AN2019-23 EVAL-1ED3124Mx12H

Evaluation board description

About this document

Scope and purpose

The gate driver evaluation board EVAL-1ED3124Mx12H with the 1ED3124MU12H or 1ED3124MC12H gate driver IC demonstrates the functionality and key features of the Infineon EiceDRIVER™ Compact gate driver ICs.

The boards contain a short circuit protection which is described in more detail in the key feature section of this document.

Details about the EiceDRIVER™ Compact 1ED3124MU12H or 1ED3124MC12H can be found at our product pages at https://www.infineon.com/gd or the product search.

The design of the EVAL-1ED3124Mx12H 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 not subject to full production test.

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™
- 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

1.1 Key features

The evaluation board EVAL-1ED3124Mx12H is intended for the product feature evaluation of the Infineon EiceDRIVER™ Compact 1ED3124MU12H or 1ED3124MC12H in an application circuit. The key elements of the board and the product are listed here.

- Evaluation board in half-bridge configuration with two gate driver ICs to drive power switches such as IGBTs and SiC MOSFETs. The switch type can be freely chosen as seen in Figure 1
- Additional gate driver IC for isolated over-current feedback signal from high voltage side to logic control side
- Fast operational amplifier used as comparator for over-current detection

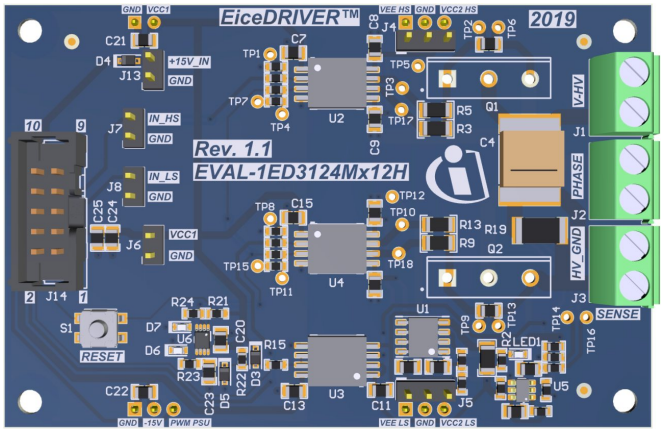


Figure 1 EVAL-1ED3124Mx12H top view

The board has a size of 85 x 55 x 15 mm^3. Power switches are not included in this evaluation board and need to be ordered separately.

This board is best suited for so-called double-pulse testing. However, it requires additional considerations on thermal and power load for continuous operation. An additional high-voltage DC blocking capacitor at 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 over-current detection and protection circuit is implemented with a galvanically isolated feedback path to the low-voltage input side. The input side flip-flop latches the over-current event information. This circuit will report the fault and turn off both gate driver ICs. The S1 button, also labeled with *RESET*, clears the flip-flop to enable the gate driver ICs again.

1.2 Absolute maximum ratings, operating conditions and supply voltages

The selected components on this evaluation board as well as the gate driver ICs have maximum ratings and operating conditions to avoid damaging the individual parts and the evaluation board overall.

Table 1 Absolute maximum ratings

Pin/parameter name	Abs. Max.	Unit	Note
+15V_IN	-0.2 … 20	V	input, support supply voltage

(table continues...)

1 Electrical description

Table 1 (continued) Absolute maximum ratings

Pin/parameter name	Abs. Max.	Unit	Note
VCC1	-0.2 … 5.3	V	input, gate driver IC supply voltage
FAULT	-0.2 … *VCC1* + 0.2	V	output, digital signal
RST	-0.2 … *VCC1* + 0.2	V	input, digital signal
IN_HS	-0.2 … *VCC1* + 0.2	V	input, digital signal
IN_LS	-0.2 … *VCC1* + 0.2	V	input, digital signal
VCC2_HS,*VCC2_LS*	-0.2 … 40	V	overall isolated secondary supply with reference to *VEE2_HS*/*VEE2_LS*
VCC2_HS,*VCC2_LS*	-0.2 … 25	V	positive secondary supply voltage with reference to *GND2_HS*/*GND2_LS*
GND2_HS,*GND2_LS*	-0.2 … 25	V	gate reference supply pin with reference to *VEE2_HS*/*VEE2_LS*
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 tests
t_{pulse}	100	µs	maximum ON pulse length for double-pulse tests
f_{sw}	100	kHz	maximum switching frequency for continuous operation, careful consideration of power dissipation required

The PCB assembly is optimized for a *VCC1* supply voltage of 3.3 V. For higher supply voltages, adjustment to the current limiting resistors of the status LEDs is required.

