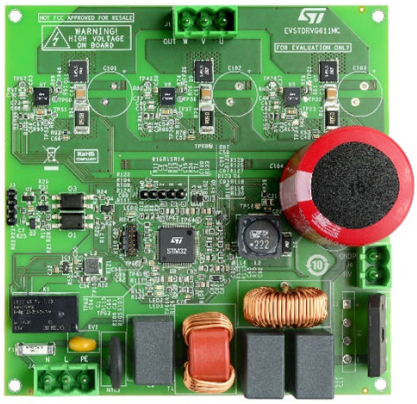
EVSTDRVG611MC

Data brief

Three-phase GaN discrete motor control board with STDRIVEG611 and STM32G4



Features

- Three-phase topology featuring the STDRIVEG611 GaN gate driver
- 75 mΩ typ., 650 V e-mode HEMT GaN SGT120R65AL in PowerFLAT 5x6 HV package with Kelvin source
- STM32G431RBT3 microcontroller for high analog integration
- 3-shunt topology for sensorless field-oriented control (FOC)
- 230 V AC mains line input filter and rectifier
- Typical power up to 600 W, 40 kHz
- Tuned at 10 V/ns dV/dt for EMI and motor reliability
- Interfaces: UART, encoder, Hall position sensors, SWD
- Shunt amplifiers integrated in STM32G4
- Overcurrent protection

Description

The EVSTDRVG611MC is a three-phase inverter based on the STDRIVEG611 half-bridge GaN gate driver, 75 mΩ 650 V e-mode HEMT GaN SGT120R65AL, and the high-performance STM32G431RBT3 with Arm Cortex®-M4 MCU at 170 MHz.

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 EVSTDRVG611MC is 109 x 110 mm wide, 2 layers, 2 Oz, FR-4 PCB, resulting in overall 8.5 °C/W $R_{th(J-A)}$ (equivalent to 50°C/W for each GaN) in still air.

Product status link
EVSTDRVG611MC

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 with isolated AC mains grid.***

When supplying the board directly from AC mains, also the board ground is biased to the dangerous AC high voltage. It is mandatory in this case to use only specifically designed 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. **EVSTDRVG611MC schematic - three-phase power stage**

