EVAL-1EDC20H12AH-SIC

1EDI20H12AH/1EDC20H12AH with CoolSiC™ MOSFET IMZ120R045M1

1EDI20H12AH, 1EDC20H12AH IMZ120R045M1

EiceDRIVER™ isolated gate driver evaluation board with 1EDC20H12AH and CoolSiC™ MOSFET IMZ120R045M1

About this document

Scope and purpose

The gate driver evaluation board EVAL-1EDC20H12AH-SIC with the EiceDRIVER™ 1EDC20H12AH or 1EDI20H12AH and CoolSiC™ MOSFET IMZ120R045M1 are developed to demonstrate the functionality and key features of the Infineon EiceDRIVER™ gate driver IC and Infineon CoolSiC™ MOSFET.

The board comes with either the 1EDC20H12AH or the 1EDI20H12AH gate driver installed.

The 1EDC20H12AH offers a certification according to UL1577 while the 1EDI20H12AH is the functional insulated variant. All other components and functions are the same.

The boards contain a short circuit protection to turn OFF the CoolSiC™ MOSFET within about 1.5 µs after a short circuit event. Main features of the boards are described in the key feature section of this document, whereas the remaining paragraphs provide information intended to enable the users to copy, modify and qualify the design for production, according to their own specific requirements.

Details about the EiceDRIVER™ 1EDC20H12AH or 1EDI20H12AH and the CoolSiC™ MOSFET IMZ120R045M1 can be found at the links:

- https://www.infineon.com/cms/en/search.html#!view=all&term=1EDI20H12AH
- https://www.infineon.com/cms/en/search.html#!view=all&term=1EDC20H12AH
- https://www.infineon.com/cms/en/search.html#!view=all&term=CoolSic

The design of the EVAL-1EDC20H12AH-SIC 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 subject to functional testing only.

Evaluation boards are not subject to the same procedures as regular products regarding Returned Material Analysis (RMA), Process Change Notification (PCN) and Product Discontinuation (PD). Evaluation boards are intended to be used under laboratory conditions and by trained specialists only.

Intended audience

- Engineers who want to learn how to use the Infineon EiceDRIVER™ and CoolSiC™ MOSFET
- Experienced design engineers designing circuits with Infineon EiceDRIVER™, IGBT and CoolSiC™ MOSFET
- Design engineers designing power electronic devices, like inverters

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1 Electrical description

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

1.1 Key features

The section describes the features of the evaluation PCBs and their key parameters.

The Evaluation Board EVAL-1EDC20H12AH-SIC is intended to evaluate the Infineon EiceDRIVER™ 1EDC20H12AH or 1EDI20H12AH together with the Infineon SiC MOSFET IMZ120R045M1 in an application circuit to understand the features and performance of both devices.

The board contains two gate drivers to drive two SiC MOSFET switches in half-bridge configuration.

An additional gate driver is used to transfer the over-current information through the isolation barrier between the power high-voltage side to the low-voltage input side.

Some supporting circuits like voltage regulator and DC-DC converter are implemented for simple use in the laboratory. The DC-DC converter provides galvanically isolated supply voltages for each SiC MOS driver stage.

The EVAL-1EDI20H12AH-SIC top view shows the top view of the EVAL-1EDC20H12AH-SIC.

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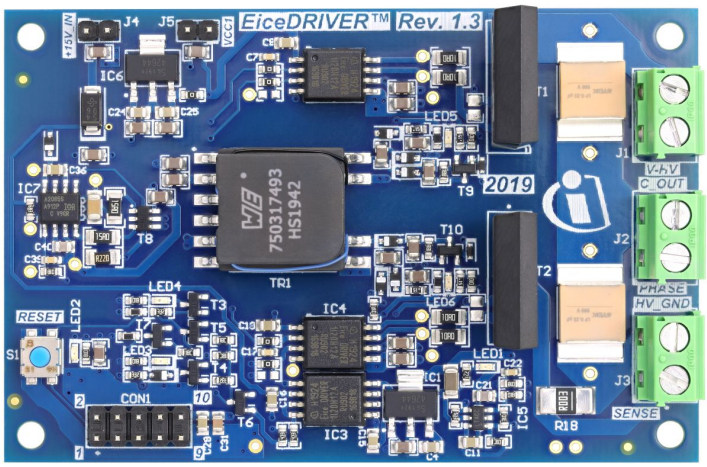


Figure 1 EVAL-1EDC20H12AH-SIC top view

The board has a size of 85 x 55 x 30 mm^3.

It is intended to be used for so-called double-pulse testing. However, it is the responsibility of the user to adapt it for testing it under continuous operation by adding a heat sink. An additional blocking capacitor to the high-voltage supply is recommended.

The low-voltage interface can be controlled by a pulse generator, a microcontroller or other digital circuits.

For safe operation, a fast overcurrent detection and protection circuit is implemented with a galvanically isolated feedback path to the low-voltage input side. The trigger flip-flop is implemented to latch the overcurrent event information. This circuit will report the overcurrent event and turns OFF both drivers after an overcurrent event. The S1 button will reset the flip-flop to enable the drivers again. A further description is provided in the Overcurrent protection section.

1.2 Electrical features

1.2.1 Supply voltage, operating conditions and absolute maximum rating

The evaluation board is intended to be used in the laboratory for so-called double pulse tests with limited power dissipation.

The user has to ensure a stable supply voltage by adding an adequate capacitor. In the event of continuous operation, the user has to ensure proper cooling of the CoolSiC™ MOSFET IMZ120R045M1 by adding adequate heatsinks. The heatsinks should be isolated from each other by using a separate heatsink for each transistor. The heatsinks should have a safe distance to the capacitors C5 and C13 to avoid arching due to high voltage.

Table 1 Absolute maximum ratings

pin/ parameter name	Abs. Max.	Unit	Note
+15V	-0.2 … 20	V	input, support supply voltage
VCC1	-0.2 … 5.3	V	output, doesn't supply external voltage regulator if internal voltage regulator is used for 5 V operation
ENABLE	-0.2 … VCC1 + 0.2	V	input, digital signal
FAULT	-0.2 … VCC1 + 0.2	V	output, digital signal

(table continues…)

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Table 1 (continued) Absolute maximum ratings

pin/ parameter name	Abs. Max.	Unit	Note
RST	-0.2 … VCC1 + 0.2	V	input, digital signal
IN_T	-0.2 … VCC1 + 0.2	V	input, digital signal
IN_B	-0.2 … VCC1 + 0.2	V	input, digital signal
V-HV	-0.2 … 1200	V	input, high voltage supply, for voltages above 42 V, special high voltage lab environment is strongly recommended
Phase peak current	25	A	Phase peak current for double pulse test without heatsink, max. pulse duration 100 µs
t_{pulse}	100	µs	maximum ON pulse length without heatsink for double pulse tests
f	100	kHz	maximum switching frequency for continuous operation, depending on power dissipation due to the load, a heatsink for the CoolSiC™ is necessary.

