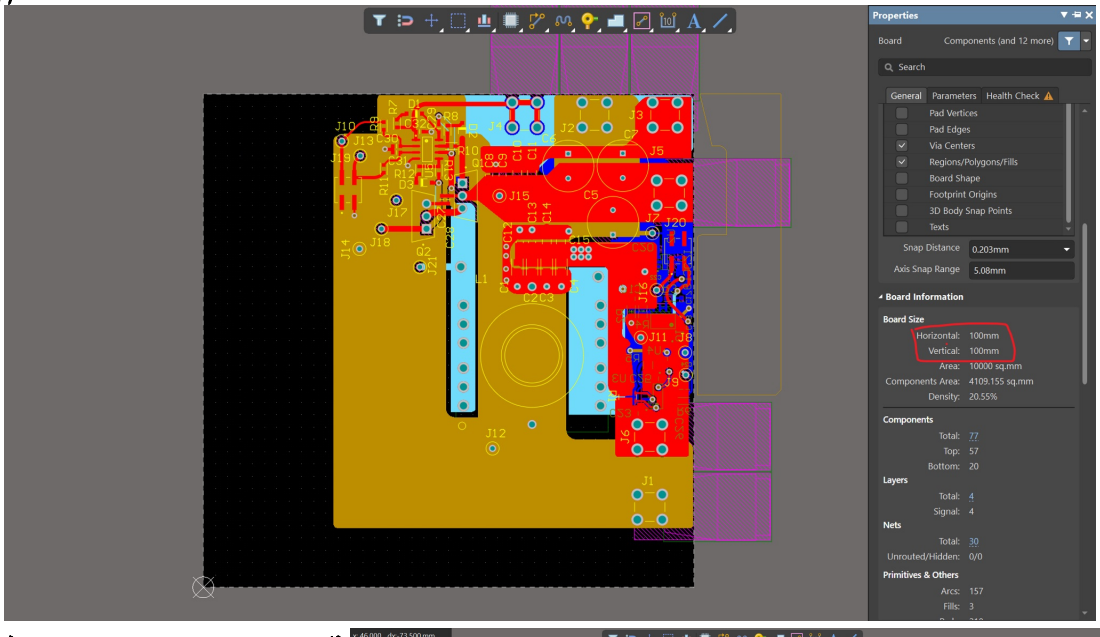
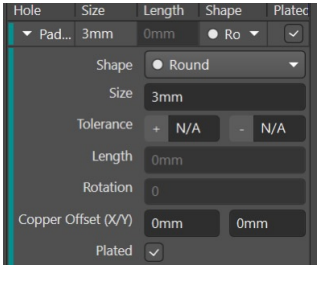
Once you have completed all routing, finalize* your PCB design and ensure the following:

1. Ensure your board is still 100x100 cm, even if you are not using all of the space.
2. Add four non-plated holes (typically in the corners) for standoffs. The standoffs in our parts library have size M3 screws.
3. Write your name in silkscreen somewhere on the top layer of your board. You are welcome to write other (class-appropriate) things in silkscreen, such as a title for your design, or additional labels.

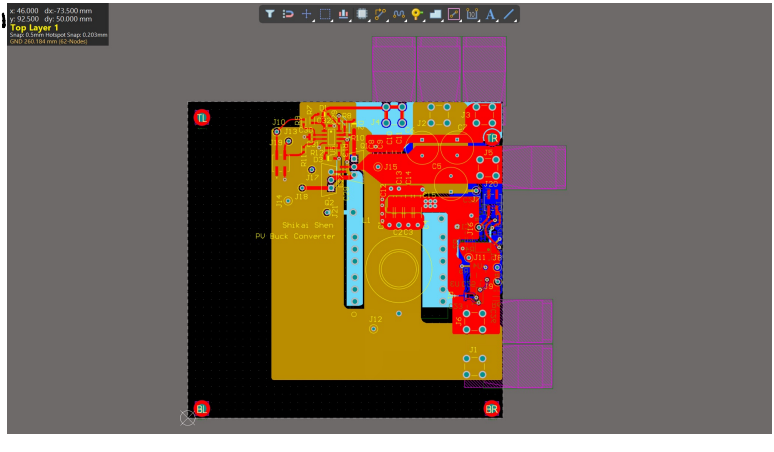
(1)



(2)

