

# Technische Information / Technical Information

IGBT-Module  
IGBT-Modules

## FZ 1600 R 12 KL4C

eupec



### Höchstzulässige Werte / Maximum rated values

#### Elektrische Eigenschaften / Electrical properties

Kollektor-Emitter-Sperrspannung collector-emitter voltage		$V_{CES}$	1200	V
Kollektor-Dauergleichstrom DC-collector current	$T_C = 80^\circ\text{C}$	$I_{C,nom.}$	1600	A
	$T_C = 25^\circ\text{C}$	$I_C$	2450	A
Periodischer Kollektor Spitzenstrom repetitive peak collector current	$t_P = 1\text{ ms}, T_C = 80^\circ\text{C}$	$I_{CRM}$	3200	A
Gesamt-Verlustleistung total power dissipation	$T_C=25^\circ\text{C}$ , Transistor	$P_{tot}$	10,0	kW
Gate-Emitter-Spitzenspannung gate-emitter peak voltage		$V_{GES}$	+/- 20V	V
Dauergleichstrom DC forward current		$I_F$	1600	A
Periodischer Spitzenstrom repetitive peak forw. current	$t_P = 1\text{ ms}$	$I_{FRM}$	3200	A
Grenzlastintegral der Diode $I^2t$ - value, Diode	$V_R = 0V, t_p = 10\text{ms}, T_{vj} = 125^\circ\text{C}$	$I^2t$	590	$\text{kA}^2\text{s}$
Isolations-Prüfspannung insulation test voltage	RMS, $f = 50\text{ Hz}, t = 1\text{ min.}$	$V_{ISOL}$	2,5	kV

### Charakteristische Werte / Characteristic values

#### Transistor / Transistor

			min.	typ.	max.	
Kollektor-Emitter Sättigungsspannung collector-emitter saturation voltage	$I_C = 1600\text{A}, V_{GE} = 15\text{V}, T_{vj} = 25^\circ\text{C}$	$V_{CE\text{ sat}}$	-	2,1	2,6	V
	$I_C = 1600\text{A}, V_{GE} = 15\text{V}, T_{vj} = 125^\circ\text{C}$		-	2,4	2,9	V
Gate-Schwellenspannung gate threshold voltage	$I_C = 64\text{mA}, V_{CE} = V_{GE}, T_{vj} = 25^\circ\text{C}$	$V_{GE(th)}$	4,5	5,5	6,5	V
Gateladung gate charge	$V_{GE} = -15\text{V}...+15\text{V}$	$Q_G$	-	17	-	$\mu\text{C}$
Eingangskapazität input capacitance	$f = 1\text{MHz}, T_{vj} = 25^\circ\text{C}, V_{CE} = 25\text{V}, V_{GE} = 0\text{V}$	$C_{ies}$	-	110	-	nF
Rückwirkungskapazität reverse transfer capacitance	$f = 1\text{MHz}, T_{vj} = 25^\circ\text{C}, V_{CE} = 25\text{V}, V_{GE} = 0\text{V}$	$C_{res}$	-	7	-	nF
Kollektor-Emitter Reststrom collector-emitter cut-off current	$V_{CE} = 1200\text{V}, V_{GE} = 0\text{V}, T_{vj} = 25^\circ\text{C}$	$I_{CES}$	-	0,04	1,5	mA
	$V_{CE} = 1200\text{V}, V_{GE} = 0\text{V}, T_{vj} = 125^\circ\text{C}$		-	3,5	-	mA
Gate-Emitter Reststrom gate-emitter leakage current	$V_{CE} = 0\text{V}, V_{GE} = 20\text{V}, T_{vj} = 25^\circ\text{C}$	$I_{GES}$	-	-	600	nA

prepared by: Mark Münzer

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approved by: M. Hierholzer

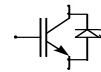
revision: 2

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### Charakteristische Werte / Characteristic values

