# EVAL_GD_BDS_GaN user guide

## CoolGaN™ BDS gate driver evaluation board

## About this document

### Scope and purpose

This user guide provides an overview of the EVAL_GD_BDS_GaN Evaluation Board including its main features, key components, pin assignments, and mechanical dimensions. It also describes the operation of a gallium nitride (GaN) bidirectional switch (BDS) with this evaluation board.

EVAL_GD_BDS_GaN is a low-power evaluation board that includes a EiceDRIVER™ 1EDB7275F single-channel isolated gate driver and a connector to solder various GaN BDS daughter cards. The board is designed to support various GaN bidirectional switches ranging up to 120 V. This evaluation board provides a berg stick board-to-board connector, where different GaN BDS daughter cards can be mounted. The supported GaN BDS daughter boards are listed in Section 2.3.

### Intended audience

This document is intended to guide engineers evaluating bidirectional GaN switch performance by using gate driver circuit on this evaluation board.

*Note: The board is sensitive to ESD and must be used only under laboratory conditions.*

## About this product group

### Target applications

- Consumer Electronics: USB-C chargers and load switches
- eFuses
- Battery management systems (BMS)

### Product family

CoolGaN™ BDS are normally-off monolithic GaN bidirectional switches with dual-gate independent control, enabling a common-drain structure for blocking voltage and current in both directions. They replace multiple unidirectional switches, reducing component count while improving switching speed and overall performance. CoolGaN™ BDS switches enhance efficiency, power density, and reliability in applications.

### Evaluation Board

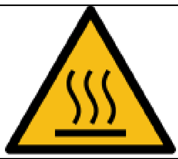
This board will be used during design-in process for evaluation and measurement of characteristics of the GaN BDS and to validate the respective device datasheet specifications.

*Note: PCB and auxiliary circuits are NOT optimized for final customer design.*

# Safety precautions

*Note:* *Please note the following warnings regarding the hazards associated with development systems.*

**Table 1** **Safety precautions**

| | |
|---|---|
|  | **Warning**: *The evaluation or reference board contains DC bus capacitors, which take time to discharge after removal of the main supply. Before working on the drive system, wait 5 minutes for capacitors to discharge to safe voltage levels. Failure to do so may result in personal injury or death. Darkened display LEDs are not an indication that capacitors have discharged to safe voltage levels.* |
|  | **Warning:** *Remove or disconnect power from the drive before you disconnect or reconnect wires or perform maintenance work. Wait five minutes after removing power to discharge the bus capacitors. Do not attempt to service the drive until the bus capacitors have discharged to zero. Failure to do so may result in personal injury or death.* |
|  | **Caution:** *The heat sink and device surfaces of the evaluation or reference board may become hot during testing. Hence, necessary precautions are required while handling the board. Failure to comply may cause injury.* |
|  | **Caution:** *Only personnel familiar with the drive, power electronics and associated machinery should plan, install, commission and subsequently service the system. Failure to comply may result in personal injury and/or equipment damage.* |
|  | **Caution:** *The evaluation or reference board contains parts and assembly's sensitive to electrostatic discharge (ESD). Electrostatic control precautions are required when installing, testing, servicing or repairing the assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with electrostatic control procedures, refer to the applicable ESD protection handbooks and guidelines.* |
|  | **Caution:** *A drive that is incorrectly applied or installed can lead to component damage or reduction in product lifetime. Wiring or application errors such as under sizing the motor, supplying an incorrect or inadequate AC supply, or excessive ambient temperatures may result in system malfunction.* |
|  | **Caution:** *The evaluation or reference board is shipped with packing materials that need to be removed prior to installation. Failure to remove all packing materials that are unnecessary for system installation may result in overheating or abnormal operating conditions.* |

# Table of contents

# 1 The board at a glance

The EVAL_GD_BDS_GaN Evaluation Board consists of a gate driver circuit for the GaN bidirectional switch (BDS). The board has $V_{D1}$, $V_{D2}$ as input/output terminals and a power ground (PGND) terminal, all realized via Banana connectors.

A 5 V external power supply (VCC) is applied at connector J2 and a 5 V gate driver enable signal at connector J5. Additionally, provide an isolated power supply V_ISO of 5 V at connector J4. The VCC and V_ISO supplies power the 1EDB7275F isolated gate driver, which drives the GaN BDS.

The board includes a provision to connect different GaN BDS switches as daughter cards via connector J3.

## 1.1 Scope

This evaluation board contains a gate driver circuit for driving a CoolGaN™ bidirectional switch that can be controlled with an external enable signal of 5 V. The input/output and a common power ground terminal are given through Banana connectors.

## 1.2 Block diagram

Figure 1 shows a EVAL_GD_BDS_GaN board typical application diagram for driving up to 120 V GaN BDS. You need to solder a daughter board with a GaN BDS switch on the J3 connector terminals of this evaluation board.

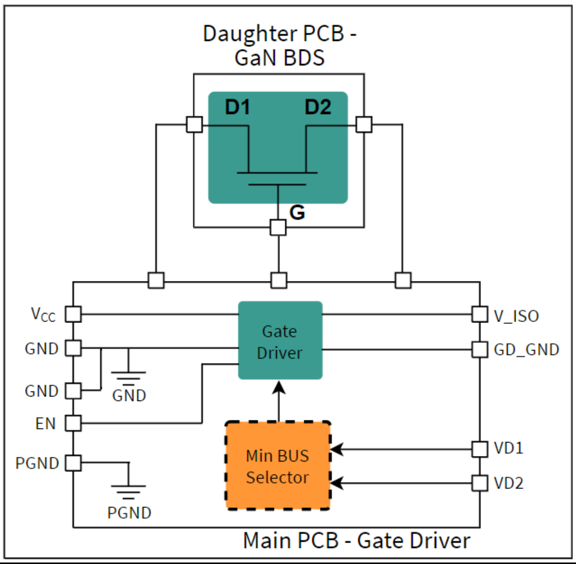



**Figure 1 EVAL_GD_BDS_GaN application diagram**

## 1.3 Main features

- Input voltage range from 5 V to 120 V
- Gate driver for bidirectional current flow
- Maximum load current of 20 A
- Microcontroller-compatible gate drive enable signal and power supply of 3.3 V/5 V
- Isolated gate driver power supply of 5 V

## 1.4 Board parameters and technical data

**Table 2 EVAL board parameters**

| Parameter | Symbol | Value | | | Unit | Conditions/notes |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Continuous drain-drain voltage | $V_{D1D2}$ | – | – | 120 | V | – |
| Input/output voltage | $V_{D1}$ or $V_{D2}$ | 5 | – | 120 | V | – |
| Output current | $I_{OUT}$ | – | – | 20 | A | $T_{amb}$ = 25°C |
| Gate enable signal | | | | | | |
| Power supply voltage | VCC | 3.3 | – | 5 | V | – |
| Isolated power supply voltage | | | | | | |
| **System environment** | | | | | | |
| Ambient temperature | $T_{amb}$ | – | 25 | – | °C | – |
| **PCB characteristics** | | | | | | |
| Dimensions | L | – | 65 | – | mm | Length |
| | W | – | 35 | – | mm | Width |
| | H | – | 25 | – | mm | Height |
| No. of layers | – | – | 2 | – | – | – |
| PCB thickness | – | – | 1.6 | 1.6 | mm | – |
| Copper thickness | – | – | 1 | – | oz. | All layers |
| Weight | – | – | – | – | g | Weight of entire PCB assembly |
| Material | – | – | – | – | – | FR-4, RoHS-compliant |

# 2 System and functional description

## 2.1 Getting started

This evaluation board is a gate driver circuit board for the GaN bidirectional switch allowing bidirectional current flow and bidirectional voltage blocking. This section explains how to set up the system and get started with BDS evaluation. Figure 2 shows the system connection and the test results are listed in Section 4.1.

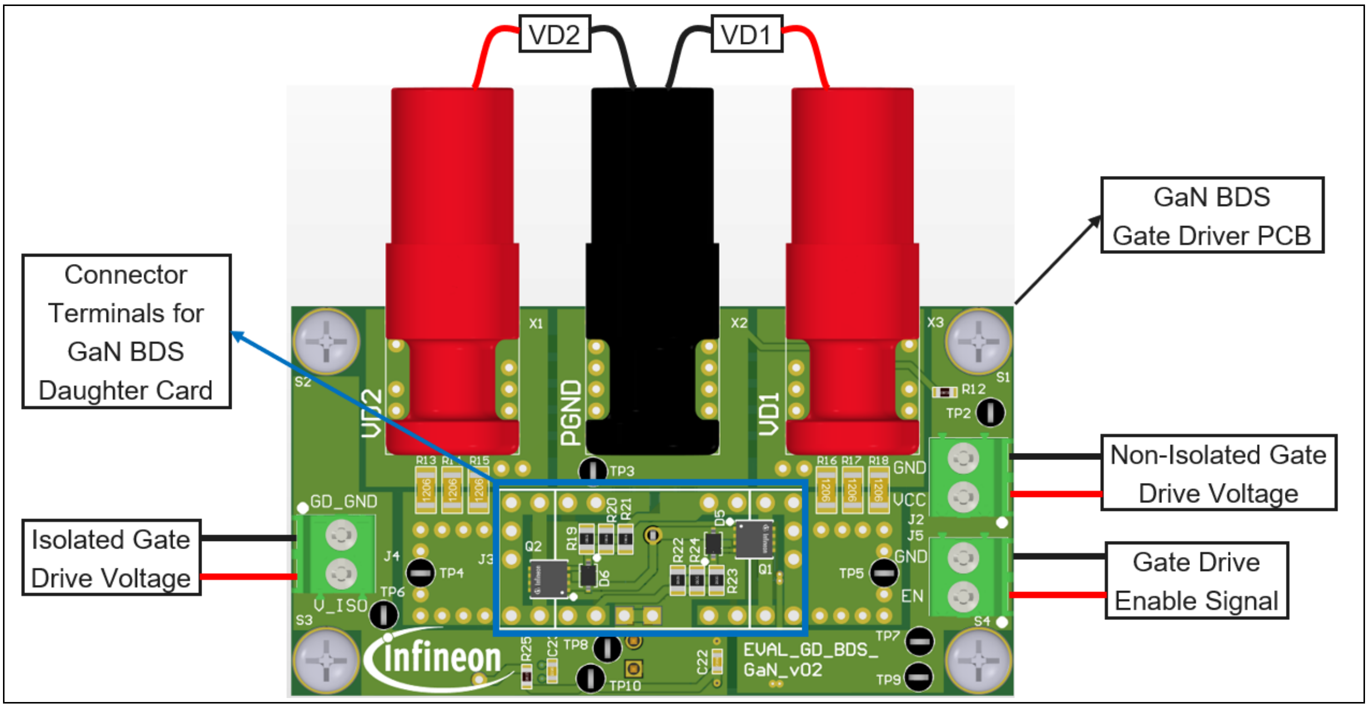



**Figure 2** EVAL_GD_BDS_GaN system connection

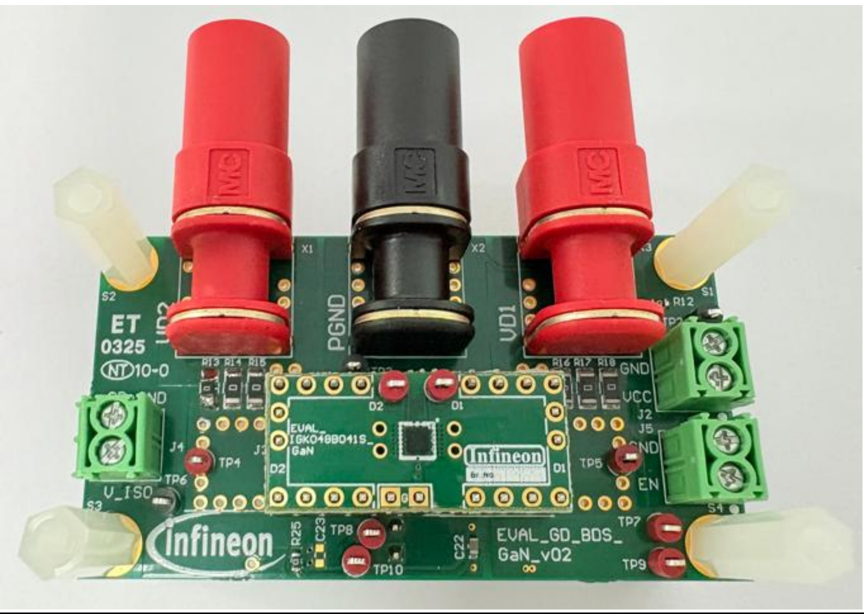



**Figure 3** EVAL_GD_BDS_GaN with GaN BDS daughter board

## 2.2 Description of the functional blocks

The hardware design in EVAL_GD_BDS_GaN board is implemented using three major modules, namely, gate driver circuit, gate drive power supply, gate driver return path selector circuit, and GaN BDS daughter card.

