Maximum Ratings / Höchstzulässige Werte

Parameter	Condition		Symbol	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_h=80°C; Tc=80°C	I_{FAV}	58 80	A
Surge forward current Stoßstrom Grenzwert	t_p=10ms	T_j=25°C	I_{FSM}	700	A
I^2t-value Grenzlastintegral	t_p=10ms	T_j=25°C	I^2t	2450	A^2s
Power dissipation per Diode Verlustleistung pro Diode	T_j=150°C	T_h=80°C T_c=80°C	P_{tot}	62 93	W
max. chip temperature max. Chiptemperatur			T_{jmax}	150	°C
Transistor Inverter **Transistor Wechselrichter**					
Collector-emitter break down voltage Kollektor-Emitter-Sperrspannung			V_{CE}	600	V
DC collector current Kollektor-Dauergleichstrom	T_j=T_{jmax}	T_h=80°C T_c=80°C	I_C	80 104	A
Repetitive peak collector current Periodischer Kollektorspitzenstrom	t_p limted by T_{jmax}		I_{cpuls}	300	A
Power dissipation per IGBT Verlustleistung pro IGBT	T_j=T_{jmax}	T_h=80°C T_c=80°C	P_{tot}	120 185	W
Gate-emitter peak voltage Gate-Emitter-Spitzenspannung			V_{GE}	±20	V
SC withstand time * Kurzschlußverhalten *	Tj≤150°C V_{CC}=360V	V_{GE}=15V	t_{SC}	5	us
max. chip temperature max. Chiptemperatur			T_{jmax}	175	°C
Diode Inverter **Diode Wechselrichter**					
DC forward current Dauergleichstrom	T_j=T_{jmax}	T_h=80°C, T_c=80°C	I_F	63 65, limted by bond wires	A
Repetitive peak forward current Periodischer Spitzenstrom	t_p limted by T_{jmax}		I_{FRM}	300	A
Power dissipation per Diode Verlustleistung pro Diode	T_j=150°C	T_h=80°C T_c=80°C	P_{tot}	85 125	W
max. chip temperature max. Chiptemperatur			T_{jmax}	175	°C

Maximum Ratings / Höchstzulässige Werte

Parameter	Condition	Symbol	Values	Unit
			max.	
Transistor BRC **Transistor BRC**				
Collector-emitter break down voltage Kollektor-Emitter-Sperrspannung		V_{CE}	600	V
DC collector current Kollektor-Dauergleichstrom	$T_j=T_{jmax}$ $T_h=80°C$ $T_c=80°C$	I_C	80 104	A
Repetitive peak collector current Periodischer Kollektorspitzenstrom	t_p limted by T_{jmax}	I_{cpuls}	300	A
Power dissipation per IGBT Verlustleistung pro IGBT	$T_j=T_{jmax}$ $T_h=80°C$ $T_c=80°C$	P_{tot}	120 185	W
Gate-emitter peak voltage Gate-Emitter-Spitzenspannung		V_{GE}	±20	V
SC withstand time * Kurzschlußverhalten *	Tj≤150°C V_{GE}=15V V_{CC}=360V	t_{SC}	5	us
max. chip temperature max. Chiptemperatur		T_{jmax}	175	°C
Diode BRC **Diode BRC**				
DC forward current Dauergleichstrom	$T_j=T_{jmax}$ $T_h=80°C$, $T_c=80°C$	I_F	63 65, limted by bond wires	A
Repetitive peak forward current Periodischer Spitzenstrom	t_p limted by T_{jmax}	I_{FRM}	300	A
Power dissipation per Diode Verlustleistung pro Diode	$T_j=150°C$ $T_h=80°C$ $T_c=80°C$	P_{tot}	85 125	W
max. chip temperature max. Chiptemperatur		T_{jmax}	175	°C
Thermal properties **Thermische Eigenschaften**				
Storage temperature Lagertemperatur		T_{stg}	-40…+125	°C
Operation temperature Betriebstemperatur		T_{op}	-40…+125	°C
Insulation properties **Modulisolation**				
Insulation voltage Isolationsspannung	t=1min	V_{is}	4000	Vdc
Creepage distance Kriechstrecke			min 12,7	mm
Clearance Luftstrecke			min 12,7	mm

* Allowed number of short circuits must be less than 1000 times, and time duration between short circuits should be more than 1 second!

