Application Note, V1.0, Feb. 2010

AN2010-01

MA200E12/17_EVAL

Module Adapter Board for EconoDUAL™3 IGBT Modules

IFAG IMM INP TM

Never stop thinking

Edition 2010-02-08

Published by
Infineon Technologies AG
59568 Warstein, Germany

© Infineon Technologies AG 2010.
All Rights Reserved.

LEGAL DISCLAIMER

THE INFORMATION GIVEN IN THIS APPLICATION NOTE IS GIVEN AS A HINT FOR THE IMPLEMENTATION OF THE INFINEON TECHNOLOGIES COMPONENT ONLY AND SHALL NOT BE REGARDED AS ANY DESCRIPTION OR WARRANTY OF A CERTAIN FUNCTIONALITY, CONDITION OR QUALITY OF THE INFINEON TECHNOLOGIES COMPONENT. THE RECIPIENT OF THIS APPLICATION NOTE MUST VERIFY ANY FUNCTION DESCRIBED HEREIN IN THE REAL APPLICATION. INFINEON TECHNOLOGIES HEREBY DISCLAIMS ANY AND ALL WARRANTIES AND LIABILITIES OF ANY KIND (INCLUDING WITHOUT LIMITATION WARRANTIES OF NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OF ANY THIRD PARTY) WITH RESPECT TO ANY AND ALL INFORMATION GIVEN IN THIS APPLICATION NOTE.

Information

For further information on technology, delivery terms and conditions and prices please contact your nearest Infineon Technologies Office (**www.infineon.com**).

Warnings

Due to technical requirements components may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies Office.

Infineon Technologies Components may only be used in life-support devices or systems with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support device or system, or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body, or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.

AN2010-01

Revision History:	--	V1.0
Previous Version:		

Page	Subjects (major changes since last revision)

Authors: Alain Siani IFAG IMM INP TM, Uwe Jansen IFAG IMM INP TM

We Listen to Your Comments

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

1 Introduction **5**

2 Design features **6**

2.1 Main features 6
2.2 Key data 7
2.3 Mechanical dimensions 7
2.4 Pin assignment 8

3 Application Note **10**

3.1 Functionality on board 10
3.2 Gate resistors 10
3.3 Gate signal amplifier 11
3.4 V_{CE} monitoring for short circuit detection 12
3.5 Active voltage clamping – boosted version 13
3.6 Maximum switching frequency 13
3.7 Parallel operation 16

4 Schematic and Layout of MA200E12/17 ..... **16**

4.1 Schematic 17
4.2 Assembly drawing 20
4.3 Layout 21
4.4 Bill of Material - MA200E12 22
4.5 Bill of Material - MA200E17 24

5 How to order Evaluation Driver Boards **25**

6 References **25**

Part number explanation:

MA 200 E12/17

- **12 or 17 – Suitable for 1200 V or 1700V EconoDual™ 3**
- **Evaluationboard**
- **200 – 20 A driver output current**
- **MA – Module Adapter board**

1 Introduction

The MA200E12/17 module adapter boards, shown in Figure 1, offer reliable connection between driver and various IGBT EconoDual™ 3 modules. MA200E12/17 are dedicated to all EconoDual™ 3 module types respecitvelly 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 EconoDual™ 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 MA200E12/17 is the same as paralleled modules.

The MA200E12/17 module adapter boards are available from Infineon in small quantities. Functions and min 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 MA200E12/17 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 ambient temperature operating 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 Discontinuation (PD) as regular products.

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

MA200E12/17 Top side **MA200E12/17 Bottom side**

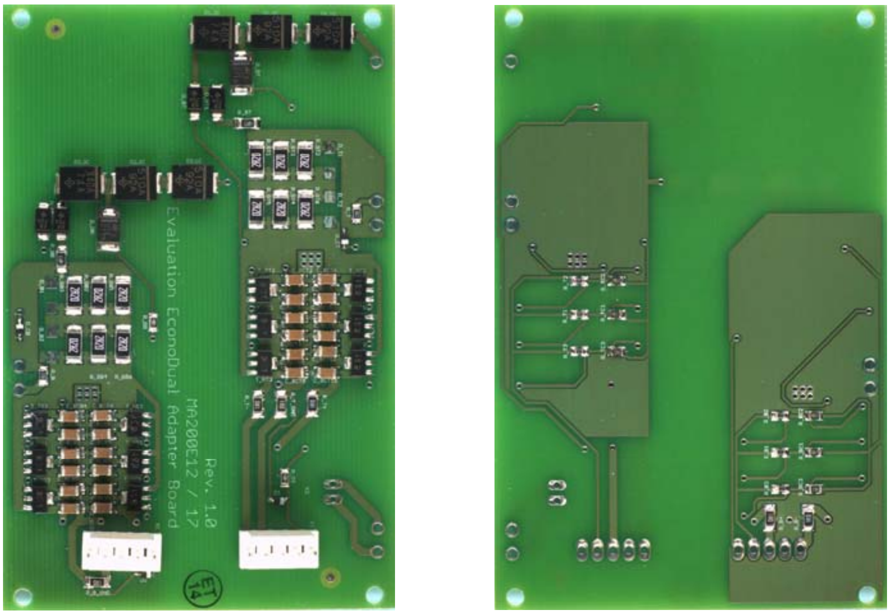


Figure 1 The EconoDual™3 Module Adapter board

Figure 2 The 'Flexible driver Starter Kit' for EconoDual™3 module

2 Design features

Electric features of the evaluation board and mechanical dimensions including necessary interface connections are presented in following sections. There are two different versions available MA200E12 and MA200E17. Both use the same bare PCB, but components vary with type. If both types are refered to the designation MA200E12/17 is used.

2.1 Main features

The MA200E12/17 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 EconoDual™ 3 modules family
- Operating temperature (design target) minimum value -40°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 mounted 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 – 11 mm)

When the MA200E12/17 is not used with 2ED300E17-SFO adapter board and 2ED300C17-S /-ST EiceDRIVER™ these following features might be useful:

- Gate-emitter amplifier input resistance is larger than 45 Ω
- Can be used with max. ±20V isolated power supply (due to IGBT short circuit performances a value of max. +16V is suggested)
- Asymmetric power supply is also allowed e.g. -8 V and +16 V
- 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 °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	±20	A
R_{Gmin} – minimum gate resistor value when V_{DC}=±15V (internal module resistor R_{INT} + external R_{EXT})	1.5	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]	-40…+85	°C
T_{sto} – storage temperature (design target)	-40…+85	°C

2.3 Mechanical dimensions

Figure 3 The MA200E12/17 mounted on EconoDual™3 module

[1] Only when MA200E12/17 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 EconoDual™ 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 MA200E12/17 load conditions.

