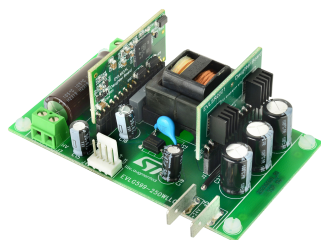


400 V - 24 V / 10.5 A DC-DC resonant LLC converter for industrial applications, using STNRG599A, MASTERGAN1L and SRK2001A



Product status link

[EVLG599-250WLLC](#)

Features

- High-efficiency and compact solution for DC-DC conversion using STNRG599A, MASTERGAN1L and SRK2001A
- Output voltage: 24 V
- Output power: up to 250 W
- Nominal input voltage: 400 V $\pm$ 10%
- Efficiency: > 92%
- Output protected against short-circuit and overcurrent
- Input voltage monitoring for correct sequencing as DC-DC converter and brown-out protection
- Integrated high-voltage startup for converter power-up
- Board size: 78 x 54 mm (W x H). Maximum component height: 23 mm
- WEEE and RoHS compliant

Application

- Industrial DC-DC applications
- Adapters
- Consumer SMPS

Description

This demonstration board is a resonant LLC converter for industrial applications providing minimum size and very high efficiency. It can be used as a DC-to-DC converter or as part of a more complex system using a front-end preconditioner such as a PFC. The board is based on the STNRG599A, a new resonant tank controller implementing the novel phase-shift control method, and on MASTERGAN1L, embedding a GaN transistor-based half-bridge leg and corresponding drivers in the same package. This allows direct interfacing with any kind of SMPS controller.

To achieve high efficiency, secondary-side synchronous rectification is implemented with SRK2001A. The board has no heat sinks on the primary side and offers very reduced dimensions. The power density is about 41 W/inch³. Its high efficiency and small size make the board suitable when available space is limited.

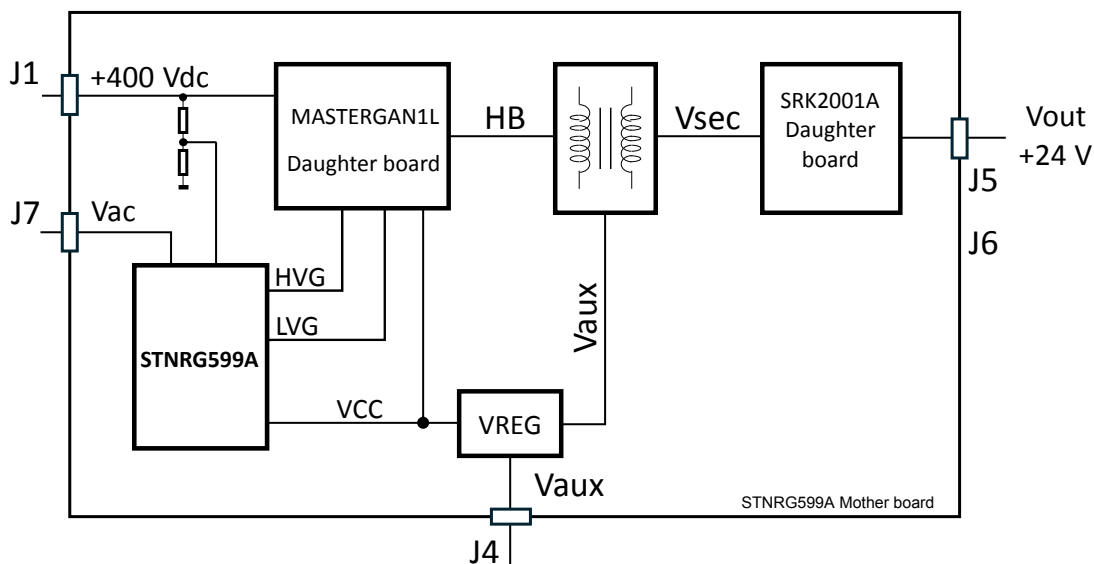
The output power of the converter can be up to 250 W at 24 Vdc. The converter provides protections against overcurrent, short-circuit and overvoltage. The STNRG599A integrated HV startup allows powering the IC from AC mains for proper power-up, with no need for auxiliary standby supplies. It can provide current also to another control IC such as, for example, the PFC control IC. The DC input voltage monitoring allows for startup with the correct sequencing of cascaded converters, preventing operation with too low input voltage.