#### Transistor / Transistor

			min.	typ.	max.	
Einschaltverzögerungszeit (ind. Last) turn on delay time (inductive load)	$I_C = 1600A, V_{CE} = 600V$	$t_{d,on}$	-	0,28	-	$\mu s$
	$V_{GE} = \pm 15V, R_G = 0,91\Omega, T_{vj} = 25^\circ C$					
	$V_{GE} = \pm 15V, R_G = 0,91\Omega, T_{vj} = 125^\circ C$					
Anstiegszeit (induktive Last) rise time (inductive load)	$I_C = 1600A, V_{CE} = 600V$	$t_r$	-	0,19	-	$\mu s$
	$V_{GE} = \pm 15V, R_G = 0,91\Omega, T_{vj} = 25^\circ C$					
	$V_{GE} = \pm 15V, R_G = 0,91\Omega, T_{vj} = 125^\circ C$					
Abschaltverzögerungszeit (ind. Last) turn off delay time (inductive load)	$I_C = 1600A, V_{CE} = 600V$	$t_{d,off}$	-	1,06	-	$\mu s$
	$V_{GE} = \pm 15V, R_G = 0,91\Omega, T_{vj} = 25^\circ C$					
	$V_{GE} = \pm 15V, R_G = 0,91\Omega, T_{vj} = 125^\circ C$					
Fallzeit (induktive Last) fall time (inductive load)	$I_C = 1600A, V_{CE} = 600V$	$t_f$	-	0,14	-	$\mu s$
	$V_{GE} = \pm 15V, R_G = 0,91\Omega, T_{vj} = 25^\circ C$					
	$V_{GE} = \pm 15V, R_G = 0,91\Omega, T_{vj} = 125^\circ C$					
Einschaltverlustenergie pro Puls turn-on energy loss per pulse	$I_C = 1600A, V_{CE} = 600V, V_{GE} = 15V$ $R_G = 0,91\Omega, T_{vj} = 125^\circ C, L_S = 70nH$	$E_{on}$	-	210	-	mWs
Abschaltverlustenergie pro Puls turn-off energy loss per pulse	$I_C = 1600A, V_{CE} = 600V, V_{GE} = 15V$ $R_G = 0,91\Omega, T_{vj} = 125^\circ C, L_S = 70nH$	$E_{off}$	-	260	-	mWs
Kurzschlußverhalten SC Data	$t_P \leq 10\mu sec, V_{GE} \leq 15V, R_G = 0,91\Omega$ $T_{vj} \leq 125^\circ C, V_{CC} = 900V, V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$	$I_{SC}$	-	12000	-	A
Modulinduktivität stray inductance module		$L_{sCE}$	-	15	-	nH
Modul Leitungswiderstand, Anschlüsse – Chip module lead resistance, terminals – chip	$T_C = 25^\circ C$	$R_{CC+EE}$	-	0,10	-	m $\Omega$

### Charakteristische Werte / Characteristic values

#### Diode / Diode

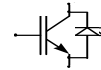
			min.	typ.	max.	
Durchlaßspannung forward voltage	$I_F = 1600A, V_{GE} = 0V, T_{vj} = 25^\circ C$	$V_F$	-	1,8	2,3	V
	$I_F = 1600A, V_{GE} = 0V, T_{vj} = 125^\circ C$					
Rückstromspitze peak reverse recovery current	$I_F = 1600A, -di_F/dt = 9000A/\mu sec$	$I_{RM}$	-	900	-	A
	$V_R = 600V, V_{GE} = -15V, T_{vj} = 25^\circ C$					
	$V_R = 600V, V_{GE} = -15V, T_{vj} = 125^\circ C$					
Sperrverzögerungsladung recovered charge	$I_F = 1600A, -di_F/dt = 9000A/\mu sec$	$Q_r$	-	150	-	$\mu As$
	$V_R = 600V, V_{GE} = -15V, T_{vj} = 25^\circ C$					
	$V_R = 600V, V_{GE} = -15V, T_{vj} = 125^\circ C$					
Abschaltenergie pro Puls reverse recovery energy	$I_F = 1600A, -di_F/dt = 9000A/\mu sec$	$E_{rec}$	-	60	-	mWs
	$V_R = 600V, V_{GE} = -15V, T_{vj} = 25^\circ C$					
	$V_R = 600V, V_{GE} = -15V, T_{vj} = 125^\circ C$					

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### Thermische Eigenschaften / Thermal properties

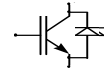
			min.	typ.	max.	
Innerer Wärmewiderstand thermal resistance, junction to case	Transistor / transistor, DC	$R_{thJC}$	-	-	0,0125	K/W
	Diode/Diode, DC		-	-	0,0210	K/W
Übergangs-Wärmewiderstand thermal resistance, case to heatsink	pro Modul / per module $\lambda_{paste} = 1 \text{ W/m} \cdot \text{K}$ / $\lambda_{grease} = 1 \text{ W/m} \cdot \text{K}$	$R_{thCK}$	-	0,006	-	K/W
Höchstzulässige Sperrschichttemperatur maximum junction temperature		$T_{vj}$	-	-	150	°C
Betriebstemperatur operation temperature		$T_{op}$	-40	-	125	°C
Lagertemperatur storage temperature		$T_{stg}$	-40	-	125	°C

