

Technische Information / Technical Information

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IGBT-Module
IGBT-Modules

FP40R12KE3

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}	60	A
Durchlaßstrom Grenzeffektivwert proChip Forward current RMS maximum per Chip	$T_C = 80^{\circ}\text{C}$	I_{FRMSM}	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	A
			260	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	A^2s
			340	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	A
			55	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	15	A
			25	A
Periodischer Kollektor Spitzenstrom repetitive peak collector current	$t_p = 1\text{ ms}, T_C = 80^{\circ}\text{C}$	I_{CRM}	30	A
Gesamt-Verlustleistung total power dissipation	$T_C = 25^{\circ}\text{C}$	P_{tot}	100	W
Gate-Emitter-Spitzenspannung gate-emitter peak voltage		V_{GES}	+/- 20V	V

Diode Brems-Chopper/ Diode Brake-Chopper

Dauergleichstrom DC forward current		I_F	10	A
Periodischer Spitzenstrom repetitive peak forw. current	$t_p = 1\text{ ms}$	I_{FRM}	20	A

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FP40R12KE3

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}	-	5	-	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	2,3	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	6,5	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					
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					
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					
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					
Einschaltverlustenergie pro Puls turn-on energy loss per pulse	I _C = I _{Nenn} , V _{CC} = 600 V	E _{on}	-	5,8	-	mWs
	V _{GE} = ±15V, T _{vj} = 125°C, R _G = 27 Ohm					
	Lσ = 45 nH					
Abschaltverlustenergie pro Puls turn-off energy loss per pulse	I _C = I _{Nenn} , V _{CC} = 600 V	E _{off}	-	4,9	-	mWs
	V _{GE} = ±15V, T _{vj} = 125°C, R _G = 27 Ohm					
	Lσ = 45 nH					
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	$T_C = 25^\circ C$	R_{CC+EE}	-	7	- mΩ	
Diode Wechselrichter/ Diode Inverter				min.	typ.	max.
Durchlaßspannung forward voltage	$V_{GE} = 0V, T_{vj} = 25^\circ C, I_F = 40 A$ $V_{GE} = 0V, T_{vj} = 125^\circ C, I_F = 40 A$	V_F	-	1,75	2,3 V	
Rückstromspitze peak reverse recovery current	$I_F = I_{Nenn}, -di_F/dt = 1000 A/\mu s$ $V_{GE} = -10V, T_{vj} = 25^\circ C, V_R = 600 V$ $V_{GE} = -10V, T_{vj} = 125^\circ C, V_R = 600 V$	I_{RM}	-	45	- A	
Sperrverzögerungsladung recovered charge	$I_F = I_{Nenn}, -di_F/dt = 1000 A/\mu s$ $V_{GE} = -10V, T_{vj} = 25^\circ C, V_R = 600 V$ $V_{GE} = -10V, T_{vj} = 125^\circ C, V_R = 600 V$	Q_r	-	4,4	- μAs	
Abschaltenergie pro Puls reverse recovery energy	$I_F = I_{Nenn}, -di_F/dt = 1000 A/\mu s$ $V_{GE} = -10V, T_{vj} = 25^\circ C, V_R = 600 V$ $V_{GE} = -10V, T_{vj} = 125^\circ C, V_R = 600 V$	E_{rec}	-	1,55	- mWs	
Transistor Brems-Chopper/ Transistor Brake-Chopper				min.	typ.	max.
Kollektor-Emitter Sättigungsspannung collector-emitter saturation voltage	$V_{GE} = 15V, T_{vj} = 25^\circ C, I_C = 15 A$ $V_{GE} = 15V, T_{vj} = 125^\circ C, I_C = 15 A$	$V_{CE sat}$	-	1,7	2,15 V	
Gate-Schwellenspannung gate threshold voltage	$V_{CE} = V_{GE}, T_{vj} = 25^\circ C, I_C = 0,5 mA$	$V_{GE(TO)}$	5,0	5,8	6,5 V	
Eingangskapazität input capacitance	$f = 1MHz, T_{vj} = 25^\circ C$ $V_{CE} = 25 V, V_{GE} = 0 V$	C_{ies}	-	1,1	- nF	
Kollektor-Emitter Reststrom collector-emitter cut off current	$V_{GE} = 0V, T_{vj} = 25^\circ C, V_{CE} = 1200 V$	I_{CES}	-	5,0	500 mA	
Gate-Emitter Reststrom gate-emitter leakage current	$V_{CE} = 0V, V_{GE} = 20V, T_{vj} = 25^\circ C$	I_{GES}	-	-	400 nA	
Schaltverluste und -bedingungen Switching losses and conditions	siehe Wechselrichter in Dbl FP15R12KE3 see inverter in datasheet FP15R12KE3					
Diode Brems-Chopper/ Diode Brake-Chopper				min.	typ.	max.
Durchlaßspannung forward voltage	$T_{vj} = 25^\circ C, I_F = 15 A$ $T_{vj} = 125^\circ C, I_F = 15 A$	V_F	-	2,05	2,5 V	
Schaltverluste und -bedingungen Switching losses and conditions	siehe Wechselrichter in Dbl FB10R12KE3 see inverter in datasheet FB10R12KE3					
NTC-Widerstand/ NTC-Thermistor				min.	typ.	max.
Nennwiderstand rated resistance	$T_C = 25^\circ C$	R_{25}	-	5	- kΩ	
Abweichung von R_{100} deviation of R_{100}	$T_C = 100^\circ C, R_{100} = 493 \Omega$	$\Delta R/R$	-5		5 %	
Verlustleistung power dissipation	$T_C = 25^\circ C$	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	

