softstart_routed

Design Report

Rev 1 | 2026-06-12 | jlcpcb-tier1

kicad-tools 0.13.0

Board Summary

Property	Value
Layers	4 copper (F.Cu, In1.Cu, In2.Cu, B.Cu)
Footprints	78 (56 SMD, 18 THT, 4 other)
Nets	41
Traces	4727 segments
Vias	158
Board Size	150.0 x 100.0 mm

Design Overview

Theory of Operation

Generator Soft-Start - Supercapacitor Power Assist

120VAC soft-start for 8000 BTU AC on Honda EU1000i

STM32G031K8T6 MCU, 2x30S supercap banks, back-to-back FETs + UCC27211 drivers

Power Architecture

Power Rails: +3V3, GND, PWR_FLAG

Regulator	Device
U4	XC6206-3.3V
U9	LM7812

Assembly Notes

1 fine-pitch component; 6 polarized components

- **Fine-pitch components**: 1 (U1)
- **Polarized components**: 6 -- check orientation markings

Off-board Assemblies

The following subsystems are part of the design but are **not placed on the PCB** -- they connect through board connectors and are assembled by hand (DNP for fab assembly).

SUPERCAP_BANK_POS

Positive half-cycle supercapacitor bank (off-board, 30S string)

Property	Value
Board connector	J3
Part	Tecate TPLH-2R7/12WR10X30
Quantity	30
Voltage	81V nominal
Capacitance	0.4F
Assembly	hand solder (DNP for fab assembly)

Wiring: J3 pin 1 -> SCAP_POS+ (bank positive terminal); J3 pin 2 -> SCAP_POS_GND (bank return, star ground). 30 cells in series, 12F 2.7V each.

SUPERCAP_BANK_NEG

Negative half-cycle supercapacitor bank (off-board, 30S string)

Property	Value
Board connector	J4
Part	Tecate TPLH-2R7/12WR10X30
Quantity	30
Voltage	81V nominal
Capacitance	0.4F
Assembly	hand solder (DNP for fab assembly)

Wiring: J4 pin 1 -> SCAP_NEG+ (bank positive terminal); J4 pin 2 -> SCAP_NEG_GND (bank return, star ground). 30 cells in series, 12F 2.7V each.

