LEB-0022
IX3407B Gate Driver Evaluation Board

Introduction

The Littelfuse IX3407B is a galvanically isolated, single-channel gate driver that provides separate source and sink outputs capable of 7 A peak current. Isolation is provided by an integrated capacitive coupling technology. The driver features an undervoltage lockout (UVLO) circuitry including active shutdown that turns off the power transistor in the event of a driver secondary side supply loss.

The purpose of this user manual is to demonstrate the design and use of the Littelfuse IX3407B gate driver evaluation board as displayed in Figure 1. Equipped with signal and power isolation, the board allows for driver evaluation under laboratory test conditions.

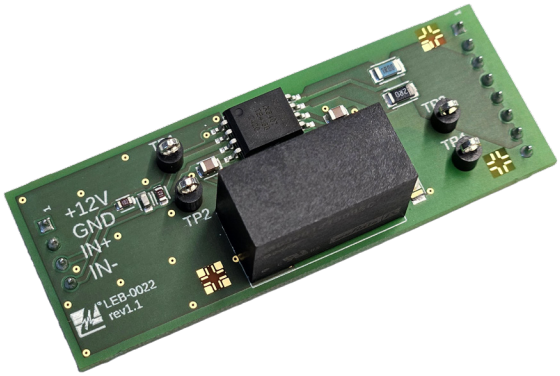

Figure 1. IX3407B gate driver evaluation board

The evaluation board is part of the Littelfuse gate driver evaluation platform for testing gate drivers with various power semiconductors. Pin headers enable easy integration into existing test setups. Additionally, the platform contains different mainboards, that allow immediate testing and comparison of Littelfuse gate drivers with various power semiconductors. All parts are available from Littelfuse upon request.

Features

Device IX3407B:

- Separate 7 A peak source/sink outputs
- Wide operating voltage range on input and output side
- 2500 V_{RMS} input to output isolation
- Common Mode Transient Immunity (CMTI): 150 V/ns
- 12 V undervoltage lockout (UVLO)
- Differential input
- Temperature range -40…125 °C

Evaluation Board:

- Single primary side 12 V power supply
- Isolated DC-DC converter with +15/-9 V output voltage
- Defined creepage of 5.5 mm between primary and secondary circuit

Target Audience

This application note is intended for engineers working on power electronics hardware design and investigating optimal driver solutions for their applications.

Contact Information

For more information on the evaluation board and application support, contact the Littelfuse Power Semiconductor team of product and applications experts: PowerSemiSupport@Littelfuse.com

Revised: TK.04/30/2025

Important Notes

Disclaimer Notice: The Customer (individually or, if you are acting on behalf of a company, the company) agrees to use the Evaluation Board solely for this purpose and subject to the terms of this Notice.

The design of the Evaluation Board has been tested by Littelfuse only as described in this document. The design is not qualified in terms of safety requirements, manufacturing, and operation over the entire operating temperature range or lifetime.

The Evaluation Board is an engineering tool intended solely for laboratory use by qualified and experienced electrical engineers to evaluate the performance of Littelfuse power semiconductors and integrated circuit products according to the terms and conditions set forth in this document or other related documents supplied with the respective Evaluation Board. The Evaluation Board should not be used at all or as part of a finished product.

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1. Overview

The block diagram of the evaluation board is displayed in Figure 2. It contains an isolated DC-DC Converter MGJ2D121509SC from Murata Power Solutions (U2) providing isolated +15/-9 V gate driver supply on the secondary side. The IX3407B driver (U1) is supplied directly via 12 V on the primary side. This minimizes the complexity of the driver board. The IX3407B gate driver delivers sink and source output currents of up to 7 A to the semiconductor's gate.

