

Maximum Ratings / Höchstzulässige Werte

Parameter	Condition	Symbol	Datasheet values	Unit
			max.	

Transistor Inverter
Transistor Wechselrichter

Collector-emitter break down voltage Kollektor-Emitter-Sperrspannung		V_{CE}	600	V
DC collector current Kollektor-Dauergleichstrom	$T_j=150^{\circ}\text{C}$ $T_h=80^{\circ}\text{C},$ $T_c=80^{\circ}\text{C}$	I_C	22 29	A
Repetitive peak collector current Periodischer Kollektorspitzenstrom	$t_p=1\text{ms}$ $T_h=80^{\circ}\text{C}$	I_{cpuls}	44	A
Power dissipation per IGBT Verlustleistung pro IGBT	$T_j=150^{\circ}\text{C}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	P_{tot}	49 74	W
Gate-emitter peak voltage Gate-Emitter-Spitzenspannung		V_{GE}	± 20	V
SC withstand time Kurzschlußverhalten	$T_j \leq 150^{\circ}\text{C}$ $V_{CE}=V_{CEBR}$	$V_{GE}=15\text{V}$ t_{SC}	10	us

Diode Inverter
Diode Wechselrichter

DC forward current Dauergleichstrom	$T_j=150^{\circ}\text{C}$ $T_h=80^{\circ}\text{C},$ $T_c=80^{\circ}\text{C}$	I_F	31 40-limited by wires	A
Repetitive peak forward current Periodischer Spitzenstrom	$t_p=1\text{ms}$ $T_h=80^{\circ}\text{C}$	I_{FRM}	62	A
Power dissipation per Diode Verlustleistung pro Diode	$T_j=150^{\circ}\text{C}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	P_{tot}	41 62	W

Thermal properties
Thermische Eigenschaften

max. Chip temperature max. Chiptemperatur		T_{jmax}	150	$^{\circ}\text{C}$
Storage temperature Lagertemperatur		T_{stg}	-40...+125	$^{\circ}\text{C}$
Operation temperature Betriebstemperatur		T_{op}	-40...+125	$^{\circ}\text{C}$

Insulation properties
Modulisation

Insulation voltage Isolationsspannung	$t=1\text{min}$	V_{is}	4000	Vdc
Creepage distance Kriechstrecke			min 12,7	mm
Clearance Luftstrecke			min 12,7	mm

Characteristic values

Description	Symbol	Conditions					Datasheet values			Unit
		T(C°)	Other conditions (Rgon-Rgoff)	VGE(V) VGS(V)	VR(V) VCE(V) VDS(V)	IC(A) IF(A) Id(A)	Min	Typ	Max	
Transistor Inverter, inductive load										
Transistor Wechselrichter										
Gate emitter threshold voltage Gate-Schwellenspannung	V _{GE(th)}	T _J =25°C T _J =125°C	VCE=VGE			0,0007	3	4	5	V
Collector-emitter saturation voltage Kollektor-Emitter Sättigungsspannung	V _{CE(sat)}	T _J =25°C T _J =125°C		15		30		2,21 2,49	2,65	V
Collector-emitter cut-off Kollektor-Emitter Reststrom	I _{CES}	T _J =25°C T _J =125°C		0	600				0,25 3	mA
Gate-emitter leakage current Gate-Emitter Reststrom	I _{GES}	T _J =25°C T _J =125°C		25	0				200	nA
Integrated Gate resistor Integriertes Gate Widerstand	R _{gint}							-		Ohm
Turn-on delay time Einschaltverzögerungszeit	t _{d(on)}	T _J =25°C T _J =125°C	Rgon=24 Ohm Rgoff=12 Ohm	15	300	30		30		ns
Rise time Anstiegszeit	t _r	T _J =25°C T _J =125°C	Rgon=24 Ohm Rgoff=12 Ohm	15	300	30			20	ns
Turn-off delay time Abschaltverzögerungszeit	t _{d(off)}	T _J =25°C T _J =125°C	Rgon=24 Ohm Rgoff=12 Ohm	15	300	30		333		ns
Fall time Fallzeit	t _f	T _J =25°C T _J =125°C	Rgon=24 Ohm Rgoff=12 Ohm	15	300	30		21		ns
Turn-on energy loss per pulse Einschaltverlustenergie pro Puls	E _{on}	T _J =25°C T _J =125°C	Rgon=24 Ohm Rgoff=12 Ohm	15	300	30		0,677		mWs
Turn-off energy loss per pulse Abschaltverlustenergie pro Puls	E _{off}	T _J =25°C T _J =125°C	Rgon=24 Ohm Rgoff=12 Ohm	15	300	30		0,695		mWs
Input capacitance Eingangskapazität	C _{ies}	T _J =25°C T _J =125°C	f=1MHz	0	25			1,6	1,92	nF
Output capacitance Ausgangskapazität	C _{oss}	T _J =25°C T _J =125°C	f=1MHz	0	25			0,15	0,18	nF
Reverse transfer capacitance Rückwirkungskapazität	C _{rss}	T _J =25°C T _J =125°C	f=1MHz	0	25			0,092	0,11	nF
Gate charge Gate Ladung	Q _{Gate}	T _J =25°C T _J =125°C		15	480	20		140	182	nC
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R _{thJH}		Thermal grease thickness≤50um Wärmeleitpaste Dicke≤50um λ = 0,61 W/mK					1,43 0,9438		K/W
Coupled thermal resistance inverter diode-transistor Gekoppelte Wärmewiderstand Wechselrichter Diode-Transistor	R _{thJH}		Thermal grease thickness≤50um Wärmeleitpaste Dicke≤50um λ = 0,61 W/mK					TBD		K/W

Characteristic values

Description	Symbol	Conditions					Datasheet values			Unit
		T(C°)	Other conditions (Rgon-Rgoff)	VGE(V) VGS(V)	VR(V) VCE(V) VDS(V)	IC(A) IF(A) Id(A)	Min	Typ	Max	

