

AN2007-06

MA300E12 / MA300E17

Module Adapter Board for PrimePACK™
IGBT Modules

IFAG AIM PMD ID AE



Never stop thinking

Edition 2008-02-05

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14	Update Table 4
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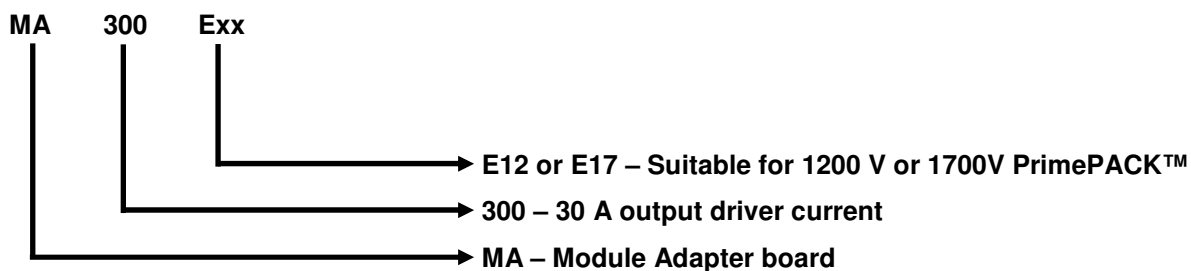
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Part number explanation:



1 Introduction

The MA300E12 and MA300E17 module adapter boards shown in Fig. 1 offer reliable connection between driver and various IGBT PrimePACK™ modules. MA300E12 and MA300E17 are dedicated to all PrimePACK™ module types respectively in 1200V and 1700V class. Used together with 2ED300E17-SFO evaluation adapter board and 2ED300C17-S /-ST EiceDRIVER™ make the 'Flexible driver Starter Kit' easy to use (Fig. 2). The 'Flexible Starter Kit' is dedicated for easy PrimePACK™ paralleling but single module operation is as well possible. In any case one 2ED300E17-SFO adapter board and one 2ED300C17-S driver is required. Number of MA300Exx is the same as paralleled modules but not more than three.

The MA300Exx module adapter 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 for production described in this application note.

The design of the MA300Exx was performed with respect to the environmental conditions. The requirements for leadfree 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 operating ambient temperature range or lifetime.

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

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

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

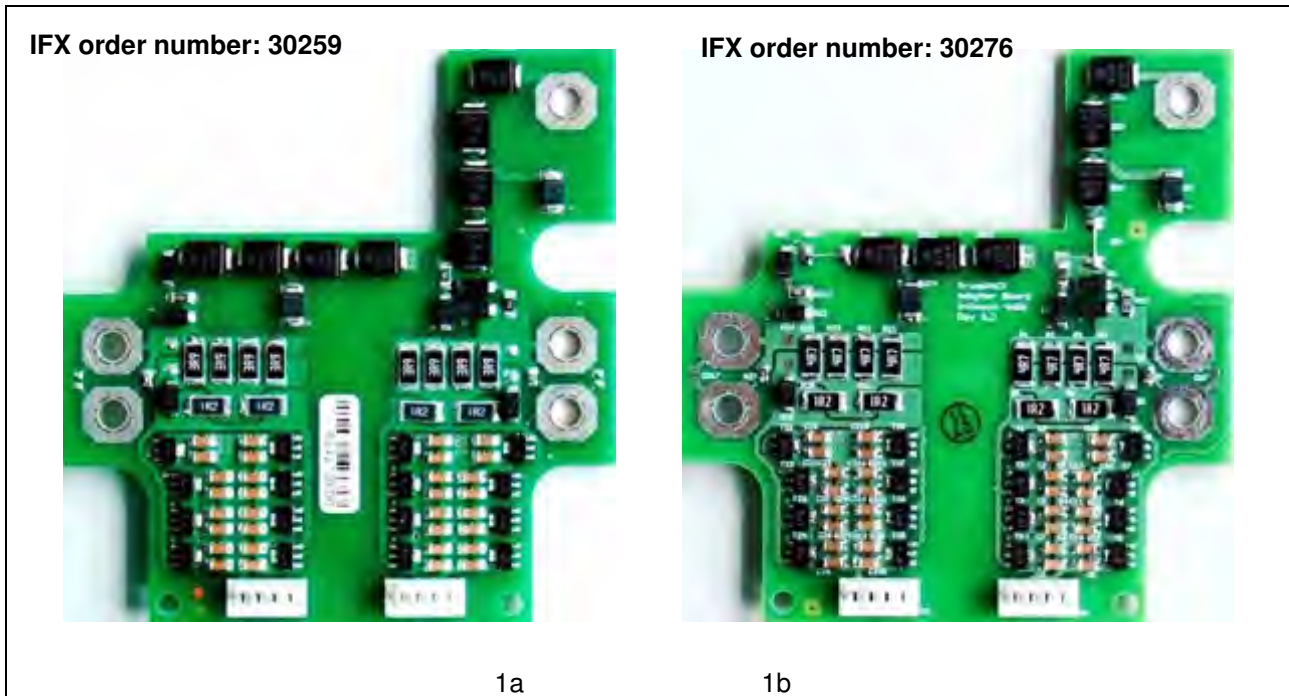


Figure 1 The PrimePACK™ Module Adapter boards, MA300E12 - 1a, MA300E17 – 1b



Figure 2 The 'Flexible driver Starter Kit' for PrimePACK™ module

2 Design features

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

2.1 Main features

The MA300Exx module adapter board offers the following features:

- Dual channel IGBT driver together with 2ED300E17-SFO (detailed description in AN2007-05) and 2ED300C17-S /-ST EiceDRIVER™
- Electrically and mechanically suitable for PrimePACK™ modules family
- Operating temperature (design target) from -55 °C
- Different gate resistor values for turning-on and -off are possible
- IGBTs are secured against temporary V_{CE} overvoltages during turn-off (Active Clamping)
- Diodes for IGBT desaturation monitoring implemented (short circuit protection)
- All components, except connectors, are surface mount devices (SMD) with lead free 260 °C soldering profile
- PCB is designed to fulfil the requirements of IEC61800-5-1, pollution degree 2, overvoltage category III (creepage – 11mm)

When the MA300Exx is used not with 2ED300E17-SFO adapter board and 2ED300C17-S /-ST EiceDRIVER™ these additional features might be useful:

- Gate-emitter amplifier input resistance is 6,75Ω
- Can be used with max. ±20V isolated power supply (due to IGBT short circuit performances the max. +15V is suggested)
- Asymmetric power supply is also allowed e.g. -8V and +15V
- Input PWM voltage level should be selected according to power supply voltage level (in the same range but not higher)

2.2 Key data

All values given in the table below are typical values, measured at $T_A = 25\text{ °C}$.

Table 1 General key data and characteristic values

Parameter	Value	Unit
V_{DC} – max. DC voltage supply	±20	V
I_G – max. peak output current	±30	A
R_{Gmin} – minimum gate resistor value when $V_{DC}=\pm 15V$ (internal module resistor R_{INT} + external R_{EXT})	1	Ω
$P_{DC/DC}$ – max DC/DC output power per one channel ¹	4	W
f_S – max. PWM signal frequency for channel A and B ²	60	kHz
T_{op} – operating temperature (design target) ³	-55...+85	°C
T_{sto} – storage temperature (design target)	-55...+85	°C

2.3 Mechanical dimensions and mounting procedure

The MA300Exx should be screwed to the PrimePACK™ auxiliary terminals accordingly to AN2006-09⁴. In that way necessary connections between module adapter and module itself are done correctly (Figure 3). PCB outline and relevant dimensions needed for better system integration are shown in Figure 4.



Figure 3 The MA300Exx correctly mounted on PrimePACK™ module

¹ Only when MA300Exx used together with 2ED300E17-SFO adapter board and 2ED300C17-S EiceDRIVER™

² Switching frequency is limited by 2ED300C17-S EiceDRIVER™ capabilities. The maximum switching frequency for every PrimePACK™ module type should be calculated separately. Limitation factors are: max. DC/DC output power of 4 W per channel and max. PCB board temperature measured around gate resistors placed on separated board closed to IGBT module. For detailed information see chapter 3.6.

³ Max. ambient temperature strictly depends on MA300Exx load conditions.

⁴ The AN2006-09 is with the title: 'Mounting process PrimePACK modules' is available on Infineon website.

