

## Technische Information / Technical Information

IGBT-Module  
IGBT-Modules

## FZ 400 R 65 KF1

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## Höchstzulässige Werte / Maximum rated values

## Elektrische Eigenschaften / Electrical properties

Kollektor-Emitter-Sperrspannung collector-emitter voltage	$T_{vj}=125^{\circ}\text{C}$ $T_{vj}=25^{\circ}\text{C}$ $T_{vj}=40^{\circ}\text{C}$	$V_{CES}$	6500 6300 5800	V
Kollektor-Dauergleichstrom DC-collector current	$T_C = 80^{\circ}\text{C}$ $T_C = 25^{\circ}\text{C}$	$I_{C,nom.}$ $I_C$	400 800	A 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	$T_C=25^{\circ}\text{C}, \text{Transistor}$	$P_{tot}$	7,4	kW
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	$V_R = 0V, t_p = 10\text{ms}, T_{vj} = 125^{\circ}\text{C}$	$I^2t$	87	$\text{k A}^2\text{s}$
Isolations-Prüfspannung insulation test voltage	RMS, $f = 50\text{ Hz}, t = 1\text{ min.}$	$V_{ISOL}$	10,2	kV
Teilentladungs Aussetzspannung partial discharge extinction voltage	RMS, $f = 50\text{ Hz}, Q_{PD} \text{ typ. } 10\text{pC (acc. To IEC 1287)}$	$V_{ISOL}$	5,1	kV

## Charakteristische Werte / Characteristic values

## Transistor / Transistor

			min.	typ.	max.	
Kollektor-Emitter Sättigungsspannung collector-emitter saturation voltage	$I_C = 400A, V_{GE} = 15V, T_{vj} = 25^{\circ}\text{C}$	$V_{CE\text{ sat}}$	-	4,3	4,9	V
	$I_C = 400A, V_{GE} = 15V, T_{vj} = 125^{\circ}\text{C}$		-	5,3	5,9	V
Gate-Schwellenspannung gate threshold voltage	$I_C = 70\text{mA}, V_{CE} = V_{GE}, T_{vj} = 25^{\circ}\text{C}$	$V_{GE(th)}$	6,4	7,0	8,1	V
Gateladung gate charge	$V_{GE} = -15V \dots +15V$	$Q_G$	-	5,6	-	$\mu\text{C}$
Eingangskapazität input capacitance	$f = 1\text{MHz}, T_{vj} = 25^{\circ}\text{C}, V_{CE} = 25V, V_{GE} = 0V$	$C_{ies}$	-	56	-	nF
Kollektor-Emitter Reststrom collector-emitter cut-off current	$V_{CE} = 6300V, V_{GE} = 0V, T_{vj} = 25^{\circ}\text{C}$	$I_{CES}$	-	0,4	-	mA
	$V_{CE} = 6500V, V_{GE} = 0V, T_{vj} = 125^{\circ}\text{C}$			40		
Gate-Emitter Reststrom gate-emitter leakage current	$V_{CE} = 0V, V_{GE} = 20V, T_{vj} = 25^{\circ}\text{C}$	$I_{GES}$	-	-	400	nA

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### Charakteristische Werte / Characteristic values

