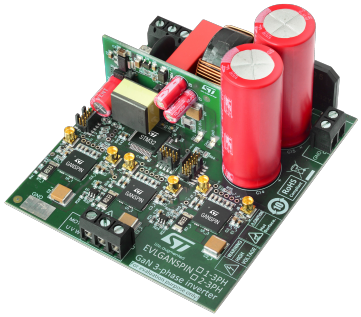
EVLGANSPIN2-3PH

Data brief

Three-phase 300 W motor control reference design with GANSPIN612 and STM32G431RB



STDRIVE

Product status link
EVLGANSPIN2-3PH

Features

- Three-phase topology featuring the GANSPIN612 half-bridge system-in-package
- GANSPIN612: 2x 270 mΩ 650 V HEMT GaN + driver in 9x9 QFN with integrated LDOs, overcurrent and bootstrap diode
- STM32G431RB MCU Arm Cortex-M4 MCU 170 MHz
- 3-shunt topology for sensorless field-oriented control (FOC)
- 230 V AC mains line input filter and rectifier
- Typical power up to 300 W, 16 kHz
- Tuned at 10 V/ns dV/dt for EMI and motor reliability
- Interfaces: UART, Hall position sensors, SWD
- Three available supply rails at 12 V, 5 V, 3.3 V with VIPER06LS
- Shunt amplifiers with TSV911ILT 8 MHz operational amplifier
- Overcurrent protection

Description

The EVLGANSPIN2-3PH is a three-phase inverter based on the GANSPIN612 half-bridge GaN system-in-package (integrating 270 mΩ 650 V e-mode HEMT GaN and the gate driver with LDOs, bootstrap diode, overcurrent protection) and the STM32G431RB with Arm Cortex®-M4 MCU at 170 MHz with 128 Kbytes of Flash memory, Math Accelerator.

The board can be used for sensorless field-oriented control (FOC), allowing driving permanent magnet synchronous motors (PMSMs) and brushless DC (BLDC) motors to cover a wide range of applications, such as refrigerator compressors, pumps, fans, and industrial appliances.

The EVLGANSPIN2-3PH is a 77 x 88 mm wide, 4-layers, 2 oz, FR-4 PCB, resulting in overall 12 °C/W $R_{th(J-A)}$ in still air (approximately 32 °C/W for a single half-bridge when operating alone).

1 Safety and operating instructions

1.1 General terms

Warning: *During assembly, testing, and operation, the evaluation board poses several inherent hazards, including bare wires, moving or rotating parts, and hot surfaces.*

Danger: *There is a danger of serious personal injury, property damage, or death due to electrical shock and burn hazards if the kit or components are improperly used or installed incorrectly.*

Danger: *The kit is not electrically isolated from the high-voltage supply AC/DC input. The evaluation board is directly linked to the mains voltage. No insulation is ensured between the accessible parts and the high voltage. All measuring equipment must use adequately insulated probes, clamps, and connecting wires; use adequate protective shields and use personal protective equipment.*

Never touch the evaluation board while it is energized as it is capable of causing an electrical shock hazard. After supply disconnection, wait and ensure that the onboard capacitors are fully discharged before touching or working on the board.

Danger: ***Board supplied with isolated AC source.***

When using an oscilloscope with single ended probes or when connecting a PC to the board as for programming the µC with a standard programmer, the board AC input shall be provided from an isolated or floating AC source. Floating AC supply is required to avoid shorting AC mains to earth ground through oscilloscope or PC with the risk of death, injury, and equipment damage. However, touching a single high-voltage point of the board could still result in an electrical shock hazard, even when supplying the board with an AC isolated source, isolation transformer, or high-voltage DC source.

Danger: ***Board supplied directly from AC mains grid.***

When supplying the board directly from AC mains, the board ground is biased to the dangerous AC high voltage. It is mandatory, in this case, to use only specifically designed high voltage differential or isolated measuring and programming equipment, which are able to safely withstand high voltage. Touching any point of the board (included ground traces) can cause an electrical shock hazard.

Important: *All operations involving transportation, installation and use, and maintenance must be performed by skilled technical personnel able to understand and implement national accident prevention regulations. For the purposes of these basic safety instructions, “skilled technical personnel” are suitably qualified people who are familiar with the installation, use, and maintenance of power electronic systems.*

1.2 Intended use of evaluation board

The evaluation board is designed for demonstration purposes only, and must not be used for electrical installations or machinery. Technical data and information concerning the power supply conditions are detailed in the documentation and should be strictly observed.

1.3 Installing the evaluation board

- The installation and cooling of the evaluation board must be in accordance with the specifications and target application.
- The board must be protected against excessive strain. In particular, components should not be bent nor should isolating distances be altered during transportation or handling.
- No contact must be made with other electronic components and contacts.
- The board contains electrostatically sensitive components that are prone to damage if used incorrectly. Do not mechanically damage or destroy the electrical components (potential health risks).

1.4 Operating the evaluation board

To properly operate the board, follow these safety rules.

1. Work area safety:
   - The work area must be clean and tidy.
   - Do not work alone when boards are energized.
   - Protect against inadvertent access to the area where the board is energized using suitable barriers and signs.
   - A system architecture that supplies power to the evaluation board must be equipped with additional control and protective devices in accordance with the applicable safety requirements (that is, compliance with technical equipment and accident prevention rules).
   - Use a non-conductive and stable work surface.
   - Use adequately insulated clamps and wires to attach measurement probes and instruments.
2. Electrical safety:
   - Remove the power supply from the board and electrical loads before taking any electrical measurements.
   - Proceed with the arrangement of measurement setup, wiring, or configuration paying attention to high-voltage sections.
   - Once the setup is complete, energize the board.

Danger: *Do not touch the board when it is energized or immediately after it has been disconnected from the voltage supply as several parts and power terminals containing potentially energized capacitors need time to discharge.*
Do not touch the board after disconnection from the voltage supply as several parts, including the PCB, may still be very hot.
The kit is not electrically isolated from AC/DC input.