Table 2 Operating conditions and supply voltages

Pin name	Min.	Typ.	Max.	Unit	Note
+15V_IN	15.5	16	16.5	V	input, support supply voltage
VCC1	3.2	3.3	3.4	V	input, gate driver IC supply voltage
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_HS	-0.1	3.3	*VCC1*+ 0.1	V	input, digital signal
IN_LS	-0.1	3.3	*VCC1*+ 0.1	V	input, digital signal
VCC2_HS,*VCC2_LS*	12	15	30	V	overall isolated secondary supply with reference to *VEE2_HS*/*VEE2_LS*

(table continues...)

Table 2 (continued) Operating conditions and supply voltages

Pin name	Min.	Typ.	Max.	Unit	Note
GND2_HS,*GND2_LS*	0		15	V	gate reference supply pin with reference to *VEE2_HS*/ *VEE2_LS*
V-HV	25		600	V	input, high voltage supply, for voltages above 42 V, special high voltage lab environment is strongly recommended

1.3 Start-up

Follow the steps below to set up, power up and perform first evaluations with the board.

Prerequisites

- Assemble fitting power switches at the location Q1 and Q2, e.g. IKQ75N120CH3 IGBTs
- Assemble an external high-voltage DC capacitor (> 100 µF) between *J1-1/2 (V-HV)* and *J3-2 (HV_GND)*
- Have low-voltage power supplies ready for input support and logic supply (*+15V_IN*, *VCC1*)
- Have isolated low-voltage power sources ready for gate driver output supply (*VCC2_LS*, *VCC2_HS*, *GND2_LS*, *GND2_HS*, *VEE2_LS* and *VEE2_HS*)
- Have a high-voltage power supply ready for HV-DC between *J1-1/2 (V-HV)* and *J3-2 (HV_GND)*
- Have an inductive load for double-pulse tests ready
- Have a dual channel PWM generator ready for half-bridge PWM input

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

Power-up sequence

1. Supply *+15V_IN* at connector *J13.2* with +16 V and connect supply *GND* to connector *J13.1*
2. Supply *VCC1* at connector *J6.2* with +3.3 V and connect supply *GND* to connector *J6.1*
3. The red LED D7 will turn on
4. Supply both secondary gate driver supplies with individual power sources at *VCC2_HS*, *GND2_HS*, and *VEE2_HS* at connector *J4*, and *VCC2_LS*, *GND2_LS* and *VEE2_LS* at connector *J5* according to the assembled power switch needs
5. The green LED1 will turn on
6. Push S1 to reset the error flip-flop
7. The red LED D7 will turn off and green LED D6 will turn on
8. Connect the digital PWM generator to the digital interface connectors *J7* and *J8* labeled with *IN_HS* and *GND* as well as *IN_LS* and *GND*
9. Connect the high-voltage supply to connector *J1.1* or *J1.2* and *HV_GND* to *J3.2*.
10. Connect one end of the inductive load to *J2.1* and the other end according to the double-pulse requirements to either *J1.1* or *J3.2* (low side or high side testing)
11. The board is now ready for double-pulse evaluation

1.4 Overcurrent protection

An overcurrent protection is implemented to protect the board and components against high current. The current is determined by measuring the voltage across the shunt resistor R19. This is available at the two test points TP14 and TP16.

The detection circuit measures the voltage across R19, sends the signal through a low pass filter R18 and C18 and compares it to a reference voltage with the comparator U5. The reference voltage is defined by the voltage

divider R12 and R20. The trip point is at approx. 32 A and can be adapted to application requirements by changing R19 and/or adapting the reference voltage divider R12 and R20.