Diode Inverter

Diode Wechselrichter

Diode forward voltage Durchlaßspannung	V _F	Tj=25°C Tj=125°C				30		1,52 1,34	1,8	V
Peak reverse recovery current Rückstromspitze	I _{RRM}	Tj=25°C Tj=125°C	Rgon=24 Ohm	15	300	30		60		A
Reverse recovery time Sperrverzögerungszeit	t _{rr}	Tj=25°C Tj=125°C	Rgon=24 Ohm	15	300	30		66		ns
Reverse recovered charge Sperrverzögerungsladung	Q _{rr}	Tj=25°C Tj=125°C	Rgon=24 Ohm	15	300	30		2,29		uC
Reverse recovered energy Sperrverzögerungsenergie	E _{rec}	Tj=25°C Tj=125°C	Rgon=24 Ohm	15	300	30		0,376		mWs
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R _{thJH}		Thermal grease thickness≤50um Wärmeleitpaste Dicke≤50um λ = 0,61 W/mK					1,7 1,122		K/W
Coupled thermal resistance inverter transistor-diode	R _{thJH}		Thermal grease thickness≤50um Wärmeleitpaste Dicke≤50um λ = 0,61 W/mK					TBD		K/W
Gekoppelte Wärmewiderstand Wechselrichter Transistor-Diode										

NTC-Thermistor

NTC-Widerstand

Rated resistance Nennwiderstand	R ₂₅	Tj=25°C	Tol. ±5%				20,9	22	23,1	kOhm
Deviation of R100 Abweichung von R100	D _{R/R}	Tc=100°C	R100=1503Ohm					2,9		%/K
Power dissipation given Epcos-Typ Verlustleistung Epcos-Typ angeben	P	Tj=25°C						210		mW
B-value B-Wert	B _(25/100)	Tj=25°C	Tol. ±3%					3980		K

Output inverter

Figure 1. Typical output characteristics
Output inverter IGBT
 $I_C = f(V_{CE})$

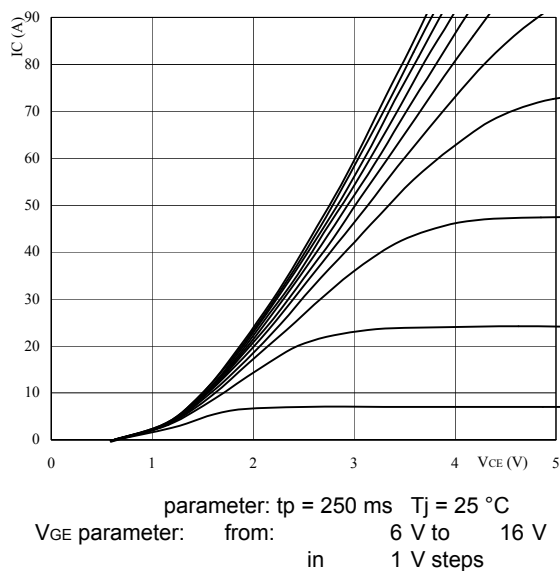


Figure 2. Typical output characteristics
Output inverter IGBT
 $I_C = f(V_{CE})$

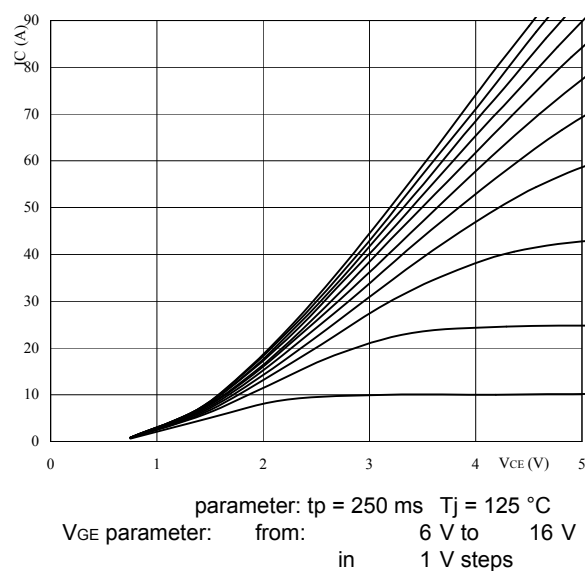


Figure 3. Typical transfer characteristics
Output inverter IGBT
 $I_C = f(V_{GE})$

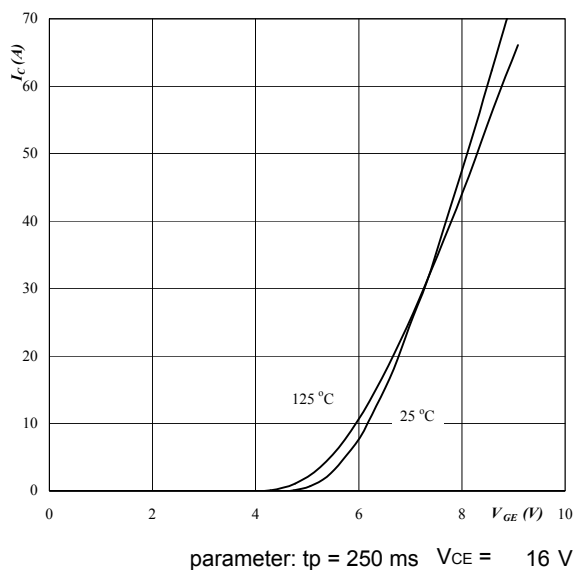
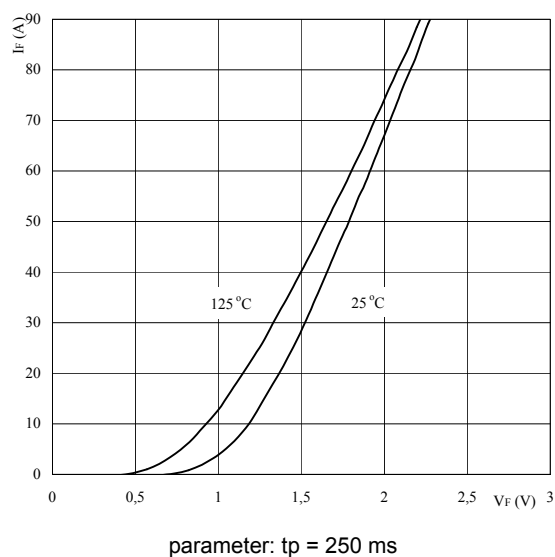