Characteristic values

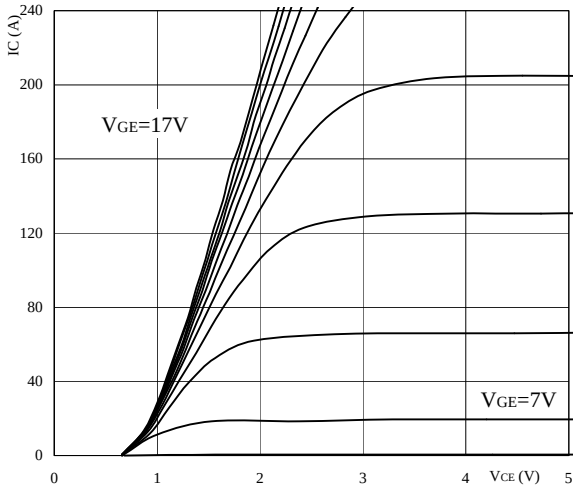
Description	Symbol	Conditions					Values			Unit
		T(C°)	Other conditions (Rgon-Rgoff)	V_{GE}(V) V_{GS}(V)	V_R(V) V_{CE}(V) V_{DS}(V)	Ic(A) IF(A) Id(A)	Min	Typ	Max	
Input Rectifier Bridge **Gleichrichter**										
Forward voltage Durchlaßpannung	V_F	Tj=25°C Tj=125°C				35	0,8	1,02 0,94	1,35	V
Threshold voltage (for power loss calc. only) Schleusenspannung	V_{to}	Tj=25°C Tj=125°C				 35		0,88 0,75		V
Slope resistance (for power loss calc. only) Ersatzwiderstand	r_t	Tj=25°C Tj=125°C				 35		0,004 0,006		Ohm
Reverse current Sperrstrom	I_r	Tj=25°C Tj=140±10°C			1500 1500		0 0		0,1 2	mA
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thickness≤50um					1,14		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitpaste Dicke≤50um λ = 0,61 W/mK					0,75		K/W
Transistor Inverter **Transistor Wechselrichter**										
Gate emitter threshold voltage Gate-Schwellenspannung	$V_{GE(th)}$	Tj=25°C Tj=125°C	VCE=VGE			0,002	4	5,8	8	V
Collector-emitter saturation voltage Kollektor-Emitter Sättigungsspannung	$V_{CE(sat)}$	Tj=25°C Tj=125°C				100	1,3	1,5 1,65	2,15	V
Collector-emitter cut-off current incl. Diode Kollektor-Emitter Reststrom	I_{CES}	Tj=25°C Tj=125°C		0	600				0,75	mA
Gate-emitter leakage current Gate-Emitter Reststrom	I_{GES}	Tj=25°C Tj=125°C		20	0				900	nA
Integrated Gate resistor Integrirter Gate Widerstand	R_{gint}							-		Ohm
Turn-on delay time Einschaltverzögerungszeit	$t_{d(on)}$	Tj=25°C Tj=125°C	Rgoff= 6 Ohm Rgon= 6 Ohm	 ±15	 300	 100		 75		ns
Rise time Anstiegszeit	t_r	Tj=25°C Tj=125°C	Rgoff= 6 Ohm Rgon= 6 Ohm	 ±15	 300	 100		 28		ns
Turn-off delay time Abschaltverzögerungszeit	$t_{d(off)}$	Tj=25°C Tj=125°C	Rgoff= 6 Ohm Rgon= 6 Ohm	 ±15	 300	 100		 260		ns
Fall time Fallzeit	t_f	Tj=25°C Tj=125°C	Rgoff= 6 Ohm Rgon= 6 Ohm	 ±15	 300	 100		 75		ns
Turn-on energy loss per pulse Einschaltverlustenergie pro Puls	E_{on}	Tj=25°C Tj=125°C	Rgoff= 6 Ohm Rgon= 6 Ohm	 ±15	 300	 100		 1,1		mWs
Turn-off energy loss per pulse Abschaltverlustenergie pro Puls	E_{off}	Tj=25°C Tj=125°C	Rgoff= 6 Ohm Rgon= 6 Ohm	 ±15	 300	 100		 3		mWs
Input capacitance Eingangskapazität	C_{ies}	Tj=25°C Tj=125°C	f=1MHz	0	25			6,2		nF
Output capacitance Ausgangskapazität	C_{oss}	Tj=25°C Tj=125°C	f=1MHz	0	25			0,4		nF
Reverse transfer capacitance Rückwirkungskapazität	C_{rss}	Tj=25°C Tj=125°C	f=1MHz	0	25			0,2		nF
Gate charge Gate Ladung	Q_{Gate}	Tj=25°C Tj=125°C	Rgoff= 6 Ohm Rgon= 6 Ohm	 ±15	 300	 100		 850		nC
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thickness≤50um					0,8		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitpaste Dicke≤50um λ = 0,61 W/mK					0,5		K/W
Diode Inverter **Diode Wechselrichter**										
Diode forward voltage Durchlaßspannung	V_F	Tj=25°C Tj=125°C				100	1	1,65 1,7	2,6	V
Peak reverse recovery current Rückstromspitze	I_{RM}	Tj=25°C Tj=125°C	Rgon= 6 Ohm diF/dt = 4900 A/us	 -15	 300	 100		 130		A
Reverse recovery time Sperreverzögerungszeit	t_{rr}	Tj=25°C Tj=125°C	Rgon= 6 Ohm diF/dt = 4900 A/us	 -15	 300	 100		 145		ns
Reverse recovered charge Sperrverzögerungsladung	Q_{rr}	Tj=25°C Tj=125°C	Rgon= 6 Ohm diF/dt = 4900 A/us	 -15	 300	 100		 7,5		uC
Reverse recovered energy Sperrverzögerungsenergie	Erec	Tj=25°C Tj=125°C	Rgon= 6 Ohm diF/dt = 4900 A/us	 -15	 300	 100		 1,9		mWs
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thickness≤50um					1,15		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitpaste Dicke≤50um λ = 0,61 W/mK					0,75		K/W