### 2.2.1 Gate driver circuit

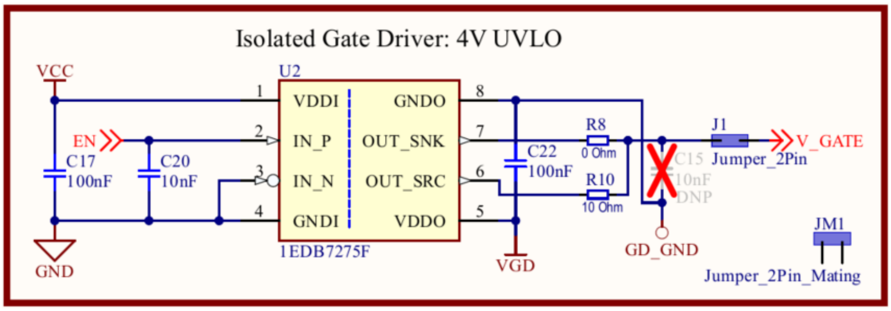



**Figure 4 Gate driver circuit (1EDB7275F)**

To drive a common source configuration, GaN BDS switch (common source point not available), apply a gate drive voltage across its gate and drain terminals. This evaluation board uses a 1EDB7275F single-channel isolated gate driver to drive the wide range of GaN BDS switches and the circuit is shown in Figure 4. The driver has a UVLO threshold of 4.2 V and therefore, it can be powered directly from a 5 V supply. The EN signal is used to turn ON/OFF the gate driver output.

### 2.2.2 Gate driver power supply

The 1EDB7275F isolated gate driver requires two independent power supplies namely, VCC with respect to GND and V_ISO with respect to GD_GND. VCC is the non-isolated power supply with respect to GND, i.e., the same ground is system ground.

The isolated power supply V_ISO with respect to GD_GND is given on J4 connector. From this V_ISO, the net VDD_5V is derived using TLS805B1LD linear regulator. With R25 populated, the VGD_5V is given to net VGD. If R25 is DNP and U3 is populated, the VGD can be boosted to a voltage of up to 6.4 V by changing the values of R7 and R9. This can be used to test the GaN BDS with a higher gate voltage.

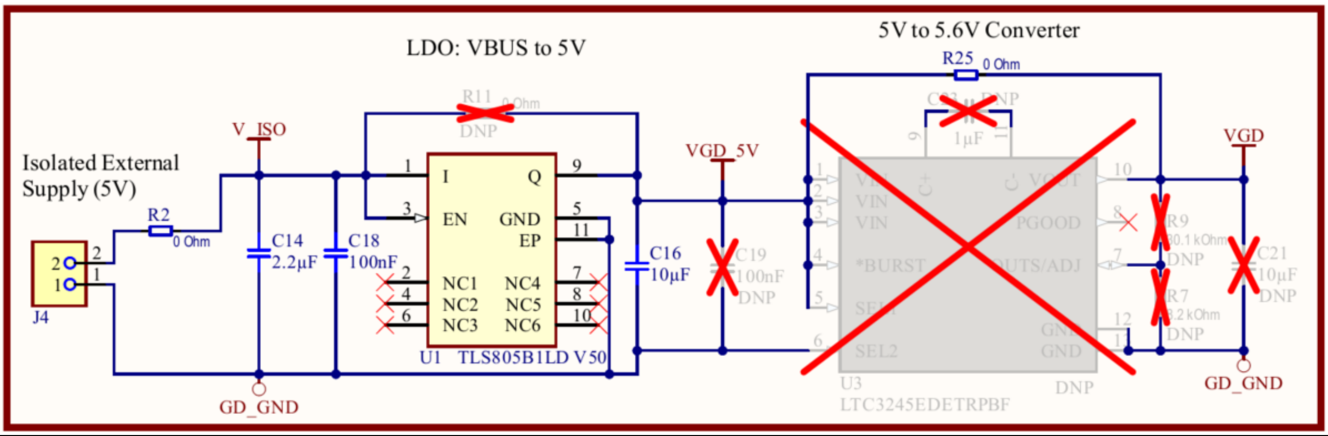



**Figure 5 Gate driver power supply**

### 2.2.3 Gate driver circuit return path

Ensure to select the GaN BDS return path circuit to functionally turn on/off the GaN BDS correctly.

The gate reference selector switches SW1 and SW2 gives the flexibility to select the gate return path, with settings as shown in the following table.

**Table 3 Selector switch setting**

| Current direction | GD_GND | SW1 position | SW2 position |
|---|---|---|---|
| D2 to D1 | D1 (BDS_D1) | 3 | 1 |
| D1 to D2 | D2 (BDS_D2) | 1 | 1 |
| Bi-directional | VIN_MIN | – | 3 |

When the gate is referenced to D2 (BDS_D2) and VGD2 exceeds VGD(th) of the GaN BDS switch, bidirectional current flow is enabled. With VGD2 = 5 V, current can flow in both directions, with minimal voltage drop (RON × ILoad) and low power loss. If the gate signal is off with respect to D2 (i.e., VGD2 = 0 V), the channel acts like a diode, permitting conduction only from D2 to D1 with a higher voltage drop (2 V to 2.5 V).

Similarly, when the gate is referenced to D1 (BDS_D1) and VGD1 exceeds VGD(th), again the bidirectional flow is enabled. When the gate is turned off with respect to D1 (i.e., VGD1 = 0 V), the channel acts like a diode in other direction and the conduction will be possible from D1 to D2 with a higher voltage drop.

Therefore, when the current direction is fixed, then referencing to a particular ground reference helps to control the GaN BDS switch effectively.

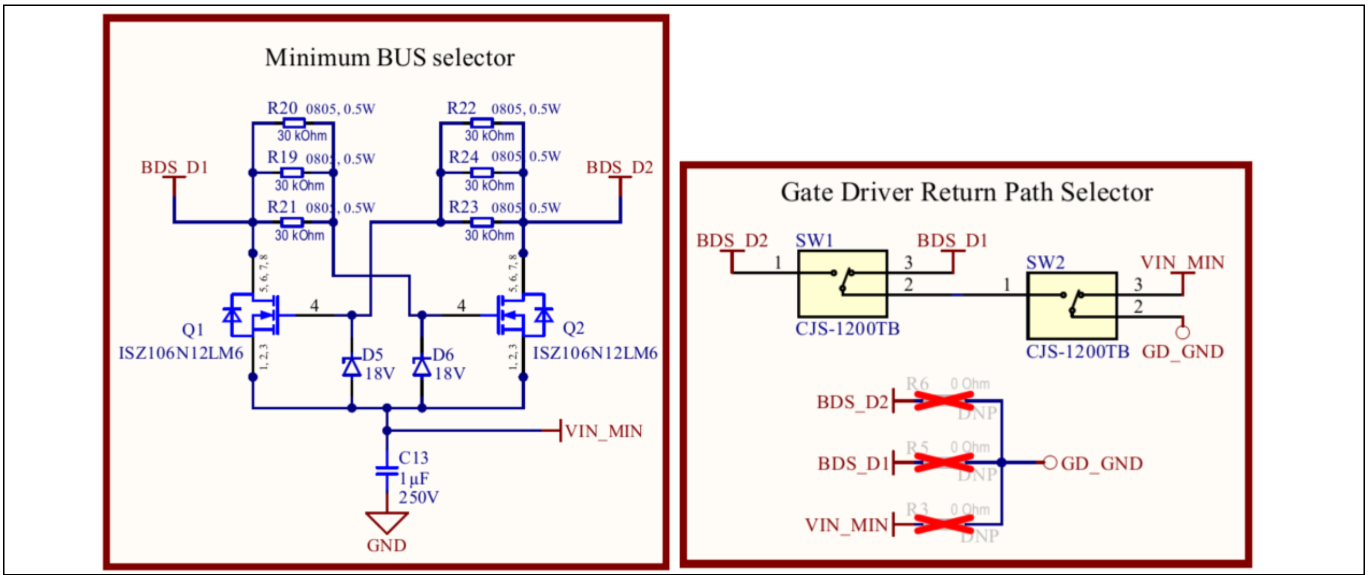



**Figure 6 Gate driver return path selection**

The minimum bus selector circuit will select the minimum voltage out of the two drain potentials, so that the gate return can be referenced to that potential and the GaN BDS operates in true bidirectional mode. There will be a voltage drop of 0.6 V across the MOSFETs Q1 and Q2, which will lower the gate drain voltage across the GaN BDS switch, effectively increasing the on resistance ($R_{on}$) of the BDS. This drop can be compensated by either increasing the V_ISO voltage equivalent to voltage drop or by depopulating R25 (disconnecting direct short of VGD_5V to VGD), populating U3, and its corresponding components.

Alternatively, resistors R5, R6, and R3 can be populated to fix the gate return path to D1, D2, or min (D1, D2) respectively, if the current direction is fixed to known.

## 2.3 GaN BDS: Daughter cards

The following are the list of the GaN BDS daughter cards available, which are compatible to be tested with this evaluation board.

