EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS evaluation board

Z8F80037256

Preface

Scope and purpose

This document describes the EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS evaluation board. Please also refer to the corresponding datasheet.

Intended audience

This document is intended for engineers who develop applications.

Table of contents

Preface . . . 1
Table of contents . . . 2
1 Safety instructions . . . 3
2 Introduction . . . 4
2.1 General description . . . 4
2.2 EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS overview . . . 5
2.3 Operating modes . . . 6
2.4 Block diagram . . . 7
3 Getting started . . . 8
4 Evaluation board . . . 9
4.1 PCB overview . . . 9
4.2 Connectors . . . 11
4.3 LED indicators . . . 12
4.4 Operating conditions . . . 13
4.5 Configuration . . . 14
4.5.1 Jumper on Enable_x . . . 15
4.5.2 Jumper on ASC_x . . . 15
4.5.3 Jumper on OCPx . . . 16
4.5.4 AIP_x signal selection jumper . . . 17
5 Schematic and layout . . . 18
5.1 Schematic . . . 18
5.2 Layout . . . 21
6 Bill of materials . . . 23
7 Restrictions . . . 25
Revision history . . . 26
Disclaimer . . . 27

1 Safety instructions

WARNING 	**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™ enhanced 1EDI302xAS/1EDI303xAS evaluation board is a versatile evaluation platform for the EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS family. It features a half bridge configuration, see ***Figure 1***. There is the option to mount either the HybridPACK™ DSC IGBT module or a discrete PG-TO247-3 power device, such as the AIMW120R045M1 CoolSIC™ MOSFET. ***Table 1*** shows the supported drivers.

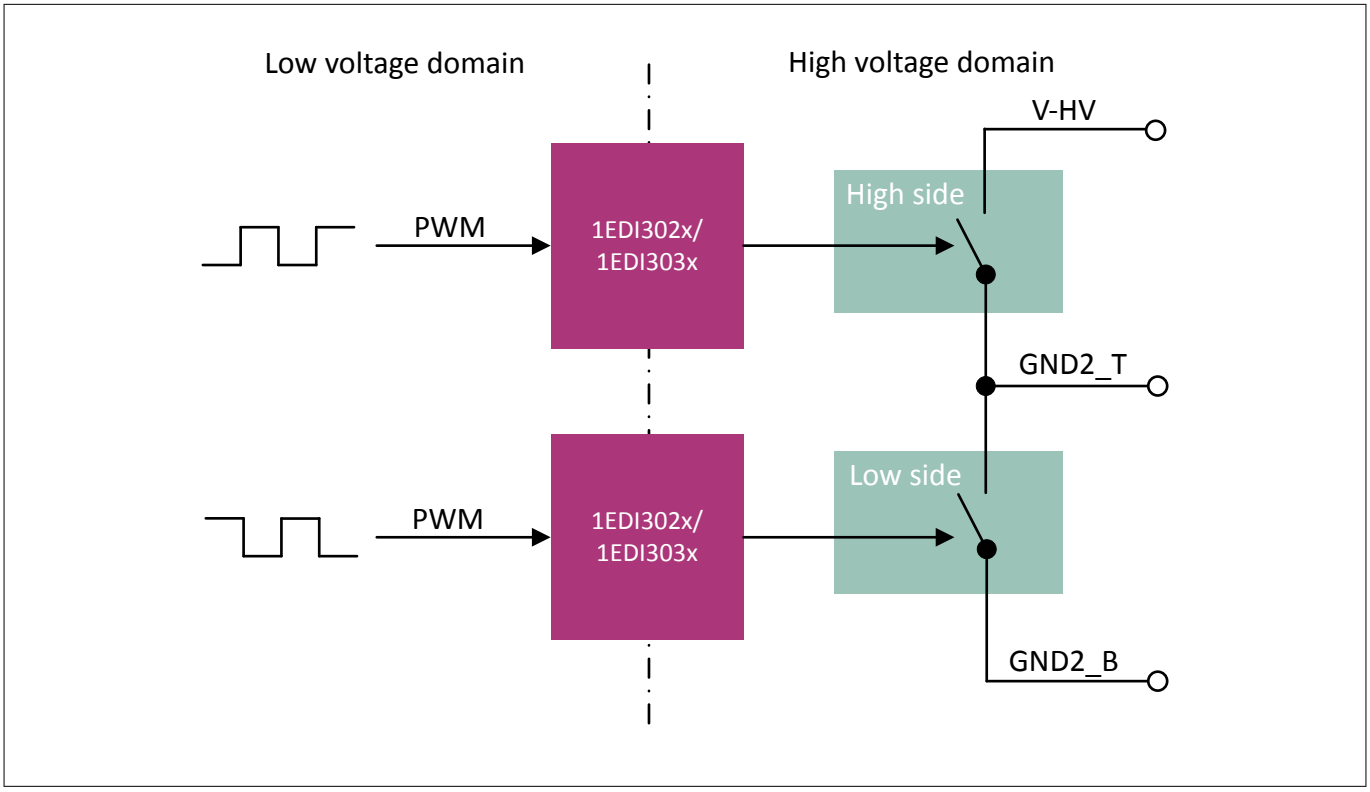


Figure 1 Board topology

Table 1 EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS family

Product	Optimized for	Specific feature
1EDI3020AS	IGBT	ADC with current source
1EDI3021AS		Secondary side active short circuit
1EDI3023AS		ADC for voltage measurement
1EDI3030AS	SiC	ADC with current source
1EDI3031AS		Secondary side active short circuit
1EDI3033AS		ADC for voltage measurement

The EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS evaluation board variants differ in the mounted EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS configuration, see ***Table 2***.

Table 2 EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS evaluation board assembly options

Evaluation board variant	High side driver	Low side driver
IGBT	1EDI3020AS	1EDI3021AS
SiC	1EDI3031AS	1EDI3033AS
Free	not mounted	not mounted

2.2 EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS overview

The EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS is a high voltage IGBT/SiC driver for automotive motor drives with a power above 5 kW. The device is based on Infineon's Coreless Transformer (CT) technology, providing galvanic insulation between the low voltage domain and the high voltage domain. The device supports 400 V, 600 V and 1200 V IGBT/SiC technologies.

The primary logic of the device supports 5 V and 3.3 V.

The high voltage domain (secondary side) can drive IGBT/Sic power switches directly or an external booster stage. Short propagation delay and controlled internal tolerances lead to minimal distortion of the PWM signal.

The device features a high output stage current of typically 10 A. The integrated Miller clamping stage with typically 10 A allows unipolar supply of the IGBT/SiC power switch.

The device supports functional safety requirements at system level according to ISO 26262. The safety related features ease the implementation of a transition to safe state.

Features

- Single channel isolated IGBT/SiC driver
- For IGBT/SiC power switches up to 1200 V
- 11.5 A peak current rail-to-rail output
- DESAT protection
- Active Miller clamp
- ASC pin for PMSM motor drive application
- Coreless transformer isolated driver
- Basic insulation recognized under UL 1577
- Integrated protection features
- Developed according to ISO 26262
- AEC-Q100 qualified
- ISO 26262 Safety Element out of Context for safety requirements up to ASIL B
- Green Product (RoHS compliant)

2.3 Operating modes

The EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS product family offers different Operating modes, see ***Figure 2***, providing intrusive diagnostic features and the ability to enter safe state" in case of system failure. For details please refer to the datasheet.

