

Maximum Ratings / Höchstzulässige Werte

Parameter	Condition	Symbol	Datasheet values	Unit
			max.	

Input Rectifier Bridge
Gleichrichter

Repetitive peak reverse voltage Periodische Rückw. Spitzensperrspannung		V_{RRM}	1600	V
Forward current per diode Dauergrenzstrom	DC current $T_n=80^\circ\text{C}$;	I_{FAV}	35	A
Surge forward current Stoßstrom Grenzwert	$t_p=10\text{ms}$ $T_j=25^\circ\text{C}$	I_{FSM}	200	A
I^2t -value Grenzlastintegral	$t_p=10\text{ms}$ $T_j=25^\circ\text{C}$	I^2t	200	A^2s
Power dissipation per Diode Verlustleistung pro Diode	$T_j=150^\circ\text{C}$ $T_n=80^\circ\text{C}$	P_{tot}	44	W

Transistor Inverter
Transistor Wechselrichter

Collector-emitter break down voltage Kollektor-Emitter-Sperrspannung		V_{CE}	600	V
DC collector current Kollektor-Dauergleichstrom	$T_j=150^\circ\text{C}$ $T_n=80^\circ\text{C}$,	I_C	22	A
Repetitive peak collector current Periodischer Kollektorspitzenstrom	$t_p=1\text{ms}$ $T_n=80^\circ\text{C}$	I_{cpuls}	44	A
Power dissipation per IGBT Verlustleistung pro IGBT	$T_j=150^\circ\text{C}$ $T_n=80^\circ\text{C}$	P_{tot}	42	W
Gate-emitter peak voltage Gate-Emitter-Spitzenspannung		V_{GE}	± 20	V
SC withstand time Kurzschlußverhalten	$T_j=125^\circ\text{C}$ $V_{GE}=15\text{V}$ $V_{ce}=390\text{V}$	t_{SC}	3	μs

Diode Inverter
Diode Wechselrichter

DC forward current Dauergleichstrom	$T_j=150^\circ\text{C}$ $T_n=80^\circ\text{C}$,	I_F	15,5	A
Repetitive peak forward current Periodischer Spitzenstrom	$t_p=1\text{ms}$ $T_n=80^\circ\text{C}$	I_{FRM}	31	A
Power dissipation per Diode Verlustleistung pro Diode	$T_j=150^\circ\text{C}$ $T_n=80^\circ\text{C}$	P_{tot}	24	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
Modulisolation

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	
Input Rectifier Bridge										
Gleichrichter										
Forward voltage Durchlaßspannung	V _F	T _j =25°C T _j =125°C				30		1,21 1,19	1,35	V
Threshold voltage (for power loss calc. only) Schleusenspannung	V _{to}	T _j =25°C T _j =125°C				30		0,92 0,81	0,85	V
Slope resistance (for power loss calc. only) Ersatzwiderstand	r _t	T _j =25°C T _j =125°C				30		0,01 0,013		Ohm
Reverse current Sperrstrom	I _r	T _j =25°C T _j =150°C			1200			2	0,01 3	mA
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					1,6		K/W

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			0,00025		5,6		V
Collector-emitter saturation voltage Kollektor-Emitter Sättigungsspannung	V _{CE(sat)}	T _j =25°C T _j =125°C		15		12		2,5 1,8	2,75	V
Collector-emitter cut-off Kollektor-Emitter Reststrom	I _{CES}	T _j =25°C T _j =125°C		0	600				0,25 2	mA
Gate-emitter leakage current Gate-Emitter Reststrom	I _{GES}	T _j =25°C T _j =125°C		25	0				300	nA
Turn-on delay time Einschaltverzögerungszeit	t _{d(on)}	T _j =25°C T _j =125°C	Rgon=12 Ohm Rgoff=2 Ohm	15	300	12		17		ns
Rise time Anstiegszeit	t _r	T _j =25°C T _j =125°C	Rgon=12 Ohm Rgoff=2 Ohm	15	300	12		8		ns
Turn-off delay time Abschaltverzögerungszeit	t _{d(off)}	T _j =25°C T _j =125°C	Rgon=12 Ohm Rgoff=2 Ohm	15	300	12		80		ns
Fall time Fallzeit	t _f	T _j =25°C T _j =125°C	Rgon=12 Ohm Rgoff=2 Ohm	15	300	12		29		ns
Turn-on energy loss per pulse Einschaltverlustenergie pro Puls	E _{on}	T _j =25°C T _j =125°C	Rgon=12 Ohm Rgoff=2 Ohm	15	300	12		0,155		mWs
Turn-off energy loss per pulse Abschaltverlustenergie pro Puls	E _{off}	T _j =25°C T _j =125°C	Rgon=12 Ohm Rgoff=2 Ohm	15	300	12		0,133		mWs
Input capacitance Eingangskapazität	C _{ies}	T _j =25°C T _j =125°C	f=1MHz	0	25			1,2		nF
Output capacitance Ausgangskapazität	C _{oss}	T _j =25°C T _j =125°C	f=1MHz	0	25			0,15		nF
Reverse transfer capacitance Rückwirkungskapazität	C _{rss}	T _j =25°C T _j =125°C	f=1MHz	0	25			0,05		nF
Gate charge Gate Ladung	Q _{Gate}	T _j =25°C T _j =125°C		15	300	12		78	96	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					1,69		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

