Vincotech

Quick Start Guide for Current Synthetizing PFC reference design

Date	**Revision Level**	**Description**	**Page Number(s)**
2024.07.12	2	Updated Safety instruction and BOM	42

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Safety Information

This board classified as an evaluation board (EVA board) dedicated for laboratory environment only. Evaluation board means a product embedded on a printed circuit board (PCB) for demonstration and/or evaluation purposes. The board should not be used for reliability testing and may not fulfill all relevant standards and requirements.

This board must be operated by qualified and skilled personnel familiar with all applicable safety standards. Operation must be carried out in a dedicated environment provided with all necessary safety and protective equipments.

This evaluation board contain ESD sensitive parts. Failing to follow the relevant ESD standards may result in device failure and/or even explosion.

This evaluation board operates at high voltages, potentially lethal voltages may be present.

Please pay attention to the following steps

Before starting the evaluation board please verify that:

- *All parts and components are not damaged or missing.*
- *No conductive foreign objects can be found on the board.*
- *In case of soldering no remaining solder splash can be found on the board.*
- *There is no condensation or water droplets on the circuit board.*
- *All board and cable assembled properly.*
- *The power module is screwed to the heatsink based on FlowS3 handling instruction*

In operation:

- *For optimal thermal behavior, the thermal interface material must be melted (the heatsink temperature must reach at least 45°C)*
- *There is no condensation or water droplets on the circuit board.*
- *Ensure that conductive objects cannot be contacted with the board.*
- *Even brief accidental contact might result in severe injury or death! Therefore, DO NOT touch the board with your bare hands or bring them close to the board.*
- *Be sure to wear insulated gloves when handling is required during operation.*
- *If used under conditions beyond its rated parameters, it may cause defects such as short-circuit or, depending on the circumstances, explosion or other permanent damages.*
- *The heatsink and the board surface may reach high temperatures that might lead to injury, necessary precautions are required*

After operation:

- ***Attention, risk of electrical shock! The voltage of the DC-link always has to be checked before touching the evaluation board!*** *Since the board contains circuits which stores the electric charges even after the input power are disconnected. Allow at least 4 minutes for the DC-Link and other capacitors to discharge to the safe voltage level (< 50 V).*

- *Please be careful when touching the board or the heatsink. The device can maintain high temperature after switch off, that might lead to burn injury.*

Failure to follow these guidelines may result personal injury or death and/or equipment damage.

Vincotech GmbH is not responsible for any damage caused by use of this evaluation board.

1 Objective

The objective of this paper is to help the user understand the board's main functionalities and provide instructions on how get started and operate it effectively. This paper only covers the most important information. For a more detailed description, please check the application notes and technical papers on the Vincotech website or contact us directly.

2 The functional blocks of the Evaluation Board

The evaluation board consists of three distinct functional blocks:

- The current synthetizing PFC (CSPFC)
- The booster
- The output inverter

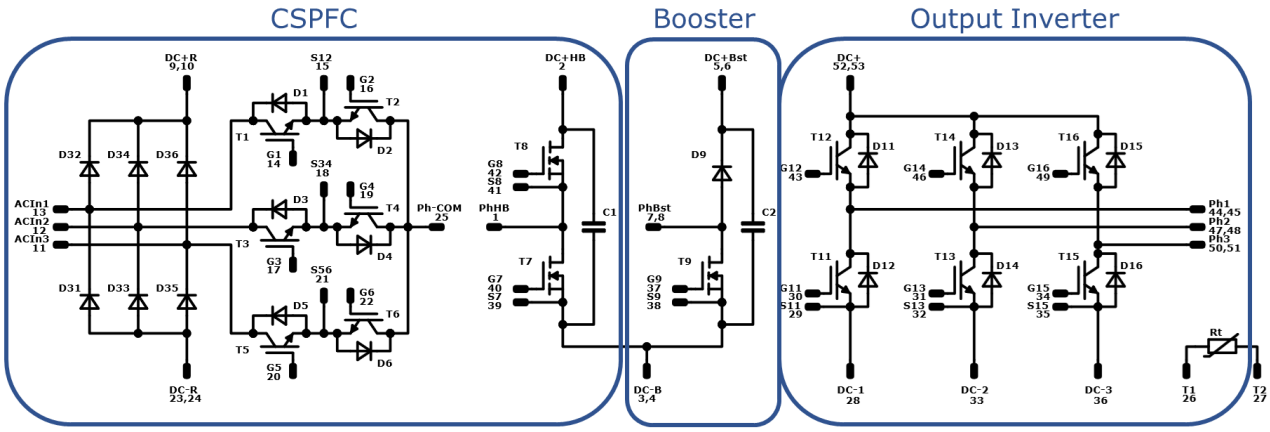


Figure 1: The schematic of the module and the functional blocks of the Evaluation Board

The CSPFC block requires constant output power for operation. The constant output power can be generated by the booster stage or the output inverter stage.

3 The power module

The evaluation board was designed for the Vincotech *flowPIM S3 + 3xPFC* 1200 V 40 A power module, B0-SL12PPA040SH-PC88L41Z-/7/. It contains the input rectifier, the MUX+HB circuit, the booster stage, and the output inverter. The schematic of the module is presented in Figure 2 and the outline drawing in Figure 3.

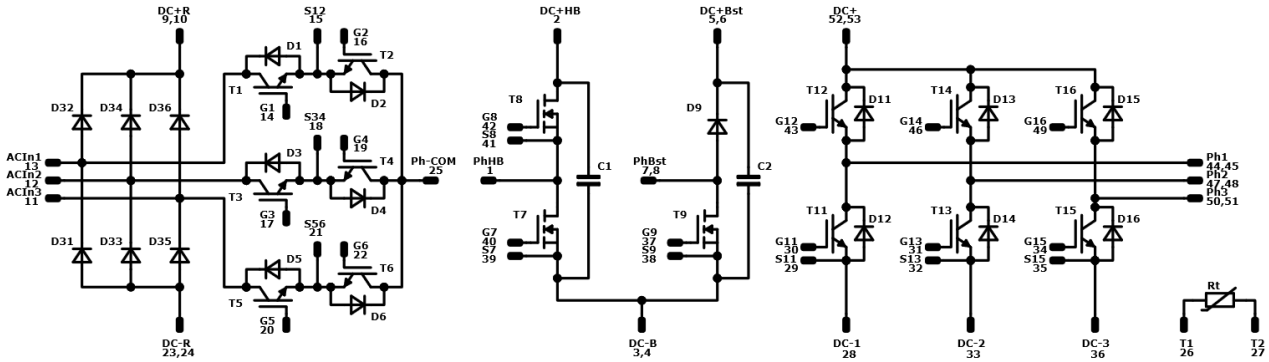


Figure 2: The schematic of the power module

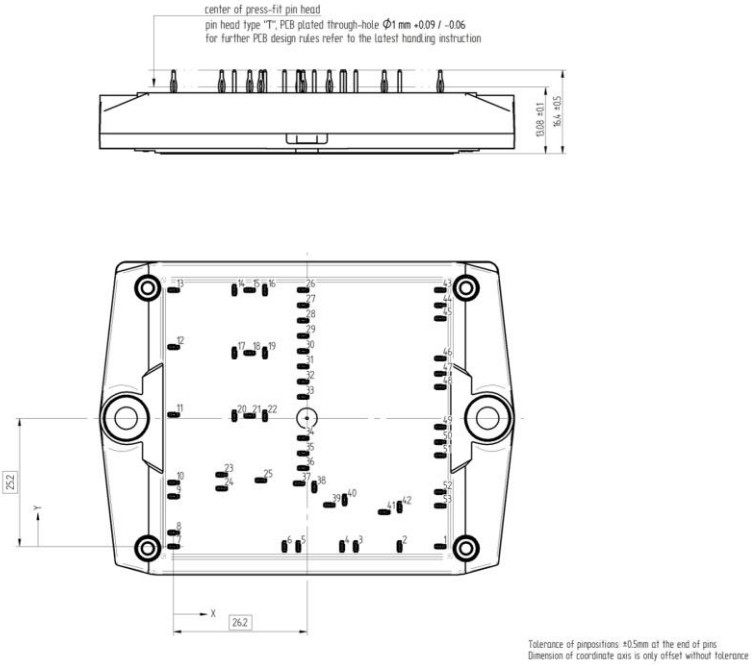


Figure 3: The pin-out of the module

For a more detailed description of the module, please visit the Vincotech web page.

4 Short introduction of the board

The main board comprises four distinct cards, listed here:

- The MUX GD card drives the MUX IGBTs, which are responsible for selecting the correct phase for the third harmonic current.
- The INV GD PS card contains an isolated power supply circuit for the output inverter gate drives.
- The Texas Instruments F28379D card is the control card and contains the MCU.
- The AUX PS card is the auxiliary power supply card and provides +12 V and +5 V for the logic circuits. This card is optional. An external DC supply can be used as an alternative power source.

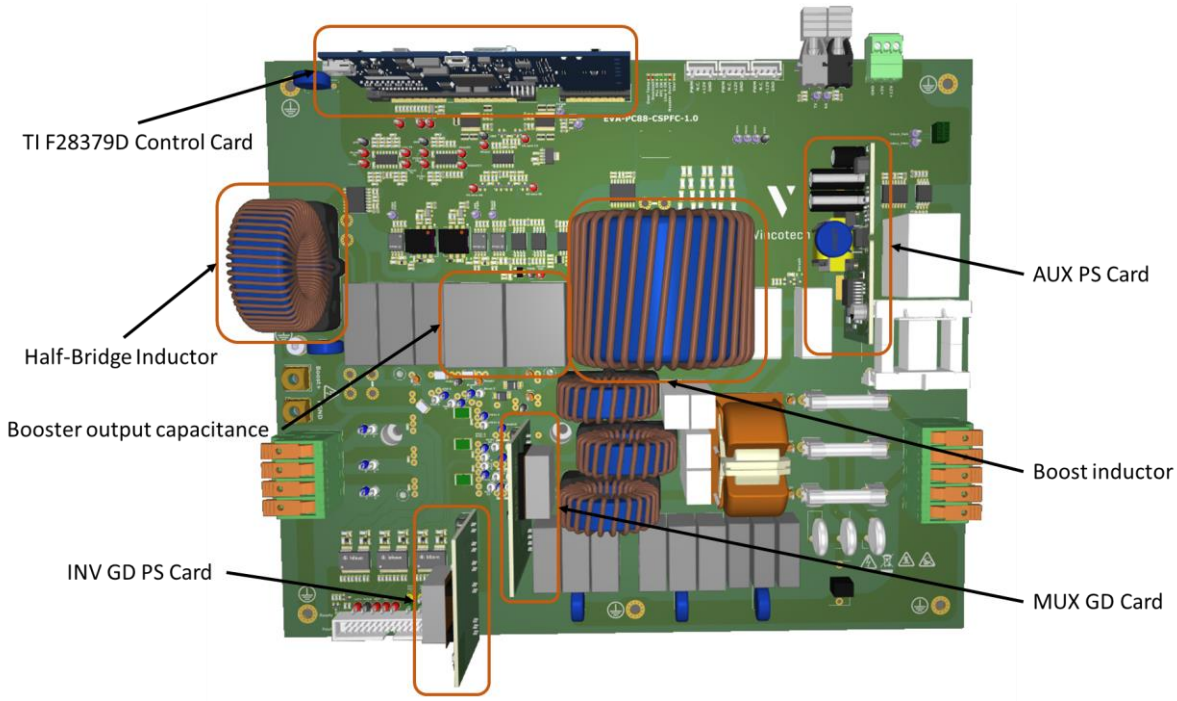


Figure 4: The parts of the evaluation board

The low voltage DC supply can be drawn from the grid using the AUX PS card or supplied by connecting an external DC supply. The evaluation board can, therefore, be ordered with two different part numbers:

- EVA-PC88L41Z-CSPFC-A-KIT without the AUX PS card
- EVA-PC88L41Z-CSPFC-B-KITwith the AUX PS card

The evaluation board contains test points to simplify signal measurement. The test points are color-coded based on their function as follows:

- White: Gate signals
- Blue: Emitter/source sense signal
- Yellow: High Voltage potentials
- Black: GND signals (e.g.: PGND and GND) These GND potentials are galvanically isolated from each other.
- Purple: Logical signals
- Red: Analog signals

5 Absolute maximum ratings

Symbol	Parameter	Conditions	Value			Unit
			Min	Typ	Max	
V_{inRMS}	AC RMS input phase voltage	P_{max} = 11 kW	219	230	253	V
V_{inRMS}	AC RMS input phase voltage	P_{max} = 10 kW	207	230	253	V
f_{in}	Input frequency		47	50	63	Hz
P_{INmax}	Maximum input power	T_s = 80 °C,		11		kW
$V_{DCboost_{max}}$	Maximum DC output voltage of the Booster			820		V
I_{inRMS}	Maximum RMS input current per phase	T_s = 80 °C, sinusoidal current waveform		16		A

$I_{OutPeak_{INV}}$	Maximum RMS output current of the output inverter	T_s = 80 °C, sinusoidal current waveform	20	A
$I_{OutPeak_{Boost}}$	Maximum peak output current of the booster	T_s = 80 °C $V_{DCboost} = 700\ V$	15.7	A
I_{FANmax}	Maximum output current of the FAN drive (per output)		400	mA
$I_{auxPSmax}$	Maximum output current of the AUX power supply card		1.5	A
T_{PCBmax}	Maximum PCB temperature		115	°C
T_{OPmax}	Maximum operation temperature		$T_{jmax} - 25\ °C$	°C

6 Starting the evaluation board

Before using the evaluation board, the module must be screwed to a heatsink! Failure to do so may result in elevated semiconductors temperatures, which can damage the module. Please use a heatsink capable of handling the associated losses.

All GND connections must be connected to the heatsink.

For proper operation, all connections must be correctly established before powering up the board. The three-phase input connector must be connected to the three-phase grid in the correct order (PHA, PHB, PHC). If the correct sequence is not followed, the evaluation board

will not start. The regulator logic requires a sinusoidal input. Please ensure a sufficiently high-quality input voltage. The presence of significant harmonics may prevent the evaluation board from synchronizing and starting.

