

**fastPACK 0 H 2nd gen**

V23990-P729-F56-01-14

Maximum Ratings / Höchstzulässige Werte		P729-F56 1200V/25A		
Parameter	Condition	Symbol	Datasheet values max.	Unit

**DC link Capacitor**
**DC link Kondensator**

Max.DC voltage Max. Gleichspannung	T <sub>C</sub> =25°C	U <sub>MAX</sub>	1000	V
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**Transistor H-bridge(IGBT)**
**Transistor H-Brücke(IGBT)**

Collector-emitter break down voltage Kollektor-Emitter-Sperrspannung		V <sub>CE</sub>	1200	V
DC collector current Kollektor-Dauergleichstrom	T <sub>j</sub> =T <sub>jmax</sub> Th=80°C, T <sub>c</sub> =80°C	I <sub>C</sub>	38	A
Repetitive peak collector current Periodischer Kollektorspitzenstrom	tp limited by T <sub>j</sub> max	I <sub>cpuls</sub>	75	A
Power dissipation per IGBT Verlustleistung pro IGBT	T <sub>j</sub> =T <sub>jmax</sub> Th=80°C T <sub>c</sub> =80°C	P <sub>tot</sub>	129	W
Gate-emitter peak voltage Gate-Emitter-Spitzenspannung		V <sub>GE</sub>	±20	V
SC withstand time* Kurzschlußverhalten*	T <sub>j</sub> =T <sub>jmax</sub> V <sub>GE</sub> =15V V <sub>CC</sub> =360V	t <sub>SC</sub>	10	us
max. Chip temperature max. Chiptemperatur		T <sub>jmax</sub>	150	°C

**Diode H-bridge**
**Diode H-Brücke**

DC forward current Dauergleichstrom	T <sub>j</sub> =T <sub>jmax</sub> Th=80°C, T <sub>c</sub> =80°C	I <sub>F</sub>	25	A
Repetitive peak forward current Periodischer Spitzenstrom	tp limited by T <sub>j</sub> max	I <sub>FRM</sub>	50	A
Power dissipation per Diode Verlustleistung pro Diode	T <sub>j</sub> =T <sub>jmax</sub> Th=80°C T <sub>c</sub> =80°C	P <sub>tot</sub>	56	W
max. Chip temperature max. Chiptemperatur		T <sub>jmax</sub>	150	°C

**Thermal properties**
**Thermische Eigenschaften**

Storage temperature Lagertemperatur		T <sub>stg</sub>	-40...+125	
Operation temperature Betriebstemperatur		T <sub>op</sub>	-40...+125	

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**Maximum Ratings / Höchstzulässige Werte**
**P729-F56 1200V/25A**

Parameter	Condition	Symbol	Datasheet values max.	Unit
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**Insulation properties**
**Modulisation**

Insulation voltage Isolationsspannung	t=1min	$V_{is}$	4000	
Creepage distance Kriechstrecke			min 12,7	
Clearance Luftstrecke			min 12,7	

**Additional notes and remarks:**

<i>* Allowed number of short circuits must be less than 1000 times, and time duration between short circuits should be more than 1 second!</i>
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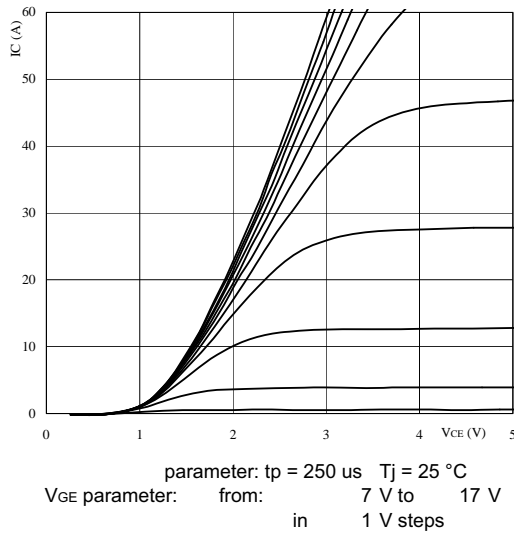
**fastPACK 0 H 2nd gen**

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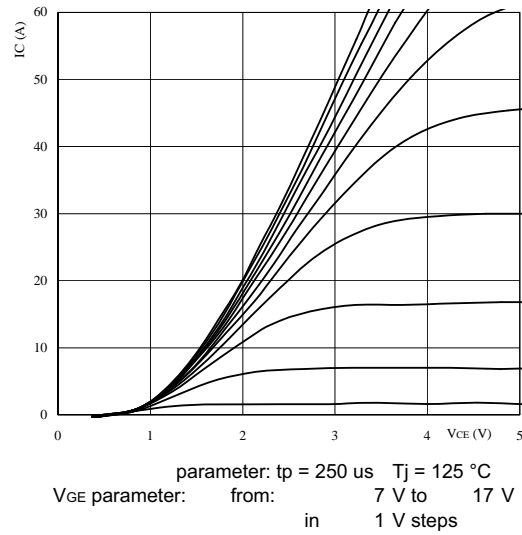
Characteristic values/ Charakteristische Werte		P729-F56									
Description	Symbol	Conditions					Datasheet values			Unit	
		T(C°)	Other conditions (Rgon-Rgoff)	VGE(V) VGS(V)	VCE(V) VDS(V)	IC(A) IF(A) Id(A)	Min	Typ	Max		
<b>Capacitor</b>											
<b>Kondensator</b>											
C value	C	Tj=25°C								nF	
C Wert		Tj=150°C									
<b>Transistor H-bridge(IGBT)</b>											
<b>Transistor H-Brücke(IGBT)</b>											
Gate emitter threshold voltage Gate-Schwelligenspannung	V <sub>GE(th)</sub>	Tj=25°C Tj=125°C	VCE=VGE			1m	3	5,5	7	V	
Collector-emitter saturation voltage Kollektor-Emitter Sättigungsspannung	V <sub>CE(sat)</sub>	Tj=25°C Tj=125°C		15		25		2,12 2,24	2,9	V	
Collector-emitter cut-off Kollektor-Emitter Reststrom	I <sub>CES</sub>	Tj=25°C Tj=125°C		0	600				0,1	mA	
Gate-emitter leakage current Gate-Emitter Reststrom	I <sub>GES</sub>	Tj=25°C Tj=125°C		20	0				200	nA	
Integrated Gate resistor Integrierter Gate Widerstand	R <sub>gint</sub>							none		Ω	
Turn-on delay time Einschaltverzögerungszeit	t <sub>td(on)</sub>	Tj=25°C Tj=125°C	Rgoff=16 Ω Rgon=16 Ω	±15	600	25		131		ns	
Rise time Anstiegszeit	t <sub>r</sub>	Tj=25°C Tj=125°C	Rgoff=16 Ω Rgon=16 Ω	±15	600	25		15		ns	
Turn-off delay time Abschaltverzögerungszeit	t <sub>td(off)</sub>	Tj=25°C Tj=125°C	Rgoff=16 Ω Rgon=16 Ω	±15	600	25		233		ns	
Fall time Fallzeit	t <sub>f</sub>	Tj=25°C Tj=125°C	Rgoff=16 Ω Rgon=16 Ω	±15	600	25		92		ns	
Turn-on energy loss per pulse Einschaltverlustenergie pro Puls	E <sub>on</sub>	Tj=25°C Tj=125°C	Rgoff=16 Ω Rgon=16 Ω	±15	600	25		1,35		mWs	
Turn-off energy loss per pulse Abschaltverlustenergie pro Puls	E <sub>off</sub>	Tj=25°C Tj=125°C	Rgoff=16 Ω Rgon=16 Ω	±15	600	25		1,76		mWs	
Input capacitance Eingangskapazität	C <sub>ies</sub>	Tj=25°C Tj=125°C	f=1MHz	0	25			2,02		nF	
Output capacitance Ausgangskapazität	C <sub>oss</sub>	Tj=25°C Tj=125°C	f=1MHz	0	25			0,19		nF	
Reverse transfer capacitance Rückwirkungskapazität	C <sub>ies</sub>	Tj=25°C Tj=125°C	f=1MHz	0	25			0,06		nF	
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R <sub>th,sh</sub>		Thermal grease thickness:50um Wärmeleitpaste Dicke:50um λ=0.61 W/mK					0,54		K/W	
<b>Diode H-bridge</b>											
<b>Diode H-Brücke</b>											
Diode forward voltage Durchlaßspannung	V <sub>F</sub>	Tj=25°C Tj=125°C				25	1	2,65 2,31	4	V	
Peak reverse recovery current Rückstromspitze	I <sub>RM</sub>	Tj=25°C Tj=125°C	Rgon=16 Ω	±15	600	25		54,5		A	
Reverse recovery time Sperrverzögerungszeit	t <sub>rr</sub>	Tj=25°C Tj=125°C	Rgon=16 Ω	±15	600	25		147		ns	
Reverse recovered charge Sperrverzögerungsladung	Q <sub>rr</sub>	Tj=25°C Tj=125°C	Rgon=16 Ω	±15	600	25		3,42		uC	
Reverse recovered energy Sperrverzögerungsenergie	E <sub>rec</sub>	Tj=25°C Tj=125°C	Rgon=16 Ω	±15	600	25		1,55		mWs	
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R <sub>th,sh</sub>		Thermal grease thickness					1,25		K/W	
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehäuse pro Chip	R <sub>th,JC</sub>		Wärmeleitpaste Dicke:50u							K/W	
<b>NTC-Thermistor</b>											
<b>NTC-Widerstand</b>											
Rated resistance Nennwiderstand	R <sub>25</sub>	Tj=25°C Tj=125°C						20,9	22	23,1	kOhm
Deviation of R100 Abweichung von R100	D <sub>R/R</sub>	Tj=25°C Tj=125°C						2,9			%/K
Power dissipation given Epcos-Typ Verlustleistung Epcos-Typ angeben	P	Tj=25°C Tj=125°C						210			mW
B-value B-Wert	B <sub>(25/100)</sub>	Tj=25°C Tj=125°C						3980			K

