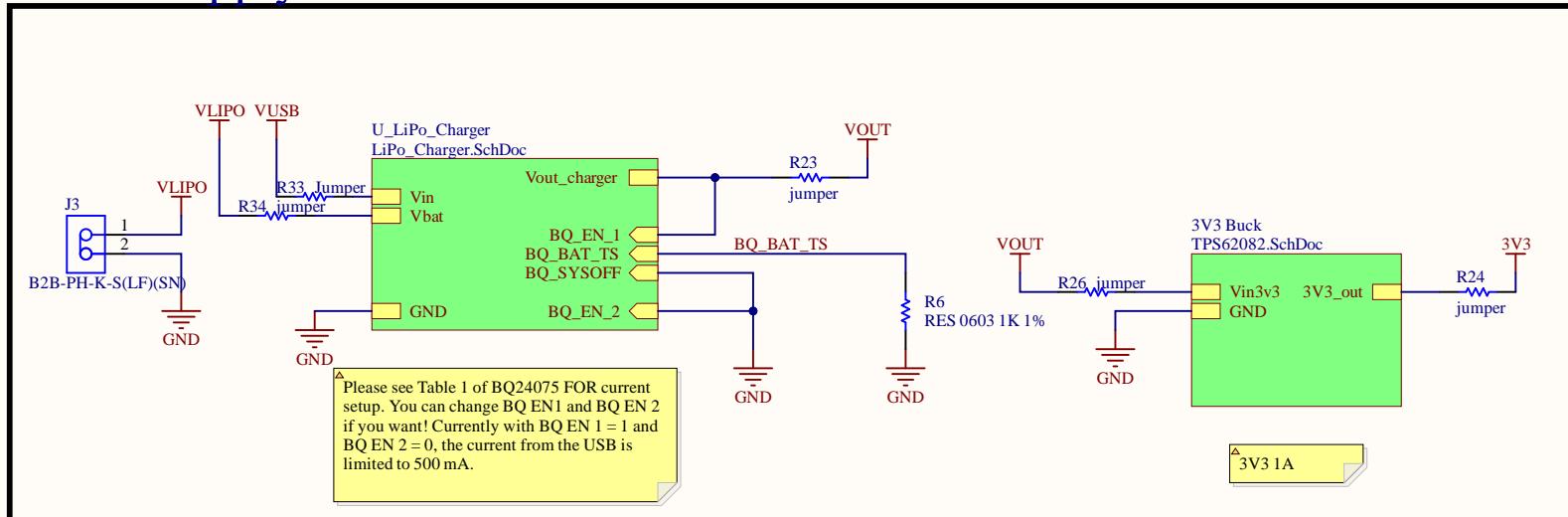
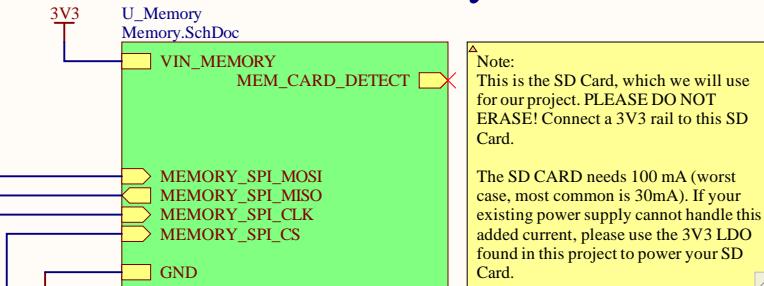


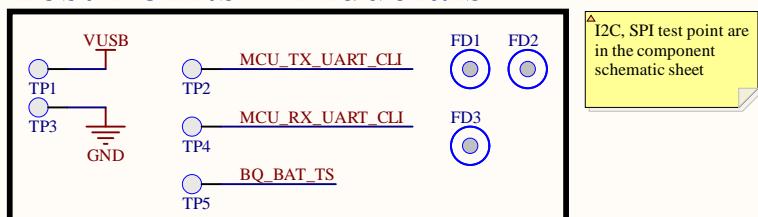
# Power Supply



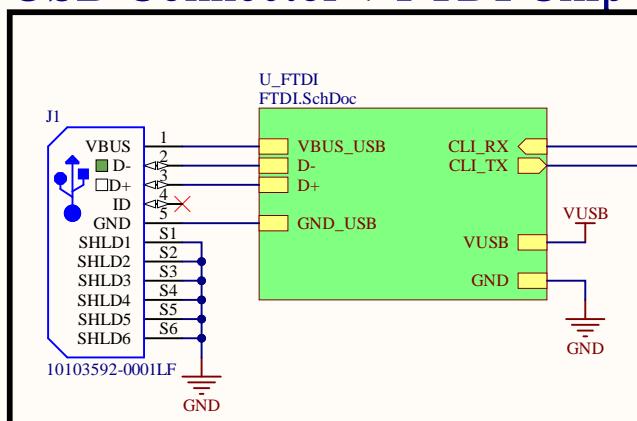
## SD Card Memory



## Test Points + Fiducials

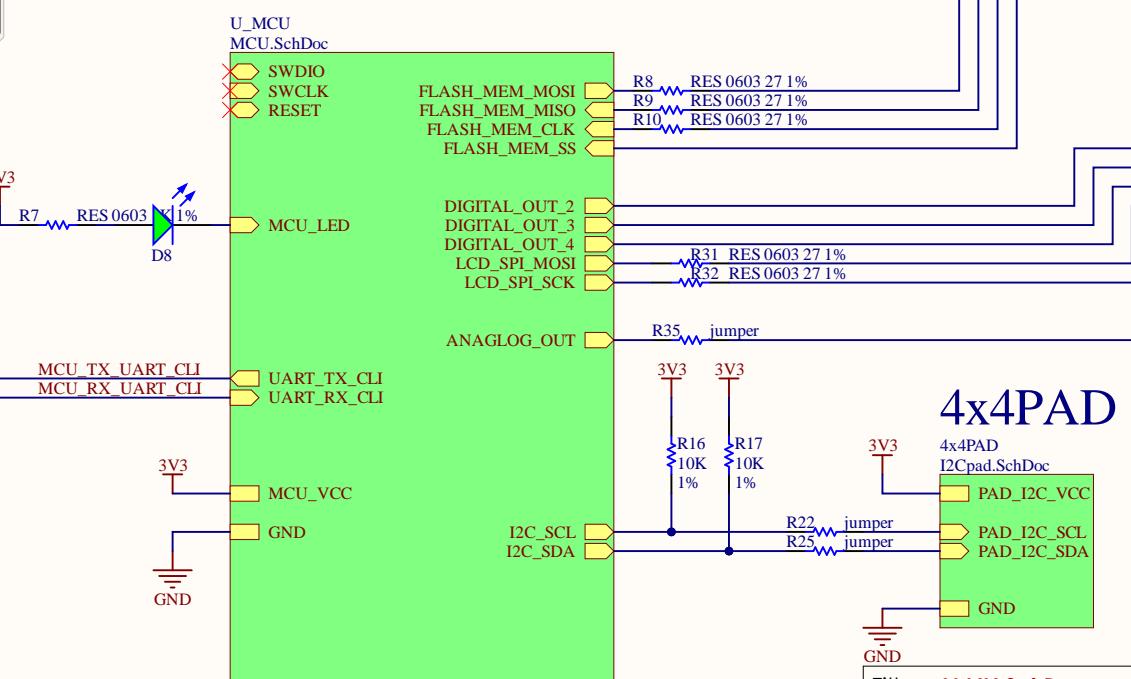


## USB Connector + FTDI Chip

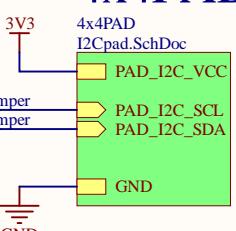


**NOTE:**  
The FTDI Chip is an useful chip that allows us to convert USART messages into USB signals. It allows us to connect the MCU directly to the USB port of a computer and use the serial terminal (it is the same bridge used on the SAMW25 Xplained Board). The FTDI device also contains protection circuitry for the USB.

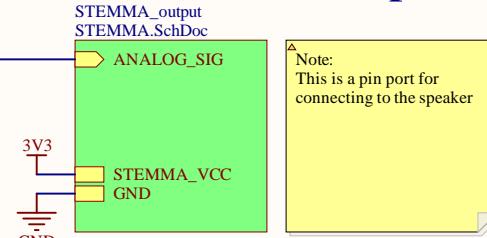
## Microcontroller



## 4x4PAD

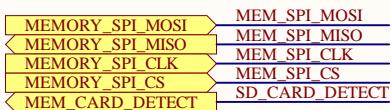


## STEMMA to Speaker



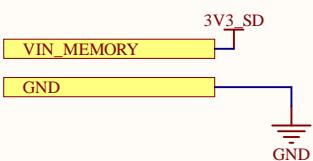
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A



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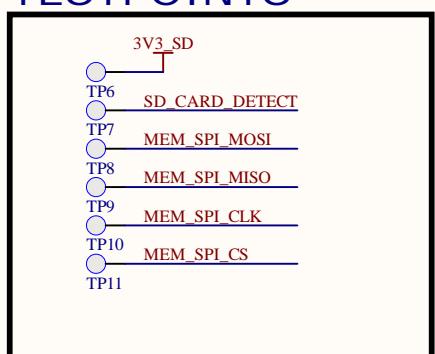
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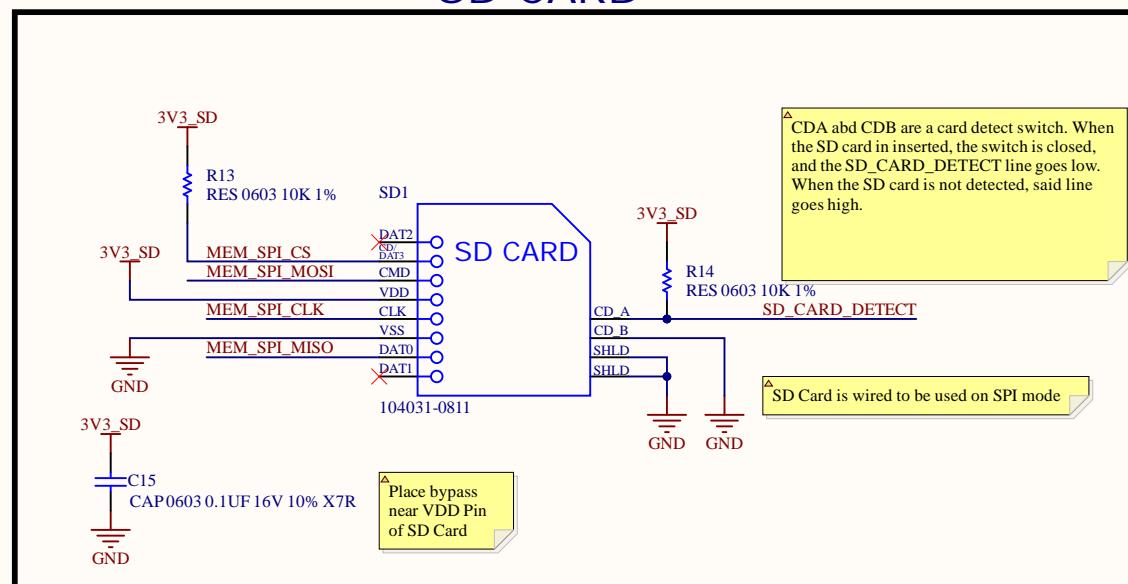
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C

## TESTPOINTS



## SD CARD



D

D

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Date: 2023/3/2 8:49:02 AD Ver. 23.2.1.34 Doc. \* Sheet 2 of 7

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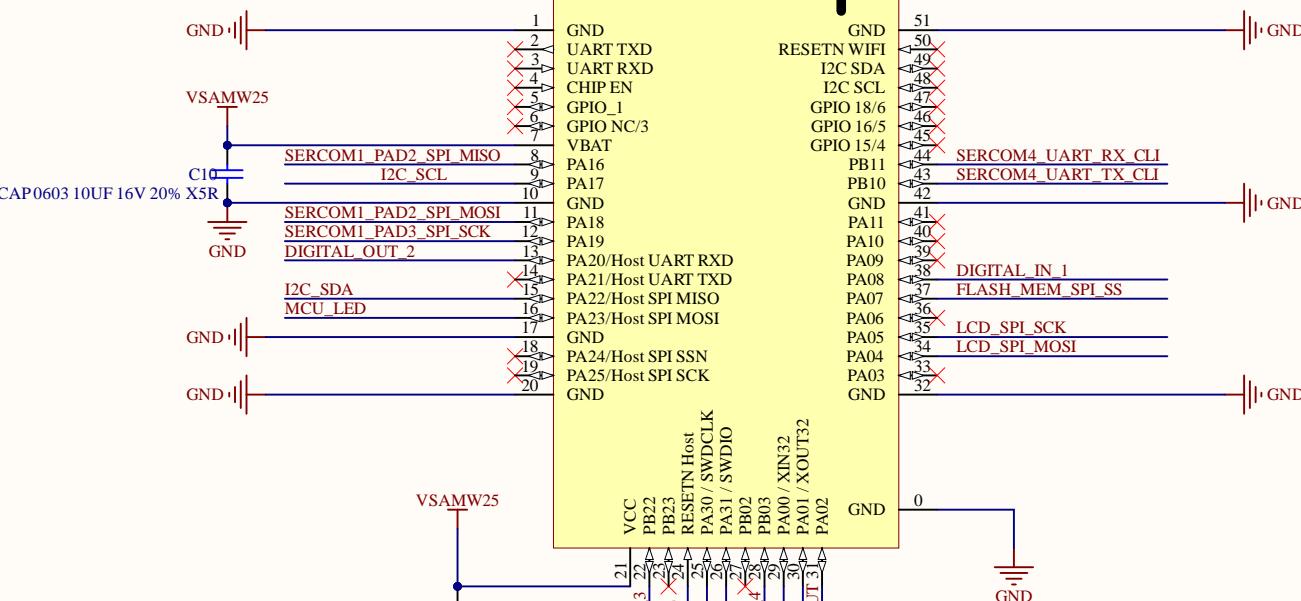
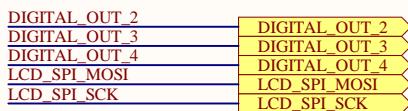
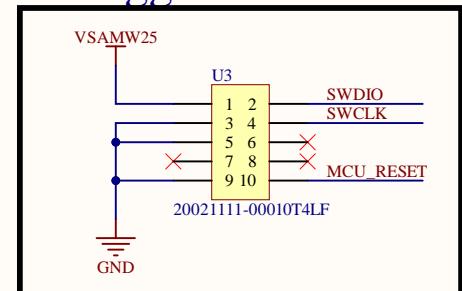