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FP40R12KE3

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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		-	-	1,2	K/W
	Diode Bremse/ Diode Brake		-	-	2,3	K/W
Übergangs-Wärmewiderstand thermal resistance, case to heatsink	Gleichr. Diode/ Rectif. Diode	R_{thCK}	-	0,08	-	K/W
	Trans. Wechr./ Trans. Inverter		-	0,04	-	K/W
	Diode Wechr./ Diode Inverter		-	0,08	-	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			180	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

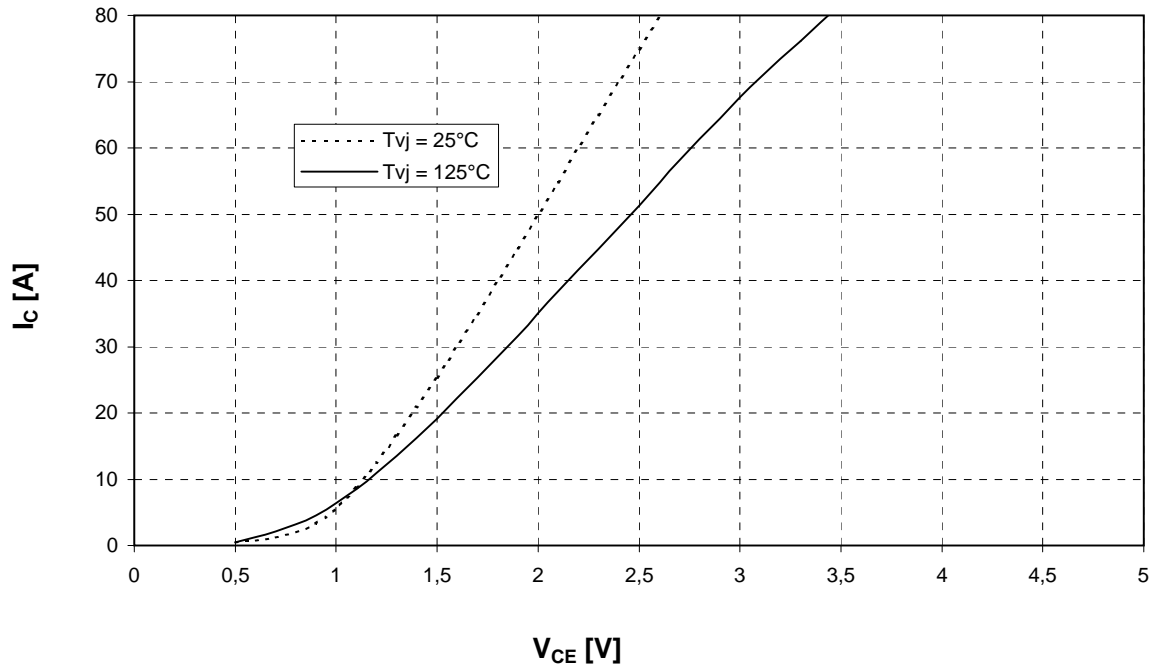
FP40R12KE3

Ausgangskennlinienfeld Wechselr. (typisch)

$I_C = f(V_{CE})$

Output characteristic Inverter (typical)

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

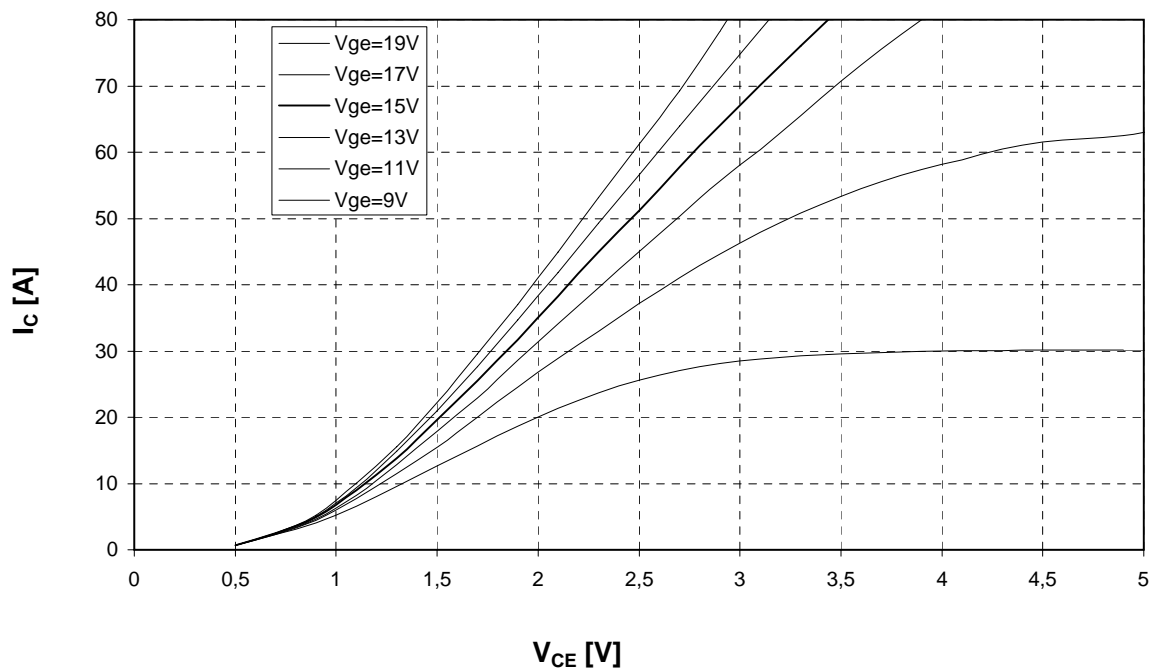


Ausgangskennlinienfeld Wechselr. (typisch)