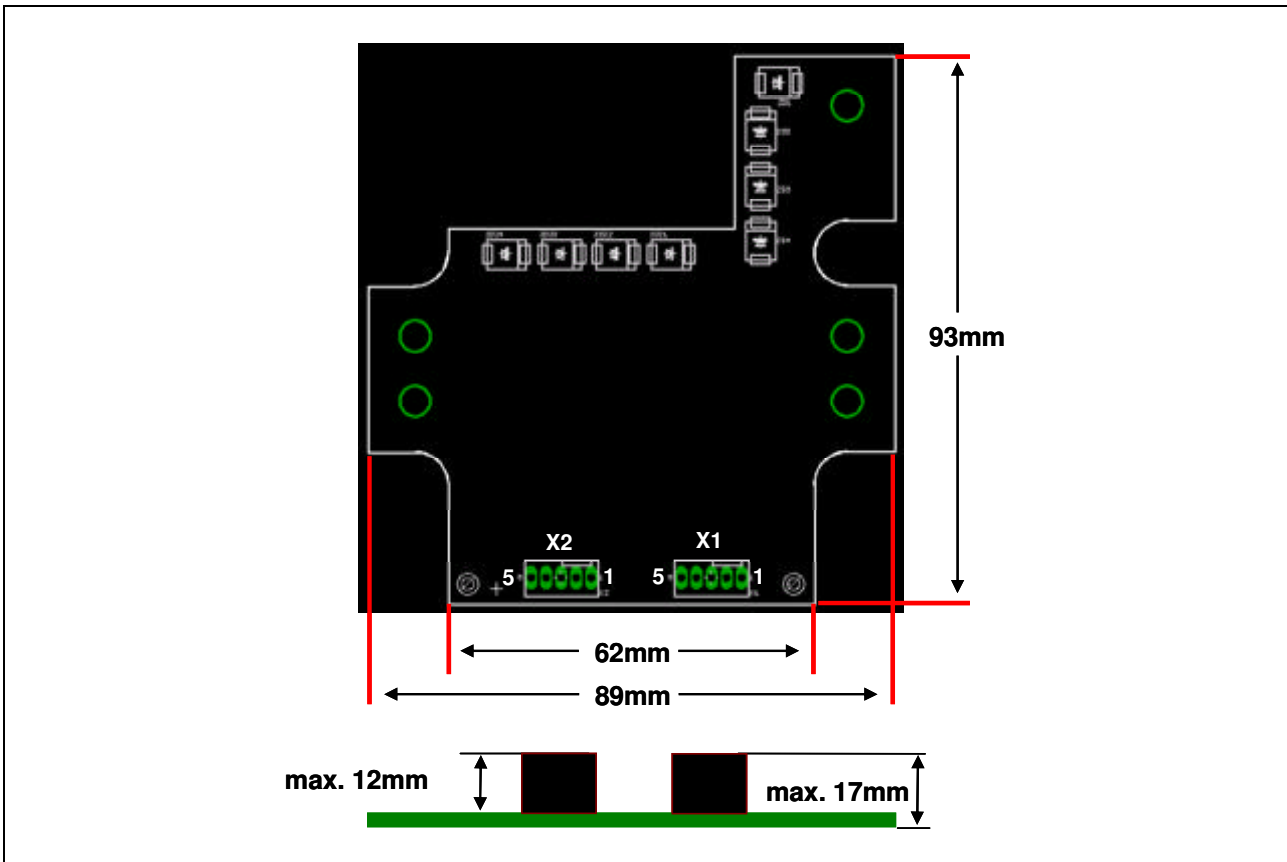


Figure 4 Dimensions of the MA300Exx module adapter board

2.4 Pin assignment

After the module adapter has been correctly mounted to the PrimePACK™ module all external electrical control signals should be applied to connector X1 and X2 as shown on Fig. 6 and listed in Table 2. When MA300Exx is used together with 2ED300E17-SFO the necessary connections to module adapter are depicted in Figure 5. Control signals required for module driving should be connected to Input Interface of 2ED300E17-SFO as described in AN2007-05. In that way no additional connections between module and IGBT driver are needed. The ready to use setup is shown in Fig. 2.

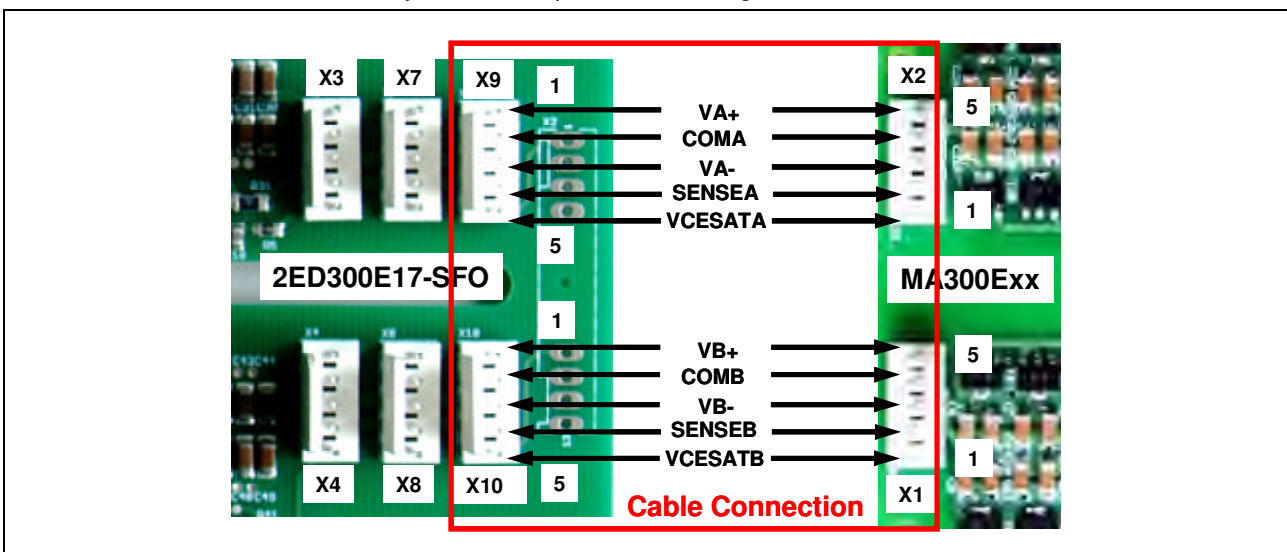


Figure 5 Connections between 2ED300E17-SFO and MA300Exx

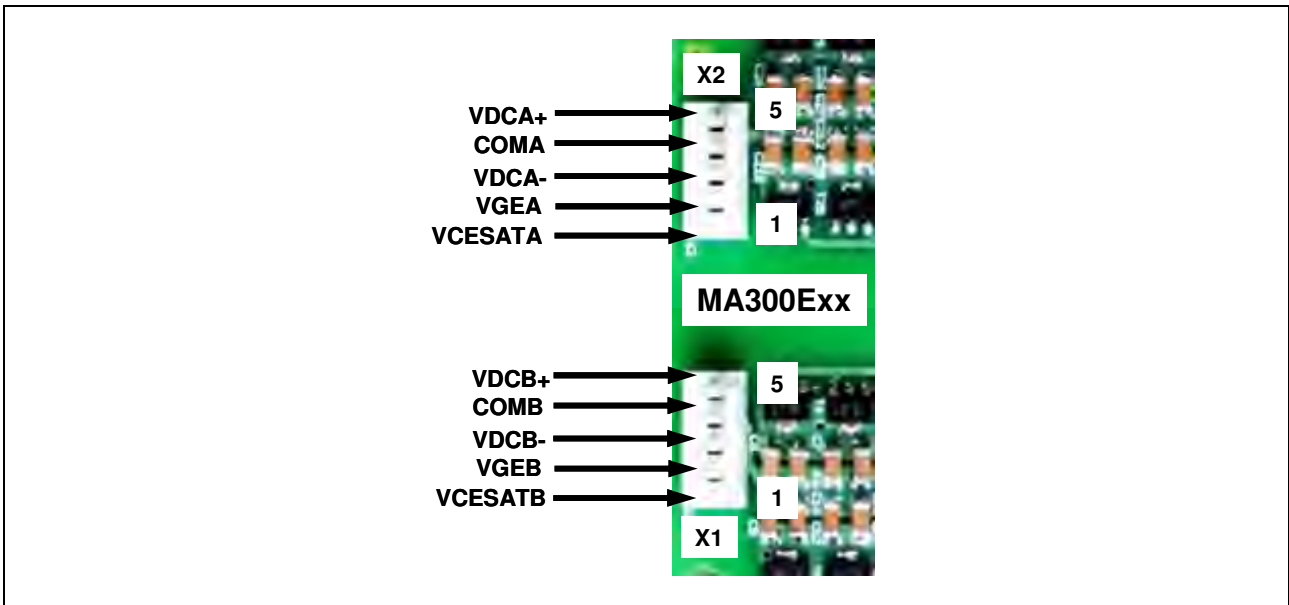


Figure 6 MA300 Module Adapter board and external electrical connections

Table 2 MA300Exx and the external electrical signals description

Pin	Label	Function
X2.5	VDC A+	Insolated DC/DC positive voltage supply channel A
X2.4	COM A	Auxiliary emitter – channel A
X2.3	VDC A-	Isolated DC/DC negative voltage supply channel A
X2.2	VGE A	Gate-emitter signal source – channel A
X2.1	VCESAT A	Desaturation voltage monitoring output – channel A
X1.5	VDC B+	Isolated DC/DC positive voltage supply channel B
X1.4	COM B	Auxiliary emitter – channel B
X1.3	VDC B-	Isolated DC/DC negative voltage supply channel B
X1.2	VGE B	Gate-emitter signal source – channel B
X1.1	VCESAT B	Desaturation voltage monitoring output – channel B

3 Application Note

3.1 Functionality on board

The MA300Exx basically supports already existing IGBT driver in half-bridge configuration and provides additional functions separately for both channels (top and bottom IGBT):

- Gate resistors
- Gate signal amplifier / emitter follower - booster
- V_{CE} monitoring for short circuit detection
- Active voltage clamping

Picture below depicts the MA300E12 with already mentioned functions and shows their physical location.