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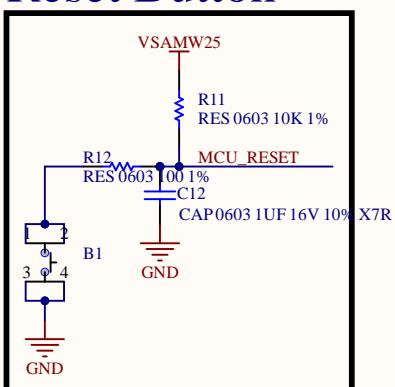
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Electrical and Systems Engineering

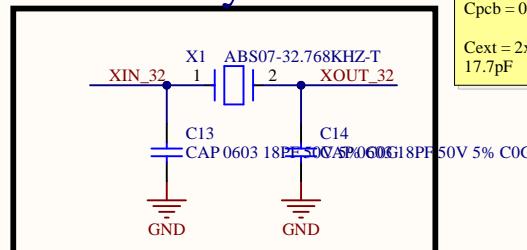
## Debugger Port



## Reset Button

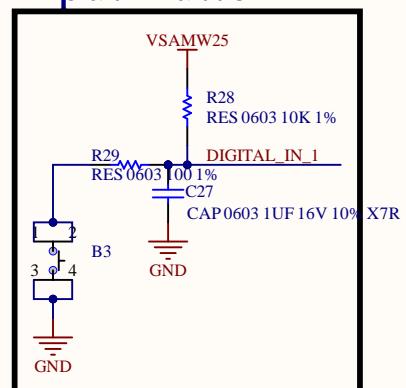


## 32.768 Crystal



Calculation of crystal load capacitors:  
 $C_{ext} = 2 \times (C_{crystal} - C_{para} - C_{pcb})$   
 $C_{crystal} = 12.5\text{pF}$  (from crystal datasheet)  
 $C_{para} = 3.15\text{pF}$  (from MCU datasheet)  
 $C_{pcb} = 0.5\text{pF}$  (estimate)  
 $C_{ext} = 2 \times (12.5\text{pF} - 3.15\text{pF} - 0.5\text{pF}) = 17.7\text{pF}$

## Input Button



Title: **MCU.SchDoc**

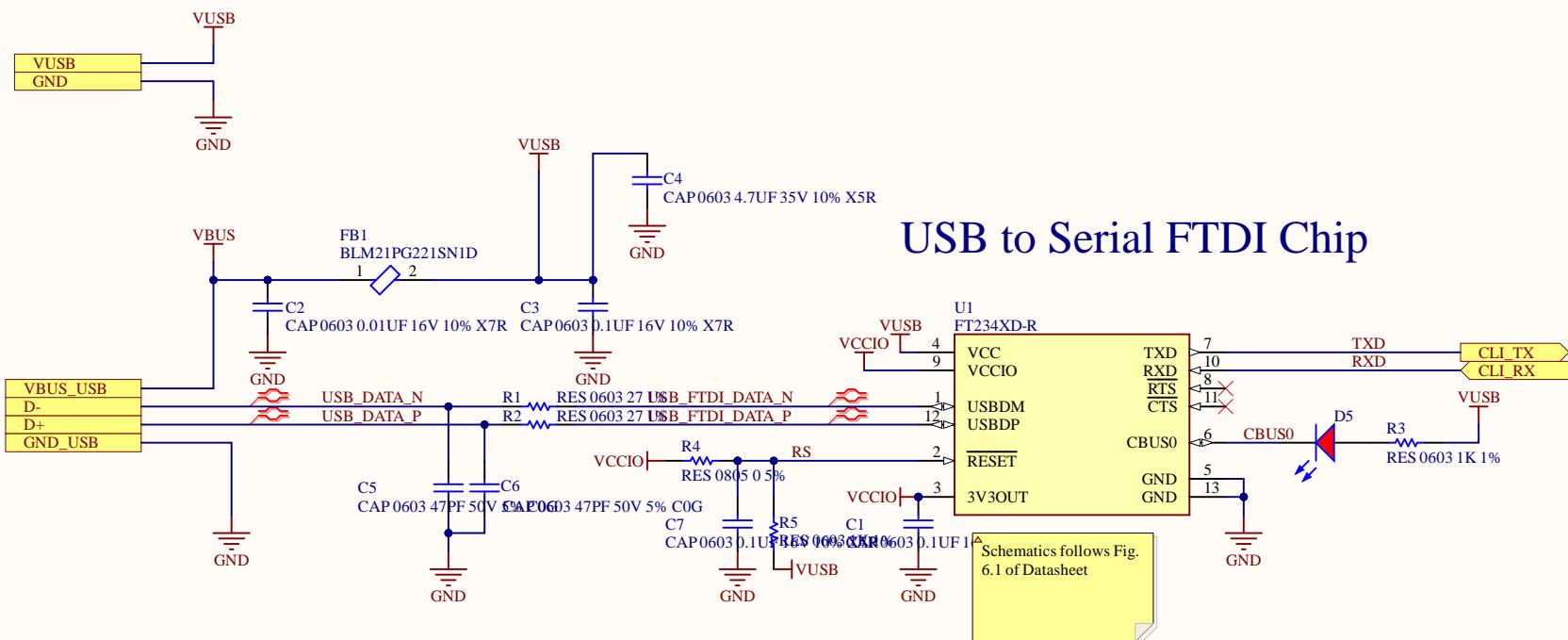
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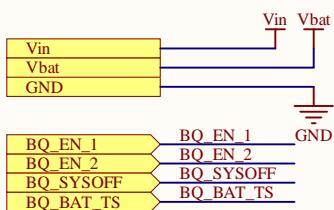
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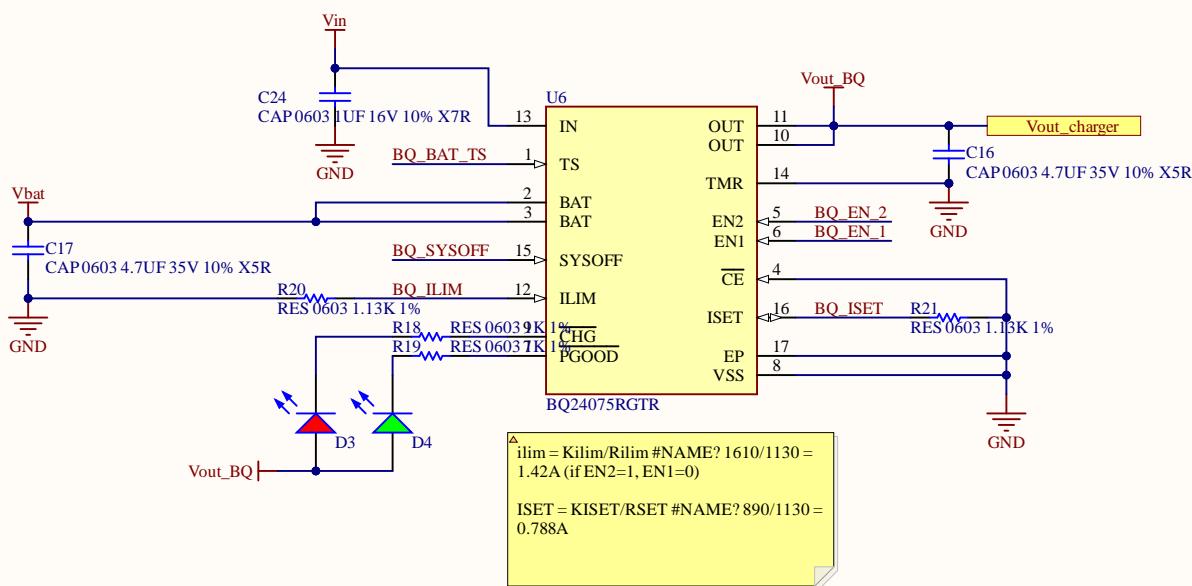


A



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Title: *LiPo\_Charger.SchDoc*

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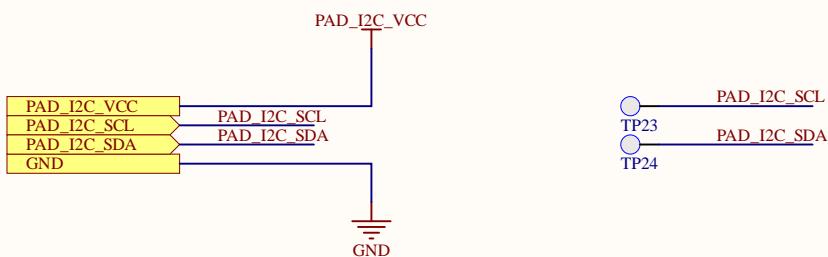
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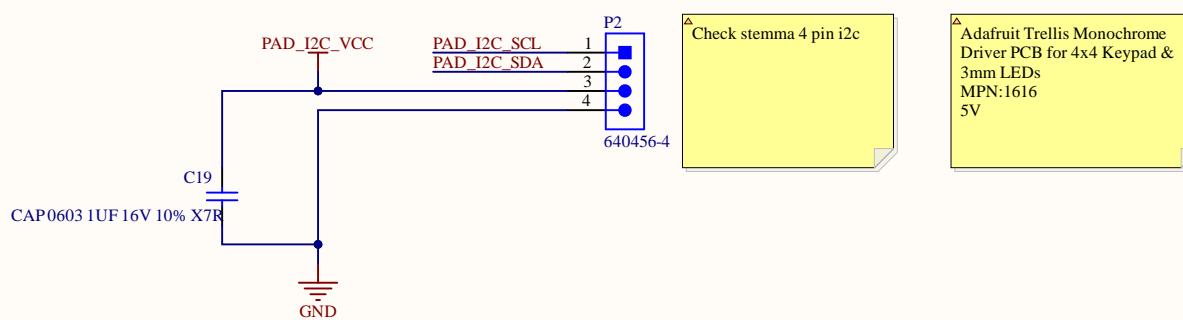
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Electrical and Systems Engineering

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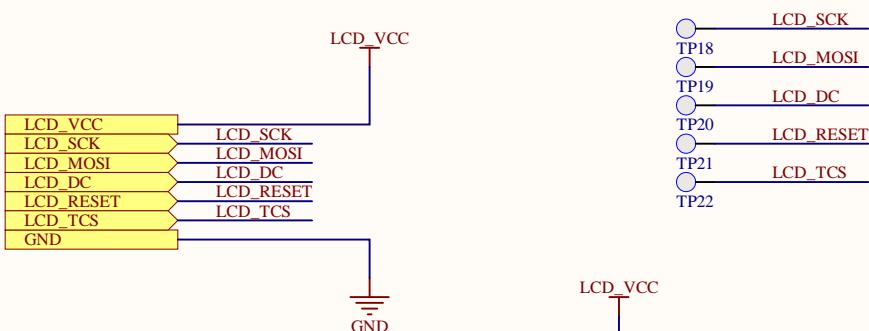
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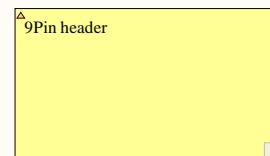
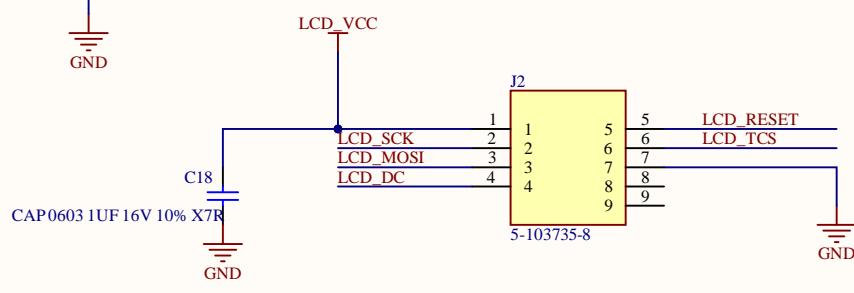
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Electrical and Systems Engineering

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B



△ 1.8" Color TFT LCD display  
with MicroSD Card Breakout -  
ST7735R  
MPN: 358  
3.3V-5V  
150mA

C

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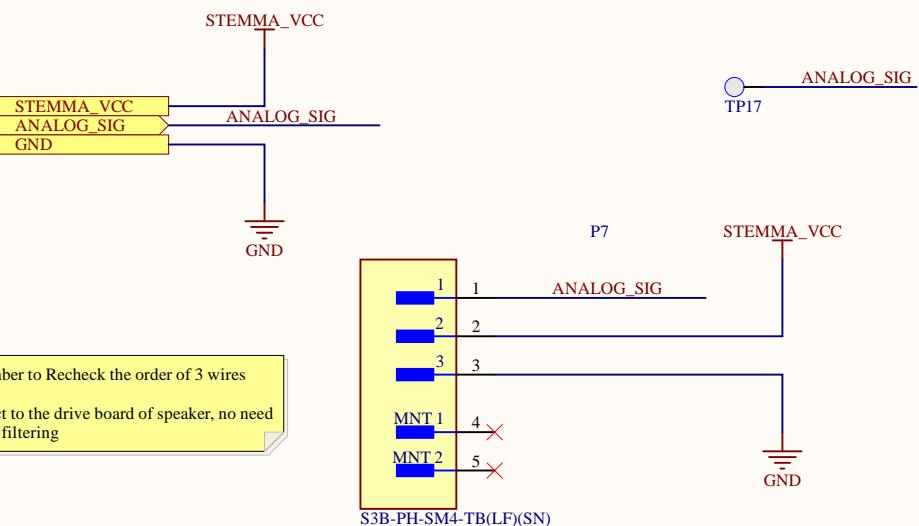
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Electrical and Systems Engineering