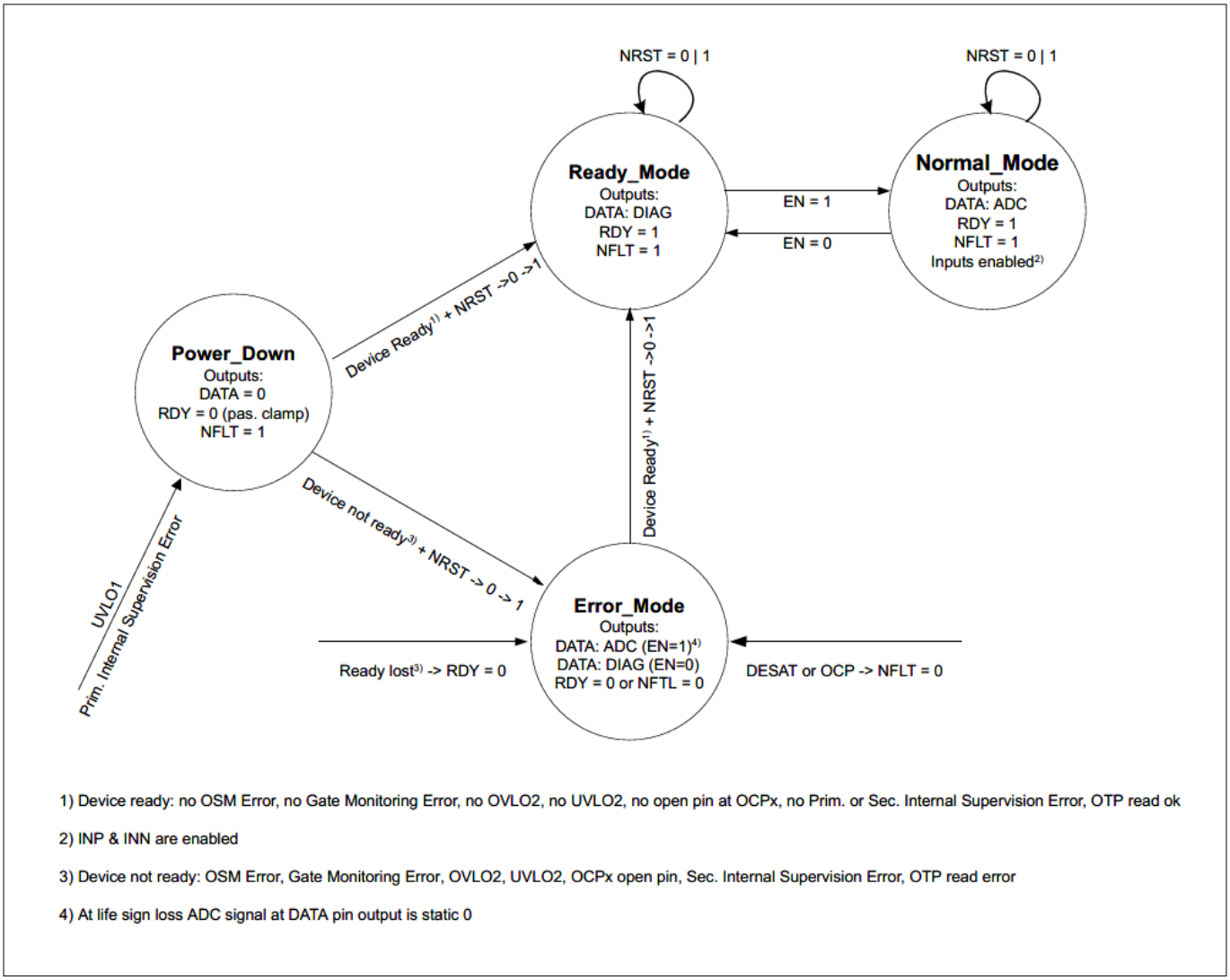


Figure 2 Operating modes

2.4 Block diagram

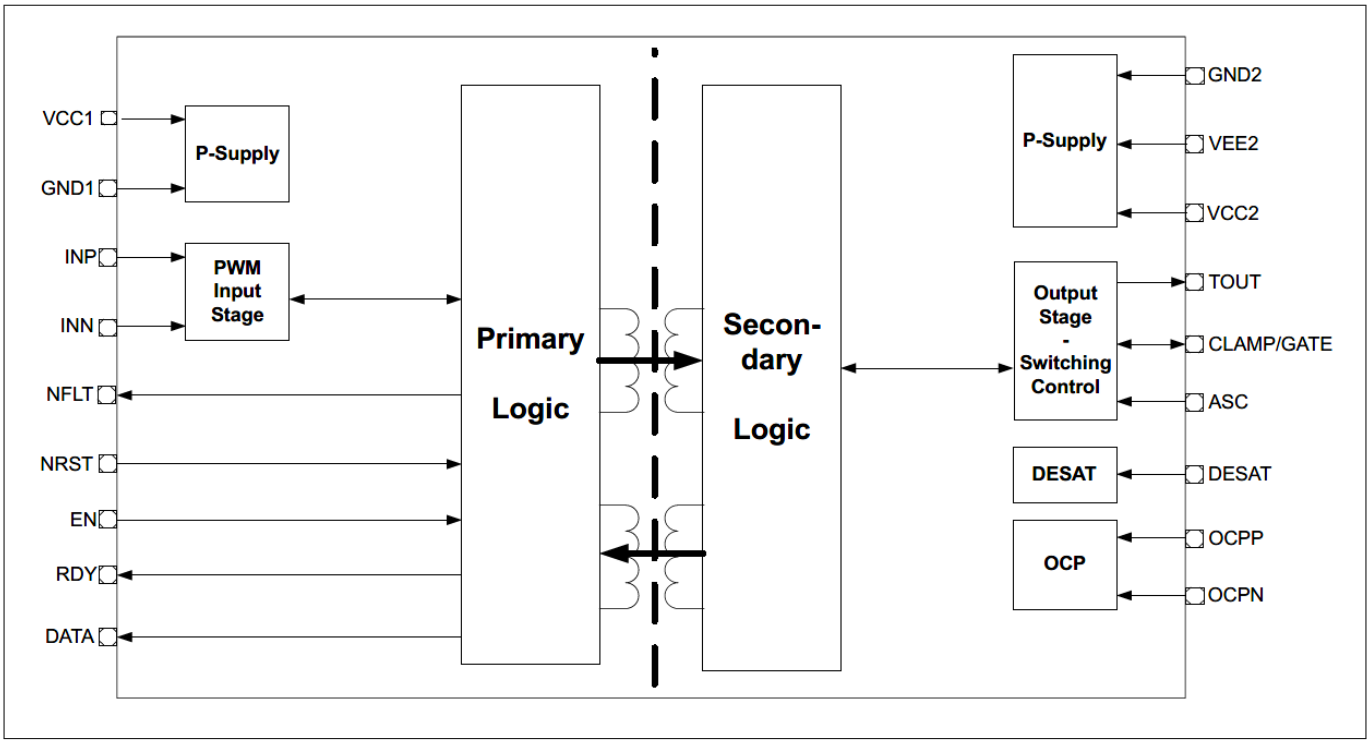


Figure 3 Block diagram 1EDI3021AS and 1EDI3031AS

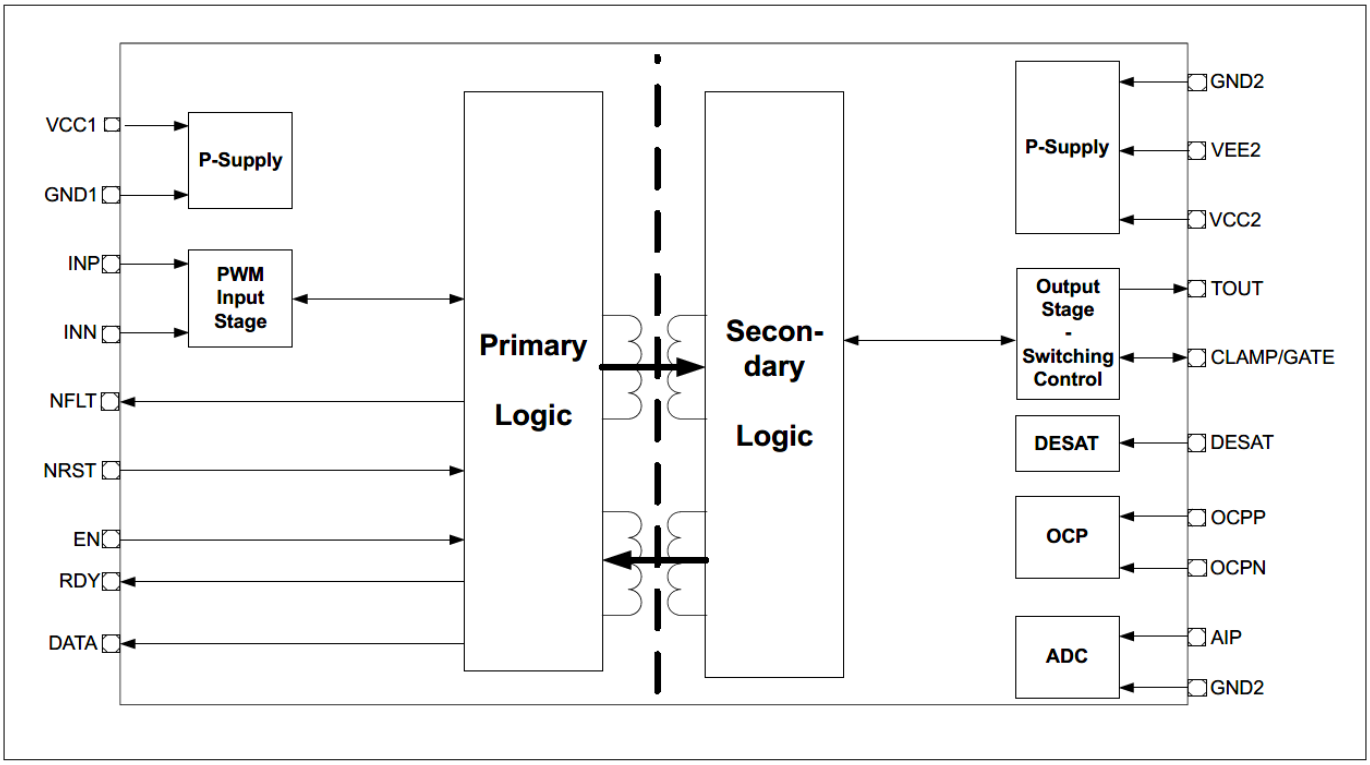


Figure 4 Block diagram 1EDI3020AS, 1EDI3023AS, 1EDI3030AS and 1EDI3033AS

3 Getting started

The EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS evaluation board is recommended to be used with the HybridPACK™ DSC or the AIMW120R045M1 CoolSIC™ MOSFET mounted. It can also be used in capacitive load emulation or with any other footprint compatible device. For load emulation place capacitors C22 and C7, see ***Figure 5***, which are not placed by default.

With capacitive load emulation the DESAT protection triggers on every switch-on event, so the device enters error mode, see ***Operating modes***. In order to suppress such unwanted triggering of DESAT protection, connect DESAT_T to GND_2T and DESAT_B to GND_2B, respectively. Each DESAT_x signal can be accessed via the respective test point.

