

# EVAL-PSIR2085 user guide

## Power supply board to support EiceDRIVER™ isolated gate driver EVAL-Boards

### About this document

#### Scope and purpose

This user guide explains how to operate the power supply board EVAL-PSIR2085 together with different EiceDRIVER™ isolated gate driver evaluation boards to evaluate power switches like MOSFETs, IGBTs and CoolSiC™ MOSFETs

#### Intended audience

This document is intended for design engineers, owners and users of these evaluation boards.

#### Evaluation Board

This board is to be used during the design-in process, for evaluation and measurement of product characteristics, and proof of data sheet specifications.

*Note: It is recommended to adapt the proposed circuits and layout to best fit the final customer design.*

### Important notice

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Safety precautions

Safety precautions

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

Table 1 Safety precautions

	<p><b>Warning:</b> The DC link potential of this board is up to 1200 V<sub>DC</sub>. When measuring voltage waveforms by oscilloscope, high voltage differential probes must be used. Failure to do so may result in personal injury or death.</p>
	<p><b>Warning:</b> The evaluation or reference board contains DC bus capacitors which take time to discharge after removal of the main supply. Before working on the drive system, wait five minutes for capacitors to discharge to safe voltage levels. Failure to do so may result in personal injury or death. Darkened display LEDs are not an indication that capacitors have discharged to safe voltage levels.</p>
	<p><b>Warning:</b> The evaluation or reference board is connected to the grid input during testing. Hence, high voltage differential probes must be used when measuring voltage waveforms by oscilloscope. Failure to do so may result in personal injury or death. Darkened display LEDs are not an indication that capacitors have discharged to safe voltage levels.</p>
	<p><b>Warning:</b> Remove or disconnect power from the drive before you disconnect or reconnect wires, or perform maintenance work. Wait five minutes after removing power to discharge the bus capacitors. Do not attempt to service the drive until the bus capacitors have discharged to zero. Failure to do so may result in personal injury or death.</p>
	<p><b>Caution:</b> The heat sink and device surfaces of the evaluation or reference board may become hot during testing. Hence, necessary precautions are required while handling the board. Failure to comply may cause injury.</p>
	<p><b>Caution:</b> Only personnel familiar with the drive, power electronics and associated machinery should plan, install, commission and subsequently service the system. Failure to comply may result in personal injury and/or equipment damage.</p>
	<p><b>Caution:</b> The evaluation or reference board contains parts and assemblies sensitive to electrostatic discharge (ESD). Electrostatic control precautions are required when installing, testing, servicing or repairing the assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with electrostatic control procedures, refer to the applicable ESD protection handbooks and guidelines.</p>
	<p><b>Caution:</b> A drive that is incorrectly applied or installed can lead to component damage or reduction in product lifetime. Wiring or application errors such as undersizing the motor, supplying an incorrect or inadequate AC supply, or excessive ambient temperatures may result in system malfunction.</p>
	<p><b>Caution:</b> The evaluation or reference board is shipped with packing materials that need to be removed prior to installation. Failure to remove all packing materials that are unnecessary for system installation may result in overheating or abnormal operating conditions.</p>

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### The board at a glance

## 1 The board at a glance

The evaluation board **EVAL-PSIR2085** was developed to provide power to the EiceDRIVER™ isolated gate driver evaluation boards, such as the [EVAL-1ED3122MX12H](#). This is a kind of default power supply board, serving various EiceDRIVER™ isolated gate driver evaluation boards. Some of the evaluation boards also contain power switches, such as MOSFETs, IGBTs and CoolSiC™ MOSFETs. The modular approach enables users to expand the platform in the future with additional gate driver evaluation boards.

Figure 1 and Figure 2 show pictures of the EVAL-PSIR2085.