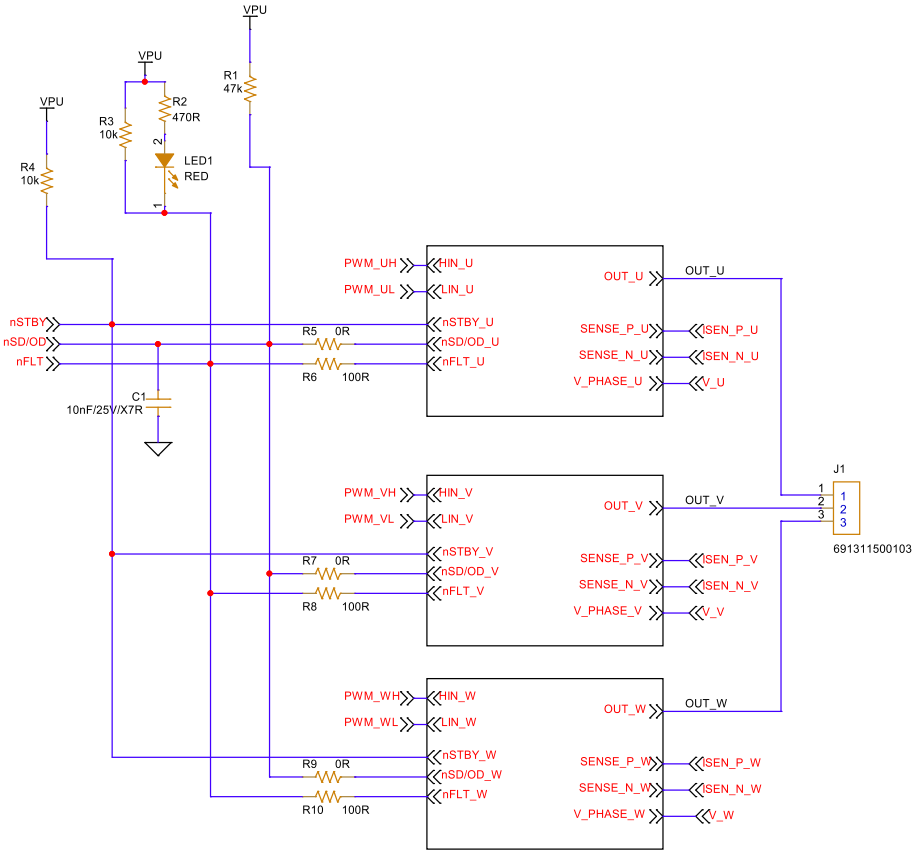


Figure 2. **EVSTDRVG611MC schematic - power supply**

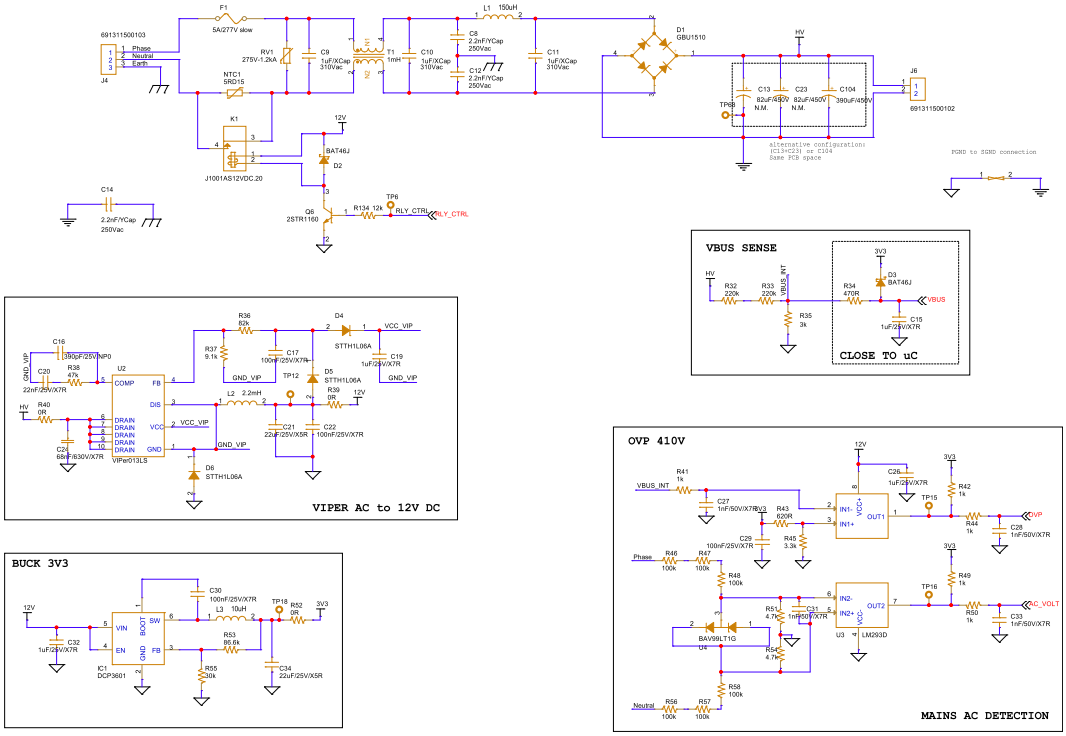


Figure 3. **EVSTDRVG611MC schematic - peripherals**

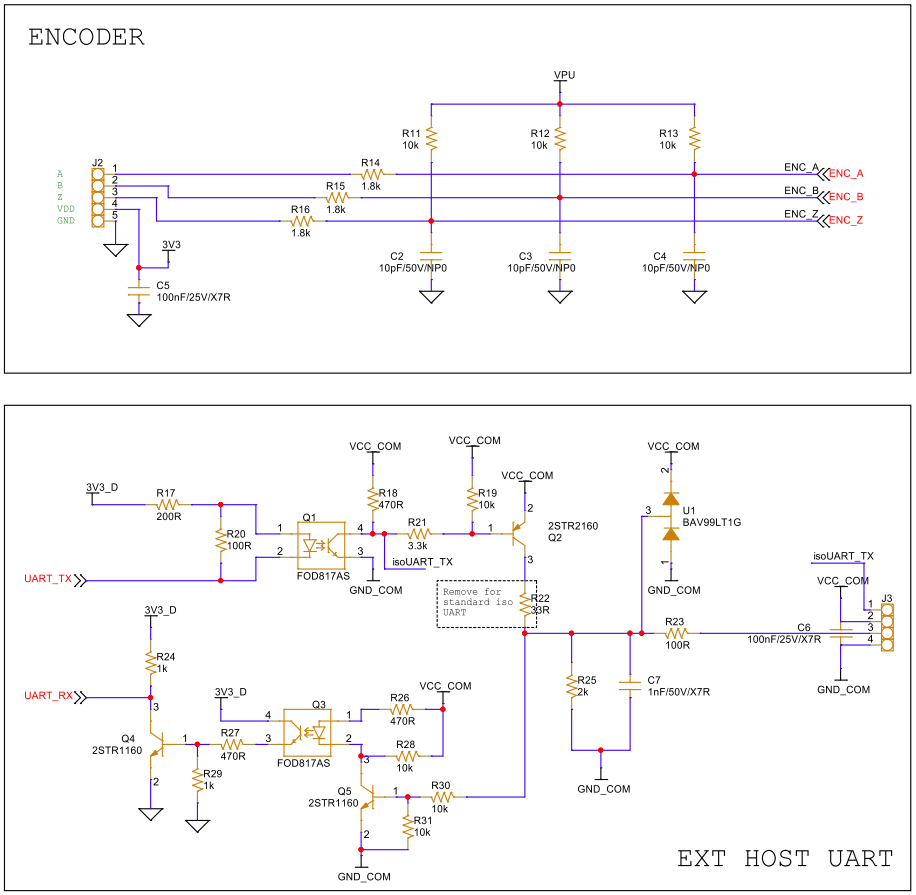


Figure 4. **EVSTDRVG611MC schematic - microcontroller**

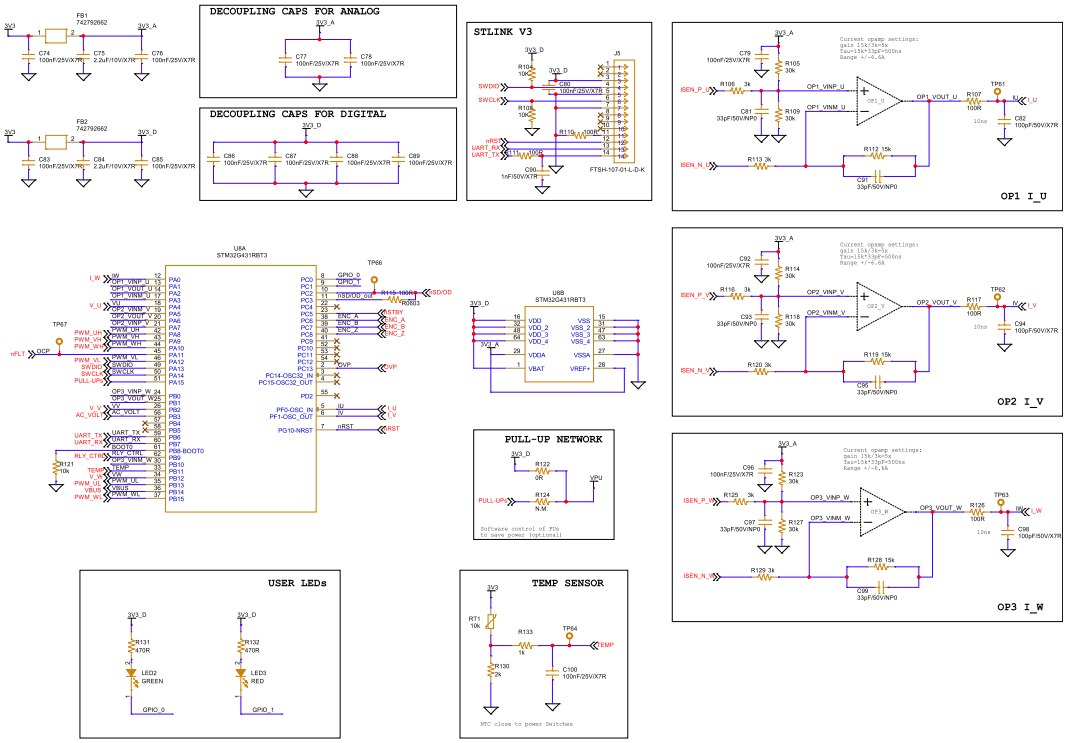


Figure 5. **EVSTDRVG611MC schematic - gate driver phase U**