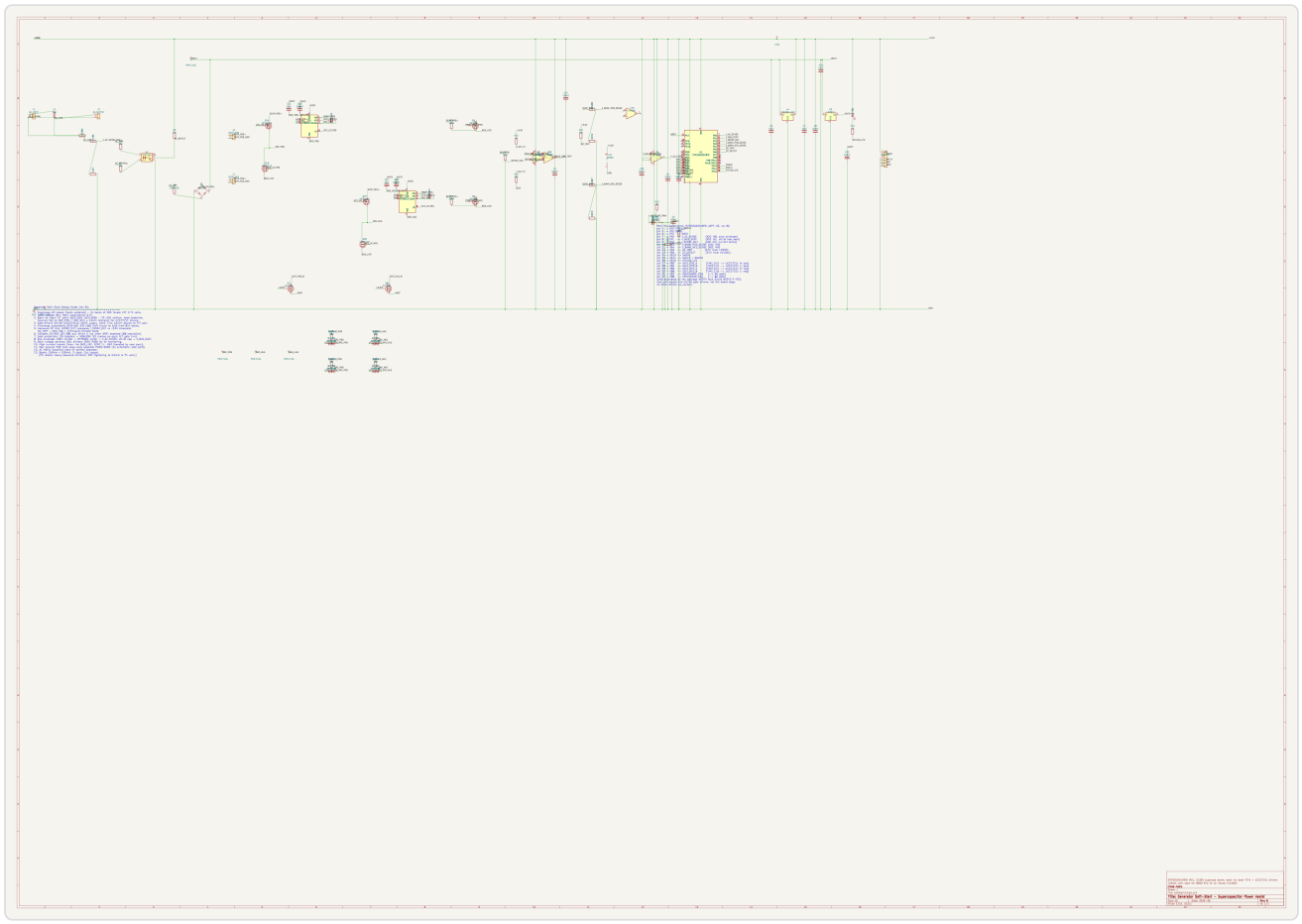
ERC Status

Metric	Count
Errors	0
Warnings	0

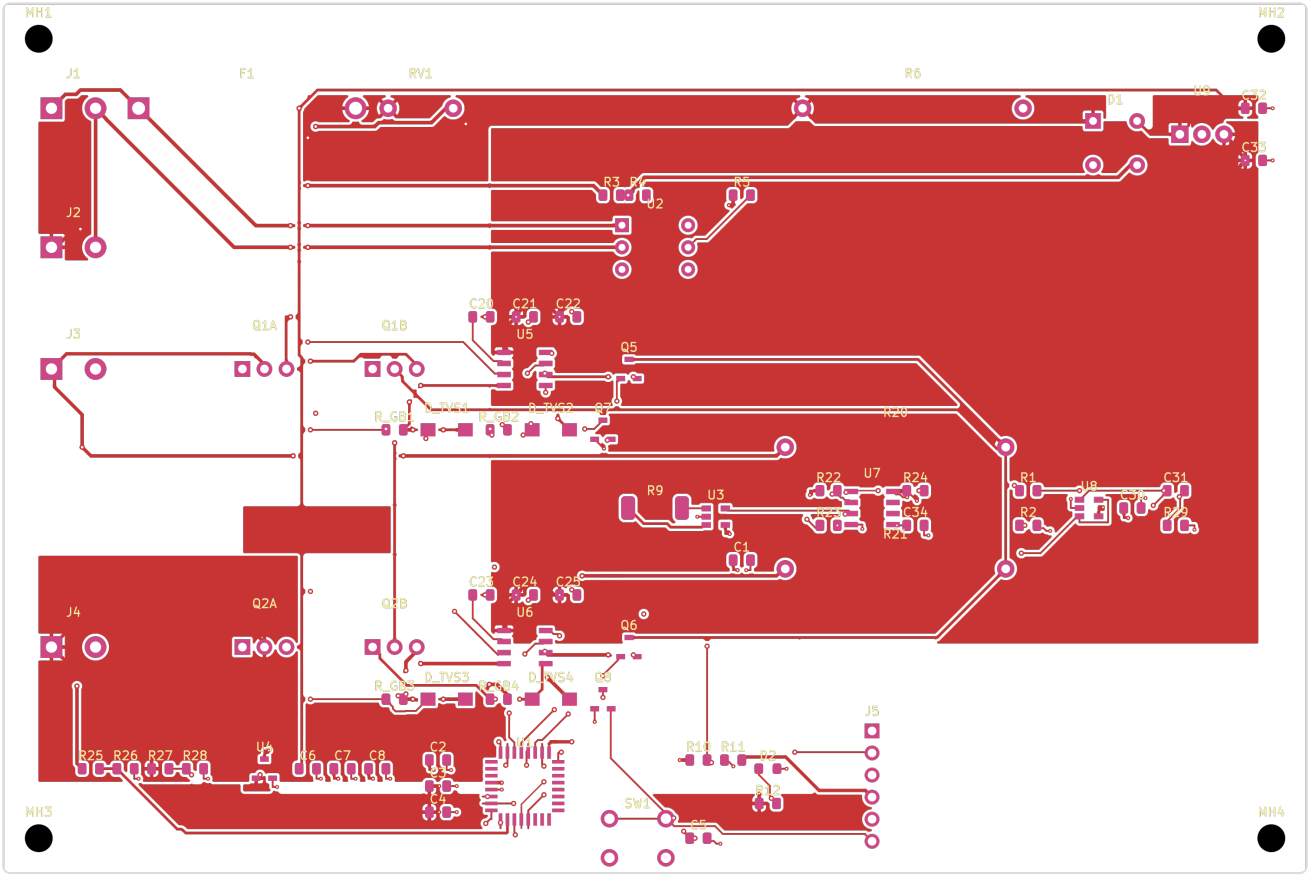
Status: SKIPPED -- ERC skipped by user request

Schematic Overview

Schematic: softstart



PCB Layout


MH1
MH2
MH3
MH4
J1
F1
RV1
R6
D1
J2
R3
R4
R5
Q2
J3
Q1A
Q1B
C20
C21
C22
U5
Q5
R_GB1
D_TVS1
R_GB2
D_TVS2
Q3
R20
R9
U3
R22
U7
R24
R1
U8
C31
C34
R21
R2
C1
J4
Q2A
Q2B
C23
C24
C25
U6
Q6
D_TVS3
D_TVS4
Q4
J5
R25
R26
R27
R28
U4
X6
C7
C8
C2
C4
R10
R11
R12
SW1
C5

