Maximum Ratings / Höchstzulässige Werte

Parameter	Condition		Symbol	Datasheet values max.	Unit
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}	34,7 40,limited by nr. of wires	A
Surge forward current Stoßstrom Grenzwert	t_p=10ms	T_j=25°C	I_{FSM}	250	A
I^2t-value Grenzlastintegral	t_p=10ms	T_j=25°C	I^2t	310	A^2s
Power dissipation per Diode Verlustleistung pro Diode	T_j=150°C	T_h=80°C Tc=80°C	P_{tot}	40 60	W
Transistor Inverter **Transistor Wechselrichter**					
Collector-emitter break down voltage Kollektor-Emitter-Sperrspannung			V_{CE}	1200	V
DC collector current Kollektor-Dauergleichstrom	T_j=150°C	T_h=80°C Tc=80°C	I_C	15,9 16,limited by nr. of wires	A
Repetitive peak collector current Periodischer Kollektorspitzenstrom	t_p=1ms	T_h=80°C	I_{cpuls}	32	A
Power dissipation per IGBT Verlustleistung pro IGBT	T_j=150°C	T_h=80°C Tc=80°C	P_{tot}	44,8 68	W
Gate-emitter peak voltage Gate-Emitter-Spitzenspannung			V_{GE}	±20	V
SC withstand time Kurzschlußverhalten	Tj≤150°C V_{CE}=1200 V	V_{GE}=15V	t_{SC}	10	us
Diode Inverter **Diode Wechselrichter**					
DC forward current Dauergleichstrom	T_j=150°C	T_h=80°C Tc=80°C	I_F	16,limited by nr. of wires 16,limited by nr. of wires	A
Repetitive peak forward current Periodischer Spitzenstrom	t_p=1ms	T_h=80°C	I_{FRM}	38	A
Power dissipation per Diode Verlustleistung pro Diode	T_j=150°C	T_h=80°C Tc=80°C	P_{tot}	32,6 49,4	W
Transistor BRC **Transistor BRC**					
Collector-emitter break down voltage Kollektor-Emitter-Sperrspannung			V_{CE}	1200	V
DC collector current Kollektor-Dauergleichstrom	T_j=150°C	T_h=80°C Tc=80°C	I_C	11,2 14,7	A
Repetitive peak collector current Periodischer Kollektorspitzenstrom	t_p=1ms	T_h=80°C	I_{cpuls}	22,4	A
Power dissipation per IGBT Verlustleistung pro IGBT	T_j=150°C	T_h=80°C Tc=80°C	P_{tot}	33 50,5	W
Gate-emitter peak voltage Gate-Emitter-Spitzenspannung			V_{GE}	±20	V
SC withstand time Kurzschlußverhalten	Tj≤150°C VCE=600/1200 V	VGE=15V	t_{SC}	10	us

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Maximum Ratings / Höchstzulässige Werte

Parameter	Condition		Symbol	Datasheet values max.	Unit
Diode BRC					
Diode BRC					
DC forward current Dauergleichstrom	T_j=150°C	T_h=80°C Tc=80°C	I_F	11,8 16	A
Repetitive peak forward current Periodischer Spitzenstrom	t_p=1ms	T_h=80°C	I_{FRM}	24	A
Power dissipation per Diode Verlustleistung pro Diode	T_j=150°C	T_h=80°C Tc=80°C	P_{tot}	21 32	W
Thermal properties					
Thermische Eigenschaften					
max. Chip temperature max. Chiptemperatur			T_{jmax}	150	°C
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

Characteristic values/ Charakteristische Werte

Description	Symbol	Conditions					Datasheet values			Unit
		T(C°)	Other conditions (Rgon-Rgoff)	VGE(V) VGS(V)	V_R(V) VCE(V) VDS(V)	IC(A) IF(A) Id(A)	Min	Typ	Max	
Input Rectifier Bridge **Gleichrichter**										
Forward voltage Durchlaßpannung	V_F	Tj=25°C				30	0,8	1,16	1,3	V
Threshold voltage (for power loss calc. only) Schleusenspannung	V_{to}	Tj=25°C				30		0,91		V
Slope resistance (for power loss calc. only) Ersatzwiderstand	r_t	Tj=25°C				30		9		mOhm
Reverse current Sperrstrom	I_r	Tj=25°C			1500				0,02	mA
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thikness≤50um					1,8		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitpaste Dicke≤50um λ = 0,61 W/mK					1,2		K/W
Transistor Inverter, inductive load **Transistor Wechselrichter**										
Gate emitter threshold voltage Gate-Schwellenspannung	$V_{GE(th)}$	Tj=25°C Tj=125°C	VCE=VGE			0,0006	4,5	5,5	6,5	V
Collector-emitter saturation voltage Kollektor-Emitter Sättigungsspannung	$V_{CE(sat)}$	Tj=25°C Tj=125°C		15		15	1,5	2,27 2,55	2,75	V
Collector-emitter cut-off incl.FRED Kollektor-Emitter Reststrom inkl.FRED	I_{CES}	Tj=25°C Tj=125°C		0	1200				0,25	mA
Gate-emitter leakage current Gate-Emitter Reststrom	I_{GES}	Tj=25°C Tj=150°C		25	0				120	nA
Integrated Gate resistor Integrirter Gate Widerstand	R_{gint}									Ohm
Turn-on delay time Einschaltverzögerungszeit	$t_{d(on)}$	Tj=25°C Tj=125°C	 Rgon=46,7 Ohm	15	600	15		34		ns
Rise time Anstiegszeit	t_r	Tj=25°C Tj=125°C	 Rgon=46,7 Ohm	15	600	15		30		ns
Turn-off delay time Abschaltverzögerungszeit	$t_{d(off)}$	Tj=25°C Tj=125°C	 Rgoff=23,35 Ohm	15	600	15		351		ns
Fall time Fallzeit	t_f	Tj=25°C Tj=125°C	 Rgoff=23,35 Ohm	15	600	15		105		ns
Turn-on energy loss per pulse Einschaltverlustenergie pro Puls	E_{on}	Tj=25°C Tj=125°C	 Rgon=46,7 Ohm	15	600	15		2,136		mWs
Turn-off energy loss per pulse Abschaltverlustenergie pro Puls	E_{off}	Tj=25°C Tj=125°C	 Rgoff=23,35 Ohm	15	600	15		1,513		mWs
Input capacitance Eingangskapazität	C_{ies}	Tj=25°C Tj=125°C	f=1MHz	0	25			1,1		nF
Output capacitance Ausgangskapazität	C_{oss}	Tj=25°C Tj=125°C	f=1MHz	0	25					nF
Reverse transfer capacitance Rückwirkungskapazität	C_{rss}	Tj=25°C Tj=125°C	f=1MHz	0	25			0,07		nF
Gate charge Gate Ladung	Q_{Gate}	Tj=25°C Tj=125°C		15	600	14		85		nC
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thikness≤50um					1,6		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitpaste Dicke≤50um λ = 0,61 W/mK					1,1		K/W