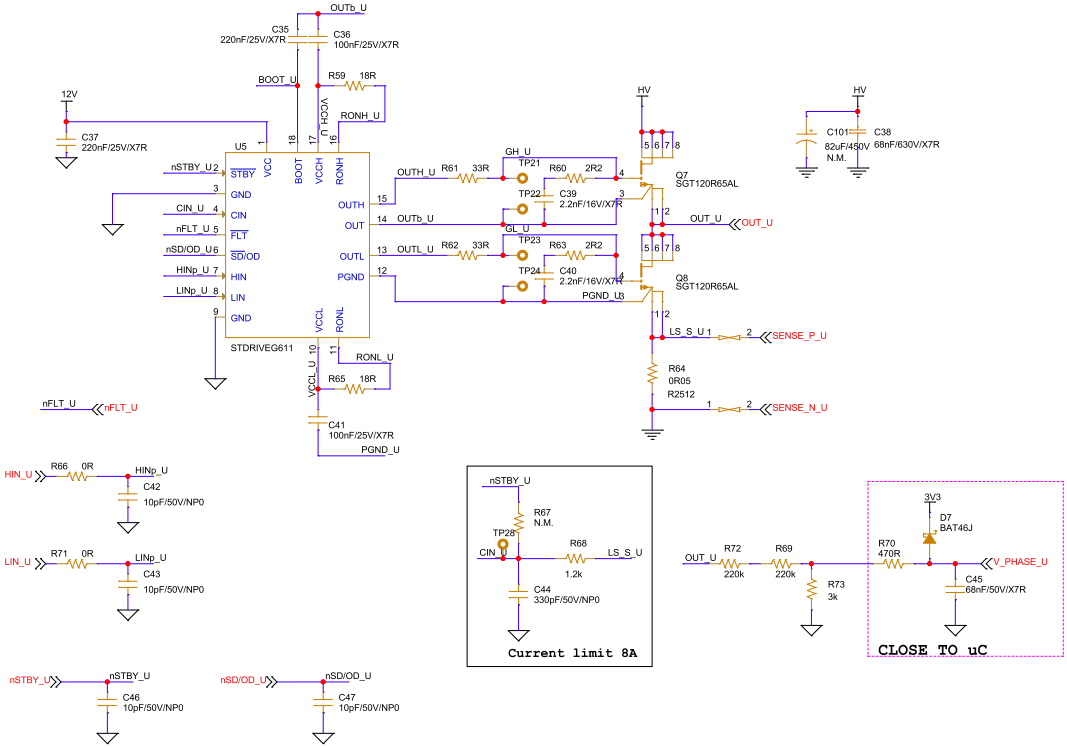


Figure 6. **EVSTDRVG611MC schematic - gate driver phase V**

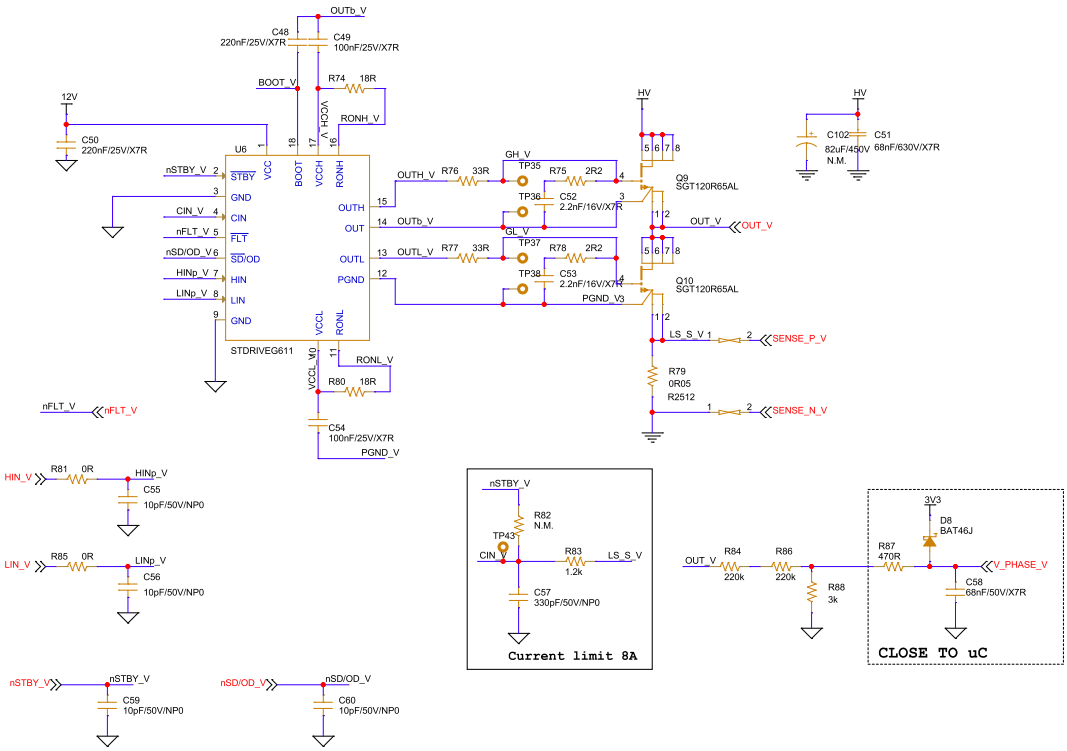
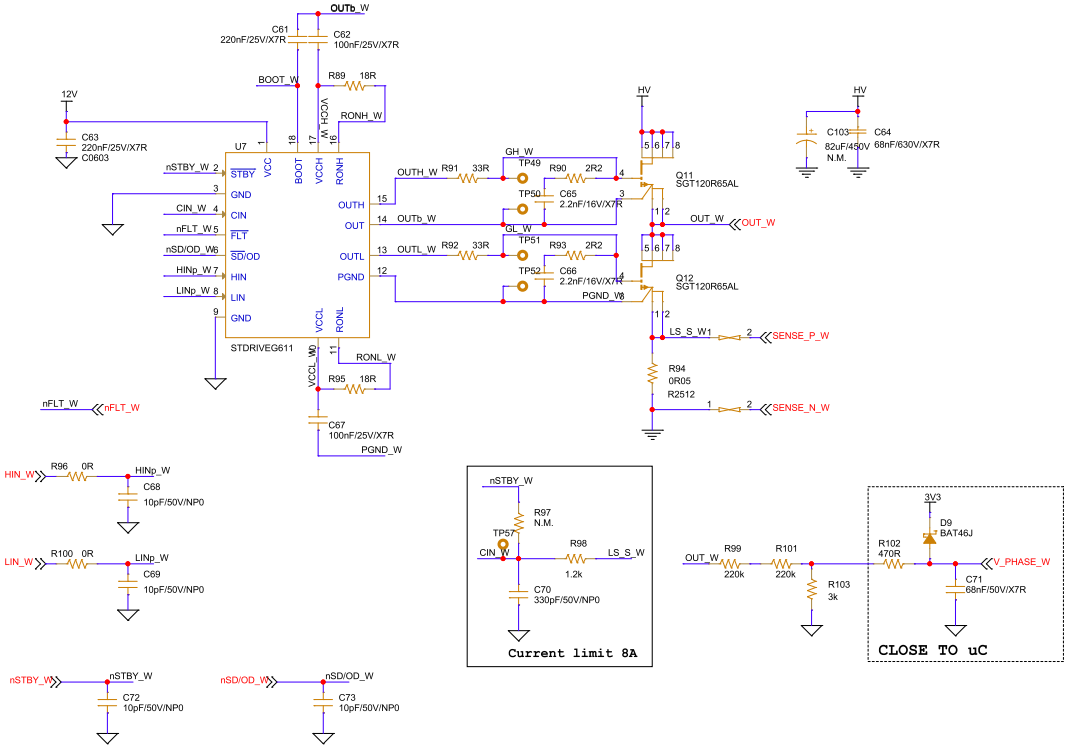


Figure 7. **EVSTDRVG611MC schematic - gate driver phase W**



3 Board main connectors and key components

The board has been developed to demonstrate the use of the STDRIVEG611 gate driver 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 ambient temperature, supply voltage, motor power factor and modulation index, inverter switching frequency. The maximum output power could likely exceed 600 W if the board is supplied from the DC connector J6. If the board is supplied from the AC mains, the max. power is limited to around 400 W, mostly due to the bridge rectifier D1 dissipation.

