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Hybrid Kit for HybridPACK™1

Evaluation Kit for applications with HybridPACK™1 module

System Engineering Automotive

Never stop thinking

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1.1	Page 6: Automotive qualified IGBT module HybridPACK™1(not included) -> included	

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1 Introduction

The Hybrid Kit for HybridPACK™1 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 HybridPACK™1 : SA000555038

Figure 1 The Hybrid Kit for HybridPACK™1

2 Design features

The Hybrid Kit for HybridPACK™1 is made up of a set of boards (6ED100HP1-FA and Adapter Board) mechanically and electrically suitable to be used with an IGBT module (HybridPACK™1) 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 mild hybrid applications up to 20KW.

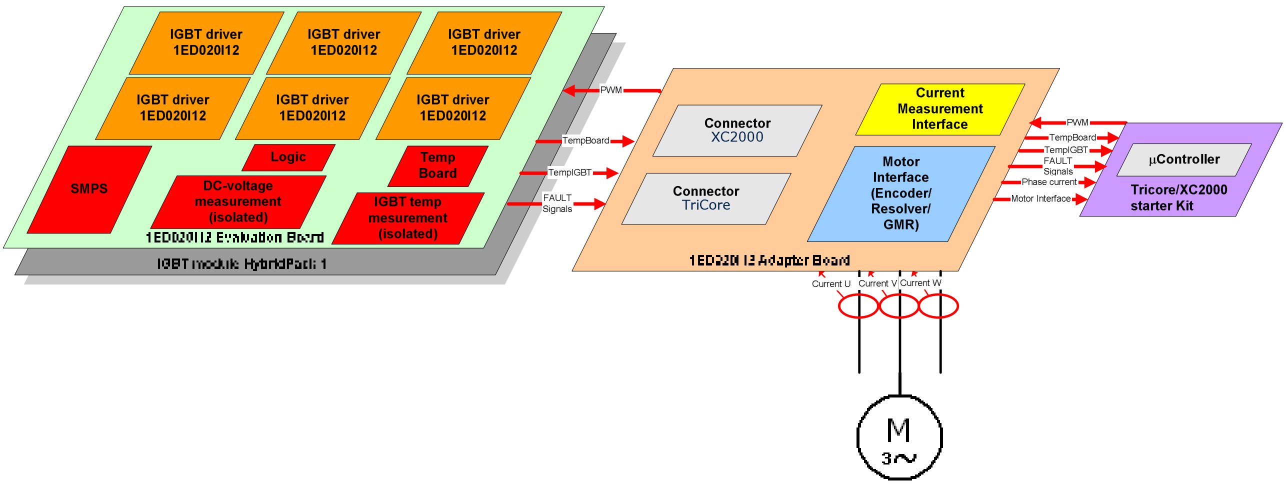


Figure 2 Block diagram of Hybrid Kit for HybridPACK™1

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 hybrid applications up to 20KW.

- Automotive qualified IGBT module HybridPACK™1 (included)
  - 600V/400A 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 6ED100HP1-FA

The Hybrid Kit for HybridPACK™1 is a six channel IGBT driver board, specially designed for the HybridPACK™1 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 HybridPACK™1 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 HybridPACK™1

The Infineon HybridPack1™ is designed for mild HEV applications with a maximum supply of up to 450 V and power range up to 20KW. The HybridPack1™ 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.

2.2.4 Logic Board (StarterKit)- Not included

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- Not included

The capacitor B25655J4267K 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	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

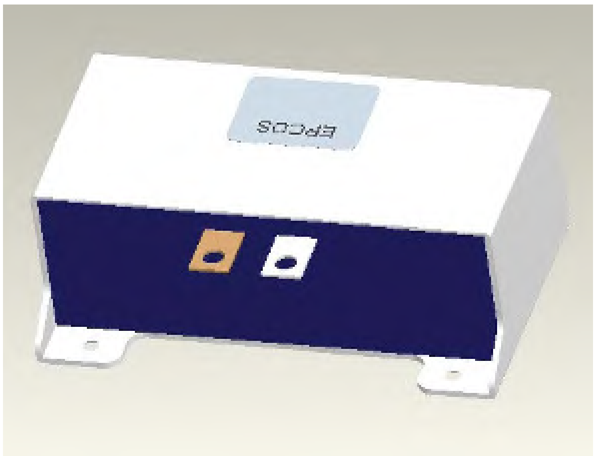


Figure 3 DC-Link Capacitor for HybridPACK™1

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 HybridPack1™ and Figure 5 shows the drawings of it.

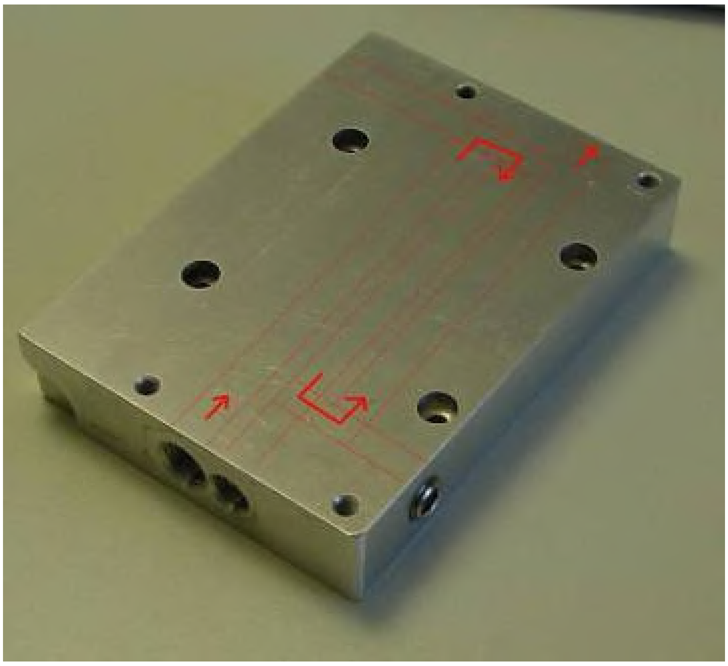


Figure 4 Example of water cooling element for HybridPACK™1

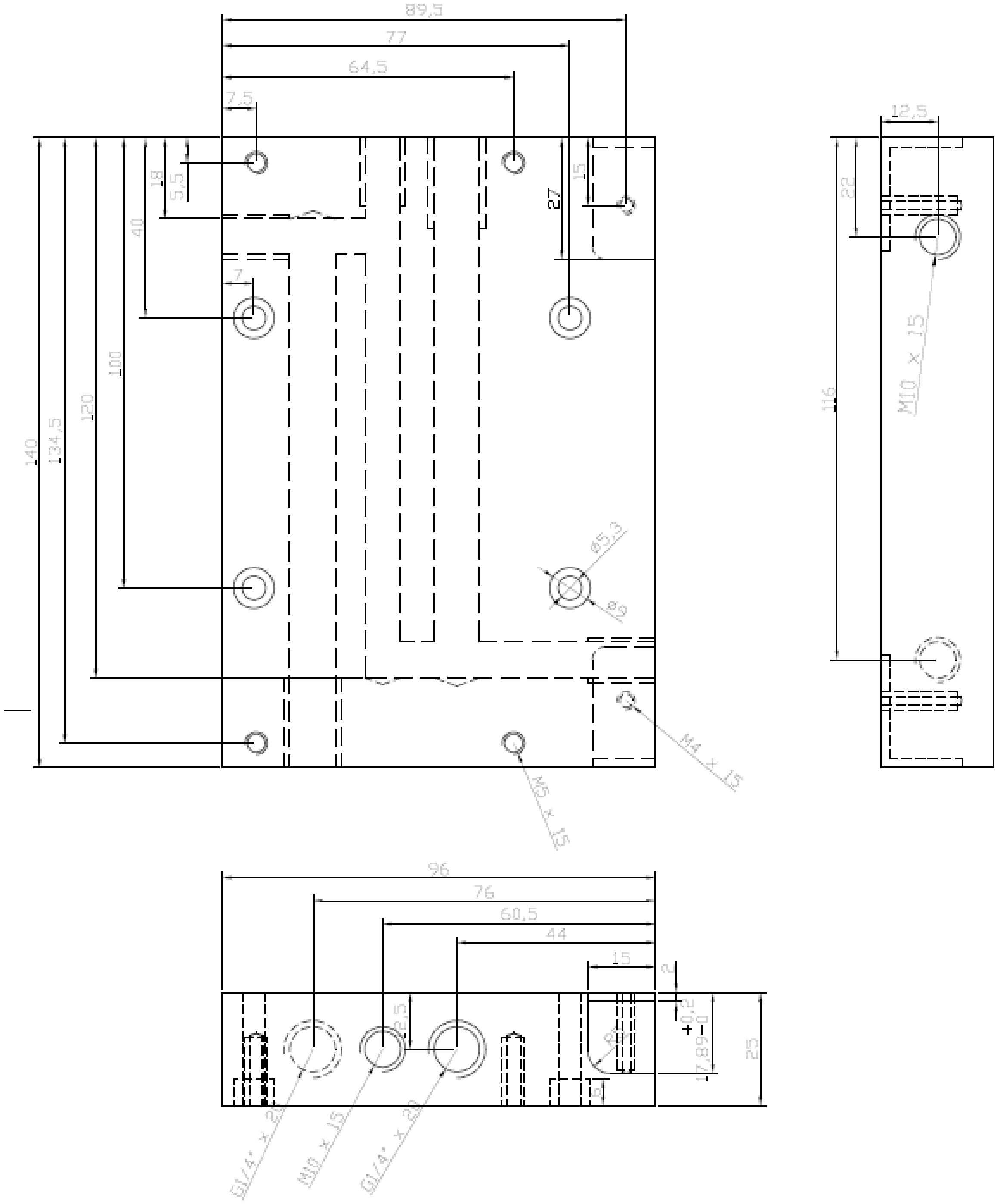


Figure 5 Water cooling system drawings

3 Evaluation Driver Board for the HybridPACK™1

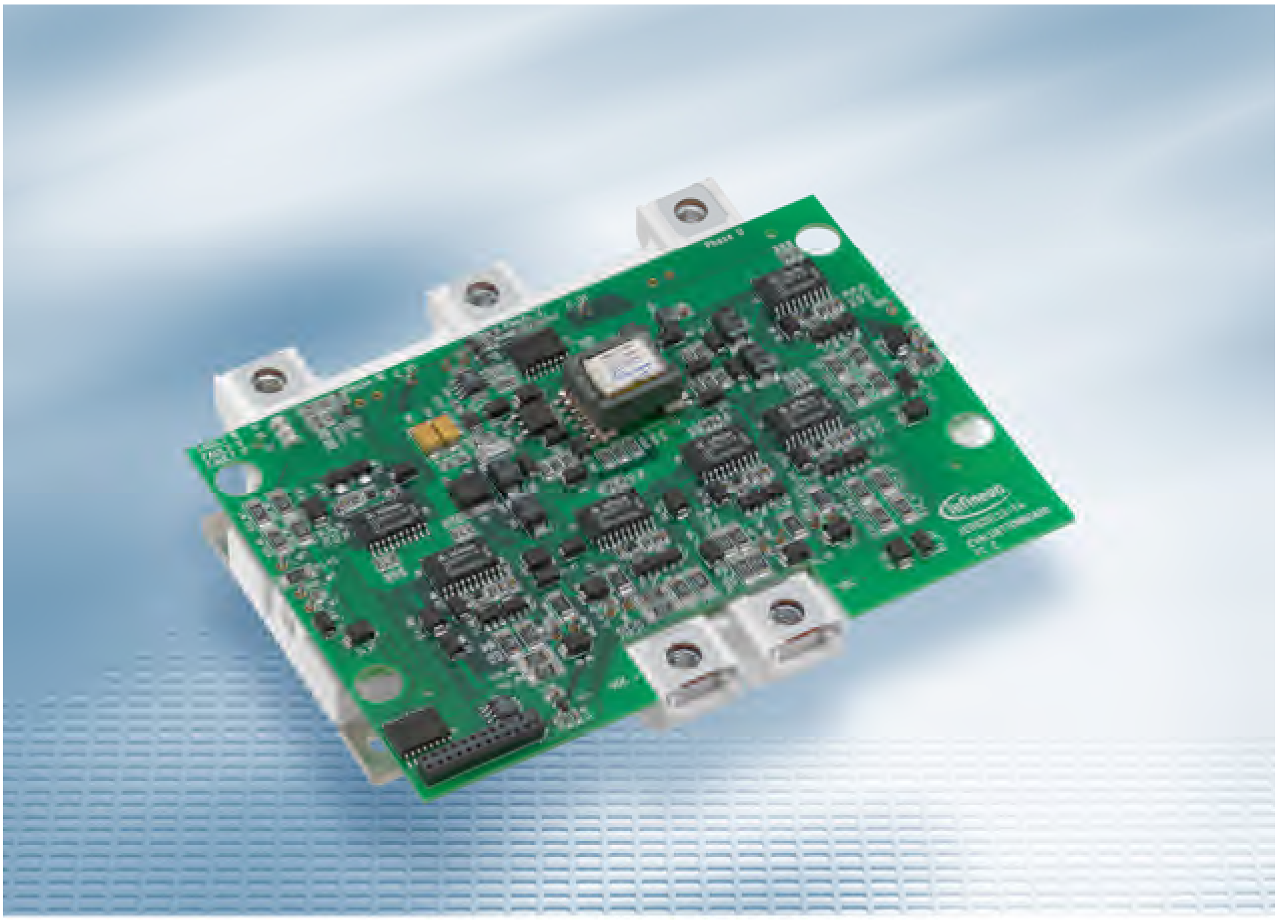


Figure 6 The Hybrid Kit for HybridPACK™1 Evaluation Driver Board mounted on the top of the HybridPACK™1 module

3.1 Main features

The Hybrid Kit for HybridPACK™1 Evaluation Driver Board offers the following features:

- Six channel IGBT driver
- Electrically and mechanically suitable for 600 V IGBT Module HybridPACK™1
- 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

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)	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
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}

[1)] The maximum switching frequency for the HybridPACK™1 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 3.5.3

[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)

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

3.3 Pin assignment

Figure 7 shows the pin assignment for the external connector (K1) on the Hybrid Kit for HybridPACK™1. 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 HybridPACK™1 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 HybridPACK™1 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.

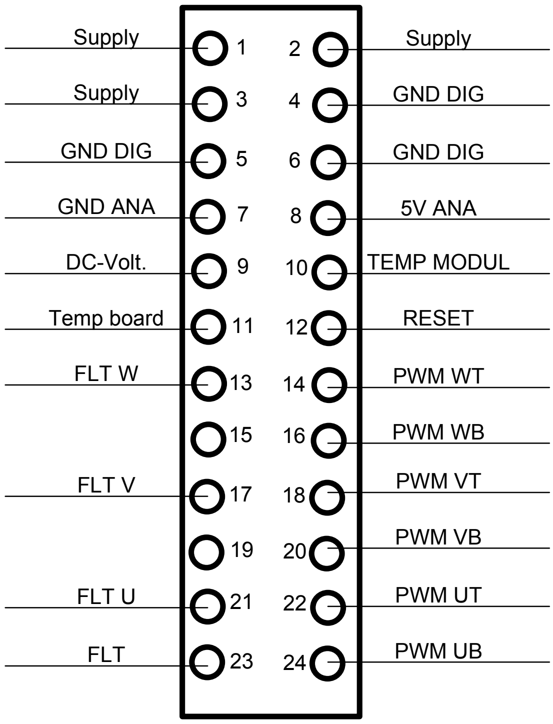


Figure 7 External connector on the Hybrid Kit for HybridPACK™1 Evaluation Driver Board

3.4 Mechanical dimensions of the HybridPACK™1 Driver Board

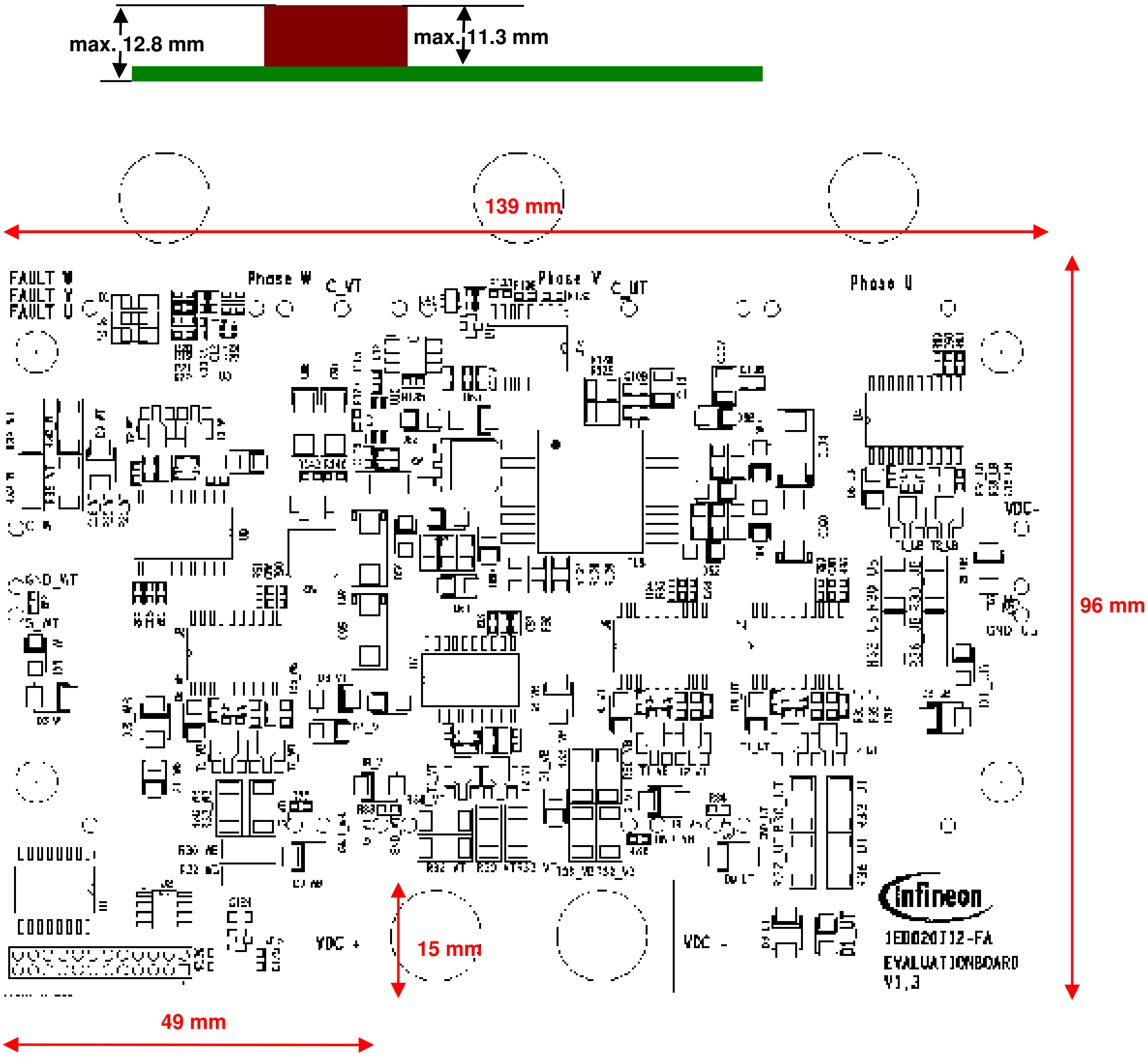


Figure 8 Dimensions of the Hybrid Kit for HybridPACK™1 Driver Board

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 HybridPACK™1 Evaluation Driver Board. The following chapter describes these blocks in detail.

