

## Technische Information / technical information



Infineon Technologies Bipolar  
GmbH & Co. KG

**Druckkontaktierter IGBT  
Press Pack IGBT**

# P2000DL45X168

### Key Parameters

#### IGBT

$V_{CES}$  4500 V

$I_{NOM}$  2000 A

$I_{CRM}$  4000 A

#### Diode

$V_{RRM}$  4500V

$I_F$  2000A

$I_{FRM}$  4000A



### Merkmale

- Druckkontaktierter IGBT mit integrierter Freilaufdiode
- Stabiler Kurzschluss im Fehlerfall
- Hohe dynamische Robustheit
- Hohe Kurzschlussrobustheit
- Niedriges VCEsat
- Trench IGBT 3

### Features

- Press Pack IGBT with integrated Freewheeling Diode
- Long term Short on Fail behavior
- High dynamic robustness
- High short-circuit capability
- Low VCEsat
- Trench IGBT 3

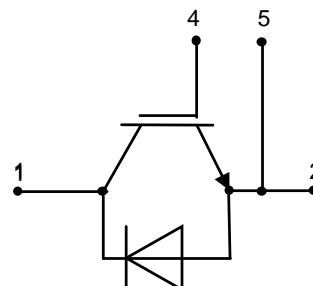
### Typische Anwendungen

- Hochleistungsumrichter
- Mittelspannungsantriebe
- Modulare Multi- Level Umrichter MMC für HGÜ und Kompensationsanlagen
- DC Leistungsschalter

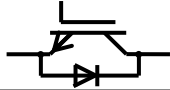
### Typical Applications

- High power converters
- Medium voltage converters
- Modular Multi Level Inverter MMC for HVDC and FACTS
- DC Breakers

content of customer DMX code	DMX code digit	DMX code digit quantity
serial number	1..7	7
SP material number	8..16	9
datecode (production day)	17..18	2
datecode (production year)	19..20	2
datecode (production month)	21..22	2
vT class (optional)	23..26	4
QR class (optional)	27..30	4



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### Elektrische Eigenschaften / electrical properties

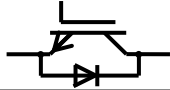
#### IGBT, Wechselrichter / IGBT, Inverter Höchstzulässige Werte / maximum rated values

Kollektor-Emitter-Sperrspannung Collector-emitter voltage		$V_{CES}$	4500	V
Kollektor-Dauergleichstrom Continuous DC collector current	$T_C = 105^\circ\text{C}, T_{vj\max} = 150^\circ\text{C}$	$I_{C\text{ nom}}$	2000	A
Periodischer Kollektor-Spitzenstrom Repetitive peak collector current	$t_P = 1\text{ ms}$	$I_{CRM}$	4000	A
Gate-Emitter-Spitzenspannung Gate-emitter peak voltage		$V_{GES}$	+/- 20	V

#### Charakteristische Werte / characteristic values

			min.	typ.	max.	
Kollektor-Emitter-Sättigungsspannung Collector-emitter saturation voltage	$I_C = 2000\text{ A}, V_{GE} = 15\text{ V};$	$T_{vj} = 25^\circ\text{C}$	$V_{CE\text{ sat}}$	2,25	2,50	V
	$I_C = 2000\text{ A}, V_{GE} = 15\text{ V};$	$T_{vj} = 125^\circ\text{C}$	$V_{CE\text{ sat}}$	2,57	2,90	V
	$I_C = 2000\text{ A}, V_{GE} = 15\text{ V};$	$T_{vj} = 150^\circ\text{C}$	$V_{CE\text{ sat}}$	2,70	3,05	V
Gate-Schwellenspannung Gate threshold voltage	$I_C = 105\text{ mA}, V_{CE} = V_{GE}, T_{vj} = 25^\circ\text{C}$		$V_{GE\text{ th}}$	6,6		V
Gateladung Gate charge	$V_{GE} = -15 / 15\text{ V}$		$Q_G$	40		$\mu\text{C}$
Interner Gatewiderstand Internal gate resistor	$T_{vj} = 25^\circ\text{C}, V_D = 12\text{ V}$		$r_G$	0,09	0,1	Ohm
Eingangskapazität Input capacitance	$f = 1\text{ MHz}, T_{vj} = 25^\circ\text{C}, V_{CE} = 25\text{ V},$ $V_{GE} = 0\text{ V}$		$C_{ies}$	420		nF
Rückwirkungskapazität Reverse transfer capacitance	$f = 1\text{ MHz}, T_{vj} = 25^\circ\text{C}, V_{CE} = 25\text{ V},$ $V_{GE} = 0\text{ V}$		$C_{ires}$	7,2		nF
Kollektor-Emitter-Reststrom Collector-emitter cut-off current	$V_{CE} = 4500\text{ V}, V_{GE} = 0\text{ V}, T_{vj} = 25^\circ\text{C}$		$I_{CES}$	150	200	$\mu\text{A}$
Gate-Emitter-Reststrom Gate-emitter leakage current	$V_{CE} = 0\text{ V}, V_{GE} = 20\text{ V}, T_{vj} = 25^\circ\text{C}$		$I_{GES}$	0,23	0,8	$\mu\text{A}$
Einschaltverzögerungszeit, induktive Last Turn-on delay time, inductive load	$I_C = 2000\text{ A}, V_{CE} = 2800\text{ V}$ $V_{GE} = -15 / 15\text{ V}$ $R_{Gon} = 1,2\ \Omega$	$T_{vj} = 25^\circ\text{C}$	$t_{d\text{ on}}$	0,32		$\mu\text{s}$
		$T_{vj} = 125^\circ\text{C}$		0,33		$\mu\text{s}$
		$T_{vj} = 150^\circ\text{C}$		0,33		$\mu\text{s}$
Anstiegszeit, induktive Last Rise time, inductive load	$I_C = 2000\text{ A}, V_{CE} = 2800\text{ V}$ $V_{GE} = -15 / 15\text{ V}$ $R_{Gon} = 1,2\ \Omega$	$T_{vj} = 25^\circ\text{C}$	$t_r$	0,26		$\mu\text{s}$
		$T_{vj} = 125^\circ\text{C}$		0,28		$\mu\text{s}$
		$T_{vj} = 150^\circ\text{C}$		0,28		$\mu\text{s}$
Abschaltverzögerungszeit, induktive Last Turn-off delay time, inductive load	$I_C = 2000\text{ A}, V_{CE} = 2800\text{ V}$ $V_{GE} = -15 / 15\text{ V}$ $R_{Goff} = 4,8\ \Omega$	$T_{vj} = 25^\circ\text{C}$	$t_{d\text{ off}}$	6,9		$\mu\text{s}$
		$T_{vj} = 125^\circ\text{C}$		7,6		$\mu\text{s}$
		$T_{vj} = 150^\circ\text{C}$		7,7		$\mu\text{s}$
Fallzeit, induktive Last Fall time, inductive load	$I_C = 2000\text{ A}, V_{CE} = 2800\text{ V}$ $V_{GE} = -15 / 15\text{ V}$ $R_{Goff} = 4,8\ \Omega$	$T_{vj} = 25^\circ\text{C}$	$t_f$	2,2		$\mu\text{s}$
		$T_{vj} = 125^\circ\text{C}$		4,2		$\mu\text{s}$
		$T_{vj} = 150^\circ\text{C}$		4,5		$\mu\text{s}$