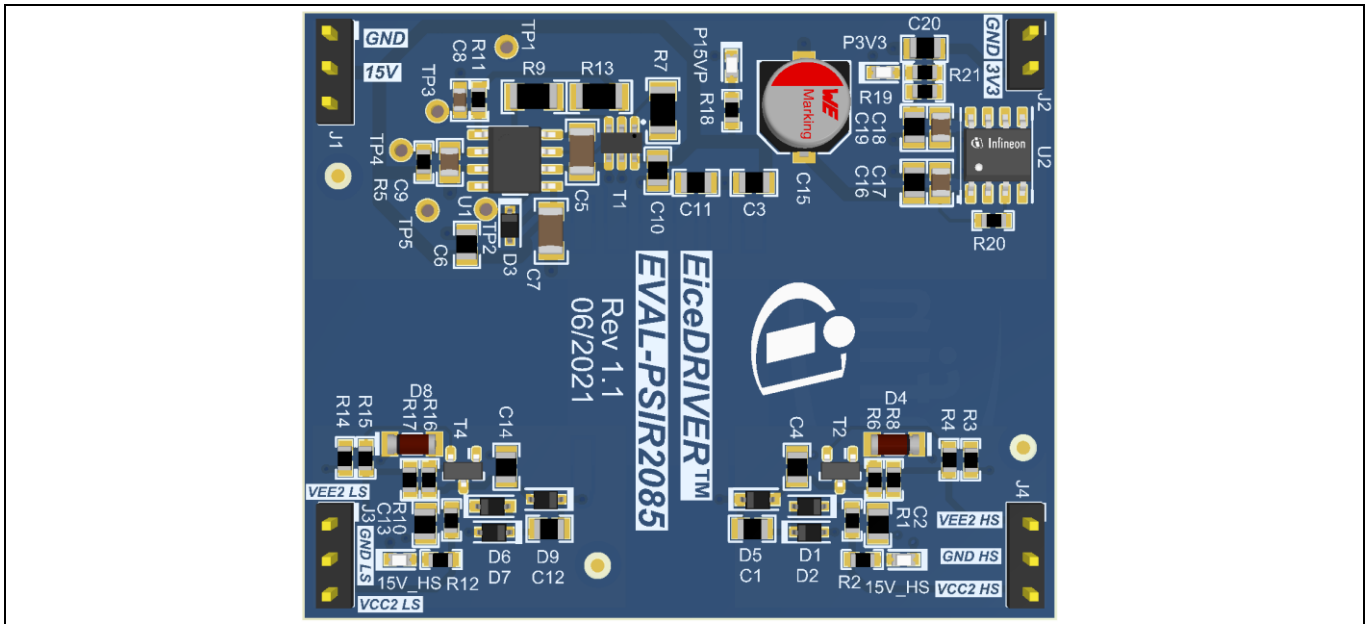


Figure 1 Top view of the power supply board EVAL-PSIR2085

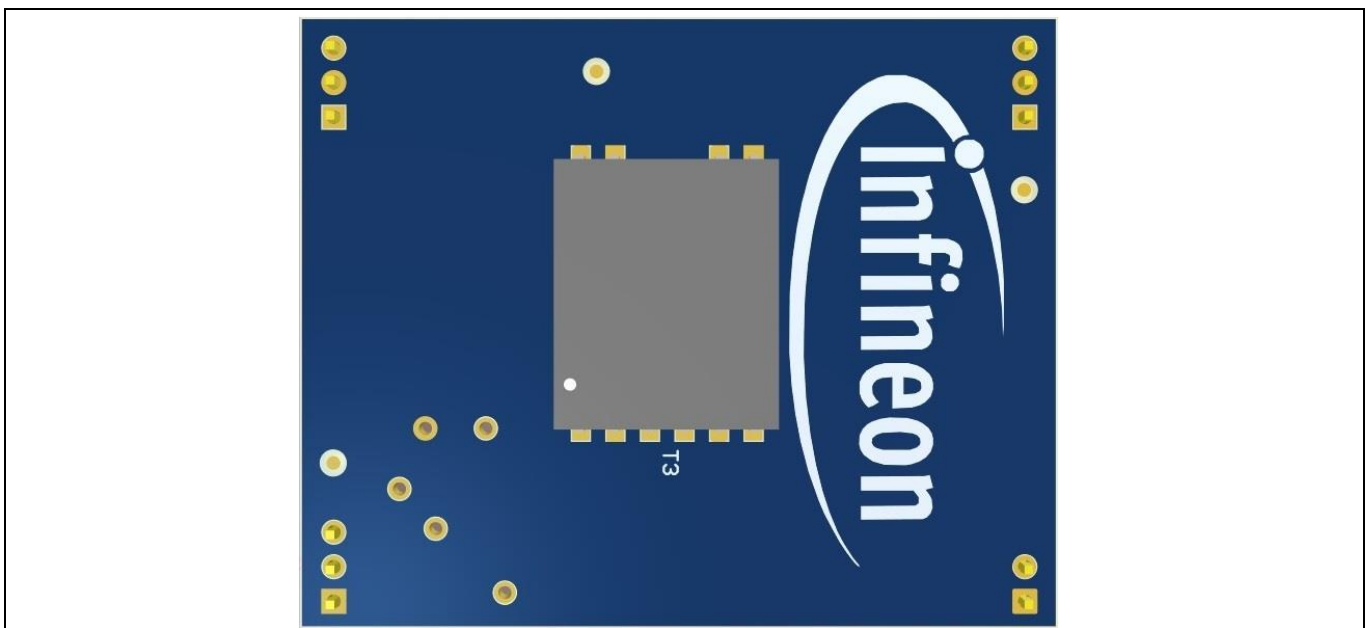


Figure 2 Bottom view of the power supply board EVAL-PSIR2085

For a more detailed description, please see Chapter 1.2.

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## Power supply board to support EiceDRIVER™ isolated gate driver EVAL-Boards

### The board at a glance

Figure 3 and Figure 4 illustrate an isolated gate driver evaluation board EVAL-1ED3122MX12H that was developed for use with the power board.