Characteristic values/ Charakteristische Werte

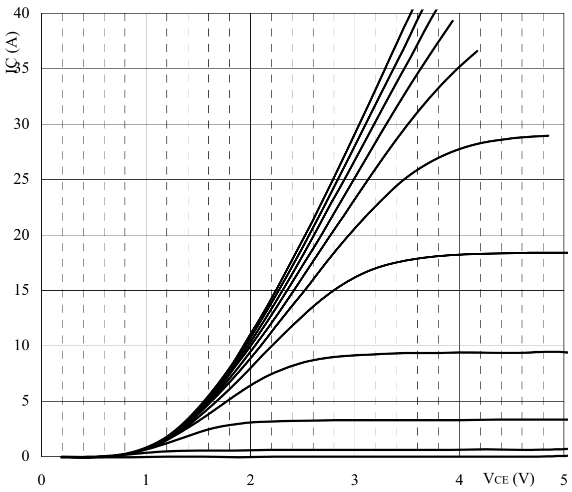
Description	Symbol	Conditions					Datasheet values			Unit
		T(C°)	Other conditions (Rgon-Rgoff)	VGE(V) VGS(V)	V_R(V) VCE(V) VDS(V)	IC(A) IF(A) Id(A)	Min	Typ	Max	
Diode Inverter										
Diode Wechselrichter										
Diode forward voltage	V_F	Tj=25°C				15	1	1,9	2,8	V
Durchlaßspannung		Tj=125°C						1,45		
Peak reverse recovery current	I_{RM}	Tj=25°C		15	600	15				A
Rückstromspitze		Tj=125°C	Rgon=46,7 Ohm					24		
Reverse recovery time	t_{rr}	Tj=25°C		15	600	15				ns
Sperreverzögerungszeit		Tj=125°C	Rgon=46,7 Ohm					260		
Reverse recovered charge	Q_{rr}	Tj=25°C		15	600	15				uC
Sperrverzögerungsladung		Tj=125°C	Rgon=46,7 Ohm					2,54		
Reverse recovered energy	E_{rec}	Tj=25°C		15	600	15				mWs
Sperrverzögerungsenergie		Tj=125°C	Rgon=46,7 Ohm					0,599		
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thikness≤50um					2,1		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitpaste Dicke≤50um λ = 0,61 W/mK					1,4		K/W
Transistor BRC										
Transistor BRC										
Gate emitter threshold voltage	$V_{GE(th)}$	Tj=25°C	VCE=VGE			0,0004	4,5	5,5	6,5	V
Gate-Schwellenspannung		Tj=125°C								
Collector-emitter saturation voltage	$V_{CE(sat)}$	Tj=25°C		15		10	1,9	2,3	2,95	V
Kollektor-Emitter Sättigungsspannung		Tj=125°C						2,7		
Collector-emitter cut-off	I_{CES}	Tj=25°C		0	600				0,05	mA
Kollektor-Emitter Reststrom		Tj=125°C								
Gate-emitter leakage current	I_{GES}	Tj=25°C		25	0				120	nA
Gate-Emitter Reststrom		Tj=150°C								
Integrated Gate resistor	R_{gint}									Ohm
Integrirter Gate Widerstand										
Turn-on delay time	$t_{d(on)}$	Tj=25°C		15	600	10				ns
Einschaltverzögerungszeit		Tj=125°C	Rgon=48 Ohm					25		
Rise time	t_r	Tj=25°C		15	600	10				ns
Anstiegszeit		Tj=125°C	Rgon=48 Ohm					25		
Turn-off delay time	$t_{d(off)}$	Tj=25°C		15	600	10				ns
Abschaltverzögerungszeit		Tj=125°C	Rgoff=24 Ohm					240		
Fall time	t_f	Tj=25°C		15	600	10				ns
Fallzeit		Tj=125°C	Rgoff=24 Ohm					84		
Turn-on energy loss per pulse	E_{on}	Tj=25°C		15	600	10				mWs
Einschaltverlustenergie pro Puls		Tj=125°C	Rgon=48 Ohm					1,166		
Turn-off energy loss per pulse	E_{off}	Tj=25°C		15	600	10				mWs
Abschaltverlustenergie pro Puls		Tj=125°C	Rgoff=24 Ohm					0,744		
Input capacitance	C_{iss}	Tj=25°C	f=1MHz	0	25			0,7		nF
Eingangskapazität		Tj=125°C								
Output capacitance	C_{oss}	Tj=25°C	f=1MHz	0	25					nF
Ausgangskapazität		Tj=125°C								
Reverse transfer capacitance	C_{rss}	Tj=25°C	f=1MHz	0	25			0,04		nF
Rückwirkungskapazität		Tj=125°C								
Gate charge	Q_{Gate}	Tj=25°C		15	600	8		53		nC
Gate Ladung		Tj=125°C								
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thikness≤50um					2,1		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitpaste Dicke≤50um λ = 0,61 W/mK					1,4		K/W

Characteristic values/ Charakteristische Werte

Description	Symbol	Conditions					Datasheet values			Unit
		T(C°)	Other conditions (Rgon-Rgoff)	V_{GE}(V) V_{GS}(V)	V_R(V) V_{CE}(V) V_{DS}(V)	I_C(A) IF(A) I_d(A)	Min	Typ	Max	
Diode BRC										
Diode BRC										
Diode forward voltage Durchlaßspannung	V_F	Tj=25°C Tj=125°C				10	1	2,2 1,8	3	V
Reverse current Sperrstrom	I_r	Tj=25°C			1200				0,06	uA
Peak reverse recovery current Rückstromspitze	IRM	Tj=25°C Tj=125°C	Rgon=48 Ohm	15	600	15		23		A
Reverse recovery time Sperreverzögerungszeit	trr	Tj=25°C Tj=125°C	Rgon=48 Ohm	15	600	15		260		ns
Reverse recovered charge Sperrverzögerungsladung	Qrr	Tj=25°C Tj=125°C	Rgon=48 Ohm	15	600	15		2,54		uC
Reverse recovered energy Sperrverzögerungsenergie	Erec	Tj=25°C Tj=125°C	Rgon=48 Ohm	15	600	15		0,599		mWs
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thikness≤50um					3,3		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitpaste Dicke≤50um λ = 0,61 W/mK					2,2		K/W
NTC-Thermistor										
NTC-Widerstand										
Rated resistance Nennwiderstand	R_{25}	TC=25°C	Tol. ±5%				4,2	4,7	5,3	kOhm
Deviation of R100 Abweichung von R100	$D_{R/R}$	TC=100°C						2,56		%/K
Power dissipation given Epcos-Typ Verlustleistung Epcos-Typ angeben	P	TC=25°C						210		mW
B-value B-Wert	$B_{(25/100)}$		Tol. ±3%					3530		K