Figure 4. Typical diode forward current as a function of forward voltage
Output inverter FRED $I_F = f(V_F)$

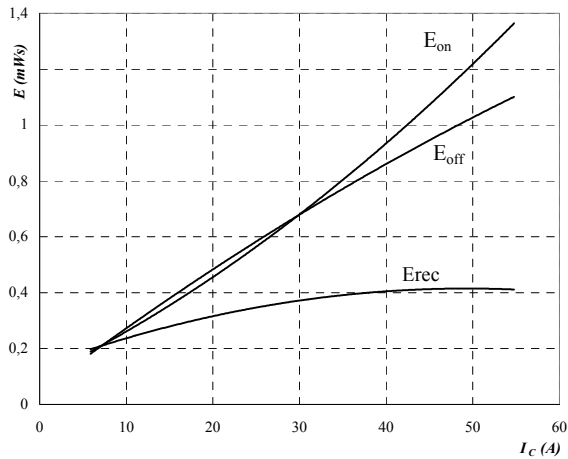


Output inverter

Figure 5. Typical switching energy losses as a function of collector current

Output inverter IGBT

$$E = f(I_c)$$



inductive load, $T_j = 125^\circ\text{C}$

$V_{CE} = 300\text{ V}$

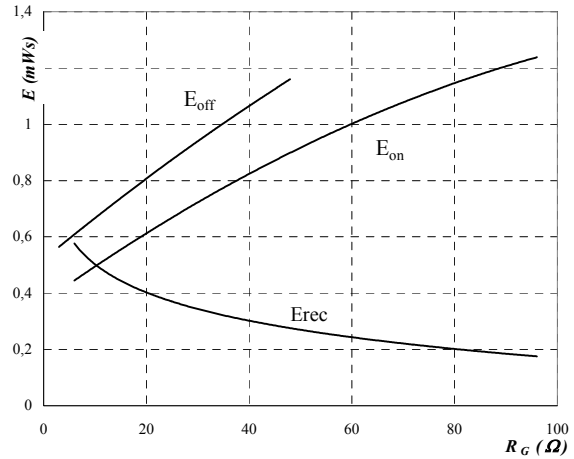
$V_{GE} = 15\text{ V}$

$R_{Gon} = 2 \cdot R_{Goff} = 24\text{ Ohm}$

Figure 6. Typical switching energy losses as a function of gate resistor

Output inverter IGBT

$$E = f(R_G)$$



inductive load, $T_j = 125^\circ\text{C}$

$V_{CE} = 300\text{ V}$

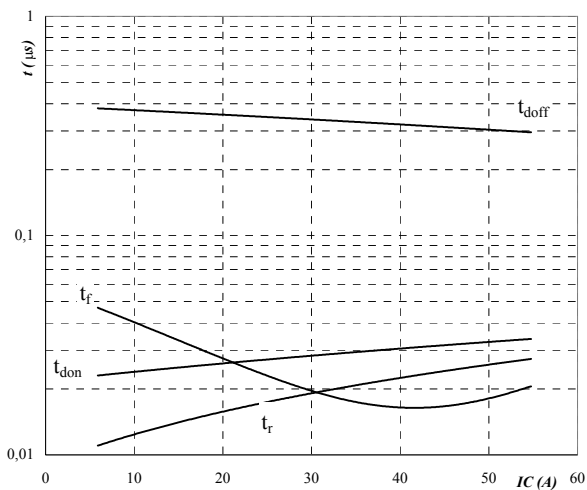
$V_{GE} = 15\text{ V}$

$I_c = 30\text{ A}$

Figure 7. Typical switching times as a function of collector current

Output inverter IGBT

$$t = f(I_c)$$



inductive load, $T_j = 125^\circ\text{C}$

$V_{CE} = 300\text{ V}$

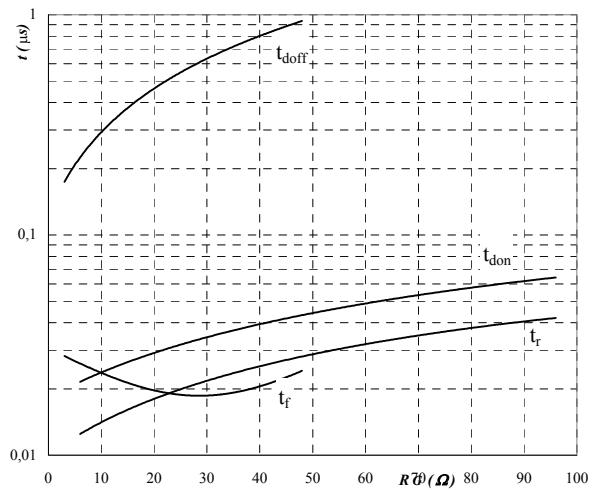
$V_{GE} = 15\text{ V}$

$R_{Gon} = 2 \cdot R_{Goff} = 24\text{ Ohm}$

Figure 8. Typical switching times as a function of gate resistor

Output inverter IGBT

