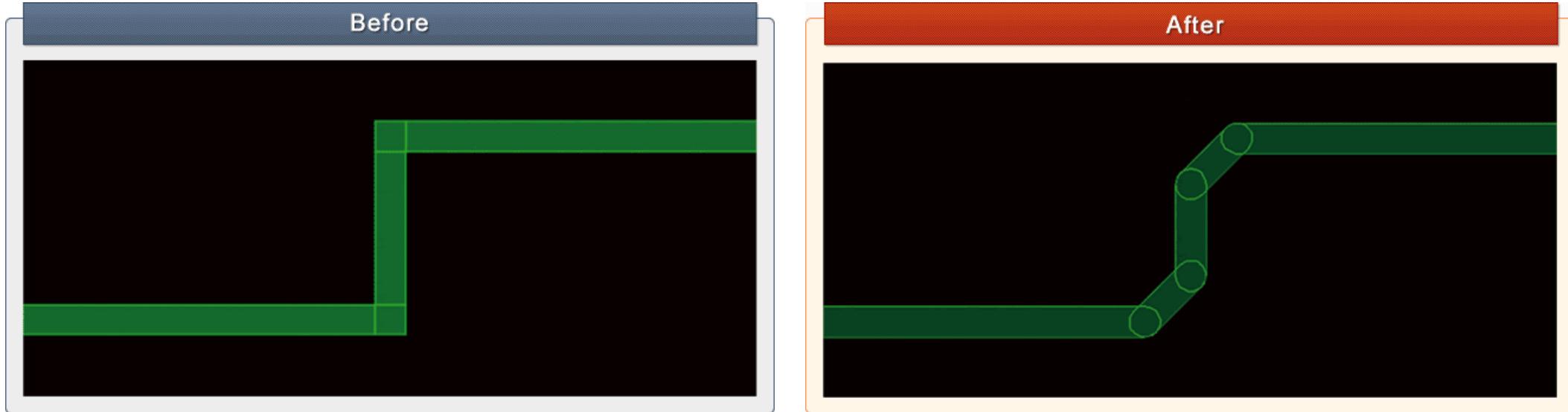
- Internal higher frequencies noise (Shorter signal risetime ns)
- Crosstalk signal
- Power supply noise
- EMI internal and External
- Ground Loop (Long Return path)

\*\*EMI : การรบกวนทางแม่เหล็กไฟฟ้า



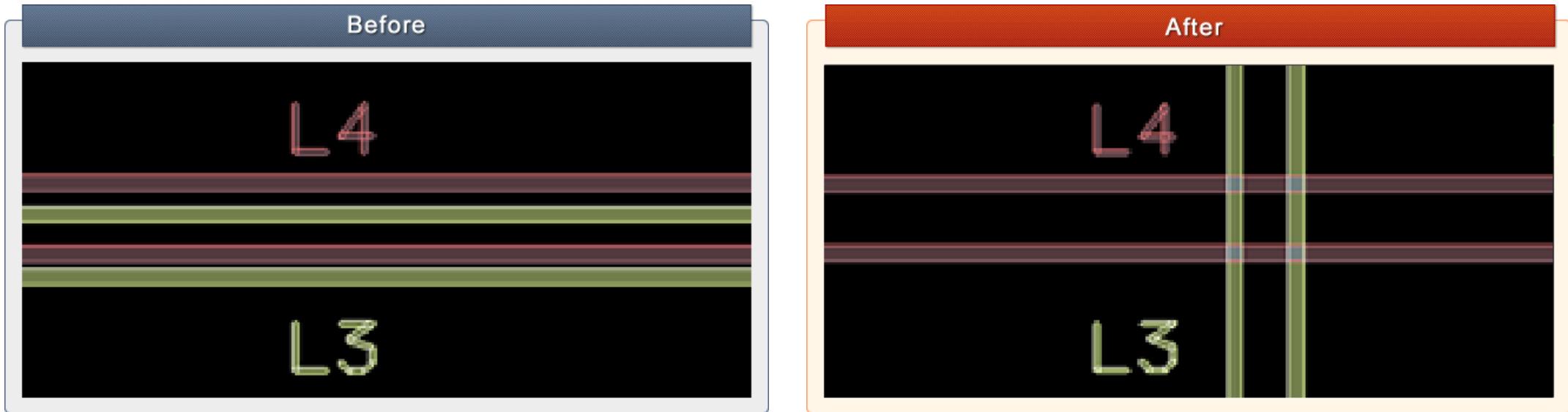
<https://www.protoexpress.com/blog/7-pcbdesign-tips-solve-emi-emc-issues/>

# 1. หลักเลี้ยงการเดินเส้นลายวงจรแบบมุ่งจาก



หากการเดินเส้นลายวงจรมีเป็นแบบมุ่งจาก สัญญาณรบกวนก็อาจเกิดขึ้นได้ เหตุผลก็คือความกว้างของเส้นส่วนที่เป็นมุ่งจากนั้นกว้างกว่าในส่วนที่เป็นเส้นตรง ดังนั้นค่าอัมพ์แวนซ์จึงเปลี่ยนไปตามความกว้างของเส้นที่ไม่เท่ากันและส่งผลให้มีแนวโน้มเกิดสัญญาณรบกวนขึ้นได้นั่นเอง

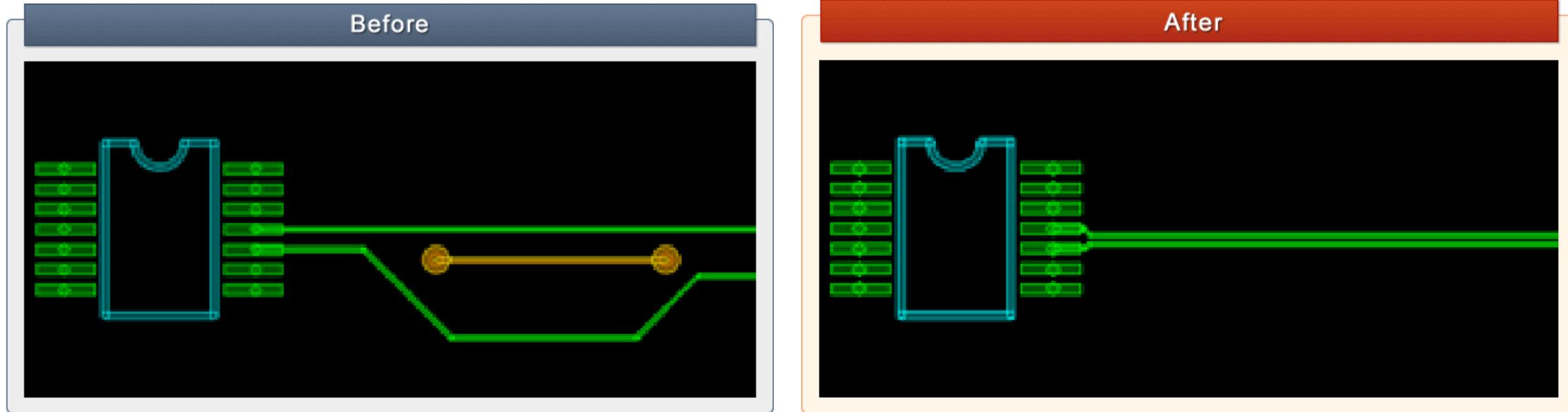
## 2. ปรับตั้งการเดินเส้นลายวงจรของเลอเยอร์ที่อยู่ติดกัน



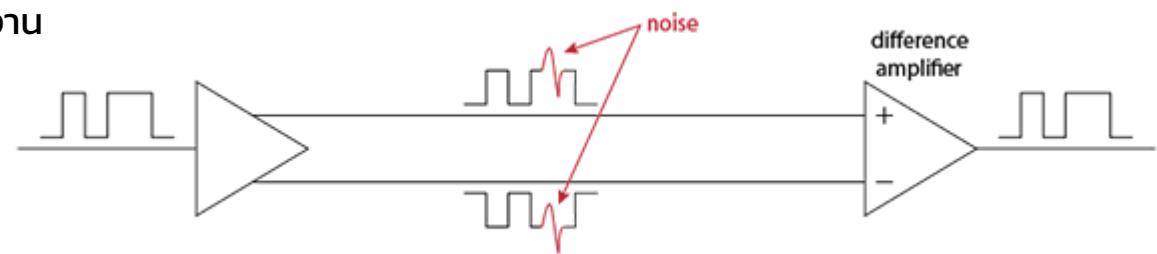
ต้องระวัง Crosstalk ระหว่างเส้นสัญญาณ ตามในรูป เส้นสัญญาณ 2 แบบที่ลากเส้นบนกันมีแนวโน้มจะเกิดการ Crosstalk กันระหว่าง Layer และมีความอ่อนไหวต่อสัญญาณรบกวนมาก

\*Crosstalk หรือ *Magnetically coupled noise* ถ้าอธิบายให้เข้าใจง่ายคือ การไหลของกระแสไฟฟ้าจากอีกเส้น จะมีผลต่อการไหลของกระแสไฟฟ้าของอีกเส้นได้ ถ้าอีกเส้นอยู่ในแนวเส้นแรงดึงดูดของสนามแม่เหล็กโดยจะมีผลกระแทกขึ้นอยู่กับระยะห่างระหว่างเส้น, ความถี่ของสัญญาณในเส้น

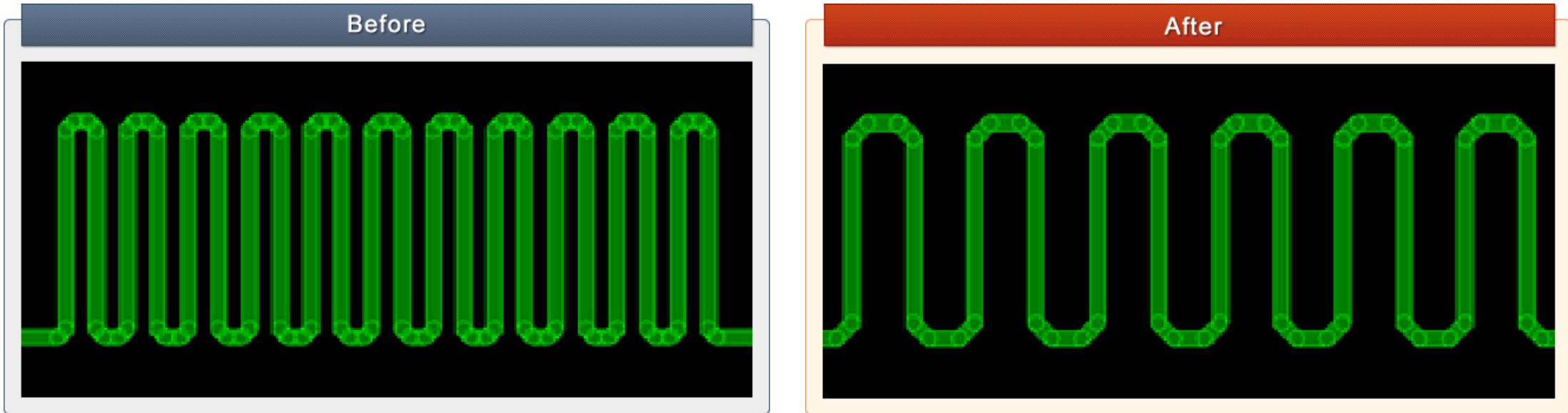
### 3. ลากเส้นสัญญาณแบบ Differential pair ให้ข้างกัน



สัญญาณ Differential pair ต้องคู่ข้างกัน เมื่อสายสัญญาณทั้งสองได้รับสัญญาณรบกวนเข้ามาจะกำให้ไม่มีผลกระทบต่อวงจร เพื่อหลีกเลี่ยงการทำงานผิดปกติอันเนื่องมาจากสัญญาณรบกวน



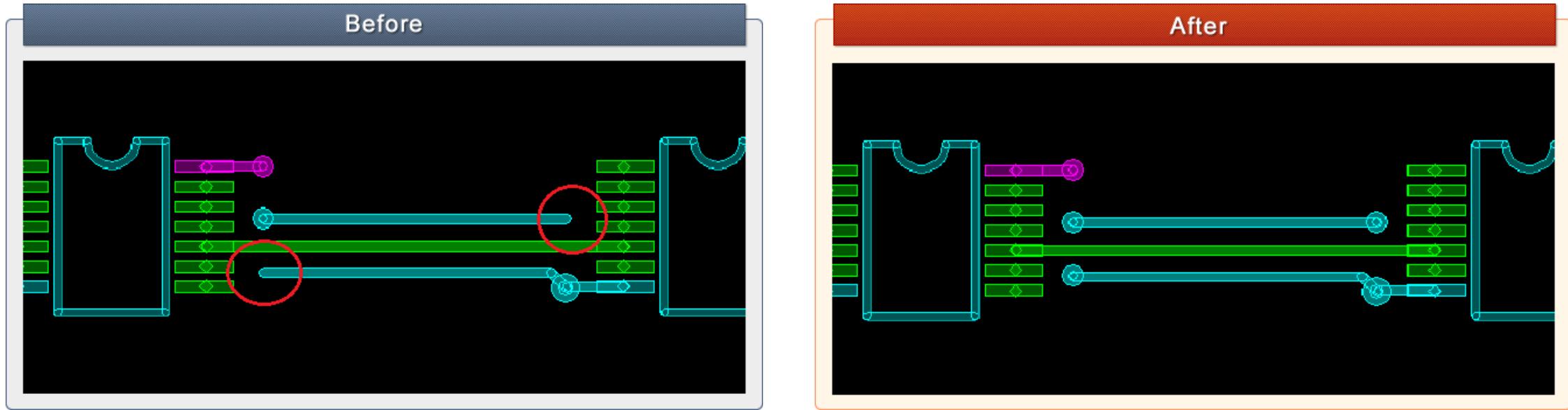
## 4. เส้นที่ทำ Length Matching มีระยะห่างที่เพียงพอ



เมื่อออคแบบบวกจะความถี่สูง สิ่งสำคัญคือต้องพิจารณาการรบกวนจากเส้นสัญญาณใกล้เคียง เพื่อให้ได้ค่าการออคแบบที่คาดหวังไว้ เมื่อมีการเดินเส้นแบบ Length Matching ถึงแม้จะมีสัญญาณรบกวนมาจากเส้นสัญญาณที่อยู่ใกล้เคียง การออคแบบที่ทำระยะห่างของเส้นโดย

ระยะห่าง = ความกว้างของเส้น  $\times 3$

## 5. ใส่ Via ที่ส่วนปลายของ GND guard



## 6. ใช่ Via ที่บริเวณส่วนกลางของ GND guard

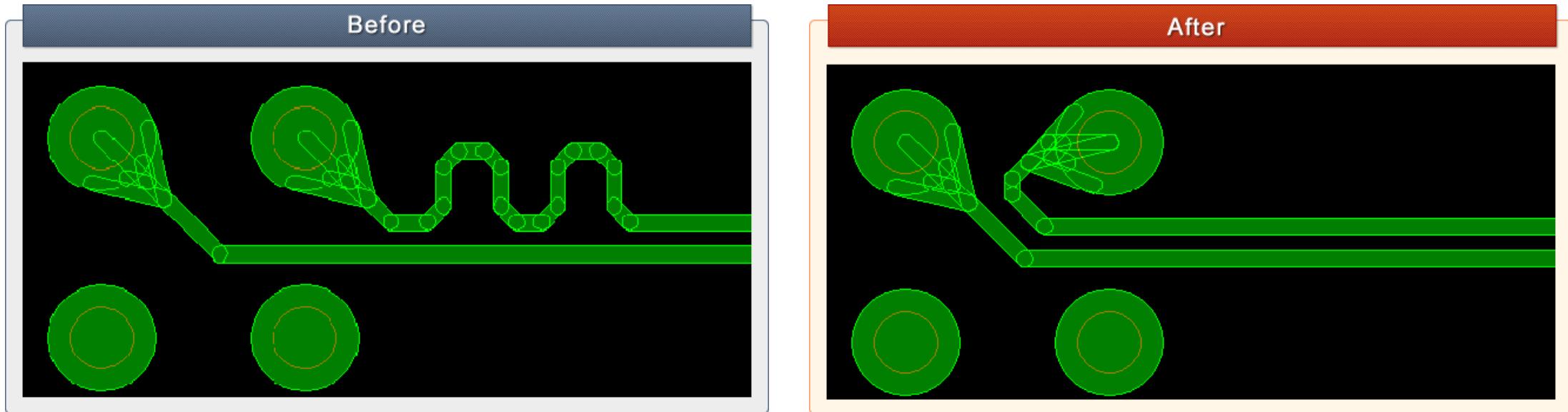


## 7. ลากเส้นให้อยู่บนเลเยอร์เดียวกันสำหรับ Return path ในกรณีไม่มี Plane ที่เลเยอร์ด้านใน



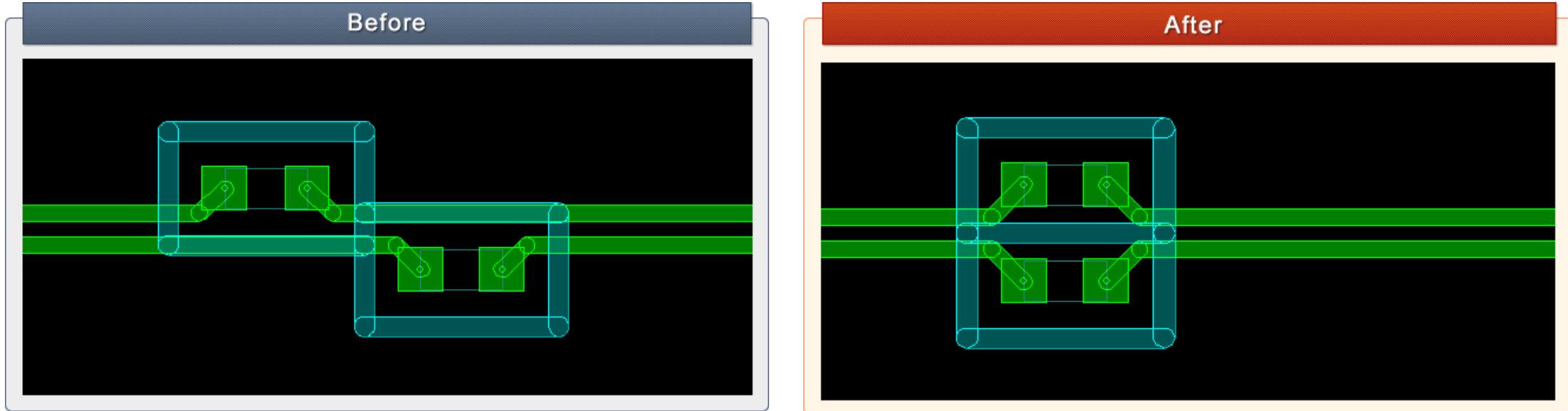
สำหรับวงจรที่ต้องการลดสัญญาณรบกวน เช่น วงจรความถี่สูง ต้องแน่ใจว่าได้ออกแบบเส้นทางกลับของสัญญาณ (Return path) ไว้ดีแล้ว ในกรณีของสัญญาณความเร็วสูง ว่ากันว่าวงจรถูกสร้างขึ้นโดยสัมพันธ์กับ GND plane ที่อยู่ด้านล่างของเส้นสัญญาณ ดังนั้นถ้าหากเส้น Return path ไม่ดี พอกการเกิด Loop area จะใหญ่และสัญญาณรบกวนจะเพิ่มขึ้น ดังนั้นควรระมัดระวังด้วย

