

# Technische Information / Technical Information

IGBT-Module  
IGBT-Modules

## FZ400R12KS4

eupec



### Höchstzulässige Werte / Maximum rated values

#### Elektrische Eigenschaften / Electrical properties

Kollektor-Emitter-Sperrspannung collector-emitter voltage	$T_{vj} = 25^\circ\text{C}$	$V_{CES}$	1200	V
Kollektor-Dauergleichstrom DC-collector current	$T_C = 70^\circ\text{C}$	$I_{C,nom.}$	400	A
	$T_C = 25^\circ\text{C}$	$I_C$	510	A
Periodischer Kollektor Spitzenstrom repetitive peak collector current	$t_p = 1\text{ ms}, T_C = 80^\circ\text{C}$	$I_{CRM}$	800	A
Gesamt-Verlustleistung total power dissipation	$T_C = 25^\circ\text{C}$ , Transistor	$P_{tot}$	2500	W
Gate-Emitter-Spitzenspannung gate-emitter peak voltage		$V_{GES}$	+/- 20V	V
Dauergleichstrom DC forward current		$I_F$	400	A
Periodischer Spitzenstrom repetitive peak forw. current	$t_p = 1\text{ ms}$	$I_{FRM}$	800	A
Grenzlastintegral der Diode $I^2t$ - value, Diode	$V_R = 0\text{V}, t_p = 10\text{ms}, T_{vj} = 125^\circ\text{C}$	$I^2t$	65	$\text{k A}^2\text{s}$
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	$I_C = 400\text{A}, V_{GE} = 15\text{V}, T_{vj} = 25^\circ\text{C}$	$V_{CE\text{ sat}}$	-	3,20	3,7	V
	$I_C = 400\text{A}, V_{GE} = 15\text{V}, T_{vj} = 125^\circ\text{C}$		-	3,85	-	V
Gate-Schwellenspannung gate threshold voltage	$I_C = 16\text{ mA}, V_{CE} = V_{GE}, T_{vj} = 25^\circ\text{C}$	$V_{GE(th)}$	4,5	5,5	6,5	V
Eingangskapazität input capacitance	$f = 1\text{MHz}, T_{vj} = 25^\circ\text{C}, V_{CE} = 25\text{V}, V_{GE} = 0\text{V}$	$C_{ies}$	-	26	-	nF
Rückwirkungskapazität reverse transfer capacitance	$f = 1\text{MHz}, T_{vj} = 25^\circ\text{C}, V_{CE} = 25\text{V}, V_{GE} = 0\text{V}$	$C_{res}$	-	1,7	-	nF
Gateladung gate charge	$V_{GE} = -15\text{V} \dots +15\text{V}, V_{CE} = 600\text{V}$	$Q_G$	-	4,2	-	$\mu\text{C}$
Kollektor-Emitter Reststrom collector-emitter cut-off current	$V_{CE} = 1200\text{V}, V_{GE} = 0\text{V}, T_{vj} = 25^\circ\text{C}$	$I_{CES}$	-	-	5	mA
Gate-Emitter Reststrom gate-emitter leakage current	$V_{CE} = 0\text{V}, V_{GE} = 20\text{V}, T_{vj} = 25^\circ\text{C}$	$I_{GES}$	-	-	400	nA

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**Charakteristische Werte / Characteristic values**