$$t = f(R_G)$$



inductive load, $T_j = 125^\circ\text{C}$

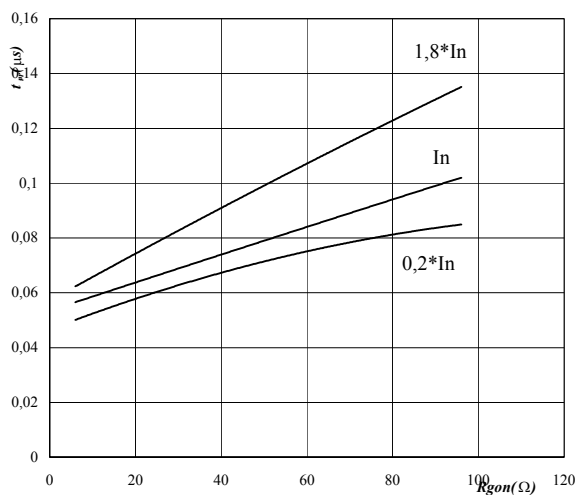
$V_{CE} = 300\text{ V}$

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

$I_c = 30\text{ A}$

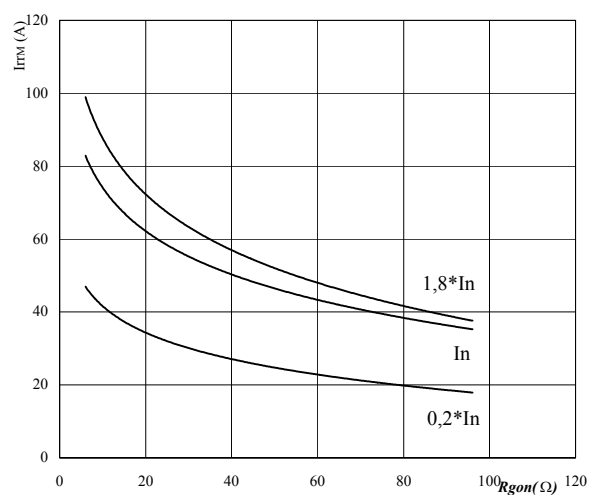
Output inverter

Figure 9. Typical reverse recovery time as a function of gate resistor
Output inverter FRED diode
 $t_{rr} = f(R_{gon})$



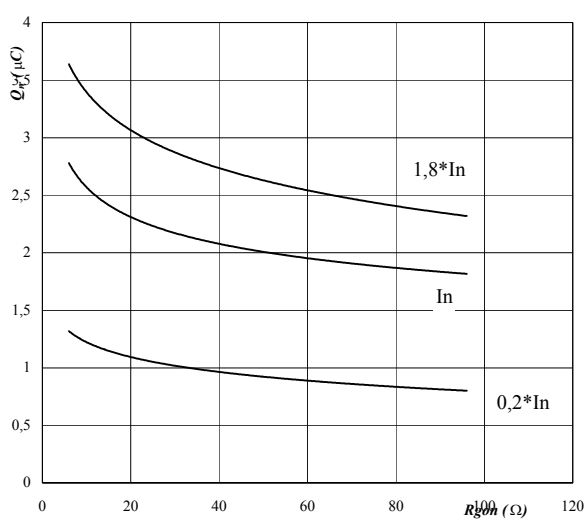
$T_j = 125^\circ C$
 $V_R = 300 V$
 $I_n = 30 A$

Figure 10. Typical reverse recovery current as a function of gate resistor
Output inverter FRED diode
 $I_{RRM} = f(R_{gon})$



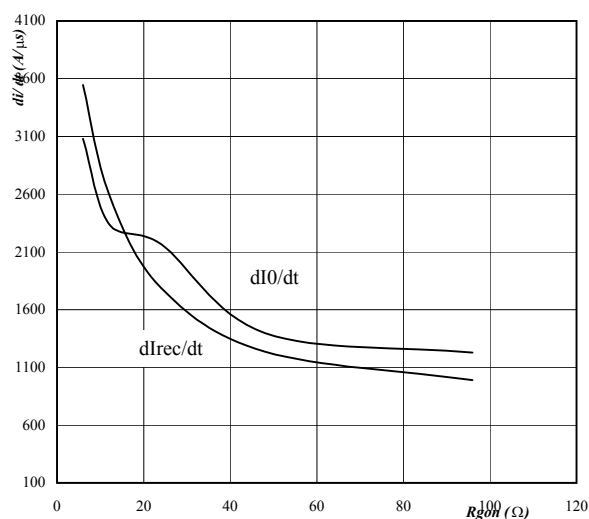
$T_j = 125^\circ C$
 $V_R = 300 V$
 $I_n = 30 A$

Figure 11. Typical reverse recovery charge as a function of gate resistor
Output inverter FRED diode
 $Q_{rr} = f(R_{gon})$



$T_j = 125^\circ C$
 $V_R = 300 V$
 $I_n = 30 A$

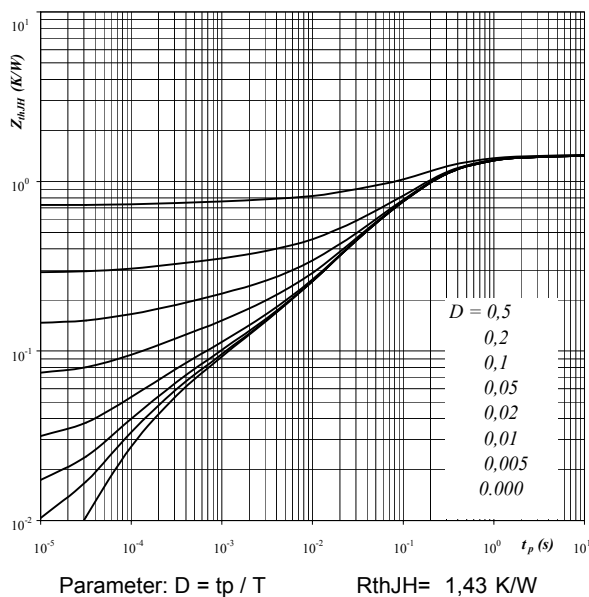
Figure 12. Typical diode peak rate of fall of forward and reverse recovery current as a function of gate resistor
Output inverter FRED diode
 $di_0/dt, dI_{rec}/dt = f(R_{gon})$



