

Elektrische Eigenschaften / Electrical properties**Höchstzulässige Werte / Maximum rated values****Diode Gleichrichter/ Diode Rectifier**

Periodische Rückw. Spitzensperrspannung repetitive peak reverse voltage	$T_{vj} = 25^{\circ}\text{C}$	V_{RRM}	1600	V
Gleichrichter Ausgang Grenzeffektivstrom maximum RMS current at Rectifier output	$T_C = 80^{\circ}\text{C}$	I_{RMSmax}	75	A
Durchlaßstrom Grenzeffektivwert proChip Forward current RMS maximum per Chip	$T_C = 80^{\circ}\text{C}$	I_{FRSM}	50	A
Stoßstrom Grenzwert surge forward current	$t_p = 10\text{ ms}, T_{vj} = 25^{\circ}\text{C}$ $t_p = 10\text{ ms}, T_{vj} = 150^{\circ}\text{C}$	I_{FSM}	315 260	A A
Grenzlastintegral I^2t - value	$t_p = 10\text{ ms}, T_{vj} = 25^{\circ}\text{C}$ $t_p = 10\text{ ms}, T_{vj} = 150^{\circ}\text{C}$	I^2t	500 340	A^2s A^2s

Transistor Wechselrichter/ Transistor Inverter

Kollektor-Emitter-Sperrspannung collector-emitter voltage	$T_{vj} = 25^{\circ}\text{C}$	V_{CES}	1200	V
Kollektor-Dauergleichstrom DC-collector current	$T_C = 80^{\circ}\text{C}$ $T_C = 25^{\circ}\text{C}$	$I_{C,nom.}$ I_C	40 55	A A
Periodischer Kollektor Spitzenstrom repetitive peak collector current	$t_p = 1\text{ ms}, T_C = 80^{\circ}\text{C}$	I_{CRM}	80	A
Gesamt-Verlustleistung total power dissipation	$T_C = 25^{\circ}\text{C}$	P_{tot}	200	W
Gate-Emitter-Spitzenspannung gate-emitter peak voltage		V_{GES}	+/- 20V	V

Diode Wechselrichter/ Diode Inverter

Dauergleichstrom DC forward current		I_F	40	A
Periodischer Spitzenstrom repetitive peak forw. current	$t_p = 1\text{ ms}$	I_{FRM}	80	A
Grenzlastintegral I^2t - value	$V_R = 0\text{V}, t_p = 10\text{ms}, T_{vj} = 125^{\circ}\text{C}$	I^2t	320	A^2s

Transistor Brems-Chopper/ Transistor Brake-Chopper

Kollektor-Emitter-Sperrspannung collector-emitter voltage	$T_{vj} = 25^{\circ}\text{C}$	V_{CES}	1200	V
Kollektor-Dauergleichstrom DC-collector current	$T_C = 80^{\circ}\text{C}$ $T_C = 25^{\circ}\text{C}$	$I_{C,nom.}$ I_C	40 55	A A
Periodischer Kollektor Spitzenstrom repetitive peak collector current	$t_p = 1\text{ ms}, T_C = 80^{\circ}\text{C}$	I_{CRM}	80	A
Gesamt-Verlustleistung total power dissipation	$T_C = 25^{\circ}\text{C}$	P_{tot}	200	W
Gate-Emitter-Spitzenspannung gate-emitter peak voltage		V_{GES}	+/- 20V	V

Diode Brems-Chopper/ Diode Brake-Chopper

Dauergleichstrom DC forward current		I_F	15	A
Periodischer Spitzenstrom repetitive peak forw. current	$t_p = 1\text{ ms}$	I_{FRM}	30	A

prepared by: Andreas Schulz

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Technische Information / Technical Information

IGBT-Module
IGBT-Modules

FP40R12KE3G

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Modul Isolation/ Module Isolation

Isolations-Prüfspannung insulation test voltage	RMS, f = 50 Hz, t = 1 min. NTC connected to Baseplate	V _{ISOL}	2,5	kV
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Elektrische Eigenschaften / Electrical properties

Charakteristische Werte / Characteristic values

Diode Gleichrichter/ Diode Rectifier		min.	typ.	max.	
Durchlaßspannung forward voltage	T _{vj} = 150°C, I _F = 40 A	V _F	-	1,2	V
Schleusenspannung threshold voltage	T _{vj} = 150°C	V _(TO)	-	-	0,8 V
Ersatzwiderstand slope resistance	T _{vj} = 150°C	r _T	-	-	10,5 mΩ
Sperrstrom reverse current	T _{vj} = 150°C, V _R = 1600 V	I _R	-	2	mA
Modul Leitungswiderstand, Anschlüsse-Chip lead resistance, terminals-chip	T _C = 25°C	R _{AA'+CC'}	-	4	mΩ

Transistor Wechselrichter/ Transistor Inverter		min.	typ.	max.	
Kollektor-Emitter Sättigungsspannung collector-emitter saturation voltage	V _{GE} = 15V, T _{vj} = 25°C, I _C = 40 A	V _{CE sat}	-	1,8	V
	V _{GE} = 15V, T _{vj} = 125°C, I _C = 40 A		-	2,15	V
Gate-Schwellenspannung gate threshold voltage	V _{CE} = V _{GE} , T _{vj} = 25°C, I _C = 1,5 mA	V _{GE(TO)}	5,0	5,8	V
Eingangskapazität input capacitance	f = 1MHz, T _{vj} = 25°C V _{CE} = 25 V, V _{GE} = 0 V	C _{ies}	-	2,5	nF
Kollektor-Emitter Reststrom collector-emitter cut off current	V _{GE} = 0V, T _{vj} = 25°C, V _{CE} = 1200 V	I _{CES}	-	-	5 mA
Gate-Emitter Reststrom gate-emitter leakage current	V _{CE} = 0V, V _{GE} = 20V, T _{vj} = 25°C	I _{GES}	-	-	400 nA
Einschaltverzögerungszeit (ind. Last) turn on delay time (inductive load)	I _C = I _{Nenn} , V _{CC} = 600 V	t _{d,on}	-	85	ns
	V _{GE} = ±15V, T _{vj} = 25°C, R _G = 27 Ohm				
	V _{GE} = ±15V, T _{vj} = 125°C, R _G = 27 Ohm			90	ns
Anstiegszeit (induktive Last) rise time (inductive load)	I _C = I _{Nenn} , V _{CC} = 600 V	t _r	-	30	ns
	V _{GE} = ±15V, T _{vj} = 25°C, R _G = 27 Ohm				
	V _{GE} = ±15V, T _{vj} = 125°C, R _G = 27 Ohm			45	ns
Abschaltverzögerungszeit (ind. Last) turn off delay time (inductive load)	I _C = I _{Nenn} , V _{CC} = 600 V	t _{d,off}	-	420	ns
	V _{GE} = ±15V, T _{vj} = 25°C, R _G = 27 Ohm				
	V _{GE} = ±15V, T _{vj} = 125°C, R _G = 27 Ohm			520	ns
Fallzeit (induktive Last) fall time (inductive load)	I _C = I _{Nenn} , V _{CC} = 600 V	t _f	-	65	ns
	V _{GE} = ±15V, T _{vj} = 25°C, R _G = 27 Ohm				
	V _{GE} = ±15V, T _{vj} = 125°C, R _G = 27 Ohm			90	ns
Einschaltverlustenergie pro Puls turn-on energy loss per pulse	I _C = I _{Nenn} , V _{CC} = 600 V V _{GE} = ±15V, T _{vj} = 125°C, R _G = 27 Ohm Lσ = 45 nH	E _{on}	-	6	mWs
Abschaltverlustenergie pro Puls turn-off energy loss per pulse	I _C = I _{Nenn} , V _{CC} = 600 V V _{GE} = ±15V, T _{vj} = 125°C, R _G = 27 Ohm Lσ = 45 nH	E _{off}	-	4,2	mWs
Kurzschlußverhalten SC Data	t _p ≤ 10μs, V _{GE} ≤ 15V, R _G = 27 Ohm T _{vj} ≤ 125°C, V _{CC} = 720 V	I _{SC}	-	160	A

