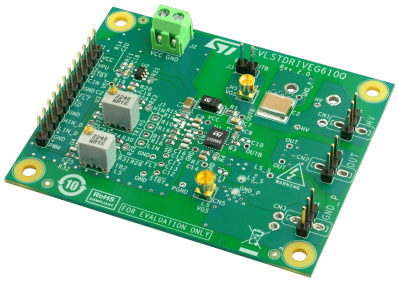
EVLSTDRIVEG610Q

Data brief

Evaluation board for STDRIVEG610 600 V high-speed half-bridge gate driver with 75 mΩ, 650 V e-mode GaN HEMT



Features

- Half-bridge topology featuring the STDRIVEG610 GaN gate driver with integrated LDOs, separated sink/source, integrated bootstrap diode, standby
- Equipped with 75 mΩ typ., 650 V e-mode GaN HEMT
- Tunable hard-on and hard-off dV/dt
- 9 to 18 V (12 V typ.) VCC supply voltage
- Onboard adjustable deadtime generator to convert a single PWM signal in independent high-side and low-side inputs with deadtime
- Separated inputs with external deadtime can also be used
- External bootstrap diode to achieve minimum high side start-up time
- Footprint for optional additional high voltage bulk capacitor
- Onboard 3.3 V regulator for external circuitry supply
- RoHS compliant.

STDRIVE

Product status link
EVLSTDRIVEG610Q

Description

The STDRIVEG610 is a high-speed, half-bridge gate driver optimized to drive high-voltage, enhanced mode, GaN HEMTs.

It features separated high current sink/source gate driving pins, integrated LDOs, undervoltage, bootstrap diode, high-side fast startup, overtemperature, fault and shutdown pins, and standby to fully support hard switching topologies in a 4x5mm QFN package.

The EVLSTDRIVEG610Q board is easy to use and quick and adapt for evaluating the characteristics of the STDRIVEG610 driving 75 mΩ typ., 650 V e-mode GaN switches in the 5x6 mm QFN package. The EVLSTDRIVEG610Q board is also suitable for evaluating the STDRIVEG210 features.

It provides an onboard programmable deadtime generator and a 3.3 V linear voltage regulator to supply external logic like microcontrollers.

Spare footprints are also included to allow customizing the board for the final application, such as separate LIN and HIN input signals or single PWM signal.

The EVLSTDRIVEG610Q is 56 x 70 mm wide, 2 layers, 1.5 Oz, FR-4 PCB, resulting in overall 24 °C/W $R_{th(J-A)}$ (equivalent to 48 °C/W for each GaN) in still air to evaluate high power applications.

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.*

Attention: *The kit is not electrically isolated from the high-voltage supply DC input. No insulation is ensured between the accessible parts and the high voltage. All measuring equipment must use adequately insulated probes, clamps, and connecting wires. Never touch the evaluation board while it is energized as it is capable of causing 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, included PCB, may still be very hot.
The kit is not electrically isolated from 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, for example, an insulating box with interlocks if necessary.

2 Schematic diagrams

Figure 1. **EVLSTDRIVEG610Q schematic - STDRIVEG610 gate driver and e-mode GaN HEMT power stage**