### Mechanische Eigenschaften / Mechanical properties

Gehäuse, siehe Anlage case, see appendix						
Innere Isolation internal insulation				$\text{Al}_2\text{O}_3$		
Kriechstrecke creepage distance				17		mm
Luftstrecke clearance				10		mm
CTI comperative tracking index				275		
Anzugsdrehmoment f. mech. Befestigung mounting torque		M1	4,25	5	5,75	Nm
Anzugsdrehmoment f. elektr. Anschlüsse terminal connection torque	terminals M4	M2	1,7	2	2,3	Nm
	terminals M8		8		10	Nm
Gewicht weight		G		1500		g

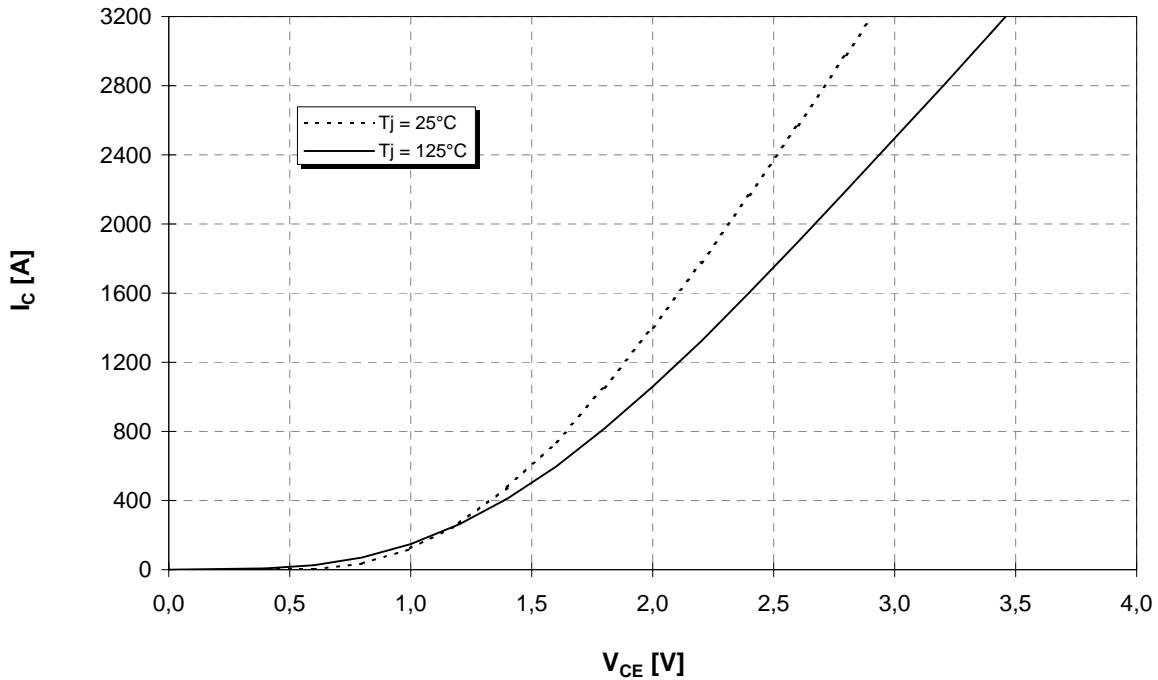
Mit dieser technischen Information werden Halbleiterbauelemente spezifiziert, jedoch keine Eigenschaften zugesichert.  
Sie gilt in Verbindung mit den zugehörigen Technischen Erläuterungen.

This technical information specifies semiconductor devices but promises no characteristics. It is valid in combination with the belonging technical notes.



