

Technische Information / Technical Information

IGBT-Module
IGBT-Modules

FD 400 R 33 KF2

eupec



Datenblatt data sheet

Höchstzulässige Werte / Maximum rated values

Elektrische Eigenschaften / Electrical properties

Kollektor-Emitter-Sperrspannung collector-emitter voltage	$T_j = 25^\circ\text{C}$ $T_j = -25^\circ\text{C}$	V_{CES}	3300 3300	V V
Kollektor-Dauergleichstrom DC-collector current	$T_C = 80^\circ\text{C}$ $T_C = 25^\circ\text{C}$	$I_{C,nom.}$ I_C	400 660	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	$T_C = 25^\circ\text{C}$, Transistor	P_{tot}	4,8	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 ² t - value, Diode	$V_R = 0\text{V}$, $t_p = 10\text{ms}$, $T_{vj} = 125^\circ\text{C}$	I^2t	55.600	A ² s
Spitzenverlustleistung der Diode maximum power dissipation diode	$T_j = 125^\circ\text{C}$	P_{RQM}	400	kW
Isolations-Prüfspannung insulation test voltage	RMS, $f = 50 \text{ Hz}$, $t = 1 \text{ min.}$	V_{ISOL}	6.000	V
Teilentladungs-Aussetzspannung partial discharge extinction voltage	RMS, $f = 50 \text{ Hz}$, $Q_{PD} \leq 10 \text{ pC}$ (acc. to IEC 1287)	V_{ISOL}	2.600	V

Charakteristische Werte / Characteristic values

Transistor / Transistor

			min.	typ.	max.	
Kollektor-Emitter Sättigungsspannung collector-emitter saturation voltage	$I_C = 400 \text{ A}$, $V_{GE} = 15\text{V}$, $T_{vj} = 25^\circ\text{C}$ $I_C = 400 \text{ A}$, $V_{GE} = 15\text{V}$, $T_{vj} = 125^\circ\text{C}$	$V_{CE \text{ sat}}$	- -	3,40 4,30	4,25 5,00	V V
Gate-Schwellenspannung gate threshold voltage	$I_C = 40 \text{ mA}$, $V_{CE} = V_{GE}$, $T_{vj} = 25^\circ\text{C}$	$V_{GE(th)}$	4,2	5,1	6,0	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}	-	50	-	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}	-	2,7	-	nF
Gateladung gate charge	$V_{GE} = -15\text{V} \dots +15\text{V}$, $V_{CE} = 1800\text{V}$	Q_G	-	8	-	μC
Kollektor-Emitter Reststrom collector-emitter cut-off current	$V_{CE} = 3300\text{V}$, $V_{GE} = 0\text{V}$, $T_{vj} = 25^\circ\text{C}$ $V_{CE} = 3300\text{V}$, $V_{GE} = 0\text{V}$, $T_{vj} = 125^\circ\text{C}$	I_{CES}	- -	0,05 20	4 50	mA 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)	$I_C = 400\text{ A}, V_{CC} = 1800\text{ V}$ $V_{GE} = \pm 15\text{ V}, R_G = 3,6\ \Omega, C_{GE} = 68\text{ nF}, T_{vj} = 25^\circ\text{C}$ $V_{GE} = \pm 15\text{ V}, R_G = 3,6\ \Omega, C_{GE} = 68\text{ nF}, T_{vj} = 125^\circ\text{C}$	$t_{d,on}$	-	370	-	ns
Anstiegszeit (induktive Last) rise time (inductive load)	$I_C = 400\text{ A}, V_{CC} = 1800\text{ V}$ $V_{GE} = \pm 15\text{ V}, R_G = 3,6\ \Omega, C_{GE} = 68\text{ nF}, T_{vj} = 25^\circ\text{C}$ $V_{GE} = \pm 15\text{ V}, R_G = 3,6\ \Omega, C_{GE} = 68\text{ nF}, T_{vj} = 125^\circ\text{C}$	t_r	-	250	-	ns
Abschaltverzögerungszeit (ind. Last) turn off delay time (inductive load)	$I_C = 400\text{ A}, V_{CC} = 1800\text{ V}$ $V_{GE} = \pm 15\text{ V}, R_G = 3,6\ \Omega, C_{GE} = 68\text{ nF}, T_{vj} = 25^\circ\text{C}$ $V_{GE} = \pm 15\text{ V}, R_G = 3,6\ \Omega, C_{GE} = 68\text{ nF}, T_{vj} = 125^\circ\text{C}$	$t_{d,off}$	-	1550	-	ns
Fallzeit (induktive Last) fall time (inductive load)	$I_C = 400\text{ A}, V_{CC} = 1800\text{ V}$ $V_{GE} = \pm 15\text{ V}, R_G = 3,6\ \Omega, C_{GE} = 68\text{ nF}, T_{vj} = 25^\circ\text{C}$ $V_{GE} = \pm 15\text{ V}, R_G = 3,6\ \Omega, C_{GE} = 68\text{ nF}, T_{vj} = 125^\circ\text{C}$	t_f	-	200	-	ns
Einschaltverlustenergie pro Puls turn-on energy loss per pulse	$I_C = 400\text{ A}, V_{CC} = 1800\text{ V}, V_{GE} = 15\text{ V}$ $R_G = 3,6\ \Omega, C_{GE} = 68\text{ nF}, T_{vj} = 125^\circ\text{C}, L_S = 60\text{ nH}$	E_{on}	-	960	-	mWs
Abschaltverlustenergie pro Puls turn-off energy loss per pulse	$I_C = 400\text{ A}, V_{CC} = 1800\text{ V}, V_{GE} = 15\text{ V}$ $R_G = 3,6\ \Omega, C_{GE} = 68\text{ nF}, T_{vj} = 125^\circ\text{C}, L_S = 60\text{ nH}$	E_{off}	-	510	-	mWs
Kurzschlußverhalten SC Data	$t_p \leq 10\ \mu\text{sec}, V_{GE} \leq 15\text{ V}$ $T_{vj} \leq 125^\circ\text{C}, V_{CC} = 2500\text{ V}, V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$	I_{SC}	-	2000	-	A
Modulinduktivität stray inductance module	IGBT (Zweig / arm 1) Diode (Zweig / arm 2)	L_{sCE}	-	25	-	nH
Modul-Leitungswiderstand, Anschlüsse - Chip lead resistance, terminals - chip	$T = 25^\circ\text{C}, \text{IGBT (Zweig / arm 1)}$ $T = 25^\circ\text{C}, \text{Diode (Zweig / arm 2)}$	$R_{CC'+EE'}$	-	0,37 0,39	-	mΩ mΩ