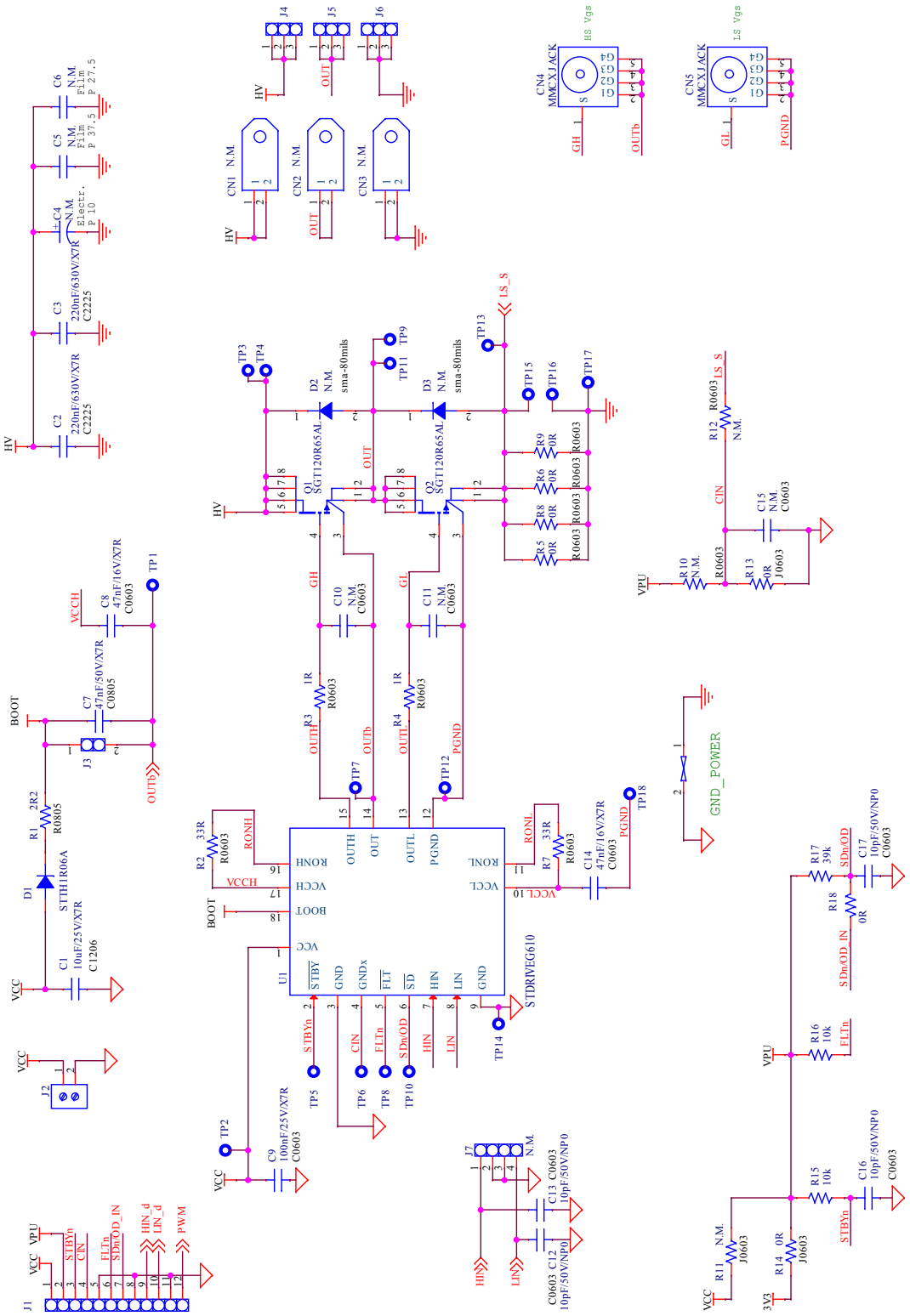
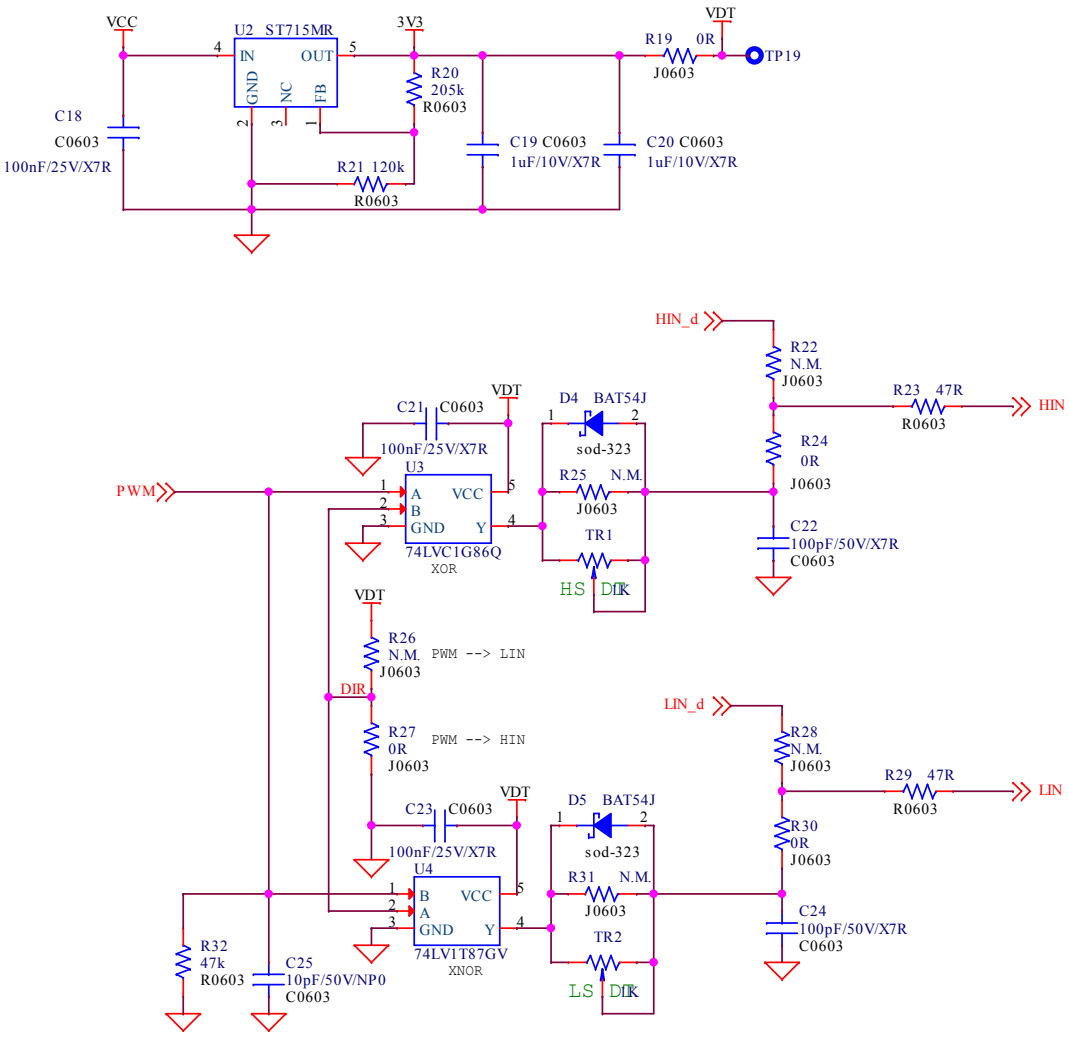