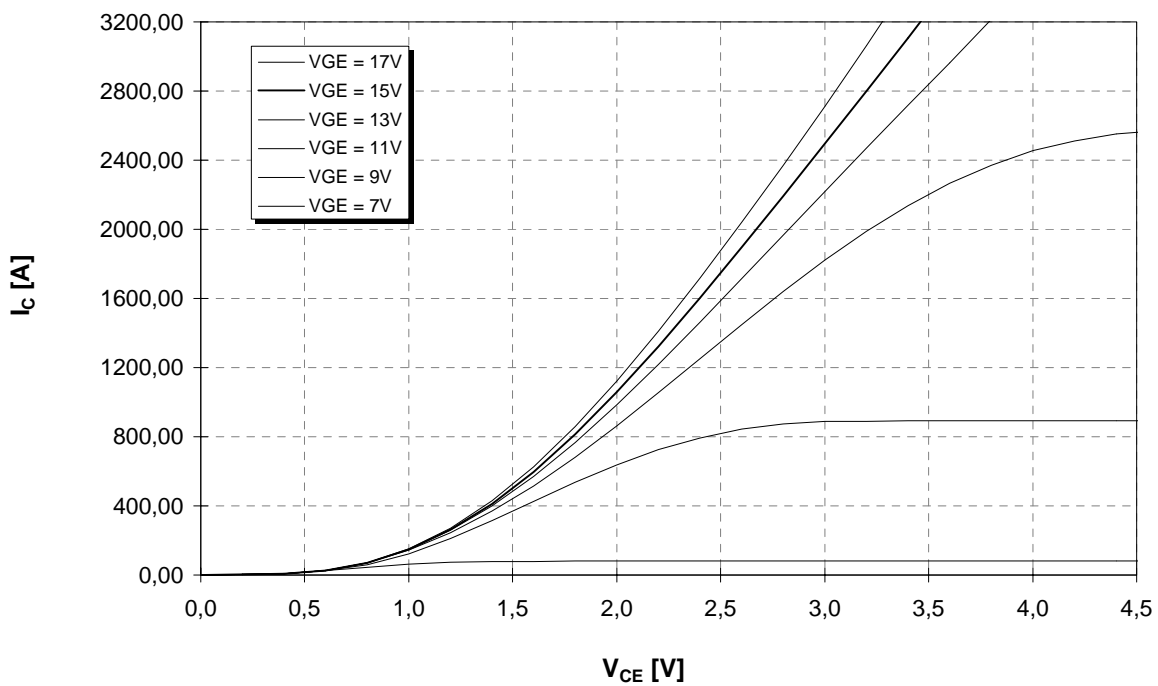
**Ausgangskennlinie (typisch)**  
**Output characteristic (typical)**