Elektrische Eigenschaften / Electrical properties

Charakteristische Werte / Characteristic values

			min.	typ.	max.	
Modulinduktivität stray inductance module		$L_{\sigma CE}$	-	-	60	nH
Modul Leitungswiderstand, Anschlüsse-Chip lead resistance, terminals-chip	$T_C = 25^\circ\text{C}$	R_{CC+EE}	-	7	-	mΩ
Diode Wechselrichter/ Diode Inverter						
			min.	typ.	max.	
Durchlaßspannung forward voltage	$V_{GE} = 0\text{V}, T_{vj} = 25^\circ\text{C}, I_F = 40\text{ A}$ $V_{GE} = 0\text{V}, T_{vj} = 125^\circ\text{C}, I_F = 40\text{ A}$	V_F	-	1,75	2,3	V
			-	1,75	-	V
Rückstromspitze peak reverse recovery current	$I_F = I_{Nenn}, -di_F/dt = 900\text{ A}/\mu\text{s}$ $V_{GE} = -10\text{V}, T_{vj} = 25^\circ\text{C}, V_R = 600\text{ V}$ $V_{GE} = -10\text{V}, T_{vj} = 125^\circ\text{C}, V_R = 600\text{ V}$	I_{RM}	-	39	-	A
			-	38	-	A
Sperrverzögerungsladung recovered charge	$I_F = I_{Nenn}, -di_F/dt = 900\text{ A}/\mu\text{s}$ $V_{GE} = -10\text{V}, T_{vj} = 25^\circ\text{C}, V_R = 600\text{ V}$ $V_{GE} = -10\text{V}, T_{vj} = 125^\circ\text{C}, V_R = 600\text{ V}$	Q_r	-	4,2	-	μAs
			-	7,8	-	μAs
Abschaltenergie pro Puls reverse recovery energy	$I_F = I_{Nenn}, -di_F/dt = 900\text{ A}/\mu\text{s}$ $V_{GE} = -10\text{V}, T_{vj} = 25^\circ\text{C}, V_R = 600\text{ V}$ $V_{GE} = -10\text{V}, T_{vj} = 125^\circ\text{C}, V_R = 600\text{ V}$	E_{rec}	-	1,35	-	mWs
			-	2,8	-	mWs
Transistor Brems-Chopper/ Transistor Brake-Chopper						
			min.	typ.	max.	
Kollektor-Emitter Sättigungsspannung collector-emitter saturation voltage	$V_{GE} = 15\text{V}, T_{vj} = 25^\circ\text{C}, I_C = 40\text{ A}$ $V_{GE} = 15\text{V}, T_{vj} = 125^\circ\text{C}, I_C = 40\text{ A}$	$V_{CE\text{ sat}}$	-	1,8	2,3	V
			-	2,15	-	V
Gate-Schwellenspannung gate threshold voltage	$V_{CE} = V_{GE}, T_{vj} = 25^\circ\text{C}, I_C = 1,5\text{ mA}$	$V_{GE(To)}$	5,0	5,8	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}	-	2,5	-	nF
Kollektor-Emitter Reststrom collector-emitter cut off current	$V_{GE} = 0\text{V}, T_{vj} = 25^\circ\text{C}, V_{CE} = 1200\text{ V}$	I_{CES}	-	5,0	500	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
Schaltverluste und -bedingungen Switching losses and conditions	siehe Wechselrichter in diesem Datenblatt see inverter in this datasheet					
Diode Brems-Chopper/ Diode Brake-Chopper						
			min.	typ.	max.	
Durchlaßspannung forward voltage	$T_{vj} = 25^\circ\text{C}, I_F = 40\text{ A}$ $T_{vj} = 125^\circ\text{C}, I_F = 40\text{ A}$	V_F	-	2,35	2,8	V
			-	2,55	-	V
Schaltverluste und -bedingungen Switching losses and conditions	siehe Wechselrichter in Dbl FP15R12KE3 see inverter in datasheet FP15R12KE3					
NTC-Widerstand/ NTC-Thermistor						
			min.	typ.	max.	
Nennwiderstand rated resistance	$T_C = 25^\circ\text{C}$	R_{25}	-	5	-	kΩ
Abweichung von R_{100} deviation of R_{100}	$T_C = 100^\circ\text{C}, R_{100} = 493\text{ }\Omega$	$\Delta R/R$	-5		5	%
Verlustleistung power dissipation	$T_C = 25^\circ\text{C}$	P_{25}			20	mW
B-Wert B-value	$R_2 = R_1 \exp [B(1/T_2 - 1/T_1)]$	$B_{25/50}$		3375		K