#### Transistor / Transistor

			min.	typ.	max.	
Einschaltverzögerungszeit (ind. Last) turn on delay time (inductive load)	$I_C = 400A, V_{CE} = 3600V$	$t_{d,on}$	-	0,75	-	$\mu s$
	$V_{GE} = \pm 15V, R_{Gon} = 6,2\Omega, C_{GE}=44nF, T_{vj} = 25^\circ C,$ $V_{GE} = \pm 15V, R_{Gon} = 6,2\Omega, C_{GE}=44nF, T_{vj} = 125^\circ C,$		-	0,72	-	$\mu s$
Anstiegszeit (induktive Last) rise time (inductive load)	$I_C = 400A, V_{CE} = 3600V$	$t_r$	-	0,37	-	$\mu s$
	$V_{GE} = \pm 15V, R_{Gon} = 6,2\Omega, C_{GE}=44nF, T_{vj} = 25^\circ C,$ $V_{GE} = \pm 15V, R_{Gon} = 6,2\Omega, C_{GE}=44nF, T_{vj} = 125^\circ C,$		-	0,40	-	$\mu s$
Abschaltverzögerungszeit (ind. Last) turn off delay time (inductive load)	$I_C = 400A, V_{CE} = 3600V$	$t_{d,off}$	-	5,50	-	$\mu s$
	$V_{GE} = \pm 15V, R_{Goff} = 36\Omega, C_{GE}=44nF, T_{vj} = 25^\circ C,$ $V_{GE} = \pm 15V, R_{Goff} = 36\Omega, C_{GE}=44F, T_{vj} = 125^\circ C,$		-	6,00	-	$\mu s$
Fallzeit (induktive Last) fall time (inductive load)	$I_C = 400A, V_{CE} = 3600V$	$t_f$	-	0,40	-	$\mu s$
	$V_{GE} = \pm 15V, R_{Goff} = 36\Omega, C_{GE}=44nF, T_{vj} = 25^\circ C,$ $V_{GE} = \pm 15V, R_{Goff} = 36\Omega, C_{GE}=44F, T_{vj} = 125^\circ C,$		-	0,50	-	$\mu s$
Einschaltverlustenergie pro Puls turn-on energy loss per pulse	$I_C = 400A, V_{CE} = 3600V, V_{GE} = \pm 15V$ $R_{Gon} = 6,2\Omega, C_{GE}=44nF, T_{vj} = 125^\circ C, L_\sigma = 280nH$	$E_{on}$	-	4000	-	mJ
Abschaltverlustenergie pro Puls turn-off energy loss per pulse	$I_C = 400A, V_{CE} = 3600V, V_{GE} = \pm 15V$ $R_{Goff} = 36\Omega, C_{GE}=44nF, T_{vj} = 125^\circ C, L_\sigma = 280nH$	$E_{off}$	-	2300	-	mJ
Kurzschlußverhalten SC Data	$t_p \leq 10\mu sec, V_{GE} \leq 15V, acc\ to\ appl.note\ 2002/05$ $T_{vj} \leq 125^\circ C, V_{CC}=4400V, V_{CEmax}=V_{CES} - L_{\sigma CE} \cdot di/dt$	$I_{SC}$	-	2000	-	A
Modulinduktivität stray inductance module		$L_{SCE}$	-	20	-	nH
Modulleitungswiderstand, Anschlüsse - Chip module lead resistance, terminals - chip		$R_{CC+EE}$	-	0,18	-	m $\Omega$

#### Diode / Diode

			min.	typ.	max.	
Durchlaßspannung forward voltage	$I_F = 400A, V_{GE} = 0V, T_{vj} = 25^\circ C$	$V_F$	3,0	3,8	4,6	V
	$I_F = 400A, V_{GE} = 0V, T_{vj} = 125^\circ C$			3,9	4,7	V
Rückstromspitze peak reverse recovery current	$I_F = 400A, -di_F/dt = 1400A/\mu s$	$I_{RM}$	-	540	-	A
	$V_R = 3600V, V_{GE} = -10V, T_{vj} = 25^\circ C$ $V_R = 3600V, V_{GE} = -10V, T_{vj} = 125^\circ C$		-	660	-	A
Sperrverzögerungsladung recovered charge	$I_F = 400A, -di_F/dt = 1400A/\mu s$	$Q_r$	-	360	-	$\mu C$
	$V_R = 3600V, V_{GE} = -10V, T_{vj} = 25^\circ C$ $V_R = 3600V, V_{GE} = -10V, T_{vj} = 125^\circ C$		-	700	-	$\mu C$
Abschaltenergie pro Puls reverse recovery energy	$I_F = 400A, -di_F/dt = 1400A/\mu s$	$E_{rec}$	-	440	-	mJ
	$V_R = 3600V, V_{GE} = -10V, T_{vj} = 25^\circ C$ $V_R = 3600V, V_{GE} = -10V, T_{vj} = 125^\circ C$		-	1050	-	mJ