The output signal is transferred with U3 to the low voltage domain to trigger the flip-flop and store the overcurrent event. Once the flip-flop is triggered, it turns off both gate driver ICs by the *ENABLE* signal. In addition, it reports the overcurrent event to the digital interface connector as *FAULT* signal and turns the LED7 on.

To return to normal operation, S1 needs to be pushed to reset the flip-flop. As a feedback, LED7 turns off and LED6 turns back on again.

1.5 Connectors and pin assignment

The following table describes connectors and their pin assignments on the PCB.

Table 3 Connectors and pin assignment

Connector	Pin	Marking/ function	Note
J1	1, 2	*V-HV*	High voltage power supply
J2	1, 2	*PHASE*	
J3	1	*SENSE*	
J3	2	*HV_GND*	
J4, J9	1	*VEE2_HS*	High side negative gate driver supply
J4, J9	2	*GND2_HS*	High side gate driver supply reference
J4, J9	3	*VCC2_HS*	High side positive gate driver supply
J5, J10	1	*VEE2_LS*	Low side negative gate driver supply
J5, J10	2	*GND2_LS*	Low side gate driver supply reference
J5, J10	3	*VCC2_LS*	Low side positive gate driver supply
J6, J7, J8, J11, J12, J13	1	*GND*	Logic side ground reference
J6, J12	2	*VCC1*	Logic side supply voltage, 3.3 V or 5 V
J7	2	*IN_HS*	Logic PWM input high side gate driver
J8	2	*IN_LS*	Logic PWM input low side gate driver
J11	2	*+15V*	15 V for external power supply without protection diode
J11	3	*PWM_PSU*	PWM output for external power supply from J14.9
J13	2	*+15V_IN*	15 V input supply voltage for external power supply
J14	1, 2	n.c.	not connected
J14	3	*VCC1*	Logic side supply voltage, 3.3 V or 5 V
J14	4	*GND*	Logic side ground reference
J14	5	*RST*	Reset input for overcurrent flip-flop, connected to S1
J14	6	*FAULT*	Fault feedback signal
J14	7	*IN_HS*	Logic PWM input high side gate driver

(table continues...)

Table 3 (continued) Connectors and pin assignment

Connector	Pin	Marking/ function	Note
J14	8	*IN_LS*	Logic PWM input low side gate driver
J14	9	*PWM_PSU*	PWM input for external power supply to J11.3
J14	10	*+15V*	15 V for external power supply without protection diode

2 Schematics

The schematics of the evaluation board are separated into the following parts:

- Gate driver ICs with surrounding circuit
- Overcurrent detection
- Overcurrent status display
- Interfaces with connectors and reset switch