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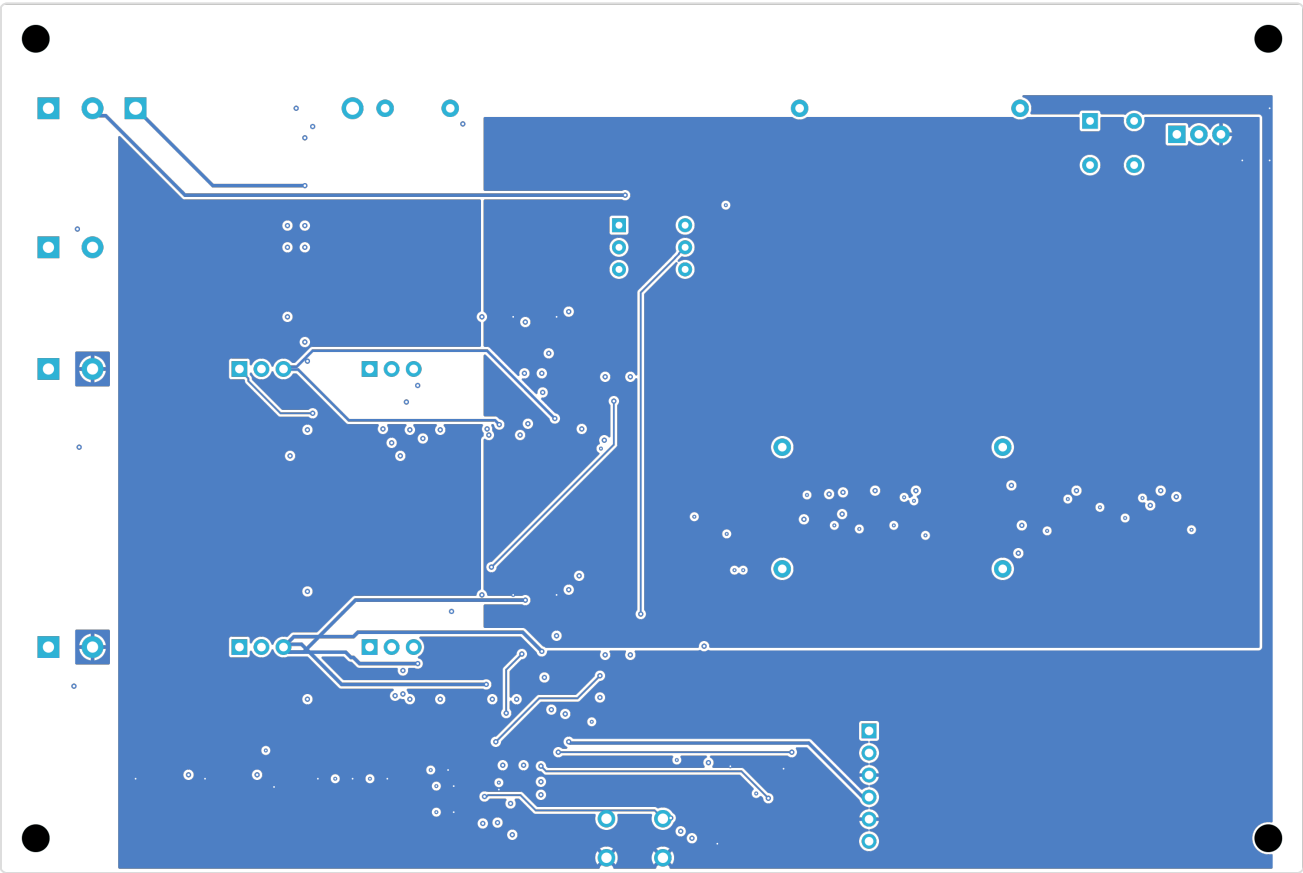