Characteristic values

Description	Symbol	Conditions					Values			Unit
		T(C°)	Other conditions (Rgon-Rgoff)	V_{GE}(V) V_{GS}(V)	V_R(V) V_{CE}(V) V_{DS}(V)	Ic(A) IF(A) Id(A)	Min	Typ	Max	
Transistor BRC										
Transistor BRC										
Gate emitter threshold voltage	$V_{GE(th)}$	Tj=25°C	VCE=VGE			0,002	4	5,8	8	V
Gate-Schwellenspannung		Tj=125°C								
Collector-emitter saturation voltage	$V_{CE(sat)}$	Tj=25°C				100	1,3	1,5	2,15	V
Kollektor-Emitter Sättigungsspannung		Tj=125°C						1,65		
Collector-emitter cut-off	I_{CES}	Tj=25°C		0	600				0,75	mA
Kollektor-Emitter Reststrom		Tj=125°C								
Gate-emitter leakage current	I_{GES}	Tj=25°C		20	0				900	nA
Gate-Emitter Reststrom		Tj=125°C								
Integrated Gate resistor	R_{gint}							-		Ohm
Integrirter Gate Widerstand										
Turn-on delay time	$t_{d(on)}$	Tj=25°C	Rgoff= 6 Ohm							ns
Einschaltverzögerungszeit		Tj=125°C	Rgon= 6 Ohm	±15	300	100		75		
Rise time	t_r	Tj=25°C	Rgoff= 6 Ohm							ns
Anstiegszeit		Tj=125°C	Rgon= 6 Ohm	±15	300	100		28		
Turn-off delay time	$t_{d(off)}$	Tj=25°C	Rgoff= 6 Ohm							ns
Abschaltverzögerungszeit		Tj=125°C	Rgon= 6 Ohm	±15	300	100		260		
Fall time	t_f	Tj=25°C	Rgoff= 6 Ohm							ns
Fallzeit		Tj=125°C	Rgon= 6 Ohm	±15	300	100		75		
Turn-on energy loss per pulse	E_{on}	Tj=25°C	Rgoff= 6 Ohm							mWs
Einschaltverlustenergie pro Puls		Tj=125°C	Rgon= 6 Ohm	±15	300	100		1,1		
Turn-off energy loss per pulse	E_{off}	Tj=25°C	Rgoff= 6 Ohm							mWs
Abschaltverlustenergie pro Puls		Tj=125°C	Rgon= 6 Ohm	±15	300	100		3		
Input capacitance	C_{iss}	Tj=25°C	f=1MHz	0	25			6,2		nF
Eingangskapazität		Tj=125°C								
Output capacitance	C_{oss}	Tj=25°C	f=1MHz	0	25			0,4		nF
Ausgangskapazität		Tj=125°C								
Reverse transfer capacitance	C_{ies}	Tj=25°C	f=1MHz	0	25			0,2		nF
Rückwirkungskapazität		Tj=125°C								
Gate charge	Q_{gate}	Tj=25°C	Rgoff= 6 Ohm							nC
Gate Ladung		Tj=125°C	Rgon= 6 Ohm	±15	300	100		850		
Thermal resistance chip to heatsink per chip			Thermal grease							
Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		thickness≤50um					0,8		K/W
Thermal resistance chip to case per chip			Warmeleitpaste Dicke≤50um							
Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		λ = 0,61 W/mK					0,5		K/W
Diode BRC										
Diode BRC										
Diode forward voltage	V_F	Tj=25°C				100	1	1,65	2,6	V
Durchlaßspannung		Tj=125°C						1,7		
Reverse current	I_r	Tj=25°C	Rgon= 6 Ohm							A
Sperrstrom		Tj=125°C	diF/dt = 4900 A/us	-15	300	100		130		
Reverse recovery time	t_{rr}	Tj=25°C	Rgon= 6 Ohm							ns
Sperreverzögerungszeit		Tj=125°C	diF/dt = 4900 A/us	-15	300	100		145		
Reverse recovered charge	Q_{rr}	Tj=25°C	Rgon= 6 Ohm							uC
Sperrverzögerungsladung		Tj=125°C	diF/dt = 4900 A/us	-15	300	100		7,5		
Reverse recovery energy	E_{rec}	Tj=25°C	Rgon= 6 Ohm							mWs
Sperrverzögerungsenergie		Tj=125°C	diF/dt = 4900 A/us	-15	300	100		1,9		
Thermal resistance chip to heatsink per chip			Thermal grease							
Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		thickness≤50um					1,15		K/W
Thermal resistance chip to case per chip			Warmeleitpaste Dicke≤50um							
Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		λ = 0,61 W/mK					0,75		K/W
PTC-Thermistor										
PTC-Widerstand										
Nominal resistance	R_{25}	Tj=25°C	tolerance = 3%				0,97	1	1,03	kOhm
Nominaler Widerstand	R_{100}	Tj=100°C	tolerance = 2%				1,637	1,67	1,703	kOhm
Typical temperature coefficient	α	Tj=25°C						0,76		%/K
Tipischer Temperaturkoeffizient		Tj=125°C								
Recommended measuring current		Tj=25°C					1		3	
Empfohlener Messstrom	I_m	Tj=125°C								mA
Measured values		Tj=25°C	I_m = 1mA				0,93		1,03	
Gemessene Werte	V_{PTC}		I_m = 3mA				2,84		3,4	V

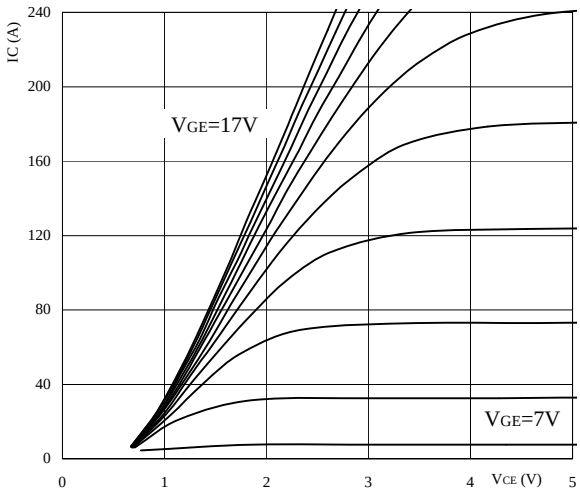
Output inverter

Figure 1. **Typical output characteristics**
Output inverter IGBT
Ic= f(VCE)