2 Schematics

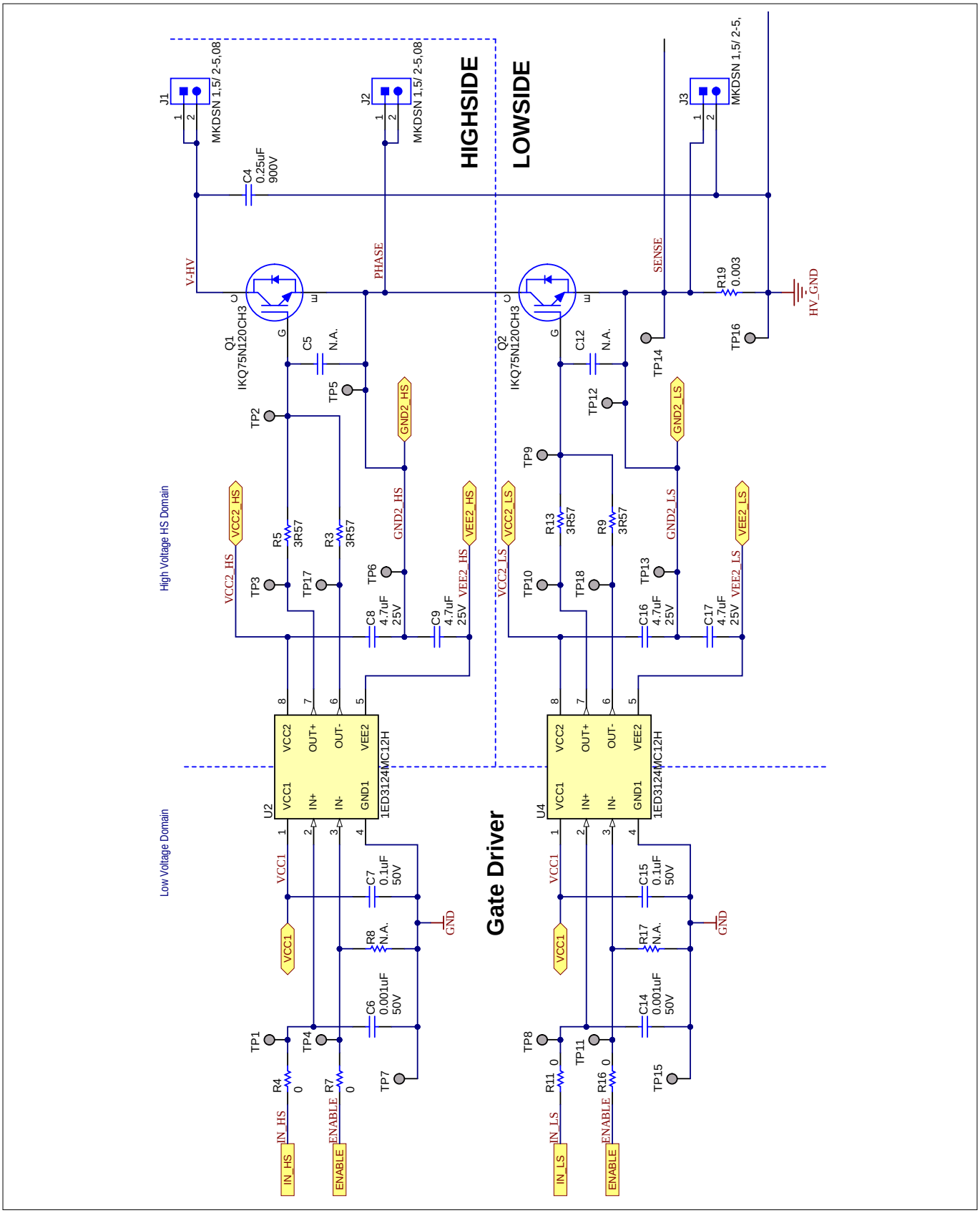


Figure 2 Schematic of gate driver ICs and surrounding circuits

Gate driver circuit with optional external input filter, output gate resistors for source and sink connection.