$I_C = f(V_{CE})$

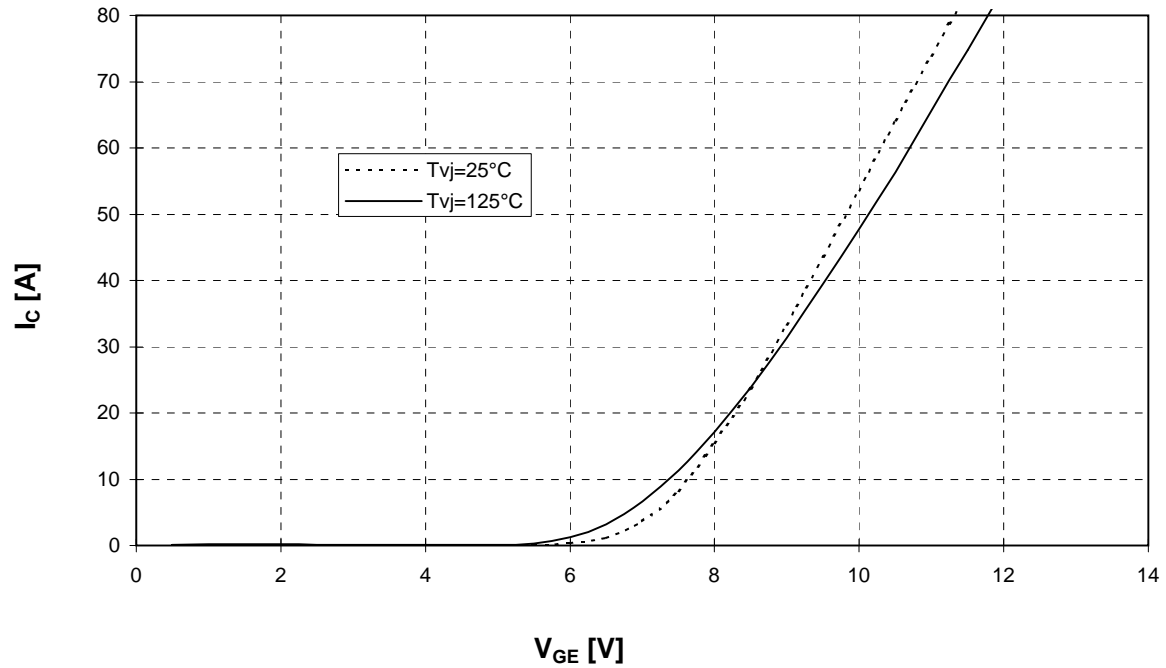
Output characteristic Inverter (typical)

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



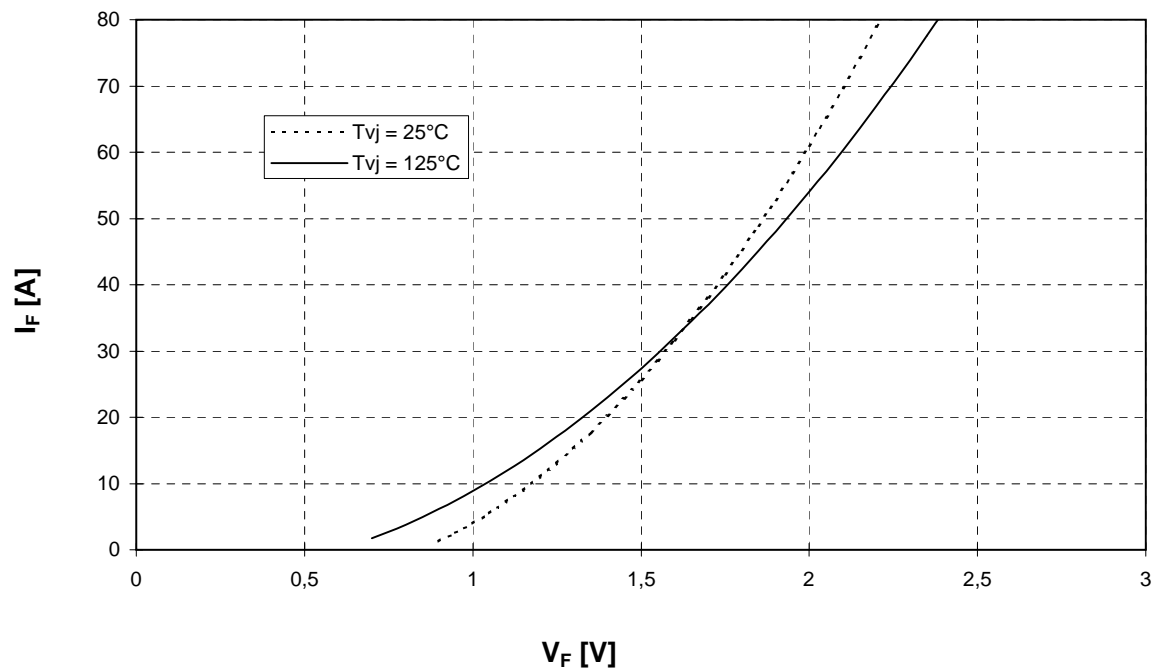
Übertragungscharakteristik Wechselr. (typisch)
Transfer characteristic Inverter (typical)