**Output inverter**

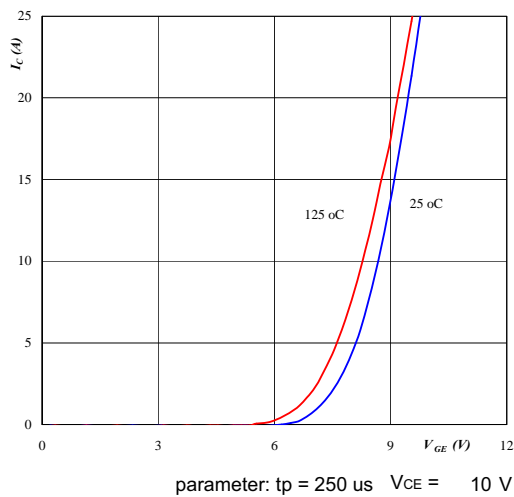
**Figure 1. Typical output characteristics**  
 Output inverter IGBT  
 $I_c = f(V_{CE})$



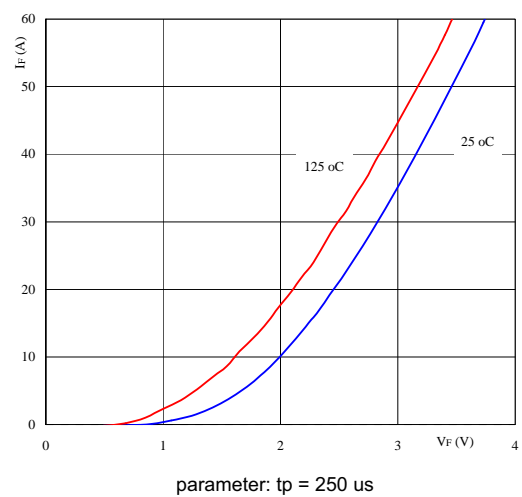
**Figure 2. Typical output characteristics**  
 Output inverter IGBT  
 $I_c = f(V_{CE})$



**Figure 3. Typical transfer characteristics**  
 Output inverter IGBT  
 $I_c = f(V_{GE})$

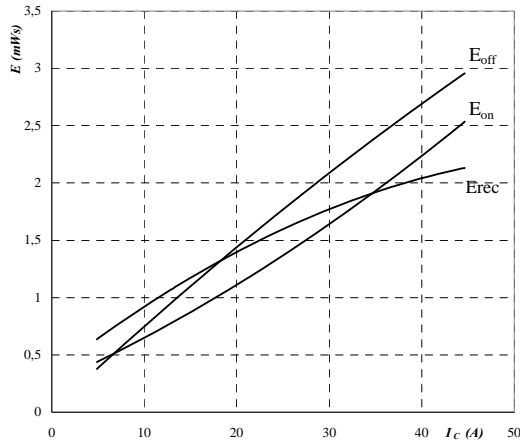


**Figure 4. Typical diode forward current as a function of forward voltage**  
 Output inverter FRED  $I_F = f(V_F)$



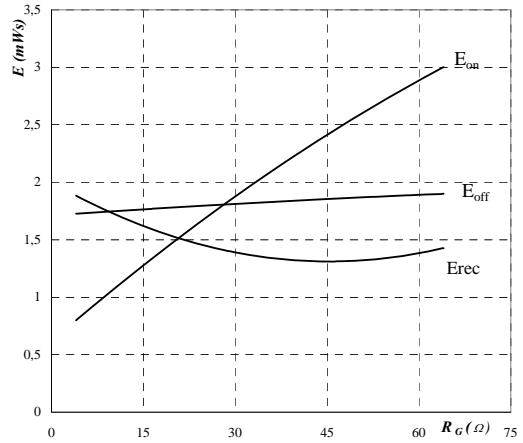
**Output inverter**

**Figure 5. Typical switching energy losses as a function of collector current**  
 Output inverter IGBT  
 $E = f(I_c)$



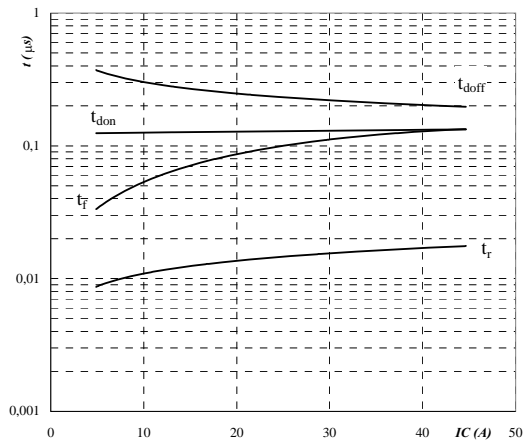
inductive load,  $T_j = 125\text{ }^\circ\text{C}$   
 $V_{CE} = 600\text{ V}$   
 $V_{GE} = \pm 15\text{ V}$   
 $R_{gon} = 16\ \Omega$   
 $R_{goff} = 16\ \Omega$