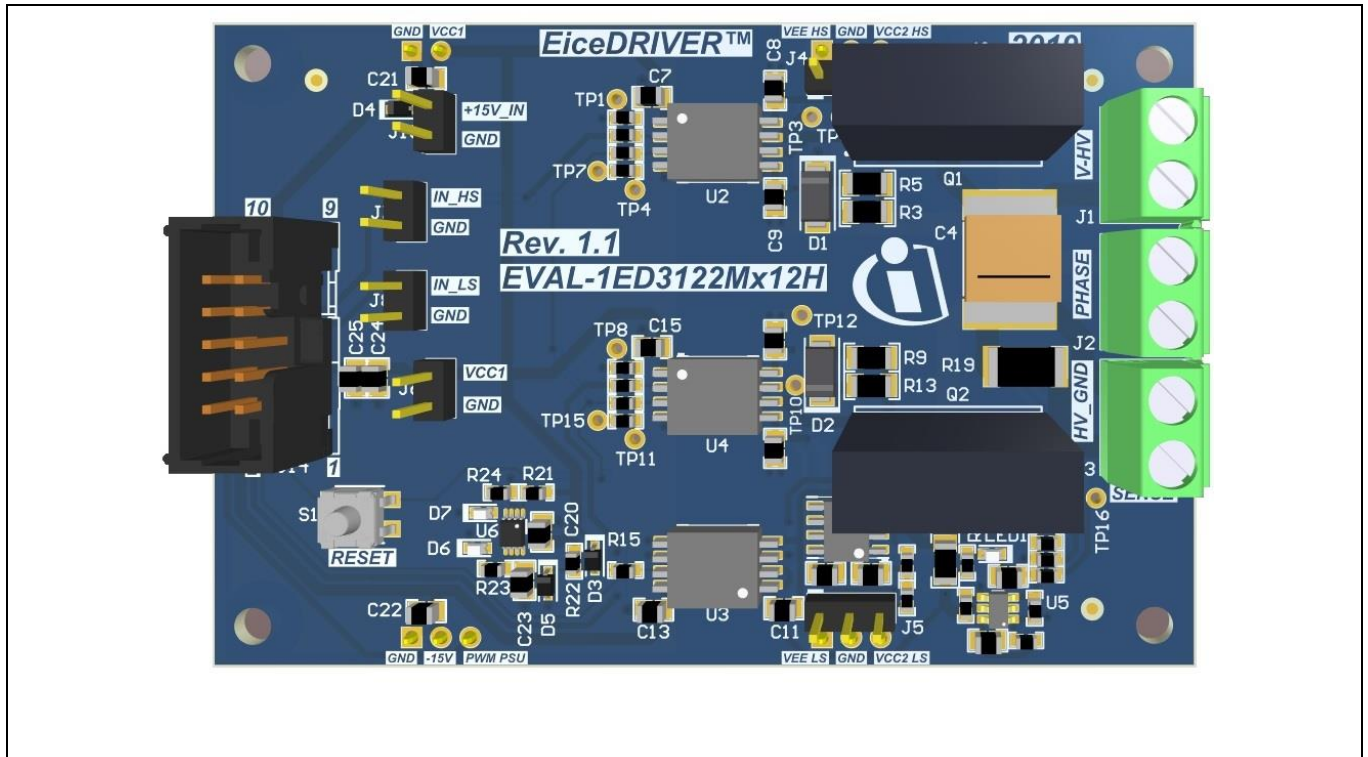


Figure 3 Top view of isolated gate driver eval-board EVAL-1ED3122MX12H

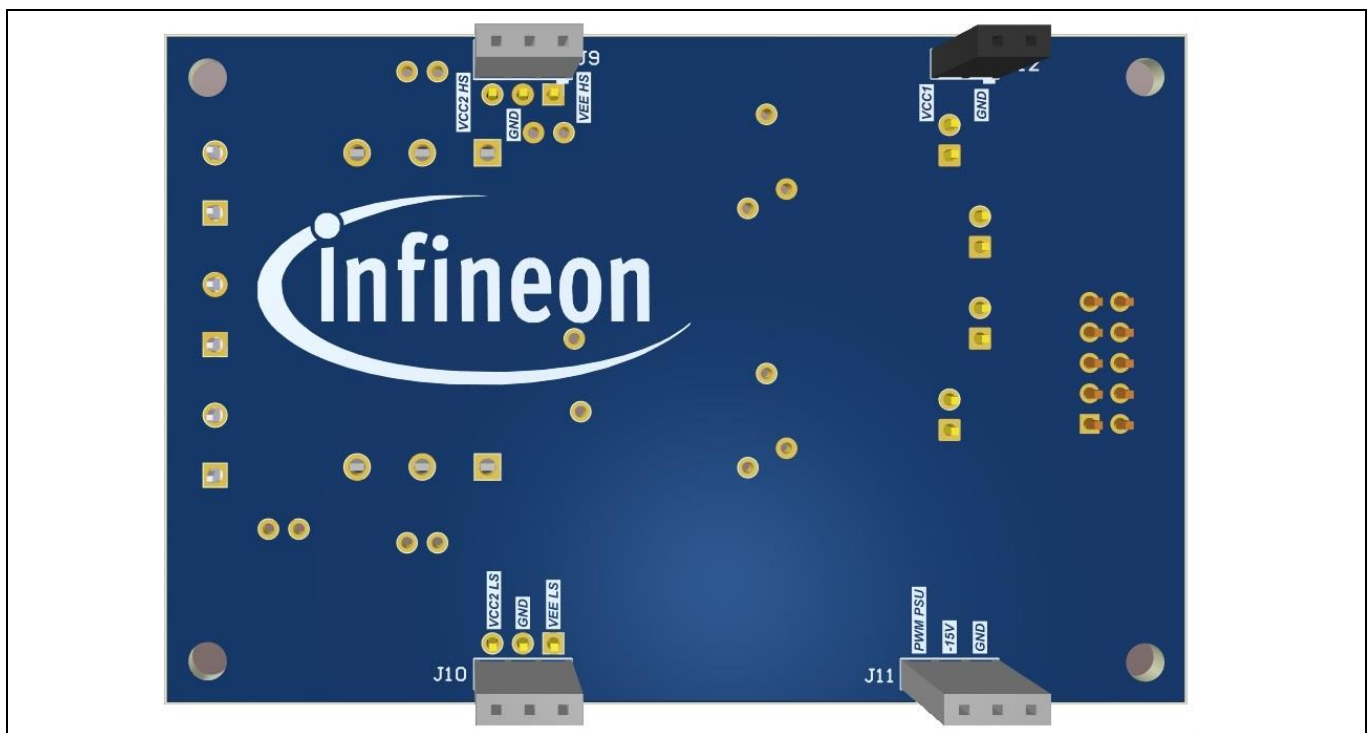
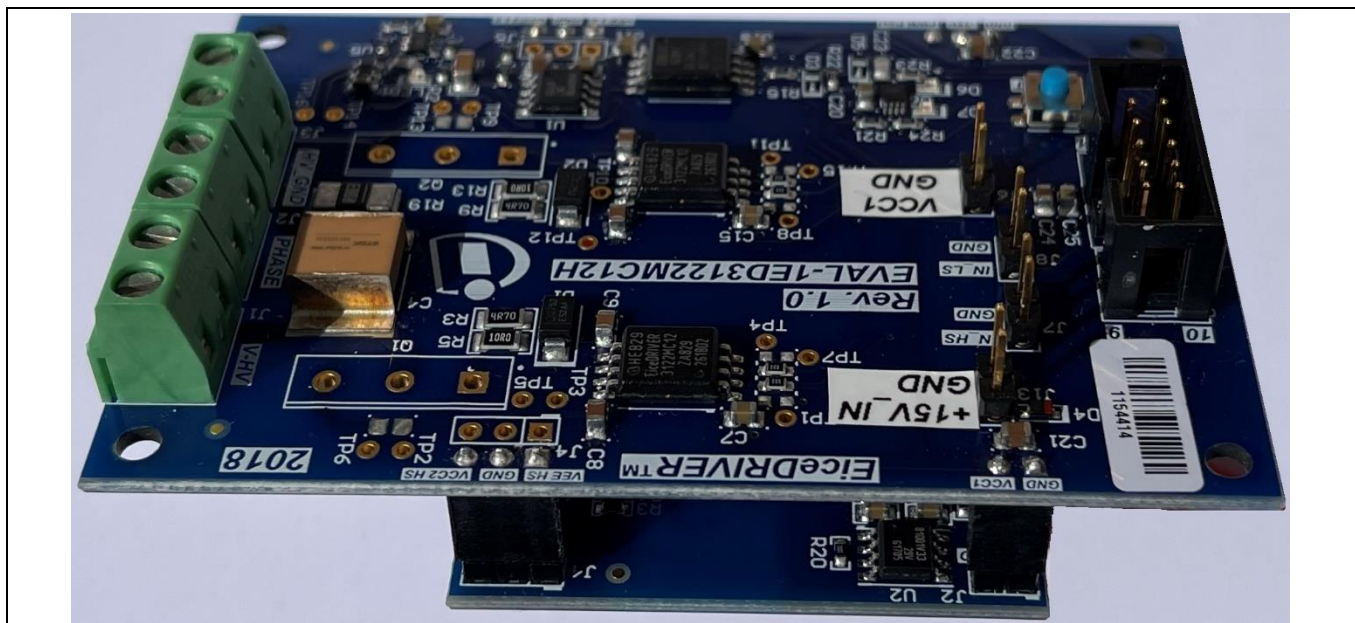


Figure 4 Back view of isolated gate driver eval-board EVAL-1ED3122MX12H





**Figure 5 View of complete solution (power supply board + isolated gate driver eval-board)**

### 1.1 Available evaluation boards for usage with EVAL-PSIR2085

The power supply board EVAL-PSIR2085 is designed to be used with the following EiceDRIVER™ isolated gate driver evaluation board, and some of the future EiceDRIVER™ isolated gate driver evaluation boards.