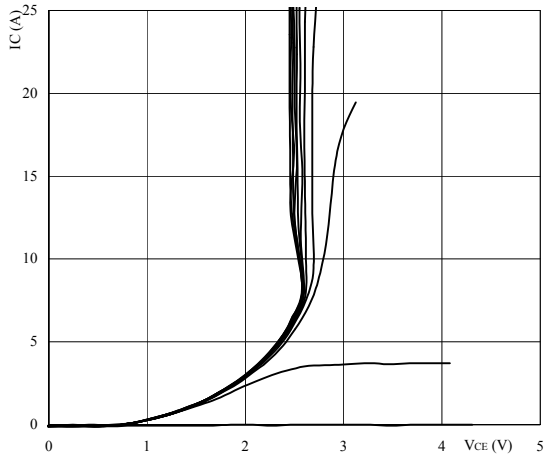
Diode forward voltage Durchlaßspannung	V_F	Tj=25°C Tj=125°C				12		1,92 1,48	2,3	V
Peak reverse recovery current Rückstromspitze	I_{RM}	Tj=25°C Tj=125°C	Rgon=120hm	15	300	12		22,7		A
Reverse recovery time Sperrverzögerungszeit	t_{rr}	Tj=25°C Tj=125°C	Rgon=120hm	15	300	12		50		ns
Reverse recovered charge Sperrverzögerungsladung	Q_{rr}	Tj=25°C Tj=125°C	Rgon=120hm	15	300	12		0,55		uC
Reverse recovered energy Sperrverzögerungsenergie	Erec	Tj=25°C Tj=125°C	Rgon=120hm	15	300	12		0,089		mWs
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thickness≤50um Wärmeleitpaste Dicke≤50um $\lambda = 0,61 \text{ W/mK}$					2,95		K/W

NTC-Thermistor
NTC-Widerstand

Rated resistance Nennwiderstand	R_{25}	Tj=25°C	Tol. ±5%					9,5	10	10,5	kOhm
Deviation of R100 Abweichung von R100	$D_{R/R}$	Tc=100°C	R100=1503Ohm					3,4			%/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%					4500			K

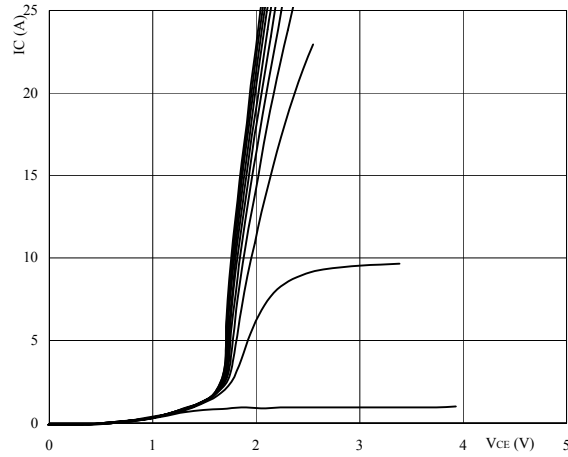
Output inverter

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



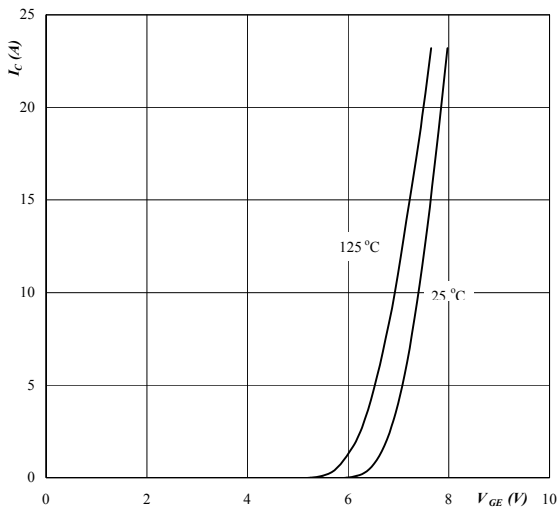
parameter: $t_p = 250 \text{ ms}$ $T_j = 25 \text{ }^\circ\text{C}$
V_{GE} parameter: from: 6 V to 16 V
in 1 V steps

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



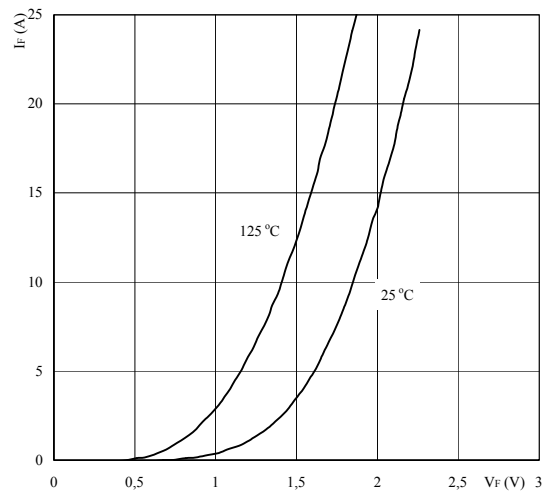
parameter: $t_p = 250 \text{ ms}$ $T_j = 125 \text{ }^\circ\text{C}$
V_{GE} parameter: from: 6 V to 16 V
in 1 V steps