Charakteristische Werte / Characteristic values

Diode / Diode

			min.	typ.	max.	
Durchlaßspannung forward voltage	$I_F = 400\text{ A}, V_{GE} = 0\text{ V}, T_{vj} = 25^\circ\text{C}$ $I_F = 400\text{ A}, V_{GE} = 0\text{ V}, T_{vj} = 125^\circ\text{C}$	V_F	-	2,80	3,50	V
Sperrstrom reverse current	$V_{CE} = 3300\text{ V}, T_{vj} = 25^\circ\text{C}, \text{Zweig / arm 2}$ $V_{CE} = 3300\text{ V}, T_{vj} = 125^\circ\text{C}, \text{Zweig / arm 2}$	I_R	-	0,005	0,8	mA
Rückstromspitze peak reverse recovery current	$I_F = 400\text{ A}, -di_F/dt = 1200\text{ A}/\mu\text{sec}$ $V_R = 1800\text{ V}, V_{GE} = -10\text{ V}, T_{vj} = 25^\circ\text{C}$ $V_R = 1800\text{ V}, V_{GE} = -10\text{ V}, T_{vj} = 125^\circ\text{C}$	I_{RM}	-	330	-	A
Sperrverzögerungsladung recovered charge	$I_F = 400\text{ A}, -di_F/dt = 1200\text{ A}/\mu\text{sec}$ $V_R = 1800\text{ V}, V_{GE} = -10\text{ V}, T_{vj} = 25^\circ\text{C}$ $V_R = 1800\text{ V}, V_{GE} = -10\text{ V}, T_{vj} = 125^\circ\text{C}$	Q_r	-	235	-	μAs
Abschaltenergie pro Puls reverse recovery energy	$I_F = 400\text{ A}, -di_F/dt = 1200\text{ A}/\mu\text{sec}$ $V_R = 1800\text{ V}, V_{GE} = -10\text{ V}, T_{vj} = 25^\circ\text{C}$ $V_R = 1800\text{ V}, V_{GE} = -10\text{ V}, T_{vj} = 125^\circ\text{C}$	E_{rec}	-	245	-	mWs

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Thermische Eigenschaften / Thermal properties

			min.	typ.	max.	
Innerer Wärmewiderstand thermal resistance, junction to case	Transistor / transistor, DC	R_{thJC}	-	-	0,026	K/W
	Diode/Diode, DC, Zweig / arm 1		-	-	0,051	K/W
	Diode/Diode, DC, Zweig / arm 2		-	-	0,051	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}	-	0,006	-	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				
Material Modulgrundplatte material of module baseplate			AlSiC	
Innere Isolation internal insulation			AlN	
Kriechstrecke creepage distance			32,2	mm
Luftstrecke clearance			19,1	mm
CTI comperative tracking index			> 400	
Anzugsdrehmoment f. mech. Befestigung mounting torque		M1	5	Nm
Anzugsdrehmoment f. elektr. Anschlüsse terminal connection torque	terminals M4	M2	2	Nm
	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.