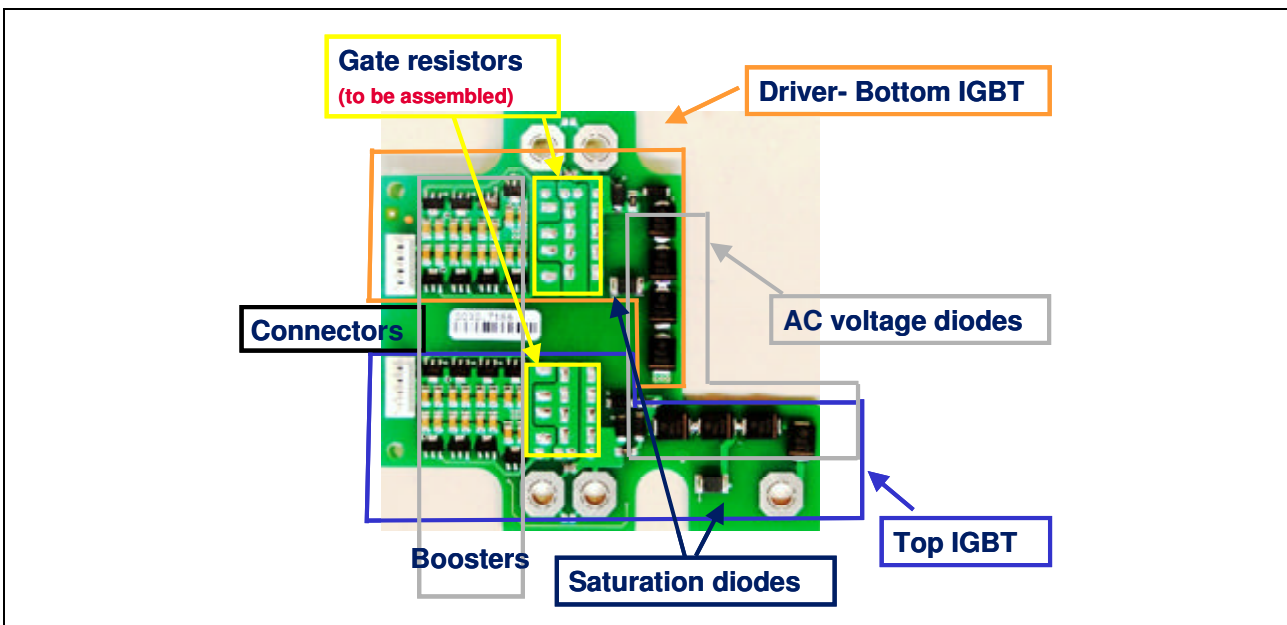


Figure 7 The MA300E12 with marked functions

3.2 Gate resistors

MA300E12 and MA300E17 are assembled and delivered as shown on Fig. 7. Proper gate resistors should be soldered by a customer. Values for 1200V modules are given in Table 3. Table 4 shows proposal for 1700V IGBTs. All of them are in 2512 package size (EIA).

Table 3 External gate resistor proposition for 1200V PrimePACK™ IGBT modules

Module	R5, R6, R25, R26	R1, R2, R3, R4, R21, R22, R23, R24	Resulting R_{Gon}	Resulting R_{Goff}
FF600R12IE4 / IP4	1,5 Ω	5,6 Ω	2.15 Ω	2.15 Ω
FF900R12IP4	0.82 Ω	4,7 Ω	1.58 Ω	1.58 Ω
FF1400R12IP4	0.33 Ω	3,3 Ω	1 Ω	1 Ω

The R_{Gon} and R_{Goff} for 1200V modules type are the same and therefore assembly of diodes D5, D25, D6, D26 is not needed.

External gate resistor proposition for 1700V PrimePACK™ IGBT modules

Module	R5, R6, R25, R26	R1, R2, R3, R4, R21, R22, R23, R24	Resulting R _{Gon}	Resulting R _{Goff}
FF650R17IE4	1,8 Ω	6,8 Ω	1.7 Ω	2.6 Ω
FF1000R17IE4	1,2 Ω	4,7 Ω	1.18 Ω	1.78 Ω

In 1700V PrimePACK™ modules type the R_{Goff} is higher than R_{Gon} and therefore assembly of following diodes: D5 and D25 must be done in direction as shown on Figure 8.

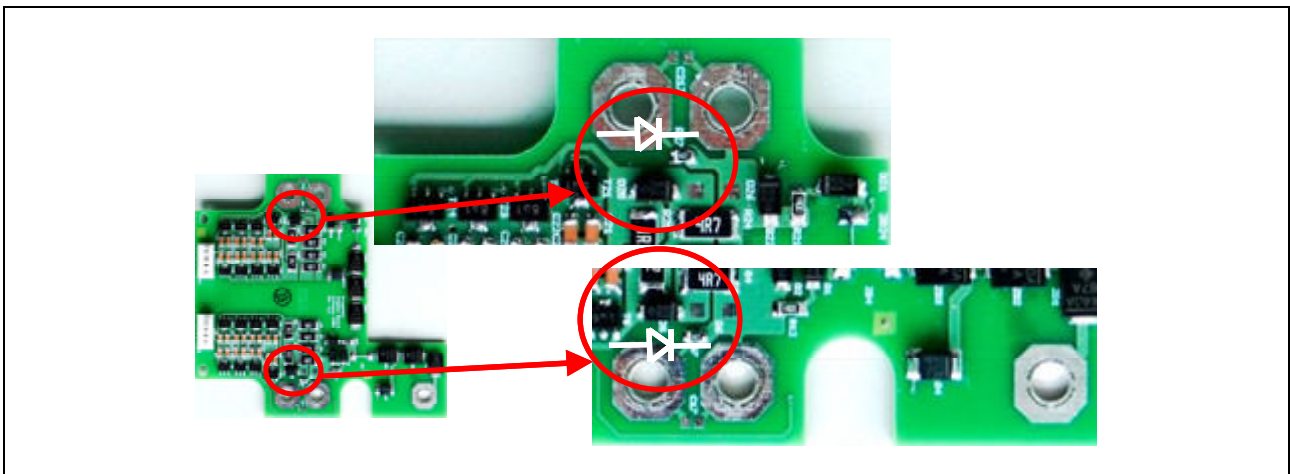


Figure 8 The MA300E17 with mounting direction for D5 and D25

3.3 Gate signal amplifier⁵

When IGBT transistor switches -on and -off the high peak of the gate current must be delivered from a driver. Usually there is no technical problem when one module is driven. When one IGBT driver is used for modules connected in parallel the driver's amplifier must deliver the cumulated gate current. This operation condition leads to gate power concentration on one relatively small physical area and may result in thermal problems. Multiplicated current gain is additionally needed.

Overcomming gain become possible when module adapter includes dedicated gate signal amplifier (Fig. 8, Fig. 13 and Fig. 14). MA300Exx have the emitter follower called booster already implemented. Thanks to four complementary bipolar transistors connected in parallel the minimum gain @I_G=30A is not smaller than 100⁶. Due to the fact that every PrimePACK™ has its own module adapter the driving conditions are equal. Input resistance of the module adapter is not smaller than 6,75Ω.

Benefits provided by booster:

- Fast control of gate-emitter voltage for every PrimePACK™ module
- Simple module paralleling

3.4 V_{CE} monitoring for short circuit detection

When IGBT transistor conducts current few times greater than nominal the V_{CE} voltage desaturates (increases close to DC-link voltage level). This action can be practically used for short circuit detection and

⁵ More information EPE07 paper 'Benefits of System-oriented Module Design for High Power Inverters', or PELINCEC2005 paper 'Dynamic Voltage Rise Controll – the Most Efficient Way to Control Turn-off Switching Behaviour of IGBT Transistors'.

⁶ Based on ZXTN2010Z and ZXTN2012Z bipolar transistors datasheets. www.zetex.com

switching-off an IGBT transistor. The short circuit duration time for Infineon high power IGBT modules must not exceed $10\mu\text{s}$. During this time the short circuit should be detected and the IGBT switched off without exceeding V_{CES} .

When MA300Exx is used together with 2ED300E17-SFO the R_{SSD} resistors (Soft Shut Down) must be chosen correctly in order to insure proper short circuit protection. AN2007-05 in chapter 3.5 describes the procedure in details.

Figure 9a shows three FF1000R17IE4 PrimePACK™ modules under short circuit operation where short circuit protection on 2ED300E17-SFO was disabled. High dI_{C}/dt during switching off creates large overvoltage spike which are limited by active voltage clamping. Figure 9b depicts how properly selected R_{SSD} resistor limits short circuit duration ($<10\mu\text{s}$) and slows down the collector current when is turning off.