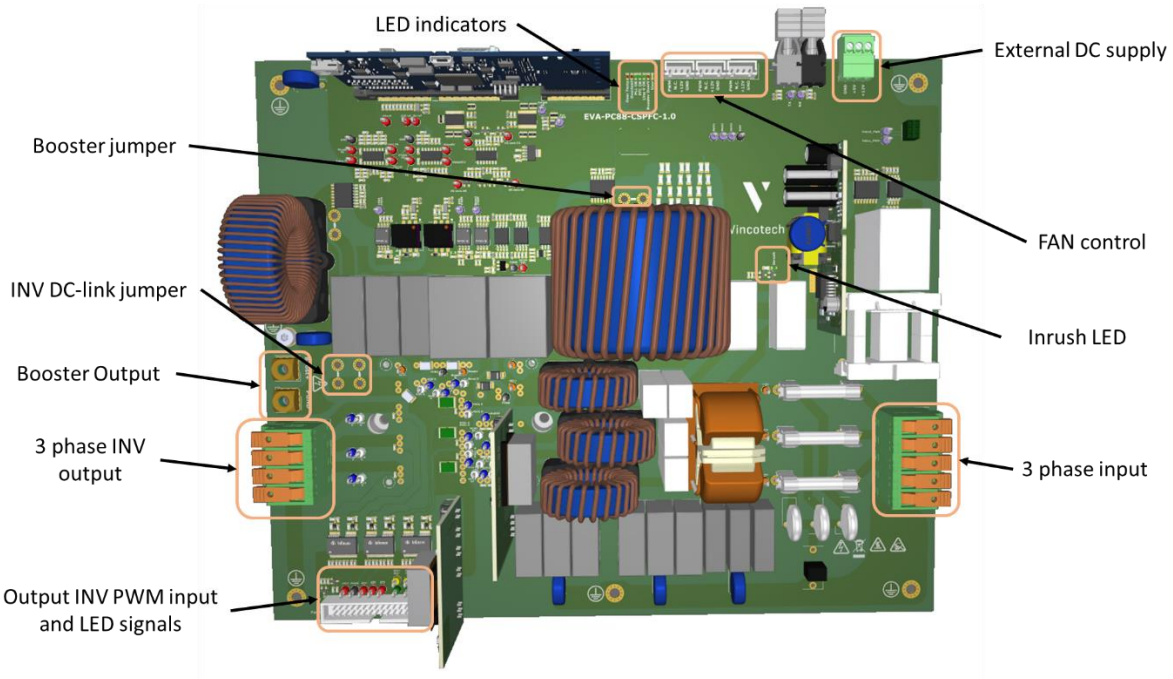


Figure 5: The connectors and the LED signals of the Board

The three stages should be connected in the right order based on the user needs. Please refer to Figure 5 for the connector and jumper locations.

1. When using the booster circuit for output and constant power generation for the CSPFC, the load must be connected to the booster output and the booster jumper must be closed. In this scenario, the output inverter is inactive and does not request any connection and drive signal.
2. When constant power is provided by the output inverter itself, the booster is not used. The load must be connected to the three-phase INV output connector, the booster jumper opened, and the INV DC-link jumper connected to REC+. In this case, external drive signals must be applied to the output inverter (see paragraph 6.1.)
3. When the booster is relied on to generate constant power and the three-phase output is generated by the output inverter, all the three stages are operational. The booster

jumper must be closed, the INV DC-link jumper connected to Boost+, and the three-phase output connected to the 3 phase INV output. In this case, external drive signals must be applied to the output inverter (see paragraph 6.1.).

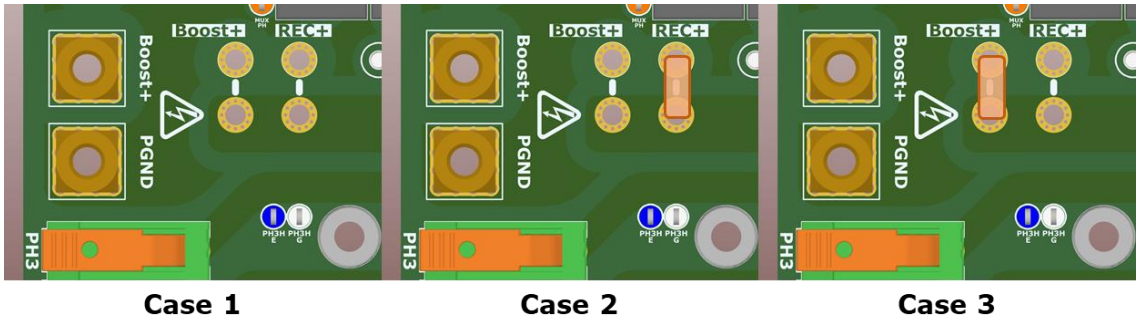


Figure 6: The INV DC-link jumper

Caution: Once the grid is connected to the input, the rectifier stage will charge up the DC-link without driving the semiconductors! This can lead to electrical shock! For discharging, please refer to the safety information.

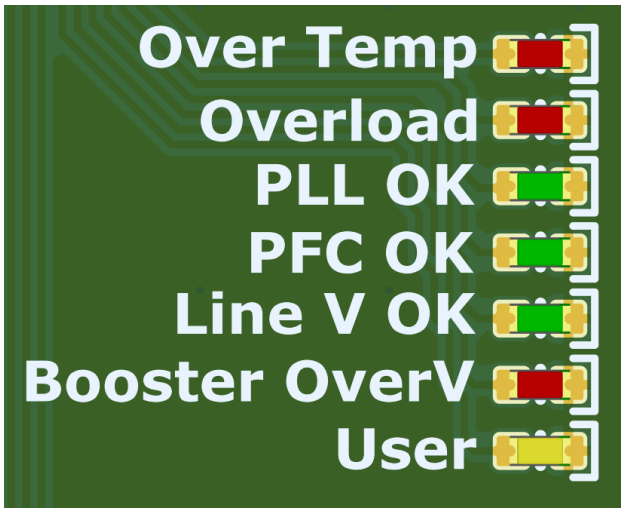
When the input line voltage amplitude is within an acceptable range, the green Line V OK LED will light up. When the phase sequence is also OK and the PFC is synchronized to the grid, the green PLL OK LED will also light up.

The evaluation board must always be powered up without a load to prevent damaging the inrush resistors! The load can be enabled when the inrush relay is closed and the inrush LED light up.

Caution: This board is only designed for unidirectional operation. When a motor is applied on the output for brake operation a brake chopper must be used!

Thermal cooling can be improved using forced air cooling. To this end, the evaluation board includes a three-channel 12 V FAN driver with a 5 V PWM signal for speed control. The control circuit attempts to maintain the temperature of the heatsink at 80 °C. When the maximum

temperature (100 °C) is attained, the MCU's PWM output is suspended. Even when the PWM control is suspended through the rectifier diodes, the power output can continue to operate, further increasing the temperature and potentially causing failure. Once the temperature returns to 90 °C, the PWM output restarts and the Evaluation Board resumes normal operation.



Over Temp	Over-temperature detected
Overload	Overload detected
PLL OK	Line sequence OK, PFC synchronized to the grid
PFC OK	Load detected, HB working
Line V OK	3-phase input voltage amplitude OK
Booster OverV	Over-voltage on the booster (>820 V)
User	Fast blinking – PWM OFF Slow blinking - PWN ON

Table 1: The LED indicators of the board

The evaluation board provides over-temperature, overload, and over-voltage sensing. In the event of failure, the evaluation board interrupts operation until operation conditions return to normal. After five successive failures, operation is permanently stopped. All voltage supplies must be disconnected to restart the board.

Figure 7 presents the correct starting sequence of the evaluation board.

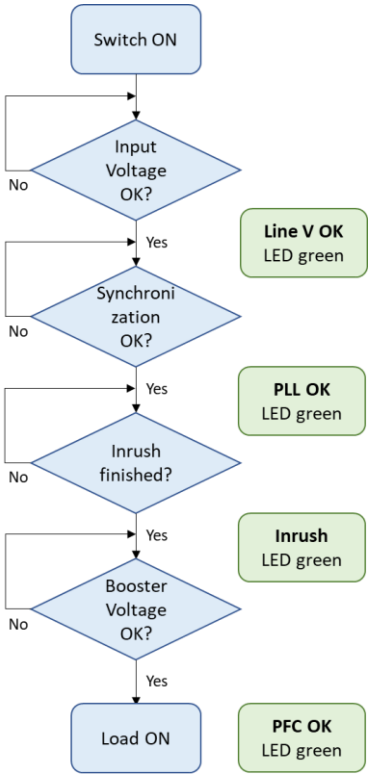
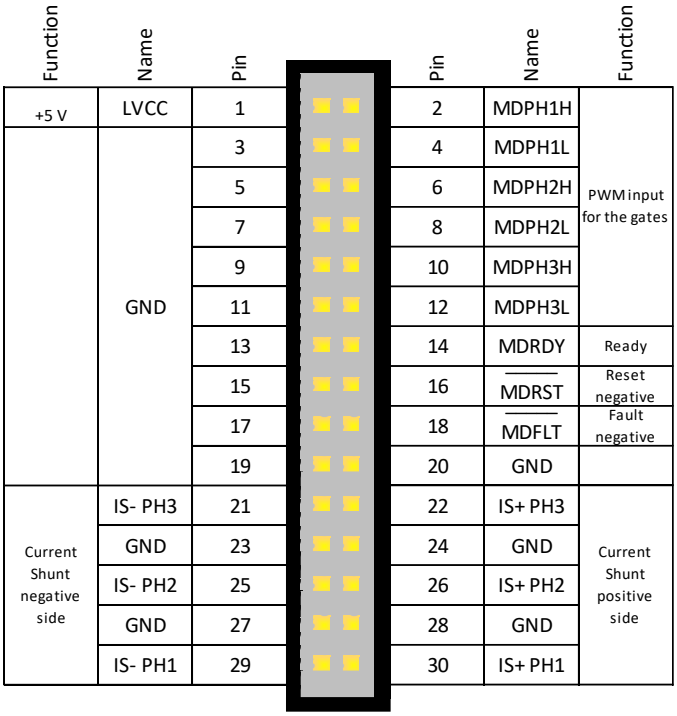


Figure 7: Starting sequence

6.1 Interface of the output inverter

The evaluation board includes the gate driver circuits and desaturation protection (Fault LED) for the output inverter but not the required control logic. The output inverter requires external drive signals to be provided using the output inverter PWM control connector. The detailed pin functions and names can be seen in Figure 8. LED indicators are used for the fault and ready signals. To power the control logic, an external +5 V DC supply should be connected to the LVCC pin. For a more detailed functional description of the output inverter, please refer to the 2ED020I12FAXUMA2 datasheet.

The output inverter's recommended maximum f_{sw} is 16 kHz. Exceeding that frequency may increase losses and damage the device.

