EiceDRIVER™ gate driver 1EDI3025AS, 1EDI3026AS Evaluation Board

Preface

Scope and Purpose

This document describes the EiceDRIVER™ gate driver 1EDI3025AS, 1EDI3026AS and 1EDI3028AS evaluation board **PCB revision 1.1**. Please also refer to the corresponding datasheet.

Intended Audience

This document is intended for engineers who develop applications.

Table of contents

1 Safety Instructions

	**ELECTRIC SHOCK HAZARD.** Contact can cause an electric shock. If a voltage above 60 V is applied to the evaluation board, then only persons trained in working with voltages above 60 V are allowed to handle the evaluation board. In addition, ensure that hazardous live parts are not accessible and that accessible live parts are not hazardous.

2 Introduction

2.1 General Description

The EiceDRIVER™ gate driver 1EDI3025AS,1EDI3026AS, 1EDI3028AS evaluation board is a versatile evaluation platform. It features a half bridge configuration. There is the option to mount either the **FF450R08A03P2** HybridPACK™ DSC or a discrete PG-TO247-3 power device, such as the **AIMW120R045M1** CoolSiC™ MOSFET.

Table 1 EiceDRIVER™ gate driver 1EDI3025AS/1EDI3026AS evaluation board assembly options

Evaluation Board Variant	High Side Driver	Low Side Driver
IGBT	1EDI3025AS	1EDI3026AS
IGBT	1EDI3028AS	1EDI3028AS

2.2 EiceDRIVER™ Gate driver overview

There is a total of five different devices in this product family: 1EDI3035AS, 1EDI3036AS, 1EDI3038AS, 1EDI3025AS, 1EDI3026AS and 1EDI3028AS. Each family member implements a slightly different feature-set and is optimized to target different power switch technologies, whereas the power stage and safety concept is shared between all members.

Table 2 shows the key product features per variant in order to ease the slection process. The user can distinguish the following feature sets:

- External active Miller clamp – AMCLP
- External softoff pin – SOFTOFF
- Overcurrent protection – OCP
- Desaturation protection – DESAT
- VEE2 OVLO monitoring – OVLO3

Table 2 Overview of product variants

Type	AMCLP	SOFTOFF	OCP	DESAT	OVLO3	ADC	Output stage rated current	Power switch target
1EDI3025AS		x		x	x	x	15 A	IGBT
1EDI3026AS		x	x		x			IGBT
1EDI3028AS		x		x			10 A	IGBT
1EDI3035AS		x		x	x		15 A	SiC
1EDI3036AS	x			x	x			SiC
1EDI3038AS		x		x			10 A	SiC

Note: 1EDI3028AS has the current source on the ADC disabled

The product 1EDI3036AS features an AMCLP pin instead of a SOFTOFF pin. It performs the safe turn-off internally by applying an active ramp-down of the TON pin. 1EDI3036AS specifically targets SiC applications with discrete power modules

The 1EDI3028AS variant is optimized for EESM application, with a disabled ADC current source for NTC measurement optimization, no OVLO3 and a lower output stage current.

The 1EDI3038AS variant is prepared for OBC and DC/DC applications, with no ADC or OVLO3 and lower output stage current.

2.3 Operating Modes

The EiceDRIVER™ gate driver 1EDI3025AS, 1EDI3026AS and 1EDI3028AS offers different operating modes, see below. They provide diagnostic features and the ability to enter safe state in case of system failure. For more details, please refer to the datasheet.

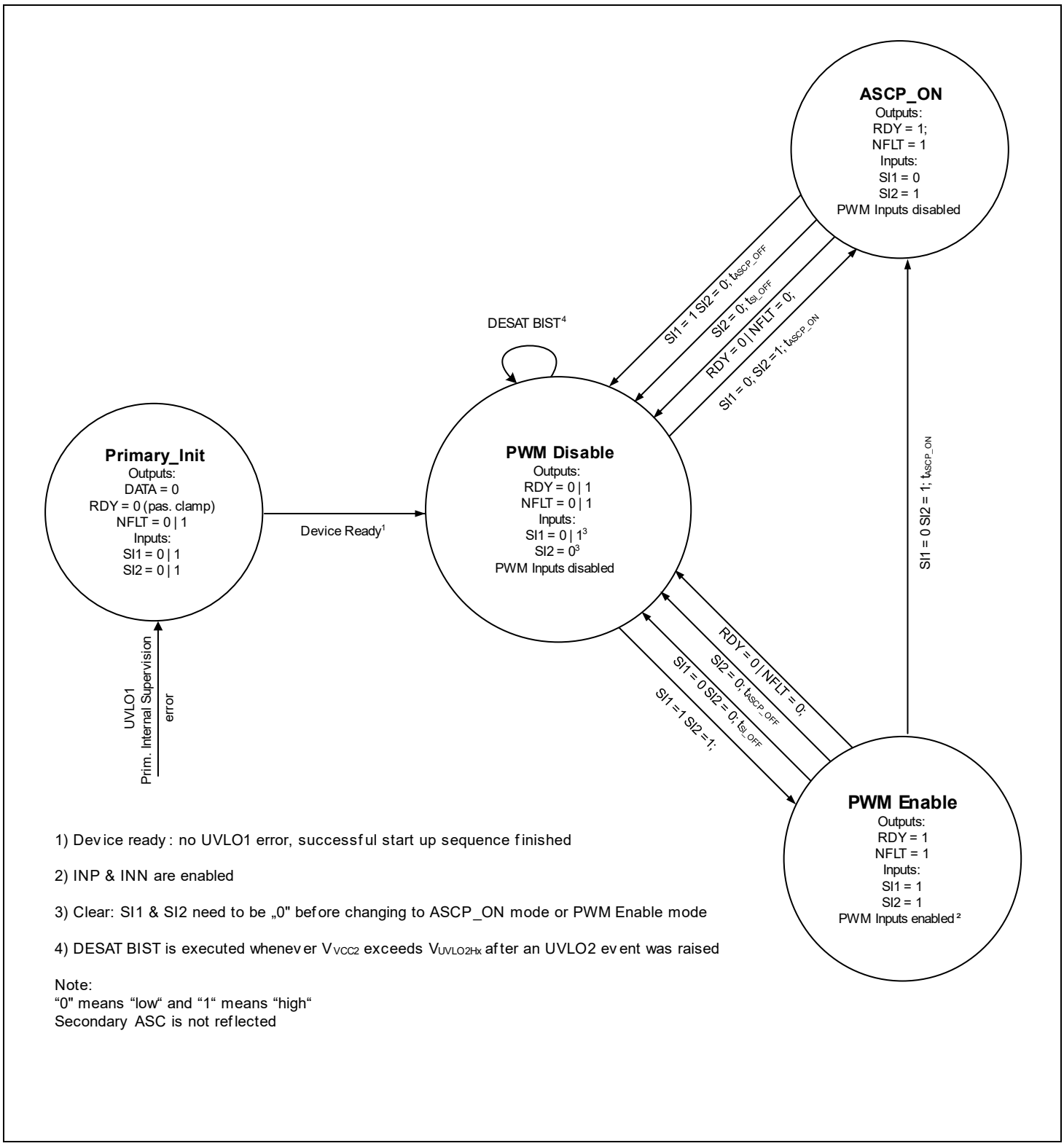
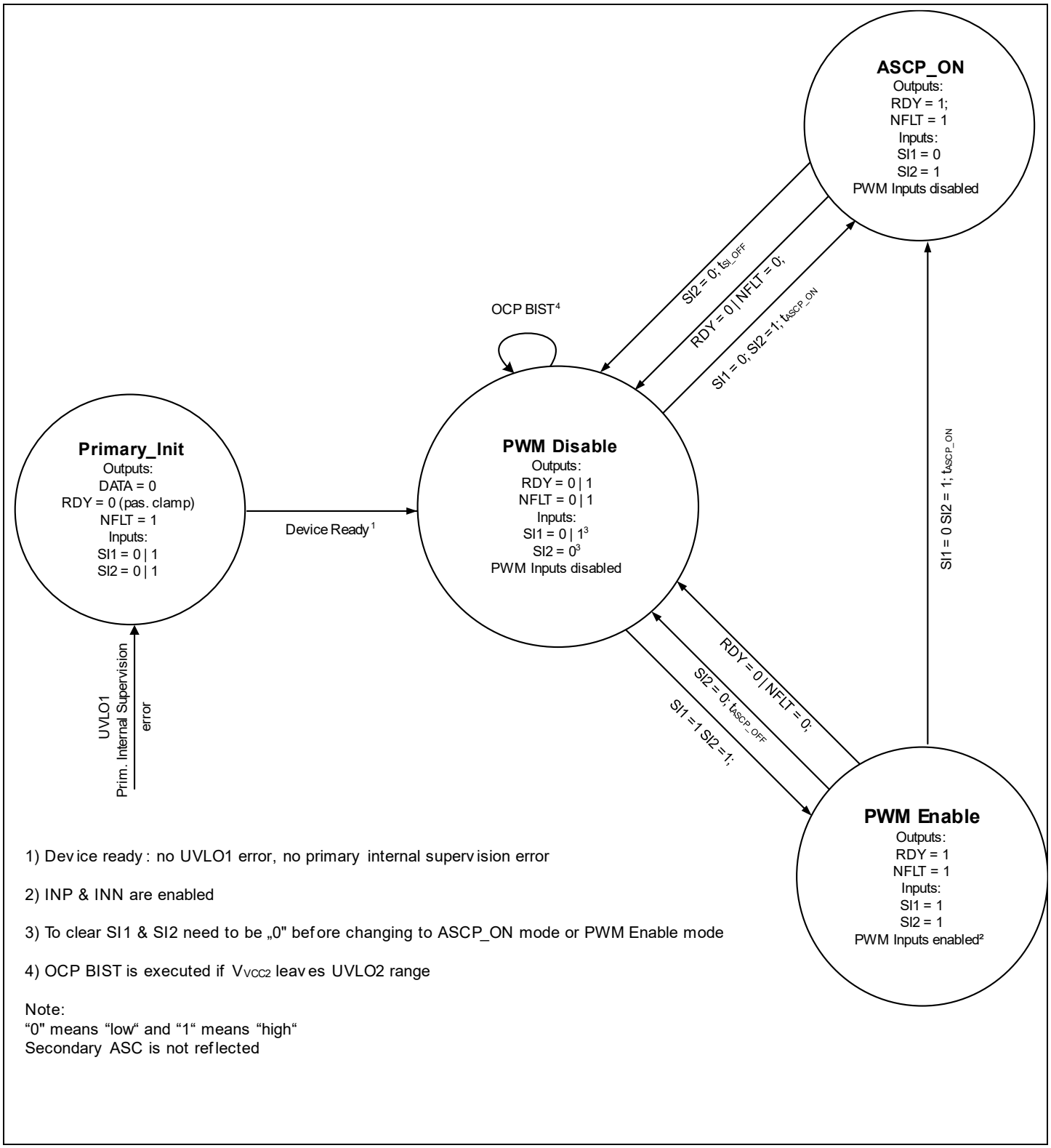


Figure 1 Operating modes diagram 1EDI3025AS



1) Device ready: no UVLO1 error, no primary internal supervision error

2) INP & INN are enabled

3) To clear SI1 & SI2 need to be „0" before changing to ASCP_ON mode or PWM Enable mode