The board consists of a motherboard with the LLC resonant tank and the primary controller, and two daughterboards: one on the primary side with MASTERGAN1L, and another on the secondary side with SRK2001A and the synchronous rectification MOSFETs. Note that the STNRG599A is the IC version with X-capacitor discharge enabled at the HV pin, suitable for adapter applications, while STNRG599B is the IC version with X-capacitor discharge disabled at the HV pin, suitable for lighting applications.

1 Block diagrams and schematic diagrams

1.1 Block diagram of the board

Figure 1. Block diagram of the board



1.2 Schematic diagrams

Figure 2. STNRG599A motherboard schematic

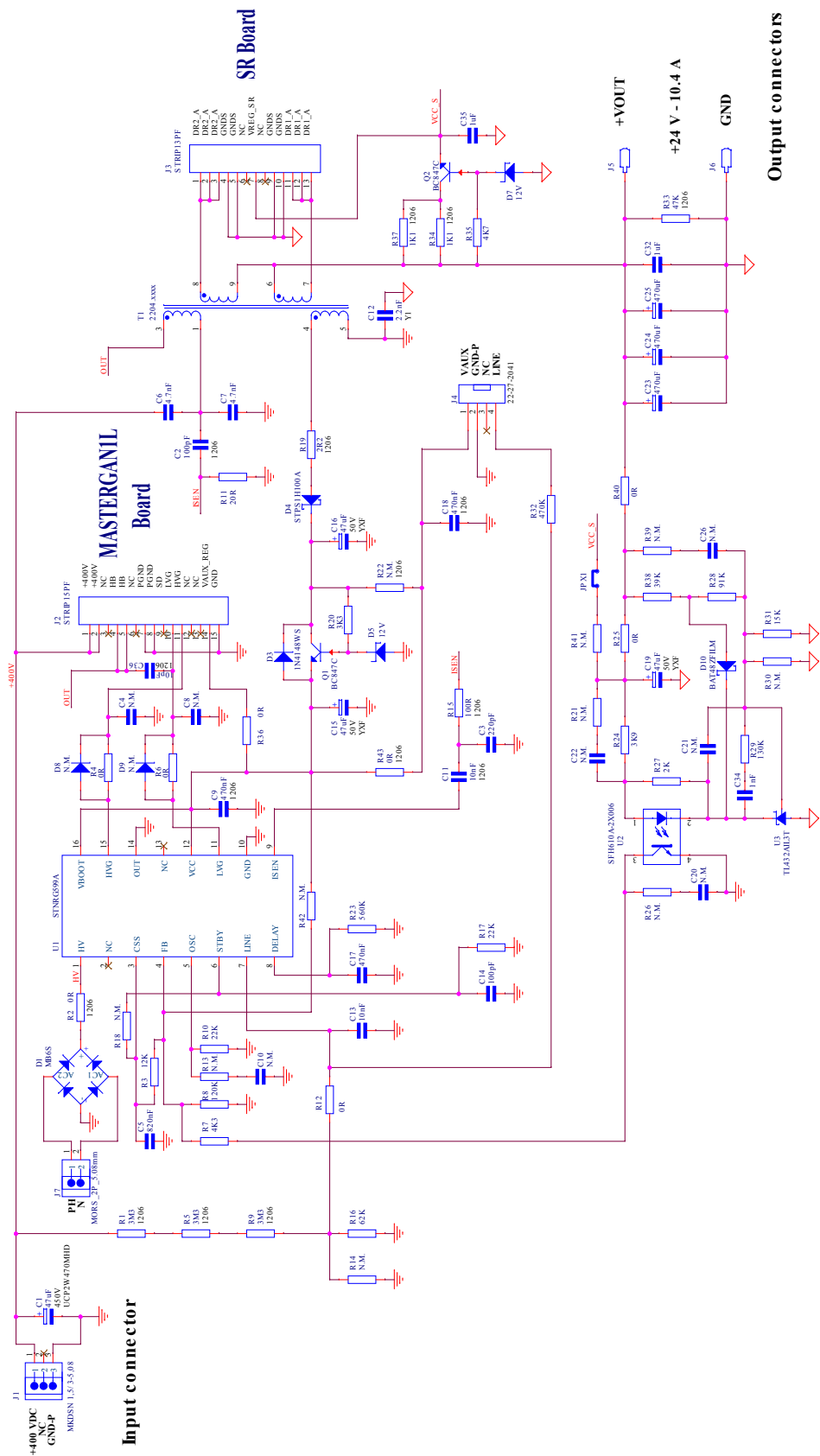


Figure 3. MASTERGAN1L daughterboard schematic

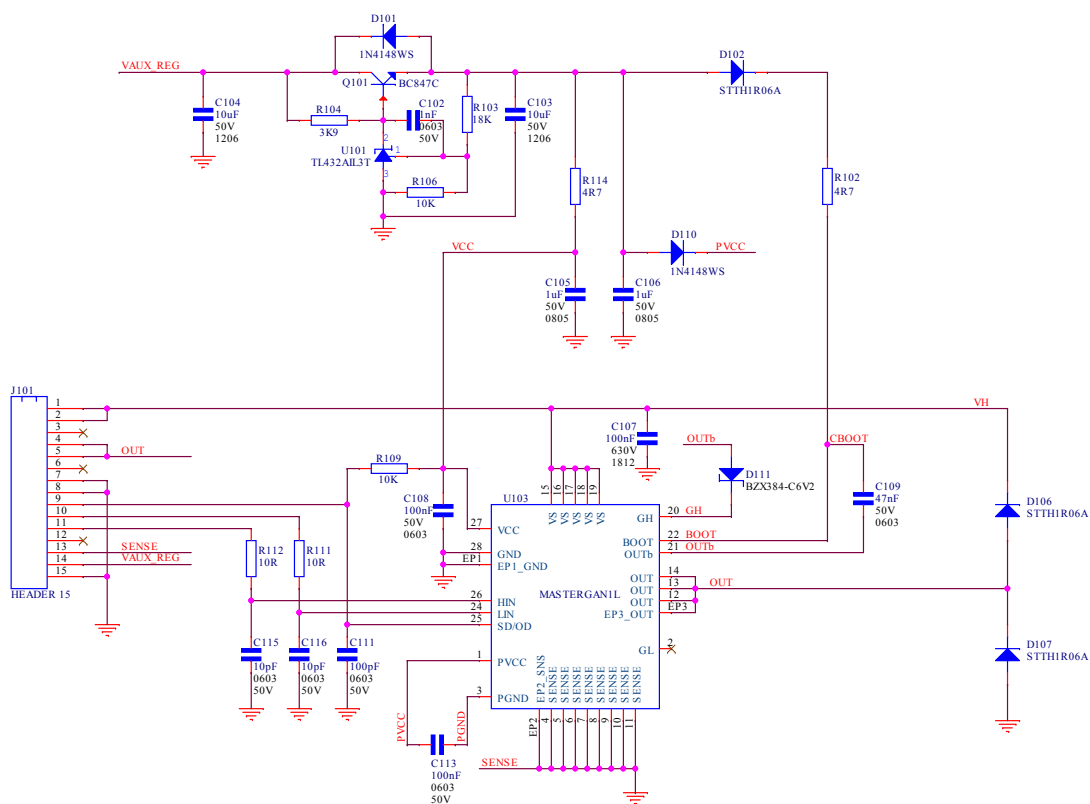
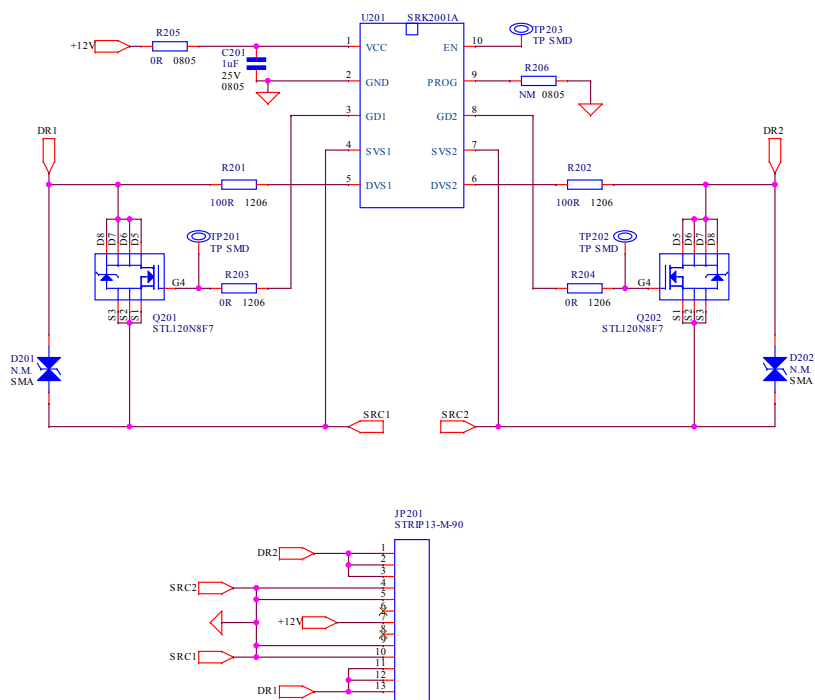