- EVAL_IGK080B041S_GaN (40 V, 6 mΩ GaN BDS switch)
- EVAL_IGK048B041S_GaN (40 V, 4 mΩ GaN BDS switch)
- EVAL_IGK120B041S_GaN (40 V, 9 mΩ GaN BDS switch)

# 3 System design

## 3.1 Schematics

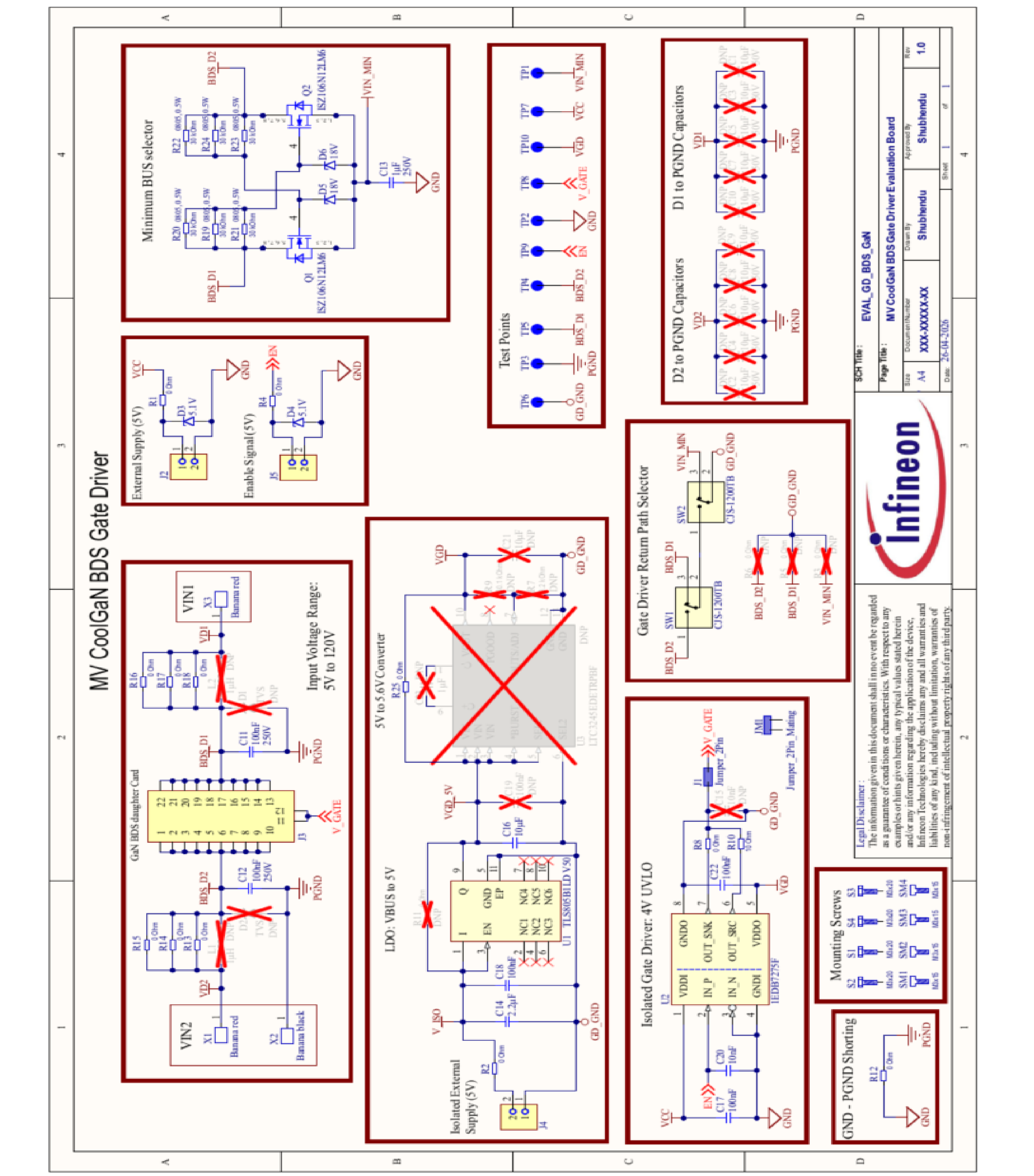


**Figure 7 Gate driver schematics**

## 3.2 Layout

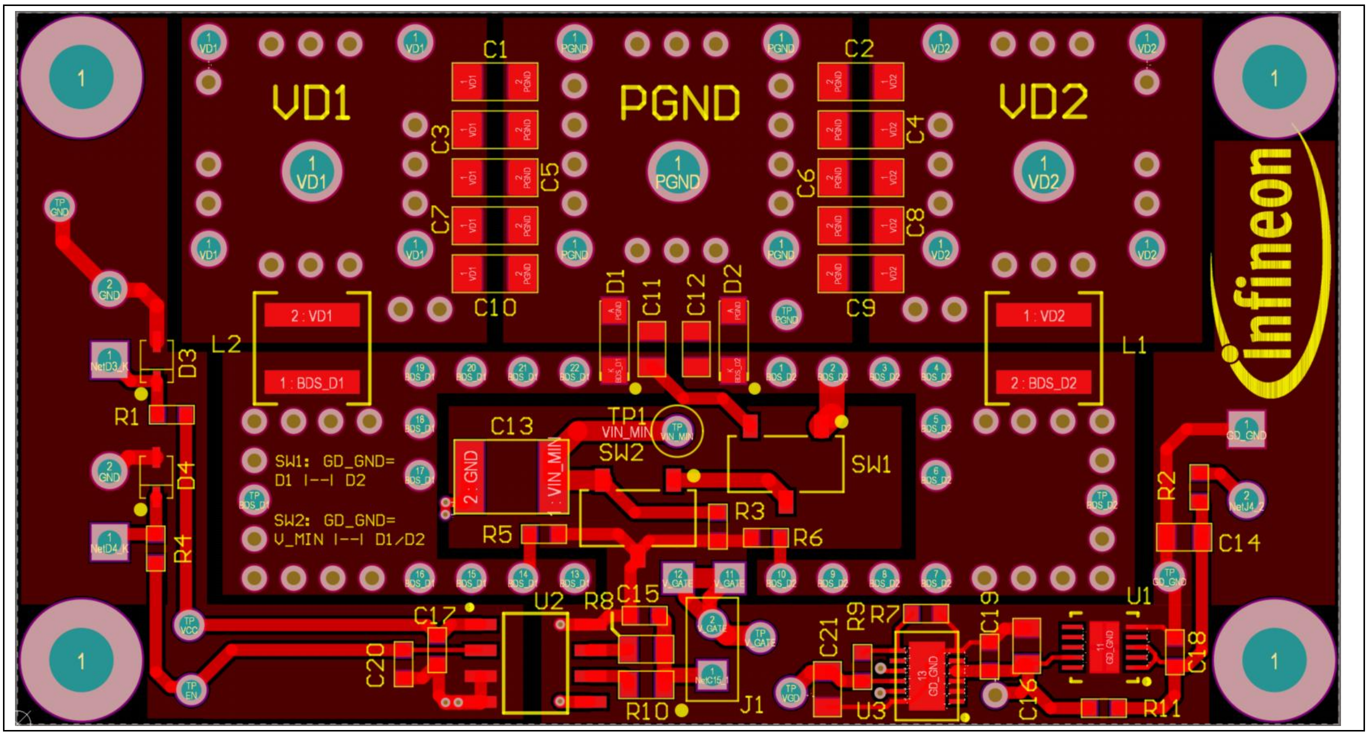



Figure 8 Top layout (top view)

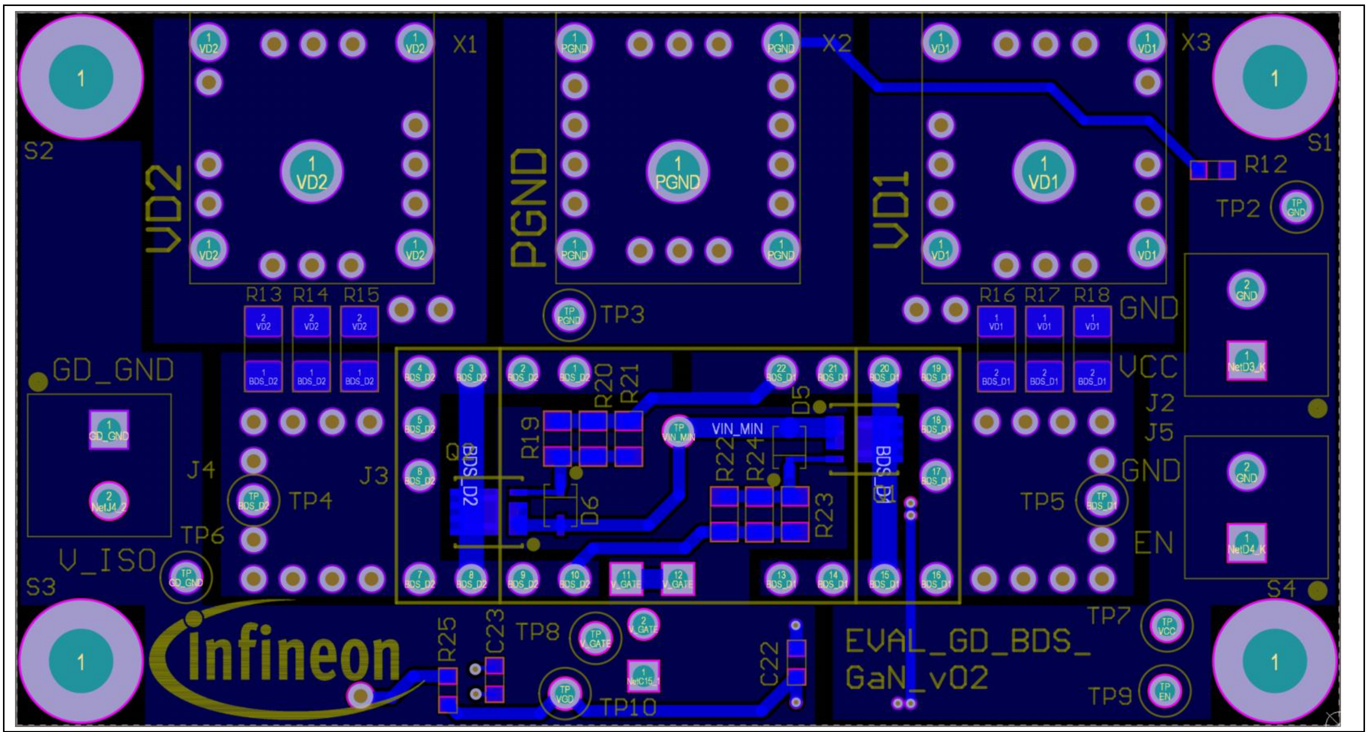



Figure 9 Bottom layout (bottom view)

## 3.3 Bill of materials

The complete bill of materials (BOM) is available on the download section of the board webpage. A log-in is required to download this material.

**Table 4 BOM of the most important/critical parts of the evaluation or reference board (example)**

| S. No. | Ref designator | Description | Manufacturer | Manufacturer P/N | Populated |
|---|---|---|---|---|---|
| 1 | C15 | CAP CER 10nF 100V X7R 0603 | Murata | GCM188R72A103KA37D | No |
| 2 | L1, L2 | FIXED IND 1uH 10.7A 9.78MOHM SM | Coilcraft | XGL5030-102ME | No |
| 3 | Q1, Q2 | N-Channel 120 V 10A 10.6mohm | Infineon | ISZ106N12LM6 | Yes |
| 4 | R3, R5, R6, R11 | RES 0 OHM JUMPER 1/10W 0603 | Yageo | RC0603JR-070RL | No |
| 5 | R8 | RES 0 OHM JUMPER 1/8W 0805 | Yageo | RC0805JR-070RL | Yes |
| 6 | R10 | RES 10 OHM 1% 1/8W 0805 | Yageo | RC0805FR-0710RL | Yes |
| 7 | R13, R14, R15, R16, R17, R18 | RES 0 OHM JUMPER 1/4W 1206 | Yageo | RC1206JR-070RL | Yes |
| 8 | R25 | RES 0 OHM JUMPER 1/10W 0603 | Yageo | RC0603JR-070RL | Yes |
| 9 | SW1, SW2 | SWITCH SLIDE SPDT 100MA 6V | Nidec Copal Electronics | CJS-1200TB | Yes |
| 10 | U1 | IC REG LINEAR 5 V 50 mA TSON-10 | Infineon Technologies | TLS805B1LDV50XUMA1 | Yes |
| 11 | U2 | Single-channel isolated gate-driver | Infineon Technologies | 1EDB7275FXUMA1 | Yes |
| 12 | U3 | IC REG CHRG PUMP ADJ 250MA 12DFN | Analog Devices Inc | LTC3245EDE#TRPBF | No |