prepared by:	CD	date of publication:	2021.09.21
approved by:	JP	revision:	3.0



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### Charakteristische Werte / characteristic values

min. typ. max.

Einschaltverlustenergie pro Puls Turn-on energy loss per pulse	$I_C = 2000\text{ A}$ , $V_{CE} = 2800\text{ V}$ , $L_\sigma = 150\text{ nH}$ $V_{GE} = -15 / 15\text{ V}$ , $R_{Gon} = 1,2\ \Omega$	$T_{vj}=25^\circ\text{C}$ $T_{vj}=125^\circ\text{C}$ $T_{vj}=150^\circ\text{C}$	$E_{on}$		8,0 8,8 9,5		J J J
Abschaltverlustenergie pro Puls Turn-off energy loss per pulse	$I_C = 2000\text{ A}$ , $V_{CE} = 2800\text{ V}$ , $L_\sigma = 150\text{ nH}$ $dv/dt = 1100\text{ V}/\mu\text{s}$ $V_{GE} = -15 / 15\text{ V}$ , $R_{Goff} = 4,8\ \Omega$	$T_{vj}=25^\circ\text{C}$ $T_{vj}=125^\circ\text{C}$ $T_{vj}=150^\circ\text{C}$	$E_{off}$		11,3 15,2 16,5		J J J
Kurzschlußverhalten SC data	$V_{GE} \leq 15\text{ V}$ , $V_{CC} = 2800\text{ V}$ , $tpsc \leq 10\ \mu\text{s}$ $V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$ $T_{vj} = 125^\circ\text{C}$		$I_{sc}$		10,5		kA

### Diode, Wechselrichter / Diode, Inverter

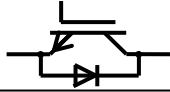
Höchstzulässige Werte / maximum rated values

Periodisch Spitzensperrspannung Repetitive peak reverse voltage		$V_{RRM}$	4500	V
Dauergleichstrom Continuous DC forward current	$T_C = 95^\circ\text{C}$ , $T_{vj\text{ max}} = 150^\circ\text{C}$	$I_F$	2000	A
Periodischer Spitzenstrom Repetitive peak forward current	$t_p = 1\text{ ms}$	$I_{FRM}$	4000	A
Stoßstrom Surge current	$V_R = 0\text{ V}$ , $t_p = 10\text{ ms}$ , $T_{vj} = 125^\circ\text{C}$	$I_{FSM}$	17000	A
Grenzlastintegral $I^2t$ - value	$V_R = 0\text{ V}$ , $t_p = 10\text{ ms}$ , $T_{vj} = 125^\circ\text{C}$	$I^2t$	1445	$\text{kA}^2\text{s}$

### Charakteristische Werte / characteristic values

min. typ. max.

Durchlassspannung Forward voltage	$I_F = 2000\text{ A}$ $I_F = 2000\text{ A}$ $I_F = 2000\text{ A}$	$T_{vj}=25^\circ\text{C}$ $T_{vj}=125^\circ\text{C}$ $T_{vj}=150^\circ\text{C}$	$V_F$		2,80 2,73 2,70		V V V
Rückstromspitze Peak reverse recovery current	$I_F = 2000\text{ A}$ , $V_R = 2800\text{ V}$ , $R_{gon} = 1,2\ \Omega$ , $V_{GE} = +15\text{ V}$ ; $L_S = 150\text{ nH}$	$T_{vj}=25^\circ\text{C}$ $T_{vj}=125^\circ\text{C}$ $T_{vj}=150^\circ\text{C}$	$I_{RM}$		1900 2460 2580		A A A
Sperrverzögerungsladung Recovered charge	$I_F = 2000\text{ A}$ , $V_R = 2800\text{ V}$ , $R_{gon} = 1,2\ \Omega$ , $V_{GE} = +15\text{ V}$ ; $L_S = 150\text{ nH}$	$T_{vj}=25^\circ\text{C}$ $T_{vj}=125^\circ\text{C}$ $T_{vj}=150^\circ\text{C}$	$Q_{rr}$		1500 3350 3900		$\mu\text{As}$ $\mu\text{As}$ $\mu\text{As}$
Abschaltenergie Reverse recovery energy	$I_F = 2000\text{ A}$ , $V_R = 2800\text{ V}$ , $R_{gon} = 1,2\ \Omega$ , $V_{GE} = +15\text{ V}$ ; $L_S = 150\text{ nH}$	$T_{vj}=25^\circ\text{C}$ $T_{vj}=125^\circ\text{C}$ $T_{vj}=150^\circ\text{C}$	$E_{rec}$		2,2 5,7 6,8		J J J