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



parameter: $t_p = 250 \text{ ms}$ $V_{CE} = 4 \text{ V}$

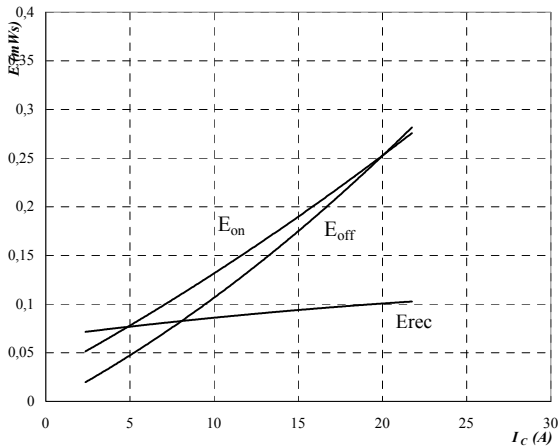
Figure 4. Typical diode forward current as a function of forward voltage
Output inverter FRED $I_F = f(V_F)$



parameter: $t_p = 250 \text{ ms}$

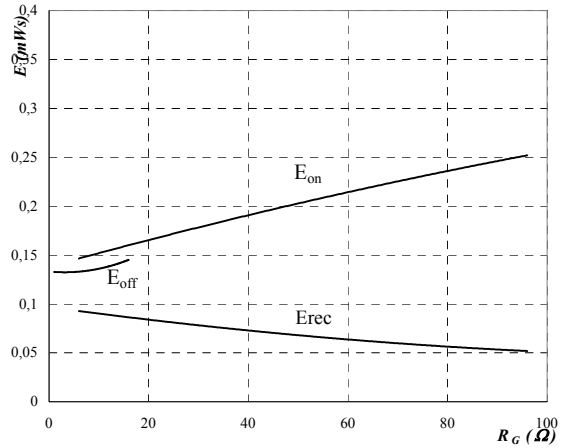
Output inverter

Figure 5. Typical switching energy losses as a function of collector current
Output inverter IGBT
 $E = f(I_C)$



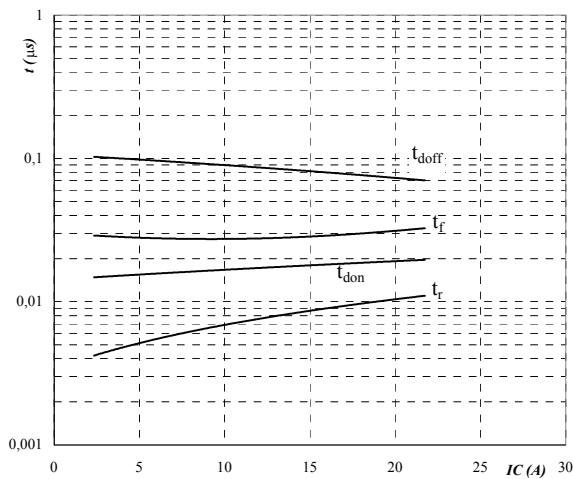
inductive load, $T_j = 125\text{ }^\circ\text{C}$
 $V_{CE} = 300\text{ V}$
 $V_{GE} = 15\text{ V}$
 $R_{Gon} = 6 * R_{Goff} = 12\text{ Ohm}$

Figure 6. Typical switching energy losses as a function of gate resistor
Output inverter IGBT
 $E = f(R_G)$



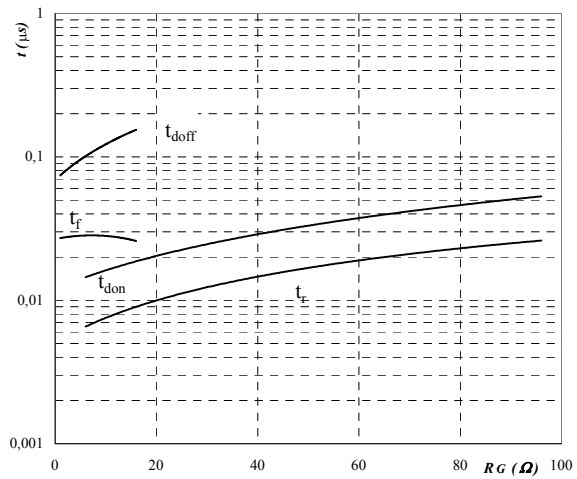
inductive load, $T_j = 125\text{ }^\circ\text{C}$
 $V_{CE} = 300\text{ V}$
 $V_{GE} = 15\text{ V}$
 $I_C = 12\text{ A}$

Figure 7. Typical switching times as a function of collector current
Output inverter IGBT
 $t = f(I_C)$



inductive load, $T_j = 125\text{ }^\circ\text{C}$
 $V_{CE} = 300\text{ V}$
 $V_{GE} = 15\text{ V}$
 $R_{Gon} = 6 * R_{Goff} = 12\text{ Ohm}$

