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MA040E12_EVAL – Isolated Gate Driver Power Supply and Logic Interface for MIPAQ™ Serve

IFAG IMM INP M AE

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1 Introduction

The MA040E12_EVAL isolated gate driver power supply and logic interface board as shown in Figure1 was developed to support customers during their first steps designing applications with the MIPAQ™ serve modules.

The MA040E12 module power supply boards are available from Infineon in small quantities. Functions and properties of these parts are described in the datasheet chapter of this document whereas the remaining paragraphs provide information intended to enable the customer to copy, modify and qualify the design described in this application note for production.

The design of the MA040E12 was performed with respect to the environmental conditions described as main features in this document. The requirements for lead-free reflow soldering have been considered when components were selected. The design was tested as described in this documentation but not qualified regarding manufacturing and operation in the whole ambient temperature operating range or lifetime.

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

Due to their purpose, the evaluation boards are not subjected to the same procedures regarding Returned Material Analysis (RMA), Process Change Notification (PCN) and Product Discontinuation (PD) as regular products.

See legal disclaimer and warnings for further restrictions on Infineon warranty and liability.

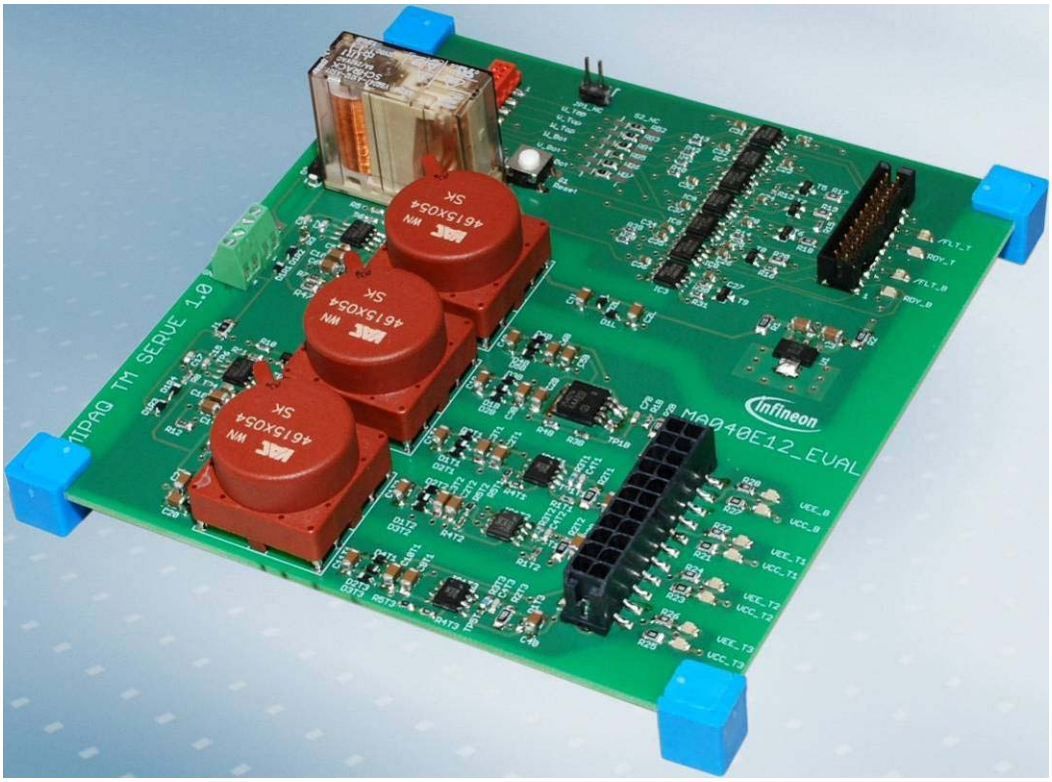


Figure 1 The Module Power supply board

1.1 Part number explanation

The notation of this evaluation has to be interpreted as explained in the following table

MA 040 E12_EVAL	MA	Module Adapter board
	040	Four voltage sources
	E12	Maximum blocking voltage 1200V
	EVAL	Evaluation Board

2 Design features

Electrical features of the evaluation board and mechanical dimensions including necessary interface connections are presented in following sections.

2.1 Main features

The MA040E12_EVAL module Power supply board offers the following features:

- Four isolated unsymmetrical voltage sources, -8V, GND, +16V each
- One logic interface with:
  - 6 PWM-Channels
  - Fault signal for desaturation monitoring
  - Ready signal for under voltage monitoring
  - Reset via connector X2 or push button S1
  - Output of the temperature measurement signal
- Safety off to avoid accidentally turn on during the standby of the equipment
- Possibility to control each IGBT with optional DIP switch array
- PCB is designed to fulfill the requirements of IEC61800-5-1, pollution degree 2, overvoltage category III

2.2 Key data

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

Table 1 General key data and characteristic values

Parameter	min	Typ	Max	Unit
Main DC voltage supply V_{CC}		15	17	V
Main input current I_G		550		mA
Positive output driver supply voltage		16		V
Negative output driver supply voltage		-8		V
Positive output driver supply current		90		mA
Negative output driver supply current		100		mA
Operating temperature, T_{op}	-40		+85	°C
Storage temperature, T_{sto}	-40		+85	°C

2.3 Mechanical dimensions

The MA040E12_EVAL board integrates the power supply and logic interface combined on one PCB. It is also possible to use the power supply part or the logical part independently.

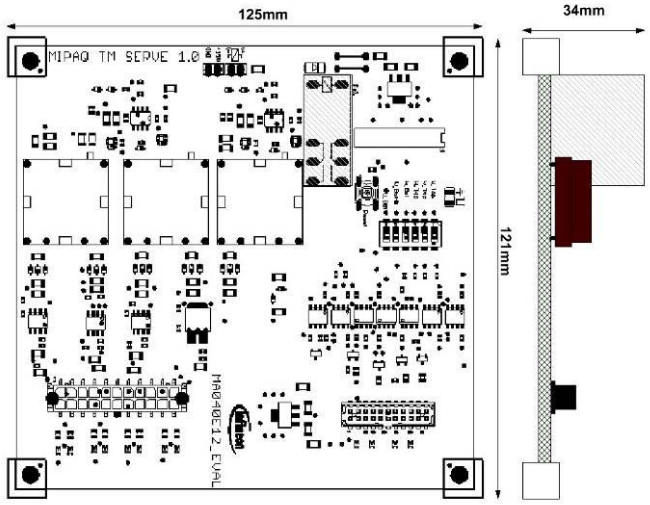


Figure 2 Dimensions of the MA040E12 MIPAQ™ Serve Power supply board

2.4 Interconnections between MA040E12_EVAL Board and MIPAQ™ serve

Interconnections between the MA040E12_EVAL Board and MIPAQ™ serve as shown in Figure 3 are also depicted in section 5 of AN2009-07. To simplify the first steps of designing, one set of connecting wires is included in the evaluation kit.