3. Personal safety
   - Always wear suitable personal protective equipment such as insulating gloves and safety glasses.
   - Take adequate precautions and install the board in such a way to prevent accidental touch. Use protective shields such as an insulating box with interlocks if necessary.

2 Schematic diagrams

Figure 1. EVLGANSPIN2-3PH schematic - Hierarchical top connections

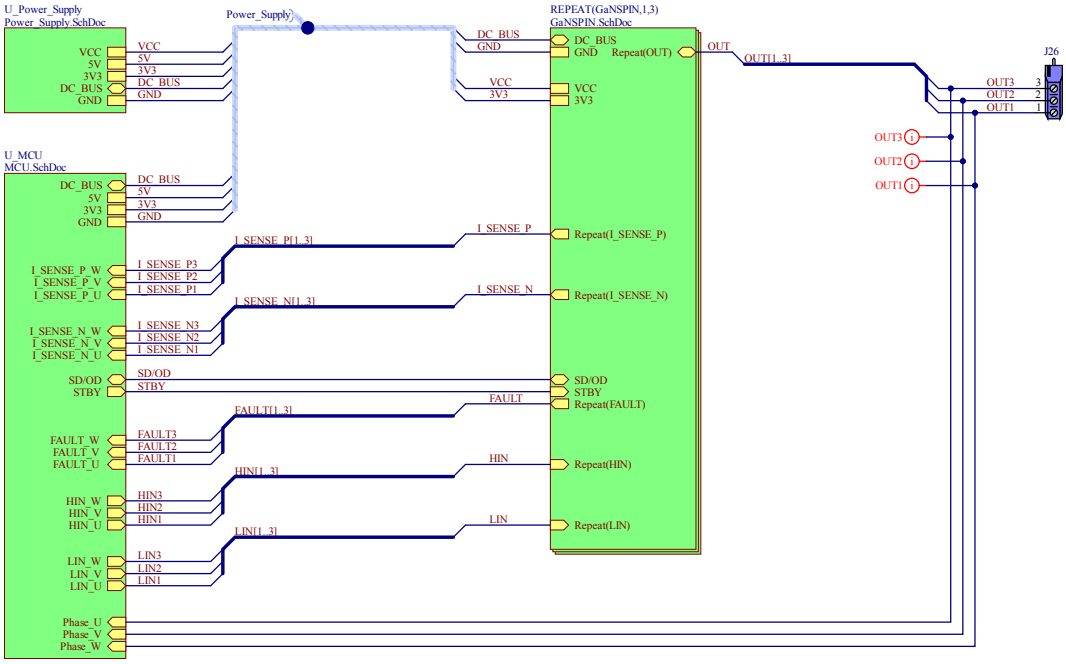


Figure 2. EVLGANSPIN2-3PH schematic - GANSPIN half bridge

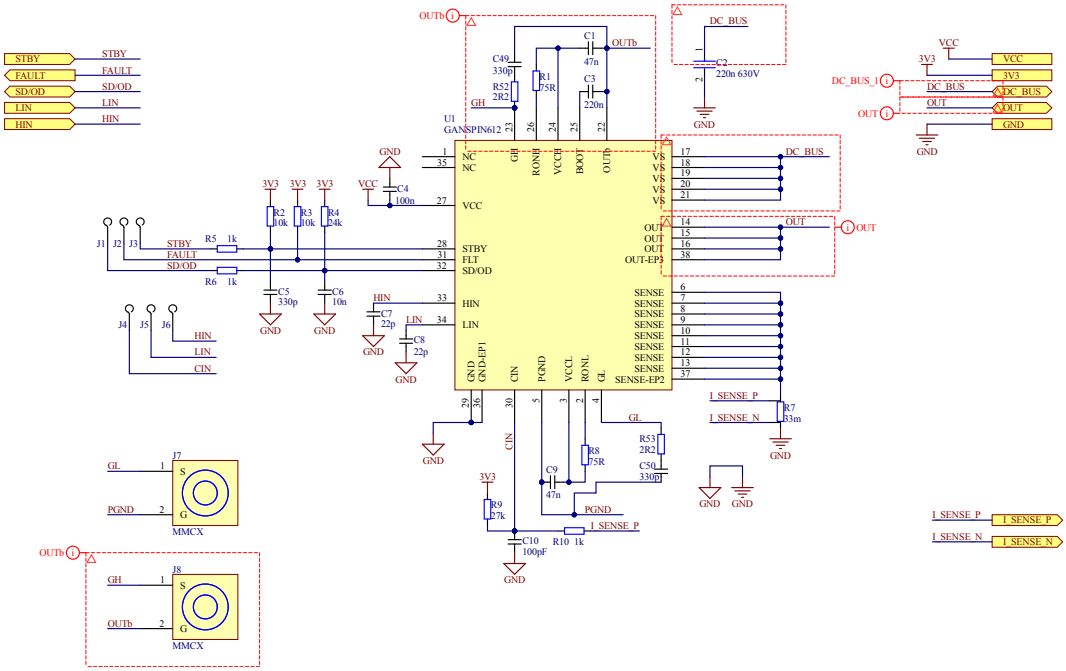


Figure 3. **EVLGANSPIN2-3PH schematic - Supply**

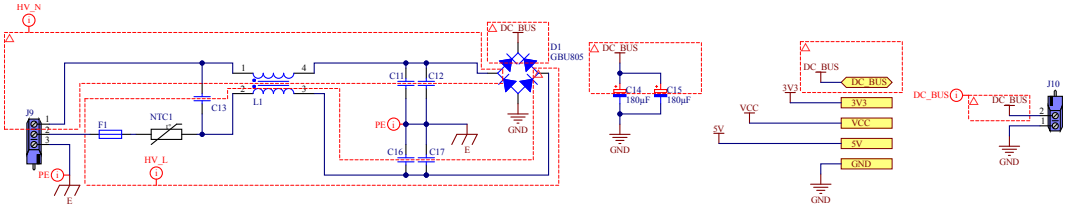


Figure 4. **EVLGANSPIN2-3PH schematic – microcontroller**

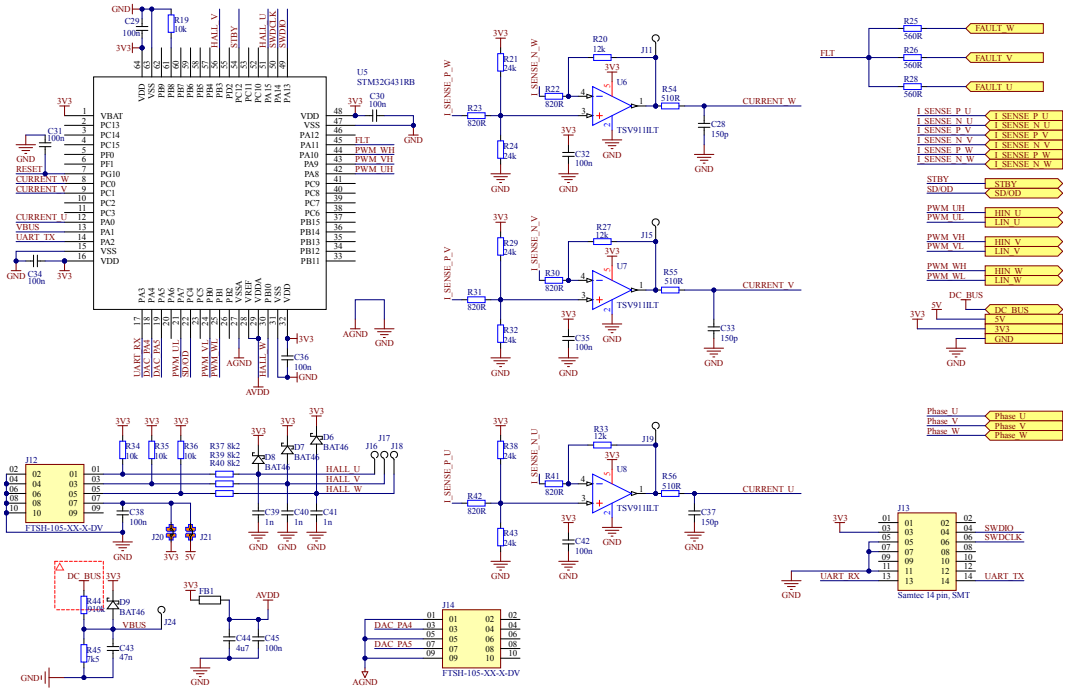
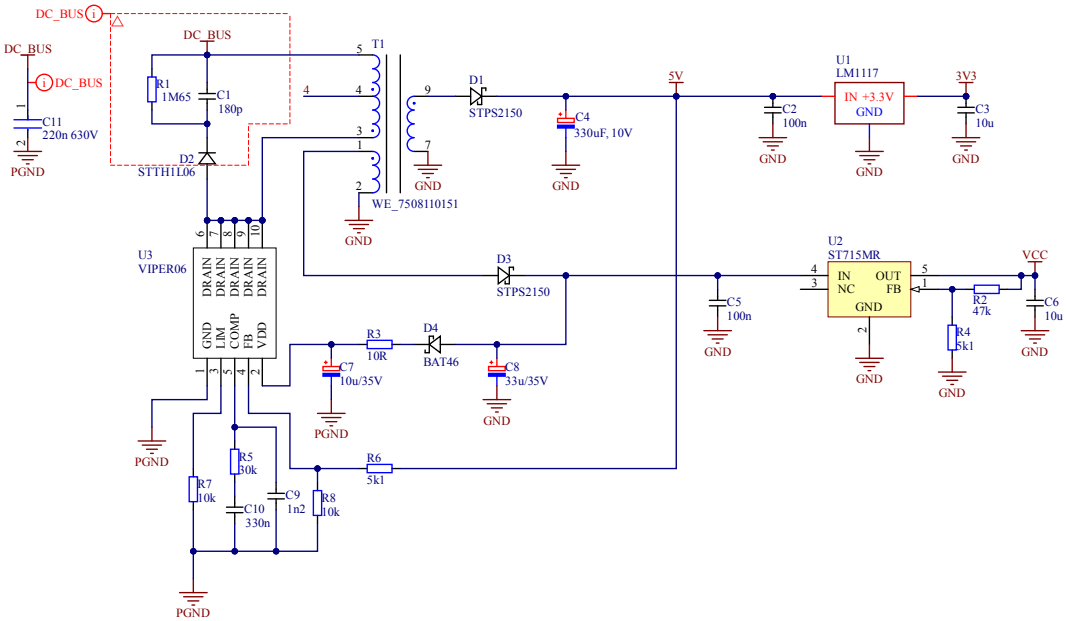