**Transistor / Transistor**

			min.	typ.	max.	
Einschaltverzögerungszeit (ind. Last) turn on delay time (inductive load)	$I_C = 400\text{ A}, V_{CC} = 600\text{ V}$	$t_{d,on}$	-	0,10	-	$\mu\text{s}$
	$V_{GE} = \pm 15\text{ V}, R_G = 2,2\ \Omega, T_{vj} = 25^\circ\text{C}$		-	0,13	-	$\mu\text{s}$
	$V_{GE} = \pm 15\text{ V}, R_G = 2,2\ \Omega, T_{vj} = 125^\circ\text{C}$		-	0,13	-	$\mu\text{s}$
Anstiegszeit (induktive Last) rise time (inductive load)	$I_C = 400\text{ A}, V_{CC} = 600\text{ V}$	$t_r$	-	0,09	-	$\mu\text{s}$
	$V_{GE} = \pm 15\text{ V}, R_G = 2,2\ \Omega, T_{vj} = 25^\circ\text{C}$		-	0,10	-	$\mu\text{s}$
	$V_{GE} = \pm 15\text{ V}, R_G = 2,2\ \Omega, T_{vj} = 125^\circ\text{C}$		-	0,10	-	$\mu\text{s}$
Abschaltverzögerungszeit (ind. Last) turn off delay time (inductive load)	$I_C = 400\text{ A}, V_{CC} = 600\text{ V}$	$t_{d,off}$	-	0,53	-	$\mu\text{s}$
	$V_{GE} = \pm 15\text{ V}, R_G = 2,2\ \Omega, T_{vj} = 25^\circ\text{C}$		-	0,59	-	$\mu\text{s}$
	$V_{GE} = \pm 15\text{ V}, R_G = 2,2\ \Omega, T_{vj} = 125^\circ\text{C}$		-	0,59	-	$\mu\text{s}$
Fallzeit (induktive Last) fall time (inductive load)	$I_C = 400\text{ A}, V_{CC} = 600\text{ V}$	$t_f$	-	0,06	-	$\mu\text{s}$
	$V_{GE} = \pm 15\text{ V}, R_G = 2,2\ \Omega, T_{vj} = 25^\circ\text{C}$		-	0,07	-	$\mu\text{s}$
	$V_{GE} = \pm 15\text{ V}, R_G = 2,2\ \Omega, T_{vj} = 125^\circ\text{C}$		-	0,07	-	$\mu\text{s}$
Einschaltverlustenergie pro Puls turn-on energy loss per pulse	$I_C = 400\text{ A}, V_{CC} = 600\text{ V}, V_{GE} = \pm 15\text{ V}$ $R_G = 2,2\ \Omega, T_{vj} = 125^\circ\text{C}, L_\sigma = 85\text{ nH}$	$E_{on}$	-	38	-	mJ
Abschaltverlustenergie pro Puls turn-off energy loss per pulse	$I_C = 400\text{ A}, V_{CC} = 600\text{ V}, V_{GE} = \pm 15\text{ V}$ $R_G = 2,2\ \Omega, T_{vj} = 125^\circ\text{C}, L_\sigma = 85\text{ nH}$	$E_{off}$	-	29	-	mJ
Kurzschlußverhalten SC Data	$t_p \leq 10\ \mu\text{s}, V_{GE} \leq 15\text{ V}$	$I_{SC}$	-	2600	-	A
	$T_{vj} \leq 125^\circ\text{C}, V_{CC} = 900\text{ V}, V_{CEmax} = V_{CES} - L_{\sigma CE} \cdot di/dt$		-	2600	-	A
Modulinduktivität stray inductance module		$L_{\sigma CE}$	-	16	-	nH
Modul-Leitungswiderstand, Anschlüsse - Chip lead resistance, terminals - chip	$T_C = 25^\circ\text{C}$	$R_{CC+EE}$	-	0,5	-	m $\Omega$

**Charakteristische Werte / Characteristic values**

**Diode / Diode**

			min.	typ.	max.	
Durchlaßspannung forward voltage	$I_F = 400\text{ A}, V_{GE} = 0\text{ V}, T_{vj} = 25^\circ\text{C}$	$V_F$	-	2,0	2,4	V
	$I_F = 400\text{ A}, V_{GE} = 0\text{ V}, T_{vj} = 125^\circ\text{C}$		-	1,7	-	V
Rückstromspitze peak reverse recovery current	$I_F = 400\text{ A}, -di_F/dt = 4100\text{ A}/\mu\text{s}$	$I_{RM}$	-	270	-	A
	$V_R = 600\text{ V}, V_{GE} = -15\text{ V}, T_{vj} = 25^\circ\text{C}$		-	450	-	A
	$V_R = 600\text{ V}, V_{GE} = -15\text{ V}, T_{vj} = 125^\circ\text{C}$		-	450	-	A
Sperrverzögerungsladung recovered charge	$I_F = 400\text{ A}, -di_F/dt = 4100\text{ A}/\mu\text{s}$	$Q_r$	-	30	-	$\mu\text{C}$
	$V_R = 600\text{ V}, V_{GE} = -15\text{ V}, T_{vj} = 25^\circ\text{C}$		-	80	-	$\mu\text{C}$
	$V_R = 600\text{ V}, V_{GE} = -15\text{ V}, T_{vj} = 125^\circ\text{C}$		-	80	-	$\mu\text{C}$
Abschaltenergie pro Puls reverse recovery energy	$I_F = 400\text{ A}, -di_F/dt = 4100\text{ A}/\mu\text{s}$	$E_{rec}$	-	16	-	mJ
	$V_R = 600\text{ V}, V_{GE} = -15\text{ V}, T_{vj} = 25^\circ\text{C}$		-	38	-	mJ
	$V_R = 600\text{ V}, V_{GE} = -15\text{ V}, T_{vj} = 125^\circ\text{C}$		-	38	-	mJ