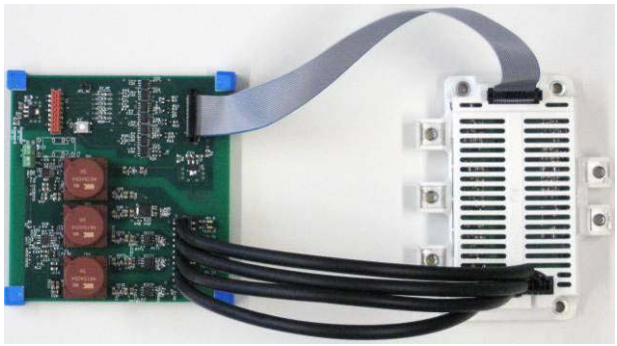


Figure 3 Assembly of MA040E12_EVAL and MIPAQ™ serve

2.5 Logic Signal Connections to MIPAQ™ serve

Connector X3 as shown in Figure 4 is for the logical connection between the power supply board and the MIPAQ™ serve. Detailed information about the pins are given in Table 2.

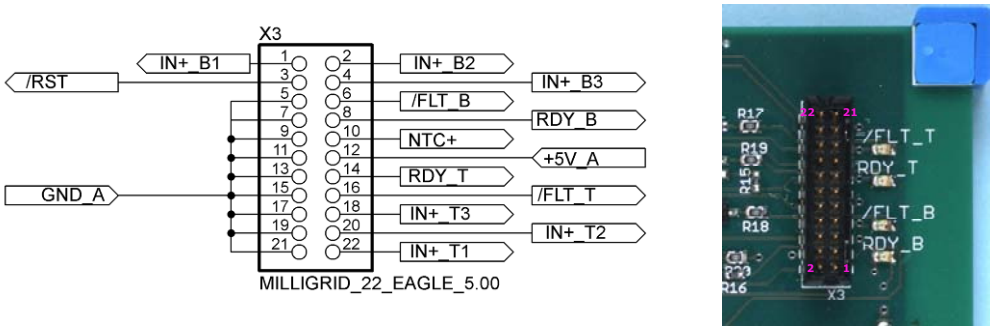


Figure 4 Logic connections between MA040E12 and MIPAQ™ serve

Pin	Label	Pin	Label
X1.1	**IN+_B1**	X1.12	**+ 5V**
X1.2	**IN+_B2**	X1.13	**GND**
X1.3	**/RST**	X1.14	**RDY_T**
X1.4	**IN+_B3**	X1.15	**GND**
X1.5	**GND**	X1.16	**/FLT_T**
X1.6	**/FLT_B**	X1.17	**GND**
X1.7	**GND**	X1.18	**IN+_T3**
X1.8	**RDY_B**	X1.19	**GND**
X1.9	**GND**	X1.20	**IN+_T2**
X1.10	**Temp**	X1.21	**GND**
X1.11	**GND**	X1.22	**IN+_T1**

Table 2 Logic connector signals description

2.6 Power Signal Connections to MIPAQ™ serve

1) The connector X1 as shown in Figure 5 is the power supply output to the MIPAQ™ serve. Detailed information about the pins are given in Table 3.

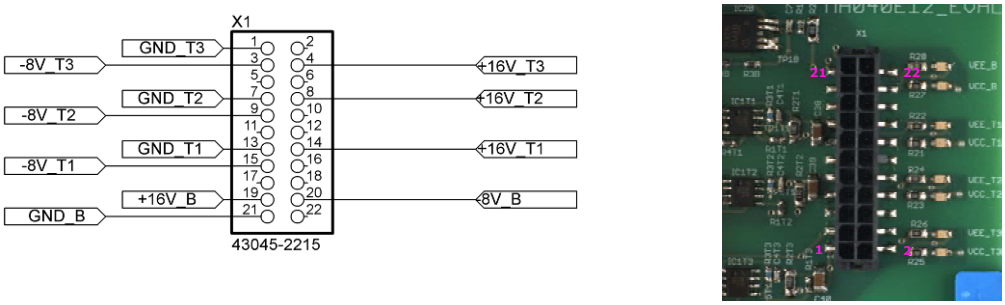


Figure 5 Power supply connections between MA040E12 and MIPAQ™ Serve

Pin	Label	Pin	Label
X1.1	**GND_T3**	X1.12	**NC**
X1.2	**NC**	X1.13	**GND_T1**
X1.3	**- 8V_T3**	X1.14	**+16V_T1**
X1.4	**+16V_T3**	X1.15	**- 8V_T1**
X1.5	**NC**	X1.16	**NC**
X1.6	**NC**	X1.17	**NC**
X1.7	**GND_T2**	X1.18	**NC**
X1.8	**+16V_T2**	X1.19	**+ 16V_B**
X1.9	**-8V_T2**	X1.20	**- 8V_B**
X1.10	**NC**	X1.21	**GND_B**
X1.11	**NC**	X1.22	**NC**

Table 3 Power connector signals description

2.7 Main Connector for external control unit

Connector X2 as shown in the Figure 6 is for the logical connection between the external control unit and the power supply board. Further information about the pins are given in Table 4.



Figure 6 Main connector from external control unit to MA040E12

Pin	Label	Pin	Label
X2.1	**U_TOP**	X2.9	**/B_FLT**
X2.2	**U_BOT**	X2.10	**B_RDY**
X2.3	**V_TOP**	X2.11	**T_B_/RST**
X2.4	**V_BOT**	X2.12	**TEMP**
X2.5	**W_TOP**	X2.13	**+ 5V**
X2.6	**W_BOT**	X2.14	**GND_S**
X2.7	**/T_FLT**	X2.15	**T_PWR_OFF -**
X2.8	**T_RDY**	X2.16	**T_PWR_OFF +**

Table 4 Main connector signals description

3 Functionality of the Board

3.1 Building blocks

The important functional blocks of the MA040E12 as shown in Figure 7 are described in Table 5. The MA040E12 is especially designed to work in conjunction with the MIPAQ™ serve modules.

A	Linear regulator for internal 5V power supply for the logic primary side. This can be used if an external +5V supply does not exist.
B	Jumper to be set in case the internal 5V supply is used.
C	Connector for the main power supply.
H	Safety relay.
D	Connector for the control of the safety relay.
E	Connector to the microcontroller unit.
F	Channel selection utilizing DIL switch.
G	Reset switch.
I	DC-DC converter.
J	Functional Isolation using ADUM1210.
K	Logic connector to MIPAQ™ serve.
L	Connector of the power supply to MIPAQ™ serve.

Table 5 Description of building blocks Figure 7

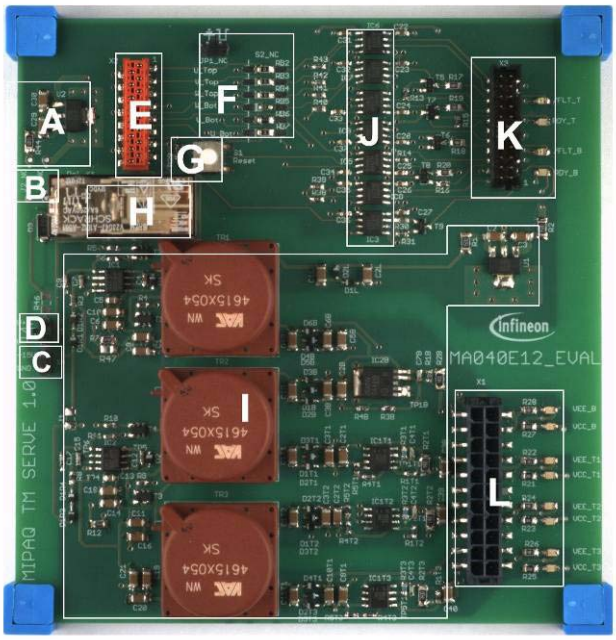


Figure 7 Location of building blocks

3.1.1 The DC-DC converter

The MA040E12_EVAL offers five separated voltage sources, which are galvanically isolated from the primary side and from each neighboring voltage source.