4) OCP BIST is executed if V_{VCC2} leaves UVLO2 range

Note:
"0" means "low" and "1" means "high"
Secondary ASC is not reflected

Figure 2 Operating modes diagram 1EDI3026AS

2.4 Block diagram

2.4.1 1EDI3025AS

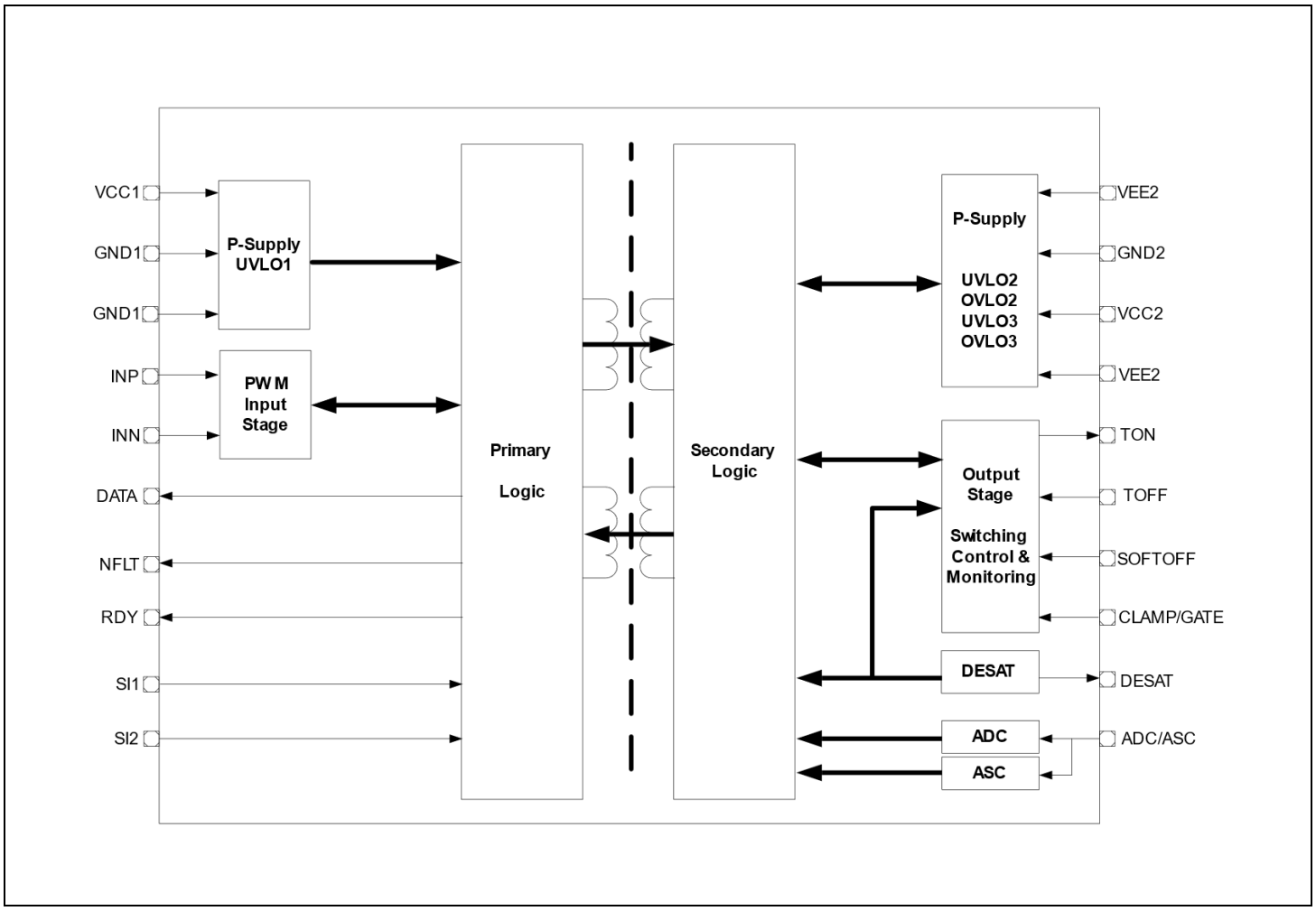


Figure 3 1EDI3025 block diagram

2.4.2 1EDI3026AS

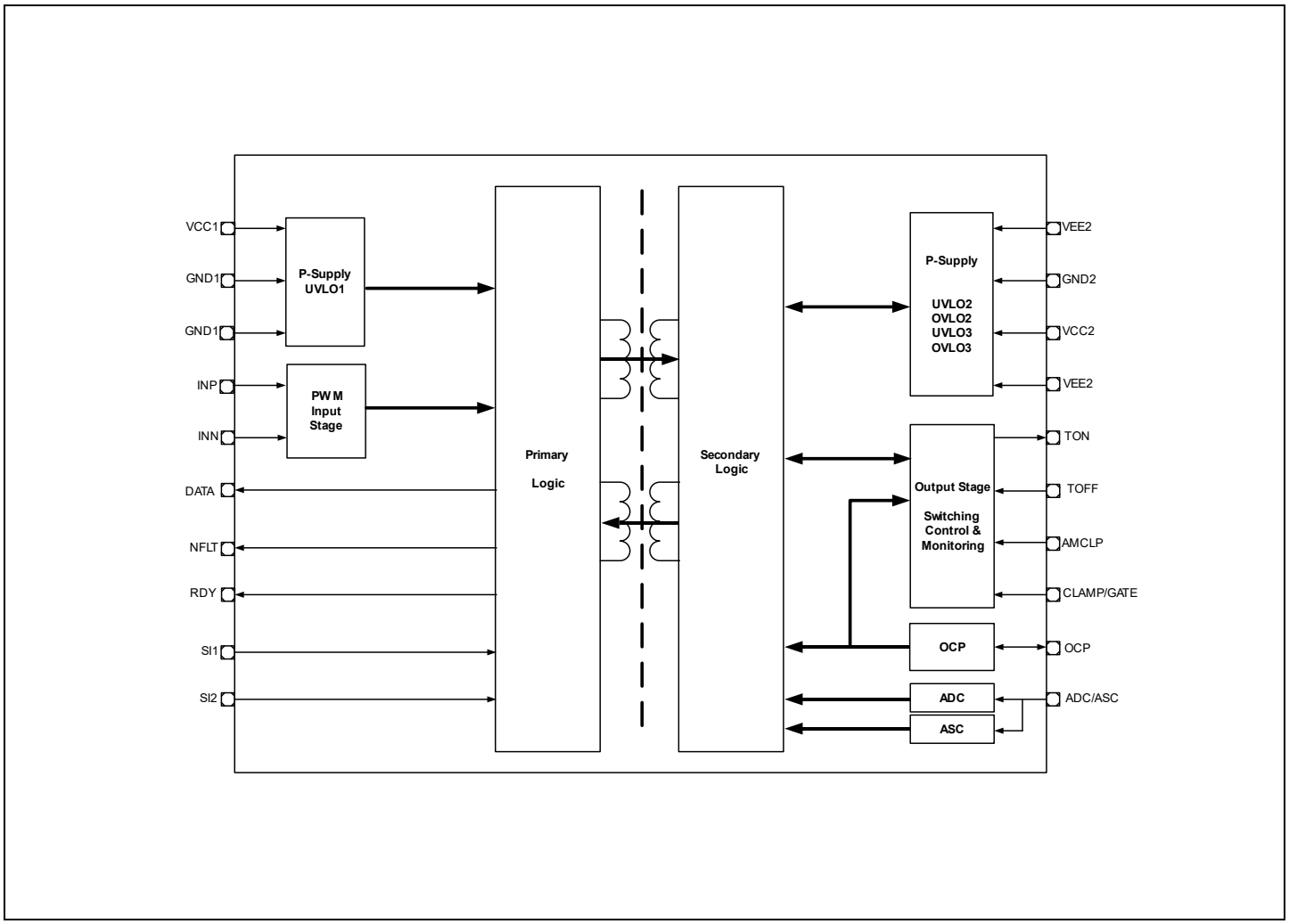


Figure 4 1EDI3026 block diagram

2.4.3 1EDI3028AS

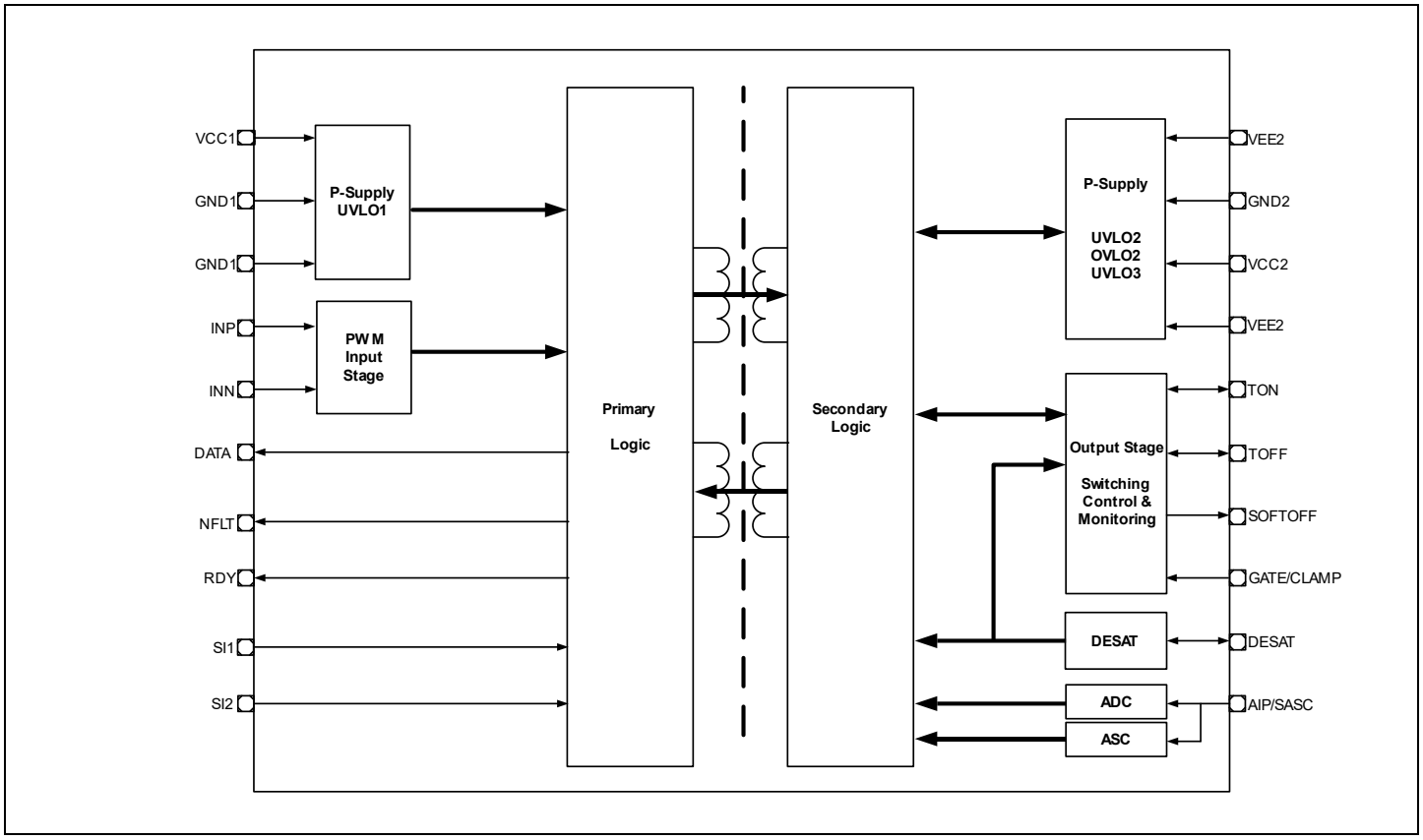


Figure 5 1EDI3028AS block diagram

3 Getting Started

It is recommended to use the Evaluation-Board with the **FF450R08A03P2** HybridPACK™ DSC or the **AIKQ120N75CP2** IGBT mounted.
It can also be used in capacitive load emulation or with any other footprint compatible device [1206(3216)]. For load emulation place capacitors C22 and C7, see Figure 6, which are not placed by default.
With capacitive load emulation the DESAT protection triggers on every switch-on event, so the device enters **PWM Disable**, see Operating Modes. In order to suppress such unwanted triggering of DESAT protection, connect DESAT_T to GND2_T and DESAT_B to GND2_B, respectively. This can be done by setting Jumper X1 and X2, similar as can be seen in the figure below.