Technische Information / Technical Information

IGBT-Module
IGBT-Modules

FP40R12KE3G

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Thermische Eigenschaften / Thermal properties

			min.	typ.	max.	
Innerer Wärmewiderstand thermal resistance, junction to case	Gleichr. Diode/ Rectif. Diode	R_{thJC}	-	-	1	K/W
	Trans. Wechr./ Trans. Inverter		-	-	0,6	K/W
	Diode Wechr./ Diode Inverter		-	-	0,95	K/W
	Trans. Bremse/ Trans. Brake		-	-	0,6	K/W
	Diode Bremse/ Diode Brake		-	-	1,5	K/W
Übergangs-Wärmewiderstand thermal resistance, case to heatsink	Gleichr. Diode/ Rectif. Diode $\lambda_{paste}=1W/m^2K$	R_{thCK}	-	0,04	-	K/W
	Trans. Wechr./ Trans. Inverter $\lambda_{grease}=1W/m^2K$		-	0,02	-	K/W
	Diode Wechr./ Diode Inverter		-	0,04	-	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

Innere Isolation internal insulation			Al_2O_3		
CTI comperative tracking index			225		
Anzugsdrehmoment f. mech. Befestigung mounting torque	Schraube M 5 screw M 5	M	3	-	6 Nm
Gewicht weight		G	300		g
Luftstrecke clearance	Pin-Erde Pin-GND		7,5		mm
Kriechstrecke creeping distance	Pin-Erde Pin-GND		10		mm

Transiente Thermische Eigenschaften / Transient Thermal properties

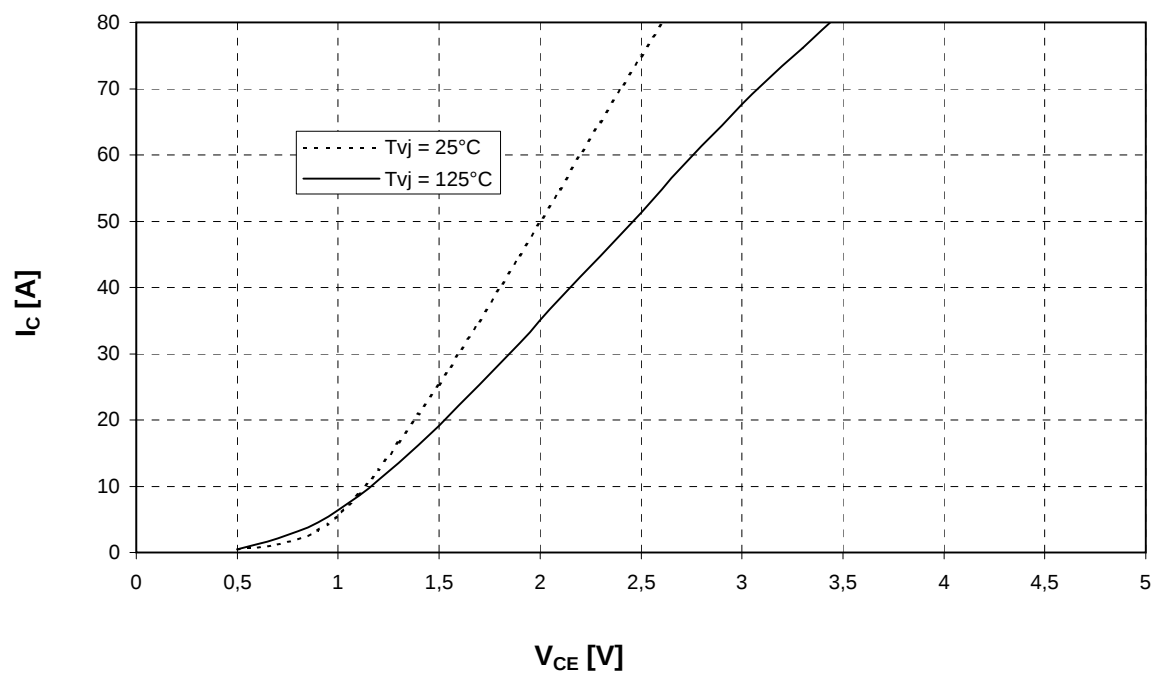
	IGBT-Wechselrichter IGBT-Inverter		Diode-Wechselrichter Diode-Inverter	
	r_i [K/W]	τ_i [s]	r_i [K/W]	τ_i [s]
1	6,769E-02	2,345E-03	9,674E-02	3,333E-03
2	1,052E-01	2,820E-01	6,249E-01	3,429E-02
3	2,709E-01	2,820E-02	1,800E-01	1,294E-01
4	1,523E-01	1,128E-01	5,701E-02	7,662E-01

Ausgangskennlinienfeld Wechselr. (typisch)

Output characteristic Inverter (typical)

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

$$V_{GE} = 15 \text{ V}$$

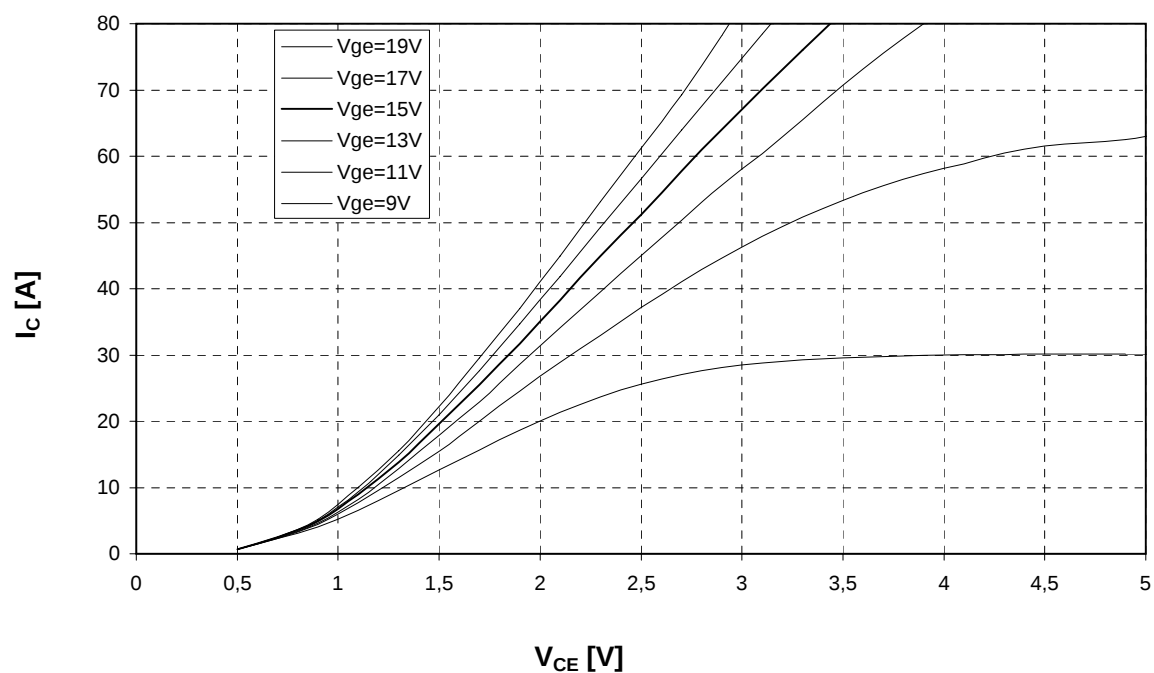


Ausgangskennlinienfeld Wechselr. (typisch)