Figure 4. SRK2001A daughterboard schematic



2 Bill of materials

2.1 STNRG599A motherboard

Table 1. Bill of materials, STNRG599A motherboard

Ref.	Value	Package	Description	Manufacturer
C1	47uF	Radial	Radial electrolytic cap. - 450V, ±20%	Nichicon
C2	100pF	1206	SMD multilayer ceramic cap. - 1kV, ±10%	Johanson Technology
C3	220pF	0805	SMD multilayer ceramic cap. - 50V, ±5%	KEMET
C4	N.M.			
C5	820nF	0805	SMD multilayer ceramic cap. - 25V, ±10%	Murata
C6	4.7nF	Plastic radial	Radial polypropylene metall. cap. - 1kV, ±5%	KEMET
C7	4.7nF	Plastic radial	Radial polypropylene metall. cap. - 1kV, ±5%	KEMET
C8	N.M.			
C9	470nF	1206	SMD multilayer ceramic cap. - 50V, ±10%	Walsin
C10	N.M.			
C11	10nF	1206	SMD multilayer ceramic cap. - 50V, ±10%	Walsin
C12	2.2nF	Radial	Radial Y1 Safety ceramic cap. - 300V, ±20%	Murata
C13	10nF	0805	SMD multilayer ceramic cap. - 50V, ±10%	Murata
C14	100pF	0805	SMD multilayer ceramic cap. - 50V, ±5%	Walsin
C15	47uF	Radial	Radial electrolytic cap. - 50V, ±20%	Rubycon
C16	47uF	Radial	Radial electrolytic cap. - 50V, ±20%	Rubycon
C17	470nF	0805	SMD multilayer ceramic cap. - 50V, ±10%	KEMET
C18	470nF	1206	SMD multilayer ceramic cap. - 50V, ±10%	Walsin
C19	47uF	Radial	Radial electrolytic cap. - 50V, ±20%	Rubycon
C20	N.M.			
C21	N.M.			
C22	N.M.			
C23	470uF	Radial	Radial electrolytic cap. - 35V, ±20%	Panasonic
C24	470uF	Radial	Radial electrolytic cap. - 35V, ±20%	Panasonic
C25	470uF	Radial	Radial electrolytic cap. - 35V, ±20%	Panasonic
C26	N.M.			
C32	1uF	1206	SMD multilayer ceramic cap. - 50V, ±10%	KEMET
C34	1uF	0805	SMD multilayer ceramic cap. - 50V, ±10%	KEMET
C35	1uF	1206	SMD multilayer ceramic cap. - 50V, ±10%	KEMET
C36	10pF	1206	SMD multilayer ceramic cap. - 1kV, ±5%	Yageo
D1	MB6S	TO-269AA	SMD bridge rectifier - 600V, 0.5A	VISHAY
D3	1N4148WS	SOD-323	SMD Fast-switching rectifier - 100V, 0.35A	onsemi
D4	STPS1H100A	SMA	SMD Schottky rectifier - 100V, 1A	STMicroelectronics
D5	12V	SOD-323	SMD Zener diode - 12V, 3W, ±5%	Nexperia
D7	12V	SOD-323	SMD Zener diode - 12V, 3W, ±5%	Nexperia
D8	N.M			