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### Thermische Eigenschaften / Thermal properties

			min.	typ.	max.	
Innerer Wärmewiderstand thermal resistance, junction to case	Transistor / transistor, DC	$R_{thJC}$	-	-	0,050	K/W
	Diode/Diode, DC		-	-	0,085	K/W
Übergangs-Wärmewiderstand thermal resistance, case to heatsink	pro Modul / per module $\lambda_{paste} = 1 \text{ W/m}^2\text{K} / \lambda_{grease} = 1 \text{ W/m}^2\text{K}$	$R_{thCK}$	-	0,010	-	K/W
Höchstzulässige Sperrschichttemperatur maximum junction temperature		$T_{vj \max}$	-	-	150	°C
Betriebstemperatur operation temperature		$T_{vj \text{ op}}$	-40	-	125	°C
Lagertemperatur storage temperature		$T_{stg}$	-40	-	125	°C

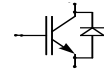
### Mechanische Eigenschaften / Mechanical properties

Gehäuse, siehe Anlage case, see appendix						
Material Modulgrundplatte material of module baseplate				Cu		
Innere Isolation internal insulation				Al <sub>2</sub> O <sub>3</sub>		
Kriechstrecke creepage distance				20	mm	
Luftstrecke clearance distance				11	mm	
CTI comperative tracking index				425		
Anzugsdrehmoment f. mech. Befestigung mounting torque	Schraube / screw M6	M	3,0	-	6,0	Nm
Anzugsdrehmoment f. elektr. Anschlüsse terminal connection torque	Anschlüsse / terminals M6	M	2,5	-	5,0	Nm
	Anschlüsse / terminals M4		1,1	-	2,0	Nm
Gewicht weight		G		340	g	

Mit dieser technischen Information werden Halbleiterbauelemente spezifiziert, jedoch keine Eigenschaften zugesichert.

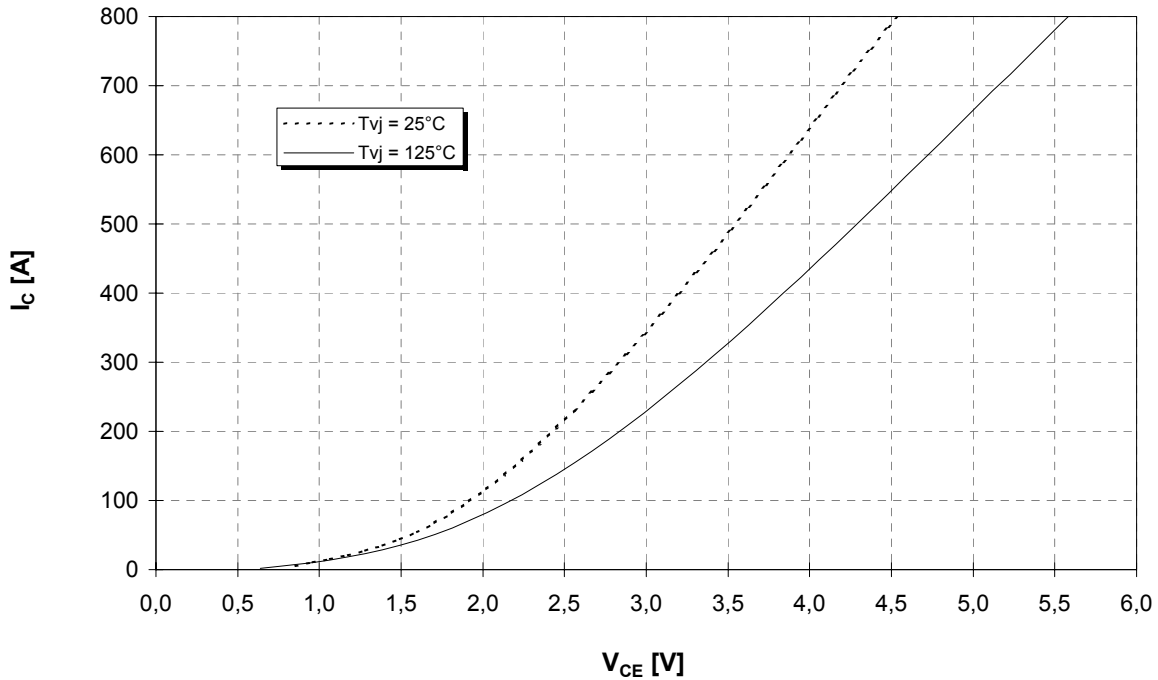
Sie gilt in Verbindung mit den zugehörigen Technischen Erläuterungen.