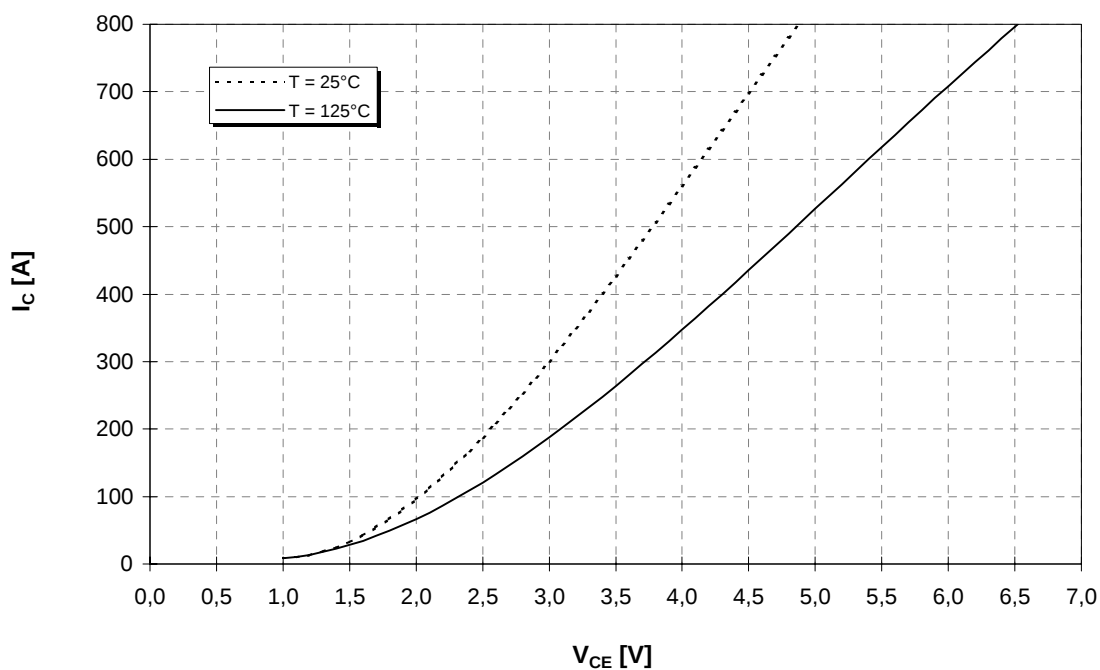
This technical information specifies semiconductor devices but promises no characteristics. It is
valid in combination with the belonging technical notes.



Ausgangskennlinie (typisch)
Output characteristic (typical)

$$I_C = f(V_{CE})$$

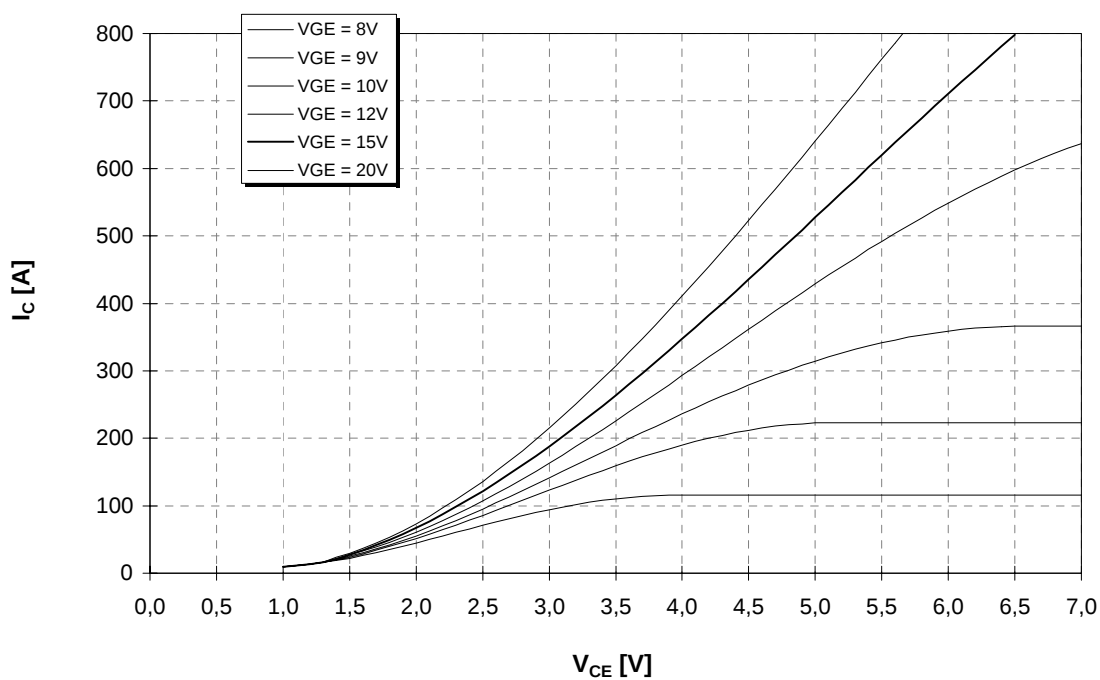
$V_{GE} = 15V$



Ausgangskennlinienfeld (typisch)
Output characteristic (typical)