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### Thermische Eigenschaften / Thermal properties

		min. typ. max.				
Innerer Wärmewiderstand thermal resistance, junction to case	Transistor / transistor, DC	$R_{thJC}$	-	-	0,017	K/W
	Diode/Diode, DC		-	-	0,032	K/W
Übergangs-Wärmewiderstand thermal resistance, case to heatsink	pro Modul / per Module $\lambda_{Paste} \leq 1 \text{ W/m}^2\text{K} / \lambda_{grease} \leq 1 \text{ W/m}^2\text{K}$	$R_{thCK}$	-	0,008	-	K/W
Höchstzulässige Sperrschichttemperatur maximum junction temperature		$T_{vj, max}$	-	-	150	°C
Betriebstemperatur Sperrschicht junction operation temperature	Schaltvorgänge IGBT(RBSOA);Diode(SOA) switching operation IGBT(RBSOA);Diode(SOA)	$T_{vj, op}$	-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			AlN		
Kriechstrecke creepage distance			56		mm
Luftstrecke clearance			26		mm
CTI comperative tracking index			>600		
Anzugsdrehmoment f. mech. Befestigung mounting torque	Schraube /screw M6	M		5	Nm
Anzugsdrehmoment f. elektr. Anschlüsse terminal connection torque	Anschlüsse / terminals M4	M		2	Nm
	Anschlüsse / terminals M8			8 - 10	Nm
Gewicht weight		G		1000	g

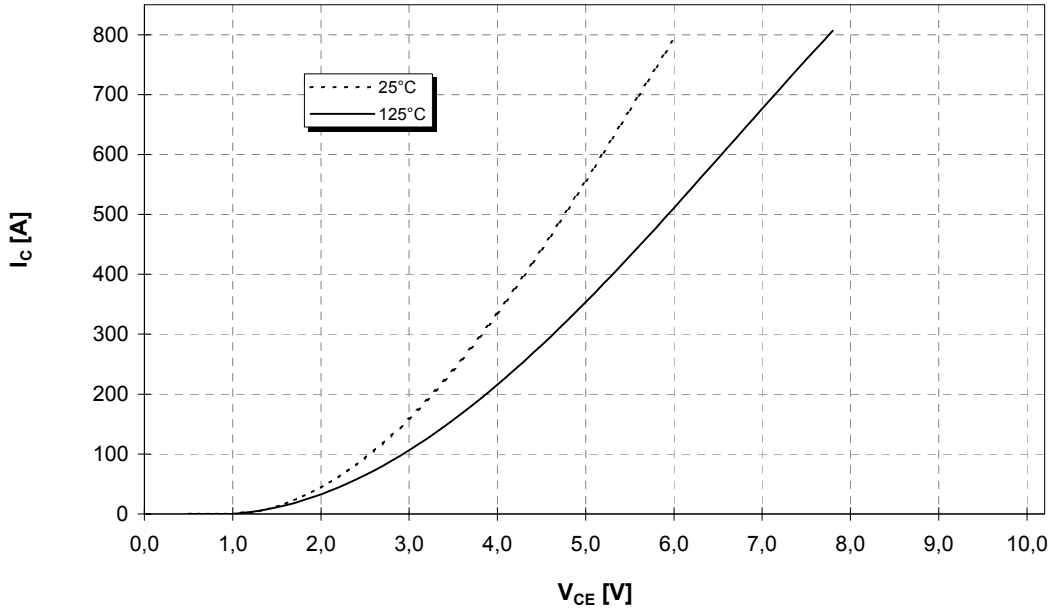
Mit dieser technischen Information werden Halbleiterbauelemente spezifiziert, jedoch keine Eigenschaften zugesichert. Sie gilt in Verbindung mit den zugehörigen Technischen Erläuterungen.

