Hybrid Kit for HybridPack2™

Evaluation Kit for applications with HybridPack2™ module

System Engineering Automotive

Never stop thinking

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Page 13	Mechanical dimensions corrected	
Page 11	$\mathbf{I_{SUPPLY}}$ – Supply current drawn (idle mode) (V_{SUPPLY}=12V) corrected to 300mA	

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1 Introduction

The Hybrid Kit for HybridPack2™ shown in Figure 1 was developed to support customers during their first steps designing applications with this IGBT 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.

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SAP number for Hybrid Kit for HybridPack2™ :

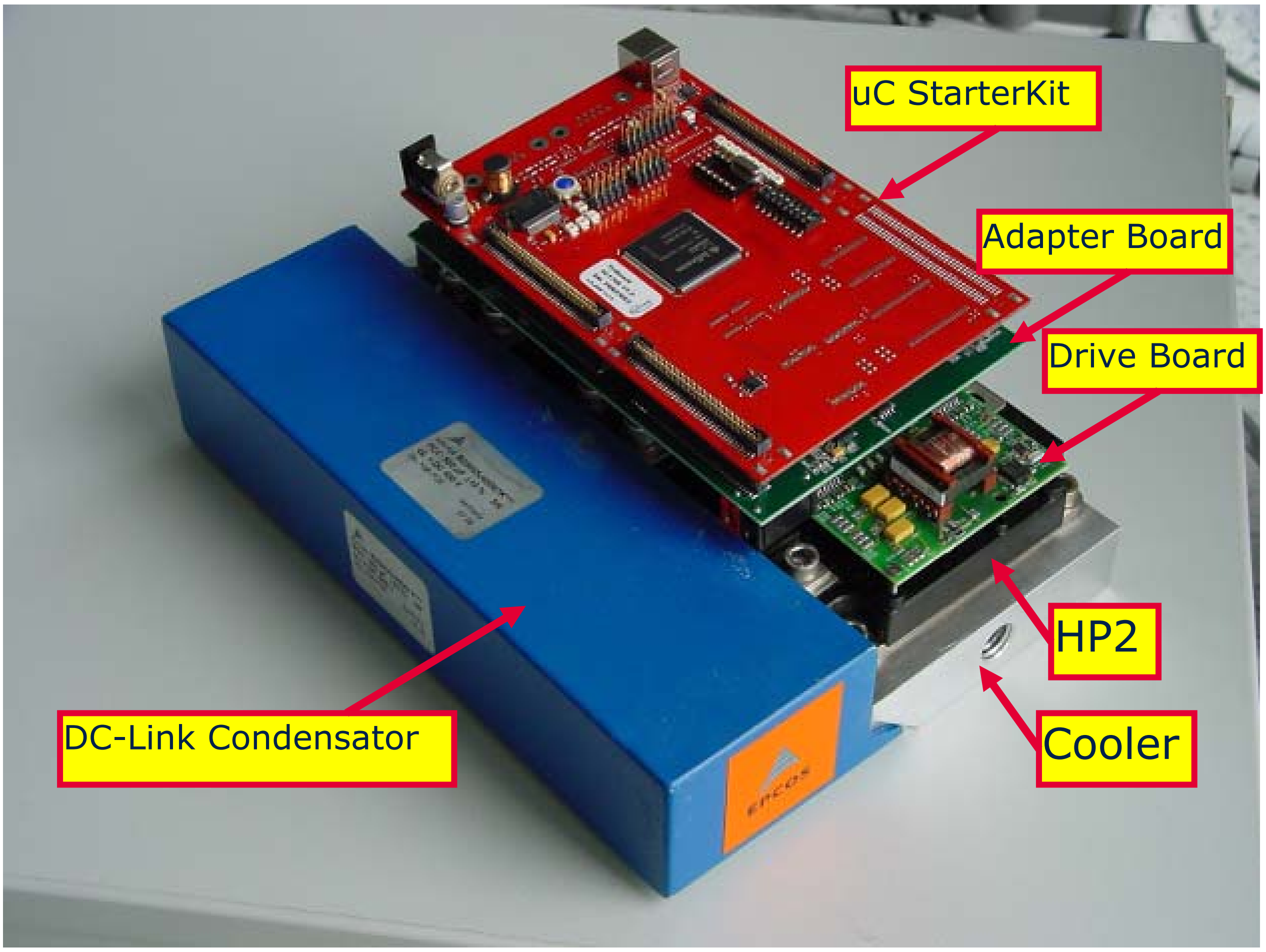


Figure 1 The Hybrid Kit for HybridPack2™

2 Design features

The Hybrid Kit for HybridPack2™ is made up of a set of boards (6ED100HP2-FA and Adapter Board) mechanically and electrically suitable to be used with an IGBT module (HybridPack2™) and which can be used together with a Microcontroller Starter Kit (TriCore or XC2200 family. Not included) a DC-Link Capacitor (not included) and a cooler (application dependent. Not included) in order to build a complete main inverter for (H)EV applications up to 80KW.

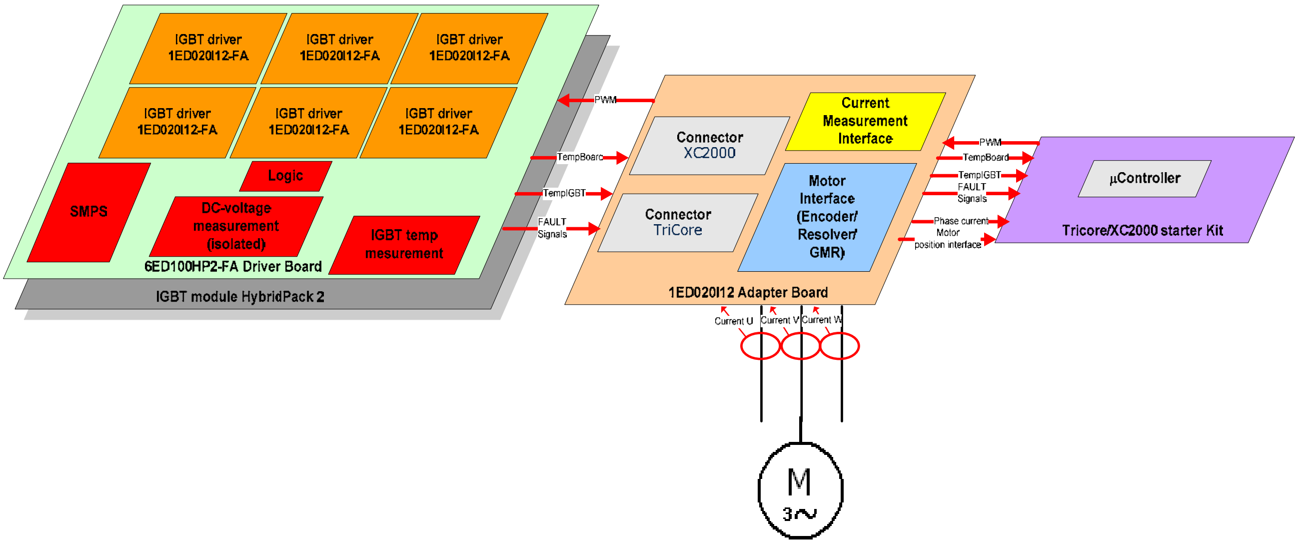


Figure 2 Block diagram of Hybrid Kit for HybridPack2™

Figure 2 shows the complete system and the following sections provide an overview of the boards including main features, key data, pin assignments and mechanical dimensions.

2.1 Main features

Complete main inverter for (H)EV applications up to 80KW.

- Automotive qualified IGBT module HybridPACK2™(not included)
  - 650V/800A IGBT & Diode chipset
- Automotive qualified Driver IC 1ED020I12-FA
  - Based on coreless transformer technology
  - Up to 1200V and 2A driving capability
  - Vcesat-detection
- Combination with different Infineon Microcontroller StarterKits (not included)
  - TriCore family (32 bit)
  - XC2200 family (16 bit)
- Possibility of different motor interfaces: encoder, GMR (Giant Magnetoresistance) and resolver (resolver to digital converter included)

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 6ED100HP2-FA

The 6ED100HP2-FA is a six channel IGBT driver board, specially designed for the HybridPack2™ IGBT Module. The main features and a detailed description of the board, including schematics and layout, can be found in chapter 3.

2.2.2 Adapter Board

The adapter board provides an interface between the Hybrid Kit for HybridPack2™ Driver Board and the Microcontroller StarterKit. Furthermore it offers the connections to the motor positioning system (encoder, resolver or GMR) and to the current measurement system. For a detailed description of the board please refer to chapter 4.

2.2.3 HybridPack2™

HybridPack2™ is a power module designed for Full Hybrid Electrical Vehicle (HEV) applications for a power range up to 80 KW. Designed for a junction operation temperature at 150°C, the module accommodates a Six-Pack configuration of 3 rd generation Trench-Field-Stop IGBT and matching emitter controlled Diodes and is rated up to 800A/600V. It is based on Infineon®'s leading IGBT Trench-Field-Stop Technology, which offers lowest conduction and switching losses.

HybridPack2™ is designed for direct watercooled inverter systems (Temp. coolant 75°C). The PinFin copper base plate combined with high-performance ceramic substrate and Infineon's enhanced wire-bonding process provides unparalleled thermal cycling and power cycling reliability for full hybrid inverter applications. For a compact inverter design the driver stage PCB can easily be soldered on top of the module. All power connections are realized with screw terminals.

2.2.4 Logic Board (StarterKit)

As Logic Board two different Microcontroller Starter Kit can be used: XC2000 family StarterKit (16-bit uC) and TC176x or TC179x (TriCore) StarterKit (32-bit uC). Please refer to the Infineon web-site for more information about these tools

2.2.5 DC-Link Capacitor

The capacitor B25655J4507K from the company Epcos AG (see Figure 3) 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	500µF±10%
U_N	DC 450V
W_N	50 Ws
I_{max}	120A
L_{self}	30nH
tanδ	$2^* 10^{-4}$
R_S	1 mΩ
Maximum ratings	
u_S	600 V
î	2 kA
I_S	8 kA
$(du/dt)_{max}$	4 V/µs
$(du/dt)_S$	16 V/µs

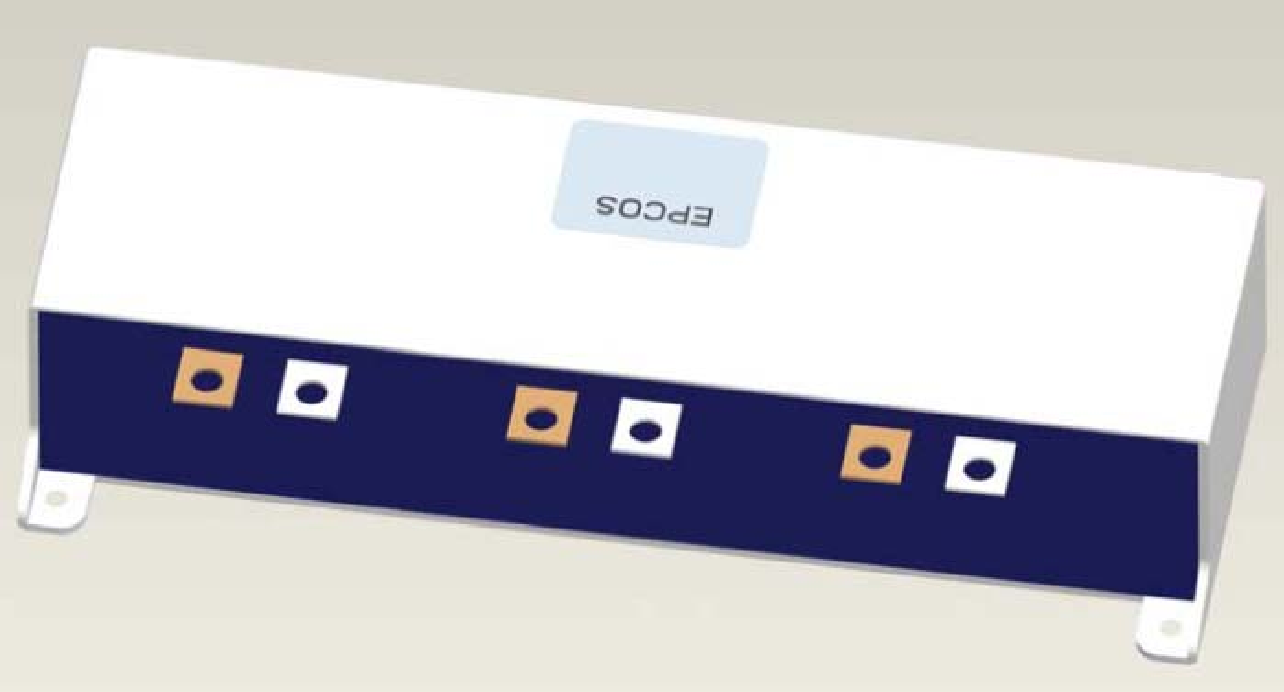


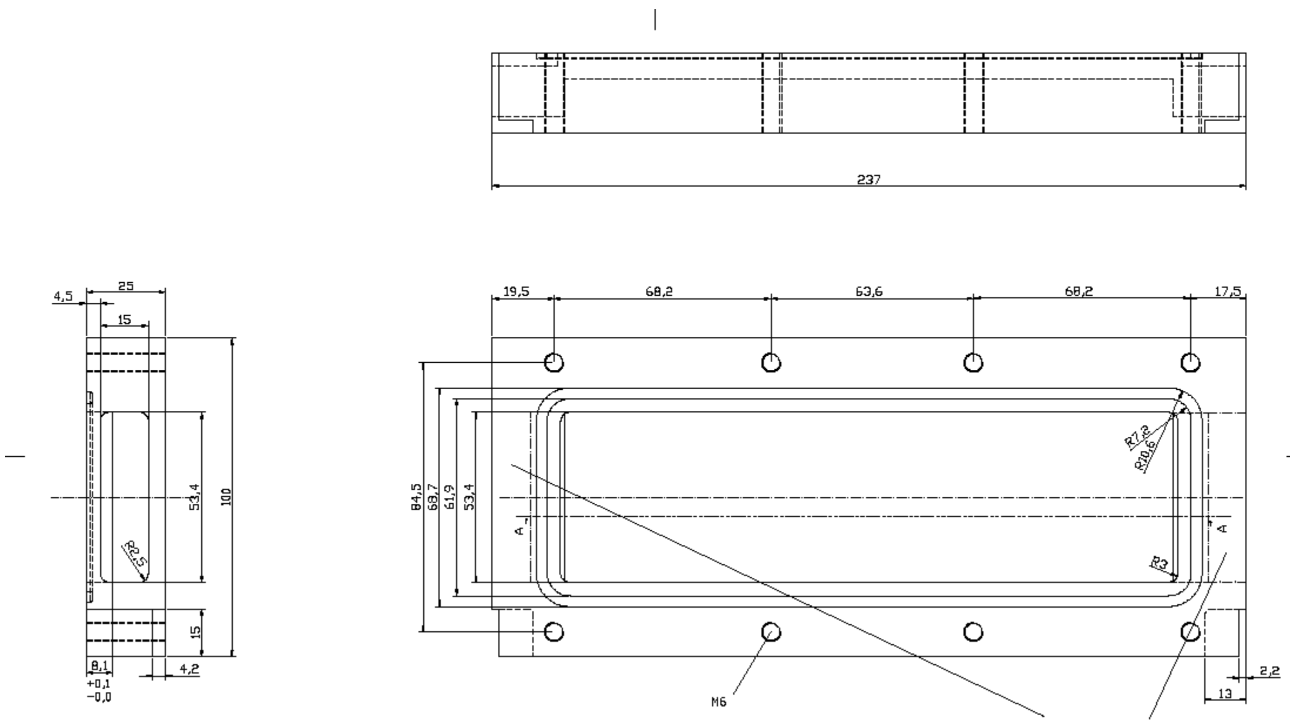
Figure 3 DC-Link Capacitor for HybridPack1™

2.2.6 Cooling element- Not included

For applications requiring higher power or higher operation temperature a water cooling element is recommended.

Figure 4 shows an example of a low cost water cooling system which can be screwed directly to HybridPack2™ and Figure 5 shows the drawings of it.

Figure 4 Example of water cooling element for HybridPack2™



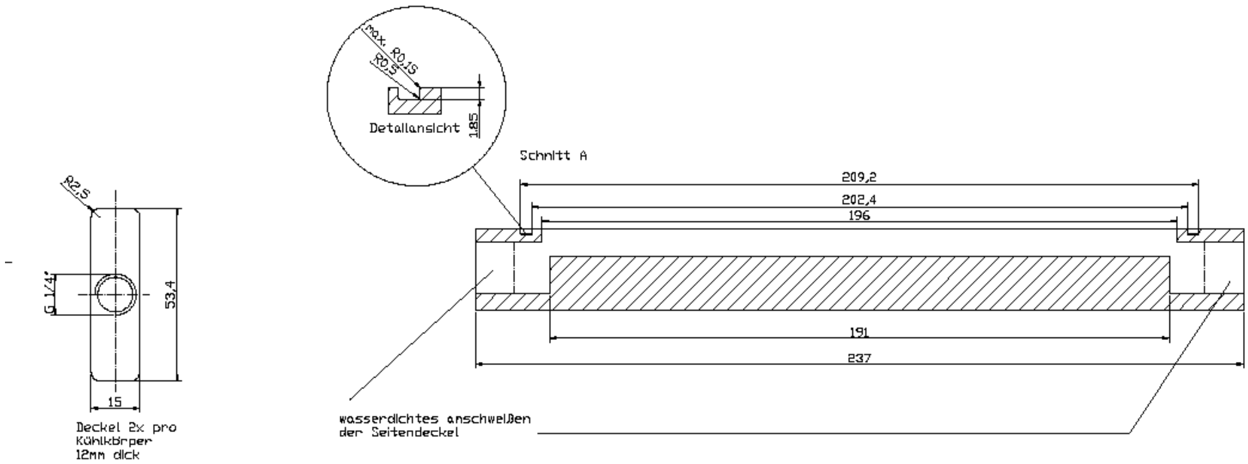


Figure 5 Water cooling system drawings

3 Evaluation Driver Board for the HybridPack2™

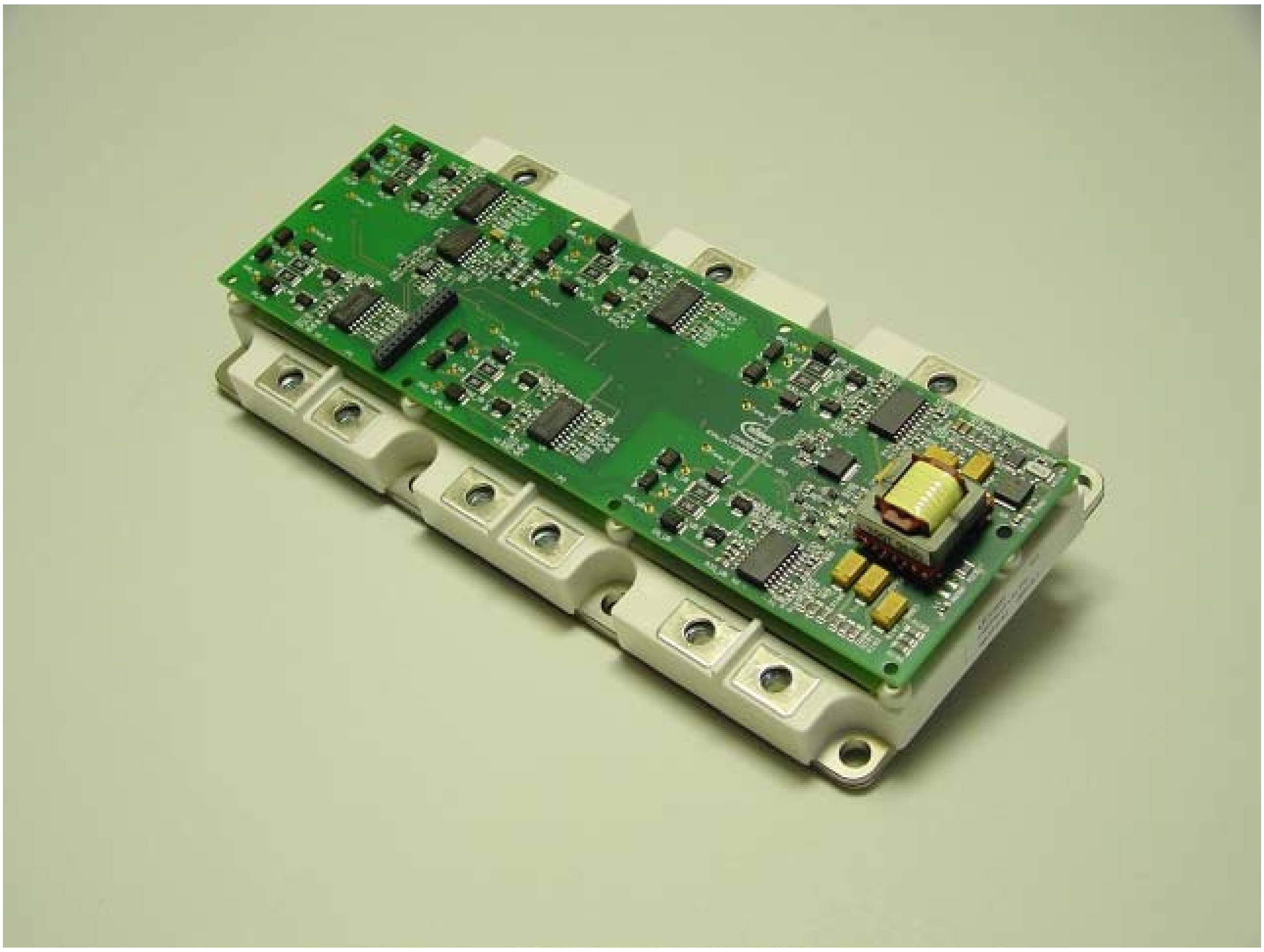


Figure 6 The Hybrid Kit for HybridPack2™ Evaluation Driver Board mounted on the top of the HybridPack2™ module

3.1 Main features

The Hybrid Kit for HybridPack2™ Evaluation Driver Board offers the following features:

- Six channel IGBT driver
- Electrically and mechanically suitable for 650 V IGBT Module HybridPack2™
- Includes DC/DC power supply
- 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

3.2 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)	300	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	4.6	W
f_S – max. PWM signal frequency [1)]	tbd	kHz
t_{PDELAY} – propagation delay time	200	ns
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)	1420	V_{peak}
V_{IORM} – Max. working insulation voltage[6)] (AD7400 Sigma-Delta Converter)	891	V_{peak}

[1)] The maximum switching frequency for the HybridPack2™module should be calculated separately. Limitation factors are: max. DC/DC output power of ??? per channel and max. PCB board temperature measured around gate resistors of 105 °C for used FR4 material. For detailed information see chapter 3.5.3

[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)

3.3 Pin assignment

Figure 7 shows the pin assignment for the external connector (K1) on the Hybrid Kit for HybridPack2™. 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 Hybrid Kit for HybridPack2™ 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 Hybrid Kit for HybridPack2™ as driver board in an inverter such as current measurement, ADC or the motor interface.

