EiceDRIVER™ driver IC evaluation board

EVAL-1EDI60I12AF user guide

About this document

Scope and purpose

This user guide is intended to provide information about the Infineon evaluation board EiceDRIVER™ Compact EVAL-1EDI60I12AF. It describes the features of the board and its use in a laboratory environment.

Intended audience

The intended audiences for this document are design engineers, technicians, and developers of electronic systems.

About this product family

Target applications

- Photovoltaic
- Motor control
- Uninterruptible power supplies (UPS)
- 3-phase string inverter solutions
- Server power supply units (PSU)

Product family

Infineon's EiceDRIVER™ isolated gate drivers deliver high output current, fast and tightly matched propagation delays, and robust CMTI for demanding power applications. They support a wide gate-voltage range, enabling bipolar operation with negative gate voltages making them ideal for driving advanced SiC MOSFETs and GaN power switches.

Table of contents

Safety precautions

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

Safety precautions

	**Warning:** *The DC link potential of this board is up to 1000 VDC. When measuring voltage waveforms by oscilloscope, high voltage differential probes must be used. Failure to do so may result in personal injury or death.*
	**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 five 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:** *The evaluation or reference board is connected to the grid input during testing. Hence, high-voltage differential probes must be used when measuring voltage waveforms by oscilloscope. 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 assemblies 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 undersizing 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.*

1 Introduction

The gate driver evaluation board EVAL-1EDI60I12AF was developed to demonstrate the functionalities and key features of Infineon's IGBT gate driver EiceDRIVER™ 1EDI60I12AF.

The board is available from Infineon in sampling quantities. Main features of this board are described in the datasheet chapter of this document, whereas the remaining paragraphs provide information intended to enable the customer to copy, modify, and qualify the design for production, according to their own specific requirements.

The design of the EVAL-1EDI60I12AF was performed with respect to the environmental conditions described in this document. The design was tested as described in this document, but not qualified regarding manufacturing, lifetime, or over the full range of ambient operating conditions.

The boards provided by Infineon are subjected to functional testing only.

Due to their purpose, evaluation boards are not subjected to the same procedures regarding returned material analysis (RMA), process change notification (PCN), and product discontinuation (PD) as regular products. The evaluation boards are intended for development support only and should not be used directly as reference designs for volume production.

See legal disclaimer and warnings for further restrictions on Infineon's warranty and liability.

2 Design features

This chapter provides an overview of the main features, specifications, pin assignments, and mechanical dimensions.

2.1 Main features

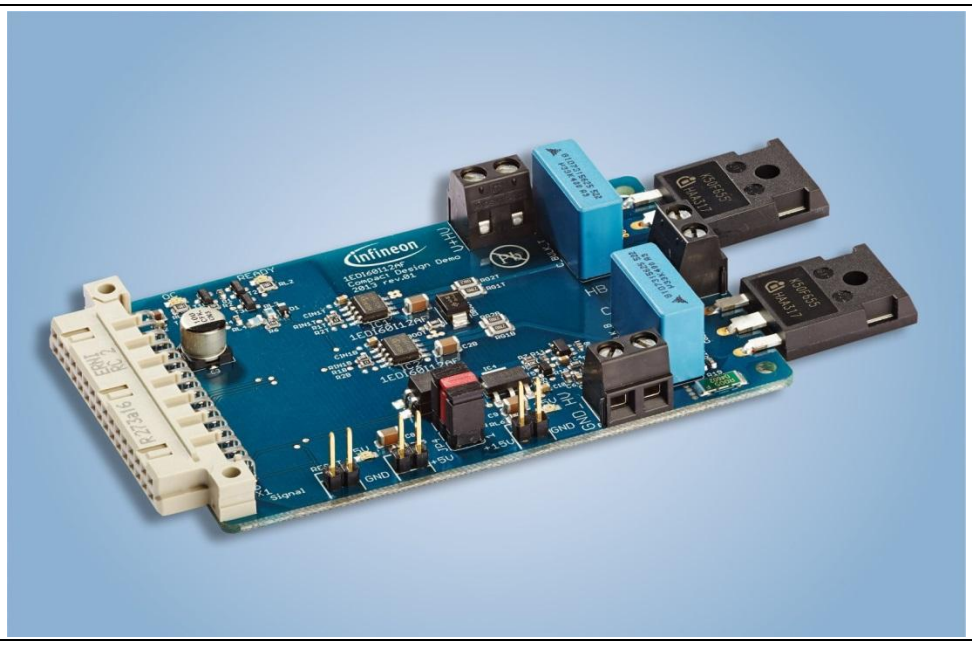

Figure 1 Top view of the EVAL-1EDI60I12AF

The EVAL-1EDI60I12AF evaluation board contains two EiceDRIVER™ 1EDI60I12AF single channel IGBT gate driver ICs and two Infineon IGBTs IKW50N65F5.

The major features of the evaluation board are:

- Short-circuit protection
- Current measurement
- Undervoltage lock-out
- Bootstrap functionality for the high-side gate driver
- Possibility to separate the input and output side

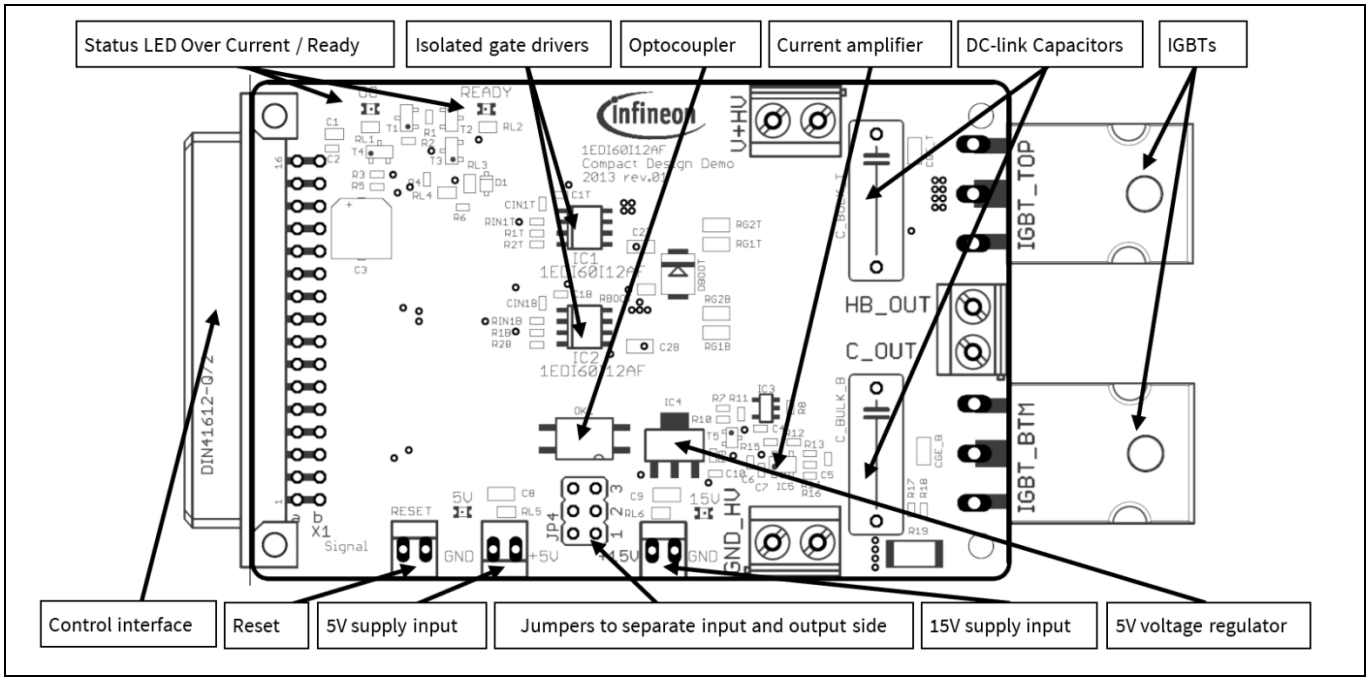

Figure 2 PCB overview

2.2 Main specifications

All values listed in the table below are values determined at an ambient temperature of 25°C.