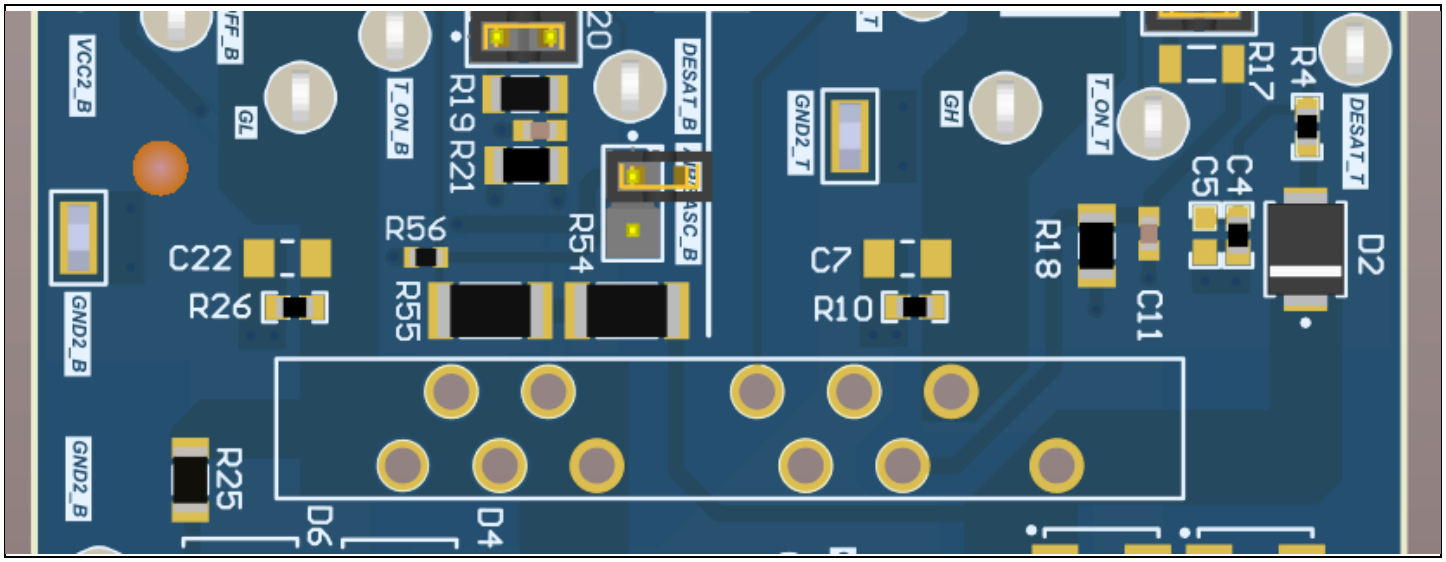


Figure 6 C22 and C7 PCB mounting location

To toggle the gate driver output, perform the following steps:

1. Set Jumper X17 and X20 in position 2-3 (Pullup)
2. In case only one gate driver shall be driven set jumper X29 to disable either the high side or low-side PWM channel by clamping it to GND
3. Provide the primary supply voltage V_{Supply} according to operating conditions (+15 V recommended)
4. Press the RESET button to perform a transition of the drivers from **PWM Disable** to **PWM Enable**, see Operating Modes
5. Verify that the device is in PWM Enable: RDY LEDs on, NFLT LEDs off
6. Apply a PWM signal to either INP_T or INN_T according to Operating conditions to start toggling the high side or low side switch, respectively.
7. If the device enters **PWM Disable** and switches off the output stage due to a triggered protection feature, then press the RESET button to perform a transition to **PWM Enable**

The high side driver and the low side driver interlock each other by crossing the INP and INN signals, see the Schematic. So, when one of the drivers is triggered to switch on, the other driver is automatically kept off, regardless of the respective input signal. This feature prevents shoot-through in case both input signals trigger a switch-on of both drivers at the same time by accident.

4 Evaluation Board

4.1 PCB Overview

Figure 7 shows an overview of the EiceDRIVER™ gate driver 1EDI3025AS, 1EDI3026AS, 1EDI3028AS evaluation board. A vertical line on the PCB marks the split between primary side and secondary side.
The transformer TR1 provides the supply voltages for the secondary side of the gate drivers.

Power switches, such as the **FF450R08A03P2** HybridPACK™ DSC or the **AIMW120R045M1** CoolSiC™ MOSFET are not included and can be ordered separately. As an alternative, a PG-TO247-3 compatible power switch can be mounted.

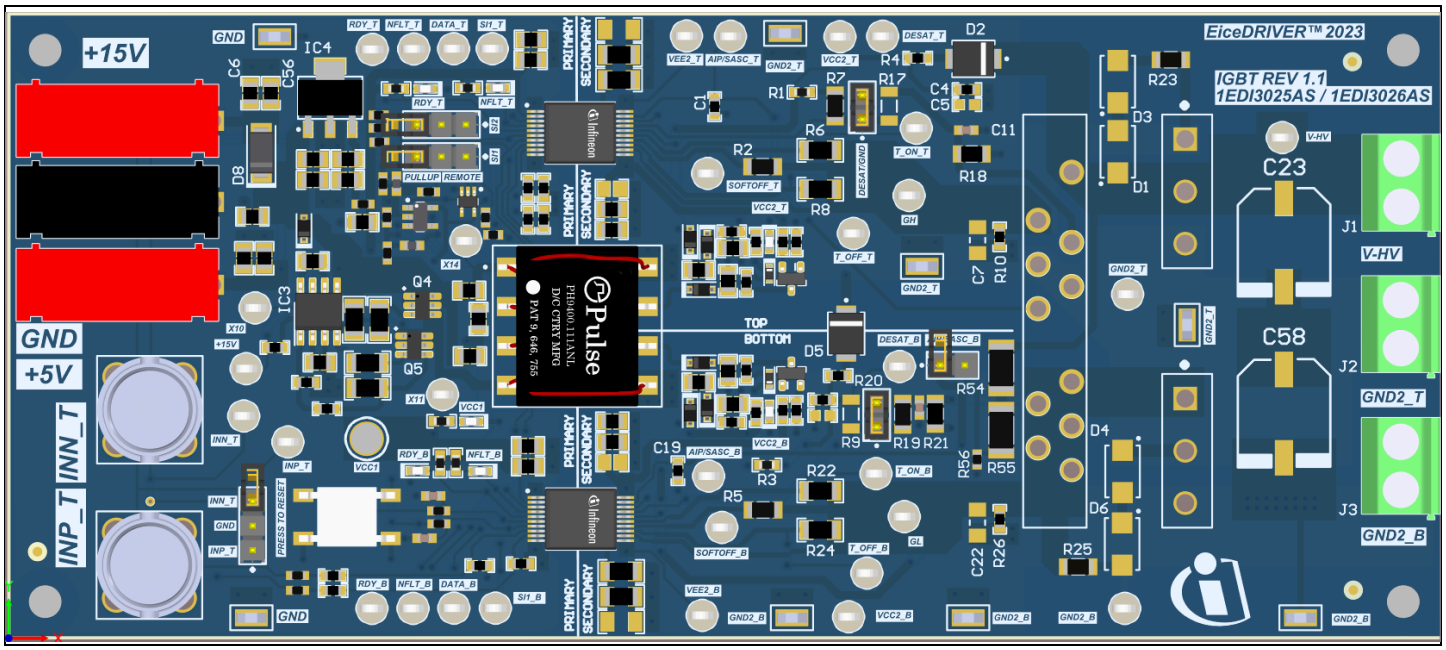


Figure 7 PCB Overview

When using the **AIKQ120N75CP2** IGBT or a PG-TO247-3 compatible power switch, an external heat sink option exists. The PCB footprint is prepared to mount the WA-T247-101E from Ohmite. The configuration is shown in Figure 8. The heat sink is not included by default and can be purchased separately.

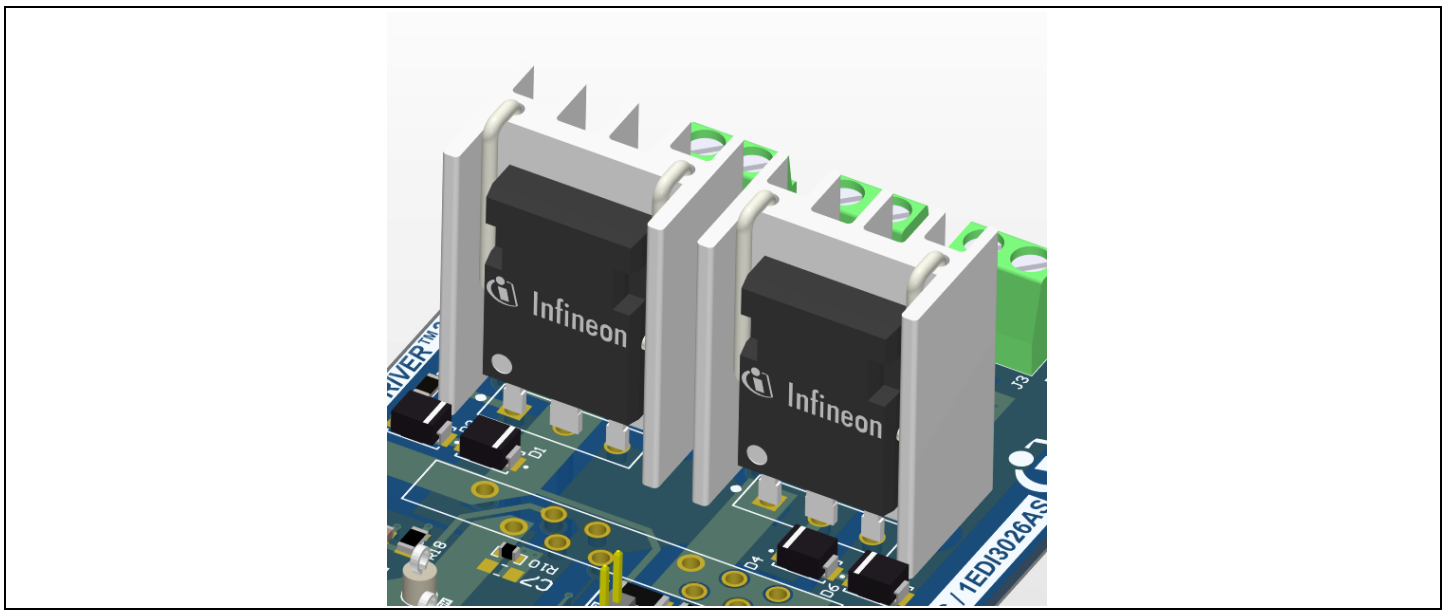


Figure 8 AIMW120R045M1 CoolSiC™ MOSFET mounted with heat sink

4.2 Connectors

There are connectors on the primary side and on the secondary side of the EiceDRIVER™ gate driver 1EDI3025AS, 1EDI3026AS and 1EDI3028AS evaluation board. The board requires a supply voltage of +15 V at the banana sockets on the primary side. For the remote reset functionality an additional banana socket is mounted, which needs to be supplied with +5 V. The BNC connectors INN_T and INP_T accept the PWM signal for the input of each driver, see Figure 7.