**Figure 6. Typical switching energy losses as a function of gate resistor**  
 Output inverter IGBT  
 $E = f(R_G)$



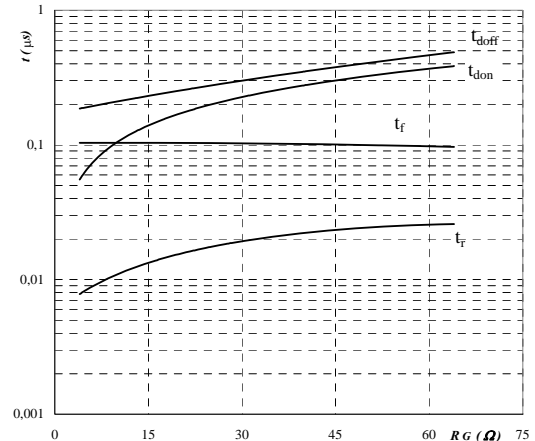
inductive load,  $T_j = 125\text{ }^\circ\text{C}$   
 $V_{CE} = 600\text{ V}$   
 $V_{GE} = \pm 15\text{ V}$   
 $I_c = 25\text{ A}$

**Figure 7. Typical switching times as a function of collector current**  
 Output inverter IGBT  
 $t = f(I_c)$



inductive load,  $T_j = 125\text{ }^\circ\text{C}$   
 $V_{CE} = 600\text{ V}$   
 $V_{GE} = \pm 15\text{ V}$   
 $R_{gon} = 16\ \Omega$   
 $R_{goff} = 16\ \Omega$

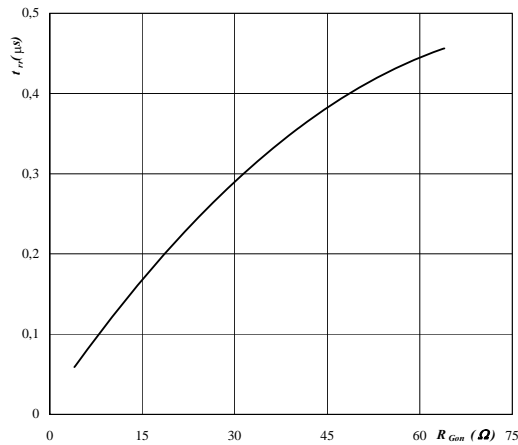
**Figure 8. Typical switching times as a function of gate resistor**  
 Output inverter IGBT  
 $t = f(R_G)$



inductive load,  $T_j = 125\text{ }^\circ\text{C}$   
 $V_{CE} = 600\text{ V}$   
 $V_{GE} = \pm 15\text{ V}$   
 $I_c = 25\text{ A}$

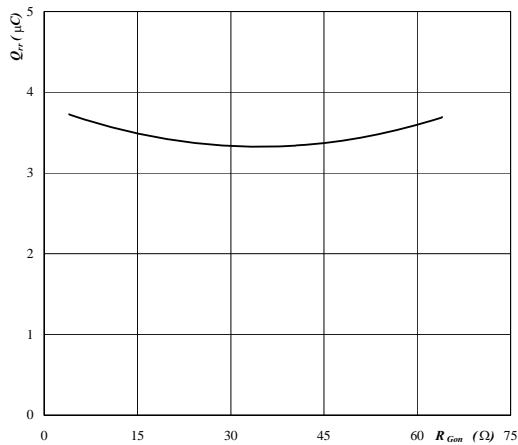
**Output inverter**

**Figure 9. Typical reverse recovery time as a function of IGBT turn on gate resistor**  
 Output inverter FRED diode  
 $t_{rr} = f(R_{gon})$



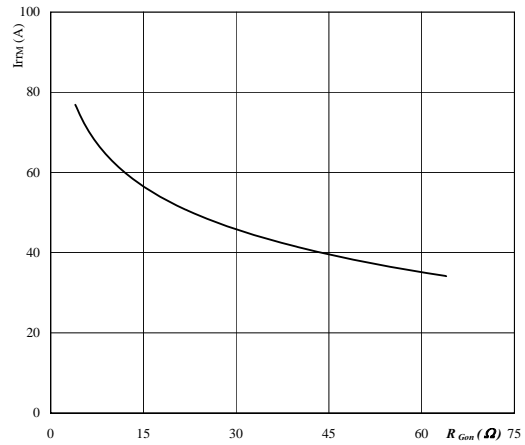
$T_j = 125\text{ °C}$   
 $V_R = 600\text{ V}$   
 $I_F = 25\text{ A}$   
 $V_{GE} = \pm 15\text{ V}$

**Figure 11. Typical reverse recovery charge as a function of IGBT turn on gate resistor**  
 Output inverter FRED diode  
 $Q_{rr} = f(R_{gon})$



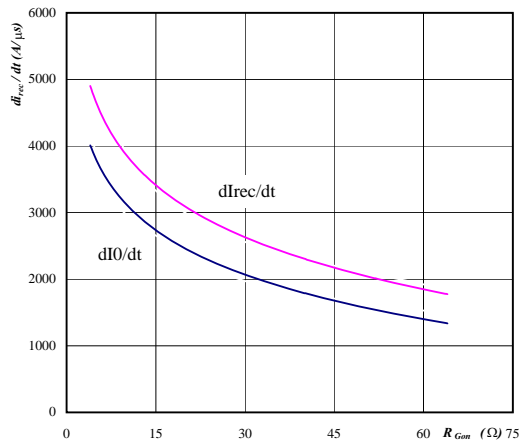
$T_j = 125\text{ °C}$   
 $V_R = 600\text{ V}$   
 $I_F = 25\text{ A}$   
 $V_{GE} = \pm 15\text{ V}$

**Figure 10. Typical reverse recovery current as a function of IGBT turn on gate resistor**  
 Output inverter FRED diode  
 $I_{RRM} = f(R_{gon})$



$T_j = 125\text{ °C}$   
 $V_R = 600\text{ V}$   
 $I_F = 25\text{ A}$   
 $V_{GE} = \pm 15\text{ V}$

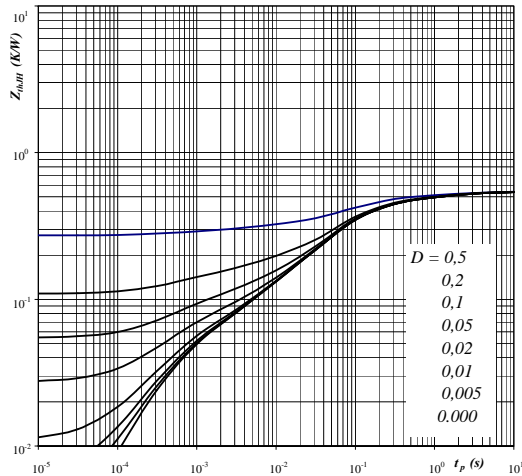
**Figure 12. Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor**  
 Output inverter FRED diode  
 $dI_O/dt, dI_{rec}/dt = f(R_{gon})$



$T_j = 125\text{ °C}$   
 $V_R = 600\text{ V}$   
 $I_F = 25\text{ A}$   
 $V_{GE} = \pm 15\text{ V}$