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



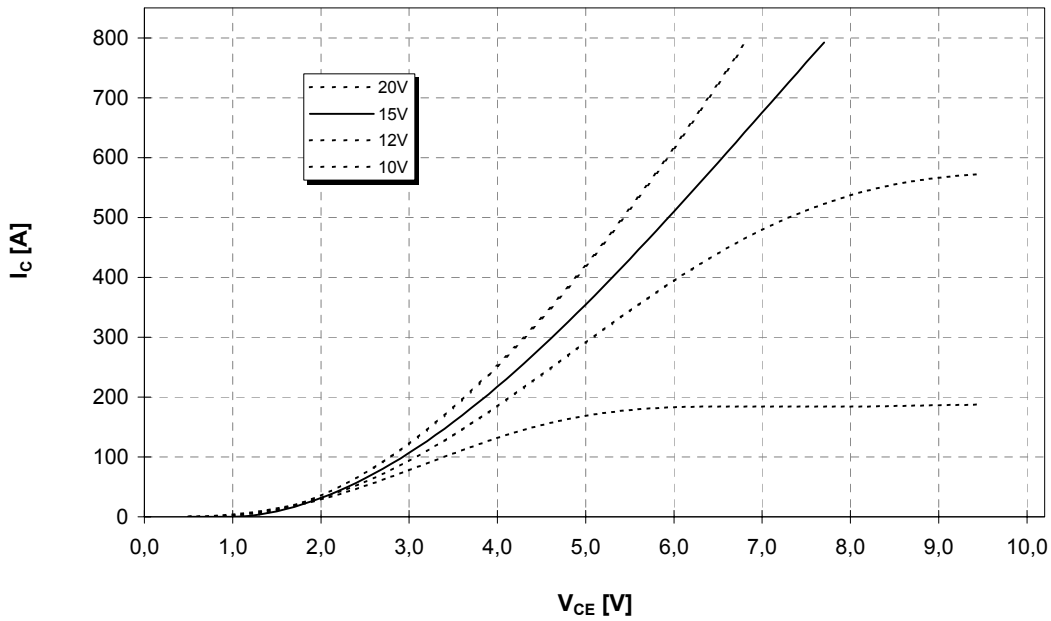
**Ausgangskennlinie (typisch)**  
**Output characteristic (typical)**

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



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

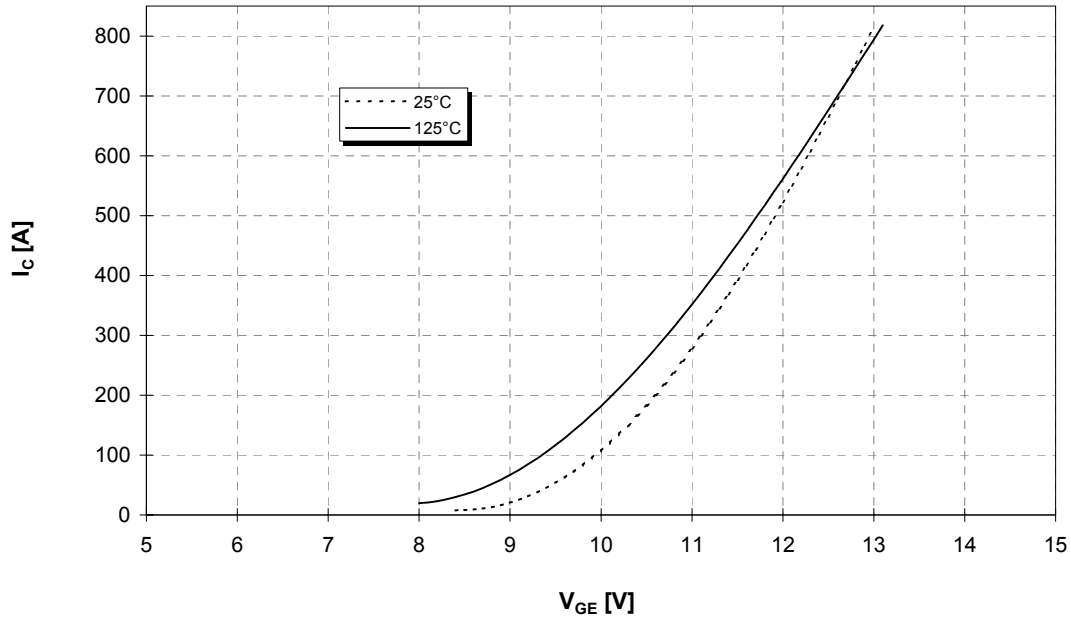
$I_c = f(V_{CE}), V_{GE} = < \text{see inset} >$   
 $T_{vj} = 125^\circ C$