## 3.4 Connector details

**Table 5 Connectors**

| Pin | Label | Function |
|---|---|---|
| $V_{D2}$ | X1 | Drain-2 power input/output |
| $V_{D1}$ | X3 | Drain-1 power input/output |
| PGND | X2 | Power ground |
| VCC and GND | J2 | Non-isolated power supply for gate driver |
| V_ISO and GD_GND | J4 | Isolated power supply for gate driver |
| EN and GND | J5 | Gate enable signal |
| $V_{D1}$, $V_{D2}$, and V_GATE | J3 | GaN BDS daughter card connector |

# 4 System performance

## 4.1 Test points

**Table 6 Test points**

| TP No. | Net | Description |
|---|---|---|
| TP1 | VIN_MIN | Minimum of $V_{D1}$, $V_{D2}$ |
| TP2 | GND | Ground |
| TP3 | PGND | Power ground |
| TP4 | BDS_D2 | GaN BDS drain-2 |
| TP5 | BDS_D1 | GaN BDS drain-1 |
| TP6 | GD_GND | Gate driver isolated ground |
| TP7 | VCC | Non-isolated power supply for gate driver |
| TP8 | V_GATE | Gate driver output |
| TP9 | EN | Gate driver enable signal |
| TP10 | VGD | Isolated power supply for gate driver |

## 4.2 Test results

### 4.2.1 Test setup

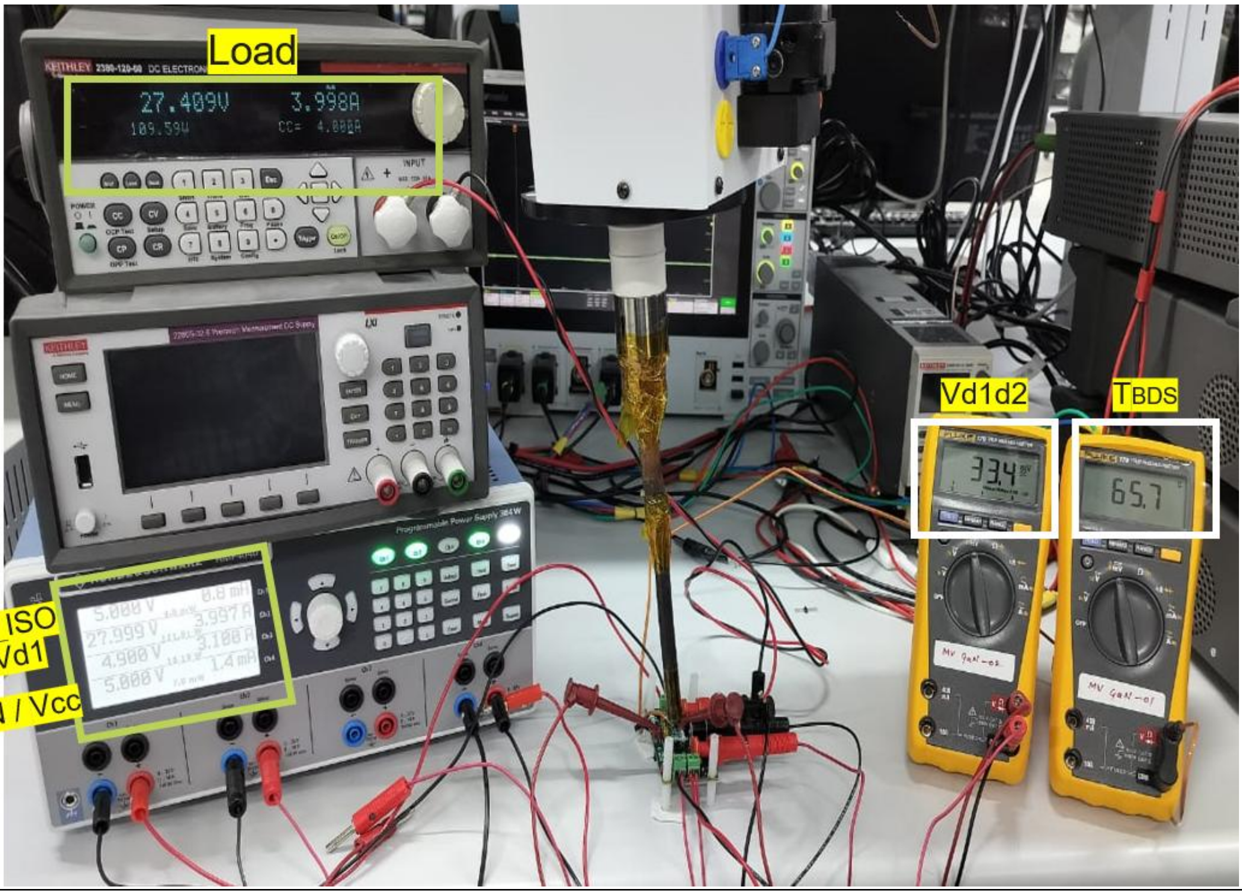



**Figure 10 Test setup**

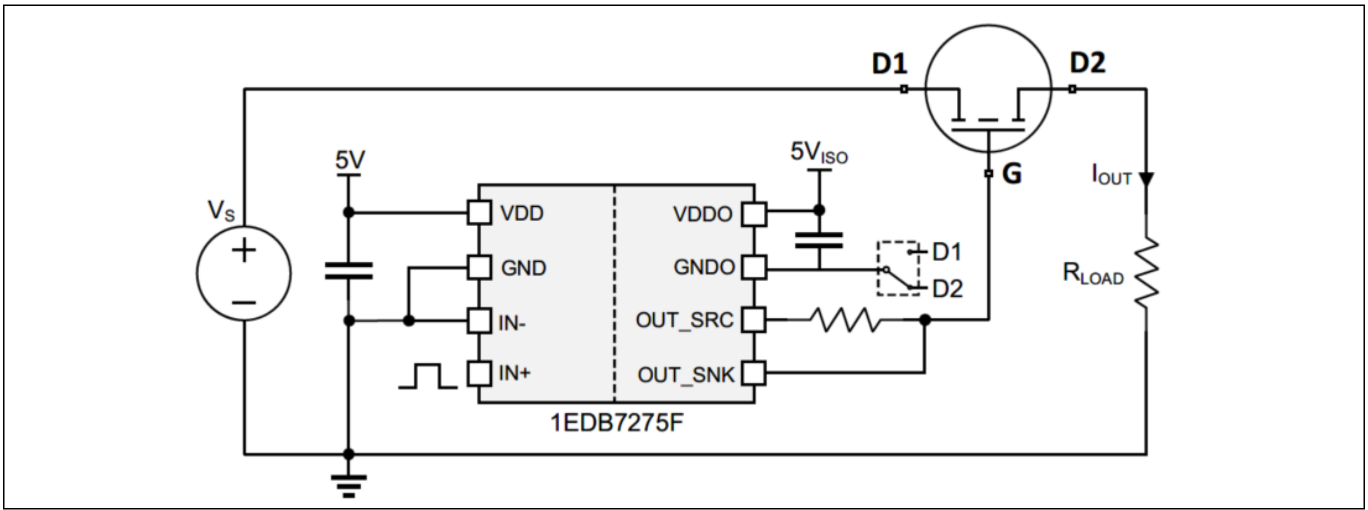



**Figure 11** **GaN BDS as a high-side switch using 1EDB7275F isolated gate driver**

Figure 11 shows high-side operation of the GaN BDS using the 1EDB7275F isolated gate driver from Infineon for unidirectional current flow. The gate reference selector switch allows the gate return path to be connected to either D1 or D2, depending on the intended direction of current flow. The 1EDB7275F gate driver has a UVLO threshold of 4.2 V and therefore, can be powered directly from a 5 V supply.

### 4.2.2 Cyclic turn on/off waveforms

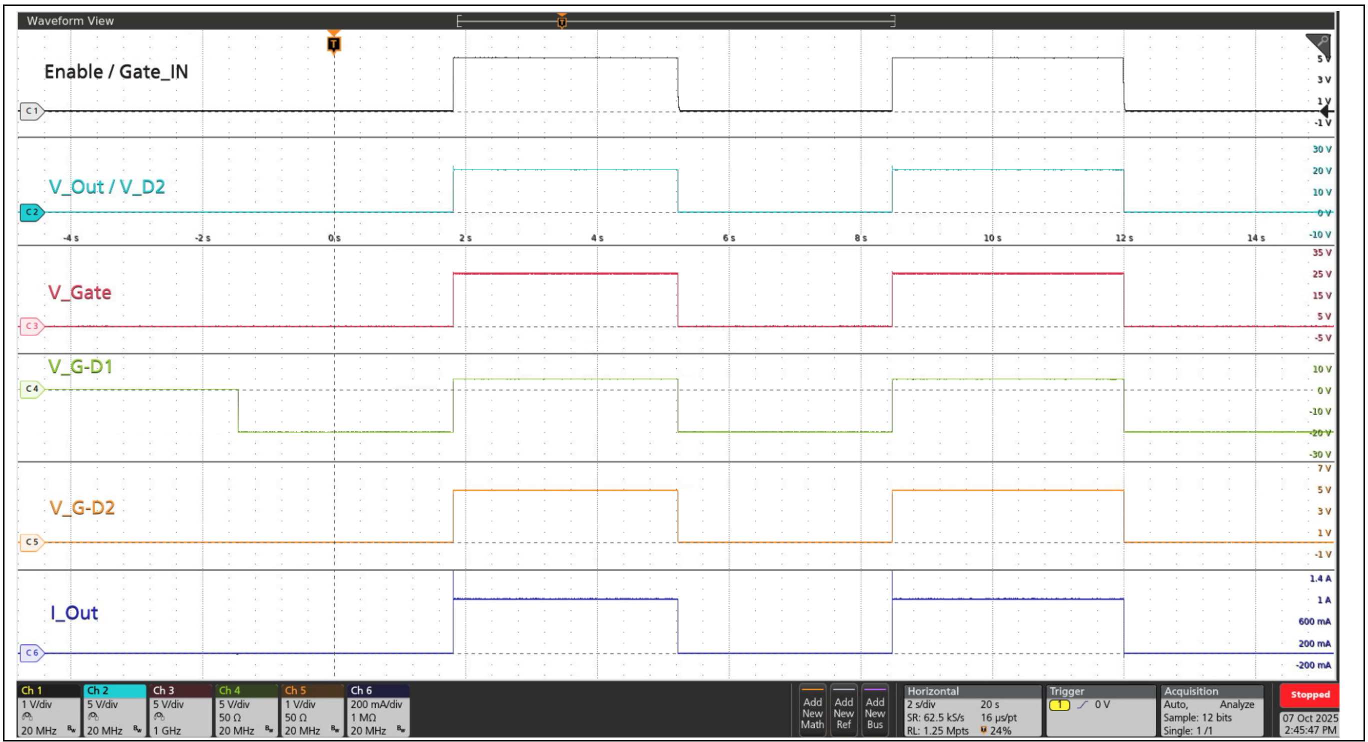



**Figure 12** **Unidirectional current flow and gate reference to D2**

For the circuit in Figure 11 with VS = 20 V and RLoad = 20 Ω, Figure 12 shows the corresponding waveforms when the gate voltage is referenced to D2. When the power supplies (VS and VDD) are on and Enable/IN is inactive, gate voltage $V_G = V_{GD2} = 0$ V, and therefore, $V_{GD1} = -20$ V. Asserting Enable/IN causes $V_{GD2}$ to increase to 5 V ($V_G = 25$ V), thereby turning on the GaN BDS.