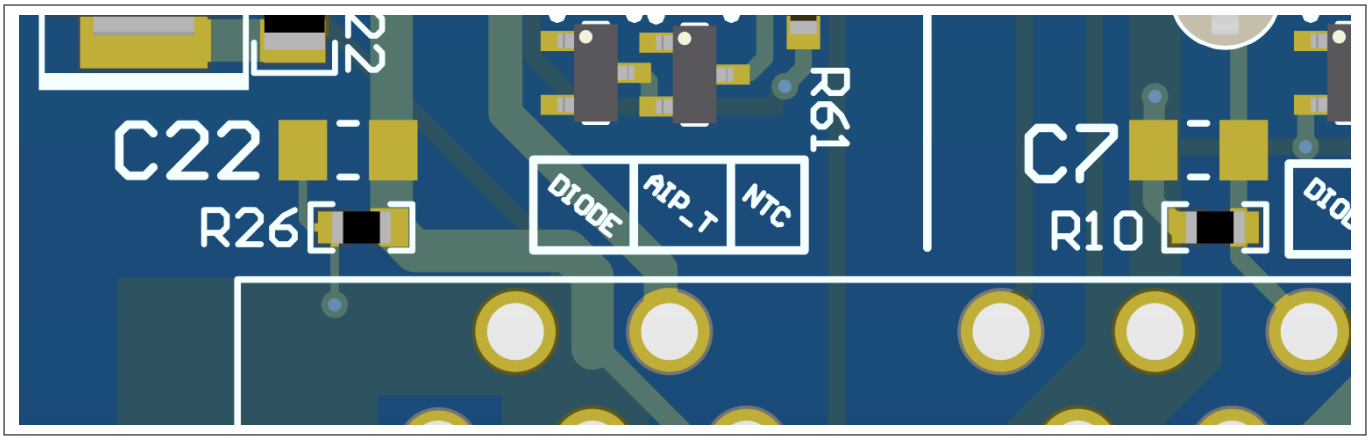


Figure 5 C22 and C7 PCB mounting location

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

1. Provide the primary supply voltage according to ***Operating conditions***.
2. Set jumpers according to ***Table 4***.
3. Verify that VCC1 and VCC2 voltages are present by checking the ***LED indicators***.
4. Press the RESET button to perform a transition of the drivers from Power_Down to Normal_Mode, see ***Operating modes***.
5. Verify that the device is in Normal_Mode: RDY LEDs on, and NLFT LEDs off.
6. Apply a PWM signal to either INP or INN according to ***Operating conditions*** to start toggling the high side or low side switch, respectively.
7. If the device enters Error_Mode switches off the output stage due to a triggered protection feature, then press the RESET button to perform a transition to Ready_Mode and Normal_Mode.

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

4 Evaluation board

4.1 PCB overview

Figure 6 shows an overview of the EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS evaluation board. A vertical line on the PCB marks the split between primary side and secondary side. The assembly applies for all variants of the EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS evaluation board, except for IC1 and IC2, which are specific to each variant, see ***Table 2***. The transformer TR1 near the center of the PCB provides the supply voltages for the secondary side of the gate drivers.

Power switches, such as the 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.

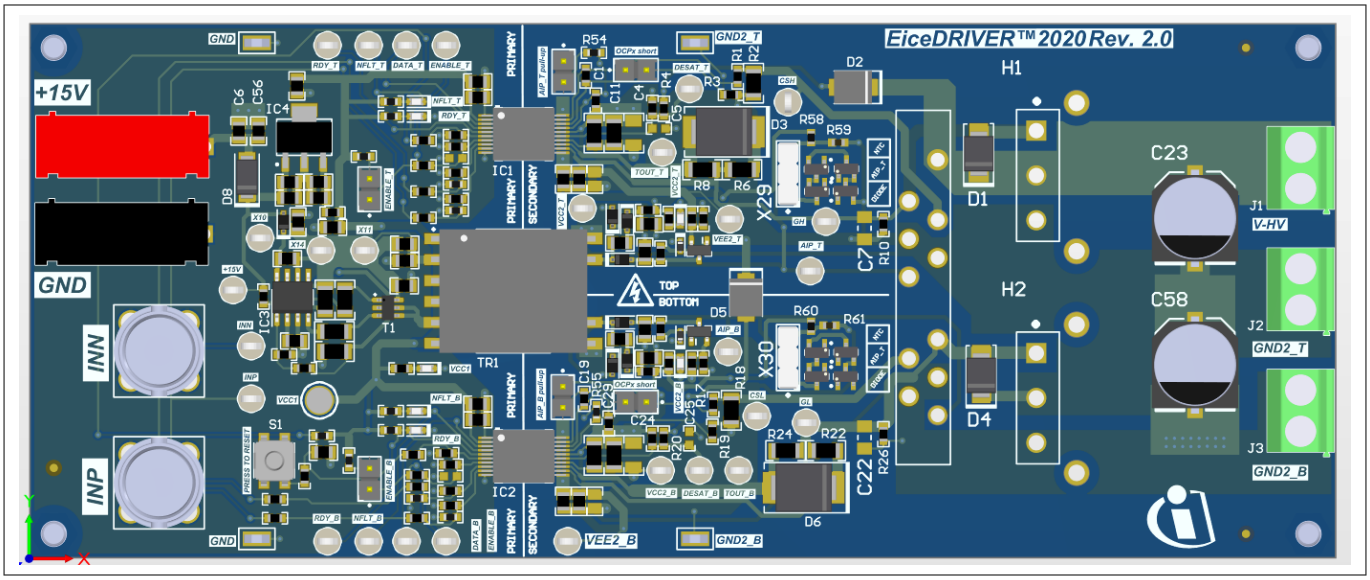


Figure 6 PCB overview

When using the AIMW120R045M1 CoolSIC™ MOSFET 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 7***. The heat sink is not included by default and can be purchased separately.

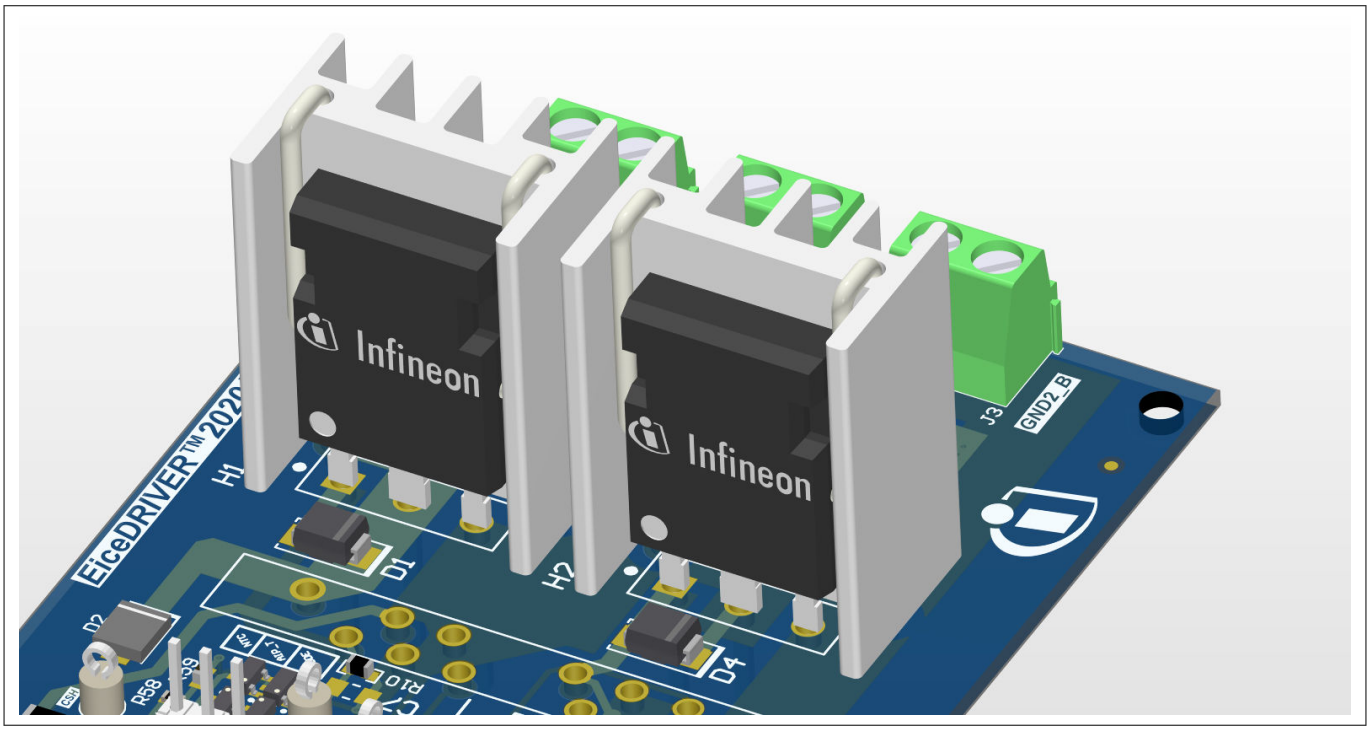


Figure 7 AIMW120R045M1 CoolSIC™ MOSFET mounted with heat sink

4.2 Connectors

There are connectors on the primary side and on the secondary side of the EiceDRIVER™ enhanced 1EDI302xAS/ 1EDI303xAS evaluation board. The board requires a supply voltage of 15 V at the banana sockets on the primary side. The BNC connectors INN and INP accept the PWM signal for the input of each driver, see ***Figure 8***.