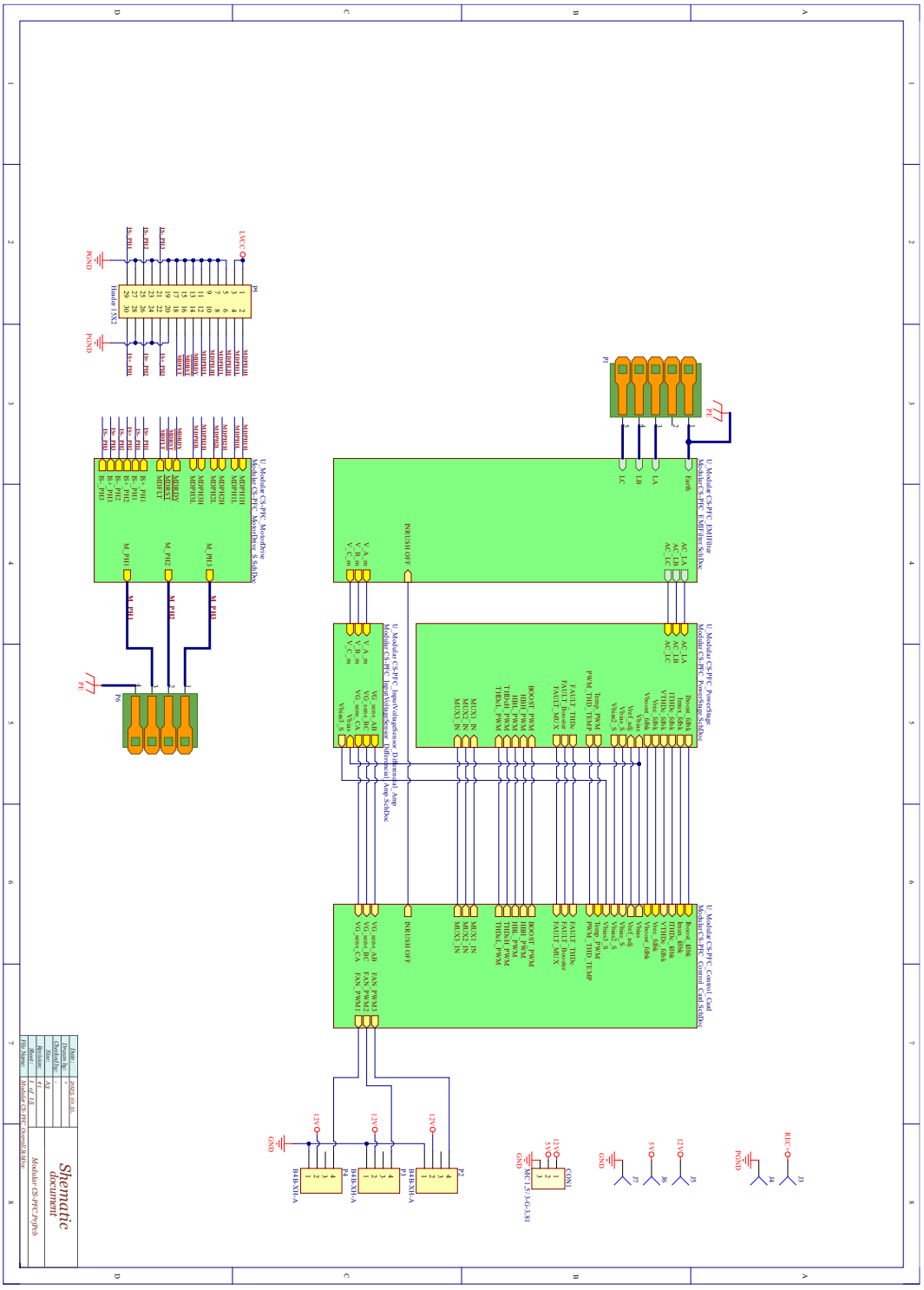


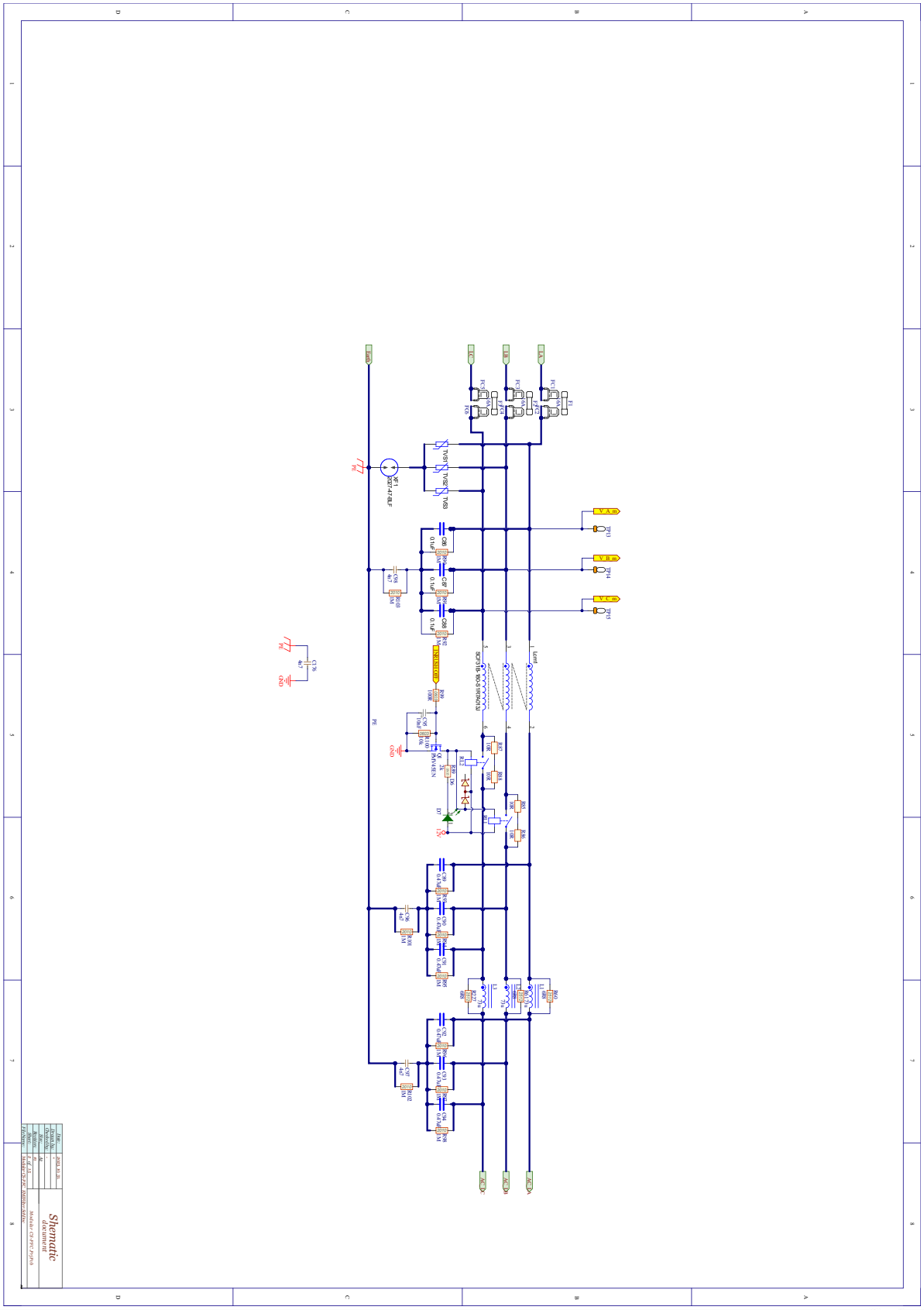
Function	Name	Pin		Pin	Name	Function
+5 V	LVCC	1		2	MDPH1H	PWM input for the gates
	GND	3		4	MDPH1L	
		5		6	MDPH2H	
		7		8	MDPH2L	
		9		10	MDPH3H	
		11		12	MDPH3L	
		13		14	MDRDY	Ready
		15		16	$\overline{\text{MDRST}}$	Reset negative
		17		18	$\overline{\text{MDFLT}}$	Fault negative
		19		20	GND	
Current Shunt negative side	IS- PH3	21		22	IS+ PH3	Current Shunt positive side
	GND	23		24	GND	
	IS- PH2	25		26	IS+ PH2	
	GND	27		28	GND	
	IS- PH1	29		30	IS+ PH1	

Figure 8: The Output Inverter Connector

7 Schematic of the evaluation board

7.1 Main board

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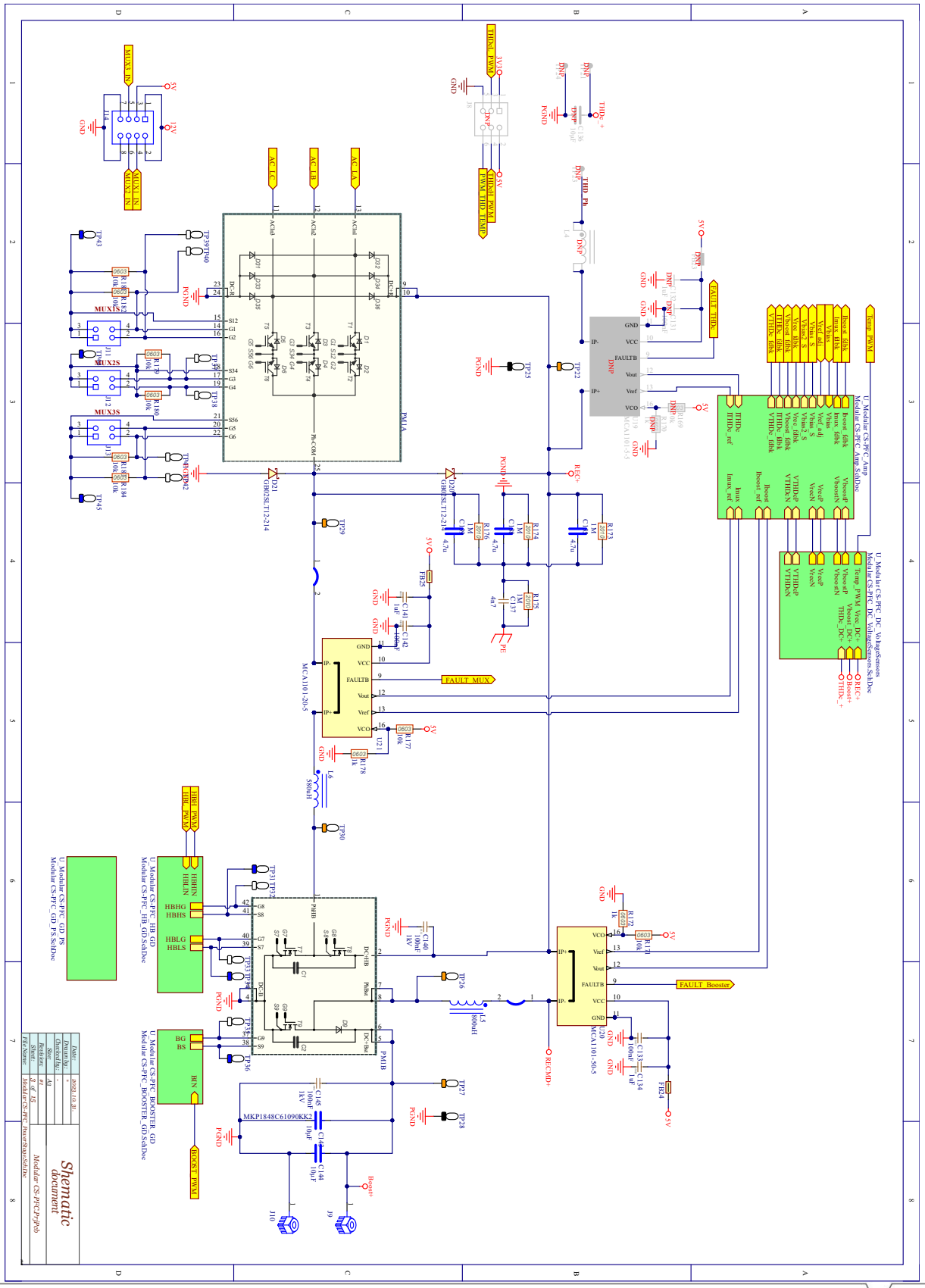
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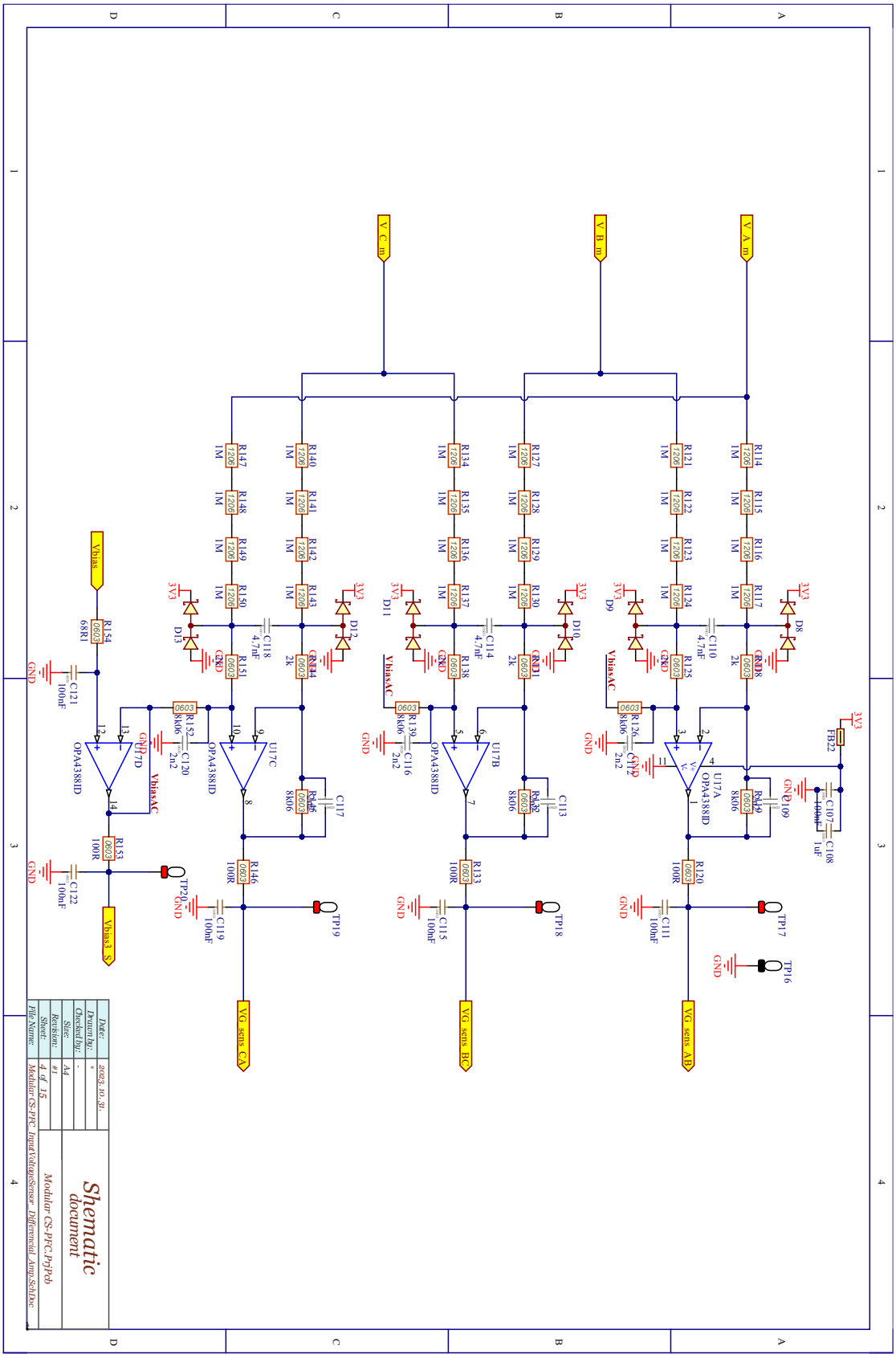
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Current Synthetizing PFC
Rev. 01
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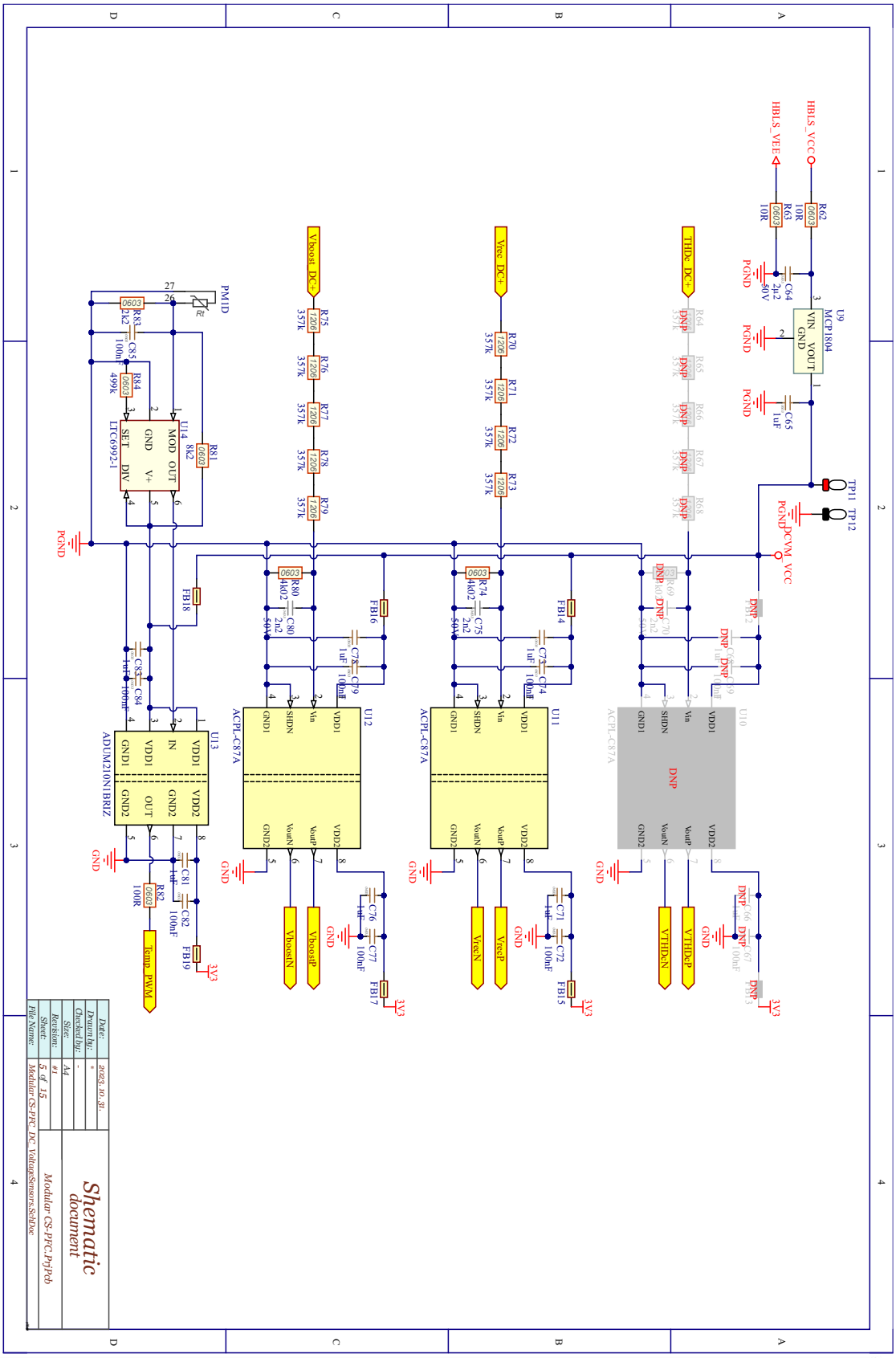
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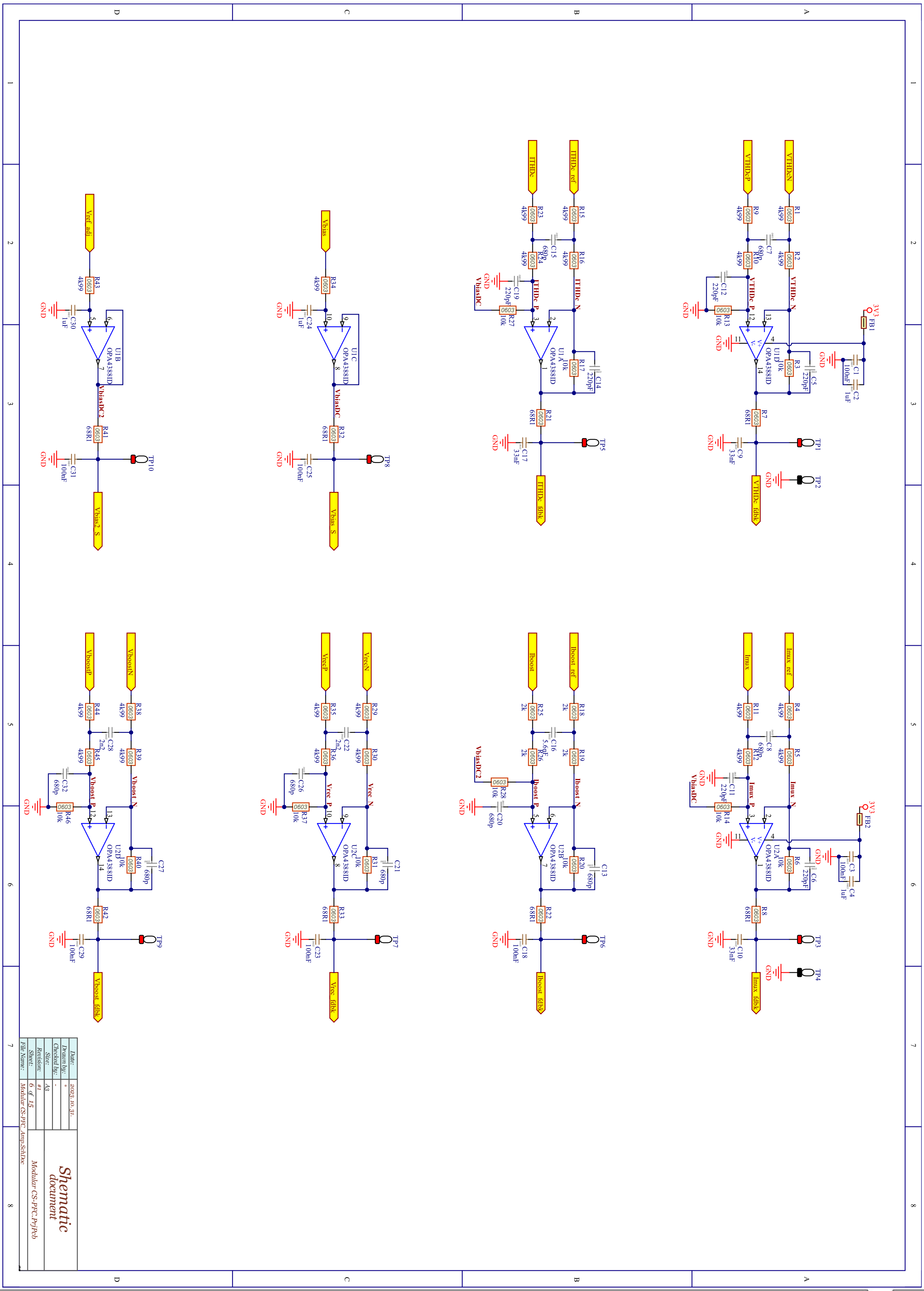