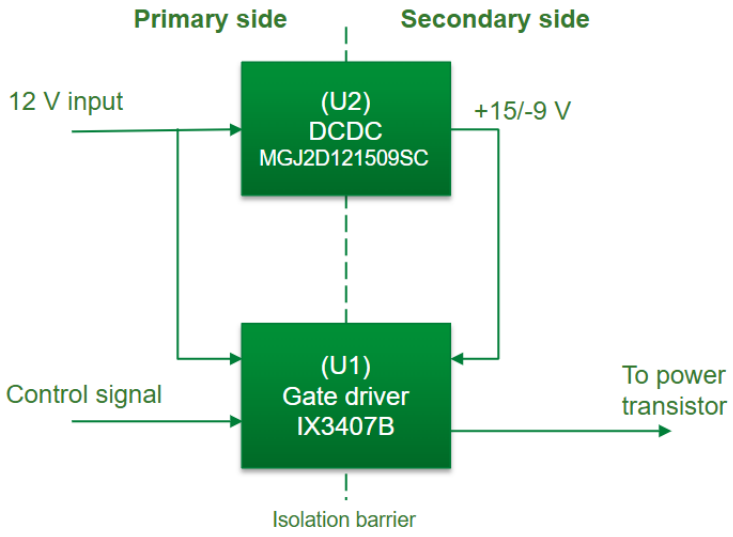

Figure 2. IX3407B evaluation board block diagram

Table 1 contains the operating conditions of the evaluation board.

Table 1. Operating conditions of the IX3407B evaluation board

Symbol	Parameter	Value			Unit
		Min.	Typ.	Max.	
V_{CC}	Board supply voltage	11	12	13	V
$V_{Control}$	Control signal input voltage	0	–	13	V
V_{IH}	Control input high signal threshold voltage	–	2	–	V
V_{IL}	Control input low signal threshold voltage	–	0.8	–	V
I_{OUTSRC}, I_{OUTSNK}	Output peak current	–	–	±7	A
dv/dt	Voltage change rate output to input	–	–	150	V/ns
d_{Creep}	Creepage distance primary to secondary side	–	5.5	–	mm
d_{Creep}	Clearance distance primary to secondary side	–	5.5	–	mm
T_{AMB}	Operation ambient temperature	0	25	50	°C

2. Pin Assignments

Table 2 lists the electrical connections of the evaluation board. A 4-terminal pin header is used to connect the PCB on the primary side. The evaluation board on the secondary side is connected via an 8-terminal pin header. Additionally, four test points are available to record driver signals during operation.

Table 2. Pin assignments of the IX3407B evaluation board

Connector Name	Pin Number	Pin Name	Description
X1	01	+12 V	Positive 12 V supply primary side
X1	02	GND	Primary side reference
X1	03	IN_+	IX3407B positive input signal
X1	04	IN_-	IX3407B negative input signal
X2	01	RES	Reserved pin
X2	02	VEE_HV	Gate-loop return path
X2	03	OUT_GATE	Gate output
X2	04	VEE_HV	Gate-loop return path
X2	05	OUT_GATE	Gate output
X2	06	VEE_HV	Gate-loop return path
X2	07	OUT_GATE	Gate output
X2	08	RES	Reserved pin
–	–	TP1	IX3407B positive input test point
–	–	TP2	IX3407B negative input test point
–	–	TP3	Gate connection test point
–	–	TP4	Gate-loop return path test point

3. Schematics

Figure 3 illustrates the schematic of the IX3407B evaluation board. The upper part of the circuit shows the isolated power supply of the board. The MGJ2D121509SC DC-DC converter provides isolated driver supply of +15/-9 V. If a unipolar supply is needed, for example to drive silicon MOSFETs, the resistor R2 can be removed and a 0 Ω jumper R1 must be added. LED1 indicates the presence of the +15 V gate driver supply voltage.

The lower part of the schematic displays the IX3407B driver stage. A low-pass filter is connected to the input side of the signal isolator. Depending on the power semiconductor in use and the required gate current, the gate resistors for turn-on and turn-off (R7, R9) must be adjusted. Test points on the PCB enable measurement of driver inputs and outputs.