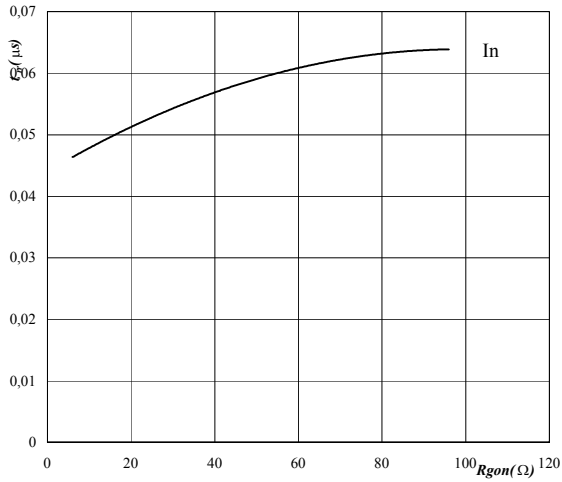
Figure 8. Typical switching times as a function of gate resistor
Output inverter IGBT
 $t = f(R_G)$



inductive load, $T_j = 125\text{ }^\circ\text{C}$
 $V_{CE} = 300\text{ V}$
 $V_{GE} = 15\text{ V}$
 $I_C = 12\text{ A}$

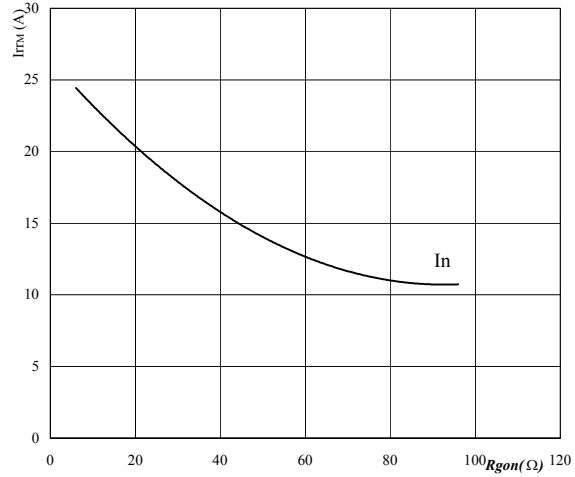
Output inverter

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



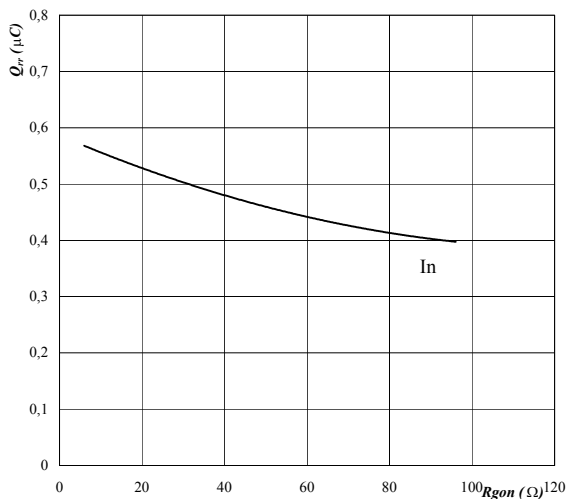
$T_j = 125\text{ }^\circ\text{C}$
 $V_R = 300\text{ V}$
 $I_n = 12\text{ A}$

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



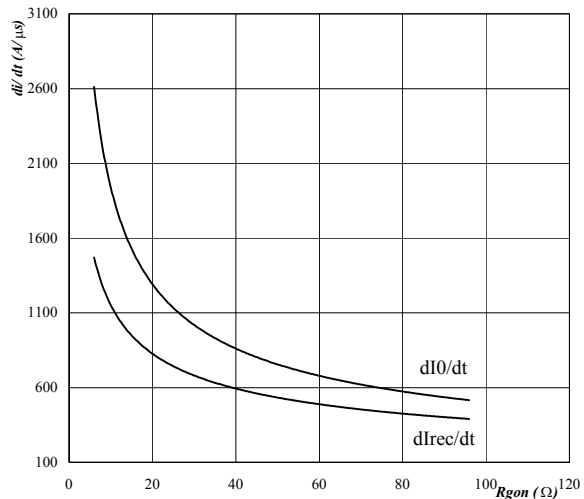
$T_j = 125\text{ }^\circ\text{C}$
 $V_R = 300\text{ V}$
 $I_n = 12\text{ A}$