$$I_C = f(V_{CE})$$

$T_{vj} = 125^\circ C$

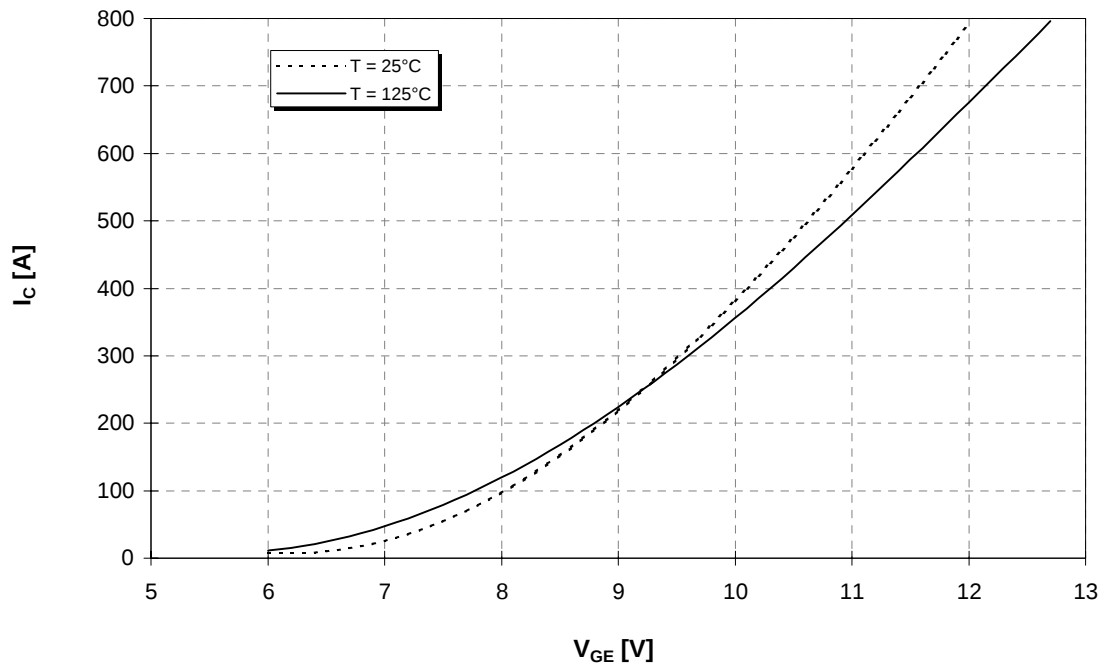




Übertragungscharakteristik (typisch)
Transfer characteristic (typical)