Three separated unsymmetrical voltage sources supplies the three top IGBTs. One unsymmetrical voltage source supplies the three bottom IGBTs and one unipolar voltage source supplies the primary logic side of MIPAQ™ serve. The isolation characteristic of the transformers Tr1, Tr2 and Tr3 meet the Isolation requirement for 1200V application according to IEC61800-5-1. Each transformer allows a power transmission up to 2.2W and delivers two unsymmetrical voltage sources of -8V / +16V on the secondary side.

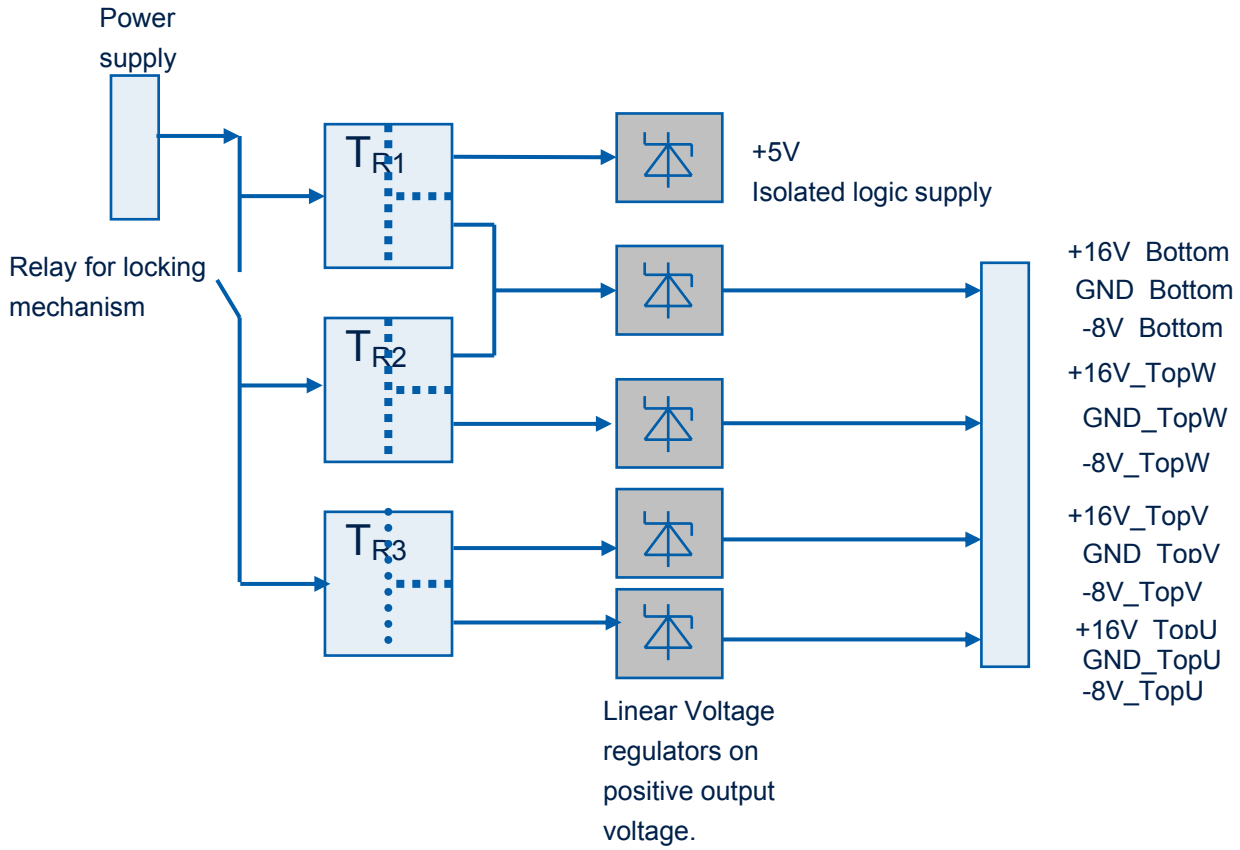


Figure 8 Architecture of the DC-DC power supply

3.1.2 Isolation Capabilities

The configuration of the MIPAQ™ serve offers a functional isolation.

Depending on the isolation needed for a given application, a further basic isolation has to be implemented on the MA040E12_EVAL increasing the isolation to higher safety degree like reinforced isolation.

The isolation between the primary and the secondary side of the DC-DC converter is achieved through the transformers Tr1, Tr2 and Tr3.

3.1.3 Locking mechanism

For some applications it is necessary to avoid the accidental operation of equipment during the standby. One way to achieve this is to cut off the power supply of the top IGBT drivers by the safety relay contact P1 Figure 9. The jumper J1 is set as default. Jumper J1 needs to be removed if this functionality is used. The status of P1 can be observed over the contact P2 for an external monitoring. P2 is available on pin 215 and 216 of connector X2

The relay of K1 can be activated by 15V / 60mA using the connector X5.

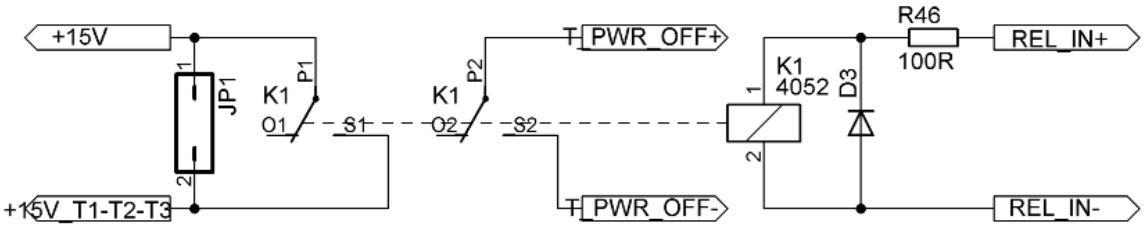


Figure 9 Circuit of locking mechanism

3.1.4 Output characteristics of the voltage source

The output power and output voltage of the MA040E12 board as shown in Figures 10 and 13 are varying as a function of the switching frequency of the IGBT at 125°C MIPAQ™ serve base plate temperature.

The variation of the negative output voltage shown on Figure 10 has no influence on the switching behavior of the MIPAQ™ serve.