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



$T_j = 125\text{ }^\circ\text{C}$
 $V_R = 300\text{ V}$
 $I_n = 12\text{ A}$

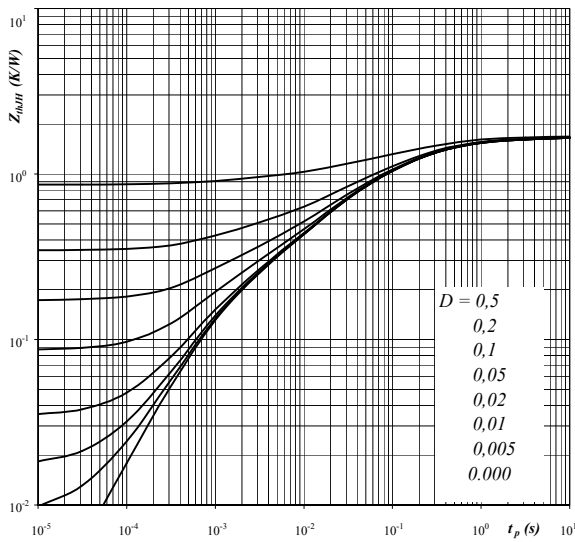
Figure 12. Typical diode peak rate of fall of forward and reverse recovery current as a function of gate resistor
 Output inverter FRED diode
 $dI_0/dt, dI_{rec}/dt = f(R_{gon})$



$T_j = 125\text{ }^\circ\text{C}$
 $V_R = 300\text{ V}$
 $I_F = 12\text{ A}$

Output inverter

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

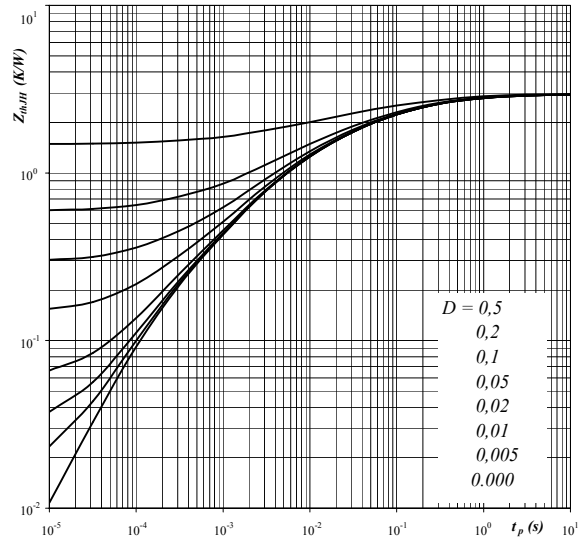


Parameter: $D = t_p / T$ $R_{thJH} = 1,69 \text{ K/W}$

IGBT thermal model values

R (C/W)	Tau (s)
0,08	1,3E+02
0,15	2,1E+00
0,55	2,6E-01
0,50	5,7E-02

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



Parameter: $D = t_p / T$ $R_{thJH} = 2,95 \text{ K/W}$

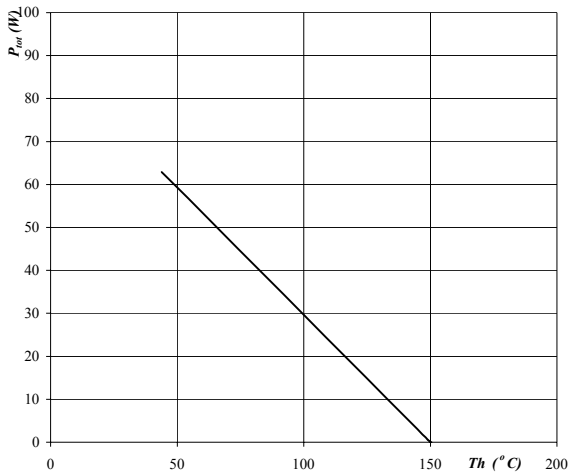
FRED thermal model values

R (C/W)	Tau (s)
0,06	5,0E+01
0,25	1,3E+00
0,69	1,9E-01
0,75	3,7E-02
0,73	7,3E-03

Output inverter

Figure 15. Power dissipation as a function of heatsink temperature

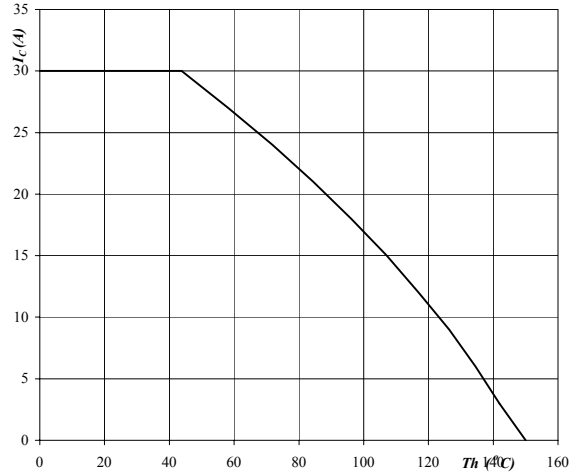
Output inverter IGBT
 $P_{tot} = f(T_h)$