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

Figure 8. EVSTDRVG611MC top view connectors and components

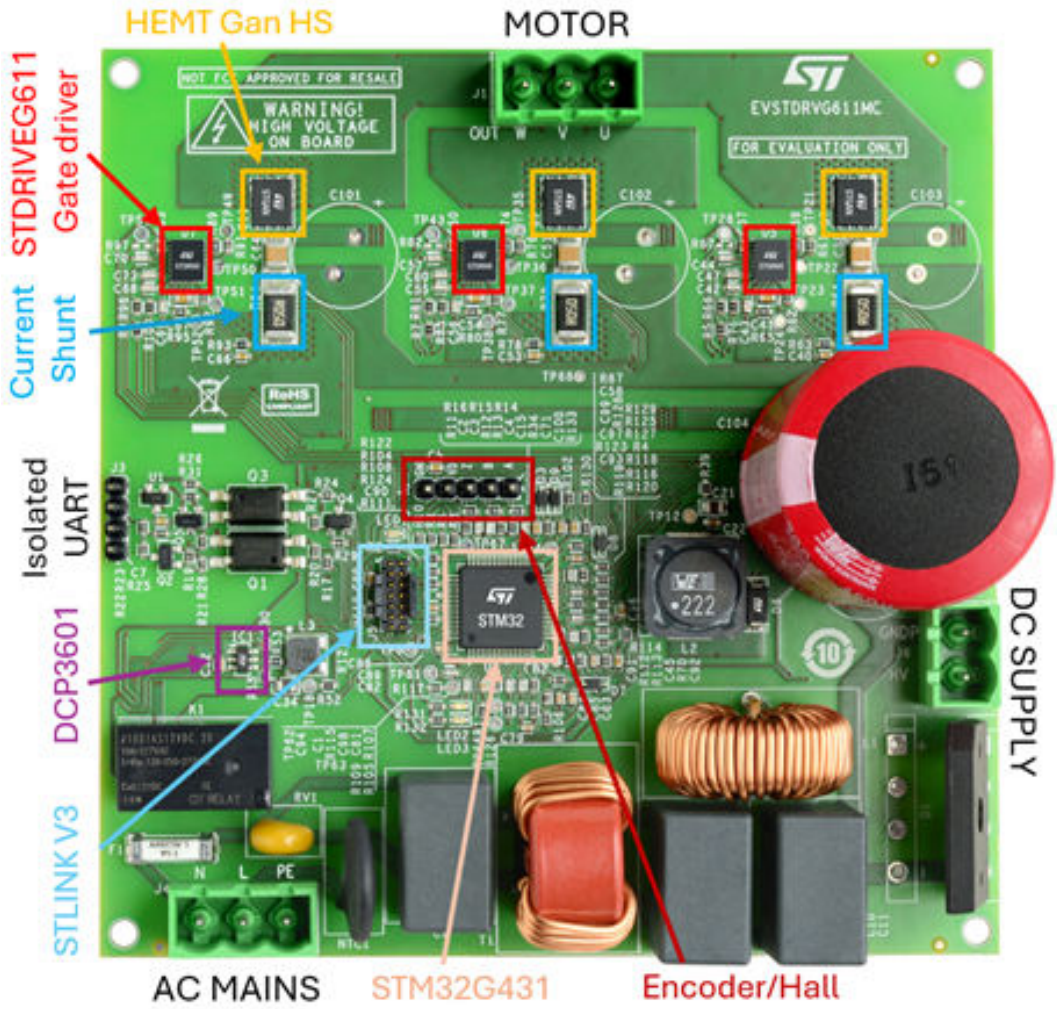
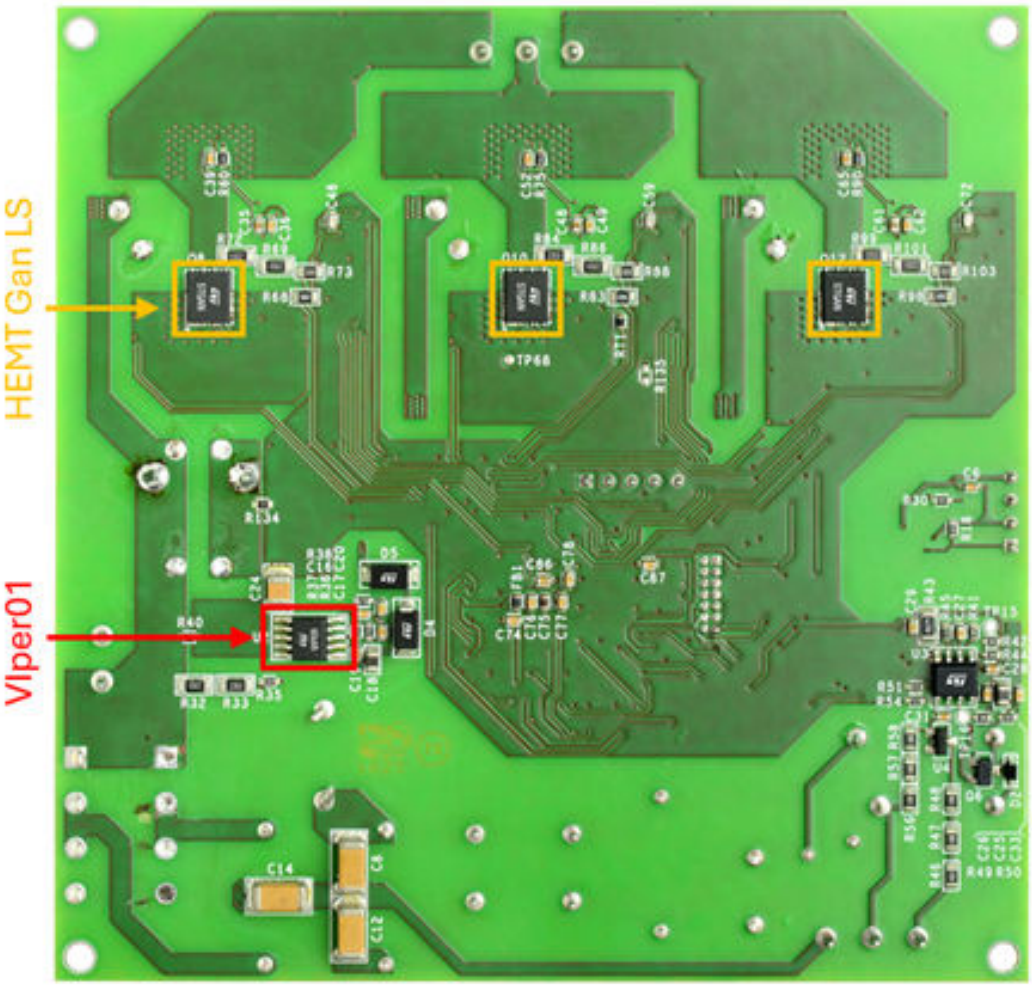