For the same circuit, when the gate is referenced to D1, Figure 13 shows the corresponding waveforms. When the power supplies (VS, VDD, and VDDO) are on and Enable/IN is inactive, gate voltage $V_G = V_{GD1} = 20$ V, turns on the GaN BDS and allows current flow from D1 to D2, with a significant voltage drop ($V_{D1D2} \approx 2$ V), similar to diode mode. Asserting enable increases VGD1 to 5 V (VG = 25 V), fully turning on the GaN BDS and decreasing the voltage drop to RON × IOUT.

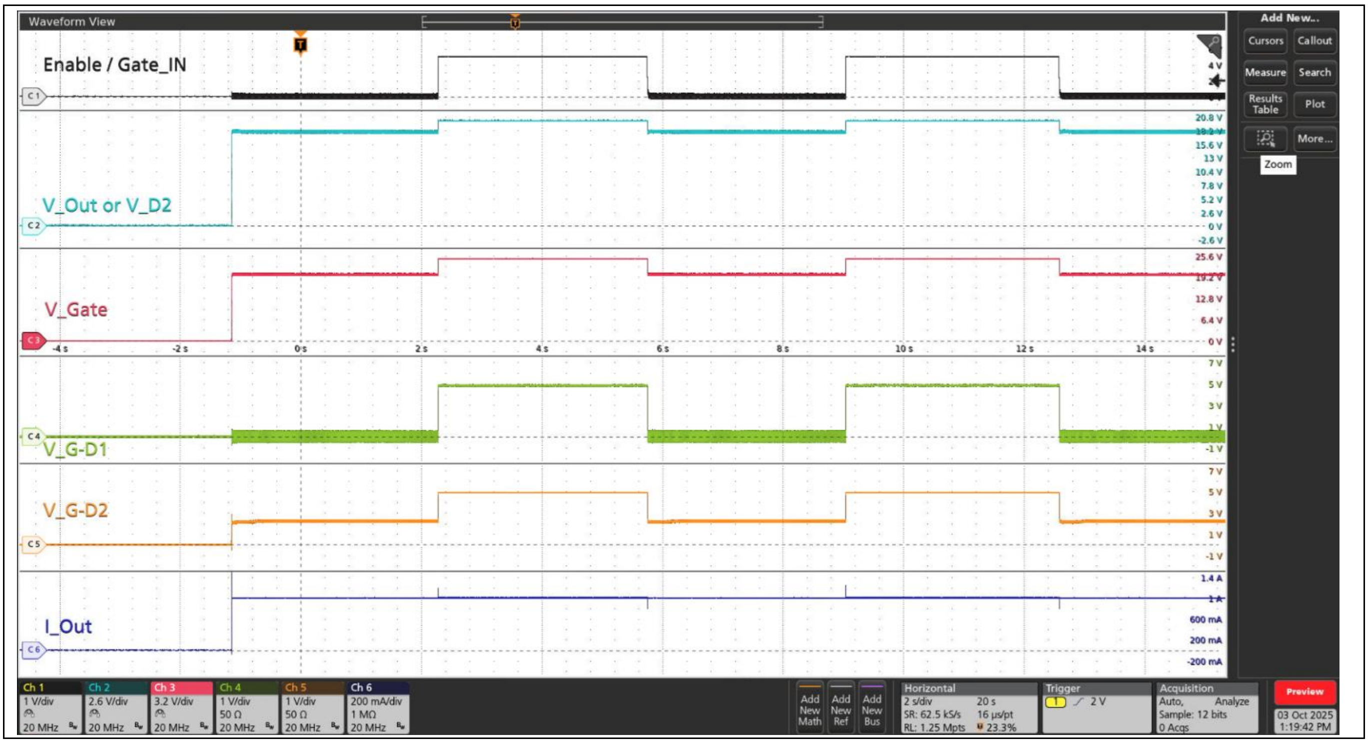



**Figure 13 Unidirectional current flow and gate reference to D1**

### 4.2.3 Startup behavior with IGK080B041S BDS

#### 4.2.3.1 Without RC delay on gate driver path

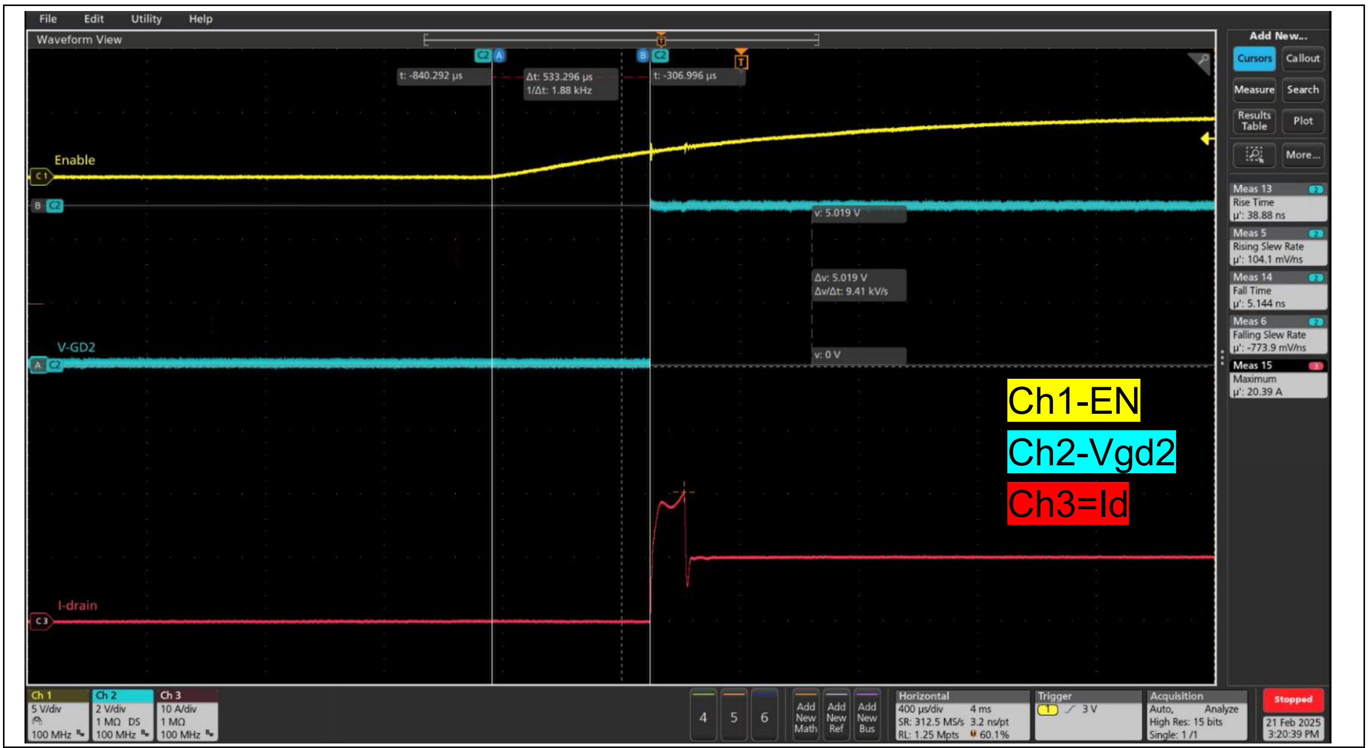



Figure 14 Turn on - $V_{D1}$ = 5 V, Id = 10 A (load), EN = 0 V to 5 V, Vgd2 = 0 V to 5 V, Id_max = 20.39 A

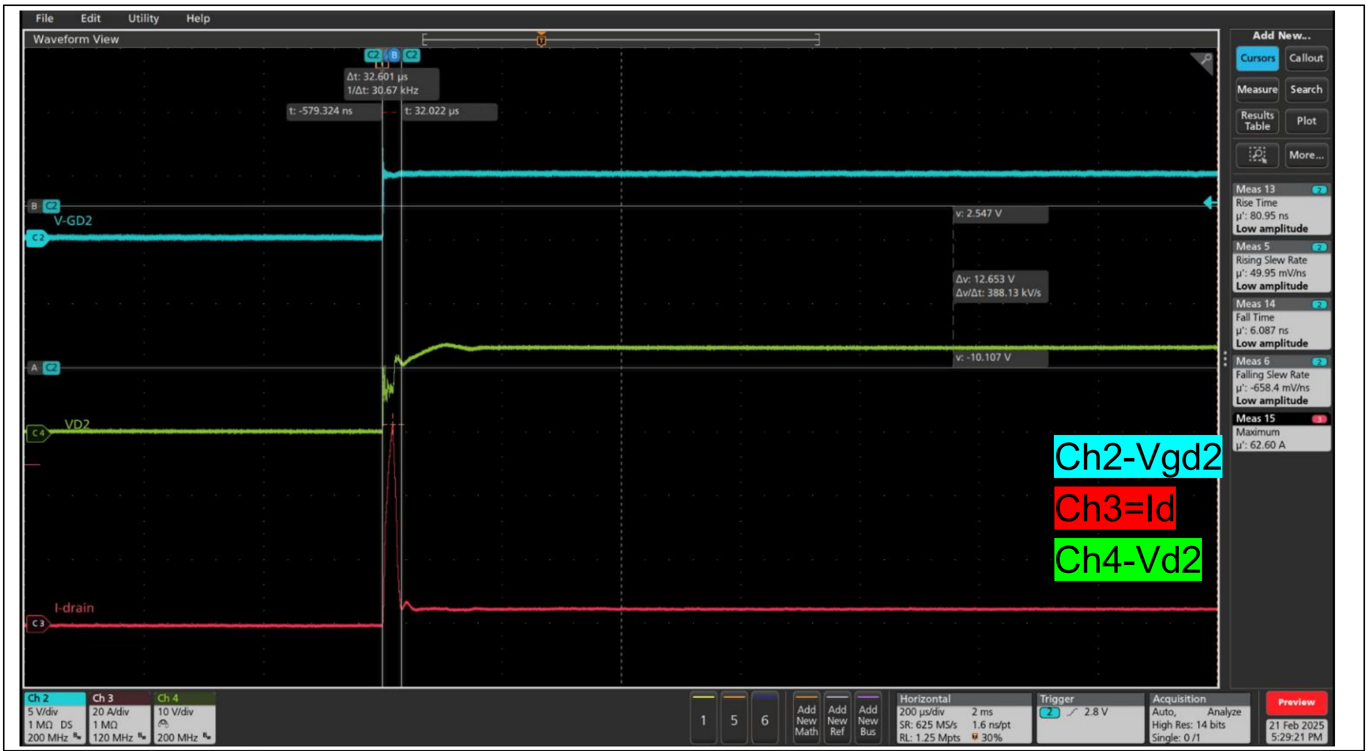



Figure 15 Turn on - $V_{D1}$ = 20 V, Id = 5 A (load), EN = 0 V to 5 V, Vgd2 = 0 V to 5 V, Id_max = 62.6 A, t_Imax = 32.6 µs