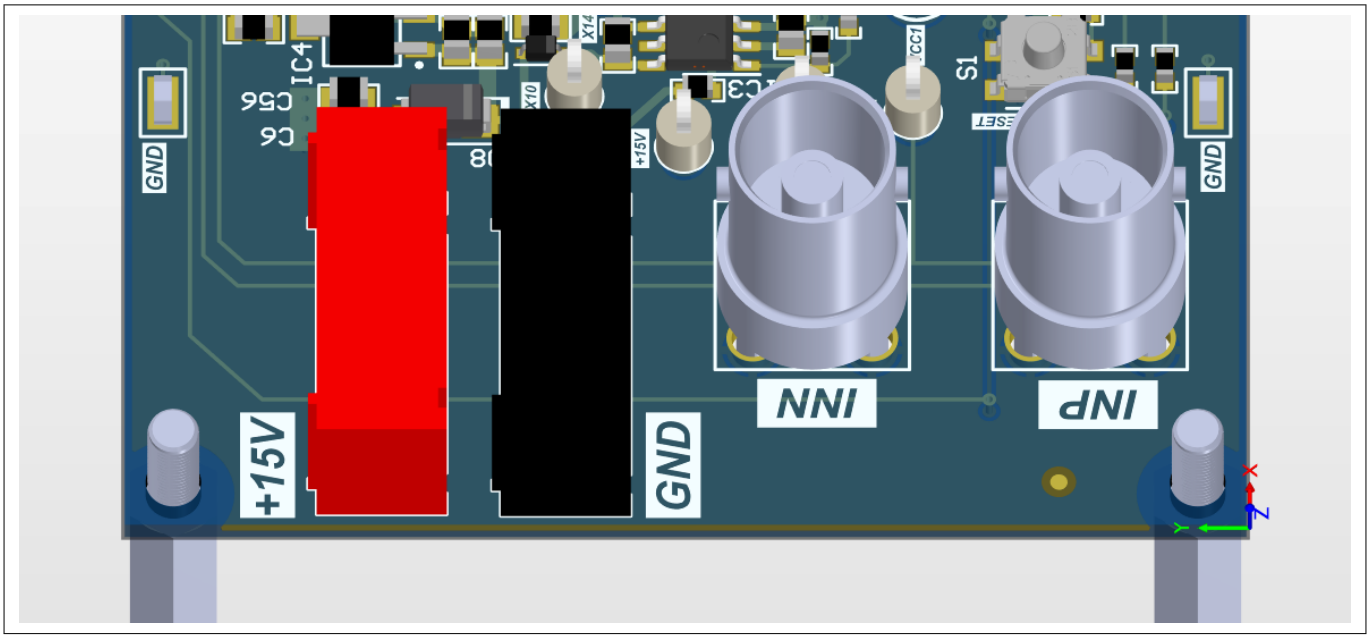


Figure 8 Primary side connectors

Figure 9 shows the secondary side screw terminals for the secondary supply voltage and the center tap of the half bridge.

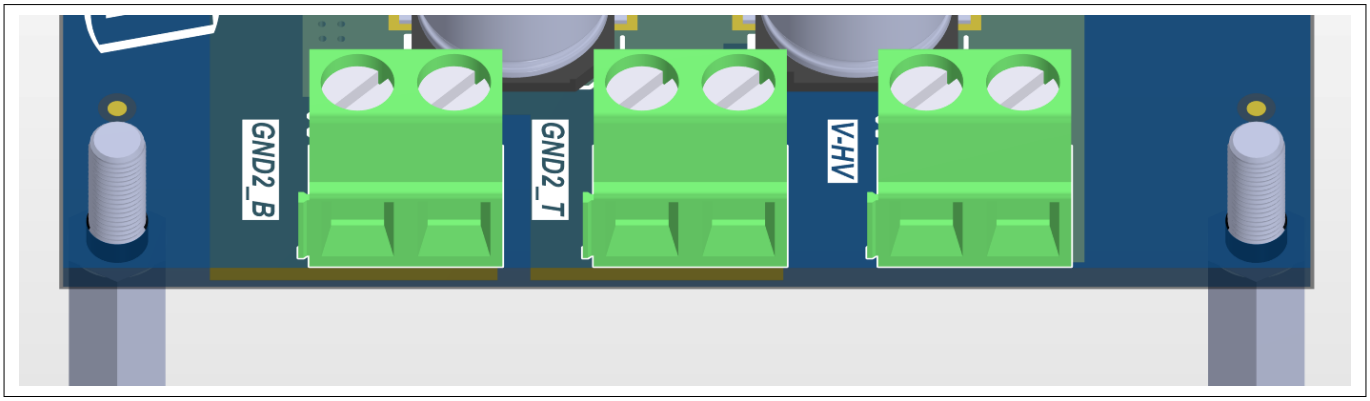


Figure 9 Secondary side connectors

4.3 LED indicators

LEDs on the EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS evaluation board indicate board health and driver status, see ***Figure 10***:

1. Dedicated NFLT_x and RDY_x indicator for each driver
2. Primary side supply indicator on VCC1
3. Secondary side VCC2 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***.

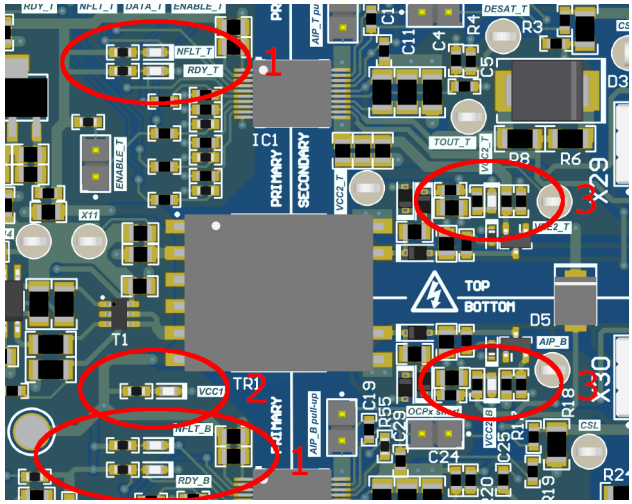


Figure 10 LED indicators

4.4 Operating conditions

To avoid electrical damage of the evaluation board, the operating range defined in ***Table 3*** must be maintained.

Table 3 Operating conditions[1)]

Parameter	Pin	Values		Unit	Note
		Min.	Max.		
V_{supply}	Banana socket	14	21	V	Limited by secondary side UVLO, OVLO and absolute maximum rating of power switch gate
$V_{HV\ to\ GND2_B}$	Screw terminal	0	600	V	Theoretical HV DC limit; not tested
V_{BNC}	BNC connectors	-0.3	5	V	Limited by VCC1 voltage

1 The evaluation board operates at an ambient temperature of 25°C.

4.5 Configuration

The EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS evaluation board can be configured via jumpers on the board. The board provides the following configuration options for each driver:

1. ENABLE_x
2. ASC pull-up
3. OCP disable
4. AIP signal selection

The reset button R triggers a power-on reset of both drivers and clears the Error_Mode, see ***Operating modes***.

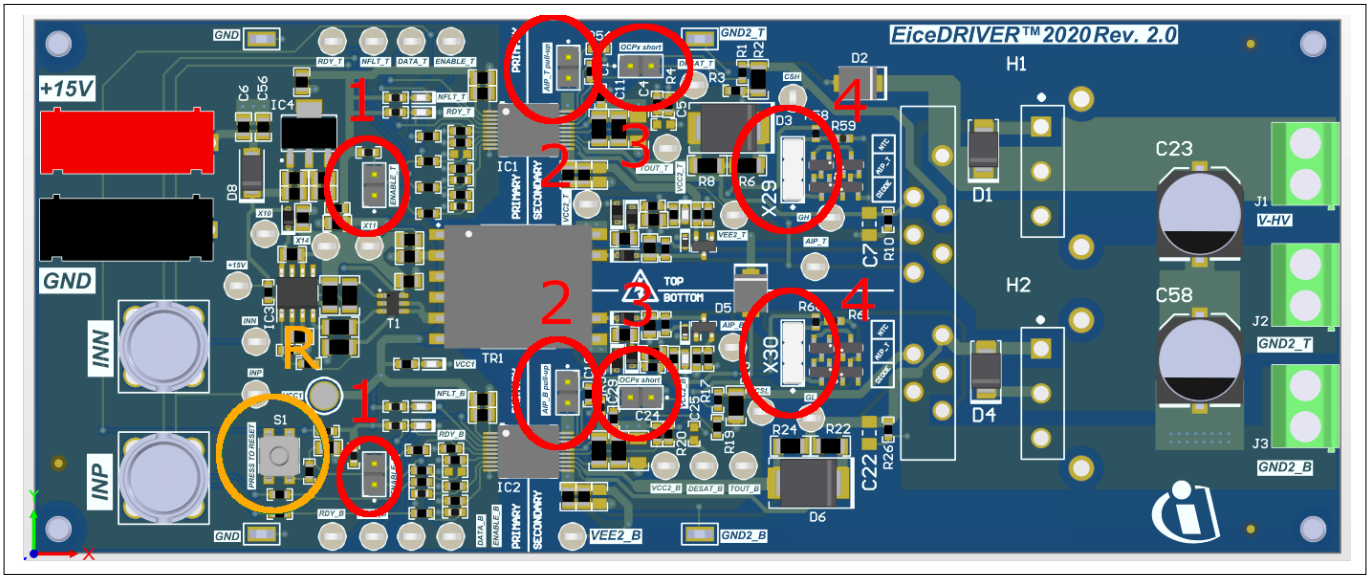


Figure 11 EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS evaluation board configuration overview

Table 4 shows the recommended default configuration. Some jumpers are only applicable to certain products of the EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS family.