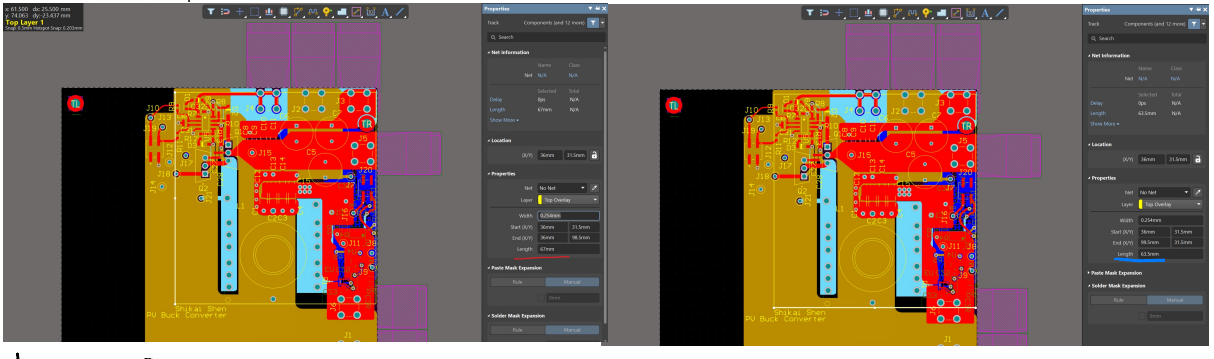


(3)



4. Draw a rectangular silkscreen border encircling all parts of your design that will be considered when evaluating your converter's power density. This should include how widely the eligible traces expand on internal layers, including planes. You are welcome to shrink planes to make this area smaller as long as you don't disrupt the performance of your power converter. As a reminder, your converter's power density will be measured based on its box volume (i.e., the volume of the smallest rectangular box that could enclose the whole design) considering all internal power traces, signal traces, planes, and all components besides connectors, test points, and unused parts of the PCB.

5. Ensure all other silkscreen labels are positioned as desired on the PCB. You are not required to keep unwanted component labels.



box area : 67mm x 62.5mm ≈ 4254.5mm²

Design Review Slide Deck

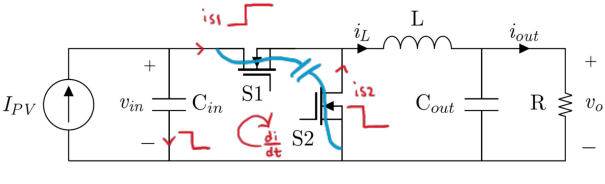
Prepare PowerPoint slides for a PCB design review appointment with course staff. The purpose of these slides is to clearly show important features of your PCB layout with screenshots. For each aspect, you are welcome to use multiple screenshots if necessary, especially if multiple layers are relevant. The slides themselves do not need to be fancy, but the feature of focus should be very clear. You should organize your slides as follows:

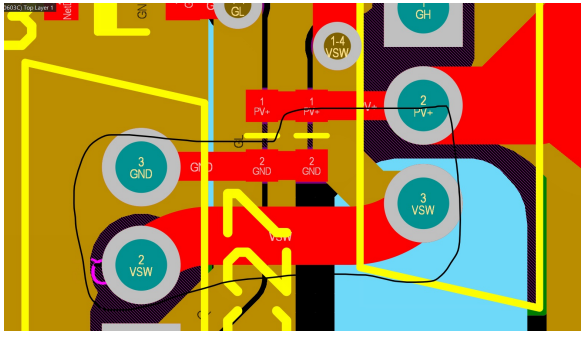
1. (213B only) Topology: Show a schematic of your converter topology.

2. Critical Loops: Clearly show with screenshots all critical loops, one by one. This includes all commutation loop(s), gate loop(s), and any other high di/dt loops. For clarity, 213B students should also show each loop of focus on the schematic.

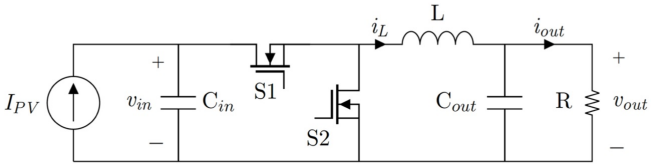
3. Critical Nodes: Clearly show with screenshots all critical nodes, one by one. This includes the switch node(s) and any other high dv/dt nodes. You should include the traces surrounding high dv/dt nodes in your screenshots to show the distance and/or shield between them. For clarity, 213B students should also show each node of focus on the schematic.

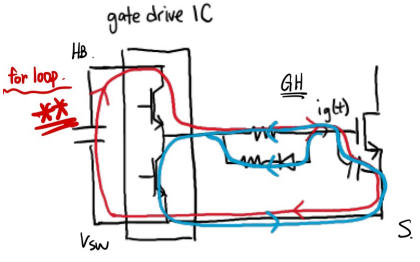
commutation loops: [high $\frac{di}{dt}$]

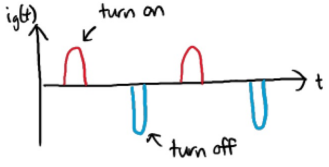




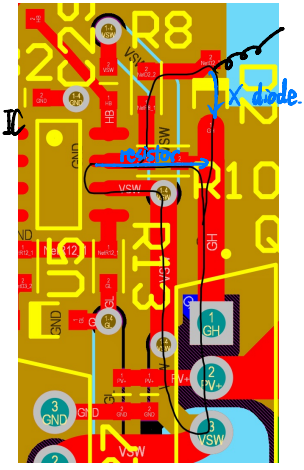
Gate Loops [high $\frac{di}{dt}$]







side view:

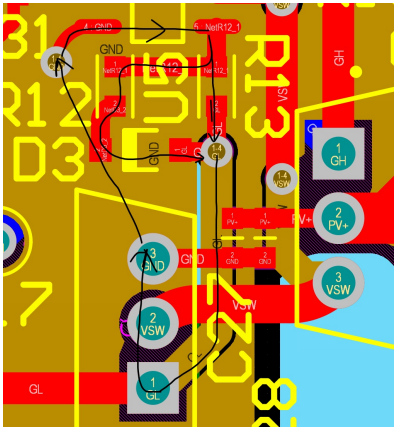


Gate High Loop: GH ⟶ VSW ⟹ BTI ⟶ Gate IC

Gate Ic

↓

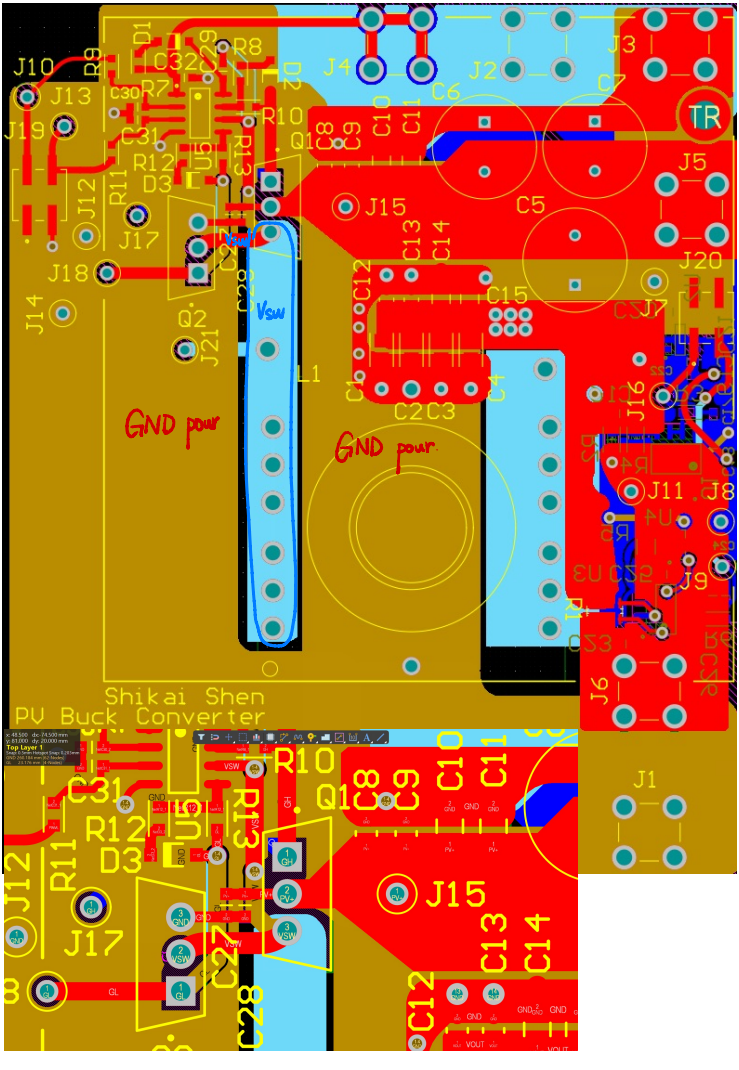
Gate Low Loop: LO → GL → GND



High $\frac{di}{dt}$ loops: commutation, gate high, gate low

3. Critical Nodes: Clearly show with screenshots all critical nodes, one by one. This includes the switch node(s) and any other high dv/dt nodes. You should include the traces surrounding high dv/dt nodes in your screenshots to show the distance and/or shield between them. For clarity, 213B students should also show each node of focus on the schematic.

high $\frac{dv}{dt}$: Vsw



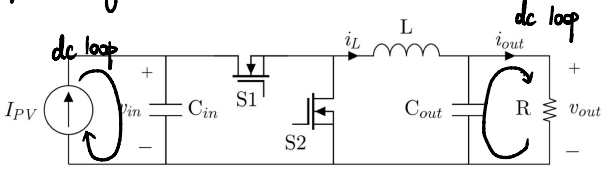
4. Power Stage Current Loops: Show screenshots of all power stage current loops, one by one. Show both the dc and ac current paths for each. For clarity, 213B students should also show each loop of focus on the schematic.