Figure 5. **EVLGANSPIN2-3PH-PSU - Daughter board schematic**



3 Board main connectors and key components

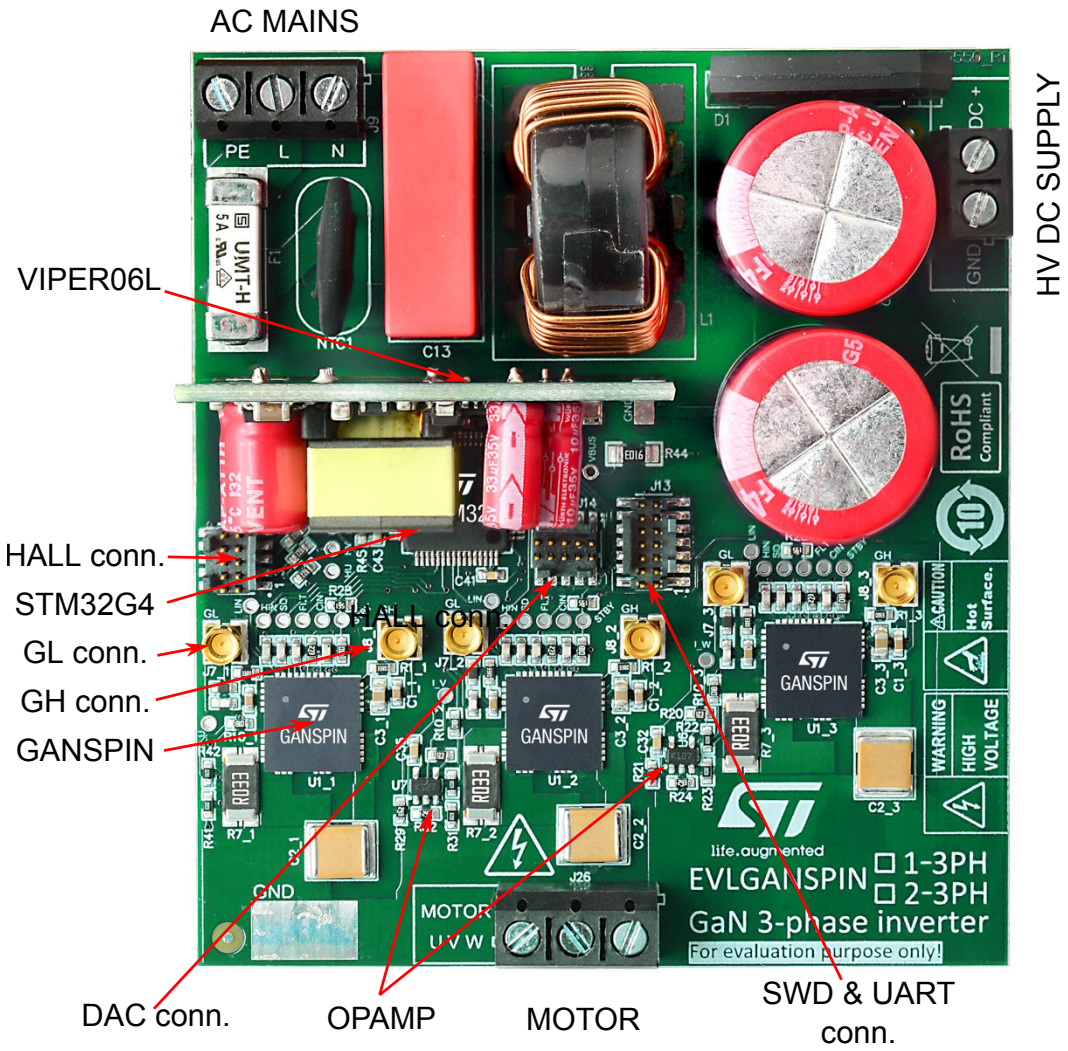
The board has been developed to demonstrate the use of the GANSPIN612 system-in-package to build a complete, HEMT GaN based, inverter for motor control.

The board can be directly supplied from the AC mains connector J4 or from a DC source from connector J6.

The inverter maximum power strongly depends on several factors such as supply voltage, motor power factor, modulation index, and inverter switching frequency. The maximum output power could likely exceed 300 W depending on ambient temperature.

The main components and board connectors are shown in the following figures.

Figure 6. EVLGANSPIN2-3PH - top view connectors and components



4 Bill of materials

Table 1. **EVLGANSPIN2-3PH - main board bill of materials**

Part reference	Part description	Part value	Package / Manufacturer' code
C1_1, C1_2, C1_3, C9_1, C9_2, C9_3, C43	SMT ceramic capacitor	47 nF / 50 V / X7R	Size 0603 Würth Elektronik 885012206093
C2_1, C2_2, C2_3	SMT ceramic capacitor	220 nF / 630 V / X7R	Size 2220 Würth Elektronik 885342214142
C3_1, C3_2, C3_3	SMT ceramic capacitor	220 nF / 25 V / X7R	Size 0805 Würth Elektronik 885012207074
C4_1, C4_2, C4_3, C29, C30, C31, C32, C34, C35, C36, C38, C42, C45	SMT ceramic capacitor	100 nF / 25 V / X7R	Size 0603 Würth Elektronik 885012206071
C5_1, C5_2, C5_3	SMT ceramic capacitor	330 pF / 50 V / NP0	Size 0603 Würth Elektronik 885012006060
C6_1, C6_2, C6_3	SMT ceramic capacitor	10 nF / 50 V / X7R	Size 0603 Würth Elektronik 885012206089
C7_1, C7_2, C7_3, C8_1, C8_2, C8_3	SMT ceramic capacitor	22 pF / 50 V / NP0	Size 0603 Würth Elektronik 885012006053
C10_1, C10_2, C10_3	SMT ceramic capacitor	100 pF / 50 V / NP0	Size 0603 Würth Elektronik 885012206077
C11, C12, C16, C17	SMT ceramic capacitor	4.7 nF / 250 V / Y2	Size 2220 Würth Elektronik 8853522140011
C13	WCAP-FTXH film capacitor	330 nF / 310 V	26.5 x 8.5 mm Würth Elektronik 890414026001CS
C14, C15	Aluminum electrolytic capacitor	180 mF / 400 V	Diam. 18, pitch 7.5 mm Würth Elektronik 860021381024
C28, C33, C37	SMT ceramic capacitor	150 pF / 50 V / X7R	Size 0603 Würth Elektronik 885012206078
C39, C40, C41	SMT ceramic capacitor	1 nF / 50 V / X7R	Size 0603 Würth Elektronik 885012206083
C44	SMT ceramic capacitor	4.7 mF / 25 V / X5R	Size 0805