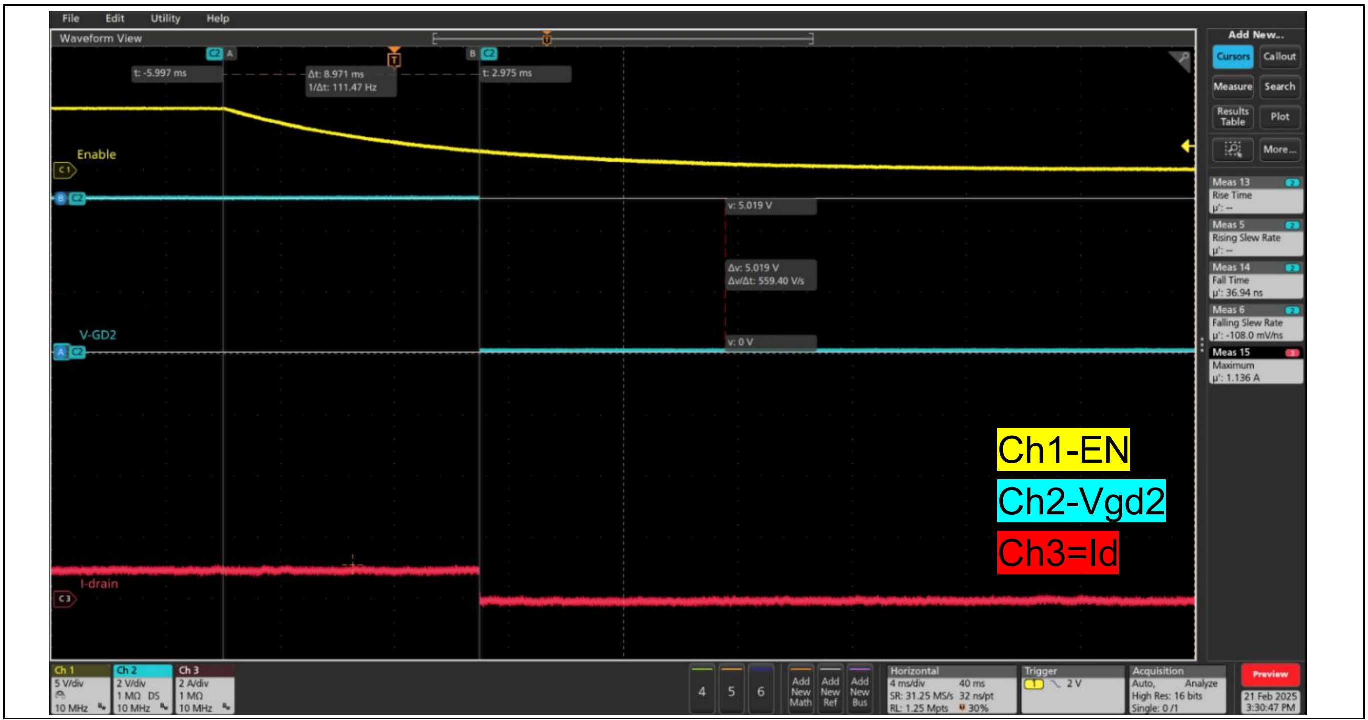



**Figure 16** Turn off - $V_{D1}$ = 5 V, Id = 1 A (load), EN = 5 V to 0 V, Vgd2 = 5 V to 0 V, t_off = 8.97 ms

As the isolated gate driver voltage is supplied externally, turn-on is fast with negligible delay. However, rapid turn-on can cause large inrush currents, which can damage the BDS if not controlled. Using an RC delay circuit between the gate and the BDS can help mitigate this issue.

### 4.2.3.2 With RC delay on gate driver path (R10 = 1 kΩ, C15 = 100 nF)

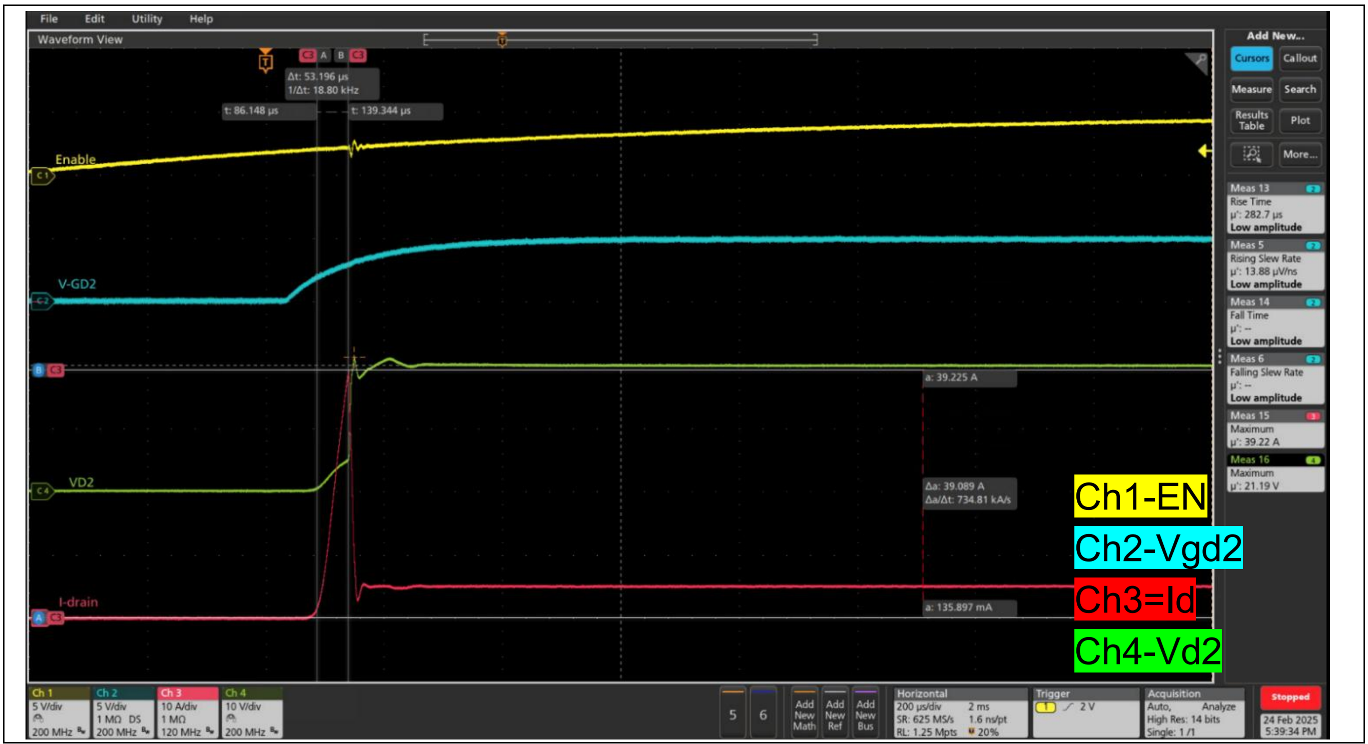



**Figure 17** Turn on - $V_{D1}$ = 20 V, Id = 5A (load), EN = 0 V to 5 V, Vgd2 = 0 V to 5 V, Id_max = 39.22 A, dI/dt = 0.735 A/µs (R10 = 1 kΩ, C15 = 100 nF)

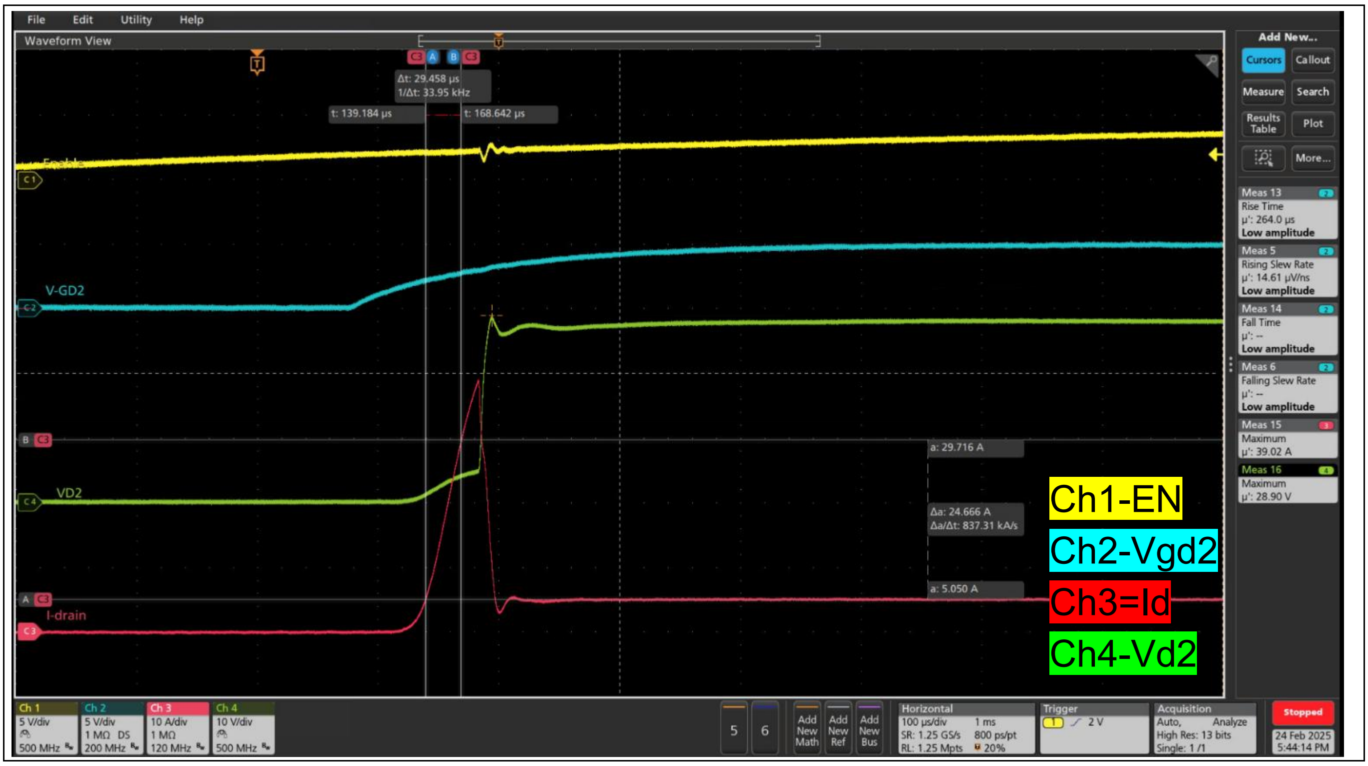



**Figure 18** Turn on - $V_{D1}$ =28 V, Id = 5 A (load), EN = 0 V to 5 V, Vgd2 = 0 V to 5 V, Id_max = 39.02 A, dI/dt = 0.837 A/µs (R10 = 1 kΩ, C15 = 100 nF)