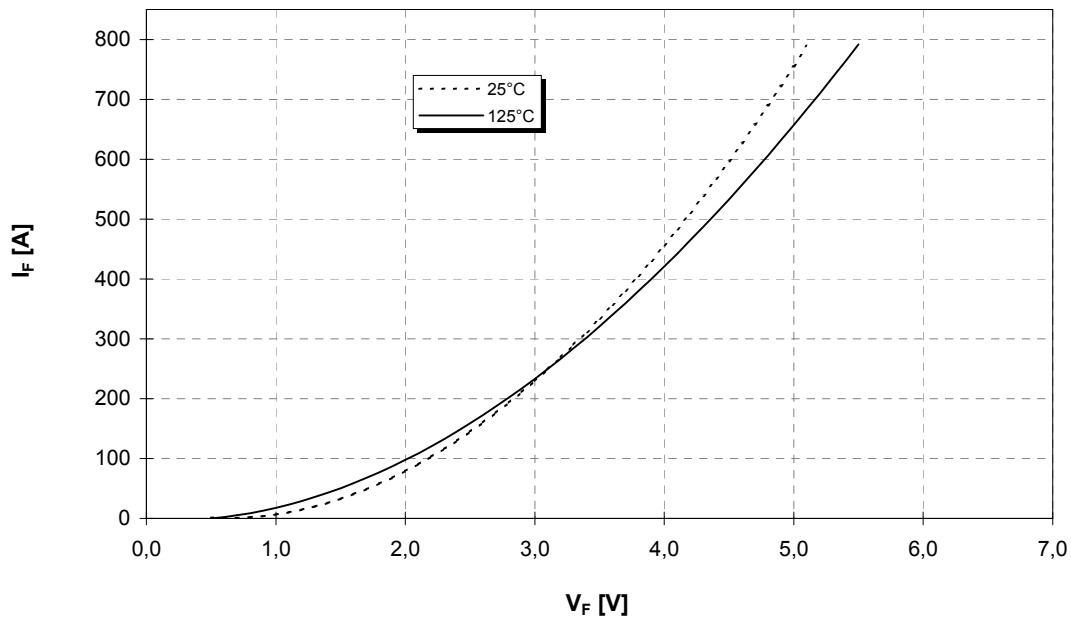
Übertragungscharakteristik (typisch)  
Transfer characteristic (typical)

$I_C = f(V_{GE})$   
 $V_{CE} = 10V$



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

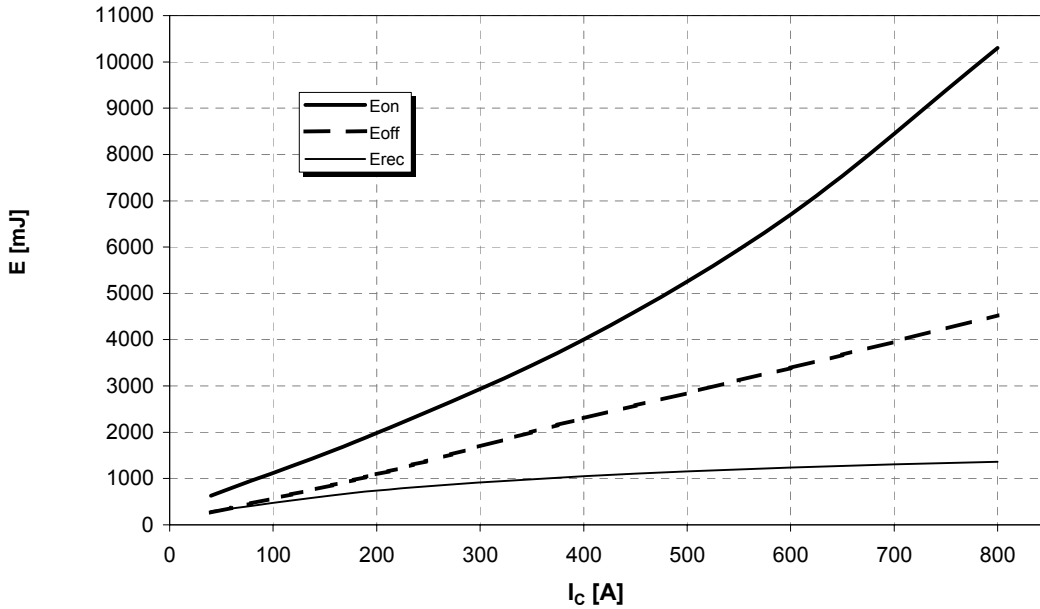
$I_F = f(V_F)$





Schaltverluste (typisch)  $E_{on} = f(I_c)$ ,  $E_{off} = f(I_c)$ ,  $E_{rec} = f(I_c)$

