Application Note, 1.0, Jun. 2008

6ED100HP1-FA

Evaluation Driver Board for HybridPack1™ module

System Engineering Automotive

Never stop thinking

Edition 2008-08-07

Published by
Infineon Technologies AG
85579 Munich, Germany

Revision History:	2008-06	V1.0
Previous Version:	none	

We Listen to Your Comments

Any information within this document that you feel is wrong, unclear or missing at all?
Your feedback will help us to continuously improve the quality of this document.
Please send your proposal (including a reference to this document) to:
Hybrid@infineon.com

Part number explanation:

6ED 100 HP1 - FA

- **FA – Functional isolation / Automotive**
- **HP1 – Suitable for HybridPACK1™ IGBT Modul**
- **100 – 10 A output driver stage**
- **6ED – 6 channel driver**

1 Introduction

The Evaluation Driver Board 6ED100HP1-FA for the HybridPack1™ module shown in Figure 1 was developed to support customers during their first steps designing applications with this module. The following sections provide a detailed description of the main components and their functionality. This information is intended to enable the customer to copy, modify and qualify the design for production, according to his specific requirements.

The boards provided by Infineon are subjected to functional testing only.

Due to their purpose the system is not subjected to the same procedures regarding Returned Material Analysis (RMA), Process Change Notification (PCN) and Product Withdraw (PWD) as regular products.

See Legal Disclaimer and Warnings for further restrictions on Infineon warranty and liability

SAP number for HybridPack1™ Evaluation Driver Board: SA000433754

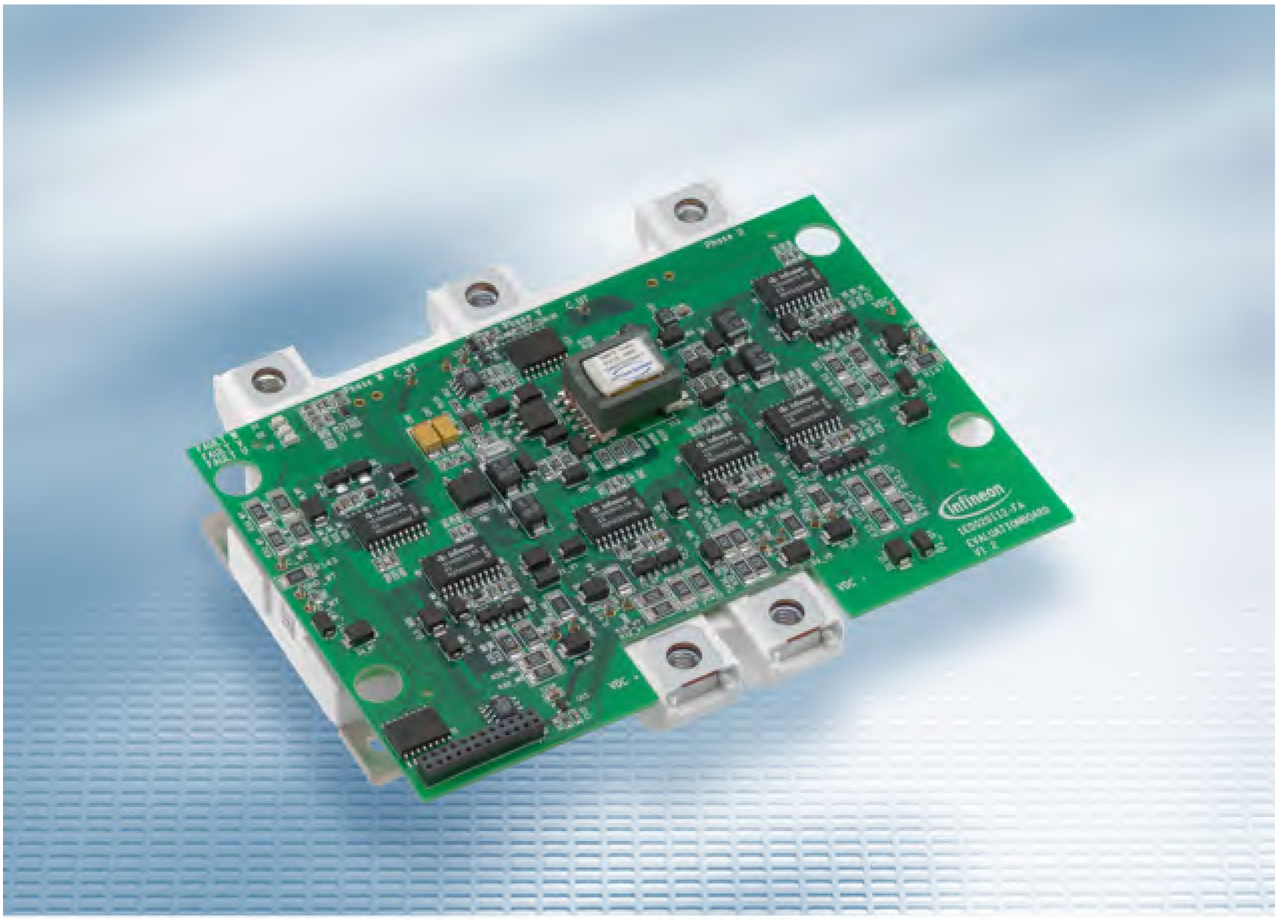


Figure 1 The 6ED100HP1-FA Evaluation Driver Board mounted on the top of the HybridPack1™ module

2 Design features

The following sections provide an overview of the boards including main features, key data, pin assignments and mechanical dimensions.

2.1 Main features

The 6ED100HP1-FA Evaluation Driver Board offers the following features:

- Six channel IGBT driver
- Electrically and mechanically suitable for 600 V IGBT Module HybridPack1™
- Includes DC/DC power supply
- Isolated temperature measurement
- Isolated voltage measurement
- Short circuit protection with $t_{off} < 6$ µs
- Under Voltage Lockout of IGBT driver IC
- Positive logic with 5 V CMOS level for PWM and Fault signals
- One fault output signal for each leg and one common for all of them

2.2 Key components

For detailed technical information about the different components please refer to the different web pages on the Infineon Internet

2.2.1 1ED020I12-FA

The 1ED020I12-FA is an advanced single channel IGBT Driver IC providing galvanic isolation that can be also used for driving power MOS devices. The main features of the device are described below:

- Coreless transformer isolated driver
- 2A rail-to-rail output
- Vcesat-detection
- Active Miller Clamp

2.2.2 HybridPack1™

The Infineon HybridPack1TM is designed for mild HEV applications with a maximum supply of up to 450 V and power range up to 20KW. The HybridPack1^{TM} is a power module with six-pack configuration, containing all power semiconductors for the inverter and an NTC resistor for temperature measurement. The module is based on third generation, 600V IGBT3 technology and matching EmCon diodes. The leading edge Trench FieldStop IGBT and EmCon diode technology enhances the junction temperature capability to 175 °C while reducing the conduction and switching losses.

2.2.3 DC-Link Capacitor

The capacitor B25655J4267K from the company Epcos AG is strongly recommended. Table 1 shows the main features of the capacitor. Please refer to the datasheet for further details.

Table 1 Key data of DC-Link Capacitor

Characteristics	Value
C_N	265µF±10%
U_N	DC 450V
W_N	27 Ws
I_{max}	80A
L_{self}	30nH

tanδ	2* 10^{-4}
R_S	1.5 mΩ
Maximum ratings	
u_S	600 V
î	1.3 kA
I_S	5.3 kA
$(du/dt)_{max}$	5 V/µs
$(du/dt)_S$	20 V/µs

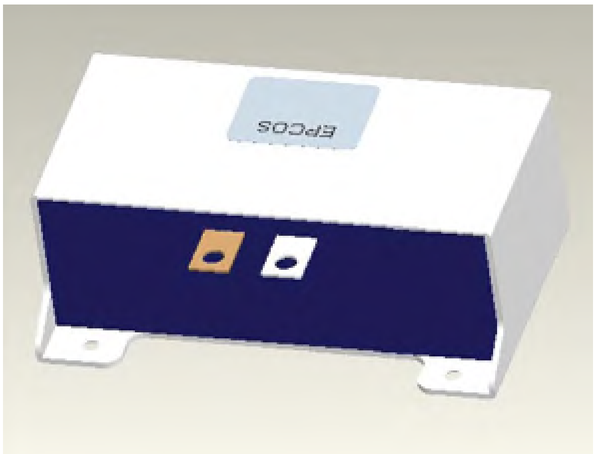


Figure 2 DC-Link Capacitor for HybridPack1™

2.3 Key data

All values given in the table bellow are typical values, measured at T_A = 25 °C

Table 2 Key data and characteristic values (typical values)

Parameter	Value	Unit
V_{SUPPLY} –Voltage supply	+[8..18]	V
V_{PWM} – PWM signals for Top and Bottom IGBT (active high)	0 / +5	V
V_{FAULT} – /FAULT detection output (active low)	0 / +5	V
I_{FAULT} – max. /FAULT detection output load current	10	mA
V_{RST} – /RST input (active low)	0 / +5	V
I_{SUPPLY} – Supply current drawn (idle mode) (V_{SUPPLY}=12V)	250	mA
V_{out} – drive voltage level	+15 / -8	V
I_G – max. peak output current	±10	A
$P_{DC/DC(TOP)}$ – max. DC/DC output power (Top channels)	4.6	W
$P_{DC/DC(BOTTOM)}$ – max. DC/DC output power (Bottom channels)	13.8	W
f_S – max. PWM signal frequency [1)]	60.7KHz	kHz
t_{PDELAY} – propagation delay time	200	ns

[1)] The maximum switching frequency for the HybridPack1™ module should be calculated separately. Limitation factors are: max. DC/DC output power of 4.6W per channel and max. PCB board temperature measured around gate resistors of 105 °C for used FR4 material. For detailed information see chapter 3.3

t_{PDISTO} – input to output propagation distortion	15	ns
t_{MININ} – min. pulse suppression for turn-on and turn-off[2)]	30	ns
V_{Desat} – Desaturation reference level	9	V
d_{max} – max. duty cycle	100	%
V_{CES} – max. collector – emitter voltage on IGBT	600	V
T_{op} – operating temperature (design target)[3)]	-40…+125	°C
T_{sto} – storage temperature (design target)	-40…+125	°C
V_{IORM} – Maximum Repetitive Insulation Voltage[5)] (1ED020I12-FA Driver IC)	1140	V_{peak}
V_{IORM} – Max. working insulation voltage[6)] (AD7400 Sigma-Delta Converter)	891	V_{peak}

[2)] Minimum value t_{MININ} given in 1ED020I12-FA IGBT driver datasheet

[3)] Maximum ambient temperature strictly depends on load and cooling conditions.

[5)] 1ED020I12-FA (Target datasheet, Version 1.0)

[6)] AD7400 (9/07 – Revision A to Revision B)

2.4 Pin assignment

Figure 3 shows the pin assignment for the external connector (K1) on the 6ED100HP1-FA. It includes all necessary signals to get the board into operation, that is, supply, control and monitoring.

Pin 1 to 6 provide the power supply. The 6ED100HP1-FA must be supplied with an external regulated DC power supply. The input voltage must be kept between 7V and 18V and the current consumption will depend on different factors (Logic Board, PWM frequency, etc.).

Pin 7-8 provide 5V analogue supply which can be used to supply different devices in case of using the 6ED100HP1-FA as driver board in an inverter such as current measurement, ADC or the motor interface.

On **pin 9, 10 and 11** the monitoring signals are connected: DC-Link voltage measurement, temperature of IGBT Module and temperature of Evaluation Board respectively.

Pin **12 to 24** (15 and 19 are NC) contains the logic signals for controlling the 6 drivers on the board, that is, the PWM signals, Fault detection and Reset signal.

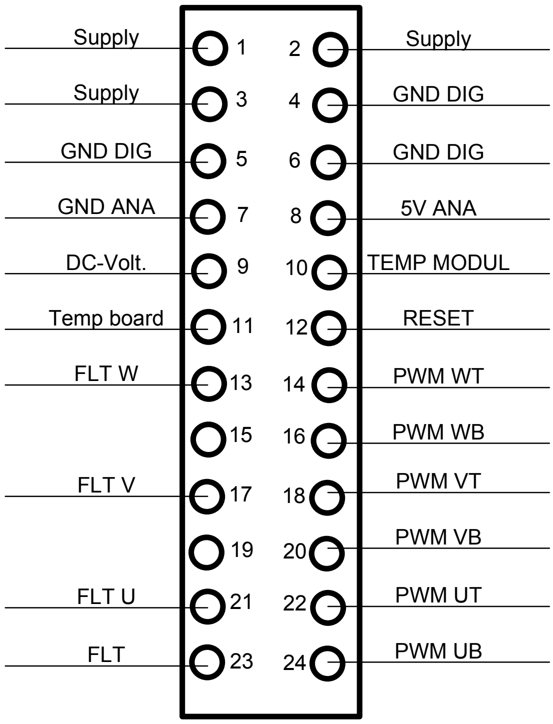


Figure 3 External connector on the 6ED100HP1-FA Evaluation Driver Board

2.5 Mechanical dimensions of the HybridPack1™ Driver Board

SAP number to order Evaluation Driver Board for HybridPack1™ modules: SA000433754