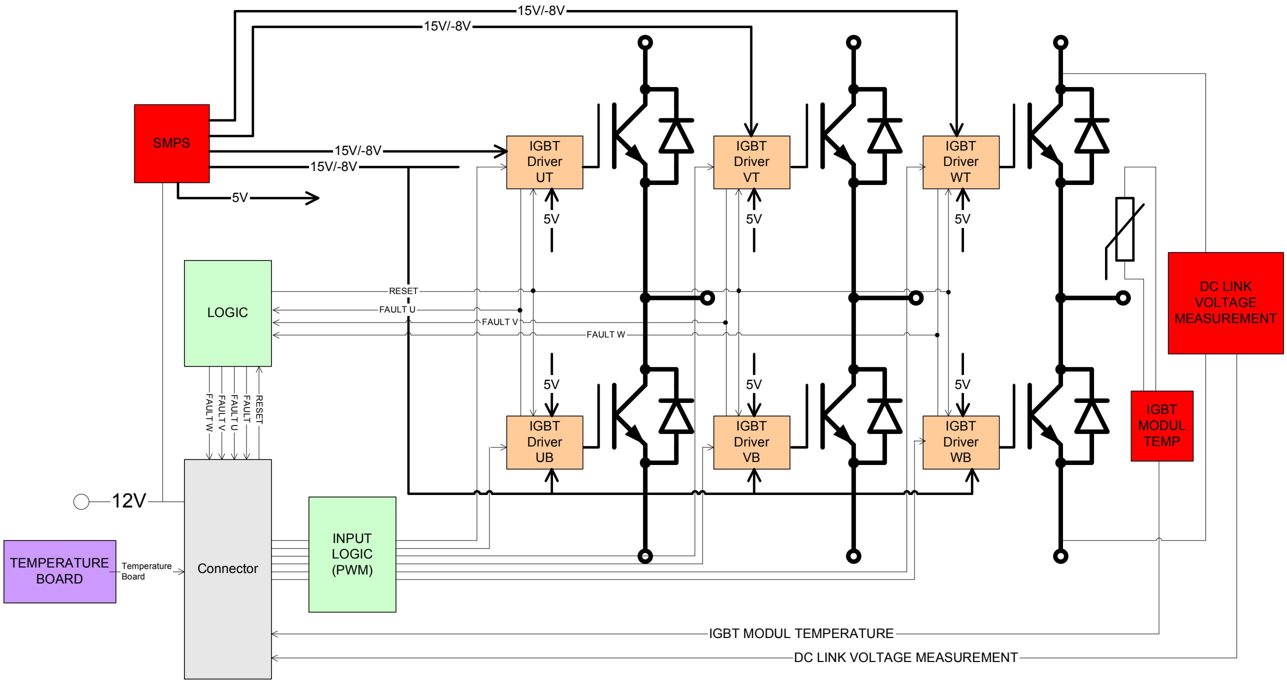


Figure 9 Evaluation Board block diagram

3.5.1 Switching Mode Power Supply (SMPS)

The Hybrid Kit for HybridPACK™1 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 further details about the transformer (InTiCa Systems, part number: 404 00 111 06) please refer to the datasheet.

For circuit details please refer to Figure 23.

3.5.2 Input logic

The Hybrid Kit for HybridPACK™1 Evaluation Driver Board is a dedicated system for a sixpack HybridPACK™1 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 HybridPACK™1 does not provide automatically a dead time; it is needed for the signals to have the correct dead time.

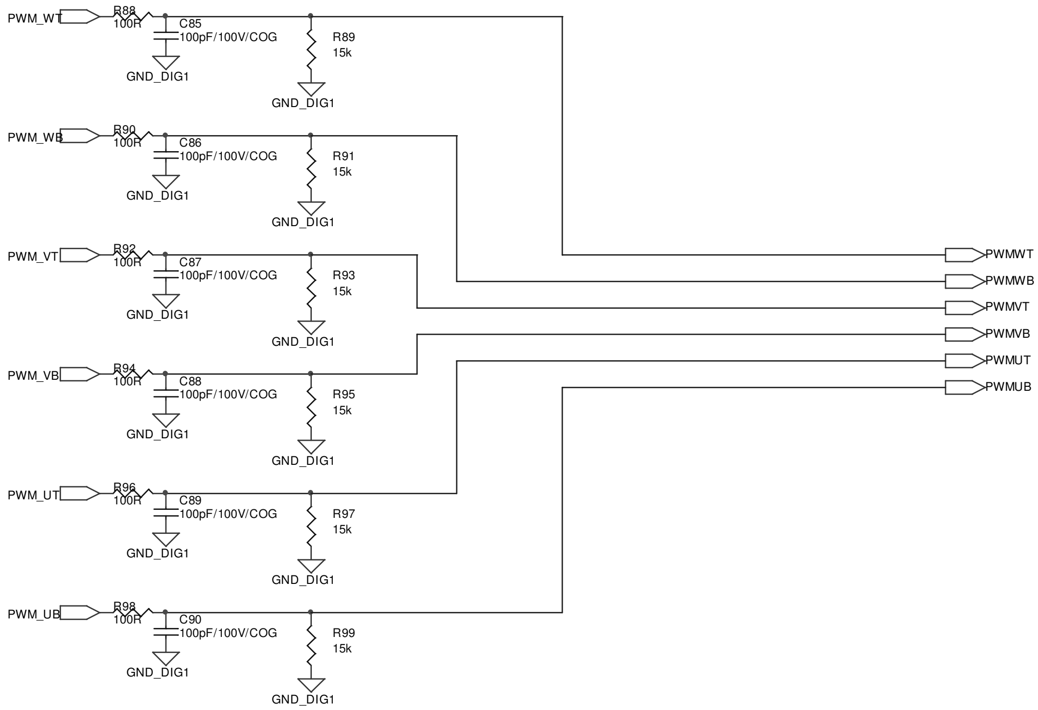


Figure 10 Schematic detail of the input logic block

3.5.3 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, $Q_{ge} = 3.3\mu C$. Therefore the maximum frequency limited by the available power will be:

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

Figure 11 shows experimentally determined board temperature dependencies with switching frequency (at 26°C ambient temperature). From Figure 11 it can be concluded that the maximum switching frequency is limited by PCB temperature.

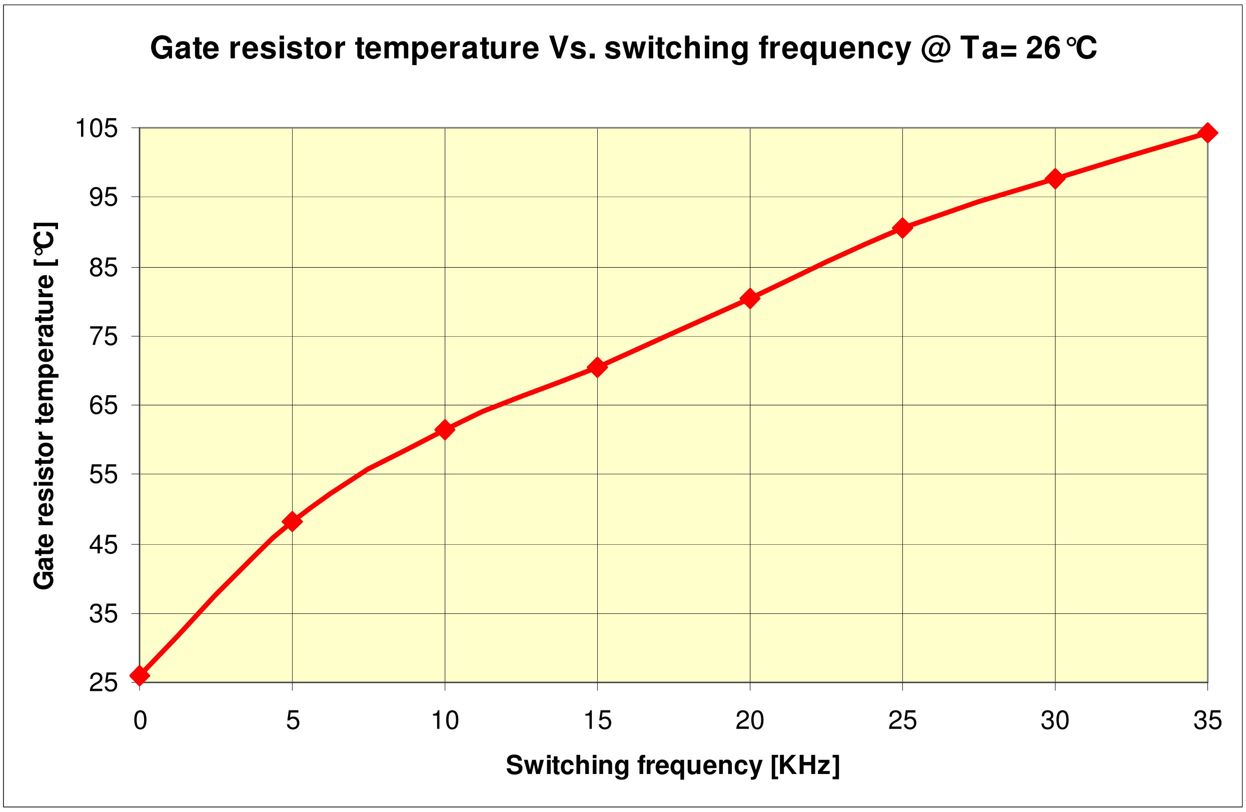


Figure 11 Temperature of gate resistors vs. switching frequency.

3.5.4 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 HybridPACK™1 modules. Peak current can be calculated like in formula (2):

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

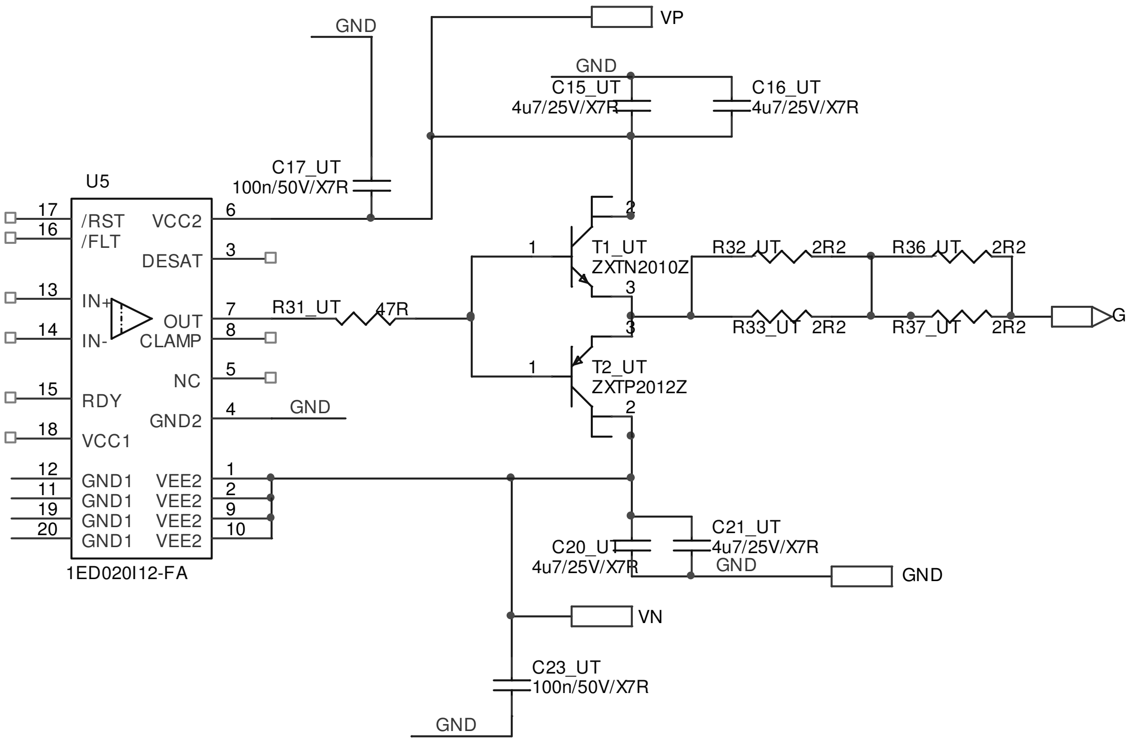


Figure 12 Booster

3.5.5 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 13 shows the parts of the circuit needed for the desaturation function and the active clamping function.

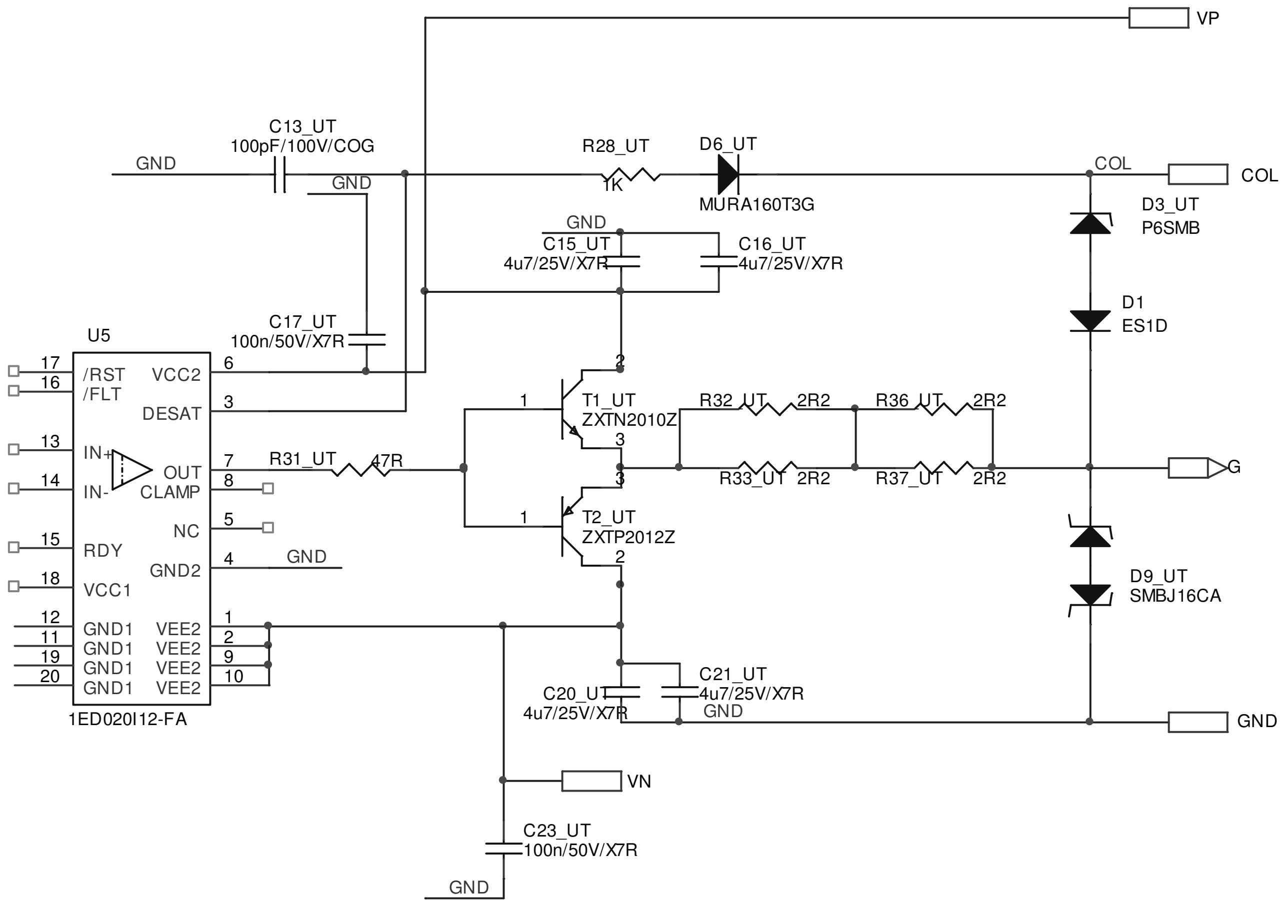
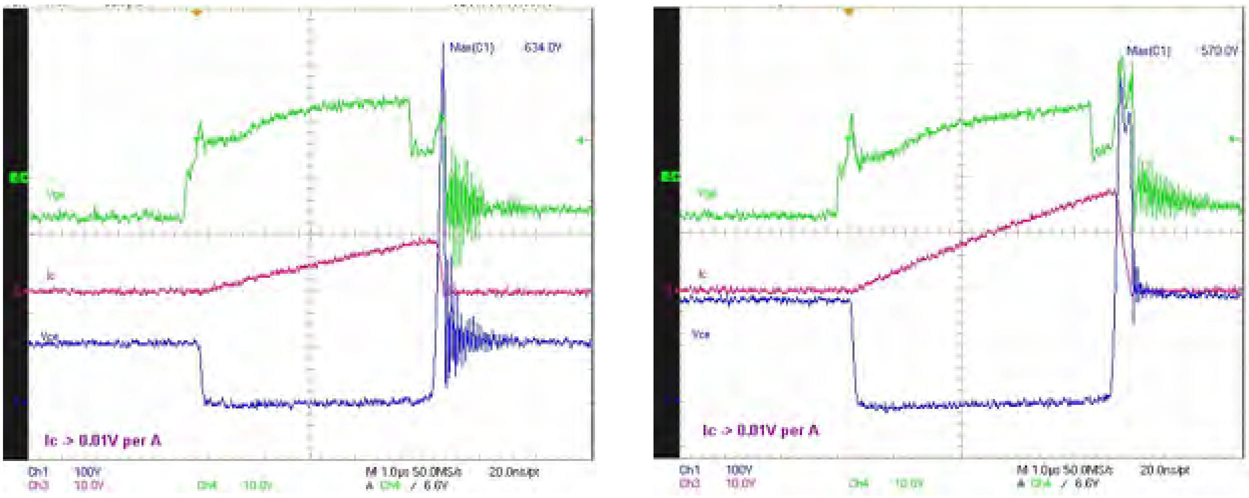


Figure 13 Desaturation protection and active clamping diodes

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 HybridPACK™1 module without any additional function is shown in Figure 14a.Typical waveform under short circuit condition with active clamp function is shown in Figure 14b 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 HybridPACK™1 (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 14 a) Short circuit w/o active clamp (DC Voltage=100V) b) with active clamp function (DC Voltage=175V)

3.5.6 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 15.

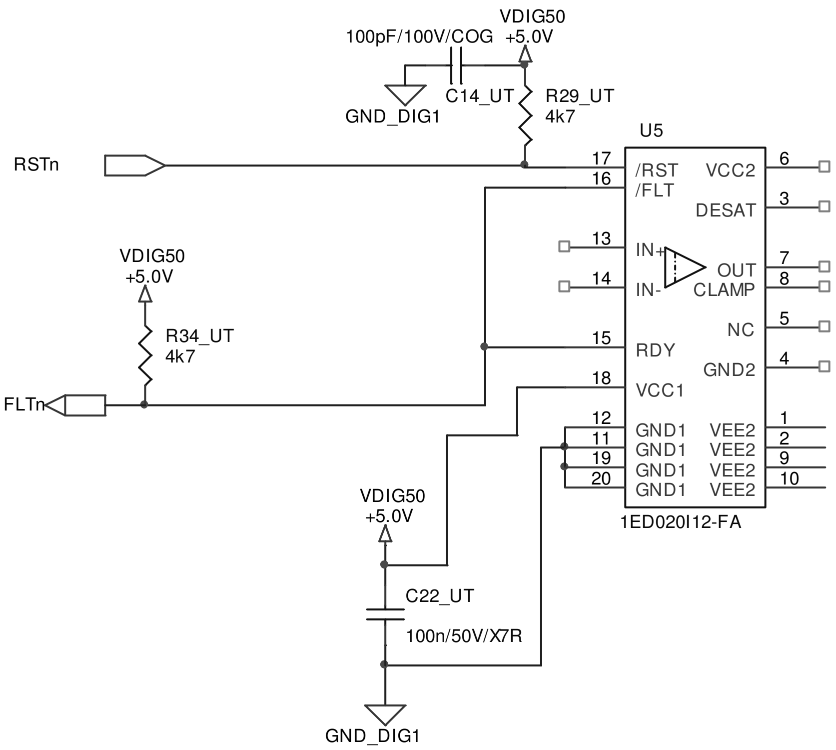


Figure 15 **/Fault output for a single driver**

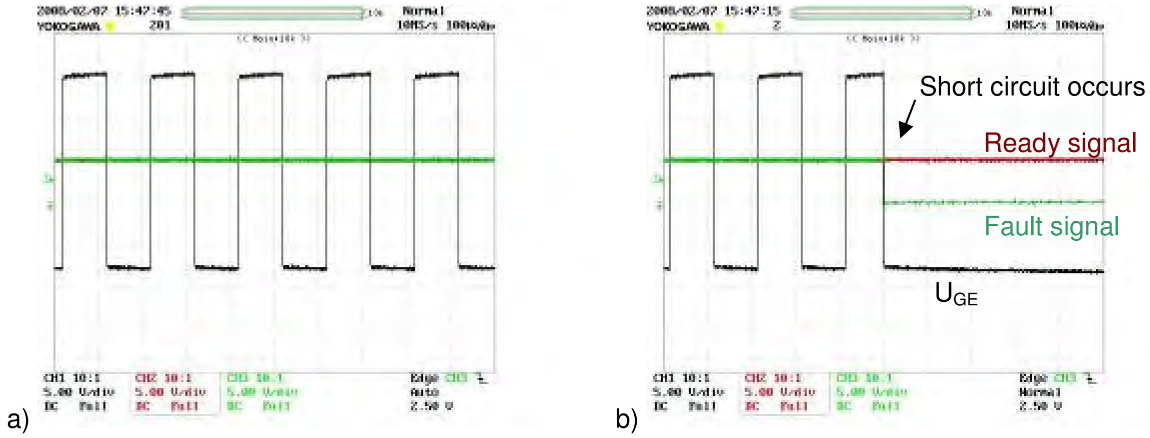


Figure 16 /Fault output during: a) normal operation b) operation under short circuit

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 17, 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).