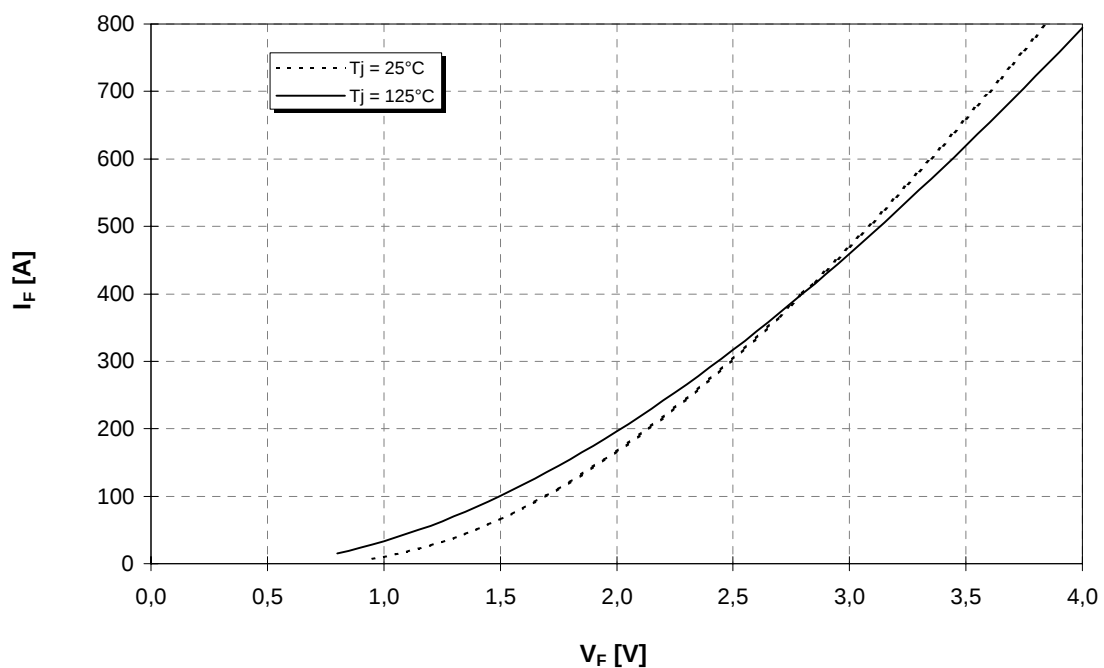
$$I_C = f(V_{GE})$$

$V_{CE} = 20V$



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

$$I_F = f(V_F)$$

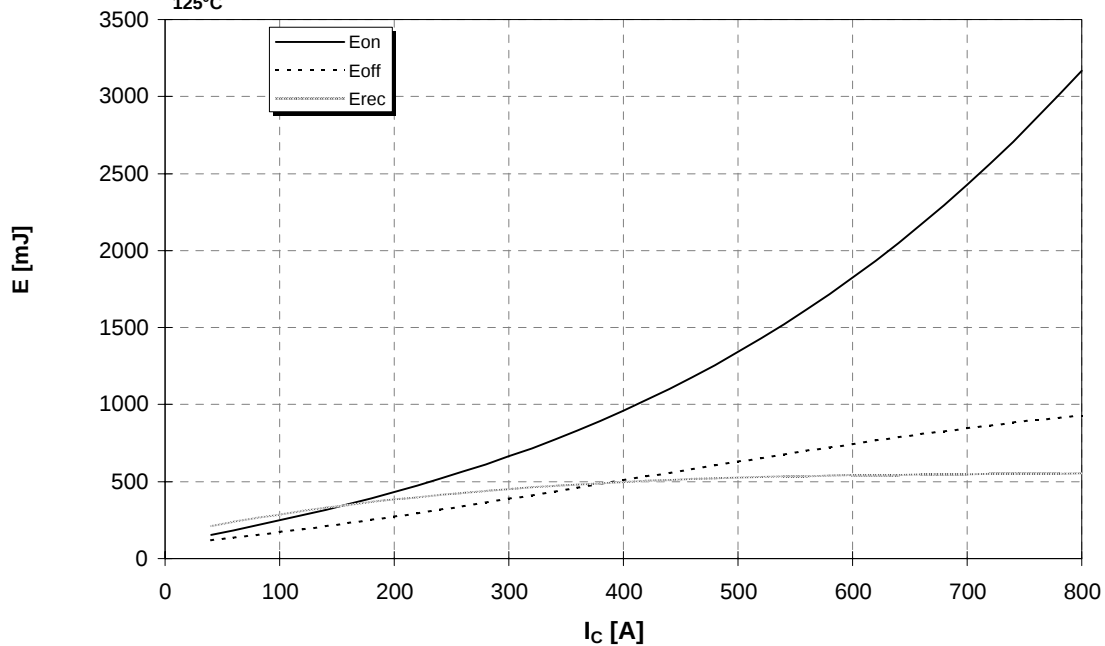



Schaltverluste (typisch)
Switching losses (typical)

125°C

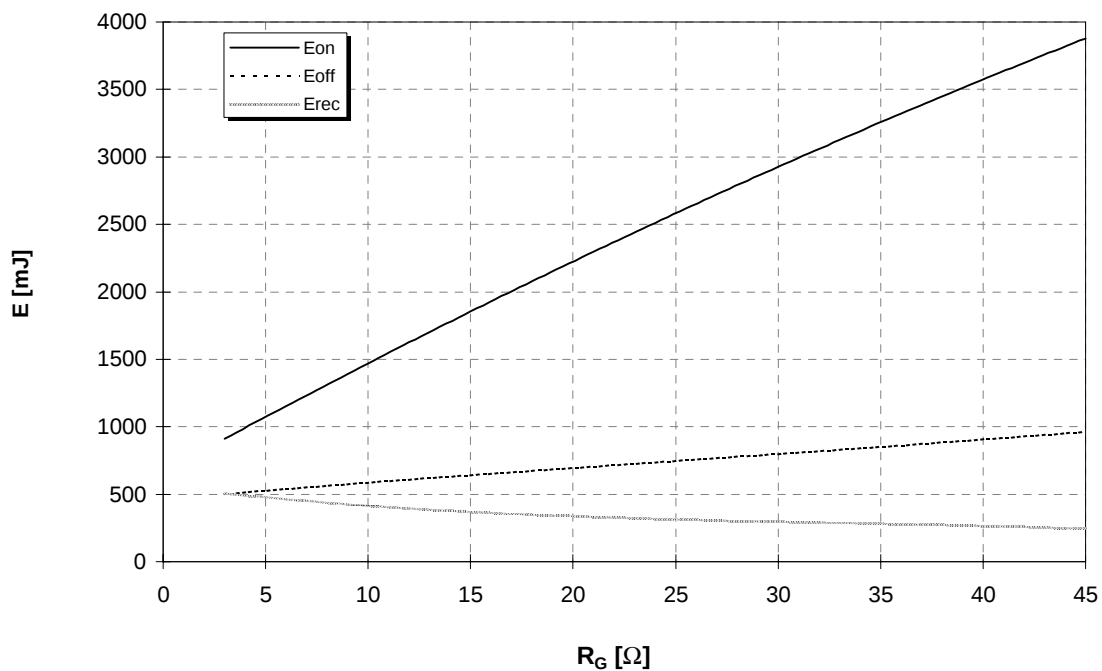
$$E_{on} = f(I_C), E_{off} = f(I_C), E_{rec} = f(I_C)$$