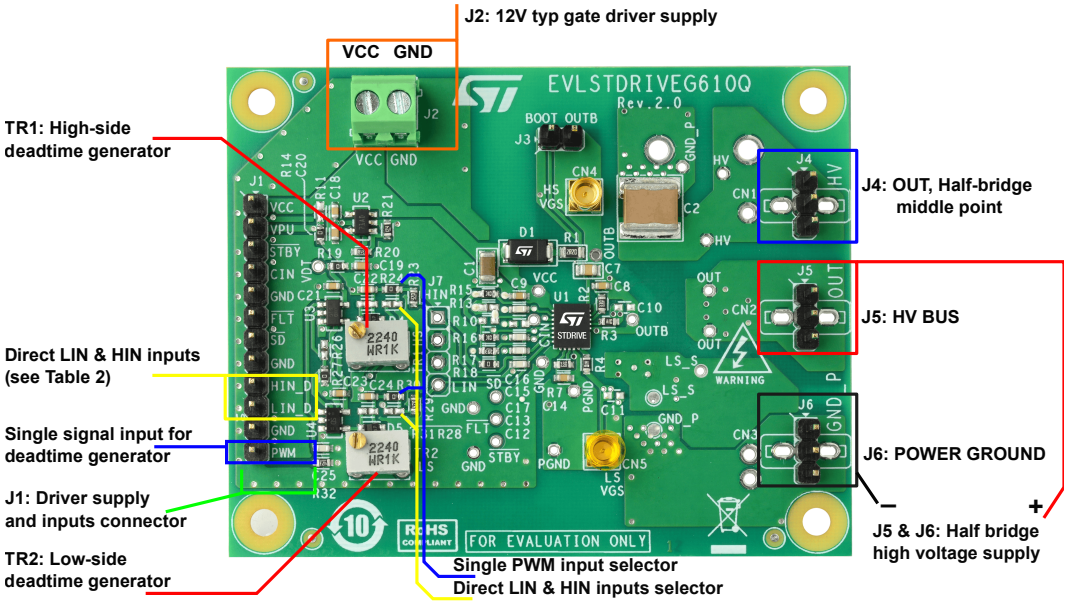
Figure 2. EVLSTDRIVEG610Q schematic - deadtime generator and supply regulator



3 Board power-up and input connection

The following image shows how to supply the EVLSTDRIVEG610Q, how to provide LIN and HIN inputs and set the programmable deadtime generator.

Figure 3. EVLSTDRIVEG610Q - supply and signal connection



The LIN, HIN inputs can be provided from the onboard deadtime generator or directly from an external generator or control device (such as DSP/MCU).

The deadtime value set by the onboard deadtime generator, fed by PWM input signal on J1, can be tuned by setting TR1 and TR2. The typical deadtime value with the trimmer in the default manufacturing middle position is about 100 ns.

It is possible to change the deadtime generator range by changing C22 and C24. Polarity of PWM input can be modified with R26 and R27 as in Table 3.

TR2 sets the deadtime between high-side turn-off and low-side turn-on.

TR1 sets the deadtime between low-side turn-off and high-side turn-on.

The on-board LDO is used to supply the deadtime generator and, by default, signal pull-ups. The supply voltage is set at 3.3 V to match a typical 3.3 V input/output microcontroller voltage levels even if the deadtime generator logics are 5 V input tolerant. To change LDO voltage and deadtime logic threshold levels to 5 V, modify R20 to 374 kΩ. LDO output and deadtime supply can be probed/connected at TP19. The LDO can be used to supply external circuitry (up to about 50 mA).