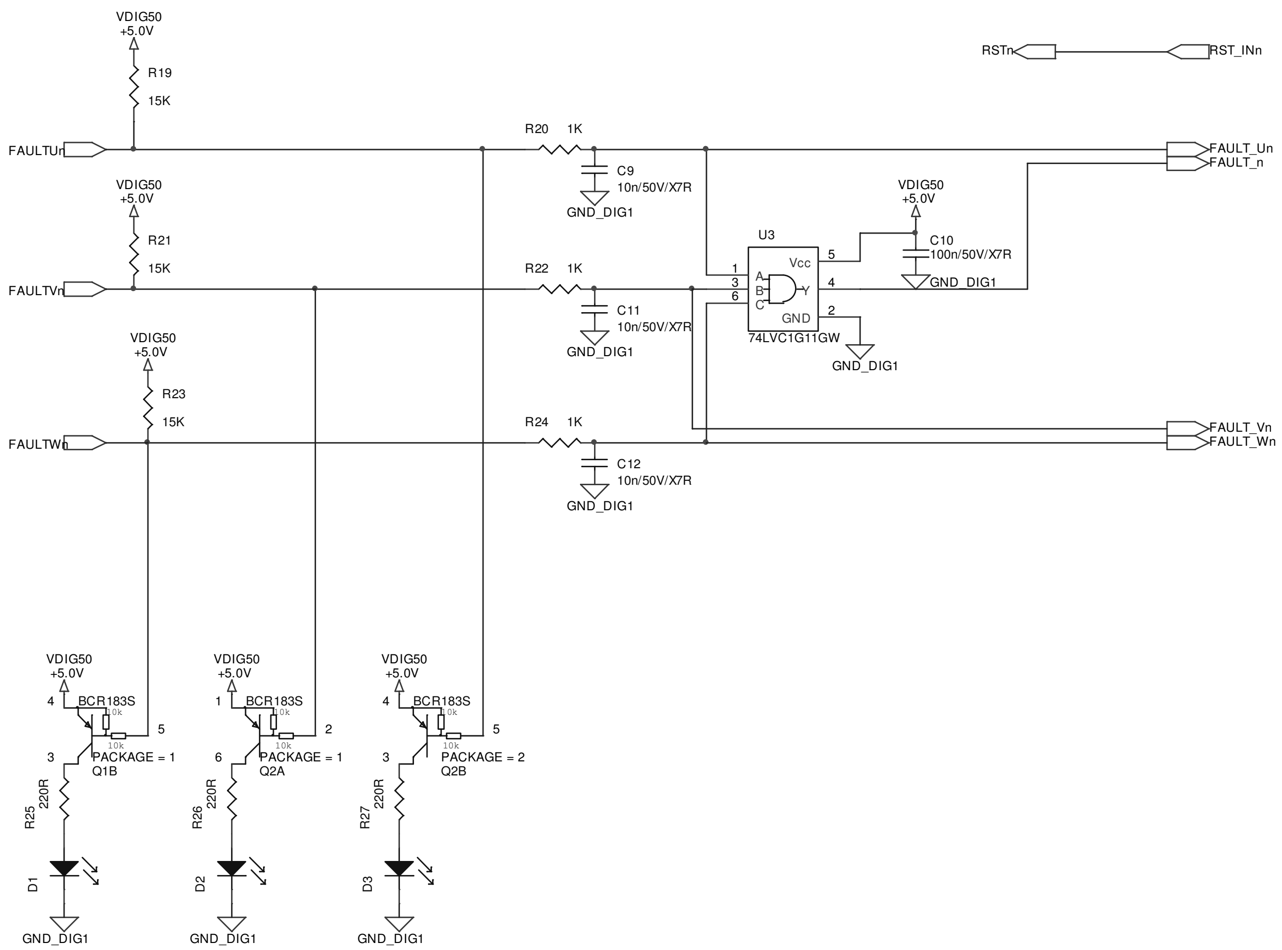


Figure 17 Schematic of the Logic Block

3.5.7 Temperature measurement

The IGBT Module HybridPACK^{TM}1 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 18

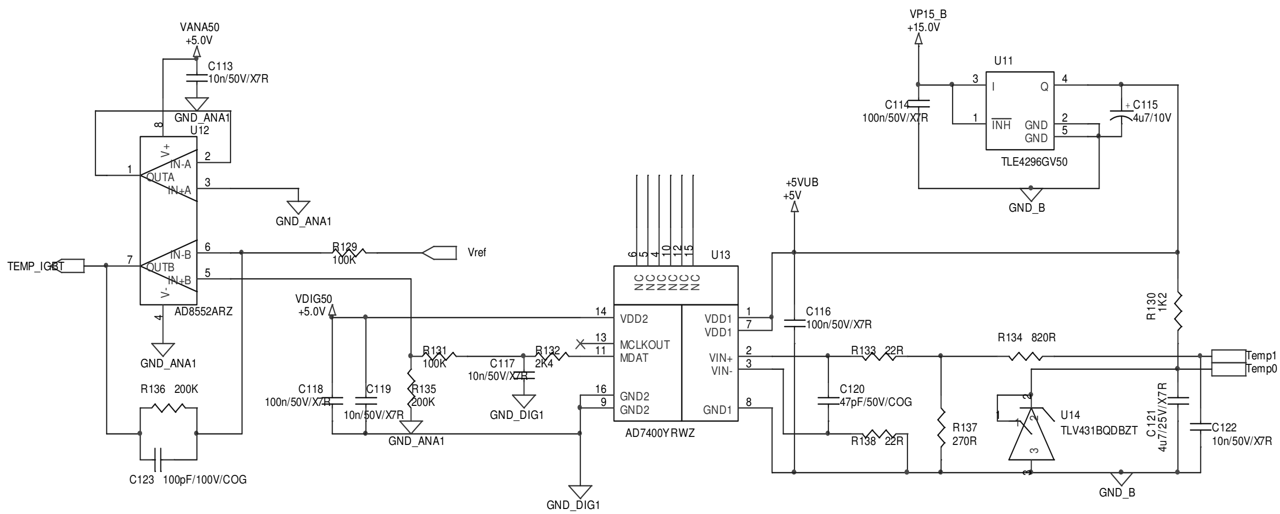


Figure 18 Schematic to convert digital Σ/Δ to analogue output

Figure 19shows the relationship between IGBT baseplate Module temperature and output voltage of IGBT Module Temperature Block (TEMP_IGBT, K3.10)

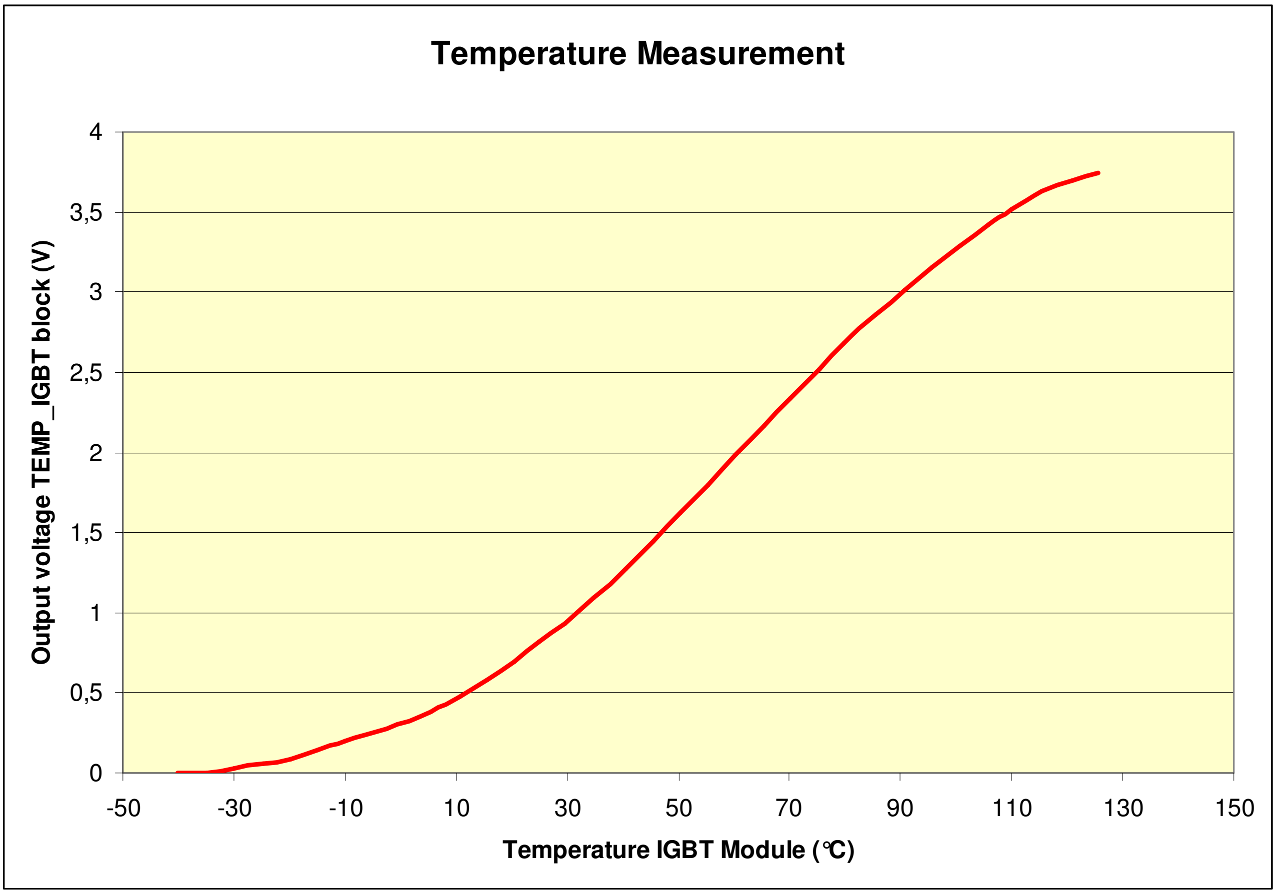


Figure 19 Characteristics of the temperature measurement

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.

3.5.8 DC voltage measurement

The voltage at the DC Link is measured on the Hybrid Kit for HybridPACK™1 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 20 shows the relationship between DC Link voltage and Vdc.

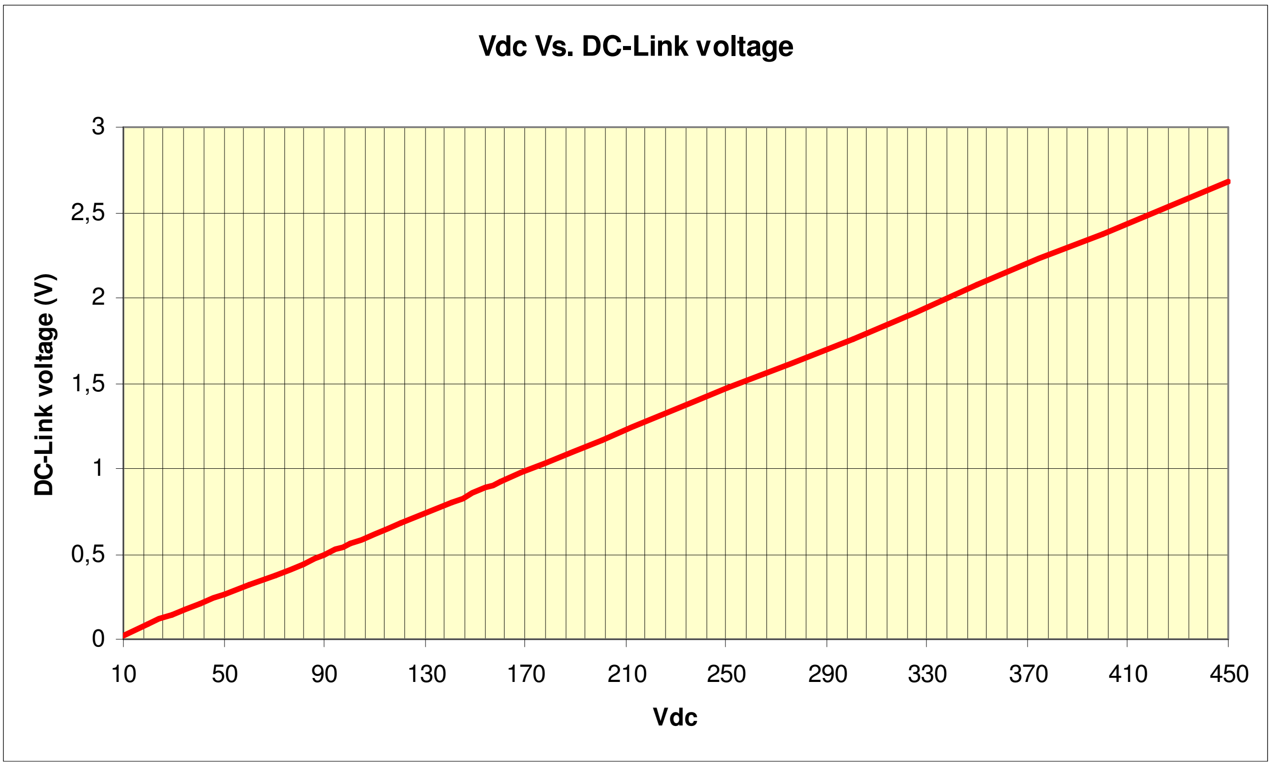


Figure 20 Characteristics of the DC voltage measurement

3.5.9 Board temperature

The temperature on the Evaluation Driver Board is measured with precision temperature sensor that can sense a -40℃ to +125℃ temperature range. The output voltage (Temp Board, K3.11) is linearly proportional to Celsius temperature (+10mV/℃) and has a DC offset of +500mV. Refer to Figure 31 for detailed description of the circuit.

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 HybridPACK™1 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 HybridPACK™1. 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 HybridPACK™1 Evaluation driver board was made keeping the following rules for the copper thickness and the space between different layers shown in Figure 21.

Layers:

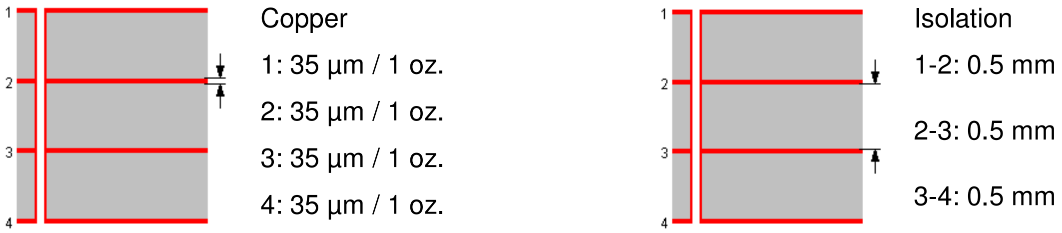


Figure 21 Copper and isolation for layers

3.8 Schematic, Layout and Bill of Material

To meet the individual customer requirements and make the Evaluation Driver Board for the HybridPACK™1 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