There are two supply modes, the VCC1 = 5 V operation, see Table 2 and VCC1 = 3.3 V operation, see Table 3

Table 2 VCC1 = 5 V operation using internal voltage regulator

pin name	Min.	Typ.	Max.	Unit	Note
+15V	15.5	16	16.5	V	input, support supply voltage
VCC1	4.8	5	5.2	V	output, does not supply external circuits
ENABLE	-0.1	0	VCC1+0.1	V	input, digital signal, low active
FAULT	-0.1	5	VCC1+0.1	V	output, digital signal
RST	-0.1	5	VCC1+0.1	V	input, digital signal
IN_T	-0.1	5	VCC1+0.1	V	input, digital signal
IN_B	-0.1	5	VCC1+0.1	V	input, digital signal
V-HV	25		600	V	input, high voltage supply, for voltages above 42 V, special high voltage lab environment is strongly recommended

Table 3 VCC1 = 3.3 V operation using external supply voltage, remove R20 to disconnect internal regulator

pin name	Min.	Typ.	Max.	Unit	Note
+15V	15.5	16	16.5	V	input, support supply voltage
VCC1	3.2	3.3	3.4	V	output, external supply , remove R20 to disconnect internal voltage regulator
ENABLE	-0.1	0	VCC1+0.1	V	input, digital signal, Low active
FAULT	-0.1	3.3	VCC1+0.1	V	output, digital signal
RST	-0.1	3.3	VCC1+0.1	V	input, digital signal
IN_T	-0.1	3.3	VCC1+0.1	V	input, digital signal

(table continues...)

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Table 3 (continued) VCC1 = 3.3 V operation using external supply voltage, remove R20 to disconnect internal regulator

pin name	Min.	Typ.	Max.	Unit	Note
IN_B	-0.1	3.3	VCC1+0.1	V	input, digital signal
V-HV	25		600	V	input, high voltage supply, for voltages above 42 V, special high voltage lab environment is strongly recommended

1.2.2 Start-up

To start the operation these steps have to be taken:

1. Supply +15V at connector J4.1 with +16 V and connect supply GND to connector J4.2
2. The red LED4 will turn on
3. Push S1 to reset the error flip-flop
4. The red LED4 will turn off and yellow LED3 will turn on
5. Connect the digital driving device to the digital interface connector, labeled CON1:
   - pin 6 for *IN_T*
   - pin 8 for *IN_B*
6. Connect the high voltage supply to connector J1.1 or J1.2 and *HV GND* to J3.2. An additional external capacitor > 100 µF from J1.1 to J3.2 helps to stabilize the supply voltage.
7. Connect the inductive load to J2.1. The other side of the load can be connected to different nodes depending on the requirements. Please see Table 4
8. The board is now ready for tests

Table 4 Load connection

To be tested	Connection 1st side of load	Connection 2nd side of load	Note
High side driver TOP	J2.1	J3.1 and J3.2	High side operation
Low side driver BOTTOM	J2.1	J1.1 or J1.2	Low side operation
High- and low side drive	J2.1	J2.2 or another gate driver board	Half or full bridge operation

ENABLE must be pulled down to low to enable a driver. The different drivers can be turned on or off by driving either *IN_T* for the high side TOP or *IN_B* for the low side BOTTOM driver at the digital interface connector. Only one input signal, either *IN_T* or *IN_B* should be pulled to high to avoid turning on both drivers at the same time.

To adapt the circuit to the application requirements, resistor or capacitor values can be changed to optimize the performance.

1.2.3 Overcurrent protection

An over current protection is implemented to protect the board and components against high current .

The current is determined by measuring the voltage across the shunt resistor R18. This is available at the two test points TP7 and TP10.

The detection circuit measures the voltage across R18, sends the signal through a low pass filter R17 and C21 and compares it to a reference voltage with the comparator IC5. The reference voltage is defined by the voltage divider R11 and R19. The trip point is about 32 A and can be adapted to customer requirements by changing R18 and/or adapting the reference voltage divider R11 and R19.

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The output signal is transferred with IC3 to the low voltage domain to trigger the flip-flop and store the over current event. Once the flip-flop is triggered, it turns off both gate drivers by the ENABLE signal. In addition, it reports the over current event to the digital interface connector as FAULT signal and will turn on the LED4.

To go back to normal operation, S1 needs to be pushed to reset the flip-flop. As feedback, LED4 will turn off and LED3 will turn on.

The turn off of both drivers due to over current is displayed in the OC Turn OFF and details in OC Turn OFF details. The low side driver with load from switching node to HV supply was used to demonstrate the protection behavior. The HV supply voltage during the test was 530 V.

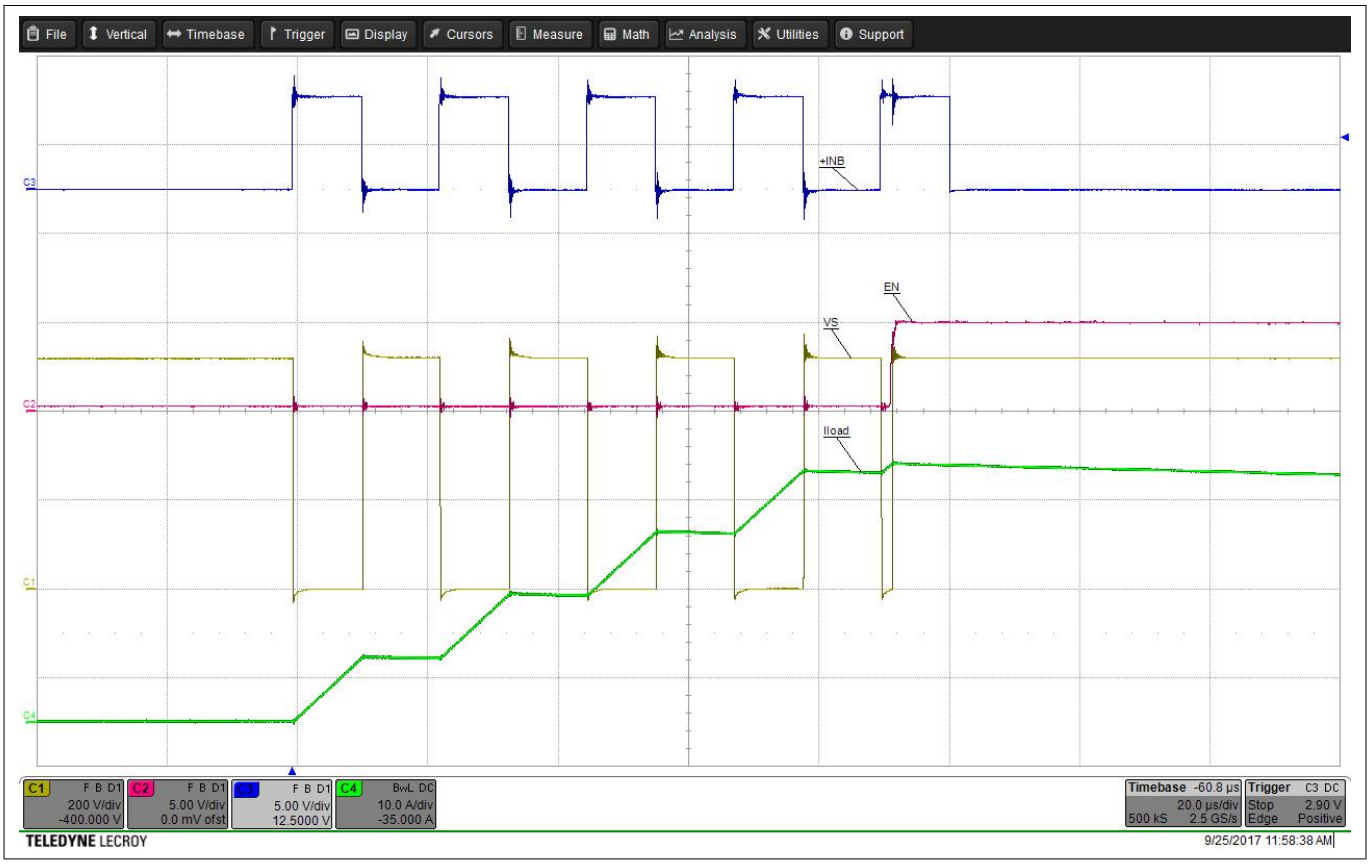


Figure 2 OC Turn off (Ch1: Phase, Ch2: Enable, Ch3: IN_B, Ch4: I_load)