On **pin 9, 10, 15 and 19** the monitoring signals are connected: DC-Link voltage measurement and temperature of the three different phases inside the IGBT.

Pin **12, 13, 14, 16, 17, 18, 20, 21, 22 and 23** contain the logic signals for controlling the 6 drivers on the board, that is, the PWM signals, Fault detection and Reset signal.

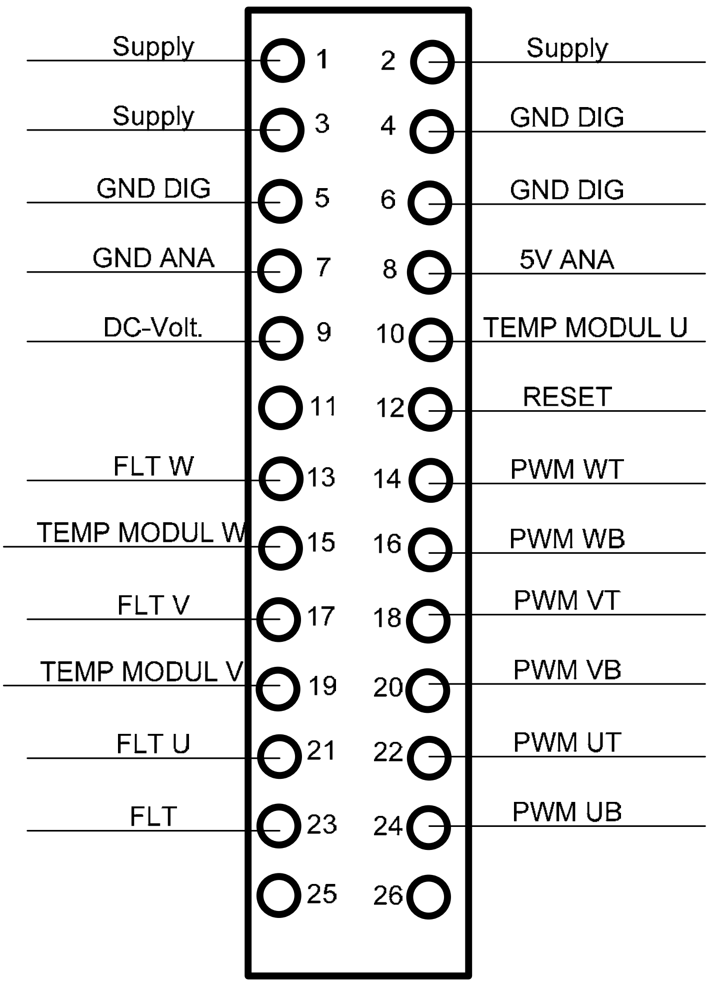


Figure 7 External connector on the Hybrid Kit for HybridPack2™ Evaluation Driver Board

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

3.4 Mechanical dimensions of the HybridPack2™ Driver Board

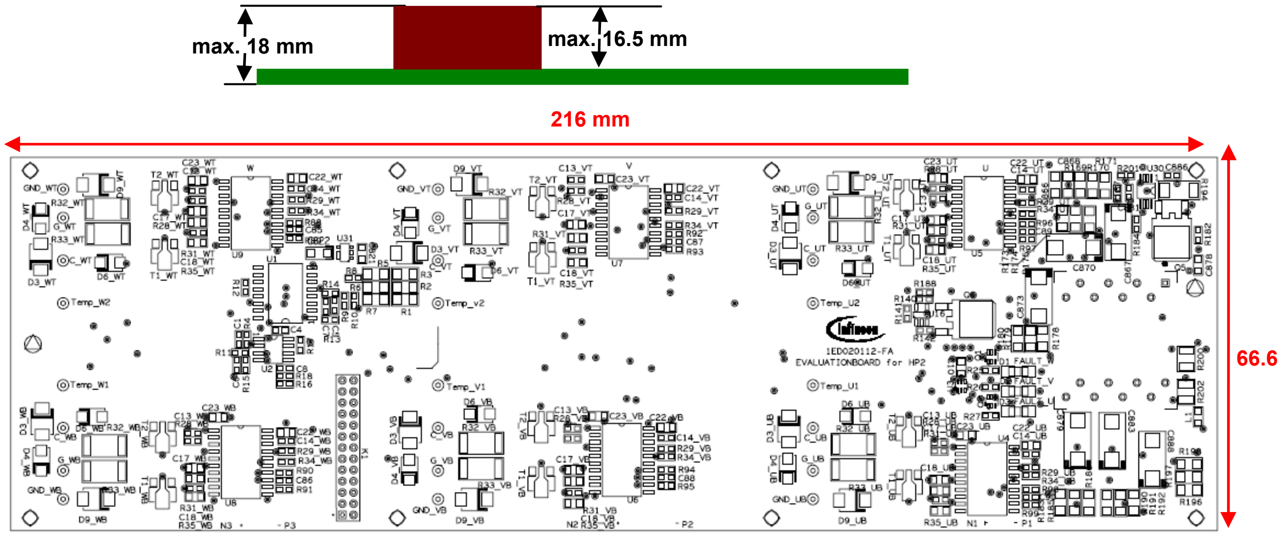


Figure 8 Dimensions of the Hybrid Kit for HybridPack2™ Driver Board

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

3.5 Application Note

Figure 9 shows the block structure of the Hybrid Kit for HybridPack2™ Evaluation Driver Board. The following chapter describes these blocks in detail.

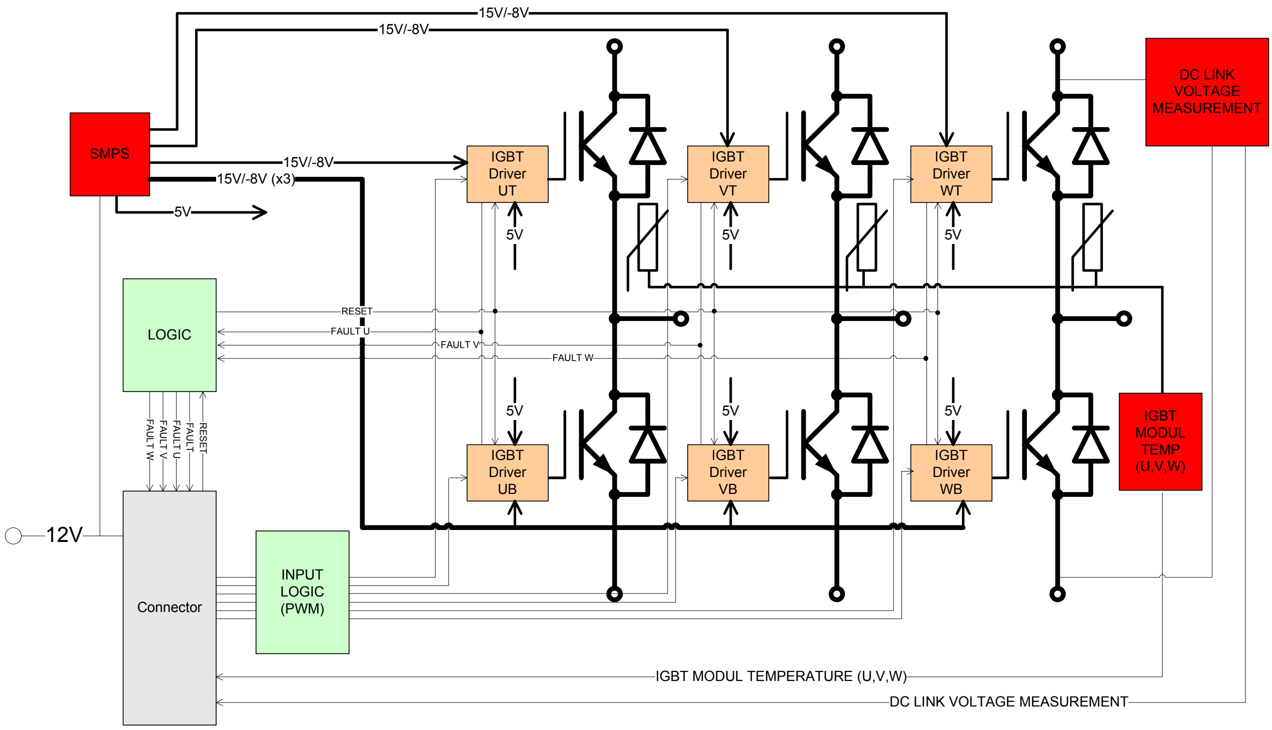


Figure 9 Evaluation Board block diagram

3.5.1 Switching Mode Power Supply (SMPS)

The Hybrid Kit for HybridPack2™ 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.

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 25.

3.5.2 Input logic

The Hybrid Kit for HybridPack2™ Evaluation Driver Board is a dedicated system for a sixpack HybridPack2™IGBT configuration, therefore it is necessary to use 6 separated PWM signals. The schematic in Figure 10 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 Hybrid Kit for HybridPack2™ does not provide automatically a dead time; it is needed for the signals to have the correct dead time.

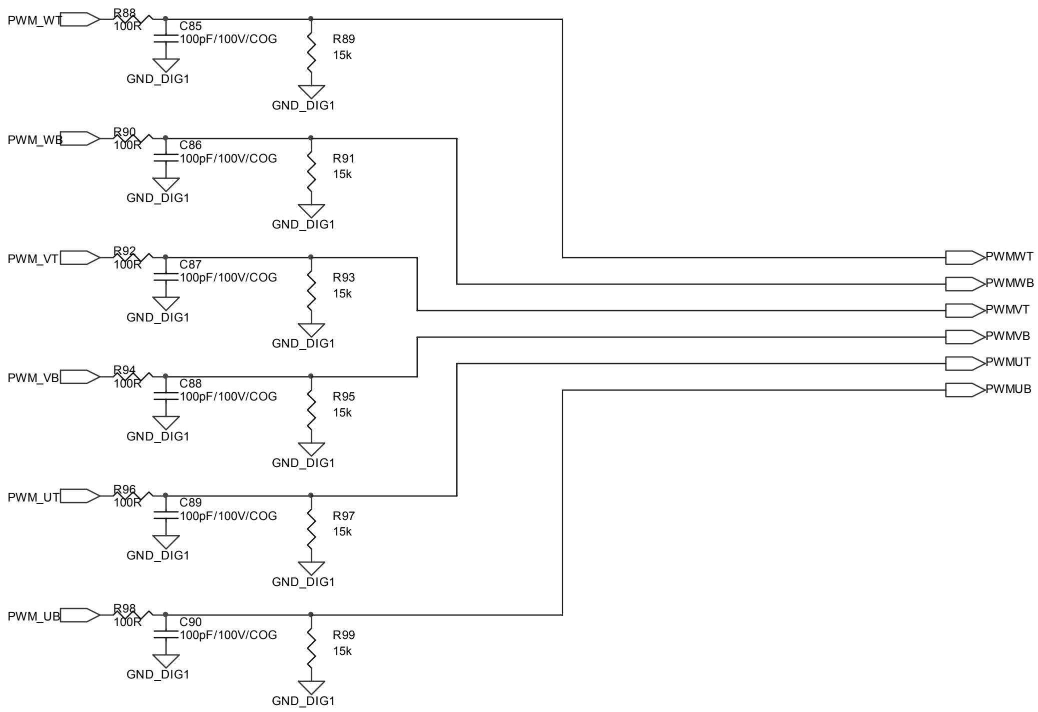


Figure 10 Schematic detail of the input logic block

3.5.3 IGBT-Switch-off behaviour

Due to the stray inductivity of the system a voltage over shoot occurs during switching-off the IGBT. Such overvoltage is added to the DC-link voltage, so that the maximum blocking voltage of the IGBT or capacitor might be exceeded causing damages in both components. In order to avoid such risks an active clamping circuit is used (see chapter 3.5.6).

Without such protective methods the maximum current would be limited by the DC-Link voltage and the overshoot at switching off. The overshoot can be minimised by increasing the gate resistor, which will reduce the di/dt value. Figure 11 shows the maximal switch-off current at different DC-link voltages for different values of the gate resistor. These results were obtained with the DC-link capacitor described in chapter 2.2.5

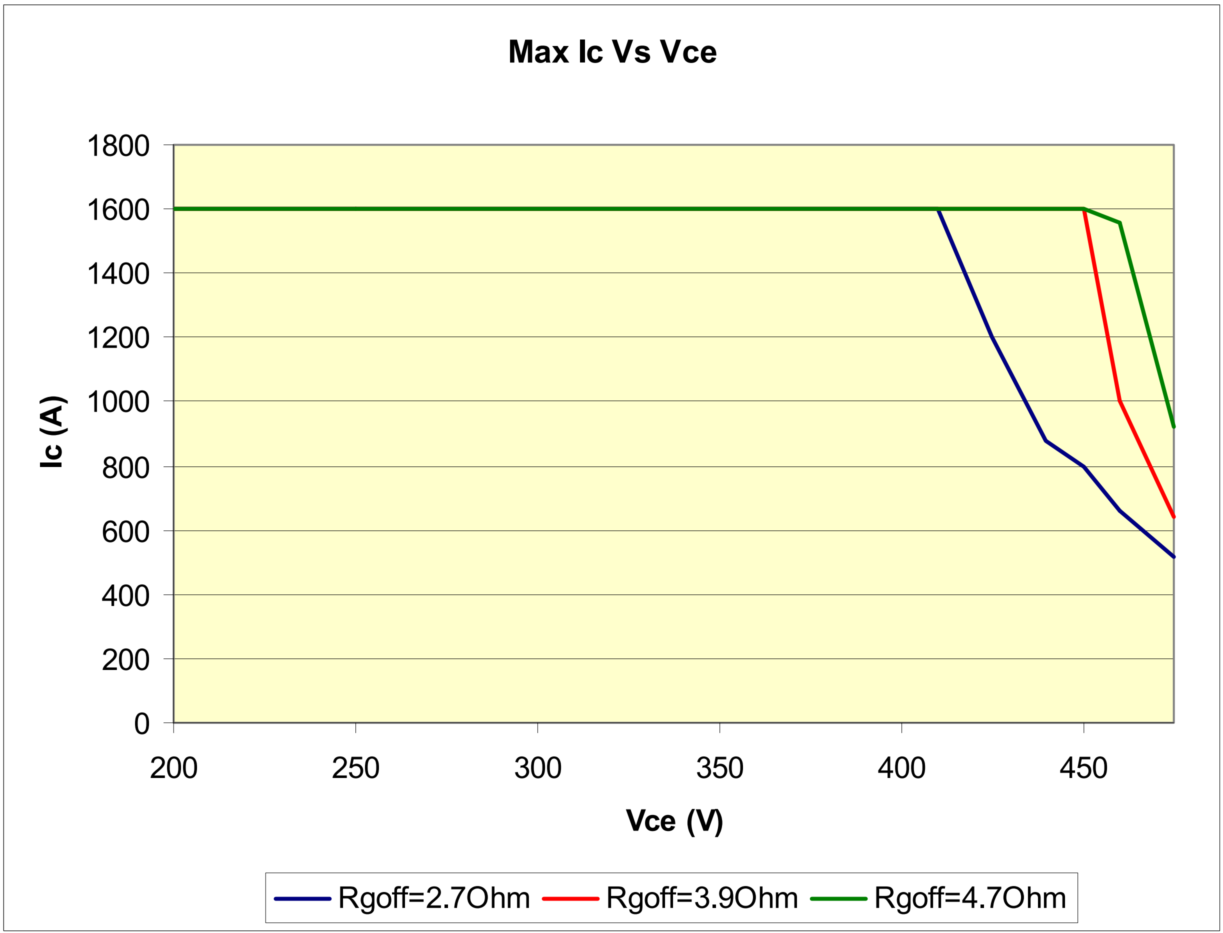


Figure 11 Maximal switch-off current at different DC-Link voltages

3.5.4 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):

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

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, $Q_{ge} = 6.6\mu C$. Therefore the maximum frequency limited by the available power will be:

$$f_{s\max} = 4.6W/(23V \cdot 6.6\mu C) = 30.3KHz$$

Figure 12 shows experimentally determined board temperature dependencies with switching frequency (at 26°C ambient temperature). From Figure 12 it can be concluded that the maximum switching frequency is limited by PCB temperature.

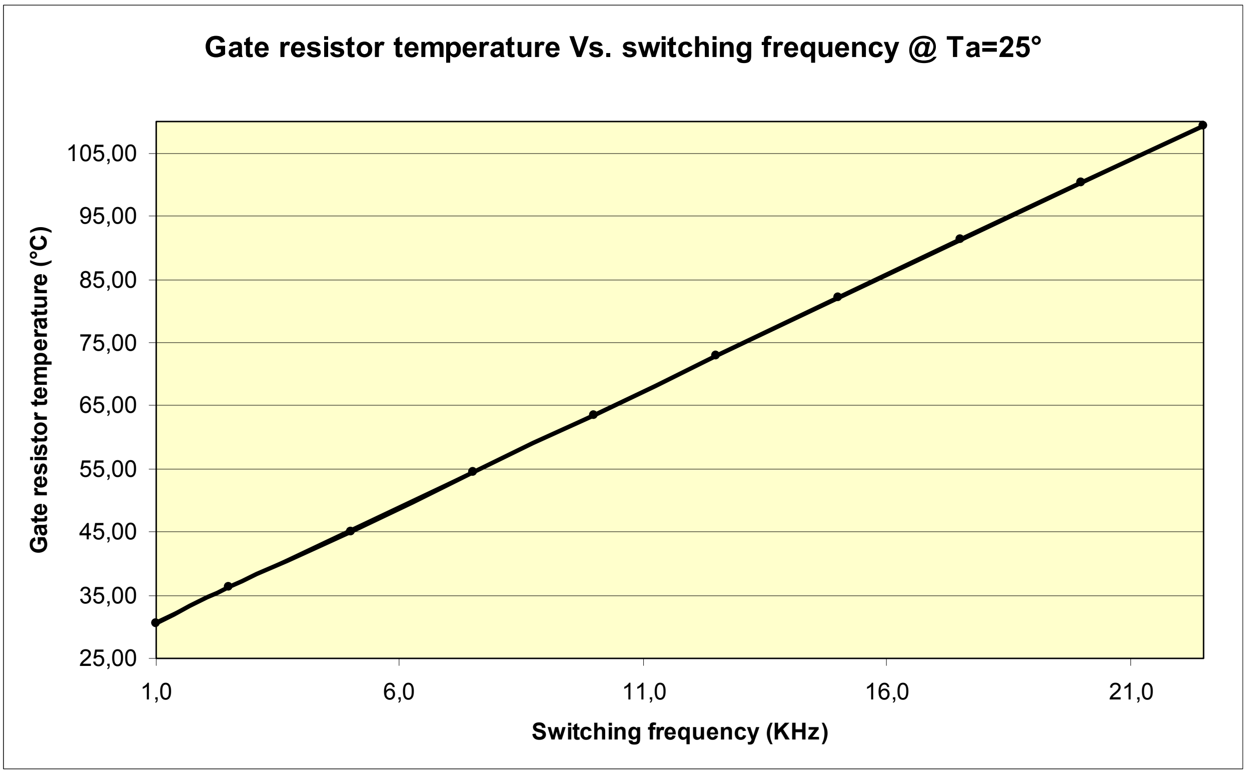


Figure 12 Temperature of gate resistors vs. switching frequency.

3.5.5 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 HybridPack2™ modules. Peak current can be calculated like in formula (2):

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

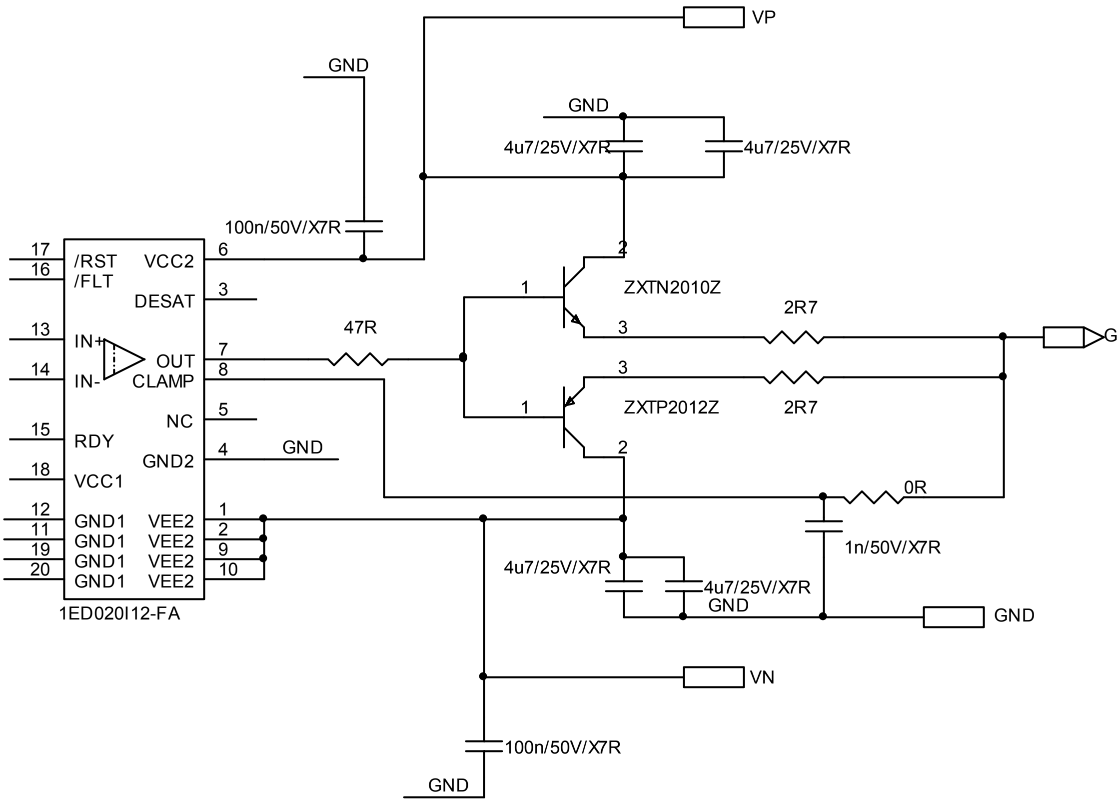


Figure 13 Booster

3.5.6 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 14 shows the parts of the circuit needed for the desaturation function and the active clamping function.