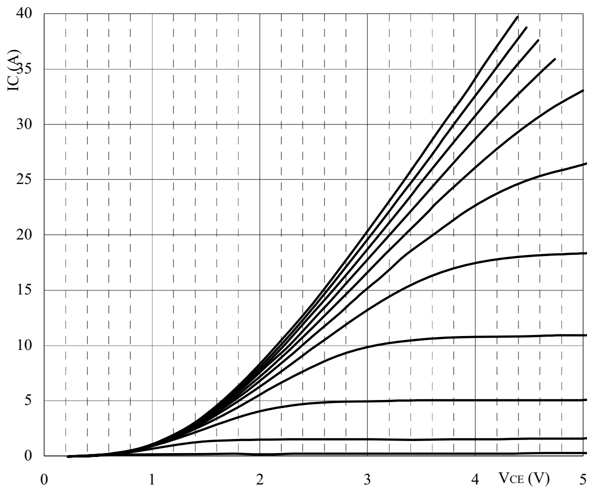
Output inverter

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



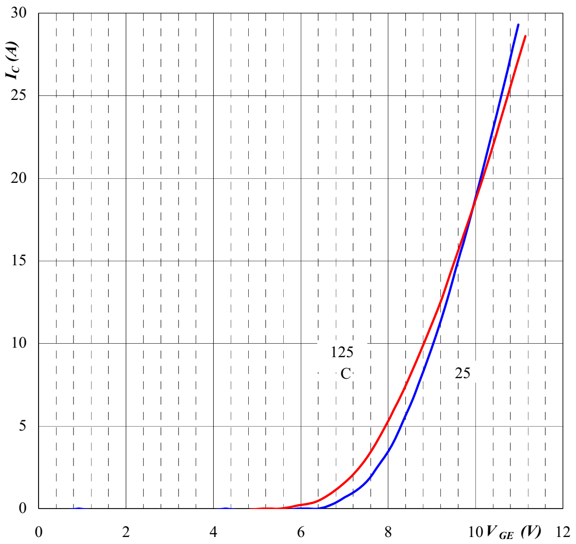
parameter: tp = 250 us Tj = 25 °C
VGE parameter: from: 6 V to 16 V
in 1 V steps

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



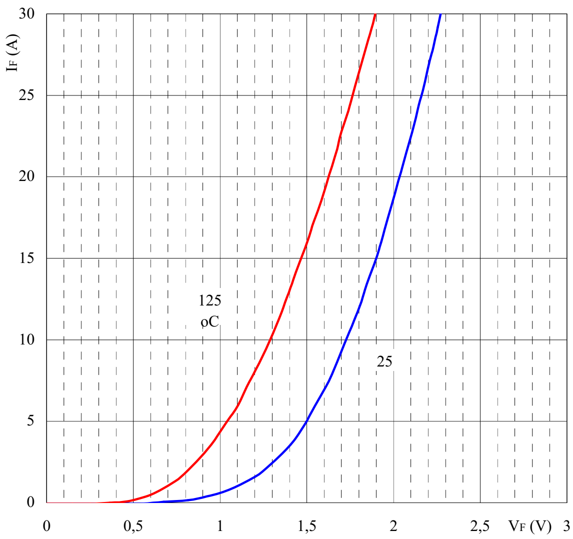
parameter: tp = 250 us Tj = 125 °C
VGE parameter: from: 6 V to 16 V
in 1 V steps

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



parameter: tp = 250 us VCE = 7 V

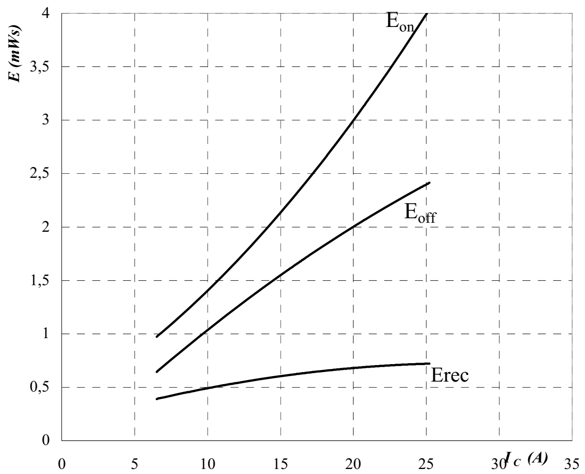
Figure 4. Typical diode forward current as a function of forward voltage
Output inverter FRED IF=f(VF)



parameter: tp = 250 us

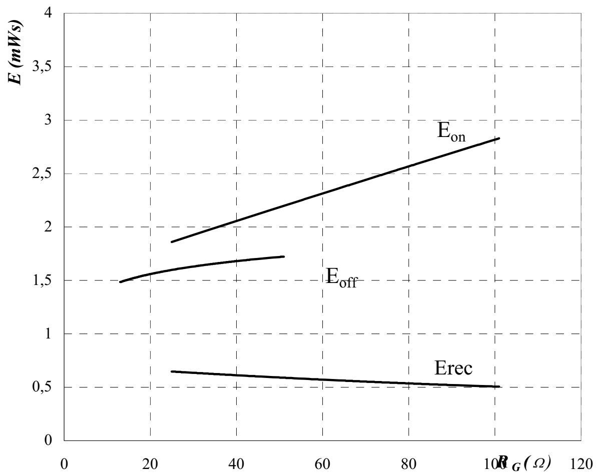
Output inverter

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



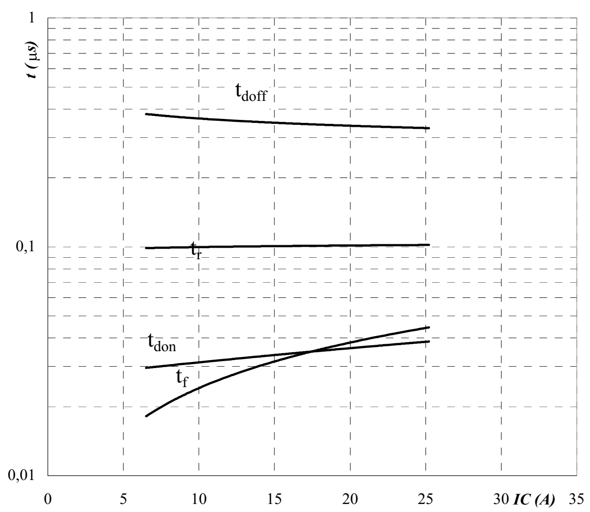
inductive load, Tj = 125 °C
VCE = 600 V
VGE= 15 V
RGon = 2*RGoff = 46,7 W

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



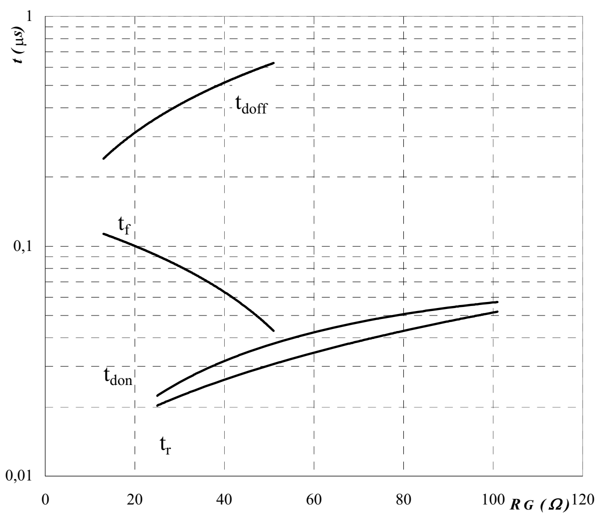
inductive load, Tj = 125 °C
VCE = 600 V
VGE= 15 V
Ic = 15 A