Table 4 EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS evaluation board default jumper configuration

Jumper ID	Applicable products	State	Signal name	Effect
1	all	placed	ENABLE_T ENABLE_B	Drivers enabled
2	1EDI3021AS 1EDI3031AS	not placed	ASC_T ASC_B	ASC disabled
3[2)]	all	placed	OCPP_T OCPP_B	Overcurrent protection disabled
4	1EDI3020AS 1EDI3023AS 1EDI3030AS 1EDI3033AS	not placed	AIP_T AIP_B	AIP signal selection: none

2 Overcurrent protection requires the HybridPACK™ DSC to be mounted.

4.5.1 Jumper on Enable_x

Place the jumpers on ENABLE_B and ENABLE_T to enable each driver respectively. ***Figure 12*** shows the location and the schematic symbol of the ENABLE_B jumper. If no jumper is placed, then an internal pull-down resistor pulls ENABLE_x to GND.

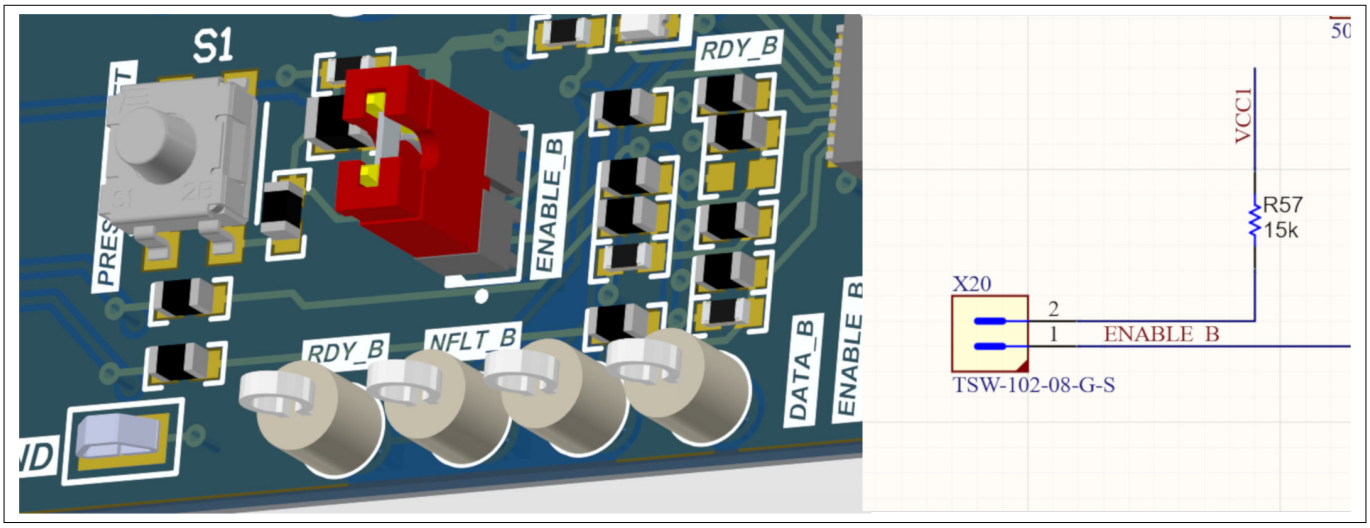


Figure 12 ENABLE_B jumper (low side driver example)

4.5.2 Jumper on ASC_x

Place this jumper on the 1EDI3021AS and 1EDI3031AS variants to enable the secondary side ASC. Secondary side ASC overrides the INP signal on the primary side and drives the gate to "high".

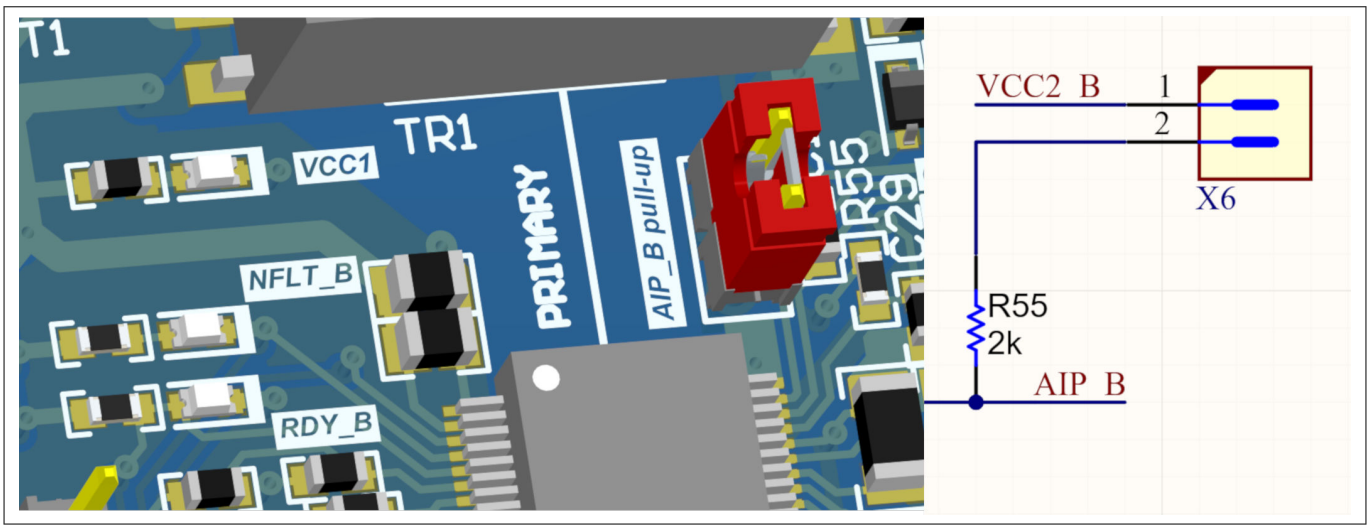


Figure 13 AIP_B jumper (low side driver example)

4.5.3 Jumper on OCPx

Overcurrent detection can be disabled by placing the jumper that connects OCPP to OCPN. The overcurrent detection feature requires the HybridPACK™ DSC module to be mounted.

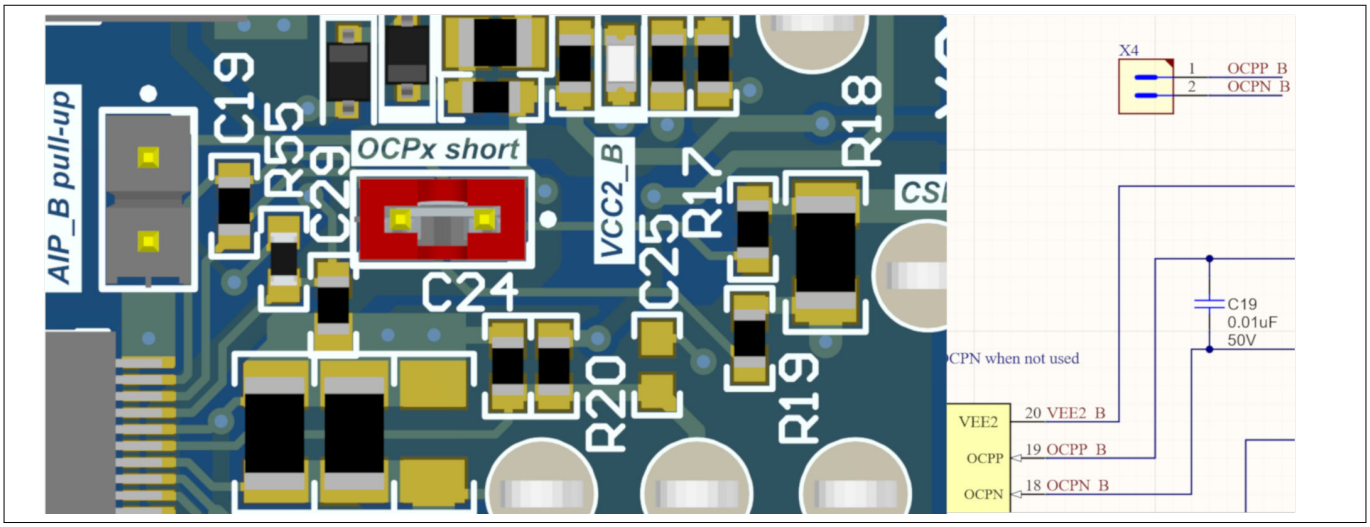


Figure 14 OCPP_B jumper (low side driver example)

4.5.4 AIP_x signal selection jumper

The AIP_x signal selection jumper is only relevant for the 1EDI3020AS, 1EDI3023AS, 1EDI3030AS, 1EDI3033AS variants. The jumper can be placed in two configurations. It is used to select an external circuit connected to the AIP_x pin. ***Figure 15*** shows the schematic and the location is shown.

Placing the jumper between pin 1 and 2 connects several bipolar transistors in diode configuration to emulate temperature measurement on the 1EDI3020AS and 1EDI3030AS. These devices have an internal current source combined with the ADC.

Placing the jumper between pin 2 and 3 connects a voltage divider to VCC2 with an NTC inside. This can be used to evaluate NTC based temperature measurements on the 1EDI3023AS and 1EDI3033AS devices. The internal current source on these devices is deactivated for the ADC. For details on all device variants please refer to the datasheet.

Do not place the jumper when the HybridPACK™ DSC is soldered to the board. In this case the ADC is automatically connected to the module's internal diode structure for temperature measurement.