**Table 2 Existing evaluation boards for usage with power supply board**

Eval-Board	Description
<a href="#">EVAL-1ED3121MX12H</a>	Eval-board with 1ED3121MC12H: 2300 V, 5.5 A, 5.7 kV (rms) 1-ch isolated driver with separate output
<a href="#">EVAL-1ED3122MX12H</a>	Eval-board with 1ED3122MC12H: 2300 V, 10 A, 5.7 kV (rms) 1-ch isolated driver with active Miller clamp
<a href="#">EVAL-1ED3124MX12H</a>	Eval-board with 1ED3124MC12H: 2300 V, 14 A, 5.7 kV (rms) 1-ch isolated driver with separate output
<a href="#">EVAL-1ED3241MC12H</a>	Eval-board with 1ED3241MC12H: 2300 V, 18 A, 5.7 kV (rms) 1-ch isolated driver with 2 level slew rate control
<a href="#">EVAL-1ED3251MC12H</a>	Eval-board with 1ED3251MC12H: 2300 V, 18 A, 5.7 kV (rms) 1-ch isolated driver with 2 level slew rate control and active Miller clamp

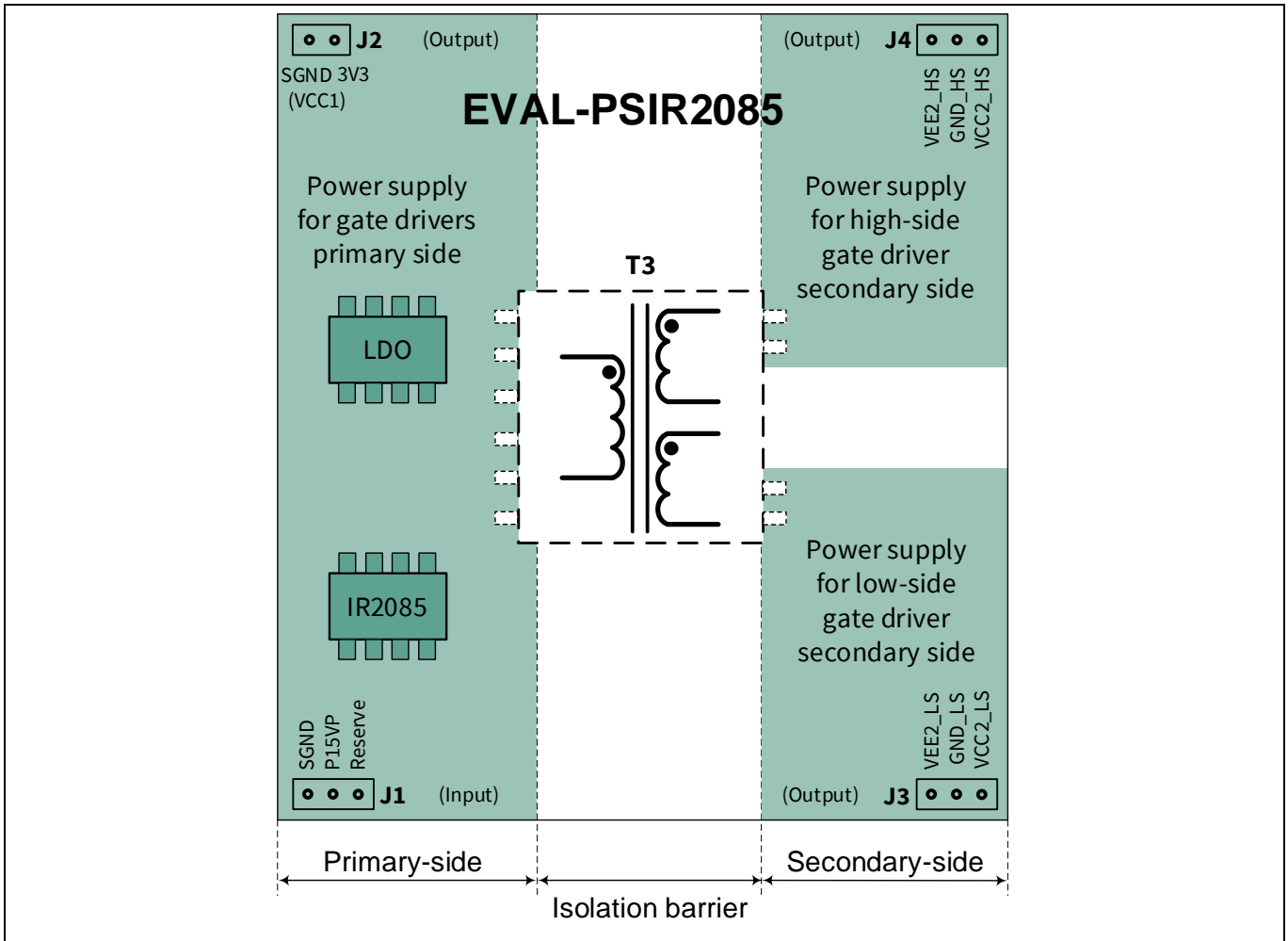
**The board at a glance**

**1.2 Delivery content**

The scope of delivery includes the EVAL-PSIR2085 board packed in a plastic bag. All other related EiceDRIVER™ isolated gate driver evaluation boards can be ordered separately.

**1.3 Block diagram**

The block diagram of the EVAL-PSIR2085 is depicted in Figure 6.



**Figure 6 Block diagram of EVAL-PSIR2085**

The male connectors J1, J2, J3 and J4 (see Figure 6 or Figure 1) are used to connect the power supply board with the isolated gate driver eval-board, where the corresponding female connectors (J9, J10, J11, J12, please see Figure 4) are placed. On each board there is one connector with only two inputs (J2 and J12); all others have three. That prevents false connection of the board.



### The board at a glance

#### 1.4 Main features

- Two galvanically isolated power supplies
- Power supply one for VCC1 (3.3 V) and GND for primary side of the gate drivers
- Power supply two with VCC2\_HS, GND\_HS and VEE2\_HS for secondary side of high-side gate driver
- Power supply three with VCC2\_LS, GND\_LS and VEE2\_LS for secondary side of low-side gate driver
- For 600 V / 1200 V power switches, like MOSFETs, IGBTs or SiC MOSFETs

#### 1.5 Board parameters and technical data

The key specifications of this board are displayed in Table 3.

**Table 3** Parameter

Parameter	Symbol	Value (max)	Unit	Test condition
Positive power supply output side (low and high side)	VCC2	20	V	<sup>1)</sup>
Negative power supply output side (low and high side)	VEE2	-10	V	<sup>1)</sup>
Positive power supply input for gate drivers	VCC1	3.3	V	<sup>2)</sup>
Positive power supply input side	15V_IN	20	V	<sup>2)</sup>
Input-to-output isolation voltage	V <sub>OFFSET</sub>	1200	V	
Maximum output current (dc) per channel	I <sub>OUT</sub>	0.1	A	
Mechanical dimensions	length	55,80	mm	
	width	45,00	mm	
	height	20,00	mm	With connectors and transformer

<sup>1)</sup> With respect to GND\_HS or GND\_LS

<sup>2)</sup> With respect to SGND

## 2 System and functional description

### 2.1 Use of the power supply board

For the combination of power supply board and EiceDRIVER™ isolated gate driver eval-board (see Figure 5), commissioning is very simple. Just connect +15 V and related GND to the connector +15V\_IN (please see Figure 3 or Figure 5). This input is directly connected to connector J1 and the isolated gate driver eval-board is now supplied with all necessary electrical voltages.