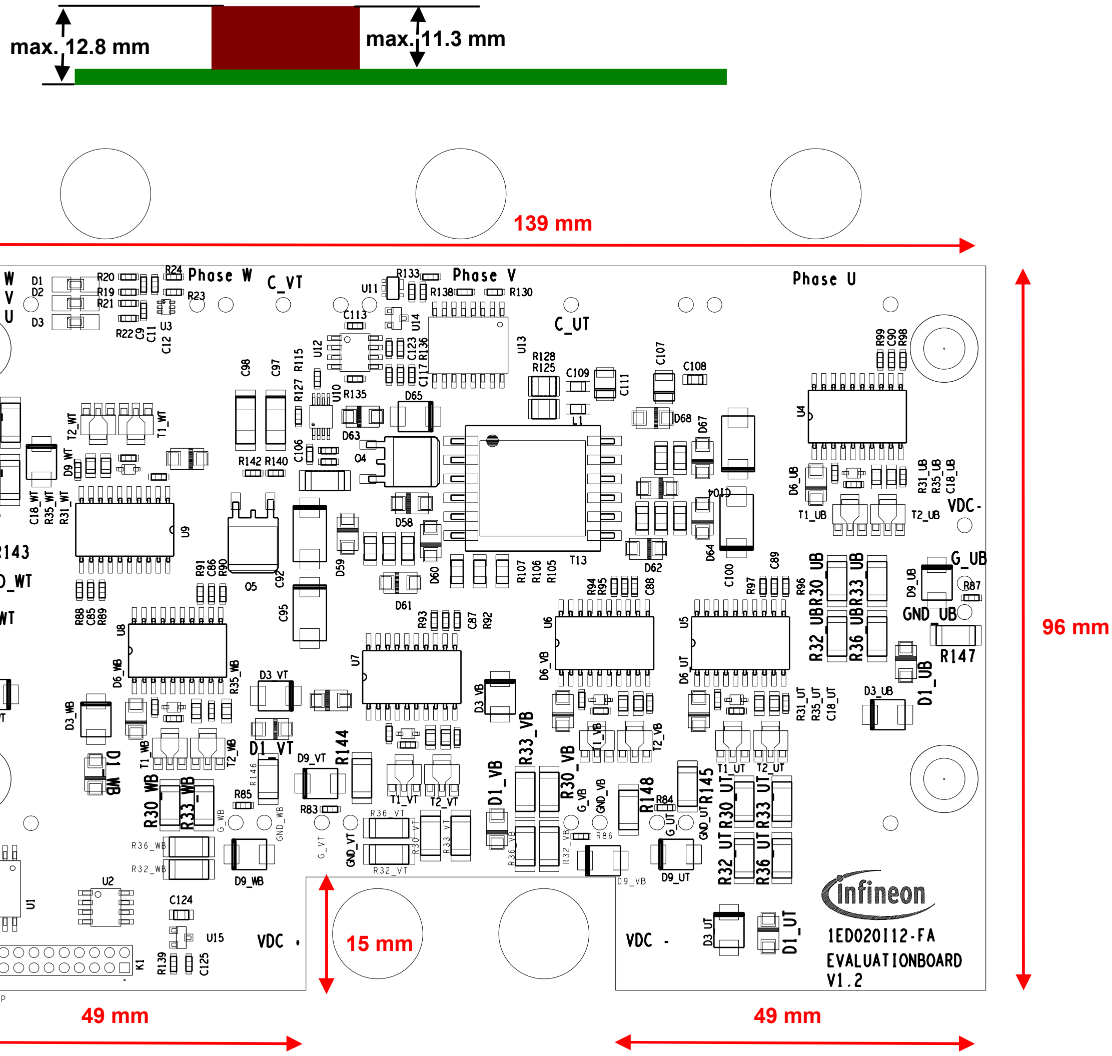


Figure 4 Dimensions of the 6ED100HP1-FA Driver Board

The Driver Boards should be fastened by self taping screws and soldered to the auxiliary connectors on top of the IGBT module.

3 Application Note

Figure 5 shows the block structure of the 6ED100HP1-FA Evaluation Driver Board. The following chapter describes these blocks in detail.

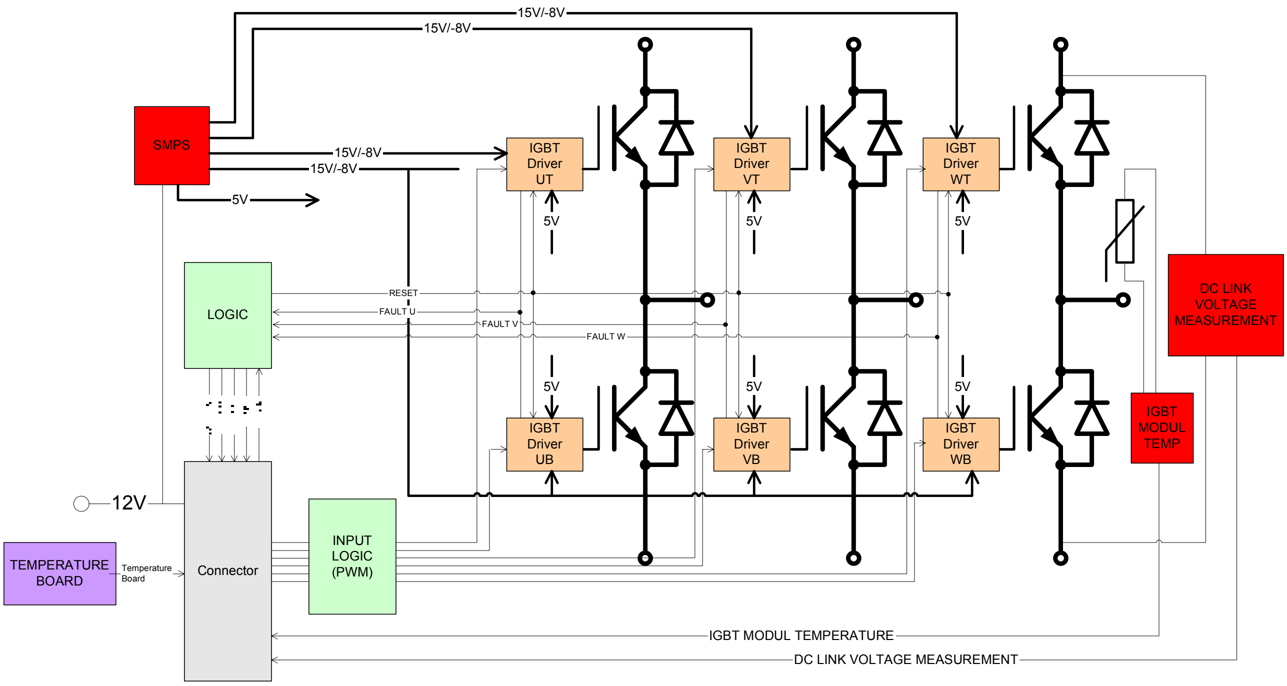


Figure 5 Evaluation Board block diagram

3.1 Switching Mode Power Supply (SMPS)

The 6ED100HP1-FA has an integrated DC/DC converter which generates the required secondary isolated unsymmetrical supply voltage of +15/-8V. Top and Bottom driver voltages are independently generated by using one unipolar input voltage of 12V. All Bottom drivers share a single supply.

An additional supply voltage (5V) is generated and forwarded to the external connector (K1) so it can be used to supply external components in the system (current measurement, motor interface, etc.)

For circuit details please refer to Figure 19.

3.2 Input logic

The 6ED100HP1-FA Evaluation Driver Board is a dedicated system for a sixpack HybridPack1™ IGBT configuration, therefore it is necessary to use 6 separated PWM signals. The schematic in Figure 6 shows the input logic block with +5V positive logic. The block is made up of RC filters for each PWM signal in order to reduce noise. Additionally these signals are pulled-down in order to avoid unwanted switches-on of the drivers. The 6ED100HP1-FA does not provide automatically a dead time; it is needed for the signals to have the correct dead time.

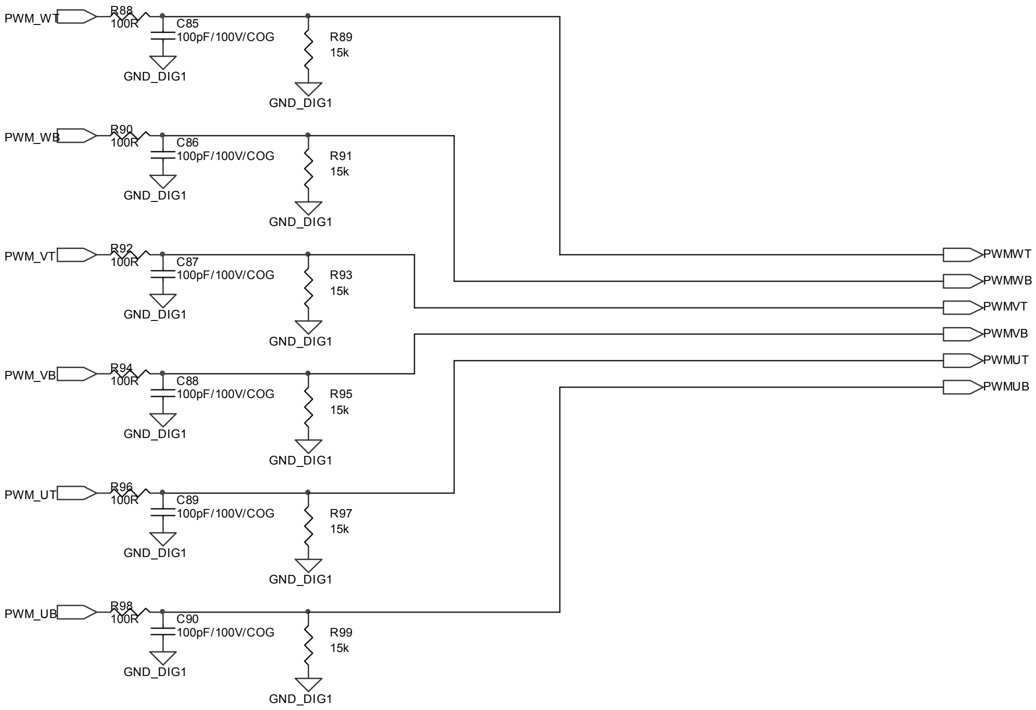


Figure 6 Schematic detail of the input logic block

3.3 Maximum switching frequency

The IGBT switching frequency is limited by the available power and by PCB temperature. According to theory the power losses generated in gate resistors are a function of gate charge, voltage step at the driver output and switching frequency. The energy is dissipated mainly through the PCB and raises the temperature around the gate resistors. When the available power of the DC/DC converter is not exceeded, the limiting factor for the switching frequency is the absolute maximum temperature for the FR4 material. The allowed operation temperature is 105 °C.

Generally the power losses generated in the gate resistors can be calculated according to formula (1):

$$P_{dis} = P_{R_{Gext}} + P_{R_{G\text{int}}} = \Delta V_{out} \cdot f_s \cdot Q_{ge} \qquad (1)$$

In this formula f_s resembles the switching frequency, ΔV_{out} represents the voltage step at the driver output P_{dis} is the dissipated power, Q_{ge} is the IGBT gate charge value corresponding to -8/+15V operation. This value can be approximately calculated from the datasheet value by multiplying by 0.77, that is, $Q_{ge} = 3.3\mu C$. Therefore the maximum frequency limited by the available power will be:

$$f_{s\max} = 4.6W/(23V \cdot 3.3\mu C) = 60.7KHz$$

Figure 7 shows experimentally determined board temperature dependencies with switching frequency (at 26°C ambient temperature). From Figure 7 it can be concluded that the maximum switching frequency is limited by PCB temperature.

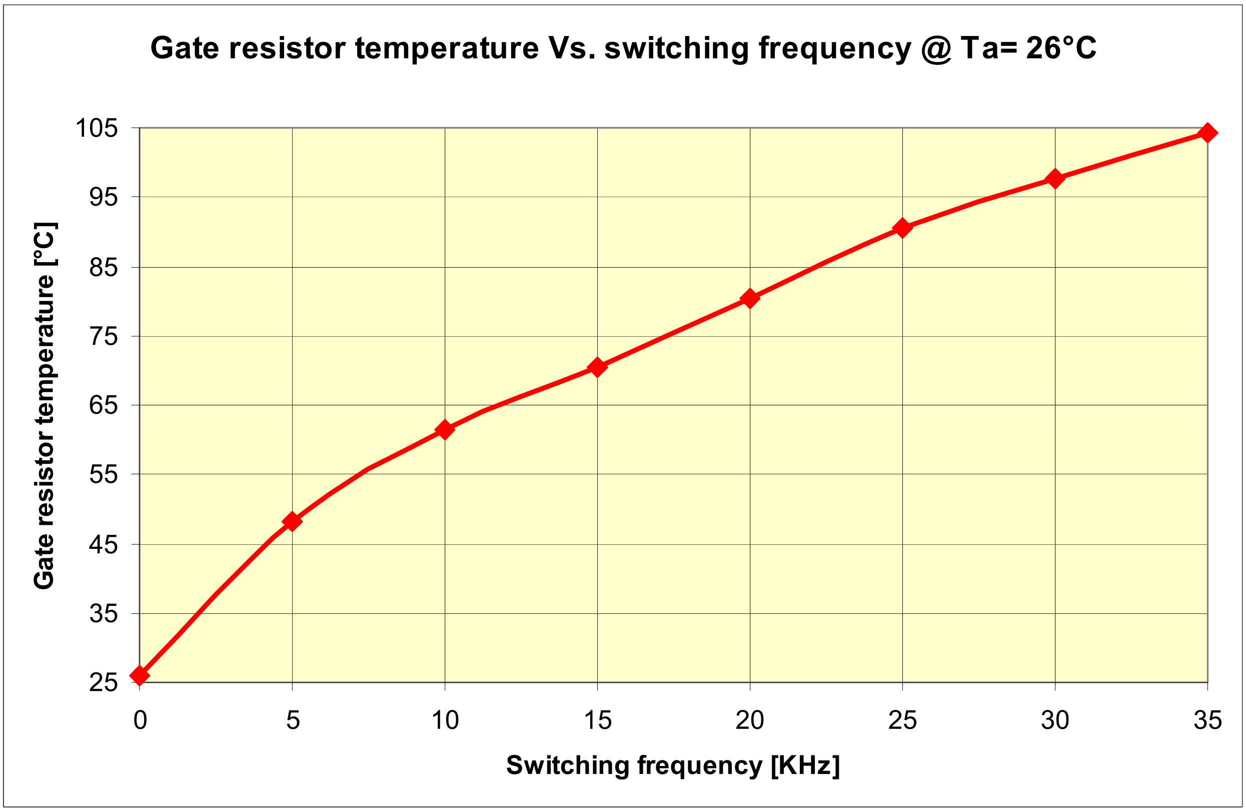


Figure 7 Temperature of gate resistors vs. switching frequency.