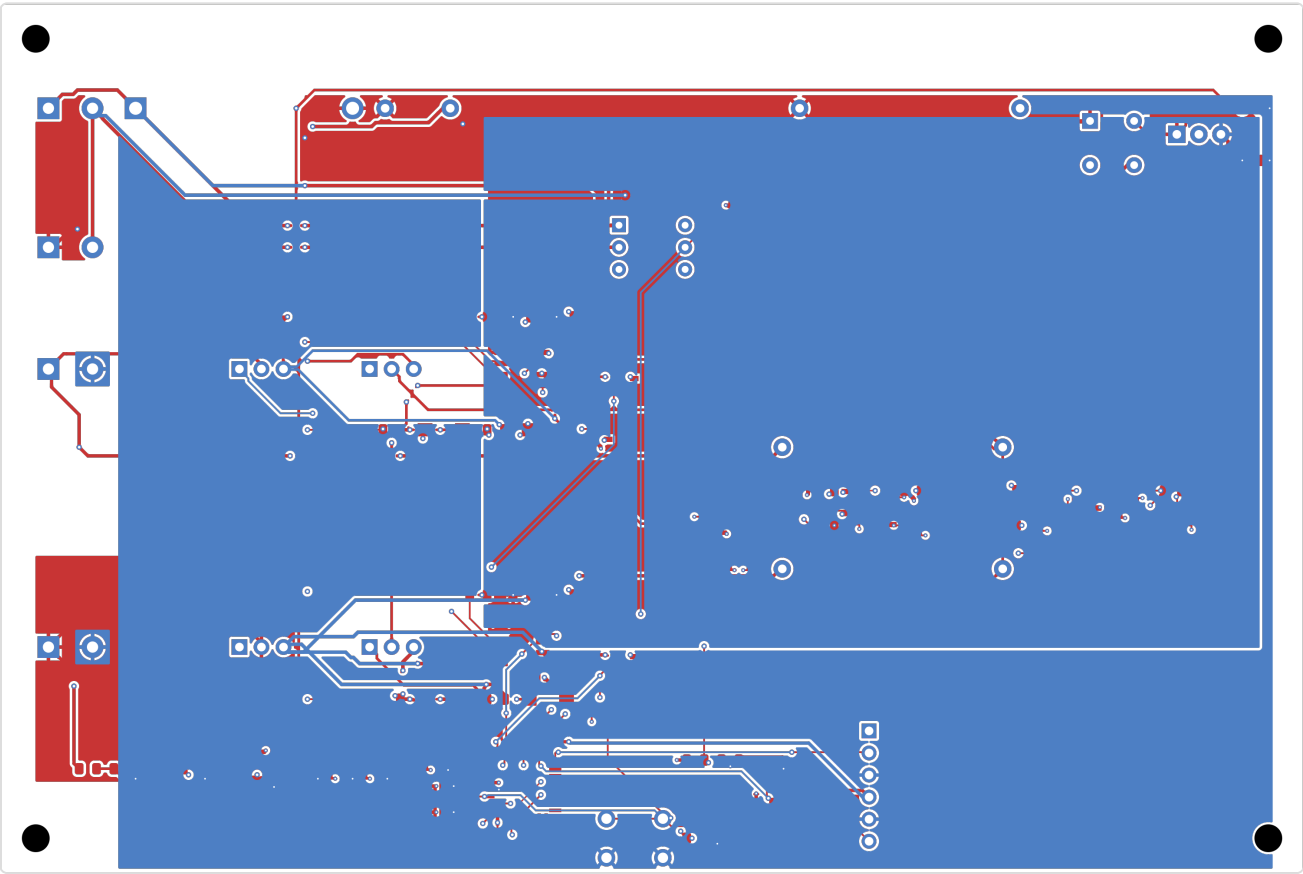
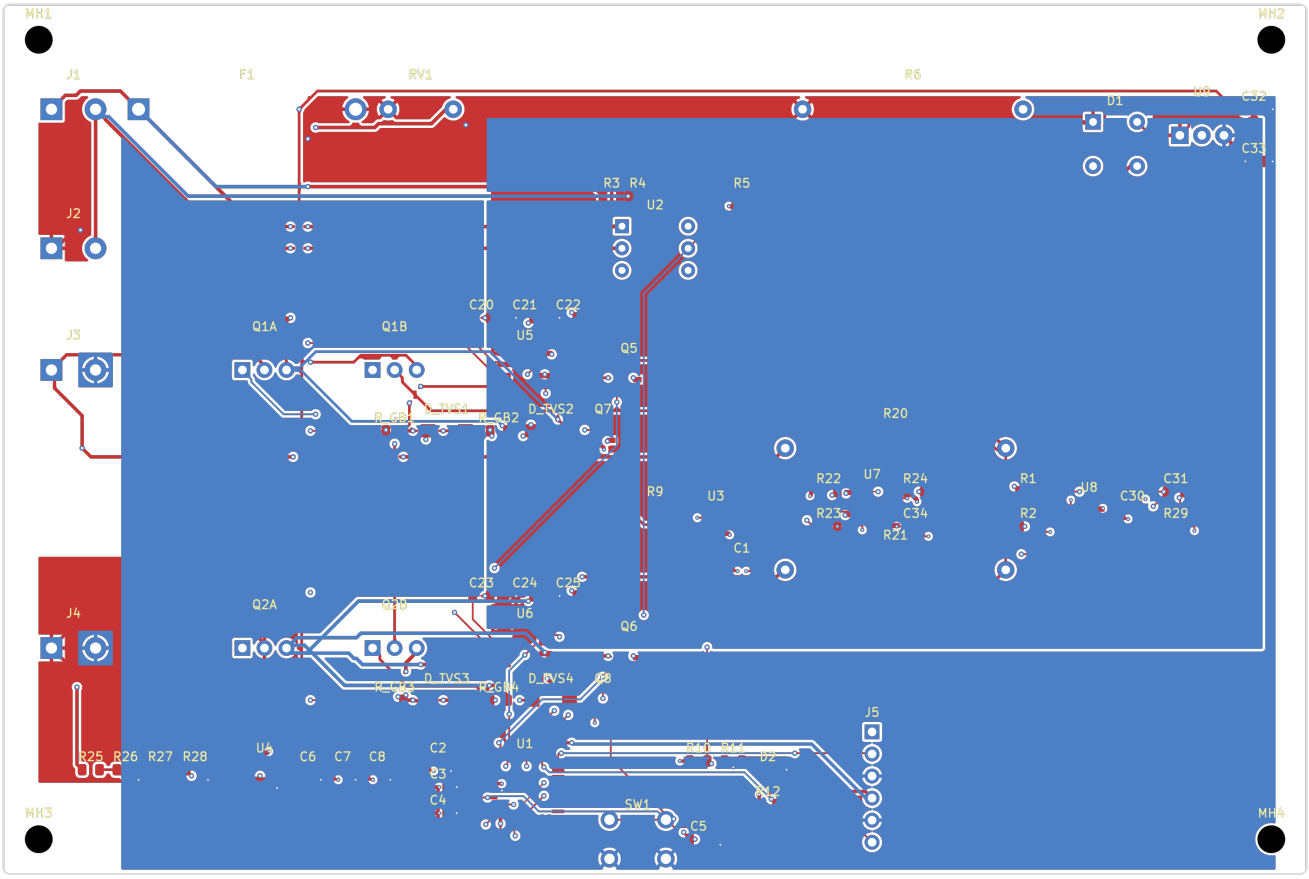