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



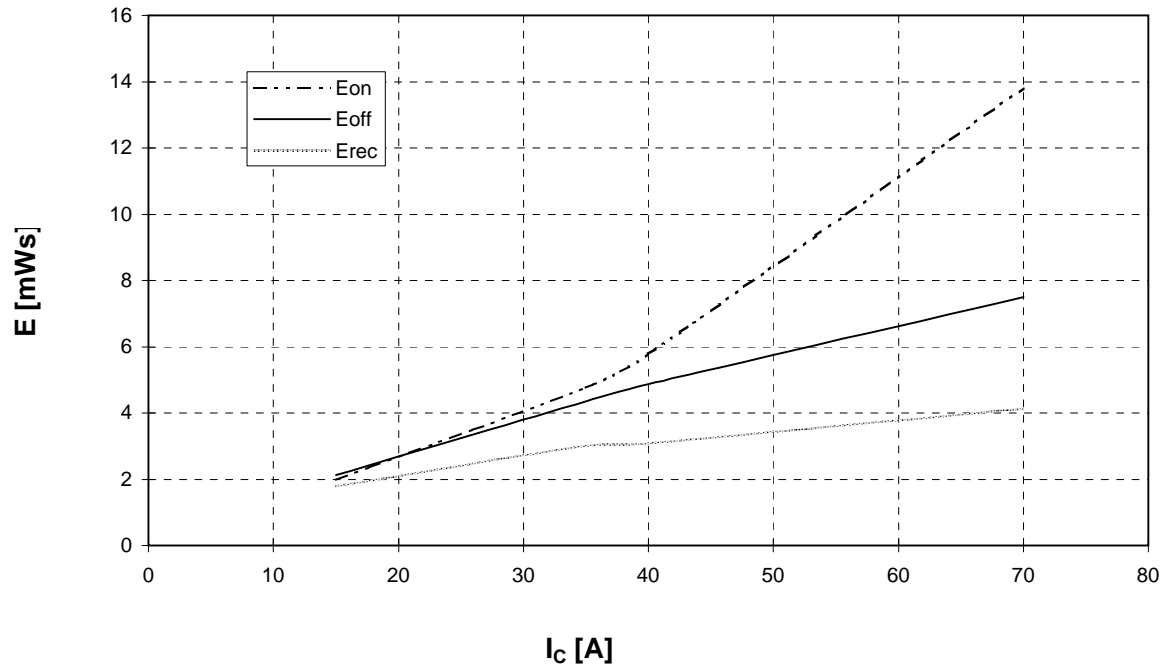
Durchlaßkennlinie der Freilaufdiode Wechselr. (typisch)
Forward characteristic of FWD Inverter (typical)

$I_F = f(V_F)$

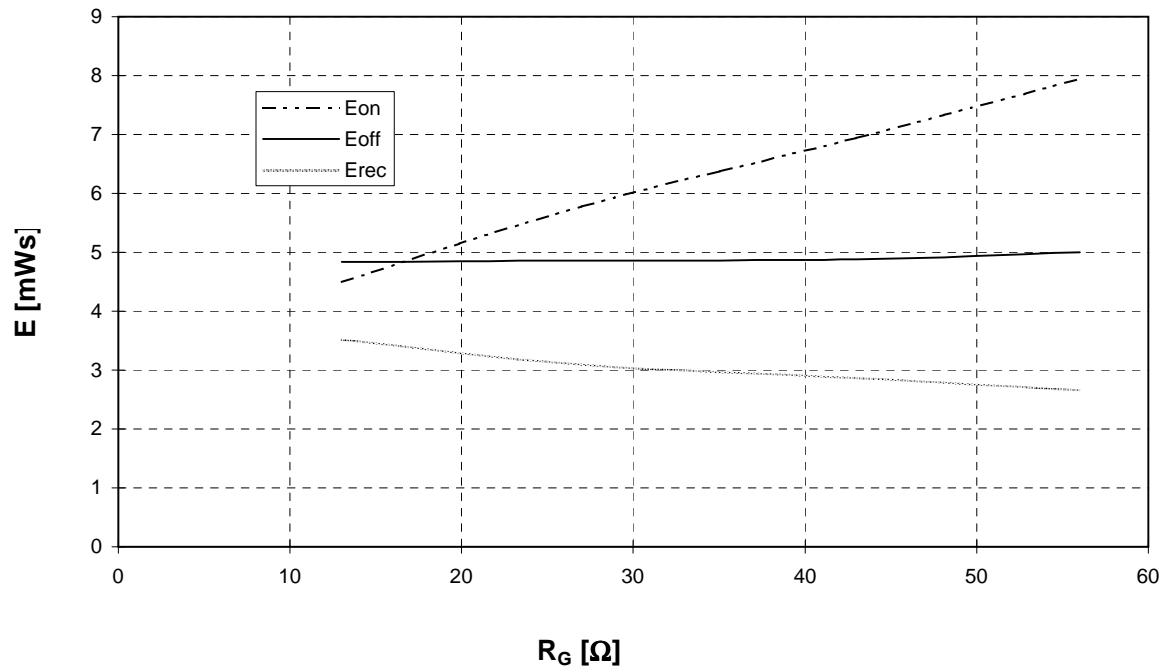


FP40R12KE3

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) $T_j = 125^\circ\text{C}, V_{GE} = \pm 15\text{ V}, R_{Gon} = R_{Goff} = 27\text{ Ohm}$