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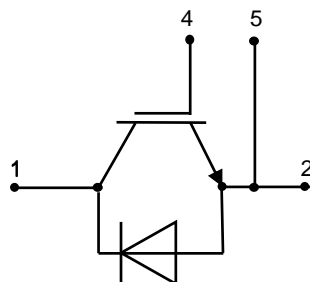
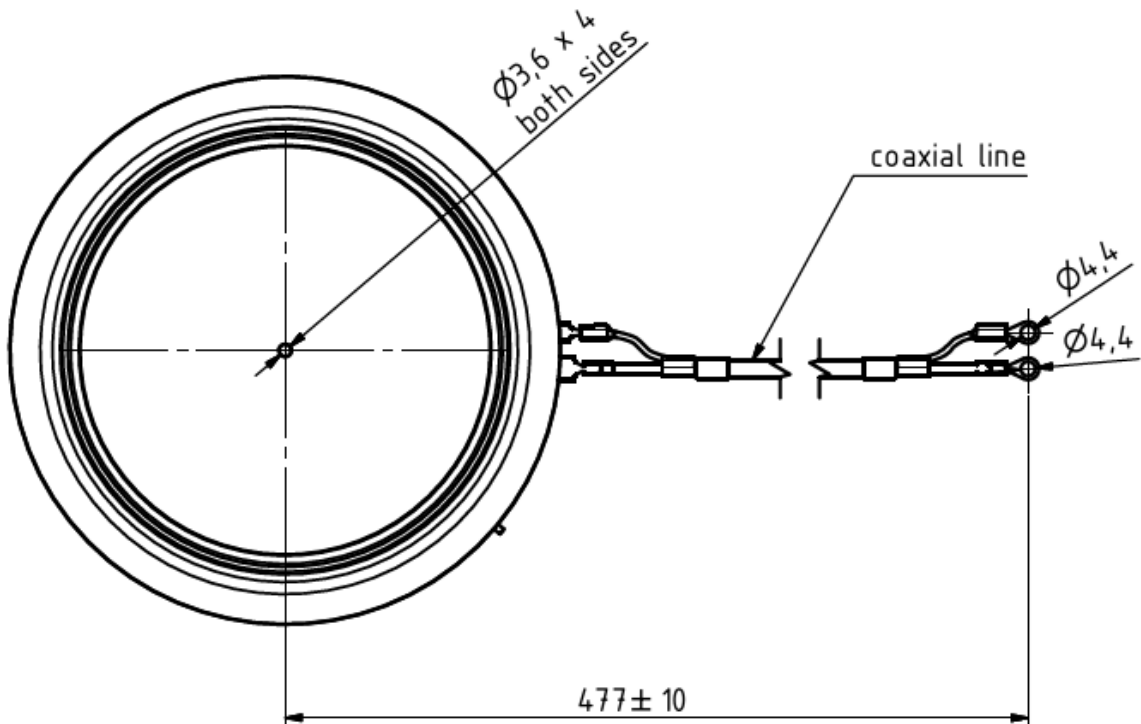
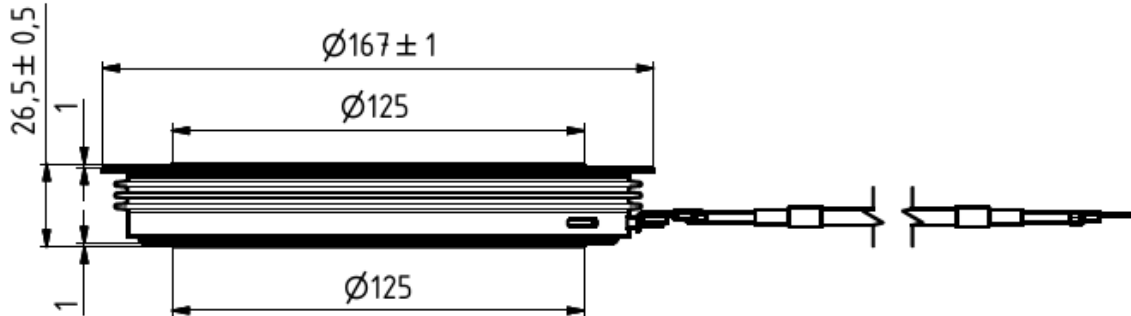
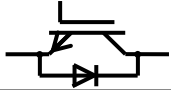
# P2000DL45X168

### Thermische Eigenschaften / thermal properties

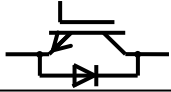
IGBT, Innerer Wärmewiderstand IGBT, thermal resistance, junction to case	<u>Kühlfläche / cooling surface</u> beidseitig / two-sided, DC	$R_{thJC\ IGBT}$	max. 6,6	K/kW
Diode, Innerer Wärmewiderstand Diode, thermal resistance, junction to case	<u>Kühlfläche / cooling surface</u> beidseitig / two-sided, DC	$R_{thJC\ Diode}$	max. 13,2	K/kW
Übergangs-Wärmewiderstand thermal resistance, case to heatsink	<u>Kühlfläche / cooling surface</u> beidseitig / two-sided	$R_{thCH\ IGBT}$ $R_{thCH\ Diode}$	typ. 1,5 typ. 3,0	K/kW K/kW
Kollektor- Emitter- Gleichspannung DC- stability	$T_{vj}=25^{\circ}C, 100\ fit$	$V_{CE\ D}$	2800	V
Höchstzulässige Sperrschichttemperatur maximum junction temperature		$T_{vj\ max}$	150	$^{\circ}C$
Betriebstemperatur operating temperature		$T_{vj\ op}$	-40...+150	$^{\circ}C$
Lagertemperatur storage temperature	)* Gate cable limitation max. 80 $^{\circ}C$	$T_{stg}$	-40...+150 )*	$^{\circ}C$

### Mechanische Eigenschaften / mechanical properties

Gehäuse, siehe Anlage case, see annex			Seite 5 page 5	
Anpresskraft clamping force		F	50...80	kN
Steueranschlüsse control terminals	DIN 46244	Gate Emitter	A 4,8x0,8 A 6,3x0,8	
Gewicht weight		G	typ. 3000	g
Kriechstrecke creepage distance			35	mm
Luftstrecke Clearance distance			12	mm
Ebenheit der Kontaktflächen Flatness of contact areas	ISO 1101		30	$\mu m$
Schwingfestigkeit vibration resistance	f = 50 Hz		50	m/s <sup>2</sup>



- 1: Kollektor/colector
- 2: Emitter/emitter
- 4: Gate
- 5: Hilfsemmitter/  
emitter (control terminal)