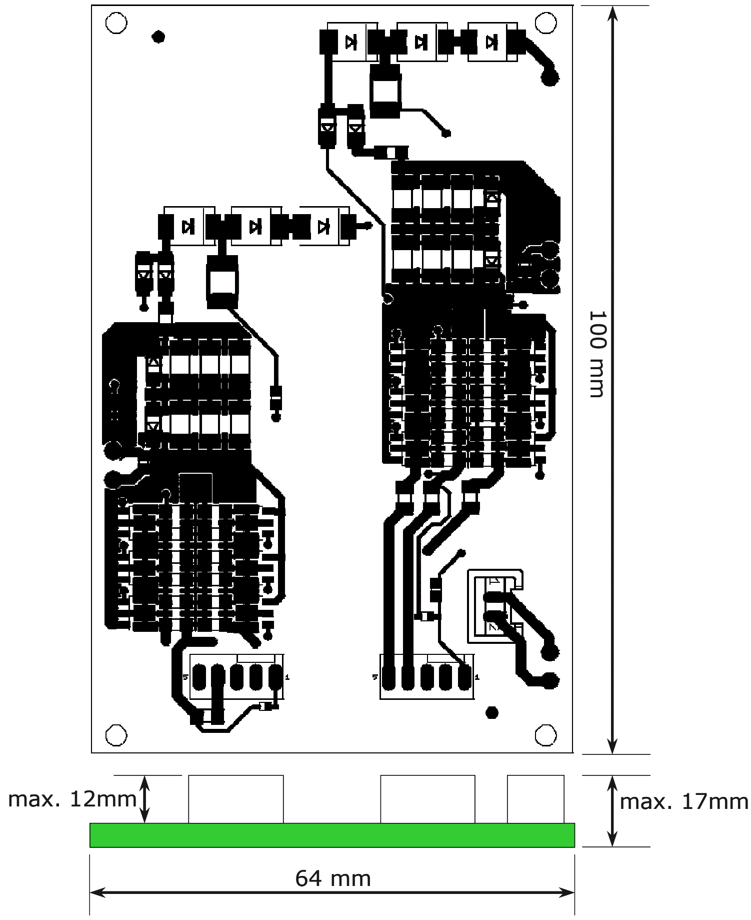


Figure 4 Dimensions of the MA200E12/17 module adapter board

2.4 Pin assignment

After the module adapter has been correctly mounted to the EconoDual™ 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 MA200E12/17 is used together with 2ED300E17-SFO the necessary connections to module adapter are depicted in Figure 5. In this case the Sense-Signal of the 2ED300S17-S driver is used instead of the Out-Signal, making the internal booster of the 2ED300C17 redundant. The 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.

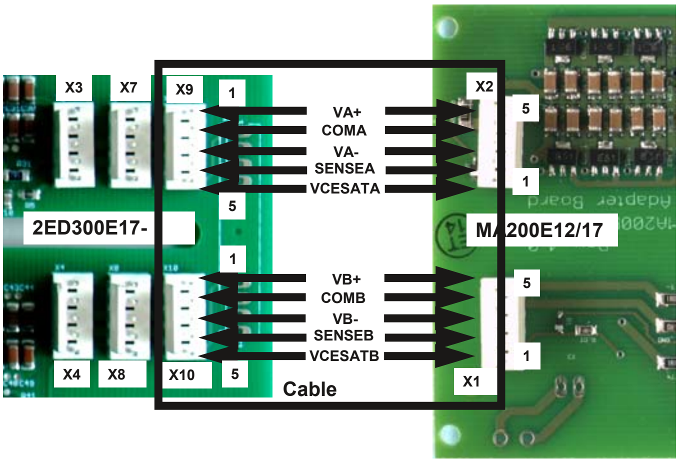


Figure 5 Connections between 2ED300E17-SFO and MA200E12/17

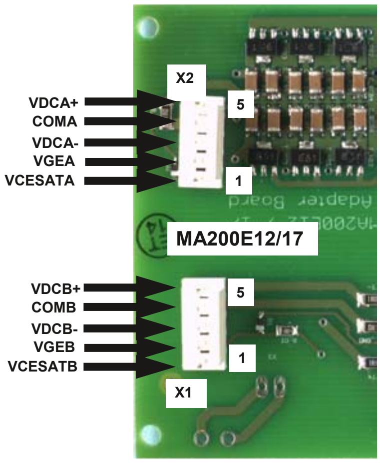


Figure 6 MA200E12/17 Module Adapter board and external electrical connections

Table 2 MA200E12/17 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 MA200E12/17 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 bellow depicts the MA200E12/17 with already mentioned functions and shows their physical location.

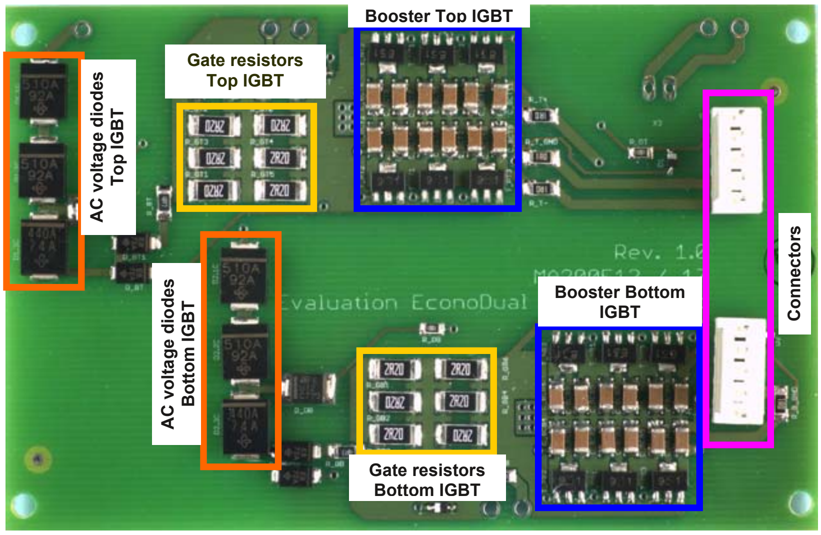


Figure 7 The MA200E12/17 with marked functions

3.2 Gate resistors

MA200E12/17 is assembled and delivered as shown on Fig. 7, but without gate resistors. Proper gate resistors should be soldered by the customer. Due to variation of switching behaviour with DC-link inductance, gate driver impedance and gate driver supply voltage no definitive values for the gate resistor values can be provided without taking the complete test setup into consideration. For 1700 V IGBT modules, operation together with the 2ED300E17-SFO board and a DC-link inductance of 35 nH values given in table 3 will provide approximately the same dI_C/dt as during device characterization. For 1200 V IGBT modules suitable values are to be evaluated within the individual project. The datasheet value of the gate resistor may be used as a starting point, but lower values are permissible as long as the datasheet value of dI_C/dt is not exceeded and the module is able to switch without oszillations. The switching losses will also vary significantly with application parameters. For more information on these topics please refer to [1] and [2].

The layout is intended for 2010 package size (EIA). These resistors are required to have a suitable rating for repetitive pulse power to avoid degradation.