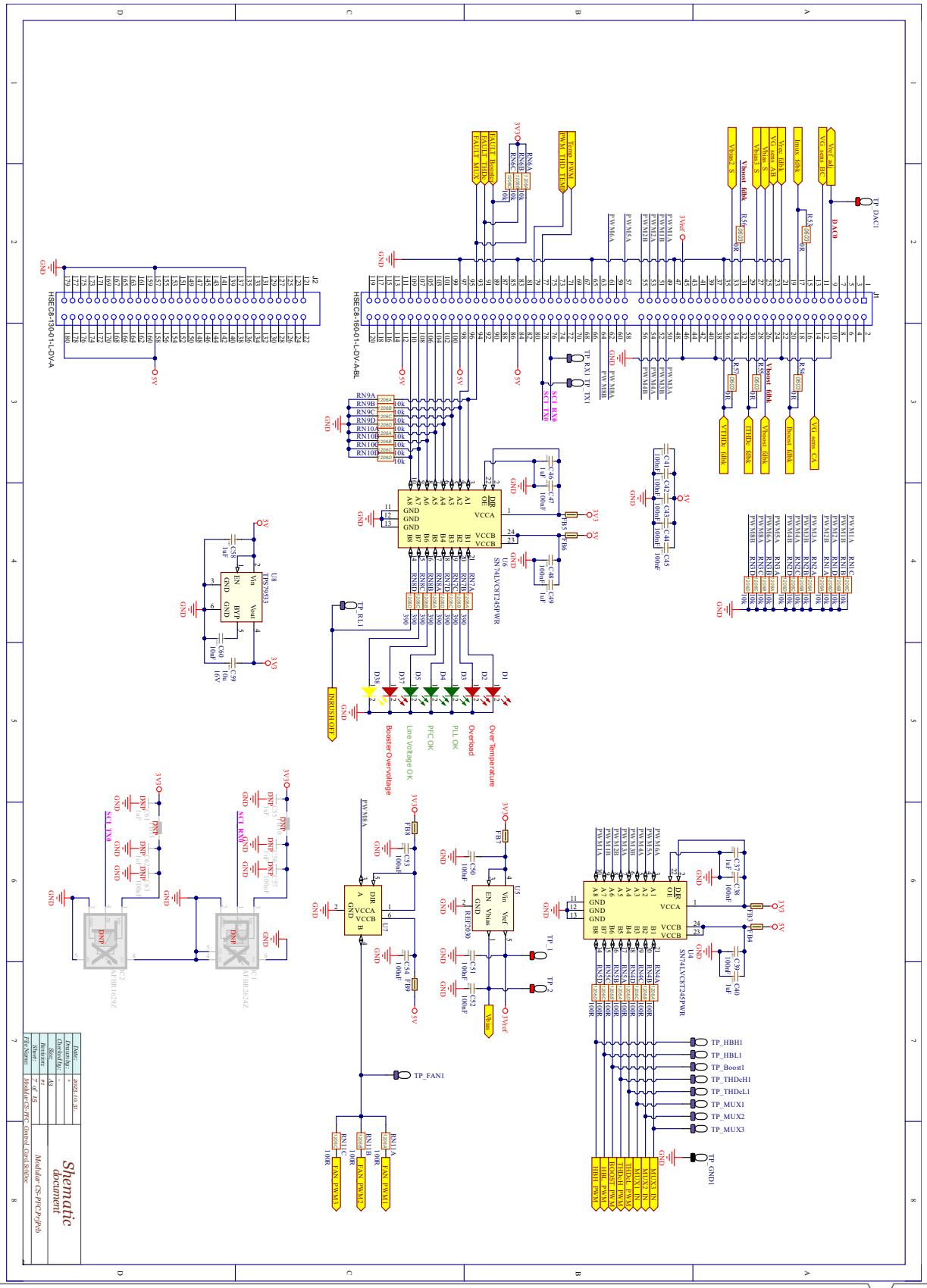
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PLL OK
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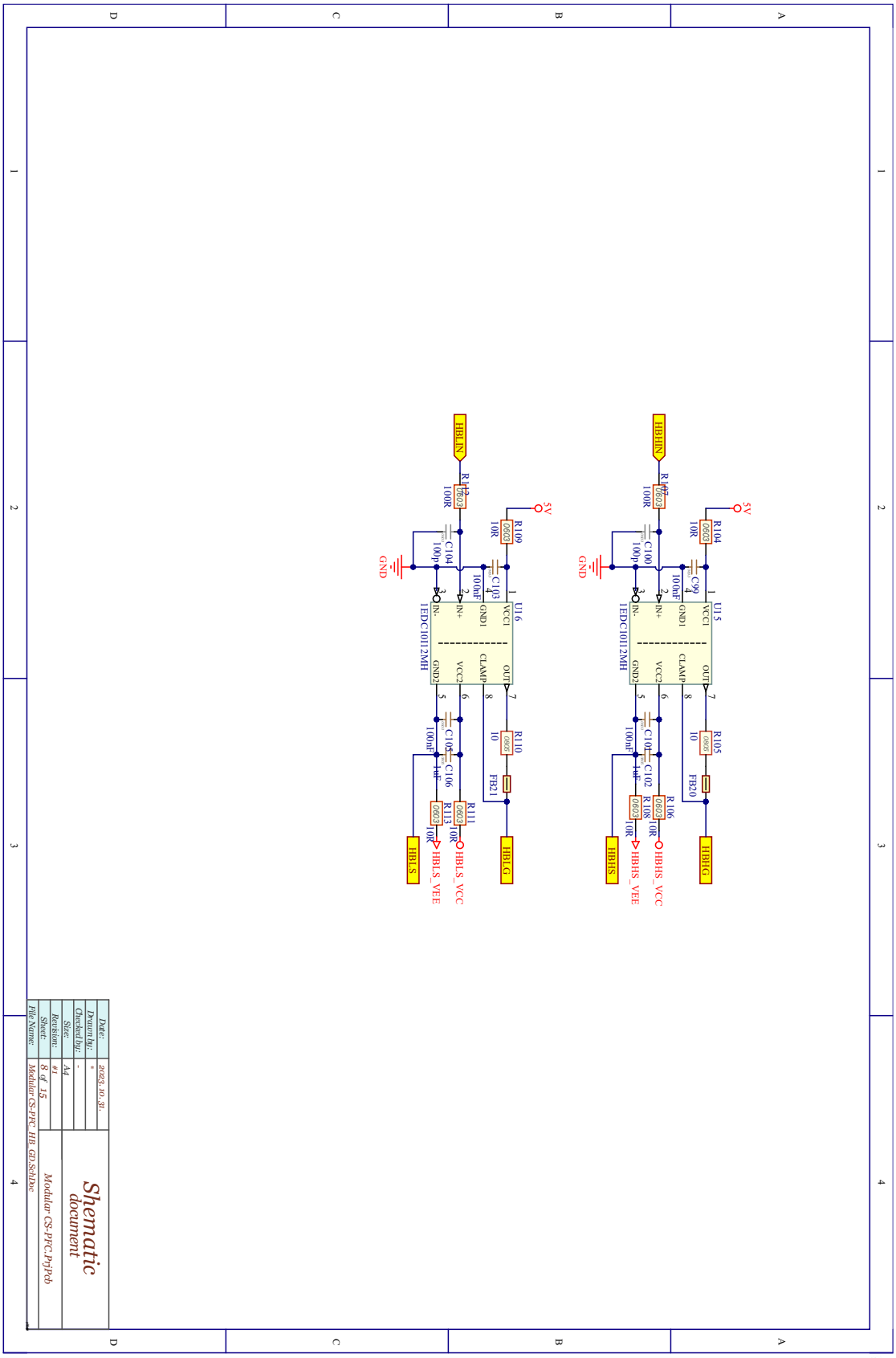
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C101
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C104
C105
C106
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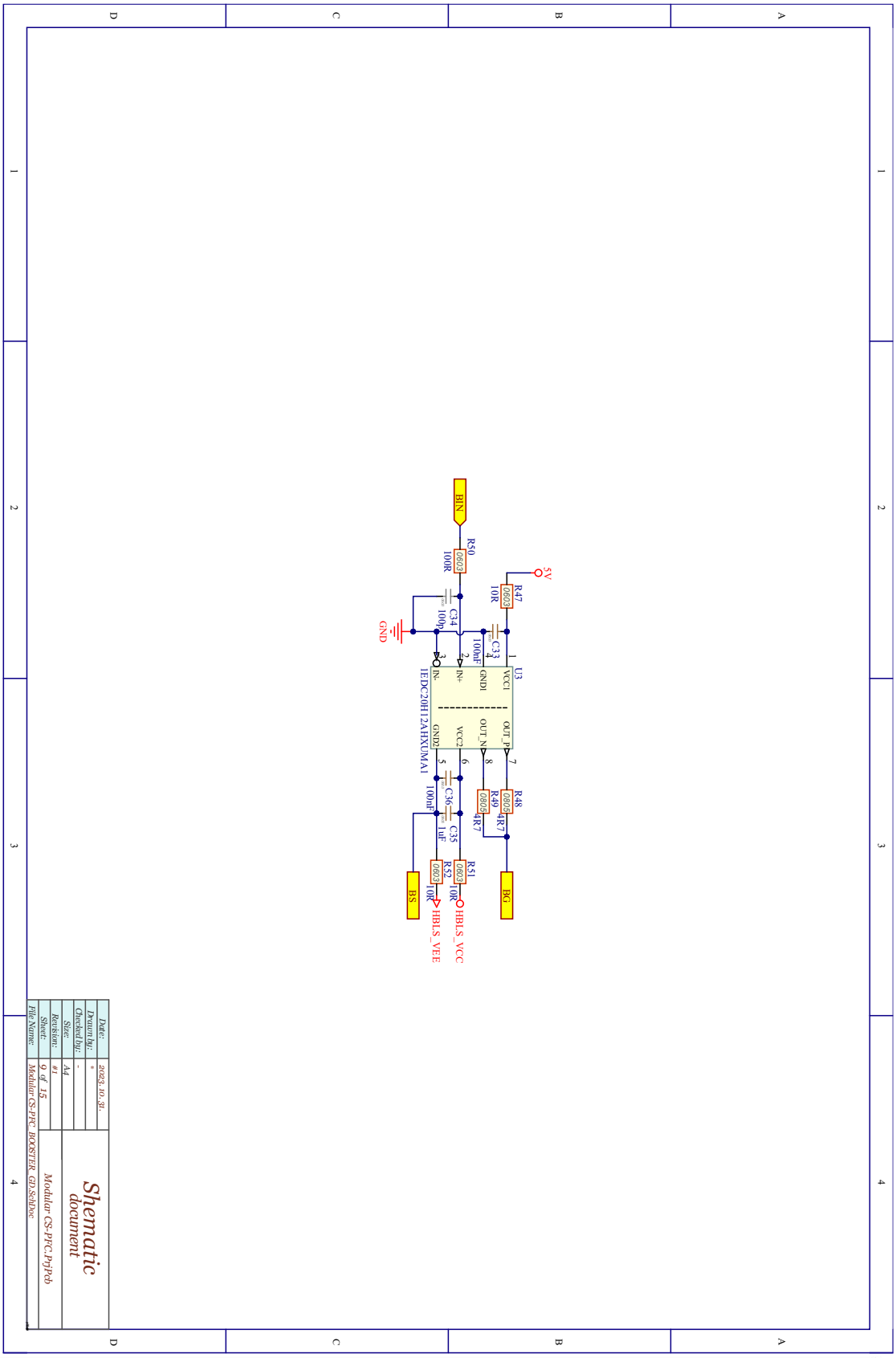