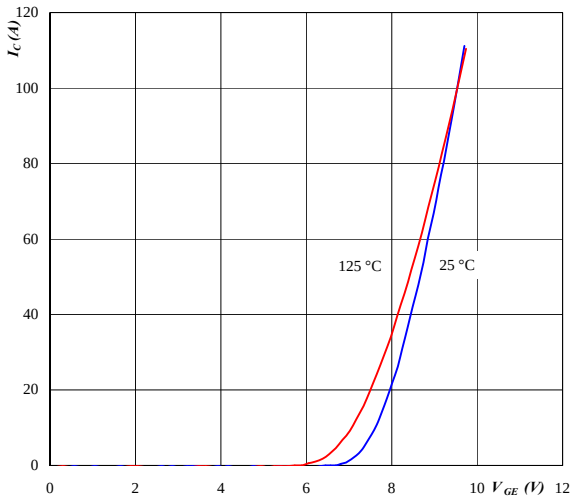
parameter: tp = 250 us Tj = 25 °C
VGE parameter: from: 7 V to 17 V
in 1 V steps

Figure 2. **Typical output characteristics**
Output inverter IGBT
Ic= f(VCE)



parameter: tp = 250 us Tj = 125 °C
VGE parameter: from: 7 V to 17 V
in 1 V steps

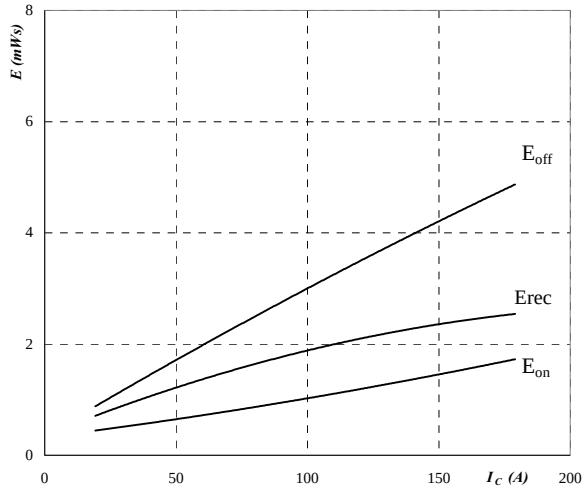
Figure 3. **Typical transfer characteristics**
Output inverter IGBT
Ic= f(VGE)



parameter: tp = 250 us VCE = 10 V

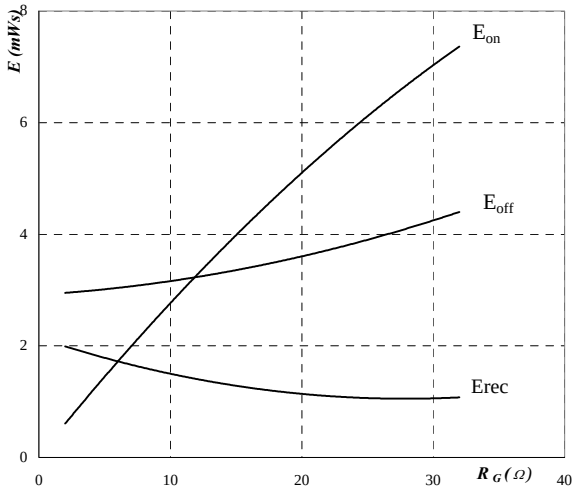
Output inverter

Figure 4. **Typical switching energy losses as a function of collector current**
Output inverter IGBT
E = f (Ic)



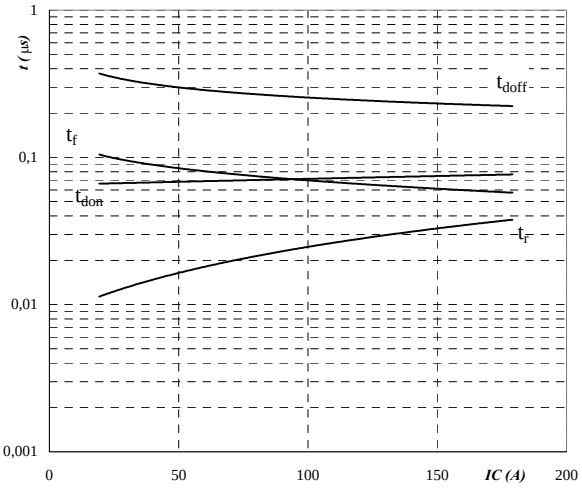
inductive load, Tj = 125 °C
VCE = 300 V
VGE= ±15 V
Rgon= 6 Ω
Rgoff= 6 Ω

Figure 5. **Typical switching energy losses as a function of gate resistor**
Output inverter IGBT
E = f (RG)



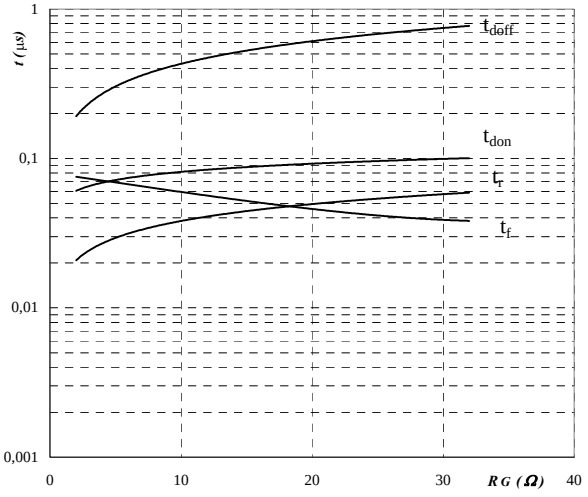
inductive load, Tj = 125 °C
VCE = 300 V
VGE= ±15 V
Ic = 100 A