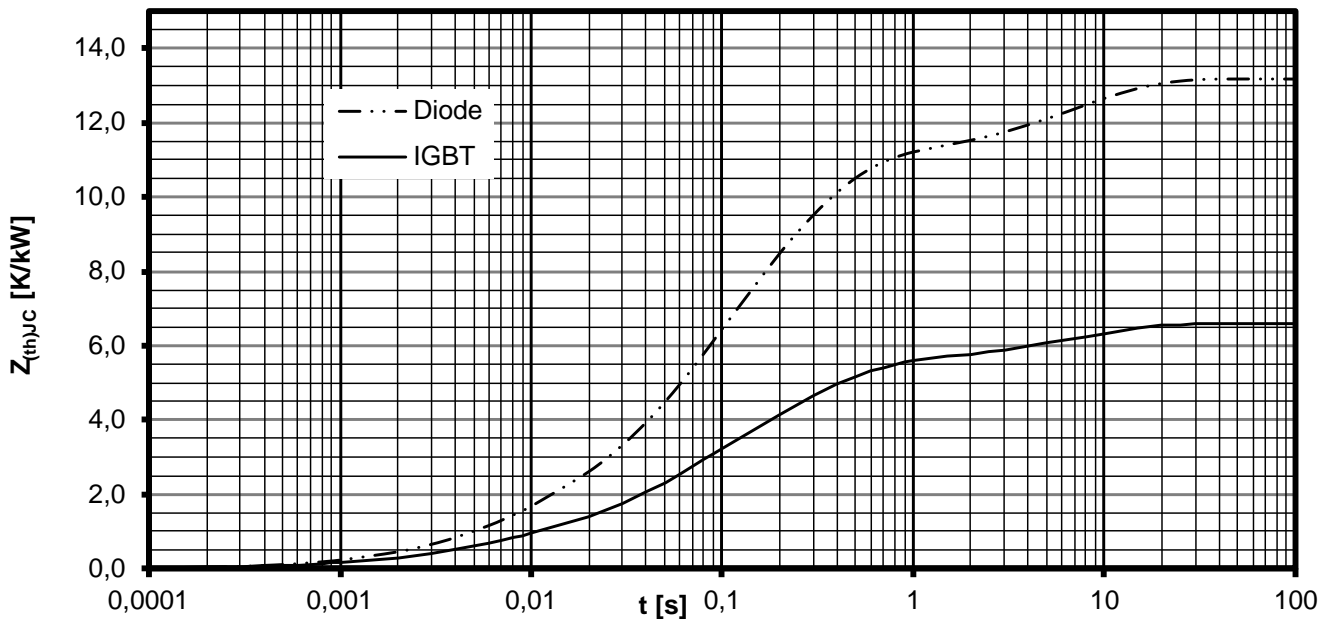


Analytische Elemente des transienten Wärmewiderstandes  $Z_{thJC}$  /  
analytical elements of transient thermal impedance  $Z_{thJC}$

Pos. n		1	2	3	4	5	6	7
IGBT beidseitig two-sided	$R_{thn}$ [K/kW]	1,1	3	2	0,5			
	$\tau_n$ [s]	7	0,2	0,06	0,005			
Diode beidseitig two-sided	$R_{thn}$ [K/kW]	2,2	6	4	1			
	$\tau_n$ [s]	7	0,22	0,06	0,006			

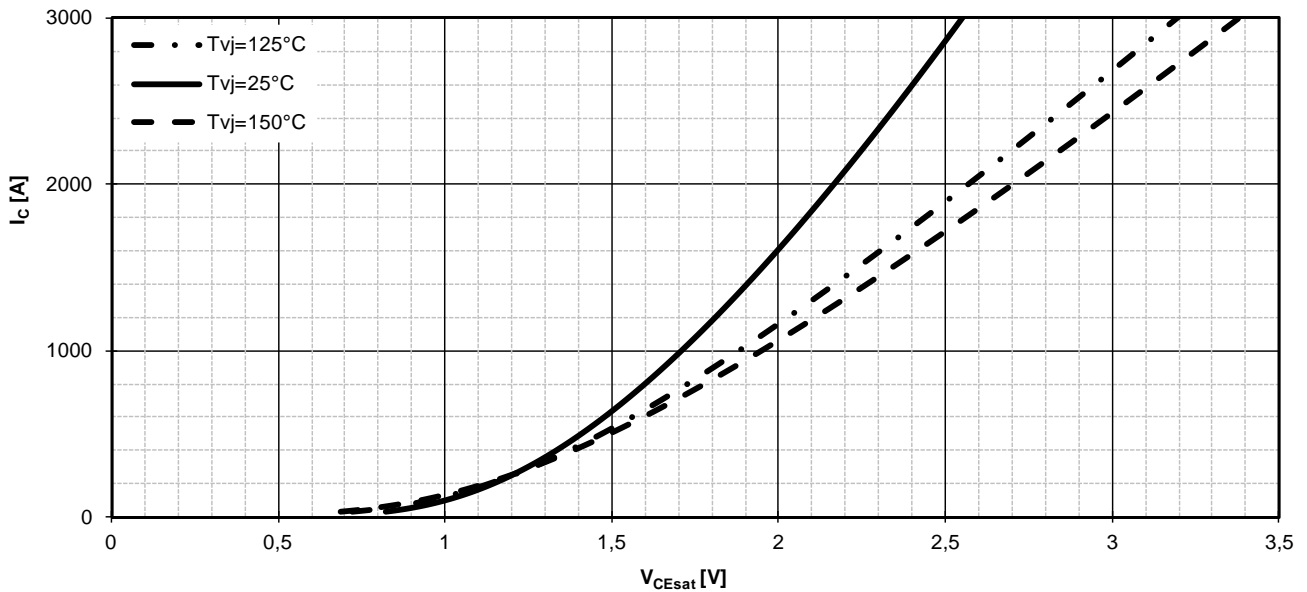
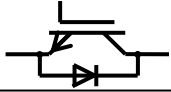
Analytische Funktion / analytical function:

$$Z_{thJC} = \sum_{n=1}^{n_{max}} R_{thn} \left( 1 - e^{-\frac{t}{\tau_n}} \right)$$