**Output inverter**

**Figure 13. IGBT transient thermal impedance as a function of pulse width**  
 $Z_{thJH} = f(t_p)$

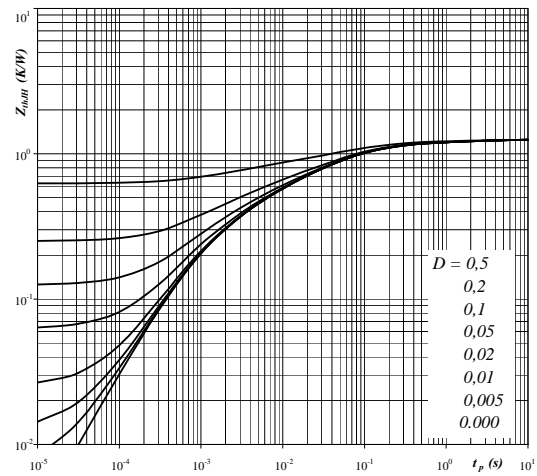


Parameter:  $D = t_p / T$        $R_{thJH} = 0,54 \text{ K/W}$

**IGBT thermal model values**

R (C/W)	Tau (s)
0,02	7,6E+00
0,07	1,3E+00
0,15	1,7E-01
0,22	4,8E-02
0,05	3,6E-03
0,04	4,5E-04

**Figure 14. FRED transient thermal impedance as a function of pulse width**  
 $Z_{thJH} = f(t_p)$



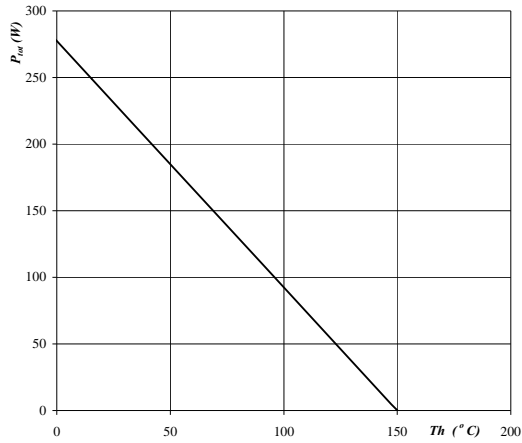
Parameter:  $D = t_p / T$        $R_{thJH} = 1,25 \text{ K/W}$

**FRED thermal model values**

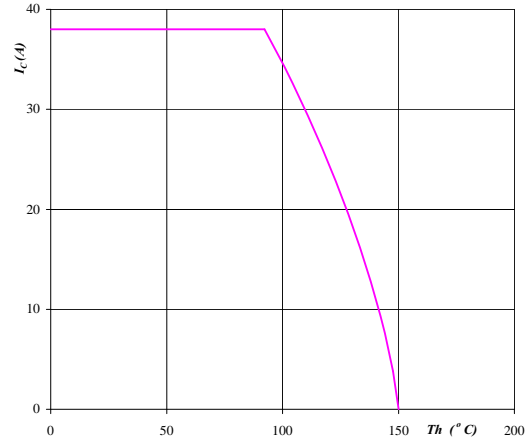
R (C/W)	Tau (s)
0,04	3,4E+00
0,10	5,6E-01
0,37	8,0E-02
0,32	2,0E-02
0,27	3,3E-03
0,15	6,9E-04

**Output inverter**

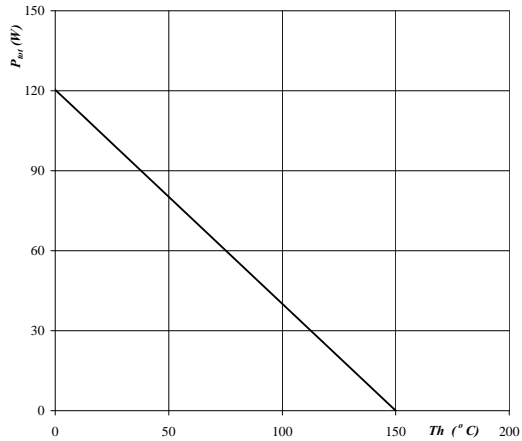
**Figure 15. Power dissipation as a function of heatsink temperature**  
 Output inverter IGBT  
 $P_{tot} = f(T_h)$


 parameter: T<sub>j</sub> = 150 °C

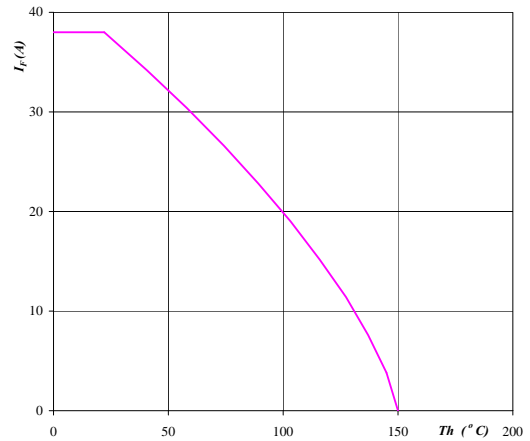
**Figure 16. Collector current as a function of heatsink temperature**  
 Output inverter IGBT  
 $I_c = f(T_h)$