Output characteristic Inverter (typical)

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

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

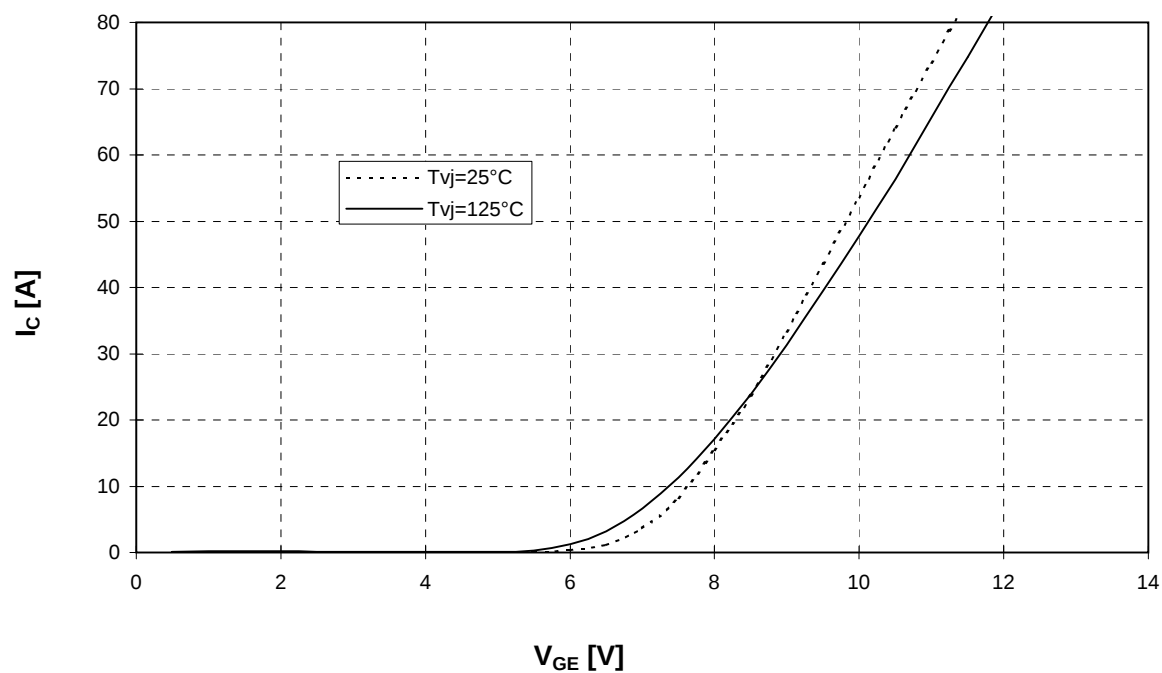


Übertragungscharakteristik Wechselr. (typisch)

Transfer characteristic Inverter (typical)