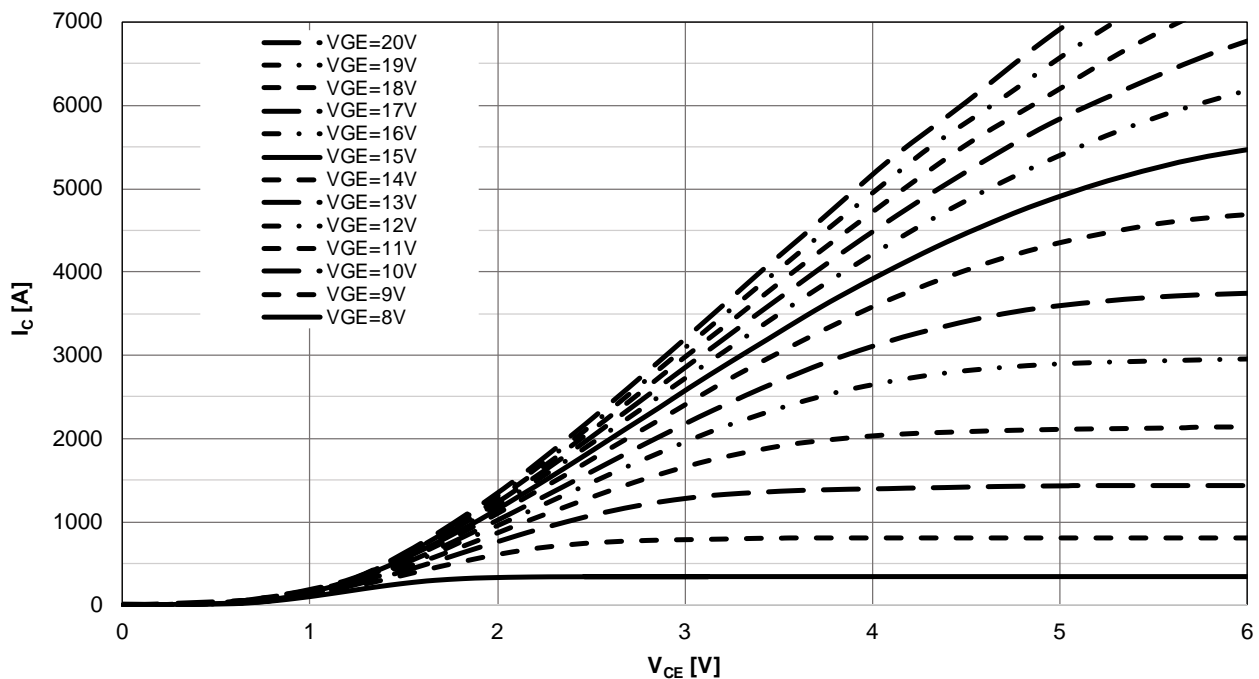
Transienter innerer Wärmewiderstand für DC  
transient thermal impedance  $Z_{thJC} = f(t)$  for DC

Beidseitige Kühlung / two-sided cooling



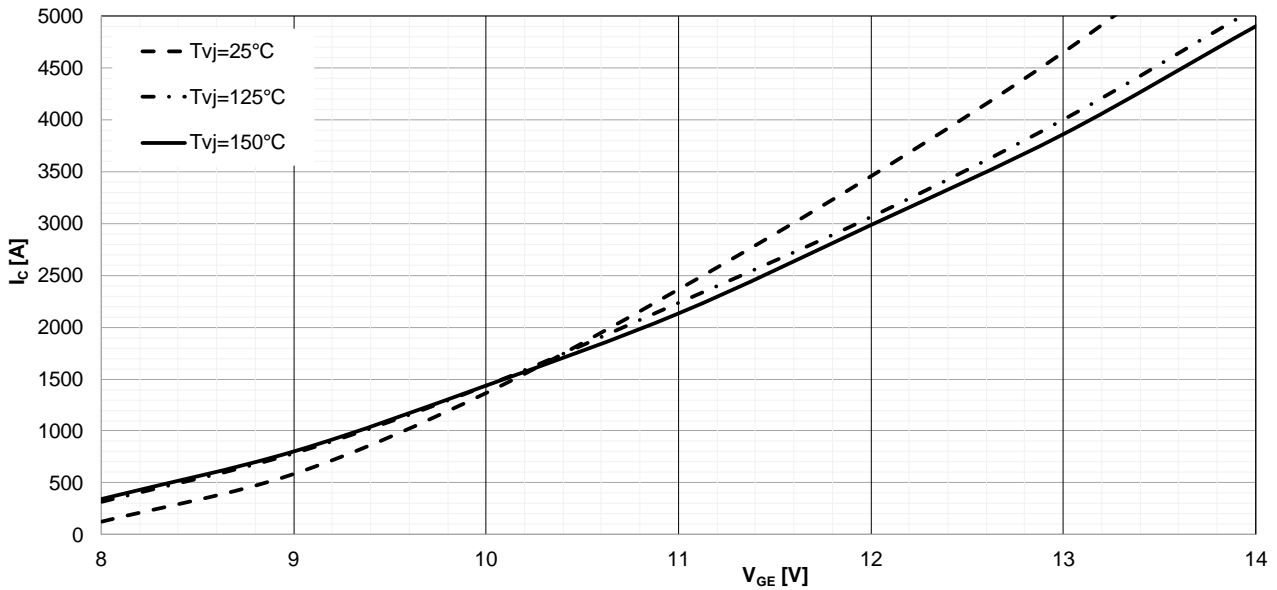
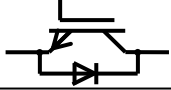
Ausgangskennlinie IGBT, Wechselrichter (typisch)  
output characteristic IGBT, Inverter (typical)