3.4 Booster

Two transistors are used to amplify the driver ICs signal. This allows driving IGBTs that need more current than the driver can deliver. One NPN transistor is used for switching the IGBT on and another PNP transistor for switching the IGBT off.

The transistors are dimensioned to have enough peak current to drive HybridPack1™ modules. Peak current can be calculated like in formula (2):

$$I_{peak} = \frac{\Delta V_{out}}{R_{G_{\text{int}}} + R_{G_{ext}} + R_{Driver}} \tag{2}$$

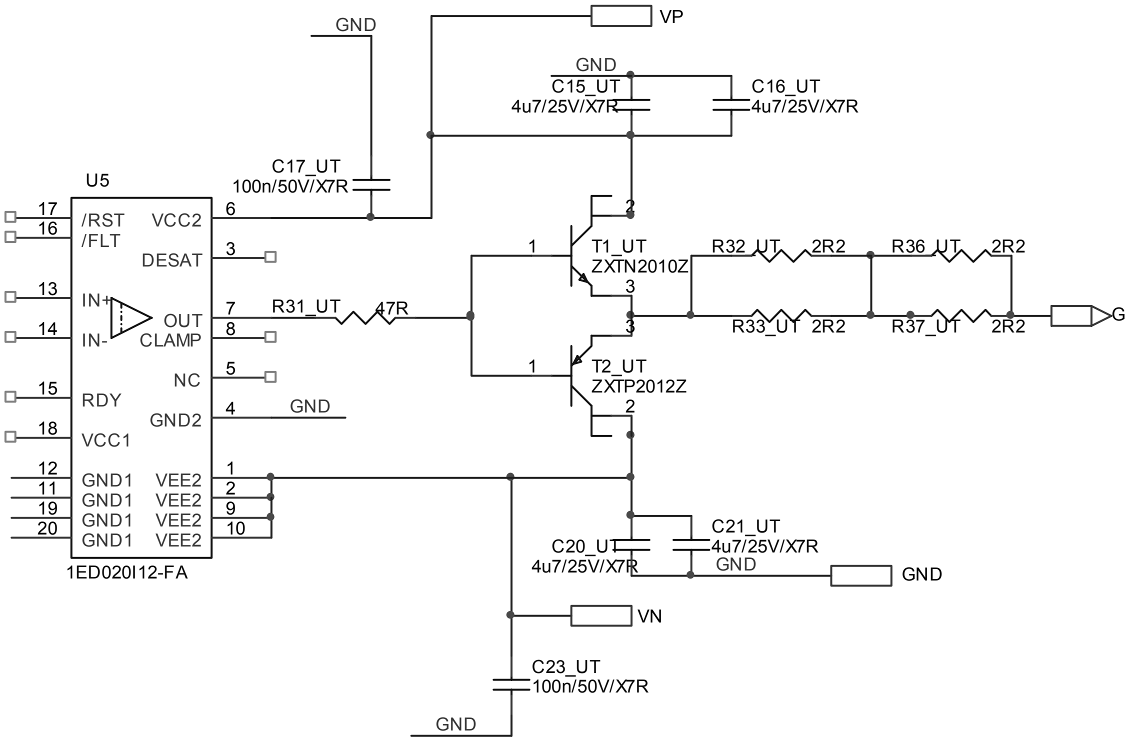


Figure 8 Booster

3.5 Short circuit protection and clamp function

The short circuit protection of the Evaluation Driver Board basically relies on the detection of a voltage level higher as 9 V on the DESAT pin of the 1ED020I12-FA driver IC and the implemented active clamp function. Thanks to this operation mode, the collector-emitter overvoltage, which is a result of the stray inductance and the collector current slope, is limited. Depending on the stray inductance, the current and the DC voltage the overvoltage shoot during turn off changes.

Figure 9 shows the parts of the circuit needed for the desaturation function and the active clamping function.

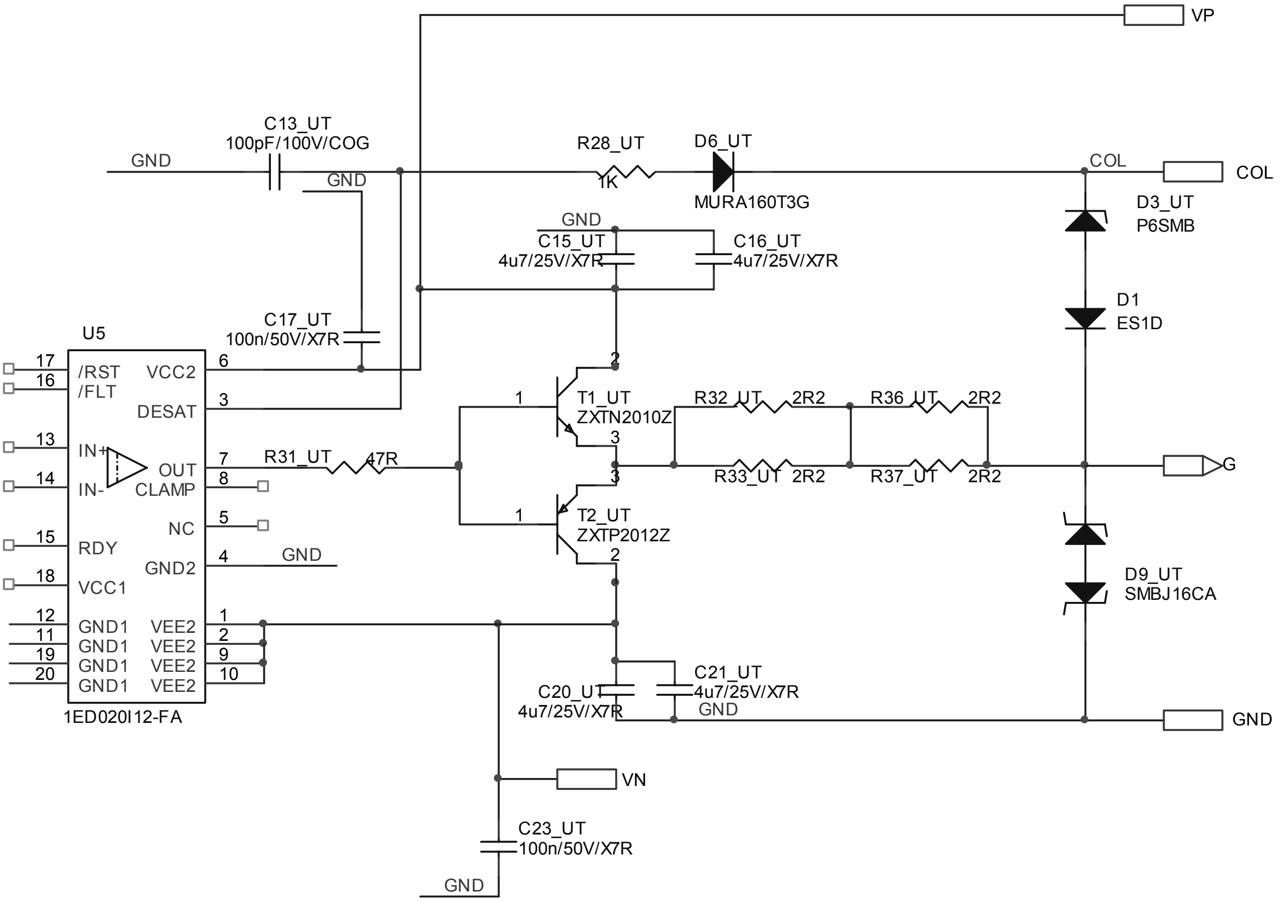
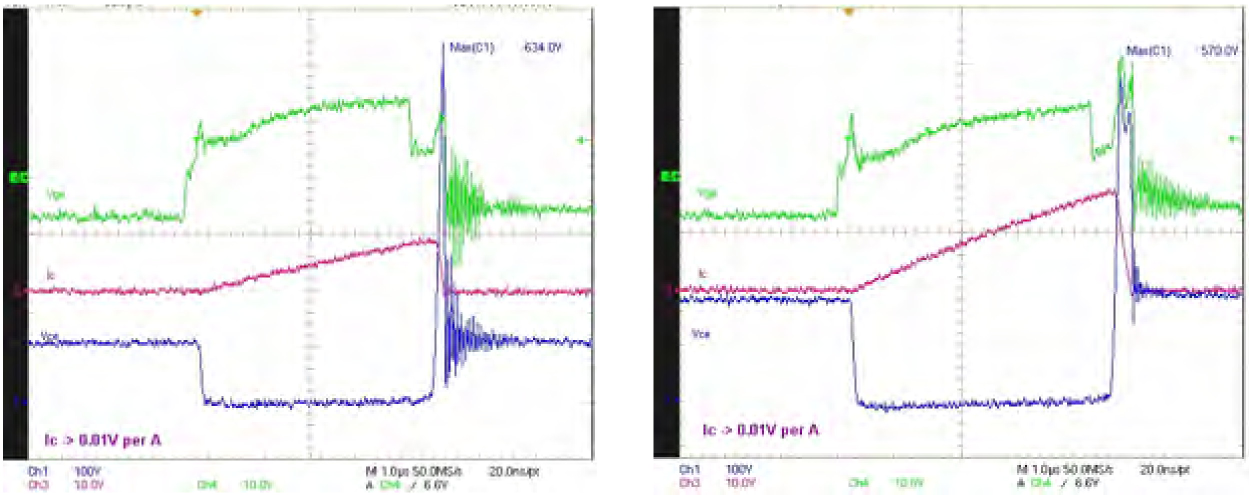


Figure 9 Desaturation protection and active clamping diodes

In case of a short circuit the saturation voltage V_{GE} will rise and the driver detects that there is a short circuit. The IGBT has to be switched off. There will be an overvoltage shoot due to the stray inductance of the module and the DC-Link. This overvoltage shoot has to be lower than the maximum IGBT blocking voltage. Therefore the evaluation driver boards consist of an active clamping function whereby the clamping will raise the voltage for the booster and also raise the voltage directly on the gate.

The typical turn-off waveform under short circuit condition and room temperature of a HybridPack1™ module without any additional function is shown in Figure 10a.Typical waveform under short circuit condition with active clamp function is shown in Figure 10b at room temperature. As it can be seen the overvoltage without active clamping at a DC voltage of 100V is above the maximum IGBT blocking voltage at the HybridPack1™ (600V), which could damage the devices. With active clamping the overvoltage can be reduced and the DC voltage increased without damaging the IGBT module. The measurements were carried out using 400V clamping diodes. The level of the clamping voltage must be adjusted depending on the application.



a) b)

Figure 10 a) Short circuit w/o active clamp (DC Voltage=100V) b) with active clamp function (DC Voltage=175V)

3.6 Fault output

When a short circuit occurs, the voltage V_{CE} is detected by the desaturation protection of the 1ED020I12-FA and the IGBT is switched off. The fault is reported to the primary side of the driver as long as there is no reset signal applied to the driver. The /FAULT signal is active low, the according schematic can be seen in Figure 11.

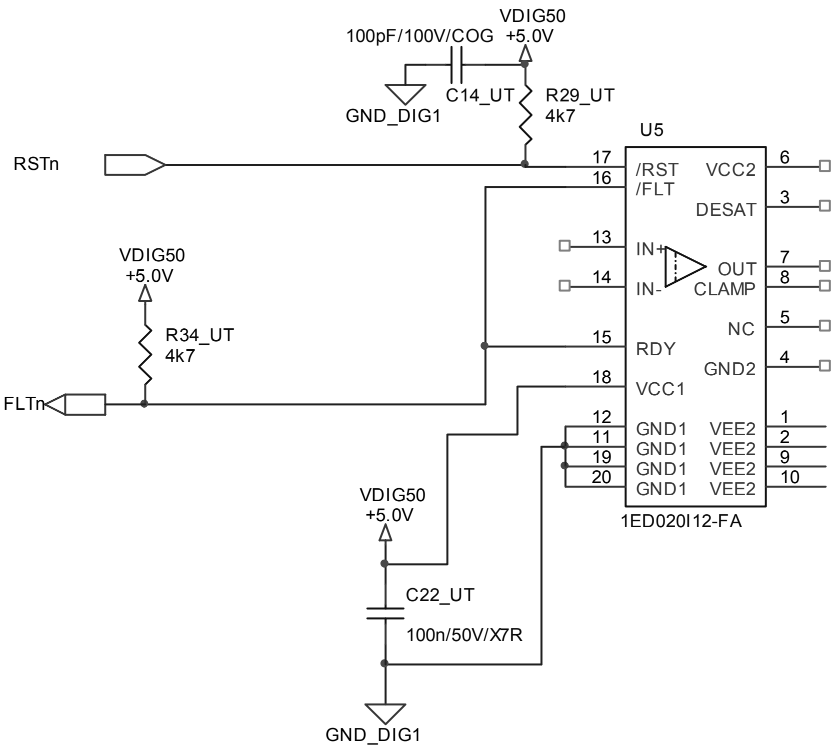


Figure 11 /Fault output for a single driver

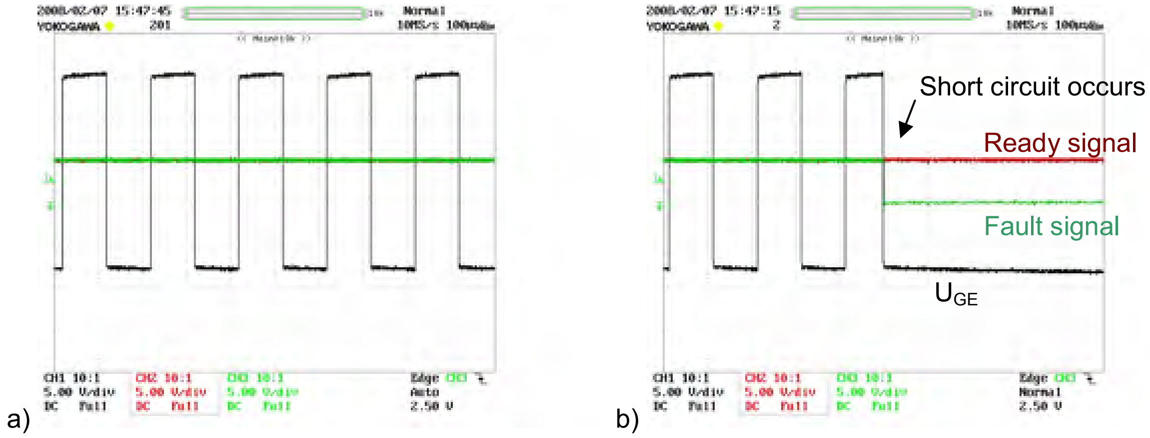


Figure 12 /Fault output during: a) normal operation b) operation under short circuit

The fault signal will be in low state in case of a short circuit until /RST is pulled down.