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IN-
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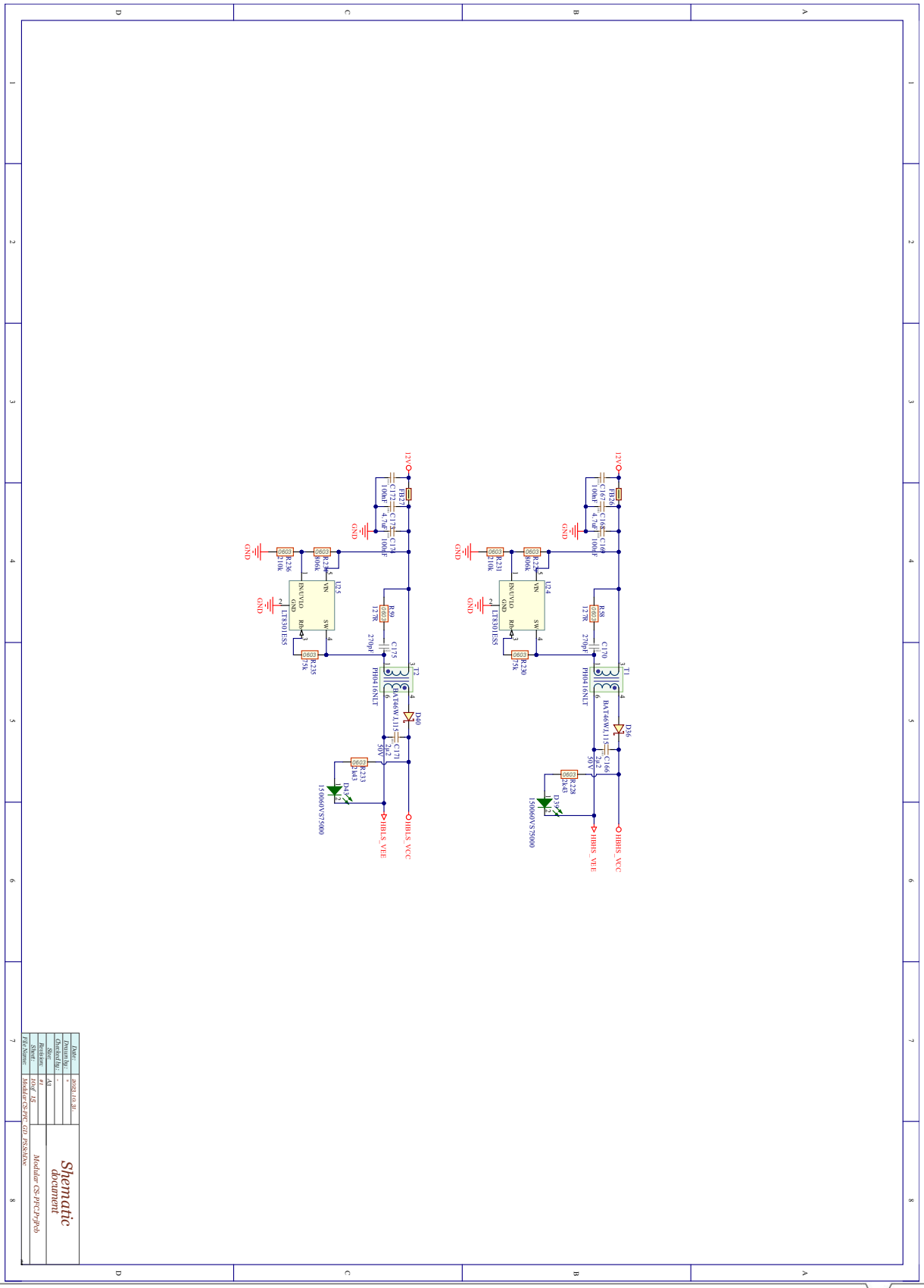
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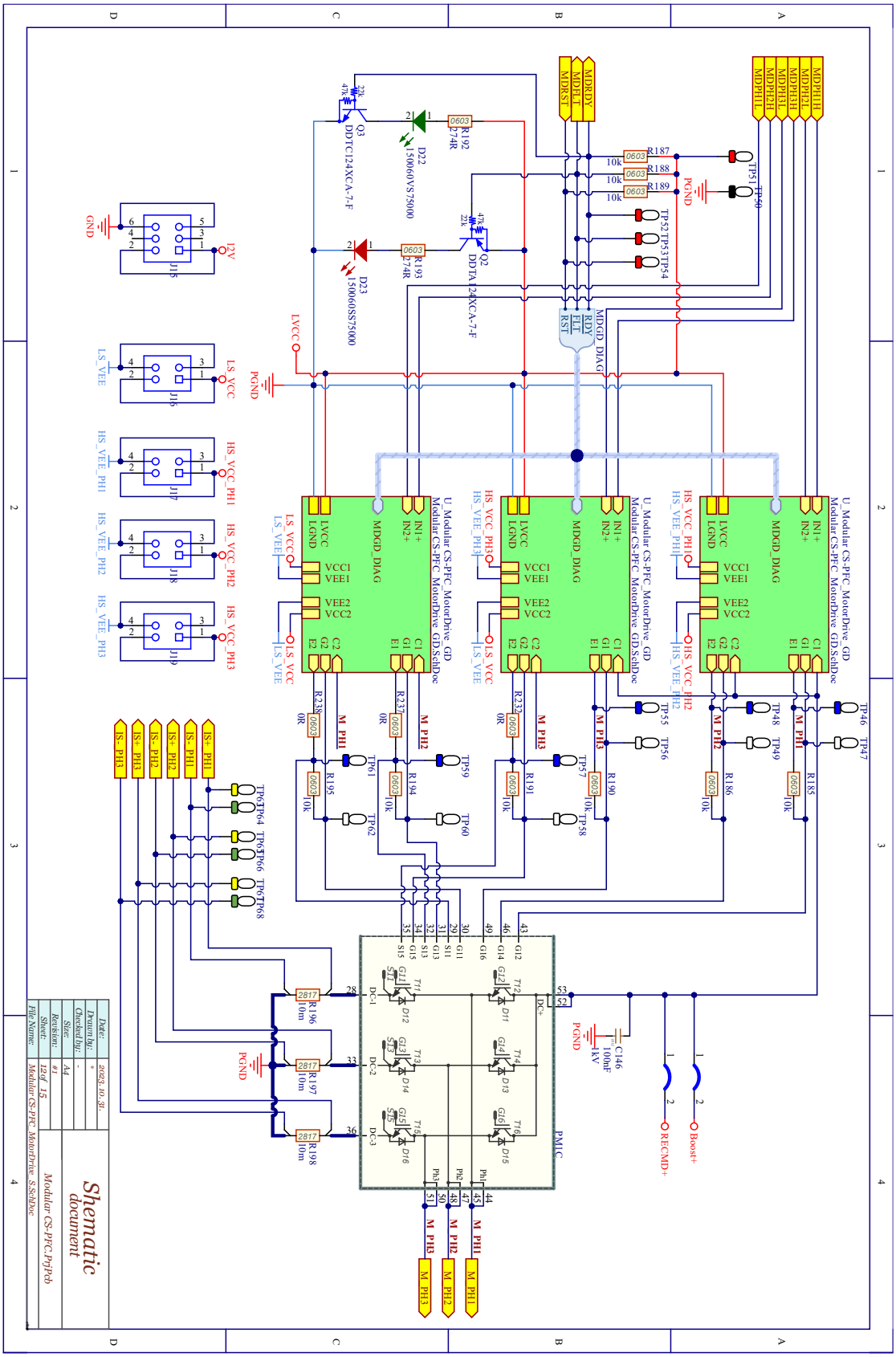
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MDPH2L
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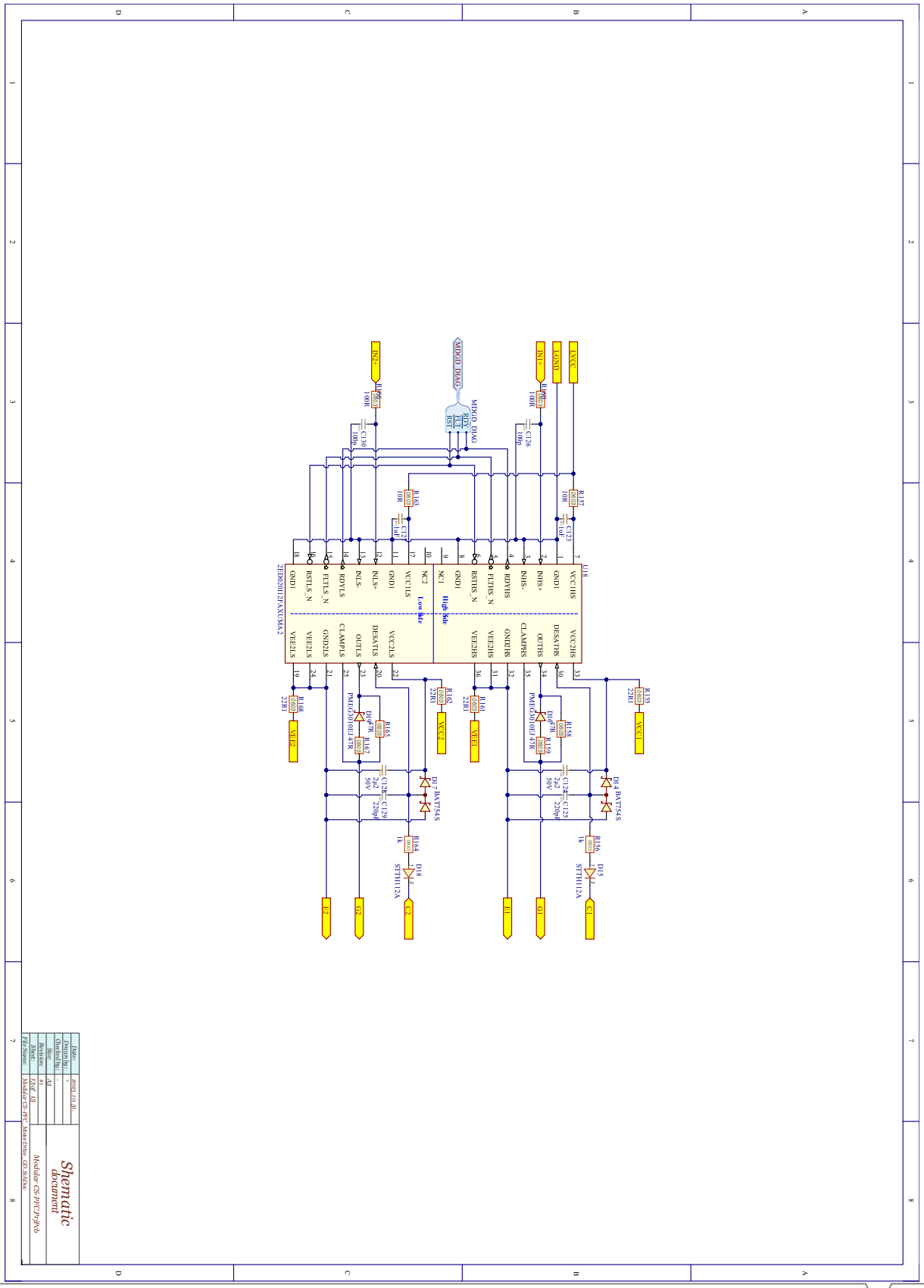