Table 1. Connector map

Ref	Pin #	Name	Function	Description
J1	1	VCC	IN power	Board supply voltage (12 V typ.)
	2	V_{PU}	Power	Pull-up supply voltage, by default connected to the 3.3 V onboard LDO. Further options to explore standby consumption listed in Table 4.
	3	$\overline{STBY}$	IN digital	Standby input signal (active low)
	4	CIN	OUT analog	Feature not available on STDRIVEG610, connected to GND.
	6	$\overline{FLT}$	OUT digital	Fault output (UVLO, overtemperature)
	7	$\overline{SD}$	IN digital	Disable input signal (0 to 3.3 V or up to 20 V) – see Table 3
	9	HIN_D	IN digital	HIN direct input signal (0 to 3.3 V or up to 20 V): mount R22 and remove R24 – see Table 2 and Table 3

Ref	Pin #	Name	Function	Description
J1	10	LIN_D	IN digital	LIN direct input signal (0 to 3.3 V or up to 20 V): mount R28 and remove R30 – see Table 2 and Table 3
	12	PWM	IN digital	PWM input signal (0 to 3.3 V or 5 V) – see Table 2 and Table 3
	5, 8, 11	GND	Power	Board reference potential
J5	1, 2, 3	OUT	OUT power	These three pins are connected to the OUT pin of the power stage: connect the load to this terminal
J4	1, 2, 3	HV	IN power	These three pins are connected to the high voltage (HV) of the GaN power stage. Connect the half-bridge high-voltage positive supply.
J6	1, 2, 3	GND_P	Power	These three pins are connected to power ground. Connect the half-bridge high-voltage negative supply.
J2	1	VCC	IN power	Board driver supply voltage 12 V typ. (as J1 pin 1)
	2	GND	Power	Board reference potential

Table 2. Device input selection

Board status	Input source	R24, R30	R22, R28	Function and description
Default	PWM J1: pin 12	0 Ω (closed)	Open	LIN & HIN are generated by the onboard deadtime generator from a single PWM signal. PWM input range: 0 to 3.3 V (5 V compatible)
	PWM J1: pin 9, 10	Open	0 Ω (closed)	Direct connection to LIN and HIN STDRIVEG610 pins. LIN, HIN input range: up to 20 V

Table 3. Input signal truth table

Board inputs			PWM polarity	Driver inputs and outputs (1)				
$\overline{STBY}$	$\overline{SD}$	PWM	R26, R27	LIN	HIN	Low-side	High-side	Half-bridge output
L	X	X	X	X	X	Off	Off	High-Z
X	L							
H (default, pull-up)	H (default, pull-up)	L	R26 open, R27 closed (default)	H	L	On	Off	GND
		H		L	H	Off	On (2)	HV (2)
		L	R26 closed, R27 open	L	H	Off	On (2)	HV (2)
		H		H	L	On	Off	GND

1. *With device not in VCC and VCCL UVLO, or overtemperature.*
2. *With device not in VCCH UVLO*

To minimize minimum wirings required to control STDRIVEG610 (VCC and PWM input signal), all pull-ups are, by BOM default, connected to the onboard 3.3 V regulator. All functions can be tested but consumption at VCC connector during standby is not as low as could be expected due to pull-up resistor bias current consumption.

To minimize overall VCC rail consumption in standby mode is suggested to supply VPU rail from STBY net. Doing so, during standby, all pull-up are de-polarized and consumption is minimized. This operating mode is described in Table 4.

Table 4. Standby and V_{PU} pull-up voltage operating mode

Mode	R11	R14	R15	Note
V_{PU} at 3.3 V from LDO (default)	Open	0 R	10 kΩ	Higher VCC rail consumption due to pull-up resistor bias currents
V_{PU} from $\overline{STBY}$	Open	Open	0 Ω	Minimal VCC rail consumption, $\overline{STBY}$ must be externally driven.
V_{PU} at VCC	0 Ω	Open	10 kΩ	$\overline{STBY}$, $\overline{SD}$ and $\overline{FLT}$ pull-up to VCC (12 V). Verify controller input voltage tolerance.

The recommended power-on sequence is to turn VCC on first, then apply the HV bus voltage. The recommended power-off sequence is to turn off the HV bus supply first, then VCC.