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Date: 2023/3/2 8:49:02	AD Ver. 23.2.1.34	Doc. * Sheet * of *
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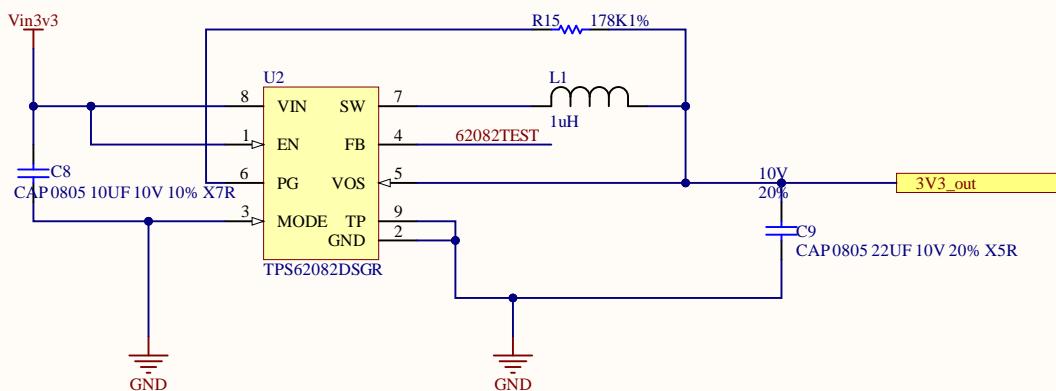
[www.seas.upenn.edu](http://www.seas.upenn.edu)

Electrical and Systems Engineering

A

Vin3v3  
GND

62082TEST  
TP25



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Title: **TPS62082.SchDoc**

Desc:

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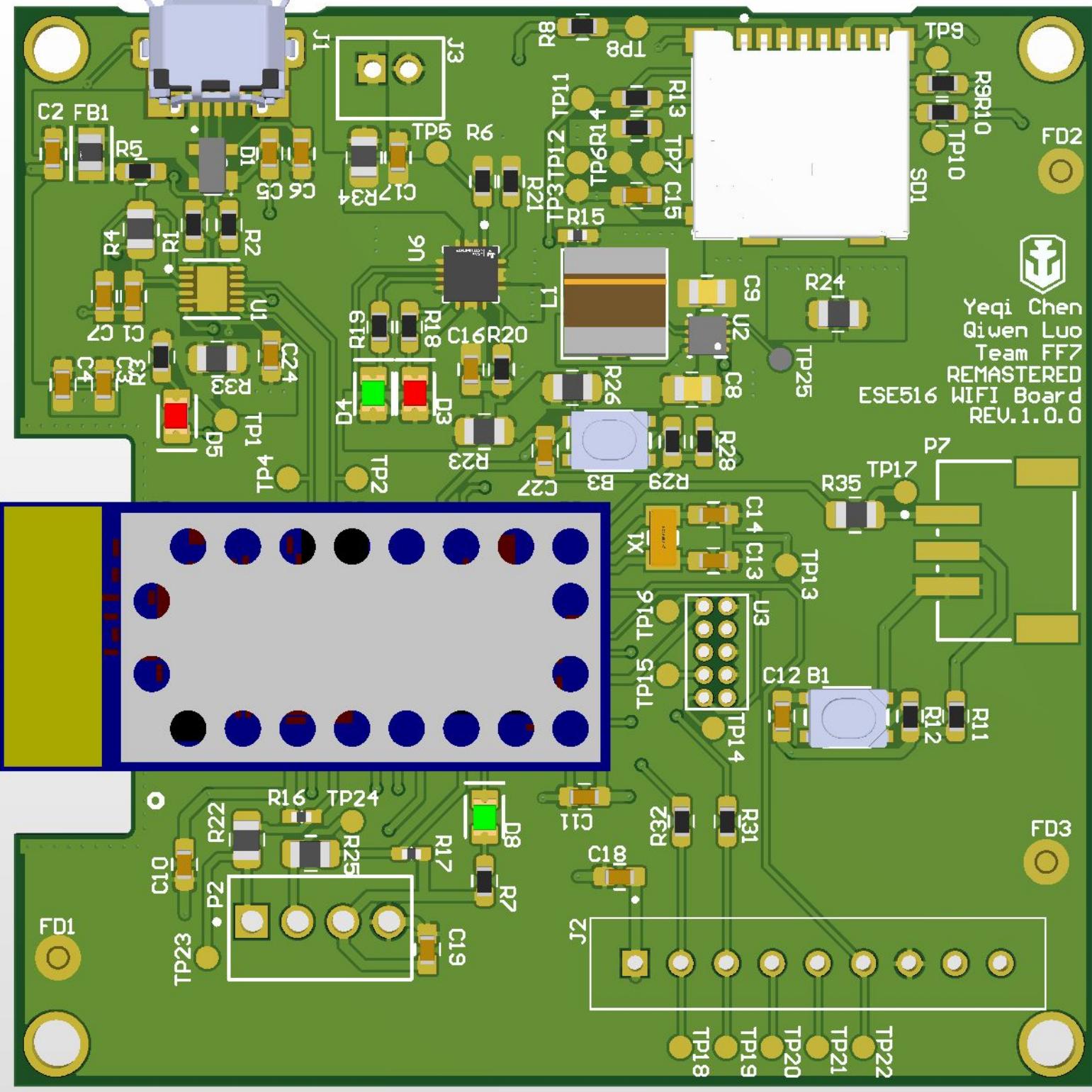
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Electrical and Systems Engineering



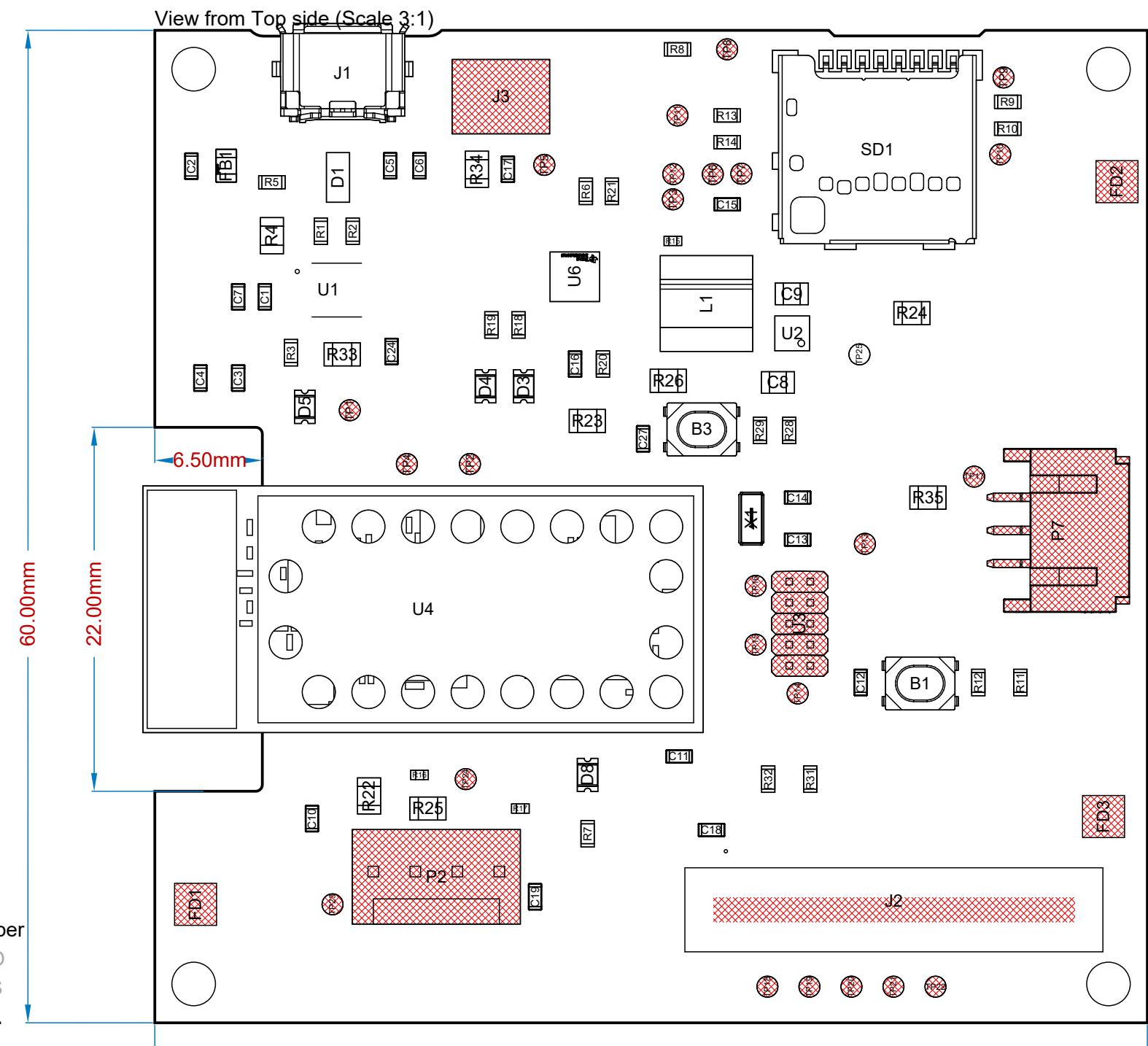
REV STATUS OF SHEETS		REV						
SHEET								

REVISIONS		DESCRIPTION	DATE	APPROVED

## Manufacturing Notes:

Four (4) Layers  
Dimensions: 60mm x 60mm  
Thickness: 1.53mm  
Number of Board: 2  
Material: FR4  
Surface Finish: ENIG  
Number of holes Per Board: 220 in total  
Minimum Hole Size: 0.02 mm or more  
Minimum Trace: 0.15mm  
Minimum Space: 0.15mm  
Solder Mask Color: Red

All layers are unmirrored - should be able to "see straight though"



### Layer Stack Legend

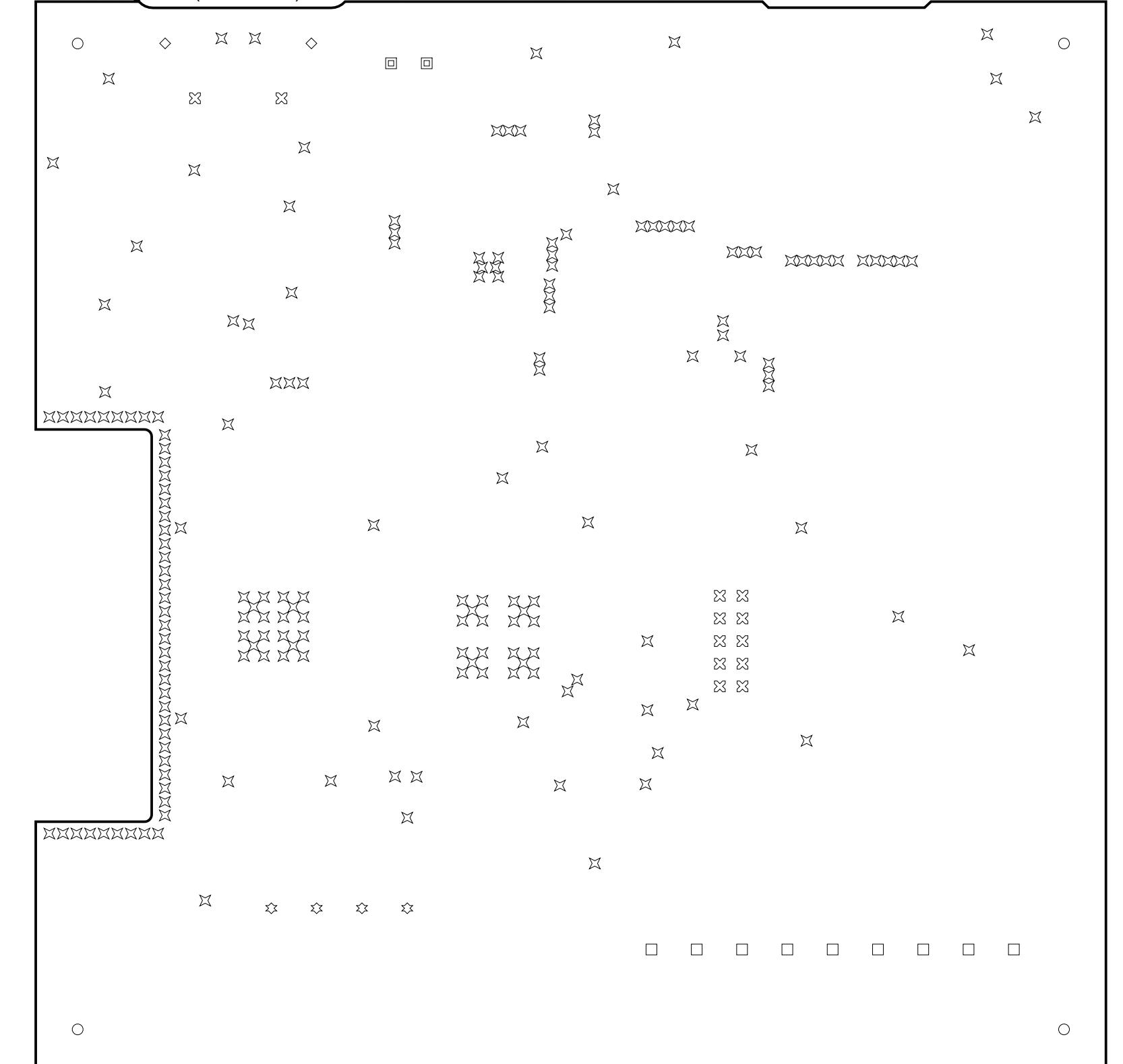
Material	Layer	Thickness	Dielectric Material	Type	Gerber
Surface Material	Top Overlay	0.03mm	Solder Resist	GTO	
Copper	Top Solder	0.04mm		GTS	
Prepreg	<b>Top Layer</b>	<b>0.33mm</b>	<b>PP-006</b>	<b>Signal</b>	<b>GTL</b>
CF-004	GND	0.02mm		Dielectric	
Core		0.71mm	Core-009	Signal	G1
CF-004	PowerPlane	0.02mm		Dielectric	
Prepreg		0.33mm	PP-006	Signal	G2
Copper	<b>Bottom Layer</b>	<b>0.04mm</b>		Dielectric	<b>GBL</b>
Surface Material	Bottom Solder	0.03mm	Solder Resist	Solder Mask	GBS
	Bottom Overlay			Legend	GBO