parameter: T_j = 150°C

Figure 16. Collector current as a function of heatsink temperature

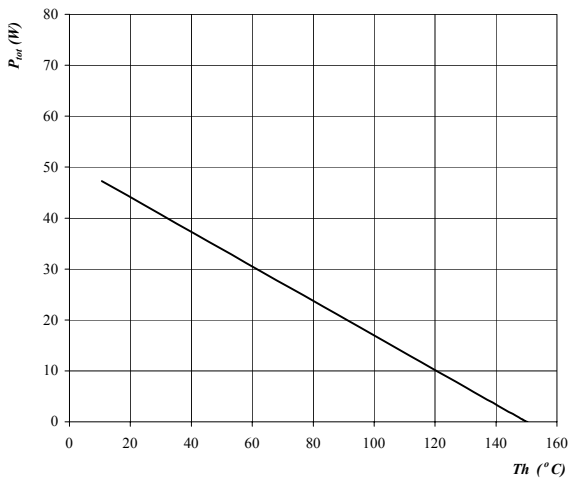
Output inverter IGBT
 $I_c = f(T_h)$



parameter: T_j = 150°C
 V_{GE} = 0 V

Figure 17. Power dissipation as a function of heatsink temperature

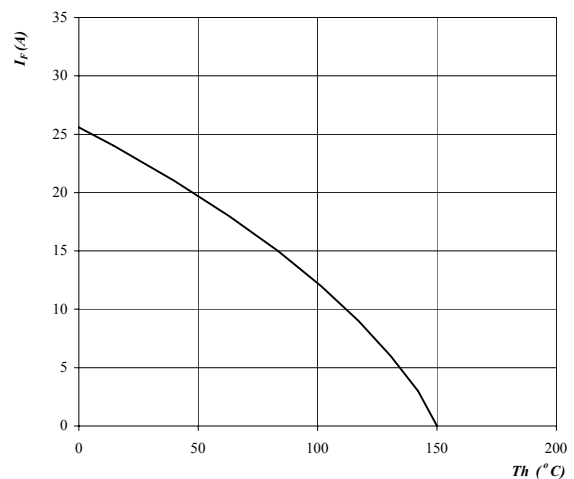
Output inverter FRED
 $P_{tot} = f(T_h)$



parameter: T_j = 150°C

Figure 18. Forward current as a function of heatsink temperature

Output inverter FRED
 $I_F = f(T_h)$



parameter: T_j = 150°C

Input rectifier bridge

Figure 19. Typical diode forward current as a function of forward voltage
 Rectifier diode $I_F = f(V_F)$

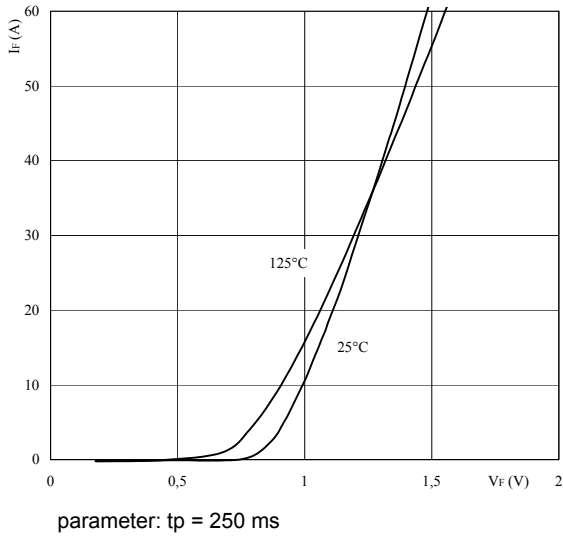


Figure 20. Diode transient thermal impedance as a function of pulse width
 $Z_{thJC} = f(t_p)$

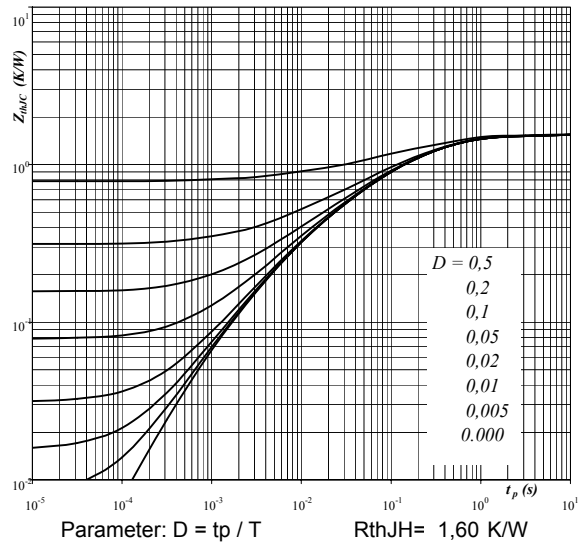


Figure 21. Power dissipation as a function of heatsink temperature
 Rectifier diode $P_{tot} = f(T_h)$