Table 3 External gate resistor proposition for 1700V EconoDual™ 3 IGBT modules

Module	R_GB1, R_GB2, R_GB3, R_GT1, R_GT2, R_GT3	R_GB4, R_GB5, R_GB6, R_GT4, R_GT5, R_GT6	Resulting R_{Gon}	Resulting R_{Goff}
FF150R17ME3G	20 Ω	4,7 Ω	8.2	8.2 Ω
FF225R17ME3	6.8 Ω	4.7 Ω	3.8 Ω	3.8 Ω
FF225R17ME4	2.2 Ω	2.2 Ω	1.5 Ω	1.5 Ω
FF300R17ME3	4.7 Ω	3.3 Ω	2.7 Ω	2.7 Ω
FF300R17ME4	3.3 Ω	3.3 Ω	1.1 Ω	1.1 Ω
FF450R17ME3	2.2 Ω	2.2 Ω	1.5 Ω	1.5 Ω
FF450R17ME4	3.3 Ω	2.2 Ω	1.83 Ω	1.83 Ω

If it is intended to use different values for R_{Gon} and R_{Goff} assembly of diodes D_T1, D_T2, D_B1, D_B2 is possible. On Figure 8 the location of these diodes is shown.

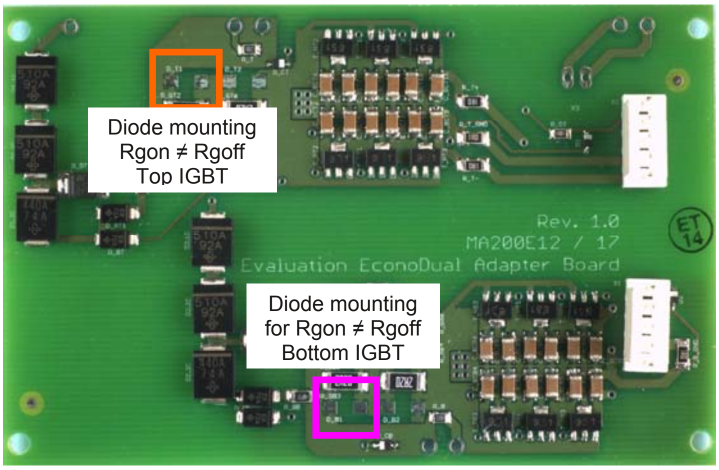


Figure 8 The MA200E12/17 location of optional diodes

Deadtime has to be adjusted according to chosen modules, driver supply voltages and gate resistors. For details refer to [3].

3.3 Gate signal amplifier

When IGBT 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 amplifier must deliver the cumulated gate current and the length of the gate leads increases. This setup suffers from multiple drawbacks as described in [4] and [5].

Overcoming these limitations becomes possible when the module adapter includes a dedicated gate signal amplifier (Fig. 8, Fig. 13 and Fig. 14). MA200E12/17 has the emitter follower called booster already implemented. Thanks to three pairs of complementary bipolar transistors connected in parallel the minimum gain @I_G=20 A is not smaller than 30[1]. Due to the fact that every EconoDual™ has its own module adapter the driving conditions are nearly equal to single module operation with driver directly on top of the module.

Benefits provided by booster:

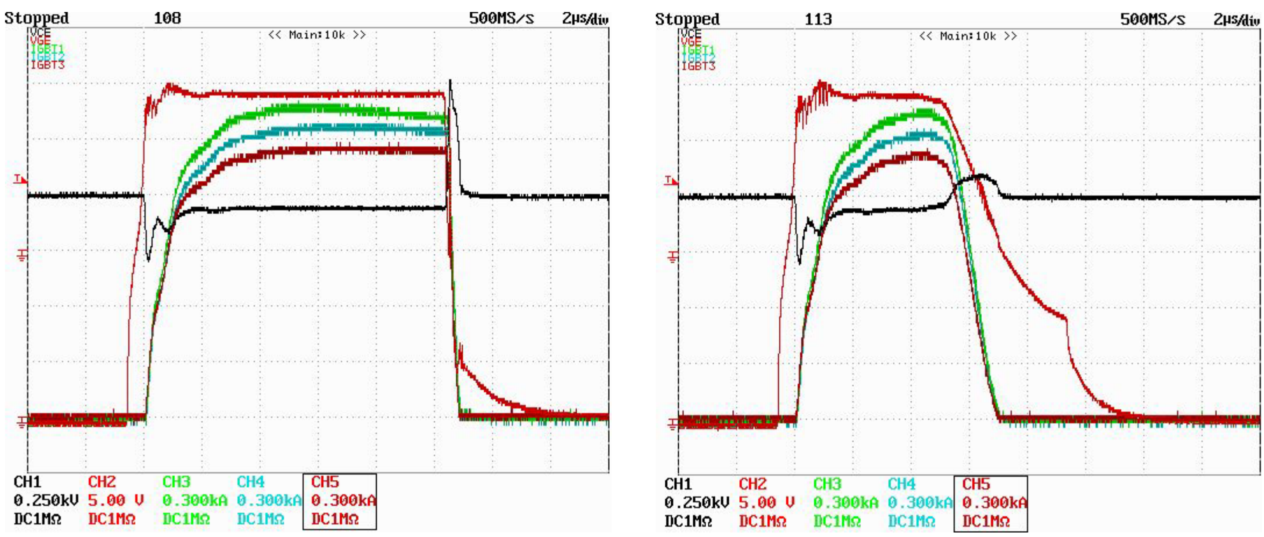
- Fast control of gate-emitter voltage for every EconoDual™ module
- Simple module paralleling

3.4 V_{CE} monitoring for short circuit detection

When the IGBT conducts a several times higher current than nominal the IGBT desaturates and the V_{CE} voltage increases (close to DC-link voltage level). This behaviour can be practically used for short circuit detection and switching-off an IGBT. The short circuit duration time for Infineon 1200 V and 1700 V IGBT modules must not exceed 10µs. During this time the short circuit should be detected and the IGBT switched off without exciding V_{CES}.

When MA200E12/17 is used together with 2ED300E17-SFO the R_{SSD} resistors (Soft Shut Down) must be chosen correctly in order to ensure proper short circuit protection. AN2007-05 in chapter 3.5 describes the procedure in details.

Figure 9a shows three FF450R17ME4 EconoDual™ modules under short circuit operation where short circuit protection on 2ED300E17-SFO was disabled and the short circuit is turned off by the control signal. High dI_C/dt during switching off creates large overvoltage spikes which are limited by active voltage clamping. Figure 9b depicts a case where the short circuit is detected by V_{CEsat}-protection and shows how a properly selected R_{SSD} slows down the collector current when the modules are turning off. These waveforms were aquired with a value for R_{SSD} of 1.8 kΩ.