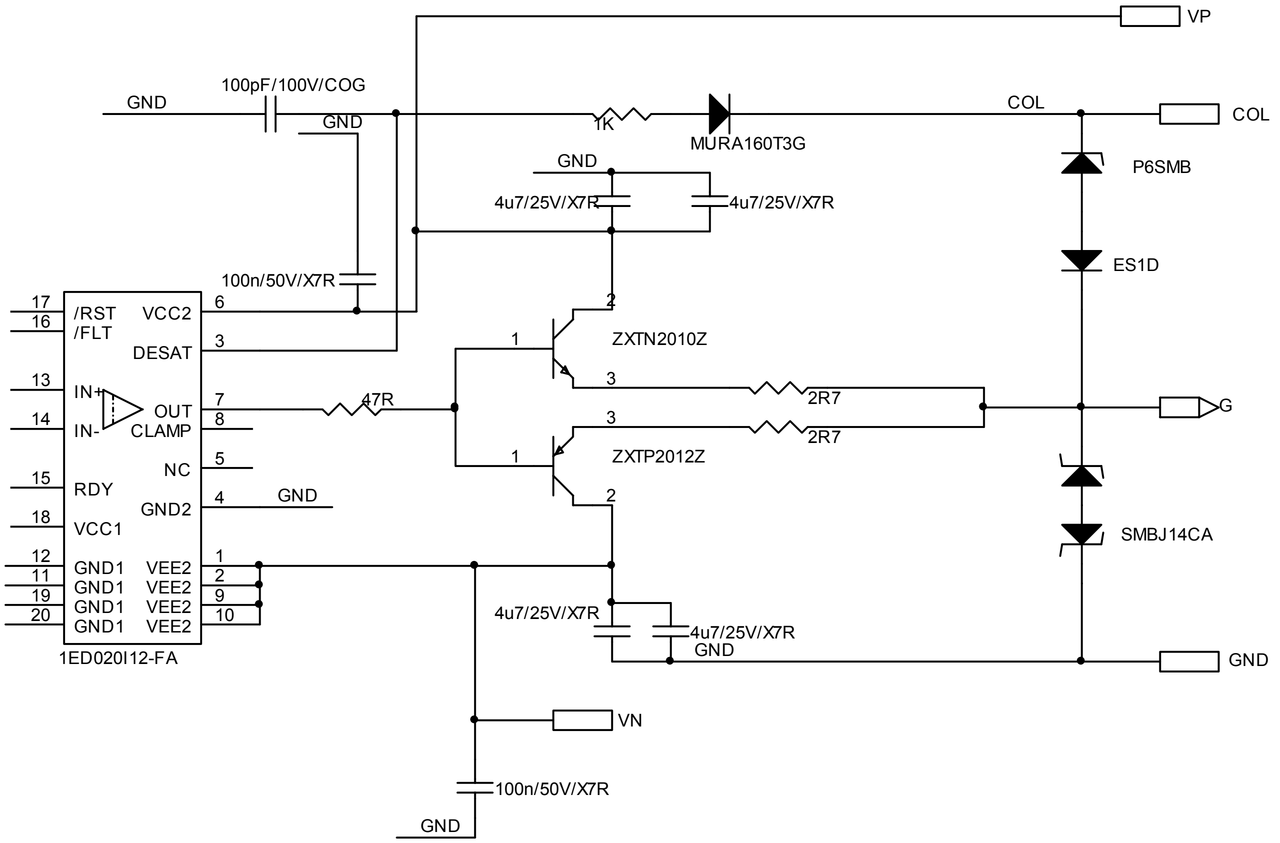
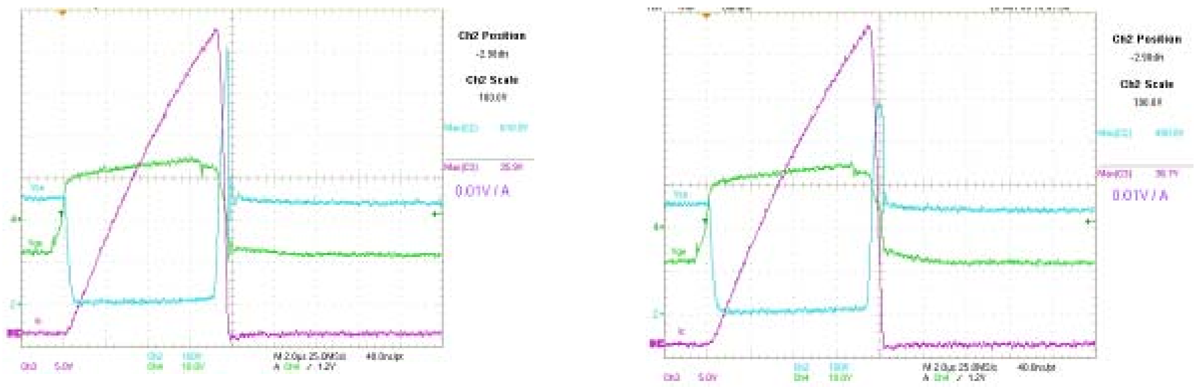


Figure 14 Desaturation protection and active clamping diodes

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 HybridPack2™module without any additional function is shown in Figure 15a.Typical waveform under short circuit condition with active clamp function is shown in Figure 15b at room temperature. As it can be seen the overvoltage without active clamping at a DC voltage of 250V is above the maximum IGBT blocking voltage at the HybridPack2™ (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 440V clamping diodes. The level of the clamping voltage must be adjusted depending on the application.



a) b)

Figure 15 a) Short circuit w/o active clamp (DC Voltage=250V) b) with active clamp function (DC Voltage=250V)

3.5.7 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 16.

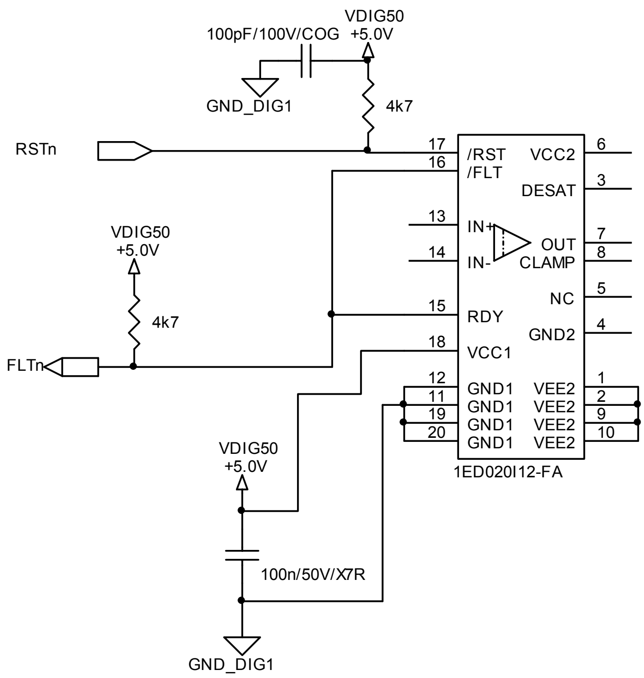


Figure 16 /Fault output for a single driver

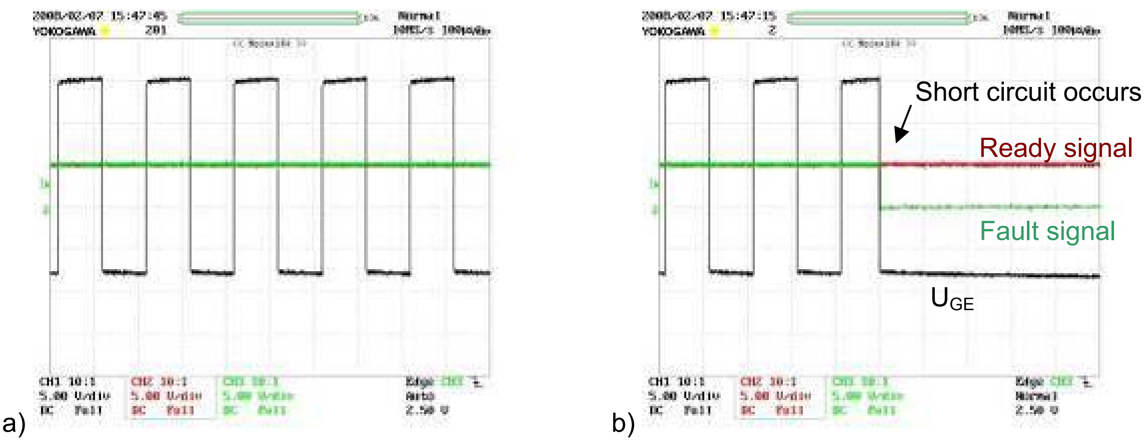


Figure 17 /Fault output during: a) normal operation b) operation under short circuit

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 18, 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).

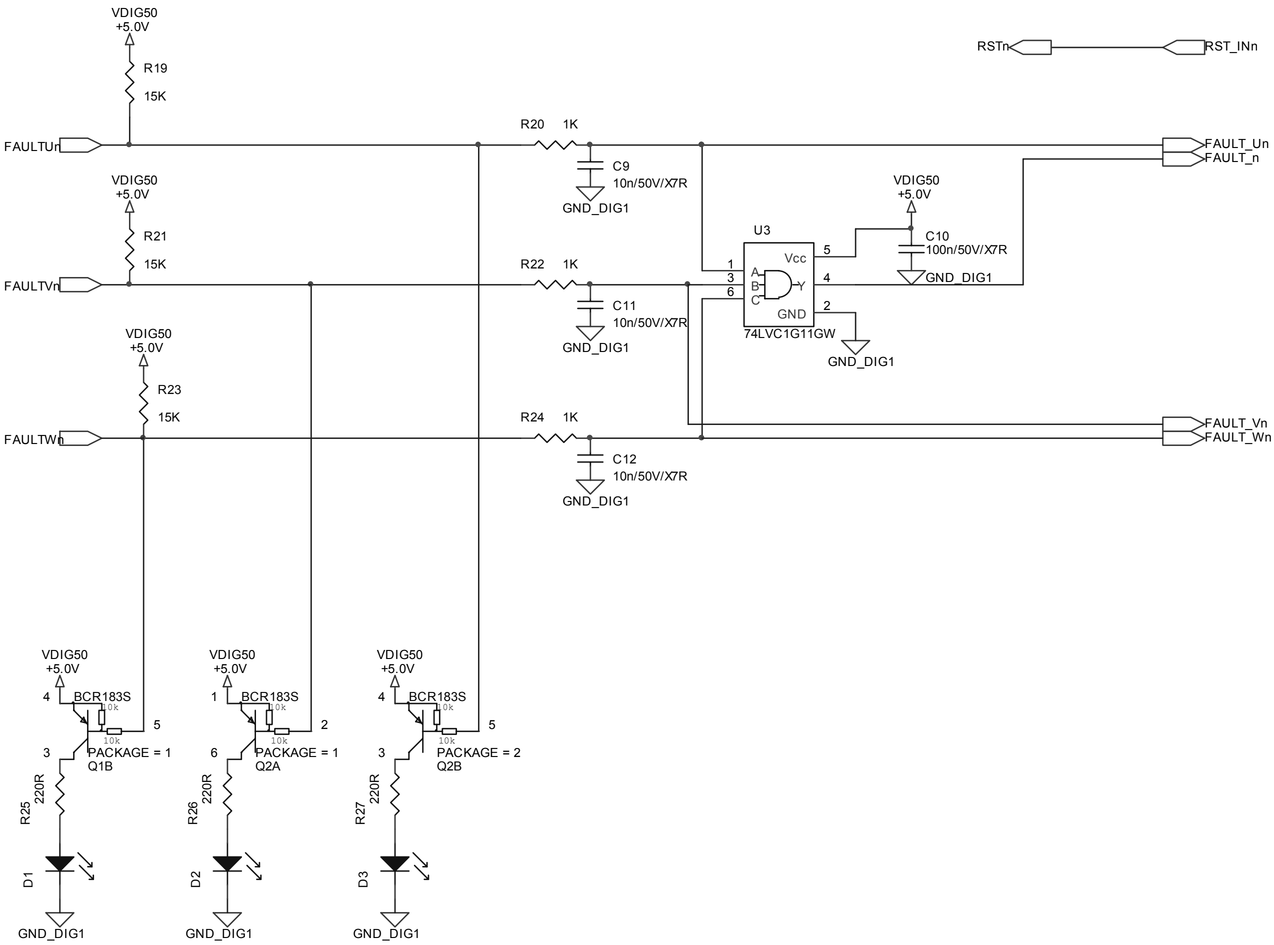


Figure 18 Schematic of the Logic Block

3.5.8 Temperature measurement

The IGBT Module HybridPack2™ includes three integrated NTC (Negative Temperature Coefficient) sensors which simplified thermal measurements in inverters significantly.

The NTCs are 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.

The NTCs are connected to the main connector K1 (pins 10, 15 and 19) by means of the circuit showed in Figure 19.

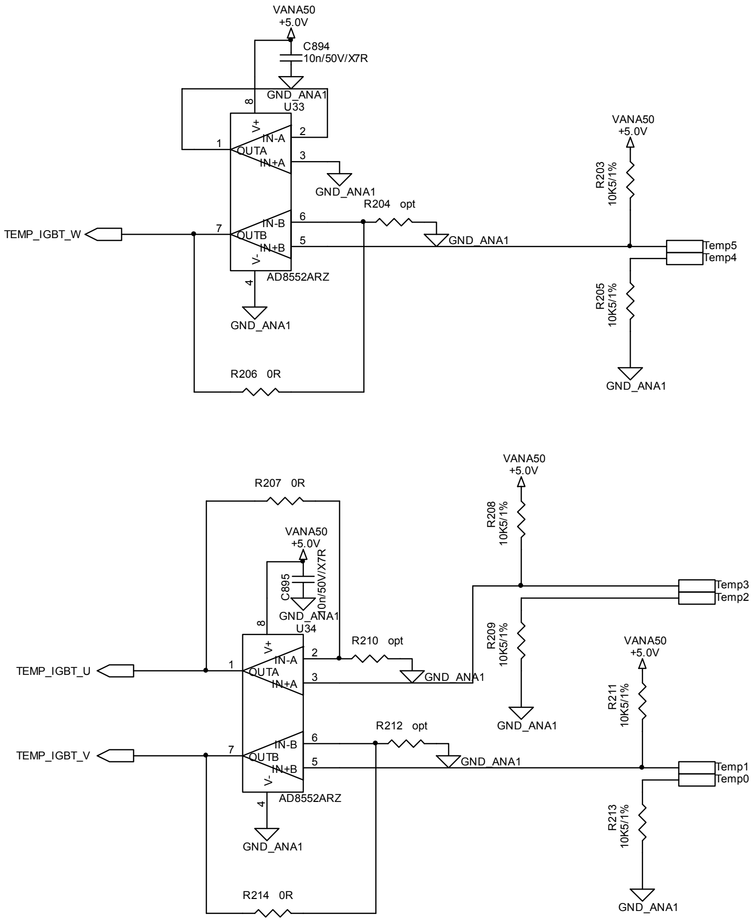


Figure 19 Interface circuit between NTCs outputs and connector K1

Figure 20 shows the relationship between IGBT baseplate Module temperature of the three phases and output voltage of IGBT Module Temperature Block (TEMP_IGBT_U/V/W, K3.10/K3.19/K3.15)

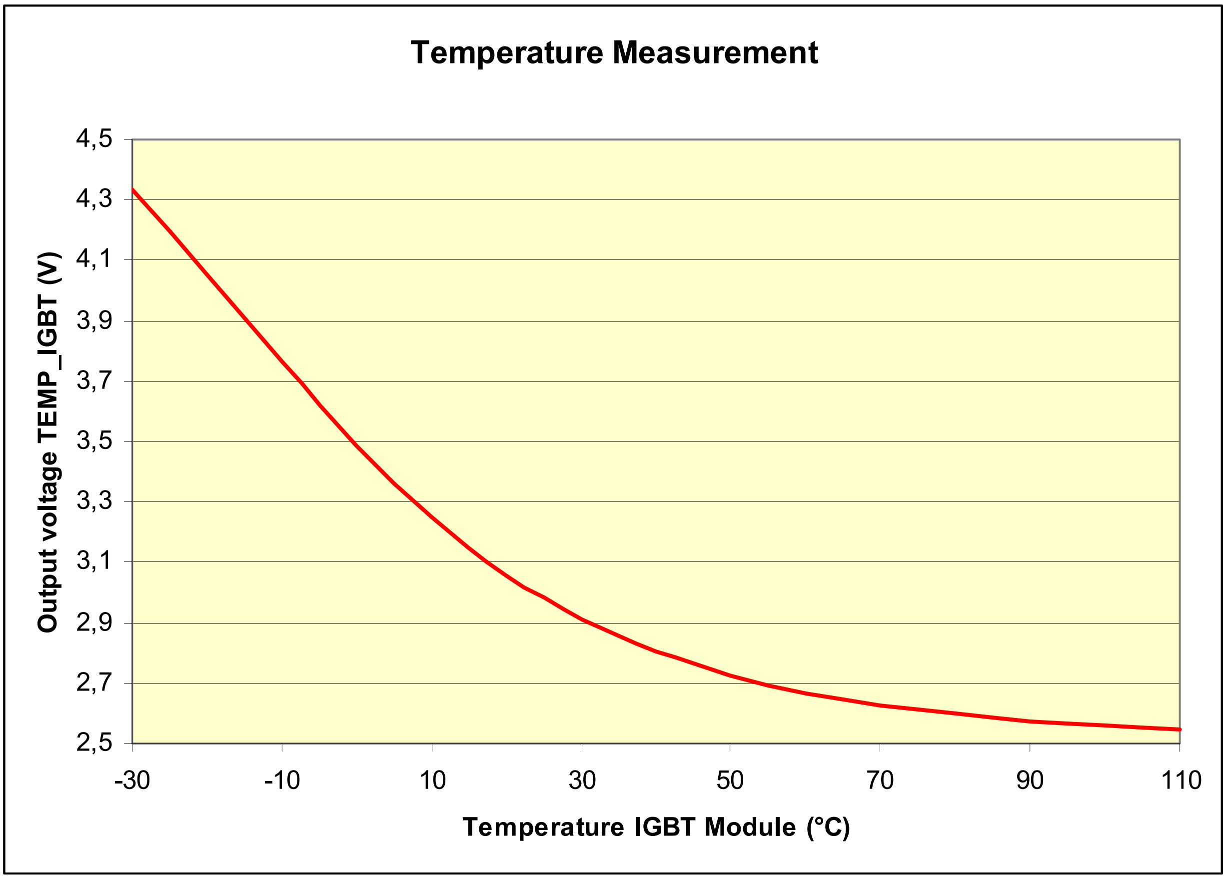


Figure 20 Characteristics of the temperature measurements

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.

3.5.9 DC voltage measurement

The voltage at the DC Link is measured on the Hybrid Kit for HybridPack2™ by means of a sigma-delta modulator which offers the necessary galvanic isolation (Figure 21).

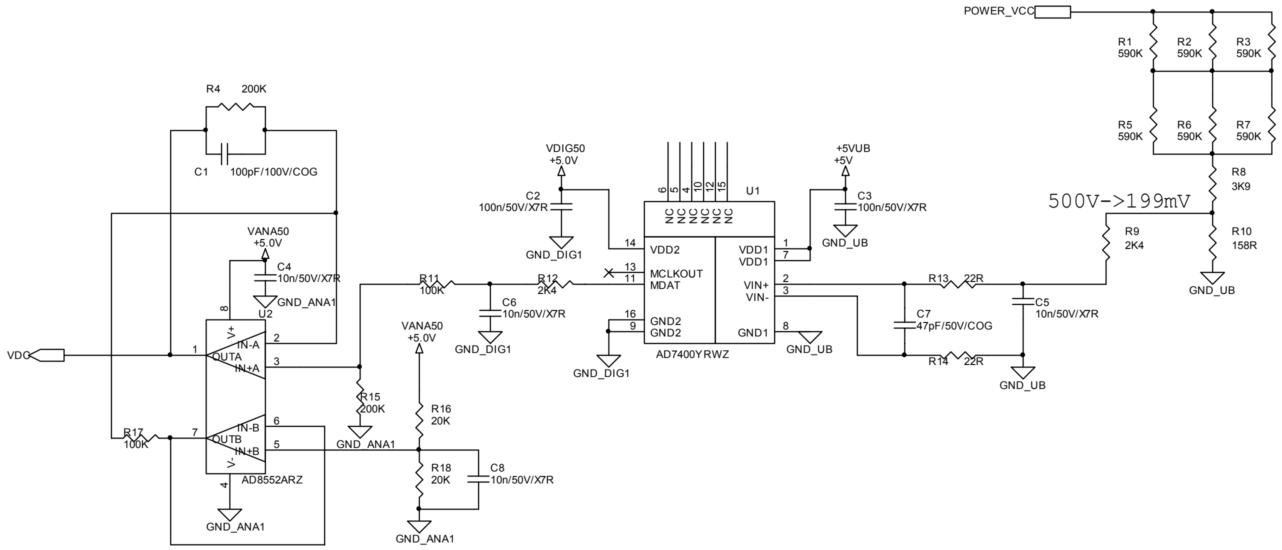


Figure 21 DC-Link voltage measurement circuit

The output of this circuit is connected to the external connector (Vdc, K3.9). Figure 22 shows the relationship between DC Link voltage and Vdc output signal.