On the Evaluation Driver Board each of the three legs has a /FAULT signal. As it can be seen in Figure 13, a LED will warn in case of a DESAT-FAULT in one of the phases. The three /FAULT signals (U,V and W) are connected to an AND-Gate. The output of this gate, together with the 3 phases /FAULT signals, is forwarded to the external connector (K1).

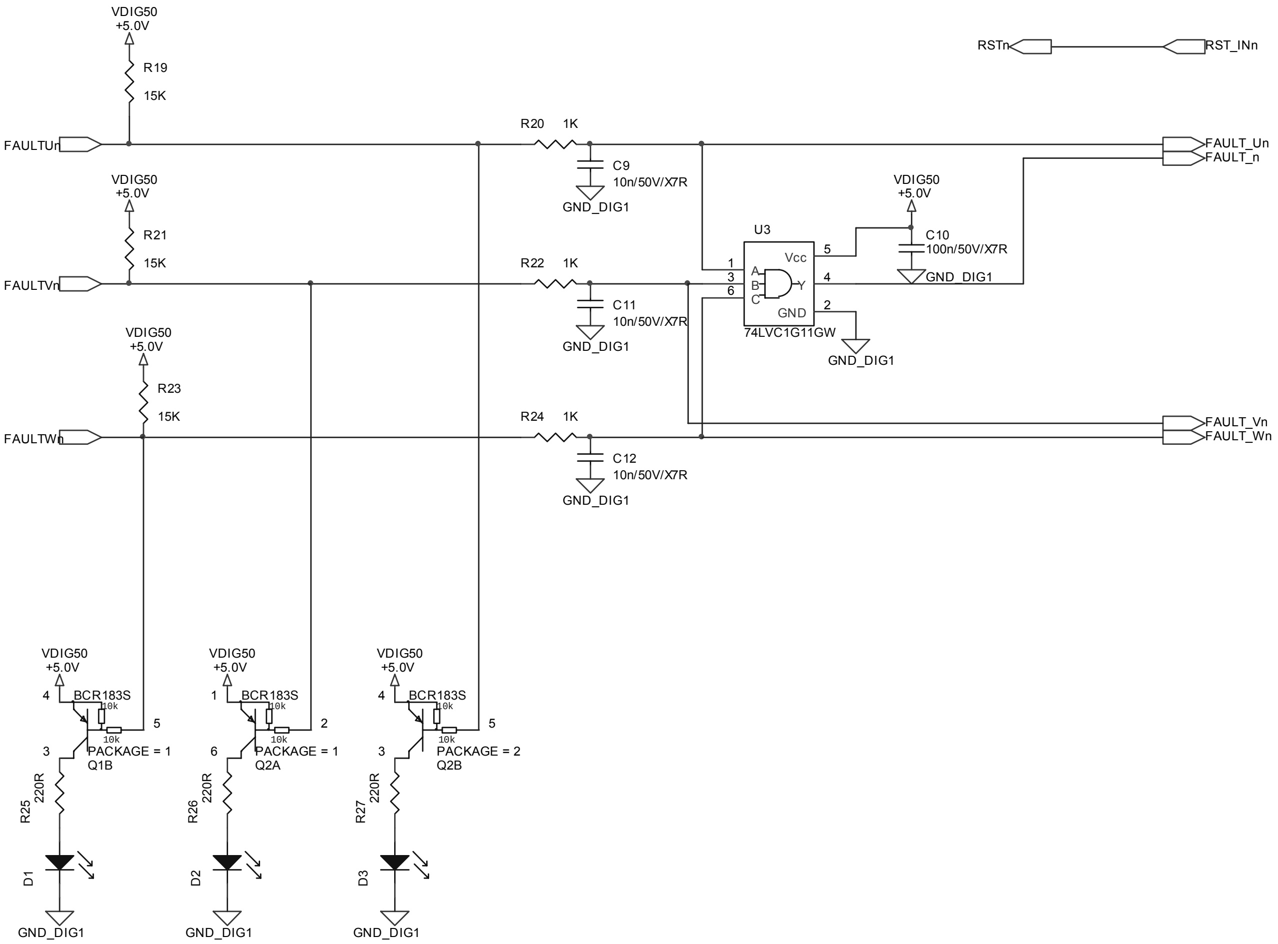


Figure 13 Schematic of the Logic Block

3.7 Temperature measurement

The IGBT Module HybridPack1™ includes an integrated NTC (Negative Temperature Coefficient) sensor which simplified thermal measurements in inverters significantly.

The NTC is located on the same ceramic substrate as the IGBT and diode chips are. The module is filled with silicon gel for isolation purpose and under normal operation conditions the requirements for isolation voltages are met. The NTC isolation capability is tested with 2,5kV AC in final test for 1 minute for 100% of module production.

Since the NTC inside the module could be exposed to a high voltage level (i.e. during a short circuit) in accordance with EN50178 this isolation has to be done externally. On the Evaluation Board such isolation is achieved by means of an isolated Sigma-Delta-Modulator and the circuit showed in Figure 14

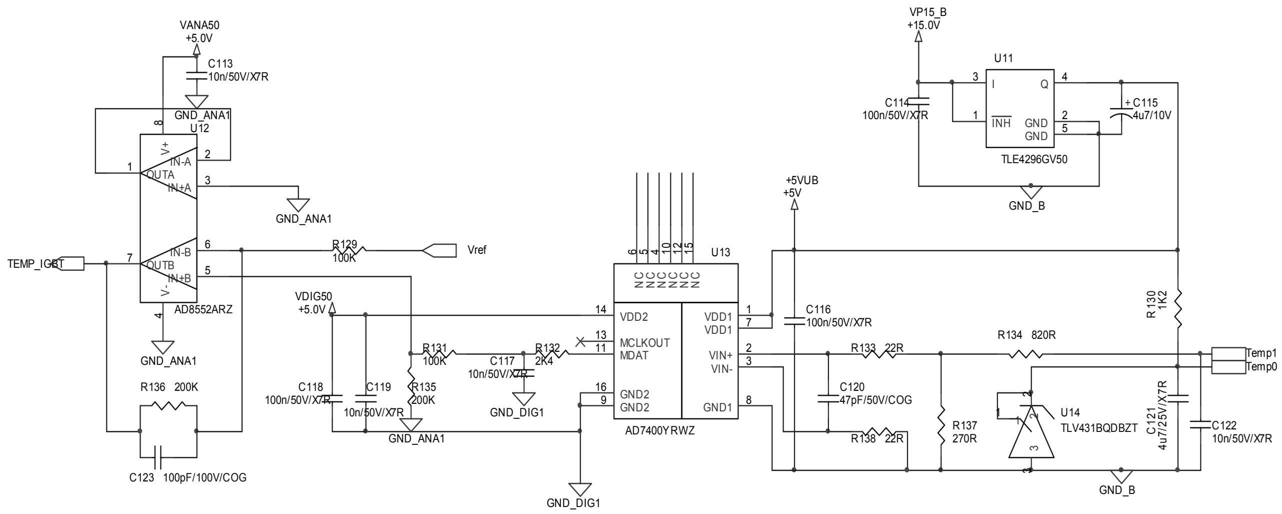


Figure 14 Schematic to convert digital Σ/Δ to analogue output

Figure 15 shows the relationship between IGBT base plate Module temperature and output voltage of IGBT Module Temperature Block (TEMP_IGBT, K3.10)

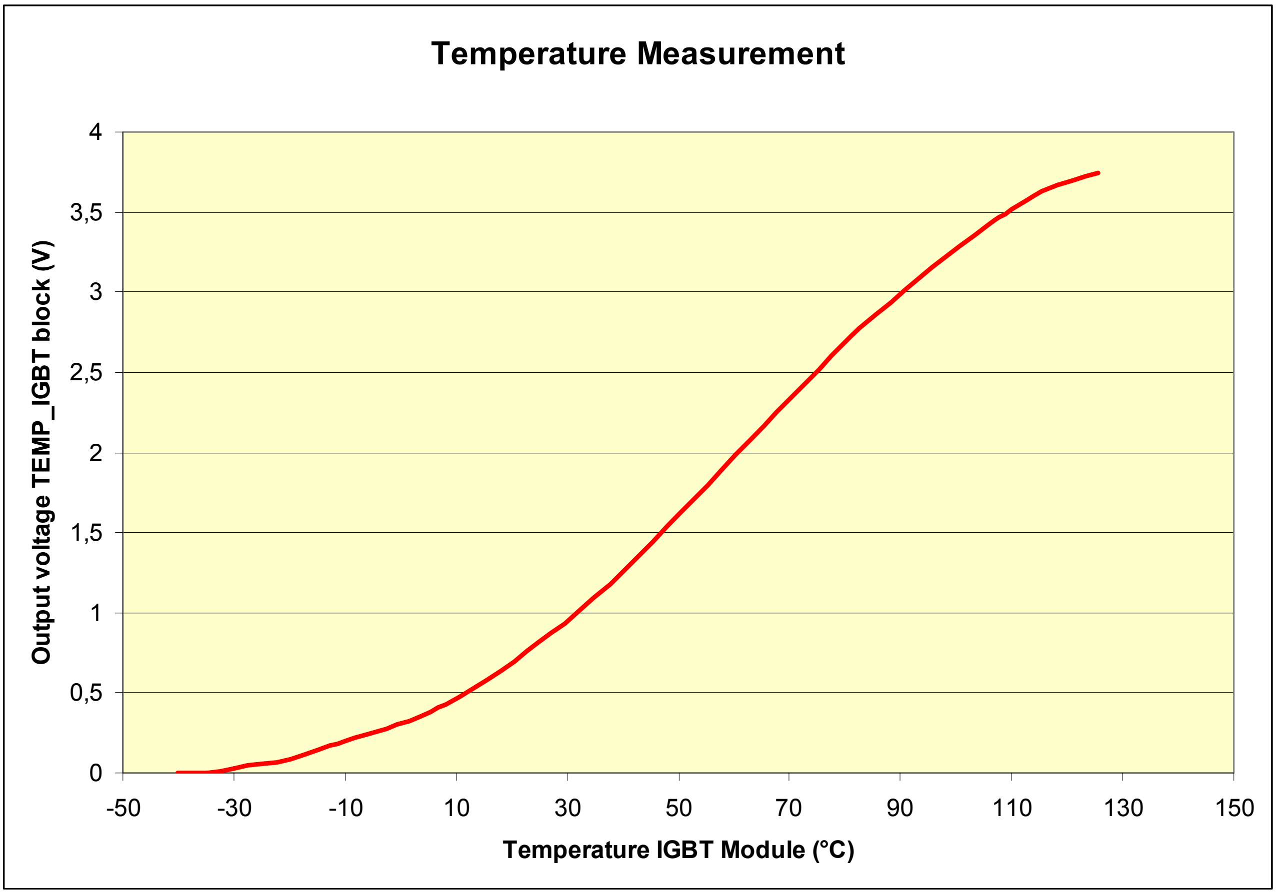


Figure 15 Characteristics of the temperature measurement

Note: This temperature measurement is not suitable for short circuit detection or short term overload and may be used to protect the module from long term overload conditions or malfunction of the cooling system.

3.8 DC voltage measurement

The voltage at the DC Link is measured on the 6ED100HP1-FA by means of a sigma-delta modulator and the same circuit explained in the previous section which offers the necessary galvanic isolation. It is forwarded to the external connector (Vdc, K3.9). Figure 16 shows the relationship between DC Link voltage and Vdc.