Total thickness: 1.53mm

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ASSY DOC: =DOC_NO_FAB_DWG			
SCH DOC: =DOC_NO_SCH_DWG			
PCB DOC: =PCB_DWG_NO			
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SCALE:	FILE NAME: StarterBoardFabrication.PCBDwf	REV:	
1 OF 12			

REV STATUS OF SHEETS				REV	DOC_NO_ASSY_DWG	REV
SHEET						

Drill Drawing View (Scale 3.5:1)



Drill Table

Symbol	Count	Hole Size	Plated	Hole Tolerance
☒	186	0.20mm	Plated	
☒	12	0.65mm	Plated	
◊	2	0.70mm	Plated	
□	9	0.89mm	Plated	
□	2	1.00mm	Plated	
☒	4	1.27mm	Plated	
○	4	2.70mm	Plated	
219 Total				

PART NO: =PCB\_PART\_NUMBER

APPROVALS DATE

ENGINEER: =PCB\_ENGINEER =PCB\_ENGINEER

DESIGNER: =PCB\_DESIGNER =PCB\_DESIGNER

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Reference Documents

BOM DOC: =DOC\_NO\_BOM

ASSY DOC: =DOC\_NO\_FAB\_DWG

SCH DOC: =DOC\_NO\_SCH\_DWG

NEXT ASSY USED ON PCB DOC: =PCB\_DWG\_NO

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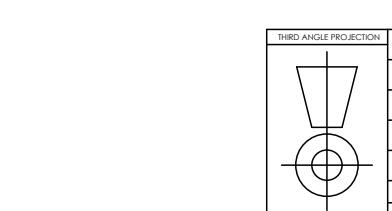
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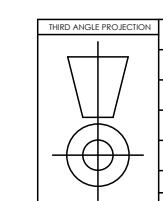
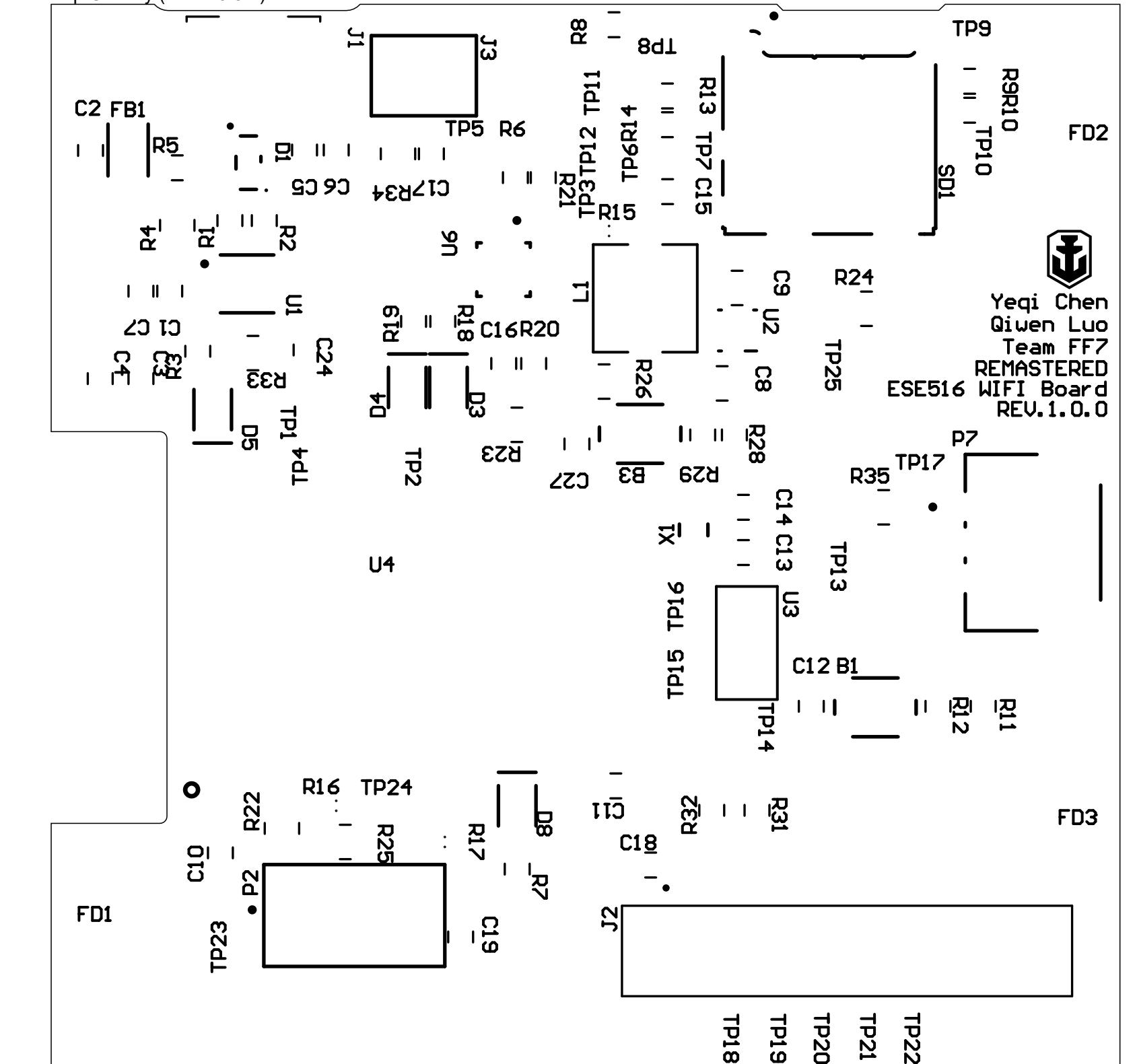
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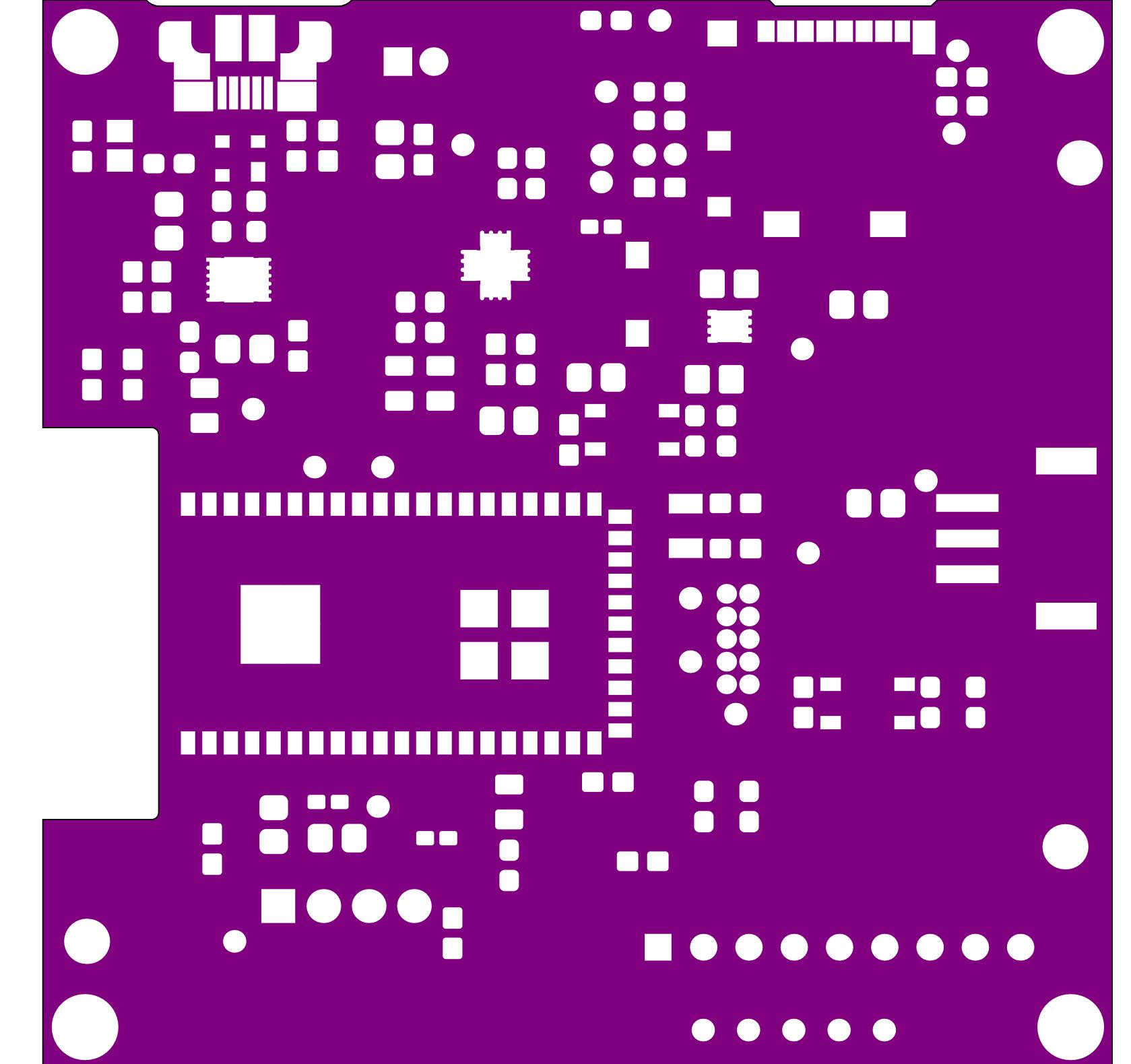


Top Overlay (Scale 3.5:)



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SCH DOC:	=DOC_NO_SCH_DWG	SIZE:	CAGE CODE:	DWG NO:
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			SHEET:	OF

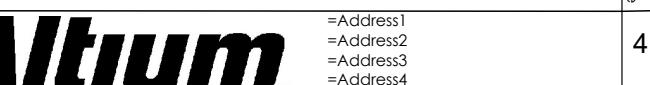
Top Solder (Scale 3.5:1)



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=Address2 4



Item	DESIGN ITEM REVISION:	ItemRevision
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FILE NAME: StarterBoardFabrication.PCBDwf SHEET: 4 OF 12

F

**THIRD ANGLE PROJECTION**

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ASSY DOC:	=DOC_NO_FAB_DWG	=PCB_TITLE_2	
SCH DOC:	=DOC_NO_SCH_DWG	SIZE: B	CAGE CODE: =CAGE_CO DWG NO: REV:
PCB DOC:	=PCB_DWG_NO	SCALE:	FILE NAME: StarterBoardFabrication.PCBDwf SHEET: 4 OF 12

Top Paste (Scale 3.5:1)