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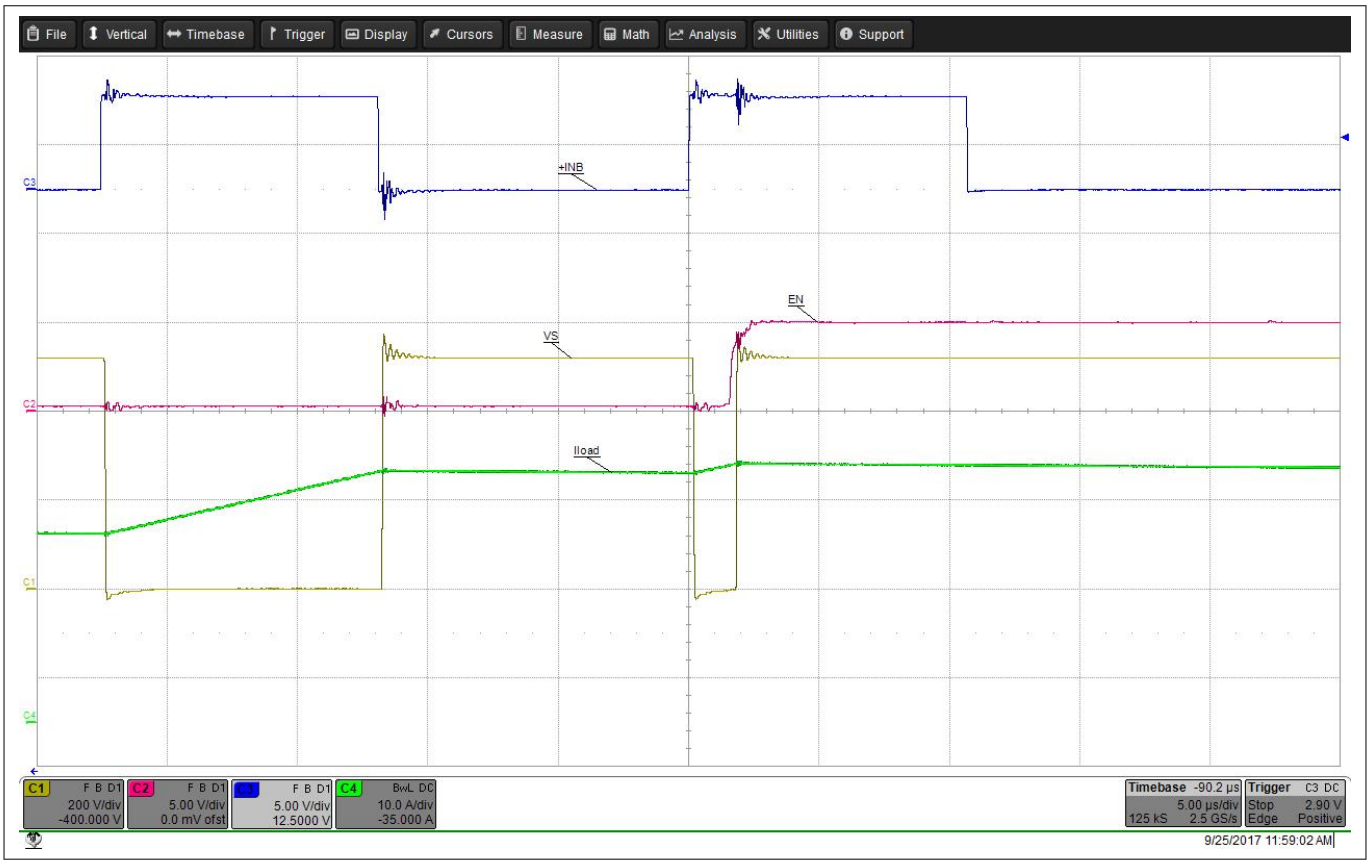


Figure 3 OC Turn off details (Ch1: Phase, Ch2: Enable, Ch3: IN_B, Ch4: I_load)

1.3 Pin assignment

Description of PCB connectors

The evaluation PCB has several connectors to supply the board and to get different signals in or out.

Table 5 PCB power connectors

Connector	Schematic	Note
J1	Gate driver	J1.1 = J1.2 = high voltage power supply
J2	Gate driver	J2.1 = *PHASE* and J2.2 = center point blocking caps
J3	Gate driver	J3.1 = *SENSE* and J3.2 = high voltage *GND*
J4	Interface	J4.1 = *+15V* to supply the PCB, J4.2 = *GND*
J5	Interface	J5.1 = *VCC1* output, J5.2 = *GND*

Table 6 Digital interface connector, labeled CON1

Pin number	Pin marking	Note
1	*ENABLE*	To enable driver pull to low
2	*FAULT*	Fault output to report over current faults, low active
3	*GND*	Ground low-voltage domain
4	*RST*	Reset of fault flip-flop, lowl active

(table continues...)

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Table 6 (continued) Digital interface connector, labeled CON1

Pin number	Pin marking	Note
5	*GND*	Ground low-voltage domain
6	*IN_T*	Input high side (top), high active
7	*GND*	Ground low-voltage domain
8	*IN_B*	Input low side (bottom), high active
9	*GND*	Ground low-voltage domain
10	*VCC1*	*VCC1* supply output, on board generated out of *+15V*

2 Schematic

The schematic of the evaluation boards is separated in three parts.

- Gate driver schematic, see Figure 4, high-side and low-side gate driver in a half-bridge configuration and the over-current detection and protection circuit with voltage regulator and feedback path.
- Power supply schematic, see Figure 5, DC-DC converter to generate the isolated power supply for the high-side and the low-side gate driver out of the *+15V* supply voltage.
- Interface schematic, see Figure 6, interface to a digital driver or a microcontroller with on board 5 V voltage regulator and the error flip-flop to store an over current event.

There are three voltage domains:

- Low-voltage domain
- High-voltage domain TOP
- High-voltage domain BOTTOM

The different domains are separated by dotted lines and marked with the respective domain names. The three domains are galvanically isolated from each other.