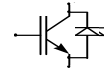
$I_c = f(V_{CE})$   
 $V_{GE} = 15V$



**Ausgangskennlinienfeld (typisch)**  
**Output characteristic (typical)**

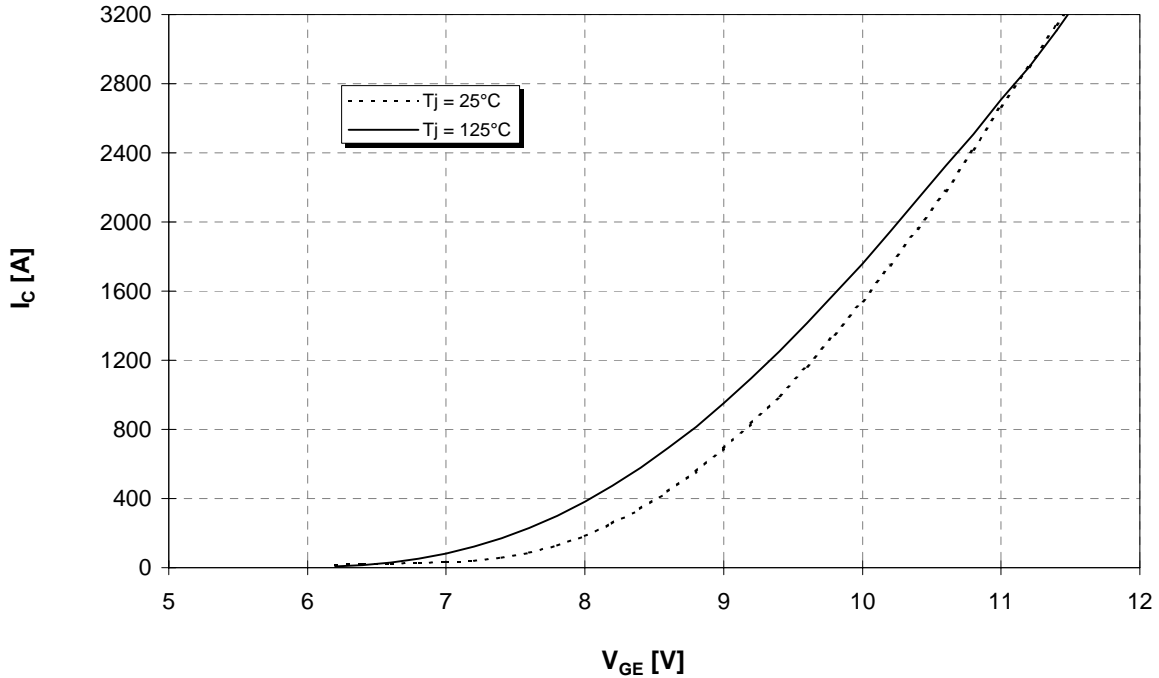
$I_c = f(V_{CE})$   
 $T_{vj} = 125°C$





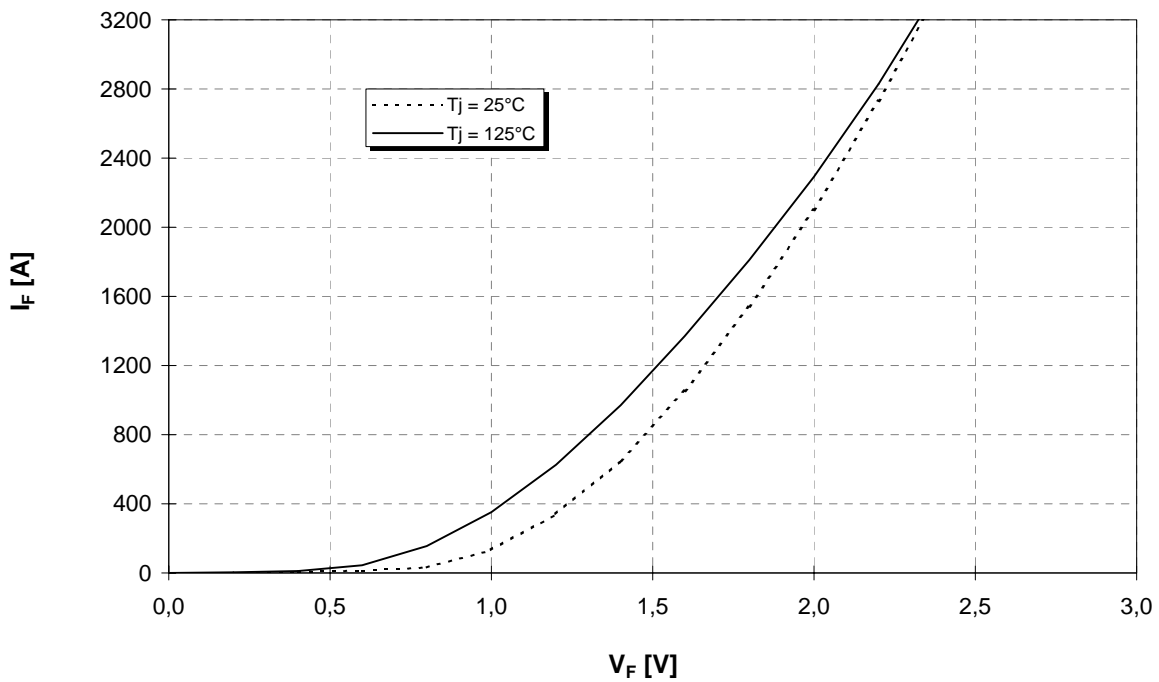
Übertragungscharakteristik (typisch)  
Transfer characteristic (typical)