$T_j = 125^\circ C$
 $V_R = 300 V$
 $I_F = 30 A$

Output inverter

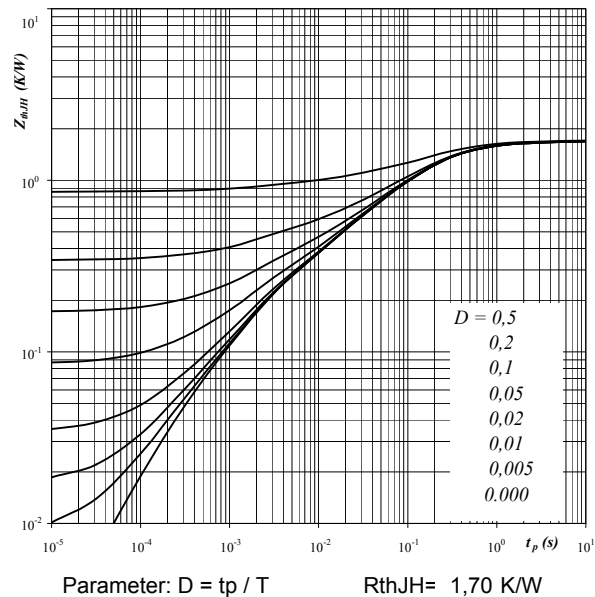
Figure 13. IGBT transient thermal impedance as a function of pulse width
 $Z_{thJH} = f(t_p)$



IGBT thermal model values

R (C/W)	Tau (s)
0,03	6,1E+01
0,10	2,2E+00
0,48	3,3E-01
0,56	9,8E-02
0,18	1,3E-02

Figure 14. FRED transient thermal impedance as a function of pulse width
 $Z_{thJH} = f(t_p)$



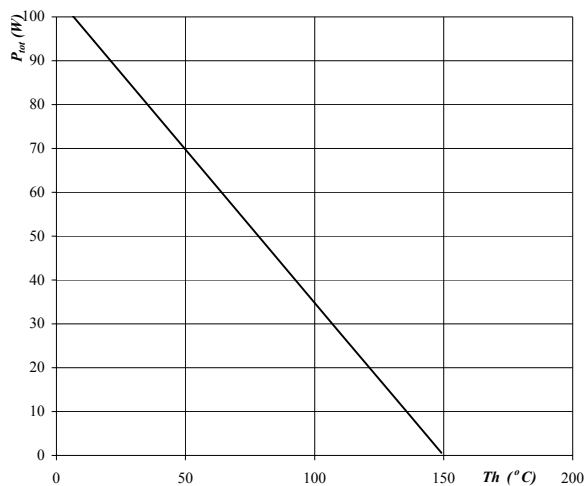
FRED thermal model values

R (C/W)	Tau (s)
0,03	3,5E+01
0,12	1,9E+00
0,57	3,0E-01
0,60	8,1E-02
0,23	1,3E-02

Output inverter

Figure 15. Power dissipation as a function of heatsink temperature

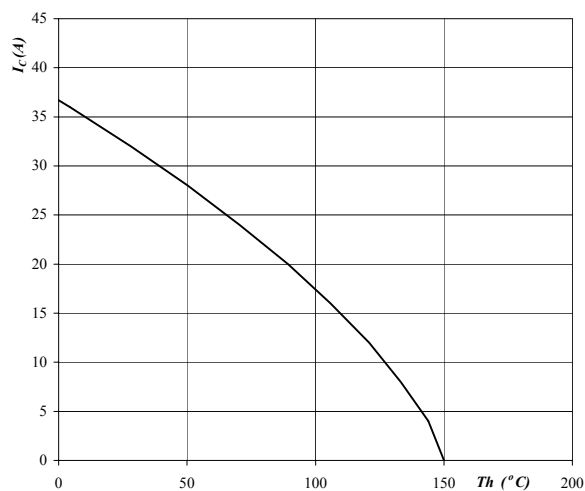
Output inverter IGBT
 $P_{tot} = f(T_h)$



parameter: $T_j = 150^{\circ}C$

Figure 16. Collector current as a function of heatsink temperature

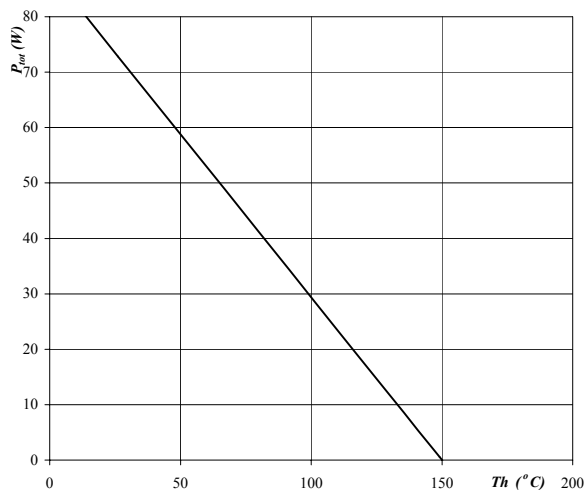
Output inverter IGBT
 $I_c = f(T_h)$



parameter: $T_j = 150^{\circ}C$
 $V_{GE} = 15\text{ V}$

Figure 17. Power dissipation as a function of heatsink temperature

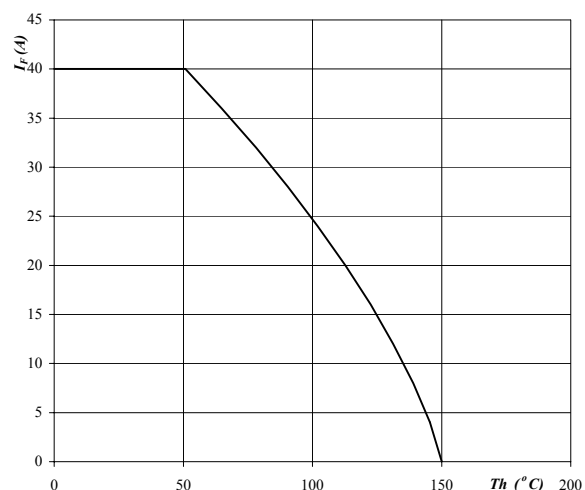
Output inverter FRED
 $P_{tot} = f(T_h)$