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2.1 Gate driver schematic

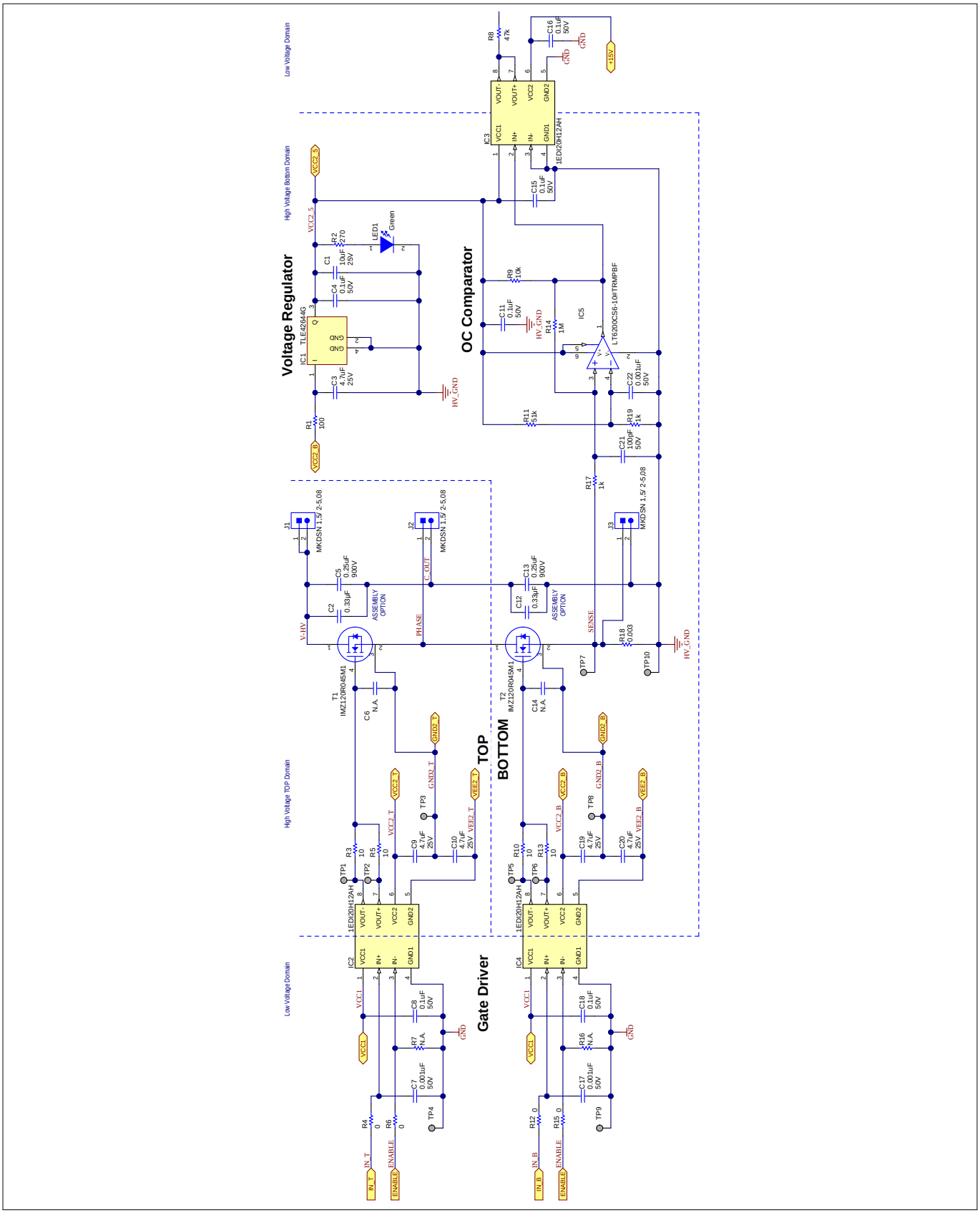


Figure 4 The gate driver schematics

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The low-voltage domain is shown on the left-hand side and on the right-hand side of Figure 4. It is typically used to connect to a microcontroller and supplied with *VCC1*. Every supply pin *VCC1* has a blocking capacitor C8 and C18 to *GND1*.

Every gate driver has two inputs:

- *IN+*, non-inverted input, high signal will turn the corresponding SiC MOSFET ON.
- *IN-*, inverted input, high signal will turn the corresponding SiC MOSFET OFF.

The circuit part on the right hand side of the schematic is the feedback interface to deliver over current signal information to the microcontroller.

C2 and C5 are high voltage supply blocking caps. Only C5 is utilized, while C2 is optional. J1 is the input connector for the high voltage supply.

The connector J2.1 is connected to the center of the half bridge called PHASE. J2.2 is connected to the blocking capacitors C5, C13.

C12 and C13 are high voltage supply blocking caps. Only C13 is utilized, while C12 is optional. J3.2 is the connector for the high-voltage supply ground. J3.1 is the connector to the shunt resistor R18.

2.1.1 High-side gate driver TOP

In the top center section the high-side driver, called TOP, is shown. It is the output of the gate driver IC2, supplied with *VCC2_T* and *VEE2_T* . *VCC2_T* is decoupled by the blocking capacitor C9 and *VEE2_T* has the blocking capacitor C10.

The charging current of the SiC MOSFET T1 is limited by R3.

The discharging current of the SiC MOSFET T1 is limited by R5.

The capacitor C6 is optional and not utilized. It can be used to decrease the switching time of T1 if needed.

2.1.2 Low-side gate driver BOTTOM

In the lower center of the schematic, the low-side driver BOTTOM is shown. It is the output of the gate driver IC4, supplied with *VCC2_B* and *VEE2_B*. *VCC2_B* has the blocking capacitor C19 and *VEE2_T* has the blocking capacitor C20.

The charging current of the SiC MOSFET T2 is limited by R10.

The discharging current of the SiC MOSFET T2 is limited by R13.

The capacitor C14 is optional and not utilized. It can be used to decrease the switching time of T2 if needed.

The shunt resistor R18 is used to detect over current. The low-pass filter R17 and C21 will filter the voltage signal across R18 and deliver it to the comparator IC5.

The reference signal for the comparator is created with the voltage divider R11 and R19 with filter capacitor C22.

The over current detection threshold can be adjusted by changing the reference voltage with divider R11 and R19 or changing the shunt resistor R18.

IC1 is a voltage regulator to create stabilized *VCC2_5* out of *VCC2_B*. *VCC2_5* is the supply voltage for IC5 and IC3. LED1 is a signal LED to show that *VCC2_5* is available. C1, C3 and C4 are blocking capacitors for proper operation of IC1.

IC3 is used as a feedback part to transfer the over-current information from the HV BOTTOM domain to the low-voltage domain. The supply voltage *VCC1* is supplied by *VCC2_5* and blocked with the capacitor C15. The output side of IC3 transfers from *OUT+* and *OUT-* through R8 to the base of T6 of the fault flip-flop in the interface schematic. *VCC2* of IC3 is supplied with pin *+15V*.

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2.2 Power-supply schematic

This part explains the schematic of the power supply containing the isolated DC-DC converter