Table 1 Electrical ratings and limits

Parameter	Description	Min.	Typ.	Max.	Unit
V_{CC}	15 V supply	13.2	15	17.5	V
V_{DC}	High voltage supply*	–	400	500	V
$I_{Out,pk}$	Single pulse peak output current	–	–	40	A
$I_{Out,rms}$	RMS output current**	–	–	10	A
f_p	Switching frequency	–	50	100	kHz

Note: Please make sure, never to exceed the maximum rated values. Also, the performance and quality cannot be guaranteed when using the board with all parameters at maximum rated values at the same time.

* High voltage supply is limited by the IGBTs used and the DC link capacitors. If higher supply voltage is required, these parts should be replaced by parts with a higher voltage rating. The gate drivers are capable of operating up to peak voltage levels of 1200 V. However, note that the board's layout was not tested for voltages exceeding 600 V.

** Use of an appropriate heat sink for IGBT devices should be considered in case of continuous operation with currents higher than approximately 2 A_{rms}.

2.3 Pin assignment

Table summarizes the connections and pins of the board with all references correlated to the overview given in:

Table 2 Connector pin description and assignments

Connector name	Pin position	Pin name	Description
RESET	Left terminal	/RST	Same as X1-B1
	Right terminal	GND	Same as X1-A16
+5 V (VCC1)	Right terminal	+5 V	Positive 5 V supply
	Left terminal	GND	5 V power supply necessary if input and output side are separated
+15 V (VCC2)	Left terminal	+15 V	Positive 15 V supply
	Right terminal	GND	
X1	A16	GND	Reference for power supplies and input signals
	B1	/RST	Reset input, 0 V for circuit reset
	B2	/FLT	Overcurrent output; OC, 0 V/5 V
	B7	IN_T	Non-inverting input high-side IGBT; 0 V off; 5 V on
	B8	IN_B	Non-inverting input low-side IGBT; 0V off; 5 V on
	B16	VCC	Positive 5 V supply
GND_HV	–	–	Reference for high voltage supply Power-GND internally connected to GND
V+HV	–	–	Positive high voltage supply up to 500 V referenced to GND_HV
HB_OUT	–	–	Output HV half-bridge related to GND_HV
C_OUT	–	–	Output filter bulk capacitors center tap

3 Electrical features

3.1 +5 V and +15 V supply voltages

The driver's high-side voltage must be supplied externally. The 5 V supply voltage, required for onboard circuits, is generated internally by an Infineon voltage regulator. The evaluation board does not provide an overvoltage supply monitoring; therefore, the user must ensure that the voltages remain within the correct range. Voltages exceeding the maximum values may lead to damage of the IGBT drivers and other circuitries.

The +5 V supply is generated on the board by using Infineon voltage regulator OPTIREG™ TLE4264G. The regulator is used to supply input as well as output circuits of the evaluation board. In case a complete input to output separation is required, the supply voltage must be provided externally.

The availability of the supply voltages is individually indicated for both power supplies via the green status LEDs. For proper operation of the evaluation board, care must be taken that both power supplies are available and stable.

The output part of the high-side gate driver is supplied by bootstrap using an external ultra-fast diode. To ensure that the bootstrap capacitor is charged before the high side IGBT is switched on, the low-side IGBT has to be switched on for at least 250 µs.

3.2 Undervoltage lockout

The +15V supply as well as the +5 V supply are monitored by the EiceDRIVER™ 1EDI60I12AF gate drivers. In case of an undervoltage, the driver's output is switched off until both input voltages are higher than the required thresholds.
The thresholds for the +5 V supply typically are V_{CCUV+} = 2.85 V on a positive slope and V_{CCUV-} = 2.75 V on a negative slope.
The thresholds for the +15 V supply typically are V_{BSUV+} = 12 V on a positive slope and V_{BSUV-} = 11.1 V on a negative slope.

3.3 Short-circuit detection

The 1EDI60I12AF evaluation board provides short-circuit detection by measuring the voltage drop across a 5 mΩ shunt as depicted in Figure 3. This voltage drop is compared to a fixed voltage level of 254.5 mV by the comparator circuit sketched in Figure 4. If the current reaches a value of typ. 50 A, a short-circuit is detected and the gate driver inputs HIN and LIN are disabled. IN– inputs are pulled high which means that PWM signals at IN+ have no effect and the driver outputs are switched off. This state is reported by the OC LED. The OC event is latched by the onboard flip-flop circuit, as given in Figure 5 and must be reset by switching the RESET signal to ground. As can be seen in Figure 4, the fault signal is fed from the output part of the board to the input part utilizing an optocoupler. This allows operating the overcurrent protection circuit even if the input to output separation of the board is used.