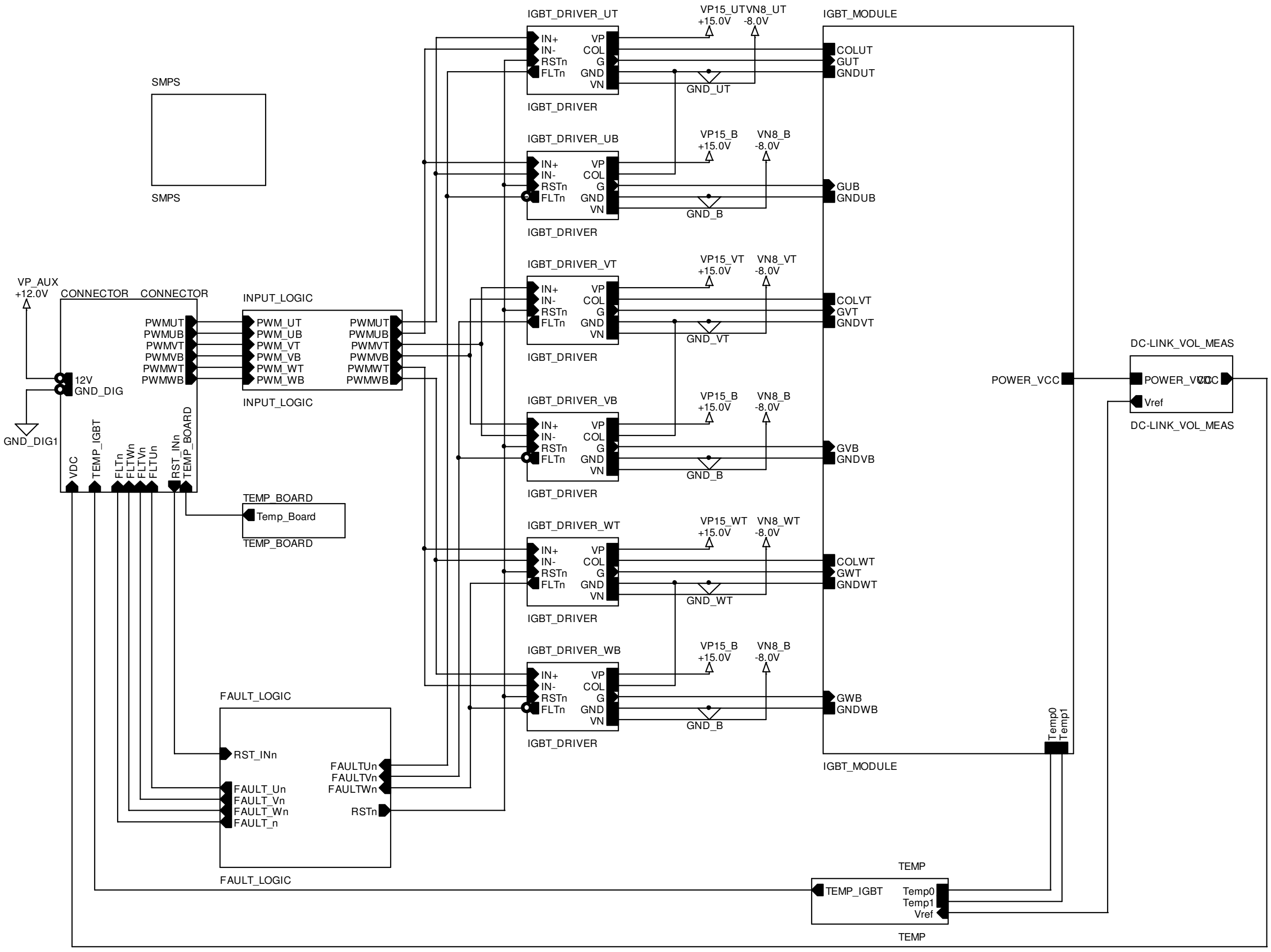


Figure 22 Schematics block overview

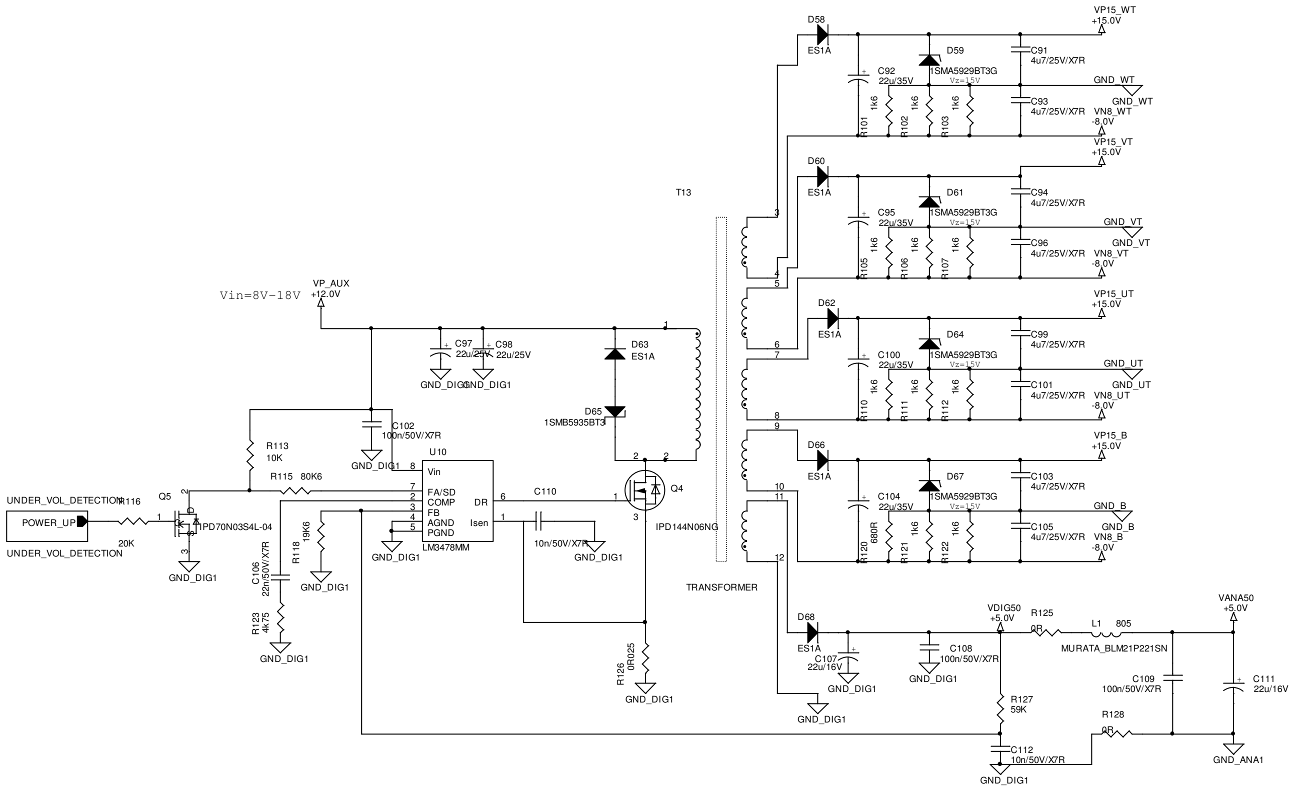


Figure 23 SMPS- Power Supply

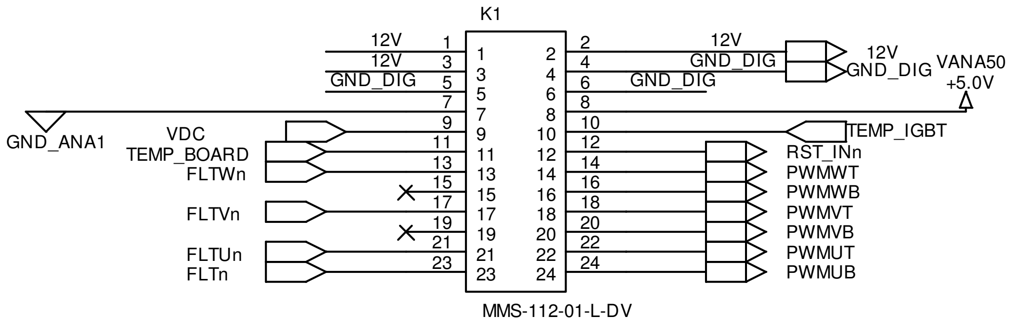


Figure 24 External connector

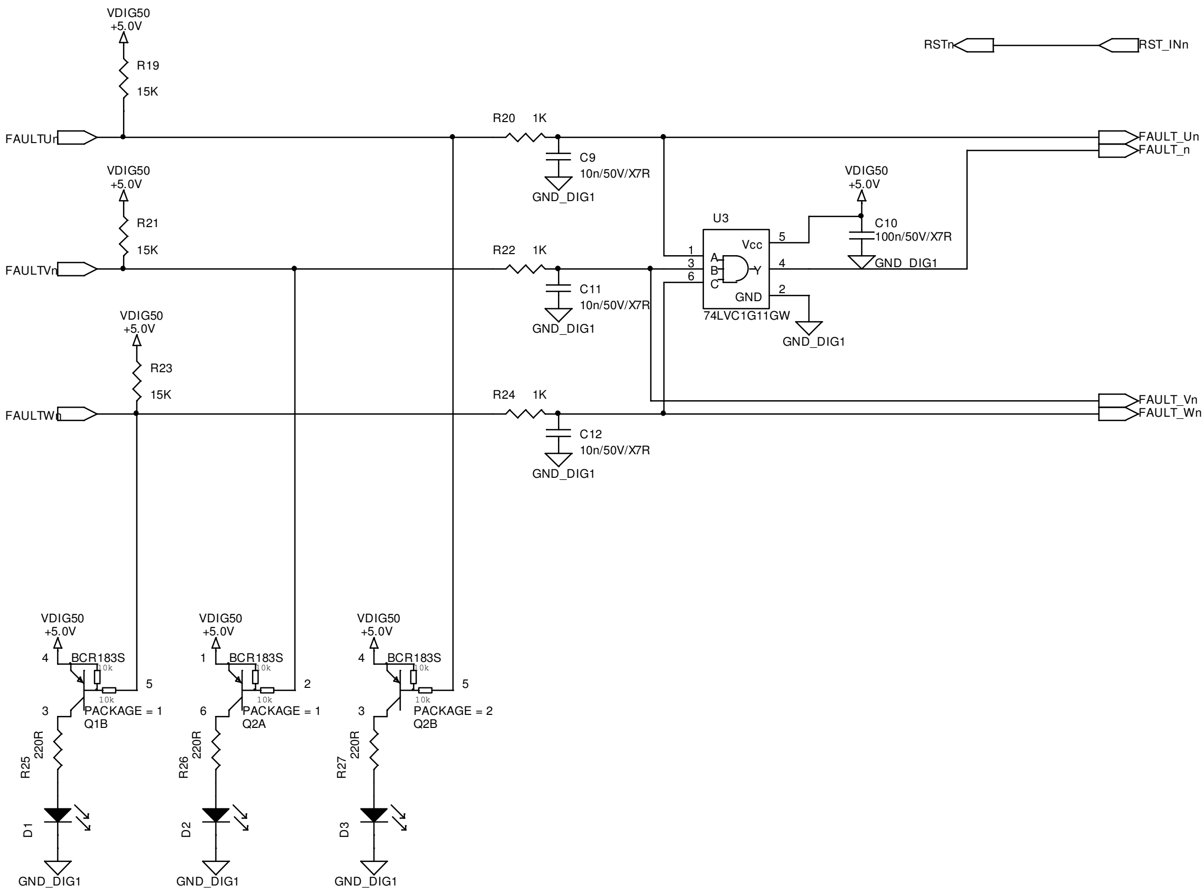


Figure 25 Fault Logic

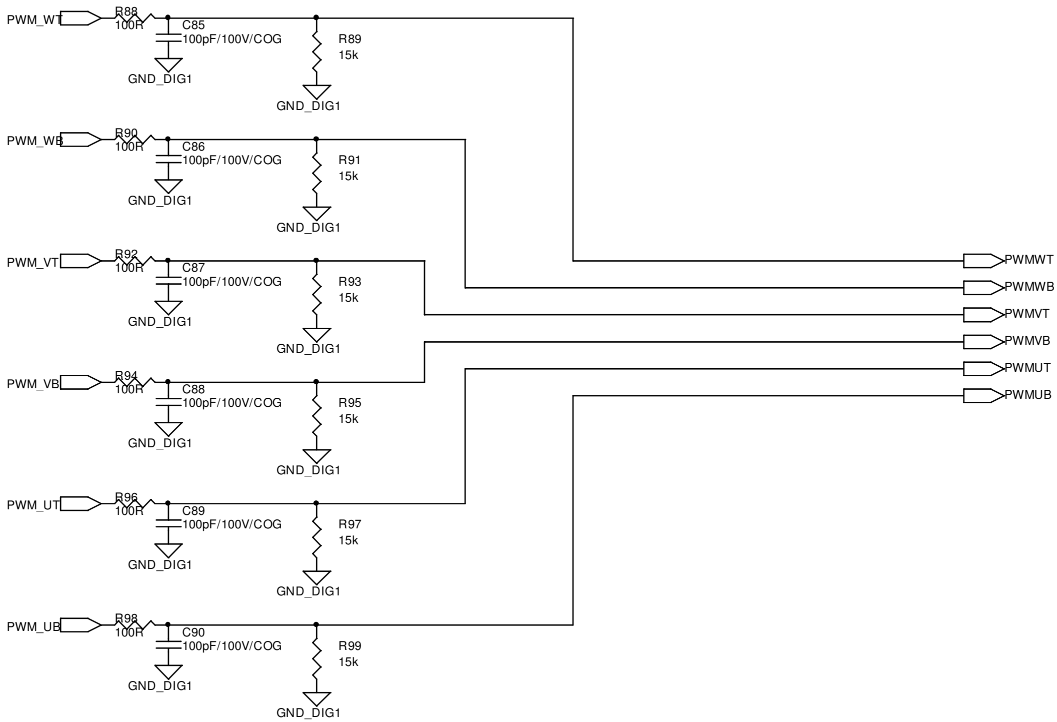


Figure 26 Input Logic

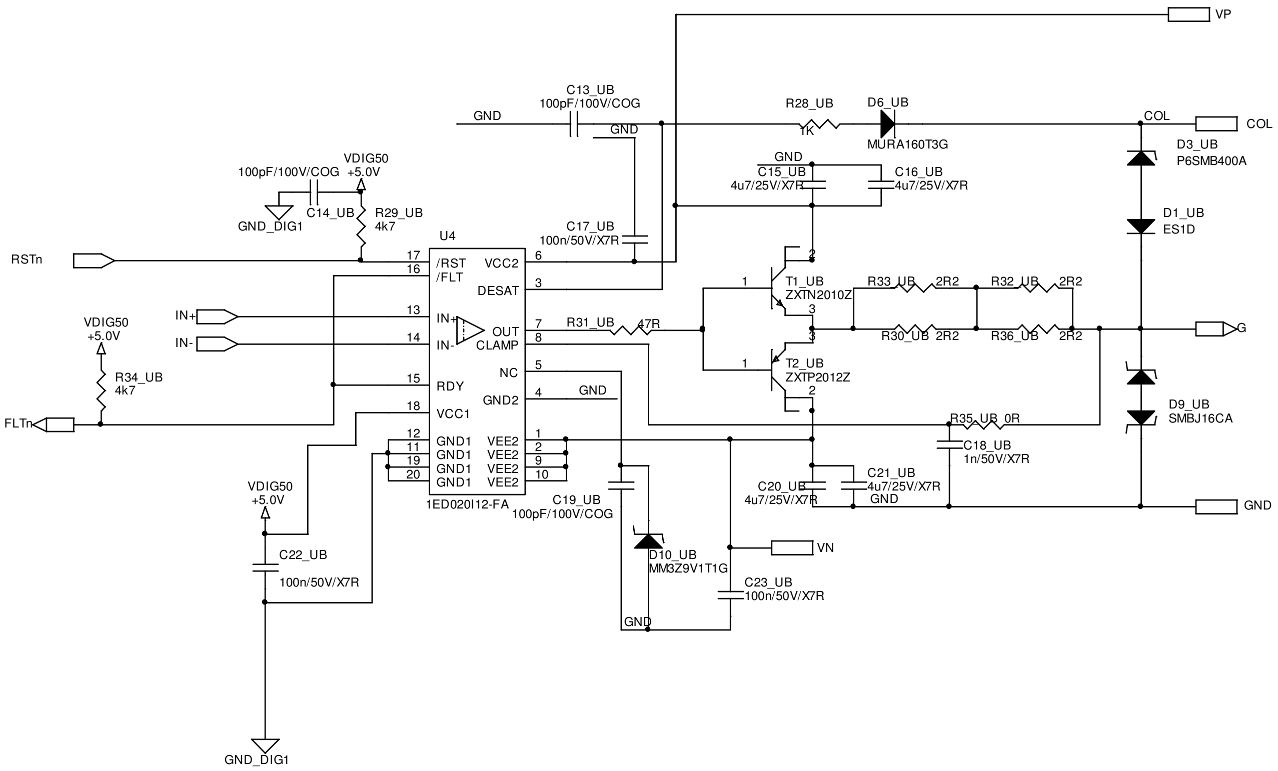


Figure 27 IGBT driver – Bottom transistor of phase U

Note: all IGBT driver blocks maintain the same structure as the one showed in Figure 27