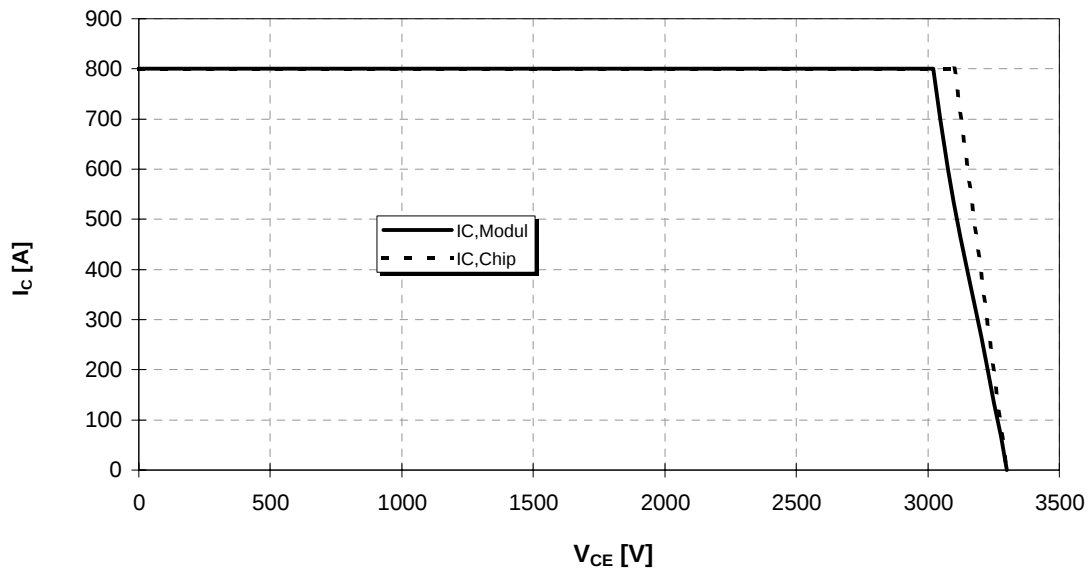
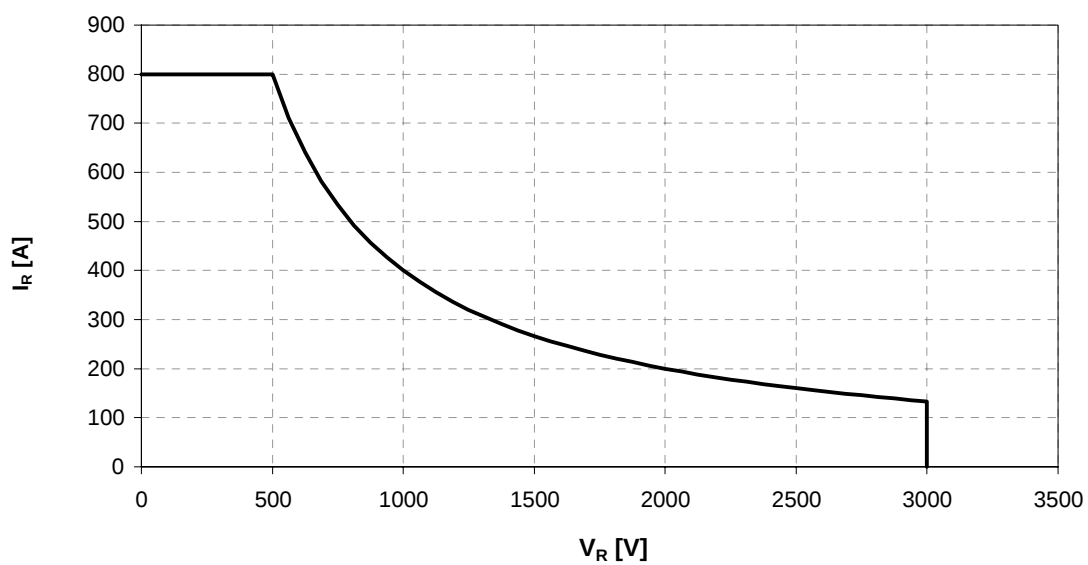
$$R_{G,on} = 3,6 \, \Omega, R_{G,off} = 3,6 \, \Omega, C_{GE} = 68 \, \text{nF}, V_{CE} = 1800 \, \text{V}, T_j =$$