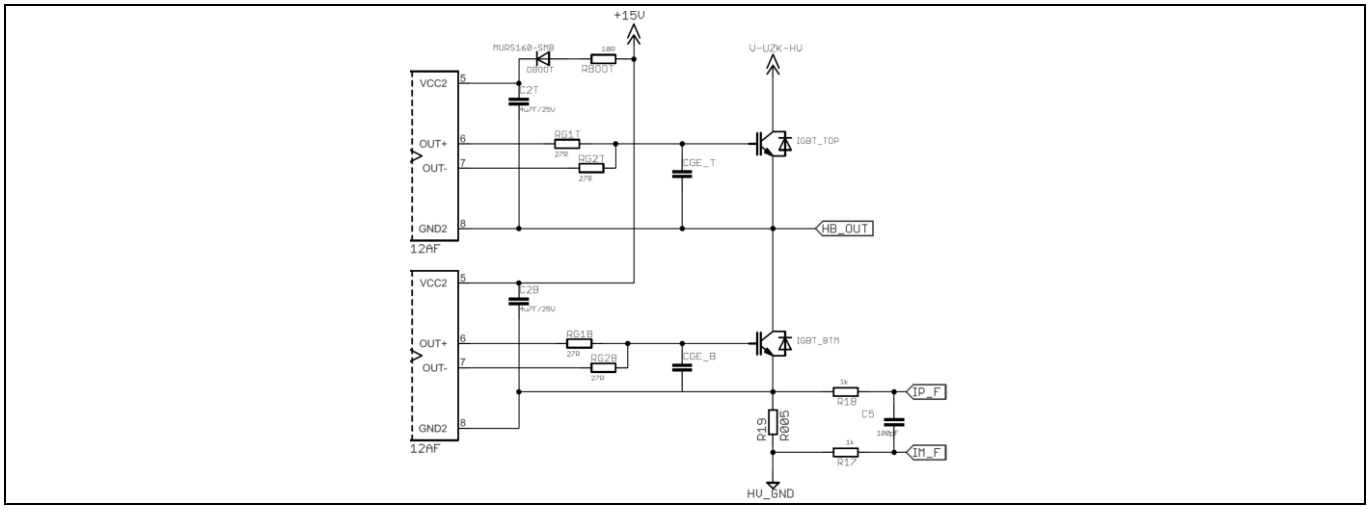

Figure 3 Shunt R19 connection in the power circuit

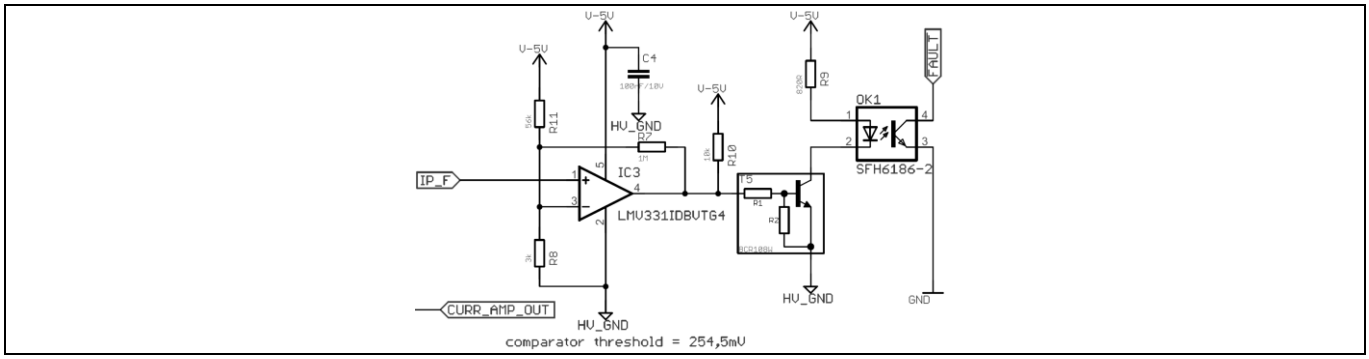

Figure 4 Overcurrent comparator circuit and error signaling

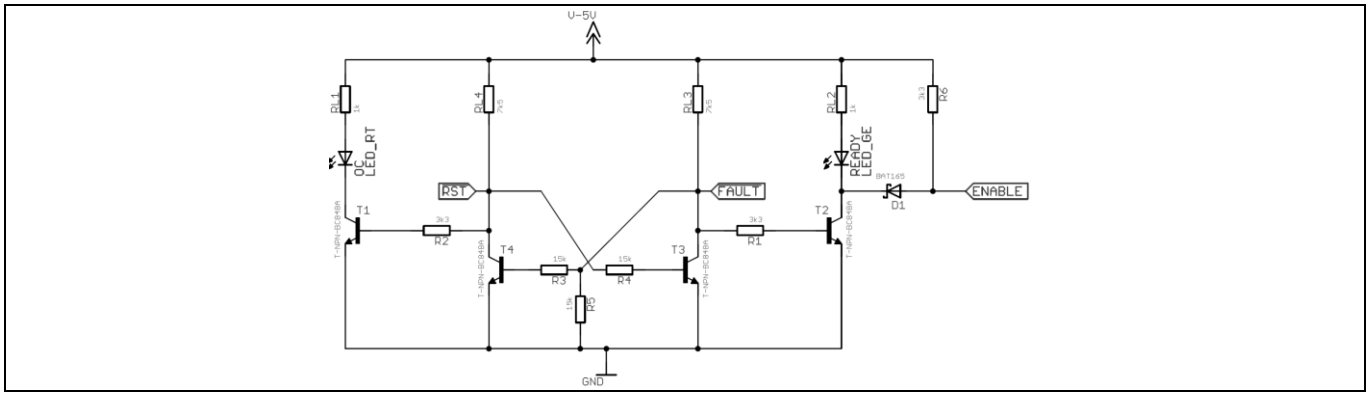

Figure 5 Fault flip-flop latch circuit

Figure 6 includes the signals of the low-side driver along with current and voltages for the IGBT during short-circuit with 20 µH inductor connected between HB_OUT and V+HV.

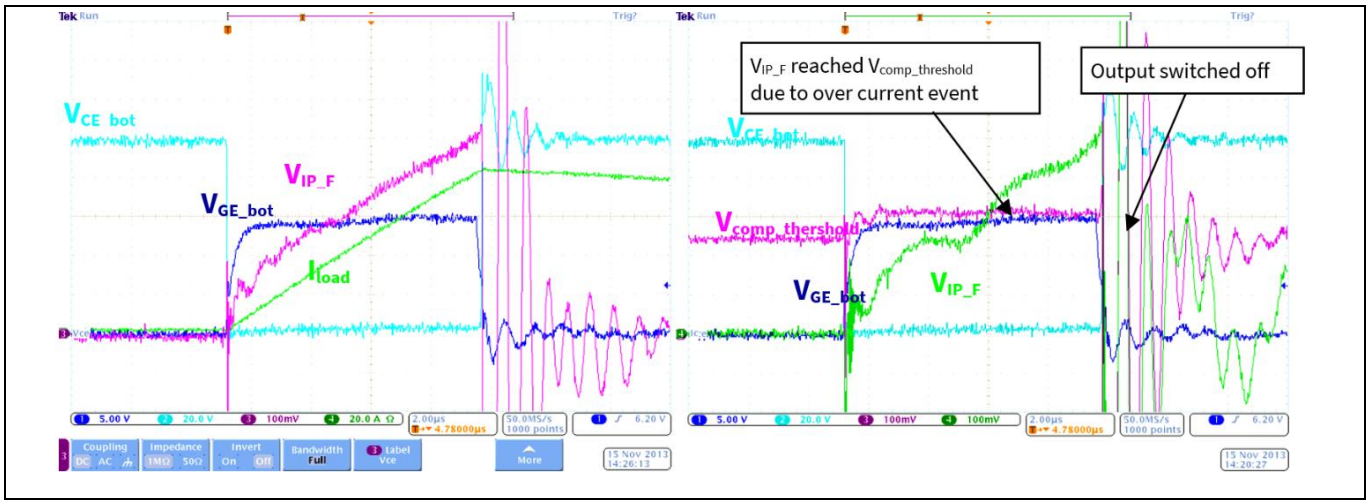

Figure 6 Detection signals, IGBT collector current, gate- and collector-emitter voltage during short-circuit event

The experiment reveals a delay of approximately 2.8 µs between the overcurrent detection and the output being switch off. During this delay time, the current continues to rise until the IGBT switches off. Depending on the inductance of the short-circuit loop, the current may rise to high values. This should be considered when using the test board in connection with sensitive loads or other external circuits.

3.4 Current sense amplifier

The EVAL-1EDI60I12AF provides an operational amplifier which amplifies the voltage drop across the shunt with a gain of 11. The amplified voltage is available to the user at connector X1 pins A9 and B9. Figure 7 shows the schematic details of the amplifier setup.

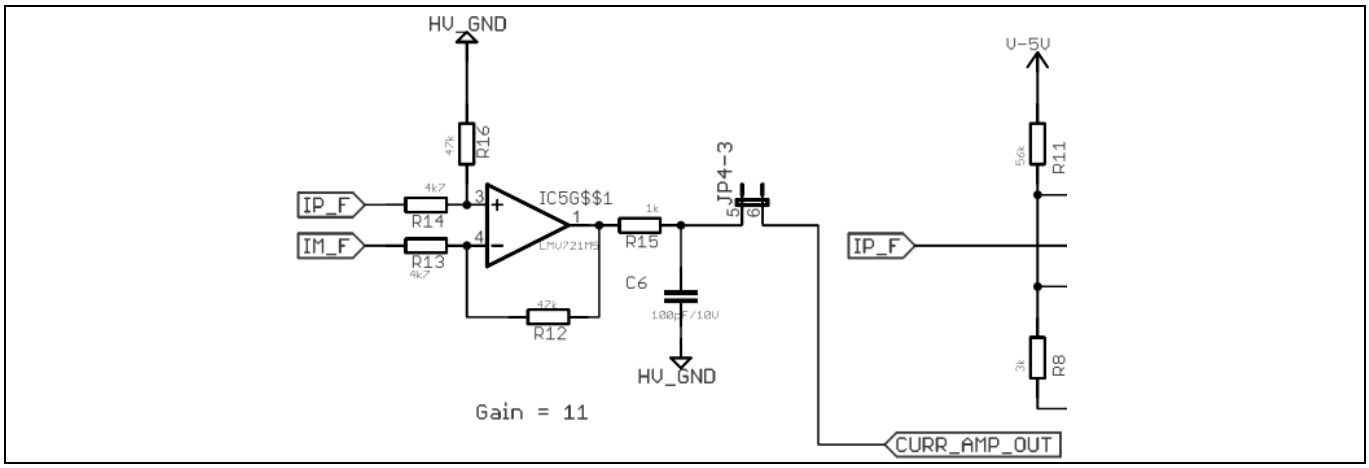

Figure 7 Current sense amplifier

The amplified voltage as a function of load current results to be:

$$V_{current\_amp\_out} = R_{shunt} \cdot I_{shunt} \cdot 11$$

Equation 1 Amplifier output voltage

The scope plot in Figure 8 gives an insight into the amplifier's output.