Figure 9. **EVSTDRVG611MC bottom view main components**



4 Bill of materials

Table 1. **EVSTDRVG611MC bill of materials**

Part reference	Part description	Value	Package	Manufacturer code
C1	SMT ceramic capacitor	10 nF / 25 V / X7R	Size 0603	
C2, C3, C4, C42, C43, C46, C47, C55, C56, C59, C60, C68, C69, C72, C73	SMT ceramic capacitor	10 pF / 50 V / NP0	Size 0603	Würth Elektronik WE-885012006051 or equivalent
C5, C6, C17, C22, C29, C30, C36, C49, C62, C74, C76, C77, C78, C79, C80, C83, C85, C86, C87, C88, C89, C92, C96, C100	SMT ceramic capacitor	100 nF / 25 V / X7R	Size 0603	Würth Elektronik WE-885012206071 or equivalent
C7, C27, C28, C31, C33, C90	SMT ceramic capacitor	1 nF / 50 V / X7R	Size 0603	
C8, C12, C14	SMT ceramic Y-Capacitor	2.2 nF / YCap	Size 2211	Würth Elektronik WE-8853522130151 or equivalent
C9, C10, C11	THT film X-Capacitor	1 µF / XCap	Pitch 15 mm, 13x18 mm	Würth Elektronik F861BZ105M310Z or equivalent
C13, C23, C101, C102, C103	THT electrolytic capacitor	N.M.	Diam. 12.5 mm p. 5 mm	Chemi-Con EKXN451ELL820MK40S or equivalent
C15, C19, C26, C32	SMT ceramic capacitor	1 µF / 25 V / X7R	Size 0603	
C16	SMT ceramic capacitor	390 pF / 25 V / NP0	Size 0603	
C20	SMT ceramic capacitor	22 nF / 25 V / X7R	Size 0603	
C21, C34	SMT ceramic capacitor	22 µF / 25 V / X5R	Size 0805	
C24, C38, C51, C64	SMT ceramic capacitor	68 nF / 630 V / X7R	Size 1210	
C35, C37, C48, C50, C61, C63	SMT ceramic capacitor	220 nF / 25 V / X7R	Size 0603	
C39, C40, C52, C53, C65, C66	SMT ceramic capacitor	2.2 nF / 16 V / X7R	Size 0603	
C41, C54, C67	SMT ceramic capacitor	100 nF / 25 V / X7R	Size 0805	
C44, C57, C70	SMT ceramic capacitor	330 pF / 50 V / NP0	Size 0603	
C45, C58, C71	SMT ceramic capacitor	68 nF / 50 V / X7R	Size 0603	
C75, C84	SMT ceramic capacitor	2.2 µF / 10 V / X7R	Size 0603	
C81, C91, C93, C95, C97, C99	SMT ceramic capacitor	33 pF / 50 V / NP0	Size 0603	
C82, C94, C98	SMT ceramic capacitor	100 pF / 50 V / X7R	Size 0603	
C104	THT electrolytic capacitor	390 µF/450 V	Diam. 30 mm p. 10 mm	Würth Elektronik WE-861011485019 or equivalent
D1	Glass passivated bridge rectifier	GBU1510	GBU-2	Panjit GBU1510_T0_00601 or equivalent
D2, D3, D7, D8, D9	SMT Schottky diode	BAT46J	SOD-323	STMicroelectronics BAT46JFILM
D4, D5, D6	SMT diode	STTH1L06A	SMA	STMicroelectronics STTH1L06A

Part reference	Part description	Value	Package	Manufacturer code
FB1, FB2	SMT ferrite bead	742792662	Size 0603	Würth Elektronik WE-742792662 or equivalent
F1	SMT fuse	5 A / 277 V slow	UMT250-SHURTER	Schurter 3403.0173.24 or equivalent
IC1	36 V, 1 A synchronous step-down converter	DCP3601	SOT23-6L	STMicroelectronics DCP3601CMR
J1, J4	PCB header, 3 pos.	691311500103	3 pins, pitch 5,08 mm	Würth Elektronik WE-691311500103 or equivalent
J2	THT strip connector	1x5 pins	1x5 pins	
J3	THT strip connector	1x4 pins	1x4 pins	
J5	TH terminal strip	FTSH-107-01-L-D-K	2x7 pins	Samtec FTSH-107-01-L-D-K or equivalent
J6	PCB header, 2 pos.	691311500102	2 pins, pitch 5,08mm	Würth Elektronik WE-691311500102 or equivalent
K1	Relay	J1001AS12VDC.20	Dim. 10,28 x 18,29, h 15,49 mm	CIT Relay and Switch J1001AS12VDC.20 or equivalent
LED1, LED3	SMT red LED	RED	Size 0603	
LED2	SMT green LED	GREEN	Size 0603	
L1	WE-FI leaded toroidal line choke	150 µH	Dim. 13x26 mm, pitch 10 mm	Würth Elektronik WE-7447055 or equivalent
L2	WE-PD HV SMT power inductor (high voltage)	2.2 mH	Size 1210	Würth Elektronik WE-7687709222 or equivalent
L3	WE-LQS SMT semi-shielded power inductor	10 µH	Size 4025	Würth Elektronik WE-74404043100A or equivalent
NTC1	NTC thermistor for inrush current limiting	5RD15	Diam. 15 mm, pitch 7.5 mm	EPCOS/TDK B57237S0509M051 or equivalent
Q1, Q3	4-Pin DIP phototransistor optocouplers	FOD817AS	FOD817	Onsemi FOD817AS / D or equivalent
Q2	Low-voltage, fast-switching PNP power transistor	2STR2160	SOT-23	STMicroelectronics 2STR2160
Q4, Q5, Q6	60 V, 1A fast-switching NPN power transistor	2STR1160	SOT-23	STMicroelectronics 2STR1160
Q7, Q8, Q9, Q10, Q11, Q12	SMT PowerGaN transistor	SGT120R65AL	PowerFLAT 5x6 HV for Power GaN	STMicroelectronics SGT120R65AL
RT1	Chip NTC thermistor temperature protection devices	10 kΩ	Size 0603 - JIS 1608 [EIA 0603]	TDK NTCG163JF103HT1A or equivalent
RV1	Disk varistor standard WE-VD	275 V - 1.2 kA	Diam. 9 mm, pitch 5 mm	Würth Elektronik WE-820572711 or equivalent
R1, R38	SMT resistor	47 kΩ	Size 0603	
R2, R18, R26, R27, R34, R70, R87, R102, R131, R132	SMT resistor	470 Ω	Size 0603	