Schaltverluste (typisch)
Switching losses (typical)

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

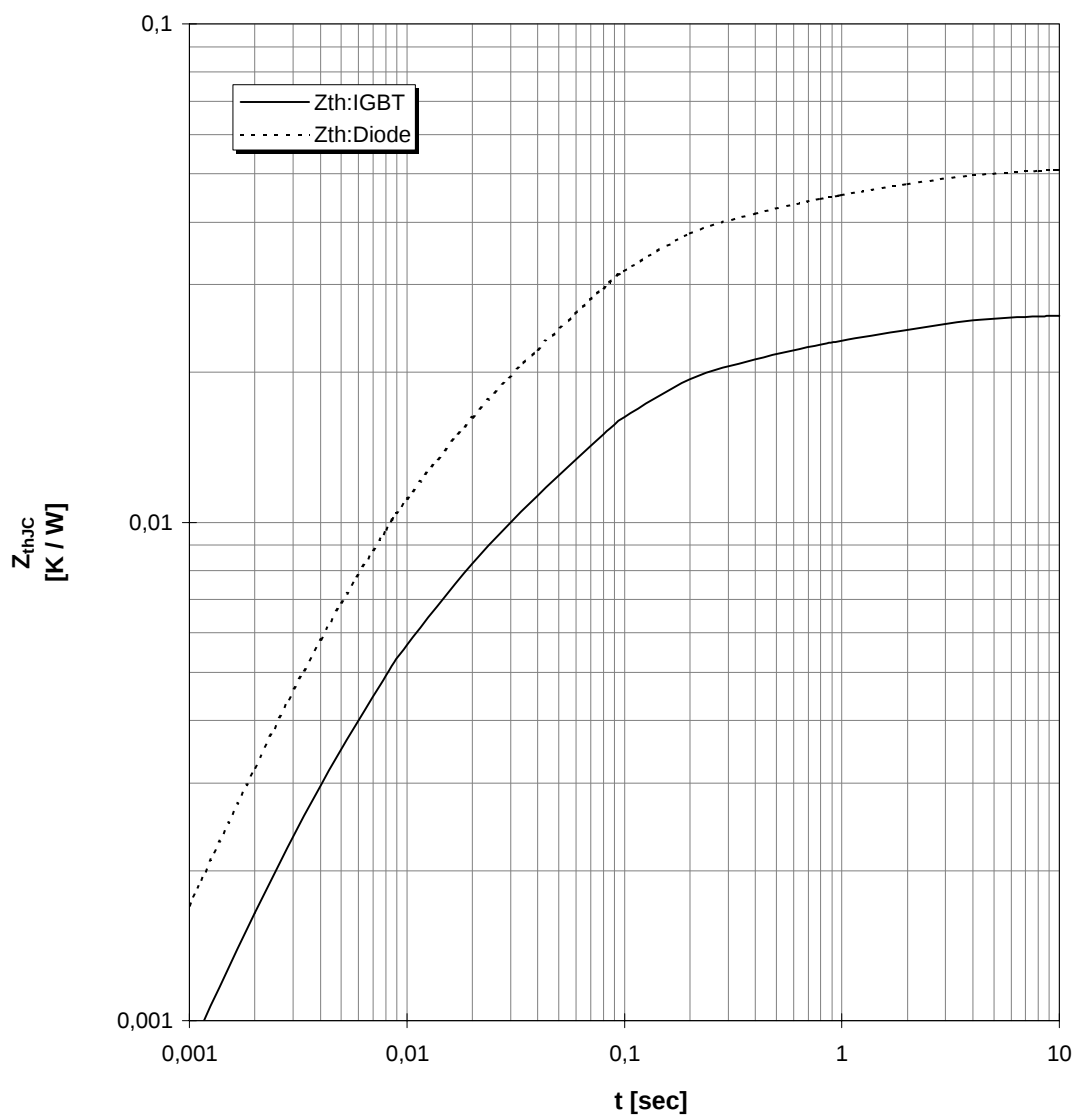
$$I_C = 400 \, \text{A}, C_{GE} = 68 \, \text{nF}, V_{CE} = 1800 \, \text{V}, T_j = 125^\circ\text{C}$$