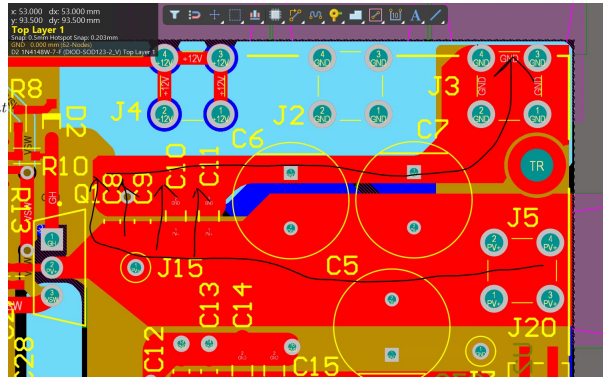
5. Analog Circuit Placement and Routing: Show screenshot(s) of how you have placed and routed analog circuits (e.g., sensing) to minimize interference and ensure minimal differences in ground potential. This includes showing the distance of such components from high di/dt loops and high dv/dt nodes, unless you are using shielding. This also includes showing the power rails and ground connections for these circuits.

6. Digital Circuit Placement and Routing: Show screenshot(s) of how you have placed and routed digital circuits (e.g., gate drive). This also includes showing the power rails and ground connections for these circuits.

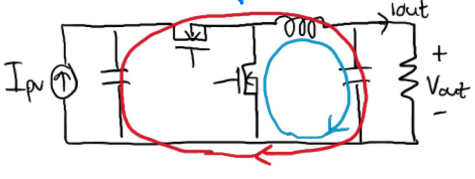
DC loops: (source) with large loop area ↓ minimize ESR

power stage current returns:

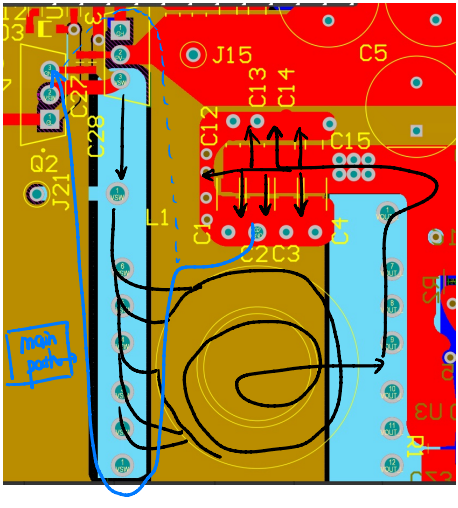




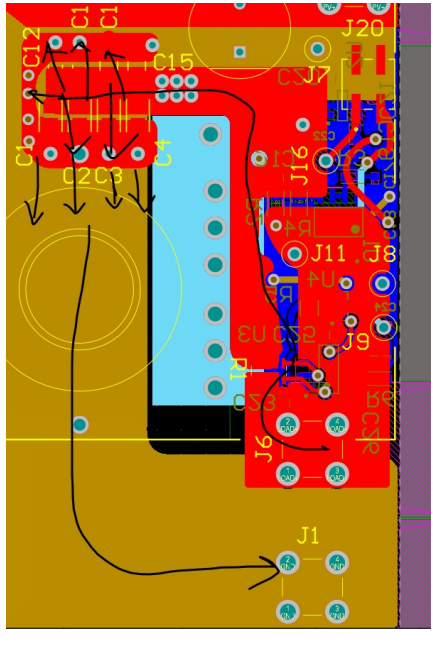
AC return paths: [every loops containing MOS]



AC loop:



DC loop (load) ← minimize ESR



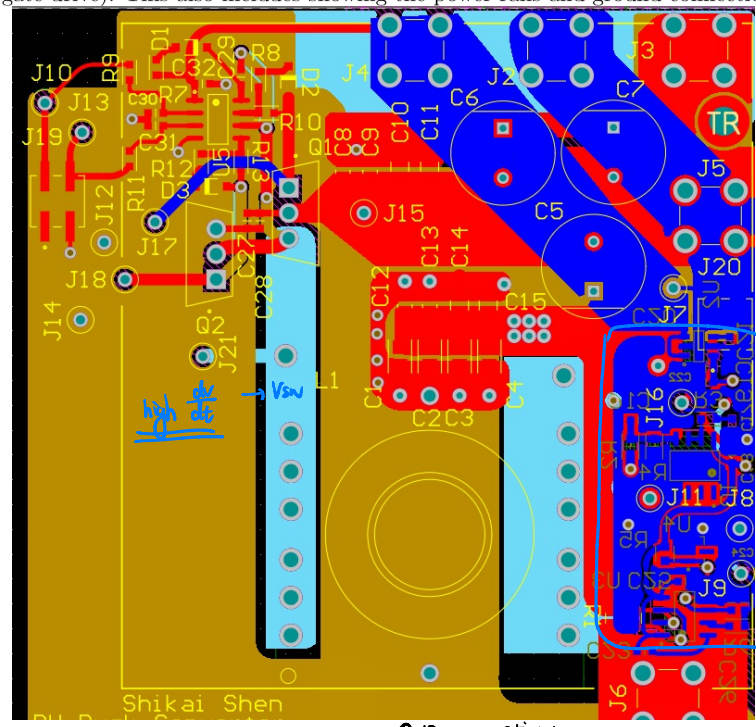
5. Analog Circuit Placement and Routing: Show screenshot(s) of how you have placed and routed analog circuits (e.g., sensing) to minimize interference and ensure minimal differences in ground potential. This includes showing the distance of such components from high di/dt loops and high dv/dt nodes, unless you are using shielding. This also includes showing the power rails and ground connections for these circuits.