## 8. สัญญาณ Differential pair กำลังเส้นเป็นคู่ข่านโดยให้มีความยาวเส้นเท่ากัน



สำหรับเส้นสัญญาณ Differential pair ให้ปรับความยาวเส้นโดยรักษาระยะห่างระหว่างเส้นให้ได้ใกล้เคียงกันให้มากที่สุดตลอดแนว ตามรูปด้านบน โดยคงค่าอัมพ์เดนซ์ให้คงที่ตลอดแนวเส้นคู่ ซึ่งทำให้การออกแบบแพลงวงจรพิมพ์กันต่อสัญญาณรบกวนได้

## 9. สัญญาณ Differential pair จัดเรียงอุปกรณ์แบบสมมาตร



การรับส่งข้อมูลแบบ Differential เช่น LVDS, MIPI, USB มีการใช้ที่เพิ่มขึ้นเนื่องจากเทคโนโลยีการส่งสัญญาณความเร็วสูง เมื่อออกรูปแบบแพลงวิชัน พิมพ์ จำเป็นต้องมีข้อควรระวังต่างๆ เช่น การเดินเส้นแบบขนานกัน/ความยาวเส้นเท่ากัน การควบคุมค่าอัมพ์เดนซ์ และการเดินสายบนเลเยอร์เดียวกัน

**Break;**

# **การออกแบบ PCB Layout**

# Measurement Units: Imperial vs Metric

- **Imperial** - the width in imperial units (**mil**). \*EIA Inches Code
- **Metric** - the width in metric units (**mm**). \*IEC/EN Metric Code

Favorite Interactive Routing Widths		
Imperial	Metric	System Units
Width / Units	Width mm	Units /
5 mil	0.127 mm	Imperial
6 mil	0.152 mm	Imperial
8 mil	0.203 mm	Imperial
10 mil	0.254 mm	Imperial
12 mil	0.305 mm	Imperial
20 mil	0.508 mm	Imperial
25 mil	0.635 mm	Imperial
50 mil	1.27 mm	Imperial
100 mil	2.54 mm	Imperial
3.937 mil	0.1 mm	Metric
7.874 mil	0.2 mm	Metric
11.811 mil	0.3 mm	Metric
19.685 mil	0.5 mm	Metric
29.528 mil	0.75 mm	Metric
39.37 mil	1 mm	Metric

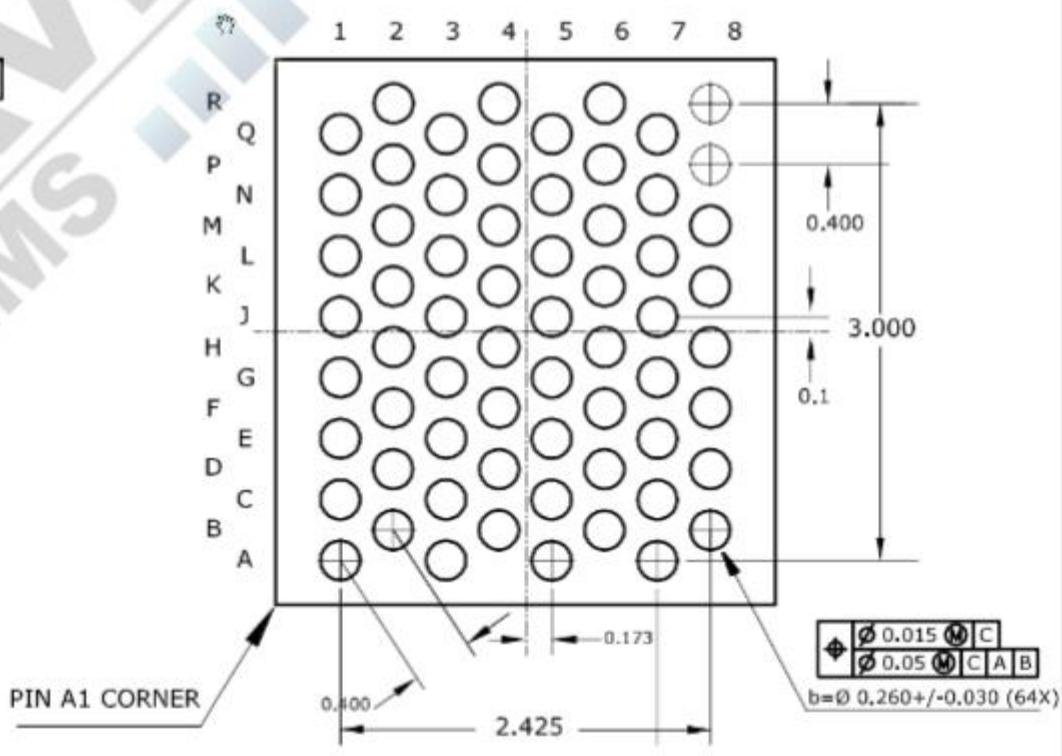
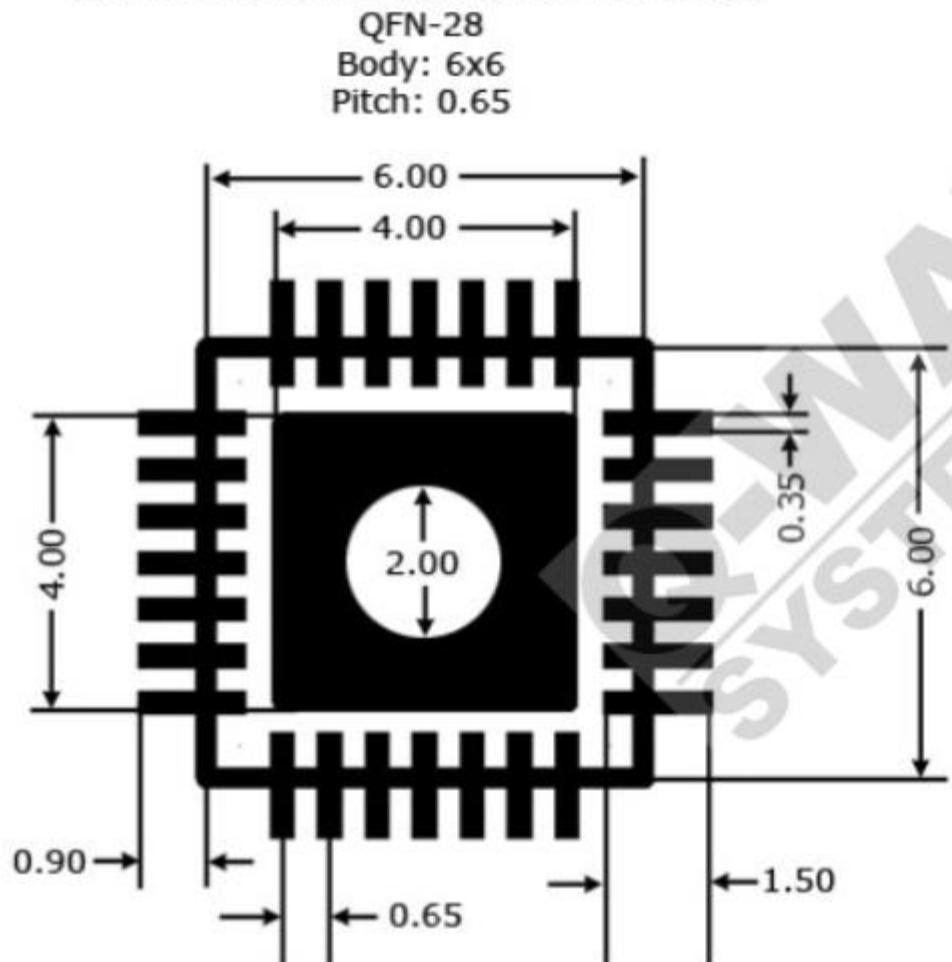
**Add...** **Delete...** **Edit...** **OK** **Cancel**

BOARD THICKNESS		COPPER THICKNESS			HOLE TYPE DESCRIPTION	HOLE SIZE TOLERANCES	
INCH	METRIC	OUNCE	INCH	METRIC		INCH	METRIC
0.020"	0.50 mm	1/4 OZ.	0.00035"	9um	Via < 0.35mm	+0 ~ Hole Size	+0 ~ Hole Size
0.031"	0.80 mm	1/2 OZ.	0.0007"	18um	Via > 0.35mm	±0.003"	±0.08 mm
0.040"	1.00 mm	1 OZ.	0.0014"	35um	Plated Hole	±0.003"	±0.08 mm
0.062"	1.60 mm	1 1/2 OZ.	0.0021"	53um	Non-plated Hole	±0.002"	±0.05 mm
0.070"	1.80 mm	2 OZ.	0.0028"	70um	Slotted Hole	±0.005"	±0.13 mm
0.093"	2.30 mm	3 OZ.	0.0042"	105um	NPT Tooling Hole	±0.001"	±0.03 mm

Measurement	Metric Units	Imperial Units
long length	meter/metre	mile, yard
short length	centimeter/centimetre	foot, inch
mass/weight	gram	ounce, pound
volume (liquid)	liter/litre	gallon, pint, quart
volume (dry)	liter/litre	bushel, peck, pint,

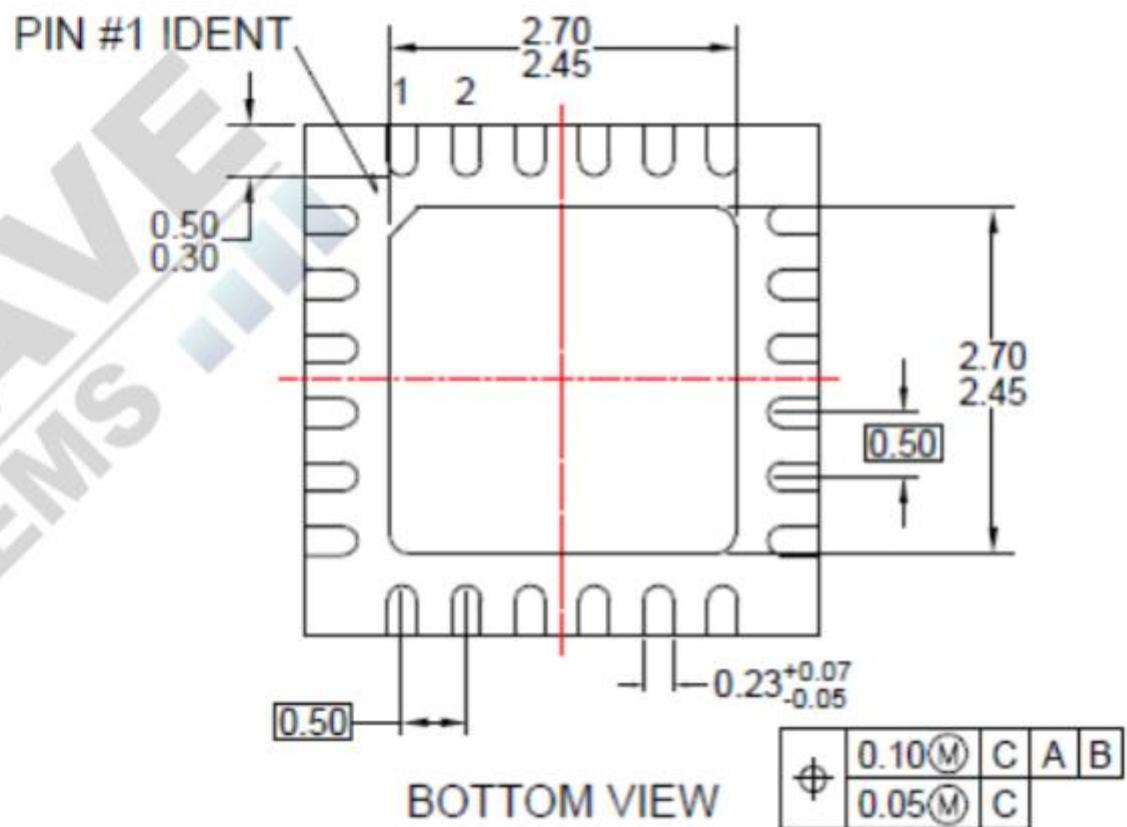
# QFN and BGA footprint using mm

All dimensions are in millimeters



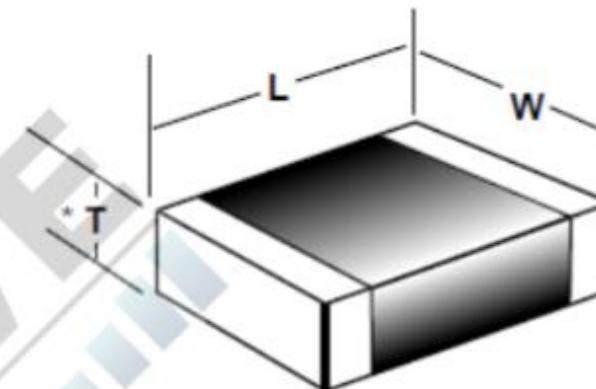
# Use “Metric” (mm) for PCB layout

- $0.65\text{mm} \neq 25 \text{ mil (25.59 mil)}$
- $0.5\text{mm} \neq 20 \text{ mil (19.68 mil)}$
- $0.4\text{mm} \neq 15 \text{ mil (15.74 mil)}$
- $0.3\text{mm} \neq 12 \text{ mil (11.81 mil)}$
- $0.2\text{mm} \neq 8 \text{ mil (7.87 mil)}$
- $0.1\text{mm} \neq 4 \text{ mil (3.93 mil)}$



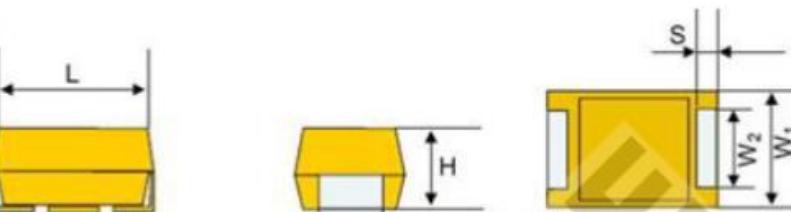
# MLCC Resistor/Capacitor: Imperial code

comparison	Metric code	Imperial code	comparison
0.1x0.1 mm	0402	01005	0.01x0.01 in (10x10 mils)
	0603	0201	
	1005	0402	
	1608	0603	
1x1mm	2012	0805	0.1x0.1 in (100x100 mils)
	2520	1008	
	3216	1206	
	3225	1210	
	4516	1806	
	4532	1812	
	5025	2010	
1x1 cm	6332	2512	0.5x0.5in (500x500 mils)
		Actual size	



# Tantalum Capacitor : Metric code (EIA)

Outline Drawings



Dimensions-Millimeters

Case Size	EIA Size	$L \pm 0.2$	$W_1 \pm 0.2$	$H \pm 0.2$	$S \pm 0.2$	$W_2 \pm 0.1$
S		$2.0 \pm 0.2$	$1.20 \pm 0.2$	$1.20 \pm 0.2$	$0.5 \pm 0.3$	$1.2 \pm 0.1$
A	3216	$3.2 \pm 0.2$	$1.6 \pm 0.2$	$1.6 \pm 0.2$	$0.8 \pm 0.3$	$1.2 \pm 0.1$
B	3528	$3.5 \pm 0.2$	$2.8 \pm 0.2$	$1.9 \pm 0.2$	$0.8 \pm 0.3$	$2.2 \pm 0.1$
C	6032	$6.0 \pm 0.3$	$3.2 \pm 0.3$	$2.5 \pm 0.3$	$1.3 \pm 0.3$	$2.2 \pm 0.1$
D	7343	$7.3 \pm 0.3$	$4.3 \pm 0.3$	$2.8 \pm 0.3$	$1.3 \pm 0.3$	$2.4 \pm 0.1$
E		$7.3 \pm 0.3$	$4.3 \pm 0.3$	$4.0 \pm 0.3$	$1.3 \pm 0.3$	$2.4 \pm 0.1$