Copper

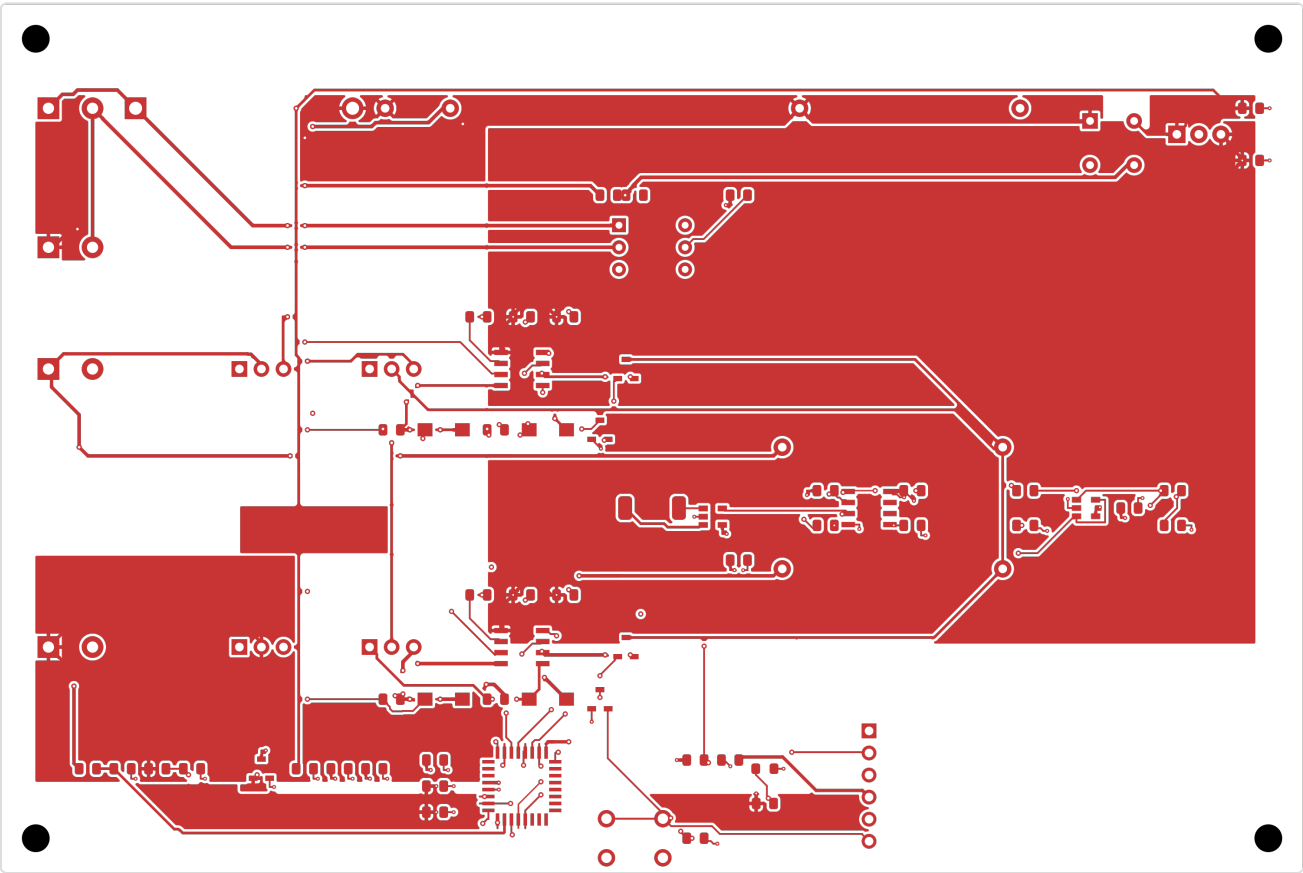


Assembly

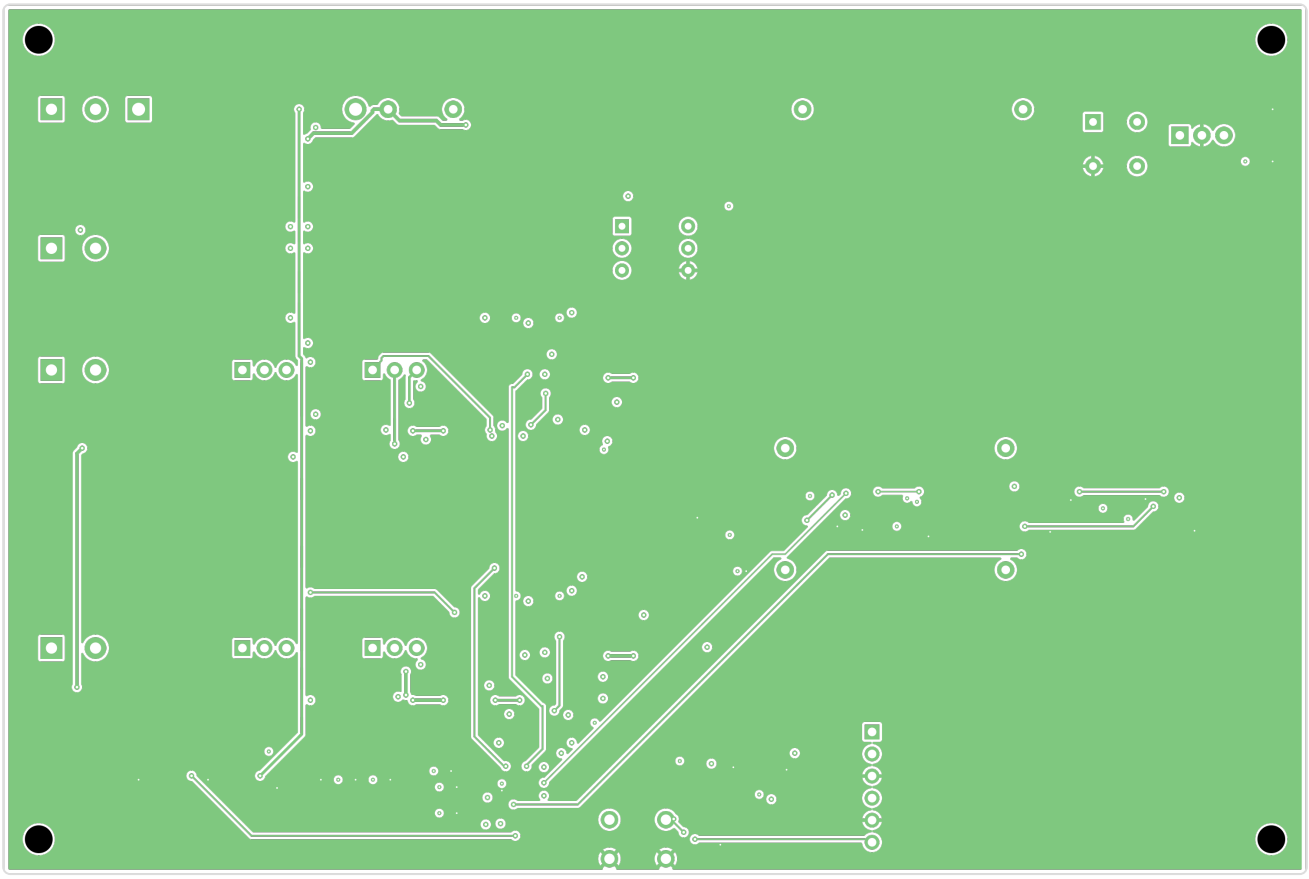

MH1
MH2
MH3
MH4
J1
F1
RV1
R6
D1
C32
C33
J2
R3
R4
R5
U2
J3
Q1A
Q1B
C20
C21
C22
U5
Q5
D_TVS2
Q7
R20
R22
U7
R24
R1
U8
C31
C30
R29
R23
C34
R2
R21
R9
U3
C1
J4
Q2A
C23
C24
C25
U6
Q6
D_TVS3
D_TVS4
J5
R25
R26
R27
R28
U4
C6
C7
C8
C2
C3
C4
U1
D2
R12
SW1
C5