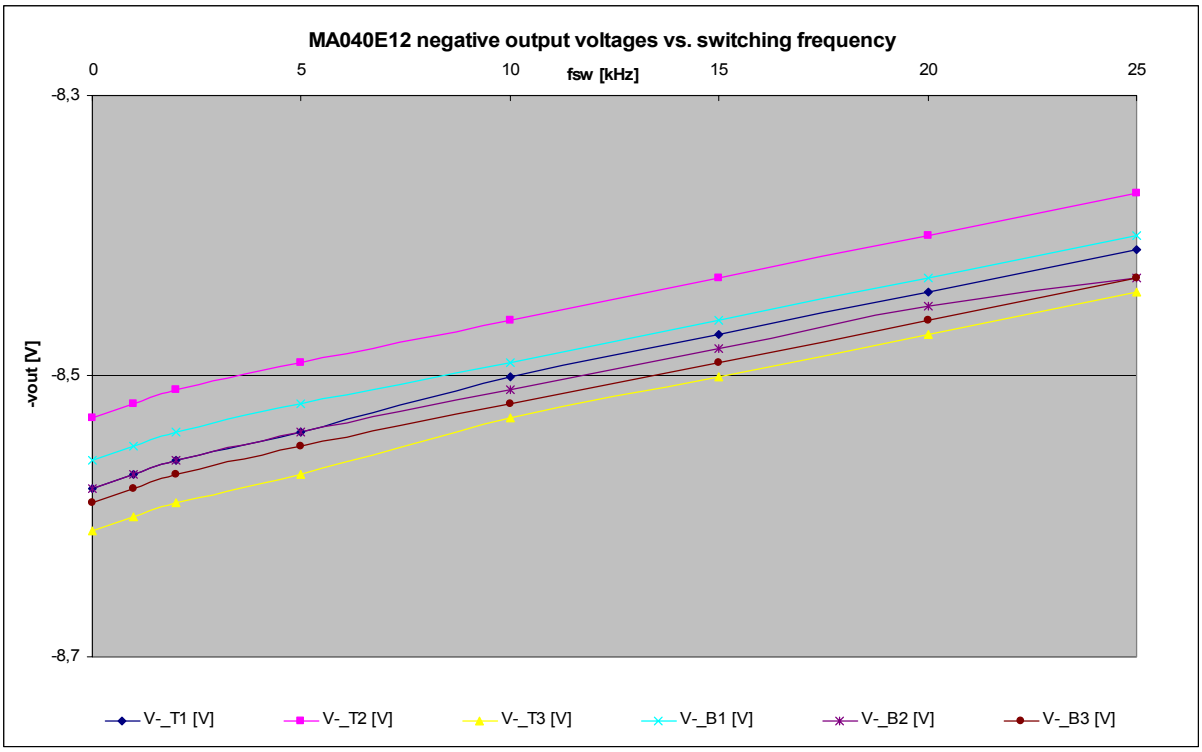


Figure 10 Negative output voltages vs. switching frequency

The positive output voltages of the top channel IGBTs are maintained constant at +16V through adjustable linear regulator as depicted in Figure 11. The negative output voltages are not regulated.

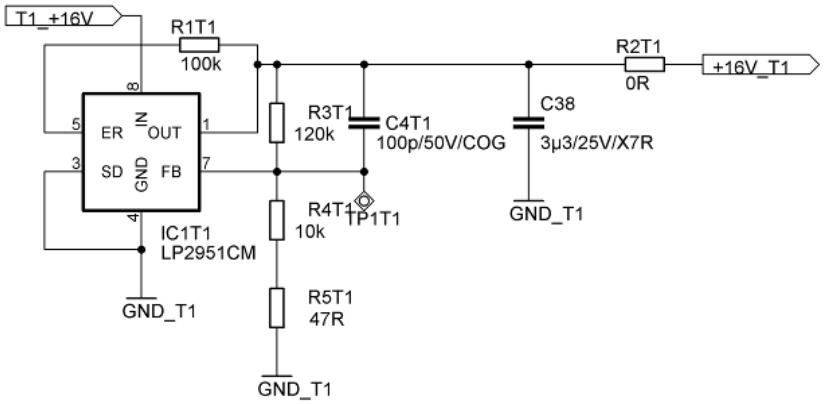


Figure 11 Voltage regulators for High-Side Supply, T1 as an example

The positive output voltages of the bottom channel IGBTs are maintained constant at +16V through adjustable linear regulator as depicted in Figure 12. The negative output voltages are not regulated.

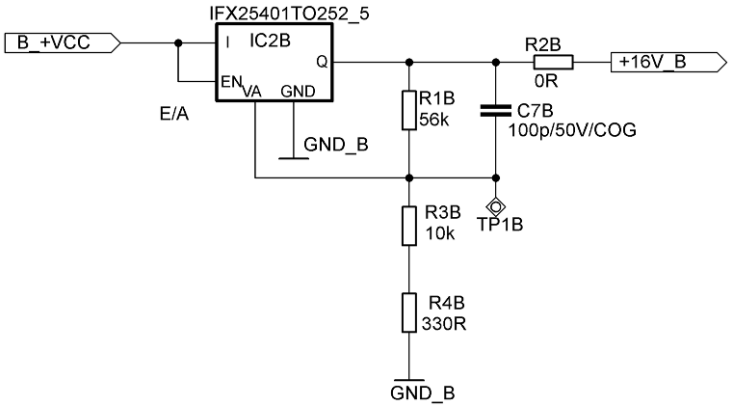


Figure 12 One voltage source for the three Bottom IGBTs

The power requirement of the bottom side as shown in Figure 13 is higher than the power dissipation of the high side drivers. The reason is that the circuit of the temperature measurement is also supplied by the power supply of the bottom side drivers. For the analysis of the base plate temperature of MIPAQ™ serve please refer to the AN2009-07.