Part reference	Part description	Part value	Package / Manufacturer' code
			Würth Elektronik 885012107018
C49_1, C49_2, C49_3, C50_1, C50_2, C50_3	SMT ceramic capacitor	330 pF / 50 V / X7R	Size 0603 Würth Elektronik 885012206080
D1	8A glass passivated single-phase bridge rectifier	GBU805	GBU Taiwan Semiconductor
D6, D7, D8, D9	100V, 150mA small signal Schottky diode	BAT46	SOD-323 STMicroelectronics BAT46JFILM
F1	Surface mount fuse, Time-Lag T	5 A / 250 V slow	UMT250 Shurter 3403.0281.23
FB1	WE-CBF SMD EMI Suppression Ferrite Bead	100 R @ 100 MHz 500mA	Size 0603 Würth Elektronik 742792620
J7_1, J7_2, J7_3, J8_1, J8_2, J8_3	MMCX PCB SMT jack	-	MMCX_SMD Würth Elektronik 66012102111404
J9, J26	Connector terminal block T.H.	-	3 poles, pitch 5 mm Würth Elektronik 691502710003
J10	Connector terminal block T.H.	-	2 poles, pitch 5 mm Würth Elektronik 691502710002
J13	Connector header	-	7x2 poles, pitch 1.27 mm Samtec
J12, J14	Connector header	-	5x2 poles, pitch 1.27 mm Samtec
L1	Common mode power line choke	15 mH / 5 A / 38 mΩ	Würth Elektronik 7448040515
NTC1	NTC thermistor for inrush current limiting	2.2 Ω	Diam. 15, pitch 7.5 mm Epcos B57237S0229M000
R1_1, R1_2, R1_3, R8_1, R8_2, R8_3	SMT resistor	75 Ω	Size 0603
R2_1, R2_2, R2_3, R3_1, R3_2, R3_3, R19, R34, R35, R36	SMT resistor	10 kΩ	Size 0603
R5_1, R5_2, R5_3, R6_1, R6_2, R6_3, R10_1, R10_2, R10_3	SMT resistor	1 kΩ	Size 0603
R7_1, R7_2, R7_3	SMT resistor	33 mΩ / 2 W / 0.5%	Size 2512 Multicomp PRO MCLRP12DTWSR033

Part reference	Part description	Part value	Package / Manufacturer' code
R9_1, R9_2, R9_3	SMT resistor	27 kΩ	Size 0603
R20, R27, R33	SMT resistor	12 kΩ	Size 0603
R4_1, R4_2, R4_3, R21, R24, R29, R32, R38, R43	SMT resistor	24 kΩ	Size 0603
R22, R23, R30, R31, R41, R42	SMT resistor	820 Ω	Size 0603
R25, R26, R28	SMT resistor	560 Ω	Size 0603
R37, R39, R40	SMT resistor	8.2 kΩ	Size 0603
R44	SMT resistor	910 kΩ	Size 1206 Würth Elektronik 560112132052
R45	SMT resistor	7.5 kΩ	Size 0603
R52_1, R52_2, R52_3, R53_1, R53_2, R53_3	SMT resistor	2.2 Ω	Size 0603
R54, R55, R56	SMT resistor	510 Ω	Size 0603
U1_1, U1_2, U1_3	600 V e-mode GaN high-power density half-bridge with high-voltage driver	GANSPIN612	QFN 9x9x 1 mm, 35 leads, 0.6 mm pitch STMicroelectronics
U5	Mainstream Arm Cortex-M4 MCU 170 MHz	STM32G431RBT3	LQFP64 10 x 10 mm STMicroelectronics
U6, U7, U8	Single Rail-to-Rail input/output 8 MHz operational amplifiers	TSV911ILT	SOT23-5 STMicroelectronics

Table 2. EVLGANSPIN2-3PH-PSU - Daughter board bill of materials

Part reference	Part description	Part value	Package / Manufacturer' code
C1	SMT ceramic capacitor	180 pF / 500 V / X7R	Size 1206
C2, C5	SMT ceramic capacitor	100 nF / 16 V / X7R	Size 0805 Würth Elektronik 885012207045
C3, C6	SMT ceramic capacitor	10 mF / 25 V / X7R	Size 1206 Würth Elektronik 885012208018
C4	Aluminum electrolytic capacitor	330 mF / 10 V	Diam. 8, pitch 3.5 mm Würth Elektronik 860240274006
C7	Aluminum electrolytic capacitors	10 mF / 35 V	Diam. 5, pitch 2 mm Würth Elektronik 860160572001
C8	Aluminum electrolytic capacitor	33 mF / 35 V	Diam. 5, pitch 2 mm Würth Elektronik 860160572005
C9	SMT ceramic capacitor	1.2 nF / 25 V / X7R	Size 0603
C10	SMT ceramic capacitor	330 nF / 25 V / X7R	Size 0603 Würth Elektronik

Part reference	Part description	Part value	Package / Manufacturer' code
			885012206074
C11	SMT ceramic capacitor	220 nF / 630 V / X7R	Size 2220 Würth Elektronik 885342214142
D1, D3	150 V, 2 A power Schottky rectifier	STPS2150	SMA STMicroelectronics STPS2150A
D2	Turbo 2 ultrafast high voltage rectifier	STTH1L06	SMA STMicroelectronics STTH1L06A
D4	100V, 150mA small signal Schottky diode	BAT46	SOD-323 STMicroelectronics BAT46JFILM
R1	SMT resistor	1.65 MΩ / 1%	Size 1206
R2	SMT resistor	47 kΩ / 1%	Size 0603
R3	SMT resistor	10 Ω / 1%	Size 0603
R4, R6	SMT resistor	5.1 kΩ / 1%	Size 0603
R5	SMT resistor	30 kΩ / 1%	Size 0603
R7, R8	SMT resistor	10 kΩ / 1%	Size 0603
T1	Transformer	1.5 mH	Würth Elektronik 7508110151
U1	Low drop fixed positive voltage regulator	LD1117 – 3.3V	SOT223 STMicroelectronics LD1117AS33TR
U2	High input voltage, 85 mA LDO linear regulator	ST715	SOT23-5L STMicroelectronics ST715MR
U3	Energy saving high-voltage converter for direct feedback	VIPER06LS	SSOP-10 STMicroelectronics VIPER06LS

5 Layout and component placements

Figure 7. **Main board layout - top with component reference designators (top view)**