Table 1

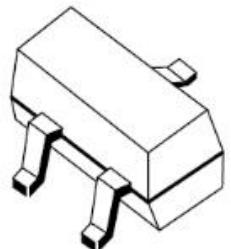
EIA/IECQ Size Code	Metric Code	Metric Footprint
A	3216	3.2 X 1.6mm
B	3528	3.5 x 2.8mm
C	6032	6.0 x 3.2mm
D	7343	7.3 x 4.3mm

MLCC Case Size			Tantalum Case Sizes		
Metric	EIA	Thickness [mm] max	Metric	Thickness [mm] max	Letter Code*
1608	[0603]	0.85	1608-09	0.9	J, L or M
2012	[0805]	1.1	2012-12	1.2	R or P
			2012-10	1.0	S,M,N
			2012-15	1.5	R or P
3216	[1206]	1.35	3216-18	1.8	A
			3216-10	1.0	K
			3216-12	1.2	S, A
			3216-15	1.5	G
3225	[1210]	1.35	3225-21	2.1	B
			3225-10	1.0	L
			3225-12	1.2	T, B
			3225-15	1.5	H

Q-WAVE  
SYSTEMS

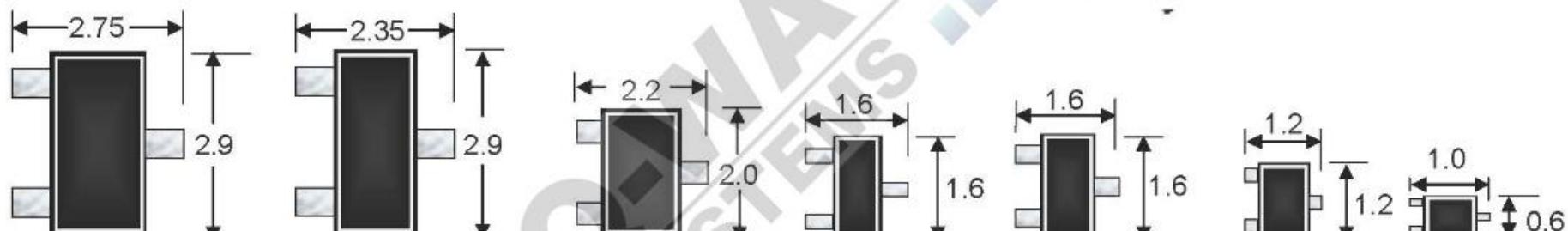
Q-Wav

# SOT: Diodes and Transistor



**SOT 23  
Most Popular**

surface mount diodes	
DO-214AA (SMB)	DO-214AB (SMC)
DO-214AC (SMA)	Melf (MMB)
MicroMelf (MMU)	MiniMelf (MMA)
SOD-80	SOD-123
SOD-128	SOD-323
SOD-523	SOD-723
SOD-882	SOD-962
SOD-1608	



**SC-59**  
(SOT-346)  
(SMT3)  
(S-Mini)  
(MPAK)  
(Mini 3)

**SOT-23**  
(SOT-23)  
(SST3)  
(Micro3)

**SC-70**  
(SOT-323)  
(UMT3)  
(S-Mini3)  
(CMPAK)  
(USM)

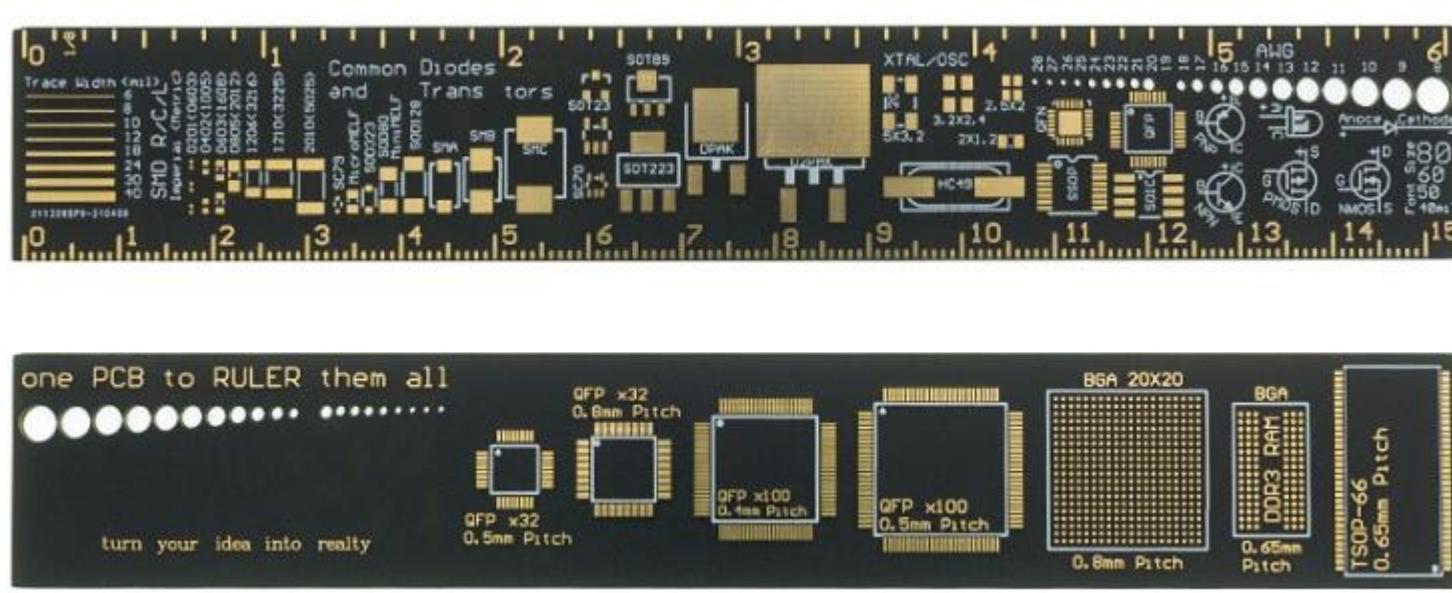
**SC-75**  
(SOT-416)  
(SOT-523)  
(EMT3)  
(SS-Mini3)  
(SMPAK)  
(SSM)

**SC-89**  
(SOT-490)  
(SOT-523)  
(EMT3FL)  
(SS-Mini3)  
(ESM)

**SOT-723**  
(VMT3)  
(SSS-Mini3)  
(VSM)  
(TSFP-3)

**SOT-1123**

# ไม้บรรทัดสำหรับช่วยออกแบบ PCB

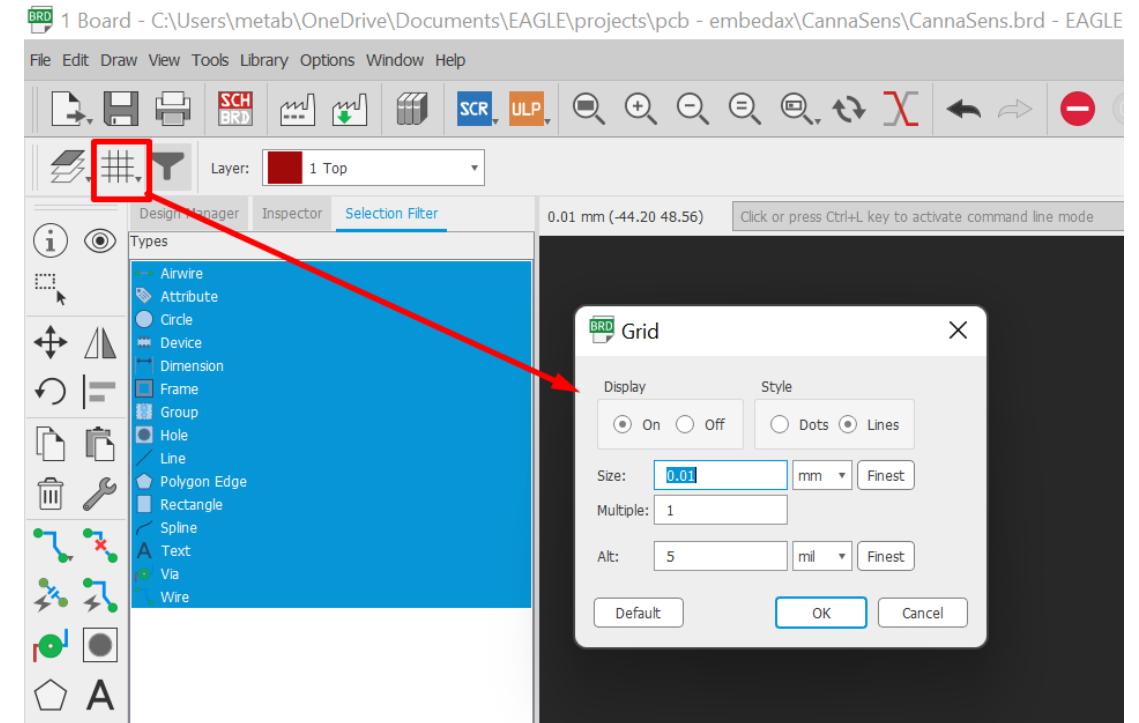
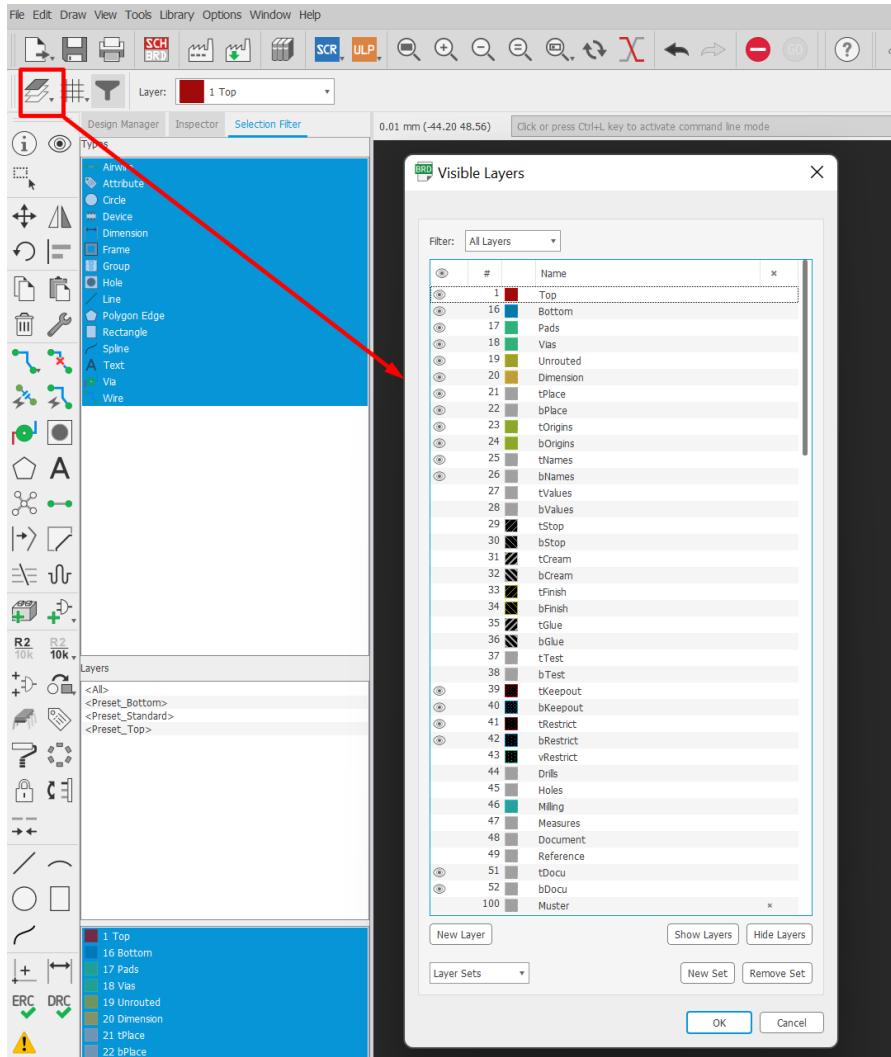


<https://www.allnewstep.com/>

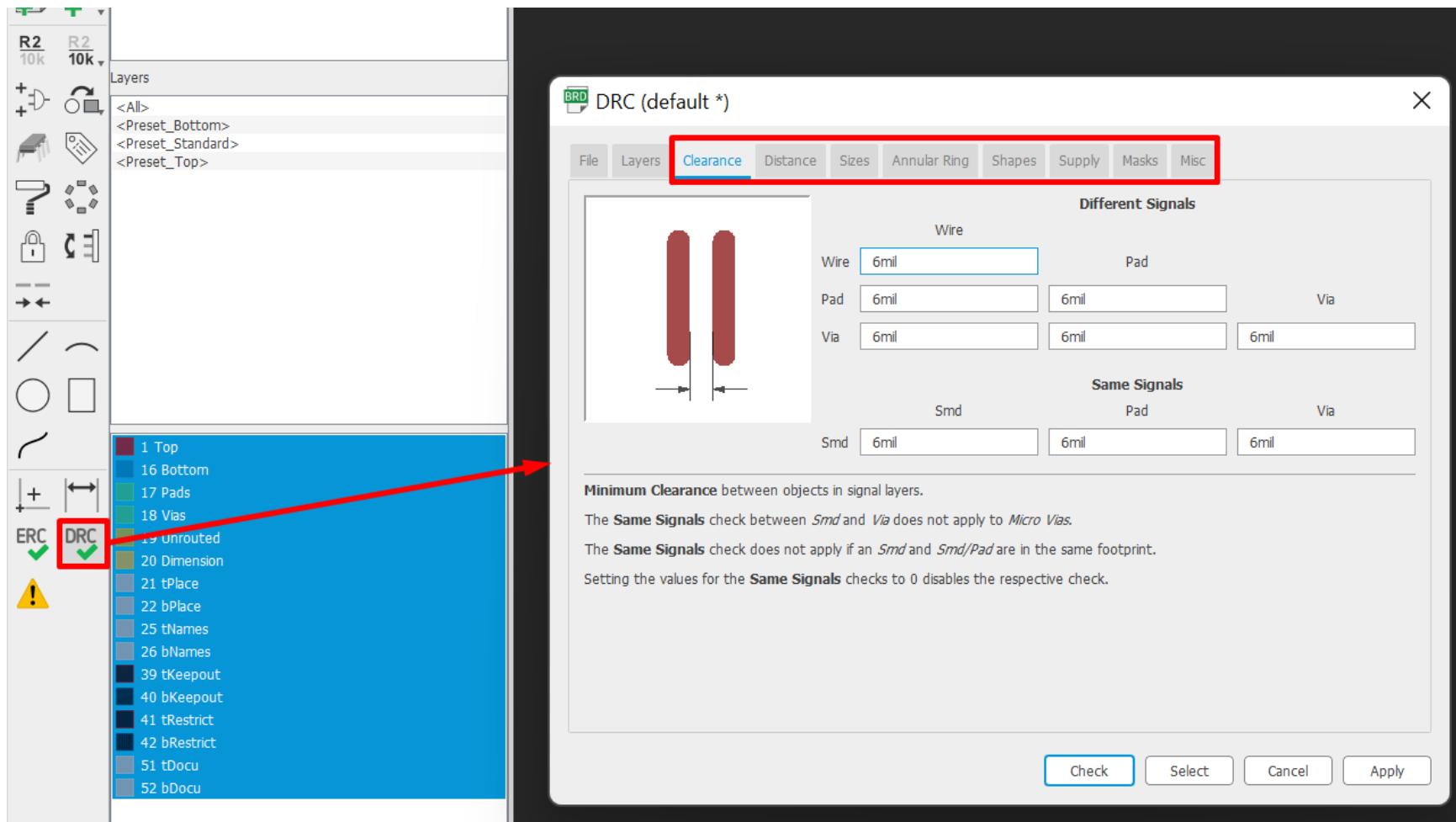
<https://www.cybertice.com/>

<https://shopee.co.th/INEX>

# Layer, Unit, Grid



# Design Rule



# JLCPCB Capability

<https://jlpcb.com/capabilities/Capabilities>



Minimum Annular Ring			
	Minimum annular ring	PTH	Patterns
1oz Copper	0.13mm	0.3mm	
2oz Copper	0.2mm	0.3mm	

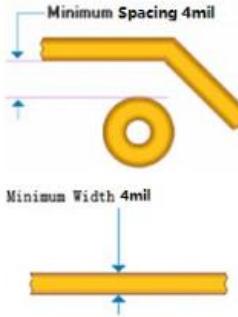
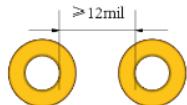
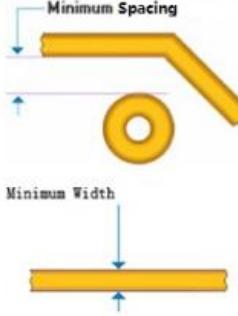
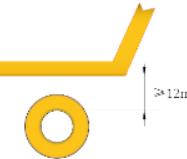
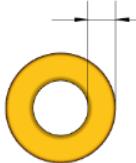
Minimum clearance			
Features	Capability	Patterns	
Hole to hole clearance(Different nets)	0.5mm		
Via to Via clearance(Same nets)	0.254mm		
Pad to Pad clearance(Pad without hole, Different nets)	0.127mm		