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



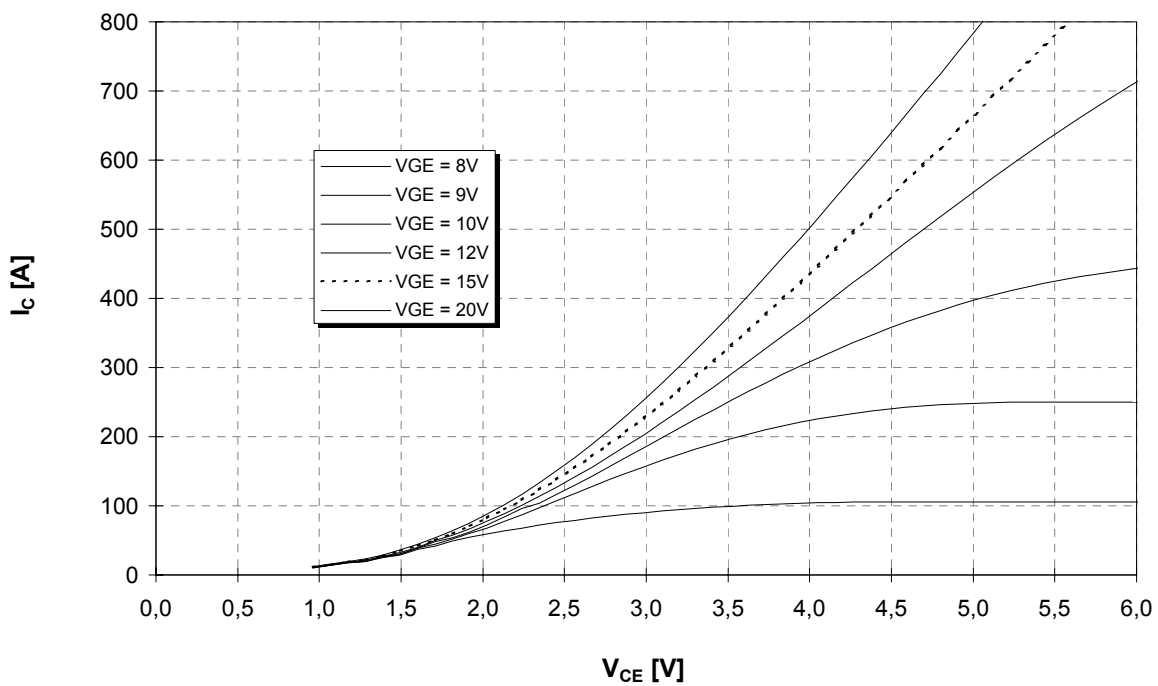
**Ausgangskennlinie (typisch)**  
**output characteristic (typical)**

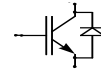
$I_C = f(V_{CE})$   
 $V_{GE} = 15V$



**Ausgangskennlinienfeld (typisch)**  
**output characteristic (typical)**

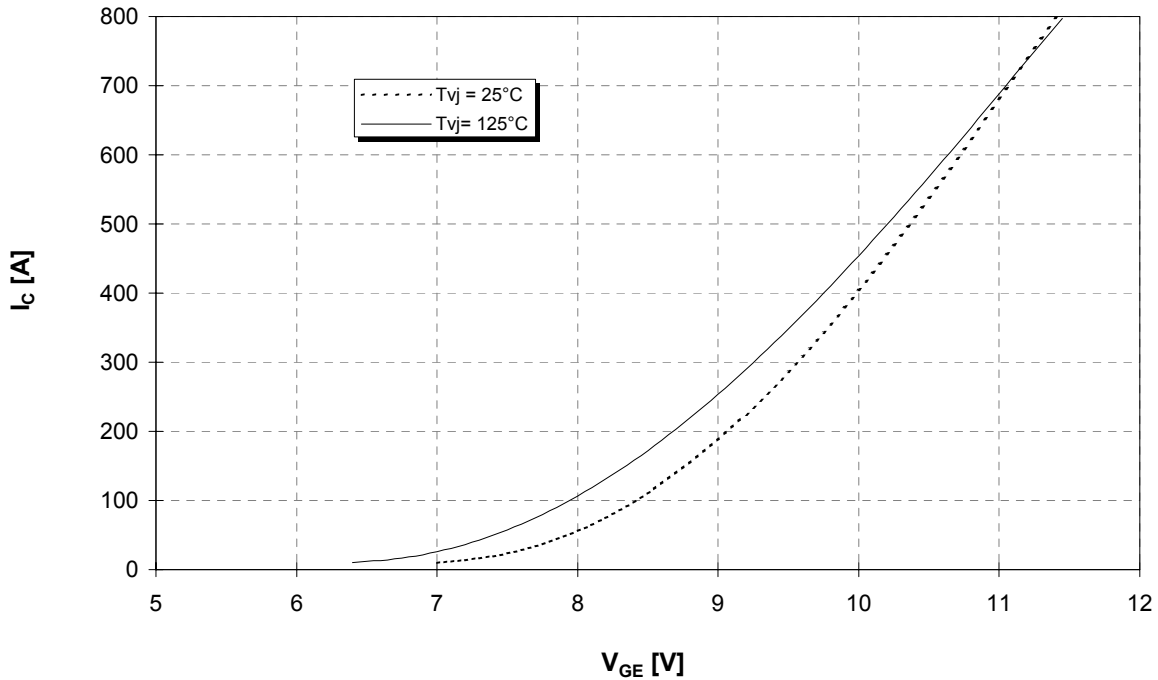
$I_C = f(V_{CE})$   
 $T_{vj} = 125^\circ C$