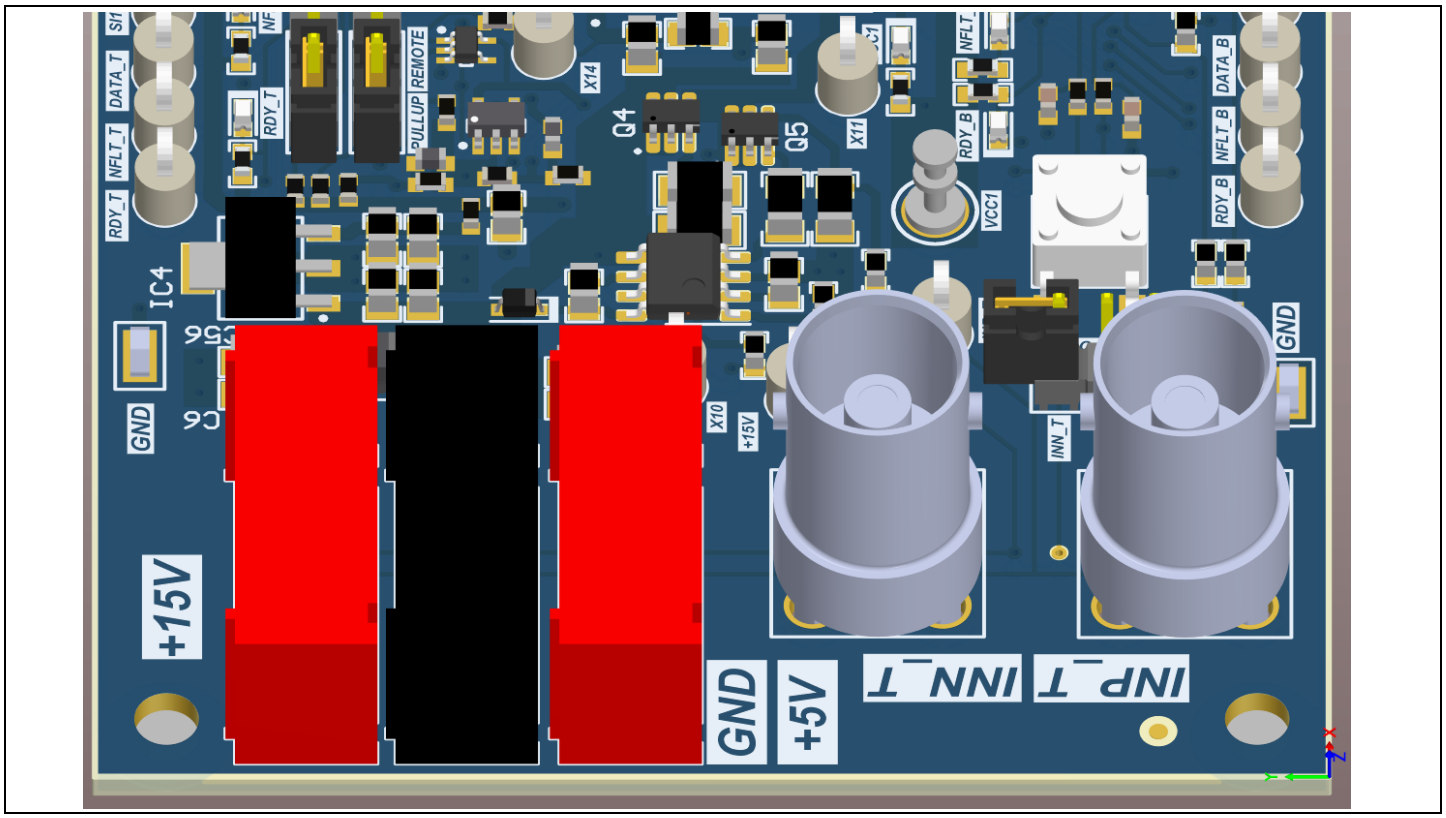


Figure 9 Primary Side Connectors

Figure 8 shows the secondary side screw terminals for the secondary supply voltage and the center tap of the half bridge.

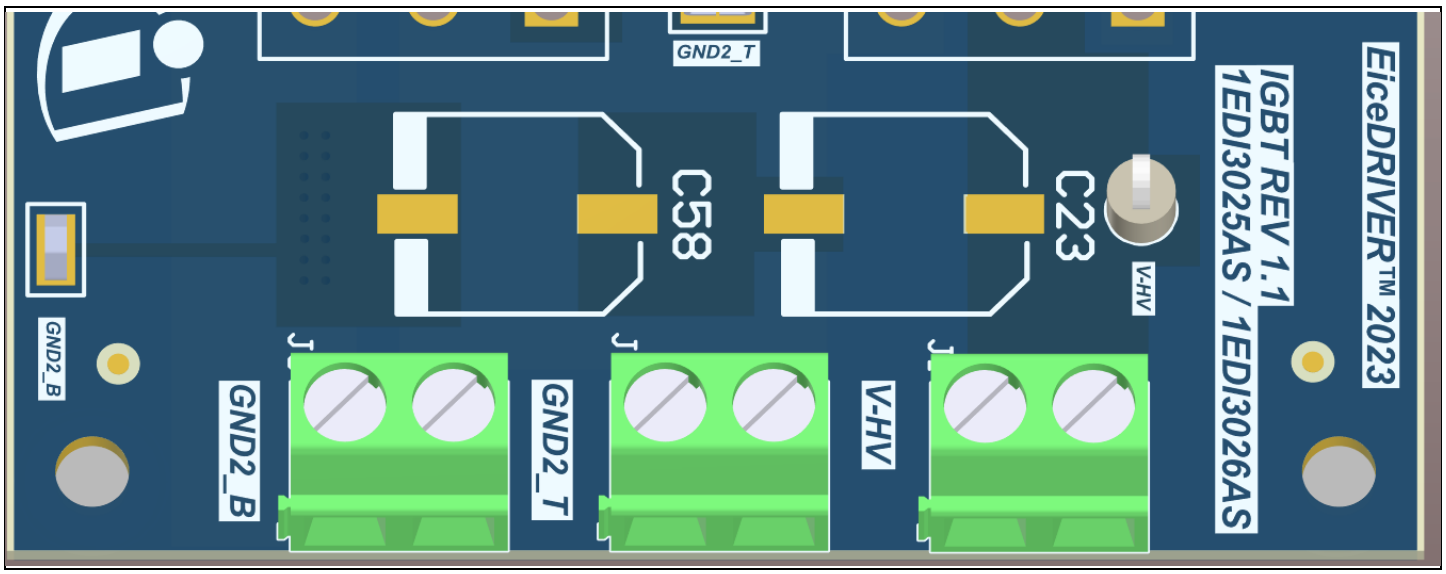


Figure 10 Secondary Side Connectors

4.3 LED Indicators

LEDs on the EiceDRIVER™ gate driver 1EDI3025AS, 1EDI3026AS, 1EDI3028AS evaluation board indicate board health and driver status, see Figure 9:

1. *Dedicated NFLT_x and RDY_x indicator for each driver*
2. *Primary side supply indicator on VCC_1*
3. *Secondary side VCC_2 indicator for each driver*

If the driver pulls the NFLT_x signal to “low”, then the NFLT_x LED is on to indicate a fault.

If the driver does not pull the RDY_x signal to “low”, then the RDY_x LED is on to indicate that the device is ready.

The status indicated by the NFLT_x and RDY_x LEDs can be used to determine the current operating mode, see Operating Modes.

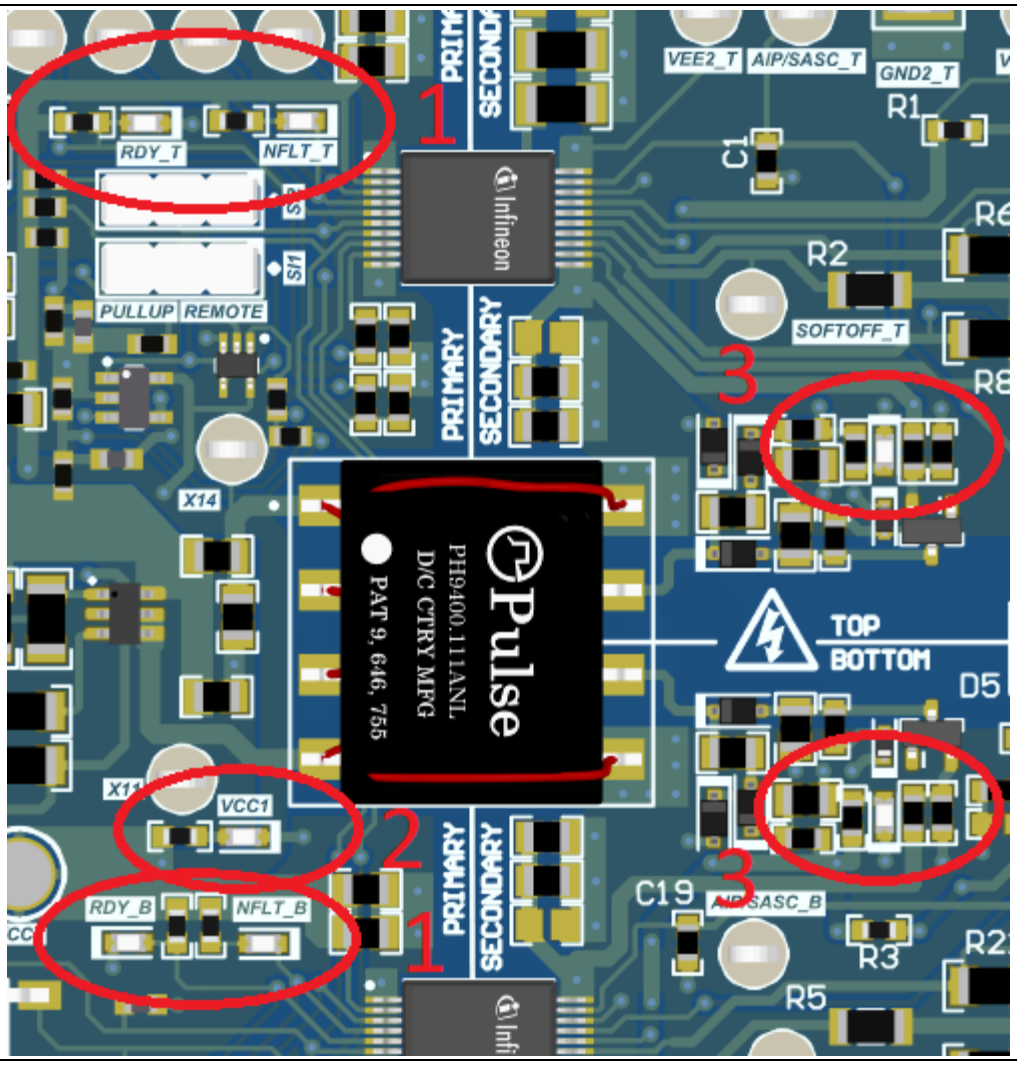


Figure 11 LED Indicators

4.4 Operating conditions

When using the 1EDI3025AS, 1EDI3026AS, 1EDI3038AS evaluation board the operating conditions of the board shall be valued. Note that the high voltage capability of the board is derived from the theoretical limit of the components on the board but not guaranteed or tested. Use at your own risk.

Table 3 Operating conditions

Parameter	Pin	Min.	Max.		Note
V_{Supply}	Banana Socket	13	21	V	Limited by secondary side UVLO, OVLO, Remote Reset Circuitry, and maximum rating of power switch gate.
$V_{Supply,2}$	Banana Socket	0	5.5	V	Limited by comparator operating range.
V_{HV} to GND_{2_B}	Screw Terminal	0	1200	V	**Theoretical HV DC limit; not tested.** Breakdown voltage given by DESAT diodes D2, D5, Diodes D1, D3, D4, D6, and Capacitors C23, C58. Replace when higher voltages are required.
V_{BNC}	BNC Connectors	-0.3	5	V	Limited by VCC1 voltage.