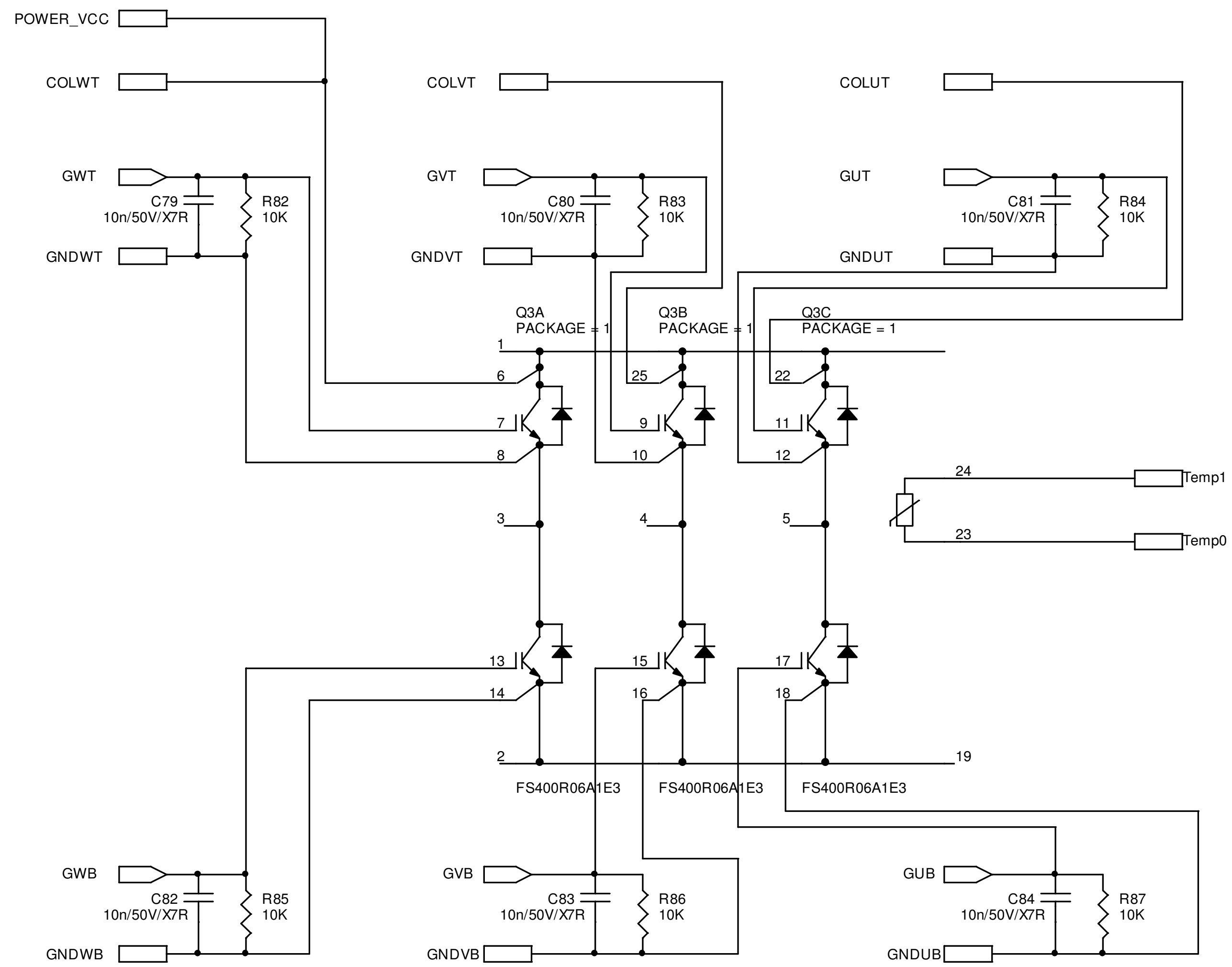


Figure 28 IGBT Module

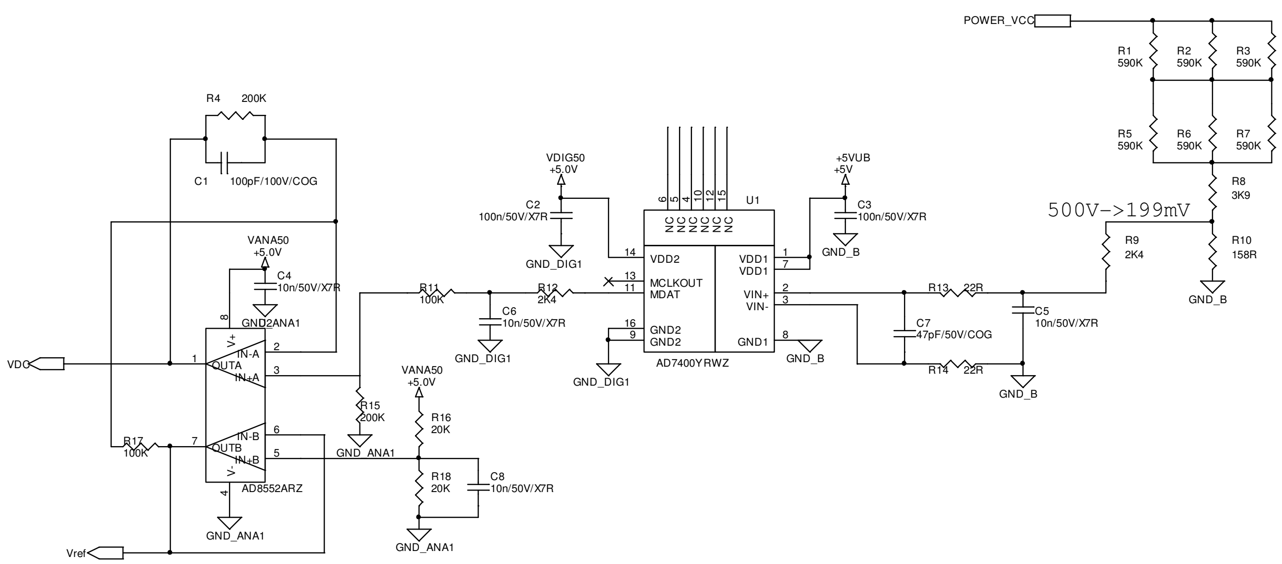


Figure 29 DC Voltage measurement

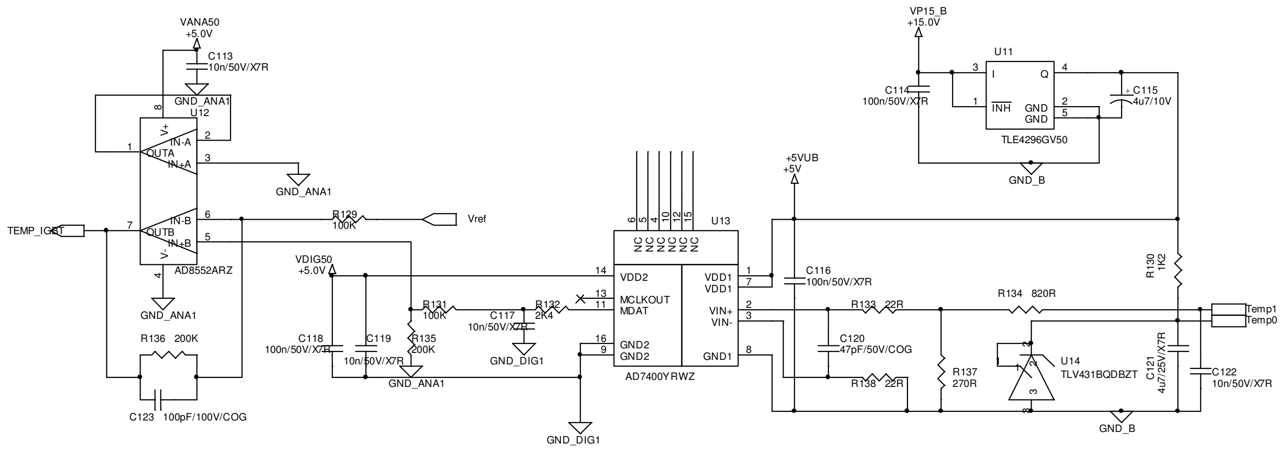


Figure 30 IGBT module temperature measurement

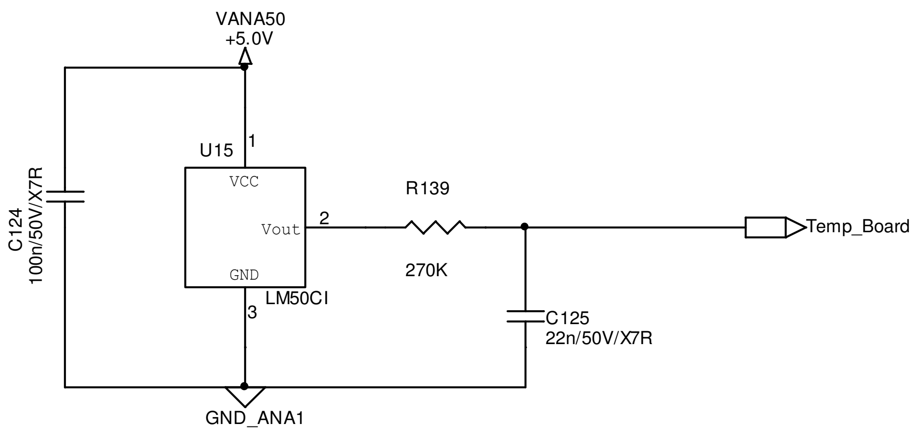


Figure 31 PCB temperature measurement

3.10 Assembly drawing

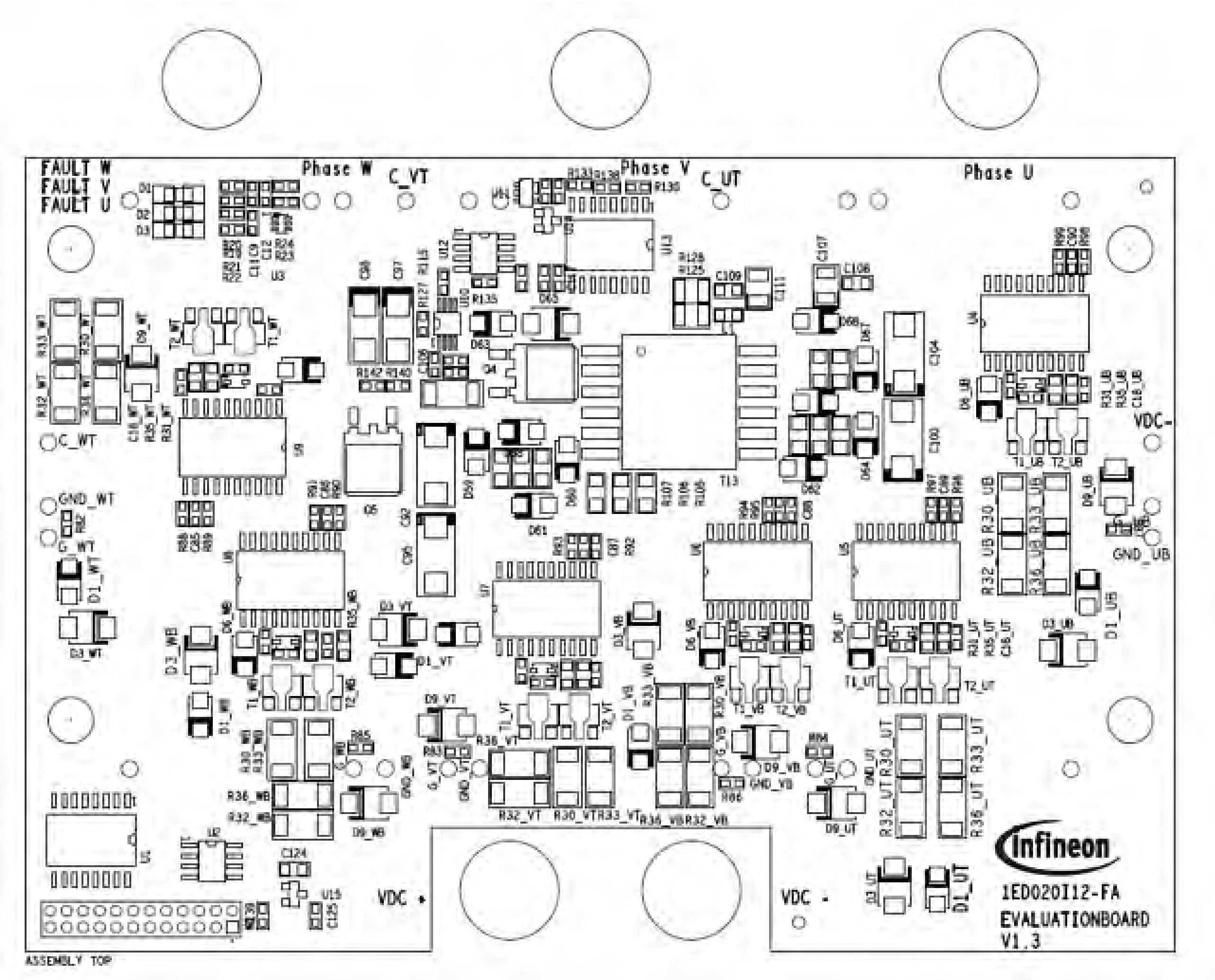


Figure 32 Assembly drawing of the HybridPACK™1 driver board (top)

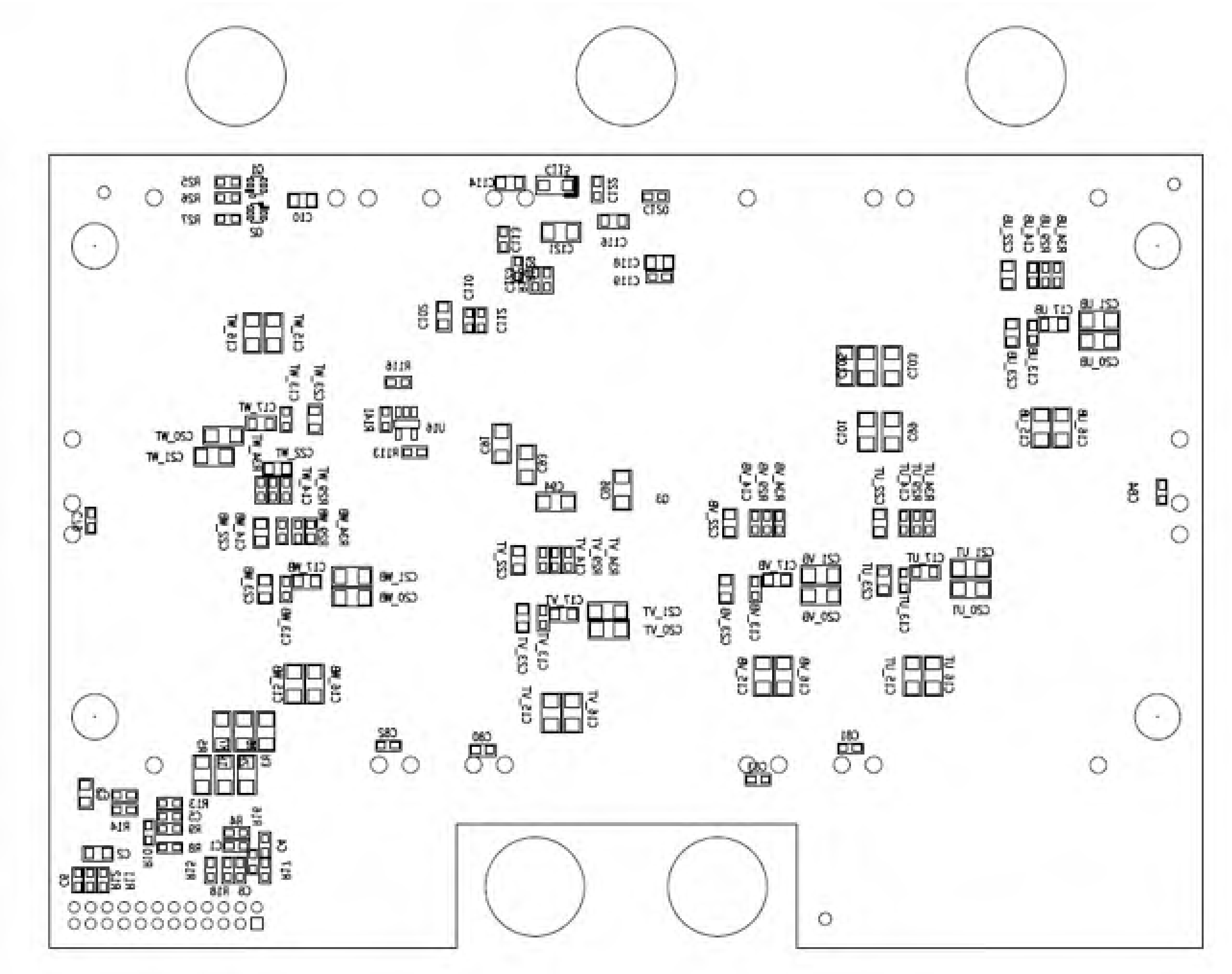


Figure 33 Assembly drawing of the HybridPACK™1 driver board (bottom)

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

3.11 Layout

Layout for the HybridPACK™1 driver board

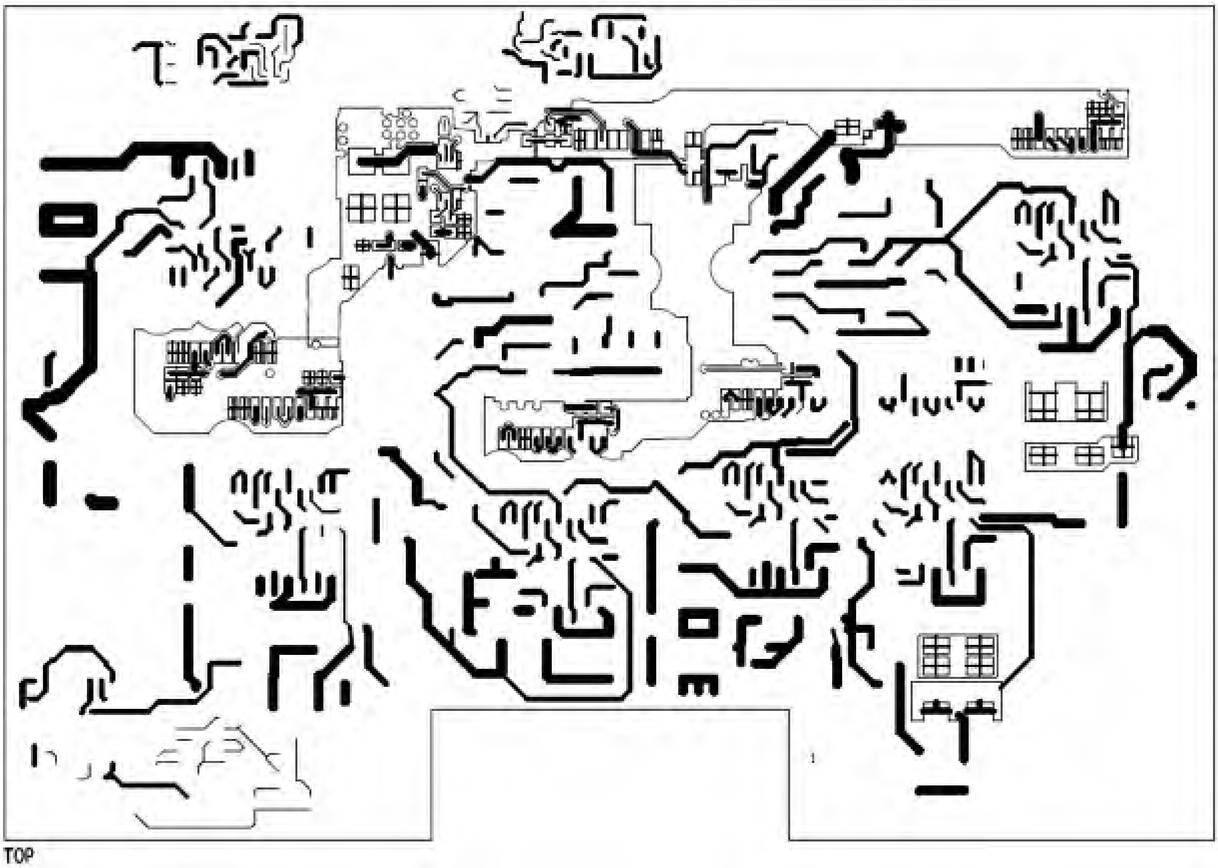


Figure 34 HybridPACK™1 IGBT driver – Top layer

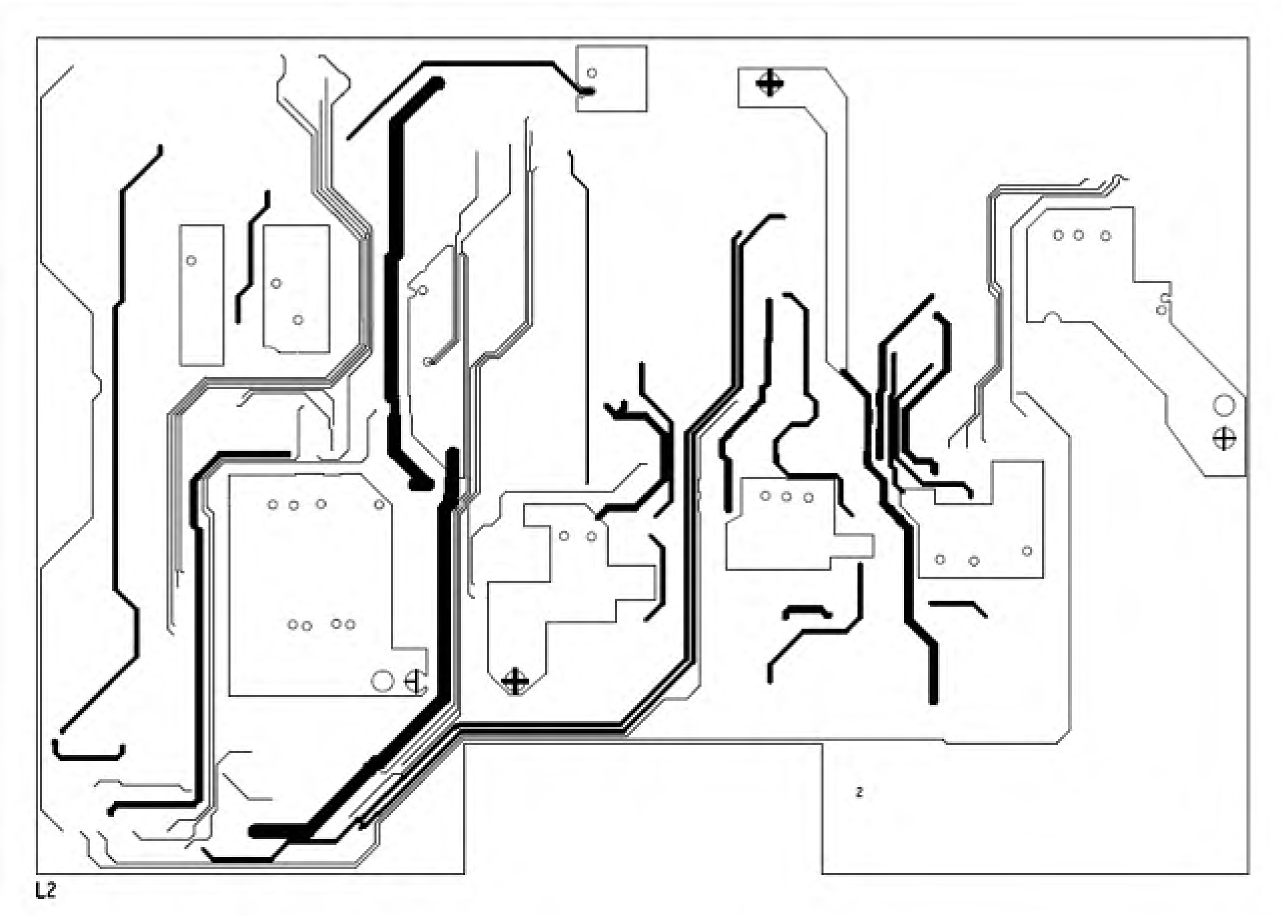


Figure 35 HybridPACK™1 IGBT driver – Layer 2

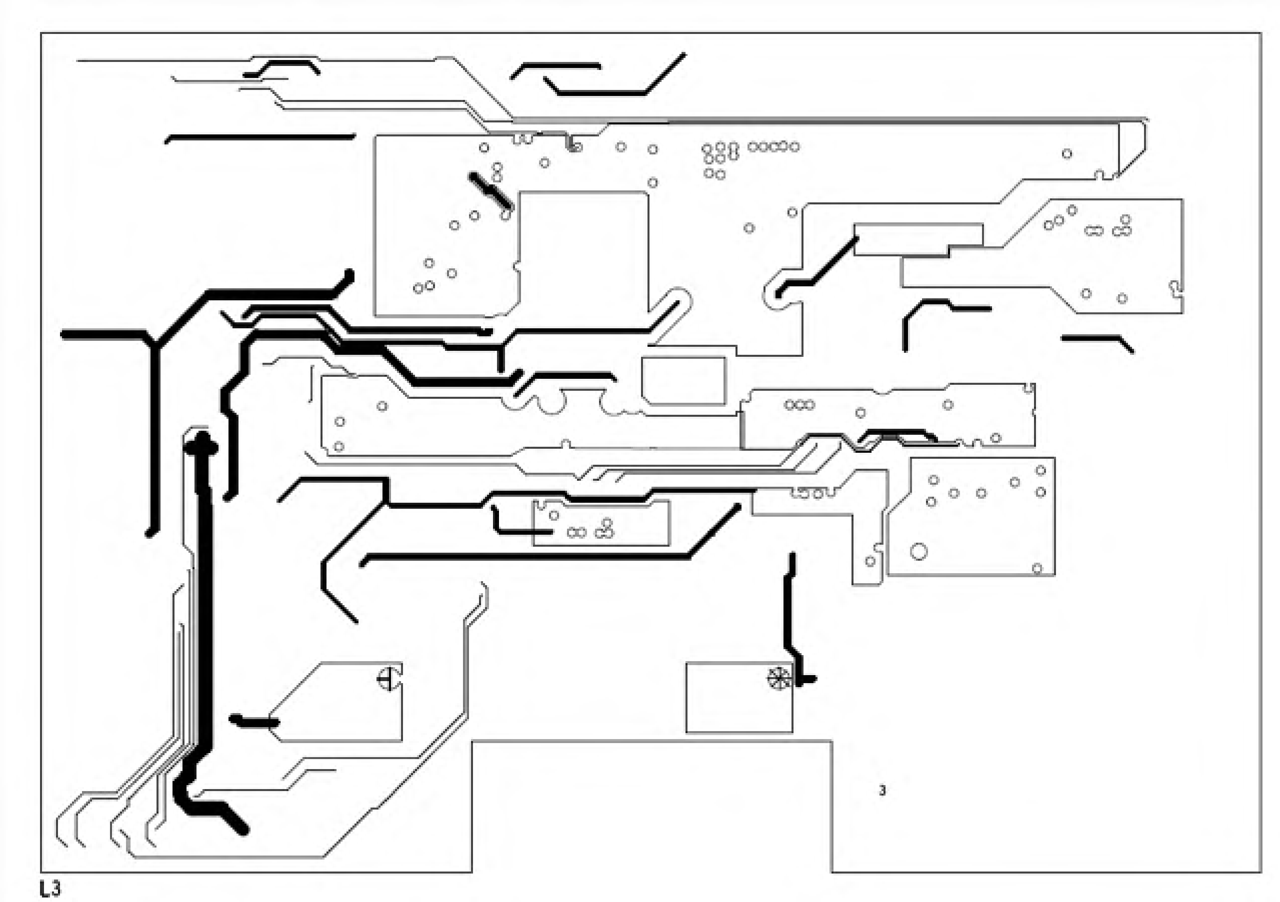


Figure 36 HybridPACK™1 IGBT driver – Layer 3

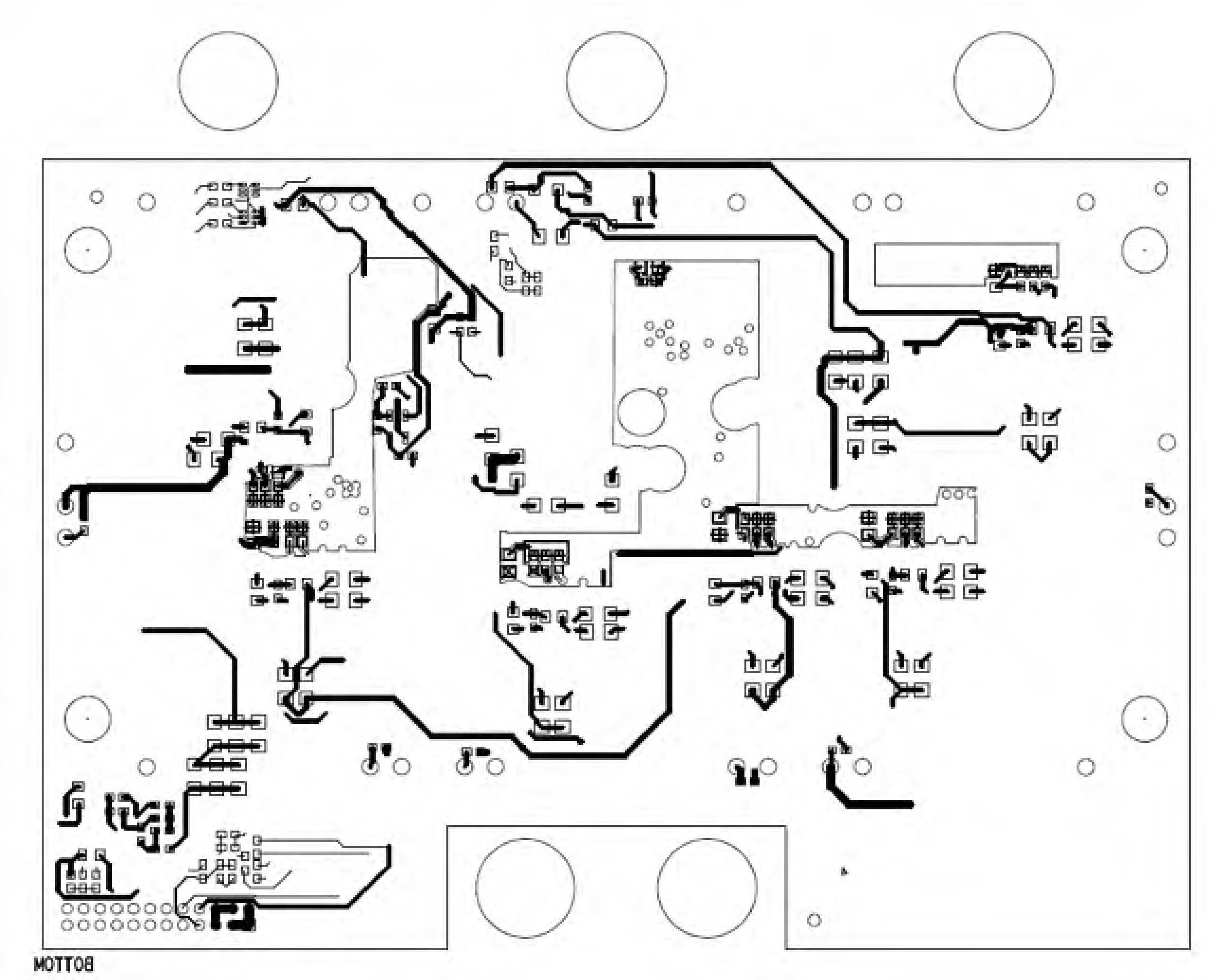


Figure 37 HybridPACK™1 IGBT driver – Bottom Layer 4

3.12 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	HybridPACK™1
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	Intica 404 00 111 06	
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