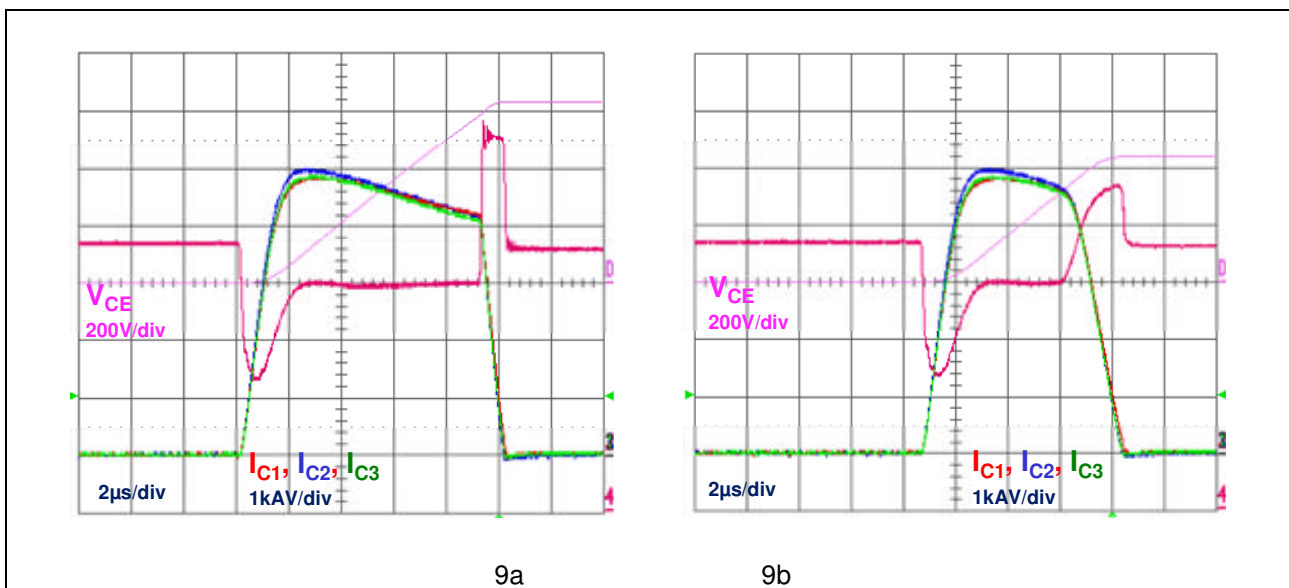


Figure 9 Switching behaviour of three paralleled FF1000R17IE4 PrimePACK™ modules under short circuit where system with 2ED300E17-SFO and MA300E17 was applied: short circuit protection disabled - 9a and where enabled – 9b

3.5 Active voltage clamping – boosted version

Active voltage clamping is a technique which keeps temporary V_{CE} overvoltages bellow V_{CES} when IGBT switches off. In classic approach avalanche diodes chain is connected between auxiliary collector and gate of an IGBT module. When V_{CE} voltage excides certain diodes brakedown voltage the diodes current is shared between IGBT gate and the driver output. Due to increased gate-emitter voltage the transistor is provided to controlled active mode and the switching off process is interrupted. The dI_{C}/dt slows down to a value which results with limited V_{CE} overshoot. Avalange diodes conduct high peak current during time periode in which V_{CE} overvoltage is limited.

Overvoltage protection of the MA300EXX is based on active clamping as described above, but the clamping diodes are not only connected directly to the IGBTs gate but also to the input of the amplifier located on the MA300EXX. Therefore the major amount of current for recharging the gate is derived from the gate driver power supply instead of via the clamping diodes. This provides more consistent clamping voltage due to operating the clamping diodes at smaller current and furthermore enables the clamping circuit to be designed independed from choice of external gate resistor. Finally the same circuit for 1200V and 1700V modules employing different diodes type has been realized and shown on Fig. 1.

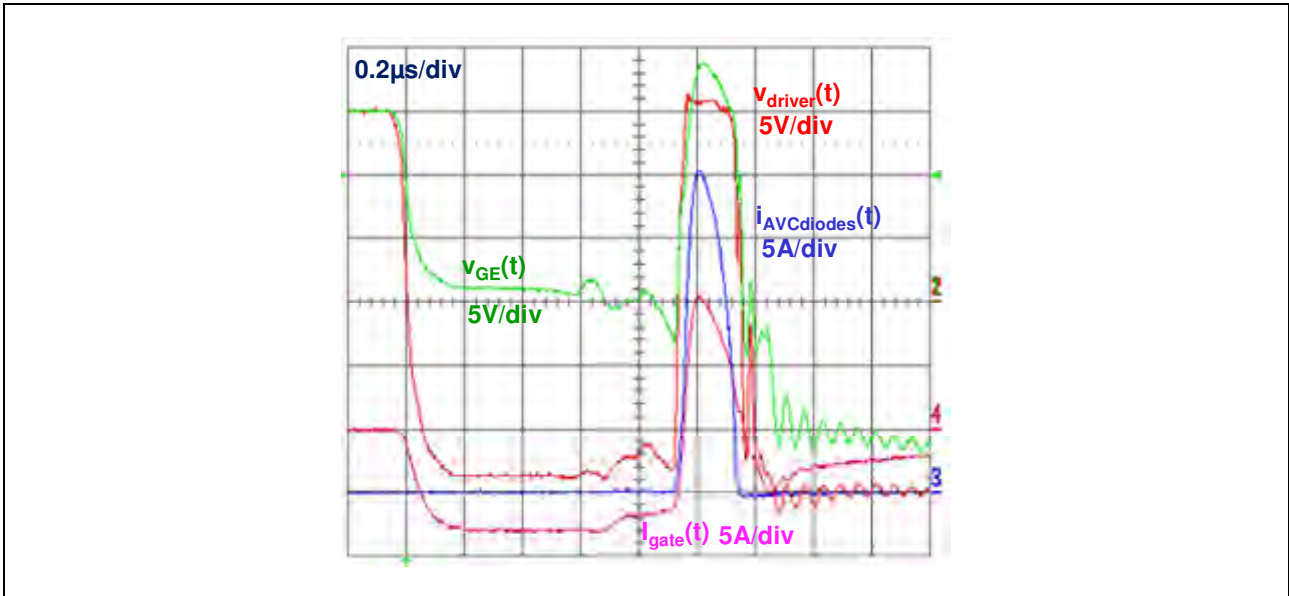


Figure 10 Switching off behaviour of the FF1000R17IE4 PrimePACK™ module with boosted active clamping where: $V_{DC}=900V$, $I_C=2500A$, $R_{Goff}=1,5\Omega$ and $T_J=25^\circ C$

3.6 Maximum switching frequency

The IGBT switching frequency is limited by the available DC/DC 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 increases the temperature around the gate resistors. When the available power of the DC/DC converter is not reached, the limiting factor for the IGBT's switching frequency is the absolute maximum temperature for the FR4 material. The temperature limit is $105^\circ C$ and shall not be exceeded.

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

$$P_{dis} = P(R_{EXT}) + P(R_{INT}) = \Delta V_{out} \cdot f_s \cdot Q_G \quad (1)$$

where:

P_{dis} – dissipated power, ΔV_{out} – voltage step at the driver output

f_s – switching frequency, Q_G – IGBT gate charge (for the given gate voltage range)

The losses are shared between the internal – $P(R_{INT})$ and the external - $P(R_{EXT})$ gate resistors. Due to the PCB temperature criteria maximum switching frequency for a given ambient and baseplate temperature can be calculated using $P(R_{EXT})$ and thermal resistance.

Based on experimentally determined board temperature dependencies $T_{PCB} \sim P(R_{EXT})$ (Fig. 11) it is possible to determine the maximal switching frequency for various modules.

As can be concluded from Figure 11, the board can dissipate approximately 1,1W per channel from the external gate resistors soldered to PCB when $T_a=25^\circ C$ and $T_{baseplate}=125^\circ C$. This value is relatively small compared to 4W available driver power⁷. Based on this assumption the Table 4 shows maximum switching frequencies for MA300Exx and PrimePACK™ modules. It has to be clearly pointed out that given switching frequencies there will differ when PCB ambient and module baseplate temperatures are changed.