4.5 Jumper configuration

The EiceDRIVER™ gate driver 1EDI3025AS, 1EDI3026AS, 1EDI3028AS evaluation board provides the following configuration options:

- Pullup or remote configuration of SI_1/SI_2
- Disable DESAT-/OCP-protection on high- or low-side
- DC-link measurement with ADC- or SASC-event on low-side

The reset button R pulls SI_1/SI_2 logic low and thus clears errors

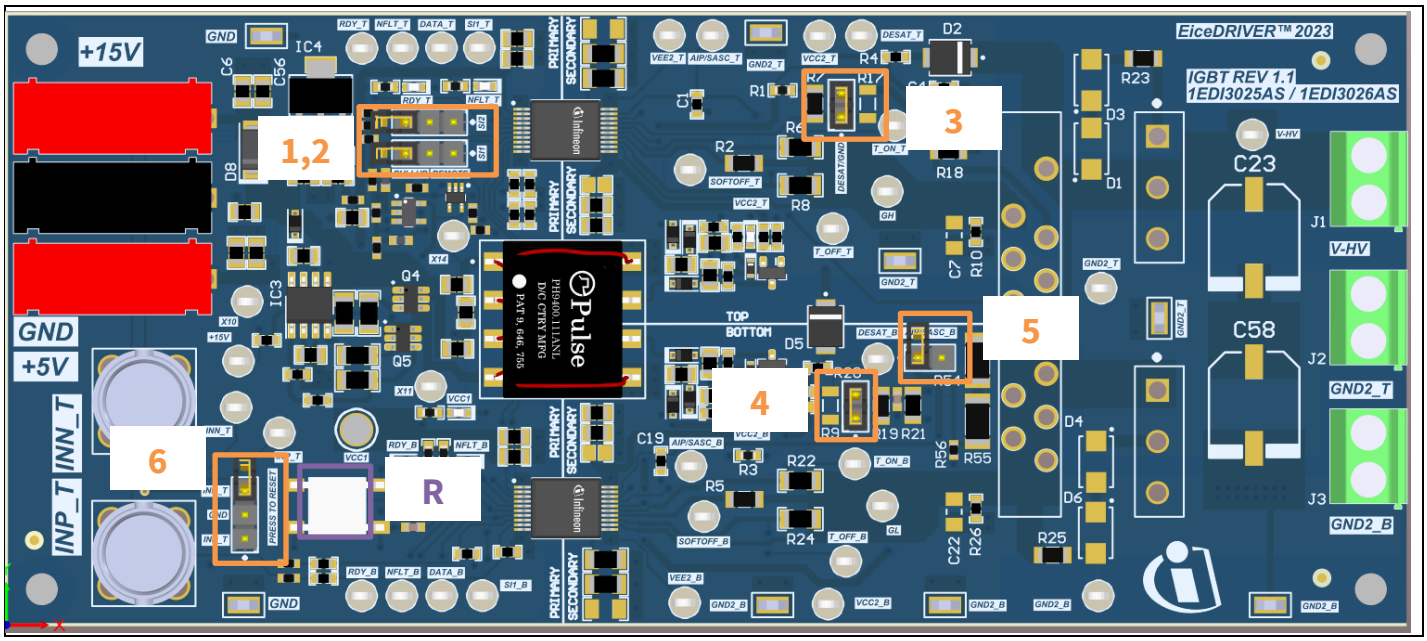


Figure 12 EiceDRIVER™ gate driver 1EDI3025AS, 1EDI3026AS evaluation board configuration overview

Table 4 Jumper configuration options

Jumper ID	Default state	Signal Name	Effect when placed
1	2-3	SI_2	Pulled HIGH
2	2-3	SI_1	Pulled HIGH
3	Placed	$DESAT_T$/OCP_T	Grounded
4	Placed	$DESAT_B$/OCP_B	Grounded
5	Not placed	AIP_B/$SASC_B$	DC-Link Measurement
6	Not placed	INP_T / INN_T	INP_T or INN_T grounded

4.5.1 SI1 and SI2 PULLUP

For test-setups without HV-connections and without a second input voltage, set Jumper 1 and Jumper 2 in Position 2-3 to reset the driver by pressing the reset button. To change to PWM Enable state, press the reset button once after setting the jumpers.

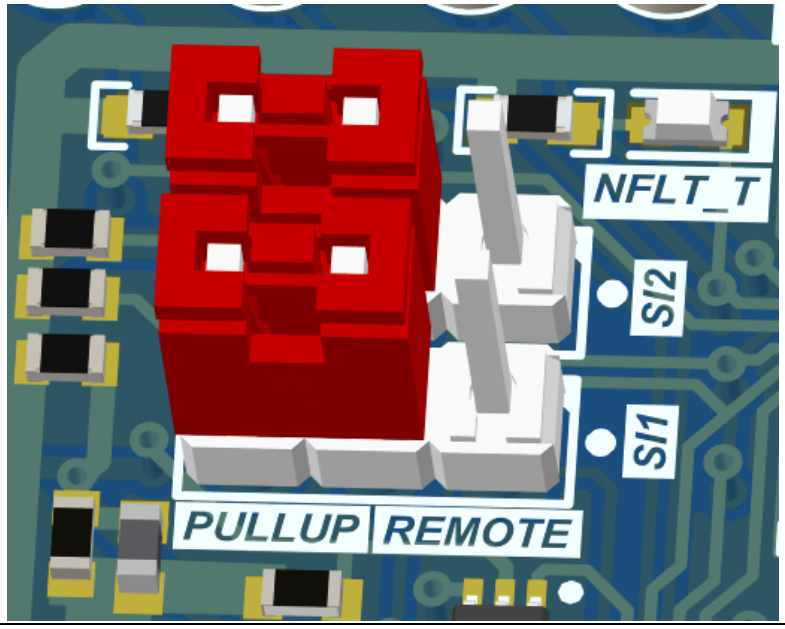


Figure 13 SI1, SI2 PULLUP

4.5.2 ASCP_ON Mode

For testing the ASCP_ON mode, where PWM Inputs are disabled, but the ADC is enabled, place Jumper 1 on position 2-3 and Jumper 2 on position 1-2 to generate the signal SI1=0, SI2=1. **Do not connect +5V** on the second banana socket. Press the reset button once to get the device ready.

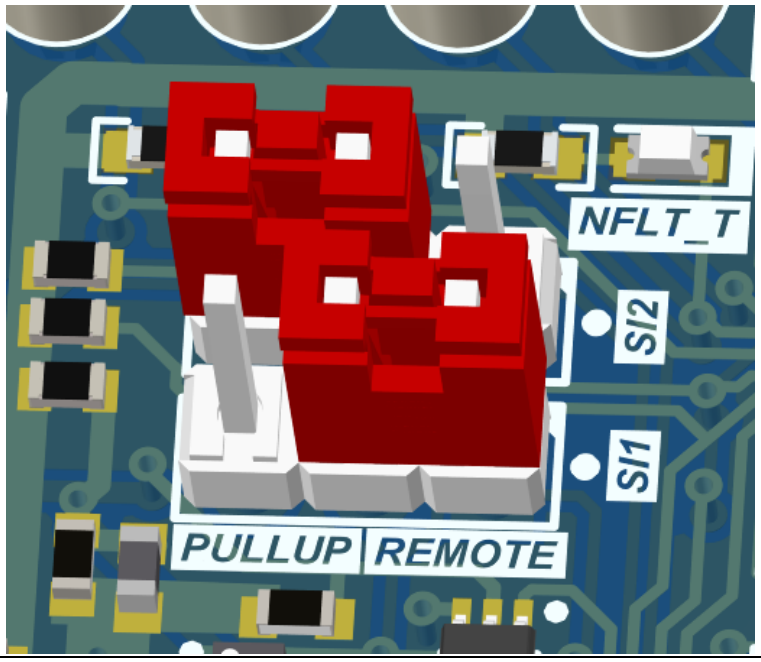


Figure 14 SI1, SI2 ASCP_ON

4.5.3 SI1 and SI2 Remote Reset

For high voltage testing it is not advised to use the button S1 to reset and transition the device from **PWM Disable** to **PWM Enable** mode. The clear function and mode transitioning can be automated by using two adjustable power supplies on the +15V and +5V input jacks.

Important note: On boards with revision “REV 1.0” the switch S1 and capacitors C8 and C9 need to removed for using the remote reset functionality. The revision of the board is printed in the top right corner of the PCB, next to the product type. Use Figure 15 to quickly identify S1, C8 and C9.

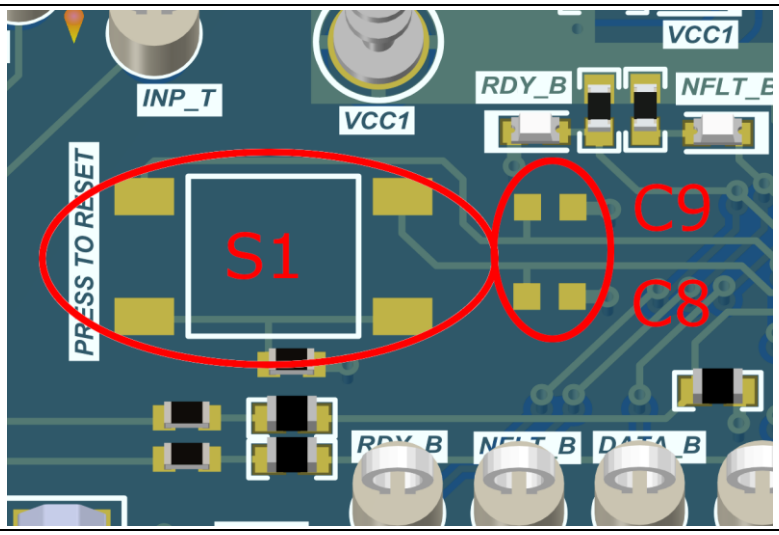


Figure 15 Components to be removed for remote reset on REV 1.0 PCBs

Place the jumpers as depicted in Figure 16. The relationship between the signals SI1_T and SI1_B is shown in Table 5, along with the resulting gate driver states. For detailed mapping of these signals to the gate driver see the **Error! Reference source not found.**.

Table 5 Configuration table for SI1 and SI2 remote reset

Voltage +15V jack [V]	Voltage +5V jack [V]	SI1_T (SI2_B)	SI1_B (SI2_T)	Operating mode Top driver	Operating mode Bottom driver
≤ 13.5	0	0	0	PWM Disable	PWM Disable
≥ 14.5	5	1	1	PWM Enable	PWM Enable
≤ 13.5	5	0	0	PWM Disable	PWM Disable
≥ 14.5	0	1	0	PWM Disable	ASCP_ON

In order to bring both gate drivers into **PWM Enable** mode on power-up, proceed as follows:

Set the voltage on the +5V jack to +5V initially, then ramp-up the voltage on the +15V jack above 14.5V. The circuit on the board will perform an operation where both signals SI1 and SI2 simultaneously switch to high. This operation transitions both gate drivers from **PWM Disable** to **PWM Enable** mode simultaneously. The gate drivers are then ready to receive a PWM signal on the primary side and switch the output accordingly.

The bottom gate driver can be transitioned to **ASCP_ON** mode by pulling the voltage on the +5V jack to 0V. It is only allowed to transition into this mode when both gate drivers where in **PWM Disable** mode before. The same principle needs to be applied when transitioning into **PWM Enable** mode.

For a defined power-down of both gate drivers, ramp-down the voltage on the +15V jack below 13.5V and thus put them into **PWM Disable** mode.