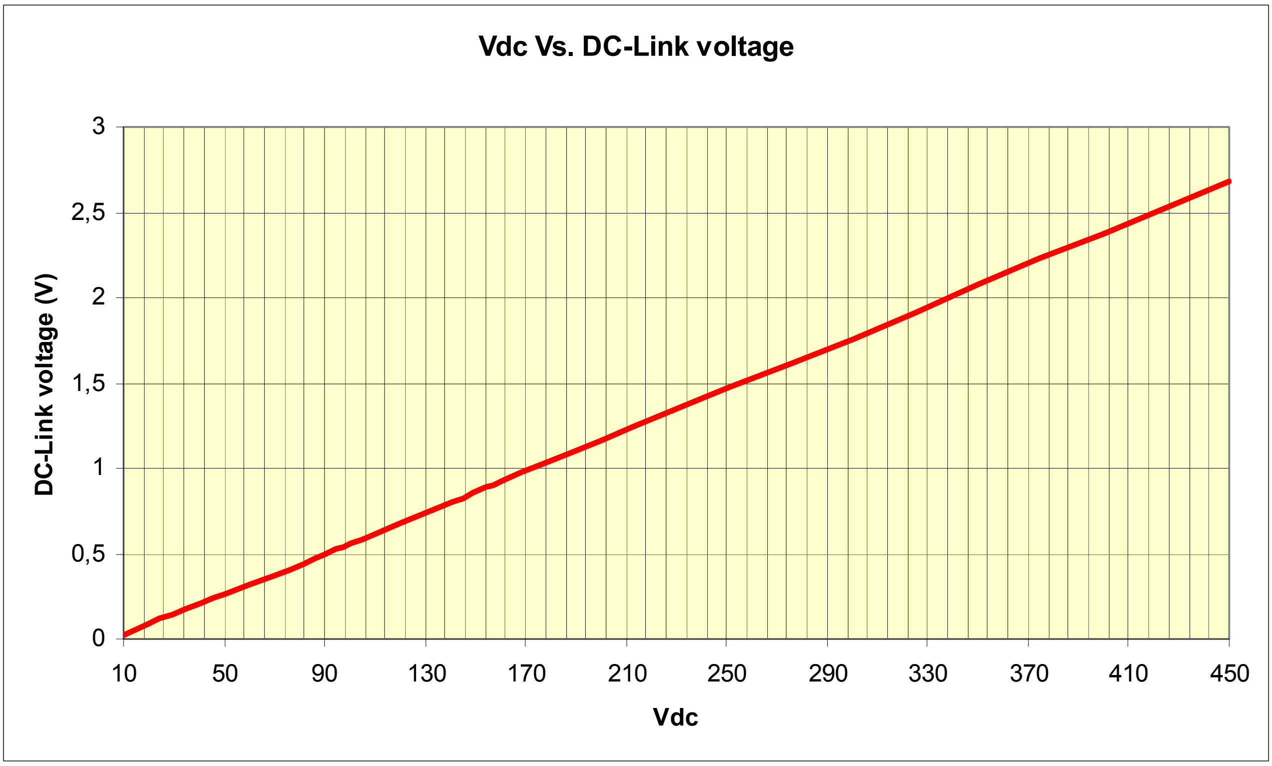


Figure 22 Characteristics of the DC voltage measurement

3.6 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 HybridPack2™ 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 HybridPack2™. 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.

3.7 Definition of layers for Evaluation Driver Boards

The Hybrid Kit for HybridPack2™ Evaluation driver board was made keeping the following rules for the copper thickness and the space between different layers shown in Figure 23.

Layers:

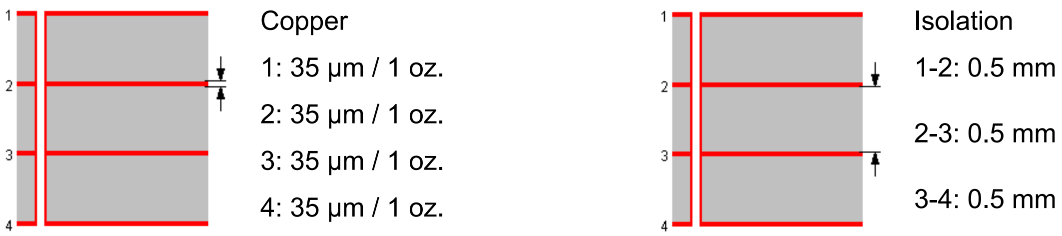


Figure 23 Copper and isolation for layers

3.8 Schematic, Layout and Bill of Material

To meet the individual customer requirements and make the Evaluation Driver Board for the HybridPack2™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 %.

3.9 Schematic

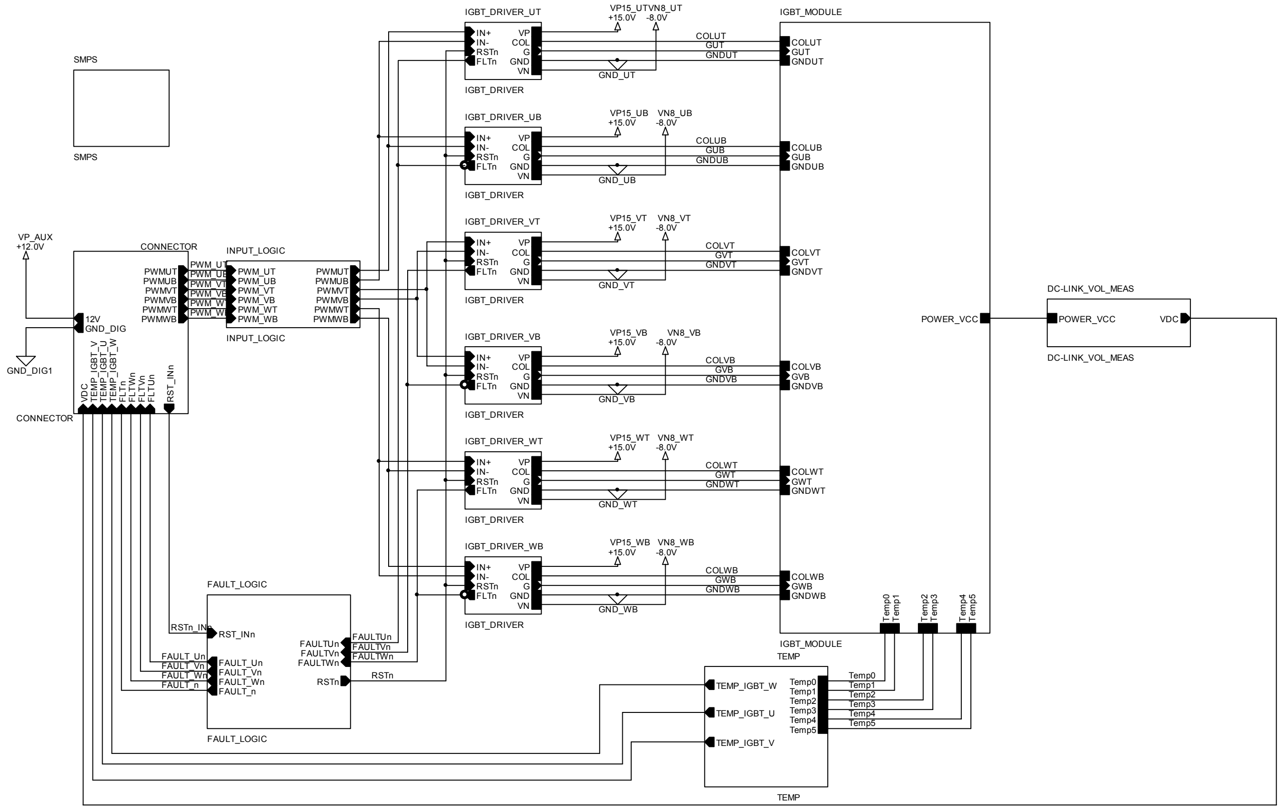


Figure 24 Schematics block overview

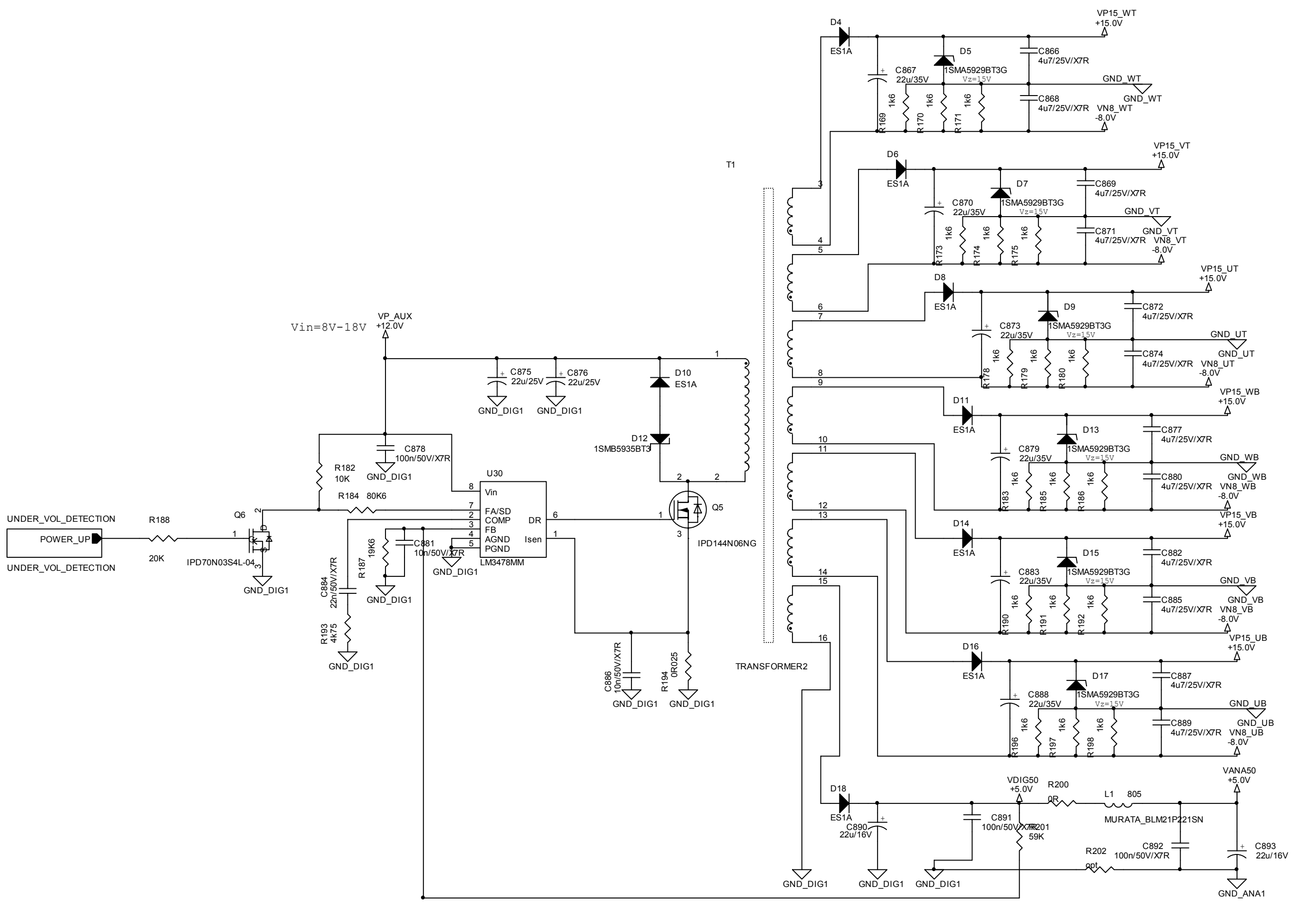


Figure 25 SMPS- Power Supply

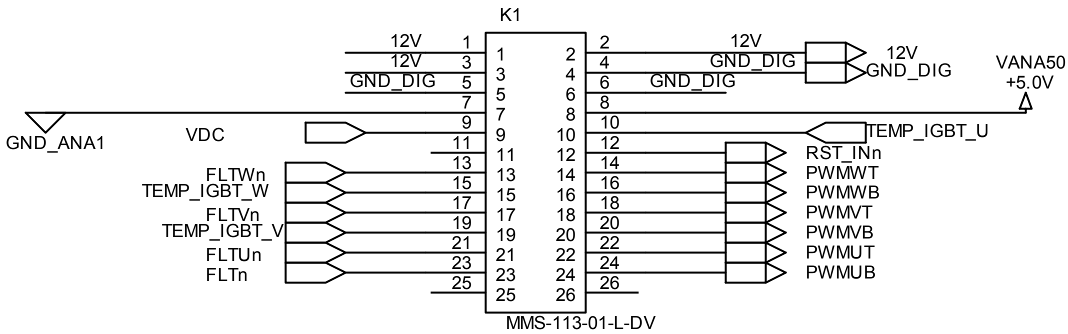


Figure 26 External connector

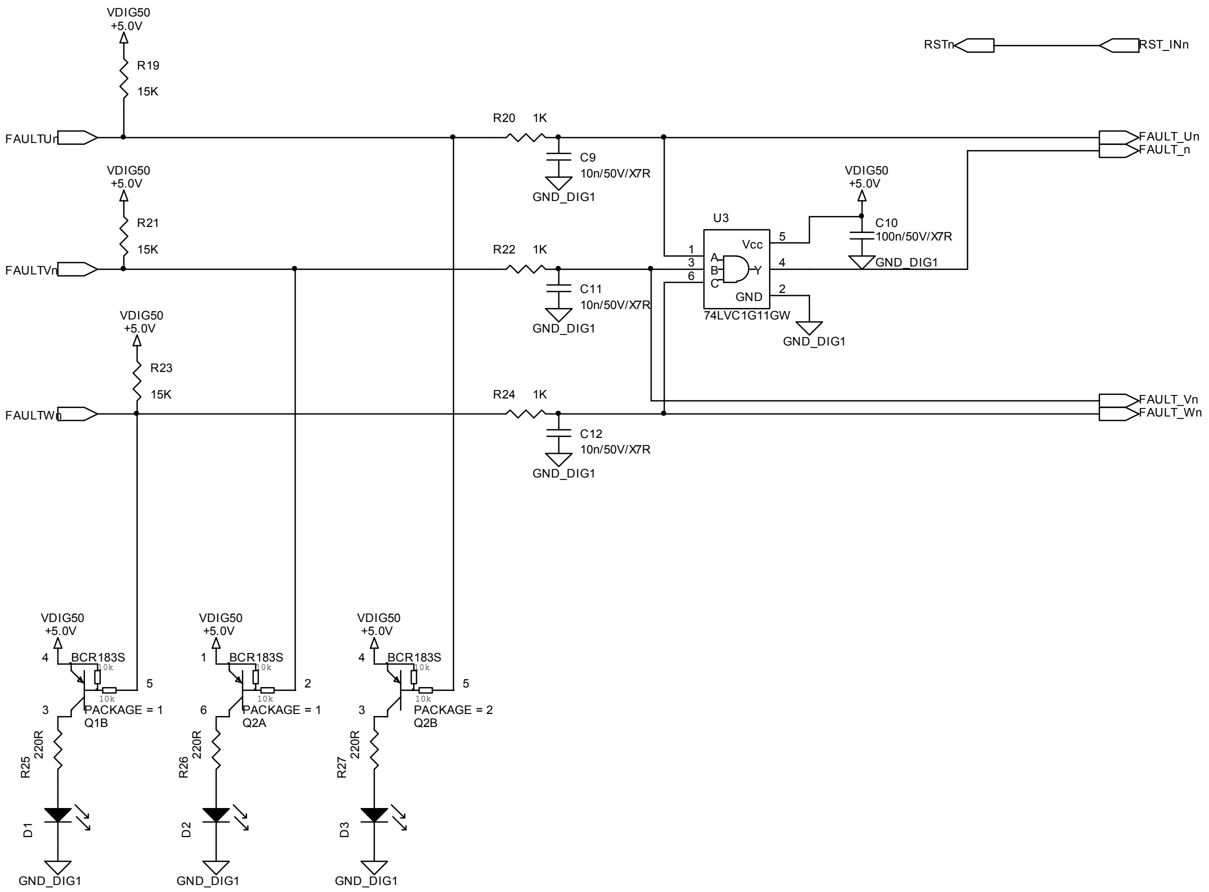


Figure 27 Fault Logic

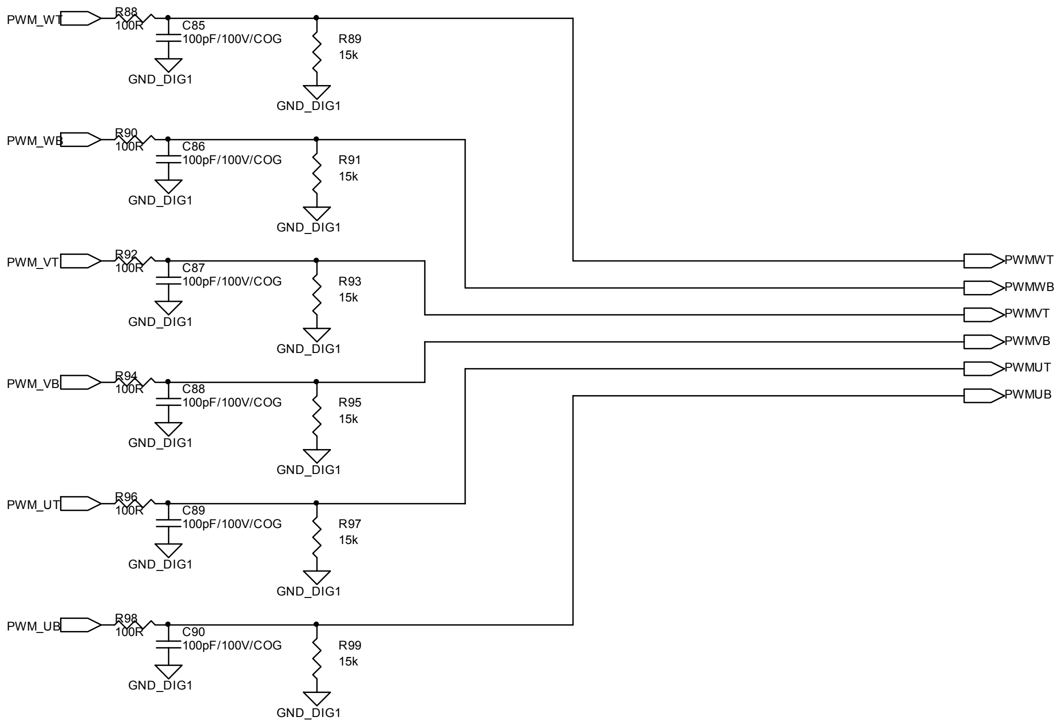


Figure 28 Input Logic

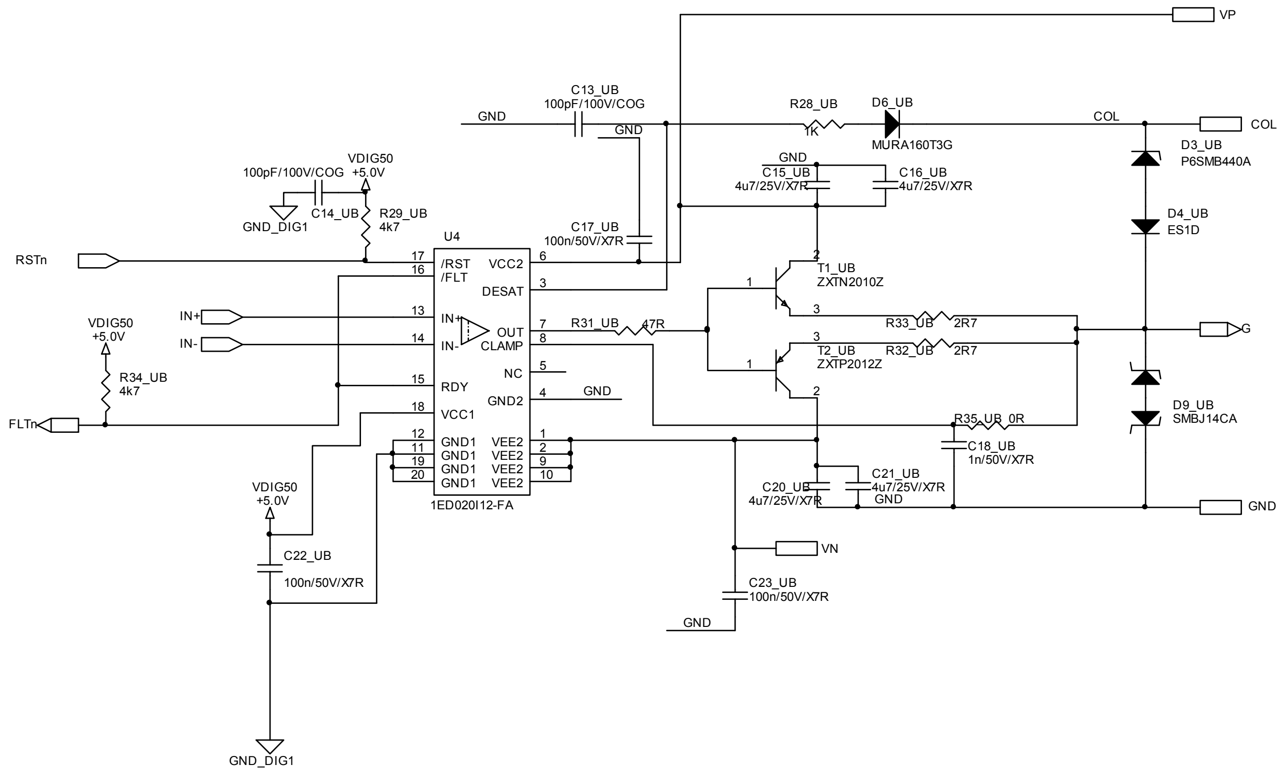


Figure 29 IGBT driver – Bottom transistor of phase U

Note: all IGBT driver blocks maintain the same structure as the one showed in Figure 29