parameter: $T_j = 150^{\circ}C$

Figure 18. Forward current as a function of heatsink temperature

Output inverter FRED
 $I_F = f(T_h)$



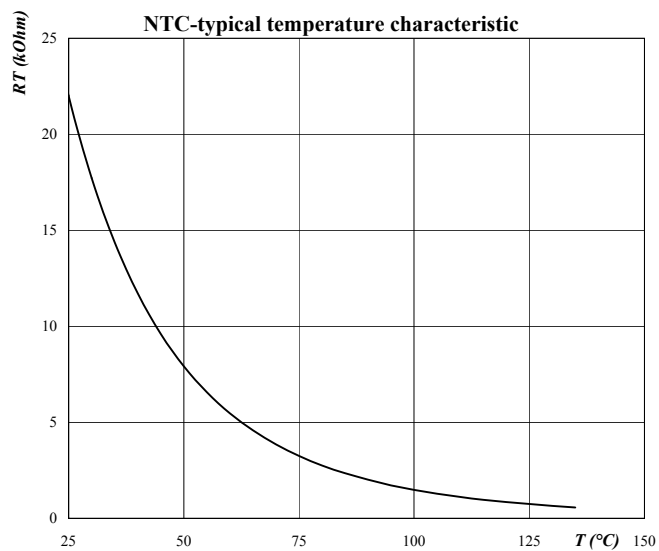
parameter: $T_j = 150^{\circ}C$

Thermistor

**Figure 23. Typical NTC characteristic
as a function of temperature**

NTC

$$RT = f(T)$$



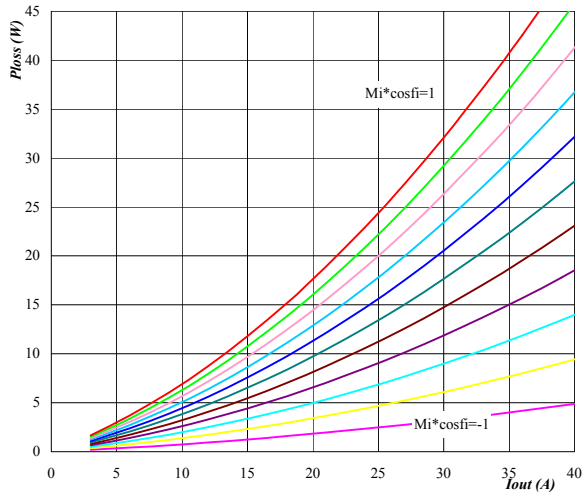
Output inverter application

General conditions: 3 phase SPWM, $V_{geon} = 15 \text{ V}$ $V_{geoff} = 0 \text{ V}$

$R_{gon} = 24 \text{ ohms}$

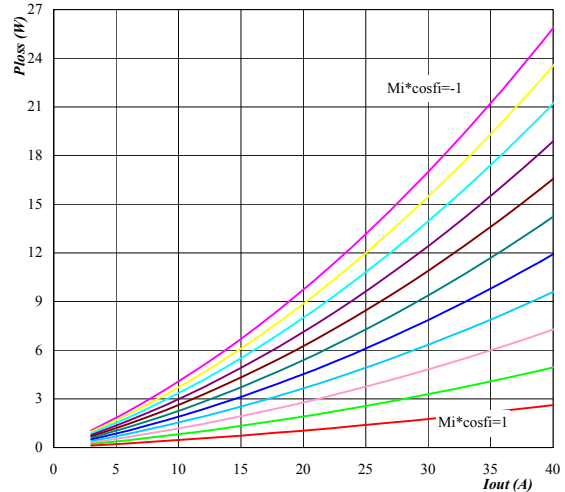
$R_{goff} = 12 \text{ ohms}$

Figure 1. Typical average static loss as a function of output current
IGBT $P_{loss} = f(I_{out})$



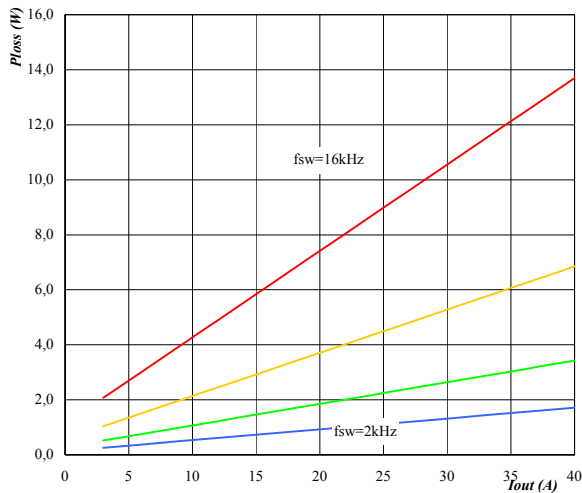
Conditions: $T_j = 125^\circ\text{C}$
Modulation index * cosfi
parameter $Mi \cdot \cos fi$ from -1,00 to 1,00
in 0,20 steps

Figure 2. Typical average static loss as a function of output current
FRED $P_{loss} = f(I_{out})$