### 2.2 Description of the functional blocks

For a description of the functional blocks of the power supply board EVAL-PSIR2085 please refer to Figure 5. All connections are shown only roughly; the detailed circuit is shown in Figure 8.

In principle, the board can be separated into two parts, the primary and the secondary side. The primary side describes the low-voltage area, the secondary side the high-voltage area, which provides the necessary electrical power for the power switches. No components or electrical traces should be placed in the isolation barrier, as otherwise the insulation between input and output (primary and secondary side) cannot be guaranteed.

The primary side is comprised of the connector J1, J2, the half-bridge gate driver IC IR2085, and a low drop-out (LDO) regulator as well. Transformer T3 links the primary- and the secondary side together and provides the galvanically isolated power supply for both power supply blocks, for high-side gate driver and for low-side gate driver. Connector J2 supplies the fixed voltage of 3.3 V (VCC1 for two gate drivers) that is provided by the LDO.

Due to the galvanic separation of the two output voltages on the secondary side, two completely separate driver circuits can be set up. The following configurations are possible: half-bridge, high-side and low-side, and two low-side or two high-side configurations.

The galvanic isolation is also valid from the primary side to the two secondary sides.

Connectors J3 and J4 on the secondary sides are used to supply two drivers with the secondary power supply, which is required for the gate voltages. Each gate driver has its own power supply. They are galvanically isolated to each other. More detailed information about the connectors J3 and J4 can be found in Chapter 3.4, Table 7 and Table 8.

#### 2.2.1 Basic operation

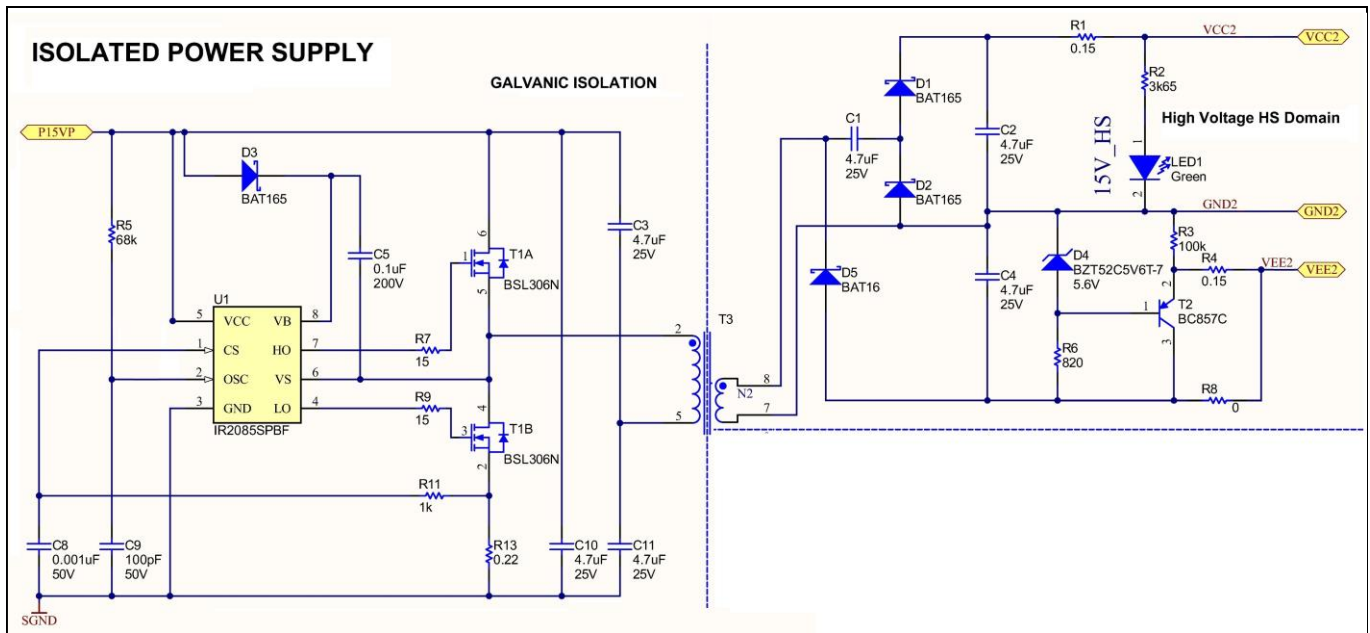
The main function of the power supply board is based on the half-bridge gate driver IC IR2085S. It is a self-oscillating half-bridge gate driver IC with 50% duty cycle ideally suited for half-bridge DC-bus converters. This product is also suitable for push-pull converters without restriction on input voltage. Each channel frequency is equal to  $f_{osc}$ , which can be set by selecting RT & CT (represented by R5 and C9 in drawing in Figure 7), where  $f_{osc} = 1/(2 \cdot RT \cdot CT)$ , where the frequency is in Hertz (Hz), RT resistance in Ohms ( $\Omega$ ) and CT capacitance in Farads (F). The recommended range of timing resistors is between 10 k $\Omega$  and 100 k $\Omega$  and the range of time capacitances is between 47 pF and 470 pF. Timing resistors with less than 10 k $\Omega$  should be avoided. The value of the timing capacitor determines the amount of dead time between the two output drivers: the lower the CT, the shorter the dead time and vice versa. It is not recommended to use a timing capacitor below 47 pF. For best performance keep the timing components physically as close as possible to the IR2085S. Dead-time can be controlled through the proper selection of CT, and can range from 50 ns to 200 ns. An internal soft-start increases the pulse width during power-up and maintains pulse width matching for the high and low outputs

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### System and functional description

throughout the start-up cycle. The IR2085S initiates a soft start at power-up and after every overcurrent condition. Undervoltage lockout prevents operation if VCC is less than 7.5 V. Figure 7 shows a section of a circuit to explain the main functionality.