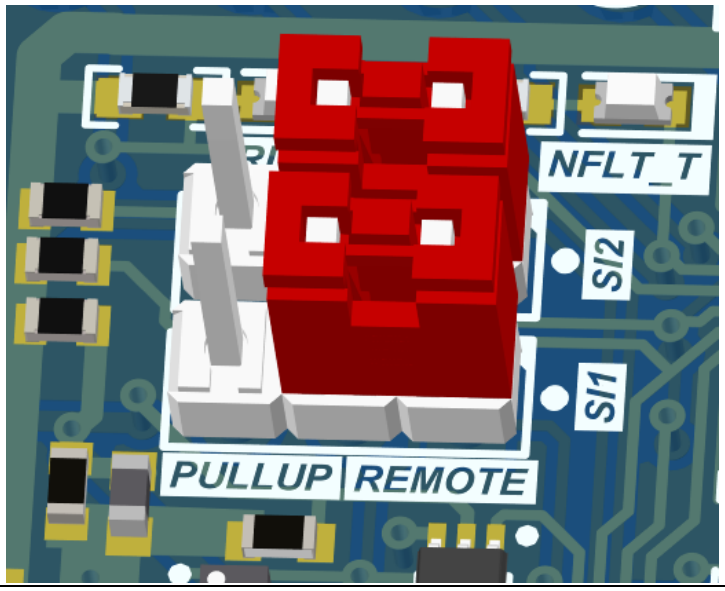


Figure 16 SI1, SI2 Remote

4.5.4 Connect DESAT and OCP to GND

Place Jumper 3 and Jumper 4 to connect the high side DESAT- and low side DESAT-signal to GND.

This avoids transitioning to **PWM Disable** when toggling the output in capacitive load emulation, as DESAT is then disabled.

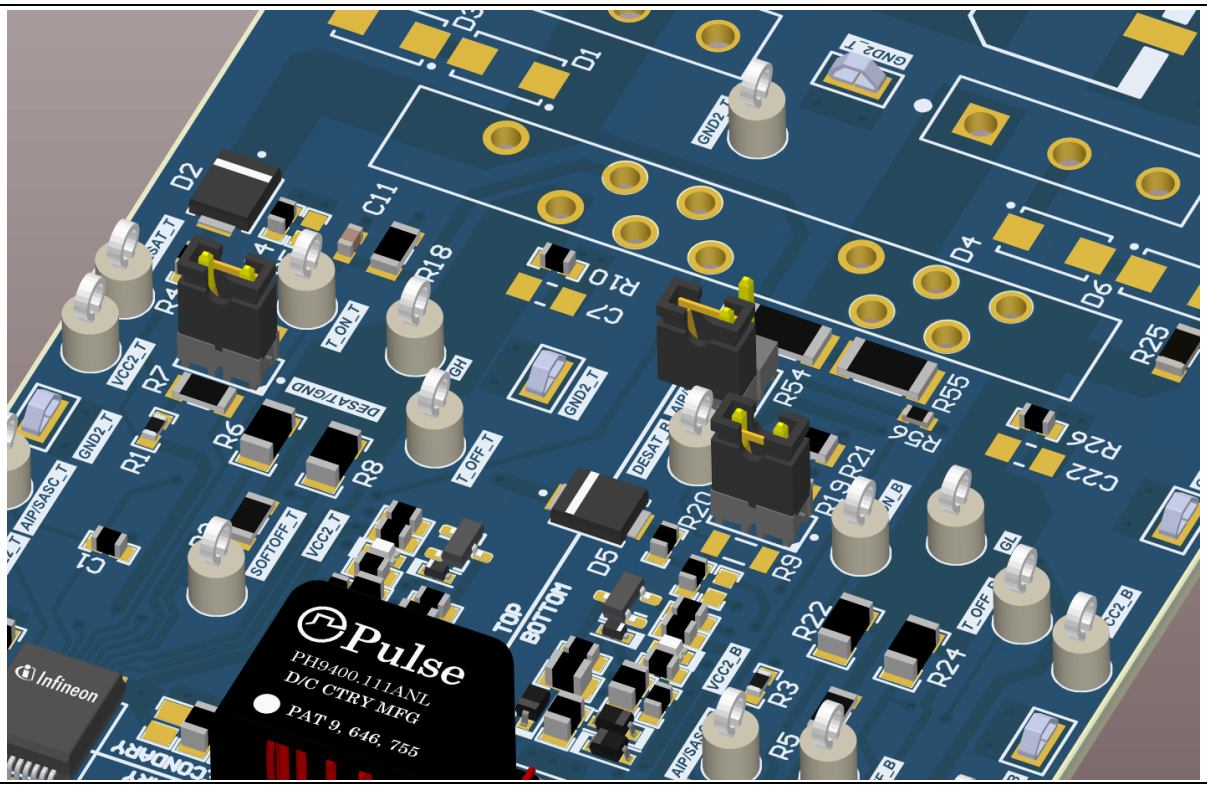


Figure 17 DESAT/OCP grounded

4.5.5 AIP_B and $SASC_B$

There is also the option to measure the DC-Link voltage via the ADC of the low-side driver or to test the Secondary Active Short Circuit (SASC) functionality.

Do not place Jumper 5 to measure DC-Link.

Place Jumper 5 to test SASC.

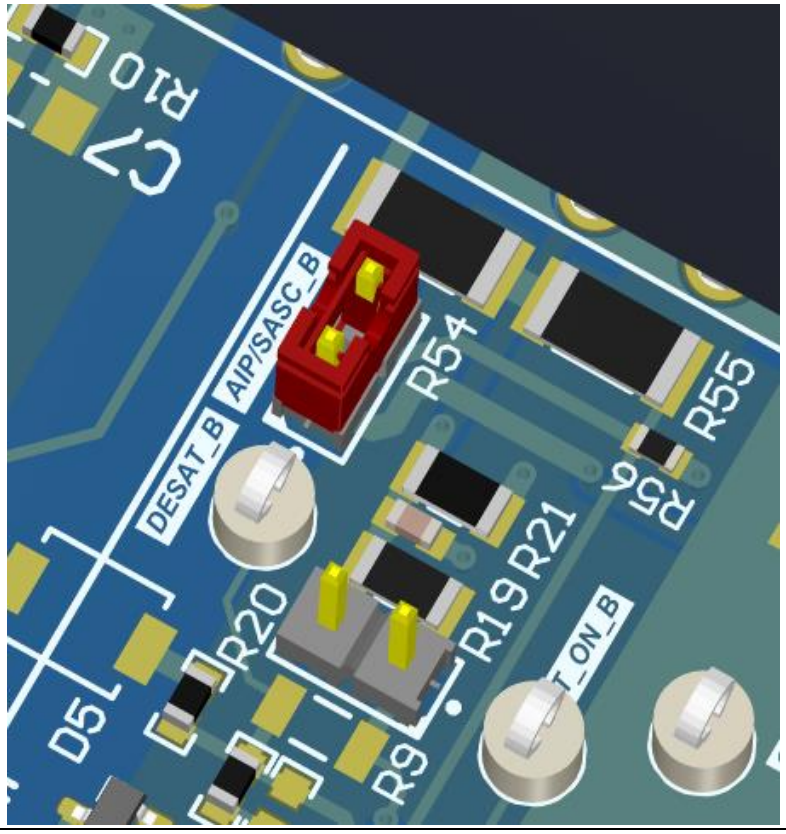


Figure 18 AIP_B and $SASC_B$ Test

4.6 Difference between High Side and Low Side

There is the possibility to conduct different measurements on the high and low side.

On the high side it is possible to measure the temperature inside the DSC module, because the diode inside the power module is directly connected to the ADC of the high side driver.

On the low side it is possible to measure the DC-Link voltage via the resistor ladder (R54, R55, R56) and ADC and to test an SASC event when setting the Jumper 5.

4.7 Change between 1EDI3025AS, 1EDI3026AS and 1EDI3028AS

If a change from driver variant x25AS to x26AS, x28AS or x26AS to x25AS, x28AS is desired, the resistors R7/R17 or R9/R19 need to be placed as follows:

Table 6 Resistor Placement for x25AS, x26AS, x28AS on High Side

Variant	R7 (DESAT)	R17 (OCP)
1EDI3025AS	Placed	Not placed
1EDI3026AS	Not Placed	Placed
1EDI3028AS	Placed	Not placed

Table 7 Resistor Placement for x25AS, x26AS, x28AS on Low Side

Variant	R9 (DESAT)	R19 (OCP)
1EDI3025AS	Placed	Not placed
1EDI3026AS	Not placed	Placed
1EDI3028AS	Placed	Not placed