Figure 6. **Typical switching times as a function of collector current**
Output inverter IGBT
t = f (Ic)



inductive load, Tj = 125 °C
VCE = 300 V
VGE= ±15 V
Rgon= 6 Ω
Rgoff= 6 Ω

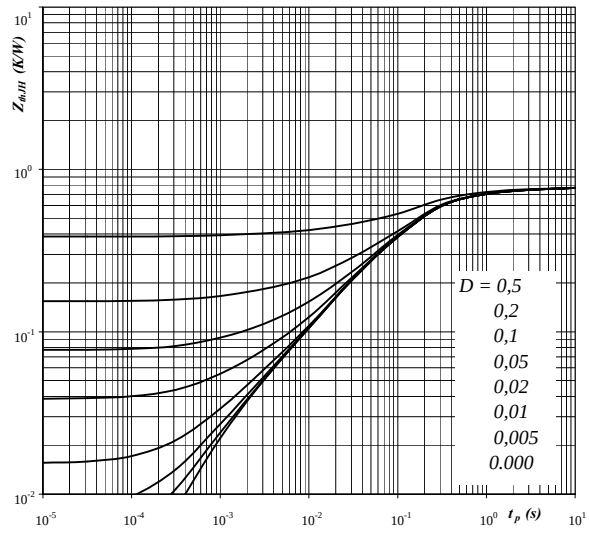
Figure 7. **Typical switching times as a function of gate resistor**
Output inverter IGBT
t = f (RG)



inductive load, Tj = 125 °C
VCE = 300 V
VGE= ±15 V
Ic = 100 A

Output inverter

Figure 8. IGBT transient thermal impedance as a function of pulse width
$Z_{thJH} = f(tp)$



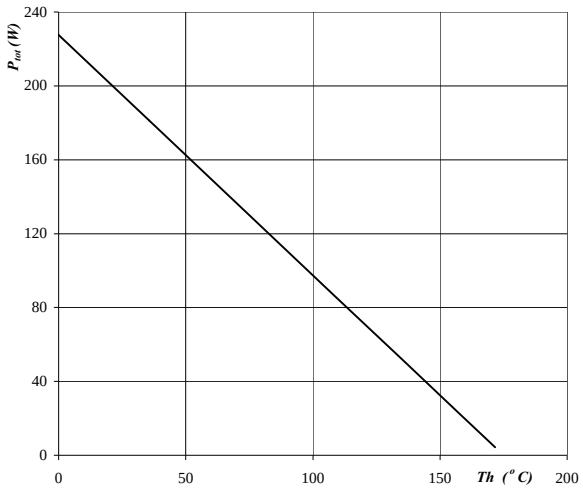
Parameter: D = tp / T RthJH= 0,80 K/W

IGBT thermal model values

R (C/W)	Tau (s)
0,06	3,2E+00
0,16	5,0E-01
0,43	1,3E-01
0,10	1,5E-02
0,02	1,4E-03

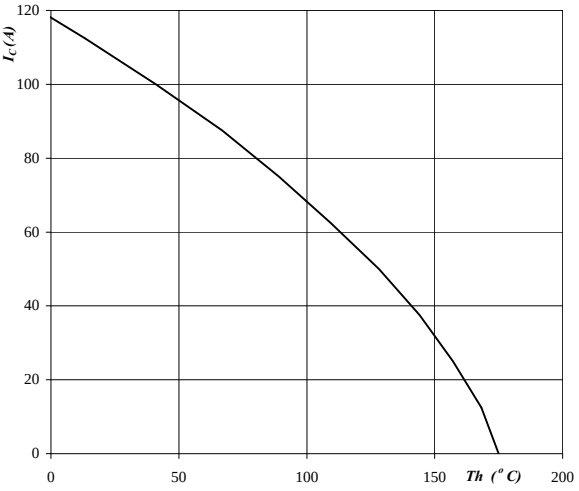
Output inverter

Figure 9. **Power dissipation as a function of heatsink temperature**
Output inverter IGBT
P_{tot} = f (Th)



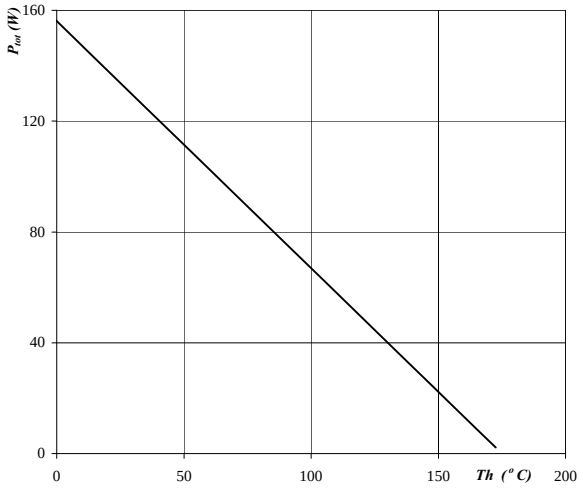
parameter: Tj = 175°C

Figure 10. **Collector current as a function of heatsink temperature**
Output inverter IGBT
I_C = f (Th)