9a 9b

Figure 9 Switching behaviour of three paralleled FF450R17ME4 EconoDual™ modules under short circuit where system with 2ED300E17-SFO and MA200E17 was applied: short circuit protection disabled - 9a and where enabled and R_{SSD} = 1,8kΩ – 9b

---

[1] Based on ZXTN2010Z and ZXTN2012Z bipolar transistors datascheets. www.zetex.com

3.5 Active voltage clamping – boosted version

Active voltage clamping is a technique which keeps temporary V_{CE} overvoltages bellow V_{CES} when the IGBT switches off. In a classic approach avalanche diodes are connected between auxiliary collector and gate of an IGBT module. When V_{CE} voltage exceeds the diode breakdown voltage the diode current is shared between IGBT gate and the driver output. Due to increased gate-emitter voltage the transistor is operated in 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. Avalanche diodes conduct high peak current during time periode in which V_{CE} overvoltage is limited.

Overvoltage protection of the MA200E12/17 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 MA200E12/17. 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 independend from choice of external gate resistor. Finally the same circuit for 1200V and 1700V modules employing different diode types has been realized.

Active Clamping is intended as a means of overvoltage protection in case of an overcurrent and short-circuit turn-off. If Active Clamping operates repetitively, e.g. because of extraordinary high DC-link stray inductance or excessive DC-link voltage a significant increase in switching loss might damage the module.

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 is105 °C and shall not be exceeded.

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

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

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. 10) it is possible to determine the maximum switching frequency for various modules.

As can be concluded from Figure 10, the board can dissipate approximately 1.5 W per channel from the external gate resistors soldered to PCB when T_a=25 °C and $T_{baseplate}$=125 °C. This value is relatively small compared to 4W available driver power[1]. Based on this assumption the Table 4 shows maximum switching frequencies for MA200E12/17 and EconoDual™ modules. It has to be clearly pointed out that these maximum switching frequencies will differ when ambient and module baseplate temperatures are changed.

[1] When MA300Exx used together with 2ED300E17-SFO

Please note also, that for these calculations datasheet value of external gate resistor has been used instead of proposed value from table 3.

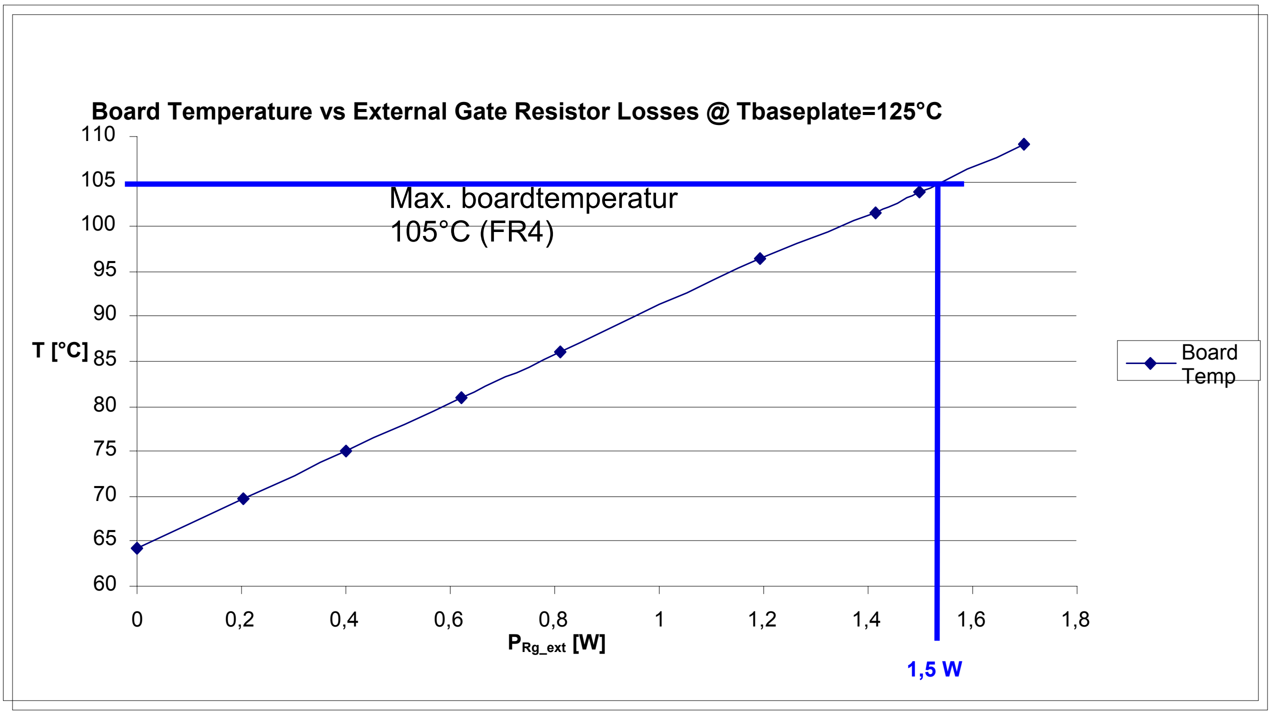


Figure 10 PCB temperature vs gate resistor power losses

Table 4 Calculated max. IGBT switching frequencies for 2ED300E17-SFO with MA200E12/17 and single EconoDual™ module

Module	R_{EXT}/Ω	R_{INT}/Ω	f_S@Ta=25°C and $T_{baseplate}$=125°C	
			limited by R_G power	limited by DC/DC power
FF150R17ME3G	9.1	3.2	33 kHz	65 kHz
FF225R17ME3	6.2	2.8	25 kHz	47 kHz
FF225R17ME4	3.3	2.8	32 kHz	47 kHz
FF300R17ME3	4.7	2.5	18 kHz	32 kHz
FF300R17ME4	3.3	2.5	24 kHz	36 kHz
FF450R17ME3	3.3	1,7	12 kHz	21 kHz
FF450R17ME4	3.3	1.7	13 kHz	24 kHz

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

$$\frac{P(R_{EXT})}{W} = \frac{(105°C - T_{baseplate})\frac{K}{°C}}{56\frac{K}{W}} + \frac{(105°C - T_{ambient})\frac{K}{°C}}{43\frac{K}{W}} \qquad (2)$$

Finally, the suggested IGBT maximum switching frequency for given $T_{baseplate}$ and $T_{ambient}$ for MA200E12/17 used together with 2ED300E17-SFO is given by formula (3), when $\Delta V_{out} = 30V$

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

where k=1.2 – tolerance factor

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 three are in parallel. Both limitation factors are considered

Table 5 Calculated max. IGBT switching frequencies for 2ED300E17-SFO with MA200E12/17 and two EconoDual™ modules in parallel

Module	R_{EXT}/Ω	R_{INT}/Ω	f_S@Ta=25°C and $T_{baseplate}$=125°C	
			limited by R_G power	limited by DC/DC power
FF150R17ME3G	9.1	3.2	33 kHz	32 kHz
FF225R17ME3	6.2	2.8	25 kHz	23 kHz
FF225R17ME4	3.3	2.8	32 kHz	23 kHz
FF300R17ME3	4.7	2.5	19 kHz	16 kHz
FF300R17ME4	3.3	2.5	24 kHz	18 kHz
FF450R17ME3	3.3	1.7	12 kHz	10 kHz
FF450R17ME4	3.3	1.7	13 kHz	12 kHz