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



inductive load, Tj = 125 °C
VCE = 600 V
VGE= 15 V
RGon = 2*RGoff = 46,7 W

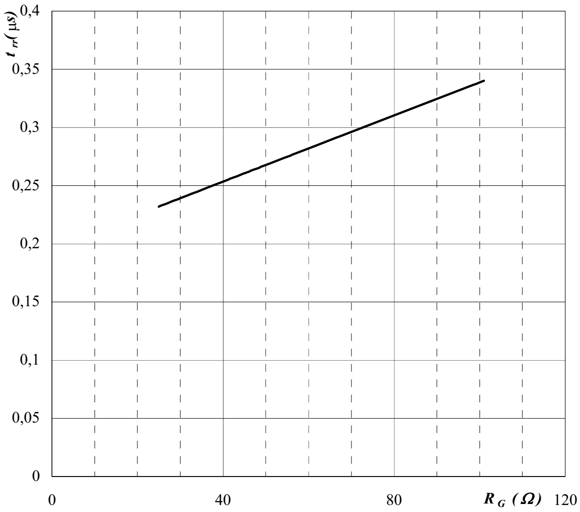
Figure 8. Typical switching times as a function of gate resistor
Output inverter IGBT
t = f (RG)



inductive load, Tj = 125 °C
VCE = 600 V
VGE= 15 V
Ic = 15 A

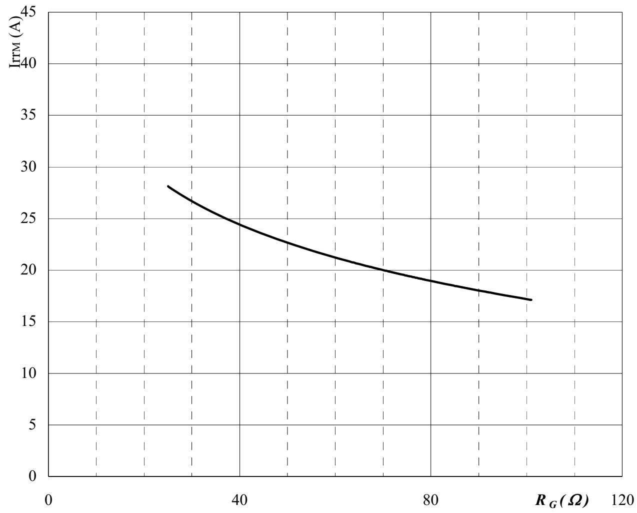
Output inverter

Figure 9. Typical reverse recovery time as a function of IGBT turn on gate resistor
Output inverter FRED diode
trr = f (Rgon)



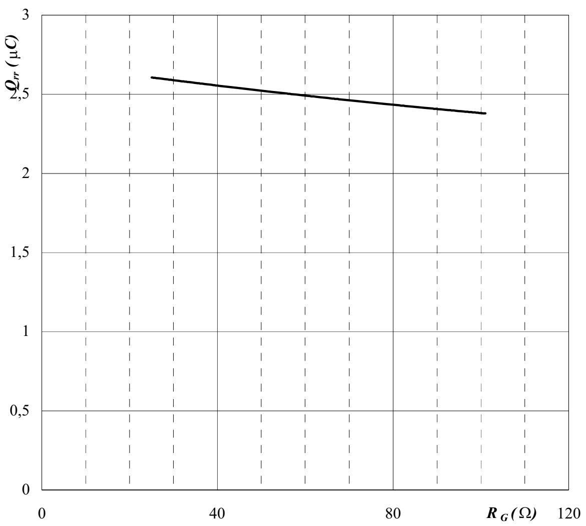
Tj = 125 °C
VR = 600 V
IF= 15 A

Figure 10. Typical reverse recovery current as a function of IGBT turn on gate resistor
Output inverter FRED diode
IRRM = f (Rgon)



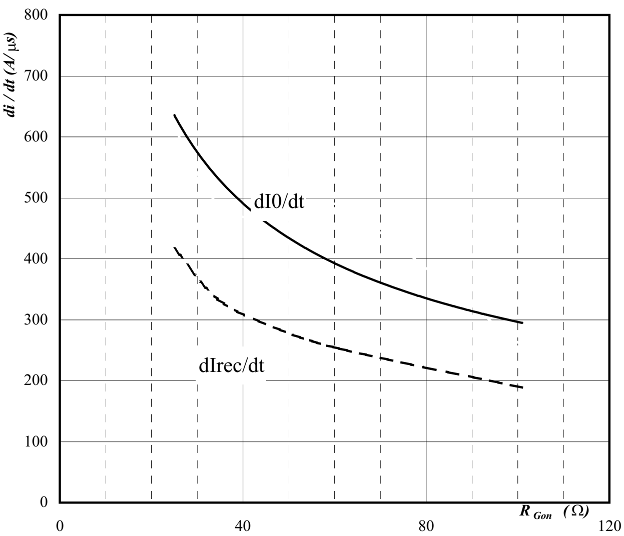
Tj = 125 °C
VR = 600 V
IF= 15 A

Figure 11. Typical reverse recovery charge as a function of IGBT turn on gate resistor
Output inverter FRED diode
Qrr = f (Rgon)



Tj = 125 °C
VR = 600 V
IF= 15 A

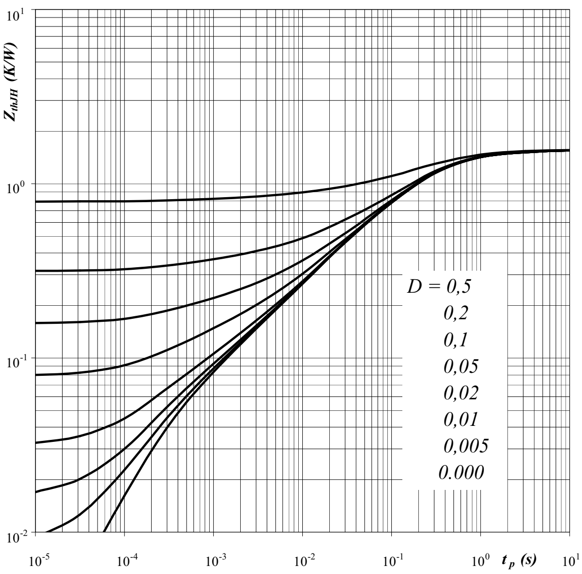
Figure 12. Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
Output inverter FRED diode
dI0/dt,dIrec/dt= f (Rgon)



Tj = 125 °C
VR = 600 V
IF= 15 A

Output inverter

Figure 13. IGBT transient thermal impedance as a function of pulse width
ZthJH = f(tp)