6. Digital Circuit Placement and Routing: Show screenshot(s) of how you have placed and routed digital circuits (e.g., gate drive). This also includes showing the power rails and ground connections for these circuits.

Sensing circuit:

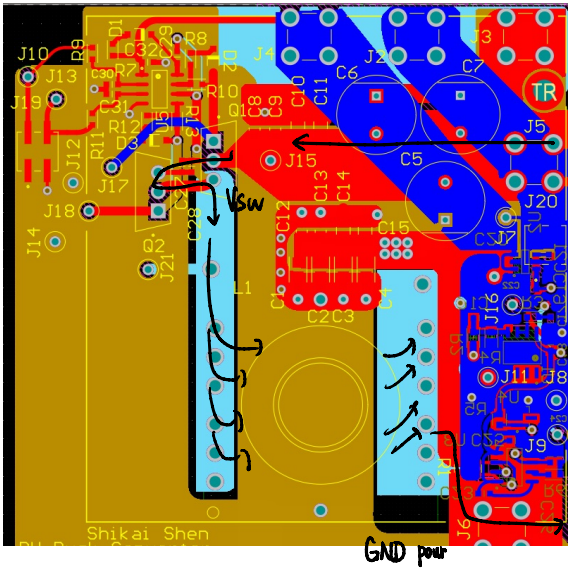
Gate IC →

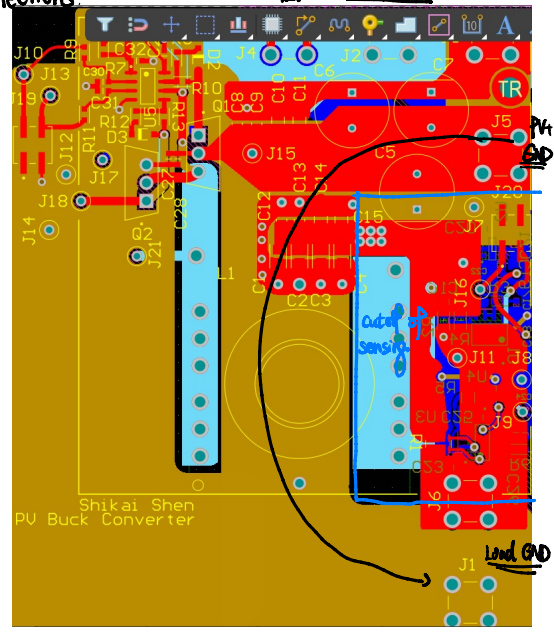
high $\frac{di}{dt}$



power rails:

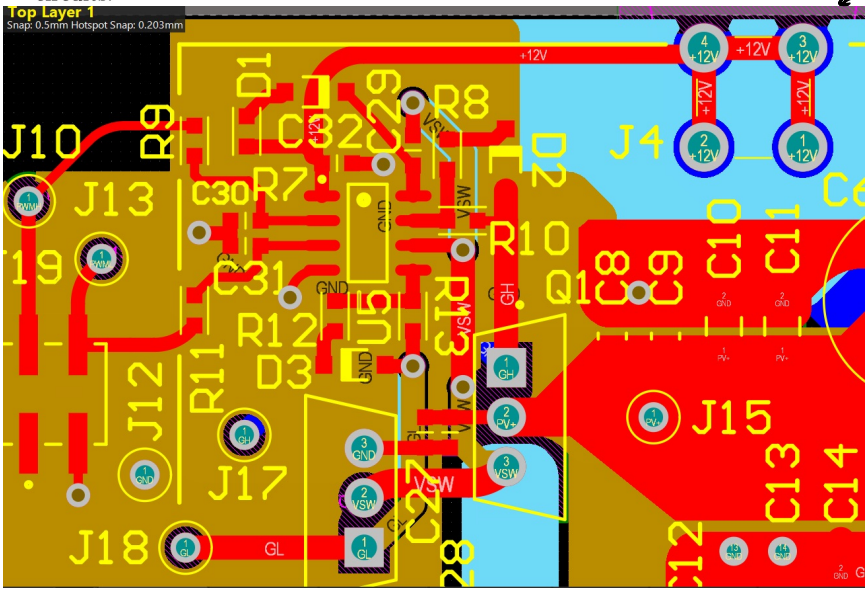
GND connections



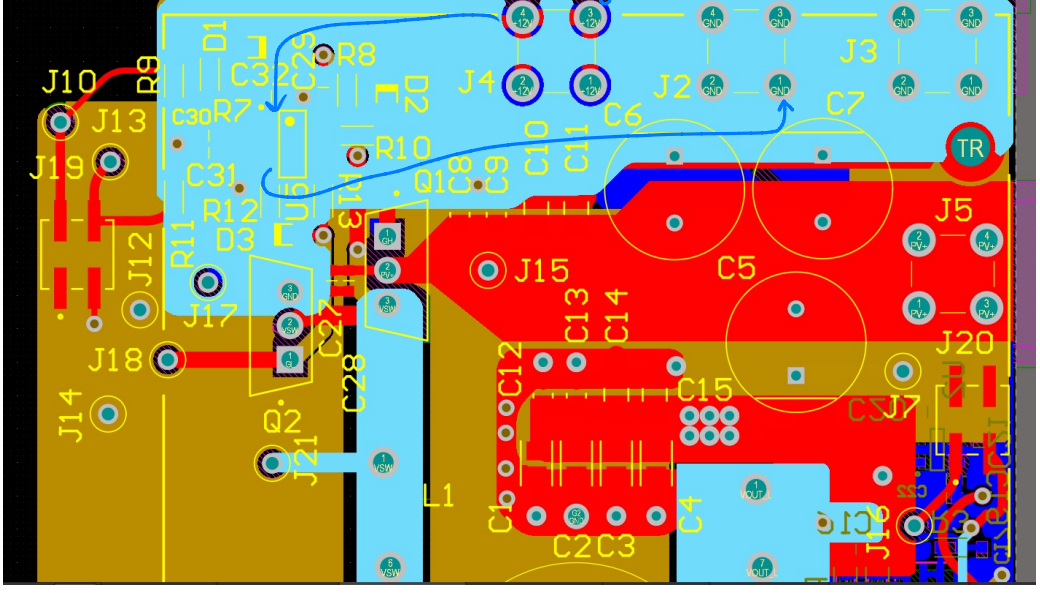


6. Digital Circuit Placement and Routing: Show screenshot(s) of how you have placed and routed digital circuits (e.g., gate drive). This also includes showing the power rails and ground connections for these circuits.

place position:



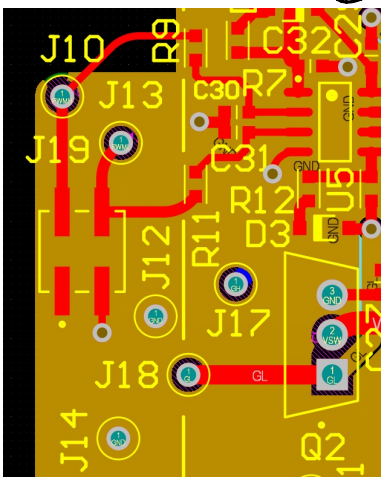
power rails and ground returns of Gate Driver.



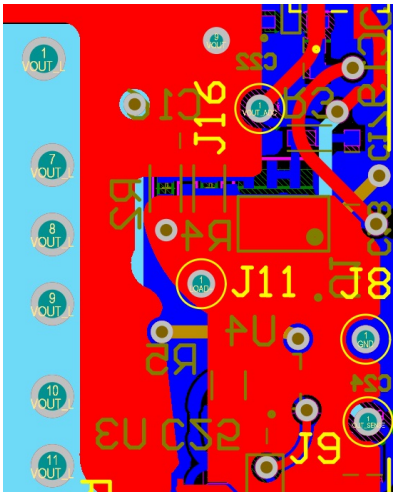
7. Test Points: Provide a list of all nets for which you have included test points for probing voltage and loops for probing current. For clarity, 213B students should also show these nets on the schematic.

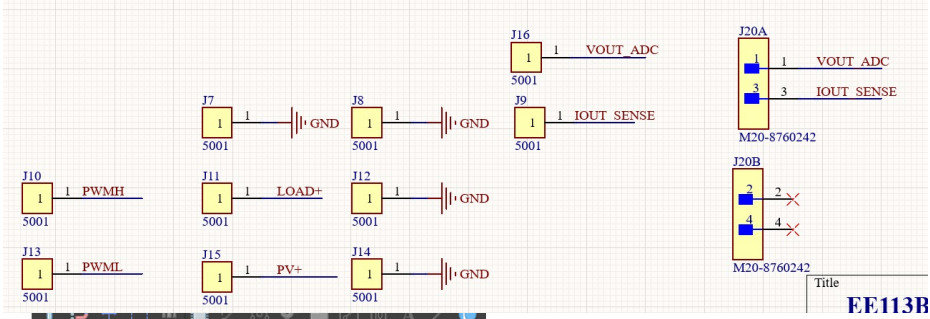
8. Silkscreen: Show a screenshot with your silkscreen layer and all four copper layers visible, to show that your silkscreen rectangle encloses all relevant traces and planes for power density. Also show that your name is written on the PCB in silkscreen.