**Figure 7 Section of drawing with IR2085S to explain main functionality**

The components like transistor T1A, T1B, the transformer T3 and the capacitors C3 and C11 make up a so-called single-ended, push-pull converter. This converter operates the potential-isolating transformer with an alternating voltage in which both half-oscillations are used for energy transmission. The transformation ratio of the transformer from primary winding N1 to secondary winding N2 is approximately one (1:1.07) in this application. The same also applies to the winding ratio of N1 to N3, see Figure 8. Pin 2 of the primary winding N1 is directly connected to the switches. If transistor T1A switches on, the potential of 15 V can be seen. T1B has to be switched off in this case of course. In the second case T1A switches off and T1B switches on, now SGND can be seen on Pin 2. In this case the direction of the current can be changed. Pin 5 of the primary winding N1 is directly connected to the capacitive voltage divider C3 and C11. The potential has approximately half the voltage of VCC (P15VP). If now a pulse sequence is applied in which T1 and T2 open and close alternately, a square-wave signal with the potential of  $+0.5 \cdot VCC$  and  $-0.5 \cdot VCC$  is created between Pin 2 and Pin 5 (voltage at coil N1). This signal is now transmitted to the secondary coil N2 with the slightly higher potentials, since the transformation ratio is 1:1.07.

However, since a gate voltage of at least 15 V has to be provided, the positive voltage of the signal is doubled. The following voltages can now be measured at the voltage outputs:

- $VCC2 \approx VCC$  Secondary positive gate voltage
- $GND2$  Secondary ground
- $VEE2 \approx -4.9 V$  Due to the Z diode, without Z diode approximately  $-0.5 \cdot VCC$ , secondary negative gate voltage

The voltage doubler was built using the components D1, D2 and C1 corresponding to Figure 7. The circuit with the Zener-diode (D4) and transistor T2 was therefore inserted in order to easily adapt the negative gate voltage to the needs of the corresponding power switches.

The complete circuit of the EVAL-PSIR2085 can be seen in Figure 8. This was developed for a half-bridge application, but, as already described in Chapter 2.2, can also be used for other configurations.

### 2.2.2 First steps for start-up

Before the entire application can be put into operation, the following commissioning steps should be done:

- 1.) Take empty power supply board out of the box
- 2.) Connect a corresponding EiceDRIVER™ isolated gate driver eval-board to the power supply board (see Figure 5)
- 3.) Connect a supply voltage of around 15 ... 20 V to the input "+ 15V\_IN".

Now the complete setup (EiceDRIVER™ isolated gate driver eval-board + power supply board) is ready for testing. Please follow the safety rules for operating equipment under high voltage.

System design

### 3 System design

#### 3.1 Schematics

Figure 8 shows the drawing of the power supply board EVAL-PSIR2085.

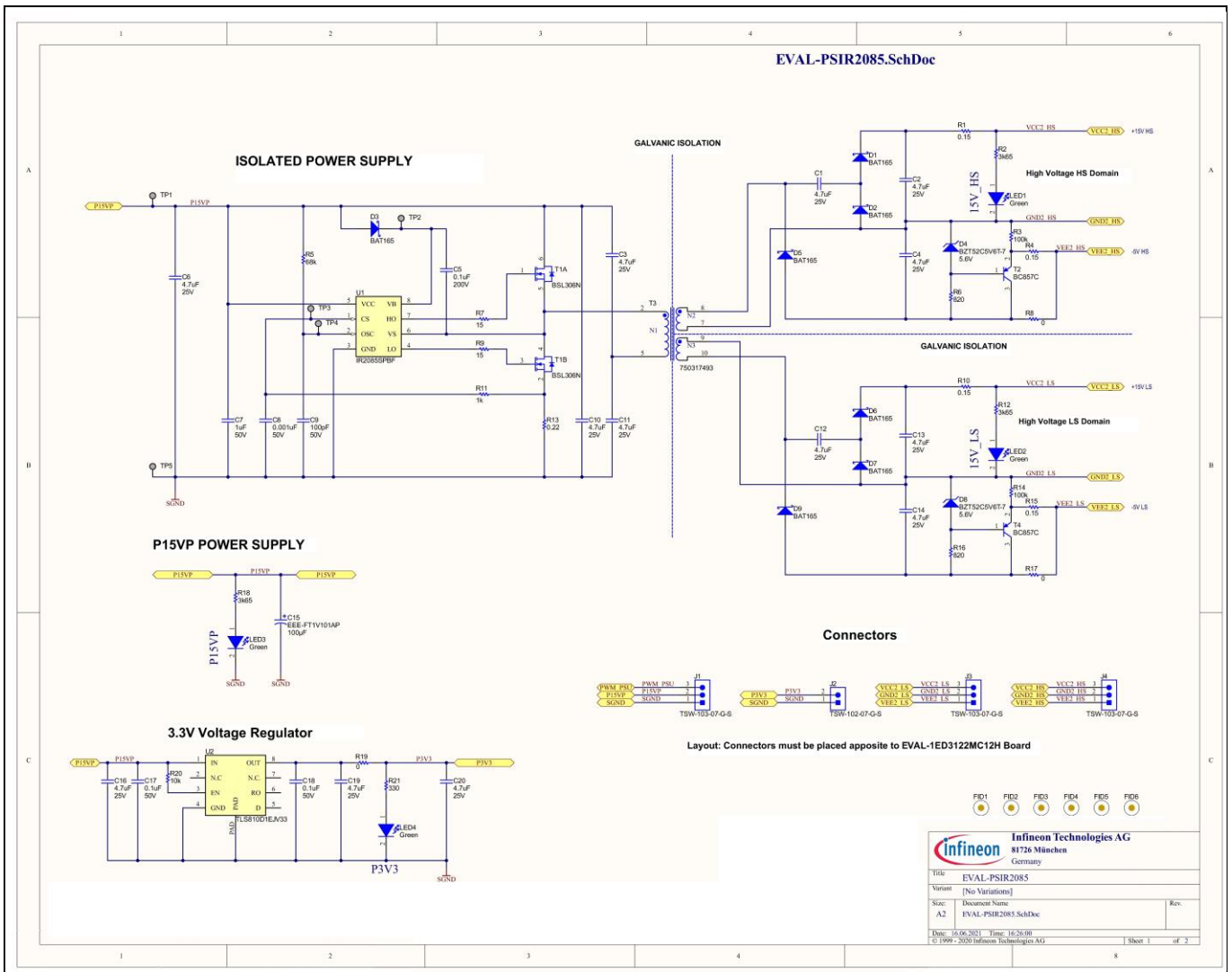


Figure 8 Drawing of EVAL-PSIR2085

#### 3.2 Layout

The following figures present the different layers of the layout from the power supply board EVAL-PSIR2085, it is a 2-layer layout. The order from the top view: top layer, bottom layer