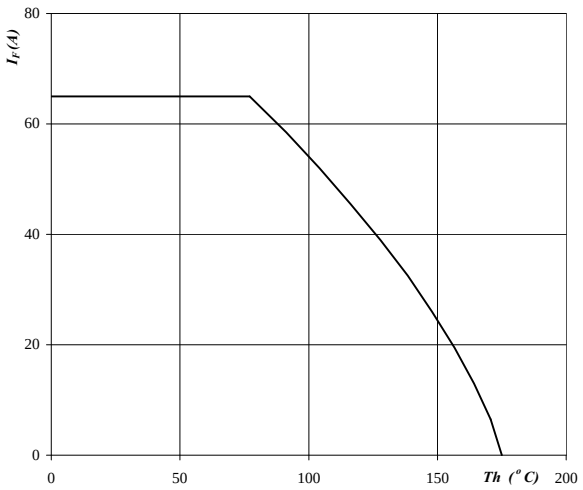
parameter: Tj = 175°C
V_{GE}= 15 V

Figure 11. **Power dissipation as a function of heatsink temperature**
Output inverter FRED
P_{tot} = f (Th)



parameter: Tj = 175°C

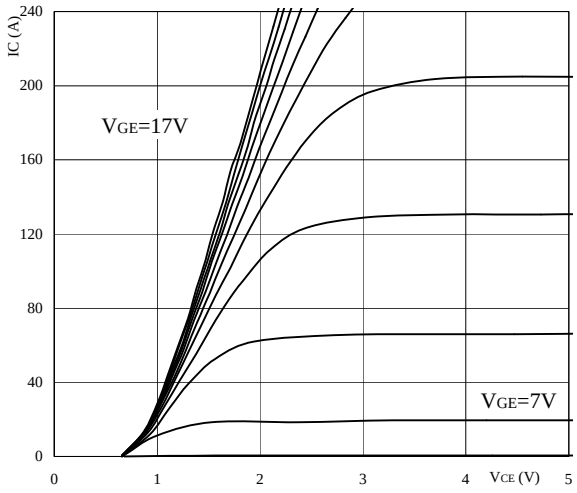
Figure 12. **Forward current as a function of heatsink temperature**
Output inverter FRED
I_F = f (Th)



parameter: Tj = 175°C

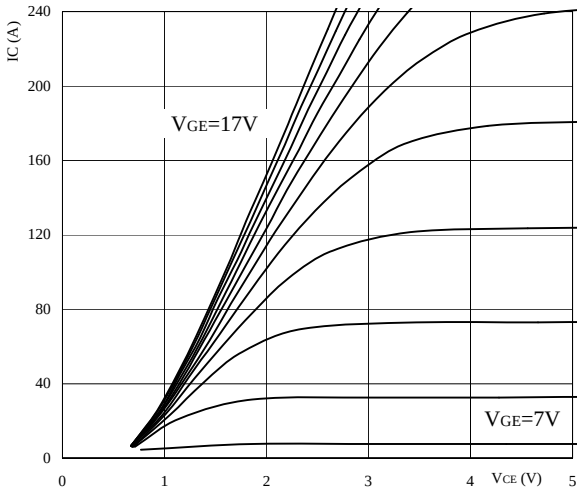
Brake

Figure 13. Typical output characteristics
Brake IGBT
Ic= f(V_{CE})



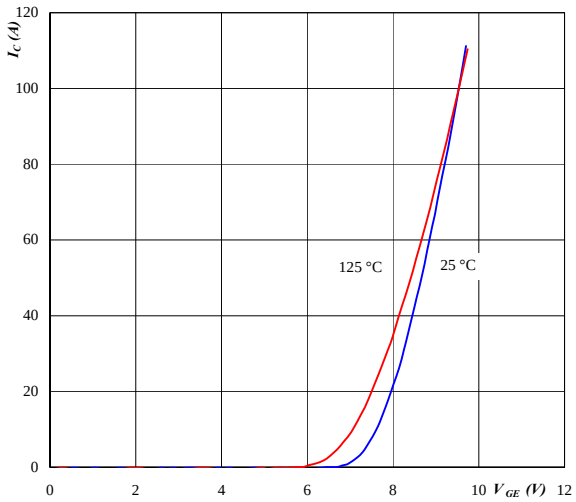
parameter: tp = 250 us Tj = 25 °C
V_{GE} parameter: from: 7 V to 17 V
in 1 V steps

Figure 14. Typical output characteristics
Brake IGBT
Ic= f(V_{CE})



parameter: tp = 250 us Tj = 125 °C
V_{GE} parameter: from: 7 V to 17 V
in 1 V steps

Figure 15. Typical transfer characteristics
Brake IGBT
Ic= f(V_{GE})



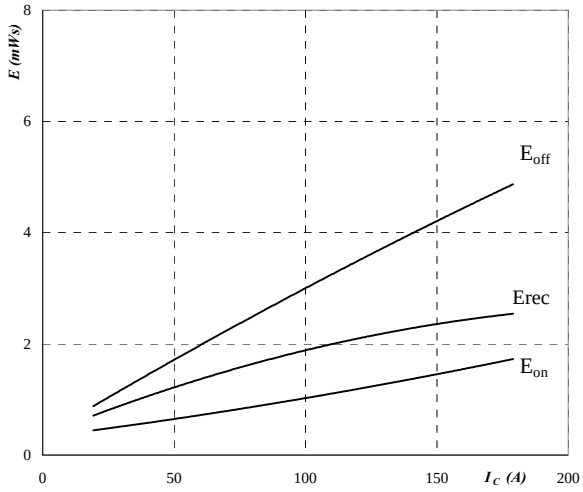
parameter: tp = 250 us V_{CE} = 10 V

Brake

Figure 16. Typical switching energy losses as a function of collector current

Brake IGBT

E = f (Ic)



inductive load, Tj = 125 °C

V_{CE} = 300 V

V_{GE} = ±15 V

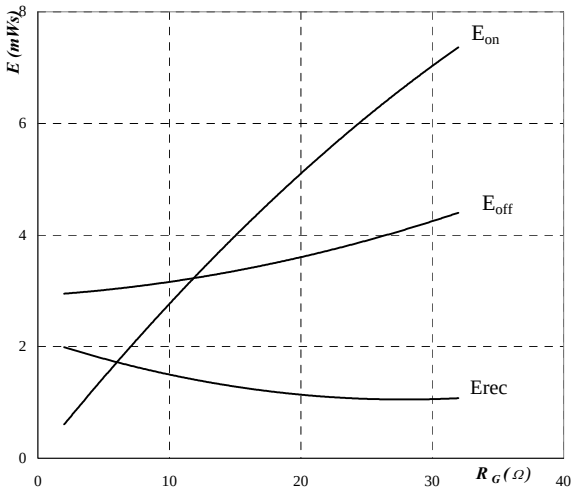
Rgon = 6 Ω

Rgoff = 6 Ω

Figure 17. Typical switching energy losses as a function of gate resistor

Brake IGBT

E = f (R_G)