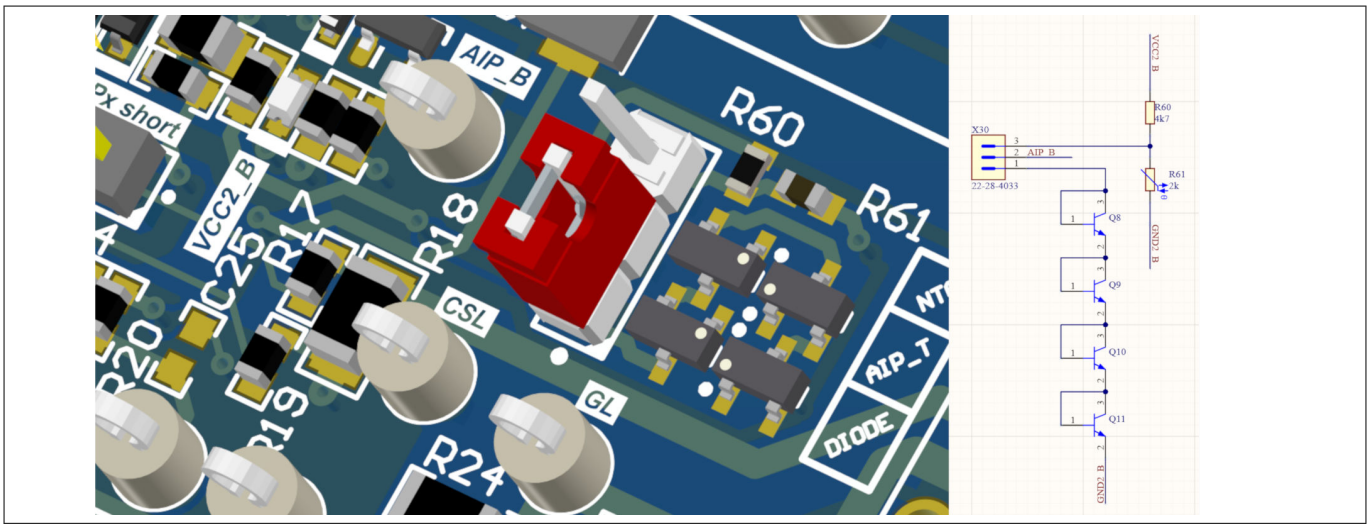


Figure 15 AIP signal selection jumper (bottom side example)

If the NTC configuration is used and the device is in Ready_Mode or in Error_Mode as shown in ***Operating modes***, then the output duty cycle at the DATA pin can be calculated according to ***Equation 1***.

$$DC = \frac{V_{ADC}}{4.86V} = \frac{V_{CC2}}{4.86V}\frac{R_{NTC}}{R_{NTC} + 4.7k\Omega}$$

Equation 1 Relation between DATA pin duty cycle and NTC value

5 Schematic and layout

5.1 Schematic

Figure 16, ***Figure 17*** and ***Figure 18*** show the EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS evaluation board schematics. The driver schematic depends on the variant of the EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS evaluation board. There is a SiC and a IGBT variant as well as a variant with unpopulated drivers, see ***Table 2***.

The variants only differ regarding the mounted driver. All other components are identical, see ***Bill of materials***.