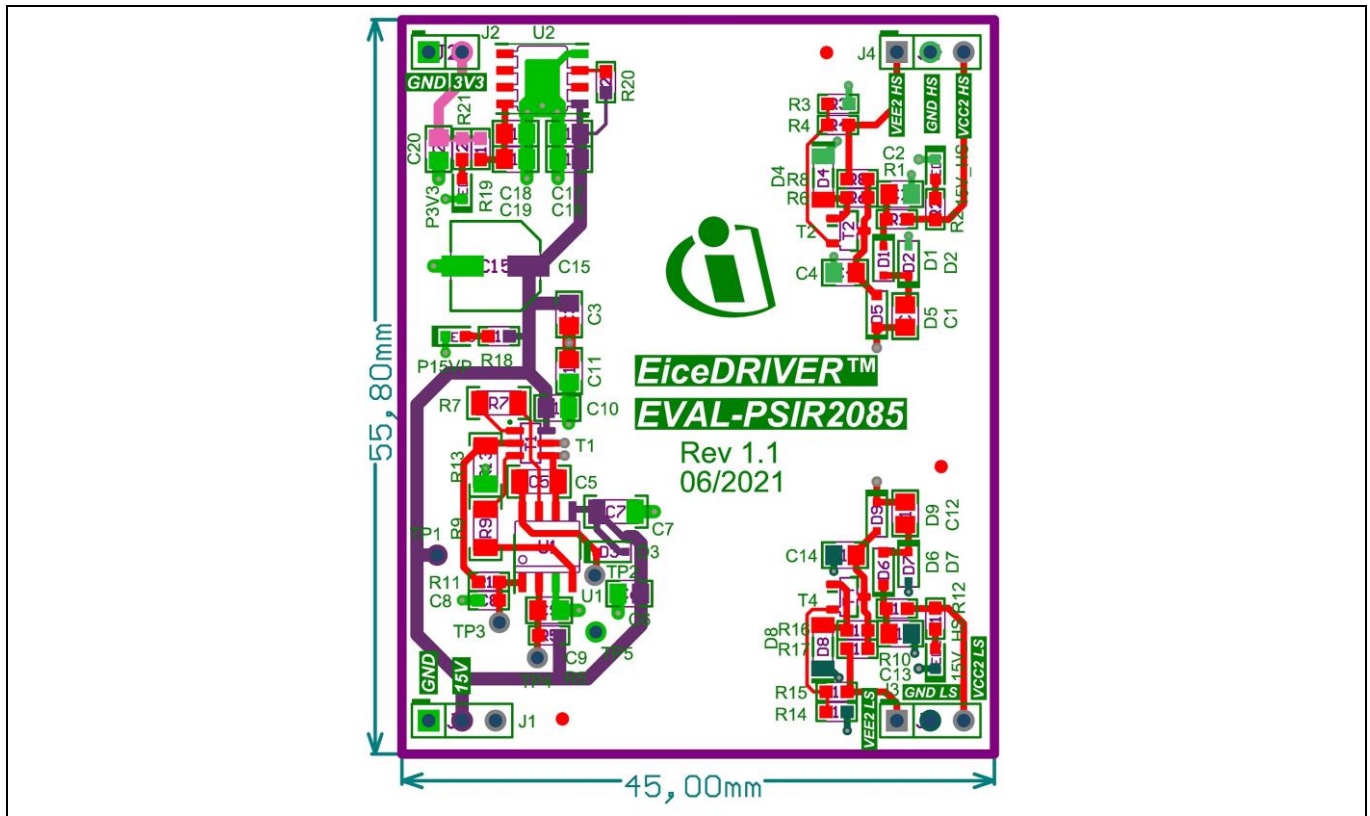


Figure 9 Top layer of EVAL-PSIR2085

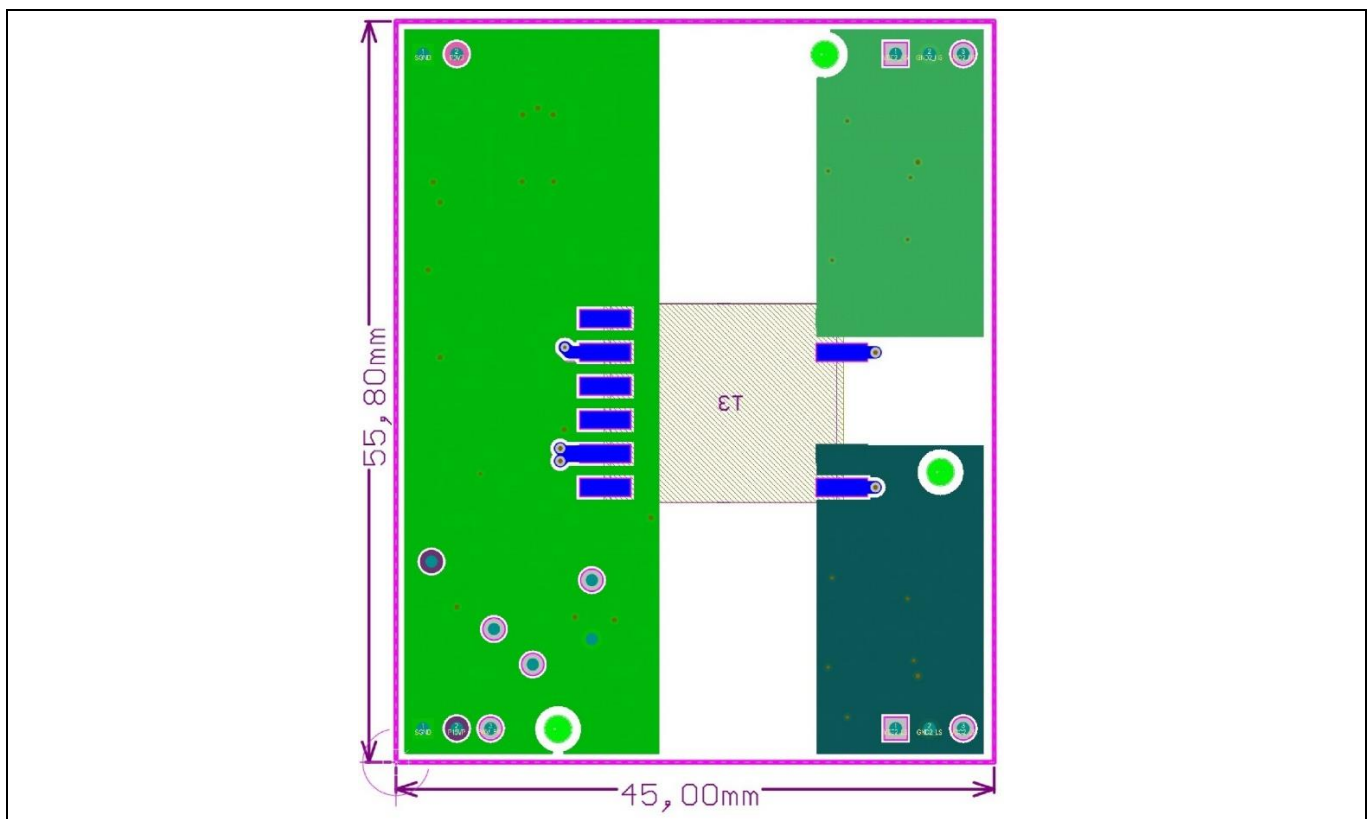


Figure 10 Bottom layer of EVAL-PSIR2085



**System design**

**3.3 Bill of material**

The complete bill of material is available on the download section of the Infineon homepage. A log-in is required to download this material.