## Minimum trace width and spacing

	Min. Trace width	Min. Spacing	Patterns
1-2 Layers	5mil (0.127mm)	5mil (0.127mm)	
4-6 Layers	3.5mil (0.09mm)	3.5mil (0.09mm)	
2oz Copper weight	8mil (0.2mm)	8mil (0.2mm)	

# Seeed studio Specification

<http://support.seeedstudio.com/knowledgebase/articles/447362-fusion-pcb-specification>

<b>Minimum trace spacing / width</b>  <p>[Spacing/Width] mil For 1 oz: 4/4 mil, 5/5 mil, 6/6 mil For 2 oz: 10/10 mil For 3 oz: 15/15 mil *Minimum trace/width spacing for RF coil designs is 6/6 mil, but please select the 4/4 mil option.</p>	<b>Minimum distance between plated holes (To prevent ion migration)</b>  <p>Vias: 0.3mm (12 mil) Plated through-holes: 0.45mm (18 mil)</p>
<b>Minimum trace width in inner layers (for 4 layers board)</b>  <p>0.15mm (6 mil)</p>	<b>Minimum distance between plated holes and traces (To prevent ion migration)</b>  <p>≥ 12 mil</p>
	<b>Annular Rings</b>  <p>≥ 0.1 mm (4 mil) for vias ≥ 0.152 mm (6 mil) for PTH</p>

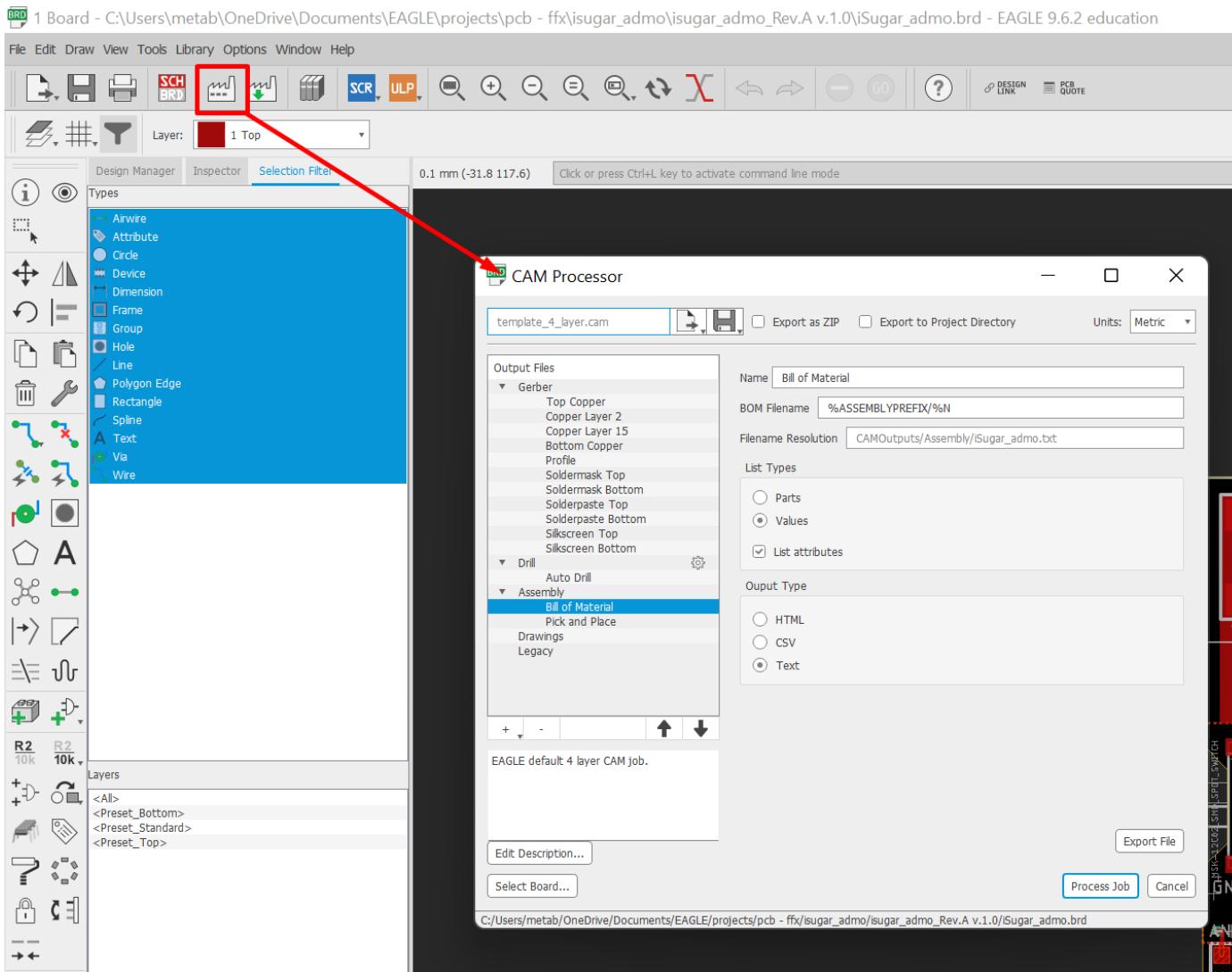
# PCBWay Capability

<https://www.pcbway.com/capabilities.html>

Min Trace		0.1mm/4mil	Min manufacturable trace is 4mil(0.1mm), strongly suggest to design trace above 6mil(0.15mm) to save cost.
Min Spacing			Min manufacturable spacing is 4mil(0.1mm), strongly suggest to design spacing above 6mil(0.15mm) to save cost.
Outer Layer Copper Thickness		1oz/2oz/3oz(35μm/70μm/105μm)	Also known as copper weight. 35μm=1oz, 70μm=2oz, 105μm=3oz. Please view the below "Standard PCB" or contact us if you need copper weight greater than 3oz.
Inner Layer Copper Thickness		1oz/1.5oz(35μm/50μm)	Inner copper weight as per customer's request for 4 and 6 layers( <a href="#">Multi-layer laminated structure</a> ). Please contact us if you need copper weight greater than 1.5oz.
Drill Sizes (CNC)		0.2-6.3mm	Min drill size is 0.2mm, max drill is 6.3mm. Any holes greater than 6.3mm or smaller than 0.3mm will be subject to extra charges.

# **การสร้างไฟล์Output เพื่อสั่งทำ PCB (Gerber, BOM, Pick and Place)**

# CAM Processor



# การนำเข้า CAM job กรณีที่เราจะสั่งจาก JLCPCB.COM

1. Download cam, design rules, ulps : <https://github.com/JLCPCB/jlcpcb-eagle>

JLCPCB modify README		
cam	add CAM for 6-layer for Eagle V6	2 years ago
design rules	Initial import of 2-layers CAM job, DR set and a basic SMTA BOM/CPL e...	3 years ago
ulps	modify README	14 months ago
LICENSE	Initial commit	3 years ago
README.md	modify README	14 months ago

> This PC > Documents > EAGLE > cam		
Name	Date modified	
2-Layer-JLC.cam	1/9/2563 11:26	
4 layer_gbr.cam	18/12/2562 15:12	
DESCRIPTION	27/7/2564 14:21	
jlcpbc_2_layer_v6.cam	18/6/2564 15:24	
jlcpbc_2_layer_v9.cam	24/9/2564 15:07	
jlcpbc_2_layer_v72.cam	18/6/2564 15:24	
jlcpbc_4_layer_v6.cam	18/6/2564 15:24	
jlcpbc_4_layer_v9.cam	21/2/2565 12:16	
jlcpbc_4_layer_v72.cam	18/6/2564 15:24	
jlcpbc_6_layer_v6.cam	18/6/2564 15:24	
jlcpbc_6_layer_v9.cam	18/6/2564 15:24	
jlcpbc_6_layer_v72.cam	18/6/2564 15:24	

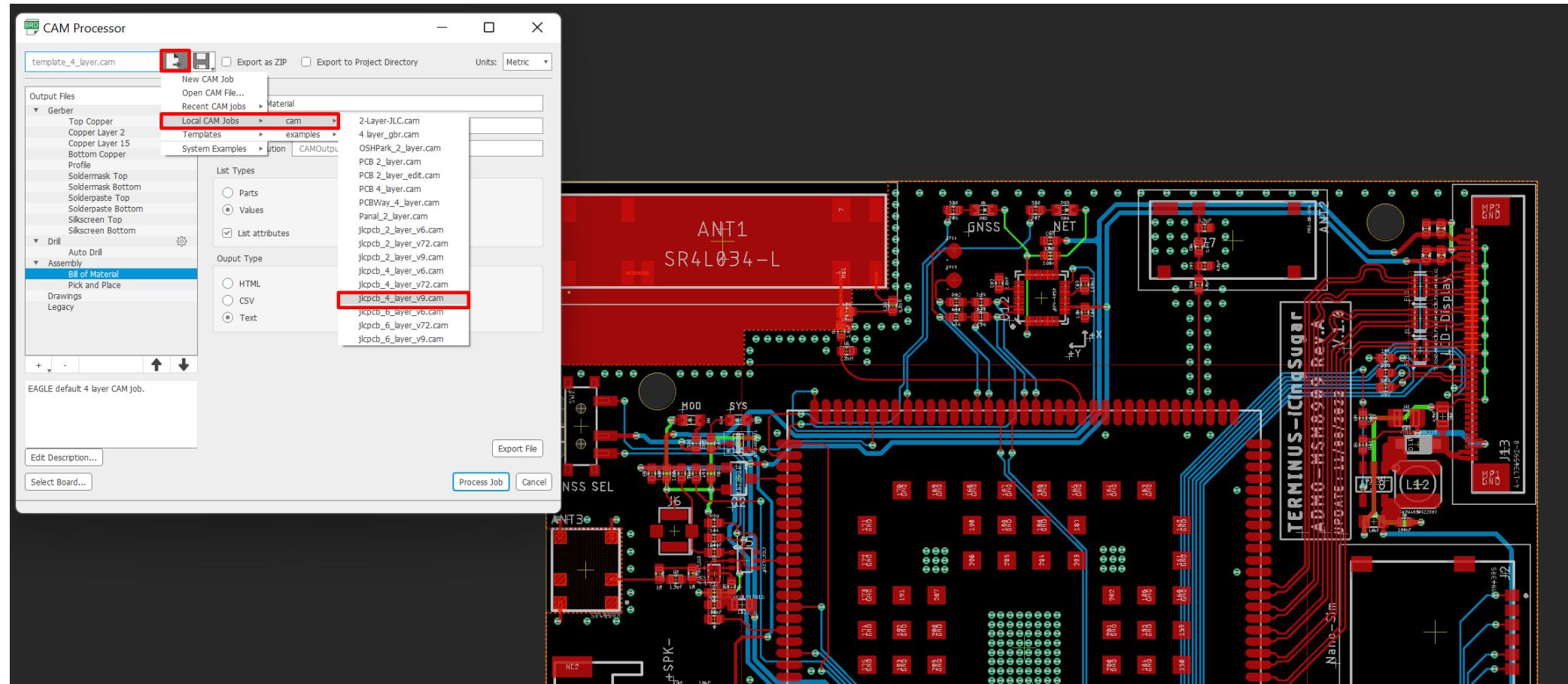
2. ให้นำไฟล์ที่ดาวน์โหลดมาไปวางไว้ในโฟลเดอร์ของ EAGLE

cam → \Documents\EAGLE\cam  
ulps → \Documents\EAGLE\ulps

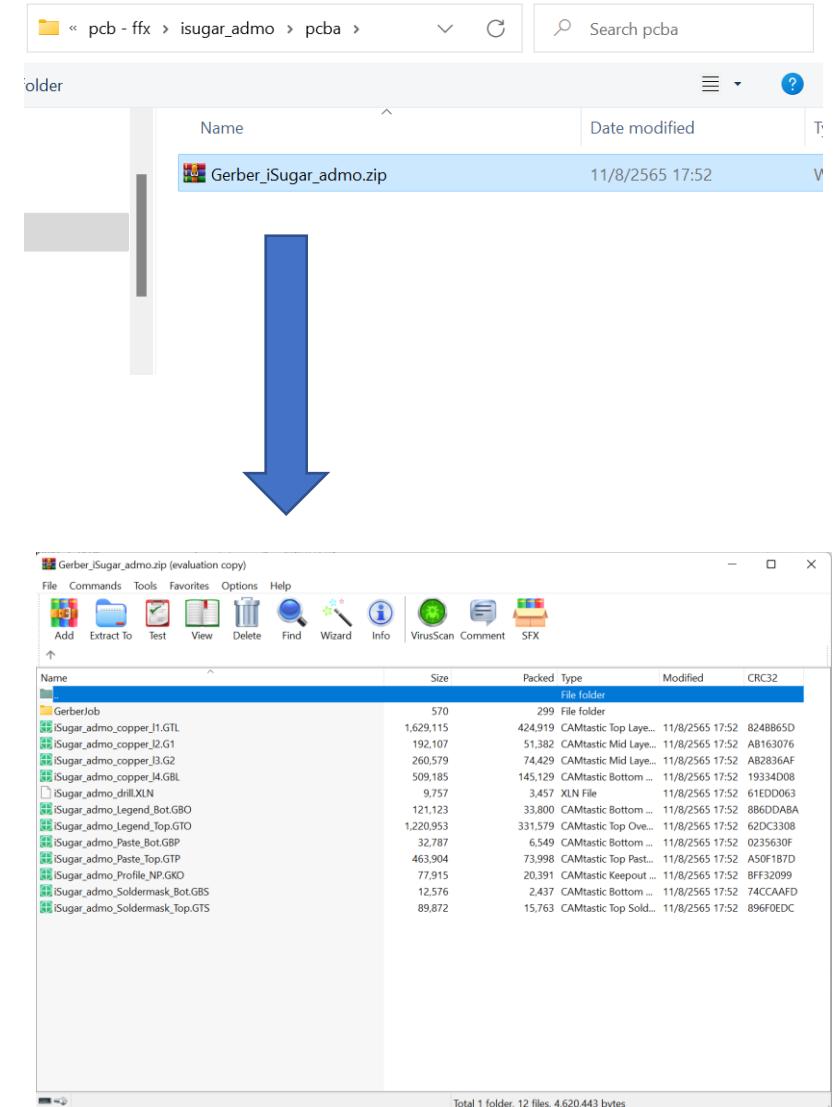
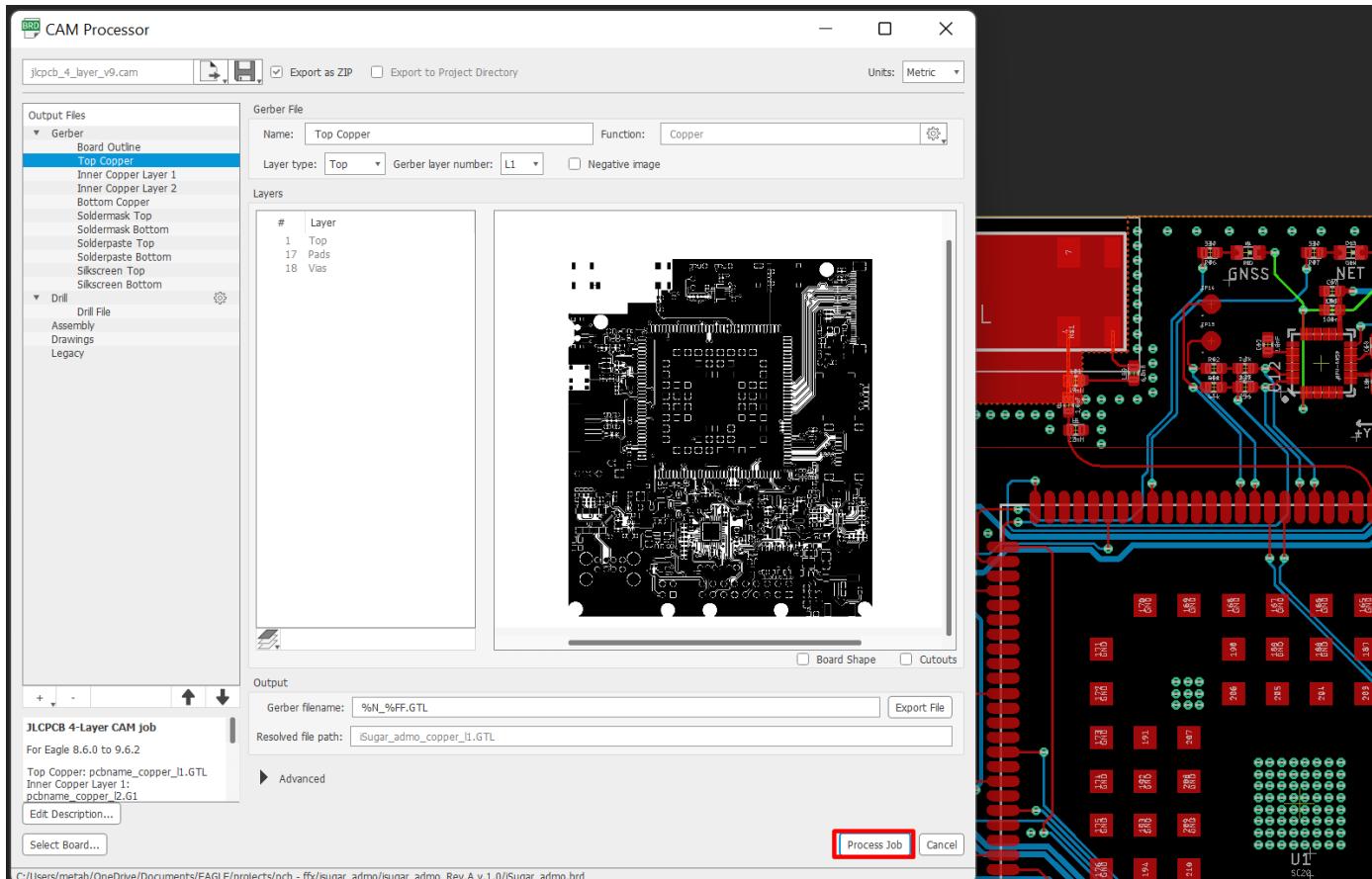
> This PC > Documents > EAGLE > ulps		
Name	^	
DESCRIPTION		
JLC PCB_SMTA_Exporter.ulp		
jlcpbc_smta_exporter.ulp		