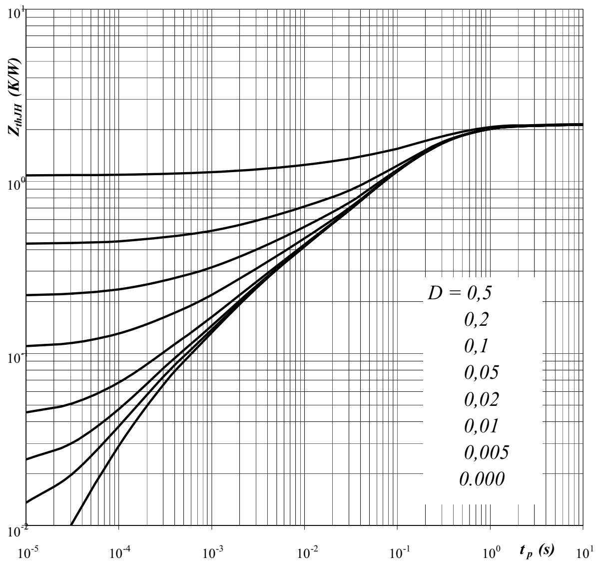


Parameter: D = tp / T RthJH 1,6 K/W

IGBT thermal model values

R (C/W)	Tau (s)
0,03	6,9E+01
0,10	3,0E+00
0,45	5,0E-01
0,64	1,3E-01
0,24	2,1E-02
0,08	2,7E-03
0,04	3,2E-04

Figure 14. FRED transient thermal impedance as a function of pulse width
ZthJH = f(tp)



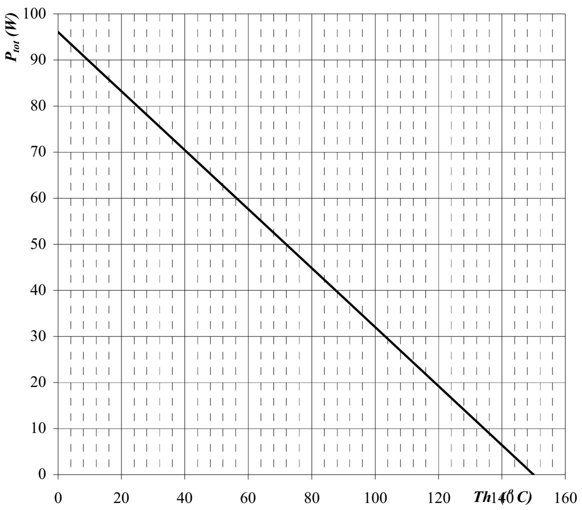
Parameter: D = tp / T RthJH= 2,1 K/W

FRED thermal model values

R (C/W)	Tau (s)
0,04	3,4E+01
0,18	1,5E+00
1,02	2,5E-01
0,56	6,8E-02
0,22	7,9E-03
0,10	1,3E-03
0,04	1,7E-04

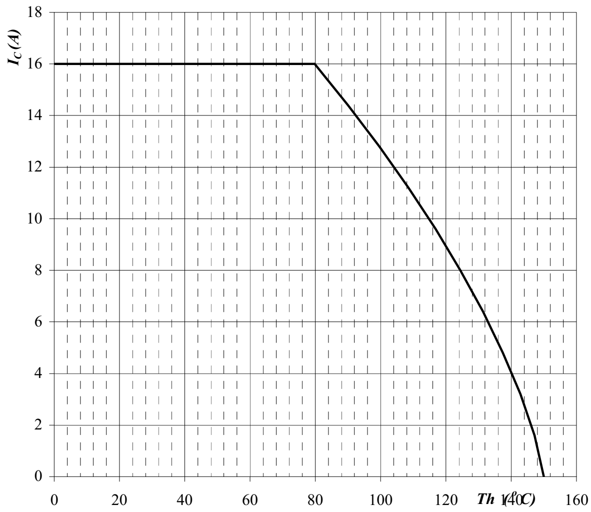
Output inverter

Figure 15. Power dissipation as a function of heatsink temperature
Output inverter IGBT
Ptot = f (Th)



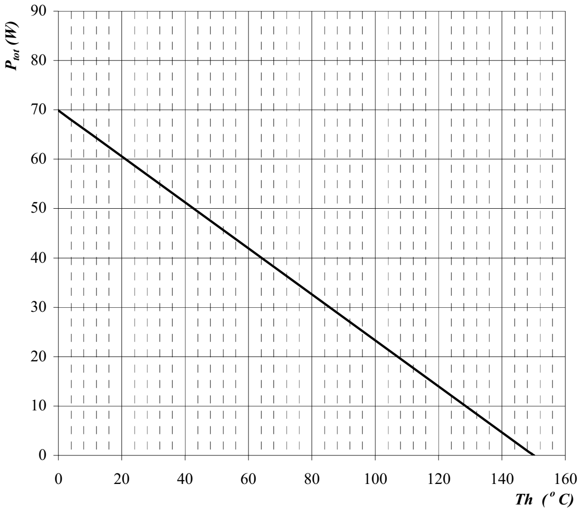
parameter: Tj = 150°C

Figure 16. Collector current as a function of heatsink temperature
Output inverter IGBT
Ic = f (Th)



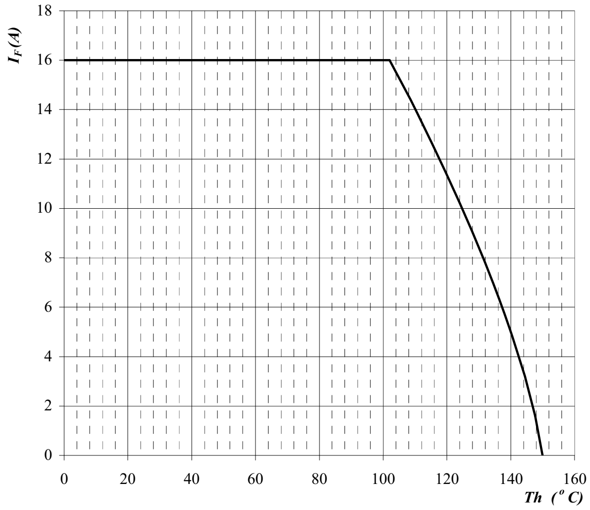
parameter: Tj = 150°C
VGE= 15 V

Figure 17. Power dissipation as a function of heatsink temperature
Output inverter FRED
Ptot = f (Th)



parameter: Tj = 150°C

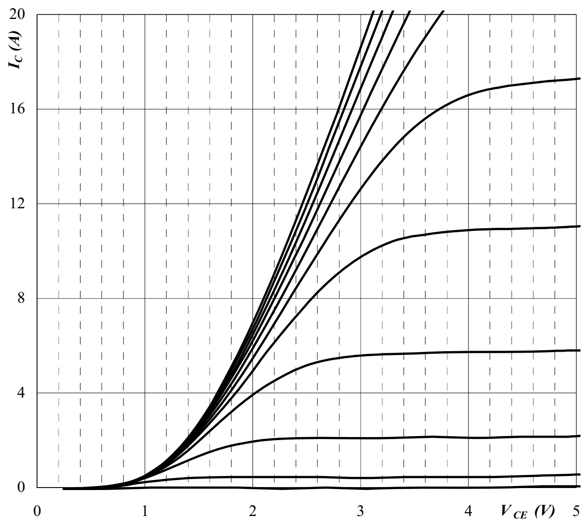
Figure 18. Forward current as a function of heatsink temperature
Output inverter FRED
IF = f (Th)