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

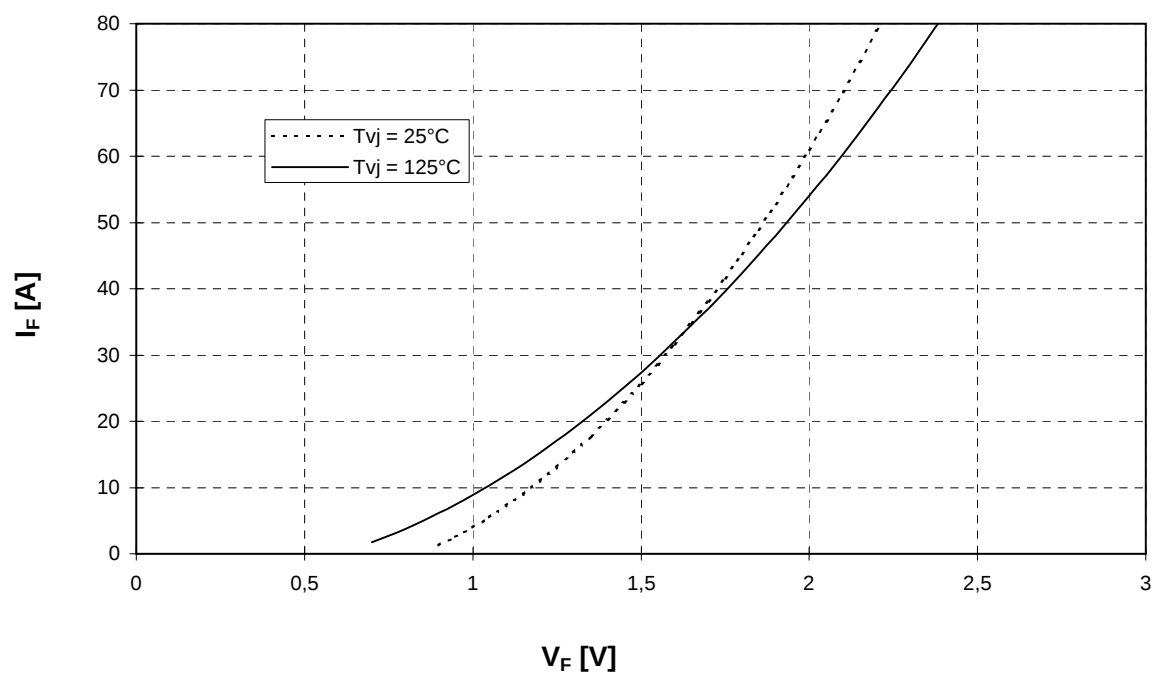
$$V_{CE} = 20 \text{ V}$$



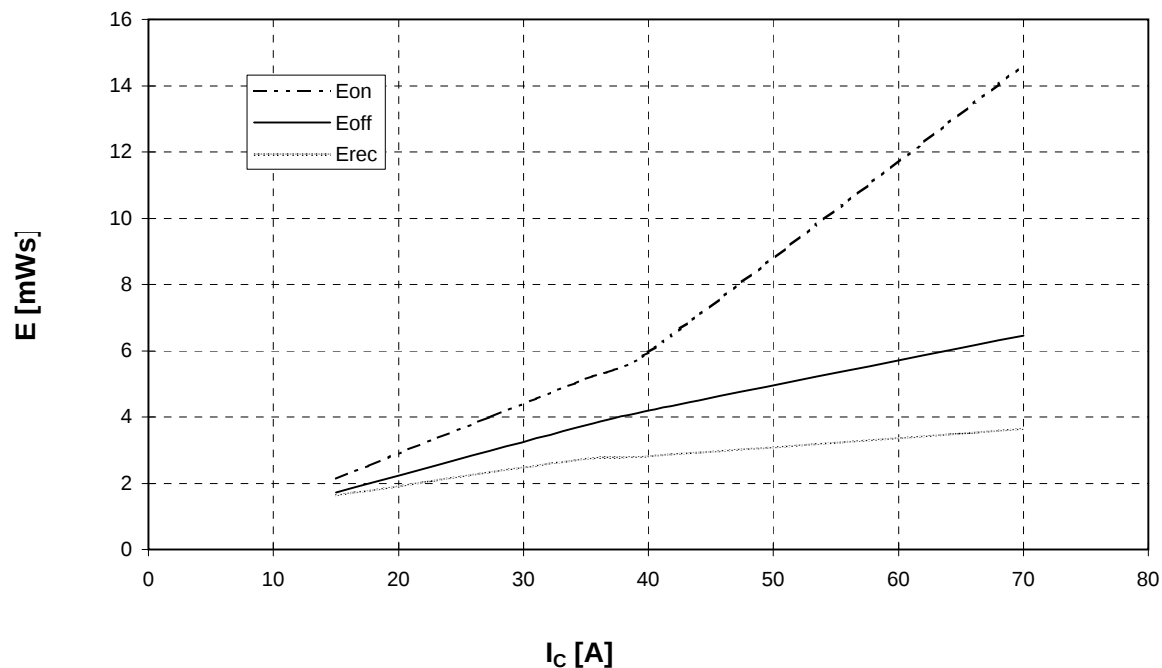
Durchlaßkennlinie der Freilaufdiode Wechselr. (typisch)

Forward characteristic of FWD Inverter (typical)

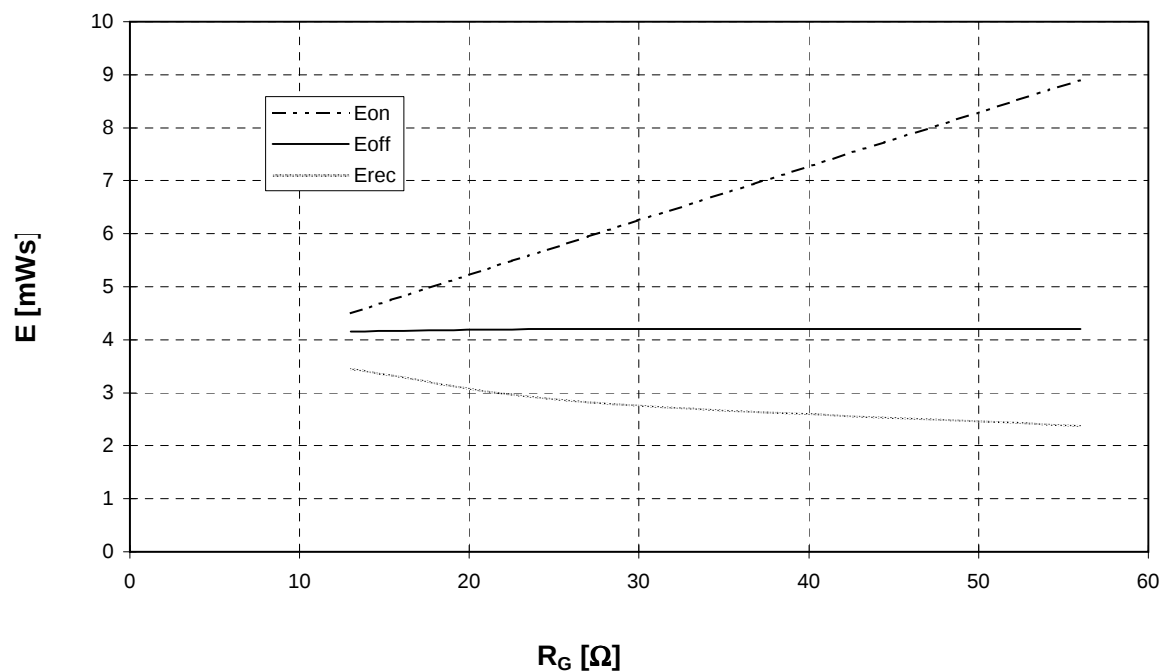
$$I_F = f(V_F)$$



Schaltverluste Wechselr. (typisch) $E_{on} = f(I_C)$, $E_{off} = f(I_C)$, $E_{rec} = f(I_C)$ $V_{CC} = 600\text{ V}$
Switching losses Inverter (typical) $T_j = 125^\circ\text{C}$, $V_{GE} = \pm 15\text{ V}$, $R_{Gon} = R_{Goff} = 27\text{ Ohm}$