# การ Export CAM file

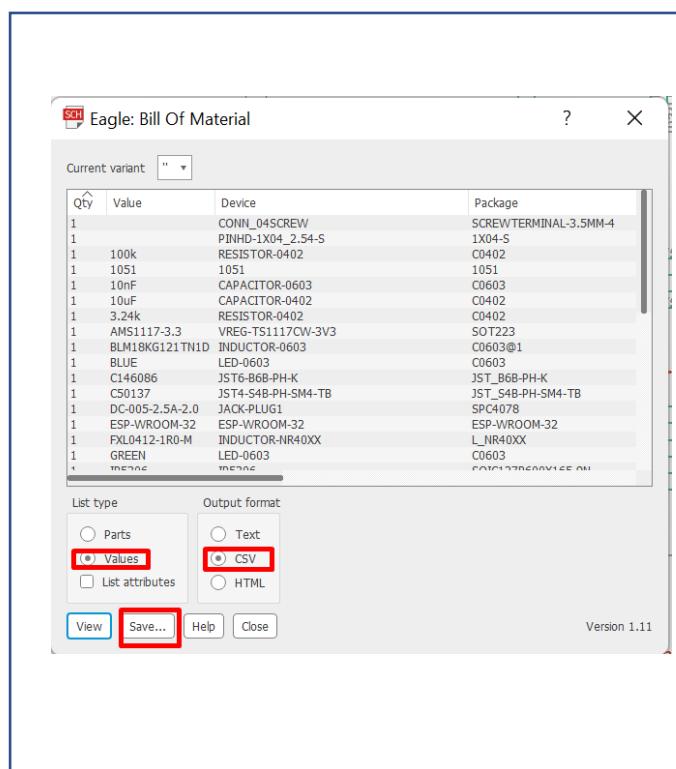
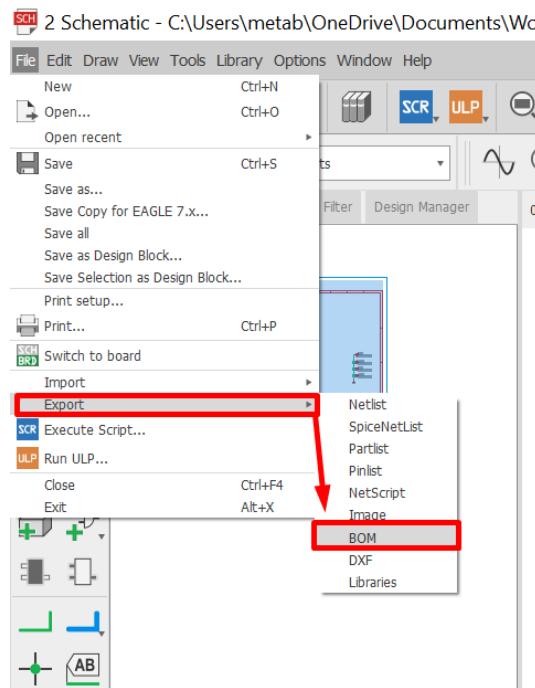
\*\*\* ตัวอย่างเป็น PCB 4 layer



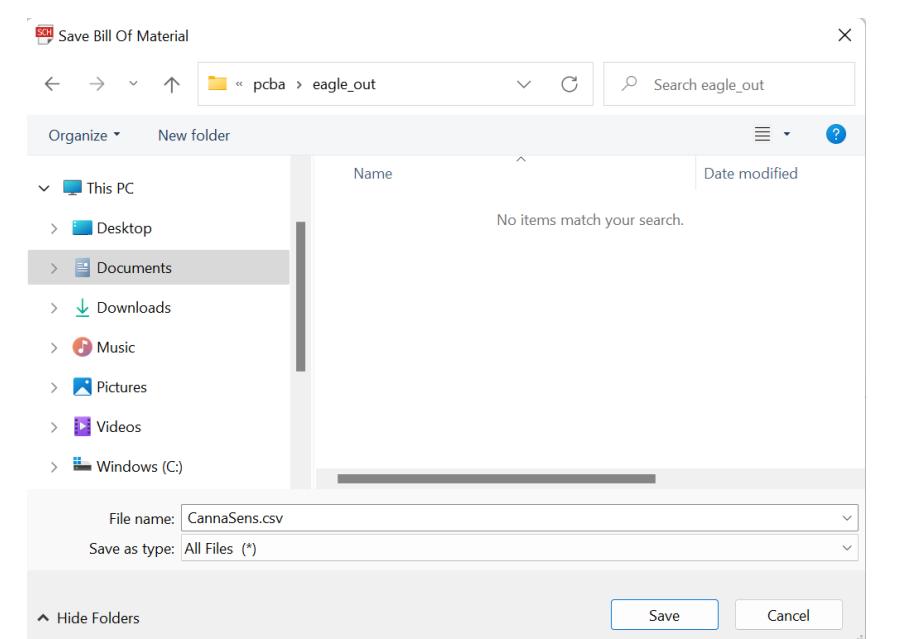
# הספה Export CAM file



# การ Export BOM



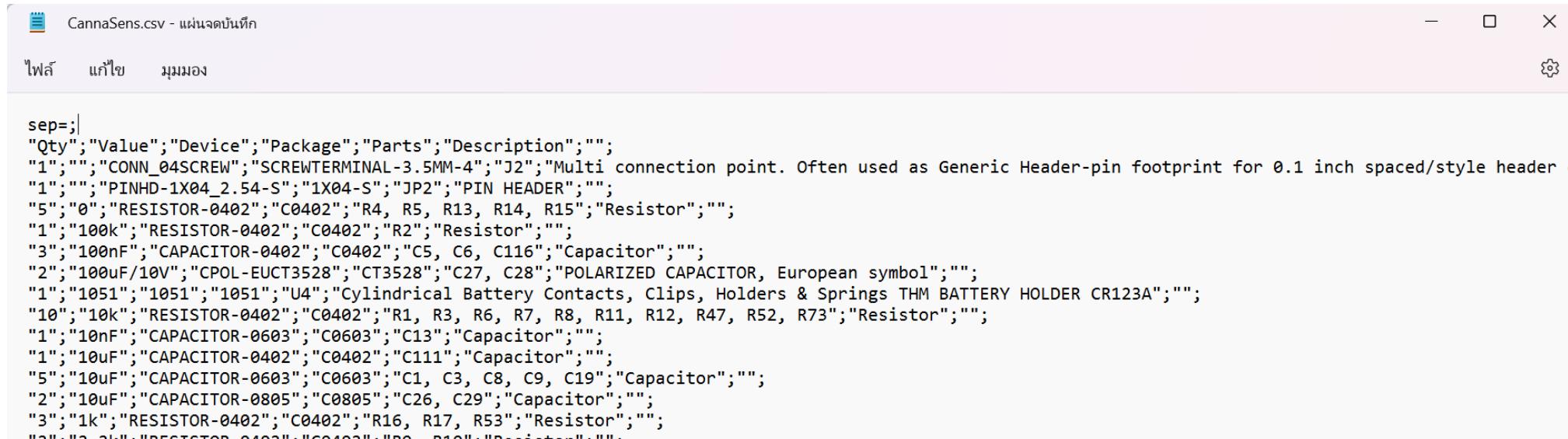
เลือก CSV แล้ว Save



# การ Export BOM

sep=;

- เปิดไฟล์ csv ด้วย Text Editer ตัวใดก็ได้ (**Notepad, WordPad, etc.**)
- พิมพ์ **sep=;** ในบรรทัดแรกแล้ว Save



The screenshot shows a Windows Notepad window titled "CannaSens.csv - แผ่นดูบันทึก". The content of the file is as follows:

```
sep=;
"Qty";"Value";"Device";"Package";"Parts";"Description";
"1";"";"CONN_04SCREW";"SCREETERMINAL-3.5MM-4";"J2";"Multi connection point. Often used as Generic Header-pin footprint for 0.1 inch spaced/style header components";
"1";"";"PINHD-1X04_2.54-S";"1X04-S";"JP2";"PIN HEADER";
"5";"0";"RESISTOR-0402";"C0402";"R4, R5, R13, R14, R15";"Resistor";
"1";"100k";"RESISTOR-0402";"C0402";"R2";"Resistor";
"3";"100nF";"CAPACITOR-0402";"C0402";"C5, C6, C116";"Capacitor";
"2";"100uF/10V";"CPOL-EUCT3528";"CT3528";"C27, C28";"POLARIZED CAPACITOR, European symbol";
"1";"1051";"1051";"U4";"Cylindrical Battery Contacts, Clips, Holders & Springs THM BATTERY HOLDER CR123A";
"10";"10k";"RESISTOR-0402";"C0402";"R1, R3, R6, R7, R8, R11, R12, R47, R52, R73";"Resistor";
"1";"10nF";"CAPACITOR-0603";"C0603";"C13";"Capacitor";
"1";"10uF";"CAPACITOR-0402";"C0402";"C111";"Capacitor";
"5";"10uF";"CAPACITOR-0603";"C0603";"C1, C3, C8, C9, C19";"Capacitor";
"2";"10uF";"CAPACITOR-0805";"C0805";"C26, C29";"Capacitor";
"3";"1k";"RESISTOR-0402";"C0402";"R16, R17, R53";"Resistor";
"2";"100uF";"RESISTOR-0402";"C0402";"R10, R12";"Resistor";"
```

# เปิด csv ด้วย Excel

# Bom template

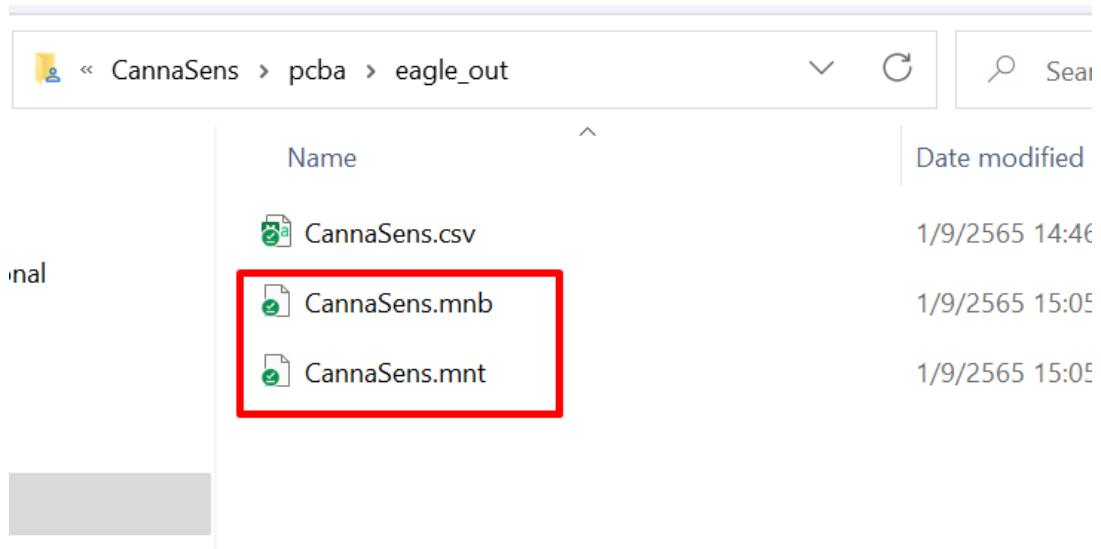
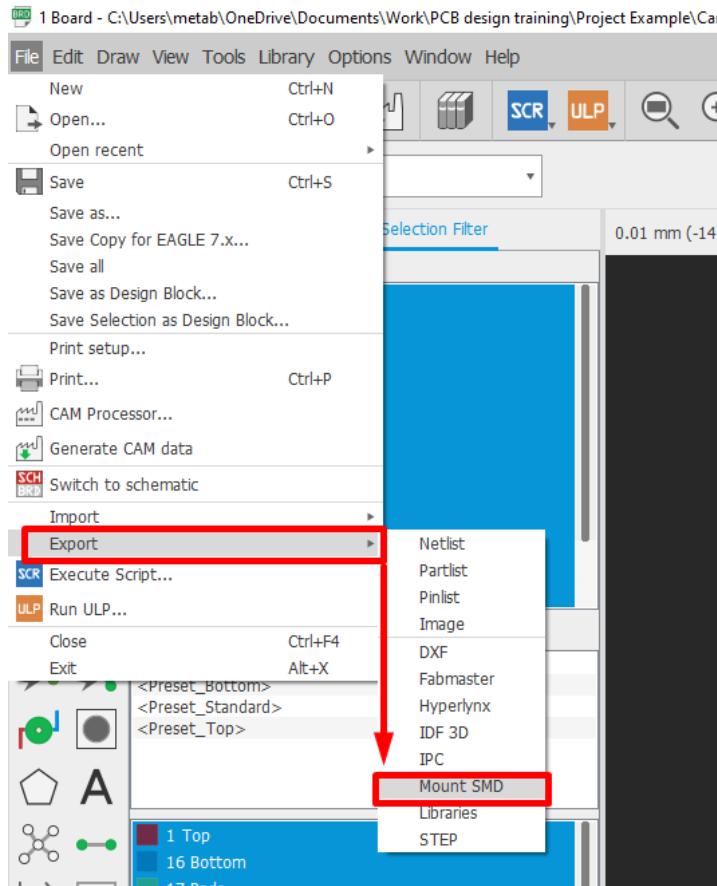
- **JLCPCB** <https://support.jlcpcb.com/article/80-bill-of-materialsbom-file-for-smt-assembly>
- **Seeed studio** <http://support.seeedstudio.com/knowledgebase/articles/1886734-how-do-i-prepare-the-bill-of-materials-bom-file>
- **Allpcb** <https://www.allpcb.com/components/bill-of-materials.html>
- **PCBWay** <https://www.pcbway.com/assembly-file-requirements.html>

PCB design training > Bom template		
Name	Date modified	Type
ALLPCB_BOM_template.xlsx	1/9/2565 14:53	Microsoft Excel
Sample_BOM_PCBWay.xlsx	1/9/2565 14:58	Microsoft Excel
Sample-BOM_JLCsmt.xlsx	1/9/2565 14:49	Microsoft Excel
Sample-BOM_SeedStudio.xlsx	1/9/2565 14:53	Microsoft Excel

N22	A	B	C	D
	Comment	Designator	Footprint	JLCPCB Part # (optional)
1	100uF	C1	CAP-SMD_L3.5-W2.8	C16133
2	15K	R5,R6	R0603	C22809
3	DC-005-20A_C136744	DC1	DC-IN-TH_DC-005-20A	C136744
4	Header-Female-2.54_1x8	P2,P3	HDR-TH_8P-P2.54-V	C27438
5	K2-1102DP-C4SW-04	SW1	KEY-TH_4P-L6.0-W6.0-P4.50-LS6.5	C110153
6	ATMEGA328P-PU	U1	DIP-28_L34.6-W7.3-P2.54-LS10.2-BL	C33901
7	670688000	USB1	USB-B-TH_67068-8000	C114097
8				

JLCPCB BOM Template

# การ Export Pick and Place



.mnb คือไฟล์ moute ด้าน Bottom  
.mnt คือไฟล์ moute ด้าน Top

# แปลง .mnt, .mnb เป็น excel

การบันทึกต่อไปนี้

ไฟล์ หน้าแรก แทรค เจ้าของหน้ากระดาษ ผู้ดูแล อื่นๆ ชื่อเอกสาร CannaSens.mnt

ค้นหา (Alt+Q)

เมธ้า บุญมา Foxit PDF

ชื่อเอกสาร

รีวิว မุมมอง รักใช่ Foxit PDF

ชื่อคิดเห็น ดู แยก

ไฟล์ หน้าแรก แทรค เจ้าของหน้ากระดาษ ผู้ดูแล อื่นๆ ชื่อเอกสาร CannaSens.mnt

ค้นหา (Alt+Q)