Table 6 Calculated max. IGBT switching frequencies for 2ED300E17-SFO with MA200E12/17 and three EconoDual™ modules in parallel

Module	R_{EXT}/Ω	R_{INT}/Ω	f_S@Ta=25°C and $T_{baseplate}$=125°C	
			limited by R_G power	limited by DC/DC power
FF150R17ME3G	9.1	3.2	33 kHz	21 kHz
FF225R17ME3	6.2	2.8	25 kHz	15 kHz
FF225R17ME4	3.3	2.8	32 kHz	15 kHz
FF300R17ME3	4.7	2.5	19 kHz	10 kHz
FF300R17ME4	3.3	2.5	24 kHz	12 kHz
FF450R17ME3	3.3	1.7	12 kHz	7 kHz
FF450R17ME4	3.3	1.7	13 kHz	8 kHz

3.7 Parallel operation

The Flexible Starter Kit consisting of one 2ED300E17-SFO, one 2ED300E17-S /-STdriver board and MA200E12/17 module adapter board can be used for driving one EconoDual™ module as shown in Fig. 2. The driver system can be easily adapted for paralleling of modules (maximum three EconoDual™ modules). In that case all EconoDual™ modules should have dedicated MA200E12/17 board connected to 2ED300E17-SFO adapter board as shown in Figure 12. It must be noticed that R_{SSD} resistor in every case should be selected accordingly to AN2007-05 chapter 3.5.

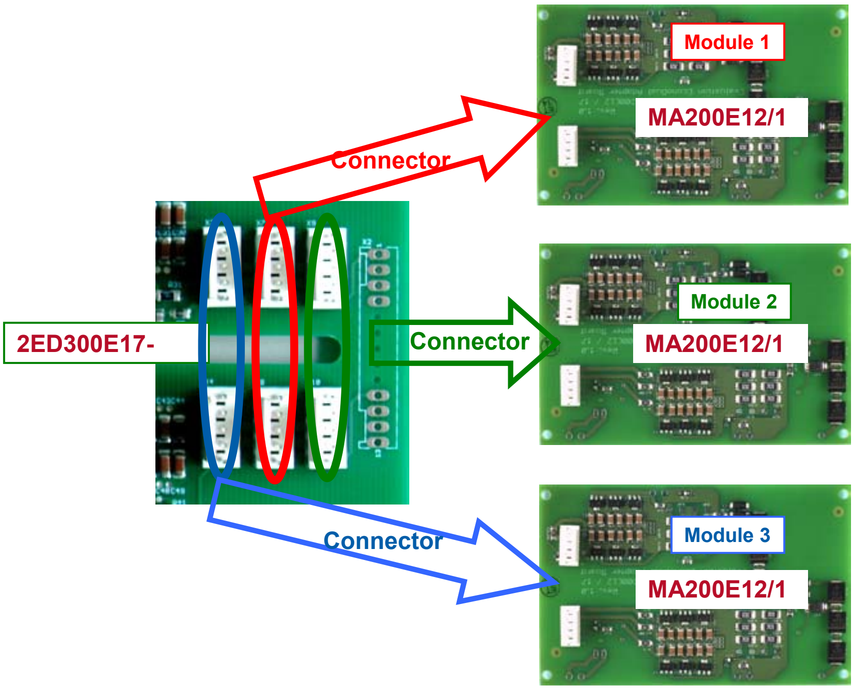


Figure 11 Connections between MA200E12/17 and 2ED300E17-SFO when three EconoDual™ modules are used in parallel