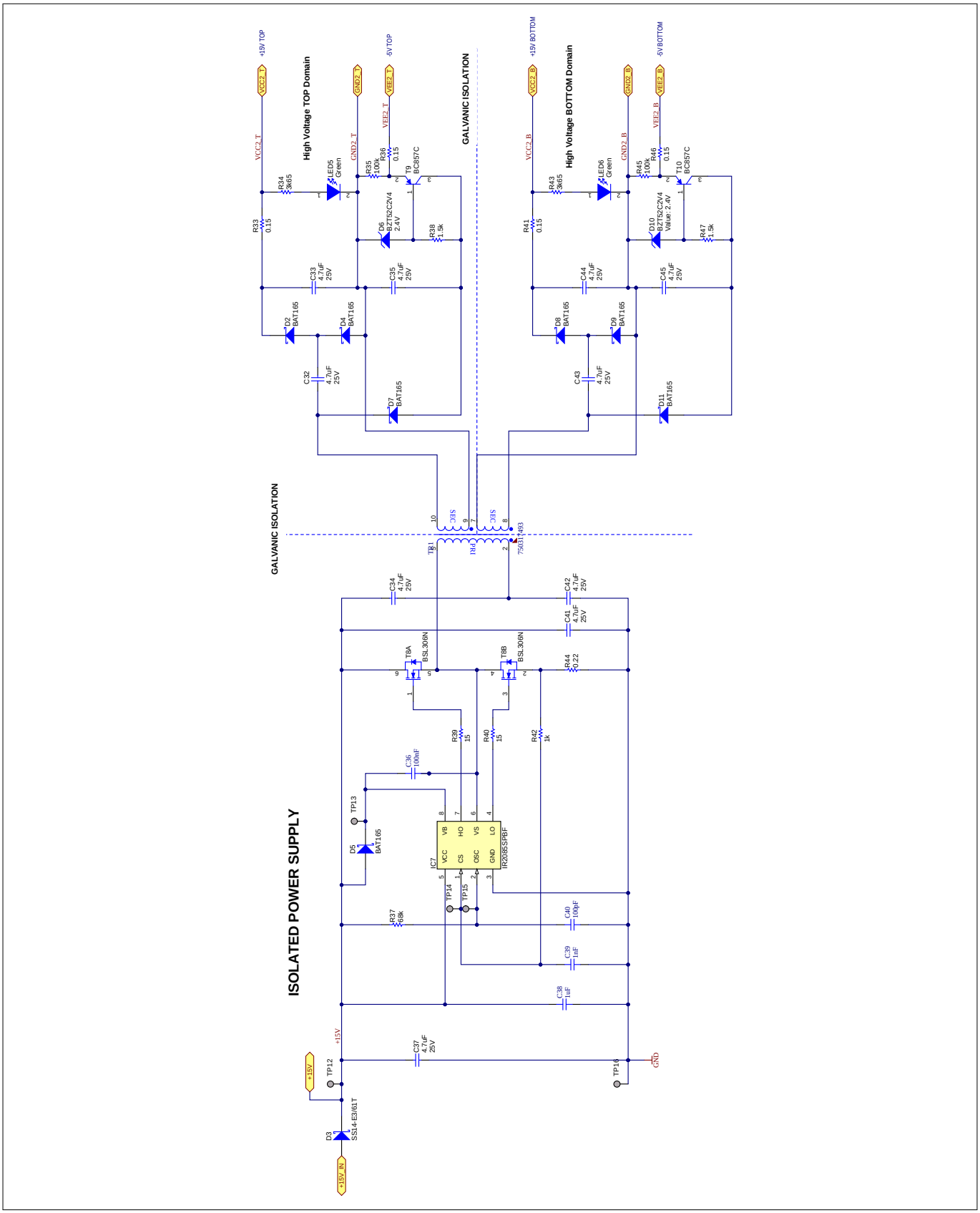


Figure 5 Power supply schematic

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2 Schematic

The power-supply schematic in Figure 5 shows the galvanically isolated DC-DC converter to generate the isolated supply *VCC2_T* and *VEE2_T* to supply the high side driver and *VCC2_B* and *VEE2_B* to supply the low side driver.

On the left-hand side the generator part with the IC7 IR2085SPBF is displayed. It works in combination with transistors BSL306N as half bridge T8A and T8B. The phase of the half bridge drives the transformer TR1 input side N1.

The supply is called +15V and connected via the diode D3 from *+15V_IN*, connector J4.1. Please see interface schematic.

N2 and N3 are the galvanically isolated output coils of the TR1 transformer .

N3 and the rectifier circuit with D7, D2, D4, D6, and T9 are used to generate the supply voltages *VCC2_T* and *VEE2_T* for the high voltage TOP domain. LED5 is showing the proper operation of this circuit part.

N2 and the rectifier circuit with D11, D8, D9, D10, and T10 are used to generate the supply voltages *VCC2_B* and *VEE2_B* for the high voltage BOTTOM domain. LED6 is indicating the proper operation of this circuit part.

The transformer galvanically isolates the three different domains:

- The low-voltage domain
- The high-voltage domain TOP
- The high-voltage domain BOTTOM

The gate-driver supply voltages can be adapted to support the voltage requirements of different power transistors:

- The positive supply voltage *VCC2_T*and *VCC2_B* can be adapted by changing the transformer TR1 with different N1 to N2 and N3 ratio or by changing the input voltage *+15V_IN*.
- The negative supply voltages *VEE2_T* and *VEE2_B* can be adapted to different voltages by changing the zener diodes D6 and D10.

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2.3 Interface schematic

This part explains the schematic of the interface to the microcontroller

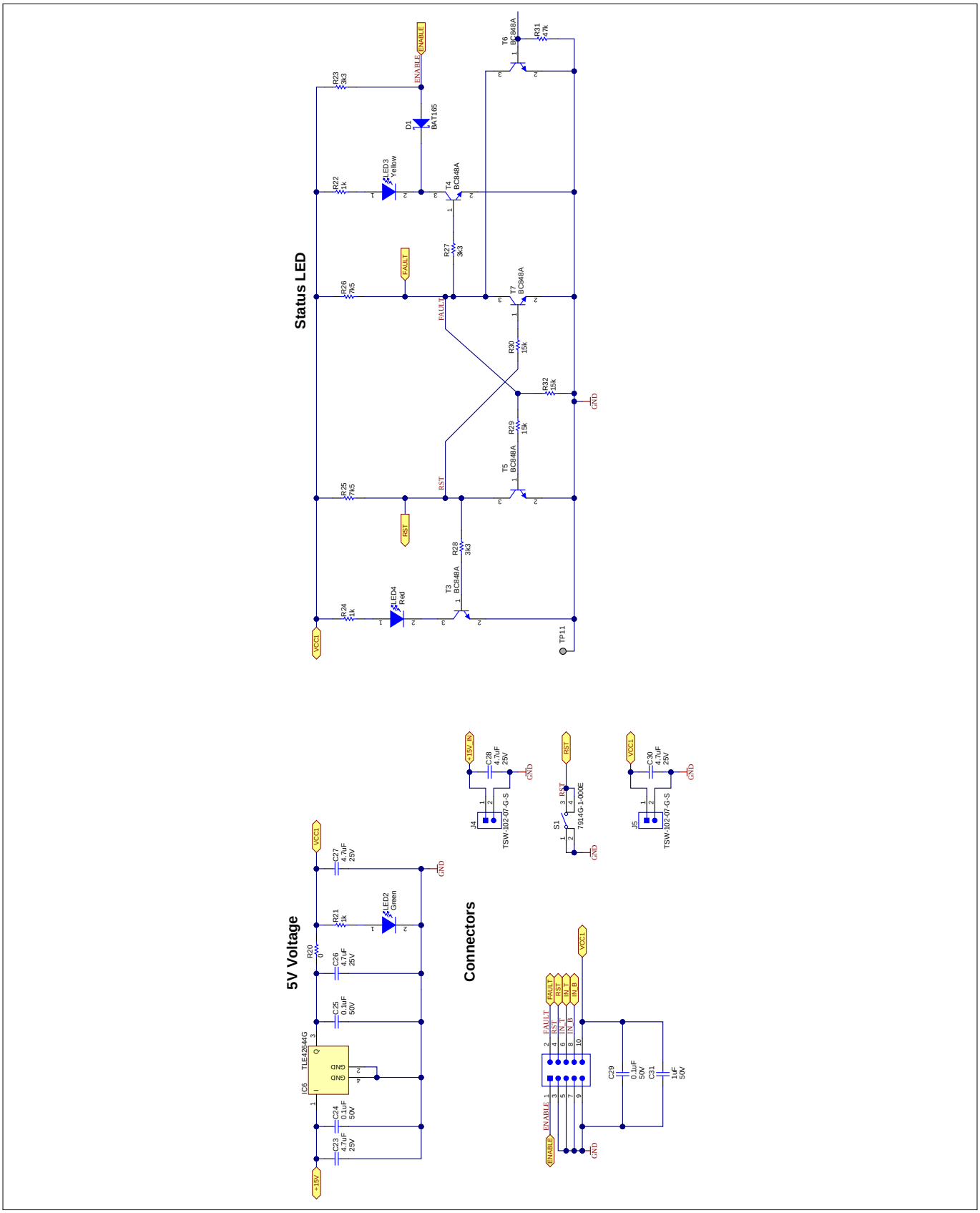


Figure 6 The interface schematic with failure flip-flop

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The interface schematic, in Figure 6, contains in the upper left corner the 5 V regulator IC6 to generate the VCC1 for the low voltage domain.