 parameter: T<sub>j</sub> = 150 °C  
 V<sub>GE</sub> = 15 V

**Figure 17. Power dissipation as a function of heatsink temperature**  
 Output inverter FRED  
 $P_{tot} = f(T_h)$


 parameter: T<sub>j</sub> = 150 °C

**Figure 18. Forward current as a function of heatsink temperature**  
 Output inverter FRED  
 $I_F = f(T_h)$


 parameter: T<sub>j</sub> = 150 °C

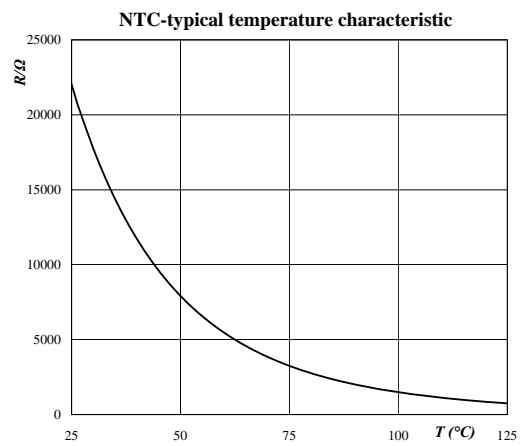


*fastPACK0 H 2nd gen*

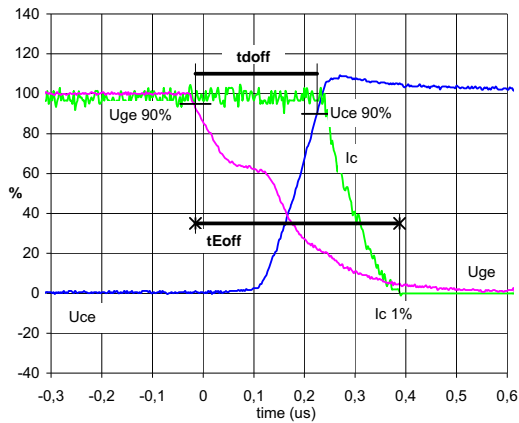
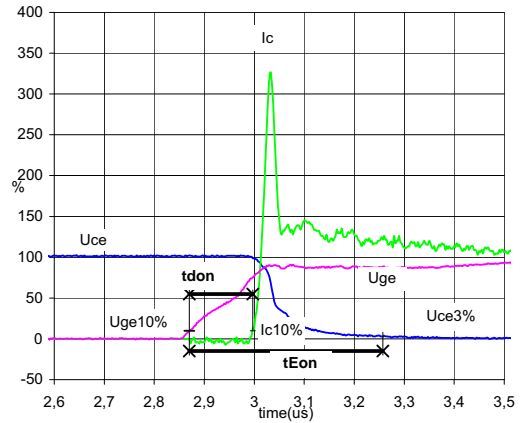
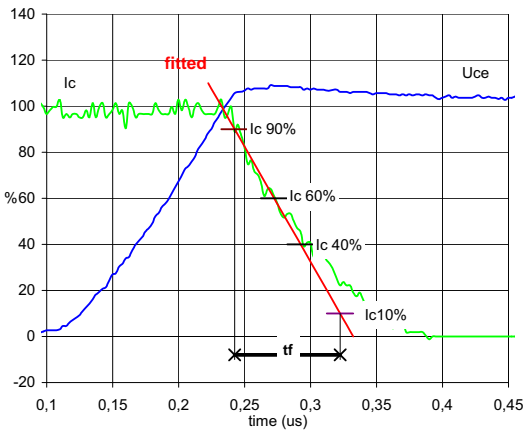
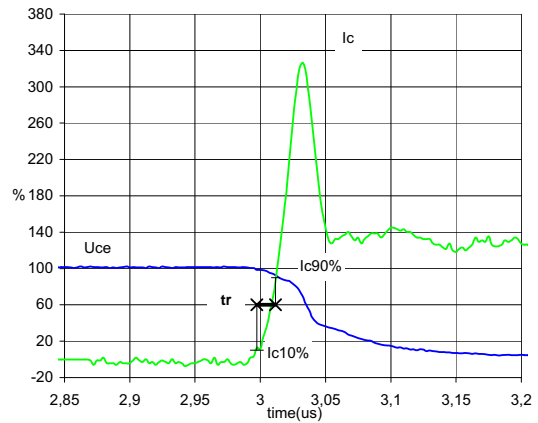
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**Thermistor****Figure 19. Typical NTC characteristic  
as a function of temperature**

$$R_T = f(T)$$

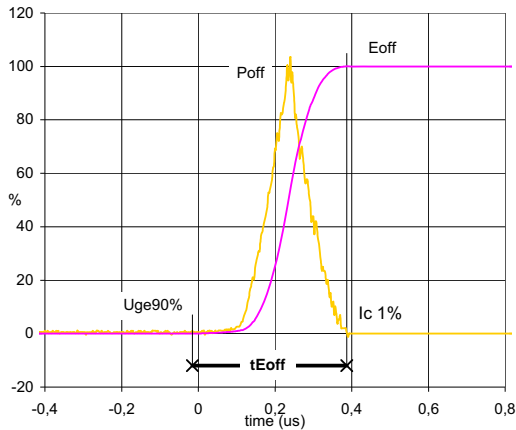


**Switching definitions**

 General conditions:  $T_J = 125\text{ }^\circ\text{C}$ 
 $R_{gon} = 16\ \Omega$        $R_{goff} = 16\ \Omega$ 
**Figure 1. Turn-off Switching Waveforms & definition of  $t_{doff}$ ,  $t_{Eoff}$**   
 ( $t_{Eoff}$  = integrating time for  $E_{off}$ )  
 Output inverter IGBT

 $U_{ge}(0\%) = -15\text{ V}$   
 $U_{ge}(100\%) = 15\text{ V}$   
 $U_c(100\%) = 600\text{ V}$   
 $I_c(100\%) = 25\text{ A}$   
 $t_{doff} = 0,23\ \mu\text{s}$   
 $t_{Eoff} = 0,40\ \mu\text{s}$ 
**Figure 2. Turn-on Switching Waveforms & definition of  $t_{don}$ ,  $t_{Eon}$**   
 ( $t_{Eon}$  = integrating time for  $E_{on}$ )  
 Output inverter IGBT

 $U_{ge}(0\%) = -15\text{ V}$   
 $U_{ge}(100\%) = 15\text{ V}$   
 $U_c(100\%) = 600\text{ V}$   
 $I_c(100\%) = 25\text{ A}$   
 $t_{don} = 0,13\ \mu\text{s}$   
 $t_{Eon} = 0,39\ \mu\text{s}$ 
**Figure 3. Turn-off Switching Waveforms & definition of  $t_f$**   
 Output inverter IGBT

 $U_c(100\%) = 600\text{ V}$   
 $I_c(100\%) = 25\text{ A}$   
 $t_f = 0,092\ \mu\text{s}$ 
**Figure 4. Turn-on Switching Waveforms & definition of  $t_r$**   
 Output inverter IGBT

 $U_c(100\%) = 600\text{ V}$   
 $I_c(100\%) = 25\text{ A}$   
 $t_r = 0,015\ \mu\text{s}$

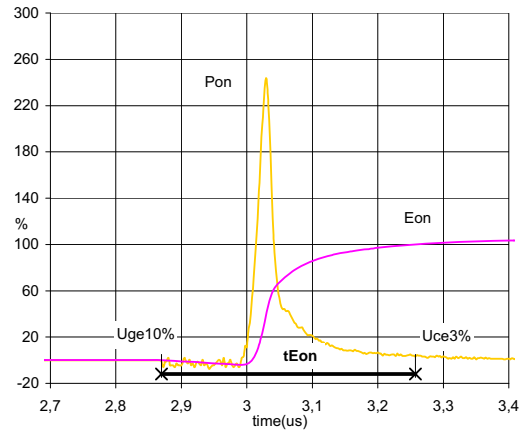
**Switching definitions**

**Figure 5. Turn-off Switching Waveforms & definition of  $t_{Eoff}$**   
Output inverter IGBT



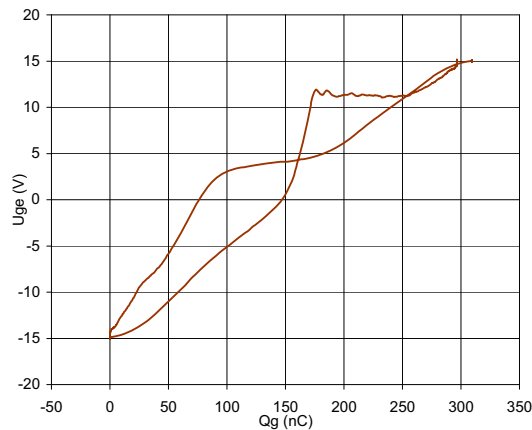
$P_{off}(100\%) = 14,96 \text{ kW}$   
 $E_{off}(100\%) = 1,76 \text{ mJ}$   
 $t_{Eoff} = 0,40 \text{ us}$

**Figure 6. Turn-on Switching Waveforms & definition of  $t_{Eon}$**   
Output inverter IGBT



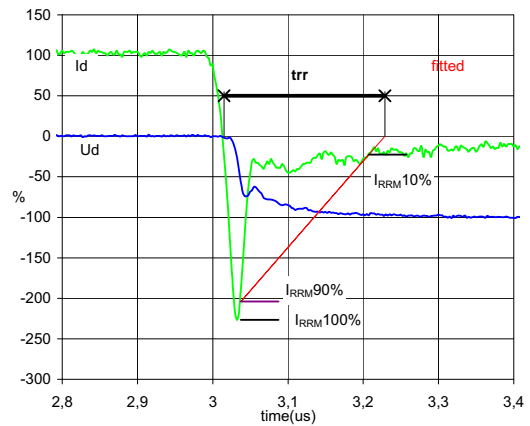
$P_{on}(100\%) = 15 \text{ kW}$   
 $E_{on}(100\%) = 1,35 \text{ mJ}$   
 $t_{Eon} = 0,39 \text{ us}$