Copper Layers

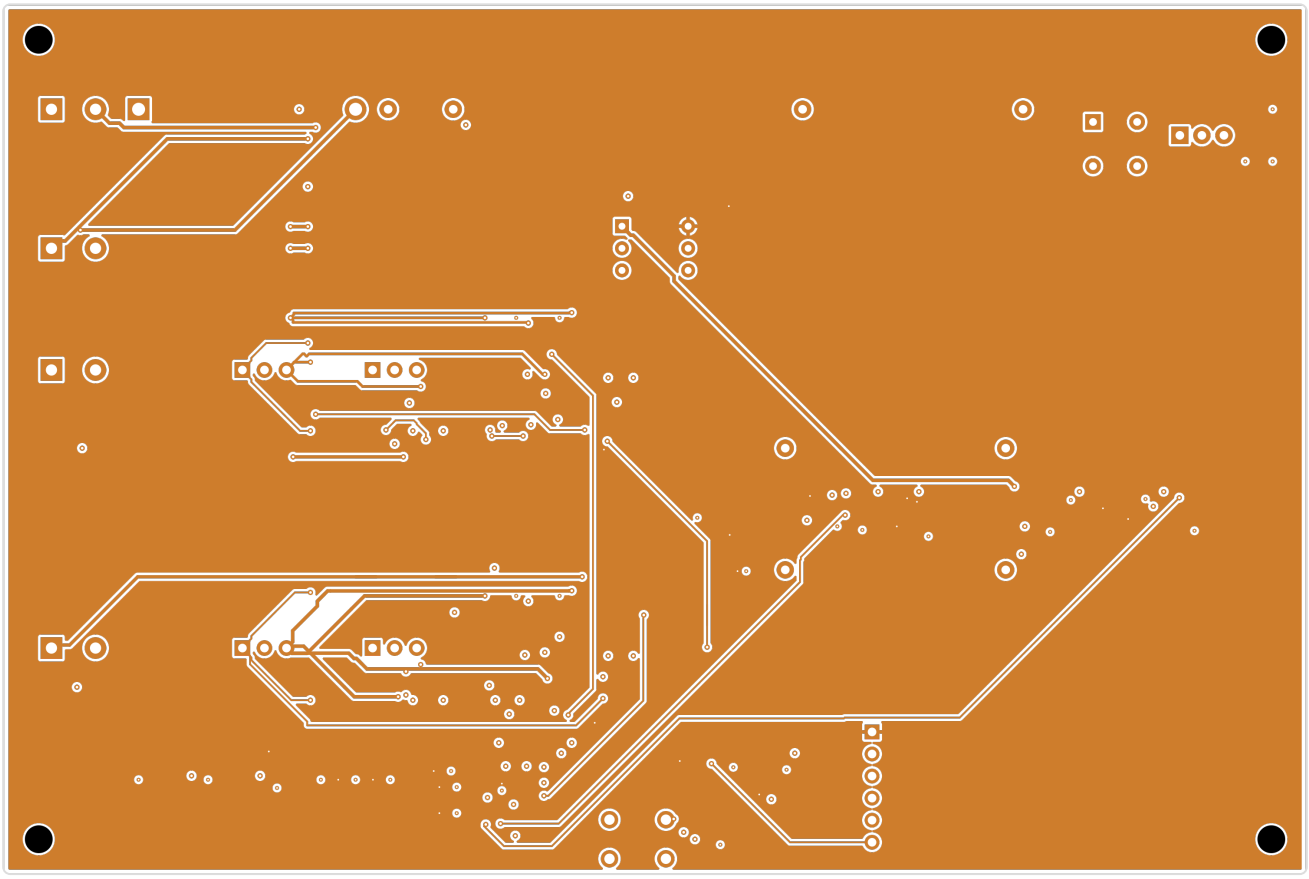
F.Cu



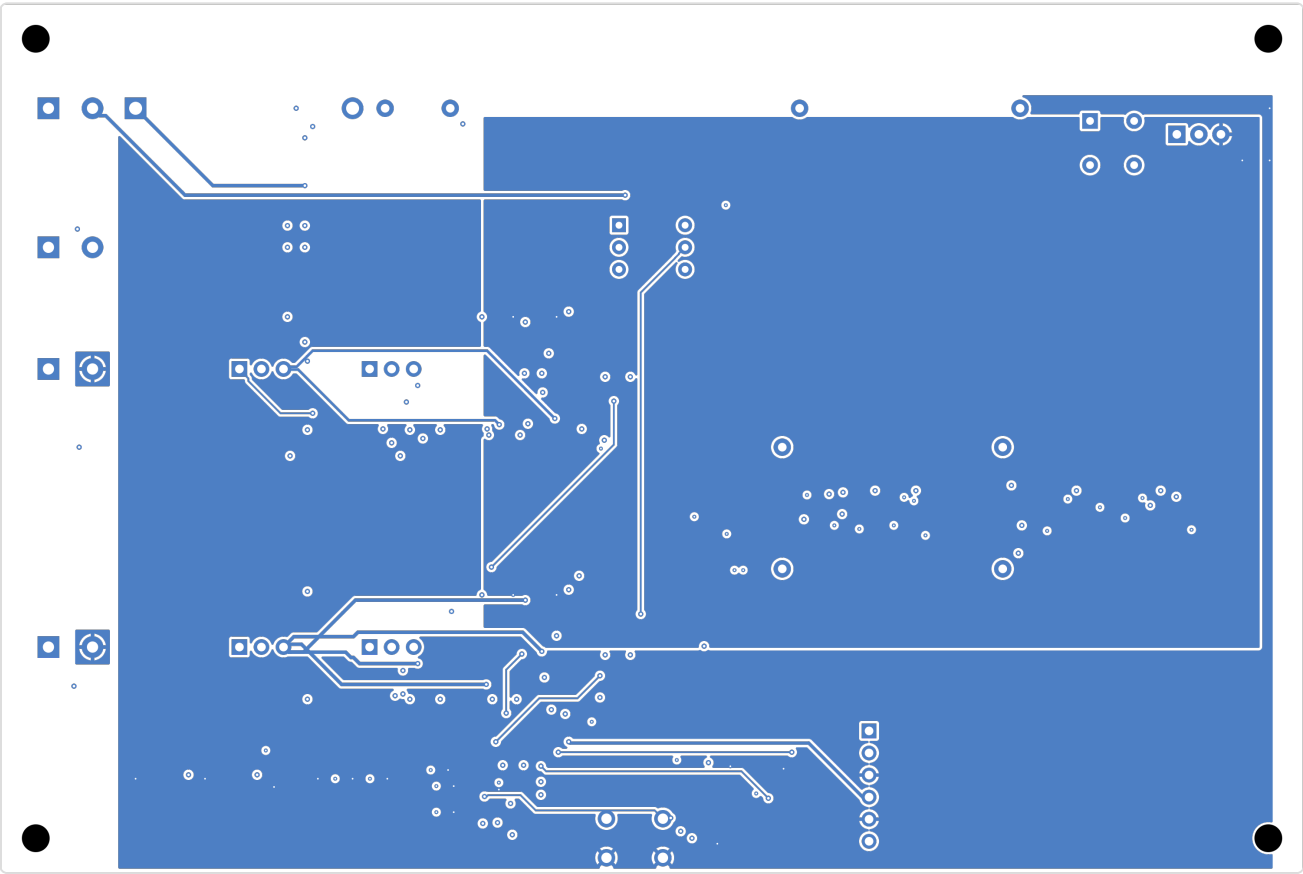
In1.Cu



In2.Cu



B.Cu



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Bill of Materials

Value	Package	Qty	References	MPN
100nF		5	C5, C20, C22, C23, C25	
100nF	C_0402_1005Metric	8	C1, C2, C3, C8, C30, C31, C33, C34	
10uF		2	C21, C24	
10uF	C_0805_2012Metric	3	C6, C7, C32	
4.7uF	C_0805_2012Metric	1	C4	
RB157	Diode_Bridge_DIP-4_W7.62mm_P5.08mm	1	D1	
SMBJ18A	D_SMB	4	D_TVS1, D_TVS2, D_TVS3, D_TVS4	
STATUS		1	D2	
15A		1	F1	
AC_INPUT	TerminalBlock_bornier-2_P5.08mm	1	J1	
AC_OUTPUT	TerminalBlock_bornier-2_P5.08mm	1	J2	
SCAP_NEG	TerminalBlock_bornier-2_P5.08mm	1	J4	
SCAP_POS	TerminalBlock_bornier-2_P5.08mm	1	J3	
SWD-6		1	J5	
2N7002	SOT-23	2	Q7, Q8	
AO3400	SOT-23	2	Q5, Q6	
IRFB4110	TO-220-3_Vertical	4	Q1A, Q1B, Q2A, Q2B	
100R	R_Axial_DIN0617_L17.0mm_D6.0mm_P25.40mm_Horizontal	2	R20, R21	

Value	Package	Qty	References	MPN
10k		7	R2, R10, R11, R23, R24, R26, R28	
10k	R_0805_2012Metric	6	R_GB1, R_GB2, R_GB3, R_GB4, R5, R29	
150R 5W	R_Axial_DIN0617_L17.0mm_D6.0mm_P25.40mm_Horizontal	1	R6	
1k		2	R12, R22	
275VAC	RV_Disc_D12mm_W4.2mm_P7.5mm	1	RV1	
290.0k		2	R25, R27	
33k	R_0805_2012Metric	2	R3, R4	
5mR	R_2512_6332Metric	1	R9	
990.0k		1	R1	
RESET		1	SW1	
H11AA1	DIP-6_W7.62mm	1	U2	
INA180A3	SOT-23-5	1	U3	
LM393	SOIC-8_3.9x4.9mm_P1.27mm	3	U7, U7, U7	
LM7812	TO-220-3_Vertical	1	U9	
MCP6001	SOT-23-5	1	U8	
STM32G031K8T6	LQFP-32_7x7mm_P0.8mm	1	U1	
UCC27211	SOIC-8_3.9x4.9mm_P1.27mm	2	U5, U6	
XC6206-3.3V		1	U4	
Tecate TPLH-2R7/12WR10X30	Off-board via J3 (hand solder, DNP for fab assembly)	30	SUPERCAP_BANK_POS	Tecate TPLH-2R7/12WR10X30

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Value	Package	Qty	References	MPN
Tecate TPLH-2R7/12WR10X30	Off-board via J4 (hand solder, DNP for fab assembly)	30	SUPERCAP_BANK_NEG	Tecate TPLH-2R7/12WR10X30

DRC Status

Metric	Count
Errors	0
Warnings	0
Blocking	0

Status: PASS

Manufacturing Readiness

Verdict: READY

Action Items

- **[OPTIONAL]** Verify zone fill in KiCad for 12 zone-connected nets