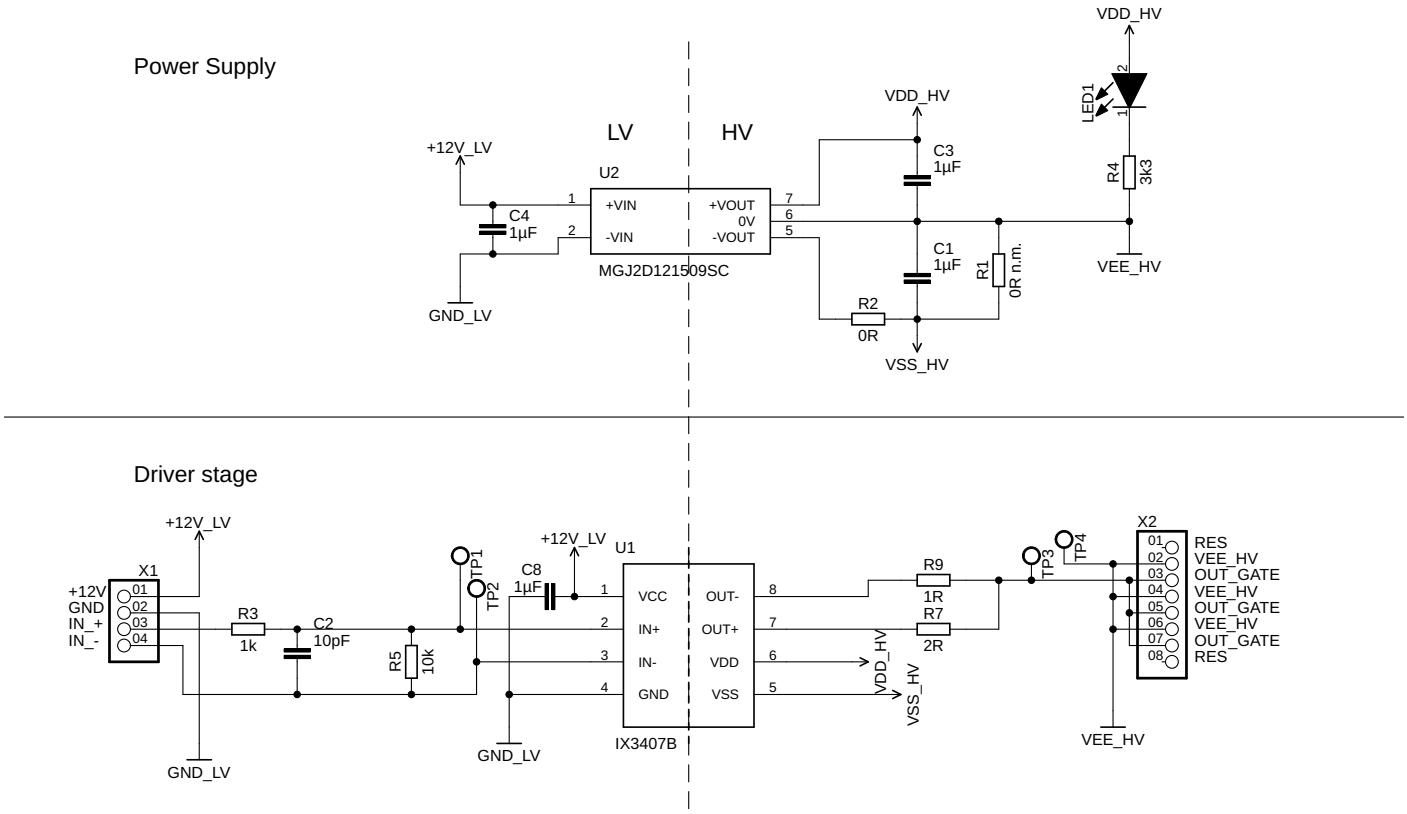

Figure 3. IX3407B evaluation board schematics

4. Bill of Materials

Table 3 lists all the components used on the evaluation board.