⁷ When MA300Exx used together with 2ED300E17-SFO

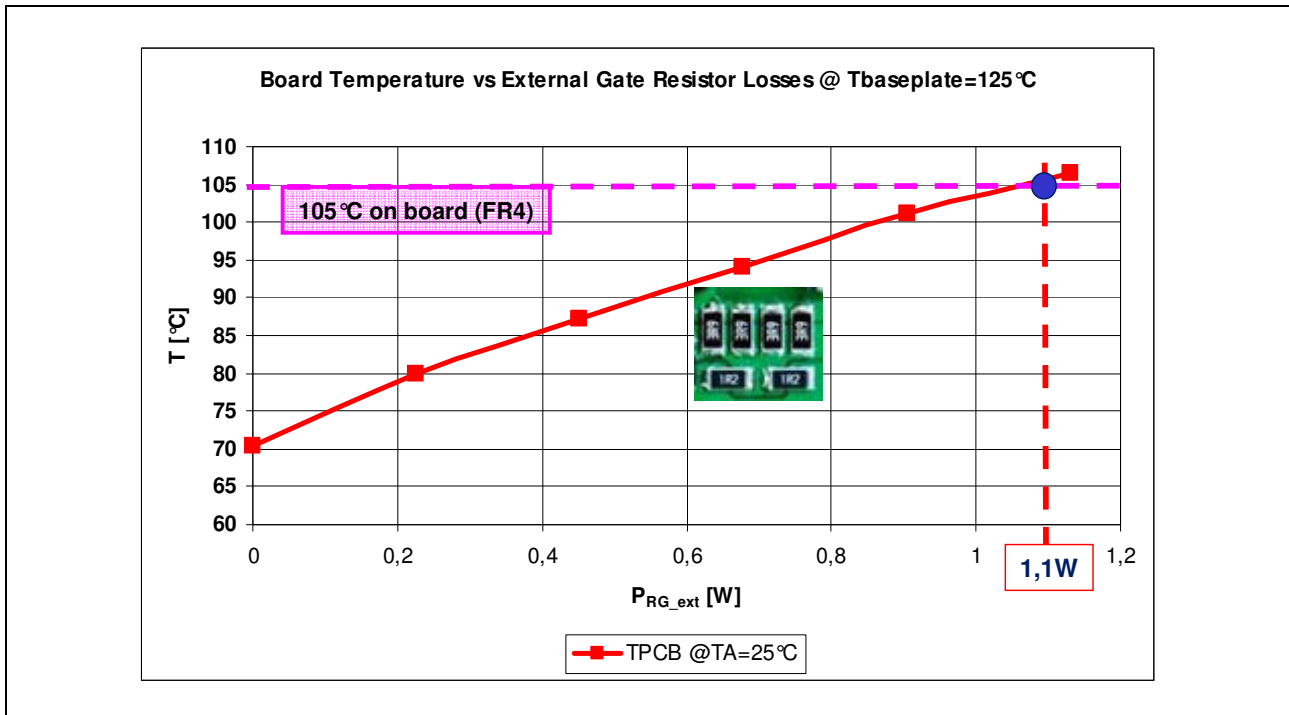


Figure 11 PCB temperature vs gate resistor power losses

Table 4 Calculated max. IGBT switching frequencies for 2ED300E17-SFO with MA300Exx and single PrimePACK™ module

Module	R_{EXT}/Ω	R_{INT}/Ω	$f_S@T_a=25^\circ C$ and $T_{baseplate}=125^\circ C$
FF600R12IE4	2,2	1,8	10,8 kHz – limited by R_G power
FF600R12IP4	2,2	1,8	10,8 kHz – limited by R_G power
FF900R12IP4	1,6	1,2	7 kHz – limited by R_G power
FF1400R12IP4	1,0	0,8	4,7 kHz – limited by R_G power
FF650R17IE4	2,7 ⁸	2,3	8 kHz – limited by R_G power
FF1000R17IE4	1,8 ⁹	1,5	5,6 kHz – limited by R_G power

In order to calculate allowed power losses $P(R_{EXT})$ when baseplate and ambient temperatures differ from the example shown above the formula (2) can be used.

$$\frac{P(R_{EXT})}{W} = \frac{(105^\circ C - T_{baseplate}) \frac{K}{^\circ C}}{71 \frac{K}{W}} + \frac{(105^\circ C - T_{ambient}) \frac{K}{^\circ C}}{58 \frac{K}{W}} \quad (2)$$

Finally, the suggested IGBT maximum switching frequency for given $T_{baseplate}$ and $T_{ambient}$ for MA300Exx used together with 2ED300E17-SFO is given by formula (3)

$$\frac{f_S}{Hz} = \frac{P(R_{EXT}) \cdot (R_{INT} + R_{EXT})}{30 \cdot k \cdot R_{EXT} \cdot Qq \mu C} \quad (3)$$

where $k=1.2$ – tolerance factor

^{8,9}, Based on highest external gate resistor value

When modules are in parallel the driving power increases accordingly to number of paralleled modules and their switching frequency. The maximum switching frequency in this case is determined not only by PCB temperature but also by available driving power (4W when used with 2ED300E17-SFO). Table 5 shows switching frequencies where two modules are in parallel and Table 6 when the number is three. Both limitation factors are considered

Table 5 Calculated max. IGBT switching frequencies for 2ED300E17-SFO with MA300Exx and two PrimePACK™ modules in parallel

Module	R _{EXT} /Ω	R _{INT} /Ω	f _s @T _a =25 °C and T _{baseplate} =125 °C
FF600R12IE4	2,2	1,8	10,8 kHz – limited by R _G power
FF600R12IP4	2,2	1,8	10,8 kHz – limited by R _G power
FF900R12IP4	1,6	1,2	7 kHz – limited by R _G power
FF1400R12IP4	1,0	0,8	4,7 kHz – limited by R _G power
FF650R17IE4	2,7	2,3	8 kHz – limited by R _G power
FF1000R17IE4	1,8	1,5	5,6 kHz – limited by R _G power

When modules are in parallel the driving power increases accordingly to number of paralleled modules and their switching frequency. The maximum switching frequency in this case is determined not only by PCB temperature but also by available driving power (4W when used with 2ED300E17-SFO). Table 5 shows switching frequencies where two modules are in parallel and Table 6 when the number is three. Both limitation factors are considered

Table 6 Calculated max. IGBT switching frequencies for 2ED300E17-SFO with MA300Exx and three PrimePACK™ modules in parallel

Module	R _{EXT} /Ω	R _{INT} /Ω	f _s @T _a =25 °C and T _{baseplate} =125 °C
FF600R12IE4	2,2	1,8	7,4 kHz – limited by DC/DC power
FF600R12IP4	2,2	1,8	7,4 kHz – limited by DC/DC power
FF900R12IP4	1,6	1,2	4,8 kHz – limited by DC/DC power
FF1400R12IP4	1,0	0,8	3,2 kHz – limited by DC/DC power
FF650R17IE4	2,7	2,3	5,2 kHz – limited by DC/DC power
FF1000R17IE4	1,8	1,5	3,7 kHz – limited by DC/DC power

When modules are in parallel the driving power increases accordingly to number of paralleled modules and their switching frequency. The maximum switching frequency in this case is determined not only by PCB temperature but also by available driving power (4W when used with 2ED300E17-SFO). Table 5 shows switching frequencies where two modules are in parallel and Table 6 when the number is three. Both limitation factors are considered

3.7 Parallel operation

The Flexible Starter Kit consisting of one 2ED300E17-SFO, one 2ED300E17-S /-STdriver board and MA300Exx module adapter board can be used for driving one PrimePACK™ module as shown on Fig. 2. The driver system can be easily adopted for modules paralleling (maximum three PrimePACK™ modules). In that case all PrimePACK™ modules should have dedicated MA300Exx board connected to 2ED300E17-SFO adapter board as shown on Figure 12. It must be noticed that R_{SSD} resistor in every case should be selected accordingly to AN200-05 chapter 3.5.

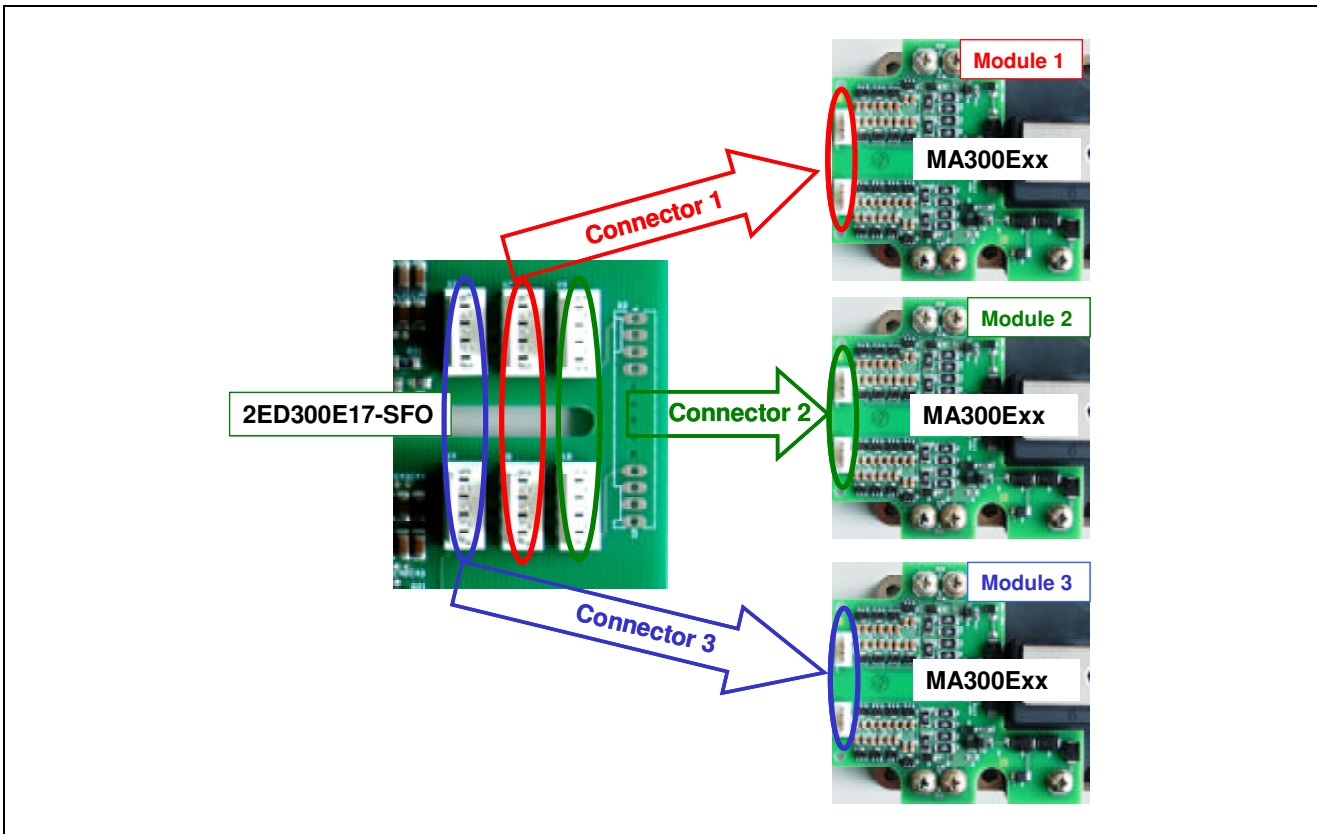


Figure 12 Connections between MA300Exx and 2ED300E17-SFO when three PrimePACK™ modules in parallel

4 Schematic and Layout of MA300Exx

To meet the individual customer requirement and make the evaluation board simple for further development or modification, all necessary technical data like schematic, layout and components are included in this chapter.