- **[OPTIONAL]** Analog-sensitive: U3 (INA180A3) — instrumentation amplifier (TI INA); manual layout review recommended
- **[OPTIONAL]** Analog net: AC_LINE — audio signal; keep short, away from digital/switching nets
- **[OPTIONAL]** Analog net: BUS_LINE — audio signal; keep short, away from digital/switching nets
- **[OPTIONAL]** Analog net: FUSED_LINE — audio signal; keep short, away from digital/switching nets
- **[OPTIONAL]** Analog net: ISENSE_NEG — analog signal; noise-sensitive, avoid crossing digital signals
- **[OPTIONAL]** Analog net: ISENSE_POS — analog signal; noise-sensitive, avoid crossing digital signals
- **[OPTIONAL]** Analog net: I_SENSE_OUT — analog signal; noise-sensitive, avoid crossing digital signals
- **[OPTIONAL]** Analog net: V_AC_SENSE — analog signal; noise-sensitive, avoid crossing digital signals
- **[OPTIONAL]** Analog net: V_AC_SENSE_RAW — analog signal; noise-sensitive, avoid crossing digital signals
- **[OPTIONAL]** Analog net: V_BANK_NEG_SENSE — analog signal; noise-sensitive, avoid crossing digital signals
- **[OPTIONAL]** Analog net: V_BANK_POS_SENSE — analog signal; noise-sensitive, avoid crossing digital signals

Analog Components

1 analog-sensitive component detected -- manual layout review recommended.

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Reference	Value	Reason
U3	INA180A3	instrumentation amplifier (TI INA)

Routing Status

Metric	Value
Signal Net Completion	100.0% (27/27)
Overall Completion	100.0%
Complete Nets	41 / 41
Zone-Connected Nets	14
Single-Pad Nets	2 (no routing needed)
Incomplete Nets	0
Unconnected Pads	0

Zone-Connected Nets

- +3.3V
- AC_LINE
- AC_NEUTRAL
- BUS_LINE
- FUSED_LINE
- GND
- SCAP_NEG+
- SCAP_NEG_GND
- SCAP_POS+
- SCAP_POS_GND
- SRC_NEG
- SRC_POS
- VGATE
- VRECT

Single-Pad Nets

2 single-pad nets (no routing needed) -- not listed individually.

Cost Estimate

Metric	Per Board (estimated)
PCB Fabrication	~5.0 USD
Components (estimated)	~5.72 USD
Assembly (estimated)	~0.0 USD
Total (estimated)	**~10.72 USD**
Batch Quantity	5
Batch Total (estimated)	~53.6 USD