parameter: Tj = 150°C

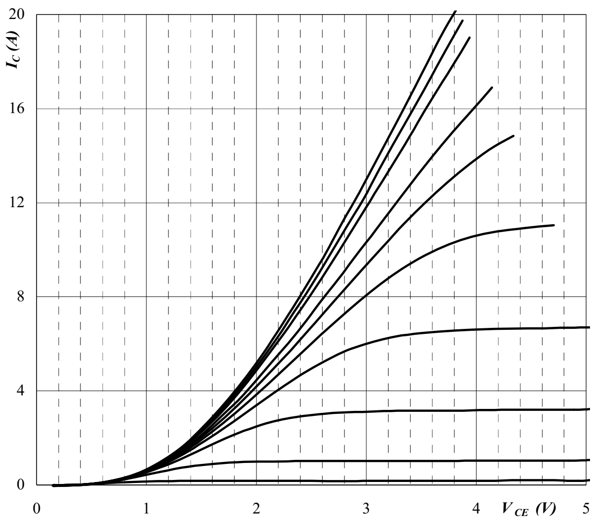
Brake

Figure 19. Typical output characteristics
Brake IGBT
Ic= f(VCE)



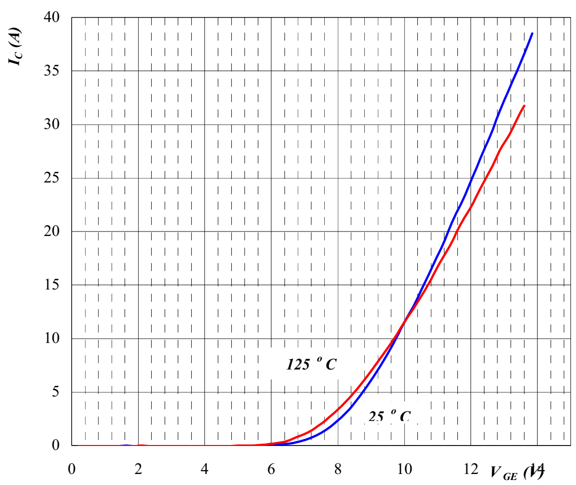
parameter: tp = 250 us   Tj = 25 °C
VGE parameter: from: 6 V to 16 V
in 1 V steps

Figure 20. Typical output characteristics
Brake IGBT
Ic= f(VCE)



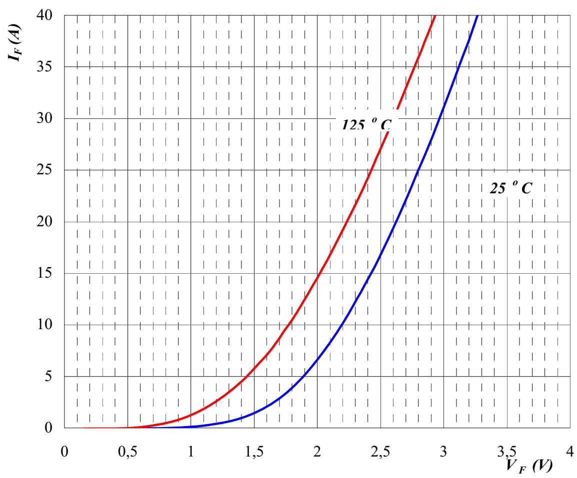
parameter: tp = 250 us   Tj = 125 °C
VGE parameter: from: 6 V to 16 V
in 1 V steps

Figure 21. Typical transfer characteristics
Brake IGBT
Ic= f(VGE)



parameter: tp = 250 us   VCE = 10 V

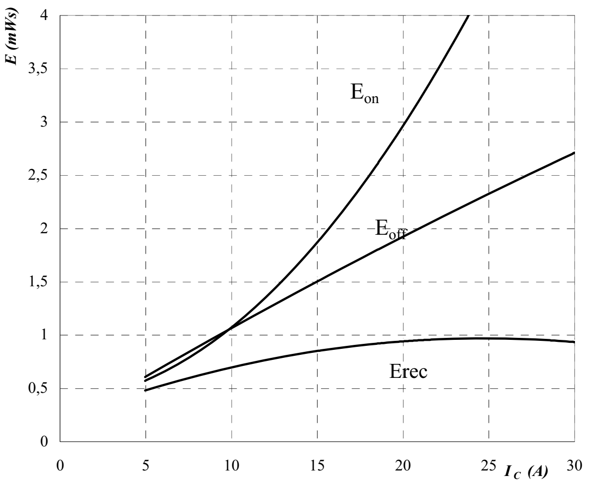
Figure 22. Typical diode forward current as a function of forward voltage
Brake FRED   IF=f(VF)



parameter: tp = 250 us

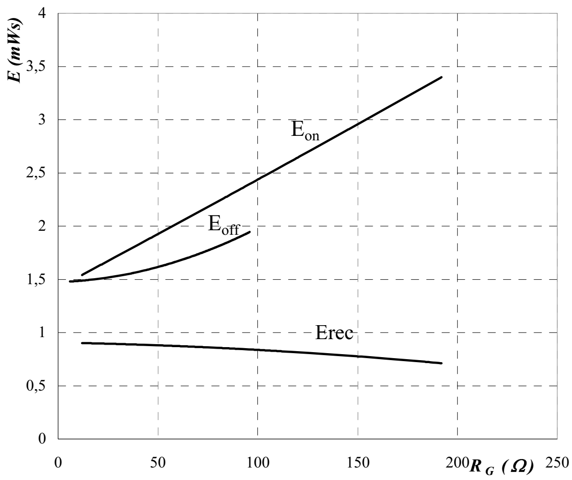
Brake

Figure 23. Typical switching energy losses as a function of collector current
Brake IGBT
E = f (Ic)



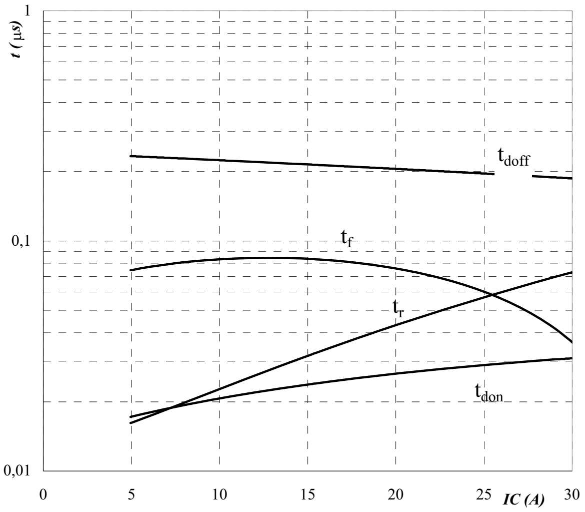
inductive load, Tj = 125 °C
VCE = 600 V
VGE= 15 V
RGon = 2*RGoff = 48 W