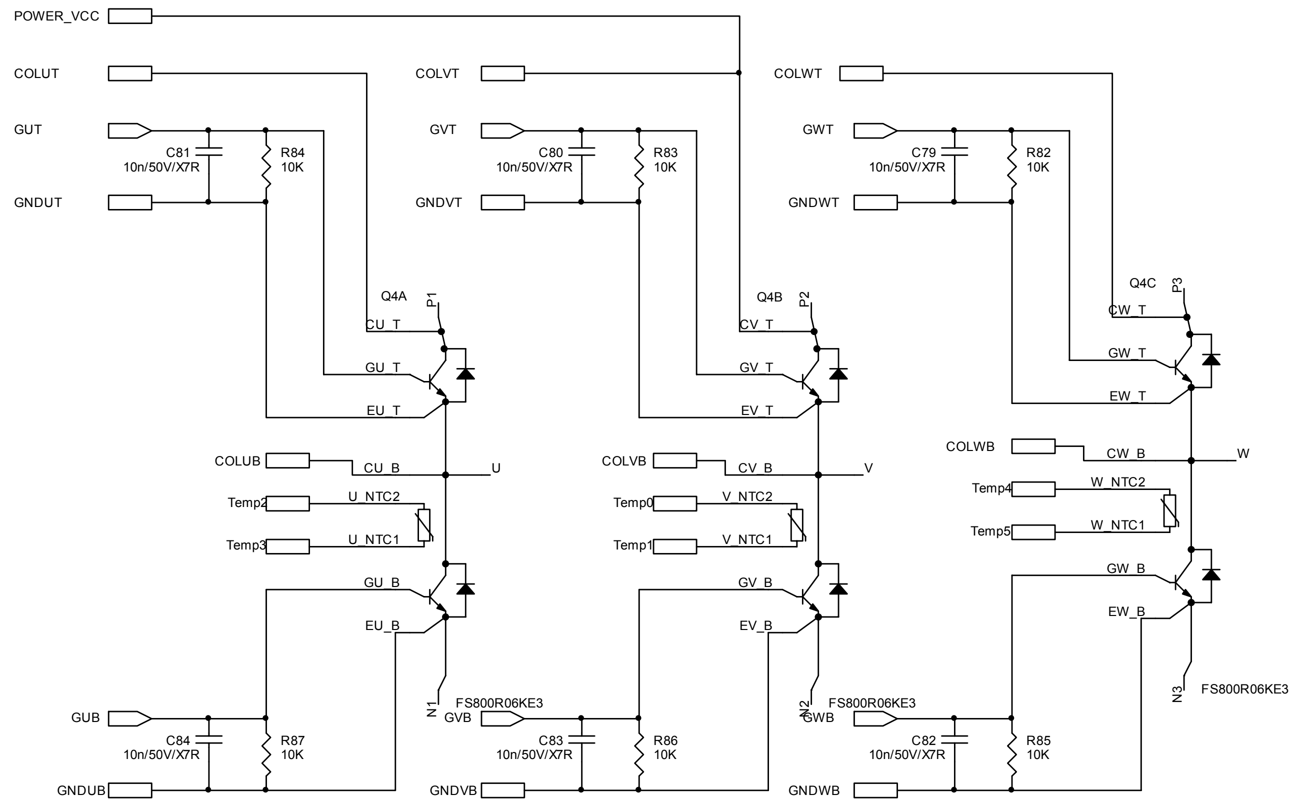


Figure 30 IGBT Module

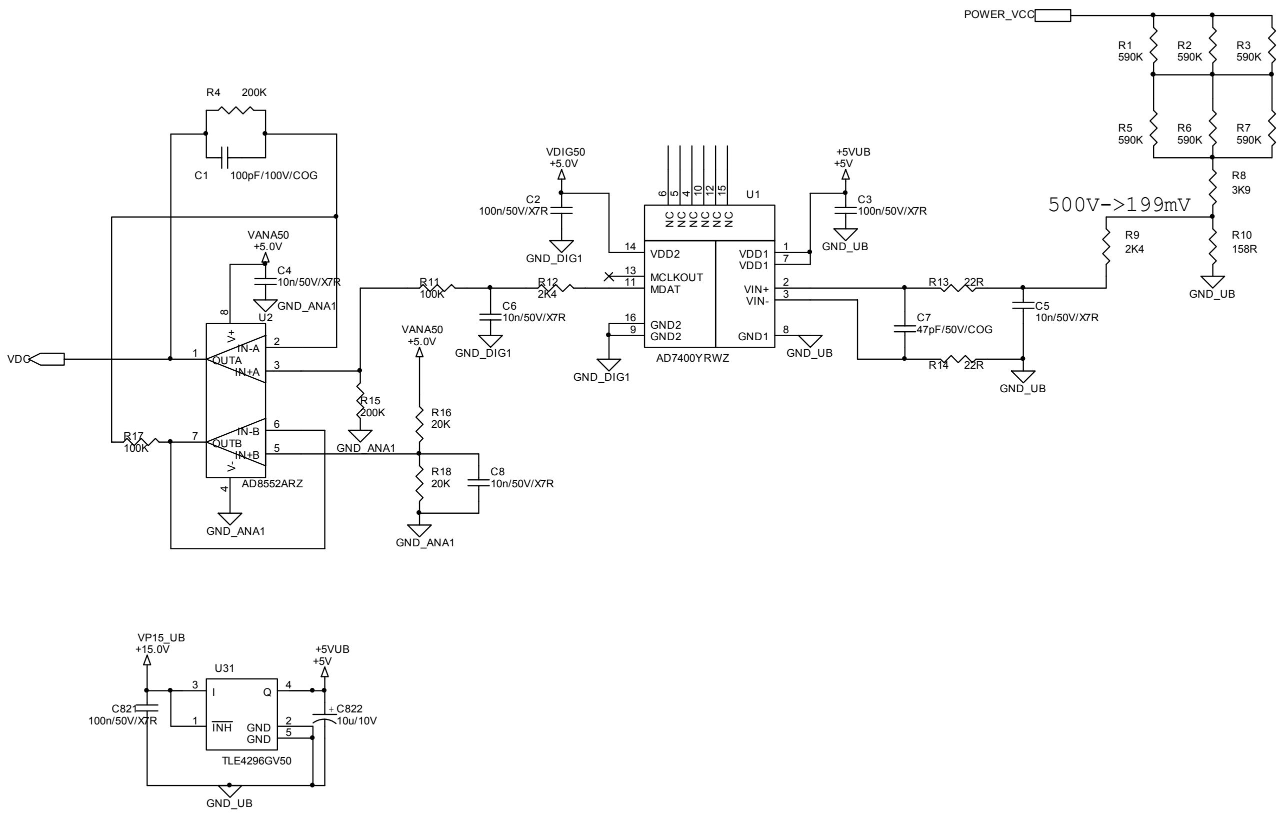


Figure 31 DC Voltage measurement

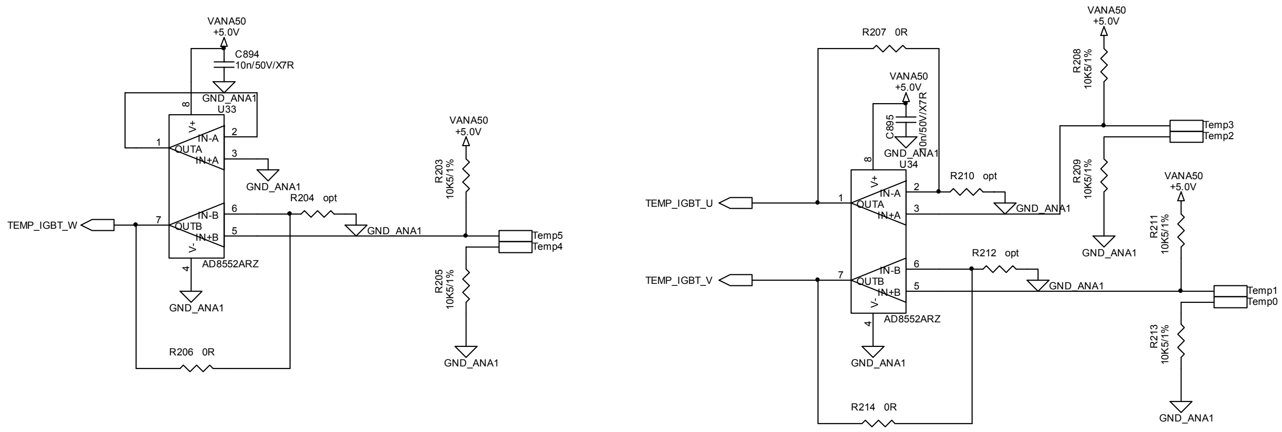


Figure 32 IGBT module temperature measurement

3.10 Assembly drawing

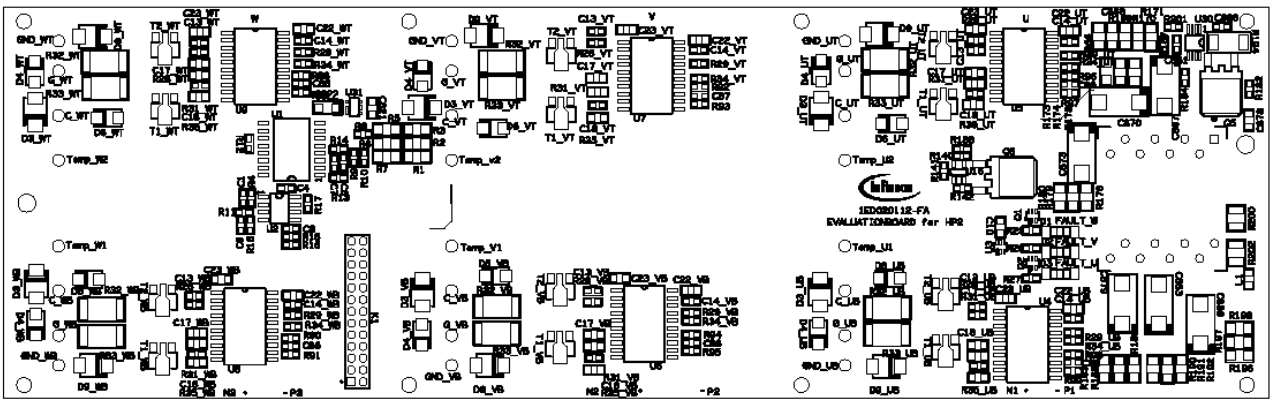


Figure 33 Assembly drawing of the HybridPack2™ driver board (top)

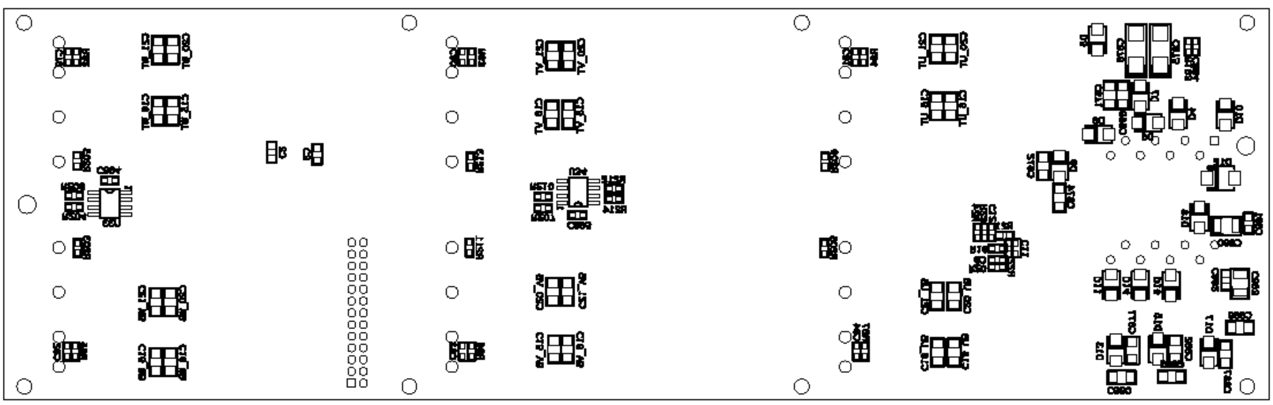


Figure 34 Assembly drawing of the HybridPack2™ driver board (bottom)

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

3.11 Layout

Layout for the HybridPack2™ driver board

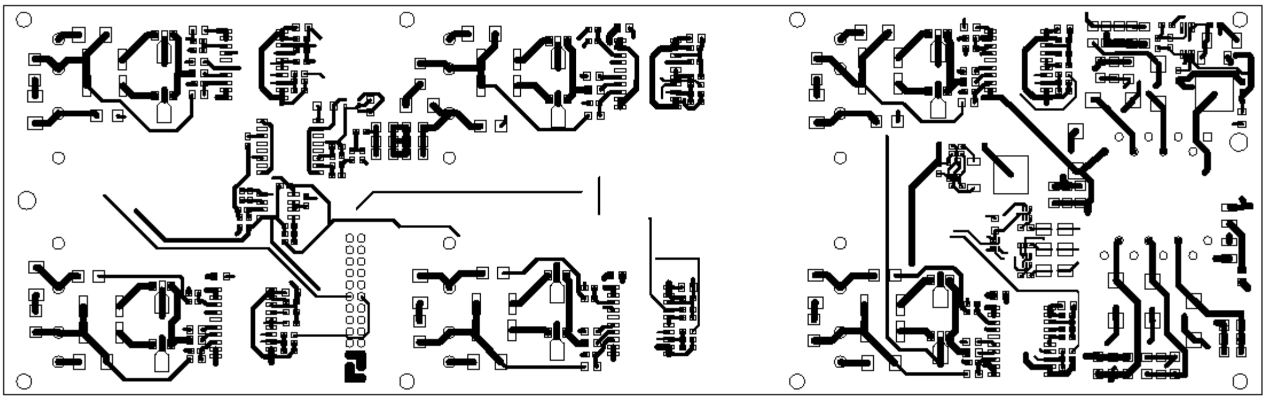


Figure 35 HybridPack2™ IGBT driver – Top layer

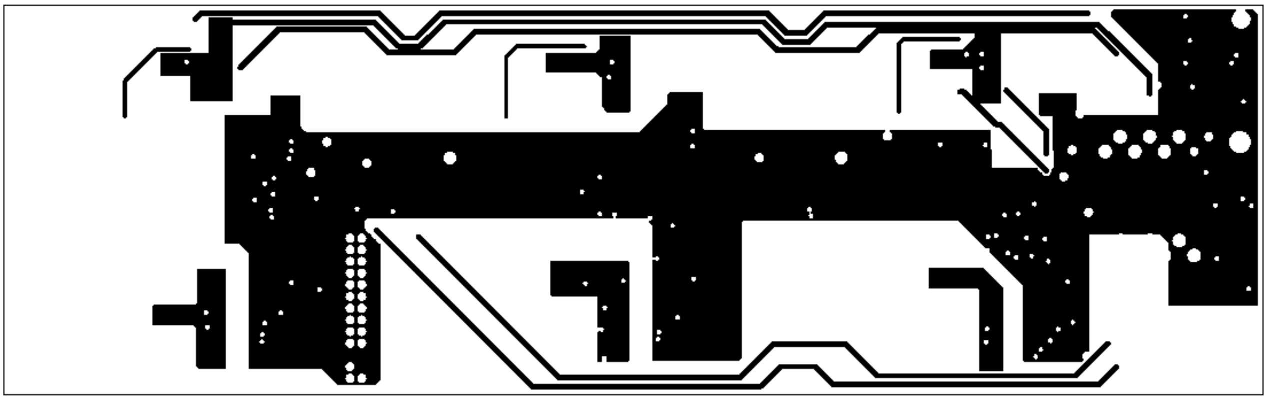


Figure 36 HybridPack2™ IGBT driver – Layer 2

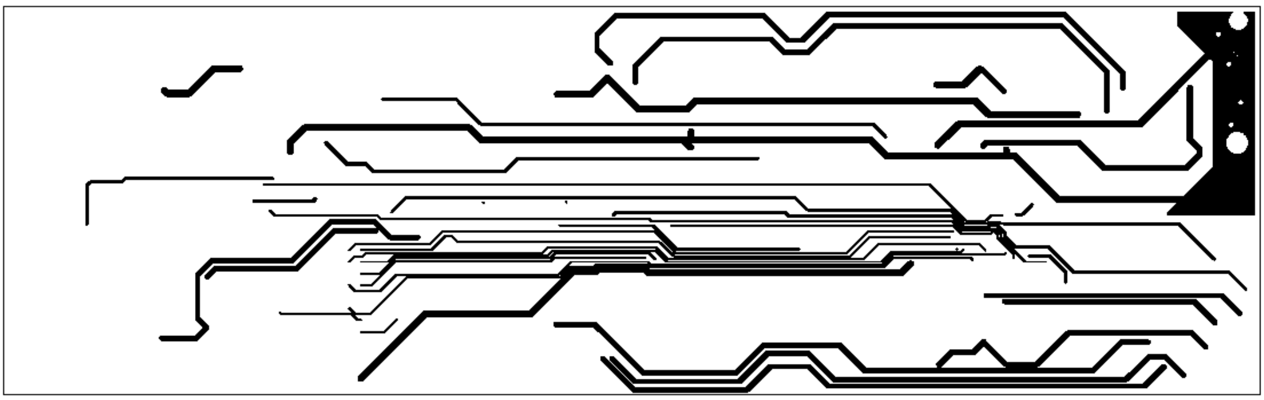


Figure 37 HybridPack2™ IGBT driver – Layer 3

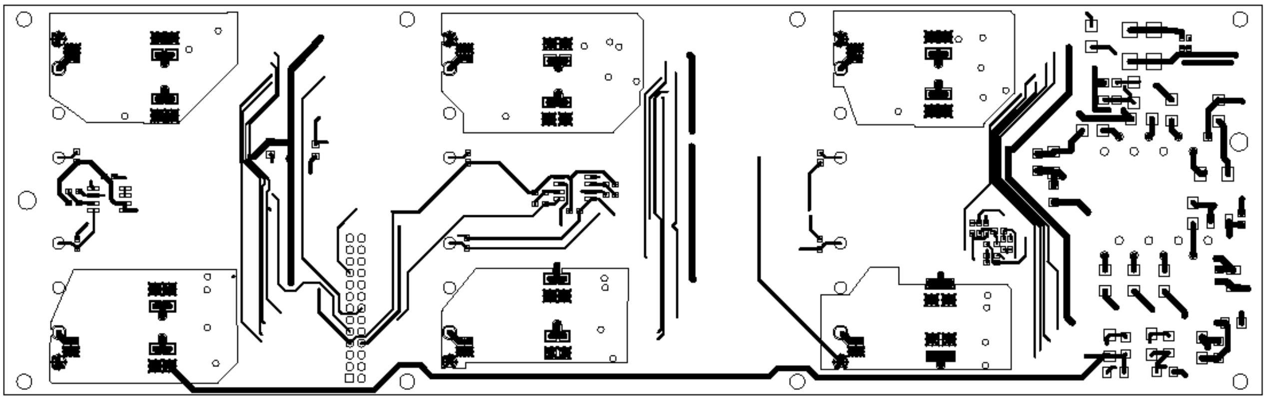


Figure 38 HybridPack2™ IGBT driver – Bottom Layer 4

3.12 Bill of material

Table 3 Bill of Material for HybridPack2™ Driver Board

Type	Reference	Value / Device	Package
Capacitor	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, C85, C86, C87, C88, C89, C90	100pF/100V/COG	C0603
Capacitor	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, C821, C878, C891, C892	100n/50V/X7R	C0805
Capacitor	C4, C5, C6, C8, C9, C11, C12, C79, C80, C81, C82, C83, C84, C881, C886, C894, C895	10n/50V/X7R	C0603
Capacitor	C7	47pF/50V/COG	C0603
Capacitor	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, C886 C868, C869, C871, C872, C874, C877, C880, C882, C885, C887, C889	4u7/25V/X7R	C1206
Capacitor	C18_WT, C18_WB, C18_VT, C18_VB, C18_UT, C18_UB	1n/50V/X7R	C0603
Capacitor	C870, C873, C879, C883, C888	22u/35V	D
Capacitor	C822	10u / 10V	A
Capacitor	C875, C876	22u/25V	C
Capacitor	C884	22n/50V/X7R	C0603
Capacitor	C890, C893	22u/16V	B
LED	D1, D2, D3	LED_LSM676-MQ	D0805
Rectifier Diode	D4_WT, D4_WB, D4_VT, D4_VB, D4_UT, D4_UB	ES1D	DO214AC
TVS Diode	D3_WT, D3_WB, D3_VT, D3_VB, D3_UT, D3_UB,	P6SMB440A	SMB
Diode	D6_WT, D6_WB, D6_VT, D6_VB, D6_UT, D6_UB	MURA160T3G	DO214AC
TVS Diode	D9_WT, D9_WB, D9_VT, D9_VB, D9_UT, D9_UB	SMBJ14CA	SMB
Rectifier Diode	D4, D6, D8, D10, D11, D14, D16, D18	ES1A	DO214AC
Zener Diode	D5, D7, D9, D13, D15, D17	1SMA5929BT3G	DO214AC
Zener Diode	D12	1SMB5935BT3	SMB
Connector	K1	MMS-113-01-L-DV	24POL
Inductor	L1	MURATA_BLM21P221SN	L0805

Transistor	Q1, Q2	BCR183S	SOT363
IGBT Module	Q4	FS800R06KE3	HybridPACK1™
Transistor	Q5	IPD144N06NG	TO252
Transistor	Q6	IPD70N03S4L-04	TO252
Resistor	R1, R2, R3, R5, R6, R7	590K	R1206
Resistor	R203, R205, R208, R209, R211, R213	10K5 / 1%	R0603
Resistor	R4, R15	200K	R0603
Resistor	R204, R210, R212	optional	R0603
Resistor	R184	80K6	R0603
Resistor	R8	3K9	R0603
Resistor	R9, R12	2K4	R0603
Resistor	R10	158R	R0603
Resistor	R11, R17	100K	R0603
Resistor	R13, R14	22R	R0603
Resistor	R16, R18, R188	20K	R0603
Resistor	R19, R21, R23, R89, R91, R93, R95, R97, R99	15K	R0603
Resistor	R20, R22, R24, R28_WT, R28_WB, R28_VT, R28_VB, R28_UT, R28_UB	1K	R0603
Resistor	R25, R26, R27	220R	R0603
Resistor	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	R32_WT, R32_WB, R32_VT, R32_VB, R32_UT, R32_UB, R33_WT, R33_WB, R33_VT, R33_VB, R33_UT, R33_UB	2R7	R2512
Resistor	R31_WT, R31_WB, R31_VT, R31_VB, R31_UT, R31_UB	47R	R0805
Resistor	R35_WT, R35_WB, R35_VT, R35_VB, R35_UT, R35_UB	0R	R0805
Resistor	R82, R83, R84, R85, R86, R87, R182	10K	R0603
Resistor	R88, R90, R92, R94, R96, R98	100R	R0603
Resistor	R169, R170, R171, R173, R174, R175, R178, R179, R180, R183, R185, R186, R190, R191, R192, R196, R197, R198	1k6	R1206
Resistor	R187	19K6	R0603
Resistor	R193	4k75	R0603
Resistor	R200	0R	R1210
Resistor	R202	optional	R1210
Resistor	R194	0R025	R2010
Resistor	R201	59K	R0603
Resistor	R140	226K	R0603
Resistor	R141	5K1	R0603
Resistor	R142	47K	R0603
Resistor	R206, R207, R214	0R	R0603
Transistor	T1_WT,T1_WB, T1_VT, T1_VB, T1_UT, T1_UB	ZXTN2010Z	SOT89
Transistor	T2_WT, T2_WB, T2_VT, T2_VB, T2_UT, T2_UB	ZXTP2012Z	SOT89
Transformer	T1	TRANSFORMER	
σ–Δ Modulator	U1	AD7400YRWZ	SO-16
Op. Amplifier	U2, U33, U34	AD8552ARZ	SO-08
AND Gate	U3	74LVC1G11GW	SOT363
Driver IC	U4, U5, U6, U7, U8, U9	1ED020I12-FA	PG-DSO-20
Swit. Regulator	U30	LM3478MM	MSOP-08
Voltage Regulator	U31	TLE4296GV50	SCT595
Voltage Monitor	U16	MAX6457UKD3A-T	SOT23