Sicherer Arbeitsbereich IGBT (RBSOA)
Reverse bias safe operation area IGBT (RBSOA)
 $R_{G,off} = 3,6 \, \Omega$, $C_{GE} = 68 \, nF$
 $T_{vj} = 125^\circ C$

Sicherer Arbeitsbereich Diode (SOA)
safe operation area Diode (SOA)
 $T_{vj} = 125^\circ C$



Transienter Wärmewiderstand
Transient thermal impedance

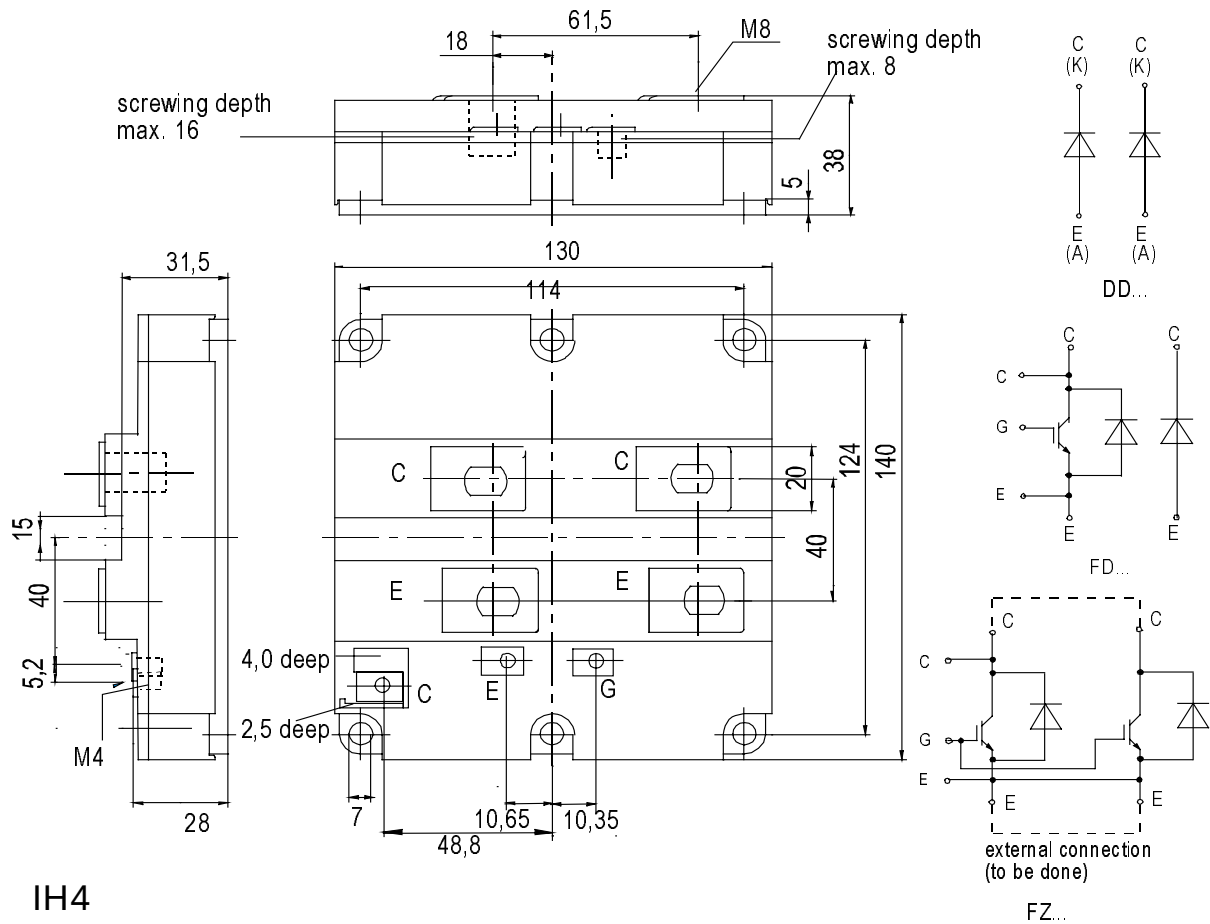
$$Z_{thJC} = f(t)$$



i	1	2	3	4
r_i [K/kW] : IGBT	4,76	12,98	3,86	4,40
τ_i [sec] : IGBT	0,0068	0,0642	0,3209	2,0212
r_i [K/kW] : Diode	9,34	25,47	7,57	8,63
τ_i [sec] : Diode	0,0068	0,0642	0,3209	2,0212



Gehäusemaße / Schaltbild
Package outline / Circuit diagram



IH4