4 Adapter Board

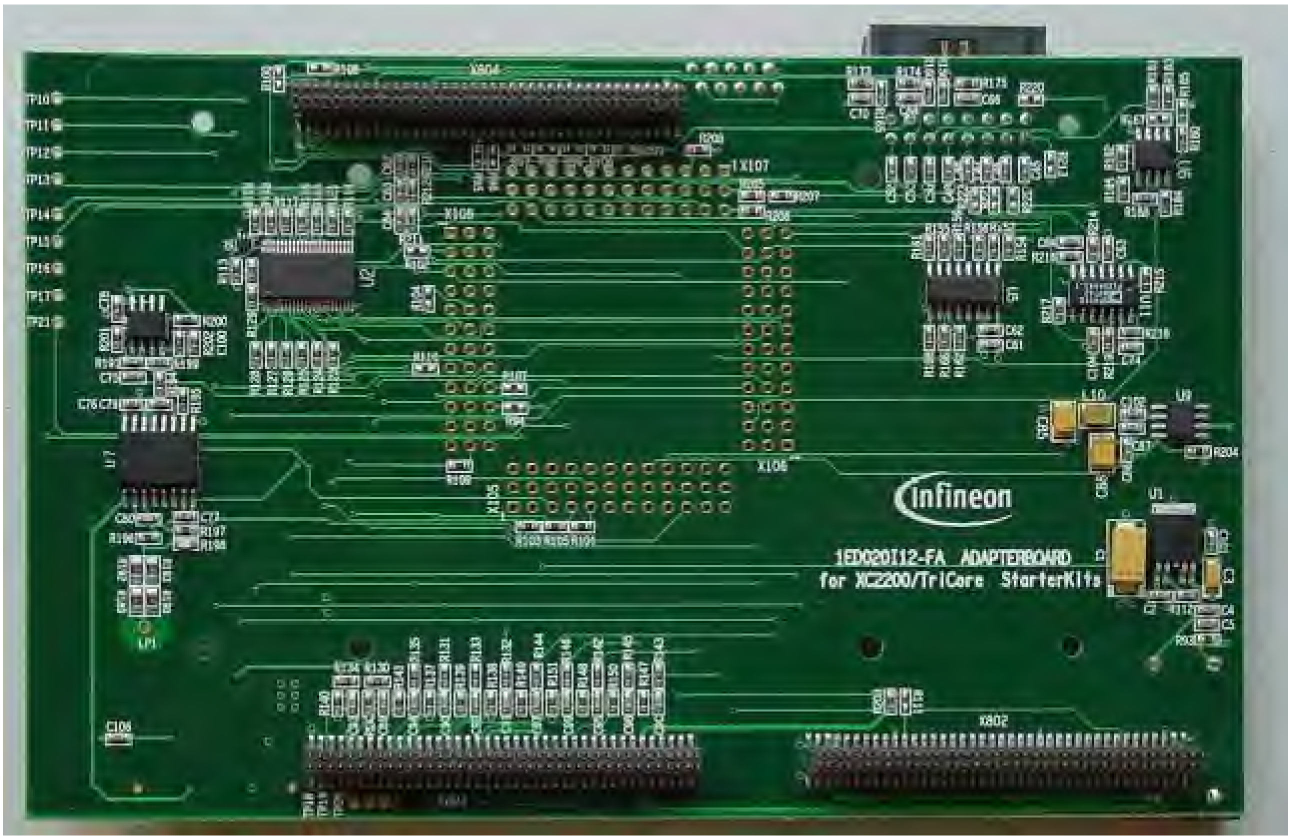


Figure 38 Adapter Board

The adapter board (Figure 38) offers the interface between the Hybrid Kit for HybridPACK™1 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 39 shows the block structure of the Adapter Board and the following chapters describe these blocks in detail.

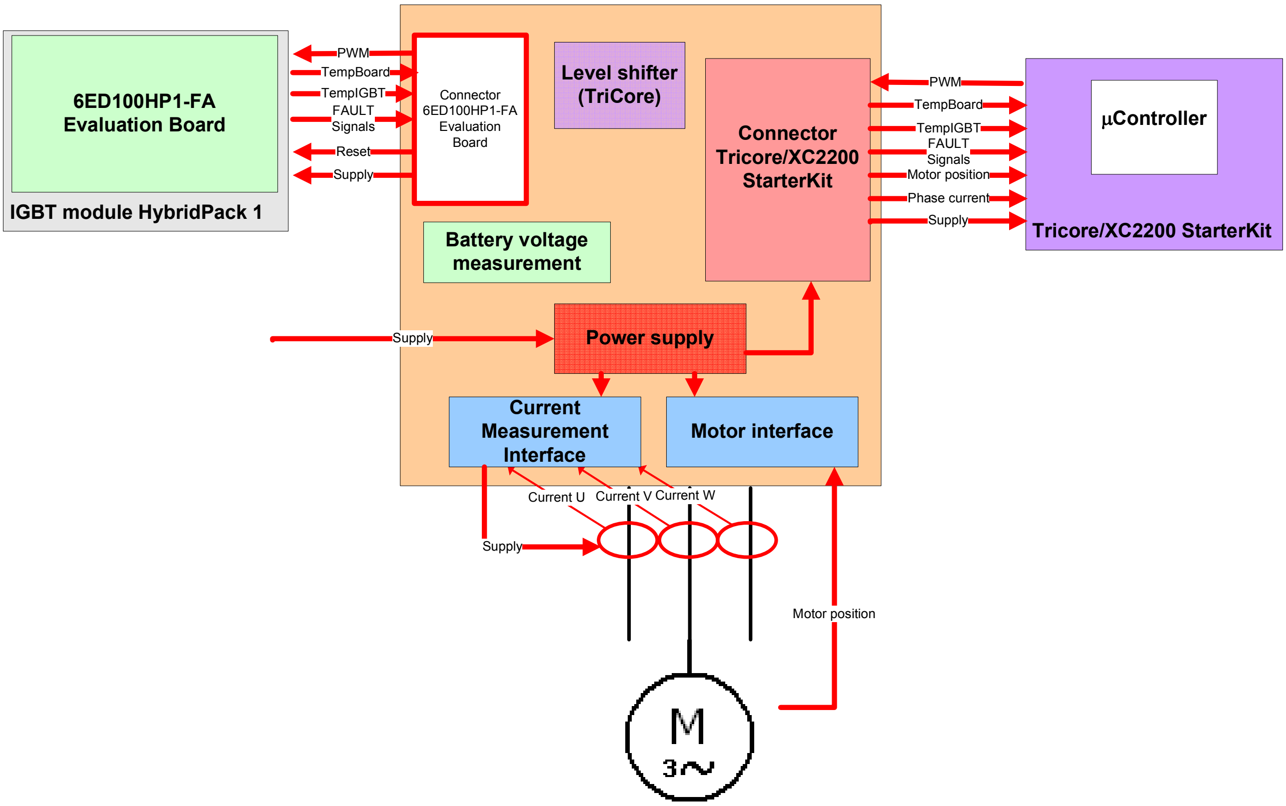


Figure 39 Block diagram of the Adapter Board

4.1 Power supply

The complete system (6ED100HP1-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 6ED100HP1-FA through the connector K1_HP1 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 6ED100HP1-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 40 shows the pin assignment.

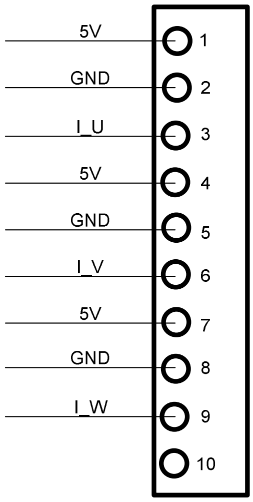


Figure 40 Connector interface to current measurement system

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 Battery voltage measurement

In case of using the Hybrid Kit for HybridPACK™1 as DC-DC converter, not only the DC-Link voltage must be measured (see chapter 3.5.8) but the battery voltage. The circuit used for such proposed is the same one already explained for DC voltage measurement and Temperature measurement and is shown in Figure 41

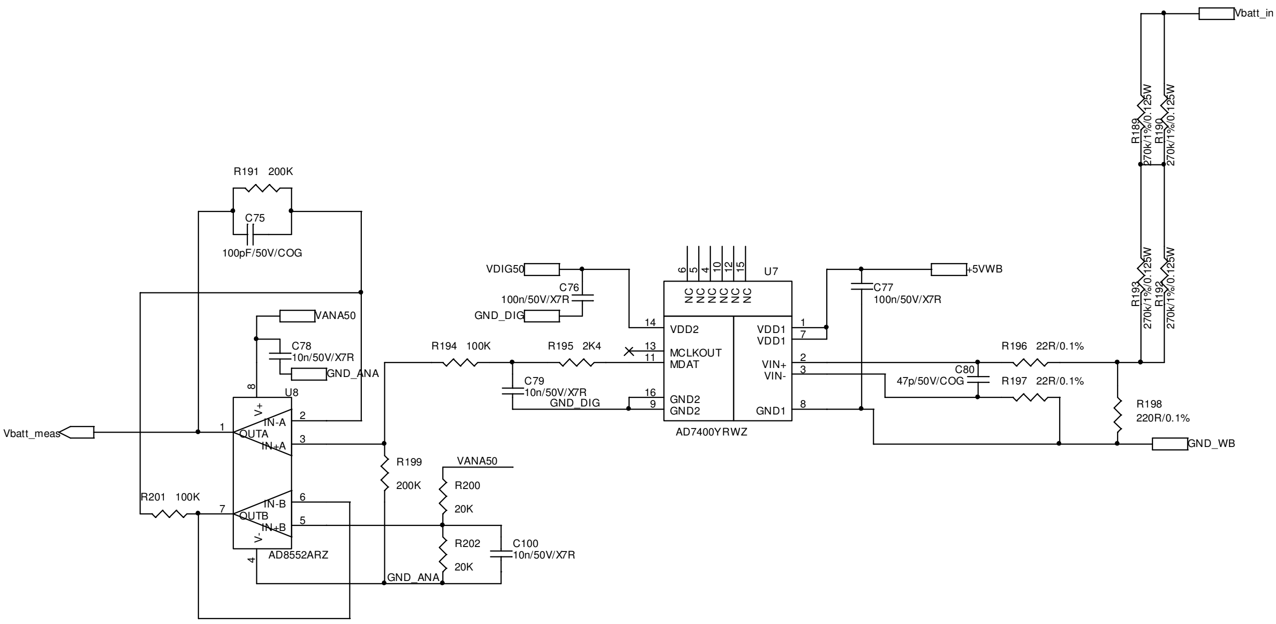


Figure 41 Battery measurement schematics

4.5 Motor interface

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

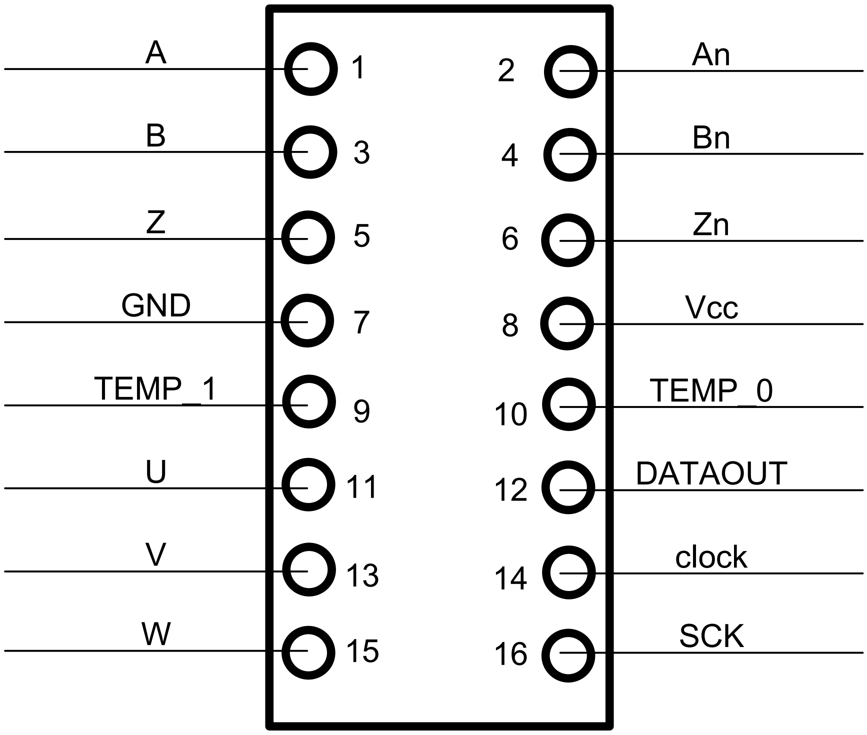


Figure 42 Connector interface to motor positioning system

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 4.7.1 for more details on the circuits for these signals

Resolver: 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 4.7.1 for more details on the circuits for these signals.

GMR (Giant Magneto Resistance) sensor: 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 4.7.1 for more details on the circuits for these signals.

4.6 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:

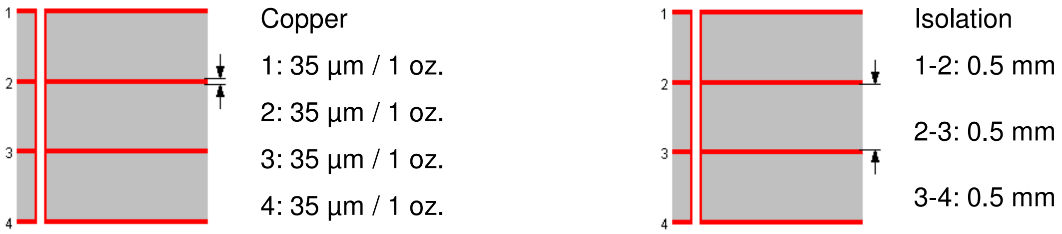


Figure 43 Copper and isolation for layers

4.7 Schematics, layout and bill of materials

To meet the individual customer requirements and make the Hybrid Kit for HybridPACK™1 module a platform for development or modifications, all necessary technical data like schematic, layout and components are included in this chapter.

4.7.1 Schematic

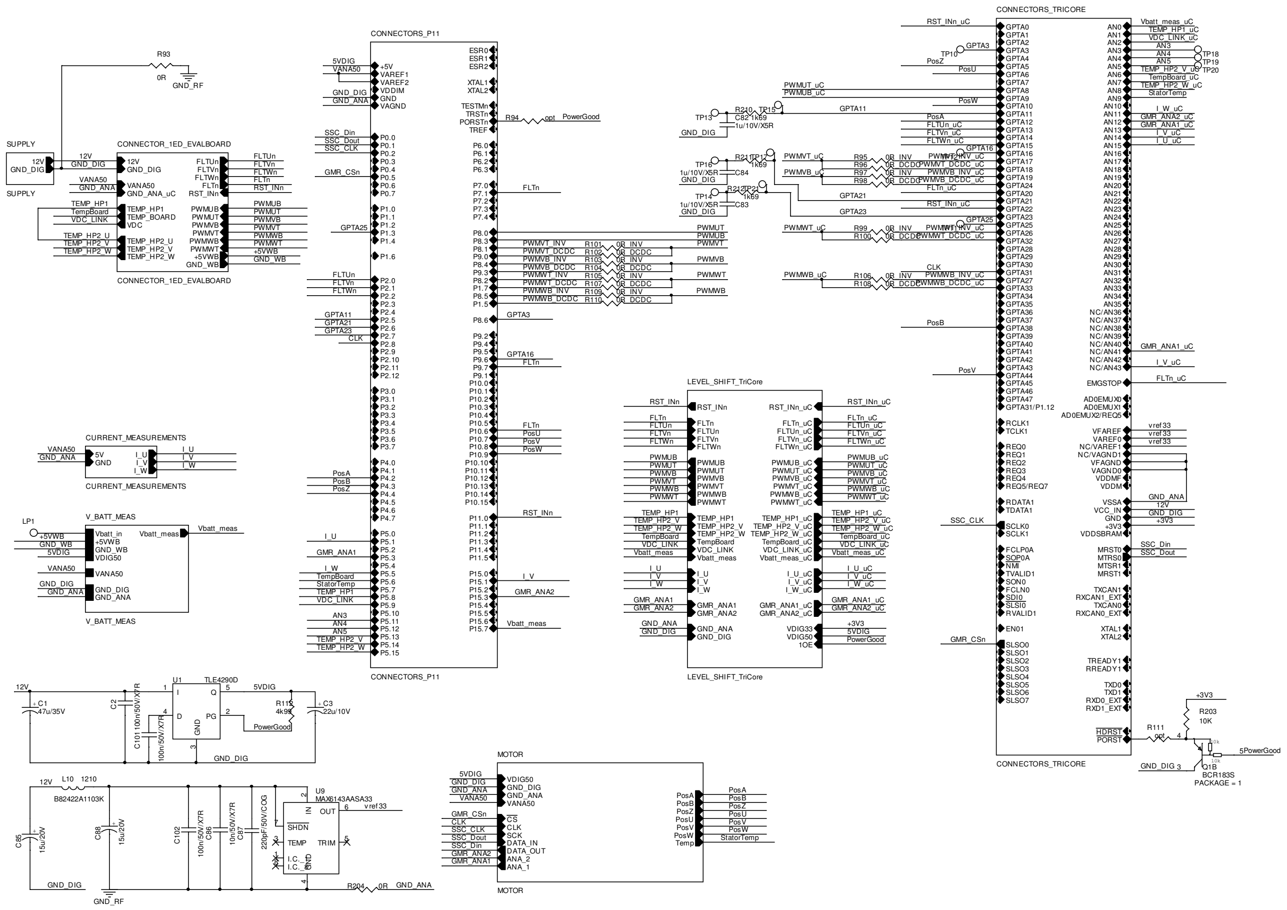


Figure 44 Schematics block overview

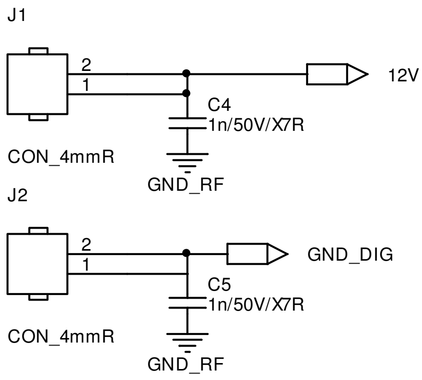
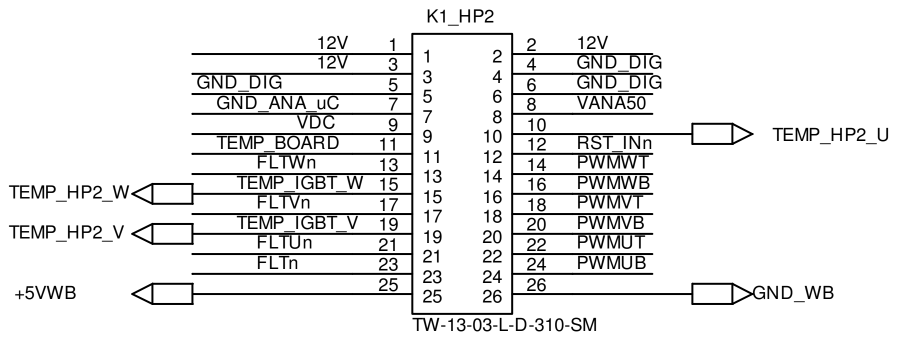