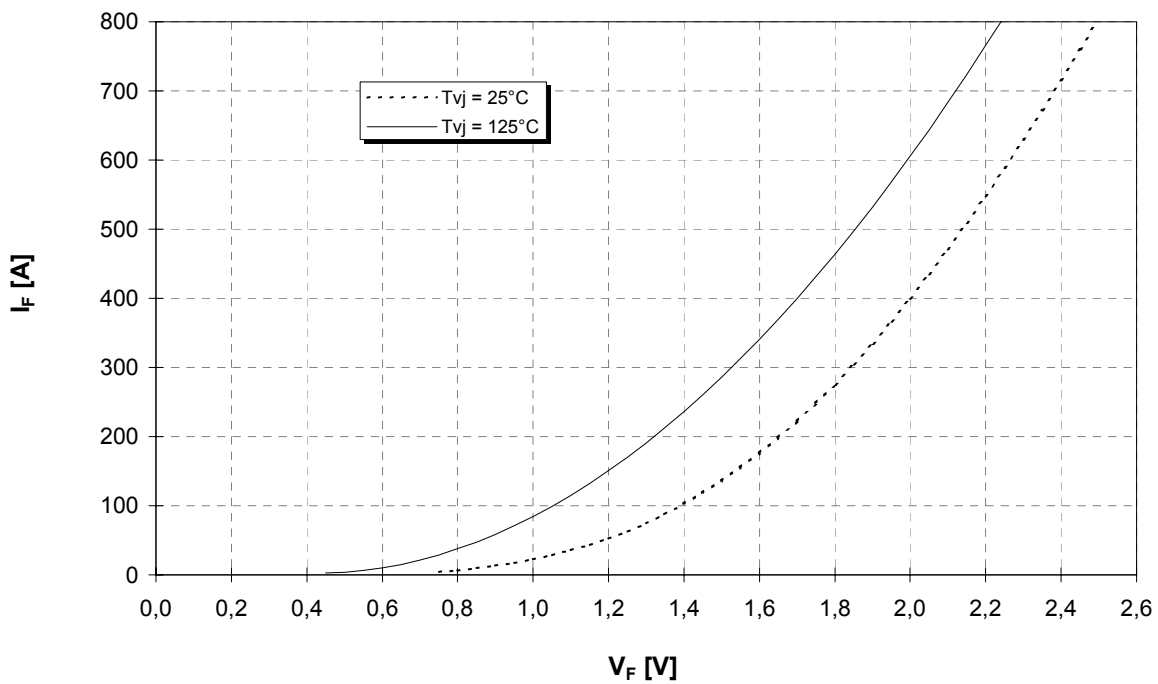
Übertragungscharakteristik (typisch)  
transfer characteristic (typical)