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



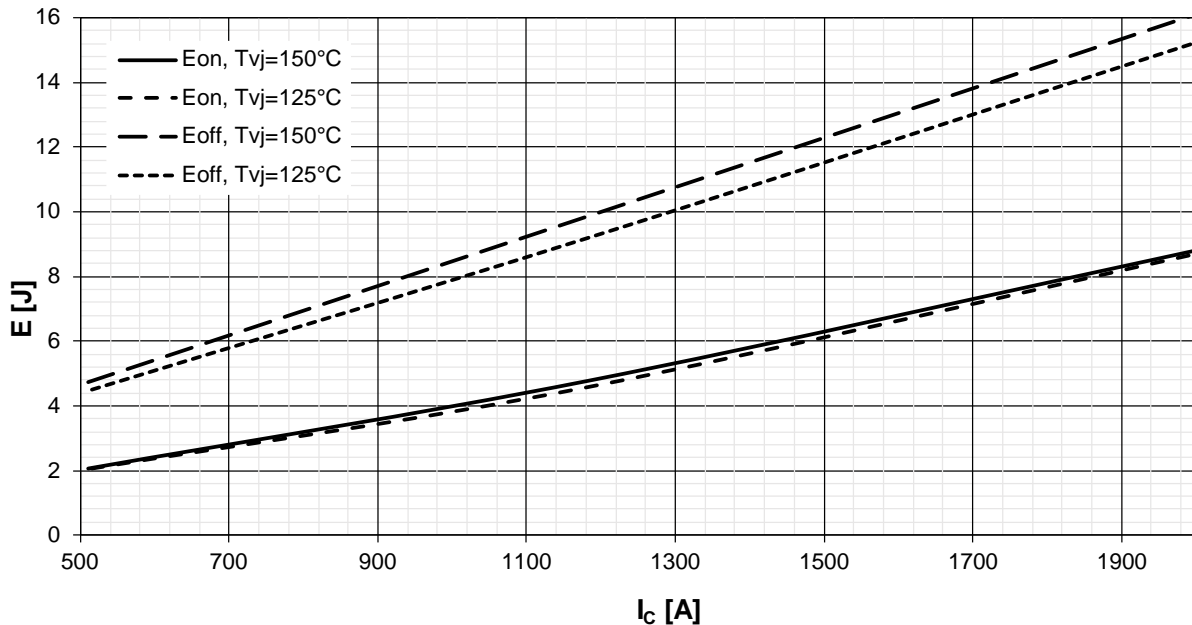
Ausgangskennlinie IGBT, Wechselrichter (typisch)  
output characteristic IGBT, Inverter (typical)

$$I_c = f(V_{CE}), T_{vj} = 150^\circ\text{C}$$



Übertragungscharakteristik IGBT, Wechselrichter (typisch)  
transfer characteristic IGBT, Inverter (typical)

$$I_c = f(V_{GE}) \quad V_{CE} = 12V$$

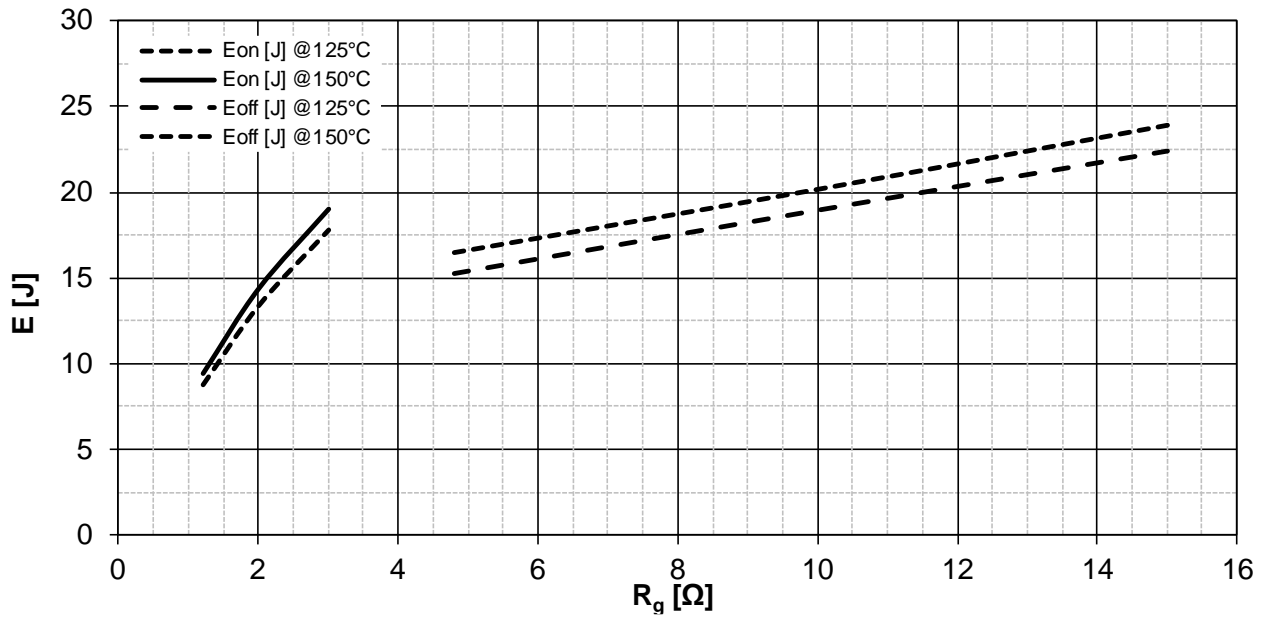
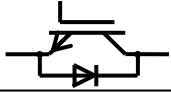


Schaltverluste IGBT, Wechselrichter (typisch)  
switching losses IGBT, Inverter (typical)

$$E_{on} = f(I_c), \quad E_{off} = f(I_c)$$

$$V_{GE} = \pm 15V, \quad R_{Gon} = 1,2\Omega, \quad R_{Goff} = 4,8\Omega, \quad V_{CE} = 2800V$$