4 Schematic and Layout of MA200E12/17

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

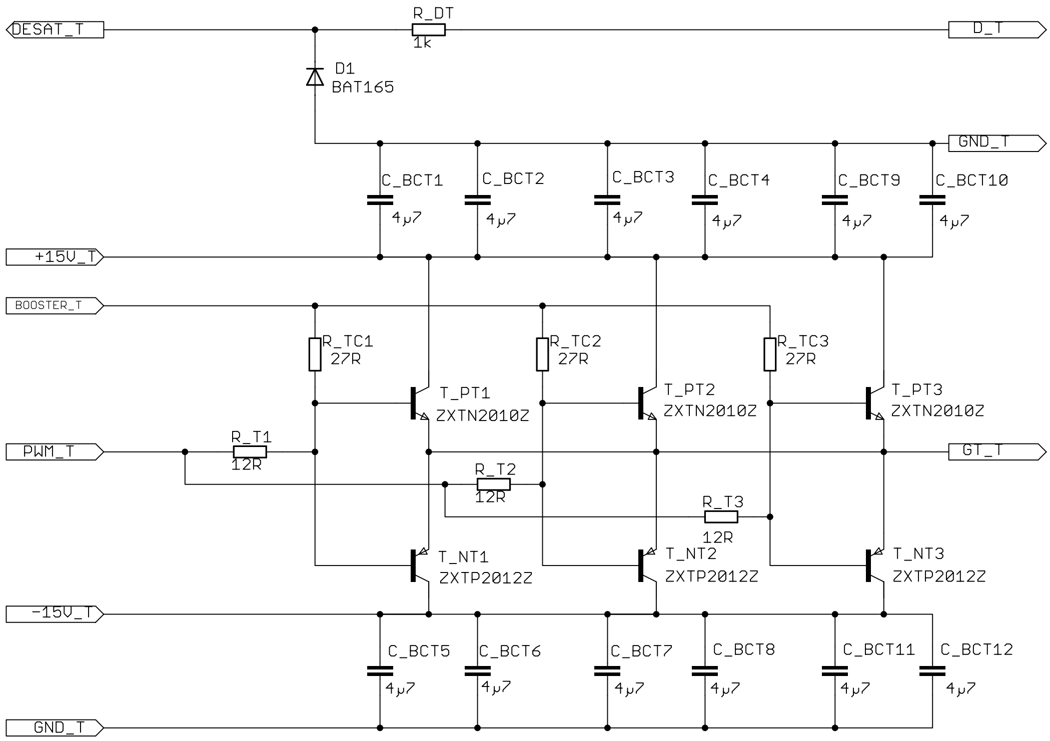


Figure 12 The MA200E12/17 – top channel

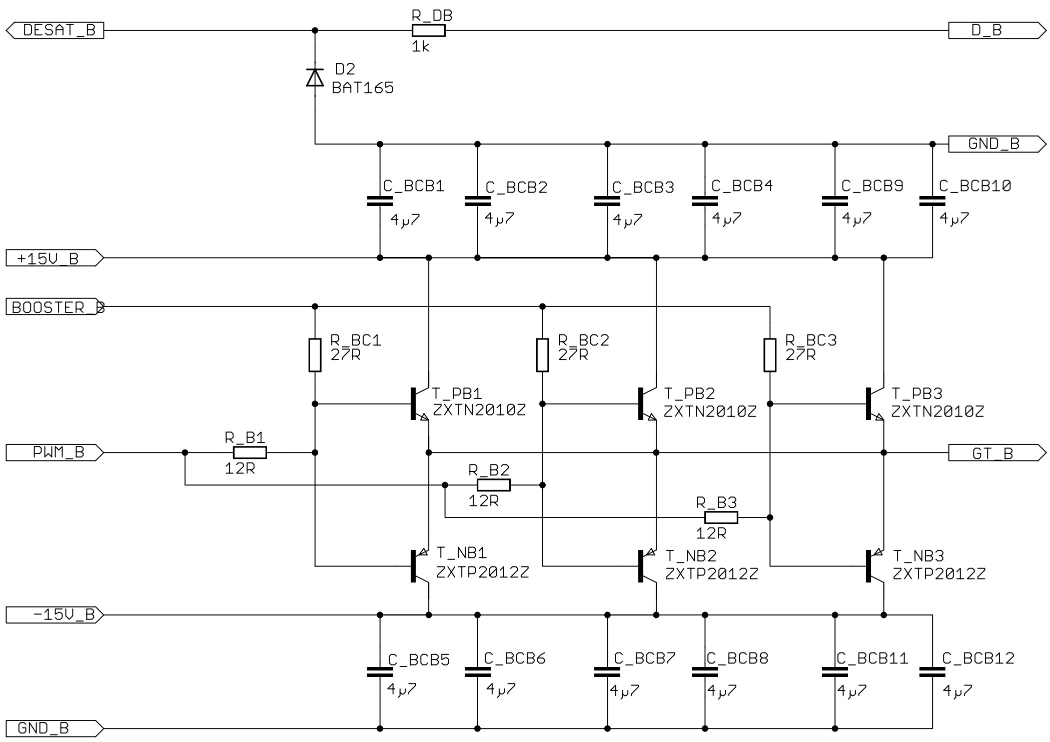


Figure 13 The MA200E12/17 – bottom channel

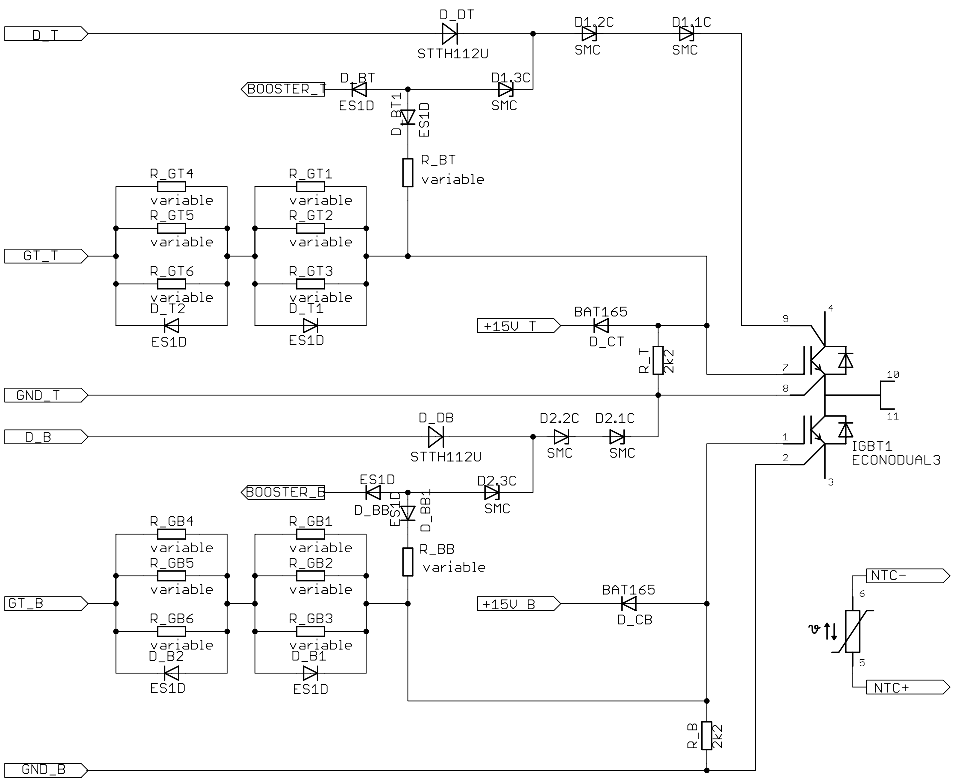


Figure 14 The MA200E12/17 – top and Bottom IGBT

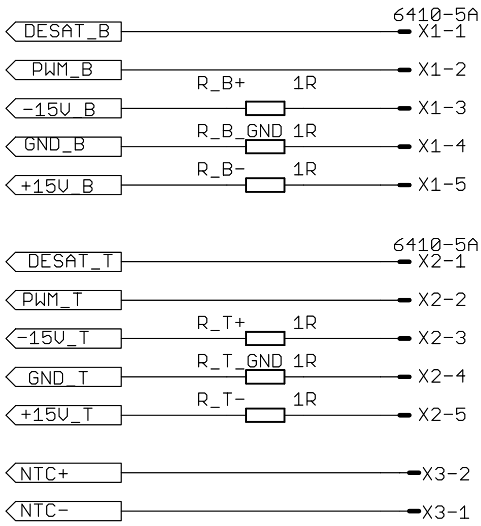


Figure 15 The MA200E12/17 – external connectors

4.2 Assembly drawing

Basic circuit and layout for MA200E12 and MA200E17 are the same. The only difference is the type of transil diode used for Active Clamping. See bill of material for details. Gate resistors should be assembled accordingly to hints given in Table 3.