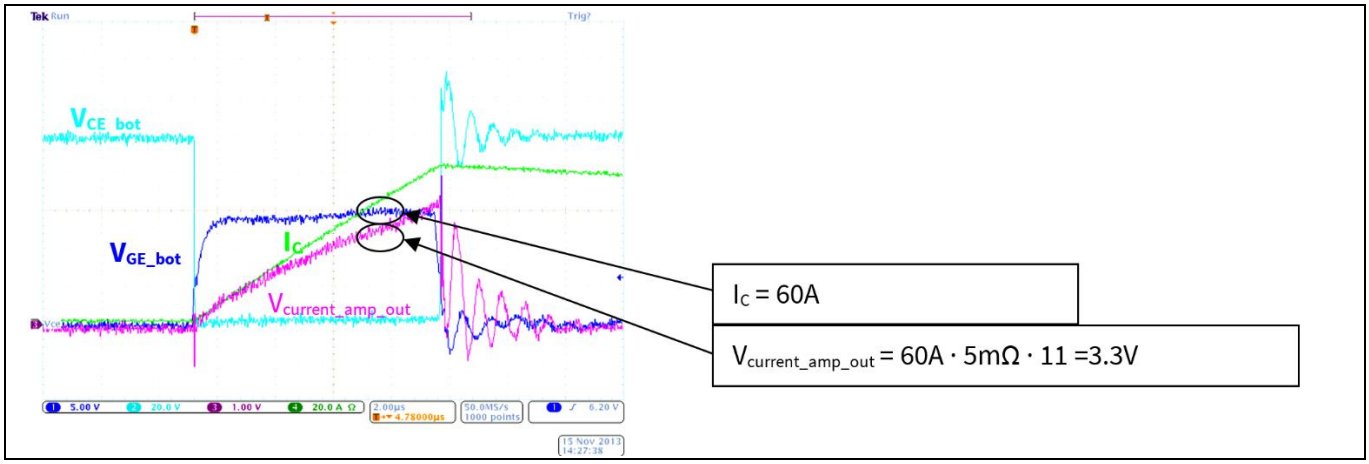

Figure 8 Current sense amplifier output and corresponding load current

3.5 IGBT turn on/off

EiceDRIVER™ 1EDI60I12AF provides separate driver source output and driver sink output signals. These allow independent control of IGBT turn-on respectively turn-off behavior. It can be seen in Figure 3 that the evaluation board is equipped with independent gate resistors RG1B, RG1T, RG2B, and RG2T. The resistors used in default configuration have a value of 27 Ω. The values can be modified by the user to obtain a required switching behavior. It should be noted that the deviation from the default values may result in increased switching noise or higher switching losses. Examples of switching transients with default gate resistors determined in a double pulse test are depicted in Figure 9.

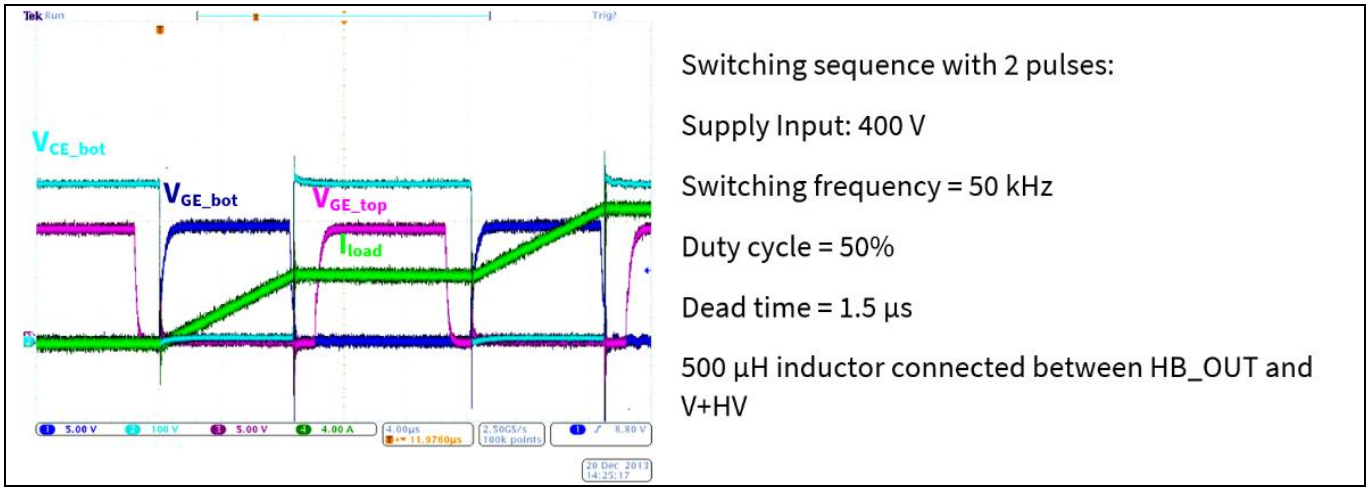

Figure 9 Example of waveforms during double pulse switching sequence

A more detailed view of the transient switching behavior is shown in Figure 10.

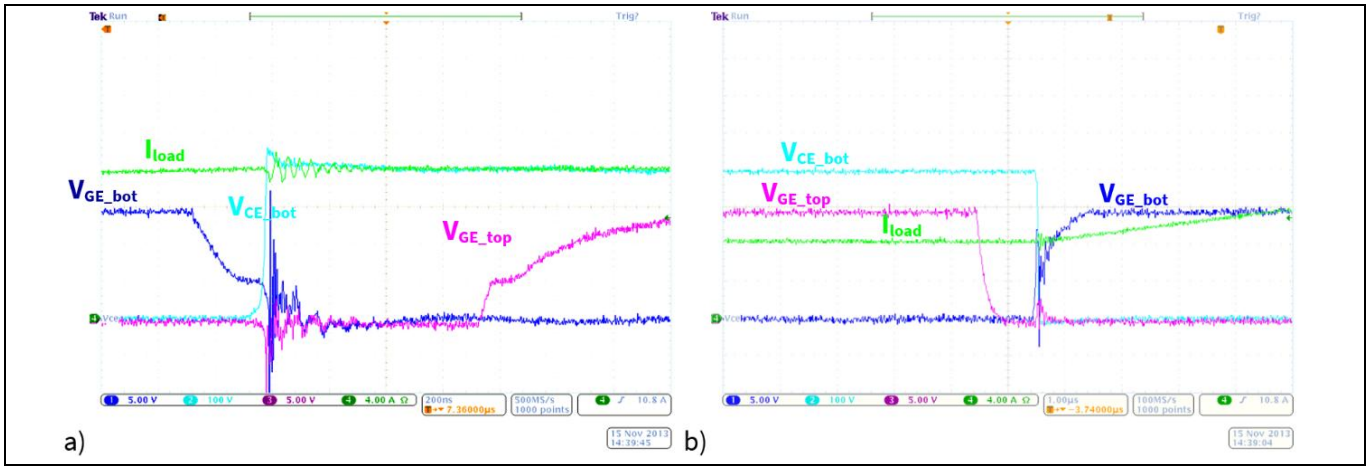

Figure 10 Switching transients; a) turning off the low-side IGBT and turning on the high-side IGBT b) vice versa, time scale is 200 ns/div