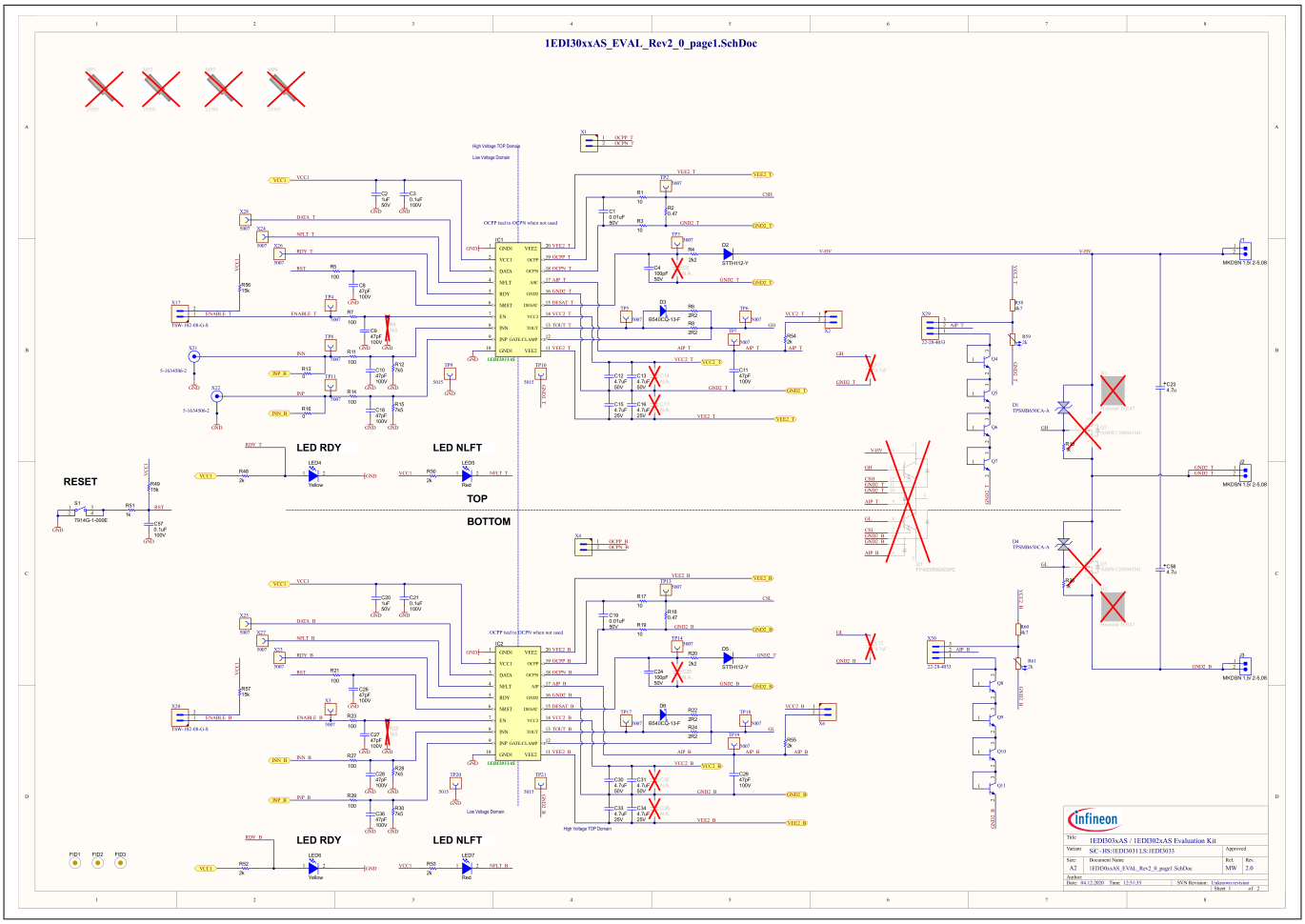


Figure 16 Driver schematic SiC variant, 1EDI3031AS and 1EDI3033AS mounted

Schematic and layout

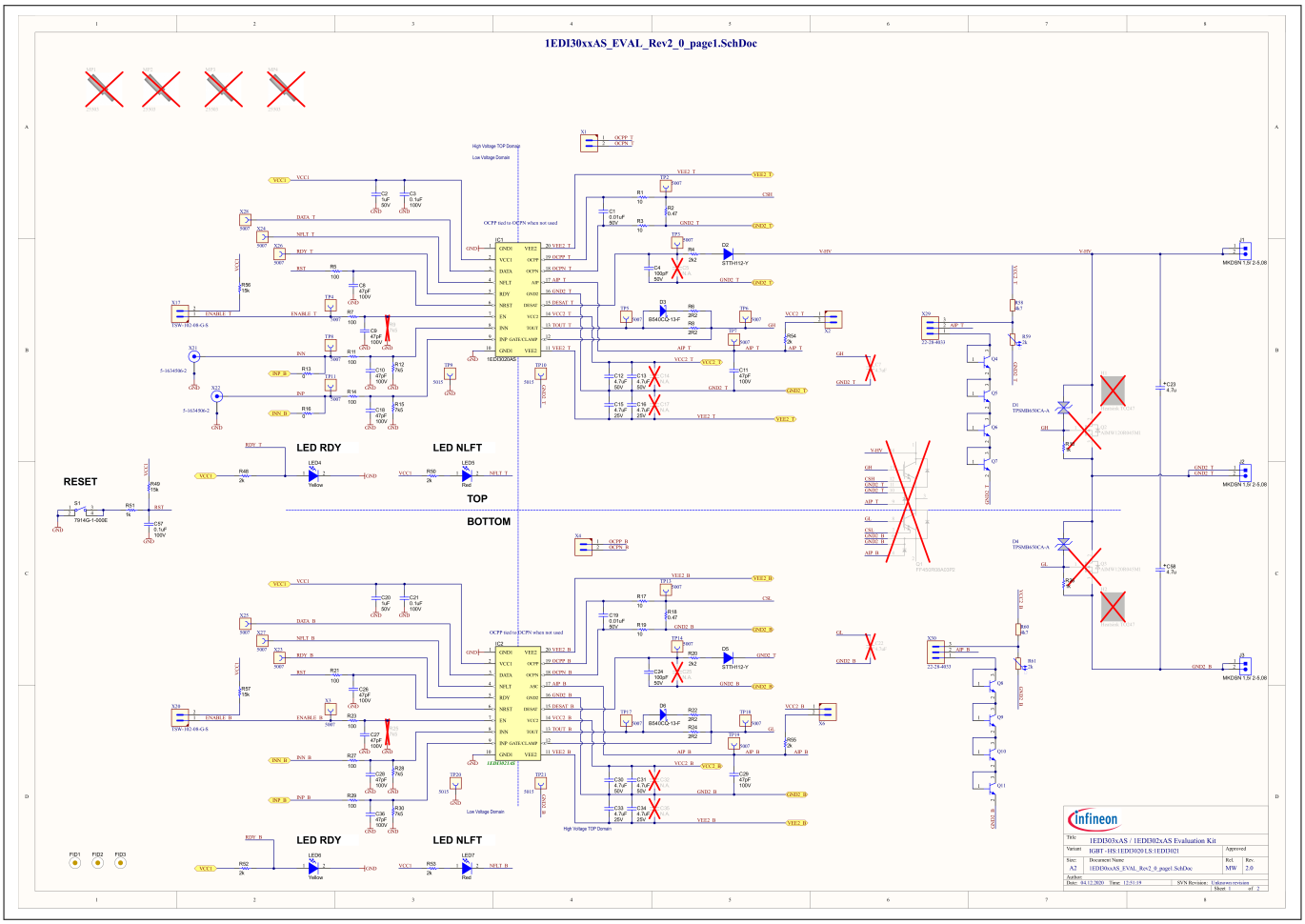


Figure 17 Driver schematic IGBT variant, 1EDI3020AS and 1EDI3021AS mounted

Schematic and layout

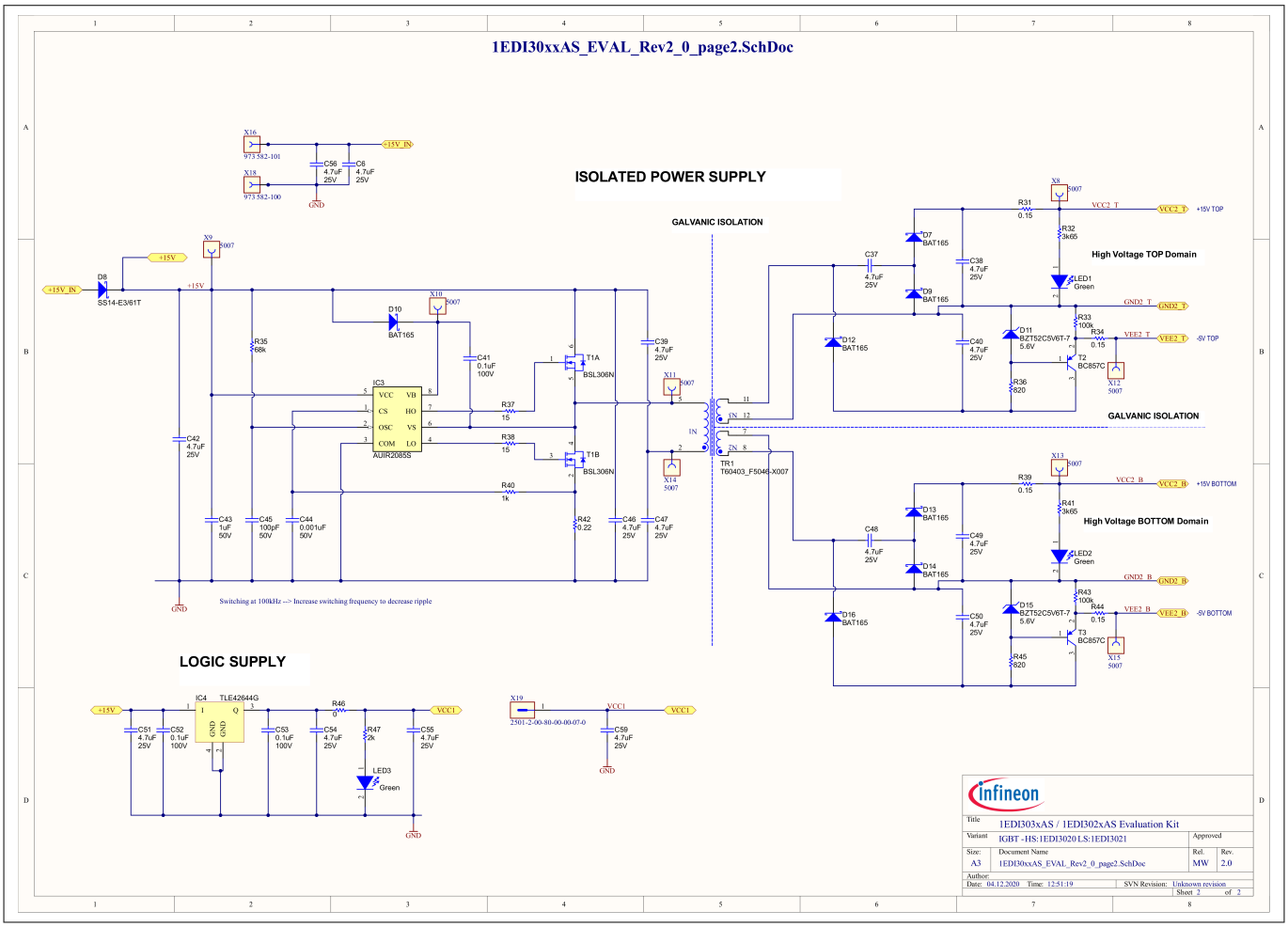


Figure 18 Primary and secondary supply schematic, all evaluation board variants

5.2 Layout

The EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS evaluation board PCB consists of two layers: top and bottom. For ease of use there are no components placed on the bottom side.