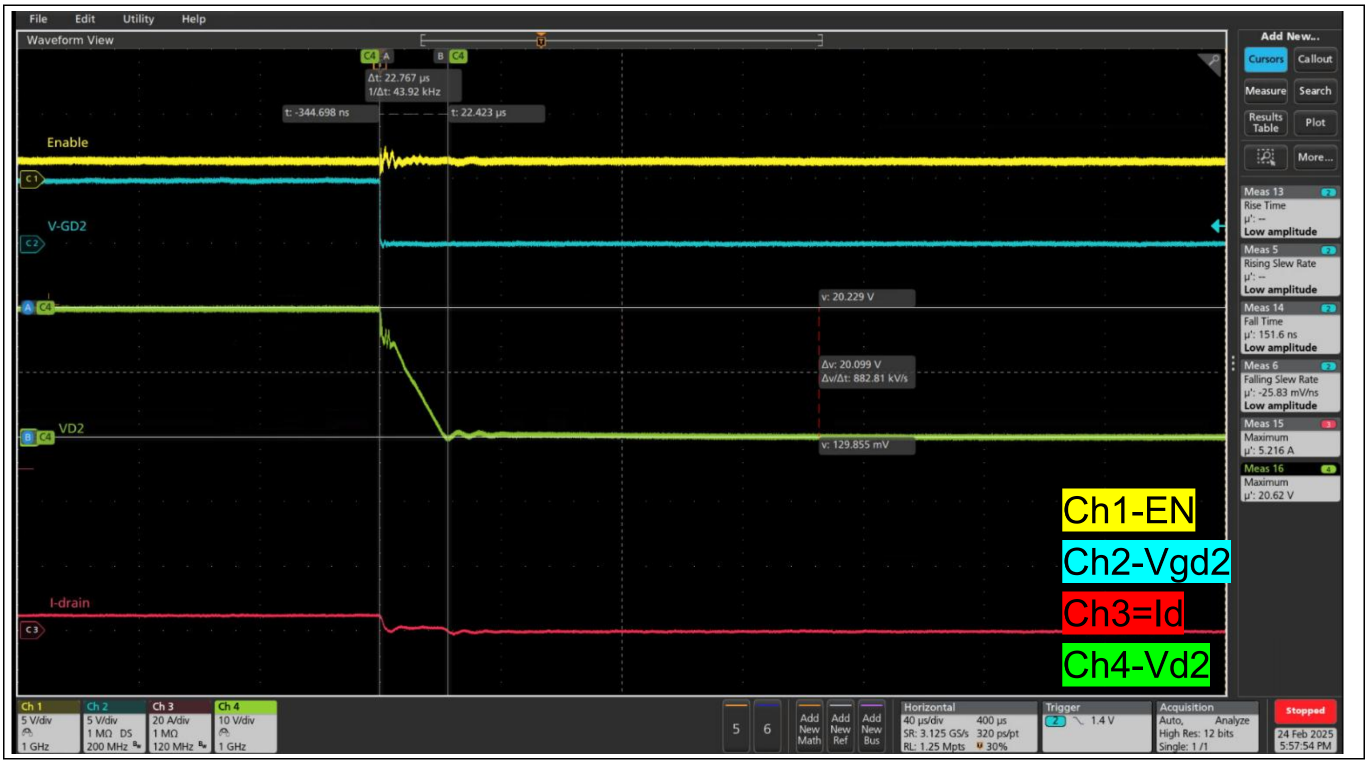



**Figure 19** Turn off – $V_{D1}$ =20 V, Id = 5 A (load), EN = 5 V to 0 V, Vgd2 = 5 V to 0 V, t_Vd2_off = 22.7 µs (R10 = 1 kΩ, C15 = 100 nF)

### 4.2.4 Ron measurements

#### 4.2.4.1 BDS – IGK080B041S (40 V, 6 mΩ)

**Table 7 Measurement results - $R_{on}$, Tc vs. Id at $V_{D1}$ = 5 V and varying ambient temperature**

| $V_{D1}$ = 5 V, $V_{GD2}$ = 5 V | $T_{amb}$ = 25°C | | $T_{amb}$ = 65°C | | $T_{amb}$ = 85°C | |
|---|---|---|---|---|---|---|
| $I_{Drain}$ | $R_{on}$ | $Tc_{BDS}$ | $R_{on}$ | $Tc_{BDS}$ | $R_{on}$ | $Tc_{BDS}$ |
| 1 A | 6.1 mΩ | 25.1°C | 7.9 mΩ | 65.0°C | 8.8 mΩ | 85.2°C |
| 2 A | 6.2 mΩ | 25.2°C | 8.0 mΩ | 65.2°C | 8.9 mΩ | 85.6°C |
| 3 A | 6.3 mΩ | 25.4°C | 8.0 mΩ | 65.4°C | 9.0 mΩ | 85.8°C |
| 4 A | 6.4 mΩ | 25.6°C | 8.1 mΩ | 65.8°C | 9.2 mΩ | 86.5°C |
| 5 A | 6.5 mΩ | 26.0°C | 8.2 mΩ | 66.2°C | 9.4 mΩ | 86.7°C |
| 6 A | 6.6 mΩ | 26.4°C | 8.7 mΩ | 67.1°C | 10.0 mΩ | 87.2°C |
| 7 A | 6.8 mΩ | 27.1°C | 8.9 mΩ | 67.8°C | 10.4 mΩ | 87.9°C |
| 8 A | 7.1 mΩ | 27.8°C | 9.3 mΩ | 68.7°C | 10.9 mΩ | 88.9°C |
| 9 A | 7.4 mΩ | 28.8°C | 9.8 mΩ | 69.8°C | 11.5 mΩ | 90.0°C |
| 10 A | 7.8 mΩ | 29.9°C | 10.4 mΩ | 71.2°C | 12.1 mΩ | 91.4°C |

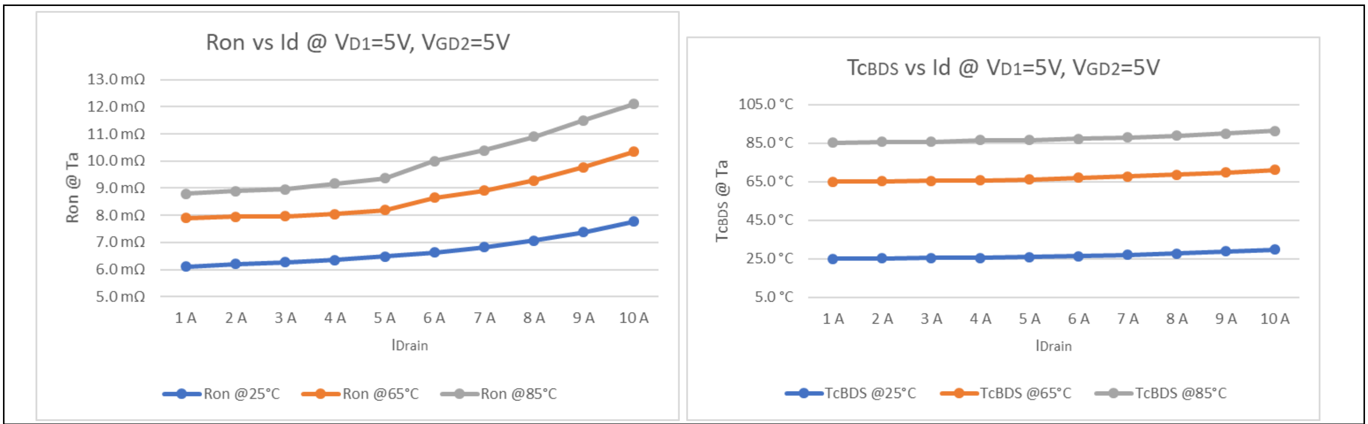



**Figure 20 BDS $R_{on}$ and case temperature (Tc) variation with respect to drain current (Id) at $V_{D1}$ = 5 V**

**Table 8 Measurement results - $R_{on}$, Tc vs. Id at $V_{D1}$ = 28 V and varying ambient temperature**

| $V_{D1}$ = 28 V, $V_{GD2}$ = 5 V | $T_{amb}$ = 25°C | | $T_{amb}$ = 65°C | | $T_{amb}$ = 85°C | |
|---|---|---|---|---|---|---|
| $I_{Drain}$ | $R_{on}$ | $Tc_{BDS}$ | $R_{on}$ | $Tc_{BDS}$ | $R_{on}$ | $Tc_{BDS}$ |
| 1 A | 6.4 mΩ | 25.0°C | 7.7 mΩ | 65.1°C | 8.9 mΩ | 85.2°C |
| 2 A | 6.6 mΩ | 25.1°C | 8.1 mΩ | 65.2°C | 9.0 mΩ | 85.4°C |
| 3 A | 6.7 mΩ | 25.3°C | 8.2 mΩ | 65.4°C | 9.1 mΩ | 85.7°C |
| 4 A | 6.8 mΩ | 25.6°C | 8.4 mΩ | 65.7°C | 9.2 mΩ | 86.3°C |
| 5 A | 6.9 mΩ | 26.2°C | 8.4 mΩ | 66.5°C | 9.5 mΩ | 87.0°C |

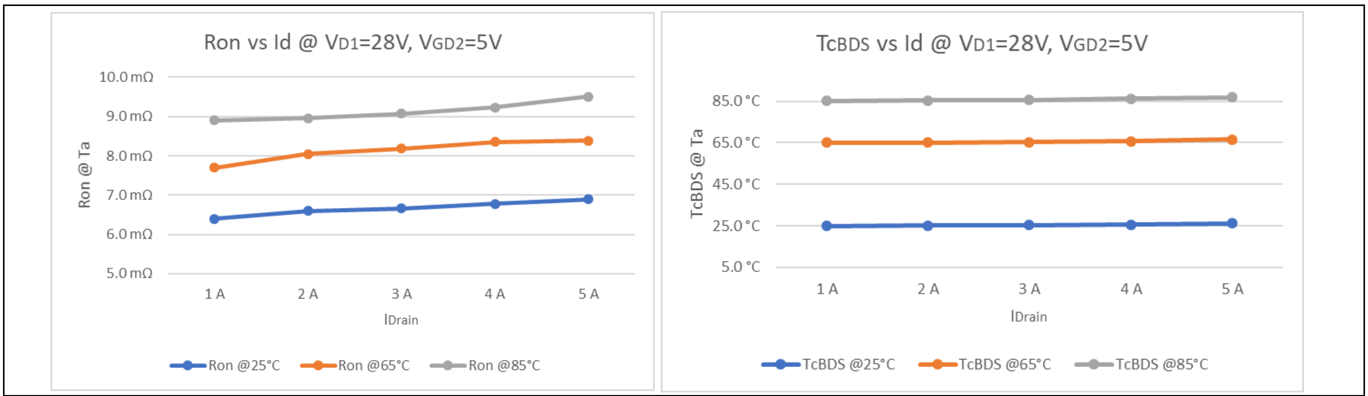



**Figure 21** BDS $R_{on}$ and case temperature (Tc) variation with respect to drain current (Id) at $V_{D1}$ = 28 V

Following are some insights from the above measurements:

- $R_{on}$ increases with both drain current and ambient temperature in all cases (similar to a typical MOSFET behavior)
- $V_{D1}$ impact (5 V vs. 28 V at $V_{GD2}$ = 5 V) is small: $R_{on}$ is slightly higher at 28 V at 25°C (e.g., ~+0.3 mΩ at 1 A and ~+0.4 mΩ at 5 A), while at 65°C to 85°C the differences are minor/mixed
- $Tc_{BDS}$ closely tracks $T_{amb}$ and increases only slightly with higher current (generally within a few °C above ambient), indicating limited self-heating over these test points. The device temperatures are measured using thermocouples placed on the device case

### 4.2.4.2 BDS – IGK048B041S (40 V, 4 mΩ)

**Table 9** Measurement results - $R_{on}$, Tc vs. Id at $V_{D1}$ = 20 V and varying ambient temperature

| $V_{D1}$ = 20 V, $V_{GD2}$ = 5 V | $T_{amb}$ = 25°C | | $T_{amb}$ = 85°C | |
|---|---|---|---|---|
| $I_{Drain}$ | $R_{on}$ | $Tc_{BDS}$ | $R_{on}$ | $Tc_{BDS}$ |
| 0.1 A | 5.0 mΩ | 25.0°C | 7.0 mΩ | 85.0 °C |
| 1 A | 5.0 mΩ | 25.1°C | 7.1 mΩ | 85.1 °C |
| 2 A | 5.0 mΩ | 25.1°C | 7.2 mΩ | 85.4 °C |
| 3 A | 5.0 mΩ | 25.3°C | 7.2 mΩ | 85.7°C |
| 4 A | 5.1 mΩ | 25.5°C | 7.2 mΩ | 86.2°C |
| 5 A | 5.1 mΩ | 25.8°C | 7.3 mΩ | 86.5°C |
| 6 A | 5.1 mΩ | 26.2°C | 7.4 mΩ | 87.1°C |
| 7 A | 5.2 mΩ | 26.7°C | 7.5 mΩ | 87.6°C |
| 8 A | 5.3 mΩ | 27.4°C | 7.7 mΩ | 88.7°C |
| 9 A | 5.4 mΩ | 28.2°C | 7.9 mΩ | 89.8°C |
| 10 A | 5.4 mΩ | 29.3°C | 8.3 mΩ | 91.1°C |