The 10 pin interface connector to the digital driving circuit like a microcontroller, the 15 V input connector J4, the reset button S1 and VCC1 output J5 are placed on the lower left side of the schematic marked as connectors.

The error flip-flop is displayed on the right hand side with the Status LED. It's triggered with the signal from R8 in the gate driver schematics. LED4 will indicate an over-current event and LED3 will indicate normal operation.

The error flip-flop with over current detection circuit is intended to protect the board during lab evaluation. In the real application it's not required.

3 PCB Layout

A special PCB layout was developed to demonstrate the excellent performance of the components used. Main part is the interaction between the gate driver and the SiC MOS transistor as well as the current path for the high power supply, load and power GND.

Also the supporting circuits like the DC-DC converter, the over current detection with the shunt resistor and the power supply of all circuit parts were optimized for this board.

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3 PCB Layout

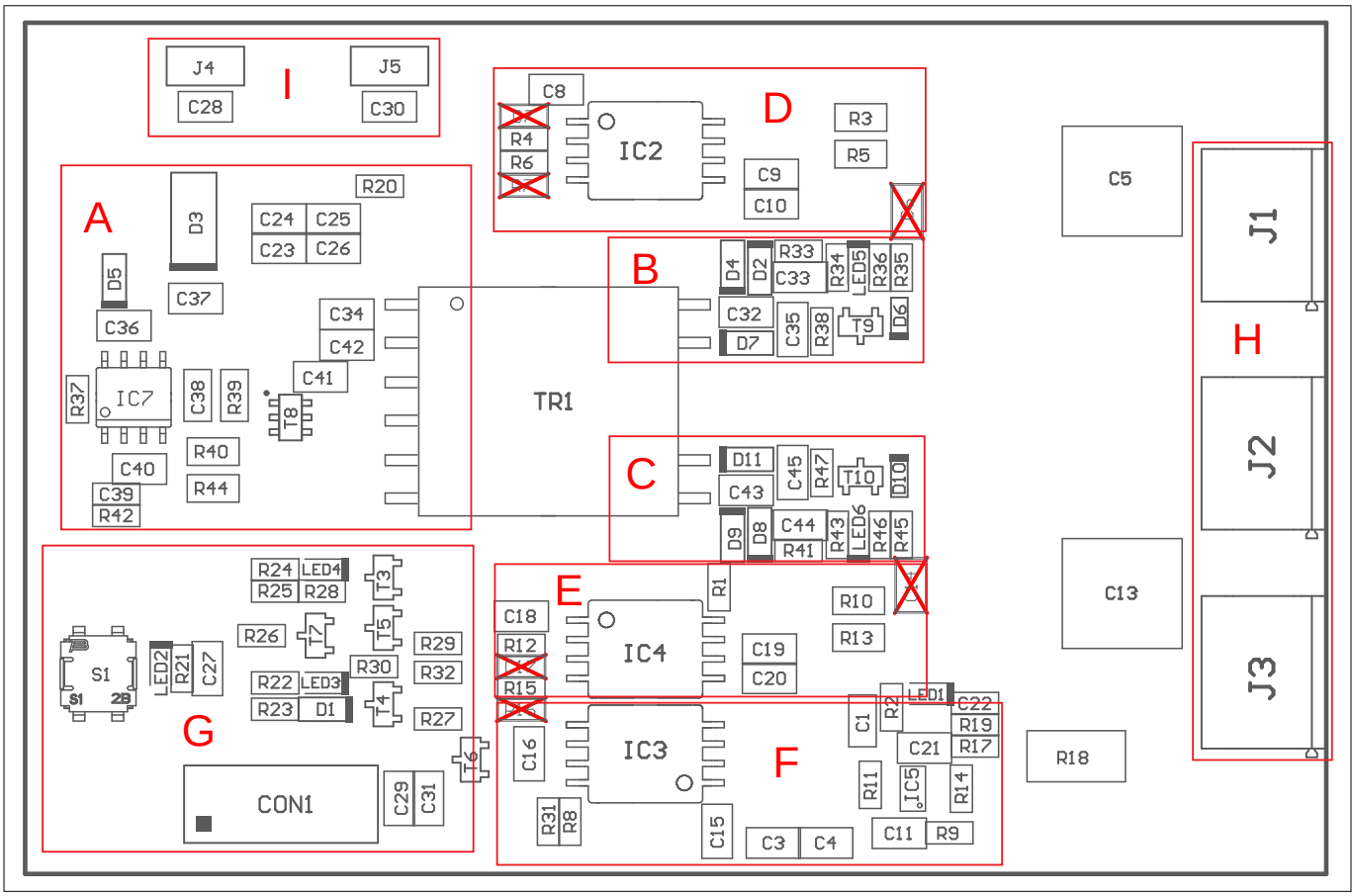


Figure 7 Layout blocks

The different blocks are marked with character A to I.

- A: DC-DC converter IR2085SPBF on primary side to generate the isolated power supply for gate driver
- B: Secondary isolated power supply for TOP domain
- C: Secondary isolated power supply for BOTTOM domain
- D: High side gate driver
- E: Low side gate driver
- F: Feedback signal to report over current information, the 5 V voltage regulator and current comparator
- G: Error flip-flop, digital connector CON1 and reset button S1
- H: Power connectors
- I: Supply connectors and the 5 V voltage regulator