Figure 24. Typical switching energy losses as a function of gate resistor
Brake IGBT
E = f (RG)



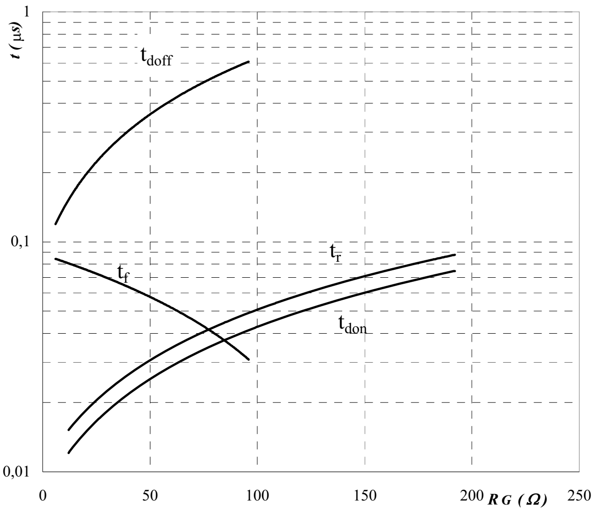
inductive load, Tj = 125 °C
VCE = 600 V
VGE= 15 V
Ic = 15 A

Figure 25. Typical switching times as a function of collector current
Brake IGBT
t = f (Ic)



inductive load, Tj = 125 °C
VCE = 600 V
VGE= 15 V
RGon = 2*RGoff = 48 W

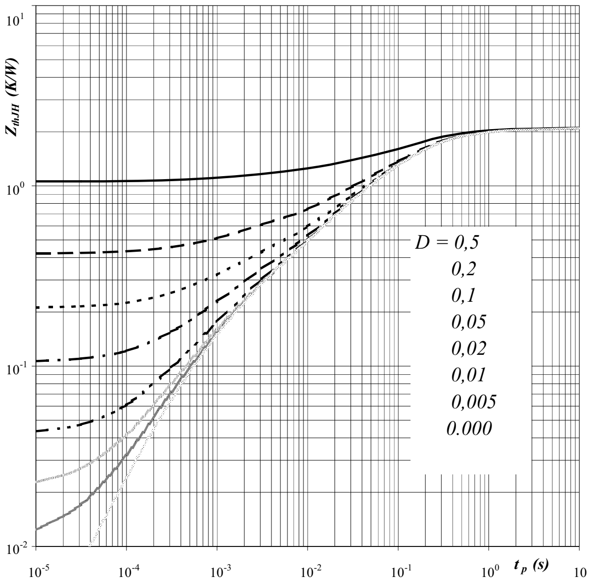
Figure 26. Typical switching times as a function of gate resistor
Brake IGBT
t = f (RG)



inductive load, Tj = 125 °C
VCE = 600 V
VGE= 15 V
Ic = 15 A

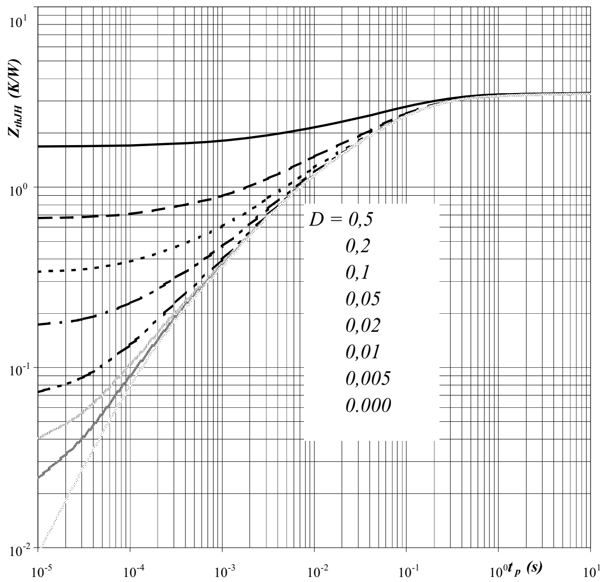
Brake

Figure 27. IGBT transient thermal impedance as a function of pulse width
ZthJH = f(tp)



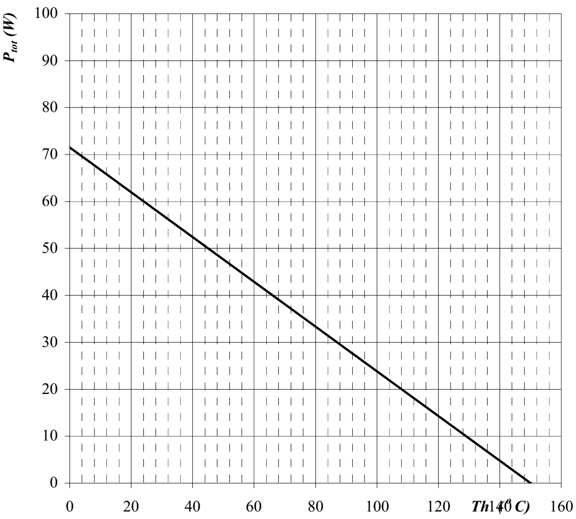
Parameter: D = tp / T   RthJH= 2,1 K/W

Figure 28. FRED transient thermal impedance as a function of pulse width
ZthJH = f(tp)



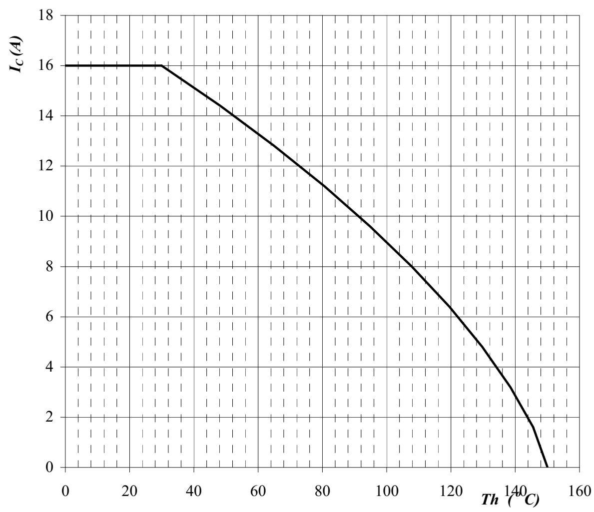
Parameter: D = tp / T   RthJH= 3,3 K/W

Figure 29. Power dissipation as a function of heatsink temperature
Brake IGBT
Ptot = f (Th)