3.6 DC-link capacitors

The evaluation board provides a split DC-link capacitor to enable connection of loads which require ac voltages and bi-directional currents. In such a case, the load can be connected between HB_OUT and C_OUT output which enables voltage inversion across the load. An example of possible bi-directional waveforms is displayed in Figure 11. It should be noted that in case of operation with bi-directional currents, the current amplifier output only provides information about the current through the low-side IGBT. In addition to that, the overcurrent protection circuit may not work properly in case of large negative current shifts. In case of symmetrical current waveforms, the overcurrent protection should not be affected but it should be noted that an overcurrent would be detected only on the positive part of the current waveform.

Due to the available space, only small DC-link capacitors of 330 nF are available on the board. If a larger DC-link capacity is necessary, it must be connected to the connectors V+HV, GND_HV and C_OUT externally.

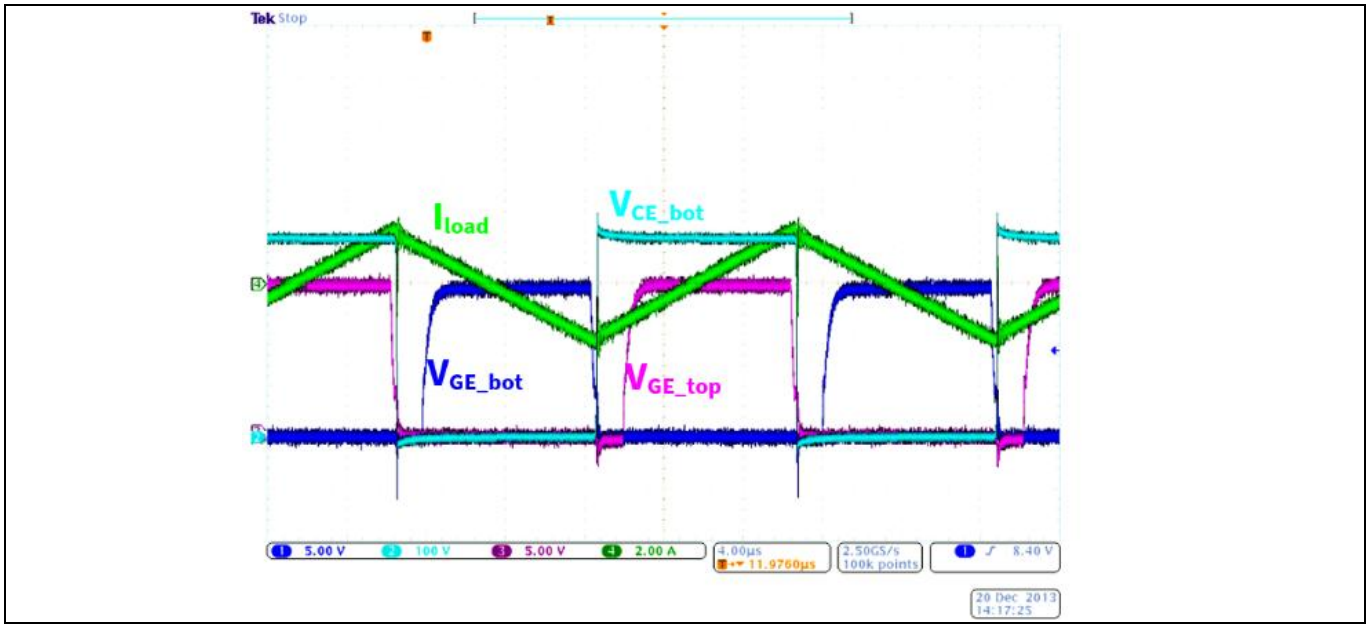

Figure 11 Example of an operation with bi-directional load current

3.7 Input PWM-Signals

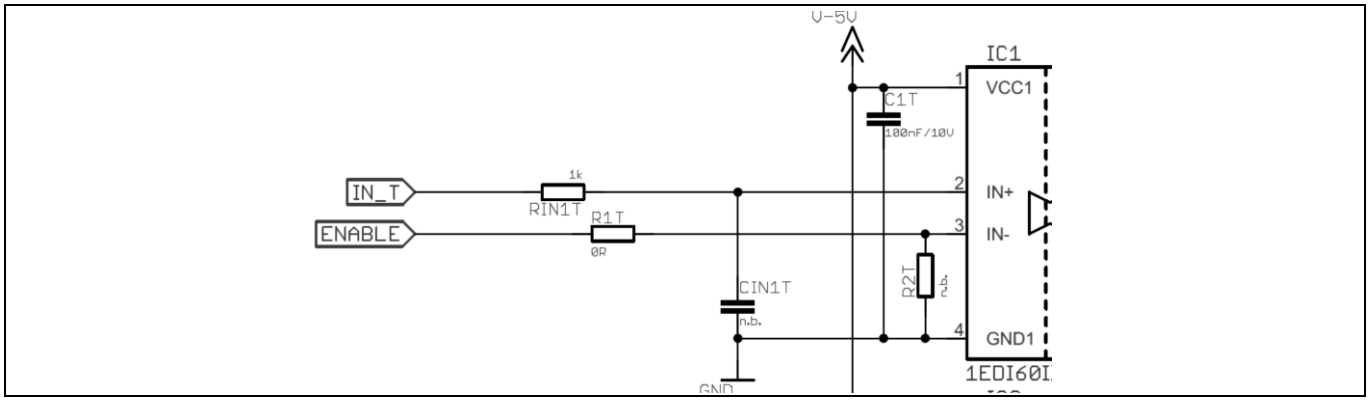

Figure 12 Details of the 1EDI60I12AF gate driver input schematic

There is a possibility to use low-pass filters inside the PWM input signals to avoid a turn-on of an IGBT by noise. This feature is not used in this evaluation board due to internal signal filtering of the driver's inputs which are sufficient in most applications. However, there is the possibility to test this feature by changing the resistors RIN1T, RIN1B and using a suitable capacitance value for the capacitors CIN1T, CIN1B, as seen in Figure 12.

3.8 Separation between input and output side

The EiceDRIVER™ 1EDI60I12AF gate driver offers an input to output isolation capability of 1200 V. The evaluation board takes advantage of this feature by offering a possibility of input to output separation. This can be done by removing the jumpers marked JP4 on the board as indicated in Figure 13. This removes all conductive connections between the input and output side and therefore completely separates the two sides. This procedure also opens the connection between the 5 V onboard voltage regulator and the input-side circuits. Thus, the +5 V for the input side must be supplied from an external, isolated source. In addition, removing the jumpers opens the connection between the current amplifier output and connector X1; therefore, the information about the current is not available in case of isolated operation. The overcurrent protection remains functional since the fault signal is fed back to the input side via an optocoupler.

It should be noted that in case of operation without this separation and all jumpers in place, the board requires the +15 V supply only.