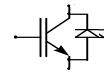
$I_c = f(V_{GE})$   
 $V_{CE} = 20V$



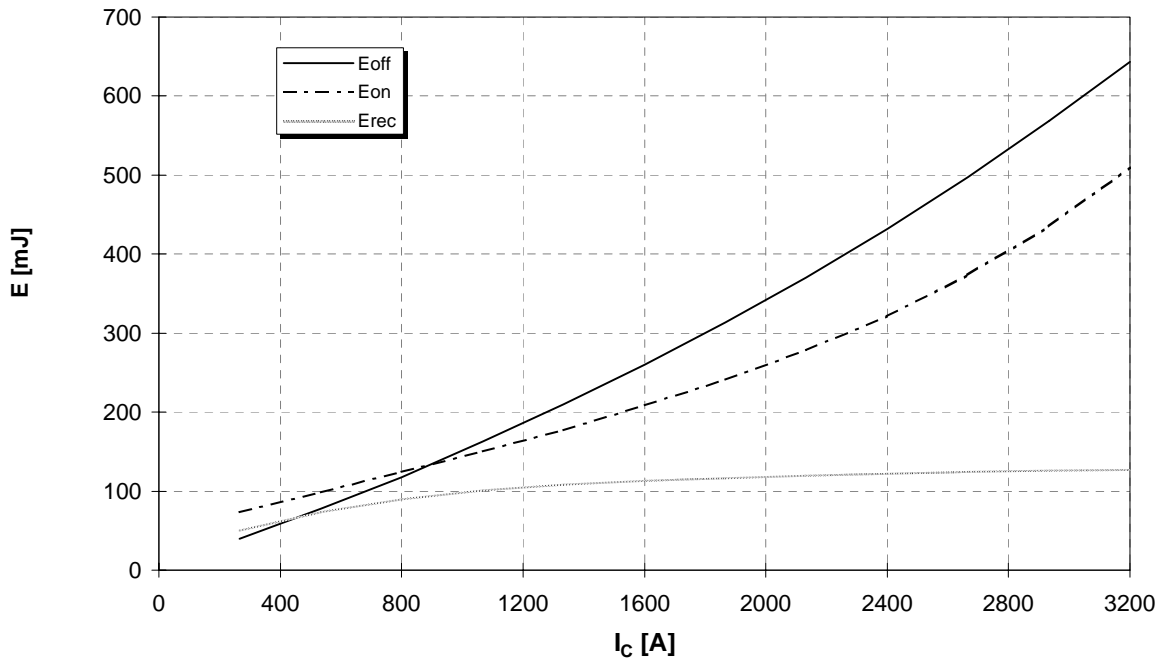
Durchlaßkennlinie der Inversdiode (typisch)  
Forward characteristic of inverse diode (typical)

$I_F = f(V_F)$

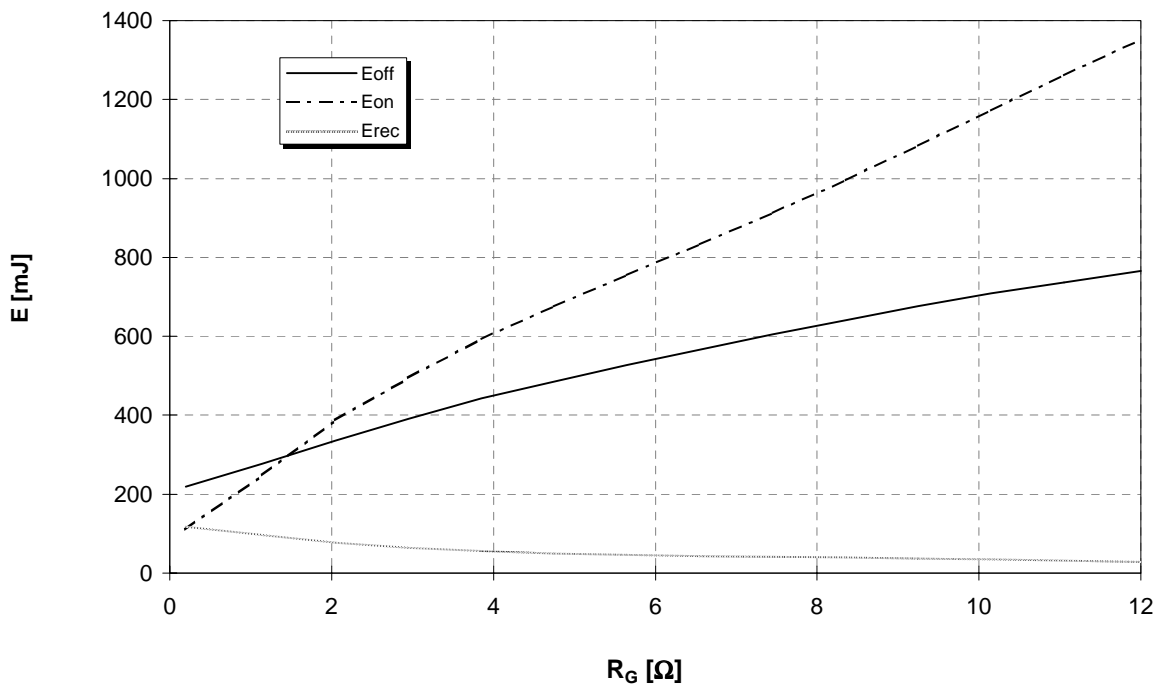


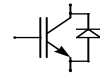


**Schaltverluste (typisch)**  $E_{on} = f(I_C), E_{off} = f(I_C), E_{rec} = f(I_C)$   
**Switching losses (typical)**  $R_{gon} = R_{goff} = 0,91 \Omega, V_{CE} = 600V, T_j = 125^\circ C$