REV STATUS OF SHEETS	REV SHEET

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

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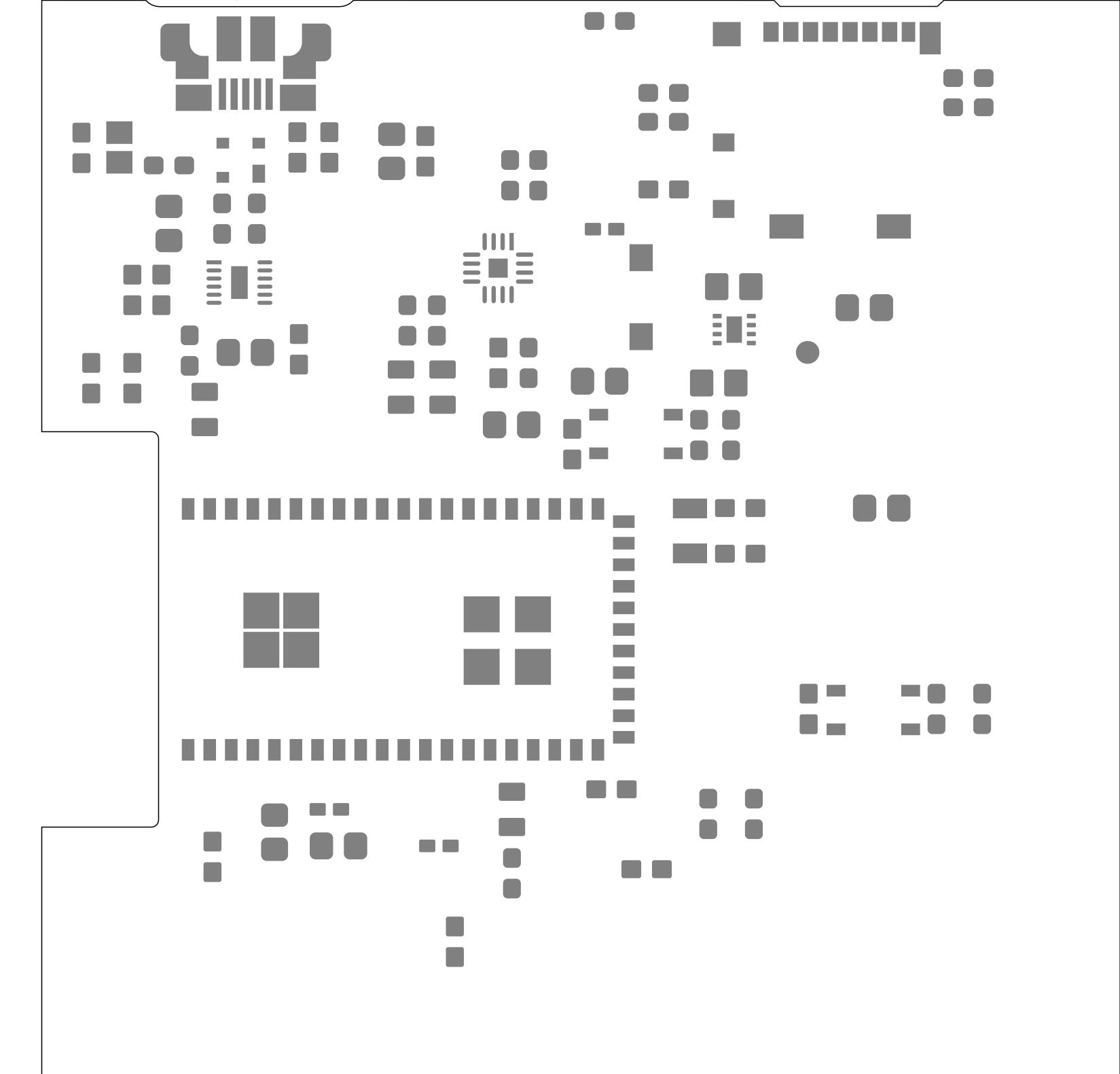
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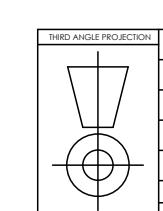
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PCB DOC:	=PCB_DWG_NO

*Altium*

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**DESIGN ITEM REVISION**



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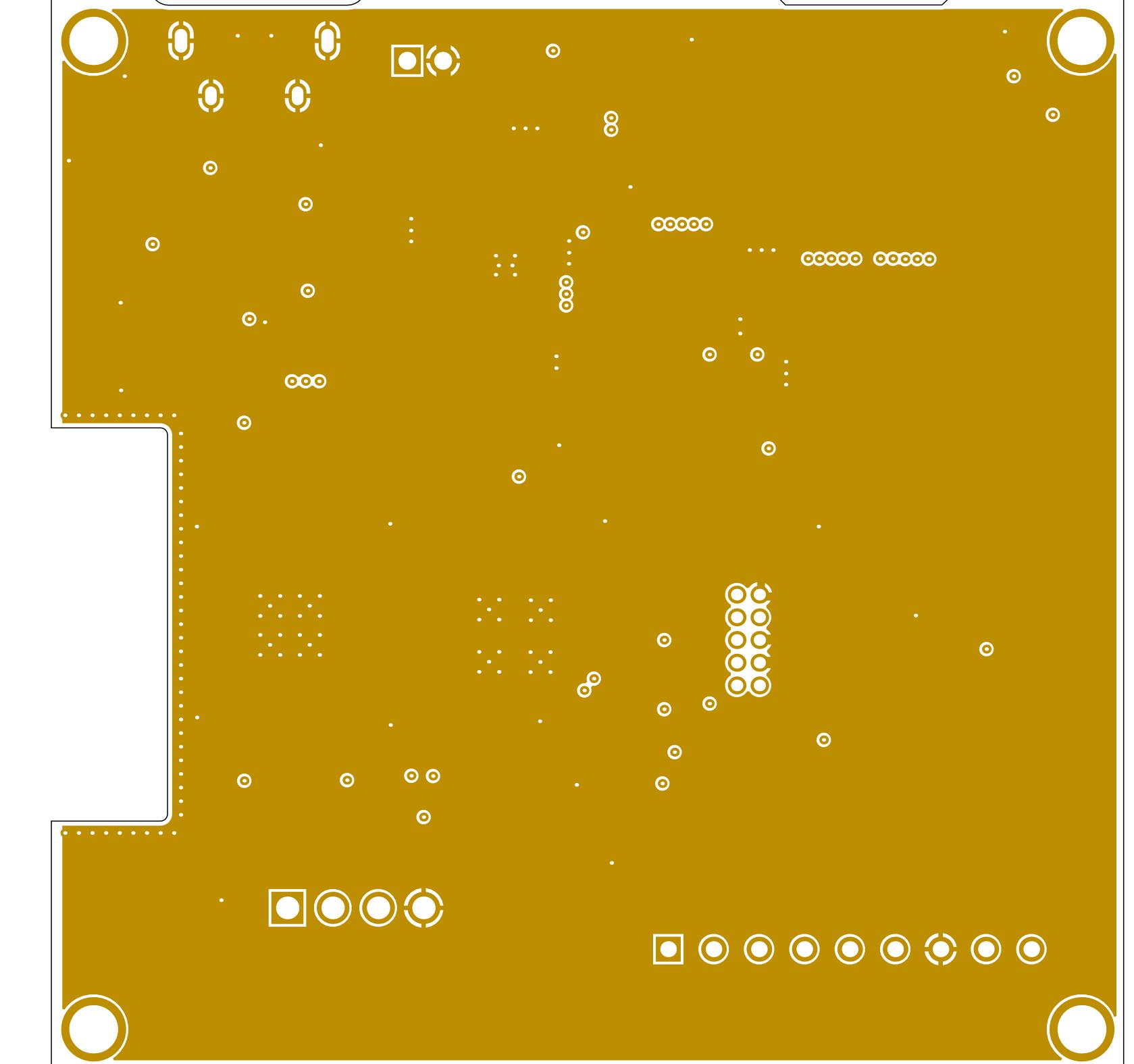
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GND (Scale 3.5:1)



REV STATUS OF SHEETS		REV									
SHEET											

ZONE	REV	DESCRIPTION	DATE	APPROVED

1

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APPROVALS DATE

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DESIGNER: =PCB\_DESIGNER =PCB\_DESIGNER

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APPLICATION

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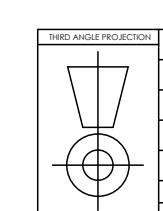
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**B** =CAGE\_CO

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DWG NO: =DOC\_NO\_ASSY\_.dwf

FILE NAME: StarterBoardFabrication.PCBDwf

7 OF 12

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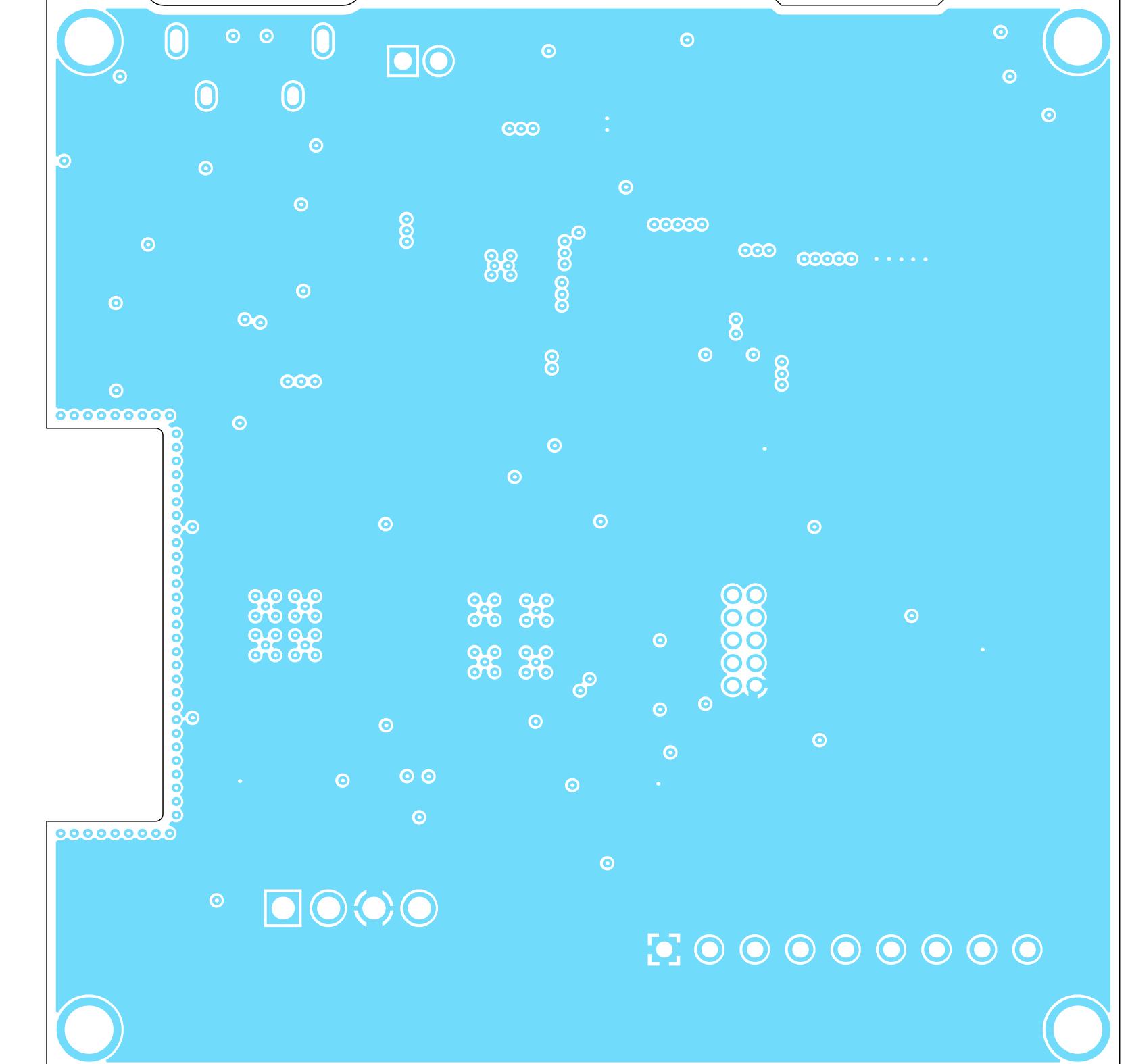
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## PowerPlane (Scale 3.5:1)



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REVISIONS		
ZONE	REV	DESCRIPTION

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USED ON			
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SCH DOC: =DOC_NO_SCH_DWG			
PCB DOC: =PCB_DWG_NO			
APPLICATION	FILE NAME: StarterBoardFabrication.PCBDwf	SCALE: 8 OF 12	

A

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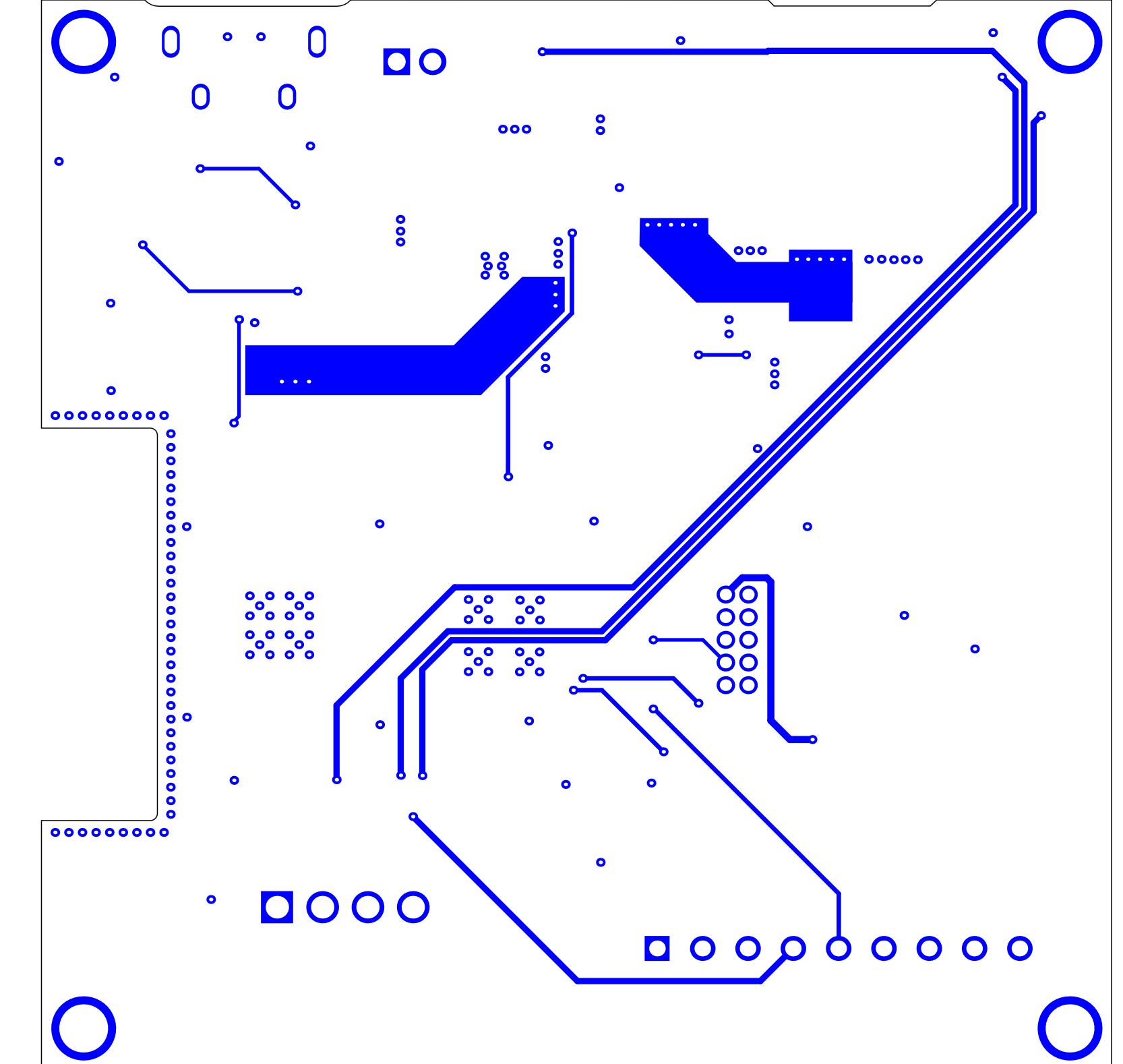
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REV STATUS OF SHEETS		REV				
SHEET						