4 Adapter Board

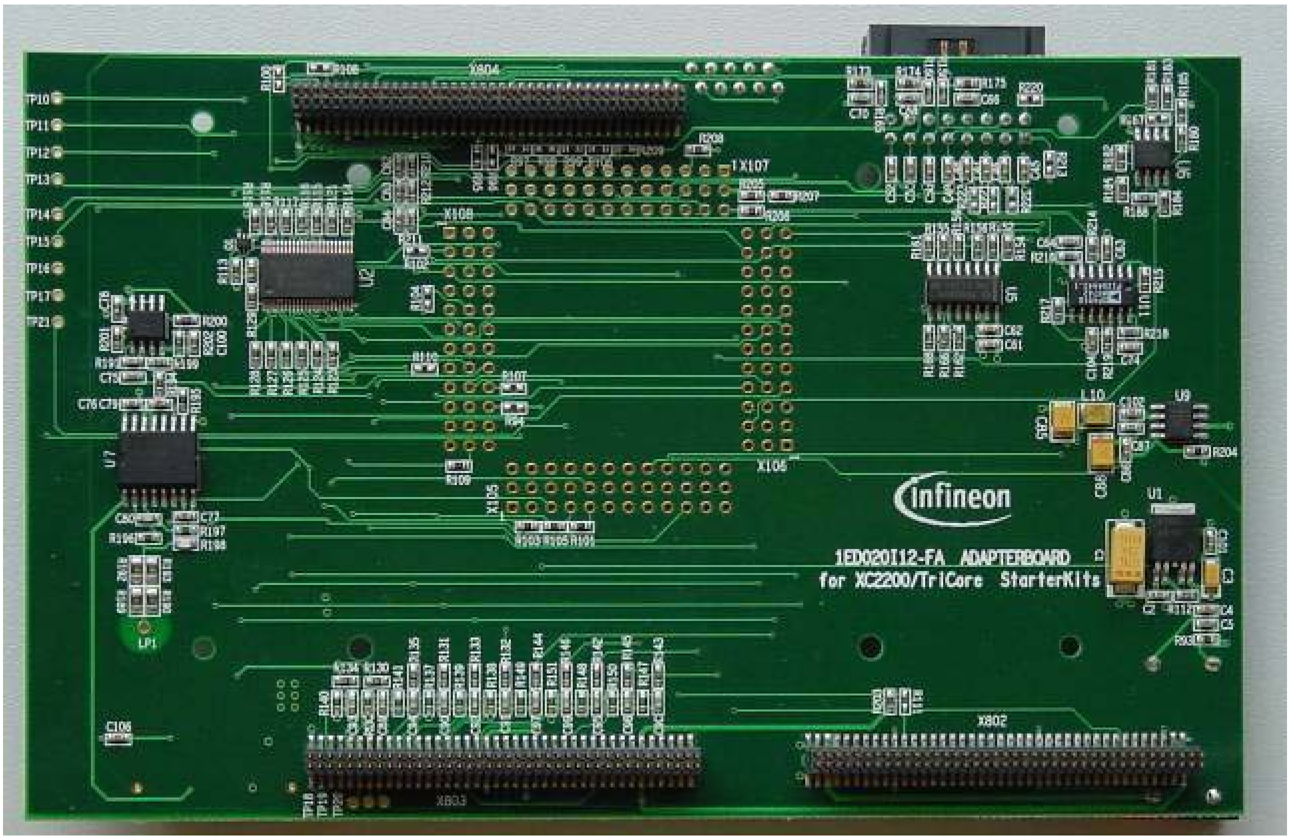


Figure 39 Adapter Board

The adapter board (Figure 39) offers the interface between the Hybrid Kit for HybridPack2™ Driver Board and the Microcontroller StarterKit (TriCore or XC2200) which can be used as “Logic Board” in a complete Inverter/DC-DC System. Furthermore it offers the connections to the motor positioning system (encoder, resolver or GMR) and to the current measurement system (i.e LEM sensors). Figure 40 shows the block structure of the Adapter Board and the following chapters describe these blocks in detail.

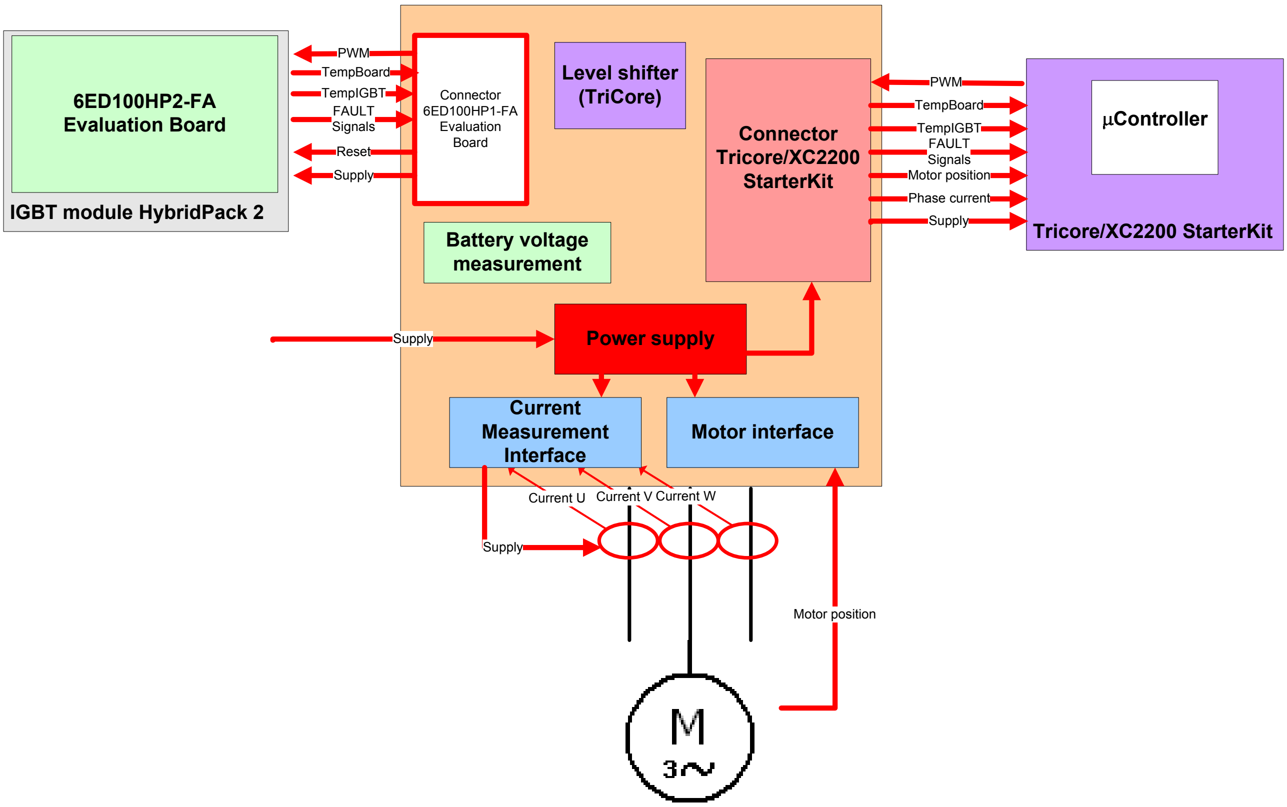


Figure 40 Block diagram of the Adapter Board

4.1 Power supply

The complete system (6ED100HP2-FA driver board, adapter board and StarterKit) must to be supplied with and external regulated DC power supply connected to J1 (12V) and J2 (GND) on the adapter board. The input voltage should be kept between 7V and 18V and the current consumption will vary depending on different factors, i.e PWM frequency.

This line will be forwarded to the 6ED100HP2-FA through the connector K1_HP2 and to the TriCore StarterKit through X802 in order to supply both boards. Furthermore, the necessary 5V to supply the XC2200 StarterKit are generated on the Adapter board.

4.2 Connector 6ED100HP2-FA Evaluation Board

See chapter 3.3

4.3 Current measurement interface

Connector K1 provides the interface to the 3-phases current measurement system (i.e. LEM sensors). Figure 41 shows the pin assignment.

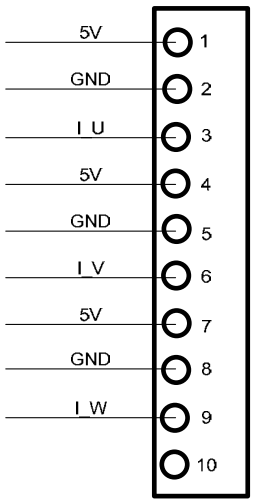


Figure 41 Connector interface to current measurement system

Pin 1, 4, and 7 provide a 5V supply and the 3-phases current measurements are connected to the pins 3, 6 and 9. The voltage input range for the current measurement signals (pins 3, 6 and 9) is from 0 to 5V.

4.4 Motor interface

Connector K2 (figure Figure 42) offers the interface to the motor positioning system.

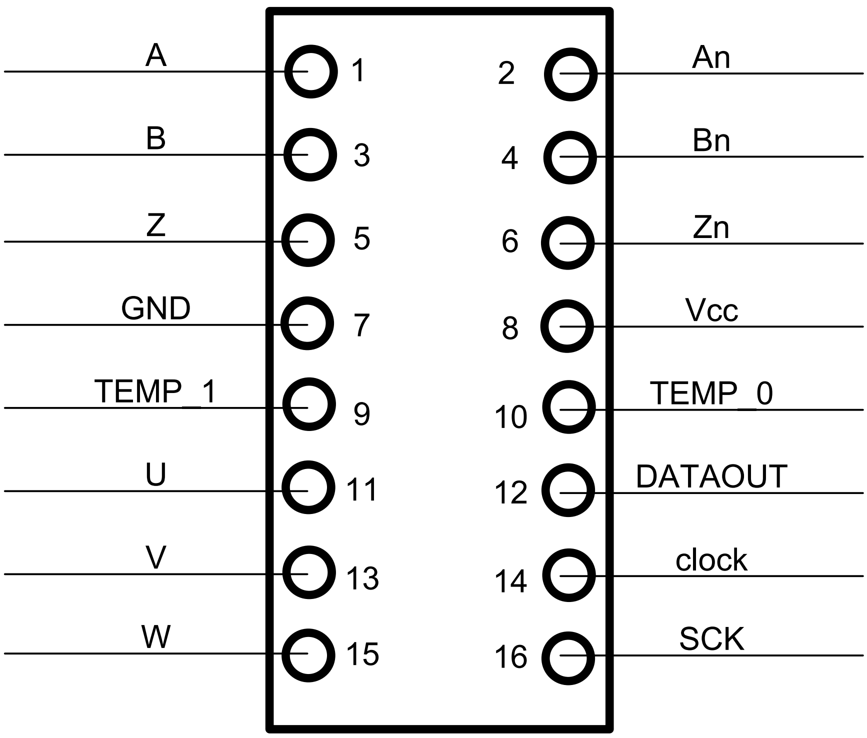


Figure 42 Connector interface to motor positioning system

Different motor positioning system can be used:

Encoder: Pins 1 to 8 and 11, 13 and 15 are reserved for encoder motor interfaces. Please refer to chapter 4.6.1 for more details on the circuits for these signals

<u>Resolver:</u> Pins 2 to 5 are reserved for resolver motor interfaces. In case of using a resolver optional resistor R228, R229, R230, R231, R232, R242, R243, R244 and R245 must be populated and resistors R152, R154, R155, R161, R166, R168, R156, R159 and R162 must be removed.

The adapter board includes a 12-Bit Resolver-to-Digital converter (AD2S1200) for digitizing resolver signals with on-board programmable sinusoidal oscillator.

Please refer to chapter 4.6.1 for more details on the circuits for these signals.

<u>GMR (Giant Magneto Resistance) sensor:</u> The Adapter Board offers the possibility of using a GMR sensor as motor positioning system. Pins 1, 12, 14 and 16 are dedicated for such an interface. Optional resistor R213 must be populated and R152 must me removed. Please refer to chapter 4.6.1 for more details on the circuits for these signals.

4.5 Definition of layers for Adapter Board

The Adapter board was made keeping the following rules for the copper thickness and the space between different layers shown in Figure 43.

Layers:

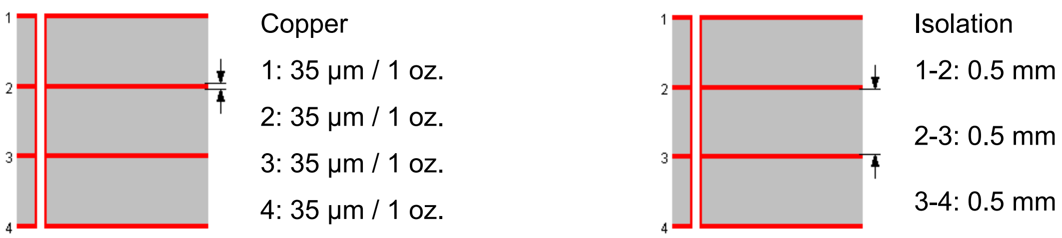


Figure 43 Copper and isolation for layers

4.6 Schematics, layout and bill of materials

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

4.6.1 Schematic

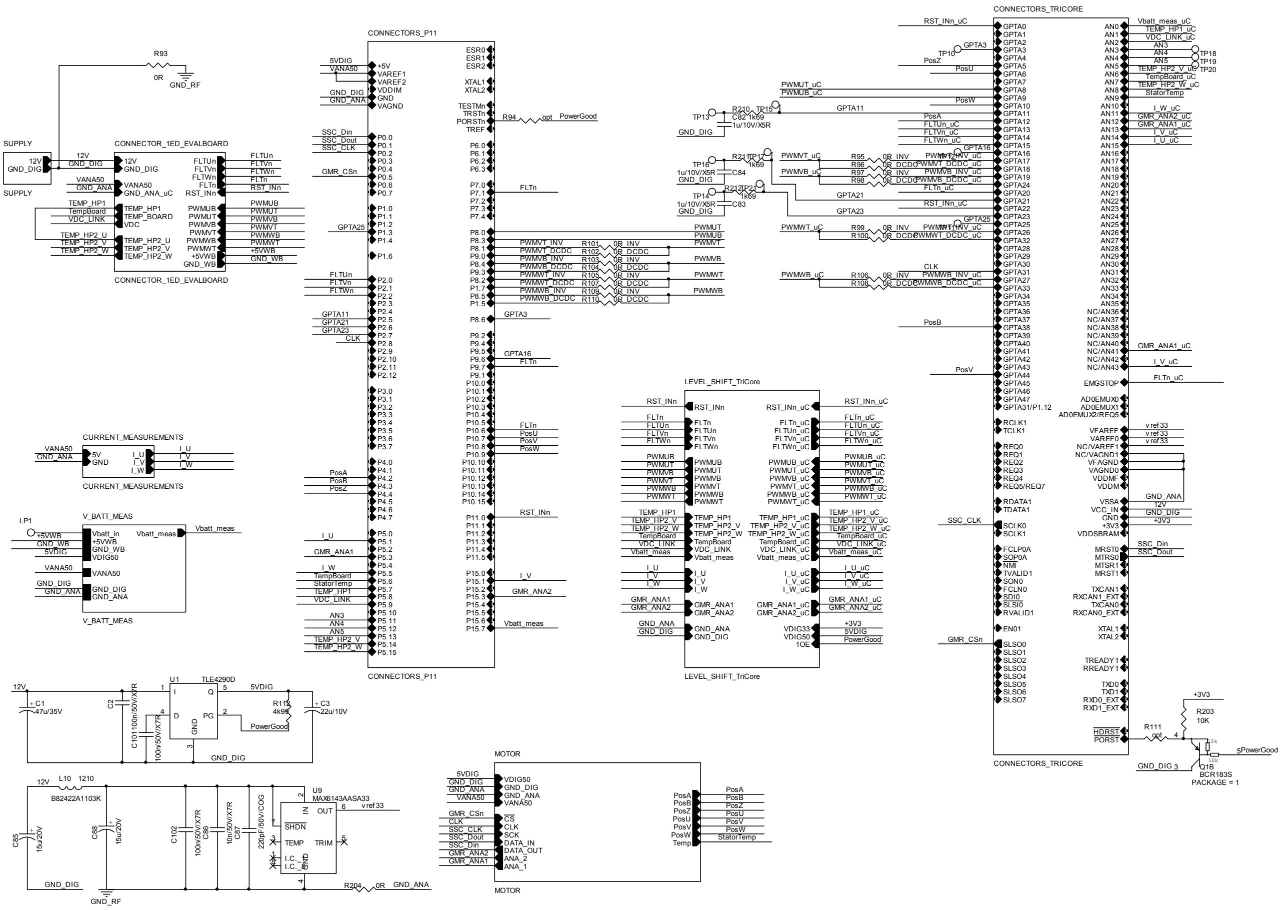


Figure 44 Schematics block overview

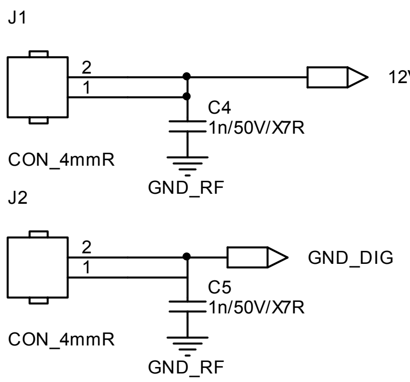


Figure 45 Supply

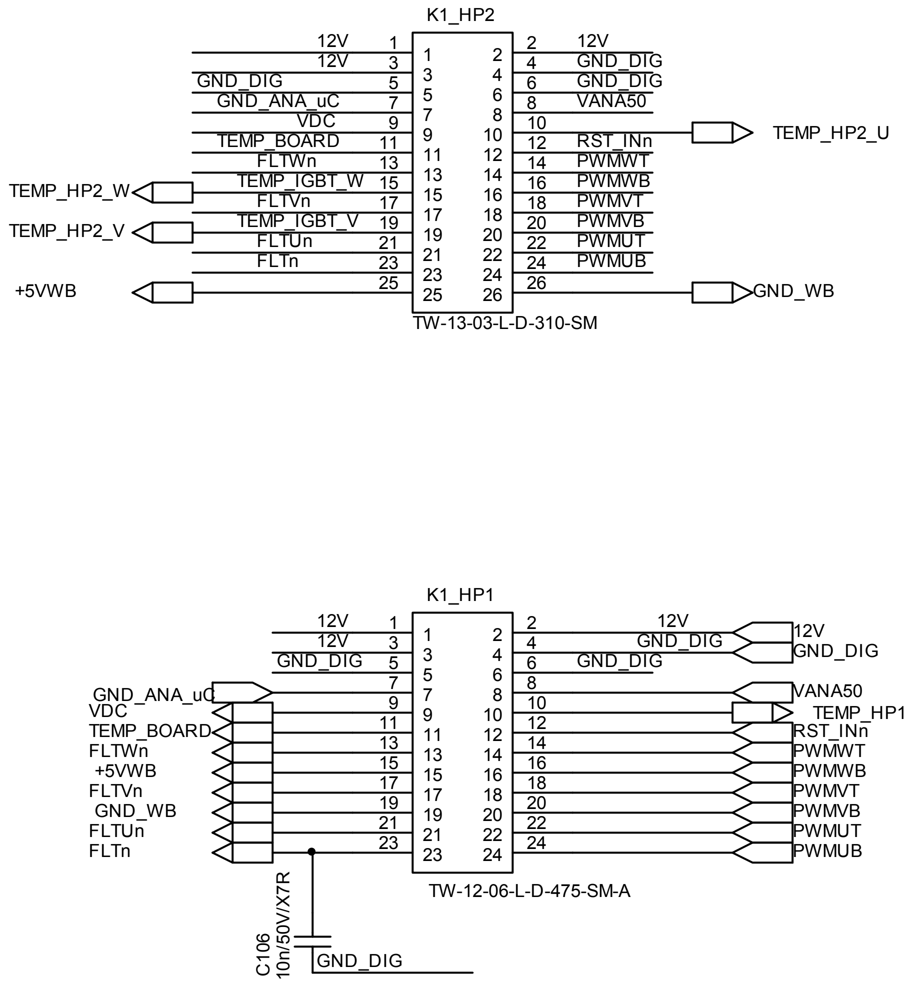


Figure 46 Connector_1ED_EVALBOARD

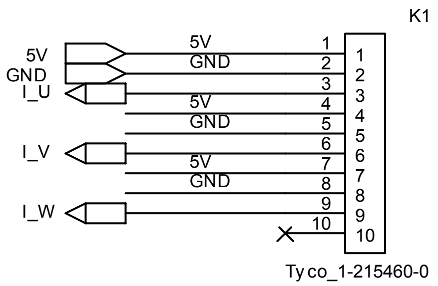


Figure 47 Current Measurement

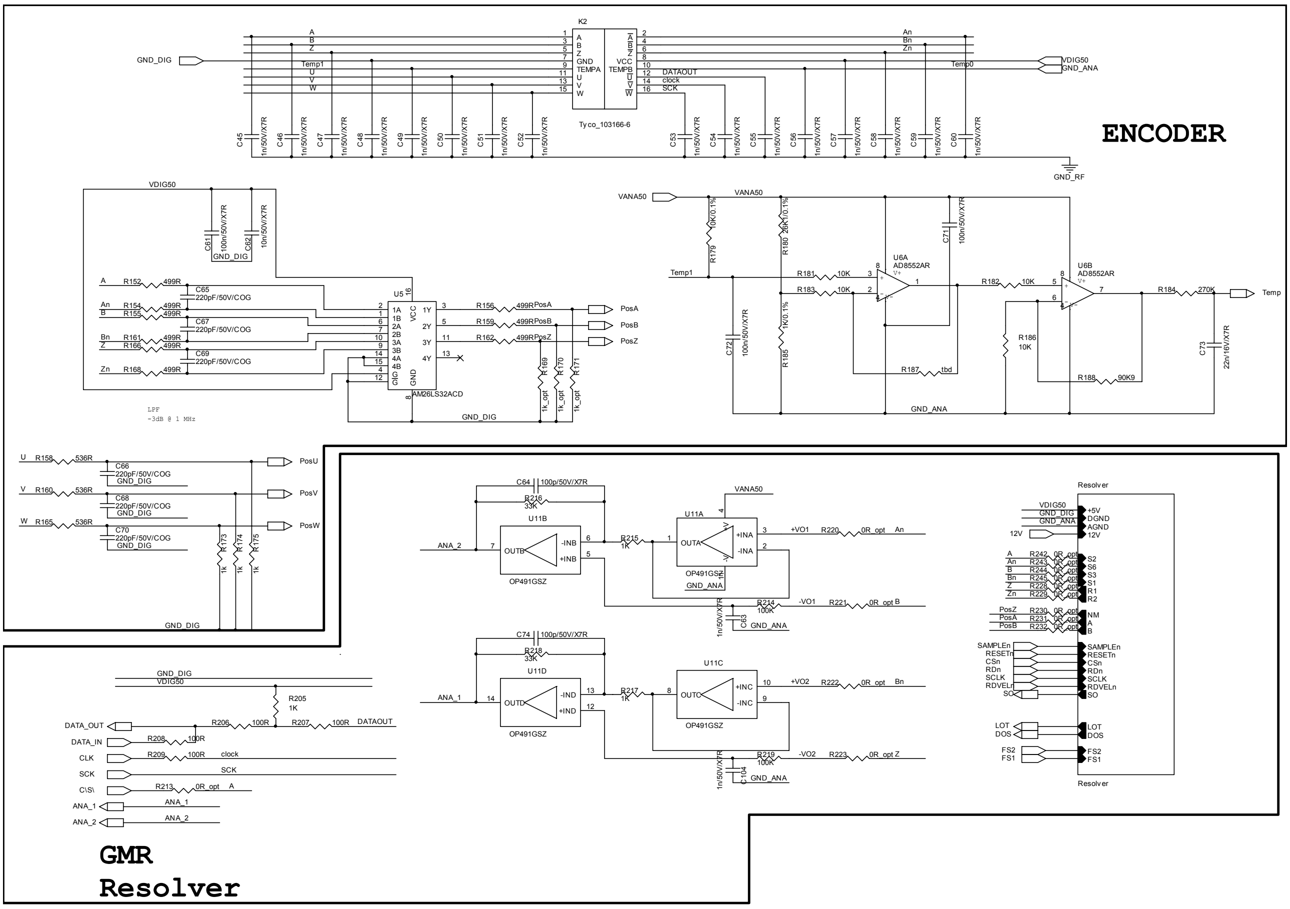


Figure 48 MOTOR

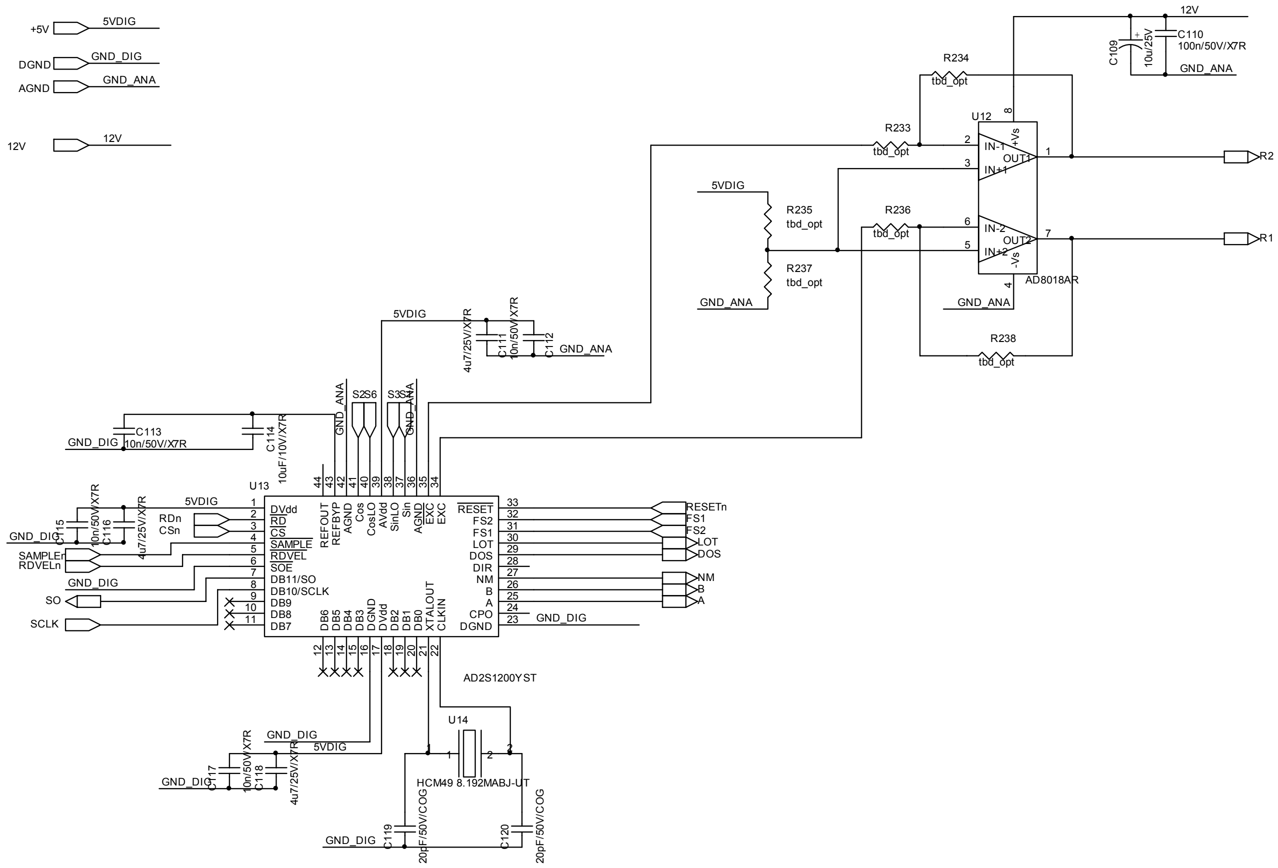


Figure 49 Resolver-to-digital

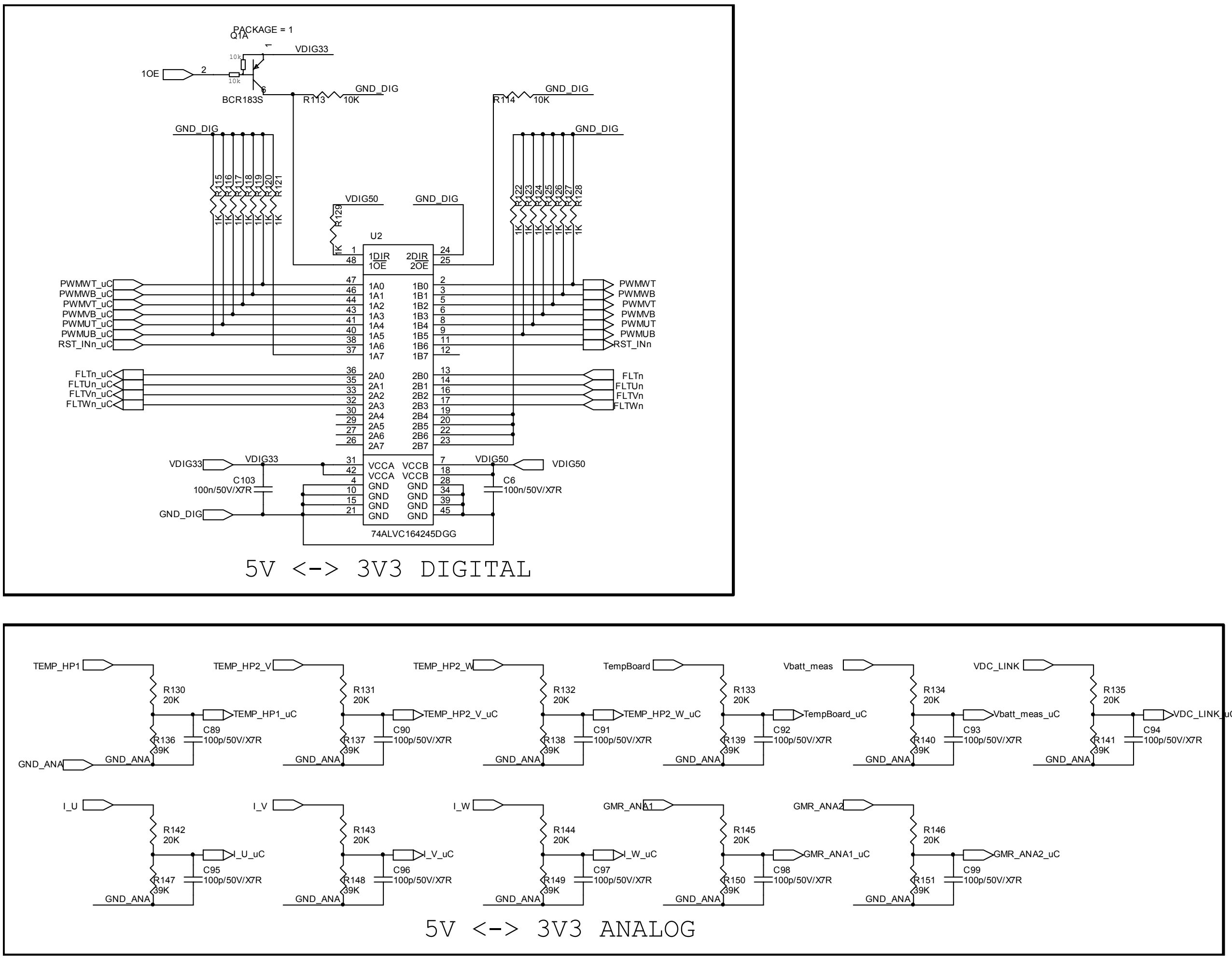


Figure 50 LEVEL_SHIFT_TriCore

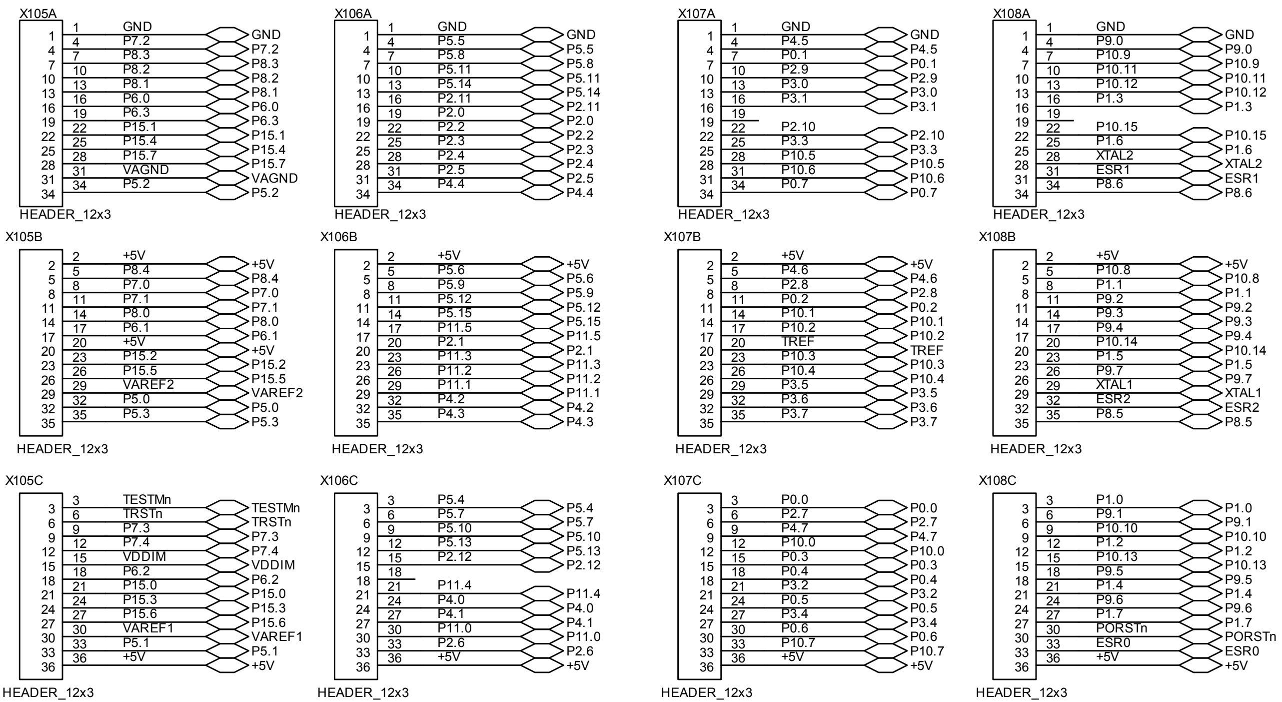


Figure 51 CONNECTORS_P11

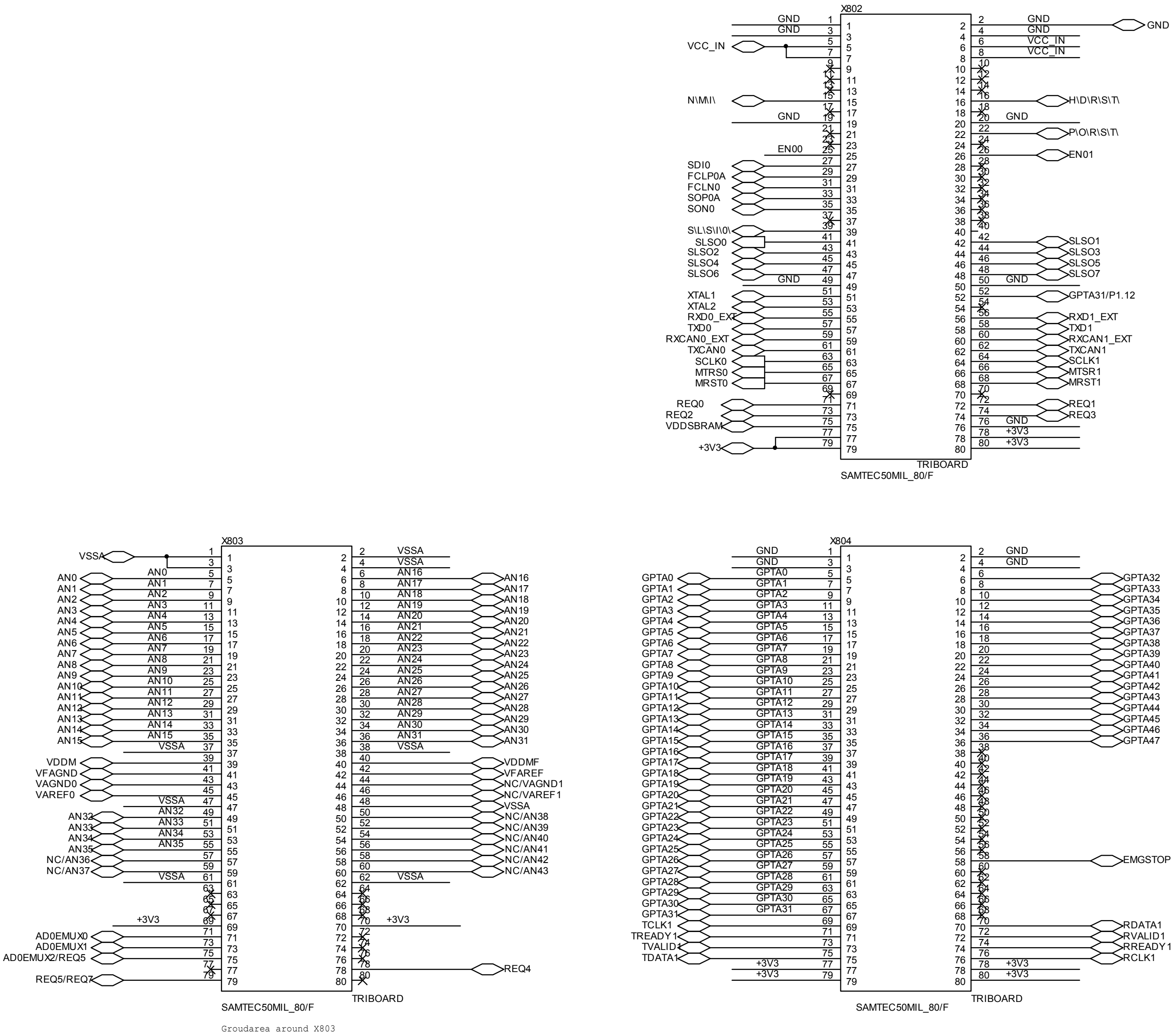


Figure 52 CONNECTORS_TRICORE

4.6.2 Assembly

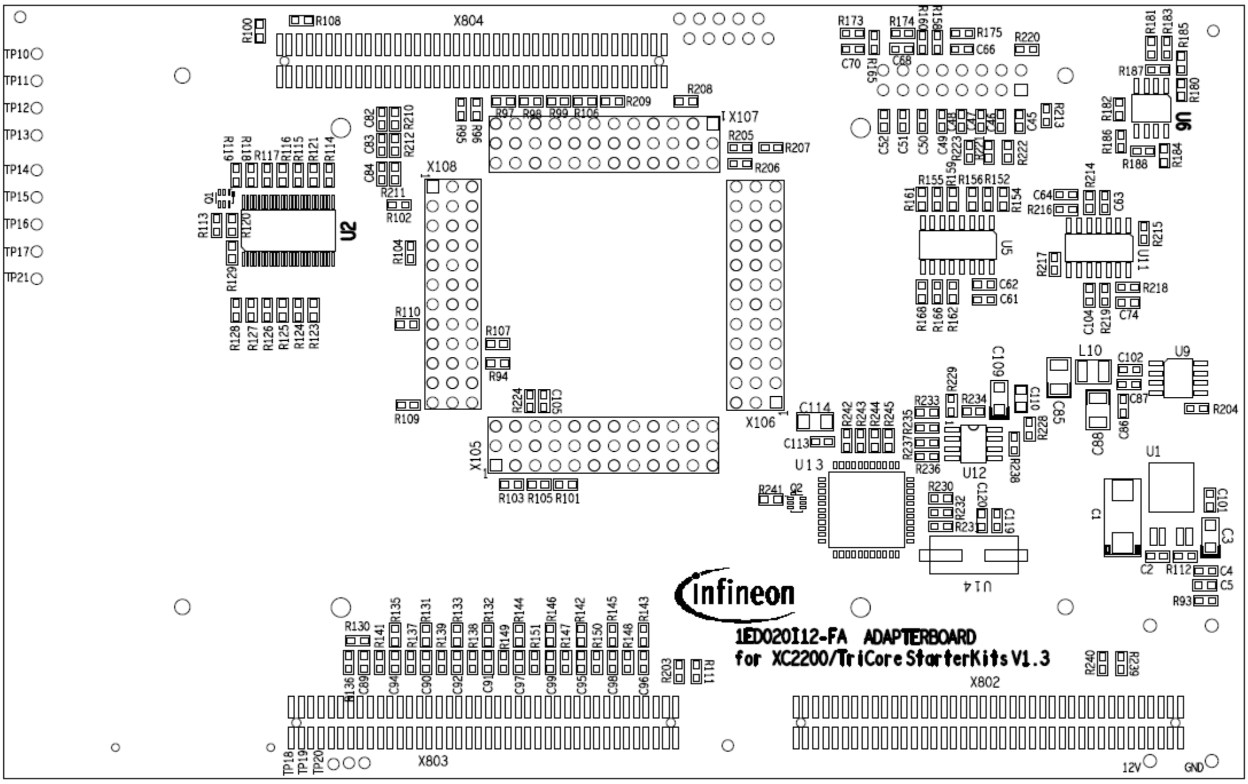


Figure 53 Assembly drawing of the Adapter Board (top)

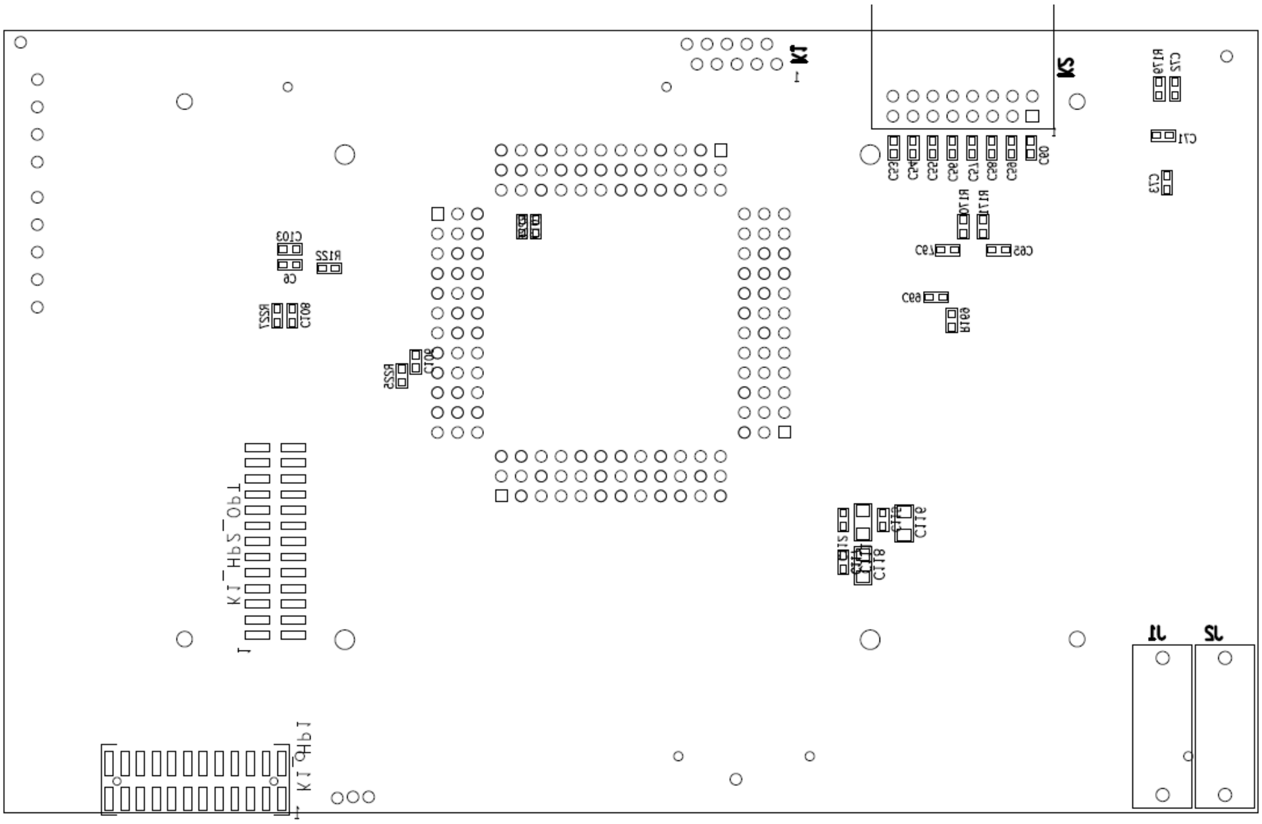


Figure 54 Assembly drawing of the Adapter Board (bottom)