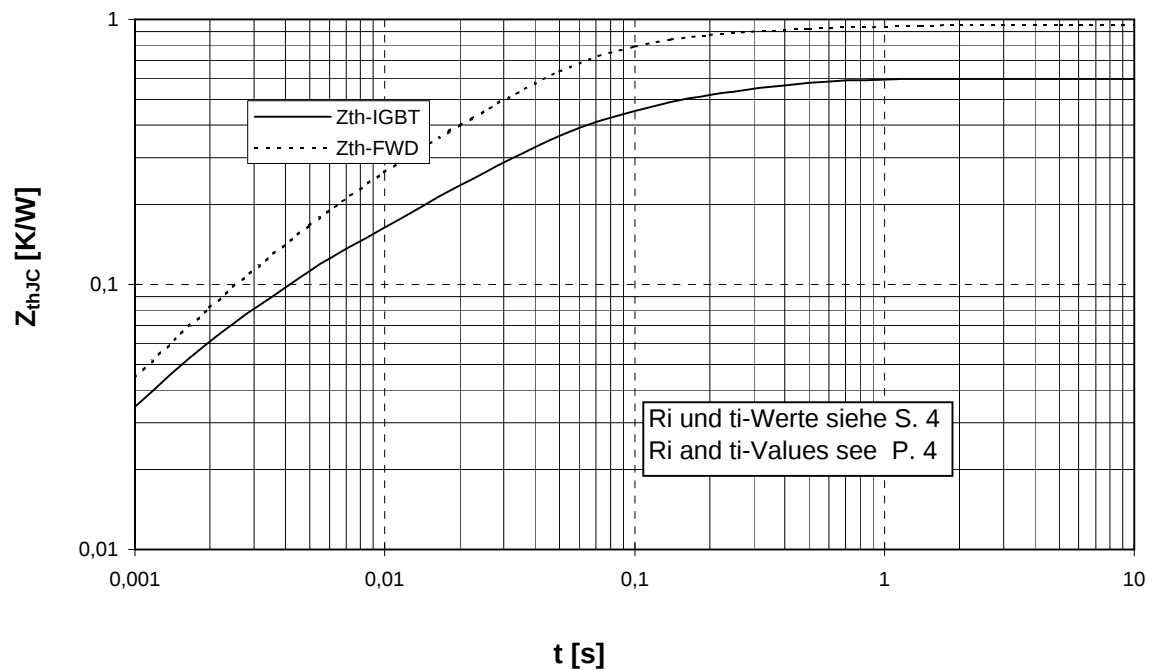


Schaltverluste Wechselr. (typisch) $E_{on} = f(R_G)$, $E_{off} = f(R_G)$, $E_{rec} = f(R_G)$
Switching losses Inverter (typical) $T_j = 125^\circ\text{C}$, $V_{GE} = \pm 15\text{ V}$, $I_C = I_{nenn}$, $V_{CC} = 600\text{ V}$

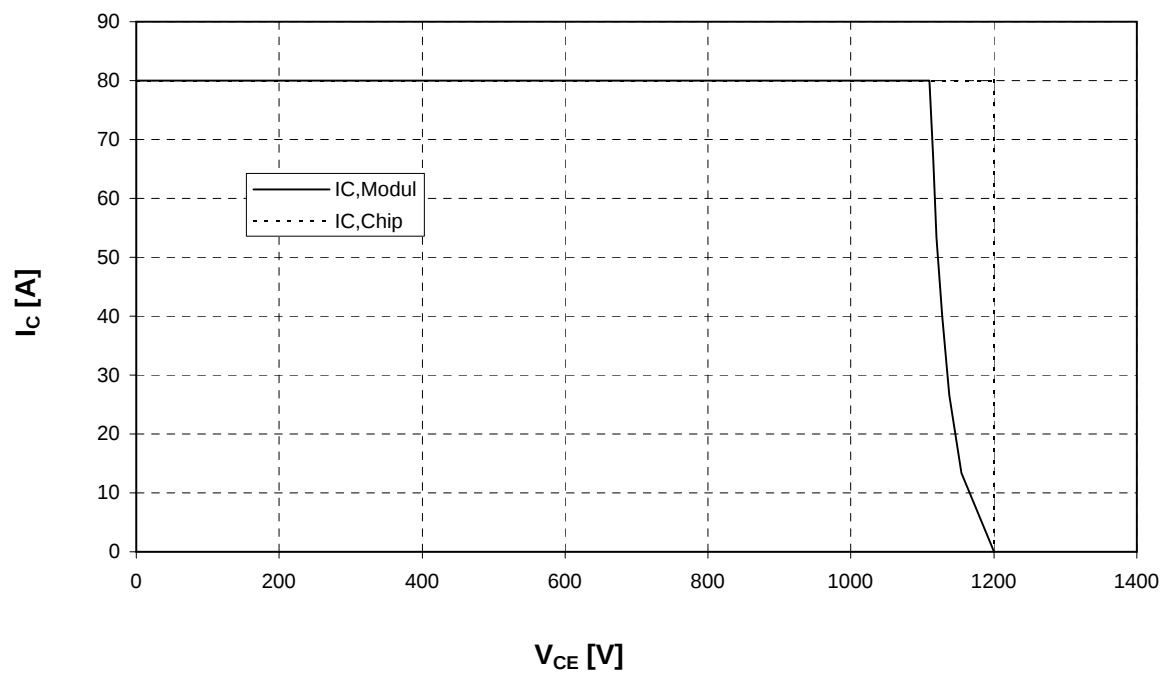


Transienter Wärmewiderstand Wechsler.

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

Transient thermal impedance Inverter

Sicherer Arbeitsbereich IGBT-Wechsler. (RBSOA)
Reverse bias safe operating area (RBSOA)

$$V_{GE} = 15V, T_J = 125^{\circ}C$$

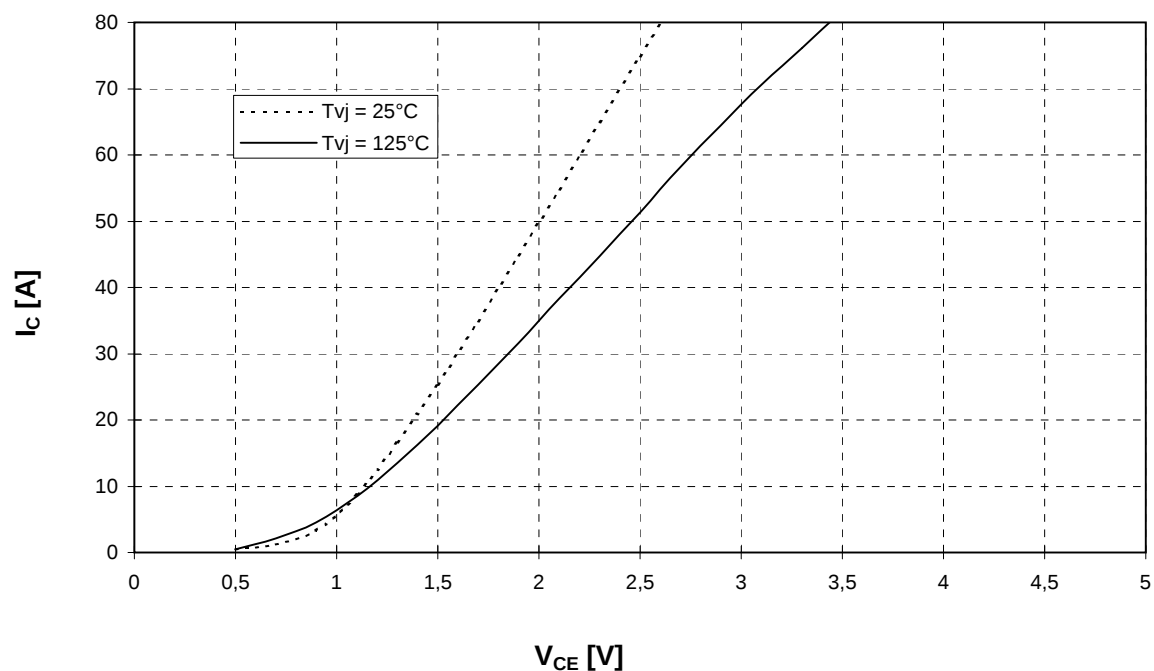


Ausgangskennlinienfeld Brems-Chopper-IGBT (typisch)