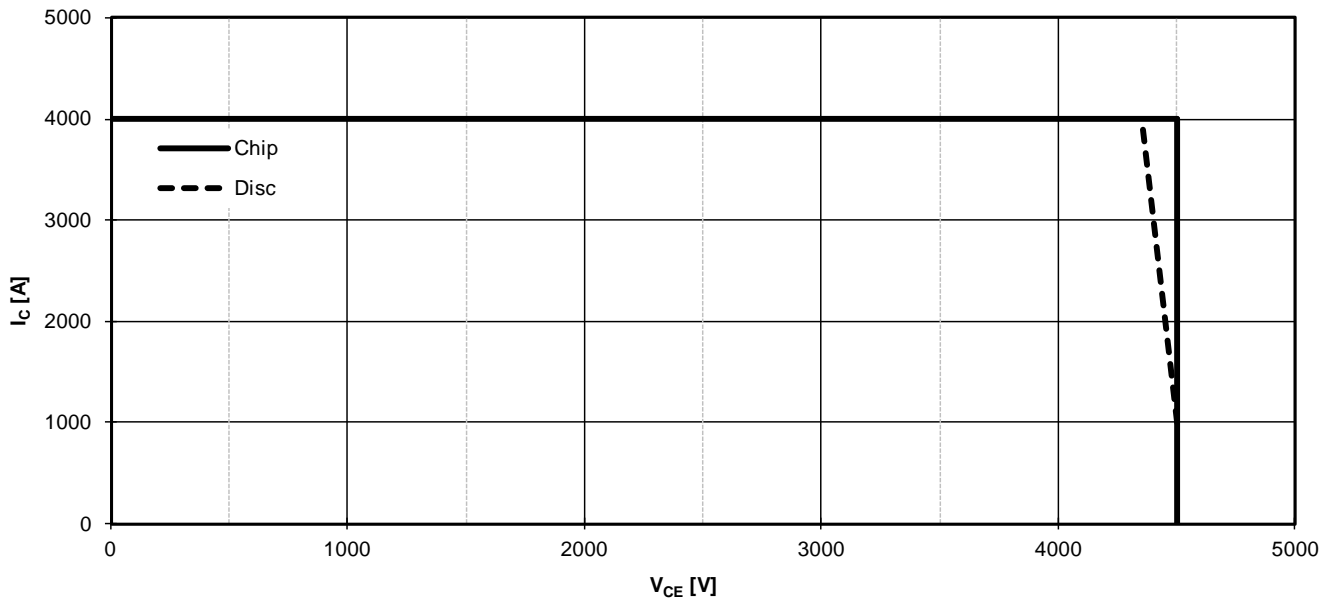




Schaltverluste IGBT, Wechselrichter (typisch)  
switching losses IGBT, Inverter (typical)

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

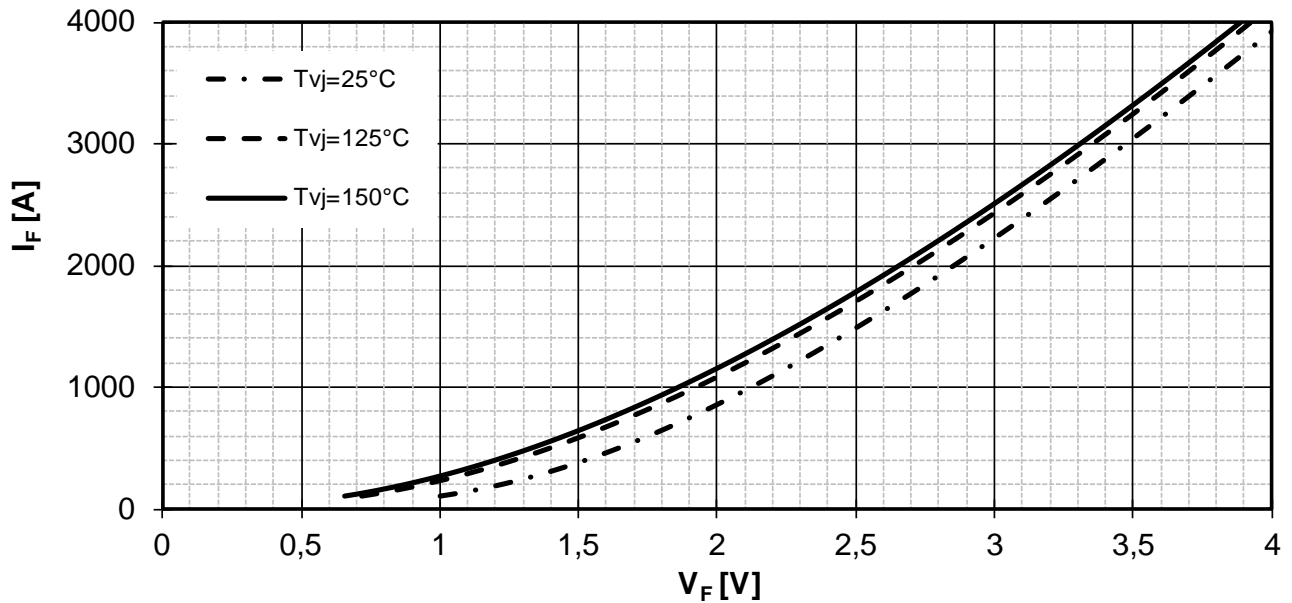
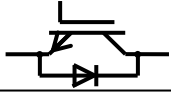
$$V_{GE}=\pm 15V, I_C=2000A, V_{CE}=2800V$$



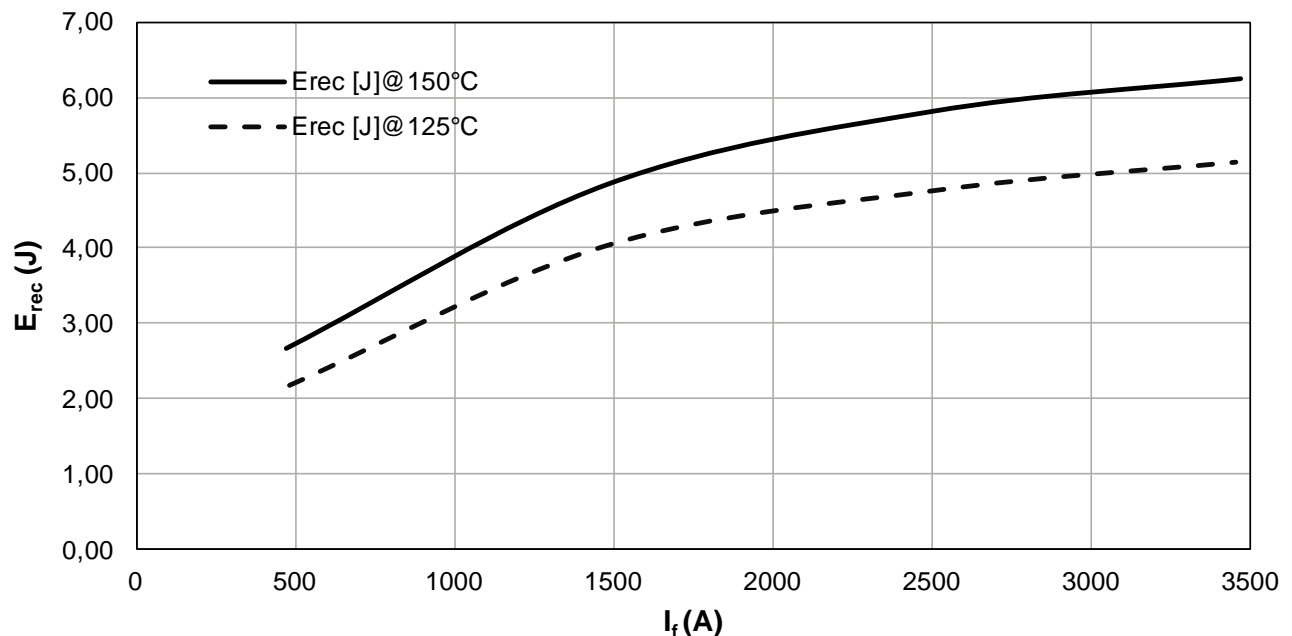
Sicherer Rückwärts-Arbeitsbereich IGBT, Wechselrichter (RBSOA)  
Reverse bias safe operating area IGBT, Inverter (RBSOA)