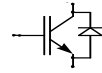
$I_C = f(V_{GE})$   
 $V_{CE} = 20V$



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

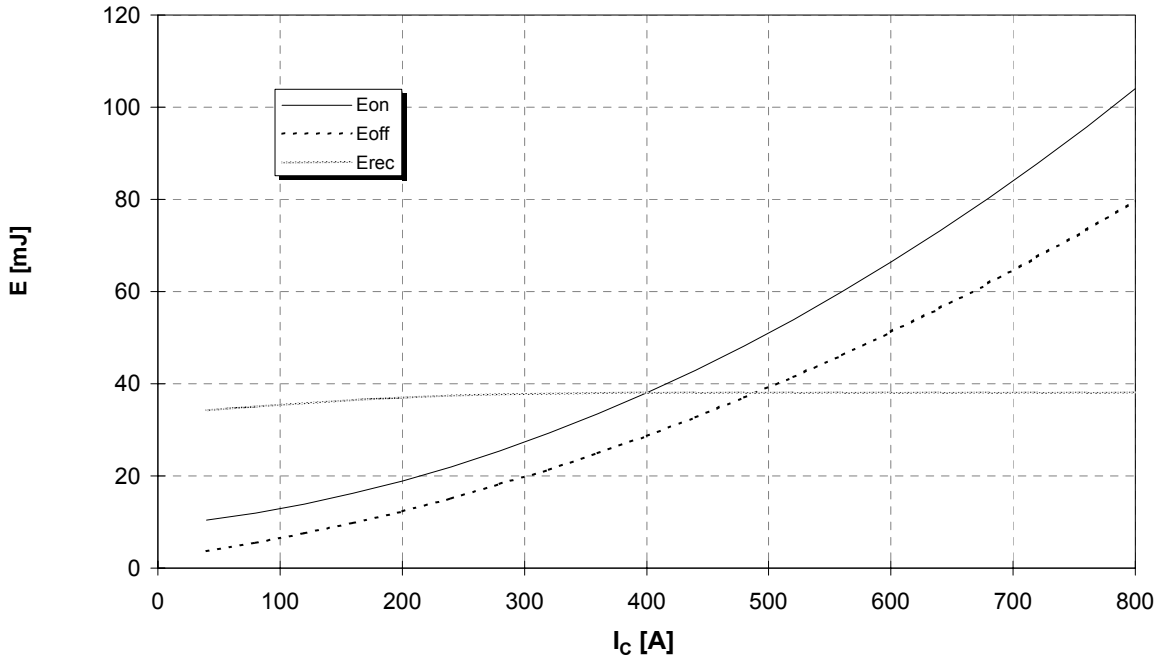
$I_F = f(V_F)$





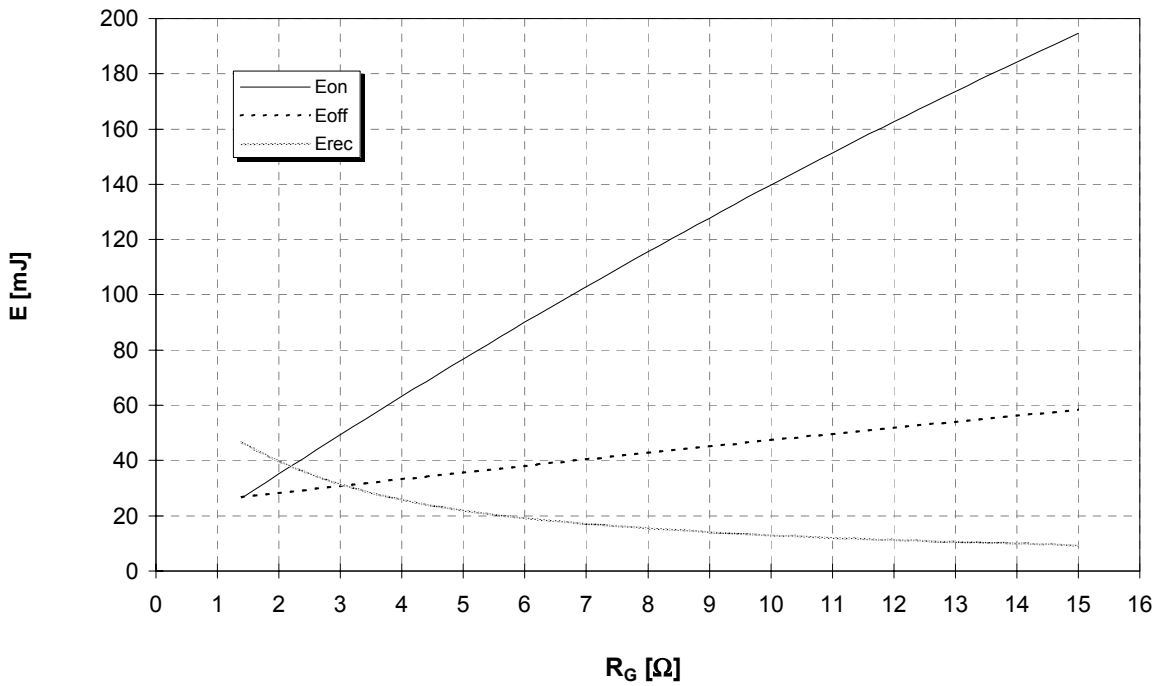
Schaltverluste (typisch)  
switching losses (typical)