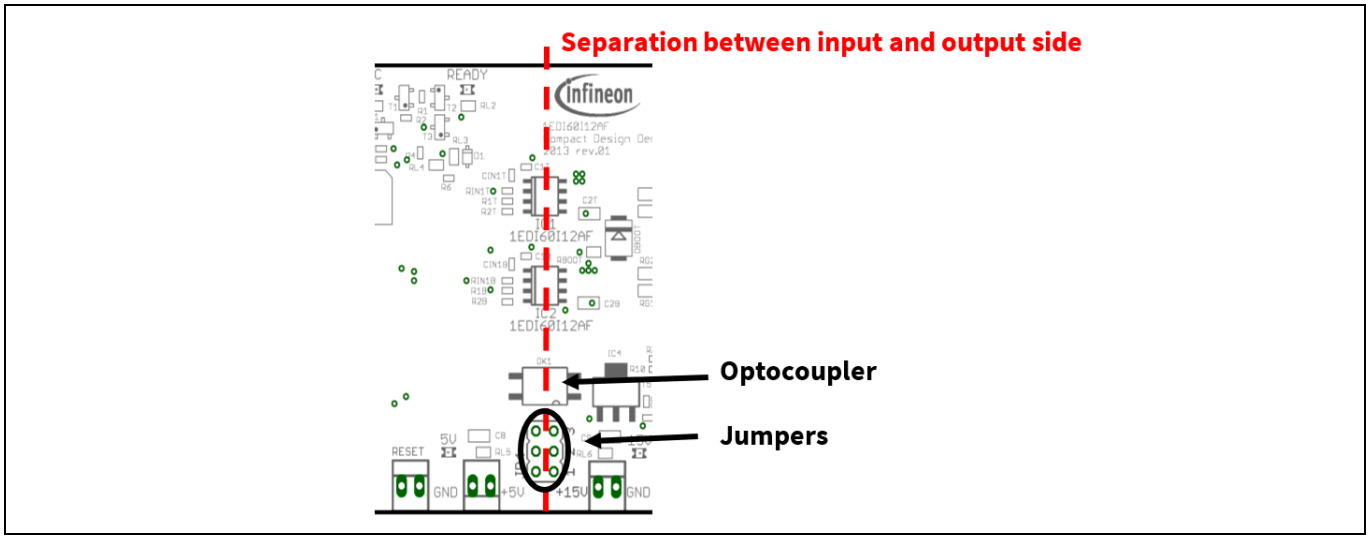

Figure 13 Jumpers and optocouplers enabling operation with input to output separation

4 Schematics

To ease reproduction of the board for further use, Figure 14 to Figure 20 display the detailed schematic of the evaluation board.