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

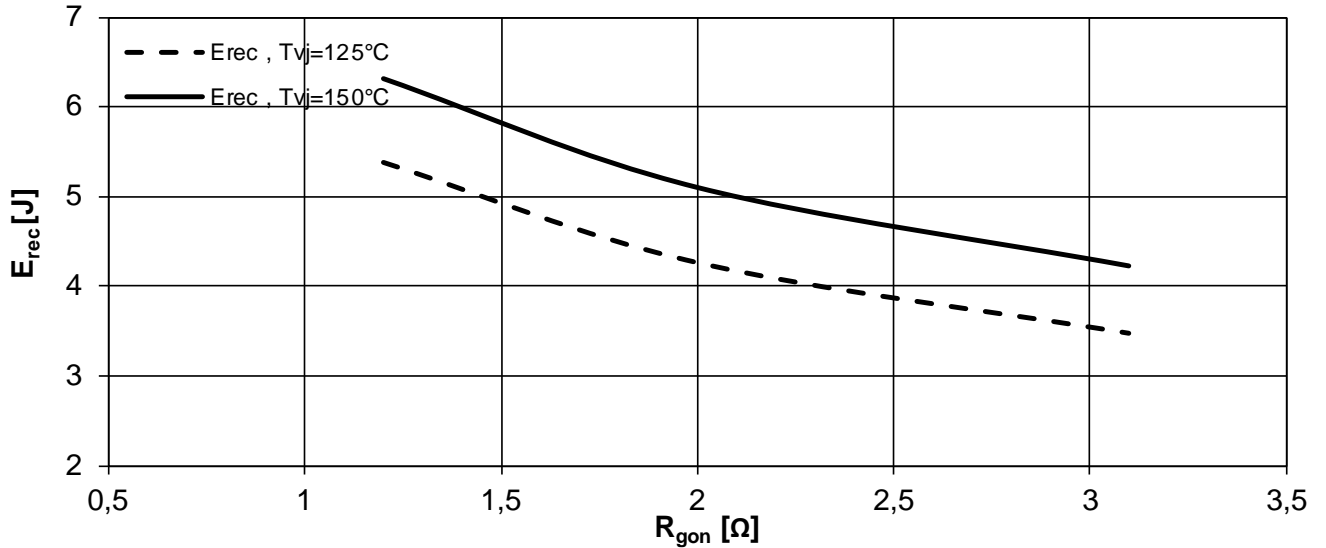
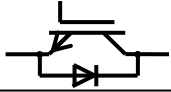
$$V_{CC}\leq 3600V, V_{GE}=\pm 15V, R_{Goff}=7\Omega, T_{vj}=150^\circ C$$



Durchlasskennlinie der Diode, Wechselrichter (typisch)  
Forward characteristic of Diode, Inverter (typical)  
 $I_F=f(V_F)$



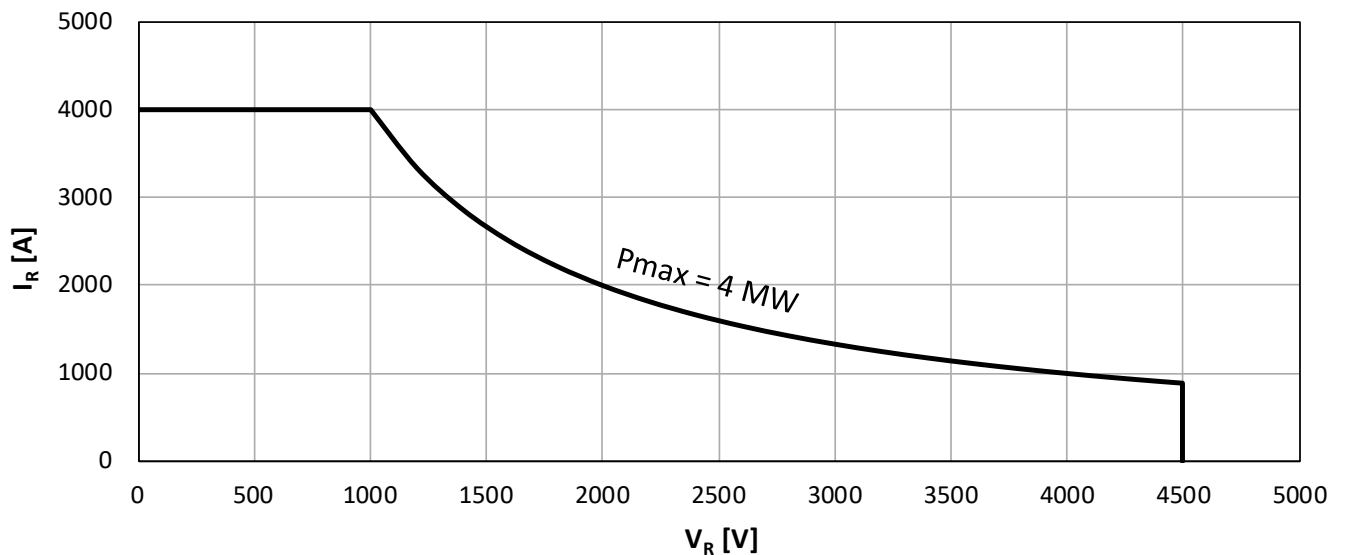
Schaltverluste Diode, Wechselrichter (typisch)  
switching losses Diode, Inverter (typical)  
 $E_{rec}=f(I_F)$   
 $R_{Gon}=1.8\Omega$ ,  $V_{CE}=2800V$



Schaltverluste Diode, Wechselrichter (typisch)  
Switching losses Diode, Inverter (typical)

$$E_{rec} = f(R_G)$$

$I_F = 2000\text{A}, V_{CE} = 2800\text{V}$



Sicherer Arbeitsbereich Diode, Wechselrichter (SOA)  
Safe operation area Diode, Inverter (SOA)

$$I_R = f(V_R) \quad T_{vj} = 150^\circ\text{C}$$