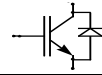
$E_{on} = f(I_C)$ ,  $E_{off} = f(I_C)$ ,  $E_{rec} = f(I_C)$   
 $V_{GE} = \pm 15V$ ,  $R_G = 2,2 \Omega$ ,  $V_{CE} = 600V$ ,  $T_{vj} = 125^\circ C$



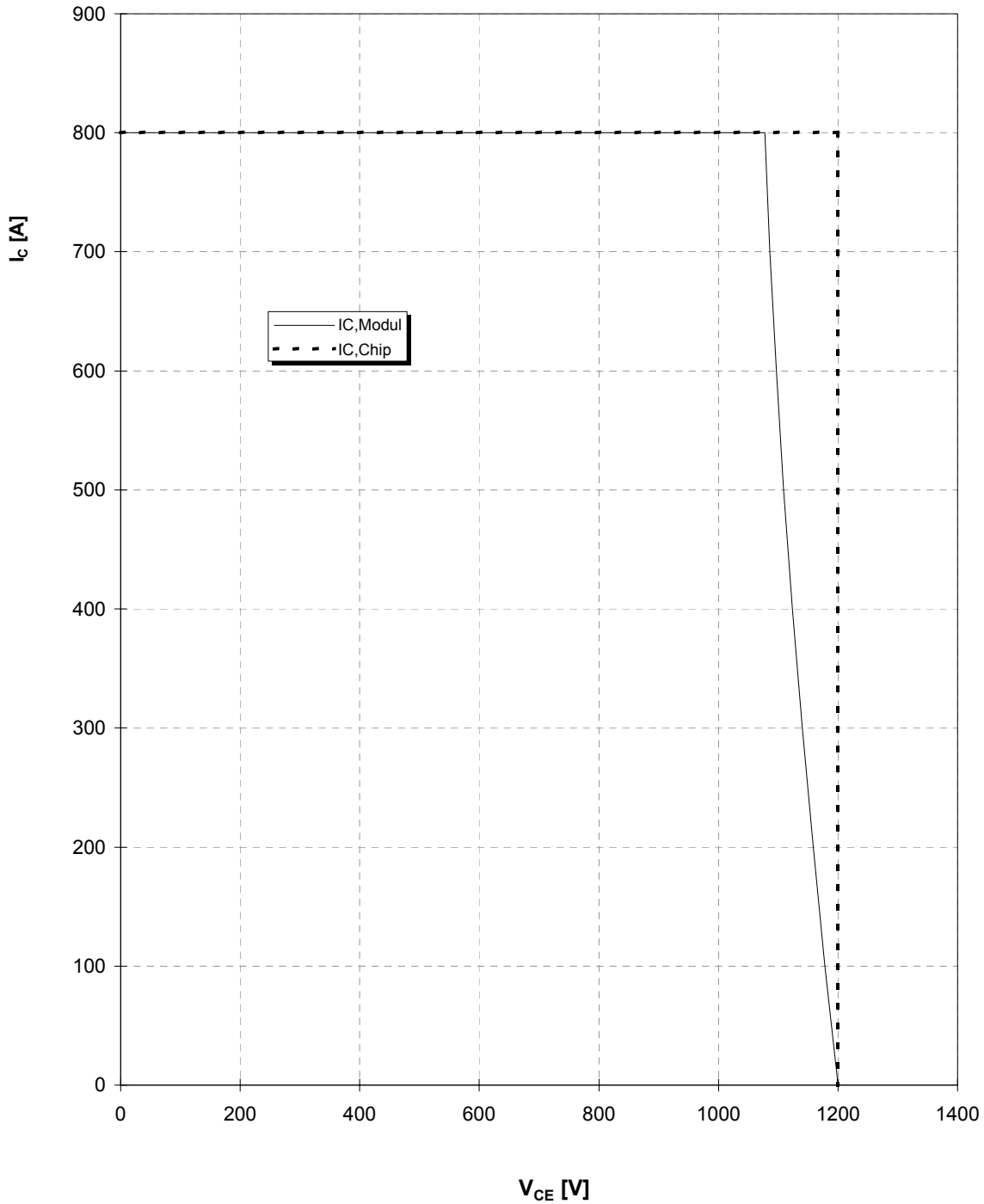
Schaltverluste (typisch)  
switching losses (typical)

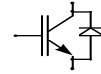
$E_{on} = f(R_G)$ ,  $E_{off} = f(R_G)$ ,  $E_{rec} = f(R_G)$   
 $V_{GE} = \pm 15V$ ,  $I_C = 400 A$ ,  $V_{CE} = 600V$ ,  $T_{vj} = 125^\circ C$