Ref.	Value	Package	Description	Manufacturer
D9	N.M			
D10	BAT48ZFILM	SOD-123	SMD Schottky rectifier - 40V, 0.35A	STMicroelectronics
J1	MKDSN	5.08mm	Screw conn. term., single-row, 5.08 pitch, 8 depth, 10 height, 13,5A AWG 16-26, 0,14-1,5mm ² - 400V	Phoenix Contact
J2	STRIP1X15PF		Female strip 15pin PRECI-DIP poles pitch 2.54mm - 3A. Extract/remove pins 3 and 6 before mounting.	PRECI-DIP
J3	STRIP1X13PF		Female strip 13pin PRECI-DIP poles pitch 2.54mm - 3A	PRECI-DIP
J4	MOLEX4P	6410	Connector header vertical 4POS 2.54 mm	MOLEX
J5	Faston_90	6.35mm	Conn. FASTON male 6,35mm right Angle (PCB hole 1.2mm)	TE Connectivity
J6	Faston_90	6.35mm	Conn. FASTON male 6,35mm right Angle (PCB hole 1.2mm)	TE Connectivity
J7	MORS_2P	5.08mm	Screw conn. term., single-row, 5.08 pitch, 8 depth, 10 height, AWG 16-28, 13.5A - 300V	TE Connectivity
JPX1			Tinned copper wire d = 0,7mm, SWG22, l ≈ 35mm Black PVC sheet d_int = 1mm, l ≈ 25mm.	
Q1	BC847C	SOT23	SMD NPN transistor General purpose	onsemi
Q2	BC847C	SOT23	SMD NPN transistor General purpose	onsemi
R1	3M3	1206	SMD resistor - 200V, 1/4W, 1%	Yageo
R2	0R	1206	SMD resistor - 200V, 1/4W, 5%	Yageo
R3	12K	0805	SMD resistor - 150V, 1/8W, 1%	Yageo
R4	0R	0805	SMD resistor - 150V, 1/8W, 5%	Yageo
R5	3M3	1206	SMD resistor - 200V, 1/4W, 1%	Yageo
R6	0R	0805	SMD resistor - 150V, 1/8W, 5%	Yageo
R7	4K3	0805	SMD resistor - 150V, 1/8W, 1%	VISHAY
R8	120K	0805	SMD resistor - 150V, 1/8W, 1%	Yageo
R9	3M3	1206	SMD resistor - 200V, 1/4W, 1%	Yageo
R10	22K	0805	SMD resistor - 150V, 1/8W, 1%	Yageo
R11	20R	0805	SMD resistor - 1/8W, 1%	Yageo
R12	0R	0805	SMD resistor - 150V, 1/8W, 5%	Yageo
R13	N.M.			
R14	N.M.			
R15	100R	1206	SMD resistor - 200V, 1/4W, 1%	Yageo
R16	62K	0805	SMD resistor - 150V, 1/10W, 1%	Yageo
R17	22K	0805	SMD resistor - 150V, 1/8W, 1%	Yageo
R18	N.M.			
R19	2R2	1206	SMD resistor - 1/4W, 1%	Yageo
R20	3K3	0805	SMD resistor - 150V, 1/8W, 1%	Yageo
R21	N.M.			
R22	N.M.			
R23	560K	0805	SMD resistor - 150V, 1/10W, 1%	Yageo