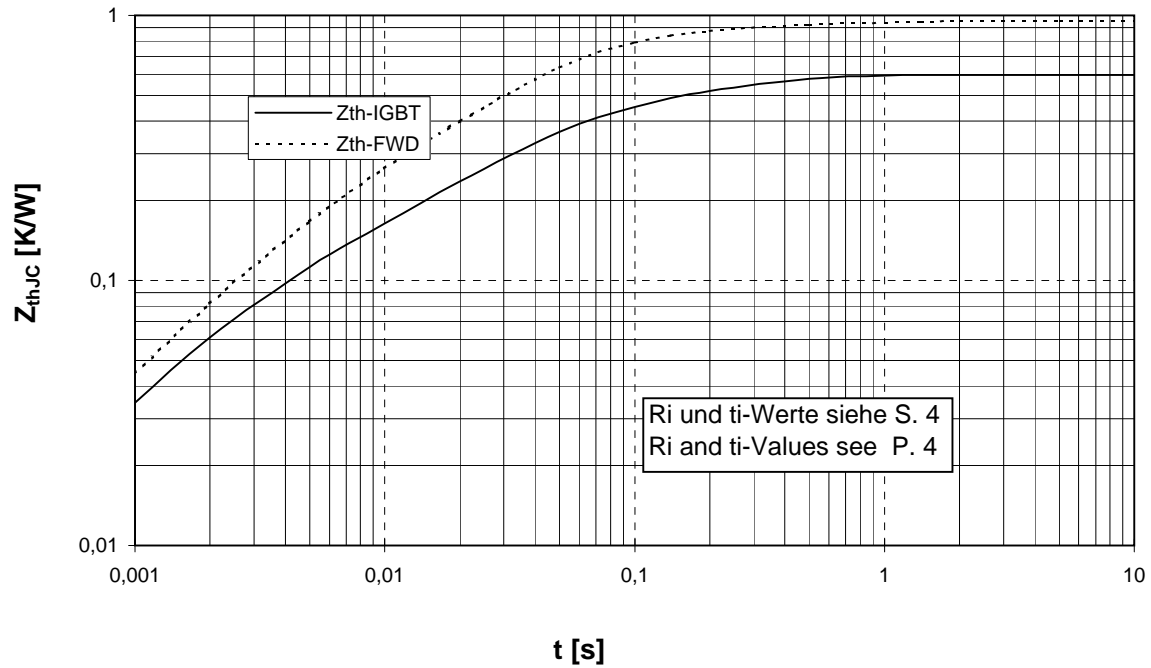


Schaltverluste Wechselr. (typisch) $E_{on} = f(R_G), E_{off} = f(R_G), E_{rec} = f(R_G)$
 Switching losses Inverter (typical) $T_j = 125^\circ\text{C}, V_{GE} = \pm 15\text{ V}, I_C = I_{nenn}, V_{CC} = 600\text{ V}$



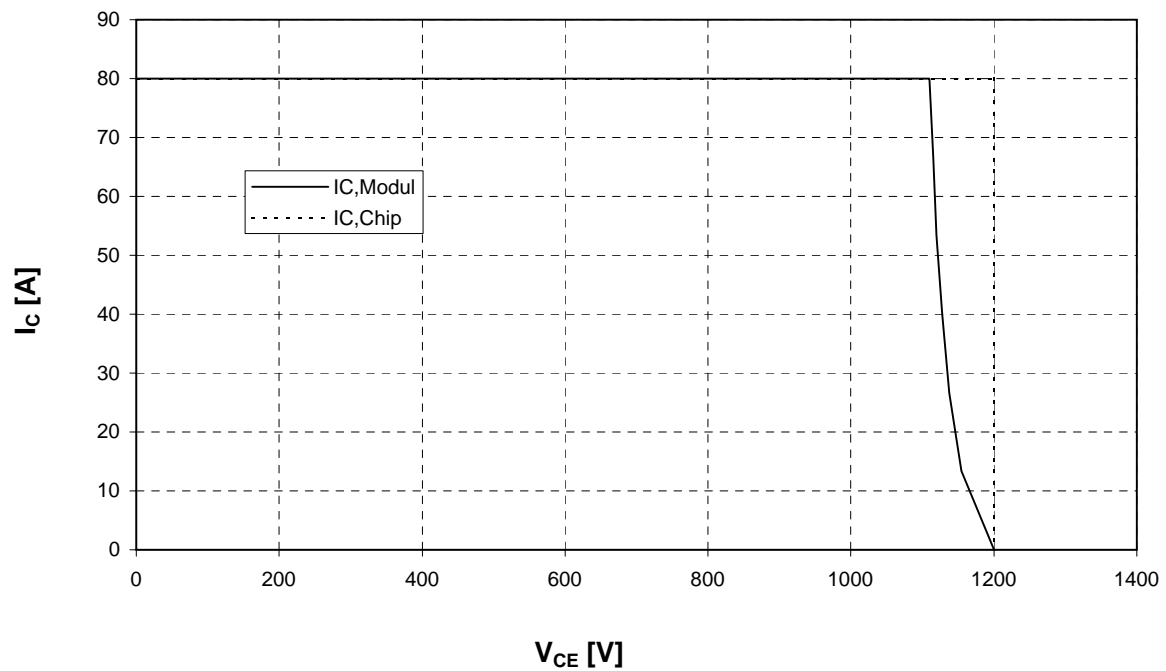
**Transienter Wärmewiderstand Wechselr.
Transient thermal impedance Inverter**