5 Schematic and Layout

5.1 Schematic

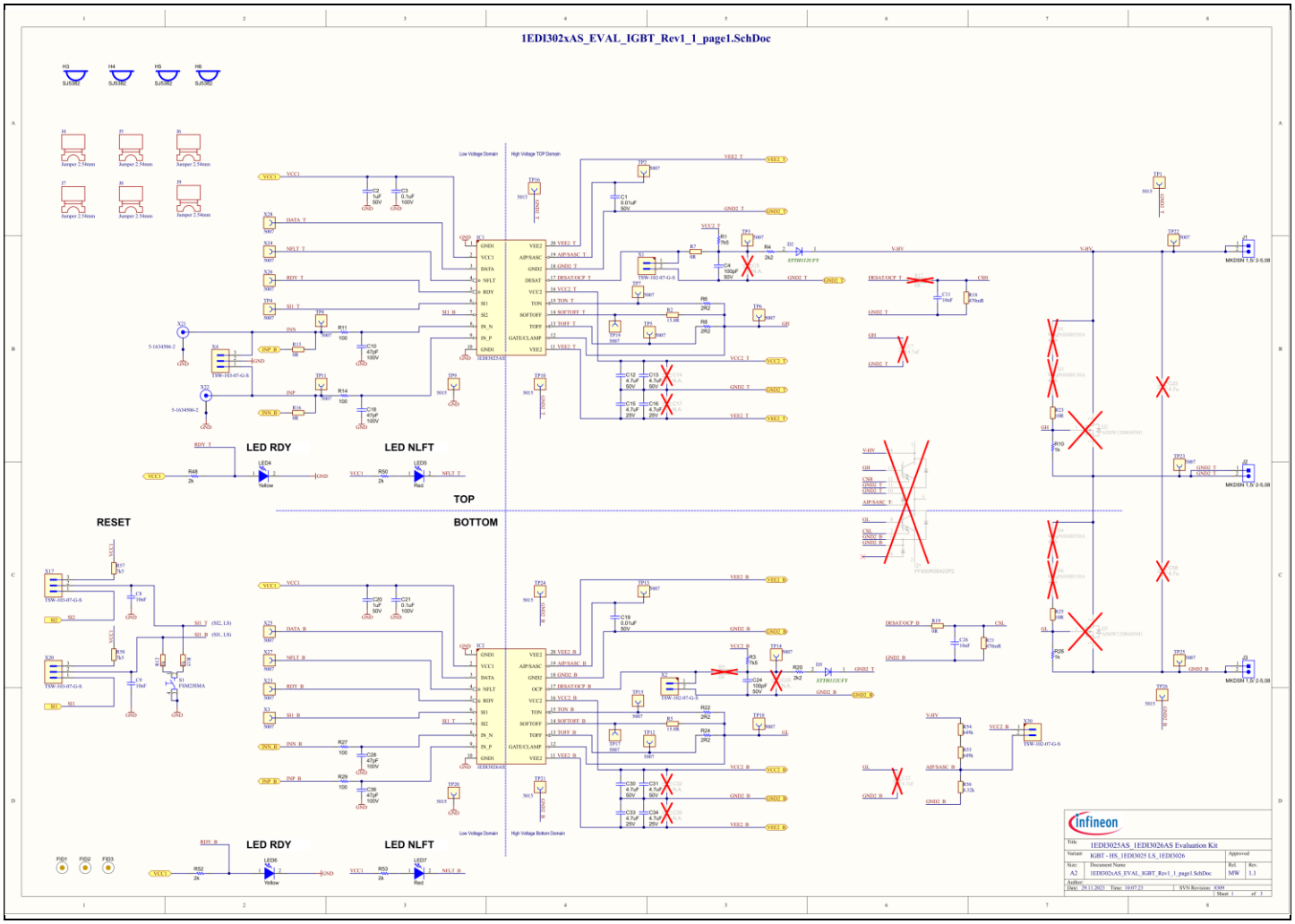


Figure 19 Driver schematic HS 1EDI3025AS, LS 1EDI3026AS

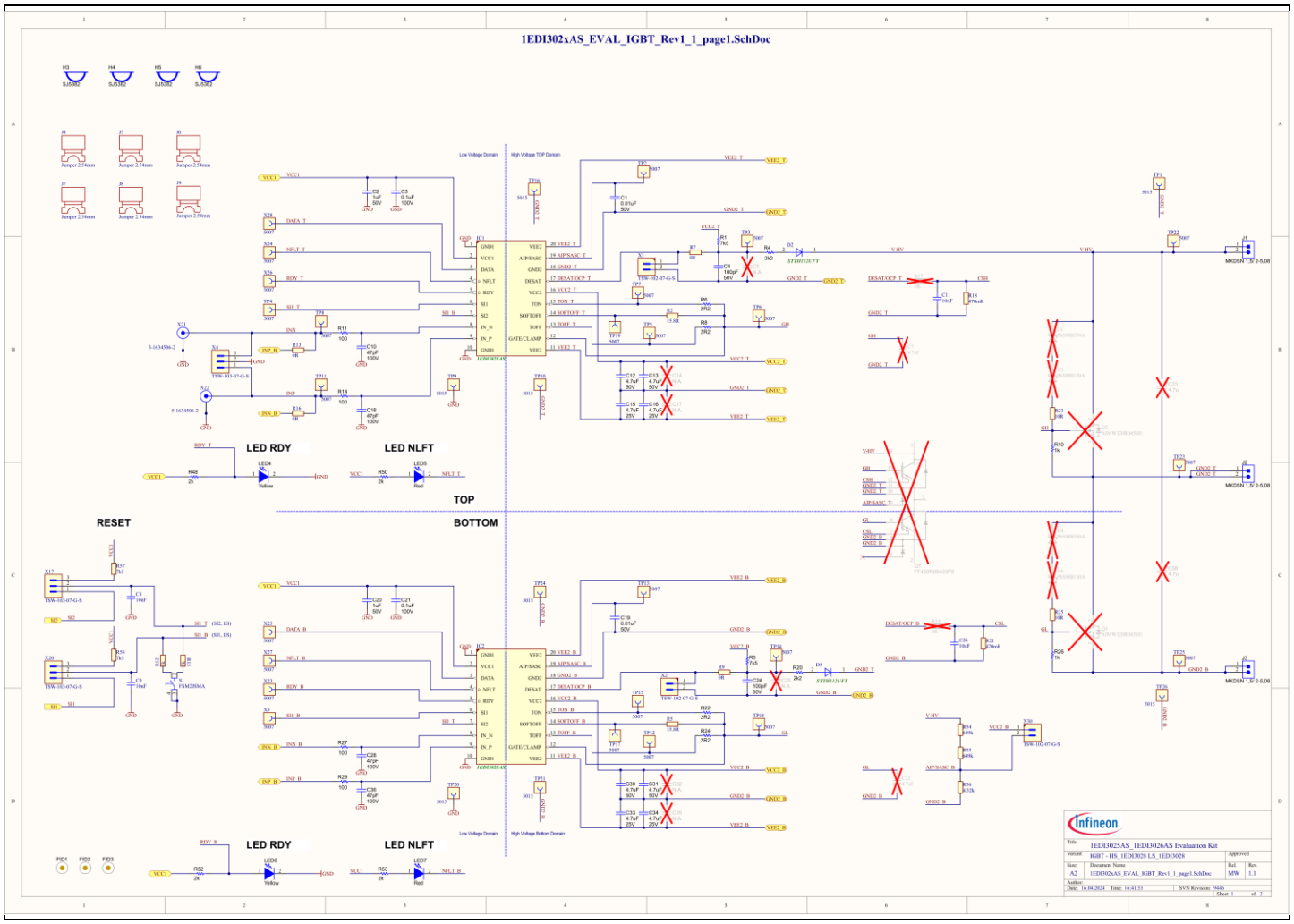


Figure 20 Driver schematic HS 1EDI3028AS, LS 1EDI3028AS

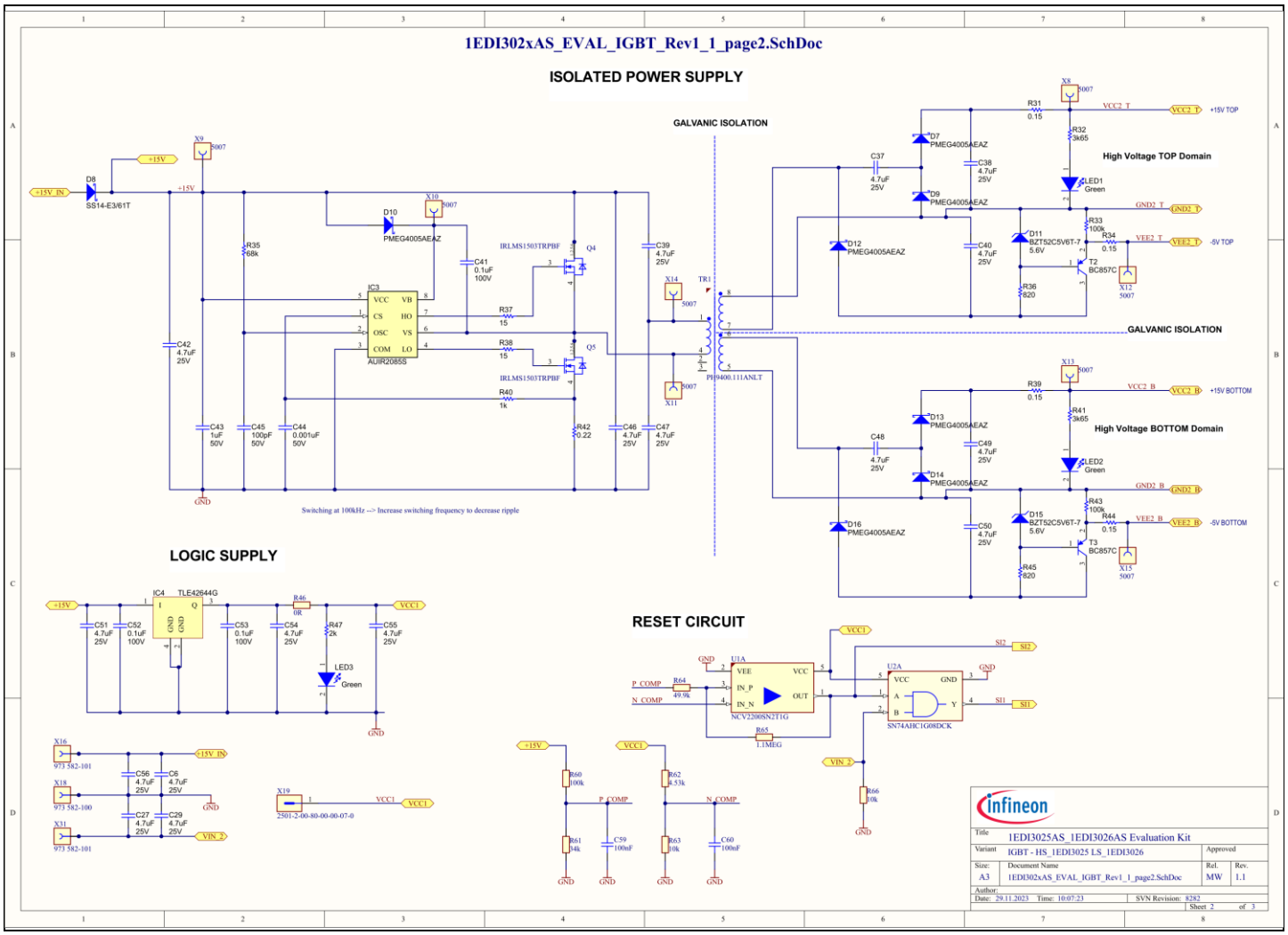


Figure 21 Primary and secondary supply schematic

5.2 Layout

The EiceDRIVER™ gate driver 1EDI3025AS/1EDI3026AS evaluation board PCB consists of two layers: top and bottom. For ease of use there are no components placed on the bottom side.