Table 3. Bill of materials for the IX3407B evaluation board

Item	Quantity	Reference	Value	Description	Manufacturer	MPN
1	4	C1, C3, C4, C8	1 µF	Cap 1 µF 50 V 10 % X7R 0805	-generic-	–
2	1	C2	10 pF	Cap 10 pF 25 V 10 % C0G 0603	-generic-	–
3	2	R1, R2	0 Ω	Resistor 0 Ω	-generic-	–
4	1	R3	1 kΩ	Res 1 kΩ 10 % 0603	-generic-	–
5	1	R4	3.3 kΩ	Res 3.3 kΩ 10 % 0805	-generic-	–
6	1	R5	10 kΩ	Res 10 kΩ 10 % 0603	-generic-	–
7	1	R7	2 Ω	Res 2 Ω 1 % 1206	-generic-	–
8	1	R9	1 Ω	Res 1 Ω 1 % 1206	-generic-	–
9	1	LED1	–	LED green 1206	Würth Elektronik	156120GS75300
10	1	U1	–	Single-Channel, Isolated IGBT Gate Driver with Separate Outputs	Littelfuse	IX3407B
11	1	U2	–	Isolated DC-DC 12 V to +15/-9 V	Murata Power Solutions	MGJ2D121509SC
12	1	X1	–	Pin header 0.1" pitch 4-pin	Samtec	HTSW-104-05-G-S
13	1	X2	–	Pin header 0.1" pitch 8-pin	Samtec	HTSW-108-05-G-S
14	4	TP1, TP2, TP3, TP4	–	Testpoint THT	Keystone	5006

5. Isolation Ratings

The isolation between the primary and secondary sides of the circuit is provided by the IX3407B Gate driver U1 and the DC-DC converter U2. The isolated IX3407B gate driver provides a withstand voltage of up to 2500 V_{RMS} with an exceptionally low coupling capacitance of 0.7 pF. The DC-DC converter is rated with high voltage insulation of up to 5200 V_{DC} with an input to output capacitance of 3 pF. For further details on insulation capability of the devices, please consult the datasheets of the MGJ2D121509SC DC-DC converter and the IX3407B gate driver respectively.

The creepage and clearance distances on the PCB between the primary- and secondary-side are 5.5 mm.

6. PCB Layout

Figures 4 to 7 display the four copper layers of the PCB.