M PH3
Boost+
RECMD+
PMIC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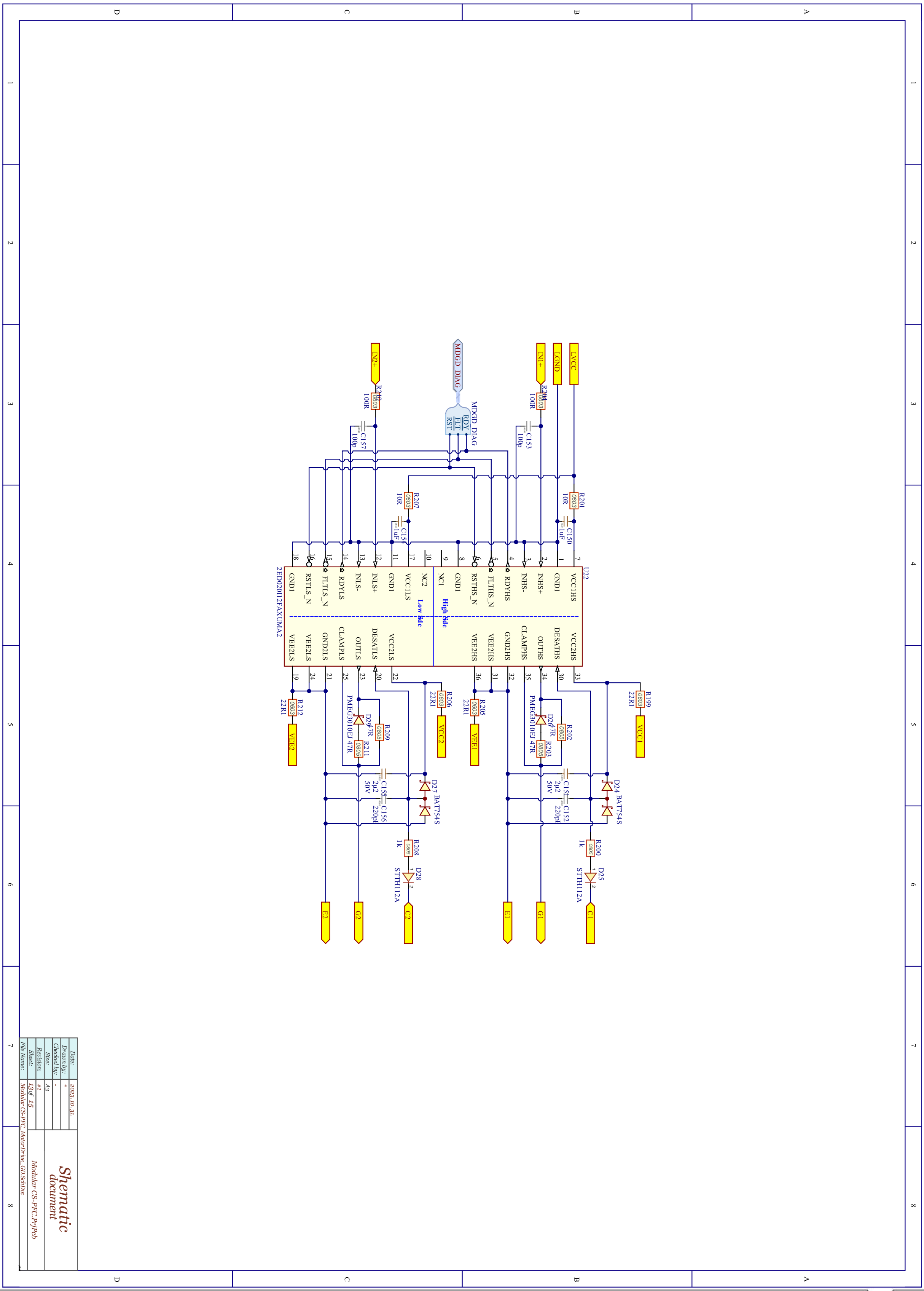
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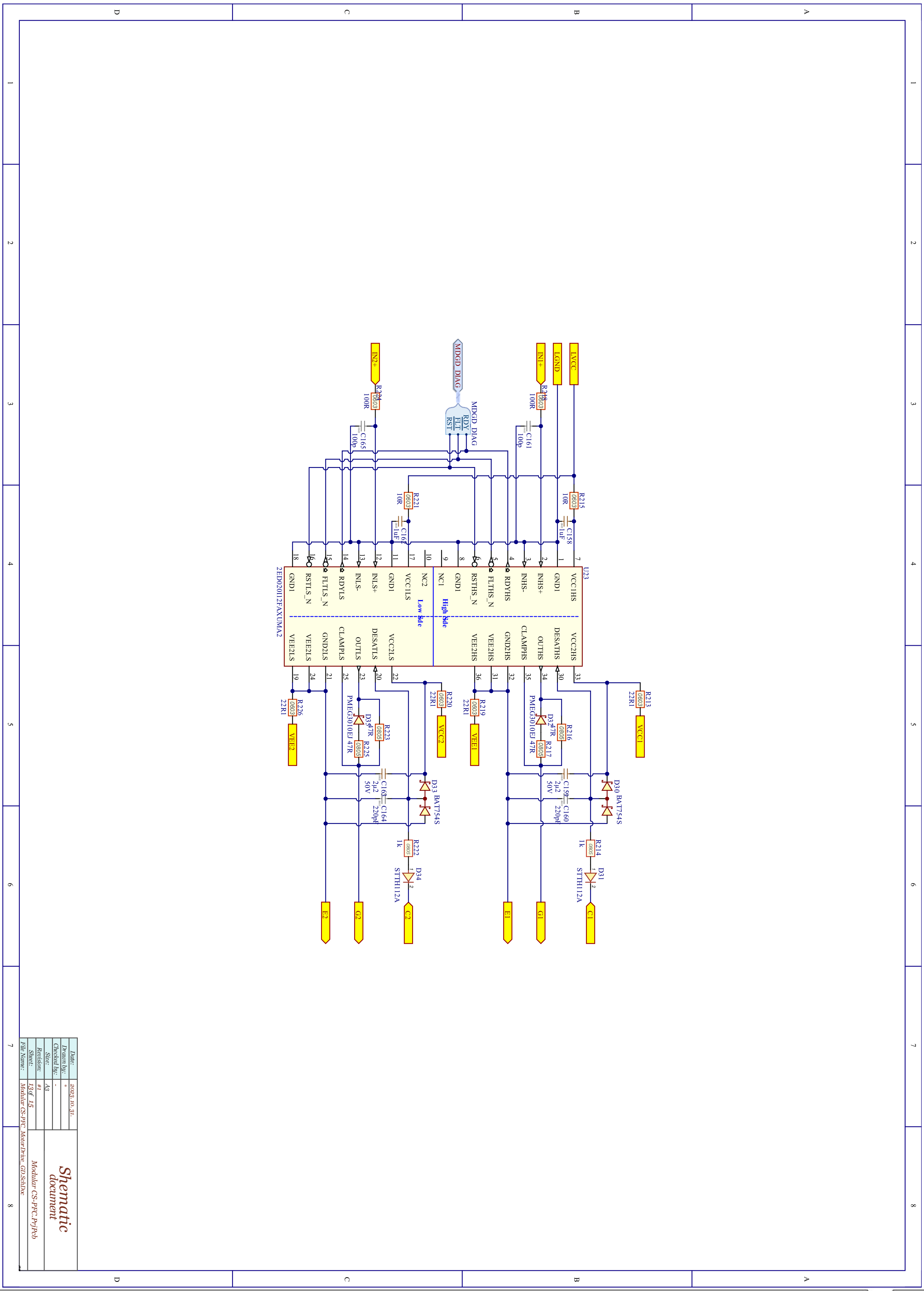
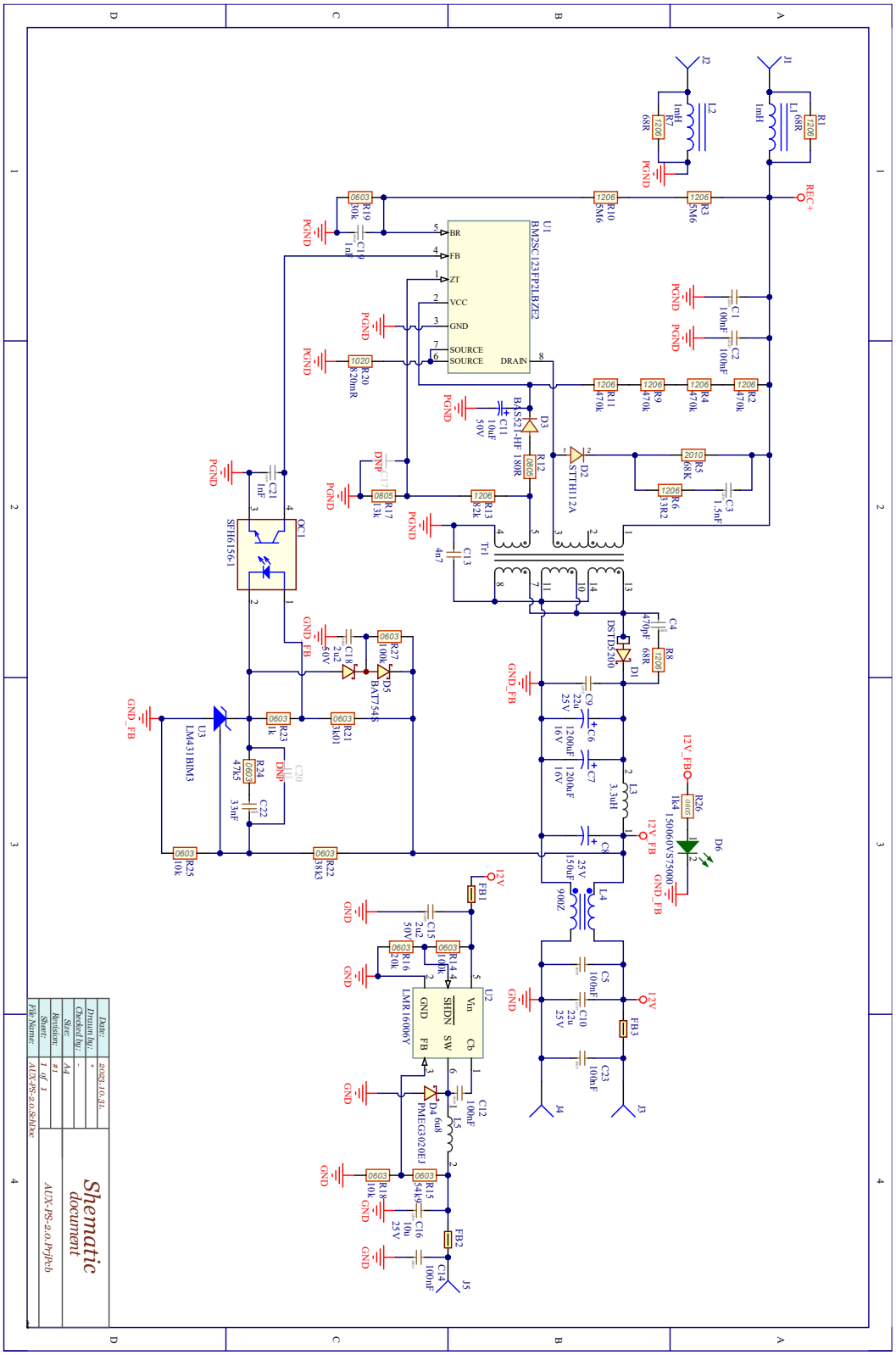
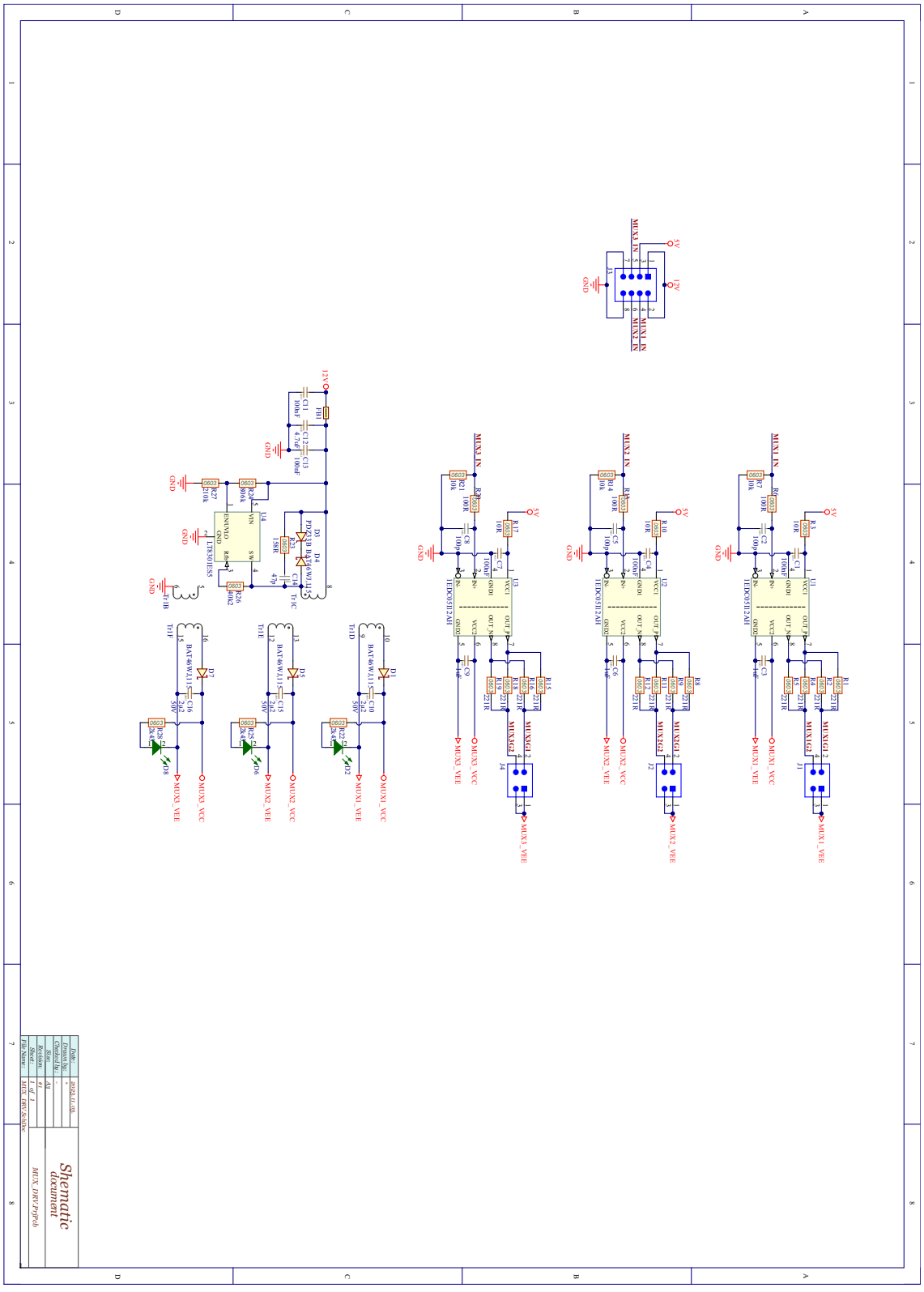
Shematic document
Modular CS-PFC.PrjPcb