$Z_{thJC} = f(t)$



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

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

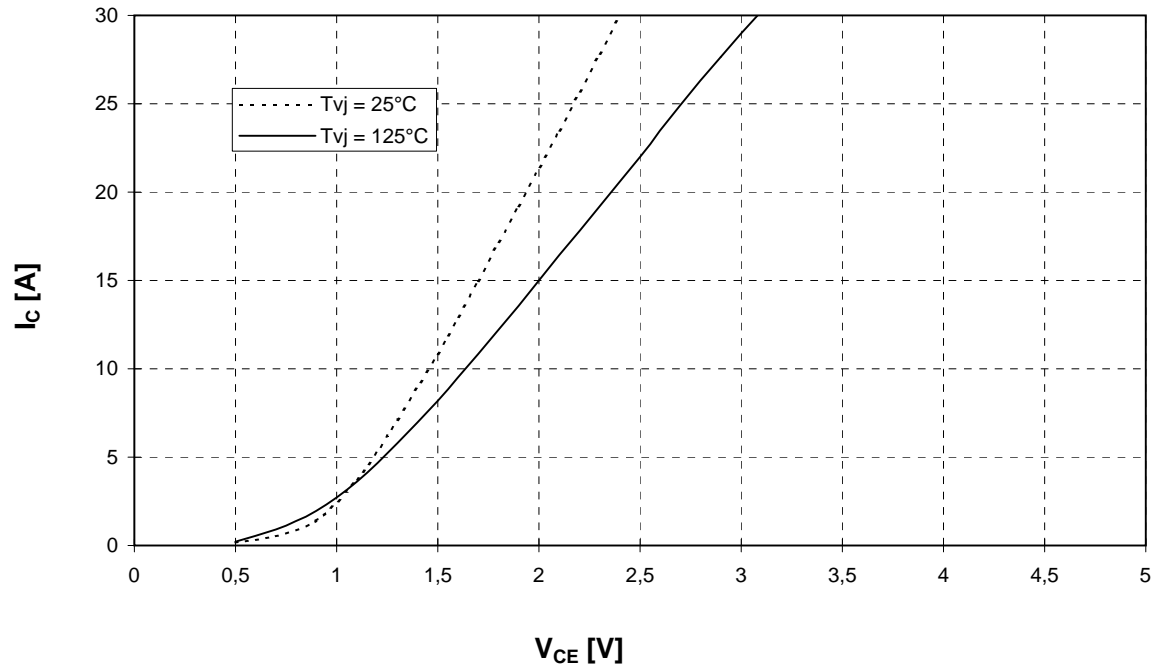


Ausgangskennlinienfeld Brems-Chopper-IGBT (typisch)

$I_C = f(V_{CE})$

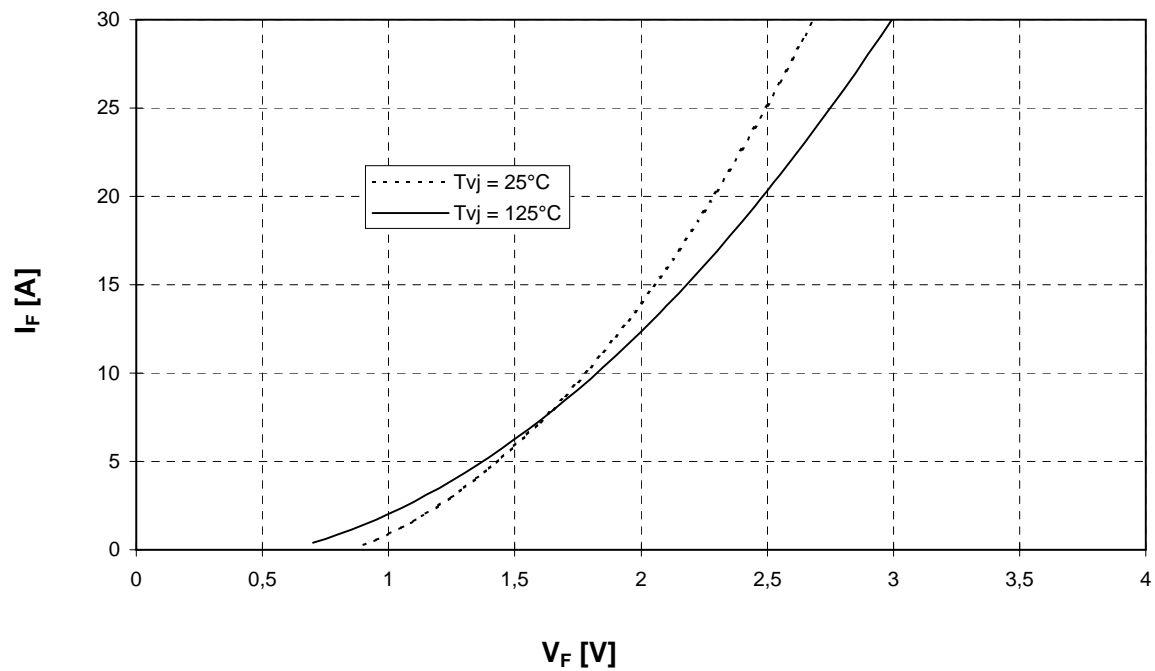
Output characteristic brake-chopper-IGBT (typical)