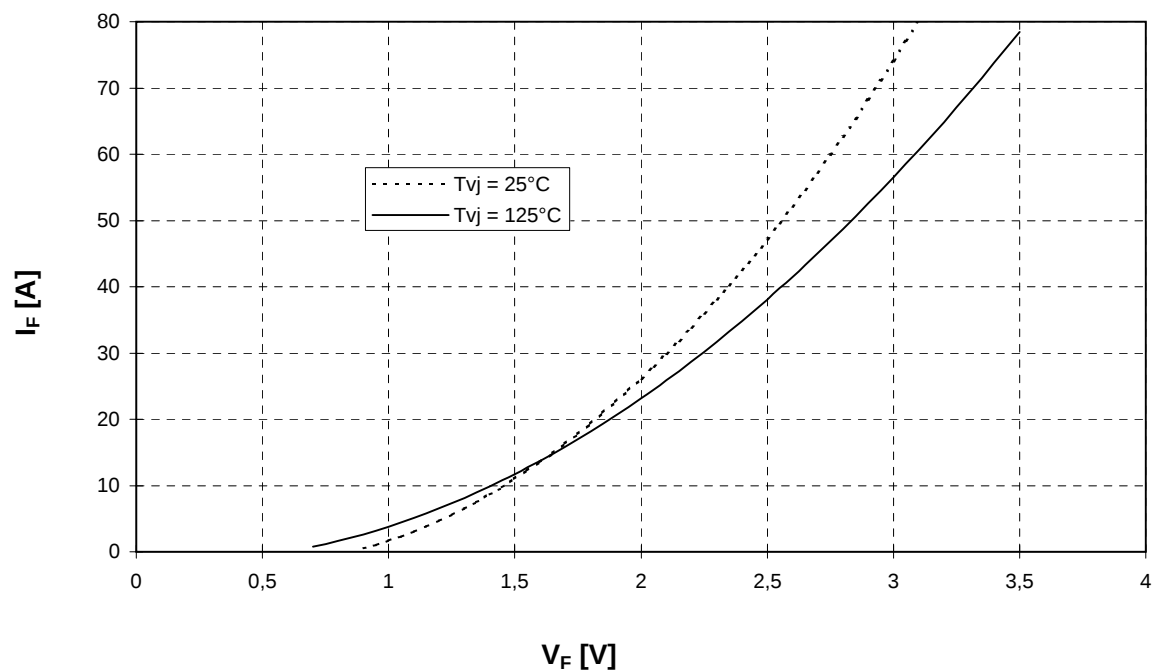
Output characteristic brake-chopper-IGBT (typical)

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

$$V_{GE} = 15 \text{ V}$$


Durchlaßkennlinie der Brems-Chopper-Diode (typisch) $I_F = f(V_F)$

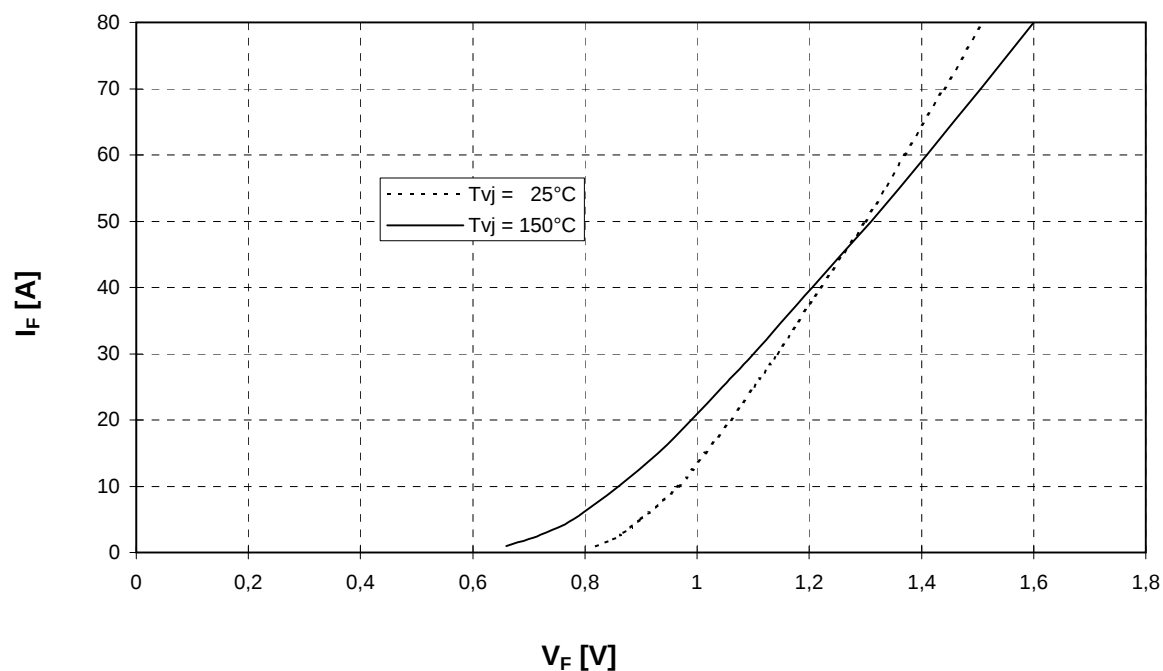
Forward characteristic of brake-chopper-FWD (typical)



Durchlaßkennlinie der Gleichrichterdiode (typisch)