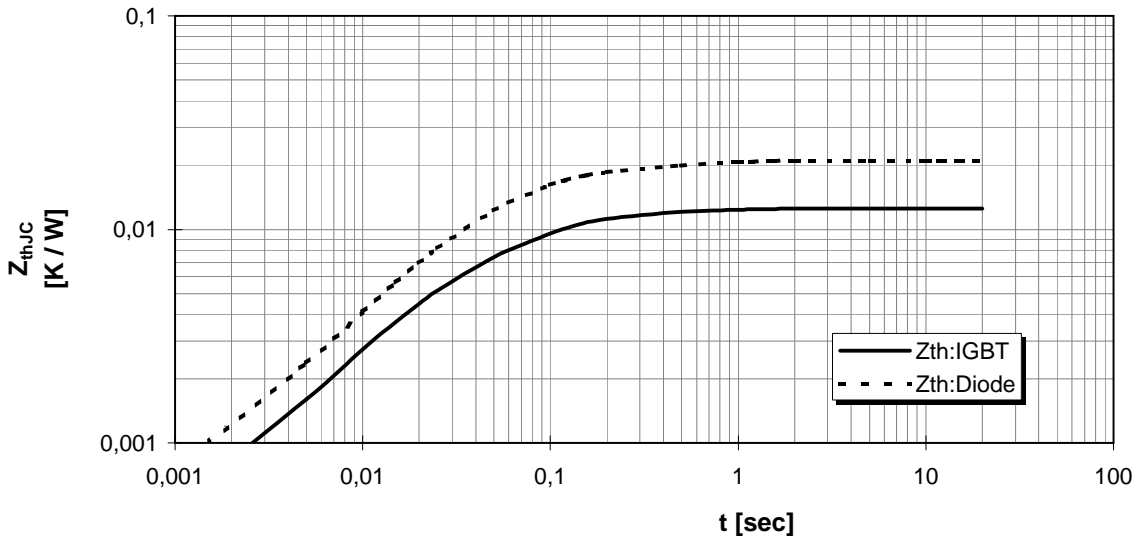
**Schaltverluste (typisch)**  $E_{on} = f(R_G), E_{off} = f(R_G), E_{rec} = f(R_G)$   
**Switching losses (typical)**  $I_C = 1200A, V_{CE} = 600V, T_j = 125^\circ C$