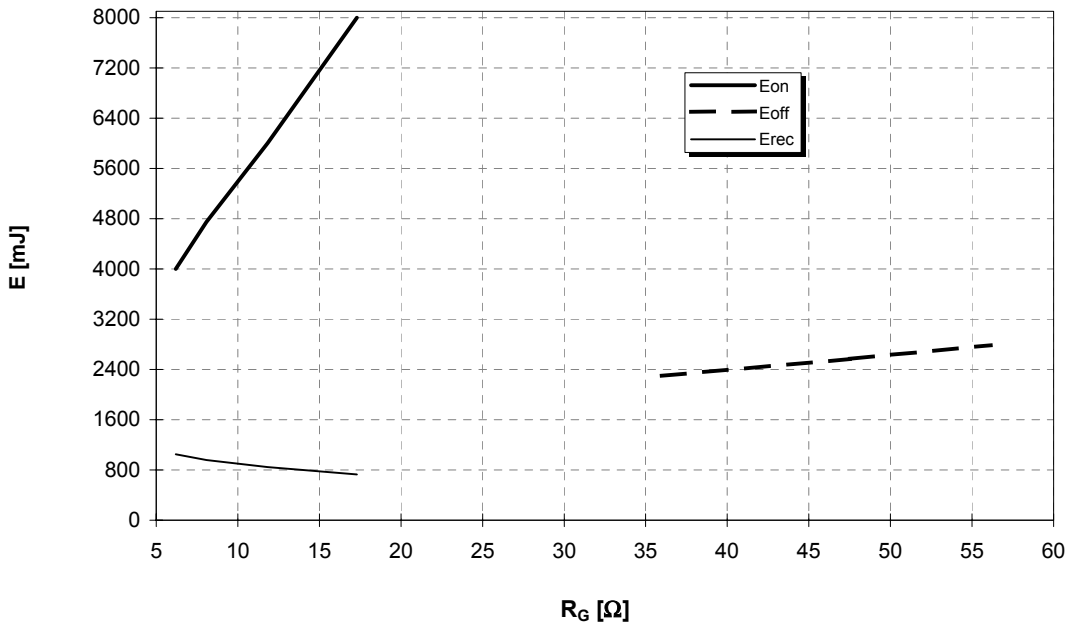
Switching losses (typical)  $R_{Gon}=6,2\Omega$ ,  $R_{Goff}=36\Omega$ ,  $C_{GE} = 44nF$ ,  $V_{GE}=\pm 15V$ ,  $V_{CE} = 3600V$ ,  $T_{vj} = 125^\circ C$ ,



Schaltverluste (typisch)  
Switching losses (typical)

$E_{on} = f(R_G)$ ,  $E_{off} = f(R_G)$ ,  $E_{rec} = f(R_G)$

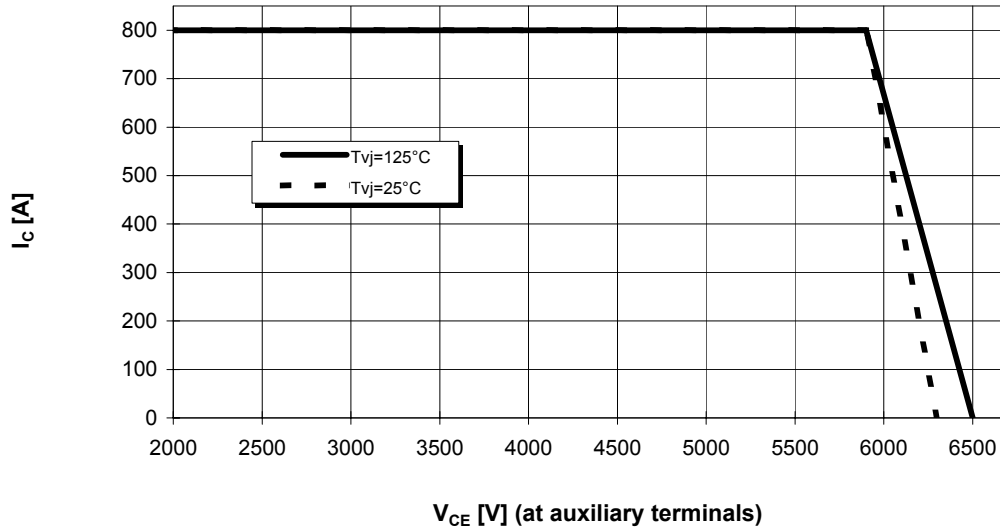
$I_c = 400A$ ,  $V_{CE} = 3600V$ ,  $V_{GE}=\pm 15V$ ,  $C_{GE}=44nF$ ,  $T_{vj} = 125^\circ C$