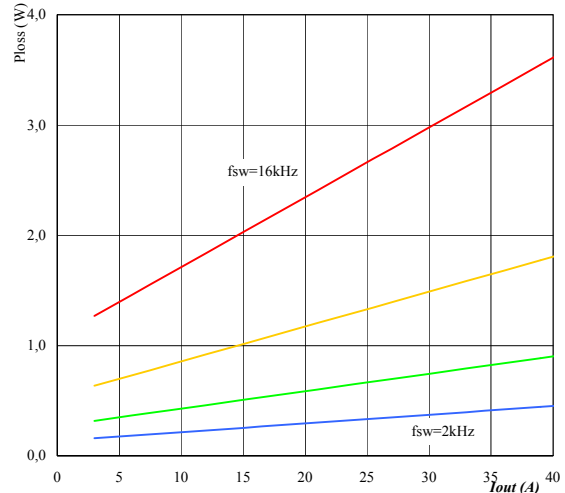
Conditions: $T_j = 125^\circ\text{C}$
Modulation index * cosfi
parameter $Mi \cdot \cos fi$ from -1,00 to 1,00
in 0,20 steps

Figure 3. Typical average switching loss as a function of output current
IGBT $P_{loss} = f(I_{out})$



Conditions: $T_j = 125^\circ\text{C}$
DC link = 320 V
Switching freq. parameter f_{sw} from 2 kHz to 16 kHz
in * 2 steps

Figure 4. Typical average switching loss as a function of output current
FRED $P_{loss} = f(I_{out})$



Conditions: $T_j = 125^\circ\text{C}$
DC link = 320 V
Switching freq. parameter f_{sw} from 2 kHz to 16 kHz
in * 2 steps

Output inverter application

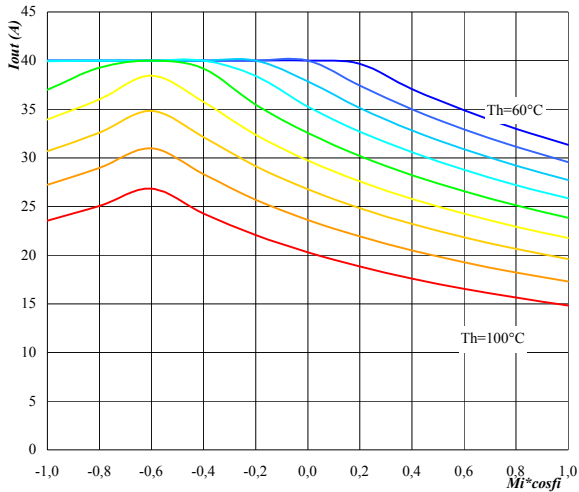
General conditions: 3 phase SPWM, $V_{geon} = 15 \text{ V}$ $V_{geoff} = 0 \text{ V}$

$R_{gon} = 24 \text{ ohms}$

$R_{goff} = 12 \text{ ohms}$

Figure 5. Typical available 50Hz output current as a function of $Mi \cdot \cos\phi_i$

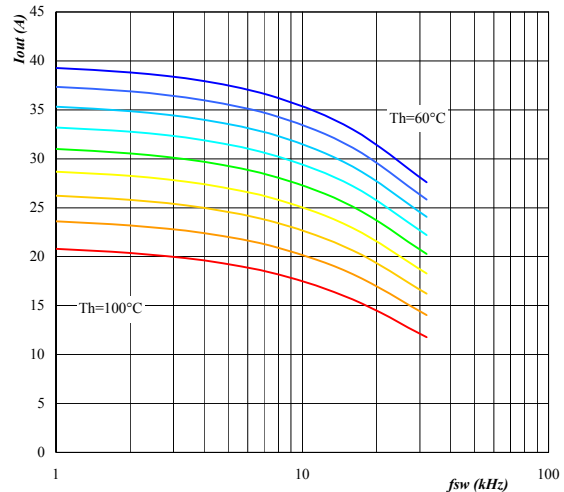
Phase $I_{out} = f(Mi \cdot \cos\phi_i)$



Conditions: $T_j = 125^\circ\text{C}$
 DC link = 320 V
 $f_{sw} = 16 \text{ kHz}$
 Heatsink temp. T_h from 60 °C to 100 °C
 parameter in 5 °C steps

Figure 6. Typical available 50Hz output current as a function of switching frequency

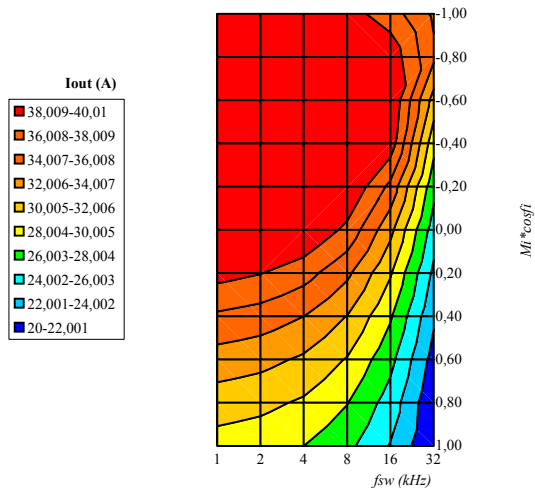
Phase $I_{out} = f(f_{sw})$



Conditions: $T_j = 125^\circ\text{C}$
 DC link = 320 V
 $Mi \cdot \cos\phi_i = 0,8$
 Heatsink temp. T_h from 60 °C to 100 °C
 parameter in 5 °C steps

Figure 7. Typical available 50Hz output current as a function of $Mi \cdot \cos\phi_i$ and f_{sw}