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

4.6.3 Layout

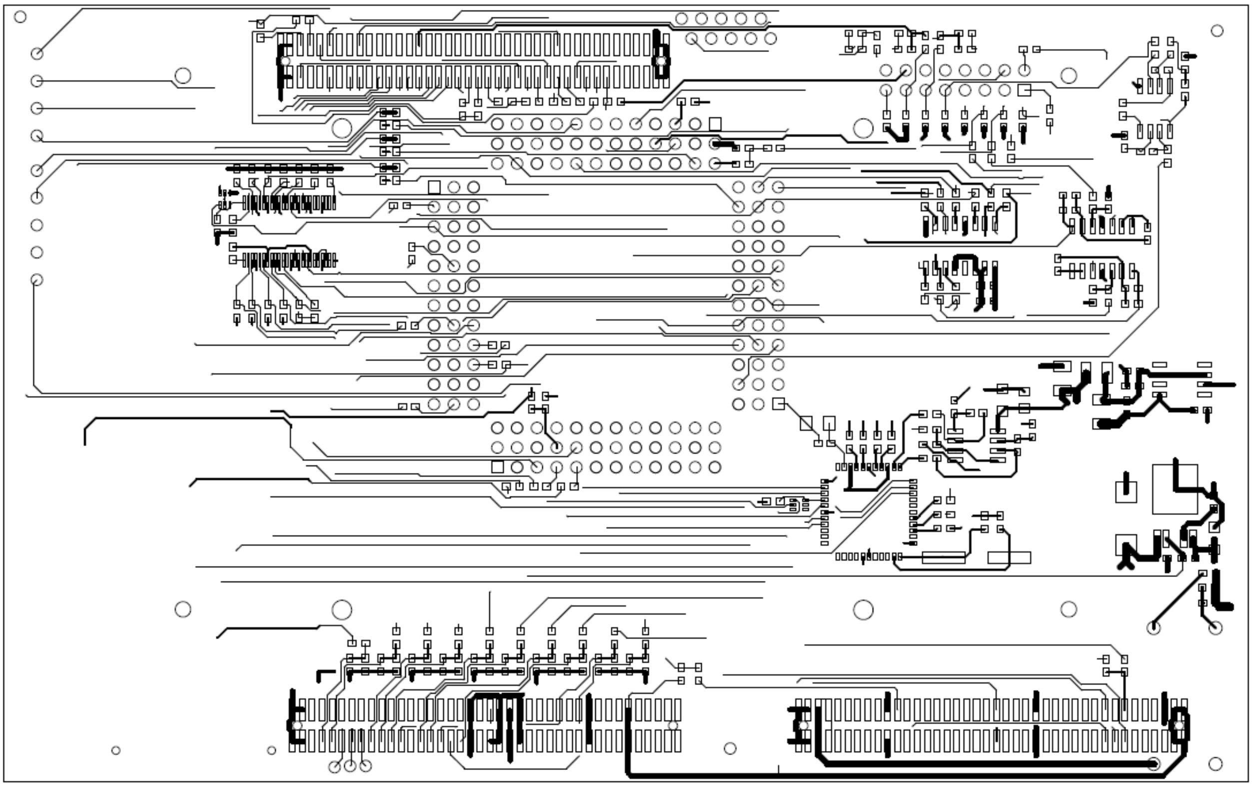


Figure 55 Adapter Board – Top layer

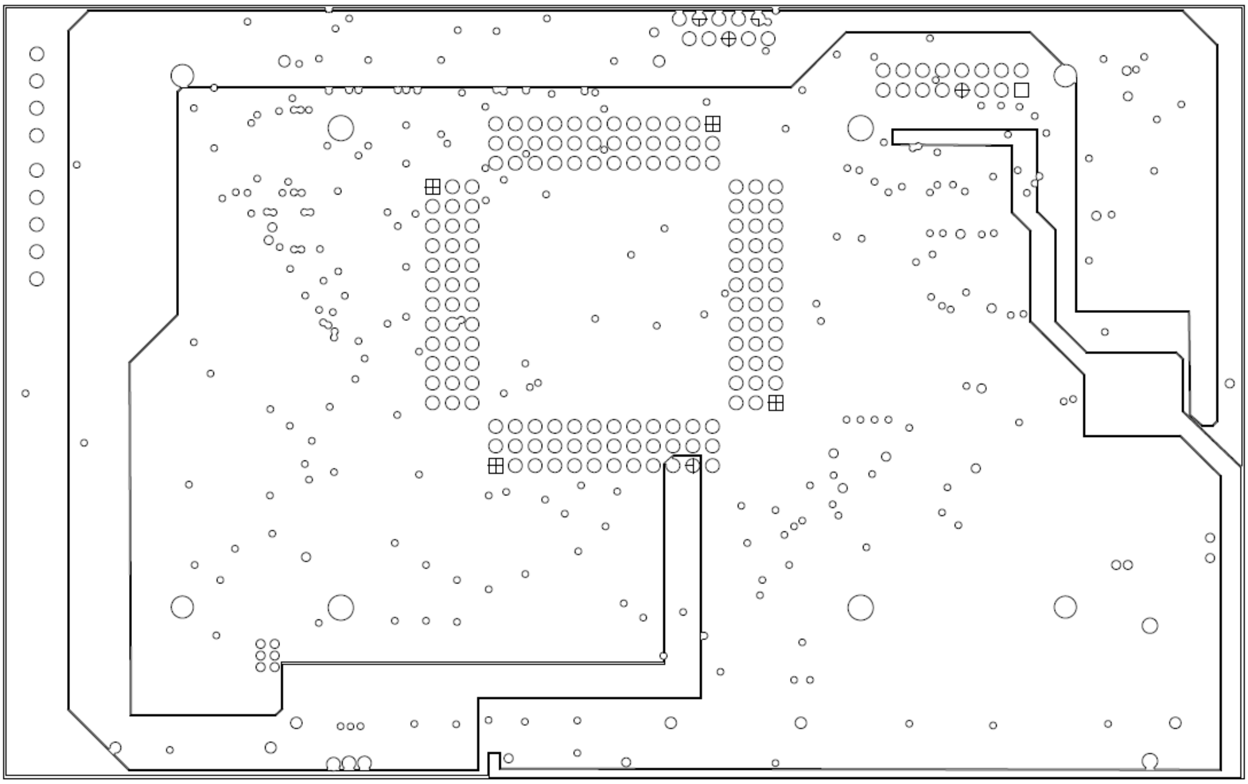


Figure 56 Adapter Board – Layer 2

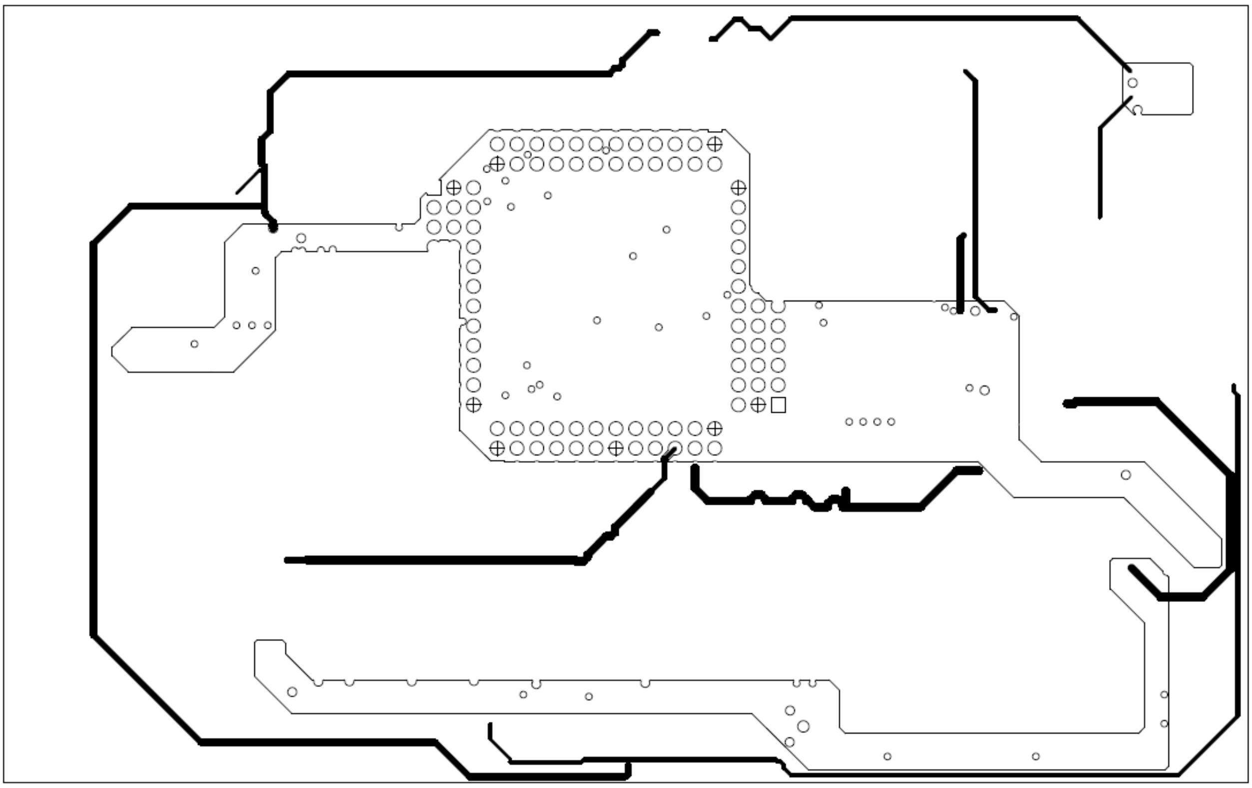


Figure 57 Adapter Board – Layer 3

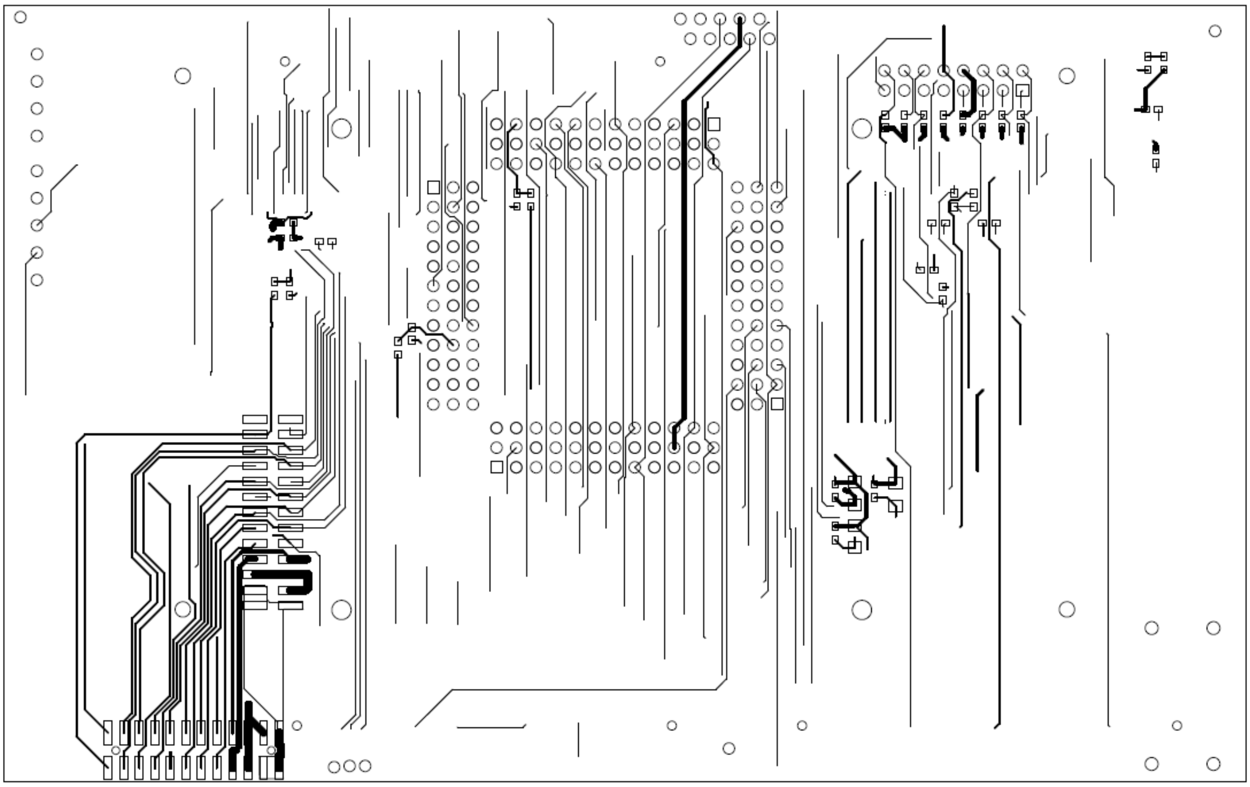


Figure 58 Adapter Board – Bottom layer

4.6.4 Bill of materials

Type	Qty	Reference	Value / Device	Package
Capacitor	1	C1	47u/35V	E
Capacitor	8	C2,C6,C61,C71,C72,C101,C102,C103	100n/50V/X7R	C0603
Capacitor	1	C3	22u/10V	A
Capacitor	20	C4,C5,C45,C46,C47,C48,C49,C50, C51,C52,C53,C54,C55,C56,C57,C58, C59,C60,C63,C104	1n/50V/X7R	C0603
Capacitor	10	C62,C86,C105,C106,C107,C108,C112, C113,C115,C117	10n/50V/X7R	C0603
Capacitor	12	C64,C74,C89,C90,C91,C92,C94,C95, C96,C97,C98,C99	100p/50V/X7R	C0603
Capacitor	7	C65,C66,C67,C68,C69,C70,C87	220pF/50V/COG	C0603
Capacitor	1	C73	22n/16V/X7R	C0603
Capacitor	3	C82,C83,C84	1u/10V/X5R	C0603
Capacitor	2	C85,C88	15u/20V	B
Capacitor	1	C109	10u/25V	A
Capacitor	1	C110	100n/50V/X7R	C0805
Capacitor	3	C111,C116,C118	4u7/25V/X7R	C1206
Capacitor	1	C114	10uF/10V/X7R	C1206
Capacitor	2	C119,C120	20pF/50V/COG	C0603
Connector	2	J1,J2	4mm Socket	
Connector	1	K1	Tyco_1-215460-0	
Connector	1	K2	Tyco_103166-6	
Connector	1	K1_HP1	Samtec_TW-12-06-L-D-475-SM-A	
Connector	1	K1_HP2_opt	Samtec_TW-13-03-L-D-310-SM	
Inductor	1	L10	B82422A1103K	L1210
Transistor	2	Q1,Q2	BCR183S	SOT363
Resistor	1	R93	0R	R0603
Resistor	3	R94,R111,R204	opt	R0603
Resistor	8	R95,R97,R99,R101,R103,R105, R106,R109	0R_INV	R0603
Resistor	8	R96,R98,R100,R102,R104,R107, R108,R110	0R_DCDC	R0603
Resistor	1	R112	4k99	R0603
Resistor	12	R113,R114,R181,R182,R183,R186, R203,R224,R225,R226,R227,R241	10K	R0603
Resistor	21	R115,R116,R117,R118,R119, R120,R121,R122,R123,R124,R125, R126,R127,R128,R129,R173,R174, R175,R205,R215,R217	1K	R0603
Resistor	11	R130,R131,R132,R133,R135, R142,R143,R144,R145,R146,R239	20K	R0603
Resistor	11	R136,R137,R138,R139,R141,R147, R148,R149,R150,R151,R240	39K	R0603
Resistor	9	R152,R154,R155,R156,R159,R161, R162,R166,R168	499R	R0603
Resistor	3	R158,R160,R165	536R	R0603
Resistor	3	R169,R170,R171	1k_opt	R0603

Resistor	1	R179	10K/0.1%	R0603
Resistor	1	R180	26K1/0.1%	R0603
Resistor	1	R184	270K	R0603
Resistor	1	R185	1K/0.1%	R0603
Resistor	1	R187	tbd	R0603
Resistor	1	R188	90K9	R0603
Resistor	4	R206,R207,R208,R209	100R	R0603
Resistor	3	R210,R211,R212	1k69	R0603
Resistor	14	R213,R220,R221,R222,R223, R228,R229,R230,R231,R232, R242,R243,R244,R245	0R_opt	R0603
Resistor	2	R214,R219	100K	R0603
Resistor	2	R216,R218	33K	R0603
Resistor	6	R233,R234,R235,R236,R237,R238	tbd_opt	R0603
Voltage reg	1	U1	TLE4290D	TO252-5-11
16-bit Translating transceiver	1	U2	74ALVC164245DGG	TSSOP-48
Quad diff rcvr	1	U5	AM26LS32ACD	SO-16
Op Amp	1	U6	AD8552AR	SO-08
Ref voltage	1	U9	MAX6143AASA33	SO-08
Op Amp	1	U11	OP491GSZ	SO-14
Op Amp	1	U12	AD8018AR	SO-08
Resolver-to-digital	1	U13	AD2S1200YST	LQFP-44
Clock	1	U14	HCM49 8.192MABJ-UT	
Connector	4	X105,X106,X107,X108	HEADER_12x3	
Connector	3	X802,X803,X804	SAMTEC_FW-40-05-G-D-393-118-A	

5 Mechanical assembly of the complete Hybrid Kit

First of all the 6ED100HP2-FA driver board must be assembly on top of the HybridPack2™ (see Figure 59).

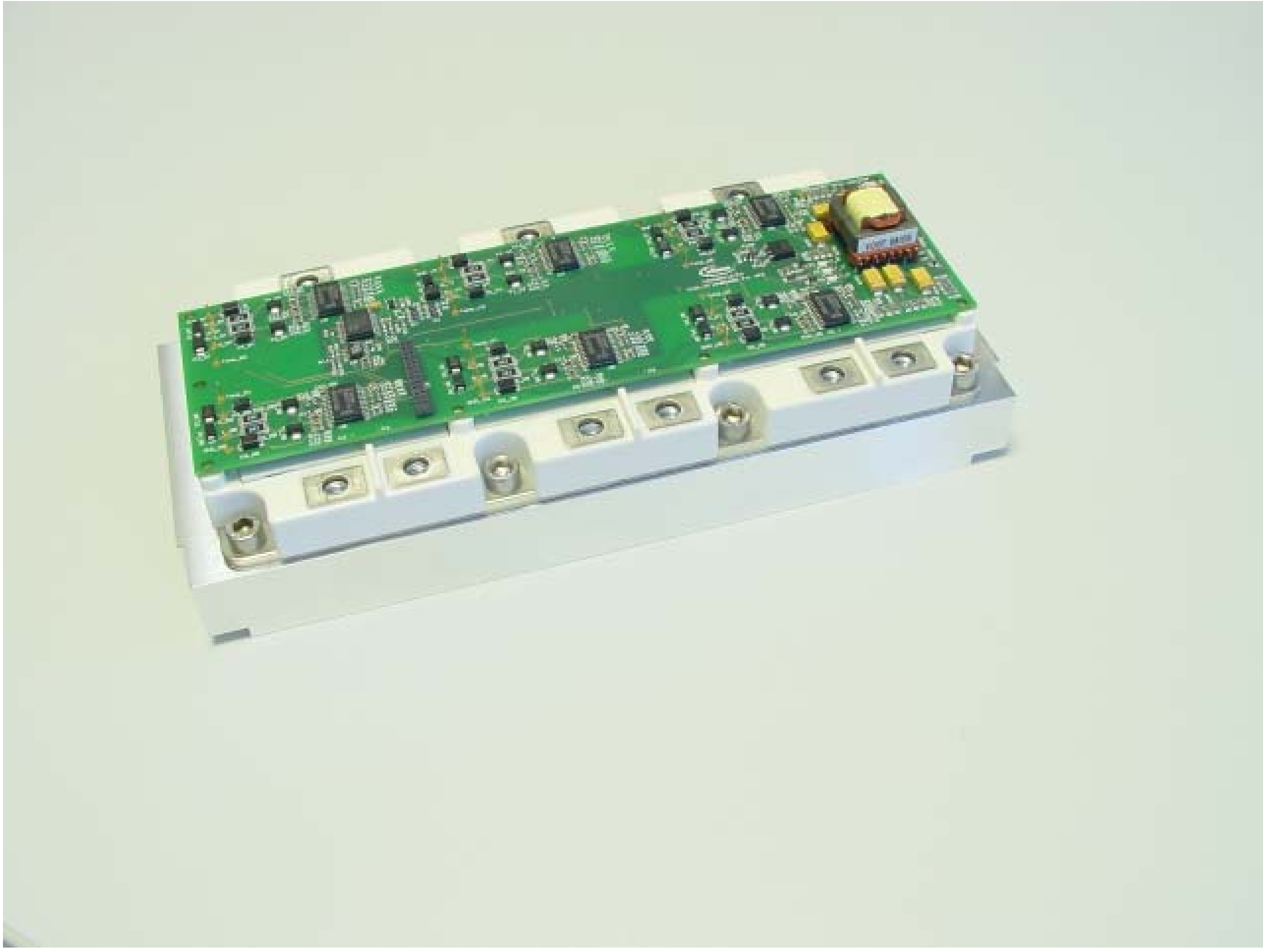


Figure 59 6ED100HP2-FA driver board on top of the HybridPack2™

Afterwards the DC-Link capacitor can be screwed to the terminals of the HybridPack2™ (see Figure 60)

Figure 60 DC-Link capacitor screwed to HybridPack2™ terminals

Next connect the Adapter Board to the 6ED100HP2-FA driver board and fix it using 15mm spacers and screws as it is shown on Figure 61

Figure 61 Adapter board connected to the 6ED100HP2-FA driver board and fixed by means of spacers and screws

Finally the microcontroller starter Kit can be plugged as it can be seen in Figure 62

Figure 62 TriCore Starter Kit

6 How to order Hybrid Kit for HybridPack2™

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 Infineons Web Page: www.infineon.com

http://www.infineon.com

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