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3.1 Assembly drawing

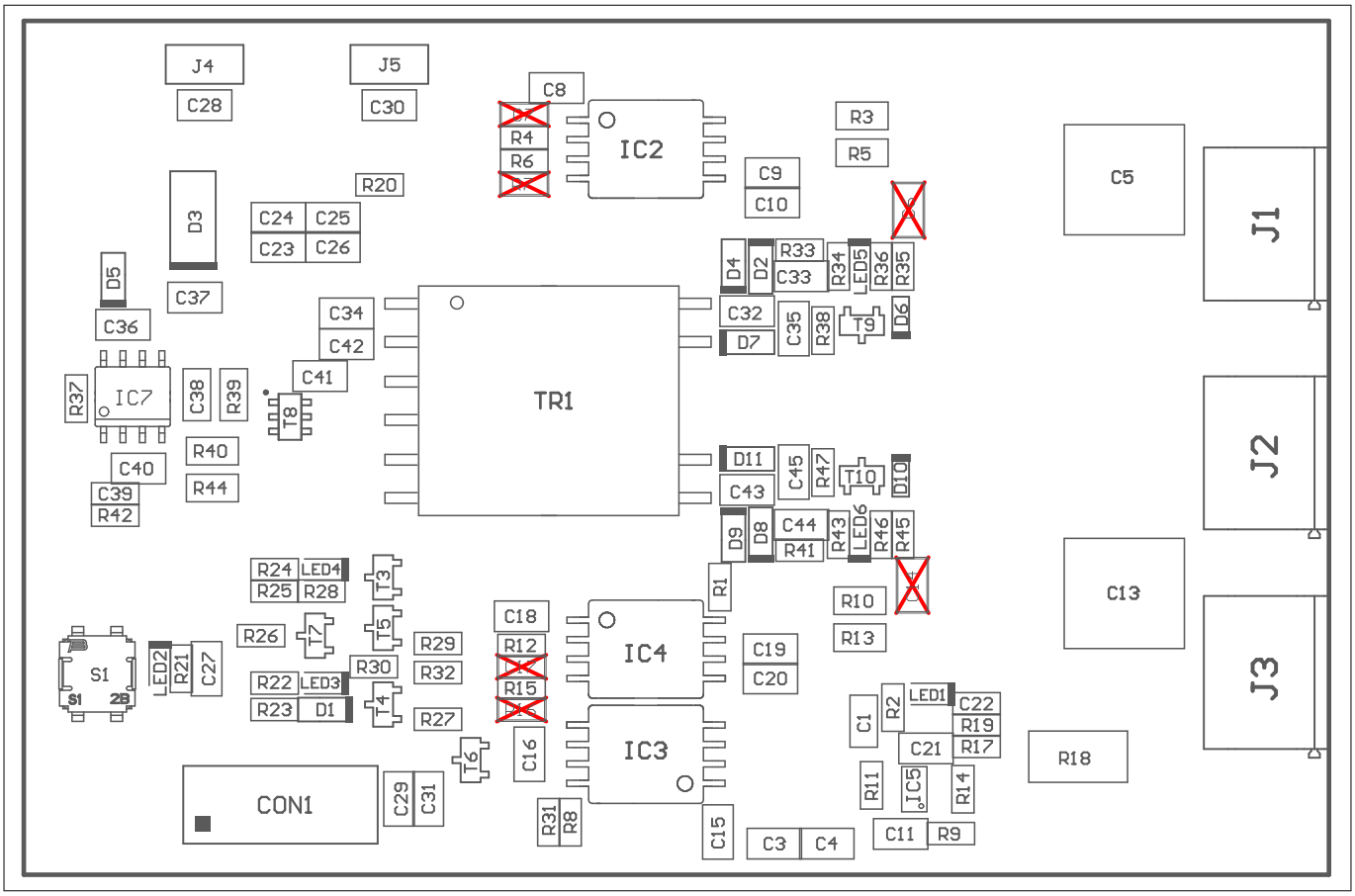


Figure 8 Assembly Drawing top side PCB

The assembly drawing is showing the assembly top side of the PCB. The components are marked with the respective identifiers. The components marked with red crosses are not populated and can be installed optional by the user.

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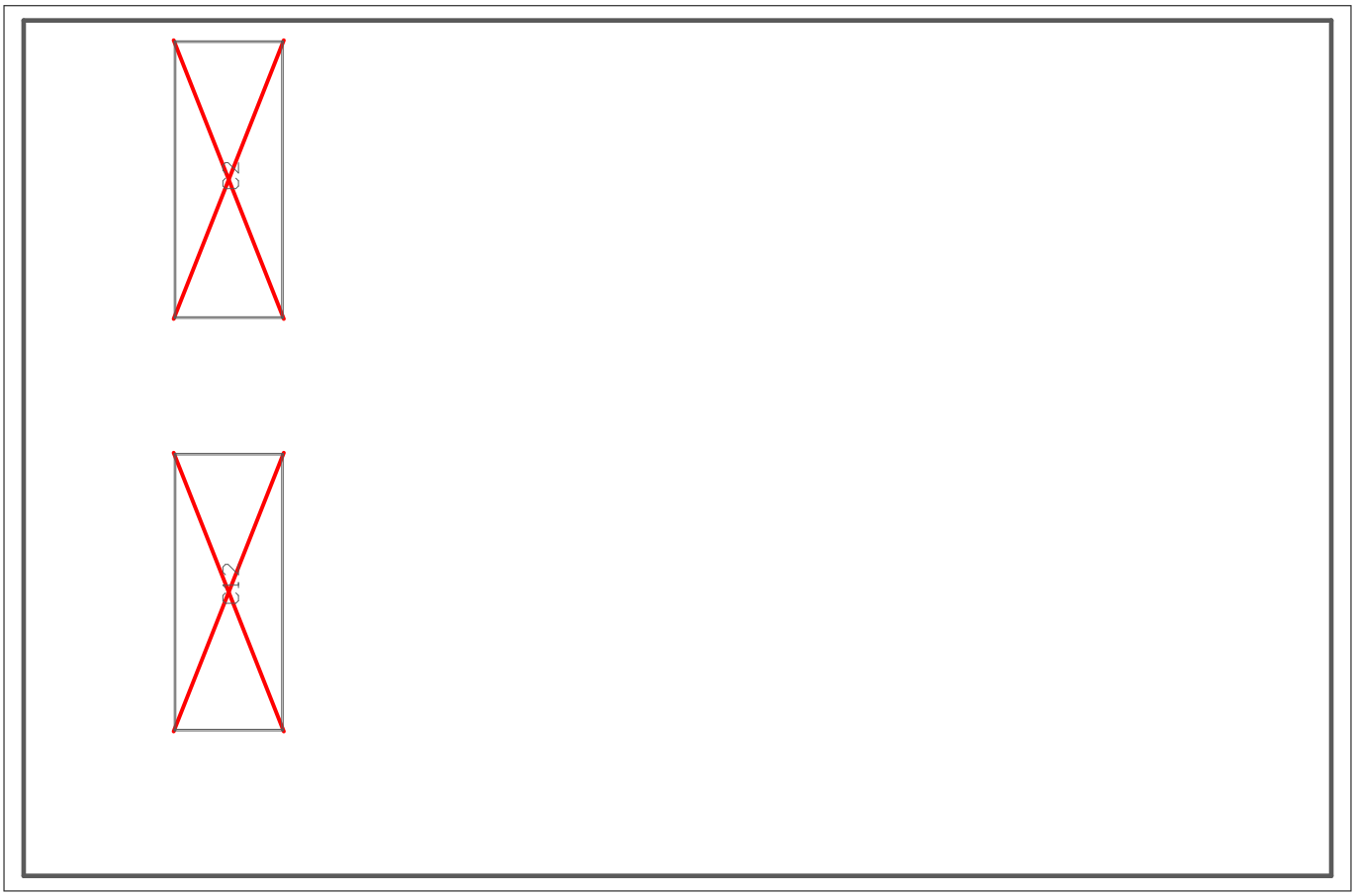


Figure 9 Assembly Drawing bottom side PCB

This is the bottom side of the PCB. The two capacitors C2 and C12 are not populated and therefore marked with a red cross. The capacitors can be installed optional in case they are needed.

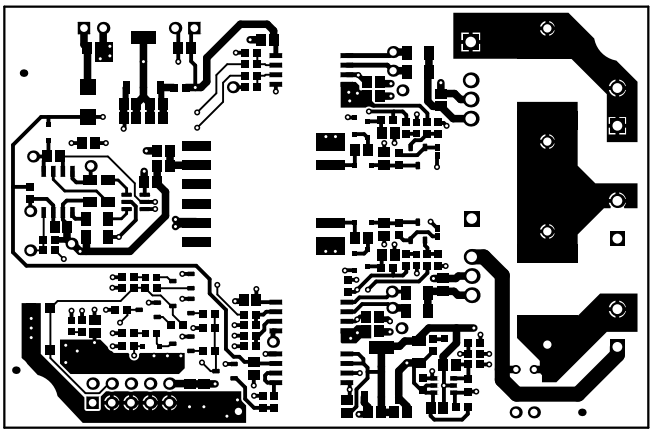


Figure 10 PCB layer TOP

This is the PCB layer 1, the top side of the board.