**Sicherer Arbeitsbereich (RBSOA)**

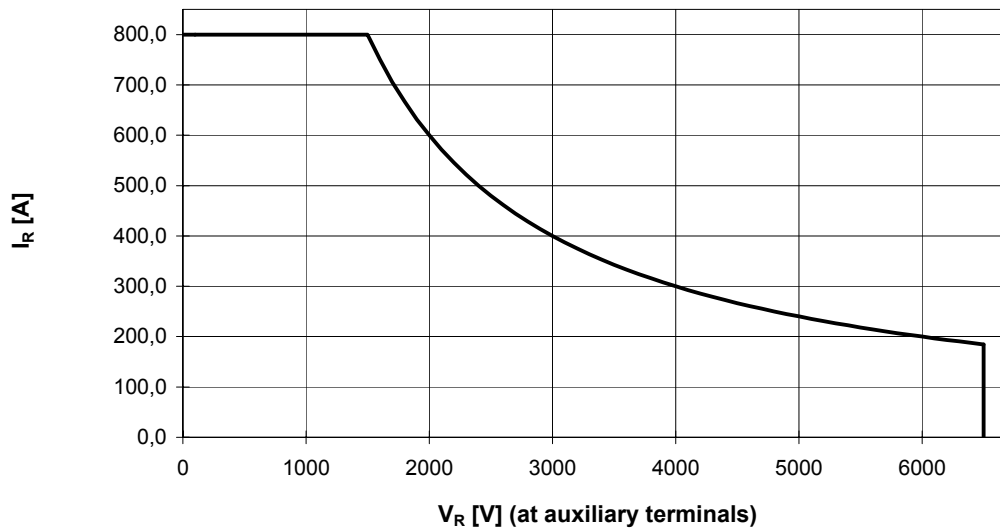
**Reverse bias safe operation area (RBSOA)**  $R_{G,off} = 36\Omega$ ,  $C_{GE}=44nF$ ,  $V_{GE}=\pm 15V$ ,  $T_{vj} = <see inset>$ ,  $V_{CC} \leq 4400V$



**Sicherer Arbeitsbereich Diode (SOA)**

**safe operation area Diode (SOA)**

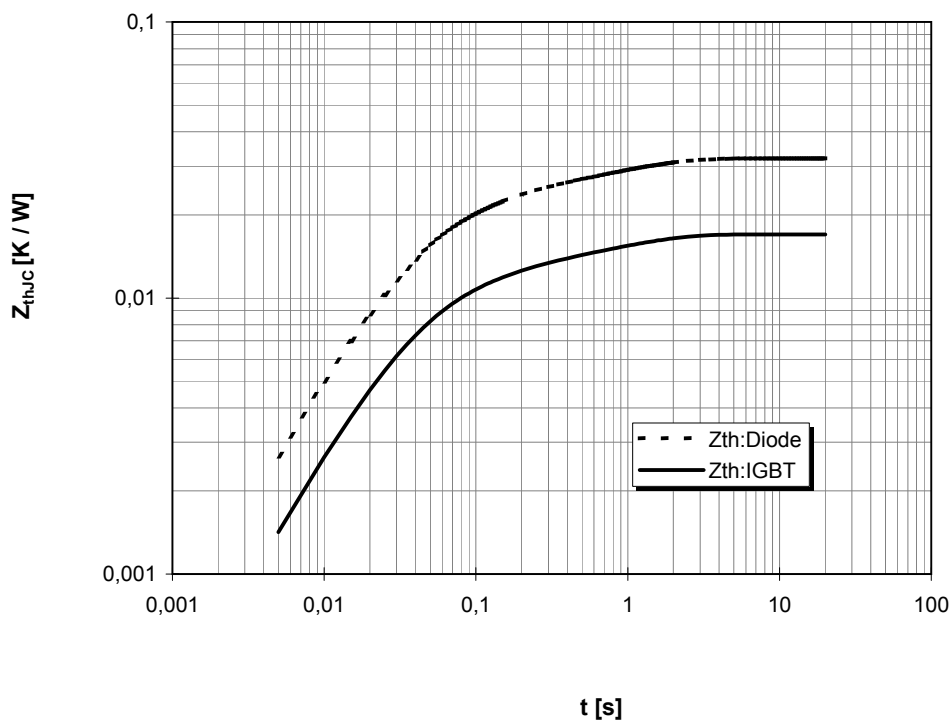
$P_{max} = 1200kW$  ;  $T_{vj} = 125^\circ C$