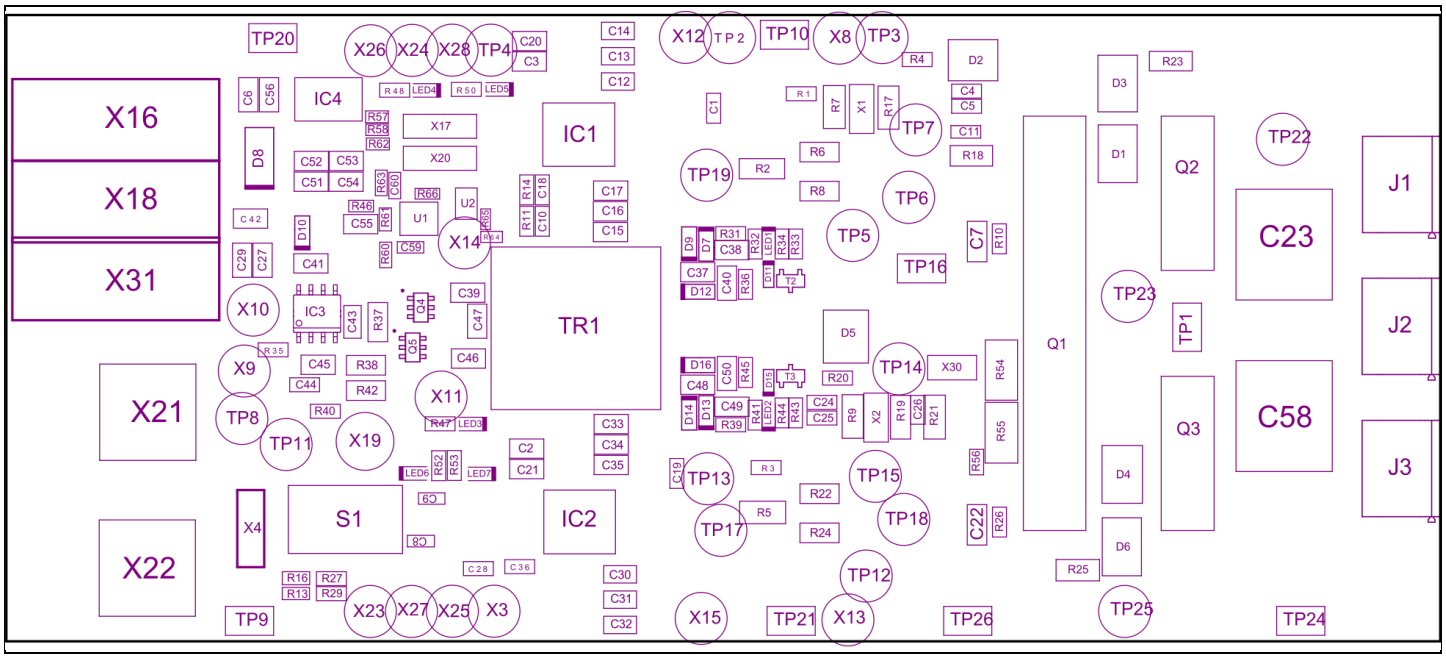


Figure 22 Assembly Top View

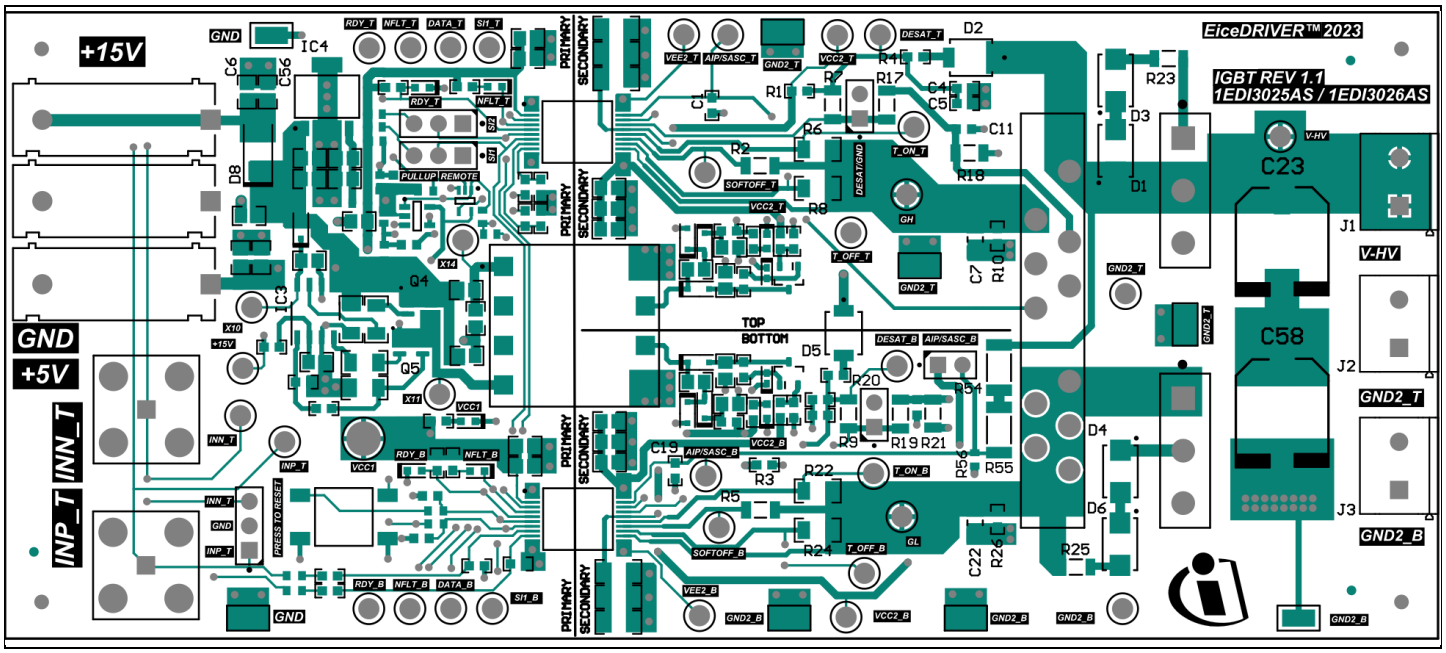


Figure 23 Top Layer

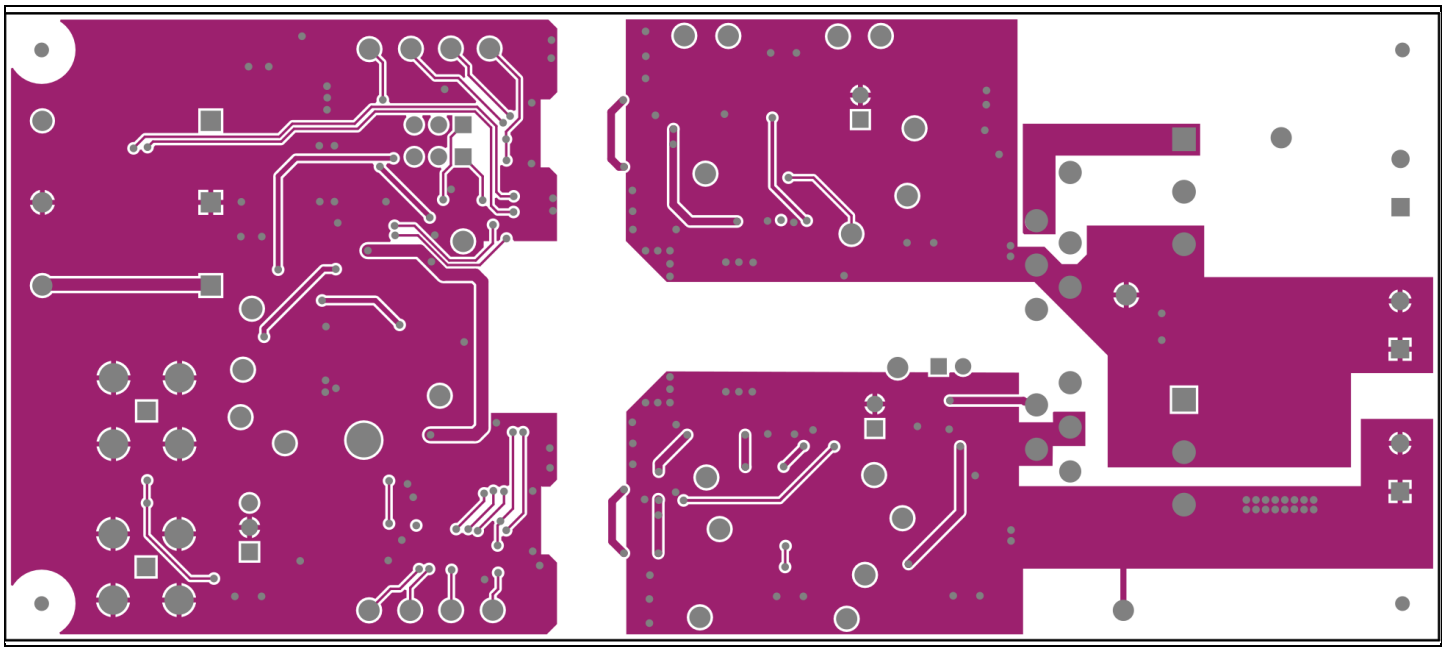


Figure 24 Bottom Layer

6 Bill of materials

Table 8 shows the bill of materials for all EiceDRIVER™ gate driver 1EDI3025AS/1EDI3026AS evaluation board variants. The driver ICs mounted depends on the variant. The power switches are not included.

Table 8 Bill of Materials for 1EDI3025AS, 1EDI3026AS board

Designator	Manufacturer Order Number	Manufacturer	Quantity
C1, C19	C0603C103K5RECAUTO	Kemet	2
C2, C20	GCM21BR71H105KA03L	MuRata	2
C3, C21, C41, C52, C53	GCM21BR72A104KA37K	MuRata	5
C4, C24	C0603C101K5RACAUTO	Kemet	2
C6, C15, C16, C27, C29, C33, C34, C37, C38, C39, C40, C42, C46, C47, C48, C49, C50, C51, C54, C55, C56	GCM21BC71E475KE36L	MuRata	21
C8, C9	GRM188R71E103MA01	MuRata	2
C10, C18, C28, C36	C0603C470K1GACAUTO	Kemet	4
C11, C26	06035C103K4Z2A	AVX	2
C12, C13, C30, C31	GCM31CC71H475KA03L	MuRata	4
C43	C1206C105K5RACAUTO	Kemet	1
C44	C0603C102K5RACAUTO	Kemet	1
C45	C0805C101K5GACAUTO	Kemet	1
C59, C60	C0603C104J3RAC	Kemet	2
D2, D5	STTH112UFY	STMicroelectronics	2
D7, D9, D10, D12, D13, D14, D16	PMEG4005AEAZ	Nexperia	7
D8	SS14-E3/61T	Vishay Semiconductor	1
D11, D15		Diodes Inc.	2
H3, H4, H5, H6	SJ-5382 (CLEAR)	3M	4
IC1	1EDI3025AS	Infineon Technologies	1

IC2	1EDI3026AS	Infineon Technologies	1
IC3	AUIR2085S	International Rectifier	1
IC4	TLE42644G	Infineon Technologies	1
J1, J2, J3	MKDSN 1,5/ 2-5,08	Phoenix Contact	3
J4, J5, J6, J7, J8, J9	M7581-05	Harwin Inc.	6
LED1, LED2, LED3	LTST-C190GKT	Lite-On	3
LED4, LED6	LTST-C190YKT	Lite-On	2
LED5, LED7	LTST-C190CKT	Lite-On	2
Q4, Q5	IRLMS1503TRPBF	Infineon Technologies	2
R1, R3, R57, R58	CRCW06037K50FKEA	Vishay-Dale, Vishay	4
R2, R5	CRCW120615R8FKEA	Vishay	2
R4, R20	CRCW06032K20FKEA	Vishay-Dale	2
R6, R8, R22, R24	CRCW12062R20JNEAHP	Vishay-Dale	4
R7, R19	CRCW12060000Z0EA	Vishay	2
R10, R26, R40	CRCW06031K00FKEA	Vishay-Dale	3
R11, R14, R27, R29	CRCW0603100RFKEA	Vishay-Dale	4
R12, R15	RC0603FR-071KL	Yageo	2
R13, R16, R46	RC0603JR-070RL	Yageo	3
R18, R21	RCWE1206R470FKEA	Vishay	2
R23, R25	RC1206FR-0710RL	Yageo	2
R31, R34, R39, R44	RCWE0603R150FKEA	Vishay-Dale	4
R32, R41	CRCW06033K65FKEA	Vishay-Dale	2
R33, R43	CRCW0603100KFKEA	Vishay-Dale	2

R35	CRCW060368K0FKEA	Vishay-Dale	1
R36, R45	CRCW0603820RFKEA	Vishay-Dale	2
R37, R38	CRCW120615R0FKEA	Vishay-Dale	2
R42	RCWE1206R220FKEA	Vishay-Dale	1
R47, R48, R50, R52, R53	CRCW06032K00FKEA	Vishay-Dale	5
R54, R55	CRCW2010649KFKEF	Vishay	2
R56	CRCW06034K32FKEA	Vishay	1
R60	RC0603FR-07100KL	Yageo	1
R61	CRCW060334K0FKEA	Vishay	1
R62	CRCW06034K53FKEA	Vishay	1
R63, R66	RC0603FR-0710KL	Yageo	2
R64	CRCW060349K9FKEA	Vishay	1
R65	CRCW06031M10FKEA	Vishay	1
S1	FSM2JSMA	Tyco Electronics	1
T2, T3	BC857C	ON Semiconductor	2
TP1, TP9, TP10, TP16, TP20, TP21, TP24, TP26	5015	Keystone Electronics Corp.	8
TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP11, TP12, TP13, TP14, TP15, TP17, TP18, TP19, TP22, TP23, TP25, X3, X8, X9, X10, X11, X12, X13, X14, X15, X23, X24, X25, X26, X27, X28	5007	Keystone Electronics Corp.	33
TR1	PH9400.111ANLT	Pulse Electronics	1
U1	NCV2200SN2T1G	ON Semiconductor	1
U2	SN74AHC1G08DCK	Texas Instruments	1
X1, X2, X30	TSW-102-07-G-S	Samtec	3

X4, X17, X20	TSW-103-07-G-S	Samtec	3
X16, X31	973 582-101	Hirschmann Test & Measurement	2
X18	973 582-100	Hirschmann Test & Measurement	1
X19	2501-2-00-80-00-00-07-0	Mill-Max	1
X21, X22	5-1634506-2	TE Connectivity	2

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Revision history

Document revision	Date	Description of changes
0.9	2022-07-13	Created initial draft
1.0	2022-08-12	Updated schematics and layout, BOM Minor editorial changes
1.1	2022-08-25	Chapter 4.5.3 updated and expanded
1.2	2023-11-24	All chapters updated to reflect new board revision
1.3	2024-04-16	Added 1EDI3028AS board variant

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Edition 2023-11-24

Published by

Infineon Technologies AG

81726 Munich, Germany

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Document reference

Z8F80327692

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