$$I_F = f(V_F)$$

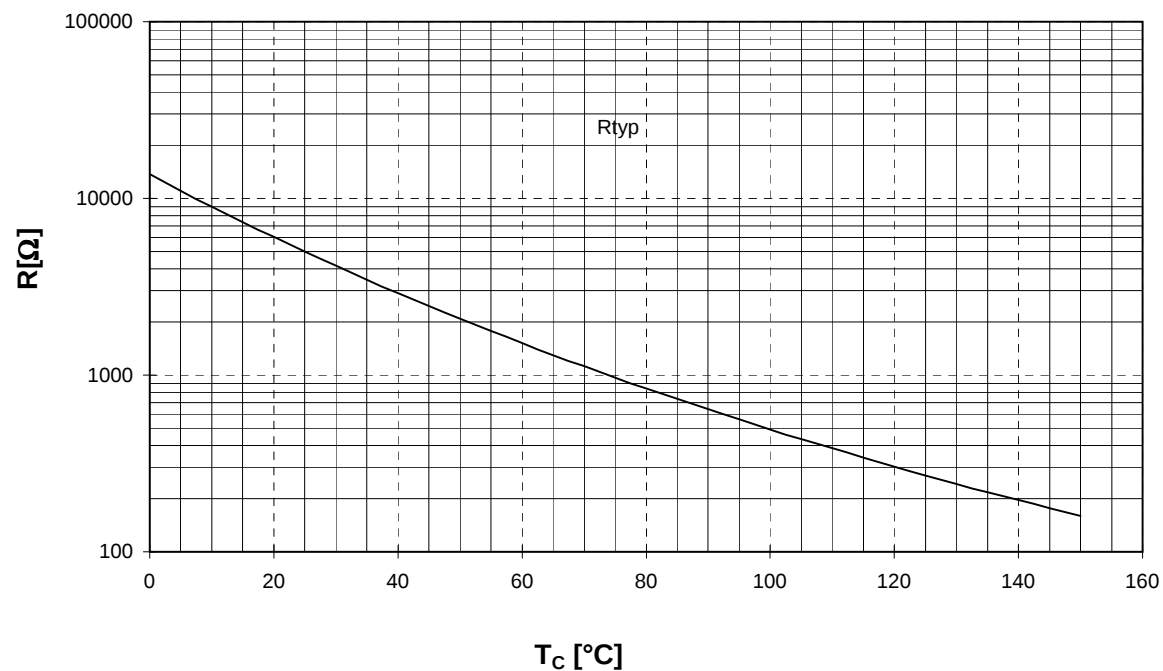
Forward characteristic of Rectifier Diode (typical)



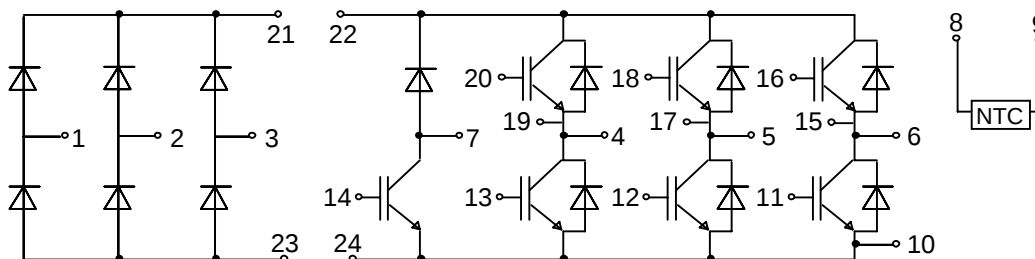
NTC- Temperaturkennlinie (typisch)

$$R = f(T)$$

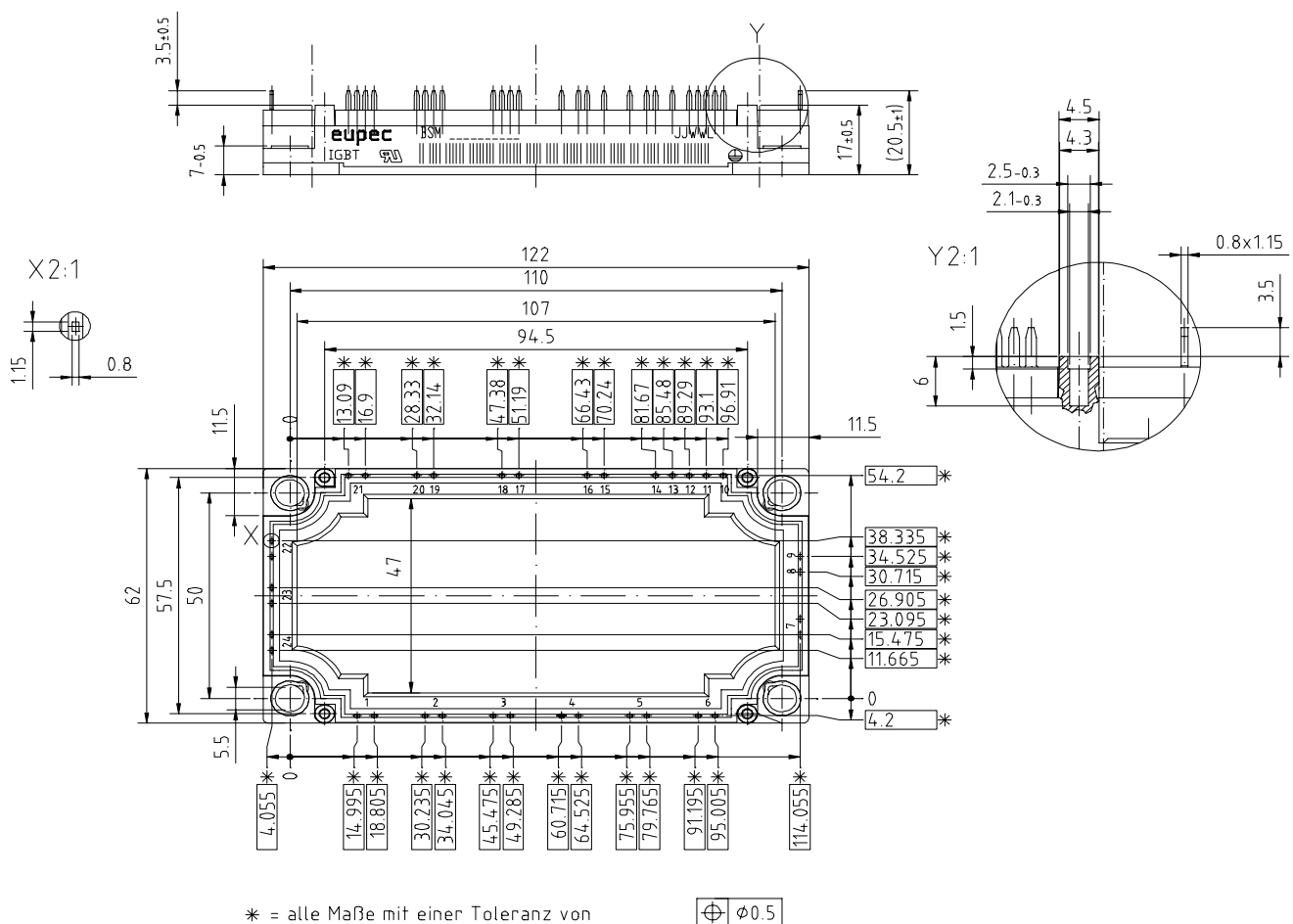
NTC- temperature characteristic (typical)



Schaltplan/ Circuit diagram



Gehäuseabmessungen/ Package outlines



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