Figure 45 Supply



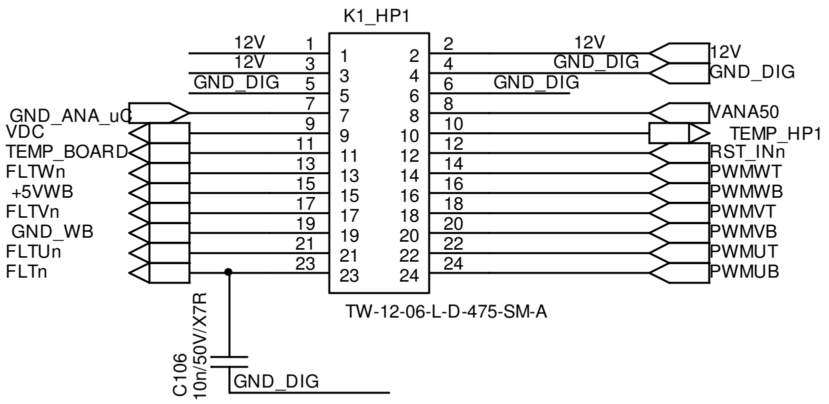


Figure 46 Connector_1ED_EVALBOARD

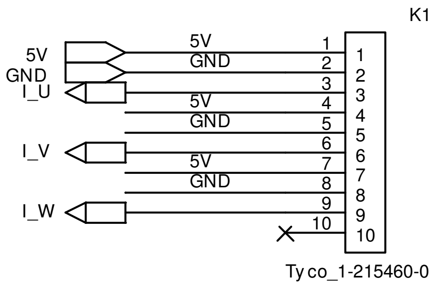


Figure 47 Current Measurement

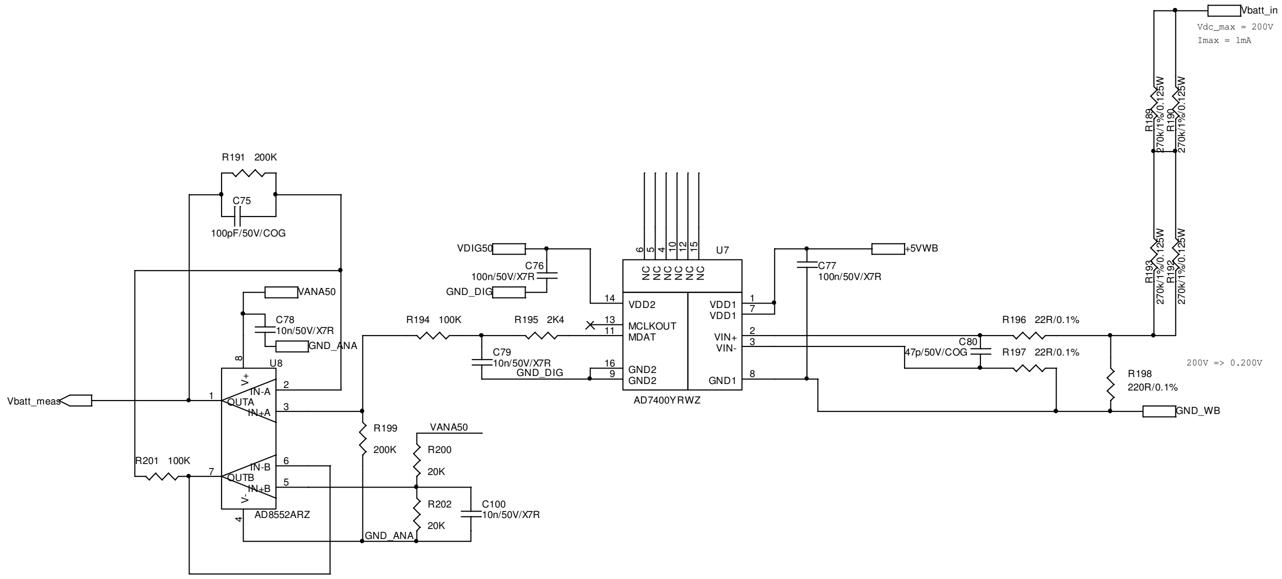


Figure 48 V_BATT_MEAS

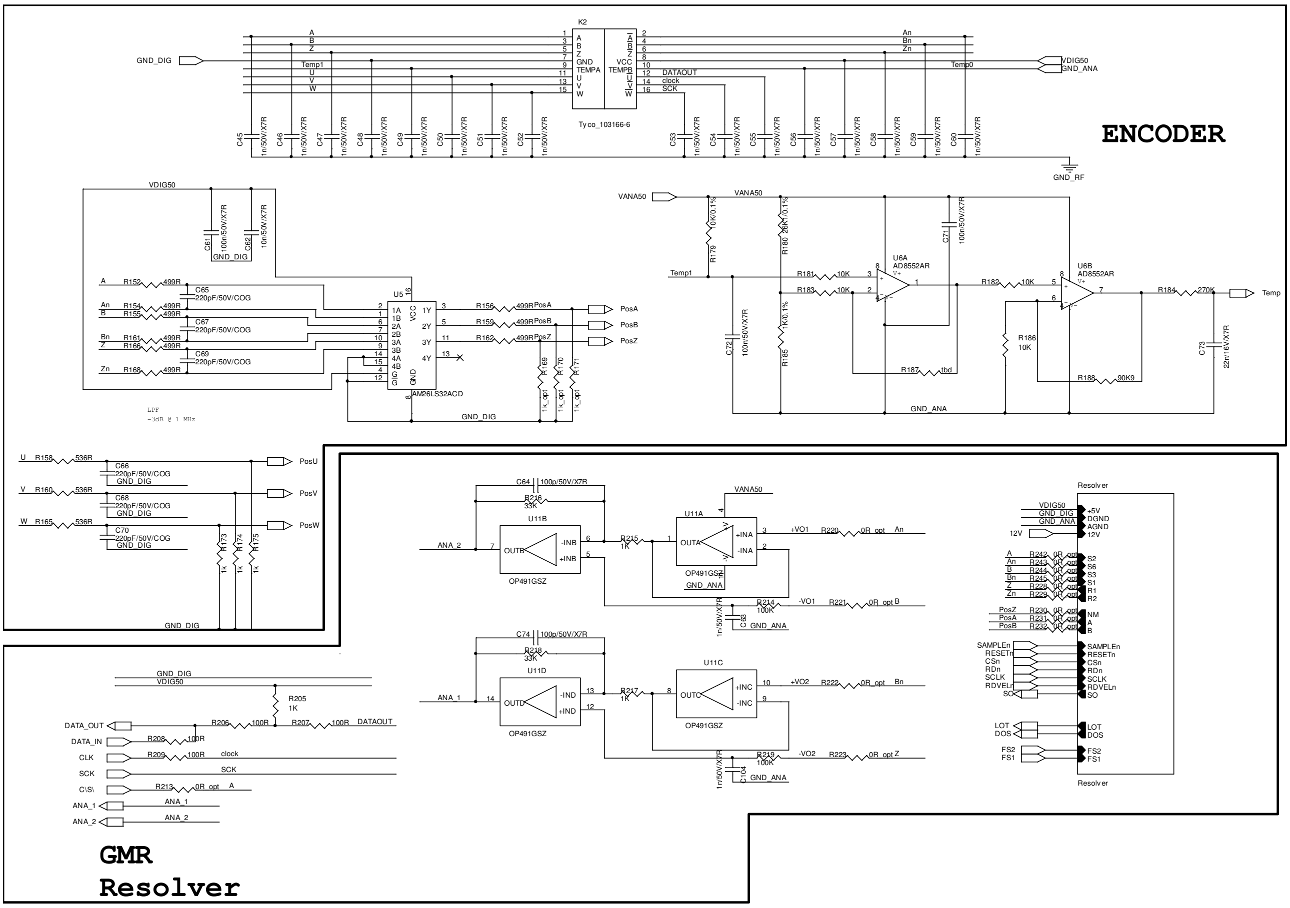


Figure 49 MOTOR

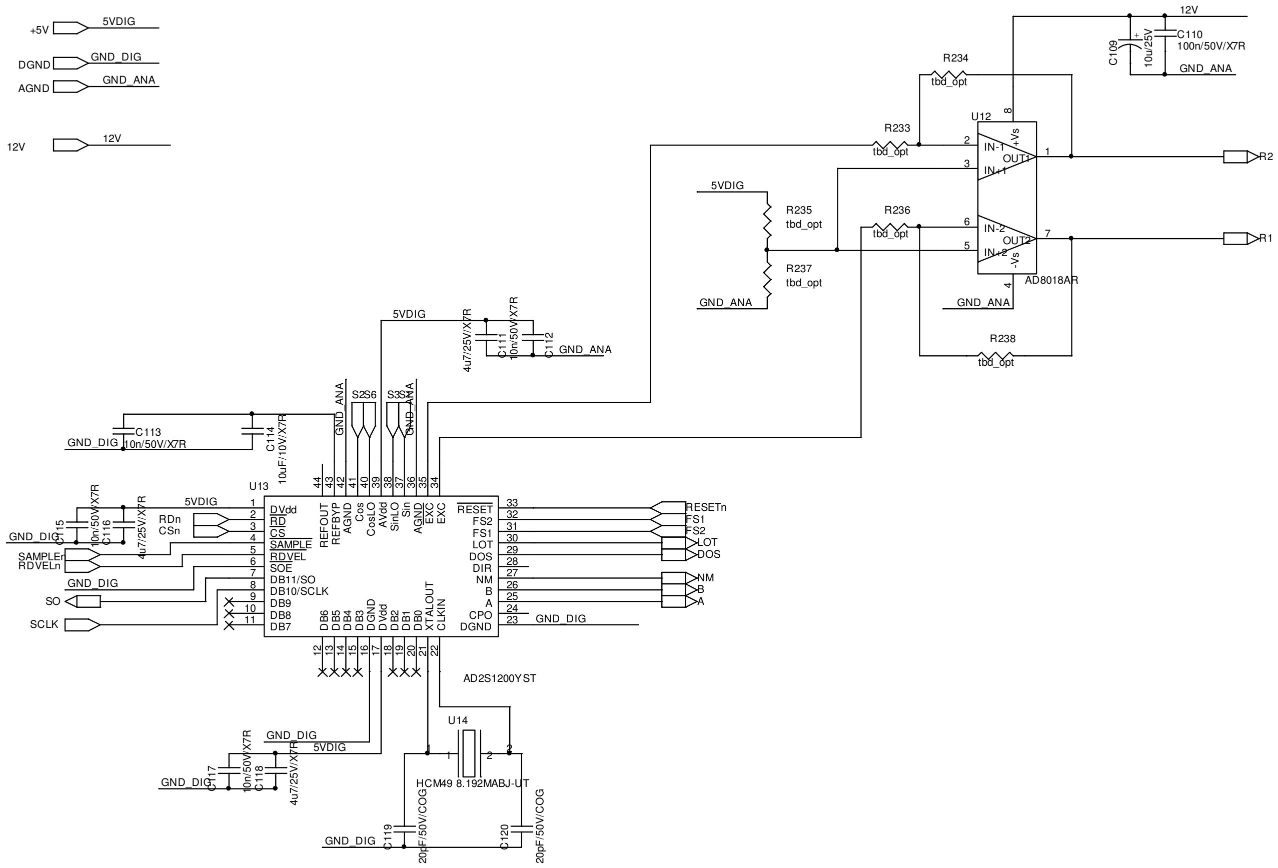


Figure 50 Resolver-to-digital

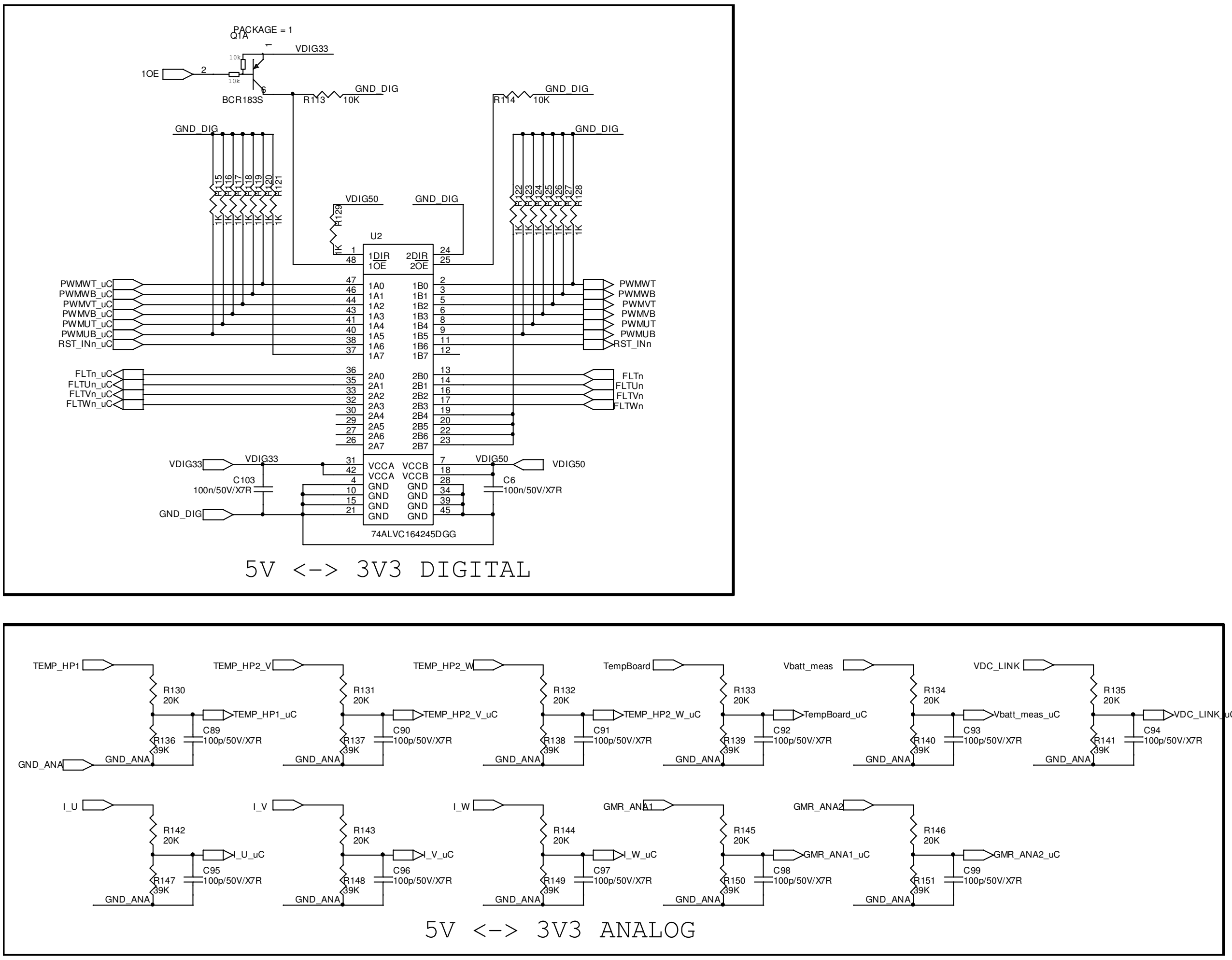


Figure 51 LEVEL_SHIFT_TriCore

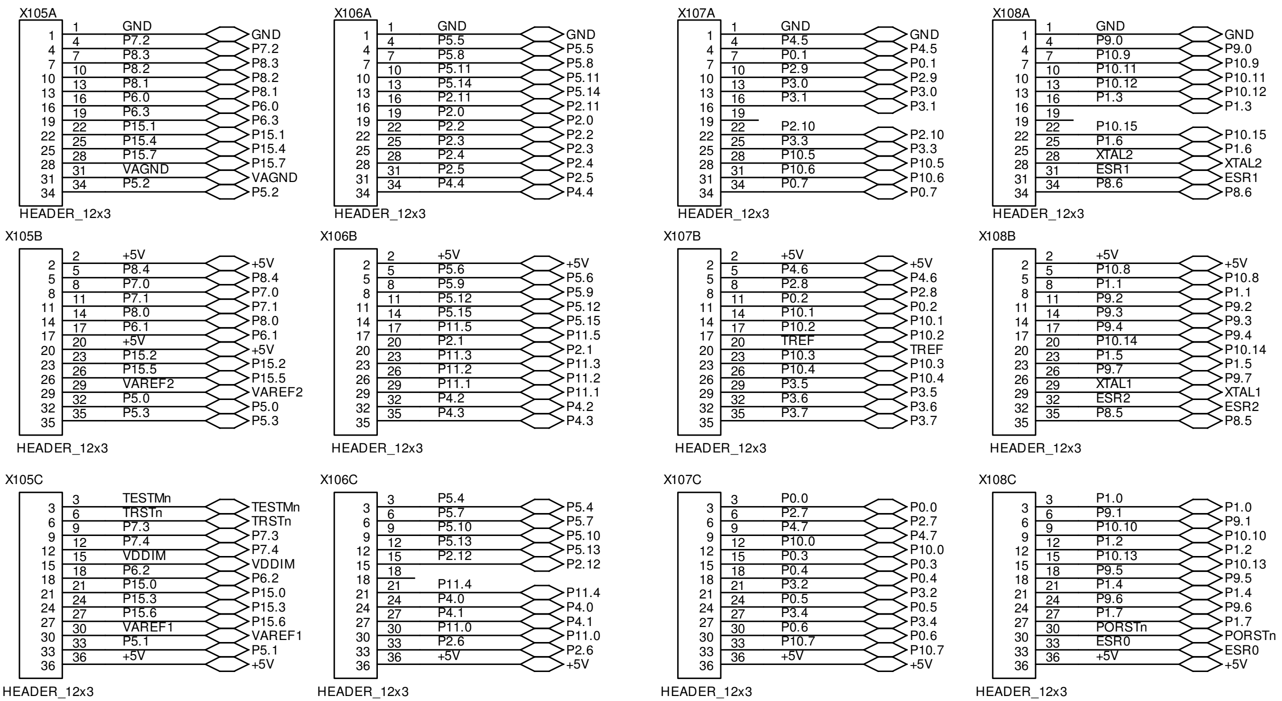


Figure 52 CONNECTORS_P11

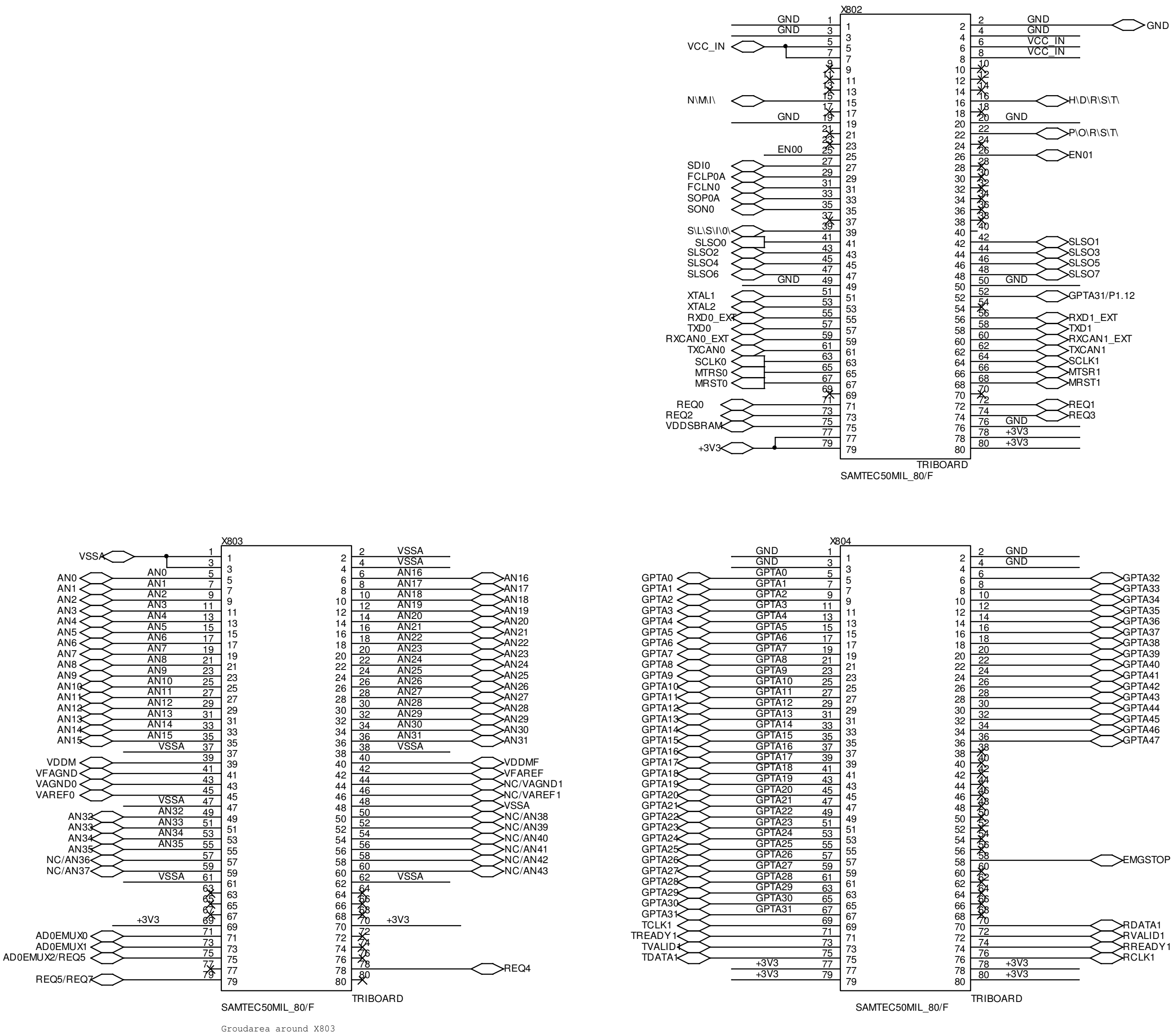


Figure 53 CONNECTORS_TRICORE

4.7.2 Assembly

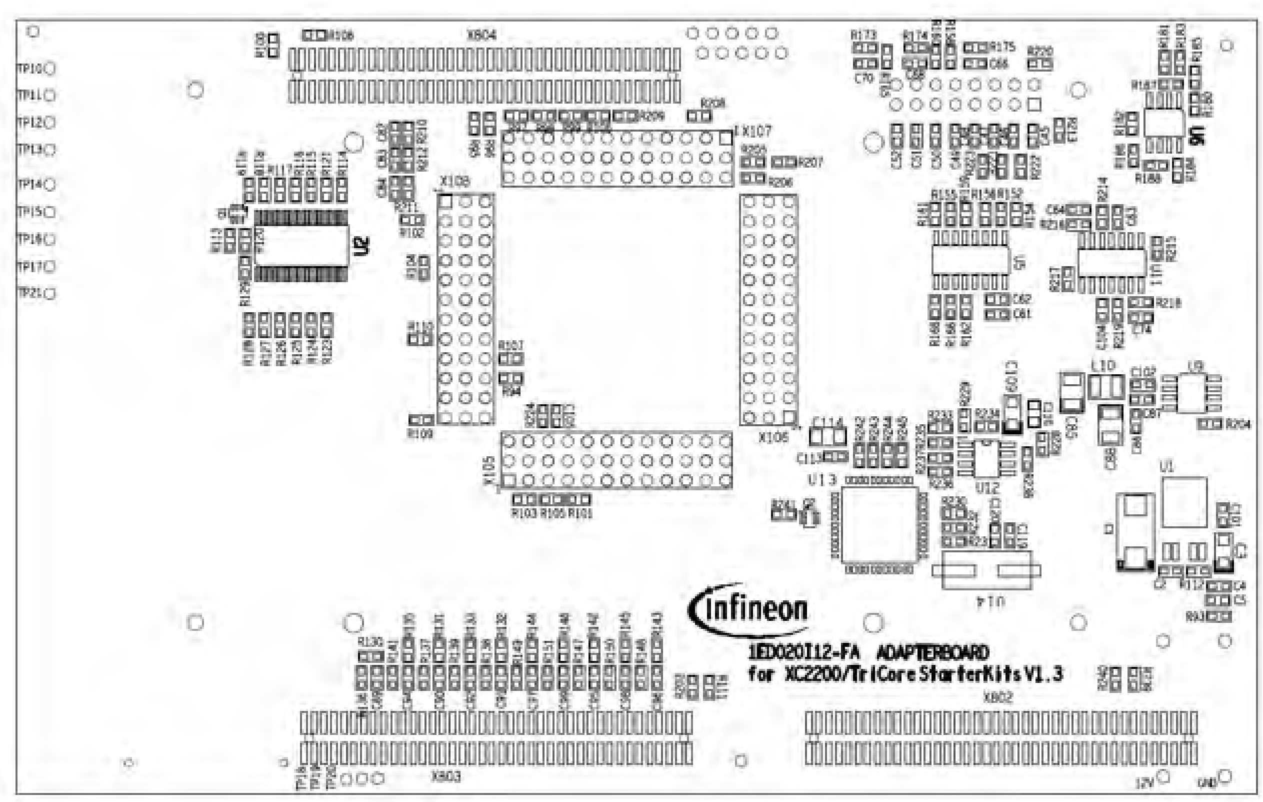


Figure 54 Assembly drawing of the Adapter Board (top)

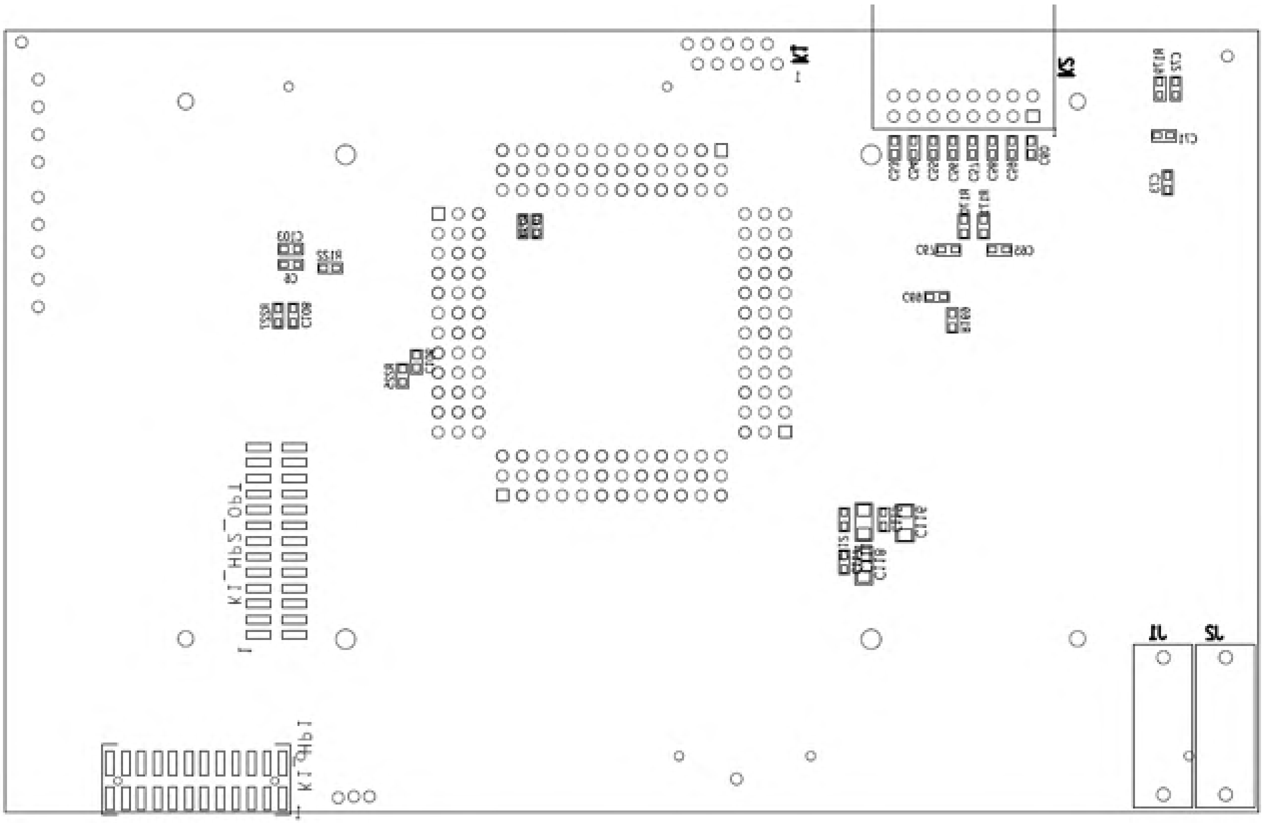


Figure 55 Assembly drawing of the Adapter Board (bottom)

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

4.7.3 Layout

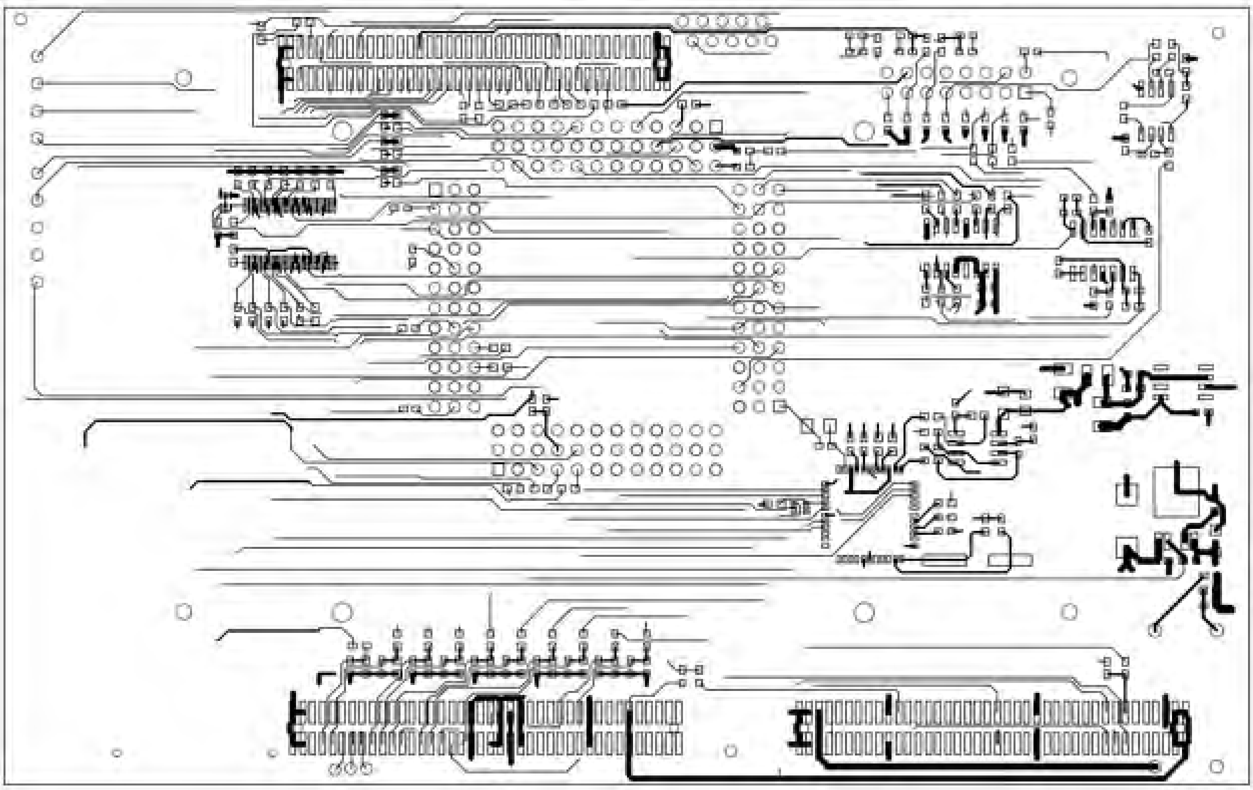


Figure 56 Adapter Board – Top layer

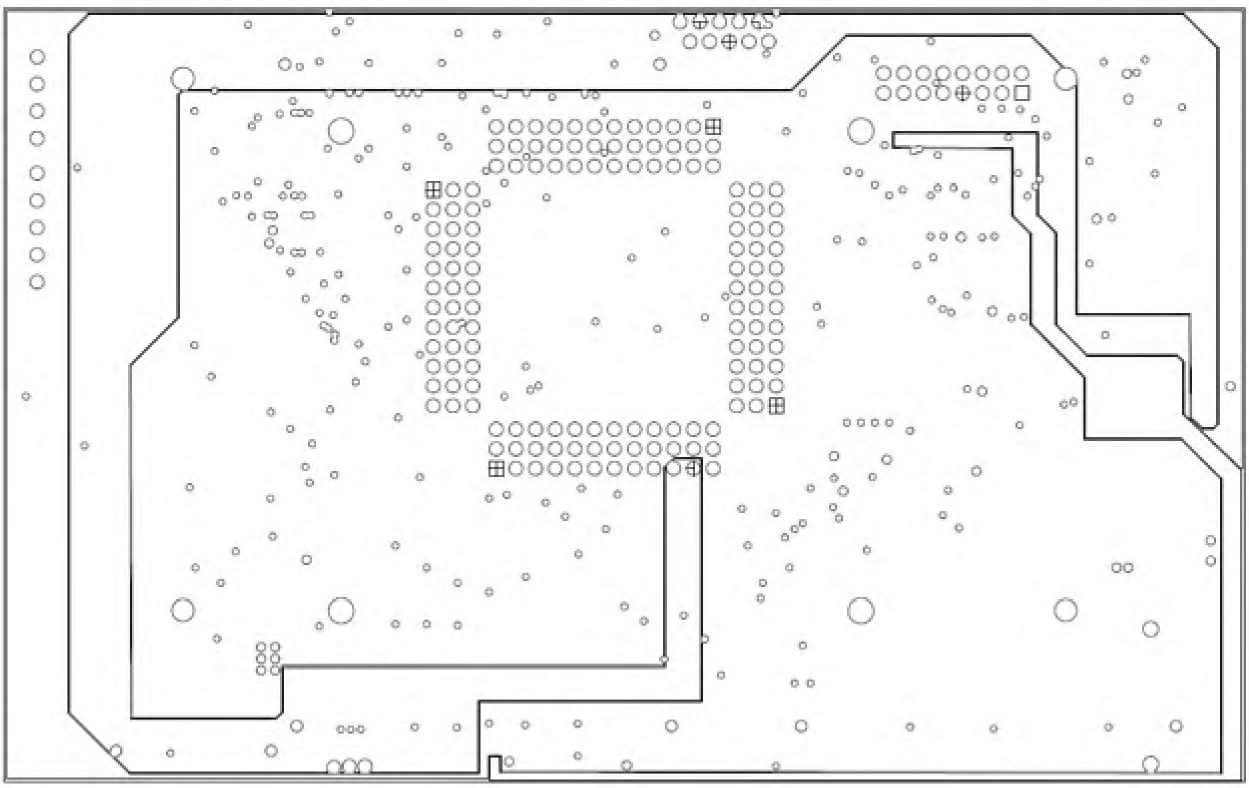