Ref.	Value	Package	Description	Manufacturer
R24	3K9	0805	SMD resistor - 150V, 1/8W, 1%	Yageo
R25	0R	0805	SMD resistor - 150V, 1/8W, 5%	Yageo
R26	N.M.			
R27	2K	0805	SMD resistor - 150V, 1/8W, 1%	VISHAY
R28	91K	0805	SMD resistor - 150V, 1/8W, 1%	Yageo
R29	130K	0805	SMD resistor - 150V, 1/8W, 1%	Yageo
R30	N.M.			
R31	15K	0805	SMD resistor - 150V, 1/8W, 1%	Yageo
R32	470K	0805	SMD resistor - 150V, 1/8W, 1%	Yageo
R33	47K	1206	SMD resistor - 1/4W, 1%	Yageo
R34	1K1	1206	SMD resistor - 1/2W, 1%	Stackpole Electr. Inc.
R35	4K7	0805	SMD resistor - 150V, 1/8W, 1%	Yageo
R36	0R	0805	SMD resistor - 150V, 1/8W, 5%	Yageo
R37	1K1	1206	SMD resistor - 1/2W, 1%	Stackpole Electr. Inc.
R38	39K	0805	SMD resistor - 150V, 1/8W, 1%	Yageo
R39	N.M.			
R40	0R	0805	SMD resistor - 150V, 1/8W, 5%	Yageo
R41	N.M.			
R42	N.M.			
R43	0R	1206	SMD resistor - 200V, 1/4W, 5%	Yageo
T1	2204.0060		250W resonant LLC transformer	AQ Magnetics
U1	STNRG599A	SOIC16	Enhanced resonant controller	STMicroelectronics
U2	SFH610A-2X006	DIP4	Optocoupler	VISHAY
U3	TL432AIL3T	SOT23	Volt. ref. adjustable shunt SOT23	STMicroelectronics

2.2 MASTERGAN1L daughterboard

Table 2. Bill of materials, MASTERGAN1L daughterboard

Ref.	Value	Package	Description	Manufacturer
C102	1nF	0603	SMD multilayer ceramic cap. - 50V, $\pm 10\%$	KEMET
C103	10uF	1206	SMD multilayer ceramic cap. - 50V, $\pm 10\%$	SAMSUNG
C104	10uF	1206	SMD multilayer ceramic cap. - 50V, $\pm 10\%$	SAMSUNG
C105	1uF	0805	SMD multilayer ceramic cap. - 50V, $\pm 10\%$	Taiyo Yuden
C106	1uF	0805	SMD multilayer ceramic cap. - 50V, $\pm 10\%$	Taiyo Yuden
C107	100nF	1812	SMD multilayer ceramic cap. - 630V, $\pm 10\%$	TDK
C108	100nF	0603	SMD multilayer ceramic cap. - 50V, $\pm 20\%$	TDK
C109	47nF	0603	SMD multilayer ceramic cap. - 50V, $\pm 10\%$	AVX
C111	100pF	0603	SMD multilayer ceramic cap. - 50V, $\pm 5\%$	TDK
C113	100nF	0603	SMD multilayer ceramic cap. - 50V, $\pm 20\%$	TDK
C115	10pF	0603	SMD multilayer ceramic cap. - 50V, $\pm 5\%$	KEMET
C116	10pF	0603	SMD multilayer ceramic cap. - 50V, $\pm 5\%$	KEMET