**Figure 7. Gate voltage vs Gate charge**  
Output inverter IGBT



$U_{geoff} = -15 \text{ V}$   
 $U_{geon} = 15 \text{ V}$   
 $U_c(100\%) = 600 \text{ V}$   
 $I_c(100\%) = 25 \text{ A}$   
 $Q_g = 309,3 \text{ nC}$

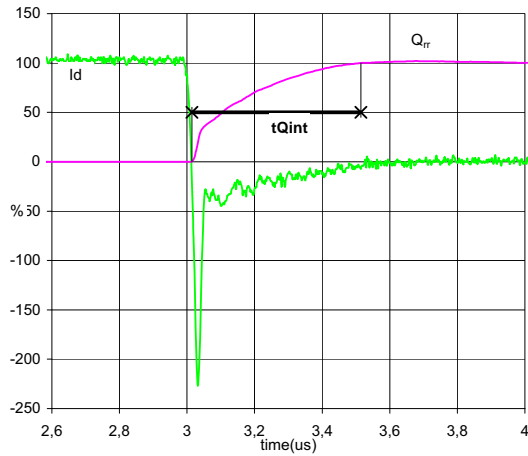
**Figure 8. Turn-off Switching Waveforms & definition of  $t_{rr}$**   
Output inverter FRED



$U_d(100\%) = 600 \text{ V}$   
 $I_d(100\%) = 25 \text{ A}$   
 $I_{RRM}(100\%) = 55 \text{ A}$   
 $t_{rr} = 0,15 \text{ us}$

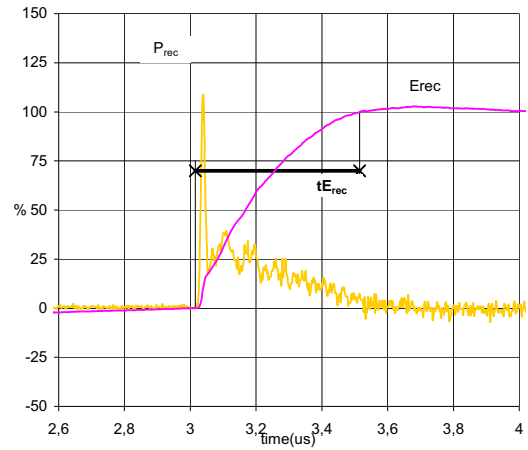
**Switching definitions**

**Figure 9. Turn-on Switching Waveforms & definition of  $t_{Qrr}$**   
**( $t_{Qrr}$ = integrating time for  $Q_{rr}$ )**  
*Output inverter FRED*



$I_d(100\%) = 25 \text{ A}$   
 $Q_{rr}(100\%) = 3,419 \text{ uC}$   
 $t_{Qint} = 0,50 \text{ us}$

**Figure 10. Turn-on Switching Waveforms & definition of  $t_{Erec}$**   
**( $t_{Erec}$ = integrating time for  $E_{rec}$ )**  
*Output inverter FRED*

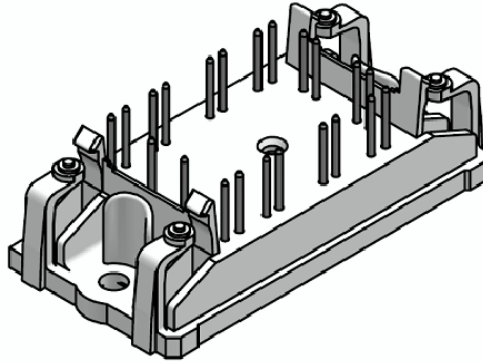


$P_{rec}(100\%) = 15 \text{ kW}$   
 $E_{rec}(100\%) = 1,55 \text{ mJ}$   
 $t_{Erec} = 0,50 \text{ us}$

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## Standard H-Bridge Module

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# *fast*PACK 0 H 2<sup>nd</sup> gen

### Features

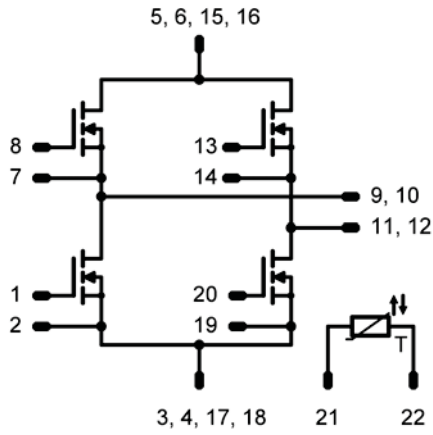
- H-bridge 600V..1200V / 20A..100A
- Standard- and high speed IGBT's or MOS-FET
- Ultra low inductive design
- Vincotech - Power Flow Through for simple PCB routing
- Vincotech - Clip In, the reliable interconnection between PCB, module and heatsink
- Temperature Sensor
- Easy paralleling to ½ bridge
- Optional capacitors

## Module Types

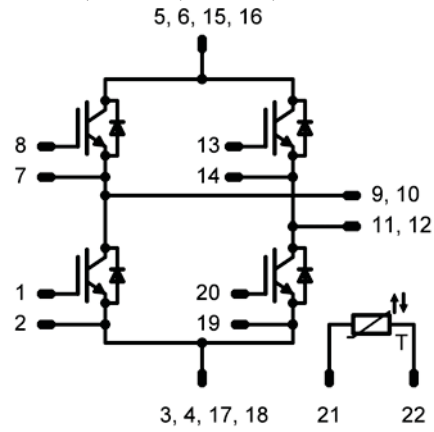
part – number V23990-	Voltage	Current
<b>MOS-FET</b>		
P622-F64-PM	600V	30A
P622-F74-PM high performance	600V	30A
<b>high speed IGBT</b>		
P623-F04-PM	600 V	60A
P623-F14-PM high performance	600 V	60A
<b>Trench Fieldstop IGBT</b>		
P623-F24-PM	600V	50A
P624-F24-PM	600V	75A
P625-F24-PM	600V	100A
<b>Phantom Speed IGBT</b>		
P629-F44-PM	1200V	25A
P629-F46-PM hyper fast FRED	1200V	25A
P629-F54-PM high performance	1200V	25A
P629-F56-PM high performance + hyper fast FRED	1200V	25A
<b>with capacitor:</b>		
<b>MOS-FET</b>		
P722-F64-PM	600V	30A
P722-F74-PM high performance	600V	30A
<b>high speed IGBT</b>		
P723-F04-PM	600 V	60A
P723-F14-PM high performance	600 V	60A
<b>Phantom Speed IGBT</b>		
P729-F44-PM	1200V	25A
P729-F46-PM hyper fast FRED	1200V	25A
P729-F54-PM high performance	1200V	25A
P729-F56-PM high performance + hyper fast FRED	1200V	25A

## Schematics

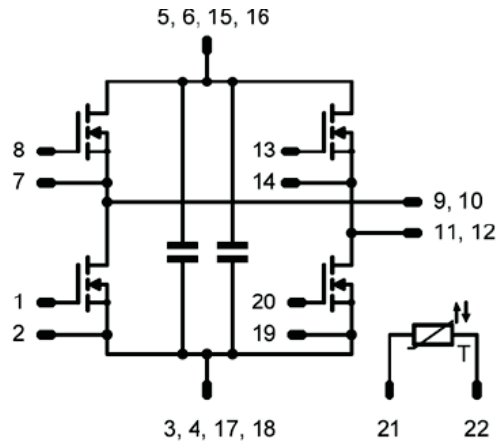
P622 modules:



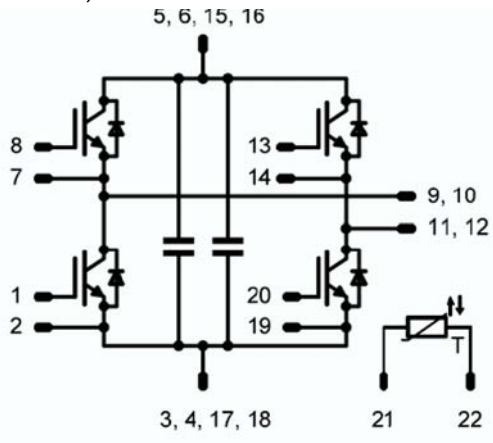
P623, P624, P625, P629 modules:



P722 modules:

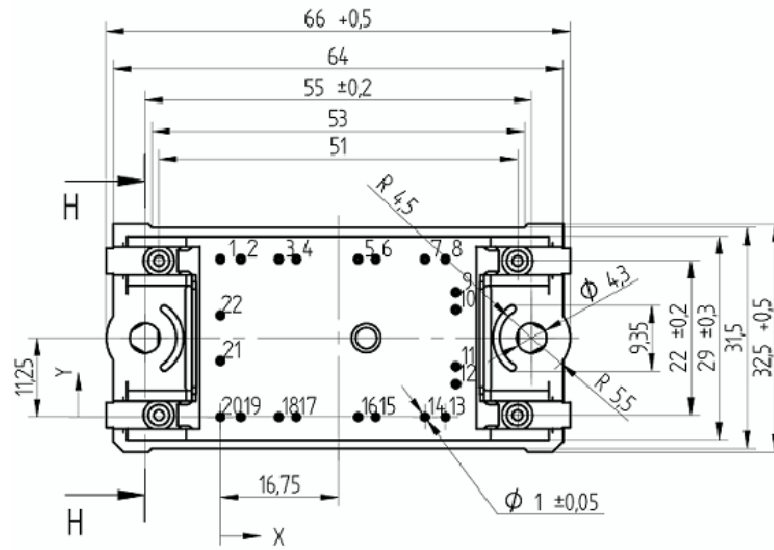


P723, P729 modules:

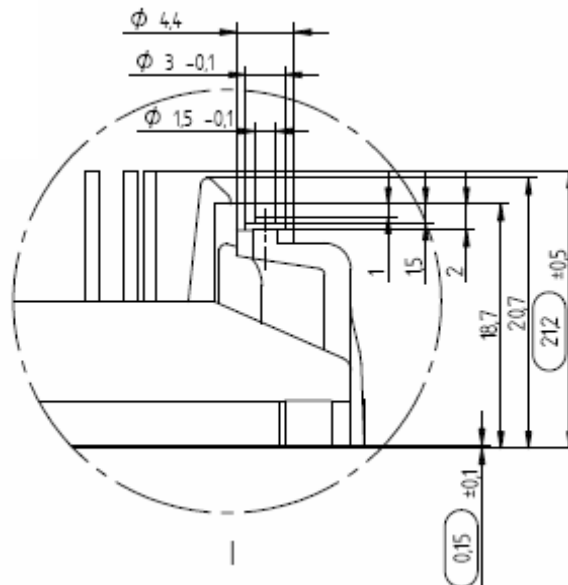


**Outline / Pinout**

Pin Table		
Pin	X	Y
1	0	22,5
2	2,9	22,5
3	8,3	22,5
4	10,8	22,5
5	19,6	22,5
6	22,1	22,5
7	29,1	22,5
8	32	22,5
9	33,5	17,8
10	33,5	15,3
11	33,5	7,2
12	33,5	4,7
13	32	0
14	29,1	0
15	22,1	0
16	19,6	0
17	10,8	0
18	8,3	0
19	2,9	0
20	0	0
21	0	8
22	0	14,5



Tolerance of pin positions: 0.5 mm at pinhead





## Handling Instructions

### PCB

- The module must be fixed to the PCB by clipping into the adequate holes before pin soldering. For further details see PCB holes and Mounting in document V23990-P-M111-\*-31.
- After fixing all pins must be soldered into the PCB. For an appropriate solderprofile for module pins soldering see document, Typical heat profile for wave soldering on page 4 of V23990-P-M111-\*-31.
- During assembly, at a max. module temperature of 25°C, the pins should not be drawn or pushed over  $\pm 0.2$  mm or loaded with higher force than 35N.
- At a maximum substrate-temperature of 100°C the load of the pin should not exceed  $\pm 5$ N.
- Vibration stress on pin is not allowed

### heatsink

- the heatsink surface must be clean and particleless.
- the flatness must be  $< 0.05$  mm for 100 mm continuous.
- the surface roughness should be less than: RZ 0.01mm.

### thermal conduction material:

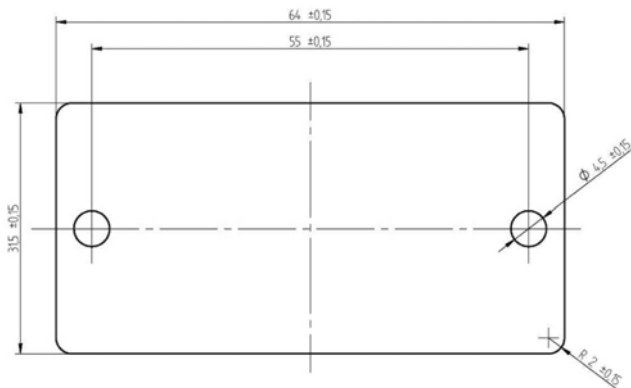
- OPTION 1: thermal paste Homogeneous applying of the thermal conductive paste over the whole module bottom with a thickness of max. 0.05 mm.

- OPTION 2: thermal foil

A thermal foil with a aluminium core layer and two outer layer made of phase change material should be used. The total thickness of the foil has to be less then 0,08mm / 0,003 inch. Thicker foils could cause braking of the ceramic substrate and will increase the thermal resistance.