inductive load, Tj = 125 °C

V_{CE} = 300 V

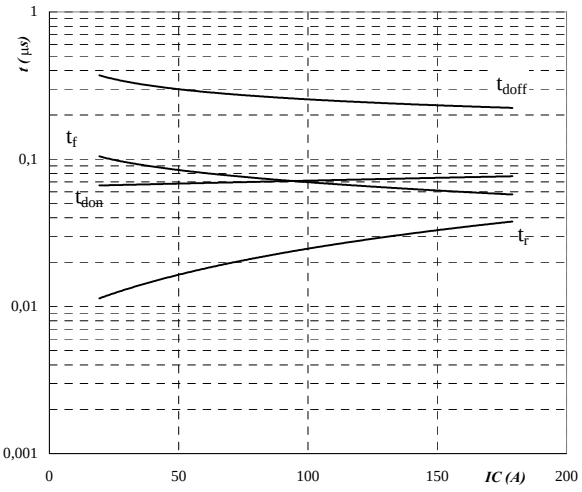
V_{GE} = ±15 V

Ic = 100 A

Figure 18. Typical switching times as a function of collector current

Brake IGBT

t = f (Ic)



inductive load, Tj = 125 °C

V_{CE} = 300 V

V_{GE} = ±15 V

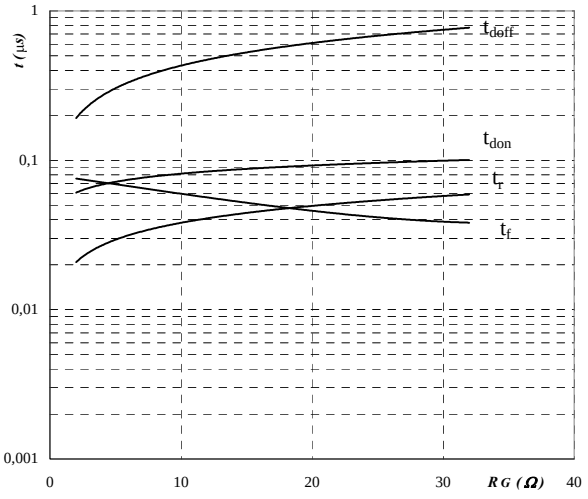
Rgon = 6 Ω

Rgoff = 6 Ω

Figure 19. Typical switching times as a function of gate resistor

Brake IGBT

t = f (R_G)



inductive load, Tj = 125 °C

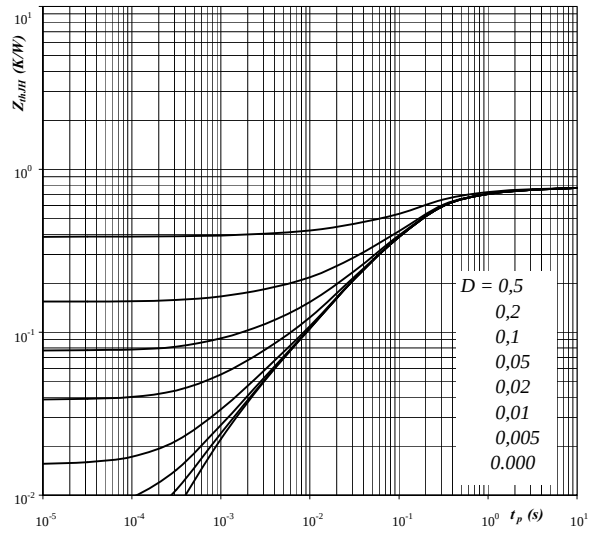
V_{CE} = 300 V

V_{GE} = ±15 V

Ic = 100 A

Brake

Figure 20. IGBT transient thermal impedance as a function of pulse width
$Z_{thJH} = f(tp)$

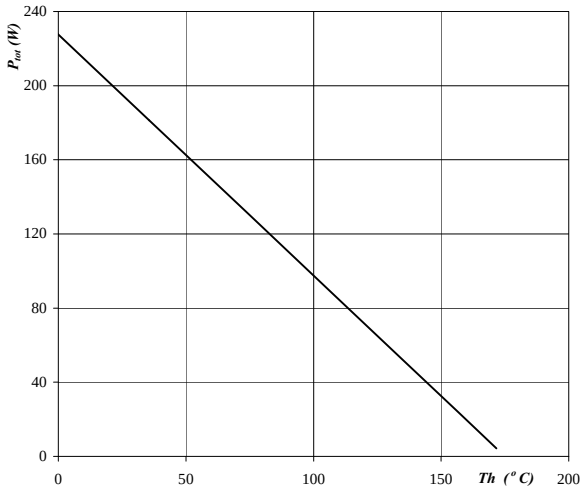


Parameter: D = tp / T RthJH= 0,80 K/W

IGBT thermal model values

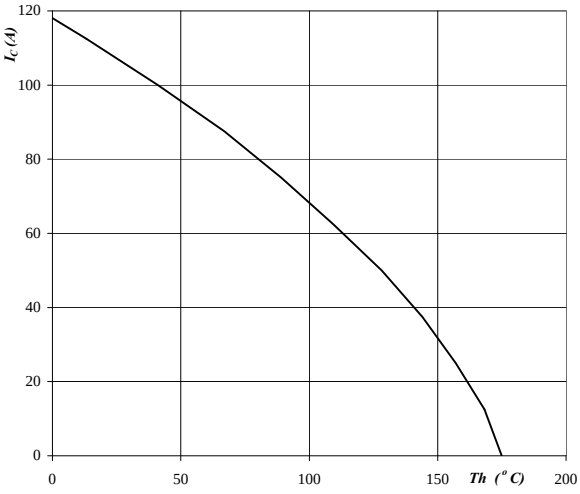
R (C/W)	Tau (s)
0,06	3,2E+00
0,16	5,0E-01
0,43	1,3E-01
0,10	1,5E-02
0,02	1,4E-03