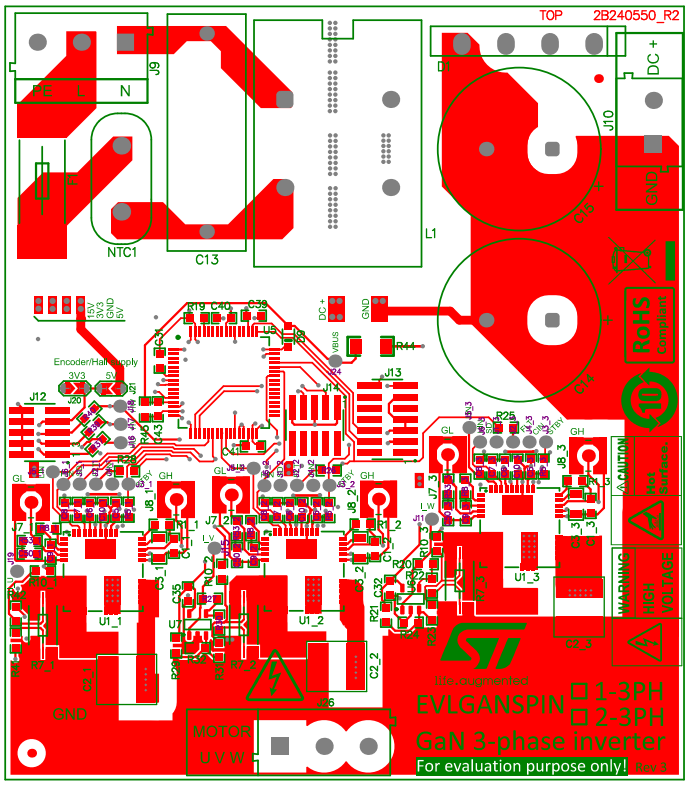


Figure 8. **Main board layout - bottom with component reference designators (top view)**