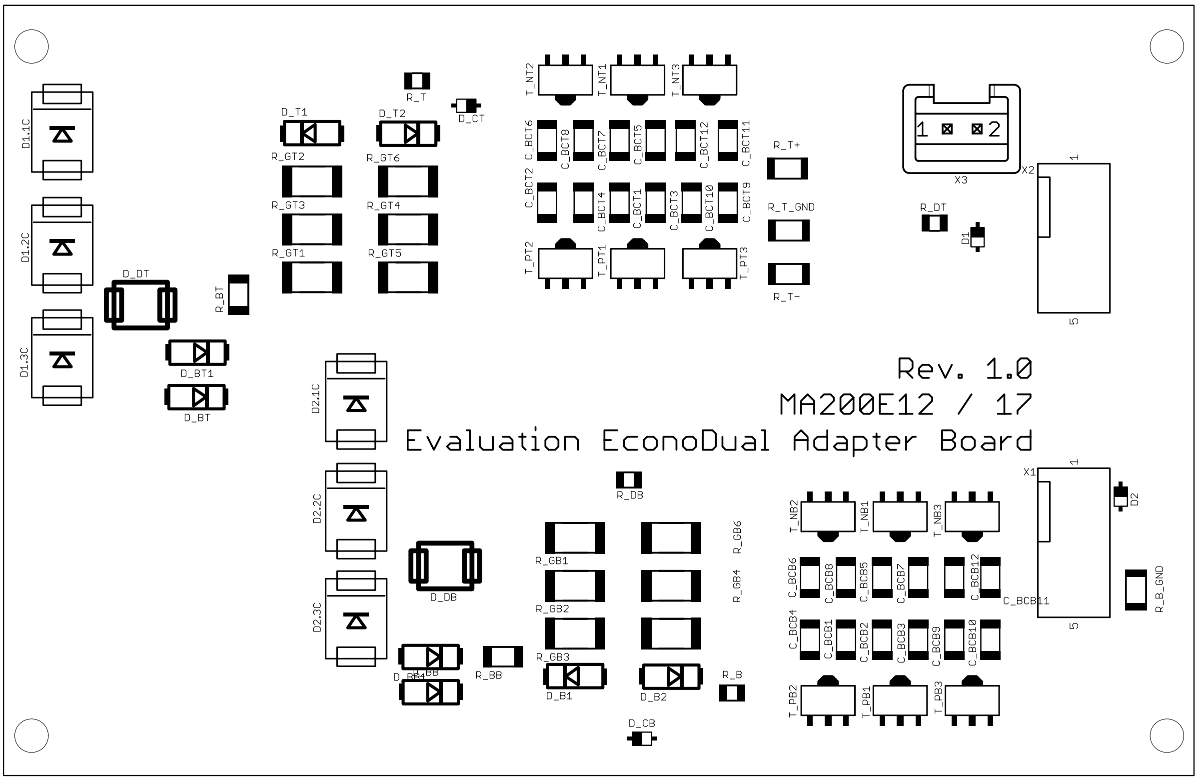


Figure 16 The MA200E12/17 – assembly drawing

4.3 Layout

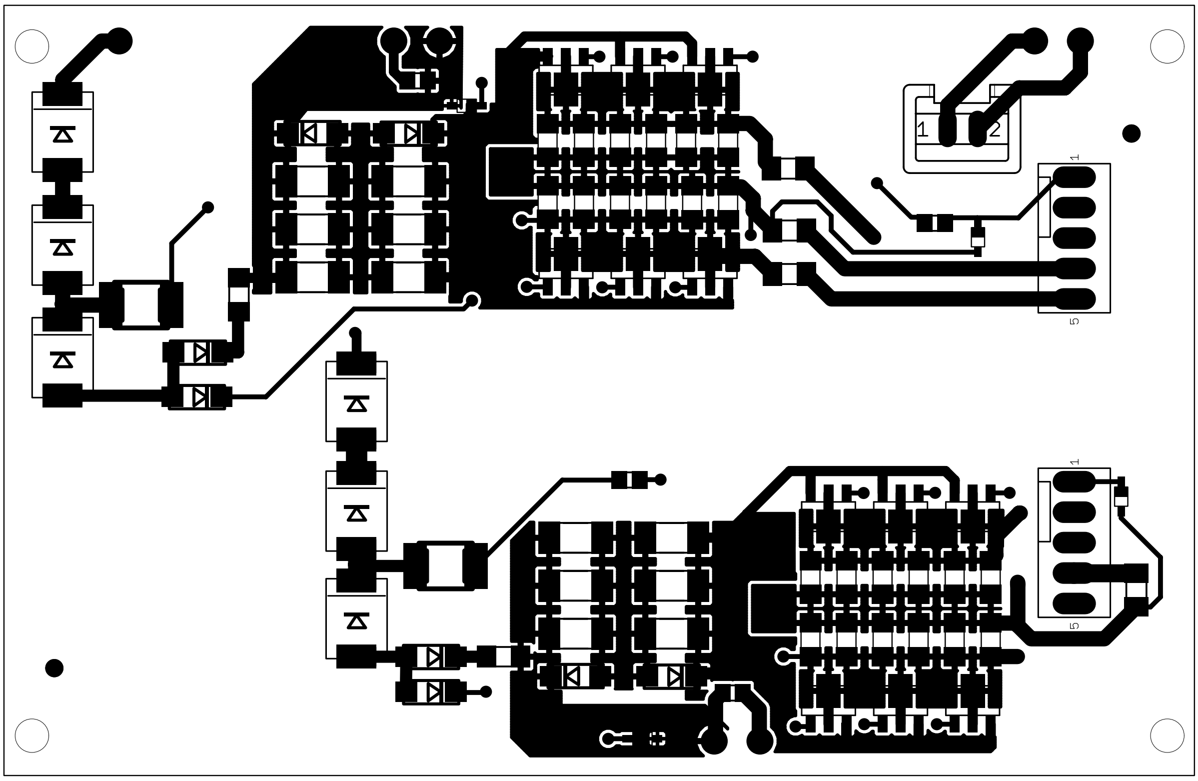


Figure 17 The MA200E12/17 – Top layer

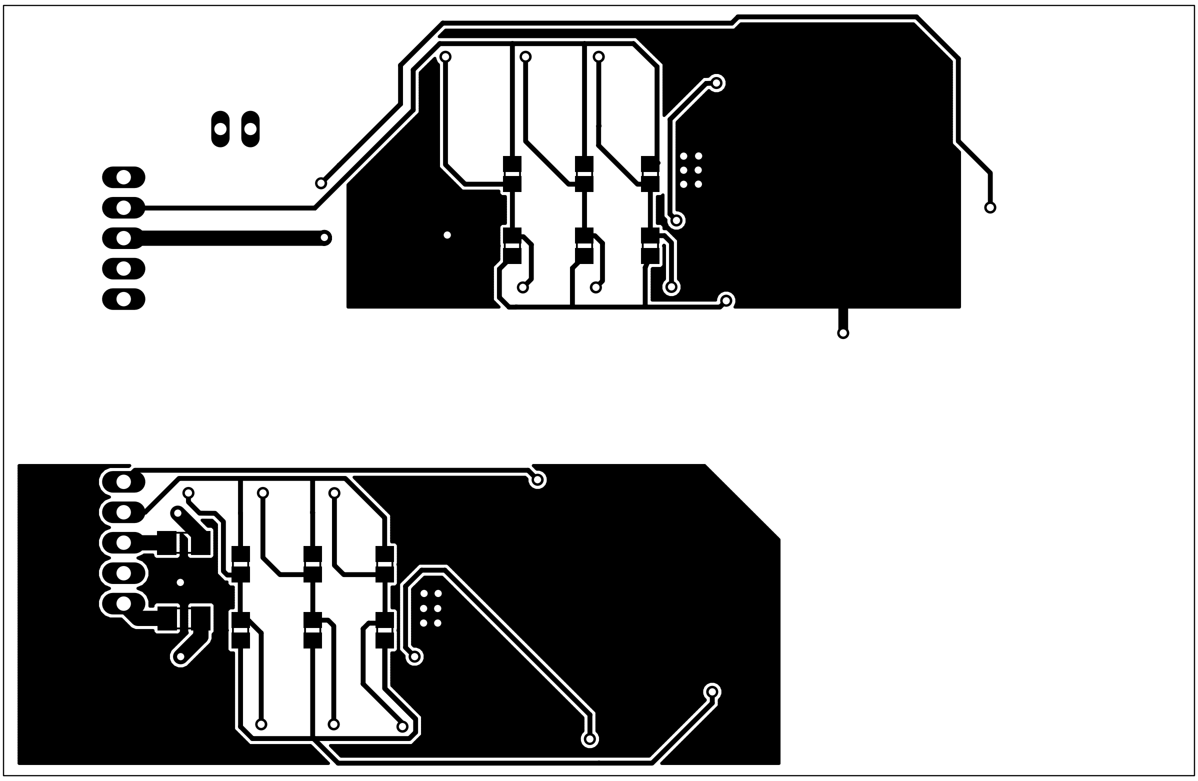


Figure 18 The MA200E12/17 – Bottom layer

4.4 Bill of Material - MA200E12

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

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 %.