เมธ้า บุญมา Foxit PDF

ชื่อเอกสาร

รีวิว မุมมอง รักใช่ Foxit PDF

ชื่อคิดเห็น ดู แยก

A1 C1 23.44 33.41 0 10uF C0603

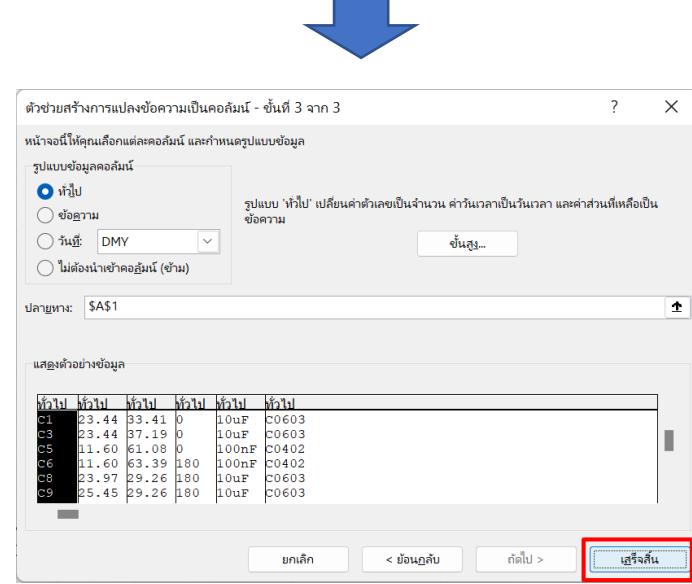
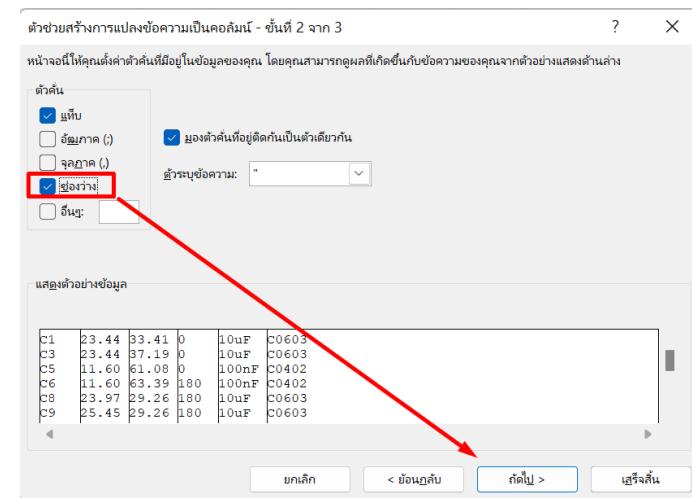
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	C1	23.44	33.41	0	10uF	C0603								
2	C3	23.44	37.19	0	10uF	C0603								
3	C5	11.60	61.08	0	100nF	C0402								
4	C6	11.60	63.39	180	100nF	C0402								
5	C8	23.97	29.26	180	10uF	C0603								
6	C9	25.45	29.26	180	10uF	C0603								
7	C13	8.19	27.88	0	10nF	C0603								
8	C19	13.09	31.82	180	10uF	C0603								
9	C26	5.73	17.21	90	10uF	C0805								
10	C27	11.02	23.72	270	100uF/10V	CT3528								
11	C28	6.28	31.78	180	100uF/10V	CT3528								
12	C29	5.73	15.20	90	10uF	C0805								
13	C111	12.33	66.79	180	10uF	C0402								
14	C116	13.65	66.79	180	100nF	C0402								
15	D1	5.23	11.02	0	SS34 SMA_D0214AC									
16	D2	11.02	17.98	180	SS34 SMA_D0214AC									
17	D3	4.00	45.00	90	GREEN	C0603								
18	D4	4.00	43.00	90	RED	C0603								
19	D9	42.00	59.50	180	BLUE	C0603								
20	IC1	18.70	30.70	0	IP5306 SOIC127P600X165-9N									
21	IC2	6.22	22.21	270	TPS5430DDAG4 SOIC127P600X170									
22	IC3	29.17	36.37	0	AMS1117-3.3 SOT223									
23	J1	27.00	5.75	90	C50137 JST_S4B-PH-SM4-TB									
24	L1	29.20	29.93	0	FXL0412-1R0-M L_NR40XX									

ชื่อเอกสาร: CannaSens

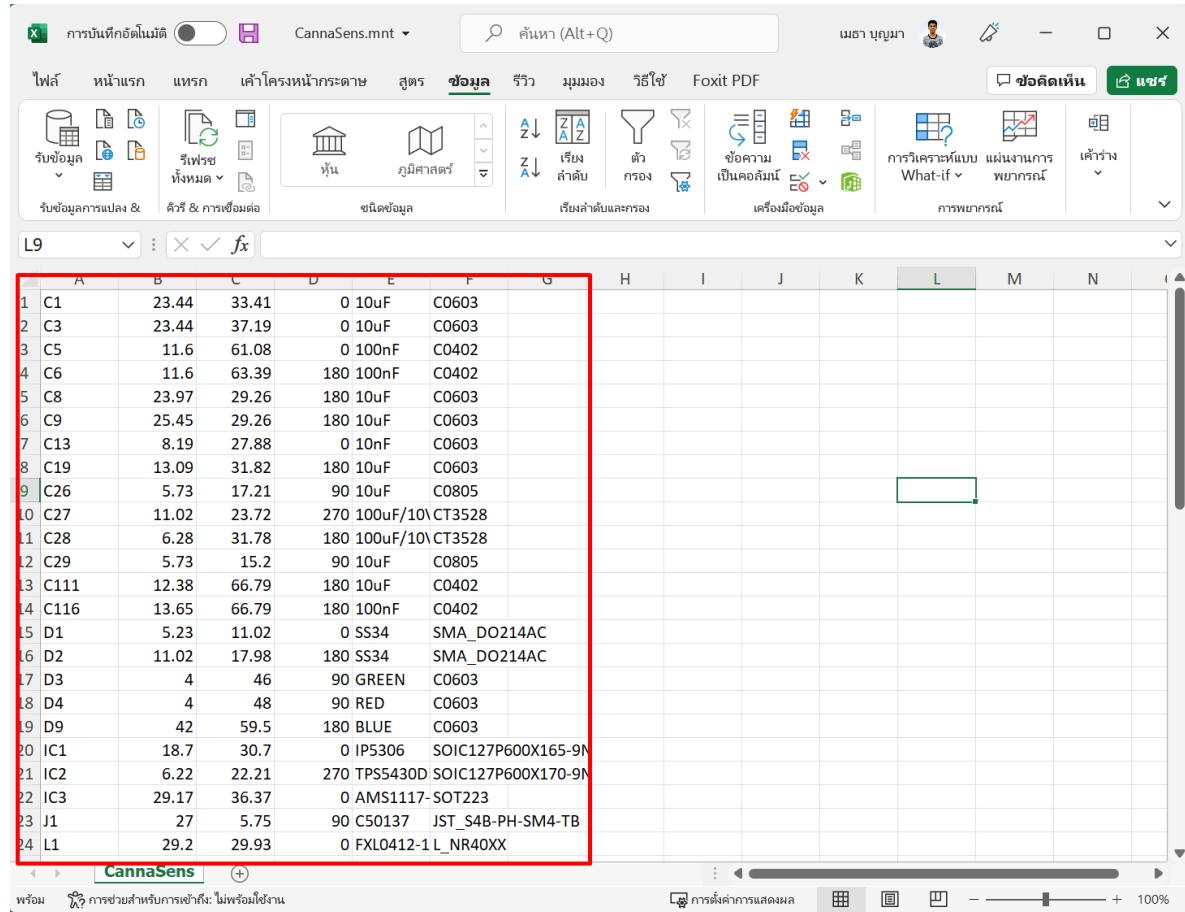
ไฟล์: การซ่อมสีหัวรีบการซ่อมสี: ไฟฟ้าเรียบงาน

หน้า: 1 หน้า 60 | การตั้งค่าการสกัดผล

ขนาดหน้า: 100% | เน้นจานวน: 60 | การตั้งค่าการสกัดผล



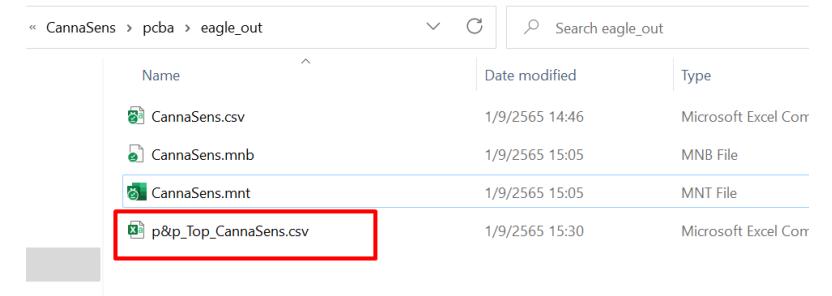
# แปลง .mnt, .mnb เป็น excel



The screenshot shows a Microsoft Excel spreadsheet titled "CannaSens.mnt". The data is organized into columns A through N, with rows numbered 1 to 24. A red box highlights the first 10 rows of data, which represent component information. The columns contain various parameters such as value, tolerance, and part number.

1	C1	23.44	33.41	0	10uF	C0603								
2	C3	23.44	37.19	0	10uF	C0603								
3	C5	11.6	61.08	0	100nF	C0402								
4	C6	11.6	63.39	180	100nF	C0402								
5	C8	23.97	29.26	180	10uF	C0603								
6	C9	25.45	29.26	180	10uF	C0603								
7	C13	8.19	27.88	0	10nF	C0603								
8	C19	13.09	31.82	180	10uF	C0603								
9	C26	5.73	17.21	90	10uF	C0805								
10	C27	11.02	23.72	270	100uF/10\CT3528									
11	C28	6.28	31.78	180	100uF/10\CT3528									
12	C29	5.73	15.2	90	10uF	C0805								
13	C111	12.38	66.79	180	10uF	C0402								
14	C116	13.65	66.79	180	100nF	C0402								
15	D1	5.23	11.02	0	SS34	SMA_DO214AC								
16	D2	11.02	17.98	180	SS34	SMA_DO214AC								
17	D3	4	46	90	GREEN	C0603								
18	D4	4	48	90	RED	C0603								
19	D9	42	59.5	180	BLUE	C0603								
20	IC1	18.7	30.7	0	IP5306	SOIC127P600X165-9N								
21	IC2	6.22	22.21	270	TPS5430D	SOIC127P600X170-9N								
22	IC3	29.17	36.37	0	AMS1117-SOT223									
23	J1	27	5.75	90	C50137	JST_S4B-PH-SM4-TB								
24	L1	29.2	29.93	0	FXL0412-1 L_NR40XX									

จากนั้น Save เป็นไฟล์xlsx หรือ CSV

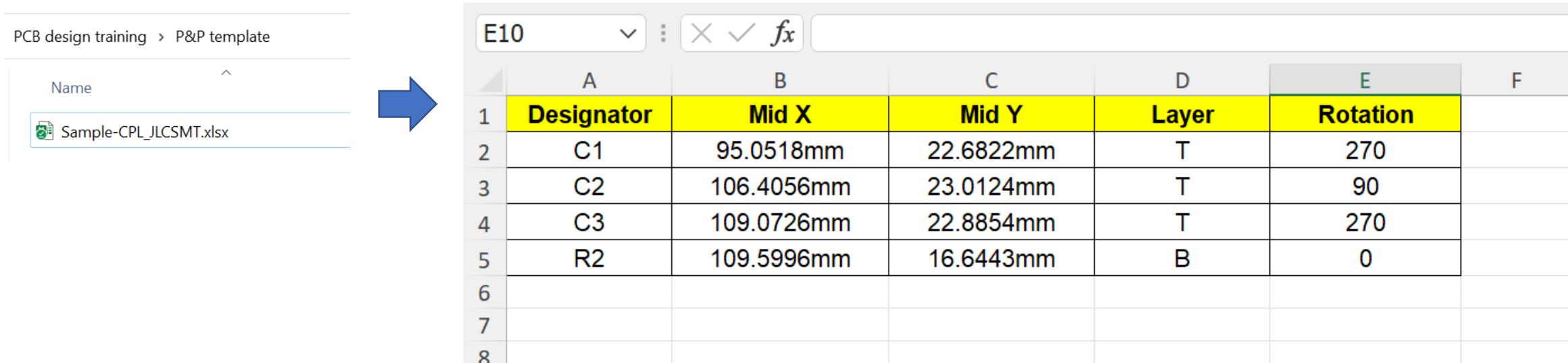


The screenshot shows a file explorer window with the path "CannaSens > pcba > eagle\_out". It lists several files: CannaSens.csv (Microsoft Excel Corr), CannaSens.mnb (MNB File), CannaSens.mnt (MNT File), and p&p\_Top\_CannaSens.csv (Microsoft Excel Corr). The CSV file is highlighted with a red box.

Name	Date modified	Type
CannaSens.csv	1/9/2565 14:46	Microsoft Excel Corr
CannaSens.mnb	1/9/2565 15:05	MNB File
CannaSens.mnt	1/9/2565 15:05	MNT File
p&p_Top_CannaSens.csv	1/9/2565 15:30	Microsoft Excel Corr

# Pick and Place Template

- JLCPCB <https://support.jlcpcb.com/article/79-pick-place-file-for-smt-assembly>

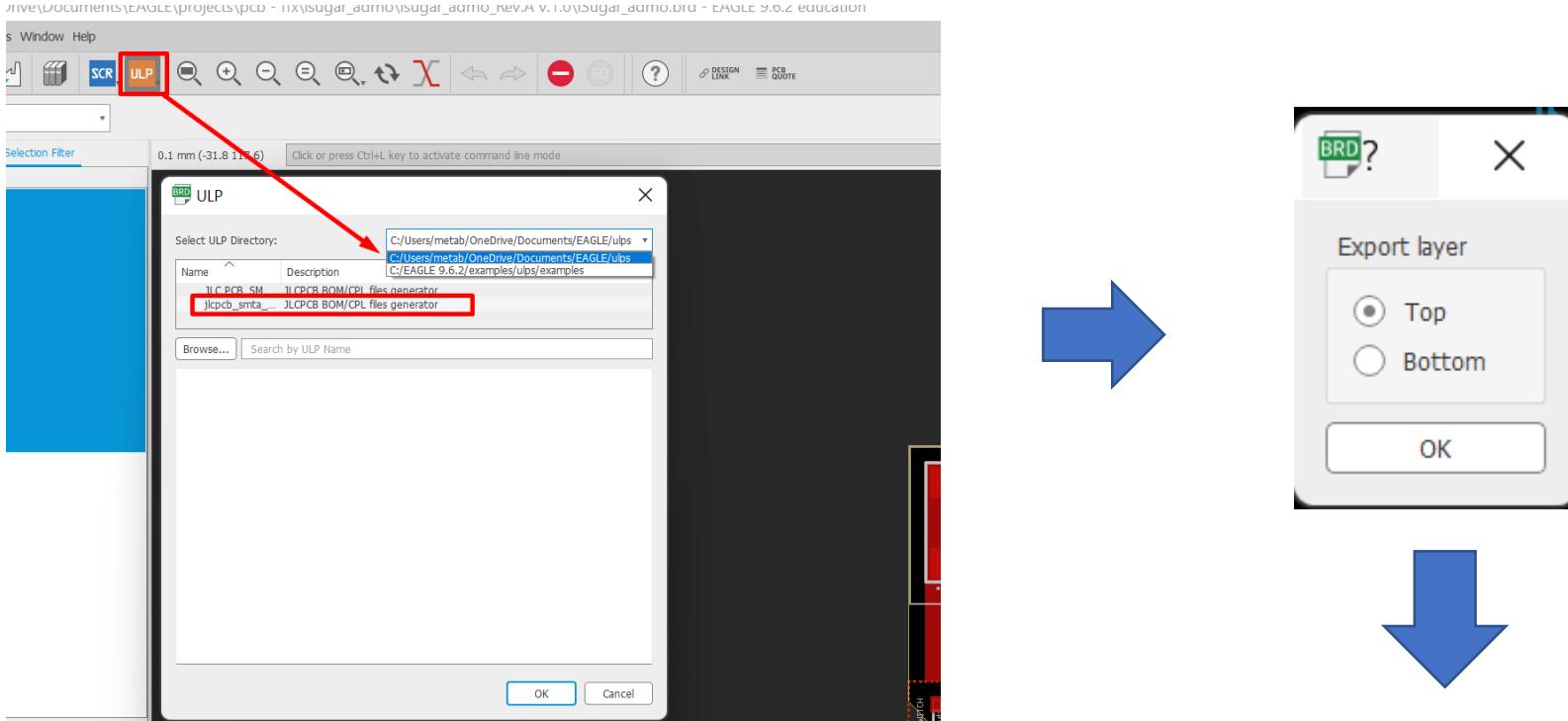


PCB design training > P&P template

Name: Sample-CPL\_JLCSMT.xlsx

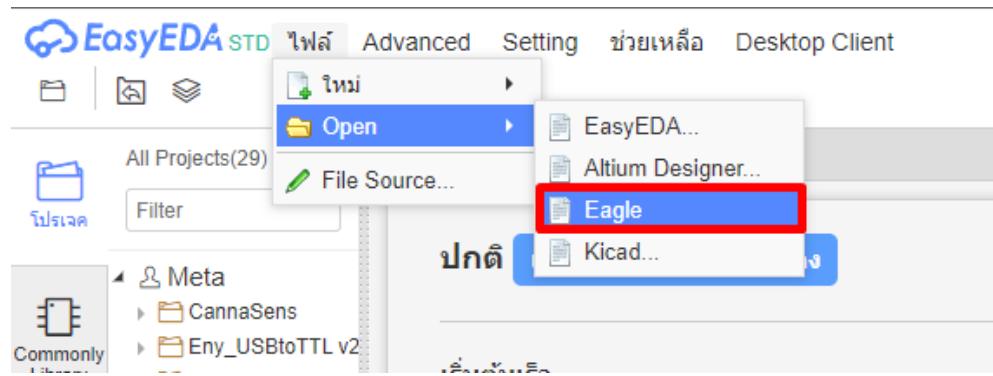
	A	B	C	D	E	F
2	C1	95.0518mm	22.6822mm	T	270	
3	C2	106.4056mm	23.0124mm	T	90	
4	C3	109.0726mm	22.8854mm	T	270	
5	R2	109.5996mm	16.6443mm	B	0	
6						
7						
8						