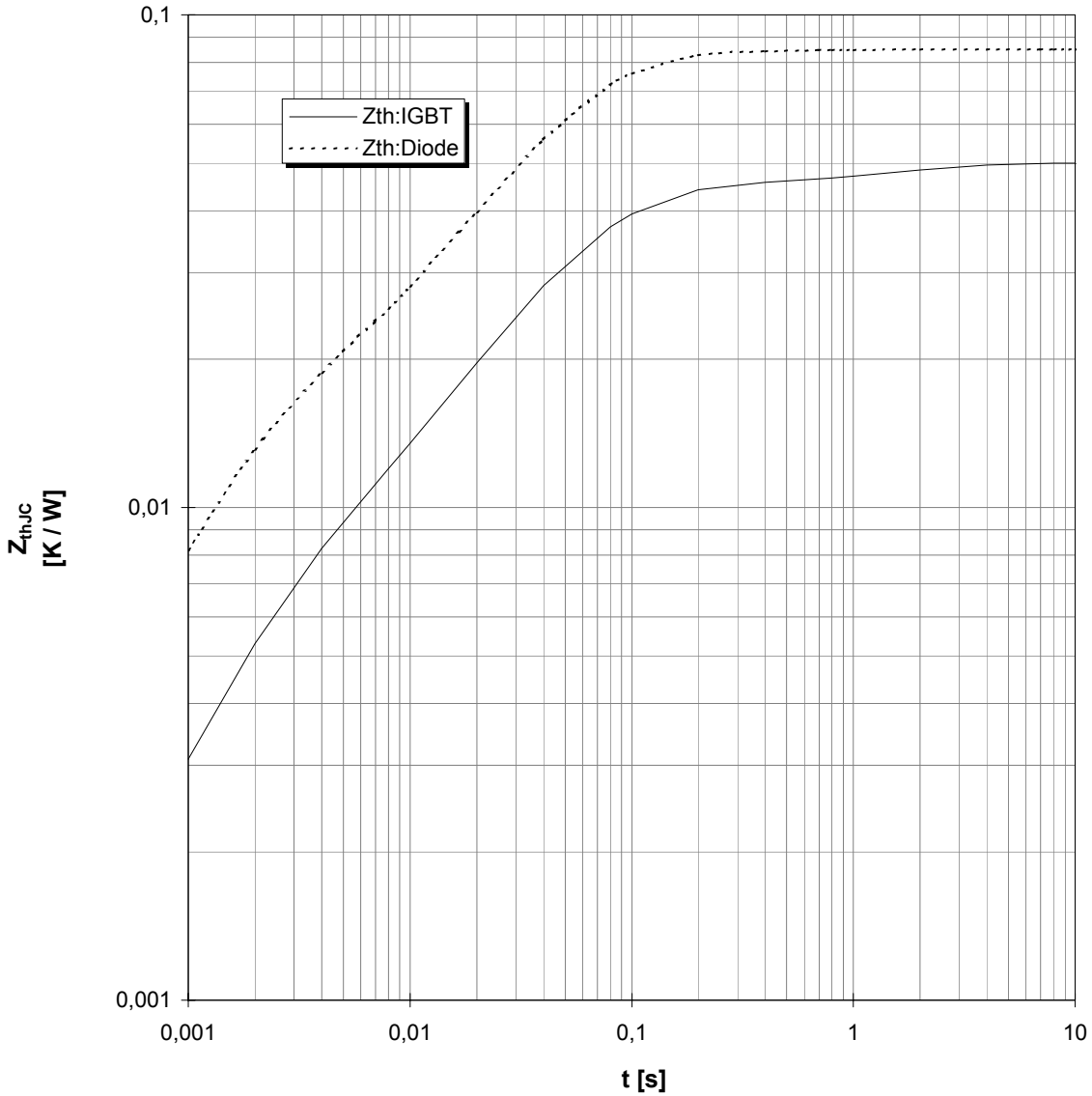
**Sicherer Arbeitsbereich IGBT (RBSOA)**  $V_{GE} = \pm 15V, R_G = 2,2 \Omega, T_{vj} = 125^\circ C$   
**reverse bias safe operation area IGBT (RBSOA)**





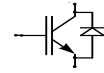
Transienter Wärmewiderstand  
transient thermal impedance

$$Z_{thJC} = f(t)$$



i	1	2	3	4
$r_i$ [K/kW] : IGBT	5,59	16,93	22,06	5,43
$\tau_i$ [s] : IGBT	0,0020	0,0300	0,0660	1,6550
$r_i$ [K/kW] : Diode	13,15	34,56	35,61	1,68
$\tau_i$ [s] : Diode	0,0015	0,0327	0,0561	0,3872





Gehäusemaße / Schaltbild  
Package outline / Circuit diagram