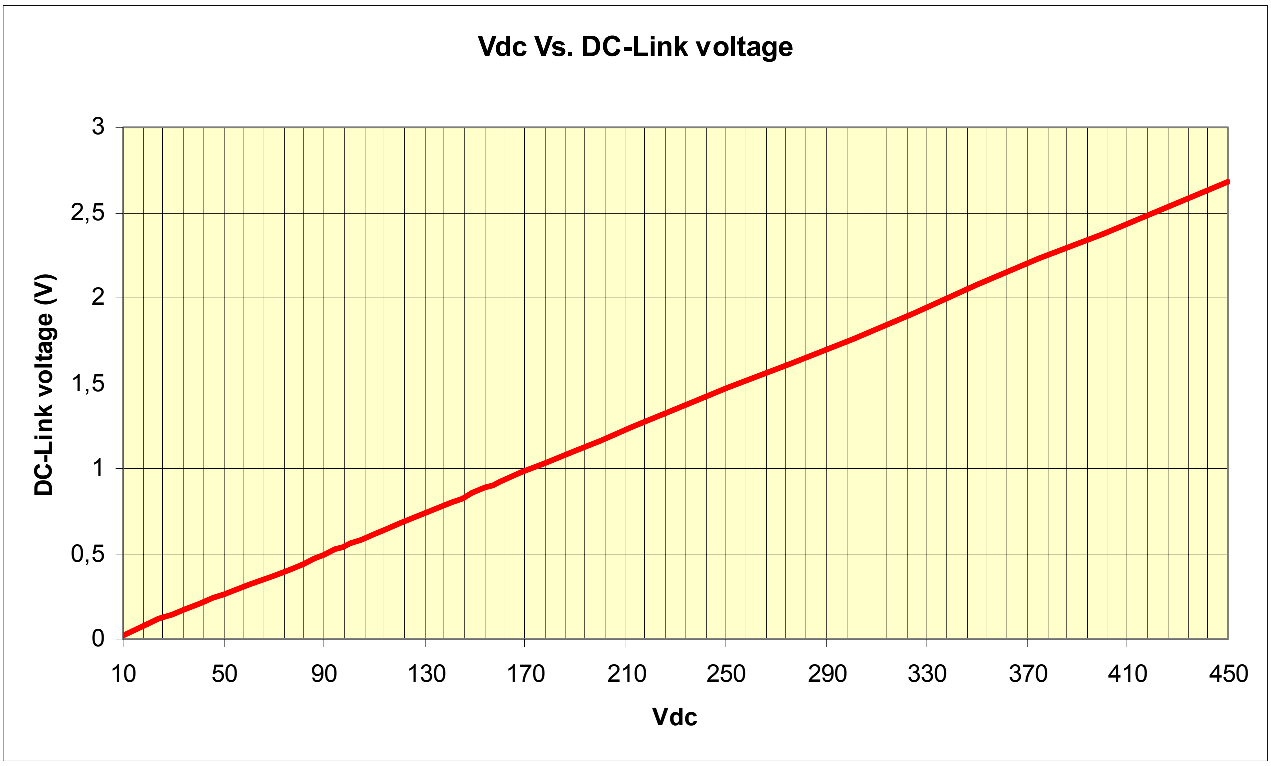


Figure 16 Characteristics of the DC voltage measurement

3.9 Board temperature

The temperature on the Evaluation Driver Board is measured with precision temperature sensor that can sense a -40°C to +125°C temperature range. The output voltage (Temp Board, K3.11) is linearly proportional to Celsius temperature (+10mV/°C) and has a DC offset of +500mV. Refer to Figure 27 for detailed description of the circuit.

4 Switching losses

The switching losses can differ from the values written in the datasheet of the used module. The reason is that the Evaluation Driver Board switches with -8 V / +15 V and HybridPack1™ is characterised with a driver board that consists of ±15 V.

The turn-on losses are expected to be close to the values of the datasheet of HybridPack1™. This will be different for the turn-off losses. In general the turn-off losses depend on the stray inductance of the DC-Link and increase linear with the DC-Link voltage. In the case of the driver board it does not increase linear because the active clamping function increases the turn-off losses due to a decrease of the di/dt.

5 Definition of layers for Evaluation Driver Boards

The 6ED100HP1-FA Evaluation driver board was made keeping the following rules for the copper thickness and the space between different layers shown in Figure 17.

Layers:

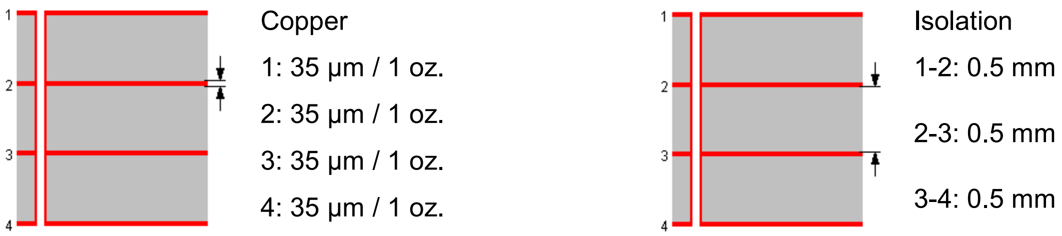


Figure 17 Copper and isolation for layers

6 Schematic, Layout and Bill of Material

To meet the individual customer requirements and make the Evaluation Driver Board for the HybridPack1™ module a platform for development or modifications, all necessary technical data like schematic, layout and components are included in this chapter.

The tolerances for resistors should be less or equal ±1 %, for capacitors of the type C0G less or equal ±5 % and for capacitors of the type X7R less or equal ±10 %.