4 Bill of materials

Table 5. EVLSTDRIVEG610Q bill of materials

Part reference	Part description	Part value	Package / manufacturer' code
CN1, CN2, CN3	Tab FASTON 250 horizontal	N.M.	
CN4, CN5	MMCX, VERTICAL JACK, 50 Ohm	-	Würth Elektronik 66012102111404 or equivalent
C1	SMT ceramic capacitor	10 µF / 25 V / X7R	Size 1206 Würth Elektronik 885012208069 or equivalent
C2, C3	SMT ceramic capacitor	220 nF / 630 V / X7R	Size 2225
C4	THT electrolytic capacitor	N.M.	Diam 22 mm, pitch 10 mm
C5	Film capacitor	N.M.	Pitch 37.5 mm, 22.5x41.5 mm Würth Elektronik 890 324 028 008 CS or equivalent
C6	Capacitor	N.M.	Pitch 27.5 mm, 22x32 mm
C7	SMT ceramic capacitor	47 nF / 50 V / X7R	Size 0805 Würth Elektronik 885012207096 or equivalent
C8, C14	SMT ceramic capacitor	47 nF / 16 V / X7R	Size 0603 Würth Elektronik 885012206093 or equivalent
C9, C18, C21, C23	SMT ceramic capacitor	100 nF / 25 V / X7R	Size 0603 Würth Elektronik 885012206071 or equivalent
C10, C11	SMT ceramic capacitor	N.M.	Size 0603
C12, C13, C16, C17, C25	SMT ceramic capacitor	10 pF / 50 V / NP0	Size 0805 Würth Elektronik 885012006051 or equivalent
C15	SMT ceramic capacitor	N.M.	Size 0603
C19, C20	SMT ceramic capacitor	1 µF / 10 V / X7R	Size 0603 Würth Elektronik 885012206026 or equivalent
C22, C22	SMT ceramic capacitor	100 pF / 50 V / X7R	Size 0603 Würth Elektronik 885012206077 or equivalent
D1	Turbo 2 ultrafast high-voltage rectifier	STTH1R06A	SMA STMicroelectronics STTH1R06A or equivalent
D2, D3	Turbo 2 ultrafast high-voltage rectifier	N.M.	SMA
D4, D5	40 V, 300 mA small signal Schottky diode	BAT54J	SOD-323 STMicroelectronics BAT54JFILM or equivalent
J1	Strip connector	1x 12 pins	Pitch 2.54 mm Würth Elektronik 61301211121 or equivalent
J2	Connector terminal block T.H	2 poles	Pitch 5.08 mm

Part reference	Part description	Part value	Package / manufacturer' code
			Würth Elektronik 691213510002 or equivalent
J3	Strip connector	1x2 pins	Pitch 2.54 mm Würth Elektronik 61300211121 or equivalent
J4, J5, J6	Strip connector 3 pos, 2.54 mm	1x3pins	Pitch 2.54 mm Würth Elektronik 61300311121 or equivalent
J7	Strip connector	N.M.	Pitch 2.54 mm Würth Elektronik 61300411121 or equivalent
Q1, Q2	Bottom-side cooled 650 V e-mode GaN transistor	SGT120R65AL	PowerFLAT 5x6 mm HV STMicroelectronics SGT120R65AL
R1	SMT resistor	2.2 Ω	Size 0805
R2, R7	SMT resistor	33 Ω	Size 0603
R3, R4	SMT resistor	1 Ω	Size 0603
R5, R6, R8, R9, R13, R18	SMT resistor	0 Ω	Size 0603
R10, R12	SMT resistor	N.M.	Size 0603
R11, R22, R25, R26, R28, R31	SMT resistor	N.M.	Size 0603
R14, R19, R24, R27, R30	SMT resistor	0 Ω	Size 0603
R15, R16	SMT resistor	10 kΩ	Size 0603
R17	SMT resistor	39 kΩ	Size 0603
R20	SMT resistor	205 kΩ	Size 0603
R21	SMT resistor	120 kΩ	Size 0603
R23, R29	SMT resistor	47 Ω	Size 0603
R32	SMT resistor	47 kΩ	Size 0603
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP17, TP18, TP19	Test point for probe	-	Metallized Hole, 0.8 mm diameter
TP15, TP16	Test point	-	Copper PAD, 1.016 mm diameter
TR1, TR2	Trimming potentiometer	1 kΩ	Bourns 3266W-1-102LF or equivalent
U1	High-voltage, high-speed half-bridge GaN gate driver	STDRIVEG610	QFN18 4x5 mm STMicroelectronics STDRIVEG610Q
U2	High input voltage, 85 mA LDO linear regulator	ST715MR	SOT23-5L STMicroelectronics ST715MR or equivalent
U3	2-inputs EXCLUSIVE-OR gate	74LVC1G86Q	SOT23-5L Diodes incorporeted 74LVC1G86QW5-7 or equivalent
U4	2-inputs EXCLUSIVE-NOR gate	74LV1T87GV	SOT23-5L Nexperia 74LV1T87GV or equivalent