Recommended foil type: *Kunze Folien KU-ALC5 or ALF5*

Recommended foil dimensions:



### fastening screws to the heatsink if plain washer is used:

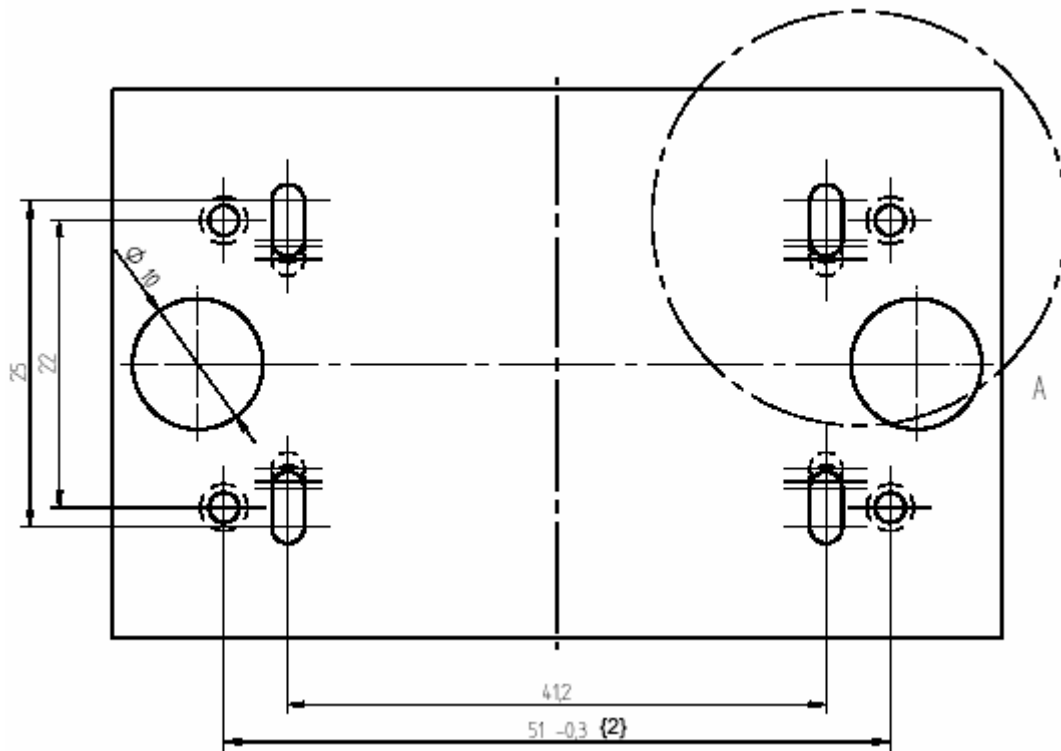
- Tighten both screws with the half torque first.
- Tighten both screws with max. torque second (if it is possible, tighten after 3 hours again). Flat washer DIN 125 or DIN 433, Screw M4 DIN 7985.

### fastening screws to the heatsink if plain washer is used together with a spring lock washer (recommended mounting):

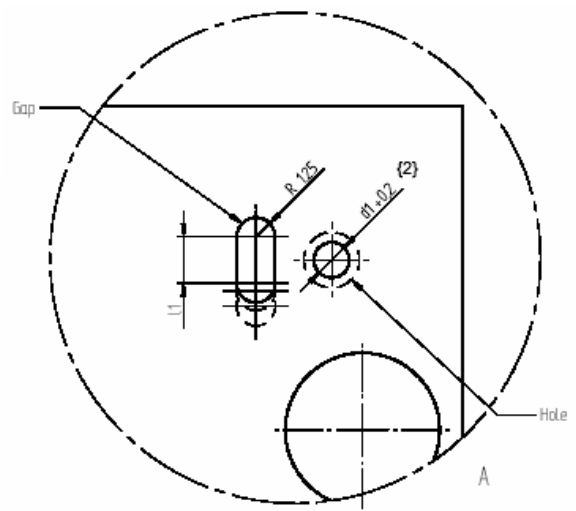
- Tighten both screws with max. torque. Flat washer DIN 125 or DIN 433, Spring washer DIN127 or DIN 128, Screw M4 DIN 7985.

### Torque instructions for the heatsink:

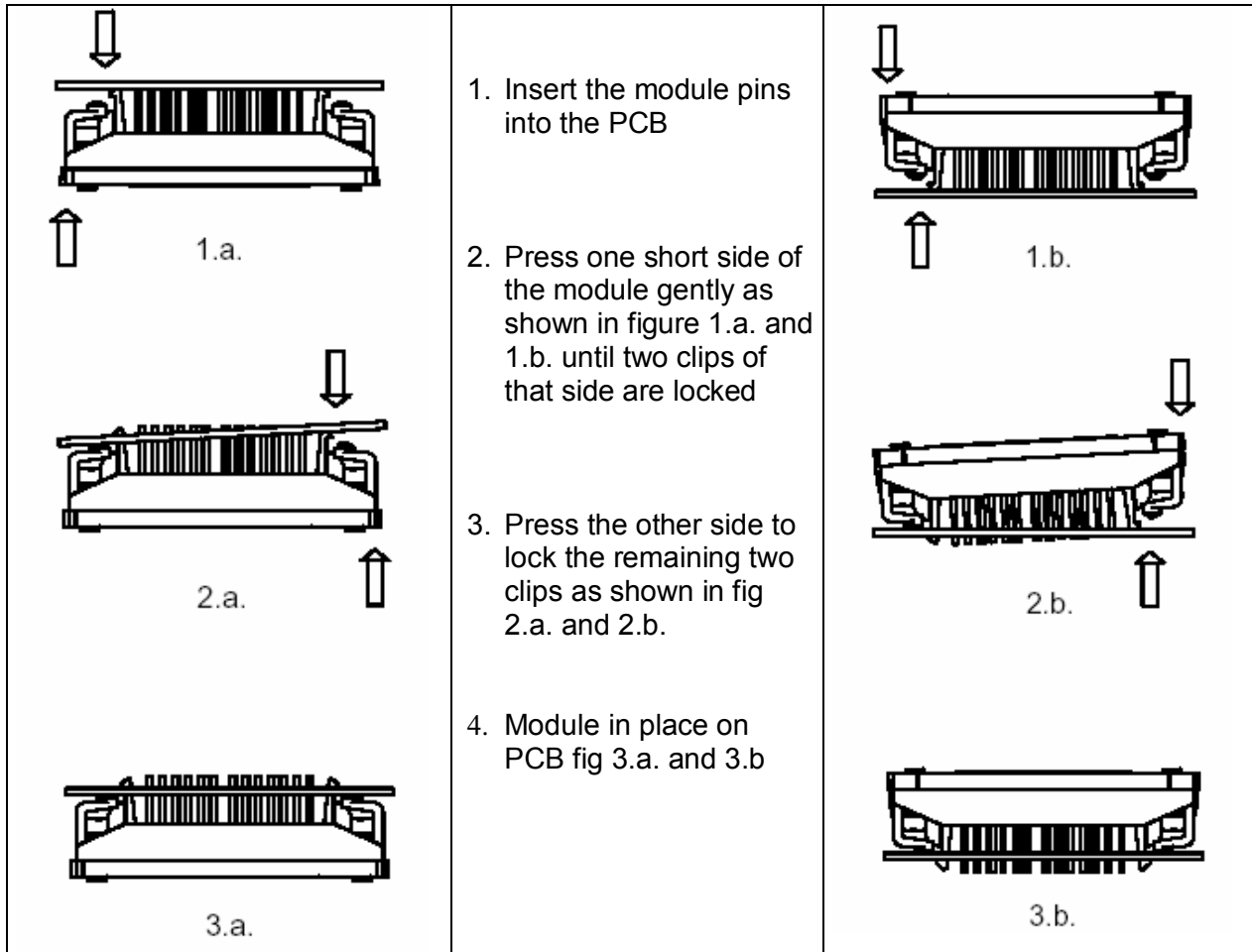
- Mounting torque  $M_a = 2.0-2.2$ Nm

**PCB holes**


PCB thickness	d1	l1
1,5 mm	without holes	3 mm
2 mm	2,3 mm	3,5 mm
2,5 mm	3,6 mm	4,5 mm



## Mounting



Vincotech does not recommend the use of its products for other applications. Especially it is not recommended to use the modules in life support applications where such use may directly threaten life or injure due to device failure or malfunction.

We reserve the right to make changes of the product at any time without notice, in order to supply the best possible product.