**Transienter Wärmewiderstand**  
**Transient thermal impedance**

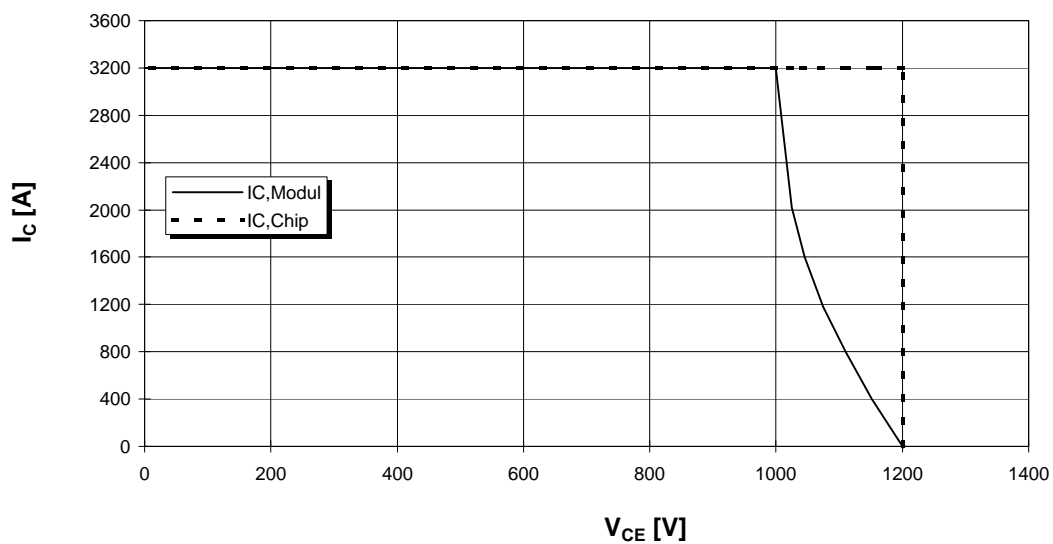
$Z_{thJC} = f(t)$

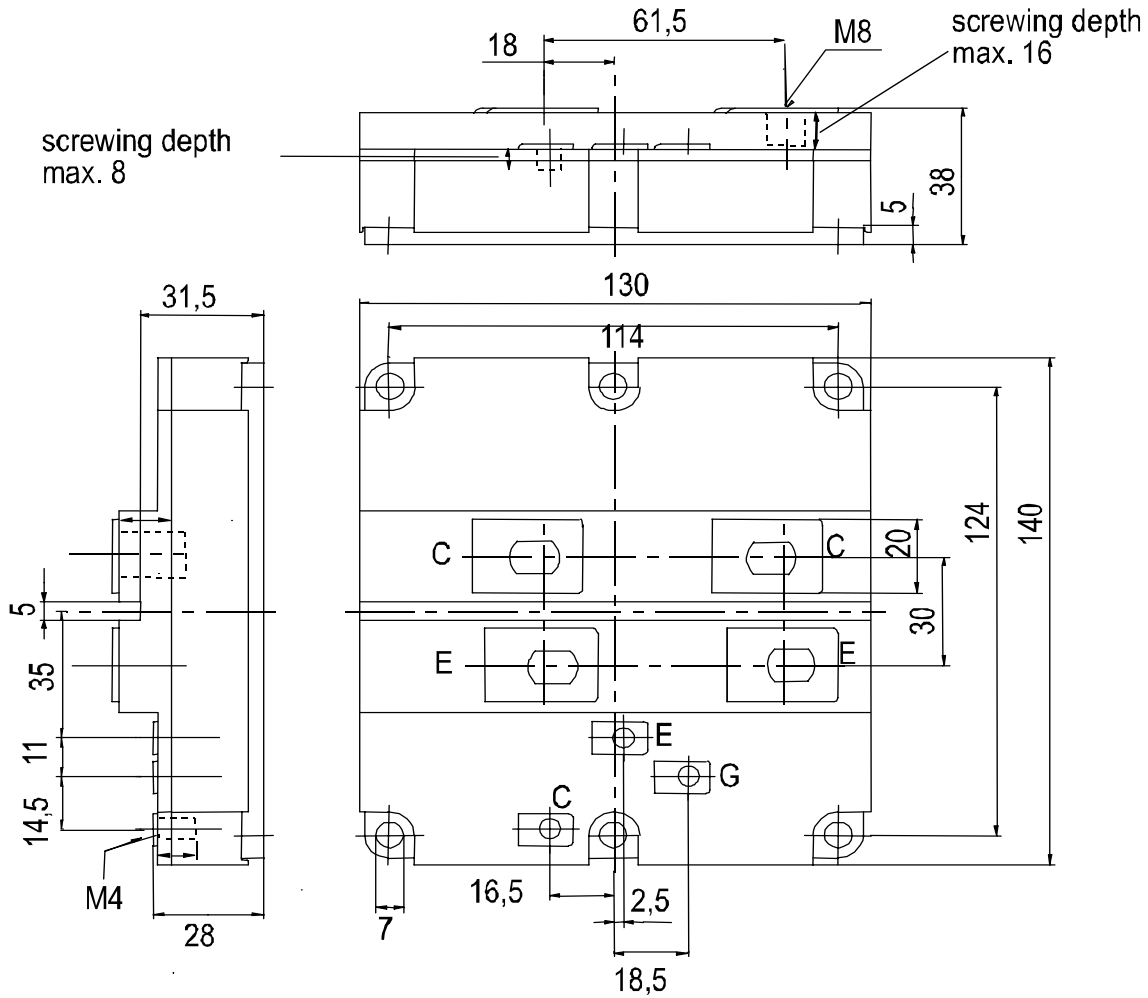
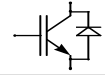


i	1	2	3	4
$r_i$ [K/kW] : IGBT	0,21	3,98	7,32	0,99
$\tau_i$ [sec] : IGBT	0,00006	0,0187	0,080	0,50
$r_i$ [K/kW] : Diode	0,32	4,70	2,93	13,05
$\tau_i$ [sec] : Diode	0,00014	0,0218	0,060	0,50

**Sicherer Arbeitsbereich (RBSOA)**

**Reverse bias safe operation area (RBSOA)**  $R_g = 0,91\Omega, T_{vj} = 125^\circ\text{C}$





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external connections ( to be done)