5 Layout and component placements

Figure 4. **EVLSTDRIVEG610Q layout - component placement top view**

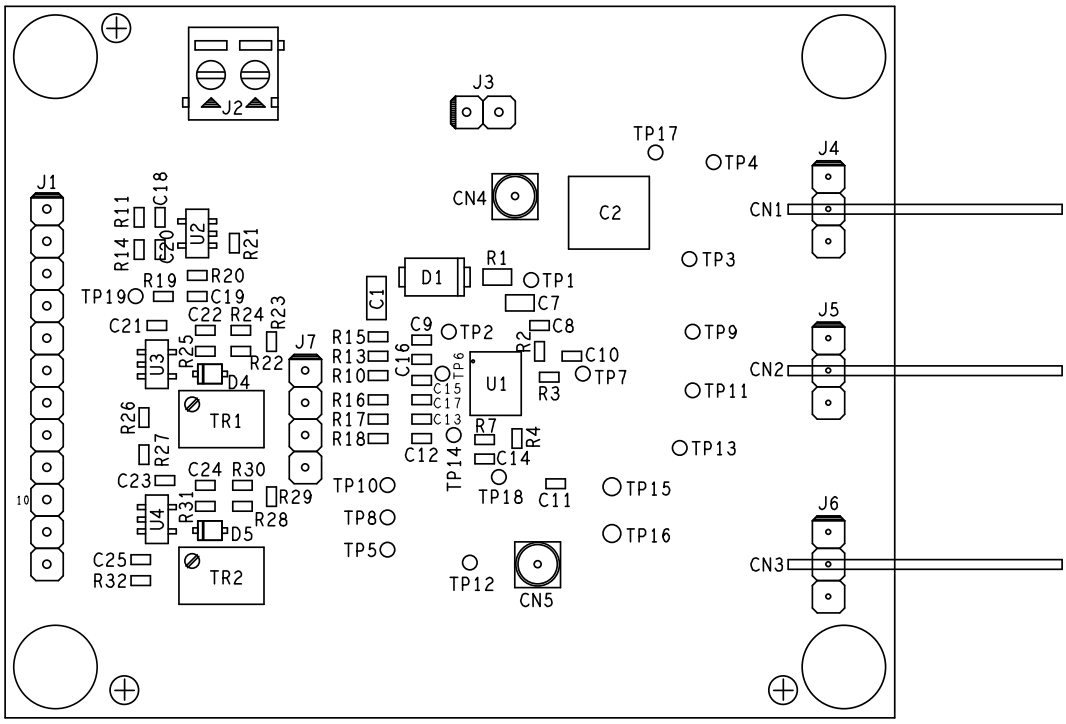


Figure 5. **EVLSTDRIVEG610Q layout - component placement bottom view**

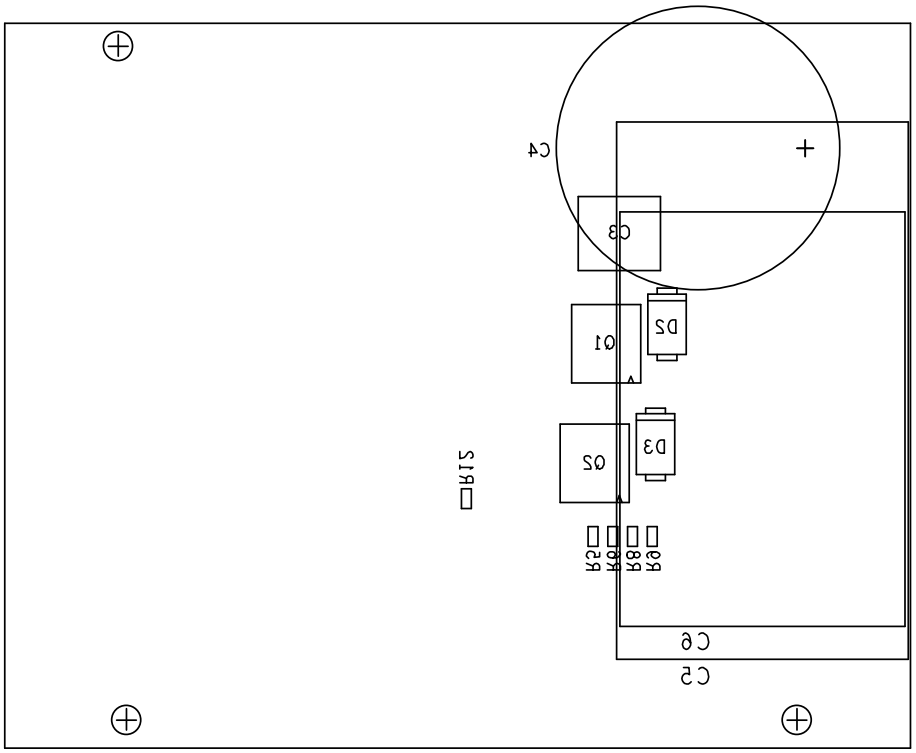


Figure 6. **EVLSTDRIVEG610Q layout - top layer**