4.1 Schematic

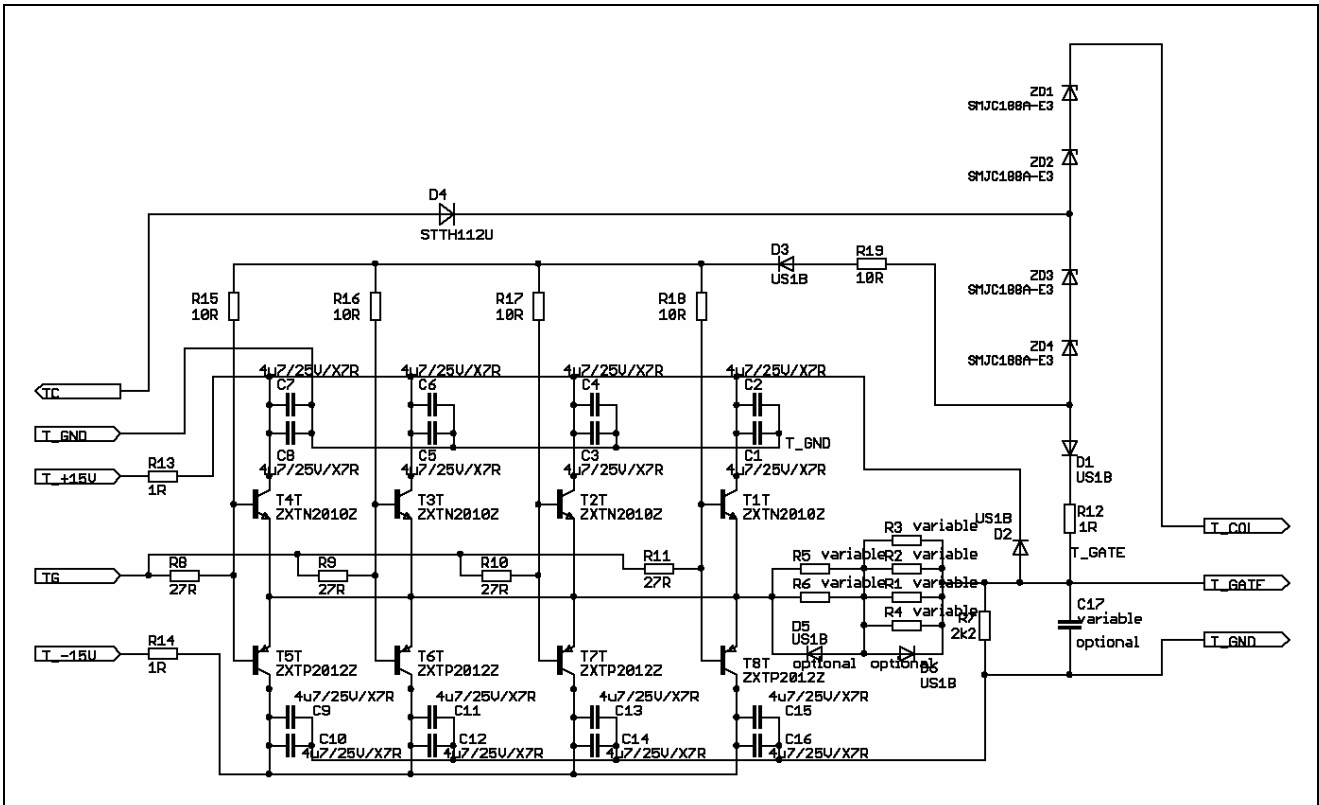


Figure 13 The MA300Exx – top transistor

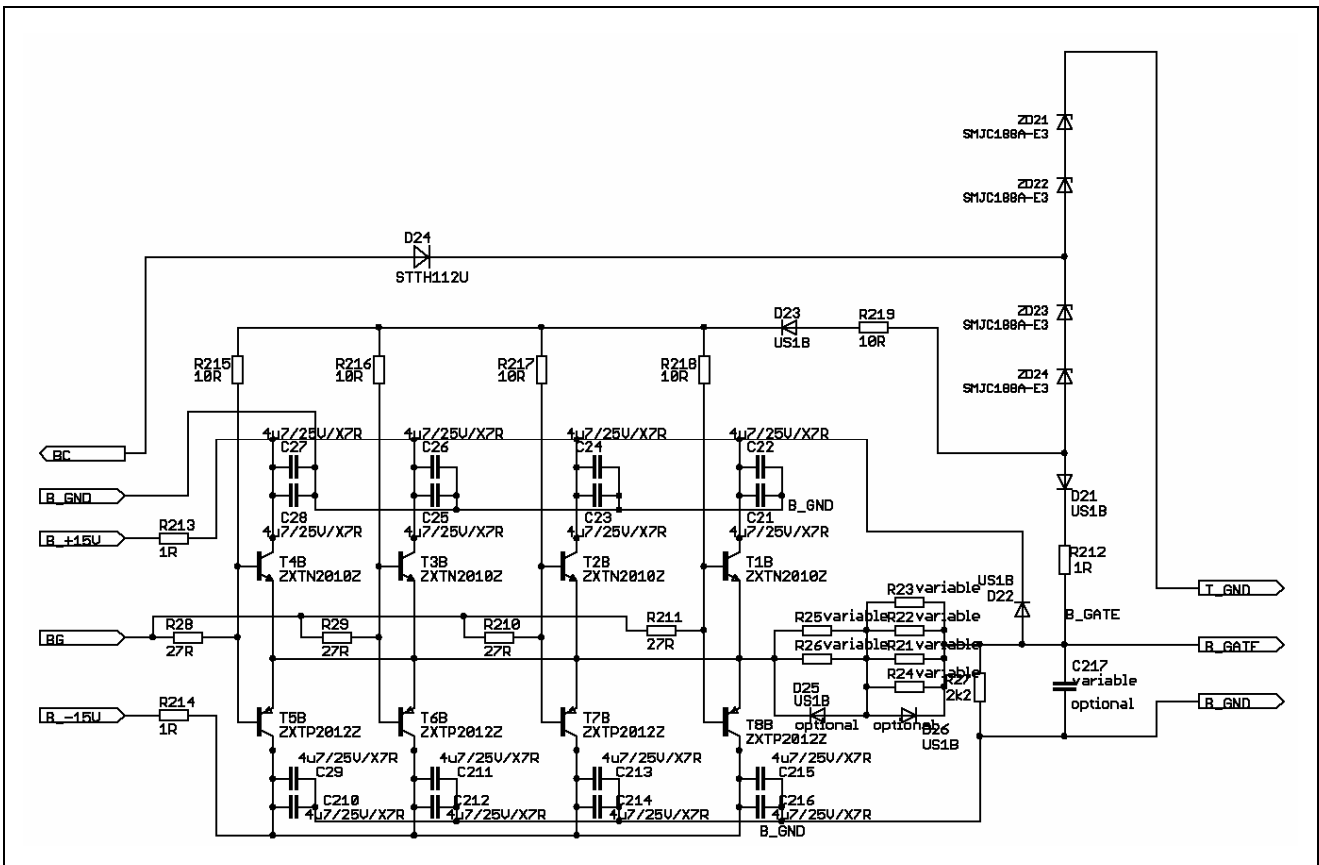


Figure 14 The MA300Exx – bottom transistor

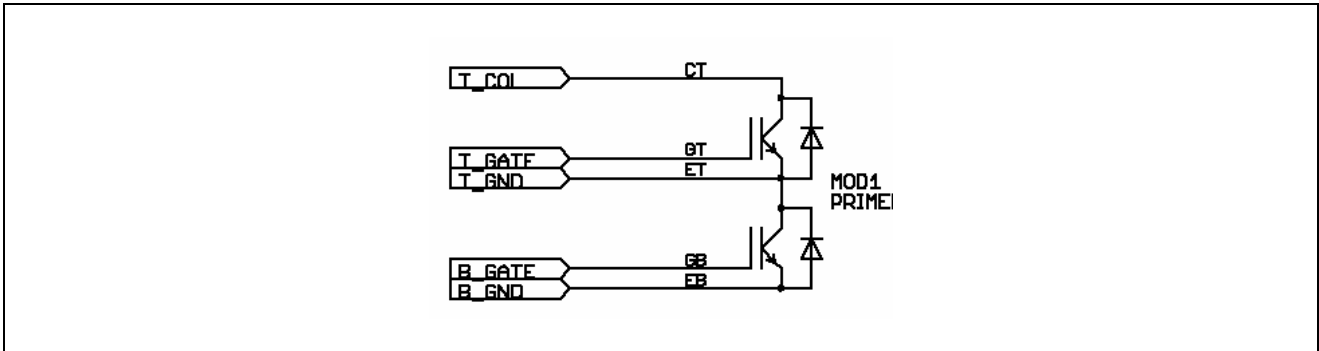


Figure 15 The MA300Exx – main connectors

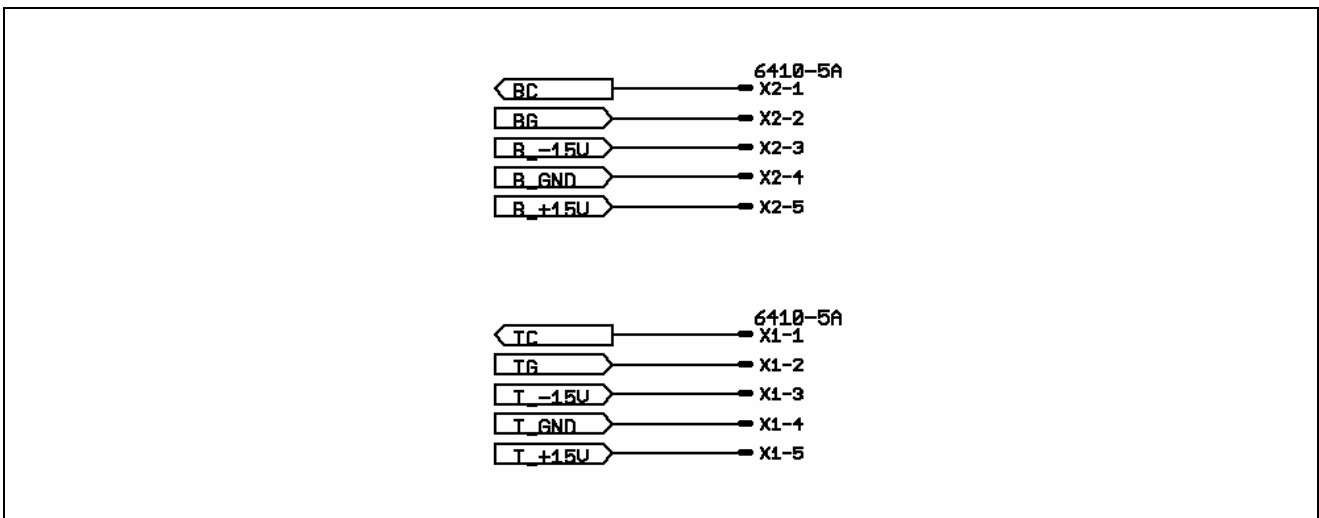


Figure 16 The MA300Exx – external connectors

4.2 Assembly drawing

Basic circuit and layout for MA300E12 and MA300E17 is the same. The only difference is with transil diodes: ZD1, ZD2, ZD3, ZD4, ZD21, ZD22, ZD23, ZD24 type and assembly. Gate resistors should be assebled accordingly to hints given in Table 3.

In MA300E12 all diodes are assembled and the type is: SMJC188A

In MA300E17 diodes: ZD1, ZD2, ZD3, ZD4, ZD21, ZD22, ZD23, ZD24 are assembled and the type is: 1.5SMC440A. Place for diodes: ZD4 and ZD24 must be shorted by wire.

Bill of material and detailed information about assembly separately for MA300E12 and MA300E17 is given respectovelly in chapter 4.4 and 4.5.

Any mistake with diodes assembly will results with not proper active voltage clamping protection!