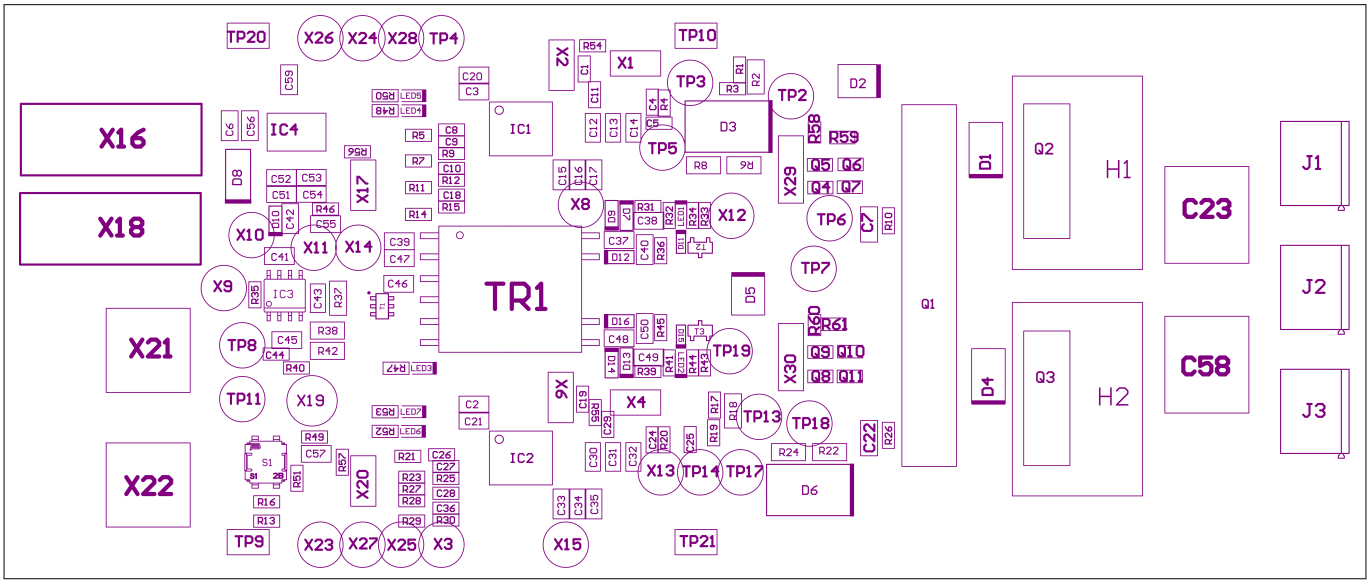


Figure 19 Assembly top view

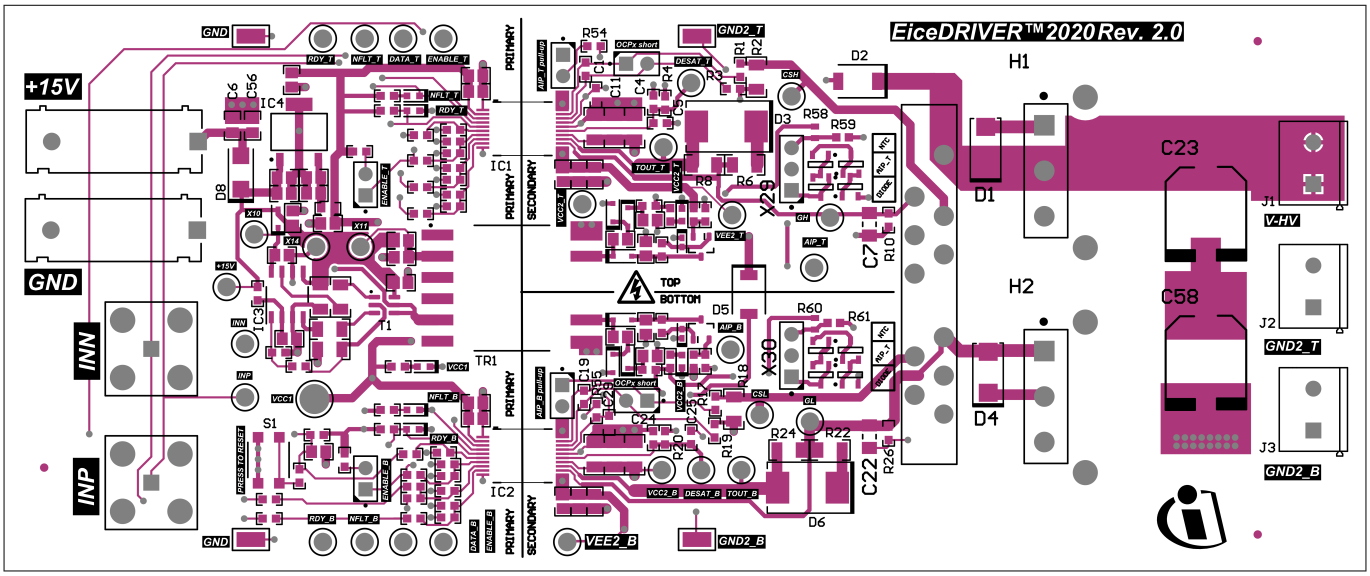


Figure 20 Top layer

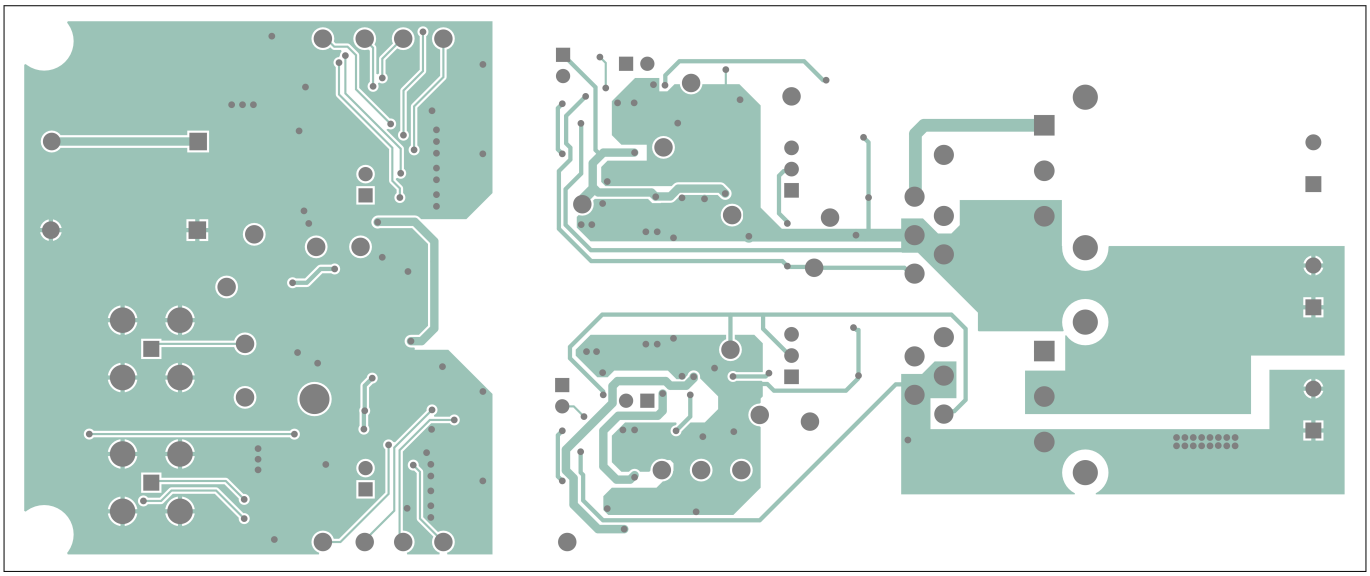


Figure 21 Bottom layer

6 Bill of materials

Table 5 shows the bill of materials for all EiceDRIVER™ enhanced 1EDI302xAS/1EDI303xAS evaluation board variants. The driver ICs mounted depend on the variant. The power switches are not included.

Table 5 Bill of materials

Designator	Part number	Manufacturer	Quantity
X29, X30	22-28-4033	Molex	2
X21, X22	5-1634506-2	TE Connectivity	2
X19	2501-2-00-80-00-00-07-0	Mill-Max	1
X18	973 582-100	Hirschmann Test & Measurement	1
X16	973 582-101	Hirschmann Test & Measurement	1
X1, X2, X4, X6, X17, X20	TSW-102-08-G-S	Samtec	6
TR1	T60403_F5046-X007	Vacuumschmelze	1
TP9, TP10, TP20, TP21	5015	Keystone Electronics Corp.	4
TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP11, TP13, TP14, TP17, TP18, TP19, X3, X8, X9, X10, X11, X12, X13, X14, X15, X23, X24, X25, X26, X27, X28	5007	Keystone Electronics Corp.	28
T2, T3	BC857C	ON Semiconductor	2
T1	BSL306N	Infineon Technologies	1
S1	7914G-1-000E	Bourns	1
R59, R61	NTCS0603E3202JLT	Vishay	2
R58, R60	CRCW06034K70	Vishay	2
R49, R56, R57	CRCW060315K0FKEA	Vishay-Dale	3
R47, R48, R50, R52, R53, R54, R55	CRCW06032K00FKEA	Vishay-Dale	7
R42	RCWE1206R220FKEA	Vishay-Dale	1
R37, R38	CRCW120615R0FKEA	Vishay-Dale	2
R36, R45	CRCW0603820RFKEA	Vishay-Dale	2
R35	CRCW060368K0FKEA	Vishay-Dale	1
R33, R43	CRCW0603100KFKEA	Vishay-Dale	2
R32, R41	CRCW06033K65FKEA	Vishay-Dale	2
R31, R34, R39, R44	RCWE0603R150FKEA	Vishay-Dale	4
R13, R16, R46	CRCW0603000Z0EA	Vishay-Dale	3
R12, R15, R28, R30	CRCW06037K50FKEA	Vishay-Dale	4
R10, R26, R40, R51	CRCW06031K00FKEA	Vishay-Dale	4
R6, R8, R22, R24	CRCW12062R20JNEAHP	Vishay-Dale	4
R5, R7, R11, R14, R21, R23, R27, R29	CRCW0603100RFKEA	Vishay-Dale	8
R4, R20	CRCW06032K20FKEA	Vishay-Dale	2

Table 5 Bill of materials (continued)

Designator	Part number	Manufacturer	Quantity
R2, R18	RCWE1206R470FKEA	Vishay-Dale	2
R1, R3, R17, R19	CRCW060310R0FKEAHP	Vishay-Dale	4
Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11	MMBT3904,215	Nexperia	8
LED5, LED7	LTST-C190CKT	Lite-On	2
LED4, LED6	LTST-C190YKT	Lite-On	2
LED1, LED2, LED3	LTST-C190GKT	Lite-On	3
J1, J2, J3	MKDSN 1,5/ 2-5,08	Phoenix Contact	3
IC4	TLE42644G	Infineon Technologies	1
IC3	AUIR2085S	International Rectifier	1
FID1, FID2, FID3	N/A	N/A	3
D11, D15	BZT52C5V6T-7	Diodes Inc.	2
D8	SS14-E3/61T	Vishay Semiconductor	1
D7, D9, D10, D12, D13, D14, D16	BAT165	Infineon Technologies	7
D3, D6	B540CQ-13-F	Diodes Incorporated	2
D2, D5	STTH112-Y	STMicroelectronics	2
D1, D4	TPSMB650CA-A	Littel Fuse	2
C45	C0805C101K5GACAUTO	Kemet	1
C44	C0603C102K5RACAUTO	Kemet	1
C43	C1206C105K5RACAUTO	Kemet	1
C23, C58	UUX2G4R7MNL1GS	Nichicon	2
C12, C13, C30, C31	GCM31CC71H475KA03L	MuRata	4
C8, C9, C10, C11, C18, C26, C27, C28, C29, C36	C0603C470K1GACAUTO	Kemet	10
C6, C15, C16, C33, C34, C37, C38, C39, C40, C42, C46, C47, C48, C49, C50, C51, C54, C55, C56, C59	GCM21BC71E475KE36L	MuRata	20
C4, C24	C0603C101K5RACAUTO	Kemet	2
C3, C21, C41, C52, C53, C57	GCM21BR72A104KA37K	MuRata	6
C2, C20	GCM21BR71H105KA03L	MuRata	2
C1, C19	C0603C103K5RECAUTO	Kemet	2

7 Restrictions

This evaluation board offers limited features only for evaluation and testing of Infineon products. The evaluation board is neither an end product nor a finished appliance, nor is it intended or authorized by Infineon to be integrated into end products. The evaluation board may not be used in any production system.

For further information please visit ***www.infineon.com***.

Revision history

Revision	Date	Changes
1.0	2020-12-18	Document created

Trademarks

All referenced product or service names and trademarks are the property of their respective owners.

Edition 2020-12-18

Published by

Infineon Technologies AG

81726 Munich, Germany

© 2021 Infineon Technologies AG

All Rights Reserved.

Do you have a question about any aspect of this document?

Email: erratum@infineon.com

Document reference
IFX-Z8F80037256

IMPORTANT NOTICE

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics ("Beschaffenheitsgarantie").

With respect to any examples, hints or any typical values stated herein and/or any information regarding the application of the product, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

In addition, any information given in this document is subject to customer's compliance with its obligations stated in this document and any applicable legal requirements, norms and standards concerning customer's products and any use of the product of Infineon Technologies in customer's applications.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer's technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

WARNINGS

Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies' products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.