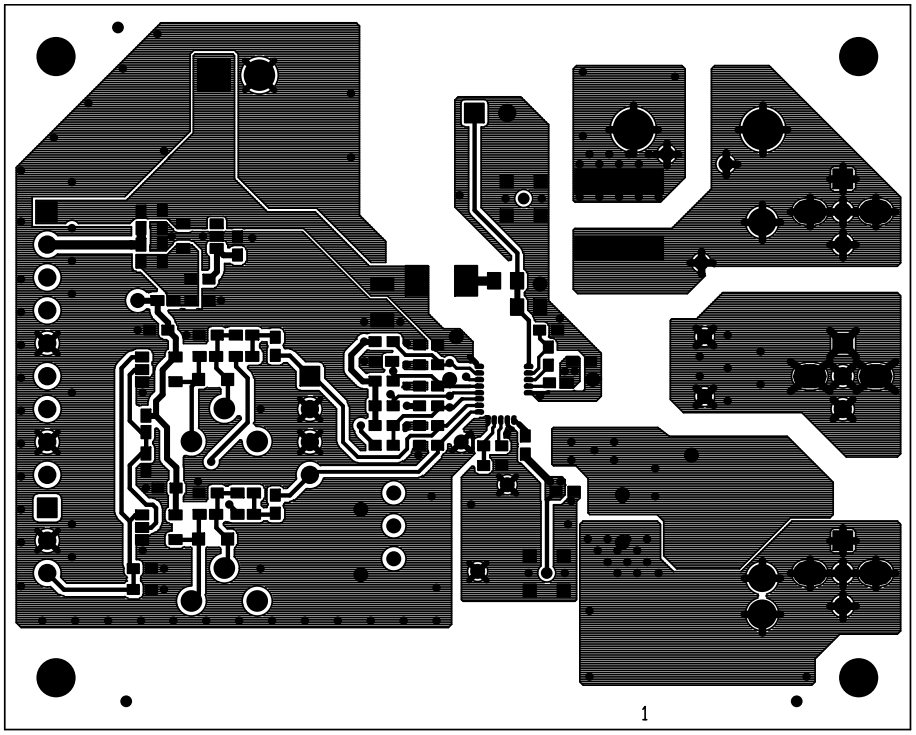


Figure 7. **EVLSTDRIVEG610Q layout - inner layer 2**

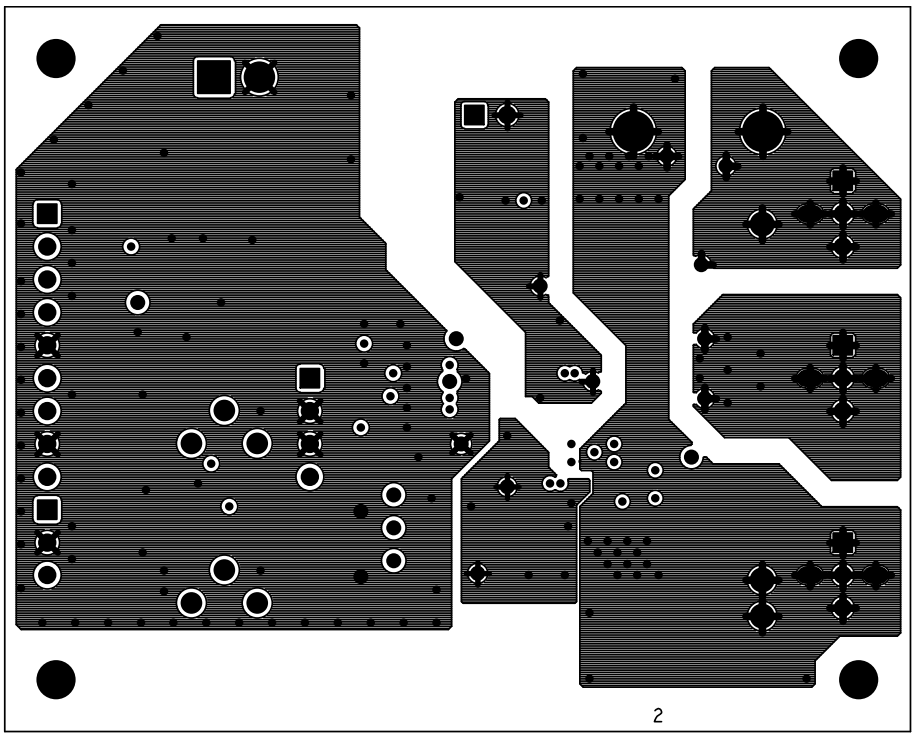


Figure 8. **EVLSTDRIVEG610Q layout - inner layer 3**

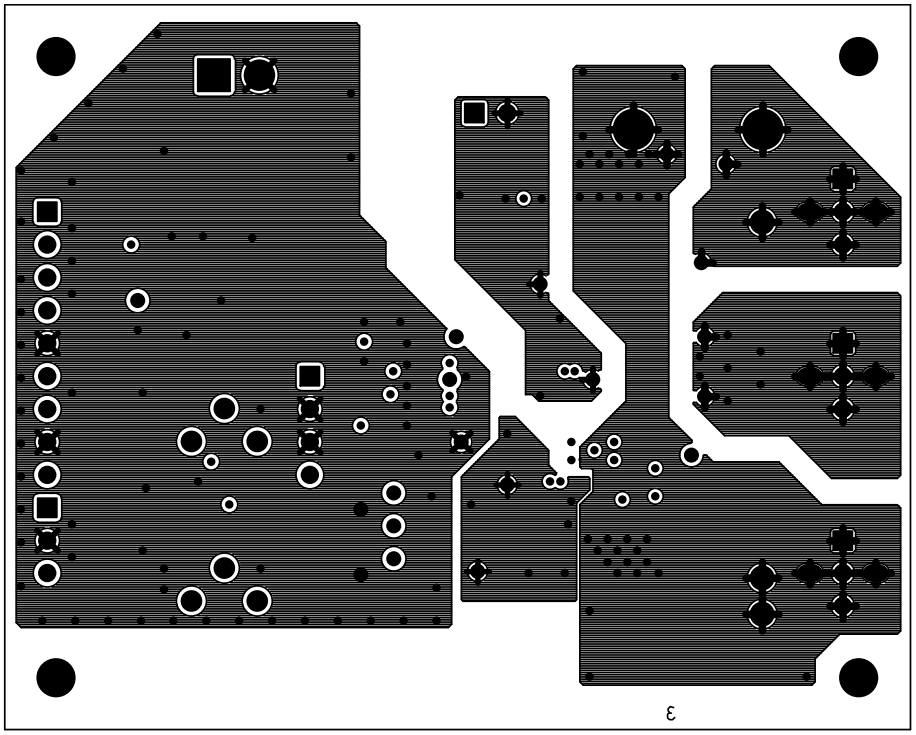
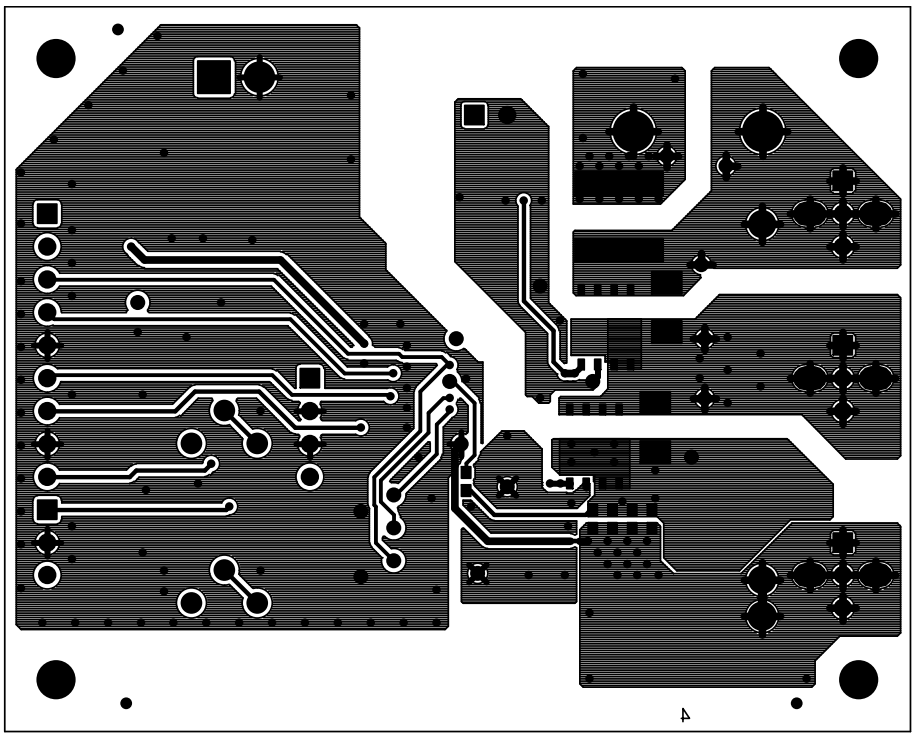


Figure 9. **EVLSTDRIVEG610Q layout - bottom layer**



Revision history

Table 6. **Document revision history**

Date	Version	Changes
08-Jan-2025	1	Initial release.
24-Jun-2025	2	Updated Section Description.
16-Sep-2025	3	Updated document title, Features, Description, labels of Figure 1 and Figure 2.

Contents

List of tables

List of figures