Table 7 Bill of Material for MA200E12 adapter board

Type	Value / Type	Package	QTY	Name Part	Recommanded Manufacturer	Assembly
resistor	4µ7	C1206	24	C_BCB1, C_BCB2, C_BCB3, C_BCB4, C_BCB5, C_BCB6, C_BCB7, C_BCB8, C_BCB9, C_BCB10, C_BCB11, C_BCB12, C_BCT1, C_BCT2, C_BCT3, C_BCT4, C_BCT5, C_BCT6, C_BCT7, C_BCT8, C_BCT9, C_BCT10, C_BCT11, C_BCT12	Murata	yes
resistor	12R	R0805	6	R_B1, RB_2, RB_3, RT_1, RT_2, RT_3	no special	yes
resistor	1k	R0805	2	R_DB, RD_T	no special	yes
resistor	1R	M1206	6	R_B+, R_B-, R_T+,R_T-,	no special	yes

				R_B_GND, R_T_GND		
resistor	27R	R0805	6	R_BC1, R_BC2, R_BC3, R_TC1, R_TC2, R_TC3	no special	yes
resistor	2k2	R0805	1	R_T	no special	yes
Semiconductor	BAT165	SOD323	4	D1, D2, D_CB, D_CT	Infineon	yes
Semiconductor	ES1D	DO214AC	8	D_B1, D_B2, D_BB, D_BB1, D_BT, D_BT1, D_T1, D_T2	Vishay	yes
Semiconductor	1.5SMC440 A	SMC	4	D1.1C, D1.2C, D2.1C, D2.2C	Vishay	yes
Semiconductor	1.5SMC188 A	SMC	2	D1.3C, D2.3C	Vishay	yes
Semiconductor	STTH112U	SOD6	2	D_DB, D_DT	STM	yes
resistor	variable	R1206	2	R_BB, R_BT	no special	yes
resistor	variable	R2010	12	R_GB1, R_GB2, R_GB3, R_GB4, R_GB5, R_GB6,R_GT1, R_GT2, R_GT3, R_GT4, R_GT5, R_GT6	special pulse resistor	no
Semiconductor	ZXTN2010Z	SOT89	6	T_PB1, T_PB2, T_PB3, T_PT1, T_PT2, T_PT3,	Zetex	yes
Semiconductor	ZXTP2012Z	SOT89	6	T_NB1, T_NB2, T_NB3, T_NT1, T_NT2, T_NT3,	Zetex	yes
connector		S02P	1	X3	Molex	yes
connector	6410-5A	6410-5A	2	X1, X2	Molex	yes

*Pulse power rated types

4.5 Bill of Material - MA200E17

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

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 %.

Table 8 Bill of Material for MA200E17 adapter board

Type	Value / Type	Package	QTY	Name Part	Recommanded Manufacturer	Assembly
resistor	4µ7	C1206	24	C_BCB1, C_BCB2, C_BCB3, C_BCB4, C_BCB5, C_BCB6, C_BCB7, C_BCB8, C_BCB9, C_BCB10, C_BCB11, C_BCB12, C_BCT1, C_BCT2, C_BCT3, C_BCT4, C_BCT5, C_BCT6, C_BCT7, C_BCT8, C_BCT9, C_BCT10, C_BCT11, C_BCT12	Murata	yes
resistor	12R	R0805	6	R_B1, RB_2, RB_3, RT_1, RT_2, RT_3	no special	yes
resistor	1k	R0805	2	R_DB, RD_T	no special	yes
resistor	1R	M1206	6	R_B+, R_B-, R_T+,R_T-, R_B_GND, R_T_GND	no special	yes
resistor	27R	R0805	6	R_BC1, R_BC2, R_BC3, R_TC1, R_TC2, R_TC3	no special	yes
resistor	2k2	R0805	1	R_T	no special	yes
Semiconductor	BAT165	SOD323	4	D1, D2, D_CB, D_CT	Infineon	yes
Semiconductor	ES1D	DO214AC	8	D_B1, D_B2, D_BB, D_BB1, D_BT, D_BT1, D_T1, D_T2	Vishay	yes
Semiconductor	1.5SMC510 A	SMC	4	D1.1C, D1.2C, D2.1C, D2.2C	Vishay	yes
Semiconductor	1.5SMC440 A	SMC	2	D1.3C, D2.3C	Vishay	yes
Semiconductor	STTH112U	SOD6	2	D_DB, D_DT	STM	yes
resistor	variable	R1206	2	R_BB, R_BT	no special	yes
resistor	variable	R2010	12	R_GB1, R_GB2, R_GB3, R_GB4, R_GB5, R_GB6, R_GT1, R_GT2, R_GT3, R_GT4, R_GT5, R_GT6	special pulse resistor	no
Semiconductor	ZXTN2010Z	SOT89	6	T_PB1, T_PB2, T_PB3, T_PT1, T_PT2, T_PT3,	Zetex	yes
Semiconductor	ZXTP2012Z	SOT89	6	T_NB1, T_NB2, T_NB3, T_NT1, T_NT2, T_NT3,	Zetex	yes
connector		S02P	1	X3	Molex	yes
connector	6410-5A	6410-5A	2	X1, X2	Molex	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 decribed 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 MA200E12: 34084

IFX order number for MA200E17: 34083

IFX order number for 2ED300E17-SFO: 30272

IFX order number for 2ED300C17-S: 29831

IFX order number for 2ED300C17-ST: 29832

6 References

[1] Infineon Technologies AG: AN2008-02, 2ED100E12-F2 - 6ED100E12-F2 - Evaluation Driver Board for EconoDUAL™3 and EconoPACK+™ modules, V1.2, August 2009

[2] Bäßler, M.; Ciliox A.; Kanschat P.: On the loss – softness trade-off: Are different chip versions needed for softness improvement? PCIM Europe 2009, Nuremberg, May 2009

[3] Infineon Technologies AG: AN2007-04, How to calculate and to minimize the dead time requirement for IGBTs properly, V1.0, May 2007

[4] Luniewski, P.; Jansen U.; Hornkamp M.: Dynamic voltage rise control –the most efficient way to control turn-off switching behaviour of IGBT transistors, Pelincec 2005, Warsaw, October 2005

[5] Luniewski, P.; Jansen. U.: Benefits of system oriented IGBT module design for high power inverters, EPE 2007, Aalborg, September 2007