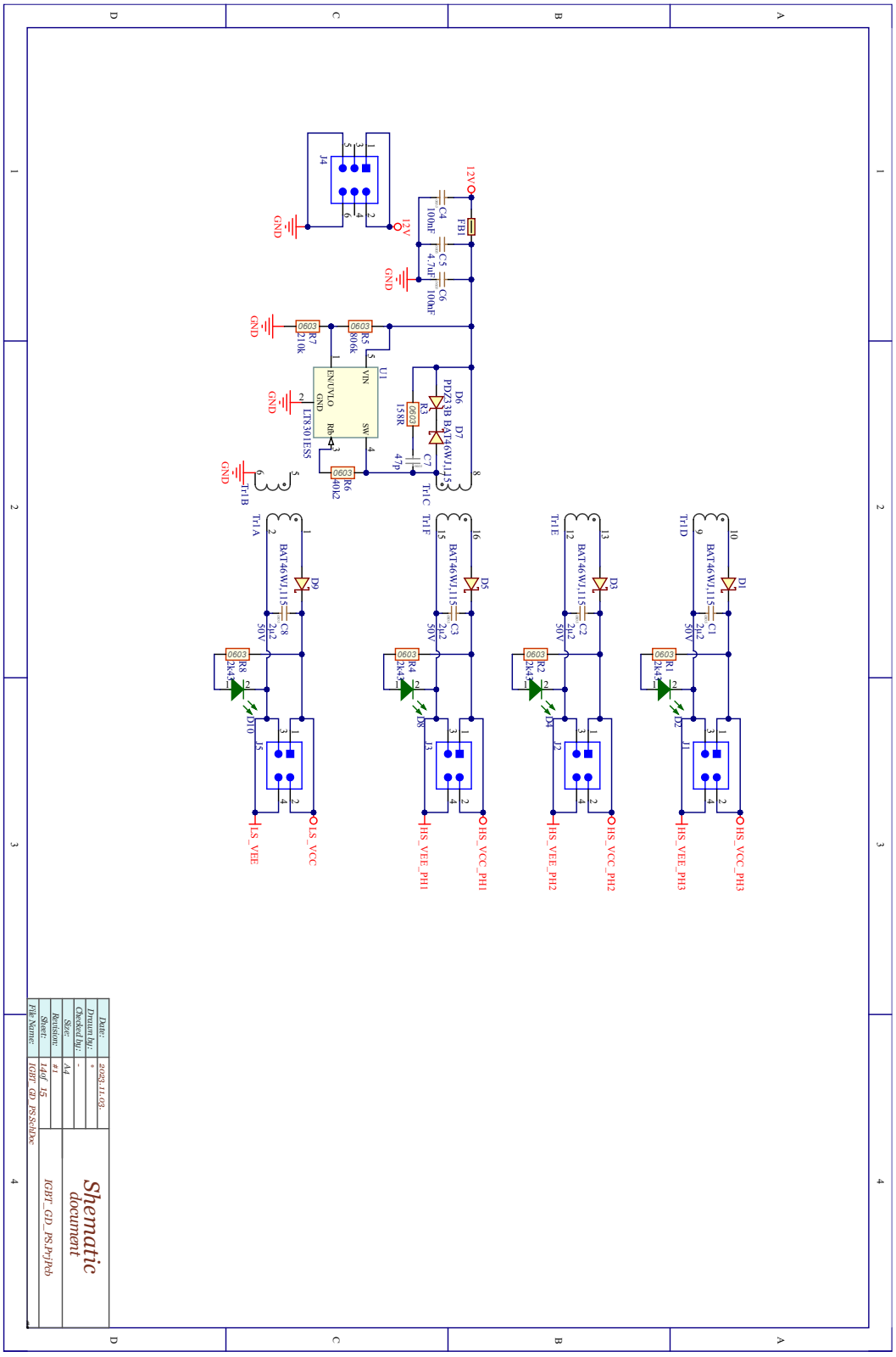
7.2 AUX PS card



7.3 MUX GD card



7.4 INV GD PS card



8 BOM

8.1 Main card

Nr.	Name	Value	Type	Manufacturer	Designators	Qty.
1	Capacitor	100 nF	GCJ188R71H104KA12D	Murata	C1, C3, C18, C23, C25, C29, C31, C33, C36, C38, C39, C41, C42, C43, C44, C45, C47, C48, C50, C51, C52, C53, C54, C72, C74, C77, C79, C82, C84, C85, C99, C101, C103, C105, C107, C111, C115, C119, C121, C122, C133, C142, C167, C169, C172, C174	46
2	Capacitor	1 µF	GRM188C81E105KAADD	Murata	C2, C4, C24, C30, C37, C40, C46, C49, C58, C65, C71, C73, C76, C78, C81, C83, C108, C123, C127, C134, C141, C150, C154, C158, C162	25
3	Capacitor	220 pF	GRM1885C1H221JA01D	Murata	C5, C6, C11, C12, C14, C19, C125, C129, C152, C156, C160, C164	12
4	Capacitor	680 pF	CGA3E2C0G1H681J080AA	TDK	C7, C8, C13, C15, C20, C21, C26, C27, C32	9
5	Capacitor	33 nF	GCJ188R71H333KA12D	Murata	C9, C10, C17	3
6	Capacitor	5,6 nF	GCM1885C1H562JA16D	Murata	C16	1
7	Capacitor	2,2 nF	GRM1885C1H222JA01D	Murata	C22, C28, C75, C80, C109, C112, C113, C116, C117, C120	10
8	Capacitor	100 pF	C0603C101J1GAC	KEMET	C34, C100, C104, C126, C130, C153, C157, C161, C165	9

9	Capacitor	1 µF	GCM21BR71H105MA03L	Murata	C35, C102, C106	3
10	Capacitor	10 µF	GRM21BC71C106KE11L	Murata	C59	1
11	Capacitor	10 nF	GRM1885C1H103JA01D	Murata	C60, C95	2
12	Capacitor	2,2 µF	C2012X7R1H225K125AE	TDK	C64, C124, C128, C151, C155, C159, C163, C166, C171	9
13	Capacitor	100 nF	R413N310040M1M	KEMET	C86, C87, C88	3
14	Capacitor	470 nF	R49AN34700001M	KEMET	C89, C90, C91, C92, C93, C94	6
15	Capacitor	4,7 nF	C971U472MVWDBA7317	KEMET	C96, C97, C98, C137, C176	5
16	Capacitor	4,7 nF	GCM1885C1H472JA16J	Murata	C110, C114, C118	3
17	Capacitor	4,7 µF	R71PR447050H6K	KEMET	C135, C138, C139	3
18	Capacitor	100 nF	C1812W104KDRACTU	KEMET	C140, C145, C146	3
19	Capacitor	10 µF	C4AQOBU5100M12J	KEMET	C143, C144	2
20	Capacitor	22 nF	GRM188R72A223KAC4D	Murata	C147, C148, C149	3
21	Capacitor	4,7 µF	C2012X6S1H475K125AC	TDK	C168, C173	2
22	Capacitor	270 pF	GCM1885C2A271JA16D	Murata	C170, C175	2
23	Connector		1803280	Phoenix Contact	CON1	1
24	LED		150060SS75000	Wurth Electronics	D1, D2, D23, D37	4
25	LED		150060VS75000	Wurth Electronics	D3, D4, D5, D7, D22, D39, D43	7
26	Diode		BAS70-04-E3-18	Vishay Semiconductors	D6, D8, D9, D10, D11, D12, D13	7
27	Diode		BAT754S,215	Nexperia	D14, D17, D24, D27, D30, D33	6
28	Diode		STTH112A	STMicroelectronics	D15, D18, D25, D28, D31, D34	6
29	Diode		PMEG3010EJ,115	Nexperia	D16, D19, D26, D29, D32, D35	6
30	Diode		GB02SLT12-214	Genesic	D20, D21	2
31	Diode		BAT46WJ,115	Nexperia	D36, D40	2
32	LED		150060YS75000	Wurth Electronics	D38	1
33	Fuse	16 A	0ADEC9160-BE	Bel	F1, F2, F3	3

34	Ferrite Beads		BLM18KG260TH1D	Murata	FB1, FB2, FB3, FB4, FB5, FB6, FB7, FB8, FB9, FB14, FB15, FB16, FB17, FB18, FB19, FB22, FB24, FB25, FB26, FB27	20
35	Ferrite Beads		782853121	Wurth Electronics	FB20, FB21	2
36	Fuse Clip		01240061H	Littelfuse	FC1, FC2, FC3, FC4, FC5, FC6	6
37	Connector		HSEC8-160-01-L-DV-A-BL	Samtec	J1	1
38	Connector		HSEC8-130-01-L-DV-A	Samtec	J2	1
39	Connector		7460408	Wurth Electronics	J9, J10	2
40	Connector		215309-2	TE Connectivity	J11, J12, J13, J16, J17, J18, J19	7
41	Connector		215309-4	TE Connectivity	J14	1
42	Connector		215309-3	TE Connectivity	J15	1
43	Common Mode Choke	1,5 mH	SCF31B-180-S1R7A013J	KEMET	Lcm1	1
44	Connector		1098170	Phoenix Contact	P1	1
45	Connector		B4B-XH-A(LF)(SN)	JST	P2, P3, P4	3
46	Connector		0878343019	Molex	P5	1
47	Connector		1098169	Phoenix Contact	P6	1
48	N-channel MOSFET		PMV45EN2R	Nexperia	Q1	1
49	PNP transistor		DDTA124XCA-7-F	Diodes	Q2	1
50	NPN transistor		DDTC124XCA-7-F	Diodes	Q3	1
51	Resistor	4.99 kΩ	RN731JTTD4991B25	KOA Speer	R1, R2, R4, R5, R9, R10, R11, R12, R15, R16, R23, R24, R29, R30, R34, R35, R36, R38, R39, R43, R44, R45	22
52	Resistor	10 kΩ	RT0603BRD1010KL	Yageo	R3, R6, R13, R14, R17, R20, R27, R28, R31, R37, R40, R46	12
53	Resistor	68,1 Ω	RC0603FR-1368R1L	Yageo	R7, R8, R21, R22, R32, R33, R41, R42, R154	9
54	Resistor	2 kΩ	RT0603BRD072KL	Yageo	R18, R19, R25, R26	4

55	Resistor	10 Ω	RT0603FRE0710RL	Yageo	R47, R51, R52, R62, R63, R104, R106, R108, R109, R111, R113, R157, R163, R201, R207, R215, R221	17
56	Resistor	4.7 Ω	ERJ-6DQF4R7V	Panasonic	R48, R49	2
57	Resistor	100 Ω	CRCW0603100RFKEAC	Vishay	R50, R82, R99, R107, R112, R120, R133, R146, R153, R160, R166, R204, R210, R218, R224	15
58	Resistor	0 Ω	RK73Z1JTTD	KOA Speer	R53, R54, R55, R56, R57	5
59	Resistor	127 Ω	CRCW0603127RFKEA	Vishay	R58, R59	2
60	Resistor	6,8 Ω	CRM2512-JW-6R8ELF	Bourns	R60, R61, R227	3
61	Resistor	375 kΩ	KTR18EZPF3573	Rohm	R70, R71, R72, R73, R75, R76, R77, R78, R79	9
62	Resistor	4,02 kΩ	RK73H1JTTD4021F	KOA Speer	R74, R80	2
63	Resistor	8,2 kΩ	RT0603BRD078K2L	Yageo	R81	1
64	Resistor	2,2 kΩ	RT0603BRE072K2L	Yageo	R83	1
65	Resistor	499 kΩ	RC0603FR-07499KL	Yageo	R84	1
66	Resistor	10 Ω	TWW10J10RE	Ohmite	R85, R86, R87, R88	4
67	Resistor	2 kΩ	PCF0805R-2K0BT1	TT Welwyn	R89	1
68	Resistor	1 MΩ	HV732HTTE1004F	KOA Speer	R90, R91, R92, R93, R94, R95, R96, R97, R98, R101, R102, R103, R173, R174, R175, R176	16
69	Resistor	10 kΩ	AC0603FR-1310KL	Yageo	R100, R171, R177, R179, R180, R181, R182, R183, R184, R185, R186, R187, R188, R189, R190, R191, R194, R195	18
70	Resistor	10 Ω	ERJ-P06F10R0V	Panasonic	R105, R110	2
71	Resistor	1 MΩ	KTR18EZPF1004	Rohm	R114, R115, R116, R117, R121, R122, R123, R124, R127, R128, R129, R130, R134, R135, R136, R137, R140, R141, R142, R143, R147, R148, R149, R150	24