(7). PWMH. PWML. GH. GL. VSW. GND

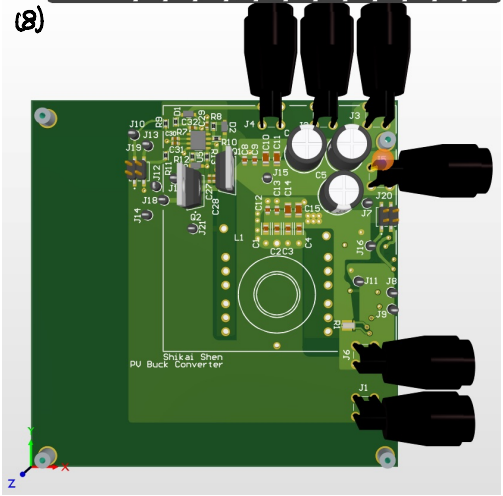


VOUT_ADC, IOUT_SENSE, LOAD+





(8)



Bill of Materials

Rather than providing a conventional Bill of Materials (BOM), open the BOM spreadsheet linked under this module on bCourses and locate the column with your name. In your column, enter the quantity of each part you will need for one build of your board (not including extra parts). For parts you do not plan to use, enter '0'. Make sure all parts on your PCB schematic are listed on this spreadsheet; this is the spreadsheet course staff will use to determine how many additional parts will need to be ordered. DO NOT modify any column but your own.

EE 213B: Enter parts not currently in our library under the "New Parts" heading at the bottom of the spreadsheet, and provide the part number, Digikey/Mouser link, and cost for a small quantity.

Assignment Feedback (Required)

How much dedicated time did you spend on this pre-lab? Add this at the end of your design review slides.

Submit a PDF of your design review slides to Gradescope.

10uF 0805: 4

470uF electrolytic: 3

22uF 0805: 4

4.7uF 1206: 4 → 10uF 1206

2.2uF 0603: 2+1=3

330pF 0603: 2

10uF 0603: 1+1=2

1uF 0603: 1+1+1+1=4

10000pF 0603: 1+1=2

0.1uF 0603: 1+1+1=3

10pF 0603: 1

2.5m 0612: 1

1R 0603: 1+2+2=5

10R 0603: 2

294KR 0603: 1

120R 0603: 1+1=2

470kR 0603: 1

47kR 0603: 1

67	4.7 ohm, 1/8 W	RNCP0603FTD4R70	https://www.digike	0.1	0	0
68	filter and gate, 10 ohm, 0603, 1/10 W	AGCR0603-QK-10R0FT-CT	https://www.digike	0.01	2	0.02
69	LED, 120 ohm 0603	ERA-3AEB121V	https://www.digike	0.13	2	0.26
70	LED, 200 ohm 0603	ERJ-PB3B2000V	https://www.digike	0.26	0	0
71	current sense resistors, 1m, 1%, 0612	CSSK0612FT1L00	https://www.digike	0.84	0	0
72	current sense resistors, 2.5m, 1%, 0612	D1FCP0612D2M50FF-T5	https://www.digike	0.57	1	0.57
73	current sense resistors, 5m, 1%, 0612	CSSK0612FT5L00	https://www.digike	0.84	0	0
74	current sense, 2.94kΩ, 1%, 0.1W, 100ppm/°C, 0603	CRCW06032K94FKEA	https://www.digike	0.1	1	0.1
75	resistor dividers, 1k, 0603	ERJ-PB3B1001V	https://www.digike	0.26	0	0
76	resistor dividers, 4.7k, 0603	ERJ-PB3B4701V	https://www.digike	0.26	0	0
77	resistor dividers, 10k, 0603	ERJ-PB3B1002V	https://www.digike	0.26	0	0
78	resistor dividers, 47k, 0603	ERJ-PB3B4702V	https://www.digike	0.26	1	0.26
79	resistor dividers, 100k, 0603	ERJ-PB3B1003V	https://www.digike	0.26	0	0
80	resistor dividers, 470k, 0603	RN73R1JTTD4703B25	https://www.digike	0.2	1	0.2