2 Schematics

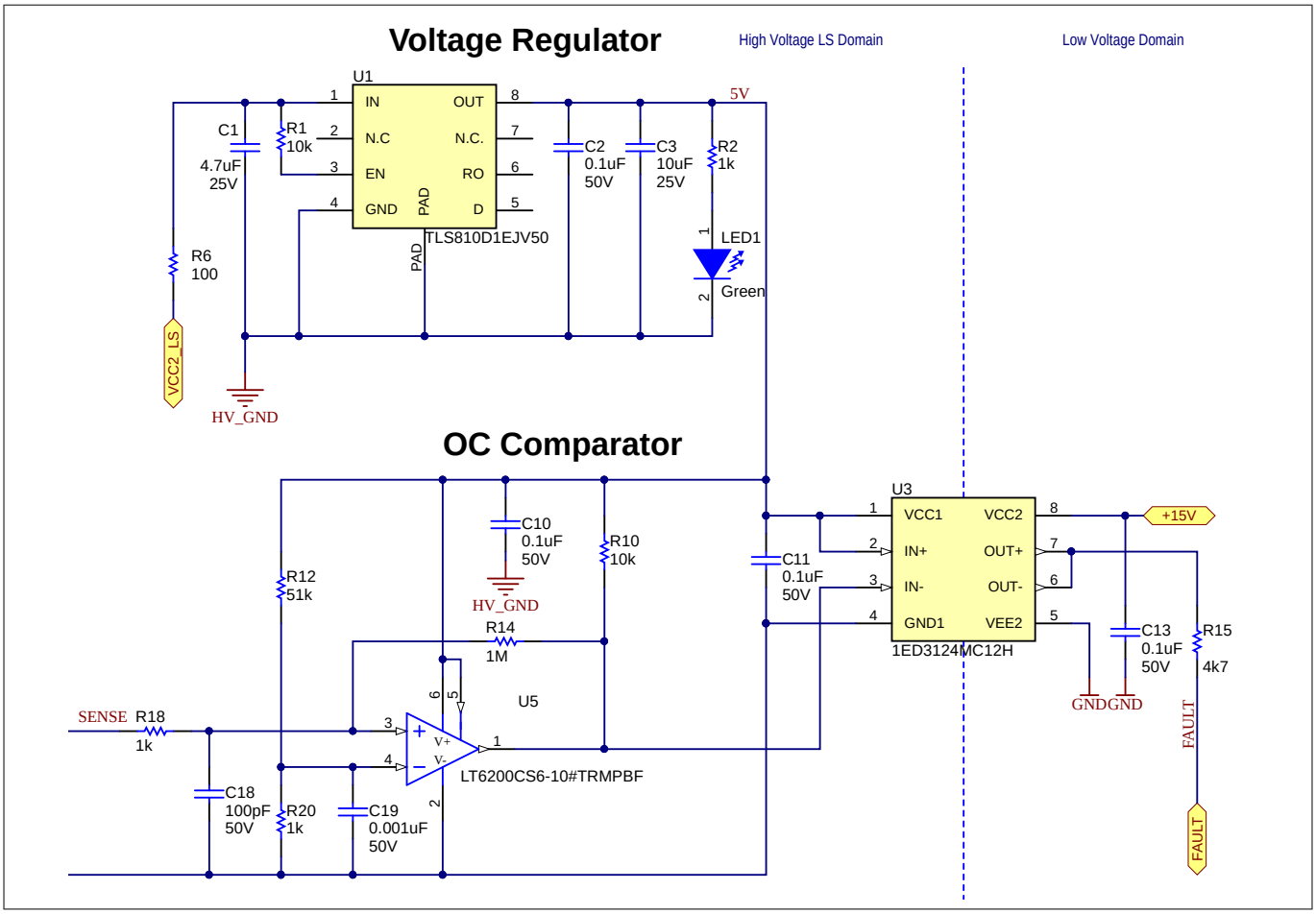


Figure 3 Schematic of overcurrent detection circuit

Overcurrent comparator with additional gate driver IC for isolated signal transmission and supporting voltage regulator.