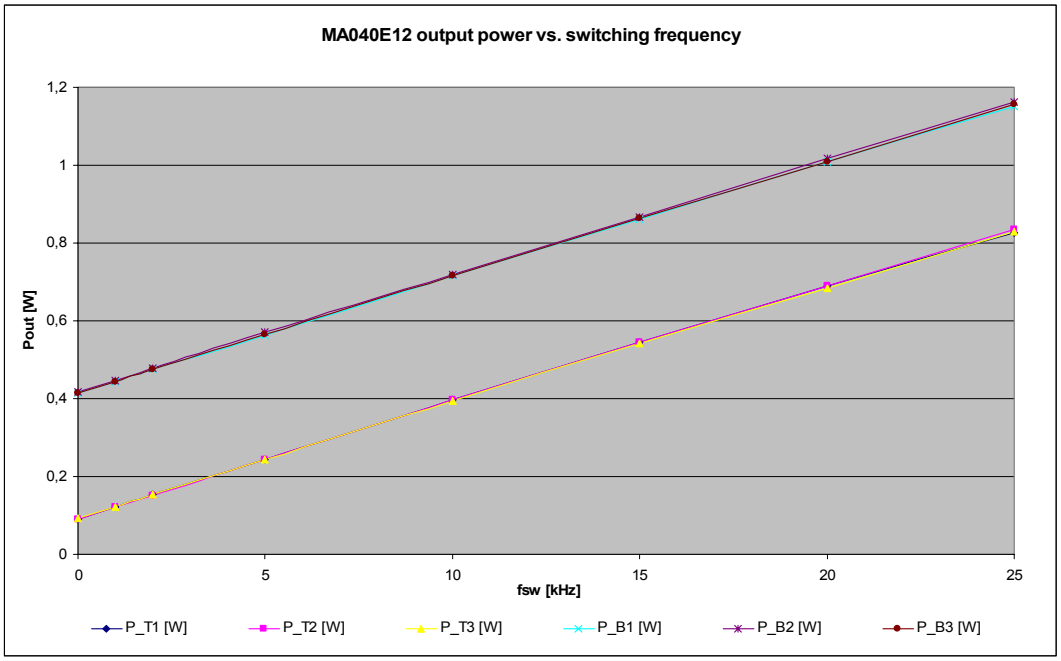


Figure 13 Output power vs. switching frequency

3.1.5 On Board LEDs

The MA040E12_EVAL Board provides 6 yellow LEDs VCC_T1, VEE_T1, VCC_T2, VEE_T2, VCC_T3, VEE_T3, VCC_B, VEE_B to indicate that the power is turned on. The desaturation monitoring of the top and bottom channel diodes /FLT_T, /FLT_B are switched on if desaturation failure occurs on one of the 6 IGBTs. The RDY_T and RDY_B LEDs are ON if the MIPAQ™ serve is sufficiently powered.

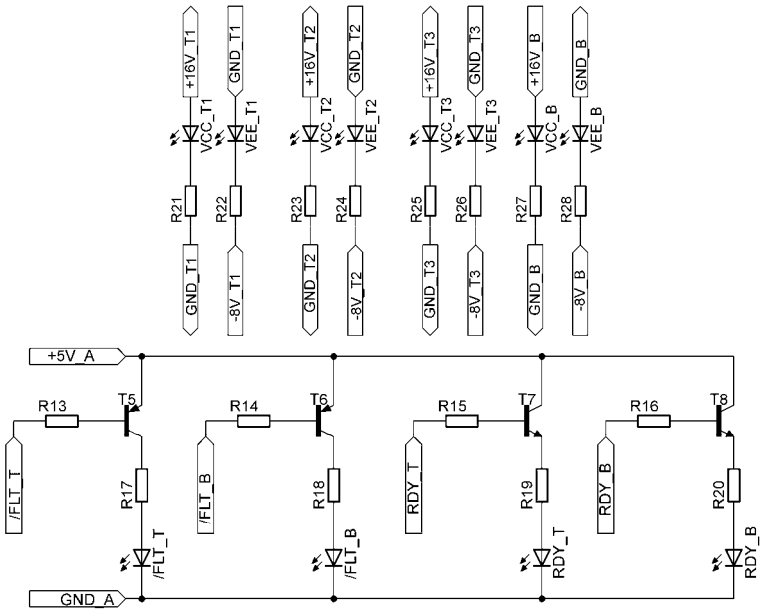


Figure 14 Indicators of power and driver status

3.1.6 Further Features

The MA040E12_EVAL offers the possibility to switch each IGBT separately using the SMT DIL switch. In this case the switching signal has to be supplied by jumper JP1. This is intended to allow simple double pulse testing. The DIL switch is not included by default.

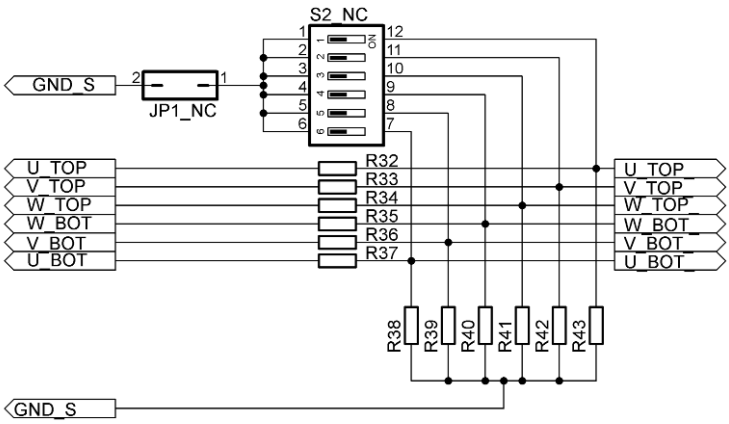


Figure 15 Channel selection

The primary logic supply voltage of the power supply board can be supplied from the main supply voltage +15V shown on Figure 17 or can be externally applied to the connector X2 pins 213 and 214.

In case of internal supply, Jumpers J2 and J3 have to be set.

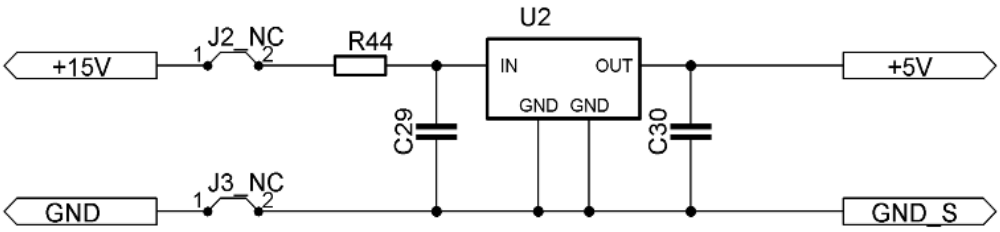


Figure 16 Supply of primary Logic

4 Schematic and Layout of MA040E12

To meet the individual customer requirements and make the evaluation board a basis for further developments or modifications, all necessary technical data like schematic, layout and components are included in this chapter.