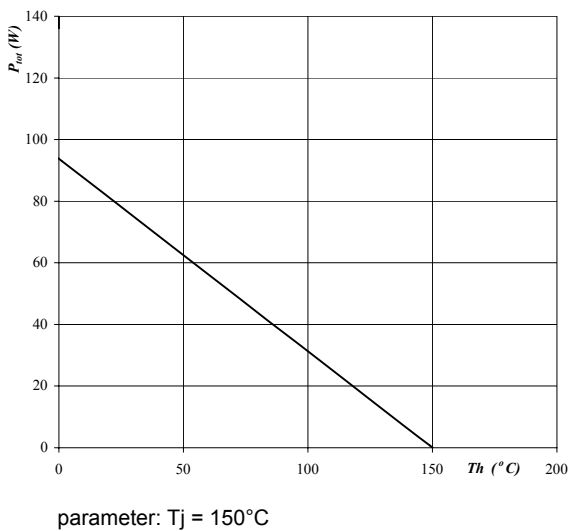
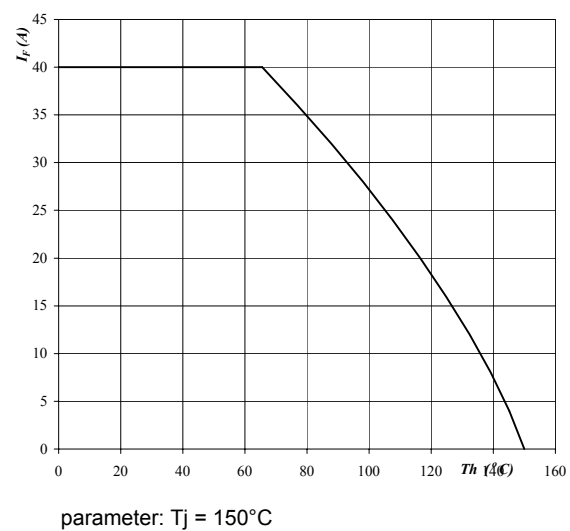


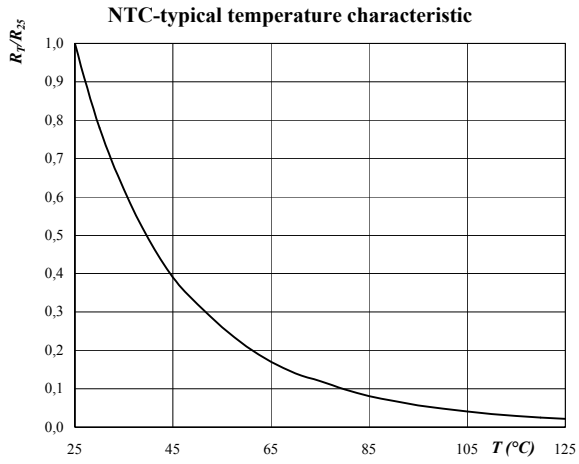
Figure 22. Forward current as a function of heatsink temperature
 Rectifier diode $I_F = f(T_h)$



Thermistor

Figure 23. Typical NTC characteristic as a function of temperature

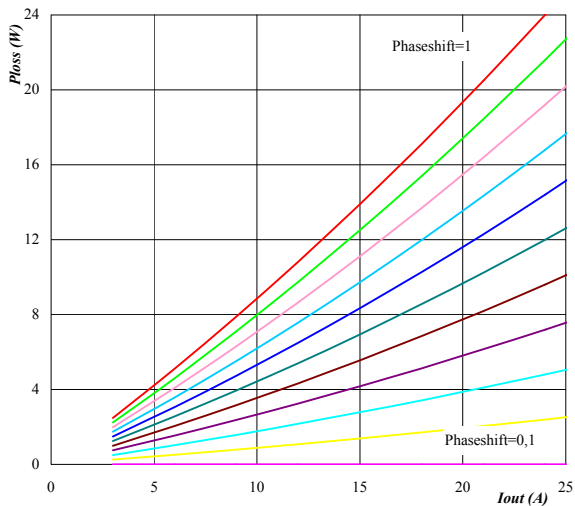
NTC
 $R_T / R_{25} = f(T)$



Output inverter application

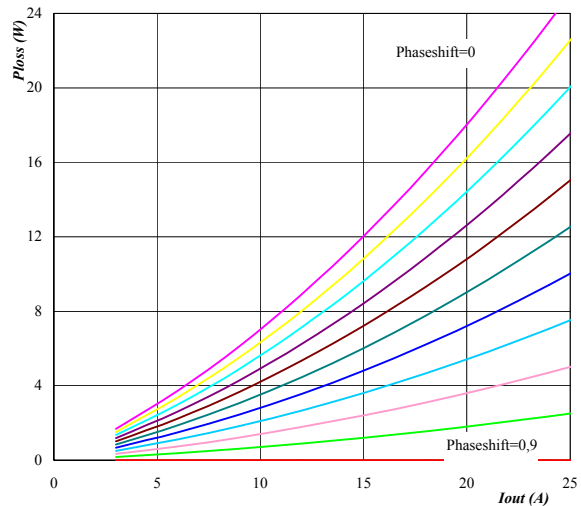
Phase shifted ZVS, $V_{geon}= 15\text{ V}$ $V_{geoff}=0\text{V}$ $R_{gon}= 12\text{ ohms}$ $R_{goff}= 2\text{ ohms}$

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



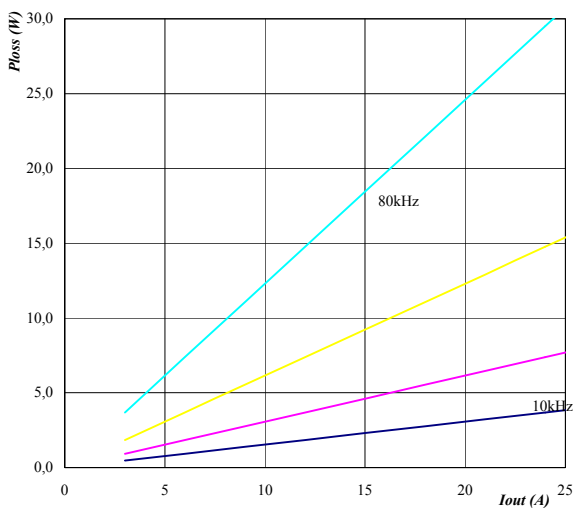
Conditions: $T_j=125^\circ\text{C}$
Phaseshift parameter Phaseshift from 0,10 to 1,00 in 0,10 steps