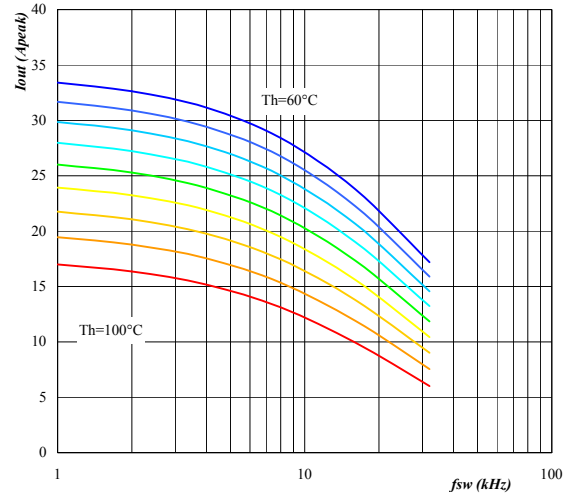
Phase $I_{out} = f(f_{sw}, Mi \cdot \cos\phi_i)$



Conditions: $T_j = 125^\circ\text{C}$
 DC link = 320 V
 $T_h = 80^\circ\text{C}$

Figure 8. Typical available 0Hz output current as a function of switching frequency

Phase $I_{outpeak} = f(f_{sw})$

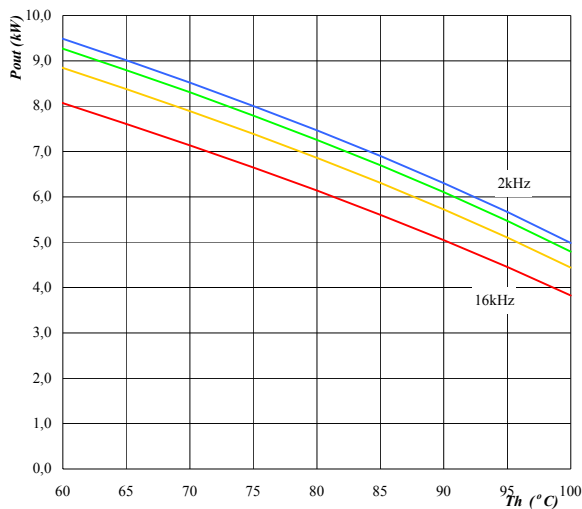


Conditions: $T_j = 125^\circ\text{C}$
 DC link = 320 V
 Heatsink temp. T_h from 60 °C to 100 °C
 parameter in 5 °C steps

Output inverter application

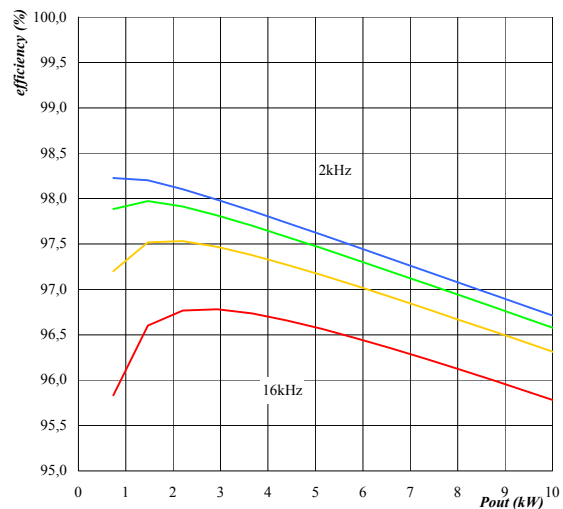
General conditions: 3 phase SPWM, $V_{geon} = 15 \text{ V}$ $V_{geoff} = 0 \text{ V}$ $R_{gon} = 24 \text{ ohms}$ $R_{goff} = 12 \text{ ohms}$

Figure 9. Typical available electric peak output power as a function of heatsink temperature
Inverter $P_{out} = f(T_h)$



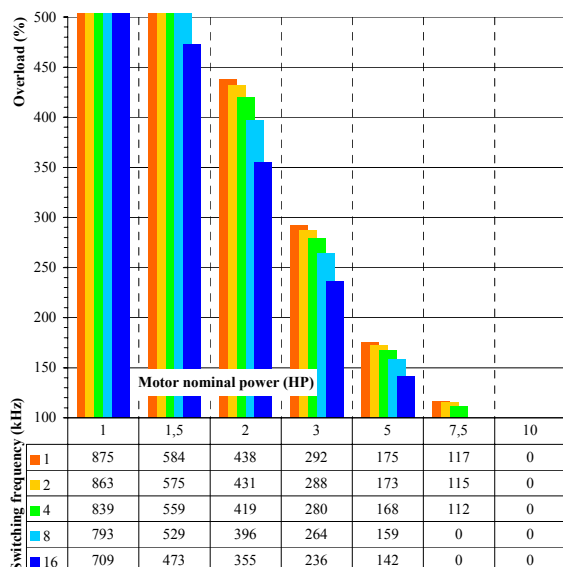
Conditions: $T_j = 125^\circ\text{C}$
DC link = 320 V
Modulation index $M_i = 1$
 $\cos\phi = 0,80$
Switching freq. parameter fsw from 2 kHz to 16 kHz
in * 2 steps

Figure 10. Typical efficiency as a function of output power
Inverter $\text{efficiency} = f(P_{out})$



Conditions: $T_j = 125^\circ\text{C}$
DC link = 320 V
Modulation index $M_i = 1$
 $\cos\phi = 0,80$
Switching freq. parameter fsw from 2 kHz to 16 kHz
in * 2 steps

Figure 11. Typical available overload factor as a function of motor power and switching frequency
Inverter $P_{peak}/P_{nom} = f(P_{nom}, f_{sw})$



Conditions: $T_j = 125^\circ\text{C}$
DC link = 320 V
Modulation index $M_i = 1$
 $\cos\phi = 0,8$
Switching freq. parameter fsw from 1 kHz to 16 kHz
in * 2 steps
Heatsink temperature = 80°C
Motor efficiency = 0,85