price: 64.78 $

	A	B	C	D	AR	AS
1	**Name**	**Part No**	**Link**	**Cost [$]**	Shen Shikai	
3	**PARTS: CONNECTORS LIBRARY**				Quantity	Cost [$/board]
4	Header connectors (10 pos)	61301011121	https://www.digike	0.95	0	0
5	Header connectors (4 pos)	M20-8760242	https://www.digike	0.39	2	0.78
6	Test point	5001	https://www.digike	0.38	13	4.94
7	Banana jack, blk	CT1151SP-0	https://www.digike	2.45	3	7.35
8	Banana jack, red	CT3151-2	https://www.mouse	2.45	3	7.35
9						0
10	**PARTS: IC LIBRARY**					0
11	Half bridge gate driver	LM5109BMAX/NOPB	https://www.digike	1.03	1	1.03
12	Op amp	LM358DR	https://www.digike	0.44	1	0.44
13	Current sense amplifier	LT1999CS8-50	https://www.digike	6.25	1	6.25
14	Voltage reference - 1.25 V	ADR1581ARTZ-REEL7	https://www.digike	2.26	1	2.26
15	Low side gate driver	UCC27517DBVR	https://www.digike	0.83	0	0
16	Digital isolator	ISO6720FBDR	https://www.digike	1.54	0	0
17	Voltage regulator - 3.3 V	LD1117ADT33TR	https://www.digike	0.71	0	0
18	LDO	LP2985-50DBVR	https://www.digike	0.55	1	0.55
19						0
20	**PARTS: SWITCH LIBRARY**					0
21	LED	TLMS1000-GS08	https://www.digike	0.45	0	0
22	Diode	1N4148W-7-F	https://www.digike	0.11	3	0.33
23	TO-220 55V 29A	IRFZ34NPBF	https://www.digike	0.92	0	0
24	TO-220 55V 47A	IRLZ44NPBF	https://www.digike	1.28	0	0
25	TO-220 55V 64A	IRFZ48NPBF	https://www.digike	1.27	0	0
26	TO-220 55V 89A	IRL3705NPBF	https://www.digike	1.85	2	3.7
27	TO-220 heat sink	507302B00000G	https://www.digike	0.3	2	0.6
28	Thermal pad	Q®-0.006-00-54	https://www.digike	0.43	2	0.86
29	MLPAK33 25 V 32A	PXNTR7-25QLJ	https://www.digike	0.58	0	0
30	MLPAK33 25 V 65A	PXN6R2-25QLJ	https://www.digike	0.58	0	0
31						0
32	**PARTS: INDUCTOR LIBRARY**					0
33	RM 8 cores (2 piece set)	RM8/I-3C95	https://www.digike	2.32	0	0
34	RM 10 cores (2 piece set)	RM10/I-3C95	https://www.digike	3.54	1	3.54
35	RM 12 cores (2 piece set)	RM12/I-3C95	https://www.digike	6.29	0	0
36	RM 8 bobbin	B65812C1512T001	https://www.digike	1.8	0	0
37	RM 10 bobbin	B65814D1512T001	https://www.digike	2.05	1	2.05
38	RM 12 bobbin	B65816C1512T001	https://www.digike	2.17	0	0
39	RM 8 clamp	CLI/P-RM8/I	https://www.digike	0.31	0	0
40	RM 10 clamp	CLI/P-RM10/I	https://www.digike	0.31	2	0.62
41	RM 12 clamp	CLI/P-RM12/I	https://www.digike	0.49	0	0
47	**PARTS: CAPACITOR LIBRARY**					0
48	Electrolytic, 330 uF	EL1V331MP51016U	https://www.digike	0.29	0	0
49	Electrolytic, 470 uF	50ZLJ470M10X20	https://www.digike	0.83	3	2.49
50	MLCC, 22 uF, 35V, X5R, 0805	C2012X5R1V226M125A	https://www.mouse	0.82	4	3.28
51	MLCC, 4.7uF, 35V, X7R, 0805	GRM21BZ7YA475KE15K	https://www.digike	0.3	0	0
52	MLCC, 22uF, 35V, X5R, 1206	C3216X5R1V226M160AC	https://www.digike	0.97	0	0
53	MLCC, 10uF, 35V, X7R, 1206	C1206X106K035T	https://www.digike	0.44	0	0
54	MLCC, 10uF, 50V, X5R, 0805	GRM21BR61H106KE43K	https://www.digike	0.34	4	1.36
55	MLCC, 10uF, 50 V, X7R, 1206	C1206X7R500-106KNE-CT	https://www.digike	0.26	4	1.04
56	2.2 uF, Commutation loop decoupling, 0603, 50V	GRM188R61H225KE11J	https://www.digike	0.21	3	0.63
57	10 uF, 25 V Decoupling for gate drive, LDO, lig reg,	GRM188R61E106KA73J	https://www.digike	0.26	2	0.52
58	1 uF, 50V	0603X105K500CT	https://www.digike	0.13	4	0.52
59	.1 uF, 25V Current sense, op amp, regulator input d	C0603Z5U250-104MNP-CT	https://www.digike	0.08	3	0.24
60	LDO bypass, 10nF, 0603, 3 V	C0603X7R250-103MNP-CT	https://www.digike	0.01	2	0.02
61	Filter cap, 330 pF, 50V, NPO, 0603	C0603C0G250-331KNE-CT	https://www.digike	0.01	2	0.02
62	Current sense SHDN cap, 10 pF, 5V max, 0603	C0603C100J3HAC7867	https://www.digike	0.1	1	0.1
63						0
64	**PARTS: RESISTOR LIBRARY**					0
65	.47 ohm, 0603, 1/4 W	73L2R47J	https://www.digike	0.31	0	0
66	boostrap and gate, 1 ohm, 0603, 1/5 W	AC0603FR-7W1RL	https://www.digike	0.1	5	0.5

Time: 2.5 hours.