Part reference	Part description	Value	Package	Manufacturer code
R3, R4, R11, R12, R13, R19, R28, R30, R31, R104, R108, R121	SMT resistor	10 kΩ	Size 0603	
R5, R7, R9, R39, R40, R52, R66, R71, R81, R85, R96, R100, R122	SMT resistor	0 Ω	Size 0603	
R6, R8, R10, R20, R23, R107, R110, R111, R115, R117, R126	SMT resistor	100 Ω	Size 0603	
R14, R15, R16	SMT resistor	1.8 kΩ	Size 0603	
R17	SMT resistor	200 Ω	Size 0603	
R21, R45	SMT resistor	3.3 kΩ	Size 0603	
R22, R61, R62, R76, R77, R91, R92	SMT resistor	33 Ω	Size 0603	
R24, R29, R41, R42, R44, R49, R50, R133	SMT resistor	1 kΩ	Size 0603	
R25	SMT resistor	2 kΩ	Size 0603	
R32, R33, R69, R72, R84, R86, R99, R101	SMT resistor	220 kΩ	Size 1206	
R35, R106, R113, R116, R120, R125, R129	SMT resistor	3 kΩ	Size 0603	
R36	SMT resistor	82 kΩ	Size 0603	
R37	SMT resistor	9.1 kΩ	Size 0603	
R43	SMT resistor	620 Ω	Size 1206	
R46, R47, R48, R56, R57, R58	SMT resistor	100 kΩ	Size 0805	
R51, R54	SMT resistor	4.7 kΩ	Size 0603	
R53	SMT resistor	86.6 kΩ	Size 0603	
R55, R105, R109, R114, R118, R123, R127	SMT resistor	30 kΩ	Size 0603	
R59, R65, R74, R80, R89, R95	SMT resistor	18 Ω	Size 0603	
R60, R63, R75, R78, R90, R93	SMT resistor	2.2 Ω	Size 0603	
R64, R79, R94	SMT resistor	0.05 Ω	Size 2512	
R67, R82, R97, R124	SMT resistor	N.M.	Size 0603	
R68, R83, R98	SMT resistor	1.2 kΩ	Size 0805	
R73, R88, R103	SMT resistor	3 kΩ	Size 0805	
R112, R119, R128	SMT resistor	15 kΩ	Size 0603	
R130	SMT resistor	2 kΩ	Size 0603	
R134	SMT resistor	12 kΩ	Size 0603	
T1	WE-CMB common-mode power line choke	1 mH	744823601-WURTH	Würth Elektronik WE-744823601 or equivalent
U1, U4	Small signal diodes	BAV99LT1G	SOT-23	Onsemi BAV99LT1G
U2	SMT AC-DC converter	VIPER013LS	SSOP10	STMicroelectronics VIPER013LSTR

Part reference	Part description	Value	Package	Manufacturer code
U3	Low-power, dual-voltage comparators	LM293D	SO-8	STMicroelectronics LM293D /T
U5, U6, U7	SMT GaN half-bridge driver	STDRIVEG611	GQFN 4x5x1 mm 18L 0.5 mm pitch	STMicroelectronics STDRIVEG611
U8	STM32 microcontroller	STM32G431RBT3	LQFP64	STMicroelectronics STM32G431RBT3