# การ Export BOM และ Pick and Place ด้วย ULP



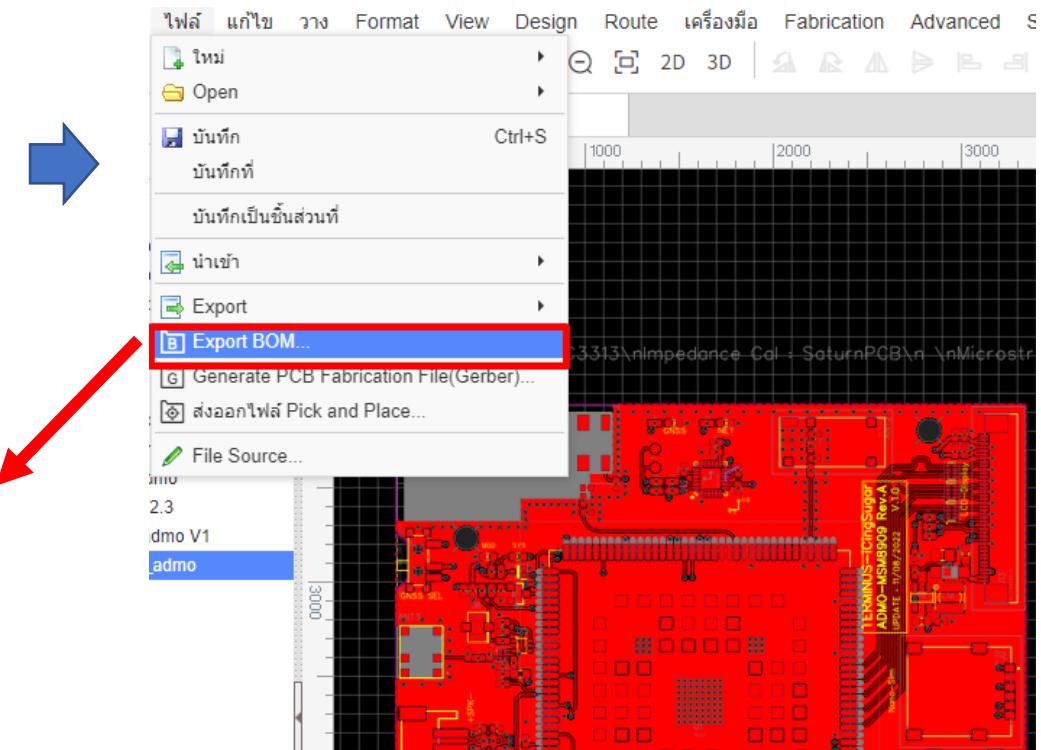
# การ Export BOM และ Pick and Place โดยใช้ Easy EDA

<https://easyeda.com/editor>



This screenshot displays the 'Export PCB BOM' dialog box. It lists various components with their details such as ID, Designator, Value, Quantity, Manufacturer Part, Manufacturer, Supplier, and Price. A series of red boxes highlights the 'Assign LCSC Part#' buttons for several components. At the bottom of the dialog, there are three buttons: 'Export BOM' (highlighted with a red box), 'One-click Order Parts', and 'Cancel'.

ID	ชื่อ	Designator	ค่ามายาง	Qu...	Manufacturer Part	Manufactu...	Supplier	Supplier Part	Price
5	1.5pF	C2,C78	C0402	2	0402CG1R5C500NT	FH	LCSC	C1552	0.001
6	100nF	C4,C5,C11...	C0402	31	CL05B104KB54PNC	Samsung ...	LCSC	C307331	0.007
7	2.2uF	C17	C0402	1	CL05A225MQ5NSNC	SAMSUNG	LCSC	C12530	0.002
8	47uF	C19,C29	C0603	2	GRM188R60J476ME...	MuRata	LCSC	C140782	0.069
9	100pF	C6,C8,C22	C0402	3	0402CG101J500NT	FH	LCSC	C1546	0.001
10	220pF	C24,C58,C...	C0402	3	0402B221K500NT	FH	LCSC	C1530	0.001
11	33pF	C7,C35,C5...	C0402	10	0402CG330J500NT	FH	LCSC	C1562	0.001
12	100uF/6.3V	C36,C47	CT3528	2	TAJB107K006RNJ	AVX	LCSC	C16133	0.092
13	4.7pF	C38	C0402	1	0402CG4R7C500NT	FH	LCSC	C1569	0.001
14	10nF	C39,C68	C0402	2	CL05B103KB5NNNC	SAMSUNG	LCSC	C15195	0.001
15	1uF	C9,C40,C55	C0402	3	CL05A105KA5NQNC	SAMSUNG	LCSC	C52923	0.003
16	10uF	C41,C42,C...	C0603	3	CL10A106MA8NRNC	SAMSUNG	LCSC	C96446	0.014
17	2pF	C56	C0402	1	0402CG2R0C500NT	FH	LCSC	C1558	0.001
18	10pF	C59,C88,C...	C0402	4	CL05C100JB5NNNC	SAMSUNG	LCSC	C32949	0.005



# JLCPCB: Add Gerber File (\*.zip)

The screenshot shows the JLCPCB website's PCB ordering interface. At the top, there is a navigation bar with links for "Why JLCPCB?", "Capabilities", "Support", and "Resources". Below the navigation bar, there are three tabs: "PCB" (selected), "SMT-Stencil", and "3D-Printing". The main area has a large blue button labeled "Add gerber file" with an upward arrow icon, which is highlighted with a red box. Below this button, there is a note: "Only accept zip or rar, Max 20 MB, View example >". To the right of the note is a lock icon and the text "All uploads are secure and confidential.". Below the note, there are two links: "Instructions For Ordering" and "Upload History >".

Base Material

Layers

Dimensions  \*  mm

PCB Qty

# JLCPCB: Online Gerber Viewer

PCB      SMT-Stencil      3D-Printing

Detected 2 layer board of 69x58mm(2.72x2.28 inches).

Your upload has finished processing. Enter the project details below and we'll move on to checking all the individual layers to make sure that they're correct.



◀ Back to Upload File      ✓ Success, this file has been saved to your File Manager

Base Material: FR-4      Aluminum

Layers: 1 (selected), 2, 4, 6

Dimensions: 69 \* 58 mm

PCB Qty: 5

Gerber Viewer

Charge Details

Special Offer \$2.00

Build Time ?  
PCB: 1-2 days \$0.00

Calculated Price \$4.00 - \$2.00  
Additional charges may apply for special cases

Weight ? 0.18kg

**SAVE TO CART**

Shipping Estimate \$19.41  
DHL Express Worldwide 2-4 business days

# JLCPCB: Online Gerber Viewer

**JLCPCB**

Why JLCPCB? Capabilities Support Resources

Online Gerber Viewer

Layers Top Bottom 3D

PCB Color: Purple

- Green
- Blue
- Red
- Black
- Yellow
- White
- Purple

ANALYSIS\_OUT\_LINE(analys...

ANALYSIS\_TOP\_PAD(analysi...

ANALYSIS\_HOLE\_PTH(analysi...

TOP(Top Layer)

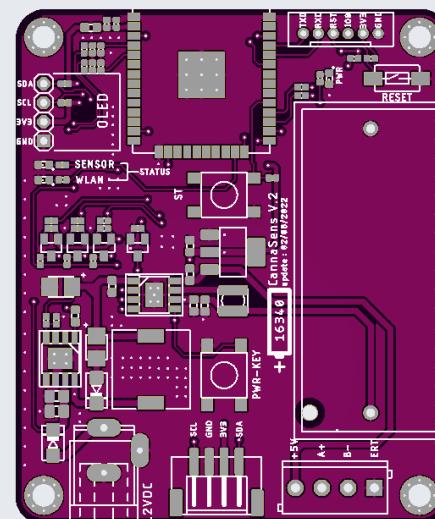
TOP\_SOLDER\_MASK(Top Solder...

TOP\_SILK(Top Silkscreen Layer)

TOP\_PASTE\_MASK(Top Paste ...)

MULTI(Multi-Layer)

OUTLINE(Board Outline Layer)



**JLCPCB**

Why JLCPCB? Capabilities Support Resources

Order now

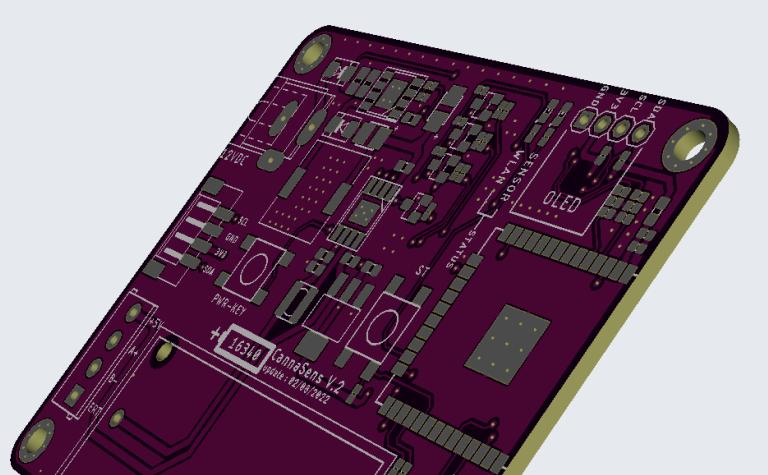
Online Gerber Viewer

Layers Top Bottom 3D

PCB Color: Purple

Surface Finish: ENIG-RoHS

- SUBSTRATE(基板1)
- HOLE\_PTH(DrillPthLayer)
- ANALYSIS\_IN\_LINE(analys...
- ANALYSIS\_OUT\_LINE(analysi...
- ANALYSIS\_TOP\_PAD(analysi...
- ANALYSIS\_BOTTOM\_PAD(anal...
- ANALYSIS\_HOLE\_PTH(analysi...
- TOP(Top Layer)
- TOP\_SOLDER\_MASK(Top Solder...
- TOP\_SILK(Top Silkscreen Layer)
- TOP\_PASTE\_MASK(Top Paste ...)
- BOTTOM(Bottom Layer)
- BOT\_SOLDER\_MASK(Bottom S...

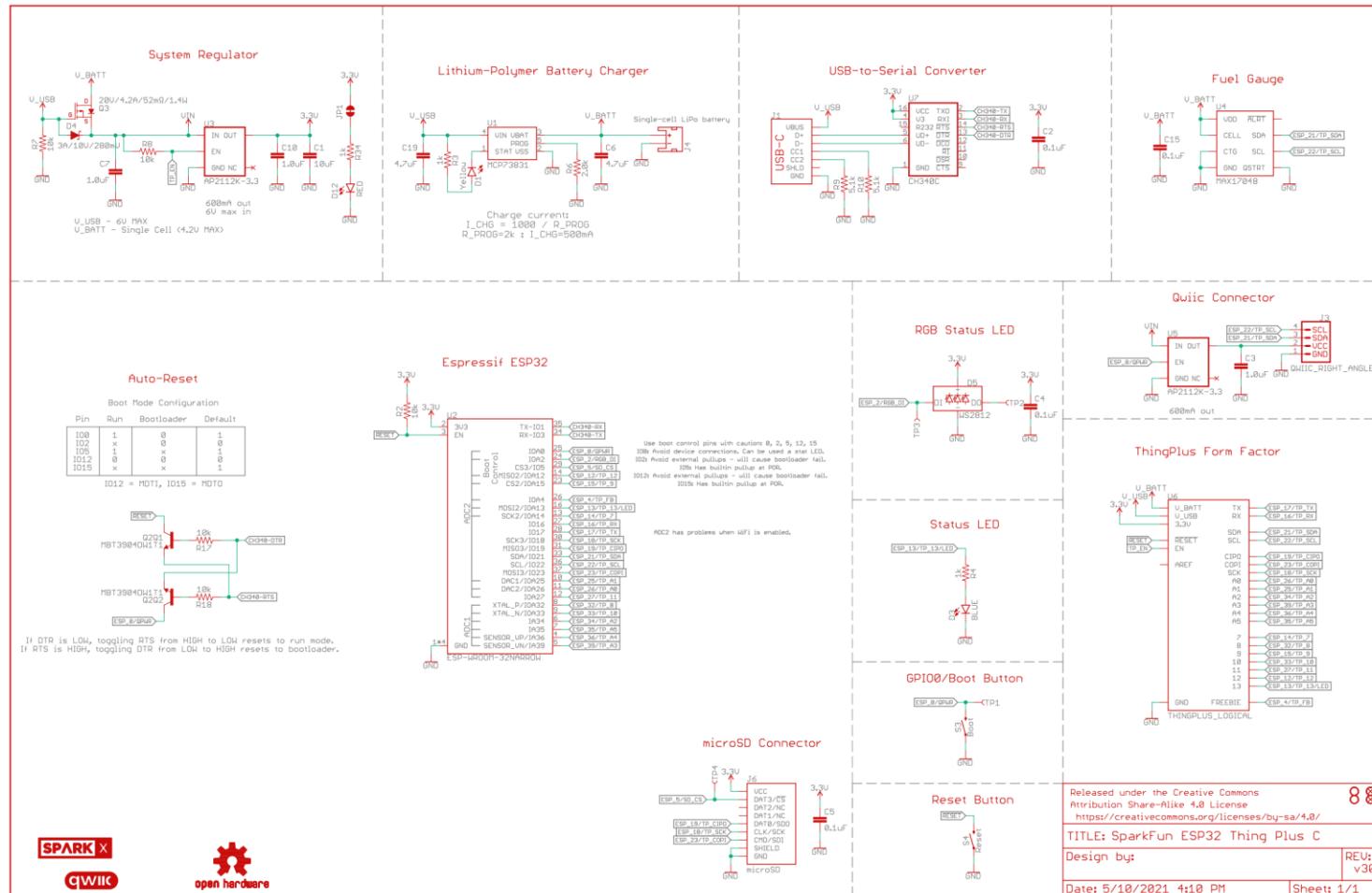


# **ตัวอย่างการอักแบบ**

# Example : SparkFun ESP32 Thing Plus C

## Eagle Project

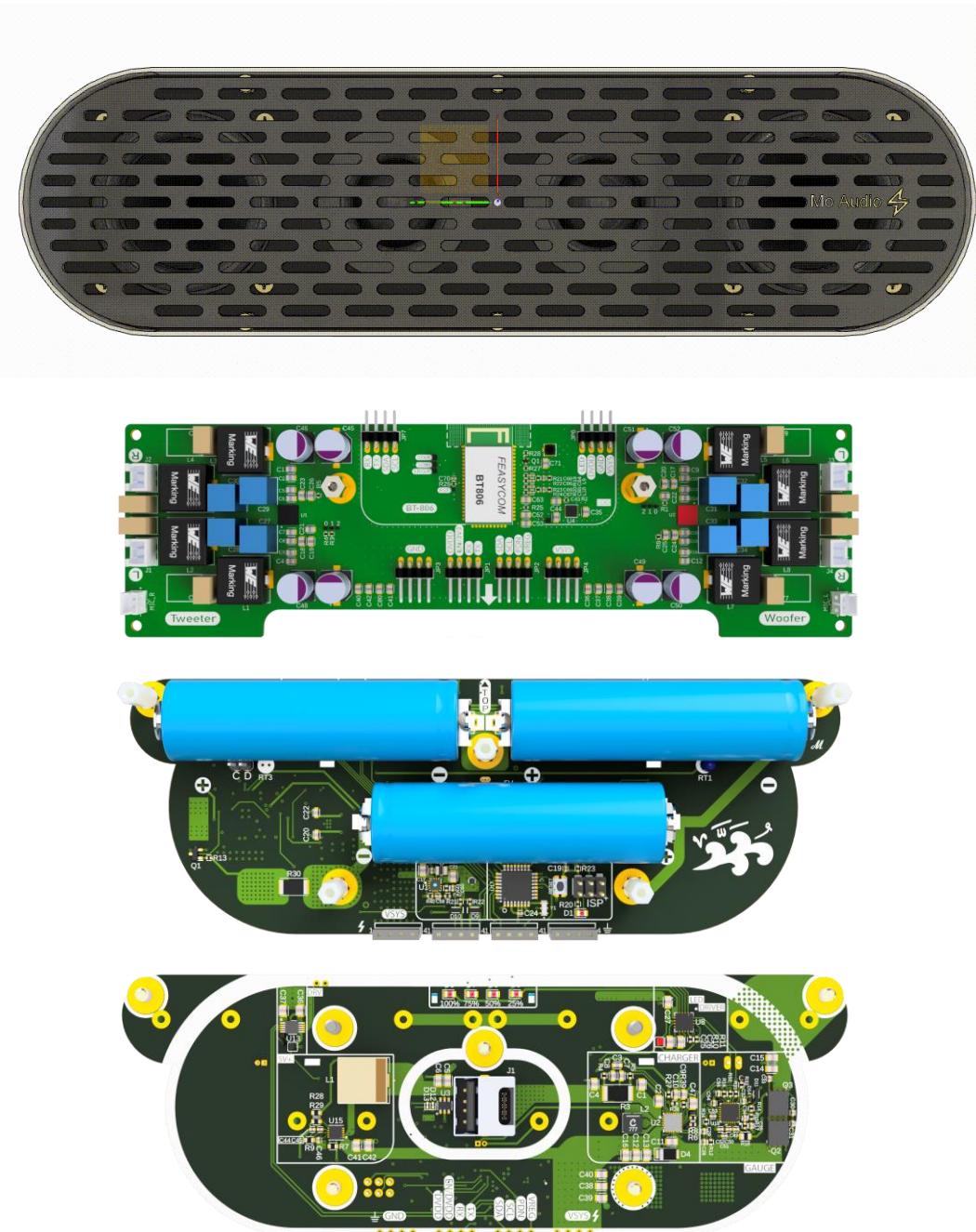
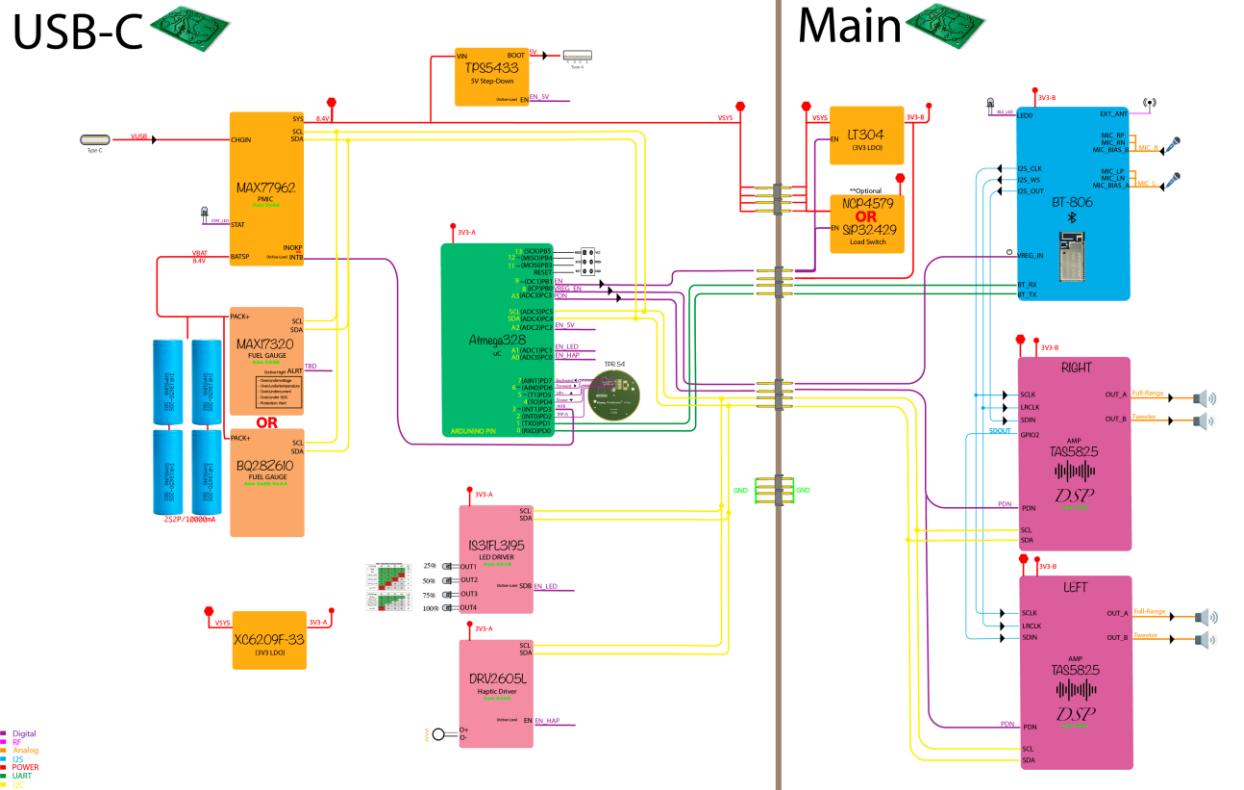
[https://github.com/sparkfunX/SparkFun\\_ESP32\\_Thing\\_Plus\\_C](https://github.com/sparkfunX/SparkFun_ESP32_Thing_Plus_C)