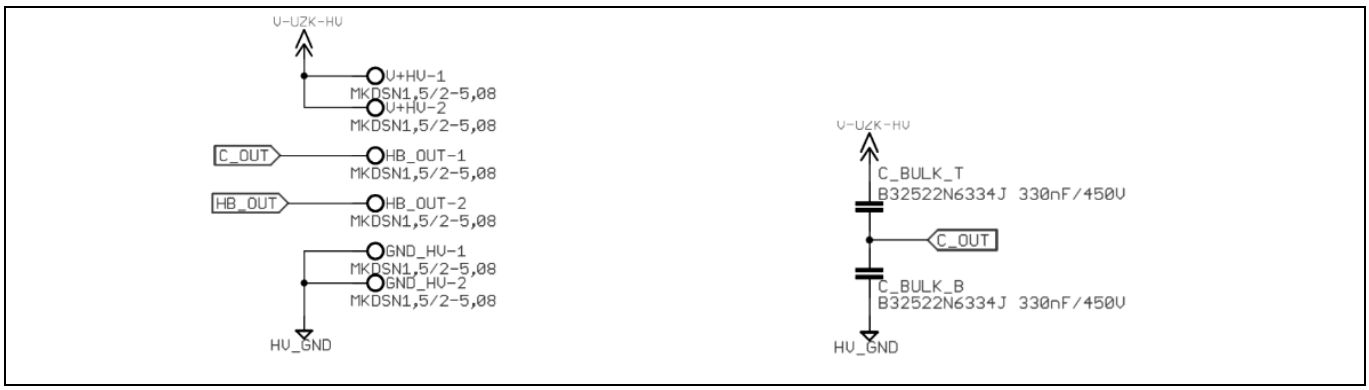

Figure 14 HV supply input and DC-link capacitors

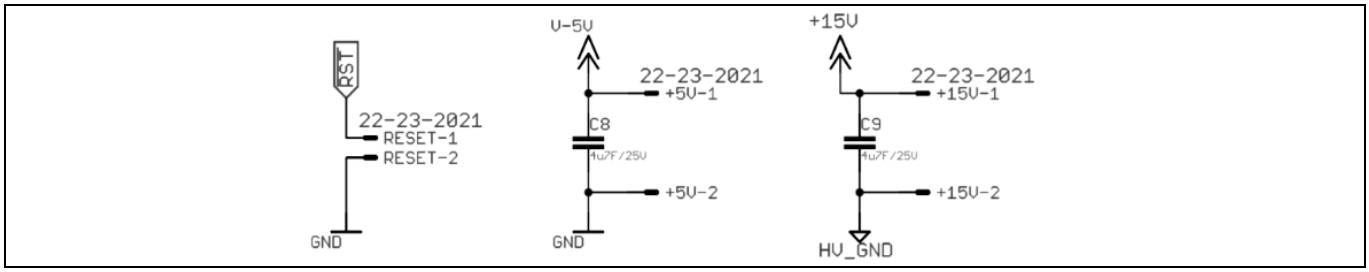

Figure 15 LV Supplies and Reset Input

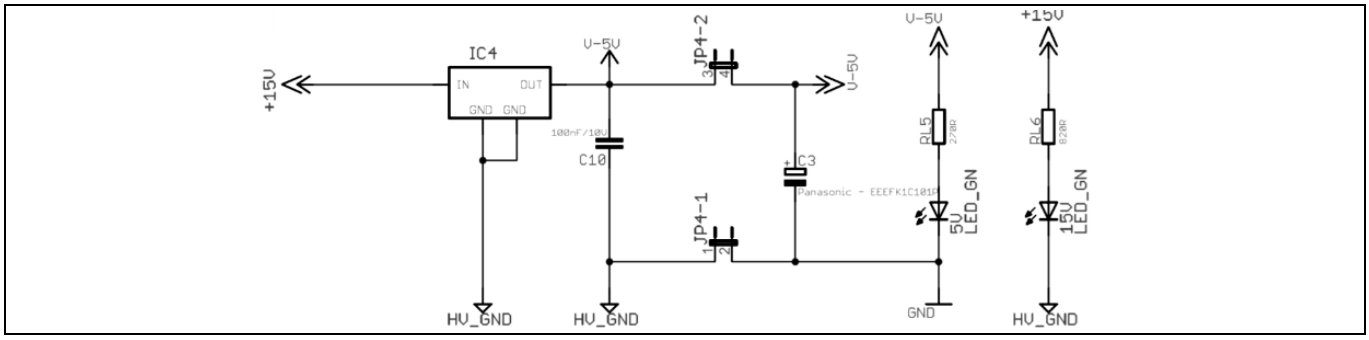

Figure 16 5 V voltage regulator and power supply status LEDs

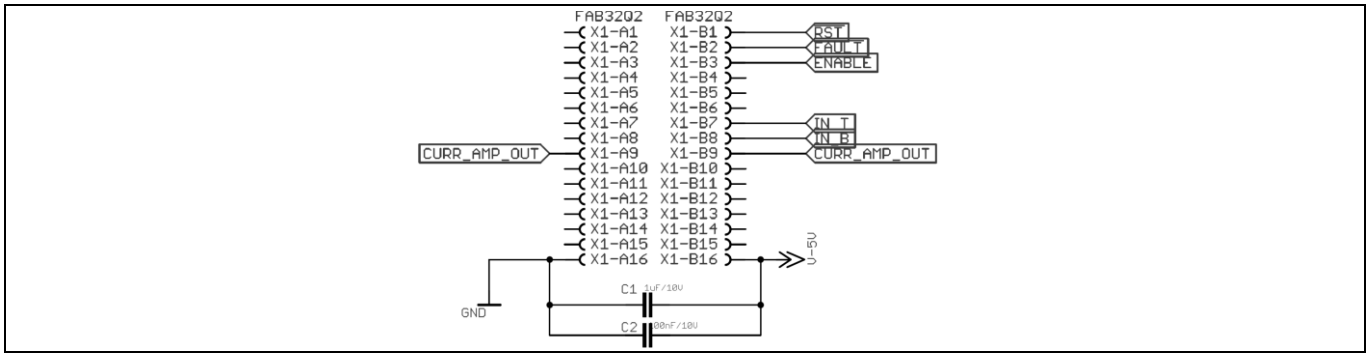

Figure 17 Communication interface - connector X1

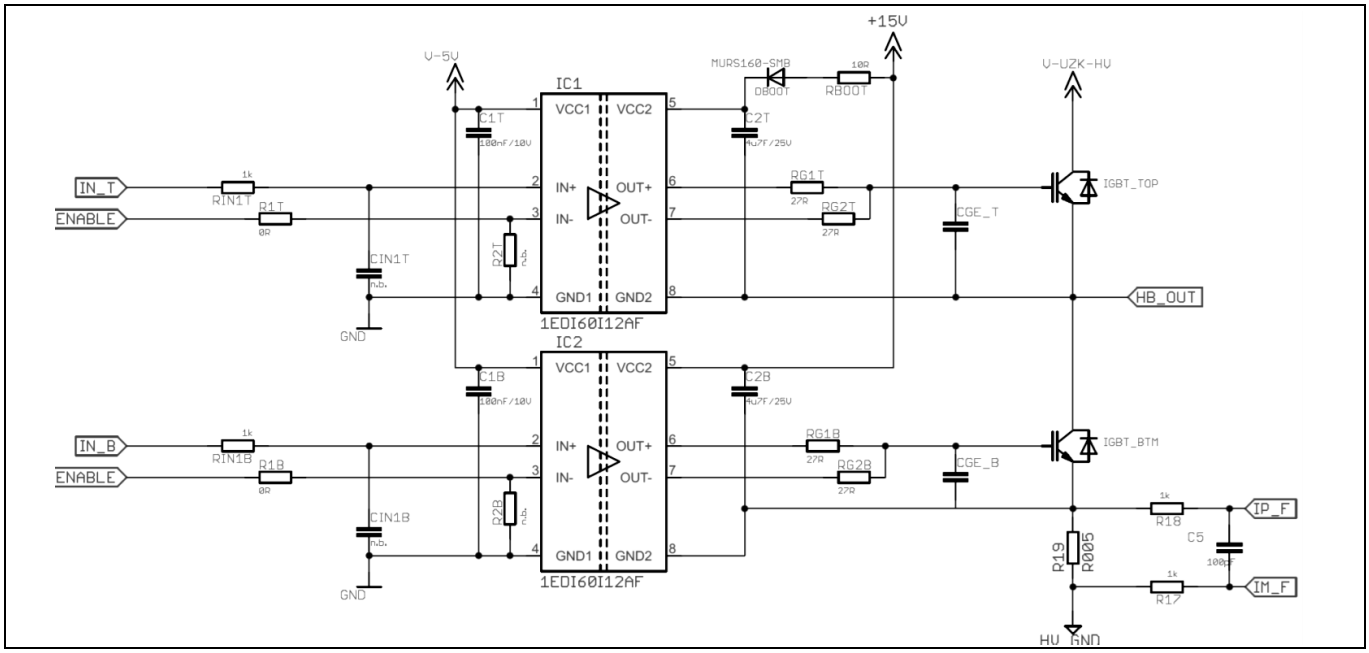

Figure 18 Infineon gate drivers 1EDI60I12AF with necessary external components

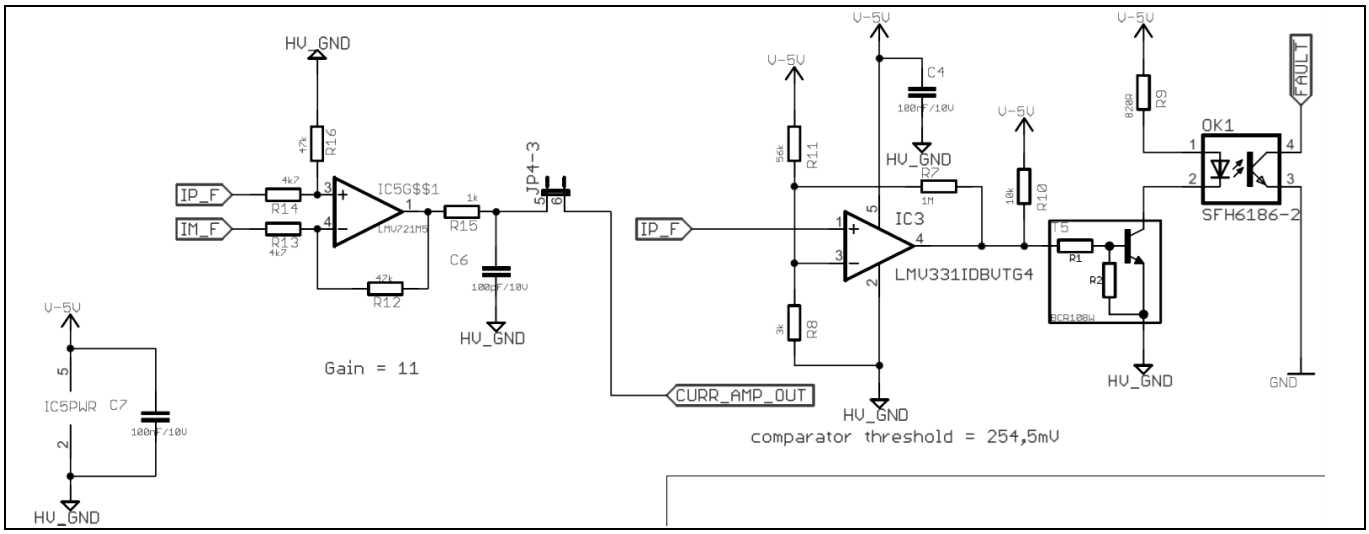

Figure 19 Current sense amplifier and overcurrent comparator

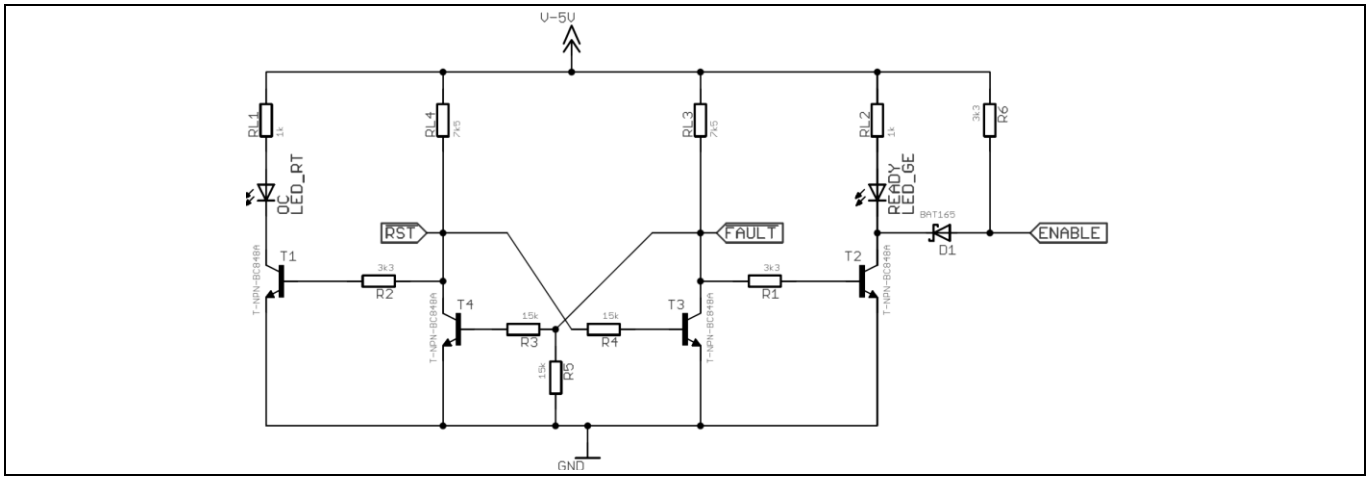

Figure 20 OC and READY LEDs, FAULT and overcurrent logic

5 Layout

As a basis to start a dedicated development, Figure 21 to Figure 23 include the layout of the PCB-layers and the component placement view.