Ref.	Value	Package	Description	Manufacturer
D101	1N4148WS	SOD-323	SMD Fast-switching rectifier - 100V, 0.35A	onsemi
D102	STTH1R06A	SMA	SMD rectifier - 600V, 1A	STMicroelectronics
D106	STTH1R06A	SMA	SMD rectifier - 600V, 1A	STMicroelectronics
D107	STTH1R06A	SMA	SMD rectifier - 600V, 1A	STMicroelectronics
D110	1N4148WS	SOD-323	SMD Fast-switching rectifier - 100V, 0.35A	onsemi
D111	6V2	SOD-323	SMD Zener diode - 6.2V, 0.3W, $\pm 5\%$	Nexperia
J101	HEADER 15		Single-row right angle PCB header 15 ways	Würth Elektronik
Q101	BC847C	SOT23	SMD NPN transistor general purpose	onsemi
R102	4R7	0805	SMD resistor - 1/10W, 1%	Yageo
R103	18K	0603	SMD resistor - 1/10W, 1%	Yageo
R104	3K9	0603	SMD resistor - 1/10W, 1%	Yageo
R106	10K	0603	SMD resistor - 1/10W, 1%	Yageo
R109	10K	0603	SMD resistor - 1/10W, 1%	Yageo
R111	10R	0603	SMD resistor - 75V, 1/10W, 1%	Yageo
R112	10R	0603	SMD resistor - 75V, 1/10W, 1%	Yageo
R114	4R7	0805	SMD resistor - 1/10W, 1%	Yageo
U101	TL432AIL3T	SOT23	Volt. ref. adjustable shunt SOT23	STMicroelectronics
U103	MASTERGAN1L	VFQFPN 9x9x1.0-48L	High-voltage enhancement mode GaN half-bridge with gate driver	STMicroelectronics

2.3 SRK2001A daughterboard

Table 3. Bill of materials, SRK2001A daughterboard

Ref.	Value	Package	Description	Manufacturer
C201	1uF	0805	SMD multilayer ceramic cap. - 25V, $\pm 10\%$	
D201	N.M.			
D202	N.M.			
HS1	HEATSINK		Heatsink black anodized aluminum 71°K/W for SMD (8x10x6mm)	Fischer Elektronik
HS2	HEATSINK		Heatsink black anodized aluminum 71°K/W for SMD (8x10x6mm)	Fischer Elektronik
JP201	STRIP13-M-90		13p right angle male header	Würth Elektronik
Q201	STL120N8F7	PowerFLAT5x6	N-Channel Power MOSFET - 80V, 120A	STMicroelectronics
Q202	STL120N8F7	PowerFLAT5x6	N-Channel Power MOSFET - 80V, 120A	STMicroelectronics
R201	100R	1206	SMD resistor - 200V, 1/4W, 1%	Yageo
R202	100R	1206	SMD resistor - 200V, 1/4W, 1%	Yageo
R203	0R	1206	SMD resistor - 200V, 1/4W, 5%	Yageo
R204	0R	1206	SMD resistor - 200V, 1/4W, 5%	Yageo
R205	0R	0805	SMD resistor - 150V, 1/8W, 5%	Yageo
R206	N.M.			
U201	SRK2001A	SSOP10	SRK2001 SR controller	STMicroelectronics

Revision history

Table 4. Document revision history

Date	Version	Changes
27-Oct-2025	1	Initial release.

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