parameter: Tj = 150°C

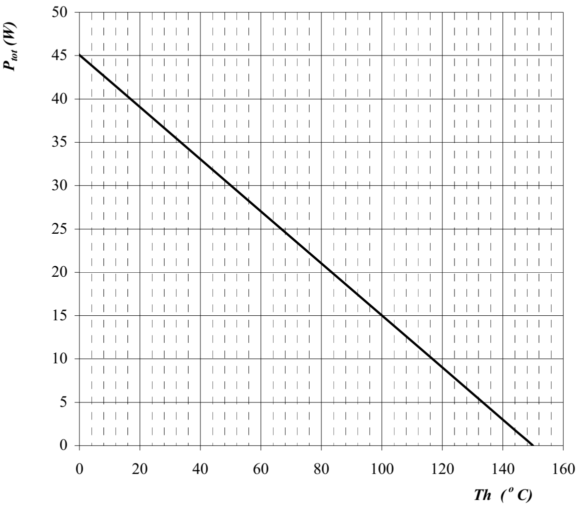
Figure 30. Collector current as a function of heatsink temperature
Brake IGBT
Ic = f (Th)



parameter: Tj = 150°C
VGE= 15 V

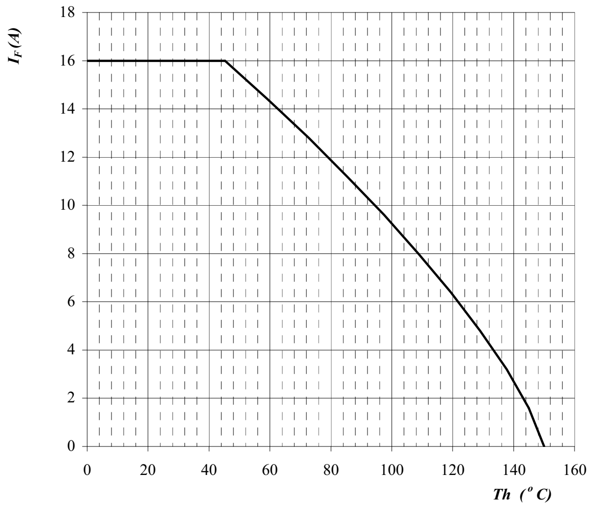
Brake

Figure 31. Power dissipation as a function of heatsink temperature
Brake FRED
Ptot = f (Th)



parameter: Tj = 150°C

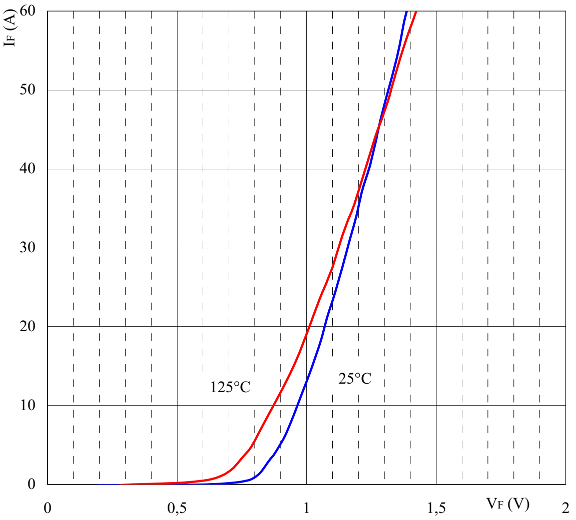
Figure 32. Forward current as a function of heatsink temperature
Brake FRED
IF = f (Th)



parameter: Tj = 150°C

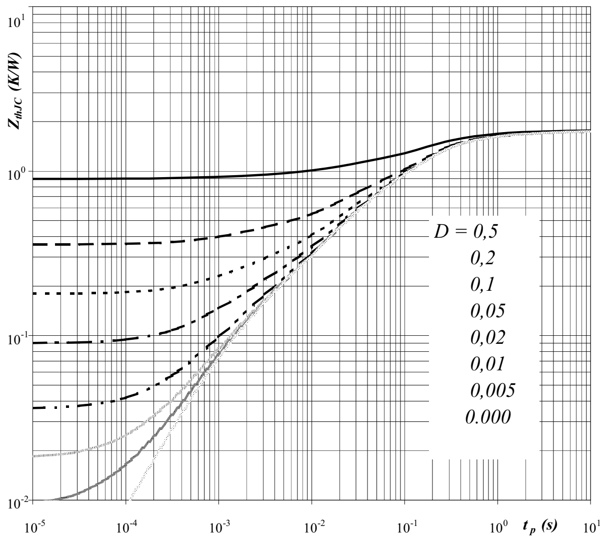
Input rectifier bridge

Figure 33. Typical diode forward current as a function of forward voltage
Rectifier diode IF=f(VF)



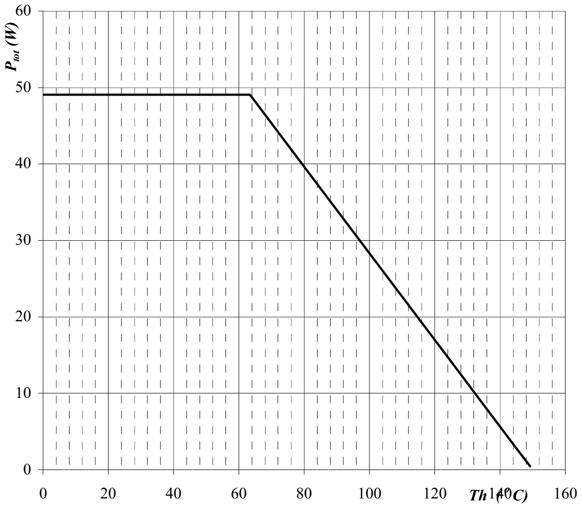
parameter: tp = 250 us

Figure 34. Diode transient thermal impedance as a function of pulse width
ZthJH = f(tp)



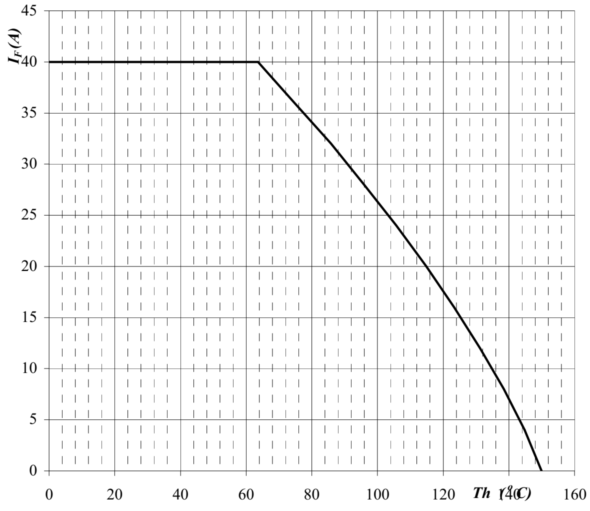
Parameter: D = tp / T RthJH= 1,8 K/W

Figure 35. Power dissipation as a function of heatsink temperature
Rectifier diode
Ptot = f (Th)



parameter: Tj = 150°C

Figure 36. Forward current as a function of heatsink temperature
Rectifier diode
IF = f (Th)



parameter: Tj = 150°C

Thermistor

Figure 37. Typical NTC characteristic as afunction of temperature

RT = f (T)