DWG NO: =DOC\_NO\_ASSY\_DWG REV: .lfe

REVISIONS		DESCRIPTION	DATE	APPROVED

Bottom Layer (Scale 3.5:1)



PART NO: =PCB\_PART\_NUMBER

APPROVALS DATE

ENGINEER: =PCB\_ENGINEER =PCB\_ENGINEER

DESIGNER: =PCB\_DESIGNER =PCB\_DESIGNER

CHECKER: =PCB\_CHECKER =PCB\_CHECKER

Reference Documents

BOM DOC: =DOC\_NO\_BOM

ASSY DOC: =DOC\_NO\_FAB\_DWG

SCH DOC: =DOC\_NO\_SCH\_DWG

NEXT ASSY USED ON PCB DOC: =PCB\_DWG\_NO

APPLICATION

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=Address3  
=Address4

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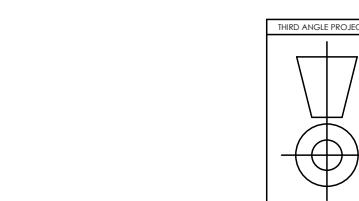
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SIZE: CAGE CODE: DWG NO:

B =CAGE\_CO REV:

FILE NAME: StarterBoardFabrication.PCBDwf SHEET: 9 OF 12

**Altium**™



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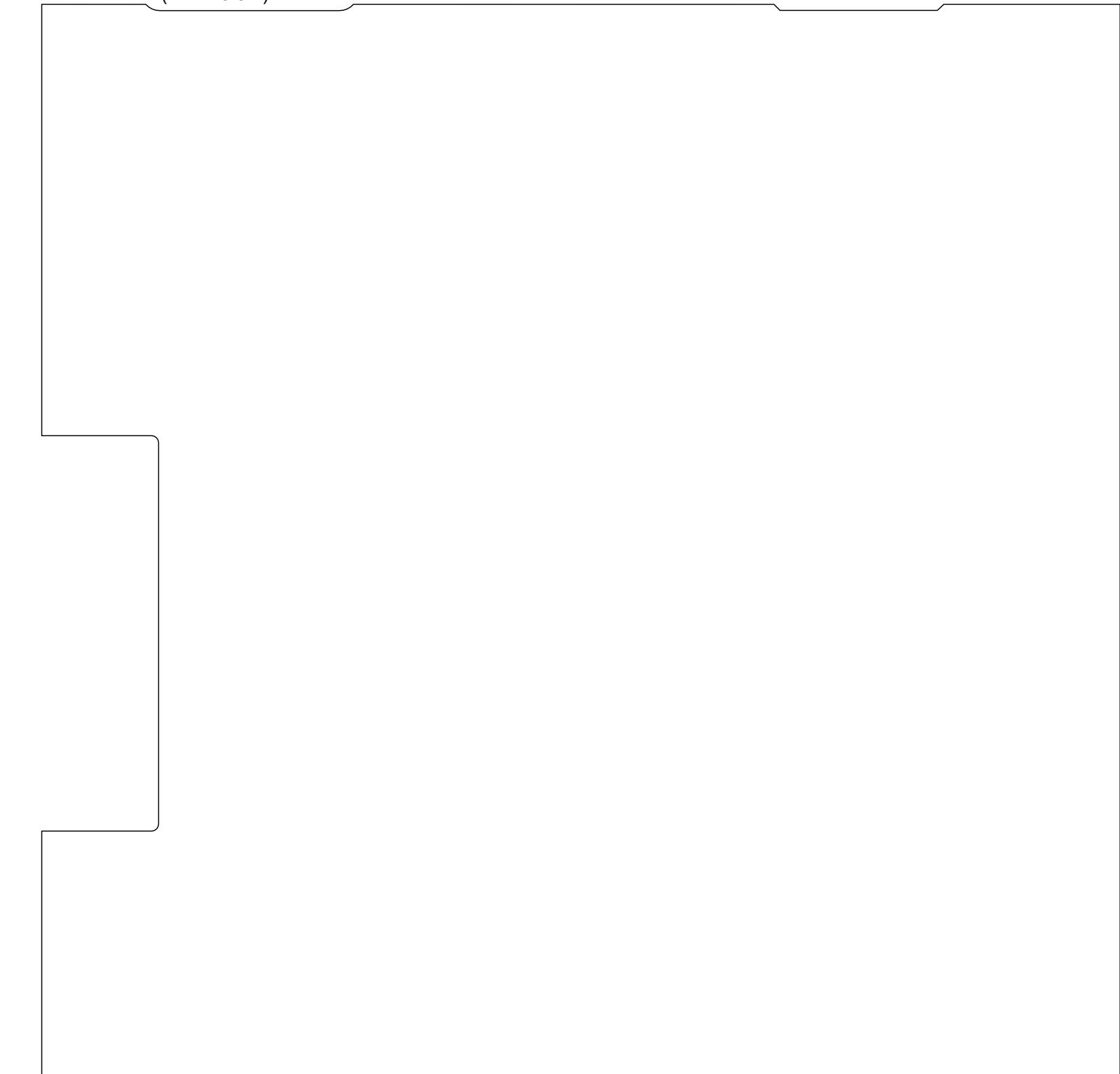
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DWG NO:		=DOC_NO_ASSY_DWG	REV:	.lfe
REV STATUS OF SHEETS	SHEET			

REVISIONS		
DESCRIPTION	DATE	APPROVED

Bottom Paste (Scale 3.5:1)



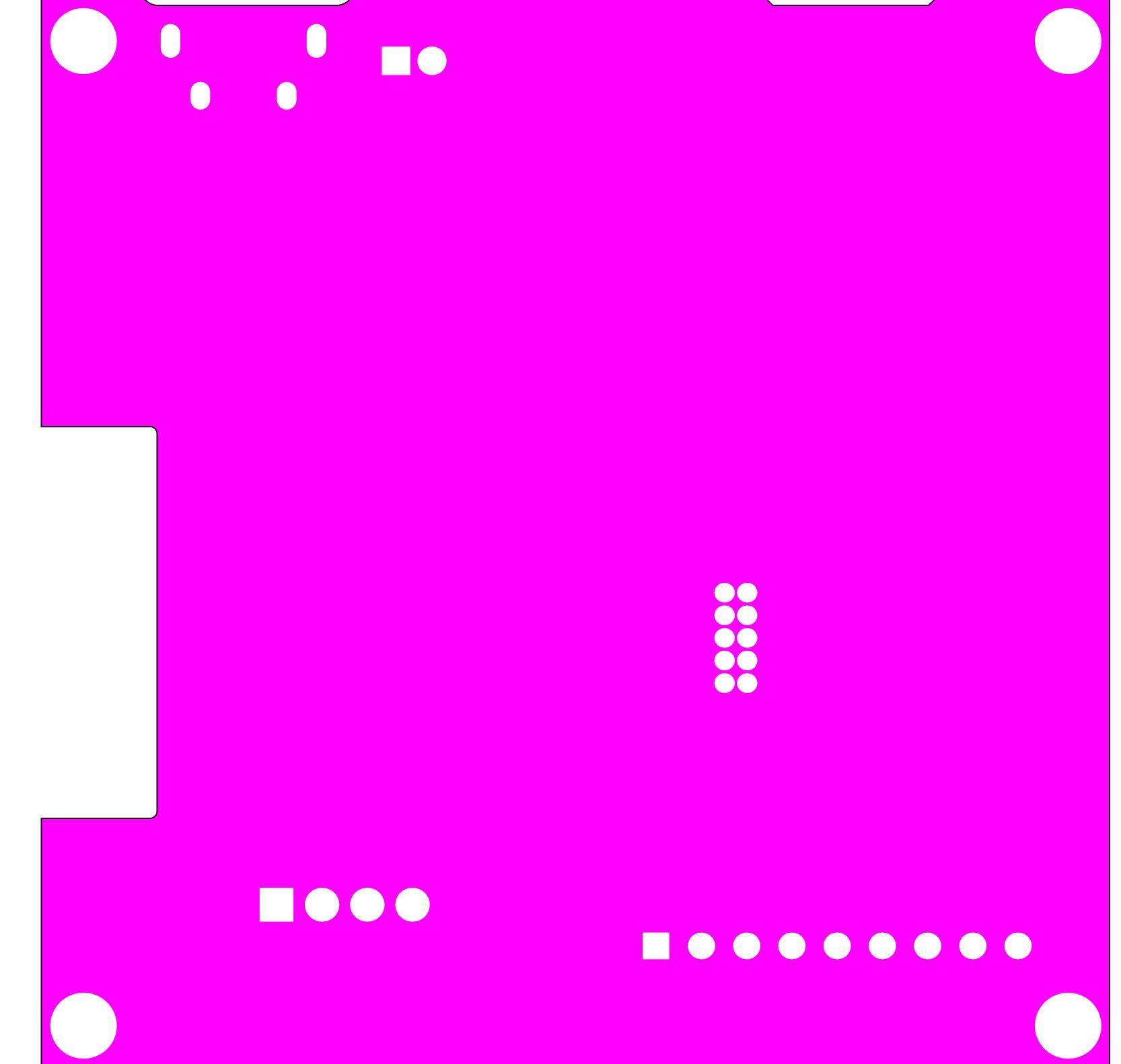
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DWG NO:  
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PART NO: =PCB_PART_NUMBER		APPROVALS	DATE	
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DESIGNER:	=PCB_DESIGNER	=PCB_DESIGNER		
CHECKER:	=PCB_CHECKER	=PCB_CHECKER		
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SCH DOC:	=DOC_NO_SCH_DWG			
NEXT ASSY	USED ON	PCB DOC:	=PCB_DWG_NO	SIZE: CAGE CODE: DWG NO: REV:
APPLICATION				B =CAGE_CO
SCALE:	FILE NAME:	StarterBoardFabrication.PCBDwf		Sheet: 10 OF 12

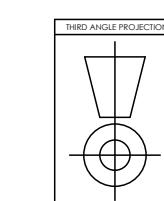
Bottom Solder (Scale 3.5:1)



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REV STATUS OF SHEETS	SHEET			

REVISIONS		
DESCRIPTION	DATE	APPROVED

PART NO: =PCB_PART_NUMBER	APPROVALS	DATE	
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DESIGNER: =PCB_DESIGNER	=PCB_DESIGNER		
CHECKER: =PCB_CHECKER	=PCB_CHECKER		
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TITLE: =PCB_TITLE_1			
=PCB_TITLE_2			
SIZE: CAGE CODE: B =CAGE_CO	DWG NO:	REV:	
FILE NAME: StarterBoardFabrication.PCBDwf			
SCALE: 11 OF 12			



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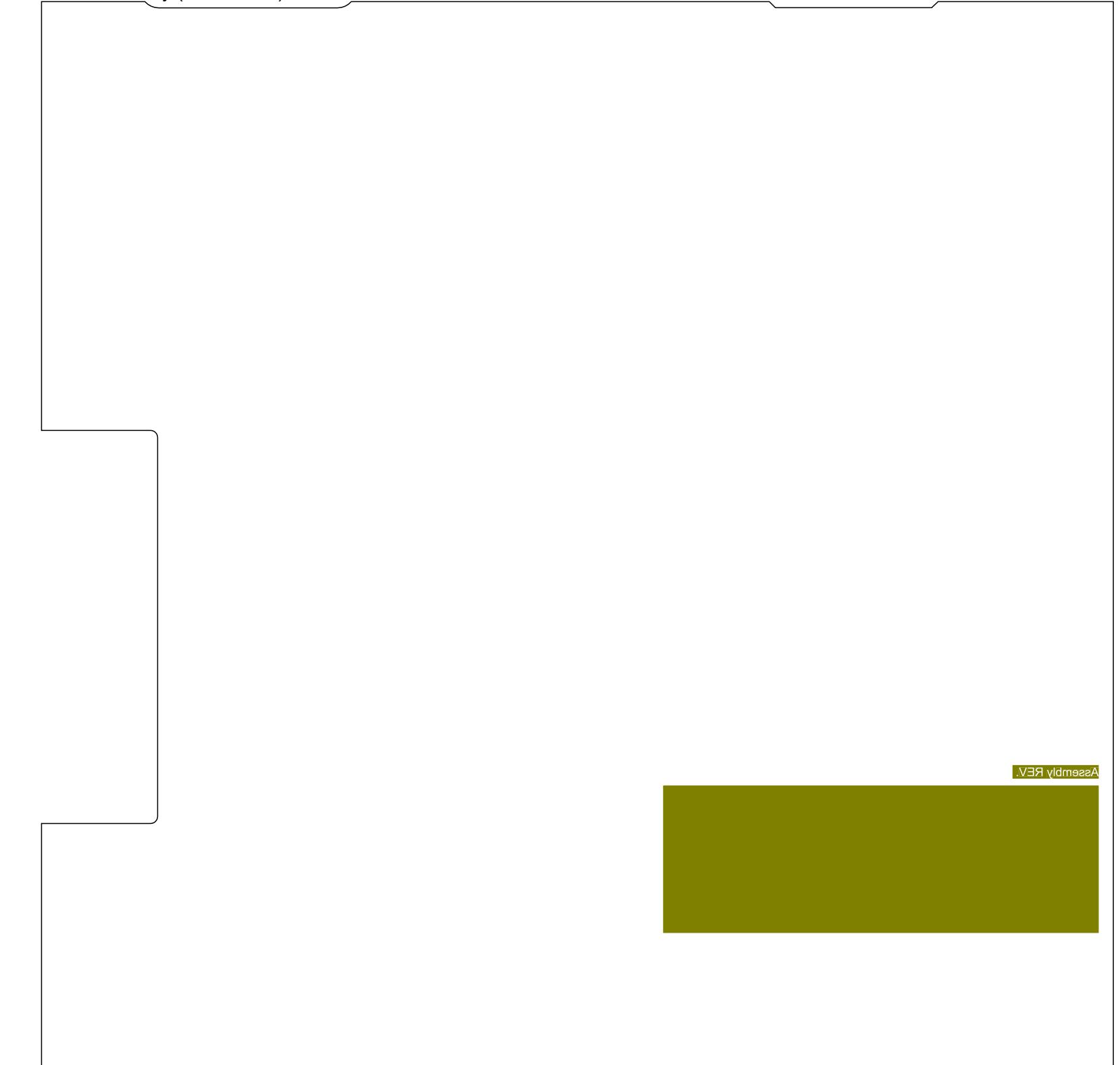
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DWG NO:		=DOC_NO_ASSY_DWG	REV:	.lfe
REV STATUS OF SHEETS	SHEET			