2 Schematics

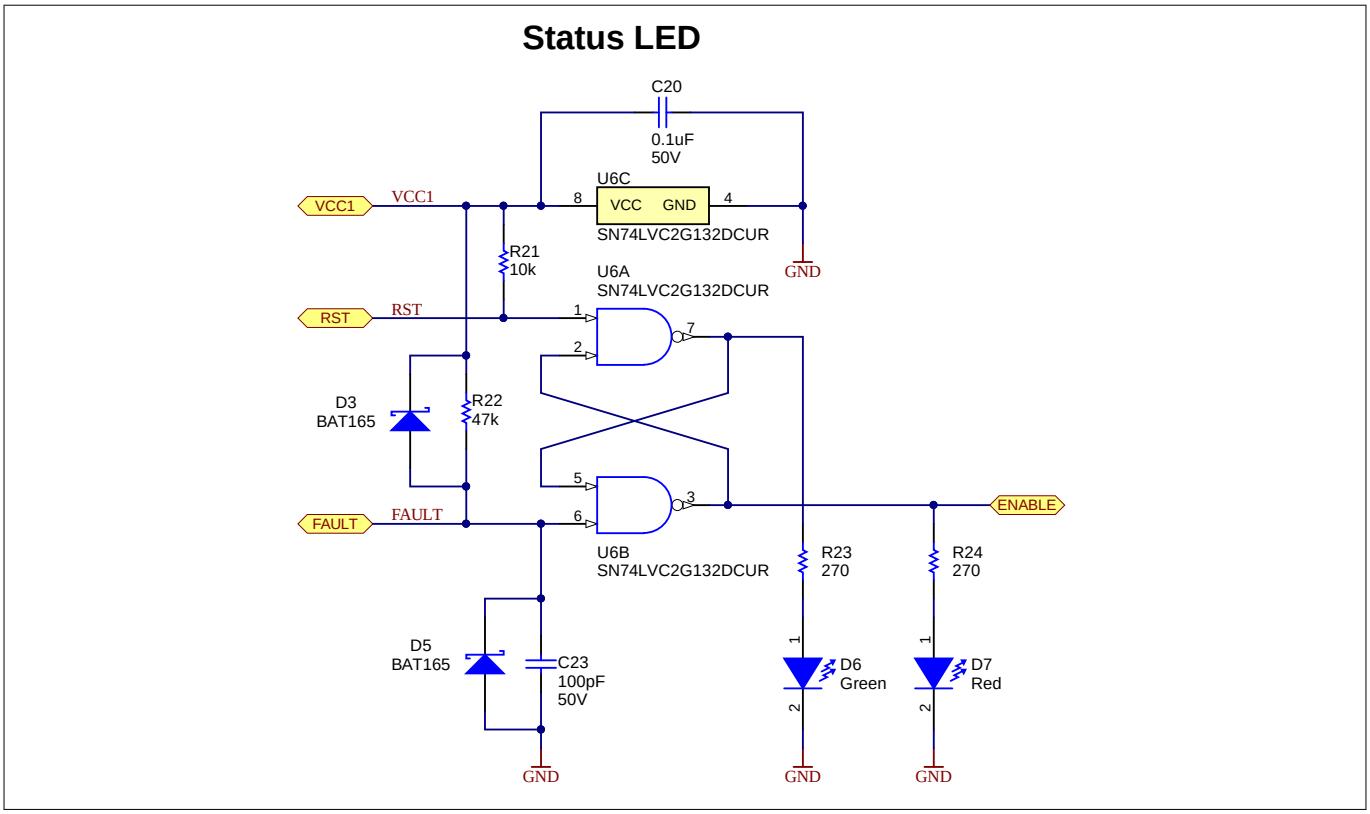


Figure 4 Schematic of overcurrent status indication

Fault signal and reset input of flip-flop including status LEDs.