6.1 Schematic

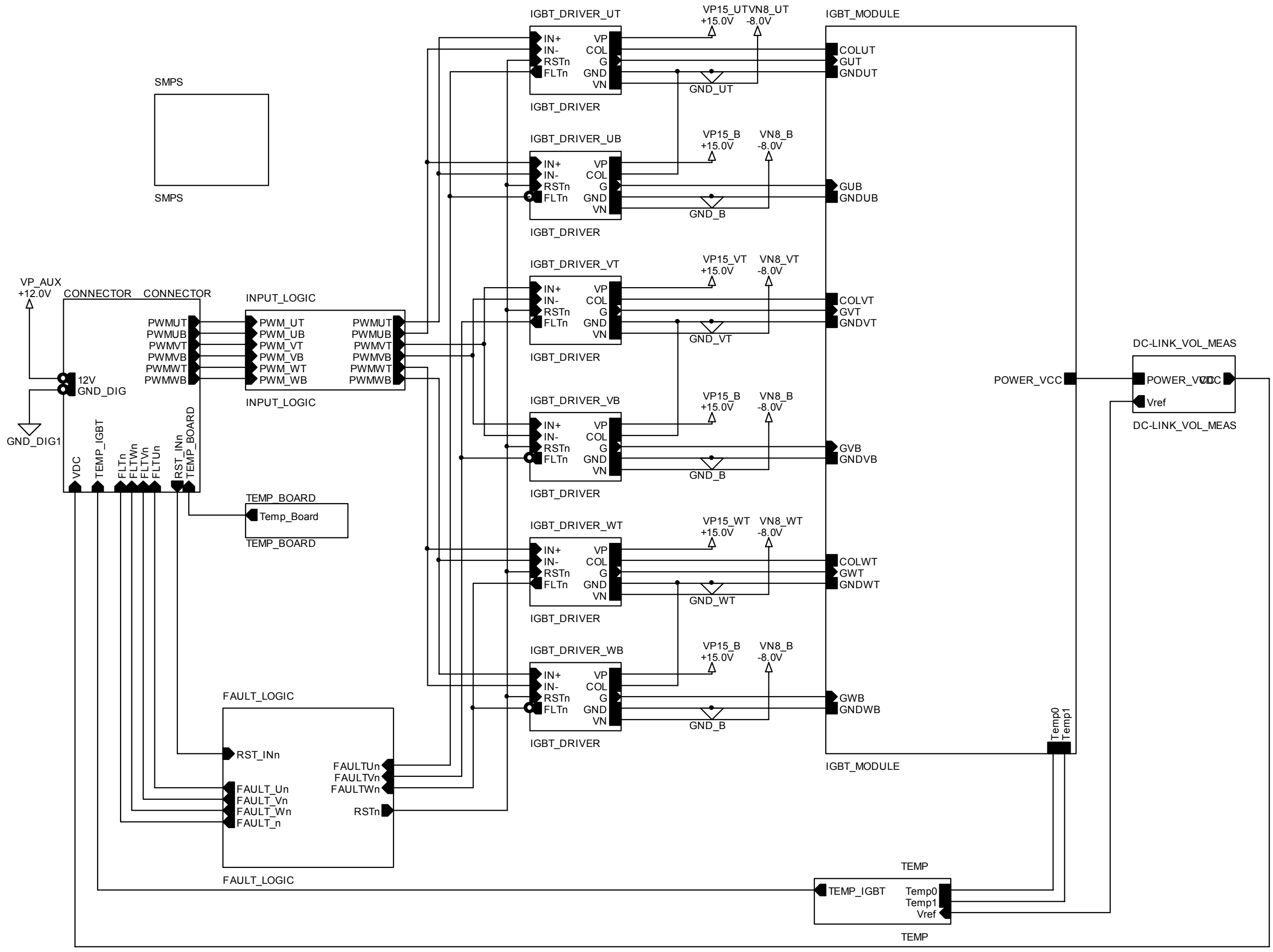


Figure 18 Schematics block overview

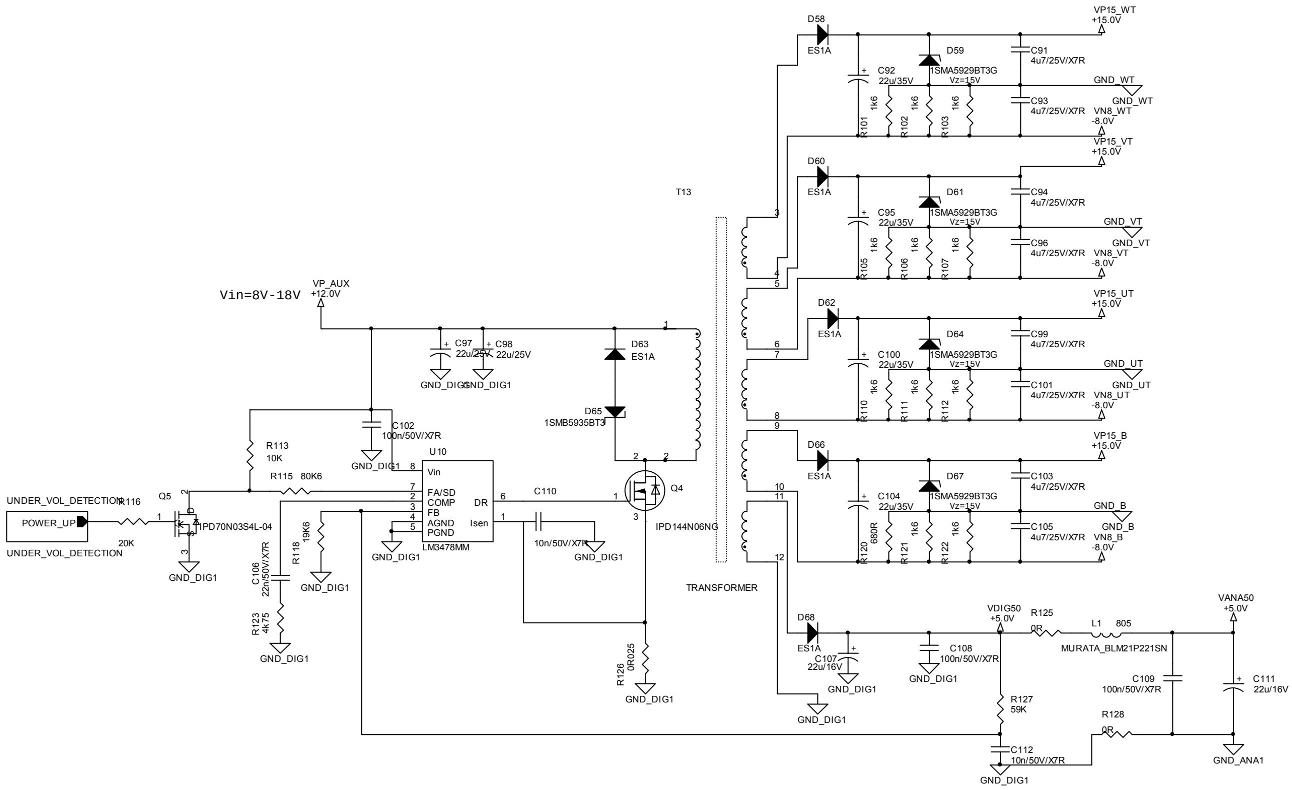


Figure 19 SMPS- Power Supply

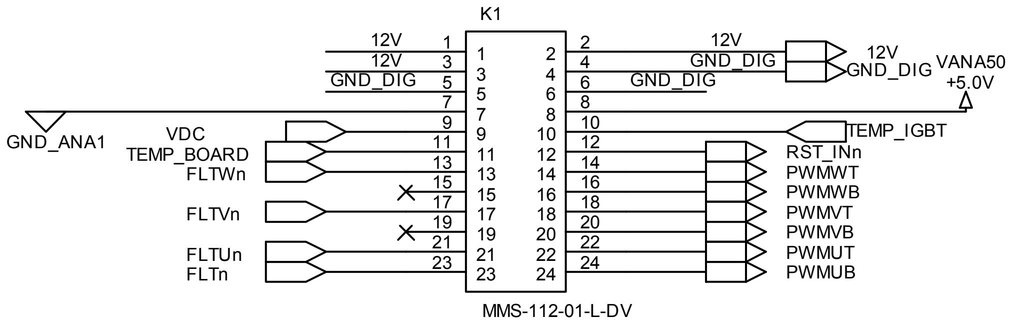


Figure 20 External connector

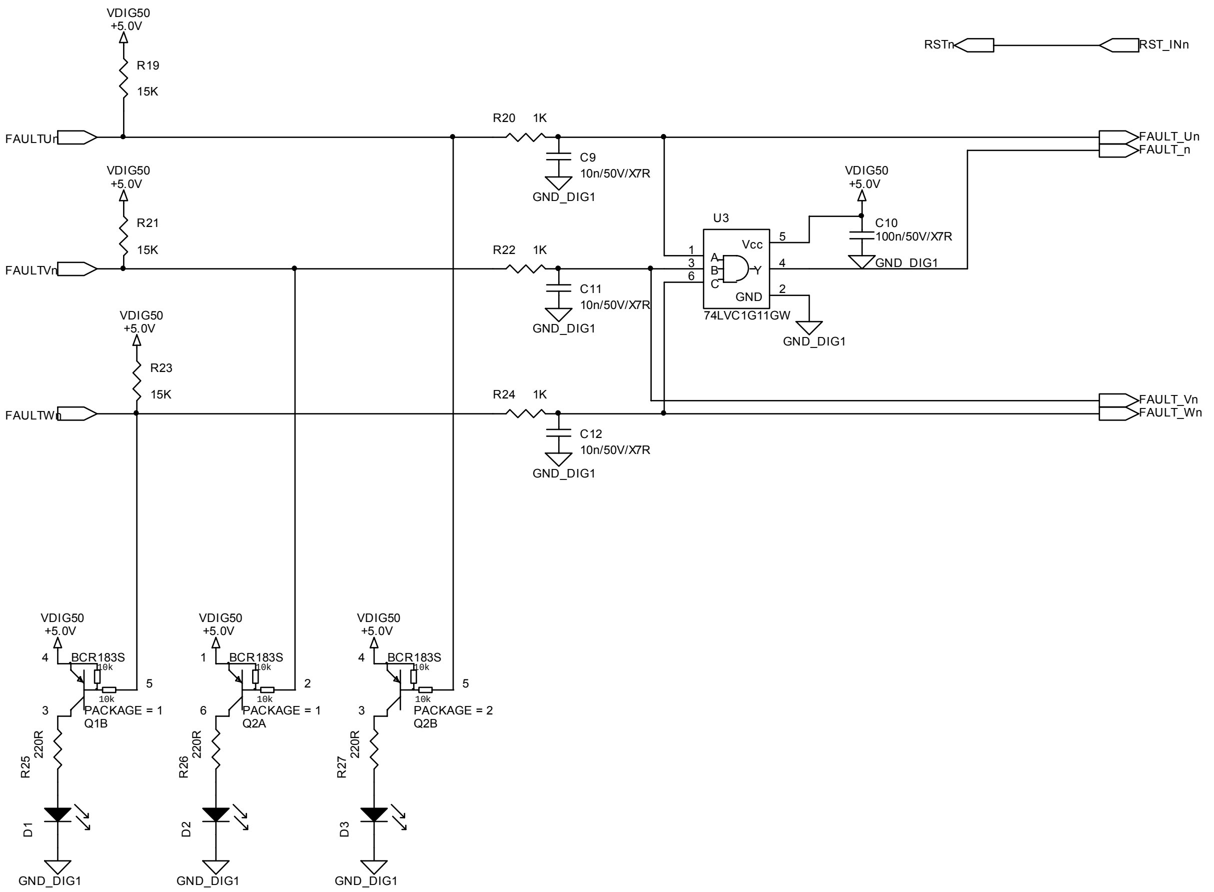


Figure 21 Fault Logic

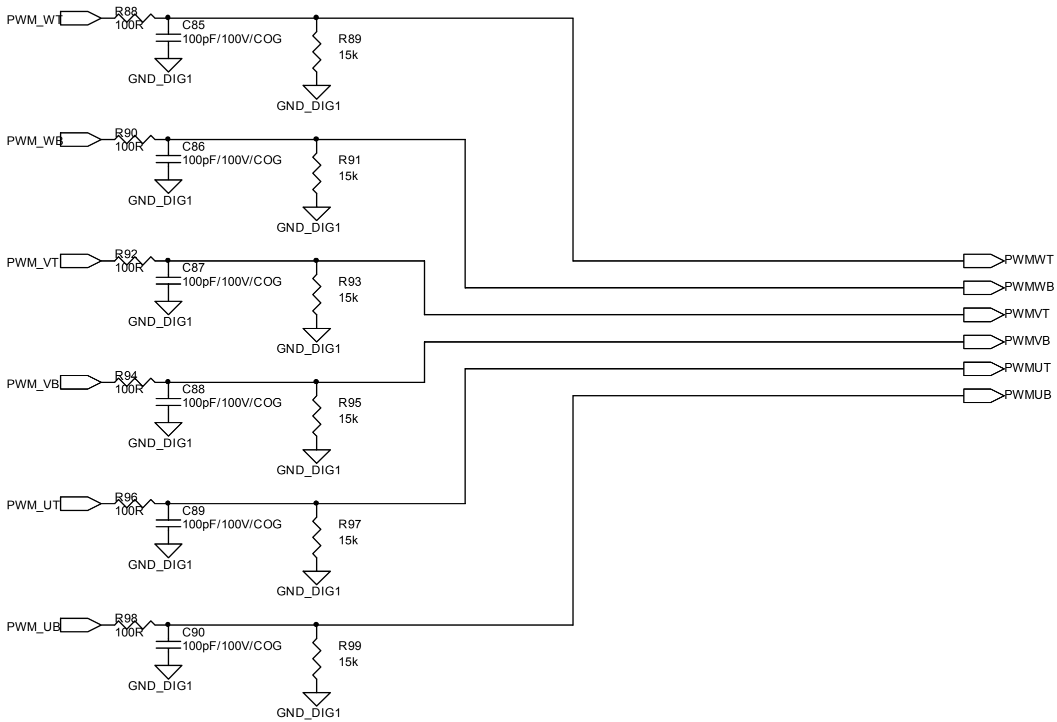


Figure 22 Input Logic

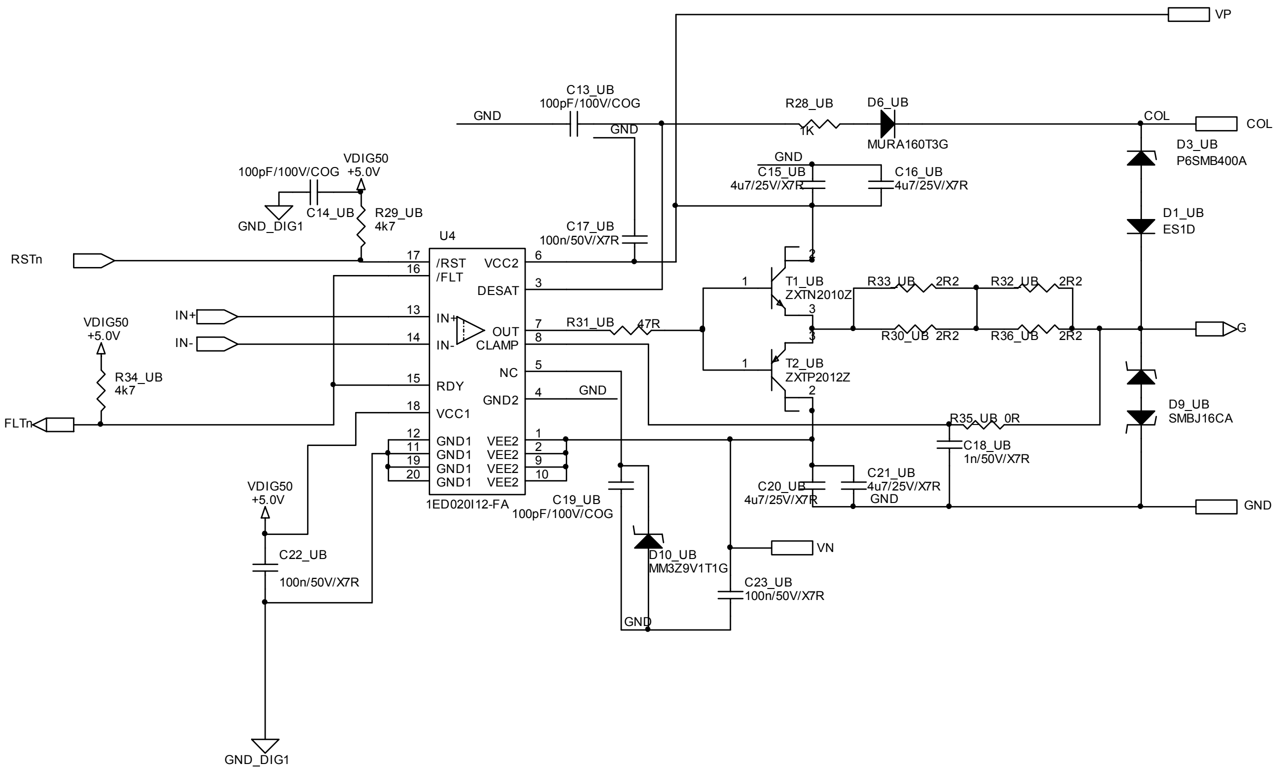


Figure 23 IGBT driver – Bottom transistor of phase U

Note: all IGBT driver blocks maintain the same structure as the one showed in Figure 23