4.1 Schematics

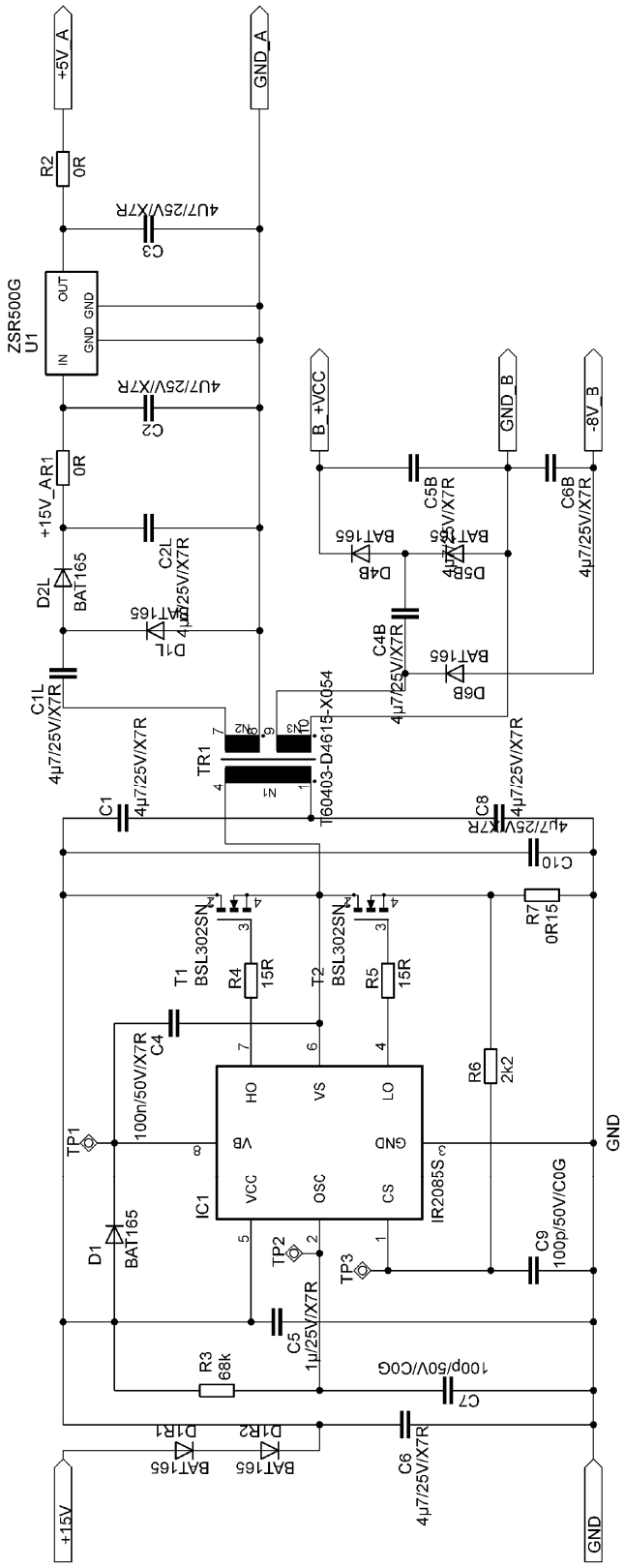


Figure 17 Power supply bottom and logical output side

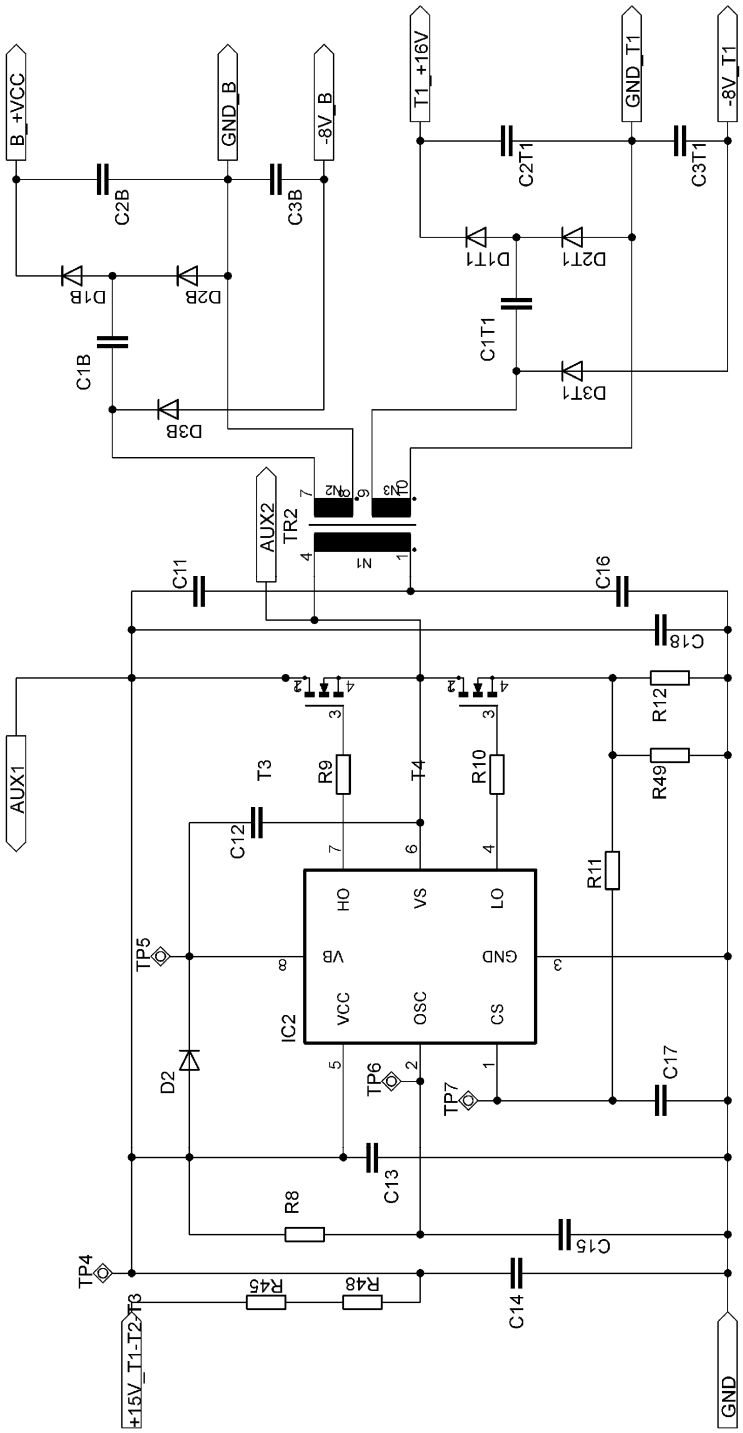


Figure 18 Power supply bottom and Top_U

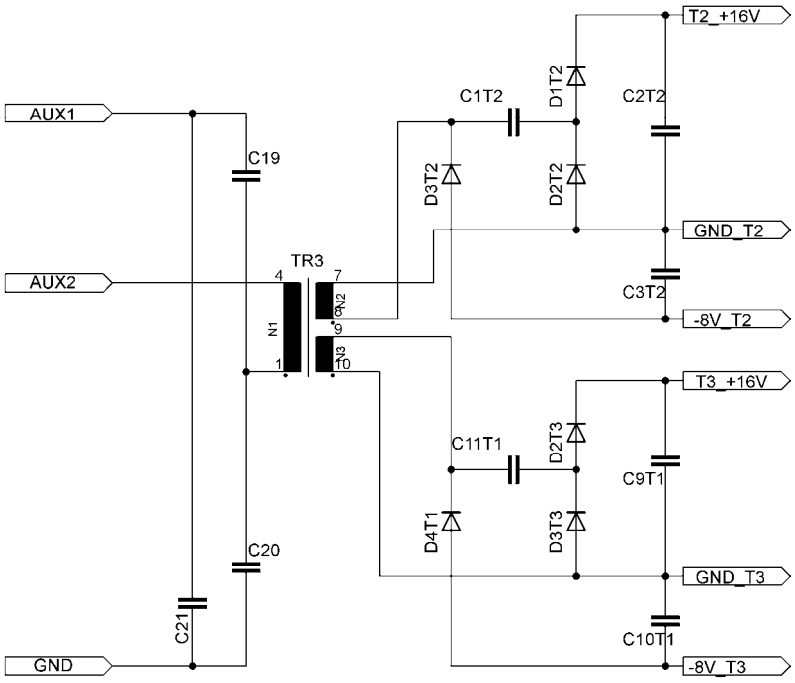


Figure 19 Power supply Top_V and Top_W

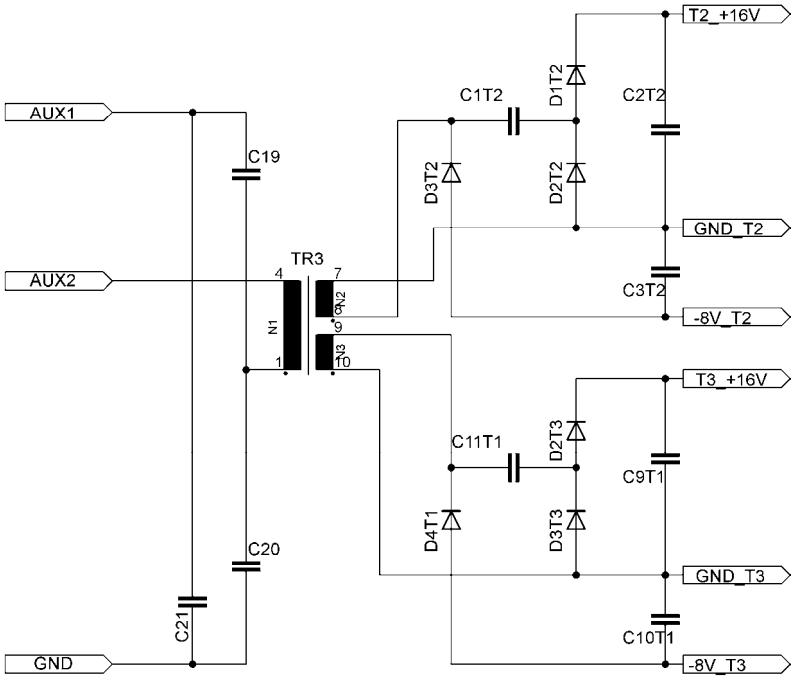


Figure 20 Power supply Top_V and Top_W

4.2 Layout

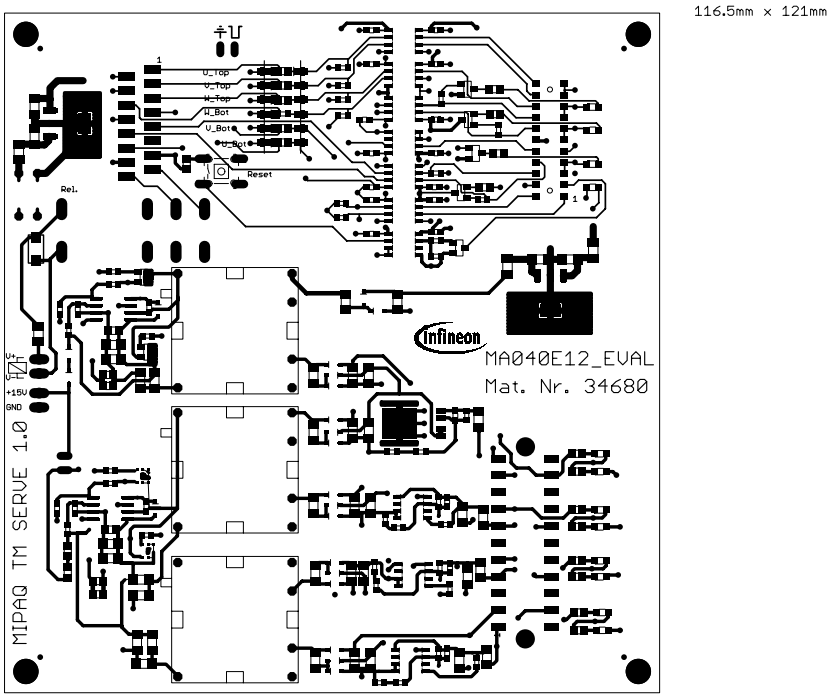


Figure 21 Top layer

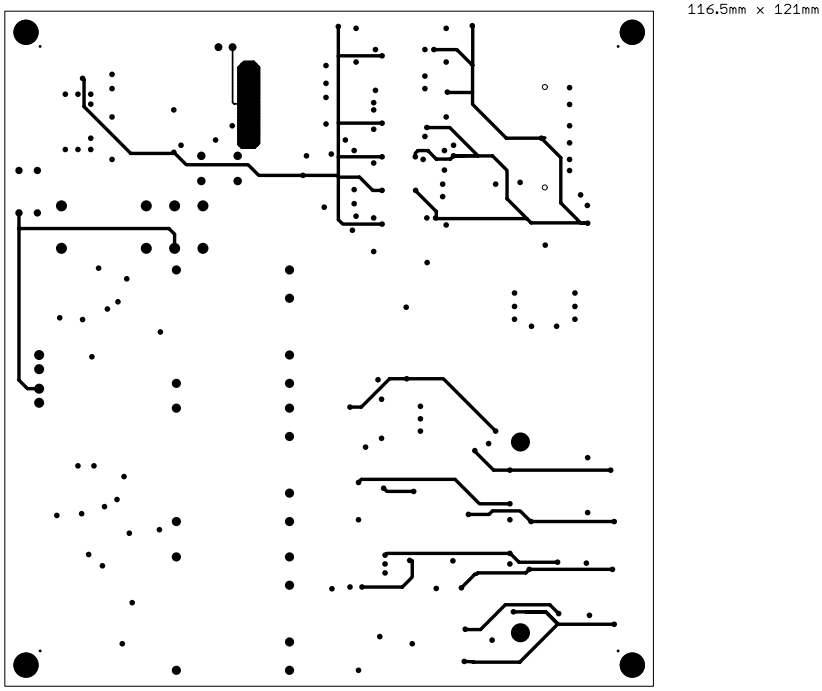


Figure 22 Bottom layer

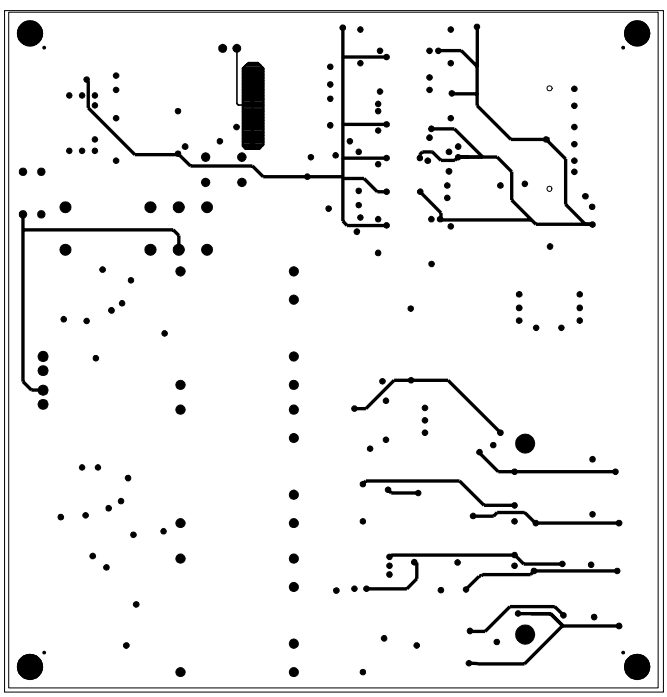


Figure 23 Vcc layer

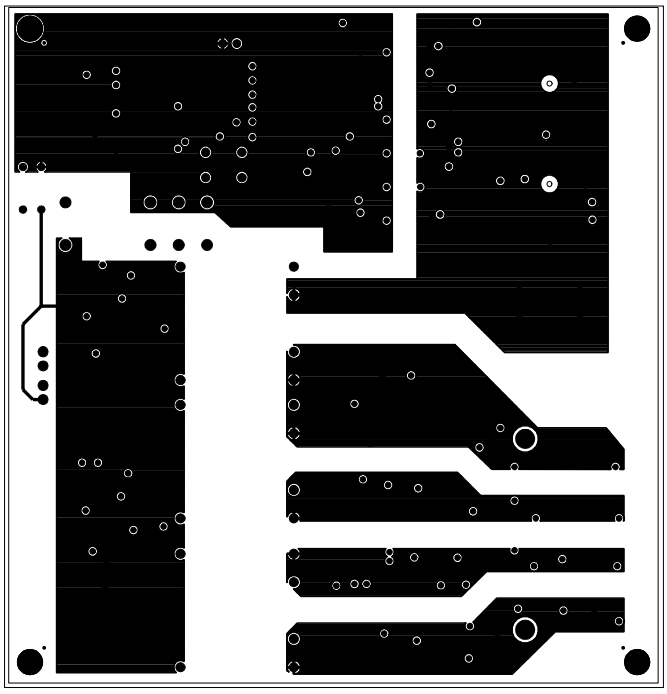


Figure 24 GND layer

4.3 Bill of Material - MA040E12_EVAL

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 %.

Type	Value / Type	Package	QTY	Name Part	Recommended Manufacturer
capacitor	100n/25V/X7R	C603	14	C22, C23, C24, C25, C26, C27, C28, C31, C32, C33, C34, C35, C36, C37	Murata
capacitor	100n/50V/X7R	C603	2	C4, C12	Murata
capacitor	100p/50V/C0G	C603	8	C4T1, C4T2, C4T3, C7, C7B, C9, C15, C17	Murata
capacitor	4µ7/25V/X7R	C1206	32	C1, C1B1, C1L, C1T1, C1T2, C2B, C2L,C2T1, C2T2, C3B,C3T1, C3T2, C4B, C5B, C6, C6B, C8, C9T1, C10, C10T1, C11, C11T1, C14, C16, C18, C19, C20, C21, C2, C3, C29, C30	Murata
capacitor	3µ3/25V/X7R	C1206	3	C38, C39, C40	Murata
diode	BAT165	SOD323R	23	D1, D1B, D1L, D1R1, D1R2, D1T1, D1T2, D2, D2B, D2L, D2T1, D2T2, D2T3, D3B, D3T1, D3T2, D3T3, D4B, D4T1, D5B, D6B	Infineon
Diode	GF1G	DO-214BA	1	D3	-
capacitor	1µ/25V/X7R	C805	2	C5, C13	Murata