REVISIONS		
DESCRIPTION	DATE	APPROVED

Bottom Overlay (Scale 3.5:1)



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APPROVALS	DATE
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DESIGNER: =PCB_DESIGNER	=PCB_DESIGNER
CHECKER: =PCB_CHECKER	=PCB_CHECKER
Reference Documents	
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ASSY DOC:	=DOC_NO_FAB_DWG
SCH DOC:	=DOC_NO_SCH_DWG
NEXT ASSY	USED ON
PCB DOC:	=PCB_DWG_NO
APPLICATION	

**Altium**™

=Address1  
=Address2  
=Address3  
=Address4

DESIGN ITEM: .Item DESIGN ITEM REVISION: .ItemRevision

TITLE:  
=PCB\_TITLE\_1  
=PCB\_TITLE\_2

SIZE: CAGE CODE: DWG NO: REV:  
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FILE NAME: StarterBoardFabrication.PCBDwf SHEET: 12 OF 12

THIRD ANGLE PROJECTION

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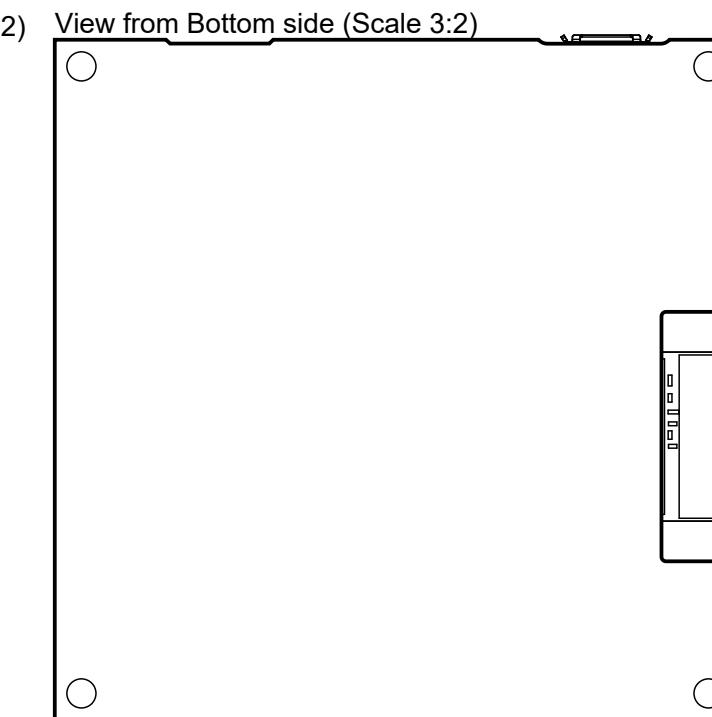
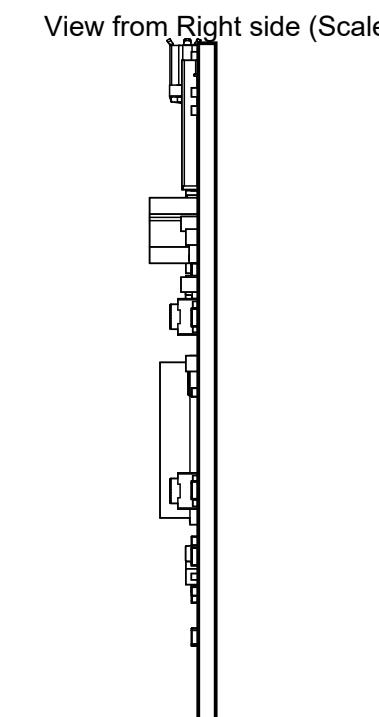
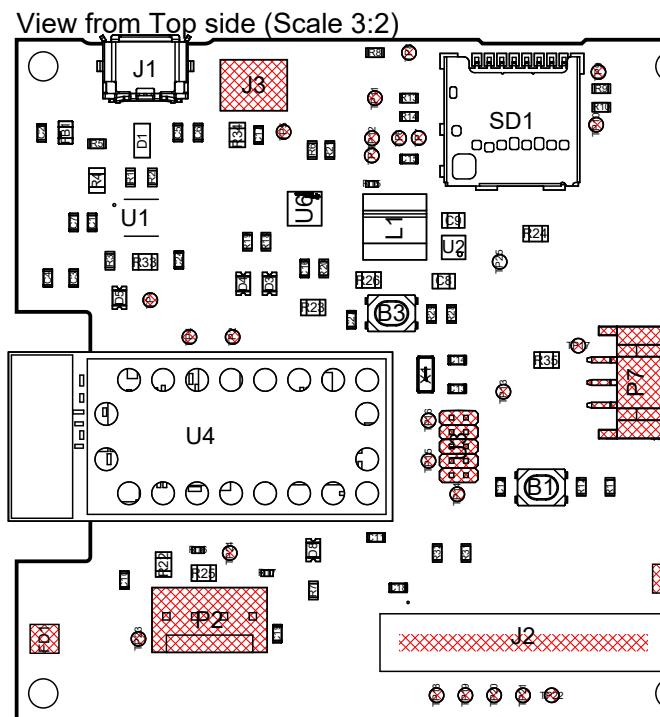
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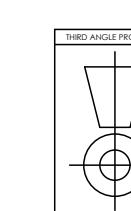
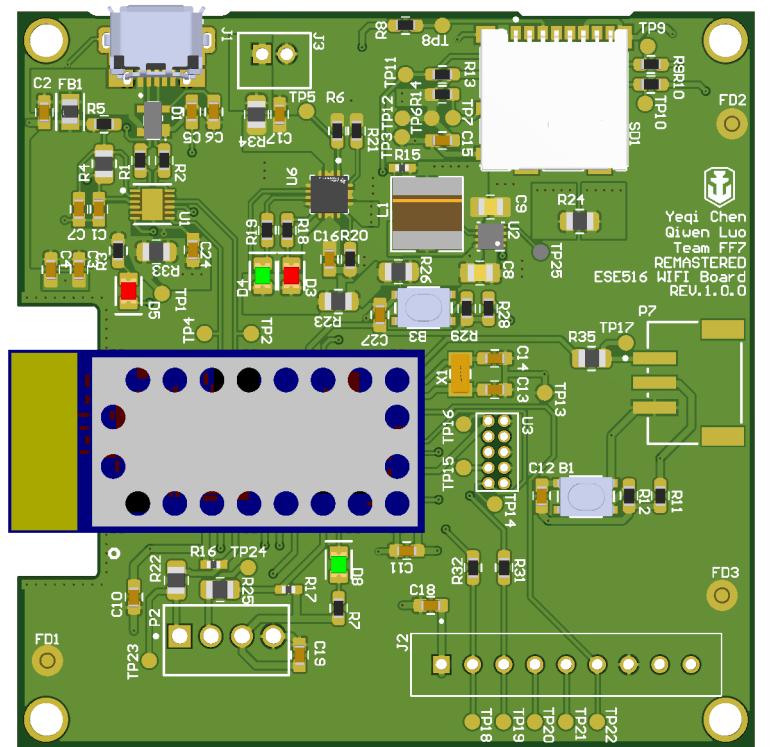
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REV STATUS OF SHEETS		REV			DWG NO: =DOC_NO_ASSY_DWG	REV: .lfe
SHEET						

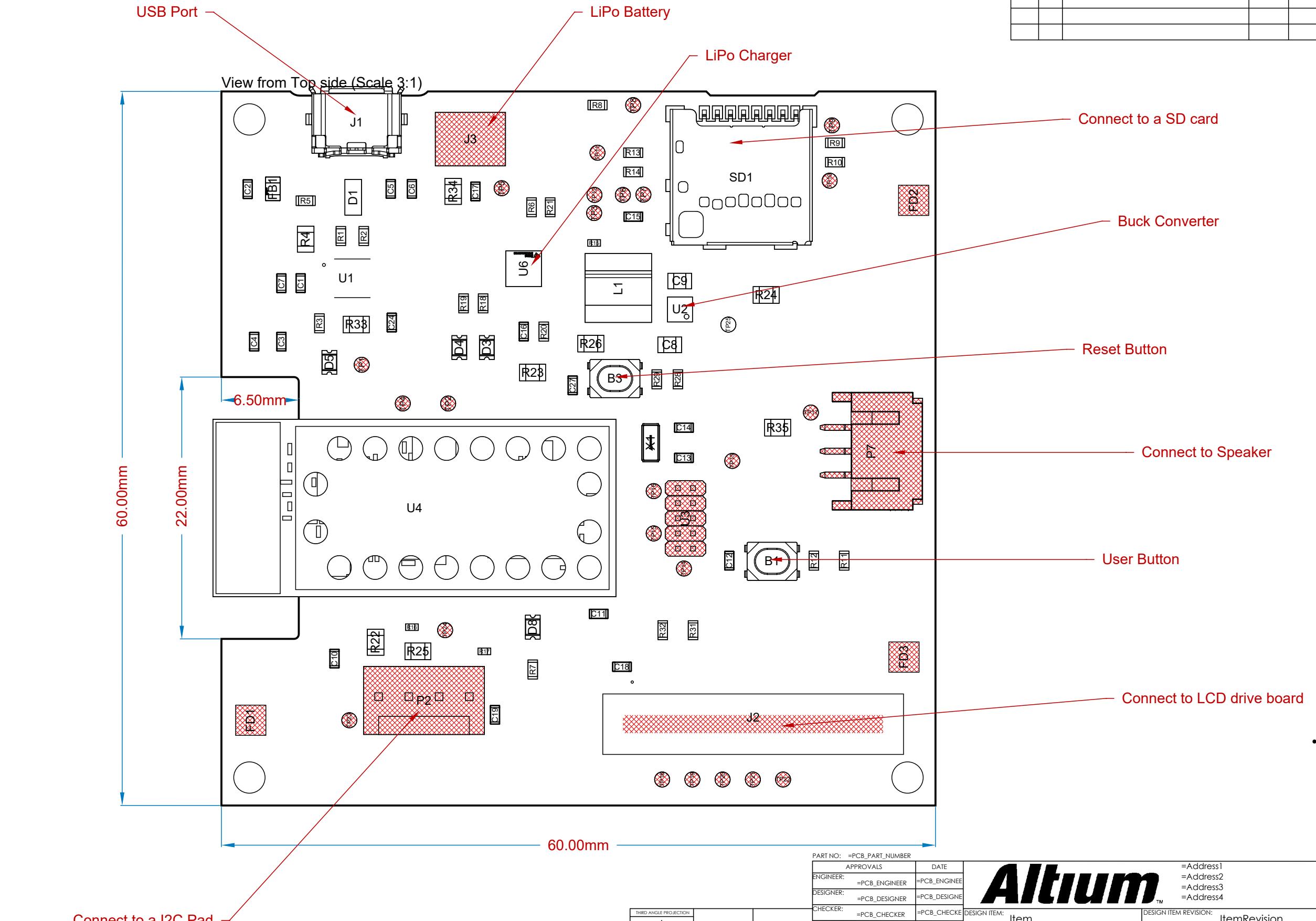
REVISIONS		DESCRIPTION	DATE	APPROVED



Realistic View



PART NO: =PCB_PART_NUMBER	APPROVALS	DATE	<b>Altium</b> DESIGN ITEM: .Item TITLE: .ItemRevision =PCB_TITLE_1 =PCB_TITLE_2	=Address1 =Address2 =Address3 =Address4
ENGINEER: =PCB_ENGINEER	=PCB_ENGINEER			
DESIGNER: =PCB_DESIGNER	=PCB_DESIGNER			
CHECKER: =PCB_CHECKER	=PCB_CHECKER			
BOM DOC:	Reference Documents			
ASSY DOC:	=DOC_NO_FAB_DWG			
SCH DOC:	=DOC_NO_SCH_DWG			
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APPLICATION				
SIZE: B	CAGE CODE: =CAGE_CO	DWG NO: .lfe		
SCALE: 1 OF 3	FILE NAME: StarterBoardAssembly.PCBDwf	REV: .lfe		



PART NO: =PCB\_PART\_NUMBER

APPROVALS DATE

ENGINEER: =PCB\_ENGINEER =PCB\_ENGINEER

DESIGNER: =PCB\_DESIGNER =PCB\_DESIGNER

CHECKER: =PCB\_CHECKER =PCB\_CHECKER

Reference Documents

BOM DOC: =DOC\_NO\_BOM

ASSY DOC: =DOC\_NO\_FAB\_DWG

SCH DOC: =DOC\_NO\_SCH\_DWG

PCB DOC: =PCB\_DWG\_NO

APPLICATION

=Address1  
=Address2  
=Address3  
=Address4

DESIGN ITEM: .Item DESIGN ITEM REVISION: .ItemRevision

TITLE: =PCB\_TITLE\_1  
=PCB\_TITLE\_2

SIZE: CAGE CODE: DWG NO:

B =CAGE\_CO REV:

SCALE: FILE NAME: StarterBoardAssembly.PCBDwf SHEET: 2 OF 3

**Altium**

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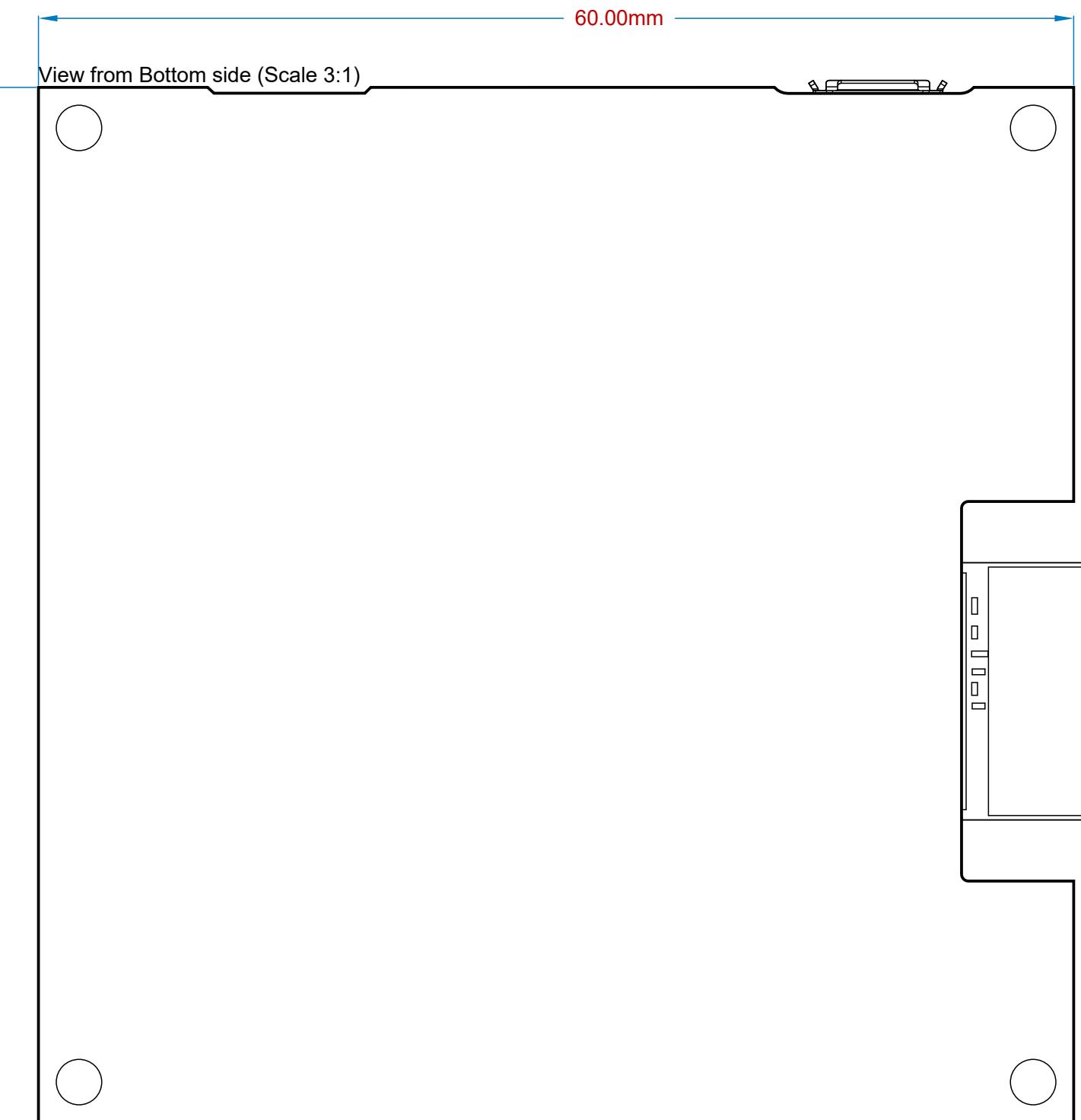
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REV STATUS OF SHEETS		REV											
SHEET													

REVISIONS		DESCRIPTION	DATE	APPROVED



PART NO: =PCB\_PART\_NUMBER

APPROVALS DATE

ENGINEER: =PCB\_ENGINEER =PCB\_ENGINEER

DESIGNER: =PCB\_DESIGNER =PCB\_DESIGNER

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ASSY DOC: =DOC\_NO\_FAB\_DWG

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NEXT ASSY USED ON PCB DOC: =PCB\_DWG\_NO

APPLICATION

**Altium**  
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SIZE: CAGE CODE: DWG NO:

**B** =CAGE\_CO

REV:

FILE NAME: StarterBoardAssembly.PCBDwf

SCALE: SHEET: 3 OF 3

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DWG NO: =DOC\_NO\_ASSY\_.dwg

REV:

Line #	Name	Description	Designator	Quantity	Manufacturer 1	Manufacturer Part Number 1	Manufacturer Lifecycle 1	Supplier 1	Supplier Part Number 1	Supplier Unit Price 1	Supplier Subtotal 1
	1uH	No Description Available	L1	1	Wurth Electronics	744316100	Volume Production	Digi-Key	732-6176-1-ND	2.72	2.72
	CAP 0603 4.7UF 35V 10% X5R	Capacitor Surface Mount 0603 Footprint 47UF 35V 10% Tolerance Ceramic X5R	C4, C16, C17	3	Yageo	CC0603KRX5R6BB475	Volume Production	Digi-Key	311-1455-1-ND	0.25	0.75
	CAP 0603 10UF 16V 20% X5R	Capacitor Surface Mount 0603 Footprint 10UF 16V 20% Tolerance Ceramic X5R	C10, C11	2	Yageo	CC0603MRX5R6BB106	Volume Production	Digi-Key	311-1448-1-ND	0.22	0.44
	CAP 0805 10UF 10V 10% X7R	Capacitor Surface Mount 0805 Footprint 10UF 10V 10% Tolerance Ceramic X7R	C8	1	Yageo	CC0805KXX7R6BB106	Volume Production	Mouser	603-CC805KXX7R6BB106	0.25	0.25
	CAP 0805 22UF 10V 20% X5R	Capacitor Surface Mount 0805 Footprint 22UF 10V 20% Tolerance Ceramic X5R	C9	1	Yageo	CC0805MKX5R6BB226	Volume Production	Digi-Key	311-1900-1-ND	0.36	0.36
	TPS62082DSGR	Buck Step Down Regulator with 2.3 to 6 V Input and 3.3 V Output, -40 to 85 degC, 8-Pin WSON (DSG), Green (RoHS & no Pb/Br)	U2	1	Texas Instruments	TPS62082DSGR	Volume Production	Digi-Key	296-49331-6-ND	1.73	1.73
1	PTS810SJ250SMTRLFS	Keypad Switch, 1 Switches, SPST, Momentary-tactile, 0.05A, 16VDC, 3.23N, Solder Terminal, Surface Mount-straight	B1, B3	2	ITT C&K	PTS810SJ250SMTRLFS	Volume Production	Digi-Key	CKN10503DKR-ND	0.34	0.68
2	CAP 0603 0.1UF 16V 10% X7R	Capacitor Surface Mount 0603 Footprint 0.1UF 16V 10% Tolerance Ceramic X7R	C1, C3, C7, C15	4	Yageo	CC0603KPx7R7BB104	Volume Production	Digi-Key	311-1335-1-ND	0.1	0.4
3	CAP 0603 0.01UF 16V 10% X7R	Capacitor Surface Mount 0603 Footprint 0.01UF 16V 10% Tolerance Ceramic X7R	C2	1	Yageo	CC0603KRX7R7BB103	Volume Production	Digi-Key	311-3369-1-ND	0.1	0.1
5	CAP 0603 47PF 50V 5% COG	Capacitor Surface Mount 0603 Footprint 47PF 50V 5% Tolerance Ceramic COG	C5, C6	2	Yageo Phycomp	CC0603JRNPO9BN470	Volume Production	Digi-Key	311-1065-1-ND	0.1	0.2
6	CAP 0603 1UF 16V 10% X7R	Capacitor Surface Mount 0603 Footprint 1UF 16V 10% Tolerance Ceramic X7R	C12, C18, C19, C24, C27	5	Yageo	CC0603KRX7R7BB105	Volume Production	Digi-Key	311-1446-1-ND	0.14	0.7
8	CAP 0603 18PF 50V 5% COG	Capacitor Surface Mount 0603 Footprint 18PF 50V 5% Tolerance Ceramic COG	C13, C14	2	Yageo	CC0603JRNPO9BN180	Volume Production	Digi-Key	311-1061-1-ND	0.1	0.2
11	PRTR5V0U2X,215	Ultra Low Capacitance Double Rail-to-Rail ESD Protection Diode, 5.5 V, 1 pF, -40 to 85 degC, 4-Pin SOT143B, RoHS, Tape and Reel	D1	1	Nexperia	PRTR5V0U2X,215	Volume Production	Digi-Key	1727-3884-1-ND	0.51	0.51
13	LSM0805412V	Single Color LED, RED, 0805	D3, D5	2	Visual Communications	LSM0805412V	Volume Production	Digi-Key	28-LSM0805412VCT-ND	0.47	0.94
14	LSM0805452V	Single Color LED, Green, 0805	D4, D8	2	Visual Communications	LSM0805452V	Volume Production	Digi-Key	28-LSM0805452VCT-ND	0.41	0.82
15	BLM21PG221SN1D	Chip Ferrite Bead, 0805, 220Ω @ 100MHz, 0.045Ω, 25%, 2A	FB1	1	Murata	BLM21PG221SN1D	Unknown	Digi-Key	490-1054-6-ND	0.12	0.12
16	10103592-0001LF	Conn Micro USB 2.0 Type B RCP 5 POS 0.65mm Solder RA SMD 5 Terminal 1 Port T/R	J1	1	Amphenol ICC / FCI	10103592-0001LF	Unknown	Mouser	649-10103592-0001LF	0.8	0.8
19	RES 0603 27 1%	Resistor Surface Mount, 27 Ohms, 0603 Footprint, 1% Tolerance 0.1W	R1, R2, R8, R9, R10, R31, R32	7	Stackpole Electronics	RMCF0603FT27R0	Volume Production	Digi-Key	RMCF0603FT27R0CT-ND	0.016	0.16
20	RES 0603 1K 1%	Resistor Surface Mount, 1K Ohms, 0603 Footprint, 1% Tolerance 0.1W	R3, R5, R6, R7, R18, R19	6	Stackpole Electronics	RMCF0603FT1K00	Volume Production	Digi-Key	RMCF0603FT1K00CT-ND	0.016	0.16
22	RES 0603 10K 1%	Resistor Surface Mount, 10K Ohms, 0603 Footprint, 1% Tolerance 0.1W	R11, R13, R14, R28	4	Stackpole Electronics	RMCF0603FT10K0	Volume Production	Digi-Key	RMCF0603FT10K0CT-ND	0.016	0.16
23	RES 0603 100 1%	Resistor Surface Mount, 100 Ohms, 0603 Footprint, 1% Tolerance 0.1W	R12, R29	2	Stackpole Electronics	RMCF0603FT100R	Volume Production	Digi-Key	RMCF0603FT100RCT-ND	0.016	0.16
27	RES 0603 1.13K 1%	Resistor Surface Mount, 1.13K Ohms, 0603 Footprint, 1% Tolerance 0.1W	R20, R21	2	Stackpole Electronics	RMCF0603FT1K13	Volume Production	Digi-Key	RMCF0603FT1K13CT-ND	0.016	0.16
28	104031-0811	Micro SD Card, RA, -25 to 85 degC, 8-Pin SMD, RoHS, Tape and Reel	SD1	1	Molex	1040310811	Unknown	Digi-Key	WM6357TR-ND	1.21	2410.58
29	FT234XD-R	IC USB SERIAL BASIC UART 12DFN	U1	1	FTDI	FT234XD-R	Volume Production	Digi-Key	768-1178-6-ND	2.26	2.26
30	RES 0402 10K 1%	Resistor Surface Mount, 10K Ohms, 0402 Footprint, 1% Tolerance 0.063W	R16, R17	2	Stackpole Electronics	RMCF0402FT10K0	Volume Production	Digi-Key	RMCF0402FT10K0CT-ND	0.014	0.14
32	ATSAMW25H18-MR210PB	2.7 - 4.2 V 65 Mbps 17 dbm 256 kB Flash 32 kB SRAM 802.11 b/g/n Smart Module	U4	1	Microchip	ATSAMW25H18-MR210PB	Unknown	One Stop Electro	55722508	12.8	12.8
33	RES 0402 178K 1%	Resistor Surface Mount, 178K Ohms, 0402 Footprint, 1% Tolerance 0.063W	R15	1	Stackpole Electronics	RMCF0402FT178K	Volume Production	Digi-Key	RMCF0402FT178KCT-ND	0.1	0.1
34	BQ24075RGTR	IC LI-ION CHARGE MGMT 16-QFN	U6	1	Texas Instruments	BQ24075RGTR	Volume Production	Digi-Key	296-38874-1-ND	2.53	2.53
35	ABS07-32.768KHZ-T	Crystal 32.768kHz ±20ppm (Tol) 12.5pF FUND 70kΩ 2-Pin CSMD T/R	X1	1	Abracan	ABS07-32.768KHZ-T	Volume Production	Digi-Key	535-9542-1-ND	0.72	0.72