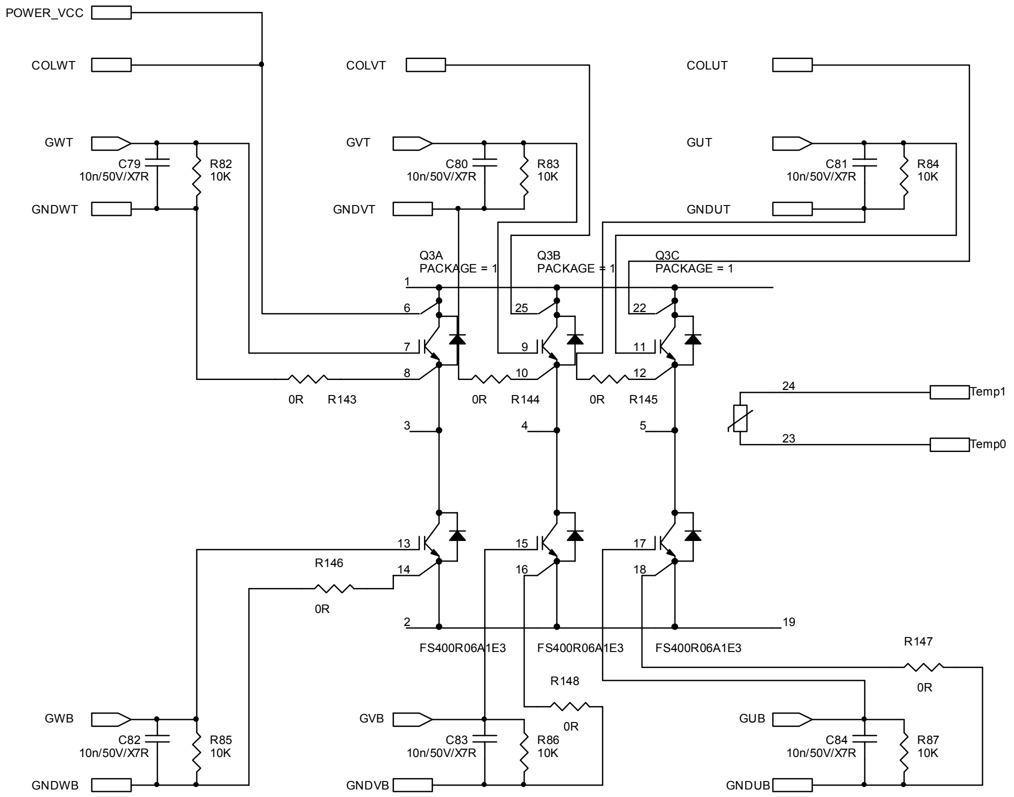


Figure 24 IGBT Module

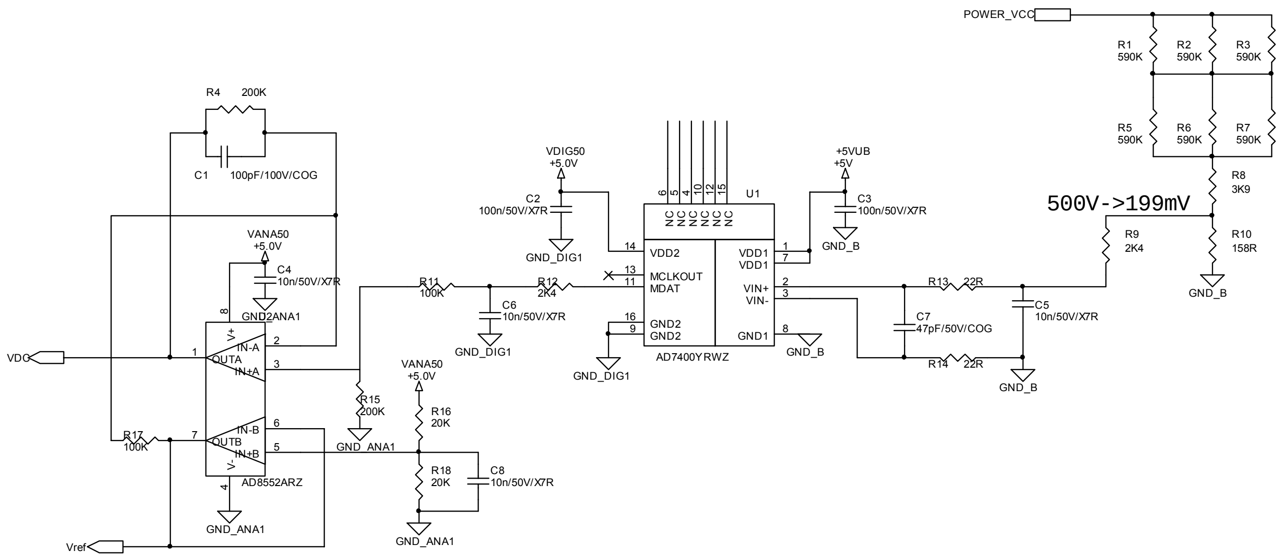


Figure 25 DC Voltage measurement

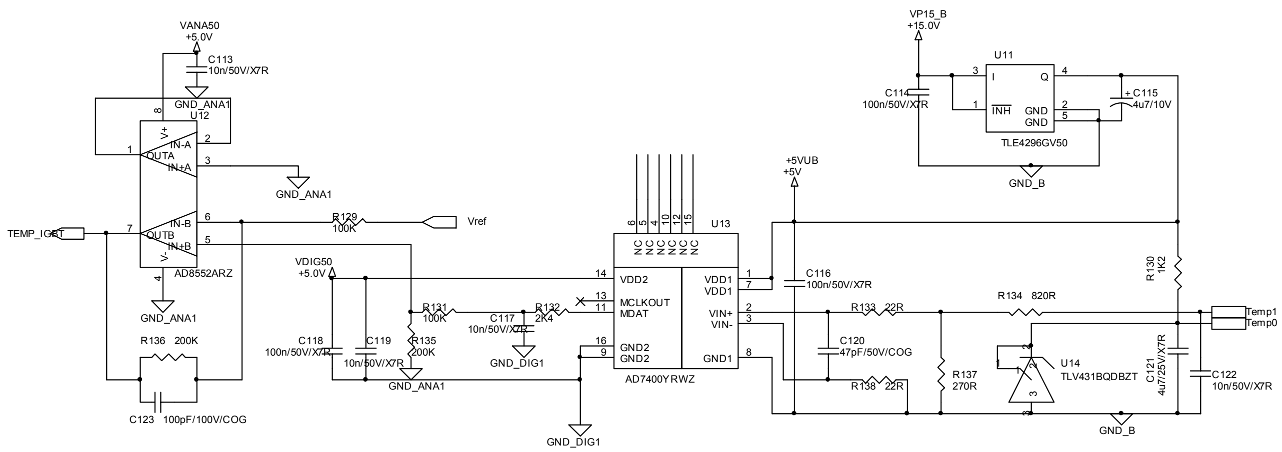


Figure 26 IGBT module temperature measurement

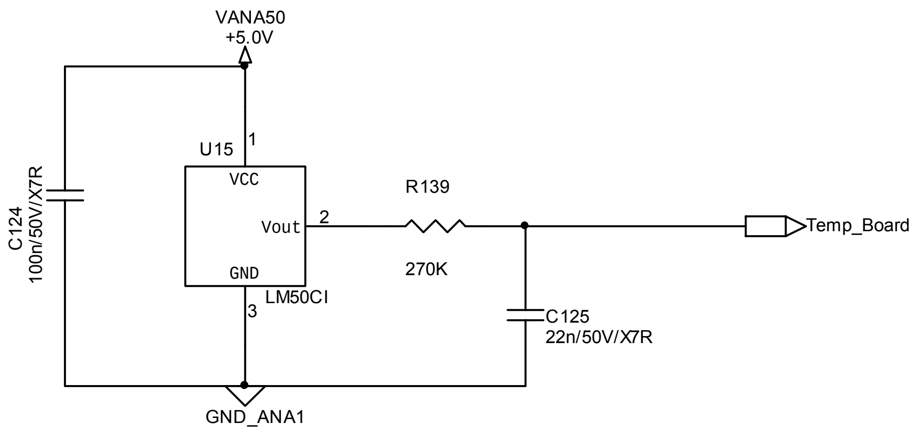


Figure 27 PCB temperature measurement

6.2 Assembly drawing

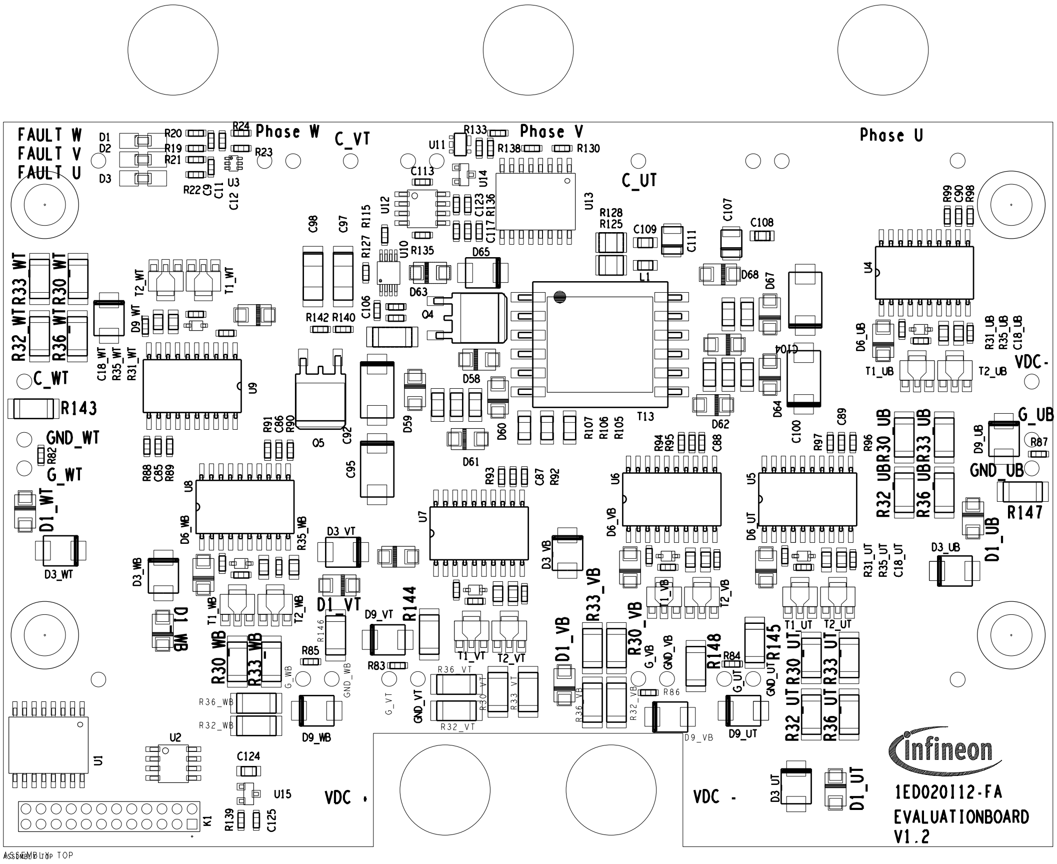


Figure 28 Assembly drawing of the HybridPack1™ driver board (top)

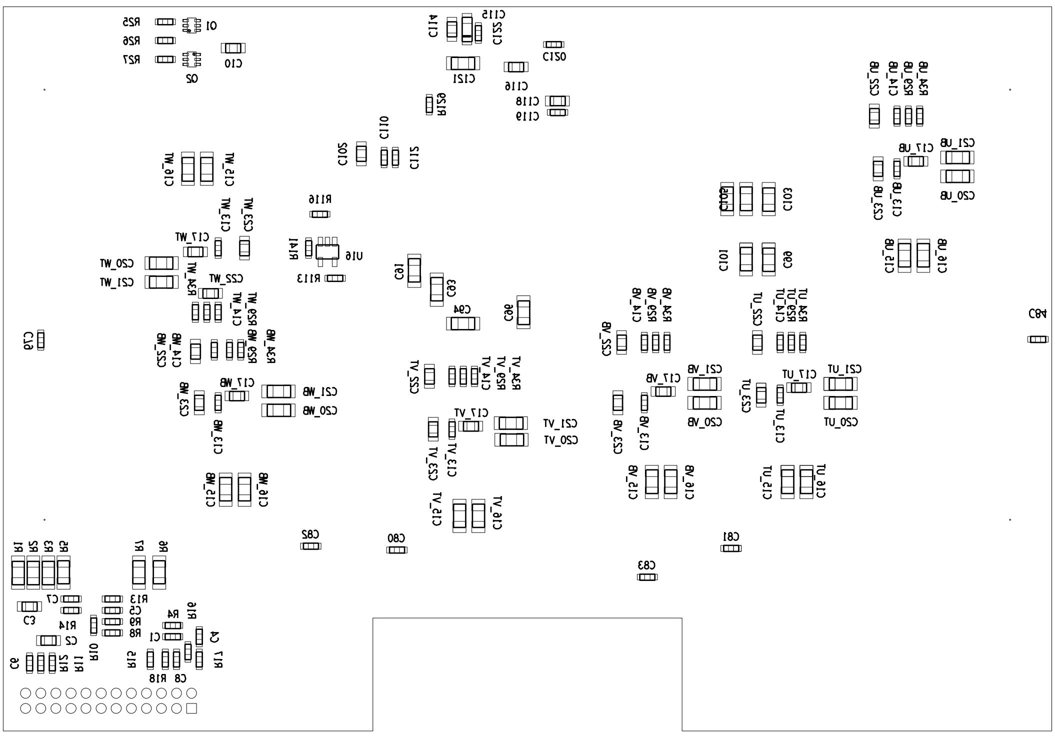


Figure 29 Assembly drawing of the HybridPack1™ driver board (bottom)

For detail information use the zoom function of your PDF viewer to zoom into the drawing.