72	Resistor	2 kΩ	RN73H1JTTD2001B25	KOA Speer	R118, R125, R131, R138, R144, R151	6
73	Resistor	8,06 kΩ	TNPW06038K06BEEA	Vishay Dale	R119, R126, R132, R139, R145, R152	6
74	Resistor	21,1 Ω	CRCW060322R1FKEA	Vishay	R155, R161, R162, R168, R199, R205, R206, R212, R213, R219, R220, R226	12
75	Resistor	1 kΩ	ERJ-P06F1001V	Panasonic	R156, R164, R200, R208, R214, R222	6
76	Resistor	47 Ω	ERJ-P06F47R0V	Panasonic	R158, R159, R165, R167, R202, R203, R209, R211, R216, R217, R223, R225	12
77	Resistor	1 kΩ	RC0603FR-071KP	Yageo	R172, R178	2
78	Resistor	274 Ω	CRCW0603274RFKEA	Vishay	R192, R193	2
79	Resistor	10 Ω	SMT-R010-1.0	Isabellenhütte	R196, R197, R198	3
80	Resistor	2,43 kΩ	CRCW06032K43FKEA	Vishay	R228, R233	2
81	Resistor	806 kΩ	WR06X8063FTL	Walsin Technologies	R229, R234	2
82	Resistor	75 kΩ	AC0603FR-0775KL	Yageo	R230, R235	2
83	Resistor	210 kΩ	CRCW0603210KFKEA	Vishay Dale	R231, R236	2
84	Relay		RTS3L012	TE Connectivity	RL1, RL2	2
85	Resistor	10 kΩ	CAY16-103J4LF	Bourns	RN1, RN2, RN3, RN6, RN9, RN10	6
86	Resistor	100 Ω	TC164-JR-07100RL	Yageo	RN4, RN5, RN11	3
87	Resistor	390 Ω	TC164-JR-07390RL	Yageo	RN7, RN8	2
88	Transforme r		PH0416NLT	Pulse	T1, T2	2
89	Test point		5010	Keystone Electronics	TP1, TP3, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP17, TP18, TP19, TP20, TP51, TP52, TP53, TP54, TP_1, TP_2, TP_DAC1	20
90	Test point		5011	Keystone Electronics	TP2, TP4, TP12, TP16, TP25, TP28, TP50, TP_GND1	8
91	Test point		5013	Keystone Electronics	TP13, TP14, TP15, TP22, TP26, TP27, TP29, TP30	8
92	Test point		5127	Keystone Electronics	TP31, TP34, TP36, TP43, TP44, TP45, TP46, TP48, TP55, TP57, TP59, TP61	12

93	Test point		5012	Keystone Electronics	TP32, TP33, TP35, TP37, TP38, TP39, TP40, TP41, TP42, TP47, TP49, TP56, TP58, TP60, TP62	15
94	Test point		5014	Keystone Electronics	TP63, TP65, TP67	3
95	Test point		5126	Keystone Electronics	TP64, TP66, TP68	3
96	Test point		5129	Keystone Electronics	TP_Boost1, TP_FAN1, TP_HBH1, TP_HBL1, TP_MUX1, TP_MUX2, TP_MUX3, TP_RL1, TP_RX1, TP_THDcH1, TP_THDcL1, TP_TX1	12
97	Varistor		B72214S2271K101	TDK EPCOS	TVS1, TVS2, TVS3	3
98	Amplifier		OPA4388ID	Texas Instruments	U1, U2, U17	3
99	Gate driver		1EDC20H12AHXUMA1	Infineon	U3	1
100	Voltage Level Translator		SN74LVC8T245PWR	Texas Instruments	U4, U6	2
101	Voltage References		REF2030QDDCRQ1	Texas Instruments	U5	1
102	Voltage Level Translator		74AXP1T45GWH	Nexperia	U7	1
103	LDO		TPS79533DCQ	Texas Instruments	U8	1
104	LDO		MCP1804T-5002I/MB	Microchip	U9	1
105	Amplifier		ACPL-C87A-000E	Broadcom Avago	U11, U12	2
106	Digital Isolator		ADUM210N1BRIZ	Analog Devices	U13	1
107	VCO		LTC6992CS6-1#TRMPBF	Analog Devices / Linear Technology	U14	1
108	Gate driver		1EDC10I12MHXUMA1	Infineon	U15, U16	2
109	Gate driver		2ED020I12F2XUMA1	Infineon	U18, U22, U23	3
110	Current sensor		MCA1101-50-5	ACEINNA	U20	1
111	Current sensor		MCA1101-20-5	ACEINNA	U21	1

112	DC/DC		LT8301ES5#TRMPBF	Analog Devices / Linear Technology	U24, U25	2
113	GDS		2027-47-BLF	Bourns	XF1	1
114	Inductance	73 uH		Vincotech	L1, L2, L3	3
115	Inductance	580 uH		Vincotech	L6	1
116	Inductance	800 uH		Vincotech	L5	1

8.2 AUX PS card

Nr.	Name	Value	Type	Manufacturer	Designators	Qty.
1	Capacitor	100 nF	C2220C104KDRACTU	KEMET	C1, C2	2
2	Capacitor	330 pF	GRM31A5C3A331JWA1D	Murata	C3	1
3	Capacitor	470 pF	C0805C471J2GACTU	KEMET	C4	1
4	Capacitor	100 nF	GCJ188R71H104KA12D	Murata	C5, C12, C14, C23	4
5	Capacitor	470 pF	EEU-FM1E471LJ	Panasonic	C6, C7	2
6	Capacitor	150 µF	UPW1E151MPD1TD	Nichicon	C8	1
7	Capacitor	22 µF	GRM32ER61E226KE15L	Murata	C9, C10	2
8	Capacitor	10 µF	50SVPF10M	Panasonic	C11	1
9	Capacitor	4,7 nF	C971U472MVWDBA7317	KEMET	C13	1
10	Capacitor	2.2 µF	C2012X7R1H225K125AC	TDK	C15, C18	2
11	Capacitor	10 µF	C3216X5R1E106K160AB	TDK	C16	1
12	Capacitor	47 pF	GRM1885C1H470JA01D	Murata	C17	1
13	Capacitor	1 nF	GRM1885C1H102JA01D	Murata	C19	1
14	Capacitor	220 pF	GRM1885C1H221JA01D	Murata	C21	1
15	Capacitor	33 nF	GCJ188R71H333KA12D	Murata	C22	1

16	Diode		DSTD5200	Littelfuse	D1	1
17	Diode		STTH112A	STMicroelectronics	D2	1
18	Diode		BAS521-HF	Comchip	D3	1
19	Diode		PMEG3020EJ,115	Nexperia	D4	1
20	Diode		BAT754S,215	Nexperia	D5	1
21	LED		150060VS75000	Wurth Electronics	D6	1
22	Ferrite Bead		BLM18KG260TH1D	Murata	FB1, FB2, FB3	3
23	Inductance	1 mH	LPS4018-105MRC	Coilcraft	L1, L2	2
24	Inductance	3,3 µH	CLF6045NIT-3R3N-D	TDK	L3	1
25	Common Mode Choke	1.6 µH	ACM4520-901-2P-T000	TDK	L4	1
26	Inductance	6.8 µH	LPS3015-682MRC	Coilcraft	L5	1
27	Optocoupler		LTV-817S-TA1-B	Vishay Lite-On	OC1	1
28	Resistor	68 Ω	ERJ-P08J680V	Panasonic	R1, R7, R8	3
29	Resistor	470 kΩ	ERJ-P08F4703V	Panasonic	R2, R4, R9, R11	4
30	Resistor	5,6 MΩ	KTR18EZPJ565	Rohm	R3, R10	2
31	Resistor	68 kΩ	CRGP2010F68K	TE Connectivity	R5	1
32	Resistor	33,2 Ω	CRCW120633R2FKEAC	Vishay	R6	1
33	Resistor	22 Ω	CRGH0805F22R	TE Connectivity	R12	1
34	Resistor	100 kΩ	ERJ-P08J104V	Panasonic	R13	1
35	Resistor	100 kΩ	CRCW0603100KFKEC	Vishay Dale	R14, R27	2
36	Resistor	54,9 kΩ	CRCW060354K9FKEA	Vishay	R15	1
37	Resistor	20 kΩ	CRCW060320K0FKEA	Vishay	R16	1
38	Resistor	13 kΩ	RC0805FR-0713KL	Yageo	R17	1
39	Resistor	10 kΩ	CRCW060310K0FKEA	Vishay	R18, R25	2
40	Resistor	30 kΩ	CRCW060330K0FKEAC	Vishay Dale	R19	1
41	Resistor	1 Ω	ERJB1BF1R0U	Panasonic	R20	1
42	Resistor	3,01 kΩ	CRCW06033K01FKEA	Vishay	R21	1
43	Resistor	38,3 kΩ	ERJ-3EKF3832V	Panasonic	R22	1
44	Resistor	1 kΩ	CRCW06031K00FKEC	Vishay Dale	R23	1
45	Resistor	68,1 kΩ	CRCW060368K1FKEA	Vishay	R24	1
46	Resistor	1,4 kΩ	ERJ-P06F1401V	Panasonic	R26	1
47	AC/DC Converter		BM2SC123FP2-LBZE2	Rohm	U1	1
48	Voltage Regulator		LMR16006YQDDCRQ1	Texas Instruments	U2	1
49	Voltage References		LM431SCCM3X	ON Semiconductor / Fairchild	U3	1

8.3 INV GD PS card

Nr.	Name	Value	Type	Manufacturer	Designators	Qty.
1	Capacitor	2,2 µF	C2012X7R1H225K125 AE	TDK	C1, C2, C3, C8	4
2	Capacitor	100 nF	GCJ188R71H104KA12 D	Murata	C4, C6	2
3	Capacitor	4.7 µF	C2012X6S1H475K125A C	TDK	C5	1
4	Capacitor	47 pF	GRM1885C1H470JA01 D	Murata	C7	1
5	Diode		BAT46WJ,115	Nexperia	D1, D3, D5, D7, D9	5
6	LED		150060VS75000	Wurth Electronics	D2, D4, D8, D10	4
7	Zener Diode		PDZ33B,115	Nexperia	D6	1
8	Ferrite Bead		BLM18KG260TH1D	Murata	FB1	1
9	Connector		826662-2	TE Connectivity	J1, J2, J3, J5	4
10	Connector		826662-3	TE Connectivity	J4	1
11	Resistor	2,43 kΩ	CRCW06032K43FKEA	Vishay	R1, R2, R4, R8	4
12	Resistor	158 Ω	ERJ-3EKF1580V	Panasonic	R3	1
13	Resistor	806 kΩ	RC0603FR-07806KL	Yageo	R5	1
14	Resistor	40,2 kΩ	CRCW060340K2FKEA	Vishay	R6	1
15	Resistor	210 kΩ	CRCW0603210KFKEA	Vishay Dale	R7	1
16	Transforme r		PG1895NLT	Pulse	Tr1	1
17	Voltage Regulator		LT8301ES5#TRMPBF	Analog Devices / Linear Technology	U1	1

8.4 MUX GD card

Nr.	Name	Value	Type	Manufacturer	Designators	Qty.

1	Capacitor	100 nF	GCJ188R71H104KA12D	Murata	C1, C4, C7, C11, C13	5
2	Capacitor	100 pF	C0603C101J1GAC	KEMET	C2, C5, C8	3
3	Capacitor	1 µF	GCM21BR71H105MA03L	Murata	C3, C6, C9	3
4	Capacitor	2.2 µF	C2012X7R1H225K125AE	TDK	C10, C15, C16	3
5	Capacitor	4.7 µF	C2012X6S1H475K125AC	TDK	C12	1
6	Capacitor	47 pF	GRM1885C1H470JA01D	Murata	C14	1
7	Diode		BAT46WJ,115	Nexperia	D1, D4, D5, D7	4
8	LED		150060VS75000	Wurth Electronics	D2, D6, D8	3
9	Zener Diode		PDZ33B115	Nexperia	D3	1
10	Ferrite Beads		BLM18KG260TH1D	Murata	FB1	1
11	Connector		826662-2	TE Connectivity	J1, J2, J4	3
12	Connector		826662-4	TE Connectivity	J3	1
13	Resistor	221 Ω	RC0603FR-13221RL	Yageo	R1, R2, R4, R5, R8, R9, R11, R12, R15, R16, R18, R19	12
14	Resistor	10 Ω	CRCW060310R0FKEA	Vishay	R3, R10, R17	3
15	Resistor	100 Ω	WR06X1000FTL	Walsin Technologies	R6, R13, R20	3
16	Resistor	10 kΩ	CRCW060310K0FKECC	Vishay	R7, R14, R21	3
17	Resistor	2,43 kΩ	CRCW06032K43FKEA	Vishay	R22, R25, R28	3
18	Resistor	158 Ω	ERJ-3EKF1580V	Panasonic	R23	1
19	Resistor	806 kΩ	RC0603FR-07806KL	Yageo	R24	1
20	Resistor	40,2 kΩ	CRCW060340K2FKEA	Vishay	R26	1
21	Resistor	210 kΩ	CRCW0603210KFKEA	Vishay Dale	R27	1
22	Transformer		PG1895NLT	Pulse	Tr1	1
23	Gate Driver		1EDC05I12AHXUMA1	Infineon	U1, U2, U3	3
24	Voltage Regulator		LT8301ES5#TRMPBF	Analog Devices / Linear Technology	U4	1