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



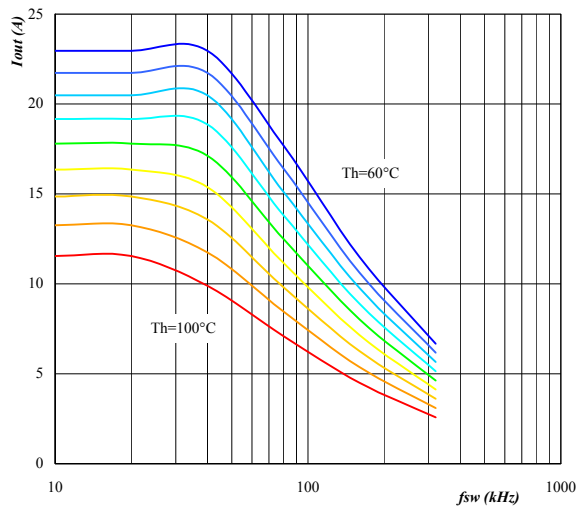
Conditions: $T_j=125^\circ\text{C}$
Phaseshift parameter Phaseshift from 0,00 to 0,90 in 0,10 steps

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



Conditions: $T_j=125^\circ\text{C}$
Ioutpk/Iout= 1,3 DC link= 320 V
Phaseshift= 1
Switching freq. fsw from 10 kHz to 80 kHz
parameter in * 2 steps

Figure 4. Typical available output current as a function of switching frequency
Phase $I_{out}=f(f_{sw})$



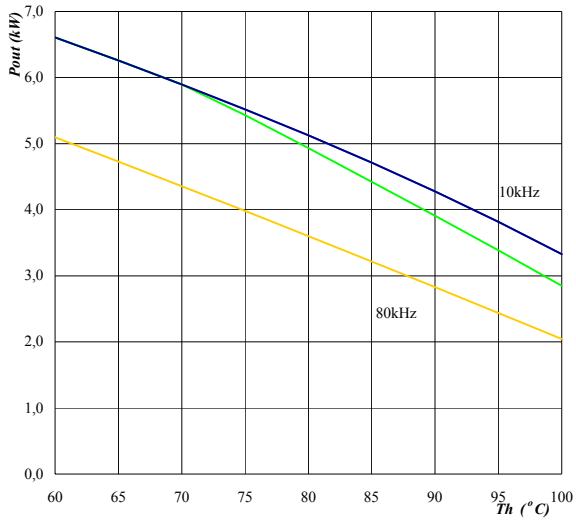
Conditions: $T_j=125^\circ\text{C}$
Ioutpk/Iout= 1,3 DC link= 320 V
Phaseshift= 1
Heatsink temp. Th from 60 °C to 100 °C
parameter in 5 °C steps

Output inverter application

Phase shifted ZVS, $V_{geon} = 15\text{ V}$ $V_{geoff} = 0\text{V}$ $R_{gon} = 12\text{ ohms}$ $R_{goff} = 2\text{ ohms}$

Figure 5. Typical available electric peak output power as a function of heatsink temperature

Inverter $P_{out} = f(T_h)$

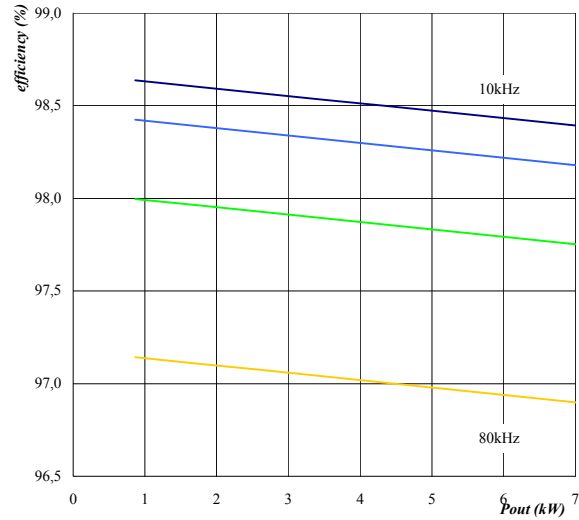


Conditions: $T_j = 125\text{C}$
 $I_{outpk}/I_{out} = 1,3$ DC link = 320 V
 Phaseshift = 1

Switching freq. parameter fsw from in 10 kHz to 80 kHz * 2 steps

Figure 6. Typical efficiency as a function of output power

Inverter efficiency = $f(P_{out})$



Conditions: $T_j = 125\text{C}$
 $I_{outpk}/I_{out} = 1,3$ DC link = 320 V
 Phaseshift = 1

Switching freq. parameter fsw from in 10 kHz to 80 kHz * 2 steps