Figure 57 Adapter Board – Layer 2

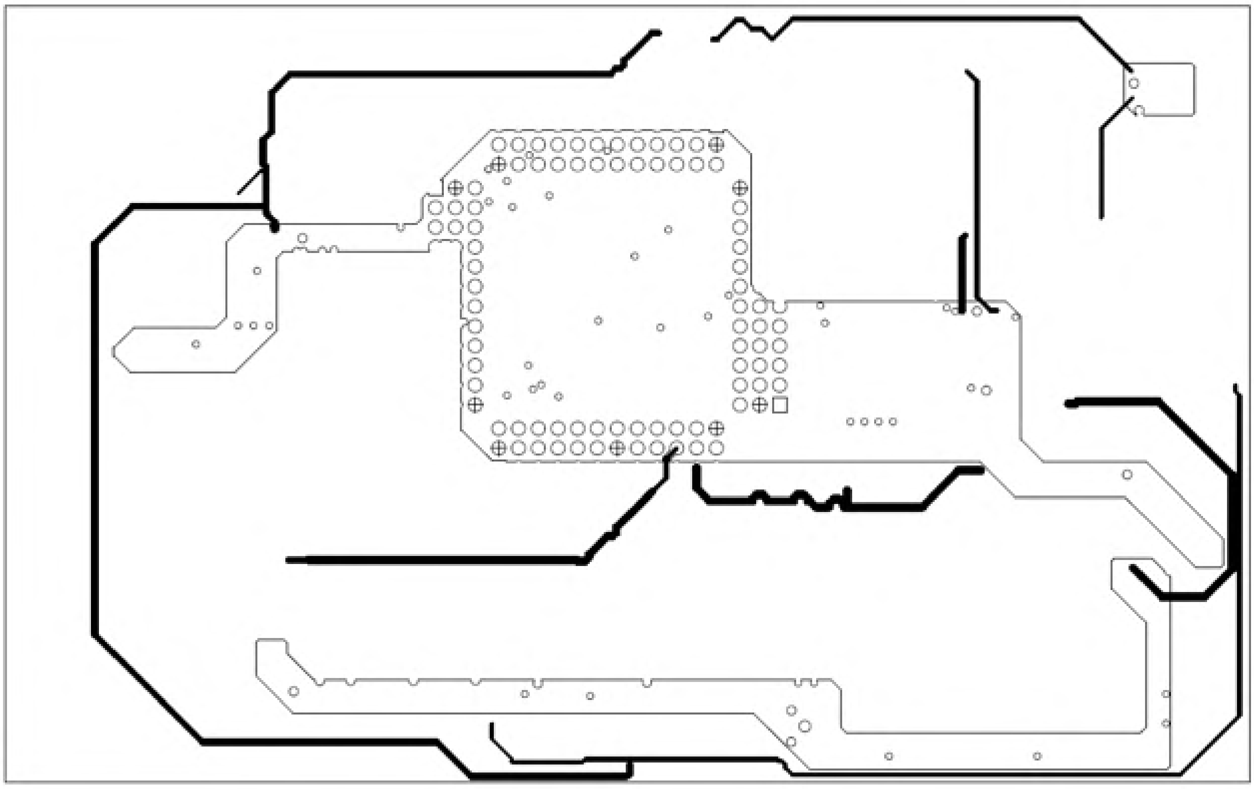


Figure 58 Adapter Board – Layer 3

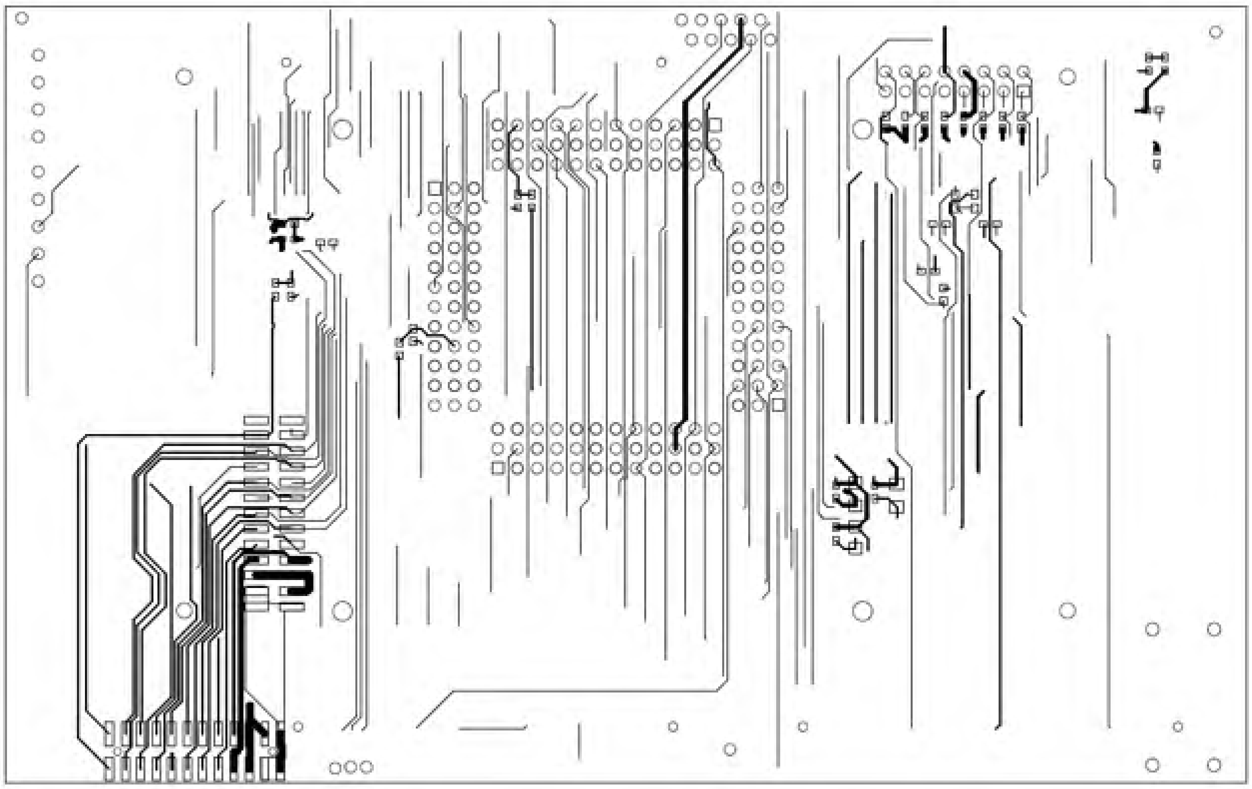


Figure 59 Adapter Board – Bottom layer

4.7.4 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 6ED100HP1-FA driver board must be assembly on top of the HybridPACK™1 (see Figure 60).

Figure 60 6ED100HP1-FA driver board on top of the HybridPACK™1

Afterwards the DC-Link capacitor can be screwed to the terminals of the HybridPACK™1 (see Figure 61)

Figure 61 DC-Link capacitor screwed to HybridPACK™1 terminals

Next connect the Adapter Board to the 6ED100HP1-FA driver board and fix it using 15mm spacers and screws as it is shown on Figure 62

Figure 62 Adapter board connected to the 6ED100HP1-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 63

Figure 63 TriCore Starter Kit

6 How to order Hybrid Kit for HybridPACK™1

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

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