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

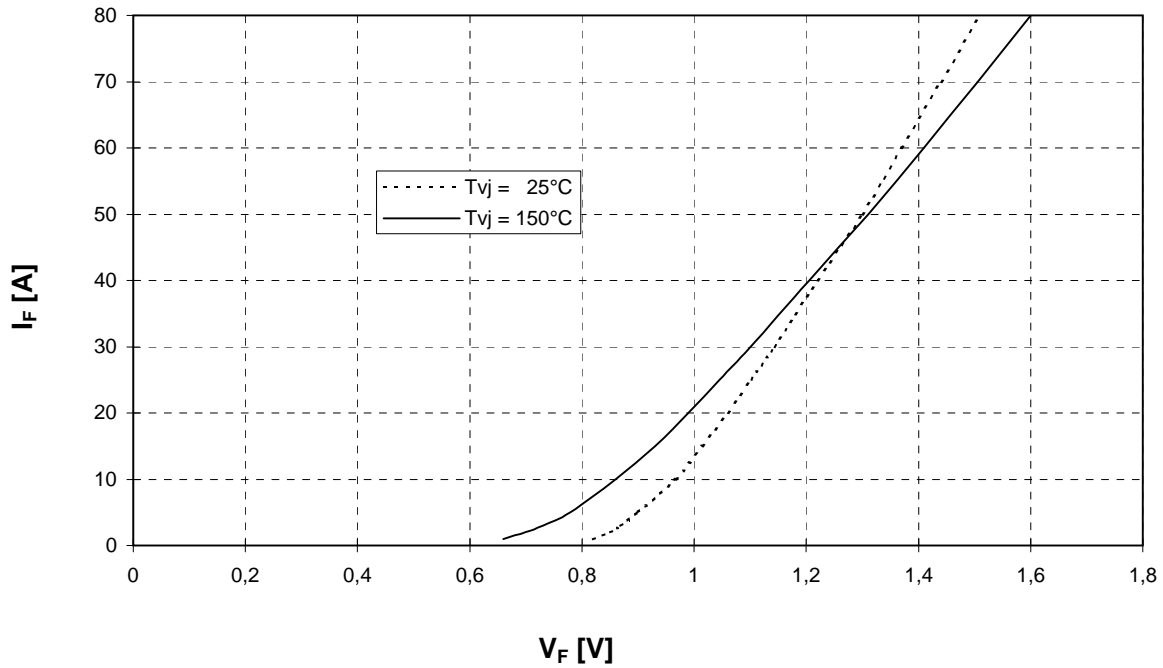


Durchlaßkennlinie der Brems-Chopper-Diode (typisch) $I_F = f(V_F)$

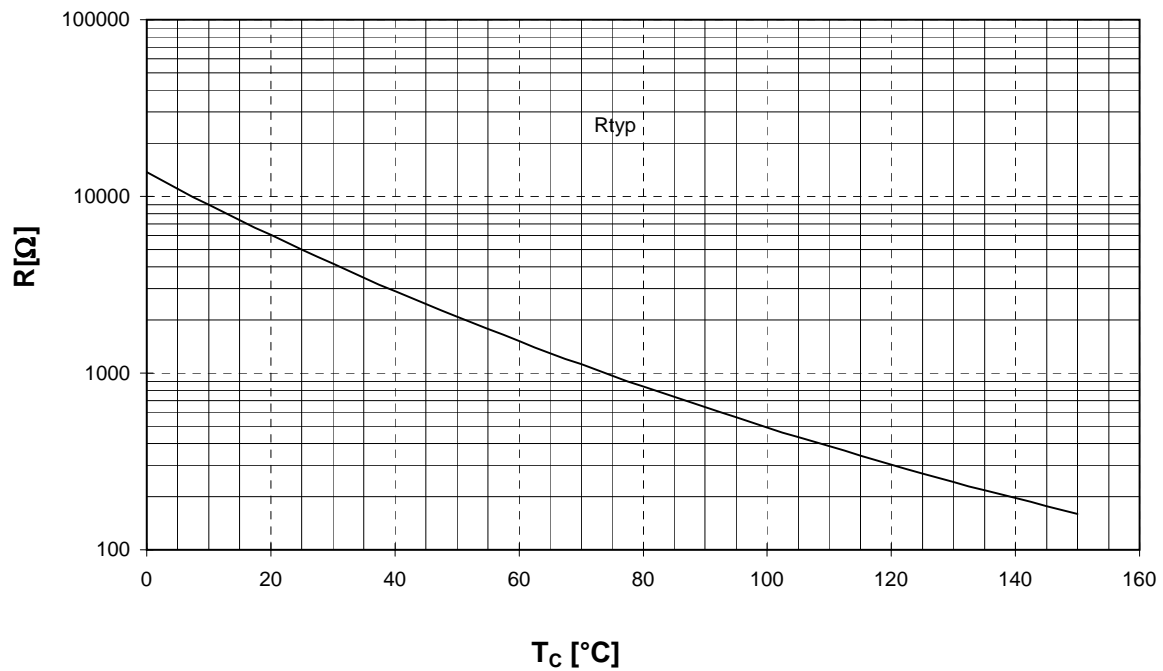
Forward characteristic of brake-chopper-FWD (typical)