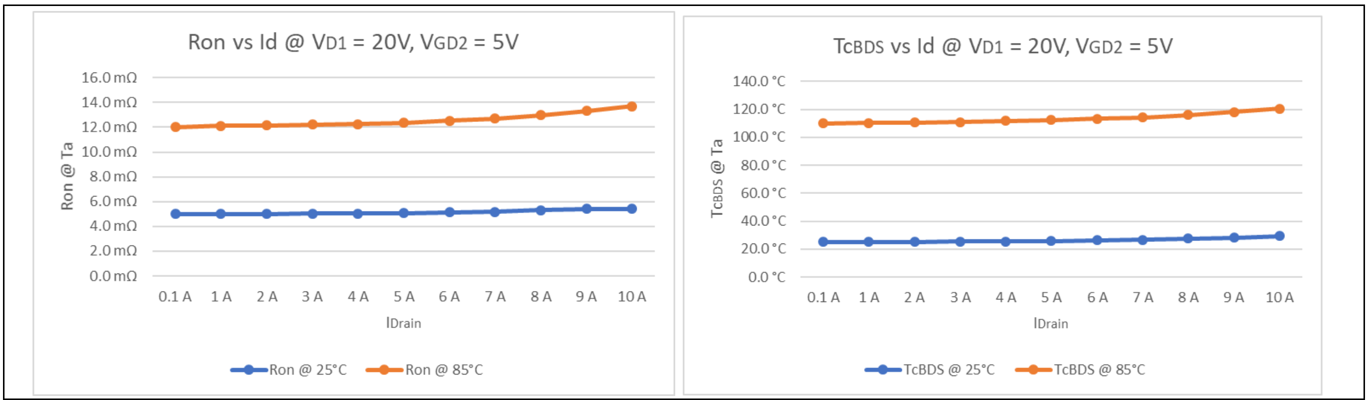



**Figure 22 BDS $R_{on}$ and case temperature (Tc) variation with respect to drain current (Id) at $V_{D1}$ = 20 V**

Following are some insights from the above measurements:

- $R_{on}$ is low and very stable vs. current, especially at 25°C:
  - 25°C: Essentially flat at 5.0 mΩ up to ~3 A, only rising to 5.4 mΩ at 10 A (~+8% from 1 A)
  - 85°C: Increases gently from 7.0 mΩ to 8.3 mΩ from 0.1 A to10 A (~+19%)
- Temperature drives $R_{on}$ more than current does:
  - At low current (0.1 A): 5.0 mΩ to 7.0 mΩ going 25°C to 85°C (+40%)
  - At 10 A: 5.4 mΩ to 8.3 mΩ (+54%)
    So, the temperature coefficient is positive and its apparent impact grows a bit at higher current (because of added self-heating)
- $Tc_{BDS}$ shows modest self-heating with increasing $I_{Drain}$:
  - At 25°C ambient: 25.0°C to 29.3°C (≈4.3°C) by 10 A
  - At 85°C ambient: 85.0°C to 91.1°C (≈6.1°C) by 10 A
    This indicates the setup/device is dissipating more power at higher current, but the thermal rise remains moderate
- The device behaves like a well-enhanced switch (low, mostly current-independent $R_{on}$), with **ambient temperature being the dominant factor** in conduction loss, and only mild additional heating up to 10 A

### 4.2.4.3 BDS – IGK120B041S (40 V, 9 mΩ)

**Table 10 Measurement results - $R_{on}$, Tc vs. Id at $V_{D1}$ = 20 V and varying ambient temperature**

| $V_{D1}$ = 20 V, $V_{GD2}$ = 5 V | $T_{amb}$ = 25°C | | $T_{amb}$= 85°C | |
|---|---|---|---|---|
| $I_{Drain}$ | $R_{on}$ | $Tc_{BDS}$ | $R_{on}$ | $Tc_{BDS}$ |
| 0.1 A | 10.0 mΩ | 25.0°C | 15.0 mΩ | 85.0°C |
| 1 A | 9.8 mΩ | 25.2°C | 15.1 mΩ | 85.3°C |
| 2 A | 9.9 mΩ | 25.4°C | 15.2 mΩ | 85.8°C |
| 3 A | 10.1 mΩ | 25.6°C | 15.4 mΩ | 86.0°C |
| 4 A | 10.3 mΩ | 25.8°C | 15.9 mΩ | 86.9°C |
| 5 A | 10.7 mΩ | 26.1°C | 16.6 mΩ | 87.3°C |
| 6 A | 11.2 mΩ | 26.5°C | 17.7 mΩ | 87.9°C |
| 7 A | 11.9 mΩ | 27.4°C | 19.3 mΩ | 89.1°C |
| 8 A | 12.6 mΩ | 28.1°C | 21.8 mΩ | 90.2°C |

| $V_{D1}$ = 20 V, $V_{GD2}$ = 5 V | $T_{amb}$ = 25°C | | $T_{amb}$= 85°C | |
|---|---|---|---|---|
| **$I_{Drain}$** | **$R_{on}$** | **$Tc_{BDS}$** | **$R_{on}$** | **$Tc_{BDS}$** |
| 9 A | 13.5 mΩ | 29.5°C | 23.9 mΩ | 91.5°C |
| 10 A | 14.4 mΩ | 30.8°C | 25.6 mΩ | 92.8°C |

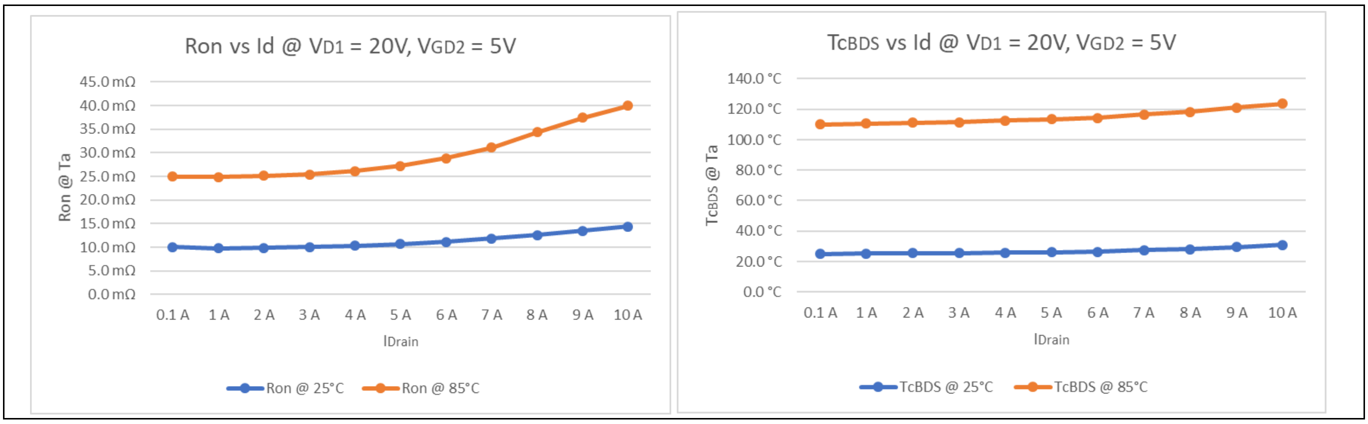



**Figure 23 BDS $R_{on}$ and case temperature (Tc) variation with respect to drain current (Id) at $V_{D1}$ = 20 V**

Following are some insights from the above measurements:

- $R_{on}$ is strongly temperature-dependent: At each current point, $R_{on}$ at 85°C is ~1.5 to 1.8 × higher than at 25°C
- Ron increases with $I_{Drain}$ (load/self-heating effects):
  - 25°C: $R_{on}$ is fairly flat up to ~3 A to 4A (≈9.8 mΩ to 10.3 mΩ), then rises to 14.4 mΩ at 10 A (~+47% from 1 A)
  - 85°C: $R_{on}$ rises more steeply with current, 15.0 mΩ at 0.1 A to 25.6 mΩ at 10A (~+71%), indicating stronger thermal/operating-point sensitivity at high ambient
- $Tc_{BDS}$ tracks ambient with modest self-heating:
  - At 25°C ambient, $Tc_{BDS}$ increases 25.0°C to 30.8°C from 0.1 A to 10 A (≈5.8°C rise)
  - At 85°C ambient, $Tc_{BDS}$ increases 85.0°C to 92.8°C (≈7.8°C rise)
    This suggests the device is not undergoing extreme heating in this setup, but the extra junction/case rise at higher current correlates with the $R_{on}$ increase
- For higher-current operation, both ambient temperature and load current noticeably raise $R_{on}$ (therefore, conduction loss). The “knee” where $R_{on}$ starts rising faster is around 5 A to 6 A, especially at 85°C

# 5 Summary

This user guide provides the implementation and results for the gate driver evaluation board of the GaN bidirectional switch. The evaluation board enables you to choose the gate return path and according to the direction of current flow. The board also provides a minimum bus selector network, which can be used to drive the device in bidirectional mode without any change in the gate refence path. But the circuit comes with a certain voltage drop, which reduces the gate voltage and therefore, can increase the on-state resistance.

The board demonstrates the on-state resistance and device temperature variations with respect to the increasing drain current. Additionally, it also provides option to delay the Gate drain voltage supplied to the GaN BDS switch to reduce the inrush current.

# 6 Related resources

- Gallium nitride (GaN) webpage
- EVAL_GD_BDS_GaN Evaluation Board
- Infineon Developer Community: GaN forum

## References

[1] Infineon Technologies AG. Datasheet (2026): *IGK080B041S*. V1.1; Available online

[2] Infineon Technologies AG. Datasheet (2026): *IGK048B041S*. V1.0; Available online

[3] Infineon Technologies AG. Datasheet (2026): *IGK120B041S*. V1.0; Available online

[4] Infineon Technologies AG. Datasheet: *EiceDRIVER™ 1EDB7275F*. V2.2; Available online

[5] Infineon Technologies AG. Datasheet: *TLS805B1LDV50*. V1.11; Available online

[6] Infineon Technologies AG. Datasheet. *OptiMOS™ 6 Power-Transistor, 120 V ISZ106N12LM6*. V2.0; Available online

[7] Infineon Technologies AG. Whitepaper: *Gate driving techniques for medium voltage GaN bidirectional switches*; Available online

[8] IEEE. *Gate driving techniques for medium voltage GaN bidirectional switch*; Available online

[9] Analog Devices. Datasheet: *LTC3245*. C; Available online

# Abbreviations

**Table 11 Abbreviations**

| Abbreviation | Expansion |
|---|---|
| BDS | Bidirectional switch |
| EN | Enable |
| EVAL | Evaluation |
| GaN | Gallium nitride |
| GD | Gate driver |
| PCB | Printed circuit board |

# Revision history

| Document revision | Date | Description of changes |
|---|---|---|
| V 1.0 | 2026-06-01 | Initial release |

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Customer shall not touch the Evaluation Board after disconnecting the power supply, several components may still store electrical voltage and can discharge through physical contact. Several parts, like heat sinks and transformers, may still be very hot. Allow the components to cool before touching or servicing.
The electrical installation must be completed in accordance with the appropriate safety requirements.