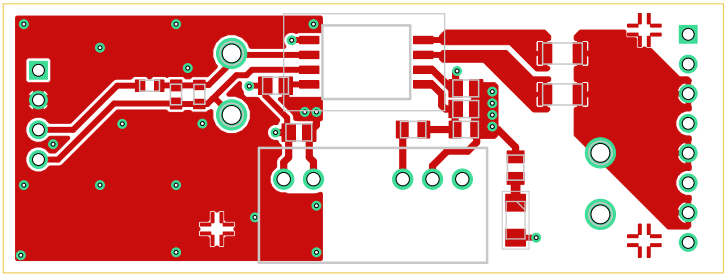

Figure 4. PCB top layer

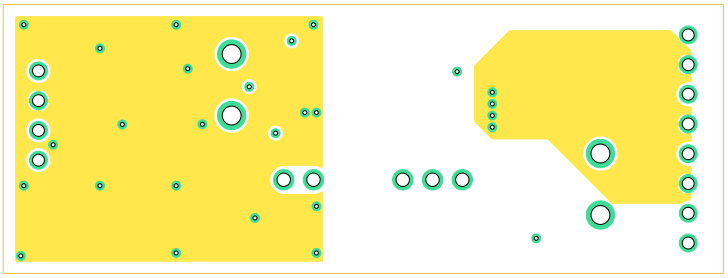

Figure 5. PCB layer 2

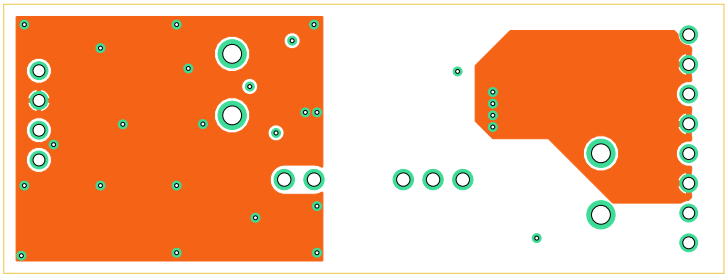

Figure 6. PCB layer 3

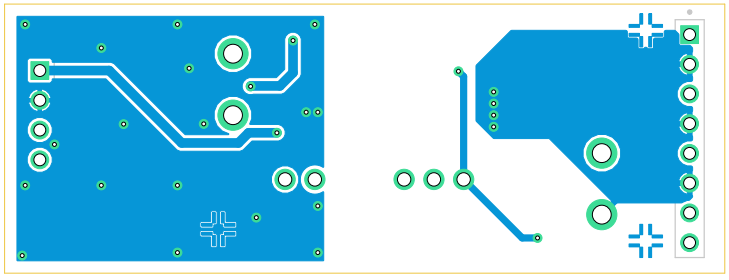

Figure 7. PCB bottom layer

7. PCB Assembly Data

Figures 8 and 9 depict the PCB assembly, including the mechanical dimensions of the evaluation board in millimeters

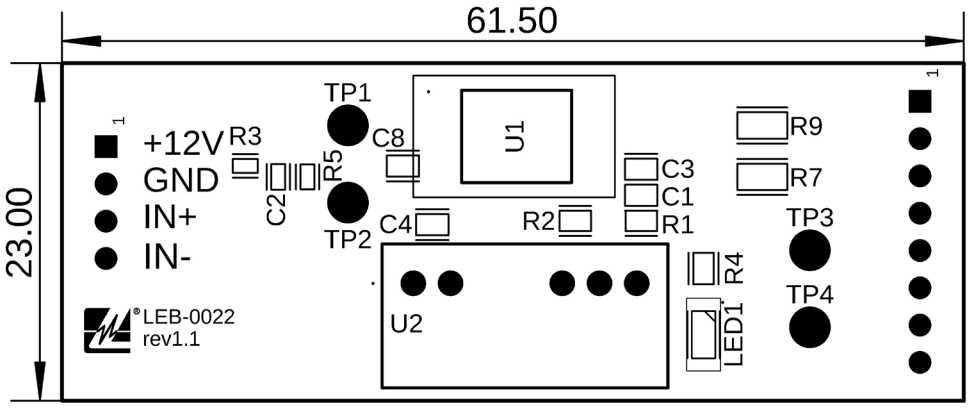

Figure 8. PCB top assembly and dimensions

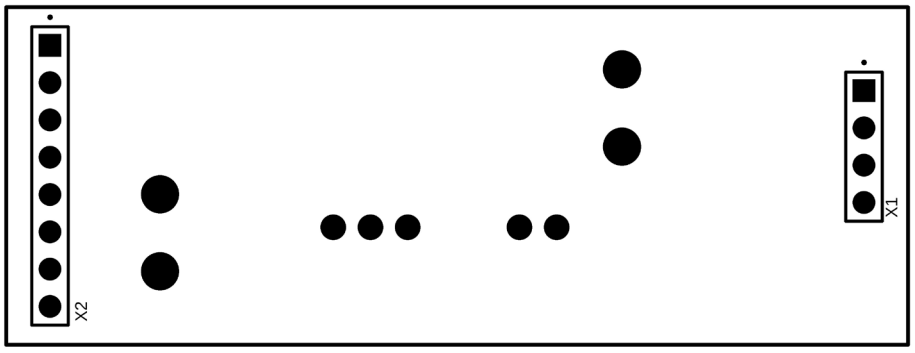

Figure 9. PCB bottom assembly (mirrored view)

8. Measurements

The IX3407B evaluation board was mounted on the LEB-0025 gate driver evaluation platform mainboard for TO-247-3L packages. The setup was used to conduct double-pulse tests driving Littelfuse IXYH50N65C3H1 IGBTs with a driver supply voltage of +15/-9 V. Figure 10 and Figure 11 depict turn-off and turn-on events of the IGBT.