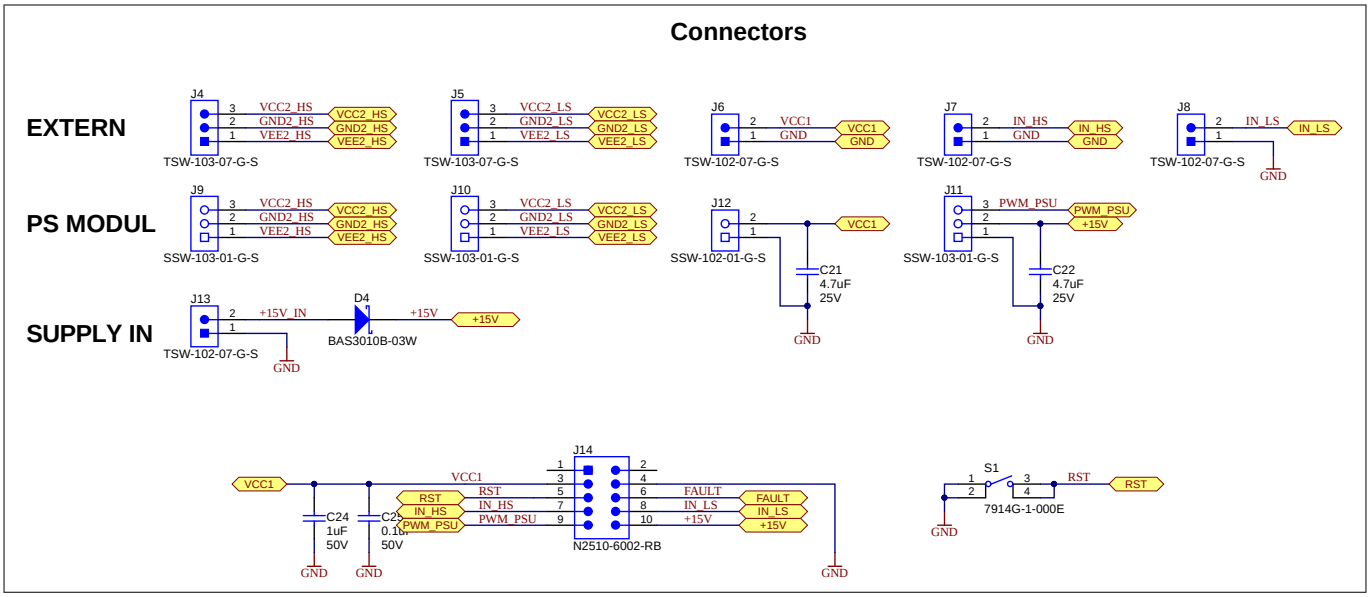


Figure 5 Schematic of connectors and reset switch

Interface connectors and reset button.

3 PCB layout

The layout from this basic schematic is intended as a starting point for developing more complex application circuits. The evaluation board has a two-layer PCB with top and bottom layer. Most components are assembled at the top layer.

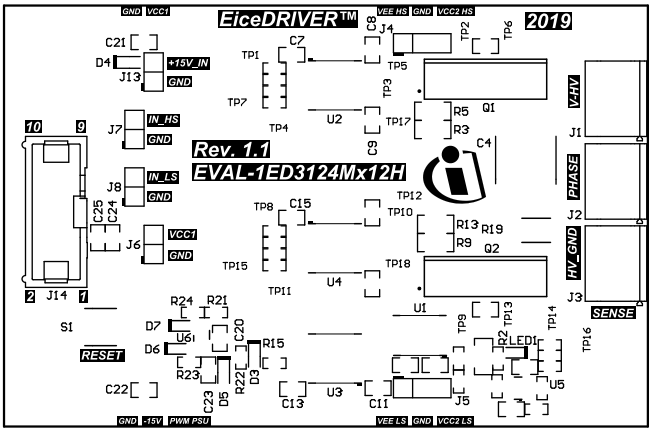


Figure 6 Assembly drawing top side PCB

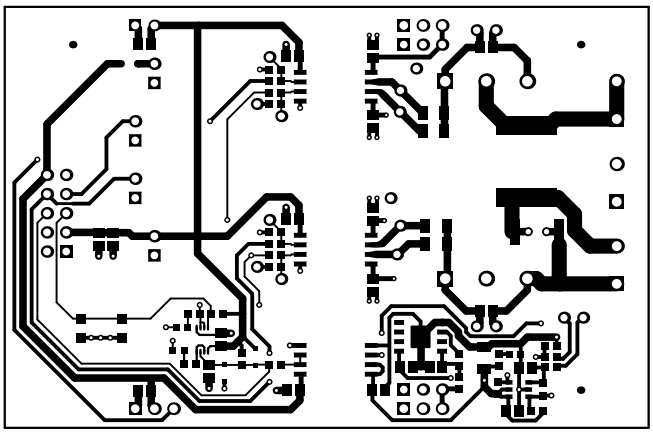


Figure 7 PCB layer top

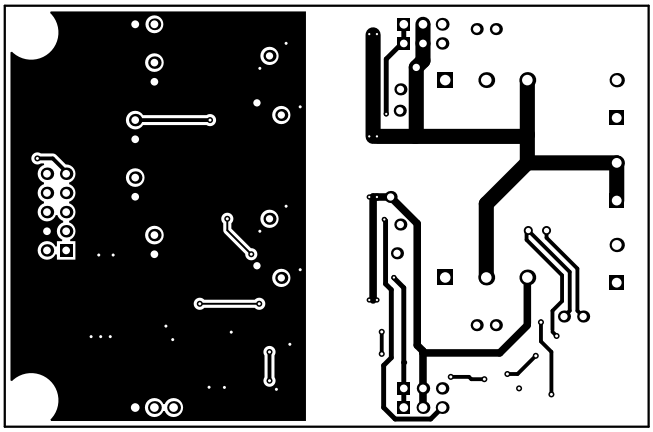


Figure 8 PCB layer bottom

4 Bill of material

The BOM lists all components used for the PCB.