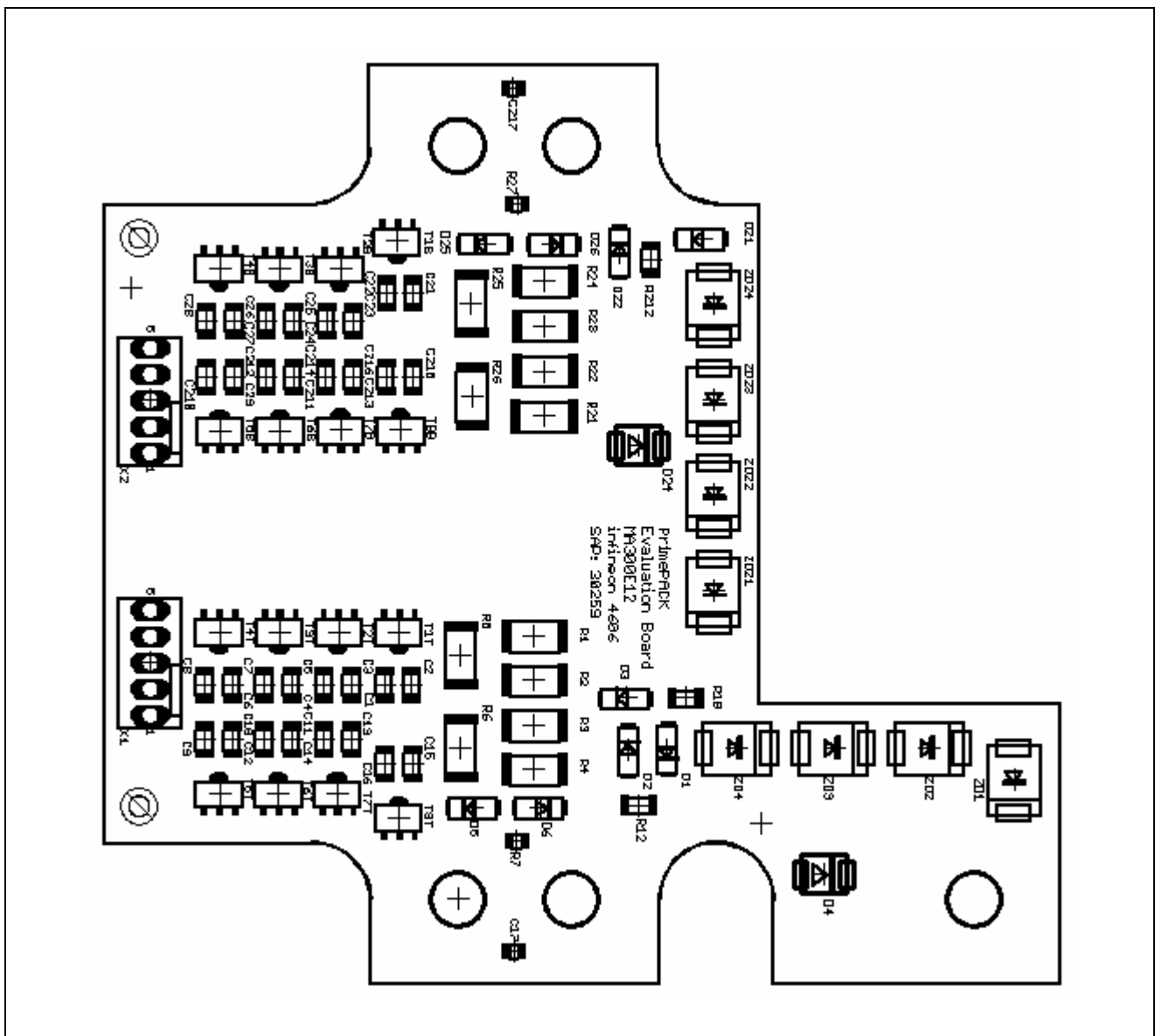


Figure 17 The MA300Exx – assembly drawing

4.3 Layout

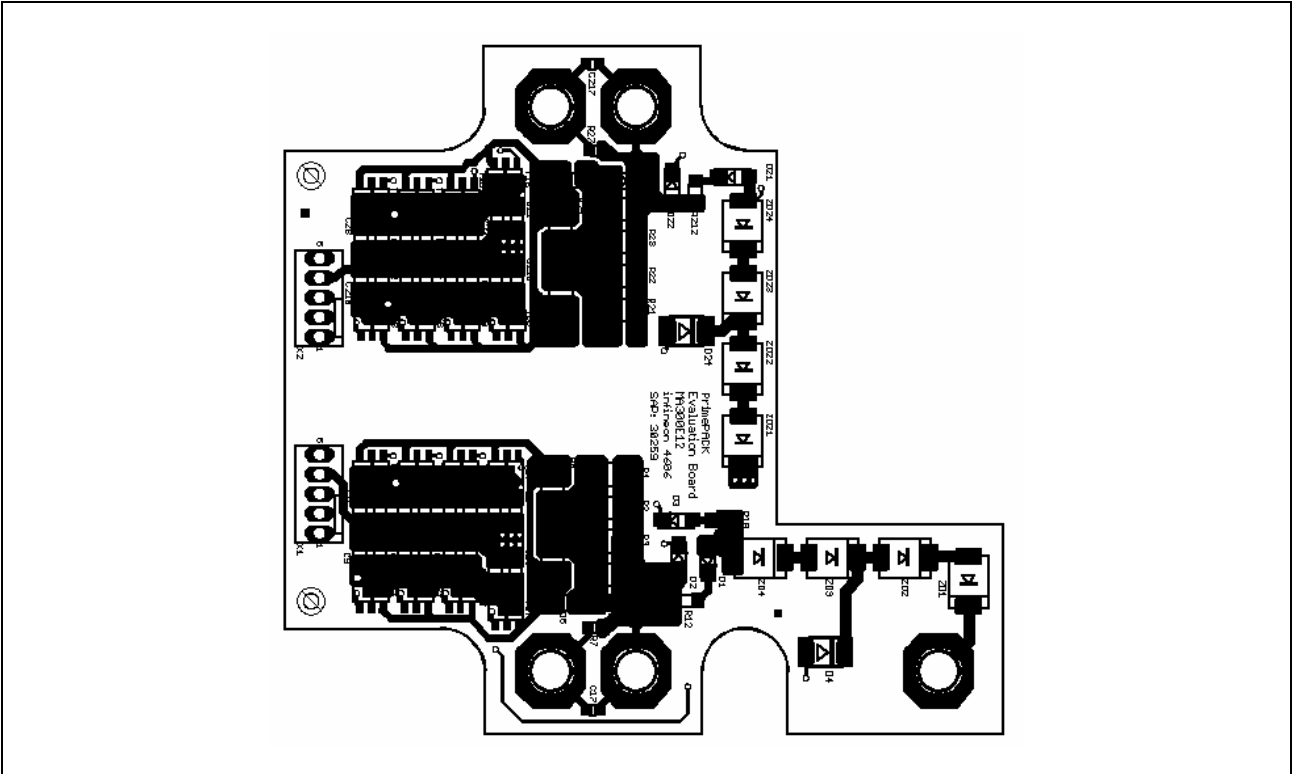


Figure 18 The MA300Exx – Top layer

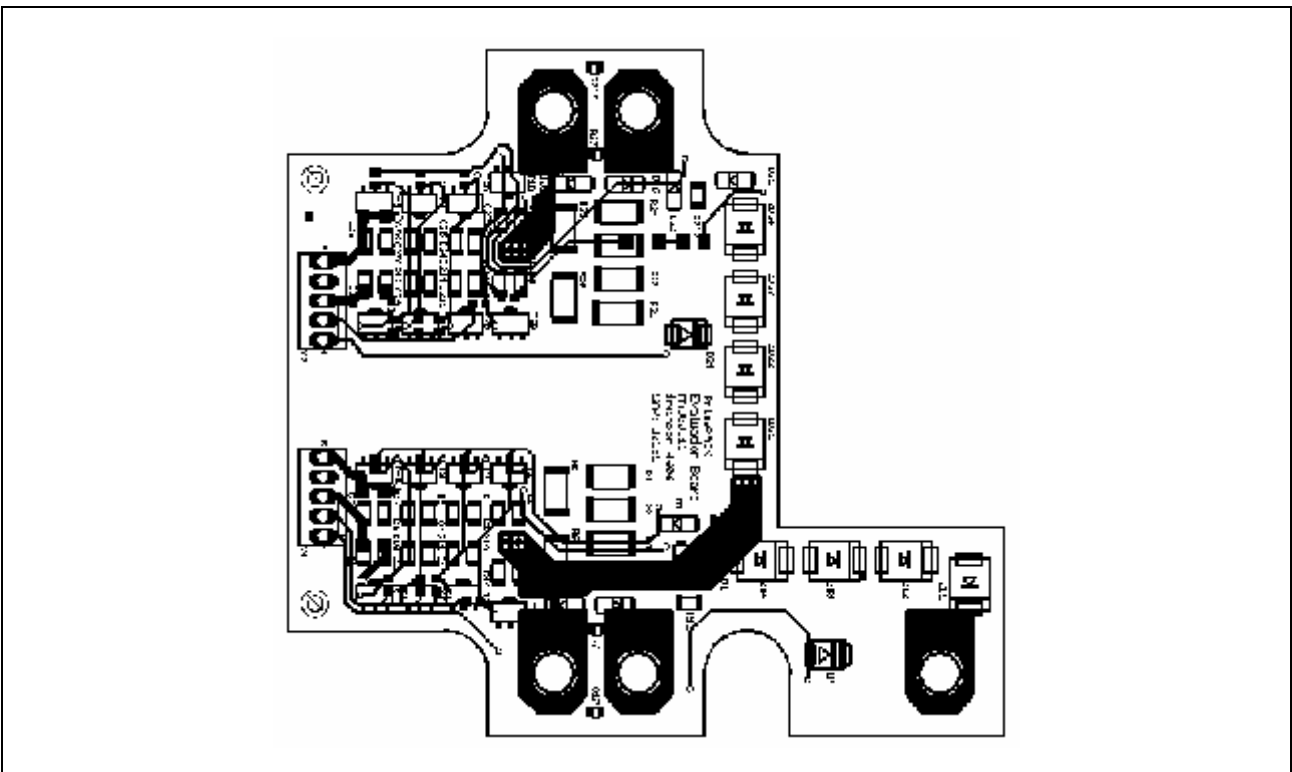


Figure 19 The MA300Exx – Bottom layer

4.4 Bill of Material - MA300E12

The bill of material not only includes a part list, but also assembly notes.

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

Table 7 Bill of Material for MA300E12 adapter board

Type	Value / Type	Package size imperial	QTY	Name Part	Recommended Manufacturer	Assembly
Resistor	see chapter 3.2*	2512	12	R1, R2, R3, R4, R5, R6, R21, R22, R23, R24, R25, R26	special pulse resistors	no
Resistor	1R	1206	6	R12, R13, R14, R212, R213, R214	no special	yes
Resistor	10R	1206	2	R19, R219	no special	yes
Resistor	10R	0603	8	R15, R16, R17, R18, R215, R216, R217, R218,	no special	yes
Resistor	27R	0603	8	R8, R9, R10, R11, R28, R29, R210, R211,	no special	yes
Resistor	2k2	0805	2	R7, R27	no special	yes
Capacitor	variable	0805	2	C17, C217	no special	no
Capacitor	4 μ 7/25V/X7R	1206	32	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C21, C22, C23, C24, C25, C26, C27, C28, C29, C210, C211, C212, C213, C214, C215, C216,	Murata	yes
Semiconductor	ZXTN2010Z	SOT89	8	T1, T2, T3, T4, T21, T22, T23, T24,	Zetex	yes
Semiconductor	ZXTP2012Z	SOT89	8	T5, T6, T7, T8, T25, T26, T27, T28	Zetex	yes
Semiconductor	ES1B (see chapter 3.2)	SMA	4	D5, D6, D25, D26	Vishay	no
Semiconductor	ES1B	SMA	6	D1, D2, D3, D21, D22, D23	Vishay	yes
Semiconductor	STTH112U	SMB	2	D4, D24	STM	yes
Semiconductor	SMCJ188A	SMC	8	ZD1, ZD2, ZD3, ZD4, ZD21, ZD22, ZD23, ZD24	Vishay	yes
Connector	6410-5A		2	X1, X2	Molex (22-27-2051)	yes

*Pulse power rated types

4.5 Bill of Material - MA300E17

The bill of material not only includes a part list, but also assembly notes.