**Table 4 BOM of the evaluation board EVAL-PSIR2085**

Value	Designator	Description	Manufacturer	PartNumber
Green	LED1, LED2, LED3, LED4	LED, Green, SMD	Lite-On	LTST-C190GKT
820	R6, R16	RES, 820R, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603820RFKEA
330	R21	RES, 330R, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603330RFKEA
100uF	C15	CAP, AL, 100 µF, 35 V, +/- 20%, 0.26 ohm, AEC-Q200 Grade 2, SMD	Panasonic	EEE-FT1V101AP
100pF	C9	CAP, CERM, 100pF, 50V, +/- 5%, NP0, 0805	MuRata	GRM2165C1H101JA01D
100k	R3, R14	RES, 100k, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603100KFKEA
68k	R5	RES, 68k, 1%, 0.1W, 0603	Vishay-Dale	CRCW060368K0FKEA
45 V	T2, T4	Transistor, PNP, 45 V, 0.1 A, SOT-23	ON Semiconductor	BC857C
40V	D1, D2, D3, D5, D6, D7, D9	Diode, Schottky, 40 V, 0.75 A, AEC-Q101, SOD-323	Infineon Technologies	BAT165
30V	T1	MOSFET, 2-CH, N-CH, 30 V, 2.3 A, TSOP-6_DUAL	Infineon Technologies	BSL306N
15	R7, R9	RES, 15R, 1%, 0.25W, 1206	Vishay-Dale	CRCW120615R0FKEA
10k	R20	RES, 10k, 1%, 0.1W, 0603	Vishay-Dale	CRCW060310K0FKEA
5.6V	D4, D8	Diode, Zener, 5.6 V, 300 mW, SOD-523	Diodes Inc.	BZT52C5V6T-7
4.7uF	C1, C2, C3, C4, C6, C10, C11, C12, C13, C14, C16, C19, C20	CAP, CERM, 4.7µF, 25V, +/- 10%, X7R, 0805	MuRata	GRM21BR71E475KA73L
3k65	R2, R12, R18	RES, 3k65, 1%, 0.1 W, 0603	Vishay-Dale	CRCW06033K65FKEA
1uF	C7	CAP, CERM, 1µF, 50V, +/- 10%, X7R, 1206	MuRata	GRM31CR71H105KA61L
1k	R11	RES, 1k, 1%, 0.1W, 0603	Vishay-Dale	CRCW06031K00FKEA
0.22	R13	RES, 0R22, 1%, 0.5W, 1206	Vishay-Dale	RCWE1206R220FKEA
0.15	R1, R4, R10, R15	RES, 0R15, 1%, 0.2W, 0603	Vishay-Dale	RCWE0603R150FKEA
0.1uF	C5	CAP, CERM, 0.1µF, 200V, +/- 10%, X7R, 1206	MuRata	GRM31CR72D104KW03L
0.1uF	C17, C18	CAP, CERM, 0.1µF, 50V, +/- 10%, X7R, 0805	MuRata	GRM21BR71H104KA01L
0.001uF	C8	CAP, CERM, 0.001µF, 50V, +/- 10%, X7R, 0603	MuRata	GRM188R71H102KA01D
0	R8, R17, R19	RES, 0R, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603000Z0EA
	J2	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S
	T3	Drive Transformer, SMT	Würth Electronics	750317493

**System design**

	U1	HIGH SPEED, 100V, SELF OSCILLATING 50% DUTY CYCLE, HALF-BRIDGE DRIVER	International Rectifier	IR2085SPBF
	U2	Linear Voltage Regulator 3V3	Infineon Technologies	TLS810D1EJV33
	J1, J3, J4	Header, 100mil, 3x1, Gold, TH	Samtec	TSW-103-07-G-S
	FID1, FID2, FID3, FID4, FID5, FID6	Fiducial mark. There is nothing to buy or mount.	N/A	N/A

**3.4 Connector details**

The following Tables 5, 6, 7 and 8 list the respective signal assignments corresponding to the plug connections.

**Table 5 Connector J1**

PIN	Label	Function
1	SGND	Input power supply primary side
2	P15VP (10...20 V)	Input power supply primary side
3	RESERVE	

**Table 6 Connector J2**

PIN	Label	Function
1	SGND	Output power supply 3.3 V
2	P3V3	Output power supply 3.3 V

**Table 7 Connector J3**

PIN	Label	Function
1	VEE2_LS	Output negative gate voltage low-side
2	GND_LS	Output ground low-side
3	VCC2_LS	Output positive gate voltage low-side

**Table 8 Connector J4**

PIN	Label	Function
1	VEE2_HS	Output negative gate voltage high-side
2	GND_HS	Output ground high-side
3	VCC2_HS	Output positive gate voltage high-side

## 4 System performance

In Chapter 4 some measurement results are introduced. These measurements are intended to demonstrate that the system is fully operational and that clear measurement data can be derived.

### 4.1 Normal operation of the power supply board

Figure 11 illustrates the main functionality of the power supply board. The measurement setup corresponds to that of the circuit in Figure 8, whereby the measurement results were only shown from the low-side output (connector J3).



**Figure 11 Normal operation of the power supply board**

The yellow square wave indicates the primary signal, which is generated by the two transistors T1 and T2 and the IR2085S. The input voltage for this measurement setup was approximately 17.23 V. The positive share is approximately +8.52 V, the negative approximately -8.71 V.

On the secondary side of the transformer, voltages of approximately +9.3 V and -9.44 V are measured. This corresponds to a total voltage of approximately 18.74 V.

The positive gate voltage of approximately 18.2 V and the negative gate voltage of -4.9 V can be measured at the output.

## **5 References and appendices**

### **5.1 Abbreviations and definitions**

**Table 9 Abbreviations**

<b>Abbreviation</b>	<b>Meaning</b>
CE	Conformité Européenne
EMI	Electromagnetic interference
UL	Underwriters Laboratories
DUT	Device under test
LDO	Low Drop Out Regulator

### **5.2 References**

[1] Infineon Technologies AG. Datasheet of IR2085S (2011) Rev.D [IR2085S - Infineon Technologies](#)

[2] Infineon Technologies AG. Datasheet of TLS810D1EJ V33 (2016) Rev. 1.1 [TLS810D - Infineon Technologies](#)

### **5.3 Additional information**



**Revision history**

<b>Document version</b>	<b>Date of release</b>	<b>Description of changes</b>
Revision 1.0	2021-07-29	Initial release

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