# Example : Pure Audio

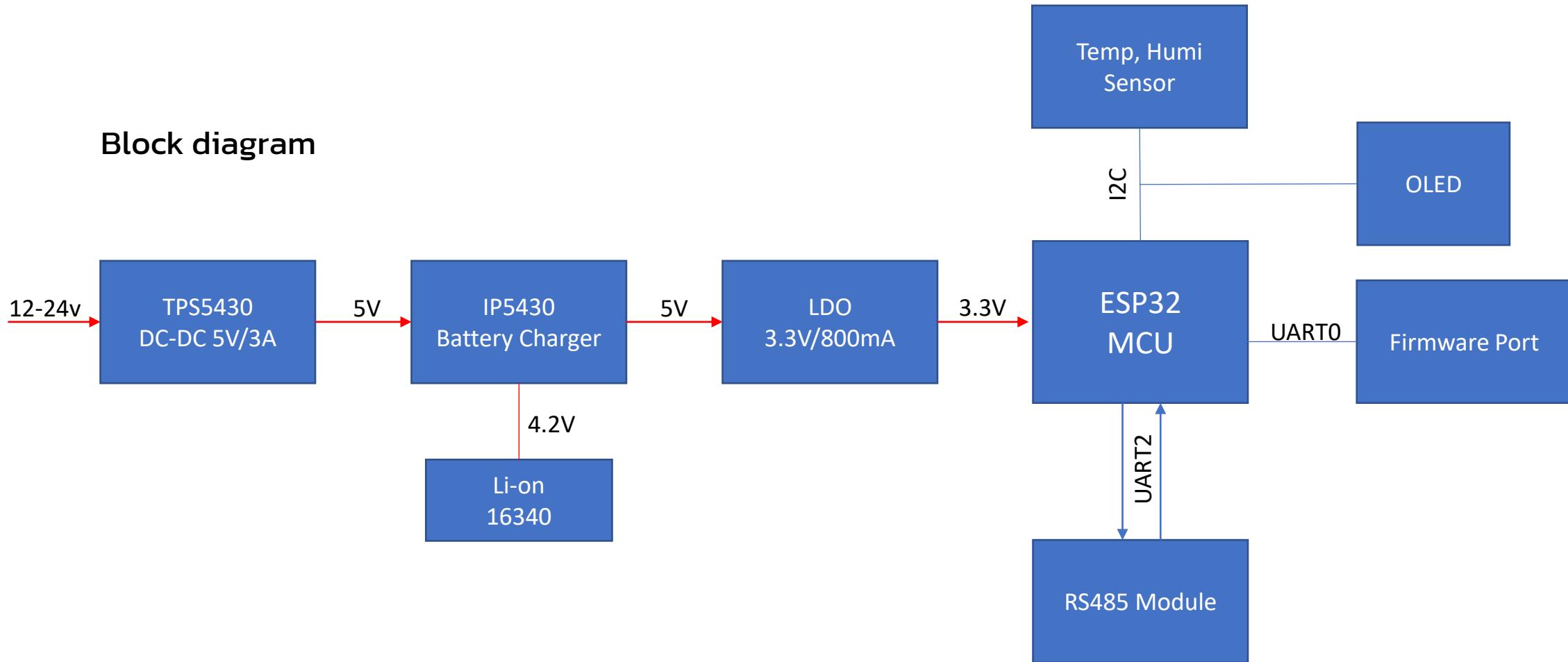
## Fusion 360 Project

<https://github.com/Mala2/Bluetooth-Speaker>

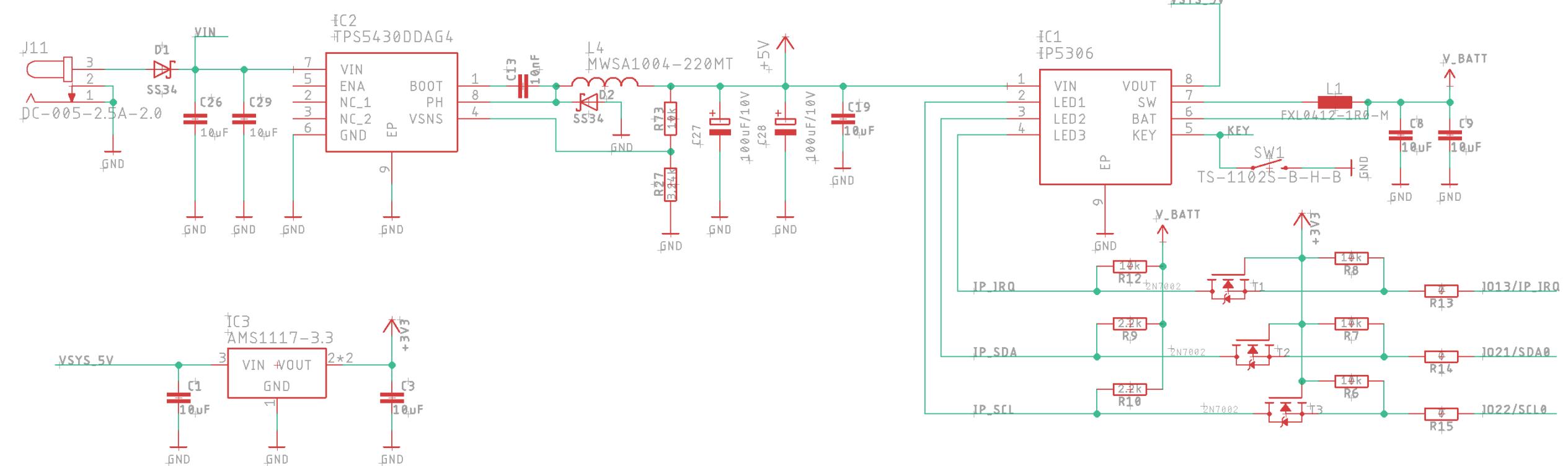


# CannaSens ESP32

Block diagram

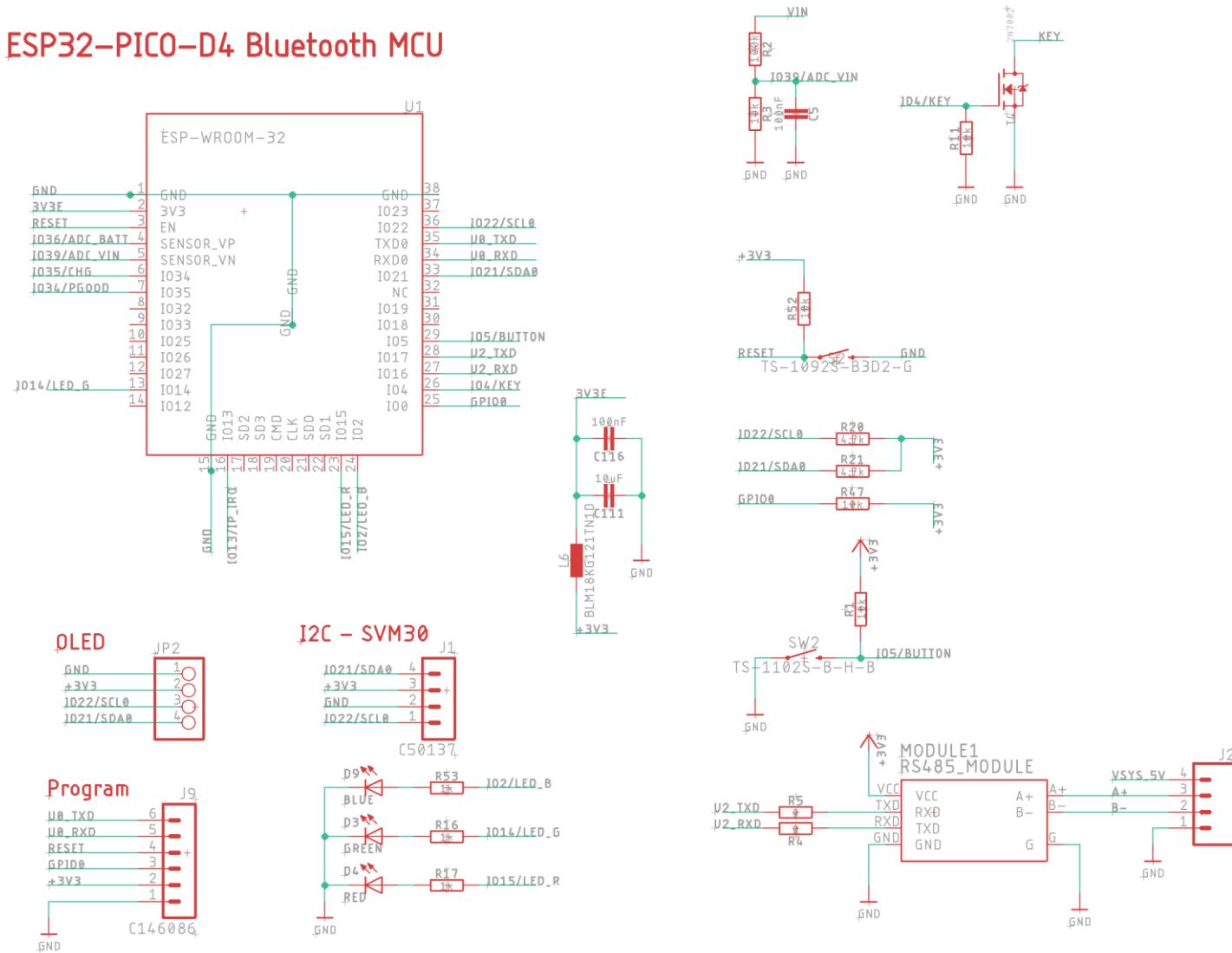


# UVS Power Supply

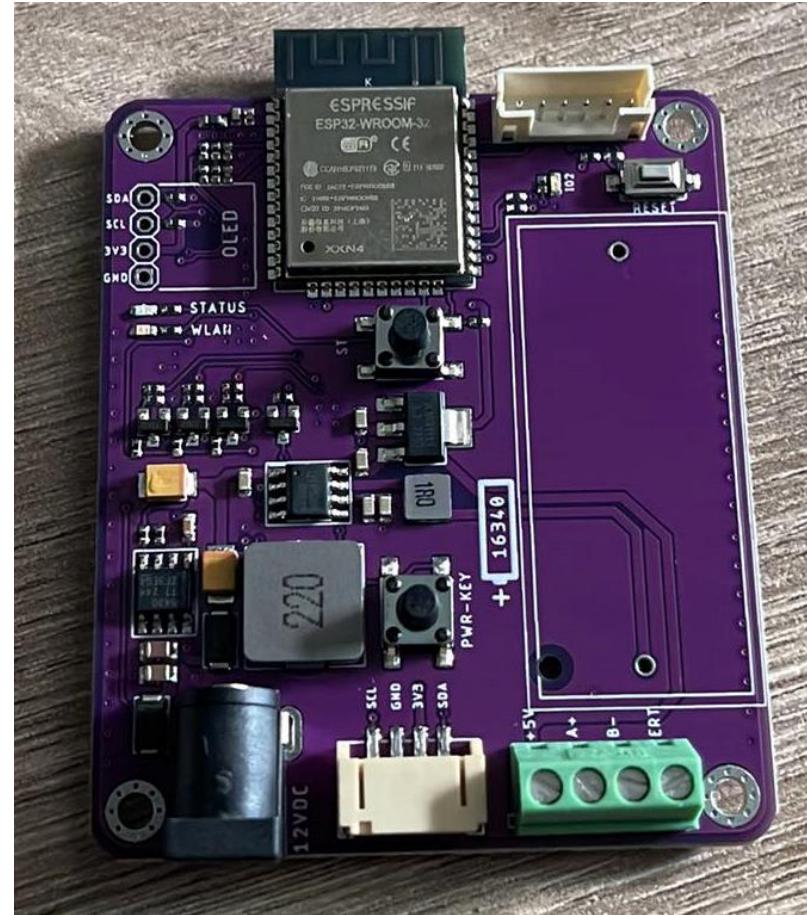
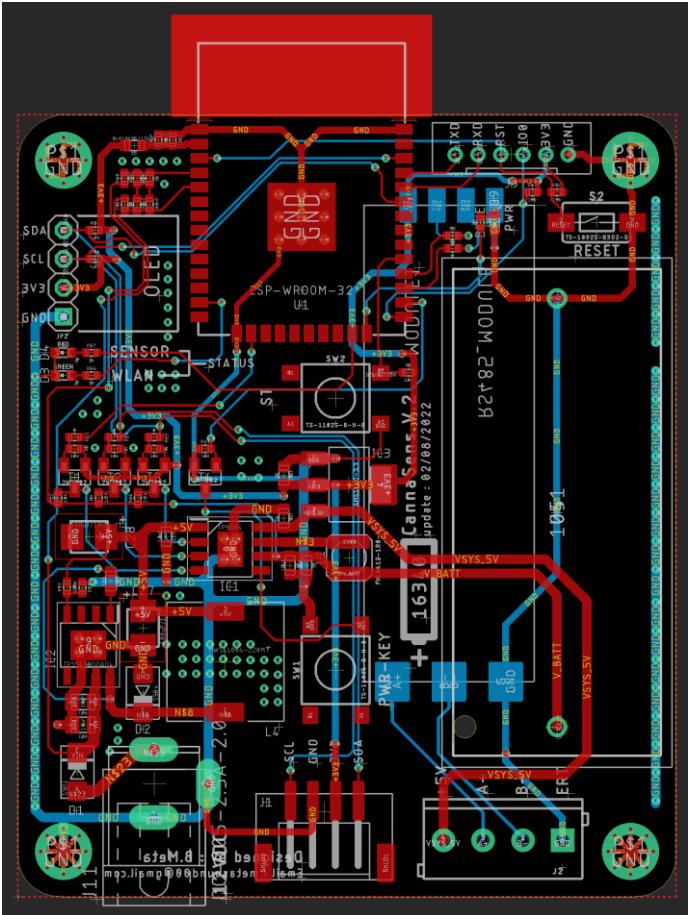


# วงจร ESP32 และอิ่มๆ

**ESP32-PICO-D4 Bluetooth MCU**



# ຕັ້ງອຍ່າງບ່ອຮດ CannaSens ESP32



# **Q & A**