5 Layout and component placements

Figure 10. **EVSTDRVG611MC layout - component placement top view**

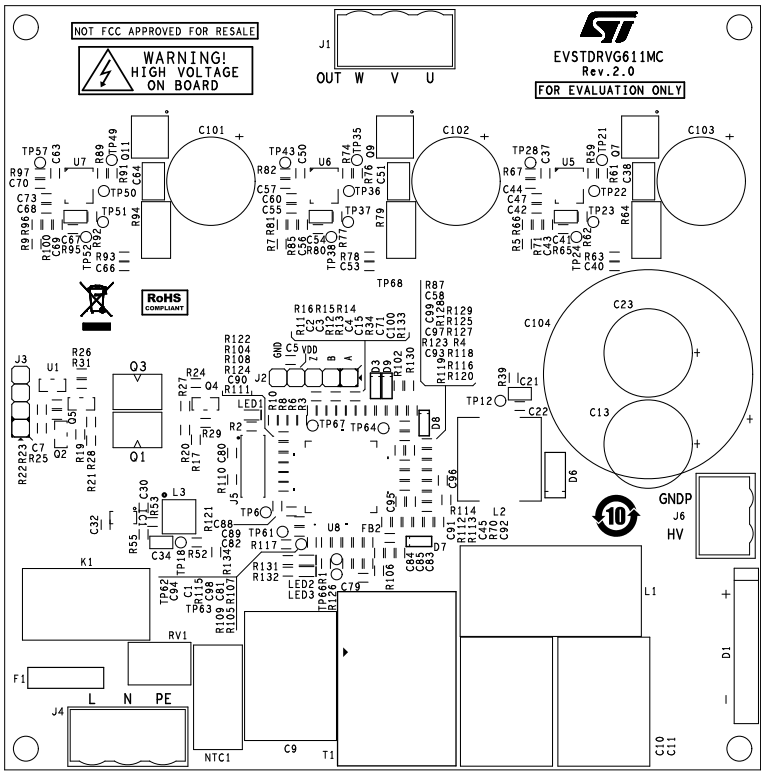


Figure 11. **EVSTDRVG611MC layout - component placement bottom view**

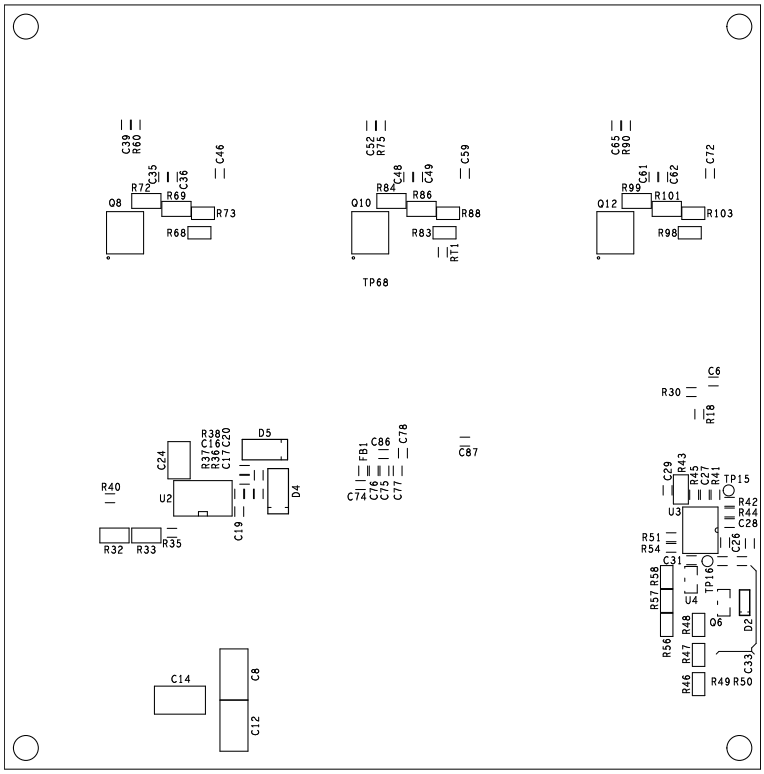


Figure 12. **EVSTDRVG611MC layout - top layer**

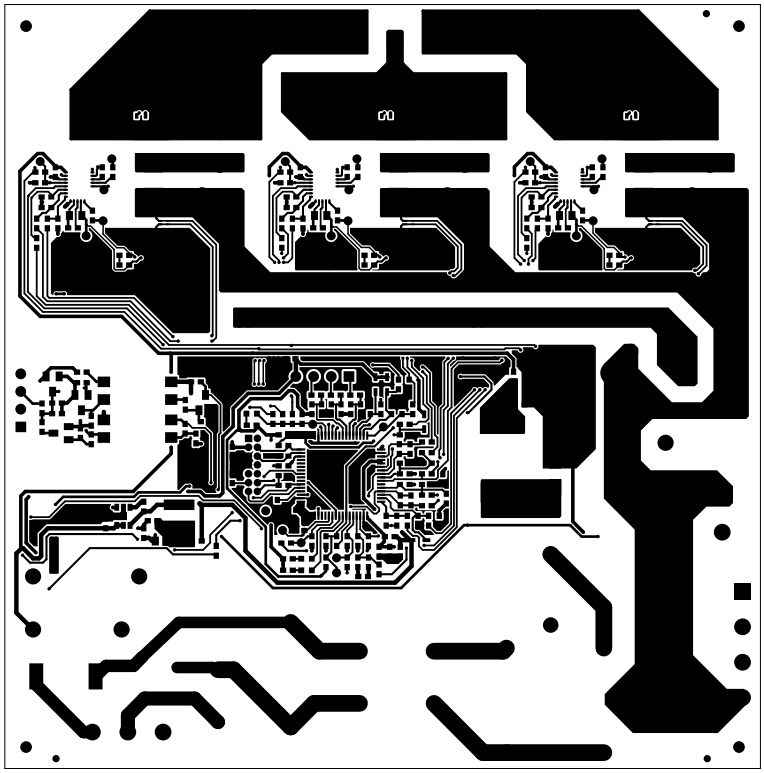
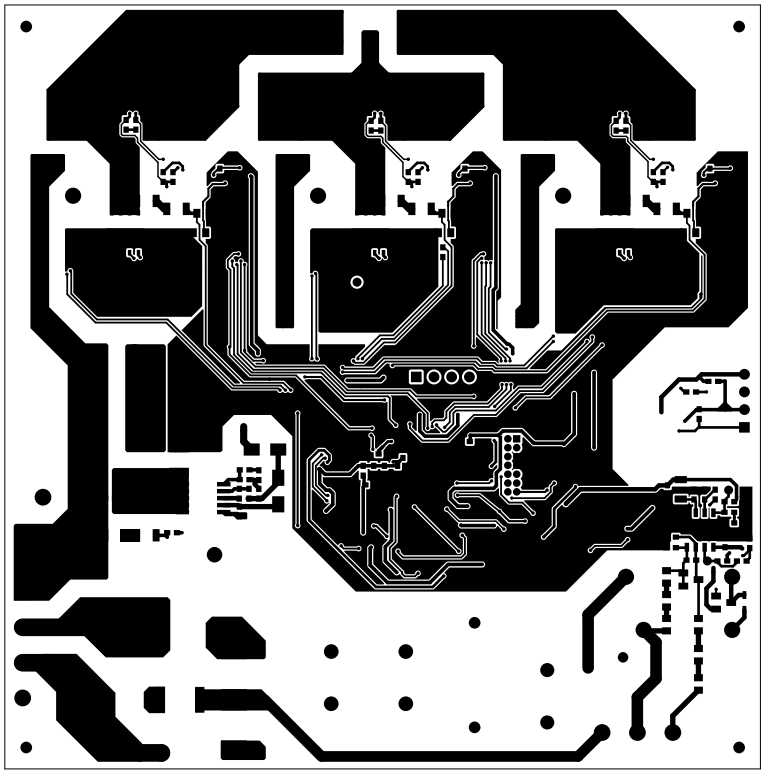


Figure 13. **EVSTDRVG611MC layout - bottom layer**



Revision history

Table 2. **Document revision history**

Date	Version	Changes
01-Aug-2025	1	Initial release.

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