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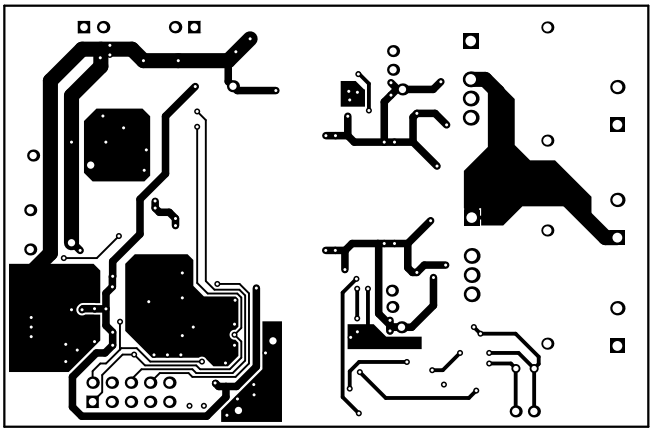


Figure 11 PCB layer BOTTOM

This is the PCB layer 2, the bottom side of the board

4 Bill of material

The BOM lists all components used for the PCB

Item	Designator	Quantity	Description	Manufacturer	PartNumber
1	C1	1	CAP, CERM, 10µF, 25V, +/- 10%, X7R, 1206	Würth Elektronik	885012208069
2	C3, C9, C10, C19, C20, C23, C26, C27, C28, C30, C32, C33, C34, C35, C37, C41, C42, C43, C44, C45	20	CAP, CERM, 4.7µF, 25V, +/- 10%, X7R, 0805	MuRata	GRM21BR71E475KA73L
3	C4, C8, C11, C15, C16, C18, C24, C25, C29, C36	10	CAP, CERM, 0.1µF, 50V, +/- 10%, X7R, 0805	Würth Elektronik	885012207098
4	C5, C13	2	CAP, CERM, 0.25uF, 900V, 20%, CeraLink	TDK	Z63000Z2910Z 1Z21
5	C21, C40	2	CAP, CERM, 100pF, 50V, +/- 5%, NP0, 0805	Würth Elektronik	885012007057
6	C7, C17, C22, C39	4	CAP, CERM, 0.001µF, 50V, +/- 10%, X7R, 0603	Würth Elektronik	885012206083
7	C31	1	CAP, CERM, 1µF, 50V, +/- 10%, X7R, 0805	Würth Elektronik	885012207103
8	C38	1	CAP, CERM, 1µF, 50V, +/- 10%, X7R, 1206	Würth Elektronik	885012208093
9	CON1	1	Header, 100mil, 5x2, Gold, TH	Würth Elektronik	61301021121
10	D1, D2, D4, D5, D7, D8, D9, D11	8	Diode, Schottky, 40 V, 0.75 A, AEC-Q101, SOD-323	Infineon Technologies	BAT165
11	D3	1			SS14-E3/61T

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			Diode, Schottky, 40 V, 1A, AEC-Q101, DO214AC	Vishay Semiconductor	
12	D6, D10	2	Diode, Zener, 2.4 V, 300 mW, SOD-523	Diodes Inc.	BZT52C2V4
13	IC1, IC6	2	Low Drop Fixed Voltage Regulator, 5.5 to 40 V Supply, 5 V Output, -40 to 150 degC, PG-SOT223 (SC-73), Reel, Green	Infineon Technologies	TLE42644G
14	IC2, IC3, IC4	3	Single channel IGBT gate driver IC in wide body package	Infineon Technologies	*1EDC20H12AH* or *1EDI20H12AH*
15	IC5	1	Rail-to-Rail Input and Output, 0.95nV/√Hz Low Noise, Op Amp Family	Linear Technology	LT6200CS6-10#TRMPBF
16	IC7	1	HIGH SPEED, 100V, SELF OSCILLATING 50% DUTY CYCLE, HALF-BRIDGE DRIVER	International Rectifier	IR2085SPBF
17	J1, J2, J3	3	TERM BLOCK 2POS 5mm, TH	691213510002	691213510002
18	J4, J5	2	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
19	LED1, LED2, LED5, LED6	4	LED, Green, SMD	Lite-On	LTST-C190GKT
20	LED3	1	LED, Yellow, SMD	Lite-On	LTST-C190YKT
21	LED4	1	LED, Red, SMD	Lite-On	LTST-C190CKT
22	R1	1	RES, 100R, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603100RFKEA
23	R2	1	RES, 270R, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603270RFKEA
24	R3, R5, R10, R13	4	RES, 10R, 1%, 0.25W, 1206	Vishay-Dale	CRCW120610R0FKEA
25	R4, R6, R12, R15, R20	5	RES, 0R, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603000Z0EA
26	R8, R31	2	RES, 47k, 1%, 0.1W, 0603	Vishay-Dale	CRCW060347K0FKEA
27	R9	1	RES, 10k, 1%, 0.1W, 0603	Vishay-Dale	CRCW060310K0FKEA
28	R11	1	RES, 51k, 1%, 0.1W, 0603	Vishay-Dale	CRCW060351K0FKEA
29	R14	1	RES, 1M, 1%, 0.1W, 0603	Vishay-Dale	CRCW06031M00FKEA
30	R17, R19, R21, R22, R24, R42	6	RES, 1k, 1%, 0.1W, 0603	Vishay-Dale	CRCW06031K00FKEA
31	R18	1	RES, 0R003, 1%, 3W, 2512	Bourns Inc.	CRE2512-FZ-R003E-3
32	R23, R27, R28	3	RES, 3k3, 1%, 0.1W, 0603	Vishay-Dale	CRCW06033K30FKEA
33	R25, R26	2	RES, 7k5, 1%, 0.1W, 0603	Vishay-Dale	CRCW06037K50FKEA
34	R29, R30, R32	3	RES, 15k, 1%, 0.1W, 0603	Vishay-Dale	CRCW060315K0FKEA

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35	R33, R36, R41, R46	4	RES, 0R15, 1%, 0.2W, 0603	Vishay-Dale	RCWE0603R150FKEA
36	R34, R43	2	RES, 3k65, 1%, 0.1 W, 0603	Vishay-Dale	CRCW06033K65FKEA
37	R35, R45	2	RES, 100k, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603100KFKEA
38	R37	1	RES, 68k, 1%, 0.1W, 0603	Vishay-Dale	CRCW060368K0FKEA
39	R38, R47	2	RES, 1k5, 1%, 0.1W, 0603	Vishay-Dale	CRCW06031K50FKEA
40	R39, R40	2	RES, 15R, 1%, 0.25W, 1206	Vishay-Dale	CRCW120615R0FKEA
41	R44	1	RES, 0R22, 1%, 0.5W, 1206	Vishay-Dale	RCWE1206R220FKEA
42	S1	1	Switch, Tactile, SPST-NO, 0.1A, 16V, SMT	Bourns	7914G-1-000E
43	T1, T2	2	CoolSiC™ MOSFET 1200V	Infineon Technologies	IMZ120R045M1
44	T3, T4, T5, T6, T7	5	Transistor, NPN, 30 V, 0.1 A, SOT-23	ON Semiconductor	BC848A
45	T8	1	MOSFET, 2-CH, N-CH, 30 V, 2.3 A, TSOP-6_DUAL	Infineon Technologies	BSL306N
46	T9, T10	2	Transistor, PNP, 45 V, 0.1 A, SOT-23	ON Semiconductor	BC857C
47	TR1	1	Drive Transformer, SMT	Würth Elektronik	750317493 or 750318016

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