safety relay	V23047-A1012-A501		1	K1	Tyco Electronics
resistor	0R15	R805	3	R7, R12, R49	-
resistor	56k	R603	1	R1B	-
resistor	10k	R805	5	R32, R33,R34, R36, R37	-
resistor	330R	R603	1	R4B	-
resistor	100k	R603	3	R1T1, R1T2, R1T3	-
resistor	10k	R603	16	R4T1, R4T2, R4T3, R13, R14, R15, R16, R31, R35, R38, R39, R40, R41, R42, R43, R3B	-
jumper		JP1	1	JP1Q	-
resistor	10R	R603	1	R30	-
resistor	47R	R603	3	R5T1, R5T2, R5T3	-
resistor	120k	R603	3	R3T1, R3T2, R3T3	-
resistor	150R	R1206	1	R44	-
resistor	15R	R603	4	R4, R5, R9, R10	-
resistor	2k	R805	4	R21, R23, R25, R27	-
resistor	1k	R805	9	R17, R18, R19, R20, R22, R24, R26, R28, R29	-
resistor	100R	R1206	1	R46	-
transformer	T60403-D4615-X054	D4615-X054	3	TR1, TR2, TR3	VAC
resistor	2k2	R603	2	R6, R11	-
resistor	0R	R805	8	R1, R2, R45, R48, R2B, R2T1, R2T2, R2T3	-
resistor	68k	R603	2	R3, R8	-
semiconductor	ADUM1210	SOIC08	7	IC3, IC4, IC5, IC6, IC7, IC8, IC9	Analog Devices
switch		B3W-1000		S1	-
semiconductor	SN7002N	SOT23	1	T9	Infineon
surface mount DIP switch series	CTS-219-06J_NC[1]	219-06J	1	S2	-

[1] Not connected

219 SMT					
connector	Molex MilliGrid 22 pins[2)]	087832-2220	1	X3	Molex
connector	Tyco Micro-Match 16 pins[3)]	8-188275-0	1	X2	Tyco Electronics
connector	Molex Microfit 22 pins[4)]	43045-2215	1	X1	Molex
connector	MPT2	2POL254	2	X4, X5	Phoenix
transistor	BC846	SOT23	2	T7, T8	-
transistor	BC856	SOT23	2	T5, T6	-
transistor	BSL302SN	TSOP6	4	T1, T2, T3, T4	Infineon