Durchlaßkennlinie der Gleichrichterdiode (typisch) $I_F = f(V_F)$
Forward characteristic of Rectifier Diode (typical)

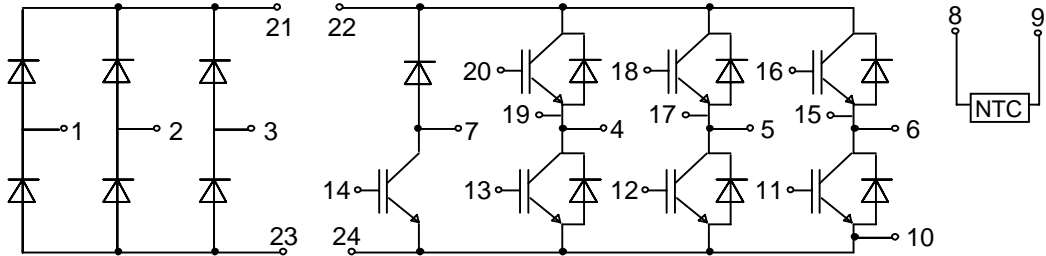


NTC- Temperaturkennlinie (typisch) $R = f(T)$
NTC- temperature characteristic (typical)

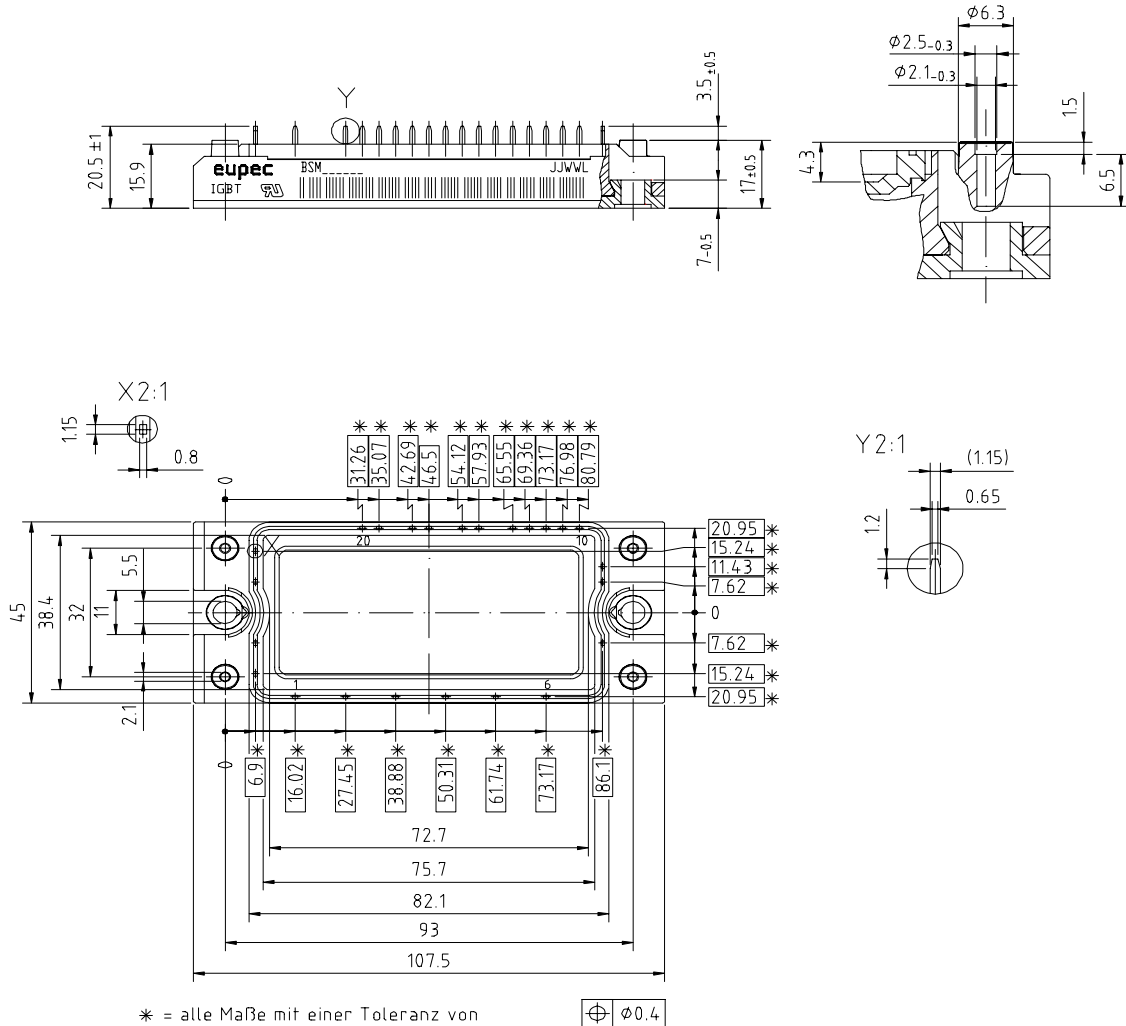


FP40R12KE3

Schaltplan/ Circuit diagram



Gehäuseabmessungen/ Package outlines



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.