Transienter Wärmewiderstand  
Transient thermal impedance

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

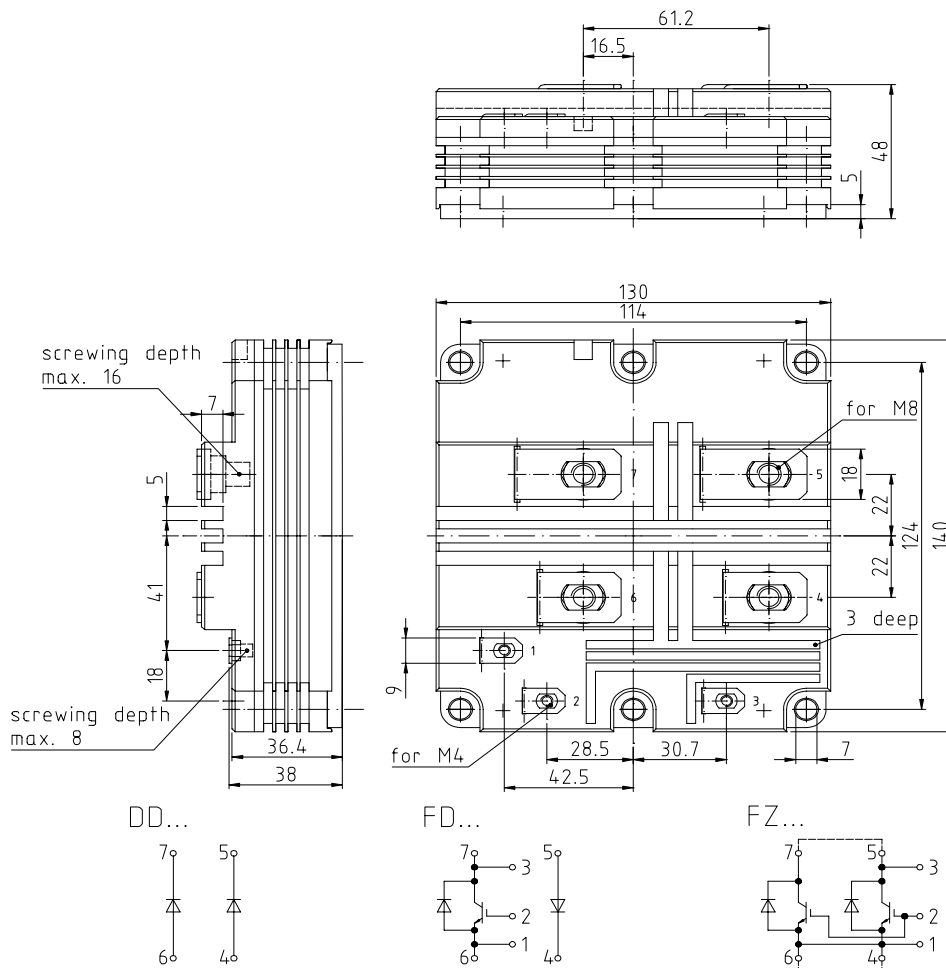


i		1	2	3	4
$r_i$ [K/kW]	: IGBT	7,65	4,25	1,02	4,08
$\tau_i$ [s]	: IGBT	0,030	0,10	0,30	1,0
$r_i$ [K/kW]	: Diode	14,40	8,00	1,92	7,68
$\tau_i$ [s]	: Diode	0,030	0,10	0,30	1,0





Äußere Abmessungen /  
external dimensions



scre  
max.

2

Anschlüsse / Terminals	1	Hilfsemitter / auxiliary emitter
	2	Gate / gate
	3	Hilfskolektor / auxiliary collector
	4,6	Emitter / emitter
	5,7	Kollektor / collector

## **Terms & Conditions of Usage**

### **Attention**

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