Table 4 Bill of material

Designator	Quantity	Description	Manufacturer	Part number
C1, C8, C9, C16, C17, C21, C22	7	CAP, CERM, 4.7µF, 25V, +/- 10%, X7R, 0805	Samsung	CL21B475KAFNNNE
C2, C7, C10, C11, C13, C15, C20, C25	8	CAP, CERM, 0.1µF, 50V, +/- 10%, X7R, 0805	Wurth Electronics	885012207098
C3	1	CAP, CERM, 10µF, 25V, +/- 10%, X7R, 1206	Wurth Electronics	885012208069
C4	1	CAP, CERM, 0.25uF, 900V, 20%, CeraLink	TDK	B58031I9254M062
C18, C23	2	CAP, CERM, 100pF, 50V, +/- 5%, NP0, 0805	Wurth Electronics	885012007057
C19	1	CAP, CERM, 0.001µF, 50V, +/- 10%, X7R, 0603	Wurth Electronics	885012206083
C24	1	CAP, CERM, 1µF, 50V, +/- 10%, X7R, 0805	Wurth Electronics	885012207103
D3, D5	2	Diode, Schottky, 40 V, 0.75 A, AEC-Q101, SOD-323	Infineon Technologies	BAT165
D4	1	Diode, Schottky, 30V, 1A, AEC-Q101, SOD-323	Infineon Technologies	BAS3010B-03W
D6, LED1	2	LED, Green, SMD	Lite-On	LTST-C190GKT
D7	1	LED, Red, SMD	Lite-On	LTST-C190CKT
J1, J2, J3	3	TERM BLOCK 2POS 5mm, TH	Phoenix Contact	MKDSN 1,5/ 2-5,08
J6, J7, J8, J13	4	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
J9, J10, J11	3	Receptacle, 2.54mm, 3x1, Gold, TH	Samtec	SSW-103-01-G-S
J12	1	Receptacle, 2x1, 2.54mm, Gold, TH	Samtec	SSW-102-01-G-S
J14	1	Header (shrouded), 100mil, 5x2, High-Temperature, Gold, TH	3M	N2510-6002-RB
Q1, Q2	n.a.	1200 V power switch (not included)	Infineon Technologies	e.g. IKQ75N120CH3
R1, R10, R21	3	RES, 10k, 1%, 0.1W, 0603	Vishay-Dale	CRCW060310K0FKEA
R2, R18, R20	3	RES, 1k, 1%, 0.1W, 0603	Vishay-Dale	CRCW06031K00FKEA
R3, R5, R9, R13	4	RES, 3R57, 1%, 0.25W, 1206	Vishay-Dale	CRCW12063R57FK
R4, R7, R11, R16	4	RES, 0R, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603000Z0EA
R6	1	RES, 100R, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603100RFKEA

(table continues...)

4 Bill of material

Table 4 (continued) Bill of material

Designator	Quantity	Description	Manufacturer	Part number
R12	1	RES, 51k, 1%, 0.1W, 0603	Vishay-Dale	CRCW060351K0FKEA
R14	1	RES, 1M, 1%, 0.1W, 0603	Vishay-Dale	CRCW06031M00FKEA
R15	1	RES, 4k7, 1%, 0.1W, 0603	Vishay-Dale	CRCW06034K70FKEA
R19	1	RES, 0R003, 1%, 3W, 2512	Bourns Inc.	CRE2512-FZ-R003E-3
R22	1	RES, 47k, 1%, 0.1W, 0603	Vishay-Dale	CRCW060347K0FKEA
R23, R24	2	RES, 270R, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603270RFKEA
S1	1	Switch, Tactile, SPST-NO, 0.1A, 16V, SMT	Bourns	7914G-1-000E
U1	1	Linear Voltage Regulator 5V	Infineon Technologies	TLS810D1EJV50
U2, U3, U4	3	Single channel IGBT gate driver IC in wide body package dual output	Infineon Technologies	1ED3124MC12H
U5	1	Rail-to-Rail Input and Output, 0.95nV/√Hz Low Noise, Op Amp	Linear Technology	LT6200CS6-10#TRMPBF
U6	1	Dual 2-Input NAND Gate with Schmitt-Trigger Inputs	Texas Instruments	SN74LVC2G132DCUR

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Edition 2024-09-05

Published by

Infineon Technologies AG

81726 Munich, Germany

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Document reference
IFX-mri1570185280777

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