Figure 21. Power dissipation as a function of heatsink temperature
Brake IGBT
$P_{tot} = f(Th)$



parameter: Tj = 175°C

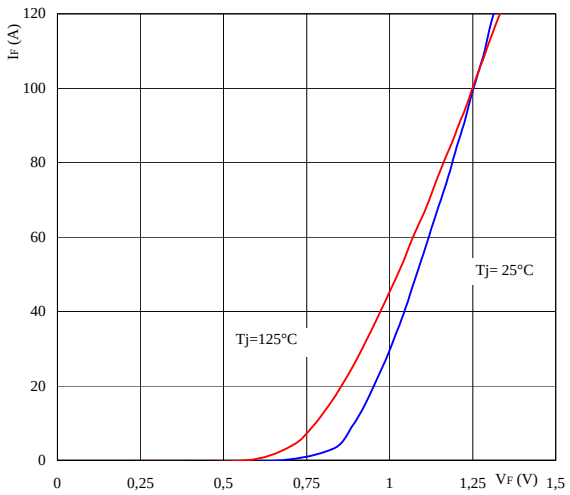
Figure 22. Collector current as a function of heatsink temperature
Brake IGBT
$I_C = f(Th)$



parameter: Tj = 175°C
V_{GE}= 15 V

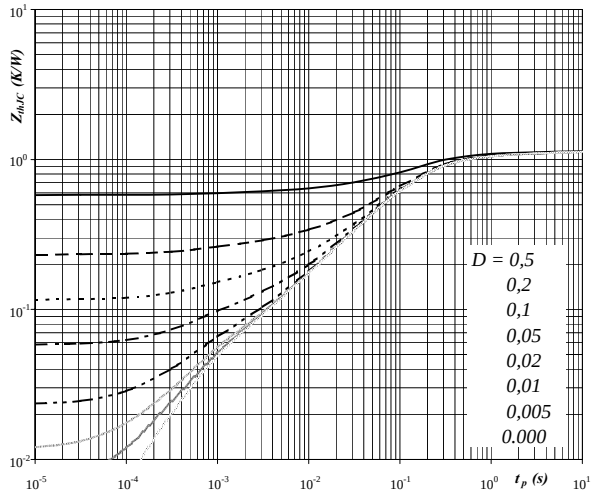
Input rectifier bridge

Figure 23. Typical diode forward current as a function of forward voltage
Rectifier diode $I_F=f(V_F)$



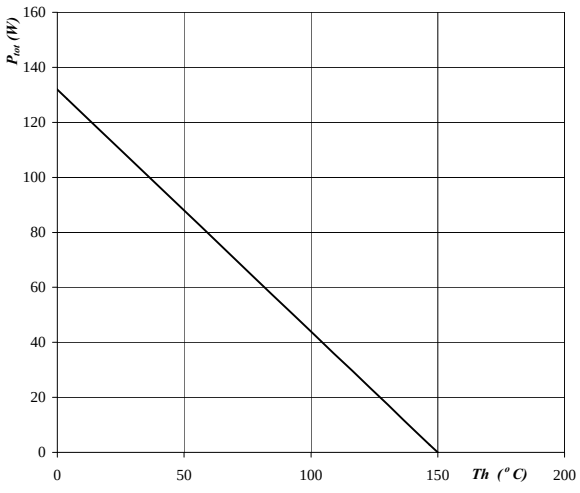
parameter: tp = 250 us

Figure 24. Diode transient thermal impedance as a function of pulse width
$Z_{thJH} = f(tp)$



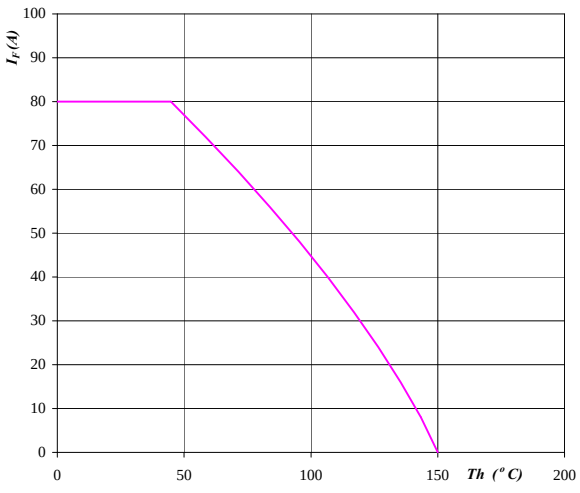
Parameter: D = tp / T RthJH= 1,14 K/W

Figure 25. Power dissipation as a function of heatsink temperature
Rectifier diode
$P_{tot} = f(Th)$



parameter: Tj = 150°C

Figure 26. Forward current as a function of heatsink temperature
Rectifier diode
$I_F = f(Th)$



parameter: Tj = 150°C

Thermistor

Figure 27. Typical PTC characteristic as afunction of temperature

$R_T = f(T)$