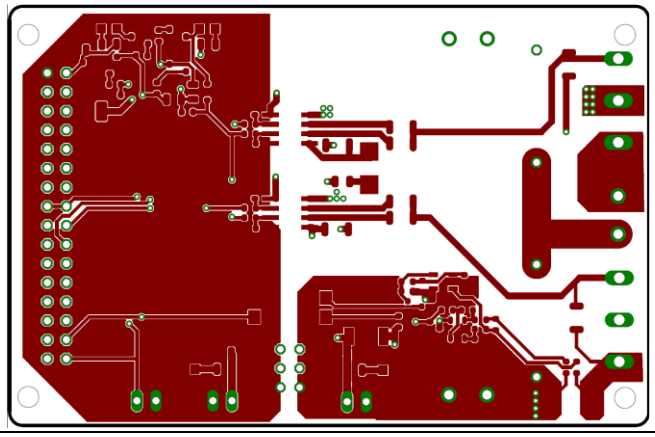

Figure 21 Top layer of EVAL-1EDI60I12AF

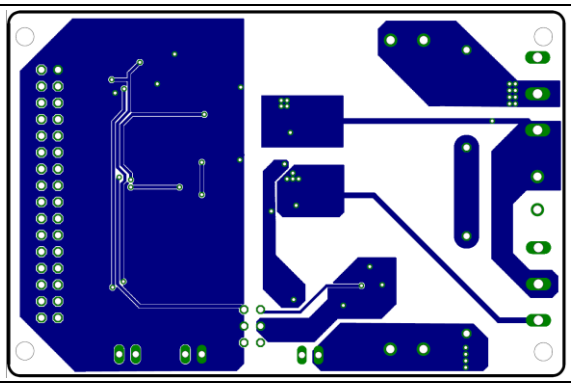

Figure 22 Bottom layer of EVAL-1EDI60I12AF

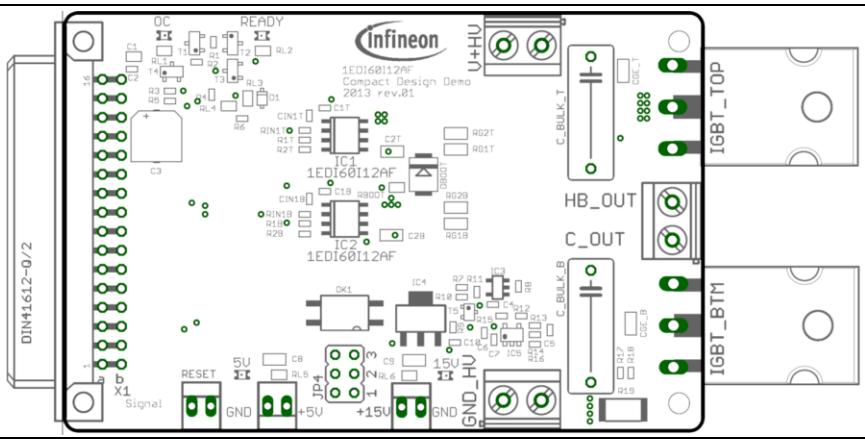

Figure 23 Top placement view of EVAL-1EDI60I12AF

6 Bill of materials

Table 3 Bill of materials

Part	Value	Package
+5 V, +15 V, RESET	22-23-2021	22-23-2021
GND_HV, HB_OUT,C_OUT, V+HV	MKDSN1,5/2-5,08	MKDSN1,5/2-5,08
5 V, 15 V	LED_GN	CHIPLED_0805
OC	LED_RT	CHIPLED_0805
READY	LED_GE	CHIPLED_0805
X1	FAB32Q2	FAB32Q2
JP1, JP2, JP3	JP1	Jumper
R2B, R2T	NA	SMD0603
R1B, R1T	0R	SMD0603
R9	820R	SMD0603
R15, R17, R18, RIN1B, RIN1T	1k	SMD0603
R8	3k	SMD0603
R1, R2, R6	3k3	SMD0603
R13, R14	4k7	SMD0603
R10	10k	SMD0603
R3, R4, R5	15k	SMD0603
R12, R16	47k	SMD0603
R11	56k	SMD0603
R7	1M	SMD0603
RL5	270R	SMD0805
RL6	820R	SMD0805
RL1, RL2	1k	SMD0805
RL3, RL4	7k5	SMD0805
RG2B, RG2T	3R3	SMD1206
RG1B, RG1T, RBOOT	10R	SMD1206
R19	R005	R2512
CIN1B, CIN1T	NA	SMD0603
C5, C6	100 pF/10 V	SMD0603
C1B, C1T, C2, C4, C7,C10	100 nF/10 V	SMD0603
C1	1 µF/10 V	SMD0805
C2B, C2T, C8, C9	4 µF/25 V	SMD1206
CGE_B, CGE_T	NA	SMD1206
C3	100 µF/16 V	EEEFK1C101P
C_BULK_B, C_BULK_T	B32522N6334J	330 nF/450 V
D1	BAT165	SOD323F
DBOOT	MURS160	SMB

Bill of materials

Part	Value	Package
IC1, IC2	1EDI60I12AF	SO08
IC3	LMV331IDBVTG4	SOT23-5
IC4	TLE4264G	SOT223
IC5	LMV721M5	SOT23-5
OK1	SFH6186-2	SMD4-7
IGBT_BTM, IGBT_TOP	IKW50N65F5	TO247BH
T1, T2, T3, T4	BC848A	SOT23
T5	BCR108W	SOT323

7 Related resources

- EiceDRIVER™ 1EDI60I12AF
- Developer Community

Glossary

ESD
electrostatic discharge

GaN
Gallium Nitride

GND
ground

GND_HV
ground for high-voltage domain

HB_OUT
half-bridge output

IGBT
insulated gate bipolar transistor

LED
light emitting diode

OC
overcurrent

RMA
returned material analysis

UVLO
undervoltage lockout

VCC
supply voltage

VDC
DC supply voltage

Revision history

Document revision	Date	Description of changes
V 1.0	2014-07-25	Initial release
V 1.1	2026-06-12	Lifecycle review: Updated to the latest template

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Safety & Operating Instructions:
Customer shall check the Evaluation Board for any physical damage which may have occurred during transport. If customer detects any damages or defects in the Evaluation Board, customer shall not connect the Evaluation Board to a power source. Customer shall contact Infineon for further support. If customer observes unusual operating behavior during the evaluation process, customer shall immediately shut off the power supply to the Evaluation Board and consult Infineon for support.
Customer shall not touch the Evaluation Board during operation and keep a safe distance.
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.