6.3 Layout

Layout for the HybridPack1™ driver board

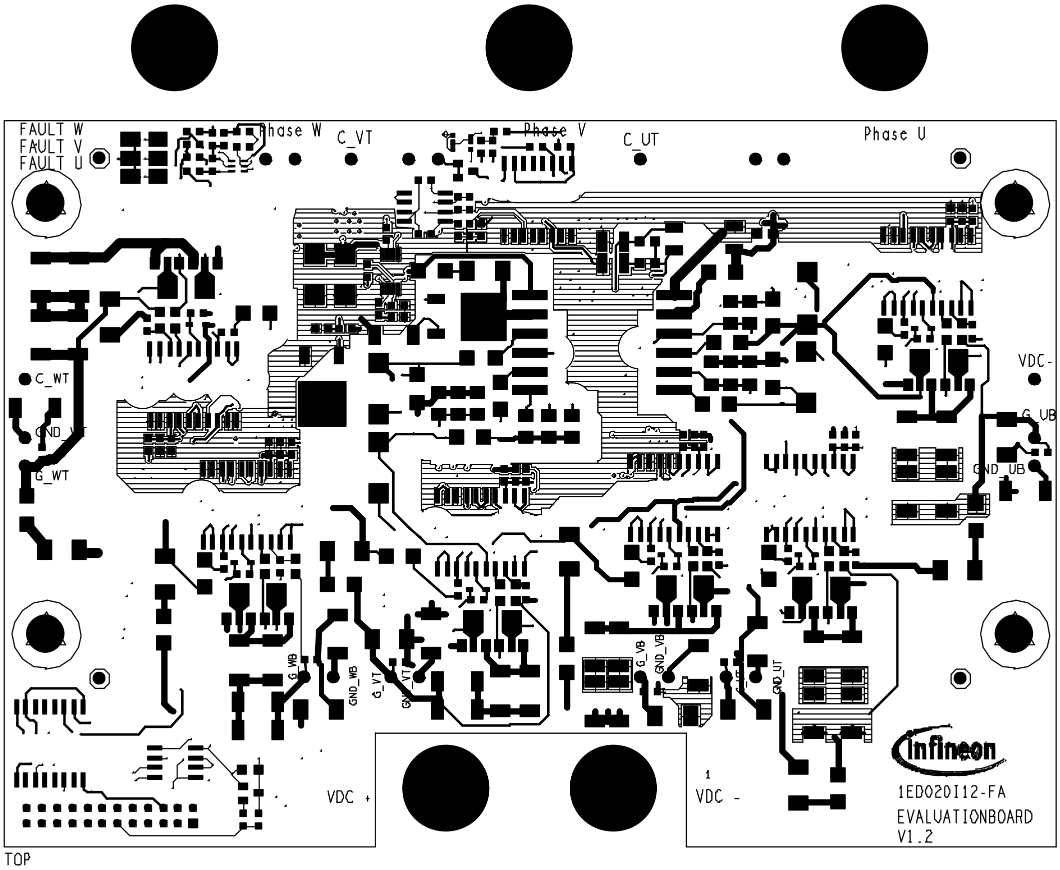


Figure 30 HybridPack1™ IGBT driver – Top layer

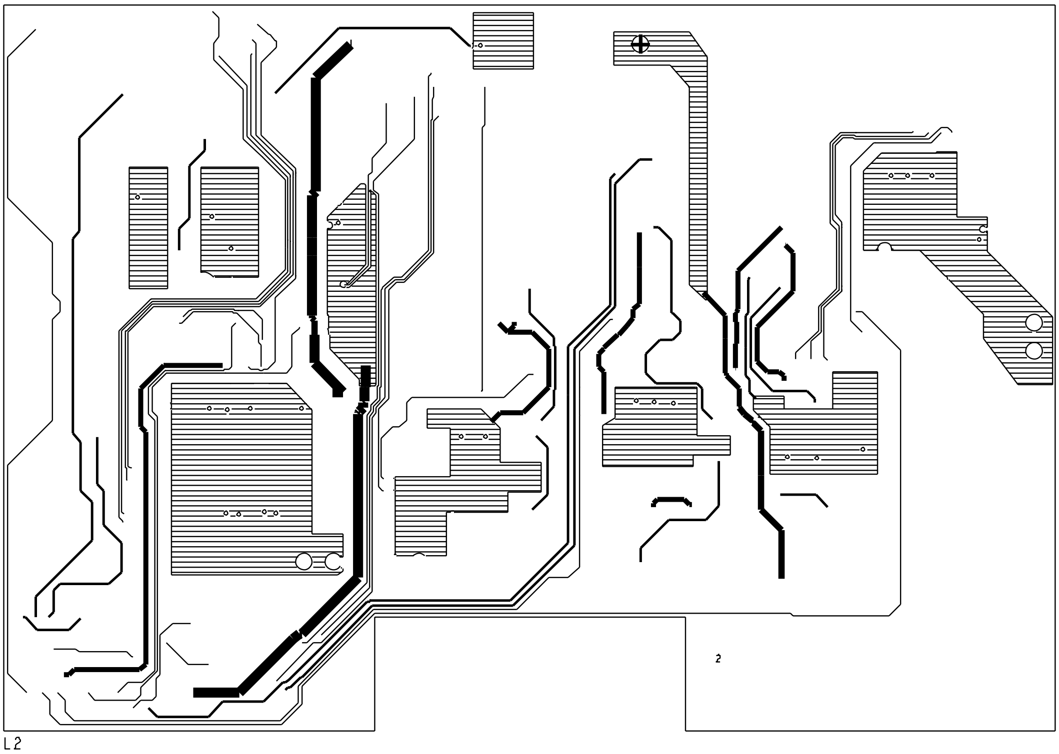


Figure 31 HybridPack1™ IGBT driver – Layer 2

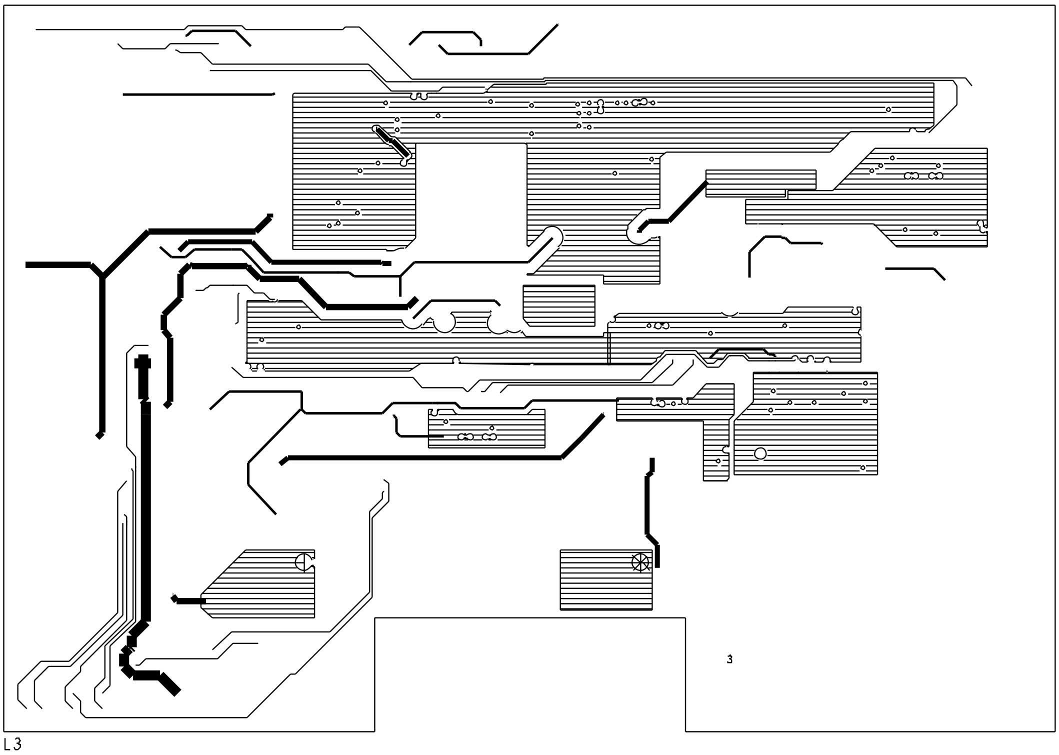


Figure 32 HybridPack1™ IGBT driver – Layer 3

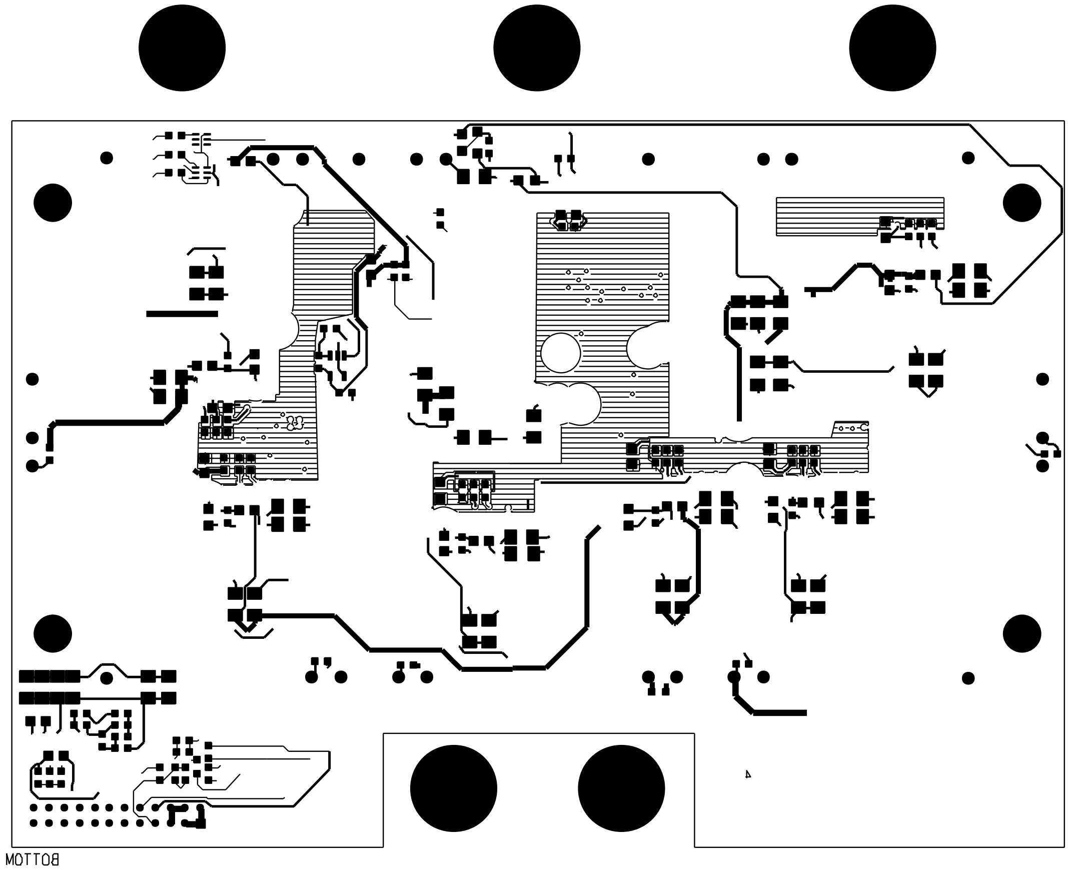


Figure 33 HybridPack1™ IGBT driver – Bottom Layer 4

6.4 Bill of material

Table 3 Bill of Material for HybridPACK™ Driver Board

Type	Qty	Reference	Value / Device	Package
Capacitor	26	C1, C13_WT, C13_WB, C13_VT, C13_VB, C13_UT, C13_UB, C14_WT, C14_WB, C14_VT, C14_VB, C14_UT, C14_UB, C19_WT, C19_WB, C19_VT, C19_VB, C19_UT, C19_UB, C85, C86, C87, C88, C89, C90, C123	100pF/100V/COG	C0603
Capacitor	28	C2, C3, C10, C17_WT, C17_WB, C17_VT, C17_VB, C17_UT, C17_UB, C22_WT, C22_WB, C22_VT, C22_VB, C22_UT, C22_UB, C23_WT, C23_WB, C23_VT, C23_VB, C23_UT, C23_UB, C102, C108, C109, C114, C116, C118, C124	100n/50V/X7R	C0805
Capacitor	19	C4, C5, C6, C8, C9, C11, C12, C79, C80, C81, C82, C83, C84, C110, C112, C113, C117, C119, C122	10n/50V/X7R	C0603
Capacitor	2	C7, C120	47pF/50V/COG	C0603
Capacitor	33	C15_WT, C15_WB, C15_VT, C15_VB, C15_UT, C15_UB, C16_WT, C16_WB, C16_VT, C16_VB, C16_UT, C16_UB, C20_WT, C20_WB, C20_VT, C20_VB, C20_UT, C20_UB, C21_WT, C21_WB, C21_VT, C21_VB, C21_UT, C21_UB, C91, C93, C94, C96, C99, C101, C103, C105, C121	4u7/25V/X7R	C1206
Capacitor	6	C18_WT, C18_WB, C18_VT, C18_VB, C18_UT, C18_UB	1n/50V/X7R	C0603

Capacitor	4	C92, C95, C100, C104	22u/35V	D
Capacitor	2	C97, C98	22u/25V	C
Capacitor	2	C106, C125	22n/50V/X7R	C0603
Capacitor	2	C107, C111	22u/16V	B
Capacitor	1	C115	4u7/10V	A
LED	3	D1, D2, D3	LED_LSM676-MQ	D0805
Rectifier Diode	6	D1_WT, D1_WB, D1_VT, D1_VB, D1_UT, D1_UB	ES1D	DO214AC
TVS Diode	6	D3_WT, D3_WB, D3_VT, D3_VB, D3_UT, D3_UB,	P6SMB400A	SMB
Diode	6	D6_WT, D6_WB, D6_VT, D6_VB, D6_UT, D6_UB	MURA160T3G	DO214AC
TVS Diode	6	D9_WT, D9_WB, D9_VT, D9_VB, D9_UT, D9_UB	SMBJ16CA	SMB
Zener Diode	6	D10_WT, D10_WB, D10_VT, D10_VB, D10_UT, D10_UB	MM3Z9V1T1G	SOD323
Rectifier Diode	6	D58, D60, D62, D63, D66, D68	ES1A	DO214AC
Zener Diode	4	D59, D61, D64, D67	1SMA5929BT3G	DO214AC
Zener Diode	1	D65	1SMB5935BT3	SMB
Connector	1	K1	MMS-112-01-L-DV	24POL
Inductor	1	L1	MURATA_BLM21P221SN	L0805
Transistor	2	Q1, Q2	BCR183S	SOT363
IGBT Module	1	Q3	FS400R06A1E3	HybridPACK1™
Transistor	1	Q4	IPD144N06NG	TO252
Transistor	1	Q5	IPD70N03S4L-04	TO252
Resistor	6	R1, R2, R3, R5, R6, R7	590K	R1206
Resistor	4	R4, R15, R135, R136	200K	R0603
Resistor	1	R8	3K9	R0603
Resistor	3	R9, R12, R132	2K4	R0603
Resistor	1	R10	158R	R0603
Resistor	4	R11, R17, R129, R131	100K	R0603
Resistor	4	R13, R14, R133, R138	22R	R0603
Resistor	3	R16, R18, R116	20K	R0603
Resistor	9	R19, R21, R23, R89, R91, R93, R95, R97, R99	15K	R0603
Resistor	9	R20, R22, R24, R28_WT, R28_WB, R28_VT, R28_VB, R28_UT, R28_UB	1K	R0603
Resistor	3	R25, R26, R27	220R	R0603
Resistor	12	R29_WT, R29_WB, R29_VT, R29_VB, R29_UT, R29_UB, R34_WT, R34_WB, R34_VT, R34_VB, R34_UT, R34_UB	4k7	R0603
Resistor	24	R30_WT, R30_WB, R30_VT, R30_VB, R30_UT, R30_UB, R32_WT, R32_WB, R32_VT, R32_VB, R32_UT, R32_UB, R33_WT, R33_WB, R33_VT, R33_VB, R33_UT, R33_UB, R36_WT, R36_WB, R36_VT, R36_VB, R36_UT, R36_UB	2R2	R2010
Resistor	6	R31_WT, R31_WB, R31_VT, R31_VB, R31_UT, R31_UB	47R	R0805
Resistor	6	R35_WT, R35_WB, R35_VT, R35_VB, R35_UT, R35_UB	0R	R0805
Resistor	7	R82, R83, R84, R85, R86, R87, R113	10K	R0603
Resistor	6	R88, R90, R92, R94, R96, R98	100R	R0603
Resistor	11	R101, R102, R103, R105, R106, R107, R110, R111, R112, R121, R122	1k6	R1206
Resistor	1	R120	680R	R1206
Resistor	1	R118	19K6	R0603
Resistor	1	R123	4k75	R0603
Resistor	2	R125, R128	0R	R1210
Resistor	1	R126	0R025	R2010
Resistor	1	R127	59K	R0603

Resistor	1	R130	1K2	R0603
Resistor	1	R134	820R	R0603
Resistor	1	R137	270R	R0603
Resistor	1	R139	270K	R0603
Resistor	1	R140	226K	R0603
Resistor	1	R141	5K1	R0603
Resistor	1	R142	47K	R0603
Resistor	6	R143, R144, R145, R146, R147, R148	0R	R2010
Transistor	6	T1_WT,T1_WB, T1_VT, T1_VB, T1_UT, T1_UB	ZXTN2010Z	SOT89
Transistor	6	T2_WT, T2_WB, T2_VT, T2_VB, T2_UT, T2_UB	ZXTP2012Z	SOT89
Transformer	1	T13	TRANSFORMER	
σ–Δ Modulator	2	U1, U13	AD7400YRWZ	SO-16
Op. Amplifier	2	U2, U12	AD8552ARZ	SO-08
AND Gate	1	U3	74LVC1G11GW	SOT363
Driver IC	6	U4, U5, U6, U7, U8, U9	1ED020I12-FA	PG-DSO-20
Swit. Regulator	1	U10	LM3478MM	MSOP-08
Voltage Regulator	1	U11	TLE4296GV50	SCT595
Shunt Regulator	1	U14	TLV431BQDBZT	SOT23
Temp. Sensor	1	U15	LM50CI	SOT23
Voltage Monitor	1	U16	MAX6457UKD3A-T	SOT23

7 How to order Evaluation Driver Boards

Every Evaluation Driver Board has its own SAP number and can be ordered via your Infineon Sales Partner.

Information can also be found at the Infineon Web Page: www.infineon.com

http://www.infineon.com

Published by Infineon Technologies AG