During the turn-off event of the IGBT, the gate voltage decreases, initiating the turn-off process. Due to a low 2 Ω turn-off gate resistance and characteristics of the IXYH50N65C3H1 IGBT, an extended miller-plateau is absent, and the measured gate voltage directly follows the collector-emitter voltage. Existing stray inductances in the switching cell cause an overvoltage across the IGBT of 100 V. An under swing of the gate-emitter voltage to approximately -18 V occurs during turn-off below the applied gate driver voltage of -9 V. This is caused by two effects. The negative di/dt of the emitter current induces a voltage across the stray inductance in the package's emitter current path. In addition, the negative dv/dt of the collector-emitter voltage after the turn-off voltage peak feeds back to the gate via the miller capacitance, leading to a further reduction in the measured gate voltage. This effect can be dampened by using a higher gate resistance value and slowing down the switching speeds. However, since the gate-emitter voltage swing does not exceed the datasheet maximum values, this behavior is not critical.

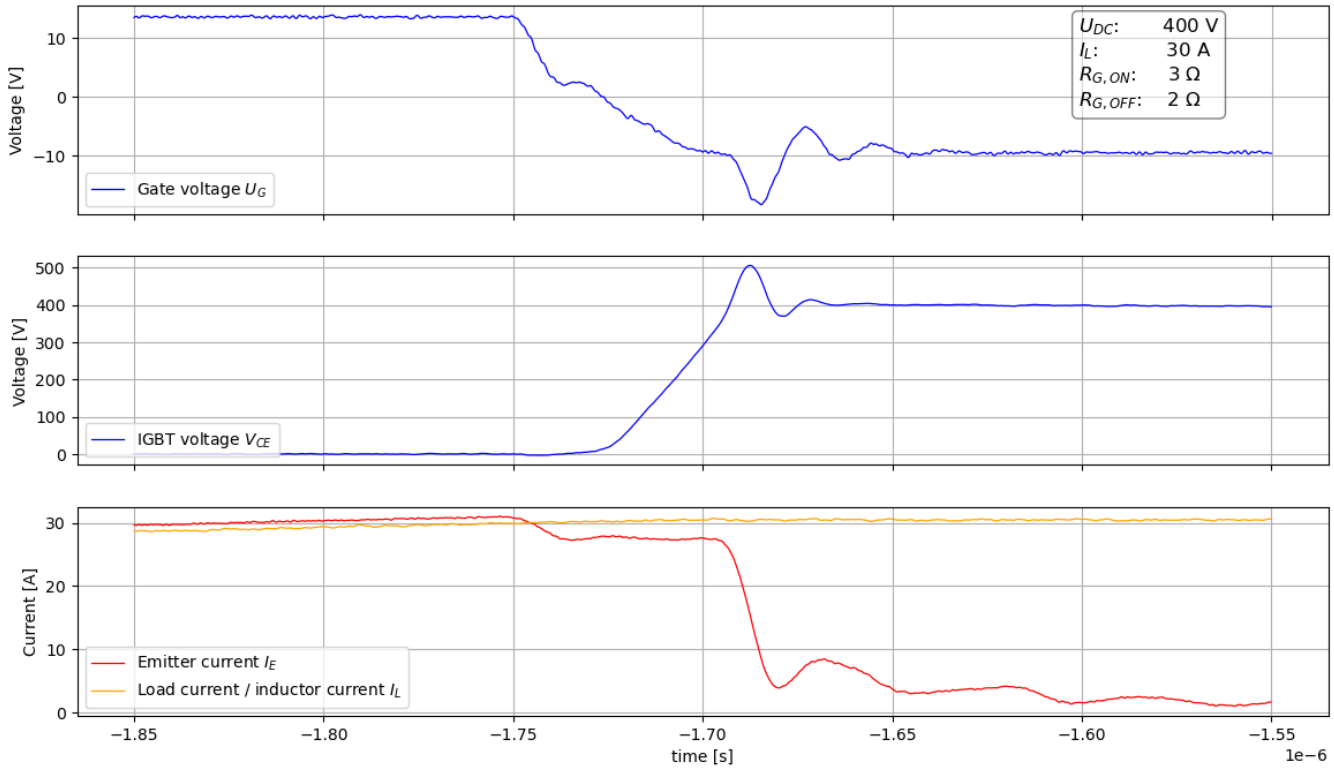

Figure 10. IXYH50N65C3H1 turn-off event at 30 A collector current driven by the IX3407B

When the IGBT is turned on, an effect similar to that for turn-off can be observed. Due to the driver's high current capability and low gate resistance, the gate-emitter voltage quickly reaches the positive voltage rail before the collector-emitter voltage drops. The emitter-current begins to rise and an overcurrent of approximately 30 A occurs, which is attributed to the reverse recovery of the free-wheeling diode. The gate voltage temporarily drops due to the negative dv/dt of the collector-emitter voltage and the negative di/dt of the emitter current.