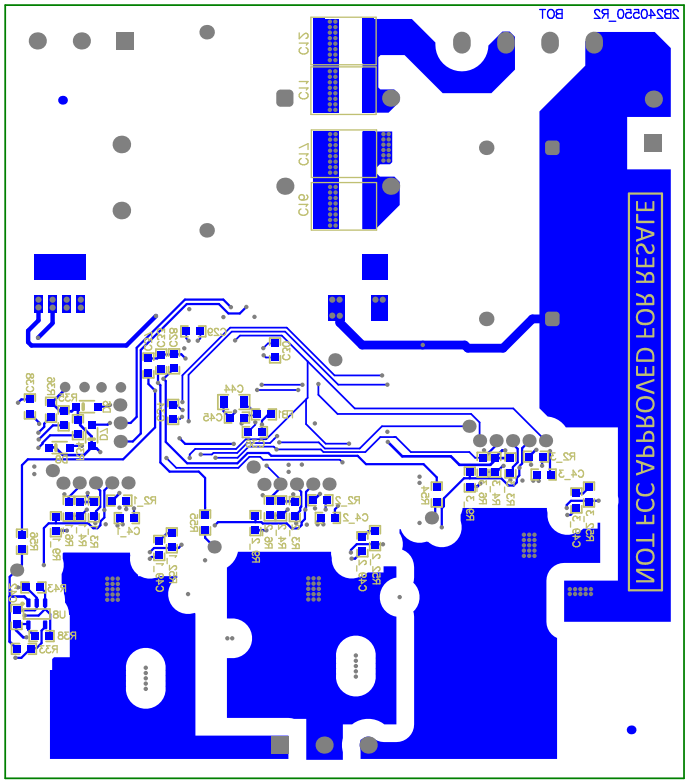


Figure 9. **Main board layout - top silk screen (top view)**

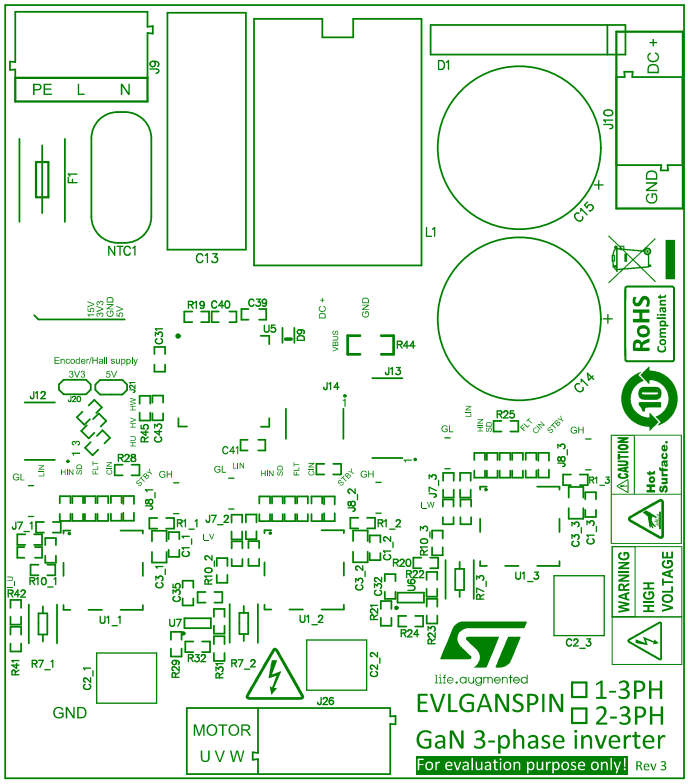


Figure 10. **Main board layout - bottom silk screen (top view)**

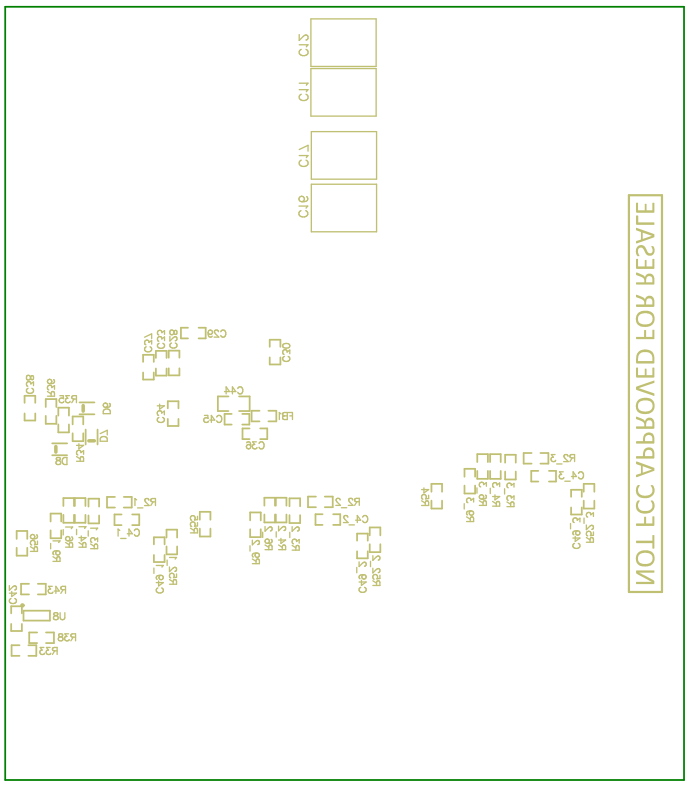


Figure 11. **Main board layout - top layer**

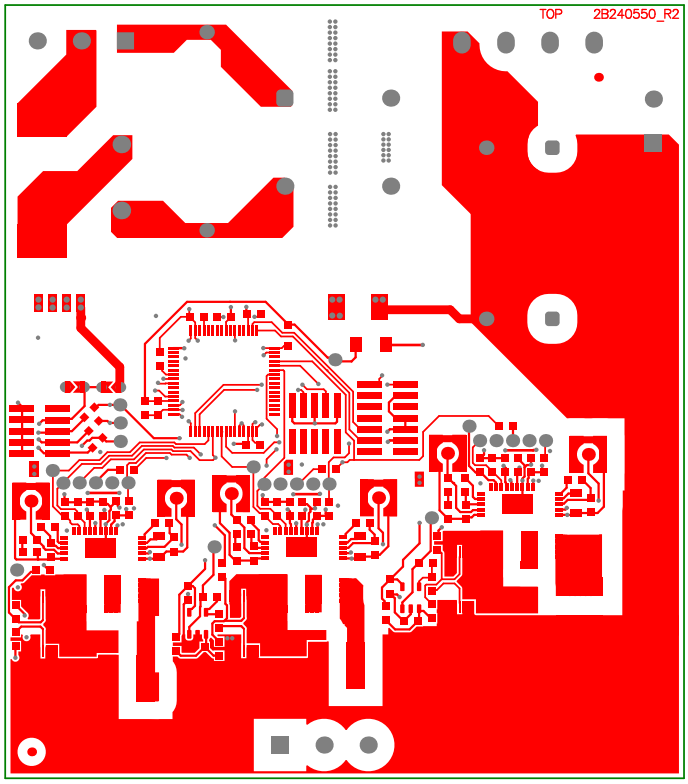


Figure 12. **Main board layout - inner 2 layer**

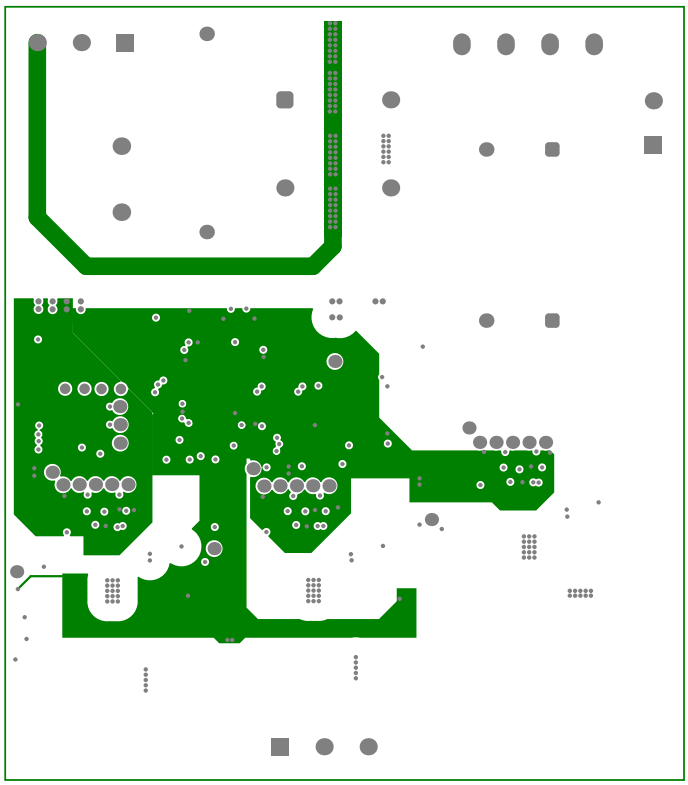


Figure 13. Main board layout - inner 3 layer

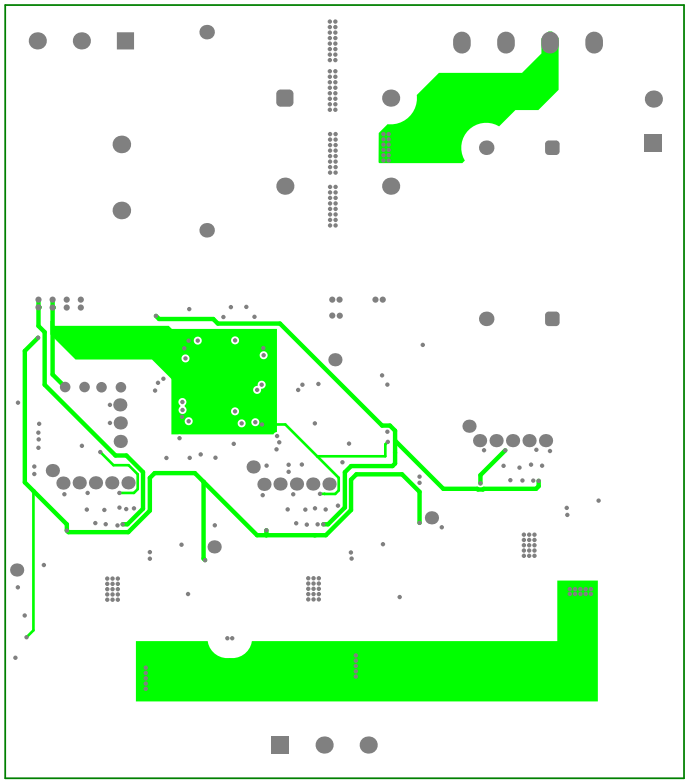


Figure 14. Main board layout - bottom layer

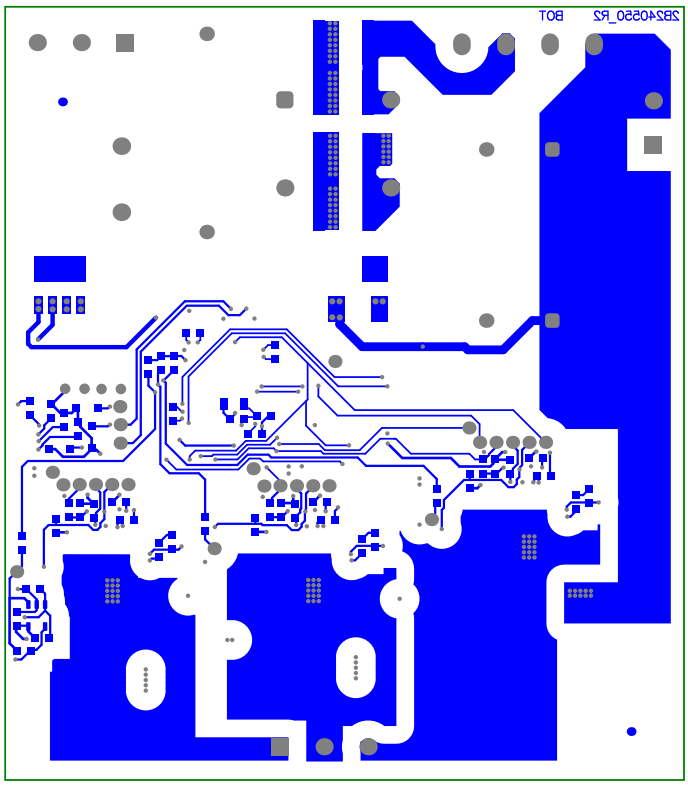


Figure 15. **PSU board layout - top with component reference designators (top view)**

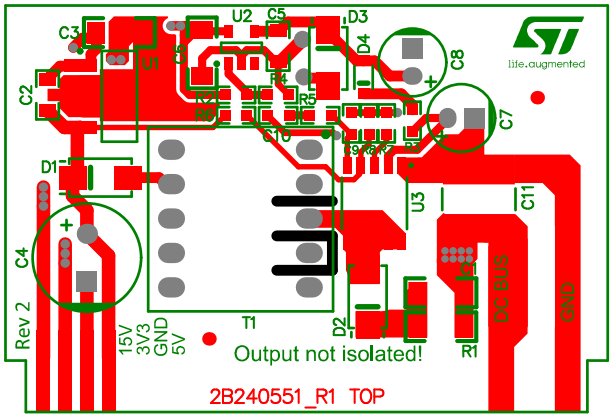


Figure 16. **PSU board layout - top silk screen**

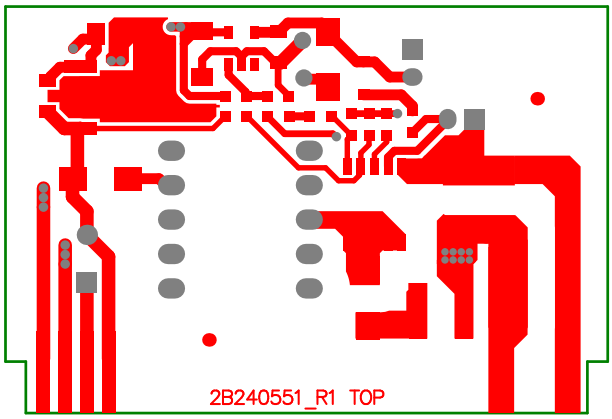
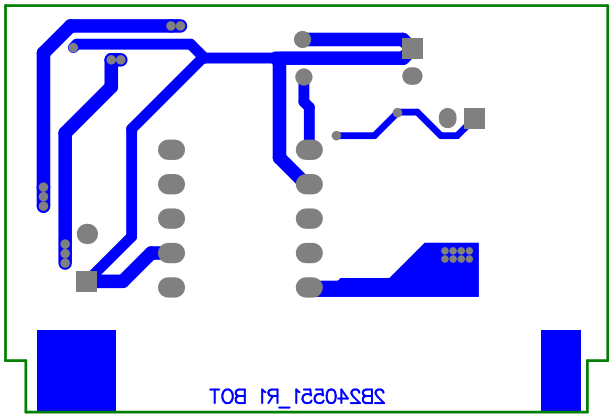


Figure 17. **PSU board layout - top layer**



Revision history

Table 3. **Document revision history**

Date	Version	Changes
11-May-2026	1	Initial release.

Contents

List of tables

List of figures

IMPORTANT NOTICE – READ CAREFULLY

STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice.

In the event of any conflict between the provisions of this document and the provisions of any contractual arrangement in force between the purchasers and ST, the provisions of such contractual arrangement shall prevail.

The purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST’s terms and conditions of sale in place at the time of order acknowledgment.

The purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of the purchasers’ products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

If the purchasers identify an ST product that meets their functional and performance requirements but that is not designated for the purchasers' market segment, the purchasers shall contact ST for more information.

ST and the ST logo are trademarks of ST. For additional information about ST trademarks, refer to www.st.com/trademarks. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.