voltage regulator	IFX25401	TO252-5	1	IC2B	Infineon
semiconductor	IR2085STR_PBF or AUIR2085S	SO08	2	IC1, IC2	International rectifier
semiconductor	LEDCHIPLED_0805_YELLOW	0805	8	+16V_B, +16V_T1, +16V_T2, +16V_T3, -8V_B, -8V_T1, -8V_T2, -8V_T3	-
semiconductor	LEDCHIPLED_0805_RED	0805	2	/FLT_B, /FLT_T	-
semiconductor	LEDCHIPLED_0805_GREEN	0805	2	RDY_B, RDY_T	-
semiconductor	LP2951CM	SOIC08	3	IC1T1, IC1T2, IC1T3	National
voltage regulator	ZSR500G	SOT223	2	U1, U2	Zetex
mechanical	Corner Part		4	CP1, CP2, CP3, CP4	-
jumper			2	J2, J3	-
jumper			1	JP1	-
PCB	Size: 89x116,5x121mm; material:FR4; Layers - Cu : 4x35ìm; Isolation: 3x0,5mm; flammability: UV94V0		1		-

5 How to order Evaluation Boards

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

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

CAD-data for the board described here are available on request. The use of these data is subjected to the disclaimer given in this AN. Please contact: WAR-IGBT-Application@infineon.com

IFX order number for MA040E12_EVAL: 34680

6 References

1) AN2009-07: MIPAQ™ serve Module with adapted driver electronics Infineon AG Warstein (Germany)

[2] The corresponding parts can be found by Molex as IDT connector and optionaly strain relief. Part number 087682293 resp. 0875691022

[3] The corresponding connector can be found by Tyco Electronics. Part number 0430252200

[4] The corresponding parts can be found by Molex as crimp Housing and crimp terminal. Part number 0430252200 resp. 0430300003