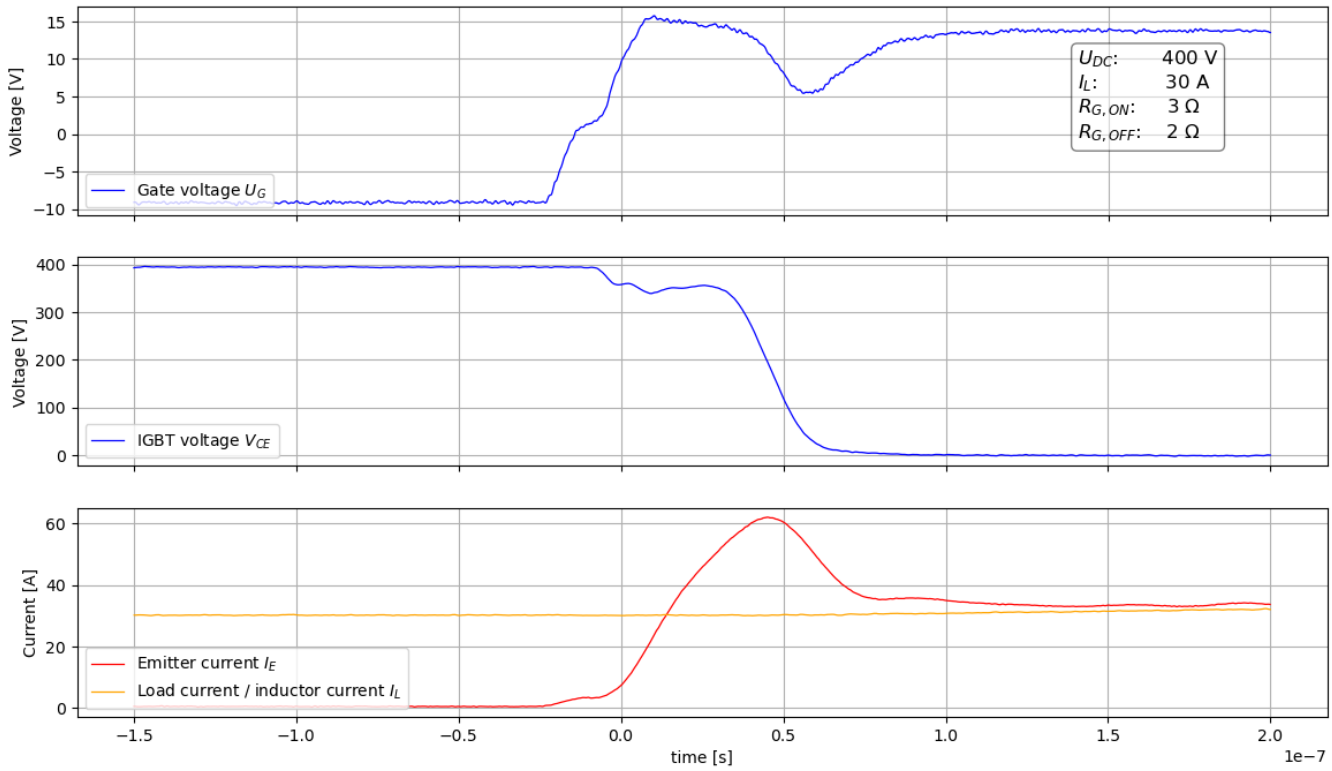

Figure 11. IXYH50N65C3H1 turn-on event at 30 A collector current driven by the IX3407B

Revision History

Date	Revision	Changes
April 2025	1.0	Initial Release
May 2025	1.1	Improved device CMTI parameters