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

Table 8 Bill of Material for MA300E17 adapter board

Type	Value / Type	Package size imperial	QTY	Name Part	Recommended Manufacturer	Assembly
Resistor	see chapter 3.2*	2512	12	R1, R2, R3, R4, R5, R6, R21, R22, R23, R24, R25, R26	special pulse resistors	no
Resistor	1R	1206	6	R12, R13, R14, R212, R213, R214	no special	yes
Resistor	10R	1206	2	R19, R219	no special	yes
Resistor	10R	0603	8	R15, R16, R17, R18, R215, R216, R217, R218,	no special	yes
Resistor	27R	0603	8	R8, R9, R10, R11, R28, R29, R210, R211,	no special	yes
Resistor	2k2	0805	2	R7, R27	no special	yes
Capacitor	variable	0805	2	C17, C217	no special	no
Capacitor	4 μ 7/25V/X7R	1206	32	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C21, C22, C23, C24, C25, C26, C27, C28, C29, C210, C211, C212, C213, C214, C215, C216,	Murata	yes
Semiconductor	ZXTN2010Z	SOT89	8	T1, T2, T3, T4, T21, T22, T23, T24,	Zetex	yes
Semiconductor	ZXTP2012Z	SOT89	8	T5, T6, T7, T8, T25, T26, T27, T28	Zetex	yes
Semiconductor	ES1B (see chapter 3.2)	SMA	4	D5, D6, D25, D26	Vishay	no
Semiconductor	ES1B	SMA	6	D1, D2, D3, D21, D22, D23	Vishay	yes
Semiconductor	STTH112U	SMB	2	D4, D24	STM	yes
Semiconductor	1.5SMC440A	SMC	6	ZD1, ZD2, ZD3, ZD21, ZD22, ZD23,	Vishay	yes
Semiconductor	wire short		6	ZD4, ZD24	Vishay	yes
Connector	6410-5A		2	X1, X2	Molex (22-27-2051)	yes

*Pulse power rated types

5 How to order Evaluation Driver Boards

Every Evaluation Driver 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 this data is subjected to the disclaimer given in this AN. Please contact: IGBT.Application@infineon.com

IFX order number for MA300E12: 30259

IFX order number for MA300E17: 30276

IFX order number for 2ED300E17-SFO: 30272

IFX order number for 2ED300C17-S: 29831

IFX order number for 2ED300C17-ST: 29832

<http://www.infineon.com>